

---

## 4 BASIC KNOWLEDGE REQUIRED

Section	Page
4.1 DDEC DIAGNOSTIC CODE .....	4-3
4.2 GENERAL DIAGNOSTIC INFORMATION .....	4-4
4.3 READING CODES WITH DIAGNOSTIC DATA READER .....	4-5
4.4 ELECTRICAL CIRCUITS .....	4-8
4.5 USE OF DIGITAL VOLT-OHM METER .....	4-9
4.6 SERVICING DDEC CONNECTORS .....	4-11
4.7 IMPORTANT INFORMATION .....	4-12
4.8 EXPLANATION OF ABBREVIATIONS AND TERMS .....	4-13
4.9 NEW FOR 2002 .....	4-17

---



## 4.1 DDEC DIAGNOSTIC CODE

Troubleshooting of the DDEC III system and the DDEC IV system is identical. DDEC IV offers several additional features. The DDEC IV system allows for an increased processor speed and increased memory. DDEC III ECMs and DDEC IV ECMs are not interchangeable.

A diagnostic code indicates a problem in a given circuit (i.e. diagnostic Code 14 indicates a problem in the oil or coolant temperature sensor circuit). This includes the oil or coolant temperature sensor, connector, harness, and Electronic Control Module (ECM). The procedure for finding the problem can be found in Flash Code 14, refer to section 14.3. Similar sections are provided for each code. Remember, diagnosis should always begin at the start of the section. For an oil or coolant temperature sensor problem, it will quickly lead you to section 14, but first you verify the code or symptom.

Since the self-diagnostics do not detect all possible faults, the absence of a code does not mean there are not problems in the system. If a DDEC problem is suspected, even in the absence of a code, refer to section 9.1, anyway. This section can lead you to other sections that can aid in the troubleshooting process - where DDEC problems may occur, but do not generate a code. Basic mechanical checks are not covered in this manual.

## 4.2 GENERAL DIAGNOSTIC INFORMATION

As a bulb and system check, the Check Engine Light (CEL) and Stop Engine Light (SEL) will come on for five seconds when the ignition switch is first turned on. If the unit is programmed for the cruise control feature, the "Cruise Active" light (if equipped) will also turn on for five seconds.

If the CEL comes on during vehicle operation, it indicates the self diagnostic system has detected a fault.

When the diagnostic request switch is held, the diagnostic system will flash the yellow or red light located on the dash of the vehicle. The light will be flashing the code(s) indicating the problem areas. If the SEL comes on during vehicle operation, it indicates the DDEC System has detected a potential engine damaging condition. The engine should be shut down immediately and checked for the problem.

Active codes will be flashed on the SEL in numerical flash code order. If there are no active codes, a code 25 will be flashed.

Inactive codes will be flashed on the CEL in most recent to least recent order. If there are no inactive codes, a code 25 will be flashed.

### 4.3 READING CODES WITH DIAGNOSTIC DATA READER

Flash codes are used for operator convenience to advise of an engine fault or sensor failure. SAE specific codes are read with the Diagnostic Data Reader (DDR). In some cases, one flash code may be used to cover more than one component fault. For this reason the DDR (or Diagnostic Data Link, DDL) must be used to identify the specific code.

The Diagnostic Code Menu selections are defined as follows.

- Active codes
- Inactive codes
- Clear codes

To read codes, start with the Menu Selection screen.

1. To call up active codes:
  - [a] Select ENGINE and ENTER three times.
2. To call up inactive codes:
  - [a] Select ENGINE and ENTER twice.
  - [b] Select INACTIVE CODES and ENTER.
3. To clear codes:
  - [a] Select ENGINE and push ENTER twice.
  - [b] Go down and select CLEAR CODES and ENTER.
  - [c] Left to YES, and ENTER.
  - [d] Wait and then push FUNC three times.
  - [e] Go to lines 1 and 2 of the Engine Data List, Active and Inactive Codes, and verify that both lines display NO.

### 4.3.1 Active Codes

Active codes are conditions that are presently occurring and causing the CEL to be illuminated. All current active codes will be displayed for the entire system, including single, dual and triple ECM applications. The display for each code is as follows:

Line 1: ## MID: XXX XXXXXXXXX

Line 2: PID Description

Line 3: FMI Description

Line 4: ↑ A## PID: XXX FMI: XX ↓

Explanation:

##: Indicates the DDC diagnostic flash code number

MID: Message Identification Character

PID: Parameter Identification Character

FMI: Failure Mode Identifier

A##: Numerical count of active codes

↑↓: Indicates additional codes are stored in ECM memory

### 4.3.2 Inactive Codes

Inactive codes are faults that have occurred previously. All current inactive codes will be displayed for the entire system, including single, dual, and triple ECM applications. The display for each code is as follows:

SCREEN #1; SCREEN #2

Line 1: ## MID: XXX XXXXXX XX ; Line 5: 1st: Last:

Line 2: PID Description; Line 6: Total#:

Line 3: FMI Description; Line 7: Total Time:

Line 4: ↑ |## PID: XXX FMI: XX ↓; Line 8: Min/Max:

Explanation:

##: Indicates the DDC diagnostic flash code number

|##: Numerical Count of inactive codes

1st: First occurrence of the diagnostic code in engine hours

Last: Last occurrence of the diagnostic code in engine hours

Total#: Total number of occurrences

Total Time: Total engine seconds that the diagnostic code was active

Min/Max: Minimum/Maximum value recorded during diagnostic condition

### 4.3.3 Clear Codes

This feature allows diagnostic codes stored in the ECMs to be erased. An audit trail of when the codes were last erased will be displayed in engine hours.

Engine Hours of Last Clear Codes: XXXX

### 4.3.4 Message Identification Descriptions

MID: 128 ENGINE, Single ECM applications

MID: 175 ENGINE, R1 Dual ECM application - engine #2 with first receiver ECM

MID: 183 ENGINE, R2 Triple ECM application - engine #3 w/second receiver ECM

MID: 184 PING, Pilot Injection Natural Gas ECM application

Diagnostic codes with Subsystem Identification Characters (SIDs) that reference Auxiliary Outputs # 1-8 (SIDs: 26, 40, 51, 52, 53, 54, 55, 56) will look up the parameter text description in a table to identify the function assigned to the auxiliary output channel.

Diagnostic codes with SIDs that reference PWM Outputs #1 through #4 (SIDs: 57, 58, 59 & 60) will look up the parameter text description in a table to identify the function assigned to the PWM output channel.

Injector Response Time Codes Long and Injector Response Time Codes Short will use a table of injector numbering to identify the appropriate engine cylinder number.

## 4.4 ELECTRICAL CIRCUITS

Before using this manual, you should understand the theory of electricity and know the meaning of voltage and ohms. You should understand what happens in a circuit with an open or shorted wire. You should be able to read and understand a wiring diagram.

You should be able to use jumper wires to make circuit checks.



## 4.5 USE OF DIGITAL VOLT-OHM METER

Before using this manual, you should be familiar with the digital volt-ohm meter (VOM). You should be able to measure voltage and resistance. You should be familiar with the controls of the meter and how to use it correctly.

For use of a typical digital volt-ohm meter, refer to section 4.5.1, refer to section 4.5.2, and refer to section 4.5.3.

### 4.5.1 Resistance Measurements

Perform the following steps to measure resistance:

1. Connect the red test lead to the V-  $\Omega$  (Volt-Ohm) input connector and the black lead to the com input connector on the meter.
2. Set the function/range switch to the desired  $\Omega$  position. If the magnitude of the resistance is not known, set the switch to the highest range, then reduce until a satisfactory reading is obtained.
3. If the resistance being measured is connected to a circuit, turn off the power to the circuit being tested. Turn off the ignition.
4. Connect the test leads to the circuit being measured. When measuring high resistance, be careful not to contact adjacent points, even if they are insulated. Some insulators have a relatively low insulation resistance which can affect the resulting measurement.
5. Read the resistance value on the digital display.

### 4.5.2 Continuity Checks

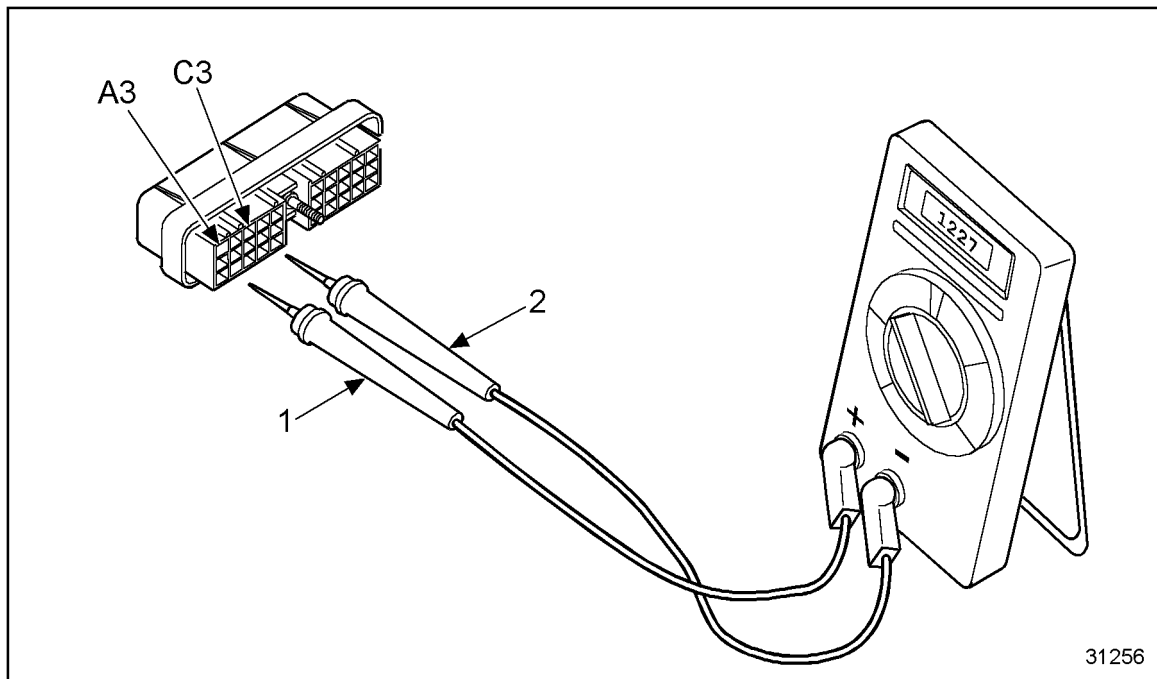
In addition to measuring the specific resistance value of a circuit, some meters will also register if a continuous electrical path exists. If a path exists, the circuit is said to have continuity. (This continuity check can be used in any section of this troubleshooting guide where the test is looking for greater than, less than, or equal to 5 ohms.) An open circuit (broken electrical path) would have  $\infty$  resistance and would not have continuity. To utilize the continuity feature of certain meters:

1. Place the function/range switch in any  $\Omega$  range.
2. Connect the red lead to the V-  $\Omega$  connector and the black lead to the com connector on the meter. With the test leads separated or measuring an out-of-range resistance, the digital display will indicate OL (over limit) Some meters show "1 +, 1, or  $\uparrow$ ."
3. Put one test probe at one end of the wire or circuit to be tested. Use the other test lead to trace the circuit. When continuity is established, an ohm ( $\Omega$ ) symbol will display in the upper left corner of the digital display. If contact in the wire is maintained long enough (about 1/4 second), the OL will disappear and the resistance value of the wire or circuit will display next to the symbol.
4. If your VOM does not work in the manner described above, you must know how your VOM operates in order to use this troubleshooting guide.

### 4.5.3 Voltage Measurements

Perform the following steps to measure voltage.

1. Connect the red test lead to the V- $\Omega$  connector and the black lead to the com input on the meter. If a DC-AC switch is present, ensure it is switched to the DC position.
2. Set the function range/switch to the desired volts position. If the magnitude of the voltage is not known, set the switch to a range that will be able to read most voltages seen on a vehicle. Typically, a 20V range will do. Then, reduce the range until a satisfactory reading is obtained.
3. Connect the test leads to the circuit being measured. In the DDEC system diagnostic procedures, voltage measurements are always given as being taken at pins, sockets, battery +, or ground. Following the voltage measurement point, the color test lead to be used is given in parenthesis (red is the V- $\Omega$  connection, and black is the com connection). Example: If the procedure displays, "Take voltage reading at socket A3 (red lead) to socket C3 (black lead)", see Figure 4-1 for the hook-up.



1. Red Lead

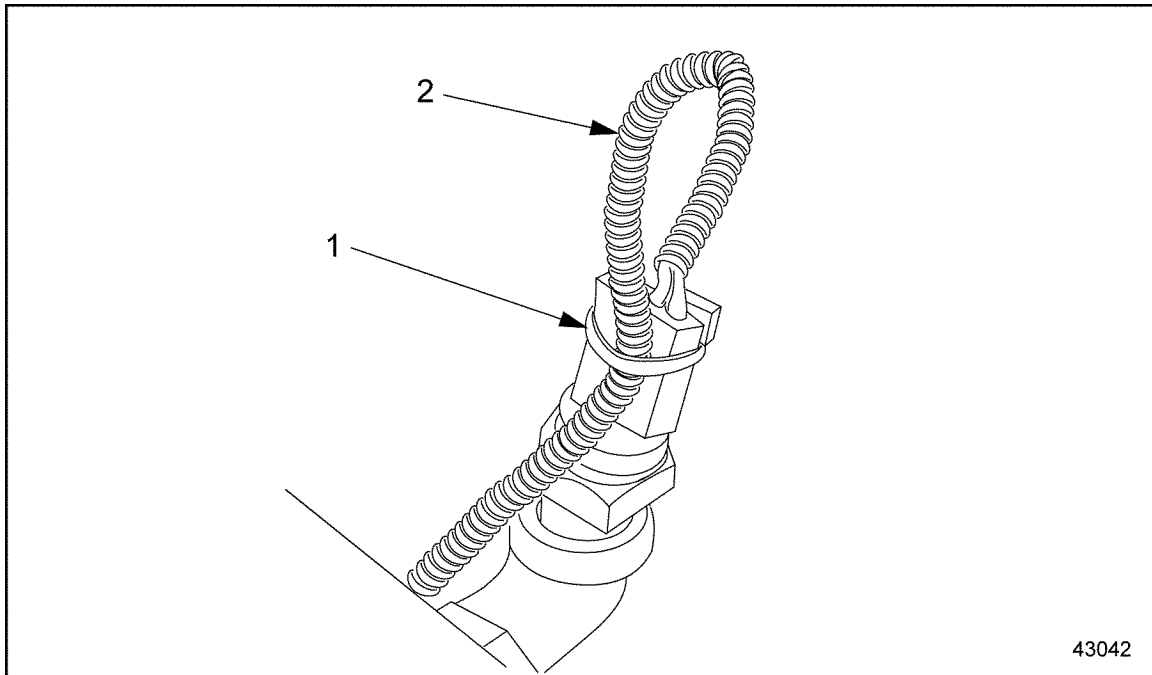
2. Black Lead

**Figure 4-1 Voltage Measurement Hook-up**

## 4.6 SERVICING DDEC CONNECTORS

Newly released kits make servicing DDEC connectors and terminals easier than ever. Crimp tools are not required for simple factory approved repairs. The connector service kit for DDEC II/III/IV is P/N: 23528593. The connector kits for DDEC IV (2002) is P/N: 23527566.

Additionally, it is recommended that whenever possible, the connector and harness incorporate a “service loop” on sensor connections. To achieve this, the harness should be looped back and tie wrapped to the sensor leaving a 3–inch loop. This size loop has proved to substantially protect the mating connector terminals. See Figure 4-2.



1. Tie Wrap

2. Service Loop

**Figure 4-2 Connector Service Loop**

Whenever a connector tie wrap is removed for testing or servicing a connection, ensure it is replaced with a new tie wrap.

## 4.7 IMPORTANT INFORMATION

The following items must be read and thoroughly understood before using this manual.

1. The engine and ignition should always be off before the harness connectors are disconnected or reconnected.
2. When disconnecting harness connectors, ensure the pulling force is applied to the connectors themselves and not the wires extending from them.

<b>NOTICE:</b>
To avoid damage to the harness connectors, ensure the pulling force is applied to the connections themselves and not the wires extending from them.

3. After harness connectors are reconnected to the DDEC system, the codes logged should be ignored and cleared.
4. In most all areas of repair/troubleshooting, a DDR will be required.
5. In diagnosing an intermittent problem, wiggling wires or harnesses may allow the fault to be repeated. This may allow a technician to better isolate the problem area.

## 4.8 EXPLANATION OF ABBREVIATIONS AND TERMS

The following abbreviations and terms listed in Table 4-1, will be used throughout the electrical flowcharts.

Abbreviations	Terms
AAT	Ambient Air Temperature — calculated via the TCI temp sensor
A/C	Air Conditioning
ACG	Air Compressor Governor
ACLS	Add Coolant Level Sensor
A/D	Analog to Digital: The computer inside the ECM uses an A/D converter to convert a sensor voltage into a number with which the computer can work.
AFRS	Air Filter Restriction Sensor
ASR	Anti-Skid Regulation: Data supplied by the ECM for use with ABS (anti-lock braking system).
ATI	Auxiliary Timed Input
ATS	Air Temperature Sensor: Monitors engine air temperature.
BAT	Battery
BOI	Beginning of Injection: The number of crank angle degrees, before top-dead-center (TDC), where the ECM is requesting the injectors be turned on.
BPS	Back Pressure Sensor
CAN	Controller Area Network: J 1939 high speed control data link.
CCM	Crankcase Monitor Sensor: Monitors crankcase pressure (currently on 149 engines only).
CCPS	Crankcase Pressure Sensor
CEL	* Check Engine Light: Typically mounted on the instrument panel. The CEL has two functions: 1. It is used as a warning lamp to inform the operator of the vehicle that a fault has occurred and the unit should be taken in for service as soon as possible. 2. It is used by the operator or technician to "flash out inactive trouble codes to help diagnose a problem.
CKT	Circuit
CLS	Coolant Level Sensor: Monitors coolant level at the radiator top tank or heat exchanger.
COM	Common
CPS	Coolant Pressure Sensor: Monitors coolant pressure.
CTS	Coolant Temperature Sensor: Monitors coolant temperature.
DDEC	Detroit Diesel Electronic Controls
DDEC III	Third generation Detroit Diesel Electronic Controls
DDEC IV	Fourth generation Detroit Diesel Electronic Controls
DDL DDDL	Diagnostic Data Link: The lines (wires) over which the ECM transmits information that can be read by a Diagnostic Data Reader.

Abbreviations	Terms
DDL+ DDDL +	Data Link, positive side: J 1587 data link.
DDL- DDDL -	Data Link, negative side: J 1587 data link.
DDR	Diagnostic Data Reader: The hand held tool used for troubleshooting the DDEC system. MPSI PRO-LINK 9000.
DPS	Delta-P Sensor – measures a difference in pressure at a given location
DRS	Distributor Reprogramming Station
DT	Diagnostic Tool; either DDR (MPSI Pro-Link) or DDDL (PC software used in a similar manner as DDR)
ECM	Electronic Control Module: The controller of DDEC system. It reads the engine and vehicle inputs, sensors and switches, calculates injector firing and duration, and fires injectors at appropriate times.
EEPROM	Electrically Erasable Programmable Read Only Memory.
EFC	Electronic Fire Commander
EFPA	Electronic Foot Pedal Assembly: Contains the throttle position sensor.
EGR	Exhaust Gas Recirculation
EOP	Engine Over-temperature Protection
ESH	Engine Sensor Harness
ESS	Engine Synchro Shift
EUI	Electronic Unit Injector
FEI	Fuel Economy Incentive
FMI	Failure Mode Identifier – number used to identify a failure mode
FPS	Fuel Pressure Sensor: Monitors fuel pressure.
FRS	Fuel Restriction Sensor
FTS	Fuel Temperature Sensor: Monitors fuel temperature.
GND	Ground
INJ	Injector (fuel)
ISD	Idle Shutdown: Programmable feature of the DDEC system.
IVS	Idle Validation Switch: A switch used to establish the idle speed position.
LSG	Limiting Speed Governor.
MAS	Maintenance Alert System
MID	Message Identification Character
MPG	Miles Per Gallon
N/A	Not Applicable.
OEM	Original Equipment Manufacturer
OI	Optimized Idle
OLS	Oil Level Sensor: Monitors oil level.

Abbreviations	Terms
OPS	Oil Pressure Sensor: Monitors oil pressure.
OTS	Oil Temperature Sensor: Monitors oil temperature.
PGS	Pressure Governor System: Regulates engine speed to maintain a selected external pump pressure.
PID	Parameter Identifier
PING	Pilot Injection Natural Gas
PTO	Power Take-Off. Also, referred to as VSG (Variable Speed Governor).
PW	Pulsewidth
PWM	Pulsewidth Modulated: Modulated signal provided by the DDEC system.
RES/ACCEL	Resume/Accelerate Switch used for cruise control.
RH	Relative Humidity
RHS	Relative Humidity Sensor
SEL	† Stop Engine Light: Typically mounted on the instrument panel. It has two functions: 1. It is used as warning to the operator that a potential engine damaging condition has been detected. If the DDEC system is programmed for shutdown, the engine will shutdown on its own within 30 seconds. The engine should not be run until the condition is corrected. 2. It is used by the operator or technician to "flash" out active trouble codes.
SEO	Stop Engine Override: Allows the stop engine condition to be overridden in case it is required.
SET/COAST	Set/Coast Switch: Used in cruise control.
SID	System Identifier – value used that identifies a sensor or a system
SNEF	Signal to Noise Enhancement Filter (Module)
SRS	Synchronous Reference Sensor: Indicates a specific cylinder in the firing order.
TBS	Turbocharger Boost Sensor: Monitors turbo boost.
TBD	To be determined.
TCI	Turbo Compressor Inlet
TCO	Turbo Compressor Outlet
TD	Tachometer Driver: An output from the ECM for electronic tachometers and or data loggers.
TPS	Throttle Position Sensor: Used to detect throttle request (a component of the EFPA). Also, referred to as LSG.
TRS	Timing Reference Sensor: Used to detect whenever any cylinder is about to be fired
VGT	Variable Geometry Turbocharger
VIH	Vehicle Interface Harness (OEM Wiring)
VIN	Vehicle Identification Number
VNT	Variable Nozzle Turbine
VOM	Volt Ohm Meter

Abbreviations	Terms
VPOD	Variable Output Pressure Device – used to accurately position the VNT and EGR valve.
VSG	Variable Speed Governor. Also, referred to as PTO (Power Take-Off).
VSS	Vehicle Speed Sensor: Used to detect vehicle speed.
VSS OC	Vehicle Speed Sensor Open Collector: An ECM input which must be used in addition to the VSS positive input when certain types of vehicle speed sensors are used. Refer to the Application and Installation manual for installation.

\* As a light bulb check and system check, the check engine light will come on for about 5 seconds when the ignition is turned on. If the CEL remains on, or comes back on, the self diagnostic system has detected a problem. If the problem goes away, the light will go out, but a trouble code will be stored in the ECM as an inactive code.

† As a light bulb check and system check, the stop engine light will come on for about 5 seconds when the ignition is turned on.

**Table 4-1 Abbreviations and Terms**



## 4.9 NEW FOR 2002

EGR Feature Operations:

### 4.9.1 Sensor Failures

The system response to specific sensor failures, as required for proper EGR operation, are listed below:

#### 4.9.1.1 Barometric Pressure Sensor

*Failure Modes:* PID 108, FMI 3 – Voltage High and FMI 4 – Voltage Low.

*Response:* When either of the two failure modes is detected, the CEL will be illuminated and an approximate value of barometric pressure shall be used. To improve the accuracy of the approximation, when the engine returns to idle with boost mode active and a failed barometric sensor, the VNT vanes will be forced open for a period of time as determined by the calibration. After the delay period, normal boost mode operation will resume. The vane forcing will only run one time per boost mode event.

#### 4.9.1.2 Turbo Boost Pressure Sensor

*Failure Modes:* PID 102, FMI 3 – Voltage High and FMI 4 – Voltage Low.

*Response:* When either of the two failure modes is detected the CEL will be illuminated and the system will be forced into **open loop** boost mode. The commanded VNT vane position will be determined by a calibration value.

#### 4.9.1.3 Intake Manifold Pressure Sensor

*Failure Modes:* PID 106, FMI 3 – Voltage High and FMI 4 – Voltage Low.

*Response:* The CEL will be illuminated and the calibration default value will be used.

#### 4.9.1.4 Turbo Compressor Outlet Temperature Sensor

*Failure Modes:* PID 404, FMI 3 – Voltage High and FMI 4 – Voltage Low.

*Response:* When either of the two failure modes is detected, the CEL will be illuminated and the system will calculate a torque limit from the ECM calibration.

#### **4.9.1.5 EGR Delta-Pressure Sensor**

*Failure Modes:* PID 411, FMI 3 – Voltage High and FMI 4 – Voltage Low.

*Response:* When either of the two failure modes is detected, the CEL will be illuminated and the system will be forced into boost mode. (EGR is disabled).

#### **4.9.1.6 EGR Temperature Sensor**

*Failure Modes:* PID 412, FMI 3 – Voltage High and FMI 4 – Voltage Low.

*Response:* The CEL will be illuminated and the calibration default value will be used.

#### **4.9.1.7 Turbo Compressor Inlet Temperature Sensor**

*Failure Modes :* PID 351, FMI 3 – Voltage High and FMI 4 – Voltage Low.

*Response:* When either of the two failure modes is detected the CEL will be illuminated and substitute values will be used.

#### **4.9.1.8 Relative Humidity Sensor**

*Failure Modes:* PID 354, FMI 3 – Voltage High and FMI 4 – Voltage Low.

*Response:* The CEL will be illuminated and the calibration default value will be used.

#### **4.9.1.9 Coolant Temperature Sensor**

*Failure Modes:* PID 110, FMI 3 – Voltage High and FMI 4 – Voltage Low.

*Response:* The CEL will be illuminated and the calibration default value will be used.

### 4.9.1.10 Turbo Speed Sensor

*Failure Modes:* PID 103, FMI 8 – Abnormal Period.

*Response:* When this failure mode is detected, the CEL will be illuminated and the system will be forced into boost mode. The VNT vane position will be restricted so it will not be allowed to close beyond a certain position; i.e. the VPOD will only be able to adjust the vanes to a more open position.

### 4.9.1.11 Ambient Air Temperature Sensor

*Failure Modes:* PID 171, FMI 3 – Voltage High and FMI 4 – Voltage Low.

*Response:* When either of the two failure modes is detected, the CEL will be illuminated. Ambient air temperature will be estimated based on the RH/TCI sensor.

## 4.9.2 Mechanical Failures

The system response to detectable mechanical failures as required for this feature, are listed below:

### 4.9.2.1 EGR Valve

- SID 146 FMI 7 – EGR Valve not responding – EGR
- SID 146 FMI 2 – EGR Leak – Boost Power
- SID 146 FMI 12 – EGR Leak – Boost Jake

146/7 – Occurs if actual EGR rate during EGR mode operation is less than it should be. This fault will lock boost mode operation and illuminate the CEL for the remainder of the ignition cycle.

146/2 – Occurs if actual EGR rate during Power Boost mode operation is greater than a calibrated value. This fault will illuminate the CEL for the duration of the fault being active.

146/12 – Occurs if actual EGR rate during Jake Boost mode operation is greater than a calibrated value. This fault will illuminate the CEL for the duration of the fault being active.

### 4.9.3 VNT Vanes

- SID 147 FMI 7 – VNT Vanes not responding – EGR
- SID 147 FMI 2 – VNT Vanes not responding – Boost Power
- SID 147 FMI 12 – VNT Vanes not responding – Jake Power
- SID 147 FMI 14 – EGR Flow too low

147/7 – Occurs if error in actual EGR rate vs desired EGR rate (Actual - Desired) during EGR mode operation. This FMI signifies excessive EGR flow. This fault will lock boost mode operation and illuminate the CEL for the remainder of the ignition cycle if the actual is greater than the desired.

147/2 – Occurs if error in actual boost vs desired boost during Power Boost mode operation. This fault will illuminate the CEL for the duration of the fault being active.

147/12 – Occurs if error in actual boost vs desired boost during Jake Boost mode operation. This fault will illuminate the CEL for the duration of the fault being active.

147/14 – Occurs if error in actual EGR rate vs desired EGR rate (Desired - Actual) during EGR mode operation. This FMI signifies low EGR flow. This fault will illuminate the CEL for the duration of the fault being active.