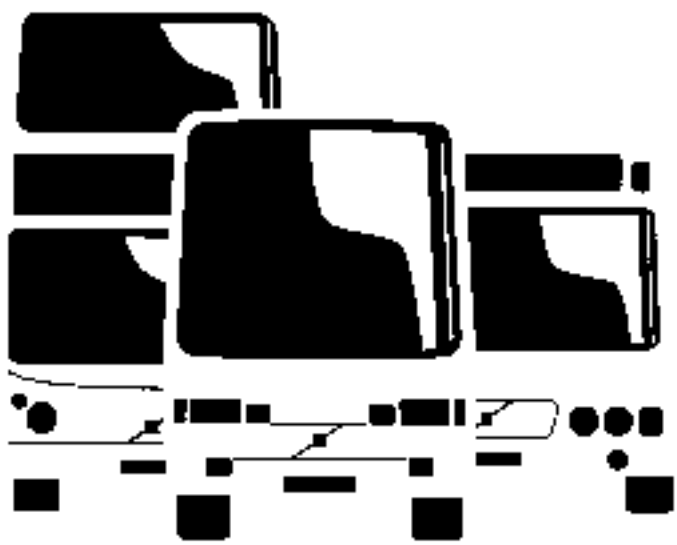
SERVICE INFORMATION
Volvo Bus Corporation

Engine Control Module (ECM), Aftertreatment Control Module (ACM), Electrical System Version3

Diagnostic Trouble Code (DTC)



Foreword

The descriptions and service procedures contained in this manual are based on designs and technical studies carried out through January 2013.

The products are under continuous development. Vehicles and components produced after the above date may therefore have different specifications and repair methods. When this is deemed to have a significant bearing on this manual, an updated version of this manual will be issued to cover the changes.

Each section of this manual contains specific safety information and warnings which must be reviewed before performing any procedure. If a printed copy of a procedure is made, be sure to also make a printed copy of the safety information and warnings that relate to that procedure. The following levels of observations, cautions and warnings are used in this Service Documentation:

Note: Indicates a procedure, practice, or condition that must be followed in order to have the vehicle or component function in the manner intended.

Caution: Indicates an unsafe practice where damage to the product could occur.

Warning: Indicates an unsafe practice where personal injury or severe damage to the product could occur.

Danger: Indicates an unsafe practice where serious personal injury or death could occur.

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Contents

Troubleshooting

Engine Control Module (ECM) Diagnostic Trouble Codes (DTCs)

The manufacturer scan tool is the preferred tool for performing diagnostic work. Contact your local dealer for more information or visit “www.premiumtechtool.com”.

System Overview

Multiple electronic control units (ECUs) are used; the engine control module (ECM), instrument control module (ICM), Vehicle Electronic Control Unit (VECU), transmission control module (TCM), the gear selector control module (GSCM) and the aftertreatment control module (ACM). Together, these modules operate and communicate data link to control a variety of engine and vehicle cab functions. The ECM controls a variety of functions related to operation of the engine. The ECM works in conjunction with the ACM to control the EATS system and reduce emissions.. The VECU controls cruise control functions, accessory relay controls and idle shutdown functions.

In addition to their control functions, the modules have on board diagnostic (OBD) capabilities. The OBD is designed to detect faults or abnormal conditions that are not within normal operating parameters. When the system detects a fault or abnormal condition, the fault will be logged, the vehicle operator will be advised that a fault has occurred by illumination a malfunction indicator lamp (MIL). The module may initiate the engine shutdown procedure if the system determines that the fault could damage the engine.

In some situations when a fault is detected, the system will enter a "derate" mode. The derate mode allows continued vehicle operation but the system may substitute a sensor or signal value that may result in reduced performance. In some instances, the system will continue to function but engine power may be limited to protect the engine and vehicle. Diagnostic trouble codes (DTCs) logged in the system memory can later be read, to aid in diagnosing the problem using a Premium Tech Tool.

The VECU and ECM are dependent on each other to perform their specific control functions. In addition to switch and sensor data, the broadcast of data between modules also includes various calculations and conclusions that each module has developed, based on the input information it has received.

Note: The use of a scan tool is necessary to perform diagnostic work as well as clearing of any diagnostic trouble codes (DTCs). DTC(s) can no longer be cleared using the vehicles instrument cluster digital display and stalk switch control.

System Electronic Control Unit (ECU) Overview

The ECM monitors engine parameters to monitor the engine system's performance in real time. This is performed to aid the ECM with its self diagnostic capabilities. Many sensors are used for input to the emission control system.

The system contains the following “emission critical” ECUs that are monitored;

- Engine Control Module (ECM)
- Vehicle Electronic Control Unit (VECU)
- Aftertreatment Control Module (ACM)
- Aftertreatment Nitrogen Oxides (NOx) Sensors
- Engine Variable Geometry Turbocharger (VGT) Smart Remote Actuator (SRA)

These ECUs all communicate with the ECM via data links. The VECU communicates across the SAE J1939 (CAN1) data link while the others use the SAE J1939-7 (CAN2) data link. The OBD systems use SAE J2284 (ISO) data link for communication with scan tools. Scan tools compliant with ISO 15031–5 (SAE J1979) or ISO 14229 will be able to access all emission critical data from the ECM and ACM. The ECM gateways all of the DTCs and descriptions from the VECU, NOx Sensors and the VGT-SRA. The use of a scan tool is necessary to perform diagnostic work as well as clearing of any diagnostic trouble codes (DTCs). DTC(s) can no longer be cleared using the vehicles instrument cluster digital display and stalk switch control.

Malfunction Indicator Lamp (MIL), Description and Location

A MIL located in the instrument cluster. This amber colored lamp is used to inform the driver that an “emission critical” malfunction signal has occurred.

W2036007

OBD2013 Code Definition

The Diagnostic Trouble Code follows a standardized format. All DTC's have a letter followed by a 4-digit code. Here is a breakdown of what an OBD code means.

First Character

- P=Powertrain
- B=Body
- C=Chassis (not used in NA yet)
- U=Network (Data Link), power supply

  - P00XX Fuel and air metering and Auxiliary Emissions controls
  - P01XX Fuel and air metering
  - P02XX Fuel and air metering
  - P03XX Ignition system or misfire
  - P04XX Auxiliary Emissions Controls
  - P05XX Vehicle Speed, Idle control, auxiliary inputs
  - P06XX Computer and Auxiliary inputs
  - P07XX Transmission
  - P08XX Transmission
  - P09XX Transmission
  - P1XX manufacturer controlled
  - P2XX SAE controlled DTCs
  - P3XX Manufacturer controlled and SAE reserved

Fifth and Sixth Digit-(if applicable)

- Failure Type Byte (FTB)

The DTC Failure Type Byte defines the DTC Failure Category and Sub Type of a base DTC. It represents the type of fault in the circuit or system (e.g. sensor open circuit, sensor shorted to ground, algorithm based failure, etc).

  - 00 = No Subtype information
  - 01 = General Electrical Failure
  - 02 = General Signal Failure
  - 03 = FM (Frequency Modulated) PWM (Pulse With Modulated) failures
  - 04 = System internal Failures
  - 05 = System Programming Failures

- 06 = Algorithm Based Failures
- 07 = Mechanical Failures
- 08 = Bus Signal/Message Failures
- 09 = Component Failures
- 10 = ISO/SAE reserved
- 11 = Circuit short to ground
- 12 = Circuit short to battery
- 13 = Circuit open
- 14 = Circuit short to ground or open
- 15 = Circuit short to battery or open
- 16 = Circuit voltage below threshold
- 17 = Circuit voltage above threshold
- 18 = Circuit current below threshold
- 19 = Circuit current above threshold
- 1A = Circuit resistance below threshold
- 1B = Circuit resistance above threshold
- 1C = Circuit voltage out of range
- 1D = Circuit current out of range
- 1E = Circuit resistance out of range
- 1F = Circuit intermittent
- 20 = ISO/SAE reserved
- 21 = Signal amplitude < minimum
- 22 = Signal amplitude > minimum
- 23 = Signal stuck low
- 24 = Signal stuck high
- 25 = Signal shape/wave form failure
- 26 = Signal rate of change below threshold
- 27 = Signal rate of change above threshold
- 28 = Signal bias level out of range/zero adjustment failure
- 29 = Signal invalid
- 2A = ISO/SAE reserved

- 2B = ISO/SAE reserved
- 2C = ISO/SAE reserved
- 2D = ISO/SAE reserved
- 2E = ISO/SAE reserved
- 2F = Signal erratic
- 30 = ISO/SAE reserved
- 31 = No signal
- 32 = Signal low time < minimum
- 33 = Signal low time > maximum
- 34 = Signal high time < minimum
- 35 = Signal high time > maximum
- 36 = Signal frequency too low
- 37 = Signal frequency too high
- 38 = Signal frequency incorrect
- 39 = Signal has too few pulses
- 3A = Signal has too many pulses
- 3B = ISO/SAE reserved
- 3C = ISO/SAE reserved
- 3D = ISO/SAE reserved
- 3F = ISO/SAE reserved
- 40 = ISO/SAE reserved
- 41 = General checksum failure
- 42 = General memory failure
- 43 = Special memory failure
- 44 = Data memory failure
- 45 = Program memory failure
- 46 = Calibration/parameter memory failure
- 47 = Watchdog/safety µC failure
- 48 = Supervision software failure
- 49 = Internal electronic failure
- 4A = Incorrect component installed

- 4B = Over temperature
- 4C = ISO/SAE reserved
- 4D = ISO/SAE reserved
- 4F = ISO/SAE reserved
- 50= ISO/SAE reserved
- 51 = Not programmed
- 52 = Not activated
- 53 = Deactivated
- 54 = Missing calibration
- 55 = Not configured
- 56 = ISO/SAE reserved
- 5A = ISO/SAE reserved
- 5B = ISO/SAE reserved
- 5C = ISO/SAE reserved
- 5D = ISO/SAE reserved
- 5F = ISO/SAE reserved
- 60 = ISO/SAE reserved
- 61 = Signal calculation failure
- 62 = Signal compare failure
- 63 = Circuit/component protection time-out
- 64 = Signal plausibility failure
- 65 = Signal has too few transitions/events
- 66 = Signal has too many transitions/events
- 67 = Signal incorrect after event
- 68 = Event information
- 69 = ISO/SAE reserved
- 6A = ISO/SAE reserved
- 6B = ISO/SAE reserved
- 6C = ISO/SAE reserved
- 6D = ISO/SAE reserved
- 6F = ISO/SAE reserved
- 70 = ISO/SAE reserved

- 71 = Actuator stuck
- 72 = Actuator stuck open
- 73 = Actuator stuck closed
- 74 = Actuator slipping
- 75 = Emergency position not reachable
- 76 = Wrong mounting position
- 77 = Commanded position not reachable
- 78 = Alignment or adjustment incorrect
- 79 = Mechanical linkage failure
- 7A = Fluid leak or seal failure
- 7B = Low fluid level
- 7C = ISO/SAE reserved
- 7D = ISO/SAE reserved
- 7C = ISO/SAE reserved
- 7D = ISO/SAE reserved
- 7F = ISO/SAE reserved
- 80 = ISO/SAE reserved
- 81 = Invalid serial data received
- 82 = Alive/sequence counter incorrect/not updated
- 83 = Value of signal protection calculation incorrect
- 84 = Signal below allowable range
- 85 = Signal above allowable range
- 86 = Signal invalid
- 87 = Missing message
- 88 = Bus off
- 89 = ISO/SAE reserved
- 8A = ISO/SAE reserved
- 8B = ISO/SAE reserved
- 8C = ISO/SAE reserved
- 8D = ISO/SAE reserved
- 8F = ISO/SAE reserved

- 90 = ISO/SAE reserved
- 91 = Parametric
- 92 = Performance or incorrect operation
- 93 = No operation

OBD2013 Diagnostic Trouble Codes (DTC)

Definitions and Terminology

Confirmed Fault Code:

The diagnostic trouble code (DTC) stored when an OBD system has confirmed that a malfunction exists.

Continuous Monitors:

Monitors that are always running after enabling criteria has been met.

Deactivate:

Means to turn-off, shutdown, desensitize, or otherwise make inoperable through software programming or other means during the actual life of the engine.

Diagnostic or Emission Critical:

Refers to the engine and any other on-board electronic control unit containing software that has primary control over any of the required monitors, excluding anti-lock brake system (ABS) control units or stability/traction control units, and has primary control over the diagnostics for more than two of the components required to be monitored.

Diagnostic Trouble Code (DTC)

In the heavy truck industry, codes that are developed by SAE standards to help diagnose and track problems in a vehicle detected by its on-board diagnostics (OBD).

Drive Cycle:

The combination of driving conditions that enable a monitor and allow it to be completed.

It is defined as a trip that meets any of the four conditions below:

- Begins with engine start and ends with engine shutoff
- Begins with engine start and ends after four hours of continuous engine-on operation
- Begins at the end of the previous four hours of continuous engine-on operation and ends after four hours of continuous engine-on operation
- Begins at the end of the previous four hours of continuous engine-on operation and ends with engine shutoff

Enable Conditions:

A combination of conditions occurring to trigger a specific monitor to run.

Engine Misfire:

Means lack of combustion in the cylinder due to absence of spark, poor fuel metering, poor compression, or any other cause. This does not include lack of combustion events in non-active cylinders due to default fuel shut-off or cylinder deactivation strategies.

Engine Start:

Is defined as the point when the engine reaches a speed 150 rpm below the normal, warmed-up idle speed (as determined in the drive position for vehicles equipped with an automatic transmission).

Fault Memory:

Information pertaining to malfunctions stored in the onboard computer, including fault codes, stored engine conditions, and MIL status.

Functional Check:

For an output component or system means verification of proper response of the component and system to a computer command.

Ignition Cycle:

A drive cycle that begins with engine start, meets the engine start definition for at least two seconds plus or minus one second, and ends with engine shutoff.

Key On, Engine Off (KOEO):

Refers to a vehicle with the ignition key in the engine run position (not engine crank or accessory position) but with the engine not running.

Key On, Engine Running (KOER):

Refers to a vehicle with the ignition key in the engine run position with the engine running.

Malfunction:

Means any deterioration or failure of a component that causes the performance to be outside of the applicable limits.

Malfunction Indicator Lamp (MIL):

An amber colored lamp located in the instrument cluster used to inform the driver that an “emission critical” malfunction signal has occurred.

MIL-On Fault Code:

For engines using ISO15765 or SAE J1979 data link, refers to the DTC stored when an OBD system has confirmed that a malfunction exists (typically on the second drive cycle that the malfunction is detected).

Monitor

Testing routines, performed by the ECM and ACM, which are designed to indicate that all of the components within a portion of the Engine Management System (EMS) are working properly to minimize emissions.

Noncontinuous Monitors:

Monitors that are only run only when their individual enabling criteria is met.

On-Board Diagnostics (OBD):

A term referring to a vehicle's self-diagnostic, monitoring and fault code reporting capability.

Pending Fault Code:

A DTC stored upon the initial detection of a malfunction (typically on a single drive cycle) prior to illumination of the MIL.

Permanent Fault Code:

A confirmed or MIL-on fault code that is currently commanding the MIL on and is stored in NVRAM.

Rationality Fault Diagnostic:

For an input component means verification of the accuracy of the input signal while in the range of normal operation and when compared to all other available information.

Warm-Up Cycle:

Means sufficient vehicle operation such that the coolant temperature has risen by at least 40 degrees Fahrenheit from engine start and reaches a minimum temperature of at least 160 degrees Fahrenheit (140 degrees Fahrenheit for applications with diesel engines).

Fuel Pressure, Timing and Quantity

All cylinders may have pressure, timing and quantity deviations which result in significant change in engine performance and exhaust gas composition. These deviations may in part be used to diagnose and evaluate a faulty fuel system.

Using the NOx sensors on the vehicle.

P026C Fuel Injector (low mass flow)

DTC	P026C
Component / System	Fuel System Monitoring Injection Quantity – Low
Monitor Strategy Description	Actual air fuel ratio based fueling compared to expected
Fault Limit	Ratio = (Air fuel ratio based estimated fuel flow Modeled Fuel flow) < 0.85
Enable Conditions	• Engine Exhaust Gas Temperature 100 - 400 °C • DOC Outlet Temperature 200 - 400 °C • DPF Outlet Temperature 200 - 400 °C • Average Engine Speed 1000 - 2000 RPM • Average Engine Torque > 1000 Nm • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0071, P0108, P0105, P0340, P0335, P2200, P2203, P221A
Time Required For DTC To Be Set	45 seconds (accumulated time)
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P026D Fuel Injector (high mass flow)

DTC	P026D
Component / System	Fuel System Monitoring Injection Quantity – High
Monitor Strategy Description	Actual air fuel ratio based fueling compared to expected
Fault Limit	Ratio = (Air fuel ratio based estimated fuel flow Modeled Fuel flow) > 1.42
Enable Conditions	• Engine Exhaust Gas Temperature 100 - 400 °C • DOC Outlet Temperature 200 - 400 °C • DPF Outlet Temperature 200 - 400 °C • Average Engine Speed 1000 - 2000 RPM • Average Engine Torque > 1000 Nm • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0071, P0108, P0105, P0340, P0335, P2200, P2203, P221A
Time Required For DTC To Be Set	45 seconds (accumulated time)
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Fuel Pressure, Timing and Quantity Threshold – Single Cylinder High Mass Flow

This OBD monitor works by observing engine acceleration as measured by the crank angle sensor. This acceleration measurement is taken during a crank angle window where the current firing cylinder should be generating it's torque. Acceleration is then filtered with a low pass filter and after all cylinders have fired, an average acceleration of all cylinders is generated. The error of each cylinder is calculated as the deviation of it's individual acceleration reading from the average acceleration value.

An average quantity offset value for all cylinders (either positive or negative) is calculated and if a single cylinder's fuel value deviates from a calibrated limit a DTC is set.

P02CD Single Cylinder High Mass Flow Monitor (Cylinder 1)

DTC	P02CD
Component / System	Fuel System Monitoring Injection Quantity – High (Cylinder 1)
Monitor Strategy Description	Single cylinder fueling offset
Fault Limit	Fueling offset of any one injector at idle < -1.5 deg CA
Enable Conditions	• Vehicle Speed < 0.1 km/h • Engine Speed 525 - 725 RPM • PTO Not Active • Engine Torque 0 - 600 Nm • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0340, P0335, P0301, P0302, P0303, P0304, P0305, P0306, P0300, P0262, P0265, P0268, P0271, P0274, P0277, P0201, P0202, P0203, P0204, P0205, P0206
Time Required For DTC To Be Set	600 seconds (accumulated time at idle)
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P02CF Single Cylinder High Mass Flow Monitor (Cylinder 2)

DTC	P02CF
Component / System	Fuel System Monitoring Injection Quantity – High (Cylinder 2)
Monitor Strategy Description	Single cylinder fueling offset
Fault Limit	Fueling offset of any one injector at idle < -1.5 deg CA
Enable Conditions	• Vehicle Speed < 0.1 km/h • Engine Speed 525 - 725 RPM • PTO Not Active • Engine Torque 0 - 600 Nm • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0340, P0335, P0301, P0302, P0303, P0304, P0305, P0306, P0300, P0262, P0265, P0268, P0271, P0274, P0277, P0201, P0202, P0203, P0204, P0205, P0206
Time Required For DTC To Be Set	600 seconds (accumulated time at idle)
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P02D1 Single Cylinder High Mass Flow Monitor (Cylinder 3)

DTC	P02D1
Component / System	Fuel System Monitoring Injection Quantity – High (Cylinder 3)
Monitor Strategy Description	Single cylinder fueling offset
Fault Limit	Fueling offset of any one injector at idle < -1.5 deg CA
Enable Conditions	• Vehicle Speed < 0.1 km/h • Engine Speed 525 - 725 RPM • PTO Not Active • Engine Torque 0 - 600 Nm • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0340, P0335, P0301, P0302, P0303, P0304, P0305, P0306, P0300, P0262, P0265, P0268, P0271, P0274, P0277, P0201, P0202, P0203, P0204, P0205, P0206
Time Required For DTC To Be Set	600 seconds (accumulated time at idle)
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P02D3 Single Cylinder High Mass Flow Monitor (Cylinder 4)

DTC	P02D3
Component / System	Fuel System Monitoring Injection Quantity – High (Cylinder 4)
Monitor Strategy Description	Single cylinder fueling offset
Fault Limit	Fueling offset of any one injector at idle < -1.5 deg CA
Enable Conditions	• Vehicle Speed < 0.1 km/h • Engine Speed 525 - 725 RPM • PTO Not Active • Engine Torque 0 - 600 Nm • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0340, P0335, P0301, P0302, P0303, P0304, P0305, P0306, P0300, P0262, P0265, P0268, P0271, P0274, P0277, P0201, P0202, P0203, P0204, P0205, P0206
Time Required For DTC To Be Set	600 seconds (accumulated time at idle)
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P02D5 Single Cylinder High Mass Flow Monitor (Cylinder 5)

DTC	P02D5
Component / System	Fuel System Monitoring Injection Quantity – High (Cylinder 5)
Monitor Strategy Description	Single cylinder fueling offset
Fault Limit	Fueling offset of any one injector at idle < -1.5 deg CA
Enable Conditions	• Vehicle Speed < 0.1 km/h • Engine Speed 525 - 725 RPM • PTO Not Active • Engine Torque 0 - 600 Nm • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0340, P0335, P0301, P0302, P0303, P0304, P0305, P0306, P0300, P0262, P0265, P0268, P0271, P0274, P0277, P0201, P0202, P0203, P0204, P0205, P0206
Time Required For DTC To Be Set	600 seconds (accumulated time at idle)
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P02D7 Single Cylinder High Mass Flow Monitor (Cylinder 6)

DTC	P02D7
Component / System	Fuel System Monitoring Injection Quantity – High (Cylinder 6)
Monitor Strategy Description	Single cylinder fueling offset
Fault Limit	Fueling offset of any one injector at idle < -1.5 deg CA
Enable Conditions	• Vehicle Speed < 0.1 km/h • Engine Speed 525 - 725 RPM • PTO Not Active • Engine Torque 0 - 600 Nm • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0340, P0335, P0301, P0302, P0303, P0304, P0305, P0306, P0300, P0262, P0265, P0268, P0271, P0274, P0277, P0201, P0202, P0203, P0204, P0205, P0206
Time Required For DTC To Be Set	600 seconds (accumulated time at idle)
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Fuel Pressure, Timing and Quantity Threshold – Single Cylinder Low Mass Flow

The single cylinder low mass flow malfunction is monitored using the misfire detection monitor. See “Misfire Monitoring at Idle Conditions”, page 29 for detailed monitor descriptions.

P0301 Single Cylinder Low Mass Flow Monitor (Cylinder 1)

DTC	P0301
Component / System	Fuel System Monitoring Injection Quantity – Low (Cylinder 1)
Monitor Strategy Description	Single cylinder engine flywheel acceleration evaluation
Fault Limit	Number of misfire events per cylinder 400 out of 500
Enable Conditions	• Average Engine Speed 525 - 725 RPM • PTO Not Active • Number of Cylinders Misfiring < 4 Cylinders • Engine Torque 0 - 400 Nm • Vehicle Speed < 0.1 km/h • Revolution Count 125 Revolutions • Delay Time After Engine Start 60 seconds • Delay Time After Enable Condition Met 10 seconds • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0340, P0335, P0262, P0265, P0268, P0271, P0274, P0277, P0201, P0202, P0203, P0204, P0205, P0206
Time Required For DTC To Be Set	180 Seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0302 Single Cylinder Low Mass Flow Monitor (Cylinder 2)

DTC	P0302
Component / System	Fuel System Monitoring Injection Quantity – Low (Cylinder 2)
Monitor Strategy Description	Single cylinder engine flywheel acceleration evaluation
Fault Limit	Number of misfire events per cylinder 400 out of 500
Enable Conditions	• Average Engine Speed 525 - 725 RPM • PTO Not Active • Number of Cylinders Misfiring < 4 Cylinders • Engine Torque 0 - 400 Nm • Vehicle Speed < 0.1 km/h • Revolution Count 125 Revolutions • Delay Time After Engine Start 60 seconds • Delay Time After Enable Condition Met 10 seconds • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0340, P0335, P0262, P0265, P0268, P0271, P0274, P0277, P0201, P0202, P0203, P0204, P0205, P0206
Time Required For DTC To Be Set	180 Seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0303 Single Cylinder Low Mass Flow Monitor (Cylinder 3)

DTC	P0303
Component / System	Fuel System Monitoring Injection Quantity – Low (Cylinder 3)
Monitor Strategy Description	Single cylinder engine flywheel acceleration evaluation
Fault Limit	Number of misfire events per cylinder 400 out of 500
Enable Conditions	• Average Engine Speed 525 - 725 RPM • PTO Not Active • Number of Cylinders Misfiring < 4 Cylinders • Engine Torque 0 - 400 Nm • Vehicle Speed < 0.1 km/h • Revolution Count 125 Revolutions • Delay Time After Engine Start 60 seconds • Delay Time After Enable Condition Met 10 seconds • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0340, P0335, P0262, P0265, P0268, P0271, P0274, P0277, P0201, P0202, P0203, P0204, P0205, P0206
Time Required For DTC To Be Set	180 Seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0304 Single Cylinder Low Mass Flow Monitor (Cylinder 4)

DTC	P0304
Component / System	Fuel System Monitoring Injection Quantity – Low (Cylinder 4)
Monitor Strategy Description	Single cylinder engine flywheel acceleration evaluation
Fault Limit	Number of misfire events per cylinder 400 out of 500
Enable Conditions	• Average Engine Speed 525 - 725 RPM • PTO Not Active • Number of Cylinders Misfiring < 4 Cylinders • Engine Torque 0 - 400 Nm • Vehicle Speed < 0.1 km/h • Revolution Count 125 Revolutions • Delay Time After Engine Start 60 seconds • Delay Time After Enable Condition Met 10 seconds • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0340, P0335, P0262, P0265, P0268, P0271, P0274, P0277, P0201, P0202, P0203, P0204, P0205, P0206
Time Required For DTC To Be Set	180 Seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0305 Single Cylinder Low Mass Flow Monitor (Cylinder 5)

DTC	P0305
Component / System	Fuel System Monitoring Injection Quantity – Low (Cylinder 5)
Monitor Strategy Description	Single cylinder engine flywheel acceleration evaluation
Fault Limit	Number of misfire events per cylinder 400 out of 500
Enable Conditions	• Average Engine Speed 525 - 725 RPM • PTO Not Active • Number of Cylinders Misfiring < 4 Cylinders • Engine Torque 0 - 400 Nm • Vehicle Speed < 0.1 km/h • Revolution Count 125 Revolutions • Delay Time After Engine Start 60 seconds • Delay Time After Enable Condition Met 10 seconds • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0340, P0335, P0262, P0265, P0268, P0271, P0274, P0277, P0201, P0202, P0203, P0204, P0205, P0206
Time Required For DTC To Be Set	180 Seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0306 Single Cylinder Low Mass Flow Monitor (Cylinder 6)

DTC	P0306
Component / System	Fuel System Monitoring Injection Quantity – Low (Cylinder 6)
Monitor Strategy Description	Single cylinder engine flywheel acceleration evaluation
Fault Limit	Number of misfire events per cylinder 400 out of 500
Enable Conditions	• Average Engine Speed 525 - 725 RPM • PTO Not Active • Number of Cylinders Misfiring < 4 Cylinders • Engine Torque 0 - 400 Nm • Vehicle Speed < 0.1 km/h • Revolution Count 125 Revolutions • Delay Time After Engine Start 60 seconds • Delay Time After Enable Condition Met 10 seconds • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0340, P0335, P0262, P0265, P0268, P0271, P0274, P0277, P0201, P0202, P0203, P0204, P0205, P0206
Time Required For DTC To Be Set	180 Seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Misfire Monitoring at Idle Conditions

This OBD monitor works by observing engine acceleration as measured by the crank angle sensor. This acceleration measurement is taken during a crank angle window where the current firing cylinder should be generating it's torque. Acceleration is then filtered with a low pass filter and after all cylinders have fired, an average acceleration of all cylinders is generated. The error of each cylinder is calculated as the deviation of its individual acceleration reading from the average acceleration value.

P0300 Misfire Multiple Cylinders

DTC	P0300
Component / System	Misfire Monitoring Misfire Multiple Cylinders
Monitor Strategy Description	Engine flywheel acceleration evaluation
Fault Limit	Number of misfire events per cylinder 400 out of 500
Enable Conditions	• Average Engine Speed 525 - 725 RPM • PTO Not Active • Number of Cylinders Misfiring < 4 Cylinders • Engine Torque 0 - 400 Nm • Vehicle Speed < 0.1 km/h • Revolution Count 125 Revolutions • Delay Time After Engine Start 60 seconds • Delay Time After Enable Condition Met 10 seconds • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0340, P0335, P0262, P0265, P0268, P0271, P0274, P0277, P0201, P0202, P0203, P0204, P0205, P0206
Time Required For DTC To Be Set	180 Seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0301 Misfire Single Cylinder (Cylinder 1)

DTC	P0301
Component / System	Misfire Monitoring Misfire Single Cylinder (Cylinder 1)
Monitor Strategy Description	Single cylinder engine flywheel acceleration evaluation
Fault Limit	Number of misfire events per cylinder 400 out of 500
Enable Conditions	• Average Engine Speed 525 - 725 RPM • PTO Not Active • Number of Cylinders Misfiring < 4 Cylinders • Engine Torque 0 - 400 Nm • Vehicle Speed < 0.1 km/h • Revolution Count 125 Revolutions • Delay Time After Engine Start 60 seconds • Delay Time After Enable Condition Met 10 seconds • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0340, P0335, P0262, P0265, P0268, P0271, P0274, P0277, P0201, P0202, P0203, P0204, P0205, P0206
Time Required For DTC To Be Set	180 Seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0302 Misfire Single Cylinder (Cylinder 2)

DTC	P0302
Component / System	Misfire Monitoring Misfire Single Cylinder (Cylinder 2)
Monitor Strategy Description	Single cylinder engine flywheel acceleration evaluation
Fault Limit	Number of misfire events per cylinder 400 out of 500
Enable Conditions	• Average Engine Speed 525 - 725 RPM • PTO Not Active • Number of Cylinders Misfiring < 4 Cylinders • Engine Torque 0 - 400 Nm • Vehicle Speed < 0.1 km/h • Revolution Count 125 Revolutions • Delay Time After Engine Start 60 seconds • Delay Time After Enable Condition Met 10 seconds • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0340, P0335, P0262, P0265, P0268, P0271, P0274, P0277, P0201, P0202, P0203, P0204, P0205, P0206
Time Required For DTC To Be Set	180 Seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0303 Misfire Single Cylinder (Cylinder 3)

DTC	P0303
Component / System	Misfire Monitoring Misfire Single Cylinder (Cylinder 3)
Monitor Strategy Description	Single cylinder engine flywheel acceleration evaluation
Fault Limit	Number of misfire events per cylinder 400 out of 500
Enable Conditions	• Average Engine Speed 525 - 725 RPM • PTO Not Active • Number of Cylinders Misfiring < 4 Cylinders • Engine Torque 0 - 400 Nm • Vehicle Speed < 0.1 km/h • Revolution Count 125 Revolutions • Delay Time After Engine Start 60 seconds • Delay Time After Enable Condition Met 10 seconds • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0340, P0335, P0262, P0265, P0268, P0271, P0274, P0277, P0201, P0202, P0203, P0204, P0205, P0206
Time Required For DTC To Be Set	180 Seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0304 Misfire Single Cylinder (Cylinder 4)

DTC	P0304
Component / System	Misfire Monitoring Misfire Single Cylinder (Cylinder 4)
Monitor Strategy Description	Single cylinder engine flywheel acceleration evaluation
Fault Limit	Number of misfire events per cylinder 400 out of 500
Enable Conditions	• Average Engine Speed 525 - 725 RPM • PTO Not Active • Number of Cylinders Misfiring < 4 Cylinders • Engine Torque 0 - 400 Nm • Vehicle Speed < 0.1 km/h • Revolution Count 125 Revolutions • Delay Time After Engine Start 60 seconds • Delay Time After Enable Condition Met 10 seconds • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0340, P0335, P0262, P0265, P0268, P0271, P0274, P0277, P0201, P0202, P0203, P0204, P0205, P0206
Time Required For DTC To Be Set	180 Seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0305 Misfire Single Cylinder (Cylinder 5)

DTC	P0305
Component / System	Misfire Monitoring Misfire Single Cylinder (Cylinder 5)
Monitor Strategy Description	Single cylinder engine flywheel acceleration evaluation
Fault Limit	Number of misfire events per cylinder 400 out of 500
Enable Conditions	• Average Engine Speed 525 - 725 RPM • PTO Not Active • Number of Cylinders Misfiring < 4 Cylinders • Engine Torque 0 - 400 Nm • Vehicle Speed < 0.1 km/h • Revolution Count 125 Revolutions • Delay Time After Engine Start 60 seconds • Delay Time After Enable Condition Met 10 seconds • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0340, P0335, P0262, P0265, P0268, P0271, P0274, P0277, P0201, P0202, P0203, P0204, P0205, P0206
Time Required For DTC To Be Set	180 Seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0306 Misfire Single Cylinder (Cylinder 6)

DTC	P0306
Component / System	Misfire Monitoring Misfire Single Cylinder (Cylinder 6)
Monitor Strategy Description	Single cylinder engine flywheel acceleration evaluation
Fault Limit	Number of misfire events per cylinder 400 out of 500
Enable Conditions	• Average Engine Speed 525 - 725 RPM • PTO Not Active • Number of Cylinders Misfiring < 4 Cylinders • Engine Torque 0 - 400 Nm • Vehicle Speed < 0.1 km/h • Revolution Count 125 Revolutions • Delay Time After Engine Start 60 seconds • Delay Time After Enable Condition Met 10 seconds • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0340, P0335, P0262, P0265, P0268, P0271, P0274, P0277, P0201, P0202, P0203, P0204, P0205, P0206
Time Required For DTC To Be Set	180 Seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Exhaust Gas Recirculation (EGR) System Monitoring

This OBD monitor is designed to detect conditions where the EGR mass flow is lower or higher than demanded by the current system operation.

Demanded EGR mass flow is modeled from the burned air fraction (see the Technical Description for detailed information) request for the current engine operating conditions.

Actual EGR mass flow is computed directly from the output of the EGR Venturi differential pressure and temperature sensors. A fault occurs if the ratio of measured EGR mass flow to the modeled (demanded) EGR mass flow meets the threshold.

Ratio = Measured EGR mass flow Modeled EGR mass flow

P0401 EGR System (Low Flow)

DTC	P0401
Component / System	EGR System - Low Flow
Monitor Strategy Description	Compare demanded EGR flow to actual
Fault Limit	Ratio = (Measured EGR mass flow Modeled EGR mass flow) < 0.55
Enable Conditions	• Engine Speed 1300 - 1800 RPM • Engine Torque 625 - 2000 Nm • EGR Position 70 - 100 % • EGR Flow Demand 0.1 - 0.4 kg/s • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0069, P046C, P0234, P0299
Time Required For DTC To Be Set	4 Seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0402 EGR System (High Flow)

DTC	P0402
Component / System	EGR System - High Flow
Monitor Strategy Description	Compare demanded EGR flow to actual
Fault Limit	Ratio = (Measured EGR mass flow Modeled EGR mass flow) > 4.0
Enable Conditions	• Engine Speed 600 - 1600 RPM • Engine Torque 400 - 2450 Nm • EGR Position 0 - 80 % • EGR Flow Demand 0 □0.083 kg/s • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0069, P046C, P0234, P0299
Time Required For DTC To Be Set	5 Seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

EGR: Slow Response Emission Threshold

This OBD monitor evaluates a slowly responding EGR system by comparing two evaluation windows. Within a window, demanded EGR flowrate is evaluated. If a transition occurs within an allowable time, the demanded EGR flow is compared to the actual flow at the target time to determine if the proper flow was achieved. If the flow is not achieved then a DTC is raised.

P240F EGR System Slow Response

DTC	P240F	
Component / System	EGR System - Slow Response	
Monitor Strategy Description	EGR mass flow fails to achieve a flow change	
Fault Limit	***Decreasing*** Delta = Modeled EGR mass flow - Measured EGR mass flow < -0.025	***Increasing*** Delta = Measured EGR mass flow - Modeled EGR mass flow < -0.01
Enable Conditions	***Decreasing*** **Low Flow Window** • Engine Speed 580 - 1600 RPM • Engine Torque > 600 Nm • EGR Mass Flow Demand < 0.05 kg/s • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C **High Flow Window** • Engine Speed 550 - 620 RPM • Engine Torque 100 - 170 Nm • EGR Mass Flow Demand 0.03 - 0.05 kg/s • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C	***Increasing*** **Low Flow Window** • Engine Speed 650 - 1100 RPM • Engine Torque 200 - 600 Nm • EGR Mass Flow Demand 0.01 - 0.2 kg/s • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C **High Flow Window** • Engine Speed 1400 - 1600 RPM • Engine Torque > 2200 Nm • EGR Mass Flow Demand 0.06 - 0.13 kg/s • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0069, P046C, P0234, P0299	
Time Required For DTC To Be Set	***Decreasing*** 33 seconds	***Increasing*** 23 seconds
MIL Illumination	2 Drive Cycles	
Probable Causes	***See Tech Tool***	

EGR: Feedback Saturation

This OBD monitor indicates if the burned air fraction error is saturated against a high or low limit. The logic for the monitor evaluates the time spent at saturation and compares the ratio between the time spent in a saturation mode and the total time with engine running. A fault is reported whenever the ratio exceeds the fault limit.

P04D9 EGR System: Feedback Control (Saturated Low)

DTC	P04D9
Component / System	EGR System - Feedback Control
Monitor Strategy Description	Saturated low: Difference between demanded and calculated burned air fraction
Fault Limit	Ratio = Time spent saturated low total time > 0.9
Enable Conditions	• Engine Torque 300 - 2500 Nm • Exhaust Mass Flow 0.1 - 1.0 kg/s • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0069, P046C, P0234, P0299, P0401, P0402
Time Required For DTC To Be Set	90 Seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P04DA EGR System: Feedback Control (Saturated High)

DTC	P04DA
Component / System	EGR System - Feedback Control
Monitor Strategy Description	Saturated high: Difference between demanded and calculated burned air fraction
Fault Limit	Ratio = Time spent saturated high total time > 0.9
Enable Conditions	• Engine Torque 300 - 2500 Nm • Exhaust Mass Flow 0.1 - 1.0 kg/s • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0069, P046C, P0234, P0299, P0401, P0402
Time Required For DTC To Be Set	90 Seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Boost Pressure: Under or Over Boost Emission Threshold

This OBD monitor is designed to detect under or over boost conditions.

A modeled version of boost pressure is calculated continuously from a map based on engine speed and torque. The modeled boost pressure is compared to the actual value read from the boost pressure sensor. A DTC is raised if the threshold is reached.

Under Boost: Threshold < (Actual boost pressure - Modeled boost pressure)

Over Boost: Threshold > (Actual boost pressure - Modeled boost pressure)

P0299 Boost Pressure: Underboost

DTC	P0299
Component / System	Boost Pressure □Underboost
Monitor Strategy Description	Comparison of actual boost pressure to a modeled boost pressure
Fault Limit	Delta = Actual boost pressure □Modeled boost pressure < □50kPa
Enable Conditions	• Engine Speed 1350 - 1700 RPM • EGR Position 10 - 96% • VGT Position 5 - 90% • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0069, P0726, P0106, P0490, P045F, P045E, P2563, P0045, U010C, U040D, P2578, P2581, P2580, P0069, U010C, P2229
Time Required For DTC To Be Set	5 Seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0234 Boost Pressure: Overboost

DTC	P0234
Component / System	Boost Pressure - Overboost
Monitor Strategy Description	Comparison of actual boost pressure to a modeled boost pressure
Fault Limit	Delta = Actual boost pressure - Modeled boost pressure > 120 kPa
Enable Conditions	• Engine Speed 1350 - 1700 RPM • EGR Position 10 - 96% • VGT Position 5 - 90% • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0069, P0726, P0106, P0490, P045F, P045E, P2563, P0045, U010C, U040D, P2578, P2581, P2580, P0069, U010C, P2229
Time Required For DTC To Be Set	5 Seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Boost Pressure: Slow Response

This OBD monitor is designed to detect conditions where the boost system is slow to respond, indicating degradation in the boost system. The monitor defines a low boost and a high boost window based on appropriate engine operating conditions. When the engine is being operated in the low window, boost pressure is sampled continuously. When operating conditions move out of the low window, the last boost pressure value is retained. At the instant the engine enters the high-speed evaluation window, an evaluation timer is started. When the timer expires, the current boost pressure is compared to the retained value from the low boost window. If the difference does not meet or exceed the calibration target, the boost pressure slow response malfunction is detected.

P226C Boost Pressure Slow Response

DTC	P226C	
Component / System	Boost Pressure - Slow Response	
Monitor Strategy Description	Comparison of boost pressures in low/high windows to verify pressures are met.	
Fault Limit	Delta = Low pressure window - high pressure window < 5 kPa	
Enable Conditions	**Low Pressure Window** • Engine Speed 400 - 1600 RPM • Engine Torque 0 - 1000 Nm • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C	**High Pressure Window** • Engine Speed 1000 - 1800 RPM • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • None	
Time Required For DTC To Be Set	5 seconds	
MIL Illumination	2 Drive Cycles	
Probable Causes	***See Tech Tool***	

Non–Methane Hydrocarbon (NMHC) Converting Calalyst: Conversion Efficiency Emission Threshold

The Diesel Oxidation Catalyst (DOC) is constructed from a porous ceramic substrate coated in precious metals. It is used to oxidize fuel in the exhaust stream after the engine, and to generate an exotherm to assist in other EATS systems functionality, such as raising the temperature of the SCR during cold start conditions. The OBD monitor for the DOC consists of two separate system evaluations- one for the effectiveness of the DOC at oxidizing fuel actively dosed by the Aftertreatment Hydrocarbon Doser System during cold start up conditions, and another portion that runs when fuel dosing is not active, where an evaluation on the physical presence of the substrate is made.

P0420 NMHC Catalyst: Conversion Efficiency

DTC	P0420
Component / System	NMHC Catalyst - Conversion Efficiency
Monitor Strategy Description	Compare calculated total HC slip rate to modeled total HC slip rate
Fault Limit	Ratio = Calculated total HC slip rate Modeled total HC slip rate > 1.4
Enable Conditions	• DPF Outlet Temperature > 100 °C • AHI Fuell Injection State Active • Start Coolant Temperature < 73 °C • Barometric Pressure 75 - 105 kPa • Ambient Air Temperature -8 - 55 °C • Total HC injected > 57g
Disable Conditions	No Active DTC's: • P2226, P2229, P0110, P0112, P0115, P0117, P20DD, P20E0, P229E, P2200, P0105, P0108; P2031, P2322, P2084, P242C, P242A, P242B, P0545, P0544, P2080, P1130, P1133, P20DC, P20D0, P20CF
Time Required For DTC To Be Set	300 seconds (with no more than 45s AHI dosing break)
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0421 NMHC Catalyst: Missing Substrate

DTC	P0421
Component / System	NMHC Catalyst - Missing Substrate
Monitor Strategy Description	Compare engine exhaust temperature rate of change to DOC temperature rate of change
Fault Limit	Ratio = Engine exhaust temperature rate of change DOC temperature rate of change < 1.5
Enable Conditions	• Exhaust Gas Temperature Derivative > 3.75 °C/s or < -3.75 °C/s • Modeled DOC Outlet Temperature Derivative > 3.75 °C/s or < -3.75 °C/s • AHI Fuel Injection State Not Active • Number of sub evaluations 8
Disable Conditions	No Active DTC's: • P2226, P2229, P0110, P0112, P0115, P0117, P20DD, P20E0, P229E, P2200, P0105, P0108; P2031, P2322, P2084, P242C, P242A, P242B, P0545, P0544, P2080, P1130, P1133, P20DC, P20D0, P20CF
Time Required For DTC To Be Set	650 seconds (8 sub evaluations. 5 pass of 8 evaluations => PASS, 6 fail of 8 evaluations => FAIL)
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Oxides of Nitrogen (NOX) Converting Catalyst: Conversion Efficiency Emission Threshold

This OBD monitor is designed to determine the DEF efficiency as calculated by using the inputs of the commanded DEF and the two NOx sensors located upstream and downstream of the NOx Catalyst.

The DEF efficiency evaluation is calculated as an average value over an accumulated exhaust NOx value. A fault condition is logged if the DEF average efficiency is less than the threshold fault limit.

P20EE NOx Catalyst: Conversion Efficiency

DTC	P20EE
Component / System	NOx Catalyst - Conversion Efficiency
Monitor Strategy Description	Low NOx conversion efficiency
Fault Limit	Calculated NOx conversion efficiency DOC temperature rate of change < 66%
Enable Conditions	• Engine Speed 1400 - 1800 RPM • Exhaust Mass Flow > 0.33 kg/s • System Out NOx Flow > 0.05 g/s • Inlet SCR Temperature 250 - 500 °C • Average SCR Temperature 250 - 500 °C • Outlet SCR Temperature 250 - 500 °C • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P2201, P229F, P242B, P0421, P0402, P0401, P225C, P225E
Time Required For DTC To Be Set	30 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0420 NOx Catalyst: Missing SCR

DTC	P0420
Component / System	NOx Catalyst - Missing SCR
Monitor Strategy Description	Missing Substrate
Fault Limit	Calculated NOx conversion efficiency DOC temperature rate of change < 66%
Enable Conditions	• Engine Speed 1400 - 1800 RPM • Exhaust Mass Flow > 0.33 kg/s • System Out NOx Flow > 0.05 g/s • Inlet SCR Temperature 250 - 500 °C • Average SCR Temperature 250 - 500 °C • Outlet SCR Temperature 250 - 500 °C • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P2201, P229F, P242B, P0421, P0402, P0401, P225C, P225E
Time Required For DTC To Be Set	30 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

NOx Catalyst: Reductant Delivery Emission Threshold

A faulty DEF delivery system operation will impact the NOx emissions and subsequently a low DEF efficiency will be detected. The fault separation from conversion efficiency is achieved by using an aftermarket/service routine.

P0420 NOx Catalyst: Reductant Delivery Performance

DTC	P0420
Component / System	NOx Catalyst - Reductant Delivery Performance
Monitor Strategy Description	Low NOx conversion efficiency
Fault Limit	Calculated NOx conversion efficiency DOC temperature rate of change < 66%
Enable Conditions	• Engine Speed 1400 - 1800 RPM • Exhaust Mass Flow > 0.33 kg/s • System Out NOx Flow > 0.05 g/s • Inlet SCR Temperature 250 - 500 °C • Average SCR Temperature 250 - 500 °C • Outlet SCR Temperature 250 - 500 °C • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P2201, P229F, P242B, P0421, P0402, P0401, P225C, P225E
Time Required For DTC To Be Set	30 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

NOx Catalyst: Feedback: Slow/Fails to Enter: Default CL

This diagnostic function indicates if the DEF feedback control is saturated against a high or low limit. The logic for this diagnostic evaluates the time spent at saturation and compares the ratio between the time spent in a saturation mode and the total time with the engine running. A fault is reported whenever the ratio exceeds a fault limit.

P249D NOx Catalyst: Feedback Control (Saturated Low Monitor)

DTC	P249D
Component / System	NOx Catalyst - Feedback Control (Saturated Low Monitor)
Monitor Strategy Description	Evaluates the time spent in Saturation Low Mode
Fault Limit	Time spent saturated low > 240 seconds
Enable Conditions	• Engine Speed > 500 RPM • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	N/A
Time Required For DTC To Be Set	300 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P249E NOx Catalyst: Feedback Control (Saturated High Monitor)

DTC	P249E
Component / System	NOx Catalyst □Feedback Control (Saturated High Monitor)
Monitor Strategy Description	Evaluates the time spent in Saturation High Mode
Fault Limit	Time spent saturated high > 240 seconds
Enable Conditions	• Engine Speed > 500 RPM • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	N/A
Time Required For DTC To Be Set	300 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Particulate Matter (PM) Filter Monitoring: Filter Emission Threshold

Failures that result in a reduction to the DPF's filtration efficiency, such as cracked or melted filter, are monitored by comparing the soot accumulation calculated by a physical DPF delta Pressure (DPF dP) sensor based soot model (Pressure Model) to the soot accumulation predicted by a chemical reaction based soot model (Chemical Model). If the filter has failed in a way that results in a high level of PM in the exhaust gas, the calculated soot load in the filter after an amount of time will be lower than the level calculated by the Chemical Model. A failure of the DPF that results in an increased DPF dP level, such as a melted substrate, can also be identified, as the higher DPF dP will result in a pressure model that reports a much higher level of soot than the chemical model.

P2002 PM Filter Efficiency Monitor

DTC	P2002		
Component / System	PM Filter - Filtering Performance		
Monitor Strategy Description	Modeled vs Measured filtration efficiency.		
Fault Limit	**Low Soot Load Evaluation** Delta = Delta pressure based soot load □reference soot load > 3g/L	**High Soot Load Evaluation** Ratio = Chemical based soot mode ldelta pressure based soot model < 50%	**Temperature Evaluation** Post DPF Temperature >725 °C
Enable Conditions	**Low Soot Load Evaluation** • Chemical Soot Load < 0.35 g/L • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C	**High Soot Load Evaluation** • Chemical Soot Load > 0.55 g/L • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C	**Temperature Evaluation** N/A
Disable Conditions	No Active DTC's: • P2453, P244A, P2080, P2084, P242B		
Time Required For DTC To Be Set	**Low Soot Load Evaluation** 60 seconds	**High Soot Load Evaluation** 200 seconds	**Temperature Evaluation** N/A
MIL Illumination	2 Drive Cycles		
Probable Causes	***See Tech Tool***		

PM Filter: Missing Substrate Functional

The Diesel Particulate Filter is constructed from a porous ceramic substrate coated in precious metals. The porous nature of the DPF results in a certain level of differential pressure (DPF dP) between the inlet and outlet of the DPF, dependant on the exhaust mass flow, the temperature at the inlet of the DPF, and the temperature at the outlet of the DPF. If the DPF substrate has been completely removed, the DPF dP will be close to zero. By comparing the measured DPF dP to a modeled DPF dP at operating conditions where the difference should be large, an evaluation on the presence of the filter can be made. If the DPF dP is below a certain threshold during the evaluation conditions, the filter substrate can be assumed to be missing.

P244A PM Filter: Missing Substrate

DTC	P244A
Component / System	PM Filter - Missing Substrate
Monitor Strategy Description	Compare modeled DPF pressure to actual
Fault Limit	Ratio = Measured modeled DPF delta pressure < 63%
Enable Conditions	• Engine Speed 1225 - 1725 RPM • Engine Torque > 1700 Nm • Exhaust Mass Flow 0.3 - 0.5 kg/s • Modeled DPF Delta Pressure 3 □15 kPa • DOC Out Temperature 300 - 400 °C • DPF Out Temperature 300 - 400 °C • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P2226, P2229, P0110, P0112, P0115, P0117, P20DD, P20E0, P229E, P2200, P0105, P0108, P2031, P2322, P2084, P242C, P242A, P242B, P0545, P0544, P2080, P1130, P1133, P20DC, P20D0, P20CF
Time Required For DTC To Be Set	7 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

NOx Sensor #1: Emission Threshold

In addition to the circuitry monitors, the two NOx sensors are subjected to plausibility checks as part of the NOx sensor diagnostics. The two NOx sensors are monitored to ensure that they are capable of accurately evaluating the NOx exhaust emissions and that they can be used by the engine emissions control strategies.

Inlet NOx Sensor

The NOx sensor located upstream of the NOx converting catalyst is rationalized against a calculated NOx value. The NOx sensor is considered faulty whenever the difference between the NOx sensor value and the calculated NOx value is greater than the threshold.

P2201 NOx Sensor #1: Rationality Monitor

DTC	P2201
Component / System	NOx Sensor #1 - Plausibilty
Monitor Strategy Description	Sensor Rationality Check
Fault Limit	Delta = Engine modeled NOx flow - NOx sensor based NOx flow < -20%
Enable Conditions	• Engine Speed 1120 - 1620 RPM • Modeled NOx FIlow > 0.15 g/s • Engine Torque 1300 - 2000 Nm • Ambient Air Temperature -7 - 40 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 70 °C • Engine Speed Stability -10 to 10 RPM • Torque Stability -15 to 15 RPM • EGR Control Stability -1.5% to 1.5%
Disable Conditions	No Active DTC's: • P0401, P0402, P0400, P0402, P225D, P225F, P242A, P0421, P221A
Time Required For DTC To Be Set	3 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P225C Inlet and Outlet NOx Sensor Stuck High

The monitor is performed during no fueling (motoring) conditions where the expected amount of exhaust NOx concentration is nearly zero. A fault condition is logged whenever the NOx sensor read value is above a limit value during no fueling.

DTC	P225C
Component / System	NOx Sensor #1 - Rationality High
Monitor Strategy Description	Rationality High
Fault Limit	NOx sensor value > 200 PPM
Enable Conditions	• Fueling Amount < 0.001 g/sec • Engine Torque < 1000 Nm
Disable Conditions	No Active DTC's: • P225D, P0400, P0402, P225F, P242A, P0421, P221A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

NOx Sensor #1: Heater Performance

This OBD monitor is designed to detect faulty startup behavior. The function monitors the time from enable command sent to the time when the sensor reports full readiness. If the time is greater than the fault limit a DTC is set.

P220E NOx Sensor #1: Sensor Start Up Monitor

DTC	P220E
Component / System	NOx Sensor #1 - Sensor Start
Monitor Strategy Description	Sensor start up
Fault Limit	Time for start up > 600 seconds
Enable Conditions	• Supply Voltage 11.5 - 16V
Disable Conditions	No Active DTC's: • P2200, P2203, P220A, U029D
Time Required For DTC To Be Set	10 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

NOx Sensor #1: Bad Device

This OBD Monitoris designed to to detect bad sensor quality. The function monitors the time when the sensor reports bad quality. If the time is greater than the fault limit a DTC is set.

P22FB NOx Sensor #1: Bad Device Monitor

DTC	P22FB
Component / System	NOx Sensor #1 - Sensor Voltage High
Monitor Strategy Description	Bad Device
Fault Limit	Signal not valid for a specified time interval > 5 seconds
Enable Conditions	• Engine Speed >550 RPM
Disable Conditions	No Active DTC's: • P2200, P2203, P220A, U029D
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P2203 NOx Sensor #1: Short Circuit Low

DTC	P2203
Component / System	NOx #1 Sensor - Short Circuit
Monitor Strategy Description	NOx Sensor Short Circuit
Fault Limit	Time with short circuit bad quality > 5 seconds
Enable Conditions	• Key On Active • Battery Voltage > 8V
Disable Conditions	No Active DTC's: • U029D
Time Required For DTC To Be Set	10 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P2200 NOx Sensor #1: Open Circuit

DTC	P2200
Component / System	NOx Sensor #1 - Open Circuit
Monitor Strategy Description	NOx Sensor Open Circuit
Fault Limit	Time with open circuit bad quality > 5 seconds
Enable Conditions	• Key On Active • Battery Voltage > 8V
Disable Conditions	No Active DTC's: • U029D
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P220A NOx Sensor #1: Supply Voltage Out of Range

DTC	P220A
Component / System	NOx Sensor #1 - Sensor Voltage
Monitor Strategy Description	Sensor evaluation of supply voltage
Fault Limit	Time with voltage out of range signal > 5 seconds
Enable Conditions	• Engine Speed > 500 RPM
Disable Conditions	No Active DTC's: • U029D
Time Required For DTC To Be Set	10 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

U029D NOx Sensor #1: Missing Signal

DTC	U029D
Component / System	NOx Sensor - Missing Signal
Monitor Strategy Description	Signal not recieved to ACM after key on
Fault Limit	Missing Signal No message for > 5 s
Enable Conditions	• Key On Active • Battery Voltage > 8V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	10 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

NOx Sensor #2: Emission Threshold

The rationality check for this sensor consists of sensor stuck low and stuck high check. It is performed whenever the engine operates on highly transient conditions. A fault condition is reached whenever the NOx sensor values are below or above a fault limit.

P229F NOx Sensor #2: Rationality Low Monitor

DTC	P229F
Component / System	NOx Sensor #2 - Plausibilty
Monitor Strategy Description	Sensor Rationality Check
Fault Limit	NOX Sensor rate of change < 0.7 ppm/sec
Enable Conditions	• Engine Speed > 1200 RPM • Average Catalyst Temperature 200 - 500 °C • Engine Torque > 1800 Nm • Ambient Air Temperature -7 - 40 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C • Filtered Torque Rise > 60 Nm
Disable Conditions	No Active DTC's: • P225D, P0400, P0402, P225F, P242A, P0421, P225C, P2201, P221A
Time Required For DTC To Be Set	300 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P225E NOx Sensor #2: Rationality High Monitor

DTC	P225E
Component / System	NOx Sensor #2 - Rationality high
Monitor Strategy Description	Sensor Rationality Check
Fault Limit	NOX Sensor Value > 125 ppm
Enable Conditions	• Fueling Amount < 0.001 g/sec • SCR Temperature 150 - 500 °C • SCR Temperature Stability < 0.2 °C/sec • Engine Torque < 1000 Nm
Disable Conditions	No Active DTC's: • P225D, P0400, P0402, P225F, P242A, P0421, P2201, P225C, P221A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

NOx Sensor #2: Heater Performance

This OBD monitoris designed to detect faulty startup behavior. The function monitors the time from enable command sent (ok for sensor to heat itself since all water is considered to be evaporated from the exhaust stream) to the time when the sensor reports full readiness. If the time is too long the sensor does not fulfill the requirements. (Activating the NOx sensors in an environment with water present, there is a risk the sensor elements will crack.)

P220F NOx Sensor #2: Sensor Start Up Monitor

DTC	P220F
Component / System	NOx #2 Sensor - Sensor Start
Monitor Strategy Description	Time to for sensor to report good quality
Fault Limit	Time evaluation > 600 seconds
Enable Conditions	• Battery Voltage 11- 16V • Engine Speed > 500 RPM • Dew point trig Enabled (ECT start delay and dew point calculation delay)
Disable Conditions	No Active DTC's: • P2200, P2203, P220A, U029E
Time Required For DTC To Be Set	10 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

NOx Sensor #2: Bad Device

This OBD Monitoris designed to to detect bad sensor quality.

The quality flag from the NOx sensor is monitored. Too long duration of not reliable sensor signal quality is considered as an error. When the NOx sensor is unable to maintain a reliable output, its signal quality will be set to not reliable. This can e.g. be the case during fast transients and fast variations in NOx Sensor measurement value. This monitor will not run until the start-up monitor is successfully completed.

P22FE NOx Sensor #2: Bad Device Monitor

DTC	P22FE
Component / System	NOx Sensor #2 - Sensor Voltage High
Monitor Strategy Description	Bad Device
Fault Limit	Signal not valid for a specified time interval > 5 seconds
Enable Conditions	• Engine Speed >550 RPM • Battery Voltage 11 - 16 V
Disable Conditions	No Active DTC's: • P2200, P2203, P220A, U029E
Time Required For DTC To Be Set	10 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

NOx Sensor #2: NOx Sensor Measurement Monitor

This OBD monitor consists of a NOx Sensor Measurement value comparison between the two NOx sensors. The fault condition is reached whenever the absolute difference between the NOx Sensor Measurement values exceeds the threshold.

P221A NOx Sensors: NOx Sensor Measurement Rationality Monitor

DTC	P221A
Component / System	NOx Sensors - NOx Sensor Measurement
Monitor Strategy Description	Plausibility
Fault Limit	Absolute dference between Lambda IN and Lambda OUT greater than threshold evaluated 30 times > 1
Enable Conditions	• Engine Speed 1300-1900 RPM • Engine Torque > 1000 Nm • Ambient Air Temperature -7 - 40 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C • Engine Speed Stability -10 - 10 RPM • Torque Stability -15 - 15 Nm
Disable Conditions	No Active DTC's: • P0400, P0402, P225D, P225F, P242A, P0421, P2201, P225C, P221A
Time Required For DTC To Be Set	0.6 seconds (30 sub evaluations. If 30 out of 30 evaluations are good => PASS, If 1 or more out of 30 evaluations is fail => FAIL)
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P22A1 NOx Sensor #2: Short Circuit Low

DTC	P22A1
Component / System	NOx #2 Sensor - Short Circuit
Monitor Strategy Description	NOx Sensor Short Circuit
Fault Limit	Time with bad signal quality > 5 seconds
Enable Conditions	• Key On Active • Battery Voltage > 8V
Disable Conditions	No Active DTC's: • U029E
Time Required For DTC To Be Set	10 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P229E NOx Sensor #2: Open Circuit

DTC	P229E
Component / System	NOx Sensor #2 - Open Circuit
Monitor Strategy Description	NOx Sensor Open Circuit
Fault Limit	Time with bad signal quality > 5 seconds
Enable Conditions	• Key On Active • Battery Voltage > 8V
Disable Conditions	No Active DTC's: • U029E
Time Required For DTC To Be Set	10 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P220B NOx Sensor #2: Supply Voltage Out of Range

DTC	P220B
Component / System	NOx Sensor #2 - Sensor Voltage
Monitor Strategy Description	Sensor evaluation of supply voltage
Fault Limit	Time with voltage out of range signal > 5 seconds
Enable Conditions	• Key On > Active
Disable Conditions	No Active DTC's: • U029E
Time Required For DTC To Be Set	10 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

U029E NOx Sensor #2: Missing Signal

DTC	U029E
Component / System	NOx Sensor #2 - Missing Signal
Monitor Strategy Description	Signal not recieved to ACM after key on
Fault Limit	Missing Signal No message for > 5 s
Enable Conditions	• Key On Active • Battery Voltage > 8V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Engine Cooling System: Time To Reach Threshold Temperature

This OBD monitor evaluates the coolant thermostat. If the coolant temperature sensor value doesn't reach the threshold or if the temperature decreases below the threshold during operation the thermostat is judged as faulty and a DTC is set.

P0128 Engine Cooling System: Stuck Open or Leaking Thermostat Monitor

DTC	P0128
Component / System	Engine Cooling System - Thermostat failure
Monitor Strategy Description	Stuck open or leaking thermostat
Fault Limit	Coolant temperature threshold < 72°C
Enable Conditions	• Engine Speed 950-1150 RPM • Engine Torque 800-1000 Nm • Vehicle Speed > 40 km/h • Ambient Air Temperature -15 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature at Start < 72 °C
Disable Conditions	No Active DTC's: • P0112, P0110, P0117, P0115, P0116, P0339, P0335, P0336, P2226, P2227, P2229
Time Required For DTC To Be Set	Ambient air temperature dependent (ambient air temperature multiplied with a warm up delay time to get total warm up time)
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0116 Engine Coolant Temperature Sensor (ECT): Sensor Stuck Low Monitor

DTC	P0116
Component / System	Engine Coolant Temperature Sensor - ECT Stuck Low Monitor
Monitor Strategy Description	ECT Stuck Below the Highest Minimum Enable Temperature
Fault Limit	Delta = Coolant temperature sensor value - estimated coolant temperature > 3 °C
Enable Conditions	• Engine Speed 1000 - 1400 RPM • Engine Torque 1000 - 1400 • Vehicle Speed > 40 km/h • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature < 65 °C • Open Thermostat evaluated True
Disable Conditions	No Active DTC's: • P0112, P0110, P0117, P0115, P0116, P0339, P0335, P0336, P2226, P2227, P2229
Time Required For DTC To Be Set	6 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Engine Coolant Temperature Sensor (ECT): Circuit Monitors

The engine coolant temperature sensor is checked for open circuit, short circuit, or out-of-range value by monitoring the analog-to-digital (A/D) input voltage.

P0115 Engine Coolant Temperature Sensor (ECT): Open Circuit Check

DTC	P0115
Component / System	ECT - Open
Monitor Strategy Description	Open Circuit
Fault Limit	Sensor Voltage > 4.87 V (-40 °C)
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0117 Engine Coolant Temperature Sensor (ECT): Short Circuit Low

DTC	P0117
Component / System	ECT - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	Sensor Voltage < 0.2767 V (140 °C)
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Crankcase Ventilation System: Disconnection

This OBD monitor diagnoses the crankcase ventilation system by looking at the crankcase pressure sensor value. By comparing the crankcase - to ambient pressure at two different states, one where the speed of the CCV separator is “HIGH” and the second where the speed of the CCV separator is “LOW”. The upper and lower limits for the crankcase pressure are established.

The separator malfunction is detected when CCV separator impeller (shaft) sticks (does not spin) resulting in a pressure above the upper limit.

The disconnected pipe malfunction is detected when the ventilator tube from the valve cover to the separator device is disconnected resulting in a pressure below the lower limit.

Both of these malfunctions will result in a DTC being set.

P04DB Crankcase Ventilation: Disconnected Pipe/Separator Monitor

DTC	P04DB	
Component / System	Crankcase Ventilation - Disconnect	
Monitor Strategy Description	Disconnected ventilation hose or faulty separator unit.	
Fault Limit	Delta = (Delta Pressure High) - (Delta Presure Low); (Absolute Value) < 0.15 kPa Delta Pressure = (Crankcase Pressure) - (Barometric Pressure)	
Enable Conditions	**High Speed Conditions** • Oil Temperature > 30 °C • Engine Run Time > 700s • Oil Pressure 375 - 800 kPa • Engine Torque > 95 Nm • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C	**Low Speed Conditions** • Oil Temperature > 30 °C • Engine Run Time > 700s • Oil Pressure 100 - 280 kPa • Engine Torque < 380 Nm • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P01BB, P01B9, P0112, P2229, P051A, P051C, P051D, P051B, P0523, P0520	
Time Required For DTC To Be Set	18 seconds	
MIL Illumination	2 Drive Cycles	
Probable Causes	***See Tech Tool***	

Barometric Pressure Sensor (BPS): Rationality Monitor

This OBD rationality monitor for the Barometric Pressure sensor evaluates the plausibility of the sensor comparing the Barometric, Intake Air and Crankcase pressure sensor values.

This evaluation is performed in two scenarios:

Pre Cranking:
A comparison of pressures from all sensors is made. The smallest difference between the three is determined and a reference pressure is calculated. The Barometric pressure sensor value is compared to the reference value and if the difference is above the threshold a DTC is reported.

Engine running:
The engine running sensor evaluation is similar to the Pre Cranking sensor evaluation. The enable conditions are defined when the vehicle is typically at idle when Intake Air and Crankcase pressure are similar to Barometric pressure.

P2227 Barometric Pressure Sensor (BPS): Rationality Monitor

DTC	P2227	
Component / System	BPS Rationality	
Monitor Strategy Description	Barometric pressure sensor evaluation	
Fault Limit	Delta = Barometric pressure - reference pressure > 10kPa	
Enable Conditions	**Engine Pre-Crank** • Key On Active • Battery Voltage > 8 V	**Engine Running** • Engine Speed 450 - 750 RPM • Engine Torque 100 - 400 Nm
Disable Conditions	No Active DTC's: • P2226, P2227, P2229, P051A, P051B, P051C, P051D, P2578	
Time Required For DTC To Be Set	8 seconds	
MIL Illumination	2 Drive Cycles	
Probable Causes	***See Tech Tool***	

Barometric Pressure Sensor (BPS): Circuit Monitors

The Barometric Pressure Sensor is checked for electrical failures by monitoring the analog-to-digital (A/D) input voltage.

P2226 Barometric Pressure Sensor (BPS): Open Circuit Check

DTC	P2226
Component / System	BPS Open
Monitor Strategy Description	Open Circuit
Fault Limit	Sensor Voltage < 0.1 V (15 kPa)
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P2229 Barometric Pressure Sensor (BPS): Short Circuit High

DTC	P2229
Component / System	BPS High
Monitor Strategy Description	Short Circuit High
Fault Limit	Sensor Voltage > 4.9 V (115 kPa)
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Intake Manifold Pressure Sensor (IMP): Rationality Monitor

This OBD rationality monitor for the Intake Manifold Pressure sensor evaluates the plausibility of the sensor comparing the Barometric, Intake Air and Crankcase pressure sensor values.

This evaluation is performed in two scenarios:

Pre Cranking:
A comparison of pressures from all sensors is made. The smallest difference between the three is determined and a reference pressure is calculated. The Intake Manifold pressure sensor value is compared to the reference value and if the difference is above the threshold a DTC is reported.

Engine Running:
The engine running sensor evaluation is similar to the Pre Cranking sensor evaluation. The enable conditions are defined when the vehicle is typically at idle when Barometric and Crankcase pressure are similar to Intake Manifold pressure.

P0069 Intake Manifold Pressure Sensor Monitor

DTC	P0069	
Component / System	IMP Rationality	
Monitor Strategy Description	Intake manifold pressure sensor evaluation	
Fault Limit	Delta = Intake manifold pressure □reference pressure > 10kPa	
Enable Conditions	**Engine Pre□Crank** • Key On Active • Battery Voltage > 8 V	**Engine Running** • Engine Speed 450 - 750 RPM • Engine Torque 100 - 400 Nm
Disable Conditions	No Active DTC's: • P2226, P2227, P2229, P051A, P051B, P051C, P051D, P2578	
Time Required For DTC To Be Set	8 seconds	
MIL Illumination	2 Drive Cycles	
Probable Causes	***See Tech Tool***	

Intake Manifold Pressure Sensor (IMP): Circuit Monitors

The Intake Manifold Pressure Sensor is located in the inlet manifold and the sensor is checked for electrical failures by monitoring the analog-to-digital (A/D) input voltage.

P0105 Intake Manifold Pressure Sensor (IMP): Open Circuit Check

DTC	P0105
Component / System	IMP Open
Monitor Strategy Description	Open Circuit
Fault Limit	Sensor Voltage < 0.3 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0108 Intake Manifold Pressure Sensor (IMP): Short Circuit High

DTC	P0108
Component / System	IMP High
Monitor Strategy Description	Short Circuit High
Fault Limit	Sensor Voltage > 4.9 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Aftertreatment Differential Pressure Sensor (DPS): Rationality Monitor

This OBD monitor diagnoses the DPF differential pressure sensor, by monitoring the deviation between estimated DPF differential pressure and the measured DPF differential pressure value.

There are two independent tests that evaluate the differential pressure sensor plausibility:

Low Flow Condition:
When the engine is in idle or in low engine speed and torque condition, the differential pressure over the DPF is expected to be close to zero. If the differential pressure exceeds a threshold then the differential pressure sensor plausibility DTC is set.

High Flow Condition:
When the engine is in higher engine speed and torque condition, the differential pressure over the DPF is expected to rise according to engine speed and torque. If the differential pressure exceeds a threshold then the differential pressure sensor plausibility DTC is set.

P2453 Aftertreatment Differential Pressure Sensor (DPS): DPS Differential Pressure Sensor

DTC	P2453	
Component / System	DPS - Plausibility	
Monitor Strategy Description	Rationality high and low	
Fault Limit	**Low Condition** Measured DPF Delta Pressure in Low Pressure Conditions > 1.5 kPa	**High Condition** Measured DPF Delta Pressure in High pressure Conditions < 2.5 kPa
Enable Conditions	**Low Condition** • Engine Speed < 750 RPM • Engine Torque < 300 Nm • Modeled DPF delta Pressure < 1.5 kPa • DOC Out Temperature 15 - 275 °C • DPF Out Temperature 15 - 275 °C • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C	**High Condition** • Engine Speed 1400 - 1900 RPM • Engine Torque > 4.5 kPa • Modeled DPF delta Pressure < 1.5 kPa • DOC Out Temperature > 325 °C • DPF Out Temperature > 325 °C • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P2226, P2229, P0110, P0112, P0115, P0117, P20DD, P20E0, P229E, P2200, P0105, P0108, P2031: P2322: P2084, P242C, P242A, P242B P0545, P0544, P2080, P1130, P1133, P20DC, P20D0, P20CF	
Time Required For DTC To Be Set	**Low Condition** 15 seconds	**High Condition** 8 seconds
MIL Illumination	2 Drive Cycles	
Probable Causes	***See Tech Tool***	

Aftertreatment Differential Pressure Sensor (DPS): Circuit Monitors

The Aftertreatment Differential Pressure Sensor is checked for electrical failures by monitoring the analog-to-digital (A/D) input voltage.

P2452 Aftertreatment Differential Pressure Sensor (DPS): Open Circuit Check

DTC	P2452
Component / System	DPF - Open
Monitor Strategy Description	Open Circuit
Fault Limit	Sensor Voltage > 4.8 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P2454 Aftertreatment Differential Pressure Sensor (DPS): Short Circuit Low

DTC	P2454
Component / System	DPS - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	Sensor Voltage < 0.2 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

EGR Differential Pressure Sensor: Rationality Monitor

This OBD monitor diagnoses the EGR differential pressure sensor.

There are two methods for monitoring the EGR differential pressure sensor:

Normal Flow Condition:

This monitors the deviation between estimated EGR differential pressure and the measured EGR differential pressure value.

Zero Flow Condition:
This monitors when the EGR differential pressure is supposed to be zero when the EGR valve closed.

P046C EGR Differential Pressure Sensor: DP Sensor Rationality

DTC	P046C	
Component / System	DP Sensor Rationality	
Monitor Strategy Description	Compare actual vs estimated EGR delta pressure	
Fault Limit	**Plausibility** Actual EGR delta pressure - estimated EGR delta pressure Low High Low < -20 kPa High > 20 kPa	**Zero** EGR delta Pressure Low < -2 kPa High > 3 kPa
Enable Conditions	**Plausibility** • Engine Speed 1100 - 1800 RPM • Engine Torque > 1600 Nm • EGR Position > 5% • VGT Position 40 - 92%	**Zero** • Engine Speed 0 - 1500 RPM • EGR Position < 0.1%
Disable Conditions	No Active DTC's: • N/A	
Time Required For DTC To Be Set	**Plausibility** 30 seconds	**Zero** 3 seconds
MIL Illumination	2 Drive Cycles	
Probable Causes	***See Tech Tool***	

EGR Differential Pressure Sensor: Circuit Monitors

The EGR Differential Pressure Sensor is checked for electrical failures by monitoring the analog-to-digital (A/D) input voltage.

P0409 EGR Differential Pressure Sensor: Open Circuit Check

DTC	P0409
Component / System	DP Sensor - Open
Monitor Strategy Description	Open Circuit
Fault Limit	Sensor Voltage < 0.2 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0406 EGR Differential Pressure Sensor: Short Circuit High

DTC	P0406
Component / System	DP Sensor - High
Monitor Strategy Description	Short Circuit High
Fault Limit	Sensor Voltage > 4.8 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Crankcase Pressure Sensor (CPS): Rationality Monitor

This OBD rationality monitor for the Crankcase Pressure sensor evaluates the plausibility of the sensor comparing the Barometric, Intake Air and Crankcase pressure sensor values.

This evaluation is performed in two scenarios:

Engine Pre-Cranking:
A comparison of pressures from all sensors is made. The smallest difference between the three is determined and a reference pressure is calculated. The Crankcase pressure sensor value is compared to the reference value and if the difference is above the threshold a DTC is reported.

Engine Running:
The engine running sensor evaluation is similar to the Pre Cranking sensor evaluation. The enable conditions are defined when the vehicle is typically at idle when Barometric and Crankcase pressure are similar to Intake Manifold pressure.

P051B Crankcase Pressure Sensor (CPS): Rationality Monitor

DTC	P051B	
Component / System	CPS - Rationality	
Monitor Strategy Description	Crankcase Pressure Sensor evaluation	
Fault Limit	Delta = Crankcase pressure □reference pressure > 10 kPa	
Enable Conditions	**Engine Pre-Cranking** • Key On Active • Battery Voltage > 8 V	**Engine Running** • Engine Speed 450 - 750 RPM • Engine Torque 100 - 400 Nm
Disable Conditions	No Active DTC's: • P2226, P2227, P2229, P051A, P051C, P051D, P2578, P0105, P010	
Time Required For DTC To Be Set	4 seconds	
MIL Illumination	2 Drive Cycles	
Probable Causes	***See Tech Tool***	

Crankcase Pressure Sensor (CPS): Circuit Monitors

The Crankcase Pressure Sensor is checked for electrical failures by monitoring the analog-to-digital (A/D) input voltage.

P051A Crankcase Pressure Sensor (CPS): Open Circuit Check

DTC	P051A
Component / System	CPS - Open
Monitor Strategy Description	Open Circuit
Fault Limit	Sensor Voltage < 0.3 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P051D Crankcase Pressure Sensor (CPS): Short Circuit High

DTC	P051D
Component / System	CPS - High
Monitor Strategy Description	Short Circuit High
Fault Limit	Sensor Voltage > 4.9 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Intake Manifold Temperature Sensor (IMT): Rationality Monitor

The Intake Manifold Temperature Sensor is monitored by comparing it with a calculated Intake Manifold temperature based on intake manifold pressure and ambient air temperature.

When the evaluation time has elapsed the average difference is compared to an upper and a lower limit resulting in a low temperature and high temperature fault.

P009A Intake Manifold Temperature Sensor (IMT): Rationality Monitor

DTC	P009A
Component / System	IMT - Rationality
Monitor Strategy Description	Intake Manifold Temperature Sensor Evaluation
Fault Limit	Delta = Intake manifold temperature - reference temperature > 18 C
Enable Conditions	• Engine Speed 450 - 750 RPM • Engine Torque 100 - 400 Nm
Disable Conditions	No Active DTC's: • P0110, P0112, P2226, P2229, P040C, P040A, P2578
Time Required For DTC To Be Set	10 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Intake Manifold Temperature Sensor (IMT): Circuit Monitors

The Intake Manifold Temperature sensor is checked for electrical failures by monitoring the analog-to-digital (A/D) input voltage.

P0110 Intake Manifold Temperature Sensor (IMT): Open Circuit Check

DTC	P0110
Component / System	IMT - Open
Monitor Strategy Description	Open Circuit
Fault Limit	Sensor Voltage > 4.9 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0112 Intake Manifold Temperature Sensor (IMT): Short Circuit Low

DTC	P0112
Component / System	IMT - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	Sensor Voltage < 0.1 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

EGR Temperature Sensor: Rationality Monitor

This OBD monitor evaluates the rationality of the EGR temperature sensor.

The monitor compares the EGR temperature with the coolant temperature during conditions where they should read the same temperature.

P040B EGR Temperature Sensor: Rationality Monitor

DTC	P040B	
Component / System	EGR Temperature Sensor - Rationality	
Monitor Strategy Description	EGR Temperature Sensor evaluation	
Fault Limit	Delta = EGR temperature - Coolant temperature < - 40 °C or > 80 °C	
Enable Conditions	**Stuck Low** • Engine Speed 1000 - 1600 RPM • Engine Torque < 1200 Nm • EGR Mass Flow < 0.08 kg/s	**Stuck High** • Engine Speed 1200 - 2000 RPM • EGR Mass Flow > 0.1 kg/s
Disable Conditions	No Active DTC's: • P040A, P040C	
Time Required For DTC To Be Set	30 seconds	
MIL Illumination	2 Drive Cycles	
Probable Causes	***See Tech Tool***	

EGR Temperature Sensor: Circuit Monitors

The EGR Temperature Sensor is checked for electrical failures by monitoring the analog-to-digital (A/D) input voltage.

P040A EGR Temperature Sensor: Open Circuit Check

DTC	P040A
Component / System	EGR Temperature Sensor - Open
Monitor Strategy Description	Open Circuit
Fault Limit	Sensor Voltage > 4.8 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P040C EGR Temperature Sensor: Short Circuit Low

DTC	P040C
Component / System	EGR Temperature Sensor - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	Sensor Voltage < 0.1 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Exhaust Gas Temperature Sensors: Rationality Monitors

The exhaust gas system has three temperature sensors. The pre-DOC sensor measures the engine exhaust gas temperature, the post-DOC sensor measures the temperature downstream of the DOC, and the post-DPF sensor measures the temperature downstream of the DPF.

The rationality monitor for the exhaust temperature sensors evaluates the plausibility of the sensor comparing the pre-DOC, DOC outlet and DPF outlet temperature sensor values.

During normal driving conditions, the temperature of the DOC outlet and the DPF outlet is very close to the engine exhaust gas temperature (pre-DOC). This difference is integrated over a period of time.

The average of the three sensors is determined and a reference temperature is calculated. The temperature sensor values are compared to the reference value and if the difference is above the threshold a DTC is reported.

P2080 Exhaust Gas Temperature Sensors: Pre-DOC Rationality Check

DTC	P2080
Component / System	Pre-DOC Temperature Sensor - Rationality
Monitor Strategy Description	Rationality check of the sensor
Fault Limit	Average Exhaust Gas Temperature deviation > 70 °C
Enable Conditions	• Modeled Exhaust Temperature < 15 °C • Modeled DOC Temperature - DPF Temperature < 15 °C • Modeled DPF Temperature - Exhaust Temperature < 15 °C • Engine Torque > 800 Nm • ModeledEngine Exhaust Temperature 250 - 475 °C • Ambient Air Temperature -8 - 55 °C • Barometric Pressure < 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P242C, P242A, P2032, P2031, P0544, P0545
Time Required For DTC To Be Set	45 seconds (accumulated time)
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P2084 Exhaust Gas Temperature Sensor: Post-DOC Rationality Check

DTC	P2084
Component / System	Post-DOC Temperature Sensor - Rationality
Monitor Strategy Description	Plausibility check of the sensor value
Fault Limit	Average DOC temperature deviation > 65 °C
Enable Conditions	• Exhaust Temperature < 15 °C • DOC Temperature - DPF Temperature < 15 °C • DPF Temperature - Exhaust Temperature < 15 °C • Engine Torque > 800 Nm • Engine Exhaust Temperature 250 - 475 °C • Ambient Air Temperature -8 - 55 °C • Barometric Pressure < 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P242C, P242A, P2032, P2031, P0544, P0545
Time Required For DTC To Be Set	45 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P242B Exhaust Gas Temperature Sensors: Post-DPF Rationality Check

DTC	P242B
Component / System	Post-DPF Temperature Sensor - Rationality
Monitor Strategy Description	Plausibility check of the sensor value
Fault Limit	Average DPF temperature deviation > 70 °C
Enable Conditions	• Modeled Exhaust Temperature < 15 °C • Modeled DOC Temperature - DPF Temperature < 15 °C • Modeled DPF Temperature - Exhaust Temperature < 15 °C • Engine Torque > 800 Nm • Modeled Engine Exhaust Temperature 250 - 475 °C • Ambient Air Temperature -8 - 55 °C • Barometric Pressure < 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P242C, P242A, P2032, P2031, P0544, P0545
Time Required For DTC To Be Set	45 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Exhaust Gas Temperature Sensors: Circuit Monitors

The Exhaust Gas Temperature Sensor circuits are monitored to check for electrical failures by monitoring the analog-to-digital (A/D) input voltages.

P0544 Pre-DOC Temperature Sensor: Open Circuit Check

DTC	P0544
Component / System	Pre-DOC Temperature Sensor - Open
Monitor Strategy Description	Open Circuit
Fault Limit	Sensor Voltage > 2.3 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0545 Pre-DOC Temperature Sensor: Short Circuit Low

DTC	P0545
Component / System	Pre-DOC Temperature Sensor - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	Sensor Voltage < 0.2 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P2031 Post-DOC Temperature Sensor: Open Circuit Check

DTC	P2031
Component / System	Post-DOC Temperature Sensor - Open
Monitor Strategy Description	Open Circuit
Fault Limit	Sensor Voltage > 2.3 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P2032 Post-DOC Temperature Sensor: Short Circuit Low

DTC	P2032
Component / System	Post-DOC Temperature Sensor - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	Sensor Voltage < 0.2 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P242A Post-DPF Temperature Sensor: Open Circuit Check

DTC	P242A
Component / System	Post-DPF Temperature Sensor - Open
Monitor Strategy Description	Open Circuit
Fault Limit	Sensor Voltage > 2.3 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P242C Post-DPF Temperature Sensor: Short Circuit Low

DTC	P242C
Component / System	Post-DPF Temperature Sensor - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	Sensor Voltage < 0.2 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Engine Oil Temperature Sensor

The oil temperature sensor monitor is designed to detect a sensor that is reporting an unrealistic oil temperature value.

P0196 Engine Oil Temperature Sensor (OTS): Rationality Monitor

DTC	P0196
Component / System	OTS - Rationality
Monitor Strategy Description	Plausibility check of the sensor by checking if the temperature rises fast enough.
Fault Limit	Oil Temperature ≤ 39 °C
Enable Conditions	• Indicated torque ≥ 800 Nm
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	Ambient air temperature dependent
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Engine Oil Temperature Sensor: Circuit Monitors

The Engine Oil Temperature Sensor circuits are monitored to check for electrical failures by monitoring the analog-to-digital (A/D) input voltages.

P0195 Engine Oil Temperature Sensor (OTS): Open Circuit Check

DTC	P0195
Component / System	OTS - High
Monitor Strategy Description	Open Circuit
Fault Limit	Sensor Voltage > 4.9 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0197 Engine Oil Temperature Sensor (OTS): Short Circuit Low

DTC	P0197
Component / System	OTS - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	Sensor Voltage < 0.1 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Engine Oil Pressure Sensor (OPS): Rationality Monitor

This OBD monitor is designed to detect a sensor that is reporting an unrealistic value.

Engine oil pressure is checked during two conditions:

Engine Pre-Cranking:
When the engine is in the Pre-Cranking state, the Engine Oil Pressure is expected to be in a respectively low range, close to ambient pressure. If this range is exceeded, a Pre-Crank DTC is set.

High Pressure Condition:

Another engine operating area is defined for high engine oil pressure. A plausible oil pressure is expected to be within a calibrated range, based on engine speed and torque. When the engine is being operated within this high area, the expected oil pressure is compared to the measured oil pressure and the difference is averaged during the test execution time. If the averaged difference is greater than a calibrated threshold, this plausibility monitor will assert the sensor plausibility DTC.

P0521 Engine Oil Pressure Sensor: Rationality Monitor

DTC	P0521	
Component / System	OPS - Rationality	
Monitor Strategy Description	Plausibility check of the sensor by comparing a high oil pressure condition to a low pressure condition.	
Fault Limit	**Low Check** Oil pressure outside range 0 - 120 kPa	**High Check** Oil pressure outside range 280 - 600 kPa
Enable Conditions	**Low Check** • Engine Speed 1600 - 1850 RPM • Engine Torque 0 - 300 Nm • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C	**High Check** • Engine Speed Delta 30 RPM • Engine Speed 1000 - 1300 RPM • Engine Torque 0 - 300 Nm • Engine Oil Temperature 80 - 120 °C • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0520, P0523, P0195, P0197	
Time Required For DTC To Be Set	100 seconds	
MIL Illumination	2 Drive Cycles	
Probable Causes	***See Tech Tool***	

Engine Oil Pressure Sensor: Circuit Monitors

The Engine Oil Pressure Sensor circuits are monitored to check for electrical failures by monitoring the analog-to-digital (A/D) input voltages.

P0520 Engine Oil Pressure Sensor (OPS): Open Circuit Check

DTC	P0520
Component / System	OPS - Open
Monitor Strategy Description	Open Circuit
Fault Limit	Sensor Voltage < 0.2 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0523 Engine Oil Pressure Sensor (OPS): Short Circuit High

DTC	P0523
Component / System	OPS - High
Monitor Strategy Description	Short Circuit High
Fault Limit	Sensor Voltage > 4.9 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Turbocharger Speed Sensor (TSS): Rationality Monitor

This OBD monitor evaluates the turbo speed sensor for missing signal and for rationality faults. The turbo speed is compared during two working conditions, one when the turbo speed is supposed to be low and another when the turbo speed is supposed to be high.

Low Flow Condition :
When the engine is in idle or in low engine speed and torque condition, the expected Turbo Speed is expected to be low. If the turbo speed exceeds a calibrated threshold, a low speed error is set.

High Flow Condition :
When the engine is in higher engine speed and torque condition, the expected Turbo Speed is expected to be high. If the turbo speed lies below a calibrated threshold, a high speed error is set.

P2581 Turbocharger Speed Sensor (TSS): Rationality High

DTC	P2581
Component / System	TSS - Rationality High
Monitor Strategy Description	Input Rationality High
Fault Limit	Average turbo speed ≥ 50 000 RPM
Enable Conditions	• Engine Speed 500 - 1000 RPM • Engine Torque 0 - 200 Nm
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P2578 Turbocharger Speed Sensor (TSS): Missing Signal Monitor

DTC	P2578
Component / System	TSS - Missing Signal
Monitor Strategy Description	Missing signal
Fault Limit	Average turbo speed ≤ 0 RPM
Enable Conditions	• Engine Speed 500 - 2000 RPM • Engine Torque > 200 Nm
Disable Conditions	No Active DTC's: • P2581
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Crankshaft Position Sensor: Rationality Monitors

The Crankshaft Position Sensor is monitored by comparing it's output signal to the output signal of the camshaft position sensor.

P0335 Crankshaft Position Sensor: Open Circuit

DTC	P0335
Component / System	Crankshaft Position Sensor - Open
Monitor Strategy Description	Input Open Circuit
Fault Limit	No signal from Crankshaft Speed Sensor No signal for number of revolutions greater than 3
Enable Conditions	• Engine Speed > 50 RPM
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0339 Crankshaft Position Sensor: Rationality Low

DTC	P0339
Component / System	Crankshaft Position Sensor - Rationality Low
Monitor Strategy Description	Input Rationality - Low
Fault Limit	Less crank teeth than expected Less crank teeth for number of revolutions greater than 3
Enable Conditions	• Engine Speed > 50 RPM
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0336 Crankshaft Position Sensor: Rationality High

DTC	P0336
Component / System	Crankshaft Position Sensor - Rationality High
Monitor Strategy Description	Input Rationality - High
Fault Limit	More crank teeth than expected More crank teeth for number of revolutions greater than 3
Enable Conditions	• Engine Speed > 50 RPM
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Camshaft Position Sensor: Rationality Monitors

The camshaft position sensor is monitored by comparing its output signal to the output signal of the crankshaft position sensor.

P0340 Camshaft Position Sensor: Open Circuit

DTC	P0340
Component / System	Camshaft Position Sensor - Open
Monitor Strategy Description	Input Open Circuit
Fault Limit	No signal from Camshaft Speed Sensor No signal for number of revolutions greater than 3
Enable Conditions	• Engine Speed > 50 RPM
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0016 Camshaft Position Sensor: Rationality Low

DTC	P0016
Component / System	Camshaft Position Sensor - Rationality Low
Monitor Strategy Description	Input Rationality - Low
Fault Limit	Difference between teeth on crank and cam wheel 5 crank angles
Enable Conditions	• Engine Speed > 50 RPM
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0341 Camshaft Position Sensor: Rationality High

DTC	P0341
Component / System	Camshaft Position Sensor - Rationality High
Monitor Strategy Description	Input Rationality - High
Fault Limit	More cam teeth than expected More cam teeth for number of revolutions greater than 3
Enable Conditions	• Engine Speed > 50 RPM
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Aftertreatment Hydrocarbon Injection System

The exhaust aftertreatment fuel injection system injects diesel fuel into the exhaust stream to increase the exhaust gas temperature during some operating conditions

This OBD monitor identifies malfunctions of the Aftertreatment Hydrocarbon Doser System by analyzing the fuel pressures during an OBD controlled sequence of the fuel cut-off valve (FCV), the air purge valve (APV) and the fuel dosing valve (FDV). A DTC will be reported if the expected pressure at any point of the check sequence is not reached within a specified time.

The following Diagnostic Sequence describes the Aftertreatment Hydrocarbon Doser System functional checks:

Air Pressure Check (AP):
During this test the Air Pressure Valve and the Fuel Dosing Valve are open. During this phase the Fuel Pressure Sensor reading shall be at the air supply pressure.

Low Pressure Check (LP):
During this test the Fuel Dosing Valve is open. During this phase the Fuel Pressure Sensor reading shall be at the pressure in the exhaust pipe.

Fuel Pressure Check (FP):
During this test the Fuel Cut-Off Valve is open. During this phase the Fuel Pressure Sensor reading shall be at the fuel delivery pressure.

Fuel Leakage Check (FL):
During this test all valves are closed. During this phase the Fuel Pressure Sensor reading shall be stable at the fuel delivery pressure.

Fuel Delivery Check (FD):
During this test the Fuel Dosing Valve is opened to release the fuel pressure. During this phase the Fuel Pressure Sensor reading shall drop to the pressure in the exhaust system.

Aftertreatment Hydrocarbon Doser Fuel Pressure Sensor: Circuit Monitors

The fuel doser pressure sensor is monitored to check for electrical failures by monitoring the analog-to-digital (A/D) input voltages.

P20DD Aftertreatment Hydrocarbon Doser Fuel Pressure Sensor: Open Circuit

DTC	P20DD
Component / System	Fuel Pressure Sensor - Open
Monitor Strategy Description	Open Circuit
Fault Limit	Sensor Voltage < 0.2 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P20E0 Aftertreatment Hydrocarbon Doser Fuel Pressure Sensor: Short Circuit High

DTC	P20E0
Component / System	Fuel Pressure Sensor - High
Monitor Strategy Description	Short Circuit High
Fault Limit	Sensor Voltage > 4.9 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P20DC Aftertreatment Hydrocarbon Doser Solenoid: Plausibility Low

DTC	P20DC
Component / System	Doser Solenoid - Plausibility Low
Monitor Strategy Description	System Pressure with Valve Commanded Closed (FP Failed)
Fault Limit	Closed Valve system pressure < 100 kPa
Enable Conditions	• Engine Speed 550 RPM • Coolant Temperature 20 °C • DOC Out Temperature 120 °C
Disable Conditions	No Active DTC's: • P2226, P2229, P0110, P0112, P0115, P0117, P20DD, P20E0, P229E, P2200, P0105, P0108, P2031, P2322, P2084, P242C, P242A, P242B, P0545, P0544, P2080, P1130, P1133, P20D0, P20CF
Time Required For DTC To Be Set	PASS: 35 seconds FAIL: 140 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P20D0 Aftertreatment Hydrocarbon Doser Solenoid: Rationality High

DTC	P20D0
Component / System	Doser Solenoid - Rationality High
Monitor Strategy Description	System Pressure with Valve Commanded Open (FD Failed)
Fault Limit	Open Valve system pressure > 100 kPa
Enable Conditions	• Engine Speed 550 RPM • Coolant Temperature 20 °C • DOC Out Temperature 120 °C
Disable Conditions	No Active DTC's: • P2226, P2229, P0110, P0112, P0115, P0117, P20DD, P20E0, P229E, P2200, P0105, P0108, P2031, P2322, P2084, P242C, P242A, P242B, P0545, P0544, P2080, P1130, P1133, P20D0, P20CF
Time Required For DTC To Be Set	PASS: 35 seconds FAIL: 140 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Aftertreatment Hydrocarbon Doser Solenoid: Circuit Monitors

The fuel doser solenoid is checked for electrical failures.

P20D7 Aftertreatment Hydrocarbon Doser Solenoid: Open Circuit

DTC	P20D7
Component / System	Doser Solenoid - Open
Monitor Strategy Description	Open Circuit
Fault Limit	Sensor Current < 0.5 A
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	6 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P20D9 Aftertreatment Hydrocarbon Doser Solenoid: Short Circuit Low

DTC	P20D9
Component / System	Doser Solenoid - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	Sensor Current > 5 A
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	6 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Aftertreatment Hydrocarbon Air Purge Valve: Rationality Monitors

P1133 Aftertreatment Hydrocarbon Air Purge Valve: Stuck Open

DTC	P1133
Component / System	Air Purge Valve - Stuck Open
Monitor Strategy Description	System Pressure with Valve Commanded Closed (LP Failed)
Fault Limit	Closed Valve system pressure < 50 kPa
Enable Conditions	• Engine Speed 550 RPM • Coolant Temperature 20 °C • DOC Out Temperature 120 °C
Disable Conditions	No Active DTC's: • P2226, P2229, P0110, P0112, P0115, P0117, P20DD, P20E0, P229E, P2200, P0105, P0108, P2031, P2322, P2084, P242C, P242A, P242B, P0545, P0544, P2080, P1130, P1133, P20D0, P20CF
Time Required For DTC To Be Set	PASS: 35 seconds FAIL: 140 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P1130 Aftertreatment Hydrocarbon Air Purge Valve: Stuck Closed

DTC	P1130
Component / System	Air Purge Valve - Stuck Closed
Monitor Strategy Description	System Pressure with Valve Commanded (AP Failed)
Fault Limit	Open Valve system pressure > 70 kPa
Enable Conditions	• Engine Speed 550 RPM • Coolant Temperature 20 °C • DOC Out Temperature 120 °C
Disable Conditions	No Active DTC's: • P2226, P2229, P0110, P0112, P0115, P0117, P20DD, P20E0, P229E, P2200, P0105, P0108, P2031, P2322, P2084, P242C, P242A, P242B, P0545, P0544, P2080, P1133, P20D0, P20CF
Time Required For DTC To Be Set	PASS: 35 seconds FAIL: 140 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Aftertreatment Hydrocarbon Air Purge Valve: Circuit Monitors

The fuel air purge valve is checked for electrical failures.

P1134 Aftertreatment Hydrocarbon Air Purge Valve: Open Circuit

DTC	P1134
Component / System	Air Purge Valve - Open
Monitor Strategy Description	Open Circuit
Fault Limit	Sensor Current < 0.6 A
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	6 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P1131 Aftertreatment Hydrocarbon Air Purge Valve: Short Circuit Low

DTC	P1131
Component / System	Air Purge Valve - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	Sensor Current > 10 A
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	6 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Aftertreatment Hydrocarbon Dosing Valve: Rationality Monitors

P20CF Aftertreatment Hydrocarbon Dosing Valve: Stuck Open

DTC	P20CF
Component / System	Aftertreatment Hydrocarbon Dosing Valve - Stuck Open
Monitor Strategy Description	System Pressure With Valve Commanded Closed (FL Failed)
Fault Limit	Closed Valve system pressure < 75 kPa
Enable Conditions	• Engine Speed 550 RPM • Coolant Temperature 20 °C • DOC Out Temperature 120 °C
Disable Conditions	No Active DTC's: • P2226, P2229, P0110, P0112, P0115, P0117, P20DD, P20E0, P229E, P2200, P0105, P0108, P2031, P2322, P2084, P242C, P242A, P242B, P0545, P0544, P2080, P1130, P1133, P20D0
Time Required For DTC To Be Set	PASS: 35 seconds FAIL: 140 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P2698 Aftertreatment Hydrocarbon Dosing Valve: Functional

DTC	P2698
Component / System	Aftertreatment Hydrocarbon Dosing Valve - Functional
Monitor Strategy Description	Nozzle Function
Fault Limit	Ratio = 1□(Calculated Energy delivered from AHI Energy released by oxidation of Fuel by EATS) > 0.75
Enable Conditions	• DPF Out Temperature > 100 °C • AHI Fuel Injection State Active
Disable Conditions	No Active DTC's: • P2226, P2229, P0110, P0112, P0115, P0117, P20DD, P20E0, P229E, P2200, P0105, P0108, P2031, P2322, P2084, P242C, P242A, P242B, P0545, P0544, P2080, P1130, P1133, P20D0, P20CF
Time Required For DTC To Be Set	600 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Aftertreatment Hydrocarbon Dosing Valve: Circuit Monitors

The fuel doser is checked for electrical failures.

P2697 Aftertreatment Hydrocarbon Dosing Valve: Open Circuit

DTC	P2697
Component / System	Aftertreatment Hydrocarbon Dosing Valve - Open
Monitor Strategy Description	Open Circuit
Fault Limit	Sensor Current < 0.6 A
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	6 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P2699 Aftertreatment Hydrocarbon Dosing Valve: Short Circuit Low

DTC	P2699
Component / System	Aftertreatment Hydrocarbon Dosing Valve - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	Sensor Current > 10 A
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	6 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Aftertreatment DEF Tank Temperature Sensor: Rationality Monitors

The DEF tank temperature sensor is checked for rational values. When heating the DEF tank by activating the coolant valve, the DEF tank temperature sensor value is expected to increase within the evaluation time.

P209F Aftertreatment DEF Tank Temperature Sensor: Rationality High

DTC	P209F
Component / System	Temperature Sensor - Rationality High
Monitor Strategy Description	Evaluate actual DEF temperature against the maximum allowed DEF temperature
Fault Limit	DEF temperature > 68 °C
Enable Conditions	• Engine Speed 550 RPM
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	2 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P205B Aftertreatment DEF Tank Temperature Sensor: Rationality Low

DTC	P205B
Component / System	Temperature Sensor - Rationality Low
Monitor Strategy Description	Monitors the DEF tank temperature increase during start up.
Fault Limit	Delta = DEF temperature after start □Temperature at end of evaluation < 5 °C
Enable Conditions	• Engine Speed 550 RPM • DEF Defrosting Active
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	900 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Aftertreatment DEF Tank Temperature Sensor: Circuit Monitors

The DEF tank temperature sensor is checked for electrical failures.

P205A Aftertreatment DEF Tank Temperature Sensor: Open Circuit

DTC	P205A
Component / System	Temperature Sensor - Open
Monitor Strategy Description	Open Circuit
Fault Limit	Sensor Voltage > 4.5 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P205C Aftertreatment DEF Tank Temperature Sensor: Short Circuit Low

DTC	P205C
Component / System	Temperature Sensor - Open
Monitor Strategy Description	Short Circuit Low
Fault Limit	Sensor Voltage < 0.5 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Aftertreatment DEF Pump: Rationality Monitors

The Aftertreatment DEF pump has internal diagnostics which evaluate whether the DEF pump is able to meet its demand. If the pump reports insufficient performance for more than a threshold time then a DTC is set.

P20E8 Aftertreatment DEF Pump: Pump Pressure Build Up

DTC	P20E8
Component / System	DEF Pump - High
Monitor Strategy Description	Pressure build up monitor
Fault Limit	DEF pressure <= 650 kPa
Enable Conditions	• Engine Speed 550 RPM
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	50 Seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P218F Aftertreatment DEF Pump: Functional Check

DTC	P218F
Component / System	DEF Pump - Functional
Monitor Strategy Description	Urea flow through the orifice functional check
Fault Limit	• DEF pressure > 1100 kPa • Time above DEF pressure limit > 20 seconds
Enable Conditions	• Engine Speed 550 RPM
Disable Conditions	No Active DTC's: • P204C, P204D, P204A, P2049, P2048, P2047, P208E
Time Required For DTC To Be Set	20 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Aftertreatment DEF Pump: Circuit Monitors

The Aftertreatment DEF Pump is checked for electrical failures.

P208A Aftertreatment DEF Pump: Open Circuit

DTC	P208A
Component / System	DEF Pump - Open
Monitor Strategy Description	Open Circuit
Fault Limit	Pump Voltage < 3.75 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	6 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P208D Aftertreatment DEF Pump: Short Circuit High

DTC	P208D
Component / System	DEF Pump - High
Monitor Strategy Description	Short Circuit High
Fault Limit	Pump Current > 9 A
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	6 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P208C Aftertreatment DEF Pump: Short Circuit Low

DTC	P208C
Component / System	DEF Pump - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	Pump Voltage < 1.5 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	6 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Aftertreatment DEF Pump Direction Valve: Rationality Monitor

After the ignition key is turned to the OFF position the aftertreatment control module (ACM) commands the aftertreatment diesel exhaust fluid (DEF) direction valve ON by grounding the control wire (-). When the aftertreatment DEF direction valve is activated, the DEF reverses flow back to the aftertreatment DEF tank, and aftertreatment DEF absolute pressure is expected to drop.

During reverse DEF flow conditions on a pressurized selective catalytic reduction (SCR) system, pressure drop is evaluated. If DEF pressure drop is too low, the aftertreatment DEF direction valve is considered to have a mechanical fault (blocked or stuck).

P20A1 Aftertreatment DEF Pump Direction Valve: Functional Check

DTC	P20A1
Component / System	Direction Valve - Functional
Monitor Strategy Description	DEF pressure too high
Fault Limit	• DEF pressure > 950 kPa • Time above DEF pressure limit > 60 s
Enable Conditions	• Key Position Off • DEF System Purge Mode
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	60 Seconds (in after run)
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Aftertreatment DEF Pump Direction Valve: Circuit Monitors

The Aftertreatment DEF Pump is checked for electrical failures.

P20A0 Aftertreatment DEF Pump Direction Valve: Open Circuit

DTC	P20A0
Component / System	Direction Valve - Open
Monitor Strategy Description	Open Circuit
Fault Limit	Valve Voltage < 3.75 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	6 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P20A3 Aftertreatment DEF Pump Direction Valve: Short Circuit High

DTC	P20A3
Component / System	Direction Valve - High
Monitor Strategy Description	Short Circuit High
Fault Limit	Pump Current > 9 A
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	6 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P20A2 Aftertreatment DEF Pump Direction Valve: Short Circuit Low

DTC	P20A2
Component / System	Direction Valve - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	Pump Voltage < 1.5 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	6 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Aftertreatment DEF Pump Pressure Sensor: Rationality Monitor

DEF pressure is compared with the expected value when the DEF pump is in initial pressure build-up mode or if the DEF pressure is above expected value when DEF pump is in idle speed mode.

P204B Aftertreatment DEF Pump Pressure Sensor: Rationality

DTC	P204B
Component / System	Pump Sensor - Rationaltiy
Monitor Strategy Description	DEF pressure
Fault Limit	Monitors the actual pressure vs expected pressure < 100 kPa
Enable Conditions	• Key On Active
Disable Conditions	No Active DTC's: • P204C, P204A
Time Required For DTC To Be Set	180 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Aftertreatment DEF Pump Pressure Sensor: Circuit Monitors

The Aftertreatment DEF Pump Pressure Sensor is checked for electrical failures.

P204A Aftertreatment DEF Pump Pressure Sensor: Open Circuit

DTC	P204A
Component / System	Pump Sensor - Open
Monitor Strategy Description	Open Circuit
Fault Limit	Sensor Voltage > 4.9 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P204C Aftertreatment DEF Pump Pressure Sensor: Short Circuit Low

DTC	P204C
Component / System	Pump Sensor - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	Sensor Voltage < 0.1 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Aftertreatment SCR Dosing Valve: Rationality Monitor

During reverse DEF flow conditions on a pressurized selective catalytic reduction (SCR) system, pressure drop is evaluated. If DEF pressure drop is too low, the aftertreatment DEF direction valve is considered to have a mechanical fault (blocked or stuck).

P208E Aftertreatment SCR Dosing Valve: Functional Check

DTC	P208E	
Component / System	SCR Dosing Valve - Functional	
Monitor Strategy Description	Pump duty cycle comparison between high and low DEF demand	
Fault Limit	Delta = High DEF pump duty cycle - Low DEF pump duty cycle < 1.5%	
Enable Conditions	**High** • DEF Pressure > 800 kPa • Dosing Valve Duty Cycle > 15%	**Low** • DEF Pressure > 800 kPa • Dosing Valve Duty Cycle < 5%
Disable Conditions	No Active DTC's: • P2048, P2049, P204C, P204D, P204A, P208B, P208D, P208C	
Time Required For DTC To Be Set	100 seconds (7 sub evaluations. If 6 out of 7 are bad => FAIL, If 2 out of 7 are good => PASS)	
MIL Illumination	2 Drive Cycles	
Probable Causes	***See Tech Tool***	

Aftertreatment SCR Dosing Valve: Circuit Monitors

The Aftertreatment SCR Dosing Valve is checked for electrical failures.

P2047 Aftertreatment SCR Dosing Valve: Open Circuit

DTC	P2047
Component / System	SCR Dosing Valve - Open
Monitor Strategy Description	Open Circuit
Fault Limit	Dosing Valve Current < 0.2A
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P2049 Aftertreatment SCR Dosing Valve: Short Circuit High

DTC	P2049
Component / System	SCR Dosing Valve - High
Monitor Strategy Description	Short Circuit High
Fault Limit	Dosing Valve Current > 10 A
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P2048 Aftertreatment SCR Dosing Valve: Short Circuit Low

DTC	P2048
Component / System	SCR Dosing Valve - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	Dosing Valve Current < 0.4 A
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

VGT Position Actuator: Electrical Check

The VGT actuator is a Smart Remote Actuator and it has both a rationality check and an electrical monitor. The rationality monitor covers detection of mechanical faults of the actuator, a bad device and a missing signal from the actuator. The electrical check monitors the VGT supply voltage.

Internal Error (Bad Device):
No valid actuator command transmitted for longer than a calibrated period of time.

CAN Communication (Missing Signal):
No CAN command received for longer than a calibrated period of time; Corresponding with SAE J1939 Datalink #3 (Engine Subnet) (U010C).

Mechanical Fault:
Detects actuator mechanical faults.

P0046 VGT Position Actuator: VGT Mechanical Fault

DTC	P0046
Component / System	Actuator Rationality
Monitor Strategy Description	VGT Mechanical Fault
Fault Limit	Malfunction determined by vendor supplied VGT Smart Remote Actuator
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P00AF VGT Position Actuator: Bad Device

DTC	P00AF
Component / System	Actuator Rationality
Monitor Strategy Description	Bad device
Fault Limit	Monitor disabled by internal diagnostics
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

U010C VGT Position Actuator: Missing Signal

DTC	U010C
Component / System	Actuator Missing Signal
Monitor Strategy Description	VGT Actuator Communication
Fault Limit	Missing communication from VGT SRA
Enable Conditions	• Ignition Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • U0080
Time Required For DTC To Be Set	2 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

VGT Position Actuator: Circuit Monitors

The electrical check monitors the VGT supply voltage and if the supply voltage is below the threshold value a DTC is set.

P006E VGT Position Actuator: Low Supply Voltage

DTC	P006E
Component / System	Actuator - Low
Monitor Strategy Description	VGT Actuator Electrical Check
Fault Limit	Supply Voltage < 10V
Enable Conditions	• Ignition Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	10 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

EGR Valve Actuator: Circuit Monitors

The EGR valve actuator is checked for electrical circuit checks by monitoring the current.

P0403 EGR Valve Actuator: Open Circuit

DTC	P0403
Component / System	Actuator - Open
Monitor Strategy Description	Open Circuit
Fault Limit	Valve Current < 0.15 A
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	1 second
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0489 EGR Valve Actuator: Short Circuit Low

DTC	P0489
Component / System	Actuator - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	Valve Current > 2.7 A
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Engine Fuel Injectors: Injectors 1 through 6: Circuit Monitors

The injection diagnostic function monitors that current level reaches specified levels, defined by the supplier, within the correct time span, typically specified with a minimum time and a maximum time. The evaluation of the current is made for every injection pulse and throughout the complete pulse.

P0262 Engine Fuel Injectors: Short Circuit High (Injector 1)

DTC	P0262
Component / System	Injector 1 - High
Monitor Strategy Description	Short Circuit High
Fault Limit	• Injector current outside of valid peak event > 9 A • Number of injections with SCH detected > 3
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	2 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0265 Engine Fuel Injectors: Short Circuit High (Injector 2)

DTC	P0265
Component / System	Injector 2 - High
Monitor Strategy Description	Short Circuit High
Fault Limit	• Injector current outside of valid peak event > 9 A • Number of injections with SCH detected > 3
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	2 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0268 Engine Fuel Injectors: Short Circuit High (Injector 3)

DTC	P0268
Component / System	Injector 3 - High
Monitor Strategy Description	Short Circuit High
Fault Limit	• Injector current outside of valid peak event > 9 A • Number of injections with SCH detected > 3
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	2 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0271 Engine Fuel Injectors: Short Circuit High (Injector 4)

DTC	P0271
Component / System	Injector 4 - High
Monitor Strategy Description	Short Circuit High
Fault Limit	• Injector current outside of valid peak event > 9 A • Number of injections with SCH detected > 3
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	2 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0274 Engine Fuel Injectors: Short Circuit High (Injector 5)

DTC	P0274
Component / System	Injector 5 - High
Monitor Strategy Description	Short Circuit High
Fault Limit	• Injector current outside of valid peak event > 9 A • Number of injections with SCH detected > 3
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	2 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0277 Engine Fuel Injectors: Short Circuit High (Injector 6)

DTC	P0277
Component / System	Injector 6 - High
Monitor Strategy Description	Short Circuit High
Fault Limit	• Injector current outside of valid peak event > 9 A • Number of injections with SCH detected > 3
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	2 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0201 Engine Fuel Injectors: Short Circuit Low (Injector 1)

DTC	P0201
Component / System	Injector 1 - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	• Injector current in valid peak event > 9 A • Number of injections with SCL detected > 3
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	2 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0202 Engine Fuel Injectors: Short Circuit Low (Injector 2)

DTC	P0202
Component / System	Injector 2 - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	• Injector current in valid peak event > 9 A • Number of injections with SCL detected > 3
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	2 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0203 Engine Fuel Injectors: Short Circuit Low (Injector 3)

DTC	P0203
Component / System	Injector 3 - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	• Injector current in valid peak event > 9 A • Number of injections with SCL detected > 3
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	2 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0204 Engine Fuel Injectors: Short Circuit Low (Injector 4)

DTC	P0204
Component / System	Injector 4 - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	• Injector current in valid peak event > 9 A • Number of injections with SCL detected > 3
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	2 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0205 Engine Fuel Injectors: Short Circuit Low (Injector 5)

DTC	P0205
Component / System	Injector 5 - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	• Injector current in valid peak event > 9 A • Number of injections with SCL detected > 3
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	2 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0206 Engine Fuel Injectors: Short Circuit Low (Injector 6)

DTC	P0206
Component / System	Injector 6 - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	• Injector current in valid peak event > 9 A • Number of injections with SCL detected > 3
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	2 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Ambient Air Temperature Sensor (AAT): Rationality Monitor

The rationality monitor for the ambient air temperature sensor monitors for missing signal from the sensor. If the sensor signal is missing for a specified time the rationality DTC is set.

U0155 Ambient Air Temperature Sensor (AAT): Missing Signal

DTC	U0155
Component / System	AAT - Missing
Monitor Strategy Description	Missing Signal From Sensor
Fault Limit	Time Out > 9 seconds
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Ambient Air Temperature Sensor (AAT): Circuit Monitors

The rationality monitor for the ambient air temperature sensor monitors for missing signal from the sensor. If the sensor signal is missing for a specified time the rationality DTC is set.

P0070 Ambient Air Temperature Sensor (AAT): Open Circuit

DTC	P0070
Component / System	AAT - Open
Monitor Strategy Description	Open Circuit
Fault Limit	Sensor Voltage > 90 °C (4.5 V)
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0072 Ambient Air Temperature Sensor (AAT): Short Circuit Low

DTC	P0072
Component / System	AAT - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	Sensor Voltage < -55 °C (0.5 V)
Enable Conditions	• Ignition Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Wheel Based Vehicle Speed: Vehicle Speed Sensor (VSS): Rationality Monitor

The VECU performs a rationality check on the computed road speed by comparing it with that reported by the ABS.

Deviations between signals greater than a pre-set value cause a fault to be reported on the network.

P215A Wheel Based Vehicle Speed: Vehicle Speed Sensor (VSS): Rationality

DTC	P215A
Component / System	VSS - Rationality
Monitor Strategy Description	Input Other Rationality
Fault Limit	Difference between vehicle speed and ABS > 12 km/h
Enable Conditions	• Engine Speed > 500 RPM
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Wheel Based Vehicle Speed: Vehicle Speed Sensor (VSS): Circuit Monitors

The VECU performs circuit checks of the sensor when the road speed is zero.

P0500 Wheel Based Vehicle Speed: Vehicle Speed Sensor (VSS): Open Circuit

DTC	P0500
Component / System	VSS - Open
Monitor Strategy Description	Input Open Circuit
Fault Limit	Sensor Current < 0.1 mA
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0502 Wheel Based Vehicle Speed: Vehicle Speed Sensor (VSS): Short Circuit Low

DTC	P0502
Component / System	VSS - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	Sensor Voltage < 2.5 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Accelerator Pedal Position #1 Sensor: Rationality Monitors

The VECU performs diagnostics on the analog voltages read from the Accelerator Pedal Position Sensor and the Idle Validation Switch (IVS).

P2109 Accelerator Pedal Position Sensor: Rationality Low

DTC	P2109
Component / System	APP - Rationality Low
Monitor Strategy Description	Pedal position switch rationality - low
Fault Limit	Sensor Voltage 0.38 - 0.65 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P2163 Accelerator Pedal Position Sensor: Rationality High

DTC	P2163
Component / System	APP - Rationality High
Monitor Strategy Description	Pedal position switch rationality - high
Fault Limit	Sensor Voltage 1.2 V - 4.25 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0122 Accelerator Pedal Position Sensor: Below Range

DTC	P0122
Component / System	APP - Low
Monitor Strategy Description	Below range
Fault Limit	Sensor Voltage < 0.38 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0123 Accelerator Pedal Position Sensor: Above Range

DTC	P0123
Component / System	APP - High
Monitor Strategy Description	Above range
Fault Limit	Sensor Voltage > 4.25 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P05E4 Parking Brake Switch: Short Circuit Low

DTC	P05E4
Component / System	Parking Brake Switch
Monitor Strategy Description	Short Circuit Low
Fault Limit	Sensor Voltage < 0.1 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

5 Volt ECM Supply: Supply #1

The 5 Volt sensor supplies are is located in the Engine Electronic Control Unit (EECU). Some sensors, especially pressure sensors, require 5 Volt supply to operate. They are fed by three 5 Volt supplies in the EECU (referred as #1, #2 and #3 below). If the 5 Volt supply fails or the feed is shorted to ground or battery the above/below range monitoring reports this. If it occurs, none of the readings from the sensors connected to the failing supply is reliable.

P06B1 ECM Supply #1: Below Range

DTC	P06B1
Component / System	ECM Supply #1
Monitor Strategy Description	Below range
Fault Limit	Voltage Sensed < 4.5 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P06B2 ECM Supply #1: Above Range

DTC	P06B2
Component / System	ECM Supply #1
Monitor Strategy Description	Above range
Fault Limit	Voltage Sensed > 5.5 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P06B4 ECM Supply #2: Below Range

DTC	P06B4
Component / System	ECM Supply #2
Monitor Strategy Description	Below range
Fault Limit	Voltage Sensed < 4.5 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P06B5 ECM Supply #2: Above Range

DTC	P06B5
Component / System	ECM Supply #2
Monitor Strategy Description	Above range
Fault Limit	Voltage Sensed > 5.5 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

5 Volt ECM Supply: Supply #3

P06E7 ECM Supply #3: Below Range

DTC	P06E7
Component / System	ECM Supply #3
Monitor Strategy Description	Below range
Fault Limit	Voltage Sensed < 4.5 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P06E8 ECM Supply #3: Above Range

DTC	P06E8
Component / System	ECM Supply #3
Monitor Strategy Description	Above range
Fault Limit	Voltage Sensed > 5.5 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Data Link Communication: CAN Links

The Engine ECU software monitors CAN messages received by the Engine ECU for detection of lost data link communication to other ECU's. In addition, the ECU monitors the electrical behavior of the data buses. It cannot detect electrical failures, but "bus off" conditions, where it is not possible to send data. The bus off conditions are monitored and a fault code set if such a condition occurs on any of the datalinks. "Bus off" conditions are typically related to electrical problems with the CAN harness.

The EECU monitors bus off conditions on the following datalinks:

- Backbone 1, 250kbit medium speed CAN communication bus
- Backbone 2, 500kbit High speed CAN communication bus
- Engine subnet, 250kbit medium speed CAN communication bus
- Powertrain CAN, 500kbit High speed CAN communication bus

U0010 CAN Link: SAE J1939-1 Missing Signal

DTC	U0010
Component / System	SAE J1939 Datalink # 1 (Public)
Monitor Strategy Description	Missing Signal
Fault Limit	Time Missing Signal > 5 seconds
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	1 Drive Cycle
Probable Causes	***See Tech Tool***

U0080 CAN Link: Powertrain CAN Missing Signal

DTC	U0080
Component / System	SAE J1939 Datalink # 2 (Powertrain)
Monitor Strategy Description	Missing Signal
Fault Limit	Time Missing Signal > 5 seconds
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	1 Drive Cycle
Probable Causes	***See Tech Tool***

U116F CAN Link: Missing ACM at Engine Subnet

DTC	U116F
Component / System	ACM
Monitor Strategy Description	Missing Signal
Fault Limit	Time Missing Signal > 9 seconds
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

U0141 CAN Link: Missing Signal from the VECU

DTC	U0141
Component / System	VECU
Monitor Strategy Description	Missing Signal
Fault Limit	Time Missing Signal > 9 seconds
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

U0001 CAN Link: Missing Signal on Backbone 2

DTC	U0001
Component / System	ISO 15765 Datalink
Monitor Strategy Description	Missing Signal
Fault Limit	Time Missing Signal > 5 seconds
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	1 Drive Cycle
Probable Causes	***See Tech Tool***

Idle Engine Speed: Idle Engine Speed Rationality

Idle speed target can be between 550 to 700 rpm. When engine is in idle governor mode fueling is controlled to get target idle speed. If it is not able to control the engine speed above 525 rpm an idle speed low fault code is logged.

P0506 Idle Engine Speed Rationality: Idle Speed Low

DTC	P0506
Component / System	Idle speed - Rationality Low
Monitor Strategy Description	Flywheel based idle speed validation
Fault Limit	Idle Speed < 525 RPM
Enable Conditions	• Vehicle Speed < 0.1 km/h • PTO Not Active • Engine Torque < 400 Nm • Acceleration Pedal Position < 0.1% • Delay Time After Engine Start 60 seconds • Delay Time After Enable Condition Met 20 seconds • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0340, P0335, P0262, P0265, P0268, P0271, P0274, P0277, P0201, P0202, P0203, P0204, P0205,
Time Required For DTC To Be Set	300 seconds (accumulated time at idle)
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0507 Idle Engine Speed Rationality: Idle Speed High

DTC	P0507
Component / System	Idle speed - Rationality High
Monitor Strategy Description	Flywheel based idle speed validation
Fault Limit	Idle Speed > 725 RPM
Enable Conditions	• Vehicle Speed < 0.1 km/h • PTO Not Active • Engine Torque < 400 Nm • Acceleration Pedal Position < 0.1% • Delay Time After Engine Start 60 seconds • Delay Time After Enable Condition Met 20 seconds • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0340, P0335, P0262, P0265, P0268, P0271, P0274, P0277, P0201, P0202, P0203, P0204, P0205,
Time Required For DTC To Be Set	300 seconds (accumulated time at idle)
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Idle Engine Speed: Idle Engine Fuel Rationality

Fuel Rationality Low:
Nominal idle fuel rate (based on engineering analysis) can be as low as 10mm3/stroke and as high as 100mm3/stroke due to various installation differences and activations of various features (AC, air compressor, alternator etc). Diagnostics is set up to detect 50% lower than the lowest possible idle fuel rates. When engine is in idle governor mode (or fuel limiter mode) if the required fueling is below limit idle fuel low fault code is logged.

Fuel Rationality High:
Nominal idle fuel rate (based on engineering analysis) can be as low as 10mm3/stroke and as high as 100mm3/stroke due to various installation differences and activations of various features (AC, air compressor, alternator etc). Diagnostics is set up to detect 50% higher than the highest possible and 50% lower than lowest possible idle fuel rates. When engine is in idle governor mode (or fuel limiter mode) if the required fueling is above limit idle fuel high fault code is logged.

P054E Idle Engine Fuel Rationality: Fuel Rationality Low

DTC	P054E
Component / System	Idle speed - Fuel Rationality low
Monitor Strategy Description	Low fuel validation at idle
Fault Limit	Idle Fuel < 5mm3 stroke
Enable Conditions	• Vehicle Speed < 0.1 km/h • PTO Not Active • Engine Torque < 400 Nm • Acceleration Pedal Position < 0.1% • Delay Time After Engine Start 60 seconds • Delay Time After Enable Condition Met 20 seconds • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0340, P0335, P0262, P0265, P0268, P0271, P0274, P0277, P0201, P0202, P0203, P0204, P0205,
Time Required For DTC To Be Set	300 seconds (accumulated time at idle)
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P054F Idle Engine Fuel Rationality: Fuel Rationality High

DTC	P054F
Component / System	Idle speed - Fuel Rationality high
Monitor Strategy Description	High fuel validation at idle
Fault Limit	Idle Fuel > 150mm3 stroke
Enable Conditions	• Vehicle Speed < 0.1 km/h • PTO Not Active • Engine Torque < 400 Nm • Acceleration Pedal Position < 0.1% • Delay Time After Engine Start 60 seconds • Delay Time After Enable Condition Met 20 seconds • Ambient Air Temperature -8 - 55 °C • Barometric Pressure 75 - 105 kPa • Coolant Temperature > 65 °C
Disable Conditions	No Active DTC's: • P0117, P0115, P2229, P2226, P0340, P0335, P0262, P0265, P0268, P0271, P0274, P0277, P0201, P0202, P0203, P0204, P0205,
Time Required For DTC To Be Set	300 seconds (accumulated time at idle)
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P2136 Idle Validation Switch (IVS): IVS Does Not Match Accelerator Pedal Position

DTC	P2136
Component / System	IVS - Rationaliy
Monitor Strategy Description	IVS Does Not Match Accelerator Pedal Position
Fault Limit	Voltage > 6 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0652 Idle Validation Switch (IVS): Short Circuit Low

DTC	P0652
Component / System	IVS - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	Voltage < 0.1 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	Continuous
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

5 Volt ACM Sensor Supply: Supply #1

The 5 Volt sensor supplies are located in the Aftertreatment Control Module (ACM). Some sensors require a 5 Volt supply to operate. They are fed by two 5 Volt supplies in the ACM (referred as #1 and #2 below). If the 5 Volt supply fails or is shorted the above/below range monitoring reports.

P06B1 ACM Sensor Supply #1: Below Range

DTC	P06B1
Component / System	ACM Sensor Supply #1
Monitor Strategy Description	Below range
Fault Limit	Voltage Sensed < 4.5 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P06B2 ACM Sensor Supply #1: Above Range

DTC	P06B2
Component / System	ACM Sensor Supply #1
Monitor Strategy Description	Above range
Fault Limit	Voltage Sensed > 5.5 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P06B4 ACM Sensor Supply #2: Below Range

DTC	P06B4
Component / System	ACM Sensor Supply #2
Monitor Strategy Description	Below range
Fault Limit	Voltage Sensed < 4.5 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P06B5 ACM Sensor Supply #2: Above Range

DTC	P06B5
Component / System	ACM Sensor Supply #2
Monitor Strategy Description	Above range
Fault Limit	Voltage Sensed > 5.5 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Actuator Supply #1 ACM: Circuit Monitors

P0657 Actuator Supply #1 ACM: Open Circuit

DTC	P0657
Component / System	Actuator Supply #1 ACM - Open
Monitor Strategy Description	Open Circuit
Fault Limit	Voltage Supply < 2V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0658 Actuator Supply #1 ACM: Short Circuit Low

DTC	P0658
Component / System	Actuator Supply #1 ACM - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	Voltage Supply < 8 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P0659 Actuator Supply #1 ACM: Short Circuit High

DTC	P0659
Component / System	Actuator Supply #1 ACM - High
Monitor Strategy Description	Short Circuit High
Fault Limit	Current Supply > 18 A
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

Actuator Supply #2 ACM: Circuit Monitors

P1080 Actuator Supply #2 ACM: Open Circuit

DTC	P1080
Component / System	Actuator Supply #2 ACM - Open
Monitor Strategy Description	Open Circuit
Fault Limit	Voltage Supply < 2V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P1095 Actuator Supply #2 ACM: Short Circuit Low

DTC	P1095
Component / System	Actuator Supply #2 ACM - Low
Monitor Strategy Description	Short Circuit Low
Fault Limit	Voltage Supply < 8 V
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

P1096 Actuator Supply #2 ACM: Short Circuit High

DTC	P1096
Component / System	Actuator Supply #2 ACM - High
Monitor Strategy Description	Short Circuit High
Fault Limit	Current Supply > 18 A
Enable Conditions	• Key On Active • Battery Voltage > 8 V
Disable Conditions	No Active DTC's: • N/A
Time Required For DTC To Be Set	5 seconds
MIL Illumination	2 Drive Cycles
Probable Causes	***See Tech Tool***

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