EPA 2013 ISB6.7 CM2350 B101
Troubleshooting & Familiarization
For NCPTA Conference
ENGINE WALK AROUND
ECM and Sensor Logic

Pressure and Temperature sensor theory of operation
ECM reaction to open and short circuits
“Fault Code State Change” method for troubleshooting
What is “Fault Code State Change”

“Fault Code State Change” is the process of creating the ‘opposite’ fault code to troubleshoot sensors, harnesses, and ECM’s.

Understanding the “Fault Code State Change” logic can make troubleshooting as easy as disconnecting a sensor or unplugging the engine harness from the ECM.
Temperature Sensor Operation

As temperature increases, the signal voltage decreases.

As temperature decreases, the signal voltage increases.
Pressure Sensor Operation

As pressure increases, the signal voltage increases.
As pressure decreases, the signal voltage decreases.
Test Lead Usage

Normal Pin to Socket relationship occurs when correct test lead is used

- Integrity of connection is maintained
- Integrity of connection is lost
- Integrity of connection is lost
Cummins offers 2 test lead kits. The original part number kit was 4919115. An updated kit was released this year. The new part number is 5299367. Contact your local Cummins dealer for pricing and availability.
The Cummins test lead kit part number 4919115 contains 15 different test leads for various connections. The Cummins test lead kit part number 5299367 contains 16 different test leads, several have been designed for the 2013 products.
Correctly using Test Leads to change Fault Code State
Using Test Leads at the ECM can still produce the same Fault Code State Change
Never use a paper clip as a test lead!!
Using the correct test leads

Not using the proper test leads can cause pin damage. These expanded pins were causing intermittent fault code in a test cell engine.

A multimeter probe was jammed into the connector.

*Damaged Pins*
Performing checks and not sure which test lead to use?

Several Cummins wiring diagrams indicate the correct test lead part number to use when testing a circuit.
Where to Connect on ISB Engine with Insite

Location
- Front of engine on the fuel pump side
Fuel System
ISB6.7 CM2350 B101
Version 1.0
HPCR Fuel System Safety

Wear your safety glasses
Use cardboard or paper for identifying/troubleshooting high-pressure leaks ... Never use your hands or fingers

1800 bar = 26,106 PSI
2.068 Bar (30 PSI) is enough to penetrate human skin and cause a pressure injection.

Always wait at least 10 minutes following engine shut down before opening the high pressure fuel system

If possible, use INSITE to monitor the fuel pressure to ensure it is safe to open the system

Never place your hands near fuel system fittings when loosening them.
Fuel System Cleanliness During Repairs Is Very Important

Clean all fuel system fittings, lines, and components before disassembly.

Make sure that no dirt or debris enters the fuel system components to prevent the passing of contaminants to the high pressure fuel rail and injectors.

Small amounts of dirt and debris can cause a malfunction of these components.

**WARNING**
Wear appropriate eye and face protection when using compressed air. Flying debris and dirt can cause personal injury.

**WARNING**
When using a steam cleaner, wear safety glasses or a face shield, as well as protective clothing. Hot steam can cause serious personal injury.

Steam clean the fuel pump and the area around the fuel pump.
Dry with compressed air.
Questions:

✓ What is a micron?

✓ What are potential sources of fuel system contamination?

✓ What can you as the technician do to prevent fuel system contamination?

✓ Can you always pre-fill fuel filters?
Fuel System Specifications

- High-pressure common rail (HPCR) system
- 1800 Bar System Pressure
- Single-Stage High Pressure Relief Valve
- Full authority electronic control of injectors
- Manually primed fuel system
- Engine mounted and off engine mounted suction side fuel filter options
- The suction side fuel filter must include:
  - Water separator
  - Water-in-fuel (WIF) sensing features
- Optional 12 or 24 VDC fuel heater with integral thermostatic control is available from Cummins
ISB CM2350 engines do not utilize an electric motor driven lift pump. The OEM installed hand priming pump is used to prime the fuel system. It can be remote or mounted on the engine. During normal engine operation, the gear pump mounted on the fuel pump will draw fuel from the OEM fuel tank.
Fuel Filter (Suction side)

The priming pump fuel filter (25 micron) and water separator is on the suction side of the fuel system.

- Requires an extension harness to connect the water in fuel (WIF) sensor
- Can be pre-filled

**Priming**

- Pump the primer handle until resistance is felt and the handle cannot be pumped anymore (approximately 140 to 150 strokes for dry filters, or 20 to 60 strokes for pre-filled filter).
- Lock the manual priming pump handle.
- Crank engine. If the engine does not start after 30 seconds, turn key to OFF position.
- Pump the priming pump again, repeating the previous steps until engine starts
Pressure Side Fuel Filtration

Provided by Cummins

- 5 micron rating
- Engine or remote mounted options

NanoNet™ media provides

- a substantial improvement in particle efficiency in the 4, 5 and 6 micron(c) range.
- a substantial improvement in particle efficiency under vibrations
- A lower ΔP across the media.
Why is pre-filling pressure-side fuel filters not recommended?

**Normal System operation**

Fuel from the suction side filter has been filtered, but not at the micron level the fuel system requires.

- **Dirty Side of Filter**
- **Clean Side of Filter**

- **Red** Fuel entering filter head and filter
- **Grey** Fuel passing through the filter media
- **Green** Fuel cleaned to the final micron level
Continued …

What really happens during pre-filling?
During pre-filling the “clean side” of the filter is exposed to any contamination in the fuel supply source.

Contamination happens that quickly
Both sides of the filter media are exposed to unfiltered fuel
Critical system parts are now at risk

Fuel from pre-fill source
Fuel passing through the filter media
High-Pressure Fuel Pump

Gear driven by the crankshaft gear.

Pump pressure is 1800 bar.

2 mounting locations:
- high position
- low position.
High-Pressure Fuel Pump

The high-pressure fuel pump consists of 3 main components:

- **Gear pump** - used to increase supply fuel pressure before delivering the fuel to the high-pressure section of the fuel pump. This is not a serviceable component.

- **Fuel pump actuator** - used to control the fuel pressure developed by the fuel pump. This is a serviceable component.

- **Pumping chamber** - uses three radial pumping plungers to build high fuel pressure (250 to 1800 bar [3626 to 26,107 psi]).
Fuel Pump Actuator

- PWM (Pulse Width Modulated) device driven by the ECM
- “Normally Open”
- The fuel pump actuator is a serviceable part.
- Troubleshooting procedures have been updated to reflect when the fuel pump actuator should be replaced vs. the entire fuel pump assembly.
INJECTORS AND FUEL LINES GROUP
Low Pressure Fuel Lines

- Quick connect fuel lines are utilized on the low pressure side of the fuel system.
- Fuel supply line connecting the fuel pump outlet to the fuel filter head inlet.
- Fuel supply line connecting the fuel filter head outlet to the fuel pump inlet.
Fuel Drain Lines

- Fuel drain connection from the fuel injection pump.
- Fuel drain line from the fuel rail pressure relief valve.
- Fuel drain line from the injector drain port at the back of the cylinder head.
Fuel Manifold

- No fuel return manifold as found on other Cummins HPCR engines
  - The OEM drain line will attach at fuel pump drain connection.
- To aid in separating fuel system drain flows, quick disconnect fittings have been added
  - Critical fuel drain flows for troubleshooting include
    - Fuel Pressure Relief Valve
    - Injector Drain
    - Fuel Pump Drain
Fuel Rail Supply Line

High pressure fuel from the high pressure pump to the fuel rail.
Fuel Rail

The fuel rail contains high pressure fuel from the fuel pump.

The fuel pressure relief valve is a cartridge located at the front end of the fuel rail, Fuel pressure relief valve

1) Fuel pressure relief valve drain
2) High pressure fuel supply fitting from fuel pump
3) Mounting bracket (s)
4) High pressure injector supply fitting (s)
5) Fuel pressure sensor
Fuel Rail Pressure sensor

New design and service procedure

Higher torque value to install

Socket must be used
Why Fuel System Clean Care Really Does Matter?
The high-pressure connector and injector must be replaced if failure is observed

- The high-pressure connector should be replaced anytime the injector is replaced

Be sure not to over torque the connector retaining nut. Over torquing the retaining nut may cause the connector to rotate out of the connector retaining slot.
High Pressure Supply Lines

Designed to withstand the 1800 bar fuel pressure and system pressure pulsations

Important to follow the installation procedure in the manual to prevent fuel line failure

If a leak is suspected never use your hand to find the leak … use paper or cardboard
Fuel System Diagnostics
ISB CM2350 Engine

- Fuel Tank
- High Pressure Common Rail
- Fuel Rail Pressure Relief Valve
- High Pressure Connectors
- CYL Head
- Injectors
- Fuel Out
- Fuel Return
- Fuel Return
- Fuel Return
- H.P. Fuel Line to Rail
- Secondary Filter
- Fuel Gear Pump
- Primary Filter
- Hand Primer Pump
- Fuel Gear Pump
- Fuel Return
- Fuel Return
- Fuel Tank
- Cummins
Using The Right Tools

Three return flows

- Injector Return
- High Pressure Pump Return
- High Pressure Relief valve Return

Isolating the flows with the allows us to determine which component is has excessive leakage.

Excessive leakage can cause.

- Hard or no start conditions
- Low power with fault codes indicating low rail pressure
Fuel System Service Strategy

Replace Fuel Connector (head mounted) if needed
- AKA “High pressure connectors”

Always re-torque the connector retaining nuts when a high pressure supply line is removed

Pre-fill the suction side filter

Pressure side filter can be prefilled if clean side block-off plug used

The fuel pump actuator is a replaceable component
AIR INTAKE AND EXHAUST SYSTEM

ISB6.7 CM2350 B101 for Navistar

Version 1.0
Air Intake Diagram
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
Exhaust Diagram
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.
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.
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.
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.
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

Pinion gear on actuator may not rotate during actuator initial installation step
- INSITE/Calibration
- May cause confusion compared to previous product that had the pinion gear move for alignment

Hash marks engraved into bearing housing
Sector gear travel gauge
Variable Geometry Turbocharger - Remove

Preparatory Steps:

NOTE: Be sure the coolant is completely drained from the engine. After draining the coolant, it may be necessary to unhook the turbocharger coolant return hose.

- Steam clean the area around the turbocharger actuator and dry with compressed air.
- Drain the coolant.
- Apply compressed air to push coolant out of the cavity between the turbocharger bearing housing and the actuator.
- Remove the turbocharger actuator wiring harness zip ties and P-clips. Take note of the wiring harness routing.
Variable Geometry Turbocharger - Remove

- Disconnect the wiring harness from the turbocharger actuator by sliding the locking tang to the open position, then push down on the release lever and pull the connection apart.
- Remove the turbocharger actuator mounting capscrews with a 5 mm Allen wrench. Discard the capscrews.
- Remove the actuator.
- Remove and discard the turbocharger actuator sealing gaskets.
Clean and Inspect for Reuse

- Inspect the sector gear on the turbocharger for excessive wear, damaged teeth, or a broken shaft.

- Grasp the sector gear by hand and move it through its operational range.

- The sector gear must move smoothly by hand through its entire range of motion. It takes considerable effort to begin moving the sector gear. However, once the sector gear begins to move, minimal force is required to continue moving the sector gear through its operating range.

- The sector gear travel gauges are designed for specific turbocharger models. To determine the correct gauge, verify the turbocharger model number from the turbocharger dataplate. Select the gauge that matches the first three characters of the model numbers, such as He5xx or He4xx.
Sector Gear Travel Marks
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 programmed. New VGT actuators are not programmed 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.
EPA 2013 ISB6.7 CM2350

Version 2.2
CM2350 Controls
CM2350 ECM

Identification
Mounting Locations (B, L, & X)

Cooling Strategies
- Air on ISB6.7, ISX12
- Fuel on ISL9
- Fuel on ISX15

Battery supply & return integrated into the OEM 96 pin connector

Integrated Aftertreatment DEF

Dosing control

More datalinked sensor Options

96 way connector service
FAULT CODES BASICS
Fault Codes Types

All Fault codes could be categorized and troubleshoot in following categories:

- Electrical failure
  - Inputs
  - Outputs
- Mechanical failure / conditions / response
- ECM Logical Faults
- Communications Faults
Fault Codes Types

**Electrical Failure**
- **INPUT Components**
  - Voltage Above Normal, or Shorted to High Source
  - Voltage Below normal, or Shorted to Low Source
- **OUTPUT Components**
  - Current above normal or grounded circuit
  - Current below normal or open circuit

**Mechanical Failure**
- Data erratic, intermittent or incorrect (also could be Communication failure)
- Mechanical system not responding or out of adjustment
- Abnormal rate of change
- Out of Calibration
96 – Way Connector

Rotate!  Do not pry
CM2350 Connector Tool Kit

Tool P/N 2892512
Used for re-pinning and circuit testing the connector that mates to the CM2350 ECM ports.
Refer to STI 3400444
Wiring Harness Repair kit for 96way ECM connector

Tool P/N 5298734
This kit includes components for repairing the CM2350 wiring harness connector that plugs into the ECM ports.
- Back shell
- Locking comb
- Wires with crimped terminals
- Butt splice connectors
- 96 way plug is not a serviceable item

Kit 2892512 contains the tools for this repair, this kit only contains the parts.

Refer to Service Procedure 19-505 in appropriate service manuals.
On-Board Diagnostics (OBD)
2013 HD OBD Requirements

- Mandated for all automotive Cummins engines
- MIL lamps strategy
- INSITE fault code reading and clearing strategy
- Inducement charts (DEF)
On-Board Diagnostics (OBD) Terminology

**Diagnostic Trouble Code (DTC)** – A code reported and stored by the engine ECM which indicates a particular malfunction has been detected. Same as Cummins Fault Code.

**Malfunction Indicator Lamp (MIL)** – A dash lamp used to notify the operator when a malfunction has been detected that could impact emissions.
Comprehensive Component Monitoring: Sensor Diagnostics

For each emission related input component (sensor) the OBD system is required to support the following:

Circuit Continuity Diagnostics
- Out of range high
- Out of range low

Rationality Diagnostics (aka In-Range Diagnostics)
- In-range high (the sensor reports a value higher than it actually should based on the operating condition)
- In-range low (the sensor reports a value lower than it actually should based on the operating condition)
- Stuck in-range (the sensor reports a somewhat constant value when operating conditions are contrary)

Additional detection capabilities are required for specified sensors
What’s different in an OBD system?

Malfunction Indicator Lamp (MIL)
- Latches ON when an OBD fault code is logged
- It takes 3 operation cycles (without the fault reoccurring) to clear the lamp

Extended diagnosing time is necessary for the various rationality and system monitors

Diagnostic approaches must be approved by the regulatory agency (including calibrations)

The OBD system detects deteriorated systems and components (not just total failures)

2 trip diagnostics exist; i.e. the failure must be detected in 2 consecutive trips before the MIL will be illuminated

Cummins must demonstrate the OBD system’s capabilities to detect failures

Changes to the system once in production must be approved by the regulatory agency
2010 / 2013 HD-OBD Driver Interface 3 Lamp Strategy

CHECK ENGINE Lamp - (Amber Warning Lamp)
This is the standard lamp that we have used in all previous Cummins applications. Used for Non-OBD faults.

Stop Engine Lamp
Used to indicate Engine Protection Fault Codes.

Malfunction Indicator Lamp (MIL)
This lamp is used to indicate an Emissions Related Failure has occurred (OBD Faults).
Recommended Service Direction

Follow “Conditions for Clearing the Fault Code” to perform one trip for verification purposes.

Once fault code is Inactive, use INSITE “Reset All Faults” option to clear the fault code and extinguish the MIL.
Conditions for Setting the Fault Codes

An internal circuit error has been detected in the aftertreatment outlet NOx sensor assembly.

Action Taken When the Fault Code is Active

- The ECM illuminates the amber CHECK ENGINE lamp and/or the Malfunction Indicator Lamp (MIL) immediately when the diagnostic runs and fails.
- Engine torque will be reduced after 10 hours of engine operation with the fault code active.
- Vehicle speed will be limited to 8 kph (5 mph) after 40 hours of engine operation with the fault code active.

Conditions for Clearing the Fault Code

- To validate the repair, start and operate the engine to raise exhaust temperatures. This can be done by either driving the vehicle or initiating a stationary regeneration using INSITE™ electronic service tool.
- The exhaust gas temperature at the aftertreatment outlet NOx sensor must be above 150°C (302°F) before the sensor can run its internal diagnostics.
- The fault code status displayed by INSITE™ electronic service tool will change to INACTIVE immediately after the diagnostic runs and passes.
- The ECM will turn off the amber CHECK ENGINE lamp after the diagnostic runs and passes.
- For On-Board Diagnostic (OBD) engines, the ECM will turn off the MIL after three consecutive trips where the diagnostic runs and passes.
- The Reset All Faults command in INSITE™ electronic service tool can be used to clear active and inactive faults, as well as extinguish the MIL for OBD applications.

Shop Talk

Possible causes of this fault code include:

- The aftertreatment outlet NOx sensor has malfunctioned or is damaged
- The aftertreatment outlet NOx sensor internal heater has malfunctioned
- The NOx sensor part number is incorrect.

Refer to Troubleshooting Fault Code 1987.
### Fault Code Details

<table>
<thead>
<tr>
<th>Fault Code</th>
<th>Status</th>
<th>Count</th>
<th>Lamp</th>
<th>Description</th>
<th>PID</th>
<th>SID</th>
<th>J1587 FMI</th>
<th>J1939 FMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM2250</td>
<td>ECM Time (Key On Time)</td>
<td>323:18:53</td>
<td>HH:MM:SS</td>
<td>Engine Hours</td>
<td>63:05:51</td>
<td>HH:MM:SS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Keyoffs</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0249</td>
<td>Inactive</td>
<td>1</td>
<td>Amber</td>
<td>Ambient Air Temperature Sensor 1 Circuit - Voltage above normal or shorted to high source</td>
<td>171</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Actions:**
- Expand All
- Collapse All
- Reset Inactive Faults
- Reset All Faults
- Refresh All
- Print
- Fault Trees Overview
- Fault Trees Troubleshooting Steps
- SAE J1589 Multiplexed Fault Data
## DEF LOW LEVEL AND INDUCEMENT

<table>
<thead>
<tr>
<th>DEF Level</th>
<th>Driver Indication Lamps</th>
<th>Fault</th>
<th>Inducement</th>
<th>Deactivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above initial warning threshold.</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Initial Warning at 10% ECM Broadcast of DEF Tank Level (default). Trimmbale between 10% - 60%</td>
<td>DEF Lamp solid</td>
<td>FC 3497</td>
<td>None</td>
<td>Fill DEF tank to a minimum of 2.5% above initial warning level.</td>
</tr>
<tr>
<td>Critical Warning at 5% ECM Broadcast of DEF Tank Level (default). Trimmbale between 5% - 55%</td>
<td>DEF Lamp flashing</td>
<td>FC 3498</td>
<td>None</td>
<td>Fill DEF tank to a minimum of 2.5% above critical warning level.</td>
</tr>
<tr>
<td>Initial Inducement at 2.5% ECM Broadcast of DEF Tank Level (default). Trimmbale between 2.5% - 50%</td>
<td>DEF Lamp flashing and Check Engine Lamp solid</td>
<td>FC 1673, FC 3714</td>
<td>25% Torque Derate</td>
<td>Fill DEF tank to a minimum of 2.5% above initial derate level.</td>
</tr>
<tr>
<td>Secondary Inducement at 0% ECM Broadcast of DEF Tank Level.</td>
<td>DEF Lamp flashing and Check Engine Lamp solid</td>
<td>FC 1673, FC 3714</td>
<td>40% Torque Derate ramped in at 1% per minute.</td>
<td>Fill DEF tank to a minimum of 4.5% above initial derate level.</td>
</tr>
<tr>
<td>Final Inducement at 0% ECM Broadcast of DEF Tank Level and Engine has been intentionally shut down (key switched off) in extended idle for 1 hour or fuel tank has been refilled.</td>
<td>DEF Lamp flashing and Check Engine Lamp solid and Red Stop Engine Lamp solid</td>
<td>FC 1673, FC 3547, FC 3712</td>
<td>40% Torque Derate, 5 mph Vehicle Speed Limit, and 1,000 rpm Engine Speed Limit.</td>
<td>Fill DEF tank to a minimum of 4.5% level and allow the system prime.</td>
</tr>
</tbody>
</table>

Note: The secondary inducement is calibrated to trigger slightly above 0% to ensure any tolerance stack up errors will not prevent the inducement from being applied. This trigger level is set to approximately 1%.
### Incorrect DEF Warning and Inducement

<table>
<thead>
<tr>
<th>Condition</th>
<th>Driver Indication Lamps</th>
<th>Inducement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct DEF.</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td><strong>Initial Warning for Incorrect DEF at detection.</strong></td>
<td>Check Engine Lamp Solid</td>
<td>None</td>
</tr>
<tr>
<td><strong>Initial Inducement for Incorrect DEF at detection + 1 hour.</strong></td>
<td>Check Engine Lamp Solid</td>
<td>25% Torque Derate</td>
</tr>
<tr>
<td><strong>Secondary Inducement for Incorrect DEF at detection + 3 hours.</strong></td>
<td>Check Engine Lamp Solid</td>
<td>40% Torque Derate ramped in at 1% per minute</td>
</tr>
<tr>
<td>Final Inducement for Incorrect DEF at detection + 3 hours and the engine has been intentionally shutdown in extended idle for 1 hour or fuel tank has been refilled.</td>
<td>Check Engine Lamp Solid and Red Stop Engine Lamp Solid</td>
<td>40% Torque Derate, 5 mph Vehicle Speed Limit, and 1,000 rpm Engine Speed Limit.</td>
</tr>
</tbody>
</table>

After one continuous hour of zero vehicle speed with Incorrect Diesel Exhaust Fluid detected, vehicle speed will be limited to 5 mph.

Final Inducement for an automatic transmission equipped vehicle will be limited to 1,100 rpm verses 1,000 rpm for all other transmission types.

Fuel tank has been refueled is defined as the fuel volume level has increased by 15%.
## SCR Faults with Inducement

<table>
<thead>
<tr>
<th>Condition</th>
<th>Driver Indication Lamps</th>
<th>Inducement</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Faults.</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Initial Warning at Fault Detection.</td>
<td>MIL Solid &amp; Check Engine Lamp Solid</td>
<td>None</td>
</tr>
<tr>
<td>Initial Inducement at Fault Detection + 1 hour.</td>
<td>MIL Solid &amp; Check Engine Lamp Solid</td>
<td>25% Torque Derate</td>
</tr>
<tr>
<td>Secondary Inducement at Fault Detection + 5 hours.</td>
<td>MIL Solid &amp; Check Engine Lamp Solid</td>
<td>40% Torque Derate ramped in at 1% per minute.</td>
</tr>
<tr>
<td>Final Inducement for Incorrect DEF at detection + 5 hours and the engine has been intentionally shutdown in extended idle for 1 hour or fuel tank has been refilled *</td>
<td>MIL Solid &amp; Check Engine Lamp Solid and Red Stop Engine Lamp Solid</td>
<td>40% Torque Derate, 5 mph Vehicle Speed Limit, and 1,000 rpm Engine Speed Limit.</td>
</tr>
</tbody>
</table>

1. The MIL will illuminate for a component fault which is covered by OBD otherwise the Check Engine Lamp will illuminate.
2. After one continuous hour of zero vehicle speed with faulted condition, vehicle speed will be limited to 5 mph.
3. Final Inducement for an automatic transmission equipped vehicle will be limited to 1,100 rpm versus 1,000 rpm for all other transmission types.
4. Fuel tank has been refueled is defined as the fuel volume level has increased by 15%.

* Correct and Clear fault Condition for Deactivation.
EPA 2013 Aftertreatment
General Information
The service model name for this product is **ISB6.7 CM2350 B101**.
This engine is being released first to meet EPA 2013.
This engine has the following agency defined emissions control system (ECS) hardware:
- Charge-air cooler (CAC)
- Direct diesel injection (DDI)
- Engine control module (ECM)
- Exhaust gas recirculation (EGR)
- Oxidation catalyst (OC)
- Periodic trap oxidizer (PTOX)
- Selective catalytic reduction - urea (SCR-U)
- Turbocharger (TC).
This engine has the following emissions related hardware:
- Aftertreatment outlet NH3 gas sensor
- CM2350 ECM
- Engine intake throttle actuator
- Integrated aftertreatment DEF controller into the ECM
- OEM ambient air temperature sensor.
Market applications include automotive, fire truck, and recreational vehicles.
2013 MR/HD System Architecture

- CHARGE AIR COOLER
- EGR-COOLER
- CM 2350 with AT Controls + DEF Doser Controls
- Air Throttle
- Aftertreatment Fuel Doser HD - ONLY
- DEF Tank
- DEF
- DEF Doser Controls
- Cyclone Mixer (end inlet SCR)
- SCR Catalyst
- dP + P
- NOx
- CM 2350 with AT Controls
- NH3
- UQ
- NOx
- DOC
- DPF
- SCR Catalyst
- Aftertreatment Fuel Doser HD - ONLY
- Change from 2010

0 = Change from 2010
Exhaust Gases Flow On MR Engines
DEF SUPPLY DIAGRAM
SENSORS AND ELECTRONICS

CHANGES
Private datalink on aftertreatment
Data Erratic Intermittent or Incorrect - Communication Issues

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3144</td>
<td>Aftertreatment 1 SCR Intake Temperature Sensor</td>
</tr>
<tr>
<td>3148</td>
<td>Aftertreatment 1 SCR Outlet Temperature Sensor</td>
</tr>
<tr>
<td>3228</td>
<td>Aftertreatment 1 Intake NOx Sensor</td>
</tr>
<tr>
<td>3315</td>
<td>Aftertreatment 1 Diesel Oxidation Catalyst Intake Temperature</td>
</tr>
<tr>
<td>3318</td>
<td>Aftertreatment 1 Diesel Particulate Filter Intake Temperature</td>
</tr>
<tr>
<td>3322</td>
<td>Aftertreatment 1 Diesel Particulate Filter Outlet Temperature</td>
</tr>
<tr>
<td>3681</td>
<td>Aftertreatment 1 Outlet NOx Sensor Power Supply</td>
</tr>
<tr>
<td>3682</td>
<td>Aftertreatment 1 Intake NOx Sensor Power Supply</td>
</tr>
<tr>
<td>3878</td>
<td>Aftertreatment Diesel Exhaust Fluid Quality</td>
</tr>
<tr>
<td>3934</td>
<td>Aftertreatment Outlet NH3 Gas Sensor Power Supply</td>
</tr>
</tbody>
</table>
Aftertreatment NOx Sensor – updated

2013 model year engines will be using updated 24 and 12 volt NOx sensors.

- Accuracy improvement to ± 10 ppm/%
- Probe cover to improve water splash resistance
- Faster response time
- Extend the temperature range
- 4 pin connector change
- 24 volts and 12 volts sensors with specific part #'s
- Inlet and Outlet sensors use different connector key
- Different internal software for Inlet and Outlet sensors (Preprogrammed)
Aftertreatment DEF Quality Sensor – OEM optional design

- Ultrasonic density meter
- Smart component (datalink)
- Shown as separate sensor
- In this configuration temperature and level sensors are hardwired to the ECM and DEF quality sensor communicates via datalink
Aftertreatment DEF Quality Sensor – OEM optional design

- Ultrasonic density meter
- Smart component (datalink)
- Shown as integrated sensor with temperature and level
- All sensors in this setup are communicating via datalink
- Codes will vary due to setup configuration
Aftertreatment Intermediate NH3 Sensor

Smart component (datalink)

Designed to measure amount of the NH3 Gas (ammonia) and determine if DEF properly utilized (overspray and underspray)
DEF HIGH CAPACITY FILTER
## Current vs New Components Pictures

<table>
<thead>
<tr>
<th>Description</th>
<th>Current</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Filter Equalizing Element</td>
<td><img src="image1.png" alt="Current Filter Equalizing Element" /></td>
<td><img src="image2.png" alt="New Filter Equalizing Element" /></td>
</tr>
<tr>
<td>3. Filter Element</td>
<td><img src="image3.png" alt="Current Filter Element" /></td>
<td><img src="image4.png" alt="New Filter Element" /></td>
</tr>
</tbody>
</table>
Non-Interchangeable Components

Proper Fit

Improper Fit
Service Kit

Service Kit for High Capacity Filter will include

- Filter element
- Compensation device/equalizing element
- Tool for filter removal
Doser Gasket

- Insulated Gasket
- Includes an insulation layer
- Utilizes current sealing surface
- Retains thermal isolator
- Addition of metal spacers under DM mounting feet
Injector Guard

- **Injector Guard**
- Customer Option
- EBU P/N – 2888113
Cyclone Mixer

Modified Cyclone Mixer for better DEF processing
DPF-DOC Insulation Change
Sensors must be removed prior Disassembly and after Assembly.