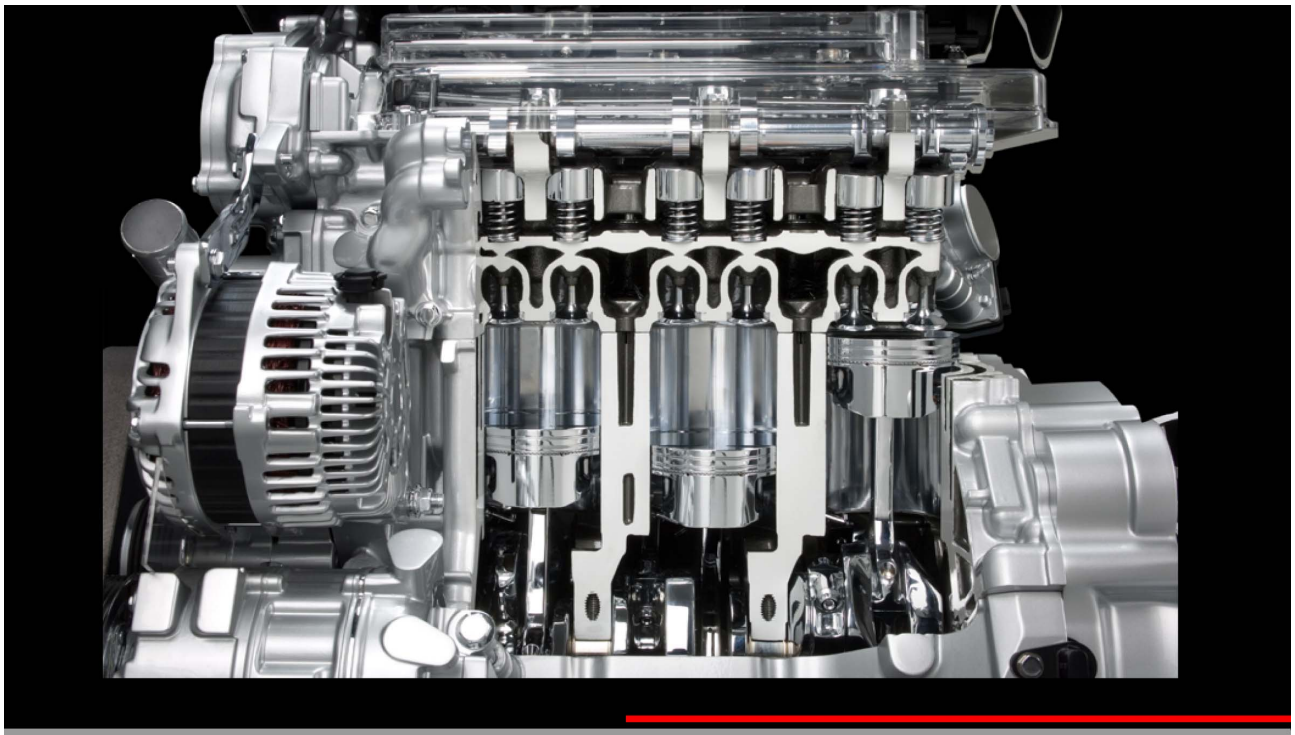
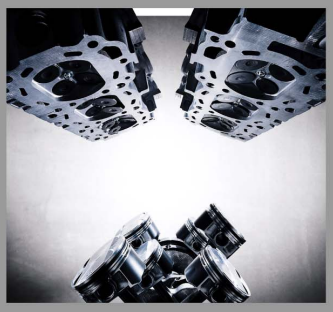
EMTC9915A



Service Technician Workbook





Engine Mechanical Service

NISSAN

INFINITI

CREATED JANUARY, 2009

This book is designed for instructional use only for authorized Nissan North America, Inc. and Nissan dealer personnel. For additional information contact:

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2008 NISSAN ENGINE MECHANICAL SERVICE
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2008 NISSAN ENGINE MECHANICAL SERV ICE OBJECTIVES

Engine Mechanical Service continues evolving as technicians do fewer and fewer internal repairs on Nissan and Infiniti engines. Many internal related engine repairs result in the replacement of either a short or long engine. This may include replacing the engine assembly with a remanufactured engine. Warranty data continues showing technicians continue replacing internal components such as crankshafts and the occasional piston/rod assembly. Instructing technicians on what to do when repairs are necessary assists the technician with making a thorough and complete diagnosis, then making the correct repair on the engine.

This informative and engaging instructor-led technical training course will help you:

- Identify the sections of the service manual that contain engine related information.
- Understand the different components available for diagnosis with CONSULT-III.
- Understand which components associated with CONSULT-III should be used at a given time.
- Technicians identify the correct procedure for performing a Power Balance Test using CONSULT-III
- Technicians learn how to use a Refractometer in measuring coolants freeze protection. They also learn how to use the cooling system refill tool by placing the cooling system in a vacuum.
- Some VQ engines no longer have an access hole for removing the water pump without removing the front cover. Yet some VQ engines continue having an access hole for the water pump and timing chain tensioner. Technicians learn the proper procedure for removing the water pump through the access cover.
- Technicians look at ways for testing oil pressure and inspecting for oil leaks.
- The C-VTC (Continuously Variable Timing Control) used on most Nissan/Infiniti engines can be diagnosed using CONSULT-III.
- The Variable Valve Event Lift is now used on three Nissan/Infiniti models. Inspecting and diagnosing this system is done using CONSULT-III.
- Nissan and Infiniti technicians use CONSULT-III to view data on the VVEL system associated with the VQ37VHR engine. Technicians learn first hand how the VVEL cylinder head operates when they disassemble the VQ37VHR cylinder head. Nissan and Infiniti technicians identify the correct procedure for inspecting, disassembling, and reassembling the cylinder head on a VQ37VHR engine.
- Technicians remove and reinstall the timing chains on the VQ37VHR, VK56DE, and QR25DE engines.
- Technicians identify the piston bore and grading for all engines on the QR25DE engine.
- The VQ35DE engine is used for identifying bearing grade and selection.
- The 2009 Murano, 2009 Maxima, and 2007 and later Altima with the VQ35DE engine all use the vacuum operated engine mounts. Technicians use CONSULT-III to engage and disengage the vacuum operated engine mounts.

- Engine noise diagnosis is done using both the information contained in the ESM and the information contained on the noise diagnosis CD.

TEXT

ENGINE MECHANICAL SERVICE

Introduction

Welcome to Nissan North America's Engine Mechanical Service Training Course. In this course you will learn engine theory, and the types of precision tools and specific procedures needed to properly diagnose and service Nissan/Infiniti engines.

Engine Identification

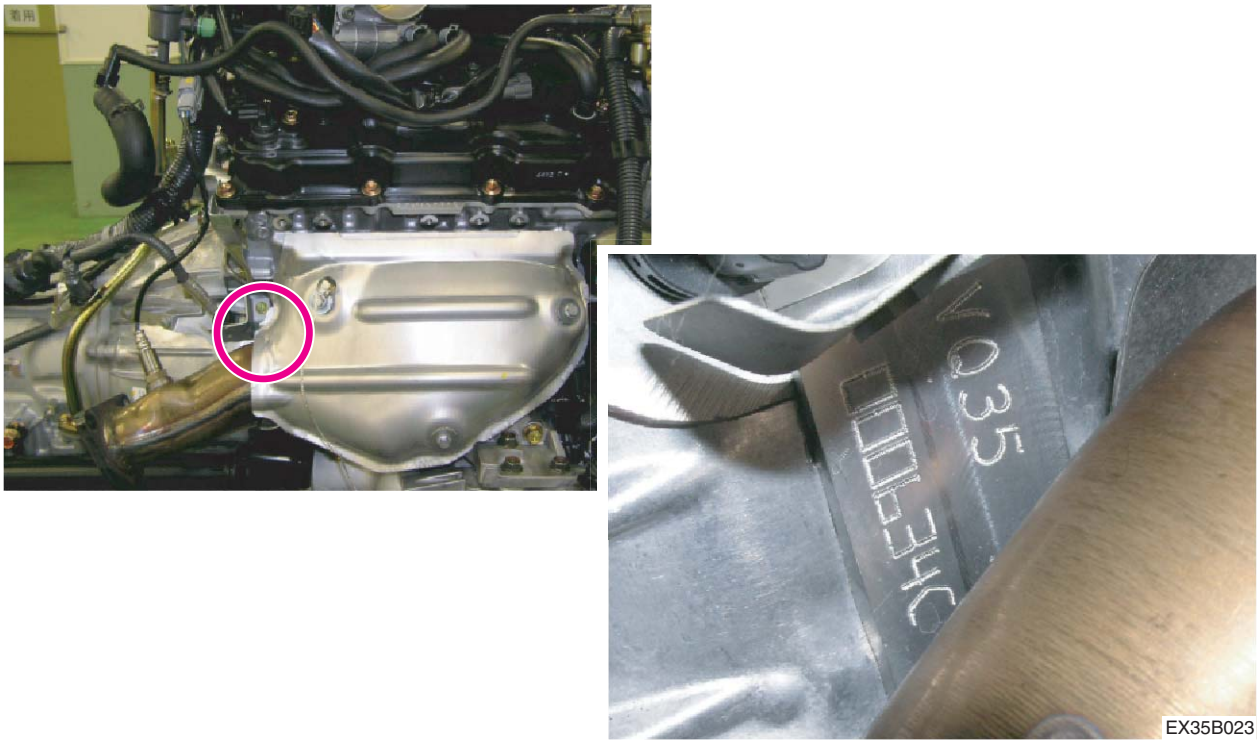
The following is a list of current Nissan and Infiniti engines and their applications.

Table 1: Engine Application Table

MR16DE	Versa
MR18DE	Versa
MR20DE	Sentra
QR25DE	Altima, Sentra, Rogue, Frontier
VK45DE	M
VK50VE	FX
VK56DE	Armada, Titan, QX56
VQ35DE	Maxima, Altima, Quest, Murano
VQ35HR	350Z, M, G35, EX35, FX
VQ37VHR	370Z, G37
VQ40DE	Pathfinder, Xterra, Frontier
VR38DETT	GT-R

Engine Serial Number Location

Engine serial numbers are located on a flat pad on the cylinder block. A typical example is shown here.



VQ35 engine serial number location

Engine Specifications

The following is an example of a typical engine specification table (Z51 Murano shown).



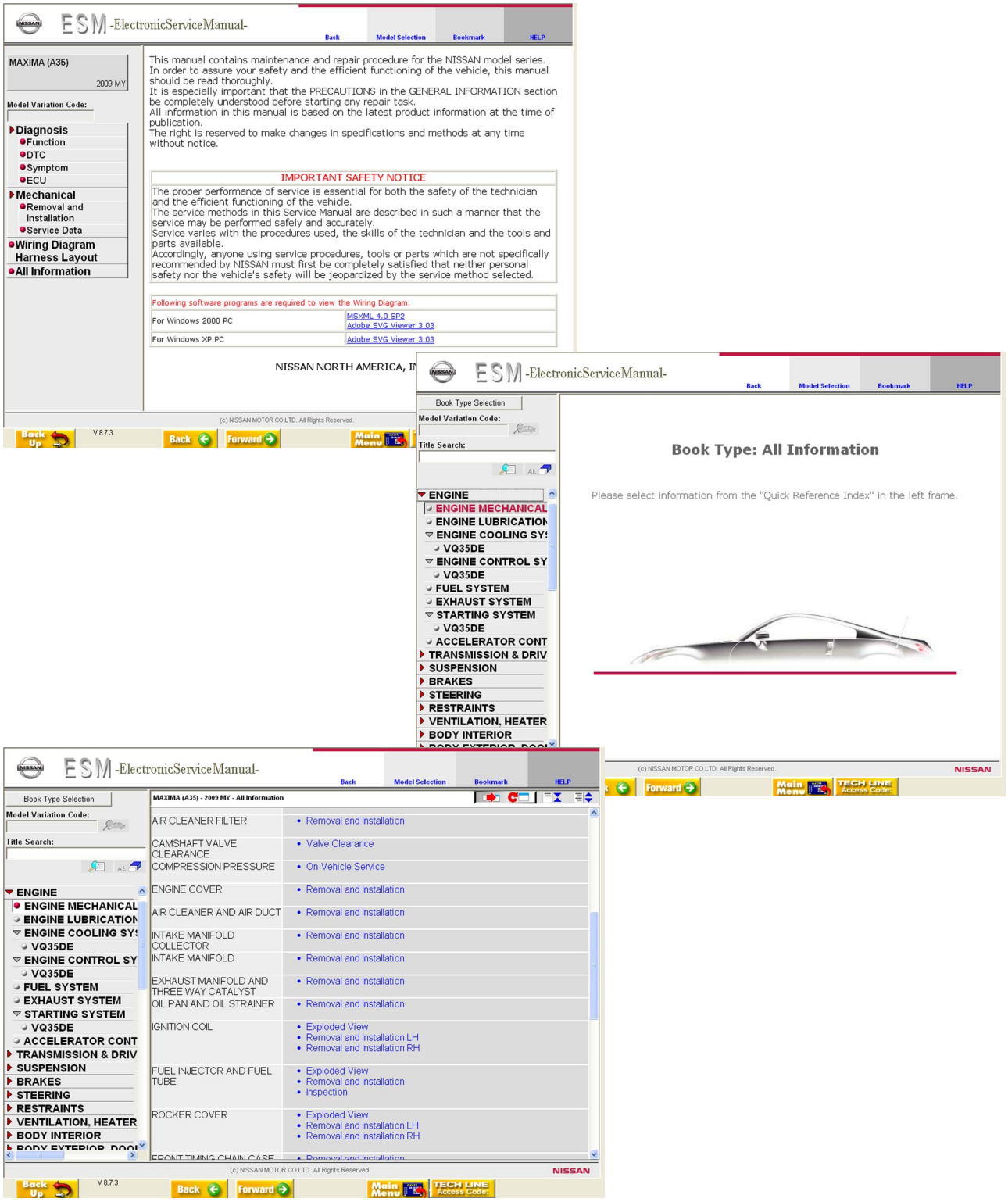


Displacement		cc (cu in)	3.498 (213.45)
Bore x Stroke		mm (in)	95.5 x 81.4 (3.76 x 3.205)
Valve arrangement			DOHC
Firing order			1-2-3-4-5-6
Number of piston rings		Compression	2
		Oil	1
Number of main bearings			4
Compression ratio			10.3 : 1
Compression pressure kPa (bar, kg/cm^2, psi) /300 rpm	Standard		1275 (13.01, 184.9)
	Minimum		981 (10.01, 142.2)
	Differential limit between cylinders		98 (1.0, 14.2)
Maximum power		kW	265 hp @ 6000 rpm
Maximum torque		N·m	248 ft-lb @ 4400 rpm
Maximum engine speed			6,600 rpm
Induction system			Sequential multi-point fuel injection
Valve train			DOHC 4 valves per cylinder with CVTS (Continuously Variable intake Valve Timing Control System)
Intake system			NICS (Nissan variable Induction Control System)

Z51B002

Engine Mechanical Repair Information

Engine mechanical repair information is found in the EM section of the ESM. Starting with 2009 vehicles, service information will be entirely internet-based (HTML).



Basic Engine Operation

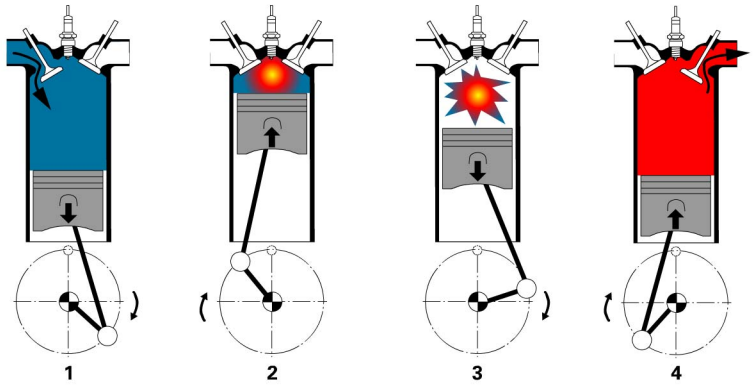
Back to Basics

A four-stroke gasoline spark ignition engine consists of just a few main components: a cylinder block, cylinder head, piston, crankshaft, connecting rod, camshaft, intake and exhaust valves with springs, ignition system, and fuel system.

As the crankshaft rotates, the piston moves up and down in the cylinder. Two revolutions of the crankshaft are required for all four strokes to occur in all engine cylinders. This is true no matter how many cylinders the engine has. The intake and exhaust valves open and close once during the four strokes of the cycle.

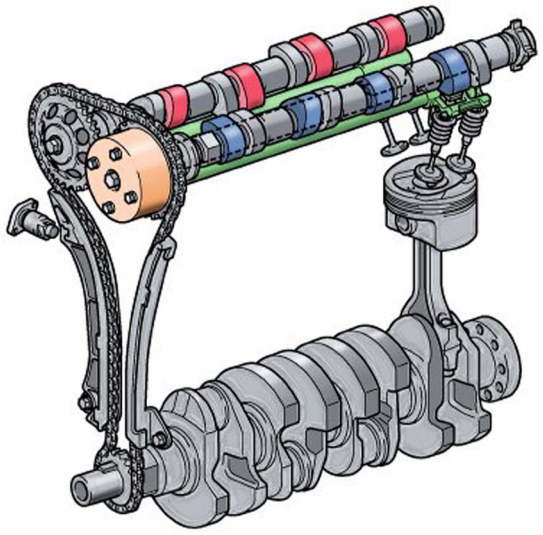
Four-Stroke Cycle

The four-stroke cycle consists of the intake compression, power, and exhaust strokes. Refer to the graphic below. During the intake stroke (1), the piston moves downward in the cylinder and the intake valve is open. Air-fuel mixture is drawn into the cylinder. The compression stroke (2) occurs when the intake valve closes and the piston moves upward in the cylinder. Since the cylinder is now an enclosed volume, the air-fuel mixture is compressed an amount equal to the compression ratio of the engine. When the piston is near the top of the cylinder (near top-dead-center or TDC), the spark plug fires, igniting the compressed air-fuel mixture. This is the power stroke (3). Since the cylinder is still an enclosed volume with both valves closed, the high pressure generated by the burning air-fuel mixture pushes the piston downward in the cylinder. Finally, the exhaust valve opens (4), and the piston moves upward, pushing exhaust gases out of the cylinder. This completes the four-stroke cycle.

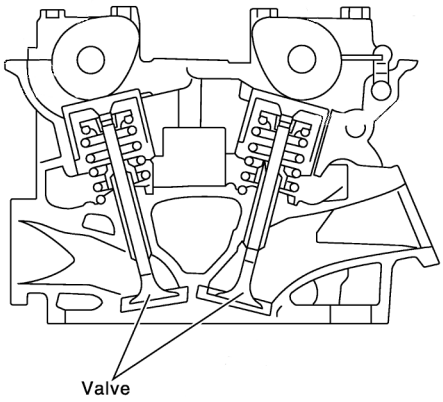


Valve Timing System

The camshafts are geared to rotate at one-half crankshaft speed and turn once for every two revolutions of the crankshaft. Therefore, completing all four strokes of the four-stroke cycle requires two turns of the crankshaft, but only one turn of the camshafts. The camshafts open each intake and exhaust valve once per cycle.



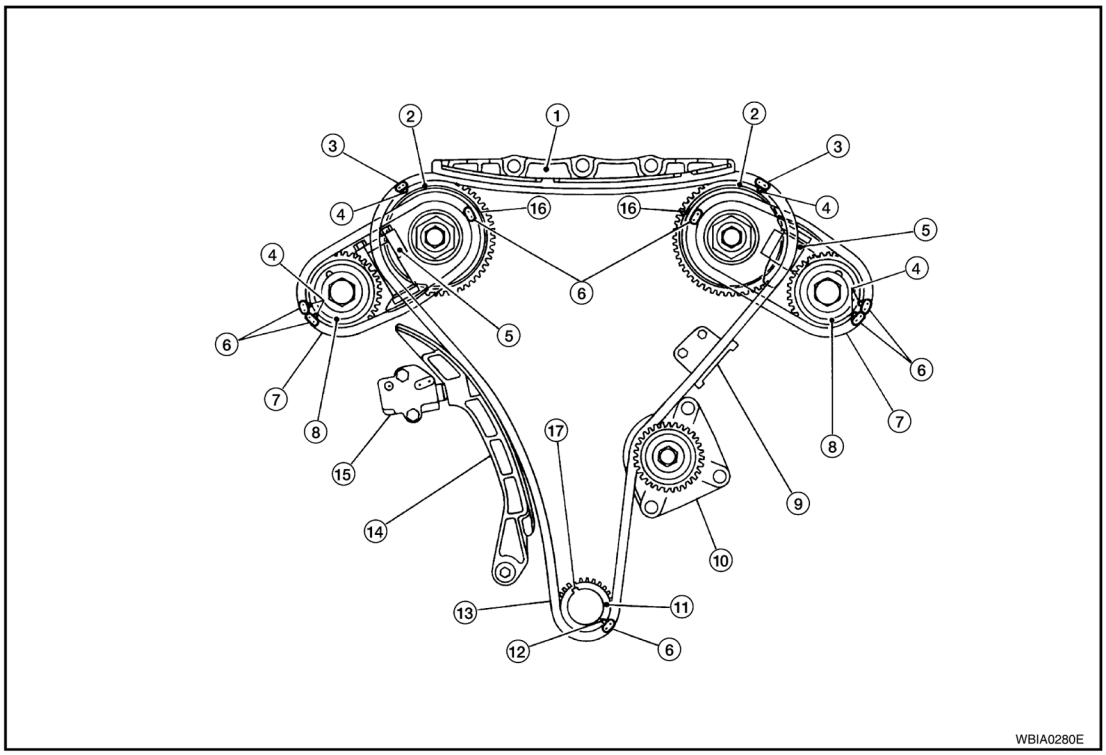
In a typical engine, the lobes of the camshaft depress bucket followers downward to open the valves. Valve springs provide the necessary force to close the valves.



Valve Timing

The purpose of the engine timing system is to keep the camshafts in the proper relationship to the crankshaft so that intake and exhaust valves open and close at the correct time in the cycle.

Reference marks are provided on timing gears and chains to ensure the correct timing relationship between the crankshaft and the camshafts. All Nissan and Infiniti engines today use silent-type timing chains. Chain tension is maintained by chain guides and a hydraulic chain tensioner. The hydraulic tensioner varies tension in proportion to engine speed.



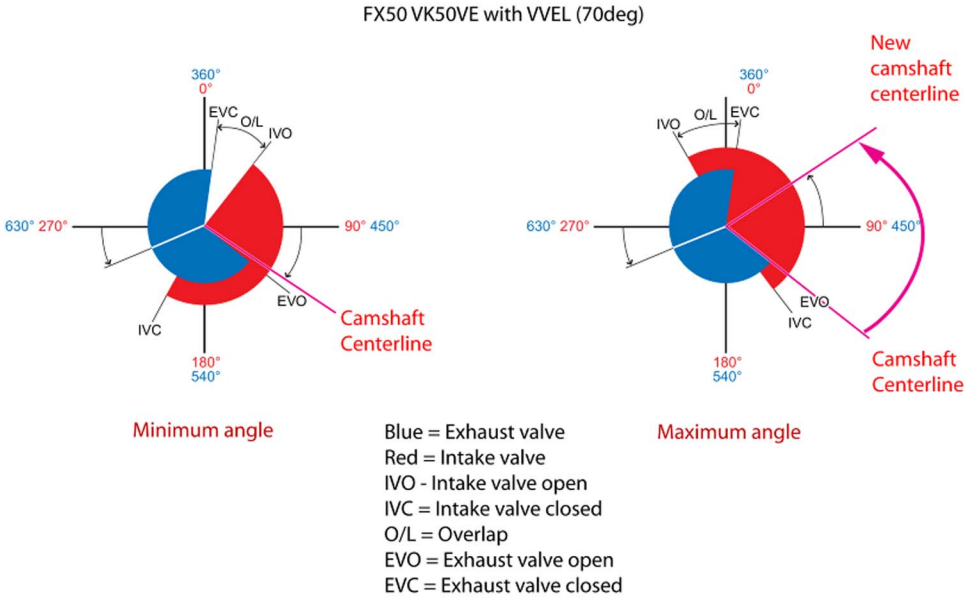
1. Internal chain guide
2. Camshaft sprocket (intake)
3. Mating mark (pink link)
4. Mating mark (punched)
5. Secondary timing chain tensioner
6. Mating mark (orange link)
7. Secondary timing chain
8. Camshaft sprocket (exhaust)
9. Tension guide
10. Water pump
11. Crankshaft sprocket
12. Mating mark (notched)
13. Primary timing chain
14. Slack guide
15. Primary timing chain tensioner
16. Mating mark (back side)
17. Crankshaft key

Previously, some engines used toothed reinforced rubber timing belts instead of chains. A spring-loaded tensioner maintained correct belt tension.

Variable Valve Timing

In engines with fixed valve timing, the relationship of valve opening and closing to crankshaft position does not change. At all engine speeds and loads, valve timing remains the same. While many successful engines have been designed this way, fixed valve timing means that engine performance, economy, and emissions can be optimized only within narrow operating parameters.

In engines with variable valve timing, intake valve timing, and sometimes also exhaust valve timing, can be advanced and retarded relative to crankshaft position.



Importance of Engine Condition

No amount of electronics or engine management system sophistication can compensate for an inherent engine mechanical problem. Troubleshooting should always begin by confirming that the engine is mechanically in good condition. When the engine is running, things are happening quickly and with precision, and there is little margin for degradation in today's engines. The engine management system delivers fuel in the right quantity and spark at the right time to match the airflow and load demands of the engine. At 3000 RPM, the crankshaft turns two revolutions and each piston completes the four stroke cycle in only 0.040 sec.

Valve duration typically allows less than 0.015 sec. for intake and exhaust events to take place. Fuel injection typically requires 0.002-0.005 sec. duration, and once the spark plug ignites the air-fuel mixture, the combustion burn time is only about 0.003 sec.

Conditions affecting an engine's combustion efficiency, power and emissions:

- Camshaft and valve timing
- Defective valves or valve train (bad camshaft, broken springs, etc.)
- Low compression
- Oil pressure
- Vacuum leak in intake or exhaust systems
- Restrictions in intake or exhaust systems
- Spark plug or ignition problems (electrical or mechanical)

Engine Cooling System

Cooling System Description

The cooling system keeps the engine running at the most efficient operating temperature under all operating conditions. Inefficient cooling system operation results in poor engine performance and driveability and may cause accelerated wear.

Begin any cooling system diagnosis with a visual inspection. This includes the condition of the hoses, radiator, drive belts and coolant. Use a pressure test to check for small leaks in the cooling system and radiator cap. Check the condition of radiator, engine inlet and outlet hoses and heater hoses to confirm their integrity. Hot engine coolant causes the rubber material to deteriorate from the inside out. When you squeeze the hose, it should be firm. If the hose feels soft, cracked, or deteriorated, replace it. Check to be sure there is no evidence of damage, such as cracked rubber or obvious breakdown of the material.

The overall purpose of the cooling system is to remove heat from the engine. Water is the best liquid for heat removal. However, water freezes at 0°C (32°F) and vaporizes at 100°C (212°F). Water also promotes corrosion. To prevent freezing and boiling and to protect metal parts, ethylene glycol-based anti-freeze is added to water. This mixture operates in a wider temperature range, but ethylene glycol transfers less heat than water. To maintain good heat removal qualities while still giving adequate protection against freezing, the coolant-to-water ratio must be maintained at 50%.

Water Control Valve and Thermostat

MR18, MR20, and QR25 engines in current production as of this writing have dual-stage engine cooling systems with two thermostatically operated valves:

- Water Control Valve
- Thermostat

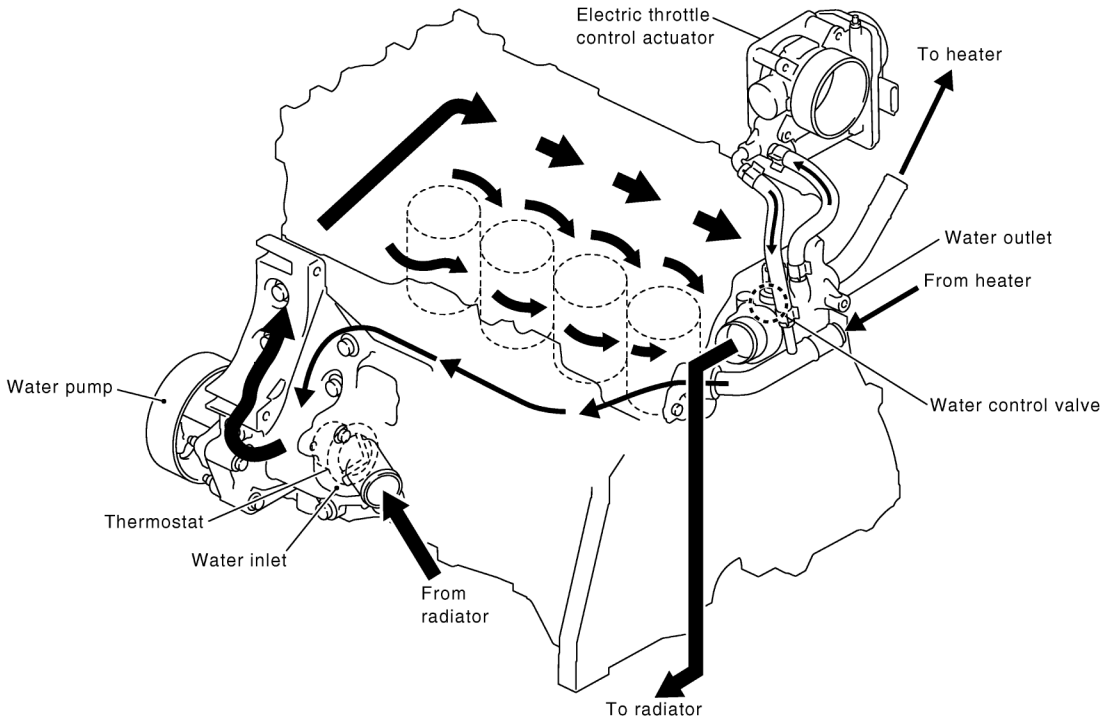
Coolant flow is divided into two systems:

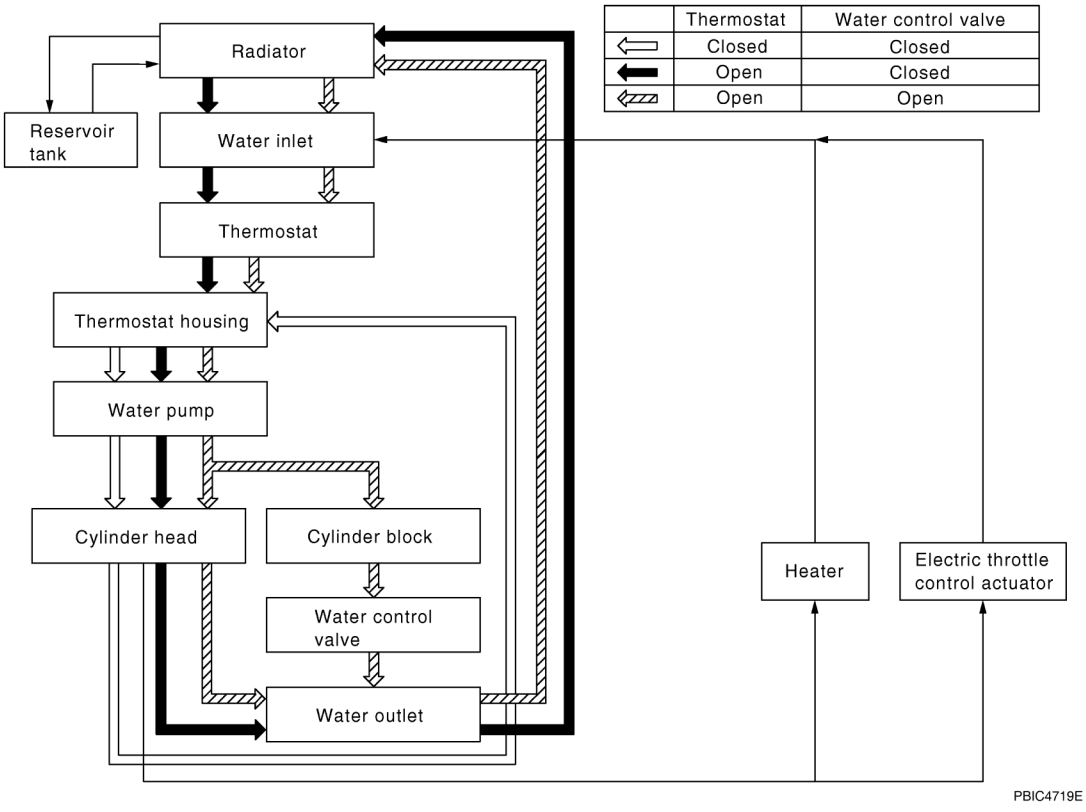
- Cylinder block
- Cylinder head

Refer to the illustration on the next page. A water control valve controls when and how much coolant flows to the block with changes in engine temperature.

When coolant temperature is < 95°C (203°F), the water control valve is closed and coolant circulates only in the cylinder head. Block cylinder wall and oil temperatures can increase faster, which reduce HC emissions, friction and improves economy.

When coolant temperature is > 95°C (203°F), the water control valve is open and coolant flows through the cylinder block in the normal way.





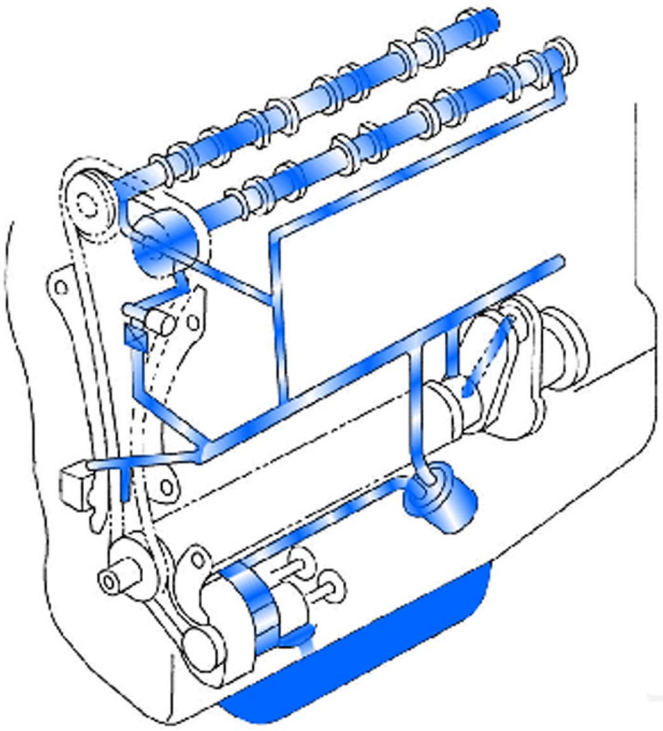
	Thermostat	Water control valve
⇦	Closed	Closed
⬅	Open	Closed
⇦	Open	Open

Lubrication System

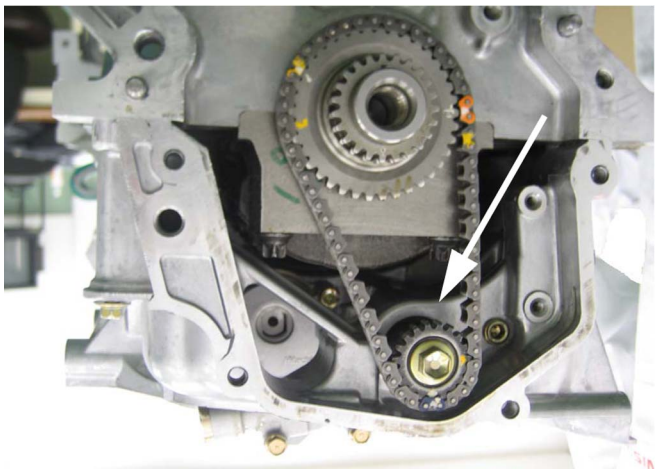
Lubrication System Description

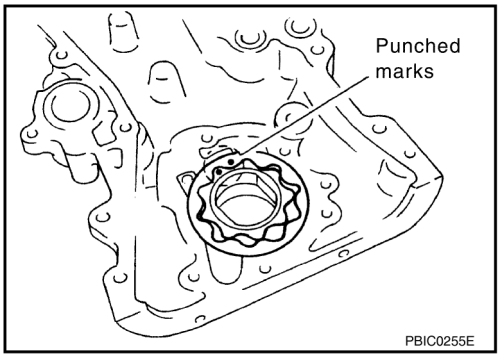
The engine lubrication system is designed to deliver clean oil at the correct temperature and pressure to every part of the engine. The oil pump pulls oil from the crankcase sump (oil pan) and pumps it under pressure to the oil filter. Oil then flows through oil passages to the main bearings and to the oil pressure sensor. From the main bearings, the oil passes through feed-holes into drilled passages in the crankshaft and on to connecting rod big-end bearings.

The cylinder walls and piston-pin bearings are lubricated by oil thrown by the rotating crankshaft. Excess oil is scraped off by the lower piston ring. Additional oil passages feed each camshaft bearing and the timing chain or gears on the camshaft drive. Excess oil then drains back to the sump, where the oil is cooled by the surrounding air.



The oil pump is mounted in the oil pan. In some engines, the oil pump is chain-driven by the crankshaft. In other engines, the rotor-type oil pump is mounted directly on the front end of the crankshaft.





Oil weight and viscosity

- 5W-30 oil is recommended for most engines for optimal performance and fuel economy.
- VQ37 and VK50 engines require the use of Nissan Ester Oil part no. 999MP-5W30EP for reducing ticking engine noises from the VVEL actuator (See TSB ITB08-28a).
- Nissan recommends using Mobil 1 0W-40 in the GT-R for maximum performance and engine life.

CONSULT-III

CONSULT-III is the new generation diagnostic tool for Nissan and Infiniti vehicles. CONSULT-III is a Panasonic® Toughbook® laptop-based diagnostic system that uses a Microsoft® Windows® user interface and is wireless capable. Consult-III supports all 2007 and newer vehicles.

- Enhanced diagnostic capability function for CAN network
- Downloads reprogramming data
- Integrates vehicle data recorder function into VI unit
- Wireless communication (between CONSULT-III and VI/MI units)
- Big screen display – much more information can be displayed on one screen



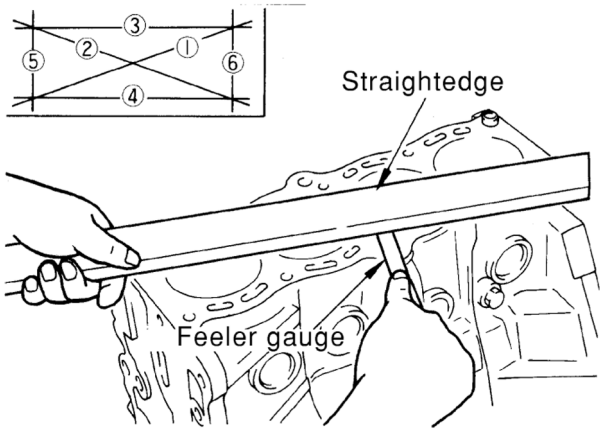
Engine Block Inspection Procedures

Block Distortion

Engine block distortion is measured across the flat cylinder head gasket sealing surface of the block using a rigid straightedge and a feeler gauge. Clean the surface thoroughly to remove water scale deposits, gasket material and old sealer before measuring surface distortion.

NOTE: Use care to prevent debris from falling into coolant and oil passages.

Check the face flatness at six points on both edges and from corner to corner in an X pattern, as shown. Typical flatness distortion limit is 0.1 mm (0.004 in). If flatness limit is exceeded, replace the cylinder block and lower block, as they are machined together as an assembly. Cylinder block distortion specifications are found in the ESM.

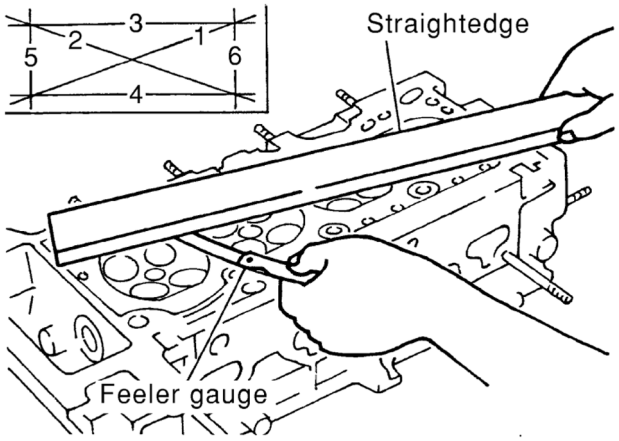


Cylinder Head Distortion

Cylinder head distortion is measured across the flat gasket sealing surface of the cylinder head using a rigid straightedge and a feeler gauge. Clean the surface thoroughly to remove water scale deposits, gasket material and old sealer before measuring surface distortion.

NOTE: Use care to prevent debris from falling into coolant and oil passages.

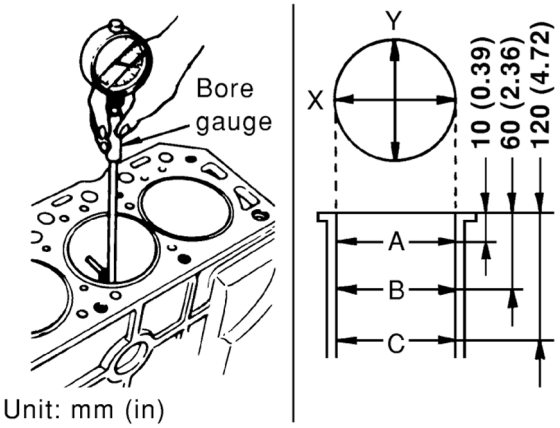
Check the face flatness at six points on both edges and from corner to corner in an X pattern, as shown. Typical flatness distortion limit is 0.1 mm (0.004 in). If flatness limit is exceeded, replace the cylinder head. Cylinder head distortion specifications are found in the ESM.



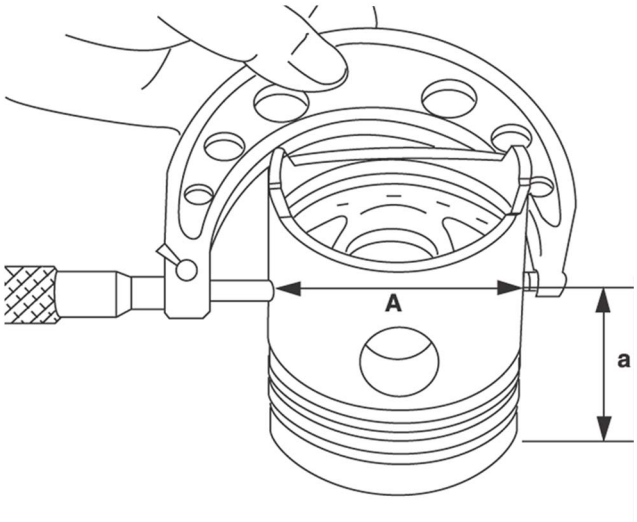
NOTE: When an engine overheats, cylinder heads warp on both the top and bottom.

Piston-to-Bore Clearance

During engine operation, piston rings can gradually wear the cylinder walls and change critical dimensions. This affects the way the pistons fit in the cylinder bores, and reduces compression and engine power. When overhauling an engine, measure all cylinders for taper and out-of-round with a bore gauge. If any of the cylinders are out of specification, you must re-bore all the cylinders and replace pistons with oversize. In some circumstances cylinders cannot be re-bored and the block must be replaced.



Check the piston-to-bore clearance by measuring the piston skirt diameter at the point specified in the ESM and comparing it to the cylinder bore diameter. Subtract the skirt diameter from the bore diameter.

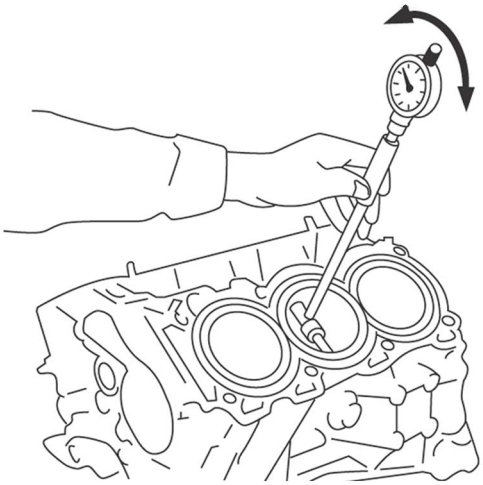


Cylinder and piston-to-bore clearance specifications are found in the ESM.

Cylinder Taper

Cylinders wear more at the top of the piston travel than at the bottom because of combustion pressures, high temperatures, and less lubrication. This varying wear pattern down the cylinder wall is called taper.

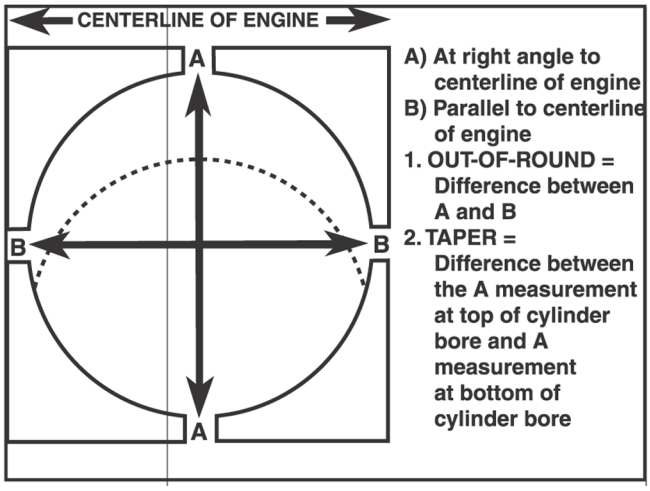
Measure cylinder diameters at both the bottom and the top of each cylinder. Take these measurements at right angles to the centerline of the crankshaft. Subtract the bottom diameter measurement from the top diameter measurement to determine the amount of cylinder taper. Cylinder taper specifications are found in the ESM.



Cylinder Out-of-Round

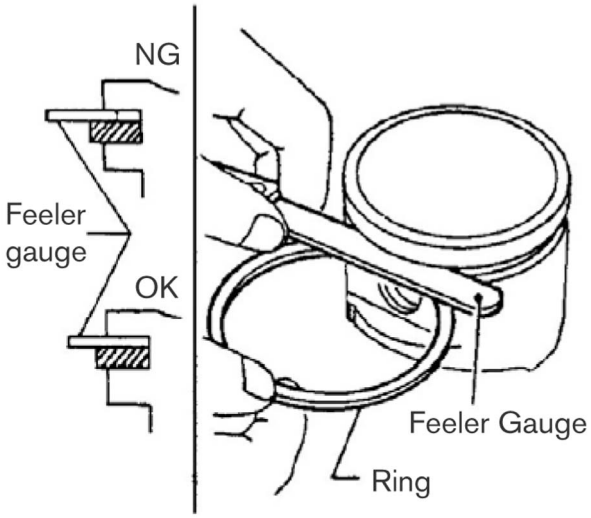
Side thrust forces on the piston can cause uneven cylinder wear and an out-of-round condition. Excessive out-of-round can prevent piston rings from properly sealing.

To determine whether cylinders are out-of-round, use a bore gauge in the area of greatest wear at right angles to the crankshaft and also in line with the crankshaft. Subtract the smallest measurement from the largest measurement. Cylinder out-of-round specifications are found in the ESM.



Piston Ring Side Clearance

Piston rings must fit properly in their grooves and must be neither too tight nor too loose. Measure piston ring side clearance with a feeler gauge. Install rings on the pistons, then measure between the ring and the groove with the feeler gauge. Piston ring side clearance specifications are found in the ESM.



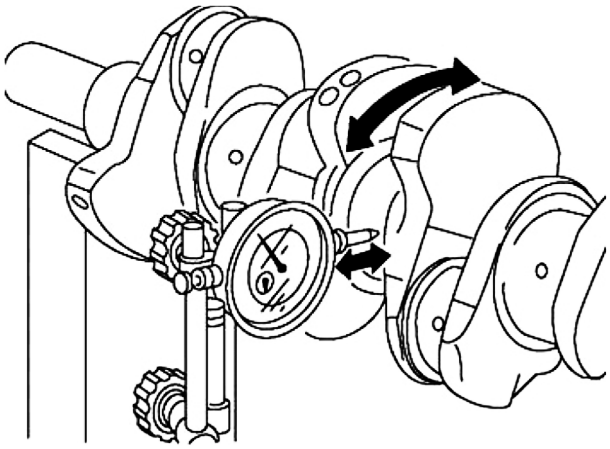
Crankshaft Inspection Procedures

Visual Inspection

When inspecting the crankshaft, pay particular attention to the bearing journal surfaces. Excessive wear may be caused by oil passage obstructions. Be sure to examine the oil supply passages. Scoring can also result from abrasive material in the oil. Examine the engine oil for evidence. Uneven wear patterns can indicate bent connecting rods or a bent crankshaft.

Crankshaft Runout

The crankshaft can warp in operation. You can determine crankshaft straightness by measuring runout. Place the crankshaft in a set of V-blocks and mount a dial indicator with the rod perpendicular to each of the main journals. Rotate the crankshaft in the V-blocks and read the amount of runout on the dial indicator at the center of each main journal. Crankshaft runout specifications are found in the ESM.

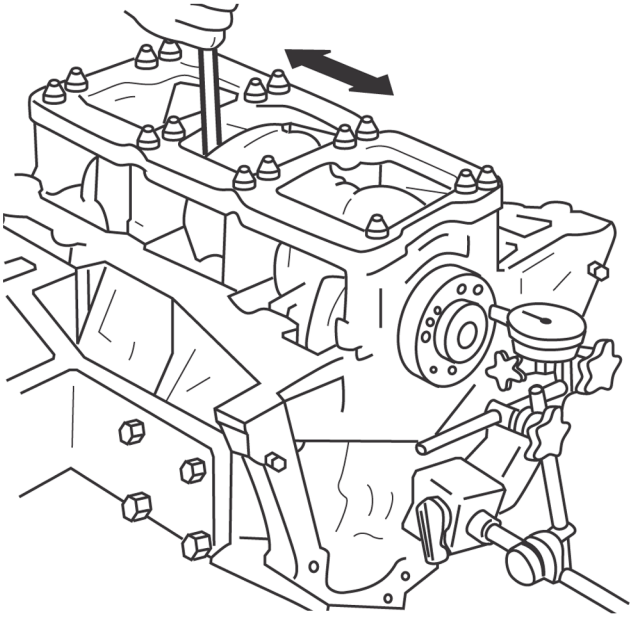


Crankshaft Endplay

Endplay is defined as how much the crankshaft can move back and forth in the cylinder block between the thrust bearings. To measure crankshaft end play:

- Install the crankshaft.
- Install the main bearing caps or bearing beam and torque to specifications.
- Turn the crankshaft by hand to ensure that it rotates freely and is properly positioned.
- Mount a dial indicator on the end of the crankshaft, with the indicator rod parallel to the crankshaft.
- Use a large screwdriver or other tool to carefully shift the crankshaft back and forth, and measure the amount of end play shown on the dial indicator.

Crankshaft endplay specifications are found in the ESM.



Crankshaft Journal Out-of-Round and Taper

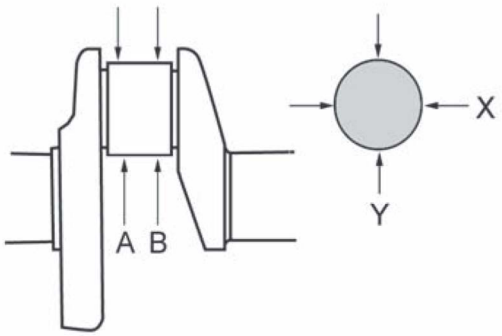
A film of oil is maintained between crankshaft bearing surfaces and rotating crankshaft journals. This oil keeps the bearing surfaces and the crankshaft journals apart and prevents actual contact between the two parts. The oil also cools the bearings.

Proper clearance between bearings and journals is extremely important to prevent wear and damage to the crankshaft due to insufficient lubrication. The engine lubrication system feeds oil through passages in the block to the crankshaft main bearings. The rotating journals distribute the oil to all parts of the bearings. Connecting rod big end bearings receive oil from the main bearing journals through drilled passages in the crankshaft.

Bearing journals wear in two ways. They may wear out-of-round or they may taper. If the crankshaft or connecting rod bearing journal were out-of-round or tapered, the result could be contact and wear between the crankshaft and the bearing or damage to the connecting rod.

- If you see evidence of out-of-round or taper on a main bearing journal, check the engine block line bore.
- Send the crankshaft and/or block to a machine shop to have it checked if you find that either out-of-round or taper are not within specifications.
- Use a micrometer to check the main and connecting rod journals for out-of-round and taper.
- Measure out-of-round at right angles to the centerline of the crankshaft (X and Y on the illustration).
- Measure taper in line with the crankshaft centerline at the two outer edges of the journal (A and B on the illustration).

Crankshaft out-of-round and taper specifications are found in the ESM.



Connecting Rod Inspection Procedures

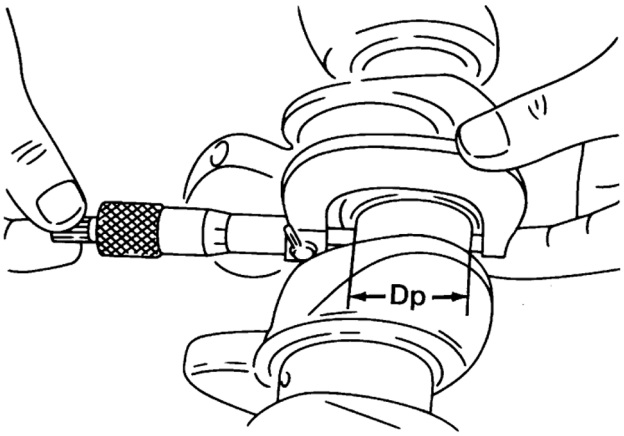
Connecting rods are the link between the piston and crankshaft. Connecting rods have a bearing at each end: the piston pin bearing is at the upper (small) end, the crankshaft connecting rod journal bearing is at the lower (big) end. These bearings are lubricated with engine oil which prevents metal-to-metal contact, wear, and noise. Connecting rods should be checked when an engine is repaired.

There are three methods to check the connecting rods and to ensure the selection of the correct size, or grade, of connecting rod bearing:

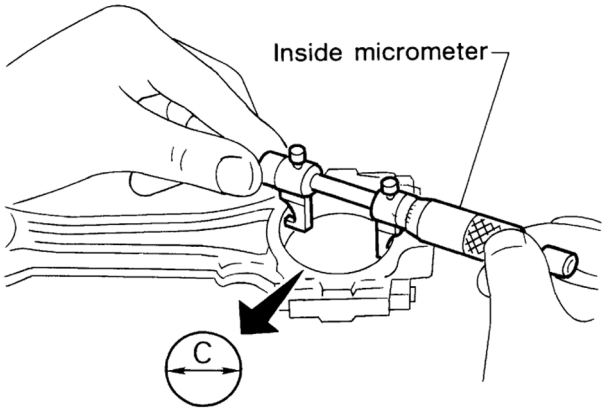
- Compare bearing journal diameter with bearing inside diameter with inside and outside micrometers
- Check actual bearing clearance with Plastigage™
- Connecting rod bearing grade number stamped on crankshaft

Measuring Bearing Clearance with a Micrometer

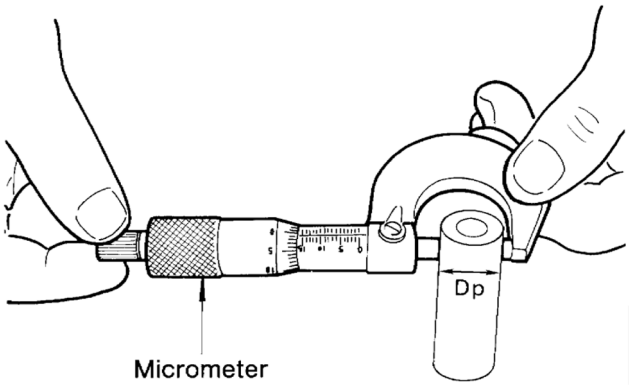
The most accurate method for measuring connecting rod bearings is with inside and outside micrometers. Use an outside micrometer to measure the crankpin journal diameter.



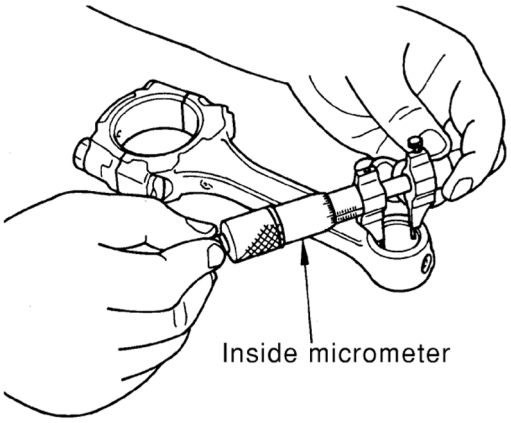
Use an inside micrometer to measure the diameter of the connecting rod big end bearing surface. Subtract the crankpin journal diameter measurement from the big end bearing inside diameter measurement to obtain the connecting rod bearing clearance.



A similar procedure is used to measure the piston pin bearing clearance at the connecting rod small end. Measure the diameter of the piston pin with an outside micrometer.



Measure the piston pin bearing inside diameter at the upper end of the connecting rod with an inside micrometer. Subtract the wrist pin diameter measurement from the piston pin bearing inside diameter measurement to obtain the piston pin bearing clearance.



If the clearance is excessive at the big end, the crankshaft should be refinished or replaced and a new connecting rod bearing must be installed in the connecting rod. Before final assembly, check actual bearing clearance with Plastigage™ (as previously described) to ensure correct clearance. If the clearance is excessive at the small end, the piston and wrist pin assembly should be replaced and a new connecting rod bushing must be installed in the connecting rod. Clearance can usually be adjusted within specifications using a new bearing, unless the crankshaft journal has been damaged. In that case, either grind or replace the crankshaft, depending on the amount of damage, and replace the connecting rod.

NOTE: If the crankshaft is replaced with new, select the connecting rod bearing according to the bearing grade number stamped on the connecting rod and listed in the "Connecting Rod Bearing Selection Table" in the ESM.

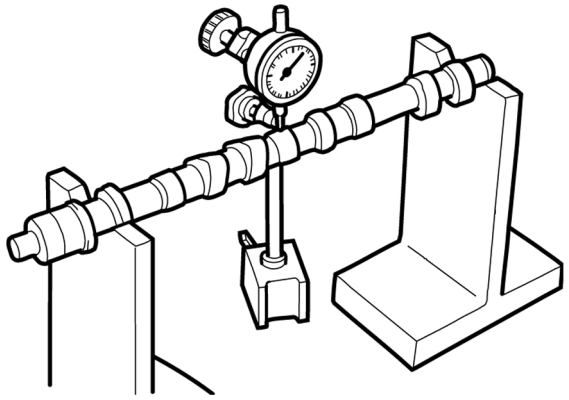
Camshaft Inspection Procedures

Cylinder head distortion or excessive heating of the cylinder head may result in camshaft warping. Camshafts can warp through normal engine wear. Runout (radial contour) measurements provide information about how much bend (warping) exists in the camshaft. Endplay measurements provide information on how much axial camshaft movement exists in the cylinder head.

Camshaft Runout

Measuring camshaft runout provides an indication of camshaft straightness. To measure the camshaft, place it on a set of V-blocks with a dial indicator. Mount the indicator rod at a 90° angle to the center camshaft journal. Slowly rotate the camshaft while reading the dial indicator.

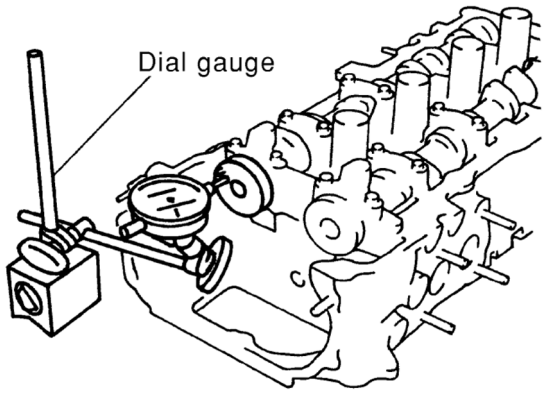
A camshaft with runout that is out of specification cannot be repaired and must be replaced. Excessive camshaft runout can cause damage to the cylinder head and valve train. Camshaft runout specifications are found in the ESM.



Camshaft Endplay

Endplay measurements provide information about how far the camshaft can move back and forth (lengthwise) in the cylinder head. Endplay is measured with the camshaft installed in the cylinder head, and a dial indicator is used to measure.

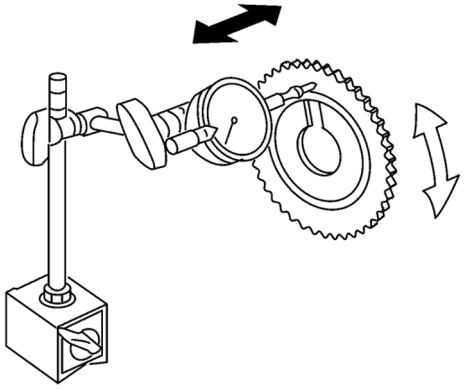
To measure camshaft endplay, mount a dial indicator with the indicator rod parallel to the direction of movement to be measured. Excessive end play may require that the camshaft, the cylinder head, or both be replaced. Camshaft endplay specifications are found in the ESM.



Camshaft Sprocket Runout

Camshaft sprocket runout should be checked before a cylinder head is reinstalled.

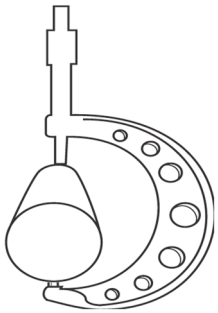
Measure camshaft sprocket runout with a dial indicator. Mount the dial indicator with the indicator rod parallel to the direction of movement to be measured. Do not mistake camshaft endplay for sprocket runout. Camshaft sprocket runout specifications are found in the ESM.



Camshaft Lobe Height

Proper valve operation affects engine combustion and driveability. Worn cam lobes may result in reduced valve opening which can cause improper engine combustion and increased emissions.

Use an outside micrometer to measure camshaft lobe height. If camshaft lobe wear exceeds the limit specification, the camshaft should be replaced. Camshaft lobe height specifications are found in the ESM.

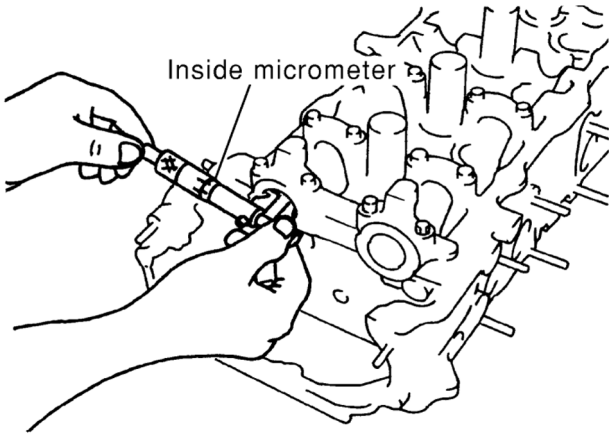


Camshaft Bearing Journal Clearance

Camshaft bearing journal clearance measurements can help determine whether align boring with new cam bearings or cylinder head replacement is required. Installing new camshaft bearings in the cylinder head may be all that is necessary to bring the journal clearances within specification. Visual inspection of the camshaft journals may show obvious signs of scratches or excessive wear.

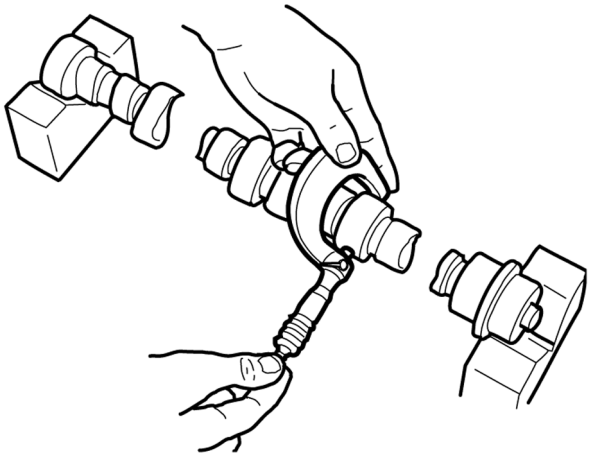
To calculate camshaft bearing journal clearance, take two separate measurements:

First measure the diameter of the camshaft bearings in the cylinder head. To measure the cylinder head, a camshaft bracket must be installed and tightened to the proper torque specification. A telescopic bore gauge measures the inner diameter of each of the camshaft bearings. Record the measurements of each cam bearing journal.



Second, measure the camshaft bearing journal diameter. To measure the camshaft journal, use an outside micrometer. Record the cam journal measurements. Subtract the outside cam journal measurement from the inner diameter measurement for each of the camshaft bearings to obtain the cam journal clearance.

If any of the cam bearing measurements exceed specifications, the camshaft is worn and should be replaced. Camshaft bearing journal clearance specifications are found in the ESM.

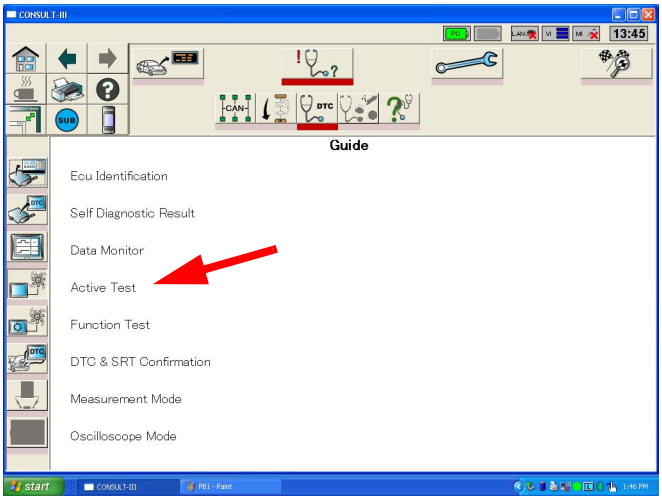


Power Balance Test using CONSULT-III

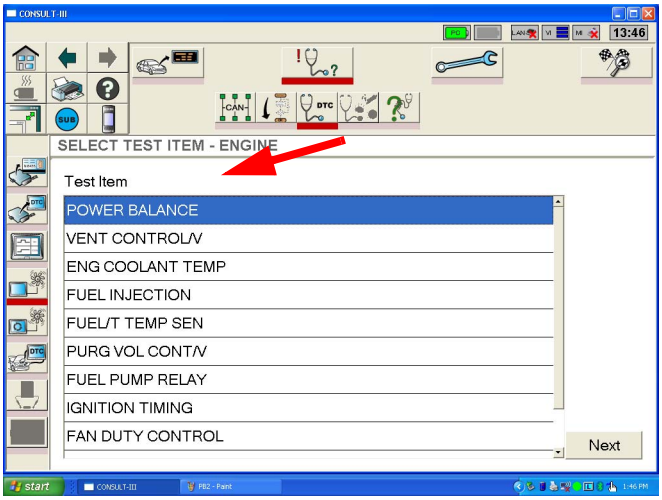
A cylinder power balance test can help locate weak cylinders in the engine. Monitoring engine rpm drop as cylinders are disabled can indicate whether all cylinders are contributing equally.

A cylinder power balance test can be easily performed using CONSULT-III. Since software updates can affect screen appearance and procedure steps, the following information is typical only:

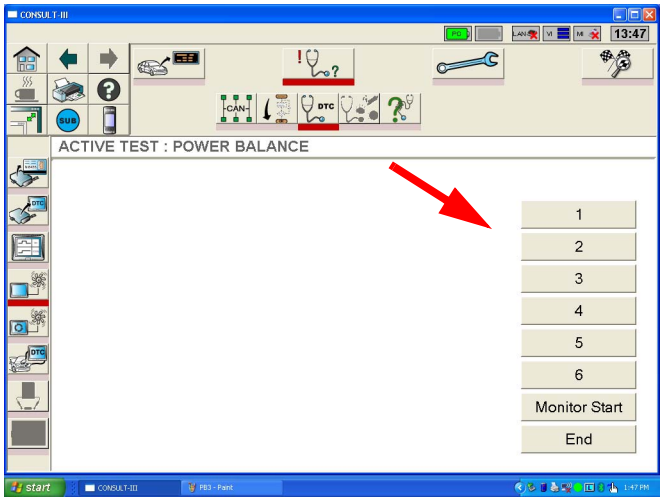
The power balance test is an active test on CONSULT-III.



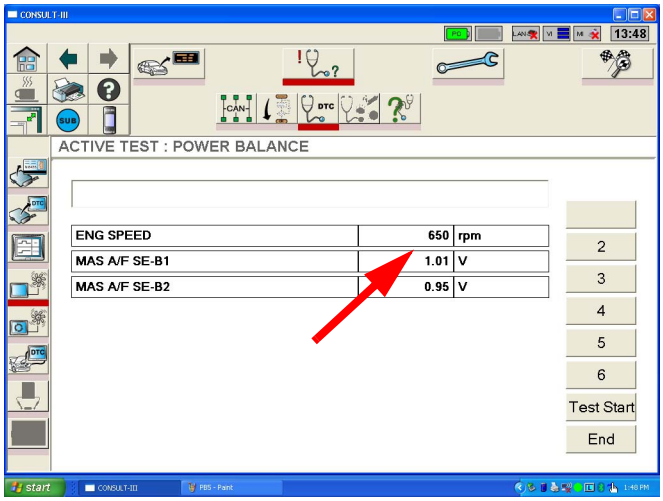
Select Power Balance from the Active Test list.



With engine at idle, disable individual cylinders by selecting cylinder number on screen.



Monitor rpm drop as cylinders are selected and disabled.



Cooling System Test Procedures

WARNING:

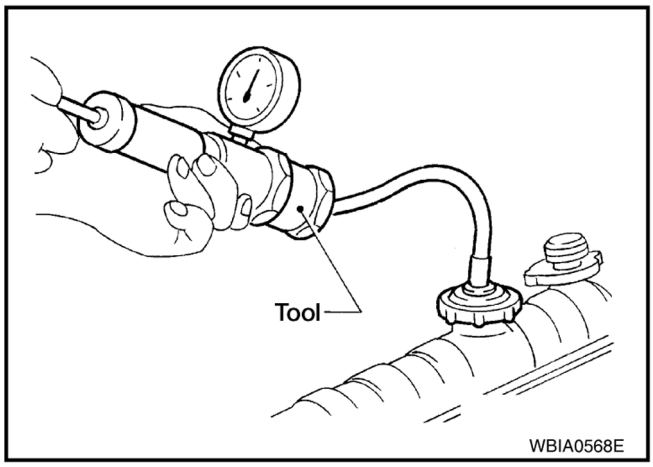
Hot coolant can scald. Never remove radiator cap when engine is hot.

CAUTION:

Exceeding test pressures may damage radiator and other cooling system components.

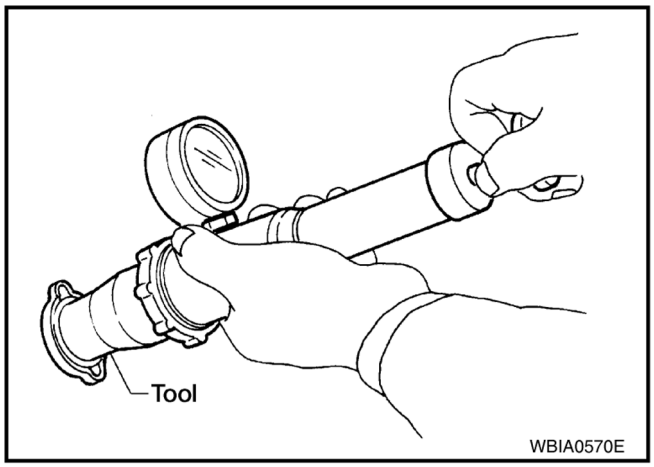
Cooling System Pressure Test

To check the engine cooling system for leaks, use the specified tool to apply pressure to the system. See ESM for test pressure specifications.



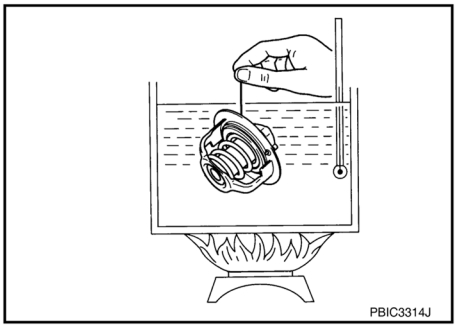
Checking Radiator Cap

To check the radiator cap, inspect cap valves, springs and rubber seals. Use the specified tool to apply pressure to the cap. See ESM for cap test pressure specifications.



Checking Thermostat and Water Control Valve

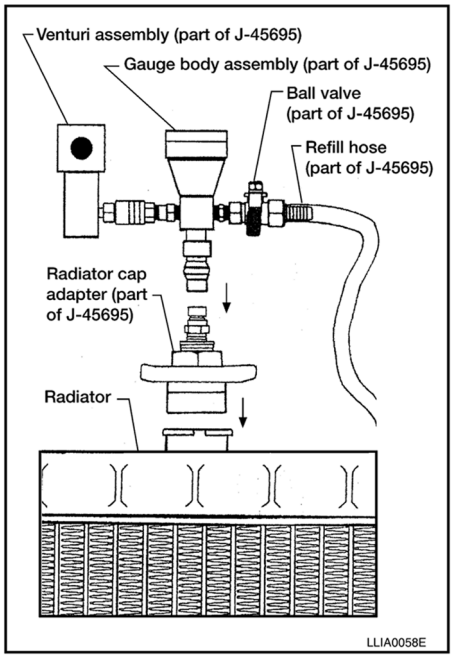
To check thermostat and water control valve, remove from vehicle, immerse in water and heat. Valve should open at specified temperature. Check amount valve opens fully. Also check valve closing temperature. See ESM for thermostat and water control valve test specifications.



Filling Cooling System

The cooling system fill tool quickly fills empty engine cooling systems with coolant and reduces the need for bleeding trapped air. The cooling system fill tool places the cooling system under a partial vacuum and removes most of the air from the radiator, block passages, heater core, and hoses before the system is refilled with coolant. Since most air is removed from the system before refilling, this reduces the possibility of trapped air and speeds the filling process.

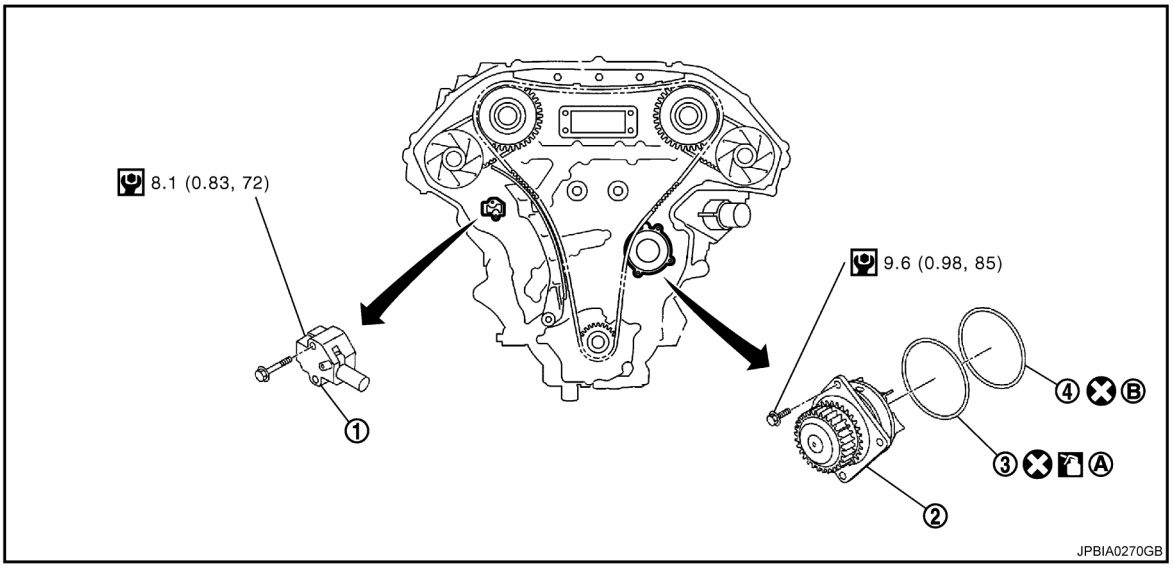
The tool uses compressed air to create a partial vacuum in the drained cooling system. Note that coolant hoses may collapse during this procedure. Once the cooling system is under vacuum, a valve on the tool is opened and premixed new coolant is pushed by atmospheric pressure from a coolant supply container to fill the system. See ESM for complete cooling system refill procedure and specifications.



Cooling System Repair Procedures

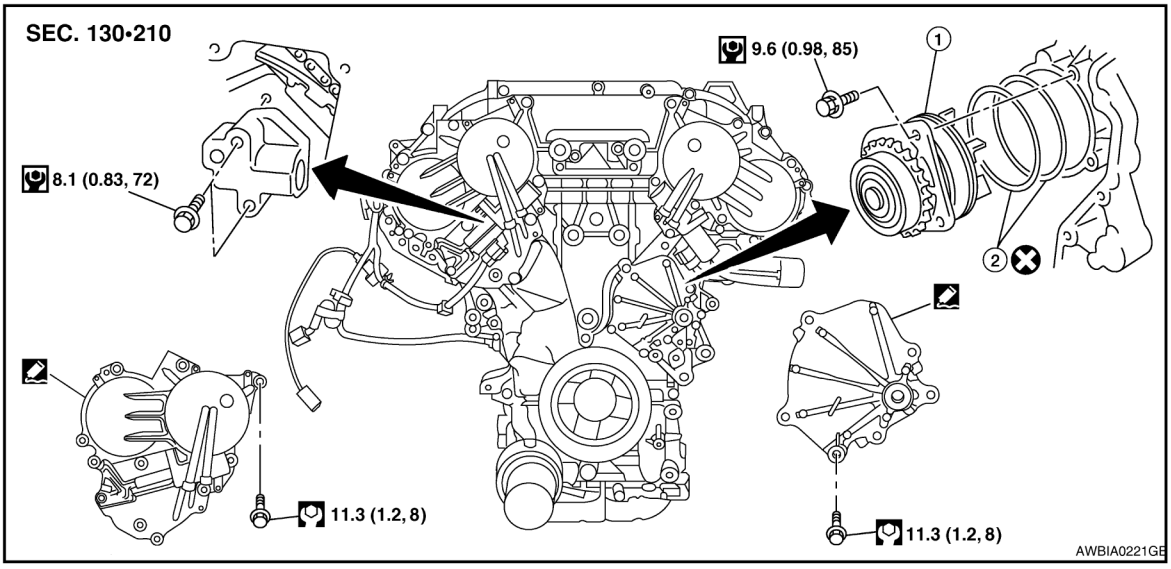
VQ35 Water Pump Removal and Installation

The water pump on the VQ35DE 6-cylinder engine is mounted internally in the engine and is driven by the camshaft primary timing chain.

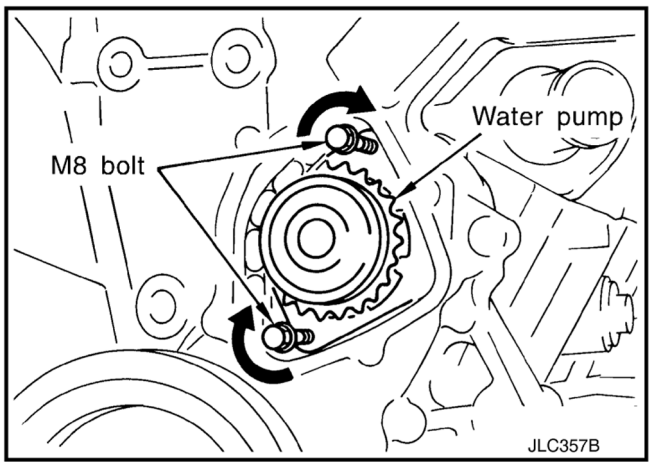


Water pump removal and installation procedure requires the following steps:

- Drain engine coolant from radiator and from block drain. Coolant level in block must be low enough so that coolant does not mix with engine oil when water pump is removed.
- Remove ITV control valve cover and water pump cover.
- Remove timing chain tensioner assembly.

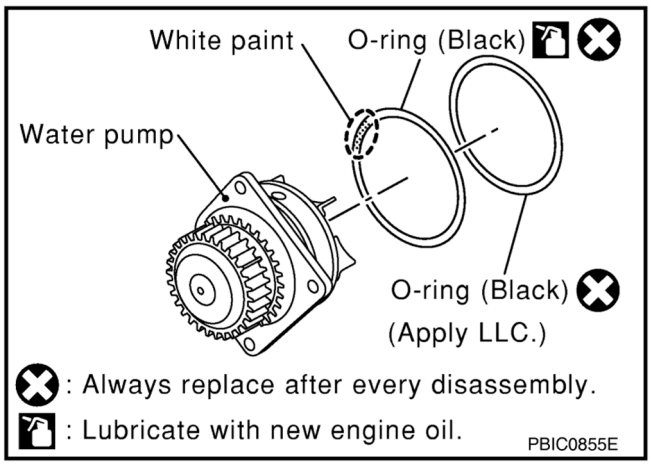


- Remove three water pump bolts.
  - To remove water pump, screw two M8 bolts (1.25 mm pitch, approx. 50 mm length) into upper and lower bolt holes until bolts contact timing chain case.
  - Alternately tighten each bolt 1/2 turn to jack water pump away from timing chain case. Continue to turn each bolt until water pump can be removed.

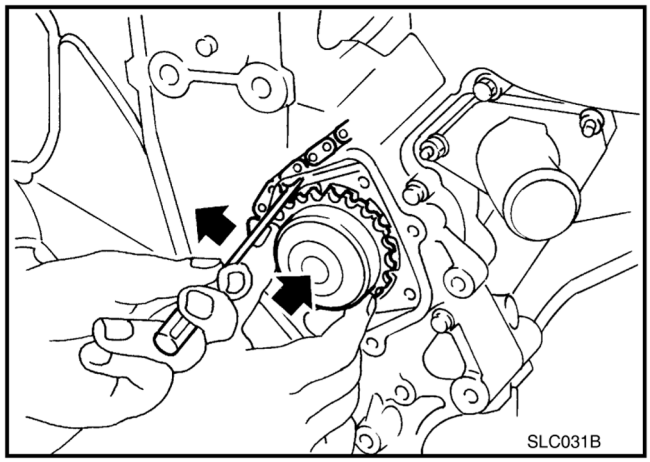


To install the water pump, keep the following steps in mind:

- Lubricate water pump o-rings with engine oil and coolant as shown.



- Be sure timing chain engages water pump sprocket.



NOTE: These procedure steps are provided here for reference only. Always refer to the ESM for the complete water pump removal and installation procedure and specifications.

Overheat protection (VK56DE)

The VK56DE engine installed in the Titan, Armada and QX56 have overheat protection designed into the Engine Control Module (ECM) logic. Under severe conditions such as low coolant, excessive heavy towing, or extremely high ambient air temperatures, the following could occur:

- Engine temperature begins to exceed 93°C (200°F).
- As engine temperature continues to increase, the Transmission Control Module (TCM) upshifts the automatic transmission from 2nd gear to 3rd gear. This limits engine rpm and throttle response.
- If engine temperature continues to increase, the ECM limits throttle response to no more than approximately 3,700 rpm.
- The electric cooling fan in front of the A/C condenser turns ON.
- The ECM shuts OFF the A/C compressor. The customer may notice that the A/C system no longer blows cold air.
- If engine temperature continues to increase, the engine temperature/oil temperature warning light turns ON, indicating excessive engine temperature.
- In a severe condition where engine temperature increases to an excessively high amount, the ECM could shut the engine OFF until the temperature decreases. This only occurs when engine temperature becomes extremely high and where engine damage could result.

NOTE: The ECM electronically limits throttle opening if the engine coolant temperature sensor detects engine overheating or low coolant level. Once the coolant reaches the correct temperature, the engine returns to normal operation. If coolant temperature continues to rise, the ECM shuts off fuel delivery until the engine temperature decreases to a safe level.

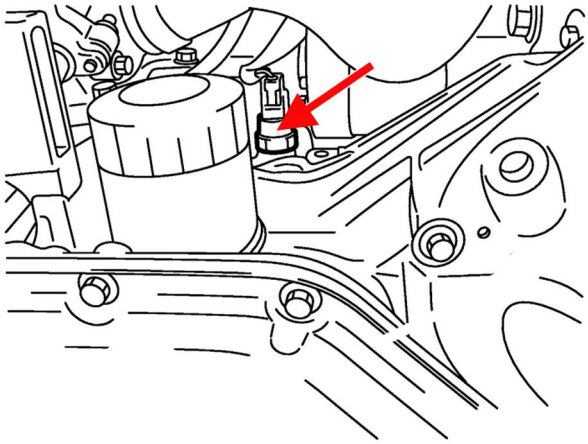
Lubrication System Inspection

Oil Pressure Testing

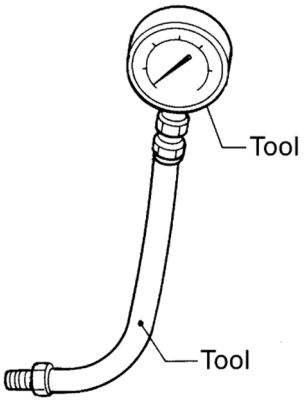
WARNING:

Engine oil may be hot. Use care to avoid burns.

- Disconnect harness connector at oil pressure switch and remove oil pressure switch. Typical switch location on MR20DE engine is shown below.



- Install oil pressure gauge and hose.



- Verify correct engine oil level.
  - Place automatic transmission in Park position, manual transmission in neutral, and set parking brake.
  - Warm engine to normal operating temperature and check oil pressure with engine running under no-load. Typical pressure values are shown below. Engine oil pressure specifications are found in LU section of the ESM.

Engine oil pressure [Engine oil temperature at 80°C (176°F)]

Engine speed rpm	Approximate discharge pressure kPa (bar, kg/cm^2, psi)
Idle speed	More than 60 (0.60, 0.61, 9)
2,000	More than 200 (2.0, 2.0, 29)

Oil Leak Diagnosis

Oil leaks are often easily visible, and may be a result of a faulty seal or improper fastener torque, especially around the oil pan and valve cover. Always clean the engine in the area of the suspected leak to help identify the source. Old oil and dirt can make it difficult to find the source of the leak.

In many cases, oil can travel a long distance along the outside of the engine or transmission case, making it difficult to find the actual source of the leak. This is especially true for leaks around camshaft and crankshaft seals which can throw oil about the engine compartment.

- Leaks usually travel from the front of the vehicle to the back because of airflow while the vehicle is moving.
- The source of the leak often contains the least amount of dirt because the leaking fluid acts as a solvent to wash away dirt closest to the leak.

Difficult leaks may be pinpointed by adding a special ultraviolet (UV) dye to the oil. UV light will make the oil glow, helping to pinpoint the actual source of the leak. The Reveal Plus Leak Detection Kit works in this way.

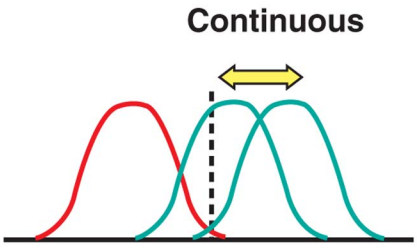


- Leak detection powder is also effective for finding leaks. Trails from active leaks will appear in the freshly sprayed powder, helping to pinpoint the source.
- Engine leaks may also be found by pressurizing the engine crankcase with air with the PCV valve blocked. Soapy water applied to the engine may produce bubbles at the leak source. A hissing sound may also be heard. When using this method, never apply more than 15-20 psi pressure to prevent damaging engine seals.
- A clogged PCV valve or hose, as well as worn piston rings, can also contribute to oil leaks and seal failure.

Variable Valve Timing

System Overview

All Nissan and Infiniti engines are capable of varying intake valve timing in relation to crankshaft position.



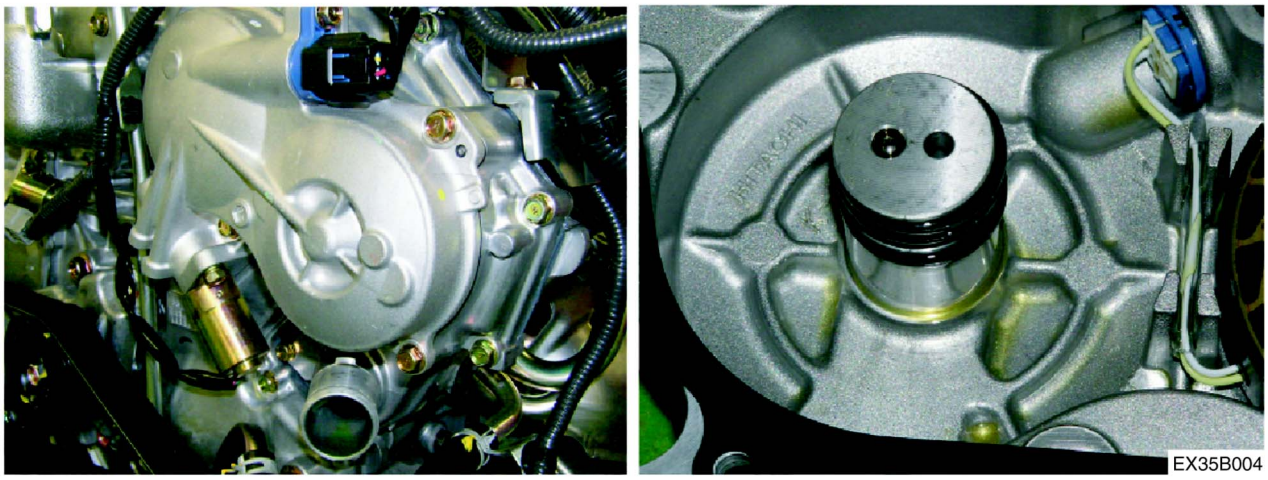
Some engines such as the VK50VE also vary exhaust valve timing. Variable valve timing provides more power, higher fuel efficiency, and lower emissions under a wide range of RPM and load conditions. The ECM receives input signals such as crankshaft position, camshaft position, engine speed, and engine oil temperature. The ECM outputs control signals to the variable timing mechanisms. Camshaft position is continuously controlled depending on the driving condition. These mechanisms may be hydraulic or electromechanical.

Table 2: Variable Valve Timing Application Table

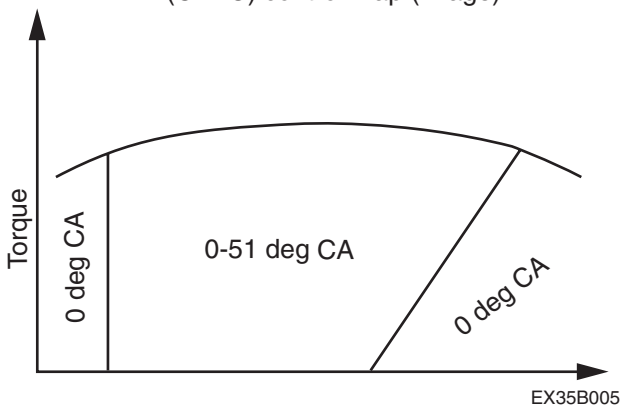
MR16DE	Versa	C-VTC
MR18DE	Versa	C-VTC
MR20DE	Sentra	C-VTC
QR25DE	Altima, Sentra, Roque, Frontier	C-VTC
VK45DE	M	C-VTC
VK50VE	FX	C-VTC
VK56DE	Armada, Titan, QX56	C-VTC
VQ35DE	Maxima, Altima, Quest, Murano	C-VTC
VQ35HR	350Z, M, G35, EX35, FX	C-VTC/Magnet Retarder
VQ37VHR	370Z, G37	VVEL
VQ40DE	Pathfinder, Xterra, Frontier	C-VTC
VR38DETT	GT-R	C-VTC

C-VTC - Continuously Variable Timing Control System

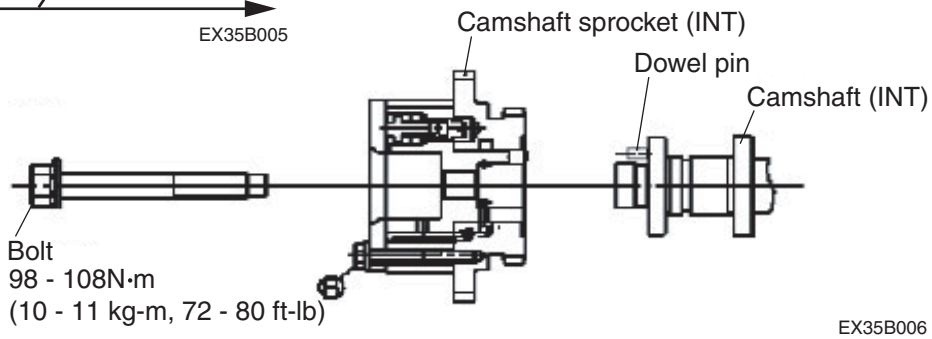
The Continuously Variable Timing Control System (C-VTC) uses hydraulic controls to vary intake valve timing (and on the VK50VE engine, also exhaust valve timing). This system uses oil under pressure to rotate the camshafts. The ECM receives camshaft position information from the PHASE sensors, which sense notches on the camshaft rear end. The ECM then outputs control signals to the oil control solenoids. The camshaft actuators may be either the vane or splined shaft type.


EX35B004

IVT (CVTC) control map (image)



EX35B005



EX35B006

EVT - Exhaust Valve Timing Control System

The VQ35HR engine is equipped with variable valve timing for both intake and exhaust valves. Exhaust valve camshaft timing varies by means of an electromechanical Exhaust Valve Timing Control System (EVT). The system uses an electromagnet retarder which controls exhaust camshaft timing over a continuously variable range.

The ECM receives input signals such as crankshaft position, camshaft position, engine speed, and engine coolant temperature. The ECM outputs ON/OFF pulse duty cycle signals to the exhaust valve timing control magnet retarder to advance or retard exhaust valve timing depending upon driving conditions. Exhaust valve timing is changed to increase engine torque and output in a range of high engine speed.

INT hydraulic VTC

EXH electric VTC



EXH electric VTC



Electromagnet retarder



EX35B007

CAUTION:

Never disassemble the magnet retarder.

Exhaust Valve Timing Control Learning

Exhaust Valve Timing Control Learning allows the ECM to learn the characteristics of the exhaust valve timing control magnet retarder by comparing the target angle of the exhaust camshaft with the actual retarded angle of the exhaust camshaft.

The procedure must be performed whenever the exhaust valve timing control magnet retarder is disconnected or replaced, or whenever the ECM is replaced.

With CONSULT-III:

1. Start engine and warm to normal operation temperature.
2. Set shift lever in the neutral position and confirm that the following electrical or mechanical loads are not applied.
   - Headlamp switch OFF.
   - Air conditioner switch OFF.
   - Rear defogger switch OFF.
   - Steering wheel in the straight-ahead position.
3. Maintain engine speed between 1,800 and 2,000 rpm.
4. Select “EXH V/T CONTROL LEARN” in “WORK SUPPORT” mode with CONSULT-III.
5. Touch “START” and wait 20 seconds.
6. Make sure that “CMPLT” is displayed on the CONSULT-III screen.

Without CONSULT-III

1. Start engine and warm to normal operation temperature.
2. Set shift lever in the neutral position and confirm that the following electrical or mechanical loads are not applied.
   - Headlamp switch OFF.
   - Air conditioner switch OFF.
   - Rear defogger switch OFF.
   - Steering wheel in the straight-ahead position.
3. Maintain engine speed between 1,800 and 2,000 rpm for 20 seconds.

Variable Valve Event Lift (VVEL)

VVEL Overview

Variable Valve Event Lift (VVEL) is an important new feature on VQ37VE and VK50VE engines. The VVEL system provides continuously variable intake valve lift and intake valve timing for all driving conditions. VVEL works with C-VTC to monitor and adjust when the intake valves open. In addition, VVEL monitors and adjusts the amount of the intake valve opening, or lift.

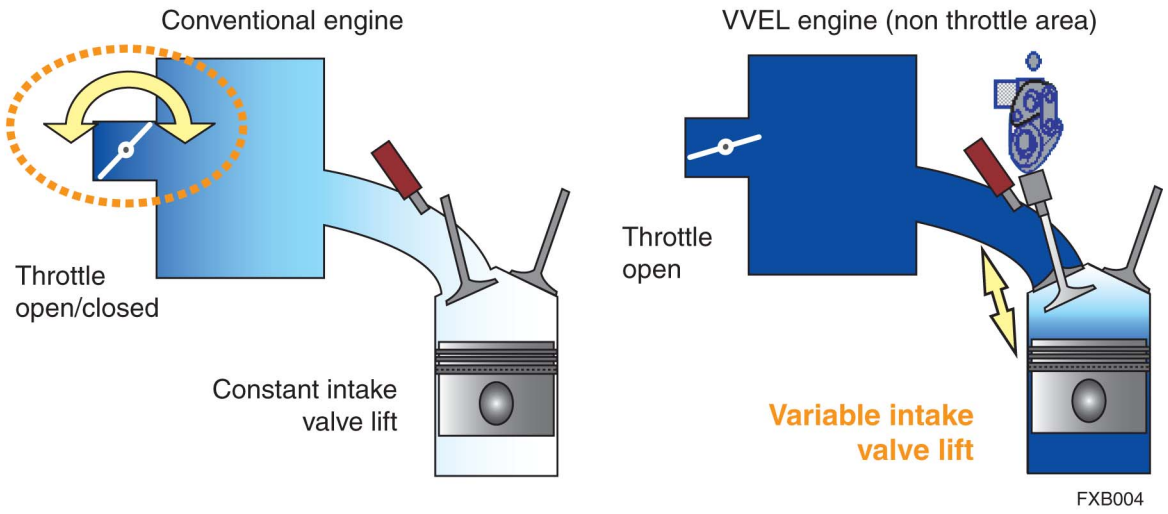
VVEL benefits include:

- Higher power output with excellent torque
- Improved throttle response
- Best-in-class emissions and fuel consumption



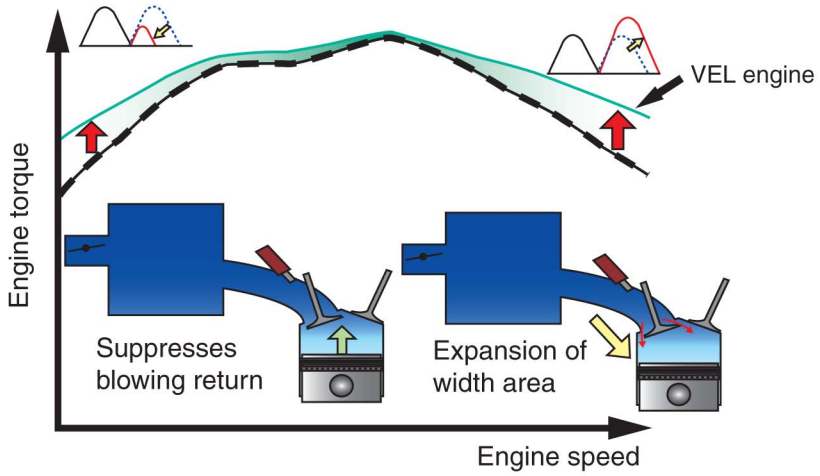
FXB001

VVEL controls intake air flow with continuously variable intake valve lift. The throttle plate is still present and provides secondary control for air flow, but the main control for air flow is now intake valve lift.



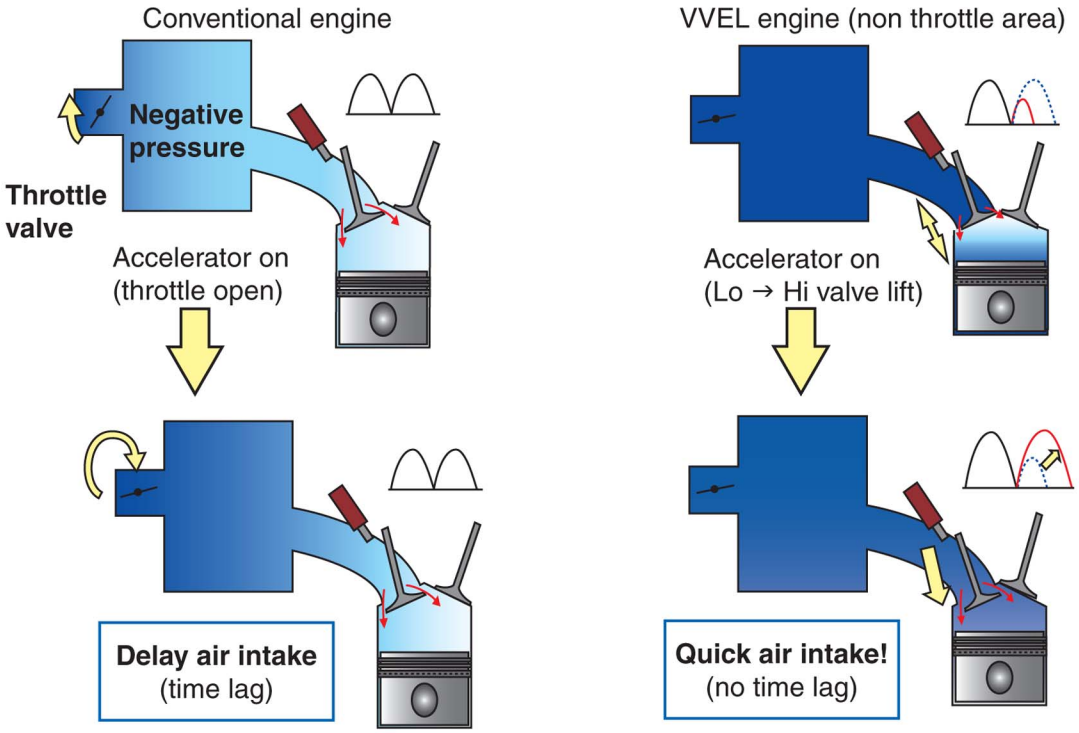
Increased engine torque at lower rpm and increased output at high speeds

Intake valve overlap is reduced at low engine speeds. This reduces blowback into the intake manifold on compression and increases engine torque. At high engine speeds, increased intake valve open time increases the intake charge. This increases engine power output.



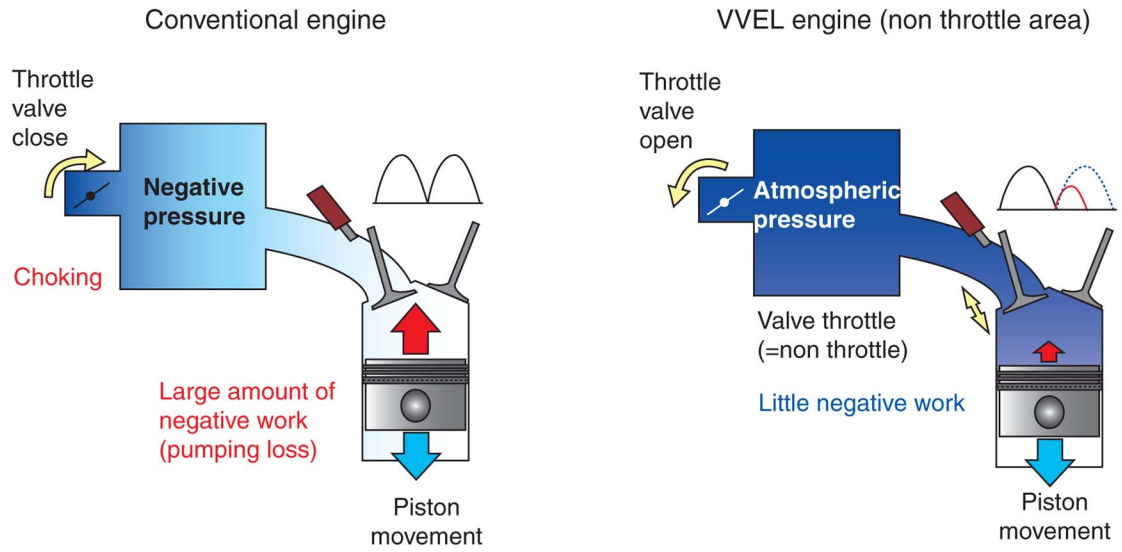
Faster throttle response

Since intake air flow is controlled by intake valve lift at the cylinders, and since the intake manifold is filled with more air (reduced vacuum), the time lag in response to throttle input and acceleration are improved.



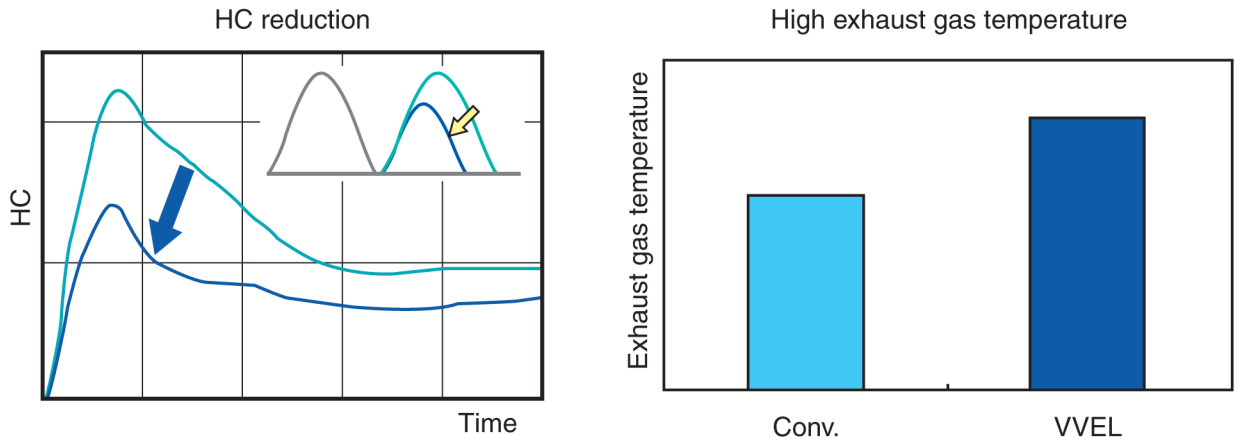
Improved fuel economy

In a conventional engine, intake air flow is controlled by the throttle plate. Intake manifold vacuum behind an almost-closed throttle plate causes pistons to work harder when drawing in the intake charge. This creates pumping losses. With VVEL, intake air flow is controlled at the cylinders by intake valve lift. Since the throttle plate can be open a greater amount, pumping losses are reduced.



Reduced hydrocarbon (HC) and carbon dioxide (CO_2) emissions

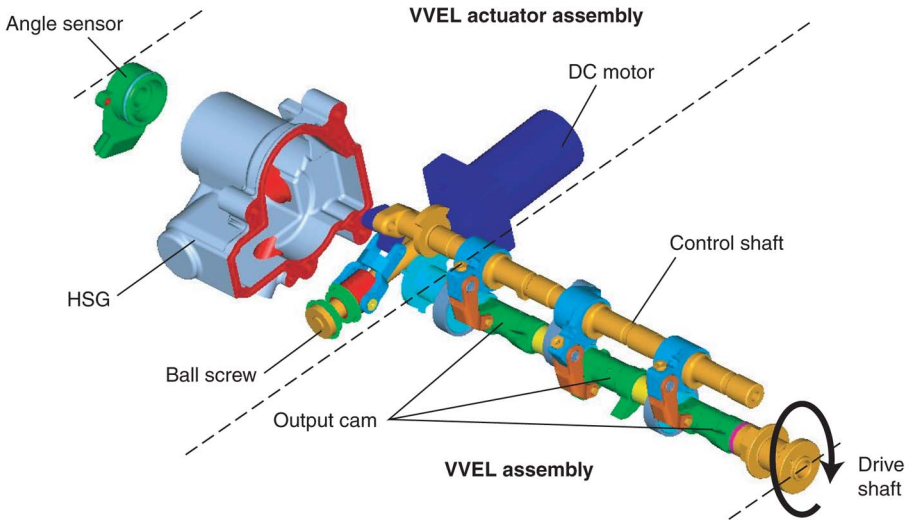
Optimized compression ratio and efficient combustion reduce HC. Ignition timing can be retarded at idle. This increases exhaust gas temperature to heat the catalyst more quickly.



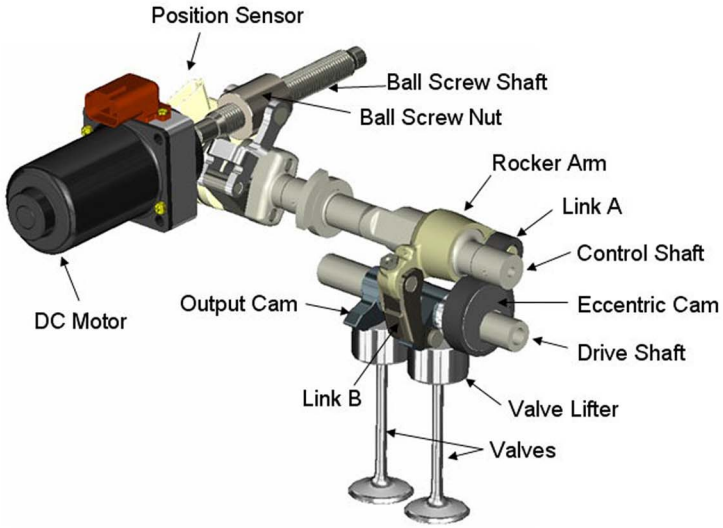
With VVEL, control of intake air is shared by both throttle valve opening and intake valve lift. VVEL works with C-VTC to monitor and adjust intake valve timing. In addition, VVEL monitors and adjusts intake valve lift.

VVEL Operation

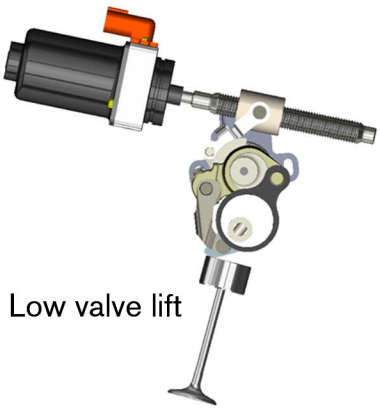
The VVEL assembly consists of the drive shaft, eccentric cam, links, rocker arm, output cam and control shaft. The ECM-controlled VVEL actuator motor drives the VEVL control shaft.



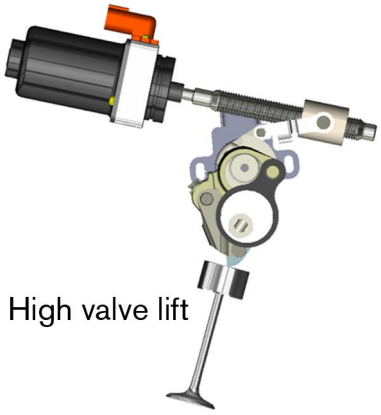
As accelerator pedal position changes, the ECM commands the electric stepper motor in the VVEL actuator assembly to change intake valve lift.



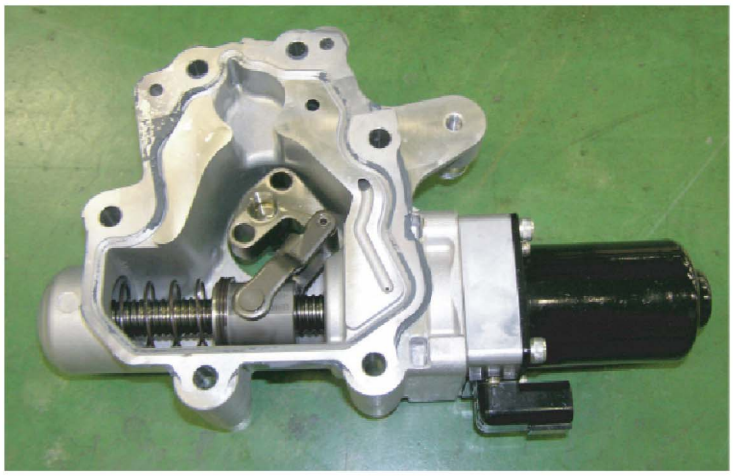
To vary the valve timing and lift, the rotary motion of the drive shaft is converted by eccentric cams into the required oscillating movement through the rocker arm and links to move the output cam. Valve lift is minimum during idle and maximum during hard acceleration. During other driving conditions, like cruising or when climbing a grade, valve lift varies depending upon the engine load requirements.



Low valve lift



High valve lift





FXB020

Throttle valve opening after engine warm-up

The intake valves control all engine intake air flow at low- to upper-mid-level rpm.

- Idle: Throttle valve 5 – 8% open
- 1/4 throttle opening: Throttle valve 10 – 40% open – Intake air controlled by VEL system & C-VTC (until approx. 4,000 rpm)
- 1/2 throttle opening: Throttle valve 10 – 60% open – Intake air controlled by VEL system & C-VTC (until approx. 4,000 rpm)
- Full throttle, full acceleration: Throttle valve 100% open – Intake air controlled by throttle valve
- 1/8 throttle opening and constant speed: Throttle valve approx. 20 – 30% open – Intake air controlled by VEL system & C-VTC (until approx. 4,000 rpm)

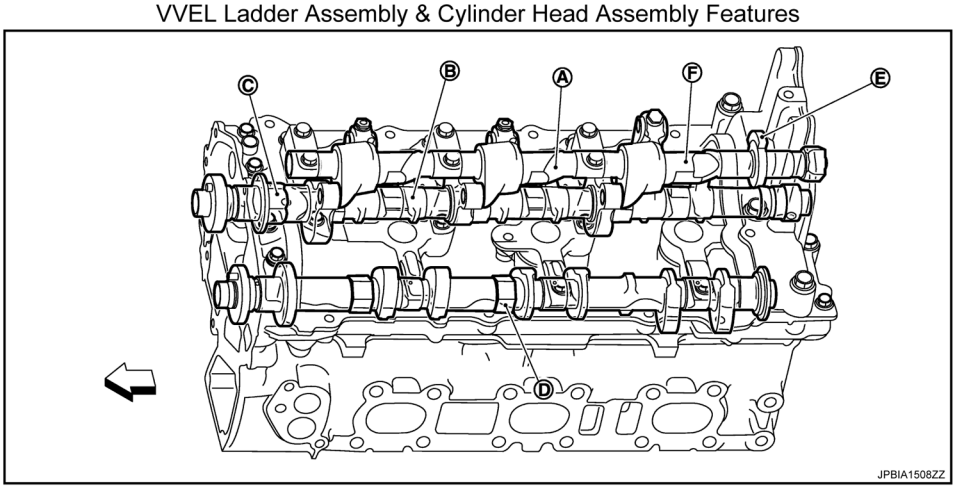
VVEL and Brakes

A manifold pressure (MAP) sensor helps improve brake performance at high altitudes. A pressure sensor for the Brake Booster also monitors brake booster vacuum for brake performance.

Variable Valve Event Lift (VVEL) Cylinder Head Inspection

The VVEL assembly is not serviceable. In case of a VVEL system malfunction, the entire cylinder head assembly should be replaced. The VVEL assembly cannot be replaced separately since it is machined together with the cylinder head. VVEL system replacement and adjustment procedures and specifications are found in EM section of the ESM.

VVEL Ladder Assembly & Cylinder Head Assembly Features



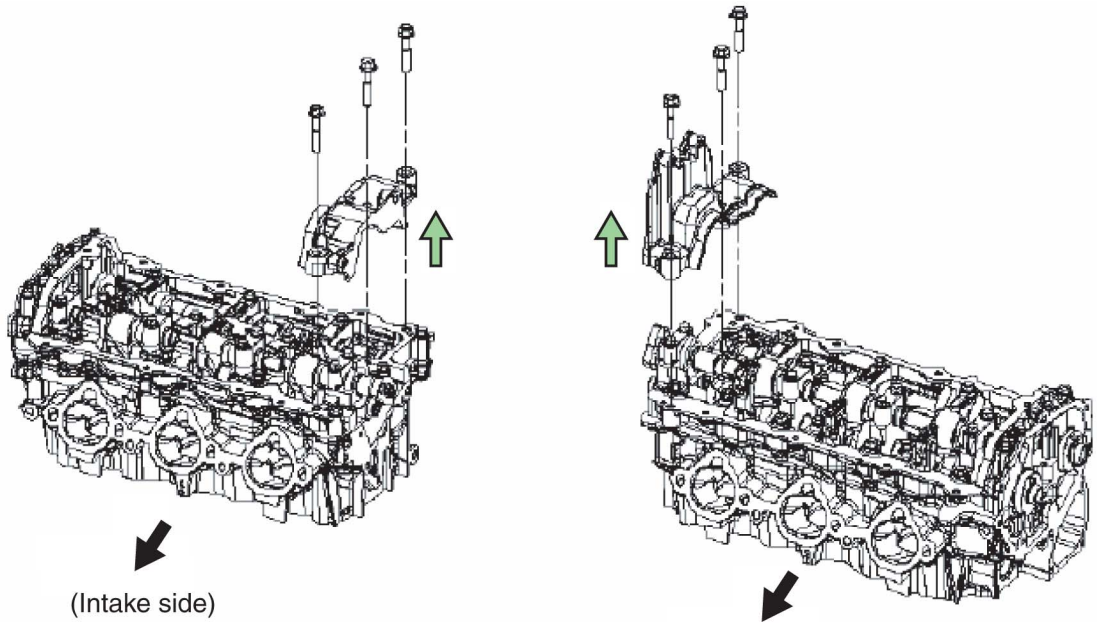
A.	Control shaft	B.	Drive shaft	C.	Hexagonal part of drive shaft (for holding)
D.	Hexagonal part of camshaft (EXH) (for holding)	E.	Stopper of control shaft	F.	Two flat area of control shaft (for holding)
⇦	: Engine front				

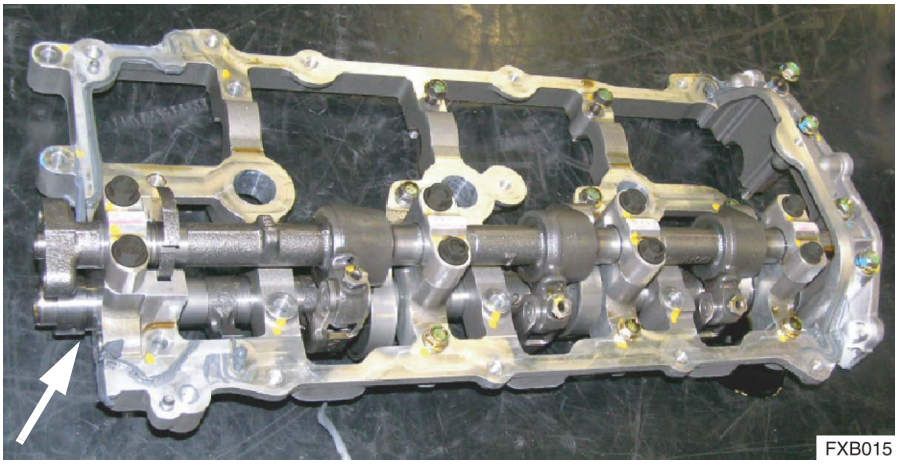
NOTE:
The figure shows an example of bank 2.

Exhaust valves can be serviced. If intake valves require service, cylinder head must be replaced.

VVEL Ladder Bracket Assembly

- To remove VVEL ladder bracket assembly, remove actuator bracket.

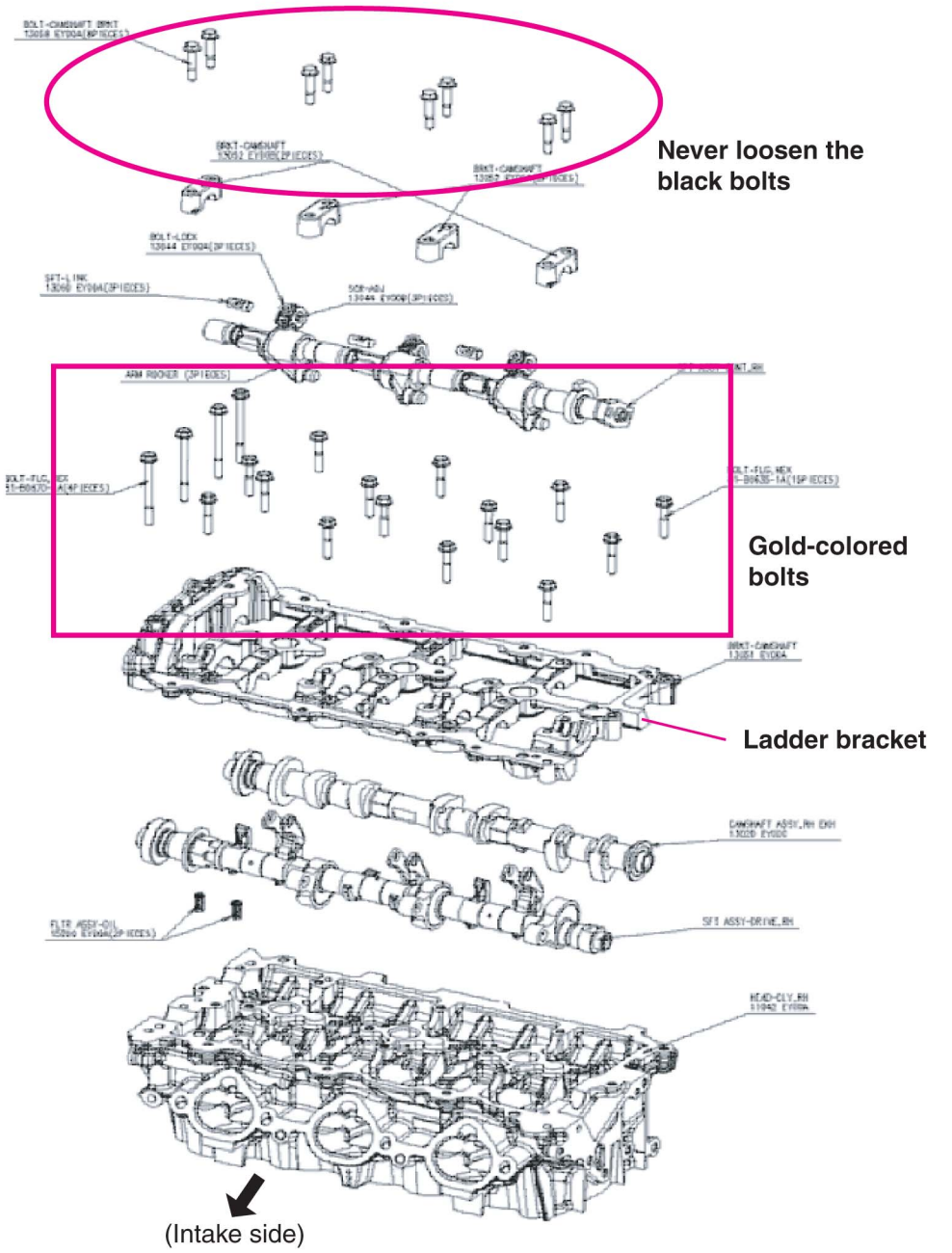




CAUTION:

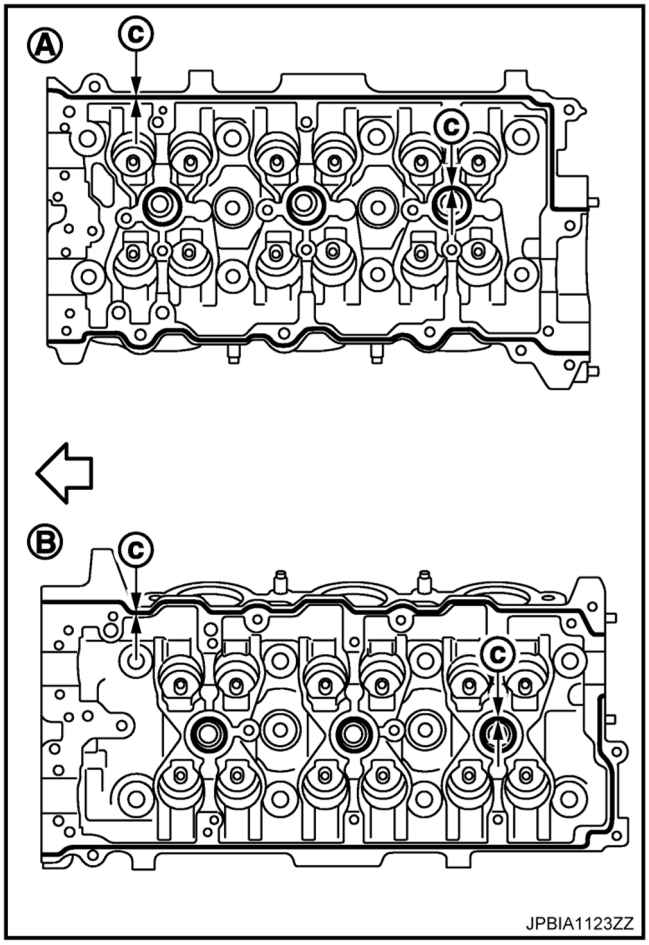
When removing VVEL ladder bracket assembly, support drive shaft underneath so it does not drop.

- Loosen gold-colored bolts and remove ladder bracket. Never remove black bolts.

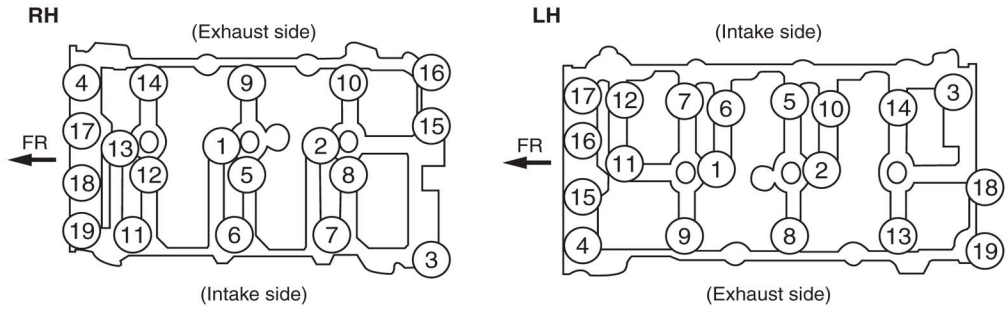


FXB013

- To install VVEL ladder assembly, apply a continuous bead of approved formed-in-place gasket (FIPG) to the cylinder head.



- Tighten mounting bolts in steps, and in the order shown.

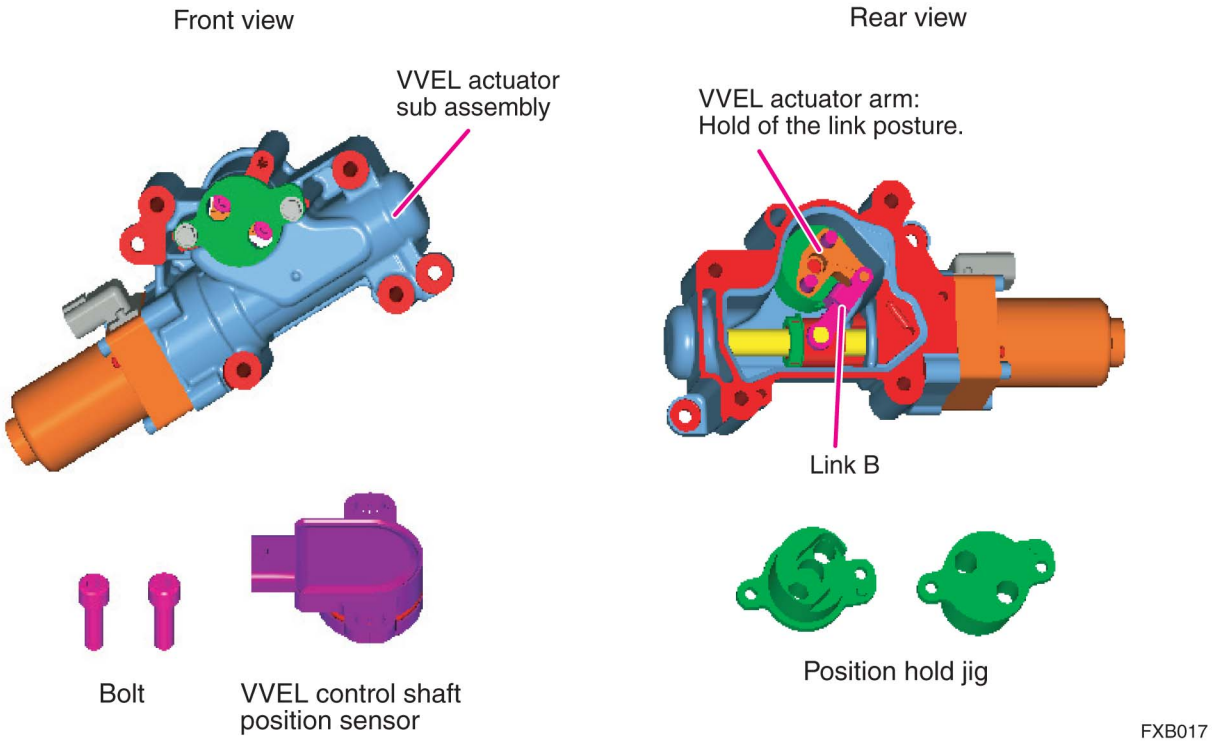


1st step: 1.96N·m (0.2 kg-m, 1 ft-lb)
2nd step: 5.88N·m (0.6 kg-m, 4 ft-lb)
3rd step: 10.4N·m (1.1 kg-m, 8 ft-lb)

VVEL component replacement and adjustment procedures and specifications are found in EM section of the ESM.

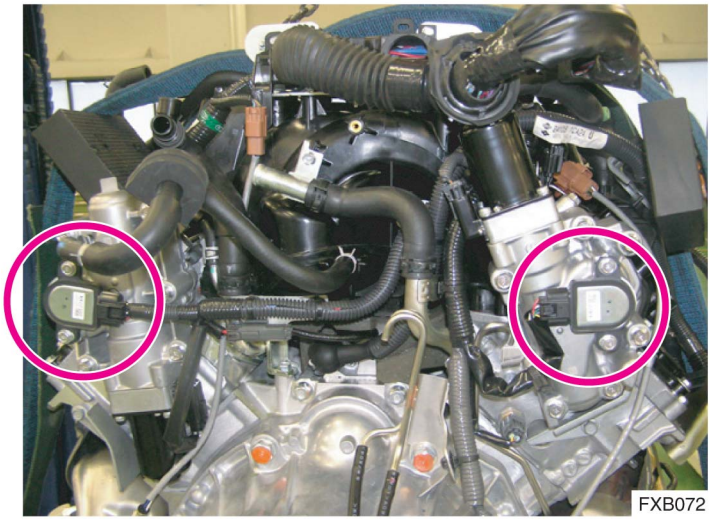
VVEL Actuator and Sensor Assembly

The VVEL actuator sub-assembly and the control shaft position sensor are non-reusable components. Do not remove unless replacement is required. Do not disassemble VVEL actuator sub-assembly. The VVEL actuator sub-assembly and control shaft position sensor are matched and must be replaced together. Replacement procedures and specifications are found in EM section of the ESM.



VVEL control shaft position sensor adjustment is required in order for the ECM to accurately know VVEL control shaft position. The initial angle adjustment must be performed each time a VVEL actuator assembly is replaced. The adjustment must be performed ONLY on the bank that is replaced.

If sensor adjustment is attempted on a used VVEL actuator assembly, the VVEL actuator assembly and sensor must be replaced with new prior to sensor adjustment.

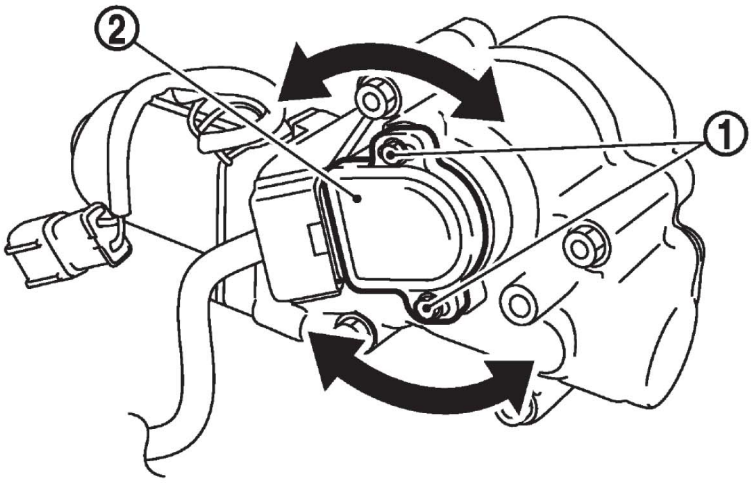

FXB072

Once the sensor is installed, it must be calibrated using the procedure outlined in the ESM. The sensor may be calibrated using CONSULT-III or a DMM.

VVEL control shaft position sensor adjustment (with CONSULT-III)

The following illustrates the VVEL control shaft position sensor adjustment procedure using CONSULT-III. Since software updates can affect screen appearance and procedure steps, the following information is typical only:

1. Turn ignition switch ON.
2. Select "VVEL POS SEN ADJ PREP" in "WORK SUPPORT" mode with CONSULT-III.
3. Touch "Start" and wait a few seconds.
4. Make sure the "CMPLT" is displayed on CONSULT-III screen.
5. Select "VVEL POSITION SEN- B1" or "VVEL POSITION SEN-B2" in "DATA MONITOR" mode with CONSULT-III.
6. Loosen the VVEL control shaft position sensor mounting bolt (1).
7. Turn the VVEL control shaft position sensor (2) right and left while monitoring the output voltage of "VVEL POSITION SEN-B1" or "VVEL POSITION SEN-B2" and adjust the output voltage to be within the standard value (Voltage: 500 ± 48 mV).
8. Tighten the VVEL control shaft position sensor mounting bolt (tightening torque: 7.0N·m (0.71 kg-m, 62 in-lb).
9. Reconfirm that the output voltage of "VVEL POSITION SEN- B1" or "VVEL POSITION-SEN-B2" is within the standard value (Voltage: 500 ± 48 mV). Note: If voltage varies from the standard value after the bolt is tightened, perform steps 6 to 8 again.
10. Turn ignition switch OFF and wait for 10 seconds or more.
11. Start engine and warm it up to normal operating temperature.
12. Turn ignition switch OFF and wait for 10 seconds or more.
13. Perform "Idle Air Volume Learning".



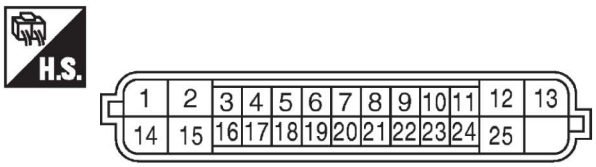
FXB030

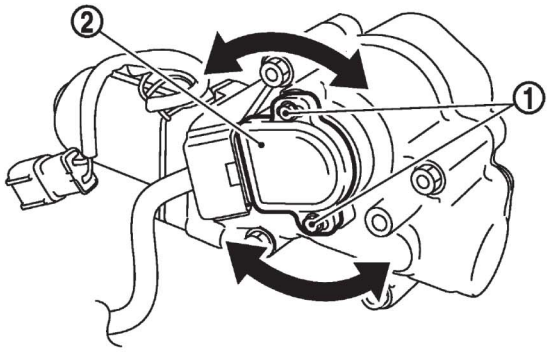
VVEL control shaft position sensor adjustment (without CONSULT-III)

The following illustrates the VVEL control shaft position sensor adjustment procedure without CONSULT-III. Since procedure steps may be updated, always consult the ESM for the latest service information. The following is typical only:

1. Disconnect VVEL control shaft position sensor harness connector.
2. Remove VVEL actuator motor relay.
3. Turn ignition switch ON, wait for 5 seconds or more and then turn OFF.
4. Reconnect all harness connectors disconnected.
5. Install VVEL actuator motor relay.
6. Turn ignition switch ON and wait for 5 seconds or more.
7. Loosen the VVEL control shaft position sensor mounting bolt (1).
8. Turn the VVEL control shaft position sensor (2) right and left while monitoring the output voltage between the VVEL control module terminals with a tester and adjust the output voltage to be within the standard value.

Connector No.	E15
Connector Name	VVEL CONTROL MODULE
Connector Type	RH18FB-AJZ8-RH





VVEL control module				Voltage
Bank	Connector	+	-	
		Terminal	Terminal	
1	E15	3	4	500±48 mV
2		5	6	

FXB031

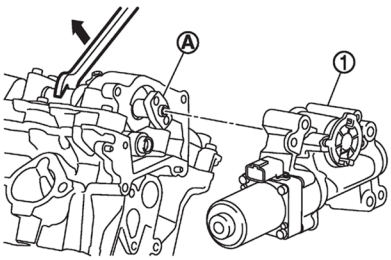
9. Tighten the VVEL control shaft position sensor mounting bolt (tightening torque: 7.0N·m (0.71 kg-m, 62 in-lb).

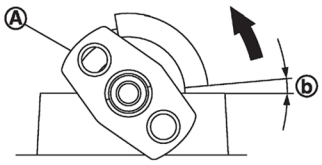
10. Reconfirm that the output voltage of VVEL control shaft position sensor is within the standard value.

NOTE: If voltage varies from the standard value after the bolt is tightened, perform steps 7 to 9 again.

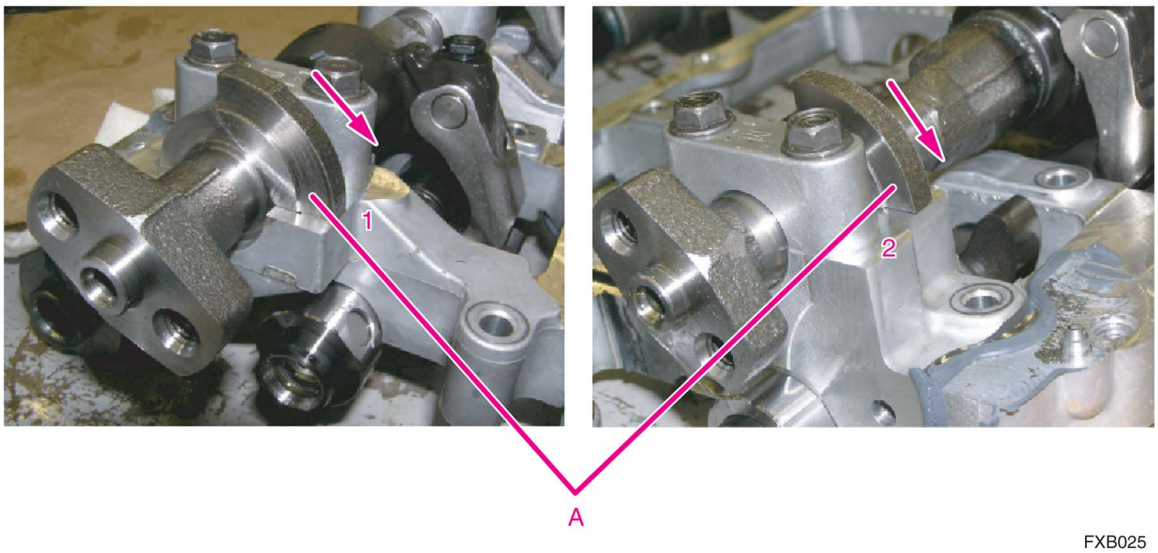
11. Turn ignition switch OFF and wait for 10 seconds or more.
12. Start engine and warm it up to normal operating temperature.
13. Turn ignition switch OFF and wait for 10 seconds or more.
14. Perform idle air volume learning.

Replacement VVEL actuators are supplied with the output set to a 5.5-degree angle and held in this position by a fixture installed at the factory. Rotate the control shaft with an open-end wrench to the required position before the actuator is installed. Complete procedures and specifications are found in EM section of the ESM.





FXB026



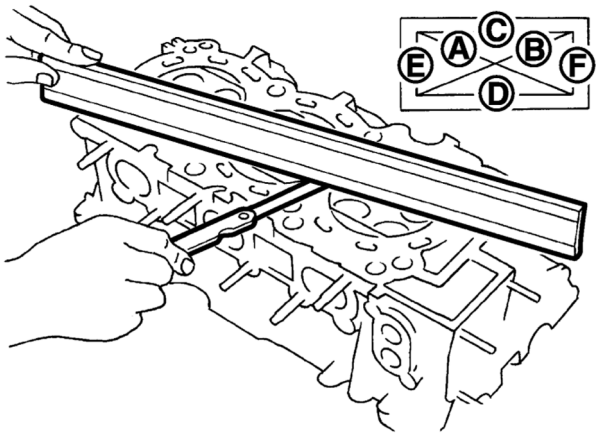
FXB025

VVEL Cylinder Head Distortion

Cylinder head distortion is measured across the flat gasket sealing surface of the cylinder head using a rigid straightedge and a feeler gauge. Clean the surface thoroughly to remove water scale deposits, gasket material and old sealer before measuring surface distortion.

NOTE: Use care to prevent debris from falling into coolant and oil passages.

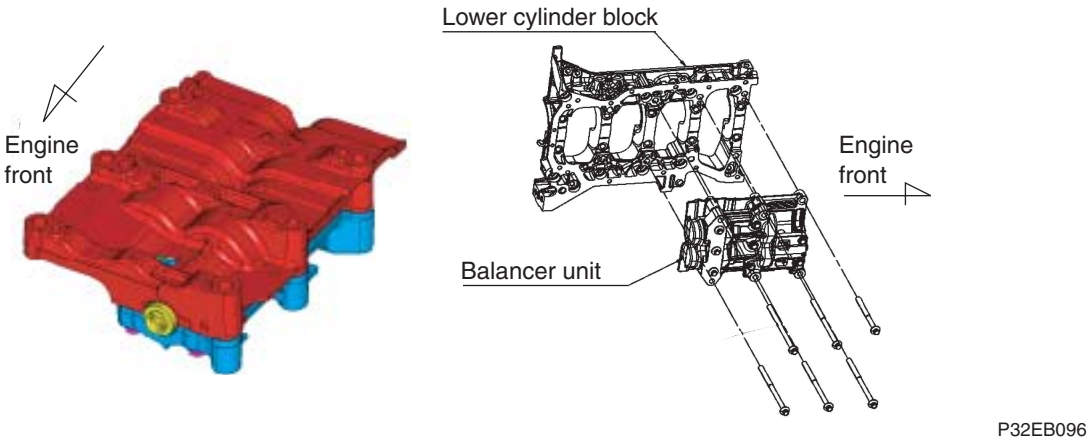
- Check the face flatness at six points on both edges and from corner to corner in an X pattern, as shown.
  - Typical flatness distortion limit is 0.1 mm (0.004 in). If flatness limit is exceeded, replace the VVEL ladder assembly and cylinder head. Cylinder head is not separately replaceable since it is machined together with VVEL ladder assembly. Cylinder head distortion specifications are found in EM section of the ESM.



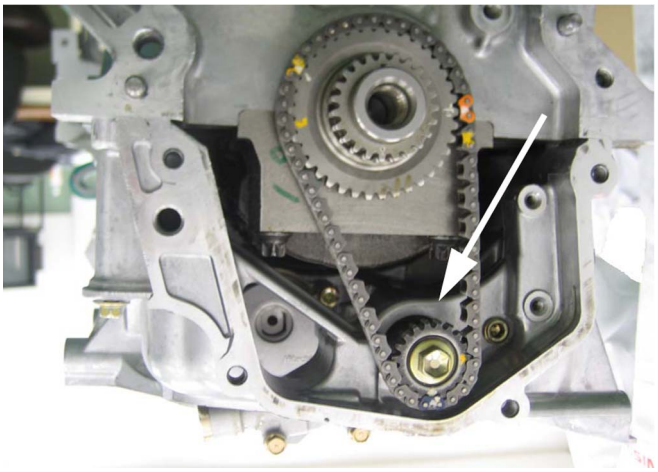
Timing Chain and Balancer Unit

Balancer unit

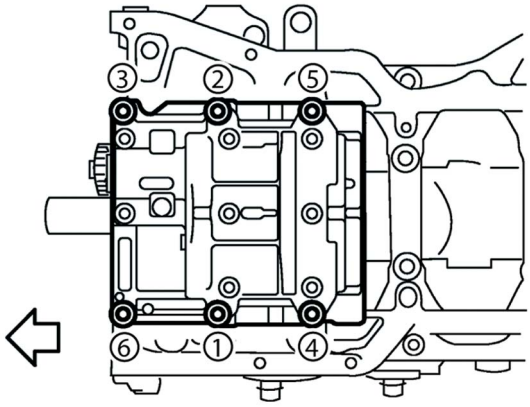
QR25DE engines (Altima and Rogue) are equipped with a balancer unit to reduce engine vibrations. The balancer unit is mounted low in the cylinder block, under the crankshaft, and reduces second order vibrations created by the rotating crankshaft and reciprocating pistons.



The balancer is integral with the engine oil pump and is driven by the oil pump drive chain.



Do not disassemble the balancer unit. When removing the balancer unit, note that bolt (**6**) is shorter than the other bolts are longer.



The tightening procedure for the balancer unit is as follows.

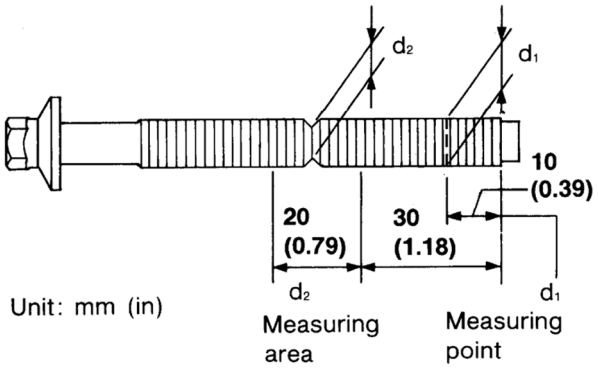
1. Tighten bolts in numerical order to the specified tightening torque.
2. Tighten bolts in numerical order to the specified angle.
3. Loosen all bolts.
4. Repeat steps 1 and 2 above.

Position	Torque	Rotate angle
(1) ~ (5)	42±3N·m (4.3±0.3 kg-m, 31±2 ft-lb)	120 0/+5°
(6)	36±3N·m (3.7±0.3 kg-m, 27±2 ft-lb)	90 0/+5°

NOTE: The above procedure is for reference only. Balancer unit installation procedure and specifications are found in EM section of the ESM.

Balancer unit mounting bolt diameter

Measure outer diameters (d1 and d2) at two positions as shown in the figure. The ESM may also specify measuring bolt length. Refer to specifications in ESM. If bolt exceeds limits (there is a large difference in dimensions), replace the balancer unit mounting bolt with new.



Timing Chain Removal and Installation

All Nissan and Infiniti engines today use silent-type timing chains to drive camshafts.



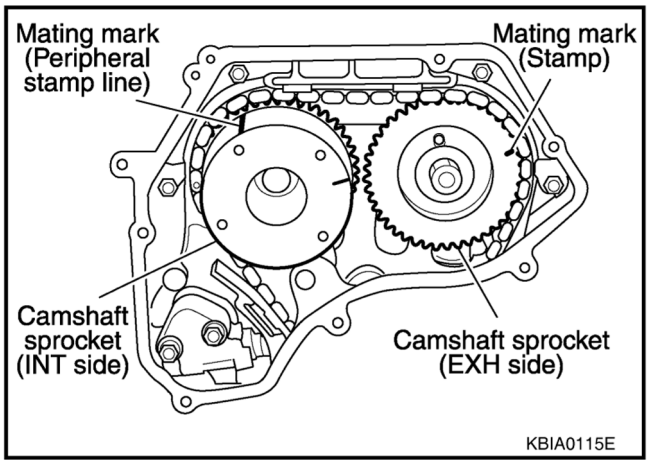
Timing chain tension is maintained by chain guides and a hydraulic chain tensioner. The hydraulic tensioner varies tension in proportion to engine speed to counteract centrifugal forces on the rotating timing chain.

Timing chain guides are curved on both tension- and slack-sides of the chain to reduce NVH from chain slap.

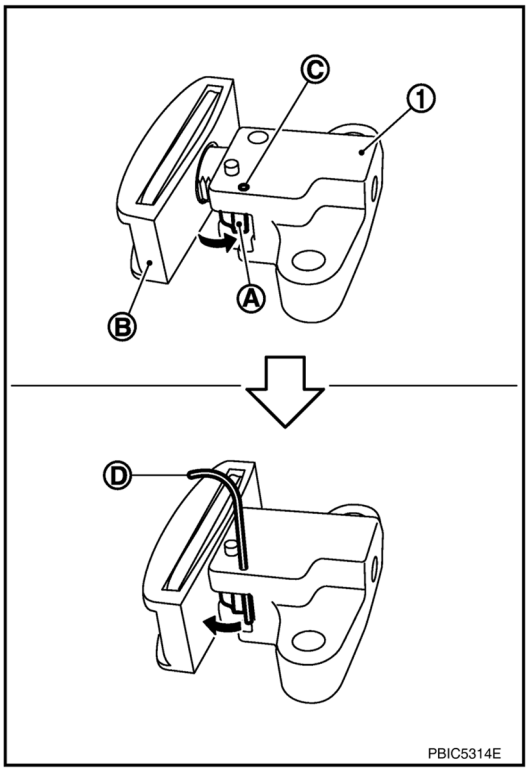


The following procedures are for reference only. Always refer to the ESM for specific timing chain replacement information.

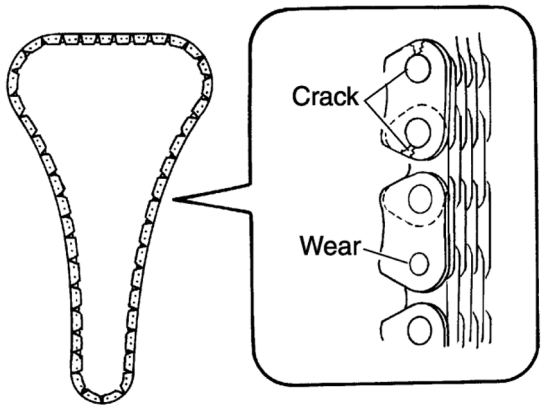
- Before removing timing chain, turn crankshaft so that reference marks line up on crankshaft and camshafts. Be sure that crankshaft does not turn once disassembly is started.



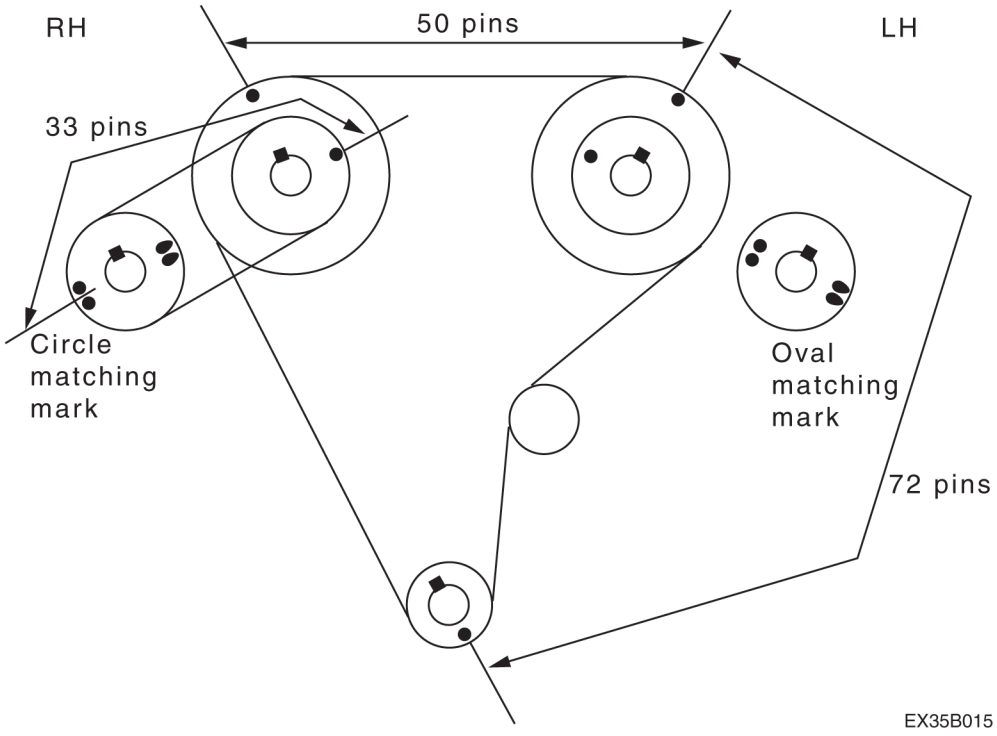
The timing chain tensioner must be retracted and held in position to create slack in the chain. Usually a pin is used to hold the retracted tensioner. This permits removal of chain guides, tensioner, and timing chain.



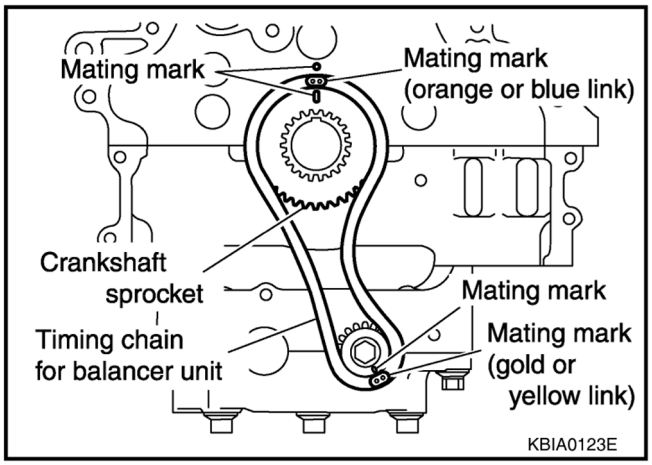
To inspect timing chain, examine chain for cracks or excessive wear.



When replacing camshaft timing chains, correctly timing a new chain is critical. ESM procedures may require lining up reference marks on gears, chain, or engine. Sometimes counting chain links is required to set timing correctly.



Engines with balance shafts have an additional timing chain to drive the oil pump and balance shafts. This timing chain must be timed by lining up reference marks, just like camshaft timing chains.



Always observe ESM recommendations for sealing engine components against leaks and for fastener tightening procedures.

Piston and Bearing Grade Selection

Today's more accurate manufacturing methods have allowed tighter and more precise bearing and piston clearances in Nissan and Infiniti engines. This reduces noise-vibration-harshness (NVH) issues at all temperatures and operating conditions and increases engine durability and life.

When replacing bearings and pistons, use care to ensure that proper clearances are maintained. Always refer to the latest bearing and piston fitment information in the ESM.

The identification grade stamped on each part is the grade for the dimension with the part in new condition. The grade does not apply for used parts. When reusing parts, measure dimensions and clearances carefully. Determine grade by comparing measurements with values in the selection table in the ESM.

How to Select Piston

Replacement pistons are provided with piston pins fitted as an assembly. Selective fitting piston pins to connecting rod upper bearing is not possible, since all piston pins in replacement pistons are grade 0.

When Reusing Cylinder Block

Measure cylinder bore diameter.

Determine bore grade by comparing measured bore diameter with values in "Piston Selection Table" in EM section of the ESM. Select new piston with same grade.

When New Cylinder Block is Used

See cylinder bore grade stamped on cylinder block. Select new piston with same grade.

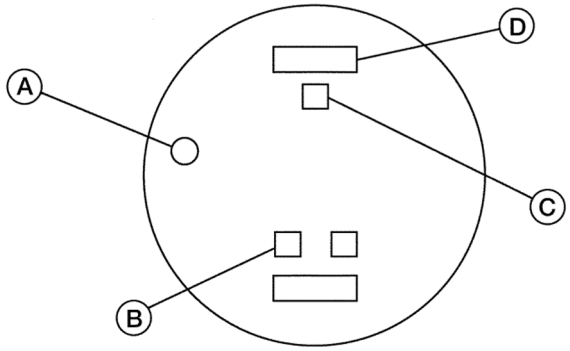
Piston grade marks are on top of piston:

A: Front mark

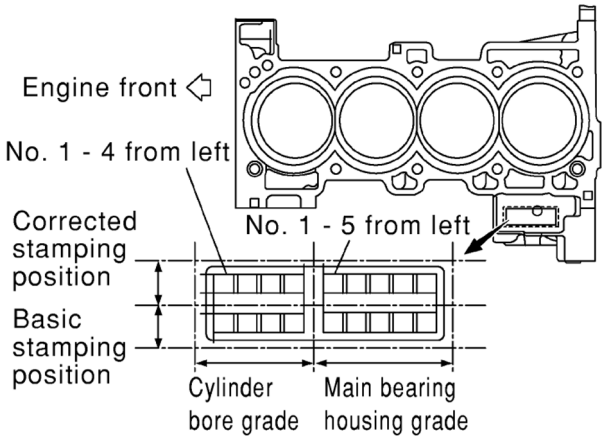
B: Piston pin bore grade

C: Piston grade

D: Piston crown ID code stamp



If there is a correction stamp mark on the cylinder block, use it as the correct reference.



How to Select Connecting Rod Bearing

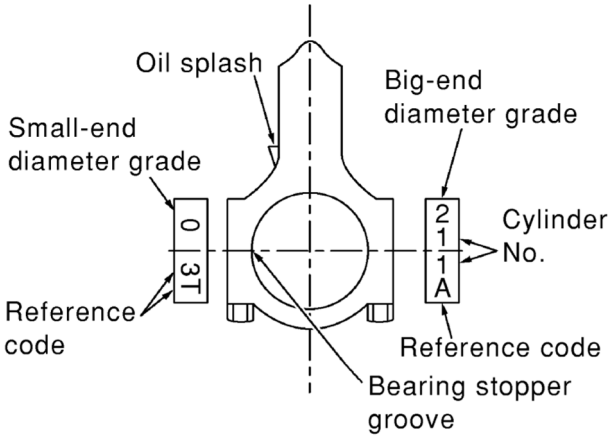
When Reusing Crankshaft and Connecting Rod

Measure dimensions of connecting rod big end inner bore diameter, and diameter of crankshaft crankpin.

Determine connecting rod bearing grade by comparing measured dimensions with values in “Connecting Rod Bearing Selection Table” in EM section of the ESM.

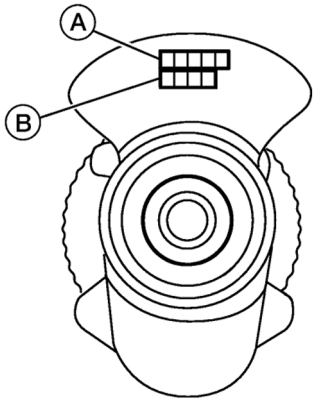
When New Crankshaft and Connecting Rod are Used

See big end inside diameter grade stamped on connecting rod side face and compare with "Connecting Rod Bearing Selection Table" in EM section of the ESM.



Refer to the illustration below. Crankpin diameter grade is stamped in location (B) on crankshaft front side. Compare with "Connecting Rod Bearing Selection Table" in EM section of the ESM.

For reference, main bearing journal diameter grade is stamped in location (A).



Read bearing selection at the cross point of selected row and column in the "Connecting Rod Bearing Selection Table".

When the specified oil clearance is not obtained with the standard size connecting rod bearing, use undersize (US) bearing. When using undersize bearing, measure the connecting rod big end inner bore diameter with US bearing installed and grind crankpin for correct specified clearance.

CAUTION:

When grinding crankshaft crankpins for undersize bearings, be sure to maintain fillet radius.

How to Select Main Bearings

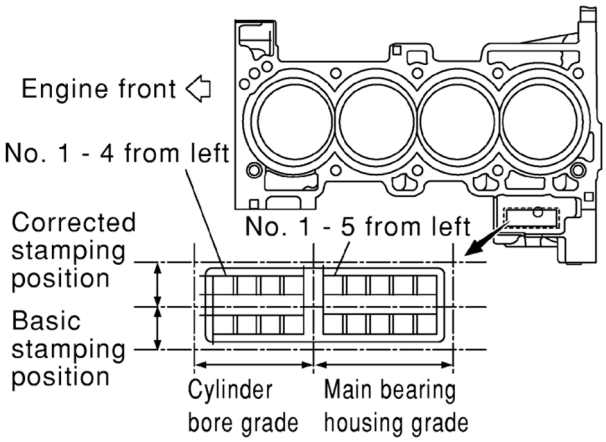
When Reusing Cylinder Block and Crankshaft

Measure dimensions of cylinder block main bearing housing inner bore diameter, and diameter of crankshaft journal.

Determine main bearing grade by comparing measured dimensions with values in “Main Bearing Selection Table” in EM section of the ESM.

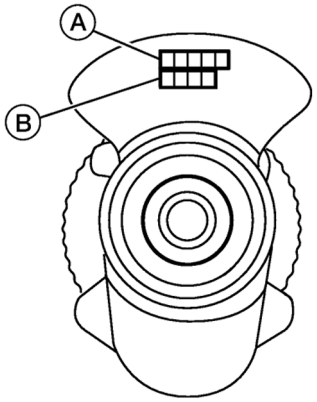
When New Cylinder Block and Crankshaft are Used

Main bearing housing grade is marked on cylinder block. If there is a correction stamp mark on the cylinder block, use it as the correct reference.



Refer to the illustration below. Main bearing journal diameter grade is stamped in location (A) on crankshaft front side. Compare with "Main Bearing Selection Table".

For reference, connecting rod crankpin diameter grade is stamped in location (B).



Read bearing selection at the cross point of selected row and column in the "Main Bearing Selection Table" in EM section of the ESM.

CAUTION:

There may be two main bearing selection tables, one for odd-numbered journals and one for even-numbered journals. Be sure to use the appropriate table as clearances may vary.

When the specified oil clearance is not obtained with the standard size main bearing, use undersize (US) bearing. When using undersize bearing, measure the inner bore diameter with US main bearing installed and grind journal for correct specified clearance.

CAUTION:

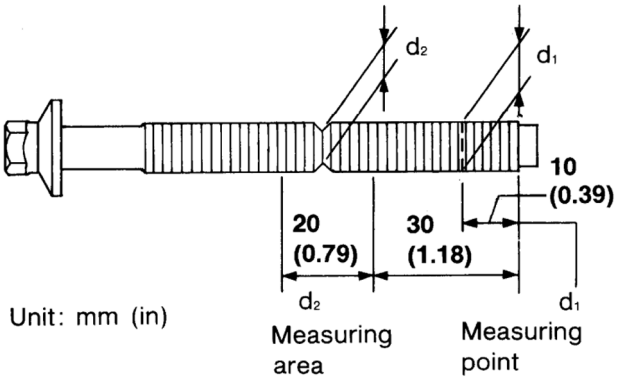
When grinding crankshaft journals for undersize bearings, be sure to maintain fillet radius.

Cylinder Head Inspection and Installation

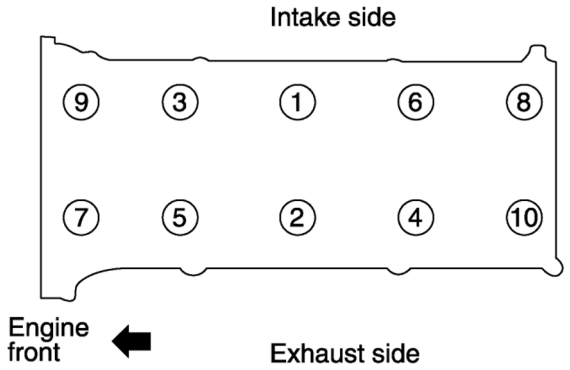
Torque Angle Tightening Procedure

Nissan and Infiniti engines use torque-to-yield fasteners (head bolts) to attach cylinder heads to blocks. All fasteners stretch when tightened. Torque-to-yield fasteners (plastic zone fasteners) are designed to be tightened beyond their elastic limit, so they are permanently stretched when tightened properly. The torque angle tightening procedure provides more consistent ultimate tightening torque and clamping force.

Whenever removing or installing a cylinder head, or whenever cylinder head bolts are torqued, it is essential to determine whether the existing cylinder head bolts can be reused or if they must be replaced. Follow ESM procedures to measure either bolt diameter or length to determine whether bolts must be replaced. Depending upon the engine, plastic zone fasteners are measured either for length or diameter in order to determine if they can be reused.



Correct bolt torquing in the correct sequence is essential to attain proper clamping force between the cylinder head and the cylinder block. Correct bolt torque also prevents damage to the cylinder head gasket.



QR25DE cylinder head tightening sequence shown

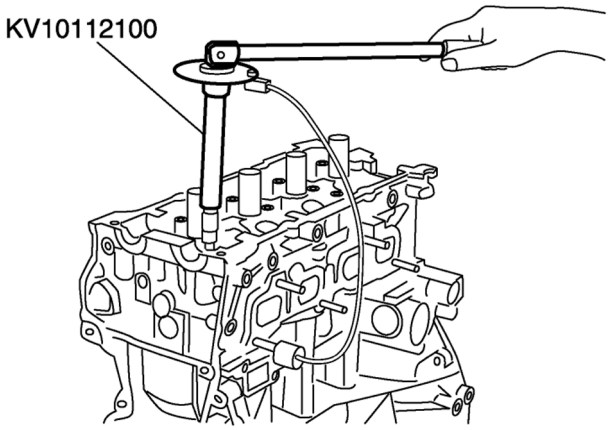
Apply a light coat of new motor oil to the threads and seating surfaces of the cylinder head bolt before installing. Without lubrication, dry threads require higher torque to overcome thread friction.

Follow the ESM procedure to tighten the cylinder head bolts. Torque the bolts in sequence, as indicated. Loosen the bolts, then torque to specification. Use the torque angle gauge and turn the bolts clockwise the specified number of degrees. This tightens the bolt to the proper torque while also stretching the bolts a specified amount in order to provide greater clamping force. Overtightening fasteners beyond specification can exceed the elasticity of the bolt and lead to fastener failure.

NOTE: Cylinder head bolts must be tightened using a multi-step process. A torque wrench AND torque angle meter must be used. A torque wrench alone will NOT tighten the bolts to the required specification.

Here is a typical tightening sequence for head bolts:

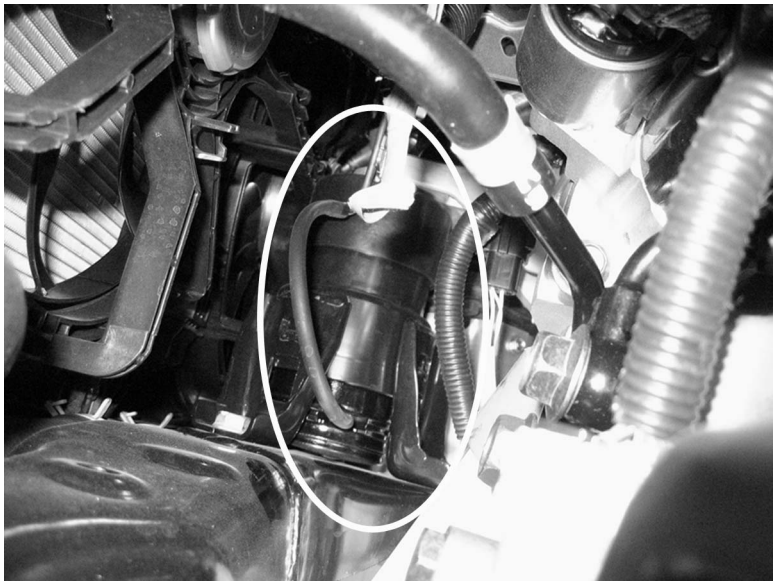
1. Tighten to 98.1 Nm (10 kg-m, 72 ft-lb).
2. Loosen to 0 Nm in the reverse order of tightening.
3. Tighten to 39.2 Nm (4.0 kg-m, 29 ft-lb).
4. Tighten 75° clockwise.
5. Tighten 75° clockwise.



Electronically Controlled Engine Mounts

VQ35DE Engine Mounts (front wheel drive only)

New electronically-controlled vacuum-operated engine mounts are used on front-wheel-drive applications for the VQ35DE engine. Applications include Altima, Maxima, and Murano FWD models. There are two settings for the mounts: “idle” and “travel”. The idle setting is softer to minimize the transmission of vibration to occupants during engine idle. The travel setting stiffens the mounts to reduce torque steer and noise-vibration-harshness (NVH) at higher engine speeds.



Electronically-controlled vacuum-operated engine mount (Altima)

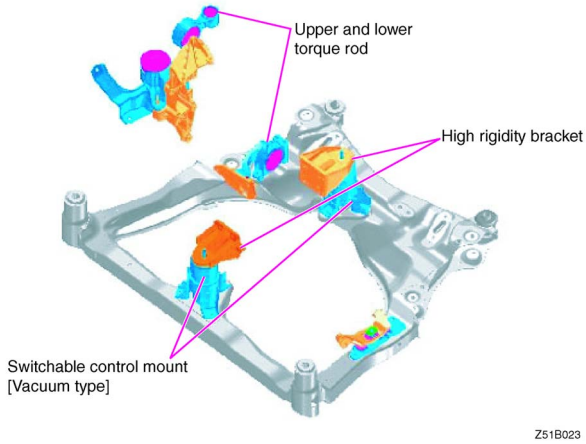


Engine mount vacuum control solenoid (Altima)

Z51 Murano Engine Mounts

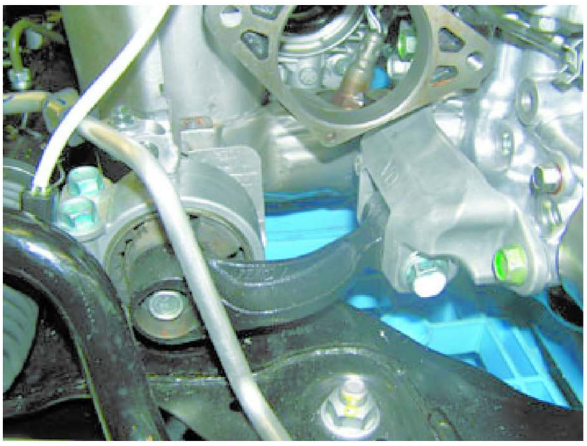
To improve NVH performance under high engine torque conditions, the engine mounts utilize a 6-point mount system.

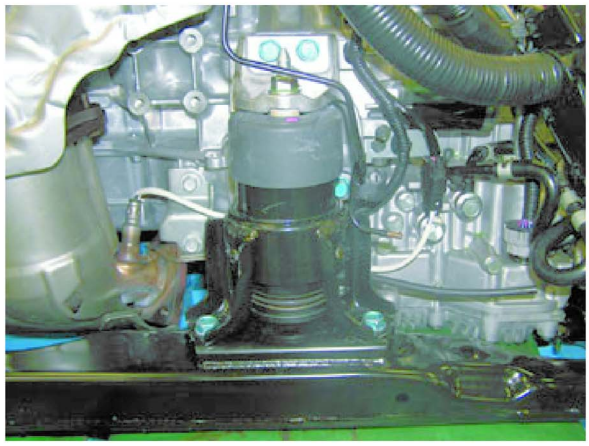
- Torque rods (UPR and LWR) added
- High rigidity aluminum brackets (FR and RR) added
- Switchable control mount vacuum type (FR and RR)



Z51 Murano Shown

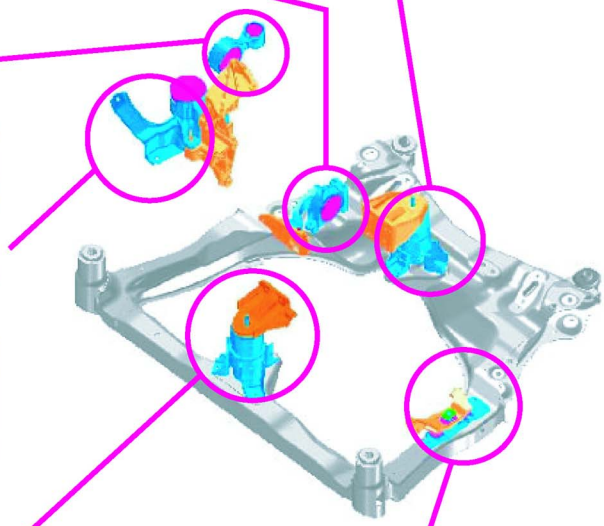
Component locations



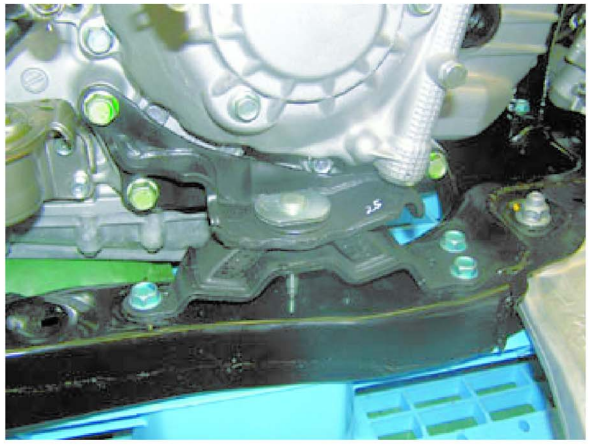


Vacuum switching insulator





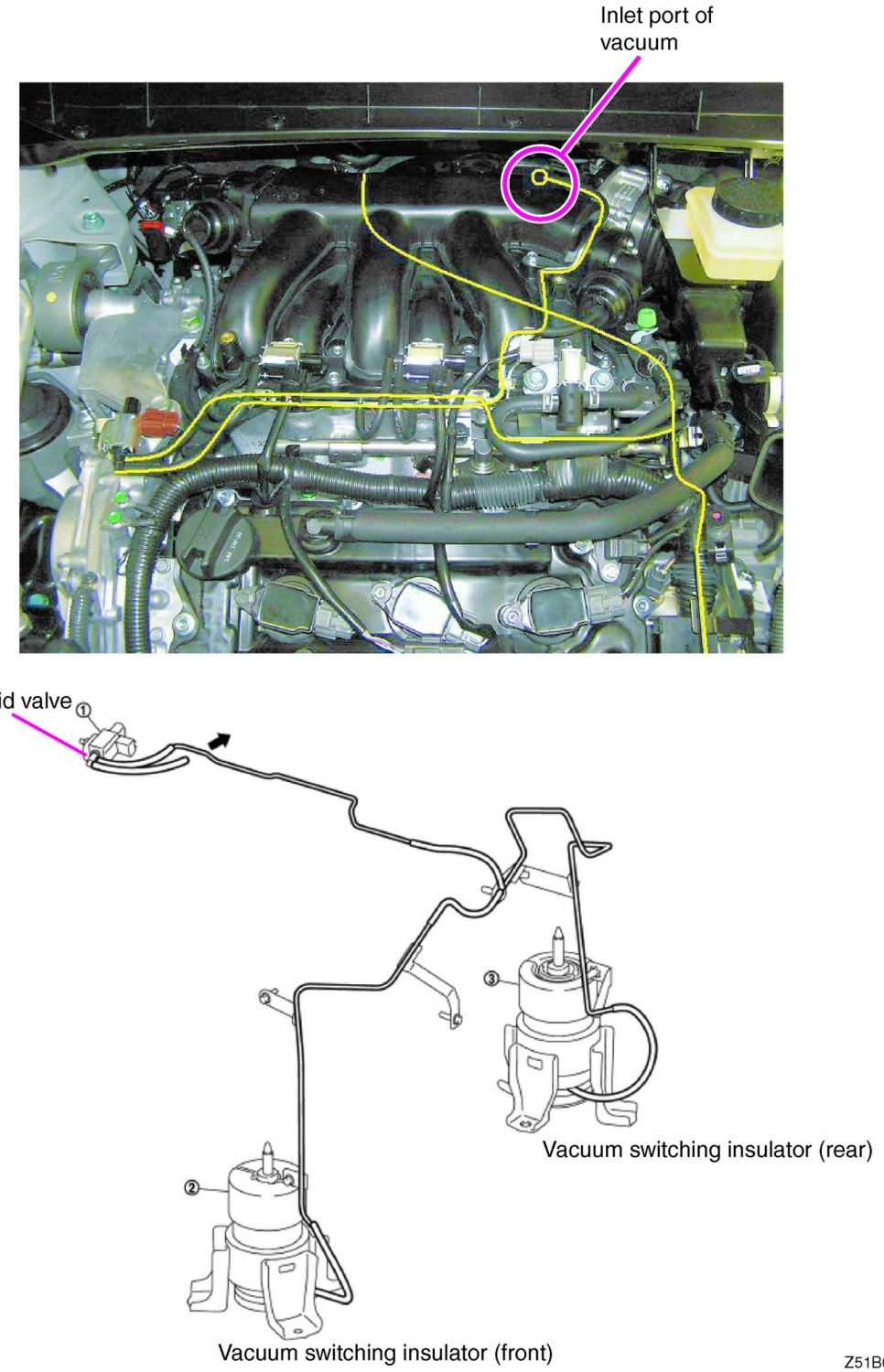




Vacuum switching insulator

Z51B024

Engine mount vacuum line



Input/output signal chart

Sensor	Input signal to ECM	ECM function	Actuator
Crankshaft position sensor (POS) Camshaft position sensor (PHASE)	Engine speed	Engine mount control	Electronic controlled engine mount control solenoid valve
Combination meter	Vehicle speed*		

*: This signal is sent to the ECM through the CAN communication line.

The ECM controls the engine mount operation corresponding to the engine speed and the vehicle speed.
The control system has 2-step control [Soft/Hard]

Vehicle condition	Engine mount control
Engine speed: Below 950 rpm	Soft
Engine speed: Above 950 rpm	Hard

Z51B026

Idle Air Volume Learning

Idle Intake Air Valve Learning

Idle intake air valve learning is used to learn the intake air valve for idle to obtain a stable idle speed. If this procedure is not done after ECM replacement, a high idle condition may occur.

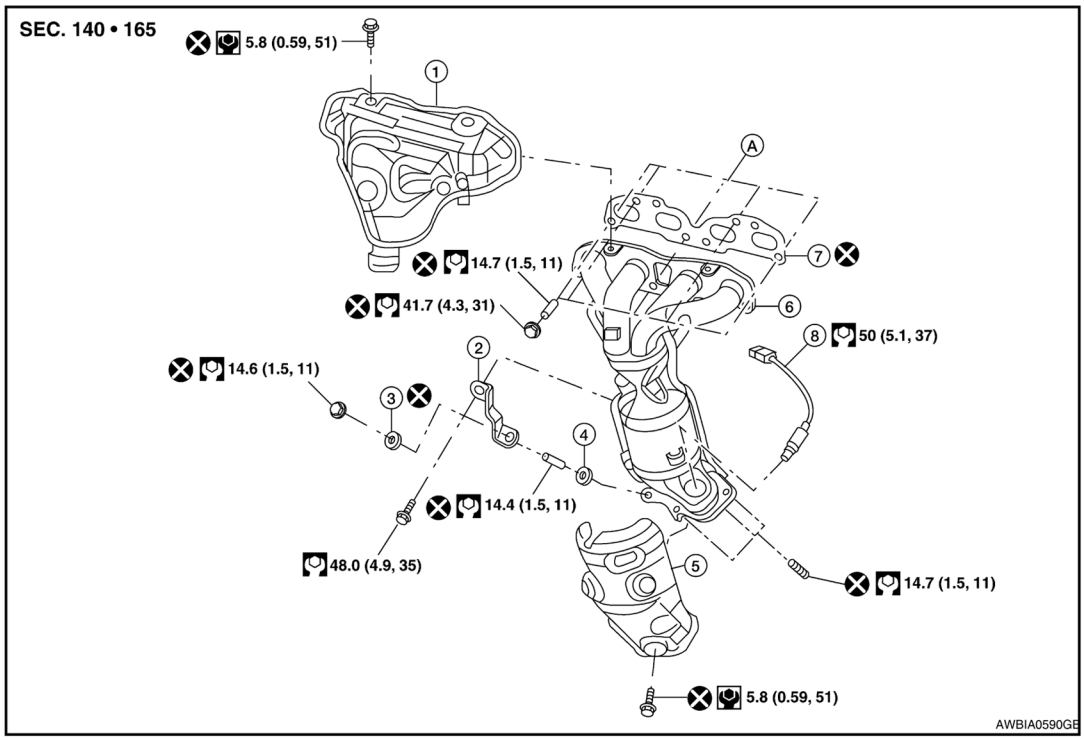
Check that the following conditions are met before performing the idle intake air valve learning. Do not perform it if any of the following conditions are not met.

- Battery voltage: 12.9 V or higher
- Coolant temperature: 70-95°C (158-203°F)
- Intake air temperature: 60°C (14°F) or below
- Parking/neutral position switch: ON
- Electric load switch: OFF (air conditioner, headlamps, rear defogger, etc.)
- Steering wheel: Neutral (straight-ahead position)
- Vehicle speed: 0 km/h
- Transmission: ATF temperature 60°C (140°F) or higher (after the engine is warmed up, drive for 10 minutes)

NOTE: Always refer to the Inspection and Adjustment in section EC of the applicable ESM for the complete Idle Intake Air Valve Learning procedure.

Catalytic Converter Operation and Inspection

The three-way catalytic converter oxidizes unburned hydrocarbons (HC) and carbon monoxide (CO), and also reduces oxides of nitrogen (NOx). The three-way catalytic converter is mounted in the exhaust manifold near the cylinder head and engine exhaust ports. Hot exhaust from the engine helps the catalyst to “light off” more quickly during a cold start.



1. Exhaust manifold cover (upper)
2. Exhaust manifold stay
3. Manifold yoke (type B)
4. Manifold yoke (type A)
5. Exhaust manifold cover (lower)
6. Exhaust manifold and three way catalyst assembly
7. Exhaust manifold gasket
8. Air fuel ratio (A/F) sensor 1
A. To cylinder head

Meltdown or breakup of the ceramic catalyst substrate can cause several engine performance problems. Catalyst failure can be caused by engine misfire and vibration. A melted catalyst can create an obstruction and can increase exhaust backpressure. Since the catalyst is located close to the cylinder head, pieces of broken catalyst may cause internal engine damage when drawn into a cylinder through an open exhaust valve.

Diagnose possible catalyst damage with a vacuum gauge. Excessive exhaust backpressure will cause a decrease in intake manifold vacuum. Remove the air fuel ratio sensor to visually examine catalyst condition with a borescope. CONSULT-III can display air fuel ratio data which also may assist diagnosis.

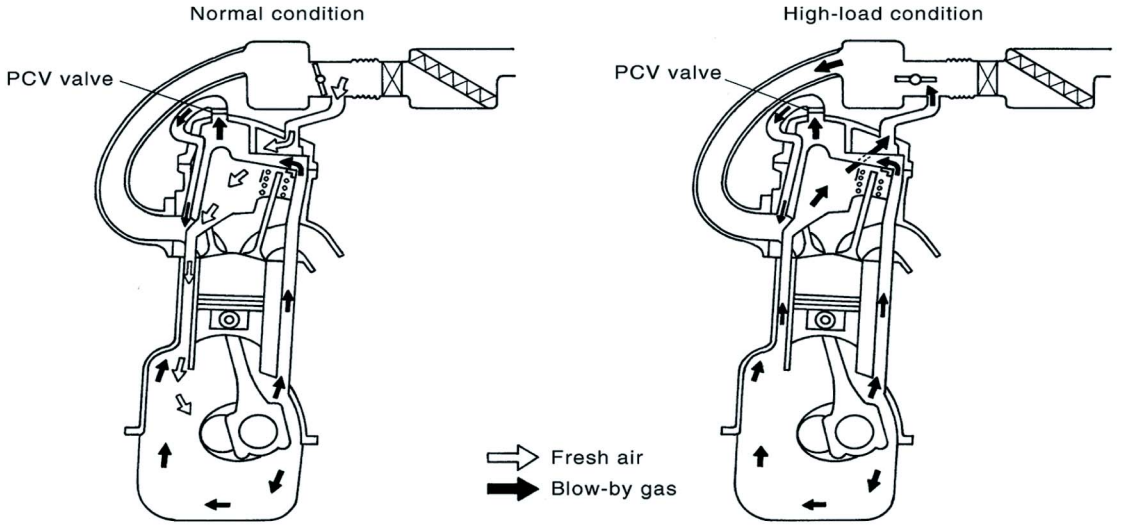
Positive Crankcase Ventilation (PCV) valve

System Description

The Positive Crankcase Ventilation (PCV) system removes blowby gases (combustion by-products and unburned hydrocarbons) that pass by piston rings and accumulate in the crankcase. These gases must be removed because they can dilute and contaminate the oil, which can shorten engine life.

The PCV system uses engine intake manifold vacuum to purge blowby gases and meter them at a controlled rate into the intake manifold where they become part of the intake mixture for the next combustion cycle.

A one-way PCV control valve controls the flow rate of the blowby gases. When engine load is low, manifold vacuum draws blowby gases through the PCV valve. Fresh air flows into the crankcase and picks up blowby gases. When engine load is high, higher cylinder pressures create a greater quantity of blowby gases. The added gases flow through the fresh air hose into the air intake system.



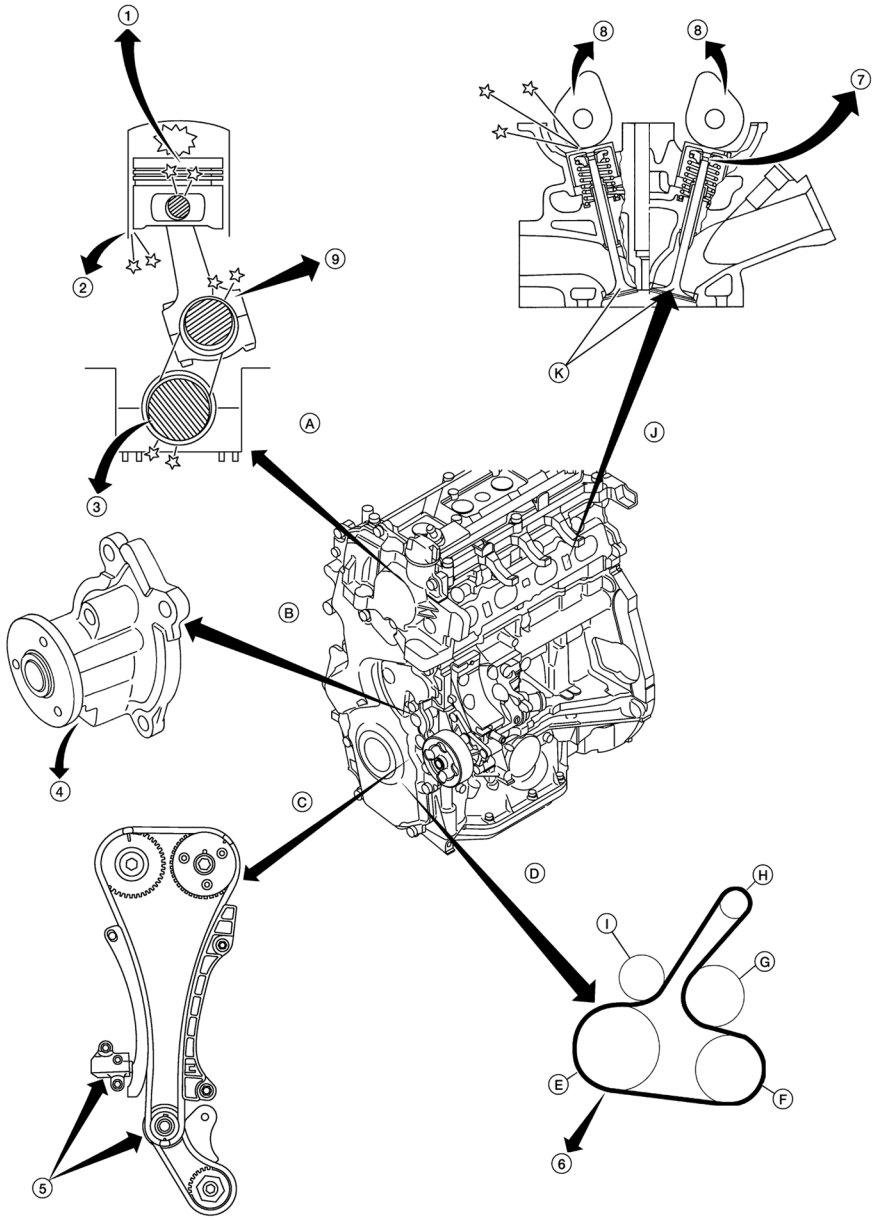
QR25 shown

Engine Noise Diagnosis

Engine noises can be difficult to diagnose. Engine noises can be a fast “ticking” sound, or a knocking or “pinging” sounds while the engine is under load.

- A fast “ticking” sound may indicate a problem with an engine valve, valve spring, or valve lifter. Incorrect valve adjustment may also cause a fast ticking sound.
- A knocking or “pinging” sound under load may be normal when low-octane gas is being used or it’s especially hot outside. If neither of these conditions exist, there could be a problem with the engine’s timing system, or carbon build-up in the cylinder is raising the engine’s compression.
- A knocking sound may also be the result of “piston slap”. This may occur with worn piston rings or a worn cylinder liner causing excessive clearance between the piston and cylinder liner.
- Cylinder wall scoring may also cause a knocking sound or loss of power. This scoring may occur when oil change intervals are not followed, or when the oil level regularly falls below the minimum value.

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1. Piston pin noise
2. Piston slap noise
3. Main bearing noise
4. Water pump noise
5. Timing chain and tensioner noise
6. Drive belt noise (stick/slipping)
7. Tappet noise
8. Camshaft bearing noise
9. Connecting rod noise
A. Rotational mechanism
B. Water pump
C. Timing chain
D. Drive belt
E. Crankshaft pulley
F. A/C compressor
G. Water pump
H. Generator
I. Tension pulley
J. Valve mechanism
K. Valves

Potential sources of noise

Use the Chart Below to Help You Find the Cause of the Symptom.

1. Locate the area where noise occurs.
2. Confirm the type of noise.
3. Specify the operating condition of engine.
4. Identify noise source.
5. Check listed items to verify cause of noise.

Location of noise	Type of noise	Operating condition of engine						Source of noise	Check item
		Before warm-up	After warm-up	When starting	When idling	When racing	While driving		
Top of engine Rocker cover Cylinder head	Ticking or clicking	C	A	—	A	B	—	Tappet noise	Valve clearance
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal oil clearance Camshaft runout
Crankshaft pulley Cylinder block (Side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston to piston pin oil clearance Connecting rod bushing oil clearance
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston to cylinder bore clearance Piston ring side clearance Piston ring end gap Connecting rod bend and torsion
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing oil clearance Connecting rod bearing oil clearance
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout
Front of engine Front cover	Tapping or ticking	A	A	—	B	B	B	Timing chain and chain tensioner noise	Timing chain cracks and wear Timing chain tensioner operation
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Drive belt (Sticking or slipping)	Drive belt deflection
	Creaking	A	B	A	B	A	B	Drive belt (Slipping)	Idler pulley bearing operation
	Squall Creak	A	B	—	B	A	B	Water pump noise	Water pump operation

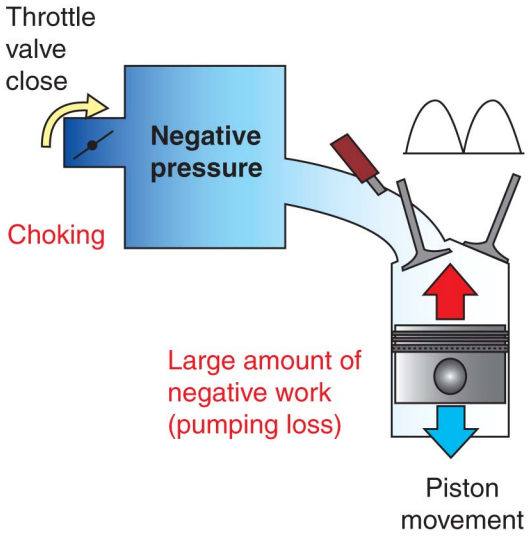
A: Closely related B: Related C: Sometimes related —: Not related

Tools for Diagnosis and Repair

Vacuum Gauge

The Vacuum Gauge is a useful and frequently overlooked diagnostic tool. It can provide an excellent overview of basic engine condition. The gasoline engine is a pump, and intake manifold vacuum is a good measure of engine efficiency as a pump.

Gasoline engines are air-throttled by means of a throttle plate (exception: VQ37VHR engines with VVEL). At low engine speeds and loads, the throttle plate is nearly closed and this creates a restriction in the intake. The pumping action of the pistons must work against this restriction.





Conditions affecting the engine as a whole, such as incorrect valve timing, restricted exhaust, restricted intake and conditions affecting only one cylinder, such as a burned valve, can affect engine vacuum.

A complete vacuum test includes checking cranking vacuum as well as intake manifold vacuum at idle and high speed. Note the vacuum reading, and also how much the needle fluctuates. A rapidly bouncing needle can indicate a problem in one cylinder only. Typical cranking vacuum is 3-6 in. Hg., and manifold vacuum at idle is approx. 16-18 in. Hg.

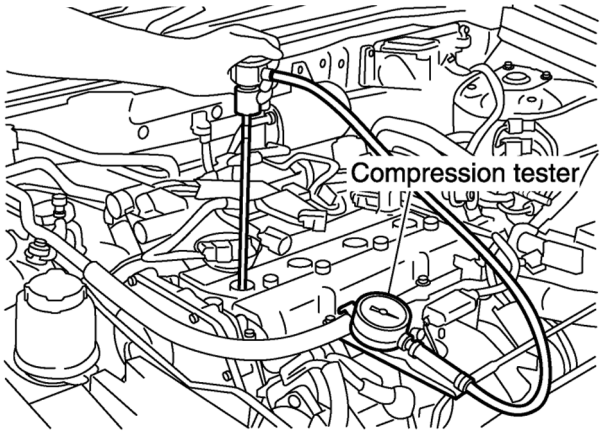
Vacuum decreases with increasing load and throttle opening. Vacuum will also decrease at higher altitudes, since atmospheric pressure drops with increasing altitude.

Compression Tester

The cylinder compression test can help to determine the mechanical condition and sealing ability of pistons and rings, head gasket, valve condition and valve timing when used along with other diagnostic tests.

The gauge indicates the maximum compression pressure in each cylinder tested. Refer to ESM information for recommended practice and specifications. Typical recommendations include:

- Warm engine to full operating temperature.
- Release fuel pressure and disable fuel delivery to prevent flooding.
- Fully depress accelerator pedal to permit unrestricted airflow.
- Disable ignition system, remove ignition coils and spark plugs from all cylinders.
- Insert tester into first cylinder. Be sure that cranking RPM is within specified range (higher than normal cranking speed may indicate incorrect valve timing).
- Rapid pressure rise is desired on first strokes. Maximum pressures cylinder to cylinder should meet specifications and vary less than specified. See ESM for specific test procedure.



Typical results can include:

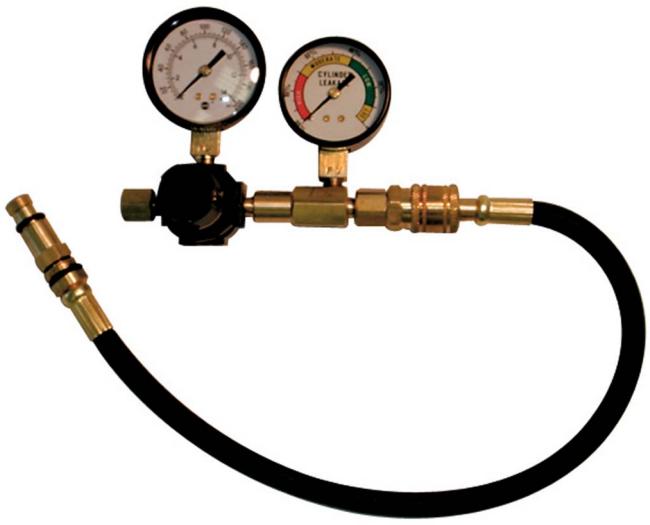
- Compression that steadily builds as you crank the engine indicates good compression.
- Low compression on the first crank that builds on subsequent cranks but does not reach specification, may indicate worn piston rings. Retesting after adding a small amount of oil to a cylinder can help determine whether rings or valves are leaking.
- A gauge reading higher than specification may indicate carbon deposit build up in the combustion chamber.

Cylinder Leakage Tester

A cylinder leakage test measures the ability of each cylinder to hold air pressure with the piston at TDC of compression. The test can help identify the location and extent of a cylinder leak. Shop air is connected to the tester and fed by the tester into the spark plug hole. The gauge on the tester indicates the total compression leakage expressed as a percentage. A zero percent gauge reading indicates no leakage from the cylinder, however all cylinders normally leak a small amount past the piston rings. Typically, less than 10% leakage is excellent, while greater than 20% leakage is excessive.

This test can be especially useful to identify the source of cylinder leakage: piston rings, valves, head gasket, etc. Perform test on hot engine if possible. Test every cylinder and compare the readings. Also listen for escaping air to help your diagnosis:

- Air escaping from the intake system indicates a leaking intake valve.
- Air escaping from the exhaust pipe indicates a leaking exhaust valve.
- Air escaping from the crankcase filler hole indicates a crankcase leak caused by broken or worn rings, a cracked piston or worn cylinder walls.
- Air bubbles in the radiator indicates cylinder leakage into the cooling system. This may indicate cracks in the water jackets, block, or head gasket.
- High percentage of leakage in two adjacent cylinders indicates a head gasket problem or an engine block crack between the cylinders.



Precision Tools

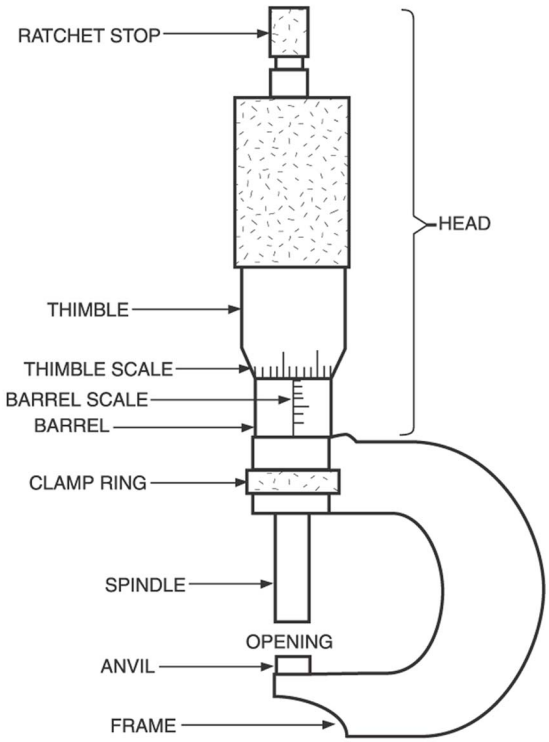
Precision measuring tools are often used for engine repair work. It is important that you be thoroughly familiar with these tools to assure accurate measurements. You will practice the use of micrometers, dial indicators, vernier calipers, torque angle gauges, and feeler gauges during this course.

Micrometers

The outside micrometer is used to measure the diameter of precision engine parts. A micrometer generally provides greater precision than a vernier caliper, but has a smaller range. Micrometers are available in many different sizes and forms and may be graduated in either English or Metric measurements. Digital micrometers can be easier to read.

To use a micrometer, place the part in the opening. Next, turn the thimble until the spindle contacts the work. To apply a consistent pressure to the part, use the ratchet stop. Do not overtighten. Use the clamp ring to hold the thimble in place while you read the micrometer. To read the micrometer:

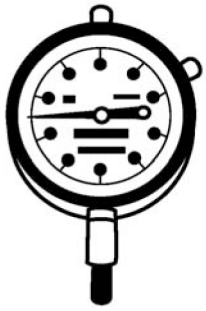
- Read the exposed number on the barrel.
- Read the number of divisions past the number. Each division is 0.635 mm (0.025 in).
- Read the division on the thimble. These usually read to less than 0.025 mm (one thousandth of an inch).



Dial Indicators

Dial indicators are commonly used to precisely measure valve lift, shaft runout, and cylinder taper, among other things. Dial indicator faces are calibrated in thousandths of an inch or in millimeters. There are a wide variety of adapters and mounting arms available so that you can use the indicator for many purposes.

It is important point to mount a dial indicator firmly, and be sure that the actuating rod is parallel to the plane of movement measured.



Vernier Calipers

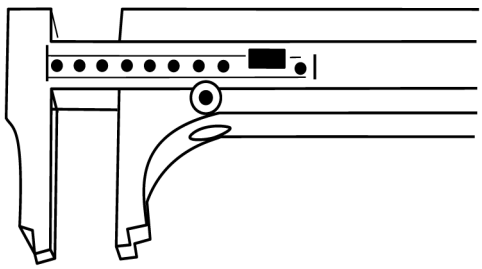
Vernier measuring instruments have two engraved scales that lie parallel to one other.

The longer scale on the beam of the instrument is graduated in actual length measurements, in either millimeters or fractions of an inch. The shorter vernier scale moves along the beam. Vernier scale divisions are slightly smaller than the divisions on the beam.

A vernier caliper consists of two basic parts:

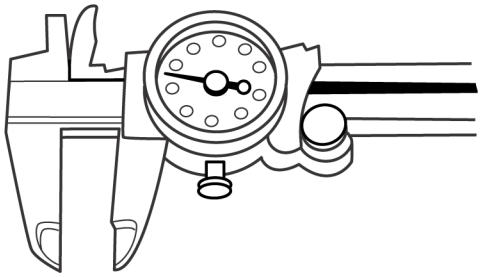
- A beam with a fixed jaw at right angles (the beam jaw)
- A moveable jaw that slides along the beam.

There may also be a block connected to the moveable jaw by a screw. This block can be fixed in position on the beam using the clamping screw. The fine adjustment wheel can then make small adjustments to the position of the moveable jaw. Most calipers have separate internal jaws.



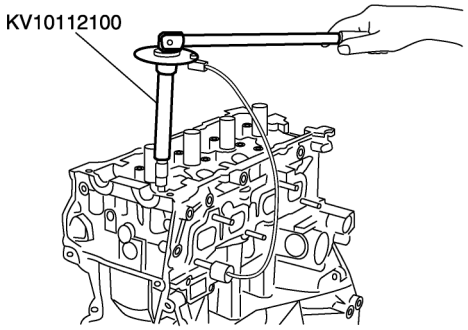
Dial Calipers

Dial calipers have a circular scale similar to a dial indicator for fine reading in addition to a vernier scale with larger divisions. Dial calipers are easier to read than vernier calipers, but are more expensive.



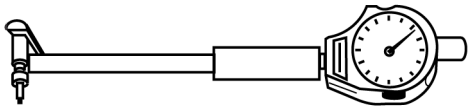
Torque Angle Gauge

The tightening procedure for some fasteners such as torque-to-yield cylinder head bolts requires use of a torque angle gauge. The procedure for tightening these fasteners requires you to tighten the bolts a certain number of degrees after torquing them to specification. A torque angle gauge helps you to do this accurately. The gauge connects between a ratchet and the socket or extension, and displays degrees of rotation of the bolt.



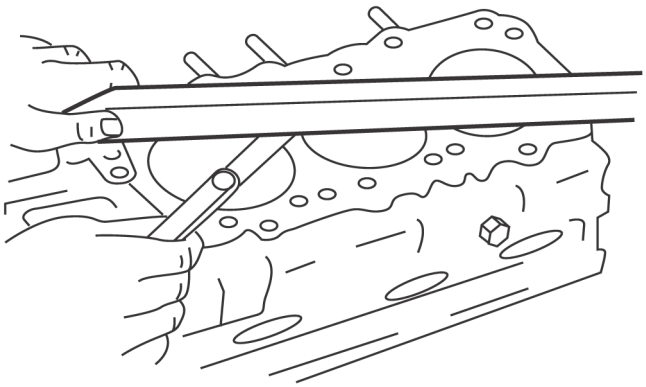
Bore Gauge (Cylinder Gauge/Telescoping Gauge)

A bore gauge is used for precision measurement of cylinder bores. It is a T-shaped device with spring-loaded anvils that can be locked into position. Lower the gauge into a bore, making sure the gauge shaft is vertical. Unlock the anvils and read the bore diameter on the attached dial indicator. To check for roundness and taper, check at several points in the bore. Older style bore gauges required to you lock the anvils into place and remove the gauge to determine the bore diameter by measuring the anvil length with a micrometer. Current bore gauges incorporate a dial indicator display that eliminates this step.



Straight Edge/Feeler Gauges

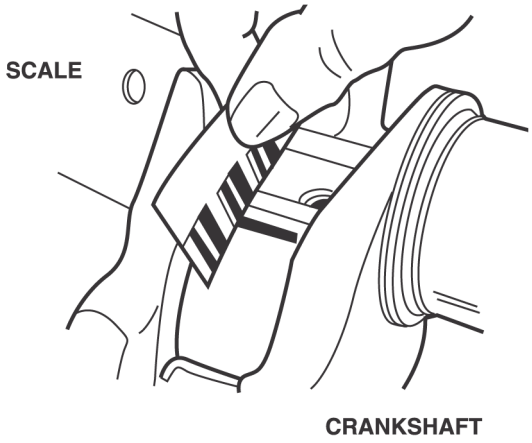
Use a rigid straightedge and a feeler gauge to measure cylinder block and head distortion. Clean the head gasket surface thoroughly prior to measuring surface distortion. Check flatness at both edges and from corner to corner in an X pattern by laying the straightedge across the surface and slipping a feeler gauge between them. Flatness specifications are found in the ESM.



Plastigage™

Plastigage™ is a flexible, thread-like putty used to measure crankshaft bearing clearances. Place a short strip of Plastigage™ lengthwise in the center of a journal, install the bearing cap and tighten the bolts to correct specifications. When you remove the cap, you will find that the Plastigage™ has been flattened. To determine the bearing clearance, compare the width of the flattened Plastigage™ strip with the scale on the Plastigage™ package.

Measure crankshaft main bearing clearance with Plastigage™. Bearing clearance specifications are found in the ESM.



Belt Tension Gauge

A belt tension gauge allows accurate accessory belt tension adjustment. Place the gauge on the installed belt between two pulleys. The gauge applies a specific force to the belt and measures the amount of belt deflection. A tighter belt will allow less deflection. Belt specifications are found in the ESM.

