Pontiac
GTO

2004

Table of Contents

Product Information

2004 Pontiac GTO - A Command Performance

GTO. No other name in automotive history says "muscle car" like those three letters. When the GTO was introduced in 1964, its performance list included words like tri-power, "four on the floor" and a 389 cubic-inch V-8, and the car virtually defined true street performance.

Now the legend is back.

Pontiac's 2004 GTO is a modern-day incarnation of classic street performance. When you turn the key and hear the throaty dual exhausts announcing the 5.7L V-8, you'll know you have your hands full. Compared to its '60s namesake, the new GTO sports a suspension that is tighter, an engine that's more powerful and a four-on-the-floor manual transmission that now boasts two additional gears. The car will hit 60 mph (97 km/h) in about five-and-a-half seconds, and run the quarter mile in under 14 seconds. There's nothing like it in its class.

Total performance

The completely new GTO isn't just about horsepower, of course. Its unique personality includes impressive cornering abilities, a smooth ride and surprising comfort. But the heart of the GTO is indeed a truly awesome 5.7L LS1 V-8 engine, also known as the base powerplant for the Chevrolet Corvette. The LS1 produces an estimated 350 horsepower (261kw) at 5200 rpm and with 365 lb.-ft. (495 Nm) of torque, it has no problem leaving a stop with purpose.

Seventeen-inch alloy wheels and performance tires are matched to a fully independent, performance-tuned suspension featuring direct-acting stabilizing bars and power rack-and-pinion steering. Traction control and a limited slip differential also come standard.

And, today's GTO revs through six forward speeds with the close-ratio manual transmission, or you can choose a four-speed Hydra-Matic. Both come with a 3.46:1 final drive ratio.

Performance-oriented interior

The GTO is, first and foremost, a driver's car. Every detail, from the satin-finish steering wheel to the race-inspired metallic pedals, gives the driver a sense of performance from the moment the car is entered. The standard feature list starts off with leather 2+2 bucket seats, in black or color-coordinated with the vehicle's exterior color. The high-tech seats provide lateral support, wrapping around the driver and front passenger and complementing the great handling characteristics of the chassis. Also standard is a six-disc CD-changer with premium 10-speaker sound system, cruise control, a multi-function driver information center, keyless entry system and a host of other features to enhance the driving experience.

Sensuous design

Rather than create an imitation of the original legend, the 2004 GTO provides a contemporary interpretation of the classic Pontiac sports coupe. The distinctive, tautly stretched exterior, aggressive lowered stance and sleek, simple form all help express the clean, athletic styling direction of Pontiac. Add this to the obvious performance of the vehicle and you have a rear-wheel-drive V-8-powered premium sports coupe wrapped in a seamless, modern design.

Safety and quality

Bringing the GTO to a safe stop is accomplished through standard four-wheel disc brakes (ventilated front, solid rear), part of a four-channel anti-lock braking system. Other standard safety features include dual front air bags, three-point safety belts for all occupants and an Emergency Mode that automatically shuts down the engine, turns off the fuel pump, unlocks the doors and turns on the dome light any time the air-bag system is deployed.

Production of the 2004 Pontiac GTO will begin in September 2003 at Holden's award-winning Elizabeth plant in Australia using the latest techniques to ensure both measurable and "perceived" quality. Projected annual production will be 18,000 vehicles.

Vehicle Highlights

- Modern version of the legendary GTO name that originally debuted as a high-performance option on the 1964 Pontiac Tempest, inspiring the term, "muscle car"
- Rear-wheel-drive coupe based on Holden Monaro CV8 with unique Pontiac brand character including dual-port grille
- Specially tuned version of 5.7L LS1 V-8 generating an estimated 350 horsepower (261 kw) and 365 lb.-ft. (495 Nm) of torque
- Choice of six-speed, close-ratio manual transmission or Hydra-Matic 4L60-E four-speed automatic
- Standard limited slip differential with traction control
- Four-wheel disc brakes with standard ABS
- 2 + 2 bucket seating with standard leather seats with optional color-coordination to select exterior colors
- Premium sound system with integrated six-disc CD changer

Model Lineup

	Engine	**Transmissions**	
	5.7L V-8	**6-spd man**	**4-spd auto (Hydra-Matic 4L60-E)**
GTO	S	O	S

Standard	S
Optional	0
Not available	–

Specifications

Overview		
Model:	GTO	
Body style / driveline:	4-passenger, front-engine, rear-drive coupe	
Construction:	unitized body frame, 1- and 2-sided galvanized steel	
EPA vehicle class:	mid-size coupe	
Manufacturing location:	Holden Elizabeth Plant, Elizabeth, Australia	
Key competitors:	Acura CL 3.2, BMW 3 Series, Infiniti G35, Chrysler Crossfire, Mazda RX8, Nissan 350Z, Ford Mustang GT Premium/Cobra, Dodge Charger	
Engine		
Type:	5.7L V-8	
Displacement (cu in / cc):	346 / 5665	
Bore & stroke (in / mm):	25 x 23 / 99 x 92	
Block material:	aluminum	
Cylinder head material:	aluminum	
Valvetrain:	OHV, 2 valves per cylinder	
Fuel delivery:	sequential-port fuel injection	
Compression ratio:	10.1:1	
Horsepower (hp / kw @ rpm):	350 / 261 @ 5200	
Torque (lb-ft / Nm @ rpm):	365 / 495 @ 4000	
Recommended fuel:	92 octane	
Maximum engine speed (rpm):	6200	
Emissions controls:	catalytic converter/EGR	
Estimated fuel economy (mpg city / hwy / combined):	Manual Transmission: 17/29/24.8 Automatic Transmission: 16/21/21.5	
Transmissions	**6-speed manual**	**Hydra-Matic 4L60-E**
Type:	6-speed manual	4-speed electronic automatic
Gear ratios (:1):		
First:	2.97	3.06
Second:	2.07	1.63
Third:	1.43	1.00
Fourth:	1.00	0.70
Fifth:	0.84	-
Sixth:	0.57	-
Reverse:	3.28	2.30
Final drive ratio:	3.46:1	3.46:1
Chassis/Suspension		
Front:	independent MacPherson struts and progressive-rate springs	
Rear:	independent semi-trailing control-link with gas pressure dampers	
Steering type:	power assisted variable ratio rack-and-pinion	
Steering ratio:	variable ratio	
Steering wheel turns, lock-to-lock:	3	
Turning circle, curb-to-curb (ft / m):	36.1 / 11	
Brakes		
Type:	4-wheel discs (ventilated front, solid rear), power assisted with 4-channel anti-lock braking system.	
Rotor diameter:	11.7 / 11.3	

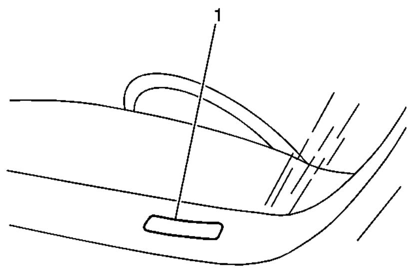
Wheels/Tires	
Wheel size and type:	17-inch alloy
Tires:	P245/45R17

Dimensions

Exterior	
Wheelbase (in / mm):	109.8 / 2789
Overall length (in / mm):	189.8 / 4821
Overall width (in / mm):	72.5 / 1841
Overall height (in / mm):	54.9 / 1397
Track (in / mm):	61.8 / 1569
Curb weight (lb / kg, estimated):	3725 / 1690
Weight distribution (% front / rear, estimated):	55 / 45
Interior	
Seating capacity (front / rear):	2 / 2
Head room (in / mm):	
Front seat:	37.3 / 947
Rear seat:	37.3 / 947
Leg room (in / mm):	
Front seat:	42.2 / 1072
Rear seat:	37.1 / 942
Shoulder room (in / mm):	
Front seat:	59.7 / 1515
Rear seat:	51.7 / 1312
Hip room (in / mm):	
Front seat:	58.0 / 1472
Rear seat:	50.2 / 1275
Capacities	
Trailer towing maximum (lb / kg):	1000 / 454
Fuel tank (gal / L):	18.5 / 70
Engine oil (qt / L):	5.3 / 6.0
Cooling system (qt / L):	auto: 11.5 / 10.9 manual: 11.8 / 11.2

Vehicle Identification

Vehicle Identification Number (VIN)



The vehicle identification number (VIN) plate is the legal identifier of the vehicle. The VIN plate is located on the upper LH corner of the Instrument Panel and can be seen through the windshield from the outside of the vehicle:

Position	Definition	Character	Description
1	Country of Origin	6	Australia
2	Manufacturer	G	General Motors
3	Division	2	Pontiac
4-5	Carline/Series	VX	GTO
6	Body Type	1	Two-Door Coupe
7	Restraint System	2	Active Manual Belts w/Driver and Passenger Inflatable Restraint System Frontal
8	Engine	G	RPO LS1, 5.7L, V8, MFI
9	Check Digit	--	--
10	Model Year	4	2004
11	Assembly Plant	L	Elizabeth, Adelaide, South Australia
12-17	Plant Sequence Number	--	--

VIN Derivative

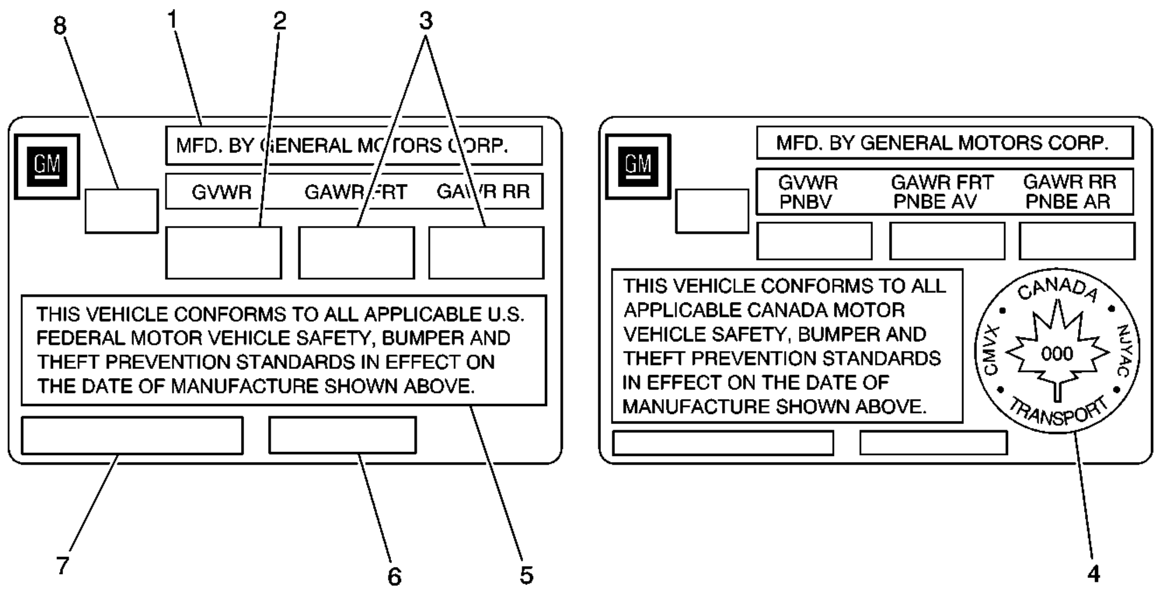
All engines and transmissions are stamped or laser etched with a partial vehicle identification number (VIN), which was derived from the complete VIN. A VIN derivative contains the following nine positions:

Position	Definition	Character	Description
1	GM Division Identifier	2	Pontiac
2	Model Year	4	2004
3	Assembly Plant	L	Elizabeth, Adelaide, South Australia
4-9	Plant Sequence Number	--	--

A VIN derivative can be used to determine if a vehicle contains the original engine or transmission, by matching the VIN derivative positions to their accompanying positions in the complete VIN:

VIN Derivative Position	Equivalent VIN Position
1	3
2	10
3	11
4-9	12-17

Label - Vehicle Certification



The vehicle certification label displays the following assessments:

- The name of the manufacturer (1)
- The Gross Vehicle Weight Rating (GVWR) (2)
- The Gross Axle Weight Rating (GAWR) (3)
- The vehicle payload rating
- The vehicle class type Pass Car, etc. (6)
- The vehicle identification number (7)
- The date of manufacture (Mo/Yr) (8)
- The original equipment tire sizes and the recommended tire pressures

Gross vehicle weight (GVW) is the weight of the vehicle and everything it carries. Include the following items when figuring the GVW:

- The base vehicle weight factory weight
- The weight of the vehicle accessories
- The weight of the driver and the passengers
- The weight of the cargo

The gross vehicle weight must not exceed the Gross Vehicle Weight Rating.

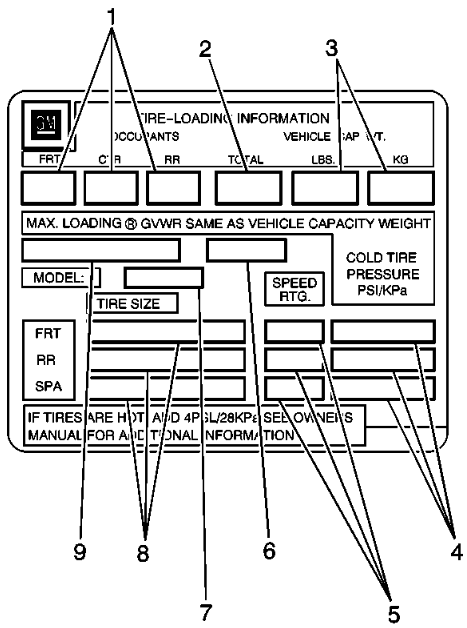
The front gross axle weight (GAW) is the weight exerted on the front axle. The rear gross axle weight (GAW) is the weight exerted on the rear axle. The front and rear gross axle weights must not exceed the front and rear gross axle weight ratings.

The payload rating defines the vehicle's maximum allowable cargo load. The cargo load includes the driver and the passengers. The payload rating is based on the vehicle's factory installed equipment. Deduct the weight of accessories added to the vehicle after the final date of manufacture from the payload rating.

The vehicle may have a Gross Combination Weight Rating (GCWR). The Gross Combination Weight Rating refers to the total maximum weight of the loaded tow vehicle including driver and passengers and a loaded trailer.

The vehicle tires must be the proper size and properly inflated for the load the vehicle is carrying. For more information on tires refer to Tire Placard.

Tire Placard

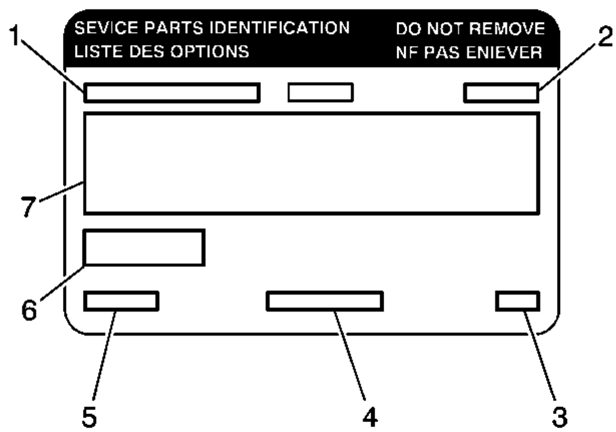


(1) Specified Occupant Seating Positions
(2) Total Occupant Seating
(3) Maximum Vehicle Capacity Weight
(4) Tire Pressures, Front, Rear, and Spare
(5) Tire Speed Rating, Front, Rear, and Spare
(6) Tire Label Code
(7) Engineering Model Minus First Character
(8) Tire Sizes, Front, Rear, and Spare
(9) Vehicle Identification Number

The Tire Placard is permanently located on the edge of the driver's door. Refer to the placard to obtain:

- The maximum vehicle capacity weight
- The cold tire inflation pressures
- The tire sizes (original equipment tires)
- The tire speed ratings (original equipment tires)

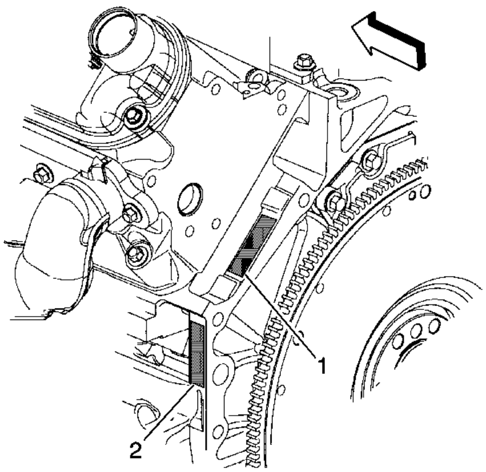
Service Parts Identification Label (SPID)



(1) Vehicle Identification Number
(2) Engineering Model Number (Vehicle Division, Vehicle Line and Body Style)
(3) Interior Trim and Decor Level
(4) Exterior (Paint Color) WA Number
(5) Paint Technology
(6) Special Order Paint Colors and Numbers
(7) Vehicle Option Content

The service parts identification label is placed on the spare tire cover panel in order to help service and parts personnel identify the vehicle's original parts and the vehicle's original options.

Engine ID and VIN Derivative Location RPO LS1

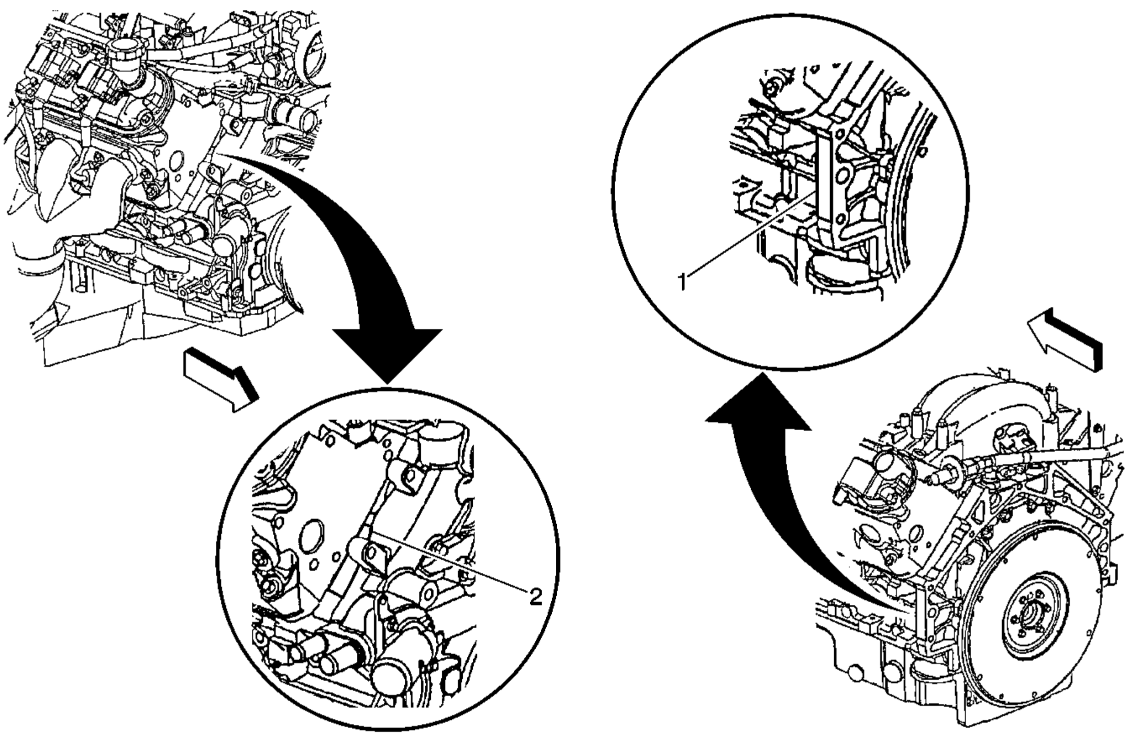


(1) Engine ID Number, Primary Location
(2) Engine ID Number, Secondary Location

The eighth digit of the vehicle identification number (VIN) is the engine code letter, which identifies the engine as a 5.7 L V8.

Stick-on labels attached to the engine, laser etching, or stampings on the engine block indicate the engine unit number/build date code.

The engine ID number will be located at either the primary or the secondary location on the rear of LH cylinder head or the front part of LH oil pan rail.

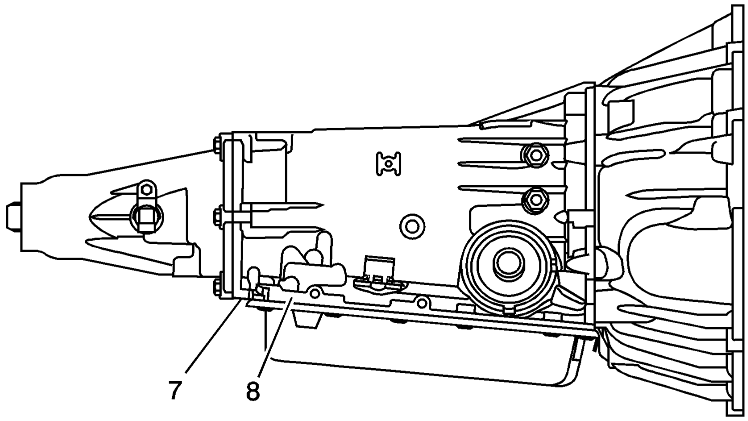


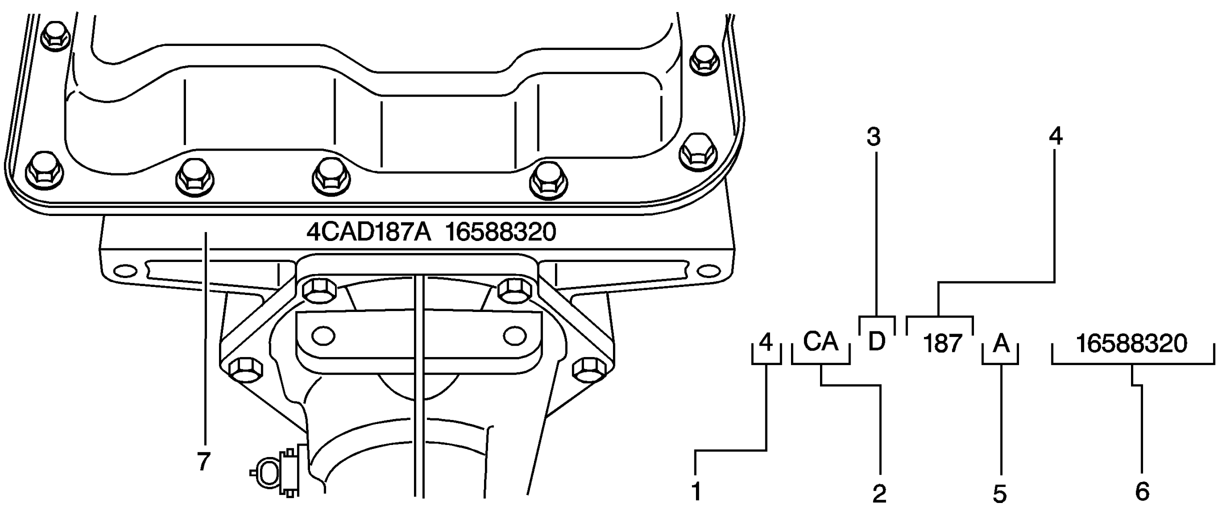
(1) VIN Derivative, Primary Location
(2) VIN Derivative, Secondary Location

The engine is also stamped with a VIN derivative which will be located at either the primary or secondary location, as shown.

Transmission ID and VIN Derivative Location

Automatic Transmission



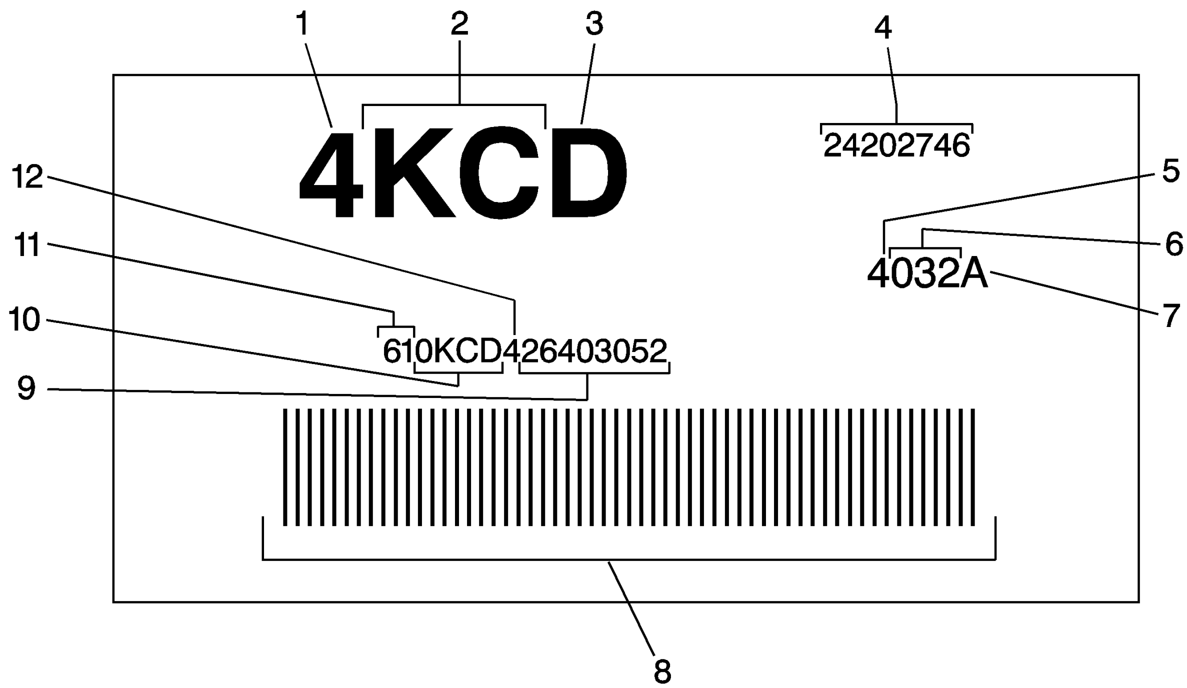


(1)	4 = 2004
(2)	Model
(3)	Hydra-Matic 4L60-E
(4)	Julian Date or Day of the Year
(5)	Shift Built, See Shift Build Chart
(6)	Serial Number
(7)	Case/Pan Frame Rail Location
(7)	Case/Pan Frame Rail Location
(8)	Optional Transmission ID Location, Tag Is Used as a Back-Up If Unable To Etch Case/Pan Area and To Bar Code Scan

Plant and Shift Build Chart

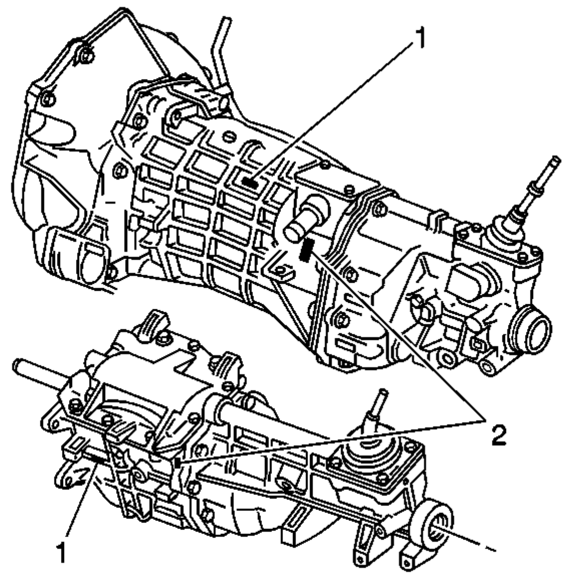
Plant	Build Line	1st Shift	2nd Shift	3rd Shift
Toledo, OH	ML1	J	W	X
	ML2	A	C	Not Used
	ML3	B	H	Not Used
	ML4	S	L	V
	ML5	K	E	Z
Romulus, MI	1	A	--	B

Bar Code Label Contents



(1) 4 = 2004
(2) Model
(3) Hydra-Matic 4L60-E
(4) Transmission Asm. as Shipped Number
(5) 4 = Model Year
(6) Julian Date or Day of the Year
(7) Letter After Julian Date Identifies the Plant Shift Build, See Shift Build Chart
(8) Bar Code
(9) Serial Number
(10) Broadcast Code
(11) Transmission ID
(12) Build Location Y = Toledo, OH, R = Romulus, MI, 4 = Ramos Arizpe, Mexico

Manual Transmission ID Location

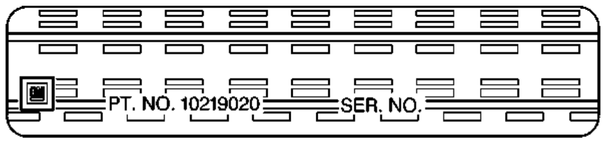


The transmission model identification is located on a label or tag on the transmission case. If this label is missing or unreadable, use the service parts identification label in order to identify the vehicle's transmission.

Engine and Transmission Usage

Car Line	VIN Code	Engine Size	Fuel System	Engine RPO	Transmission Used	Transmission RPO
GTO	G	5.7L V8	MFI	LS1	Man 6 Speed Auto 4 Speed	M12 M30

Labeling - Anti-Theft



Notice

The anti-theft label found on some major body panels MUST be covered before performing any painting, rustproofing or undercoating procedures. The mask must also be removed following those procedures. Failure to follow these precautionary steps may result in liability for violation of the Federal Vehicle Theft Prevention Standard, and subject the vehicle owner to possible suspicion that the part was stolen.

Federal law requires General Motors (GM) to affix a label to certain parts on selected vehicles with the Vehicle Identification Number (VIN). The purpose of this law is to reduce the number of motor vehicle thefts by helping in the tracing and recovery of parts from stolen vehicles. The certification label on the driver's door qualifies as a theft deterrent label.

The theft deterrent label will be permanently affixed to an interior surface of the part and will contain the complete VIN. The label on replacement parts will contain the letter R, the manufacturer's logo, and the acronym for the Department of Transportation (DOT). DO NOT deface, or remove these labels.

RPO Code List

The production/process codes provide the description of the Regular Production Options (RPOs) used on the vehicle. The RPO list is printed on the Service Parts Identification Label. The following is a list of the RPO abbreviations and the description of each:

RPO	Description
A88	Restraint, Head
AH5	Adjuster, Seat, 8 Way, Power, Driver and Passenger
AJ7	Restraint System, Seat, Inflatable, Driver and Passenger, Front and Side
AQ9	Seat, Front, Bucket, Sport
B58	Covering Front and Rear, Floor Mats
C60	Heating, Ventilation, Air Conditioning System, Manual
C95	Lamp, Interior, Front Door, Courtesy, Illuminated, Roof, Dual Reading
DL6	Mirror, Outside, Left Hand and Right Hand, Remote Control, Electric
FE2	Suspension System, Ride, Handling
GS9	Axle, Rear, 3.46:1 Ratio
G80	Limited Slip Differential
JL9	Brake System, Power, Front and Rear Disc, Antilock, Front and Rear Wheel
K30	Cruise Control, Automatic, Electronic
LS1	Engine, Gasoline, 8 Cylinder, 5.7 Liter, Sequential Fuel Injection, Aluminum, General Motors
M12	Transmission, Manual 6 Speed, Tremec, 85 mm, 2.97 First, 0.57 Sixth, Overdrive
M30	Transmission, Automatic 4 Speed, 4L60-E, Electronic
N08	Lock Control, Fuel Filler Door, Remote Control
N40	Steering, Power, Variable Ratio
NP5	Steering Wheel, Leather Wrapped, Radio Controls, Height and Reach Adjust
NW9	Traction Control, Electronic
P29	Wheel, 17 X 8, Aluminum, Sport, 5 Spoke
T82	Headlamps, Automatic On and Off
TH5	Height Adjustment, Safety Belt Front Seat
U1X	Radio, Premium, 200 Watt, Multiple Compact Disc
U77	Antenna, In Glass, Rear Window
UA6	Theft Deterrent System
VK3	Front License Plate Attachment

Technical Information

Capacities - Approximate Fluid

Application	Capacities	
	English	Metric
Air Conditioning Refrigerant R134a	1.8 lbs	0.8 kg
Automatic Transmission (Drain and Refill)	5.3 quarts	5.0 L
Cooling System	15.1 quarts	14.3 L
Engine Oil with Filter (Drain and Refill)	6.5 quarts	6.2 L
Fuel Tank	18.5 gallons	70.0 L
Manual Transmission	4.6 quarts	4.4 L
Rear Axle Fluid	1.690 quarts	1.6 L

All capacities are approximate. When adding, be sure to fill to the appropriate level, as recommended in this manual. Recheck fluid level after filling

Maintenance Items

Part	GM Part Numbers	Accolade Part Numbers
Battery	--	85-7YR
Engine Air Cleaner/Filter	92082656	--
Engine Oil Filter	88984215	PF-46
Spark Plugs	12571164	41-985

Fluid and Lubricant Recommendations

Application	Fluid/Lubricant
Automatic Transmission, Manual Transmission, Power Steering System Fluid	GM Goodwrench® Automatic Transmission Fluid-DEXRON®-III GM P/N 12378470, or the equivalent DEXRON®-III automatic transmission fluid
Engine Coolant	A 50/50 mixture of water and GM Vehicle Care DEX-COOL® Antifreeze, GM P/N 12346290, or the equivalent DEX-COOL® antifreeze
Engine Oil	GM Goodwrench® Motor Oil SAE 5W-30, GM P/N 12345610, or the equivalent engine oil SAE 5W-30 SJ ILSAC GF-3.
Door Hinges, Door Check Assembly, Engine Compartment Lid Hinges and Latch, Rear Compartment Hinges and Latch, Window Guides, Runners, and Regulator Lubricant	GM Vehicle Care Lubriplate Lubricant, GM P/N 1052196, or the equivalent lithium zinc oxide lubricant
Door Lock Striker, Door Lock Assembly Fork, Front Seat Adjuster, Front Seat Track and Rail Assembly, Pedal Pivot Point, Park Brake Shoe Actuator Pivot Point, and Windshield Wiper Pivot Point Lubricant	GM Vehicle Care Dri-Slide Lubricant, GM P/N 1052948, or the equivalent lithium molybdenum disulphide lubricant
Hydraulic Brake System, Hydraulic Clutch System Fluid	GM Vehicle Care Brake and Clutch Fluid Super DOT-4, GM P/N 88958860, or the equivalent DOT-4 brake fluid
Key Lock Cylinder Lubricant	Powdered graphite
Rear Axle Limited-Slip Differential	GM Vehicle Care Synthetic Gear Oil® 75W-140 GL-5, GM P/N 89021809, and GM Vehicle Care Limited Slip Differential Friction Modifier® 7098, GM P/N 89021958.
Weatherstrip Conditioning	GM Vehicle Care Weatherstrip Lubricant, GM P/N 3634770, or the equivalent weatherstrip lubricant
Windshield Washer Solvent	GM Vehicle Care Optikleen® GM P/N 1051515, or the equivalent windshield washer fluid

Tire Inflation Pressure Specifications

Application	Specification	
	Metric	English
Tires, Front and Rear	245 kPa	35 psi
Compact Spare	420 kPa	60 psi

Descriptions and Operations

Power Steering System Description and Operation

The power steering system is a closed loop system. The system consists of the following components:

- The power steering fluid reservoir
- The power steering pump
- The power steering gear
- The power steering pipes and hoses

The power steering fluid flows from the fluid reservoir through a hose to the power steering pump. The engine drive belt rotates the pump pulley. The pulley turns the pump drive shaft. The shaft turns the pump rotor. The vanes in the rotor pressurize the power steering fluid. The engine speed sensing type flow control valve controls the fluid pressure. This valve reduces the fluid pressure as the engine speed increases. The fluid flows, under pressure, from the pump, through the pipe and the hose, to the steering gear.

Important

DO NOT disassemble the power steering gear.

The steering gear is a rack and pinion type steering system. The steering gear has a control valve which directs the fluid to either side of the rack piston. The piston uses hydraulic pressure to move the rack to the left and to the right. The rack moves the tie rods. The tie rods move the steering knuckles. The steering knuckles rotate on ball joints and strut bearings and turn the front wheels and tires.

The power steering fluid flows from the steering gear, through the pipe and the hose, to the reservoir.

If the hydraulic assist fails, the driver maintains manual steering control. Under this condition, however, the driver must use more steering effort.

Power Steering Pump Specifications

Vehicle	Engine Code	Engine Size	High Flow		Pressure Relief	
			LPM	GPM	kPa	psi
V Car	LS1	5.7L	7.4/8.9	1.95/2.35	7584/8274	1100/1200

Steering Wheel and Column

The steering wheel and column has 4 primary functions:

- Vehicle steering
- Vehicle security
- Driver convenience
- Driver safety

Vehicle Steering

The steering wheel is the first link between the driver and the vehicle. The steering wheel is fastened to a steering shaft within the column. At the lower end of the column, the intermediate shaft connects the column to the steering gear.

Vehicle Security

Theft deterrent components are mounted and designed into the steering column. The following components allow the column to be locked in order to minimize theft:

- The ignition switch
- The steering column lock
- The ignition cylinder

Driver Convenience

The steering wheel and column may also have driver controls attached for convenience and comfort. The following controls may be mounted on or near the steering wheel or column.

- The turn signal switch
- The hazard switch
- The headlamp dimmer switch
- The wiper/washer switch
- The horn pad/cruise control switch
- The redundant radio/entertainment system controls
- The tilt or tilt/telescoping functions
- The HVAC controls

Driver Safety

The energy-absorbing steering column compresses in the event of a front-end collision, which reduces the chance of injury to the driver. The mounting capsules break away from the mounting bracket in the event of an accident.

Suspension Description and Operation

Front Suspension

The front suspension has 2 primary purposes:

- Isolate the driver from irregularities in the road surface.
- Define the ride and handling characteristics of the vehicle.

The front suspension absorbs the impact of the tires travelling over irregular road surfaces and dissipates this energy throughout the suspension system. This process isolates the vehicle occupants from the road surface. The rate at which the suspension dissipates the energy and the amount of energy that is absorbed is how the suspension defines the vehicle's ride characteristics. Ride characteristics are designed into the suspension system and are not adjustable. The ride characteristics are mentioned in this description in order to aid in the understanding of the functions of the suspension system. The suspension system must allow for the vertical movement of the tire and wheel assembly as the vehicle travels over irregular road surfaces while maintaining the tire's relationship with the road.

The steering knuckle is suspended between a lower control arm, a lower control arm rod, and a strut assembly. The lower control arm attaches to the steering knuckle at the outermost point of the control arm. The attachment is through a ball and socket type joint. The ball joint allows the steering knuckle to maintain the perpendicular relationship to the road surface. The innermost end of the control arm is attached to the front frame with a semi-rigid bushing. The lower control arm is allowed to pivot at the vehicle frame in a vertical fashion. The rod is attached to the lower control arm with a semi-rigid bushing. The front of the lower control arm rod is attached to the front frame with a fluid filled insulator bushing. The upper portion of the steering knuckle is attached to a strut assembly. The strut assembly is attached to the vehicle body with an upper bearing. The steering knuckle moves up and down independent of the vehicle body structure.

This up and down motion of the steering knuckle as the vehicle travels over bumps is absorbed predominantly by the coil spring. This spring is retained under tension over the strut assembly. The strut has an absorber in order to dampen out the oscillations of the coil spring. A strut is a basic hydraulic cylinder. The strut is filled with oil and has a moveable shaft that connects to a piston inside the strut. Valves inside the strut offer resistance to oil flow and consequently inhibit rapid movement of the piston and shaft. Each end of the strut is designed as the connection point of the suspension system to the vehicle and acts as the coil spring seat. This allows the strut to utilize the dampening action to reduce the recoil of a spring alone.

The front suspension has a stabilizer shaft. The stabilizer shaft connects between the left strut and the right strut through the stabilizer shaft links. Insulators and clamps retain the stabilizer shaft to the front frame. The stabilizer shaft controls the amount of independent movement of the suspension when the vehicle turns. Limiting the independent movement defines the vehicles handling characteristics in turns.

Rear Suspension

The rear suspension has 2 primary purposes:

- Isolate the driver from irregularities in the road surface.
- Define the ride and handling characteristics of the vehicle.

The rear suspension absorbs the impact of the tires travelling over irregular road surfaces and dissipates this energy throughout the suspension system. This process isolates the vehicle occupants from the road surface. The rate at which the suspension dissipates the energy and the amount of energy that is absorbed is how the suspension defines the vehicle's ride characteristics. Ride characteristics are designed into the suspension system and are not adjustable. The ride characteristics are mentioned in this description in order to aid in the understanding of the functions of the suspension system. The suspension system must allow for the vertical movement of the tire and wheel assembly as the vehicle travels over irregular road surfaces while maintaining the tire's relationship to the road.

The up and down motion of the tire and wheel assembly as the vehicle travels over bumps is absorbed predominantly by the coil spring. The shock absorber dampens the oscillations of the coil spring. A shock absorber is a basic hydraulic cylinder. The shock absorber is filled with oil and has a moveable shaft that connects to a piston inside the shock absorber. Valves inside the shock absorber offer resistance to oil flow and consequently inhibit rapid movement of the piston and shaft. This allows the shock absorber to utilize the dampening action to reduce the recoil of a spring alone.

The tire and wheel assembly is retained to the hub by wheel nuts and studs. The studs are pressed into the hub. The hub is retained to the wheel drive shaft flange by a nut. The hub rotates inside a sealed wheel bearing assembly. The wheel bearing is pressed into the lower control arm. The forward end of the lower control arm attaches to the rear suspension support with semi-rigid bushings.

The adjustment link assembly connects between the rear suspension support and the lower control arms. The inner adjustment link has a bushing. The outer adjustment link has a ball joint. The adjustment link assembly controls rear wheel camber and toe angles during suspension travel. The adjustment link assembly also provides a means of adjusting the rear wheel toe.

The stabilizer shaft connects between the left lower control arm and the right lower control arm through the stabilizer shaft links. Insulators and clamps retain the stabilizer shaft to the rear suspension support. The stabilizer shaft controls the amount of independent movement of the suspension when the vehicle turns. Limiting the independent movement defines the handling characteristics of the vehicle in turns.

Wheels and Tires

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Wheel Nuts		
• First Pass	70 N·m	50 lb ft
• Second Pass	140 N·m	100 lb ft

General Description

The factory installed tires are designed to operate satisfactorily with loads up to and including the full rated load capacity when these tires are inflated to the recommended pressures.

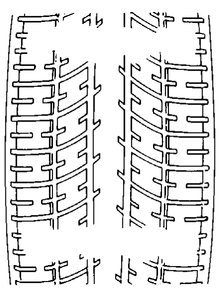
The following factors have an important influence on tire life:

- Correct tire pressures
- Correct wheel alignment
- Proper driving techniques
- Tire rotation

The following factors increase tire wear:

- Heavy cornering
- Excessively rapid acceleration
- Heavy braking

Tread Wear Indicators Description



The original equipment tires have tread wear indicators that show when you should replace the tires.

The location of these indicators are at 72 degree intervals around the outer diameter of the tire. The indicators appear as a 6 mm (0.25 in) wide band when the tire tread depth becomes 1.6 mm (2/32 in).

Metric Wheel Nuts and Bolts Description

Metric wheel/nuts and bolts are identified in the following way:

- The wheel/nut has the word Metric stamped on the face.
- The letter M is stamped on the end of the wheel bolt.

The thread sizes of metric wheel/nuts and the bolts are indicated by the following example: M12 x 1.5.

- M = Metric
- 12 = Diameter in millimeters
- 1.5 = Millimeters gap per thread

Tire Inflation Description

When you inflate the tires to the recommended inflation pressures, the factory-installed wheels and tires are designed in order to handle loads to the tire's rated load capacity. Incorrect tire pressures, or under-inflated tires, can cause the following conditions:

- Vehicle handling concerns
- Poor fuel economy
- Shortened tire life
- Tire overloading

Inspect the tire pressure when the following conditions apply:

- The vehicle has been sitting at least 3 hours.
- The vehicle has not been driven for more than 1.6 km (1 mi).
- The tires are cool.

Inspect the tires monthly or before any extended trip. Adjust the tire pressure to the specifications on the tire label. Install the valve caps or the extensions on the valves. The caps or the extensions keep out dust and water.

The kilopascal (kPa) is the metric term for pressure. The tire pressure may be printed in both kilopascal (kPa) and psi. One psi equals 6.9 kPa.

Inflation Pressure Conversion (Kilopascals to PSI)

kPa	psi	kPa	psi
140	20	215	31
145	21	220	32
155	22	230	33
160	23	235	34
165	24	240	35
170	25	250	36
180	26	275	40
185	27	310	45
190	28	345	50
200	29	380	55
205	30	415	60
Conversion: 6.9 kPa = 1 psi			

Tires with a higher than recommended pressure can cause the following conditions:

- A hard ride
- Tire bruising
- Rapid tread wear at the center of the tire

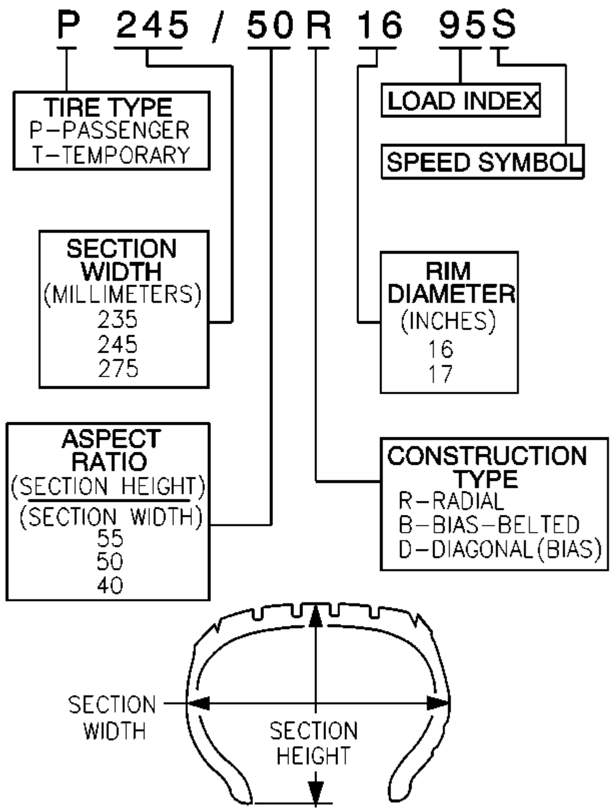
Tires with a lower than recommended pressure can cause the following conditions:

- A tire squeal on turns
- Hard steering
- Rapid wear and uneven wear on the edge of the tread
- Tire rim bruises and tire rim rupture
- Tire cord breakage
- High tire temperatures
- Reduced vehicle handling
- High fuel consumption
- Soft riding

Unequal pressure on the same axle can cause the following conditions:

- Uneven braking
- Steering lead
- Reduced vehicle handling

P-Metric Sized Tires Description

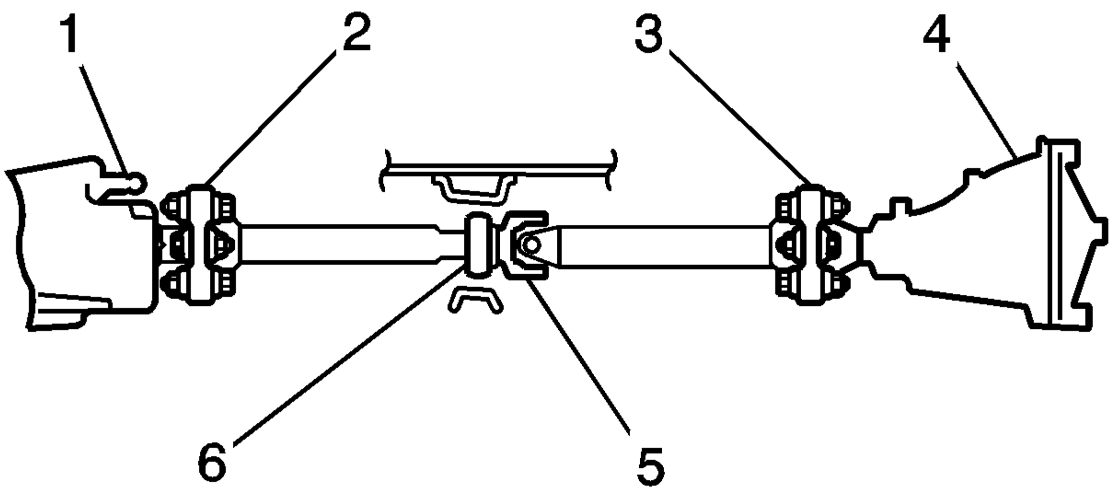


Most P-metric tire sizes do not have exact corresponding alphanumeric tire sizes. Replacement tires should be of the same tire performance criteria (TPC) specification number including the same size, the same load range, and the same construction as those originally installed on the vehicle. Consult a tire dealer if you must replace the P-metric tire with other sizes. Tire companies can best recommend the closest match of alphanumeric to P-metric sizes within their own tire lines.

Driveline System Description and Operation

Driveline/Axle – Propeller Shaft

Two Piece Propeller Shaft



(1) Transmission
(2) Front Coupling
(3) Rear Coupling
(4) Differential
(5) Universal Joint
(6) Center Carrier Bearing

The propeller shaft assembly is a two piece tubular design that incorporates a center support bearing, a conventual cross type universal joint, and two rubber couplings, one on the front and one at the rear. The center support bearing prevents angular movement or whipping of the propeller shaft. The support bearing is a sealed, ball bearing type mounted in a reinforced rubber cushion. The rubber cushion is mounted in a cup guide and attached to the carrier and is bolted to the underbody.

Drive is transmitted between the two halves of the propeller shaft through a center universal joint directly behind the center bearing. the universal joint is a conventual cross design and is located and secured in each of two propeller shaft yoke by staking.

The rubber coupling fitted to the front the propeller shaft is bolted to a slip yoke at the transmission. The rubber coupling at the rear of the shaft is bolted to the pinion flange at the front of the differential assembly.

The universal joint is located directly behind the center support bearing on the rear propeller shaft. The universal joint allows for the driveline angle differences between the transmission and the rear axle.

The center bearing and the universal joint are lubricated for life and do not require any periodic lubrication.

By using the rubber couplings and having an interference fit between the two propeller shaft halves, measuring the driveline angles and propeller shaft phasing is not required.

The only serviceable components on the propeller shaft are the rubber couplings, the front slip yoke, and the associated fasteners for the following reasons:

- The center universal joint bearing cups are set and retained by staking and sophisticated equipment is required during reassembly to ensure concentric reassembly. In the event the universal joint needs to be replaced, the propeller shaft assembly must be replaced.
- In order to separate shaft halves, the interference fit of the splined joint requires sophisticated equipment to separate and reassemble the propeller shaft. In addition the propeller shaft would require rebalancing of the assembly. In the event the center bearing assembly needs to be replaced, the propeller shaft assembly must be replaced.

Wheel Drive Shafts

Wheel drive shaft assemblies are flexible assemblies.

The wheel drive axles consist of the following components:

- An inner constant velocity joint.
- An outer constant velocity joint.
- A drive shaft bar. The drive shaft bar connects the inner and outer constant velocity joints.

The inner wheel drive shaft constant velocity joint is completely flexible. The joint also moves in and out.

The outer wheel drive shaft constant velocity joint is flexible, but will not move in and out.

Seal and Clamp

The constant velocity joint seals are made of a thermoplastic material.

The clamps on rear wheel drive axle seals are made of stainless steel.

The seals provide the following functions:

- Protection of the internal parts of the drive shaft constant velocity joints. The seals protect the grease from the following sources of damage:
  - Harmful atmospheric conditions, such as extreme temperatures or ozone gas.
  - Foreign material, such as dirt or water.
- Allows angular movement of the drive shaft constant velocity joints.

Important

Protect the seals from sharp tools and from the sharp edges of the surrounding components.

Any damage to the seals or the clamps will result in leakage. Leakage will allow water to leak into the constant velocity joints. Damage will also allow grease to leak out of the constant velocity joints.

Leakage may cause noisy rear wheel drive axle operation and eventual failure of the internal components.

The clamps provide a leak proof connection for the shaft constant velocity joints at the following locations:

- The dust shield housing.
- The rear wheel drive shaft bar.

The thermoplastic material performs well under normal conditions and normal operation. However, the material is not strong enough to withstand the following conditions:

- Abusive handling.
- Damage from sharp objects, such as tools or sharp edges of the surrounding vehicle components.

Inner Joint

The inner joint is of a constant velocity design and bolted to the axle stub shaft.

The shaft end mating with the constant velocity joint incorporate a male spline to assure a tight press type fit.

The joint is identified by a single groove cut into the outer race.

Outer Joint

The outer joint is of a constant velocity design and bolted to the knuckle and hub assembly.

The shaft end mating with the constant velocity joint incorporate a male spline to assure a tight press type fit.

The joint is identified by two grooves cut into the outer race.

Rear Drive Axle Description and Operation

Differential Carrier Assembly Description

The differential assembly, is a four pinion type limited slip differential final drive assembly mounted to and independent rear suspension. The differential is mounted directly to the crossmember which is rubber mounted to the underbody. The differential case and drive pinon are mounted in opposed taper roller bearing in the carrier. Differential case side bearing preload adjustment is provided by screw adjusters in the sides of the case. Pinon bearing pre-load is provided by a collapsible spacer. Torque is transferred from the propeller shaft to the differential via the pinon flange which is splined to the hypoid pinon. The torque is then transferred from the pinon through the ring gear, differential case, differential pinon cross shafts, differential pinons, side gears, and then via splines to the inner axle shafts and the drive shafts.

The limited slip differential performs the same functions as the conventual type differential. However, should the opposite wheel begin to spin, it transfers driving force to the wheel with traction. The differential case houses a cone type clutch pack that is an integral part of the side gears. The four pinon type limited slip differential has three pre-load springs inclosed in the center pinon cross shaft. The limited slip differential directs the major driving force to the wheel with greater amount of traction, but will not interfere with steering characteristics of differential action. The partial locking action, due to the spring load on the cones, is automatically increased by the inherent separating forces between the side gears and pinon, which progressively increases the resistance in the differential as applied torque is increased.

When the rear wheels are under extremely unbalanced conditions, such as one wheel on dry road and the other in mud or snow, with a standard differential, wheel spin easily occurs if over acceleration is attempted. However, with a limited slip differential, when the tendency for wheel spin occurs friction generated inside the case transfers driving force to the non-spinning wheel. In the event of continued spinning, a whirring sound from the over-running cones is produced, but this condition/sound does not indicate a failure of the unit.

Braking System Description and Operation

Hydraulic Brake System Description and Operation

System Component Description

The hydraulic brake system consists of the following:

Hydraulic Brake Master Cylinder Fluid Reservoir

Contains supply of brake fluid for the hydraulic brake system.

Hydraulic Brake Master Cylinder

Converts mechanical input force into hydraulic output pressure.

Hydraulic output pressure is distributed from the master cylinder through two hydraulic circuits, supplying diagonally-opposed wheel apply circuits.

Hydraulic Brake Pressure Balance Control System

Regulates brake fluid pressure delivered to hydraulic brake wheel circuits, in order to control the distribution of braking force.

Pressure balance control is achieved through dynamic rear proportioning (DRP), which is a function of the ABS modulator.

Hydraulic Brake Pipes and Flexible Brake Hoses

Carries brake fluid to and from hydraulic brake system components.

Hydraulic Brake Wheel Apply Components

Converts hydraulic input pressure into mechanical output force.

System Operation

Mechanical force is converted into hydraulic pressure by the master cylinder, regulated to meet braking system demands by the pressure balance control system, and delivered to the hydraulic brake wheel circuits by the pipes and flexible hoses. The wheel apply components then convert the hydraulic pressure back into mechanical force which presses linings against rotating brake system components.

Brake Assist System Description and Operation

System Component Description

The brake assist system consists of the following:

Brake Pedal

Receives, multiplies and transfers brake system input force from driver.

Brake Pedal Pushrod

Transfers multiplied input force received from brake pedal to brake booster.

Vacuum Brake Booster

Uses source vacuum to decrease effort required by driver when applying brake system input force.

When brake system input force is applied, air at atmospheric pressure is admitted to the rear of both vacuum diaphragms, providing a decrease in brake pedal effort required. When input force is removed, vacuum replaces atmospheric pressure within the booster.

Vacuum Source

Supplies force used by vacuum brake booster to decrease brake pedal effort.

Vacuum Source Delivery System

Enables delivery and retention of source vacuum for vacuum brake booster.

System Operation

Brake system input force is multiplied by the brake pedal and transferred by the pedal pushrod to the hydraulic brake master cylinder. Effort required to apply the brake system is reduced by the vacuum brake booster.

Disc Brake System Description and Operation

System Component Description

The disc brake system consists of the following components:

Disc Brake Pads

Applies mechanical output force from the hydraulic brake calipers to friction surfaces of brake rotors.

Disc Brake Rotors

Uses mechanical output force applied to friction surfaces from the disc brake pads to slow speed of tire and wheel assembly rotation.

Disc Brake Pad Hardware

Secures disc brake pads firmly in proper relationship to the hydraulic brake calipers. Enables a sliding motion of brake pads when mechanical output force is applied.

Disc Brake Caliper Hardware

Provides mounting for hydraulic brake caliper and secures the caliper firmly in proper relationship to caliper bracket. Enables a sliding motion of the brake caliper to the brake pads when mechanical output force is applied.

System Operation

Mechanical output force is applied from the hydraulic brake caliper pistons to the inner brake pads. As the pistons press the inner brake pads outward, the caliper housings draw the outer brake pads inward. This allows the output force to be equally distributed. The brake pads apply the output force to the friction surfaces on both sides of the brake rotors, which slows the rotation of the tire and wheel assemblies. The correct function of both the brake pad and brake caliper hardware is essential for even distribution of braking force.

Parking Brake System Description and Operation

The park brake system is a mechanical system. The lever is connected to the front cable. The front cable runs from the lever to the equalizer. The equalizer connects the front cable to the two rear cables. One rear cable runs from the equalizer to each rear wheel. The rear cable engages the park brake mechanism. Applying the park brake prevents the rear wheels from turning.

Park Brake Lever

Pull the lever all the way up in order to apply the park brake.

Complete the following steps in order to release the park brake:

1. Pull the lever up slightly.
2. Push in the release button.
3. Lower the lever.

Park Brake Cables

The twisted strand park brake cables are covered by a plastic material that allows the cables to slide freely.

The front cable is connected to the two rear cables by an equalizer. The equalizer ensures that the braking tension is applied to both brakes at the same time, and with the same amount of pressure.

BRAKE Indicator

Applying the park brake illuminates the BRAKE indicator on the instrument cluster.

Park Brake Switch

The park brake switch mounts to the park brake lever. The switch is open when the park brake releases. When the park brake lever is pulled up, the switch closes, illuminating the BRAKE indicator.

Daytime Running Lamps (DRL)

If the engine is started with the park brake engaged, the daytime running lamps (DRL) will not illuminate.

Release the park brake in order to illuminate the DRL.

If the engine is started with the park brake released, the DRL will illuminate. Applying the park brake after starting the engine will not disable the DRL.

ABS Description and Operation

General System Description

When wheel slip is detected during a brake application, the ABS enters antilock mode. During antilock braking, hydraulic pressure in the individual wheel circuits is controlled to prevent any wheel from slipping. A separate hydraulic line and specific solenoid valves are provided for each wheel. The ABS can decrease, hold, or increase hydraulic pressure to each wheel brake. The ABS cannot, however, increase hydraulic pressure above the amount which is transmitted by the master cylinder during braking.

During antilock braking, a series of rapid pulsations is felt in the brake pedal. These pulsations are caused by the rapid changes in position of the individual solenoid valves as the EBCM responds to wheel speed sensor inputs and attempts to prevent wheel slip. These pedal pulsations are present only during antilock braking and stop when normal braking is resumed or when the vehicle comes to a stop. A ticking or popping noise may also be heard as the solenoid valves cycle rapidly. During antilock braking on dry pavement, intermittent chirping noises may be heard as the tires approach slipping. These noises and pedal pulsations are considered normal during antilock operation.

Vehicles equipped with ABS may be stopped by applying normal force to the brake pedal. Brake pedal operation during normal braking is no different than that of previous non-ABS systems. Maintaining a constant force on the brake pedal provides the shortest stopping distance while maintaining vehicle stability.

Engine Description and Operation

5.7L V-8 Engine

Engine Mechanical Specifications

Application	Specification	
	Metric	English
General		
• Engine Type	V 8	
• Displacement	5.7L - 5665 cc	346 CID
• RPO	LS1	
• VIN	G	
• Bore	99.0-99.018 mm	3.897-3.898 in
• Stroke	92.0 mm	3.622 in
• Compression Ratio	10.1:1	
• Firing Order	1-8-7-2-6-5-4-3	
• Spark Plug Gap	1.016 mm	0.04 in
Block		
• Camshaft Bearing Bore 1 and 5 Diameter - First Design	59.08-59.13 mm	2.325-2.327 in
• Camshaft Bearing Bore 2 and 4 Diameter - First Design	58.83-58.88 mm	2.316-2.318 in
• Camshaft Bearing Bore 3 Diameter - First Design	58.58-58.63 mm	2.306-2.308 in
• Camshaft Bearing Bore 1 and 5 Diameter - Second Design	59.58-59.63 mm	2.345-2.347 in
• Camshaft Bearing Bore 2 and 4 Diameter - Second Design	59.08-59.13 mm	2.325-2.327 in
• Camshaft Bearing Bore 3 Diameter - Second Design	58.58-58.63 mm	2.306-2.308 in
• Crankshaft Main Bearing Bore Diameter	69.871-69.889 mm	2.75-2.751 in
• Crankshaft Main Bearing Bore Out-of-Round	0.005 mm	0.0002 in
• Cylinder Bore Diameter	99.0-99.018 mm	3.897-3.898 in
• Cylinder Bore Taper - Thrust Side	0.018 mm	0.0007 in
• Cylinder Head Deck Height - Measuring from the Centerline of Crankshaft to the Deck Face	234.57-234.82 mm	9.235-9.245 in
• Cylinder Head Deck Surface Flatness - Measured within a 152.4 mm (6.0 in) Area	0.08 mm	0.003 in
• Cylinder Head Deck Surface Flatness - Measuring the Overall Length of the Block Deck	0.22 mm	0.008 in
• Valve Lifter Bore Diameter	21.417-21.443 mm	0.843-0.844 in
Camshaft		
• Camshaft End Play	0.025-0.305 mm	0.001-0.012 in
• Camshaft Journal Diameter	54.99-55.04 mm	2.164-2.166 in
• Camshaft Journal Out-of-Round	0.025 mm	0.001 in
• Camshaft Lobe Lift - Exhaust	7.43 mm	0.292 in
• Camshaft Lobe Lift - Intake	7.43 mm	0.292 in
• Camshaft Runout - Measured at the Intermediate Journals	0.05 mm	0.002 in
Connecting Rod		
• Connecting Rod Bearing Clearance - Production	0.023-0.065 mm	0.0009-0.0025 in
• Connecting Rod Bearing Clearance - Service	0.023-0.076 mm	0.0009-0.003 in
• Connecting Rod Bore Diameter - Bearing End	56.505-56.525 mm	2.224-2.225 in
• Connecting Rod Bore Out-of-Round - Bearing End -	0.006 mm	0.00023 in

Production		
• Connecting Rod Bore Out-of-Round - Bearing End - Service	0.006 mm	0.00023 in
• Connecting Rod Side Clearance	0.11-0.51 mm	0.00433-0.02 in
Crankshaft		
• Connecting Rod Journal Diameter - Production	53.318-53.338 mm	2.0991-2.0999 in
• Connecting Rod Journal Diameter - Service	53.308 mm	2.0987 in
• Connecting Rod Journal Out-of-Round - Production	0.005 mm	0.0002 in
• Connecting Rod Journal Out-of-Round - Service	0.01 mm	0.0004 in
• Connecting Rod Journal Taper - Maximum for 1/2 of Journal Length - Production	0.005 mm	0.0002 in
• Connecting Rod Journal Taper - Maximum for 1/2 of Journal Length - Service	0.02 mm	0.00078 in
• Crankshaft End Play	0.04-0.2 mm	0.0015-0.0078 in
• Crankshaft Main Bearing Clearance - Production	0.02-0.052 mm	0.0008-0.0021 in
• Crankshaft Main Bearing Clearance - Service	0.02-0.065 mm	0.0008-0.0025 in
• Crankshaft Main Journal Diameter - Production	64.992-65.008 mm	2.558-2.559 in
• Crankshaft Main Journal Diameter - Service	64.992 mm	2.558 in
• Crankshaft Main Journal Out-of-Round - Production	0.003 mm	0.000118 in
• Crankshaft Main Journal Out-of-Round - Service	0.008 mm	0.0003 in
• Crankshaft Main Journal Taper - Production	0.01 mm	0.0004 in
• Crankshaft Main Journal Taper - Service	0.02 mm	0.00078 in
• Crankshaft Rear Flange Runout	0.05 mm	0.002 in
• Crankshaft Reluctor Ring Runout - Measured 1.0 mm (0.04 in) Below the Tooth Diameter	0.7 mm	0.028 in
• Crankshaft Thrust Surface - Production	26.14-26.22 mm	1.029-1.0315 in
• Crankshaft Thrust Surface - Service	26.22 mm	1.0315 in
• Crankshaft Thrust Surface Runout	0.025 mm	0.001 in
Cylinder Head		
• Cylinder Head Height/Thickness - Measured from the Cylinder Head Deck to the Valve Rocker Arm Cover Seal Surface	120.2 mm	4.732 in
• Surface Flatness - Block Deck - Measured Within a 152.4 mm (6.0 in) Area	0.08 mm	0.003 in
• Surface Flatness - Block Deck - Measuring the Overall Length of the Cylinder Head	0.1 mm	0.004 in
• Surface Flatness - Exhaust Manifold Deck	0.22 mm	0.008 in
• Surface Flatness - Intake Manifold Deck	0.22 mm	0.008 in
Intake Manifold		
• Surface Flatness - Measured at Gasket Sealing Surfaces	0.5 mm	0.02 in
Lubrication System		
• Oil Capacity - with Filter	5.7 Liters	6.0 Quarts
• Oil Capacity - without Filter	5.1 Liters	5.4 Quarts
• Oil Pressure - Minimum - Hot	41 kPa at 1,000 engine RPM 124 kPa at 2,000 engine RPM 165 kPa at 4,000 engine RPM	6 psig at 1,000 engine RPM 18 psig at 2,000 engine RPM 24 psig at 4,000 engine RPM
Oil Pan		
• Front Cover Alignment - at Oil Pan Surface	0.0-0.5 mm	0.0-0.02 in

• Rear Cover Alignment - at Oil Pan Surface	0.0-0.5 mm	0.0-0.02 in
• Oil Pan Alignment - to Rear of Engine Block at Transmission Bellhousing Mounting Surface	0.0-0.25 mm	0.0-0.01 in
Piston Rings		
• Piston Ring End Gap - First Compression Ring - Measured in Cylinder Bore - Production	0.23-0.44 mm	0.009-0.017 in
• Piston Ring End Gap - First Compression Ring - Measured in Cylinder Bore - Service	0.23-0.5 mm	0.009-0.0196 in
• Piston Ring End Gap - Second Compression Ring - Measured in Cylinder Bore - Production	0.44-0.7 mm	0.017-0.027 in
• Piston Ring End Gap - Second Compression Ring - Measured in Cylinder Bore - Service	0.44-0.76 mm	0.0173-0.03 in
• Piston Ring End Gap - Oil Control Ring - Measured in Cylinder Bore - Production	0.18-0.75 mm	0.007-0.029 in
• Piston Ring End Gap - Oil Control Ring - Measured in Cylinder Bore - Service	0.18-0.81 mm	0.007-0.032 in
• Piston Ring-to-Groove Clearance - First Compression Ring - Production	0.04-0.086 mm	0.00157-0.0033 in
• Piston Ring-to-Groove Clearance - First Compression Ring - Service	0.04-0.068 mm	0.00157-0.0033 in
• Piston Ring-to-Groove Clearance - Second Compression Ring - Production	0.05-0.088 mm	0.002-0.0034 in
• Piston Ring-to-Groove Clearance - Second Compression Ring - Service	0.05-0.088 mm	0.002-0.0034 in
• Piston Ring-to-Groove Clearance - Oil Control Ring - Production	-0.008 to +0.176 mm	-0.0003 to +0.0069 in
• Piston Ring-to-Groove Clearance - Oil Control Ring - Service	-0.008 to +0.176 mm	-0.0003 to +0.0069 in
Pistons and Pins		
• Piston - Piston Diameter - Non Coated Skirt - at Size Point	98.969-98.987 mm	3.8964-3.8997 in
• Piston - Piston Diameter - Measured Over Coating	98.984-99.027 mm	3.897-3.899 in
• Piston - Piston to Bore Clearance - Non Coated Skirt - Production	0.013-0.049 mm	0.0005-0.0019 in
• Piston - Piston to Bore Clearance - Non Coated Skirt - Service	0.013-0.074 mm	0.0005-0.0029 in
• Piston - Piston to Bore Clearance - Coated Skirt - Production	-0.027 to +0.029 mm	-0.001 to +0.0011 in
• Piston - Piston to Bore Clearance - Coating Worn Off - Service Limit	0.074 mm	0.0029 in
• Pin - First Design Press Fit Pin Fit in Connecting Rod Bore	0.02-0.043 mm - Interference	0.00078-0.00169 in - Interference
• Pin - First Design Press Fit Pin Clearance to Piston Pin Bore - Production	0.01-0.02 mm	0.0004-0.00078 in
• Pin - First Design Press Fit Pin Clearance to Piston Pin Bore - Service	0.01-0.022 mm	0.0004-0.00086 in
• Pin - First Design Press Fit Pin Diameter	23.997-24.0 mm	0.9447-0.9448 in
• Pin - Second Design Full Floating Pin Fit in Connecting Rod Bore - Production	0.007-0.02 mm	0.00027-0.00078 in
• Pin - Second Design Full Floating Pin Fit in Connecting Rod Bore - Service	0.007-0.022 mm	0.00027-0.00086 in
• Pin - Second Design Full Floating Pin Clearance to Piston Pin Bore - Production	0.002-0.01 mm	0.00008-0.0004 in

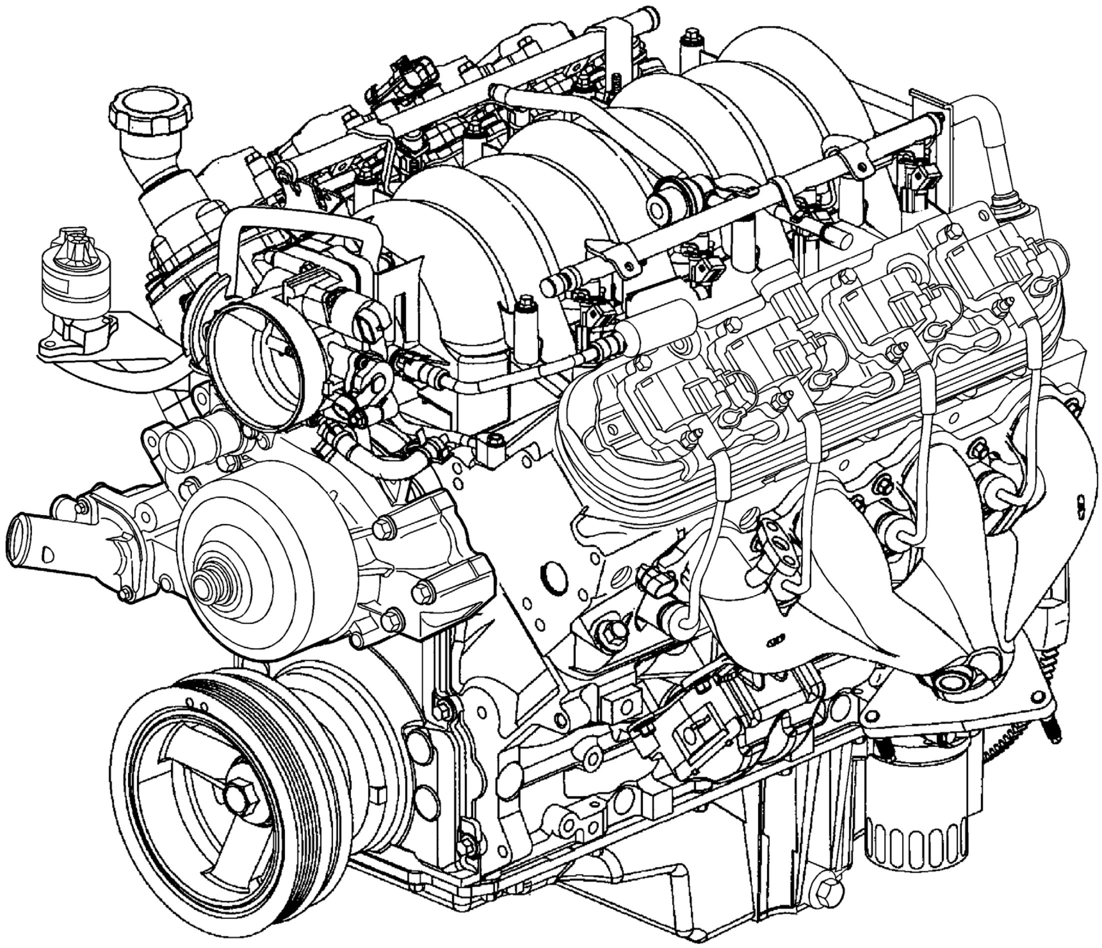
• Pin - Second Design Full Floating Pin Clearance to Piston Pin Bore - Service	0.002-0.015 mm	0.00008-0.0006 in
• Pin - Second Design Full Floating Pin Diameter	23.952-23.955 mm	0.943-0.943 in
Valve System		
• Valves - Valve Face Angle	45 degrees	
• Valves - Valve Face Width	1.25 mm	0.05 in
• Valves - Valve Lash	Net Lash - No Adjustment	
• Valves - Valve Lift - Intake	11.79 mm	0.464 in
• Valves - Valve Lift - Exhaust	12.16 mm	0.479 in
• Valves - Valve Seat Angle	46 degrees	
• Valves - Valve Seat Runout	0.05 mm	0.002 in
• Valves - Valve Seat Width - Exhaust	1.78 mm	0.07 in
• Valves - Valve Seat Width - Intake	1.02 mm	0.04 in
• Valves - Valve Stem Diameter - Production	7.955-7.976 mm	0.313-0.314 in
• Valves - Valve Stem Diameter - Service	7.96 mm	0.314 in
• Valves - Valve Stem-to-Guide Clearance - Production - Intake	0.025-0.066 mm	0.001-0.0026 in
• Valves - Valve Stem-to-Guide Clearance - Service - Intake	0.093 mm	0.0037 in
• Valves - Valve Stem-to-Guide Clearance - Production - Exhaust	0.025-0.066 mm	0.001-0.0026 in
• Valves - Valve Stem-to-Guide Clearance - Service - Exhaust	0.093 mm	0.0037 in
• Rocker Arms - Valve Rocker Arm Ratio	1.70:1	
• Valve Springs - Valve Spring Free Length	52.9 mm	2.08 in
• Valve Springs - Valve Spring Installed Height	45.75 mm	1.8 in
• Valve Springs - Valve Spring Load - Closed	340 N at 45.75 mm	76 lb at 1.8 in
• Valve Springs - Valve Spring Load - Open	980 N at 33.55 mm	220 lb at 1.32 in

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Accelerator Control Cable Bracket Bolts	10 N·m	89 lb in
Camshaft Retainer Bolts	25 N·m	18 lb ft
Camshaft Sensor Bolt	25 N·m	18 lb ft
Camshaft Sprocket Bolts	35 N·m	26 lb ft
Connecting Rod Bolts - First Pass	20 N·m	15 lb ft
Connecting Rod Bolts - Final Pass	75 degrees	
Coolant Temperature Gage Sensor	20 N·m	15 lb ft
Crankshaft Balancer Bolt - Installation Pass to Ensure the Balancer is Completely Installed	330 N·m	240 lb ft
Crankshaft Balancer Bolt - First Pass Install a NEW Bolt After the Installation Pass and Tighten as Described in the First and Final Passes	50 N·m	37 lb ft
Crankshaft Balancer Bolt - Final Pass	140 degrees	
Crankshaft Bearing Cap Bolts - Inner Bolts - First Pass in Sequence	20 N·m	15 lb ft
Crankshaft Bearing Cap Bolts - Inner Bolts - Final Pass in Sequence	80 degrees	
Crankshaft Bearing Cap Side Bolts	25 N·m	18 lb ft
Crankshaft Bearing Cap Studs - Outer Studs - First Pass in Sequence	20 N·m	15 lb ft
Crankshaft Bearing Cap Studs - Outer Studs - Final Pass in Sequence	53 degrees	
Crankshaft Oil Deflector Nuts	25 N·m	18 lb ft
Crankshaft Position Sensor Bolt	25 N·m	18 lb ft
Cylinder Head Bolts - First Design - First Pass all M11 Bolts in Sequence	30 N·m	22 lb ft
Cylinder Head Bolts - First Design - Second Pass all M11 Bolts in Sequence	90 degrees	
Cylinder Head Bolts - First Design - Final Pass all M11 Bolts in Sequence - Excluding the Medium Length Bolts at the Front and Rear of Each Cylinder Head	90 degrees	
Cylinder Head Bolts - First Design - Final Pass M11 Medium Length Bolts at the Front and Rear of Each Cylinder Head	50 degrees	
Cylinder Head Bolts - Second Design - First Pass all M11 Bolts in Sequence	30 N·m	22 lb ft
Cylinder Head Bolts - Second Design - Second Pass all M11 Bolts in Sequence	90 degrees	
Cylinder Head Bolts - Second Design - Final Pass all M11 Bolts in Sequence	70 degrees	
Cylinder Head Bolts - M8 Inner Bolts in Sequence	30 N·m	22 lb ft
Cylinder Head Coolant Plug	20 N·m	15 lb ft
Cylinder Head Core Hole Plug	20 N·m	15 lb ft
Engine Block Coolant Drain Plugs	60 N·m	44 lb ft
Engine Block Oil Gallery Plugs	60 N·m	44 lb ft
Engine Coolant Air Bleed Pipe Bolts and Studs	12 N·m	106 lb in
Engine Flywheel Bolts - First Pass	20 N·m	15 lb ft
Engine Flywheel Bolts - Second Pass	50 N·m	37 lb ft
Engine Flywheel Bolts - Final Pass	100 N·m	74 lb ft
Engine Front Cover Bolts	25 N·m	18 lb ft
Engine Rear Cover Bolts	25 N·m	18 lb ft
Engine Service Lift Bracket M10 Bolts	50 N·m	37 lb ft
Engine Service Lift Bracket M8 Bolt	25 N·m	18 lb ft
Engine Valley Cover Bolts	25 N·m	18 lb ft
Exhaust Manifold Bolts - First Pass	15 N·m	11 lb ft

Exhaust Manifold Bolts - Final Pass	25 N·m	18 lb ft
Exhaust Manifold Heat Shield Bolts	9 N·m	80 lb in
Fuel Injection Fuel Rail Bolts	10 N·m	89 lb in
Ignition Coil-to-Bracket Bolts	12 N·m	106 lb in
Ignition Coil Bracket-to-Valve Rocker Arm Cover Bolts	12 N·m	106 lb in
Intake Manifold Bolts - First Pass in Sequence	5 N·m	44 lb in
Intake Manifold Bolts - Final Pass in Sequence	10 N·m	89 lb in
Knock Sensors	20 N·m	15 lb ft
Oil Filter	30 N·m	22 lb ft
Oil Filter Fitting	55 N·m	40 lb ft
Oil Level Indicator Tube Bolt	25 N·m	18 lb ft
Oil Pan Baffle Bolts	12 N·m	106 lb in
Oil Pan Closeout Cover Bolt - Left Side	12 N·m	106 lb in
Oil Pan Closeout Cover Bolt - Right Side	12 N·m	106 lb in
Oil Pan Drain Plug	25 N·m	18 lb ft
Oil Pan M8 Bolts - Oil Pan-to-Engine Block and Oil Pan-to-Front Cover	25 N·m	18 lb ft
Oil Pan M6 Bolts - Oil Pan-to-Rear Cover	12 N·m	106 lb in
Oil Pan Oil Gallery Plugs	25 N·m	18 lb ft
Oil Pressure Sensor	20 N·m	15 lb ft
Oil Pump-to-Engine Block Bolts	25 N·m	18 lb ft
Oil Pump Cover Bolts	12 N·m	106 lb in
Oil Pump Relief Valve Plug	12 N·m	106 lb in
Oil Pump Screen Nuts	25 N·m	18 lb ft
Oil Pump Screen-to-Oil Pump Bolt	12 N·m	106 lb in
Oil Transfer Cover Nuts	12 N·m	106 lb in
Oil Transfer Tube Bolts	12 N·m	106 lb in
Oil Transfer Tube Studs	12 N·m	106 lb in
Spark Plugs - New Cylinder Heads	20 N·m	15 lb ft
Spark Plugs - all Subsequent Installations	15 N·m	11 lb ft
Throttle Body Bolts	12 N·m	106 lb in
Timing Chain Guide Bolts	35 N·m	26 lb ft
Valve Lifter Guide Bolts	12 N·m	106 lb in
Valve Rocker Arm Bolts	30 N·m	22 lb ft
Valve Rocker Arm Cover Bolts	12 N·m	106 lb in
Water Inlet Housing Bolts	15 N·m	11 lb ft
Water Pump Bolts - First Pass	15 N·m	11 lb ft
Water Pump Bolts - Final Pass	30 N·m	22 lb ft
Water Pump Cover Bolts	15 N·m	11 lb ft

Engine Component Description



The 5.7 Liter V8 engine is identified as RPO LS1 and VIN G.

Camshaft and Drive System

A billet steel one piece camshaft is supported by five bearings pressed into the engine block. The camshaft has a machined camshaft sensor reluctor ring incorporated between the fourth and fifth bearing journals. The camshaft timing sprocket is mounted to the front of the camshaft and is driven by the crankshaft sprocket through the camshaft timing chain. The crankshaft sprocket is splined and drives the oil pump driven gear. A retaining plate mounted to the front of the engine block maintains camshaft location.

Crankshaft

The crankshaft is cast nodular iron. The crankshaft is supported by five crankshaft bearings. The bearings are retained by crankshaft bearing caps which are machined with the engine block for the proper alignment and clearance. The crankshaft journals are undercut and rolled. The center main journal is the thrust journal. A crankshaft position reluctor ring is mounted at the rear of the crankshaft. The reluctor ring is not serviceable separately.

Cylinder Heads

The cylinder head assemblies are cast aluminum and have pressed in place powdered metal valve guides and valve seats. Passages for the Engine Coolant Air Bleed system are at the front and rear of each cylinder head. There are no exhaust gas passages within the cylinder head. The cylinder head design has changed. Valve rocker arm covers are now retained to the cylinder head by four center mounted rocker arm cover bolts.

Engine Block

The engine block is a cam-in-block deep skirt 90 degree V configuration with five crankshaft bearing caps. The engine block is aluminum with cast in place iron cylinder bore liners. The five crankshaft bearing caps each have four vertical M10 and two horizontal M8 mounting bolts. The camshaft is supported by five camshaft bearings pressed into the block.

Exhaust Manifolds

The exhaust manifolds are one piece cast iron design. The exhaust manifolds direct exhaust gasses from the combustion chambers to the exhaust system. Each manifold has a single inlet for the Air Injection Reaction (AIR) system and the left exhaust manifold has a threaded opening for installation of an oxygen sensor. Exhaust system gasses are directed from the right exhaust manifold through the Exhaust Gas Recirculation (EGR) pipe assembly and valve to the intake manifold. The EGR pipe assembly is retained to the exhaust manifold by two bolts and sealed at the exhaust manifold flange with a gasket. Each manifold also has an externally mounted heat shield that is retained by bolts.

Intake Manifold

The IAFM or integrated air fuel module is a one piece composite design that incorporates brass threaded inserts for mounting the fuel rail, throttle cable bracket, throttle body, and EGR inlet pipe. The intake manifold is sealed to the cylinder heads by eight separate nonreusable silicone sealing gaskets which press into the grooves of the intake housing. The cable actuated throttle body assembly bolts to the front of the intake manifold. The throttle body is sealed to the intake manifold by a one piece push in place silicone gasket. The fuel rail assembly with eight separate fuel injectors is retained to the intake by four bolts. The injectors are seated in their individual manifold bores with O-ring seals to provide sealing. A fuel rail stop bracket is retained at the rear of the left fuel rail by the intake manifold mounting bolts. A snap fit Manifold Absolute Pressure (MAP) sensor housing is mounted at the rear of the manifold and sealed by an O-ring seal. The MAP sensor is installed and retained to the MAP sensor housing. An externally mounted Exhaust Gas Recirculation (EGR) pipe assembly installs into the top front of the intake manifold. The EGR pipe assembly is sealed to the intake manifold by an O-ring seal and is retained to the manifold by one bolt. There are no coolant passages within the intake manifold.

Oil Pan

The structural oil pan is cast aluminum. Incorporated into the design are the oil filter mounting boss, drain plug opening, oil level sensor mounting bore, and oil pan baffle. The oil pan cover and oil level sensor mount to the side of the oil pan. The alignment of the structural oil pan to the rear of the engine block and transmission bell housing is critical.

Piston and Connecting Rod Assemblies

The pistons are cast aluminum. The pistons use two compression rings and one oil control ring assembly. The piston is a low friction, lightweight design with a flat top and barrel shaped skirt. The piston pins are chromium steel. They have a floating fit in the piston and are retained by a press fit in the connecting rod. The connecting rods are powdered metal. The connecting rods are fractured at the connecting rod journal and then machined for the proper clearance. The piston, pin, and connecting rod are to be serviced as an assembly.

Valve Rocker Arm Cover Assemblies

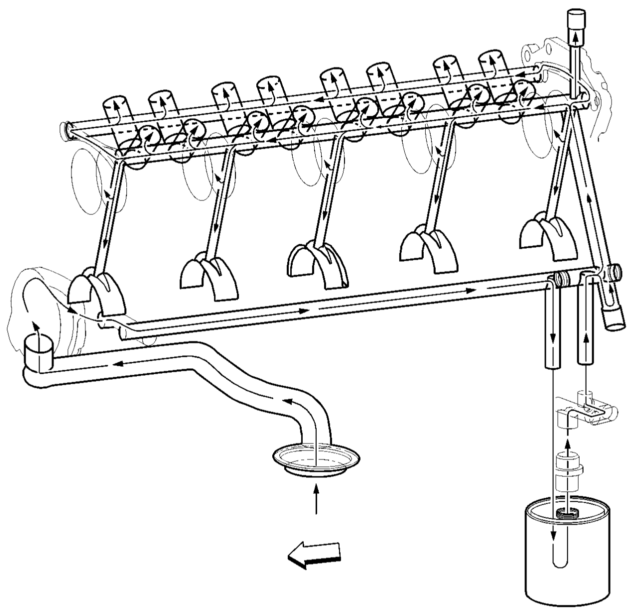
The valve rocker arm covers are cast aluminum and use a pre-molded silicone gasket for sealing. Mounted to each rocker cover is an ignition coil and bracket assembly. Incorporated into the covers are the oil fill tube, the Positive Crankcase Ventilation (PCV) system passages, and the engine fresh air passages. Rocker arm cover design has changed. The covers are now retained to the cylinder head by four center mounted rocker cover bolts.

Valve Train

Motion is transmitted from the camshaft through the hydraulic roller valve lifters and tubular pushrods to the roller type rocker arms. The valve lifter guides position and retain the valve lifters. The valve rocker arms for each bank of cylinders are mounted on pedestals (pivot supports). Each rocker arm is retained on the pivot support and cylinder head by a bolt. Valve lash is net build.

Lubrication

Lubrication Flow Schematic



Engine lubrication is supplied by a gerotor type oil pump assembly. The pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump through a pick-up screen and pipe. The oil is pressurized as it passes through the pump and is sent through the engine block oil galleries. Contained within the oil pump assembly is a pressure relief valve that maintains oil pressure within a specified range. Pressurized oil is directed through the lower gallery to the full flow oil filter where harmful contaminants are removed. A bypass valve is incorporated into the oil pan which will permit oil flow in the event the filter becomes restricted. At the rear of the block, oil is then directed to the upper main oil galleries which are drilled just above the camshaft assembly. From there oil is then directed to the crankshaft and camshaft bearings. Oil that has entered the upper main oil galleries also pressurizes the valve lifter assemblies and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems. Oil returning to the pan is directed by the crankshaft oil deflector. Oil temperature, pressure and crankcase level are each monitored by individual sensors.

Drive Belt System Description

The drive belt system consists of the following components:

- The drive belt
- The drive belt tensioner
- The drive belt idler pulley
- The crankshaft balancer pulley
- The accessory drive component mounting brackets
- The accessory drive components

- The power steering pump, if belt driven
- The generator
- The A/C compressor, if equipped
- The engine cooling fan, if belt driven
- The water pump, if belt driven
- The vacuum pump, if equipped
- The air compressor, if equipped

The drive belt system may use one belt or two belts. The drive belt is thin so that it can bend backwards and has several ribs to match the grooves in the pulleys. There also may be a V-belt style belt used to drive certain accessory drive components. The drive belts are made of different types of rubbers (chloroprene or EPDM) and have different layers or plys containing either fiber cloth or cords for reinforcement.

Both sides of the drive belt may be used to drive the different accessory drive components. When the back side of the drive belt is used to drive a pulley, the pulley is smooth.

The drive belt is pulled by the crankshaft balancer pulley across the accessory drive component pulleys. The spring loaded drive belt tensioner keeps constant tension on the drive belt to prevent the drive belt from slipping. The drive belt tensioner arm will move when loads are applied to the drive belt by the accessory drive components and the crankshaft.

The drive belt system may have an idler pulley, which is used to add wrap to the adjacent pulleys. Some systems use an idler pulley in place of an accessory drive component when the vehicle is not equipped with the accessory.

Crankcase Ventilation System Description

The engine ventilation system was developed to remove the engine combustion blow-by vapors and minimize the following:

- Crankcase pressure build-up
- Oil deterioration
- Oil consumption
- Evaporative exhaust emissions

During normal idle and part throttle operation, filtered fresh air is routed from upstream of the throttle body blade to the front of the right rocker cover via the fresh air inlet hose.

Blow-by gas in the crankcase valley passes through the oil separator and then flows through the fixed internal flow-restricting orifice.

Via the foul air hose, the blow-by gas is directed from the valley cover right-hand corner to the inlet manifold downstream of the throttle body.

Under heavy load operation and high engine speeds, and acceptable reverse flow condition may occur in the fresh air inlet hose.

During sustained maximum lateral acceleration, the outboard rocker cover may be overloaded with oil. If the blow-by gas is drawn from the rocker cover as in previous design, oil may be ingested into the intake manifold.

The Central Valley Ventilation System is designed to eliminate oil ingestion during severe vehicle cornering maneuvers.

Instead of the blow-by gas being drawn from the rocker cover, a high efficiency oil separator in conjunction with an internal flow-restricting orifice is fitted under the valley cover to draw the blow-by gas from the crankcase.

Engine Cooling

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Automatic Transmission Oil Cooler Line Fitting	25 N·m	18 lb ft
Cooling Fan Motor Bolt	5 N·m	44 lb in
Oil Pan Shield	30 N·m	22 lb ft
Radiator Surge Tank Nut	10 N·m	89 lb in
Water Pump Bolts		
First Pass	15 N·m	11 lb ft
Final Pass	25 N·m	18 lb ft
Water Pump Inlet	14 N·m	10 lb ft

Cooling System Description and Operation

The cooling system's function is to maintain an efficient engine operating temperature during all engine speeds and operating conditions. The cooling system is designed to remove approximately one-third of the heat produced by the burning of the air-fuel mixture. When the engine is cold, the system cools slowly or not at all. This allows the engine to warm quickly.

Cooling Cycle

Coolant is drawn from the radiator outlet and into the water pump inlet by the water pump. Some coolant will then be pumped from the water pump, to the heater core, then back to the water pump. This provides the passenger compartment with heat and defrost.

Coolant is also pumped through the water pump outlet and into the engine block. In the engine block, the coolant circulates through the water jackets surrounding the cylinders where it absorbs heat.

The coolant is then forced through the cylinder head gasket openings and into the cylinder heads. In the cylinder heads, the coolant flows through the water jackets surrounding the combustion chambers and valve seats, where it absorbs additional heat.

Coolant is also directed to the throttle body. There it circulates through passages in the casting. During initial start-up, the coolant assists in warming the throttle body. During normal operating temperatures, the coolant assists in keeping the throttle body cool.

From the cylinder heads, the coolant is then forced to the thermostat. The flow of coolant will either be stopped at the thermostat until the engine is warmed, or it will flow through the thermostat and into the radiator where it is cooled and the coolant cycle is completed.

Operation of the cooling system requires proper functioning of all cooling system components. The cooling system consists of the following components:

Coolant

The engine coolant is a solution made up of a 50-50 mixture of DEX-COOL and clean drinkable water. The coolant solution carries excess heat away from the engine to the radiator, where the heat is dissipated to the atmosphere.

Radiator

The radiator is a heat exchanger. It consists of a core and 2 tanks. The aluminum core is a crossflow tube and fin design. This is a series of tubes that extend side to side from the inlet tank to the outlet tank. Fins are placed around the outside of the tubes to improve heat transfer from the coolant to the atmosphere. The inlet and outlet tanks are molded with a high temperature, nylon reinforced plastic. A high temperature rubber gasket seals the tank flange edge. The tanks are clamped to the core with clinch tabs. The tabs are part of the aluminum header at each end of the core.

The radiator removes heat from the coolant passing through it. The fins on the core absorb heat from the coolant passing through the tubes. As air passes between the fins, it absorbs heat and cools the coolant.

During vehicle use, the coolant heats and expands. The coolant that is displaced by this expansion flows into the surge tank. As the coolant circulates, air is allowed to exit. This is an advantage to the cooling system. Coolant without bubbles absorbs heat much better than coolant with bubbles.

Screw On Pressure Cap

The pressure cap is a cap that seals and pressurizes the cooling system. It contains a blow off or pressure valve and a vacuum or atmospheric valve. The pressure valve is held against its seat by a spring of predetermined strength, which protects the radiator by relieving pressure if it exceeds 15 psi. The vacuum valve is held against its seat by a spring, which permits opening of the valve to relieve vacuum created in the cooling system as it cools off. The vacuum, if not relieved, might cause the radiator to collapse.

The pressure cap allows pressure in the cooling system to build up. As the pressure builds, the boiling point of the coolant goes up as well. Therefore, the coolant can be safely run at a temperature much higher than the boiling point of the coolant at atmospheric pressure. The hotter the coolant is, the faster the heat moves from the radiator to the cooler, passing air. The pressure in the cooling system can get too high; however, when the pressure exceeds the strength of the spring, it raises the pressure valve so that the excess pressure can escape. As the engine cools down, the temperature of the coolant drops and a vacuum is created in the cooling system. This vacuum causes the vacuum valve to open, allowing outside air into the cooling system. This equalizes the pressure in the cooling system with atmospheric pressure, preventing the radiator from collapsing.

Coolant Surge Tank

The coolant surge tank is connected to the engine cooling system by a pressure hose from the heater connection at the coolant pump and a vapor hose from the left hand radiator side tank.

As the engine temperature rises, the coolant heats and expands. The fluid displaced by the expansion flows into the coolant surge tank. When the engine is turned OFF, the coolant contracts as it cools and the pressure in the surge tank returns to atmospheric, by the unsealing of the vacuum valve in the screw-on pressure cap, if necessary.

Coolant level should be maintained at the indicated point on the side of the surge tank, when the engine is cold, by sighting the level externally. A coolant level switch is installed in the surge tank to alert the operator if the coolant level gets too low.

Air Baffles and Seals

The cooling system uses deflectors and air baffles to increase system cooling. Deflectors are installed under the vehicle to redirect air flow beneath the vehicle to flow through the radiator and increase cooling. Air baffles are also used to direct air flow into the radiator and increase cooling.

Water Pump

The water pump is a centrifugal vane impeller type pump. The pump consists of a housing with coolant inlet and outlet passages and an impeller. The impeller is a flat plate mounted on the pump shaft with a series of flat or curved blades or vanes. When the impeller rotates, the coolant between the vanes is thrown outward by centrifugal force. The impeller shaft is supported by one or more sealed bearings. These sealed bearings never need to be lubricated. With a sealed bearing, grease cannot leak out, and dirt and water cannot get in.

The purpose of the water pump is to circulate coolant throughout the cooling system. The water pump is driven by the crankshaft via the drive belt.

Thermostat

The thermostat is a coolant flow control component. It's purpose is to regulate the operating temperature of the engine. It utilizes a temperature sensitive wax-pellet element. The element connects to a valve through a piston. When the element is heated, it expands and exerts pressure against a rubber diaphragm. This pressure forces the valve to open. As the element is cooled, it contracts. This contraction allows a spring to push the valve closed.

When the coolant temperature is below 86°C (186°F), the thermostat valve remains closed. This prevents circulation of the coolant to the radiator and allows the engine to warm up quickly. After the coolant temperature reaches 86°C (186°F), the thermostat valve will open. The coolant is then allowed to circulate through the thermostat to the radiator where the engine heat is dissipated to the atmosphere. The thermostat also provides a restriction in the cooling system, even after it has opened. This restriction creates a pressure difference which prevents cavitation at the water pump and forces coolant to circulate through the engine block.

Transmission Oil Cooler

The transmission oil cooler is a heat exchanger. It is located inside the left side end tank of the radiator. The transmission fluid temperature is regulated by the temperature of the engine coolant that surrounds the oil cooler as the transmission fluid passes down through the cooler.

The transmission oil pump pumps the fluid through the transmission oil cooler feed line to the oil cooler. The fluid then flows down through the cooler while the engine coolant absorbs heat from the fluid. The fluid is then pumped through the transmission oil cooler return line to the transmission.

Cooling Fan Operation

The cooling system includes 2 dual speed engine cooling fan motors, both of which drive fans with 5 asymmetrical blades to reduce air noise. The fans remove heat from both the engine coolant flowing through the radiator and the refrigerant flowing through the air conditioning condenser. The fan and motor assemblies are mounted on a common shroud, which in turn is mounted onto the engine side of the radiator. The A/C condenser is mounted to the front of the radiator.

Engine Electrical

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Battery Hold Down Retainer Bolt	18 N·m	13 lb ft
Battery Tray Bolt	12 N·m	106 lb in
Engine Harness Cable Nut	13 N·m	10 lb ft
Generator Bolt	50 N·m	37 lb ft
Generator Bracket Bolt	50 N·m	37 lb ft
Generator Shaft Nut	75 N·m	55 lb ft
Ground Strap Bolt	32 N·m	24 lb ft
Ground Strap Nut	8 N·m	71 lb in
Instrument Panel (I/P) Wiring Harness Junction Block Nut	10 N·m	89 lb in
Negative Battery Cable Ground Nut	8 N·m	71 lb in
Negative Battery Cable Terminal Bolt	8 N·m	71 lb in
Negative Battery Cable to Battery Bolt	15 N·m	11 lb ft
Positive Battery Cable Bolt	15 N·m	11 lb ft
Positive Battery Cable Nut at Fuse/Relay Center	8 N·m	71 lb in
Positive Battery Cable Nut at Solenoid	10 N·m	89 lb in
Positive Battery Cable to Starter Motor Stud Nut	15 N·m	11 lb ft
S Terminal Nut	4 N·m	35 lb in
Starter Motor Bolt	50 N·m	37 lb ft

Battery Usage

Application	Specification
Cold Cranking Amperage (CCA)	600 A
Reserve Capacity	115 Minutes
Replacement Model Number	86-7YR

Battery Temperature vs Minimum Voltage

Estimated Temperature °F	Estimated Temperature °C	Minimum Voltage
70 or above	21 or above	9.6
50	10	9.4
32	0	9.1
15	-10	8.8
0	-18	8.5
Below 0	Below -18	8.0

Starter Motor Usage

Application	Model
5.7L (LS1)	Mitsubishi

Generator Usage

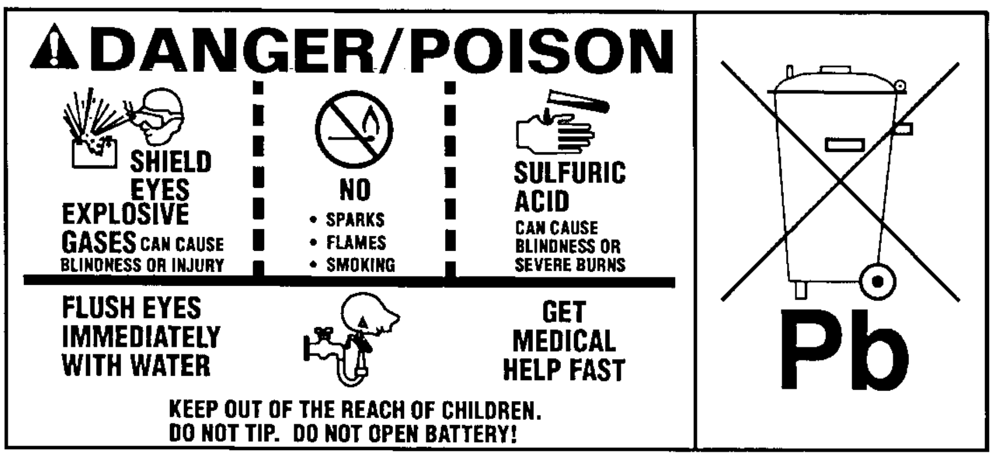
Application	Specification
Model	Mitsubishi
Rated Output	140 A

Battery Description and Operation

Caution

Batteries produce explosive gases, contain corrosive acid, and supply levels of electrical current high enough to cause burns. Therefore, to reduce the risk of personal injury when working near a battery:

- **Always shield your eyes and avoid leaning over the battery whenever possible.**
- **Do not expose the battery to open flames or sparks.**
- **Do not allow the battery electrolyte to contact the eyes or the skin. Flush immediately and thoroughly any contacted areas with water and get medical help.**
- **Follow each step of the jump starting procedure in order.**
- **Treat both the booster and the discharged batteries carefully when using the jumper cables.**



The maintenance free battery is standard. There are no vent plugs in the cover. The battery is completely sealed except for two small vent holes in the side. These vent holes allow the small amount of gas that is produced in the battery to escape.

The battery has three functions as a major source of energy:

- Engine cranking
- Voltage stabilizer
- Alternate source of energy with generator overload.

The battery specification label (example below) contains information about the following:

- The test ratings
- The original equipment catalog number
- The recommended replacement model number

CATALOG NO.

1819

CCA	LOAD TEST
770	**380**
REPLACEMENT MODEL	
100 – 6YR	

A battery has 2 ratings:

- Reserve capacity
- Cold cranking amperage

When a battery is replaced use a battery with similar ratings. Refer to the battery specification label on the original battery or refer to Battery Usage .

Reserve Capacity

Reserve capacity is the amount of time in minutes it takes a fully charged battery, being discharged at a constant rate of 25 amperes and a constant temperature of 27°C (80°F) to reach a terminal voltage of 10.5 V. Refer to Battery Usage for the reserve capacity rating of the original equipment battery.

Cold Cranking Amperage

The cold cranking amperage is an indication of the ability of the battery to crank the engine at cold temperatures. The cold cranking amperage rating is the minimum amperage the battery must maintain for 30 seconds at -18°C (0°F) while maintaining at least 7.2 volts. Refer to Battery Usage for the cold cranking amperage rating for this vehicle.

Circuit Description

The battery positive terminal supplies Battery Positive voltage to the under hood fuse block and the rear fuse block. The under hood fuse block provides a cable connection for the generator and a cable connection for the starter.

The battery negative terminal is connected to chassis ground G305 and supplies ground for the AD converter in the DIM.

Starting System Description and Operation

General Information

The GEN III V8 engine is fitted with a Mitsubishsi, 6-pole, 4-brush starter motor. This consists of a solenoid switch on a DC motor that has permanent magnet excitation. This has the advantage of low weight with high output torque.

The Mitsubishi starter motor does not have field coil windings or pole shoes. These parts have been replaced by permanent magnets that are held in the pole housing clips. The positive brushes are now part of the brush plate assembly.

Operation

The battery cable supplies a constant connection from the battery to terminal 30 of the solenoid switch . The ignition switch and the neutral-start switch for automatic vehicles controls the activation of the start relay.

With the ignition switch in the START position and the automatic transmission in P (park) or N (neutral) and the manual clutch pressed to the floor on manual transmission only, current flows via the start relay to terminal 50 of the solenoid switch. This activated the solenoid switch winding. The pull-in winding causes powerful magnetism to pull in the solenoid switch plunger. The hold-in winding holds the plunger in and the pull-in winding deactivates.

The solenoid switch simultaneously closes the switch contacts to connect terminal 30 to the DC motor and pivots the fork lever to engage the drive assembly to the flexplate or flywheel ring gear.

When the solenoid switch contacts closed, current flows from the battery through the DC motor, which spins and provides cranking torque.

Starter Relay

The Powertrain Integration Module (PIM) controls the operation of the starter relay. When the ignition switch is turned to the ON position , the PIM will enable the starter relay for one second. If the PIM does not receive the correct theft deterrent signal from the Body Control Module (BCM), it will disable the starter relay. If the PIM receives the correct signal from the BCM, it will continue to enable the start relay. When the engine has started and the engine speed is above 500 RPM, the PIM will disable the starter relay, preventing starter engagement while the engine is running.

If the serial data bus between the BCM and the PIM should fail (no polling from the BCM for more than 60 seconds) after successful theft deterrent communications, the PIM will allow subsequent starts, however there will be a crank delay of one second. If the PIM receives valid communication, normal operation will resume.

If the Class II serial date bus between the PIM and the Powertrain Control Module (PCM) should fail, no communications for 20 seconds, after successful theft deterrent communications, the PCM will allow subsequent starts, however there will be a crank delay of one second. If communications between the PCM and the PIM are re-established, normal operation will resume.

Solenoid Switch

The solenoid switch is used to activate the DC motor and has 2 windings; the pull-in winding and the hold-in winding. The pull-in winding has heavier wire and is grounded through the DC motor winding and brushes. The hold-in winding is grounded to the solenoid casing.

Planetary Drive Train

The planetary drive train consists of an internally toothed ring gear and 3 planetary gear wheels which rotate on needle bearings on the planetary drive shaft. The ring gear is keyed into the drive-end housing and is made from high-grade polyamide with mineral additives.

When the starter motor is operated, the armature turns the planetary gears inside the fixed planetary ting gear. This drives the planetary shaft at a reduced speed ratio approximately 3.36:1, which turns the drive assembly. A fork lever in the drive end housing forces the drive assembly to slide forward and engage with the engine flexplate or flywheel ring gear to transmit cranking torque.

An internal clutch allows the drive assembly pinion gear to rotate freely when the engine starts. This prevents the armature from being driven at excessive speed by the engine.

Armature

The armature shaft is supported at each end by oil absorbent sintered metal bushings; one in the commutator end shield and one in the planetary drive shaft. These bushings require lubrication only at the time of overhaul. The front end of the armature has a gear profile. This meshes with the three planetary gear wheels. These in turn mesh with the internal teeth of the ting gear.

Brushes

A brush plate supports 4 commutator brushes. This plate is fixed to the commutator end shield with 2 retaining screws. Two negative brushes are grounded to the pole housing. Two positive brushes are insulated from the pole housing and connected to the solenoid switch M terminal.

Charging System Description and Operation

Generator

The GTO is fitted with a Mitsubishi 140-amp generator. This generator is mounted on the lower , left --hand side of the engine. It has an internally mounted regulator; a single lower mounting lug and no external cooling fans.

The generator is 3 phase, incorporating a rotor with 6 pole pairs and 2 internal cooling fans; one on the drive end and one on the slip-ring end. The rotor is supported by ball bearing races in both the drive and slip-ring end housings. The stator surrounds the rotor and has a 3-phase star connected output winding on a ring shaped lamination pack.

The output of the stator winding is rectified by 8 diodes within the slip-rind end housing, Excitation current is supplied to the rotor field coil via the voltage regulator, the brushes and slip-rings. The electronic voltage regulator requires no adjustment in service.

The generator has 4 external connections:

- B+ lead to the battery positive terminal
- L lead to the generator warning lamp (max. 2 watts)
- S lead for battery voltage sensing
- ground connection (via the installation bolts)

Circuit Description

With the ignition switched on , current is supplied via the warning lamp to the L terminal of the regulator. This allows current to flow (within the regulator) from the generator B+ to the brushes and rotor winding.

The current in the rotor winding creates magnetic fields between adjacent rotor poles. As the rotor spins, the stator winding cut through this field at right angles and induce voltage. As the speed increases, this induced voltage increases. Current then flows through the three-phase diode bridge in the rectifier to convert the AC voltage to DC. This is supplied to the B+ output ant hen to the battery.

The regulator S terminal monitors the system voltage. When this voltage reaches approximately 14.2 volts, the regulator breaks the circuit through the rotor winding, causing the generator output voltage to drop. When the regulator S terminal senses a voltage below a preset value, the regulator completes the circuit and voltage to the battery again increases. This cycle repeats very rapidly.

If the warning lamp fails, the generator self excites by using current from the phase connection until the voltage builds up to the regulating level

Current does not flow through the rotor winding when the engine is cranking.

Standby Mode

With the ignition on and the engine at rest, the regulator defaults to active standby mode. This limits the current through the rotor by switching ON and OFF at 50 percent duty cycle with a frequency of approximately 4 kHz. This is audible at times.

Backup mode

The regulator compares voltage at the B+ terminal with voltage sensed at the S terminal. The regulator defaults to backup mode if the difference exceeds a preset value. Backup mode limits the output voltage to a safe level approximately 1-3 volts above the normal setting.

Warning Lamp Conditions

The regulator illuminate the warning lamp when it detects a fault condition in the generator or the external circuits. The warning lamp remains illuminated until all faults are repaired.

Fault conditions include:

- Open circuit in the regulator battery sensing wire S terminal
- Open circuit or excessive voltage drop in the B+ cable
- Open circuit in the generator phase connection
- Overcharge of the battery
- Short circuit in the regulator output stage
- Open circuit in the rotor winding
- Poor contact in a wiring harness connector
- Poor contact between the rectifier and the regulator
- High resistance in the fusible link assembly
- Poor contact between the battery terminals and cables

Engine Controls

Fuel System Specifications

If you have the 5.7L V8 engine (VIN Code G), use premium unleaded gasoline rated at 91 octane or higher for best performance. You may use middle grade or regular unleaded gasolines, but your vehicle may not accelerate as well.

It is recommended that the gasoline meet specification which have been developed by the American Automobile Manufactures Association (AAMA) and endorsed by the Canadian Motor Vehicle Manufacturers Association for better vehicle performance and engine protection. Gasolines meeting the AAMA specification could provide improved driveability and emission control system performance compared to other gasolines. For more information, write to : American Automobile Manufacturer's Association, 7430 Second Ave, Suite 300, Detroit MI 48202.

Be sure the posted octane for premium is at least 91 (at least 89 for middle grade and 87 for regular). If the octane is less than 87, you may get a heavy knocking noise when you drive. If it's bad enough, it can damage your engine.

If you're using fuel rated at the recommended octane or higher and you hear heavy knocking, your engine needs service. But don't worry if you hear a little pinging noise when you're accelerating or driving up a hill. That's normal, and you don't have to buy a higher octane fuel to get rid of pinging. It's the heavy, constant knock that means you have a problem.

Notice

Your vehicle was not designed for fuel that contains methanol. Do not use methanol fuel which can corrode metal parts in your fuel system and also damage plastic and rubber parts. This kind of damage would not be covered under your warranty.

If your vehicle is certified to meet to meet California Emission Standards (indicated on the under hood emission control label), it is designed to operate on fuels that meet California specifications. If such fuels are not available in states adopting California emissions standards, your vehicle will operate satisfactorily on fuels meeting federal specifications, but emission control system performance may be affected. The malfunction indicator lamp on your instrument panel may turn on and/or your vehicle may fail a smog-check test. If this occurs, return to your authorized dealer for diagnosis to determine the cause of failure. In the event it is determined that the cause of the condition is the type of fuels used, repairs may not be covered by your warranty.

Some gasolines that are not reformulated for low emissions may contain an octane-enhancing additive called methylcyclopentadienyl manganese tricarbonyl (MMT); ask your service station operator whether or not the fuel contains MMT.

Ignition System Specifications

Application	Specification	
	Metric	English
Firing Order	1-8-7-2-6-5-4-3	
Spark Plug Gap	1.52 mm	0.060 in
Spark Plug Torque	15 N·m	11 lb ft
Spark Plug Type	41-952 [AC plug type]	
Spark Plug Wire Resistance	700 ohms per ft	

Fastener Tightening Specifications

Application	Specifications	
	Metric	English
Air Cleaner Lower Housing Securing Bolts	10 N·m	89 lb in
Air Cleaner Upper Housing Securing Screws	5 N·m	44 lb in
A/C Refrigerant Pressure Sensor	6 N·m	53 lb in
Camshaft Position (CMP) Sensor Bolt	25 N·m	18 lb ft
Crankshaft Position (CKP) Sensor Bolt	25 N·m	18 lb ft
Engine Coolant Temperature (ECT) Sensor	20 N·m	15 lb ft
Evaporative Emissions (EVAP) Canister Retaining Nut	6 N·m	53 lb in
Fuel Pump And Sender Assembly Ground Terminal Nut	7 N·m	62 lb in
Fuel Filler Pocket Fastening Nut	5 N·m	44 lb in
Fuel Fill Hose Clamps	2.5 N·m	22 lb in
Fuel Pipe Shield Nuts and Bolts	5 N·m	44 lb in
Fuel Rail Attaching Bolts	10 N·m	89 lb in
Fuel Tank Strap Upper Fastening Nut	20 N·m	15 lb ft
Fuel Tank Strap Lower Fastening Nut	40 N·m	30 lb ft
Heated Oxygen Sensor (HO2S)	41 N·m	30 lb ft
Idle Air Control (IAC) Valve Attaching Screws	3 N·m	27 lb ft
Ignition Coil Mounting Bolt	12 N·m	106 lb in
Knock Sensor (KS)	20 N·m	15 lb ft
Powertrain Control Module (PCM) Connector End Bolts	8 N·m	70 lb in
Powertrain Control Module (PCM) Mounting Bracket Assembly Fastener	7 N·m	62 lb in
Spark Plug New Cylinder Head	20 N·m	15 lb ft
Spark Plug Old Cylinder Head	15 N·m	11 lb ft
Throttle Body Attaching Bolts	12 N·m	106 lb in
Throttle Position (TP) Sensor Attaching Screws	2 N·m	18 lb in

Exhaust System

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Engine Coolant Temperature Sensor	20 N·m	15 lb ft
Exhaust Catylitic Converter to Muffler Flange Bolt	45 N·m	33 lb ft
Exhaust Manifold Bolts		
• First Pass	15 N·m	11 lb ft
• Final Pass	25 N·m	18 lb ft
Exhaust Manifold Heat Shield Bolt	9 N·m	80 lb in
Exhaust Manifold to Exhaust Pipe Flange Nut	25 N·m	18 lb ft
Exhaust Rear Pipe Ring Clamp Nuts	43 N·m	32 lb ft
Exhaust Support Brace Bracket Bolts	35 N·m	26 lb ft

Exhaust System Description

Important

Use of non-OEM parts may cause driveability concerns.

The exhaust system design varies according to the model designation and the intended use of the vehicle.

In order to secure the exhaust pipe to the exhaust manifold, the exhaust system utilizes a flange and seal joint coupling. A flange and gasket coupling secures the catalytic converter assembly to the muffler assembly.

Hangers suspend the exhaust system from the underbody, allowing some movement of the exhaust system and disallowing the transfer of noise and vibration into the vehicle.

Heat shields protect the vehicle from the high temperatures generated by the exhaust system.

Resonator

Some exhaust systems are equipped with a resonator. The resonator, located either before or after the muffler, allows the use of mufflers with less back pressure. Resonators are used when vehicle characteristics require specific exhaust tuning.

Catalytic Converter

The catalytic converter is an emission control device added to the engine exhaust system in order to reduce hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx) pollutants from the exhaust gas.

The catalytic converter is comprised of a ceramic monolith substrate, supported in insulation and housed within a sheet metal shell. The substrate may be washcoated with 3 noble metals:

- Platium (Pt)
- Palladium (Pd)
- Rhodium (Rh)

The catalyst in the converter is not serviceable.

Muffler

The exhaust muffler reduces the noise levels of the engine exhaust by the use of tuning tubes. The tuning tubes create channels inside the exhaust muffler that lower the sound levels created by the combustion of the engine.

Transmission Description and Operation

Automatic Transmission – 4L60E

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Accumulator Cover to Case Bolt	12.0 N·m	9 lb ft
Converter Cover Bolt	8 N·m	6 lb ft
Converter Housing to Case Bolt	70.0 N·m	52 lb ft
Cooler Pipe Quick Connect Fittings to Case	38.0 N·m	28 lb ft
Detent Spring to Valve Body Bolt	25.0 N·m	18 lb ft
Extension Housing to Case Bolt	45.0 N·m	33 lb ft
Floorshift Control Bolt	15 N·m	11 lb ft
Flywheel to Torque Converter Bolt	65 N·m	48 lb ft
Forward Accumulator Cover to Valve Body Bolt	12 N·m	9 lb ft
Manual Shaft to Inside Detent Lever Nut	25 N·m	18 lb ft
Oil Level Indicator Bolt	25 N·m	18 lb ft
Oil Pan to Transmission Case Bolt	12 N·m	9 lb ft
Oil Passage Cover to Case Bolt	12 N·m	9 lb ft
Park/Neutral Position Switch Retaining Bolt	25 N·m	18 lb in
Pressure Control Solenoid Bracket to Valve Body Bolt	12 N·m	9 lb ft
Pump Assembly to Case Bolt	30 N·m	22 lb ft
Pump Cover to Pump Body Bolt	25 N·m	18 lb ft
Shift Control Cable Attachment	20 N·m	15 lb ft
Speed Sensor Retainer Bolt	12 N·m	9 lb ft
TCC Solenoid Assembly to Case Bolt	12 N·m	9 lb ft
Trans Mount to Transmission Extension Bolt	58 N·m	43 lb ft
Trans Mount to Transmission Nut	25 N·m	18 lb ft
Transmission Oil Cooler Pipe Quick Connect Fitting To Transmission	38 N·m	28 lb ft
Transmission Oil Pan to Case Bolt	12 N·m	9 lb ft
Transmission to Engine Bolt	38 N·m	28 lb ft
Valve Body to Case Bolt	12 N·m	9 lb ft

Transmission General Specifications

Name	Hydra-Matic 4L60-E
Vehicle Platform, Engine/Transmission, Usage	V
Transmission Drive	Longitudinally-Mounted Rear Wheel Drive
1st Gear Ratio	3.059:1
2nd Gear Ratio	1.625:1
3rd Gear Ratio	1.000:1
4th Gear Ratio	0.696:1
Reverse	2.294:1
Nominal Torque Converter Diameter	300 mm
Pressure Taps	Line Pressure
Transmission Fluid Type	DEXRON® III
Transmission Fluid Capacity, Approximate	300 mm Converter Dry: 10.8 l (11.4 qt)
Transmission Type: 4	Four Forward Gears
Transmission Type: L	Longitudinal Mount
Transmission Type: 60	Product Series
Transmission Type: E	Electronic Controls
Position Quadrant	P, R, N, Overdrive, 3, 2, 1
Case Material	Die Cast Aluminum
Transmission Weight Dry, Approximate	300 mm Converter 86.17 kg (190.5 lb)
Transmission Weight Wet, Approximate	300 mm Converter 98.4 kg (218.0 lb)

Fluid Capacity Specifications

Application	Specification	
	Metric	English
Bottom Pan Removal	5 liters	5.2 quarts
Complete Overhaul	10.8 liters	11.4 quarts
(measurements are approximate)		

Transmission Component and System Description

The 4L60E transmission consists primarily of the following components:

- Torque converter assembly
- Servo assembly and 2-4 band assembly
- Reverse input clutch and housing
- Overrun clutch
- Forward clutch
- 3-4 clutch
- Forward sprag clutch assembly
- Lo and reverse roller clutch assembly
- Lo and reverse clutch assembly
- Two planetary gear sets: Input and Reaction
- Oil pump assembly
- Control valve body assembly

The electrical components of the 4L60-E are as follows:

- 1-2 and 2-3 shift solenoid valves
- 3-2 shift solenoid valve assembly
- Transmission pressure control (PC) solenoid
- Torque converter clutch (TCC) solenoid valve
- TCC pulse width modulation (PWM) solenoid valve
- Automatic transmission fluid pressure (TFP) manual valve position switch
- Automatic transmission fluid temperature (TFT) sensor
- Vehicle speed sensor assembly

Adapt Function

Transmission Adapt Function

The 4L60-E transmission uses a line pressure control system, which has the ability to continuously adapt the system's line pressure. This compensates for normal wear of the following parts:

- The clutch fiber plates
- The seals
- The springs

The PCM maintains the Upshift Adapt parameters for the transmission The PCM monitors the AT ISS sensor and the AT OSS during commanded shifts in order to determine if a shift is occurring too fast or too slow. The PCM adjusts the signal from the transmission pressure control solenoid in order to maintain a set shift feel.

Transmission adapts must be reset whenever the transmission is overhauled or replaced.

Automatic Transmission Shift Lock Control Description

The automatic transmission shift lock control is a safety device that prevents an inadvertent shift out of PARK when the ignition is ON. The driver must press the brake pedal before moving the shift lever out of the PARK position. The system consist of the following components:

- The automatic transmission shift lock control solenoid.
- The automatic transmission shift lock control switch.
- The park/neutral position switch.

With the ignition in the ON position battery positive voltage is supplied to the park/neutral position switch. With the transmission in the PARK position the contacts in the park/neutral position switch are closed. This allows current to flow through the switch to the automatic transmission shift lock control switch. The circuit continues through the normally-closed switch to the automatic transmission shift lock control solenoid. The automatic transmssion shift lock control soleniod is permanently grounded. This energizes the automatic transmission shift lock control solenoid, locking the shift linkage in the PARK position. When the driver presses the brake pedal the contacts in the automatic transmission shift lock control switch open, causing the automatic transmission shift lock control solenoid to release. This allows the shift lever to move from the PARK position.

Manual Transmission – Tremec 6-Speed

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Backup Lamp Switch	27 N·m	20 lb ft
Clutch Actuator Cylinder Bolt	8 N·m	71 lb in
Clutch Housing Bolt	50 N·m	37 lb ft
Control Lever Handle Bolt	25 N·m	18 lb ft
Gear Select/Skip Shift Solenoid	40 N·m	30 lb ft
Reverse Lockout Assembly Bolt	18 N·m	13 lb ft
Reverse Lockout Solenoid	40 N·m	30 lb ft
Shift Control Bolt	18 N·m	13 lb ft
Shift Control Closeout Boot Bolt	2 N·m	18 lb in
Shift Control Closeout Nut	15 N·m	11 lb ft
Shift Control Knob	3 N·m	27 lb in
Transmission Bolt	50 N·m	37 lb ft
Transmission Drain/Fill Plug	27 N·m	20 lb ft
Transmission Mount Bolt	48 N·m	38 lb ft
Transmission Mount Nut	105 N·m	77 lb ft
Transmission Support Bolt	90 N·m	66 lb ft
Vehicle Speed Sensor Bolt	10 N·m	89 lb in

Lubrication Specifications

Application	Metric	English
DEXRON® III	4.4 liters	4.6 quarts

Manual Transmission Description and Operation

Manual transmissions are identified by the number of forward gears and the measured distance between the centerline of the output shaft and the counter gear.

The 6-speed manual transmission (RPO M12), incorporates the following features:

- An aluminum case
- Fully synchronized gearing with an enhanced synchronizer cone arrangement:
  - Triple-cone: FIRST, SECOND
  - Double-cone: THIRD, FOURTH, FIFTH, SIXTH
  - Single-cone: REVERSE
- An internal shift rail mechanism
- A remote transmission shift control mounted forward of the transmission
- An external transmission shift rod enabling the forward mount location of the transmission shift control
- An extended-length transmission output shaft mating directly to the rear axle drive pinion, in the rear of the differential housing
- Tapered roller bearings supporting the mainshaft and countershaft
- Caged roller bearings under all speed gears
- Solenoid inhibit of SECOND and THIRD gears
- Solenoid inhibit of REVERSE gear during predefined forward motion

These features combine to yield a rugged, reliable system capable of handling input torques of up to 610 N·m (450 lb ft) for the M12.

The gear ratios are as follows:

Gear	M12 Ratio (:1)
FIRST	2.97
SECOND	2.07
THIRD	1.43
FOURTH	1.00
FIFTH	0.84
SIXTH	0.57
REVERSE	3.28

Skip Shift Description and Operation

The skip shift solenoid is a performance feature which forces the driver to shift from first gear to fourth gear during light acceleration and low engine load conditions. This feature is used to ensure good fuel economy and compliance with federal economy standards. The skip shift system consist of the following components:

- The powertrain control module (PCM)
- The skip shift solenoid
- The skip shift lamp

With the ignition ON, battery voltage is supplied directly to the skip shift solenoid. The PCM controls the solenoid by grounding the control circuit. When the skip shift system is active the PCM also grounds the control circuit of the skip shift lamp. The lamp illuminates to inform the driver that the 1-4 skip shift is engaged. The PCM determines when the skip shift system is active when the following parameters are met:

- The vehicle speed is between 24-31 km/h (15-19 mph).
- The engine coolant temperature (ECT) is greater than 77°C (171°F).
- The barometric pressure (BARO) is greater than 76 kPa.
- The accelerator pedal position (APP) is less than 26 percent.

When the conditions are met the PCM grounds the skip shift solenoid control circuit. This energizes the skip shift solenoid and mechanically blocks the gear shift lever from going into the second or third gear positions. When the driver pulls back on the shift lever with the system enabled, the transmission will go into fourth gear.

When the conditions for skip shift engagement are no longer met the PCM disables the skip shift solenoid, allowing the driver to use second and third gears.

Once the skip shift solenoid is enabled the system will not be re-enabled until the vehicle speed returns to 0 km/h (0 mph) and the conditions for enabling skip shift solenoid are met.

Reverse Inhibit Description and Operation

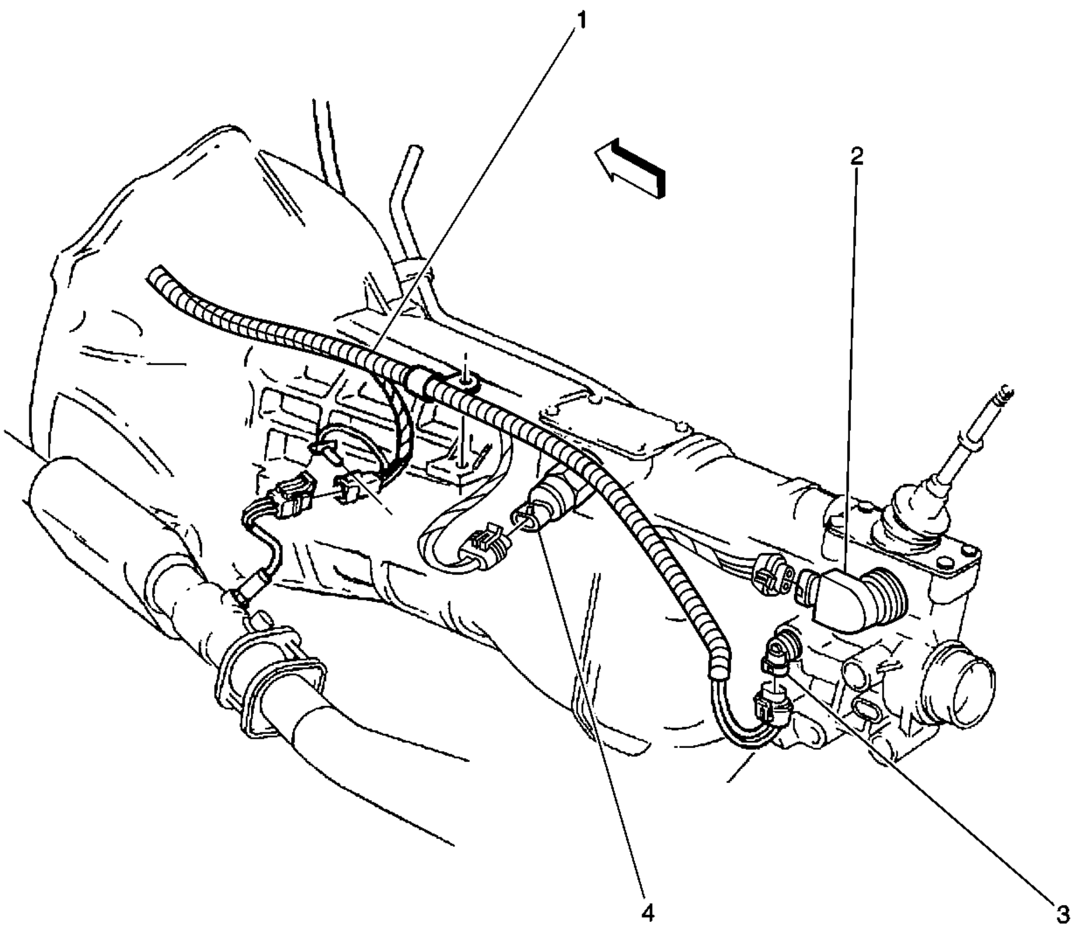
The reverse inhibit solenoid is a safety feature which prevents an inadvertent shift into reverse at speeds above 5 km/h (3 mph). The system consist of the following components:

- The engine control module (ECM)
- The transmission control module (TCM)
- The reverse inhibit solenoid

With the ignition ON battery voltage is supplied directly to the reverse inhibit solenoid. At forward speeds above 5 km/h (3 mph) the PCM grounds the control circuit of the reverse inhibit solenoid. This energizes the solenoid and mechanically blocks the shift lever from going into the REVERSE position.

Manual Transmission Component Views

Left Side of the Manual Transmission(c)



(1) Engine Wiring Harness
(2) Reverse Lockout Solenoid
(3) Vehicle Speed Sensor (VSS)
(4) Skip Shift Solenoid

Clutch

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Clutch Pedal Pivot Nut	15 N·m	11 lb ft
Clutch Actuator Cylinder Bolt	10 N·m	88 lb in
Clutch Pressure Plate Bolt		
• Step 1	10 N·m	7 lb ft
• Step 2	25 N·m	18 lb ft
• Step 3	40 N·m	30 lb ft
• Step 4	70 N·m	52 lb ft
Clutch Master Cylinder Nut	25 N·m	18 lb ft
Transmission Bolt	50 N·m	37 lb ft

Sealers and Lubricants

Application	Description
GM Brake and Clutch Fluid Super Dot 4	GM P/N 88958860
Dri-Slide Lubricant-Aerosol	GM P/N 1052948

Principal Components

The following are the principal components of the clutch system:

- The driving members; attached to the engine and turning with the engine.
- The driven member; attached to the engine driveline and transmission and turning with the driveline and transmission.
- The operating members; including the spring, the clutch hydraulic system, and the clutch pedal linkage, required to apply and release the pressure, which hold the driving and driven members in contact with each other.

Clutch Driving Members

The clutch driving members consist of two, flat surfaced, iron plates, machined to a smooth finish. One of these surfaces is the rear face of the engine flywheel and the other is a comparatively heavy flat ring, with one side machined, known as the clutch pressure plate.

Clutch Driven Members

The driven member (friction or clutch disc) consists of a hub and a plate, with facings attached to the plate. The clutch disc has cushion springs and dampening springs. The cushion springs are slightly waved, or curled. The cushion springs are attached to the plat, and the clutch facings are attached to the springs. When the clutch is engaged, the cushion springs compress slightly to take up the shock of engagement. The dampening springs are heavy coil springs set in a circle around the hub. The hub is driven through these springs. They help to smooth out the torsional vibration so that the power flow to the transmission is smooth. There are grooves in both sides of the clutch disc facings. These grooves prevent the facings from sticking to the flywheel face and pressure plate when the clutch is disengaged. The grooves break any vacuum that might form and cause the facings to stick to the flywheel ore pressure plate.

Clutch Operating Members

The driving member and the driven member are held in contact by spring pressure. This pressure is exerted by a one-piece conical or diaphragm spring.

A diaphragm spring is a conical piece of spring steel that has been specially stamped to give it greater flexibility. The diaphragm is positioned between the cover and the pressure plate so that the diaphragm spring is nearly flat when the clutch is in the engaged position. The action of this type of spring is similar to that of an ordinary oil can.

The pressure of the inner rim of the spring on the pressure plate decreases as the flat position is passed. The inner rim of the diaphragm bears on the pressure plate and is pivoted on a ring on the outer edge of the pressure plate. The application of a pulling load on the inner section of the pressure plate will cause the inner rim to move away from the flywheel and allow the pressure plate to move away from the clutch disc, thereby releasing or disengaging the clutch. When the pressure is released from the inner section, the OIL CAN action of the diaphragm causes the inner section to move in, and the movement of the inner rim forces the pressure plate against the clutch disc, thus engaging the clutch.

The clutch release bearing is moved by the actuator assembly to move the release levers which move the pressure plate to the rear, thus separating the clutch disc from the flywheel when the clutch pedal is depressed by the driver. A piston return spring in the actuator cylinder preloads the clutch linkage and assures a small load on the release bearing with the actuator assembly at all times. As the clutch disc wears, the diaphragm spring fingers move forward forcing the release bearing, actuator assembly, and pushrod to move. This movement forces the actuator cylinder piston to move forward in its bore, consuming hydraulic fluid from the master cylinder reservoir, thereby providing the SELF-ADJUSTING feature of the hydraulic clutch linkage system.

Hydraulic Clutch Description

Principal Components

The driving member and the driven member are held in contact by spring pressure. This pressure is exerted by a one-piece conical or diaphragm spring.

A diaphragm spring is a conical piece of spring steel that has been specially stamped to give it greater flexibility. The diaphragm is positioned between the cover and the pressure plate so that the diaphragm spring is nearly flat when the clutch is in the engaged position. The action of this type of spring is similar to that of an ordinary oil can.

The pressure of the inner rim of the spring on the pressure plate decreases as the flat position is passed. The inner rim of the diaphragm bears on the pressure plate and is pivoted on a ring on the outer edge of the pressure plate. The application of a pulling load on the inner section of the pressure plate will cause the inner rim to move away from the flywheel and allow the pressure plate to move away from the clutch disc, thereby releasing or disengaging the clutch. When the pressure is released from the inner section, the OIL CAN action of the diaphragm causes the inner section to move in, and the movement of the inner rim forces the pressure plate against the clutch disc, thus engaging the clutch.

The clutch release bearing is moved by the actuator assembly to move the release levers which move the pressure plate to the rear, thus separating the clutch disc from the flywheel when the clutch pedal is depressed by the driver. A piston return spring in the actuator cylinder preloads the clutch linkage and assures a small load on the release bearing with the actuator assembly at all times. As the clutch disc wears, the diaphragm spring fingers move forward forcing the release bearing, actuator assembly, and pushrod to move. This movement forces the actuator cylinder piston to move forward in its bore, consuming hydraulic fluid from the master cylinder reservoir, thereby providing the SELF-ADJUSTING feature of the hydraulic clutch linkage system.

Clutch Driving Members

The clutch driving members consist of two, flat surfaced, iron plates, machined to a smooth finish. One of these surfaces is the rear face of the engine flywheel and the other is a comparatively heavy flat ring, with one side machined, known as the clutch pressure plate.

Clutch Driven Members

The driven member (friction or clutch disc) consists of a hub and a plate, with facings attached to the plate. The clutch disc has cushion springs and dampening springs. The cushion springs are slightly waved, or curled. The cushion springs are attached to the plat, and the clutch facings are attached to the springs. When the clutch is engaged, the cushion springs compress slightly to take up the shock of engagement. The dampening springs are heavy coil springs set in a circle around the hub. The hub is driven through these springs. They help to smooth out the torsional vibration so that the power flow to the transmission is smooth. There are grooves in both sides of the clutch disc facings. These grooves prevent the facings from sticking to the flywheel face and pressure plate when the clutch is disengaged. The grooves break any vacuum that might form and cause the facings to stick to the flywheel ore pressure plate.

Clutch Operating Members

The driving member and the driven member are held in contact by spring pressure. This pressure is exerted by a one-piece conical or diaphragm spring.

A diaphragm spring is a conical piece of spring steel that has been specially stamped to give it greater flexibility. The diaphragm is positioned between the cover and the pressure plate so that the diaphragm spring is nearly flat when the clutch is in the engaged position. The action of this type of spring is similar to that of an ordinary oil can.

The pressure of the inner rim of the spring on the pressure plate decreases as the flat position is passed. The inner rim of the diaphragm bears on the pressure plate and is pivoted on a ring on the outer edge of the pressure plate. The application of a pulling load on the inner section of the pressure plate will cause the inner rim to move away from the flywheel and allow the pressure plate to move away from the clutch disc, thereby releasing or disengaging the clutch. When the pressure is released from the inner section, the OIL CAN action of the diaphragm causes the inner section to move in, and the movement of the inner rim forces the pressure plate against the clutch disc, thus engaging the clutch.

The clutch release bearing is moved by the actuator assembly to move the release levers which move the pressure plate to the rear, thus separating the clutch disc from the flywheel when the clutch pedal is depressed by the driver. A piston return spring in the actuator cylinder preloads the clutch linkage and assures a small load on the release bearing with the actuator assembly at all times. As the clutch disc wears, the diaphragm spring fingers move forward forcing the release bearing, actuator assembly, and pushrod to move. This movement forces the actuator cylinder piston to move forward in its bore, consuming hydraulic fluid from the master cylinder reservoir, thereby providing the SELF-ADJUSTING feature of the hydraulic clutch linkage system.

Hydraulic Clutch Description

The clutch hydraulic system consists of a master cylinder and an actuator cylinder. When pressure is applied to the clutch pedal (pedal depressed), the pushrod contacts the plunger and pushes it down the bore of the master cylinder. In the first 0.8 mm (0.031 in) of movement, the recuperation seal closes the port to the fluid reservoir tank, and as the plunger continues to move down the bore of the cylinder, the fluid is forced through the outlet line to the actuator cylinder. As fluid is pushed down the pipe from the master cylinder, this in turn forces the pistons in the actuator cylinder outward. As the actuator cylinder piston moves forward, it forces the release bearing to disengage the clutch pressure plate from the clutch disc. On the return stroke (pedal released), the plunger moves back as a result of the return pressure of the clutch. Fluid returns to the master cylinder and the final movement of the plunger opens the port to the fluid reservoir, allowing an unrestricted flow of fluid between system and reservoir.

Hydraulic Clutch Fluid Description

When adding, refilling or replacing hydraulic clutch fluid after service operations, use hydraulic clutch fluid GM P/N 12345347 or an equivalent fluid that meets DOT 3 specifications only (such as DOT 3 brake fluid).

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Abbreviations and Meanings

Abbreviation	Meaning
A	
A	Ampere(s)
ABS	Antilock Brake System
A/C	Air Conditioning
AC	Alternating Current
ACC	Accessory, Automatic Climate Control
ACL	Air Cleaner
ACR4	Air Conditioning Refrigerant, Recovery, Recycling, Recharging
AD	Automatic Disconnect
A/D	Analog to Digital
ADL	Automatic Door Lock
A/F	Air/Fuel Ratio
AH	Active Handling
AIR	Secondary Air Injection
ALC	Automatic Level Control, Automatic Lamp Control
AM/FM	Amplitude Modulation/Frequency Modulation
Ant	Antenna
AP	Accelerator Pedal
APCM	Accessory Power Control Module
API	American Petroleum Institute
APP	Accelerator Pedal Position
APT	Adjustable Part Throttle
ASM	Assembly, Accelerator and Servo Control Module
ASR	Acceleration Slip Regulation
A/T	Automatic Transmission/Transaxle
ATC	Automatic Transfer Case, Automatic Temperature Control
ATDC	After Top Dead Center
ATSLC	Automatic Transmission Shift Lock Control
Auto	Automatic
avg	Average
A4WD	Automatic Four-Wheel Drive
AWG	American Wire Gage
B	
B+	Battery Positive Voltage
BARO	Barometric Pressure
BATT	Battery
BBV	Brake Booster Vacuum
BCA	Bias Control Assembly
BCM	Body Control Module
BHP	Brake Horsepower
BLK	Black
BLU	Blue
BP	Back Pressure
BPCM	Battery Pack Control Module
BPMV	Brake Pressure Modulator Valve
BPP	Brake Pedal Position
BRN	Brown

BTDC	Before Top Dead Center
BTM	Battery Thermal Module
BTSI	Brake Transmission Shift Interlock
Btu	British Thermal Units
C	
°C	Degrees Celsius
CAC	Charge Air Cooler
CAFE	Corporate Average Fuel Economy
Cal	Calibration
Cam	Camshaft
CARB	California Air Resources Board
CC	Coast Clutch
cm_	Cubic Centimeters
CCM	Convenience Charge Module, Chassis Control Module
CCOT	Cycling Clutch Orifice Tube
CCP	Climate Control Panel
CD	Compact Disc
CE	Commutator End
CEAB	Cold Engine Air Bleed
CEMF	Counter Electromotive Force
CEX	Cabin Exchanger
cfm	Cubic Feet per Minute
cg	Center of Gravity
CID	Cubic Inch Displacement
CKP	Crankshaft Position
CKT	Circuit
C/Ltr	Cigar Lighter
CL	Closed Loop
CLS	Coolant Level Switch
CMC	Compressor Motor Controller
CMP	Camshaft Position
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO2	Carbon Dioxide
Coax	Coaxial
COMM	Communication
Conn	Connector
CPA	Connector Position Assurance
CPP	Clutch Pedal Position
CPS	Central Power Supply
CPU	Central Processing Unit
CRT	Cathode Ray Tube
CRTC	Cathode Ray Tube Controller
CS	Charging System
CSFI	Central Sequential Fuel Injection
CTP	Closed Throttle Position
cu ft	Cubic Foot/Feet
cu in	Cubic Inch/Inches
CV	Constant Velocity Joint
CVRSS	Continuously Variable Road Sensing Suspension

Cyl	Cylinder(s)
D	
DAB	Delayed Accessory Bus
dB	Decibels
dBA	Decibels on A-weighted Scale
DC	Direct Current, Duty Cycle
DCM	Door Control Module
DE	Drive End
DEC	Digital Electronic Controller
DERM	Diagnostic Energy Reserve Module
DI	Distributor Ignition
dia	Diameter
DIC	Driver Information Center
Diff	Differential
DIM	Dash Integration Module
DK	Dark
DLC	Data Link Connector
DMCM	Drive Motor Control Module
DMM	Digital Multimeter
DMSDS	Drive Motor Speed and Direction Sensor
DMU	Drive Motor Unit
DOHC	Dual Overhead Camshafts
DR, Drvr	Driver
DRL	Daytime Running Lamps
DTC	Diagnostic Trouble Code
E	
EBCM	Electronic Brake Control Module
EBTCM	Electronic Brake and Traction Control Module
EC	Electrical Center, Engine Control
ECC	Electronic Climate Control
ECI	Extended Compressor at Idle
ECL	Engine Coolant Level
ECM	Engine Control Module, Electronic Control Module
ECS	Emission Control System
ECT	Engine Coolant Temperature
EEPROM	Electrically Erasable Programmable Read Only Memory
EEVIR	Evaporator Equalized Values in Receiver
EFE	Early Fuel Evaporation
EGR	Exhaust Gas Recirculation
EGR TVV	Exhaust Gas Recirculation Thermal Vacuum Valve
EHPS	Electro-Hydraulic Power Steering
EI	Electronic Ignition
ELAP	Elapsed
ELC	Electronic Level Control
E/M	English/Metric
EMF	Electromotive Force
EMI	Electromagnetic Interference
Eng	Engine
EOP	Engine Oil Pressure
EOT	Engine Oil Temperature

EPA	Environmental Protection Agency
EPR	Exhaust Pressure Regulator
EPROM	Erasable Programmable Read Only Memory
ESB	Expansion Spring Brake
ESC	Electronic Suspension Control
ESD	Electrostatic Discharge
ESN	Electronic Serial Number
ETC	Electronic Throttle Control, Electronic Temperature Control, Electronic Timing Control
ETCC	Electronic Touch Climate Control
ETR	Electronically Tuned Receiver
ETS	Enhanced Traction System
EVAP	Evaporative Emission
EVO	Electronic Variable Orifice
Exh	Exhaust
F	
°F	Degrees Fahrenheit
FC	Fan Control
FDC	Fuel Data Center
FED	Federal All United States except California
FEDS	Fuel Enable Data Stream
FEX	Front Exchanger
FF	Flexible Fuel
FFH	Fuel-Fired Heater
FI	Fuel Injection
FMVSS	Federal U.S. Motor Vehicle Safety Standards
FP	Fuel Pump
ft	Foot/Feet
FT	Fuel Trim
F4WD	Full Time Four-Wheel Drive
4WAL	Four-Wheel Antilock
4WD	Four-Wheel Drive
FW	Flat Wire
FWD	Front Wheel Drive, Forward
G	
g	Grams, Gravitational Acceleration
GA	Gage, Gauge
gal	Gallon
gas	Gasoline
GCW	Gross Combination Weight
Gen	Generator
GL	Gear Lubricant
GM	General Motors
GM SPO	General Motors Service Parts Operations
gnd	Ground
gpm	Gallons per Minute
GRN	Green
GRY	Gray
GVWR	Gross Vehicle Weight Rating

H	
H	Hydrogen
H2O	Water
Harn	Harness
HC	Hydrocarbons
H/CMPR	High Compression
HD	Heavy Duty
HDC	Heavy Duty Cooling
hex	Hexagon, Hexadecimal
Hg	Mercury
Hi Alt	High Altitude
HO2S	Heated Oxygen Sensor
hp	Horsepower
HPL	High Pressure Liquid
HPS	High Performance System
HPV	High Pressure Vapor
HPVS	Heat Pump Ventilation System
Htd	Heated
HTR	Heater
HUD	Head-up Display
HVAC	Heater-Ventilation-Air Conditioning
HVACM	Heater-Vent-Air Conditioning Module
HVIL	High Voltage Interlock Loop
HVM	Heater Vent Module
Hz	Hertz
I	
IAC	Idle Air Control
IAT	Intake Air Temperature
IC	Integrated Circuit, Ignition Control
ICCS	Integrated Chassis Control System
ICM	Ignition Control Module
ID	Identification, Inside Diameter
IDI	Integrated Direct Ignition
IGBT	Insulated Gate Bi-Polar Transistor
ign	Ignition
ILC	Idle Load Compensator
in	Inch/Inches
INJ	Injection
inst	Instantaneous, Instant
IP	Instrument Panel
IPC	Instrument Panel Cluster
IPM	Instrument Panel Module
I/PEC	Instrument Panel Electrical Center
ISC	Idle Speed Control
ISO	International Standards Organization
ISS	Input Speed Shaft, Input Shaft Speed
K	
KAM	Keep Alive Memory
KDD	Keyboard Display Driver
kg	Kilogram

kHz	Kilohertz
km	Kilometer
km/h	Kilometers per Hour
km/l	Kilometers per Liter
kPa	Kilopascals
KS	Knock Sensor
kV	Kilovolts
L	
L	Liter
L4	Four Cylinder Engine, In-Line
L6	Six-Cylinder Engine, In-Line
lb	Pound
lb ft	Pound Feet Torque
lb in	Pound Inch Torque
LCD	Liquid Crystal Display
LDCL	Left Door Closed Locking
LDCM	Left Door Control Module
LDM	Lamp Driver Module
LED	Light Emitting Diode
LEV	Low Emissions Vehicle
LF	Left Front
lm	Lumens
LR	Left Rear
LT	Left
LT	Light
LT	Long Term
LTPI	Low Tire Pressure Indicator
LTPWS	Low Tire Pressure Warning System
M	
MAF	Mass Air Flow
Man	Manual
MAP	Manifold Absolute Pressure
MAT	Manifold Absolute Temperature
max	Maximum
M/C	Mixture Control
MDP	Manifold Differential Pressure
MFI	Multiport Fuel Injection
mi	Miles
MIL	Malfunction Indicator Lamp
min	Minimum
MIN	Mobile Identification Number
mL	Milliliter
mm	Millimeter
mpg	Miles per Gallon
mph	Miles per Hour
ms	Millisecond
MST	Manifold Surface Temperature
MSVA	Magnetic Steering Variable Assist, Magnasteer®
M/T	Manual Transmission/Transaxle
MV	Megavolt

mV	Millivolt
N	
NAES	North American Export Sales
NC	Normally Closed
NEG	Negative
Neu	Neutral
NI	Neutral Idle
NiMH	Nickel Metal Hydride
NLGI	National Lubricating Grease Institute
N·m	Newton-meter Torque
NO	Normally Open
NOx	Oxides of Nitrogen
NPTC	National Pipe Thread Coarse
NPTF	National Pipe Thread Fine
NOVRAM	Non-Volatile Random Access Memory
O	
O2	Oxygen
O2S	Oxygen Sensor
OBD	On-Board Diagnostics
OBD II	On-Board Diagnostics Second Generation
OC	Oxidation Converter Catalytic
OCS	Opportunity Charge Station
OD	Outside Diameter
ODM	Output Drive Module
ODO	Odometer
OE	Original Equipment
OEM	Original Equipment Manufacturer
OHC	Overhead Camshaft
ohms	Ohm
OL	Open Loop, Out of Limits
ORC	Oxidation Reduction Converter Catalytic
ORN	Orange
ORVR	On-Board Refueling Vapor Recovery
OSS	Output Shaft Speed
oz	Ounce(s)
P	
PAG	Polyalkylene Glycol
PAIR	Pulsed Secondary Air Injection
PASS, PSGR	Passenger
PASS-Key®	Personalized Automotive Security System
P/B	Power Brakes
PC	Pressure Control
PCB	Printed Circuit Board
PCM	Powertrain Control Module
PCS	Pressure Control Solenoid
PCV	Positive Crankcase Ventilation
PEB	Power Electronics Bay
PID	Parameter Identification
PIM	Power Inverter Module
PM	Permanent Magnet Generator

P/N	Part Number
PNK	Pink
PNP	Park/Neutral Position
PRNDL	Park, Reverse, Neutral, Drive, Low
POA	Pilot Operated Absolute Valve
POS	Positive, Position
POT	Potentiometer Variable Resistor
PPL	Purple
ppm	Parts per Million
PROM	Programmable Read Only Memory
P/S, PS	Power Steering
PSCM	Power Steering Control Module, Passenger Seat Control Module
PSD	Power Sliding Door
PSP	Power Steering Pressure
psi	Pounds per Square Inch
psia	Pounds per Square Inch Absolute
psig	Pounds per Square Inch Gauge
pt	Pint
PTC	Positive Temperature Coefficient
PWM	Pulse Width Modulated
Q	
QDM	Quad Driver Module
qt	Quart(s)
R	
R-12	Refrigerant-12
R-134a	Refrigerant-134a
RAM	Random Access Memory, Non-permanent memory device, memory contents are lost when power is removed.
RAP	Retained Accessory Power
RAV	Remote Activation Verification
RCDLR	Remote Control Door Lock Receiver
RDCM	Right Door Control Module
Ref	Reference
Rev	Reverse
REX	Rear Exchanger
RIM	Rear Integration Module
RF	Right Front, Radio Frequency
RFA	Remote Function Actuation
RFI	Radio Frequency Interference
RH	Right Hand
RKE	Remote Keyless Entry
Rly	Relay
ROM	Read Only Memory, Permanent memory device, memory contents are retained when power is removed.
RPM	Revolutions per Minute Engine Speed
RPO	Regular Production Option
RR	Right Rear
RSS	Road Sensing Suspension
RTD	Real Time Damping
RT	Right

RTV	Room Temperature Vulcanizing Sealer
RWAL	Rear Wheel Antilock
RWD	Rear Wheel Drive
S	
s	Second(s)
SAE	Society of Automotive Engineers
SC	Supercharger
SCB	Supercharger Bypass
SCM	Seat Control Module
SDM	Sensing and Diagnostic Module
SEO	Special Equipment Option
SFI	Sequential Multiport Fuel Injection
SI	System International Modern Version of Metric System
SIAB	Side Impact Air Bag
SIR	Supplemental Inflatable Restraint
SLA	Short/Long Arm Suspension
sol	Solenoid
SO2	Sulfur Dioxide
SP	Splice Pack
S/P	Series/Parallel
SPO	Service Parts Operations
SPS	Service Programming System, Speed Signal
sq ft, ft_	Square Foot/Feet
sq in, in_	Square Inch/Inches
SRC	Service Ride Control
SRI	Service Reminder Indicator
SRS	Supplemental Restraint System
SS	Shift Solenoid
ST	Scan Tool
STID	Station Identification Station ID
S4WD	Selectable Four-Wheel Drive
Sw	Switch
SWPS	Steering Wheel Position Sensor
syn	Synchronizer
T	
TAC	Throttle Actuator Control
Tach	Tachometer
TAP	Transmission Adaptive Pressure, Throttle Adaptive Pressure
TBI	Throttle Body Fuel Injection
TC	Turbocharger, Transmission Control
TCC	Torque Converter Clutch
TCS	Traction Control System
TDC	Top Dead Center
TEMP	Temperature
Term	Terminal
TFP	Transmission Fluid Pressure
TFT	Transmission Fluid Temperature
THM	Turbo Hydro-Matic
TIM	Tire Inflation Monitoring, Tire Inflation Module
TOC	Transmission Oil Cooler

TP	Throttle Position
TPA	Terminal Positive Assurance
TPM	Tire Pressure Monitoring, Tire Pressure Monitor
TR	Transmission Range
TRANS	Transmission/Transaxle
TT	Tell Tail Warning Lamp
TV	Throttle Valve
TVRS	Television and Radio Suppression
TVV	Thermal Vacuum Valve
TWC	Three Way Converter Catalytic
TWC+OC	Three Way + Oxidation Converter Catalytic
TXV	Thermal Expansion Valve
U	
UART	Universal Asynchronous Receiver Transmitter
U/H	Underhood
U/HEC	Underhood Electrical Center
U-joint	Universal Joint
UTD	Universal Theft Deterrent
UV	Ultraviolet
V	
V	Volt(s), Voltage
V6	Six-Cylinder Engine, V-Type
V8	Eight-Cylinder Engine, V-Type
Vac	Vacuum
VAC	Vehicle Access Code
VATS	Vehicle Anti-Theft System
VCIM	Vehicle Communication Interface Mode
VCM	Vehicle Control Module
V dif	Voltage Difference
VDOT	Variable Displacement Orifice Tube
VDV	Vacuum Delay Valve
vel	Velocity
VES	Variable Effort Steering
VF	Vacuum Fluorescent
VIO	Violet
VIN	Vehicle Identification Number
VLR	Voltage Loop Reserve
VMV	Vacuum Modulator Valve
VR	Voltage Regulator
V ref	Voltage Reference
VSES	Vehicle Stability Enhancement System
VSS	Vehicle Speed Sensor
W	
w/	With
W/B	Wheel Base
WHL	Wheel
WHT	White
w/o	Without
WOT	Wide Open Throttle
W/P	Water Pump

W/S	Windshield
WSS	Wheel Speed Sensor
WU-OC	Warm Up Oxidation Converter Catalytic
WU-TWC	Warm Up Three-Way Converter Catalytic
X	
X-valve	Expansion Valve
Y	
yd	Yard(s)
YEL	Yellow

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Conversion - English/Metric

English	Multiply/ Divide by	Metric
In order to calculate English measurement, divide by the number in the center column. In order to calculate metric measurement, multiply by the number in the center column.		
Length		
in	25.4	mm
ft	0.3048	m
yd	0.9144	
mi	1.609	km
Area		
sq in	645.2	sq mm
	6.45	sq cm
sq ft	0.0929	sq m
sq yd	0.8361	
Volume		
cu in	16,387.00	cu mm
	16.387	cu cm
	0.0164	L
qt	0.9464	
gal	3.7854	
cu yd	0.764	cu m
Mass		
lb	0.4536	kg
ton	907.18	
	0.907	tonne (t)
Force		
Kg F	9.807	newtons (N)
oz F	0.278	
lb F	4.448	
Acceleration		
ft/s_	0.3048	m/s_
In/s_	0.0254	
Torque		
Lb in	0.11298	N·m
lb ft	1.3558	
Power		
hp	0.745	kW
Pressure (Stress)		
inches of H2O	0.2488	kPa
lb/sq in	6.895	
Energy (Work)		
Btu	1055	J (J= one Ws)
lb ft	1.3558	
kW hour	3,600,000.00	
Light		
Foot Candle	10.764	lm/m_

Velocity		
mph	1.6093	km/h
Temperature		
(°F - 32) 5/9	=	°C
°F	=	(9/5 °C + 32)
Fuel Performance		
235.215/mpg	=	100 km/L

Equivalents - Decimal and Metric

Fraction (in)	Decimal (in)	Metric (mm)
1/64	0.015625	0.39688
1/32	0.03125	0.79375
3/64	0.046875	1.19062
1/16	0.0625	1.5875
5/64	0.078125	1.98437
3/32	0.09375	2.38125
7/64	0.109375	2.77812
1/8	0.125	3.175
9/64	0.140625	3.57187
5/32	0.15625	3.96875
11/64	0.171875	4.36562
3/16	0.1875	4.7625
13/64	0.203125	5.15937
7/32	0.21875	5.55625
15/64	0.234375	5.95312
1/4	0.25	6.35
17/64	0.265625	6.74687
9/32	0.28125	7.14375
19/64	0.296875	7.54062
5/16	0.3125	7.9375
21/64	0.328125	8.33437
11/32	0.34375	8.73125
23/64	0.359375	9.12812
3/8	0.375	9.525
25/64	0.390625	9.92187
13/32	0.40625	10.31875
27/64	0.421875	10.71562
7/16	0.4375	11.1125
29/64	0.453125	11.50937
15/32	0.46875	11.90625
31/64	0.484375	12.30312
1/2	0.5	12.7
33/64	0.515625	13.09687
17/32	0.53125	13.49375
35/64	0.546875	13.89062
9/16	0.5625	14.2875
37/64	0.578125	14.68437
19/32	0.59375	15.08125
39/64	0.609375	15.47812
5/8	0.625	15.875
41/64	0.640625	16.27187

Fraction (in)	Decimal (in)	Metric (mm)
21/32	0.65625	16.66875
43/64	0.671875	17.06562
11/16	0.6875	17.4625
45/64	0.703125	17.85937
23/32	0.71875	18.25625
47/64	0.734375	18.65312
3/4	0.75	19.05
49/64	0.765625	19.44687
25/32	0.78125	19.84375
51/64	0.796875	20.24062
13/16	0.8125	20.6375
53/64	0.828125	21.03437
27/32	0.84375	21.43125
55/64	0.859375	21.82812
7/8	0.875	22.225
57/64	0.890625	22.62187
29/32	0.90625	23.01875
59/64	0.921875	23.41562
15/16	0.9375	23.8125
61/64	0.953125	24.20937
31/32	0.96875	24.60625
63/64	0.984375	25.00312
1	1.0	25.4

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Fasteners

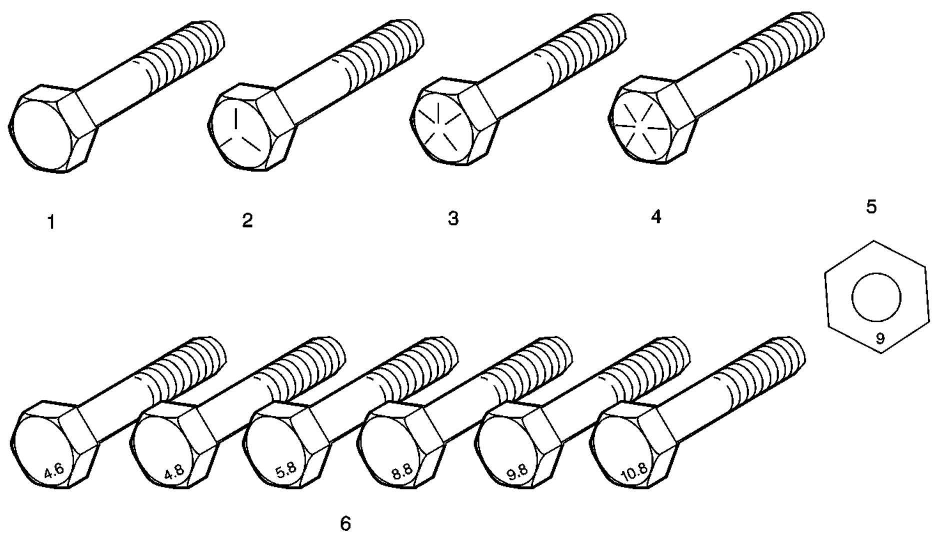
Metric Fasteners

This vehicle provides fastener dimensions using the metric system. Most metric fasteners are approximate in diameter to equivalent English fasteners. Make replacements using fasteners of the same nominal diameter, thread pitch, and strength.

A number marking identifies the OE metric fasteners except cross-recess head screws. The number also indicates the strength of the fastener material. A Posidrive® or Type 1A cross-recess identifies a metric cross-recess screw. For best results, use a Type 1A cross-recess screwdriver, or equivalent, in Posidrive® recess head screws.

GM Engineering Standards and North American Industries have adopted a portion of the ISO-defined standard metric fastener sizes. The purpose was to reduce the number of fastener sizes used while retaining the best thread qualities in each thread size. For example, the metric M6.0 X 1 screw, with nearly the same diameter and 25.4 threads per inch replaced the English 1/4-20 and 1/4-28 screws. The thread pitch is midway between the English coarse and fine thread pitches.

Fastener Strength Identification



1. English Bolt, Grade 2 (Strength Class)
2. English Bolt, Grade 5 (Strength Class)
3. English Bolt, Grade 7 (Strength Class)
4. English Bolt, Grade 8 (Strength Class)
5. Metric Nut, Strength Class 9
6. Metric Bolts, Strength Class Increases as Numbers Increase

The most commonly used metric fastener strength property classes are 9.8 and 10.9. The class identification is embossed on the head of each bolt. The English, inch strength classes range from grade 2 to grade 8. Radial lines are embossed on the head of each bolt in order to identify the strength class. The number of lines on the head of the bolt is 2 lines less than the actual grade. For example, a grade 8 bolt will have 6 radial lines on the bolt head. Some metric nuts are marked with a single digit strength identification number on the nut face.

The correct fasteners are available through GM SPO. Many metric fasteners available in the aftermarket parts channels are designed to metric standards of countries other than the United States, and may exhibit the following:

- Lower strength
- No numbered head marking system
- Wrong thread pitch

The metric fasteners on GM products are designed to new, international standards. The following are the common sizes and pitches, except for special applications:

- M6.0 X 1
- M8 X 1.25
- M10 X 1.5
- M12 X 1.75
- M14 X 2.00
- M16 X 2.00

Prevailing Torque Fasteners

Prevailing torque fasteners create a thread interface between the fastener and the fastener counterpart in order to prevent the fastener from loosening.

All Metal Prevailing Torque Fasteners

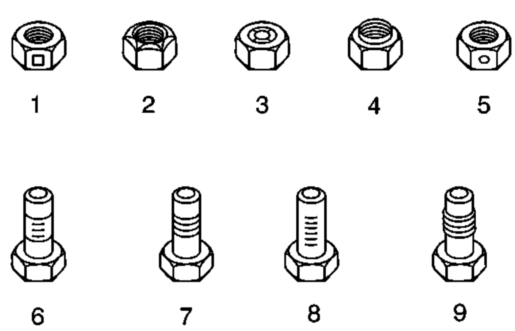
These fasteners accomplish the thread interface by a designed distortion or deformation in the fastener.

Nylon Interface Prevailing Torque Fasteners

These fasteners accomplish the thread interface by the presence of a nylon material on the fastener threads.

Adhesive Coated Fasteners

These fasteners accomplish the thread interface by the presence of a thread-locking compound on the fastener threads. Refer to the appropriate repair procedure in order to determine if the fastener may be reused and the applicable thread-locking compound to apply to the fastener.



1. Prevailing Torque Nut, Center Lock Type
2. Prevailing Torque Nut, Top Lock Type
3. Prevailing Torque Nut, Nylon Patch Type
4. Prevailing Torque Nut, Nylon Washer Insert Type
5. Prevailing Torque Nut, Nylon Insert Type

6. Prevailing Torque Bolt, Dry Adhesive Coating Type
7. Prevailing Torque Bolt, Thread Profile Deformed Type
8. Prevailing Torque Bolt, Nylon Strip Type
9. Prevailing Torque Bolt, Out-of-Round Thread Area Type

A prevailing torque fastener may be reused ONLY if:

- The fastener and the fastener counterpart are clean and not damaged
- There is no rust on the fastener
- The fastener develops the specified minimum torque against its counterpart prior to the fastener seating

Metric Prevailing Torque Fastener Minimum Torque Development

Application	Specification	
	Metric	English
All Metal Prevailing Torque Fasteners		
6 mm	0.4 N·m	4 lb in
8 mm	0.8 N·m	7 lb in
10 mm	1.4 N·m	12 lb in
12 mm	2.1 N·m	19 lb in
14 mm	3 N·m	27 lb in
16 mm	4.2 N·m	37 lb in
20 mm	7 N·m	62 lb in
24 mm	10.5 N·m	93 lb in
Nylon Interface Prevailing Torque Fasteners		
6 mm	0.3 N·m	3 lb in
8 mm	0.6 N·m	5 lb in
10 mm	1.1 N·m	10 lb in
12 mm	1.5 N·m	13 lb in
14 mm	2.3 N·m	20 lb in
16 mm	3.4 N·m	30 lb in
20 mm	5.5 N·m	49 lb in
24 mm	8.5 N·m	75 lb in

English Prevailing Torque Fastener Minimum Torque Development

Application	Specification	
	Metric	English
All Metal Prevailing Torque Fasteners		
1/4 in	0.5 N·m	4.5 lb in
5/16 in	0.8 N·m	7.5 lb in
3/8 in	1.3 N·m	11.5 lb in
7/16 in	1.8 N·m	16 lb in
1/2 in	2.3 N·m	20 lb in
9/16 in	3.2 N·m	28 lb in
5/8 in	4 N·m	36 lb in
3/4 in	7 N·m	54 lb in
Nylon Interface Prevailing Torque Fasteners		
1/4 in	0.3 N·m	3 lb in
5/16 in	0.6 N·m	5 lb in
3/8 in	1 N·m	9 lb in
7/16 in	1.3 N·m	12 lb in
1/2 in	1.8 N·m	16 lb in
9/16 in	2.5 N·m	22 lb in
5/8 in	3.4 N·m	30 lb in
3/4 in	5 N·m	45 lb in