2020 - 2023 MY OBD System Operation

Summary for Gasoline Engines

(PCED Pinpoint Test)

** NOTE: In this document, a monitor or sensor is considered OK if there are no DTCs stored for that component or system at the time the monitor is running.

CATALYST MONITOR OPERATION:	
DTCs	P0420 - Catalyst System Efficiency Below Threshold, Bank 1 (or Y-pipe), P0430 - Catalyst System Efficiency Below Threshold, Bank 2
Monitor execution	once per driving cycle
Monitor Sequence	The monitor will not make the pass or fail call until the following diagnostics complete: UEGO sensor (all), CMS heater, CMS circuit.
Sensors OK	There are MIL DTCs that will disable the monitor for the rest of the key cycle if they have failed this key cycle. Sensors and systems included include: Primary O2, Rear O2, ECT, IAT, TP, VSS, CKP, MAF, fuel level, fuel pressure, barometric pressure, misfire, ignition coil, fuel monitor, VCT, evap system, electronic throttle control, intake manifold runner control, cylinder head temperature, closed loop fuel control, fuel rail pressure, fuel volume regulator, direct injector, port fuel injector, cam position, knock sensor, output shaft sensor, purge control, transmission control module data, variable displacement engine.
Monitoring Duration	Approximately 700 seconds during appropriate FTP conditions (approximately 100 to 200 oxygen sensor switches are collected) for switching O2 control sensors Approximately 10 to 20 seconds for wide range O2 index ratio monitor. 3 Decel Fuel Cutoff events for IAF catalyst monitor

TYPICAL IAF CATALYST MONITOR ENTRY CONDITIONS:		
Entry condition	Minimum	Maximum
Engine Coolant Temp	71 °C	121 °C
Intake Air Temp	-6.7 °C	60 °C
Inferred catalyst mid-bed temperature	510 C	815 C
Fuel Level	15%	
Air Mass Flow		2.0 lb/min
Minimum inferred rear O2 sensor temperature	800 °F	
closed loop fuel adaptation within limits	97%	103%
Rear O2 sensor rich since last monitor attempt	0.45 volts	
Rear O2 sensor lean with injectors off (voltage needed to enter monitor)		0.1 volts
Rear O2 sensor reads rich after fuel turned back on (voltage needed to complete monitor)	0.45 volts	
Engine speed		3000 RPM
Vehicle speed during decel fuel cut off		5 KPH
VDE not disabling cylinders during decel fuel shut off		

TYPICAL MALFUNCTION THRESHOLDS:
Catalyst monitor index ratio > 0.75 (bank monitor)
Catalyst monitor index-ratio > 0.60 (Y-pipe monitor)

Catalyst monitor index ratio > 0.50 for E10 to > 0.90 for E85 (flex fuel vehicles)

Mode $06 reporting for IAF Catalyst Monitor

The catalyst monitor results are converted to a ratio for Mode $06 reporting to keep the same look and feel for the service technician. The equation for calculating the Mode $06 monitor result is:

1 – (Actual reactivation fuel/ Good catalyst reactivation fuel)

J1979 CATALYST MONITOR MODE $06 DATA			
Monitor ID	Test ID	Description	
$21	$81	Bank 1 Oxygen Storage Capacity and max. limit (P0420)	unitless
$22	$81	Bank 2 Oxygen Storage Capacity and max. limit (P0430)	unitless

Catalyst Efficiency Monitor: Model Based (New)

CATALYST MONITOR OPERATION:	
DTCs	P0420 - Catalyst System Efficiency Below Threshold, Bank 1 (or Y-pipe), P0430 - Catalyst System Efficiency Below Threshold, Bank 2
Monitor execution	once per driving cycle
Monitor Sequence	The monitor will not make the pass or fail call until the following diagnostics complete: UEGO sensor response, CMS heater, CMS circuit.
Sensors OK	There are MIL DTCs that will disable the monitor for the rest of the key cycle if they have failed this key cycle. Sensors and systems included include: Primary O2, Rear O2, ECT, IAT, TP, VSS, CKP, MAF, fuel level, fuel pressure, barometric pressure, misfire, ignition coil, fuel monitor, VCT, evap system, electronic throttle control, intake manifold runner control, cylinder head temperature, closed loop fuel control, fuel rail pressure, fuel volume regulator, direct injector, port fuel injector, cam position, knock sensor, output shaft sensor, purge control, transmission control module data, variable displacement engine.
Monitoring Duration	100 seconds of 'enabled time' (calibratable). Enabled time occurs during more steady 'cruise' driving conditions.

TYPICAL MODEL BASED CATALYST MONITOR ENTRY CONDITIONS:		
Entry condition	Minimum	Maximum
Engine Coolant Temp	71 °C	127 °C
Intake Air Temp	-6.7 °C	60 °C
Inferred catalyst mid-bed temperature	538 C	825 C
Fuel Level	15%	
Air Mass Flow	17 g/s	75 g/s
Minimum inferred rear O2 sensor temperature	800 °F	
Fuel adaptation learned within limits	97%	103%

battery voltage	11 volts	
ambient air temperature	-6.7 ºC	60 ºC
flex fuel adaptation complete		
Normalized engine load	0	2
FAOS (outer loop control using rear O2 sensor) is enabled	n/a	n/a
Air flow	17 g/s	75 g/s
Engine speed	1100 rpm	2500 rpm
Seondary O2 sensor voltage: (slow – heavily filtered)	0.45 V	0.85 V
Rear O2 sensor voltage (fast – no filtering). Only used when the rear O2 sensor output has crossed 0.45 V < calibratable number (typically 4 to 12) times.	0.35 V	0.9 V
Air flow fractional change per 0.02 s loop		0.5

TYPICAL MALFUNCTION THRESHOLDS:
Catalyst gain with compensation > 1.5 (bank monitor)

Mode $06 reporting for model based Catalyst Monitor

J1979 CATALYST MONITOR MODE $06 DATA			
Monitor ID	Test ID	Description	
$21	$81	Bank 1 Oxygen Storage Capacity and max. limit (P0420)	unitless
$22	$81	Bank 2 Oxygen Storage Capacity and max. limit (P0430)	unitless

Misfire Monitor

Misfire Monitor Operation:	
DTCs	P0300 to P0310 (general and specific cylinder misfire) P033F or P1336 (noisy crank sensor, no cam/crank synchronization) P0315 (unable to learn profile) P0316 (misfire during first 1,000 revs after start-up) P0313 (misfire detected with low fuel level)
Monitor execution	Continuous, misfire rate calculated every 200 or 1000 revs
Monitor Sequence	None
Sensors OK	CKP, CMP, MAF
Monitoring Duration	Entire driving cycle (see disablement conditions below)

Typical misfire monitor entry conditions:		
Entry condition	Minimum	Maximum
Time since engine start-up	0 seconds	0 seconds
Engine Coolant Temperature	20 °F	250 °F
RPM Range (Full-Range Misfire certified, with 2 rev delay)	2 revs after exceeding 150 rpm below "drive" idle rpm	redline on tach or fuel cutoff
Profile correction factors learned in NVRAM	Yes	
Fuel tank level	15%	

Typical misfire temporary disablement conditions:
Temporary disablement conditions:
Closed throttle decel (negative torque, engine being driven) > -100 ft lbs
Fuel shut-off due to vehicle-speed limiting or engine-rpm limiting mode
High rate of change of torque (heavy throttle tip-in or tip out) > -450 deg/sec or 250 deg/sec ; > -200 ft lbs/sec or > 250 ft lbs/sec
Rough Road conditions present

Typical misfire monitor malfunction thresholds:
Type A (catalyst damaging misfire rate): misfire rate is an rpm/load table ranging from 40% at idle to 5% at high rpm and loads
Type B (emission threshold rate): 0.9% to 1.5%

J1979 Misfire Mode $06 Data			
Monitor ID	Test ID	Description	
A1	$80	Total engine misfire and catalyst damage misfire rate (updated every 200 revolutions) (P030x)	percent

A1	$81	Total engine misfire and emission threshold misfire rate (updated every 1,000 revolutions) (P030x)	percent
A1	$82	Highest catalyst-damage misfire and catalyst damage threshold misfire rate (updated when DTC set or clears) (P030x)	percent
A1	$83	Highest emission-threshold misfire and emission threshold misfire rate (updated when DTC set or clears) (P030x)	percent
A1	$84	Inferred catalyst mid-bed temperature (P030x)	°C
A2 – AD	$0B	EWMA misfire counts for last 10 driving cycles (P030x)	events
A2 – AD	$0C	Misfire counts for last/current driving cycle (P030x)	events
A2 – AD	$80	Cylinder X misfire rate and catalyst damage misfire rate (updated every 200 revolutions) (P030x)	percent
A2 – AD	$81	Cylinder X misfire rate and emission threshold misfire rate (updated every 1,000 revolutions) (P030x)	percent

Profile Correction Operation	
DTCs	P0315 - unable to learn profile in three 60 to 40 mph decels
Monitor Execution	Once per profile learning sequence.
Monitor Sequence:	Profile must be learned before misfire monitor is active.
Sensors OK:	CKP, CMP, CKP/CMP in synch
Monitoring Duration;	10 cumulative seconds in conditions (a maximum of three 60-40 mph defueled decels)

Typical profile learning entry conditions (Assembly Plant or Service Bay):		
Entry condition	Minimum	Maximum
Engine in decel-fuel cutout mode for 4 engine cycles		
Park/Neutral gear		
Engine RPM	2000 rpm	3000 rpm
Learning tolerance		1%

Typical profile learning entry conditions (Customer drive cycle):		
Entry condition	Minimum	Maximum
Engine in decel-fuel cutout mode for 4 engine cycles		
Brakes applied (Brake On/Off Switch)	No	No
Engine RPM	1300 rpm	3700 rpm
Change in RPM		600 rpm/background loop
Vehicle Speed	30 mph	75 mph
Learning tolerance		1%

EVAP System Monitor - 0.040” dia. Vacuum Leak Check

0.040” EVAP Monitor Operation:	
DTCs	P0455 - EVAP System Leak Detected (large leak) P0457 - EVAP System Leak Detected (fuel cap loose/off) P0442 - EVAP System Leak Detected (small leak) (0.040” leak), P1450 - Unable to Bleed Up Fuel Tank Vacuum (excessive vacuum) or P0496 - EVAP System High Purge Flow Note: P1450 is being replaced by P0496
Monitor execution	once per driving cycle
Monitor Sequence	HO2S monitor completed and OK
Sensors/Components OK	MAF, IAT, VSS, ECT, CKP, TP, FTP, CPV, CVS
Monitoring Duration	360 seconds (see disablement conditions below)

Typical 0.040” EVAP monitor entry conditions, Phases 0 through 4:		
Entry condition	Minimum	Maximum
Engine off (soak) time time OR ECT at start – IAT at start <= 12 ºF	4 - 6 hours	
Time since engine start-up	330 seconds	1800 to 2700 seconds
Intake Air Temp	40 ºF	95 - 100 ºF
BARO (<8,000 ft altitude)	22.0 “ Hg	
Engine Load	20%	70%
Vehicle Speed	40 mph	90 mph
Purge Duty Cycle	75%	100%
Purge Flow	0.05 lbm/min	0.10 lbm/min
Fuel Fill Level	15%	85%
Fuel Tank Pressure Range	- 17 H_2O	1.5 H_2O
Battery Voltage	11 volts	18 volts
Clean Canister		

Typical 0.040” EVAP abort (fuel slosh) conditions for Phase 2:
Change in load: > 30%
Change in tank pressure: > 1 “ H_2O
Change in fuel fill level: > 15%
Number of aborts: > 255
Vehicle Accel > 1 mph / sec

Typical 0.040 EVAP monitor malfunction thresholds:

P1450/P0496 (Excessive vacuum): < -4.0 in H_2O delta vacuum from time that CVS is closed, or > -4. in H_2O stagnant vapor over a 10 second evaluation time.

P0455 (Gross leak): > -8.0 in H_2O over a 30 second evaluation time.

P0457 (Gross leak, cap off): > -8.0 in H_2O over a 30 second evaluation time after a refueling event.

P0442 (0.040" leak): > 2.5 in H_2O bleed-up over a 15 second evaluation time at 75% fuel fill. (Note: bleed-up and evaluation times vary as a function of fuel fill level and ambient air temperature)

P0442 vapor generation limit: < 2.5 in H_2O over a 120 second evaluation time

J1979 Evaporative System Mode $06 Data prior to 2017 MY

Test ID	Comp ID	Description	Units
$3A	$80	Phase 0 end pressure result and test limits (data for P1450/P0496 – excessive vacuum)	Pa
$3A	$81	Phase 4 vapor generation minimum change in pressure and test limits (data for P1450/P0496, CPV stuck open)	Pa
$3A	$82	Phase 0 end pressure result and test limits (data for P0455/P0457 – gross leak/cap off)	Pa
$3B	$80	Phase 2 0.040" cruise leak check vacuum bleed-up and test limits (data for P0442 – 0.040" leak)	Pa
Note: Default values (0.0 Pa) will be displayed for all the above TIDs if the evap monitor has never completed. Each TID is associated with a particular DTC. The TID for the appropriate DTC will be updated based on the current or last driving cycle, default values will be displayed for any phases that have not completed.			

J1979 Evaporative System Mode $06 Data for 2017 MY and beyond

Test ID	Comp ID	Description	Units
$39	$82	HD 0.150" Leak test - Phase 0 end pressure result and test limits (data for P0455/P0457 – gross leak/cap off) (P0455)	Pa
$3A	$83	0.090" Leak test - Phase 2 0.040"/0.090" leak check vacuum bleed-up and maximum 0.040"/0.090" leak threshold (P0442)	Pa
$3B	$83	0.040" Leak test - Phase 2 0.040" leak check vacuum bleed-up and maximum 0.040" leak threshold (P0442)	Pa
$3D	$88	Purge Flow Monitor - Excessive vacuum limit (Fail on time out) (P1450/P0496)	Pa
$3D	$88	Purge Flow Monitor - Excessive vacuum limit (Fail on delta pressure) (P1450/P0496)	Pa
Note: Default values (0.0 Pa) will be displayed for all the above TIDs if the evap monitor has never completed. Each TID is associated with a particular DTC. The TID for the appropriate DTC will be updated based on the current or last driving cycle, default values will be displayed for any phases that have not completed.			

EVAP System Monitor - 0.020” dia. Engine Off Natural Vacuum

0.020” EONV EVAP Monitor Operation:	
DTCs	P0456 (0.020” leak) P260F (Evaporative System Monitoring Processor Performance)
Monitor execution	Once per key-off when entry conditions are met during drive. Monitor will run up to 2 times per day, or 90 cumulative minutes per day (whichever comes first)
Monitor Sequence	none
Sensors/Components OK	EONV Processor, Canister Vent Solenoid, Fuel Tank Pressure Sensor, Fuel Level Input, Vapor Management Valve, CAN communication link
Monitoring Duration	45 minutes in key-off state if fault present. Tests will likely complete quicker if no fault is present.

Typical 0.020” EONV EVAP monitor entry conditions:		
Entry conditions to allow EONV test (prior to key off)	Minimum	Maximum
Engine off (soak) time	3.5 - 6 hours	
OR		
Inferred soak criteria met: - (ECT at start – IAT at start)		12 ºF F
Inferred soak criteria met – ECT at start	35 ºF F	105 ºF F
Inferred soak criteria met - minimum engine off soak time	0 sec	
Time since engine start-up to allow EONV test	20 minutes	90 minutes
Ambient Temperature at start-up	40 ºF	95 ºF
Battery Voltage to start EONV test	11 volts	
Number of completed EONV tests in 24hr cycle		6
Cumulative test time in 24hr cycle		90 minutes
Fuel level	15%	85%
ECU time since power-up to allow EONV test	180 seconds	
Flex fuel inference complete	Learned	
BARO (<8,000 ft altitude)	22.0 “ Hg	
Summation of air mass of the combustion engine since start ensures that vehicle has been operated off idle (function of ambient temperature).	7500 to 15000 lbm/min	
Ratio of drive time to (drive + soak) time. (This allows for the driver to key-off for a short time without losing the initial soak condition.)	0.8	

Typical 0.020" EONV EVAP key-off abort conditions:
Tank pressure at key-off > 1.5" H_20 during stabilization phase (indicates excessive vapor)
Tank pressure not stabilized for tank pressure offset determination
Rapid change in tank pressure > 0.5"H_20 (used for refuel/slosh detection)
Rapid change in fuel level > 5% (used for refuel/slosh detection)
Battery voltage < 11 Volts
Rapid change in battery voltage > 1 Volt
Loss of CAN network (only for standalone satellite micro applications)
Canister Vent Solenoid fault detected
Driver turns key-on

Typical 0.020 EONV EVAP monitor malfunction thresholds:
P0456 (0.020" leak): < 0.75 in H_2O pressure build and < 0.50 in H_2O vacuum build over a 45 minute maximum evaluation time Note: EONV monitor can be calibrated to illuminate the MIL after two malfunctions (an average of four key-off EONV tests, eight runs in all) or after a single malfunction (an average of five key-off EONV tests, five runs in all), or using EWMA with Fast Initial Response and Step Change Logic. Most new 2006 MY and later vehicles will use the five-run approach, most new 2009 MY and later use the EWMA approach.

J1979 EONV EVAP monitor Mode $06 Data			
Monitor ID	Comp ID	Description	Units
$3C	$81	EONV Positive Pressure Test Result and Limits (data for P0456)	Pa
$3C	$82	EONV Negative Pressure (Vacuum) Test Result and Limits(data for P0456)	Pa
$3C	$83	Normalized Average of Multiple EONV Tests Results and Limits (where 0 = pass, 1 = fail) (data for P0456)	unitless
Note: Default values (0.0) will be displayed for all the above TIDs if the evap monitor has never completed. The appropriate TID will be updated based on the current or last driving cycle, default values will be displayed for any phases that have not completed.			

EVAP System Monitor Component Checks

Canister Purge Valve Check Operation:	
DTCs	P0443 – Evaporative Emission System Purge Control Valve "A" Circuit
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	5 seconds to obtain smart driver status

Typical Canister Purge Valve check malfunction thresholds:
P0443 (CPV): open/shorted at 0 or 100% duty cycle

Canister Vent Solenoid Check Operation:	
DTCs	P0446 – Canister Vent Solenoid Circuit
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	5 seconds to obtain smart driver status

Typical Canister Vent Solenoid check malfunction thresholds:
P0446 (Canister Vent Solenoid Circuit): open/shorted

Evap Switching Valve Check Operation:	
DTCs	P2418 - Evap Switching Valve Circuit
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	5 seconds to obtain smart driver status

Evap Switching Valve check malfunction thresholds:
P2418 (Evap Switching Valve Circuit): open/shorted

Fuel Tank Pressure Sensor Transfer Function		
FTP volts = [Vref * (0.14167 * Tank Pressure) + 2.6250] / 5.00		
Volts	A/D Counts in PCM	Fuel Tank Pressure, Inches H_2O
0.100	20	-17.82
0.500	102	-15.0

1.208	247	-10.0
2.625	464	0
3.475.	712	6.0
4.750	973	15.0
4.90	1004	16.06

Fuel Tank Pressure Sensor Check Operation:	
DTCs	P0452 – Fuel Tank Pressure Sensor Circuit Low P0453 – Fuel Tank Pressure Sensor Circuit High P0454 – Fuel Tank Pressure Sensor Intermittent/Erratic (noisy)
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	5 seconds for electrical malfunctions, 10 seconds for noisy sensor test

Typical Fuel Tank Pressure Sensor check malfunction thresholds:
P0452 (Fuel Tank Pressure Sensor Circuit Low): < -17.82 in H_2O
P0453 (Fuel Tank Pressure Sensor Circuit High): > 16.06 in H_2O
P0454 (Fuel Tank Pressure Sensor Circuit Noisy): > open circuit, short circuit or > 4 in H_2O change between samples, sampled every 100 msec

Fuel Tank Pressures Sensor Offset Check Operation	
DTCs	P0451 – Fuel Tank Pressure Sensor Range/Performance (offset)
Monitor execution	once per driving cycle
Monitor Sequence	No P0443 or P1450/P0496 DTCs
Sensors OK	not applicable
Monitoring Duration	< 1 second

Typical Fuel Tank Pressure Sensor Offset Check Entry Conditions:		
Entry condition	Minimum	Maximum
Ignition key on, engine off, engine rpm		0 rpm
Purge Duty Cycle		0%
Engine off (soak) time	4 - 6 hours	
Fuel Tank Pressure Sensor Variation during test		0.5 in H_2O
Battery Voltage	11.0 Volts	

Typical Fuel Tank Pressure Sensor Offset Check Malfunction Thresholds:
Fuel tank pressure at key on, engine off is 0.0 in H_2O +/- 2.0 in H_2O

Fuel Level Input Check Operation:	
DTCs	P0461 – Fuel Level Sensor A Circuit Noisy P0462 – Fuel Level Sensor A Circuit Low P0463 – Fuel Level Sensor A Circuit High P2066 – Fuel Level Sensor B Circuit Noisy P2067 – Fuel Level Sensor B Circuit Low P2068 – Fuel Level Sensor B Circuit High
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	30 seconds for electrical malfunctions,

Typical Fuel Level Input check malfunction thresholds:
P0460 or P0462 (Fuel Level Input Circuit Low): < 5 ohms (< 1 A/D count)
P0460 or P0463 (Fuel Level Input Circuit High): > 200 ohms (>253 A/D counts)
P0461 or P2066 (Fuel Level Input Noisy): > 40% change between samples, > 100 occurrences, sampled every 0.100 seconds

Fuel Level Input Stuck Check Operation:	
DTCs	P25B0 - Fuel Level Sensor "A" Stuck P25B1 - Fuel Level Sensor "B" Stuck P25B2 - Fuel Level Sensor "A" or "B" Stuck
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	Between 15 and 85%, monitoring can take from100 to 120 miles to complete

Typical Fuel Level Input Stuck check malfunction thresholds:
P25B0/P25B1/P25B2 (Fuel Level Input Stuck):
Fuel level stuck at greater than 90%: > 60% difference in calculated fuel tank capacity consumed versus change in fuel level input reading
Fuel level stuck at less than 10%: > 30% difference in calculated fuel tank capacity consumed versus change in fuel level input reading
Fuel level stuck between 10% and 90%: > 25% difference in calculated fuel tank capacity consumed versus change in fuel level input reading

Evap Monitor Microprocessor Performance:	
DTCs	P260F - Evap System Monitoring Processor Performance
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	5 seconds

Evap Switching Valve (EVAPSV) Diagnostics

EVAP Switching Valve (EVAPSV) Monitor Operation:	
DTC	P2450
Monitor execution	once per driving cycle
Monitor Sequence	Runs during Phase 3 of the evap 0.040" cruise test
Sensors/Components OK	MAF, IAT, VSS, ECT, CKP, TP, FTP, CPV, CVS
Monitoring Duration	2 to 3 seconds (see disablement conditions below)

Typical EVAP Switching Valve (EVAPSV) monitor entry conditions:		
Entry condition	Minimum	Maximum
0.040" Cruise Test completes		

Typical EVAP Switching Valve (EVAPSV) abort conditions:
Change in fuel fill level: > 15%

Typical EVAP Switching Valve (EVAPSV) malfunction thresholds:
P2418: Presence of short, open, or intermittent fault for more than 5 seconds P2450: Calculated ratio < 2.75

J1979 Evaporative System Mode $06 Data			
Test ID	Comp ID	Description	Units
$3D	$82	Vapor blocking valve performance (P2450)	Unitless
Note: Default values (0.0) will be displayed for all the above TIDs if the evap monitor has never completed. Each TID is associated with a particular DTC. The TID for the appropriate DTC will be updated based on the current or last driving cycle, default values will be displayed for any phases that have not completed.			

Blocked Purge Line Diagnostics

EVAP Blocked Line Monitor Operation:	
DTC	P144A - EVAP System Purge Vapor Line Restricted/Blocked or P00FE - EVAP System Tank Vapor Line Restricted/Blocked Note: P144A DTC is being replaced by P00FE
Monitor execution	once per driving cycle
Monitor Sequence	Runs during Phase 0 of evap 0.040" cruise test. Performs an intrusive test in Phases 3 & 4 to confirm a fault.
Sensors/Components OK	MAF, IAT, VSS, ECT, CKP, TP, FTP, CPV, CVS
Monitoring Duration	30 seconds (see disablement conditions below)

Typical Blocked Line monitor entry conditions:		
Entry condition	Minimum	Maximum
General 0.040" Cruise Test conditions apply		
Air mass high enough for intrusive portion of test	1.5 (lb/min)	
Manifold vacuum high enough for intrusive portion of test	5 "Hg	
Not in open loop fueling		
CPV purging		

Typical EVAP Blocked Line abort conditions:
All items cited under entry conditions apply.

Typical EVAP Blocked Line malfunction thresholds:
P144A/P00FE: Phase 0 portion of test delta pressure < -5 "H_20/sec
P144A/P00FE: Phase 3 & 4 (intrusive test) pressure response < -2 "H_20

J1979 Evaporative System Mode $06 Data			
Test ID	Comp ID	Description	Units
$3D	$80	Blocked Evap System Line - Screening test (P144A/P00FE)	Pa/sec
$3D	$81	Blocked Evap System Line - Fault confirmation test (P144A/P00FE)	Pa
Note: Default values (0.0) will be displayed for all the above TIDs if the evap monitor has never completed. Each TID is associated with a particular DTC. The TID for the appropriate DTC will be updated based on the current or last driving cycle, default values will be displayed for any phases that have not completed.			

Single Path Purge Check Valve Diagnostics

Evaporative System Purge Check Valve Performance Diagnostic Operation:	
DTC	P144C - Evaporative Emission System Purge Check Valve Performance or P04F0 - EVAP System High Load Purge Line "A" Performance Note: P144C is being replaced by P04F0
Monitor execution	Once per driving cycle, during boosted operation
Monitor Sequence	None
Sensors/Components OK	ECT/CHT, IAT, MAP, CPV, CVV, FTPT, FLI, BARO, TIP
Monitoring Duration	5 to 10 seconds depending on level of boost

Typical Evaporative System Purge Check Valve Performance Entry Conditions		
Entry condition	Minimum	Maximum
Ambient temperature (IAT)	40 °F	95 °F
Battery Voltage	11.0 Volts	
Fuel level	15%	85%
Engine Coolant Temperature (CHT/ECT)	160 °F	
Atmospheric Pressure (BARO)	23” Hg	
Boost Pressure (MAP – BARO)	4 to 8” Hg	
Engine Delta Load	0.2	
Vehicle Acceleration	0.5 mph / sec	

Typical Evaporative System Purge Check Valve Diagnostic malfunction thresholds:
Pressure Rise Rate (delta pressure / delta time) > 0.50 " H_2O/sec Threshold is a function of fuel level with a range of 0.5 to 1.0

Dual Path Purge Check Valve Diagnostics

Evaporative System Purge Check Valve Performance Diagnostic Operation:	
DTC	P144C - Evaporative Emission System Purge Check Valve Performance or P04F0 - EVAP System High Load Purge Line "A" Performance Note: P144C is being replaced by P04F0
Monitor execution	Once per driving cycle, during boosted operation
Monitor Sequence	None
Sensors/Components OK	ECT/CHT, IAT, MAP, CPV, CVV, FTPT, FLI, BARO, TIP, WASTEGATE
Monitoring Duration	5 to 10 seconds depending on level of boost

Typical Evaporative System Purge Check Valve Performance Entry Conditions		
Entry condition	Minimum	Maximum
Ambient air temperature	40 ° F	105 ° F
Battery Voltage	11.0 Volts	
Fuel level	15%	90%
Engine Coolant Temperature	160 ° F	
Atmospheric Pressure (BARO)	23” Hg	
Boost Pressure (MAP – BARO)	8” Hg	

Typical Evaporative System Purge Check Valve Diagnostic malfunction thresholds:
CV1- Pressure Rise Rate (delta pressure / delta time) > 1 " H_2O/sec
CV1- Threshold is a function of fuel level with a range of 1.5 to 2.6
CV2- Vacuum Rate (delta vacuum / delta time) >-0.4 and < 0.5 H_2O/sec
CV2- Threshold is a function of fuel level with a range of 0.5 to 0.7 for the upper band and -0.4 to -0.3 for the lower band

J1979 Evaporative System Mode $06 Data			
Test ID	Comp ID	Description	Units
$3D	$89	Check valve test for dual path purge. (Check Valve 1 Failed-P144C/P04F0)	Pa/sec
$3D	$89	Check valve test for dual path purge. (Check Valve 2 Failed-P144C/P04F0)	Pa/sec
$3D	$89	Check valve test for dual path purge. (Check Valve 1 and 2 Passed - P144CP04F0)	Pa/sec
Note: Default values (0.0) will be displayed for all the above TIDs if the evap monitor has never completed. Each TID is associated with a particular DTC. The TID for the appropriate DTC will be updated based on the current or last driving cycle, default values will be displayed for any phases that have not completed.			

Fuel System Monitor

Fuel Monitor Operation:	
DTCs	P0171 Bank 1 Lean, P0174 Bank 2 Lean P0172 Bank 1 Rich, P0175 Bank 2 Rich
Monitor execution	continuous while in closed loop fuel
Monitor Sequence	none
Sensors OK	Fuel Rail Pressure (if available), IAT, CHT/ECT, MAF, TP
Monitoring Duration	2 seconds to register malfunction

Typical fuel monitor entry conditions:		
Entry condition	Minimum	Maximum
Engine Coolant Temp	170 ºF / 70 ºC	230 ºF/ 110 ºC
Engine load	12%	
Intake Air Temp	-30 ºF / -40 ºC	150 ºF / 65 ºC
Fuel Level	10%	
Purge Duty Cycle	0%	0%

Typical fuel monitor malfunction thresholds:
Long Term Fuel Trim correction cell currently being utilized in conjunction with Short Term Fuel Trim: Lean malfunction: LONGFT > 25%, SHRTFT > 1% Rich malfunction: LONGFT < 25%, SHRTFT < 1%

FAOSC (Rear Fuel Trim) Monitor

UEGO "FAOS Monitor" Operation:	
DTCs	P2096 – Post catalyst fuel trim system too lean (Bank 1) P2097 – Post catalyst fuel trim system too rich (Bank 1) P2098 – Post catalyst fuel trim system too lean (Bank 2) P2099 – Post catalyst fuel trim system too rich (Bank 2)
Monitor execution	Continuous while in closed loop fuel
Monitor Sequence	> 30 seconds time in lack of movement test, > 30 seconds time in lack of switch test
Sensors OK	ECT, IAT, MAF, MAP, VSS, TP, ETC, FRP, FVR, DPFE EGR, VCT, VMV/EVMV, CVS, CPV, EVAPSV, FTP, CKP, CMP, ignition coils, injectors, no misfire DTCs, no system failures affecting fuel, no EVAP gross leak failure, UEGO heaters OK, rear HO2S heaters OK, no "lack of switching" malfunction, no "lack of movement" malfunction, no UEGO circuit malfunction, no rear stream 2 HO2S circuit malfunction, no rear stream 2 HO2S functional DTCs, no rear stream 2 HO2S response rate malfunction.
Monitoring Duration	5 seconds to register a malfunction

Typical UEGO "FAOS Monitor" entry conditions:		
Entry condition	Minimum	Maximum
Closed loop stoich fuel control		
Time since engine start	20 seconds	
Engine Coolant Temp	160 ºF	250 ºF
Time since entering closed loop fuel	20 seconds	
Fuel Level	15%	
Short Term Fuel Trim Range	-13%	18%
Air mass range	2 lbm/min	8 lbm/min
Learning conditions stability time (based on air mass)	15 seconds	
Injector fuel pulse width (not at minimum clip)	650 usec	
Inferred HO2S 2 Heated Tip Temperature	1100 ºF	
No excessive movement between currently utilized long term fuel trim cells (1 = complete change from one cell to adjacent cell)		0.5
UEGO sensor within +/- 2 % from the fuel control target		
UEGO ASIC not in recalibration mode		
Stream1 UEGO response test not running		
Intrusive UEGO catalyst monitor not running		
Not performing intrusive UEGO Lack-of-Movement fuel control defib		
No air passing through during valve overlap (scavenging).		
Battery Voltage	11.0 Volts	18.0 Volts

Typical UEGO "FAOS Monitor" malfunction thresholds:
>= 5 seconds since reaching the FAOSC lean or rich limits while system bias maturity is met.
Lean malfunction: -0.083 rear bias trim limit
Rich malfunction: 0.087 rear bias trim limit

Air Fuel Ratio Imbalance Monitor – O2 Sensor Monitor

Air Fuel Ratio Imbalance Operation	
DTCs	P219A – Bank 1 Air-Fuel Ratio Imbalance P219B – Bank 2 Air-Fuel Ratio Imbalance
Monitor execution	Once per driving cycle during closed loop
Monitor Sequence	Monitor runs after fuel monitor has adapted
Sensors OK	ECT, IAT, MAF, VSS, TP, ETC, FRP, DPFE EGR, VCT, VMV/EVMV, CVS, FTP, CKP, CMP, ignition coils, injectors, no misfire DTCs, no system failures affecting fuel, no EVAP gross leak failure, UEGO heaters OK, rear HO2S heaters OK, no "lack of switching" malfunction, no "lack of movement" malfunction, no UEGO circuit malfunction, no rear stream 2 HO2S circuit malfunction, no rear stream 2 HO2S functional DTCs, no rear stream 2 HO2S response rate malfunction.
Monitoring Duration	Time to complete monitor ranges from 300 to 700 seconds

Air Fuel Ratio Imbalance entry conditions:		
Entry condition	Minimum	Maximum
Closed Loop Fuel Control		
Engine Air Mass	2 lb/min	10 lb/min
Engine RPM Cell 0	1250 rpm	1700 rpm
Engine RPM Cell 1	1700 rpm	2100 rpm
Engine RPM Cell 2	2100 rpm	3400 rpm
Engine Load Cell 0	40%	70%
Engine Load Cell 1	50%	80%
Engine Load Cell 2	60%	90%
Engine Coolant Temp	150 ºF	250 ºF
Intake Air Temp	20 ºF	150 ºF
Throttle Position Rate of Change		0.122 v/100 msec
Fuel percentage from purge		40%
Fuel Level	15%	
Fuel monitor has adapted		
No purge on/off transition		
Fuel type leaning is complete (FFV only)		

Air Fuel Ratio Imbalance malfunction thresholds:
Imbalance Ratio Bank 1 > .75
Imbalance Ratio Bank 2 > .75

J1979 AFIMN MONITOR MODE $06 DATA			
Monitor ID	Test ID	Description	
$81	$80	Bank 1 imbalance-ratio and max. limit (P219A/P219B)	unitless
$82	$80	Bank 2 imbalance-ratio and max. limit (P219A/P219B)	unitless

Front HO2S Monitor

HO2S "Lack of Switching" Operation:	
DTCs	P2195 - Lack of switching, sensor indicates lean, Bank 1 P2196 - Lack of switching, sensor indicates rich, Bank 1 P2197 - Lack of switching, sensor indicates lean, Bank 2 P2198 - Lack of switching, sensor indicates rich, Bank 2
Monitor execution	continuous, from startup and while in closed loop fuel or open loop fuel due to HO2S fault
Monitor Sequence	None
Sensors OK	ECT, IAT, MAF, VSS, TP, ETC, FRP, DPFE EGR, VCT, VMV/EVMV, CVS, FTP, CKP, CMP, ignition coils, injectors, no misfire DTCs, no system failures affecting fuel, no EVAP gross leak failure, front HO2S heaters OK, no front HO2S over voltage
Monitoring Duration	30 seconds to register a malfunction

Typical HO2S "Lack of Switching" entry conditions:		
Entry condition	Minimum	Maximum
Closed Loop or Open Loop Requested due to HO2S fault		
Stream 1 HO2S not in CSD recovery mode		
No fuel flow entering thru PCV during cold start when flashing off fuel in oil (for O2 Sensor Stuck Rich DTCs only)		
No air passing through during valve overlap (scavenging).		
Inferred Ambient Temperature	-40 °F	
Time within entry conditions	10 seconds	
Fuel Tank Pressure		10 in H_2O
Fuel Level	15%	
Battery Voltage	11.0 Volts	18.0 Volts

Typical HO2S "Lack of Switching" malfunction thresholds:
< 5 switches since startup for > 30 seconds in test conditions or > 30 seconds since last switch while closed loop fuel

Front HO2S "Circuit Open/Shorted to Ground Test via HO2S Impedance Measurement" Operation:	
DTCs	P0131 HO2S11 Circuit Low Voltage (Bank 1 Sensor 1) P0151 HO2S21 Circuit Low Voltage (Bank 2 Sensor 1)
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	front HO2S heaters OK
Monitoring Duration	10 seconds to register a malfunction

Typical HO2S "Circuit Open/Shorted to Ground Test via HO2S Impedance Measurement" entry conditions:		
Entry condition	Minimum	Maximum
Closed Loop		
Inferred Stream 1 HO2S Temperature	680 ºF	1526 ºF (short to ground)
Inferred Stream 1 HO2S Element Temperature (applicable only if Stream 1 HO2S Impedance Monitor is enabled)	480 ºF	
Time Stream 1 HO2S inferred element temperature within 10% of the predicted steady state temperature (applicable only if Stream 1 HO2S Impedance Monitor is enabled)	1 second	
Sensor 1 HO2S heater-on time	60 seconds	
All injectors on (no Decel Fuel Shut Off)		
Not commanding lean lambda due to torque reduction		
Not requesting enrichment due to catalyst reactivation following decel fuel shut off		
Sensor 1 HO2S voltage (open circuit voltage fault band): Conti-Moto CBP-A2 PCM Other PCMs or depending on feedback circuit	 -0.05 Volts 0.27 Volts 1.30 Volts	 0.05 Volts 0.50 Volts 1.90 Volts
Sensor 1 HO2S voltage (circuit shorted to ground voltage fault band):	-3.00 Volts	0.06 Volts
Voltage at sensor 1 HO2S connector	11.0 Volts	
Battery Voltage	11.0 Volts	18.0 Volts

Typical HO2S "Circuit Open/Shorted to Ground Test" malfunction thresholds:

HO2S Circuit Open:

HO2S Impedance > 500k ohms (Conti-Moto CBP-A2, Conti-Siemens CBP-C2, Bosch Green Oak, Bosch MED ECM, Conti EMS22xx processors)

> 250k ohms (Conti EMS22xx, Conti EMS23xx, Conti EMS24xx without feedback circuit processors)

> 150k ohms (Bosch MEDG, Bosch MED ECM with feedback circuit, Bosch MG1 multicore, Bosch ME processors)

> 20k ohms (Conti EMS24xx with feedback circuit, Conti EMX25xx, Conti EMS27xx, Conti EMS28xx, Conti EMS290x, Conti EMS295x processors)

Fault counter > 14 (200 msec test every 500 msec check)

HO2S Circuit Shorted to ground:

HO2S Impedance < 10 ohms

Fault counter > 17 (100 msec test every 500 msec check)

HO2S "Over Voltage Test" Operation:	
DTCs	P0132 – O2 Sensor Circuit High Voltage, Bank 1 P0152 - O2 Sensor Circuit High Voltage, Bank 2
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	front HO2S heaters OK
Monitoring Duration	10 seconds to register a malfunction

Typical HO2S "Over Voltage Test" entry conditions:		
Entry condition	Minimum	Maximum
Inferred Stream 1 HO2S temperature	400 ºF	
Battery Voltage	11.0 Volts	18.0 Volts

Typical HO2S "Over Voltage Test" malfunction thresholds:
HO2S Voltage > 1.1 volts or 1.9 volts (pending on feedback circuit) for 10 seconds for over voltage test

HO2S Response Rate Operation:	
DTCs	P0133 - O2 Sensor Circuit Slow Response Bank 1) P0153 - O2 Sensor Circuit Slow Response Bank 2)
Monitor execution	once per driving cycle
Monitor Sequence	> 30 seconds time in lack of switch test
Sensors OK	ECT, IAT, MAF, VSS, TP, ETC, FRP, DPFE EGR, VCT, VMV/EVMV, CVS, FTP, CKP, CMP, ignition coils, injectors, no misfire DTCs, no system failures affecting fuel system, no EVAP gross leak failure, no "lack of switching" malfunctions, front HO2S heaters OK no front HO2S over voltage
Monitoring Duration	6 seconds

Typical HO2S response rate entry conditions:		
Entry condition	Minimum	Maximum
Stream 1 HO2S not in CSD recovery mode		
Flex Fuel Composition not changing		
Not in Phase 0 of Evaporative System Monitor		
No Purge System reset		
Purge intrusive test not running		
Not performing CSER spark retard		
Engine Coolant Temp	150 ºF	240 ºF
Intake Air Temp		140 ºF
Time since entering closed loop fuel	10 seconds	
Inferred Catalyst Midbed Temperature		1600 ºF
Fuel Level	15%	
Short Term Fuel Trim Range	-9%	11%
Short Term Fuel Trim Absolute Change while in monitor		10%
Engine Load	20%	50%
Maximum change in engine load while in monitor		0.13
Vehicle Speed	30 mph	80 mph
Maximum change in vehicle speed while in monitor		3 mph
Engine RPM	1000 rpm	2000 rpm
Maximum change in engine rpm while in monitor		150 rpm
Battery Voltage	11.0 Volts	18.0 Volts

Typical HO2Sresponse rate malfunction thresholds:
Voltage amplitude: < 0.5 volts

J1979 Front HO2S Mode $06 Data			
Monitor ID	Test ID	Description	
$01	$80	HO2S11 voltage amplitude and voltage threshold P0133)	Volts
$01	$01	H02S11 sensor switch-point voltage	Volts
$05	$80	HO2S21 voltage amplitude and voltage threshold P0153)	Volts
$05	$01	H02S21 sensor switch-point voltage	Volts

Front HO2S Heaters

HO2S Heater Monitor Operation:	
DTCs Sensor 1	P0030 – HO2S11 Heater Control Circuit, Bank 1 P0050 – HO2S21 Heater Control Circuit, Bank 2 P0135 - O2 Sensor Heater Circuit, Bank 1 P0155 - O2 Sensor Heater Circuit, Bank 2 P0053 - HO2S Heater Resistance, Bank 1 P0059 - HO2S Heater Resistance, Bank 2
Monitor execution	once per driving cycle for heater current, continuous for voltage monitoring and HO2S heater temperature control monitoring.
Monitor Sequence	Heater current monitor: Stream 1 HO2S response test completed (2010 MY and earlier), Stream 2 and 3 HO2S functional tests completed (2010 MY and earlier), HO2S heater voltage check completed. HO2S heater temperature control monitor: Stream 1 HO2S heater voltage check completed, Stream 1 HO2S circuit check completed, intrusive heater current monitor completed (if applicable).
Sensors OK	Heater current monitor: no HO2S heater voltage DTCs. HO2S heater temperature control monitor: Stream 1 HO2S heater voltage check completed, Stream 1 HO2S circuit check completed, intrusive heater current monitor completed (if applicable).
Monitoring Duration	< 10 seconds for heater voltage check, < 5 seconds for heater current check, >= 30 seconds for the HO2S heater temperature control monitor to register a malfunction.

Typical HO2S heater monitor entry conditions:		
Entry condition	Minimum	Maximum
Heater Voltage Test:		
Inferred HO2S 1 Temperature	150 ºF	1250 ºF
Battery Voltage	11.0	18.0 Volts
Heater Current Test:		
Inferred HO2S 1 Temperature	250 ºF	1250 ºF
HO2S 1 heater-on time	30 seconds	
Engine RPM		5000 rpm

Battery Voltage	11.0	18.0 Volts
HO2S Heater Temperature Control Monitor:		
Heater voltage test completed		
Stream 1 HO2S circuit check completed		
Intrusive heater current monitor completed (if applicable)		
Battery Voltage	11.0	18.0 Volts

Typical HO2S heater check malfunction thresholds:	
Smart driver status indicated malfunction	
Number monitor retries allowed for malfunction > = 30	
Heater current outside limits:	< 0.220 Amps or > 3 Amps, (NTK Thimble)
	< 0.400 Amps or > 3 Amps, (Bosch Thimble)
	< 0.550 Amps or > 3 Amps, (Bosch Planar)
	< 0.465 Amps or > 3 Amps, (NTK Fast Light Off)
	< 0.230 Amps or > 3 Amps, (Bosch Fast Light Off)

J1979 HO2S Heater Mode $06 Data			
Monitor ID	Test ID	Description	Units
$41	$81	HO2S11 Heater Current (P0053)	Amps
$45	$81	HO2S21 Heater Current (P0059)	Amps

Front UEGO Monitor

UEGO "Lack of Switching" Operation:	
DTCs	P2195 – Lack of switching, sensor indicates lean, Bank 1 P2196 – Lack of switching, sensor indicates rich, Bank 1 P2197 – Lack of switching, sensor indicates lean, Bank 2 P2198 – Lack of switching, sensor indicates rich, Bank 2
Monitor execution	continuous, from startup and while in closed loop fuel or open loop fuel due to UEGO sensor fault
Monitor Sequence	None
Sensors OK	ECT, IAT, MAF, MAP, VSS, TP, ETC, FRP, FVR, DPFE EGR, VCT, VMV/EVMV, CVS, CPV, EVAPSV, FTP, CKP, CMP, ignition coils, injectors, no misfire DTCs, no system failures affecting fuel, no EVAP gross leak failure, UEGO heaters OK, no "lack of movement" malfunction, no UEGO circuit malfunction
Monitoring Duration	30 seconds to register a malfunction

Typical UEGO "Lack of Switching" entry conditions:		
Entry condition	Minimum	Maximum
Closed Loop or Open Loop Requested due to UEGO sensor fault		
No fuel flow entering thru PCV during cold start when flashing off fuel in oil (for O2 Sensor Stuck Rich DTCs only)		
Inferred Ambient Temperature	-40 °F	
Time within entry conditions	10 seconds	
Fuel Tank Pressure		10 in H_2O
Fuel Level	15%	
UEGO ASIC not in recalibration mode		
No air passing through during valve overlap (scavenging).		
Battery Voltage	11.0 Volts	18.0 Volts

Typical UEGO "Lack of Switching" malfunction thresholds:
Stage 1: > 30 seconds since reaching the short term fuel trim limits while closed loop fuel.
Stage 2 (2016MY and earlier): < 0.5 seconds rich or < 0.5 seconds lean since startup for > 30 seconds in test conditions while open loop fuel is requested due to UEGO sensor fault.
Stage 2 (2017MY+): > 5 seconds since reaching the short term fuel trim limits while closed loop fuel.
Stuck UEGO test (2019MY+): Change in filtered lambda < 0.0001 for > 30 seconds and in fuel control defib mode for > 10 seconds. A stuck lean DTC (P2195, P2197) will set if filtered lambda is >= 1, and a stuck rich DTC (P2196, P2198) will set if filtered lambda is less than 1.

UEGO "Open Circuit Diagnostic – RE, VM " Operation (Bosch UEGO only using Bosch CJ125 or Conti-Siemens ATIC42 ASIC):	
DTCs	P2243 – O2 Sensor Reference Voltage Circuit/Open (Bank 1, Sensor 1). (replaces P0130) P2247 – O2 Sensor Reference Voltage Circuit/Open (Bank 2, Sensor 1). (replaces P0150) P2251 – O2 Sensor Negative Current Control Circuit/Open (Bank 1, Sensor 1) (replaces P0130) P2254 – O2 Sensor Negative Current Control Circuit/Open (Bank 2, Sensor 1) (replaces P0150)
Monitor execution	continuous
Monitor Sequence	Intrusive Stream 1 UEGO heater current monitor completed
Sensors OK	UEGO heaters OK, no UEGO circuit malfunction
Monitoring Duration	10 seconds to register a malfunction

Typical UEGO "Open Circuit Diagnostic – RE, VM " entry conditions (Bosch UEGO only using Bosch CJ125 or Conti-Siemens ATIC42 ASIC):		
Entry condition	Minimum	Maximum
UEGO ASIC not in recalibration mode		
All injectors on (no Decel Fuel Shut Off)		
Short term fuel trim		33%
Time heater control voltage at maximum limit during open loop heater control		9 seconds (Bosch UEGO) 20 seconds (NTK UEGO)
Time heater control voltage at maximum or minimum limit during closed loop heater control		7 seconds (Bosch UEGO) 1 second (NTK UEGO)
Battery Voltage	11.0 Volts	18.0 Volts

Typical UEGO "Open Circuit Diagnostic – RE, VM" malfunction thresholds (Bosch UEGO only using Bosch CJ125 or Conti-Siemens ATIC42 ASIC):
Open RE circuit: UEGO voltage: > 4.7 V or < 0.2 V for 10 seconds to set a DTC.
Open VM circuit: 1.45 V < UEGO voltage < 1.55 V for 10 seconds to set a DTC (Bosch CJ125). 1.95 V < UEGO voltage < 2.05 V for 10 seconds to set a DTC (Conti-Siemens ATIC42).

UEGO "Lack of Movement – Open Pump Current Circuit" Operation (Bosch UEGO only using Bosch CJ125 or Conti-Siemens ATIC42 ASIC):	
DTCs	P2237 – O2 Sensor Positive Current Control Circuit/Open (Bank 1, Sensor 1) (replaces P0134) P2240 – O2 Sensor Positive Current Control Circuit/Open (Bank 2, Sensor 1) (replaces P0154)
Monitor execution	continuous, from startup and while in closed loop fuel or open loop fuel due to UEGO sensor fault
Monitor Sequence	None
Sensors OK	ignition coils, injectors, no misfire DTCs, no system failures affecting fuel, UEGO heaters OK, no "lack of switching" malfunction, no "lack of movement- open reference ground circuit" malfunction, no UEGO circuit malfunction
Monitoring Duration	10 - 20 seconds to register a malfunction

Typical UEGO "Lack of Movement – Open Pump Current Circuit " entry conditions (Bosch UEGO only using Bosch CJ125 or Conti-Siemens ATIC42 ASIC):		
Entry condition	Minimum	Maximum
Closed Loop or Open Loop Requested due to UEGO sensor fault		
Constant lambda near stoich (~1)	0.99	1.01
Time since no lambda activity seen since start up	30 sec	
Time since no lambda activity during intrusive Stream 1 response monitor	3 sec	
Inferred Ambient Temperature	- 40 °F	
Injector fuel pulsewidth	650 usec	
UEGO ASIC not in recalibration mode		
No air passing through during valve overlap (scavenging).		
Battery Voltage	11.0 Volts	18.0 Volts

Typical UEGO "Lack of Movement – Open Pump Current Circuit" malfunction thresholds (Bosch UEGO only using Bosch CJ125 or Conti-Siemens ATIC42 ASIC):
Stage 1: > 20 seconds in test conditions without lambda movement during fuel control and reference current "defib" while in closed loop fuel and < = 0.05 change in lambda movement. Stage 2: < 0.2 seconds without lambda movement since startup for > 30 seconds in test conditions during reference current "defib" while open loop fuel is requested due to UEGO sensor fault and < = 0.05 change in lambda movement.

UEGO "Lack of Movement – Open Reference Ground Circuit " Operation (Bosch UEGO only using Bosch CJ125 or Conti-Siemens ATIC42 ASIC):	
DTCs	P2251 – O2 Sensor Negative Current Control Circuit/Open (Bank 1, Sensor 1) (replaces P0130) P2254 – O2 Sensor Negative Current Control Circuit/Open (Bank 2, Sensor 1) (replaces P0150)
Monitor execution	continuous, from startup and while in closed loop fuel or open loop fuel due to UEGO sensor fault
Monitor Sequence	None
Sensors OK	ignition coils, injectors, no misfire DTCs, no system failures affecting fuel, UEGO heaters OK, no "lack of switching" malfunction, no "lack of movement- open pump current circuit" malfunction, no UEGO circuit malfunction
Monitoring Duration	10 - 20 seconds to register a malfunction

Typical UEGO "Lack of Movement – Open Reference Ground Circuit " entry conditions (Bosch UEGO only using Bosch CJ125 or Conti-Siemens ATIC42 ASIC):		
Entry condition	Minimum	Maximum
Closed Loop or Open Loop Requested due to UEGO sensor fault		
Constant lambda near stoich (~1)	0.99	1.01
Time since no lambda activity seen since start up	30 sec	
Time since no lambda activity during intrusive Stream 1 response monitor	3 sec	
Injector fuel pulsewidth	650 usec	
UEGO ASIC not in recalibration mode		
No air passing through during valve overlap (scavenging).		
Battery Voltage	11.0 Volts	18.0 Volts

Typical UEGO "Lack of Movement – Open Reference Ground Circuit" malfunction thresholds (Bosch UEGO only using Bosch CJ125 or Conti-Siemens ATIC42 ASIC):
Stage 1: > 20 seconds in test conditions without lambda movement during fuel control and reference current "defib" while in closed loop fuel and > 0.05 change in lambda movement. Stage 2: > 20 seconds in test conditions without lambda movement during reference current "defib" while open loop fuel is requested due to UEGO sensor fault and > 0.05 change in lambda movement.

UEGO "Wire Diagnostic via ASIC" Operation:	
DTCs	P0131 – O2 Sensor Circuit Low Voltage (Bank 1, Sensor 1). Note: Sets for short to ground on Bosch UEGO- IP, IA, RE, VM; NTK UEGO – IP, VS, COM. (replaces P0130 in Bosch UEGO applications.) P0151 – O2 Sensor Circuit Low Voltage (Bank 2, Sensor 1). Note: Sets for short to ground on Bosch UEGO- IP, IA, RE, VM; NTK UEGO – IP, VS, COM. (replaces P0150 in Bosch UEGO applications.) P0132 – O2 Sensor Circuit High Voltage (Bank 1, Sensor 1). Note: Sets for short to battery on Bosch UEGO- IP, IA, RE, VM; NTK UEGO – IP, VS, COM. (replaces P0130 in Bosch UEGO applications.) P0152 – O2 Sensor Circuit High Voltage (Bank 2, Sensor 1). Note: Sets for short to battery on Bosch UEGO- IP, IA, RE, VM; NTK UEGO – IP, VS, COM. (replaces P0150 in Bosch UEGO applications.) P2237 – O2 Sensor Positive Current Control Circuit/Open (Bank 1, Sensor 1). Note: This DTC sets for open IP. (replaces P0130 in NTK UEGO applications.) P2240 – O2 Sensor Positive Current Control Circuit/Open (Bank 2, Sensor 1). Note: Sets for open IP. (replaces P0150 in NTK UEGO applications.) P2243 – O2 Sensor Reference Voltage Circuit/Open (Bank 1, Sensor 1). Note: Sets for open VS. (replaces P0130 in NTK UEGO applications.) P2247 – O2 Sensor Reference Voltage Circuit/Open (Bank 2, Sensor 1). Note: Sets for open VS. (replaces P0150 in NTK UEGO applications.) P2251 – O2 Sensor Negative Current Control Circuit/Open (Bank 1, Sensor 1). Note: Sets for open COM. (replaces P0130 in NTK UEGO applications.) P2254 – O2 Sensor Negative Current Control Circuit/Open (Bank 2, Sensor 1). Note: Sets for open COM. (replaces P0150 in NTK UEGO applications.) P164A – O2 Sensor Positive Current Trim Circuit Performance (Bank 1, Sensor 1). Note: Sets for an erratic RL in NTK UEGO applications only. P164B – O2 Sensor Positive Current Trim Circuit Performance (Bank 2, Sensor 1). Note: Sets for an erratic RL in NTK UEGO applications only. P2626 - O2 Sensor Positive Current Trim Circuit Open (Bank 1, Sensor 1) P2629 - O2 Sensor Positive Current Trim Circuit Open (Bank 2, Sensor 1) P2627 – O2 Sensor Positive Current Trim circuit Low (Bank 1, Sensor 1). Note: Sets for open or short to ground RL in NTK UEGO applications only. P2630 – O2 Sensor Positive Current Trim Circuit Low (Bank 2, Sensor 1). Note: Sets for open or short to ground RL in NTK UEGO applications only. P2628 – O2 Sensor Positive Current Trim Circuit High (Bank 1, Sensor 1). Note: Sets for short to battery RL in NTK UEGO applications only. P2631 – O2 Sensor Positive Current Trim Circuit High (Bank 2, Sensor 1). Note: Sets for short to battery RL in NTK UEGO applications only. P1646 – Linear O2 Sensor Control Chip, Bank 1. P1647 – Linear O2 Sensor Control Chip, Bank 2. P064D – Internal Control Module O2 Sensor Processor Performance (Bank 1). P064E – Internal Control Module O2 Sensor Processor Performance (Bank 2).
Monitor execution	continuous
Monitor Sequence	None

Sensors OK	UEGO heaters OK
Monitoring Duration	10 seconds to register a malfunction

Typical UEGO "Wire Diagnostics via ASIC" entry conditions:		
Entry condition	Minimum	Maximum
Fault reported by UEGO ASIC		
Battery Voltage	11.0 Volts	18.0 Volts

Typical UEGO "Wire Diagnostics via ASIC " malfunction thresholds:
UEGO ASIC indicated malfunction, DTC sets after 10 seconds when circuit failure is present.

UEGO "Air Rationality Test" Operation (Bosch UEGO only using Bosch CJ125 or Conti-Siemens ATIC42 ASIC):	
DTCs	P2626 – O2 Sensor Positive Current Trim Circuit Open (Bank 1, Sensor 1) P2629 – O2 Sensor Positive Current Trim Circuit Open (Bank 2, Sensor 1)
Monitor execution	continuous, every DFSO event
Monitor Sequence	Stream 1 UEGO heater voltage check completed, > 30 seconds time in lack of movement test, > 30 seconds time in lack of switch test
Sensors OK	FTP, injectors, UEGO heaters OK, no "lack of switching" malfunction, no "lack of movement" malfunction, no purge system failure, no UEGO circuit malfunction, no UEGO FAOS monitor malfunction, no front UEGO response rate malfunction
Monitoring Duration	2 seconds to register a malfunction

Typical UEGO "Air Rationality Test" entry conditions (Bosch UEGO only using Bosch CJ125 or Conti-Siemens ATIC42 ASIC):		
Entry condition	Minimum	Maximum
No injectors stuck open		
No purge system failure		
Fuel Tank Pressure		10 in H_2O
Closed pedal		
DFSO entry conditions met		
DFSO requested		
DFSO injectors cut		
No purge flow being requested (pass criteria only)		
No fuel flow entering thru PCV during cold start when flashing off fuel in oil (pass criteria only)		
Transport delay (pass criteria only)	2 sec	
UEGO ASIC not in recalibration mode		

Battery Voltage	11.0 Volts	18.0 Volts

Typical UEGO "Air Rationality Test" malfunction thresholds (Bosch UEGO only using Bosch CJ125 or Conti-Siemens ATIC42 ASIC):
UEGO voltage: > 4.55 V (max UEGO sensor voltage in air, normal range) or > 3.0 V (max UEGO sensor voltage in air, wide range) for >= 2 seconds in test conditions. UEGO pumping current: > 0.00309 Amps for >= 2 seconds in test conditions.

Front UEGO Slow/Delayed Response Monitor (2010 MY+)

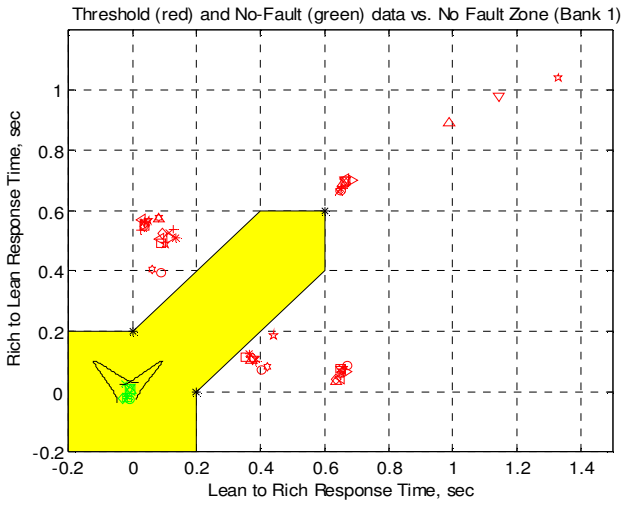
UEGO "Response Rate" Operation:	
DTCs	P0133 - O2 Sensor Circuit Slow/Delayed Response Bank 1 P0153 - O2 Sensor Circuit Slow/Delayed Response Bank 2
Monitor execution	once per driving cycle
Monitor Sequence	> 30 seconds time in lack of movement test, > 30 seconds time in lack of switch test
Sensors OK	ECT, IAT, MAF, MAP, VSS, TP, ETC, FRP, FVR, DPFE EGR, VCT, VMV/EVMV, CVS, CPV, EVAPSV, FTP, CKP, CMP, ignition coils, injectors, no misfire DTCs, no system failures affecting fuel, no EVAP gross leak failure, UEGO heaters OK, no "lack of switching" malfunction, no "lack of movement" malfunction, no UEGO circuit malfunction, no UEGO FAOS monitor malfunction
Monitoring Duration	12 seconds

Typical UEGO "Response Rate" entry conditions:		
Entry condition	Minimum	Maximum
Flex Fuel Composition not changing		
Not in Phase 0 of Evap Monitor, Purge intrusive test not running		
No Purge System reset		
Not performing CSER spark retard		
Not performing intrusive UEGO Lack of Movement "defib"		
No IMRC transition in progress before entering the monitor and while in monitor		
Engine Coolant Temp	150 ºF	240 ºF
Intake Air Temp		140 ºF
Time since entering closed loop fuel	10 seconds	
Inferred Catalyst Midbed Temperature		1600 ºF
Fuel Level	15%	
Short Term Fuel Trim Range	-5%	5%
Short Term Fuel Trim Absolute Change while in monitor		15%
Air Mass	1.2 lbs/min	
Engine Load	20%	70%
Maximum change in engine load while in monitor		0.25
Vehicle Speed	35 mph	80 mph
Maximum change in vehicle speed while in monitor		9 mph
Engine RPM	1000 rpm	3000 rpm
Maximum change in engine rpm while in monitor		150 rpm
Commanded versus actual lambda range while in monitor	0.85	1.15
No excessive cam angle movement over a half cycle A/F modulation when exhaust cam position is >= 40 degree or intake cam position >=		3 degree

-10 degree to indicate an acceptable A/F disturbance due to cam angle movement.		
No excessive movement between currently utilized long term fuel trim cells (1 = complete change from one cell to adjacent cell)		0.5
No excessive change in fuel injection ratio		50%
UEGO ASIC not in recalibration mode		
No air passing through during valve overlap (scavenging).		
Battery Voltage	11.0 Volts	18.0 Volts

Typical UEGO "Response Rate" malfunction thresholds:

Threshold depends on failure type (symmetric slow/delay vs. Asymmetric slow/delay)



Example shown with lean-to-rich (0.2 sec), rich-to-lean (0.2 sec), and symmetric (0.6 sec) thresholds creating the yellow no-fault zone. The completeted monitor results in two measurements, a lean-to-rich response time and a rich-to-lean response time. These response time values are used as x-y pairs to make a single point and then compared to the no-fault zone. Anywhere in the yellow is a pass and outside the yellow is a failure.

J1979 Front UEGO Mode $06 Data

Monitor ID	Test ID	Description	
$01	$87	UEGO11 Rich to Lean Response Time (P0133)	seconds
$01	$88	UEGO11 Lean to Rich Response Time (P0133)	seconds
$05	$87	UEGO21 Rich to Lean Response Time (P0153)	seconds
$05	$88	UEGO21 Lean to Rich Response Time (P0153)	seconds

UEGO "Response Rate" Operation:	
DTCs	P0133 - O2 Sensor Circuit Slow/Delayed Response Bank 1 P0153 - O2 Sensor Circuit Slow/Delayed Response Bank 2
Monitor execution	once per driving cycle
Monitor Sequence	Measurements of response and delay are done on DFSO entry and DFSO exit. DFSO events are created during vehicle deceleration or coast Three measurements of rich to lean and lean to rich are required (calibratable).
Sensors OK	ECT, IAT, MAF, MAP, VSS, TP, ETC, FRP, FVR, DPFE EGR, VCT, VMV/EVMV, CVS, CPV, EVAPSV, FTP, CKP, CMP, ignition coils, injectors, no misfire DTCs, no system failures affecting fuel, no EVAP gross leak failure, UEGO heaters OK, no "lack of switching" malfunction, no "lack of movement" malfunction, no UEGO circuit malfunction, no UEGO FAOS monitor malfunction
Monitoring Duration	Three (calibratable) 2 second long DFSO entry events Three (calibratable) 2 second long DFSO exit events

Typical UEGO "Response Rate" entry conditions:		
Entry condition	**Minimum**	**Maximum**
Flex Fuel Composition not changing		
Not in Phase 0 of Evap Monitor, Purge intrusive test not running		
No Purge System reset		
Not performing CSER spark retard		
Not performing intrusive UEGO Lack of Movement "defib"		
Engine Coolant Temp	150 ºF	240 ºF
Inferred Catalyst Midbed Temperature		1600 ºF
Fuel Level	15%	
Air Mass, DFSO Entry	0.6 lb/min	1.2 lb/min
Air mass, DFSO exit	0.6 lb/min	3 lb/min
Engine Load	10%	80%
Vehicle Speed	0 mph	80 mph
Engine RPM, rich to lean	1200 rpm	3000 rpm

Engine RPM, lean to rich	500 rpm	3000 rpm
UEGO ASIC not in recalibration mode		
No air passing through during valve overlap (scavenging).		
Battery Voltage	11.0 Volts	18.0 Volts

Typical UEGO Response and Delay malfunction thresholds:

Symmetric response fault:

UEGO rich To lean average time constant > 0.55 s
<AND>
UEGO lean to rich average time constant > 0.55 s

Rich to lean response fault

UEGO rich to lean average time constant > 0.55 s

Lean to rich response fault

UEGO lean to rich average time constant > 0.55 s

Symmetric delay fault

UEGO rich to lean average delay > 0.4 s
<AND>
UEGO lean to rich average delay > 0.4 s

Rich to lean delay

UEGO rich to lean average delay > 0.55 s

Lean to rich delay

UEGO lean to rich average delay > 0.55 s

Typical UEGO Response and Delay Compensation thresholds:

Symmetric response fault:

UEGO rich To lean average time constant > large number (typically not used)

<AND>

UEGO lean to rich average time constant > large number (typically not used)

Rich to lean response fault

UEGO rich to lean average time constant > large number (typically not used)

Lean to rich response fault

UEGO lean to rich average time constant > large number (typically not used)

Symmetric delay fault

UEGO rich to lean average delay > 0.3 s <AND> UEGO lean to rich average delay > 0.3 s

< OR if UEGO diagnostic has not yet completed >

Closed loop fuel TD offset rich to lean > 0.3 s <AND> Closed loop fuel TD offset lean to rich > 0.3 s

Rich to lean delay

UEGO rich to lean average delay > large number (typically not used)

Lean to rich delay

UEGO lean to rich average delay > large number (typically not used)

J1979 Front UEGO Mode $06 Data			
Monitor ID	Test ID	Description	
$01	$89	UEGO11 Rich to Lean Response Time (P0133)	seconds
$01	$8A	UEGO11 Lean to Rich Response Time (P0133)	Seconds
$01	$8C	UEGO11 Rich To Lean Delay (P0133)	seconds
$01	$8D	UEGO11 Lean To Rich Delay (P0133)	Seconds
$05	$89	UEGO21 Rich to Lean Response Time (P0153)	seconds
$05	$8A	UEGO21 Lean to Rich Response Time (P0153)	Seconds
$05	$8C	UEGO21 Rich To Lean Delay (P0153)	seconds
$05	$8D	UEGO21 Lean To Rich Delay (P0153)	Seconds

UEGO Heaters

UEGO Heater Monitor Operation:	
DTCs	P0030 – HO2S Heater Control Circuit, Bank 1 P0050 – HO2S Heater Control Circuit, Bank 2 P0135 - HO2S Heater Circuit, Bank 1 P0155 - HO2S Heater Circuit, Bank 2 P0053 - HO2S Heater Resistance, Bank 1 P0059 - HO2S Heater Resistance, Bank 2
Monitor execution	once per driving cycle for heater current monitor, continuous for voltage monitoring and UEGO heater temperature control monitoring
Monitor Sequence	Heater current monitor: Stream 1 UEGO response test completed (2010 MY and earlier), Stream 2 and 3 HO2S functional tests completed (2010 MY and earlier), Stream 1 UEGO heater voltage check completed. UEGO heater temperature control monitor: Stream 1 UEGO heater voltage check completed, Stream 1 UEGO circuit check completed, intrusive heater current monitor completed (if applicable).
Sensors OK	Heater current monitor: no HO2S/UEGO heater circuit malfunction, no UEGO heater temperature control malfunction, no UEGO circuit malfunction UEGO heater temperature control monitor: no UEGO circuit malfunction, no UEGO heater circuit malfunction, no UEGO heater current monitor DTCs.
Monitoring Duration	< 10 seconds for heater voltage check, < 5 seconds for heater current check, >= 30 seconds for the UEGO heater temperature control monitor to register a malfunction

Typical UEGO heater monitor entry conditions:		
Entry condition	Minimum	Maximum
Inferred UEGO unheated tip temperature (heater voltage check only)	75 ºF	1706 ºF
Inferred UEGO heated tip temperature (heater current check only)	1346 ºF	1616 ºF
UEGO heater-on time (heater current check only)	30 seconds	
Engine RPM (heater current check only)		5000 rpm
Time heater control voltage at maximum limit during open loop heater control (intrusive heater current check only		9 seconds (Bosch UEGO) 20 seconds (NTK UEGO)
Time heater control voltage at maximum or minimum limit during closed loop heater control (intrusive heater current check only)		7 seconds (Bosch UEGO) 1 second (NTK UEGO)
Inferred UEGO unheated tip temperature (heater control monitor only)	75 ºF	1000 ºF
UEGO ASIC not in recalibration mode		
Battery Voltage	11.0 Volts	18.0 Volts

Typical UEGO heater check malfunction thresholds:

Smart driver status indicated malfunction (heater voltage check)

Number monitor retries allowed for malfunction > = 30 (heater voltage check)

Heater current outside limits:

< 1.0 Amps or > 3 Amps (intrusive test) or < 0.55 Amps or > 3 Amps (Bosch UEGO)

< 1.45 Amps or > 3 Amps (intrusive test) or < 1.05 Amps or > 3 Amps (NTK UEGO)

< 1.62 Amps or > 3.80 Amps (intrusive test) or < 1.12 Amps or > 3.80 Amps (Conti-Moto CBP-A2 PCM with NTK UEGO)

UEGO heater temperature control monitor: > = 30 seconds to register a malfunction while the heater control integrator is at its maximum or minimum limit

J1979 UEGO Heater Mode $06 Data

Monitor ID	Test ID	Description	Units
$41	$81	HO2S11 Heater Current (P0053)	Amps
$45	$81	HO2S21 Heater Current (P0059)	Amps

Rear HO2S Monitor

Rear HO2S Signal

Rear HO2S Functional Check Operation:	
DTCs Sensor 2	P0136 - HO2S12 No activity or P2270 - HO2S12 Signal Stuck Lean P2271 - HO2S12 Signal Stuck Rich P0156 - HO2S22 No activity or P2272 - HO2S22 Signal Stuck Lean P2273 - HO2S22 Signal Stuck Rich
Monitor execution	once per driving cycle for activity test
Monitor Sequence	> 30 seconds time in lack of movement test (UEGO only), > 30 seconds time in lack of switch test, front HO2S/UEGO response test completed, Stream 2 HO2S circuit open/short to ground test time slice completed.
Sensors OK	ECT, IAT, MAF, MAP, VSS, TP, ETC, FRP, FVR, DPFE EGR, VCT, VMV/EVMV, CVS, CPV, EVAPSV, FTP, CKP, CMP, ignition coils, injectors, no misfire DTCs, no system failures affecting fuel, no EVAP gross leak failure, UEGO/HO2S (front and rear) heaters OK, no "lack of switching" malfunction, no "lack of movement" malfunction (UEGO only), no UEGO/HO2S (front and rear) circuit malfunction, no rear HO2S out of range low malfunction, no UEGO FAOS monitor malfunction, no front HO2S/UEGO response rate malfunction
Monitoring Duration	continuous until monitor completed

Typical Rear HO2S functional check entry conditions:		
Entry condition	Minimum	Maximum
Stream 1 HO2S not in CSD recovery mode		
Flex Fuel Composition not changing		
Not in Phase 0 of Evaporative System Monitor		
No Purge System reset		
Purge intrusive test not running		
Not performing CSER spark retard		
Engine Coolant Temp	150 ºF	240 ºF
Intake Air Temp		140 ºF
Time since entering closed loop fuel	10 seconds	
Inferred Catalyst Midbed Temperature		1600 ºF
Heater-on Inferred Sensor(s) 2/3 HO2S Temperature Range	400 ºF	1400 ºF
Sensor(s) 2/3 HO2S heater-on time	90 seconds	
Short Term Fuel Trim Range	-9%	11%
Fuel Level (forced excursion only)	15%	
Throttle position	Part throttle	

Engine RPM (forced excursion only)	1000 rpm	2000 rpm
UEGO ASIC not in recalibration mode		
No air passing through during valve overlap (scavenging).		
Battery Voltage	11.0 Volts	18.0 Volts

Typical Rear HO2S functional check malfunction thresholds:
Does not exceed rich and lean HO2S voltage threshold envelope: Rich < 0.42 volts Lean > 0.48 volts

J1979 Rear HO2S Functional Check Mode $06 Data			
Monitor ID	Test ID	Description	
$02	$01	HO2S12 sensor switch-point voltage	volts
$06	$01	HO2S22 sensor switch-point voltage	volts

Rear HO2S "Over Voltage Test" Operation:	
DTCs	P0138 - HO2S12 Circuit High Voltage P0158 - HO2S22 Circuit High Voltage
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	rear HO2S heaters OK
Monitoring Duration	10 seconds to register a malfunction

Typical HO2S "Over Voltage Test" entry conditions:		
Entry condition	Minimum	Maximum
Inferred Stream 2/3 HO2S Temperature	400 °F	
Sensor(s) 2/3 HO2S heater-on time	90 seconds	
Voltage at sensor 2 HO2S connector	11.0 Volts	
Battery Voltage	11.0 Volts	18.0 Volts

Typical HO2S "Over Voltage Test" malfunction thresholds:
HO2S Voltage > 1.1 volts or 1.9 volts (pending on feedback circuit) for 10 seconds for over voltage test

Rear HO2S "Out of Range Low Test" Operation:	
DTCs	P2A01 HO2S12 Circuit Range/Performance (Bank 1 Sensor 2) P2A04 HO2S22 Circuit Range/Performance (Bank 2 Sensor 2)
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	rear HO2S heaters OK, no rear HO2S shorted to ground malfunction
Monitoring Duration	10 seconds to register a malfunction

Typical HO2S "Out of Range Low Test" entry conditions:		
Entry condition	Minimum	Maximum
Inferred Stream 2 HO2S Temperature	400 ºF	
Sensor 2 HO2S heater-on time	90 seconds	
Voltage at sensor 2 HO2S connector	11.0 Volts	
Battery Voltage	11.0 Volts	18.0 Volts

Typical HO2S "Out of Range Low Test" malfunction thresholds:
HO2S Voltage < -0.2 volts for 10 seconds for out of range low test

Rear HO2S "Circuit Open/Shorted to Ground Test via HO2S Impedance Measurement" Operation:	
DTCs	P0137 HO2S12 Circuit Low Voltage (Bank 1 Sensor 2) P0157 HO2S22 Circuit Low Voltage (Bank 2 Sensor 2)
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	rear HO2S heaters OK, no rear HO2S out of range low malfunction, no rear HO2S functional DTCs
Monitoring Duration	10 seconds to register a malfunction

Typical HO2S "Circuit Open/Shorted to Ground Test via HO2S Impedance Measurement" entry conditions:		
Entry condition	Minimum	Maximum
Closed Loop		
Inferred Stream 2 HO2S Temperature	680 ºF	1526 ºF (short to ground)
Inferred Stream 2 HO2S Element Temperature (applicable only if Stream 2 HO2S Impedance Monitor is enabled)	480 ºF	
Time Stream 2 HO2S inferred element temperature within 10% of the predicted steady state temperature (applicable only if Stream 2 HO2S Impedance Monitor is enabled)	1 second	
Sensor 2 HO2S heater-on time	60 seconds	
All injectors on (no Decel Fuel Shut Off)		
Not commanding lean lambda due to torque reduction		
Not requesting enrichment due to catalyst reactivation following decel fuel shut off		
Sensor 2 HO2S voltage (open circuit voltage fault band): Conti-Moto CBP-A2 PCM Other PCMs or depending on feedback circuit	 -0.05 Volts 0.27 Volts 1.30 Volts	 0.05 Volts 0.50 Volts 1.90 Volts
Sensor 2 HO2S voltage (circuit shorted to ground voltage fault band):	-3.00 Volts	0.06 Volts
Voltage at sensor 2 HO2S connector	11.0 Volts	
Battery Voltage	11.0 Volts	18.0 Volts

Typical HO2S "Circuit Open/Shorted to Ground Test" malfunction thresholds:

HO2S Circuit Open:

HO2S Impedance > 500k ohms (Conti-Moto CBP-A2, Conti-Siemens CBP-C2, Bosch Green Oak, Bosch MED ECM, Conti EMS22xx processors)

> 250k ohms (Conti EMS22xx, Conti EMS23xx, Conti EMS24xx without feedback circuit processors)

> 150k ohms (Bosch MEDG, Bosch MED ECM with feedback circuit, Bosch MG1 multicore, Bosch ME processors)

> 20k ohms (Conti EMS24xx with feedback circuit, Conti EMX25xx, Conti EMS27xx, Conti EMS28xx, Conti EMS290x, Conti EMS295x processors)

Fault counter > 14 (200 msec test every 500 msec check)

HO2S Circuit Shorted to ground:

HO2S Impedance < 10 ohms

Fault counter > 17 (100 msec test every 500 msec check)

HO2S "Wire Diagnostics via ASIC" Operation:	
DTCs	P0137 - HO2S12 Circuit Low Voltage (Bank 1 Sensor 2) P0157 - HO2S22 Circuit Low Voltage (Bank 2 Sensor 2) P0138 - HO2S12 Circuit High Voltage P0158 - HO2S22 Circuit High Voltage
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	HO2S heaters OK
Monitoring Duration	10 seconds to register a malfunction

Typical HO2S "Wire Diagnostics via ASIC" entry conditions:		
Entry condition	Minimum	Maximum
Fault reported by UEGO ASIC		
Battery Voltage	11.0 Volts	18.0 Volts

Typical HO2S "Wire Diagnostics via ASIC " malfunction thresholds:
UEGO ASIC indicated malfunction, DTC sets after 10 seconds when circuit failure is present.

Rear HO2S Decel Fuel Shut Off Response Test (2009 MY+)

Rear O2 DFSO Response Monitor Operation:	
DTCs	P013A – O2 Sensor Slow Response – Rich to Lean (Bank 1 Sensor 2) P013C – O2 Sensor Slow Response – Rich to Lean (Bank 2 Sensor 2) Model year 2018 and previous: P013E – O2 Sensor Delayed Response – Rich to Lean (Bank 1 Sensor 2) (sensor stuck in range) P014A – O2 Sensor Delayed Response – Rich to Lean (Bank 2 Sensor 2) (sensor stuck in range) Model year 2019 and later: P2270 – O2 sensor stuck lean (bank 1 sensor 2) P2271 – O2 sensor stuck rich (bank 1 sensor 2) P2272 – O2 sensor stuck lean (bank 2 sensor 2) P2273 – O2 sensor stuck rich (bank 2 sensor 2)
Monitor execution	Once per driving cycle, after 3 DFSO events, with a “learn ahead” additional 3 DFSO events
Monitor Sequence	> 30 seconds time in lack of movement test (UEGO only), > 30 seconds time in lack of switch test, front HO2S/UEGO response test completed, HO2S 2 and 3 functional tests completed, HO2S/UEGO heater voltage and current checks completed,
Sensors OK	ECT, IAT, MAF, VSS, TP, ETC, FRP, EGR, VCT, VMV/EVMV, CVS, FTP, CKP, CMP, ignition coils, injectors, no misfire DTCs, no system failures affecting fuel, no EVAP gross leak failure, UEGO heaters OK, rear HO2S heaters OK, no "lack of switching" malfunction, no "lack of movement" malfunction, no UEGO circuit malfunction, no rear stream 2 HO2S circuit malfunction, no rear stream 2 HO2S functional DTCs, Not performing CSER spark retard. Flex fuel composition not changing. No intrusive EGO monitors running.
Monitoring Duration	3 DFSO events, 450 seconds on the FTP.

Typical DFSO Response Monitor entry conditions:		
Entry condition	Minimum	Maximum
Air Mass	0.5	6
Vehicle Speed		90
Engine Coolant Temp	155 ºF	240 ºF
Catalyst Temperature (Inferred)	800 ºF	1600 ºF
Rear Ego Tip Temperature (Inferred)	800 ºF	
Fuel Level	15%	
Fuel In Control	-3%	3%
Adaptive Fuel Within Limits	-3%	3%
Battery Voltage	11.0 Volts	18.0 Volts
Rich Voltage on downstream CMS sensor(s)	0.6 Volts	

Rich Voltage on upstream HEGO / UEGO sensor(s)	0.45 Volts (HEGO)	1 (UEGO)

Typical DFSO response rate malfunction thresholds:

Rich to lean response rate thresholds:

Normal Threshold = > 0.0 mV/sec

Fast Initial Response Threshold = > 0.0 mV/sec

Step Change Threshold = > 0.3 mV/sec

Note that the thresholds use a normalized offset and the threshold is set at "zero".

Typical DFSO delayed response malfunction (P013E / P014A) thresholds (MY18 and prior):

Successive failures are counted up (5 to 10 faults). Monitor will now intrusively force rich fuel to run the test.

Intrusive controls will time out based on drivability (1 to 2 sec).

Successive drivability failures are counted up (3 faults).

Intrusive controls will now time out at a slower time (5 to 10 sec) and count a fault. After 3 faults are counted, a DTC is set.

J1979 DFSO response rate Mode $06 Data (Model Year 18 and previous)

Monitor ID	Test ID	Description	
$02	$85	HO2S12 Fuel Shut off Rich to Lean Response Rate (P013A)	mV/sec
$02	$86	HO2S12 Fuel Shut off Rich to Lean Response Time (P013E)	msec
$06	$85	HO2S22 Fuel Shut off Rich to Lean Response Rate (P013C)	mV/sec
$06	$86	HO2S22 Fuel Shut off Rich to Lean Response Time (P014A)	msec

J1979 DFSO response rate Mode $06 Data (Model Year 19 and later)

Monitor ID	Test ID	Description	
$02	$85	HO2S12 Fuel Shut off Rich to Lean Response Rate (P013A)	mV/sec
$02	$87	HO2S12 stuck in range rich (P2271)	Volts
$02	$88	HO2S12 stuck in range lean (P2270)	Volts
$06	$85	HO2S22 Fuel Shut off Rich to Lean Response Rate (P013C)	mV/sec
$06	$87	HO2S22 stuck in range rich (P2273)	Volts
$06	$88	HO2S22 stuck in range lean (P2272)	Volts

Rear HO2S Heaters

HO2S Heater Monitor Operation:	
DTCs Sensor 2	P0036 – HO2S12 Heater Control Circuit, Bank 1 P0056 – HO2S22 Heater Control Circuit, Bank 2 P0141 - O2 Sensor Heater Circuit, Bank 1 P0161 - O2 Sensor Heater Circuit, Bank 2 P0054 - HO2S Heater Resistance, Bank 1 P0060 - HO2S Heater Resistance, Bank 2
DTCs Sensor 3	P00D2 - HO2S Heater Control Circuit Range/Performance (Bank 1, Sensor 2) P00D4 - HO2S Heater Control Circuit Range/Performance (Bank 2, Sensor 2) P0147 - O2 Sensor Heater Circuit, Bank 1 P0167 - O2 Sensor Heater Circuit, Bank 2 P0055 - HO2S Heater Resistance, Bank 1 P0061 - HO2S Heater Resistance, Bank 2
Monitor execution	once per driving cycle for heater current monitor and HO2S impedance monitor, continuous for voltage monitoring and HO2S heater temperature control monitoring.
Monitor Sequence	Heater current monitor: Stream 1 HO2S/UEGO response test complete (2010 MY and earlier), Stream 2 and 3 HO2S functional tests completed (2010 MY and earlier), HO2S/UEGO heater voltage check completed. HO2S heater temperature control monitor: Stream 2 HO2S heater voltage check completed, Stream 2 HO2S circuit check completed, intrusive heater current monitor completed (if applicable). HO2S impedance monitor: Stream 2 HO2S heater voltage check complete, Stream 2 HO2S circuit check and test time slice completed.
Sensors OK	Heater current monitor: no HO2S/UEGO heater voltage DTCs. HO2S heater temperature control monitor: no rear HO2S circuit malfunction, no rear HO2S out of range low malfunction, no rear HO2S heater circuit malfunction, no HO2S heater current monitor DTCs. HO2S impedance monitor: rear HO2S heaters OK, no rear HO2S out of range low malfunction, no rear HO2S functional DTCs, no rear HO2S circuit malfunction.
Monitoring Duration	< 10 seconds for heater voltage check, < 5 seconds for heater current check, >= 30 seconds for the HO2S heater temperature control monitor to register a malfunction, < 11 seconds for HO2S impedance test.

Typical HO2S heater monitor entry conditions:		
Entry condition	Minimum	Maximum
Heater Voltage Test:		
Inferred HO2S 2/3 Temperature	400 ºF	1562 ºF
Battery Voltage	11.0	18.0 Volts
Heater Current Test:		
Inferred HO2S 2 Temperature	250 ºF	1436 ºF
Inferred HO2S 3 Temperature	250 ºF	1400 ºF
HO2S 1/2/3 heater-on time	30 seconds	
Engine RPM		5000 rpm
Battery Voltage	11.0	18.0 Volts
HO2S Heater Temperature Control Monitor:		
Heater voltage test completed		
Stream 2 HO2S circuit check completed		
Intrusive heater current monitor completed (if applicable)		
Battery Voltage	11.0	18.0 Volts
HO2S Impedance Monitor:		
Inferred Stream 2 HO2S Temperature	680 ºF	
Inferred Stream 2 HO2S Element Temperature	480 ºF	1020 ºF
Time Stream 2 HO2S inferred element temperature within 10% of the predicted steady state temperature	1 second	
Sensor 2 HO2S heater-on time	60 seconds	
All injectors on (no Decel Fuel Shut Off)		
Not commanding lean lambda due to torque reduction		
Not requesting enrichment due to catalyst reactivation following decel fuel shut off		
Sensor 2 HO2S voltage (open circuit voltage fault band- intrusive test only): Conti-Moto CBP-A2 PCM Other PCMs or depending on feedback circuit	 -0.05 Volts 0.27 Volts 1.30 Volts	 0.05 Volts 0.50 Volts 1.90 Volts
Sensor 2 HO2S voltage (circuit shorted to ground voltage fault band- intrusive test only):	-3.00 Volts	0.06 Volts
Voltage at sensor 2 HO2S connector	11.0 Volts	
Battery Voltage	11.0 Volts	18.0 Volts

Typical HO2S heater check malfunction thresholds:

Heater Voltage Test:

Smart driver status indicated malfunction

Number monitor retries allowed for malfunction > = 30

Heater Current Test:

Heater current outside limits: < 0.220 Amps or > 3 Amps, (NTK Thimble)

< 0.400 Amps or > 3 Amps, (Bosch Thimble)

< 0.550 Amps or > 3 Amps, (Bosch Planar)

< 0.465 Amps or > 3 Amps, (NTK Fast Light Off)

< 0.230 Amps or > 3 Amps, (Bosch Fast Light Off)

HO2S Heater Temperature Control Monitor:

>= 30 seconds to register a malfunction while the heater control integrator is at its maximum or minimum limit and HO2S Impedance >= 1 k ohms (Bosch), 11,500 ohms (NTK)

HO2S Impedance Test:

HO2S internal impedance > table below (ohms), fault counter > = 10

Voltage at HO2S (Volts)/ HO2S inferred element temp (ºF)	11	13	14	15	18
480	71734	26000	14583	9268	2856
570	25864	10522	6496	3733	1644
671	8629	4057	2905	2083	1175
730	3253	1862	1399	1066	576
770	2906	1614	1223	941	530
905	838	575	470	383	273
1020	675	473	410	359	251

J1979 HO2S Heater Mode $06 Data

Monitor ID	Test ID	Description	Units
$42	$81	HO2S12 Heater Current (P0054)	Amps
$46	$81	HO2S22 Heater Current (P0060)	Amps
$42	$82	O2S12 Heater Impedance (P00D2)	kOhm
$46	$82	O2S22 Heater Impedance (00D4)	kOhm

Stepper Motor EGR System Monitor

EGR Stepper Monitor Electrical Check Operation:	
DTCs	P0403
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	
Monitoring Duration	4 seconds to register a malfunction

Stepper motor electrical check entry conditions:
Battery voltage > 11.0 volts

Typical EGR electrical check malfunction thresholds:
“Smart” Coil Output Driver status indicates open or short to ground, or short to power

MAP Sensor Check Operation	
DTCs	P0107 (low voltage), P0108 (high voltage)
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	not applicable
Monitoring Duration	5 seconds to register a malfunction

MAP electrical check entry conditions:
Battery voltage > 11.0 volts

Typical MAP sensor check malfunction thresholds:
Voltage < 0.024 volts or voltage > 4.96 volts

MAP Sensor Rationality Check Operation	
DTCs	P0106
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	ECT, ACT, TP (Throttle Position)
Monitoring Duration	10 seconds to register a malfunction

Typical MAP Rationality check entry conditions:		
Entry Conditions	Minimum	Maximum
Change in load		5%
Engine rpm	580 rpm	2500 rpm

Typical MAP Rationality check malfunction thresholds:
Difference between inferred MAP and actual MAP > 10 in Hg

MAP Sensor Intermittent Check Operation	
DTCs	P0109 (MIL)
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	25 occurrences

Typical MAP Intermittent check malfunction thresholds:
Voltage < 0.024 volts or voltage > 4.96 volts

EGR Flow Check Operation:	
DTCs	P0400
Monitor execution	once per driving cycle
Monitor Sequence	None
Sensors OK	CPS, ECT, IAT, MAF, MAP (P0106/7/8), TP, BARO not available yet
Monitoring Duration	200 seconds (600 data samples)

Typical EGR flow check entry conditions:		
Entry Condition	Minimum	Maximum
Engine RPM	1400 rpm	2600 rpm
Inferred Ambient Air Temperature	32 ºF	140 ºF
Engine Coolant Temperature	80 ºF	250 ºF
Engine RPM Steady (change/0.050 sec)		100 rpm
MAP Steady (change/0.050 sec)		0.5 in Hg
Engine Load Steady (change/0.050 sec)		1.5 %
BARO	22.5 " Hg	
Intake Manifold Vacuum	9.0 "Hg	16.0 "Hg
Vehicle Speed	35 MPH	70 MPH
Engine Throttle Angle steady(absolute change)	0.0 degrees	4.0 degrees

Typical EGR flow check malfunction thresholds:
< 1.0 MAP differential

J1979 Mode $06 Data			
Monitor ID	Test ID	Description	Units
$31	$82	Normalized MAP differential (range 0 – 2) (P0400)	unitless

High Pressure Cooled EGR Monitor (HPEGR)

EGR DPFE Electrical Check Operation:	
DTCs	P044C EGR Sensor "C" Circuit Low P044D EGR Sensor "C" Circuit High
Monitor execution	Continuous, during EGR monitor
Monitor Sequence	None
Sensors OK	
Monitoring Duration	5 seconds to register a malfunction

Typical DPFE EGR electrical check entry conditions:
Continuous

Typical DPFE EGR electrical check malfunction thresholds:
DPFE sensor outside voltage: > 4.65 volts, < 0.25 volts

DPFE Sensor Transfer Function	
Pressure Range: -10.989 [kPa] to +18.315 [kPa] Vout = Vref * (0.027304 * P + 0.40031), P in [kPa], Vref is 5.0 volts	
Volts	Delta Pressure, kPa
0.500	-11.00
0.90	-8.07.0
1.50	-3.6750
1.90	-0.745
2.10	0.720
2.50	3.65
3.70	12.44
4.50	18.3

DPFE EGR Hose Check Operation:	
DTCs	P139A EGR Sensor "C" Hoses Reversed P139B EGR Sensor "C" Upstream Hose Off or Plugged P139C EGR Sensor "C" Downstream Hose Off or Plugged
Monitor execution	Continuous during the driving cycle
Monitor Sequence	after electrical checks completed
Sensors OK	P0071, P0072, P0073, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P2227, P2228. P2229, P04FA, P042E, P042F, P044C, P044D, P0405, P0406, P0472, P0473
Monitoring Duration	25 to 50 seconds to register a malfunction

Typical DPFE EGR hose check entry conditions:		
Entry Conditions	Minimum	Maximum
Ambient Air Temperature	> 35 deg F	< 200 deg F
BARO	> 22.0 in Hg	
Entry conditions for hoses reversed		
EGR Valve Position (EGR commanded on)	> 0%	100%
Entry conditions for hoses off or plugged		
EGR flow near zero	>0.5 g/s	
Manifold Pressure	> -85 kPa	< 102 kPa

Typical EGR hose check malfunction thresholds:
P139A: DPFE signal < -0.5 kPa for 30 sec
P139B: DPFE Signal > 13.0 kPa for 25 sec
P139C: DPFE Signal < -4.0 kPa for 50 sec

EGR Control Valve Electrical Check Operation:	
DTCs	EGR valve position sensor tests P0405 EGR Sensor "A" Circuit Low P0406 EGR Sensor "A" Circuit High P046D EGR Sensor "A" Circuit Intermittent/Erratic EGR valve control circuit tests P0404 EGR “A” Control Stuck P04FA EGR "A" Control Temperature Too High
Monitor execution	Continuous, during EGR monitor
Monitor Sequence	None
Sensors OK	P0071, P0072, P0073, P0106, P0107, P0108, P2227, P2228. P2229, P044C, P044D, P0405, P0406 P0071, P0072, P0073, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P2227, P2228. P2229, P044C, P044D, P0472, P0473
Monitoring Duration	4 seconds to register a malfunction

Typical EGR Control Valve entry conditions:		
Entry Conditions	Minimum	Maximum
Battery Voltage	> 8.25 volts	
H-Bridge Voltage	> 8.25 volts	
Engine rpm	> 400 rpm	

EGR Valve Position Sensor Transfer Function	
Vout = 0.625 * (mm) – 0.25. (6 mm maxiumum travel)	
Volts	Valve Lift (mm)
0.25 (5% of full scale)	0
0.50 (10% of full scale)	1.2
1.00 (20% of full scale)	2.0
1.50 (30% of full scale)	2.8
2.50 (50% of full scale)	4.4
3.50 (70% of full scale)	6.0
4.75 (95% of full scale)	8.0

Typical EGR Control Valve electrical check malfunction thresholds:
P0405: EGR Valve Position signal < 5% of full scale for 4 sec
P0406: EGR Valve Position signal > 95% of full scale for 4 sec
P046D: EGR Valve Position signal > 95% or < 5% of full scale for 0.4 sec
P042E: Observed actuator A position < calculated low limit minus calculated margin and observed actuator A position and observed actuator A position calculated high limit > 11mm.
P042F: Observed actuator A position < calculated low limit minus calculated margin and observed actuator A position and observed actuator A position calculated high limit < 11 mm.
P04FA: 2 * observed position > 5.5mmk and 8 * estimated position < 5.5 mm and observed velocity of position > 5.5 mm/s and opening by percent <10%.

EGR Flow Check Operation:	
DTCs	P0401 – Insufficient EGR Flow P0402 – Excessive EGR Flow
Monitor execution	once per driving cycle
Monitor Sequence	Must pass circuit (P044C, P044D) & hose tests (P139B, P139C) before a flow test fault is determined
Sensors OK	P0071, P0072, P0073, P0106, P0107, P0108, P2227, P2228. P2229, P044C, P044D, P0405, P0406, P139A, P139B, P139C
Monitoring Duration	70 seconds to register a malfunction

Typical EGR Flow check entry conditions:		
Entry Conditions	Minimum	Maximum
Ambient Air Temperature	> 35 deg F	< 200 deg F
BARO	> 22.0 in Hg	
Engine running		

Typical EGR flow check malfunction thresholds:
P0401: Insufficient flow rate ratio > 0.6 after sufficienct EGR flow accumulation
P0402: Excessive flow rate ratio > 0.4 after sufficienct EGR flow accumulation

J1979 Mode $06 Data			
Monitor ID	Test ID	Description for ESM DPFE	Units
$32	$85	Flow ratio for insufficient flow test and threshold (P0401)	Unitless
$32	$84	Flow ratio for excessive flow test and threshold (P0402)	Unitless

EGR Cooler and Diagnostics

EGR Temperature Senor "B" Electrical Check Operation:	
DTCs	P041C EGR Temperature Sensor "B" Circuit Low P041D EGR Temperature Sensor "B" Circuit High P041B EGR Temperature Sensor "B" Range/Performance
Monitor execution	Continuous, during EGR monitor
Monitor Sequence	None
Sensors OK	No EGR flow faults (P0401, P0402)
Monitoring Duration	5 seconds to register a malfunction

Typical EGR Temperature Senor "B" check entry conditions:
Continuous

Typical EGR Temperature Senor "B" check malfunction thresholds:
EGR Temp Sensor "B" voltage: > 4.94 volts, < 0.32 volts

Dual Range EGR Temperature Sensor Transfer Function Range Switched at 100ºC +/-5ºC			
Volts	Cold Range Temp (ºC)	Volts	Hot Range Temp (ºC)
0.198	130	0.378	250
0.331	110	0.438	240
0.567	90	0.511	230
0.747	80	0.596	220
0.984	70	0.697	210
1.677	50	0.818	200
2.137	40	0.960	190
2.913	25	1.127	180
3.668	10	1.323	170
4.087	0	1.548	160
4.416	-10	2.091	140
4.648	-20	2.732	120
4.799	-30	3.069	110
4.891	-40	3.708	90

Exhaust Pressure Sensor “A” Electrical Check Operation:	
DTCs	P0472 Exhaust Pressure Sensor "A" Circuit Low P0473 Exhaust Pressure Sensor "A" Circuit High P0474 Exhaust Pressure Sensor "A" Circuit Intermittent/Erratic P0471 Exhaust Pressure Sensor "A" Circuit Range/Performance
Monitor execution	Continuous, during EGR monitor
Monitor Sequence	None
Sensors OK	
Monitoring Duration	5 seconds to register a malfunction

Typical Exhaust Pressure Senor “A” check entry conditions:
Continuous

Typical Exhaust Pressure Senor “A” check malfunction thresholds:
Exhaust Pressure Sensor ”A” voltage: > 4.80 volts, < 0.21 volts

Exhaust Pressure Sensor Transfer Function	
Pressure Range: 49 [kPa] to +378 [kPa] Vout = Vref * (0.0027 * Pexh) + -0.0715) Pexh in [kPa], Vref is 5.0 volts	
Volts	Pressure, kPa
0.300	49
0.982	100
1.518	140
2.053	180
2.522	215
3.058	255
3.527	290
4.70	378

EGR Cooler Check Operation:	
DTCs	P2457 – EGR Cooler Efficiency Below Threshold
Monitor execution	once per driving cycle
Monitor Sequence	
Sensors OK	P0071, P0072, P0073, P0106, P0107, P0108, P2227, P2228. P2229, P044C, P044D, P0405, P0406
Monitoring Duration	70 seconds to register a malfunction

Typical EGR Cooler check entry conditions:		
Entry Conditions	Minimum	Maximum
Ambient Air Temperature	> 35 deg F	< 200 deg F
BARO	> 22.0 in Hg	
Engine running		

Typical EGR Cooler check malfunction thresholds:
P2457: Insufficient flow rate ratio > 0.5 after sufficienct EGR flow accumulation

Low Pressure Cooled EGR Monitor (LPEGR)

EGR DPFE Electrical Check Operation:	
DTCs	P044C EGR Sensor "C" Circuit Low P044D EGR Sensor "C" Circuit High
Monitor execution	Continuous, during EGR monitor
Monitor Sequence	None
Sensors OK	
Monitoring Duration	5 seconds to register a malfunction

Typical DPFE EGR electrical check entry conditions:
Continuous

Typical DPFE EGR electrical check malfunction thresholds:
DPFE sensor outside voltage: > 4.65 volts, < 0.25 volts

DPFE Sensor Transfer Function	
Pressure Range: -10.989 [kPa] to +18.315 [kPa] Vout = Vref * (2.7300E-02 * P + 4.0000E-01), P in [kPa]], Vref is 5.0 volts	
Volts	Delta Pressure, kPa
0.500	-11.00
0.90	-8.07.0
1.50	-3.6750
1.90	-0.745
2.10	0.720
2.50	3.65
3.70	12.44
4.50	18.3

DPFE EGR Hose Check Operation:	
DTCs	P139A EGR Sensor "C" Hoses Reversed P139B EGR Sensor "C" Upstream Hose Off or Plugged P139C EGR Sensor "C" Downstream Hose Off or Plugged
Monitor execution	once per driving cycle
Monitor Sequence	after electrical checks completed
Sensors OK	P0071, P0072, P0073, P0106, P0107, P0108, P2227, P2228. P2229, P044C, P044D, P0405, P0406
Monitoring Duration	25 to 50 seconds to register a malfunction

Typical DPFE EGR hose check entry conditions:		
Entry Conditions	Minimum	Maximum
Ambient Air Temperature	> 35 deg F	< 200 deg F
BARO	> 22.0 in Hg	
Entry conditions for hoses reversed		
EGR Valve Position (EGR commanded on)	> 0%	0%
Entry conditions for hoses off or plugged		
EGR flow near zero		< 0.5 g/s
Manifold Pressure	> 50 kPa	< -11 kPa

Typical EGR hose check malfunction thresholds:
P139A: DPFE signal < -0.5 kPa for 30 sec
P139B: DPFE Signal > 13.0 kPa for 25 sec
P139C: DPFE Signal < -4.0 kPa for 50 sec

EGR Control Valve Electrical Check Operation:	
DTCs	EGR valve position sensor tests P0405 EGR Sensor "A" Circuit Low P0406 EGR Sensor "A" Circuit High P046D EGR Sensor "A" Circuit Intermittent/Erratic EGR valve control circuit tests P042E EGR "A" Control Stuck Open P042F EGR "A" Control Stuck Closed P04FA EGR "A" Control Temperature Too High
Monitor execution	Continuous, during EGR monitor
Monitor Sequence	None
Sensors OK	P0071, P0072, P0073, P0106, P0107, P0108, P2227, P2228. P2229, P044C, P044D, P0405, P0406
Monitoring Duration	4 seconds to register a malfunction

Typical DPFE EGR hose check entry conditions:		
Entry Conditions	Minimum	Maximum
Battery Voltage	> 8.25 volts	
H-Bridge Voltage	> 8.25 volts	
Engine rpm	> 400 rpm	

EGR Valve Position Sensor Transfer Function	
Vout = 0.625 * (mm) – 0.25. (max. 6 mm travel)	
Volts	Valve Lift (mm)
0.25 (5% of full scale)	0
0.50 (10% of full scale)	1.2
1.00 (20% of full scale)	2.0
1.50 (30% of full scale)	2.8
2.50 (50% of full scale)	4.4
3.50 (70% of full scale)	6.0
4.75 (95% of full scale)	8.0

Typical EGR Control Valve electrical check malfunction thresholds:
P0405: EGR Valve Position signal < 5% of full scale for 4 sec
P0406: EGR Valve Position signal > 95% of full scale for 4 sec
P046D: EGR Valve Position signal > 95% or < 5% of full scale for 0.4 sec
P042E: Observed actuator A position < calculated low limit minus calculated margin and observed actuator A position and observed actuator A position calculated high limit > 11 mm.
P042F: Observed actuator A position < calculated low limit minus calculated margin and observed actuator A position and observed actuator A position calculated high limit < 11 mm.
P04FA: 2 * observed position > 5.5mmk and 8 * estimated position < 5.5 mm and observed velocity of position > 5.5 mm/s and opening by percent <10%.

EGR Flow Check Operation:	
DTCs	P0401 – Insufficient EGR Flow P0402 – Excessive EGR Flow
Monitor execution	once per driving cycle
Monitor Sequence	done after P0402 completed
Sensors OK	P0071, P0072, P0073, P0106, P0107, P0108, P2227, P2228. P2229, P044C, P044D, P0405, P0406
Monitoring Duration	70 seconds to register a malfunction

Typical EGR FLow check entry conditions:		
Entry Conditions	Minimum	Maximum
Ambient Air Temperature	> 35 deg F	< 200 deg F
BARO	> 22.0 in Hg	
Engine running		

Typical EGR flow check malfunction thresholds:
P0401: Insufficient flow rate ratio > 0.5 after sufficienct EGR flow accumulation
P0402: Excessive flow rate ratio > 0.5 after sufficienct EGR flow accumulation

J1979 Mode $06 Data			
Monitor ID	Test ID	Description for ESM DPFE	Units
$32	$86	Flow ratio for insufficient flow test and threshold (P0401)	Unitless
$31	$87	Flow ratio for excessive flow test and threshold (P0402)	Unitless

PCV Monitor Operation

DTCs	P2282 - Air Leak Between Throttle Body and Intake Valve
Monitor execution	Continuous
Monitor Sequence	None
Monitoring Duration	N/A
Sensors OK	No fault is present in any of the sensors or systems affecting the PCV monitor. BARO sensor, MAP sensor, throttle charge temperature sensor, throttle inlet pressure sensor, manifold charge temperature sensor, no VCT malfunction

Typical P2282 check entry conditions:

Entry Condition	Minimum	Maximum
Throttle angle (at condition for 300 msec minimum)	N/A	4 deg
Intake Air Temp	-20 deg. F.	
Engine coolant temperature	-20 deg. F.	
Barometric pressure	20 in. Hg.	

Typical P2282 malfunction thresholds:

Calculated air leak of 1 lbm/min or greater that persists for at least 5 seconds.

PCV System Monitor – Turbocharged Engine with MAP Sensor

CKCP Sensor Electrical Check Operation	
DTCs	Analog Sensor: P051C – Crankcase Pressure Sensor “A” Circuit Low P051D – Crankcase Pressure Sensor “A” Circuit High P051B – Crankcase Pressure Sensor “A” Circuit Range/Performance SENT sensor: P051A – Crankcase Pressure Sensor “A” Circuit U060E – Lost Communication with Crankcase Pressure Sensor “A”
Monitor execution	Continuous for circuit checks
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	5 seconds to register a malfunction

CKCP Sensor Electrical check entry conditions:		
Entry Conditions	Minimum	Maximum
Engine not cranking (for offset check only)		

Typical CKCP sensor electrical check malfunction thresholds:
P051C: Voltage < 0.44 volts P051D: Voltage > 4.56 volts, P051B: Sensor offset > 0.15” Hg OR Crankcase pressure > 5.0 “ Hg or Crankcase pressure < -0.6 “ Hg at air flows < 1.0 lb/min P051A/U060E: Faulted signal patterns recognized.

PCV Fresh Air Disconnect Check Operation:	
DTCs	P04DB – Crankcase Ventilation System Disconnected
Monitor execution	Dirty side - once per driving cycle at crank Clean side - once per driving cycle at airflows > 5 lb/min
Monitor Sequence	none
Sensors OK	CKCP (P051B, P051C, P051D) ; or P051A/U060E SENT sensor
Monitoring Duration	up to 15 minutes to register a clan side malfunction

PCV Fresh Air Disconnect check entry conditions:		
Entry Conditions	Minimum	Maximum

Ambient temperature	40 deg F	
BARO	22.5”Hg	
Air Mass	5 lbm/min	

PCV Fresh Air Disconnect check malfunction thresholds:
P04DB:
Clean side: expected sum > 2.5 in Hg
Dirty side test: dip signal or pulse signal > 0.004

Thermostat Monitor

THERMOSTAT MONITOR OPERATION	
DTC	P0128 - Coolant Thermostat (Coolant temperature below thermostat regulating temperature)
Monitor Execution	Once per driving cycle, during a cold start
Monitoring Duration	Drive cycle dependent. Monitor completes in less than 300 seconds, when inferred ECT exceeds threshold (at 70 deg F ambient temperature)

TYPICAL THERMOSTAT MONITOR ENTRY AND COMPLETION CONDITIONS		
Entry conditions	Minimum	Maximum
Engine Coolant Temperature at start	None	125 °F
Intake Air Temperature at start (ambient temp)	20 °F	None
Inferred Percent Ethanol (flex fuel vehicles only)	Learned	N/A
Completion condition	Minimum	Maximum
Modeled ECT	172 °F	None
Time Since Modeled ECT Exceeded WUT Threshold	3 sec.	None
Time at Idle/Low Load Compared with Total Engine Run Time	None	50%

TYPICAL MALFUNCTION THRESHOLD
Engine Coolant Temperature < 172 °F (for a typical 192 °F thermostat)

Time To Closed Loop Monitor

TIME TO CLOSED LOOP MONITOR OPERATION	
DTC	P0125 - Insufficient Coolant Temp For Closed Loop Fuel Control
Monitor Execution	Once per driving cycle, during a cold start
Monitoring Duration	Drive cycle

TYPICAL TIME TO CLOSED LOOP MONITOR ENTRY AND COMPLETION CONDITIONS		
Entry conditions	Minimum	Maximum
Engine Coolant Temperature at start	None	80 °F
Intake Air Temperature at start (ambient temp)	20 °F	None
Inferred Percent Ethanol (flex fuel vehicles only)	Learned	N/A
Completion condition	Minimum	Maximum
Modeled ECT	80 °F	None
Time Since Modeled ECT Exceeded Threshold	3 sec.	None
Time at Idle/Low Load Compared with Total Engine Run Time	None	50%

TYPICAL TIME TO CLOSED LOOP MALFUNCTION THRESHOLD
Engine Coolant Temperature < 50 °F

Cold Start Emission Reduction Component Monitor

Throttle Plate Controller and Actuator Operation:	
DTCs	P2107 – processor test (MIL) P2111 – throttle actuator system stuck open (MIL) P2112 – throttle actuator system stuck closed (MIL) Note: For all the above DTCs, in addition to the MIL, the ETC light will be on for the fault that caused the FMEM action.
Monitor execution	Continuous
Monitor Sequence	None
Monitoring Duration	60 msec for processor fault, 500 msec for stuck open/closed fault

Throttle Plate Controller and Actuator malfunction thresholds:
P2111 - Desired throttle angle vs. actual throttle angle > 6 degrees
P2112 - Desired throttle angle vs. actual throttle angle < 6 degrees
P2107 - Internal processor fault, lost communication with main CPU

Engine Speed and Spark Timing Component Monitor (2010 MY and beyond)

CSER COMPONENT MONITOR OPERATION	
Component Monitor DTCs	P050A: Cold Start Idle Air Control System Performance P050B: Cold Start Ignition Timing Performance
Monitor Execution	Once per driving cycle, during a cold start
Monitor Sequence	Monitor data collection takes place during first 15 seconds of cold start
Sensors OK	No fault is present in any of the sensors or systems affecting the catalyst temperature model: Mass Air Flow (P0102, P0103), Throttle Position (P0122, P0123, P0222, P0223), Misfire (P0316, P0300-P0312), Injectors (P0201-P0212), Fuel System (P0171, P0172, P0174, P0175), Secondary Air (P0412, P2258), Crank Position Sensor (P0320), Ignition Coil (P0351-P0360), Intake Air Temp (P0112, P0113), Engine Coolant Temp/Cylinder Head Temp (P0117, P0118, P1289, P1290), Variable Cam Timing (P0010, P0020, P0011, P0012, P0021, P0022), Intake Manifold Runner Control (P2008).
Monitoring Duration	Monitor completes 300 seconds after initial engine start

TYPICAL CSER COMPONENT MONITOR ENTRY AND COMPLETION CONDITIONS		
Entry condition	Minimum	Maximum
Barometric Pressure	22 in. Hg	
Engine Coolant Temperature at Start	20 °F	100 °F
Catalyst Temperature at Start	20 °F	125 °F
Fuel Level	15%	
No Torque Reduction by Injector Cutout		
Power Takeout Not Active		
Completion condition	Minimum	Maximum
Length of Time Entry Conditions are Satisfied	11 sec.	
Expected Change in Catalyst Temperature	50 °F	
Time in Idle	10 sec.	
Selected Gear	Neutral	Drive

TYPICAL CSER COMPONENT MONITOR MALFUNCTION THRESHOLDS
Engine speed discrepancy > 200 rpm
Spark timing discrepancy > 10 deg.

Cold Start Variable Cam Timing Monitor (2008 MY and beyond)

CSER VCT Target Error Check Operation:]	
DTCs	P052A – Cold start camshaft position timing over-advanced (Bank 1) P052B – Cold start camshaft timing over-retarded (Bank 1) P052C – Cold start camshaft timing over-advanced (Bank 2) P052D – Cold start camshaft timing over-retarded (Bank 2)
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	
Monitoring Duration	5 seconds

Typical CSER VCT target error entry conditions:		
Entry condition	Minimum	Maximum
VCT control enabled and commanded to advance or retard cam during CSER	n/a	n/a
Time since start of CSER cam phase monitoring		60 seconds

Typical CSER VCT target error malfunction thresholds:
CSER Response/target error - VCT over-advance: 11 degrees
CSER Response/target error - VCT over-retard: 11 degrees
CSER Response/Stuck Pin – 10 degrees phasing commanded, and not seeing at least 2 degrees of movement.

Cold Start Emission Reduction System Monitor

CSER SYSTEM MONITOR OPERATION	
System Monitor DTC	P050E: Cold Start Engine Exhaust Temperature Too Low
Monitor Execution	Once per driving cycle, during a cold start
Monitor Sequence	Monitor data collection takes place during first 15 seconds of cold start
Sensors OK	No fault is present in any of the sensors or systems affecting the catalyst temperature model: Mass Air Flow (P0102, P0103), Throttle Position (P0122, P0123, P0222, P0223), Misfire (P0316, P0300-P0312), Injectors (P0201-P0212), Fuel System (P0171, P0172, P0174, P0175), Secondary Air (P0412, P2258), Crank Position Sensor (P0320), Ignition Coil (P0351-P0360), Intake Air Temp (P0112, P0113), Engine Coolant Temp/Cylinder Head Temp (P0117, P0118, P1289, P1290), Variable Cam Timing (P0010, P0020, P0011, P0012, P0021, P0022), Intake Manifold Runner Control (P2008).
Monitoring Duration	Monitor completes 300 seconds after initial engine start

TYPICAL CSER SYSTEM MONITOR ENTRY AND COMPLETION CONDITIONS		
Entry condition	Minimum	Maximum
Barometric Pressure	22 in. Hg	
Engine Coolant Temperature at Start	20 °F	100 °F
Catalyst Temperature at Start	20 °F	125 °F
Fuel Level	15%	
No Torque Reduction by Injector Cutout		
Power Takeout Not Active		
Completion condition	Minimum	Maximum
Length of Time Entry Conditions are Satisfied	11 sec.	
Expected Change in Catalyst Temperature	50 °F	
Time in Idle	10 sec.	
Selected Gear	Neutral	Drive

TYPICAL CSER SYSTEM MONITOR MALFUNCTION THRESHOLDS
Cold start warm-up temperature ratio > 0.4

Variable Cam Timing System Monitor

VCT Monitor Operation:	
DTCs	P0010 - Camshaft Position Actuator Circuit (Bank 1) P0011 - Intake Camshaft Position Timing - Over-Advanced (Bank 1) P0012 - Intake Camshaft Position Timing - Over-Retarded (Bank 1) P0014 - Exhaust Camshaft Position Timing - Over-Advanced (Bank 1) P0015 - Exhaust Camshaft Position Timing - Over-Retarded (Bank 1) P0016 - Crank/Cam Position Correlation (Bank 1) P0020 - Camshaft Position Actuator Circuit (Bank 2) P0021 - Intake Camshaft Position Timing - Over-Advanced (Bank 2) P0022 - Intake Camshaft Position Timing - Over-Retarded (Bank 2) P0024 - Exhaust Camshaft Position Timing - Over-Advanced (Bank 2) P0025 - Exhaust Camshaft Position Timing - Over-Retarded (Bank 2) P0018 – Crank/Cam Position Correlation (Bank 2)
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	IAT, ECT, EOT, IMRC, TP, MAF, CKP, and CMP
Monitoring Duration	5 - 10 seconds for circuit faults and functional checks, 300 - 900 seconds for target error

Typical VCT response/functional monitor entry conditions:		
Entry condition	Minimum	Maximum
Engine RPM (rpm to get minimum oil pressure)	400	
Engine RPM (for P0016/P0018 only)	500	4500
Engine Coolant Temperature	18 ºF	
Time Since Start (function of ECT at start) (time to build oil pressure at start)	2 sec	
VCT control enabled and commanded to advance or retard cam **	n/a	n/a
** VCT control of advance and retard by the engine is disabled in crank mode, when engine oil is, while learning the cam/crank offset, while the control system is "cleaning" the solenoid oil passages, throttle actuator control in failure mode, and if one of the following sensor failures occurs: IAT, ECT, EOT, MAF, TP, CKP, CMP, or IMRC or a VCT solenoid fails.		

Typical VCT monitor malfunction thresholds:
VCT solenoid circuit: Open/short fault set by the PCM driver
Cam/crank misalignment: > or = one tooth difference, or 16 crank degrees
Response/target error - VCT over-advance variance too high: 40 to 700 degrees squared
Response/target error - VCT over-retard variance too high: 40 to 700 degrees squared
Response/target error - Cam bank-to-bank variance too high: 40 to 700; degrees squared

J1979 VCT Monitor Mode $06 Data			
Monitor ID	Test ID	Description for CAN	Units
$35	$80	Camshaft Advanced Position Error Bank 1 (P011/P0014)	Unsigned, Angular degrees
$35	$81	Camshaft Retarded Position Error Bank 1 (P0012/P0015)	Unsigned, Angular degrees
$36	$80	Camshaft Advanced Position Error Bank 2 (P0021/P0024)	Unsigned, Angular degrees
$36	$81	Camshaft Retarded Position Error Bank 2 (P0022/P0025)	Unsigned, Angular degrees

Variable Displacement Engine (VDE) System Monitor

VDE Control Circuit Check Operation:]	
DTCs	P3401 - Cylinder 1 Deactivation/Intake Valve Control Circuit/Open P3403 - Cylinder 1 Deactivation/Intake Valve Control Circuit Low P3404 - Cylinder 1 Deactivation/Intake Valve Control Circuit High
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	
Monitoring Duration	5 seconds

Typical VDE Control Circuit malfunction thresholds:
"Smart" Output Driver status indicates open or short to ground, or short to power

VDE Performance Monitor Operation:	
DTCs	P3402 - Cylinder 1 Deactivation/Intake Valve Control Circuit Performance
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	
Monitoring Duration	Continuous during VDE, entry and exit

Typical VDE performance monitor entry conditions:		
Entry condition	Minimum	Maximum
Engine RPM (rpm to get minimum oil pressure)	400	
Engine RPM (for P0016/P0018 only)	500	4500
Engine Coolant Temperature	18 °F	
Time Since Start (function of ECT at start) (time to build oil pressure at start)	2 sec	
VCT control enabled and commanded to advance or retard cam **	n/a	n/a

Barometric Pressure Sensor (BARO)

BARO Sensor Transfer Function		
Vout=Vref * (0.007895 * Pressure (in kPa)		
Volts	Pressure, kPa	Pressure, Inches Hg
0.3	7.6	2.2
0.5	12.7	3.8
2.638	60	17.7
4.54	115	34.0
4.75	120.3	35.5
4.8	121.6	35.9

Barometric Pressure Sensor Range Check	
DTCs	P2228 Barometric Pressure Circuit Low P2229 Barometric Pressure Circuit High
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	5 seconds to register a malfunction

Typical Barometric Pressure Sensor Range Check Malfunction Thresholds
P2228 BP < 2.0 volts (above 15,000 ft altitude)
P2229 BP > 4.4 volts (below -1,000 ft altitude)

Turbocharger Boost Sensor A (TCB-A)

TCB-A and MAP Sensor Transfer Function		
Vout=(Vref / 5) * (0.0146428 * Pressure (in kPa) + 0.1072)		
Volts	Pressure, kPa	Pressure, Inches Hg
0.3	13.16	3.89
0.4	20	5.91
0.986	60.0	17.72
2.157	140	41.34
3.329	220.0	64.97
4.5	300	88.59
4.8	320.49	94.64

Throttle Inlet Pressure Sensor Range Circuit Check	
DTCs	P0237 Turbocharger/Supercharger Boost Sensor A Circuit Low P0238 Turbocharger/Supercharger Boost Sensor A Circuit High
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	5 seconds to register a malfunction

Typical Throttle Inlet Pressure Sensor Range Circuit Check Malfunction Thresholds
P0237 TCB-A voltage < 0.19 volts
P0238 TCB_A voltage > 4.88 volts

Throttle Inlet Pressure Sensor Range Circuit Intermittent Check	
DTCs	P025E Turbocharger/Supercharger Boost Sensor "A" Intermittent/Erratic
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	not applicable
Monitoring Duration	counts intermittent events per trip

Typical Throttle Inlet Pressure Sensor Range Circuit Malfunction Thresholds
10 intermittent out-of-range events per driving cycle

Intake Manifold Pressure (MAP) Sensor

TCB-A nd MAP Sensor Transfer Function		
Vout=Vref * (0.0044736 * Pressure (in kPa) + 0.035263)		
Volts	Pressure, kPa	Pressure, Inches Hg
0.3	5.53	1.63
0.40	10.0	2.95
1.630	65.0	19.19
2.301	95.0	28.05
3.643	155.0	45.77
4.65	200.0	59.06
4.8	206.71	61.04

Intake Manifold Pressure Sensor Range Circuit Check	
DTCs	P0107 Manifold Absolute Pressure/BARO Sensor Low P0108 Manifold Absolute Pressure/BARO Sensor High
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	5 seconds to register a malfunction

Typical Intake Manifold Pressure Sensor Range Circuit Check Malfunction Thresholds
P0107 MAP voltage < 0.19 volts
P0108 MAP voltage > 4.88 volts

Intake Manifold Pressure Sensor Range Circuit Intermittent Check	
DTCs	P0109 Manifold Absolute Pressure/BARO Sensor Intermittent
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	not applicable
Monitoring Duration	counts intermittent events per trip

Typical Intake Manifold Pressure Sensor Range Circuit Malfunction Thresholds
25 intermittent out-of-range events per driving cycle

BARO, TCB-A, MAP Sensor 3-Way Correlation Check at Key-Up

BP, TIP, MAP Sensor 3-Way Correlation Check at Key-Up	
DTCs	P2227 P0236 P0106 Barometric Pressure Circuit Range/Performance
Monitor execution	At key-up
Monitor Sequence	None
Sensors OK	BP, MAP, TIP
Monitoring Duration	0.2 seconds

BP, TIP, MAP Sensor 3-Way Correlation Check at Key-Up Entry Conditions		
Entry condition	Minimum	Maximum
Engine off (soak) time	10 seconds	
Battery Voltage	6.75 volts	

Typical BP, TIP, MAP Sensor 3-Way Correlation Check at Key-Up Malfunction Thresholds
|TCB-A – MAP| < 2.72"Hg
|BARO – MAP| < 2.03"Hg
|BARO – TCB-A| < 2.14"Hg

BARO, TCB-A and TCB-A, MAP Sensor 2-Way Correlation Check

BARO, TCB-A Sensor 2-Way Correlation Check Entry	
DTCs	P2227 Barometric Pressure Sensor "A" Circuit Range/Performance P0236 Turbocharger/Supercharger Boost Sensor "A" Circuit Range/Performance P0106 Barometric Pressure Circuit Range/Performance
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	BP, TIP, MAP
Monitoring Duration	10 seconds

BARO, TCB-A Sensor 2-Way Correlation Check Entry Conditions		
Entry condition	Minimum	Maximum
Low TP		4.0°
Low engine rpm		1500 rpm

Typical BARO, TCB-A Sensor 2-Way Correlation Check Entry Malfunction Thresholds	
pass	(|BARO – TCB-A| < 5.5"Hg) AND (|MAP – Estimated MAP| < 3.5"Hg)
P2227	(|BARO – TCB-A| > 5.5"Hg) AND (|MAP – Estimated MAP| < 1.8"Hg)
P0106	(|BARO – TCB-A| < 1.8"Hg) AND (|MAP – Estimated MAP| > 3.5"Hg)
P0236	(if none of above conditions met)

Compressor Bypass Valve(s)

Compressor Bypass Valve Circuit Check Operation:	
DTCs	P0034 Turbocharger/Supercharger Bypass Valve "A" Control Circuit Low P0035 Turbocharger/Supercharger Bypass Valve "A" Control Circuit High P00C1 Turbocharger/Supercharger Bypass Valve "B" Control Circuit Low P00C2 Turbocharger/Supercharger Bypass Valve "B" Control Circuit High
Monitor execution	Continuous
Monitor Sequence	None
Monitoring Duration	5 seconds

Compressor Bypass Valve Circuit malfunction thresholds:
PCM smart driver hardware detects faults for circuit short to battery, short to ground, and open circuit. Fault status reported to PCM to set appropriate DTC.

Wastegate Pneumatic Solenoid Valve

Wastegate Pneumatic Solenoid Valve Circuit Check Operation	
DTCs	P0245 Turbocharger/Supercharger Wastegate Solenoid A Low P0246 Turbocharger/Supercharger Wastegate Solenoid A High
Monitor execution	Continuous
Monitor Sequence	None
Monitoring Duration	5 seconds

Wastegate Pneumatic Solenoid Valve Circuit malfunction thresholds:
PCM smart driver hardware detects faults for circuit short to battery, short to ground, and open circuit. Fault status reported to PCM to set appropriate DTC.

Vacuum Actuated Wastegate System

Wastegate Pneumatic Solenoid Valve Circuit Check Operation	
DTCs	P0245 Turbocharger/Supercharger Wastegate Solenoid A Low P0246 Turbocharger/Supercharger Wastegate Solenoid A High
Monitor execution	Continuous
Monitor Sequence	None
Monitoring Duration	2 - 3 seconds

Wastegate Pneumatic Solenoid Valve Circuit malfunction thresholds:
PCM smart driver hardware detects faults for circuit short to battery, short to ground, and open circuit. Fault status reported to PCM to set appropriate DTC.

Wastegate Pneumatic Solenoid Valve Circuit Check Operation	
DTCs	P0249 Turbocharger/Supercharger Wastegate Solenoid B Low P0250 Turbocharger/Supercharger Wastegate Solenoid B High
Monitor execution	Continuous
Monitor Sequence	None
Monitoring Duration	2 - 3 seconds

Wastegate Pneumatic Solenoid Valve Circuit malfunction thresholds:
PCM smart driver hardware detects faults for circuit short to battery, short to ground, and open circuit. Fault status reported to PCM to set appropriate DTC.

Wastegate Control Pressure Check Operation	
DTCs	P1015 Wastegate Control Pressure Lower Than Expected P1016 Wastegate Control Pressure Lower Than Expected
Monitor execution	Continuous
Sensors OK	No P100F, P1011, P1012, P1013, P0245, P0246 DTCs
Monitor Sequence	None
Monitoring Duration	5 seconds

Wastegate Control Pressure Check Entry Conditions		
Entry Condition	Minimum	Maximum
Desired wastegate control pressure is stable: (desired pressure - expected pressure).		0.5 in Hg

Wastegate Pneumatic Solenoid Valve Circuit malfunction thresholds:
P1015 - Wastegate control pressure error > 3 in Hg
P1016 - Wastegate control pressure error > 5 in Hg

Wastegate Control Pressure Sensor

Wastegate Control Pressure Sensor Check Operation	
DTCs	P1012 Wastegate Control Pressure Sensor Circuit Low P1013 Wastegate Control Pressure Sensor Circuit High P1014 Wastegate Control Pressure Sensor Circuit Intermittent/Erratic
Monitor execution	Continuous
Monitor Sequence	None
Monitoring Duration	5 seconds

Wastegate Control Pressure Sensor Transfer Function		
Vout=(Vref / 5) * (0.04399 * Pressure (in kPa) - 0.140)		
Volts	Pressure, kPa	Pressure, Inches Hg
0.3	10.0	2.95
0.4	12.3	3.62
1.0	25.9	7.65
2.0	48.6	14.36
3.0	71.4	21.07
4.5	105.5	31.14
4.8	112.8	33.31

Wastegate Control Pressure Sensor Check Entry Conditions		
Entry Condition	Minimum	Maximum
none		

Wastegate Pneumatic Solenoid Valve Circuit malfunction thresholds:
P1012 – voltage < 0.20 V
P1013 – voltage > 4.93 V
P1014 – open or shorted > 10 events in a driving cycle

Wastegate Control Pressure Sensor Check Operation	
DTCs	P1011 Wastegate Control Pressure Sensor Circuit Range/Performance P100F Wastegate Control Pressure/BARO Correlation
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	No P1012, P1013, P1011, P2228, P2229, P2227, P0236, P0106 DTCs.
Monitoring Duration	5 seconds

Wastegate Control Pressure Sensor Check Entry Conditions		
Entry Condition	Minimum	Maximum
Engine off time (P100F only)	20 sec	

Wastegate Pneumatic Solenoid Valve Circuit malfunction thresholds:
P100F – pressure error exceeds 2.5 in Hg P1011 – pressure exceeds BARO by > 3.0 in Hg

Electric Turbocharger Wastegate

Wastegate Actuator "A"

Wastegate Circuit A Check Operation	
DTCs	P0243 - Turbocharger/Supercharger Wastegate Solenoid A Low P2ABD - Turbocharger/Supercharger Wastegate Actuator "A" Driver Current/Temp Too High
Monitor execution	Continuous
Monitor Sequence	None
Monitoring Duration	0.4 seconds

Wastegate Circuit A malfunction thresholds:
PCM smart driver hardware detects faults for circuit short to battery, short to ground, and open circuit. Fault status reported to PCM to set DTC.

Wastegate A Functional Check Operation	
DTCs	P25B3 Turbocharger/Supercharger Wastegate "A" Stuck Open P25B4 Turbocharger/Supercharger Wastegate "A" Stuck Closed
Monitor execution	Continuous
Sensors OK	No P0243, P2ABD DTCs
Monitor Sequence	None
Monitoring Duration	2.5 seconds

Wastegate A Functional Check malfunction thresholds:
P25B3 - Wastegate position error > 20 mm
P25B4 - Wastegate position error > 20 mm

Wastegate Position Sensor A

Wastegate Position Sensor Circuit Check Operation	
DTCs	P2AB8 - Wastegate Position Sensor "A" Circuit Low P2AB9 - Wastegate Position Sensor "A" Circuit High
Monitor execution	Continuous
Monitor Sequence	None
Monitoring Duration	4 seconds

Wastegate Position Sensor A Circuit malfunction thresholds:
P2AB8 Wastegate Position Sensor “A” voltage < 0.50 volts
P2AB9 Wastegate Position Sensor “A” voltage > 4.50 volts

Wastegate Actuator “B”

Wastegate Circuit B Check Operation	
DTCs	P0247 - Turbocharger/Supercharger Wastegate Solenoid B Low P2ABE - Turbocharger/Supercharger Wastegate Actuator "B" Driver Current/Temp Too High
Monitor execution	Continuous
Monitor Sequence	None
Monitoring Duration	0.4 seconds

Wastegate Circuit B malfunction thresholds:
PCM smart driver hardware detects faults for circuit short to battery, short to ground, and open circuit. Fault status reported to PCM to set DTC.

Wastegate B Functional Check Operation	
DTCs	P25B5 Turbocharger/Supercharger Wastegate "B" Stuck Open P25B6 Turbocharger/Supercharger Wastegate "B" Stuck Closed
Monitor execution	Continuous
Sensors OK	No P0247, P2ABE DTCs
Monitor Sequence	None
Monitoring Duration	2.5 seconds

Wastegate B Functional Check malfunction thresholds:
P25B5 - Wastegate position error > 20 mm
P25B6 - Wastegate position error > 20 mm

Wastegate Position Sensor B

Wastegate Position Sensor B Circuit Check Operation	
DTCs	P2ABB - Wastegate Position Sensor "B" Circuit Low P2ABC - Wastegate Position Sensor "B" Circuit High
Monitor execution	Continuous
Monitor Sequence	None
Monitoring Duration	4 seconds

Wastegate Position Sensor B Circuit malfunction thresholds:	
P2ABB	WGP “A” voltage < 0.50 volts
P2ABC	WGP “A” voltage > 4.50 volts

Boost Control

OverBoost Control Functional Check Operation:	
DTCs	P0234 (Turbocharger/Supercharger A Overboost Condition)
Monitor execution	continuous
Monitor Sequence	none
Sensors/Actuators OK	CBV, TCB-A, WGS, BARO
Monitoring Duration	5 seconds (up/down timer)

OverBoost Control Functional Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Wastegate Duty Cycle		0.05

OverBoost Control Functional Check Malfunction Thresholds:
(Boost Pressure Desired – Boost Pressure Actual) > 4 psi

UnderBoost Control Functional Check Operation:	
DTCs	P0299 (Turbocharger/Supercharger A Underboost Condition)
Monitor execution	continuous
Monitor Sequence	none
Sensors/Actuators OK	CBV, TCB-A, WGS, BARO
Monitoring Duration	5 seconds (up/down timer)

OverBoost Control Functional Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Wastegate Duty Cycle	0.95	

OverBoost Control Functional Check Malfunction Thresholds:
(Boost Pressure Desired – Boost Pressure Actual) > 4 psi

Fuel Injectors

Injector Circuit Check Operation	
DTCs	P0201 through P0206 (Cylinder x Injector Circuit) P062D Fuel Injector Driver Circuit Performance
Monitor execution	Continuous within entry conditions
Monitor Sequence	None
Monitoring Duration	10 seconds

Typical Injector Circuit Check Entry Conditions		
Entry Condition	Minimum	Maximum
Battery Voltage	11.0 volts	

Fuel Volume Regulator

Fuel Volume Regulator Circuit Check Operation	
DTCs	P0001 Fuel Volume Regulator Control Circuit / Open P0003 Fuel Volume Regulator Control Circuit Low P0004 Fuel Volume Regulator Control Circuit High
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	none
Monitoring Duration	not applicable

Fuel Rail Pressure Sensor

FRP Sensor Transfer Function		
FRP = –471.37 psi + (FRP_voltage / 5.0 volts) * 4713.73 psi		
Volts	Pressure, MPa (gauge)	Pressure, psi (gauge)
4.80	27.95	4054
4.50	26	3771
3.50	19.5	2828
2.50	13.0	1885
1.50	6.5	943
0.50	0	0
0.20	-1.95	-283

FRP Open/Short Check Operation:	
DTCs	P0192 - Fuel Rail Pressure Sensor A Circuit Low P0193 - Fuel Rail Pressure Sensor A Circuit High
Monitor execution	Continuous
Monitor Sequence	none
Sensors OK	none
Monitoring Duration	5 seconds to register a malfunction

Typical FRP Sensor Check Malfunction Thresholds:
FRP voltage < 0.20 volts or FRP voltage > 4.80 volts

Fuel Rail Pressure Control

Fuel Rail Pressure Control (Normal) Functional Check Operation:	
DTCs	P0087 (Fuel Rail Pressure Too Low) P0088 (Fuel Rail Pressure Too High)
Monitor execution	continuous
Monitor Sequence	P0087 and P0088 must complete before setting P00C6 or P053F
Sensors/Actuators OK	FLI, FRP, FVR, Lift Pump
Monitoring Duration	not applicable

Typical Fuel Rail Pressure Control (Normal) Functional Check Entry Conditions:		
Entry Condition	Minimum	Maximum
High Pressure Pump Enabled	Enabled	
Fuel level	15%	
Injector Cut Off	No Injector Cut Off	
Injection Volume / (720° Pump Volume / Number of Cylinders)	0.05	0.90
Engine Coolant Temperature	20°F / 7°C	250°F / 121°C
CSER Mode	Not in CSER	

Typical Fuel Rail Pressure Control (Normal) Functional Check Malfunction Thresholds:
P0087: (Fuel_Pressure_Desired – Fuel_Pressure_Actual) / Fuel_Pressure_Desired > 0.25
P0088: – (Fuel_Pressure_Desired – Fuel_Pressure_Actual) / Fuel_Pressure_Desired > 0.25

Fuel Rail Pressure Control (Cranking)

Fuel Rail Pressure Control (Cranking) Functional Check Operation:	
DTCs	P00C6 (Fuel Rail Pressure Too Low – Engine Cranking)
Monitor execution	Minimum pressure met instantaneously once during cranking
Monitor Sequence	P0087 and P0088 must pass before setting P00C6 or P053F
Sensors/Actuators OK	FLI, FRP, FVR, Lift Pump
Monitoring Duration	Minimum met instantaneously once during cranking

Typical Fuel Rail Pressure Control (Cranking) Functional Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Fuel level	15%	

Typical Fuel Rail Pressure Control (Cranking) Functional Check Malfunction Thresholds:
Fuel_Pressure_Actual >= Fuel_Pressure_Desired

Fuel Rail Pressure Control (CSER)

Fuel Rail Pressure Control (CSER) Functional Check Operation:	
DTCs	P053F (Cold Start Fuel Pressure Control Performance)
Monitor execution	During CSER
Monitor Sequence	None
Sensors/Actuators OK	FLI, FRP, FVR, Lift Pump
Monitoring Duration	Entire CSER monitoring period

Typical Fuel Rail Pressure Control (CSER) Functional Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Fuel level	15%	

Typical Fuel Rail Pressure Control (CSER) Functional Check Malfunction Thresholds:
Time in Fuel Injection Pressure Window / CSER Duration > 0.70
Fuel Injection Pressure Window defined as follows:
Minimum Fuel Pressure to Support Desired Injection Mode <= Fuel Pressure Actual
Fuel Pressure Actual <= Maximum Fuel Pressure to Support Desired Injection Mode

Controlled Valve Operation (CVO)

CVO Functional Check Operation:	
DTCs	P02EE - Cylinder 1 Injector Circuit Range/Performance P02EF - Cylinder 2 Injector Circuit Range/Performance P02F0 - Cylinder 3 Injector Circuit Range/Performance P02F1 - Cylinder 4 Injector Circuit Range/Performance P02F2 - Cylinder 5 Injector Circuit Range/Performance P02F3 - Cylinder 6 Injector Circuit Range/Performance P02F4 - Cylinder 7 Injector Circuit Range/Performance P02F5 - Cylinder 8 Injector Circuit Range/Performance
Monitor execution	Continuous
Monitor Sequence	none
Sensors/Actuators OK	FRP (P0192, P0193, P0087, P0088), FVR (P0001, P0003, P0004), INJ (P0201, P0202, P0203, P0204, P0205, P0206)
Monitoring Duration	25 seconds

Typical CVO Functional Check Malfunction Thresholds:
Driver software indicates CVO circuit fault or unable to adapt/adaption at limits

High Pressure Fuel Rail Pressure Sensor (DI Fuel Rail)

FRP Open/Short Check Operation:	
DTCs	P0192 - Fuel Rail Pressure Sensor A Circuit Low P0193 - Fuel Rail Pressure Sensor A Circuit High
Monitor execution	Continuous
Monitor Sequence	none
Sensors OK	none
Monitoring Duration	5 seconds to register a malfunction

Typical FRP Sensor Check Malfunction Thresholds:
FRP voltage < 0.27 volts or FRP voltage > 4.76 volts

FRP Sensor Transfer Function		
FRP = –471.37 psi + (FRP_voltage / 5.0 volts) * 4713.73 psi		
Volts	Pressure, MPa (gauge)	Pressure, psi (gauge)
4.76	27.69	4016
4.50	26	3771
3.50	19.5	2828
2.50	13.0	1885
1.50	6.5	943
0.50	0	0
0.27	-1.49	-217

Fuel Rail Pressure Control

Fuel Rail Pressure Control (Normal) Functional Check Operation:	
DTCs	P0087 (Fuel Rail Pressure Too Low) P0088 (Fuel Rail Pressure Too High)
Monitor execution	continuous
Monitor Sequence	P0087 and P0088 must complete before setting P00C6 or P053F
Sensors/Actuators OK	FLI, FRP, FVR, Lift Pump
Monitoring Duration	not applicable

Typical Fuel Rail Pressure Control (Normal) Functional Check Entry Conditions:		
Entry Condition	Minimum	Maximum
High Pressure Pump Enabled	Enabled	
Fuel level	15%	
Injector Cut Off	No Injector Cut Off	
Injection Volume / (720° Pump Volume / Number of Cylinders)	0.05	0.90
Engine Coolant Temperature	20°F / 7°C	250°F / 121°C
CSER Mode	Not in CSER	

Typical Fuel Rail Pressure Control (Normal) Functional Check Malfunction Thresholds:
P0087: (Fuel_Pressure_Desired – Fuel_Pressure_Actual) / Fuel_Pressure_Desired > 0.25
P0088: – (Fuel_Pressure_Desired – Fuel_Pressure_Actual) / Fuel_Pressure_Desired > 0.25

Fuel Rail Pressure Control (Cranking)

Fuel Rail Pressure Control (Cranking) Functional Check Operation:	
DTCs	P00C6 (Fuel Rail Pressure Too Low – Engine Cranking)
Monitor execution	Minimum pressure met instantaneously once during cranking
Monitor Sequence	P0087 and P0088 must pass before setting P00C6 or P053F
Sensors/Actuators OK	FLI, FRP, FVR, Lift Pump
Monitoring Duration	Minimum met instantaneously once during cranking

Typical Fuel Rail Pressure Control (Cranking) Functional Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Fuel level	15%	

Typical Fuel Rail Pressure Control (Cranking) Functional Check Malfunction Thresholds:
Fuel_Pressure_Actual >= Fuel_Pressure_Desired

Fuel Rail Pressure Control (CSER)

Fuel Rail Pressure Control (CSER) Functional Check Operation:	
DTCs	P053F (Cold Start Fuel Pressure Control Performance)
Monitor execution	During CSER
Monitor Sequence	None
Sensors/Actuators OK	FLI, FRP, FVR, Lift Pump
Monitoring Duration	Entire CSER period

Typical Fuel Rail Pressure Control (CSER) Functional Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Fuel level	15%	

Typical Fuel Rail Pressure Control (CSER) Functional Check Malfunction Thresholds:
Time in Fuel Injection Pressure Window / CSER Duration > 0.70
Fuel Injection Pressure Window defined as follows:
Minimum Fuel Pressure to Support Desired Injection Mode <= Fuel Pressure Actual
Fuel Pressure Actual <= Maximum Fuel Pressure to Support Desired Injection Mode

Low Pressure Fuel Rail Pressure Sensor (PFI Fuel Rail)

Fuel Rail Pressure Sensor B Check Operation:	
DTCs	P018C (low input), P018D (high input)
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	8 seconds to register a malfunction

Typical FRP sensor check malfunction thresholds:
Voltage < 0.049 volts or voltage > 4.88 volts

Fuel Rail Pressure Sensor Transfer Function		
FRP volts = [Vref * (4 * Fuel Pressure / 70) + 0.50] / 5.00		
Volts	**A/D counts in PCM**	**Pressure, psi**
4.85	993	76.125
4.50	922	70
4.00	820	61.25
3.50	717	52.5
3.00	614	43.75
2.50	512	35
2.00	410	26.25
1.50	307	17.5
1.00	205	8.75
0.50	102	0
0.15	31	-6.125

Fuel Rail Pressure Control (Normal) Functional Check Operation:	
DTCs	P008A (Fuel Rail Pressure Too Low) P008B (Fuel Rail Pressure Too High)
Monitor execution	continuous
Monitor Sequence	P018C, P018D and P018B must complete
Sensors/Actuators OK	FRP
Monitoring Duration	not applicable

Typical Fuel Rail Pressure Control (Normal) Functional Check Entry Conditions:		
Entry Condition	Minimum	Maximum
High Pressure Pump Enabled	Enabled	
Fuel level	15%	

Injector Cut Off	No Injector Cut Off	
Injection Volume / (720° Pump Volume / Number of Cylinders)	0.05	0.90
Engine Coolant Temperature	20°F / 7°C	250°F / 121°C
CSER Mode	Not in CSER	

Typical Fuel Rail Pressure Control (Normal) Functional Check Malfunction Thresholds:
P008A: (Fuel_Pressure_Desired – Fuel_Pressure_Actual) / Fuel_Pressure_Desired > 0.25
P008B: – (Fuel_Pressure_Desired – Fuel_Pressure_Actual) / Fuel_Pressure_Desired > 0.25

FRP Range/Performance Check Operation:	
DTCs	P018B (FRP range/performance)
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	FRP
Monitoring Duration	8 seconds to register a malfunction

Typical FRP Sensor Range/Performance check entry conditions:		
Entry Condition	Minimum	Maximum
Demand pressure reasonable	35 psig	60 psig
Fuel level	15%	

Typical FRP Range/Performance check malfunction thresholds:
Fuel pressure error (demand – actual pressure) > 20 psig

Fuel Volume Regulator

Fuel Volume Regulator Circuit Check Operation	
DTCs	P0001 Fuel Volume Regulator Control Circuit / Open P0003 Fuel Volume Regulator Control Circuit Low P0004 Fuel Volume Regulator Control Circuit High
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	none
Monitoring Duration	5 seconds

Fuel Injector (DI System)

Fuel System "A" Injector Check Operation:	
DTCs	P0201 through P0208 - Cylinder X Injector "A" Circuit (opens/shorts)
Monitor execution	Continuous within entry conditions
Monitor Sequence	None
Monitoring Duration	8 seconds

Typical injector circuit check entry conditions:		
Entry Condition	Minimum	Maximum
Battery Voltage	11 volts	

Fuel Injector (PFI System)

Fuel System "B " Injector Check Operation:	
DTCs	P21CF through P21D6 - Cylinder X Injector "B" Circuit (opens/shorts)
Monitor execution	Continuous within entry conditions
Monitor Sequence	None
Monitoring Duration	5 seconds

Typical injector circuit check entry conditions:		
Entry Condition	Minimum	Maximum
Battery Voltage	11 volts	

Controlled Valve Operation (CVO) / Closed Loop Injection Control (CLIC)

CVO Functional Check Operation:	
DTCs	P02EE - Cylinder 1 Injector Circuit Range/Performance P02EF - Cylinder 2 Injector Circuit Range/Performance P02F0 - Cylinder 3 Injector Circuit Range/Performance P02F1 - Cylinder 4 Injector Circuit Range/Performance P02F2 - Cylinder 5 Injector Circuit Range/Performance P02F3 - Cylinder 6 Injector Circuit Range/Performance P02F4 - Cylinder 7 Injector Circuit Range/Performance P02F5 - Cylinder 8 Injector Circuit Range/Performance
Monitor execution	Continuous
Monitor Sequence	none
Sensors/Actuators OK	FRP (P0192, P0193, P0087, P0088, P018C, P018D, P008A, P008B), FVR (P0001, P0003, P0004), INJ (P0201, P0202, P0203, P0204, P0205, P0206)
Monitoring Duration	25 seconds

Typical CVO Functional Check Malfunction Thresholds:
Driver software indicates CVO circuit fault or unable to adapt/adaption at limits

PFI/DI Fuel Adaptive Monitor

Fuel Monitor Operation:	
DTCs	Common mode faults: P0171 System Too Lean (Bank 1) P0172 System Too Rich (Bank 1) P0174 System Too Lean (Bank 2) P0175 System Too Rich (Bank 2) DI mode faults: P2BEC Fuel Control System "A" Too Lean Bank 1 P2BED Fuel Control System "A" Too Rich Bank 1 P2BEE Fuel Control System "A" Too Lean Bank 2 P2BEF Fuel Control System "A" Too Rich Bank 2 PFI mode faults: P2BF0 Fuel Control System "B" Too Lean Bank 1 P2BF1 Fuel Control System "B" Too Rich Bank 1 P2BF2 Fuel Control System "B" Too Lean Bank 2 P2BF3 Fuel Control System "B" Too Rich Bank 2
Monitor execution	continuous while in closed loop fuel
Monitor Sequence	none
Sensors OK	Fuel Rail Pressure (if available), IAT, CHT/ECT, MAF, TP
Monitoring Duration	2 seconds to register malfunction

Typical fuel monitor entry conditions:		
Entry condition	Minimum	Maximum
Engine Coolant Temp	170 ºF / 70 ºC	230 ºF/ 110 ºC
Engine load	12%	
Intake Air Temp	-30 ºF / -40 ºC	150 ºF / 65 ºC
Fuel Level	10%	
Purge Duty Cycle	0%	0%

Typical fuel monitor malfunction thresholds:
Long Term Fuel Trim correction cell currently being utilized in conjunction with Short Term Fuel Trim: Lean malfunction: LONGFT > 25%, SHRTFT > 1% Rich malfunction: LONGFT < 25%, SHRTFT < 1%

Electronic Throttle Control (Dependability Monitor)

Level 1 Monitor – Main Control system limits or diagnostics.

Pedal On-Demand Tests

On-demand KOEO / KOER Sensor Check Operation:	
DTCs	P1124 – TP out of self-test range (non-MIL) P1575 – APP out of self-test range (non-MIL) P1703 – Brake switch out of self-test range (non-MIL)
Monitor execution	On-demand
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	< 1 seconds to register a malfunction

Accelerator Pedal Position

Accelerator Pedal Position Sensor Check Operation:	
DTCs	P2122, P2123 – APP D circuit continuity (wrench light, MIL) P2127, P2128 – APP E circuit continuity (wrench light, MIL) P2138 – APP D/E circuit disagreement (wrench light, MIL)
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	not applicable
Monitoring Duration	< 1 seconds to register a malfunction

APP sensor check malfunction thresholds:
Circuit continuity - Voltage < 0.25 volts or voltage > 4.75 volts Range/performance – disagreement between sensors > 0.9 degrees

Brake Pedal Position

Brake On Off Switch Check Operation:	
DTCs	P0504 – Brake switch A/B correlation (wrench light, non-MIL) P0572 – Brake switch circuit low (wrench light, non-MIL) P0573 – Brake switch circuit high (wrench light, non-MIL)
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	> 25 brake application cycles to register a malfunction

Brake Pressure Sensor Check Operation:	
DTCs	P1561 – Brake Line Pressure Sensor Circuit (wrench light, non-MIL)
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	< 2 seconds to register a malfunction

Brake Diagnostics for Stop-Start Dependability

Brake Torque Message Diagnostics for Stop Start Dependability Operation:	
DTCs	P05FF – Brake pressure/brake pedal position correlation (non-MIL) P1935 – Brake pressure sensor out of range over network (MIL for MHT, non-MIL for other vehicles)
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	< 1 second to register a malfunction

Clutch Pedal Position

a. Dual Clutch Switches

Clutch Pedal Position Switch Check Operation:	
DTCs	P0704 – Clutch Switch continuous compare check (non-MIL) P0830 – Clutch Switch stuck high (non-MIL) P0833 – Clutch Switch stuck low (non-MIL)
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	> 40 clutch application cycles while driving at different speeds

b. Dual PWM Clutch Sensors

Clutch Pedal Position Sensor Check Operation:	
DTCs	P08A9 – Clutch pedal position sensor A circuit low P08AA – Clutch pedal position sensor A circuit high P08B6 – Clutch pedal position sensor B circuit low P08B7 – Clutch pedal position sensor B circuit high P08B9 – Clutch pedal position sensor A/B correlation
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	< 1 seconds to register a malfunction

c. Single Analog sensor with Dual Clutch Switch Hardware

Clutch Pedal Position Sensor w. Switches Check Operation:	
DTCs	P08A9 – Clutch pedal position sensor A circuit low P08AA – Clutch pedal position sensor A circuit high P08B9 – Clutch pedal position sensor in range rationality (or) any malfunction with the dual switch hardware
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	< 1 seconds to register a malfunction for the sensor and 40 drive cycles at different vehicle speeds for the switches

d. Clutch Actuation Position Sensor

Clutch Actuation Position Operation:	
DTCs	P2C4C – Clutch actuation position sensor A circuit low P2C4D – Clutch actuation position sensor A circuit high P2C50 – Clutch actuation position sensor in range rationality
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	< 1 seconds to register a malfunction for the sensor

Throttle Position

a. Analog Throttle Position

Throttle Position Sensor Check Operation:	
DTCs	P0122, P0123 – TP A circuit continuity (MIL, wrench light) P0222, P0223 – TP B circuit continuity (MIL, wrench light) P2135 – TP A / TP B correlation (non-MIL, wrench light)
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	< 1 seconds to register a malfunction

TP sensor check malfunction thresholds:
Circuit continuity - Voltage < 0.25 volts or voltage > 4.75 volts
Correlation and range/performance – disagreement between sensors > 7 degrees

b. SENT Throttle Position

Throttle Position Sensor Check Operation:	
DTCs	P0120 – Throttle/Pedal Position Sensor/Switch "A" Circuit (MIL, wrench light) U0606 – Lost Communication With Throttle/Pedal Position Sensor/Switch "A"(MIL, wrench light) P0124 - Throttle/Pedal Position Sensor/Switch "A" Intermittent (MIL, wrench light) U210F - Throttle/Pedal Position Sensor/Switch "A" Communication Circuit Low (MIL, wrench light) U2110 - Throttle/Pedal Position Sensor/Switch "A" Communication Circuit High (MIL, wrench light) P0068 - MAP / MAF - Throttle Position Correlation (MIL, wrench light)
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	< 0.4 to 4 seconds to register a malfunction

TP sensor check malfunction thresholds:
P0120 (TP sensor fault) – SENT device faulted > 4 seconds
P0124 (TP intermittent) – fault present for > 0.4 seconds
U0606 (Lost Comm with TP sensor) – wiring or SENT device fault > 4 seconds
U210F/U2110 (SENT Comm line shorted high or low > 4 sec.

Throttle Position Sensor Check Operation (for ETB B on dual throttle applications):	
DTCs	P0225 – Throttle/Pedal Position Sensor/Switch "C" Circuit (MIL, wrench light) U0608 – Lost Communication With Throttle/Pedal Position Sensor/Switch "C"(MIL, wrench light) P0229 - Throttle/Pedal Position Sensor/Switch "C" Intermittent (MIL, wrench light) U2111 - Throttle/Pedal Position Sensor/Switch "B" Communication Circuit Low (MIL, wrench light) U2112 - Throttle/Pedal Position Sensor/Switch "B" Communication Circuit High (MIL, wrench light)
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	< 0.4 to 4 seconds to register a malfunction

TP sensor check malfunction thresholds:
P0225 (TP sensor fault) – SENT device faulted > 4 seconds
P0229 (TP intermittent) – fault present for > 0.4 seconds
U0608 (Lost Comm with TP sensor) – wiring or SENT device fault > 4 seconds
U2111/U2112 (SENT Comm line shorted high or low > 4 sec.

Throttle Plate Position Controller (TPPC)

Throttle Plate Controller and Actuator Operation:	
DTCs	P2118 – Throttle Actuator “A” Control Motor Current Range/Performance (MIL, wrench light) P2111 – Throttle Actuator “A” Control System – Stuck Open (MIL, wrench light) P2112 – Throttle Actuator “A” Control System – Stuck Closed (MIL, wrench light) P2119 – Throttle Actuator “A” Control Throttle Body Range/Performance (MIL, wrench light) P2101 – Throttle Actuator “A” Control Motor Circuit Range/Performance (MIL, wrench light) P115E – Throttle Actuator “A” Control Throttle Body Air Flow Trim at Max Limit (MIL, legacy) P0FB6 – Throttle Actuator “A” Control Throttle Body Air Flow Trim at Max Limit (MIL, replaces P115E from new 23MY)
Monitor execution	Continuous
Monitor Sequence	None
Monitoring Duration	< 5 seconds to register a malfunction

Throttle Plate Controller and Actuator Operation (for ETB B on dual throttle applications):	
DTCs	P211C – Throttle Actuator “B” Control Motor Current Range/Performance (MIL, wrench light) P211A – Throttle Actuator “B” Control System – Stuck Open (MIL, wrench light) P211B – Throttle Actuator “B” Control System – Stuck Closed (MIL, wrench light) P211D – Throttle Actuator “B” Control Throttle Body Range/Performance (MIL, wrench light) P210B – Throttle Actuator “B” Control Motor Circuit Range/Performance (MIL, wrench light) P0FB7 – Throttle Actuator “B” Control Throttle Body Air Flow Trim at Max Limit (MIL)
Monitor execution	Continuous
Monitor Sequence	None
Monitoring Duration	< 5 seconds to register a malfunction

Level 2 Monitoring – IPC and Input Validation

Electronic Throttle Monitor Operation:	
DTCs	P060D – Internal control module accelerator pedal performance (MIL, wrench) P061A – Internal control module torque performance (non-MIL, wrench light for cruise fault, no wrench light for torque clipping) P061B – Internal control module torque calculation performance (MIL, wrench light) P061C – Internal control module engine rpm performance (MIL, wrench light) P061D – Internal control module engine air mass performance (MIL, wrench light) P061E – Internal control module brake signal performance (non-MIL, wrench light) – Replaced by U1012 on new 18MY+ vehicles P062B – Internal control module fuel injector control performance (MIL for VDE in US and China 6, non-MIL for Europe VDE, OFF for non-VDE applications) P062C – Internal control module vehicle speed performance (non-MIL, wrench light) P162D – Internal control module cruise control performance (non-MIL, wrench light) P162E – Internal Control Module PTO Control Performance (non-MIL for PTO programs) P164C – Internal control module stop/start performance (non-MIL, wrench light) P166F – Internal Control Module Clutch Actuation Position Performance (non-MIL for Stop in Gear functional Manual Transmission vehicles) P26C3 – Internal Control Module Transmission Range Sensor Performance (non-MIL) P26C4 – Internal control module clutch pedal performance (non-MIL for manual transmission vehicles) U0515 – Invalid Data Received From Remote Function Actuation Module (non-MIL for Remote Park Assist programs) U053B – Invalid Data Received From Image Processing Module A (non-MIL Remote Park Assist programs and Auto Hitch programs) U1010 – Invalid Internal control module Monitoring Data received from Hybrid Powertrain module (non-MIL, wrench light) U1011 – Torque Plausibility Communication Error – ECM signal to TCM (non-MIL for TCM) U1012 – Invalid Internal Control Module Monitoring Data received from ABS module (MIL for MHT, non-MIL for all others) U1013 – Torque Plausibility Communication error – TCM signal to ECM (non-MIL for ECM with Auto Trans) U101E – Invalid Internal Control Module Monitoring Data Received from Gear Shift Module (non-Mil for Park by Wire only) U101F – Invalid Internal Control Module Monitoring Data Received from Transmission Range Control Module (non-MIL for Park by Wire only). U102C – Invalid Internal Control Module Monitoring Data Received from Park Assist Control Module (non-MIL for Fully Aided Park Assist vehicles) U102F – Invalid Internal Control Module Monitoring Data Received from Driveline Control Module (non-MIL for R-AWD with a DLCM)

	U1022 – Invalid Internal Control Module Monitoring Data Received from Body Control Module (non-MIL for OTA) U3003 – Low Battery Voltage (MIL, wrench light) P27B2 – Invalid Internal Control Module Transmission Range Control Performance (non-MIL for Shift by Wire vehicles) P27B3 – Invalid Internal Control Module Transmission Actuator Manager Performance (non-MIL for Park by Wire vehicles) P27B4 – Invalid Internal Control Module Transmission Gear Detection Control Performance (non-MIL for Shift by Wire vehicles) P27B5 – Invalid Internal Control Module Transmission Gear Ratio Control Performance (non-MIL for Shift by Wire vehicles) P27B6 – Invalid Internal Control Module Transmission Speed Sensor Performance (non-MIL for shift-by-wire)
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	< 1 seconds to register a malfunction

Level 3 Monitoring – Quizzer assesses Main processor/IPC health

Electronic Throttle Monitor Operation:	
DTCs	P0600 – Serial Communication Link (MIL, wrench light) P060A – Internal control module monitoring processor performance (MIL, wrench light) P060B – Internal control module A/D processing performance (MIL, wrench light) P060C – Internal control module main processor performance (MIL, wrench light) P0606 – Control Module Processor (MIL, wrench light) P1674 – Internal control module software corrupted (MIL, wrench light) U0300 – ETC software version mismatch, IPC, Quizzer or TPPC (MIL, wrench light)
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	< 1 seconds to register a malfunction

Stop Start Diagnostics

Stop Start Enable Conditions:

Input	Stop-Start Inhibit Conditions	Rationale
ECT	140 deg F < ECT > 230 deg F	Combustion Stability
BARO	BARO <= 20 in Hg (Altitude <= 10,000 ft)	Minimum Air Charge
FRP at Idle	Fuel Rail Pressure (FRP) at Idle >= 45 Bar	Restart Combustion Stability
FRP w/Engine Off	FRP at engine off >= FRP at Idle with max drop of 5 Bar. If FRP at eng off drops below threshold, request pull-up	Restart Combustion Stability
Time Since Key-Start	10 seconds	Oil Stabilization and Learn Closed Throttle
Max Crank Time	Max Crank Time should be min of 5 sec below limit to allow a shutdown	To avoid a possible max crank fault
Low Fuel Level	fuel level below 15%	Avoid starts on empty fuel tank
Purge complete	Canister Purge Valve no closed before end of pre stop period	Wait for purge to complete before pulling down engine
Adaptive Fuel Complete	Adaptive fuel learning not complete	If Adaptive fuel learning is in process, wait for it to complete before pull down

Stop Start Disable Conditions:

FVR (P0001, P0003, P0004), **Low Pressure Fuel** (P008A, P008B), **Crank Fuel Pressure** (P00C6),
VVT (P0010, P0011, P0012, P0013, P0014, P0015, P0016, P0017),
AAT (P0072, P0073, P0074), **IAT** (P00CE), **High Pressure Fuel** (P0087, P0088),
IAT2 (P0096, P0097, P0098), **MAF** (P0100, P0102, P0103, P1101), **MAF/TP** (P0068),
MAP (P0106, P0107, P0108, P0109), **IAT1** (P0111, P0112, P0113, P0114),
ECT (P0116, P0117, P0118, P0119), **TP1** (P0122, P0123), **TP2** (P0222, P0223),
Fuel Monitor (P0148, P0171, P0172), **LP FP** (P018C, P018D), **FRP** (P0192, P0193),
Injectors (P0201, P0202, P0203, P0204), **Misfire** (P0300, P0301, P0302, P0303, P0304),
Fuel Pump (P025A, P025B, P0230, P0231, P0232, P0627, P064A),
CMP A (P0340, P0341, P0344), **Coils** (P0351, P0352, P0353, P0354),
CMP B (P0365, P0366, P0369), **Idle Speed** (P0505, P0506, P0507), **Starter** (P0615, P06E9, P162F),
ETC (P2100, P2101, P2107, P2111, P2112), **APP** (P2122, P2123, P2127, P2128, P2135, P2138),
BARO (P2227, P2228, P2229, P2230), **PCV** (P2282),
Coils (P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310)

Comprehensive Component Monitor - Engine

Engine Temperature Sensor Inputs

Engine Coolant Temperature Sensor Check Operation:	
DTCs	P0117 (low input), P0118 (high input)
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	5 seconds to register a malfunction

Typical ECT sensor check malfunction thresholds:
Voltage < 0.244 volts or voltage > 4.96 volts

ECT Sensor Rationality Check Operation:	
DTCs	P0116 (ECT stuck high or midrange)
Monitor execution	Once per driving cycle
Monitor Sequence	None
Sensors OK	ECT, CHT, IAT
Monitoring Duration for stuck high	On first valid sample after key on (engine does not have to start)
Monitoring Duration for stuck midrange	5 seconds to register a malfunction

Typical ECT Sensor Rationality check entry conditions:		
Entry Condition	Minimum	Maximum
Engine-off time (soak time)	360 min	
Difference between ECT and IAT (stuck high only)		50 deg
Engine Coolant Temperature for stuck high condition	230 ºF	
Engine Coolant Temperature for stuck midrange condition	175 ºF	230 ºF

Typical ECT Sensor Rationality check malfunction thresholds:
ECT stuck high after first valid sample OR ECT stuck midrange for > 5 seconds

Cylinder Head Temperature Sensor Check Operation:	
DTCs	P1289 (high input), P1290 (low input), P1299 (fail-safe cooling activated)
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	not applicable
Monitoring Duration	5 seconds to register a malfunction

Typical CHT sensor check malfunction thresholds:
Voltage < 0.244 volts or voltage > 4.96 volts For P1299, MIL illuminates immediately if CHT > 270 °. Fuel shut-off is activated to reduce engine and coolant temperature

Cylinder Head Temperature Sensor Check Operation:	
DTCs	P1289 (high input), P1290 (low input), P1299 (fail-safe cooling activated)
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	not applicable
Monitoring Duration	5 seconds to register a malfunction

Typical CHT sensor check malfunction thresholds:
Voltage < 0.244 volts or voltage > 4.96 volts For P1299, MIL illuminates immediately if CHT > 270 °. Fuel shut-off is activated to reduce engine and coolant temperature

Intake Air Temperature Sensor Check Operation:	
DTCs	P0112 (low input), P0113 (high input)
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	not applicable
Monitoring Duration	5 seconds to register a malfunction

Typical IAT sensor check malfunction thresholds:
Voltage < 0.244 volts or voltage > 4.96 volts

Engine Oil Temperature Sensor Check Operation:	
DTCs	P0197 (low input), P0198 (high input)
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	not applicable
Monitoring Duration	5 seconds to register a malfunction

Typical EOT sensor check malfunction thresholds:
Voltage < 0.20 volts or voltage > 4.96 volts

Fuel Rail Temperature Sensor Check Operation:	
DTCs	P0182 (low input), P0183 (high input)
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	not applicable
Monitoring Duration	5 seconds to register a malfunction

Typical FRT sensor check malfunction thresholds:
Voltage < 0.12 volts or voltage > 4.82 volts

Ambient Air Temperature

Ambient Air Temperature Sensor Check Operation:	
DTCs	P0072 - AAT Sensor Circuit Low P0073 - AAT Sensor Circuit High
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	5 seconds to register a malfunction

Typical AAT sensor check malfunction thresholds:
Voltage < 0.51 volts or voltage > 4.93 volts

ECT, IAT, EOT Temperature Sensor Transfer Function		
Volts	**A/D counts in PCM**	**Temperature, degrees F**
4.89	1001	-40
4.86	994	-31
4.81	983	-22
4.74	970	-13
4.66	954	-4
4.56	934	5
4.45	910	14
4.30	880	23
4.14	846	32
3.95	807	41
3.73	764	50
3.50	717	59
3.26	666	68
3.00	614	77
2.74	561	86
2.48	508	95
2.23	456	104
1.99	407	113
1.77	361	122
1.56	319	131
1.37	280	140
1.20	246	149
1.05	215	158
0.92	188	167
0.80	165	176
0.70	144	185
0.61	126	194

0.54	110	203
0.47	96	212
0.41	85	221
0.36	74	230
0.32	65	239
0.28	57	248
0.25	51	257
0.22	45	266
0.19	40	275
0.17	35	284
0.15	31	293
0.14	28	302

CHT Temperature Sensor Transfer Function, Cold End		
Volts	**A/D counts in PCM**	**Temperature, degrees F**
4.899	1002	-40
4.861	995	-31
4.812	985	-22
4.75	972	-14
4.671	956	-4
4.572	936	4
4.452	911	14
4.309	882	22
4.14	847	32
3.95	808	40
3.737	765	48
3.508	717	58
3.26	666	68
3.00	614	77
2.738	560	87
2.478	507	96
2.226	455	105
1.985	406	114
1.759	360	122
1.551	317	132
1.362	279	141
1.193	244	149
1.043	213	159
0.91	186	168
0.794	162	176
0.693	142	186
0.604	124	194
0.528	108	203
0.462	95	204

CHT Temperature Sensor Transfer Function, Hot End		
Volts	**A/D counts in PCM**	**Temperature, degrees F**
4.235	866	168
4.119	843	168
3.993	817	176
3.858	789	185
3.714	760	194
3.563	729	203
3.408	697	212
3.244	664	221
3.076	629	230
2.908	595	239
2.740	561	248
2.575	527	257
2.411	493	266
2.252	461	275
2.099	430	284
1.953	400	294
1.813	371	303
1.680	344	312
1.556	318	320
1.439	294	329
1.329	272	338
1.228	251	347
1.133	232	356
1.046	214	366
0.965	197	375
0.891	182	383
0.822	168	392
0.760	155	401
0.701	144	408
0.648	133	415
0.599	123	422
0.555	113	428
0.513	105	433
0.476	97	438
0.441	90	442
0.409	84	447
0.380	78	450
0.353	72	454
0.328	67	457
0.306	63	460
0.285	58	463
0.265	54	465

0.248	51	468
0.231	47	470
0.216	44	472
0.202	41	474
0.190	39	475
0.178	36	477
0.167	34	478
0.156	32	480

Intake Air Temperature 1 Sensor (IAT1)

Intake Air Temperature 1 Sensor Circuit Range Check	
DTCs	P0112 Intake Air Temperature Sensor 1 Circuit Low (Bank 1) P0113 Intake Air Temperature Sensor 1 Circuit High (Bank 1)
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	not applicable
Monitoring Duration	5 seconds to register a malfunction

Typical Intake Air Temperature 1 Sensor Circuit Range Check Malfunction Thresholds
P0112 IAT1 voltage < 0.244 volts
P0113 IAT1 voltage > 4.96 volts

Intake Air Temperature Sensor 1 Circuit Intermittent Check	
DTCs	P0114 Intake Air Temperature Sensor 1 Intermittent/Erratic (Bank 1)
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	not applicable
Monitoring Duration	counts intermittent events per trip

Typical Air Charge Temperature Sensor Check Malfunction Thresholds
10 intermittent out-of-range events per driving cycle

Charge Air Cooler Temperature Sensor (CACT)

Throttle Charge Temperature Sensor Circuit Range Check	
DTCs	P007C Charge Air Cooler Temperature Sensor Circuit Low (Bank 1) P007D Charge Air Cooler Temperature Sensor Circuit High (Bank 1)
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	not applicable
Monitoring Duration	5 seconds to register a malfunction

Typical Throttle Charge Temperature Sensor Circuit Range Check Malfunction Thresholds
P007C CACT voltage < 0.244 volts
P007D CACT voltage > 4.96 volts

Intake Air Temperature 2 Sensor (IAT2)

Manifold Charge Temperature Sensor Circuit Range Check	
DTCs	P0097 Intake Air Temperature Sensor 2 Circuit Low (Bank 1) P0098 Intake Air Temperature Sensor 2 Circuit High (Bank 1)
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	5 seconds to register a malfunction

Typical Manifold Charge Temperature Sensor Circuit Range Malfunction Thresholds
P0097 IAT2 voltage < 0.244 volts
P0098 IAT2 voltage > 4.96 volts

IAT1, CACT, IAT2, EOT Temperature Sensor Transfer Function		
Volts	**A/D counts in PCM**	**Temperature, degrees F**
4.89	1001	-40
4.86	994	-31
4.81	983	-22
4.74	970	-13
4.66	954	-4
4.56	934	5
4.45	910	14
4.30	880	23
4.14	846	32
3.95	807	41
3.73	764	50
3.50	717	59
3.26	666	68
3.00	614	77
2.74	561	86
2.48	508	95
2.23	456	104
1.99	407	113
1.77	361	122
1.56	319	131
1.37	280	140
1.20	246	149
1.05	215	158
0.92	188	167
0.80	165	176
0.70	144	185
0.61	126	194
0.54	110	203
0.47	96	212
0.41	85	221
0.36	74	230
0.32	65	239
0.28	57	248
0.25	51	257
0.22	45	266
0.19	40	275
0.17	35	284
0.15	31	293
0.14	28	302

Relative Humidity Temperature Sensor (RHT)

Relative Humidity Temperature Sensor Circuit Range Check	
DTCs	P0f5a RHT Sensor SENT Circuit
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	3 seconds to register a malfunction

IAT1, CACT, IAT2 Key-Up Correlation Check

Engine Air Temperature Sensor Key-Up Correlation Check	
DTCs	P0111 Intake Air Temperature Sensor 1 Circuit Range/Performance (Bank 1) P007B Charge Air Cooler Temperature Sensor Circuit Range/Performance (Bank 1) P0096 Intake Air Temperature Sensor 2 Circuit Range/Performance (Bank 1) P00CE Intake Air Temperature Measurement System – Multiple Sensor Correlation
Monitor execution	Once per driving cycle, at start-up
Monitor Sequence	None
Sensors OK	ECT/CHT, IAT1, CACT, IAT2, TFT
Monitoring Duration	Immediate

Engine Air Temperature Sensor Key-Up Correlation Check Entry Conditions		
Entry condition	Minimum	Maximum
Engine off (soak) time	6 hours	
CHT – TFT at start (block heater inferred)		+10 °F

Typical Engine Air Temperature Sensor Key-Up Correlation Check Malfunction Thresholds
CHT at least 10°F hotter than TFT means block heater detected.

IAT Rationality Test

Intake Air Temperature Sensor Range/Performance Check Operation:	
DTCs	P0111 (IAT11 range/performance) P0096 (IAT12 range/performance) P00ab (IAT21 range/performance)
Monitor execution	Once per driving cycle, at start-up
Monitor Sequence	None
Sensors OK	ECT/CHT, IAT, VSS
Monitoring Duration	Immediate or up to 30 minutes to register a malfunction

Typical Engine Air Temperature Sensor Out of Range Hot Check Malfunction Thresholds
P0111 IAT1 > 150°F
P007B CACT > 220°F
P0096 IAT2 > 240°F

IAT1, CACT, IAT2 Out of Range Hot Check

Engine Air Temperature Sensor Out of Range Hot Check	
DTCs	P0111 Intake Air Temperature Sensor 1 Circuit Range/Performance (Bank 1) P007B Charge Air Cooler Temperature Sensor Circuit Range/Performance (Bank 1) P0096 Intake Air Temperature Sensor 2 Circuit Range/Performance (Bank 1)
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	ECT/CHT, IAT, VSS
Monitoring Duration	250 seconds to register a malfunction

Engine Air Temperature Sensor Out of Range Hot Check Entry Conditions		
Entry condition	Minimum	Maximum
Vehicle speed	40 mph	
Time above minimum vehicle speed (if driving req'd)	5 min	
For IAT1, Load below a maximum load threshold	1.0	

Typical Engine Air Temperature Sensor Out of Range Hot Check Malfunction Thresholds
P0111 IAT1 > 150°F
P007B CACT > 220°F
P0096 IAT2 > 240°F

RHT Rationality Test

Relative Humidity Temperature Sensor Range/Performance Check Operation:	
DTCs	P05fb (range/performance)
Monitor execution	Once per driving cycle, at start-up
Monitor Sequence	None
Sensors OK	IAT
Monitoring Duration	Immediate or up to 30 minutes to register a malfunction

Relative Humidity Temperature Sensor Out of Range High Check Operation:	
DTCs	P05fb (Out of Range High)
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	IAT
Monitoring Duration	Immediate or up to 30 minutes to register a malfunction

AAT Rationality Test

Ambient Air Temperature Sensor Range/Performance Check Operation:	
DTCs	P0071 - AAT Sensor Range/Performance
Monitor execution	Once per driving cycle, at start-up
Monitor Sequence	None
Sensors OK	ECT/CHT, IAT, VSS, P2610
Monitoring Duration	Immediate or up to 5 minutes to register a malfunction

Typical Ambient Air Temperature Sensor Range/Performance Entry Conditions		
Entry condition	Minimum	Maximum
Engine off (soak) time	6 hours	
Battery Voltage	11.0 Volts	
Time since engine start (if driving req'd)		30 min
Vehicle speed (if driving req'd)	25 mph	
Time above minimum vehicle speed (if driving req'd)	5 min	
IAT - ECT at start (block heater inferred)	-30 °F	-90 °F

Typical AAT sensor check malfunction thresholds:
AAT and IAT and ECT/CHT error at start-up > +/-30 deg F

Ambient Air Temperature Sensor Out of Range High Check Operation:	
DTCs	P0071 (Out of Range High)
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	ECT/CHT, IAT, VSS, P2610
Monitoring Duration	300 seconds to register a malfunction

Typical Ambient Air Temperature Sensor Out of Range high Entry Conditions		
Entry condition	Minimum	Maximum
Engine off (soak) time	6 hours	
Battery Voltage	11.0 Volts	
Load		200%
Vehicle speed	10 mph	
Time above minimum vehicle speed (if driving req'd)	5 min	

Typical AAT Sensor Out of Range High check malfunction thresholds:
IAT > 150 deg F

Fuel Rail Pressure Sensor

Fuel Rail Pressure Sensor Check Operation:	
DTCs	P0192 (low input), P0193 (high input)
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	8 seconds to register a malfunction

Typical FRP sensor check malfunction thresholds:
Voltage < 0.049 volts or voltage > 4.88 volts

Fuel Rail Pressure Sensor Transfer Function		
FRP volts = [Vref * (4 * Fuel Pressure / 70) + 0.50] / 5.00		
Volts	**A/D counts in PCM**	**Pressure, psi**
4.85	993	76.125
4.50	922	70
4.00	820	61.25
3.50	717	52.5
3.00	614	43.75
2.50	512	35
2.00	410	26.25
1.50	307	17.5
1.00	205	8.75
0.50	102	0
0.15	31	-6.125

FRP Range/Performance Check Operation:	
DTCs	P0191 (FRP range/performance), P1090 (stuck in range)
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	FRP
Monitoring Duration	8 seconds to register a malfunction

Typical FRP Sensor Range/Performance check entry conditions:		
Entry Condition	Minimum	Maximum
Demand pressure reasonable	35 psig	60 psig
Fuel level	15%	

Typical FRP Range/Performance check malfunction thresholds:
Fuel pressure error (demand – actual pressure) > 20 psig

Typical FRP Sensor Stuck check entry conditions:		
Entry Condition	Minimum	Maximum
FRP sensor input	0 psig	46 psig
FRP input not moving		1 psig / sec

Typical FRP Stuck check malfunction thresholds:
Fuel pressure error (demand – actual pressure) > 5 psig

Mass Air Flow Sensor

MAF Sensor Check Operation:	
DTCs	Digital MAF Sensor A: P0100 (broken element), P0102 (low input), P0103 (high input), P0104 (intermittent) Digital MAF Sensor B: P010A (broken element), P010C (low input), P010D (high input), P010E (intermittent)
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	not applicable
Monitoring Duration	5 seconds to register a malfunction

Typical MAF Sensor check entry conditions:		
Entry Condition	Minimum	Maximum
P0100		
Time since last PIP edge (engine has not stalled)		
P0102		
Time since last PIP edge (engine has not stalled)		150 msec
Engine rpm	Base idle speed – 25 rpm	
Relative throttle position	1 degree	
P0103		
Engine rpm		6000 rpm

Typical MAF sensor check malfunction thresholds:
Digital Sensor:
P0100/P010A – MAF sensor signal period > 1300 microseconds (< 0.78 kHz) for > 0.5 sec
P0102/P010C - MAF sensor signal period > 658 microseconds (< 1.5 kHz) for > 5 sec
P0103/P010D - MAF sensor signal period < 83 microseconds (> 0.78kHz) for > 5 sec
P0104/P010E – MAF sensor open/shorted > 25 occurrences

Manifold Absolute Pressure Sensor

MAP Sensor Transfer Function		
Vout=(Vref / 5) * 0.0409523809* Pressure (in kPa) + -0.1095238095)		
Volts	Pressure, kPa	Pressure, Inches Hg
0.30	10.0	2.59
0.38	12.0	3.54
1.00	27.0	7.97
2.35	60.0	17.72
3.37	85.0	25.10
4.48	112.0	33.07
4.60	115.0	33.96

MAP Sensor Check Operation	
DTCs	P0107 (low voltage), P0108 (high voltage)
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	5 seconds to register a malfunction

MAP electrical check entry conditions:
Battery voltage > 11.0 volts

Typical MAP sensor check malfunction thresholds:
Voltage < 0.19 volts or voltage > 4.88 volts

MAP Sensor Rationality Test (Naturally Aspirated Speed Density Engines)

Key-Up Test (MAP signal vs. BP signal)	
DTC	P0106 Manifold Absolute Pressure Circuit Range/Performance
Monitor execution	At key-up
Monitor Sequence	None
Sensors OK	BP, MAP
Monitoring Duration	0.3 seconds

Typical Key-Up Test Entry Conditions		
Entry condition	Minimum	Maximum
Engine off (soak) time	4 seconds	

Engine Running Test (MAP signal vs. Estimated MAP signal/BP signal)	
DTC	P0106 Manifold Absolute Pressure Circuit Range/Performance
Monitor execution	Continuous, if entry conditions are met
Monitor Sequence	None
Sensors OK	BP, MAP, TPS
Monitoring Duration	10~15 seconds (one monitoring event)

Typical Engine Running Test Entry Conditions		
Entry conditions	Minimum	Maximum
Throttle Position	10 degrees	
Engine Speed	525 RPM	
Change in Throttle Position	1.0 degree	
Change in MAP signal	1.0"Hg	
Change in estimated MAP signal	1.0"Hg	

Typical MAP Sensor Rationality Test Malfunction Thresholds
|BARO – MAP| < 3.0"Hg (Key-Up test)
|MAP – Estimated MAP / BARO| < 2.20"Hg (Engine Running Test)

Intake Manifold Pressure Sensor Range Circuit Intermittent Check	
DTCs	P0109 Manifold Absolute Pressure/BARO Sensor Intermittent
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	not applicable
Monitoring Duration	25 counts intermittent events per trip

Typical Intake Manifold Pressure Sensor Range Circuit Malfunction Thresholds
25 intermittent out-of-range events per driving cycle

MAP Sensor Rationality Test (Supercharged Engine)

Key-Up Test (MAP signal vs. BP signal)	
DTC	P0106 Manifold Absolute Pressure Circuit Range/Performance
Monitor execution	At key-up
Monitor Sequence	None
Sensors OK	BP, MAP
Monitoring Duration	0.3 seconds

Typical Key-Up Test Entry Conditions		
Entry condition	Minimum	Maximum
Engine off (soak) time	4 seconds	

Engine Running Test (MAP signal vs. Estimated MAP signal)	
DTC	P0106 Manifold Absolute Pressure Circuit Range/Performance
Monitor execution	Continuous, if entry conditions are met
Monitor Sequence	None
Sensors OK	BP, MAP, TPS, SIP
Monitoring Duration	2~5 seconds (after 2~4 seconds of stabilization time)

Typical Engine Running Test Entry Conditions		
Entry conditions	Minimum	Maximum
Engine Coolant Temperature	70 degrees F	
Throttle Position	10 degrees	
Change in Throttle Position	0.3 degree	

Typical MAP Sensor Rationality Test Malfunction Thresholds
|BARO – MAP| < 1.5"Hg (Key-Up test)
|MAP – Estimated MAP| < 2.50"Hg (Engine Running Test)

Intake Manifold Pressure Sensor Range Circuit Intermittent Check	
DTCs	P0109 Manifold Absolute Pressure/BARO Sensor Intermittent
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	not applicable
Monitoring Duration	25 counts intermittent events per trip

Typical Intake Manifold Pressure Sensor Range Circuit Malfunction Thresholds
25 intermittent out-of-range events per driving cycle

MAF/MAP - TP Rationality Test

MAF/TP Rationality Check Operation:	
DTCs	P0068 - MAP / MAF - Throttle Position Correlation
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	
Monitoring Duration	5 seconds within test entry conditions

Typical MAF/TP rationality check entry conditions:		
Entry Condition	Minimum	Maximum
Engine RPM	550 rpm	minimum of 5000 rpm
Engine Coolant Temp	150 ºF	

Typical MAF/TP rationality check malfunction thresholds:
Load > 60% and TP < 2.4 volts or Load < 30% and TP > 2.4 volts

Engine Off Timer Monitor

Engine Off Timer Check Operation:	
DTCs	P2610
Monitor execution	Continuous within entry conditions
Monitor Sequence	None
Monitoring Duration	Immediately on startup or after 5 minutes

Typical Engine Off Timer check malfunction thresholds:
Engine off time < 30 seconds after inferred soak
Engine off timer accuracy off by > 15 sec.
Engine off time CAN message missing at startup

5 Volt Sensor Reference Voltage A Check:	
DTCs	P0642 - Sensor Reference Voltage "A" Circuit Low P0643 - Sensor Reference Voltage "A" Circuit High
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	5 sec to register a malfunction

Typical 5 Volt Sensor Reference Voltage A check entry conditions:		
Entry Condition	Minimum	Maximum
Ignition "ON"	NA	NA

Typical 5 Volt Sensor Reference Voltage A check malfunction thresholds:
P0642 Short to ground (signal voltage): < 4.75 V P0643 Short to battery plus (signal voltage): > 5.25 V

5 Volt Sensor Reference Voltage A/B/C Check:	
DTCs	P06A6 - Sensor Reference Voltage "A" Circuit Range/Performance P06A7 - Sensor Reference Voltage "B" Circuit Range/Performance P06A8 - Sensor Reference Voltage "C" Circuit Range/Performance
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	0.5 sec to register a malfunction

Typical 5 Volt Sensor Reference Voltage A/B/C check entry conditions:		
Entry Condition	Minimum	Maximum
Ignition "ON"	NA	NA

Typical 5 Volt Sensor Reference Voltage A/B/C check malfunction thresholds:
P0646, P0647, P06A8 (used for Bosch Tricore modules) Reference voltage: < 4.7 V or reference voltage: > 5.2 V

Ignition System Tests

CKP Ignition System Check Operation:	
DTCs	P0320 Ignition Engine Speed Input Circuit P0322 Ignition Engine Speed Input Circuit No Signal P0339 Crankshaft Position Sensor "A" Circuit Intermittent P0335 Crankshaft Position Sensor "A" Circuit
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	
Monitoring Duration	< 5 seconds

Typical CKP ignition check entry conditions:		
Entry Condition	Minimum	Maximum
Engine RPM for CKP	500 rpm	

Typical CKP ignition check malfunction thresholds:
P0320 or P0339: Incorrect number of teeth after the missing tooth is recognized, time between teeth too low (< 30 rpm or > 9,000 rpm), missing tooth was not where it was expected to be. P0322 or P0335: Camshaft indicates > 1 engine revolution while crankshaft signal missing

CMP Ignition System Check Operation:	
DTCs	P0340 - Intake Cam Position Circuit, Bank 1 P0344 – Intake Cam Position Circuit Intermittent, Bank 1 P0345 - Intake Cam Position Circuit, Bank 2 P0349 – Intake Cam Position Circuit Intermittent Bank 2 P0365 - Exhaust Cam Position Circuit, Bank 1 P0369 – Intake Cam Position Circuit Intermittent, Bank 1 P0390 - Exhaust Cam Position Circuit, Bank 2 P0394 – Exhaust Cam Position Circuit Intermittent Bank 2
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	
Monitoring Duration	< 5 seconds

Typical CMP ignition check entry conditions:		
Entry Condition	Minimum	Maximum
Engine RPM for CMP	200 rpm	

Typical CMP ignition check malfunction thresholds:
Ratio of PIP events to CMP events: 4:1, 6:1, 8:1 or 10:1 based on engine cyl. Intermittent CMP signal – CMP signal in unexpected location

Coil Primary Ignition System Check Operation:	
DTCs	P0351 – P0360 (Coil primary) P2300, P2303, P2306, P2309, P2312, P2315, P2318, P2321, P2324, P2327 (Coil driver short circuit low) P2301, P2304, P2307, P2310, P2313, P2316, P2319, P2322, P2325, P2328 (Coil driver short circuit high) P06D1 (Internal control module ignition coil control module performance)
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	
Monitoring Duration	< 1 seconds

Typical Coil primary ignition check entry conditions:		
Entry Condition	Minimum	Maximum
Engine RPM for coil primary	200 rpm	Minimum of 3200 rpm
Positive engine torque	Positive torque	
Battery Voltage	11 volts	16 volts

Typical Coil primary ignition check malfunction thresholds:
P035x (driver in module Ignition systems): Ratio of PIP events to IDM or NOMI events 1:1 P035x, P23xx (driver on coil Ignition systems): Coil driver circuit current and/or voltage out of range of open and short circuit limits. P06D1 (driver on coil Ignition systems): Missing communication from coil driver IC.

Knock Sensor

Knock Sensor Check Operation:	
DTCs	P0325 – Knock Sensor 1 Circuit P0330 – Knock Sensor 2 Circuit P032A – Knock Sensor 3 Circuit P033A – Knock Sensor 4 CircuitP0327 – Knock Sensor 1 Circuit Low P0328 – Knock Sensor 1 Circuit High P0332 – Knock Sensor 2 Circuit Low P0333 – Knock Sensor 2 Circuit High P032C – Knock Sensor 3 Circuit Low P032D – Knock Sensor 3 Circuit High P033C – Knock Sensor 4 Circuit Low P033D – Knock Sensor 4 Circuit High P130D – Engine Knock / Combustion Performance – Forced Limited Power
Monitor execution	Continuous within entry conditions Supplemental circuit low and high codes: Semi-continuous (periodically active) within entry conditions. Knock sensor lines are actively tested for a single combustion event once every 250 engine cycles.
Monitor Sequence	None
Sensors OK	Not in failsafe cooling mode
Monitoring Duration	Circuit codes: ~10 seconds to detect fault. Supplemental circuit low and high codes: ~1 to 2 minutes after engine start to detect fault. This is a typical amount of time to acquire 2 consecutive failed samples from the periodically active test. Mega Knock: Event based. See Malfunction thresholds below.

Typical Knock Sensor check entry conditions:		
Entry Condition	Minimum	Maximum
Time since engine start	2 to 5 sec	
Engine Coolant Temperature	140 °F	
Engine load (circuit codes)	35%	
Engine load (supplemental circuit low and high codes)		
Engine load (Mega Knock codes)	90%	
Engine speed (circuit codes)	1500 rpm	6000 rpm
Engine speed (supplemental circuit low and high codes)		4500 rpm
Engine speed (Mega Knock codes)	1000 rpm	4000 rpm

Typical Knock Sensor functional check malfunction thresholds:
P0325 & P0330, P032A, P033A Knock signal too low (function of engine speed): < 20 normalized A/D counts (out of 255)
P0327, P0332, P032C, P033C (used only for PCM/ECM with corresponding diagnostic circuit)
Voltage level from active knock sensor circuit probe below limit
P0328, P0333, P032D, P033D (used only for PCM/ECM with corresponding diagnostic circuit)
Voltage level from active knock sensor circuit probe above limit)
P130D Mega Knock detection rate too high: > 10 Mega Knock events within span of several thousand combustion events.

Engine Oil System Components

Engine Oil Pressure (EOP) Sensor

Analog EOP Sensor Transfer Function		
Vout=(Vref) * (0.0008 * Pressure (in kPa) + 0.10)		
Volts	Pressure, kPa	Pressure, psi
0.500	0	0
0.660	40	5.80
0.820	80	11.60
0.980	120	17.40
1.140	160	23.21
1.300	200	26.11
1.460	240	34.81
1.620	280	40.61
1.780	320	46.41
1.940	360	52.21
2.100	400	58.02
2.260	440	63.82
2.420	480	69.62
2.580	520	75.42
2.740	560	81.22
2.900	600	87.02
3.060	640	92.82
3.220	680	98.63
3.380	720	104.43
3.700	800	116.03
4.020	880	127.63
4.340	960	139.24
4.420	980	142.14
4.500	1000	145.04

Analog EOP Sensor Circuit Fault Check Operation:	
DTCs	Analog EOP Sensor P0522: Engine Oil Pressure Sensor “A” Circuit Low P0523: Engine Oil Pressure Sensor “A” Circuit High
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Monitoring Duration	5 seconds to register a malfunction

Typical Analog EOP Sensor Circuit Check Malfunction Thresholds:
Voltage < 0.25 volts or voltage > 4.75 volts

SENT EOP Sensor Internal Signal and Communication Fault Check Operation:	
DTCs	SENT EOP Sensor P0520: Engine Oil Pressure Sensor “A” Circuit U0600: Lost Communication With Engine Oil Pressure Sensor “A”
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Monitoring Duration	5 seconds to register a malfunction

EOP Sensor Circuit Check Entry Conditions:
Battery voltage > 11.0 volts

EOP Sensor Rationality Test

EOP Sensor Rationality Check Operation:	
DTCs	P0521: Engine Oil Pressure Sensor “A” Range/Performance
Monitor Execution	Stuck High: Once (up to three times) per driving cycle Stuck In-range: Once per driving cycle Stuck Low: Once per driving cycle Signal lower than estimated: Continuous Signal greater than estimated: Continuous
Monitor Sequence	None
Sensors OK	EOP, EOT, ECT
Monitoring Duration for Stuck High	Stuck High: When first valid engine-off average pressure value is available Stuck In-range: When first valid engine-off and engine-on average pressure values are available Stuck Low: When first valid engine-on average pressure value is available Signal lower than estimated: 5~10 seconds to register a malfunction Signal greater than estimated: 5~10 seconds to register a malfunction

Engine Oil Pressure Out of Range Test

Engine Oil Pressure (EOP) Check Operation:	
DTCs	P0524 - Engine Oil Pressure Too Low P055F - Engine Oil Pressure Out Of Range (Too High)
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	EOP, EOT, ECT
Monitoring Duration	P0524 Engine Protection from low oil pressure: 5 seconds P0524 Extended VCT hard-locking command (Mid-lock VCT engine only): 10~25 seconds P055F Engine Protection from high oil pressure: 5 seconds

Oil Pressure Control Solenoid

Oil Pressure Control Solenoid Circuit Check:	
DTCs	P06DA – Engine Oil Pressure Control Circuit/Open P06DB – Engine Oil Pressure Control Circuit Low P06DC – Engine Oil Pressure Control Circuit High
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	Not applicable
Monitoring Duration	5 seconds

Typical Oil Control Solenoid Circuit Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Battery Voltage	11.0 volts	

Typical Oil Control Solenoid Circuit Check Malfunction Thresholds:
P06DA/P06DB/P06DC - Smart driver reports output circuit fault.

Oil Pressure Control Solenoid Rationality Test

Oil Pressure Control Solenoid Functional Check:	
DTC	P06DD – Engine Oil Pressure Control Performance/Stuck Off P06DE – Engine Oil Pressure Control Stuck On
Monitor execution	2 stage: On pressure mode (Hi/Lo) change Continuous variable: Continuous
Monitor Sequence	None
Sensors/Actuators OK	EOP, EOT, ECT
Monitoring Duration	2 stage: < 1 seconds to register a malfunction once occurred Continuous variable: 10 seconds

Typical Oil Control Solenoid Functional Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Time since engine start	30 seconds	

Engine Oil Temperature (EOT) Sensor

EOP Sensor Transfer Function		
Volts	**Temperature, degrees F**	**Temperature, degrees C**
4.886	-40	-40
4.845	-31	-35
4.792	-22	-30
4.640	-4	-20
4.409	14	-10
4.084	32	0
3.664	50	10
3.173	68	20
2.650	86	30
2.142	104	40
1.685	122	50
1.299	140	60
0.994	158	70
0.757	176	80
0.577	194	90
0.441	212	100
0.339	230	110
0.262	248	120
0.205	266	130
0.161	284	140
0.143	293	145
0.128	302	150

EOT Sensor Circuit Check Operation:	
DTCs	Analog Sensor P0197: Engine Oil Temperature Sensor “A” Circuit Low P0198: Engine Oil Temperature Sensor “A” Circuit High
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Monitoring Duration	5 seconds to register a malfunction

EOT Senor Circuit Check Entry Conditions:
Battery voltage > 11.0 volts

Typical EOT Censor Circuit Check Malfunction Thresholds:
Voltage < 0.16 volts or Voltage > 4.93 volts

EOT Sensor Rationality Test

EOT Sensor Rationality Check Operation:	
DTCs	P0196: Engine Oil Pressure Sensor “A” Range/Performance P1184: Engine Oil Temperature Sensor Out Of Self Test Range
Monitor Execution	P0196: Continuous P1184: As requested
Monitor Sequence	None
Sensors OK	ECT
Monitoring Duration	Usually 5 seconds to register a malfunction

Engine Outputs

IAC Check Operation:	
DTCs	P0507 - Idle Control System – RPM Higher Than Expected P0506 - Idle Control System – RPM Lower Than Expected
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	ECT, VSS (Vehicle Speed Sensor)
Monitoring Duration	P0507 (overspeed): 15 seconds P0506 (underspeed): 10 seconds

Typical IAC functional check entry conditions:		
Entry Condition	Minimum	Maximum
Engine Coolant Temp	150 °F	
Time since engine start-up	100 seconds	
Closed loop fuel	Yes	
Throttle Position (at idle, closed throttle, no dashpot)	Closed	Closed

Typical IAC functional check malfunction thresholds:
For underspeed error: Actual rpm 100 rpm below target, closed-loop IAC correction > 1 lb/min
For overspeed error: Actual rpm 200 rpm above target, closed-loop IAC correction < .2 lb/min

The PCM monitors the "smart" driver fault status bit that indicates either an open circuit, short to power or short to ground.

Injector Check Operation:	
DTCs	P0201 through P0210 (opens/shorts)
Monitor execution	Continuous within entry conditions
Monitor Sequence	None
Monitoring Duration	5 seconds

Typical injector circuit check entry conditions:		
Entry Condition	Minimum	Maximum
Battery Voltage	11.0 volts	

Fuel Pump Diagnostics

Single speed MRFS Check Operation:	
DTCs	P0230 – Fuel Pump Primary Circuit (opens/shorts) P0231 – Fuel Pump Secondary Circuit Low P0232 – Fuel Pump Secondary Circuit High
Monitor execution	Continuous within entry conditions
Monitor Sequence	None
Sensors OK	
Monitoring Duration	2-5 seconds

Typical Single speed MRFS check entry conditions:		
Entry Condition	Minimum	Maximum
Battery Voltage	11 volts	16 volts

Fuel Pump Driver Module Check Operation:	
DTCs	P1233 – FPDM disabled of offline P1235 – Fuel pump control out of range P1237 – Fuel pump secondary circuit
Monitor execution	Continuous, voltage > 11 volts
Monitor Sequence	None
Monitoring Duration	3 seconds

Typical ERFS check entry conditions:		
Entry Condition	Minimum	Maximum
Battery Voltage	11 volts	16 volts

MRFS FP A Check Operation:	
DTCs	P0230 – PEM Power Relay Circuit P025A – Fuel Pump A Control Circuit (opens/shorts) P025B – Invalid Fuel Pump A Control Data P0627 – Fuel Pump A Secondary Circuit P064A – Fuel Pump A Driver Module Internal Error U210B – Fuel Pump A Disabled Circuit (obsolete) U0109 – Loss of Communication with Fuel Pump Module A
Monitor execution	Continuous with entry conditions
Monitor Sequence	None
Sensors OK	
Monitoring Duration	2-5 seconds

Typical MRFS FP A check entry conditions:		
Entry Condition	Minimum	Maximum
Battery Voltage	11 volts	16 Volts

Typical MRFS FP A check malfunction thresholds:
P0230 – no threshold (fuel pump driver detects PEM relay circuit fault)
P025A – no threshold (fuel pump driver detects FPC signal fault)
P025B - Fuel Pump Monitor duty cycle feedback of 20 ± 4%
P0627 – Fuel Pump Monitor duty cycle feedback correspondent to open/short or overtemperature faults
P064A – Fuel Pump Monitor duty cycle feedback of 30 ± 4%
U210B – Fuel Pump Monitor duty cycle feedback of 40% (obsolete)
U0109 - No Fuel Pump Monitor duty cycle feedback (i.e. 0% or 100% duty cycle)

MRFS FP B Check Operation:	
DTCs	P025A – Fuel Pump A/B Control Circuit (opens/shorts) P027B – Invalid Fuel Pump B Control Data P2632 – Fuel Pump B Secondary Circuit P26EA – Fuel Pump B Driver Module Internal Error U210C – Fuel Pump B Disabled Circuit (obsolete) U016C – Loss of Communication with Fuel Pump Module B
Monitor execution	Continuous with entry conditions
Monitor Sequence	None
Sensors OK	
Monitoring Duration	2-5 seconds

Typical MRFS FP B check entry conditions:		
Entry Condition	Minimum	Maximum
Battery Voltage	11 volts	16 volts

Typical MRFS FP B check malfunction thresholds:
P025A - no threshold (fuel pump driver detects FPC signal fault)
P027B - Fuel Pump Monitor duty cycle feedback of 20% ± 4%
P2632 – Fuel Pump Monitor duty cycle feedback correspondent to open/short or overtemperature faults
P26EA – Fuel Pump Monitor duty cycle feedback of 30% ± 4%
U210C – Fuel Pump Monitor duty cycle feedback of 40% (obsolete)
U016C - No Fuel Pump Monitor duty cycle feedback (i.e. 0% or 100% duty cycle)

Intake Manifold Runner Control Systems

IMRC System Check Operation:	
DTCs	Vacuum actuated, V engine: P2004 – IMRC stuck open, Bank 1 P2005 – IMRC stuck open, Bank 2 P2006 – IMRC stuck closed, Bank 1 P2007 – IMRC stuck closed, Bank 2 P2008 - IMRC Control Circuit P2011 – IMRC Control Circuit, Bank 2 P2016 – IMRC Position Sensor Circuit Low, Bank 1 P2021 – IMRC Position Sensor Circuit Low, Bank 2 P2017 – IMRC Position Sensor Circuit High, Bank 1 P2022 – IMRC Position Sensor Circuit High, Bank 2 P2015 – IMRC Position Sensor Over Travel, Bank 1 P2020 – IMRC Position Sensor Over Travel, Bank 2
Monitor execution	Continuous, after ECT > 40 deg F
Monitor Sequence	None
Sensors OK	
Monitoring Duration	Electrical: 5 seconds for circuit check Functional: 4 events for stuck/over travel check

Typical IMRC Solenoid Circuit Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Battery Voltage	11.0 volts	

Typical IMRC functional check malfunction thresholds
IMRC plates do not match commanded position / exceed operational range (functional)
IMRC position sensors open/shorted, (< 0.24 volts, > 4.7 volts)
IMRC control circuit (electrical, indicated by driver circuit)

Intake Manifold Tuning Valve Systems

IMTV Check Operation:	
DTCs	P1549 or P0660 - IMTV output electrical check (does not illuminate MIL)
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	
Monitoring Duration	5 seconds

Engine Cooling System Outputs

Engine Coolant Bypass Valve Check Operation:	
DTCs	P26B7 – Engine Coolant Bypass Valve "C" Control Circuit where "C" is defined as "Engine Coolant Radiator"
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	5 seconds

Typical Engine Coolant Bypass Valve check malfunction thresholds:
P26B7 - Smart driver reports output circuit fault.

Engine Coolant Cabin Heating Bypass Valve Check Operation:	
DTCs	P26BD – Engine Coolant Bypass Valve "D" Control Circuit where "D" is defined as "Engine Coolant Cabin Heating"
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	5 seconds

Typical Engine Coolant Cabin Heating Bypass Valve check malfunction thresholds:
P26BD - Smart driver reports output circuit fault.

Active Transmission Heating Valve Solenoid Check Operation:	
DTCs	P2681 – Engine Coolant Bypass Valve "A" Control Circuit where "A" is defined as "Engine Coolant Auto Trans Cooler Flow"
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	5 seconds

Typical Active Transmission Heating Valve Solenoid check malfunction thresholds:
P26B7 - Smart driver reports output circuit fault.

Active Transmission Cooling Valve Solenoid Check Operation:	
DTCs	P26AC – Engine Coolant Bypass Valve "B" Control Circuit Where "B" is defined as "Engine Coolant Auto Trans Cooling"
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	5 seconds

Typical Active Transmission Cooling Valve Solenoid check malfunction thresholds:
P26AC - Smart driver reports output circuit fault.

Auxiliary Coolant System Pumps

Coolant Pump "A"

Auxiliary Coolant Pump "A" Check Operation:	
DTCs	P2600 – Coolant Pump "A" Control Circuit/Open P2601 – Coolant Pump "A" Control Performance/Stuck Off P2602 – Coolant Pump "A" Control Circuit Low P2603 – Coolant Pump "A" Control Circuit High "A" is defined as "High Temp Loop Aux Pump - Cabin Heating"
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	5 seconds

Typical auxiliary cooling pump "A"circuit check entry conditions:		
Entry Condition	Minimum	Maximum
Battery Voltage	11.0 volts	

Typical auxiliary cooling pump "A"circuit check malfunction thresholds:
P2602/P2603 - Smart driver reports output circuit fault.

Coolant Pump "B"

Auxiliary Coolant Pump "B" Check Operation:	
DTCs	P261A – Coolant Pump "B" Control Circuit/Open P261B1 – Coolant Pump "B" Control Performance/Stuck Off P261C – Coolant Pump "B" Control Circuit Low P261D – Coolant Pump "B" Control Circuit High "B" is defined as High Temp Loop Aux Pump - Component Cooling #1"
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	5 seconds

Typical auxiliary cooling pump "B"circuit check entry conditions:		
Entry Condition	Minimum	Maximum
Battery Voltage	11.0 volts	

Typical auxiliary cooling pump "B"circuit check malfunction thresholds:
P261C/P261D - Smart driver reports output circuit fault.

Exhaust Flow Control Valve - Exhaust Tuning

Exhaust Flow Control Valve Check Operation:	
DTCs	**Bank 1:** P26C5: Exhaust Flow Control Valve “A” Control Circuit/Open P26C6: Exhaust Flow Control Valve “A” Control Circuit Low P26C7: Exhaust Flow Control Valve “A” Control Circuit High P26FE: Exhaust Flow Control Valve “A” Control Performance **Bank 2:** P2BF8: Exhaust Flow Control Valve “A” Control Circuit/Open P2BF9: Exhaust Flow Control Valve “A” Control Circuit Low P2BFA: Exhaust Flow Control Valve “A” Control Circuit High P2BFB: Exhaust Flow Control Valve “A” Control Performance
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	5 seconds

Typical Exhaust Flow Control Valve check malfunction thresholds:
P26C5, P25C6, P25C7, P2BF8, P2BF9, P2BFA – Exhaust Valve Smart driver reports output circuit fault
P26FE, P2BFB – Exhaust Flow Control Valve Smart driver reports stuck valve (via PWM signal line)

Exhaust Flow Control Valve - Rationality Test

Exhaust Flow Control Valve Rationality Check Operation:	
DTCs	P26FE: Exhaust Flow Control Valve "A" Control Performance P2BFB: Exhaust Flow Control Valve "B" Control Performance
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Monitoring Duration	Varies depending on ambient conditions

Typical Exhaust Flow Control Valve Rationality Check Malfunction Thresholds:
Measured valve position outside the threshold band of Commanded valve position on any of the two valves

Active Mounts (ACMTS)

Active Mounts Circuit Check Operation:	
DTCs	**Bank 1:** P0A14: Engine Mount Control "A" Circuit/Open P0A15: Engine Mount Control "A" Circuit Low P0A16: Engine Mount Control "A" Circuit High **Bank 2:** P0AB6: Engine Mount Control "B" Circuit/Open P0AB7: Engine Mount Control "B" Circuit Low P0AB8: Engine Mount Control "B" Circuit High
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Monitoring Duration	5 seconds to register a malfunction

Typical Active Mounts check malfunction thresholds:
All DTCs listed above – Low level driver reports a fault which is matured in the PCM strategy

Comprehensive Component Monitor - Transmission

Transmission Inputs

Transmission Range Sensor Check Operation:	
DTCs	P0705 invalid pattern for digital TRS P0706 Out of range signal frequency for PWM TRS P0707 Signal out of range low for PWM TRS P0708 Open circuit for digital TRS or signal out of range high for PWM TRS
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	
Monitoring Duration	Up to 30 seconds for pattern recognition, 5 seconds for analog faults

Typical TRS check entry conditions:		
Auto Transmission Entry Conditions	Minimum	Maximum
Gear selector position	each position for up to 30 seconds	480 seconds

Typical TRS malfunction thresholds:

Digital TRS: Invalid pattern from 3 or 5 digital inputs and/or 1 analog circuit open for 5 seconds

4-bit digital TRS: Invalid pattern for 200 ms

Dual analog TRS: Voltage > 4.84 volts or < 0.127 volts for 200 ms or

Sum of both inputs is outside the range of 5.0 volts +/- 0.29 volts for 200 ms

PWM TRS: Frequency > 175 Hz or < 100 Hz,

Duty Cycle > 90% or < 10%

Dual PWM TRS: each signal tested for:

- Frequency > 175 Hz or < 100 Hz (HF32); > 300 Hz or < 200 Hz (DPS6)
- Duty Cycle > 90% or < 10%

Sum of both inputs = 100% +/- 4%

Vehicle Speed Sensor Functional Check Operation:	
DTCs	P0500 – VSS circuit
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	
Monitoring Duration	30 seconds

Typical VSS functional check entry conditions:		
Auto Transmission Entry Conditions	Minimum	Maximum
Gear selector position	drive	
Engine rpm (above converter stall speed) OR	3000 rpm	
Turbine shaft rpm (if available) OR	1500 rpm	
Output shaft rpm	650 rpm	
Vehicle speed (if available)	15 mph	
Manual Transmission Entry Conditions		
Engine load	50 %	
Engine rpm	2400 rpm	

Typical VSS functional check malfunction thresholds:
Vehicle is inferred to be moving with positive driving torque and VSS is < 1 - 5 mph for 5 seconds

Output Shaft Speed Sensor Functional Check Operation:	
DTCs	P0720 – OSS circuit P0721 – OSS range/performance -F-21, 6HP26 P0722 – OSS no signal P0723 – OSS intermittent/erratic – 6HP26
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	TSS, Wheel Speed
Monitoring Duration	30 seconds

Typical OSS functional check entry conditions:		
Auto Transmission Entry Conditions	Minimum	Maximum
Gear selector position	drive	
Engine rpm (above converter stall speed) OR	3000 rpm	
Primary Pulley Speed (CFT30) OR	400 rpm	
Turbine shaft rpm (if available) OR	1500 rpm	
Output shaft rpm	300 - 650 rpm	
Vehicle speed (if available)	12.5 - 15 mph	

Typical OSS functional check malfunction thresholds:
Circuit/no signal - vehicle is inferred to be moving with positive driving torque and OSS < 100 to 200 rpm for 5 to 30 seconds
6HP26 Circuit/no signal: open or short circuit for > 0.6 seconds
6HP Range/Performance: > 200 rpm difference between OSS and wheel speed and > 250 rpm difference between OSS and input shaft speed
F21 Range/Performance: TSS, ABS wheel speed and engine rpm correlate properly, but OSS error is greater than 15% for 10 seconds
CFT30 Range/Performance: ABS wheel speed indicates a 6.24 mph difference with OSS calculated wheel speed
6HP26 Intermittent/Erratic: > -1000 rpm instantaneous change with locked torque converter clutch
CFT30 Intermittent/Erratic: > 6000 rpm/sec change

Intermediate Shaft Speed Sensor Functional Check Operation:	
DTCs	P0791 – ISS circuit
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	
Monitoring Duration	30 seconds

Typical ISS functional check entry conditions:		
Auto Transmission Entry Conditions	Minimum	Maximum
Gear selector position	drive	
Engine rpm (above converter stall speed) OR	3000 rpm	
Turbine shaft rpm (if available) OR	1500 rpm	
Output shaft rpm	650 rpm	
Vehicle speed (if available)	15 mph	

Typical ISS functional check malfunction thresholds:
Vehicle is inferred to be moving with positive driving torque and ISS < 250 rpm for 5 seconds

Turbine Shaft Speed Sensor Functional Check Operation:	
DTCs	P0715 – TSS circuit / no signal P0718 – TSS erratic signal
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	OSS, Wheel Speed
Monitoring Duration	30 seconds

Typical TSS functional check entry conditions:		
Auto Transmission Entry Conditions	Minimum	Maximum
Gear selector position	Forward range	
Engine rpm (above converter stall speed) OR	3000 rpm	
Output shaft rpm OR	600 - 650 rpm	
Vehicle speed (if available)	12.5 - 15 mph	

Typical TSS functional check malfunction thresholds:
Circuit/no signal - vehicle is inferred to be moving with positive driving torque and TSS < 200 rpm for 5 – 30 seconds Erratic signal – observe 200 turbine speed spikes > 400 rpm with no more than 1.5 seconds between spikes

Transmission Fluid Temperature Sensor Functional Check Operation:	
DTCs	P0711 – in range failure P0712 – short to ground P0713 – open circuit
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	ECT substituted if TFT has malfunction TFT inferred from pressure solenoids on CFT30
Monitoring Duration	5 seconds for electrical, 600 seconds for functional check

Typical TFT Stuck Low/High check entry conditions:		
Auto Transmission Entry Conditions	Minimum	Maximum
Engine Coolant Temp (hot or cold, not midrange)	> 100 °F	< 20 °F
Time in run mode	500 – 600 sec	
Time in gear, vehicle moving, positive torque	150 sec	
Vehicle Speed	15 mph	
Time with engine off (cold start) OR	420 min	
Engine Coolant Temp AND Trans Fluid Temp (inferred cold start)		122 °F

Typical TFT malfunction thresholds:
Opens/shorts: TFT voltage <0.05 or > 4.6 volts for 5 – 12 seconds TFT Stuck low/high, i.e. TFT stuck at high temperature or stuck at low temperature): Stores a fault code if TFT stabilizes (stops increasing if temperature < 70 deg F, stops decreasing if temperature > 225 deg F) before reaching the temperature region where all MIL tests are enabled (70 to 225 deg F). If TFT remains constant (+/- 2 deg F) for approximately 2.5 minutes of vehicle driving outside the 70 to 225 deg F zone a P0711 fault code will be stored. Old logic used to indicate a "pass" for a single delta, and not test until the normal operating region (70-225 deg F) was reached.

Transmission Outputs

Shift Solenoid Check Operation:	
DTCs	SS A - P0750 - open circuit, P0751 – functionally failed off P0752 – functionally failed on P0973 – short to ground P0974 - shorts to power P1714 ISIG functional (4R70 only, replaces P0751, P0752) SS B - P0755 - open circuit P0756 – functionally failed off P0757 – functionally failed on P0976 – short to ground P0977 - shorts to power P1715 ISIG functional (4R70 only, replaces P0756, P0757) SS C - P0760 - open circuit P0761 – functionally failed off P0762 – functionally failed on P0979 – short to ground P0980 - shorts to power SS D P0765 - open circuit P0766 – functionally failed off P0767 – functionally failed on P0982 – short to ground P0983 - shorts to power SS E - P0770 - open circuit P0771 – functionally failed off P0772 – functionally failed on P0985 – short to ground P0986 - shorts to power
Monitor execution	electrical - continuous, functional - during off to on solenoid transitions
Monitor Sequence	None
Sensors OK	
Monitoring Duration	0.5 to 5 seconds for electrical checks, 3 solenoid events for functional check

Typical Shift Solenoid ISIG functional check entry conditions:		
Entry Conditions	Minimum	Maximum
Transmission Fluid Temp	70 ºF	225 ºF
Throttle position	positive drive torque (actual TP varies)	

Typical Shift Solenoid mechanical functional check entry conditions:		
Entry Conditions (with turbine speed)	Minimum	Maximum
Gear ratio calculated	each gear	
Throttle position	positive drive torque	

Typical Shift Solenoid mechanical functional check entry conditions:		
Entry Conditions (without turbine speed)	Minimum	Maximum
Rpm drop is obtained	each shift	
Throttle position	positive drive torque	

Typical Shift Solenoid malfunction thresholds:
Electrical circuit check: Output driver feedback circuit does not match commanded driver state for 0.5 – 5.0 seconds Electrical current check: Feedback current out of range for 0.5 seconds ISIG functional check: ISIG chip hardware circuit does not detect characteristic current dip and rise produced by solenoid movement. Mechanical functional check: Actual obtained gear or shift pattern indicates which shift solenoid is stuck on or off.

Gear Ratio Check Operation:	
DTCs	P0731 incorrect gear 1 ratio P0732 incorrect gear 2 ratio P0733 incorrect gear 3 ratio P0734 incorrect gear 4 ratio P0735 incorrect gear 5 ratio P0729 incorrect gear 6 ratio P0736 incorrect reverse ratio
Monitor execution	Continuous, in each gear
Monitor Sequence	None
Sensors OK	TSS, OSS, wheel speed
Monitoring Duration	12 seconds

Typical Forward Gear Ratio check entry conditions:		
Entry Conditions	Minimum	Maximum
Gear selector position	forward range, > 8 seconds	
Engine Torque	100 NM	
Throttle position	10%	
Not shifting	> 0.5 seconds	
Engine/input Speed	550 rpm	
Output Shaft Speed	250 rpm	1350 rpm

Typical Neutral Gear Ratio check entry conditions:		
Entry Conditions	Minimum	Maximum
Gear selector position	forward range, > 1 second	
Absolute value of Engine rpm – Turbine rpm		150 rpm
Output Shaft Speed		500 rpm

Typical Gear Ratio malfunction thresholds:
Forward gear check: > 30 rpm error in commanded ratio for > 1.8 seconds that repeats 3 times

Torque Converter Clutch Check Operation:	
DTCs	P0740 – open circuit P0742 – short to ground P0744 – short to power P0741 – functionally stuck off P2758 – functionally stuck on P1740 – Inductive signature (4R70 only, replaces P0741 / P2758)
Monitor execution	electrical - continuous, mechanical - during lockup
Monitor Sequence	None
Sensors OK	TSS, OSS
Monitoring Duration	Electrical – 5 seconds, Functional - 5 lock-up events

Typical TCC ISIG functional check entry conditions:		
Entry Conditions	Minimum	Maximum
Transmission Fluid Temp	70 ºF	225 ºF
Engine Torque	positive drive torque	
Commanded TCC duty cycle for 0 rpm slip	60%	90%

Typical TCC mechanical functional check stuck off entry conditions:		
Entry Conditions	Minimum	Maximum
Throttle Position	steady	
Engine Torque	positive drive torque	
Transmission Fluid Temp	70 ºF	225 ºF
Commanded TCC duty cycle (0 rpm slip)	60%	100%
Not shifting		

Typical TCC malfunction thresholds:
Electrical circuit check: Output driver feedback circuit does not match commanded driver state for 0.5 – 5.0 seconds
Electrical current check: Feedback current out of range for 0.5 seconds
ISIG functional check: ISIG chip hardware circuit does not detect characteristic current dip and rise produced by solenoid movement.
Mechanical check, stuck off: Slip across torque converter > 100 – 200 rpm or speed ratio < 0.93
Mechanical check, stuck on: Slip across torque converter < 20 rpm with converter commanded off
Mechanical check, stuck on: engine rpm < 100 after drive engagement (engine stall)

Pressure Control Solenoid Check Operation:	
DTCs	P0960 – open circuit P0962 – short to ground P0963 – short to power
Monitor execution	Continuous
Monitor Sequence	none
Sensors OK	
Monitoring Duration	Electrical: 5 seconds, Mechanical functional: up to 30 seconds

Typical Pressure Control Solenoid mechanical functional check entry conditions:		
Entry Conditions	Minimum	Maximum
Gear ratio calculated	each gear	
Transmission Fluid Temperature	70 °F	225 °F
Throttle Position	positive drive torque	

Typical Pressure Control Solenoid malfunction thresholds:
Electrical circuit check: Output driver feedback circuit does not match commanded driver state for 0.5 – 5.0 seconds
Electrical current check: Feedback current out of range for 0.5 seconds
Mechanical functional check: Actual obtained gear pattern indicates Pressure Control solenoid fault

Inductive Signature or ADLER Chip Communication Check Operation:	
DTCs	P1636 ISIG or ADLER chip loss of communication
Monitor execution	off-to-on solenoid transitions (ISIG) continuous for ADLER (driver chip that controls shift solenoids on the 6 speed transmissions)
Monitor Sequence	none
Sensors OK	
Monitoring Duration	< 100 solenoid events (ISIG) 5 30ms loops without communication (ADLER)

Typical Inductive Signature or ADLER Chip Communication Check entry conditions:		
Entry Conditions	Minimum	Maximum
Transmission Fluid Temp	70 °F	225 °F
Solenoid commanded off duration		< 2 seconds

Typical Inductive Signature or ADLER Communication Chip malfunction thresholds:
Checksum error, chip not responding