SECTION : 1F

ENGINE CONTROLS

CAUTION : Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

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ENGINE DATA DISPLAY TABLES

Engine Data Display

At idle / Upper Radiator / Closed Throttle / Park or Neutral / Closed loop / Acc. OFF		
Scan Tool Parameter	**Units Displayed**	**Typical Data Value**
Engine Speed	RPM	±100 rpm from the Desired rpm
Desired Idle Speed	RPM	PCM/ECM Idle Command (Varies with the calibration)
Engine Coolant Temperature	C – F	85˚–115˚C(185˚–239˚F) (Varies with the coolant temperature)
Intake Air Temperature	C – F	10˚–80˚C(50˚–176˚F) (Varies with the coolant temperature)
Throttle Position Angle	%	0% (up to 100% at wide open throttle)
Throttle Position Sensor	Volts	0.200–0.900 v (up to 5.0 at wide open throttle)
MAP	kPa	25–35 kPa
BARO	kPa	65–100 kPa (varies with altitude and with the BARO pressure)
EGR Actual Position	%	0
EGR Desired Position	%	0%
EGR Feedback	Volt	–
IAC Position	Counts	5–60
Cam Speed Activity	Counts	0–255
Ignition Voltage	Volts	12.0–15.0
Engine Run Time	Seconds	Varies (since start up)
BPW Bank 1	mS	0–999.9
Air Fuel Ratio	Ratio	14.6:1 (Varies)
Spark	Degrees	Varies
Knock Retard	Degrees	Varies

Scan Tool Parameter	Units Displayed	Typical Data Value
Knock Active Counter	Counts	0–255
Knock Present	Yes/No	No
Calculated Load	%	0–100
Vehicle Speed	mph	0
Air Condition Pressure	Volt	0–5
Oxygen Bank 1 Sensor 1	mV	0–1000 and varying
Oxygen Bank 1 Sensor 2	mV	0–1000 and varying
Decel Fuel Mode	Yes/No	–
Power Enrichment Mode	Yes/No	–
Closed Loop	Yes/No	Yes
Loop Status	Close/Open	Close
Hot Loop Open	Yes/No	–
Rich/Lean Bank 1	Rich/Lean	–
Short Term Fuel Trim	%	–100 to 100 (Varies)
Long Term Fuel Trim	%	–100 to 100 (Varies)
EVAP Purge Solenoid	%	0–100
EVAP Vent Solenoid	On/Off	–
IAC Base Position	Counts	–
Fuel Trim Cell	Cell Number	18–12 at idle (Varies with the air flow, RPM, P/N, and A/C)
Calculated Air Flow	g/sec	Varies
Weak Cylinder		–
Rough Road Sensor	Volt	
5 Volt Reference	Volt	
Throttle at Idle	Yes/No	–
Power Steering Cramp	Yes/No	–
Air Conditioning Request	On/Off	OFF
Air Conditioning Clutch	On/Off	OFF (On with the A/C request)
Fuel Pump	On/Off	ON
Malfunction Indicator Lamp	On/Off	–
Upshift Lamp	On/Off	–
Low Fuel Lamp	On/Off	–
Hot Open Loop Lamp	On/Off	–
Variable Gate Intake	Long/Short	Long
Fuel Trim Learned	On/Off	–
Fan 1	On/Off	OFF (Varies with fan request)
Fan 2	On/Off	OFF (Varies with fan request)
Park/Neutral	Yes/No	Yes

EVAP Data Display

At idle / Upper Radiator / Closed Throttle / Park or Neutral / Closed loop / Acc. OFF		
Scan Tool Parameter	**Units Displayed**	**Typical Data**
Engine Speed	RPM	±100 rpm from the Desired rpm
Ignition Voltage	Volts	12.0–15.0
Engine Coolant Temperature	C – F	85˚–115˚C (185˚–239˚F) (Varies with the coolant temperature)
Start Up Coolant Temperature	C – F	4˚–34˚C (39˚–93˚F) Varies with underhood temperature when start-ing
Intake Air Temperature	C – F	10˚–80˚C Varies with underhood temperature
Start Up Intake Air Temperature	C – F	12˚ – 42˚C (54˚ – 108˚F) Varies with underhood temperature when starting
Engine Run Time	Seconds	Varies (Since start up)
Fuel Level Sensor	Volt	0.4–4.5
Fuel Gauge	On/Off	On
EVAP Purge Solenoid	%	0–100
EVAP Vent Solenoid	On/Off	Off
EVAP Tank Vacuum	Inches of H2O	Depends on Pressure / Vacuum
Throttle Position Angle	%	0% (up to 100% at wide open throttle)
Throttle Position Sensor	Volts	0.200–0.900 v (up to 5.0 at wide open throttle)
IAC Position	Counts	5–60
BPW Bank 1	mS	0–999.9
Air Fuel Ratio	Ratio	14.6:1 (Varies)
Spark	Degrees	Varies
MAP	kPa	25–35 kPa
BARO	kPa	65–100 kPa (varies with altitude and with the BARO pressure)
Calculated Load	%	0–100
Vehicle Speed	mph	0
Oxygen Sensor Bank 1 Sensor 1	mV	0—1000 and varying
Oxygen Sensor Bank 1 Sensor 2	mV	0–1000 and varying

EGR Data Display

At idle / Upper Radiator / Closed Throttle / Park or Neutral / Closed loop / Acc. OFF		
Scan Tool Parameter	**Units Displayed**	**Typical Data**
Engine Speed	RPM	±100 rpm from the Desired rpm
Ignition Voltage	Volts	12.0–15.0
IAC Position	Counts	5–60
Engine Coolant Temperature	C – F	85˚–115˚C(185˚–239˚F) Varies with the coolant temperature
Throttle Position Angle	%	0% (up to 100% at wide open throttle)
Throttle Position Sensor	Volts	0.200–0.900v (up to 5.0 at wide open throttle)
EGR Actual Position	%	0%
EGR Desired Position	%	0%
EGR Feedback	Volt	
EGR Closed Pintle Position	Counts	–
EGR Trip Sample Count	Counts	0
EGR EWMA Threshold	Counts(signed)	
EGR EWMA	Counts(signed)	
EGR Pintle Position Error	Counts(signed)	
Engine Run Time	Seconds	Varies (Since start up)
BPW Bank 1	mS	0–999.9
Air Fuel Ratio	Ratio	14.6:1 (Varies)
Spark	Degrees	Varies
MAP	kPa	25–35 kPa
BARO	kPa	65–100 kPa (varies with altitude and with the BARO pressure)
Calculated Load	%	0–100
Vehicle Speed	mph	0

Oxygen Sensor Data Display

At idle / Upper Radiator / Closed Throttle / Park or Neutral / Closed loop / Acc. OFF		
Scan Tool Parameter	**Units Displayed**	**Typical Data**
Engine Speed	RPM	±100 rpm from the Desired rpm
Engine Run Time	Seconds	Varies (Since start up)
Loop Status	Open/Closed	Closed
O2S Bank 1 Sensor 1	mV	0–1132
O2S Bank 1 Sensor 1	Not Ready, Ready	Ready
Rich/Lean Bank 1	Lean, Rich	–
Injector Pulse Bank 1	mS	Varies
Start Up Coolant Temperature	C – F	4˚–34˚C (39˚–93˚F) Varies with the underhood temperature when starting
Engine Coolant Temperature	C – F	85˚–115˚C (185˚–239˚F) Varies with the coolant temperature
Start Up Intake Air Temperature	C – F	12˚–42˚C (54˚–108˚F) Varies with the underhood temperature when starting
Intake Air Temperature	C – F	Varies with the underhood temperature
O2S Time to Activity Bank 1 Sensor 1	Seconds	Varies
Short Term FT Bank 1	%	–100 to 100 (Varies)
Long Term FT Bank 1	%	–100 to 100 (Varies)
TP Angle	%	0% (up to 100% at wide open throttle)
Calculated Air Flow	g/sec	Varies
MAP	kPa	25–35 kPa
EVAP Purge PWM	%	0–100
Ignition 1	Volts	12.0–15.0
Air Fuel Ratio	Ratio	14.6:1 (Varies)
Decel Fuel Mode	Inactive/Active	–
Power Enrichment	Inactive/Active	–
O2S Warm Up Time Bank 1 – Senor 1	Seconds	Varies
HO2S Bank 1 Sensor 2	mV	0–1000 and varying

Misfire Data Display

At idle / Upper Radiator / Closed Throttle / Park or Neutral / Closed loop / Acc. OFF		
Scan Tool Parameter	**Units Displayed**	**Typical Data**
Misfire Current #1	0–255 counts	0 (increase with a misfire)
Misfire History #1	0–255 counts	0 (increase with a misfire)
Misfire Current #2	0–255 counts	0 (increase with a misfire)
Misfire History #2	0–255 counts	0 (increase with a misfire)
Misfire Current #3	0–255 counts	0 (increase with a misfire)
Misfire History #3	0–255 counts	0 (increase with a misfire)
Misfire Current #4	0–255 counts	0 (increase with a misfire)
Misfire History #4	0–255 counts	0 (increase with a misfire)
Misfire Failures First Fail	0–255 counts	0 (increase with a misfire)
Misfire Passes First Fail	0–255 counts	0 (increase with a misfire)
Total Misfire Current Count	0–255 counts	0 (increase with a misfire)
Weak Cylinder		–
Engine Speed	RPM	±100 rpm from the Desired RPM
TP Angle	%	0% (up to 100% at wide open throttle)
Calculated Load	%	0–100
Engine Coolant Temperature	C•F	85˚–115˚C(185˚–239˚F) Varies with the coolant temperature
Intake Air Temperature	C•F	10˚–80˚C(50˚–176˚F) Varies with the underhood temperature
Cam Active Counter	Counts	0–255
Spark Advance	Degrees	Varies
G Sensor	Volts	–
EGR Desired Position	%	0%
EGR Actual Position	%	0%
MAP	kPa	25–35 kPa
Vehicle Speed	mph	0
Air Conditioning Request	On/Off	Off
Air Conditioning Clutch	On/Off	Off
Knock Active Counter	Counts	0–255
Knock Retard	Degrees	Varies
Decel Fuel Mode	Yes/No	–
Power Enrichment Mode	Yes/No	–
Injector Pulse Bank 1	mS	Varies
O2S Bank 1 Sensor 1	mV	0–1000 and varying
HO2S Bank 1 Sensor 2	mV	0–1000 and varying
Short Term FT Bank 1	%	–100 to 100 (Varies)
Long Term FT Bank 1	%	–100 to 100 (Varies)

TEC Display Table

At idle / Upper Radiator / Closed Throttle / Park or Neutral / Closed loop / Acc. OFF		
Scan Tool Parameter	**Units Displayed**	**Typical Data**
Engine Speed	RPM	±100 rpm from the Desired RPM
TP Angle	%	0 (up to 100% at wide open throttle)
Engine Coolant Temperature	C,F	85˚–115˚C (185˚–239˚F) Varies with the coolant temperature
Intake Air Temperature	C,F	10˚–80˚C(50˚–176˚F) Varies with the underhood temperature
Cam Active Counter	Counts	0–255
Spark	Degrees	Varies
MAP	kPa	25–35 kPa
Vehicle Speed	mph	0
Decel Fuel Mode	Yes/No	–
Power Enrichment Mode	Yes/No	–
Injector Pulse Bank 1	mS	Varies
Crank Error Latched	Yes/No	–
Sum Out Of Range	Yes/No	–
Opposing Factor Out Of Range	Yes/No	–
Factor Out Of Range	Yes/No	–
Enable Criteria Not Met	Yes/No	–
Cat Damaging Misfire	Yes/No	–
Test is Running	Yes/No	–
Learned This Key Cycle	Yes/No	–
Attempts to Learn	Counts	

ENGINE DATA DISPLAY TABLE DEFINITIONS

PCM/ECM Data Description

The following information will assist in diagnosing emission or driveability problems. A first technician can view the displays while the vehicle is being driven by second technician. Refer to Powertrain On–Board Diagnostic (OBD II) System Check for additional information.

A/C Clutch

The A/C Relay represents the commanded state of the A/C clutch control relay. The A/C clutch should be engaged when the scan tool displays ON.

A/C Pressure

The A/C High Side displays the pressure value of the A/C refrigerant pressure sensor. The A/C High Side helps to diagnose the diagnostic trouble code (DTC) P0533.

A/C Request

The A/C Request represents whether the air conditioning is being requested from the HVAC selector. The input is received by the instrument panel cluster and then sent over universal asynchronous receiver transmitter (UART) serial data to the powertrain control module (PCM)/engine control module (ECM) and finally to the scan tool over class 2 serial data.

Air Fuel Ratio

The Air Fuel Ration indicates the air to fuel ratio based on the Oxygen Sensor (O2S 1) inputs. The PCM/ECM uses the fuel trims to adjust fueling in order to attempt to maintain an air fuel ratio of 14.7:1.

BARO

The Barometric Pressure (BARO) sensor measures the change in the intake manifold pressure which results from altitude changes. This value is updated at ignition ON and also at Wide Open Throttle (WOT).

BPW Bank 1

Indicates the base Pulse Width Modulation (PWM) or ON time of the indicated cylinder injector in milliseconds. When the engine load is increased, the injector pulse width will increase.

Calculated Air Flow

The calculated air flow is a calculation based on manifold absolute pressure. The calculation is used in several diagnostics to determine when to run the diagnostics.

Calculated Load

Indicates engine load based on Manifold Absolute Pressure (MAP). The higher the percentage, the more load the engine is under.

Camshaft Activity Counter

The Camshaft Position (CMP) activity counter displays the activity sent to the PCM/ECM from the CMP sensor. The counter will continually increment while the engine is running. The CMP activity counter is helpful in diagnosing DTC P0342.

Desired Idle

The PCM/ECM commands the idle speed. The PCM/ECM compensates for various engine loads in order to maintain the desired idle speed. The actual engine speed should remain close to the desired idle under the various engine loads with the engine idling.

Engine Coolant Temperature

The Engine Coolant Temperature (ECT) sensor sends engine temperature information to the PCM/ECM. The PCM/ECM supplies 5 volts to the engine coolant temperature sensor circuit. The sensor is a thermistor which changes internal resistance as temperature changes. When the sensor is cold (internal resistance high), the PCM/ECM monitors a high voltage which it interprets as a cold engine. As the sensor warms (internal resistance decreases), the voltage signal will decrease and the PCM/ECM will interpret the lower voltage as a warm engine.

EGR Desired Position

The desired exhaust gas recirculation (EGR) position is the commanded EGR position. The PCM/ECM calculates the desired EGR position. The higher the percentage, the longer the PCM/ECM is commanding the EGR valve ON.

Engine Run Time

The engine run time is a measure of how long the engine has been running. When the engine stops running, the timer resets to zero.

Engine Speed

Engine Speed is computed by the PCM/ECM from the fuel control reference input. It should remain close to desired idle under the various engine loads with the engine idling.

EVAP Purge

The Evaporative (EVAP) Emission purge valve solenoid is a proportional signal used in order to control the EVAP canister purge function. At 0% the valve is commanded fully closed. 100% implies that the valve is fully open.

EVAP Purge Solenoid

When energized, the EVAP Emission Canister Purge Solenoid allows the fuel vapor to flow from the EVAP Canister to the engine. The EVAP Emission Canister Purge Solenoid is normally closed. The EVAP Emission Canister Purge Solenoid is pulse width modulated by the PCM/ECM. The EVAP Emission Canister Purge Solenoid reads 0% when closed and 100% when fully opened.

EVAP Vent Solenoid

The EVAP Emission Vent Solenoid allows fresh outside air to the EVAP Emission Canister during purge mode. The EVAP Emission Vent Solenoid allows the diagnostic to pull a vacuum on the fuel tank by closing the vent solenoid.

Fan

The Fan Control (FC) Relay is commanded by the PCM/ECM. The FC Relay displays the command as ON or OFF.

Fuel Level Sensor

The Fuel Level Sensor monitors the fuel level in the tank. The Fuel Level Sensor monitors the rate of change of the air pressure in the EVAP Emission Canister Purge System. Several of the Enhanced EVAP Emission Canister Purge System diagnostics are dependent upon the correct fuel level.

Fuel Tank Pressure Sensor

The fuel tank pressure sensor measures the difference between the pressure or the vacuum in the fuel tank and the outside air pressure. When the air pressure in the fuel tank equals the outside air pressure, the output voltage of the sensor is 1.3 to 1.7 volts.

IAC Position

The scan tool displays the PCM/ECM command for the Idle Air Control (IAC) pintle position in counts. The higher the number of counts, the greater the commanded idle speed reads. The Idle Air Control responds to changes in the engine load in order to maintain the desired idle rpm.

Intake Air Temperature

The PCM/ECM converts the resistance of the Intake Air emperature (IAT) sensor to degrees in the same manner as the ECT sensor. Intake air temperature is used by the PCM/ECM to adjust fuel delivery and spark timing according to incoming air density.

Ignition 1 (Voltage)

The ignition volts represent the system voltage measured y the PCM/ECM at the ignition feed circuit.

Knock Retard

The Knock Sensor (KS) Retard indicates the amount of park advance the PCM/ECM is decreasing in response o the KS signal.

Knock Present

The KS Noise Channel indicates when the PCM/ECM etects the KS signal. The PCM/ECM should display O at idle.

Long Term FT

The Long Term Fuel Trim (FT) is derived from the short term fuel trim value. The Long Term FT is used for the long term correction of the fuel delivery. A value of 128 counts (0%) indicates that the fuel delivery requires no compensation in order to maintain a 14.7:1 air to fuel ratio. A value below 128 counts means that the fuel system is too rich and the fuel delivery is being reduced. The PCM/ECM is decreasing the injector pulse width. A value above 128 counts indicates that a lean condition exists for which the PCM/ECM is compensating.

Long Term FT Average

Long Term FT Average is derived from the long term fuel trim from all of the cells. The PCM/ECM then takes all of the values and then creates one average value.

Loop Status

The Closed Loop is displayed indicating that the PCM/ECM is controlling the fuel delivery according to the Oxygen Sensor (O2S 1) voltage as close to an air/fuel ratio of 14.7 to 1 as possible.

MAP

The MAP sensor measures the change in the intake manifold pressure which results from engine load and speed changes. As the intake manifold pressure increases, the air density in the intake also increases and the additional fuel is required.

Misfire Current #1–4

Indicates the number of current misfires that are present in the indicated cylinder. Increments only when misfire is current.

Misfire History #1–4

Indicates the number of misfires that have occurred after 195 current misfires have been counted. The current misfire counter will add its misfires to the history misfire counter after 195 total misfires have taken place. If 1 cylinder is misfiring, the misfiring current counter will have 195 misfires counted before adding to its history counter. If 2 cylinders are misfiring, the misfiring current counter will add to their history counters after 97 misfires. The counter increments only after a misfire diagnostic trouble code (DTC) has been set.

Oxygen Sensor Bank 1 Sensor 1

The pre–converter Oxygen Sensor (O2S 1) reading represents the exhaust oxygen sensor output voltage. This voltage will fluctuate constantly between 100 mv (lean exhaust) and 900 mv (rich exhaust) when the system is operating in a Closed Loop.

Oxygen Sensor Bank 1 Sensor 2

The post–converter Heated Oxygen Sensor (HO2S 2) represents the exhaust oxygen output voltage past the catalytic converter. This voltage remains inactive, or the voltage will appear lazy within a range of 100 mv (lean exhaust) and 900 mv (rich exhaust) when operating in a Closed Loop.

Short Term FT

The Short Term FT represents a short term correction to fuel delivery by the PCM/ECM in response to the amount of time the oxygen sensor voltage spends above or below the 450 mv threshold. If the oxygen sensor has mainly been below 450 mv, indicating a lean air/fuel mixture, short term fuel trim will increase to tell the PCM/ECM to add fuel. If the oxygen sensor voltage stays mainly above the threshold, the PCM/ECM will reduce fuel delivery to compensate for the indicated rich condition.

Short Term FT Average

The Short Term FT Average is derived from the short term fuel trim from all of the cells. The PCM/ECM takes all of the values and then creates one average value.

Spark

This is a display of the spark advance Ignition Coil (IC) calculation which the PCM/ECM is programming in the ignition system. It computes the desired spark advance using data such as engine temperature, rpm, engine load, vehicle speed and operating mode.

TCC Brake Switch

When the brake pedal is applied, the Torque Converter Clutch (TCC) brake switch sends a signal to the PCM/ECM to disengage the TCC and disable the cruise control.

Total Misfire Current Counter

Indicates the total number of misfires that have been detected in all the cylinders after 100 engine cycles. One cycle equals one complete 4 stroke cycle. The total misfire only increments during the steady state cruise conditions.

TP Angle

From the Throttle Position (TP) Sensor voltage input, the PCM/ECM computes the TP. The TP Angle will auto zero to 0% at idle (TP voltage below 0.90 volts). The TP Angle will read 100% at WOT.

TP Sensor

The PCM/ECM uses the TP Sensor in order to determine the amount of the throttle demanded by the vehicle's operator. The TP Sensor reads between 0.36–0.96 volts at idle to above 4 volts at WOT.

Vehicle Speed

The vehicle speed sensor signal is converted into mph or km/h for display. The vehicle speed output from the PCM/ECM is 4000 pulses per mile. The scan tool uses the class 2 serial data from the PCM/ECM to obtain vehicle speed,

while the Instrument Panel Cluster (IPC), cruise control module and the chime alarm module use the 4000 ppm output.

FASTENER TIGHTENING SPECIFICATIONS

Application	N•m	Lb–Ft	Lb–In
Accessory Mounting Bracket Bolts	35	26	–
Camshaft Position Sensor Bolts	12	–	106
Crankshaft Position Sensor Retaining Bolt	10	–	89
Electronic Ignition System Ignition Coil Retaining Bolts	10	–	89
Engine Coolant Temperature Sensor	25	18	–
Evaporative Emission Canister Flange Bolt	20	15	–
Evaporative Emission Canister Protective Cover	8	–	71
Evaporative Emission Canister Purge Solenoid Bracket Bolt	5	–	44
Exhaust Gas Recirculation Valve Retaining Bolts	20	15	–
Fuel Cutoff Switch Mounting Bolts	3	–	27
Fuel Filter Mounting Bracket Assembly Bolt	10	–	89
Fuel Pressure Regulator Retaining Screw	12	–	106
Fuel Rail Retaining Bolts	25	18	–
Fuel Tank Strap Retaining Nuts	13	–	115
Heated Oxygen Sensor	41	30	–
Idle Air Control Valve Retaining Bolts	3	–	27
Knock Sensor Bolt	20	15	–
Manifold Absolute Pressure Sensor Mounting Bracket Nuts	10	–	89
Manifold Absolute Pressure Sensor Retaining Bolts and Nuts	10	–	89
Oxygen Sensor	41	30	–
Rear A/C Compressor Mounting Bracket Bolts	35	26	–
Spark Plug Cover Bolts	3	–	27
Throttle Body Retaining Nuts	9	–	80
Throttle Position Sensor Retaining Bolts	2	–	18

FUEL SYSTEM SPECIFICATIONS

Gasoline

All engines are designed to use unleaded fuel only. Unleaded fuel must be used for proper emission control system operation. Its use will also minimize spark plug fouling and extend engine oil life. Using leaded fuel can damage the emission warranty coverage. The fuel should meet specification ASTM D4814 for the U.S. or CGSB 3.5 M93 for Canada. All engines are designed to use unleaded fuel with a minimum U(R+M)/2e (pump) octane number of 87, where R=research octane number, and M=motor octane number.

Ethanol

You may use fuel containing ethanol (ethyl alcohol) or grain alcohol providing that there is not more than 10 percent ethyl alcohol by volume.

Methanol

Do not use fuels containing methanol. Methanol can corrode metal parts and also cause damage to plastic and rubber parts in the fuel system.

Methyl Tertiary–Butyl Ether (MTBE)

You may use fuel containing Methyl Tertiary–Butyl Ether (MTBE) providing there is not more than 15 percent MTBE by volume.

TEMPERATURE VS RESISTANCE

˚C	˚F	OHMS
Temperature vs Resistance Values (Approximate)		
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
–5	23	12300
–10	14	16180
–15	5	21450
–20	–4	28680
–30	–22	52700
–40	–40	100700