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SURFACE VEHICLE RECOMMENDED PRACTICE

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VEHICLE APPLICATION LAYER

Foreword—This series of SAE Recommended Practices has been developed by the Truck and Bus Control and Communications Network Subcommittee of the Truck and Bus Electrical and Electronics Committee. The objectives of the subcommittee are to develop information reports, recommended practices, and standards concerned with the requirements design and usage of devices which transmit electronic signals and control information among vehicle components. The usage of these documents 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 documents are intended as a guide toward standard practice and are subject to change so as to keep pace with experience and technical advances.

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Errata

Section 3.2.1.17	Resolution should read 1%/bit gain, -125% offset not 1%/bit gain, 125% offset
Section 3.2.2.18.5	Should read Resume 100, not Resume 011
Section 3.2.5.20	Offset should read 0 MPa, not 0 kPa
	Range should read 0 MPa to 251 MPa, not 0 kPa to 251 MPa
Section 3.2.5.21	Offset should read 0 MPa, not 0 kPa
	Range should read 0 MPa to 251 MPa, not 0 kPa to 251 MPa
Section 3.3.2	Parameter group number should read 256 (000100_{16}), not 1 (000001_{16})
Section 3.3.15	Data length should read 19 bytes, not 18 bytes
Section 3.3.28	Engine intercooler temperature is 1 byte in length, byte 8 is not defined
Section 3.3.29	Byte 2 is not listed, it should be listed as Not defined
Section 3.3.46	Bytes 3,4 should read Injector metering rail pressure, not Injector rail metering pressure

New parameters

3.2.5.96 *Throttle Position*–The position of the valve used to regulate the supply of a fluid, usually air or fuel/air mixture, to an engine. 0% represents no supply and 100% is full supply.

Data Length:	1 byte
Resolution:	0.4%/bit gain, 0 % offset
Data Range:	0% to 100%
Type:	Measured
Reference:	

3.2.5.97 *Alternator Speed*–Actual rotation speed of the alternator.

Data Length:	2 bytes
Resolution:	0.5 rpm gain, 0 rpm offset
Data Range:	0 to 32 127.5
Type:	Measured
Reference:	3.3.49

3.2.6.18 *Auxiliary discrete I/O channel status*–Identifies the current status of auxiliary input/output functions that are configured uniquely per application.

00 - auxiliary channel off
01 - auxiliary channel on
Type: dependent on application
Reference: 3.3.48

3.3.5 ELECTRONIC TRANSMISSION CONTROLLER #1: ETC1

Transmission repetition rate:	10 ms
Data length:	8 bytes
Data page:	0
PDU format:	240
PDU specific:	2
Default priority:	3
Parameter group number:	61,442 ($00F002_{16}$)

3.3.5 ELECTRONIC TRANSMISSION CONTROLLER #1: ETC1, continued:

Byte:	1	Status_ETC1	Bit:	8-7	Not defined	
				6,5	Shift in process	3.2.2.14
				4,3	Torque converter lockup engaged	3.2.2.13
				2,1	Driveline engaged	3.2.2.6
	2,3	Output shaft speed				3.2.1.14
	4	Percent clutch slip				3.2.1.20
	5	Command_ETC1	Bit:	8-5	Not defined	
				4,3	Progressive shift disable	3.2.3.11
				2,1	Momentary engine overspeed enable	3.2.3.12
	6,7	Input shaft speed				3.2.5.55
	8	Not defined				

3.3.48 AUXILIARY DISCRETE INPUT/OUTPUT STATUS

Transmission repetition rate: on request
Data length: 8 bytes
Data page: 0
PDU format: 254
PDU specific: 217
Default priority: 6
Parameter group number: 65,241 ($00FED9_{16}$)

Byte:	1	I/O_Status1	Bit: 8,7	I/O channel #1		3.2.6.18
			6,5	I/O channel #2		3.2.6.18
			4,3	I/O channel #3		3.2.6.18
			2,1	I/O channel #4		3.2.6.18
	2	I/O_Status2	Bit: 8,7	I/O channel #5		3.2.6.18
			6,5	I/O channel #6		3.2.6.18
			4,3	I/O channel #7		3.2.6.18
			2,1	I/O channel #8		3.2.6.18
	3	I/O_Status3	Bit: 8,7	I/O channel #9		3.2.6.18
			6,5	I/O channel #10		3.2.6.18
			4,3	I/O channel #11		3.2.6.18
			2,1	I/O channel #12		3.2.6.18
	4	I/O_Status4	Bit: 8,7	I/O channel #13		3.2.6.18
			6,5	I/O channel #14		3.2.6.18
			4,3	I/O channel #15		3.2.6.18
			2,1	I/O channel #16		3.2.6.18
	5-8	Not defined				

3.3.49 ALTERNATOR SPEED

Transmission repetition rate: 1 s
Data length: 8 bytes
Data page: 0
PDU format: 254
PDU specific: 213
Default priority: 6
Parameter group number: 65,237 ($00FED5_{16}$)

Byte:	1,2	Alternator speed	3.2.5.97
	3-8	Not defined	

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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 complete version of this network. This particular SAE Recommended Practice, SAE J1939/71, describes an Application Layer for vehicle use.

2. ***References***

2.1 Applicable Documents—General information regarding this series of recommended practices is found in SAE J1939. The latest issue of SAE publications shall apply.

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

SAE J1349—Engine Power Test Code-Spark Ignition and Compression Ignition-Net Power Rating
SAE J1843—Accelerator Pedal Position Sensor for Use with Electronic Controls in Medium- and Heavy-Duty Diesel On-Highway Engines
SAE J1939 (Draft)—Recommended Practice for a Serial Control and Communication Vehicle Network
SAE J1939/21—Data Link Layer

2.1.2 ISO PUBLICATIONS—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

2.2 Definitions—See SAE J1939 for terms and definitions that are not defined in this document.

2.3 Abbreviations

ATA	American Trucking Association
EBS	Electronic Braking System
Kp	Engine endspeed governor gain
VMRS	Vehicle Maintenance Reporting System

See SAE J1939 for additional abbreviations that may be used in this document.

3. ***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.

3.1 General Guidelines

3.1.1 SIGNAL CHARACTERIZATION—It is the intent of the SAE J1939 network to provide current data and signals from a source so that it may be used by other nodes. It is recommended that the time between physical data acquisition of a signal and the transmission of the data should not exceed two times the repetition rate defined for the data. Additional constraints may be defined for certain parameters (see also 3.1.6.2).

3.1.2 MESSAGE FORMAT—The message format of SAE J1939 uses the parameter group number as the label for a group of parameters. Each of the parameters within the group can be expressed in ASCII, as scaled data defined by the ranges described in 3.1.3, or as function states consisting of one or more bits. Alphanumeric data will be transmitted with the most significant byte first. Other parameters consisting of 2 or more data bytes shall be transmitted least significant byte first.

The type of data shall also be identified for each parameter. Data may be either status or measured. Status 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 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.

3.1.3 PARAMETER RANGES—Table 1 defines the ranges used to determine the validity of a transmitted signal. Table 2 defines the ranges used to denote the state of a discrete parameter and Table 3 defines the ranges used to denote the state of a control mode command. The values in the range "error indicator" provide 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 values in the range "not available" provide a means for a module to transmit a message which contains a parameter that is not available or not supported in that module. The values in the range "not requested" provide a means for a device to transmit a command message and identify those parameters where no response is expected from the receiving device.

If a component failure prevents the transmission of valid data for a parameter, the error indicator as described in Tables 1 and 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 should not be used. The data should be transmitted using the appropriate minimum or maximum parameter value.

3.1.4 ASSIGNMENT OF RANGES TO NEW PARAMETERS—This section is intended to define a set of recommended SLOTs (Scaling, Limit, Offset, and Transfer Function) which can be used when parameters are added to J1939. This permits data consistency to be maintained as much as possible between parameters of a given type (temperature, pressure, speed, etc.). Each SLOT is intended to provide a range and resolution suitable for most parameters within a given type. When necessary, a different scaling factor or offset can be used. All SLOTs should be based on a power of 2 scaling from another SLOT. This will minimize the math required for any internal scaling and reduce the opportunity for misinterpreted values. Offsets should be selected preferably on the following basis:

a. Offset = 0, or
b. Offset = 50% (equal ± range)

Table 4 defines the recommended SLOTs to be used when ranges are assigned to new parameters.

TABLE 1—TRANSMITTED SIGNAL RANGES

	Range Name	1 byte	2 bytes	4 bytes	ASCII
	Valid Signal	0 to 250 00_{16} to FA_{16}	0 to 64 255 0000_{16} to $FAFF_{16}$	0 to 4 211 081 215 00000000_{16} to $FAFFFFFF_{16}$	1 to 254 01_{16} to FE_{16}
(R)	Parameter specific indicator	251 FB_{16}	64 256 to 64 511 $FB00_{16}$ to $FBFF_{16}$	4 211 081 216 to 4 227 858 431 $FBxxxxxx_{16}$	none
(R)	Reserved range for future indicator bits	252 to 253 FC_{16} to FD_{16}	64 512 to 65 023 $FC00_{16}$ to $FDFF_{16}$	4 227 858 432 to 4 261 412 863 $FC000000_{16}$ to $FDFFFFFF_{16}$	none
	Error indicator	254 FE_{16}	65 024 to 65 279 $FExx_{16}$	4 261 412 864 to 4 278 190 079 $FExxxxxx_{16}$	0 00_{16}
	Not available or not requested	255 FF_{16}	65 280 to 65 535 $FFxx_{16}$	4 278 190 080 to 4 294 967 294 $FFxxxxxx_{16}$	255 FF_{16}

TABLE 2—TRANSMITTED VALUES FOR DISCRETE PARAMETERS (MEASURED)

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

TABLE 3—TRANSMITTED VALUES FOR CONTROL COMMANDS (STATUS)

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

(R) TABLE 4—RECOMMENDED SLOT DEFINITIONS

Parameter	Scaling (Resolution)	Limits (Range)	Offset	Parameter Size
Angle/Direction	10^{-7} deg/bit	–211 to 211.108 122 deg	–210	32 bit
	1/128 deg/bit	–200 to 301 deg	–200	16 bit
	1/128 deg/bit	0 to 502 deg	0	16 bit
Distance	0.125 km/bit	0 to 526 385 151.9 km	0	32 bit
	0.125 m/bit	–2500 to 2500 m	–2500	16 bit
Economy	1/512 km/L per bit	0 to 125.5 km/L	0	16 bit
Electrical Current	1 A/bit	–125 to 125 A	–125	8 bit
	1 A/bit	0 to 250 A	0	8 bit
Electrical Potential	0.05 V/bit	0 to 3212.75 V	0	16 bit
Flow Rate	0.05 L/h per bit	0 to 3212.75 L/h	0	16 bit
Force	5 N/bit	0 to 321 275 N	0	16 bit
Governor Gain	1/1280 %/rpm per bit	0 to 50.2 %/rpm	0	8 bit
Mass (cargo)	0.5 kg/bit	0 to 32 127.5 kg	0	16 bit
	2 kg/bit	0 to 128 510 kg	0	16 bit
Percent	0.4%/bit	0 to 100%	0	8 bit
(Position/Level)	1%/bit	–125 to 125%	–125	8 bit
Power	0.5 kW/bit	0 to 32 127.5 kW	0	16 bit
Pressure	4 kPa/bit	0 to 1000 kPa	0	8 bit
	0.05 kPa/bit	0 to 12.5 kPa	0	8 bit
	16 kPa/bit	0 to 4000 kPa	0	8 bit
	0.5 kPa/bit	0 to 32 127.5 kPa	0	16 bit
	1/256 MPa/bit	0 to 251 MPa	0	16 bit
	1/128 kPa/bit	–250 to 251.99 kPa	–250	16 bit
	2 kPa/bit	0 to 500 kPa	0	8 bit
	0.5 kPa/bit	0 to 125 kPa	0	8 bit
Ratio	0.1/bit	0 to 25.0	0	8 bit
	0.001/bit	0 to 64.255	0	16 bit
	1/bit	0 to 250	0	8 bit
Revolutions	1000 r/bit	0 to 4 211 081 215 000 r	0	32 bit
Temperature	1 °C/bit	–40 to 210 °C	–40	8 bit
	0.03125 °C/bit	–273 to 1735 °C	–273	16 bit

(R) TABLE 4—RECOMMENDED SLOT DEFINITIONS (CONTINUED)

Parameter	Scaling (Resolution)	Limits (Range)	Offset	Parameter Size
Time	0.25 s/bit	0 to 62.5 s	0	8 bit
	1 s/bit	0 to 64 255 s	0	16 bit
	1 min/bit	0 to 250 min	0	8 bit
	1 h/bit	0 to 250 min	0	8 bit
	0.05 h/bit	0 to 210 554 060.75 h	0	32 bit
	0.25 day/bit	0 to 62.5 days	0	8 bit
	1 month/bit	0 to 250 months	0	8 bit
	1 year/bit	1985 to 2235 years	+1985	8 bit
Torque	1 Nm/bit	–32 000 to 32 255 Nm	–32 000	16 bit
	1 Nm/bit	0 to 64 255 Nm	0	16 bit
Velocity, linear (speed)	1/256 kph/bit	0 to 250.996 kph (1 kph/bit for upper byte)	0	16 bit
	1/128 kph/bit	–250 to 251.992 kph	–250	16 bit
	1 kph/bit	0 to 250 kph	0	8 bit
Velocity, rotational	0.125 rpm/bit	0 to 8031.875 rpm (32 rpm/bit for upper byte)	0	16 bit
	4 rpm/bit	0 to 257 020 rpm	0	16 bit
	0.5 rpm/bit	0 to 32 127.5 rpm	0	16 bit
	10 rpm/bit	0 to 2500 rpm	0	8 bit
Volume	0.5 L/bit	0 to 2 105 540 608 L	0	32 bit

3.1.5 ADDING PARAMETERS TO PARAMETER GROUPS—Several of the Parameter Groups contain bytes that are not defined and may be replaced with new parameters as appropriate. 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 for additional definitions and abbreviations for instructions for adding new parameters to parameter groups and for requesting new parameter group numbers.

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)

3.1.6 TRANSMISSION REPETITION RATES (UPDATE RATES)

3.1.6.1 Definition of Transmission Repetition Rate—All transmission repetition rates defined in SAE J1939/71 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.

3.1.6.2 Transmission Repetition Rate for Engine Speed and Directly Associated Data (Crank Angle or Time Based Update Rates)—Some parameters may be calculated and/or updated based on engine crank angle rather than at a specific time interval. When this is the case the reference to a specific update rate is not accurate because this time will 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 1). 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 1

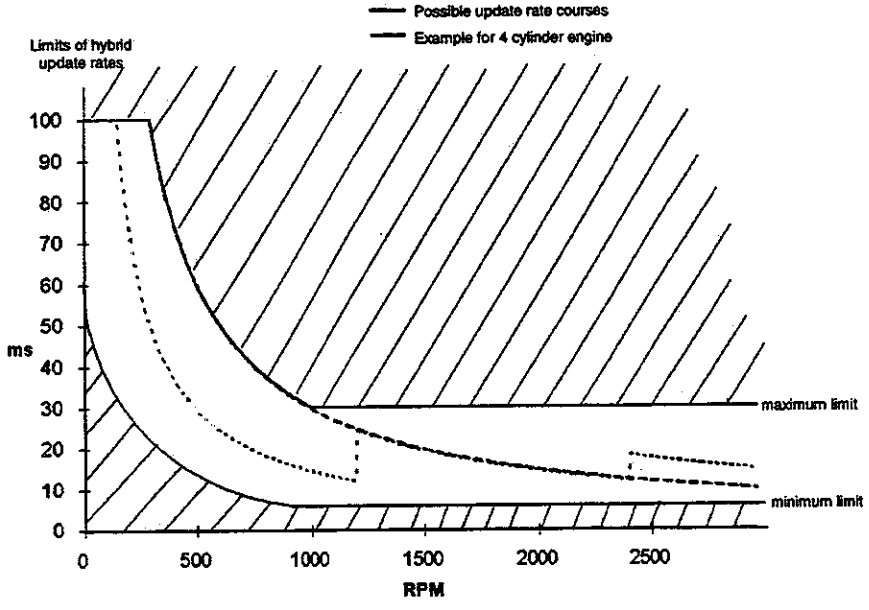


FIGURE 1—LIMITS OF HYBRID UPDATE RATES

3.2 Parameter Definitions—This section provides a description of each parameter used for 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 transmitting, undefined bytes should be sent as 255 (FF_{16}) and undefined bits should be sent as 1.

3.2.1 CONTROL PARAMETERS

3.2.1.1 Net Brake Torque (Power)—The measured torque (or power output) of a "fully equipped" engine. A fully equipped engine is an engine equipped with accessories necessary to perform its intended service. This includes, but is not restricted to, the basic engine, including fuel, oil, and cooling pumps, plus intake air system, exhaust system, cooling system, alternator, starter, emissions, and noise control. Accessories which are not necessary for the operation of the engine, but may be engine mounted, are not considered part of a fully equipped engine. These items include, but are not restricted to, power steering pump systems, vacuum pumps, and compressor systems for air conditioning, brakes, and suspensions. When these accessories are integral with the engine, the torque/power absorbed in an unloaded condition may be determined and added to the net brake torque. (Refer to SAE J1349.)

Net brake torque is calculated by subtracting friction torque from indicated torque for the purposes of this document.

3.2.1.2 Friction Torque—The torque required to drive the engine alone as "fully equipped."

3.2.1.3 Indicated Torque—Indicated torque is the torque developed in the cylinders. It is defined as the sum of the net brake torque and friction torque.

3.2.1.4 Driver's Demand Engine - Percent Torque—The requested torque output of the engine by the driver. It is based on input from the following requestors external to the powertrain: operator (via the accelerator pedal), cruise control and/or road speed limit governor. Dynamic commands from internal powertrain functions such as smoke control, low- and high-speed engine governing; ASR and shift control are excluded from this calculation. The data is transmitted in indicated torque as a percent of the indicated peak engine torque. See 3.3.17 for the engine configuration message. Several status bits are defined separately to indicate the request which is currently being honored. This parameter may be used for shift scheduling.

Data Length:	1 byte
Resolution:	1%/bit gain, –125% offset (00 = –125%, 125 = 0%, 250 = +125%)
Data Range:	–125 to 125%
Operating Range:	0 to 125%
Type:	Measured
Suspect Parameter Number:	512
Reference:	3.3.7

Figure 2 and Figure 3 show two typical torque calculations in an engine controller. On the left side of the figures there are single engine controller functions. The output torque signals of these functions are connected in the manner shown. The result is the actual engine percent torque which is realized by the engine.

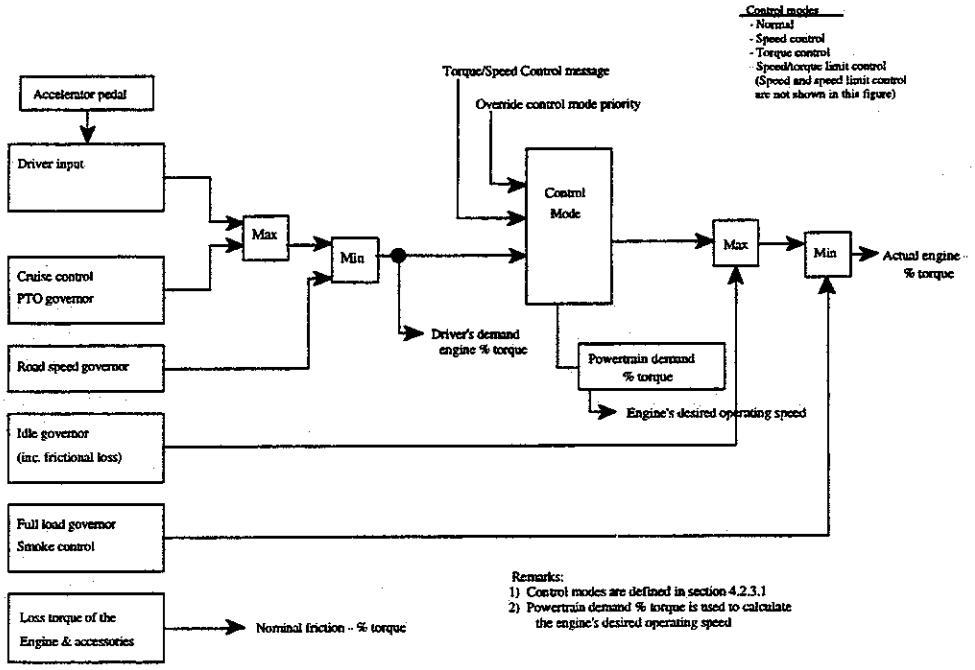


FIGURE 2—TORQUE COMMANDS AND CALCULATIONS WHEN A "MAXIMUM SELECTION FOR LOW IDLE" TECHNIQUE IS USED

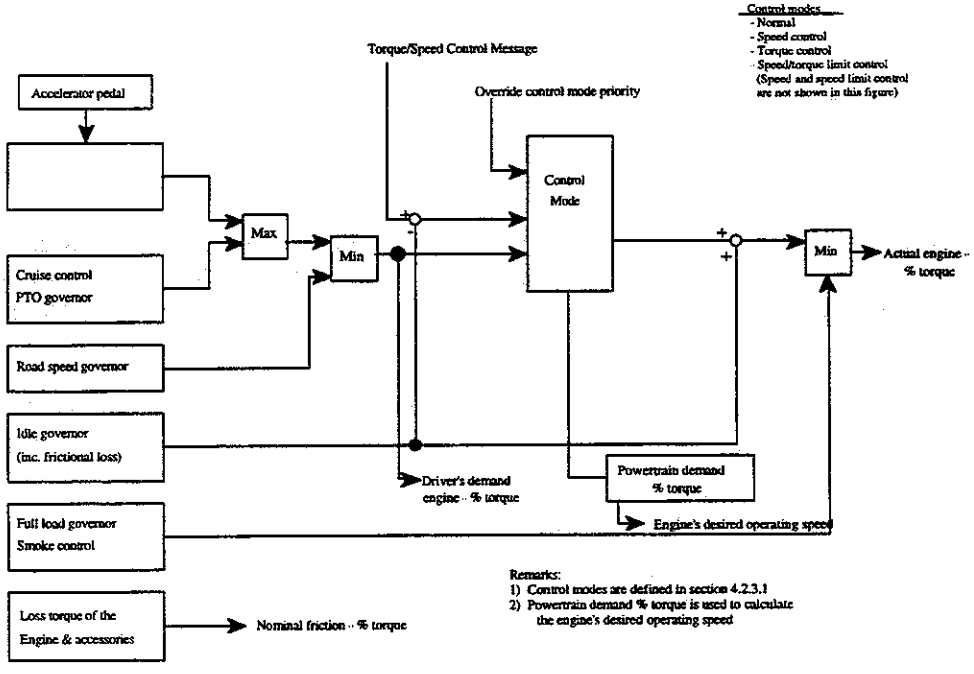


FIGURE 3—TORQUE COMMANDS AND CALCULATIONS WHEN A "SUMMATION WITH LOW IDLE" TECHNIQUE IS USED

On top of the figures, external torque commands (e.g., traction and transmission control) can control the engine. These commands can influence the engine torque by four control modes. Four engine internal signals are transmitted to the network:

a. Driver's demand engine - percent torque
b. Actual engine - percent torque
c. Nominal friction - percent torque
d. Engine's desired operating speed

The difference between Figure 2 and Figure 3 is the connection of the idle governor output to the torque calculation. In Figure 2 there is a maximum selection, while in Figure 3 a summation is used. The summation method needs a subtraction point for each external command input because the starting point of an ASR or a shift operation should be the present actual engine - percent torque value. As the actual engine - percent torque signal contains the idle governor output and the external commands are compared with the driver's demand engine - percent torque or the powertrain demand which don't contain the idle governor output, the external commands must be subtracted by the idle governor output to get the correct signals for comparison.

The advantage of the maximum selection (Figure 2) is that no other speed controller can work parallel to the idle governor. This allows for a better optimization of the different speed control loops. The advantage of the summation method (Figure 3) is that changes of the idle governor output influence the engine directly (no dead zones exist).

3.2.1.5 Actual Engine - Percent Torque—The calculated output torque of the engine. The data is transmitted in indicated torque as a percent of peak engine torque. The engine percent torque value will not be less than zero and it includes the torque developed in the cylinders required to overcome friction as described in 3.2.1.3.

Data Length:	1 byte
Resolution:	1%/bit gain, –125% offset
Data Range:	–125 to 125%
Operating Range:	0 to 125%
Type:	Measured
Suspect Parameter Number:	513
Reference:	3.3.7

3.2.1.6 Nominal Friction - Percent Torque—The calculated torque that indicates the amount of torque required by the basic engine itself added by the loss torque of accessories. It contains the frictional and thermodynamic loss of the engine itself, and the losses of fuel, oil and cooling pumps. The data is transmitted in indicated torque as a percent of peak engine torque (see the engine configuration message, 3.3.17).

The realization can be done by a map dependent on engine speed and engine temperature and an offset value for additional loss torques.

Data Length:	1 byte
Resolution:	1%/bit gain, –125% offset
Data Range:	–125 to 125%
Operating Range:	0 to 125%
Type:	Status
Suspect Parameter Number:	514
Reference:	3.3.13

3.2.1.7 Percent Load at Current Speed—The ratio of actual engine percent torque (indicated) to maximum indicated torque available at the current engine speed, clipped to zero torque during engine braking.

Data Length:	1 byte
Resolution:	1%/bit gain, 0% offset
Range:	0 to 125%
Type:	Status
Suspect Parameter Number:	92
Reference:	3.3.6

3.2.1.8 Accelerator Pedal Position—The ratio of actual accelerator pedal position to maximum pedal position. Although it is used as an input to determine powertrain demand, it also provides anticipatory information to transmission and ASR algorithms about driver actions.

Data Length:	1 byte
Resolution:	0.4%/bit gain, 0% offset
Data Range:	0 to 100%
Type:	Measured
Suspect Parameter Number:	91
Reference:	3.3.6

3.2.1.9 Engine Speed—Actual engine speed which is calculated over a minimum crankshaft angle of 720 degrees divided by the number of cylinders.

Data Length:	2 bytes
Resolution:	0.125 rpm/bit gain, 0 rpm offset (upper byte resolution = 32 rpm/bit)
Data Range:	0 to 8031.875 rpm
Type:	Measured
Suspect Parameter Number:	190
Reference:	3.3.7

3.2.1.10 Engine's Desired Operating Speed—An indication by the engine of the optimal operating speed of the engine for the current existing conditions. These conditions may include the torque generated to accommodate powertrain demands from the operator (via the accelerator pedal), cruise control, road speed limit governors, or ASR. Dynamic commands from functions such as smoke control or shift control are excluded from this calculation.

Data Length:	2 bytes
Resolution:	0.125 rpm/bit gain, 0 rpm offset (upper byte resolution = 32 rpm/bit)
Data Range:	0 to 8031.875 rpm
Type:	Status
Suspect Parameter Number:	515
Reference:	3.3.13

3.2.1.11 Ground-based Vehicle Speed—Actual ground speed of the vehicle, measured by a device such as RADAR. (1 km/h = 0.621 mph)

Data Length:	2 bytes
Resolution:	1/256 km/h/bit gain, 0 km/h offset (1/412 mph/bit gain, 0 mph offset) upper byte resolution = 1.0 km/h/bit (0.62 mph/bit)
Data Range:	0 to 251 km/h (0 to 156 mph)
Type:	Measured
Suspect Parameter Number:	516
Reference:	

3.2.1.12 Wheel-based Vehicle Speed—Speed of the vehicle as calculated from wheel or tailshaft speed.

Data Length:	2 bytes
Resolution:	1/256 km/h/bit gain, 0 km/h offset (1/412 mph/bit gain, 0 mph offset) upper byte resolution = 1.0 km/h/bit (0.62 mph/bit)
Data Range:	0 to 251 km/h (0 to 156 mph)
Type:	Measured
Suspect Parameter Number:	84
Reference:	3.3.31

3.2.1.13 Navigation-based Vehicle Speed—Speed of the vehicle as calculated from a device such as a Global Positioning System (GPS).

Data Length:	2 bytes
Resolution:	1/256 km/h/bit gain, 0 km/h offset (1/412 mph/bit gain, 0 mph offset) upper byte resolution = 1.0 km/h/bit (0.62 mph/bit)
Data Range:	0 to 251 km/h (0 to 156 mph)
Type:	Measured
Suspect Parameter Number:	517
Reference:	3.3.22

3.2.1.14 Output Shaft Speed—Calculated speed of the transmission output shaft. This parameter can also be used for cruise control because it does not prohibit gear shifts (changes in engine speed).

Data Length:	2 bytes
Resolution:	0.125 rpm/bit gain, 0 rpm offset (upper byte resolution = 32 rpm/bit)
Data Range:	0 to 8031.875 rpm
Type:	Measured
Suspect Parameter Number:	191
Reference:	3.3.5

3.2.1.15 Requested Torque—Parameter provided to the engine or retarder in the torque/speed control message for controlling or limiting the output torque.

Requested torque to the engine is measured in indicated torque as a percentage of peak engine torque. This is the engine torque at which the engine is expected to operate if the torque control mode is active or the engine torque which the engine is not expected to exceed in the torque limit mode is active.

Zero torque can be requested which implies zero fuel and, according to Figures 2 and 3, the engine will not be allowed to stall. The actual engine percent torque (3.2.1.5) should be zero and the engine should decelerate until the low idle governor kicks in, at which time the actual engine percent torque will be calculated as shown in Figures 2 and 3 and the engine torque mode bits (3.2.2.1) should be equal to 0000_2 - Low Idle Governor.

Requested torque to the retarder is measured in indicated torque as a percentage of peak retarder torque. The logic used in enabling or disabling the retarder is based on the override control mode priority bits (3.2.3.3).

Data Length:	1 byte
Resolution:	1%/bit gain, –125% offset
Data Range:	–125 to 125%
Operating range:	0 to 125% for engine torque requests –125 to 0% for retarder torque requests
Type:	Status
Suspect Parameter Number:	518
Reference:	3.3.1

The driver input in Table 5 refers to the enable retarder - brake assist switch (3.2.2.11). The driver input switch should not power the retarder control directly, otherwise it is not possible for other devices on the network to request retardation and override the driver. Engine retarders cannot be activated while the engine is being fuelled. During simultaneous network commands for both retarder enable and engine speed or torque control, the retarder commands will be restricted if the engine is not zero brake torque, and allowed once the engine achieves zero brake torque. During Electronically Controlled Braking, where the brake pedal position (or pressure) directly relates to the amount or retardation, the driver preselected level is not used to determine the amount of retardation provided by the engine brake.

A separate enable retarder - shift assist switch (3.2.2.12) is used by the transmission to decide if network control should be used to activate the engine retarder for shift assist. When this switch is enabled, the transmission may use network commands to activate the engine retarder in order to enhance engine decel rates and improve shift control.

The retarder is available for cruise control only if the retarder is first enabled by the driver using the brake assist switch.

The "previous state" when all devices become "don't care" may depend on an earlier set of conditions (i.e., a device may request retardation temporarily and then "don't care." The retarder should then return to its "previous state." This is typically zero retardation, but not in all cases).

Multiple retarder control messages from the network are handled through the use of the override control mode priority bits described in 3.2.3.3.

TABLE 5—PRIMARY RETARDER - BEFORE TRANSMISSION (Engine Retarder)

Input Pedal	Input Cruise	Input Driver	Input Network	Output Retarder	
00 (ap)	--	01	11	0	ap pressed
11	00	01	11	0	cc fueling
--	--	00	11	0	driver disable (brake assist)
--	--	--	00	0	network control
01 (bp)	--	01	11	1	bp pressed[1]
11	01	01	11	1	cc initiated
11	11	01	11	x	previous state
--	--	--	01	1	network control

INPUTS: 00 = Requesting zero retardation = disable
01 = Requesting retardation
11 = Don't care (Control mode set to 00 = normal or no request sent)
-- = Any state

OUTPUTS: 0 = Disable retarder
1 = Enable retarder

[1] Not all implementations of engine retarders use the brake pedal as an input to activate the retarder.

The driver input in Table 6 refers to the switch setting (i.e., off, percent on). The driver select switch should not power the retarder control directly, otherwise it is not possible for other devices on the network to request retardation and override the driver.

The retarder is available for cruise control only if the retarder is first enabled by the driver.

The "previous state" when all devices become "don't care" may depend on an earlier set of conditions (i.e., a device may request retardation temporarily and then "don't care." The retarder should then return to its "previous state." This is typically zero retardation, but not in all cases).

Multiple retarder control messages from the network are handled through the use of the override control mode priority bits described in 3.2.3.3.

TABLE 6—PRIMARY RETARDER - BEFORE TRANSMISSION (Exhaust Brake)

Input Cruise	Input Driver	Input Network	Output Retarder	
00	01	11	0	cc fueling
--	00	11	0	driver disable
--	--	00	0	network control
--	01	11	1	driver enable
01	01	11	1	cc initiated
11	01	11	x	previous state
--	--	01	1	network control

INPUTS: 00 = Requesting zero retardation = disable
01 = Requesting retardation
11 = Don't care (Control mode set to 00 = normal or no request sent)
-- = Any state

OUTPUTS: 0 = Disable retarder
1 = Enable retarder

The driver input in Table 7 refers to the selector switch setting of the retarder (e.g., off, 20%, 40%, 50%, 80%, 100%). During Electronically Controlled Braking, where the brake pedal position (or pressure) directly relates to the amount or retardation, the driver preselected level is not used to determine the amount of retardation. Also note that cruise control or the driver can independently disable the retarder, but that the cruise control can only override the driver select switch to use the retarder if the driver selector switch is not off.

Multiple retarder control messages from the network are handled through the use of the override control mode priority bits described in 3.2.3.3.

TABLE 7—SECONDARY RETARDER - AFTER TRANSMISSION
(Transmission/Driveline Retarders)

Input Cruise	Input Driver	Input Network	Output Retarder	
00	01	11	0	cc fueling
--	00	11	0	driver disable
--	--	00	0	network control
--	01	11	1	driver activate
01	01	11	1	cc initiated
11	01	11	x	previous state
--	--	01	1	network control
--	11	--	NA	

INPUTS: 00 = Requesting zero retardation = disable
01 = Requesting retardation
11 = Don't care (Control mode set to 00 = normal or no request sent)
-- = Any state

OUTPUTS: 0 = Disable retarder
1 = Enable retarder
NA = Not allowed condition

3.2.1.16 Engine's Desired Operating Speed Asymmetry Adjustment—This byte is utilized in transmission gear selection routines and indicates the engine's preference of lower versus higher engine speeds should its desired speed not be achievable. This is a scaled ratio such that 125 represents an equal preference for a speed lower or higher that the engine's indicated desired speed. The higher the asymmetry adjustment value is above 125, the more the engine prefers to be operated at or above its indicated desired speed. Conversely, the lower the asymmetry adjustment value is below 125, the more the engine prefers to operate at or below its indicated desired speed. Typically, the engine's asymmetry adjustment will be predicated on fuel consumption considerations, and under these conditions, the method for computing the asymmetry adjustment is indicated in Figure 4. The engine may include other factors into its asymmetry adjustment calculation such as temperatures, pressures, and other operating parameters.

Data Length:	1 byte
Resolution:	ratio
Range:	0 to 250
Type:	Status
Suspect Parameter Number:	519
Reference:	3.3.13

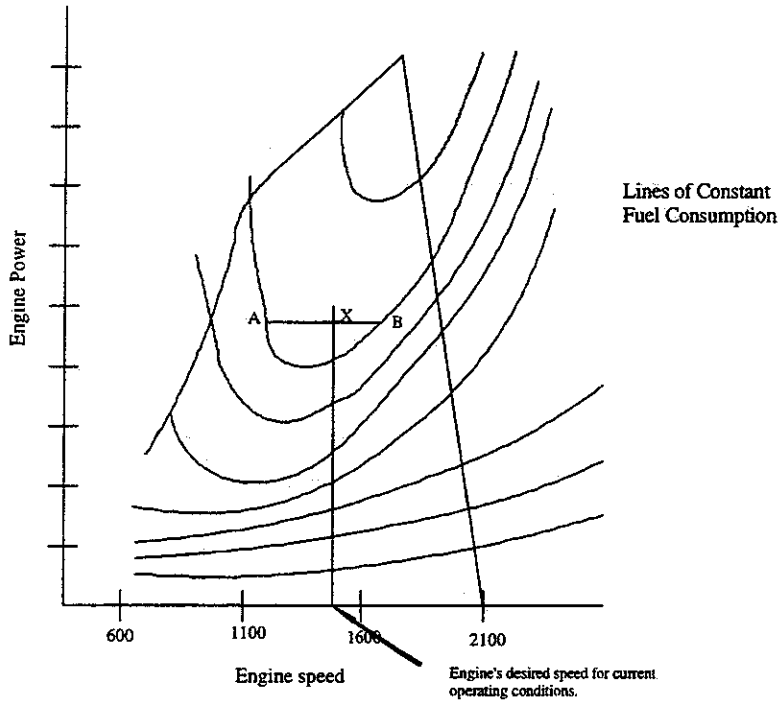


FIGURE 4—DESIRED OPERATING SPEED ASYMMETRY ADJUSTMENT

3.2.1.17 *Actual Retarder - Percent Torque*—Actual braking torque of the retarder as a percent of maximum.

Data Length:	1 byte
(R) Resolution:	1%/bit gain, –125% offset
Data Range:	–125 to 125%
Operating range:	–125 to 0%
Type:	Status
Suspect Parameter Number:	520
Reference:	3.3.3

3.2.1.18 Brake Pedal Position—Ratio of brake pedal position to maximum pedal position. Used for electric brake applications.

Data Length:	1 byte
Resolution:	0.4%/bit gain, 0% offset
Data Range:	0 to 100%
Type:	Measured
Suspect Parameter Number:	521
Reference:	3.3.4

3.2.1.19 Requested Speed—Parameter provided to the engine from external sources in the torque/speed control message. This is the engine speed which the engine is expected to operate at if the speed control mode is active or the engine speed which the engine is not expected to exceed if the speed limit mode is active.

Data Length:	2 bytes
Resolution:	0.125 rpm/bit gain, 0 rpm offset (upper byte resolution = 32 rpm/bit)
Data Range:	0 to 8031.875 rpm
Type:	Status
(R) Suspect Parameter Number:	898
Reference:	3.3.1

3.2.1.20 Percent Clutch Slip—Parameter which represents the ratio of input shaft speed to current engine speed (in percent).

$$\text{Percent Clutch Slip} = \frac{\text{Engine rpm} - \text{Input shaft rpm}}{\text{Engine rpm}} \qquad \text{(Eq.1)}$$

Data Length:	1 byte
Resolution:	0.4%/bit gain, 0% offset
Data Range:	0 to 100%
Type:	Measured
Suspect Parameter Number:	522
Reference:	3.3.5

3.2.1.21 Requested Percent Clutch Slip—Parameter which represents the percent clutch slip.

Data Length:	1 byte
Resolution:	0.4%/bit gain, 0% offset
Data Range:	0 to 100%
Type:	Status
(R) Suspect Parameter Number:	684
Reference:	3.3.2

3.2.1.22 Current Gear—The gear currently engaged in the transmission or the last gear engaged while the transmission is in the process of shifting to the new or selected gear. Transitions toward a destination gear will not be indicated. Once the selected gear has been engaged then Current Gear will reflect that gear.

Data Length:	1 byte
Resolution:	1 gear value/bit, –125 offset
(R) Data Range:	–125 to +125, negative values are reverse gears, positive values are forward gears, zero is neutral
(R) Parameter Specific Indicator:	FB_{16} is park
Type:	Measured
Suspect Parameter Number:	523
Reference:	3.3.8

3.2.1.23 Selected Gear—The gear that the transmission will attempt to achieve during the current shift if a shift is in progress, or the next shift if one is pending (i.e., waiting for torque reduction to initiate the shift).

Data Length:	1 byte
Resolution:	1 gear value/bit, –125 offset
(R) Data Range:	–125 to +125, negative values are reverse gears, positive values are forward gears, zero is neutral
(R) Parameter Specific Indicator:	FB_{16} is park
Type:	Status
Suspect Parameter Number:	524
Reference:	3.3.8

3.2.1.24 Requested Gear—Gear requested by the operator, ABS, or engine.

Data Length:	1 byte
Resolution:	1 gear value/bit, –125 offset
(R) Data Range:	–125 to +125, negative values are reverse gears, positive values are forward gears, zero is neutral
(R) Parameter Specific Indicator:	FB_{16} is park
Type:	Status
Suspect Parameter Number:	525
Reference:	3.3.2

3.2.1.25 Actual Gear Ratio—Actual ratio of input shaft speed to output shaft speed.

Data Length:	2 bytes
Resolution:	0.001/bit, 0 offset
Data Range:	0 to 64.255
Type:	Measured
Suspect Parameter Number:	526
Reference:	3.3.8

3.2.1.26 Engine Speed at Idle, Point 1 (Engine configuration)—Stationary low idle speed of engine which includes influences due to engine temperature (after power up) and other stationary changes (calibration offsets, sensor failures, etc). This parameter is point 1 of the engine configuration map (see 3.2.4.1).

Data Length:	2 bytes
Resolution:	0.125 rpm/bit, 0 rpm offset
Data Range:	0 to 8031.875 rpm
Type:	Measured
Suspect Parameter Number:	188
Reference:	3.3.17

3.2.1.27 Engine Speed at Point 2 (Engine configuration)—Engine speed of point 2 of the engine torque map (see 3.2.4.1). In engine configuration mode 1 and 3, point 2 is defined as the kick-in point from which torque is reduced to zero. In mode 2 (see Table 11), there are no special requirements for the definition of this point.

Data Length:	2 bytes
Resolution:	0.125 rpm/bit, 0 rpm offset
Data Range:	0 to 8031.875 rpm
Type:	Measured
Suspect Parameter Number:	528
Reference:	3.3.17

3.2.1.28 Engine Speed at Points 3, 4, and 5 (Engine configuration)—Engine speed of point 3, 4, and 5 of the engine torque map (see 3.2.4.1). It is recommended that one of these points indicate the peak torque point for the current engine torque map. Points 3, 4 and 5 are optional and lie between idle and point 2.

Data Length:	2 bytes
Resolution:	0.125 rpm/bit, 0 rpm offset
Data Range:	0 to 8031.875 rpm
Type:	Measured
Suspect Parameter Number:	529 (Point 3) 530 (Point 4) 531 (Point 5)
Reference:	3.3.17

3.2.1.29 Engine Speed at High Idle, Point 6 (Engine configuration)—Engine speed of high idle (point 6) of the engine torque map (see 3.2.4.1). In engine configuration mode 3 (see Table 11), point 6 is not defined by the engine torque map but by the governor characteristic and the zero torque line.

Data Length:	2 bytes
Resolution:	0.125 rpm/bit, 0 rpm offset
Data Range:	0 to 8031.875 rpm
Type:	Measured
Suspect Parameter Number:	532
Reference:	3.3.17

3.2.1.30 Maximum Momentary Engine Override Speed, Point 7 (Engine configuration)—The maximum engine speed above high idle allowed by the engine control during a momentary high idle override. This duration of the override is limited by the maximum momentary override time limit.

Data Length:	2 bytes
Resolution:	0.125 rpm/bit, 0 rpm offset
Data Range:	0 to 8031.875 rpm
Type:	Measured
Suspect Parameter Number:	533
Reference:	3.3.17

3.2.1.31 Maximum Momentary Override Time Limit—The maximum time limit allowed to override the engine's high idle speed.

Data Length:	1 byte
Resolution:	0.1 s/bit gain, 0 s offset
Data Range:	0 s to 25 s 0 = no override of high idle allowed 255 = not applicable (no time restriction)
Type:	Measured
Suspect Parameter Number:	534
Reference:	3.3.17

3.2.1.32 Requested Speed Control Range Lower Limit (Engine configuration)—The minimum engine speed that the engine will allow when operating in a speed control/limit mode.

Data Length:	1 byte
Resolution:	10 rpm/bit gain, 0 rpm offset
Data Range:	0 to 2500 rpm
Type:	Measured
Suspect Parameter Number:	535
Reference:	3.3.17

3.2.1.33 Requested Speed Control Range Upper Limit (Engine configuration)—The maximum engine speed that the engine will allow when operating in a speed control/limit mode, excluding any maximum momentary engine override speed, if supported.

Data Length:	1 byte
Resolution:	10 rpm/bit gain, 0 rpm offset
Data Range:	0 to 2500 rpm
Type:	Measured
Suspect Parameter Number:	536
Reference:	3.3.17

3.2.1.34 Requested Torque Control Range Lower Limit (Engine configuration)—The minimum engine torque that the engine will allow when operating in a torque control/limit mode.

Data Length:	1 byte
Resolution:	1%/bit gain, –125% offset
Data Range:	–125 to 125%
Operating Range:	0 to 125%
Type:	Measured
Suspect Parameter Number:	537
Reference:	3.3.17

3.2.1.35 Requested Torque Control Range Upper Limit (Engine configuration)—The maximum engine torque that the engine will allow when operating in a torque control/limit mode.

Data Length:	1 byte
Resolution:	1%/bit gain, –125% offset
Data Range:	–125 to 125%
Operating Range:	0 to 125%
Type:	Measured
Suspect Parameter Number:	538
Reference:	3.3.17

3.2.1.36 Percent Torque at Idle, Point 1 (Engine configuration)—The torque limit that indicates the available engine torque which can be provided by the engine at idle speed. This parameter may be influenced by engine temperature (after power up) and other stationary changes (calibration offsets, sensor failures, etc.) See also 3.2.1.26. The data is transmitted in indicated torque as a percent of the reference engine torque.

Data Length:	1 byte
Resolution:	1%/bit gain, –125% offset
Data Range:	–125 to 125%
Operating Range:	0 to 125%
Type:	Measured
Suspect Parameter Number:	539
Reference:	3.3.17

3.2.1.37 Percent Torque at Point 2 (Engine configuration)—The torque limit that indicates the available engine torque which can be provided by the engine at point 2 of the engine map (see 3.2.4.1). In engine configuration mode 1 and 3 (see Table 11), point 2 is defined as the kick-in point from which torque is reduced to zero. In mode 2, there are no special requirements for the definition of this point. The data is transmitted in indicated torque as a percent of the reference engine torque.

Data Length:	1 byte
Resolution:	1%/bit gain, –125% offset
Data Range:	–125 to 125%
Operating Range:	0 to 125%
Type:	Measured
Suspect Parameter Number:	540
Reference:	3.3.17

3.2.1.38 Percent Torque at Points 3, 4, and 5 (Engine configuration)—The torque limit that indicates the available engine torque which can be provided by the engine at point 3, 4 and 5 of the engine map (see 3.2.4.1). It is recommended that one of these points indicate the peak torque point for the current engine torque map. Points 3, 4 and 5 are optional and lie between idle and point 2. The data is transmitted in indicated torque as a percent of the reference engine torque.

Data Length:	1 byte
Resolution:	1%/bit gain, –125% offset
Data Range:	–125 to 125%
Operating Range:	0 to 125%
Type:	Measured
Suspect Parameter Number:	541 (Point 3) 542 (Point 4) 543 (Point 5)
Reference:	3.3.17

3.2.1.39 Reference Engine Torque (Engine configuration)—This parameter is the 100% reference value for all defined indicated engine torque parameters. It is only defined once and doesn't change if a different engine torque map becomes valid.

Data Length:	2 bytes
Resolution:	1 Nm/bit gain, 0 Nm offset
Data Range:	0 to 64 255 Nm
Type:	Measured
Suspect Parameter Number:	544
Reference:	3.3.17

3.2.1.40 Gain (KP) of the Endspeed Governor (Engine configuration)—The endspeed governor is defined as a linear line with the following equations (Capital letters mean physical values, small letters mean normalized values). Refer to Figures 9 and 10.

The gain KP/kp is defined as a positive value. The factor 4096 is necessary for realizing flat curves with sufficient resolution as well as very steep curves.

KP = ΔTorque / ΔSpeed
kp (normalized) = KP * 250/100% * 8031 rpm/64255 * 4096 = KP * 1280 rpm/%

Data Length:	2 bytes
Resolution:	0.0007813 % engine reference torque/rpm per bit gain (normalized), 0 %/rpm per bit offset
Data Range:	0 to 50.2 %/rpm
Type:	Measured
Suspect Parameter Number:	545
Reference:	3.3.17

3.2.1.41 Retarder Speed at Idle, Point 1 (Retarder configuration)—See 3.2.4.3.

Data Length:	2 bytes
Resolution:	0.125 rpm/bit, 0 rpm offset
Data Range:	0 to 8031.875 rpm
Type:	Measured
Suspect Parameter Number:	546
Reference:	3.3.15

3.2.1.42 Retarder Speed at Peak Torque, Point 5 (Retarder configuration)—See 3.2.4.3.

Data Length:	2 bytes
Resolution:	0.125 rpm/bit, 0 rpm offset
Data Range:	0 to 8031.875 rpm
Type:	Measured
Suspect Parameter Number:	547
Reference:	3.3.15

3.2.1.43 Maximum Retarder Speed, Point 2 (Retarder configuration)—Maximum speed of retarder (see 3.2.4.3).

Data Length:	2 bytes
Resolution:	0.125 rpm/bit, 0 rpm offset
Data Range:	0 to 8031.875 rpm
Type:	Measured
Suspect Parameter Number:	548
Reference:	3.3.15

3.2.1.44 Retarder Speed at Points 3 and 4 (Retarder configuration)—Retarder speed of point 3 and 4 of the engine retarder torque map (see 3.2.4.3).

Data Length:	2 bytes
Resolution:	0.125 rpm/bit, 0 rpm offset
Data Range:	0 to 8031.875 rpm
Type:	Measured
Suspect Parameter Number:	549 (Point 3) 550 (Point 4)
Reference:	3.3.15

3.2.1.45 Percent Torque at Idle, Point 1 (Retarder configuration)—The torque limit that indicates the available retarder torque which can be provided by the retarder at idle speed. The data is transmitted in indicated torque as a percent of the reference retarder torque.

Data Length:	1 byte
Resolution:	1%/bit gain, –125% offset
Data Range:	–125 to 125%
Operating Range:	–125 to 0%
Type:	Measured
Suspect Parameter Number:	551
Reference:	3.3.15

3.2.1.46 Percent Torque at Maximum Speed, Point 2 (Retarder configuration)—The torque limit that indicates the available retarder torque which can be provided by the retarder at its maximum speed (see 3.2.4.3). The data is transmitted in indicated torque as a percent of the reference retarder torque.

Data Length:	1 byte
Resolution:	1%/bit gain, –125% offset
Data Range:	–125 to 125%
Operating Range:	–125 to 0%
Type:	Measured
Suspect Parameter Number:	552
Reference:	3.3.15

3.2.1.47 Percent Torque at Points 3 and 4 (Retarder configuration)—The torque limit that indicates the available retarder torque which can be provided by the retarder at points 3 and 4 of the retarder torque map (see 3.2.4.3). The data is transmitted in indicated torque as a percent of the reference retarder torque.

Data Length:	1 byte
Resolution:	1%/bit gain, –125% offset
Data Range:	–125 to 125%
Operating Range:	–125 to 0%
Type:	Measured
Suspect Parameter Number:	553 (Point 3) 554 (Point 4)
Reference:	3.3.15

3.2.1.48 Percent Torque at Peak Torque, Point 5 (Retarder configuration)—The torque limit that indicates the available retarder torque which can be provided by the retarder at point 5 of the retarder torque map (see 3.2.4.3). The data is transmitted in indicated torque as a percent of the reference retarder torque.

Data Length:	1 byte
Resolution:	1%/bit gain, –125% offset
Data Range:	–125 to 125%
Operating Range:	–125 to 0%
Type:	Measured
Suspect Parameter Number:	555
Reference:	3.3.15

3.2.1.49 Reference Retarder Torque (Retarder configuration)—This parameter is the 100% reference value for all defined indicated retarder torque parameters. It is only defined once and doesn't change if a different engine torque map becomes valid.

Data Length:	2 bytes
Resolution:	1 Nm/bit gain, 0 Nm offset
Data Range:	0 to 64 255 Nm
Type:	Measured
Suspect Parameter Number:	556
Reference:	3.3.15

3.2.1.50 Retarder Control Method (Retarder configuration)—This parameter identified the number of steps used by the retarder.

Data Length:	1 byte
Resolution:	1 step/bit, 0 offset
Data Range:	0 to 250
Operating Range:	0: continuous control 1: On/off control 2 to 250: Number of steps
Type:	Measured
Suspect Parameter Number:	557
Reference:	3.3.15

R) *3.2.1.51 Front Axle Speed*—The average speed of the two front wheels.

Data Length:	2 bytes
Resolution:	1/256 km/h/bit gain, 0 km/h offset (1/412 mph/bit gain, 0 mph offset) upper byte resolution = 1.0 km/h/bit (0.62 mph/bit)
Data Range:	0 to 251 km/h (0 to 156 mph)
Type:	Measured
Suspect Parameter Number:	904
Reference:	3.3.56

R) *3.2.1.52 Relative Speed; Front Axle, Left Wheel*—The speed of the front axle, left wheel relative to the front axle (see 3.2.1.51).

Data Length:	1 byte
Resolution:	1/16 km/h/bit gain, 7.8125 km/h offset (1/26 mph/bit gain, 4.844 mph offset)
Data Range:	–7.8125 km/h to +7.8125 km/h (–4.844 mph to +4.844 mph)
Type:	Measured
Suspect Parameter Number:	905
Reference:	3.3.56

R) *3.2.1.53 Relative Speed; Front Axle, Right Wheel*—The speed of the front axle, right wheel relative to the front axle (see 3.2.1.51).

Data Length:	1 byte
Resolution:	1/16 km/h/bit gain, 7.8125 km/h offset (1/26 mph/bit gain, 4.844 mph offset)
Data Range:	–7.8125 km/h to +7.8125 km/h (–4.844 mph to +4.844 mph)
Type:	Measured
Suspect Parameter Number:	906
Reference:	3.3.56

(R) *3.2.1.54 Relative Speed; Rear Axle #1, Left Wheel*—The speed of the rear axle #1, left wheel relative to the front axle (see 3.2.1.51).

Data Length:	1 byte
Resolution:	1/16 km/h/bit gain, 7.8125 km/h offset (1/26 mph/bit gain, 4.844 mph offset)
Data Range:	–7.8125 km/h to +7.8125 km/h (–4.844 mph to +4.844 mph)
Type:	Measured
Suspect Parameter Number:	907
Reference:	3.3.56

(R) *3.2.1.55 Relative Speed; Rear Axle #1, Right Wheel*—The speed of the rear axle #1, right wheel relative to the front axle (see 3.2.1.51).

Data Length:	1 byte
Resolution:	1/16 km/h/bit gain, 7.8125 km/h offset (1/26 mph/bit gain, 4.844 mph offset)
Data Range:	–7.8125 km/h to +7.8125 km/h (–4.844 mph to +4.844 mph)
Type:	Measured
Suspect Parameter Number:	908
Reference:	3.3.56

(R) *3.2.1.56 Relative Speed; Rear Axle #2, Left Wheel*—The speed of the rear axle #2, left wheel relative to the front axle (see 3.2.1.51).

Data Length:	1 byte
Resolution:	1/16 km/h/bit gain, 7.8125 km/h offset (1/26 mph/bit gain, 4.844 mph offset)
Data Range:	–7.8125 km/h to +7.8125 km/h (–4.844 mph to +4.844 mph)
Type:	Measured
Suspect Parameter Number:	909
Reference:	3.3.56

(R) *3.2.1.57 Relative Speed; Rear Axle #2, Right Wheel*—The speed of the rear axle #2, right wheel relative to the front axle (see 3.2.1.51).

Data Length:	1 byte
Resolution:	1/16 km/h/bit gain, 7.8125 km/h offset (1/26 mph/bit gain, 4.844 mph offset)
Data Range:	–7.8125 km/h to +7.8125 km/h (–4.844 mph to +4.844 mph)
Type:	Measured
Suspect Parameter Number:	910
Reference:	3.3.56

3.2.2 DRIVETRAIN STATE PARAMETERS

3.2.2.1 Engine and Retarder Torque Mode (4 bits)—State signal which indicates which engine or retarder torque mode is currently generating, limiting or controlling the torque. Note that the modes are not in prioritized order. Not all modes may be relevant for a given device. Some devices may not implement all functions. For typical priorities refer to Figures 2 and 3 for engine control and Tables 5 to 7 for retarder control. The data type of this parameter is measured. (Reference: 3.3.3, 3.3.7)

Mode 0000_2 means "No request": engine torque may range from 0 to full load only due to low idle governor output; retarder torque = 0 (no braking).

Modes 0001_2 to 1110_2 indicate that there is either a torque request or the identified function is currently controlling the engine/retarder: engine/retarder torque may range from 0 (no fueling/no braking) to the upper limit.

(R) Suspect Parameter Number: Engine Mode: 899
Retarder Mode: 900

TABLE 8—ENGINE/RETARDER TORQUE MODES

Bit States	Engine/Retarder Torque Mode
0000	Low idle governor/no request (default mode)
0001	Accelerator pedal/operator selection
0010	Cruise control
0011	PTO governor
0100	Road speed governor
0101	ASR control
0110	Transmission control
0111	ABS control
1000	Torque limiting
1001	High speed governor
1010	Braking system
1011	not defined
1100	not defined
1101	not defined
1110	Other
1111	Not available

3.2.2.1.1 Low Idle Governor/No request (Default mode)—This mode is active if the accelerator pedal (not necessarily the torque output of the driver input, see Figure 2 and Figure 3) is zero. This is the default mode. At low speed the low idle governor may be active while at higher speed it is zero.

3.2.2.1.2 Accelerator Pedal—This mode is active if the accelerator pedal position is active (being followed). This mode is active for the retarder if it is turned on by the operator. Note that it may be disabled by the accelerator pedal or clutch switches (operator selection).

3.2.2.1.3 Cruise Control—This mode is active if cruise control is active and greater than the accelerator pedal request.

3.2.2.1.4 PTO Governor—This mode is active if the PTO governor is active.

3.2.2.1.5 Road Speed Governing—Indicates that road speed governing is active and limiting torque.

3.2.2.1.6 ASR Control—Indicates that the ASR command is active (Speed, Torque, or Speed/Torque Limit Control).

3.2.2.1.7 Transmission Control—Indicates that the transmission command is active (Speed, Torque, or Speed/Torque Limit Control).

3.2.2.1.8 ABS Control—Indicates that the ABS is controlling torque.

3.2.2.1.9 Torque Limiting—This mode is active if the demanded or commanded engine torque is limited by internal logic due to full load, smoke and/or emissions control, engine protection and/or other factors. A reduced torque limit may be necessary for engine protection if the engine temperature is too high or a sensor fails (speed, timing, or boost pressure), as examples.

3.2.2.1.10 High Speed Governor—This mode is active if the engine is controlled by the high speed governor due to normal operation.

3.2.2.1.11 Brake System (Electronic)—This indicates that the brake pedal is controlling the torque. Note that this may include enabling of the retarder when the brake pedal is depressed (touched).

Note that if there is a request to the retarder but operating conditions do not allow braking, this situation will be reflected by the Percent Retarder Torque = 0 when broadcast.

3.2.2.1.12 Other—Torque control by a type of device which is different than those defined in 3.2.2.1.1 through 3.2.2.1.11.

3.2.2.2 Retarder Type (4 bits)—A vehicle retarder is a supplementary device to the wheel brakes for the driver to better control the vehicle. The wheel brakes used in the vehicle are not designed for continuous retarding operation. In a prolonged period of braking, the brakes can be thermally over-stressed, causing the braking effect to be reduced or even lead to complete braking system failure. The vehicle retarder is designed for continuous operation for braking during downhill operation and is also used for braking the vehicle to comply with speed limits and traffic conditions.

This parameter provides some indication of the retarder dynamics. It is used in the retarder configuration message (See 3.3.15). The data type of this parameter is measured.

(R) Suspect Parameter Number: 901

TABLE 9—RETARDER TYPES

Bit States	Retarder Type
0000	Electric/Magnetic
0001	Hydraulic
0010	Cooled Friction
0011	Compression Release (Engine retarder)
0100	Exhaust
0101-1101	Not defined
1110	Other
1111	Not available

3.2.2.2.1 Electric/Magnetic Retarder—The electric/magnetic retarder functions by creating eddy currents generated in a conductive armature when placed in a variable magnetic field. Currently, electric retarders have a stator on which field coils are mounted. The rotors, mounted on both sides of the drive shaft, are ribbed for heat dissipation. In order to brake the vehicle, voltage is applied to the field coils which generate a magnetic field inducing eddy currents in the rotors as they pass through the field. Magnetic retarders use a permanent magnet to generate the eddy currents. Braking-torque is dependent on stator excitation and on the air gap between the rotor and the stator.

3.2.2.2.2 Hydraulic Retarder—The hydraulic retarder is a hydrodynamic coupling device. Two impellers which face each other, a rotor and a stator, are filled with oil. When the rotor, which is connected to the vehicle drive shaft rotates, it drives the oil in the direction of rotation. The mechanical energy produced by the rotor is converted into kinetic energy in the operating fluid. Hydrodynamic coupling between the rotor and stator converts the kinetic energy into heat and the rotor is retarded. This retardation effect is transmitted to the drive shaft and the vehicle is retarded.

3.2.2.2.3 Cooled Friction Brake—The cooled friction brake uses air or hydraulic fluid to dissipate heat from the friction surface of the service brake. By controlling the friction surface temperature, retarding torque is improved, along with a reduced rate of wear.

3.2.2.2.4 Compression Release Engine Retarder—The compression release engine retarder converts a power-producing diesel engine into a power-absorbing retarding mechanism by opening the exhaust valve near the top dead center in the engine compression cycle. No positive power will be produced, since the compressed air mass is released. The vehicle is retarded as it must provide energy to compress the cylinder air charge and subsequently to return the piston to the bottom position.

3.2.2.2.5 Exhaust Brake—The exhaust brake restricts the escape of the exhaust gas from the exhaust manifold. Each succeeding exhaust stroke builds up a back pressure in the manifold which exerts a retarding effect to the pistons during the exhaust stroke. The engine turns against this back pressure creating a braking effect to the vehicle.

3.2.2.2.6 Auxiliary Retarder—Fans, air conditioners, or any power-absorbing device in the vehicle can also function as retarders as they impose parasitic loading on the engine or vehicle.

3.2.2.3 Retarder Location (4 bits)—This parameter defines whether the "torque/speed curve" defined by the retarder configuration message (see 3.3.15) is dependent on engine rpm, output shaft rpm, or other parameter. The data type of this parameter is measured.

(R) Suspect Parameter Number: 902

TABLE 10—RETARDER LOCATION

Bit States	Retarder Location
0000 (Primary)	Engine Compression Release Brake (Engine rpm)
0001 (Primary)	Engine Exhaust Brake (Exhaust pressure)
0010 (Primary)	Transmission Input (Engine rpm)
0011 (Secondary)	Transmission Output (Output Shaft rpm)
0100 (Secondary)	Driveline (Output Shaft rpm)
0101	Trailer (Vehicle speed)
0110-1101	Not defined
1110	Other
1111	Not available

3.2.2.4 Accelerator Pedal Low Idle Switch—Switch signal which indicates whether the accelerator pedal low idle switch is opened or closed. The low idle switch is defined in SAE J1843.

00 - Accelerator pedal not in low idle condition
01 - Accelerator pedal in low idle condition
Type: Measured
Suspect Parameter Number: 558
Reference: 3.3.6

3.2.2.5 Accelerator Pedal Kickdown Switch—Switch signal which indicates whether the accelerator pedal kickdown switch is opened or closed. The kickdown switch is defined in SAE J1843.

00 - Kickdown passive
01 - Kickdown active
Type: Measured
Suspect Parameter Number: 559
Reference: 3.3.6

3.2.2.6 Driveline Engaged—Driveline engaged indicates the transmission controlled portion of the driveline is engaged sufficiently to allow a transfer of torque through the transmission. Driveline engaged is ACTIVE whenever the transmission is in gear and the clutch (if controlled by the transmission controller) is less than 100% clutch slip (clutch able to transfer torque). This parameter should be used in conjunction with the parameter "Shift in Process" (3.2.2.14). While a shift is in process, the receiver should not assume that the driveline is either fully engaged or disengaged (i.e., cruise control).

00 - Driveline disengaged
01 - Driveline engaged
Type: Measured
Suspect Parameter Number: 560
Reference: 3.3.5

3.2.2.7 ASR Engine Control Active—State signal which indicates that ASR engine control has been commanded to be active. Active means that ASR actually tries to control the engine. This state signal is independent of other control commands to the engine (e.g., from the transmission) which may have higher priority.

00 - ASR engine control passive but installed
01 - ASR engine control active
Type: Status
Suspect Parameter Number: 561
Reference: 3.3.4

3.2.2.8 ASR Brake Control Active—State signal which indicates that ASR brake control is active. Active means that ASR actually controls wheel brake pressure at one or more wheels of the driven axle(s).

00 - ASR brake control passive but installed
01 - ASR brake control active
Type: Status
Suspect Parameter Number: 562
Reference: 3.3.4

3.2.2.9 Anti-lock Braking (ABS) Active—State signal which indicates that the ABS is active. The signal is set active when wheel brake pressure actually starts to be modulated by ABS and is reset to passive when all wheels are in a stable condition for a certain time. The signal can also be set active when driven wheels are in high slip (e.g., caused by retarder).

00 - ABS passive but installed
01 - ABS active
Type: Status
Suspect Parameter Number: 563
Reference: 3.3.4

3.2.2.10 Differential Lock State—State used which indicates the condition of the various differential locks. The differential locks are located as defined in Figure 5.

00 - Differential lock disengaged
01 - Differential lock engaged
Type: Status
Suspect Parameter Number: 564 (Central)
565 (Central front)
566 (Central rear)
567 (Front axle 1)
568 (Front axle 2)
569 (Rear axle 1)
570 (Rear axle 2)
Reference: 3.3.9

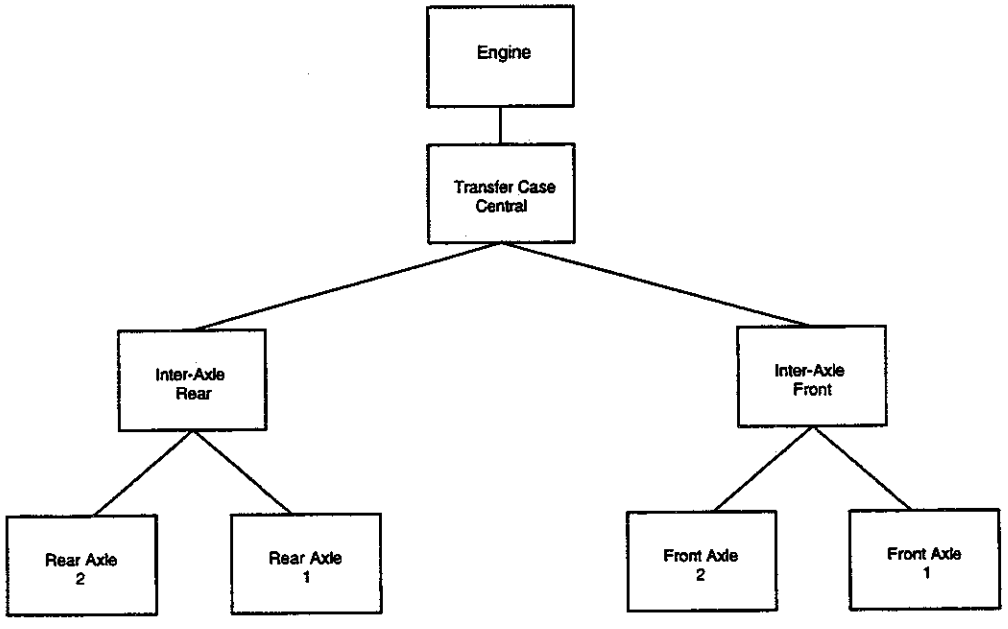


FIGURE 5—DIFFERENTIAL LOCK POSITIONS

3.2.2.11 Retarder Enable - Brake Assist Switch—Switch signal which indicates whether the retarder is enabled for vehicle braking assist. It is not ensured that the retarder is braking. See also 3.2.2.12.

00 - Retarder - brake assist disabled
01 - Retarder - brake assist enabled
Type: Measured
Suspect Parameter Number: 571
Reference: 3.3.3

3.2.2.12 Retarder Enable - Shift Assist Switch—Switch signal which indicates whether the retarder is enabled for transmission shift assist. It is not ensured that the retarder is braking. When this mode is enabled, the transmission may activate the retarder to increase the rate of engine deceleration to assist in shift control. See also 3.2.2.11.

00 - Retarder - shift assist disabled
01 - Retarder - shift assist enabled
Type: Measured
Suspect Parameter Number: 572
Reference: 3.3.3

3.2.2.13 Torque Converter Lockup Engaged—State signal which indicates whether the torque converter lockup is engaged.

00 - Torque converter lockup disengaged
01 - Torque converter lockup engaged
Type: Status
Suspect Parameter Number: 573
Reference: 3.3.5

3.2.2.14 Shift in Process—Indicates that the transmission is in process of shifting from the current gear to the selected gear. This state is generally ACTIVE during the entire time that the transmission controls the vehicle. This includes any transmission clutch control, all engine control sequences, pulling to transmission neutral, and engaging the destination gear (e.g., until it is no longer sending commands and/or limits to the engine). See also 3.2.2.6. (See Figure 6.)

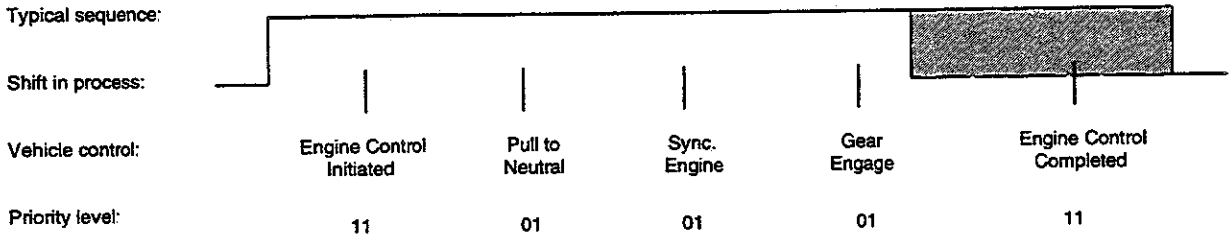


FIGURE 6—SHIFT IN PROCESS

00 - Shift is not in process
01 - Shift in process
Type: Measured
Suspect Parameter Number: 574
Reference: 3.3.5

3.2.2.15 ABS Offroad Switch—Switch signal which indicates the position of the ABS offroad switch.

00 - ABS offroad switch passive
01 - ABS offroad switch active
Type: Measured
Suspect Parameter Number: 575
Reference: 3.3.4

3.2.2.16 ASR Offroad Switch—Switch signal which indicates the position of the ASR offroad switch.

00 - ASR offroad switch passive
01 - ASR offroad switch active
Type: Measured
Suspect Parameter Number: 576
Reference: 3.3.4

3.2.2.17 ASR "Hill Holder" Switch—Switch signal which indicates the position of the ASR "hill holder" switch.

00 - ASR "hill holder" switch passive
01 - ASR "hill holder" switch active
Type: Measured
Suspect Parameter Number: 577
Reference: 3.3.4

3.2.2.18 Cruise Control States (3 bits)—This parameter is used to indicate the current state, or mode, of operation by the cruise control device. This is a status parameter. (Reference: 3.3.31)

(R) Suspect Parameter Number: 527

TABLE 11—CRUISE CONTROL STATES

	Bit States	Cruise Control State
	000	Off/Disabled
	001	Hold
	010	Accelerate
	011	Decelerate/Coast
	100	Resume
(R)	101	Set
(R)	110	Accelerator override
	111	Not available

(R) 3.2.2.18.1 Off/Disabled 000—Used to indicate that the cruise control device is off or on standby. Note that the cruise control system switch does not necessarily have to be off to be in this mode.

3.2.2.18.2 Hold 001—Used to indicate that the cruise control device is active and currently maintaining a captured operating speed.

3.2.2.18.3 Accelerate 010—Used to indicate that the cruise control device is in the process of ramping up the operating speed.

3.2.2.18.4 Decelerate 011—Used to indicate that the cruise control device is in the process of ramping down, or coasting, the operating speed.

(R) 3.2.2.18.5 Resume 100—Used to indicate that the cruise control device is in the process of resuming the operating speed to a previously captured value.

(R) 3.2.2.18.6 Set 101—Used to indicate that the cruise control device is establishing the current vehicle speed as the operating speed (captured value).

(R) 3.2.2.18.7 Accelerator Override 110—Used to indicate that the cruise control device is active but not currently maintaining the captured operating speed.

3.2.3 DRIVETRAIN CONTROL PARAMETERS

3.2.3.1 *Override Control Mode (2 bits)*—The override control mode defines which sort of command is used:

00 - Override disabled - Disable any existing control commanded by the source of this command.
01 - Speed control - Govern speed to the included "desired speed" value.
10 - Torque control - Control torque to the included "desired torque" value.
11 - Speed/torque limit control - Limit speed and/or torque based on the included limit values. The speed limit governor is a droop governor where the speed limit value defines the speed at the maximum torque available during this operation.

Type: Status
(R) Suspect Parameter Number: 695
Reference: 3.3.1

If a device wants to know whether it has access to the engine, there are several possibilities:

a. Comparing its command with the actual engine broadcasts.
b. Looking at command modes from other devices.
c. Looking to the engine and retarder torque mode.

Remarks:

a. The realization of a torque limit (minimum selection) is possible by setting the speed limit to a high value ($FAFF_{16}$).
b. The realization of a speed limit (minimum selection) is possible by setting the torque limit to a high value (FA_{16}).
c. Limiting the retarder torque means to limit the magnitude of the torque request. As the brake torque is represented by negative torque values, the limitation must be done by a maximum selection of the requested torque and the retarder internal torque signals.
d. For torque increasing functions, time limits for the torque or speed value (command) and the direct modes are desirable.

e. The selection of which device has control of the engine's speed or torque depends on the override mode priority (see 3.2.3.3) with the highest priority device gaining control. In the case of two devices with identical priority, the engine responds to speed/torque control commands over speed/torque limit commands and will act on the speed or torque commands on a first come, first served basis. The torque limit will be a "lowest wins" selection (e.g, if one device commands 60% limit and another 80% limit, then the engine will limit torque to 60%). Figure 7 provides a flowchart of the torque/speed control priority selection logic.

3.2.3.2 Requested Speed Control Conditions (2 bits)—This mode tells the engine control system the governor characteristics that are desired during speed control. The four characteristics defined are:

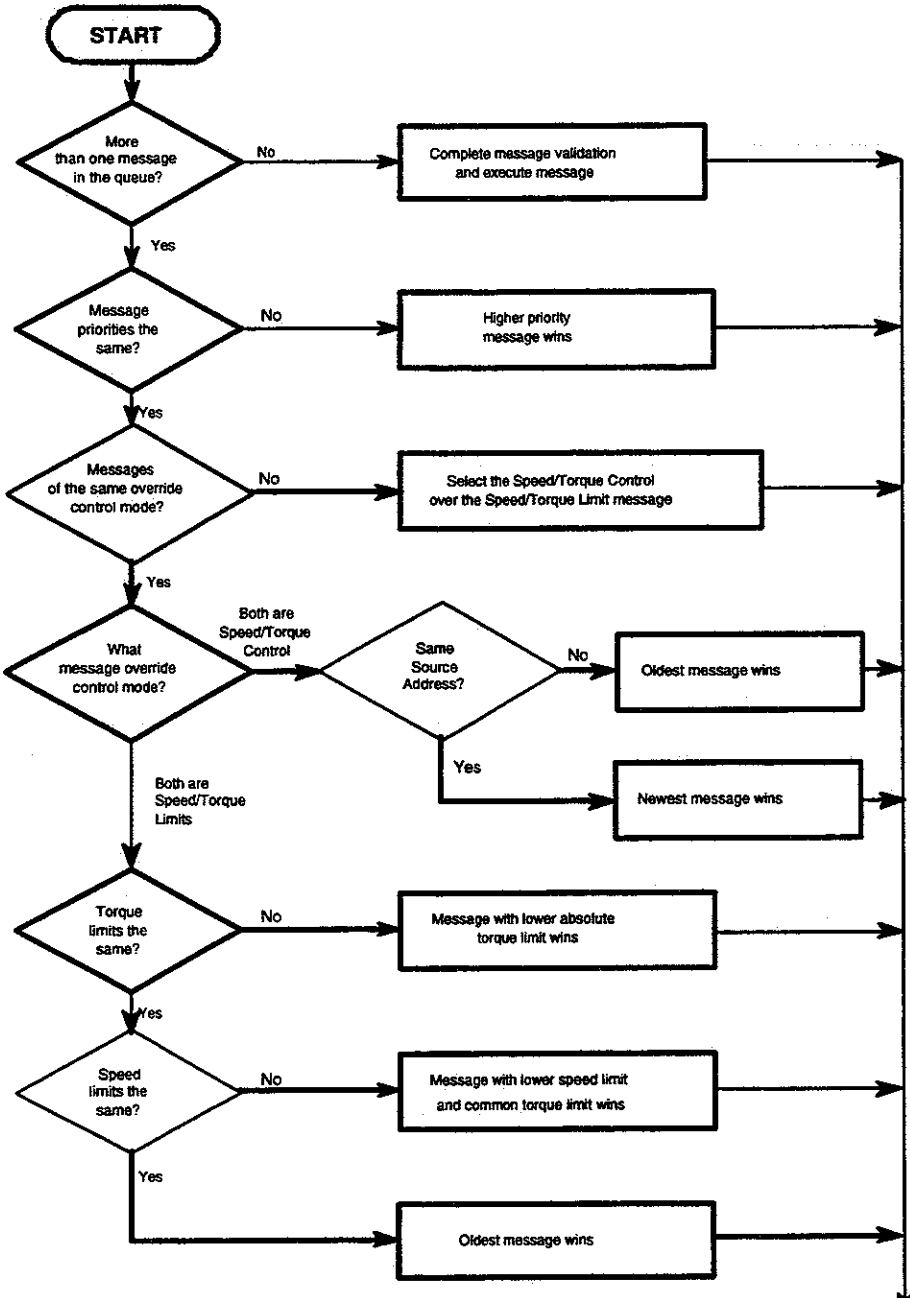
00 - Transient Optimized for driveline disengaged and non-lockup conditions
01 - Stability Optimized for driveline disengaged and non-lockup conditions
10 - Stability Optimized for driveline engaged and/or in lockup condition 1 (e.g., vehicle driveline)
11 - Stability Optimized for driveline engaged and/or in lockup condition 2 (e.g., PTO driveline)
Type: Status
(R) Suspect Parameter Number: 696
Reference: 3.3.1

3.2.3.2.1 Speed Control Characteristic 00—This speed governor gain selection is adjusted to provide rapid transition between speed setpoints. RPM overshoot and undershoot may be greater than what is seen when the "speed control characteristic" is set to be stability optimized.

3.2.3.2.2 Speed Control Characteristic 01—This control condition has been optimized to minimize rpm overshoot and undershoot given an expected plant consisting of the engine and its accessory loads. This gain adjustment is not intended to compensate for driveline characteristics. This characteristic is most appropriate when no driveline is connected.

3.2.3.2.3 Speed Control Characteristic 10—This control condition has been optimized to minimize rpm overshoot and undershoot given a more complex plant. For instance, the more complex plant would contain the engine, its accessory loads and the driveline characteristics. As an example the driveline characteristics might include the effective spring mass relationship of pumps, tires, clutches, axles, driveshafts, and multiple gear ratios. This characteristic is most appropriate when a driveline is engaged.

3.2.3.2.4 Speed Control Characteristic 11—This speed control characteristic is available for applications requiring compensation for more than one driveline characteristic. It has been optimized to minimize rpm overshoot and undershoot given a more complex plant of the second variety. This more complex plant would again contain the engine, its accessory loads and a second driveline characteristic unique from the one described in speed control characteristic 10.



Torque/Speed override modes that have timed out are discarded before the priority selection process is executed.

Messages are stored in the order received on the data link with the messages received first, referred to as the "oldest", stored at the top of the priority selection queue.

The focus in this diagram is on the message priority selection. Other message disposition issues are ignored in this context.

FIGURE 7—TORQUE/SPEED CONTROL PRIORITY SELECTION LOGIC

3.2.3.3 Override Control Mode Priority (2 bits)—This field is used as an input to the engine or retarder to determine the priority of the Override Control Mode received in the Torque/Speed Control message (see 3.3.1). The default is 11 (Low priority). It is not required to use the same priority during the entire override function. For example, the transmission can use priority 01 (High priority) during a shift, but can set the priority to 11 (Low priority) at the end of the shift to allow traction control to also interact with the torque limit of the engine.

The four priority levels defined are:

00 -	Highest priority
01 -	High priority
10 -	Medium priority
11 -	Low priority
Type:	Status
(R) Suspect Parameter Number:	897
Reference:	3.3.1

3.2.3.3.1 Highest Priority 00—Used for situations that require immediate action by the receiving device in order to provide safe vehicle operation (i.e., braking systems). This level of priority should only be used in safety critical conditions.

3.2.3.3.2 High Priority 01—Used for control situations that require prompt action in order to provide safe vehicle operation. An example is when the transmission is performing a shift and requires control of the engine in order to control driveline reengagement.

3.2.3.3.3 Medium Priority 10—Used for powertrain control operations which are related to assuring that the vehicle is in a stable operating condition. An example is when the traction control system is commanding the engine in order to achieve traction stability.

3.2.3.3.4 Low Priority 11—Used to indicate that the associated command desires powertrain control but is needed for function which improves the driver comfort which may be overridden by other devices. An example is cruise control or the non-critical part of a transmission shift to a new gear.

3.2.3.4 Gear Shift Inhibit Request—Command signal to inhibit gear shifts.

00 -	Gear shifts are allowed (disable function)
01 -	Gear shifts are inhibited (enable function)
11 -	Take no action (leave function as is)
Type:	Status
(R) Suspect Parameter Number:	681
Reference:	3.3.2

3.2.3.5 Torque Converter Lockup Disable Request—Command signal to prevent torque converter lockup, which may cause problems in certain circumstances for ASR.

00 -	Allow torque convertor lockup
01 -	Disable torque convertor lockup
11 -	Take no action
Type:	Status
(R) Suspect Parameter Number:	682
Reference:	3.3.2

3.2.3.6 Disengage Driveline Request—Command signal used to simply disengage the driveline, e.g., to prevent engine drag torque from causing high wheel slip on slippery surfaces.

00 - Allow driveline engagement
01 - Disengage driveline
11 - Take no action
Type: Status
(R) Suspect Parameter Number: 683
Reference: 3.3.2

3.2.3.7 Disengage Differential Lock Request—Command signal used to disengage the various differential locks, e.g., to allow an undistributed individual wheel control by ABS. The differential locks are located as defined in Figure 5.

00 - Engage differential lock
01 - Disengage differential lock
11 - Take no action
Type: Status
(R) Suspect Parameter Number: Front axle 1 - 685
Front axle 2- 686
Rear axle 1 - 687
Rear axle 2 - 688
Central - 689
Central front - 690
Central rear - 691
Reference: 3.3.2

3.2.3.8 ABS Offroad Switch Request—Command signal used by the driver via a dashboard switch to choose the ABS offroad function.

00 - Switch off ABS offroad function
01 - Switch on ABS offroad function
11 - Take no action
Type: Status
(R) Suspect Parameter Number: 692
Reference:

3.2.3.9 ASR Offroad Switch Request—Command signal used by the driver via a dashboard switch to choose the ASR offroad function.

00 - Switch off ASR offroad function
01 - Switch on ASR offroad function
11 - Take no action
Type: Status
(R) Suspect Parameter Number: 693
Reference:

3.2.3.10 ASR "Hill Holder" Switch Request—Command signal used by the driver via a dashboard switch to choose a special ASR function.

00 -	Switch off ASR special function
01 -	Switch on ASR special function
11 -	Take no action
Type:	Status
Suspect Parameter Number:	694
Reference:	

3.2.3.11 Progressive Shift Disable—Command signal used to indicate that progressive shifting by the engine should be disallowed.

00 -	Progressive shift is not disabled
01 -	Progressive shift is disabled
11 -	Take no action
Type:	Status
(R) Suspect Parameter Number:	607
Reference:	3.3.5

3.2.3.12 Momentary Engine Overspeed Enable—Command signal used to indicate that the engine speed may be boosted up to the maximum engine overspeed value to accommodate transmission downshifts. The maximum time for overspeed is limited by the time defined in the engine configuration message (see 3.3.17). The transmission module must command a "override disabled" state at least once before the engine will accept a subsequent request for overspeed.

00 -	Momentary engine overspeed is disabled
01 -	Momentary engine overspeed is enabled
11 -	Take no action
Type:	Status
(R) Suspect Parameter Number:	606
Reference:	3.3.5

3.2.4 DRIVETRAIN CONFIGURATION PARAMETERS—The configuration messages are sent to describe a controller's configuration to other controllers on the network. The configuration messages are sent in response to a configuration request message.

3.2.4.1 Engine Configuration—This map describes the stationary behavior of the engine and the speed dependent available indicated torque. This map should reflect the effect of changes due to barometric pressure, engine temperature, and any other stationary changes (sensor failures, etc.) which influence the engine torque curve more than 10%. This map is only valid for maximum boost pressure. At low boost pressures the torque limit may be much lower.

The engine configuration message must be sent at any time that the engine configuration map has changed by more than 10% of speed or torque (due to events other than boost pressure) since that last time the message was transmitted. As an alternative, it may be sent periodically, once every 5 s. It shall also be sent on response to a configuration request message.

The engine characteristic can be described in one of three modes. Mode 1 provides a complete curve of speed and torque points (see Figure 8). Modes 2 and 3 provide a partial curve of speed and torque points and a separate endspeed governor characteristic. In modes 2 and 3, the receiver of the engine configuration message has to calculate the minimum of the engine torque curve and the endspeed governor characteristic to get the final available engine torque.

Mode 2 provides a high idle point where torque equals zero (point 6) and the endspeed governor gain Kp (see Figure 9). Mode 3 provides the kick-in point of the endspeed governor (point 2) and the governor gain Kp (see Figure 10).

The selection of the three modes can be done by setting the parameters as shown in Table 12.

TABLE 12—ENGINE CONFIGURATION CHARACTERISTIC MODES

Mode	Torque/Speed Point 2	Governor Gain KP	High Idle Speed
1	Available	Not available	Available
2	Not Available	Available	Available
3	Available	Available	Not available

The following points are shown in Figures 8, 9, and 10.

Point 1 (required):	Torque/speed point at idle
Point 2 (required):	Mode 1 & 3: Torque/speed point at which the high speed governor becomes active Mode 2: Normal torque/speed point
Point 3,4,5 (required):	Torque/speed points between points 1 and 2 to permit linear interpolation over the entire torque range. It is required that one of these points indicate the peak torque point for the current engine torque map.
Point 6 (mode dependent):	Mode 1 & 2: High idle speed (torque = 0) Mode 3: Not available (point is defined by the endspeed governor where torque = 0)
Point 7 (optional):	Maximum momentary engine override speed (torque = 0)
Reference engine torque:	Engine torque in Nm. This parameter is the reference value of 100% for all defined indicated engine torque parameters. It is only defined once and doesn't change if a different engine torque map becomes valid.

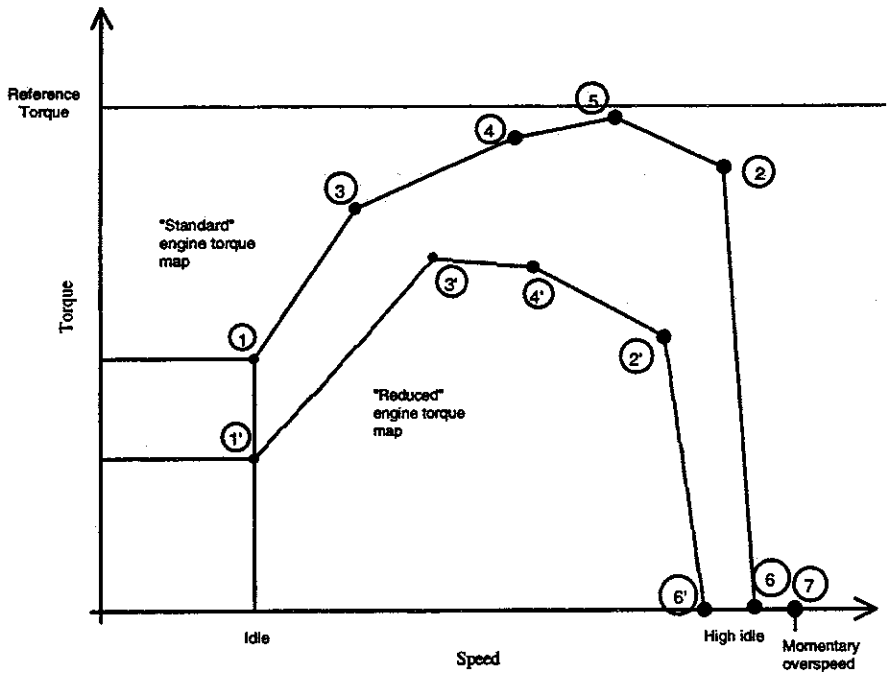


FIGURE 8—ENGINE CONFIGURATION MAP-MODE 1

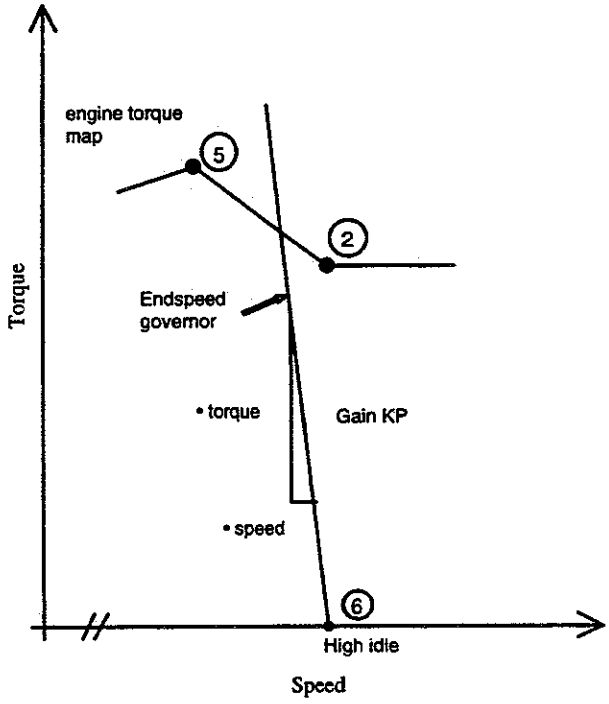


FIGURE 9—ENGINE CONFIGURATION MAP-MODE 2

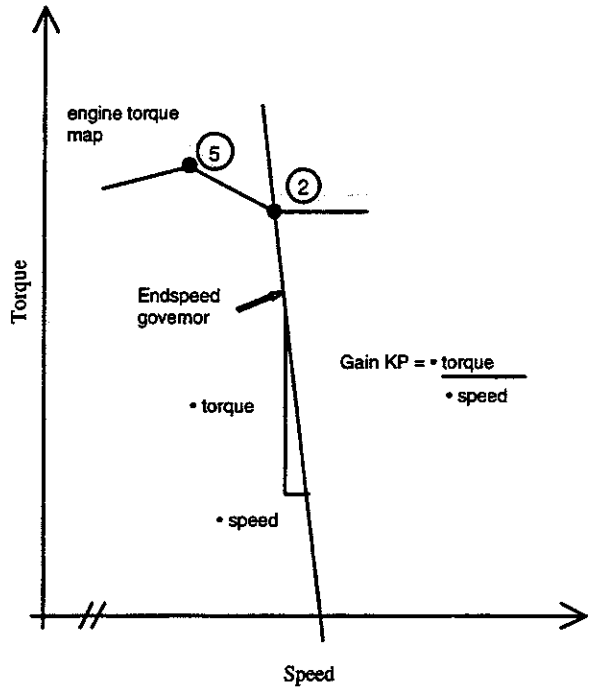


FIGURE 10—ENGINE CONFIGURATION MAP-MODE 3

3.2.4.2 Transmission Configuration—The transmission configuration describes the number of forward gears, the number of reverse gears, and the ratio of each gear with the following resolution:

Data Length:	2 bytes
Resolution:	0.001/bit, 0 offset
Data Range:	0 to 64.255
Type:	Measured
(R) Suspect Parameter Number:	581
Reference:	3.3.16

3.2.4.3 Retarder Configuration—This map describes the stationary behavior of the retarder.

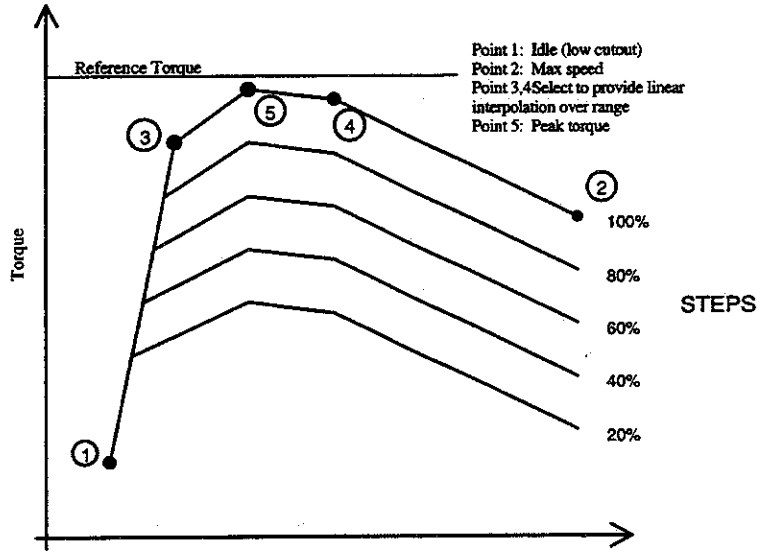


FIGURE 11—TYPICAL HYDRAULIC RETARDER TORQUE CURVE

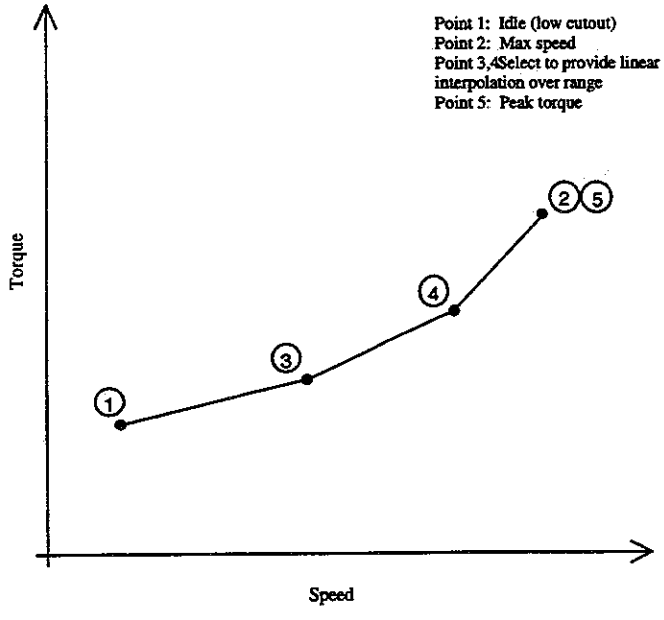


FIGURE 12—TYPICAL ENGINE COMPRESSION BRAKE TORQUE CURVE

(R) *3.2.4.4 Number of Forward Gear Ratios*—Number of forward gear ratios in the transmission, provided as part of the configuration.

Data Length:	1 byte
Resolution:	1 gear ratios/bit, 0 offset
Operating Range:	0 to 125 gear ratios
Type:	Measured
Suspect Parameter Number:	957
Reference:	3.3.16

(R) *3.2.4.5 Number of Reverse Gear Ratios*—Number of reverse gear ratios in the transmission, provided as part of the transmission configuration.

Data Length:	1 byte
Resolution:	1 gear ratios/bit, 0 offset
Operating Range:	0 to 125 gear ratios
Type:	Measured
Suspect Parameter Number:	958
Reference:	3.3.16

3.2.5 INFORMATIONAL PARAMETERS

3.2.5.1 Steering Axle Temperature—Temperature of lubricant in steering axle.

Data Length:	1 byte
Resolution:	1 °C/bit gain, –40 °C offset
Data Range:	–40 to +210 °C (–40 to 410 °F)
Type:	Measured
Suspect Parameter Number:	75
Reference:	3.3.39

3.2.5.2 Drive Axle Temperature—Temperature of axle lubricant in drive axle.

Data Length:	1 byte
Resolution:	1 °C/bit gain, –40 °C offset
Data Range:	–40 to +210 °C (–40 to 410 °F)
Type:	Measured
Suspect Parameter Number:	578
Reference:	3.3.39

3.2.5.3 Power Takeoff Oil Temperature—Temperature of lubricant in device used to transmit engine power to auxiliary equipment.

Data Length:	1 byte
Resolution:	1 °C/bit gain, –40 °C offset
Data Range:	–40 to +210 °C (–40 to 410 °F)
Type:	Measured
Suspect Parameter Number:	90
Reference:	3.3.30

3.2.5.4 Intake Manifold Temperature—Temperature of precombustion air found in intake manifold of engine air supply system.

Data Length:	1 byte
Resolution:	1 °C/bit gain, –40 °C offset
Data Range:	–40 to +210 °C (–40 to 410 °F)
Type:	Measured
Suspect Parameter Number:	105
Reference:	3.3.36

3.2.5.5 Engine Coolant Temperature—Temperature of liquid found in engine cooling system.

Data Length:	1 byte
Resolution:	1 °C/bit gain, –40 °C offset
Data Range:	–40 to +210 °C (–40 to 410 °F)
Type:	Measured
Suspect Parameter Number:	110
Reference:	3.3.28

3.2.5.6 Engine Intercooler Temperature—Temperature of liquid found in the intercooler located after the turbocharger.

Data Length:	1 byte
Resolution:	1 °C/bit gain, –40 °C offset
Data Range:	–40 to +210 °C (–40 to 410 °F)
Type:	Measured
Suspect Parameter Number:	52
Reference:	3.3.28

3.2.5.7 Hydraulic Retarder Oil Temperature—Temperature of oil found in a hydraulic retarder.

Data Length:	1 byte
Resolution:	1 °C/bit gain, –40 °C offset
Data Range:	–40 to +210 °C (–40 to 410 °F)
Type:	Measured
Suspect Parameter Number:	120
Reference:	3.3.41

3.2.5.8 Exhaust Gas Temperature—Temperature of combustion byproducts leaving the engine.

Data Length:	2 bytes
Resolution:	0.03125 °C/bit gain, –273 °C offset
Data Range:	–273 to +1735.0 °C (–459.4 to 3155.0 °F)
Type:	Measured
Suspect Parameter Number:	173
Reference:	3.3.36

3.2.5.9 Road Surface Temperature—Indicated temperature of road surface over which vehicle is operating.

Data Length:	2 bytes
Resolution:	0.03125 °C/bit gain, –273 °C offset
Data Range:	–273 to +1735.0 °C (–459.4 to 3155.0 °F)
Type:	Measured
Suspect Parameter Number:	79
Reference:	3.3.35

3.2.5.10 Cargo Ambient Temperature—Temperature of air inside vehicle container used to accommodate cargo.

Data Length:	2 bytes
Resolution:	0.03125 °C/bit gain, –273 °C offset
Data Range:	–273 to +1735.0 °C (–459.4 to 3155.0 °F)
Type:	Measured
Suspect Parameter Number:	169
Reference:	3.3.42

3.2.5.11 Cab Interior Temperature—Temperature of air inside the part of the vehicle that encloses the driver and vehicle operating controls.

Data Length:	2 bytes
Resolution:	0.03125 °C/bit gain, –273 °C offset
Data Range:	–273 to +1735.0 °C (–459.4 to 3155.0 °F)
Type:	Measured
Suspect Parameter Number:	170
Reference:	3.3.35

3.2.5.12 Ambient Air Temperature—Temperature of air surrounding vehicle.

Data Length:	2 bytes
Resolution:	0.03125 °C/bit gain, –273 °C offset
Data Range:	–273 to +1735.0 °C (–459.4 to 3155.0 °F)
Type:	Measured
Suspect Parameter Number:	171
Reference:	3.3.35

3.2.5.13 Air Inlet Temperature—Temperature of air entering vehicle air induction system.

Data Length:	1 byte
Resolution:	1 °C/bit gain, –40 °C offset
Data Range:	–40 to +210 °C (–40 to 410 °F)
Type:	Measured
Suspect Parameter Number:	172
Reference:	3.3.35

3.2.5.14 Fuel Temperature—Temperature of fuel entering injectors.

Data Length:	1 byte
Resolution:	1 °C/bit gain, –40 °C offset
Data Range:	–40 to +210 °C (–40 to 410 °F)
Type:	Measured
Suspect Parameter Number:	174
Reference:	3.3.28

3.2.5.15 Engine Oil Temperature—Temperature of the engine lubricant.

Data Length:	2 bytes
Resolution:	0.03125 °C/bit gain, –273 °C offset
Data Range:	–273 to +1735.0 °C (–459.4 to 3155.0 °F)
Type:	Measured
Suspect Parameter Number:	175
Reference:	3.3.28

3.2.5.16 Turbo Oil Temperature—Temperature of the turbocharger lubricant.

Data Length:	2 bytes
Resolution:	0.03125 °C/bit gain, –273 °C offset
Data Range:	–273 to +1735.0 °C (–459.4 to 3155.0 °F)
Type:	Measured
Suspect Parameter Number:	176
Reference:	3.3.28

3.2.5.17 Transmission Oil Temperature—Temperature of the transmission lubricant.

Data Length:	2 bytes
Resolution:	0.03125 °C/bit gain, –273 °C offset
Data Range:	–273 to +1735.0 °C (–459.4 to 3155.0 °F)
Type:	Measured
Suspect Parameter Number:	177
Reference:	3.3.38

3.2.5.18 Tire Temperature—Temperature at the surface of the tire sidewall.

Data Length:	2 bytes
Resolution:	0.03125 °C/bit gain, –273 °C offset
Data Range:	–273 to +1735.0 °C (–459.4 to 3155.0 °F)
Type:	Measured
Suspect Parameter Number:	242
Reference:	3.3.34

3.2.5.19 Gas Supply Pressure—Gage pressure of gas supply to fuel metering device.

Data Length:	2 bytes
Resolution:	0.5 kPa/bit gain, 0 kPa offset
Data Range:	0 to +32 127.5 kPa (0 to 4 659.7 psi)
Type:	Measured
Suspect Parameter Number:	159
Reference:	3.3.43

3.2.5.20 Injection Control Pressure—The gage pressure of the engine oil in the hydraulic accumulator that powers an intensifier used for fuel injection.

Data Length:	2 bytes
R) Resolution:	1/256 MPa/bit gain, 0 MPa offset
R) Data Range:	0 to +251 MPa (0 to 36 404 psi)
Type:	Measured
Suspect Parameter Number:	164
Reference:	3.3.46

3.2.5.21 Injector Metering Rail Pressure—The gage pressure of fuel in the metering rail as delivered from the supply pump to the injector metering inlet.

Data Length:	2 bytes
R) Resolution:	1/256 MPa/bit gain, 0 MPa offset
R) Data Range:	0 to +251 MPa (0 to 36 404 psi)
Type:	Measured
Suspect Parameter Number:	157
Reference:	3.3.46

3.2.5.22 Auxiliary Pump Pressure—Gage pressure of auxiliary water pump driven as a PTO device.

Data Length:	1 byte
Resolution:	16 kPa/bit gain, 0 kPa offset
Data Range:	0 to +4000 kPa (0 to 580 psi)
Type:	Measured
Suspect Parameter Number:	73
Reference:	3.3.44

3.2.5.23 Clutch Pressure–Gage pressure of oil within a wet clutch.

Data Length:	1 byte
Resolution:	16 kPa/bit gain, 0 kPa offset
Data Range:	0 to +4000 kPa (0 to 580 psi)
Type:	Measured
Suspect Parameter Number:	123
Reference:	3.3.38

3.2.5.24 Transmission Oil Pressure—Gage pressure of lubrication fluid in transmission, measured after pump.

Data Length:	1 byte
Resolution:	16 kPa/bit gain, 0 kPa offset
Data Range:	0 to +4000 kPa (0 to 580 psi)
Type:	Measured
Suspect Parameter Number:	127
Reference:	3.3.38

3.2.5.25 Drive Axle Lift Air Pressure—Gage pressure of air in system that utilizes compressed air to provide force between axle and frame.

Data Length:	1 byte
Resolution:	4 kPa/bit gain, 0 kPa offset
Data Range:	0 to +1000 kPa (0 to 145 psi)
Type:	Measured
Suspect Parameter Number:	579
Reference:	3.3.39

3.2.5.26 Air Start Pressure—Gage pressure of air in an engine starting system that utilizes compressed air to provide the force required to rotate the crankshaft.

Data Length:	1 byte
Resolution:	4 kPa/bit gain, 0 kPa offset
Data Range:	0 to +1000 kPa (0 to 145 psi)
Type:	Measured
Suspect Parameter Number:	82
Reference:	3.3.12

3.2.5.27 Fuel Delivery Pressure—Gage pressure of fuel in system as delivered from supply pump to the injection pump.

Data Length:	1 byte
Resolution:	4 kPa/bit gain, 0 kPa offset
Data Range:	0 to +1000 kPa (0 to 145 psi)
Type:	Measured
Suspect Parameter Number:	94
Reference:	3.3.29

3.2.5.28 Engine Oil Pressure—Gage pressure of oil in engine lubrication system as provided by oil pump.

Data Length:	1 byte
Resolution:	4 kPa/bit gain, 0 kPa offset
Data Range:	0 to +1000 kPa (0 to 145 psi)
Type:	Measured
Suspect Parameter Number:	100
Reference:	3.3.29

3.2.5.29 Turbo Oil Pressure—Gage pressure of oil in turbocharger lubrication system.

Data Length:	1 byte
Resolution:	4 kPa/bit gain, 0 kPa offset
Data Range:	0 to +1000 kPa (0 to 145 psi)
Type:	Measured
Suspect Parameter Number:	104
Reference:	3.3.11

3.2.5.30 Brake Application Pressure—Gage pressure of compressed air or fluid in vehicle braking system measured at the brake chamber when brake shoe (or pad) is placed against brake drum (or disc).

Data Length:	1 byte
Resolution:	4 kPa/bit gain, 0 kPa offset
Data Range:	0 to +1000 kPa (0 to 145 psi)
Type:	Measured
Suspect Parameter Number:	116
Reference:	3.3.40

3.2.5.31 Brake Primary Pressure—Gage pressure of air in the primary, or supply side, of the air brake system.

Data Length:	1 byte
Resolution:	4 kPa/bit gain, 0 kPa offset
Data Range:	0 to +1000 kPa (0 to 145 psi)
Type:	Measured
Suspect Parameter Number:	117
Reference:	3.3.40

3.2.5.32 Brake Secondary Pressure—Gage pressure of air in the secondary, or service side, of the air brake system.

Data Length:	1 byte
Resolution:	4 kPa/bit gain, 0 kPa offset
Data Range:	0 to +1000 kPa (0 to 145 psi)
Type:	Measured
Suspect Parameter Number:	118
Reference:	3.3.40

3.2.5.33 Hydraulic Retarder Pressure—Gage pressure of oil in hydraulic retarder system.

Data Length:	1 byte
Resolution:	16 kPa/bit gain, 0 kPa offset
Data Range:	0 to +4000 kPa (0 to 580 psi)
Type:	Measured
Suspect Parameter Number:	119
Reference:	3.3.41

3.2.5.34 Tire Pressure—Pressure at which air is contained in cavity formed by tire and rim.

Data Length:	1 byte
Resolution:	4 kPa/bit gain, 0 kPa offset
Data Range:	0 to +1000 kPa (0 to 145 psi)
Type:	Measured
Suspect Parameter Number:	241
Reference:	3.3.34

3.2.5.35 Fuel Filter Differential Pressure—Change in fuel delivery pressure, measured after the filter, due to accumulation of solid or semisolid matter on the filter element.

Data Length:	1 byte
Resolution:	2 kPa/bit gain, 0 kPa offset
Data Range:	0 to +500 kPa (0 to 72.5 psi)
Type:	Measured
Suspect Parameter Number:	95
Reference:	3.3.42

3.2.5.36 Boost Pressure—Gage pressure of air measured downstream on the compressor discharge side of the turbocharger.

Data Length:	1 byte
Resolution:	2 kPa/bit gain, 0 kPa offset
Data Range:	0 to +500 kPa (0 to 72.5 psi)
Type:	Measured
Suspect Parameter Number:	102
Reference:	3.3.36

3.2.5.37 Air Inlet Pressure—Absolute air pressure at inlet to intake manifold or air box.

Data Length:	1 byte
Resolution:	2 kPa/bit gain, 0 kPa offset
Data Range:	0 to +500 kPa (0 to 72.5 psi)
Type:	Measured
Suspect Parameter Number:	106
Reference:	3.3.36

3.2.5.38 Coolant Pressure—Gage pressure of liquid found in engine cooling system.

Data Length:	1 byte
Resolution:	2 kPa/bit gain, 0 kPa offset
Data Range:	0 to +500 kPa (0 to 72.5 psi)
Type:	Measured
Suspect Parameter Number:	109
Reference:	3.3.29

3.2.5.39 Transmission Filter Differential Pressure—Change in transmission fluid pressure, measured after the filter, due to accumulation of solid or semisolid material on or in the filter.

Data Length:	1 byte
Resolution:	2 kPa/bit gain, 0 kPa offset
Data Range:	0 to +500 kPa (0 to 72.5 psi)
Type:	Measured
Suspect Parameter Number:	126
Reference:	3.3.38

3.2.5.40 Crankcase Pressure—Gage pressure inside engine crankcase.

Data Length:	2 bytes
Resolution:	7.8125×10^{-3} kPa/bit gain (1/128 kPa/bit), –250 kPa offset
Data Range:	–250 to +251.99 kPa (–36.259 to +36.548 lbf/in^2)
Type:	Measured
Suspect Parameter Number:	101
Reference:	3.3.29

3.2.5.41 Particulate Trap Inlet Pressure—Exhaust back pressure as a result of particle accumulation on filter media placed in the exhaust stream.

Data Length:	1 byte
Resolution:	0.5 kPa/bit gain, 0 kPa offset
Data Range:	0 to +125 kPa (0 to +18.1 psi)
Type:	Measured
Suspect Parameter Number:	81
Reference:	3.3.36

3.2.5.42 Engine Oil Filter Differential Pressure—Change in engine oil pressure, measured across the filter, due to the filter and any accumulation of solid or semisolid material on or in the filter.

Data Length:	1 byte
Resolution:	0.5 kPa/bit gain, 0 kPa offset
Data Range:	0 to +125 kPa (0 to +18.1 psi)
Type:	Measured
Suspect Parameter Number:	99
Reference:	3.3.42

3.2.5.43 Barometric Pressure—Absolute air pressure of the atmosphere.

Data Length:	1 byte
Resolution:	0.5 kPa/bit gain, 0 kPa offset
Data Range:	0 to +125 kPa (0 to +18.1 psi)
Type:	Measured
Suspect Parameter Number:	108
Reference:	3.3.35

3.2.5.44 Coolant Filter Differential Pressure—Change in coolant pressure, measured across the filter, due to the filter and any accumulation of solid or semisolid matter on or in the filter.

Data Length:	1 byte
Resolution:	0.5 kPa/bit gain, 0 kPa offset
Data Range:	0 to +125 kPa (0 to +18.1 psi)
Type:	Measured
Suspect Parameter Number:	112
Reference:	3.3.36

3.2.5.45 Air Filter Differential Pressure—Change in engine air system pressure, measured across the filter, due to the filter and any accumulation of solid foreign matter on or in the filter.

Data Length:	1 byte
Resolution:	0.05 kPa/bit gain, 0 kPa offset
Data Range:	0 to +12.5 kPa (0 to +1.8 psi)
Type:	Measured
Suspect Parameter Number:	107
Reference:	3.3.36

3.2.5.46 Maximum Vehicle Speed Limit—Maximum vehicle velocity allowed.

Data Length:	1 byte
Resolution:	1 km/h/bit gain, 0 km/h offset
Data Range:	0 to +250 km/h (0 km/h to +155 mph)
Type:	Measured
Suspect Parameter Number:	74
Reference:	3.3.27

3.2.5.47 Cruise Control Set Speed—Value of set (chosen) velocity of velocity control system.

Data Length:	1 byte
Resolution:	1 km/h/bit gain, 0 km/h offset
Data Range:	0 to +250 km/h (0 km/h to +155 mph)
Type:	Measured
Suspect Parameter Number:	86
Reference:	3.3.31

3.2.5.48 Cruise Control High Set Limit Speed—Maximum vehicle velocity at which cruise can be set.

Data Length:	1 byte
Resolution:	1 km/h/bit gain, 0 km/h offset
Data Range:	0 to +250 km/h (0 km/h to +155 mph)
Type:	Measured
Suspect Parameter Number:	87
Reference:	3.3.27

3.2.5.49 Cruise Control Low Set Limit Speed—Minimum vehicle velocity at which cruise can be set or minimum vehicle velocity for cruise operation before it will dropout.

Data Length:	1 byte
Resolution:	1 km/h/bit gain, 0 km/h offset
Data Range:	0 to +250 km/h (0 km/h to +155 mph)
Type:	Measured
Suspect Parameter Number:	88
Reference:	3.3.27

3.2.5.50 Trip Distance—Distance traveled during all or part of a journey.

Data Length:	4 bytes
Resolution:	0.125 km/bit gain, 0 km offset
Data Range:	0 to +526 385 151.9 km (0 to +327 080 569.4 mi)
Type:	Measured
Suspect Parameter Number:	244
Reference:	3.3.14

R) NOTE—See 3.2.5.107 for alternate resolution.

3.2.5.51 Total Vehicle Distance—Accumulated distance travelled by vehicle during its operation.

Data Length:	4 bytes
Resolution:	0.125 km/bit gain, 0 km offset
Data Range:	0 to +526 385 151.9 km (0 to +327 080 569.4 mi)
Type:	Measured
Suspect Parameter Number:	245
Reference:	3.3.14

R) NOTE—See 3.2.5.106 for alternate resolution.

3.2.5.52 Altitude—Altitude of the vehicle referenced to sea level at standard atmospheric pressure and temperature.

Data Length:	2 bytes
Resolution:	0.125 m/bit gain, –2500 m offset
Data Range:	–2500 to +5531.875 m (–8202.1 to +15 896.193 ft)
Type:	Measured
Suspect Parameter Number:	580
Reference:	3.3.22

3.2.5.53 Turbo Speed—Rotational velocity of rotor in turbocharger.

Data Length:	2 bytes
Resolution:	4 rpm/bit gain, 0 rpm offset
Data Range:	0 to +257 020 rpm
Type:	Measured
Suspect Parameter Number:	103
Reference:	3.3.11

3.2.5.54 Main Shaft Speed—Rotational velocity of the first intermediate shaft of the transmission.

Data Length:	2 bytes
Resolution:	0.125 rpm/bit gain, 0 rpm offset
Data Range:	0 to +8031.875 rpm
Type:	Measured
Suspect Parameter Number:	160
Reference:	

3.2.5.55 Input Shaft Speed—Rotational velocity of the primary shaft transferring power into the transmission. When a torque converter is present, it is the output of the torque converter.

Data Length:	2 bytes
Resolution:	0.125 rpm/bit gain, 0 rpm offset
Data Range:	0 to +8031.875 rpm
Type:	Measured
Suspect Parameter Number:	161
Reference:	3.3.2

3.2.5.56 Power Takeoff Speed—Rotational velocity of device used to transmit engine power to auxiliary equipment.

Data Length:	2 bytes
Resolution:	0.125 rpm/bit gain, 0 rpm offset
Data Range:	0 to +8031.875 rpm
Type:	Measured
Suspect Parameter Number:	186
Reference:	3.3.30

3.2.5.57 Power Takeoff Set Speed—Rotational velocity selected by operator for device used to transmit engine power to auxiliary equipment.

Data Length:	2 bytes
Resolution:	0.125 rpm/bit gain, 0 rpm offset
Data Range:	0 to +8031.875 rpm
Type:	Measured
Suspect Parameter Number:	187
Reference:	3.3.30

3.2.5.58 Total Engine Revolutions—Accumulated number of revolutions of engine crankshaft during its operation.

Data Length:	4 bytes
Resolution:	1000 r/bit gain, 0 r offset
Data Range:	0 to +4 211 081 215 000 r
Type:	Measured
Suspect Parameter Number:	249
Reference:	3.3.19

3.2.5.59 Total Idle Hours—Accumulated time of operation of the engine while under idle conditions.

Data Length:	4 bytes
Resolution:	0.05 h/bit gain, 0 h offset
(R) Data Range:	0 to +210 554 060.75 h
Type:	Measured
Suspect Parameter Number:	235
Reference:	3.3.10

3.2.5.60 Total Vehicle Hours—Accumulated time of operation of vehicle.

Data Length:	4 bytes
Resolution:	0.05 h/bit gain, 0 h offset
(R) Data Range:	0 to +210 554 060.75 h
Type:	Measured
Suspect Parameter Number:	246
Reference:	3.3.21

3.2.5.61 Total Engine Hours—Accumulated time of operation of engine.

Data Length:	4 bytes
Resolution:	0.05 h/bit gain, 0 h offset
(R) Data Range:	0 to +210 554 060.75 h
Type:	Measured
Suspect Parameter Number:	247
Reference:	3.3.19

3.2.5.62 Total Power Takeoff Hours—Accumulated time of operation of power takeoff device.

Data Length:	4 bytes
Resolution:	0.05 h/bit gain, 0 h offset
(R) Data Range:	0 to +210 554 060.75 h
Type:	Measured
Suspect Parameter Number:	248
Reference:	3.3.21

3.2.5.63 Fuel Rate—Amount of fuel consumed by engine per unit of time.

Data Length:	2 bytes
Resolution:	0.05 L/h per bit gain, 0 L/h offset (13.9×10^{-6} L/s per bit)
Data Range:	0 to +3212.75 L/h
Type:	Measured
Suspect Parameter Number:	183
Reference:	3.3.32

3.2.5.64 Trip Fuel—Fuel consumed during all or part of a journey.

Data Length:	4 bytes
Resolution:	0.5 L per bit gain, 0 L offset
Data Range:	0 to +2 105 540 608 L
Type:	Measured
Suspect Parameter Number:	182
Reference:	3.3.23

3.2.5.65 Total Idle Fuel Used—Accumulated amount of fuel used during vehicle operation while under idle conditions.

Data Length:	4 bytes
Resolution:	0.5 L per bit gain, 0 L offset
Data Range:	0 to +2 105 540 608 L
Type:	Measured
Suspect Parameter Number:	236
Reference:	3.3.10

3.2.5.66 Total Fuel Used—Accumulated amount of fuel used during vehicle operation.

Data Length:	4 bytes
Resolution:	0.5 L per bit gain, 0 L offset
Data Range:	0 to +2 105 540 608 L
Type:	Measured
Suspect Parameter Number:	250
Reference:	3.3.23

3.2.5.67 Instantaneous Fuel Economy—Current fuel economy at current vehicle velocity.

Data Length:	2 bytes
Resolution:	1/512 km/L per bit gain, 0 km/L offset
Data Range:	0 to +125.5 km/L
Type:	Measured
Suspect Parameter Number:	184
Reference:	3.3.32

3.2.5.68 Average Fuel Economy—Average of instantaneous fuel economy for that segment of vehicle operation of interest.

Data Length:	2 bytes
Resolution:	1/512 km/L per bit gain, 0 km/L offset
Data Range:	0 to +125.5 km/L
Type:	Measured
Suspect Parameter Number:	185
Reference:	3.3.32

3.2.5.69 Blower Bypass Valve Position—Relative position of the blower bypass valve.

Data Length:	1 byte
Resolution:	0.4 %/bit gain, 0 % offset
Data Range:	0 to +100 %
Type:	Measured
Suspect Parameter Number:	72
Reference:	3.3.43

3.2.5.70 Washer Fluid Level—Ratio of volume of liquid to total container volume of fluid reservoir in windshield wash system.

Data Length:	1 byte
Resolution:	0.4 %/bit gain, 0 % offset
Data Range:	0 to +100 %
Type:	Measured
Suspect Parameter Number:	80
Reference:	3.3.42

3.2.5.71 Fuel Level—Ratio of volume of fuel to the total volume of fuel storage container.

Data Length:	1 byte
Resolution:	0.4 %/bit gain, 0 % offset
Data Range:	0 to +100 %
Type:	Measured
Suspect Parameter Number:	96
Reference:	3.3.42

3.2.5.72 Engine Oil Level—Ratio of current volume of engine sump oil to maximum required volume.

Data Length:	1 byte
Resolution:	0.4 %/bit gain, 0 % offset
Data Range:	0 to +100 %
Type:	Measured
Suspect Parameter Number:	98
Reference:	3.3.29

3.2.5.73 Coolant Level—Ratio of volume of liquid found in engine cooling system to total cooling system volume.

Data Length:	1 byte
Resolution:	0.4 %/bit gain, 0 % offset
Data Range:	0 to +100 %
Type:	Measured
Suspect Parameter Number:	111
Reference:	3.3.29

3.2.5.74 Transmission Oil Level—Ratio of volume of transmission sump oil to recommended volume.

Data Length:	1 byte
Resolution:	0.4 %/bit gain, 0 % offset
Data Range:	0 to +100 %
Type:	Measured
Suspect Parameter Number:	124
Reference:	3.3.38

3.2.5.75 Battery Potential (Voltage), Switched—Electrical potential measured at the input of the electronic control unit supplied through a switching device.

Data Length:	2 bytes
Resolution:	0.05 V/bit gain, 0 V offset
Data Range:	0 to +3212.75 V
Type:	Measured
Suspect Parameter Number:	158
Reference:	3.3.37

3.2.5.76 Alternator Potential (Voltage)—Electrical potential measured at the alternator output.

Data Length:	2 bytes
Resolution:	0.05 V/bit gain, 0 V offset
Data Range:	0 to +3212.75 V
Type:	Measured
Suspect Parameter Number:	167
Reference:	3.3.37

3.2.5.77 Electrical Potential (Voltage)—Measured electrical potential of the battery.

Data Length:	2 bytes
Resolution:	0.05 V/bit gain, 0 V offset
Data Range:	0 to +3212.75 V
Type:	Measured
Suspect Parameter Number:	168
Reference:	3.3.37

3.2.5.78 Net Battery Current—Net flow of electrical current into/out of the battery or batteries.

Data Length:	1 byte
Resolution:	1.0 A/bit gain, –125 A offset
Data Range:	–125 to +125 A
Type:	Measured
Suspect Parameter Number:	114
Reference:	3.3.37

3.2.5.79 Alternator Current—Measure of electrical flow from the alternator.

Data Length:	1 byte
Resolution:	1.0 A/bit gain, 0 A offset
Data Range:	0 to +250 A
Type:	Measured
Suspect Parameter Number:	115
Reference:	3.3.37

3.2.5.80 Axle Weight—Total force of gravity imposed by the tires on the road surface at the specified axle.

Data Length:	2 bytes
Resolution:	0.5 kg/bit gain, 0 kg offset
Data Range:	0 to +32 127.5 kg (0 to 70 829 lb)
Type:	Measured
Suspect Parameter Number:	582
Reference:	3.3.24

3.2.5.81 Trailer Weight—Total force of gravity of freight-carrying vehicle designed to be pulled by truck, including the weight of the contents.

Data Length:	2 bytes
Resolution:	2.0 kg/bit gain, 0 kg offset
Data Range:	0 to +128 510 kg (0 to 283 316 lb)
Type:	Measured
Suspect Parameter Number:	180
Reference:	3.3.24

3.2.5.82 Cargo Weight—The force of gravity of freight carried.

Data Length:	2 bytes
Resolution:	2.0 kg/bit gain, 0 kg offset
Data Range:	0 to +128 510 kg (0 to 283 316 lb)
Type:	Measured
Suspect Parameter Number:	181
Reference:	3.3.24

3.2.5.83 Compass Bearing—Present compass bearing of vehicle.

Data Length:	2 bytes
Resolution:	1/128 degree/bit gain, 0 degree offset
Data Range:	0 to +502 degrees
Type:	Measured
Suspect Parameter Number:	165
Reference:	3.3.22

3.2.5.84 Pitch—Pitch of the vehicle as calculated by the navigation device(s).

Data Length:	2 bytes
Resolution:	1/128 degree/bit gain, –200 degrees offset
Data Range:	–200 degrees (DESCENT) to +302 degrees (ASCENT)
Type:	Measured
Suspect Parameter Number:	583
Reference:	3.3.22

3.2.5.85 Latitude—Latitude position of the vehicle.

Data Length:	4 bytes
Resolution:	10^{-7} degree/bit gain, –210 degree offset
Data Range:	–210 degrees (SOUTH) to + 211.108 122 degrees (NORTH)
Type:	Measured
Suspect Parameter Number:	584
Reference:	3.3.33

3.2.5.86 Longitude—Longitude position of the vehicle.

Data Length:	4 bytes
Resolution:	10^{-7} degree/bit gain, –210 degree offset
Data Range:	–210 degrees (WEST) to + 211.108 121 degrees (EAST)
Type:	Measured
Suspect Parameter Number:	585
Reference:	3.3.33

3.2.5.87 Vehicle Identification Number—Vehicle Identification Number (VIN) as assigned by the vehicle manufacturer.

(R)

Data Length:	variable - up to 200 characters
Resolution:	ASCII
Data Range:	ASCII
Type:	Measured
Suspect Parameter Number:	237
Reference:	3.3.26

(R) NOTE—The ASCII character "*" is reserved as a delimiter.

3.2.5.88 Software Identification—Software identification of an electronic module. As an example, this parameter may be represented with ASCII characters MMDDYYaa where MM is the month, DD is the day, YY is the year, and aa is the revision number.

(R)

Data Length:	variable - up to 200 characters
Resolution:	ASCII
Data Range:	ASCII
Type:	Measured
Suspect Parameter Number:	234
Reference:	3.3.47

NOTE—The ASCII character "*" is reserved as a delimiter.

(R) *3.2.5.89 Unit Number (Power Unit)*—Owner assigned unit number for the power unit of the vehicle.

(R)

Data Length:	variable - up to 200 characters
Resolution:	ASCII
Data Range:	ASCII
Type:	Measured
Suspect Parameter Number:	233
Reference:	3.3.25

NOTE—The ASCII character "*" is reserved as a delimiter.

3.2.5.90 Make—Make of the component corresponding to the codes defined in the American Trucking Association Vehicle Maintenance Reporting Standard (ATA/VMRS). It is suggested that spaces (ASCII 32) are used to fill the remaining characters if the ATA/VMRS make code is less than five characters in length.

Data Length:	5 bytes
Resolution:	ASCII
Data Range:	ASCII
Type:	Measured
Suspect Parameter Number:	586
Reference:	3.3.25

NOTE—The ASCII character "*" is reserved as a delimiter.

3.2.5.91 Model—Model of the component.

(R)

Data Length:	Variable - up to 200 characters
Resolution:	ASCII
Data Range:	ASCII
Type:	Measured
Suspect Parameter Number:	587
Reference:	3.3.25

NOTE—The ASCII character "*" is reserved as a delimiter.

3.2.5.92 Serial Number—Serial number of the component.

Data Length:	Variable
Resolution:	ASCII
Data Range:	ASCII
Type:	Measured
Suspect Parameter Number:	588
Reference:	3.3.25

NOTE—The ASCII character "*" is reserved as a delimiter.

(R) *3.2.5.93 Seconds*—Part of a parameter used to represent time.

Data Length:	1 byte
Resolution:	0.25 s/bit gain, 0 s offset
Operating Range:	0 to 59.75 s
Type:	Measured
Suspect Parameter Number:	959
Reference:	3.3.20

(R) *3.2.5.94 Minutes*—Part of a parameter used to represent time.

Data Length:	1 byte
Resolution:	1 min/bit gain, 0 min offset
Operating Range:	0 to 59 min
Type:	Measured
Suspect Parameter Number:	960
Reference:	3.3.20

3.2.5.95 Location—To identify to which of several similar devices (such as tires or fuel tanks) the information applies.

Data Length:	1 byte
Resolution:	Bit-mapped
Data Range:	N/A
Type:	Measured
(R) Suspect Parameter Number:	927, 928, 929, 930
References:	3.3.9, 3.3.24, 3.3.34, 3.3.39

The low order 4 bits represent a position number, counting left to right when facing in the direction of normal vehicle travel (forward).

The high order 4 bits represent a position number, counting front to back on the vehicle.

The value FF_{16} indicates not available.

It is recommended that output devices add 1 to the position number (range 1 to 15, not 0 to 14) for use by drivers and service technicians.

Examples: Tire pressure for location 00_{16} would be left front tire.

Tire pressure for location 23_{16} would be right outside rear rear on a 3-axle tractor with dual axles per side (3rd axle, 4th tire).

(R) *3.2.5.96 Throttle Position*—The position of the valve used to regulate the supply of a fluid, usually air or fuel/air mixture, to an engine. 0% represents no supply and 100% is full supply.

Data Length:	1 byte
Resolution:	0.4%/bit gain, 0 % offset
Data Range:	0 to 100%
Type:	Measured
Suspect Parameter Number:	51
Reference:	

(R) *3.2.5.97 Alternator Speed*—Actual rotation speed of the alternator.

Data Length:	2 bytes
Resolution:	0.5 rpm gain, 0 rpm offset
Data Range:	0 to 32 127.5
Type:	Measured
(R) Suspect Parameter Number:	589
Reference:	3.3.49

(R) *3.2.5.98 Shift Finger Rail Position*—The current position of the shift finger in the rail direction.

Data Length:	1 byte
Resolution:	0.4%/bit gain, 0% offset
Data Range:	0 to +100%
Type:	Measured
Suspect Parameter Number:	60
Reference:	3.3.50

(R) *3.2.5.99 Shift Finger Gear Position*—The current position of the shift finger in the gear direction.

Data Length:	1 byte
Resolution:	0.4%/bit gain, 0% offset
Data Range:	0 to +100%
Type:	Measured
Suspect Parameter Number:	59
Reference:	3.3.50

(R) *3.2.5.100 Transmission Synchronizer Clutch Value*—The current modulated value for the air supply to the synchronizer clutch.

Data Length:	1 byte
Resolution:	0.4%/bit gain, 0% offset
Data Range:	0 to +100%
Type:	Measured
Suspect Parameter Number:	53
Reference:	3.3.51

(R) *3.2.5.101 Transmission Synchronizer Brake Value*—The current modulated value for the air supply to the synchronizer brake.

Data Length:	1 byte
Resolution:	0.4%/bit gain, 0% offset
Data Range:	0 to +100%
Type:	Measured
Suspect Parameter Number:	54
Reference:	3.3.51

(R) *3.2.5.102 Service Component Identification*—Identification of component needing service. See Table 13.

Data Length:	1 byte
Resolution:	n/a
Data Range:	0 to 250
Type:	Measured
Suspect Parameter Number:	911, 912, 913
Reference:	3.3.55

(R) *3.2.5.103 Service Distance*—The distance which can be travelled by the vehicle before the next service inspection is required. A negative distance is transmitted if the service inspection has been passed. The component that requires service is identified by the service component identification (see 3.2.5.102).

Data Length:	2 bytes
Resolution:	5 km/bit gain, –160 635 km offset (3.1 mi/bit gain, 99 593.7 mi offset)
Data Range:	–160 635 to +160 640 km (–99 593.7 to +99 596.8 mi)
Type:	Measured
Suspect Parameter Number:	914
Reference:	3.3.55

(R) *3.2.5.104 Service Delay/Calendar Time Based*—The time in weeks until the next vehicle service inspection is required. A negative value is transmitted if the service inspection has been passed. The component that requires service is identified by the service component identification (see 3.2.5.102).

Data Length:	1 byte
Resolution:	1 week/bit gain, –125 weeks offset
Data Range:	–125 to +125 weeks
Type:	Measured
Suspect Parameter Number:	915
Reference:	3.3.55

(R) TABLE 13—SERVICE COMPONENT IDENTIFICATION

Identification	Component
0	Service check for entire vehicle
1	Brake lining; left front axle
2	Brake lining; right front axle
3	Brake lining; left rear axle
4	Brake lining; right rear axle
5	Clutch lining
6-15	Not defined
16	Regulated general check for entire vehicle
17	Brake system special check
18	In-between check
19	Check trip recorder
20	Check exhaust gas
21	Check vehicle speed limiter
22-31	Not defined
32	Engine oil—engine #1
33	Engine oil—engine #2
34	Not defined
35	Steering oil
36	Not defined
37	Transmission oil—transmission #1
38	Transmission oil—transmission #2
39	Not defined
40	Intermediate transmission oil
41	Not defined
42	Front axle oil
43	Rear axle oil
44-47	Not defined
48	Tires
49	Engine air filter
50	Engine oil filter
51-239	Not defined
240-249	Manufacturer specific
250-253	Reserved
254	Error
255	Component identification not available

R) *3.2.5.105 Service Delay/Operational Time Based*—The time in vehicle operational time until the next vehicle service inspection is required. A negative value is transmitted if the service inspection has been passed. The component that requires service is identified by the service component identification (see 3.2.5.102).

Data Length:	2 bytes
Resolution:	1 h/bit gain, –32 127 h offset
Data Range:	–32 127 to 32 128 h
Type:	Measured
Suspect Parameter Number:	916
Reference:	3.3.55

R) *3.2.5.106 High Resolution Total Vehicle Distance*—Accumulated distance travelled by the vehicle during its operation.

Data Length:	4 bytes
Resolution:	5 m/bit gain, 0 m offset (16.4 ft/bit gain, 0 ft offset)
Data Range:	0 to +21 055 406 km (0 to 13 054 351.8 mi)
Type:	Measured
Suspect Parameter Number:	917
Reference:	3.3.54

NOTE—See 3.2.5.51 for alternate resolution.

R) *3.2.5.107 High Resolution Trip Distance*—Distance travelled during all or part of a journey.

Data Length:	4 bytes
Resolution:	5 m/bit gain, 0 m offset (16.4 ft/bit gain, 0 ft offset)
Data Range:	0 to +21 055 406 km (0 to 13 054 351.8 mi)
Type:	Measured
Suspect Parameter Number:	918
Reference:	3.3.54

NOTE—See 3.2.5.50 for alternate resolution.

R) *3.2.5.108 Transmission Requested Range*—Range requested by the operator. Characters may include P, Rx, Rx-1...R2, R1, R, Nx, Nx-1...N2, N1, N, D, D1, D2..., Dx, L, L1, L2..., Lx-1, 1, 2, 3,... If only one character is required, the second character shall be used and the first character shall be a space (ASCII 32).

Data Length:	2 bytes
Resolution:	ASCII
Data Range:	0 to 250 (each byte)
Type:	Status
Suspect Parameter Number:	162
Reference:	3.3.8

R) *3.2.5.109 Transmission Current Range*—Range currently being commanded by the transmission control system. Characters may include P, Rx, Rx-1...R2, R1, R, Nx, Nx-1...N2, N1, N, D, D1, D2..., Dx, L, L1, L2..., Lx-1, 1, 2, 3,... If only one character is required, the second character shall be used and the first character shall be a space (ASCII 32).

Data Length:	2 bytes
Resolution:	ASCII
Data Range:	0 to 250 (each byte)
Type:	Status
Suspect Parameter Number:	163
Reference:	3.3.8

R) *3.2.5.110 Hours*—Part of a parameter used to represent time.

Data Length:	1 byte
Resolution:	1 h/bit gain, 0 h offset
Operating Range:	0 to 23 h
Type:	Measured
Suspect Parameter Number:	961
Reference:	3.3.20

R) *3.2.5.111 Day*—Part of a parameter used to represent a calendar date.

Data Length:	1 byte
Resolution:	0.25 day/bit gain, 0 day offset
Operating Range:	0.25 to 31.75 day
Type:	Measured
Suspect Parameter Number:	962
Reference:	3.3.20

NOTE—A value of 0 for the date is null. The values 1, 2, 3, and 4 are used to identify the first day of the month; 5, 6, 7, and 8 identify the second day of the month; etc.

R) *3.2.5.112 Month*—Part of a parameter used to represent a calendar date.

Data Length:	1 byte
Resolution:	1 month/bit gain, 0 month offset
Operating Range:	1 to 12 month
Type:	Measured
Suspect Parameter Number:	963
Reference:	3.3.20

NOTE—A value of 0 for the month is null. The value 1 identifies January; 2 identifies February; etc.

(R) *3.2.5.113 Year*—Part of a parameter used to represent a calendar date.

Data Length:	1 byte
Resolution:	1 year/bit gain, +1985 year offset
Operating Range:	1985 to 2235 year
Type:	Measured
Suspect Parameter Number:	964
Reference:	3.3.20

NOTE—A value of 0 for the year identifies the year 1985; a value of 1 identifies 1986; etc.

(R) *3.2.5.114 Number of Software Identification Fields*—Number of software identification designators represented in the software identification parameter group.

Data Length:	1 byte
Resolution:	1 software identifier/bit, 0 offset
Operating Range:	0 to 125
Type:	Measured
Suspect Parameter Number:	965
Reference:	3.3.47

(R) *3.2.5.115 Rated Engine Power*—Net brake power that the engine will deliver continuously, specified for a given application at a rated speed.

Data Length:	1 byte
Resolution:	0.5 kW/bit, 0 kW offset (0.67 hp/bit, 0 hp offset)
Range:	0 to 32 127.5 kW (0 to 43 083.7 hp)
Type:	Measured
Suspect Parameter Number:	166
Reference:	3.3.57

(R) *3.2.5.116 Rated Engine Speed*—The maximum governed rotational velocity of the engine crankshaft under full load conditions. Note that the engine speed at point 2 (3.2.1.27) is equal to rated engine speed only in the case when the engine has not been derated. See also 3.2.4.1.

Data Length:	1 byte
Resolution:	0.125 rpm/bit, 0 offset
Range:	0 to 8031.875 rpm
Type:	Measured
Suspect Parameter Number:	189
Reference:	3.3.57

3.2.6 INFORMATIONAL STATUS PARAMETERS

3.2.6.1 Two Speed Axle Switch—Switch signal which indicates the current axle range.

00 -	Low speed range
01 -	High speed range
Type:	Measured
Suspect Parameter Number:	69
Reference:	3.3.31

3.2.6.2 Idle Shutdown Timer State—Status signal which indicates the current mode of operation of the idle shutdown timer system.

00 -	Inactive
01 -	Active
Type:	Status
Suspect Parameter Number:	590
Reference:	3.3.18

3.2.6.3 Idle Shutdown Timer Function—Parameter which indicates the configuration of the idle shutdown timer system.

00 -	Disabled in calibration
01 -	Enabled in calibration
Type:	Measured
Suspect Parameter Number:	591
Reference:	3.3.18

3.2.6.4 Idle Shutdown Timer Override—Status signal which indicates the status of the override feature of the idle shutdown timer system.

00 -	Inactive
01 -	Active
Type:	Status
Suspect Parameter Number:	592
Reference:	3.3.18

3.2.6.5 Engine Has Shutdown By Idle Timer—Status signal which identifies whether or not the engine has been shutdown by the idle shutdown timer system.

00 -	No
01 -	Yes
Type:	Status
Suspect Parameter Number:	593
Reference:	3.3.18

3.2.6.6 Driver Alert Mode—Status signal which indicates the status of the driver alert mode of the idle shutdown timer system. While the driver alert mode is active, the idle shutdown timer may be overridden.

00 -	Inactive
01 -	Active
Type:	Status
Suspect Parameter Number:	594
Reference:	3.3.18

3.2.6.7 Water In Fuel Indicator—Signal which indicates the presence of water in the fuel.

00 -	No
01 -	Yes
Type:	Measured
Suspect Parameter Number:	97
Reference:	3.3.45

3.2.6.8 Parking Brake Switch—Switch signal which indicates when the parking brake is set. (See also 3.2.6.13.)

00 -	Parking brake not set
01 -	Parking brake set
Type:	Measured
Suspect Parameter Number:	70
Reference:	3.3.31

3.2.6.9 Cruise Control Active—Cruise control is switched on. It is not ensured that the engine is controlled by cruise control, as in the case of a large driver's demand the engine is controlled by the driver while cruise control is active (maximum selection of cruise control and driver's demand). The cruise control is set to 0 if a switch off condition occurs.

00 -	Cruise control switched off
01 -	Cruise control switched on
Type:	Measured
Suspect Parameter Number:	595
Reference:	3.3.31

3.2.6.10 Cruise Control Enable Switch—Switch signal which indicates that it is possible to manage the cruise control function.

00 -	Cruise control disabled
01 -	Cruise control enabled
Type:	Measured
Suspect Parameter Number:	596
Reference:	3.3.31

3.2.6.11 Brake Switch—Switch signal which indicates that the brake pedal is being pressed. It is necessary for a safe drivetrain behavior that the brake switch is set before the brakes are active (cruise control function).

00 -	Brake pedal released
01 -	Brake pedal depressed
Type:	Measured
Suspect Parameter Number:	597
Reference:	3.3.31

3.2.6.12 Clutch Switch—Switch signal which indicates that the clutch pedal is being pressed. It is necessary for a safe drivetrain behavior that the clutch switch is set before the clutch is opened (cruise control function).

00 -	Clutch pedal released
01 -	Clutch pedal depressed
Type:	Measured
Suspect Parameter Number:	598
Reference:	3.3.31

3.2.6.13 Parking Brake Actuator—Signal which indicates the current state of the actuator(s) that control the parking brake (see also 3.2.6.8).

00 -	Parking brake actuator inactive
01 -	Parking brake actuator active
Type:	Measured
Suspect Parameter Number:	619
Reference:	3.3.40

3.2.6.14 Cruise Control Set Switch—Switch signal of the cruise control activator which indicates that the activator is in the position "set."

00 -	Cruise control activator not in the position "set"
01 -	Cruise control activator in position "set"
Type:	Measured
Suspect Parameter Number:	599
Reference:	3.3.31

3.2.6.15 Cruise Control Coast (Decelerate) Switch—Switch signal of the cruise control activator which indicates that the activator is in the position "coast (decelerate)."

00 -	Cruise control activator not in the position "coast"
01 -	Cruise control activator in position "coast"
Type:	Measured
Suspect Parameter Number:	600
Reference:	3.3.31

3.2.6.16 Cruise Control Resume Switch—Switch signal of the cruise control activator which indicates that the activator is in the position "resume."

00 -	Cruise control activator not in the position "resume"
01 -	Cruise control activator in position "resume"
Type:	Measured
Suspect Parameter Number:	601
Reference:	3.3.31

3.2.6.17 Cruise Control Accelerate Switch—Switch signal of the cruise control activator which indicates that the activator is in the position "accelerate."

00 -	Cruise control activator not in the position "accelerate"
01 -	Cruise control activator in position "accelerate"
Type:	Measured
Suspect Parameter Number:	602
Reference:	3.3.31

3.2.6.18 Auxiliary Discrete I/O Channel Status—Identifies the current status of auxiliary input/output functions that are configured uniquely per application.

00 -	Auxiliary channel off
01 -	Auxiliary channel on
Type:	Dependent on application
(R) Suspect Parameter Number:	701-716
Reference:	3.3.48

(R) *3.2.6.19 Shift Finger Neutral Indicator*—Indicates the status of the shift finger in the neutral position.

00 -	off
01 -	on
Type:	Status
Suspect Parameter Number:	780
Reference:	3.3.50

(R) *3.2.6.20 Shift Finger Engagement Indicator*—Identifies the status of the shift finger in the engagement position.

00 -	off
01 -	on
Type:	Status
Suspect Parameter Number:	781
Reference:	3.3.50

(R) *3.2.6.21 Shift Finger Center Rail Indicator*—Identifies the status of the shift finger in the center rail position.

00 -	off
01 -	on
Type:	Status
Suspect Paramter Number:	782
Reference:	3.3.50

(R) *3.2.6.22 Gear Actuator #1*—Identifies the status of the actuator that moves the shift finger identified as gear actuator #1.

00 -	off
01 -	on
Type:	Status
Suspect Parameter Number:	773
Reference:	3.3.50

(R) *3.2.6.23 Gear Actuator #2*—Identifies the status of the actuator that moves the shift finger identified as gear actuator #2.

00 -	off
01 -	on
Type:	Status
Suspect Parameter Number:	784
Reference:	3.3.50

(R) *3.2.6.24 Rail Actuator #1*—Identifies the status of the actuator that moves the shift finger identified as rail actuator #1.

00 -	off
01 -	on
Type:	Status
Suspect Parameter Number:	772
Reference:	3.3.50

(R) *3.2.6.25 Rail Actuator #2*—Identifies the status of the actuator that moves the shift finger identified as rail actuator #2.

00 -	off
01 -	on
Type:	Status
Suspect Parameter Number:	783
Reference:	3.3.50

(R) *3.2.6.26 Splitter Indirect Actuator*—Identifies the status of the splitter indirect actuator in the auxiliary unit.

00 -	off
01 -	on
Type:	Status
Suspect Parameter Number:	771
Reference:	3.3.50

(R) *3.2.6.27 Splitter Direct Actuator*—Identifies the status of the splitter direct actuator in the auxiliary unit.

00 -	off
01 -	on
Type:	Status
Suspect Parameter Number:	770
Reference:	3.3.50

(R) *3.2.6.28 Range Low Actuator*—Identifies the status of the range low actuator in the auxiliary unit.

00 -	off
01 -	on
Type:	Status
Suspect Parameter Number:	769
Reference:	3.3.50

(R) *3.2.6.29 Range High Actuator*—Identifies the status of the range high actuator in the auxiliary unit.

00 -	off
01 -	on
Type:	Status
Suspect Parameter Number:	768
Reference:	3.3.50

(R) *3.2.6.30 Inertia Brake Actuator*—Identifies the status of the actuator that controls the inertia brake.

00 -	off
01 -	on
Type:	Status
Suspect Parameter Number:	787
Reference:	3.3.50

(R) *3.2.6.31 Defuel Actuator*—Identifies the status of the actuator that controls the engine defuel mechanism.

00 -	off
01 -	on
Type:	Status
Suspect Parameter Number:	786
Reference:	3.3.50

(R) *3.2.6.32 Lockup Clutch Actuator*—Identifies the status of the actuator that controls the lockup clutch.

00 -	off
01 -	on
Type:	Status
Suspect Parameter Number:	740
Reference:	3.3.50

(R) *3.2.6.33 Clutch Actuator*—Identifies the status of the actuator that controls the clutch.

00 -	off
01 -	on
Type:	Status
Suspect Parameter Number:	788
Reference:	3.3.50

(R) *3.2.6.34 Transmission Low Range Sense Switch*—Identifies the status of the switch that represents low range.

00 -	off
01 -	on
Type:	Status
Suspect Parameter Number:	779
Reference:	3.3.52

(R) *3.2.6.35 Transmission High Range Sense Switch*—Identifies the status of the switch that represents high range.

00 -	off
01 -	on
Type:	Status
Suspect Parameter Number:	778
Reference:	3.3.52

(R) *3.2.6.36 Transmission Forward Direction Switch*—Identifies the status of the switch that indicates forward direction.

00 -	off
01 -	on
Type:	Status
Suspect Parameter Number:	903
Reference:	3.3.52

(R) *3.2.6.37 Transmission Neutral Direction Switch*—Identifies the status of the switch that indicates neutral.

00 -	off
01 -	on
Type:	Status
Suspect Parameter Number:	604
Reference:	3.3.52

(R) *3.2.6.38 Transmission Reverse Direction Switch*—Identifies the status of the switch that indicates reverse direction.

00 -	off
01 -	on
Type:	Status
Suspect Parameter Number:	767
Reference:	3.3.52

(R) *3.2.6.39 Transmission Output Retarder*—Identifies the status of the transmission output retarder.

00 -	off
01 -	on
Type:	Status
Suspect Parameter Number:	748
Reference:	3.3.53

(R) *3.2.6.40 Engine Test Mode Switch*—Switch signal which indicates the position of the engine test mode switch.

00 -	off
01 -	on
Type:	Measured
Suspect Parameter Number:	966
Reference:	3.3.31

(R) *3.2.6.41 Idle Decrement Switch*—Switch signal which indicates the position of the idle decrement switch.

00 -	off
01 -	on
Type:	Measured
Suspect Parameter Number:	967
Reference:	3.3.31

(R) *3.2.6.42 Idle Increment Switch*—Switch signal which indicates the position of the idle increment switch.

00 -	off
01 -	on
Type:	Measured
Suspect Parameter Number:	968
Reference:	3.3.31

3.3 Parameter Group Definitions—This section defines the parameter groups for use on the J1939 network. All undefined bits are to be transmitted 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.

Messages that are requesting control over the receiving device (TSC1, TC1) are transmitted at high rate only during the time when the control is active. It is expected that the transmitting device indicate to the receiving device that it no longer requests control by sending one broadcast with the override control modes set to 00. In the absence of continued broadcasts from a requesting module, the receiving device shall default to its normal mode after two update periods.

The size of the CAN data field is 8 bytes. Parameter groups that are 0-8 data bytes in length use the services of the Data Link layer (Refer to SAE J1939/21). Parameter groups that exceed 8 data bytes or parameter group definitions that are variable in length and may exceed 8 data bytes shall utilize the services of the Transport Protocol. (Refer to Section 3.10 of SAE J1939/21.)

3.3.1 TORQUE/SPEED CONTROL #1: TSC1

Transmission repetition rate:	when active; 10 ms to the engine - 50 ms to the retarder
Data length:	8 bytes
Data page:	0
PDU format:	0
PDU specific:	Destination address
Default priority:	3
Parameter group number:	0 (000000_{16})

Byte:			Bit:			
	1	Control bits		8-7	Not defined	
				6,5	Override control mode priority	3.2.3.3
				4,3	Requested speed control conditions	3.2.3.2
				2,1	Override control modes	3.2.3.1
	2,3	Requested speed/Speed limit				3.2.1.19
	4	Requested torque/Torque limit				3.2.1.15
	5-8	Not defined				

NOTE—Retarder may be disabled by commanding a torque limit of 0%. For example, this permits the brake switch to enable the retarder, up to an amount selected by another device or the operator. Note that the brake switch can be treated as an operator input (mode 0001_2) or as a brake system input (mode 1010_2) relative to the active torque mode.

3.3.2 TRANSMISSION CONTROL #1: TC1

Transmission repetition rate:	when active; 50 ms to the transmission and axles
Data length:	8 bytes
Data page:	0
PDU format:	1
PDU specific:	Destination address
Default priority:	3
(R) Parameter group number:	256 (000100_{16})

Byte:						
	1	Control bits	Bit:	8-7	Not defined	
				6,5	Disengage driveline request	3.2.3.6
				4,3	Torque converter lockup disable request	3.2.3.5
				2,1	Gear shift inhibit request	3.2.3.4
	2	Requested percent clutch slip				3.2.1.21
	3	Requested gear				3.2.1.24
	4	Disengage diff. lock 1	Bit:	8,7	Rear axle 2	3.2.3.7
				6,5	Rear axle 1	3.2.3.7
				4,3	Front axle 2	3.2.3.7
				2,1	Front axle 1	3.2.3.7
	5	Disengage diff. lock 2	Bit:	8-7	Not defined	
				6,5	Central rear	3.2.3.7
				4,3	Central front	3.2.3.7
				2,1	Central	3.2.3.7
	6-8	Not defined				

3.3.3 ELECTRONIC RETARDER CONTROLLER #1: ERC1

Transmission repetition rate:	100 ms
Data length:	8 bytes
Data page:	0
PDU format:	240
PDU specific:	0
Default priority:	6
Parameter group number:	61,440 ($00F000_{16}$)

NOTE—This message can also be used by the engine exhaust brake. The distinction of engine brake and retarder is done by the source address.

Byte:						
	1	Status_ERC1	Bit:	8,7	Retarder enable - shift assist switch	3.2.2.12
				6,5	Retarder enable - brake assist switch	3.2.2.11
				4-1	Engine/retarder torque mode	3.2.2.1
	2	Actual retarder - percent torque				3.2.1.17
	3-8	Not defined				

3.3.4 ELECTRONIC BRAKE CONTROLLER #1: EBC1—Used for brake control information.

Transmission repetition rate:	100 ms
Data length:	8 bytes
Data page:	0
PDU format:	240
PDU specific:	1
Default priority:	6
Parameter group number:	61,441 ($00F001_{16}$)

Byte:			Bit:			
	1	Status_EBC1		8-7	Not defined	
				6,5	ABS active	3.2.2.9
				4,3	ASR brake control active	3.2.2.8
				2,1	ASR engine control active	3.2.2.7
	2	Brake pedal position				3.2.1.18
	3	Status_EBC2	Bit:	8-7	Not defined	
				6,5	ASR "hill holder" switch	3.2.2.17
				4,3	ASR offroad switch	3.2.2.16
				2,1	ABS offroad switch	3.2.2.15
	4-8	Not defined				

3.3.5 ELECTRONIC TRANSMISSION CONTROLLER #1: ETC1

Transmission repetition rate:	10 ms
Data length:	8 bytes
Data page:	0
PDU format:	240
PDU specific:	2
Default priority:	3
Parameter group number:	61,442 ($00F002_{16}$)

Byte:			Bit:			
	1	Status_ETC1		8-7	Not defined	
				6,5	Shift in process	3.2.2.14
				4,3	Torque converter lockup engaged	3.2.2.13
				2,1	Driveline engaged	3.2.2.6
	2,3	Output shaft speed				3.2.1.14
	4	Percent clutch slip				3.2.1.20
	5	Command_ETC1	Bit:	8-5	Not defined	
				4,3	Progressive shift disable	3.2.3.11
				2,1	Momentary engine overspeed enable	3.2.3.12
(R)	6,7	Input shaft speed				3.2.5.55
	8	Not defined				

3.3.6 ELECTRONIC ENGINE CONTROLLER #2: EEC2

Transmission repetition rate: 50 ms
Data length: 8 bytes
Data page: 0
PDU format: 240
PDU specific: 3
Default priority: 3
Parameter group number: 61,443 ($00F003_{16}$)

Byte:			Bit:		
1	Status_EEC2		8-5	Not defined	
			4-3	AP kickdown switch	3.2.2.5
			2-1	AP low idle switch	3.2.2.4
2	Accelerator pedal (AP) position				3.2.1.8
3	Percent load at current speed				3.2.1.7
4-8	Not defined				

3.3.7 ELECTRONIC ENGINE CONTROLLER #1: EEC1

Transmission repetition rate: engine speed dependent (see 3.1.6.2)
Data length: 8 bytes
Data page: 0
PDU format: 240
PDU specific: 4
Default priority: 3
Parameter group number: 61,444 ($00F004_{16}$)

Byte:			Bit:		
1	Status_EEC1		8-5	Not defined	
			4-1	Engine/retarder torque mode	3.2.2.1
2	Driver's demand engine - percent torque				3.2.1.4
3	Actual engine - percent torque				3.2.1.5
4,5	Engine speed				3.2.1.9
6-8	Not defined				

3.3.8 ELECTRONIC TRANSMISSION CONTROLLER #2: ETC2

Transmission repetition rate: 100 ms
Data length: 8 bytes
Data page: 0
PDU format: 240
PDU specific: 5
Default priority: 6
Parameter group number: 61,445 ($00F005_{16}$)

Byte:			
1	Selected gear		3.2.1.23
2,3	Actual gear ratio		3.2.1.25
4	Current gear		3.2.1.22
(R) 5,6	Transmission requested range		3.2.5.108
(R) 7,8	Transmission current range		3.2.5.109

3.3.9 ELECTRONIC AXLE CONTROLLER #1: EAC1

Transmission repetition rate: 500 ms
Data length: 8 bytes
Data page: 0
PDU format: 240
PDU specific: 6
Default priority: 6
Parameter group number: 61,446 ($00F006_{16}$)

Byte:					
	1	Location			3.2.5.95
	2	Differential lock status 1 Bit:	8,7	Rear axle 2	3.2.2.10
			6,5	Rear axle 1	3.2.2.10
			4,3	Front axle 2	3.2.2.10
			2,1	Front axle 1	3.2.2.10
	3	Differential lock status 2 Bit:	8-7	Not defined	
			6,5	Central rear	3.2.2.10
			4,3	Central front	3.2.2.10
			2,1	Central	3.2.2.10
	4-8	Not defined			

3.3.10 IDLE OPERATION

Transmission repetition rate: on request
Data length: 8 bytes
Data page: 0
PDU format: 254
PDU specific: 220
Default priority: 6
Parameter group number: 65,244 ($00FEDC_{16}$)

Byte:			
	1-4	Total idle fuel used	3.2.5.65
	5-8	Total idle hours	3.2.5.59

3.3.11 TURBOCHARGER

Transmission repetition rate: 1 sec
Data length: 8 bytes
Data page: 0
PDU format: 254
PDU specific: 221
Default priority: 6
Parameter group number: 65,245 ($00FEDD_{16}$)

Byte:			
	1	Turbo oil pressure	3.2.5.29
	2,3	Turbo speed	3.2.5.53
	4-8	Not defined	

3.3.12 AIR START PRESSURE

Transmission repetition rate:	on request
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	222
Default priority:	6
Parameter group number:	65,246 ($00FEDE_{16}$)

Byte:	1	Air start pressure	3.2.5.26
	2-8	Not defined	

3.3.13 ELECTRONIC ENGINE CONTROLLER #3: EEC3

Transmission repetition rate:	250 ms
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	223
Default priority:	6
Parameter group number:	65,247 ($00FEDF_{16}$)

Byte:	1	Nominal friction - percent torque	3.2.1.6
	2,3	Engine's desired operating speed	3.2.1.10
	4	Engine's operating speed asymmetry adjustment	3.2.1.16
	5-8	Not defined	

3.3.14 VEHICLE DISTANCE

Transmission repetition rate:	on request
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	224
Default priority:	6
Parameter group number:	65,248 ($00FEE0_{16}$)

Byte:	1-4	Trip distance	3.2.5.50
	5-8	Total vehicle distance	3.2.5.51

3.3.15 RETARDER CONFIGURATION

(R)

Transmission repetition rate:	on request
Data length:	19 bytes
Data page:	0
PDU format:	254
PDU specific:	225
Default priority:	6
Parameter group number:	65,249 ($00FEE1_{16}$)

Byte:					
	1	Type and location	Bit: 8-5	Retarder location	3.2.2.3
			4-1	Retarder type	3.2.2.2
	2	Retarder control method			3.2.1.50
	3,4	Retarder speed at idle, point 1			3.2.1.41
	5	Percent torque at idle, point 1			3.2.1.45
	6,7	Maximum retarder speed, point 2			3.2.1.43
	8	Percent torque at maximum speed, point 2			3.2.1.46
	9,10	Retarder speed at point 3			3.2.1.44
	11	Percent torque at point 3			3.2.1.47
	12,13	Retarder speed at point 4			3.2.1.44
	14	Percent torque at point 4			3.2.1.47
	15,16	Retarder speed at peak torque, point 5			3.2.1.42
	17,18	Reference retarder torque			3.2.1.49
	19	Percent torque at peak torque, point 5			3.2.1.48

3.3.16 TRANSMISSION CONFIGURATION

Transmission repetition rate:	On request
Data length:	Depends on total number of forward and reverse gear ratios
Data page:	0
PDU format:	254
PDU specific:	226
Default priority:	6
Parameter group number:	65,250 ($00FEE2_{16}$)

Byte:			
	1	Number of reverse gear ratios	
	2	Number of forward gear ratios	
	3,4	Highest reverse gear ratio	3.2.4.2
	.		
	.		
	a,b	Lowest reverse gear ratio	
	c,d	Lowest forward gear ratio	
	.		
	.		
	e,f	Highest forward gear ratio	

3.3.17 ENGINE CONFIGURATION—(reference 3.2.4.1)

Transmission repetition rate:	On change of torque/speed points of more than 10% since last transmission, or every 5 s
Data length:	28 bytes
Data page:	0
PDU format:	254
PDU specific:	227
Default priority:	6
Parameter group number:	65,251 ($00FEE3_{16}$)

Byte:			
	1,2	Engine speed at idle, point 1	3.2.1.26
	3	Percent torque at idle, point 1	3.2.1.36
	4,5	Engine speed at point 2	3.2.1.27
	6	Percent torque at point 2	3.2.1.37
	7,8	Engine speed at point 3	3.2.1.28
	9	Percent torque at point 3	3.2.1.38
	10,11	Engine speed at point 4	3.2.1.28
	12	Percent torque at point 4	3.2.1.38
	13,14	Engine speed at point 5	3.2.1.28
	15	Percent torque at point 5	3.2.1.38
	16,17	Engine speed at high idle, point 6	3.2.1.29
	18,19	Gain (KP) of endspeed governor	3.2.1.40
	20,21	Reference engine torque	3.2.1.39
	22,23	Maximum momentary engine override speed, point 7	3.2.1.30
	24	Maximum momentary engine override time limit	3.2.1.31
	25	Requested speed control range lower limit	3.2.1.32
	26	Requested speed control range upper limit	3.2.1.33
	27	Requested torque control range lower limit	3.2.1.34
	28	Requested torque control range upper limit	3.2.1.35

3.3.18 IDLE SHUTDOWN

Transmission repetition rate:	1 s
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	228
Default priority:	6
Parameter group number:	65,252 ($00FEE4_{16}$)

Byte:						
	1	Idle shutdown_1	Bit	8,7	Idle shutdown timer state	3.2.6.2
				6,5	Idle shutdown timer override	3.2.6.4
				4,3	Driver alert mode	3.2.6.6
				2,1	Engine has shutdown by system	3.2.6.5
	2	Idle shutdown_2	Bit	8,7	Idle shutdown timer function	3.2.6.3
				6-1	Not defined	
	3-8	Not defined				

3.3.19 ENGINE HOURS, REVOLUTIONS

Transmission repetition rate:	on request
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	229
Default priority:	6
Parameter group number:	65,253 ($00FEE5_{16}$)

Byte:	1-4	Total engine hours	3.2.5.61
	5-8	Total engine revolutions	3.2.5.58

3.3.20 TIME/DATE

Transmission repetition rate:	on request
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	230
Default priority:	6
Parameter group number:	65,254 ($00FEE6_{16}$)

(R)	Byte:	1	Seconds	3.2.5.93
(R)		2	Minutes	3.2.5.94
(R)		3	Hours	3.2.5.110
(R)		4	Month	3.2.5.112
(R)		5	Day	3.2.5.111
(R)		6	Year	3.2.5.113
		7,8	Not defined	

3.3.21 VEHICLE HOURS

Transmission repetition rate:	on request
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	231
Default priority:	6
Parameter group number:	65,255 ($00FEE7_{16}$)

Byte:	1-4	Total vehicle hours	3.2.5.60
	5-8	Total power takeoff hours	3.2.5.62

3.3.22 VEHICLE DIRECTION/SPEED

Transmission repetition rate: on request
Data length: 8 bytes
Data page: 0
PDU format: 254
PDU specific: 232
Default priority: 6
Parameter group number: 65,256 ($00FEE8_{16}$)

Byte:			
	1,2	Compass bearing	3.2.5.83
	3,4	Navigation-based vehicle speed	3.2.1.13
	5,6	Pitch	3.2.5.84
	7,8	Altitude	3.2.5.52

3.3.23 FUEL CONSUMPTION

Transmission repetition rate: on request
Data length: 8 bytes
Data page: 0
PDU format: 254
PDU specific: 233
Default priority: 6
Parameter group number: 65,257 ($00FEE9_{16}$)

Byte:			
	1-4	Trip fuel	3.2.5.64
	5-8	Total fuel used	3.2.5.66

3.3.24 VEHICLE WEIGHT

Transmission repetition rate: on request
Data length: 8 bytes
Data page: 0
PDU format: 254
PDU specific: 234
Default priority: 6
Parameter group number: 65,258 ($00FEEA_{16}$)

Byte:			
	1	Axle location	3.2.5.95
	2,3	Axle weight	3.2.5.80
	4,5	Trailer weight	3.2.5.81
	6,7	Cargo weight	3.2.5.82
	8	Not defined	

3.3.25 COMPONENT IDENTIFICATION

Transmission repetition rate:	on request
Data length:	Variable
Data page:	0
PDU format:	254
PDU specific:	235
Default priority:	6
Parameter group number:	65,259 ($00FEEB_{16}$)

Field:			
	a	Make	3.2.5.90
		Delimiter (ASCII "*")	
	b	Model	3.2.5.91
		Delimiter (ASCII "*")	
	c	Serial number	3.2.5.92
		Delimiter (ASCII "*")	
	d	Unit number (Power unit)	3.2.5.89
R)		Delimiter (ASCII "*")	

NOTE—The make, model, serial number and unit number fields in this message are optional and separated by an ASCII "*". It is not necessary to include all fields; however, the delimiter ("*") is always required.

3.3.26 VEHICLE IDENTIFICATION

Transmission repetition rate:	on request
R) Data length:	Variable
Data page:	0
PDU format:	254
PDU specific:	236
Default priority:	6
Parameter group number:	65,260 ($00FEEC_{16}$)

Byte:			
(R)	1-n	Vehicle Identification Number	3.2.5.87
(R)		Delimiter (ASCII "*")	

3.3.27 CRUISE CONTROL/VEHICLE SPEED SETUP

Transmission repetition rate:	on request
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	237
Default priority:	6
Parameter group number:	65,261 ($00FEED_{16}$)

Byte:			
	1	Maximum vehicle speed limit	3.2.5.46
	2	Cruise control high set limit speed	3.2.5.48
	3	Cruise control low set limit speed	3.2.5.49
	4-8	Not defined	

3.3.28 ENGINE TEMPERATURE

Transmission repetition rate: 1 s
Data length: 8 bytes
Data page: 0
PDU format: 254
PDU specific: 238
Default priority: 6
Parameter group number: 65,262 ($00FEEE_{16}$)

	Byte:			
(R)		1	Engine coolant temperature	3.2.5.5
		2	Fuel temperature	3.2.5.14
		3,4	Engine oil temperature	3.2.5.15
		5,6	Turbo oil temperature	3.2.5.16
		7	Engine intercooler temperature	3.2.5.6
(R)		8	Not defined	

3.3.29 ENGINE FLUID LEVEL/PRESSURE

Transmission repetition rate: 0.5 s
Data length: 8 bytes
Data page: 0
PDU format: 254
PDU specific: 239
Default priority: 6
Parameter group number: 65,263 ($00FEEF_{16}$)

	Byte:			
		1	Fuel delivery pressure	3.2.5.27
(R)		2	Not defined	
		3	Engine oil level	3.2.5.72
		4	Engine oil pressure	3.2.5.28
		5,6	Crankcase pressure	3.2.5.40
		7	Coolant pressure	3.2.5.38
		8	Coolant level	3.2.5.73

3.3.30 POWER TAKEOFF INFORMATION

Transmission repetition rate: 100 ms
Data length: 8 bytes
Data page: 0
PDU format: 254
PDU specific: 240
Default priority: 6
Parameter group number: 65,264 ($00FEF0_{16}$)

Byte:			
	1	Power takeoff oil temperature	3.2.5.3
	2,3	Power takeoff speed	3.2.5.56
	4,5	Power takeoff set speed	3.2.5.57
	6-8	Not defined	

3.3.31 CRUISE CONTROL/VEHICLE SPEED

Transmission repetition rate: 100 ms
Data length: 8 bytes
Data page: 0
PDU format: 254
PDU specific: 241
Default priority: 6
Parameter group number: 65,265 ($00FEF1_{16}$)

Byte:						
	1	Measured_SW1	Bit:	8-5	Not defined	
				4,3	Parking brake switch	3.2.6.8
				2,1	Two speed axle switch	3.2.6.1
	2,3	Wheel-based vehicle speed				3.2.1.12
	4	Measured_CC_SW1	Bit:	8,7	Clutch switch	3.2.6.12
				6,5	Brake switch	3.2.6.11
				4,3	Cruise control enable switch	3.2.6.10
				2,1	Cruise control active	3.2.6.9
	5	Measured_CC_SW2	Bit:	8,7	Cruise control accelerate switch	3.2.6.17
				6,5	Cruise control resume switch	3.2.6.16
				4,3	Cruise control coast switch	3.2.6.15
				2,1	Cruise control set switch	3.2.6.14
	6	Cruise control set speed				3.2.5.47
	7	State_CC	Bit:	8-6	Cruise control state	3.2.2.18
				5-1	Not defined	
(R)	8	Measured_Idle_SW1	Bit:	8,7	Not defined	
(R)				6,5	Engine test mode switch	3.2.6.40
(R)				4,3	Idle decrement switch	3.2.6.41
(R)				2,1	Idle increment switch	3.2.6.42

3.3.32 FUEL ECONOMY

Transmission repetition rate: 100 ms
Data length: 8 bytes
Data page: 0
PDU format: 254
PDU specific: 242
Default priority: 6
Parameter group number: 65,266 ($00FEF2_{16}$)

Byte:			
	1,2	Fuel rate	3.2.5.63
	3,4	Instantaneous fuel economy	3.2.5.67
	5,6	Average fuel economy	3.2.5.68
	7,8	Not defined	

3.3.33 VEHICLE POSITION

Transmission repetition rate:	5 s
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	243
Default priority:	6
Parameter group number:	65,267 ($00FEF3_{16}$)

Byte:			
	1-4	Latitude	3.2.5.85
	5-8	Longitude	3.2.5.86

3.3.34 TIRE CONDITION

Transmission repetition rate:	10 s
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	244
Default priority:	6
Parameter group number:	65,268 ($00FEF4_{16}$)

Byte:			
	1	Location	3.2.5.95
	2	Tire pressure	3.2.5.34
	3,4	Tire temperature	3.2.5.18
	5-8	Not defined	

3.3.35 AMBIENT CONDITIONS

Transmission repetition rate:	1 s
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	245
Default priority:	6
Parameter group number:	65,269 ($00FEF5_{16}$)

Byte:			
	1	Barometric pressure	3.2.5.43
	2,3	Cab interior temperature	3.2.5.11
	4,5	Ambient air temperature	3.2.5.12
	6	Air inlet temperature	3.2.5.13
	7,8	Road surface temperature	3.2.5.9

3.3.36 INLET/EXHAUST CONDITIONS

Transmission repetition rate:	0.5 s
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	246
Default priority:	6
Parameter group number:	65,270 ($00FEF6_{16}$)

Byte:			
	1	Particulate trap inlet pressure	3.2.5.41
	2	Boost pressure	3.2.5.36
	3	Intake manifold temperature	3.2.5.4
	4	Air inlet pressure	3.2.5.37
	5	Air filter differential pressure	3.2.5.45
	6,7	Exhaust gas temperature	3.2.5.8
	8	Coolant filter differential pressure	3.2.5.44

3.3.37 VEHICLE ELECTRICAL POWER

Transmission repetition rate:	1 s
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	247
Default priority:	6
Parameter group number:	65,271 ($00FEF7_{16}$)

Byte:			
	1	Net battery current	3.2.5.78
	2	Alternator current	3.2.5.79
	3,4	Alternator potential (voltage)	3.2.5.76
	5,6	Electrical potential (voltage)	3.2.5.77
	7,8	Battery potential (voltage), switched	3.2.5.75

3.3.38 TRANSMISSION FLUIDS

Transmission repetition rate:	1 s
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	248
Default priority:	6
Parameter group number:	65,272 ($00FEF8_{16}$)

Byte:			
	1	Clutch pressure	3.2.5.23
	2	Transmission oil level	3.2.5.74
	3	Transmission filter differential pressure	3.2.5.39
	4	Transmission oil pressure	3.2.5.24
	5,6	Transmission oil temperature	3.2.5.17
	7,8	Not defined	

3.3.39 AXLE INFORMATION

Transmission repetition rate:	1 s
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	249
Default priority:	6
Parameter group number:	65,273 ($00FEF9_{16}$)

Byte:	1	Steering axle temperature	3.2.5.1
	2	Drive axle location	3.2.5.95
	3	Drive axle lift air pressure	3.2.5.25
	4	Drive axle temperature	3.2.5.2
	5-8	Not defined	

3.3.40 BRAKES

Transmission repetition rate:	1 s
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	250
Default priority:	6
Parameter group number:	65,274 ($00FEFA_{16}$)

Byte:	1	Brake application pressure			3.2.5.30
	2	Brake primary pressure			3.2.5.31
	3	Brake secondary pressure			3.2.5.32
	4	Brake_status	Bit:	8-3 Not defined	
				2,1 Parking brake actuator	3.2.6.13
	5-8	Not defined			

3.3.41 RETARDER FLUIDS

Transmission repetition rate:	1 s
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	251
Default priority:	6
Parameter group number:	65,275 ($00FEFB_{16}$)

Byte:	1	Hydraulic retarder pressure	3.2.5.33
	2	Hydraulic retarder oil temperature	3.2.5.7
	3-8	Not defined	

3.3.42 DASH DISPLAY

Transmission repetition rate: 1 s
Data length: 8 bytes
Data page: 0
PDU format: 254
PDU specific: 252
Default priority: 6
Parameter group number: 65,276 ($00FEFC_{16}$)

Byte:			
	1	Washer fluid level	3.2.5.70
	2	Fuel level	3.2.5.71
	3	Fuel filter differential pressure	3.2.5.35
	4	Engine oil filter differential pressure	3.2.5.42
	5,6	Cargo ambient temperature	3.2.5.10
	7-8	Not defined	

3.3.43 ALTERNATE FUEL #1

Transmission repetition rate: 500 ms
Data length: 8 bytes
Data page: 0
PDU format: 254
PDU specific: 253
Default priority: 6
Parameter group number: 65,277 ($00FEFD_{16}$)

Byte:			
	1	Blower bypass valve position	3.2.5.69
	2,3	Gas supply pressure	3.2.5.19
	2-8	Not defined	

3.3.44 AUXILIARY WATER PUMP PRESSURE

Transmission repetition rate: 1 s
Data length: 8 bytes
Data page: 0
PDU format: 254
PDU specific: 254
Default priority: 6
Parameter group number: 65,278 ($00FEFE_{16}$)

Byte:			
	1	Auxiliary pump pressure	3.2.5.22
	2-8	Not defined	

3.3.45 WATER IN FUEL INDICATOR

Transmission repetition rate:	10 s
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	255
Default priority:	6
Parameter group number:	65,279 ($00FEFF_{16}$)

Byte:	1	Water in fuel indicator	3.2.6.7
	2-8	Not defined	

3.3.46 ENGINE FLUID LEVEL/PRESSURE #2

Transmission repetition rate:	0.5 s
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	219
Default priority:	6
Parameter group number:	65,243 ($00FEDB_{16}$)

Byte:	1,2	Injection control pressure	3.2.5.20
R)	3,4	Injector metering rail pressure	3.2.5.21
	5-8	Not defined	

3.3.47 SOFTWARE IDENTIFICATION

Transmission repetition rate:	on request
Data length:	Variable
Data page:	0
PDU format:	254
PDU specific:	218
Default priority:	6
Parameter group number:	65,242 ($00FEDA_{16}$)

Byte:	1	Number of software identification fields	
	2-n	Software identification(s)	3.2.5.88
R)		Delimiter (ASCII "*")	

R) NOTE—The software identification field is variable in length and may contain up to 125 software identification designators. An ASCII "*" is used as a delimiter to separate multiple software identifications. Additional software identification fields may be added at the end, each separated by an ASCII "*" as a delimiter. An ASCII "*" is required at the end of the last software identification field, even if there is only one software identification designator.

3.3.48 AUXILIARY DISCRETE INPUT/OUTPUT STATUS

Transmission repetition rate: on request
Data length: 8 bytes
Data page: 0
PDU format: 254
PDU specific: 217
Default priority: 6
Parameter group number: 65,241 ($00FED9_{16}$)

Byte:			Bit:			
	1	I/O_Status1		8,7	I/O channel #1	3.2.6.18
				6,5	I/O channel #2	3.2.6.18
				4,3	I/O channel #3	3.2.6.18
				2,1	I/O channel #4	3.2.6.18
	2	I/O_Status2	Bit:	8,7	I/O channel #5	3.2.6.18
				6,5	I/O channel #6	3.2.6.18
				4,3	I/O channel #7	3.2.6.18
				2,1	I/O channel #8	3.2.6.18
	3	I/O_Status3	Bit:	8,7	I/O channel #9	3.2.6.18
				6,5	I/O channel #10	3.2.6.18
				4,3	I/O channel #11	3.2.6.18
				2,1	I/O channel #12	3.2.6.18
	4	I/O_Status4	Bit:	8,7	I/O channel #13	3.2.6.18
				6,5	I/O channel #14	3.2.6.18
				4,3	I/O channel #15	3.2.6.18
				2,1	I/O channel #16	3.2.6.18
	5-8	Not defined				

3.3.49 ALTERNATOR SPEED

Transmission repetition rate: 1 s
Data length: 8 bytes
Data page: 0
PDU format: 254
PDU specific: 213
Default priority: 6
Parameter group number: 65,237 ($00FED5_{16}$)

Byte:			
	1,2	Alternator speed	3.2.5.97
	3-8	Not defined	

R) 3.3.50 ELECTRONIC TRANSMISSION CONTROLLER #3: ETC3

Transmission repetition rate:	on request
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	199
Default priority:	7
Parameter group number:	65,223 ($00FEC7_{16}$)

Byte:						
1	Shift finger gear position					3.2.5.99
2	Shift finger rail position					3.2.5.98
3	Shift_finger_status_1	Bit:	8-7	Not defined		
			6,5	Center rail indicator		3.2.6.21
			4,3	Engagement indicator		3.2.6.20
			2,1	Neutral indicator		3.2.6.19
4	Shift_finger_status_2	Bit:	8,7	Gear actuator #2		3.2.6.23
			6,5	Rail actuator #2		3.2.6.25
			4,3	Gear actuator #1		3.2.6.22
			2,1	Rail actuator #1		3.2.6.24
5	Transmission_actuator_1	Bit:	8,7	Splitter indirect actuator		3.2.6.26
			6,5	Splitter direct actuator		3.2.6.27
			4,3	Range low actuator		3.2.6.28
			2,1	Range high actuator		3.2.6.29
6	Transmission_actuator_2	Bit:	8,7	Inertia brake actuator		3.2.6.30
			6,5	Defuel actuator		3.2.6.31
			4,3	Lockup clutch actuator		3.2.6.32
			2,1	Clutch actuator		3.2.6.33
7-8	Not defined					

R) 3.3.51 ELECTRONIC TRANSMISSION CONTROLLER #4: ETC4

Transmission repetition rate:	on request
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	197
Default priority:	7
Parameter group number:	65,221 ($00FEC5_{16}$)

Byte:			
1	Transmission synchronizer clutch value		3.2.5.100
2	Transmission synchronizer brake value		3.2.5.101
3-8	Not defined		

R) 3.3.52 ELECTRONIC TRANSMISSION CONTROLLER #5: ETC5

Transmission repetition rate: on request
Data length: 8 bytes
Data page: 0
PDU format: 254
PDU specific: 195
Default priority: 7
Parameter group number: 65,219 ($00FEC3_{16}$)

Byte: 1	Range_switch	Bit:	8-5	Not defined	
			4,3	Low range sense	3.2.6.34
			2,1	High range sense	3.2.6.35
2	Direction_switch	Bit:	8-7	Not defined	
			6,5	Forward switch	3.2.6.36
			4,3	Neutral switch	3.2.6.37
			2,1	Reverse switch	3.2.6.38
3-8	Not defined				

R) 3.3.53 ELECTRONIC RETARDER CONTROLLER #2: ERC2

Transmission repetition rate: 1 s when active; or on change of state
Data length: 8 bytes
Data page: 0
PDU format: 254
PDU specific: 194
Default priority: 7
Parameter group number: 65,218 ($00FEC2_{16}$)

Byte: 1	Retarder_status	Bit:	8-3	Not defined	
			2,1	Transmission output retarder	3.2.6.39
2-8	Not defined				

R) 3.3.54 HIGH RESOLUTION VEHICLE DISTANCE

Transmission repetition rate: 1 s
Data length: 8 bytes
Data page: 0
PDU format: 254
PDU specific: 193
Default priority: 6
Parameter group number: 65,217 ($00FEC1_{16}$)

Byte: 1-4	High resolution total vehicle distance	3.2.5.106
5-8	High resolution trip distance	3.2.5.107

R) 3.3.55 SERVICE—Transmitted with the service component identification that has the shortest distance or nearest time until the next service inspection.

Transmission repetition rate:	On request
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	192
Default priority:	6
Parameter group number:	65,216 ($00FEC0_{16}$)

Byte: 1	Service component identification	3.2.5.102
2,3	Service distance	3.2.5.103
4	Service component identification	3.2.5.102
5	Service delay/calendar time based	3.2.5.104
6	Service component identification	3.2.5.102
7,8	Service delay/operational time based	3.2.5.105

R) 3.3.56 WHEEL SPEED INFORMATION

Transmission repetition rate:	100 ms
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	191
Default priority:	6
Parameter group number:	65,215 ($00FEBF_{16}$)

Byte: 1,2	Front axle speed	3.2.1.51
3	Relative speed; front axle, left wheel	3.2.1.52
4	Relative speed; front axle, right wheel	3.2.1.53
5	Relative speed; rear axle #1, left wheel	3.2.1.54
6	Relative speed; rear axle #1, right wheel	3.2.1.55
7	Relative speed; rear axle #2, left wheel	3.2.1.56
8	Relative speed; rear axle #2, right wheel	3.2.1.57

3.3.57 ELECTRONIC ENGINE CONTROLLER #4: EEC4

Transmission repetition rate:	On request
Data length:	8 bytes
Data page:	0
PDU format:	254
PDU specific:	190
Default priority:	7
Parameter group number:	65,214 ($00FEBE_{16}$)

Byte: 1,2	Rated engine power	3.2.5.115
3,4	Rated engine speed	3.2.5.116
5-8	Not defined	

3.4 Application Notes

3.4.1 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 configure each receiving device on a network identically.

4. Notes

4.1 Marginal Indicia—The (R) is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. If the symbol is next to the report title, it indicates a complete revision of the report.

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

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, J1939/71, describes an Application Layer for vehicle use.

Reference Section

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

SAE J1843—Accelerator Pedal Position Sensor for Use with Electronic Control in Medium- and Heavy-Duty Diesel On-Highway Engines

SAE J1939 (Draft)—Recommended Practice for a Serial Control and Communication Vehicle Network

SAE J1939/21—Data Link Layer

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Sponsored by the SAE Truck and Bus Electrical and Electronics Committee