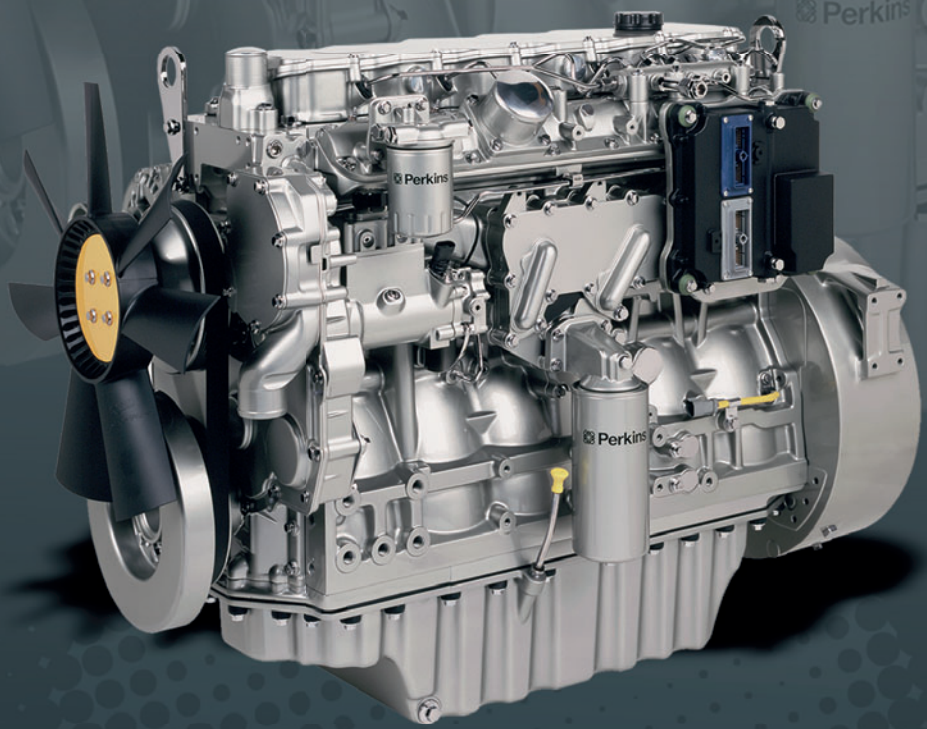
647413EN (30/01/2013)

PERKINS ENGINE
1106D - EURO 3

Repair Manual



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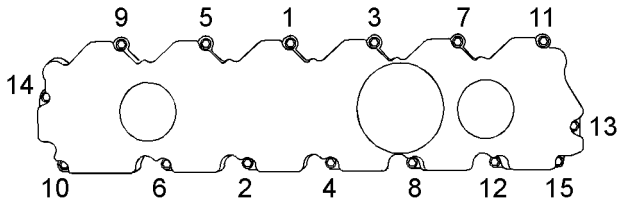
Valve Mechanism Cover



g01332103

Illustration 12

Typical example

Tighten the bolts for the valve mechanism cover in the sequence that is shown in illustration 12 to the following torque. ..... 6 N·m (53 lb in)

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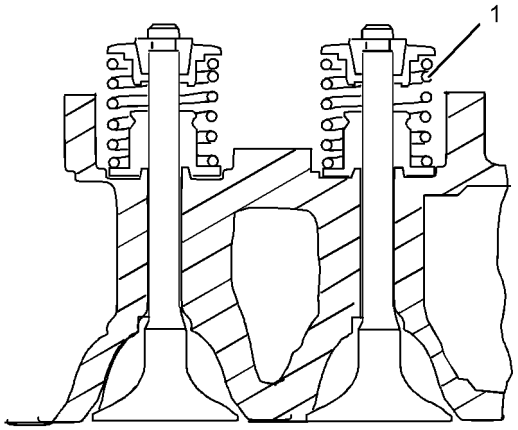
Cylinder Head Valves



g01333841

Illustration 13

Typical example

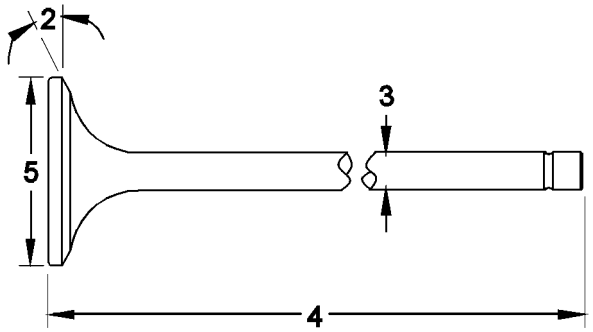
The same valve spring (1) is used on both valves.

When the valve springs are replaced the valve springs must be replaced in pairs.

Refer to table 1 for information on the length of the valve spring and the load of the valve spring.

Table 1

The load for the valve spring	The length of the valve spring
147.3 to 162.8 N (33.1145 to 36.5991 lb)	31.5 mm (1.2402 inch)
296.4 to 327.6 N (66.6337 to 73.6478 lb)	22.2 mm (0.8740 inch)



g01333842

Illustration 14

(2) Valve face angle

Inlet ..... 30 degrees
Exhaust ..... 45 degrees

(3) Valve stem diameter

Inlet .. 5.942 to 5.957 mm (0.2339 to 0.2345 inch)
Exhaust ..... 5.927 to 5.942 mm (0.2333 to 0.2339 inch)

Clearance

Maximum clearance of the inlet valve stem ..... 0.05 mm (0.0020 inch)
The service limit for the inlet valve stem ..... 0.08 mm (0.0031 inch)

Clearance

Maximum clearance of the exhaust valve stem ..... 0.065 mm (0.0026 inch)
The service limit for the inlet valve stem ..... 0.09 mm (0.0035 inch)

(4) Length of valve

Inlet valve ..... 107.925 to 108.375 mm (4.2490 to 4.2667 inch)
Exhaust valve ..... 107.703 to 108.153 mm (4.2403 to 4.2580 inch)

(5) Valve head

Refer to the Disassembly and Assembly, “Engine Oil Pan” for tooling information.

The Cast Iron Oil Pan

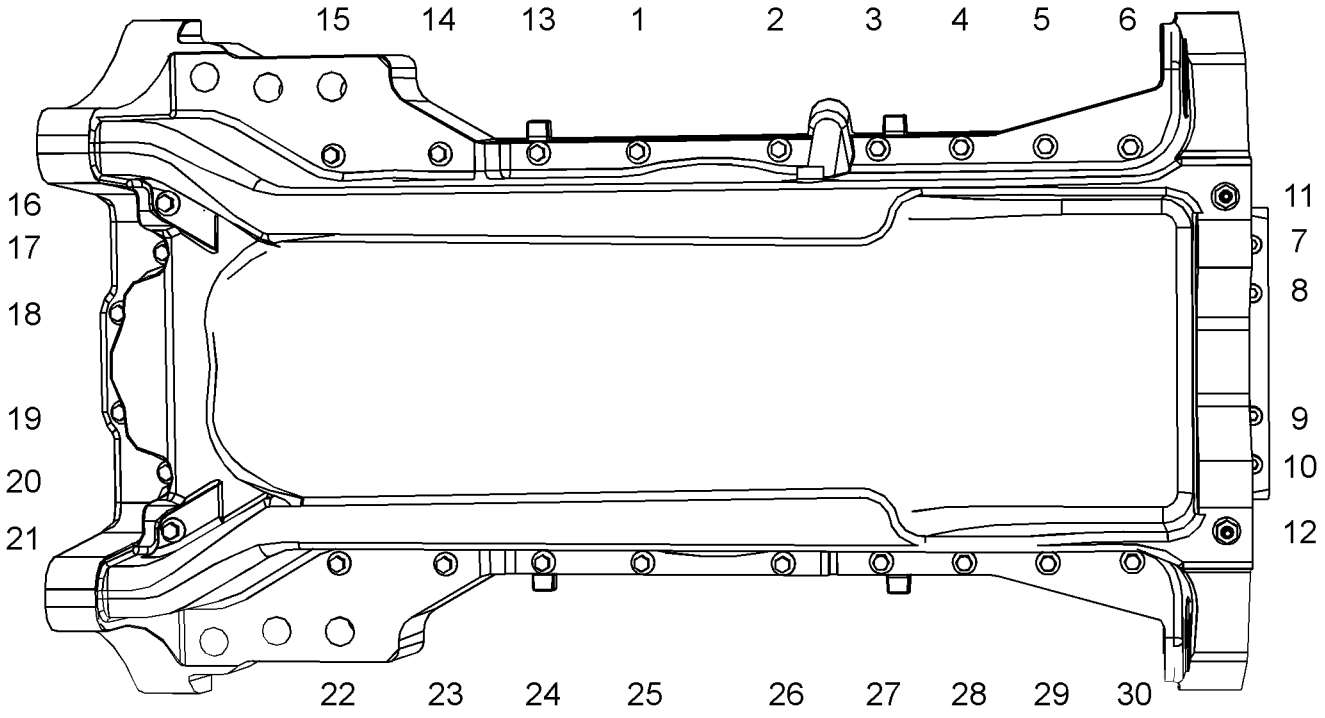


Illustration 36 g01397669

Tightening sequence

Tighten the fasteners in the sequence that is shown in illustration 36 to the following torque. ..... 22 N·m (16 lb ft)

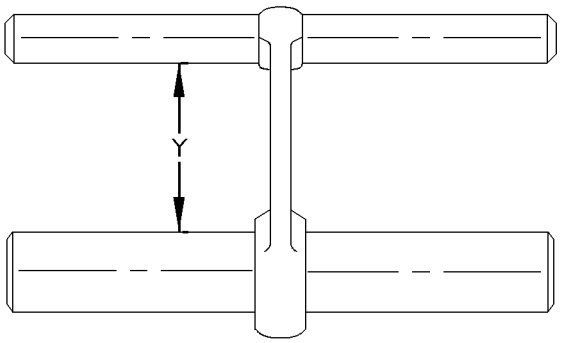


Illustration 51 g00915056

Connecting rods are color coded. The color code is a reference for the length (Y) of the connecting rod. Refer to table 11 for the different lengths of connecting rods.

Table 11

Length Grades for Connecting Rods		
Grade Letter	**Color Code**	**Length (Y)**
F	Red	161.259 to 161.292 mm (6.3488 to 6.3501 inch)
J	Green	161.183 to 161.216 mm (6.3458 to 6.3471 inch)
L	Blue	161.107 to 161.140 mm (6.3428 to 6.3441 inch)

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Piston and Rings

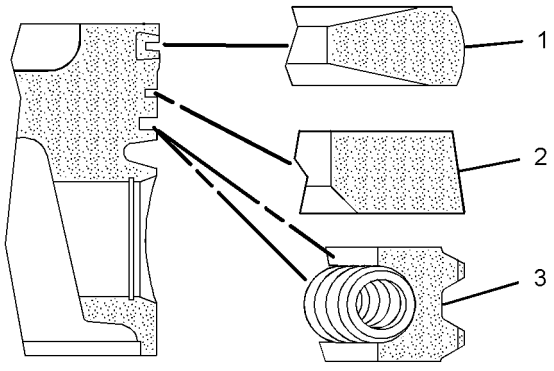

Illustration 52 g01352562

(1) Top compression ring

The shape of the top compression ring .. tapered

Ring gap ..... 0.30 to 0.45 mm (0.0118 to 0.0177 inch)

Note: When you install a new top compression ring, make sure that the word “TOP” is facing the top of the piston. New top piston rings have a yellow identification mark which must be on the left of the ring end gap when the top piston ring is installed on an upright piston.

(2) Intermediate compression ring

The shape of the intermediate compression ring ..... Internal bevel in the bottom edge with a tapered face

Width of intermediate compression ring .... 2.47 to 2.495 mm (0.0972 to 0.0982 inch)

The clearance between a new intermediate compression ring and the piston groove in a new piston ..... 0.065 to 0.011 mm (0.0026 to 0.0004 inch)

Ring gap ..... 0.65 to 0.85 mm (0.0256 to 0.0335 inch)

Note: When you install a new intermediate compression ring, make sure that the word “TOP” is facing the top of the piston. New intermediate rings have a blue identification mark which must be on the left of the ring end gap when the top piston ring is installed on an upright piston.

(3) The oil control ring

Width of oil control ring ..... 2.97 to 2.99 mm (0.1169 to 0.1177 inch)

The clearance between a new oil control ring and the groove in a new piston ..... 0.03 to 0.07 mm (0.0011 to 0.0027 inch)

Ring gap ..... 0.30 to 0.55 mm (0.0118 to 0.0216 inch)

Note: The oil control ring is a two-piece ring that is spring loaded. A pin is used in order to hold both ends of the spring of the oil control ring in position. The ends of the spring of the oil control ring must be installed opposite the end gap of the oil control ring.

Note: Ensure that the ring end gaps of the piston rings are spaced 120 degrees from each other.

Piston

Note: An arrow which is marked on the piston crown must be toward the front of the engine.

Piston height above cylinder block .. 0.21 to 0.35 mm (0.008 to 0.014 inch)

Width of top groove in the piston ..... Tapered

Width of second groove in new piston ..... 2.56 to 2.58 mm (0.1008 to 0.1016 inch)

Note: Refer to Systems Operation, Testing and Adjusting, “Cleanliness of Fuel System Components” for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

Ensure that all adjustments and repairs are performed by personnel that have had the correct training.

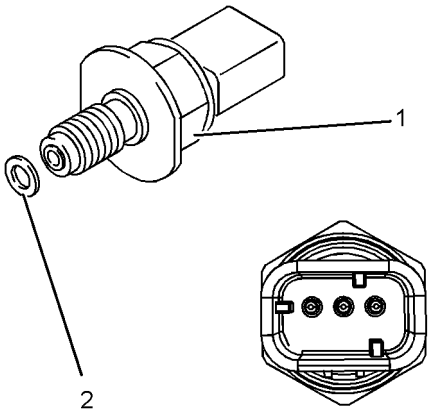

Illustration 72 g01332533

(1) Fuel pressure sensor
(2) Washer

Fuel pressure sensor

Tighten the fuel pressure sensor to the following torque. ..... 34 N·m (25 lb ft)

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Engine Oil Pressure Sensor

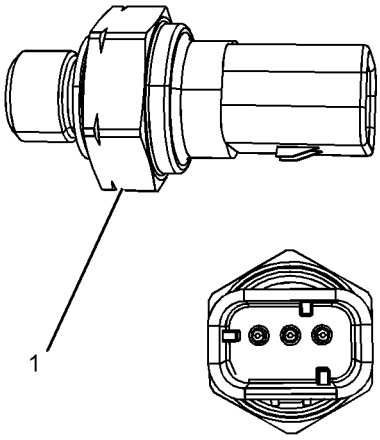

Illustration 73 g01332534

Typical example

(1) Sensor

Tighten the sensor to the following torque. ..... 10 N·m (7 lb ft)

Safety Section

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Safety Messages

There may be several specific warning signs on your engine. The exact location and a description of the warning signs are reviewed in this section. Please become familiar with all warning signs.

Ensure that all of the warning signs are legible. Clean the warning signs or replace the warning signs if the words cannot be read or if the illustrations are not visible. Use a cloth, water, and soap to clean the warning signs. Do not use solvents, gasoline, or other harsh chemicals. Solvents, gasoline, or harsh chemicals could loosen the adhesive that secures the warning signs. The warning signs that are loosened could drop off of the engine.

Replace any warning sign that is damaged or missing. If a warning sign is attached to a part of the engine that is replaced, install a new warning sign on the replacement part. Your Perkins distributor can provide new warning signs.

(1) Universal Warning

⚠ WARNING

Do not operate or work on this equipment unless you have read and understand the instructions and warnings in the Operation and Maintenance Manuals. Failure to follow the instructions or heed the warnings could result in serious injury or death.

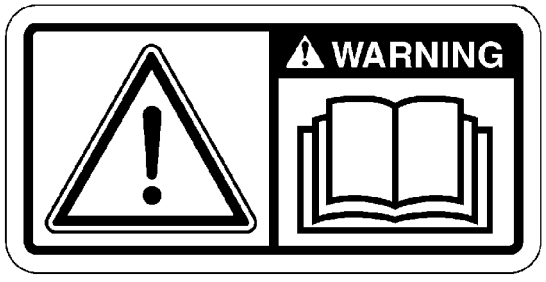

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Illustration 1

Typical example

The Universal Warning label (1) is located on both sides of the valve mechanism cover base.

Grounding Practices

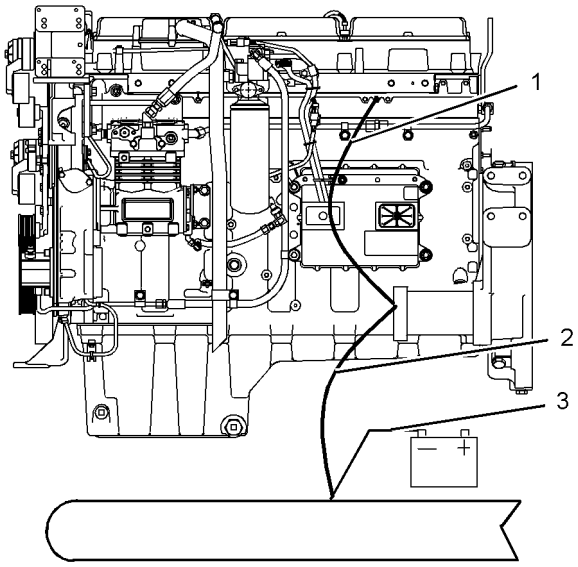

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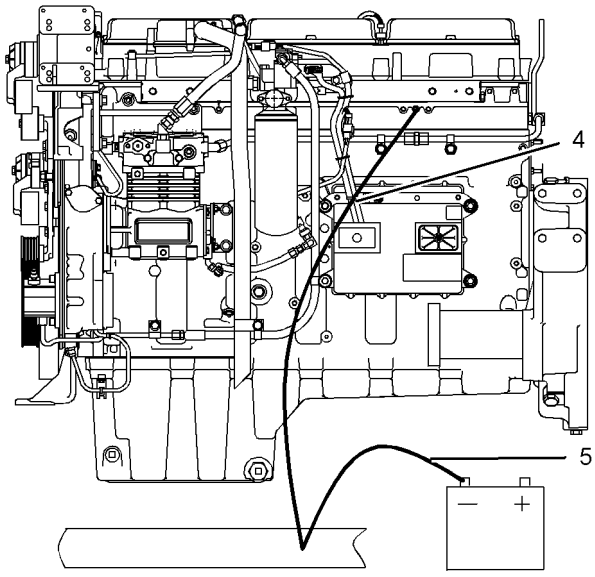
Illustration 13

Typical example

(1) Starting motor to engine block
(2) Ground to starting motor
(3) Ground to battery



g01162918

Illustration 14

Typical example

(4) Ground to engine
(5) Ground to battery

Correct grounding for the engine electrical system is necessary for optimum engine performance and reliability. Incorrect grounding will result in uncontrolled electrical circuit paths and in unreliable electrical circuit paths.

Uncontrolled electrical circuit paths can result in damage to the crankshaft bearing journal surfaces and to aluminum components.

Engines that are installed without engine-to-frame ground straps can be damaged by electrical discharge.

To ensure that the engine and the engine electrical systems function correctly, an engine-to-frame ground strap with a direct path to the battery must be used. This path may be provided by way of a direct engine ground to the frame.

The connections for the grounds should be tight and free of corrosion. The engine alternator must be grounded to the negative “-” battery terminal with a wire that is adequate to handle the full charging current of the alternator.

The power supply connections and the ground connections for the engine electronics should always be from the isolator to the battery.

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Engine Electronics

⚠ WARNING

Tampering with the electronic system installation or the OEM wiring installation can be dangerous and could result in personal injury or death and/or engine damage.

⚠ WARNING

Electrical Shock Hazard. The electronic unit injectors use DC voltage. The ECM sends this voltage to the electronic unit injectors. Do not come in contact with the harness connector for the electronic unit injectors while the engine is operating. Failure to follow this instruction could result in personal injury or death.

This engine has a comprehensive, programmable Engine Monitoring System. The Electronic Control Module (ECM) has the ability to monitor the engine operating conditions. If any of the engine parameters extend outside an allowable range, the ECM will initiate an immediate action.

The following actions are available for engine monitoring control:

- Warning

⚠ WARNING

Personal injury can result from hot coolant. Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

4. Drain and refill the cooling system. Refer to this Operation and Maintenance Manual, “Cooling System coolant (Commercial Heavy Duty - Change or Cooling System coolant (ELC) - Change” for information on draining, flushing and refilling the cooling system.

⚠ WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

5. Operate the engine until the engine reaches normal operating temperature. Stop the engine. After the engine has stopped, you must wait for 60 seconds in order to allow the fuel pressure to be purged from the high pressure fuel lines before any service or repair is performed on the engine fuel lines. If necessary, perform minor adjustments. Repair any leaks from the low pressure fuel system and from the cooling, lubrication or air systems. Replace any high pressure fuel line that has leaked. Refer to Disassembly and assembly Manual, “Fuel Injection Lines - Install”.

6. Drain the lubricating oil from the oil pan.

   Renew the canister(s) of the lubricating oil filter.

   Fill the oil pan to the Full Mark on the engine oil level gauge with new, clean lubricating oil. Add 1762811 POWERPART Lay-Up 2 to the oil in order to protect the engine against corrosion. If 1762811 POWERPART Lay-Up 2 is not available, use a preservative of the correct specification instead of the lubricating oil. If a preservative is used, this must be drained completely at the end of the storage period and the oil pan must be refilled to the correct level with normal lubricating oil.

7. Operate the engine in order to circulate engine oil.

8. Disconnect the battery. Ensure that the battery is in a fully charged condition. Protect the terminals against corrosion. 1734115 POWERPART Lay-Up 3 can be used on the terminals. Put the battery into safe storage.

9. If equipped, replace the crankcase breather element. Seal the end of the breather pipe.

10. Remove the valve mechanism cover. Spray 1762811 POWERPART Lay-Up 2 around the rocker shaft assembly.

11. Remove the glow plugs. Slowly rotate the crankshaft. By checking the valves, position the piston at BDC. Spray 1762811 POWERPART Lay-Up 2 for two seconds into the cylinder bore. This procedure must be carried out on each cylinder.

12. Install the glow plugs. Install the valve mechanism cover.

13. Remove the pipes that are installed between the air filter assembly and the turbocharger. Spray 1762811 POWERPART Lay-Up 2 into the turbocharger. The duration of the spray is printed on the container. Seal the turbocharger with waterproof tape.

14. Remove the exhaust pipe from the output side of the turbocharger. Spray 1762811 POWERPART Lay-Up 2 into the turbocharger. The duration of the spray is printed on the container. Seal the turbocharger with waterproof tape.

15. Seal the vent of the fuel tank or the fuel filler cap with waterproof tape.

16. Remove the alternator drive belt and put the drive belt into storage.

17. In order to prevent corrosion to the outside of the engine, spray the engine with 1734115 POWERPART Lay-Up 3. Do not spray the area inside the alternator.

Engine Diagnostics

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Self-Diagnostics

Perkins electronic engines have the capability to perform a self-diagnostics test. When the system detects an active problem, a diagnostic lamp is activated. Diagnostic codes will be stored in permanent memory in the Electronic Control Module (ECM). The diagnostic codes can be retrieved by using the electronic service tool. Refer to Troubleshooting , “Electronic Service Tools” for further information.

Some installations have electronic displays that provide direct readouts of the engine diagnostic codes. Refer to the manual that is provided by the OEM for more information on retrieving engine diagnostic codes. Alternatively refer to Troubleshooting , “Indicator Lamps” for further information.

Active codes represent problems that currently exist. These problems should be investigated first.

Logged codes represent the following items:

- Intermittent problems
- Recorded events
- Performance history

The problems may have been repaired since the logging of the code. These codes do not indicate that a repair is needed. The codes are guides or signals when a situation exists. Codes may be helpful to troubleshoot problems.

When the problems have been corrected, the corresponding logged fault codes should be cleared.

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Diagnostic Lamp

A diagnostic lamp is used to indicate the existence of an active fault. Refer to Troubleshooting , “Indicator Lamps” for more information. A fault diagnostic code will remain active until the problem is repaired. The diagnostic code may be retrieved by using the electronic service tool. Refer to Troubleshooting , “Electronic Service Tools” for more information.

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Diagnostic Flash Code Retrieval

“Diagnostic” Lamp

Use the “DIAGNOSTIC” lamp or an electronic service tool to determine the diagnostic flash code.

Use the following procedure to retrieve the flash codes if the engine is equipped with a “DIAGNOSTIC” lamp:

1. Move the keyswitch from the on/off two times within three seconds.

A flashing YELLOW lamp indicates a 3 digit code for the engine. The sequence of flashes represents the system diagnostic message. Count the first sequence of flashes in order to determine the first digit of the flash code. After a two second pause, the second sequence of flashes will identify the second digit of the flash code. After the second pause, the third sequence of flashes will identify the flash code.

Any additional flash codes will follow after a pause. These codes will be displayed in the same manner. Flash Code 551 indicates that No Detected Faults have occurred since the ignition keyswitch has been turned to the ON position.

For further information, assistance for repairs, or troubleshooting, refer to the Service Manual or consult your Perkins distributor.

Table3 lists the flash codes and the table also gives a brief description of the flash codes.

Note: Table3 indicates the potential effect on engine performance with “ACTIVE” flash codes.

Some codes record events. Also, some codes may also indicate that a mechanical system needs attention. Troubleshooting is not required for code “551”. Code 001 will not display a flash code. Some codes will limit the operation or the performance of the engine.

Table3 indicates the potential effect on the engine performance with active flash codes. Table 3 also forms a list of Electronic diagnostic codes and descriptions.

Cold Weather Operation

i02717265

Cold Weather Operation

Perkins Diesel Engines can operate effectively in cold weather. During cold weather, the starting and the operation of the diesel engine is dependent on the following items:

- The type of fuel that is used
- The viscosity of the engine oil
- The operation of the glow plugs
- Optional Cold starting aid
- Battery condition

This section will cover the following information:

- Potential problems that are caused by cold weather operation
- Suggest steps which can be taken in order to minimize starting problems and operating problems when the ambient air temperature is between 0° to−40 °C (32° to 40 °F).

The operation and maintenance of an engine in freezing temperatures is complex . This is because of the following conditions:

- Weather conditions
- Engine applications

Recommendations from your Perkins dealer or your Perkins distributor are based on past proven practices. The information that is contained in this section provides guidelines for cold weather operation.

Hints for Cold Weather Operation

- If the engine will start, operate the engine until a minimum operating temperature of 81 °C (177.8 °F) is achieved. Achieving operating temperature will help prevent the intake valves and exhaust valves from sticking.
- The cooling system and the lubrication system for the engine do not lose heat immediately upon shutdown. This means that an engine can be shut down for a period of time and the engine can still have the ability to start readily.
- Install the correct specification of engine lubricant before the beginning of cold weather.
- Check all rubber parts (hoses, fan drive belts, etc) weekly.
- Check all electrical wiring and connections for any fraying or damaged insulation.
- Keep all batteries fully charged and warm.
- Fill the fuel tank at the end of each shift.
- Check the air cleaners and the air intake daily. Check the air intake more often when you operate in snow.
- Ensure that the glow plugs are in working order. Refer to Testing and Adjusting Manual, “Glow Plug - Test”.

WARNING

Personal injury or property damage can result from alcohol or starting fluids.

Alcohol or starting fluids are highly flammable and toxic and if improperly stored could result in injury or property damage.

WARNING

Do not use aerosol types of starting aids such as ether. Such use could result in an explosion and personal injury.

- For jump starting with cables in cold weather, refer to the Operation and Maintenance Manual, “Starting with Jump Start Cables.” for instructions.

Viscosity of the Engine Lubrication Oil

Correct engine oil viscosity is essential. Oil viscosity affects the amount of torque that is needed to crank the engine. Refer to this Operation and Maintenance Manual, “Fluid Recommendations” for the recommended viscosity of oil.

Recommendations for the Coolant

Provide cooling system protection for the lowest expected outside temperature. Refer to this Operation and Maintenance Manual, “Fluid Recommendations” for the recommended coolant mixture.

Fuel for Cold Weather Operation

The European standard “EN590” contains climate dependant requirements and a range of options. The options can be applied differently in each country. There are 5 classes that are given to arctic climates and severe winter climates. 0, 1, 2, 3, and 4.

Fuel that complies with “EN590 ” CLASS 4 can be used at temperatures as low as −44 °C (−47.2 °F). Refer to “EN590” for a detailed discretion of the physical properties of the fuel.

The diesel fuel “ASTM D975 1-D” that is used in the united states of america may be used in very cold temperatures that are below −18 °C (−0.4 °F).

In extreme cold ambient conditions, you may also use fuels that are listed in the table 8. These fuels are intended to be used in temperatures that can be as low as −54 °C (−65.2 °F).

Table 8

Light Distillate Fuels (1)	
Specification	Grade
“MIL-T-5624R”	JP-5
“MIL-T-83133D”	JP-8
“ASTM D1655”	Jet-A-1

(1) The use of these fuels is acceptable with an appropriate fuel additive and the fuels must meet minimum requirements that are stated in Table 6. Fuel samples should be analyzed for the compliance. Fuels MUST NOT exceed 0.52 mm lubricity wear scar diameter that is tested on a HFFR . The test must be performed at 60 °C. Refer to “ISO 12156-1”. Fuels must have minimum viscosity of 1.4 centistokes that is delivered to the fuel injection pump. Fuel cooling may be required in order to maintain minimum viscosity of 1.4 centistokes that is delivered to the fuel injection pump.

⚠ WARNING

Mixing alcohol or gasoline with diesel fuel can produce an explosive mixture in the engine crankcase or the fuel tank. Alcohol or gasoline must not be used in order to dilute diesel fuel. Failure to follow this instruction may result in death or personal injury.

There are many other diesel fuel specifications that are published by governments and by technological societies. Usually, those specifications do not review all the requirements that are addressed in table 6. To ensure optimum engine performance, a complete fuel analysis should be obtained before engine operation. The fuel analysis should include all of the properties that are stated in the table 6.

Fuel Additive

Supplemental diesel fuel additives are not generally recommended. This is due to potential damage to the fuel system or the engine. Your fuel supplier or the fuel manufacturer will add the appropriate supplemental diesel fuel additives.

Perkins recognizes the fact that additives may be required in some special circumstances. Fuel additives need to be used with caution. Contact your fuel supplier for those circumstances when fuel additives are required. Your fuel supplier can recommend the appropriate fuel additive and the correct level of treatment.

Note: For the best results, your fuel supplier should treat the fuel when additives are required. The treated fuel must meet the requirements that are stated in table 6.

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Fluid Recommendations (Coolant Specifications)

General Coolant Information

NOTICE
Never add coolant to an overheated engine. Engine damage could result. Allow the engine to cool first.

NOTICE
If the engine is to be stored in, or shipped to an area with below freezing temperatures, the cooling system must be either protected to the lowest outside temperature or drained completely to prevent damage.

NOTICE
Frequently check the specific gravity of the coolant for proper freeze protection or for anti-boil protection.

Clean the cooling system for the following reasons:

- Contamination of the cooling system
- Overheating of the engine
- Foaming of the coolant

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Maintenance Interval Schedule

When Required

Daily

Every Week

Every 50 Service Hours or Weekly

Every 250 Service Hours

Initial 500 Service Hours

Every 500 Service Hours

Every 500 Service Hours or 1 Year

Every 1000 Service Hours

Every 2000 Service Hours

Every 3000 Service Hours

Every 3000 Service Hours or 2 Years

Every 4000 Service Hours

Every 12 000 Service Hours or 6 Years

Commissioning

1. Slowly loosen the cooling system filler cap in order to relieve the pressure. Remove the cooling system filler cap.

Note: Always discard drained fluids according to local regulations.

2. If necessary, drain some coolant from the cooling system into a suitable container in order to allow space for the extra SCA.

3. Add the correct amount of SCA. Refer to the Operation and Maintenance Manual, “Refill Capacities and Recommendations” for more information on SCA requirements.

4. Clean the cooling system filler cap and inspect the gasket. If the gasket is damaged, discard the old filler cap and install a new filler cap. If the gasket is not damaged, use a suitable pressurizing pump in order to pressure test the filler cap. The correct pressure is stamped on the face of the filler cap. If the filler cap does not retain the correct pressure, install a new filler cap.

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Crankcase Breather (Canister) - Replace

NOTICE
Ensure that the engine is stopped before any servicing or repair is performed.

1. Place a container under canister (2).

2. Clean the outside of the canister. Use a suitable tool in order to remove the canister.

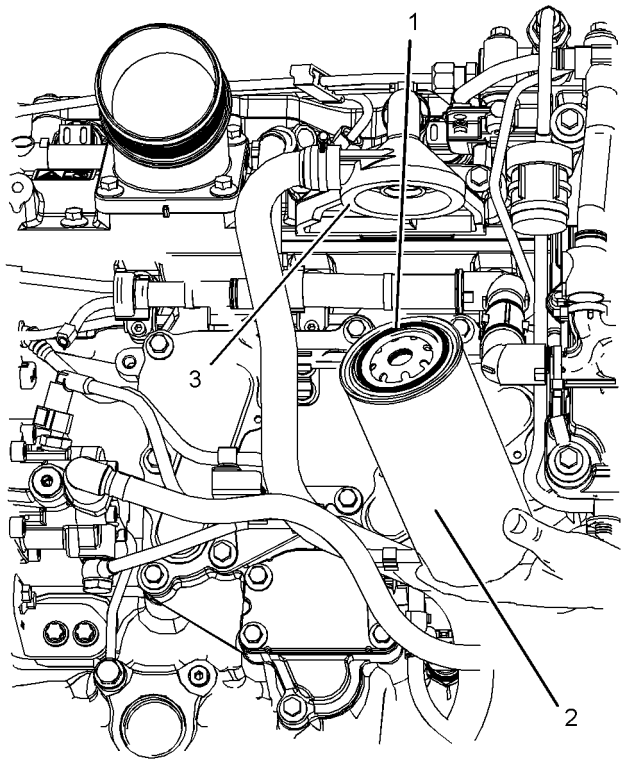

Illustration 36 g01392831
Typical example

3. Lubricate O ring seal (1) on the new canister with clean engine lubricating oil.

4. Install the new canister. Spin on the canister until the O ring seal contacts the sealing surface (3). Then rotate the canister ¾ of a full turn.

5. Remove the container. Dispose of the old canister and any split oil in a safe place.

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Driven Equipment - Check

Refer to the OEM specifications for more information on the following maintenance recommendations for the driven equipment:

- Inspection
- Adjustment
- Lubrication
- Other maintenance recommendations

Perform any maintenance for the driven equipment which is recommended by the OEM.

Adjustment of the cover will change the clearance (gap) between the edge of the cover and the tip of the fan blade. Ensure that the cover is centralized to the fan.

The maximum clearance is 12.5 mm (0.4921 inch). The minimum clearance is 6 mm (0.2362 inch).

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Fuel System - Prime

⚠ WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

Refer to the Operation and Maintenance Manual , “General Hazard Information and High Pressure Fuel Lines” before adjustments and repairs are performed.

Note: Refer to Testing and Adjusting Manual , “Cleanliness of Fuel System Components” for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

Ensure that all adjustments and repairs are performed by authorized personnel that have had the correct training.

NOTICE
Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

If air enters the fuel system, the air must be purged from the fuel system before the engine can be started. Air can enter the fuel system when the following events occur:

- The fuel tank is empty or the fuel tank has been partially drained.
- The low pressure fuel lines are disconnected.
- A leak exists in the low pressure fuel system.
- The fuel filter has been replaced.

Hand Fuel Priming Pump

Use the following procedures in order to remove air from the fuel system:

1. Ensure that the fuel system is in working order. Check that the fuel supply valve (if equipped) is in the “ON” position.

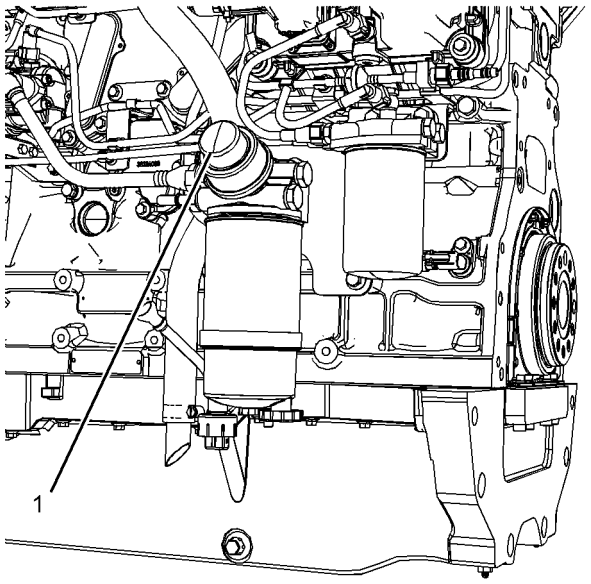


Illustration 48 g01333855
typical example

2. Operate fuel priming pump (1). Count the number of operations of the fuel priming pump. After 100 depressions of the fuel priming pump stop.
3. The engine fuel system should now be primed and the engine should now be able to start.
4. Operate the engine starter and crank the engine. After the engine has started, operate the engine at low idle for a minimum of five minutes, immediately after air has been removed from the fuel system.

Note: Operating the engine for this period of time will help ensure that the fuel system is free of air.

Note: Do not loosen the high pressure fuel line in order to purge air from the fuel system. This procedure is not required.

⚠ WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

1. Stop the engine. Allow the engine to cool.
2. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.

Note: Drain the coolant into a suitable, clean container. The coolant can be reused.

3. Drain the coolant from the cooling system to a level that is below the hose that is being replaced.
4. Remove the hose clamps.
5. Disconnect the old hose.
6. Replace the old hose with a new hose.
7. Install the hose clamps with a torque wrench.

Note: For the correct coolant, see this Operation and Maintenance Manual, “Fluid Recommendations”.

8. Refill the cooling system. Refer to the OEM information for further information on refilling the cooling system.
9. Clean the cooling system filler cap. Inspect the cooling system filler cap’s seals. Replace the cooling system filler cap if the seals are damaged. Install the cooling system filler cap.
10. Start the engine. Inspect the cooling system for leaks.

i02335774

Radiator - Clean

The radiator is not usually supplied by Perkins. The following text describes a typical cleaning procedure for the radiator. Refer to the OEM information for further information on cleaning the radiator.

Note: Adjust the frequency of cleaning according to the effects of the operating environment.

Inspect the radiator for these items: Damaged fins, corrosion, dirt, grease, insects, leaves, oil, and other debris. Clean the radiator, if necessary.

⚠ WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction to the fan’s air flow. Hold the nozzle approximately 6 mm (0.25 inch) away from the radiator fins. Slowly move the air nozzle in a direction that is parallel with the radiator tube assembly. This will remove debris that is between the tubes.

Pressurized water may also be used for cleaning. The maximum water pressure for cleaning purposes must be less than 275 kPa (40 psi). Use pressurized water in order to soften mud. Clean the core from both sides.

Use a degreaser and steam for removal of oil and grease. Clean both sides of the core. Wash the core with detergent and hot water. Thoroughly rinse the core with clean water.

If the radiator is blocked internally, refer to the OEM Manual for information regarding flushing the cooling system.

After cleaning the radiator, start the engine. Allow the engine to operate at low idle speed for three to five minutes. Accelerate the engine to high idle. This will help in the removal of debris and the drying of the core. Slowly reduce the engine speed to low idle and then stop the engine. Use a light bulb behind the core in order to inspect the core for cleanliness. Repeat the cleaning, if necessary.

Inspect the fins for damage. Bent fins may be opened with a “comb”. Inspect these items for good condition: Welds, mounting brackets, air lines, connections, clamps, and seals. Make repairs, if necessary.

i02335775

Severe Service Application - Check

Severe service is the application of an engine that exceeds the current published standards for that engine. Perkins maintains standards for the following engine parameters:

Product and Dealer Information

Note: For product identification plate locations, see the section “Product Identification Information” in the Operation and Maintenance Manual.

Delivery Date: _____

Product Information

Model: _____

Product Identification Number: _____

Engine Serial Number: _____

Transmission Serial Number: _____

Generator Serial Number: _____

Attachment Serial Numbers: _____

Attachment Information: _____

Customer Equipment Number: _____

Dealer Equipment Number: _____

Dealer Information

Name: _____ Branch: _____

Address: _____

_____

_____

	Dealer Contact	Phone Number	Hours
Sales:	_____	_____	_____
Parts:	_____	_____	_____
Service:	_____	_____	_____

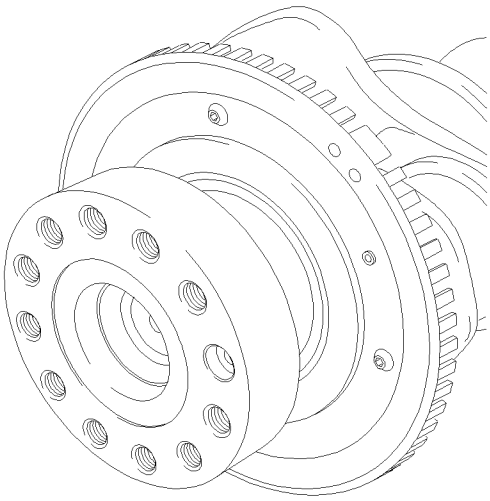


Illustration 8 g01205646

Vibration Damper

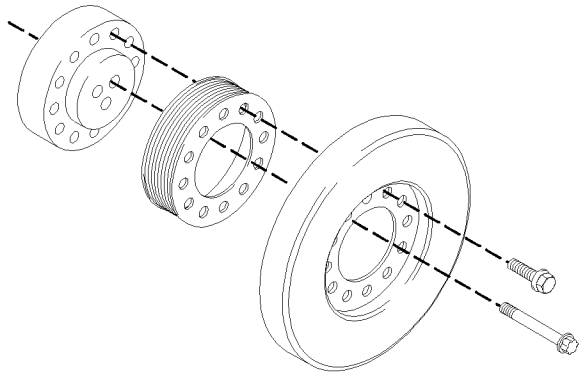


Illustration 9 g01180539

Typical example

The force from combustion in the cylinders will cause the crankshaft to twist. This is called torsional vibration. If the vibration is too great, the crankshaft will be damaged. The vibration damper is filled with viscous fluid in order to limit the torsional vibration.

Gears and Timing Gear Case

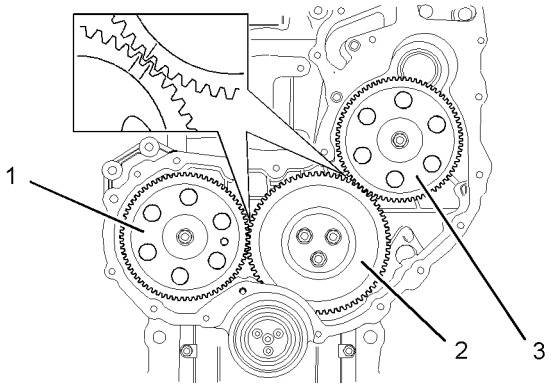


Illustration 10 g01194949

The crankshaft oil seal is mounted in the aluminum timing case. The timing case cover is made from pressed steel.

The timing gears are made of steel.

The crankshaft gear drives an upper idler gear and a lower idler gear. The upper idler gear drives the camshaft and the fuel injection pump. The lower idler gear drives the oil pump. The water pump drive gear is driven by the fuel injection pump gear.

The camshaft and the fuel injection pump rotate at half the engine speed.

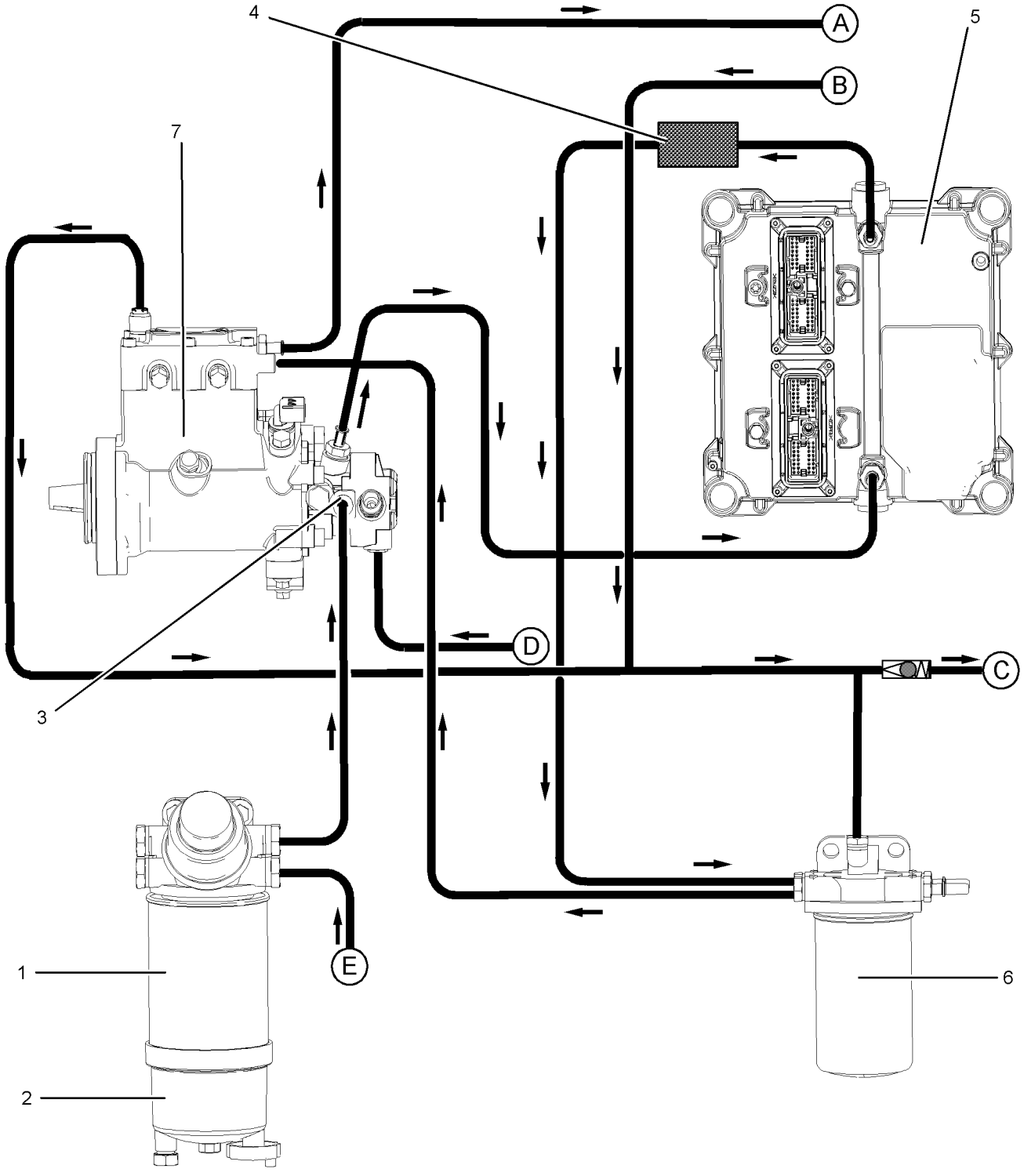
Camshaft

The engine has a single camshaft. The camshaft is made of cast iron. The camshaft lobes arechill hardened.

The camshaft is driven at the front end. As the camshaft turns, the camshaft lobes move the valve system components. The valve system components move the cylinder valves.

The camshaft gear must be timed to the crankshaft gear. The relationship between the lobes and the camshaft gear causes the valves in each cylinder to open at the correct time. The relationship between the lobes and the camshaft gear also causes the valves in each cylinder to close at the correct time.

Low Pressure Fuel System



g01360010

Illustration 20

Low pressure fuel system (typical example)

(1) Primary fuel filter
(2) Water separator
(3) Fuel transfer pump
(4) Fuel cooler (if equipped)
(5) ECM
(6) Secondary fuel filter
(7) Fuel injection pump
(A) Outlet for high pressure fuel to the fuel manifold (rail)
(B) Return from the pressure relief valve on the fuel manifold (rail)
(C) Return to fuel tank
(D) Return from the electronic unit injectors
(E) The fuel inlet from the fuel tank

ECM

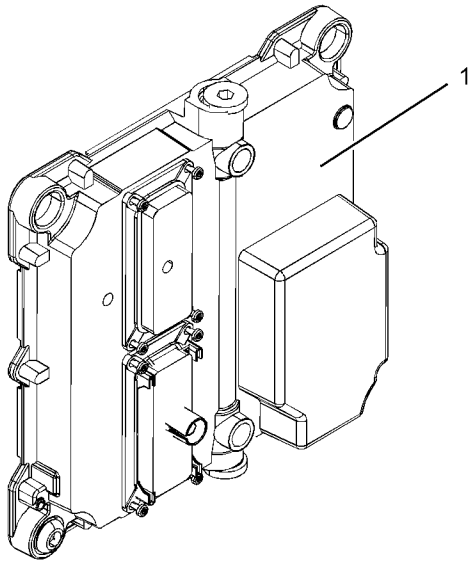


Illustration 32 g01199973

Typical example

The Electronic Control Module (ECM) (1) functions as a governor and a computer for the fuel system. The ECM receives signals from the sensors in order to control the timing and the engine speed.

The electronic system consists of the ECM, the engine sensors and inputs from the parent machine. The ECM is the computer. The flash file is the software for the computer. The flash file defines the following characteristics of the engine:

- Engine power
- Torque curves
- Engine speed (rpm)
- Engine Noise
- Smoke and Emissions

The factory passwords restrict changes to authorized personnel. Factory passwords are required to clear any event code. Refer to the following Troubleshooting, “Factory Passwords” for more information on the passwords.

The ECM has an excellent record of reliability. Any problems in the system are most likely to be the connectors and the wiring harness. The ECM should be the last item in troubleshooting the engine.

The flash file contains the software with all the fuel setting information. The information determines the engine performance.

Flash programming is the method of programming or updating the flash file. Refer to the following Troubleshooting, “Flashing Programming ” for the instructions on the flash programming of the flash file.

The ECM is sealed and the ECM needs no routine adjustment or maintenance.

Engine Speed Governor

The electronic controls determine the injection timing, the amount of fuel that is delivered to the cylinders and the intake manifold pressure if an electronically controlled wastegate is installed on the turbocharger. These decisions are based on the actual conditions and the desired conditions at any given time.

The governor has software that compares the desired engine speed to the actual engine speed. The actual engine speed is determined through the primary speed/timing sensor and the secondary speed/timing sensor. If the desired engine speed is greater than the actual engine speed, the governor injects more fuel in order to increase engine speed.

Timing Considerations

Fuel injection timing is determined by the ECM after considering input from the following components:

- Engine coolant temperature sensor
- The sensor for the intake manifold air temperature
- The sensor for the intake manifold pressure
- Speed/timing sensors

At start-up, the ECM determines the top center position of the number 1 cylinder from the secondary speed/timing sensor in the fuel injection pump. The ECM decides when fuel injection should occur relative to the top center position. The ECM optimizes engine performance by control of each of the electronic unit injectors so that the required amount of fuel is injected at the precise point of the engine’s cycle. The electronic unit injectors are supplied high pressure fuel from the fuel injection pump. The ECM also provides the signal to the solenoid in the fuel injection pump. The solenoid in the fuel injection pump controls a valve in the fuel injection pump. This valve controls the pressure in the fuel injection pump. Fuel that is not required for the engine is diverted away from the fuel injection pump back to the fuel tank.

The ECM adjusts injection timing and fuel pressure for the best engine performance, the best fuel economy and the best control of exhaust emissions. The actual timing can be viewed with an electronic service tool. Also, the desired timing can be viewed with an electronic service tool.

Glow Plug – The glow plug is an optional starting aid for cold conditions. One glow plug is installed in each combustion chamber in order to improve the ability of the engine to start. The ECM uses information from the engine sensors such as the engine temperature to determine when the glow plug relay must provide power to each glow plug. Each of the glow plugs then provides a very hot surface in the combustion chamber in order to vaporize the mixture of air and fuel. This improves ignition during the compression stroke of the cylinder.

Glow Plug Relay – The glow plug relay is controlled by the ECM in order to provide high current to the glow plugs that are used in the starting aid system.

Harness – The harness is the bundle of wiring (loom) that connects all components of the electronic system.

Hertz (Hz) – Hertz is the measure of frequency in cycles per second.

High Pressure Fuel Rail Pump – See “Fuel Rail Pump”.

High Pressure Fuel Rail Pump Solenoid Valve – See “Fuel Rail Pump Solenoid Valve”.

High Pressure Fuel Rail – See “Fuel Rail”.

Injector Trim Files – Injector trim files are downloaded from a disk to the ECM. The injector trim files compensate for variances in manufacturing of the electronic unit injector. The serial number for the electronic unit injector must be obtained in order to retrieve the correct injector trim file.

Inlet Manifold Air Temperature Sensor – The inlet manifold air temperature sensor detects the air temperature in the inlet manifold. The ECM monitors the air temperature and other data in the inlet manifold in order to adjust injection timing and other performance functions.

Integrated Electronic Controls – The engine is designed with the electronic controls as a necessary part of the system. The engine will not operate without the electronic controls.

Intake Manifold Pressure Sensor – The Intake Manifold Pressure Sensor measures the pressure in the intake manifold. The pressure in the intake manifold may be different to the pressure outside the engine (atmospheric pressure). The difference in pressure may be caused by an increase in air pressure by a turbocharger (if equipped).

J1939 CAN Data Link – Logged diagnostic codes are codes which are stored in the memory. These codes are meant to be an indicator of possible causes for intermittent problems. Refer to the term “Diagnostic Code” in this glossary for more information.

Open Circuit – An open circuit is a condition that is caused by an open switch, or by an electrical wire or a connection that is broken. When this condition exists, the signal or the supply voltage can no longer reach the intended destination.

OEM – OEM is an abbreviation for the Original Equipment Manufacturer. This is the manufacturer of the machine or the vehicle that uses the engine.

Parameter – A parameter is a value or a limit that is programmable. This helps determine specific characteristics or behaviors of the engine.

Parameter Identifier (PID) – A PID is a numerical code that contains two digits or three digits. A numerical code is assigned to each component. The numerical code identifies data via the data link to the ECM.

Password – A password is a group of numeric characters or a group of alphanumeric characters that is designed to restrict access to parameters. The electronic system requires correct passwords in order to change some parameters (Factory Passwords). Refer to Troubleshooting, “Factory Passwords” for more information.

Programmable Software – The software is programmed into the ECM. The software contains all the instructions (software) for the ECM and the software contains the performance maps for a specific engine. The software may be reprogrammed through flash programming.

Power Cycled – Power cycled happens when power to the ECM is cycled: ON, OFF, and ON. Power cycled refers to the action of cycling the keyswitch from any position to the OFF position, and to the START/RUN position.

Primary Speed/Timing Sensor – This sensor determines the position of the crankshaft during engine operation. If the primary speed/timing sensor fails during engine operation, the secondary speed/timing sensor is used to provide the signal.

Pulse Width Modulation (PWM) – The PWM is a signal that consists of pulses that are of variable width. These pulses occur at fixed intervals. The ratio of “TIME ON” versus total “TIME OFF” can be varied. This ratio is also referred to as a duty cycle.

2. Ensure that the crankshaft and the camshaft are locked in the correct position. Refer to Disassembly and Assembly, “Gear Group (Front) - Remove and Install” for the correct procedure. Ensure that the fuel injection pump is locked in the correct position. Refer to Disassembly and Assembly, “Fuel Injection Pump - Remove” for the correct procedure.

3. Install the idler gear (2). Refer to Disassembly and Assembly, “Idler Gear - Remove and Install” for the correct procedure.

4. Install the fuel injection pump gear (3). Refer to Disassembly and Assembly, “Fuel Injection Pump Gear - Install” for the correct procedure.

5. Make sure that the timing marks on the gears (1), (2) and (3) are in alignment. If the timing marks are not aligned, refer to Disassembly and Assembly, “Gear Group (Front) - Remove and Install”.

Lubrication System

i02648880

Engine Oil Pressure - Test

Low Oil Pressure

The following conditions will cause low oil pressure.

- The oil level is low in the crankcase.
- A restriction exists on the oil suction screen.
- Connections in the oil lines are leaking.
- The connecting rod or the main bearings are worn.
- The rotors in the oil pump are worn.
- The oil pressure relief valve is operating incorrectly.

A worn oil pressure relief valve can allow oil to leak through the valve which lowers the oil pressure.

The minimum oil pressure at the maximum engine speed and at normal operating temperature is 315 kPa (45 psi). A lower pressure is normal at low idle.

A suitable pressure gauge can be used in order to test the pressure of the lubrication system.

High Oil Pressure

High oil pressure can be caused by the following conditions.

- The spring for the oil pressure relief valve is installed incorrectly.
- The plunger for the oil pressure relief valve becomes jammed in the closed position.
- Excessive sludge exists in the oil which makes the viscosity of the oil too high.

i02400036

Engine Oil Pump - Inspect

If any part of the oil pump is worn enough in order to affect the performance of the oil pump, the oil pump must be replaced.

Perform the following procedures in order to inspect the oil pump. Refer to the Specifications Module, “Engine Oil Pump” for clearances and torques.

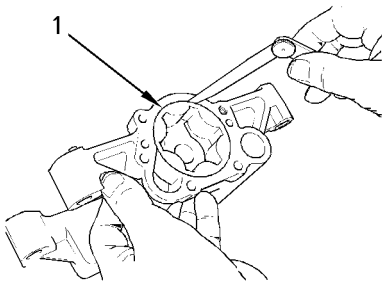


Illustration 57 g00938064

1. Remove the oil pump from the engine. Remove the cover of the oil pump.
2. Remove the outer rotor (1). Clean all of the parts. Look for cracks in the metal or other damage.
3. Install the outer rotor. Measure the clearance of the outer rotor to the body .

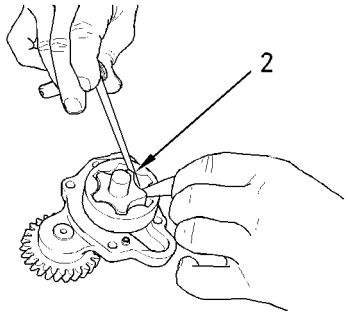


Illustration 58 g00938061

Clearance for the inner rotor body

4. Measure the clearance of the inner rotor to the outer rotor (2).

- New connecting rod assemblies that are the correct grade of length must be installed. Refer to “Length Of The Connecting Rod”.
- New piston pin bearings must be bored after installation in the original connecting rods. Refer to “Piston Pin Bearings”.

Note: When the piston pin is installed, always install new retaining rings on each end of the piston pin. If the piston pin cannot be removed by hand, heat the piston to a temperature of 45° ± 5 °C (113° ± 9 °F) in order to aid the removal of the piston pin. Heating the piston to this temperature may also aid the installation of the piston pin.

Length of The Connecting Rod

The connecting rod length (CRL) is the length of the connecting rod. Refer to Table 10 for each grade of length of connecting rod.

In order to ensure that the piston height above the cylinder block is correct, three grades of connecting rods “F” to “L” are used during manufacture at the factory. Replacement connecting rods are available in three grades. These grades of connecting rod are “F” to “L”. The grade of length is identified by a letter or a color which is marked on the side of the connecting rod. The longest grade is marked with the letter “F”. The shortest grade is marked with the letter “L”. The difference in length between each grade of connecting rods is the following value: 0.076 mm (0.0030 inch)

The grade of length of a connecting rod is determined in the factory by machining an eccentric hole in a semi-finished piston pin bushing. Therefore, the grade of length is determined by the position of the center of the hole in the piston pin bearing.

If the connecting rod must be replaced, a new connecting rod assembly must be purchased and installed. Refer to Table 10 for more information.

A new piston pin bearing is installed in the new connecting rod at the factory. The bore of the piston pin bearing is reamed to the correct eccentricity.

Piston Pin Bearings

Note: This procedure requires personnel with the correct training and the use of specialized equipment for machining.

If the piston pin bearing requires replacement but the original connecting rod is not replaced, the following procedures must be performed:

1. Determine the grade of length of the connecting rod. Use one of the following characteristics:
   - The mark
   - The color
   - Measuring the length
2. Ensure that the connecting rod is aligned parallel and that the connecting rod is not distorted. Refer to “Distortion Of A Connecting Rod” in this service module.
3. Remove the piston pin bearing from the connecting rod. Install a new bearing in the connecting rod. The new bearing is partially finished. The new bearing must be bored off-center to the correct diameter. This off-center position is determined by the grade of length of the connecting rod. Refer to Table 10. The correct diameter of the bore in the piston pin bearing is given in the Specifications Module, “Connecting Rod”.

   Surface finish of the bored hole in the piston pin bearing ..... Ra 0.8 micrometers
4. Machine the ends of the piston pin bearing to the correct length. Remove any sharp edges. Refer to the Specifications Module, “Connecting Rod”.
5. If the grade of length of the connecting rod is changed, the letter that is stamped on the connecting rod must be removed. Etch a letter that is for the new grade of length on the side of the connecting rod.

Note: Do not stamp a new letter on the connecting rod. The force of stamping may damage the connecting rod.

Table 10 references the following information: Grade of letter of the connecting rod, the color code of the connecting rods, and the lengths of the connecting rods.

Table 10

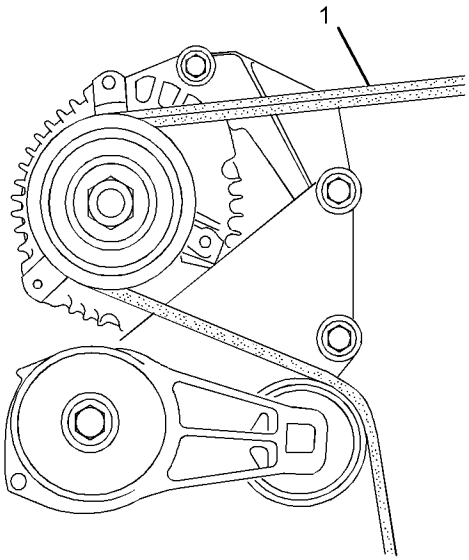
Length Grades for Connecting Rods		
Grade Letter	**Color Code**	**Length Of The Connecting Rod (CRL)**
F	Red	161.259 to 161.292 mm (6.3488 to 6.3501 inch)
J	Green	161.183 to 161.216 mm (6.3458 to 6.3471 inch)
L	Blue	161.107 to 161.140 mm (6.3428 to 6.3441 inch)

Measure The Length Of The Connecting Rod

If the mark or the color of the grade of length cannot be observed on the connecting rod, perform the following procedure:

Poly V-Belt

NOTICE
Ensure that the engine is stopped before any servicing or repair is performed.



g01344345

Illustration 78
Typical example

To maximize the engine performance, inspect the poly v-belt (1) for wear and for cracking. Replace the poly v-belt if the belt is worn or damaged.

- Check the poly v-belt (1) for cracks, splits, glazing, grease, and splitting.
- If the poly v-belt (1) has more than four cracks per 25.4 mm (1.00 inch) the belt must be replaced.

To replace the poly v-belt, refer to Disassembly and Assembly Manual, “Alternator Belt - Remove and Install”. If necessary, replace the belt tensioner. Refer to Disassembly and Assembly Manual, “Alternator Belt - Remove and Install” for the correct procedure.

i02399802

Electric Starting System - Test

General Information

All electrical starting systems have four elements:

- Keyswitch
- Start relay
- Starting motor solenoid
- Starting motor

Keyswitches have a capacity of 5 to 20 amperes. The coil of a start relay draws about 1 ampere between test points. The switch contacts of the start relay for the starting motor are rated between 100 and 300 amperes. The start relay can easily switch the load of 5 to 50 amperes for the starting motor solenoid.

The starting motor solenoid is a switch with a capacity of about 1000 amperes. The starting motor solenoid supplies power to the starter drive. The starting motor solenoid also engages the pinion to the flywheel.

The starting motor solenoid has two coils. The pull-in coil draws about 40 amperes. The hold-in coil requires about 5 amperes.

When the magnetic force increases in both coils, the pinion gear moves toward the ring gear of the flywheel. Then, the solenoid contacts close in order to provide power to the starting motor. When the solenoid contacts close, the ground is temporarily removed from the pull-in coil. Battery voltage is supplied on both ends of the pull-in coil while the starting motor cranks. During this period, the pull-in coil is out of the circuit.

Cranking of the engine continues until current to the solenoid is stopped by releasing the keyswitch.

Power which is available during cranking varies according to the temperature and condition of the batteries. Table 16 shows the voltages which are expected from a battery at the various temperature ranges.

Table 16

Typical Voltage Of Electrical System During Cranking At Various Ambient Temperatures		
Temperature	**12 Volt System**	**24 Volt System**
−23 to −7°C (−10 to 20°F)	6 to 8 volts	12 to 16 volts
−7 to 10°C (20 to 50°F)	7 to 9 volts	14 to 18 volts
10 to 27°C (50 to 80°F)	8 to 10 volts	16 to 24 volts

Table 17 shows the maximum acceptable loss of voltage in the battery circuit. The battery circuit supplies high current to the starting motor. The values in the table are for engines which have service of 2000 hours or more.

Disassembly and Assembly Section

i02654356

Fuel Priming Pump - Remove and Install (Mechanical Priming Pump)

Removal Procedure

NOTICE

Ensure that all adjustments and repairs that are carried out to the fuel system are performed by authorised personnel that have the correct training.

Before begining ANY work on the fuel system, refer to Operation and Maintenance Manual, "General Hazard Information and High Pressure Fuel Lines" for safety information.

Refer to System Operation, Testing and Adjusting, "Cleanliness of Fuel System Components" for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

1. Isolate the fuel supply.
2. Make a temporary identification mark on plastic tube assemblies (1) in order to show the correct position of the tube assemblies.
3. Place a suitable container below the fuel priming pump in order to catch any fuel that might be spilled. Drain the primary filter (7). Refer to Operation and Maintenance Manual, "Fuel System Primary Filter (Water Seperator) Element - Replace".

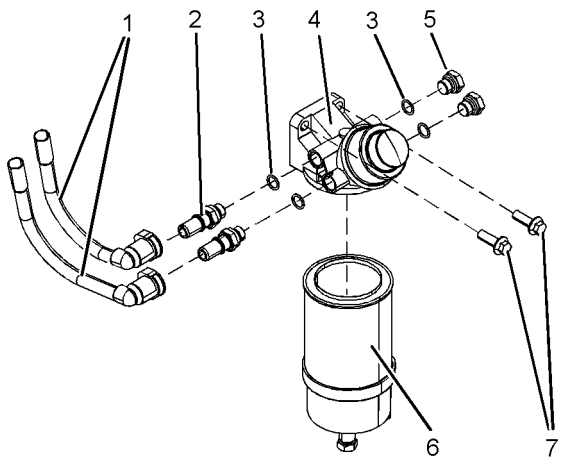


Illustration 1 g01334872

Typical example

4. Disconnect plastic tube assemblies (1). Plug the tube assemblies with new plugs. Cap open connectors (2) on the fuel priming pump with new caps.
5. Remove primary filter (6) from fuel priming pump (4). Refer to Operation and Maintenance, "Fuel System Primary Filter (Water Seperator) Element - Replace".
6. Remove bolts (7) from fuel priming pump (4). Remove fuel priming pump (4) from the mounting bracket.
7. If necessary, follow Steps 7.a through 7.c in order to disassemble fuel priming pump (4).
   a. Remove connectors (2) from fuel priming pump (4).
   b. Remove plugs (5) from fuel priming pump (4).
   c. Remove O-ring seals (3) from connectors (2) and plugs (5).

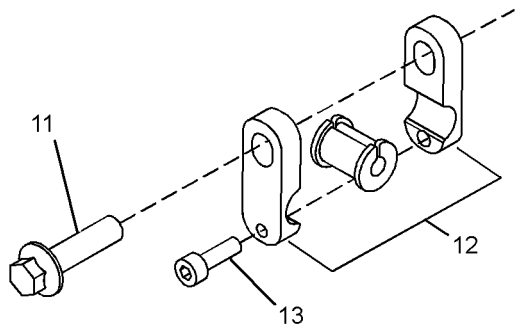


Illustration 18 g01335197

14. Remove bolts (11) from tube clips (12) that secure fuel injection line (6). Loosen allen head screws (13). Position the tube clips in order to allow removal of the fuel injection line.

15. Disconnect fuel injection line (6) at fuel injection pump (7).

16. Disconnect fuel injection line (6) at fuel manifold (4).

17. Plug all open ports immediately. Use Tooling (A) in order to plug the open ports in fuel manifold (4) and in fuel injection pump (7).

18. Remove fuel injection line (6).

19. Remove allen head screws (13) and tube clips (12) from fuel injection line (6). Discard the fuel injection line.

i02654497

Fuel Injection Lines - Install

Installation Procedure

Table 2

Required Tools			
Tool	Part Number	Part Name	Qty
A	27610294	Injector Pipe Nut Tool	1

NOTICE

Ensure that all adjustments and repairs that are carried out to the fuel system are performed by authorised personnel that have the correct training.

Before begining ANY work on the fuel system, refer to Operation and Maintenance Manual, "General Hazard Information and High Pressure Fuel Lines" for safety information.

Refer to System Operation, Testing and Adjusting, "Cleanliness of Fuel System Components" for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

Note: The following procedure should be adopted in order to install the fuel injection lines when the electronic unit injectors or the fuel manifold have not been removed. If the electronic unit injectors or the fuel manifold have been removed, refer to Disassembly and Assembly, "Electronic Unit Injector - Install" and Disassembly and Assembly, "Fuel Manifold - Install" for more information.

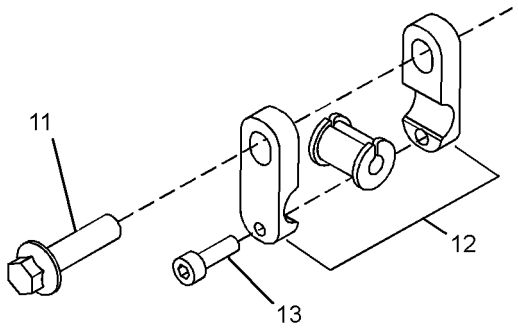


Illustration 19 g01335197

Assembly of the tube clip

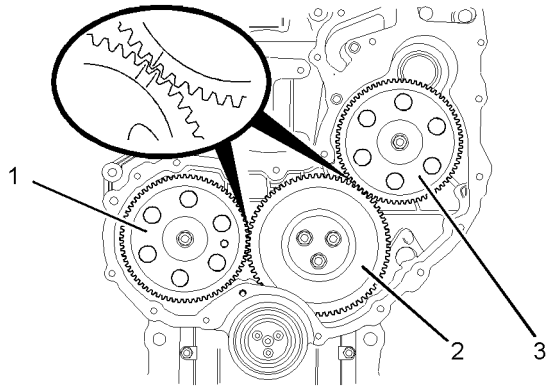


Illustration 38 g01335384

Alignment of timing marks

7. Install fuel pump gear (3) to shaft (9) of the fuel injection pump. Ensure that the timing marks on gears (2) and (3) are in alignment and that the mesh of the gears is correct.

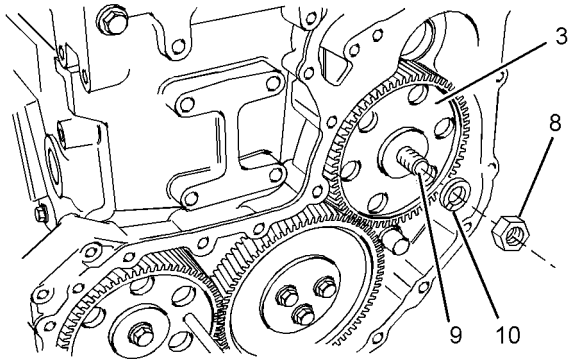


Illustration 39 g01335395

Typical example

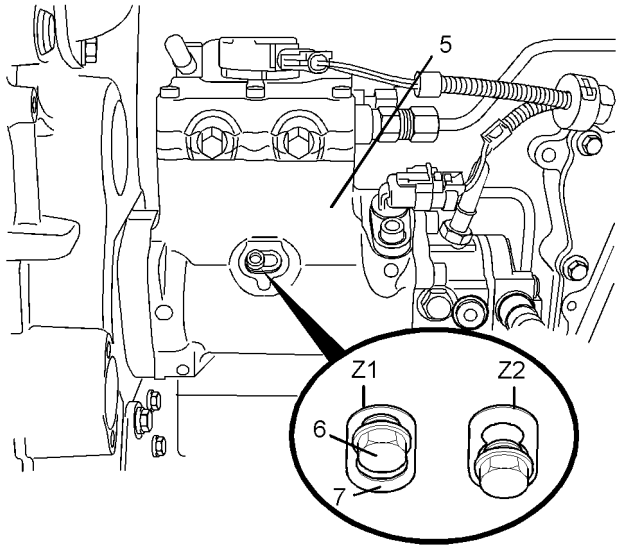


Illustration 40 g01335382

Typical example

8. Install a new spring washer (10) and install nut (8) to shaft (9) of the fuel injection pump. Apply sufficient pressure to fuel injection pump gear (3) in a counterclockwise direction in order to remove the backlash. Tighten nut (8) to a torque of 25 N·m (18 lb ft). Unlock the fuel injection pump (5).

In order to unlock fuel injection pump (5), loosen the locking bolt (5) in the fuel injection pump. Slide spacer (7) into position (Z1). Tighten locking bolt (6) against the spacer to a torque of 9 N·m (80 lb in). This will prevent the locking bolt from tightening against the shaft of the fuel injection pump.

9. Remove Tooling (B) and (C). Install plug (4) into hole (Y) in the cylinder block. Refer to Illustration 36.

10. Tighten nut (8) to a torque of 90 N·m (66.4 lb ft).

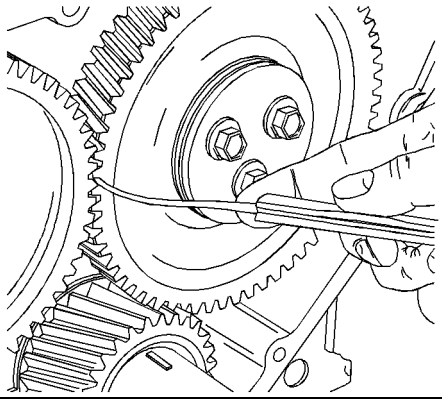


Illustration 41 g01335426

Typical example

11. Ensure that the backlash for gears (2) and (3) is within specified values. Refer to the Specifications, “Gear Group (Front)” for further information.

12. Lubricate the teeth of the gears with clean engine oil.

End By:

a. Install the front cover. Refer to Disassembly and Assembly, “Front Cover - Remove and Install”.

1. Disconnect the air hose for the turbocharger inlet and for the turbocharger outlet.

2. If the turbocharger has a remote wastegate solenoid, disconnect the hose to the solenoid from the turbocharger.

3. Disconnect the exhaust pipe.

4. If the turbocharger has an exhaust elbow, remove the exhaust elbow. Refer to Disassembly and Assembly, “Exhaust Elbow - Remove and Install”.

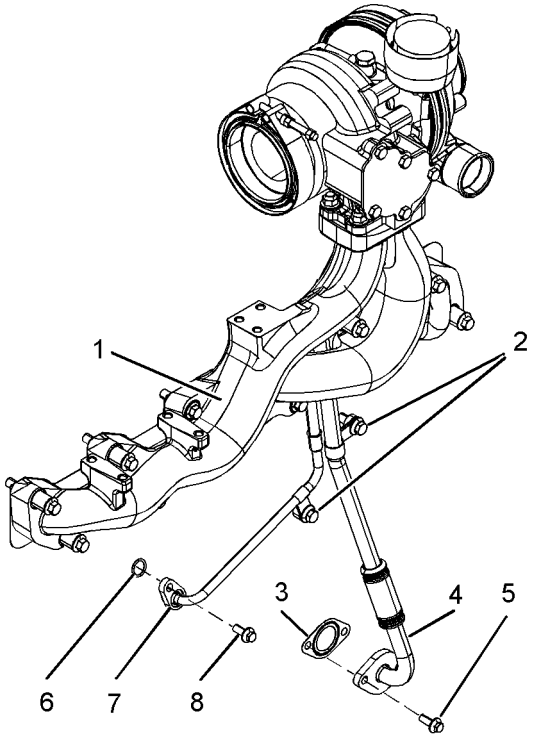


Illustration 62 g01335754

5. Remove bolts (5) in order to disconnect tube assembly (4) from the cylinder block. Remove joint (3).

6. Remove bolt (8) in order to disconnect tube assembly (7) from the cylinder block.

7. Remove the bolts for tube clips (2).

8. Loosen nuts (11). Refer to Illustration 63.

9. Remove exhaust manifold (1) and the assembly of the turbocharger from the cylinder head. Refer to Disassembly and Assembly, “Exhaust Manifold - Remove and Install” for the correct procedure.

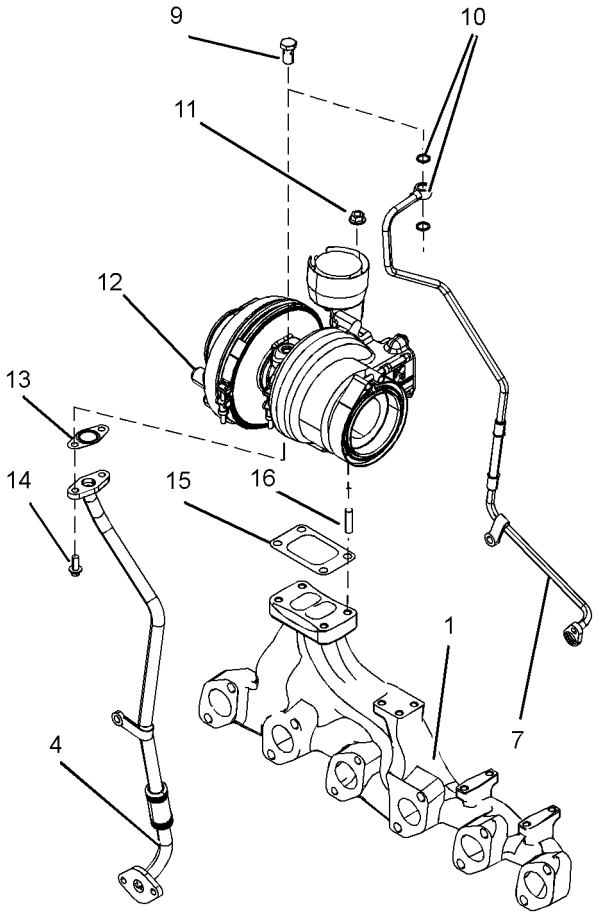


Illustration 63 g01335756

10. Remove banjo bolt (9) and remove tube assembly (7) for the oil feed from turbocharger (12). Remove sealing washers (10).

11. Remove O-ring seal (6) from tube assembly (7). Refer to Illustration 62.

12. Remove bolts (14) and remove tube assembly (4) for the oil drain from turbocharger (12).

13. Remove joint (13).

14. Remove nuts (11) and remove turbocharger (12) from exhaust manifold (1).

Note: Ensure that the exhaust manifold and the turbocharger are adequately supported during the removal of the turbocharger.

15. Remove joint (15) from the exhaust manifold (1).

16. If necessary, remove studs (16) from exhaust manifold (1).

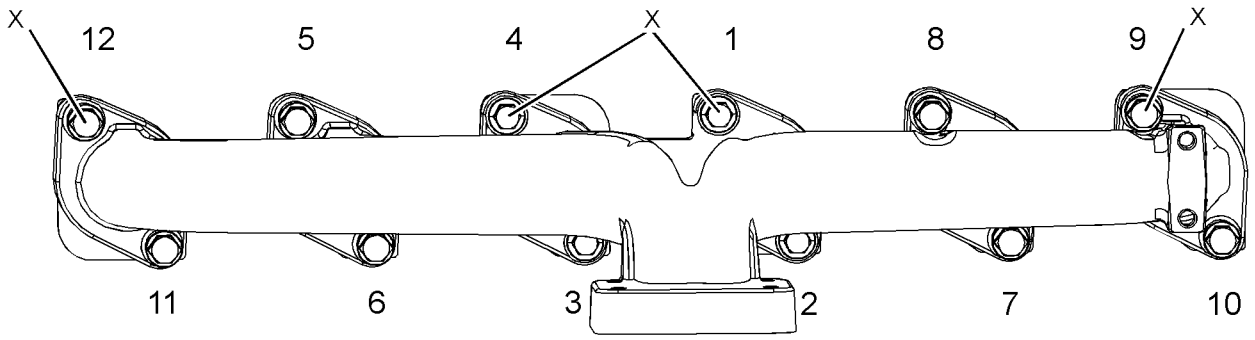


Illustration 78 g01335790

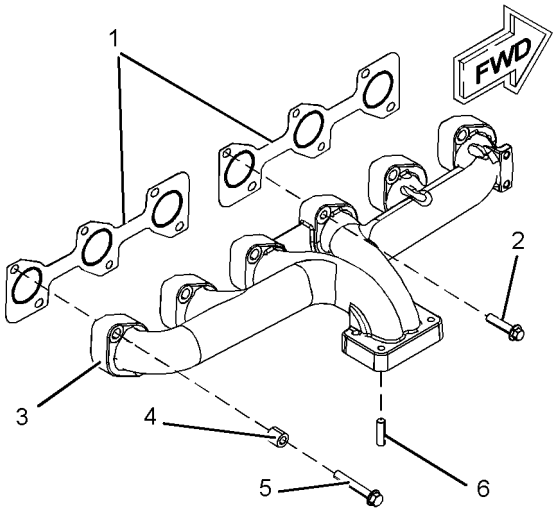


Illustration 79 g01335788

1. Ensure that the exhaust manifold is clean and free from damage. If necessary, replace the exhaust manifold. Clean the joint face of the cylinder head.

2. If necessary, install studs (6) to exhaust manifold (3). Tighten the studs to a torque of 18 N·m (13 lb ft).

3. Install Tooling (A) to the cylinder head in positions (X). Refer to Illustration 78.

4. Position two new exhaust manifold gaskets (1) onto Tooling (A).

Note: Ensure that the word TOP is outward and upward.

5. Align exhaust manifold (3) with Tooling (A). Install the exhaust manifold to the cylinder head.

6. If bolts (2) and (5) have been previously used, the bolts should be thoroughly cleaned. Tooling (B) should be applied to the first two threads of the bolts.

Note: Do not apply Tooling (B) to new bolts.

7. Install bolts (2) finger tight. Install bolts (5) and spacers (4) finger tight.

8. Remove Tooling (A). Install remaining bolts (2) finger tight. Install remaining bolts (5) and spacers (4) finger tight.

9. Tighten bolts (2) and (5) to a torque of 44 N·m (32 lb ft). Tighten the bolts in the sequence that is shown in Illustration 78.

End By:

a. Install the turbocharger. Refer to Disassembly and Assembly, “Turbocharger - Install”.

i02654362

Exhaust Manifold - Remove and Install (Top Mounted Exhaust Manifold)

Removal Procedure

1. Disconnect all hoses, tube assemblies and wire leads from the turbocharger. Refer to Disassembly and Assembly, “Turbocharger - Remove” Steps 1 through 7.

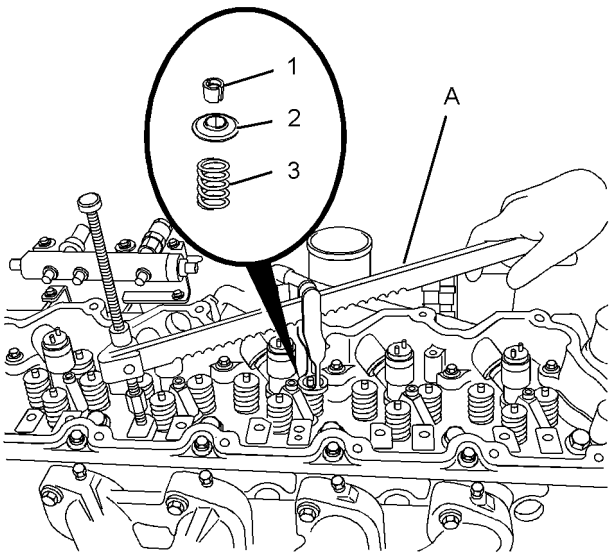


Illustration 93 g01335985

Typical example

4. Install Tooling (A) in position on the cylinder head in order to compress appropriate valve spring (3).

NOTICE
Ensure that the valve spring is compressed squarely or damage to the valve stem may occur.

5. Apply sufficient pressure to Tooling (A) in order to remove valve keepers (1).

Note: Do not compress the spring so that valve spring retainer (2) touches valve stem seal (4).

6. Slowly release pressure on Tooling (A).

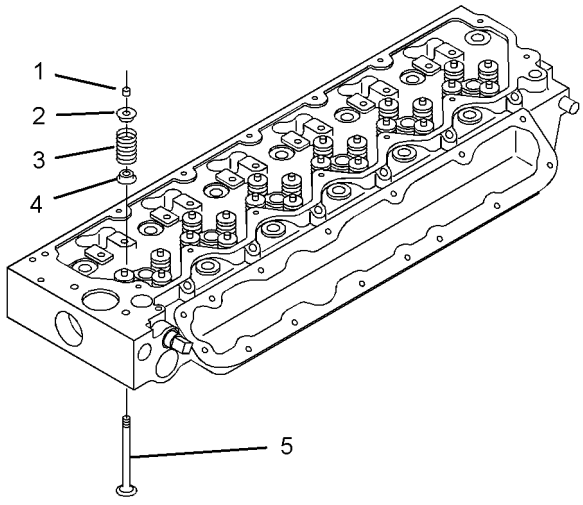


Illustration 94 g01335986

7. Remove valve spring retainer (2). Remove valve spring (3).

8. Repeat steps 4 to 7 for the remaining valves.

9. Remove Tooling (A).

10. Remove valve stem seals (4).

11. Use a suitable lifting device to carefully turn over the cylinder head.

12. Remove valves (5).

Installation Procedure

Table 19

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	21825666	Valve Spring Compressor	1
	27610235	Adapter	1
	27610295	Head	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Clean all components of the cylinder head assembly. Ensure that all ports, all coolant passages and all lubrication passages in the cylinder head are free from debris. Follow Steps 1.a through 1.d in order to inspect the components of the cylinder head assembly. Replace any components that are worn or damaged.

   a. Inspect the cylinder head for wear and for damage. Refer to System Operation, Testing and Adjusting, “Cylinder Head Inspect”.

   b. Inspect the valve seats for wear and for damage. Refer to Specifications, “Cylinder Head Valves” for further information.

   c. Inspect the valve guides for wear and for damage. Refer to Specifications, “Cylinder Head Valves” and System Operation, Testing and Adjusting, “Valve Guide - Inspect” for further information.

   d. Inspect the valves for wear and for damage. Refer to Specifications, “Cylinder Head Valves ”.

   e. Inspect valve springs (3) for damage and for the correct length. Refer to Specifications, “Cylinder Head Valves ”.

3. Tighten bolts (7) to a torque of 22 N·m (16 lb ft) in sequence that is shown in Illustration 112. Tighten remaining bolts that secure oil filter base to a torque of 22 N·m (16 lb ft).

4. Remove plugs from tube assembly (6). Remove caps for the fuel return from cylinder head and from transfer pump (5). Install tube assembly (6) to cylinder head and to transfer pump (5).

5. Follow Steps 5.a through 5.e in order to connect engine wiring harness (4).

   a. Place the harness in position.

   b. Connect engine wiring harness (3) to position sensor (1) for the fuel injection pump.

   c. Connect engine wiring harness (3) to oil pressure sensor (8).

   d. Reconnect wiring harness (3) to the solenoid for the fuel injection pump.

   e. Install new cable straps in order to secure engine wiring harness (3) to assembly of oil cooler (4).

6. Remove plugs from all plastic tube assemblies (2). Remove caps from appropriate ports. Install plastic tube assemblies (2).

7. Fill the cooling system to the correct level. Refer to Operation and Maintenance Manual, “Cooling System Coolant - Change” for the correct procedure.

8. Check level of engine lubricating oil. Refer to Operation and Maintenance Manual, “Engine Oil Level - Check” for the correct procedure.

End By:

a. Install the bracket for the Electronic Control Module. Refer to Disassembly and Assembly, “ECM Bracket - Remove”.

i02654488

Engine Oil Relief Valve - Remove and Install

Removal Procedure

Start By:

a. Remove the engine oil pan. Refer to Disassembly and Assembly, “Engine Oil Pan - Remove”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

⚠ WARNING

Personal injury can result from being struck by parts propelled by a released spring force.

Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

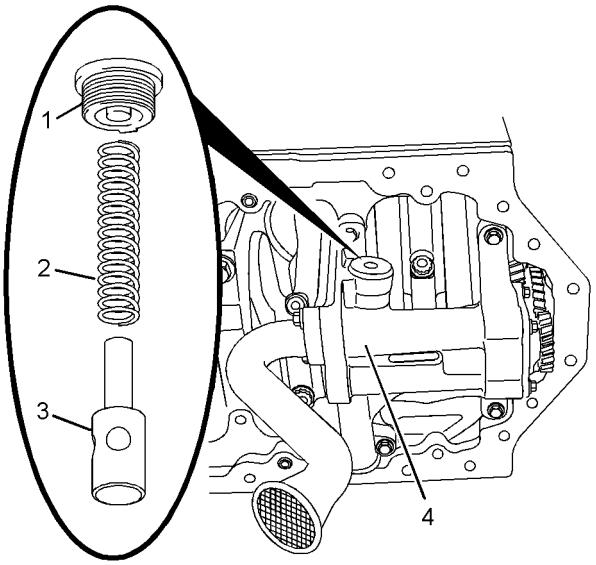


Illustration 113 g01336497

1. Use an allen wrench to loosen cap (1). Carefully remove cap (1) from the housing of engine oil pump (4).

Note: The spring force will be released when the cap is removed.

2. Remove spring (2) from the bore for the relief valve in the housing of engine oil pump (4).

3. Use long nose pliers to remove plunger (3) from the bore for the relief valve in the housing of engine oil pump (4).

i02654469

Crankshaft Rear Seal - Remove

Removal Procedure

Table 25

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	T40 Torx Socket	1
B	-	E12 Torx Socket	1

Start By:

a. Remove the flywheel housing. Refer to Disassembly and Assembly, “Flywheel Housing - Remove and Install”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

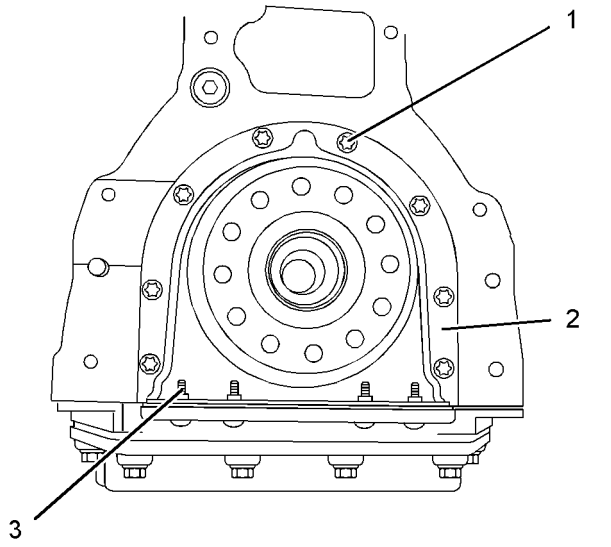


Illustration 131 g01337506
Typical example

Note: The assembly of the crankshaft rear seal is nonserviceable. If the assembly of the crankshaft rear seal is removed, the assembly must be replaced.

1. Use Tooling (B) in order to remove torx screws (1) from the assembly of crankshaft rear seal (2).

2. Use Tooling (A) in order to remove torx screws (3) from the assembly of the crankshaft rear seal.

3. Remove the assembly of crankshaft rear seal (2) from the cylinder block. Discard the assembly of crankshaft rear seal (2).

Note: It is not necessary to remove the adapter for the engine oil pan in order to remove the crankshaft rear seal.

i02662126

Crankshaft Rear Seal - Install

Installation Procedure With Oil Pan in Position

Table 26

Required Tools			
Tool	Part Number	Part Description	Qty
A	-	T40 Torx Socket	1
B	-	E12 Torx Socket	1

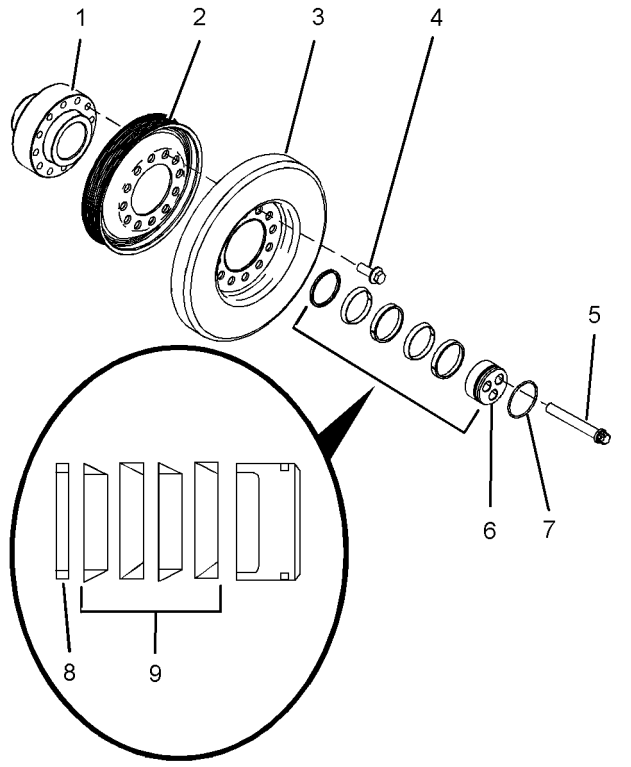


Illustration 151 g01337777

1. Install Tooling (A) into one of the unused threads in the assembly of the crankshaft pulley, the vibration damper and the crankshaft adapter.

2. Remove bolts (4).

3. Remove vibration damper (3) and crankshaft pulley (2) from crankshaft adapter (1). Remove Tooling (A) from crankshaft adapter (1).

4. Use a suitable tool in order to prevent the crankshaft from rotating. Use Tooling (B) to remove torx screws (5).

5. Hold a wood block against crankshaft adapter (1). Strike the wood block with a hammer in order to loosen split lock rings (9).

6. Carefully remove crankshaft adapter (1) from the crankshaft. Remove thrust block (6) from crankshaft adapter (1). Remove O-ring seal (7) from thrust block (6). Remove split lock rings (9) and spacer (8) from crankshaft adapter (1). Note the position and orientation of the split lock rings and the spacer.

i02654371

Vibration Damper and Pulley - Install (Pulleys without Split Lock Rings)

Installation Procedure

Table 33

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Guide Stud (M12 by 70 mm)	1
B	27610299	E18 Torx socket	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

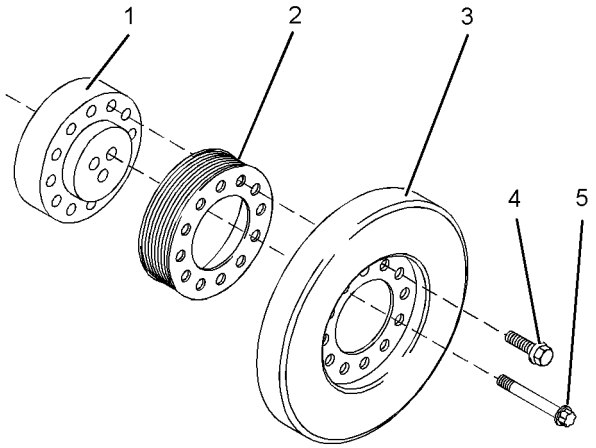


Illustration 152 g01337793

1. Ensure that the crankshaft adapter and the front of the crankshaft are clean and free from damage. Install crankshaft adapter (1) to the crankshaft.

2. Install torx screws (3) to crankshaft adapter (1).

3. Use a suitable tool in order to prevent the crankshaft from rotating. Use Tooling (B) to tighten the torx screws to a torque of 200 N·m (147 lb ft).

Note: The idler gear must be tilted during removal.

Removal Procedure (Latest Heavy-Duty Idler Gear)

Table 42

Required Tools			
Tool	**Part Number**	**Part Name**	**Qty**
A	27610212	Camshaft Timing Pin	1
B	27610211	Crankshaft Timing Pin	1
C	-	Bolt (M8x80mm)	1

Start By:

a. If the engine is equipped with an air compressor, remove the air compressor. Refer to Disassembly and Assembly, “Air Compressor - Remove and Install”.

b. If the engine is equipped with a vacuum pump, remove the vacuum pump. Refer to Disassembly and Assembly, “Vacuum Pump - Remove and Install”.

c. If the engine is equipped with an accessory drive, remove the accessory drive. Refer to Disassembly and Assembly, “Accessory Drive - Remove and Install”.

d. Remove the fuel injection pump gear. Refer to Disassembly and Assembly, “Fuel Pump Gear - Remove”.

e. Remove the valve mechanism cover. Refer to Disassembly and Assembly, “Valve Mechanism Cover - Remove and Install”.

Note: Care must be taken in order to ensure that the fuel injection pump timing is not lost during the removal of the fuel pump gear. Carefully follow the procedure in order to remove the fuel pump gear.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: The assembly of heavy-duty idler gear is not serviceable. Do not disassemble the heavy-duty idler gear.

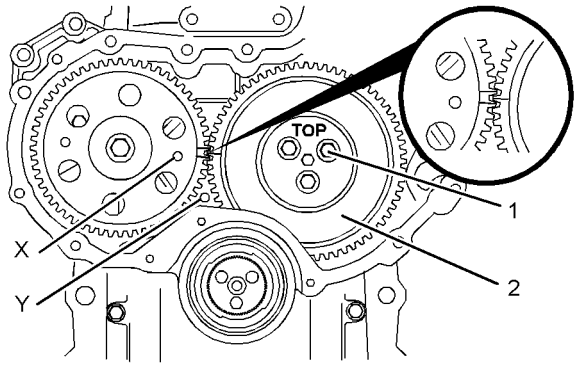


Illustration 176 g01343977
Alignment of timing marks

1. Ensure that Tooling (A) is installed into hole (X) in the camshaft gear. Use Tooling (A) in order to lock the camshaft in the correct position.

Note: Ensure that the gears are marked in order to show alignment. Refer to Illustration 176.

2. Ensure that Tooling (B) is installed in hole (Y) in the front housing. Use Tooling (B) in order to lock the crankshaft in the correct position.

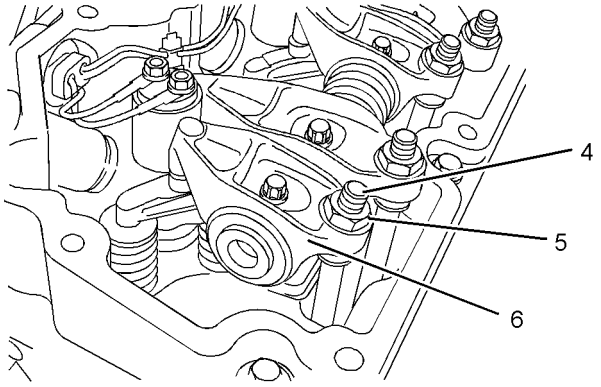


Illustration 177 g01337921
Typical example

3. Loosen nuts (5) on all rocker arms (6). Unscrew adjusters (4) on all rocker arms (5) until all valves are fully closed.

Note: Failure to ensure that ALL adjusters are fully unscrewed can result in contact between the valves and pistons.

4. Remove bolts (1) from the assembly of heavy-duty idler gear (2). Refer to Illustration 176.

b. Place accessory drive housing (8) onto a suitable support. Press the assembly of gear (4) and bearings (3) and (5) out of accessory drive housing (8). Use a suitable puller in order to remove bearings (3) and (5) from gear (4).

c. Remove O-ring seal (7) from accessory drive housing (8).

Installation Procedure

Table 47

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	21820603	POWERPART Retainer	-
B	21820221	POWERPART Rubber Grease	1
C	21820117	3 Bond 1386D	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

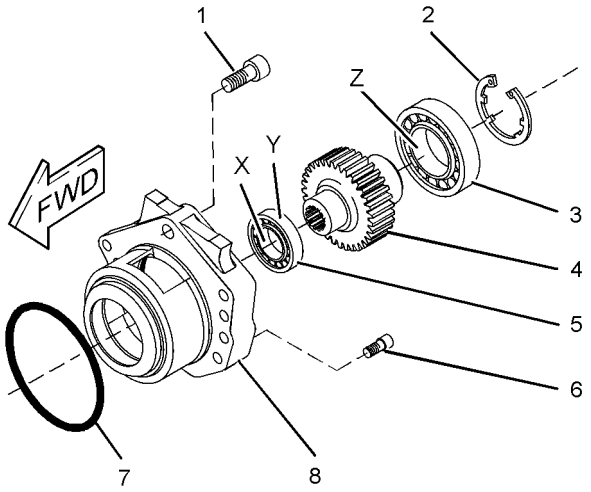


Illustration 205 g01339559

1. If necessary, follow Steps 1.a through 1.e in order to assemble the accessory drive.

a. Inspect the condition of the teeth and the splines of gear (4) for wear or damage. Inspect bearings (3) and (5), circlip (2), and the front housing for wear or damage. Replace any components that are worn or damaged.

b. Apply a small continuous bead of Tooling (A) to inner surface (X) of bearing (5). Place the gear shaft on a suitable support. Press on the inner race of bearing (5) until bearing (5) is against the shoulder of gear (4). Remove any excess sealant.

c. Apply a small continuous bead of Tooling (A) to inner surface (Z) of bearing (3). Place the front face of the inner race of bearing (3) onto a suitable support. Press the shaft of gear (4) into bearing (3) until the shoulder of the gear is against the bearing. Remove any excess sealant.

d. Apply a small continuous bead of Tooling (A) to outer surface (Y) of bearing (5). Place accessory drive housing (8) on a suitable support. Press the assembly of gear (4) and bearings (3) and (5) into the accessory drive housing . Ensure that bearing (5) is against the front face of the recess in accessory drive housing (8). Remove any excess sealant.

e. Install circlip (2) into the groove in accessory drive housing (8). Ensure that circlip (2) is correctly positioned in the groove.

2. Lightly lubricate a new O-ring seal (7) with Tooling (B) and install the O-ring seal into the groove in accessory drive housing (8).

3. Inspect the bore in the front housing for damage. If necessary, replace the front housing. Refer to Disassembly and Assembly, “Housing (Front) - Remove” and Disassembly and Assembly, “Housing (Front) - Install”.

4. Lightly lubricate bearing (3), bearing (5), and gear (4) with clean engine lubricating oil. Install the assembly of the accessory drive to the front housing.

5. Apply Tooling (C) to Allen head screws (1) and (6). Install Allen head screws (6) to accessory drive housing (8). Install Allen head screw (1) to accessory drive housing (8).

6. Tighten the Allen head screws to a torque of 22 N·m (16 lb ft).

7. Ensure that there is tactile backlash between the idler gear and the accessory drive gear.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Use a deep socket in order to remove the electrical connections from the electronic unit injectors. Use of incorrect tooling will result in damage to the electronic unit injectors.

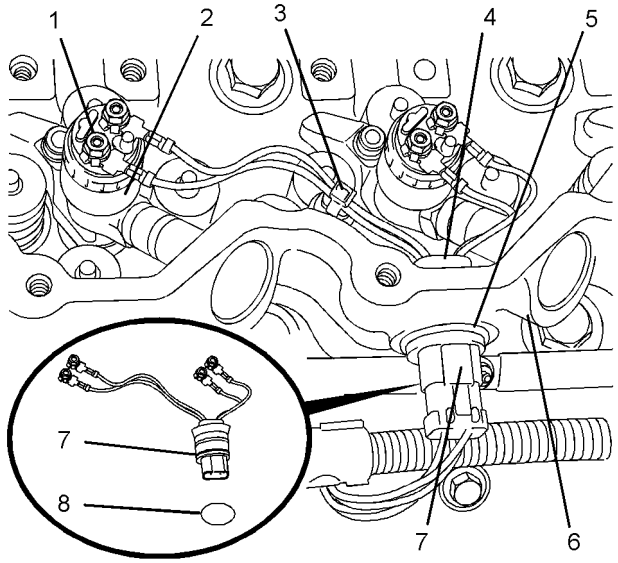


Illustration 226 g01355167
Typical example

1. Make a temporary identification mark on connections (1).
2. Use a deep socket to remove connections (1) from electronic unit injectors (2).
3. Disconnect plugs (7) from harness assemblies (4).
4. If necessary, follow Steps 4.a through 4.e in order to remove harness assemblies (4) from valve mechanism cover base (6).
   a. Cut cable strap (3).
   b. Use Tooling (A) to remove circlip (5).
   c. From the outside of valve mechanism cover base (6), push harness assembly (4) inward. Withdraw the harness assembly from valve mechanism cover base (6).
   d. Remove O-ring seal (8) from harness assembly (4).
   e. Repeat Steps 4.a through 4.d in order to remove the remaining harness assembly.

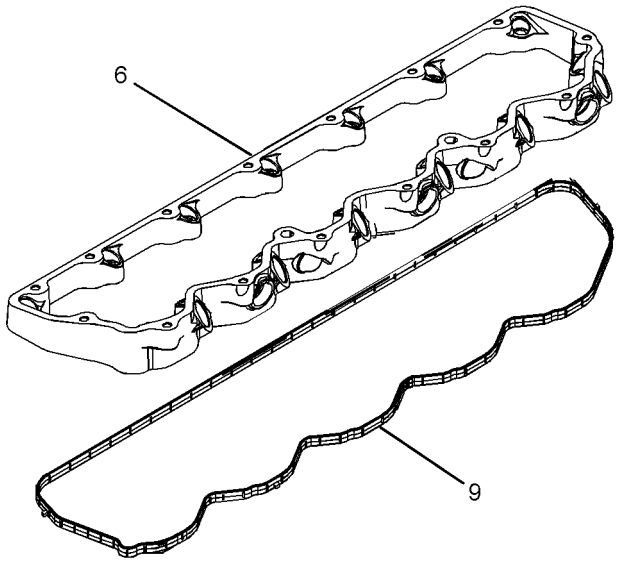


Illustration 227 g01354234
Typical example

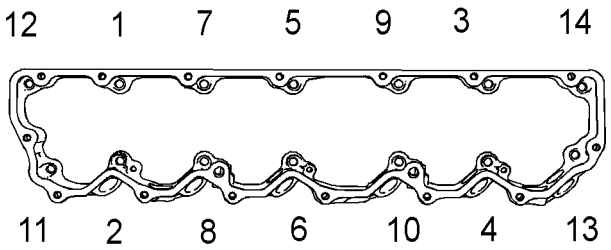


Illustration 228 g01354235
Sequence for loosening the valve mechanism cover base

5. Gradually loosen the captive bolts that secure the valve mechanism cover base in reverse numerical order. Refer to Illustration 228. This will help prevent distortion of the valve mechanism cover base.

Note: The captive bolts cannot be removed from the valve mechanism cover base.

6. Remove valve mechanism cover base (6) from the cylinder head.
7. Remove seal (9) from valve mechanism cover base (6).

2. Disconnect the upper radiator hose from water temperature regulator housing (1) on the cylinder head.

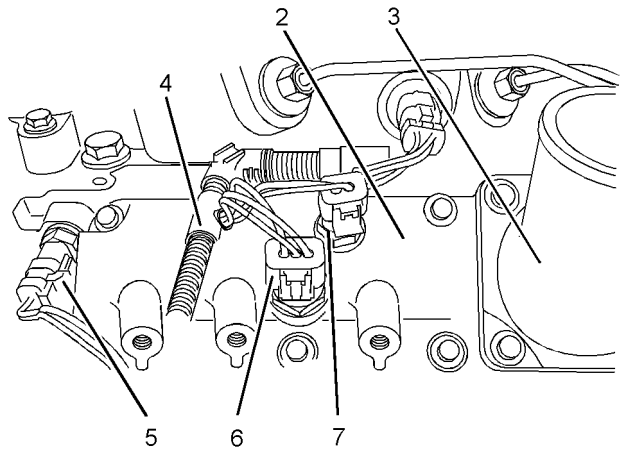


Illustration 250 g01340075
Typical example

3. Remove the air inlet hose from inlet connection (3) on inlet manifold (2).

4. Follow Steps 4.a and 4.b in order to disconnect harness assembly (4) from coolant temperature sensor (5).

a. Slide the locking tab into the unlocked position.

b. Disconnect harness assembly (4) from coolant temperature sensor (5).

5. Follow Steps 5.a and 5.b in order to disconnect harness assembly (4) from boost pressure sensor (6).

a. Slide the locking tab into the unlocked position.

b. Disconnect harness assembly (4) from boost pressure sensor (6).

6. Follow Steps 6.a and 6.b in order to disconnect harness assembly (4) from inlet air temperature sensor (7).

a. Slide the locking tab into the unlocked position.

b. Disconnect harness assembly (4) from inlet air temperature sensor (7).

7. Remove all cable straps that secure harness assembly (4) to the cylinder head or to the inlet manifold. The harness assembly should be positioned in order to avoid causing an obstruction during the removal of the cylinder head.

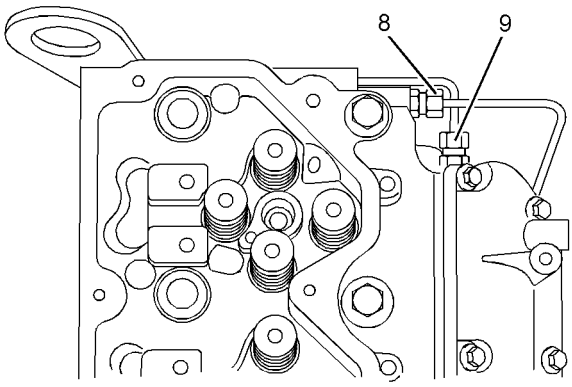


Illustration 251 g01340077
Typical example

8. Loosen the tube clips for tube assembly (8). Remove tube assembly (8) for the fuel return from the cylinder head and from the transfer pump. Plug the port in the transfer pump with a new plug. Cap the tube assembly with new caps.

9. If the engine has a wastegate solenoid, loosen the tube clips for tube assembly (9). Remove tube assembly (9) from the wastegate solenoid and from the cylinder head. Plug the port in the wastegate solenoid with a new plug. Cap the tube assembly with new caps.

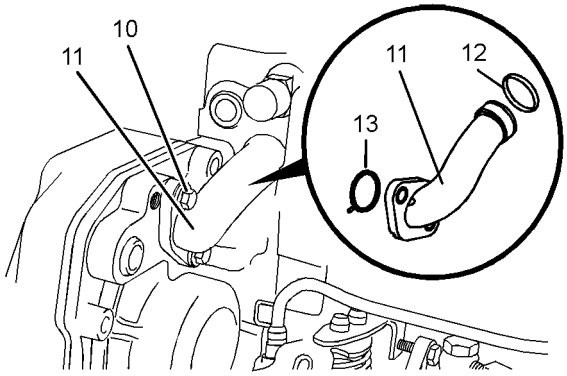


Illustration 252 g01340080
Typical example

10. Remove bolts (10). Remove bypass tube (11) from the cylinder head. Remove O-ring seals (12) and (13) from bypass tube (11).

Installation Procedure

Table 61

Required Tools			
Tool	**Part Number**	**Part Name**	**Qty**
B	27610212	Camshaft Timing Pin	1
C	27610286	Crankshaft Timing Pin	1
	27610287	Adapter	1

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that number one piston is at top dead center on the compression stroke. Refer to System Operation, Testing and Adjusting, “Finding Top Center for No. 1 Piston”.

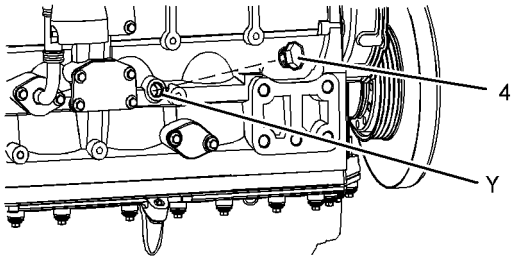


Illustration 277 g01335380

2. Ensure that Tooling (C) is installed in hole (Y) in the cylinder block. Use Tooling (C) in order to lock the crankshaft in the correct position. Refer to System Operation, Testing and Adjusting, “Finding Top Centre Position for No.1 Piston”.

3. Ensure that the camshaft gear and the key are clean and free from wear or damage.

4. If necessary, install the key into the nose of the camshaft.

Note: Ensure that the key is squarely seated.

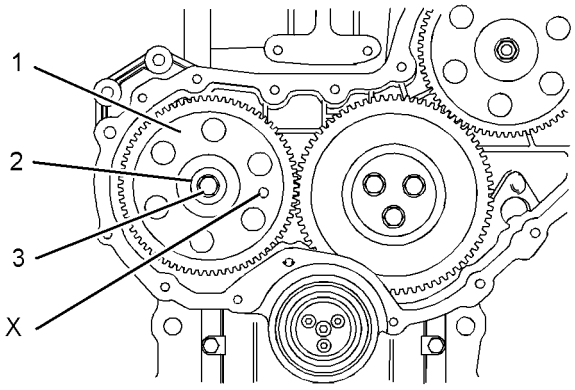


Illustration 278 g01340534

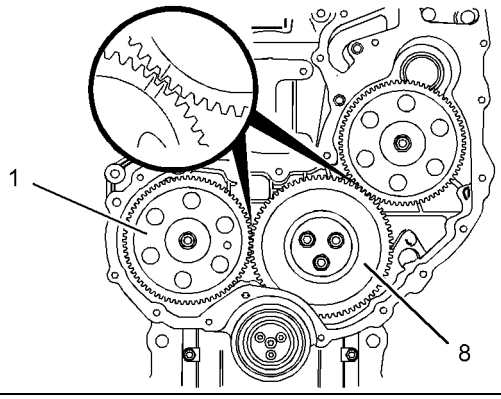


Illustration 279 g01340551

Alignment of timing marks

5. Align the keyway in camshaft gear (1) with the key in the camshaft. Install camshaft gear onto the camshaft. Ensure that the timing marks on gears (1) and (8) are in alignment and that the mesh of the gears is correct. Refer to Illustration 279.

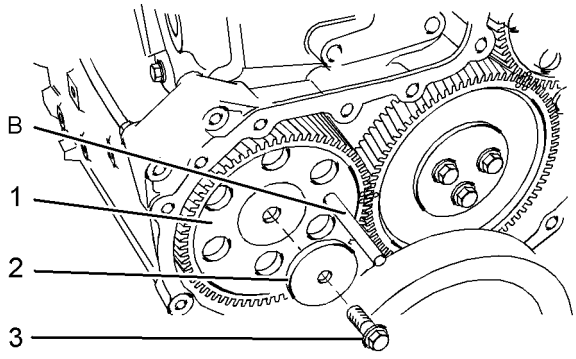


Illustration 280 g01340554

6. Install Tooling (B) through hole (X) in the camshaft gear into the front housing. Install washer (2) and bolt (3) to camshaft gear (1).

7. Remove Tooling (B) and (C). Install plug (4) into hole (Y) in the cylinder block. Refer to Illustration 277.

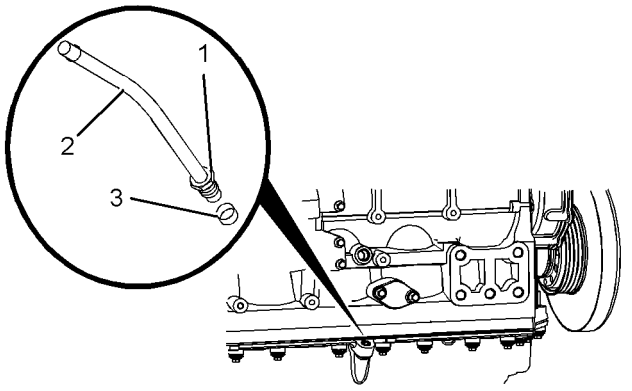


Illustration 297 g01340605

Typical example

10. If necessary, follow Steps 10.a through 10.c in order to install the assembly of the dipstick tube.

a. Install a new seal (3) to the tube assembly (2).

b. Apply Tooling (B) to the nut (1). Install the tube assembly to the engine oil pan.

Note: Ensure that the orientation of the tube assembly is correct.

c. Tighten the nut (1) to a torque of 18 N·m (13 lb ft). Install the dipstick (not shown).

11. Fill the engine oil pan to the correct level. Refer to Operation and Maintenance Manual, “Oil Filter Change” for the procedure.

i02652928

Engine Oil Pan Plate - Remove and Install (Aluminum Oil Pan)

Removal Procedure

Table 66

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	T40 Torx Socket	1

Start By:

a. Remove the engine oil pan. Refer to Disassembly and Assembly, “Engine Oil Pan - Remove”.

b. Remove the flywheel housing. Refer to Disassembly and Assembly, “Flywheel Housing - Remove and Install”.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

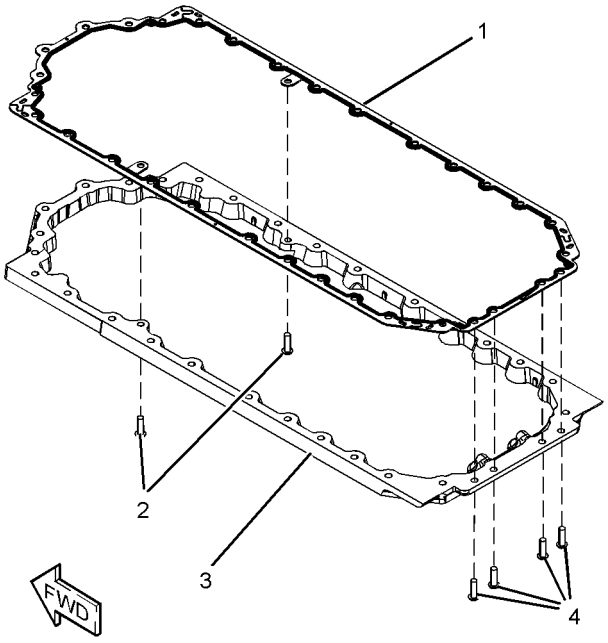


Illustration 298 g01342059

1. Remove isolating frame from the cylinder block. Follow steps 1.a through 1.c in order to remove the isolating frame from the cylinder block.

a. Support the isolating frame (3). Use Tooling (A) to remove the torx screws (2) and (4).

b. Remove the isolating frame (3) from the cylinder block.

c. Remove the joint (1).

4. Remove lower bearing shell (3) from connecting rod cap (2). Keep the bearing shell and the connecting rod cap together.

5. Carefully push connecting rod (5) into the cylinder bore until connecting rod (5) is clear of the crankshaft. Remove upper bearing shell (4) from the connecting rod. Keep the bearing shells together.

Note: Do not push on the fracture split surfaces of the connecting rod as damage may result. Do not allow the connecting rod to contact the piston cooling jet.

6. Repeat Steps 1 through 5 for the remaining bearing shells.

Note: Fracture split connecting rods should not be left without the connecting rod caps installed. After the removal procedure for the bearing shells is complete, carry out the installation procedure as soon as possible. Refer to Disassembly and Assembly, “Connecting Rod Bearings - Install”.

i02654458

Connecting Rod Bearings - Install (Connecting rods in position)

Installation Procedure

Table 75

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	21825576	Crankshaft Turning Tool	1
A	27610291	Barring Device Housing	1
	27610289	Gear	1
B	21825607	Angle Gauge	1

Note: Either Tooling (A) can be used. Use the Tooling that is most suitable.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE
Discard all used Connecting Rod fasteners.

1. Inspect the pins of the crankshaft for damage. If the crankshaft is damaged, replace the crankshaft. Refer to Disassembly and Assembly, “Crankshaft - Remove” and Disassembly and Assembly, “Crankshaft - Install”. Ensure that the bearing shells are clean and free from wear or damage. If necessary, replace the bearing shells.

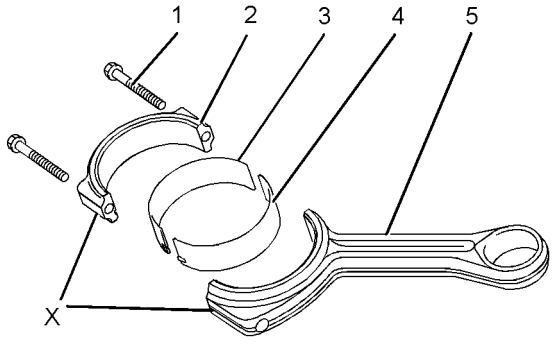


Illustration 315 g01341322

2. Install the upper bearing shell (4) into connecting rod (5). Ensure that the locating tab for the upper bearing shell is correctly seated in the slot in the connecting rod.

Note: The ends of the upper bearing shell must be centered in the connecting rod. The ends of the upper bearing shell must be equally positioned in relation to the mating faces of the connecting rod.

3. Lubricate upper bearing shell (4) with clean engine oil.

4. Use Tooling (A) to rotate the crankshaft until the crankshaft pin is at the bottom dead center position.

5. Carefully pull connecting rod (5) against the crankshaft pin.

Note: Do not allow the connecting rod to contact the piston cooling jet.

6. Clean connecting rod cap (2). Install lower bearing shell (3) into connecting rod cap (2). Ensure that the locating tab for the lower bearing shell is correctly seated in the slot in the connecting rod cap.

Note: The ends of the lower bearing shell must be centered in the connecting rod cap. The ends of the lower bearing shell must be equally positioned in relation to the mating faces of the connecting rod cap.

7. Lubricate the pin of the crankshaft and lubricate lower bearing shell (3) with clean engine oil.

i02654464

Crankshaft Gear - Remove and Install

Removal Procedure

Table 80

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Bearing Puller	1
	-	Puller	1
	-	Crossblock	1
	-	Puller Leg	2

Start By:

a. Remove the front housing. Refer to Disassembly and Assembly, “Housing (Front) - Remove”.

b. Remove the engine oil pump. Refer to Disassembly and Assembly, “Engine Oil Pump - Remove”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Note: The crankshaft gear may be a sliding fit on the crankshaft or an interference fit on the crankshaft.

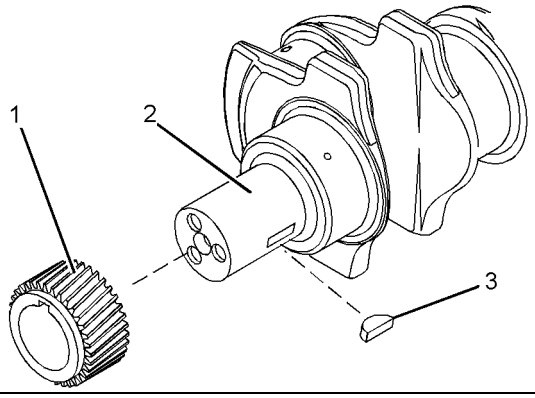


Illustration 338 g01341481
Typical example

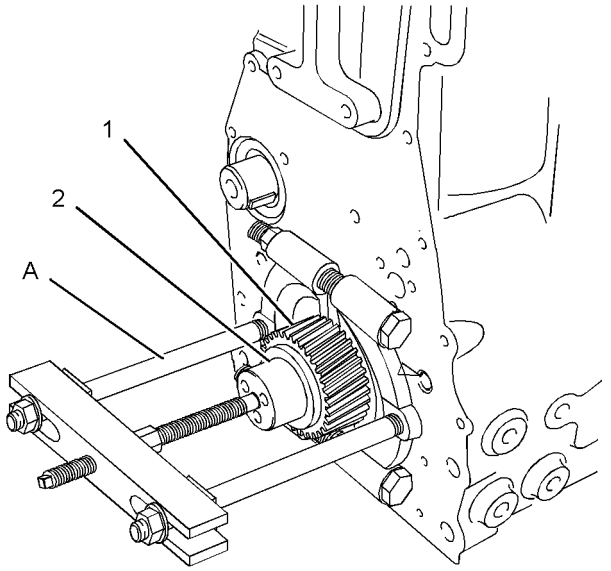


Illustration 339 g01341488
Typical example

1. If the crankshaft gear is a sliding fit on the crankshaft, remove crankshaft gear (1) from crankshaft (2).

If the crankshaft gear is an interference fit on the crankshaft, use Tooling (A) in order to remove crankshaft gear (1) from crankshaft (2).

2. If necessary, remove key (3) from crankshaft (2).

Note: Do not remove the key from the crankshaft unless the key is damaged.

Installation Procedure

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Ensure that all components are clean and free from wear or damage. If necessary, replace any components that are worn or damaged.

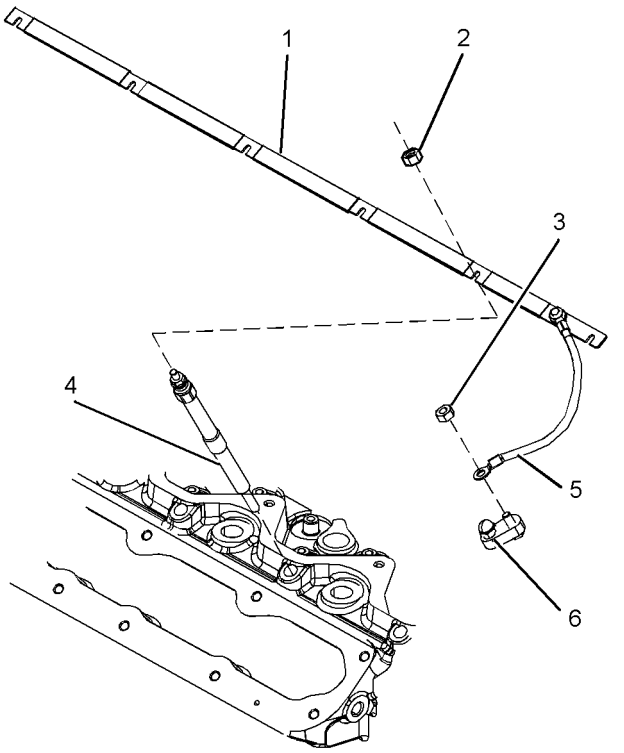


Illustration 357 g01341735

1. Ensure that the threads of the glow plugs are clean and free from damage. Replace any damaged glow plugs.

2. Install glow plugs (4) into the cylinder head. Tighten the glow plugs to a torque of 15 N·m (132 lb in).

3. Position bus bar (1) onto glow plugs (4). Install nuts (2) onto the glow plugs. Tighten the nuts to a torque of 2 N·m (17 lb in).

4. Connect wire (5) to the stud on terminal insulator (6).

5. Install nut (3) to the stud on terminal insulator (6). Tighten the nut to a torque of 6 N·m (53 lb in).

6. Connect the breather hose to the crankcase breather. Refer to Disassembly and Assembly, “Crankcase Breather - Install”.

7. Restore the electrical supply to the engine.

i02654452

Alternator Belt - Remove and Install

Removal Procedure

Table 83

Required Tools			
Tool	**Part Number**	**Part Description**	**Qty**
A	-	Locking Pin (Ø 8mm by 85 mm)	1

1. If the engine has fan guards, remove the fan guards.

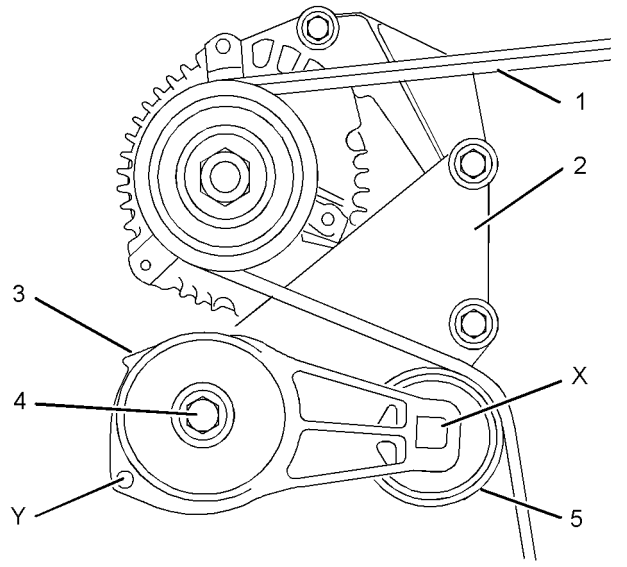


Illustration 358 g01341758

2. Install a suitable square drive tool into hole (X) in tensioner (3). From the front of the engine, turn the tool in a clockwise direction.

3. Insert Tooling (A) into hole (Y). Release the pressure on the square drive tool.

4. Remove alternator belt (1).

Note: Mark the direction of rotation if the belt will be reused.

5. From the front of the engine, turn the square drive tool in a clockwise direction. Release the pressure on Tooling (A). Remove Tooling (A) from hole (Y).

6. Release the pressure on the square drive tool and remove the tool from hole (X).

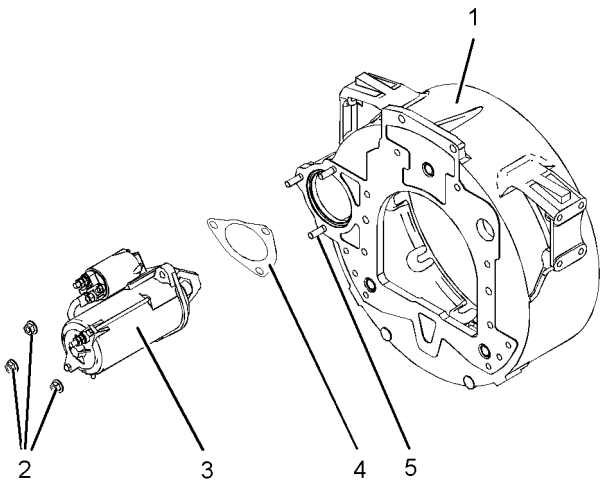


Illustration 378 g01342054
Typical example

3. Disconnect the harness assembly from the electric starting motor and the solenoid.
4. Remove nuts (2) for electric starting motor (3).
5. Remove electric starting motor (3).
6. If a joint is installed, remove joint (4).
7. If necessary, remove studs (5) from flywheel housing (1).

Installation Procedure

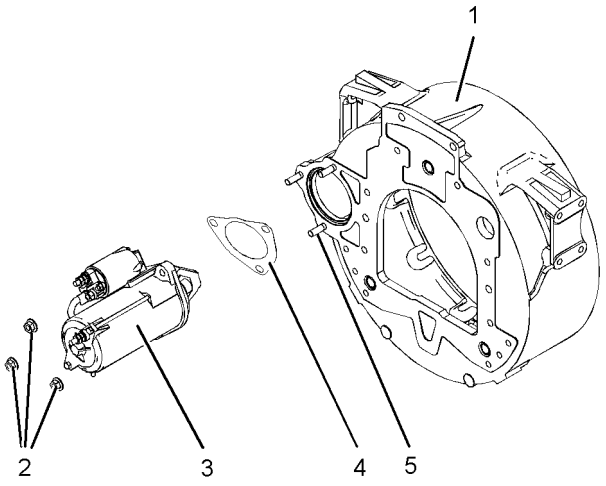


Illustration 379 g01342054
Typical example

1. If necessary, install studs (5) into flywheel housing (1).
2. If necessary, install a new joint (4) onto the studs in flywheel housing (1).
3. Position electric starting motor (3) onto the studs in flywheel housing (1).
4. Install nuts (2).

   Tighten M10 nuts to a torque of 44 ± 11 N·m (32 ± 8 lb ft).

   Tighten M12 nuts to a torque of 78 ± 19.5 N·m (57 ± 14 lb ft).
5. Connect the harness assembly to the electric starting motor and the solenoid.
6. Connect the battery.

i02654446

Air Compressor - Remove and Install

Removal Procedure

Table 85

Required Tools			
Tool	**Part Number**	**Part Name**	**Qty**
A[1]	21825576	Crankshaft Turning Tool	1
A[2]	27610291	Barring Device Housing	1
	27610289	Gear	1
B	27610286	Crankshaft Timing Pin	1
	27610287	Adapter	1
C	-	Puller (Three Leg)	1

Note: Either Tooling (A) can be used. Use the Tooling that is most suitable.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

Duty Cycle – Refer to “Pulse Width Modulation”.

Electronic Engine Control – The electronic engine control is a complete electronic system. The electronic engine control monitors the engine operation under all conditions. The electronic engine control also controls the engine operation under all conditions.

Electronic Control Module (ECM) – The ECM is the control computer of the engine. The ECM provides power to the electronics. The ECM monitors data that is input from the sensors of the engine. The ECM acts as a governor in order to control the speed and the power of the engine.

Electronic Service Tool – The electronic service tool allows a computer (PC) to communicate with the ECM.

Engine Monitoring – Engine Monitoring is the part of the electronic engine control that monitors the sensors. This also warns the operator of detected problems.

Engine Oil Pressure Sensor – The engine oil pressure sensor measures engine oil pressure. The sensor sends a signal to the ECM that is dependent on the engine oil pressure.

Engine Speed/Timing Sensor – An engine speed/timing sensor is a hall effect switch that provides a digital signal to the ECM. The ECM interprets this signal as the crankshaft position and the engine speed. Two sensors are used to provide the speed and timing signals to the ECM. The primary sensor is associated with the crankshaft and the secondary sensor is associated with the camshaft.

Event Code – An event code may be activated in order to indicate an abnormal engine operating condition. These codes usually indicate a mechanical problem instead of an electrical system problem.

Failure Mode Identifier (FMI) – This identifier indicates the type of failure that is associated with the component. The FMI has been adopted from the SAE practice of J1587 diagnostics. The FMI follows the parameter identifier (PID) in the descriptions of the fault code. The descriptions of the FMIs are in the following list.

0 – The data is valid but the data is above the normal operational range.

1 – The data is valid but the data is below the normal operational range.

2 – The data is erratic, intermittent, or incorrect.

3 – The voltage is above normal or the voltage is shorted high.

4 – The voltage is below normal or the voltage is shorted low.

5 – The current is below normal or the circuit is open.

6 – The current is above normal or the circuit is grounded.

7 – The mechanical system is not responding properly.

8 – There is an abnormal frequency, an abnormal pulse width, or an abnormal time period.

9 – There has been an abnormal update.

10 – There is an abnormal rate of change.

11 – The failure mode is not identifiable.

12 – The device or the component is damaged.

Flash File – This file is software that is inside the ECM. The file contains all the instructions (software) for the ECM and the file contains the performance maps for a specific engine. The file may be reprogrammed through flash programming.

Flash Programming – Flash programming is the method of programming or updating an ECM with an electronic service tool over the data link instead of replacing components.

Fuel Injector E-Trim – Fuel injector E-trim is a software process that allows precise control of fuel injectors by parameters that are programmed into the ECM for each fuel injector. With the use of the electronic service tool, the service technician can read status information for the E-Trim. Data for E-Trim can also be programmed.

FRC – See “Fuel Ratio Control”.

Fuel Pump – See “Fuel Rail Pump”.

Fuel Rail – This item is sometimes referred to as the High Pressure Fuel Rail. The fuel rail supplies fuel to the electronic unit injectors. The fuel rail pump and the fuel rail pressure sensor work with the ECM in order to maintain the desired fuel pressure in the fuel rail. This pressure is determined by calibration of the engine in order to enable the engine to meet emissions and performance requirements.

Fuel Rail Pressure Sensor – The fuel rail pressure sensor sends an electronic signal to the ECM that is dependent on the pressure of the fuel in the fuel rail.

Fuel Rail Pump – This item is sometimes referred to as the High Pressure Fuel Rail Pump. This is a device that supplies fuel under pressure to the fuel rail (high pressure fuel rail).

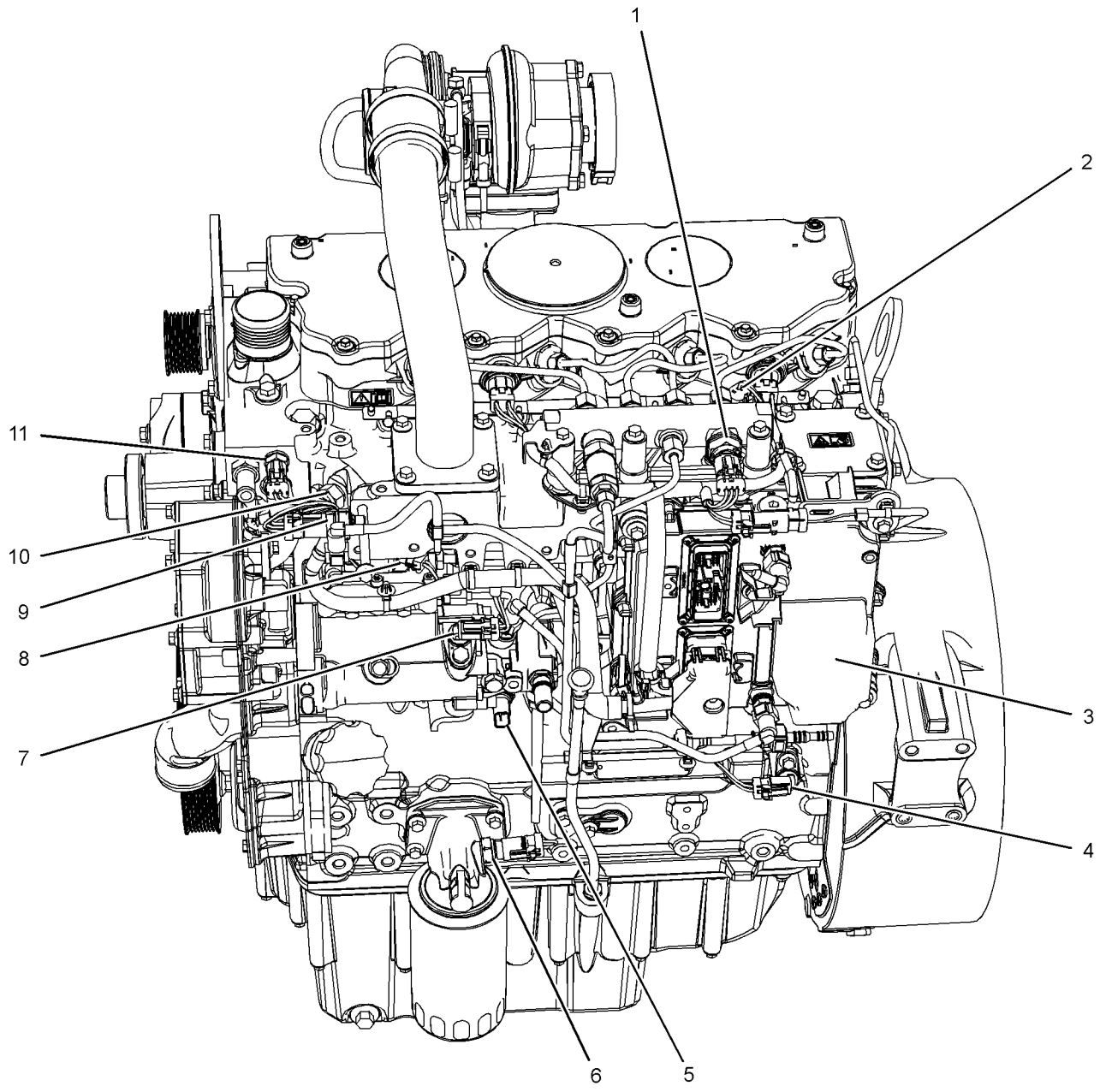


Illustration 6 g01779721

Sensor locations on the 1104D engine

(1) Fuel Rail Pressure Sensor
(2) Intake Manifold Air Temperature Sensor
(3) Electronic Control Module (ECM)
(4) Primary Speed/Timing Sensor
(5) Oil Pressure Sensor
(6) Oil Pressure Sensor (alternative location)
(7) Secondary Speed/Timing Sensor
(8) Solenoid for the Fuel Rail Pump
(9) Intake Manifold Pressure Sensor
(10) Intake Manifold Pressure Sensor (alternative location)
(11) Coolant Temperature Sensor

Note: If equipped, the wastegate regulator is installed on the right side of the engine.

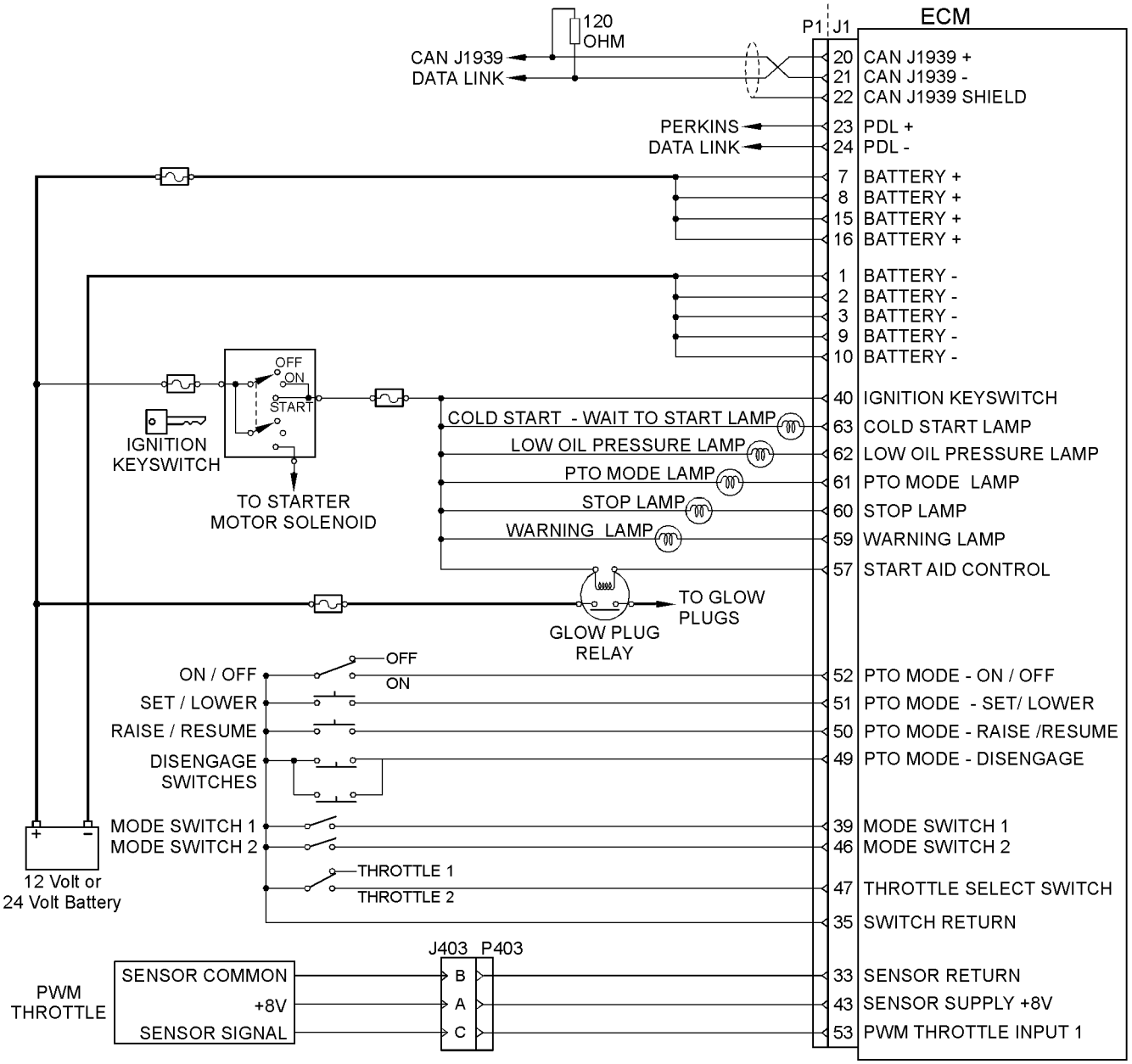


Illustration 14 g01783140

Schematic Diagram for a Typical Application

Note: The functionality of most of the connections to the J1 connector depend on the engine application.

i03434106

ECM Harness Connector Terminals

The Electronic Control Module (ECM) uses connectors that have 64 terminals to interface to the wiring harness.

Customer Specified Parameters

i02517248

Customer Specified Parameters

Customer specified parameters allow the engine to be configured to the exact needs of the application.

Customer parameters may be changed repeatedly as a customer's operation changes.

The following information is a brief description of the customer specified parameters. The following parameter values are included with the descriptions:

- Minimum
- Maximum
- Default

Engine Rating Parameter

Rating Number

The rating number is the selected rating within a power rating family. The flash file defines the power rating family. The flash file can contain one to four ratings. The rating number defines the power rating that is used within the power rating family.

Table 33

Minimum	Maximum	Default
1	4	1

Low/High Idle Parameters

Low Idle Speed

The “Low Idle Speed” is the minimum engine rpm.

Table 34

Minimum	Maximum	Default
700 rpm	1200 rpm	750 rpm

High Idle Speed

The “High Idle Speed” is the maximum engine rpm.

Table 35

Minimum	Maximum	Default
1900 rpm	2900 rpm	2650 rpm

ECM Identification Parameter

Equipment ID

“Equipment ID” is the identification of the equipment that is assigned by the customer. The “Equipment ID” is only for reference only by the customer. The “Equipment ID” is not required by the Electronic Control Module (ECM).

Table 36

Value	Default
17 digits The available characters are dependent on the service tool that is being used.	Not programmed

PTO and Throttle Lock Parameters

Throttle Lock Feature Installation Status

The “Throttle Lock Feature Installation Status” is used to turn on the throttle lock features. When this parameter is changed to “Installed”, the “PTO engine Speed Setting”, the “Throttle Lock Increment Speed Ramp Rate” and the “Throttle Lock Engine Set Speed Increment” parameters are active and the parameters can be programmed.

Table 37

Value	Default
Not Installed Installed	Not Installed

PTO Engine Speed Setting

The “PTO Engine Speed Setting” is the engine speed that is attained when the PTO switch is moved to the ON position. If the “PTO Engine Speed Setting” parameter is programmed, the feature is turned off. If the “PTO Engine Speed Setting” parameter is set to a value that is between “1” and the low idle speed, the parameter is set to the low idle speed value. If the “PTO Engine Speed Setting” parameter is set to a value that is higher than the high idle speed, the parameter is set to the high idle speed value.

Table 38

Minimum	Maximum	Default
0 rpm	3000 rpm	0 rpm

2. Remove the oil filter element. Install a new engine oil filter element. Fill the engine with clean engine oil to the correct level. Refer to the Operation and Maintenance Manual, “Engine Oil and Filter - Change” for more information.

i03438642

Coolant Temperature Is Too High

Note: This is not an electronic system fault.

Probable Causes

- Radiator fins
- Coolant level
- Radiator cap and/or pressure relief valve
- Coolant temperature gauge
- Restriction in the coolant system
- Water temperature regulator
- Engine cooling fan
- Coolant pump
- Cylinder head gasket

Recommended Actions

Radiator Fins

Check the radiator fins for dirt, debris, and/or damage. Remove any dirt and/or debris and straighten any bent fins.

Coolant Level

1. Inspect the coolant level. If necessary, add coolant.
2. Check the cooling system for leaks. Repair any leaks immediately.

Radiator Cap and/or Pressure Relief Valve

1. Pressure test the cooling system. Refer to Systems Operation, Testing and Adjusting, “Cooling System” for the correct procedure.
2. Check that the seating surfaces of the pressure relief valve and the radiator cap are clean and undamaged.
3. Check operation of the pressure relief valve and/or the radiator cap. If necessary, clean the components and/or replace the components.

Coolant Temperature Gauge

Compare the reading for the coolant temperature from the electronic service tool to the reading for the coolant temperature from a calibrated test gauge.

Restriction in the Coolant System

1. Visually inspect the cooling system for collapsed hoses and/or other restrictions.
2. Clean the radiator and flush the radiator. Refer to Systems Operation, Testing and Adjusting, “Cooling System”.

Water Temperature Regulator

Check the water temperature regulator for correct operation. Refer to Systems Operation, Testing and Adjusting, “Cooling System” for the proper procedure. If necessary, replace the water temperature regulator. Refer to Disassembly and Assembly, “Water Temperature Regulator - Remove and Install” for more information.

Engine Cooling Fan

1. Make sure that the engine cooling fan is correctly installed.
2. Make sure that the engine cooling fan is being driven correctly by the drive belt. If necessary, tighten the drive belt or replace the drive belt. Refer to Disassembly and Assembly, “Alternator Belt - Remove and Install”.
3. Check the engine cooling fan for damage. If necessary, replace the fan. Refer to Disassembly and Assembly, “Fan - Remove and Install”.

Coolant Pump

1. Inspect the impeller of the coolant pump for damage and/or erosion.
2. Make sure that the drive gear is not loose on the drive shaft of the coolant pump.
3. If necessary, replace the coolant pump. Refer to Disassembly and Assembly, “Water Pump - Remove” and Disassembly and Assembly, “Water Pump - Install”.

Use the electronic service tool to check the setup of the throttle.

Multi-position Throttle Switch

Note: When the engine is operating and the fault occurs, the configuration of the throttle will not change. The configuration of the throttle only needs to be checked if the engine has never run.

If a fault with the multi-position throttle switch is suspected, refer to Troubleshooting, “Throttle Switch Circuit - Test”.

Throttle Position Sensor

Refer to Troubleshooting, “Analog Throttle Position Sensor Circuit - Test” or Troubleshooting, “Digital Throttle Position Sensor Circuit - Test” if any of the following diagnostic codes are active:

- 0041-03 8 Volt DC Supply voltage above normal
- 0041-04 8 Volt DC Supply voltage below normal
- 0091-08 Throttle Position Sensor abnormal frequency, pulse width or period
- 0774-08 Sec Throttle Position Sensor abnormal frequency, pulse width or period

i03439009

Engine Stalls at Low RPM

Probable Causes

- Diagnostic codes
- Accessory equipment
- Power mode control (if equipped)
- Fuel supply
- Electronic unit injectors

Recommended Actions

Diagnostic Codes

Check for active diagnostic codes on the electronic service tool. Troubleshoot any active codes before continuing with this procedure.

Accessory Equipment

Check all accessory equipment for faults that may create excessive load on the engine. Repair any damaged components or replace any damaged components.

If there are no faults with the accessory equipment, refer to “Power Mode Control (If Equipped)”.

Power Mode Control (If Equipped)

1. Check the data link. Refer to Troubleshooting, “ Data Link Circuit - Test”.
2. Check the engine wiring harness for defects. Refer to Troubleshooting, “Electricial Connectors - Inspect”.
3. If there are no apparent faults, refer to “Fuel Supply”.

Fuel Supply

1. Visually check the fuel tank for fuel. The fuel gauge may be faulty.
2. Ensure that the fuel supply valve (if equipped) is in the full OPEN position.
3. If the temperature is below 0 °C (32 °F), check for solidified fuel (wax).
4. Check the primary filter/water separator for water in the fuel.
5. Check for fuel supply lines that are restricted.
6. Check that the low pressure fuel lines are tight and correctly secured.
7. Check the fuel filters.
8. Check the diesel fuel for contamination. Refer to Systems Operation, Testing and Adjusting, “Fuel Quality - Test”.
9. Check for air in the fuel system. Refer to Systems Operation, Testing and Adjusting, “Air in Fuel - Test”.
10. Ensure that the fuel system has been primed. Refer to Systems Operation, Testing and Adjusting, “Fuel System - Prime”.
11. Check the fuel pressure. Refer to Systems Operation, Testing and Adjusting, “Fuel System Pressure - Test”.
12. If necessary, repair any faults.

Intake Air Restriction and/or High Altitude

Low air pressure at the air intake for the turbocharger can be caused by a restriction in the air intake or a high altitude. When the pressure of the intake air is low, the turbocharger (if equipped) works harder in order to achieve the desired intake manifold pressure. This increases intake air temperature.

Measure the intake manifold pressure while the engine is operating under load. For specific data, refer to the Perkins Technical Marketing Information for the engine.

Intake Air Restriction

1. Check for blocked air filters. Check for obstructions in the air intake.
2. Replace the air filters or remove the obstruction from the air intake.

High Altitude

Make sure that the settings for the engine are correct for the altitude.

Intake Air from a Heated Area

1. Ensure that the air inlet system is not receiving air from a heated area.
2. If necessary, relocate the air supply to the intake manifold to the outside of the engine enclosure.
3. Check for air leaks in the pipe between the air inlet and the inlet to the turbocharger compressor.

Intake Manifold Air Temperature Sensor and/or the Circuit

1. Allow the intake manifold air temperature sensor to cool and remove the sensor. Check the reading for the intake air temperature. If the sensor is operating correctly, the reading and the ambient temperature are approximately equal.
2. If the readings are approximately equal, reinstall the sensor.
3. If the reading is not correct, replace the sensor with a sensor that is known to be good. Verify that the fault is rectified.

Insufficient Ambient Air Flow over the Engine

1. If equipped, check the condition of the cooling fan and the drive belt.
2. If equipped, check that the cooling fan is operating correctly.

Reduced Ambient Air Flow through the Air Charge Cooler

1. Check that the ambient air flow through the air charge cooler is not obstructed.
2. Inspect the air charge cooler for contamination and/or bent fins or damaged fins.
3. If necessary, clean the air charge cooler.
4. If necessary, carefully straighten any bent fins on the air charge cooler.

Reduced Flow of Intake Air through the Air Charge Cooler

1. Check for contamination in the air pipe that connects the turbocharger to the air charge cooler.
   a. If dirt is found in the air pipe from the turbocharger to the air charge cooler, check all of the air inlet pipes upstream of the turbocharger for leaks.
   b. Clean all contaminated air inlet pipes or replace all contaminated air inlet pipes.
   c. Service the air cleaner and replace the air cleaner element.
2. If a thick oil film is found in the air pipe, inspect the turbocharger compressor housing. Examine both the inlet to the turbocharger compressor housing and the outlet from the turbocharger compressor for oil.
   a. If oil is found in the inlet to the turbocharger compressor housing, the oil originates from the engine crankcase breather.
   b. If oil is found in the outlet from the turbocharger compressor housing but oil is not found in the inlet to the compressor housing, the oil originates from the seals for the turbocharger bearings.

i03447282

Intermittent Engine Shutdown

Note: Use this procedure only if the engine shuts down completely and the engine must be restarted.

Probable Causes

- Diagnostic codes
- Air Intake

(Table 51, contd)

CDL Code	Description	3rd Party Device J1939 Code	Flash Code
2246-06	Glow Plug Start Aid Relay current above normal	676-06	199
Event Codes			
E172-1	High Air Filter Restriction - Warning	107-15	151
E194-1	High Exhaust Temperature - Warning	173-15	185
E232-1	High Fuel/Water Separator Water Level - Warning	97-15	-
E360-1	Low Oil Pressure - Warning	100-17	157
E360-2	Low Oil Pressure - Derate	100-18	157
E360-3	Low Oil Pressure - Shutdown	100-01	157
E361-1	High Engine Coolant Temperature - Warning	110-15	168
E361-2	High Engine Coolant Temperature - Derate	110-16	168
E361-3	High Engine Coolant Temperature - Shutdown	110-00	168
E362-1	Engine Overspeed - Warning	190-15	141
E396-1	High Fuel Rail Pressure - Warning	157-00	159
E398-1	Low Fuel Rail Pressure - Warning	157-01	159
E539-1	High Intake Manifold Air Temperature - Warning	105-15	133
E539-2	High Intake Manifold Air Temperature - Derate	105-16	133
E2143-3	Low Engine Coolant Level - Shutdown	111-01	169

i03449822

No Diagnostic Codes Detected

Conditions Which Generate This Code:

A flash code 0551 indicates that there are no detected faults in the system.

System Response:

This code will not appear on the electronic service tool. The indicator lamps will flash the diagnostic code. For more information on flash codes, refer to Troubleshooting, “Indicator Lamps”.

Possible Performance Effect:

None

There are no faults that require troubleshooting.

Results:

- OK – STOP.

i02655551

CID 0001 FMI 02

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects the following condition:

- Data from the electronic unit injector for the No. 1 cylinder is out of limits.
- Diagnostic code 0168-01 is not active.
- Diagnostic codes 0001-05 and 0001-06 are not active.
- No 0041 diagnostic codes are active.
- No 0262 diagnostic codes are active.
- Diagnostic code 0190-08 is not active.
- No 0110 diagnostic codes are active.

This diagnostic code is designed to indicate an open circuit (low current) in either the solenoid or the wiring for the electronic unit injector for No. 6 cylinder.

The Electronic Control Module (ECM) detects the following condition:

- A low current condition (open circuit) for each of five consecutive attempts to operate
- Battery voltage is higher than 9 Volts DC for 2 seconds.

System Response:

If equipped, the warning light will come on. The ECM will log the diagnostic code.

Possible Performance Effect:

The engine will have low power and/or rough running.

Troubleshooting:

When an injector cutout test is performed, a faulty electronic unit injector will indicate a low reading in comparison with the other electronic unit injectors.

An electrical fault can prevent the electronic unit injector from operating. An open circuit in the wiring that is unique to the electronic unit injector will prevent that individual electronic unit injector from operating. On four cylinder engines, an open circuit in common wiring within the ECM can prevent the two electronic unit injectors that share that common wiring from operating. On six cylinder engines, an open circuit in common wiring within the ECM can prevent the three electronic unit injectors that share that common wiring from operating.

The ECM will continue to attempt to operate the electronic unit injector after the diagnostic code has been logged but an open circuit will prevent the operation of the electronic unit injector.

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP.

i02655585

CID 0006 FMI 06

Conditions Which Generate This Code:

This diagnostic code is applicable to six cylinder engines only.

This diagnostic code is designed to indicate a short circuit (high current) in either the solenoid or the wiring for the electronic unit injector for No. 6 cylinder.

The Electronic Control Module (ECM) detects the following conditions:

- A high current condition (short circuit) for each of five consecutive attempts to operate
- Battery voltage above 9 Volts DC for 2 seconds

System Response:

If equipped, the warning light will come on. The ECM will log the diagnostic code.

Possible Performance Effect:

The engine will have low power and/or rough running.

Troubleshooting:

When an injector cutout test is performed, a faulty electronic unit injector will indicate a low reading in comparison with the other electronic unit injectors.

An electrical fault can prevent the electronic unit injector from operating. A short circuit in the wiring or the ECM that is unique to one electronic unit injector will prevent that individual electronic unit injector from operating. On four cylinder engines, a short circuit in common wiring within the ECM can prevent the two electronic unit injectors that share that common wiring from operating. On six cylinder engines, a short circuit in common wiring within the ECM can prevent the three electronic unit injectors that share that common wiring from operating.

The ECM will continue to attempt to operate the electronic unit injector after the diagnostic code has been logged but a short circuit will prevent the operation of the electronic unit injector.

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP.

i03449944

CID 0006 FMI 07

Conditions Which Generate This Code:

This diagnostic code is applicable to six cylinder engines only.

i02527037

CID 0253 FMI 02

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects incorrect engine software.

System Response:

If equipped, the warning light will come on.

This diagnostic code is not logged.

Factory passwords are required to clear this diagnostic code.

Possible Performance Effect:

The engine will not start.

Troubleshooting:

The flash file in the ECM is from the wrong engine family.

Use the electronic service tool to install the correct flash file into the ECM. Refer to the Troubleshooting Guide, “Flash Programming”.

Perform the following diagnostic procedure: “None”

Results:

- OK – STOP.

i03451880

CID 0261 FMI 11

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects the following conditions:

- The outputs from the primary speed/timing sensor and the secondary speed/timing sensor differ by more than 8 crankshaft degrees.
- The engine has been running for more than five seconds.
- Diagnostic code 0190-08 is not active.
- No 0041 diagnostic codes are active.

System Response:

If equipped, the warning light will come on. This code will not be logged.

Possible Performance Effect:

The pressure in the fuel rail may be unstable and the engine may not run smoothly.

Troubleshooting:

Check the timing of the fuel rail pump. Refer to Disassembly and Assembly, “Fuel Injection Pump - Install”.

Results:

- OK – STOP.

i03451885

CID 0262 FMI 03

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects the following conditions:

- The 5 Volt supply is greater than 5.16 Volts DC for more than one second.
- The ECM has been powered for at least three seconds.
- Diagnostic code 0168-01 is not active.

System Response:

The ECM sets all of the pressure sensors and temperature sensors to the default values.

Possible Performance Effect:

The engine will be derated.

Troubleshooting:

This diagnostic code will detect an excessively high voltage in the 5 Volt supply circuit.

Perform the following diagnostic procedure: “5 Volt Sensor Supply Circuit - Test”

Results:

- OK – STOP.

Troubleshooting with an Event Code

i02411237

Event Codes

The ECM can log events. Events refer to engine operating conditions such as low oil pressure or high coolant temperature. Logged events usually indicate a mechanical problem instead of an electronic system problem.

Note: If a diagnostic code has already been logged then any associated event code to that fault will not be logged as well.

i03455720

E172 High Air Filter Restriction

Conditions Which Generate This Code:

This event code will only be generated if the switch for the air filter restriction is installed and the customer programmable feature is enabled.

The Electronic Control Module (ECM) detects a problem with the air flow. If the air flow has been restricted for more than thirty seconds, the ECM will generate this code.

Note: This code is generated only when the engine is running. This event code will become inactive when the restriction decreases for more than 5 seconds.

System Response:

If equipped, the warning lamp will come on.

The event code will be logged.

Possible Performance Effect:

E172-1

A blocked filter may cause the engine to experience symptoms such as low power.

Troubleshooting:

This event code detects a restriction in the air intake system.

The event code may represent a fault in the electronic system. This event code normally indicates high air filter restriction. Refer to Systems Operation, Testing and Adjusting Manual, “Air Inlet and Exhaust System - Inspect”.

Results:

- OK – STOP.

i03455721

E194 High Exhaust Temperature

Conditions Which Generate This Code:

The Electronic Control Module (ECM) monitors the following parameters in order to estimate the exhaust temperature:

- Intake manifold air temperature
- Barometric pressure
- Engine speed

High intake manifold air temperature, high altitude operation, and high engine loads can cause the exhaust temperature to increase to a level that may damage the components of the exhaust system. When this occurs, the ECM derates the engine in order to reduce the exhaust temperature. This protects the components of the exhaust system from damage.

System Response:

If equipped, the warning lamp may come on and the event code will be logged.

Possible Performance Effect:

Engine power is reduced.

Test Step 1. Determine the Operating Conditions

Determine if the engine was under heavy load or the engine is operating at a high altitude.

Expected Result:

The event occurred because of abnormal engine operation.

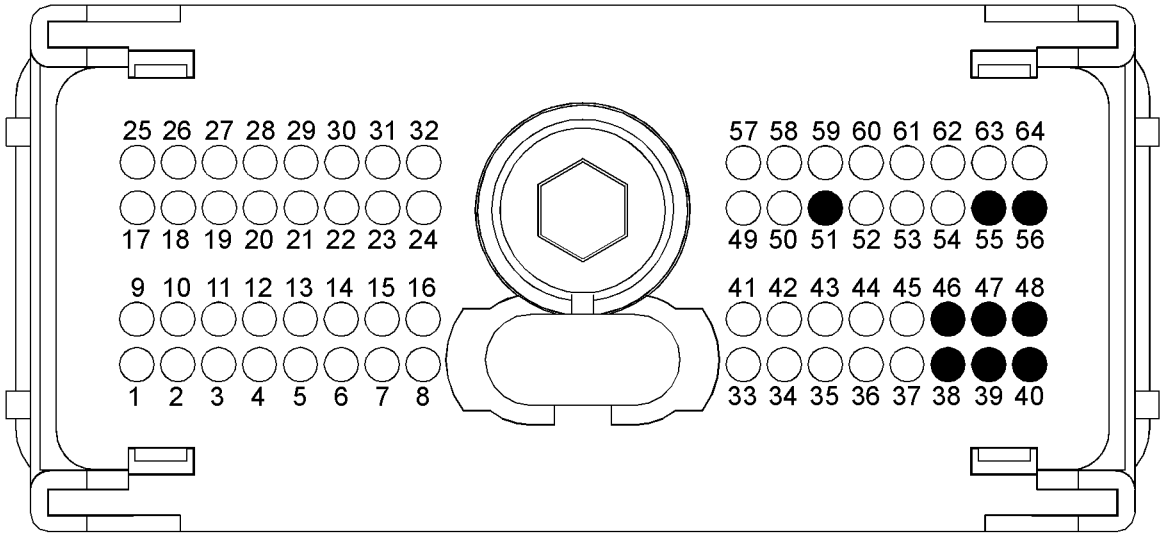


Illustration 26 g01800553

Typical example of the P2 pressure sensor pin locations

(38) Ground (GND) Intake Manifold Pressure Sensor
(39) Ground (GND) Oil Pressure Sensor
(40) Ground (GND) Fuel Rail Pressure Sensor
(46) Voltage supply (5 Volts) Intake Manifold Pressure Sensor
(47) Voltage supply (5 Volts) Oil Pressure Sensor
(48) Voltage supply (5 Volts) Fuel Rail Pressure Sensor
(51) Signal (SIG) Fuel Rail Pressure Sensor
(55) Signal (SIG) Intake Manifold Pressure Sensor
(56) Signal (SIG) Oil Pressure Sensor

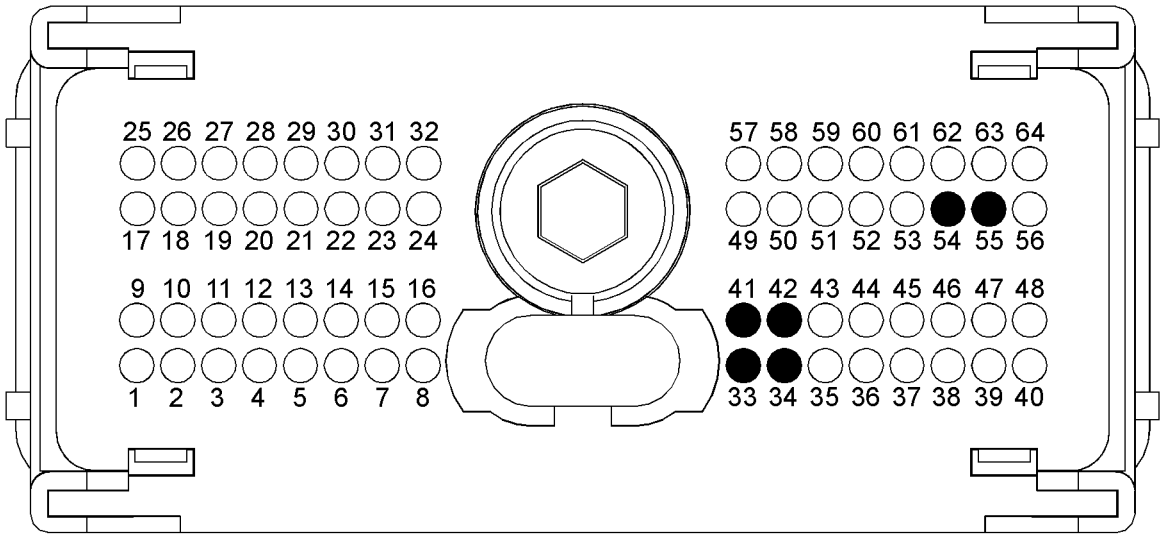


Illustration 27 g01800573

Typical example of the P1 pin locations for the analog throttle demand sensor

(33) Throttle 1 ground (GND)
(34) Throttle 2 ground (GND)
(41) Throttle 1 voltage supply (5 Volts)
(42) Throttle 2 voltage supply (5 Volts)
(54) Throttle 1 position
(55) Throttle 2 position

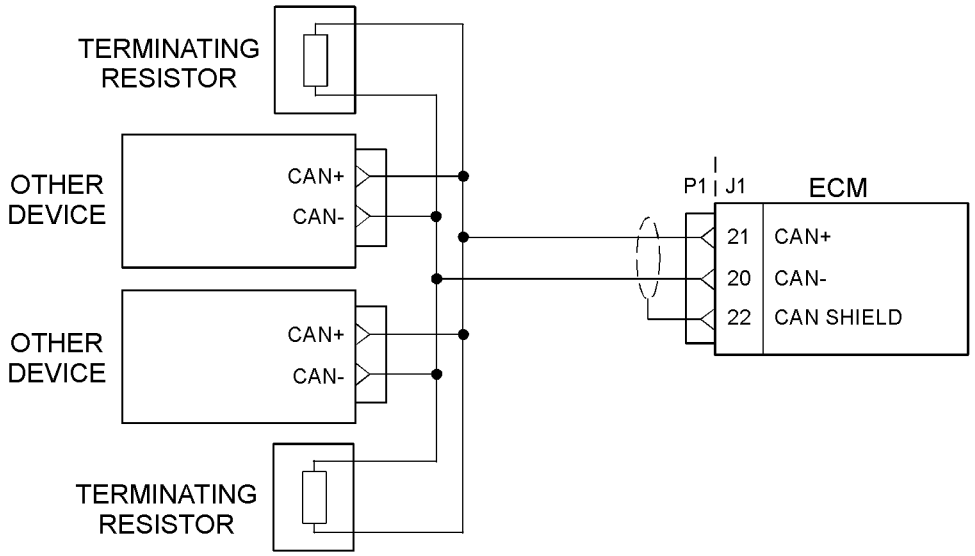


Illustration 33 g01801898

Typical example of the schematic for the CAN data link

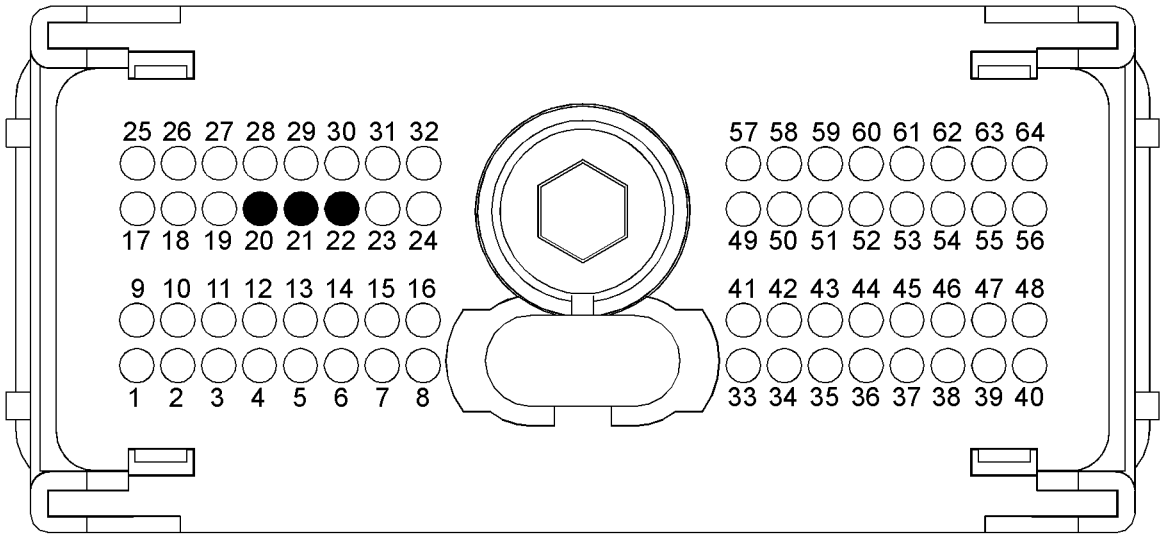


Illustration 34 g01801913

Typical view of the P1 connector pin locations

(20) CAN- (21) CAN+ (22) CAN Shield

Test Step 1. Inspect Electrical Connectors and Wiring

A. Turn the keyswitch to the OFF position.

B. Thoroughly inspect the harness connector P1/J1 and any other connectors in the CAN data link circuit.

Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the CAN data link. Refer to Illustration 34.

D. Check the harness for abrasion and pinch points from the keyswitch to the ECM.

Expected Result:

All connectors, pins and sockets should be completely coupled and/or inserted. The harness should be free of corrosion, abrasion and/or pinch points.

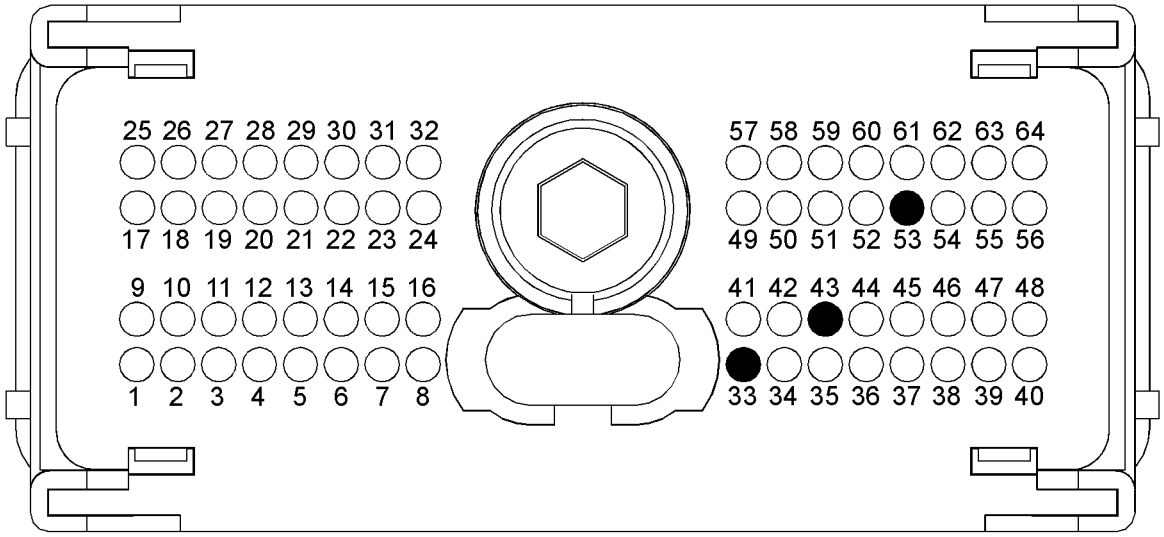


Illustration 42 g01802315

Typical example of the pin locations on the P1 connector

(33) Sensor return (43) Sensor supply (8 Volts) (53) Sensor input

Test Step 1. Inspect Electrical Connectors and Wiring

A. Inspect the P1/J1 connector, OEM harness and the OEM connectors. Thoroughly inspect the digital throttle position sensor connector. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

B. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the digital throttle position sensor:

- P1:33
- P1:43
- P1:53

C. Check the screw for the ECM connector for the correct torque of 5.0 N·m (44 lb in).

D. Check the harness for abrasion and pinch points from the digital throttle position sensor to the ECM.

Expected Result:

All connectors, pins and sockets are completely coupled and/or inserted and the harness is free of corrosion, of abrasion or of pinch points.

Results:

- OK – Proceed to Test Step 2.
- Not OK

Repair: Perform the following repair:

Repair the connectors or the harness and/or replace the connectors or the harness. Ensure that all of the seals are correctly in place and ensure that the connectors are completely coupled.

Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault.

STOP.

Test Step 2. Check for Active Diagnostic Codes

A. Connect the electronic service tool to the diagnostic connector.

B. Turn the keyswitch to the ON position.

C. Monitor the active diagnostic code screen on the electronic service tool. Check and record active diagnostic codes.

Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault.

STOP.

Test Step 8. Perform the "Wiggle Test" on the Electronic Service Tool

A. Select the "Wiggle Test" from the diagnostic tests on the electronic service tool.

B. Choose the appropriate group of parameters to monitor.

C. Press the "Start" button. Wiggle the wiring harness in order to reproduce intermittent faults.

If an intermittent fault exists, the status will be highlighted and an audible beep will be heard.

Expected Result:

No intermittent faults were indicated during the "Wiggle Test".

Results:

- OK – No intermittent faults were found. The harness and connectors appear to be OK. If this test was required as part of another procedure, return to that procedure and continue testing. If this test has resolved the fault, return the engine to service. STOP.
- Not OK – At least one intermittent fault was indicated.

  Repair: Repair the harness or the connector.

  Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault.

  STOP.

i03459023

Engine Pressure Sensor Open or Short Circuit - Test

System Operation Description:

Use this procedure under the following conditions:

Use this procedure if another procedure has directed you here. Use this procedure if any of the following diagnostic codes are active:

- 0100-03 Engine Oil Pressure Sensor voltage above normal
- 0100-04 Engine Oil Pressure Sensor voltage below normal
- 0100-10 Engine Oil Pressure Sensor abnormal rate of change
- 1785-03 Intake Manifold Pressure Sensor voltage above normal
- 1785-04 Intake Manifold Pressure Sensor voltage below normal
- 1785-10 Intake Manifold Pressure Sensor abnormal rate of change
- 1797-03 Fuel Rail Pressure Sensor voltage above normal
- 1797-04 Fuel Rail Pressure Sensor voltage below normal

The following background information is related to this procedure:

The troubleshooting procedures for the diagnostic codes of each pressure sensor are identical. The 5 volt sensor supply provides power to all 5 Volt sensors. The Electronic Control Module (ECM) supplies 5.0 ± 0.2 Volts DC to terminal "A" of each sensor connector. The sensor common from the ECM connector goes to terminal "B" of each sensor connector. The sensor supply is output short circuit protected. A short circuit to the battery will not damage the circuit inside the ECM.

Pull-up Voltage

The ECM continuously outputs a pull-up voltage on the circuit for the sensor signal wire. The ECM uses this pull-up voltage in order to detect an open in the signal circuit. When the ECM detects the presence of a voltage that is above a threshold on the signal circuit, the ECM will generate an open circuit diagnostic code (03) for the sensor.

If the sensor is disconnected at the sensor connector, the presence of pull-up voltage at the sensor connector indicates that the wires from the sensor connector to the ECM are not open or shorted to ground. If the sensor is disconnected at the sensor connector, the absence of pull-up voltage at the sensor connector indicates an open in the signal wire or a short to ground. If the sensor is disconnected at the sensor connector and the voltage at the sensor connector is different from pull-up voltage, the signal wire is shorted to another wire in the harness.

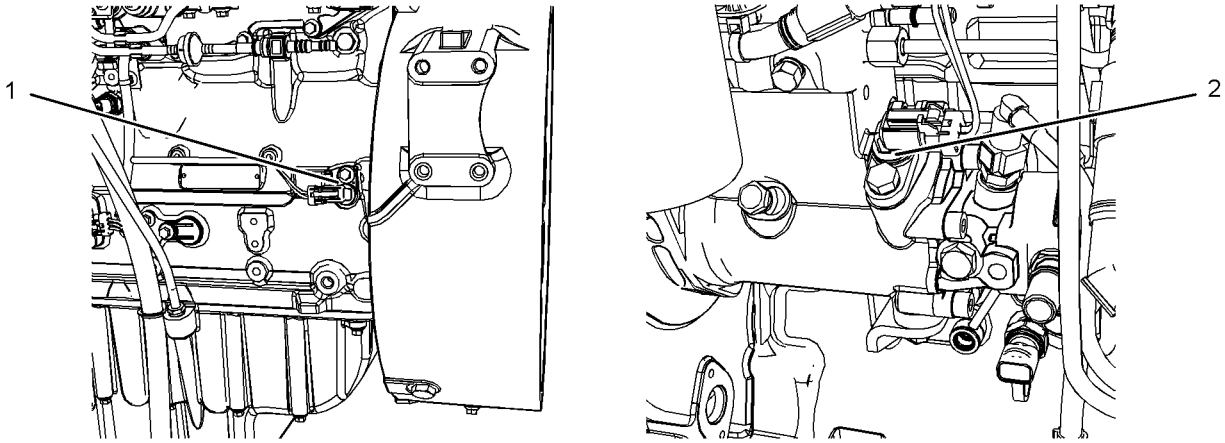


Illustration 60 g01803514

Detailed view of the sensor locations on the 1104D engine

(1) Primary speed/timing sensor (2) Secondary speed/timing sensor

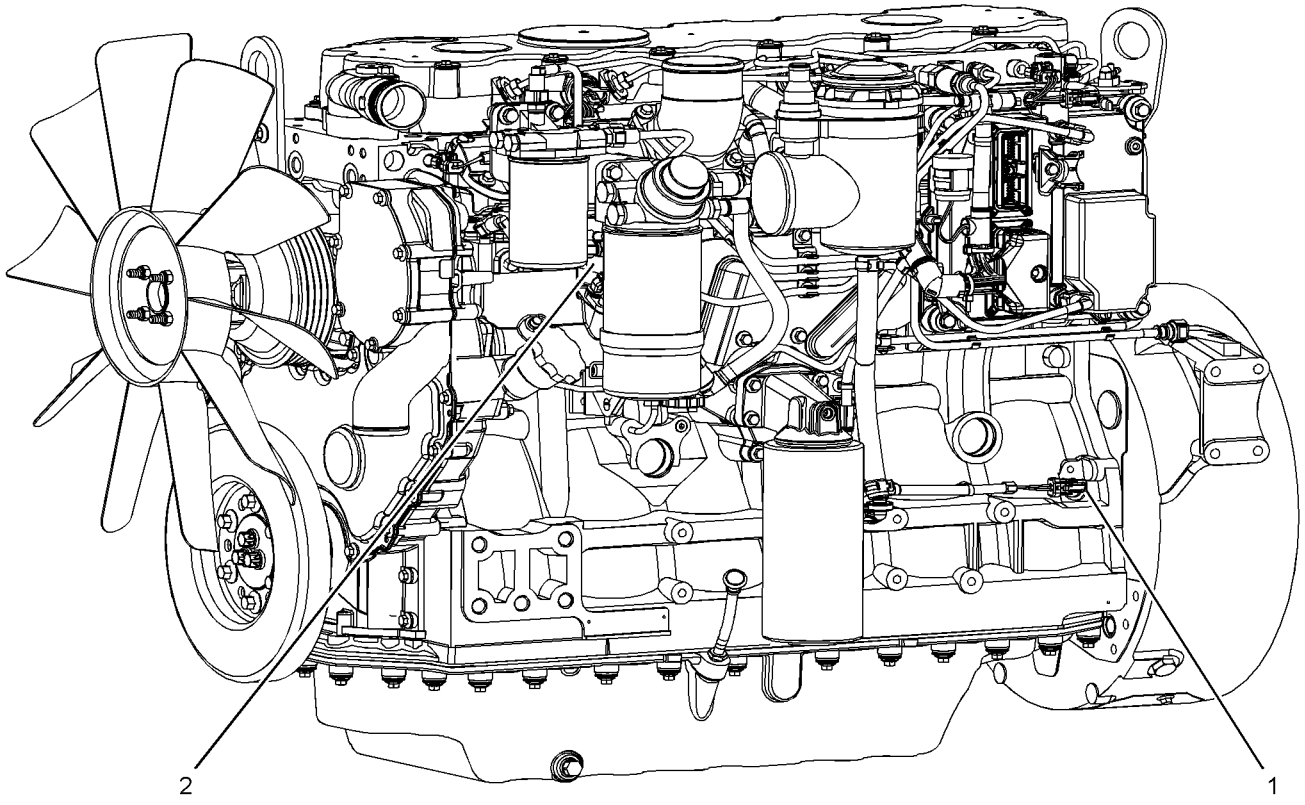


Illustration 61 g01803515

Typical view of the sensor locations on the 1106D engine

(1) Primary speed/timing sensor (2) Secondary speed/timing sensor

3. Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault.

STOP.

- Not OK **–** The fault is intermittent. Proceed to Test Step 8.

Test Step 8. Perform the “Wiggle Test” on the Perkins Electronic Service Tool (EST)

A. Select the “Wiggle Test” from the diagnostic tests on the electronic service tool.

B. Choose the appropriate group of parameters to monitor.

C. Press the “Start” button. Wiggle the wiring harness in order to reproduce intermittent faults.

If an intermittent fault exists, the status will be highlighted and an audible beep will be heard.

Expected Result:

No intermittent faults were indicated during the “Wiggle Test”.

Results:

- OK – No intermittent faults were found. The harness and connectors appear to be OK. If this test was required as part of another procedure, return to that procedure and continue testing. If this test has resolved the fault, return the engine to service. STOP.
- Not OK – At least one intermittent fault was indicated.

  Repair: Repair the harness or the connector.

  Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault.

  STOP.

i03460681

Fuel Rail Pump Solenoid - Test

System Operation Description:

Use this procedure to troubleshoot the system when one of the following diagnostic codes is active or easily repeated:

- 1779-05 Fuel Rail #1 Pressure Valve Solenoid current below normal
- 1779-06 Fuel Rail #1 Pressure Valve Solenoid current above normal

Note: The fuel rail pump is installed on the engine at the factory. The fuel rail pump is not serviceable part.

The fuel rail pump solenoid is used to control the output from the fuel rail pump. The solenoid receives an electrical supply from the Electronic Control Module (ECM). The fuel rail pump solenoid is then energized when the fuel is required to be pumped into the fuel rail. Varying the timing of the voltage to the solenoid controls the fuel delivery from the fuel rail pump.

When the fuel rail pump solenoid is deactivated, the fuel that is not sent to the fuel rail is returned to the fuel tank.

The fuel rail pump solenoid forms part of the closed loop control system for the fuel rail pressure in conjunction with the fuel rail pressure sensor, ECM and the software. The fuel rail pressure sensor measures the fuel pressure in the high pressure fuel rail. The signal from the fuel rail pressure sensor is processed by the ECM and software. The measured pressure is compared to the desired fuel rail pressure for the given engine operating conditions.

If the fuel rail pump solenoid fails, it is likely that the fuel will not be pumped into the high pressure fuel rail and engine shutdown or failure to start the engine is expected. Fuel rail pressure can be observed on the status screen of the electronic service tool.

Some applications may be equipped with an engine protection shutdown system or an idle timer shutdown system that interrupts electrical power to the keyswitch. The engine protection shutdown system can be an aftermarket device and the idle timer shutdown system can be external to the ECM. Some of these systems will not supply power to the ECM until one of the following conditions is met:

- The engine is cranked.
- The engine oil pressure achieves acceptable limits.
- An override button is pressed.

Keep in mind that these devices may be the cause of intermittent power to the ECM. These devices may also shut down the engine.

Usually, battery power to the diagnostic connector is available and the battery power to the data link connector is independent of the keyswitch. Therefore, you will be able to power up the electronic service tool, but you may not be able to communicate with the engine ECM. The engine ECM requires the keyswitch to be in the ON position in order to maintain communications. The ECM may power down a short time after connecting the electronic service tool if the keyswitch is in the OFF position. This is normal.

For intermittent faults such as intermittent shutdowns that could be caused by the application wiring, temporarily bypassing the application wiring may be an effective means of determining the root cause. If the symptoms disappear with the bypass wiring, the application wiring is the cause of the fault. A means of bypassing the application wiring is explained in this test procedure. This is especially important for applications that do not provide dedicated circuits for the unswitched battery and the connections for the keyswitch.

Use the electronic service tool in order to program the replacement injector trim files . Refer to Troubleshooting, “Injector Trim File” for further information.

Use the electronic service tool in order to clear the logged codes.

Turn the keyswitch to the ON position.

Start the engine.

Use the electronic service tool in order to perform the “Fuel System Verification Test”. If the cylinders indicate “PASS”, then the fault has been cleared.

Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault.

STOP.

Test Step 3. Check the ECM

A. Make sure that the latest flash file for the application is installed in the ECM. Refer to Troubleshooting, “Flash Programming”.

B. Contact the Technical Help Desk.

Note: This consultation can greatly reduce the repair time.

C. If the Technical Help Desk recommends the use of a test ECM, install a test ECM. Refer to Troubleshooting, “Replacing the ECM”.

D. Use the electronic service tool in order to perform the “Fuel System Verification Test”. Verify that the test eliminates the fault.

Note: The “Fuel System Verification Test” will indicate if the cylinder has a “Pass” or “Fail”. If the cylinders indicate “Pass” then the fault has been cleared.

E. If the fault is resolved with the test ECM, reconnect the suspect ECM.

F. Use the electronic service tool in order to perform the “Fuel System Verification Test”.

Expected Result:

The test ECM clears the fault. Using the electronic service tool in order to perform the “Fuel System Verification Test” with the suspect ECM indicates a “FAIL” condition.

Results:

- OK

  Repair: The test ECM eliminates the fault and the suspect ECM indicates a “FAIL” condition. Perform the following procedure:

  1. Replace the faulty ECM.
  2. Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair eliminates the fault.

  STOP.

- Not OK – The test ECM did not eliminate the fault. Carefully repeat this procedure from Test Step 1.

i03462471

Injector Solenoid Circuit - Test

System Operation Description:

Use this procedure to troubleshoot any suspected faults with the injector solenoids.

Use this procedure for the following diagnostic codes:

- 0001-05 Cylinder #1 Injector current below normal
- 0001-06 Cylinder #1 Injector current above normal
- 0002-05 Cylinder #2 Injector current below normal
- 0002-06 Cylinder #2 Injector current above normal
- 0003-05 Cylinder #3 Injector current below normal
- 0003-06 Cylinder #3 Injector current above normal
- 0004-05 Cylinder #4 Injector current below normal
- 0004-06 Cylinder #4 Injector current above normal
- 0005-05 Cylinder #5 Injector current below normal (1106D engine only)
- 0005-06 Cylinder #5 Injector current above normal (1106D engine only)
- 0006-05 Cylinder #6 Injector current below normal (1106D engine only)
- 0006-06 Cylinder #6 Injector current above normal (1106D engine only)

Perform this procedure under conditions that are identical to the conditions that exist when the fault occurs. Typically, faults with the injector solenoid occur when the engine is warmed up and/or when the engine is under vibration (heavy loads).

Measure the resistance of the return wire between connector P2 and the engine ground stud.

If the resistance is less than 10 Ohms, the fault is in the return wire between the ECM and the valve cover base.

If the resistance is greater than 10 Ohms, the fault is in the return wire under the valve cover.

Repair the injector harness or replace the injector harness.

Use the electronic service tool to clear all logged diagnostic codes and then perform the “Injector Solenoid Test” in order to verify that the repair eliminates the fault.

STOP.

i03462542

Mode Selection Circuit - Test

System Operation Description:

Use this procedure under the following circumstances:

- Diagnostic code 1743-02 has been generated.
- Check if the mode switch operates correctly.

The mode switch inputs provide the operator with the ability to select a maximum of four different modes of operation. Different modes of operation can be used in a particular situation by giving the operator a means to select the most efficient method of completing the required work.

Each mode has a single fuel limit map, a rated speed, and a matched fuel delivery. Each mode also has a specific droop value for throttle 1 and throttle 2.

For 1104D engines, refer to table 58 for a list of examples of different modes of operation.

For 1106D engines, refer to table 59 for a list of examples of different modes of operation. Refer to table 60 for a list of mode switch connections.

Test Step 1. Inspect Electrical Connectors and Wiring

A. Inspect the following connectors:

- P1 connector
- P2 connector

B. Inspect the terminal connections on the glow plug start aid relay. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the glow plug starting aid.

D. Check the screw for the ECM connector for the correct torque of 5.0 N·m (44 lb in).

E. Check the harness for abrasion and pinch points from the glow plugs back to the ECM.

F. Check that the fuses are not blown.

Expected Result:

All connectors, pins and sockets are correctly coupled and/or inserted. The harness is free of corrosion, abrasion and pinch points. The fuses are not blown.

Results:

- OK – The harness and the connectors appear to be OK. Proceed to Test Step 2.
- Not OK – There is a fault with the harness and connectors.

  Repair: Repair the connectors or the harness or replace the connectors or the harness. Ensure that all of the seals are correctly installed and ensure that the connectors are completely coupled. Replace blown fuses.

  Use the electronic service tool in order to clear all logged diagnostic codes and then verify that the repair has eliminated the fault.

  STOP.

Test Step 2. Check for Active Diagnostic Codes

A. Connect the electronic service tool to the diagnostic connector.

B. Turn the keyswitch to the ON position. Do not start the engine.

C. Use the electronic service tool to select the “Glow Plug Override Test” in order to turn on the power for the glow plugs.

D. Check for active diagnostic codes or recently logged diagnostic codes.

Expected Result:

The following diagnostic code is active or recently logged:

- 2246-06 Glow Plug Start Aid Relay Current above normal

Results:

- OK – The expected diagnostic code is active or recently logged. Proceed to Test step 3.
- Not OK – An active diagnostic code or a recently logged diagnostic code was not displayed.

  Repair: Perform one of the following procedures:

  - If an intermittent fault is suspected, use the electronic service tool to perform a “Wiggle Test” in order to locate intermittent connections.
  - If there is a fault on the glow plug or a fault on the starting aid and a diagnostic code is not displayed, there may be a fault with the glow plug switched power circuit or there may be an open circuit in the relay coil circuit. The ECM does not monitor the status of these items. Refer to Testing and Adjusting, “Glow Plugs - Test”.

  STOP.

Test Step 3. Check the Wiring for a Short Circuit

A. Turn the keyswitch to the OFF position.

B. Remove the P1 connector from the ECM.

C. Check the connector, pins and the sockets for corrosion or damage.

D. Check the resistance between P1:57 and each of the pins on the P1 connector.

Expected Result:

The resistance between P1:57 and each of the pins on the P1 connector is more than 10,000 Ohms.

Results:

- OK – The harness connects the ECM to the glow plug start aid relay and there are no shorts to other circuits. The ECM or the glow plug start aid relay is suspect. Proceed to Test Step 4.
- Not OK – The harness is faulty.