2009 GM 3.6L V6 VVT DI (LLT)
3.6L V6 VVT DI (LLT) CAR ENGINE

- New base engine in the Saturn Outlook, Buick Enclave, GMC Acadia and Chevrolet Traverse.
- Continues as the base engine for the Cadillac STS, and optional in CTS
- Advanced multi-outlet fuel injectors for direct combustion chamber fuel injection
- High-pressure engine-driven fuel pump for multiple injection events
- Variable pressure, stainless steel fuel rail
- Advanced engine control module (ECM) for direct injection control
- RWD applications matched to 6L50 six-speed automatic transmission
- FWD applications matched to 6T75 six speed automatic transmission. It is an advanced transmission with clutch-to-clutch shift operation for front- and all-wheel drive vehicles. The transmission's six-gear configuration allows for a "steep" 4.48:1 first gear, which helps deliver exceptional launch feel, and a 0.74:1 overdrive sixth gear – the "tall" overdrive gear lowers rpm at high speeds, reducing noise and vibration. Also, the 6T75 offers automatic grade braking, shift stabilization and precise shift control.
- New direct injection engine keeps oil life monitoring system
- Cam phasing coupled with direct injection further reduces exhaust emissions
- Cast aluminum cylinder block and heads
- Double overhead cams with four valves per cylinder
- Cams driven by small-pitch, quiet chain
- Variable valve timing with four-cam phasing for precise intake and exhaust tuning
- High-power and high efficiency 11.3:1 compression ratio
- Cast aluminum polymer coated oil cooled pistons, with a fully floating wristpin
- Oil jets cool the pistons, while polymer-coated skirts reduce noise and friction
- Durable forged crankshaft, and precision sinter-forged connecting rods
- Cast aluminum structural oil pan and steel baffles stiffens block and reduces noise
- Electronic throttle control with advanced integrated cruise control
- Reliable coil-on-spark-plug ignition
- Optimally tuned exhaust manifolds with close-coupled catalytic converters
- Composite camshaft covers are fully isolated and reduce noise
- Numerous other noise, vibration and harshness controls
- Exclusive durability enhancements and minimal maintenance requirements
- Manufacturing techniques refined for exceptional quality and line efficiency

Full Description of New and Updated Features

New base engine in Saturn Outlook, Buick Enclave, GMC Acadia and Chevrolet Traverse.

The 3.6L VVT V6 DI engine is introduced as the base engine in the Saturn Outlook, Buick Enclave, GMC Acadia and Chevrolet Traverse and continues in the CTS as an optional engine. The Outlook, Enclave, Acadia and Traverse are powered by an efficient and powerful 3.6L DOHC V-6 with variable valve timing and new, direct-injection technology – introduction in the Traverse is the first application of the sophisticated engine in a Chevrolet. It is backed by a fuel-saving six-speed automatic transmission.

The powertrain combination delivers strong, on-demand performance – including 0-60 acceleration in approximately 8 seconds – and a projected 25 mpg in highway driving

Advanced multi-outlet fuel injectors for direct combustion chamber fuel injection
Conventional port-injected engines inject fuel upstream of the intake valve into the intake port, and this fuel and air mixture enters the combustion chamber when the intake valve opens. On the direct-injection 3.6-liter VVT DI, fuel is injected directly into the combustion chamber during the intake stroke, at which time only air flows through the intake system and into the combustion chamber when the intake valve opens. During the subsequent compression stroke, the fuel and air mixture now in the combustion chamber is ignited conventionally by the spark plug. As the fuel vaporizes in the cylinder, the air and fuel mixture is cooled. This enables the use of a higher compression ratio in the combustion chamber, which improves engine performance and efficiency. Less fuel is required to produce the equivalent horsepower, especially at normal cruising speeds, of a conventional port-injection combustion system. Also, the use of unique pistons with the direct-injection system helps reduced cold-start emissions by 25 percent.

The special injectors that inject fuel directly into the combustion chamber are located beneath the intake ports, which transfer only air. Because the ports are not used to mix the fuel and air, efficiency of the air flow is increased. In addition, the accuracy in which the fuel can be injected through special direct injectors is greater, and the end result is better fuel consumption at all throttle openings, and better mixture control which allows higher compression. The higher compression ratio also increases combustion efficiency over a conventionally injected engine. The special direct injectors have been developed to withstand the greater heat and pressure inside the combustion chamber, and also utilize multiple outlets for best injection control.

The increased combustion efficiency helps to reduce emissions, particularly during cold starts, which is when the bulk of emissions are created. In the example of the new 3.6L VVT DI, the compression ratio is increased to 11.3:1, aiding power output and fuel efficiency.

The 3.6-liter VVT DI is based on GM Powertrain's sophisticated 60-degree dual overhead cam (DOHC) V6 engine. It is the latest member of a growing family of GM Powertrain V6 engines developed for applications around the world, drawing on the best practices and creative expertise of GM technical centers in Australia, Germany, North America, and Sweden.

High-pressure engine-driven fuel pump for multiple injection events
To overcome the higher pressures inside the combustion chamber, as well as supply the multiple injection points of the direct injection nozzles, an engine-driven high-pressure pump supplies fuel to the injectors. This high-pressure pump feeds a high-strength fuel rail that feeds a continuously variable pressure fuel rail attached to the injectors. The high-pressure pump is supplied by a conventional fuel pump mounted in the fuel tank. The high-pressure pump can supply up to 1,740 psi (120 bar) of pressure, although it is dependent upon fuel demand by the engine. For example, at idle, the fuel system is regulated to about 508 psi (35 bar) and increases with demand. The high-pressure pump is mounted on the end of the cylinder head and is driven by the exhaust cam.

Advanced electronic control module (ECM) for direct injection control

The engine management system uses a new controller designed to drive the new high pressure fuel injectors and the fuel pump and provide software and calibration capability to fully utilize the capabilities of the hardware.

New applications matched to 6T75 six-speed automatic transmission
The 3.6 VVT V6 DI engine will be mated to the 6T75 six-speed automatic transmission. It is an advanced transmission with clutch-to-clutch shift operation for front- and all-wheel drive vehicles. The transmission's six-gear configuration allows for a "steep" 4.48:1 first gear, which helps deliver exceptional launch feel, and a 0.74:1 overdrive sixth gear – the "tall" overdrive gear lowers rpm at high speeds, reducing noise and vibration. Also, the 6T75 offers automatic grade braking, shift stabilization and precise shift control.

New direct injection engine keeps oil life monitoring system
It also allows a number of other customer-friendly features, including GM's industry-leading Oil Life System, which determines oil change intervals by actual operation parameters, rather than a preset mileage limit.

Cam phasing coupled with direct injection further reduces exhaust emissions
Cam phasing pays big dividends in reducing exhaust emissions by optimizing exhaust valve overlap and eliminating the need for a separate exhaust gas recirculation (EGR) system.

Overview

Introduced in the 2008 Saturn Outlook, Buick Enclave and GMC with the 3.6L V6 VVT (RPO LY7) was the first in GM Powertrain's global family of high-feature V6 engines, with four cam, four valves per cylinder configuration, with the cams driven by maintenance free silent primary chain drive. Its architecture was jointly developed by GM technical centers in Australia, Germany, the United States and Sweden. The 3.6L VVT DI V6 is based on the philosophy that a true family of global engines provides the best value and performance for the customer and the best return on investment for General Motors. It applies the most advanced automotive engine technology available, from state-of-the-art casting processes to full four-cam phasing to ultra-fast data processing and torque-based engine management. Since its launch, application has spread to an expanding number of vehicles for one primary reason. The 3.6L V6 VVT delivers a market-leading balance of good specific output, high torque over a broad rpm band, fuel economy, low emissions and first-rate noise, vibration and harshness control, with exclusive durability enhancing features and very low maintenance.

Like earlier versions of the high-feature V6, the 3.6-liter VVT DI employs four cam phasing to change the timing of valve operation as operating conditions such as rpm and engine load vary. The result is linear delivery of torque, with near-peak levels over a broad rpm range, and high specific output (maximum horsepower per liter of displacement) without sacrificing overall engine response and drivability. When combined, direct-injection and cam phasing technologies enable an unmatched combination of power, efficiency and low-emissions in gasoline V6 engines.

By closing the exhaust valves late at appropriate times, the cam phasers allow the engine to draw the desired amount of exhaust gas back into the combustion chamber, reducing unburned hydrocarbon emissions. The return of exhaust gases also decreases

peak temperatures which contributes to the reduction of oxides of nitrogen (NOx) emissions. In tandem with the dramatic 25-percent reduction in cold-start hydrocarbon emissions brought on by direct-injection, the 3.6-liter VVT DI V6 surpasses all emissions mandates, and does so without complex, weight-increasing emissions control systems such as EGR and air injection reaction (AIR).

The 3.6L V6 VVT DI has a new timing chain with a smaller pitch (7.7 mm compared to 9.5mm previously) and more links. The chain features an inverted tooth design. The smaller links engage at a lower impact speed, which decreases the noise generated. In conjunction with the new chain, the number of teeth on the sprockets is also increased, increasing the meshing frequency and further reducing noise and vibration.

The new timing chain is a running change that will occur in all of GM Powertain's V6 VVT engines through the course of the 2007 model year.

The oil pan on 3.6L V6 VVT DI is stiffened to improve powertrain rigidity and reduce vehicle vibration. The oil pan bolts to the transmission bell housing as well as the engine block, eliminating points of vibration. The oil pan provides another example of extensive efforts to minimize noise and vibration in the 3.6L V6 VVT. Cast aluminum dampens internal engine noise better than a conventional stamped steel pan. Structurally, it is considerably stiffer. The design was optimized with math-based analysis and carefully crafted curves in the pan's sides and bottom. These reduce the broadcasting or "drumming'' of noise created as oil flows through the crankcase, and they increase bending stiffness in the pan.

Like the conventionally injected 3.6L V6 VVT, the direct injection engine's block is cast with sand molds from A319 aluminum, with strong cast-in iron bore liners, six-bolt main bearing journals and inter-bay breather vents. Cylinder heads are also aluminum. Four valves per cylinder and a silent chain valvetrain contribute to both smoothness and high output. Four-cam phasing changes the timing of valve operation as operating conditions such as rpm and engine load vary. That means smooth, even torque delivery with high specific output (horsepower per liter of displacement) and excellent specific fuel consumption. Cam phasing also pays big dividends in reducing exhaust emissions. By closing the exhaust valves late at appropriate times, the cam phasers create an internal exhaust-gas recirculation system. The 3.8L V6 VVT meets all emissions mandates without complex, weight-increasing emissions control systems such as EGR and air injection reaction (AIR).

Aluminum-intensive construction extends to the pistons, which are manufactured as cast aluminum polymer coated oil cooled pistons, with a fully floating wristpin, and these pistons are considerably lighter than conventional pistons. Less weight means less reciprocating mass in the engine, which in turn means less inertia and greater operating efficiency. Moreover, the V6 VVT pistons are crafted with a number of features that enhance durability and reduce noise and harshness, including a high-tech polymer coating and floating wrist pins. The V6 VVT engine family was developed with pressure-actuated oil squirters in all applications. Three jet assemblies in the block hold a pair of oil-squirting nozzles that drench the underside of each piston and the surrounding cylinder wall with an extra layer of cooling, friction-reducing oil. The jets reduce piston temperature, which in turn allows the engine to produce more power without reducing long-term durability.

The crankshaft is a strong forged steel, and connecting rods are sinter forged, as are other 3.6L V6 VVT engines. The camshaft covers are fully isolated composite material covers that also perform as a noise barrier.

The 3.6L V6 VVT is managed the Bosch Motronic MED9 controller. This sophisticated electronic control module (ECM) uses a torque-based control strategy, which improves upon throttle-based management systems that rely exclusively on a throttle position sensor to manage electronic throttle control. Cruise control is also integrated into the electronic throttle control. The torque-based strategy measures the cam phasing positions and other operational parameters and translates that data into an ideal throttle position and engine output, based on the driver's positioning of the accelerator pedal. The ECM and a wide range of sensors allow failsafe systems, including ignition operation in the event of timing sensor failures. The ignition is individual coil-on-plug. The control software protects the V6 VVT from permanent damage in the event of complete coolant loss, and allows the engine to operate at reduced power for a prescribed distance sufficient for the driver to find service. It also allows a number of other customer-friendly features, including GM's industry-leading Oil Life System, which determines oil change intervals by actual operation parameters, rather than a preset mileage limit.

Low Maintenance

The cam drive and valvetrain components require no scheduled maintenance. A sophisticated cam-chain tensioner, high-quality cam phasing components and hydraulic lash adjusters are designed to ensure optimal valvetrain performance for the life of the engine with no adjustment. Even perishable components provide extended useful life. The spark plugs have dual-platinum electrodes and a service life of 100,000 miles without degradation in spark density. The plugs are easy to remove because they are located in the center of the cam cover. Extended life coolant retains its cooling and corrosion-inhibiting properties for 100,000 miles in normal use. The two accessory-drive belts were specified primarily for low-noise operation, yet they are manufactured of EPDM rather than neoprene and should last the same 100,000 miles before replacement is recommended. The oil filter requires only element replacement, and it's designed to virtually eliminate spillage when the cartridge is removed.

The 3.6L direct injection V6 VVT variant can be built with no significant casting changes to major components than the conventionally injected 3.6L VVT V6 built in St. Catharines, Ontario and Melbourne, Australia. Core engine components are designed to be common whenever possible. The basic V6 block is used in all vehicle applications, with differences limited to machining. While different vehicles require different oil pans, the pan's mating surfaces with the engine block and transmission are common in all cases, allowing considerable assembly efficiencies. The net result is streamlined procurement practices, fewer tool changes in the plant, shorter assembly time and improved quality for the customer.

Production of the 3.6L V6 VVT DI is located in Flint, Michigan and St. Catharines Engine plant in Ontario, Canada.