

2013 ENGINE

Engine Mechanical - 2.0L (LTG) or 2.5L (LCV) - Description and Operation - Malibu

DESCRIPTION AND OPERATION

TURBOCHARGER SYSTEM DESCRIPTION

Turbocharger Description and Operation

A turbocharger is a compressor that is used to increase the power output of an engine by increasing the mass of the oxygen and therefore the fuel entering the engine. A turbocharger is mounted either to the exhaust manifold or directly to the head. The turbine is driven by the energy generated by the flow of the exhaust gases. The turbine is connected by a shaft to the compressor which is mounted in the induction system of the engine. The centrifugal compressor blades compress the intake air above atmospheric pressure, thereby increasing the density of the air entering the engine.

The turbocharger incorporates a wastegate that is controlled by a pressure differential that is determined by the engine control module (ECM) by means of a PWM solenoid, in order to control boost pressure. A compressor recirculation valve, also controlled by the ECM, prevents compressor surging and damage by opening during sudden throttle closures. When the recirculation valve is opened it allows the air to recirculate back to the turbocharger compressor inlet.

The turbocharger is connected to the engine oiling system by a supply and drain pipe. Oil is required for the bearing system function and also serves to carry some heat from the turbocharger. There is a cooling system circuit in the turbocharger that further reduces operating temperatures and passively dissipates bearing housing heat away from the turbocharger on shut down.

Charge Air Cooler Description

The turbocharger engine system is supported by an air-to-air charge air cooler system, which uses fresh air drawn through a heat exchanger to reduce the temperature of the hot compressed air exiting the turbo compressor, prior to delivery to the engine combustion system. Inlet air temperature can be reduced by up to 100°C (180°F), enhancing performance because cooler air is denser in oxygen and promotes optimal combustion. The charge air cooler is connected to the turbocharger and to the throttle body by flexible ductwork that requires the use of special high torque fastening clamps. In order to prevent any type of air leak when servicing the ductwork, the tightening specifications, cleanliness and proper positioning of the clamps is critical, and must be strictly adhered to.

Benefits of Dual Cam Phasing

The camshafts of the Ecotec 2.0 liter turbocharged engine have camshaft position sensors and camshaft position actuators that the ECM uses to accurately control the continuously variable intake and exhaust valve timing. This allows the combustion process to be optimized by the ECM to increase the response of the turbocharger, providing a more immediate feeling of power to the driver.

Benefits of Gasoline Direct Injection

In the Ecotec 2.0 liter turbocharged engine, the fuel is introduced directly into the combustion chamber during the intake stroke. As the piston approaches top-dead center, the mixture is ignited by the spark plug, thereby giving the name spark ignition direct injection. Direct injection allows the mixture to be leaner, with less fuel and more air at full power, and allows a slightly higher compression ratio, resulting in improved fuel consumption at part and full throttle.

The fact that the fuel is injected after the exhaust valve closes allows particularly high valve overlap values in certain engine operating ranges. This enhances the turbocharger response time. This would not be possible in a port fuel injection engine due to the fact that unburned fuel would escape through the open exhaust valve.

Direct injection's precise fuel delivery enables more complete combustion which reduces emissions particularly on cold starts.

Electronic Vacuum Pump

The purpose of the electronic vacuum pump, if equipped, is to keep the vacuum in the brake booster at an acceptable level under various operating conditions. The ECM monitors the input signal from the brake booster pressure sensor. When the vacuum in the brake booster is not in an acceptable range the control module will command the relay ON that controls the vacuum pump.

Recommendations for Service

The turbocharger is designed so that it does not require any special maintenance, and inspection is limited to a few periodic procedures. To ensure that the turbocharger's lifetime corresponds to that of the engine, the following engine manufacturer's service instructions must be strictly adhered to:

- Oil and filter change intervals
- Air filter change intervals
- Engine coolant change intervals
- Ignition system maintenance
- Injection system maintenance

The following causes are responsible for a majority of all turbocharger failures:

- Misdiagnosis of a non-failed turbocharger
- Penetration of foreign bodies into the turbine or the compressor
- Dirt or contaminants in the oil
- Inadequate oil supply and/or pressure
- Clogged oil return
- Higher than normal exhaust gas temperatures due to improper operation of the following:
 - The ignition system
 - The fuel injection system
 - The exhaust system

These failures can be avoided by regular maintenance.

CRANKCASE VENTILATION SYSTEM DESCRIPTION (LTG)

General Description

A crankcase ventilation system is used to consume crankcase vapors in the combustion process instead of venting them to atmosphere. Fresh air from the intake system is supplied to the crankcase, mixed with blow by gases and then passed through a calibrated orifice into the intake manifold.

Operation

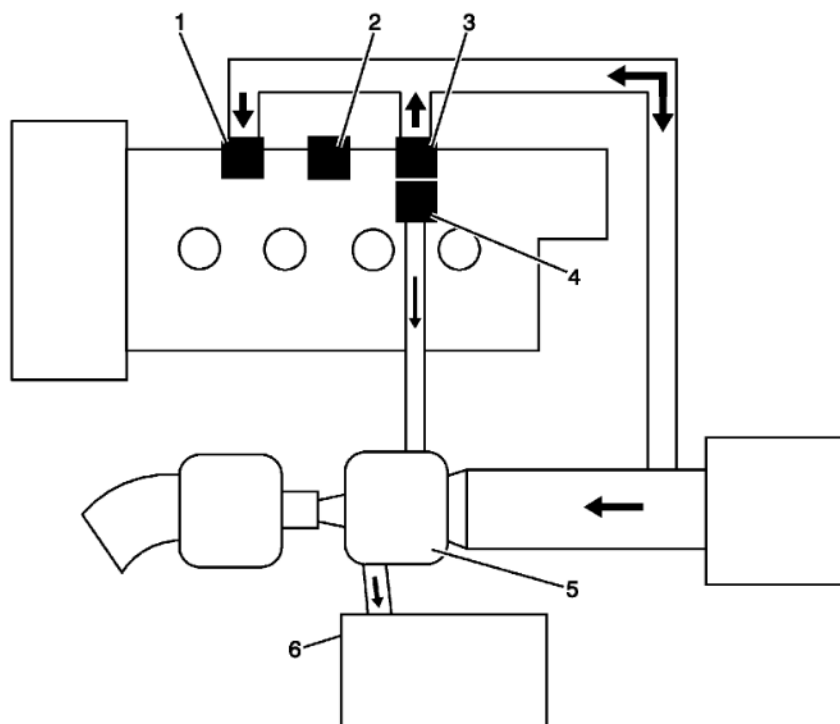


Fig. 1: Crankcase Ventilation System Components And Operational Diagram (LTG)
Courtesy of GENERAL MOTORS COMPANY

The primary control is through the positive crankcase ventilation (PCV) valve (2) which meters the flow at a rate depending on intake manifold vacuum. The PCV valve is an integral part of the camshaft cover. Fresh air is introduced to the engine through PVC (1) under normal operating conditions. If abnormal operating conditions occur, the system is designed to allow excessive amounts of blow by gases to back flow through the crankcase vent valve (3) into the intake system to be consumed by normal combustion.

Only on turbocharged engines, there is a one way valve (2) in the camshaft cover in order to prevent the crankcase from being pressurized by positive pressure in the intake manifold when the turbocharger is in operation. When the turbocharger is operational, the pressure in the intake manifold can exceed atmospheric pressure which, without the one way valve, would force oil and PCV gases out of the camshaft cover and into the induction system, via the hose to the camshaft cover. This can cause coking of the throttle body and induction system, and can reduce the efficiency of both combustion and the intercooler system, in normal operation the PCV gases are drawn into the air stream post intercooler (6). However, when the turbo is spooled up the turbo can become the vacuum source for the vent system. PVC#4 controls the max. flow so the crankcase

stays at a normal vacuum during normal operating conditions.

Results of Incorrect Operation

A plugged orifice may cause the following conditions:

- Rough idle
- Stalling or slow idle speed
- Oil leaks
- Sludge in engine

A leaking orifice may cause the following conditions:

- Rough idle
- Stalling
- High idle speed

CRANKCASE VENTILATION SYSTEM DESCRIPTION (LCV)

General Description

A crankcase ventilation system is used to consume crankcase vapors in the combustion process instead of venting them to atmosphere. Fresh air from the intake system is supplied to the crankcase, mixed with blow by gases and then passed through a calibrated orifice into the intake manifold.

Operation

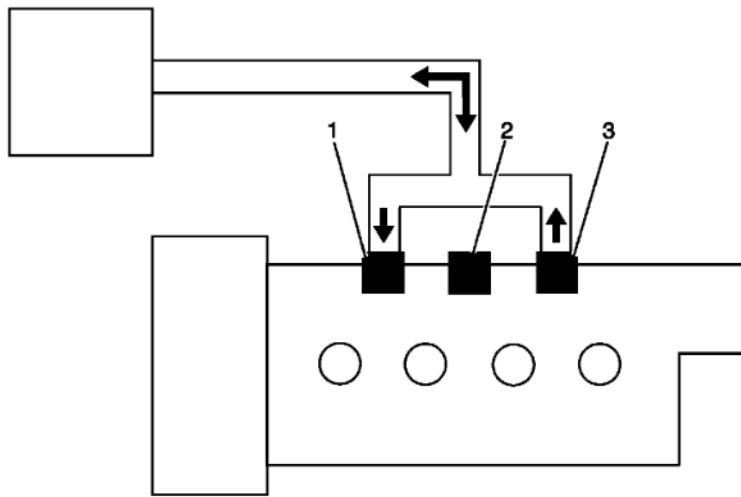


Fig. 2: Positive Crankcase Ventilation (PCV) Valve
 Courtesy of GENERAL MOTORS COMPANY

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ENGINE COMPONENT DESCRIPTION

Engine Description

Cylinder Block

The cylinder block is constructed of aluminum alloy by precision sand-casting. The block has 5 crankshaft bearings with the thrust bearing located on the second bearing from the front of the engine. The cylinder block incorporates a bedplate design that forms an upper and lower crankcase. This design promotes cylinder block rigidity and reduced noise and vibration.

Crankshaft

The crankshaft is cast nodular iron with 8 counterweights. The number 8 counterweight is also the ignition system reluctor wheel. The main bearing journals are cross-drilled, and the upper bearings are grooved. The crankshaft has a slip fit balance shaft drive sprocket. Number 2 main bearing is the thrust bearing. The crankshaft balancer is used to control torsional vibration.

Connecting Rod and Piston

The connecting rods are powdered metal. The connecting rod incorporates the floating piston pin. The pistons are cast aluminum. The piston rings are of a low tension type to reduce friction. The top compression ring is ductile steel with a molybdenum facing and phosphate coated sides. The second compression ring is gray iron. The oil ring is a 3-piece spring construction with chromium plating for applications without a turbocharger. For applications with turbocharger, the oil ring is a 3-piece spring construction with nitride plating.

Oil Pan

The oil pan is die cast aluminum. The oil pan includes an attachment to the transmission to provide additional structural support.

Balance Shaft Assembly

The dual balancer shaft assembly is mounted to the lower crankcase located within the oil pan. The balance shafts are driven by a single inverted tooth chain that also drives the oil pump. The chain is tensioned by a hydraulic tensioner that is supplied pressure by the engine oil pump. This design promotes the maximum effectiveness of the balance shaft system and reduces noise and vibration.

Cylinder Head

The cylinder head is a semi-permanent mold. Pressed-in powdered metal valve guides and valve seat insets are used. The cylinder head incorporates camshaft journals and camshaft caps. The fuel injection nozzle is located in the intake port. The high pressure fuel pump is mounted on intake side. The secondary air injection valve is mounted to the exhaust side of cylinder head for applications without a turbocharger.

Valves

There are 2 intake and 2 exhaust valves per cylinder. Rotators are used on all of the intake valves. The rotators are located at the bottom of the valve spring to reduce valve train reciprocating mass. Positive valve stem seals are used on all valves.

Camshaft

Two camshafts are used, one for all intake valves and high pressure fuel pump, the other for all exhaust valves and mechanical vacuum pump. The camshafts are cast iron.

Valve Lash Adjusters

The valve train uses a roller finger follower acted on by a hydraulic lash adjuster. The roller finger follower reduces friction and noise.

Camshaft Cover

The camshaft cover has a steel crankcase ventilation baffling incorporated. The camshaft cover has mounting locations for the ignition system.

Camshaft Drive

A roller chain is used for camshaft drive. There is a tensioner and active guide used on the slack side of the chain to control chain motion and noise. The chain drive promotes long valve train life and low maintenance.

Intake and Exhaust Manifold

The intake manifold is made of composite plastic. The exhaust manifold is cast iron. The intake manifold incorporates a distribution and control system for positive crankcase ventilation (PCV) gases. The exhaust manifold is a dual plane design that promotes good low end torque and performance.

Variable Flow Oil Pump Assembly

The oil pump assembly is located within the oil pan. The oil pump assembly is fastened directly to the rear of the balancer shaft assembly and is driven by the rotation of the balance shaft spline.

The oil pump assembly possesses variable flow capability which is made possible by a shift of the circular vane arrangement and the actuation of an oil control valve assembly guided by the ECM. The variable flow capability of the pump optimizes oil flow to the engine components when needed. During performance maneuvers and acceleration the oil pump operates in a steady high pressure state. However, during steady low load touring speeds on level terrain the oil pump operates in a steady low pressure state.

The ECM guided "on" and "off" actuation of the oil control valve assembly allows the chamber to be pressurized which takes the switch from high to low pressure mode. The high pressure state of the chamber compressing the spring and shifting the center of the circular vane arrangement nearer to that of the balancer drive shaft, decreasing the difference of the volume of oil contained between each vane. It is this small variation in volume which produces the steady low pressure flow. It is in this mode that the pump behaves as a smaller pump.

Advantages of variable flow oil pumping modes:

- The high performance steady pressure mode is where engine temperatures and friction are reduced

because the pump only delivers the oil that the engine requires.

- The low load touring steady pressure mode is where the volume of oil flow is reduced to even more efficient levels when engine requirements allow. This efficiency reduces the resistance on reciprocating component, allowing engine revolutions with less power resulting in fuel economy savings.

LUBRICATION DESCRIPTION

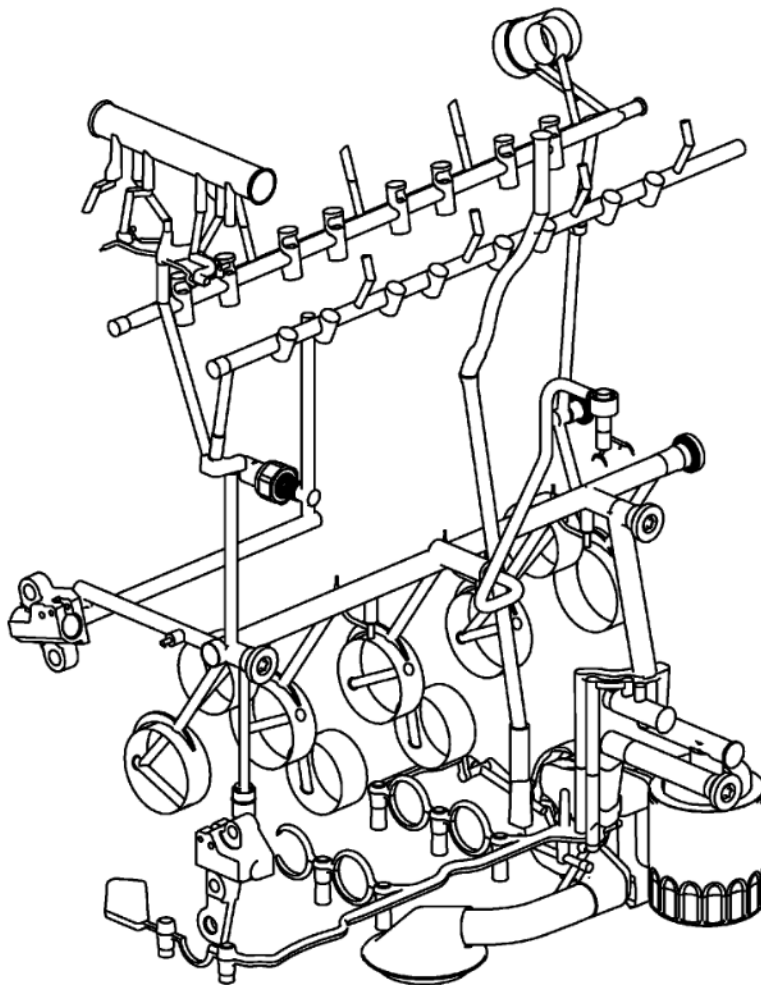


Fig. 3: Lubrication System

Courtesy of GENERAL MOTORS COMPANY

Oil is applied under pressure to the crankshaft, connecting rods, balance shaft assembly, camshaft bearing surfaces, rocker arms, valve lash adjusters and timing chain hydraulic tensioner. All other moving parts are lubricated by gravity flow or splash. Oil enters the oil pump through a fixed inlet screen. The oil pump is driven by the balancer shaft assembly's sprocket. The oil pump body is attached to the rear of balancer shaft assembly. The pressurized oil passes through the cylinder head assembly restrictor orifice into the cylinder head's OCV and routed through passages cast into the camshaft cover assembly to each camshaft feed gallery and camshaft drip rail. OCV actuates the 2-Step intake rocker arm assemblies to control valve travel. The oil filter is a metal canister type. A by-pass valve in the filter assembly allows continuous oil flow in case the oil filter should become restricted. Oil then enters the gallery where it is distributed to the balance shafts, crankshaft, camshafts

and camshaft timing chain oiler nozzle. The connecting rod bearings are oiled by constant oil flow passages through the crankshaft connecting the main journals to the rod journals. A groove around each upper main bearing furnishes oil to the drilled crankshaft passages. The pressurized oil passes through the cylinder head restrictor orifice into the cylinder head and then into each camshaft feed gallery. Cast passages feed each hydraulic element adjuster and drilled passages feed each camshaft bearing surface, rocker arm, and drip rail. An engine oil pressure switch or sensor is installed at the end. Oil returns to the oil pan through passages cast into the cylinder head. The timing chain lubrication drains directly into the oil pan.

CLEANLINESS AND CARE

An automobile engine is a combination of many machined, honed, polished, and lapped surfaces with tolerances that are measured in ten thousandths of an inch. When any internal engine parts are serviced, care and cleanliness are important. A liberal coating of engine oil should be applied to friction areas during assembly to protect and lubricate the surfaces during initial operation. Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas are part of the repair procedure. This is considered standard shop practice even if not specifically stated.

When valve train components are removed for service, they should be retained in order. At the time of installation, they should be installed in the same locations and with the same mating surfaces as when removed.

SEPARATING PARTS

NOTE:

- **Disassembly of the piston, press fit design piston pin, and connecting rod may create scoring or damage to the piston pin and piston pin bore. If the piston, pin, and connecting rod have been disassembled, replace the components as an assembly.**
- **Many internal engine components will develop specific wear patterns on their friction surfaces.**
- **When disassembling the engine, internal components MUST be separated, marked, or organized in a way to ensure installation to their original location and position.**

Separate, mark, or organize the following components:

- Piston and the piston pin
- Piston to the specific cylinder bore
- Piston rings to the piston
- Connecting rod to the crankshaft journal
- Connecting rod to the bearing cap

A paint stick or etching/engraving type tool are recommended. Stamping the connecting rod or cap near the bearing bore may affect component geometry.

- Crankshaft main and connecting rod bearings
- Camshaft and valve lash adjusters

- Valve lash adjusters, lash adjuster guides, pushrods and rocker arm assemblies
- Valve to the valve guide
- Valve spring and shim to the cylinder head location
- Engine block main bearing cap location and direction
- Oil pump drive and driven gears

REPLACING ENGINE GASKETS

Special Tools

EN-28410 Gasket Remover

For equivalent regional tools, refer to **Special Tools** .

Gasket Reuse and Applying Sealants

- Do not reuse any gasket unless specified.
- Gaskets that can be reused will be identified in the service procedure.
- Do not apply sealant to any gasket or sealing surface unless called out in the service information.

Separating Components

- Use a rubber mallet to separate components.
- Bump the part sideways to loosen the components.
- Bumping should be done at bends or reinforced areas to prevent distortion of parts.

Cleaning Gasket Surfaces

- Remove all gasket and sealing material from the part using the **EN-28410** remover or equivalent.
- Care must be used to avoid gouging or scraping the sealing surfaces.
- Do not use any other method or technique to remove sealant or gasket material from a part.
- Do not use abrasive pads, sand paper, or power tools to clean the gasket surfaces.
 - These methods of cleaning can cause damage to the component sealing surfaces.
 - Abrasive pads also produce a fine grit that the oil filter cannot remove from the oil.
 - This grit is abrasive and has been known to cause internal engine damage.

Assembling Components

- When assembling components, use only the sealant specified or equivalent in the service procedure.
- Sealing surfaces should be clean and free of debris or oil.
- Specific components such as crankshaft oil seals or valve stem oil seals may require lubrication during assembly.
- Components requiring lubrication will be identified in the service procedure.

- When applying sealant to a component, apply the amount specified in the service procedure.
- Do not allow the sealant to enter into any blind threaded holes, as it may prevent the bolt from clamping properly or cause component damage when tightened.
- Tighten bolts to specifications. Do not overtighten.

USE OF ROOM TEMPERATURE VULCANIZING (RTV) SEALANT

Room Temperature Vulcanizing sealant is specified for use. The correct sealer and amount must be used in the proper location to prevent oil leaks. Use only the specific sealer or the equivalent as recommended in the service procedure.

Room Temperature Vulcanizing (RTV) Sealer

- RTV sealant hardens when exposed to air. This type sealer is used where 2 rigid parts, such as the lower crankcase and the engine block, are assembled together.
- Do not use RTV sealant in areas where extreme temperatures are expected. These areas include: exhaust manifold, head gasket, or other surfaces where a gasket eliminator is specified.
- Follow all safety recommendations and directions that are on the container.

To remove the sealant or the gasket material, refer to **Replacing Engine Gaskets**.

- Apply RTV to a clean surface. Use a bead size as specified in the procedure. Run the bead to the inside of any bolt holes. Do not allow the sealer to enter any blind threaded holes, as it may prevent the bolt from clamping properly or cause damage when the bolt is tightened.
- Assemble components while RTV is still wet, within 3 minutes. Do not wait for RTV to skin over.
- Tighten bolts to specifications. Do not overtighten.

TOOLS AND EQUIPMENT

Special tools are listed and illustrated throughout this section with a complete listing at the end of the section. These tools, or their equivalents, are specially designed to quickly and safely accomplish the operations for which they are intended. The use of these special tools will also minimize possible damage to engine components. Some precision measuring tools are required for inspection of certain critical components. Torque wrenches and a torque angle meter are necessary for the proper tightening of various fasteners.

To properly service the engine assembly, the following items should be readily available:

- Approved eye protection and safety gloves
- A clean, well lit, work area
- A suitable parts cleaning tank
- A compressed air supply
- Trays or storage containers to keep parts and fasteners organized
- An adequate set of hand tools
- Approved engine repair stand

- An approved engine lifting device that will adequately support the weight of the components