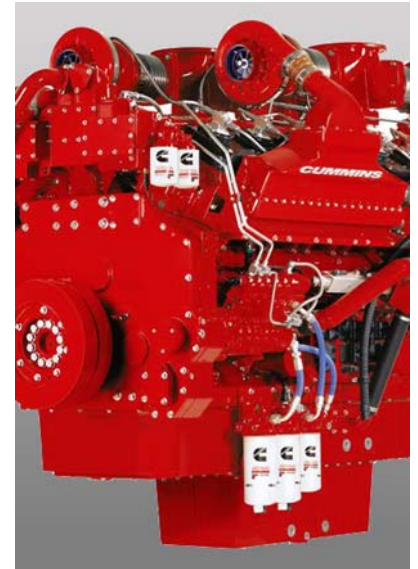
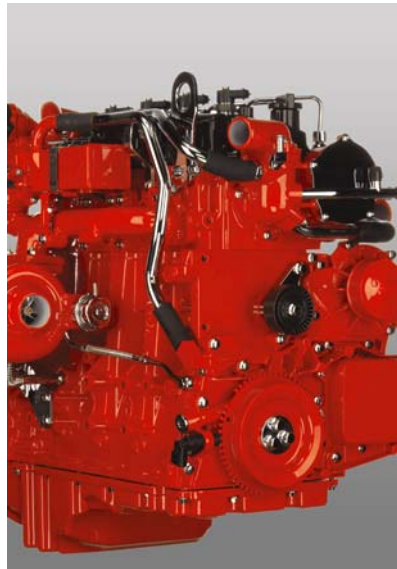




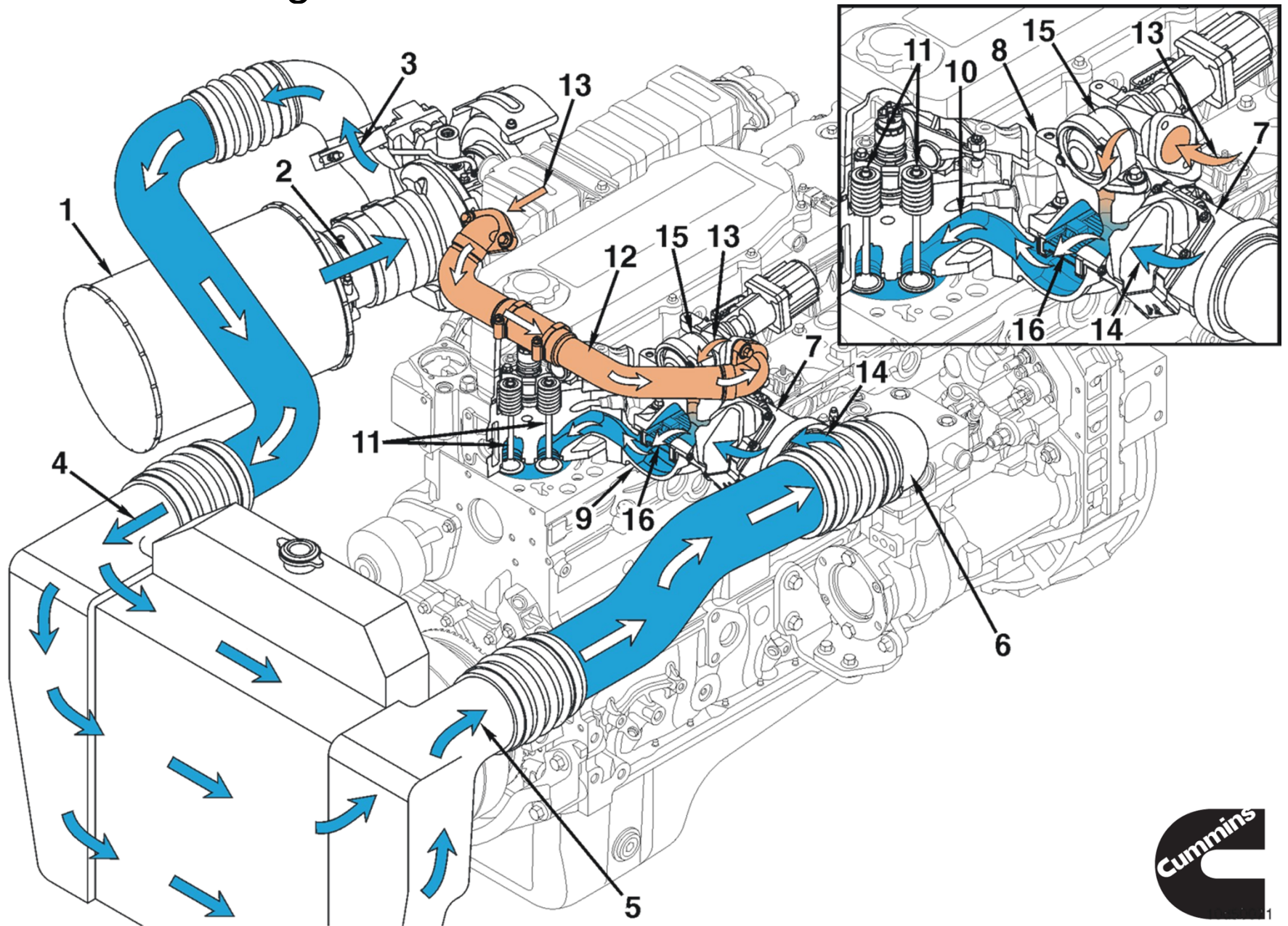
AIR INTAKE AND EXHAUST SYSTEM

ISB6.7 CM2350 B101

Version 1.2



Air Intake Diagram



Intake Specifications

Maximum Intake Restriction

- Clean air filter element 10 in H₂O
- Dirty air filter element 25 in H₂O

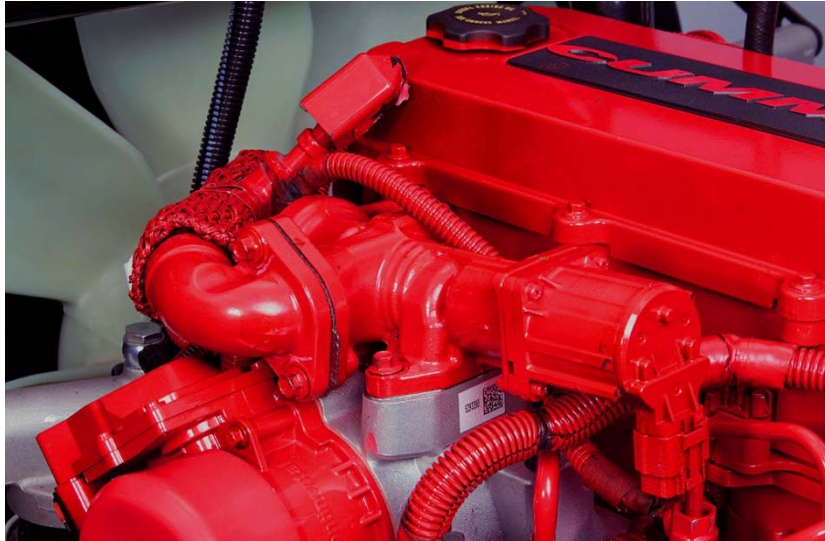
Charge Air Cooler Temperature Differential:

- Minimum Differential (Intake manifold - Ambient air temperature) 38°F

Maximum Charge Air Cooler Pressure Difference

3 psi

Air Intake Connection



Two drillings for easier cleaning

- Change made on 2010 product



Same Differential pressure sensor for B & L



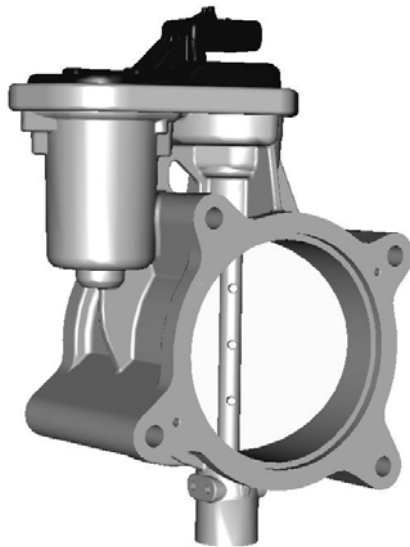
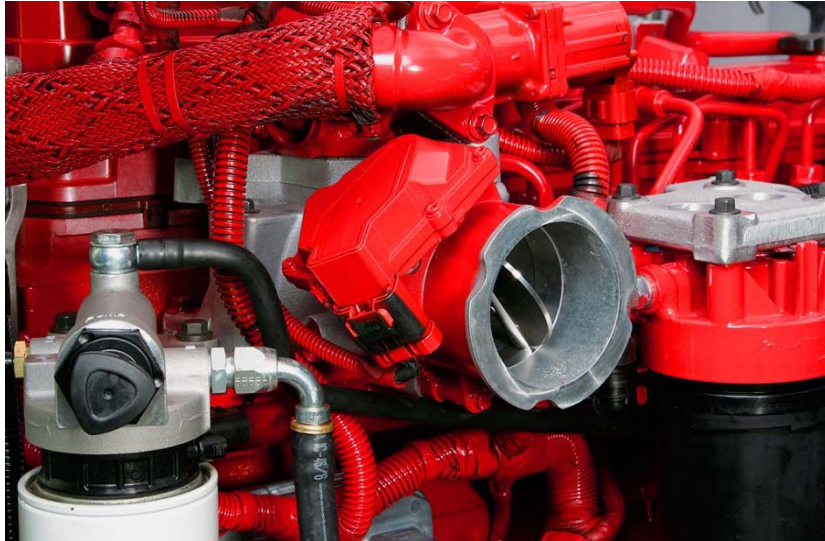
ENGINE INTAKE THROTTLE ACTUATOR



- Intake throttle actuator is used on the midrange engines provides better air control for EGR mixing
- The ITA acts as an EGR assist device to reduce pumping losses to EGR flow and exhaust restriction
- Allows for greater optimization of engine timing. Closing the ITA limits the intake (boost) air and reduces the pressure the EGR flow works against
- ITA closes when EGR and VGT are not capable of providing the commanded EGR flow without assistance



ENGINE INTAKE THROTTLE ACTUATOR



Actuator controls the movement of the throttle plate.

- The position of the engine intake throttle actuator moves between fully open (100 percent) and fully closed (0 percent).
- Normally Open / Spring Loaded

Expected Actuator Position

- At key off – 100 %
- At engine start - 90 %
- While the engine is running, the engine intake throttle actuator should never be fully open (100 %)
- Actuator position could be monitored with INSITE™



ENGINE INTAKE THROTTLE ACTUATOR - Codes

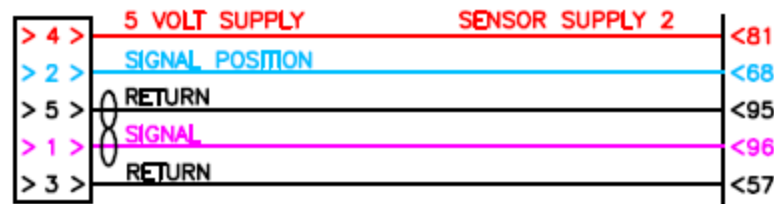
■ Actuator Codes

- 175 - Electronic Throttle Control Actuator Driver Circuit - Voltage above normal, or shorted to high source
- 176 - Electronic Throttle Control Actuator Driver Circuit - Voltage below normal, or shorted to low source
- 177 - Electronic Throttle Control Actuator - Mechanical system not responding or out of adjustment

■ Position Sensor Codes

- 3539 - Engine Intake Throttle Actuator Position Sensor Circuit - Voltage above normal, or shorted to high source
- 3541 - Engine Intake Throttle Actuator Position Sensor Circuit - Voltage below normal, or shorted to low source
- 3542 - Engine Intake Throttle Actuator Position Sensor - Data erratic, intermittent or incorrect

ENGINE
INTAKE
THROTTLE
ACTUATOR



ENGINE INTAKE THROTTLE ACTUATOR - Codes

Fault code 175

- Electronic Throttle Control Actuator Driver Circuit - Voltage above normal, or shorted to high source
- If the ECM has detected that the ITA actuator voltage is above a set value for a calibrated amount of time, actuator shorted high error is set.
- Lamp: 1 Trip, Red Stop Lamp (3 Trip to clear MIL and RSL)

Fault code 176

- Electronic Throttle Control Actuator Driver Circuit - Voltage below normal, or shorted to low source
- If the ECM has detected that the ITA actuator voltage is below a set value for a calibrated amount of time, actuator shorted low error is set, shorted to ground
- Lamp: 1 Trip, Red Stop Lamp (3 Trip to clear MIL and RSL)



ENGINE INTAKE THROTTLE ACTUATOR - Codes

Fault code 177

- Electronic Throttle Control Actuator - Mechanical system not responding or out of adjustment
- The actuator is commanded in both the valve open and close directions to determine two reference positions of the device in the allowed time. These reference positions are used to determine the zero position and the span of the actuator. If the zero position or the span of the actuator is not within allowed limits, or auto-zero process could not finish in the allowed time, the valve is considered failed in auto-zero and span check

3 conditions can set this fault;

- Zero position offset is larger than the limit.
- Span of the valve is out of the limits.
- Auto-zero and span check cannot complete within allowed time

Lamp: 1 Trip, Red Stop Lamp (3 Trips to clear MIL and RSL)



ENGINE INTAKE THROTTLE ACTUATOR - Codes

Fault code 3539

- Engine Intake Throttle Actuator Position Sensor Circuit - Voltage above normal, or shorted to high source
- Lamp: 1 Trip, MIL (3 Trips to clear the MIL)

Fault code 3541

- Engine Intake Throttle Actuator Position Sensor Circuit - Voltage below normal, or shorted to low source
- Lamp: 1 Trip, MIL (3 Trips to clear the MIL)

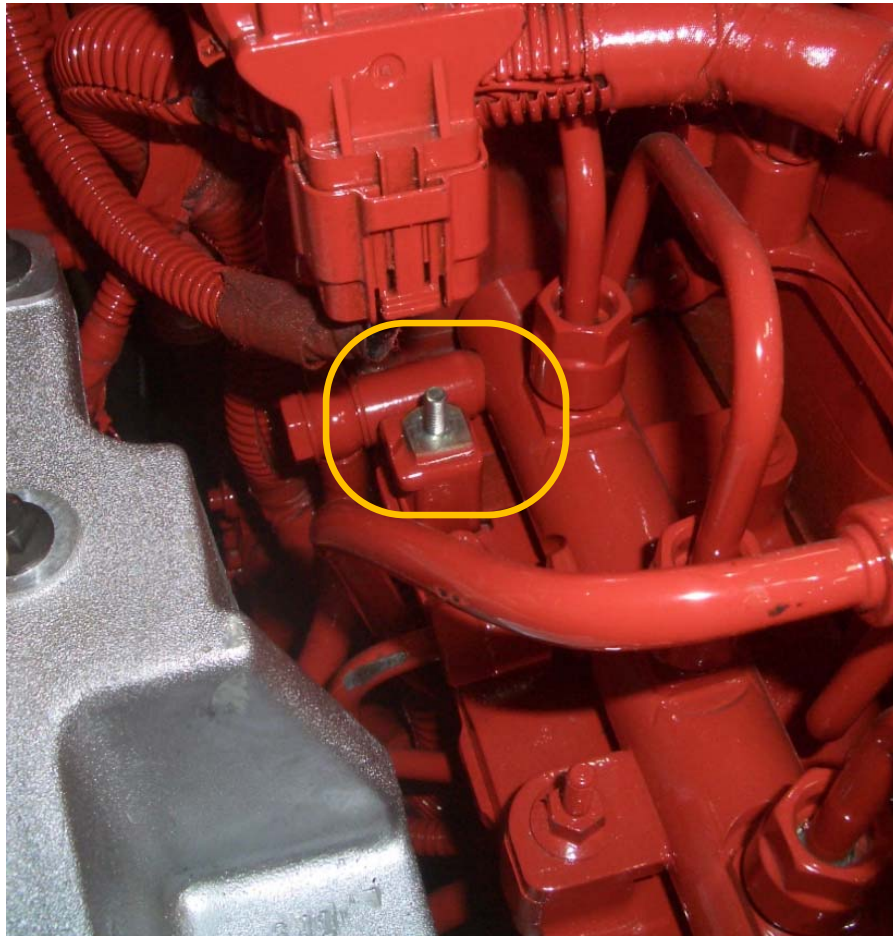
Fault code 3542

- Engine Intake Throttle Actuator Position Sensor - Data erratic, intermittent or incorrect
- Lamp: 1 Trip, MIL (3 Trips to clear the MIL)

Note: If diagnostics determine any failure of ITA, the actuator assembly must be replaced



Intake Air Heater Operation



Standard equipment

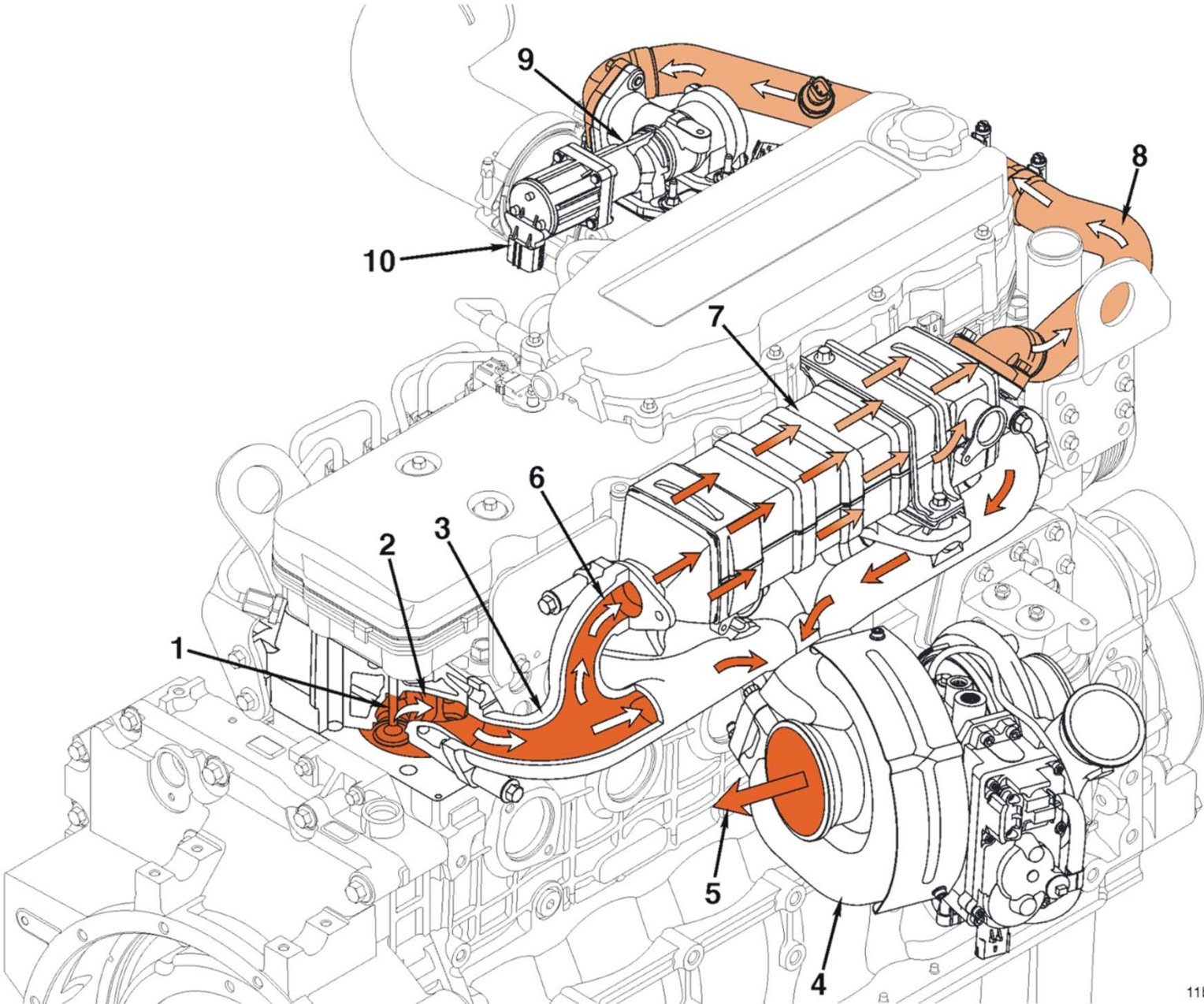
Phases of intake air heater operation:

- Pre-heat (after key-on and before cranking)
- Post-heat (just after a successful engine start)
- There is no heat during cranking.

A “Wait to Start” lamp is also controlled by the ECM and is illuminated to indicate that it is not the optimal time to crank the engine. This will not prohibit the engine from starting.



Exhaust Diagram



Exhaust Specifications

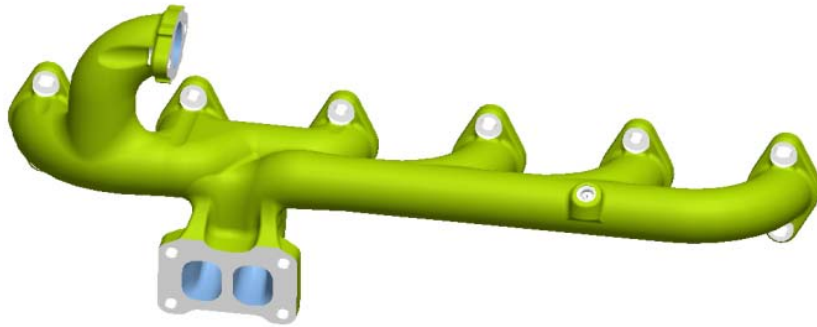
Several exhaust manifold configurations are offered to support turbo locations.

The exhaust valve springs and train have capability for exhaust brake operation to 60 psi

Maximum Back Pressure measured at the turbocharger outlet (at maximum engine rated speed and load) 1.5 psi



Exhaust Manifold



Single Piece manifold



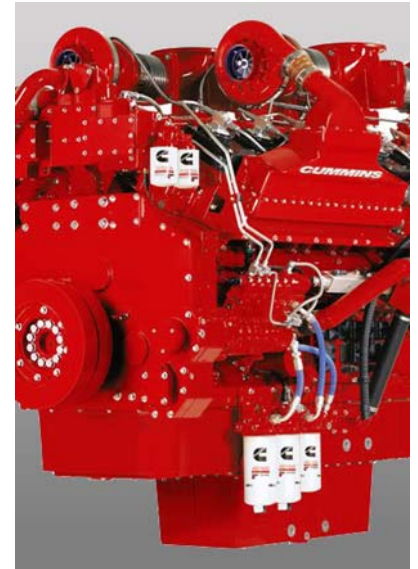
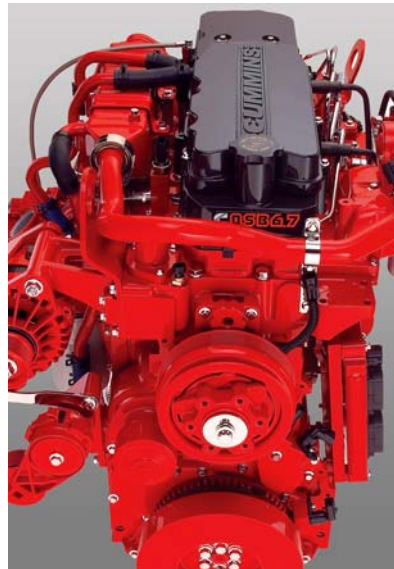
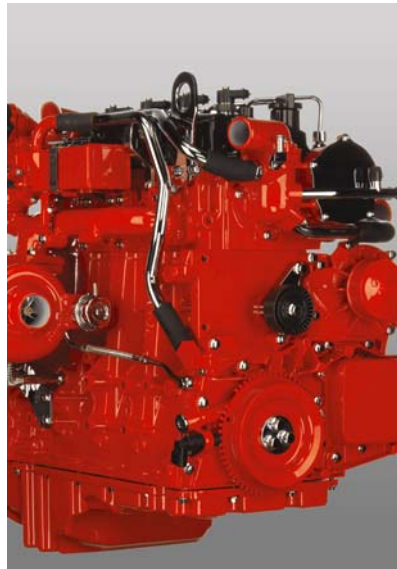
Exhaust Capscrews mounted with spacers to increase bolt “stretch” and eliminate exhaust leaks





Variable Geometry Turbocharger

Images shown are from ISB6.7 CM2350

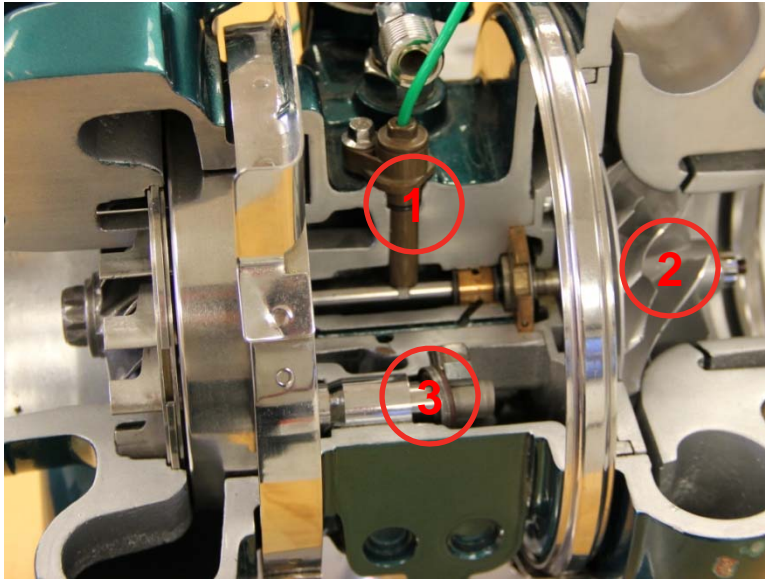


Variable Geometry Turbochargers Function

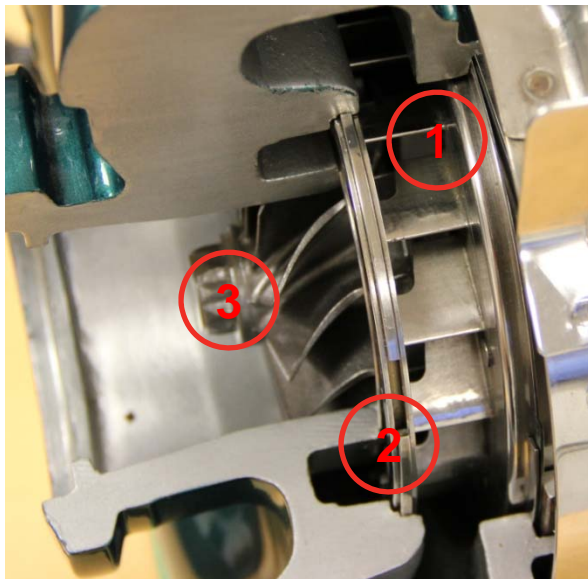
- ✓ The Variable Geometry Turbochargers primary function is to build boost pressure more quickly to improve transient response.
- ✓ The VG turbo can also be used to increase the exhaust manifold backpressure. This increased backpressure is used to force a portion of the exhaust gases through the EGR system. This helps to increase the pressure on the exhaust gas over that of the boosted air from the charge-air-cooler.
- ✓ The VGT can also be used to provide exhaust braking.



VGT Components

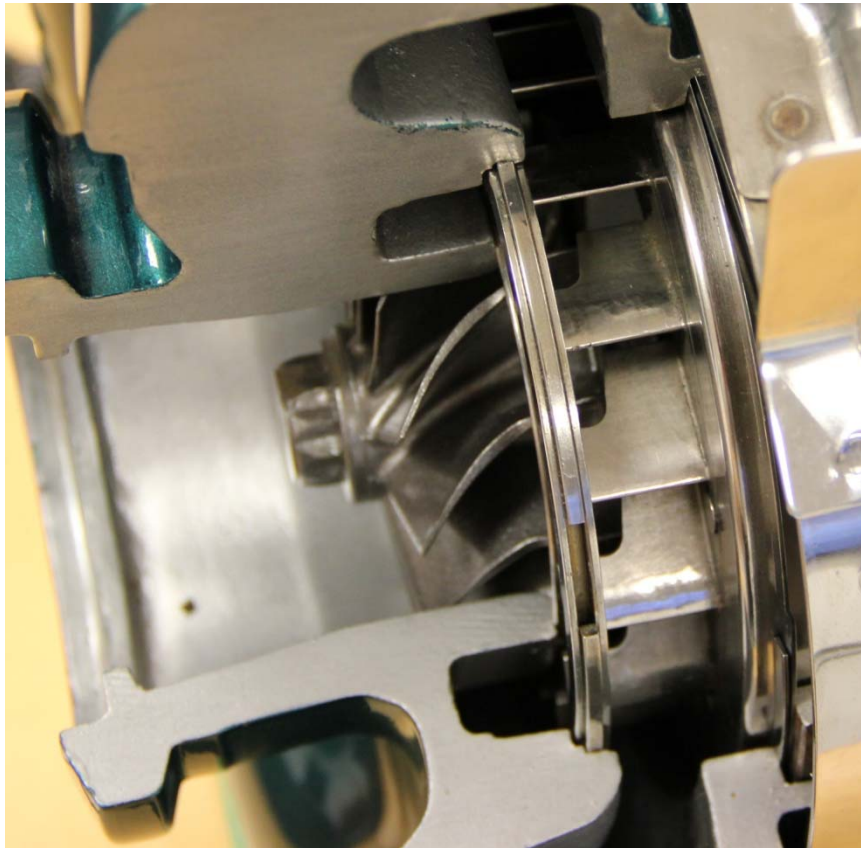


1. Turbo Speed Sensor
2. The turbine and housing
3. Yoke Mechanism



1. Nozzle Ring
2. Shroud Plate
3. The compressor and housing

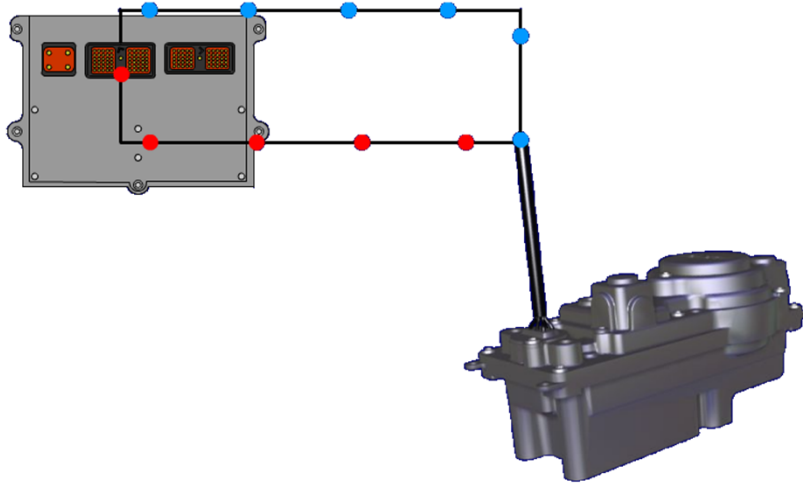
VGT operation



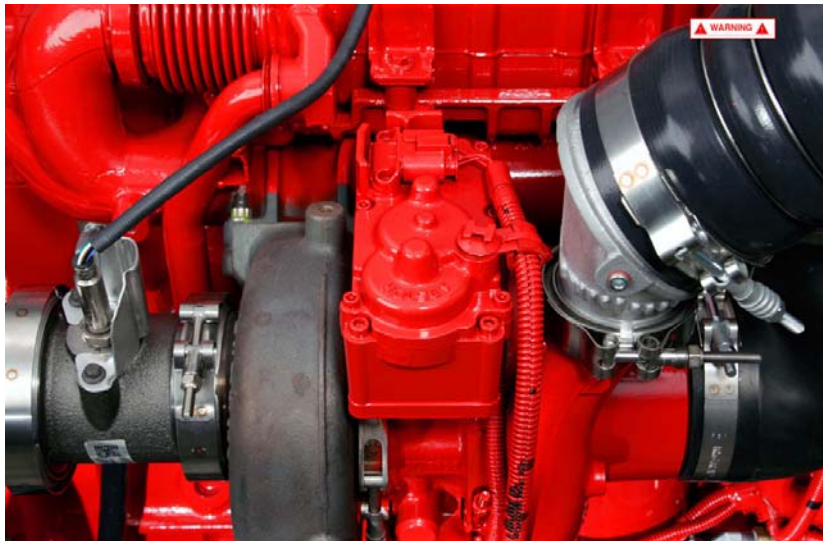
- ❑ The sliding nozzle inside of the turbine housing adjusts to vary the turbine volute exit area.
- ❑ This action creates the increased backpressure in the exhaust manifold to force some of the exhaust gas through the EGR Valve, when it opens.
- ❑ The sliding nozzle is adjusted by the VG actuator.



VGT Actuator



- ✓ The VGT Actuator has built in electronics that send information to the ECM about its travel capabilities.
- ✓ The travel capabilities include total range of movement (fully opened/ fully closed) the amount of energy required to accomplish movement and current position of the actuator.
- ✓ All of these electronic capabilities of the actuators provide diagnostic and fault code reporting through the ECM.

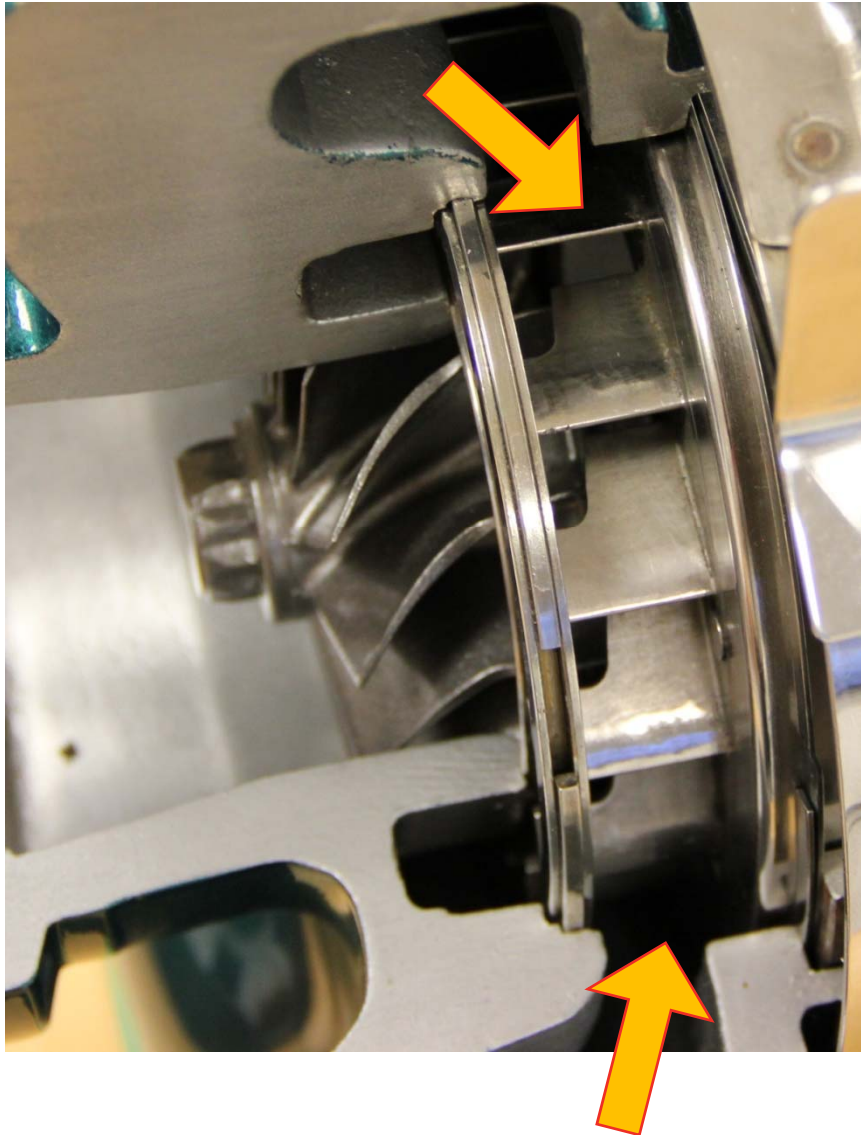


Fully Closed Nozzle Ring



- With the nozzle ring fully closed the turbine volute exit area is at its minimum.
- This creates the maximum exhaust manifold pressure.
- Turbocharger shaft speed and boost pressure are at their highest.

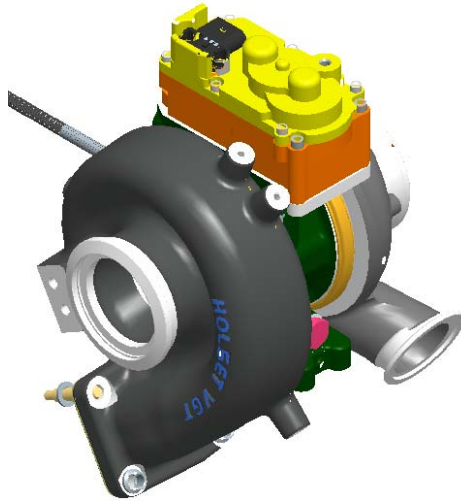
Fully Open Nozzle Ring



- With the nozzle ring in the fully open position the turbine volute exit area is at its maximum.
- This creates the minimum exhaust manifold pressure.
- Turbocharger shaft speed and boost are at their lowest.
- The sliding nozzle position is infinitely variable between opened and closed.



Sector gear setup



Smaller frame size turbo on the ISL (same as B, but with Top mount actuator)

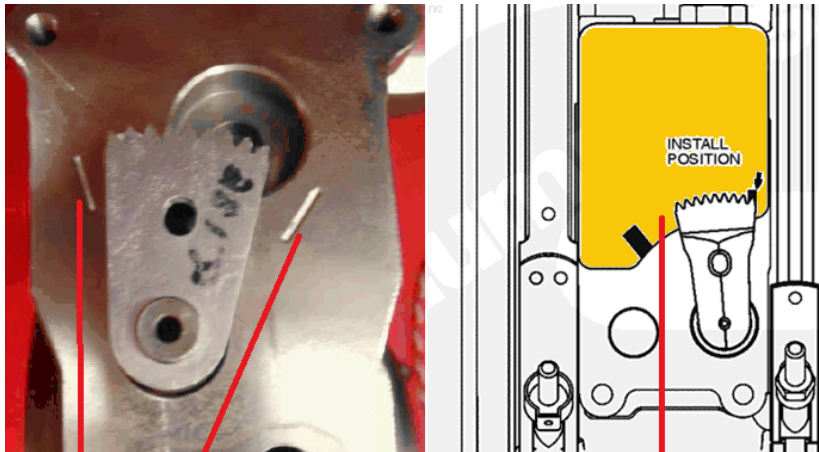
New Actuator

- Re-flashable

There will be markings on the bearing housing for sector gear travel checks and installation alignment

Pinon gear on actuator may not rotate during actuator initial installation step

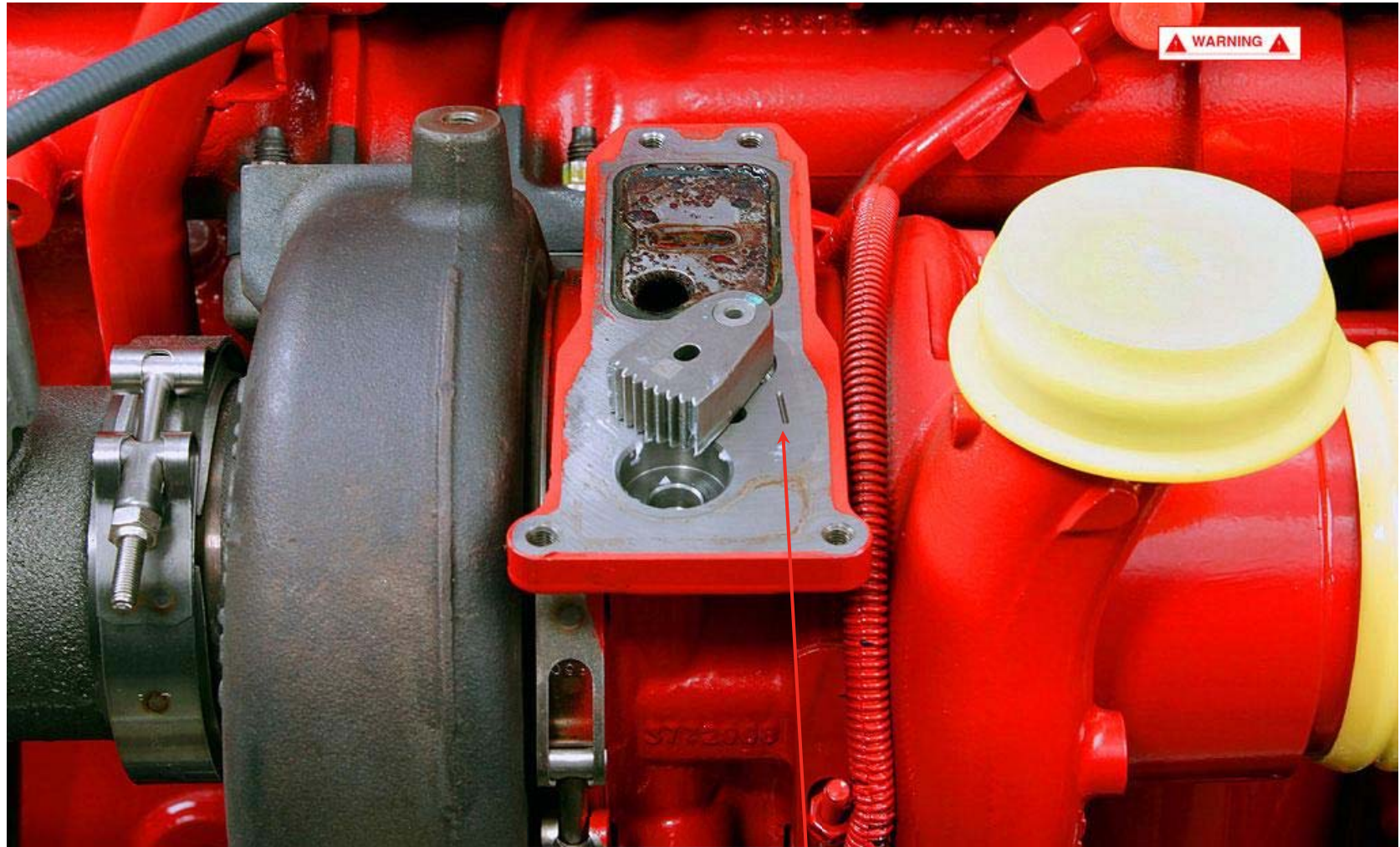
- INSITE/Calibration
- May cause confusion compared to previous product that had the pinon gear move for alignment



Hash marks engraved into bearing housing

Sector gear travel gauge

Sector Gear Travel Marks



New



Variable Geometry Turbocharger - Install

NOTE: Following these instructions in order is very important.

NOTE: If the VGT actuator must be replaced, the new device must be calibrated. New VGT actuators are not calibrated by the manufacturer. !?!

- Continue through the entire turbocharger actuator installation procedure before attempting to troubleshoot any other fault codes.
- Verify that the turbocharger actuator is removed from the turbocharger bearing housing.
- Verify that the turbocharger actuator electrical connector is disconnected from the engine wiring harness.
- Turn the keyswitch ON. Connect INSITE™ electronic service tool and wait 60 seconds.
- Connect the turbocharger actuator electrical connector to the engine wiring harness.
- If Fault Code 2634 becomes active, disconnect the turbocharger actuator connector from the engine wiring harness with the keyswitch ON. Connect the turbocharger actuator electrical connector. Fault Code 2634 will go inactive.
- It is normal and expected to have Fault Code 2449 active when a new turbocharger actuator is connected to the engine, because it is **not** calibrated to the turbocharger.
- Continue through the engine turbocharger actuator installation procedure before attempting to troubleshoot any other fault codes.

Variable Geometry Turbocharger - Install

- In INSITE™ electronic service tool, go to the engine control module (ECM) Diagnostic Tests screen.
- From the list, select VGT Electronic Actuator Installation and Calibration, and click on the “next” button.

NOTE: The VGT Electronic Actuator Installation and Calibration is not a diagnostic test. It is the procedure used to properly install and calibrate the turbocharger actuator. Performing this procedure improperly can result in additional fault codes and/or damage to the turbocharger or actuator.

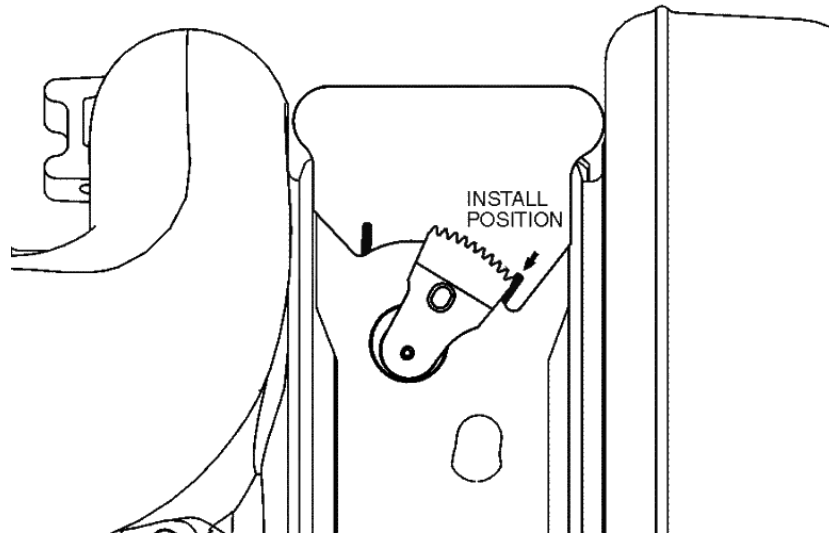
- The INSITE™ electronic service tool INSTALL ACTUATOR command **must only** be performed with the actuator **not** mounted to the turbocharger.
- Locate the column labeled Value and left click on the down arrow. Select INSTALL ACTUATOR and select START.
- This will set the actuator pinion gear to a known position to prepare it for installation to the turbocharger. This step should take less than 30 seconds to complete with INSITE™ electronic service tool.

NOTE: The actuator gear may not move, but will still pass the test. This is acceptable and the actuator can still be installed on the turbocharger.

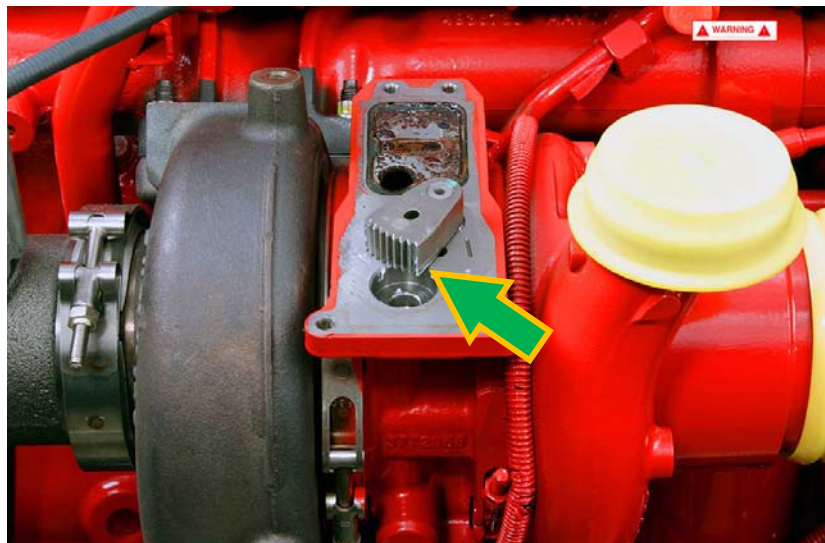
- INSITE™ electronic service tool will indicate when this step is complete.
- *Do not move the actuator gear after this point.*
- Fault Code 2449 will be active at this point in the procedure. Continue through the turbocharger actuator procedure before troubleshooting any fault codes.
- If at any point, INSITE™ electronic service tool status message indicates the procedure was stopped or failed, leave the key ON and cycle the power to the actuator by disconnecting and connecting it from/to the harness.
- If cycling power to the actuator does **not** work, unplug the actuator, turn the keyswitch OFF for 30 seconds, and start INSITE™ electronic service tool. Then start over, beginning with the actuator INSTALL step.



Variable Geometry Turbocharger - Install



- With the sector gear travel gauge installed, grasp the sector gear by hand and **rotate the sector gear toward the turbocharger turbine housing**. Be sure the edge of the sector gear is rotated all the way toward the INSTALL POSITION arrow.
- Coat the teeth on the sector gear with the grease packet supplied in the installation kit.



NOTE: It is critical for smooth reliable operation of the actuator to use the full amount of the Holset® supplied grease

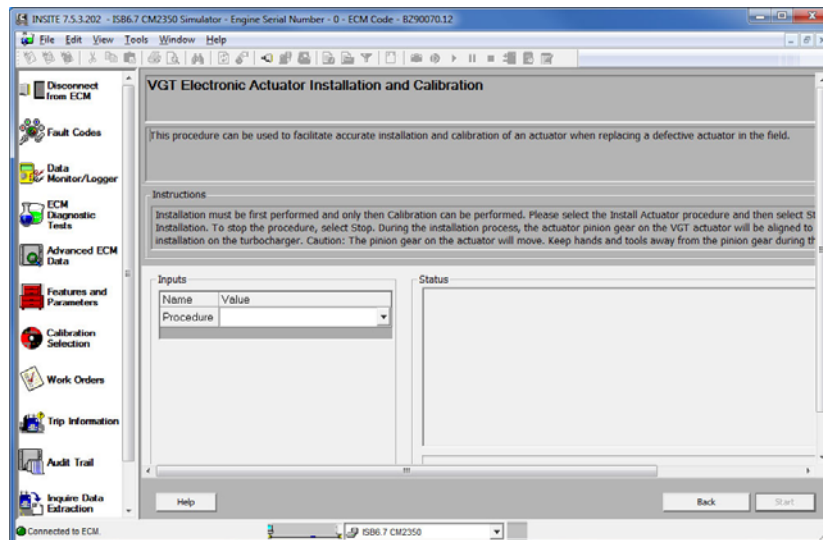
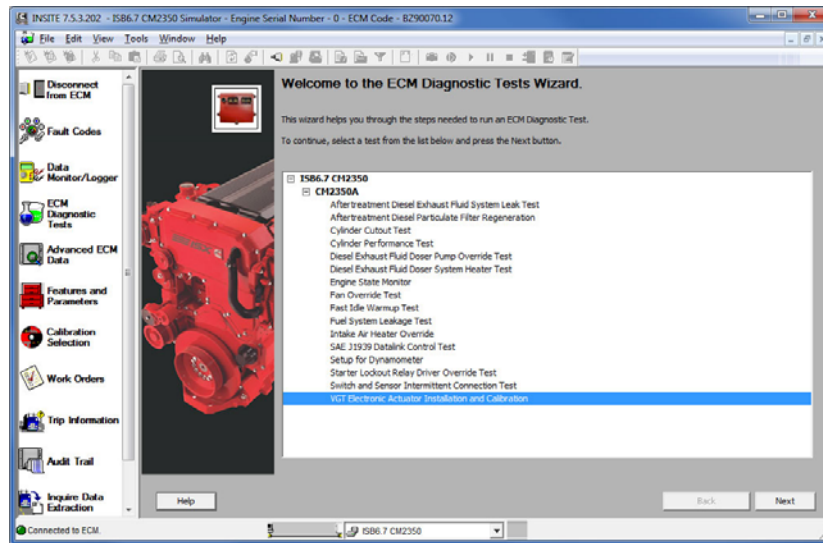


Variable Geometry Turbocharger - Install



- **Install two new sealing o-rings on the turbocharger actuator. Be sure to use the new capscrews contained in the turbocharger actuator mounting kit.**
- Insert the threaded guide pins into the diagonally opposite fastener holes in the bearing housing and locate the actuator onto the guide pins. Slide the actuator into position, making sure the gear spigot and shroud locate into the mating holes in the bearing housing face. Insert the long and short actuator socket head capscrews in the remaining fastener holes and hand-tighten.
- The actuator pinion gear and the turbocharger sector gear must engage smoothly. If they do not engage smoothly, verify that the sector gear through-hole and the bearing housing blind hole are aligned.
- With the actuator aligned on the bearing housing, replace the guide pins with the actuator capscrews. Install the remaining two capscrews.
- Tighten the four capscrews in a crisscross pattern, in two steps.
 - **Torque Value:**
 - 3 n.m [27 in-lb]
 - 11 n.m [97 in-lb]

Variable Geometry Turbocharger - Install



- **The turbocharger actuator must be calibrated to the turbocharger. This step must be performed to be sure proper turbocharger operation is achieved.**
- With INSITE™ electronic service tool screen labeled VGT Electric Actuator Install and Calibrate, locate the column labeled Value and left click on the down arrow. Select CALIBRATE ACTUATOR.
- INSITE™ electronic service tool CALIBRATE ACTUATOR command **must only** be performed with the actuator mounted to the turbocharger.
- Follow the instructions on the screen in order to calibrate the turbocharger actuator to the turbocharger. INSITE™ electronic service tool will indicate when this step is complete.
- If INSITE™ electronic service tool status message indicates the procedure was stopped or failed, turn the keyswitch OFF for 30 seconds, then turn the keyswitch ON. Then start over, beginning with the INSTALL ACTUATOR instructions.
- If the CALIBRATE ACTUATOR step does **not** pass, restart with the Install step.
- It is normal to have an active Fault Code 2387 at this point.
- Turn the keyswitch to the OFF position for 30 seconds. Turn the keyswitch ON and refresh the fault code screen. All turbocharger actuator fault codes should be inactive. Use INSITE™ electronic service tool to clear all fault codes



Turbocharger Actuator Code Programming

NOTE: Downloading a calibration code into the turbocharger actuator is only required if directed by a Campaign, Temporary Repair Practice, or warrantable repair.

- Turbocharger actuator calibration code downloads can be performed with INSITE™ electronic service tool.
 - INSITE™ electronic service tool connects to the turbocharger actuator through the engine control module (ECM) by using the J1939 data link.
 - The turbocharger actuator calibration code download can be performed with the actuator installed or removed from the turbocharger when installing a new actuator. If performing a calibration code download into an existing actuator do not remove the actuator.
-
- **Where do I get new CODE ???**
 - **INCAL CD**
 - **QSOL – in the future**
 - **From engineer. DFSE (USB,CD, E-mail)**



Turbocharger Actuator Calibration Code

- The "Install" and "Calibrate" sections must be performed after the calibration code download process if the actuator is not yet installed onto the turbocharger.
- If the turbocharger actuator is not removed during the calibration code download, no further steps are required.

NOTE: Although either the engine-mounted service tool connector or the vehicle-mounted service tool connector can be used for the software installation, Cummins Inc. recommends that the engine-mounted service tool connector be used for the software installation process, whenever possible.

- Connect the INSITE™ electronic service tool to the J1939 data link, located on the engine or in the vehicle cab.
- Follow the steps in INSITE™ electronic service tool screens to complete the turbocharger actuator calibration code download.
- Once completed, use INSITE™ electronic service tool to clear all fault codes. Turn the keyswitch OFF for 30 seconds. Turn the keyswitch ON and check for fault codes.



FINISHING Steps

NOTE: If the connection is lost during the download process, it can result in Fault Code 2636. If this occurs, the turbocharger actuator calibration process must be performed a second time to clear Fault Code 2636.

- See the Help Section of INSITE™ electronic service tool for detailed turbocharger actuator calibration code download procedures.
- If necessary, complete the variable geometry turbocharger actuator installation.
- Use INSITE™ electronic service tool to clear all inactive fault codes.

Programmable Datalink Device (PDD) Calibration Download Capability

- INSITE provides the capability to download a calibration to a PDD
- This capability is found in the Calibration Selection
- The latest INLINE 4/5 and INLINE 6 Drivers Firmware are needed to support the calibration download



Programmable Datalink Device (PDD) Calibration Download

INSITE 7.6.0.267

File Edit View Tools Window Help

Connect to ECM

Fault Codes

Data Monitor/Logger

ECM Diagnostic Tests

Advanced ECM Data

Features and Parameters

Calibration Selection

Work Orders

Trip Information

Audit Trail

Inquire Data Extraction

OBD Monitors

Datalink Selection

Datalink Adapter Vendor

Datalink Adapter

PEAK-Sytem Technik GmbH
Cummins, Inc.
Cummins Inc. INLINE6
Cummins Inc. J2534 Inline6

Calibration Selection

Select Database Location

Select Product

Compatible Calibration

Reflash Status

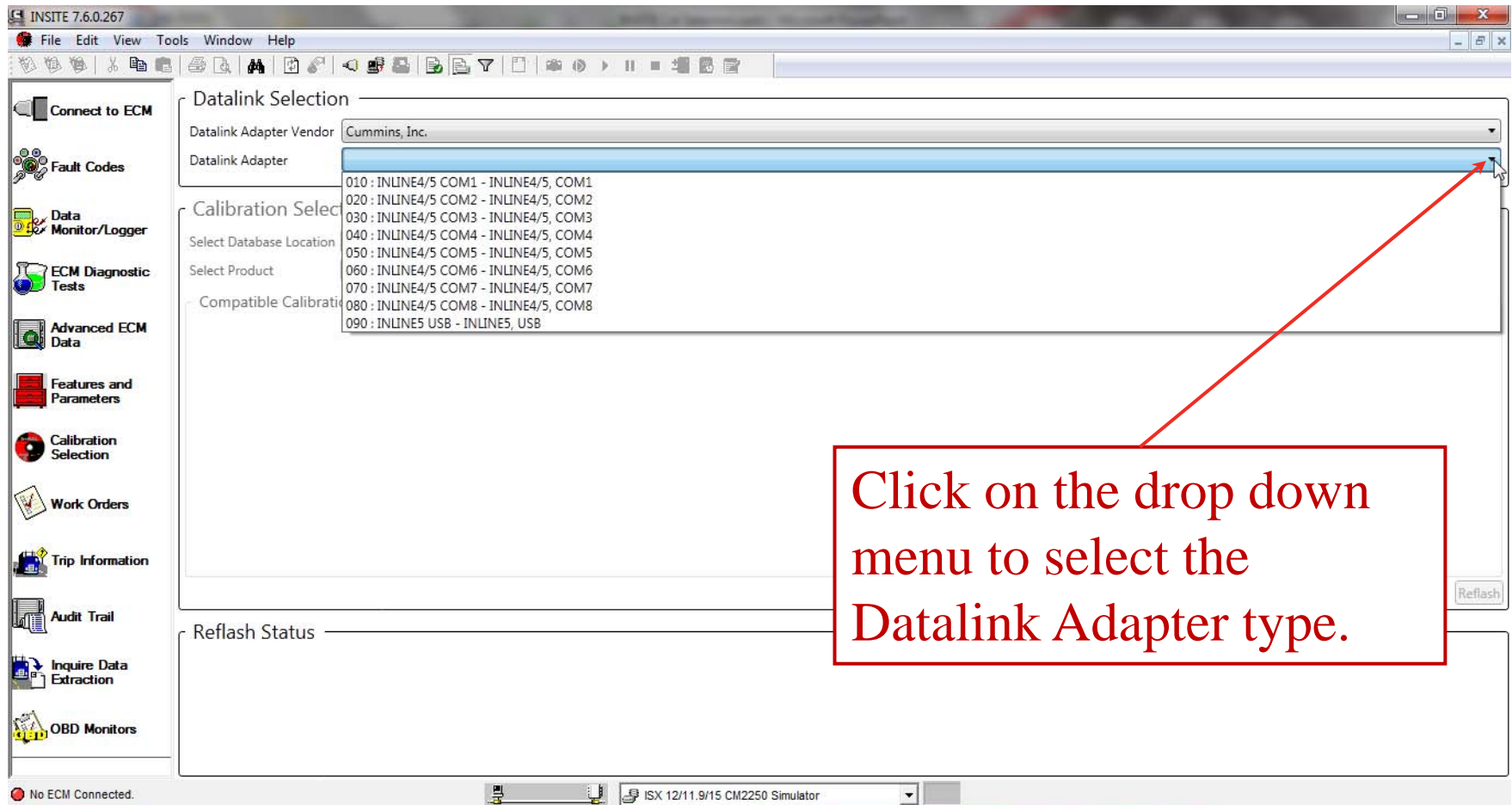
Reflash

No ECM Connected.

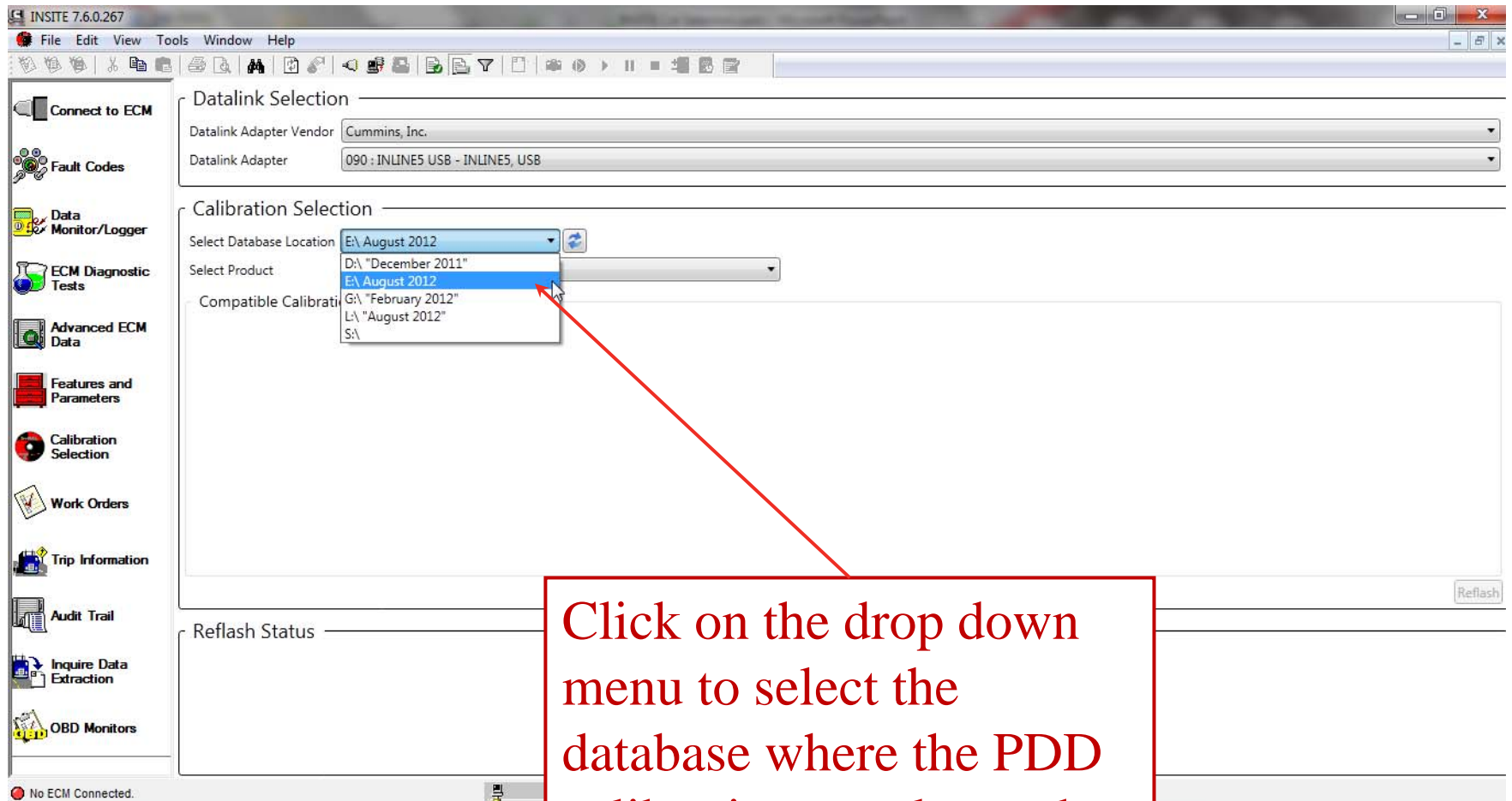
ISX 12/11.9/15 CM2250 Simulator

Click on the drop down menu to select the Datalink Adapter Vendor.

Programmable Datalink Device (PDD) Calibration Download



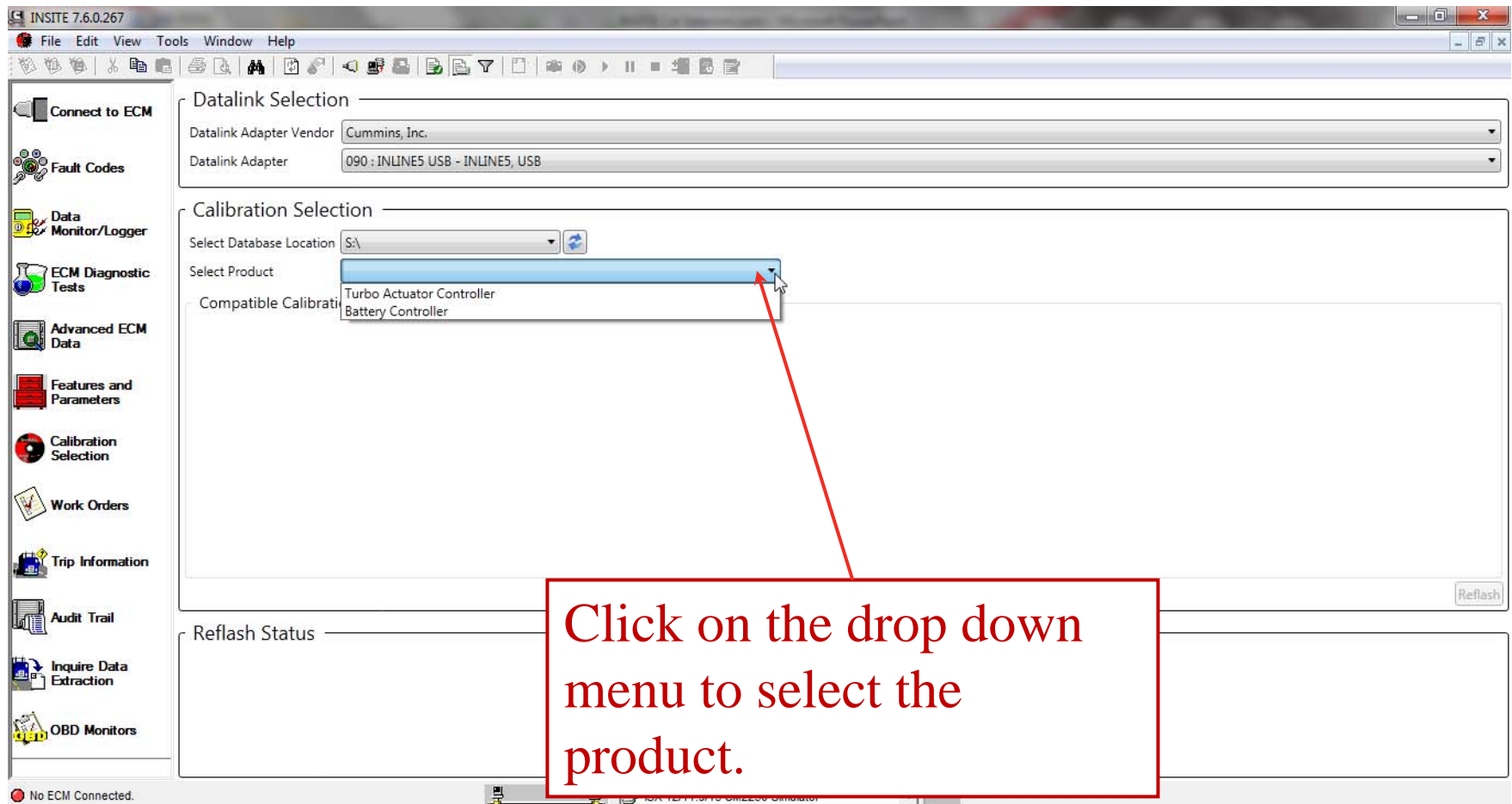
Programmable Datalink Device (PDD) Calibration Download



Click on the drop down menu to select the database where the PDD calibrations are located.



Programmable Datalink Device (PDD) Calibration Download



The screenshot displays the INSITE 7.6.0.267 software interface. The left sidebar contains navigation options: Connect to ECM, Fault Codes, Data Monitor/Logger, ECM Diagnostic Tests, Advanced ECM Data, Features and Parameters, Calibration Selection, Work Orders, Trip Information, Audit Trail, Inquire Data Extraction, and OBD Monitors. The main window is divided into sections: 'Datalink Selection' with fields for 'Datalink Adapter Vendor' (Cummins, Inc.) and 'Datalink Adapter' (090 : INLINES USB - INLINES, USB); 'Calibration Selection' with 'Select Database Location' (S:\) and an open 'Select Product' dropdown menu showing 'Turbo Actuator Controller' and 'Battery Controller'; and 'Refresh Status' with a 'Refresh' button. A red arrow points to the dropdown arrow, and a red text box contains the instruction: 'Click on the drop down menu to select the product.'

Programmable Datalink Device (PDD) Calibration Download

The screenshot displays the INSITE 7.6.0.267 software interface. The left sidebar contains navigation options: Connect to ECM, Fault Codes, Data Monitor/Logger, ECM Diagnostic Tests, Advanced ECM Data, Features and Parameters, Calibration Selection, Work Orders, Trip Information, Audit Trail, Inquire Data Extraction, and OBD Monitors. The main window is titled 'Calibration Selection' and includes the following sections:

- Datalink Selection:** Datalink Adapter Vendor: Cummins, Inc.; Datalink Adapter: 090 : INLINES USB - INLINES, USB.
- Calibration Selection:** Select Database Location: D:\; Select Product: Turbo Actuator Controller.
- Compatible Calibration:** A list of calibration options with a green bar highlighting the selected item, which is pointed to by a red arrow.
- Refresh Status:** A 'Refresh' button is visible at the bottom right of the calibration list.

A red text box with a white background and a red border is overlaid on the interface, containing the text: "After selecting the product INSITE will detect the calibration." A red arrow points from this text box to the green bar in the 'Compatible Calibration' list.

Programmable Datalink Device (PDD) Calibration Download

Datalink Selection

Datalink Adapter Vendor: Cummins, Inc.

Datalink Adapter: 090 : INLINES USB - INLINES, USB

Calibration Selection

Select Database Location: D:\

Select Product: Turbo Actuator Controller

Compatible Calibration

Device Address	Device PN	Software PN
0x02	3773941	12CCWNR
0x02	3773941	E112V
0x02	3773941	EE124V
0x02	3773941	24CCWNR

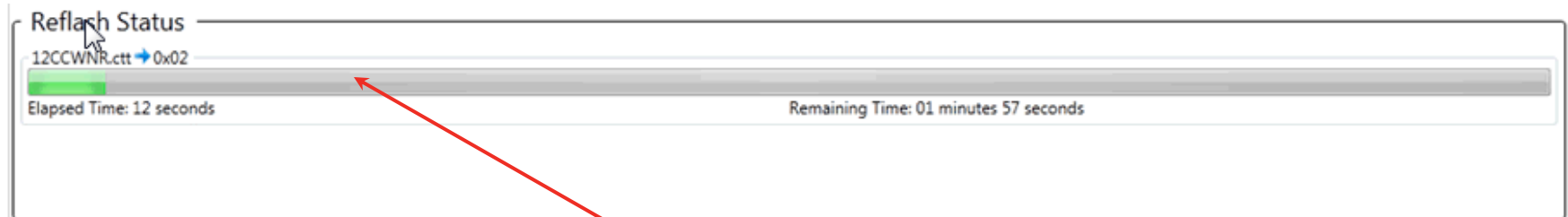
Refresh

Refresh Status

Select a calibration then
click Refresh.



Programmable Datalink Device (PDD) Calibration Download



INSITE displays the Reflash Status during the calibration process.

Programmable Datalink Device (PDD) Calibration Download

Datalink Selection

Datalink Adapter Vendor: Cummins, Inc.
Datalink Adapter: 090 : INLINES USB - INLINES, USB

Calibration Selection

Select Database Location: D:\
Select Product: Turbo Actuator Controller

Compatible Calibration

Device Address	Device PN	Software PN
0x02	3773941	12CCWNR
0x02	3773941	E112V
0x02	3773941	EE124V
0x02	3773941	24CCWNR

Cummins INSITE
Calibration Transfer Successful.
OK

Refresh

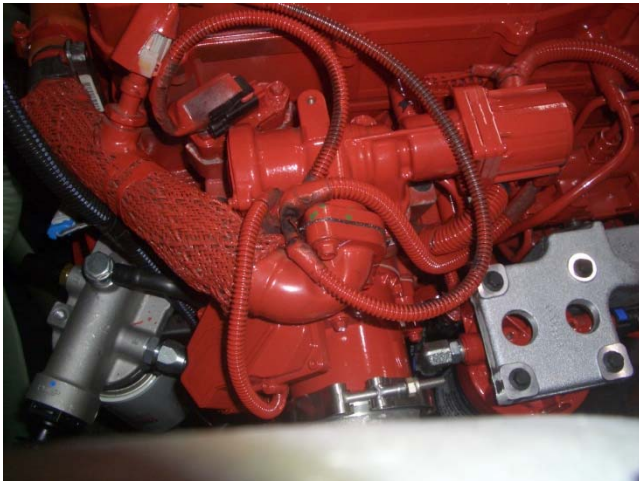
Reflash Status

12CCWNR.ctt → 0x02
Reflash is completed successfully.
Elapsed Time: 30 seconds

INSITE displays Calibration Transfer Successful upon completing the reflash.



EGR Valve



Service Strategy

- One piece valve assembly (non-serviceable)

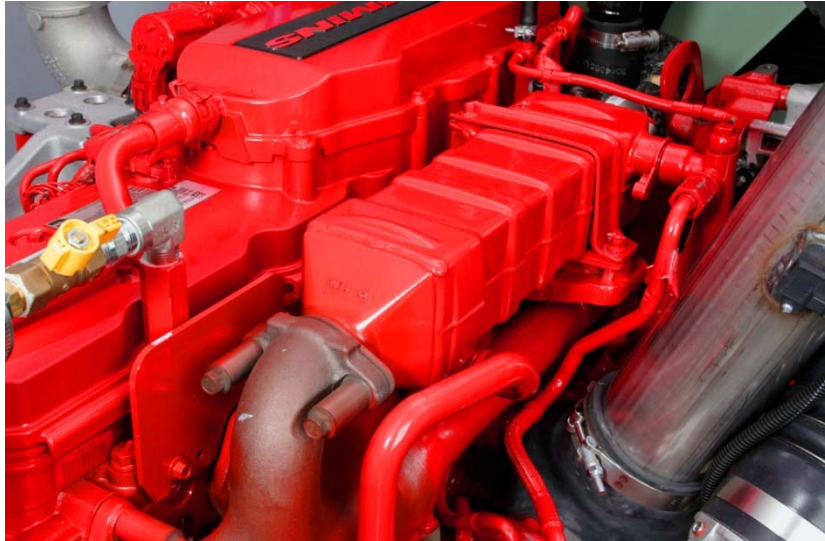
Service Procedures

- 011-022 EGR Valve
- 011-025 EGR Connection Tubes

EGR crossover tube is sealed with gaskets at each end – Exhaust manifold style gaskets

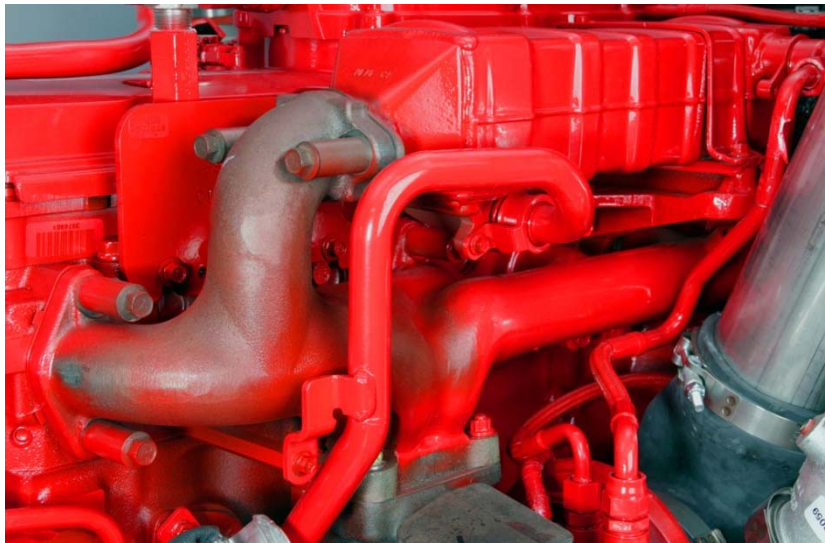


EGR Cooler



Same as 2010 cooler design

- 2010 EGR leak test kit and procedure
- EGR cooler o-rings must never be reused



No V-band clamps on crossover tubes (all 2 bolt flanges) with common gasket B, C, & L



Shop Activity

- **REVIEW EGR COOLER PRESSURE TEST**
- **REVIEW PROPER DE-AERATION OF THE COOLING SYSTEM**

Shop Activity

- **VGT ACTUATOR R & I**
- **VGT ACTUATOR CODE CALIBRATE**
- **COOLANT REPLACER TOOL**

