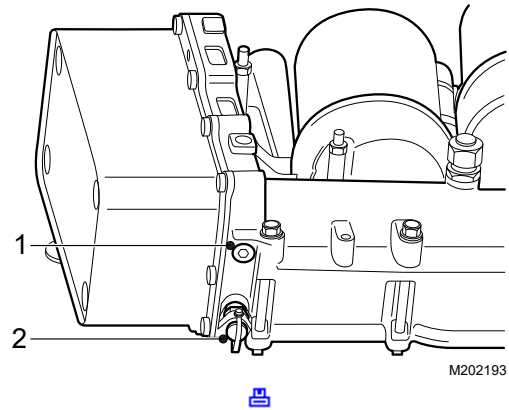


4. After draining, install the drain plug (1) and tighten it to the specified torque.

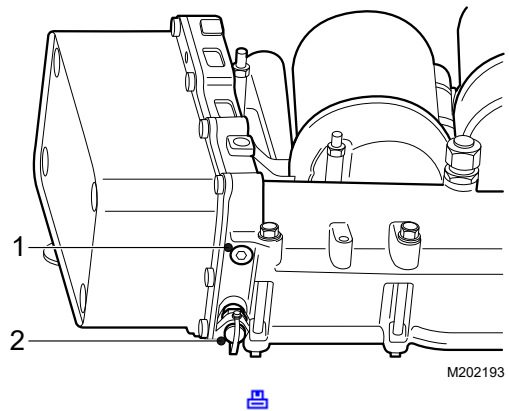


M034618 - 03.07.2016

Technical data

Tightening torque, drain plugs, oil module

Oil drain plug (1)	15 Nm [133 lb-in]
Coolant drain valve (2)	15 Nm [133 lb-in]



M033691 - 02.10.2016

1.5 drain coolant oil module (Lubrication system)

Explanation

Warning, coolant



- Coolant is toxic. Avoid prolonged or repeated contact with the skin. In case of contact, immediately wash the skin with soap and water. In case of eye contact, rinse with plenty of water. Do not ingest. If swallowed, seek immediate medical attention. Do not induce vomiting.
- Do not remove the radiator cap from a hot or running engine. When the coolant is hot, there is overpressure in the cooling system. It can cause scalding coolant to spray out and cause serious personal injury. Carefully remove the filler cap to release the overpressure.
If the engine has been operated within the last 30 minutes, be very careful when removing the radiator cap. Protect face, hands, and arms against escaping fluid and steam by covering the cap with a large, thick rag while carefully removing it.
- Handle coolant and antifreeze carefully. Ethylene glycol antifreeze is poisonous. Store it in the original fluid container only, and always keep it out of the reach of children. • Also, never remove the cap on the surge tank while the engine is still hot. Wait until the coolant temperature is below 50°C (120°F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.

been identified and/or removed. If the substance makes contact with the skin, contact a doctor immediately.

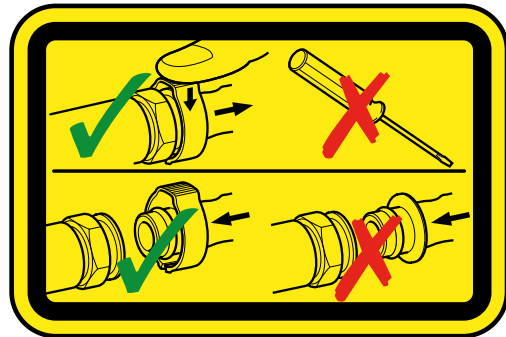


- Dirt or debris in the fuel system can lead to severe engine damage.
- Blocking and/or clamping the fuel pipes can lead to severe engine damage.
- Never block or plug the common rail release valve output, as this can lead to severe rail and common rail pressure release valve damage.
- Immediately plug the openings of the fuel system.
- Clean the area before performing maintenance.
- Cover the crankcase pressure sensor and make sure that it cannot come in contact with any fuel or fuel vapors.

M035658 - 01.09.2017

Disconnecting quick-release coupling

- No tooling is allowed for disconnecting or connecting the quick-release coupling.
- The pipe must be free of any fluid pressure before disconnecting.



i403864



New situation

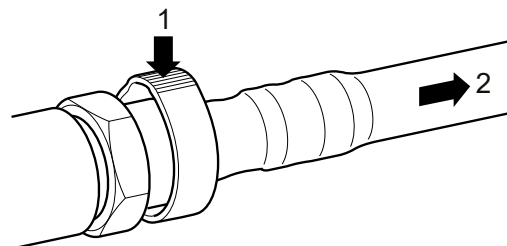
1. Clean the area around the connection.
2. Press and hold the release element (1).



To reach the ribbed surface (1), rotate the release element.

Do not remove the release element from the quick-release coupling.

3. Pull the male quick-release coupling (2) out of the female coupling.



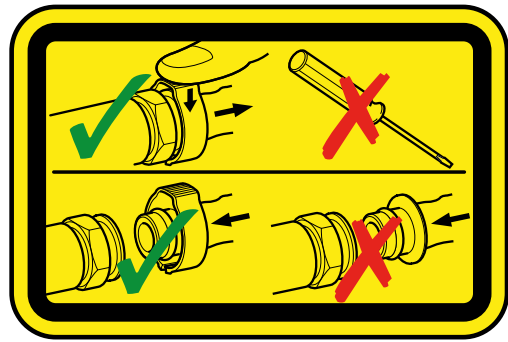
i403787



Old situation

1. Clean the area around the connection.
2. Press and hold the release element (1).
3. Pull the male quick-release coupling (2) out of the female coupling.

Old



i403864



New situation

1. Clean the area around the connection.
2. Press and hold the release element (1).

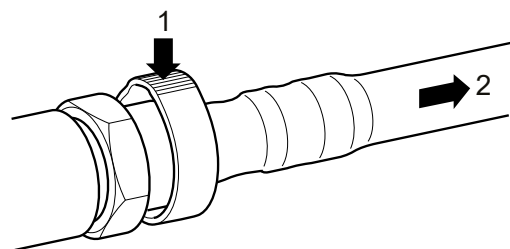


To reach the ribbed surface (1), rotate the release element.

Do not remove the release element from the quick-release coupling.

3. Pull the male quick-release coupling (2) out of the female coupling.

New



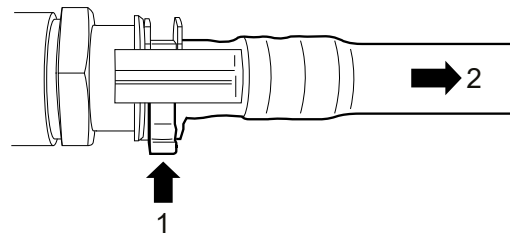
i403787



Old situation

1. Clean the area around the connection.
2. Press and hold the release element (1).
3. Pull the male quick-release coupling (2) out of the female coupling.

Old



R601501



M035352 - 08.17.2016

1.33 loosen supply coolant pipe (Air compressor)

Explanation

Warning, coolant



- Coolant is toxic. Avoid prolonged or repeated contact with the skin. In case of contact, immediately wash the skin with soap and water. In case of eye contact, rinse

Explanation

Warning, Fuel System



- **Eye contact:** Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Consult a doctor.
- **Skin contact:** Wash off immediately with plenty of water. If symptoms persist, consult a doctor.
- **Inhalation:** Get some fresh air. If symptoms persist, consult a doctor.
- **Ingestion:** Rinse mouth with water and then drink plenty of water. Do not induce vomiting. Consult a doctor.



- **Fuel vapors and spills are potential fire hazards.**
- **When opening a fuel system, fuel can escape. Collect the fuel during servicing and dispose of it properly to avoid the risk of fire.**
- **Mixing other fuels, such as gasoline, alcohol or gasohol with diesel can produce an explosive mixture.**



To avoid injury from fuel while performing service on any fuel-system-related component(s):

- **Prevent fuel from leaking or dripping onto the starter motor.**
- **Check the fuel components for leakage very carefully.**
- **Clean spilled or leaked fuel.**
- **Keep people who are not directly involved in the servicing away from the immediate area.**
- **Wear protective clothing (including face shield, insulated gloves and apron).**
- **Keep the work area well ventilated to prevent build-up of volatile fuel vapors.**
- **Keep all potential ignition sources away from the fuel. This includes: excessive heat, open flames, cigarettes, sparks and electrical sources.**



- **Do not touch any of the fluoroelastomer seals or O-rings if they have been exposed to a temperature of 315°C or higher. The material of this product does not burn but decomposes into a charred, black, sticky substance. This decomposition may contain hydrofluoric acid. This is very aggressive and difficult to remove once it has contaminated the skin. Use PVC or rubber gloves until the decomposed material has been identified and/or removed. If the substance makes contact with the skin, contact a doctor immediately.**



- **Dirt or debris in the fuel system can lead to severe engine damage.**
- **Blocking and/or clamping the fuel pipes can lead to severe engine damage.**
- **Never block or plug the common rail release valve output, as this can lead to severe rail and common rail pressure release valve damage.**
- **Immediately plug the openings of the fuel system.**
- **Clean the area before performing maintenance.**
- **Cover the crankcase pressure sensor and make sure that it cannot come in contact with any fuel or fuel vapors.**

M035658 - 01.09.2017

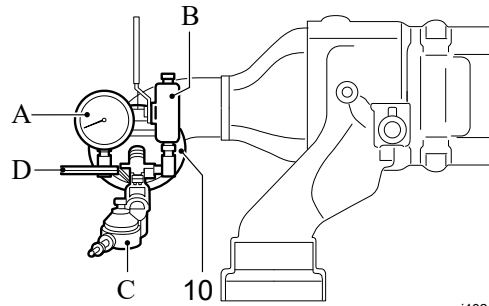
Disconnecting quick-release coupling

- **No tooling is allowed for disconnecting or connecting the quick-release coupling.**
- **The pipe must be free of any fluid pressure before disconnecting.**



Do not use a silicon-based product. Silicon-based products can damage the equipment.

6. Install the special tool (A) to the EGR cooler exhaust inlet.
7. Refit the V clamp (10) and tighten it to the specified torque.

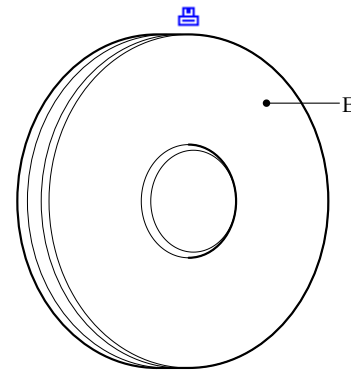


i402467

8. Insert the plug (E) into the EGR cooler exhaust gas outlet.
9. Install the safety cap (H) over the EGR cooler exhaust gas outlet.

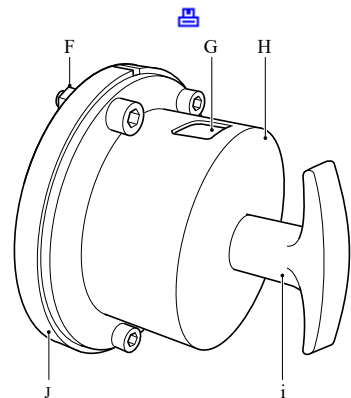


Make sure that the view and leak test port (G) is located on top.



i402537

10. Install the half moon flanges (J).
11. Install the safety cap attachment nuts and bolts (F) and hand tighten them.
12. Install the handle (I) and hand tighten it.



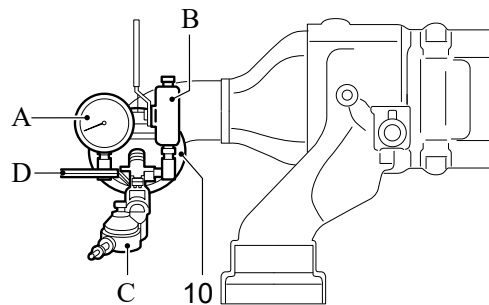
i402468

13. Close the pressure release valve (B).
14. Close the air flow valve (D).
15. Back off the pressure regulator (C) until it is unloaded.



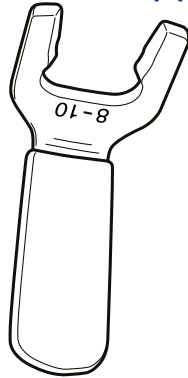
Failure to back off the pressure regulator (C) can damage the equipment.

16. Supply shop air.
17. Open air flow valve (D).
18. Adjust the pressure regulator (C) to have around 1.40 bar [20 psi] at the pressure gauge of special tool (A).
19. Pressurize the exhaust passages of the EGR cooler for 5 seconds.



i402467

Release tool cool water pipe. Tool for removing coolant pipes from EGR and back pressure valve.



93778



ST1893778 - 02.13.2014

- 1.80 remove flexible EGR pipe from control valve to EGR cooler (EGR system)
- 1.81 remove pressure sensor pipe after BPV (EGR system)
- 1.82 remove mounting bracket (EGR system)
- 1.83 remove assembly venturi (EGR system)
- 1.84 disconnect turbocharger speed sensor (Inlet and exhaust element)

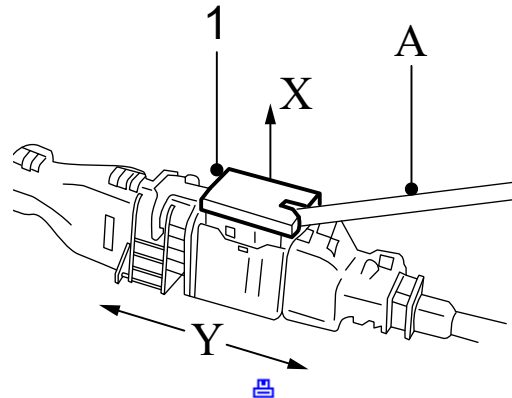
Explanation

Disconnecting HDSCS connector

1. Use a small flathead screwdriver (A) to release (X) the lock clip (1).
2. Disconnect the connector by pulling (Y) it apart.



It might be necessary to release the lock clip (1) further.



M041856 - 05.13.2014

- 1.85 loosen oil pipe, delivery side (Inlet and exhaust element)
- 1.86 loosen oil return pipe (Inlet and exhaust element)
- 1.87 loosen supply coolant pipe (Inlet and exhaust element)
- 1.88 loosen return coolant pipe (Inlet and exhaust element)
- 1.89 loosen assembly Back Pressure Valve (Engine brake)
- 1.90 remove turbocharger with VTG (Inlet and exhaust element)

Explanation

Warning: Turbocharger Replacement



- If the warning and instructions below are not observed, the result can be a runaway engine.
- This can result in personal injury.

- Do not carry out any work underneath an engine that is only supported by a jack or lifting device.
- Do not use the oil sump to lift or support the engine.



If the engine is lifted only slightly, it is not necessary to disconnect coolant hoses, air inlet hoses and torque rods between the engine and the radiator.

M029202 - 12.09.2015

1.98 remove assembly cylinder head, engine (Basic assembly)

Explanation

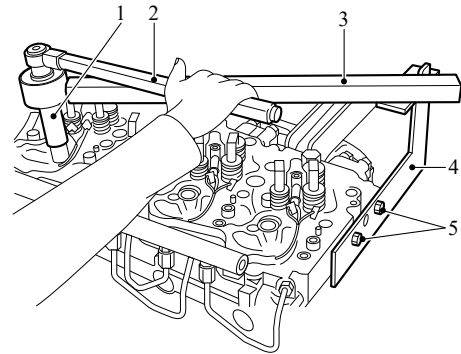
Removing assembly cylinder head

1. Remove the cylinder head bolts in the specified sequence.



To remove the cylinder head bolts, use, for instance, special tool (0882233):

1. Fit the bracket (4) to the cylinder head at the flywheel side. Use attachment bolts (5) to secure the bracket (4).
2. Mount the impact socket (1) of special tool (0911724) to the torque multiplier (3), and fit the assembly onto the cylinder head bolt.
3. Place the torque wrench (2) on the torque multiplier (3).



1402427

2. Remove the cylinder head.
3. Position the cylinder head on suitable supports.

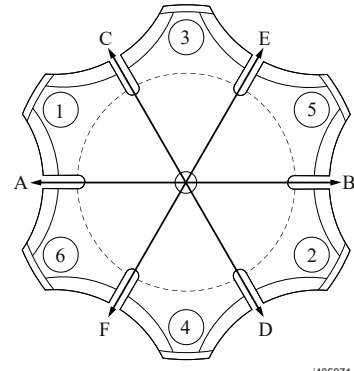


- **Be careful; When removing a cylinder head with the injectors still installed, do not place the cylinder head on a flat surface. Use wood blocks to prevent the cylinder head surface and injector tips from contacting any table or bench surface.**

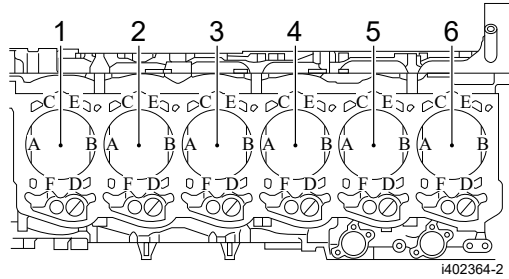
The injector tips extend beyond the plane of the cylinder head and can be easily damaged. Any tip contact can result in micro-cracks that may lead to severe engine damage.

- **Avoid damaging the rail, fuel injection pipes.**

M036590 - 10.22.2015



I405071



I402364-2



M032175 - 07.21.2016

Check form cylinder liner height

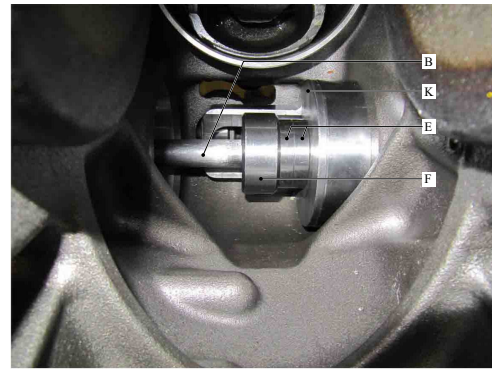
	Cylinder 1 (mm) (in)	Cylinder 2 (mm) (in)	Cylinder 3 (mm) (in)	Cylinder 4 (mm) (in)	Cylinder 5 (mm) (in)	Cylinder 6 (mm) (in)
A						
B						
C						
D						
E						
F						

M045394 - 06.18.2015

Special tools

Special tool category: Mandatory special tool for: NA region
1809948

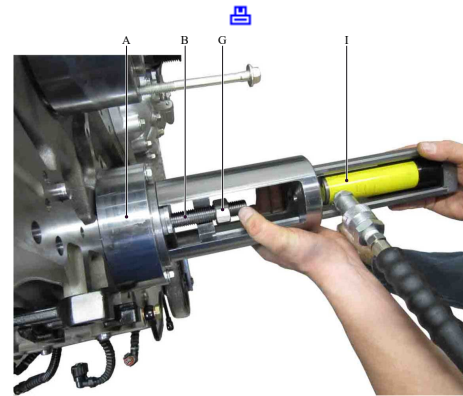
Auxiliary tool for height measurement of cylinder liner



12. Turn the nut (G) onto the spindle (B).
13. Mount the hydraulic puller (I) to the adapter (A) as shown.



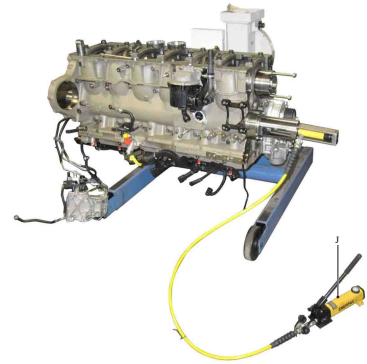
Turn the puller a quarter of a turn to secure it.



14. Use the hydraulic press (J), and carefully press the 1st camshaft bearing into the cylinder block.



The 1st camshaft bearing is 'in position' if the fixation pin (L) reaches the other end of the slotted hole in the stamp (K) as shown.



15. Depressurize the hydraulic press (J) and remove the hydraulic puller (I) from the adapter (A) by turning it a quarter of a turn.
16. Remove the locking ring (F).
17. Carefully pull out the spindle (B) and collect the two shim rings (E).
18. Remove the adapter (A).
19. Turn the bolt on stamp (K) clockwise to release the stamp (K) from the camshaft bearing.
20. Remove the fixation pin (L).
21. Carefully remove the stamp (K) out of the bearing and from the engine block.
22. Install the adapter (A) and tighten the attachment bolts to 30 Nm.



Installing camshaft bearings 2 to 6

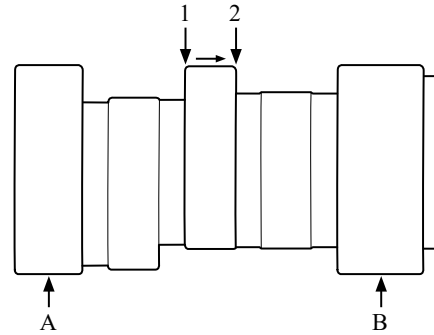
1. Camshaft bearings 2 to 6 must be installed in the same way as the 1st camshaft bearing.



The difference is that the adapter (A) does not need to be removed.

Cam

Parallelism, for each cam, measured in reference to the adjoining bearing journals (A, B) maximum 0.008 mm [0.00031 in]



M201948



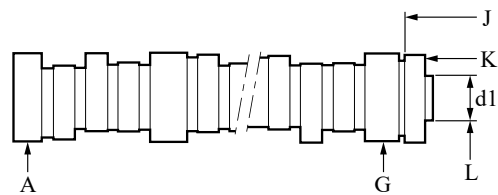
Camshaft gear journal

Diameter (d_1) minimum 49.985 mm [1.96791 in] maximum 50.015 mm [1.96909 in]

Axial runout (J), in reference to the bearing journals (A, G) 0.04 mm [0.00157 in]

Axial runout (K), in reference to the bearing journals (A, G) 0.05 mm [0.00197 in]

Radial runout (L), in reference to the bearing journals (A, G) 0.04 mm [0.00157 in]



M202007

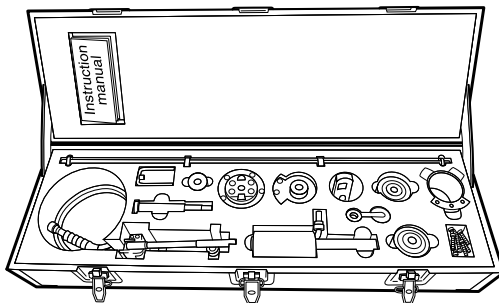


M032198 - 02.26.2014

Special tools

Special tool category: Recommended special tool 1809975

Camshaft bearings, disassembly and assembly tool



ST1809975 - 08.25.2011

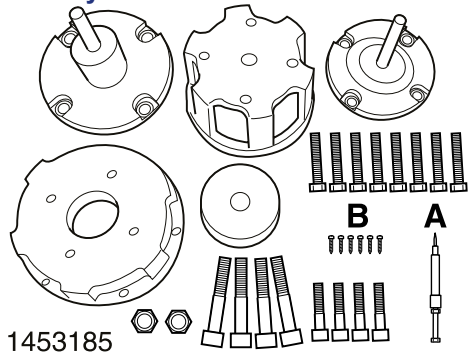
1.140 install all crankshaft main bearing shell (Basic assembly)

Explanation

Special tools

Special tool category: Mandatory special tool for: NA region, NA Service Support
1453185

Assembly and disassembly tool set for front and rear crankshaft seals



"Contents 1453185"



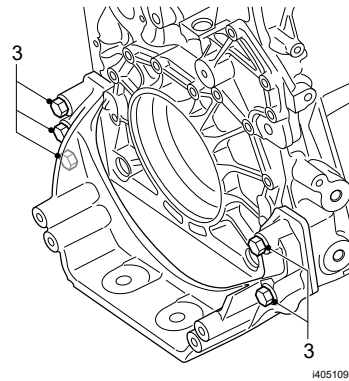
ST1453185 - 10.22.2018

1.152 install front engine bracket (Engine mountings)

Technical data

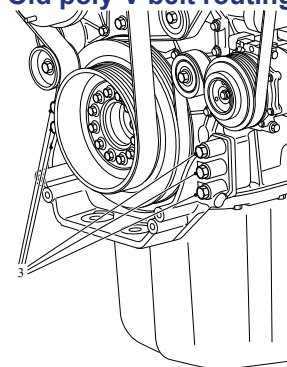
Tightening torque, front engine bracket

Attachment bolts (3) 110 Nm + 60° [81 lb-ft + 60°]

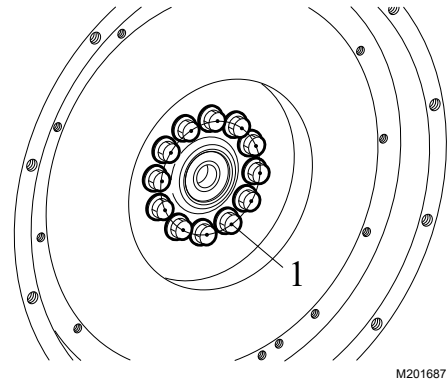


Attachment bolts (3) 110 Nm [81 lb-ft]

Old poly-V-belt routing:



M032335 - 04.30.2018



M201687

M028410 - 03.24.2010

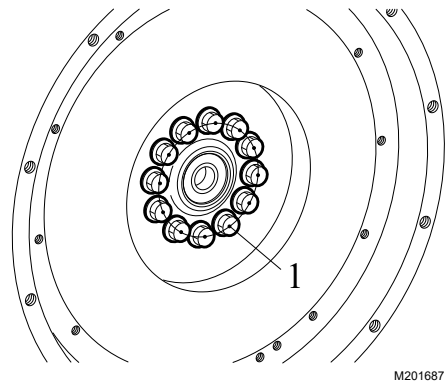
Technical data

Tightening torque, flywheel

Attachment bolts (1)⁽¹⁾


- 1st phase 80 Nm [59 lb-ft]
- 2nd phase 260 Nm [192 lb-ft]
- 3rd phase 120°

(1) Bolts can be used again if a new nut can be screwed on over the complete cleaned bolt thread by hand.



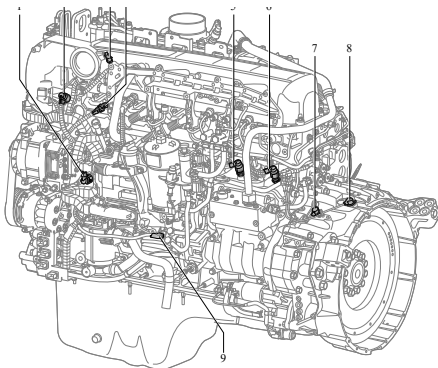
M201687

M031000 - 03.19.2015

 1.164 install camshaft sensor (Sensors electrical system, engine)

Technical data

Tightening torque, sensors left side view



40223-2

- Oil pressure sensor (1)
- Inlet air boost pressure sensor (2)

- 30 Nm [266 lb-in]⁽²⁾
- 30 Nm [266 lb-in]⁽²⁾



For V clamp (15), two different V clamps are used, and both require a different tightening torque.

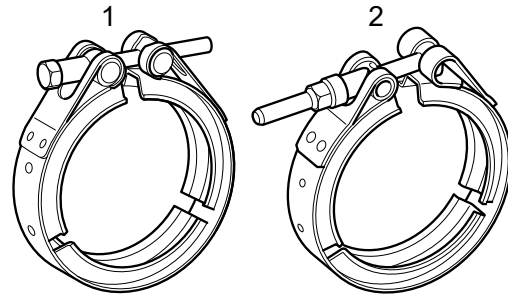
V clamp (15)

Type 1

Type 2

8 Nm [71 lb-in]

12 Nm [106 lb-in]



i403831



M030412 - 04.04.2017

Mounting product, sealing ring

Rubber lubricant

"P80"

M025429 - 02.21.2017

1.180 install mounting bracket (EGR system)

Technical data

Tightening torque, mounting bracket

Attachment studs

30 Nm [265 lb-in]

M033576 - 01.16.2013

1.181 install pressure sensor pipe after BPV (EGR system)

Technical data

Tightening torque, pressure sensor pipe after BPV

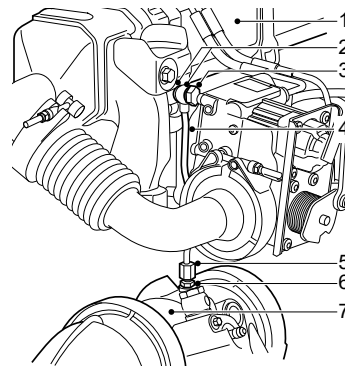
Banjo bolt, sensor pipe (3) 26 Nm [230 lb-in]⁽¹⁾

Union nut, sensor pipe (5) 40 Nm [355 lb-in]^(Diagonal 2)

Fitting in BPV (6) 20 Nm [177 lb-in]

(1) Always fit new sealing washers.

(2) Use a second wrench to avoid overtorquing the fitting in the BPV.



i403646



M034395 - 04.04.2017

1.182 check condition flexible EGR pipe from control valve to EGR cooler (EGR system)

especially when this is measured on one cylinder only.

- Make sure to check all the valve train parts of that specific cylinder before adjusting the valve clearance to the specified value.

M031813 - 03.05.2013

Definition, warm and cold engine

Cold engine	A cold engine is an engine that, having reached operating temperature, has been allowed to cool down for at least six hours .
Warm engine	A warm engine is an engine that, having reached operating temperature, has been at a standstill for not more than thirty minutes .

M031814 - 07.31.2012

Tightening torque, rocker seat

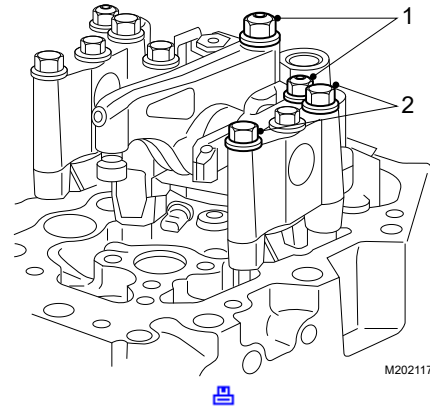
Lock nut (1) for valve adjusting bolt

64 Nm [566 lb-in]

Attachment bolts (2):

Phase 1
Phase 2

50 Nm [443 lb-in]
90°



- Attachment bolts may only be reused when a new nut can be screwed by hand over the complete cleaned bolt thread.
- Apply a drop of clean engine oil to the thread of the bolts and the bearing surface of the bolt heads.

M030452 - 05.02.2017

Special tools

Special tool category: Mandatory special tool for: NA region
1903018

Engine Cranking Tool

helps improve engine cranking in low temperature conditions,
reduces deposit formation and increases engine durability.

	-40	-25	-20	-15	0	38	50
°C	-40	-13	-4	5	32	100	122
5W40	A	A	A	A	A	A	A
10W40	A	A	A	A	A	A	A
15W40	A	A	A	A	A	A	A
5W30	A	A	A	A	A	A	A
10W30	A	A	A	A	A	A	A

A
 B

M02192



- A Permitted temperature range
 B Permitted temperature range if the engine is equipped with an active oil sump heater that is used before engine start

Initial oil fill from factory:

API CJ-4 10W30

M021451 - 02.23.2017

Filling capacities lubrication system

Filling capacity for service, including oil filter

approximately 40 liters [42.3 quarts]

Filling capacity, first filling

approximately 46 liters [48.6 quarts]⁽¹⁾

Range of minimum - maximum level

approximately 9 liters [9.5 quarts]

(1) Filling capacity after engine overhaul.

M032190 - 11.13.2014

- 1.262 install filler cap, oil filling pipe (Lubrication system)
- 1.263 install dipstick, engine
- 1.264 fill oil turbocharger with VTG (Inlet and exhaust element)

Explanation

Filling oil, turbocharger



- The turbocharger bearing housing must be filled with engine oil after replacement.
- Only the procedure below guarantees that oil reaches the turbine shaft bearing.

1. Check the engine oil level and, if necessary, refill with engine oil.
2. Disconnect the crankshaft and camshaft sensor.
3. Crank the engine for 60 seconds.

Now the turbocharger is filled with engine oil.