



Selective Catalytic Reduction (SCR) Muffler Troubleshooting Guide - US10+OBD13 And Newer Emissions



Component Overview

The SCR contains a coated substrate that, with the input of heat and DEF, changes NOx into nitrogen and water vapor. The SCR's job in the Emissions After-Treatment System (EATS) is to lower the NOx level emitted into the atmosphere.

The performance of the SCR is evaluated by the NOx sensors. There are NOx sensors that are located on upstream (inlet) and downstream (outlet) ends of the SCR.

Important: the SCR is the last component in the EATS which makes it susceptible to any upstream failures.

Primary failure mode of the Muffler (SCR) is:

- Coating of the substrate being compromised
- Indigestions of foreign objects such as oil, coolant, fuel, etc.

Diagnosis and Repair

Prior to proceeding with any of the information below, any codes, symptoms or failures of upstream components must be diagnosed and corrected first.

Upstream components include:

- Base Engine (Starting or operation issues)
- EGR System
- Fuel System (Engine supply and aftertreatment hydrocarbon injector supply)
- Turbocharger/Boost
- Diesel Oxidation Catalyst (DOC)
- Diesel Particulate Filter (DPF)
- Aftertreatment sensors (Exhaust temperature)



The three DTCs below indicate problems with SCR function. These DTCs should only be diagnosed if they are active or if the DTC Confirmed status is True in the Detailed status information section.

Fault Code	Descriptions
P20EE	SCR NOx Catalyst Efficiency Below Threshold (Bank 1)
P103C	NOx Catalyst Efficiency Inducement, Selective Catalytic Reduction (SCR) Unit
P207F	SCR NOx Catalyst Efficiency Below Threshold (Bank 1)

Evaluations for SCR Muffler Replacement

The following systems need to be evaluated in progressive order to determine the state of the SCR.

1. DEF System - Test the Urea/DEF Systems functionality for proper:

- Quality
 - Check DEF Quality using Refractometer (88890105)
 - Litmus Test paper (88890110)
- Quantity
 - SCR Dosing Test in PTT, Operation 2589-08-03-05 subsection 1-3.
 - With the dosing nozzle removed, inspect for crystal build up.

If any of the above tests fail: Correct the issue, clear fault codes, and release the truck.

2. NOx Sensor Condition - Evaluate the condition of both NOx Sensors.

- Look for the following:
 - Non-OEM (3rd party) sensors, use CBR-2114 for guidance.
 - Any/All NOx sensor fault codes. See CBR-2116 for a list of these faults and recommendations.

If Non-OEM or faulty Nox Sensor(s) is found: Replace the sensor(s), clear faults and release the truck.

indicated below. Follow the directions in the Action column for Nox or SCR Replacements.

Emission Level	PTT Operation	Action
OBD 13-16	2549-08-03-03 Nox Conversion Test	Follow test recommendation, if no fault found replace the SCR in accordance with Impact procedures.
OBD 17-18 VGT Only	2589-08-03-18 Exhaust Aftertreatment System Analysts (make sure Nox and SCR Subtest are selected)	Follow test recommendation and release truck.
OBD 17-18 TC Only	No test...	Replace Both Nox Sensors if not replaced within past 3 months and release truck. If truck has received both Nox sensors within past 3 months replace the SCR in accordance to impact procedures.
OBD 19 and Newer VGT Only	2549-08-03-03 Nox Conversion Test OR (whichever is available) 2589-08-03-18 Exhaust Aftertreatment System Analysts (only Nox Subtest available)	Follow test recommendation, if no fault found replace the SCR in accordance to Impact procedure.
OBD 19 and Newer TC Only	2549-08-03-03 Nox Conversion Test	Follow test recommendation, if no fault found replace the SCR in accordance to Impact procedures.

Rules for Replacement



Standard Diagnostic time is 3 hours.

Note that Warranty will only cover replacement of the SCR if one of the three codes in the section above is present. If the SCR is suspected to have failed due to upstream contamination with no codes present, an eService case is required for further evaluation.

 Tags

- [p103c00](#)
- [p207f00](#)
- [volvo](#)
- [mack](#)
- [scr](#)
- [p20ee00](#)
- [unlocking uptime](#)

Related links and attachments

No links or attachments available

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Non-OEM (3rd Party) NOx Sensor Identification



> Internal Content

If one or more of the codes below are present it is recommended to inspect for 3rd party NOx sensors.

- P103C-00
- P207F-00
- P026D-00

3rd party NOx sensors have been found to induce erroneous faults and cause various system failures. If 3rd party NOx sensors are found they should be removed and replaced with a genuine OEM sensor. Clear faults and verify the repair.

Use the below information to identify 3rd party NOx sensors.

How To Verify An OEM Sensor

For Trucks MY 2017 and newer products run **Premium Tech Tool Test 1700-08-03-06 Sensor and Parameter Values**. All genuine OEM NOx sensors will display the expected values as seen below. All other values are components from a 3rd party.

1700-08-03-06 Sensor and Parameter Values, Monitoring
 Information >> Conditions >> Execution

Selected signals	<input type="checkbox"/>
P1M4N[1][3] - CVN NOx 1 (EMS)	<input checked="" type="checkbox"/>
P1M4N[1][4] - CVN NOx 2 (EMS)	<input checked="" type="checkbox"/>

Expected Values	
NOx1	NOx2
791293237	541003308



Refer to the illustrations below to help identify 3rd party NOx sensor.

OEM sensor with markings and part number for reference





3rd party NOx Sensor in bag





3rd party sensors with and with out markings





OEM sensor tip design for reference	3rd party sensor with incorrect sensor tip
	

The table below illustrates how difficult it can be to identify 3rd party sensors when compared to an OEM sensor

	
---	--



Sticker says "Warranty void"	No such sticker
Marking text: "PreSCR"	Marking text: "Pre SCR"
Marking text: "CONTINENT AL"	Marking text: "CONTINENTAL"
Marking text font: different from Volvo part	
Conclusion: The sensor on the left is not a Genuine Volvo NOx Sensor	



[3rd party nox sensor](#)

[p103c](#)

[p207f](#)

[p026d](#)

[volvo](#)

[mack](#)

[spn 1231 fmi 2](#)

Related links and attachments

No links or attachments available



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NOx Sensor Replacement Guide - US10+OBD13 And Newer Emissions



Review the tables below to determine which category the DTC currently being diagnosed falls under. Proceed according to the instructions for the appropriate section.

I. Diagnostic Trouble Codes With NOx Sensor in the Description

Fault Code	Fault Description	Comments
P220A-1C	NOx Sensor Supply Voltage Circuit (Bank 1 Sensor 1), Circuit voltage out of range	Power supply - not sensor
P220B-1C	NOx Sensor Gas Outlet High Voltage, Circuit voltage out of range	Power supply - not sensor
P225D-00	NOx Sensor Performance - Signal Stuck Low Bank 1 Sensor 1	Sensor reading fresh air (unlikely to be sensor issue)
P225F-00	NOx Sensor Performance - Signal Stuck Low Bank 1 Sensor 2	Sensor reading fresh air (unlikely to be sensor issue)
U029D-00	Lost Communication With NOx Sensor "A"	Most likely Harness Issue (Rarely sensor)
U029E-00	Lost Communication with NOx Sensor B	Most likely Harness Issue (Rarely sensor)
P229F-64	NOx Sensor Gas Outlet Removed, Signal plausibility failure	Nuisance code, most likely "Confirmed = False".



Although the codes above have the term "NOx sensor" in their descriptions, it is highly unlikely that the sensor is the cause of any of these codes. The table above specifies the likely cause of each code.

Direction/Repair: DO NOT REPLACE the NOx sensor(s) for these codes. Diagnostics should be performed in accordance with the table above.


II. Inlet NOx Sensor (NOx1) Diagnostic Trouble Codes - Sensor Failure Likely

Fault Code	Fault Description
P22FB-92	NOx Sensor Performance - Sensing Element Bank 1 Sensor 1, Performance or Incorrect Operation
P220E-93	NOx Sensor Heater Control Circuit Range/Performance (Bank 1 Sensor 1), No operation
P2200-13	NOx Sensor Bank 1 Sensor 1, Circuit Open
P2203-00	NOx Sensor Circuit High Bank 1 Sensor 1
P2205-13	NOx Sensor Gas Outlet Open Circuit, Circuit open
P2206-00	NOx sensor heater control circuit low, bank 1 sensor 1
P2208-00	NOx sensor heater sense circuit, bank 1 sensor 1

These codes indicate that the inlet NOx sensor is likely damaged and needs to be replaced.



Direction: In Premium Tech Tool, verify that either the code is Active, or if Inactive that the Confirmed DTC value is True under the detailed status information as shown in the example below.

DTC List (2 Items)

Control Unit ▲	DTC	Status
Brake ECU (MID 136)	SID 69: Axel load sensor, FMI 2: Data erratic, intermittent, or incorrect	Active
Engine Control Module (EMS)	P229F64: NOx Sensor Gas Outlet Removed, Signal Plausibility Failure	Active  0

NOx Sensor Gas Outlet Removed

Detailed status information

Title ▲	Value
Confirmed DTC 	True 
Pending DTC	False
Test failed	True
Test failed since last clear	True
Test failed this operation cycle	True
Test not completed since last clear	False
Test not completed this operation cycle	False
Warning indicator requested	False

Repair: If the DTC meets either of the above criteria, replace the Inlet NOx Sensor ONLY. No other diagnosis or testing is required.

III. Inlet NOx Sensor (NOx1) Diagnostic Trouble Codes - Potential Sensor Failure

Fault Code	Fault Description
P026C-00	Fuel Injection Quantity Lower Than Expected
P026D-00	Fuel Injection Quantity Higher Than Expected
P2201-64	NOx Sensor Bank 1 Sensor 1, Signal plausibility failure
P225C-00	NOx Sensor Performance - Signal Stuck High Bank 1 Sensor 1

These codes indicate that the inlet NOx sensor is potentially damaged, but further investigation is required to verify sensor condition.

Direction:

 Live UI

- For US17+OBD2016, US17+OBD2017, and US17+OBD2018 emissions vehicles: PTT test [2589-08-03-18 Exhaust After-treatment System Test, NOx Sensor Test](#) should be performed.
- For all other emissions levels: PTT test [2549-08-03-03 NOx Conversion Test](#) should be performed.

Repair:

- If the NOx1 sensor fails the evaluation, replace the Inlet NOx Sensor ONLY.
- If the NOx2 sensor (Outlet NOx Sensor) fails the test, disregard the results.


IV. Outlet NOx Sensor (NOx2) Diagnostic Trouble Codes - Sensor Failure Likely

Fault Code	Fault Description
P220F-93	NOx Sensor Incorrect Value at Startup, No operation
P229E-13	NOx Sensor Bank 1 Sensor 2, Circuit open
P22A6-00	NOx sensor heater sense circuit, bank 1 sensor 2
P22A1-00	NOx Sensor Circuit High Bank 1 Sensor 2
P22A3-13	NOx Sensor Heater Control Bank 1 Sensor 2, Circuit open
P22A4-00	NOx sensor heater control circuit low, bank 1 sensor 2
P22FE-00	NOx Sensor Performance - Sensing Element Bank 1 Sensor 2

These codes indicate that the outlet NOx sensor is likely damaged and needs to be replaced.



Direction: In Premium Tech Tool, verify that either the code is Active, or if Inactive that the Confirmed DTC value is True under the detailed status information as shown in the example below.

DTC List (2 Items)

Control Unit ▲	DTC	Status
Brake ECU (MID 136)	SID 69: Axel load sensor, FMI 2: Data erratic, intermittent, or incorrect	Active
Engine Control Module (EMS)	P229F64: NOx Sensor Gas Outlet Removed, Signal Plausibility Failure	Active  0

NOx Sensor Gas Outlet Removed

Detailed status information

Title ▲	Value
Confirmed DTC 	True 
Pending DTC	False
Test failed	True
Test failed since last clear	True
Test failed this operation cycle	True
Test not completed since last clear	False
Test not completed this operation cycle	False
Warning indicator requested	False

Repair: If the DTC meets either of the above criteria, replace the Outlet NOx Sensor ONLY. No other diagnosis or testing is required.

V. Diagnostic Trouble Codes For Emissions System - Either Sensor Possible

Fault Code	Fault Description
P225E-00	NOx Sensor Performance - Signal Stuck High Bank 1 Sensor 2
P20EE-00	SCR NOx Catalyst Efficiency Below Threshold (Bank 1)
P103C-00	NOx Catalyst Efficiency Inducement, Selective Catalytic Reduction (SCR) Unit
P207F-00	Reductant Quality

These codes indicate an issue with the emissions system, which could be caused by a failed NOx sensor.

Direction:

- For US17+OBD2016, US17+OBD2017, and US17+OBD2018 emissions vehicles: PTT test [2589-08-03-18 Exhaust After-treatment System Test, NOx Sensor Test](#) should be performed.



- For all other emissions levels: PTT test [2549-08-03-03 NOx Conversion Test](#) should be performed.

Repair: Follow guidance from test results.

 Tags

- [p2200-13](#)
- [p2203-00](#)
- [p2205-13](#)
- [p2206-00](#)
- [p2208-00](#)
- [p026c-00](#)
- [p026d-00](#)
- [p2201-64](#)
- [p225c-00](#)
- [p220f-93](#)
- [p229e-13](#)
- [p220a-1c](#)
- [p220b-1c](#)
- [p225d-00](#)
- [p225f-00](#)
- [u029d-00](#)
- [u029e-00](#)
- [p229f-64](#)
- [p22fb-92](#)
- [p220e-93](#)
- [p22a6-00](#)
- [p22a1-00](#)
- [p22a3-13](#)
- [p22a4-00](#)
- [p22fe-00](#)
- [p225e-00](#)
- [p20ee-00](#)
- [p103c-00](#)
- [p207f-00](#)

Related links and attachments

No links or attachments available

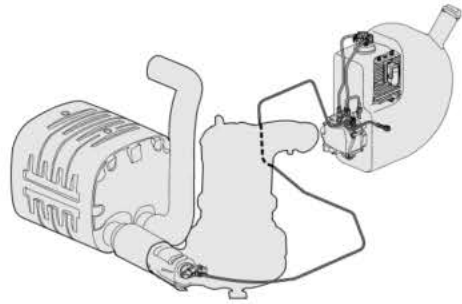
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Aftertreatment selective catalytic reduction (SCR) system



2549-08-03-03 NOx Conversion

Simulation

Information >> Conditions >> Execution

Purpose

Check NOx sensor offset

Components to be tested are:

- NOx sensor

Note: This operation should only be used in the following circumstances:

- Reference from diagnostic/service information or Technical support
- Relevant DTCs: P207F, P20EE, P225E, P225C

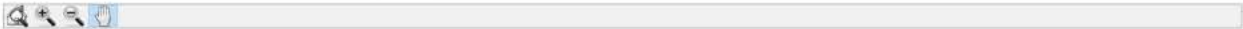
Description






The test can be used when:

- Verification - To compare system behaviour before and after repair

Note: Operation may take approximately 20 - 30 minute(s) to complete

Information



- 1 
- 2  = Released
- 3  > 600rpm
rpm
- 4 
- 5 

2549-08-03-03 NOx Conversion

Simulation

Information >> Conditions >> Execution

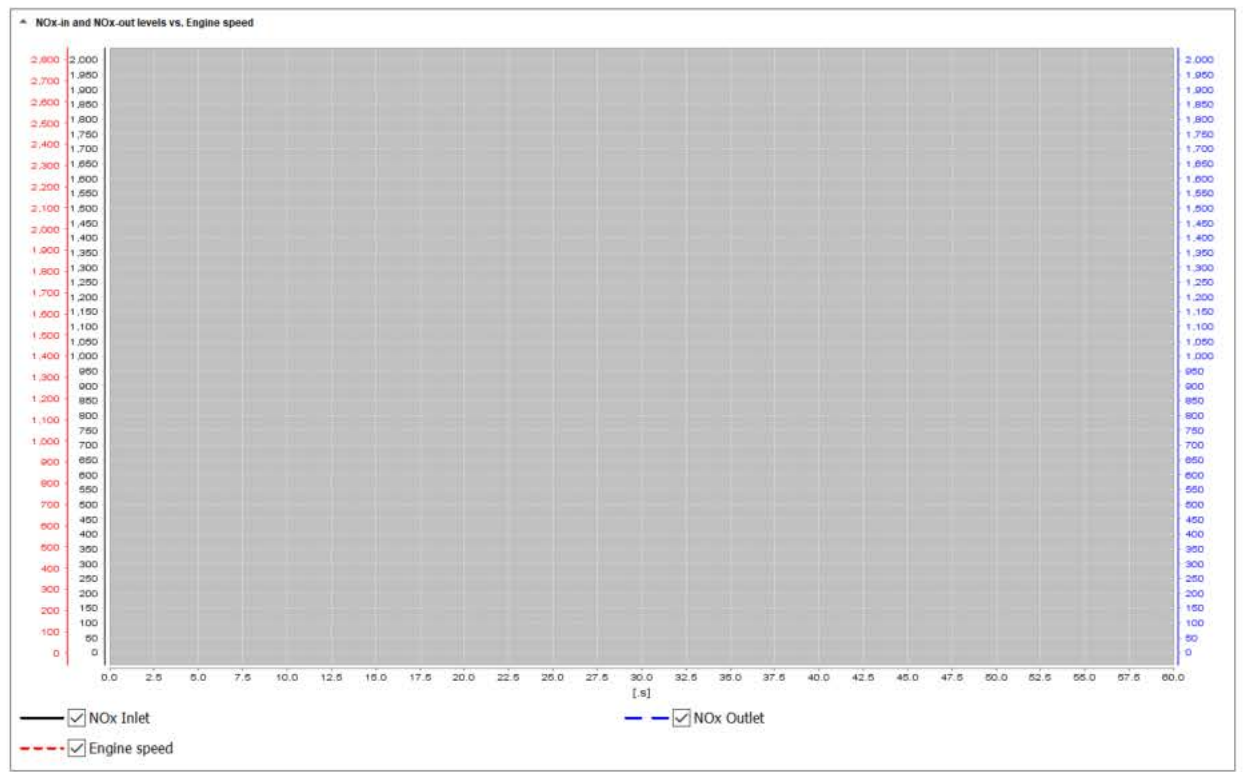
Manual conditions

- 1 Parking brake applied
- 2 Accelerator pedal (AP) released
- 3 Engine running
- 4 Vehicle outdoors in a suitable area
- 5 Reference from diagnostic/service information or Technical support (DTCs: P207F, P20EE, P225E, P225C)

Confirmed

NOx Conversion Test

▶



Exhaust gas temperatures

Other sensors

2549-08-03-03 NOx Conversion

Simulation

Information >> Conditions >> Execution

Information

Action

In order for the test to make a proper evaluation, the engine must shut down once the test is completed. If the engine does not shut down, the test did not complete correctly.

- 1 Start the test
- 2 Wait for the engine to shut down
- 3 Once the engine shuts down wait until message "Engine cranking needed" appears (next to Start/Stop button)
- 4 Crank the engine continuously until the pop-up message appears (10 - 15 seconds)

"After engine cranking has been completed, the key must NOT be turned to the OFF position until the operation has completely finished"

Note: "The engine must be cranked within 1 minute(s) after the engine shuts down. If engine cranking is not done within this time period, the test may have to be restarted."

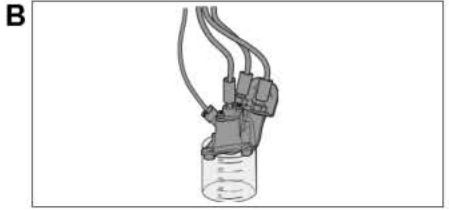
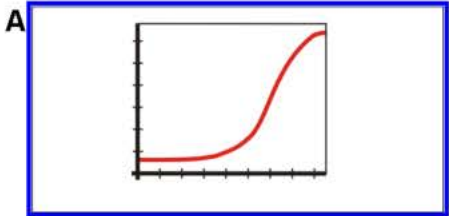
NOx-in and NOx-out levels vs. Engine speed

Exhaust gas temperatures

Other sensors

Result

Continue >



C

Exit inducement mode

D

SCR efficiency test values

2589-08-03-05 Aftertreatment selective catalytic reduction (SCR) system

Simulation

Information >> Conditions >> Execution

Purpose

Check that a newly installed, repaired, overhauled or replaced SCR system works correctly

Selections

Select the illustration corresponding to the method or test to be performed

A - System pressure build up

Check function/leakage of pump and hoses

B - Dosing test

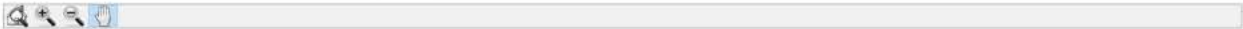
- Check function/leakage of dosing valve
- Perform the Dosing test after the dosing valve has been replaced in order to exit inducement and clear **DTC_P208E** or **P103B**

C - Exit inducement mode

- This should only be performed to exit inducement mode in order to find the root cause of **DTC_P207F** or **P103C**
- Reset SCR system inducement timers

D - SCR efficiency test values

The following diagnostic trouble codes (DTCs) are concerned: **P207F** or **P20EE**



1				
2		= 0 rpm	0 rpm	
3		> 10 %	11 %	
4		> 41 °F	41 °F	

2589-08-03-05 Aftertreatment selective catalytic reduction (SCR) system

Simulation

Information >> Conditions >> Execution

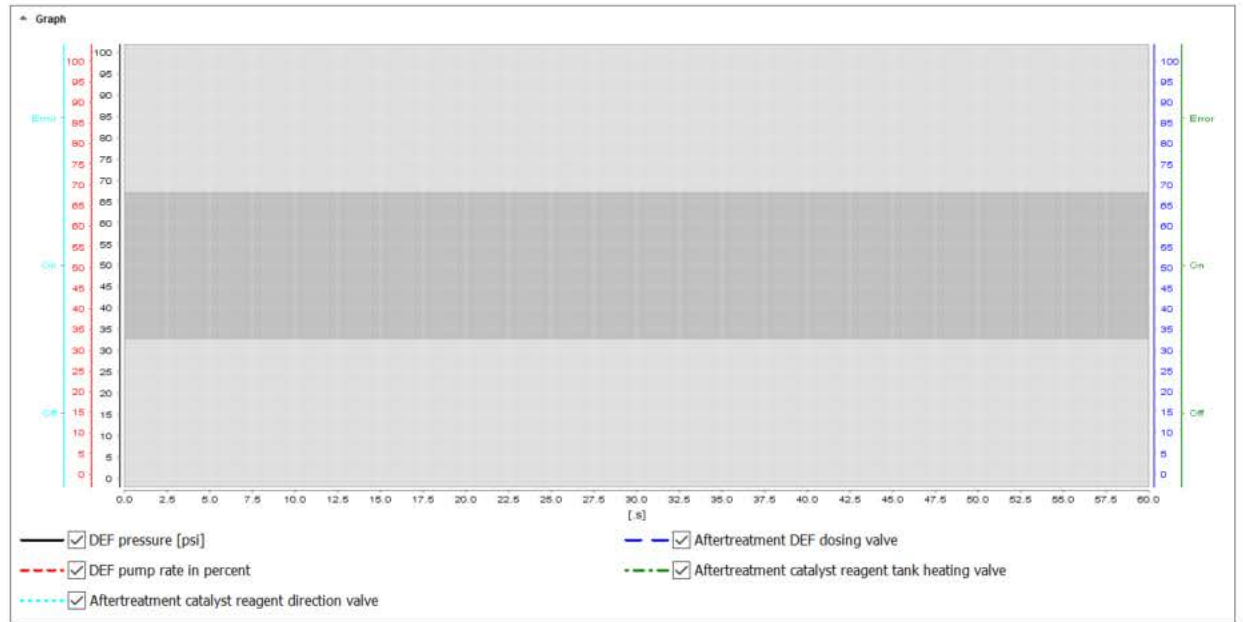
Automatically checked conditions

- 1. Parking brake applied
- 2. Engine not running
- 3. DEF tank level above 10 %
- 4. Ambient temperature above 41 °F

SCR Start-up Test (Pressure build up)

▶ ◻

DEF System Status:
Waiting for start



2589-08-03-05 Aftertreatment selective catalytic reduction (SCR) system

Simulation

Information >> Conditions >> Execution

Information

This test gives the possibility to start up / build up the pressure without starting the engine
The test can be used to check that the repaired, serviced or replaced dosing system is working correctly

Action

- Before starting the test, monitor the signals and make sure the DEF pressure is near 0 kPa (0 psi) without a large deviation
- Start the test

Note: The SCR Start-up test should be run for several minutes to verify that the system can hold pressure over time

Parameter values

14.5038 psi	DEF pressure
0 %	DEF pump rate in percent
0	Aftertreatment DEF dosing valve
	DEF tank heating valve
	DEF direction valve
60 %	DEF concentration

Evaluation

The pressure should build up to approximately 900 kPa (130 psi)

Test result

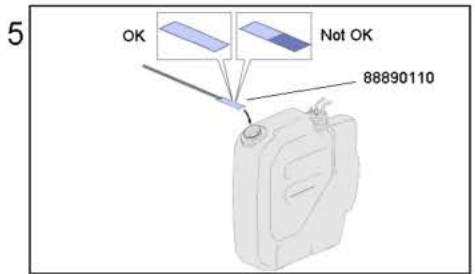
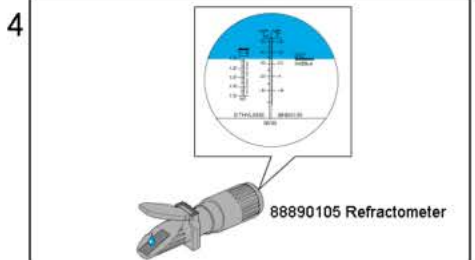
Select one of the following alternatives

OK

Not OK

Restart the operation

Continue >



2589-08-03-18 Exhaust Aftertreatment System Analysis

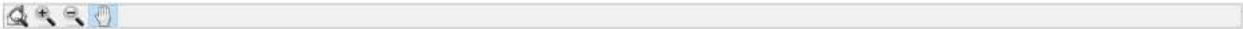
Simulation

Information >> Conditions >> Execution >> Result



Manual conditions

- 1 Reference from diagnostic/service information or Technical support (DTCs: P103C, P20EE, P225E, P225C, P229F, P2201, P0422)
- 2 Parking brake applied
- 3 Vehicle outdoors in a suitable area
- 4 DEF concentration within specifications
- 5 DEF free from contamination

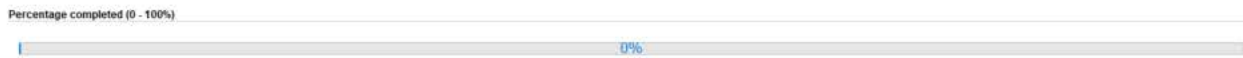
Confirmed



Start

DEF System Status:
Waiting for start



- Primary Parameters
- Secondary Parameters

2589-08-03-18 Exhaust Aftertreatment System Analysis

Simulation

Information >> Conditions >> Execution >> Result

Information

Action

It is highly recommended to run all the subtests at the same time in order to achieve an optimal system evaluation. However, each subtest can be selected individually on recommendation from diagnostic/service information or Technical Support.

Note: All subtests are enabled by default

Deselect which subtests are not to run

- NOx sensors
- DEF dosing system
- SCR efficiency

Ignition Key ON and Engine OFF

- 1 Read out the status of the operating conditions
- 2 Check that all signals and values are stable and without abnormal deviations
- 3 Check that all signals are displaying realistic values according to the actual conditions

Start the engine and let it idle

- 1 Start the test
- 2 Wait until test has completed
- 3 Continue to the Result step

- Primary Parameters
- Secondary Parameters
- Static parameters, initial readout

Continue >

Test result

NOx inlet response



NOx outlet response



DEF dosing system



SCR efficiency



Reference

Icon	Description
	Test Completed, no errors detected
	Test Completed, error detected
	Test not completed
	Not tested
	Sensor signal out of expected range

2589-08-03-18 Exhaust Aftertreatment System Analysis

Simulation

Information >> Conditions >> Execution >> Result

Result

Recommended actions	
NOx inlet response	Not tested
NOx outlet response	Not tested
DEF dosing system	Not tested
SCR efficiency	Not tested

Detailed information



NOx sensor values
DEF dosing system values
SCR efficiency test values



Continue >