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ENGINE TERMINOLOGY

When discussing engine specifications and performance, the conversation almost always includes terms like “horsepower” and “torque.” “Power-to-weight ratio” is another common measure of engine performance. Finally, “fuel economy” is an important topic for almost every vehicle buyer.

Horsepower

Horsepower is the customary unit for measuring the power of an engine. By definition, one horsepower is the power needed to lift 33,000 pounds a distance of one foot in one minute. The horsepower rating of an engine gives an indication of how strong the engine is. However, other factors, such as the weight of the vehicle, affect how useful the horsepower will be. The more a vehicle weighs, the more horsepower is needed to move it.

Power-to-weight ratio

The power-to-weight ratio is a more useful measurement of engine power. The power-to-weight ratio is the ratio of horsepower to vehicle weight. If a vehicle’s engine has a high horsepower rating, but a heavy weight, it may not perform as well as a vehicle that is lighter, even if it has less horsepower. A power-to-weight ratio is often expressed as a single number. For example, a power-to-weight ratio of 18.5 means one horsepower has to move 18.5 pounds of vehicle weight. A lower power-to-weight ratio may mean superior vehicle performance, regardless of the horsepower rating.

Torque

Torque is a measure of the twisting force generated by the engine’s crankshaft. The transmission and final drive (differential) are used to multiply the torque output of the engine. The amount of torque an engine generates, calculated in “foot-pounds,” is an indication of how effectively it can generate its power. Different engines develop their peak torque at different rpm levels. Therefore it is important to recognize the level at which a given engine develops its peak torque.

- Engines that develop peak torque at *low rpm* are more responsive at lower rpm, but will “run out of steam” as rpm increase.
- Engines that develop peak torque at *high rpm* will be very responsive at high rpm, but will react slowly at low speeds.

Nissan and Infiniti engines are designed to provide a balance between low-end and high-end torque. They produce maximum torque at levels that match vehicle performance requirements. For example, the engines in Nissan and Infiniti utility vehicles are designed to provide more low-end torque for optimum response in towing, off-road, and utility uses. Sedans and sports cars, which are lighter and less frequently used for utility purposes, have engines that provide maximum torque at higher rpm levels to provide more responsiveness at normal driving speeds.

EXPLAINING | TORQUE

Take a pencil and slide the eraser end along a paper with a steady force. At first it is difficult to move the pencil. This represents “high-end” torque — engine power that’s available at a high rpm level. The eraser is hard to start, but once it’s moving, it’s pretty easy. Now, turn the pencil around and do the same thing with the pointed end. It’s a lot easier to start. That’s “low-end” torque — the power that’s generated at low rpm. It makes it easier to get started.

Fuel economy

Today’s sophisticated engine technologies make it possible for a vehicle to produce plenty of power efficiently without using excessive fuel. Electronic engine management systems, fuel injection, variable valve timing, and other specialized technologies make this possible.

At the Environmental Protection Agency (EPA) facilities, production vehicles run a series of “City” and “Highway” cycles on a special device called a chassis dynamometer that measures the engine’s performance at the drive-wheels. This provides an estimated, rather than an actual, mileage figure, because the results are not achieved through actual driving. However, identical tests are conducted for every vehicle, so the results are reliable for comparative purposes.

For specific EPA city and highway results for a particular vehicle, see your Nissan or Infiniti *Product & Price Guide*.

ENGINE DESIGNS

The heart of a vehicle is its internal combustion engine. The basic 4-stroke engine is still the most common engine design on the road today. It hasn’t changed significantly since it was invented.

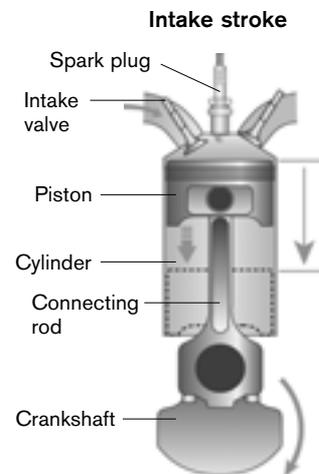
Generally, there are two major types of gasoline engines: overhead valve (OHV) and overhead cam (OHC). All Nissan and Infiniti engines are overhead cam (OHC) engines. A large number of Nissan and Infiniti vehicles in

the 21st century will be powered by specially tuned versions of the following overhead cam engines:

- QR25 4-cylinder engine
- VQ Series V6 engines
- VK45 V8 engine
- VK56 V8 engine

4-stroke engine

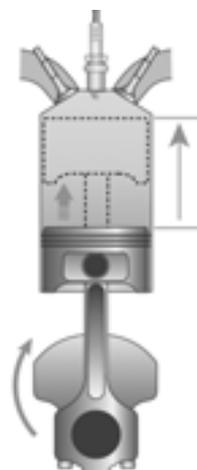
The 4-stroke engine takes its name from the fact that it takes four strokes of the piston to complete one cycle.



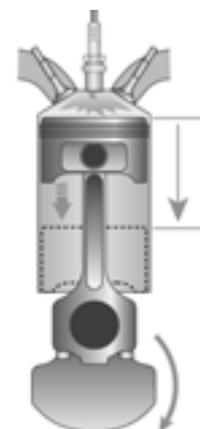
On the first stroke the intake valve (or valves) opens, and as the piston goes down in the cylinder, the air/fuel mixture is drawn into the cylinder. During this stroke the airflow meter in the fuel injection system sends a signal to indicate how much air is coming in. Then a computer-controlled fuel injector sprays a precise amount of fuel into the cylinder at just the right moment.

Next is the compression stroke. The intake valves close as the piston travels up the cylinder, and the piston compresses the air/fuel mixture. The higher the compression, the more power is generated in the next stroke.

Compression stroke

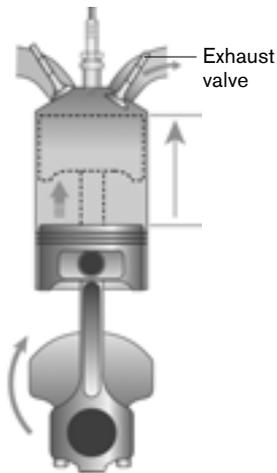


Power stroke



As the piston approaches the top of the compression stroke, the spark plug fires, igniting the compressed air/fuel mixture. The rapidly expanding gases push the piston back down the cylinder. This is the stroke that generates the engine's power. The strokes in each cylinder are timed so they occur at intervals that create a smooth-running engine and quiet performance.

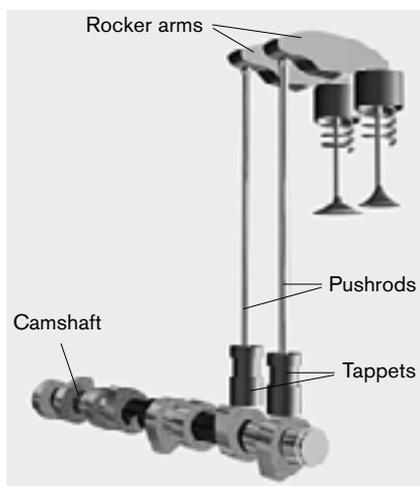
Exhaust stroke



During the fourth, or exhaust stroke, the turning crankshaft forces the piston back up the cylinder, the exhaust valve (or valves) opens, and the piston pushes out the burnt air/fuel mixture past the exhaust valve. From there, the exhaust gases travel through the exhaust manifold, catalytic converter, muffler, and out the tailpipe.

This 4-stroke process generates the power that is used to turn the wheels. The piston is attached to a connecting rod, which converts the piston's linear motions to the circular motion at the crankshaft. The action is very similar to the way the up-and-down motion of a bicycle rider's legs is converted to a circular motion at the sprocket.

Overhead valve (OHV) engine

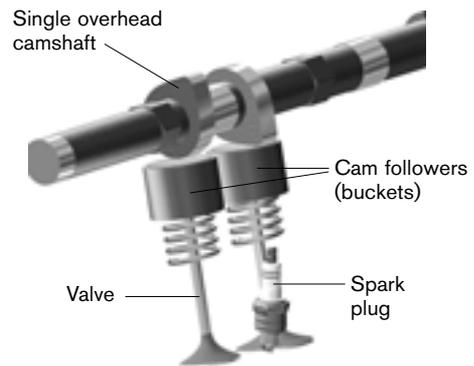


The overhead valve (OHV) engine is still found in many domestic vehicles. With the overhead valve design, a system of rocker arms, pushrods, and tappets opens and closes the valves. A single camshaft located in the cylinder block actuates the pushrods. Generally, the OHV design works well in large-capacity, low-revving engines like those used in large trucks.

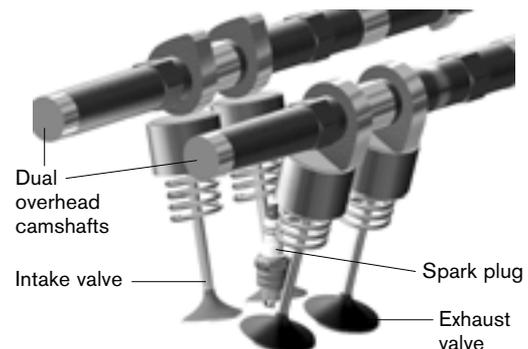
Overhead cam (OHC) engine

With the overhead cam engine, one or more camshafts located in the cylinder head open and close the valves for each cylinder. The OHC design is superior for the smaller, higher-revving engines found in passenger vehicles. OHC allows a more efficient and compact design and more positive actuation of the valves. OHC engines have fewer moving parts, so there is less inertia, or moving weight. Therefore the engines can be run at higher speeds and often produce more power than larger-capacity OHV engines.

SOHC Engine



DOHC Engine



On single overhead cam (SOHC) engines, one camshaft operates both the intake and exhaust valves. On double overhead cam (DOHC) engines, one camshaft actuates the intake valves and a separate camshaft actuates the exhaust valves, providing even more precise control for enhanced performance. That means on V6 or V8 engines, there are four camshafts in total (two for each cylinder head).

QR25 4-cylinder engine

Introduced in model year 2002, the QR25 is the in-line 4-cylinder engine that Nissan has adopted on a global basis for the 21st century.

Power and efficiency

The QR25 engine incorporates several technologies that increase its efficiency and power.

- Its double overhead cam design provides precise, efficient control of the valves for enhanced performance.
- The Continuously Variable Valve Timing Control System (CVTCS) allows the engine to run smoothly and efficiently at low rpm. But as rpm increases, sensors signal the system to change the intake valve timing to increase the power delivered by the combustion cycle.
- A variable-flow intake manifold improves the ability of the engine to “breathe in”; it promotes the efficient flow of air into the engine.
- A variable-flow muffler helps improve engine horsepower at middle and high speeds.
- The electronic drive-by-wire system delivers more precise throttle response compared to a mechanical cable.

Quiet operation

The QR25 also incorporates several technologies that allow it to operate very quietly, with little vibration.

- The silent-type camshaft timing chain is designed specifically so it meshes with its drive sprockets with a minimum amount of impact noise.
- Liquid-filled engine mounts absorb engine noise and vibration more effectively than conventional solid rubber mounts.
- QR25 integrates a ladder frame to support the crankshaft more rigidly. It reduces engine noise and vibration more effectively than an engine without a ladder frame.
- The QR25 also features a unique compact engine balancer system that controls the noise and vibration inherent in all in-line 4-cylinder engines larger than two liters.

VG33 V6 engine (Pre-owned)

Nissan’s 3.3-liter single overhead cam V6 engine has been designed to produce maximum torque at low rpm, making it ideal for use in utility vehicles. It is available in a supercharged version that produces more horsepower and torque.

Power and efficiency

The supercharger improves horsepower and torque by pumping extra air into the engine. The concentrated charge of air provides a more powerful combustion stroke, resulting

in improved performance. Unlike a turbocharger, which must spin up to speed to produce power, a supercharger is connected directly to the crankshaft by a belt, resulting in instant response. (See “Superchargers” on page 15.)

The VG33 engine incorporates several technologies that increase its efficiency and power, including thinner-sectioned piston rings and microfinished camshafts that help reduce friction, optimizing fuel economy and engine throttle response.

Quiet operation

The VG33 also uses liquid-filled front engine mounts that help absorb engine noise and vibration more effectively than conventional solid rubber mounts.

VQ Series V6 engines

Ward’s AutoWorld has recognized the VQ engine series as one of the “Ten Best Engines” for 11 consecutive years. The VQ series began with the VQ30 in 1995 Maxima and 1996 I30. The 3.5-liter VQ35 and 4.0-liter VQ40 versions are tuned specially to meet the driveability requirements of V6 Nissan and Infiniti vehicles.

Power and efficiency

Depending on the vehicle in which it’s installed, the VQ engine incorporates the following technologies that increase its efficiency and power.

- Its double overhead cam design provides precise, efficient control of the valves for enhanced performance. (All current engine versions)
- The Continuously Variable Valve Timing Control System (CVTCS) allows the engine to run smoothly and efficiently at low rpm. But as rpm increases, sensors signal the system to change the intake valve timing to increase the power delivered by the combustion cycle. (All current engine versions; on selected models, the system also varies exhaust valve timing)
- A variable-flow intake manifold improves the ability of the engine to “breathe in”; it promotes the efficient flow of air into the engine. (Selected models)
- A variable-flow muffler helps improve engine horsepower at middle and high speeds. (Selected models)
- The electronic drive-by-wire system delivers more precise throttle response than a mechanical cable and allows the engine to rapidly alter its power based on demands from Vehicle Dynamic Control (VDC) and/or Traction Control System (TCS) (if equipped). (All current engine versions)

Quiet operation

The VQ also incorporates several technologies that allow it to operate very quietly, with little vibration.

- The silent-type camshaft timing chain is designed specifically so it meshes with its drive sprockets with a minimum amount of impact noise.
- Liquid-filled engine mounts absorb engine noise and vibration more effectively than conventional solid rubber mounts. (Selected models)

VK45 V8 engine

The VK45 is a 4.5-liter double overhead cam 32-valve V8 engine that produces outstanding response.

Power and efficiency

The VK45 features several advanced technologies that contribute to its performance.

- Its double overhead cam design provides precise, efficient control of the lightweight titanium valves for enhanced performance.
- The Continuously Variable Valve Timing Control System (CVTCS) allows the engine to run smoothly and efficiently at low rpm. But as rpm increases, sensors signal the system to change the intake valve timing to increase the power delivered by the combustion cycle.
- Infiniti Torque Demand (ITD) maintains vehicle speed without having to press the accelerator pedal more when climbing a hill.
- A variable-flow intake manifold improves the ability of the engine to “breathe in”; it promotes the efficient flow of air into the engine.
- An electronically controlled variable-flow exhaust system varies exhaust back pressure at all rpm to enhance power output and driveability. (Selected models)
- The electronic drive-by-wire system delivers more precise throttle response than a mechanical cable and allows the engine to rapidly alter its power based on demands from Vehicle Dynamic Control (VDC) and Traction Control System (TCS).

Quiet operation

The VK45 engine also incorporates several technologies that allow it to operate very quietly, with little vibration.

- Lightweight engine components include titanium intake and exhaust valves, an aluminum-alloy engine block and oil pan, and aluminum-alloy cylinder heads.
- The silent-type camshaft timing chain is designed specifically so it meshes with its drive sprockets with a minimum amount of impact noise. Its single-stage design reduces weight, friction, and noise for improved throttle response.
- The use of a hydraulically driven cooling fan for the engine helps reduce noise and increases engine efficiency.

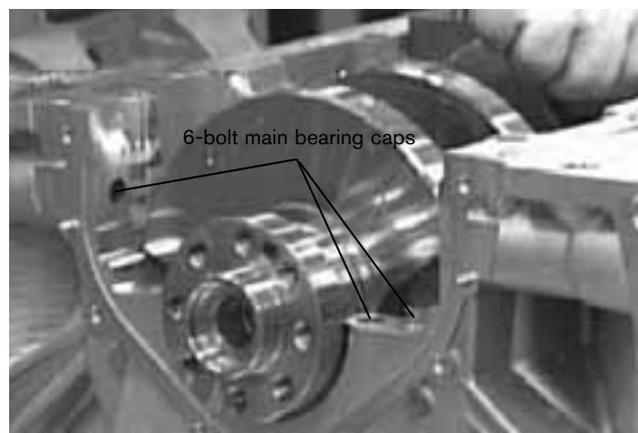
VK56 V8 engine

The VK56 “Endurance” engine is a 5.6-liter double overhead cam 32-valve V8 that was designed from the start to handle the hard work required of a full-size truck or SUV. It’s one of the most powerful standard V8 engines among its primary competitors, with outstanding power and acceleration as well as good fuel economy.

Strength and durability

The Endurance engine is designed to provide the kind of power and acceleration needed for hauling heavy loads or towing trailers.

- It delivers exceptional low-end torque. In fact, 90% of the engine’s torque is available under 2500 rpm.
- The engine also provides strong mid-range torque. Some competitors begin to run out of steam as engine speed rises.
- The 130-amp alternator supports installation of accessories such as electric trailer brakes, auxiliary lights, or a winch.
- The heavy-duty radiator enhances cooling performance when towing heavy loads.
- The heavy-duty battery provides longer battery life and more electrical power for quicker starting response under heavy demands.

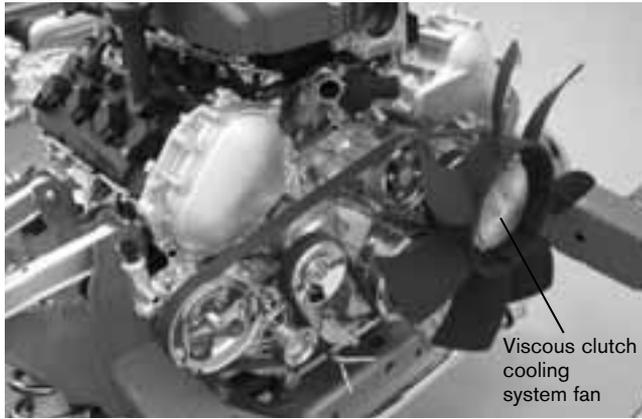


- The forged steel crankshaft adds durability, and the 6-bolt main bearing caps provide greater strength and rigidity than conventional 2- or 4-bolt versions.

Power and efficiency

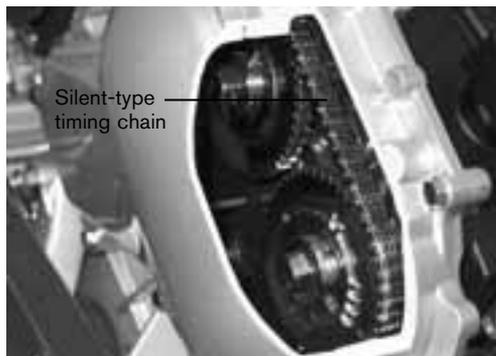
The VK56 engine incorporates the following technologies that increase its efficiency and power.

- Its double overhead cam design provides precise, efficient control of the valves for enhanced performance.
- The low-restriction exhaust reduces back pressure for improved power output and enhanced torque at all rpm.



- The electronic drive-by-wire system delivers more precise throttle response than a mechanical cable and allows the engine to rapidly alter its power based on demands from Vehicle Dynamic Control (VDC) and/or Traction Control System (TCS) (if equipped).
- Microfinished crankshaft and camshafts reduce heat (friction) and vibration, improving engine efficiency, power, and durability.
- A viscous clutch (see illustration) allows the cooling fan to operate at low speeds and disconnect at higher speeds when there is sufficient airflow through the radiator. This allows the engine to operate more efficiently and helps reduce noise.
- Teflon^{®1}-coated pistons help reduce power losses due to friction, improving engine response and fuel efficiency.

Quiet operation



The silent-type camshaft timing chain is designed specifically so it meshes with its drive sprockets with a minimum amount of impact noise. Its single-stage design reduces weight, friction, and noise for improved throttle response.

Lightweight engine components allow engine speed to rise faster for improved response with less vibration. Lightweight components include an aluminum-alloy cylinder block,

¹ Teflon is a registered trademark of DuPont.

cylinder heads, and oil pan, as well as reduced-weight pistons, lightweight valve covers, and hollow camshafts.

Fail-safe feature

With the Engine Protection System, the ECM limits the throttle opening electronically if sensors detect engine overheating or low coolant level. Once coolant reaches the proper temperature, the engine returns to normal operation. Should the coolant temperature continue to rise, the ECM shuts the fuel off until the temperature cools to a safe level.

Machining and assembly

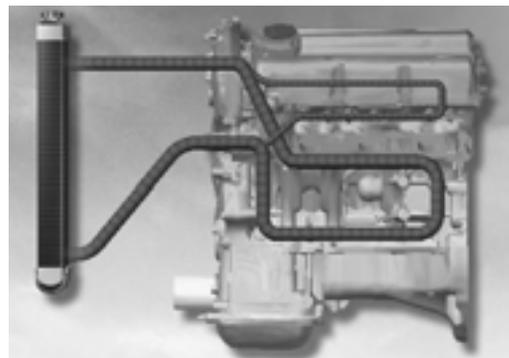
The QR25, VQ35, VQ40, and VK56 engines are machined and assembled at the 1-million-square-foot plant in Decherd, Tennessee. Machining is a highly automated process that includes more than 100 inspection points. The assembly process includes rigorous inspections and tests to ensure engine quality.

The ultimate assessment of each newly assembled engine is the hot-run test. Before it is installed in a vehicle, the engine is started and checked for leaks, noise, or any other faults. This hot-run test and all of the standard quality assurance tests are performed on every Nissan/Infiniti engine, regardless of where it is assembled.

ADVANCED ENGINE TECHNOLOGIES

Automotive engineers are continually challenged to produce engines that are more fuel-efficient and less polluting, yet still produce exceptional performance. Nissan and Infiniti engineers have responded by bringing several advanced technologies to their vehicles.

2-stage cooling system (QR25, VQ35, VQ40, VK45, VK56 engines)



In a conventional engine cooling system, water flows from the radiator to the water pump to the cylinder block and then to the cylinder heads.

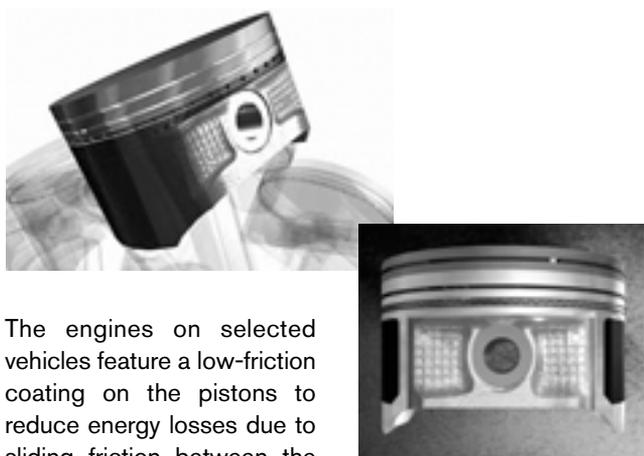
In the 2-stage cooling system, however, water is supplied to the block and heads separately, because these areas

require different quantities of coolant to control their temperatures (high temperatures at the cylinder heads with relatively lower temperatures at the cylinder block). In effect, this provides the top and bottom halves of the engine with separate cooling systems.

The main benefits of the 2-stage cooling system are faster warm-up (both the engine and heater), lower hydrocarbon emissions, and increased fuel efficiency.

Added benefits of the 2-stage cooling system include its smaller size, which contributes to overall engine compactness; its smaller total coolant capacity; and its reliability (the VQ's water pump is driven by the engine's timing chain, and is mounted inside the timing case).

Coated pistons



The engines on selected vehicles feature a low-friction coating on the pistons to reduce energy losses due to sliding friction between the pistons and cylinder walls.

Some engines have pistons coated with molybdenum. The peculiar shape of the molybdenum molecules helps reduce friction by "filling in" microscopic surface irregularities on the piston skirts, thus providing a smoother sliding surface for reduced friction.

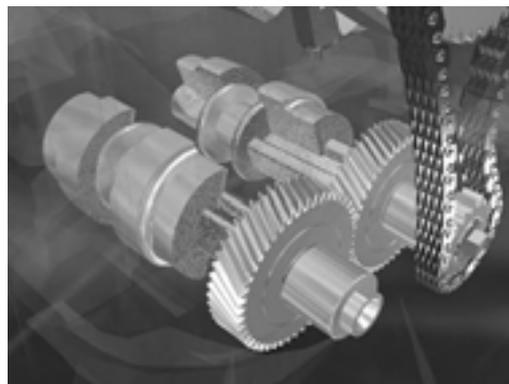
Molybdenum coatings have been used in high-performance engines for decades, and molybdenum is also used as an anti-vibration coating on the gears in gas turbine aircraft engines.

Other vehicles have pistons coated with Teflon®, which provides similar friction-reducing benefits.

Compact engine balancer system (QR25 engine)

Engine vibration becomes noise in the passenger compartment. It is inherent in in-line 4-cylinder engines that are larger than two liters.

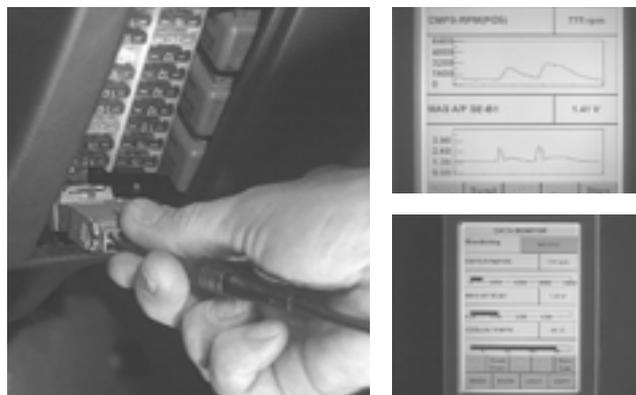
To compensate for this vibration, the QR25 4-cylinder engine uses a separate chain-driven compact engine balancer that is ideally located to generate force in the opposite direction of the vibration, reducing noise in the passenger compartment.



The engine balancer is very compact, mounted low, and located inside the engine's oil pan so it does not increase engine size or add much weight. In contrast, some belt-driven competitive engine balancer systems are bulkier and heavier to compensate for their less-than-ideal location inside the engine.

CONSULT-II

CONSULT stands for Nissan's Computerized On-board System Universal Tester. This system is a handheld computer, called the Nissan CONSULT Diagnostic Tool. CONSULT has been used by Nissan and Infiniti service technicians since 1989 to detect, diagnose, and correct problems. The original CONSULT is compatible with 1989–1999 vehicles.



CONSULT-II is a more powerful version of CONSULT that is designed to troubleshoot more systems on the vehicle and to be more efficient to use. The new tester employs a 32-bit Motorola Power PC computer — similar to the central processing unit found in the most recent Macintosh computers. CONSULT-II carries both a Nissan proprietary communications protocol (found in the original CONSULT) as well as the new EPA-dictated protocol for standardized OBD II systems.

Beginning with 2000 model year vehicles, the new protocol allows reprogramming the engine ECCS software in the service department. For example, if a customer

experiences a malfunction light relating to emission control, the problem may be in the software instead of the control unit. Reprogramming the software with CONSULT-II means the problem can be solved without the need to physically remove and replace the control unit. New diagnostic software also expands the list of CONSULT-compatible systems, including:

- Body Control Module (BCM)
- Vehicle Security System (VSS)
- Controller Area Network (CAN)
- Vehicle Dynamic Control (VDC)
- Intelligent Cruise Control (ICC)
- Infiniti Torque Demand (ITD)
- Electronic Brake force Distribution (EBD)
- Vehicle Immobilizer System
- Xtronic CVT (Continuously Variable Transmission)

When plugged into the data link connector located in a Nissan or Infiniti vehicle, the CONSULT-II system can read the signals being sent to and from individual components, such as:

- Engine (ECCS)
- On-Board Diagnostic System (OBD II)
- Automatic transmission
- Anti-lock Braking System (ABS)
- Traction Control System (TCS)
- Electronically controlled engine mounts
- Cruise control
- Engine-speed/vehicle-speed-sensitive power steering
- Air bag sensors
- Vehicle Immobilizer System

It can detect most problems with these systems. The computer can even simulate actual driving and atmospheric conditions, thus reducing diagnostic time. And because of its small size and light weight, CONSULT-II can be used on a road test.

CONSULT-II is a sophisticated tool that assists service technicians in a variety of ways. For example:

- The work support mode enables technicians to adjust some components faster and more accurately than by hand.
- The self-diagnosis mode searches for large failures in ECCS circuits (such as open or short circuits).
- The function test mode guides technicians through diagnostic procedures to test individual components and circuits.
- The data monitor mode collects data while the technician

duplicates conditions that cause a malfunction, and then prints out data in graph form for comparative analysis.

- The freeze frame mode stores data for later analysis about the driving conditions at the moment a malfunction is detected. This mode is particularly useful for discovering the cause of intermittent problems, because the CONSULT-II unit can be left in the vehicle and programmed to “wake up” when the intermittent problem occurs.

Due to vehicle wiring changes, the original CONSULT is not compatible with model year 2000 and later vehicles, but continues to be a useful tool for 1989–1999 vehicles. CONSULT-II, on the other hand, will support all Nissan and Infiniti vehicles and systems back to 1989.

Double platinum-tipped spark plugs

Spark plugs initiate combustion by igniting the air/fuel mixture in the engine's cylinders. Naturally, after igniting several hundred million times, spark plug electrodes will eventually wear down.

In the past, conventional spark plugs generally had a service interval of 30,000 miles. Engineers determined, however, that adding platinum to one or both electrode surfaces dramatically increases the service life of spark plugs.

- Single platinum-tipped spark plugs have a replacement interval of 60,000 miles.
- Double platinum-tipped spark plugs have a 105,000-mile replacement interval.

Since the 2000 model year, all Nissan and Infiniti vehicles use double platinum-tipped spark plugs, which means all Nissan and Infiniti vehicles have 105,000-mile tune-up-free engines.

In addition, all current Nissan and Infiniti vehicles have platinum-tipped spark plugs with a “long-reach” thread section that allows more efficient cooling of the cylinder head(s) and improves control of pre-ignition, or “knocking.”

Electronic Concentrated Control System (ECCS)

Every new passenger vehicle available in North America benefits from some type of electronic engine management system. In all Nissan and Infiniti vehicles, this engine management system is called the Electronic Concentrated Control System, or ECCS, and it provides a link among the electronic sequential fuel injection, ignition systems, and the engine. On all vehicles, ECCS also links the engine and the Transmission Control Module (TCM). The computer that manages ECCS is called the Engine Control Module (ECM).

The ECCS monitors many environmental and driving parameters, and then tailors engine operation continuously to optimize fuel economy, performance, and exhaust emissions.



It tailors the engine operation by controlling fuel injection amount and timing, plus ignition timing. ECCS monitors:

- Crankshaft position sensor
- Mass airflow sensor
- Engine intake air temperature sensor
- Engine coolant temperature sensor
- Oxygen sensors
- Ignition switch
- Starter switch
- Throttle position sensor
- Air conditioner switch
- Neutral position switch (on vehicles with a manual transmission), and the inhibitor switch (on vehicles with an automatic transmission)
- Vehicle speed sensor
- Power steering oil pressure switch
- Battery voltage
- Detonation sensor(s)
- Air pressure (barometric) sensor
- Fuel pump
- CONSULT sensors
- OBD II sensors

The ECCS has the ability to adjust air/fuel mix (or ratio) in response to changes in atmospheric conditions, which helps ensure driveability even at high altitudes. It also has a “self-learning” function that allows it to adjust engine response based on the driving habits of individual owners. The random access memory function of the Engine Control Module (ECM) stores information about an individual’s driving style (whether the driver tends to accelerate gently or aggressively, for example). It uses this information to continually adjust fuel injection and ignition timing for optimum driveability for each individual driver.

Finally, it has a “fail-safe” mode that enables the engine to function in a reduced capacity in case of failure by any one

of four critical components (coolant temperature sensor, crankshaft angle sensor, throttle position sensor, or airflow meter), helping the driver to reach a safe destination.

If you’d like a more detailed explanation of ECCS, take advantage of the experience and resources available to you in your Dealership’s service department.

Electronic drive-by-wire system

The electronic drive-by-wire system opens and closes the throttle electronically instead of using a conventional cable. It provides coordinated communication among the vehicle’s major drivetrain components to help maximize engine efficiency and improve performance. It is an integrated system that uses the Electronic Concentrated Control System (ECCS) to monitor and adjust various functions within the vehicle.

As part of this system, an electronically controlled throttle eliminates the conventional throttle cable found on some other vehicles, and provides more precise throttle control. When the driver presses the accelerator pedal, a signal is sent to the Engine Control Module (ECM), which instantly determines how much to open the throttle based on input from other components in the system.

Depending on the vehicle and feature availability, the electronic drive-by-wire system is integrated with the Transmission Control Module (TCM), Infiniti Torque Demand (ITD), Traction Control System (TCS), Intelligent Cruise Control (ICC), and Vehicle Dynamic Control (VDC).

If the electronic drive-by-wire system malfunctions, the throttle continues to operate in a slower fail-safe mode, which is controlled by the ECM.

The electronic drive-by-wire system provides more precise throttle control and better fuel economy than mechanical cable throttle systems.

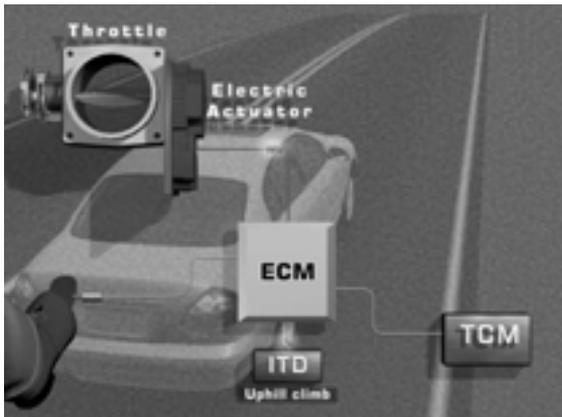
Engine emissions

There are two types of emission control devices on all Nissan and Infiniti vehicles: engine control and fuel vapor recovery.

- A sophisticated computer system constantly monitors, controls, and adjusts the engine thousands of times each second to achieve the lowest possible emissions without sacrificing engine performance or fuel economy. (See “On-Board Diagnostic System” on page 14.)
- All fuel vapors are collected in the fuel tank where they are transferred to the intake manifold and burned in the engine’s combustion chambers.

Both of these systems work invisibly and help reduce the vehicle’s impact on the environment.

Infiniti Torque Demand (ITD)



Infiniti Torque Demand (ITD) automatically maintains vehicle speed when driving uphill. The driver does not have to continuously press and release the accelerator pedal to maintain a set speed. Infiniti Torque Demand adjusts engine power and the transmission's shift schedule to meet driving conditions.

EXPLAINING | ITD

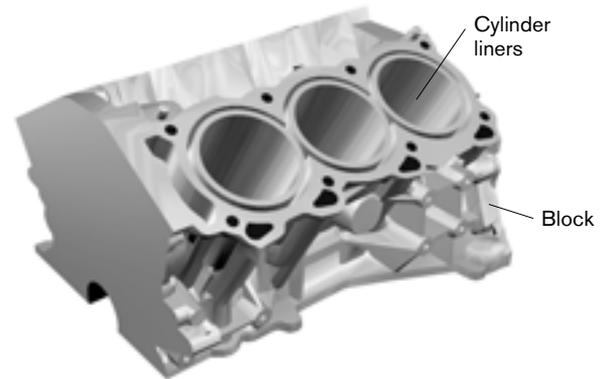
Just as your thermostat at home senses the demand for heating or cooling in your house, Infiniti Torque Demand senses the demand for greater acceleration in the vehicle. When your house gets cold, the thermostat senses the need for heat and automatically turns on the furnace. In a similar manner, when driving uphill, ITD senses the need for additional power and automatically compensates for different driving conditions.

Lightweight engine components

Small reductions in the weight of individual components can have a major cumulative effect in reducing overall engine weight. But reducing the weight of engine components does more than just lighten the weight of the engine. It also reduces energy losses, allowing engine speed to rise faster for improved response with less vibration. Lightweight engine components play a significant role in many Nissan and Infiniti engines (current models), including:

- QG18 4-cylinder
- SR20 4-cylinder (Pre-owned)
- QR25 4-cylinder
- VG33 V6 (Pre-owned)
- VQ Series V6
- VK45 V8
- VK56 V8

Aluminum-alloy engine block with cast iron cylinder liners (sleeves)



Engine

- Short stroke/compact design (VG33, VQ Series)
- High-pressure die-cast aluminum-alloy block (SR20, QR25, VQ Series, VK45, VK56)
- Aluminum-alloy oil pan (SR20, QR25, VQ Series, VK45, VK56)
- Triple-forged crankshaft (VQ Series, VK45, VK56)
- Resin valve covers and intake manifolds (QG18, QR25, VK45, VK56)
- Thinner-sectioned piston rings (All engines)

Main moving parts

- Lightweight pistons (QR25, VQ Series, VK45, VK56)
- Lightweight connecting rods (VQ Series, VK45)
- Compact crankshaft (VQ Series, VK45)
- Titanium intake and exhaust valves (VK45)

Valvetrain

- Direct-acting camshaft mechanism (to open and close valves) (QG18, QR25, VQ Series, VK45, VK56)
- Compact cylinder heads (QG18, VQ Series, VK45)
- Hollow camshafts with smaller journal diameter (QR25, VQ Series, VK45, VK56)
- Camshaft drive system also used to operate the water pump (VQ Series)
- Microfinished valve adjustment shims (High-output versions of VQ Series) (Pre-owned)
- Microfinished 1-piece camshaft followers (VQ Series, VK Series)

Liquid-cooled engine oil cooler

The liquid-cooled engine oil cooler uses engine coolant flow to maintain consistent engine oil temperature. Using engine coolant has two benefits:

- It brings the oil up to correct operating temperature faster.

- It maintains correct temperature because coolant is at a fixed temperature.

Liquid-filled engine mounts

The way the engine is mounted to the frame or body structure of the vehicle affects the amount of noise, vibration, and harshness that is transmitted to the passenger compartment. Almost all Nissan and Infiniti vehicles use one or more mounts that are filled with a viscous liquid. These liquid-filled mounts absorb engine noise, vibration, and harshness more effectively than traditional solid rubber mounts.

Electronically controlled liquid-filled engine mounts



Some Nissan and Infiniti front-wheel-drive vehicles also have electronically controlled front and rear liquid-filled engine mounts. The electronically controlled engine mounts take the advantage of fluid technology a step further than normal liquid-filled engine mounts. A 2-chamber mount works in conjunction with the engine's Engine Control Module (ECM) to vary the volume of fluid in the mount, based on engine rpm. It does this by opening or closing a valve between two chambers inside the engine mount. At low rpm, the volume of fluid is increased to provide maximum damping. At higher rpm the volume is decreased, providing the firmness needed for optimum feedback to the driver. The electronically controlled engine mounts are CONSULT-compatible.

Floating membrane engine mounts

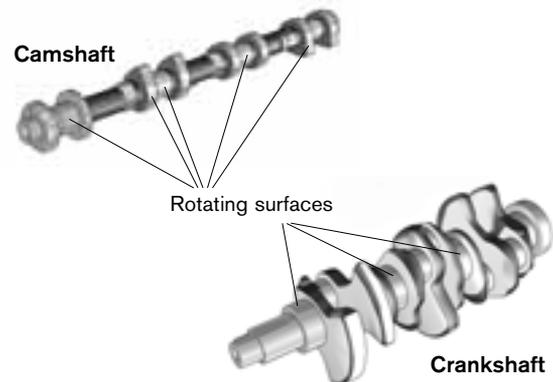
Selected vehicles have liquid-filled engine mounts that include a floating membrane that provides benefits similar to electronically controlled liquid-filled engine mounts. The membrane varies damping to improve NVH absorption.

Microfinishing

Microfinishing is a separate manufacturing process used to put an ultra-smooth finish on the rotating surfaces of components such as crankshafts, camshafts, and camshaft followers.

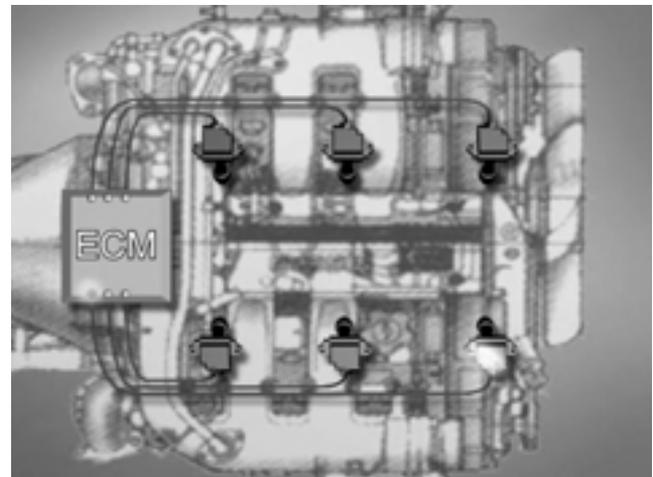
Typically, crankshaft and camshaft surfaces are ground and polished to reduce friction, so the shafts turn with a limited

amount of resistance. Microfinishing is a separate and extra-cost process that is even more effective in eliminating minute irregularities, enabling shafts to turn with the least possible resistance.



Less friction means reduced heat and vibration, which in turn improves engine efficiency, power, and durability. Less friction also allows engine rpm to rise faster for improved response with less vibration. Finally, microfinishing helps maintain correct valve clearances, eliminating scheduled inspections and maintenance.

Nissan Direct Ignition System (NDIS)



The ignition system provides the high voltage spark that ignites the air and fuel mixture in the engine's combustion chamber. A traditional ignition system includes a single high-voltage coil and a mechanical distributor that distributes power from the coil to the spark plugs through high-tension/voltage wires.

The Nissan Direct Ignition System (NDIS) eliminates the need for the traditional distributor and high-tension wires. Instead, NDIS provides a separate ignition coil for each cylinder, with one coil placed directly over each spark plug. Each coil is precisely controlled by a separate power

transistor actuated by the ECCS (Electronic Concentrated Control System).

As a result, NDIS enhances performance by providing consistent and reliable high voltage to the spark plugs. At the same time, maintenance expenses are reduced because there is no need for spark plug wire inspection and replacement during the vehicle's service life.

On-Board Diagnostic System (OBD II)

The On-Board Diagnostic System (OBD II) monitors the operating condition of the vehicle's emission control system. In effect, it is the continuous quality inspector for the Electronic Concentrated Control System (ECCS). It monitors all sensors of the ECCS and, as a final check, it monitors the oxygen sensors that measure the exhaust gases before and after the catalytic converter to verify compliance with emission standards. A 29-item function test of all sensors and actuators for the system is conducted at the plant as part of the factory inspection process before each vehicle receives final approval.

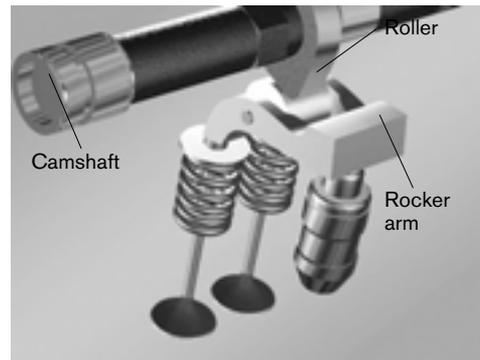
OBD II illuminates a "Service Engine Soon" light in the event of an engine malfunction that will increase vehicle emissions. (On vehicles with electronically controlled automatic transmissions, it also detects malfunctions in the automatic transmission that will affect emissions.) The system records component and system deterioration that affects emissions. It stores this data in the Engine Control Module (ECM) which can be accessed with CONSULT-II.

OBD II uses more sensors and actuators than previous on-board diagnostic systems, making it more sensitive to emissions problems. Even though the "Service Engine Soon" warning light illuminates if the system detects an emissions incident, the vehicle can still be driven to the Dealership for diagnosis and/or repair of the emissions system.

One simple but common problem that can cause the "Service Engine Soon" light to illuminate is a loose fuel cap. A fuel cap that has not been properly tightened can sometimes indicate a leak in the vehicle's gasoline vapor recovery system. Properly tightening the gas cap may solve the problem. As a precaution, tell your customers that when they replace the fuel cap after filling the tank with gas, they should always tighten the fuel cap until they hear it click.

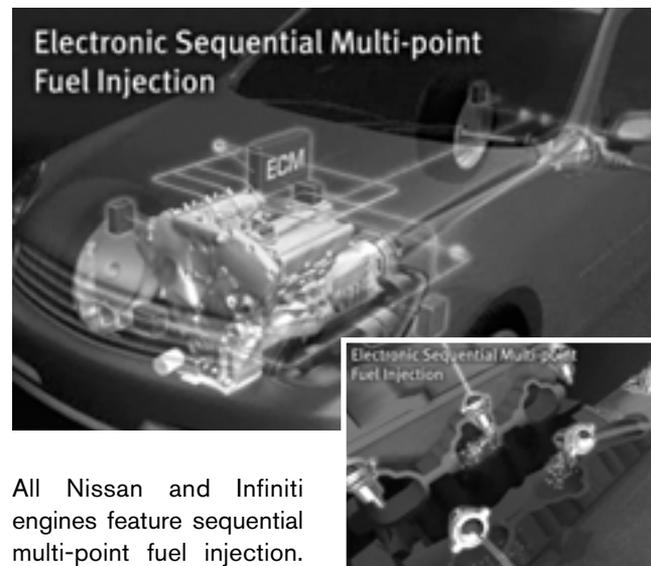
Note: *If you notice that this warning light is lit during your inspection of a vehicle before delivery to your customer, make sure that the service department diagnoses and repairs the problem, rather than merely turning off the warning light. (If the proper diagnosis and repair procedure is not followed, the warning light will go on again after the customer leaves the Dealership, which can reduce customer confidence in the vehicle and their level of satisfaction with you.)*

Roller-type rocker arms (Pre-owned)



The 2.0-liter double overhead cam 4-cylinder (SR20) engine uses roller-type rocker arms. One camshaft lobe actuates two valves via a Y-shaped roller-type rocker arm. The rolling action reduces friction between the camshafts and valves, which helps improve throttle response and fuel economy.

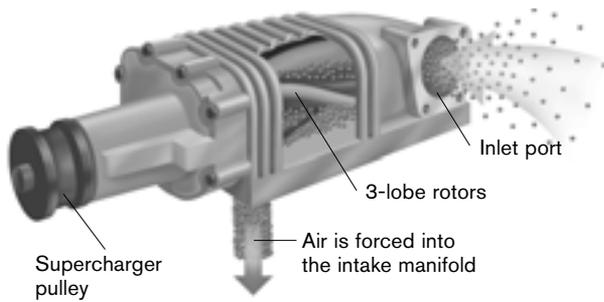
Sequential multi-point fuel injection



All Nissan and Infiniti engines feature sequential multi-point fuel injection. "Sequential" means the air/fuel mixture is injected into the cylinder in the precise quantity and at the exact time in relation to valve timing and piston position. This enhances overall driveability and, especially, hot and cold starting capability. "Multi-point" means each cylinder has its own injector for an efficient and precise delivery of the air/fuel mixture. The sequential multi-point fuel injection system provides optimum power under all driving conditions, and this super-precise control of the air-fuel ratio produces cleaner exhaust.

The fuel injection systems on some competitors still use a single injector for the entire engine, or use multi-point injectors that do not time the injection of fuel into the cylinders.

Superchargers (Pre-owned)



The basic concept of a supercharger is to force extra air into the intake manifold, mixing it with an appropriate amount of fuel, to create a more powerful combustion stroke than in a normally aspirated engine. The more power created during combustion, the more power generated by the engine. The supercharger provides additional boost at all engine speeds.

Key benefits of the supercharger include immediate throttle response, increased horsepower and torque across the complete engine operating range, and a relatively small effect on fuel economy (less than 10%).

Supercharger vs. turbocharger

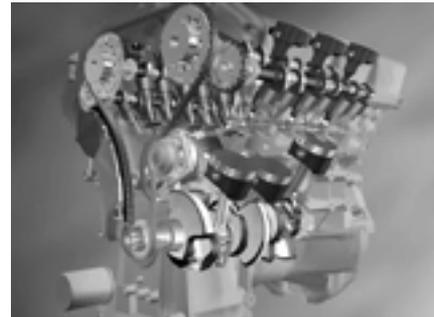
Superchargers and turbochargers both pump extra air into the engine. A supercharger, however, is connected directly to the engine's crankshaft by a belt (with a 105,000-mile service replacement interval). The positive connection yields instant response. In contrast, exhaust gases drive a turbocharger. The turbo must overcome its own inertia and spin up to speed as the flow of exhaust gas increases. This can result in a momentary delay in throttle response or "turbo lag." The Nissan supercharger also has a self-contained, sealed-for-life lubrication system, while a turbocharger requires engine oil constantly circulating through it.

Factory-installed vs. aftermarket

Nissan's factory-installed supercharger is covered by Nissan's 5-year/60,000-mile powertrain coverage. Aftermarket supercharger kits do not provide factory warranty coverage, and in some cases may invalidate factory warranty coverage.

Note: *Premium fuel is recommended for Nissan supercharged engines. Although lower-grade fuel can be used, the engine's knock sensor detects regular or mid-grade fuel. It then retards ignition timing and opens a bypass valve so the engine does not receive any boost from the supercharger. Because a supercharged V6 engine has a lower compression ratio than the normally aspirated V6, the result will be a decrease in performance compared to non-supercharged V6 models.*

Timing-chain- and timing-belt-driven camshafts

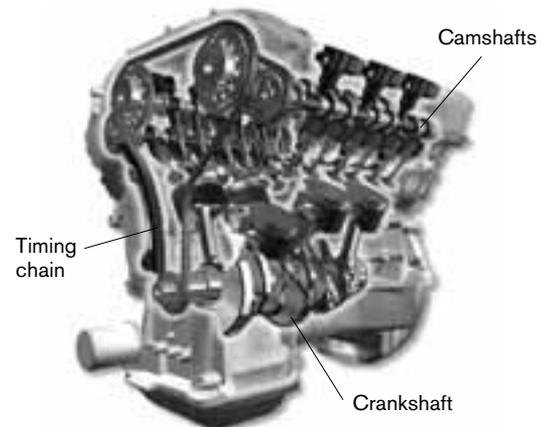


In overhead cam engines, the camshafts rotate to open and close intake and exhaust valves. The vehicle's timing chain(s) or timing belt(s) provides the means to rotate the camshafts.

Timing-chain-driven camshafts

All current Nissan and Infiniti engines use timing-chain-driven camshafts. Timing chains provide more precise and reliable actuation of the camshafts. Unlike a timing belt, a timing chain does not require maintenance inspections or replacement for the service life of the engine.

All current Nissan and Infiniti engines have silent-type camshaft timing chains that are designed specifically to reduce engine noise. Some engines have single-stage camshaft timing chains that are more compact than a double-stage camshaft timing chain. The single-stage design also eliminates the need for a second timing chain and/or an idler-gear pulley. It reduces weight and friction for less noise and enhanced throttle response.



The VQ V6 engines also use the timing chain to drive the water pump, which is located inside the engine's timing case. The use of the timing chain to operate the water pump allows for precise delivery of coolant, because the possibility of engine accessory belt slippage is eliminated. This allows for the use of a smaller volume of coolant and a smaller pump, which in turn helps reduce the overall

engine size. In addition, the water pump uses long-life bearings and seals to help ensure that the pump lasts as long as the engine.

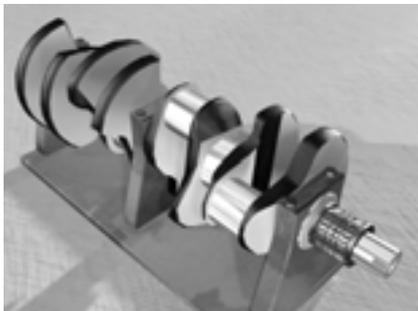
EXPLAINING | A TIMING CHAIN

Compare a rubber band and a chain made of paper clips. The rubber band stretches and the paper clip chain doesn't. Over time, a timing belt also stretches (like a rubber band) and eventually needs to be replaced. It can break or slip and create serious damage to the engine. A timing chain is far less likely to break (similar to a paper clip chain).

Timing-belt-driven camshafts (Pre-owned)

Although the VG33 V6 engine uses a timing belt to actuate the camshafts, the belt has a 105,000-mile maintenance interval regardless of the maintenance schedule. On some competitive vehicles, the timing belt(s) must be serviced every 60,000 miles.

Triple-forged crankshaft

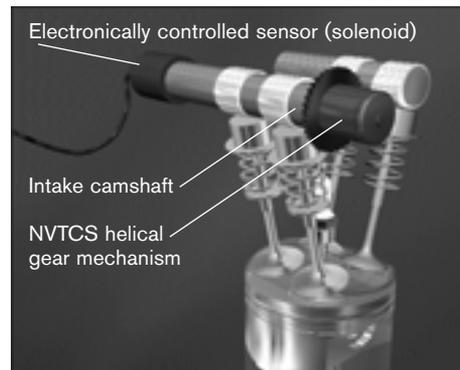


A crankshaft is forged by forcing molten metal into a mold. In contrast, a crankshaft that is cast relies on gravity for the molten metal to fill the mold. Crankshafts for the VQ and VK engines use a triple-forging process, which means the crankshaft is rotated at 120° intervals during the forging process. With this process, the density of the metal throughout the molding can be made more uniform, and microscopic cavities in the forging can be eliminated.

Triple-forged crankshafts have optimum stiffness, yet are lighter and more compact than a conventionally cast crankshaft. The result is outstanding durability and improved throttle response.

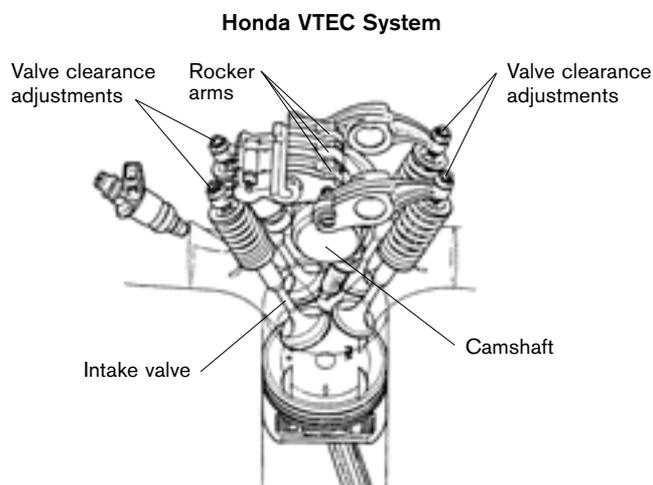
Variable valve timing

Variable valve timing helps the engine deliver remarkable power at high speeds and still run smoothly and efficiently at low engine speeds. Several pre-owned Nissan and



Infiniti vehicles use Nissan Valve Timing Control System (NVTCS), while most current Nissan and Infiniti vehicles have Continuously Variable Valve Timing Control System (CVTCS).

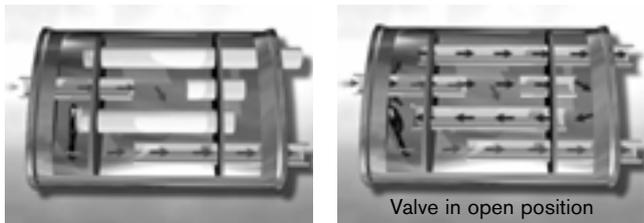
- NVTCS varies valve timing depending on whether engine speed is low or high. Valve timing changes at fixed intervals. NVTCS is similar to Honda's highly publicized VTEC (Variable Valve Timing and Lift Electronic Control System), but NVTCS is simpler, quieter, and requires no maintenance. VTEC uses a series of traditional rocker arms and differently profiled camshaft lobes to externally actuate the valves at different rpm, hence variable valve timing. The system is more complex and requires periodic inspection and adjustment of clearances between the rocker arms and camshafts, which can increase operating expense.



- The more advanced CVTCS varies valve timing continuously, depending on engine rpm and intake manifold length, or intake flow. The advantage of CVTCS is that while valve timing that occurs at fixed intervals produces its best power and fuel economy in certain operating conditions, CVTCS provides optimum performance and efficiency in all operating conditions. Even if CVTCS malfunctions, the Engine Control Module (ECM) enters a fail-safe mode.

Variable-flow exhaust system

A variable-flow exhaust system contributes to the power output of certain Nissan and Infiniti engines. The variable-flow exhaust system improves engine horsepower at middle and high speeds by reducing exhaust pressure. It also reduces exhaust noise at low speeds.



On some QR and VQ engines, the system uses a special internal muffler flap valve — which uses high-temperature aerospace material for the valve spring — that opens and closes according to exhaust pressure inside the muffler.

- At low exhaust pressure, while idling, driving under light throttle conditions, or coasting, the muffler valve remains closed. Exhaust exits from one of the muffler's tailpipes.
- As the pressure becomes higher, the muffler valve opens and the exhaust gases flow through an internal bypass — reducing exhaust system pressure. Exhaust gases exit using both of the muffler's tailpipes. The valve starts opening at approximately 2000 rpm and is always open at wide-open throttle.

On some VK45 engines, the same result is achieved with an electronically controlled valve in one of the exhaust pipes between the center and rear muffler. It varies exhaust back pressure at all rpm.

Note: *Several Nissan and Infiniti vehicles use a “free-flow” muffler that performs a similar function. The internal muffler design reduces back pressure, increases flow of exhaust gases, and improves exhaust sound.*

Variable-flow intake manifold

The variable-flow intake manifold improves the ability of the engine to “breathe in”; it promotes the efficient flow of air into the engine.

At low and medium engine rpm, the use of a long-length manifold enhances engine torque.

- On Altima, Maxima, Murano, Pathfinder, Xterra, Frontier, and I35 at higher rpm, a single throttle valve with six separate openings, or ports, inside the manifold rotates to shorten the path that air travels to the engine, increasing airflow — or volume.
- On the previous-generation Pathfinder and QX4 at higher rpm, six throttle valves attached to common

throttle shafts inside the manifold open simultaneously for increased airflow.

- On M45 and Q45 at higher rpm, eight throttle valves attached to common throttle shafts inside the manifold open simultaneously for increased airflow.

By varying the intake paths, the airflow is “tuned” to match the needs of the engine, enhancing its power output and driveability.

Vehicle Immobilizer System

The vehicle immobilizer system is a sophisticated theft-deterrent system that totally immobilizes the vehicle. The only way to move the car is to tow it. It's completely separate from the Vehicle Security System. No car is theft-proof, but the immobilizer is among the most advanced systems available to guard against car theft.

Vehicle immobilizer systems were first developed in Europe, where car theft is an even greater problem than it is in the United States. Responding to enormous pressure from the insurance industry in Europe, manufacturers developed vehicle immobilizers. Now Nissan and Infiniti have taken the technology a step further.



The immobilizer consists of four components:

- An ignition key that contains a hard coded computer microchip
- An antenna located in the ring around the ignition switch
- The Body Control Module (BCM)
- The Engine Control Module (ECM) of the Electronic Concentrated Control System (ECCS)

When the driver puts the key in the ignition to start the engine, the antenna around the ignition switch reads the microchip's ID code and sends it to the BCM. If the BCM verifies the key code, it sends another code to the ECM. If the ECM verifies this code, the engine starts. If either code is not verified, the engine will start momentarily and then die.

The immobilizer has several advantages over other theft-deterrent systems:

- The microchip has its own “fingerprint,” one of 65,000 unique ID codes. The key blade can be cut

mechanically into 23,000 different combinations. As a result, the chances of stealing a key and chip that would operate another car is virtually nil.

- Each time the ignition is turned off, the ECM generates a new code that will be used for the next start. This makes it even tougher for car thieves to steal the code.
- Because the system must interact with the ECM, it is difficult for a thief to bypass, such as by making a direct connection through the wiring harness.
- The ignition switch antenna reads the key's microchip code, so it does not require a battery.

A vehicle immobilizer is an ingenious and effective system. But it has some serious consequences that you and your customers need to be aware of.

- **If a key is lost**, the duplicate key that the driver received with the car will start the car, but only Nissan and Infiniti dealerships have the technology necessary to replace a lost key.
- **Immobilizer keys can be purchased ONLY as Genuine Nissan or Infiniti Replacement Parts. If an extra key is made or replaced, ALL keys must be reinitialized by a Nissan or Infiniti dealership so that the immobilizer system will recognize them.**
- **If the system is reset to accept the new key**, it will no longer respond to the old keys. Your dealership can reinitialize the old keys to match the new one. The system can recognize up to five keys.

The immobilizer is a sophisticated system. Make sure your customers understand it. Explaining it fully will help you ensure high customer satisfaction ratings. Failure to do so will undoubtedly hurt customer satisfaction. Take the time during vehicle delivery to explain how it works, and emphasize the importance of not misplacing or losing the key.

FOR ADDITIONAL INFORMATION

Every vehicle product guide lists the applicable engine features described in this chapter. Be sure to study each product guide to determine which features are available on each vehicle, and to review the advantage and benefit for each feature.

Resource materials that provide additional information about Nissan and Infiniti engines include the following:

NPLS/Sales Encyclopedia Video Library on DVD

- Engine Performance
- Nissan Engine, Drivetrain, and Electrical Systems
- Presenting Technical Features to Your Customers (“torque” and “timing chain”)
- Advanced Technologies (“immobilizer”)
- Nissan’s Advanced Engine Technologies
- Nissan’s Full-size Engine and Frame

ILS/Sales Encyclopedia Video Library on DVD

- VQ Engine
- Presenting Technical Features to Your Clients (“torque” and “timing chain”)
- Advanced Technologies (“immobilizer”)
- Infiniti’s Full-size Engine and Frame