Chevrolet

Colorado

2004

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Product Information

2004 Chevy Colorado: Redefining Mid-Size Pickups

Surf, snow, hike or bike. It's all about choices. And Chevrolet has designed its all-new 2004 Colorado to give mid-size pickup buyers an array of models and functional features to meet their individual needs.

From powertrains to sound systems, wheels to seals, this truck is completely redesigned. Colorado will redefine the standard for the mid-size pickup truck segment by offering an unexpected combination of features that provide increased functionality and capability.

Colorado is more than just a tough truck. It was crafted with a healthy dose of distinctive style and refinement. Colorado is not a smaller version of its full-size Silverado pickup kin, nor a revised design of the TrailBlazer SUV. It sits on its own distinct body-on-frame platform, and from its inception was conceived to be the best mid-size truck on the road.

"One thing that absolutely stands out in my mind," said Colorado Vehicle Line Executive Tom Wallace, "is that when you get into a Colorado you can feel the difference - see that it has been absolutely redesigned. And when you add in the exceptional ride and handling and the new inline engines, a customer's going to walk away with exceptional value."

Ready, willing and able

While Colorado is bigger than the vehicles it replaces in Chevy's lineup, it is by no means intended to steal from the full-size segment. These are different trucks, meeting different needs, and targeted at a different buyer.

That buyer is a younger, more diverse customer. Colorado was not designed to appeal to the full-size pickup intender, but to the customer who needs a mid-size pickup. It is ready, willing and able to meet the specific needs of an entirely different type of truck buyer, the buyer who doesn't need the higher payloads, towing capacities and expenses of owning a full-size pickup.

The focus is on customers who are looking for vehicle packaging efficiency, driving and parking ease, and efficient costs of ownership in a vehicle that meets their specific work and recreational needs.

"This is a personal-use truck for singles, couples or families who want more out of their mid-size pickups, but who still share one thing in common: Any truck they drive had better be 'a real truck.' As soon as buyers see and drive Colorado, they'll discover that this truck delivers on that promise," said Janet Eckhoff, Colorado marketing director.

Colorado is a true pickup truck, with body-on-frame design; Crew, Extended and Regular Cab models; manual and automatic transmissions; 2WD and 4WD; and ample power from two completely new engines, the Vortec 2800 inline four-cylinder and the Vortec 3500 inline five-cylinder engines.

These engines are both derived from the highly acclaimed Vortec 4200 4.2L inline six-cylinder powerplant. In addition, these trucks offer the performance, towing, and payload capacity that meet and exceed what these customers demand.

Inside, Colorado looks and feels more like a spacious, well-appointed full-size pickup than a typical mid-size truck. It brings a new level of comfort and capability to the segment, with craftsmanship and attention to detail evident throughout.

Colorado also positions Chevrolet to compete more effectively in the mid-size truck segment, where 80 percent of all models are either extended or crew cab models. Crew cabs, alone, comprise one-third of the segment.

Colorado's Crew Cab offers a 60/40-split folding rear seat capable of accommodating three adults. The Extended Cab model comes standard with four doors. And the Regular Cab features 60/40 bench seats, in cloth or vinyl, with bucket seats available.

From its superb torsional rigidity to its aerodynamically efficient exterior, Colorado was designed to be the smoothest, quietest pickup in its class.

Rugged, rigid and versatile

With its ladder-type frame, Colorado's chassis offers superb torsional stiffness and durability. Independent front suspension and a live rear axle are standard on rear-drive models, as is torsion-bar suspension on four-wheel-drive models.

Colorado's standard anti-lock braking system (ABS) was designed for heavy-duty service, with tandem power boosters, dual-piston disc front brakes with audible wear sensors, and 295-mm diameter rear drums. Fifteen-inch wheels and tires are standard, with step-up optional aluminum wheels available. Rack-and-pinion steering is standard.

Colorado offers several traction-assistance options. The shift-on-the-fly 4WD system is activated with a dash-mounted switch. A segment-exclusive automatic locking differential is available on both 2WD and 4WD models with either the inline four-cylinder or inline five-cylinder engine, along with a segment-first traction-control option on rear-wheel-drive models.

Colorado is ahead of its class with optional roof-rail side air bags. Dual-stage front air bags are standard; on the Regular Cab model and Extended Cab without rear seats the passenger-side air bag can be disabled. A battery saver system is standard on Colorado as well. Options include a remote locking system, heated leather seats, the OnStar safety and security system, XM Satellite Radio (continental U.S. only) and a driver information system including an oil life monitoring system.

OnStar is the leading provider of in-vehicle safety, security and information services in the U.S. and Canada. Using the Global Positioning System (GPS) satellite network and wireless technology, OnStar services include automatic notification of air-bag deployment, stolen vehicle location, remote door unlock, emergency services dispatch, roadside assistance, remote diagnostics, route support, convenience services and OnStar Concierge. OnStar Personal Calling allows drivers to make and receive hands-free, voice-activated phone calls through a nationwide network in cooperation with Verizon Wireless. Virtual Advisor (U.S. only) gives subscribers access to personalized information in a hands-free, voice-activated manner with no screens or displays.

XM Satellite Radio provides 100 coast-to-coast, digital-quality channels of original music, news, sports and talk. Consumers can subscribe to the basic service for $9.99 a month - less than the cost of a single CD. In addition, GM customers with GMAC financing can choose to include the XM subscription in their car payments.

Advanced powertrain choices

The 2004 Chevrolet Colorado will feature new inline five-cylinder and four-cylinder engines that provide outstanding combinations of power and efficiency. The Vortec 3500 inline five-cylinder and Vortec 2800 inline four-cylinder are derivatives of the award-winning Vortec 4200 inline six-cylinder engine featured in the Chevy TrailBlazer and TrailBlazer EXT.

"The American public discovered the inherent advantages of inline engine technology with the introduction of the TrailBlazer, and this year they're going to realize the same thing in the Colorado," said Bruce Mader, Colorado product manager. "Both of these all-new inline engines are among the most advanced engines in the world. These powertrains are indicative of just what a 'true Chevy truck' Colorado really is."

With their common design, the new inline-five cylinder and inline four-cylinder engines feature the same all-aluminum construction, dual overhead camshafts and four-valves-per-cylinder technology as the Vortec 4200. The new engines also share the I-6's high 10:1 compression ratio, electronic throttle control, exhaust cam phasing, coil-on-plug ignition, direct-mount accessories and easy maintenance features.

The cast aluminum four- and five-cylinder engine blocks and aluminum cylinder heads are produced using the same lost foam casting process as the Vortec 4200. This process allows more exact dimensional control while reducing machining efforts in oil galleries, coolant and other internal passages.

Overall, the new engines share 75 percent of their components with the Vortec 4200 and 89 percent of their components with each other. This provides customers with highly proven design features and enables GM to develop and introduce them more quickly and at a lower cost.

The Vortec 3500 I-5 produces 220 horsepower (164 kw) and 225 lb.-ft. (305 Nm) of torque. The Vortec 2800 I-4 delivers 175 horsepower (130 kw) and 185 lb.-ft. (251 Nm) of torque. A key advantage of the inline engine is that 90 percent of peak torque is available across a much wider range of the driving cycle: from 1400 to 5200 rpm for the Vortec 3500 and from 1200 through 5600 rpm for the Vortec 2800. Both engines, inline-five and inline-four, are powerful enough for a 4x4.

"The real key to these engines is that they're part of a carefully planned and developed inline family," said Ron Kociba, Vortec inline engine chief engineer. "The Vortec 4200 I-6 was the first and the I-5 and I-4 take advantage of much of the same technology to provide the same benefits for Colorado customers as the I-6 provides in the TrailBlazer."

Smooth-shifting transmissions

Available with both the Vortec 3500 and 2800 engines is the precisely controlled, smooth shifting Hydra-Matic 4L60-E four-speed automatic transmission. Used in all of GM's light-duty truck applications, it has a long history of customer-pleasing performance and dependability.

Both the Vortec 3500 and 2800 also link to a standard new high-torque capacity Aisin five-speed manual transmission. Used by GM for the first time, it provides smoother, higher quality shifts; better launch; improved durability and a higher degree of fuel efficiency.

Lifestyle Accessories Enhance Chevrolet Colorado Versatility

Several individual accessories designed specifically for the Chevy Colorado offer customers personalization opportunities to fit their specific lifestyles.

"Featuring flexibility, dependability and ruggedness, Chevrolet Accessories offer fun-seeking and spontaneous individuals the ability to engage in activities that satisfy their can-do attitude," said Nancy Philippart, GM Service and Parts Operations (SPO) executive director - GM Accessories Business Channel. The integration of accessories offers a combination of versatile, comfortable and dependable products.

Truck bed accessories

To complement the Colorado's distinctive design, bed side rails offer customers durability and functionality. Bed-rail and tailgate edge protectors follow the contours of the vehicle, extend the full length of the truck bed and protect the truck rails and tailgate edge from damage. A bed extender adds hauling capabilities and easily swings out over the open tailgate for additional length or swings into the truck bed to provide a stable cargo area.

Tonneau covers

The Colorado also can be accessorized with either a hard or soft tonneau cover. Polystyrene-filled aluminum panels firmly clamp to the bed rails and fold back in seconds to allow easy access to the truck's cargo area at either end of the box. This lockable, hard, UV-protected cover folds up to a compact position behind the cab for customers looking to haul large items in the truck bed. With the soft, snapless tonneau cover, cargo can be accessed through the tailgate without removing the cover. This unique accessory has the Colorado logo embossed across the rear of the cover.

Exterior functional accessories

Chrome tubular assist steps provide sure footing for the Colorado driver and passengers. The assist steps meet GM engineering standards for corrosion resistance, paint adhesion and color retention. Molded splash guards are available in injection-molded plastic. The splash guards are contoured to the wheel opening area and help protect the vehicle from stone chips, gravel and mud. In addition, the splash guards maintain flexibility, are able to withstand extreme temperatures and feature the Chevy bowtie logo.

Available at Chevrolet dealers

All Colorado accessories can be purchased through Chevrolet dealerships.

Chevrolet Accessories permanently installed on a new GM vehicle at the time of delivery will be covered under the GM New Vehicle Limited Bumper-to-Bumper Warranty. GM parts and accessories permanently installed by a GM dealer after vehicle purchase will be covered for the balance of the new vehicle warranty, but in any event no less than 12 months or 12,000 miles.

Please visit www.gmaccessorieszone.com or call toll-free 866-901-9001 to speak to one of GM's knowledgeable accessory agents.

SPO, headquartered in Grand Blanc, Mich., markets automotive replacement parts and accessories worldwide under the GM Parts and ACDelco brand names. For more information, visit the Goodwrench web site at http://www.goodwrench.com.

Vehicle Highlights

- All-new for 2004 in three body styles: Crew Cab, Extended Cab and Regular Cab
- Two powerful all-new inline engines:
  - Vortec 3500 3.5L I-5 with 220 horsepower (164 kw) and 225 lb.-ft. (305 Nm) of torque
  - Vortec 2800 2.8L I-4 with 175 horsepower (130 kw) and 185 lb.-ft. (251 Nm) of torque
- Segment-leading features:
  - Locking rear differential on both 2WD and 4WD models
  - Available traction-control on rear-wheel-drive models
  - Roof-rail side air bags
  - OnStar
- Innovative two-position locking tailgate
- Comprehensive package of safety features:
  - Dual-stage front air bags, driver and right front, with passenger-side deactivation switch (on Regular Cab and Extended Cab without rear seats) with available side-curtain air bags
  - Lower Anchors and Tethers for CHildren (LATCH) child seat anchors (plus top tether anchorage for child seats in the front seat of Regular Cabs and rear seat of Extended and Crew Cabs)
  - Standard ABS
  - Foldaway outside rearview mirrors

Model Lineup

	Engines		Transmissions	
	Vortec 2800 2.8L I-4	**Vortec 3500 3.5L I-5**	**5-spd man (MA5)**	**4-spd auto (Hydra-Matic 4L60E)**
2WD Crew Cab	s	o	s	o
2WD Extended Cab	s	o	s	o
2WD Regular Cab	s	o	s	o
4WD Crew Cab	s	o	s	o
4WD Extended Cab	s	o	s	o
4WD Regular Cab	s	o	s	o

Standard s
Optional o
Not available -

Specifications

Overview		
Models:	• 2004 Chevrolet Colorado Pickup • 2WD Regular Cab • 2WD Extended Cab • 2WD Crew Cab • 4x4 Regular Cab • 4x4 Extended Cab • 4x4 Crew Cab • 2WD Chassis Cab	
Body style / driveline:	Crew Cab (5-6 passengers), Extended Cab (4-5 passengers), Regular Cab (2-3 passengers), front-engine rear-wheel-drive and 4-wheel-drive pickup	
Construction:	welded steel frame, electro galvanized steel	
EPA vehicle class:	compact pickup	
Manufacturing locations:	Shreveport, Louisiana	
Key competitors:	Ford Ranger, Dodge Dakota, Toyota Tacoma, Nissan Frontier, Mazda B-Series Crew Cab: Dodge Dakota Quad Cab, Nissan Frontier Crew Cab, Toyota Tacoma Double Cab, Ford Explorer Sport Trac	
Engines	**Vortec 2800 2.8L I-4**	**Vortec 3500 3.5L I-5**
Application:	std on Regular Cab, Crew Cab and Extended Cab	opt on Regular Cab, Crew Cab and Extended Cab; std on ZQ8 Crew Cab and Z71 Crew Cab
Type:	2.8L inline four cylinder	3.5L inline five cylinder
Displacement (cu in / cc):	169 / 2770	211 / 3460
Bore & stroke (in / mm):	3.66 x 4 / 93 x 102	3.66 x 4 / 93 x 102
Block material:	A356-T6 lost foam cast aluminum	A356-T6 lost foam cast aluminum
Cylinder head material:	A356-T6 lost foam cast aluminum	A356-T6 lost foam cast aluminum
Valvetrain:	dual overhead camshafts, continuously variable exhaust valve timing, variable exhaust cam phasing, 4 valves-per-cylinder, with "couple" design balance shafts	dual overhead camshafts, continuously variable exhaust valve timing, variable exhaust cam phasing, 4 valves-per-cylinder, with dual balance shafts
Ignition system:	distributorless electronic spark, coil-on-plug, platinum-tipped spark plugs	distributorless electronic spark, coil-on-plug, platinum-tipped spark plugs
Fuel delivery:	multipoint sequential fuel injection	multipoint sequential fuel injection
Compression ratio:	10.0:1	10.0:1
Horsepower (hp / kw @ rpm):	175 / 130 @ 5600	220 / 164 @ 5600
Torque (lb-ft / Nm @ rpm):	185 / 251 @ 2800	225 / 305 @ 2800
Recommended fuel:	87 octane	87 octane
Maximum engine speed (rpm):	6300	6300
Emissions controls:	dual "split converter" design; LEV II	dual "split converter" design; LEV II
Estimated fuel economy (mpg city / hwy / combined):	TBD	TBD

Transmissions	**MA5**	**Hydra-Matic 4L60-E**
Type:	5-speed manual	4-speed automatic
Gear ratios (:1):		
First:	3.75	3.06
Second:	2.26	1.63
Third:	1.37	1.00
Fourth:	1.00	0.70
Fifth:	0.73	-
Reverse:	3.67	2.29
Final drive ratio:		
3.42 axle:	2.49:1	2.39:1
3.73 axle:	2.72:1	2.61:1

Chassis/Suspension	
Front:	independent with coil springs for rear-drive, independent with torsion bars for 4WD and High Stance, with stabilizer bar
Rear:	live axle with steel leaf springs; stabilizer bar with sport package
Steering type:	power-assisted rack-and-pinion
Steering ratio:	18:1 (2WD); 19:1 (4WD)
Steering wheel turns, lock-to-lock:	• 2WD Z85 3.31; • ZQ8 2.92; • Z71 3.20; 4WD: 3.20
Turning circle, curb-to-curb (ft / m):	• 2WD short wheelbase: 37 / 11.2; • Z71 39 / 11.8; • long wb: 41 / 12.6; Z71 43 / 13.2; • 4WD short wb: 39 / 11.8; • long wb: 43 / 13.2

Brakes	
Type:	vacuum power, front disc/rear drum, 4-wheel anti-lock brakes
Rotor diameter x thickness (in/mm):	front: 11.2 x 1.6 / 284.5 x 40.6
Drum diameter x width (in / mm):	rear: 11.6 x 2.5 / 294.6 x 63.5
Drum swept area (sq in / sq cm):	38.5 / 248.4
Total swept area (sq in / sq cm):	155.7 / 1005

Wheels/Tires	
Wheel size & type:	• 2WD / 4WD: 15-inch x 6-inch steel; • opt 15 x 6.5-inch aluminum;15 x 7-inch aluminum with Z71 • Off Road suspension; 17 x 8-inch aluminum with ZQ8 Sport suspension
Tires:	• 205/75R15 std all-season steel-belted radial tires (2WD) • P225/70R15 all-season steel-belted radial tires (std on 2WD Crew Cab) • P235/75R15 all-season steel-belted radial tires (std on 4WD) • P265/75R15 on/off-road steel-belted radial (with Z71 Off Road package) • P235/50R17 low-profile radial (with ZQ8 package) • full-size spare standard on all models

Dimensions

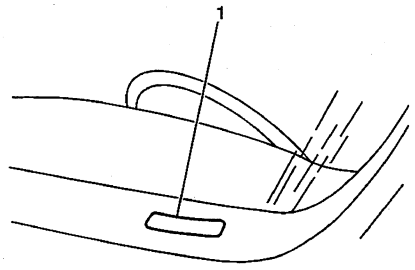
Exterior	Regular Cab 2WD	Extended Cab 2WD	Crew Cab 2WD	Regular Cab 4WD	Extended Cab 4WD	Crew Cab 4WD
Wheelbase (in / mm):	111.3 / 2827	125.9 / 3198	125.9 / 3198	111.3 / 2827	125.9 / 3198	125.9 / 3198
Overall length (in / mm):	192.4 / 4887	207 / 5258	207 / 5258	192.4 / 4887	207 / 5258	207 / 5258
Overall width (in / mm):	67.6 / 1717	67.6 / 1717	67.6 / 1717	67.6 / 1717	67.6 / 1717	67.6 / 1717
Overall height (in / mm):						
ZQ8	63.5 / 1613	63.5 / 1613	63.7 / 1618	NA	NA	NA
Z85	64.9 / 1648	64.9 / 1648	65.2 / 1656	66.3 / 1684	66.3 / 1684	66.5 / 1689
Z71	66.7 / 1694	66.7 / 1694	67 / 1702	66.7 1694	66.7 1694	67 / 1702
Overall height (in / mm):	64.8 / 1646	64.8 / 1646	64.8 / 1646	64.8 / 1646	64.8 / 1646	64.8 / 1646
Track (in / mm):						
Front:	57.5 / 1460	57.5 / 1460	57.5 / 1460	59.6 / 1514	59.6 / 1514	59.6 / 1514
Rear:	57.5 / 1460	57.5 / 1460	57.5 / 1460	57.5 / 1460	57.5 / 1460	57.5 / 1460
Minimum ground clearance front (in / mm):	8.5 / 216	8.5 / 216	8.5 / 216	8.5 / 216	5 / 127	5 / 127
Z71	9.3 / 236	9.3 / 236	8.5 / 216	9.3 / 236	9.3 / 236	9.3 / 236
ZQ8	5 / 127	5 / 127	5 / 127	-	-	-
rear	7.5 / 191	7.5 / 191	7.5 / 191	7.5 / 191	6.4 / 160	6.4 / 160
Z71	8.4 / 213	8.4 / 213	8.4 / 213	8.4 / 213	8.4 / 213	8.4 / 213
ZQ8	6.4 / 160	6.4 / 160	6.4 / 160	-	-	-
Ground to top of load floor (in/mm):	26.9 / 683	26.9 / 683	26.9 / 683	29.6 / 752	29.6 / 752	29.6 / 752
Z71	30.5 / 775	30.5 / 775	30.5 / 775	30.5 / 775	30.5 / 775	30.5 / 775
ZQ8	24.7 / 62	24.7 / 62	24.7 / 62			
Step-in height (in / mm):	17.6 / 447	17.6 / 447	17.6 / 447	21.1 / 535	21.1 / 535	21.1 / 535
Curb weight:						
base suspension, I-4 with manual (lb / kg):	3351 / 1523	3607/1639	3752 / 1705	3623 / 1647	3802 / 1728	4002 / 1819
I-4 with automatic:	3447 / 1566	3631 / 1650	3774 / 1715	3706 / 1685	3910 / 1777	4037 / 1835
I-5 with manual:	3464 / 1574	3625 / 1648	NA	3765 / 1711	3917 / 1780	NA
I-5 with automatic:	3518 / 1599	3715 / 1688	3747 / 1703	3712 / 1687	3945 / 1793	4150 / 1886

Cargo Box	**Regular Cab**	**Extended Cab**	**Crew Cab Box**
Cargo volume (cu ft / L):	43.9 / 1243	43.9 / 1243	36.7 / 1039
Length at floor (in / mm):	73 / 1854	73 / 1854	61 / 1549
Width at floor (in / mm):	57 / 1448	57 / 1448	57 / 1448
Width between wheelhousings (in / mm):	43 / 1092	43 / 1092	43 / 1092
Tailgate width (in / mm):	52.4 / 1331	52.4 / 1331	52.4 / 1331
Inside height (in / mm):	18.5 / 470	18.5 / 470	18.5 / 470
Interior	**Regular Cab**	**Extended Cab**	**Crew Cab**
Seating capacity:	2-3	4-5	5-6
Head room (in / mm):	40 / 1016	front: 39.3 / 998 rear 37.9 / 963	front: 39.3 / 998 rear 37.9 / 963
Leg room (in / mm):	42 / 1067	front:42 / 1067 rear: 23.1 / 587	front:42 / 1067 rear: 34.7 / 881
Shoulder room (in / mm):	57 / 1448	front: 57.1 / 1450 rear: 57.1 / 1450	front: 57.1 / 1450 rear: 57.1 / 1450
Hip room (in / mm):	53 / 1346	front: 53 / 1346 rear: 57.6 / 1463	front: 53 / 1346 rear: 53 / 1346
Capacities	**Regular Cab**	**Extended Cab**	**Crew Cab**
GVWR, standard (lb / kg):	2WD: 4700 / 2132 4WD: 5150 / 2336	2WD: 5000 / 2268 4WD: 5300 / 2404	2WD: 5000 / 2268 4WD: 5300 / 2404
Payload, base (lb / kg):	2WD: 1503 / 682 4WD: 1613 / 732	2WD: 1429 / 648 4WD: 1584 / 718	2WD: 1304 / 591 4WD: 1366 / 620
Fuel tank (gal / L):	19.6 / 74.2	19.6 / 74.2	19.6 / 74.2

	Vortec 2800		**Vortec 3500**	
	manual	**automatic**	**manual**	**automatic**
Engine oil (qt / L):	5 / 4.7	5 / 4.7	6 / 5.7	6 / 5.7
Maximum trailer weight (lb / kg):				
Regular Cab 2WD 3.42 axle:	1800 / 816	NA	3300 / 1500	4000 / 1814
-3.73 axle:	2300 / 1043	3200 / 1451	3800 / 1727	4000 / 1814
Extended Cab 2WD 3.42 axle:	1500 / 680	NA	3100 / 1409	4000 / 1814
-3.73 axle:	2000 / 907	3000 / 1361	3600 / 1636	4000 / 1814
Crew Cab 2WD 3.42 axle:	1400 / 635	NA	NA	4000 / 1814
-3.73 axle:	1900 / 862	2900 / 1315	NA	4000 / 1814
Regular Cab 4WD 3.42 axle:	1500 / 680	NA	3000 / 1364	4000 / 1814
-3.73 axle:	2000 / 907	2900 / 1315	3000 / 1364	4000 / 1814
Extended Cab 4WD 3.42 axle:	1300 / 590	NA	2800 / 1273	4000 / 1814
-3.73 axle:	1800 / 816	2700 / 1224	3300 / 1500	4000 / 1814
Crew Cab 4WD 3.42 axle:	1100 / 499	NA	NA	4000 / 1814
-3.73 axle:	1600 / 726	2600 / 1179	NA	4000 / 1814
Maximum tongue weight:	Trailer tongue weight should be 10% to 15% of total loaded trailer weight up to 400 lb / 182 kg.			

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	1,4	U.S. Built
2	Manufacturer	G	General Motors
3	Make	C T	Chevrolet Truck GMC Truck
4	GVWR/Brake System	C D	4001-5000/Hydraulic 5001-6000/Hydraulic
5	Truck Line/Chassis Type	S T	Sm Conventional Cab--4x2 Sm Conventional Cab--4x4
6	Series	1 6	½ Ton Nominal ½ Ton Luxury
7	Body Type	4 9 8 3	Two Door Cab Two Door Extended Cab Two Door Utility Four Door Utility or Crew Cab
8	Engine Type	8 6	2.8L Inline 4 (LK5) 3.5L Inline 5 (L52)
9	Check Digit	--	Check Digit
10	Model Year	4	2004
11	Plant Location	8	Shreveport,LA
12-17	Plant Sequence Number	--	Plant Sequence Number

VIN Derivative

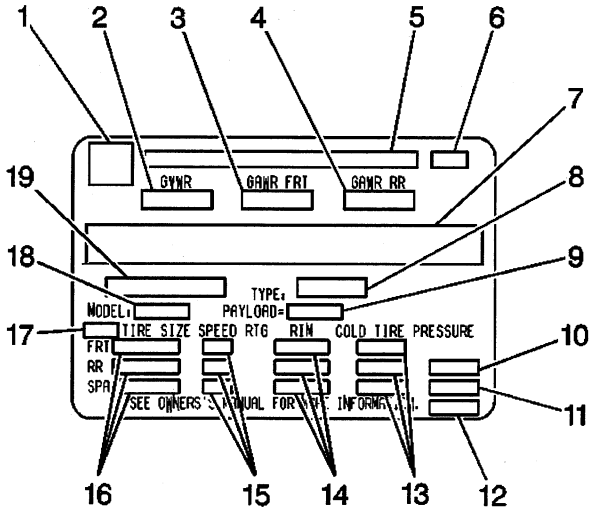
All engines and transmissions are stamped or laser etched with a partial vehicle identification number (VIN), which was derived from the complete VIN. A VIN derivative contains the following nine positions:

Position	Definition	Character	Description
1	GM Division Identifier	C T	Chevrolet Truck GMC Truck
2	Model Year	4	2004
3	Assembly Plant	K 8	Linden, NJ Shreveport, LA
4-9	Plant Sequence Number	--	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 Certification w/o RPO Z49



(1) GM Logo
(2) Gross Vehicle Weight Rating
(3) Gross Axle Weight Rating - Front
(4) Gross Axle Weight Rating - Rear
(5) Name Of Manufacturer
(6) Final Manufacturer's Date
(7) Manufacturer's Statement
(8) Model Designation
(9) Payload
(10) DUAL - When Equipped
(11) Front Axle Reserve - When Equipped
(12) Total Capacity - When Required
(13) Tire Pressure
(14) Rim Size
(15) Speed Rating - When Required
(16) Tire Size
(17) GVW Rating Code
(18) Engineering Model
(19) Vehicle Identification Number

The vehicle certification label displays the following assessments:

- The Gross Vehicle Weight Rating (GVWR)
- The Gross Axle Weight Rating (GAWR) -- Front and Rear
- The vehicle's payload rating
- 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 all vehicle accessories, like the winches or the plows
- 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.

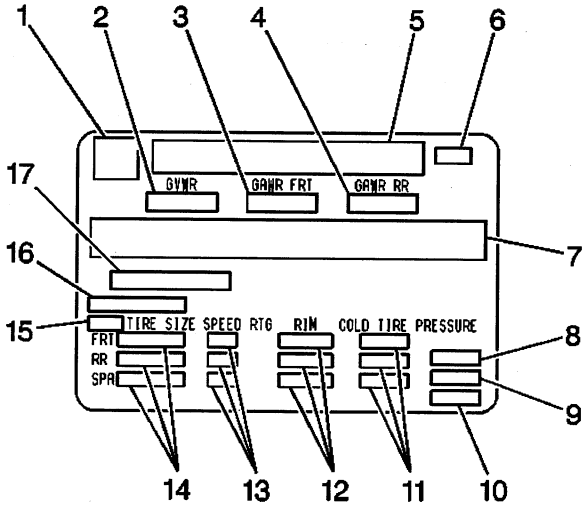
The front gross axle weight rating (GAWR FRT) is the weight exerted on the front axle. The rear gross axle weight rating (GAW RR) is the weight exerted on the rear axle. The front and rear gross axle weights must not exceed the front and rear gross axle weight ratings.

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 from the payload rating the weight of accessories added to the vehicle after the final date of manufacture .

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's tires must be the proper size and properly inflated for the load the vehicle is carrying.

Label Certification w/o RPO Z49 – Incomplete Vehicle



(1) Logo
(2) Gross Vehicle Weight Rating
(3) Gross Axle Weight Rating - Front
(4) Gross Vehicle Weight Rating - Rear
(5) Name of Manufacturer
(6) Manufacturer's Date
(7) Manufacturer's Statement
(8) DUAL - When Equipped
(9) Front Axle Reserve - When Required
(10) Total Capacity - When Required
(11) Tire Pressure - Spare Optional
(12) Rim Size - Spare Optional
(13) Speed Rating - When required - Spare Optional
(14) Tire Size - Spare Optional
(15) GVW Rating Code
(16) Engineering Model
(17) Vehicle Identification Number

The vehicle certification label displays the following assessments:

- The Gross Vehicle Weight Rating (GVWR)
- The Gross Axle Weight Rating (GAWR) -- Front and Rear
- The vehicle's payload rating

- The original equipment tire sizes and the recommended tire pressures

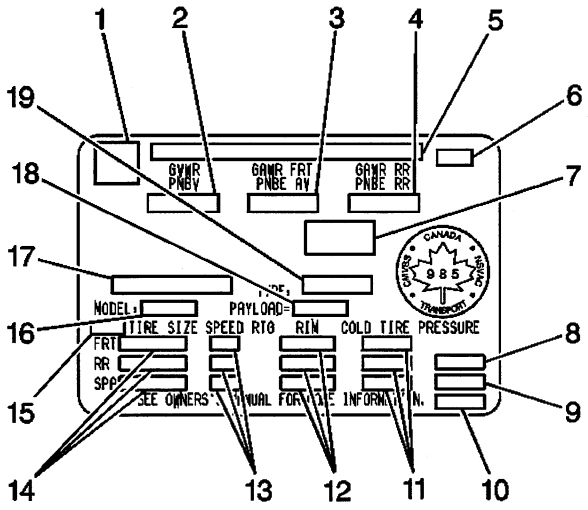
Gross vehicle weight (GVW) is the weight of the vehicle and everything it carries. Include the following items when figuring the GVW:

- The base vehicle weight factory weight
- The weight of all vehicle accessories, like the winches or the plows
- 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 rating (GAWR FRT) is the weight exerted on the front axle. The rear gross axle weight rating (GAW RR) 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.

Label Certification with RPO Z49



(1) Logo
(2) Gross Vehicle Weight Rating
(3) Gross Axle Weight Rating - Front
(4) Gross Axle Weight Rating - Rear
(5) Name of Manufacturer
(6) Final Manufacturer's Date
(7) RFI Statement - Canada Only
(8) DUAL - When Equipped
(9) Front Axle Reserve - When Equipped
(10) Total Capacity - When Required
(11) Tire Pressure
(12) Rim Size
(13) Speed Rating - When Required
(14) Tire Size
(15) GVW Rating Code
(16) Engineering Model
(17) Vehicle Identification Number
(18) Payload
(19) Model Designation

The vehicle certification label displays the following assessments:

- The Gross Vehicle Weight Rating (GVWR)

- The Gross Axle Weight Rating (GAWR) -- Front and Rear
- The vehicle's payload rating
- 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 all vehicle accessories, like the winches or the plows
- 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.

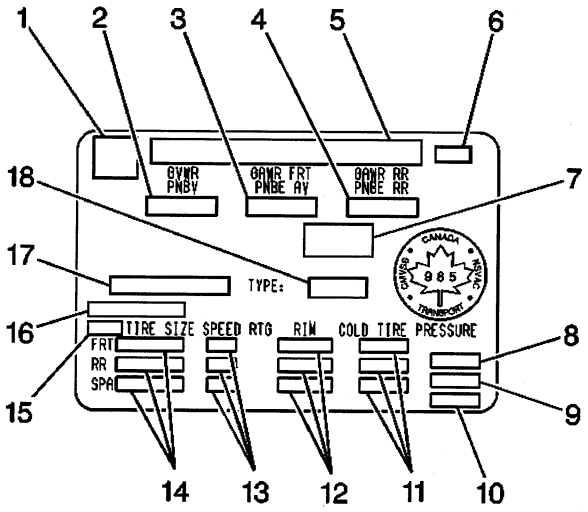
The front gross axle weight rating (GAWR FRT) is the weight exerted on the front axle. The rear gross axle weight rating (GAW RR) is the weight exerted on the rear axle. The front and rear gross axle weights must not exceed the front and rear gross axle weight ratings.

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 from the payload rating the weight of accessories added to the vehicle after the final date of manufacture .

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.

Label Certification with RPO Z49 – Incomplete Vehicle



(1) Logo
(2) Gross Vehicle Weight Rating
(3) Gross Axle Weight Rating - Front
(4) Gross Axle Weight Rating - Rear
(5) Name Of Manufacturer
(6) Manufacturer's Date
(7) RFI Statement - Canada Only
(8) DUAL - When Equipped
(9) Front Axle Reserve - When Required
(10) Total Capacity - When Required
(11) Tire Pressure - Spare Optional

(12) Rim Size - Spare Optional
(13) Speed Rating - When Required - Spare Optional
(14) Tire Size - Spare Optional
(15) GVW Rating Code
(16) Engineering Model
(17) Vehicle Identification Number
(18) Model Designation

The vehicle certification label displays the following assessments:

- The Gross Vehicle Weight Rating (GVWR)
- The Gross Axle Weight Rating (GAWR) -- Front and Rear
- The vehicle's payload rating
- The original equipment tire sizes and the recommended tire pressures

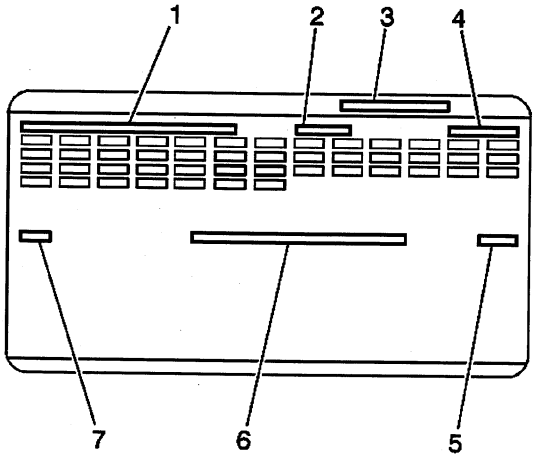
Gross vehicle weight (GVW) is the weight of the vehicle and everything it carries. Include the following items when figuring the GVW:

- The base vehicle weight factory weight
- The weight of all vehicle accessories, like the winches or the plows
- 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 rating (GAWR FRT) is the weight exerted on the front axle. The rear gross axle weight rating (GAW RR) 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.

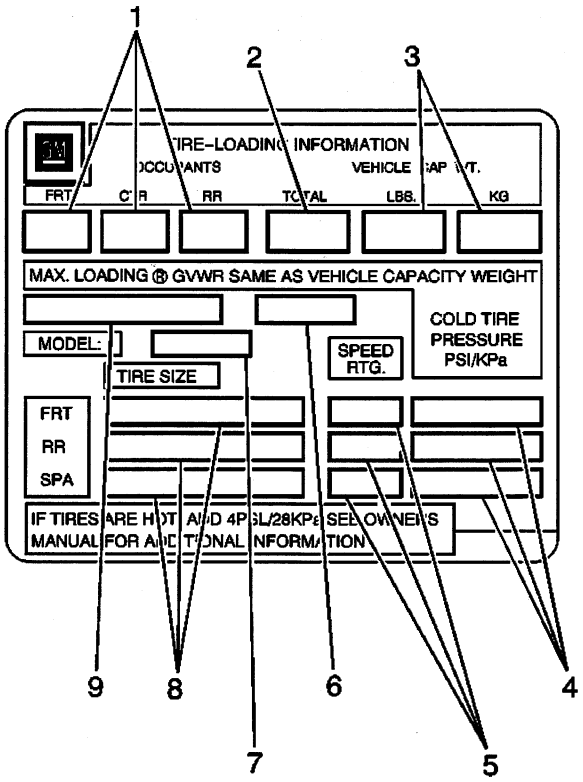
Service Parts Identification Label (SPID)



(1) Vehicle Identification Number
(2) Wheel Base
(3) Part Number Location
(4) Model Designation
(5) Order Number
(6) Exterior Color
(7) Paint Technology

The service parts identification label is located on the instrument panel storage compartment door in order to help service and parts personnel identify the vehicle's original parts and the vehicle's original options.

Tire Placard

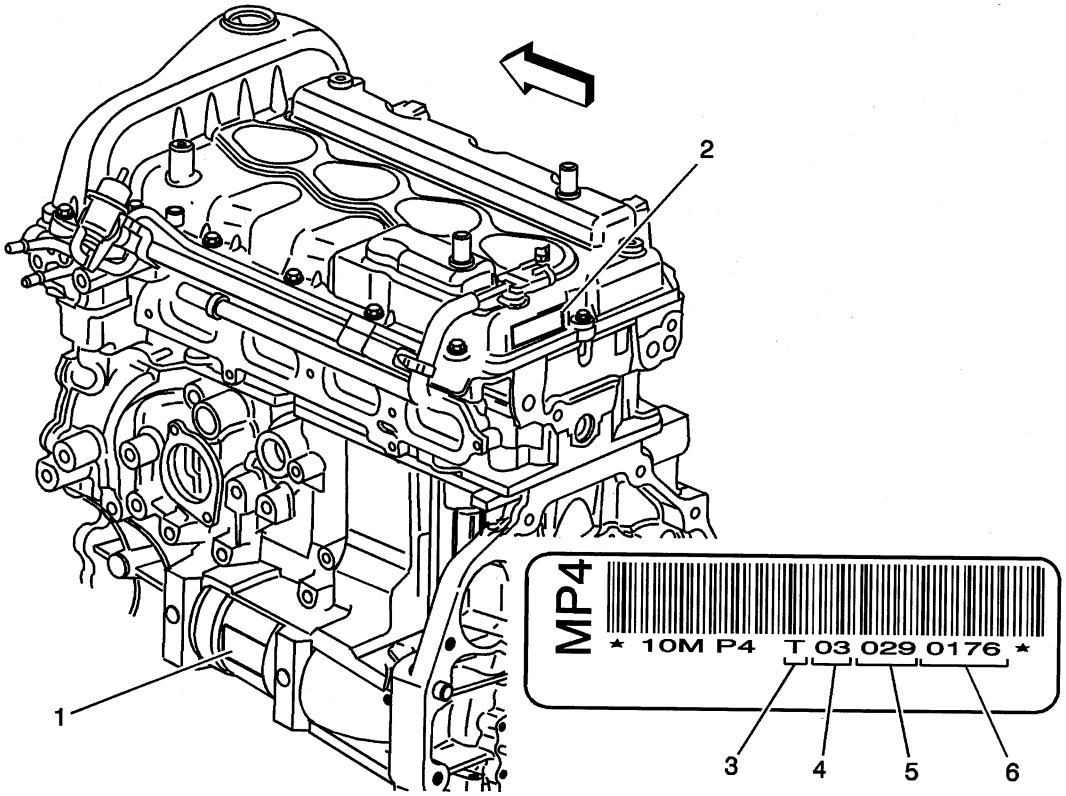


(1) Specified Occupant Seating Positions
(2) Total Occupant Seating
(3) Maximum Vehicle Capacity Weight
(4) Tire Pressures, Front, Rear, and Spare
(5) Tire Speed Rating, Front, Rear, and Spare
(6) Tire Label Code
(7) Engineering Model Minus First Character
(8) Tire Sizes, Front, Rear, and Spare
(9) Vehicle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

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

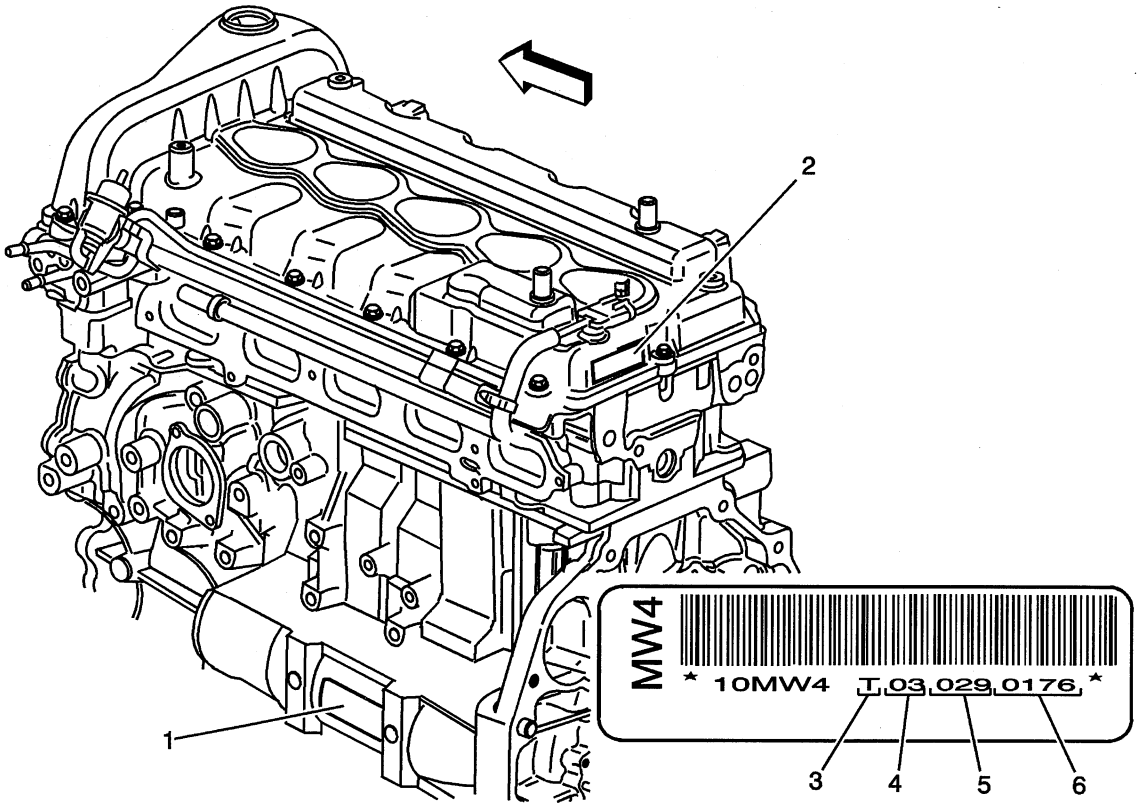
- The maximum vehicle capacity weight
- The cold tire inflation pressures
- The tire sizes (original equipment tires)
- The tire speed ratings (original equipment tires)

Engine ID and VIN Derivative Location 2.8L (LK5)



(1) Engine ID Location
(2) Engine ID Location
(3) The first digit identifies the engine build location - All first digits will be a T, this engine is only being built at Tonawanda
(4) The second and third digit identifies the build year
(5) The fourth, fifth and sixth digits identify the build month - Julian Date
(6) The seventh through tenth digits identify the engine build sequence

Engine ID and VIN Derivative Location 3.5L (L52)



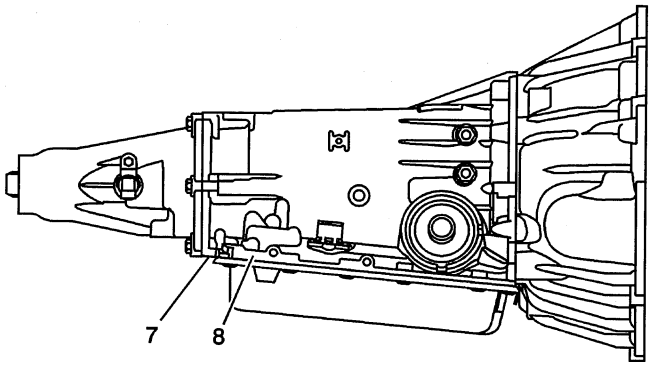
(7) Engine ID Location
(8) Engine ID Location
(9) The first digit identifies the engine build location - All first digits will be a T, this engine is only being built at Tonawanda
(10) The second and third digit identifies the build year
(11) The fourth, fifth and sixth digits identify the build month - Julian Date
(12) The seventh through tenth digits identify the engine build sequence

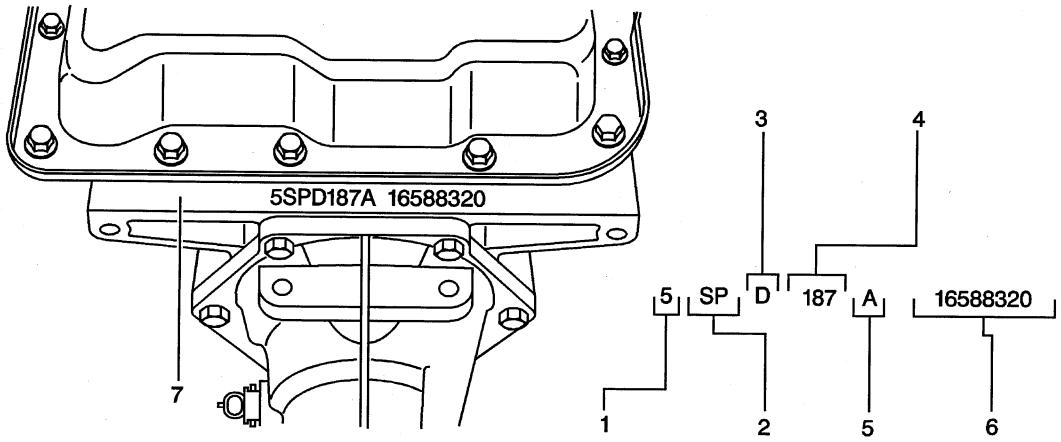
Transmission ID and VIN Derivative Location

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
Ramos Arizpe, Mexico	1	A	--	--

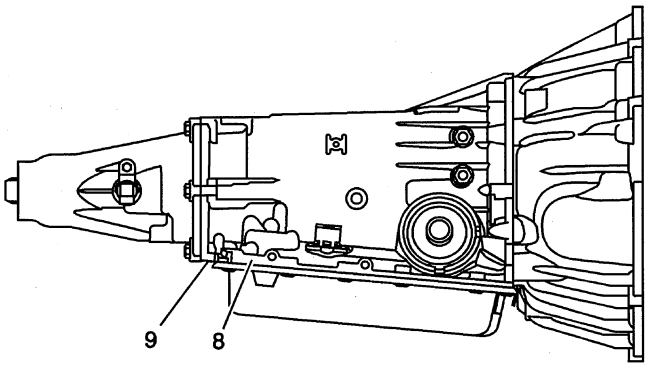
4L60-E/4I65-E Transmission ID Location – Toledo or Romulus Build

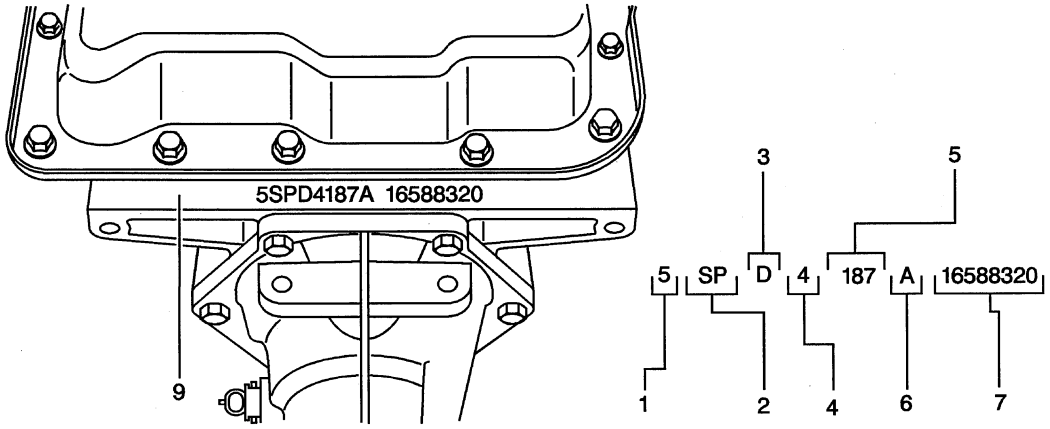




(1) 4 = 2004
(2) Model
(3) Hydra-Matic 4L60-E
(4) Julian Date or Day of the Year
(5) Shift Built, See Shift Build Chart
(6) Serial Number
(7) Case/Pan Frame Rail Location
(7) Case/Pan Frame Rail Location
(8) Optional Transmission ID Location, Tag Is Used as a Back-Up If Unable To Etch Case/Pan Area and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

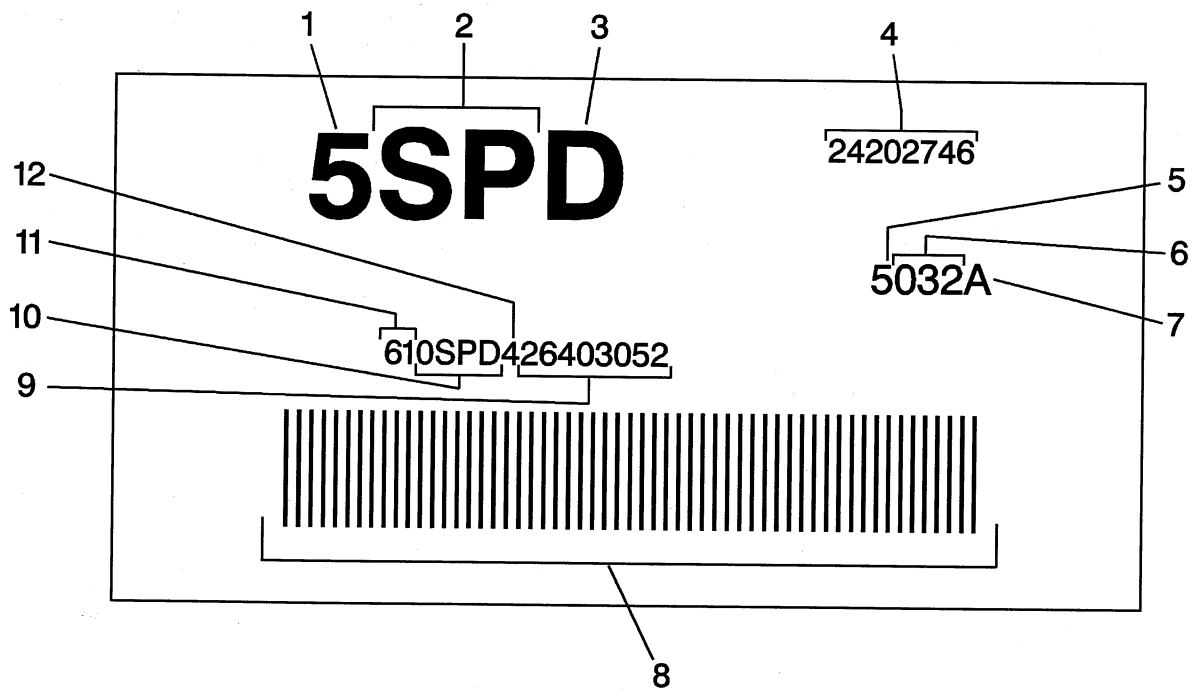
4L60-E/4I65-E Transmission ID Location – Ramos Arizpe Mexico Build





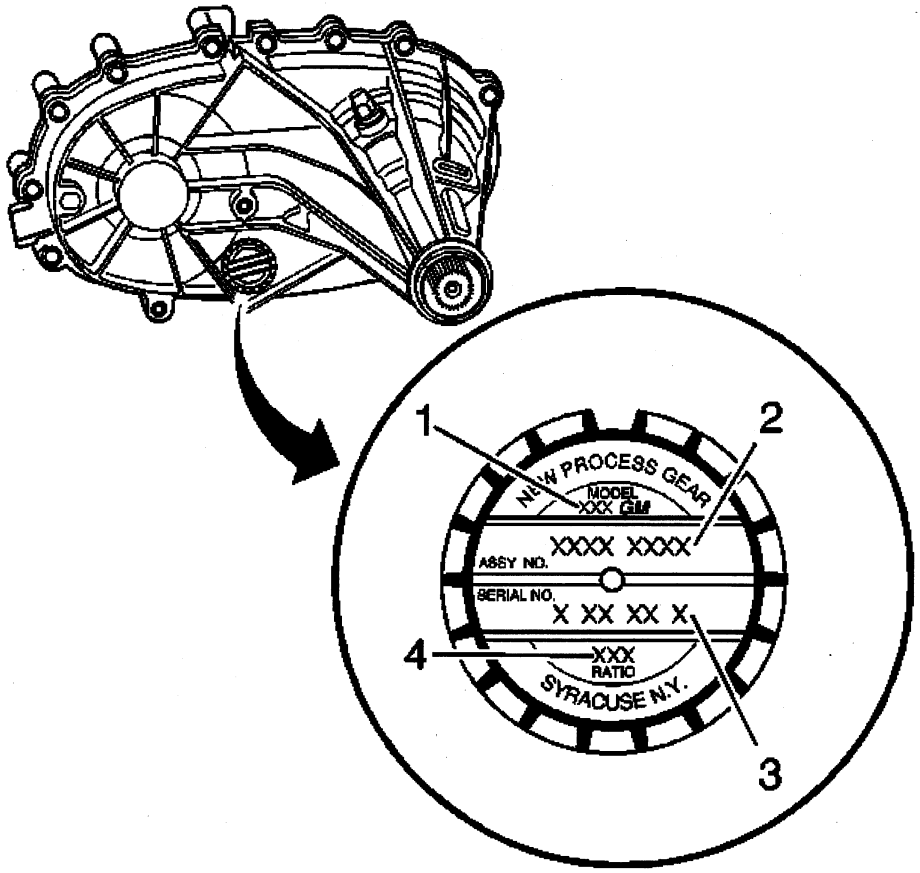
(1) 4 = 2004
(2) Model
(3) Hydra-Matic 4L60-E
(4) Plant of Manufacture, 4 is Ramos
(5) Julian Date or Day of the Year
(6) Shift Built, See Shift Build Chart
(7) Transmission Serial Number
(8) Optional Transmission ID Tag Location, Tag Is Used as a Back-Up If Unable To Etch Case/Pan Area and To Bar Code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

Barcode Label Contents – All Builds



(1) 4 = 2004
(2) Model
(3) Hydra-Matic 4L60-E
(4) Transmission Asm. as Shipped Number
(5) 5 = 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

Transfer Case Identification

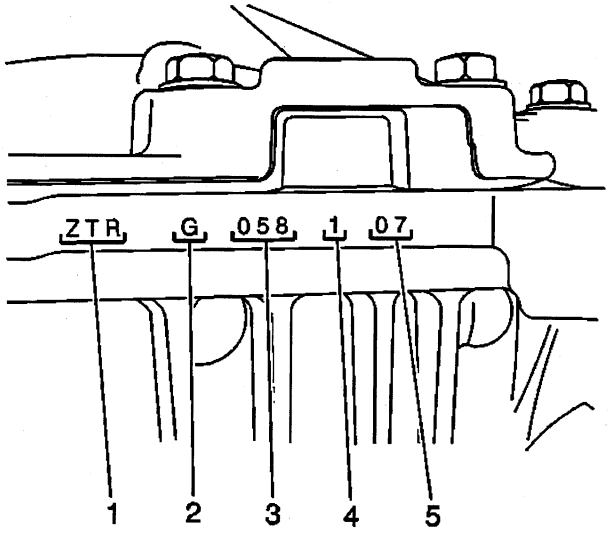


An identification tag is attached to the rear half of the transfer case. The tag provides the following information:

1 Model number (1)
   A First Digit-1 =Single Speed, 2=Two-Speed
   B Second Digit-2 = T Utility, 3 =T-Truck, L-Van, 4 or 6 = K Truck and Utility
   C Third Digit-1 = Manual, 3 = Electric Shift, 6 = Automatic, 9 = All Wheel Drive
2 Assembly number (2)
3 Serial number (Date and Shift Code) (3)
4 Low range reduction ratio (4)

The information on this tag is necessary for servicing the transfer case. If the tag is removed or becomes dislodged during service operations, keep the identification tag with the unit.

Axle Identification – Front



(1) Broadcast Code
(2) Supplier Code (G = American Axle)
(3) Julian Date (Day of Year)
(4) Shift Built (1 = First Shift; 2 = Second Shift) (Optional for 8.25" and 9.25" axles)
(5) Hour Built

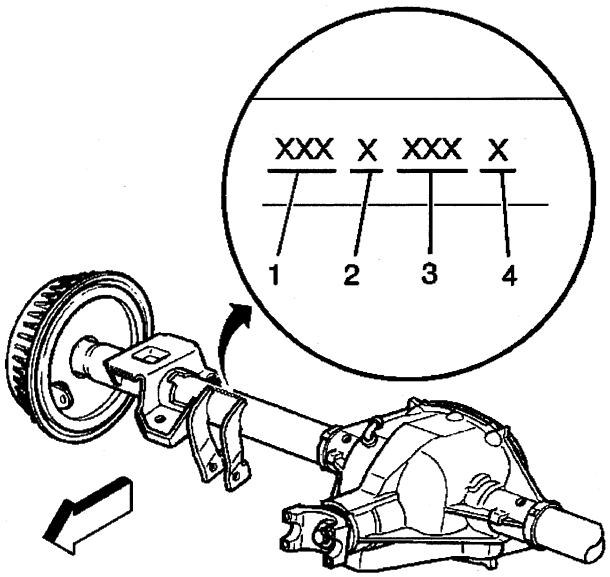
Front axle identification information is stamped on the top of the differential carrier assembly.

The following broadcast codes identifies the axle ratio:

Broadcast Code	Ratio
ZTM	3.08
ZTN, ZTU, ZTW, ZSY, ZA2, ZC2	3.42
ZTP, ZTR, ZTS, ZTX, ZSZ, ZB2,ZD2	3.73
ZTT,ZF2	4.10
ZH2	4.56

The information on the differential carrier assembly is necessary for servicing.

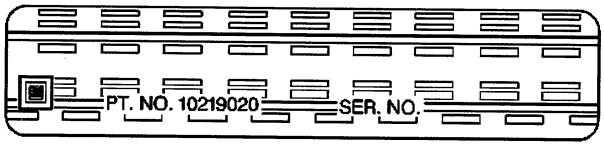
Axle Identification – Rear



(1) Rear Axle Ratio
(2) Build Source (C = Buffalo; K = Canada)
(3) Julian Date
(4) Shift Built (1 = First; 2 = Second)

All rear axles are identified by a broadcast code on the right axle tube near the carrier. The rear axle identification and manufacturer's codes must be known before attempting to adjust or to repair axle shafts or the rear axle case assembly. Rear axle ratio, differential type, manufacturer, and build date information is stamped on the right axle tube on the forward side.

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
AG1	Adjuster, Driver Seat, Power 6-Way
AG2	Adjuster, Passenger Seat, Power 6-Way
AJ1	Window Tinted, Deep Tint
AJ1	Window Tinted Deep, all except W/S and DRS
AM4	Rear Split Back Seat, Folding, Custom
AM6	Seat, Front Split, 3 Passenger, Center Arm Rest
AR9	Seat, Front, Bucket, Deluxe
ASF	Restraing Roof Side, Left and Right, Inflatable
AU0	Remote Keyless Entry
AU3	Power Door Locks
A28	Window, Rear Full Width, Sliding
A31	Window Power Operated, Side
BAG	Parts Package Export
BKE	Covering Floor Mat Set, Molded Carpet
BPA	Compartment Stowage, Rear Seat
BVE	Side Steps Running Board
B30	Covering, Floor Carpet
B32	Covering Floor Mats, Front Auxiliary
B33	Covering Rear Floor Mats, Auxiliary
B38	Covering Floor Vinyl, Front and Rear, Full Width
B4L	Label, Price Refer Geographic Chart
B4U	Performance Package Sport
B84	Molding B/S Exterior
C3H	GVW RATING 5300 lb
C42	HVAC System Heater Deluxe, Outside Air
C5A	GVW Rating 4900 lb
C5C	GVW Rating 5000 lb
C6F	GVW Rating 5150 lb
C6I	GVW Rating 4850 lb
C60	HVAC System Air Conditioner, Front Manual Controls
C7Y	GVW Rating 4700 lb
C8T	Tail Lamp, Clear Lens
DC4	Mirror, Inside, R/V Tilt, Dual Reading Lamps
DE2	Mirror, Outside Manual Control, Folding, Color
DE6	Mirror, Outside Remote Control, Electric, Dual Folding, Color
DF8	Mirror, Inside, R/V Light Sensative, Compass, Outside Temperature Display, Dual Reading Lamps
DNR	Equipment Dealer Installed
D06	Console Front Compartment Floor, Arm Rest
D31	Mirror Inside R/V Tilt
EN6	Cover, Rear Compartment Hard Folding, Rear Compartment, Cargo
EVA	Test DVT, Evaporator Emission Requirement
E01	Assist Steps
E15	Assist Steps, Chrome
E16	Assist Steps, Natural
E62	Body Equipment Stepside
E63	Body Equipment Fleetside PUBX

RPO	Description
E95	Cover, Rear Compartment Tonneau, Rear Compartment
FF4	Arm Torsion Bar Spring Adjustment (C)
FF5	Arm Torsion Bar Spring Adjustment (D)
FK2	Arm Torsion Bar Spring Adjustment (A)
FK3	Arm Torsion Bar Spring Adjustment (B)
GT4	Axle Rear 3.73 Ratio (Dup with 5X1)
GU6	Axle Rear 3.42 Ratio
G80	Axle Positraction Limited, Slip
JA1	Brake, Light Weight, Disc/Drum
JJA	PT Dress Subassembly Installed (Modular Optimization Method Only)
KA1	Heater Seat, Front
KC5	Electrical Receptacle, Accessory
K05	Heater, Engine Block
K34	Cruise Control Automatic, Electronic
K60	Generator, 100 Amp
LK5	Engine, Gas, 4 Cylinder, 2.8 L, MFI, L4, Aluminum, DOHC, GM
L52	Engine, Gas, 5 Cylinder, 3.5 L, MFI, L5, Aluminum, DOHC, GM
MA5	Transmission, Manual 5-Speed, 82 mm, 3.753 1st, 0.729 5th
M30	Transmission, Automatic 4-Speed, 4L60E, Electronic
NP1	Transfer Case Electric Shift Control, Two-Speed
NP5	Steering Wheel Leather Wrapped
NT7	Emission System, Federal, Tier 2
NU1	Emission System, California, Level 2
NW7	Traction Control Powertrain, Management Only
NZZ	Sales Package Skid Plate, Off-Road Spot
N33	Steering Column Tilt Type
N40	Steering Power, Non-Variable Ration
N90	Wheel 15 x 7, Aluminum Cast, 4.75 inch Bolt
PF3	Wheel 15 x 6.5, Aluminum
PG1	Wheel 15 x 6, Steel
PPB	Equipment PUBX Extender
PUB	Cap PUBX Bed Rail
QA8	Wheel 17 x 8, Aluminum
QCE	Tire, P205/75R15/N Black Wall, All Season
QET	Tire P225/75R15/N Black Wall, R/PE ST TL All Season
QFL	Tire P235/75R15-105S Black Wall, R/PE ST TL All Season
QGR	Tire P235/50R17-95S Black Wall, TL All Season
QWU	Tire P265/75R15-112S Black Wall, TL, OOR
RDE	Rail PUBX Bed, Chrome
RDF	Rail PUBX Bed, Natural
RDG	Rail PUBX Bed, Gray
SLA	Plant Code Shreveport, LA, GM T&B
TR9	Lamp Group
TT5	Headlamps, Halogen, 2
T61	Lighting, Daytime Running
T62	Lighting, Daytime Running - Delete
T82	Headlamps Control Automatic On-Off
T96	Front Fog Lamp
UAA	Equipment Cluster Package - Tachometer, Trip Odometer, Volts, Oil, DIC
UA1	Battery, High Capacity, Wet
UB0	Radio AM/FM Stereo, Seek/Scan, Compact Disc, Auto Tone, Data System, Clock, ETR

RPO	Description
UC6	Radio AM/FM Stereo, Seek/Scan, RDS, Multiple Compact Disc, Auto Tone Control, Clock, ETR
UE1	Communication System Vehicle, GPS 1
UL5	Radio - Delete
UM7	Radio, AM/FM Stereo, Seek/Scan, Clock
UQ3	Speaker System Performance, Enhanced Audio
UQ5	Speaker System 4, Dual Front Drive Mounted, Dual Extended Range, Quarter Mounted
U19	Speedometer Inst. Kilometer and Miles, Kilometer Odometer
U2K	Digital Audio System S-Band
VC4	Label Price/Fuel Economy Puerto Rico
VC5	Label Shipping, except US, US Possessions, or Japan
VC7	Label Price/Fuel Economy, Guam
VGC	Protector Film, Paint Etch Preventive
VG8	Vehicle Buyer Notice Label
VH4	Mud Flaps
VJA	Protector Endgate
VK3	License Plate Front, Front Mounting Package
VPH	Vehicle Preparation, Overseas Delivery
VP6	Noise Control
VR6	Hook Tie Down
VXS	Vehicle Complete
VXT	Vehicle Incomplete
V22	Grille Radiator, Chrome
V73	Vehicle Statement, US and Canada
V76	Hook Tow
V78	Vehicle Statement - Delete
V98	Factory Delivery Processing
XCE	Tire Front P205/75R15/N Black Wall
XET	Tire Front P225/75R15 Black Wall, R/PE ST TL All-Season
XFL	Tire Front P235/75R15-105S Black Wall, R/PE ST TL All-Season
XGR	Tire Front 235/50R17-195H Black Wall TL AL2
XWU	Tire Front P265/75R15-112S Black Wall TL OOR
X88	Conversion Name PLate, Chevrolet
YCE	Tire Rear P205/75R15/N Black
YC0	Convenience Package Decor Level Base
YC1	Convenience Package Decor Level #1
YC3	Convenience Package Decor Level #3
YET	Tire Rear P225/75R15 Black Wall
YFL	Tire Rear P235/75R15-105S Black Wall R/PE ST TL All Season
YGR	Tire Rear P235/50R17-95S Black Wall TL AL2
YWU	Tire Rear 265/75R15-112S Black Wall TL OOR
ZAA	Tire, Spare Compact
ZFL	Tire, Spare P235/75R15-105S Black Wall R/PE ST TL All Season
ZQ8	Chassis Package Sport
ZW9	Body Equipment Base Body OR Chassis
Z49	Export Canadian Modified, Mandatory Base Equipment
Z59	Chassis Package High Stance 4x2
Z71	Chassis Package Off-Road
Z82	Trailer Provisions Special Equipment, H.D.
Z85	Chassis Package Increased Capacity
Z88	Conversion Name Plate "GMC"

RPO	Description
1Q6	Vehicle Inspection Pre-delivery Form

Technical Information

Maintenance and Lubrication

Capacities - Approximate Fluid

Application	Specification	
	Metric	English
Cooling System		
2.8L Engine (RPO LK5)	9.8 L	10.4 qt
3.5L Engine (RPO L52)	10 L	10.6 pt
Differential Fluid		
Rear Axle	1.6-1.8 L	3.4-3.8 pt
Front Axle	1.5 L	3.2 pt
Engine Oil with Filter		
2.8L Engine (RPO LK5)	4.7 L	5 qt
3.5L Engine (RPO L52)	5.6 L	6 qt
Fuel Tank	76 L	19.5 gal
Transmission Drain and Refill		
Automatic - Pan Removal	4.7 L	5 qt
Automatic - Overhaul	10.6 L	11 qt
Manual	2.4 L	2.5 qt

Maintenance Items

Item	Part Number
Transmission Filter Kit	
• Automatic	GM P/N 24225323
Engine Air Cleaner/Filter	GM P/N 15202408
Engine Oil Filter	
• 2.8L Engine	GM P/N 88984215 ACDelco® P/N PF46
• 3.5L Engine	GM P/N 89017342 ACDelco® P/N PF61
Fuel Filter	GM P/N 25121800 ACDelco® P/N GF624
Spark Plugs	GM P/N 25337472 ACDelco® P/N 41-981
Windshield Wiper Blades	
• Driver Side	GM P/N 15169017
• Passenger Side	GM P/N 15169018
• Wiper Blade Length - Driver	55 cm (22 in)
• Wiper Blade Length - Passenger	48 cm (19 in)

Fluid and Lubricant Recommendations

Usage	Fluid/Lubricant
Engine Oil	Engine oil with the American Petroleum Institute Certified for Gasoline Engines starburst symbol of the proper viscosity. To determine the preferred viscosity for your vehicle's engine.
Engine Coolant	50/50 mixture of clean, drinkable water and use only GM DEX-COOL.
Hydraulic Brake System	Delco Supreme 11 Brake Fluid or equivalent DOT-3 Brake fluid.
Windshield Washer Solvent	GM Optikleen Washer Solvent.
Parking Brake Cable Guides	Chassis Lubricant GM P/N 12377985, Canadian P/N 88901242 or equivalent or lubricant meeting requirements of NLGI #2, Category LB or GC-LB.
Power Steering System	GM Power Steering Fluid GM P/N 89021184, Canadian P/N 89021186 or equivalent.
Automatic Transmission	DEXRON-III Automatic Transmission Fluid.
Manual Transmission	Manual Transmission Fluid GM P/N 89021806, Canadian P/N 89021807 or equivalent.
Hydraulic Clutch System	Hydraulic Clutch Fluid GM P/N 12345347, Canadian P/N 10953517 or equivalent DOT-3 brake fluid.
Key Lock Cylinders	Multi-Pupose Lubricant, Superlube GM P/N 12346241, Canadian P/N 10953474 or equivalent.
Chassis Lubrication	Chassis Lubricant GM P/N 12377985, Canadian P/N 88901242 or equivalent or lubricant meeting requirements of NLGI #2, Category LB or GC-LB.
Front and Rear Axle	SAE 75W-90 Synthetic Axle Lubricant GM P/N 12378261, Canadian P/N 10953455 or equivalent.
Transfer Case	Synchromesh Transmission Fluid GM P/N 12345349, Canadian P/N 10953465 or equivalent.
Rear Driveline Center Spline and Universal Joints	Chassis Lubricant GM P/N 12377985, Canadian P/N 88901242 or equivalent or lubricant meeting requirements of NLGI #2, Category LB or GC-LB.
Constant Velocity Universal Joint	Chassis Lubricant GM P/N 12377985, Canadian P/N 88901242 or equivalent or lubricant meeting requirements of NLGI #2, Category LB or GC-LB.
Hood Latch Assembly, Secondary Latch, Pivots, Spring Anchor and Release Pawl	Lubriplate Lubricant Aerosol GM P/N 1052349, Canadian P/N 992723 or equivalent or lubricant meeting requirements of NLGI #2, Category LB or GC-LB.
Hood and Door Hinges, Body Door Hinges Pins, Liftgate Hinge and Linkage, Folding Seats and Fuel Door Hinge	Multi-Purpose Lubricant, Superlube GM P/N 12346241, Canadian P/N 10953474 or equivalent.
Outer Tailgate Handle Pivot Points and Hinges	Multi-Purpose Lubricant, Superlube GM P/N 12346241, Canadian P/N 10953474 or equivalent.
Weatherstrip Conditioning	Dielectric Silicone Grease GM P/N 12345579, Canadian P/N 1974984 or equivalent.
Weatherstrip Squeaks	Synthetic Grease with Teflon, Superlube GM P/N 12371287, Canadian P/N 10953437 or equivalent.

GM Oil Life System - Resetting

The vehicle has a computer system that has a change engine oil message, indicating when to change the engine oil and filter. This is based on engine revolutions and engine temperature, and not on mileage. Based on driving conditions, the kilometers or mileage at which an oil change will be indicated can vary considerably. For the oil life system to work properly, the system must be reset every time the oil is changed.

When the system has calculated that oil life has been diminished, it will indicate that an oil change is necessary. The change engine oil message will come on. The oil must be changed as soon as possible. It is possible that, if the vehicle is driven under the best conditions, the oil life system may not indicate that an oil change is necessary for over a year. However, the engine oil and filter must be changed at least once a year and at this time the system must be reset. If the system is ever reset accidentally, the oil must be changed at 3,000 miles (5 000 km) since the last oil change. Remember to reset the oil life system whenever the oil and filter is changed.

Resetting Procedure

1. Turn the ignition to RUN with the engine OFF.
2. Press and release the reset stem in the lower center of the instrument panel (I/P) cluster until the OIL LIFE message is displayed.
3. Once the alternating OIL LIFE and RESET messages appears in the display, press and hold the reset stem until several beeps sound. This confirms the OIL LIFE system has been reset.
4. Turn the key to lock. If the CHANGE OIL message comes back on when you start the engine, the ENGINE OIL LIFE system has not reset. Repeat the procedure.

Alternate Method

1. Turn the ignition key to RUN with the engine off.
2. Fully press the release the accelerator pedal 3 times within 5 seconds. Several beeps sound. This confirms the oil life system has been reset.
3. If the CHANGE/OIL message comes back on when you start the engine, the engine oil life system has not been reset. Repeat the procedure.

Descriptions and Operations

Power Steering System

The hydraulic power steering pump is a constant displacement vane-type pump that provides hydraulic pressure and flow for the power steering gear. The hydraulic power steering pump is belt-driven.

The power steering fluid reservoir holds the power steering fluid and is integral with the power steering pump. The reservoir can be serviced seperatly from the pump.

This vehicle uses a rack and pinion system.

In the rack and pinion system, the rack and the pinion are the 2 components that convert steering wheel rotation to lateral movement. The steering shaft is attached to the pinion in the steering gear. The pinion rotates with the steering wheel. Gear teeth on the pinion mesh with the gear teeth on the rack. The rotating pinion moves the rack from side to side. The lateral action of the rack pushes and pulls the tie rods in order to change the direction of the vehicle's front wheels.

The power steering pressure hose connects the power steering pump fitting to the power steering gear and allows pressurized power steering fluid to flow from the pump to the gear.

The power steering return hose returns fluid from the power steering gear back to the power steering fluid reservoir. The power steering return line may contain an integral fin-type or line-type power steering fluid cooler.

In a typical power steering system, a pump generates hydraulic pressure, causing fluid to flow, via the pressure hose, to the steering gear valve assembly. The steering gear valve assembly regulates the incoming fluid to the right and left chambers in order to assist in right and left turns.

Turning the steering wheel activates the valve assembly, which applies greater fluid pressure and flow to 1 side of the steering gear piston, and lower pressure and flow to the other side of the piston. The pressure assists the movement of the gear piston. Tie rods transfer this force to the front wheels, which turn the vehicle right or left.

Steering Wheel and Column - Standard Description and Operation

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.

Ignition Lock Cylinder Control Actuator

If the vehicle is equipped with a floor mounted console gear shifter, it has a ignition lock cylinder control actuator system in the steering column as an added safety feature. The ignition lock cylinder control actuators purpose is to prevent the steering wheel from being locked when the transmission is in gear and the vehicle may still be moving. The column ignition lock system consists of a ignition lock cylinder control acutator, and a park position switch that is located in the A/T shift lock control switch. The ignition lock cylinder control acutator contains a pin that is spring loaded out to mechanically prevent the ignition key cylinder from being turned to the lock position when vehicle transmission is not in the Park position. If vehicle power is lost, and/or the transmission is not in the Park position the operator will not be able to turn the ignition key to the lock position and will not be able to remove the ignition key from the column.

Suspension Description and Operation

Front Suspension

The front suspension allows each wheel to compensate for changes in the road surface without affecting the opposite wheel. Each wheel independently connects to the frame with a steering knuckle, ball joint assemblies, and upper and lower control arms.

Two tie rods connect to the steering arms on the knuckles and to a steering gear.

Rear wheel drive models have a front suspension that consists of the following components:

- Control arms
- Stabilizer shaft
- Shock/Coil spring modules

The upper part of each Shock/Coil spring module bolts to the frame. Three insulators, a mounting plate and a nut secure the coil spring to the shock housing. One bolt secures the lower part of the shock to the lower control arm.

A spring steel stabilizer shaft controls the side roll of the front suspension. This shaft is mounted in rubber insulators that are held by clamps to the frame side rails. The ends of the stabilizer shaft connect to the lower control arms with link assemblies.

The upper ball joint assembly is bolted into the upper control arm and is serviceable. The assembly attaches to the steering knuckle with a prevailing torque nut.

The lower ball joint assembly is bolted into the control arm and is serviceable. The assembly attaches to the steering knuckle with a prevailing torque nut.

The upper and the lower control arms have pressed-in bushings. The bolts pass through the bushings and join the arms to the frame.

Ball joint assemblies have rubber grease seals. These seals prevent the entry of moisture and dirt. This prevents damage to the bearing surfaces. All ball joints have grease fittings for routine maintenance.

Four-wheel drive models have a front suspension that consists of the following components:

- Control arms
- Stabilizer shaft
- Shock absorbers
- Torsion bars (right and left side)

The upper part of each shock absorber extends through a frame bracket. Two insulators and a nut secure the upper part of the shock to the frame. A through bolt secures the lower part of the shock to the lower control arm.

A spring steel stabilizer shaft controls the side roll of the front suspension. This shaft is mounted in rubber insulators that are held by clamps to the frame side rails. The ends of the stabilizer shaft connect to the lower control arms with link assemblies.

The upper ball joint assembly is bolted into the upper control arm and is serviceable. The assembly attaches to the steering knuckle with a prevailing torque nut.

The lower ball joint assembly is bolted into the control arm and is serviceable. The assembly attaches to the steering knuckle with a prevailing torque nut.

The lower control arms also include a bolted on torsion bar anchor which is serviceable.

Torsion bars replace the conventional coil springs. The front end of the torsion bar attaches to the lower control arm. The rear of the torsion bar mounts into an adjustable arm at the torsion bar crossmember. This arm adjustment controls the vehicle trim height.

Both RWD and S4WD models have sealed front wheel bearings. These bearings are pre-adjusted and need no lubrication.

Rear Suspension

These vehicles use a leaf spring and a solid rear axle suspension system.

The rear axle assembly is attached to multi-leaf springs with U-bolts. The front ends of the springs are attached to the frame at the front hangers with rubber bushings. The rear ends of the springs are attached to the frame with shackles that use rubber bushings. Shackles allow the springs to change position while the vehicle is in motion.

Two direct double-acting shock absorbers provide ride control. The shock absorbers are angle-mounted between the frame. The shock absorbers are attached with brackets. The brackets are attached to the anchor plate.

The rear spring steel stabilizing shaft helps minimize body roll and sway during cornering. The rear stabilizer shaft is connected to the rear axle and the frame with the following components:

- The rubber insulators
- The clamps
- The link assemblies

Wheels and Tires

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Spare Wheel Hoist Assembly Mounting Bolts	50 N·m	37 lb ft
Wheel Nut	140 N·m	103 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.

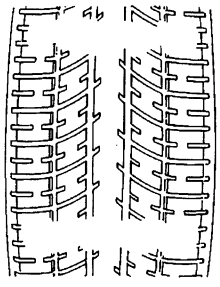
The following factors have an important influence on tire life:

- 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

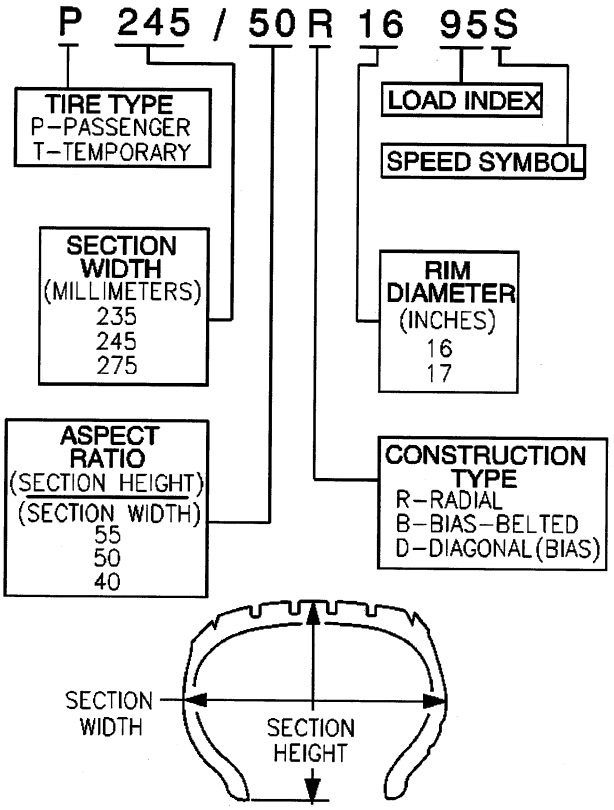
Tires with a lower than recommended pressure can cause the following conditions:

- 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

The propeller shaft is a tube with universal joints at both ends which do not require periodic maintenance, that transmit power from the transfer case or transmission output shaft to the differential.

Front Propeller Shaft Description

The front propeller shaft transmits rotating force from the transfer case to the front differential when the transfer case is engaged. The front propeller shaft connects to the transfer case using a splined slip joint.

One Piece Propeller Shaft Description

A 1 piece propeller shaft uses a splined slip joint to connect the driveline to the transmission or transfer case.

Two Piece Propeller Shaft Description

There are 3 universal joints used on the two piece propeller shaft, A center bearing assembly is used to support the propeller shaft connection point, and help isolate the vehicle from vibration.

Propeller Shaft Phasing Description

The propeller shaft is designed and built with the yoke lugs (ears) in line with each other. This produces the smoothest running shaft possible. A propeller shaft designed with built in yoke lugs in line is known as in - phase. An out of phase propeller shaft often causes vibration. The propeller shaft generates vibration from speeding up and slowing down each time the universal joint goes around. The vibration is the same as a person snapping a rope and watching the wave reaction flow to the end. An in phase propeller shaft is similar to 2 persons snapping a rope at the same time and watching the waves meet and cancel each other out. A total cancellation of vibration produces a smooth flow of power in the drive line. All splined shaft slip yokes are keyed in order to ensure proper phasing.

Universal Joint Description

The universal joint is connected to the propeller shaft. The universal consist of 4 caps with needle bearings and grease seals mounted on the trunnions of a cross or spider. These bearings and caps are greased at the factory and no periodic maintenance is required. There are 2 universal joints used in a one piece propeller shaft and 3 used in two piece propeller shaft. The bearings and caps are pressed into the yokes and held in place with snap rings, except for 2 bearings on some models witch are strapped onto the pinion flange of the differential. Universal joints are designed to handle the effects of various loads and rear axle windup conditions during acceleration and braking. The universal joint operates efficiently and safely within the designed angle variations. when the design angles are exceeded, the operational life of the joint decreases.

Center Bearing Description

Center bearings support the driveline when using 2 or more propeller shafts. The center bearing is a ball bearing mounted in a rubber cushion that attaches to a frame crossmember. The manufacturer prelubricates and seals the bearing. The cushion allows vertical motion at the driveline and helps isolate the vehicle from vibration.

Wheel Drive Shafts Description and Operation

Front Wheel Drive Shafts are flexible assemblies which consist of the following components:

- Front wheel drive shaft constant velocity joint outer joint.
- Front wheel drive shaft tri-pot joint inner joint.
- The front wheel drive shaft connects the front wheel drive shaft tri-pot joint and the front wheel drive shaft constant velocity joint.
- The front wheel drive shaft tri-pot joint is completely flexible, and moves with an in and out motion.
- The front wheel drive shaft constant velocity joint is flexible but can not move in and out.

The Wheel Drive Shaft is a balanced shaft that transmits rotational force from the front differential to the front wheels when the transfer case is engaged. The wheel drive shaft is mounted to the front differential by bolting the flange of the wheel drive shaft to the flange on the inner output shaft of the front differential.

The other end of the wheel drive shaft is splined to fit into and drive the hub assembly when the transfer case is engaged. The tri-pot joint and constant velocity joint on the wheel drive shaft allows the shaft to be flexible to move with the suspension travel of the vehicle.

Front Drive Axle Description and Operation

The Front Drive Axle consist of the following components:

- Differential Carrier Housing
- Differential Assembly
- Intermediate Shaft
- Intermediate Shaft Housing
- Electric Motor Actuator
- Shift Fork /Clutch Assembly

The front axle on four wheel drive model vehicles has a central disconnect feature. The axle uses a conventional ring and pinion gear set in order to transmit the driving force of the engine to the wheels. The open differential allows the wheels to turn at different rates of speed while the axle continues to transmit the driving force. This prevents tire scuffing when going around corners and premature wear on internal axle parts. The ring and pinion set and the differential are contained within the carrier. The axle identification number on top of the differential carrier assembly or on a label on the right half of differential carrier assembly. The drive axles are completely flexible assemblies consisting of inner and outer constant velocity CV joints protected by thermoplastic boots and connected by a wheel drive shaft.

Rear Drive Axle Description and Operation

The rear axle for this vehicle consist of the following components:

- Aluminum Differential Carrier Housing
- Differential Case Assembly (Open or Locking)
- Ring Gear and Drive Pinion Shaft
- Left and right axle shaft tubes
- Left and right axle shafts
- Fill Plug
- Drain Plug

The rear axle receives power from the propeller shaft and transfers it to the drive pinion through the universal joint and the pinion yoke, which is attached to the drive pinion. The drive pinion transfers the power to the ring gear which is splined to the drive pinion at a 90 degree angle. The ring gear is attached to the differential case which contains four gears inside of it. Two of the gear are side gears and two are pinion gears. Each side gear is splined to an axle shaft so each axle shaft turns when it's side gear rotates. The pinion gears are mounted on a differential pinion shaft, and the pinion gears are free to rotate on this shaft. The pinion shaft is fitted into a bore in the differential case and is at right angles to the axle shafts. Power is transmitted through the differential as follows: the drive pinion rotates the ring gear. The ring gear rotates the differential case. The ring gear, as it rotates with the differential case, forces the pinion gears against the side gears. The side gears rotate the axle shafts to which the wheels are attached to. When both wheels have an equal amount of traction, the pinion gears do not rotate on the pinion shaft because of input force on the pinion gears is equally divided between the two side gears. Therefore, the pinion gears revolve with the pinion shaft, but do not rotate around the shaft itself. As long as the input force is equal between the two axle shafts, the axle shafts could be solidly attached to the ring gear. The addition of the two pinion gears and the two side gears are needed to allow the axle shafts to turn at different speeds. When the vehicle turns a corner, the inner wheel turns slower than the outer wheel. The amount slower the inner wheel spins is equal to the same amount the outer wheel spins faster, as compared to the straight line speed. When this happens, the pinion gears rotate around the pinion shaft and allow the wheels to spin at different speeds.

Locking Differential Description and Operation

The locking differential consists of the following components:

- Differential case - 1 or 2 piece
- Locking differential spider - 2 piece case only
- Pinion gear shaft - 1 piece case only

- Differential pinion gear shaft lock bolt - 1 piece case only
- 2 clutch discs sets
- Locking differential side gear
- Thrust block
- Locking differential clutch disc guides
- Differential side gear shim
- Locking differential clutch disc thrust washer
- Locking differential governor
- Latching bracket
- Cam plate assembly
- Differential pinion gears
- Differential pinion gear thrust washers

The optional locking differential (RPO G80) enhances the traction capability of the rear axle by combining the characteristics of a limited-slip differential and the ability of the axle shafts to "lock" together when uneven traction surfaces exist. The differential accomplishes this in 2 ways. First by having a series of clutch plates at each side of the differential case to limit the amount of slippage between each wheel. Second, by using a mechanical locking mechanism to stop the rotation of the right differential side gear, or the left differential side gear on the 10.5 inch axle, in order to transfer the rotating torque of the wheel without traction to the wheel with traction. Each of these functions occur under different conditions.

Limited-Slip Function

Under normal conditions, when the differential is not locked, a small amount of limited-slip action occurs. The gear separating force developed in the right-hand (left-hand side on 10.5 inch axle) clutch pack is primarily responsible for this.

The operation of how the limited-slip function of the unit works can be explained when the vehicle makes a right-hand turn. Since the left wheel travels farther than the right wheel, it must rotate faster than the ring gear and differential case assembly. This results in the left axle and left side gear rotating faster than the differential case. The faster rotation of the left-side gear causes the pinion gears to rotate on the pinion shaft. This causes the right-side gear to rotate slower than the differential case.

Although the side gear spreading force produced by the pinion gears compresses the clutch packs, primarily the right side, the friction between the tires and the road surface is sufficient to overcome the friction of the clutch packs. This prevents the side gears from being held to the differential case.

Locking Function

Locking action occurs through the use of some special parts:

- A governor mechanism with 2 flyweights
- A latching bracket
- The left side cam plate and cam side gear

When the wheel-to-wheel speed difference is 100 RPM or more, the flyweights of the governor will fling out and one of them will contact an edge of the latching bracket. This happens because the left cam side gear and cam plate are rotating at a speed different, either slower or faster, than that of the ring gear and differential case assembly. The cam plate has teeth on its outer diameter surface in mesh with teeth on the shaft of the governor.

As the side gear rotates at a speed different than that of the differential case, the shaft of the governor rotates with enough speed to force the flyweights outward against spring tension. One of the flyweights catches its edge on the closest edge of the latching bracket, which is stationary in the differential case. This latching process triggers a chain of events.

When the governor latches, it stops rotating. A small friction clutch inside the governor allows rotation, with resistance, of the governor shaft while one flyweight is held to the differential case through the latching bracket. The purpose of the governor's latching action is to slow the rotation of the cam plate as compared to the cam side gear. This will cause the cam plate to move out of its detent position.

The cam plate normally is held in its detent position by a small wave spring and detent humps resting in matching notches of the cam side gear. At this point, the ramps of the cam plate ride up on the ramps of the cam side gear, and the cam plate compresses the left clutch pack with a self-energizing action.

As the left clutch pack is compressed, it pushes the cam plate and cam side gear slightly toward the right side of the differential case. This movement of the cam side gear pushes the thrust block which compresses the right-hand side gear clutch pack.

At this point, the force of the self-energizing clutches and the side gear separating force combine to hold the side gears to the differential case in the locking stage.

The entire locking process occurs in less than 1 second. The process works with either the left or right wheel spinning, due to the design of the governor and cam mechanism. A torque reversal of any kind will unlatch the governor, causing the cam plate to ride back down to its detent position. Cornering or deceleration during a transmission shift will cause a torque reversal of this type. The differential unit returns to its limited-slip function.

The self-energizing process would not occur if it were not for the action of one of the left clutch discs. This energizing disc provides the holding force of the ramping action to occur. It is the only disc which is splined to the cam plate itself. The other splined discs fit on the cam side gear.

If the rotating speed of the ring gear and differential case assembly is high enough, the latching bracket will pivot due to centrifugal force. This will move the flyweights so that no locking is permitted. During vehicle driving, this happens at approximately 32 km/h (20 mph) and continues at faster speeds.

When comparing the effectiveness of the locking differential, in terms of percent-of-grade capability to open and limited-slip units, the locking differential has nearly 3 times the potential of the limited-slip unit under the same conditions.

Locking Differential Torque-Limiting Disc

The locking differential design was modified in mid-1986 to include a load-limiting feature to reduce the chance of breaking an axle shaft under abusive driving conditions. The number of tangs on the energizing disc in the left-hand clutch pack was reduced allowing these tangs to shear in the event of a high-torque engagement of the differential locking mechanism.

At the time of failure of the load-limiting disc, there will be a loud bang in the rear axle and the differential will operate as a standard differential with some limited-slip action of the clutch packs at low torques.

The service procedure, when the disc tangs shear, involves replacing the left-hand clutch plates and the wave spring. It is also necessary to examine the axle shafts for twisting because at high torques it is possible to not only shear the load-limiting disc, but to also twist the axle shafts.

Transfer Case Description – Isuzu T150

The Isuzu T150 transfer case features a 3-button accessory switch located on the instrument panel. When the vehicle has the ignition key in the RUN position, the transfer case shift control module starts monitoring the accessory switch to determine if the driver desires a new mode/range position. At a single press of the accessory switch, the lamp of the new desired position will begin flashing to inform the driver that the transfer case shift control module has received the request for a new mode/range position. The lamp will continue to flash until all shifting criteria have been met and the new mode/range position has been reached, or has been engaged. Once the new mode/range position is fully active, the switch indicator lamp for the new position will remain ON constantly.

During normal driving situations, the transfer case operates in the 2HI mode. When the 2HI mode is selected, the transfer case shift control module sends 12 volts to an electrical motor, which is the transfer case encoder motor. This motor rotates the transfer case shift detent lever shaft which moves the shift forks and range sleeve to obtain different modes/ranges.

The Isuzu T150 transfer case has the added feature of also providing the driver with 2 selectable mode/range positions:

- 2HI
- 4HI
- 4LO

The transfer case does not allow a shift into or out of 4LO unless the following criteria is met:

- The engine is running.
- The automatic transmission is in NEUTRAL.
- The vehicle speed is less than 5 km/h (3 mph).

This transfer case also has a NEUTRAL position. A shift to the NEUTRAL position allows the vehicle to be towed without the transmission output shaft rotating. Refer to the Owner's Manual for instructions for proper towing of the vehicle.

NEUTRAL position is obtained only if the following criteria is met:

- The ignition is ON.
- The automatic transmission is in NEUTRAL.
- The vehicle speed is less than 5 km/h (3 mph).
- The transfer case is in the 2HI mode.

Once these conditions have been met, press and hold both the 2HI and 4LO Lock buttons for 10 seconds. When the system completes the shift to NEUTRAL, the red NEUTRAL indicator will illuminate.

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.

Drum Brake System Description and Operation

System Component Description

The drum brake system consists of the following:

Drum Brake Shoes

Applies mechanical output force (from hydraulic brake wheel cylinders) to friction surface of brake drums.

Brake Drums

Uses mechanical output force applied to friction surface from drum brake shoes to slow speed of tire and wheel assembly rotation.

Drum Brake Hardware

Secures drum brake shoes firmly in proper relationship to hydraulic brake wheel cylinders. Enables sliding motion of brake shoes needed to expand toward friction surface of drums when mechanical output force is applied; provides return of brake shoes when mechanical output force is relieved.

Drum Brake Adjusting Hardware

Provides automatic adjustment of brake shoes to brake drum friction surface whenever brake apply occurs during rearward motion of the vehicle.

System Operation

Mechanical output force is applied from the hydraulic brake wheel cylinder pistons to the top of the drum brake shoes. The output force is then distributed between the primary and secondary brake shoes as the shoes expand toward the friction surface of the brake drums. The brake shoes apply the output force to the friction surface of the brake drums, which slows the rotation of the tire and wheel assemblies. The proper function of both the drum brake hardware and adjusting hardware is essential to the proper distribution of braking force.

Park Brake System Description and Operation

System Component Description

The park brake system consists of the following:

Park Brake Pedal Assembly

Receives and transfers park brake system apply input force from driver to park brake cable system.

Park Brake Release Handle Assembly

Releases applied park brake system when pulled.

Park Brake Cables

Transfers input force received from park brake pedal, through park brake cable equalizer, to park brake apply lever.

Park Brake Cable Equalizer

Evenly distributes input force to both the left and right park brake units.

Threaded park brake cable equalizers are also used to remove slack in park brake cables.

Park Brake Apply Lever

Multiplies and transfers input force to park brake actuator/adjuster.

System Operation

Depressing the Park Brake Pedal creates INPUT FORCE. The INPUT FORCE is transferred and evenly distributed through the park park cables and the equalizer to the left and right rear park brake cables. The INPUT FORCE, is then transferred to the apply levers located in each of the rear brake drums. The levers then multiply the INPUT FORCE and transfer the force to the rear brake shoes. At that point, the brake shoes are forced to expand and make contact with the friction surface of the rear brake drums, preventing the rotation of the rear wheels. Use the park brake release handle to disengage the park brake.

ABS Description and Operation

Antilock Brake System

This vehicle is equipped with an Advics electronic brake control module (EBCM) and brake pressure modulator valve (BPMV).

The following vehicle performance enhancement systems are provided.

- Antilock Brake System (ABS)
- Dynamic Rear Proportioning (DRP)
- Traction Control System (TCS) (w/NW7)

The EBCM controls the system functions and detects faults. The EBCM contains six solenoids that are commanded ON and OFF by the EBCM to operate the appropriate valves in the brake pressure modulator valve (BPMV).

The BPMV uses a 3-circuit configuration to control hydraulic pressure to each front wheel independently, and to the rear wheels as a pair.

Antilock Brake System (ABS) Operation

When wheel slip is detected during a brake application, an ABS event occurs. 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. The ABS does not, 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 electronic brake control module (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

Engine Mechanical – 2.8L (LK5)

General Specifications

Application	Specifications	
	Metric	English
General		
Engine Type	In-Line-4	
Displacement	2.8L	170 cu in
RPO	LK5	
VIN	8	
Bore	93 mm	3.66 in
Stroke	102 mm	4.02 in
Compression Ratio	10:1	
Engine Compression Test	1482 kPa	215 psi
Firing Order	1-3-4-2	
Spark Plug Gap	1.14-1.25 mm	0.044-0.050 in
Block		
Crankshaft Main Bearing Bore Diameter	78.070-78.088 mm	3.0760-3.0766 in
Cylinder Bore Diameter	92.990-93.006 mm	3.6638-3.6644 in
Cylinder Bore Out-of-Round	0.013 mm	0.0005 in
Cylinder Head Deck Surface Flatness	0.08 mm	0.003 in
Cylinder Liner Recession	0.015 mm	0.0006 in
Camshaft		
Camshaft End Play - Exhaust	0.045-0.215 mm	0.0017-0.0084 in
Camshaft End Play - Intake	0.051-0.201 mm	0.0020-0.0079 in
Camshaft Journal Diameter - All Intake and Exhaust #2-#7	26.936-26.960 mm	1.0612-1.0622 in
Camshaft Journal Diameter - Exhaust #1	29.936-29.960 mm	1.1794-1.1804 in
Camshaft Journal to Bore Clearance	0.040-0.085 mm	0.0015-0.0033 in
Connecting Rod		
Connecting Rod Bearing Clearance	0.021-0.065 mm	0.0008-0.0025 in
Connecting Rod Bore Diameter - Bearing End	60.322-60.338 mm	2.3749-2.3755 in
Connecting Rod Bore Out-of-Round - Bearing End	0.006 mm	0.0002 in
Connecting Rod Side Clearance	0.05-0.35 mm	0.0019-0.0137 in
Crankshaft		
Crankshaft End Play	0.112-0.388 mm	0.0044-0.0153 in
Crankshaft Main Bearing Clearance	0.012-0.064 mm	0.0004-0.0025 in
Crankshaft Main Journal Diameter	69.968-69.984 mm	2.7567-2.7574 in
Crankshaft Main Journal Out-of-Round	0.005 mm	0.0002 in
Crankshaft Main Journal Taper	0.005 mm	0.0002 in
Cylinder Head		
Surface Flatness - Block Deck	0.08 mm	0.003 in
Surface Flatness - Exhaust Manifold Deck	0.08 mm	0.003 in
Surface Flatness - Intake Manifold Deck	0.08 mm	0.003 in
Exhaust Manifold		
Surface Flatness	0.08 mm	0.003 in

Application	Specifications	
	Metric	English
Lubrication System		
Oil Pressure - Minimum	85 kPa	12 psi @ 1200 RPM
Oil Pump		
Oil Capacity - with Filter	4.7 L	5.0 qts
Oil Capacity - without Filter	4.2 L	4.5 qts
Gear Diameter - Drive	73.415-73.370 mm	2.893-2.891 in
Gear Diameter - Driven	87-86.975 mm	3.428-3.426 in
Gear Pocket - Depth	15.609-15.584 mm	0.615-0.614 in
Gear Pocket - Diameter	87.065-87.040 mm	3.430-3.429 in
Gear Thickness - Drive	15.546-15.521 mm	0.613-0.611 in
Gear Thickness - Driven	15.360-15.511 mm	0.605-0.611 in
Lobe Inner Diameter - Maximum	11.9 mm	0.469 in
Relief Valve-to-Bore Clearance	2.57-1.63 mm	0.101-0.064 in
Piston Rings		
Piston Ring End Gap - First Compression Ring	0.20-0.40 mm	0.00787-0.0157 in
Piston Ring End Gap - Second Compression Ring	0.36-0.51 mm	0.0142-0.0201 in
Piston Ring End Gap - Oil Control Ring	0.250-0.760 mm	0.0098-0.0299 in
Piston Ring to Groove Clearance - First Compression Ring	0.043-0.093 mm	0.0017-0.0037 in
Piston Ring to Groove Clearance - Second Compression Ring	0.053-0.093 mm	0.0021-0.0037 in
Piston Ring to Groove Clearance - Oil Control Ring	0.059-0.215 mm	0.0023-0.0085 in
Pistons and Pins		
Piston - Piston Diameter	92.971-93.005 mm	3.6603-3.6616 in
Piston - Piston Pin Bore Diameter	23.002-23.008 mm	0.9056-0.9058 in
Piston - Piston to Bore Clearance	-0.015-0.035 mm	-0.0006-0.0014 in
Pin - Piston Pin Clearance to Connecting Rod Bore	0.001-0.018 mm	0.0004-0.0007 in
Pin - Piston Pin Clearance to Piston Pin Bore	0.003-0.012 mm	0.00012-0.0005 in
Pin - Piston Pin Diameter	22.996-22.999 mm	0.9054-0.9055 in
Valve System		
Valves - Valve Face Runout	0.038 mm	0.0015 in
Valves - Valve Seat Runout	0.05 mm	0.002 in
Valves - Valve Stem-to-Guide Clearance - Exhaust	0.0375-0.0775 mm	0.0015-0.0030 in
Valves - Valve Stem-to-Guide Clearance - Intake	0.030-0.065 mm	0.0011-0.0025 in
Valve Springs - Valve Spring Load - Closed	211-233 N at 35 mm	47.4-52.4 lb at 1.701 in
Valve Springs - Valve Spring Load - Open	578-632 N at 24.5 mm	130-142 lb at 1.260 in

Fastener Tightening Specifications

Application	Specifications	
	Metric	English
A/C Compressor Hose/Pipe Bracket Bolt	9 N·m	80 lb in
A.I.R. Cover Stud	25 N·m	18 lb ft
Balance Shaft Retaining Bolt	10 N·m	89 lb in
Balance Shaft Chain Guide Bolt	10 N·m	89 lb in
Balance Shaft Chain Tensioner Bolt	10 N·m	89 lb in
Battery Negative Cable to Engine Block Bolt	35 N·m	26 lb ft
Battery Positive Cable to Starter Terminal Nut	9 N·m	80 lb in
Camshaft Cap Bolt	12 N·m	106 lb in
Camshaft Cover Bolt	10 N·m	89 lb in
Camshaft Position Actuator Valve Bolt	10 N·m	89 lb in
Connecting Rod Cap Bolt		
• First Pass	25 N·m	18 lb ft
• Final Pass	110 degrees	
Coolant Temperature Sensor	14 N·m	124 lb in
Crankshaft Balancer Bolt		
• First Pass	150 N·m	110 lb ft
• Final Pass	180 degrees	
Crankshaft Main Bearing Cap Bolt		
• First Pass	25 N·m	18 lb ft
• Final Pass	180 degrees	
Crankshaft Position Sensor Bolt	10 N·m	89 lb in
Crankshaft Rear Oil Seal Housing Bolt	10 N·m	89 lb in
Cylinder Head Access Hole Plug - Plastic	5 N·m	44 lb in
Cylinder Head Bolt - 10		
• First Pass	30 N·m	22 lb ft
• Final Pass	155 degrees	
Cylinder Head End Bolts - 2 Short		
• First Pass	7 N·m	62 lb in
• Final Pass	60 degrees	
Cylinder Head End Bolts - 1 Long		
• First Pass	7 N·m	62 lb in
• Final Pass	120 degrees	
Cylinder Head Oil Gallery Plug	38 N·m	28 lb ft
Differential Carrier Assembly Bushing to Frame Bolt	152 N·m	112 lb ft
Drive Belt Idler Pulley Bolt	50 N·m	37 lb ft
Drive Belt Tensioner Bolt	50 N·m	37 lb ft
Engine Block Oil Gallery Plug - Front and Rear	80 N·m	60 lb ft
Engine Block Oil Gallery Plug - Side	35 N·m	26 lb ft
Engine Flywheel Bolt		
• First Pass	40 N·m	30 lb ft
• Final Pass	45 degrees	
Engine Front Cover Bolt	10 N·m	89 lb in
Engine Front Cover Center Bolt - Small	8 N·m	71 lb in
Engine Front Cover Spacer Bolt	10 N·m	89 lb in
Engine Front Lift Bracket Bolt		
• First Pass	5 N·m	44 lb in
• Final Pass	50 N·m	37 lb ft
Engine Mount Bolt	50 N·m	37 lb ft

Application	Specifications	
	Metric	English
Engine Mount-to-Frame Bracket Bolt	85 N·m	63 lb ft
Engine Wiring Ground Lead Bolt	20 N·m	15 lb ft
Engine Wiring Harness Bracket Bolt	10 N·m	89 lb in
EVAP Purge Solenoid Valve Bolt	10 N·m	89 lb in
Exhaust Camshaft Actuator Bolt		
• First Pass	25 N·m	18 lb ft
• Final Pass	135 degrees	
Exhaust Camshaft Position Sensor Bolt	10 N·m	89 lb in
Exhaust Manifold Bolt -- 3 Times in Sequence	20 N·m	15 lb ft
Exhaust Manifold Heat Shield Nut	10 N·m	89 lb in
Exhaust Manifold Heat Shield Stud	10 N·m	89 lb in
Fuel Hose/Pipe Bracket Nut	20 N·m	15 lb ft
Fuel Injector Rail Bolt	10 N·m	89 lb in
Fuel Pressure Regulator Bolt	8 N·m	71 lb in
Generator Mounting Bolt	50 N·m	37 lb ft
Heater Hole Plug	50 N·m	37 lb ft
Heater Inlet Pipe Bolt	10 N·m	89 lb in
Heater Outlet Hose Fitting	45 N·m	33 lb ft
Heater Outlet Hose/Pipe Bracket to Left Engine Mount Bolt	9 N·m	80 lb in
Ignition Control Module Bolt	10 N·m	89 lb in
Intake Camshaft Sprocket Bolt		
• First Pass	20 N·m	15 lb ft
• Final Pass	100 degrees	
Intake Manifold Bolt	10 N·m	89 lb in
Knock Sensor	25 N·m	18 lb ft
Oil Filter		
• First Pass	10 N·m	89 lb in
• Final Pass	150 degrees	
Oil Filter Adapter Bolts	10 N·m	89 lb in
Oil Filter Bypass Hole Plug	14 N·m	124 lb in
Oil Level Indicator Tube Bolt	10 N·m	89 lb in
Oil Pan Bolt - Ends	10 N·m	89 lb in
Oil Pan Bolt - Sides	25 N·m	18 lb ft
Oil Pan Drain Plug	26 N·m	19 lb ft
Oil Pressure Switch	20 N·m	15 lb ft
Oil Pump Cover Bolt	10 N·m	89 lb in
Oil Pump Pipe and Screen Assembly Bolt Plug	10 N·m	89 lb in
Oil Pump Pressure Relief Valve	14 N·m	124 lb in
Power Steering Pump Bolt	25 N·m	18 lb ft
Power Steering Pump Bracket Bolt	50 N·m	37 lb ft
Spark Plug	18 N·m	13 lb ft
Starter Motor Bolt	50 N·m	37 lb ft
Starter Motor Nut	50 N·m	37 lb ft
Starter Motor Stud	16 N·m	12 lb ft
Starter Solenoid - S Terminal Nut	3.5 N·m	31 lb in
Thermostat Housing bolt	10 N·m	89 lb in
Throttle Control Module Bolt	10 N·m	89 lb in
Timing Chain Tensioner Bolt	25 N·m	18 lb ft
Timing Chain Tensioner Guide Bolt	18 N·m	13 lb ft
Timing Chain Tensioner Shoe Bolt	25 N·m	18 lb ft

Application	Specifications	
	Metric	English
Timing Chain Top Guide Bolt	10 N·m	89 lb in
Torque Converter Bolts	60 N·m	44 lb ft
Transmission Mounting Bolts	50 N·m	37 lb ft
Transmission Oil Cooler Pipes Bracket Bolt	20 N·m	15 lb ft
Water Outlet Bolt	10 N·m	89 lb in
Water Pump Bolt	10 N·m	89 lb in
Water Pump Pulley Bolt	25 N·m	18 lb ft

Engine Component Description

Engine Block

The lost foam all aluminum engine block utilizes a deep skirt design for increased rigidity. The cylinders are positioned in a straight in-line orientation. The crankshaft bearing caps have a bearing beam or "ladder" for enhanced structural rigidity and vibration reduction.

Oil Pan

A single piece cast aluminum oil pan contributes to crankshaft and block rigidity while reducing overall weight. The oil pan bolts to the bell housing as well as the block. This eliminates points of vibration and makes the complete powertrain act as a single casting. Jack screws are used to remove the oil pan.

Crankshaft

The crankshaft is a nodular iron design with 7 main bearings.

Connecting Rods

The connecting rods are forged powdered metal. The connecting rods and caps are of a fractured split design to improve durability and reduce internal friction. Care must be taken to ensure the mating surfaces are not damaged during service procedures.

Pistons

The pistons are a full-floating design. The piston pins are a slip fit in the bronze bushed connecting rod and are retained in the piston by round wire retainers. There are 2 compression rings and 1 oil control ring.

Cylinder Head

The cylinder head is also made of the lost foam aluminum for lighter weight and rapid heat dissipation. There are 4 valves per cylinder and the ports are of a high swirl design for improved combustion. The cylinder head gasket consists of a steel laminated construction.

Valve Train

The engine utilizes dual overhead camshafts and roller followers for reduced friction, which results in improved gas mileage.

Fuel System

A new electronic throttle control system is used on the engine. A throttle actuator control or TAC system eliminates cable linkage from the pedal to the throttle control module. All throttle movements are controlled by the powertrain control module (PCM).

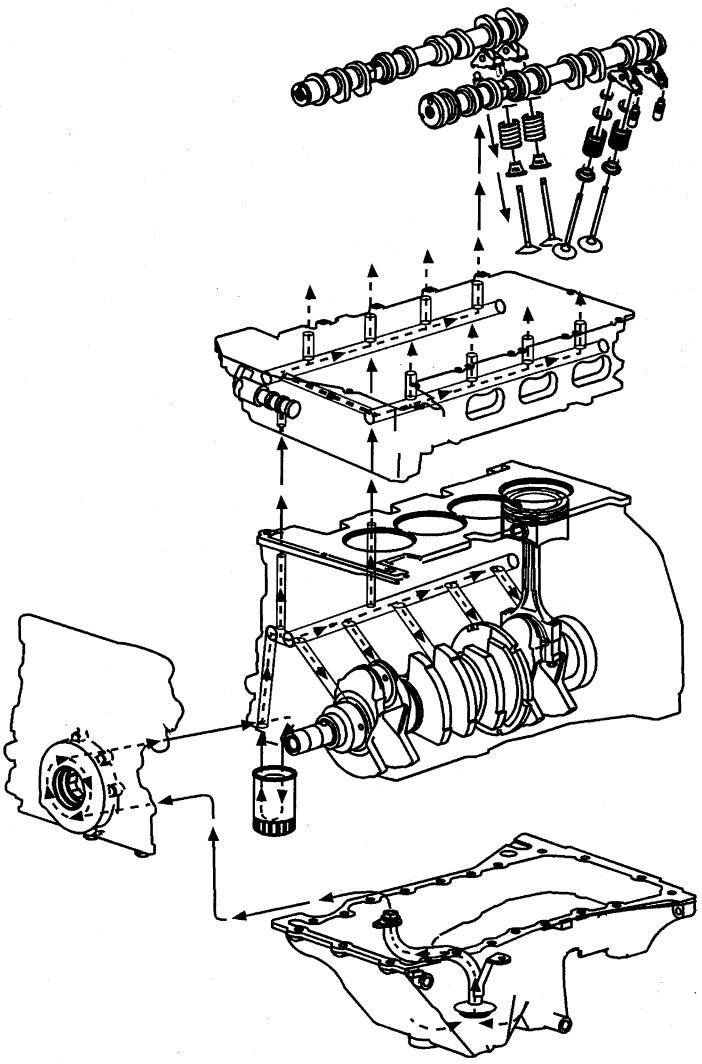
Oil Pump

The oil pump is gear driven directly from the crankshaft. The oil pump drive gear is a slip fit to the crankshaft.

Engine Covers

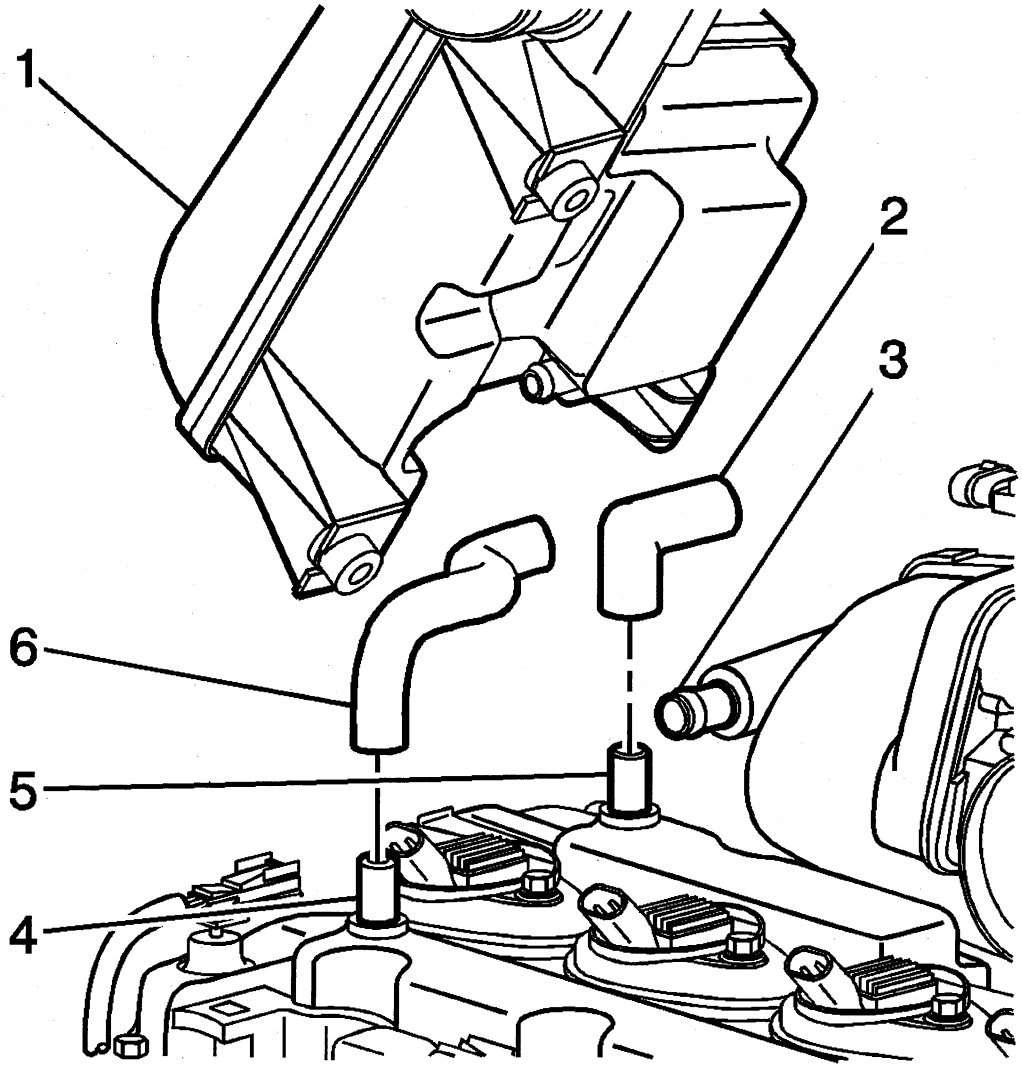
There is a front engine cover and a rear engine cover, both are made of aluminum. The front engine cover and rear engine cover have "T" sealing joints and need to be removed after the oil pan. The front and rear covers need to be installed before the oil pan. Jack screws are used to remove the covers. Guide pins are used to aid in the installation of both covers.

Lubrication Description



The engine lubrication system is of the force-feed type. The oil is supplied under full pressure to the crankshaft, connecting rods, valve lash adjusters, and cam phasing system. A controlled volume of oil is supplied to the camshaft and valve rocker arms. Gravity flow or splash lubricates all other parts. The engine oil is stored in the oil pan, which is filled through a fill cap in the camshaft cover. A removable oil level indicator, on the right side of the engine block, is provided to check the oil level. The oil pump is located in the engine front cover and is driven by the crankshaft. It is a gerotor-style pump, which is a combination of a gear, and a rotor pump. It is connected by a passage in the cylinder block to an oil screen and pipe assembly. The screen is submerged in the oil supply and has ample volume for all operating conditions. Oil is drawn into the pump through the screen and pipe assembly, and a passage in the crankcase, connecting to the passages in the engine front cover. Oil is discarged from the oil pump to the oil filter. The oil pressure relief valve limits the oil pressure. The oil filter bypass valve opens when the oil filter is restricted to approximately 68.95 kPa (10 psi) of pressure difference between the oil filter inlet and discharge. The oil will then bypass the oil filter and channel unfiltered oil directly to the main oil galleries of the engine. A full-flow oil filter is mounted to the oil filter adapter on the lower right front side of the engine. The main oil galleries run the full length of the engine block and cut into the valve lash adjuster holes to supply oil at full pressure to the valve lash adjusters. Holes are drilled from the crankshaft bearings to the main oil gallery. Oil is transferred from the crankshaft bearings to the connecting rod bearings through holes drilled in the crankshaft. Pistons, piston pins, and cylinder walls are lubricated by oil splash from the crankshaft and connecting rods. The camshafts and valve rocker arms are supplied with oil from the oil passages drilled into the camshaft mounting areas.

Crankcase Ventilation System Description



A crankcase ventilation system is used to consume crankcase vapors created during the combustion process instead of venting them to the atmosphere.

Fresh air is supplied through a filter to the crankcase, the crankcase mixes the fresh air with the blow-by gases and then passed through a positive crankcase ventilation (PCV) orificed tube (5) into the intake manifold (3).

The PCV orificed tube (5) restricts the flow rate of the blow-by gases using a 2.1 mm (0.083 in) orifice located in the camshaft cover tube (5). If abnormal operating conditions arise, the system is designed to allow excessive amounts of blow-by gases to back flow through the crankcase ventilation fresh air tube (6) into the air cleaner resonator (1) in order to be consumed by normal combustion.

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 1 belt or 2 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.

Exhaust Camshaft Position Actuator Description

The camshaft position actuator is bolted to the front of the exhaust camshaft and is integral with the sprocket. The actuator and sprocket can only be replaced as one unit. The actuator has a hydraulically actuated piston located in the hub. The piston has an internal helical spline that slides in mesh with the gear. As the piston moves, the piston and gear mechanism changes the timing of the exhaust camshaft, relative to the cam drive sprocket. When oil pressure is applied to one side of the piston, the cam moves clockwise and timing is advanced. When oil pressure is applied to the other side of the piston the cam moves counter-clockwise to retard timing. The total range of actuator rotation is 0 to 25 camshaft degrees. At idle, the exhaust camshaft position actuator is at full advance or 0 degrees.

Engine Mechanical – 3.5L (L52)

General Specifications

Application	Specifications	
	Metric	English
General		
Engine Type	In-Line-5	
Displacement	3.5L	212 cu in
RPO	L52	
VIN	6	
Bore	93 mm	3.66 in
Stroke	102 mm	4.02 in
Compression Ratio	10:1	
Engine Compression Test	1482 kPa	215 psi
Firing Order	1-3-5-4-2	
Spark Plug Gap	1.14-1.25 mm	0.044-0.050 in
Block		
Crankshaft Main Bearing Bore Diameter	78.070-78.088 mm	3.0760-3.0766 in
Cylinder Bore Diameter	92.990-93.006 mm	3.6638-3.6644 in
Cylinder Bore Out-of-Round	0.013 mm	0.0005 in
Cylinder Head Deck Surface Flatness	0.08 mm	0.003 in
Cylinder Liner Recession	0.015 mm	0.0006 in
Camshaft		
Camshaft End Play - Exhaust	0.045-0.215 mm	0.0017-0.0084 in
Camshaft End Play - Intake	0.051-0.201 mm	0.0020-0.0079 in
Camshaft Journal Diameter - All Intake and Exhaust #2-#7	26.936-26.960 mm	1.0612-1.0622 in
Camshaft Journal Diameter - Exhaust #1	29.936-29.960 mm	1.1794-1.1804 in
Camshaft Journal to Bore Clearance	0.040-0.085 mm	0.0015-0.0033 in
Connecting Rod		
Connecting Rod Bearing Clearance	0.021-0.065 mm	0.0008-0.0025 in
Connecting Rod Bore Diameter - Bearing End	60.332-60.338 mm	2.3749-2.3755 in
Connecting Rod Bore Out-of-Round - Bearing End	0.006 mm	0.0002 in
Connecting Rod Side Clearance	0.05-0.35 mm	0.0019-0.0137 in
Crankshaft		
Crankshaft End Play	0.112-0.388 mm	0.0044-0.0153 in
Crankshaft Main Bearing Clearance	0.012-0.064 mm	0.0004-0.0025 in
Crankshaft Main Journal Diameter	69.968-69.984 mm	2.7567-2.7574 in
Crankshaft Main Journal Out-of-Round	0.005 mm	0.0002 in
Crankshaft Main Journal Taper	0.005 mm	0.0002 in
Cylinder Head		
Surface Flatness - Block Deck	0.08 mm	0.003 in
Surface Flatness - Exhaust Manifold Deck	0.08 mm	0.003 in
Surface Flatness - Intake Manifold Deck	0.08 mm	0.003 in
Exhaust Manifold		
Surface Flatness	0.08 mm	0.003 in
Lubrication System		
Oil Capacity - with Filter	5.6 L	6.0 qts
Oil Capacity - without Filter	5.1 L	5.5 qts
Oil Pressure - Minimum	85 kPa	12 psi at 1200 RPM

Application	Specifications	
	Metric	English
Oil Pump		
Gear Diameter - Drive	73.415-73.370 mm	2.893-2.891 in
Gear Diameter - Driven	87-86.975 mm	3.428-3.426 in
Gear Pocket - Depth	15.609-15.584 mm	0.615-0.614 in
Gear Pocket - Diameter	87.065-87.040 mm	3.430-3.429 in
Gear Thickness - Drive	15.546-15.521 mm	0.613-0.611 in
Gear Thickness - Driven	15.360-15.511 mm	0.605-0.611 in
Lobe Inner Diameter - Maximum	11.9 mm	0.469 in
Relief Valve-to-Bore Clearance	2.57-1.63 mm	0.101-0.064 in
Piston Rings		
Piston Ring End Gap - First Compression Ring	0.2-0.4 mm	0.0079-0.0157 in
Piston Ring End Gap - Second Compression Ring	0.36-0.51 mm	0.0142-0.0201 in
Piston Ring End Gap - Oil Control Ring	0.250-0.760 mm	0.0098-0.0299 in
Piston Ring to Groove Clearance - First Compression Ring	0.043-0.093 mm	0.0017-0.0037 in
Piston Ring to Groove Clearance - Second Compression Ring	0.053-0.093 mm	0.0021-0.0037 in
Piston Ring to Groove Clearance - Oil Control Ring	0.059-0.215 mm	0.0023-0.0085 in
Pistons and Pins		
Piston - Piston Diameter	92.963-92.977 mm	3.6627-3.6633 in
Piston - Piston Pin Bore Diameter	23.002-23.008 mm	0.9056-0.9058 in
Piston - Piston to Bore Clearance	0.013-0.043 mm	0.0004-0.0017 in
Pin - Piston Pin Clearance to Connecting Rod Bore	0.001-0.018 mm	0.0004-0.0007 in
Pin - Piston Pin Clearance to Piston Pin Bore	0.003-0.012 mm	0.00012-0.0005 in
Pin - Piston Pin Diameter	22.996-22.999 mm	0.9054-0.9055 in
Valve System		
Valves - Valve Face Runout	0.038 mm	0.0015 in
Valves - Valve Seat Runout	0.05 mm	0.002 in
Valves - Valve Stem-to-Guide Clearance - Exhaust	0.0375-0.0775 mm	0.0015-0.0030 in
Valves - Valve Stem-to-Guide Clearance - Intake	0.030-0.065 mm	0.0011-0.0025 in
Valve Springs - Valve Spring Load - Closed	211-233 N at 35 mm	47.4-52.4 lb at 1.701 in
Valve Springs - Valve Spring Load - Open	578-632 N at 24.5 mm	130-142 lb at 1.260 in

Fastener Tightening Specifications

Application	Specifications	
	Metric	English
A/C Compressor Hose/Pipe Bracket Bolt	9 N·m	80 lb in
A.I.R. Cover Stud	25 N·m	18 lb ft
Balance Shaft Retaining Bolt	10 N·m	89 lb in
Balance Shaft Chain Guide Bolt	10 N·m	89 lb in
Balance Shaft Chain Tensioner Bolt	10 N·m	89 lb in
Battery Negative Cable to Engine Block Bolt	35 N·m	26 lb in
Battery Positive Cable to Starter Terminal Nut	9 N·m	80 lb in
Camshaft Cap Bolt	12 N·m	106 lb in
Camshaft Cover Bolt	10 N·m	89 lb in
Camshaft Position Actuator Valve Bolt	10 N·m	89 lb in

Application	Specifications	
	Metric	English
Connecting Rod Cap Bolt		
• First Pass	25 N·m	18 lb ft
• Final Pass	110 degrees	
Coolant Temperature Sensor	16 N·m	12 lb ft
Crankshaft Balancer Bolt		
• First Pass	150 N·m	110 lb ft
• Final Pass	180 degrees	
Crankshaft Main Bearing Cap Bolt		
• First Pass	25 N·m	18 lb ft
• Final Pass	180 degrees	
Crankshaft Position Sensor Bolt	10 N·m	89 lb in
Crankshaft Rear Oil Seal Housing Bolt	10 N·m	89 lb in
Cylinder Head Access Hole Plug - Plastic	5 N·m	44 lb in
Cylinder Head Bolt - 12		
• First Pass	30 N·m	22 lb ft
• Final Pass	155 degrees	
Cylinder Head End Bolts - 2 Short		
• First Pass	7 N·m	62 lb in
• Final Pass	60 degrees	
Cylinder Head End Bolts - 1 Long		
• First Pass	7 N·m	62 lb in
• Final Pass	120 degrees	
Cylinder Head Oil Gallery Plug	38 N·m	28 lb ft
Differential Carrier Assembly Bushing to Frame Bolt	152 N·m	112 lb ft
Drive Belt Idler Pulley Bolt	50 N·m	37 lb ft
Drive Belt Tensioner Bolt	50 N·m	37 lb ft
Engine Block Coolant Plug	50 N·m	37 lb ft
Engine Block Oil Gallery Plug - Side	35 N·m	26 lb ft
Engine Flywheel Bolt		
• First Pass	40 N·m	30 lb ft
• Final Pass	45 degrees	
Engine Front Cover Bolt	10 N·m	89 lb in
Engine Front Cover - Center - Small Bolt	8 N·m	71 lb in
Engine Front Cover Spacer Bolt	10 N·m	89 lb in
Engine Front Lift Bracket Bolt		
• First Pass	5 N·m	44 lb in
• Final Pass	50 N·m	37 lb ft
Engine Mount Bolt	50 N·m	37 lb ft
Engine Mount-to-Frame Bracket Bolt	85 N·m	63 lb ft
Engine Wiring Ground Lead Bolt	20 N·m	15 lb ft
Engine Wiring Harness Bracket Bolt	10 N·m	89 lb ft
EVAP Purge Solenoid Valve Bolt	10 N·m	89 lb in
Exhaust Camshaft Actuator Bolt		
• First Pass	25 N·m	18 lb ft
• Final Pass	135 degrees	
Exhaust Camshaft Position Sensor Bolt	10 N·m	89 lb in

Application	Specifications	
	Metric	English
Exhaust Manifold Bolt		
• First Pass	20 N·m	15 lb ft
• Second Pass	20 N·m	15 lb ft
• Final Pass	20 N·m	15 lb ft
Exhaust Manifold Heat Shield Nut	10 N·m	89 lb in
Exhaust Manifold Heat Shield Stud	10 N·m	89 lb in
Fuel Hose/Pipe Bracket Nut	20 N·m	15 lb ft
Fuel Injector Rail Bolt	10 N·m	89 lb in
Fuel Pressure Regulator Bolt	8 N·m	70 lb in
Generator Mounting Bolt	50 N·m	37 lb in
Heater Inlet Pipe Bolt	10 N·m	89 lb in
Heater Outlet Fitting	45 N·m	33 lb ft
Ignition Control Module Bolt	10 N·m	89 lb in
Heater Outlet Hose/Pipe Bracket to Left Engine Mount Bolt	9 N·m	80 lb in
Intake Camshaft Position Sensor Bolt	10 N·m	89 lb in
Intake Camshaft Sprocket Bolt		
• First Pass	20 N·m	15 lb ft
• Final Pass	100 degrees	
Intake Manifold Bolt	10 N·m	89 lb in
Knock Sensor	25 N·m	18 lb ft
Oil Filter	30 N·m	22 lb ft
Oil Filter Adapter	50 N·m	37 lb ft
Oil Filter Bypass Hole Plug	14 N·m	124 lb in
Oil Level Indicator Tube Bolt	10 N·m	89 lb in
Oil Pan Bolt - Ends	10 N·m	89 lb in
Oil Pan Bolt - Sides	25 N·m	18 lb ft
Oil Pan Drain Plug	26 N·m	19 lb ft
Oil Pressure Switch	20 N·m	15 lb ft
Oil Pump Cover Bolt	10 N·m	89 lb in
Oil Pump Pipe and Screen Assembly Bolt	10 N·m	89 lb in
Oil Pump Pressure Relief Valve Plug	14 N·m	124 lb in
Power Steering Pump Bolt	25 N·m	18 lb ft
Power Steering Pump Bracket Bolt	50 N·m	37 lb ft
Spark Plug	18 N·m	13 lb ft
Starter Motor Bolt	50 N·m	37 lb ft
Starter Motor Nut	50 N·m	37 lb ft
Starter Motor Stud	16 N·m	12 lb ft
Starter Solenoid -S Terminal Nut	3.5 N·m	31 lb in
Thermostat Housing bolt	10 N·m	89 lb in
Throttle Control Module Bolt	10 N·m	89 lb in
Timing Chain Tensioner Bolt	25 N·m	18 lb ft
Timing Chain Tensioner Guide Bolt	18 N·m	13 lb ft
Timing Chain Tensioner Shoe Bolt	25 N·m	18 lb ft
Timing Chain Top Guide Bolt	10 N·m	89 lb in
Torque Converter Bolts	60 N·m	44 lb ft
Transmission Mounting Bolts	50 N·m	37 lb ft
Transmission Oil Cooler Pipes Bracket Bolt	20 N·m	15 lb ft
Water Outlet Bolt	10 N·m	89 lb in
Water Pump Bolt	10 N·m	89 lb in
Water Pump Pulley Bolt	25 N·m	18 lb ft

Engine Component Description

Engine Block

The lost foam all aluminum engine block utilizes a deep skirt design for increased rigidity. The cylinders are positioned in a straight in-line orientation. The crankshaft bearing caps have a bearing beam or "ladder" for enhanced structural rigidity and vibration reduction.

Oil Pan

A single piece cast aluminum oil pan contributes to crankshaft and block rigidity while reducing overall weight. The oil pan bolts to the bell housing as well as the block. This eliminates points of vibration and makes the complete powertrain act as a single casting. Jack screws are used to remove the oil pan.

Crankshaft

The crankshaft is a nodular iron design with 7 main bearings.

Connecting Rods

The connecting rods are forged powdered metal. The connecting rods and caps are of a fractured split design to improve durability and reduce internal friction. Care must be taken to ensure the mating surfaces are not damaged during service procedures.

Pistons

The pistons are a full-floating design. The piston pins are a slip fit in the bronze bushed connecting rod and are retained in the piston by round wire retainers. There are 2 compression rings and 1 oil control ring.

Cylinder Head

The cylinder head is also made of the lost foam aluminum for lighter weight and rapid heat dissipation. There are 4 valves per cylinder and the ports are of a high swirl design for improved combustion. The cylinder head gasket consists of a steel laminated construction.

Valve Train

The engine utilizes dual overhead camshafts and roller followers for reduced friction, which results in improved gas mileage.

Fuel System

A new electronic throttle control system is used on the engine. A throttle actuator control or TAC system eliminates cable linkage from the pedal to the throttle control module. All throttle movements are controlled by the powertrain control module (PCM).

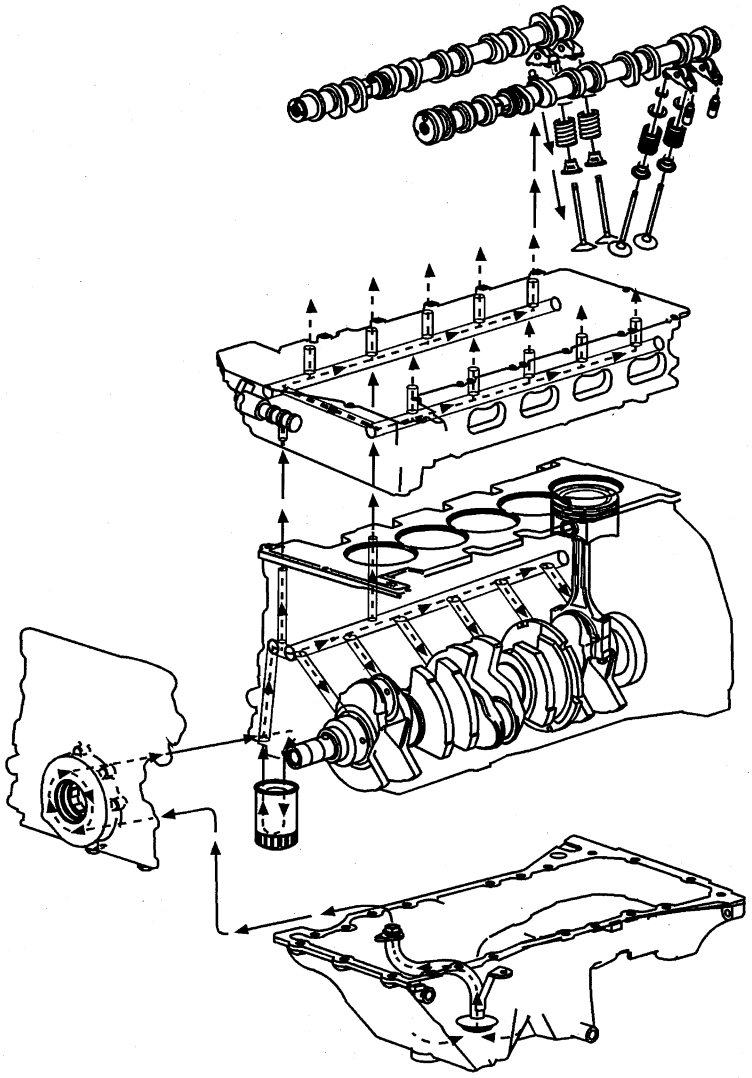
Oil Pump

The oil pump is gear driven directly from the crankshaft. The oil pump drive gear is a slip fit to the crankshaft.

Engine Covers

There is a front engine cover and a rear engine cover, both are made of aluminum. The front engine cover and rear engine cover have "T" sealing joints and need to be removed after the oil pan. The front and rear covers need to be installed before the oil pan. Jack screws are used to remove the covers. Guide pins are used to aid in the installation of both covers.

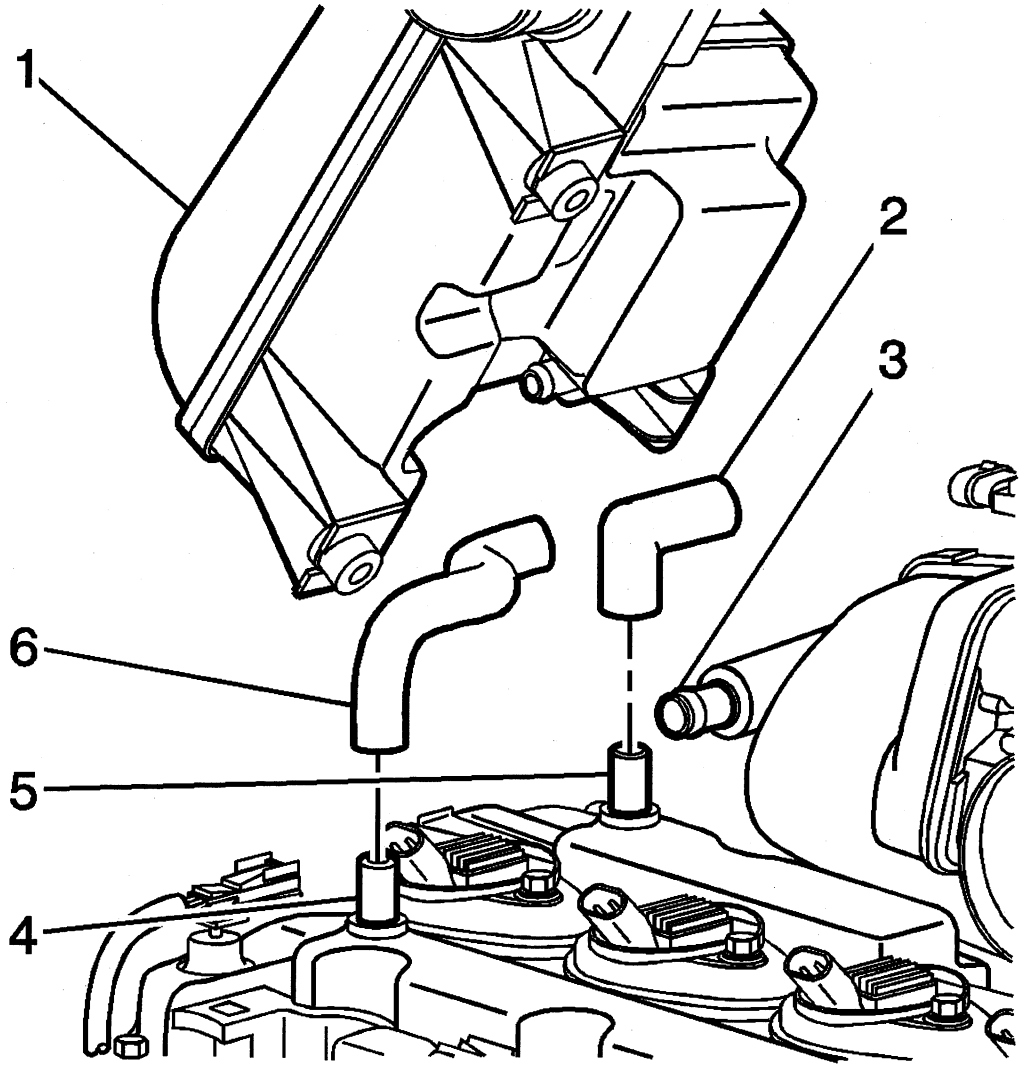
Lubrication Description



The engine lubrication system is of the force-feed type. The oil is supplied under full pressure to the crankshaft, connecting rods, valve lash adjusters, and cam phasing system. A controlled volume of oil is supplied to the camshaft and valve rocker arms. Gravity flow or splash lubricates all other parts. The engine oil is stored in the oil pan, which is filled through a fill cap in the camshaft cover. A removable oil level indicator, on the right side of the engine block, is provided to check the oil level. The oil pump is located in the engine front cover and is driven by the crankshaft. It is a gerotor-style pump, which is a combination of a gear, and a rotor pump. It is connected by a passage in the cylinder block to an oil screen and pipe assembly. The screen is submerged in the oil supply and has ample volume for all operating conditions. Oil is drawn into the pump through the screen and pipe assembly, and a passage in the crankcase, connecting to the passages in the engine front cover. Oil is discarged from the oil pump to the oil filter. The oil pressure relief valve limits the oil pressure. The oil filter bypass valve opens when the oil filter is restricted to approximately 68.95 kPa (10 psi) of pressure difference between the oil filter inlet and discharge. The oil will then bypass the oil filter and channel unfiltered oil directly to the main oil galleries of the engine. A full-flow oil filter is mounted to the oil filter adapter on the lower right front side of the engine. The main oil galleries run the full length of the engine block and cut into the valve lash adjuster holes to supply oil at full pressure to the valve lash adjusters. Holes are drilled from the

crankshaft bearings to the main oil gallery. Oil is transferred from the crankshaft bearings to the connecting rod bearings through holes drilled in the crankshaft. Pistons, piston pins, and cylinder walls are lubricated by oil splash from the crankshaft and connecting rods. The camshafts and valve rocker arms are supplied with oil from the oil passages drilled into the camshaft mounting areas.

Crankcase Ventilation System Description



A crankcase ventilation system is used to consume crankcase vapors created during the combustion process instead of venting them to the atmosphere.

Fresh air is supplied through a filter to the crankcase, the crankcase mixes the fresh air with the blow-by gases and then passed through a positive crankcase ventilation (PCV) orificed tube (5) into the intake manifold (3).

The PCV orificed tube (5) restricts the flow rate of the blow-by gases using a 2.1 mm (0.083 in) orifice located in the camshaft cover tube (5). If abnormal operating conditions arise, the system is designed to allow excessive amounts of blow-by gases to back flow through the crankcase ventilation fresh air tube (6) into the air cleaner resonator (1) in order to be consumed by normal combustion.

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 1 belt or 2 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.

Exhaust Camshaft Position Actuator Description

The camshaft position actuator is bolted to the front of the exhaust camshaft and is integral with the sprocket. The actuator and sprocket can only be replaced as one unit. The actuator has a hydraulically actuated piston located in the hub. The piston has an internal helical spline that slides in mesh with the gear. As the piston moves, the piston and gear mechanism changes the timing of the exhaust camshaft, relative to the cam drive sprocket. When oil pressure is applied to one side of the piston, the cam moves clockwise and timing is advanced. When oil pressure is applied to the other side of the piston the cam moves counter-clockwise to retard timing. The total range of actuator rotation is 0 to 25 camshaft degrees. At idle, the exhaust camshaft position actuator is at full advance or 0 degrees.

Engine Cooling

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Coolant Heater	50 N·m	37 lb ft
Thermostat Housing Bolt	10 N·m	89 lb in
Water Outlet Housing Bolt	10 N·m	89 lb in
Water Pump Bolt	10 N·m	89 lb in
Water Pump Pulley Bolt	25 N·m	18 lb ft

Cooling System Description and Operation

Coolant Heater

The optional engine coolant heater (RPO K05) operates using 110-volt AC external power and is designed to warm the coolant in the engine block area for improved starting in very cold weather -29°C (-20°F). The coolant heater helps reduce fuel consumption when a cold engine is warming up. The unit is equipped with a detachable AC power cord. A weather shield on the cord is provided to protect the plug when not in use.

Cooling System

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 coolant does not flow to the radiator until the thermostat opens. This allows the engine to warm quickly.

Cooling Cycle

Coolant flows from the radiator outlet and into the water pump inlet. Some coolant flows from the water pump, to the heater core, then back to the water pump. This provides the passenger compartment with heat and defrost capability as the coolant warms up.

Coolant also flows from 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 then flows 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.

From the cylinder heads, the coolant flows to the thermostat. The flow of coolant will either be stopped at the thermostat until the engine reaches normal operating temperature, or it will flow through the thermostat and into the radiator where it is cooled. At this point, the coolant flow cycle is completed.

Efficient 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 suitable drinking 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 two tanks. The aluminum core is a tube and fin crossflow design that extends from the inlet tank to the outlet tank. Fins are placed around the outside of the tubes to improve heat transfer to the atmosphere.

The inlet and outlet tanks are a molded, high temperature, nylon reinforced plastic material. A high temperature rubber gasket seals the tank flange edge to the aluminum core. 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 also has a drain cock located in the bottom of the left hand tank. The drain cock unit includes the drain cock and drain cock seal.

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

Pressure Cap

The pressure cap seals 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, which protects the radiator from excessive cooling system pressure. 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 and/or coolant hoses to collapse.

The pressure cap allows cooling system pressure to build up as the temperature increases. As the pressure builds, the boiling point of the coolant increases. Engine 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 transfers from the radiator to the cooler, passing air.

The pressure in the cooling system can get too high. When the cooling system pressure exceeds the rating of the pressure cap, it raises the pressure valve, venting the excess pressure.

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 surge tank. This equalizes the pressure in the cooling system with atmospheric pressure, preventing the radiator and coolant hoses from collapsing.

Coolant Recovery System

The coolant recovery system consists of a plastic coolant recovery reservoir and overflow tube. The recovery reservoir is also called a recovery tank or expansion tank. It is partially filled with coolant and is connected to the radiator fill neck with the overflow tube. Coolant can flow back and forth between the radiator and the reservoir.

In effect, a cooling system with a coolant recovery reservoir is a closed system. When the pressure in the cooling system gets too high, it will open the pressure valve in the pressure cap. This allows the coolant, which has expanded due to being heated, is allowed to flow through the overflow tube and into the recovery reservoir. As the engine cools down, the temperature of the coolant drops and a vacuum is created in the cooling system. This vacuum opens the vacuum valve in the pressure cap, allowing some of the coolant in the reservoir to be siphoned back into the radiator. Under normal operating conditions, no coolant is lost. Although the coolant level in the recovery reservoir goes up and down, the radiator and cooling system are kept full. An advantage to using a coolant recovery reservoir is that it eliminates almost all air bubbles from the cooling system. Coolant without bubbles absorbs heat much better than coolant with bubbles.

Air Baffles and Seals

The cooling system uses deflectors, air baffles and air seals to increase cooling system capability. Deflectors are installed under the vehicle to redirect airflow beneath the vehicle and through the radiator to increase engine cooling. Air baffles are also used to direct airflow through the radiator and increase cooling capability. Air seals prevent air from bypassing the radiator and A/C condenser, and prevent recirculation of hot air for better hot weather cooling and A/C condenser performance.

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 mounted on the pump shaft and consists of a series of flat or curved blades or vanes on a flat plate. 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. The sealed bearings never need to be lubricated. Grease cannot leak out, dirt and water cannot get in as long as the seal is not damaged or worn.

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 help regulate the operating temperature of the engine. It utilizes a temperature sensitive wax-pellet element. The element connects to a valve through a small piston. When the element is heated, it expands and exerts pressure against the small piston. 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 the rated thermostat opening temperature, the thermostat valve remains closed. This prevents circulation of the coolant to the radiator and allows the engine to warm up. After the coolant temperature reaches the rated thermostat opening temperature, 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, 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 right side end tank of the radiator. The transmission fluid temperature is regulated by the temperature of the engine coolant in the radiator.

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

Engine Electrical

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Battery Cables to Battery Nut	9 N·m	80 lb in
Battery Negative Cable to Battery Tray Bolt	9 N·m	80 lb in
Battery Negative Cable to Engine Block Bolt	35 N·m	26 lb ft
Battery Positive Cable to Starter Terminal Nut	9 N·m	80 lb in
Battery Positive Cable to Underhood Fuse Block Nut	9 N·m	80 lb in
Battery Retainer Nut	15 N·m	11 lb ft
Generator Mounting Bolt	50 N·m	37 lb ft
Generator Output BAT Terminal Nut	20 N·m	15 lb ft
Generator Positive Cable to Underhood Fuse Block Nut	9 N·m	80 lb in
Starter Motor Mounting Fastener	50 N·m	37 lb ft
Starter Solenoid S Terminal Nut	3.5 N·m	31 lb in

Battery Usage

Base	
Cold Cranking Amperage (CCA)	690 A
Reserve Capacity Rating	90 Minutes
Replacement Battery 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

Applications	Starter Type
2.8L (LK5), 3.5L (L52)	PG-260L

Generator Usage

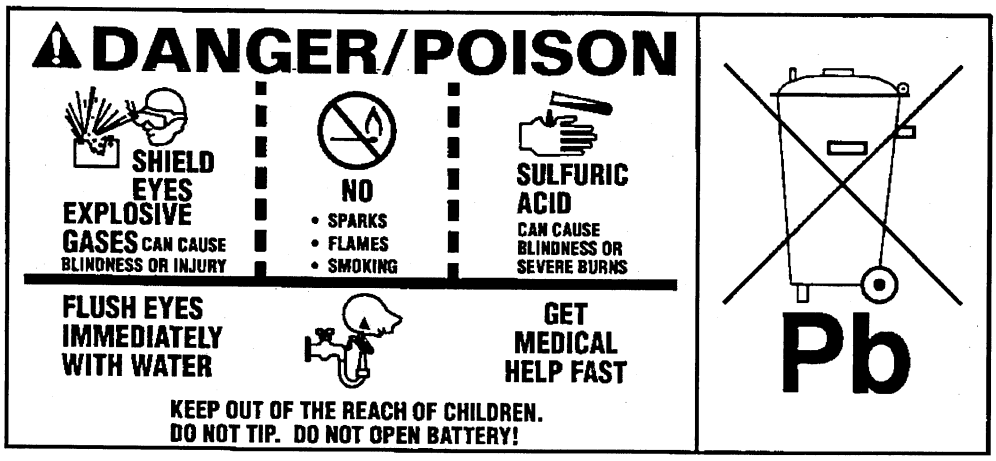
Engine	Rated Output AMPS	Load Test Output AMPS
Gasoline Engine	100 A	70 A

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

The PG-260L is a non-repairable starter motor. It has pole pieces that are arranged around the armature within the starter housing. When the solenoid windings are energized, the pull-in winding circuit is completed to ground through the starter motor. The hold-in winding circuit is completed to ground through the solenoid. The windings work together magnetically to pull in and hold in the plunger. The plunger moves the shift lever. This action causes the starter drive assembly to rotate on the armature shaft spline as it engages with the flywheel ring gear on the engine. At the same time, the plunger closes the solenoid switch contacts in the starter solenoid. Full battery voltage is then applied directly to the starter motor and it cranks the engine.

As soon as the solenoid switch contacts close, current stops flowing thorough the pull-in winding as battery voltage is now applied to both ends of the windings. The hold-in winding remains energized; its magnetic field is strong enough to hold the plunger, shift lever, starter drive assembly, and solenoid switch contacts in place to continue cranking the engine. When the engine starts, the pinion gear overrun sprag protects the armature from excessive speed until the switch is opened.

When the ignition switch is released from the CRANK position, voltage is removed from the starter solenoid S terminal. Current flows from the motor contacts through both windings to ground at the end of the hold-in winding. However, the direction of the current flow through the pull-in winding is now in the opposite direction of the current flow when the winding was first energized.

The magnetic fields of the pull-in and hold-in windings now oppose one another. This action of the windings, along with the help of the return spring, cause the starter drive assembly to disengage and the solenoid switch contacts to open simultaneously. As soon as the contacts open, the starter motor is turned off.

Charging System Description and Operation

Generator

The generator features the following major components:

- The delta stator
- The rectifier bridge
- The rotor with slip rings and brushes
- A conventional pulley
- Dual internal fans
- The regulator

The pulley and the fan cool the slip ring and the frame.

The generator features permanently lubricated bearings. Service should only include tightening of mount components. Otherwise, replace the generator as a complete unit.

Regulator

The voltage regulator controls the rotor field current in order to limit the system voltage. When the field current is on, the regulator switches the current on and off at a rate of 400 cycles per second in order to perform the following functions:

- Radio noise control
- Obtain the correct average current needed for proper system voltage control

At high speeds, the on-time may be 10 percent with the off-time at 90 percent. At low speeds, the on-time may be 90 percent and the off-time 10 percent.

Circuit Description

The generator provides voltage to operate the vehicle's electrical system and to charge its battery. A magnetic field is created when current flows through the rotor. This field rotates as the rotor is driven by the engine, creating an AC voltage in the stator windings. The AC voltage is converted to DC by the rectifier bridge and is supplied to the electrical system at the battery terminal.

When the engine is running, the generator turn-on signal is sent to the generator from the PCM, turning on the regulator. The generator's voltage regulator controls current to the rotor, thereby controlling the output voltage. The rotor current is proportional to the electrical pulse width supplied by the regulator. When the engine is started, the regulator senses generator rotation by detecting AC voltage at the stator through an internal wire. Once the engine is running, the regulator varies the field current by controlling the pulse width. This regulates the generator output voltage for proper battery charging and electrical system operation. The generator F terminal is connected internally to the voltage regulator and externally to the PCM. When the voltage regulator detects a charging system problem, it grounds this circuit to signal the PCM that a problem exists. The PCM monitors the generator field duty cycle signal circuit. The system voltage sense circuit receives battery positive voltage that is Hot At All Times through a fuse link that is connected to the starter motor. This voltage is used by the regulator as the reference for system voltage control.

Engine Controls

Engine Controls – 2.8L (LK5)

Ignition System Specifications

Application	Specification	
	Metric	English
Firing Order	1-3-4-2	
Spark Plug Gap	1.08 mm	0.042 in
Spark Plug Torque	18 N·m	13 lb ft
Spark Plug Type	GM P/N 12569190	

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Accelerator Pedal Position (APP) Sensor Mounting Nut	9 N·m	80 lb in
Air Cleaner Assembly Bolt	10 N·m	89 lb in
Air Cleaner Assembly Nut	15 N·m	11 lb ft
Air Cleaner Outlet Duct Clamp	6 N·m	53 lb in
Air Cleaner Resonator Bolt	6 N·m	53 lb in
Air Cleaner Resonator Outlet Duct Clamp	6 N·m	53 lb in
Camshaft Position (CMP) Actuator Solenoid Valve Bolt	10 N·m	89 lb in
Camshaft Position (CMP) Sensor Bolt	10 N·m	89 lb in
Crankshaft Position (CKP) Sensor Bolt	10 N·m	89 lb in
Engine Coolant Temperature (ECT) Sensor	14 N·m	124 lb in
Evaporative Emission (EVAP) Canister Bolt	25 N·m	18 lb ft
Evaporative Emission (EVAP) Canister Purge Solenoid Valve Bolt	10 N·m	89 lb in
Fuel Filler Hose Clamp	2.5 N·m	22 lb in
Fuel Filler Hose Ground Strap Bolt	9 N·m	80 lb in
Fuel Filler Hose Screw	2 N·m	18 lb in
Fuel Pressure Regulator Screw	8 N·m	71 lb in
Fuel Rail Bolt	10 N·m	89 lb in
Fuel Tank Strap Bolt	32 N·m	24 lb ft
Heated Oxygen Sensor (HO2S)	42 N·m	31 lb ft
Ignition Coil Bolt	10 N·m	89 lb in
Knock Sensor (KS) Bolt	25 N·m	18 lb ft
Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor Screw	2.25 N·m	20 lb in
Spark Plug	18 N·m	13 lb ft
Throttle Control Module Bolt	10 N·m	89 lb in

Fuel System Specifications

Use regular unleaded gasoline rated at 87 octane or higher. It is recommended that the gasoline meet specifications which have been developed by the American Automobile Manufacturers Association (AAMA) and endorsed by the Canadian Motor Vehicle Manufacturers Association for better vehicle performance and engine protection. Gasoline 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 is at least 87. If the octane is less than 87, you may get a heavy knocking noise when you drive. If the knocking is bad enough, the knocking can damage your engine.

If you are using fuel rated at 87 octane or higher and you hear heavy knocking, your engine needs service. But do not worry if you hear a little pinging noise when you are accelerating or driving up a hill. That is normal, and you do not have to buy a higher octane fuel to get rid of the pinging. However, if there is a 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 California Emission Standards, indicated on the under hood emission control label, your vehicle 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 there is a determination 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.

Engine Controls – 3.5L (L52)

Ignition System Specifications

Application	Specification	
	Metric	English
Firing Order	1-3-5-4-2	
Spark Plug Gap	1.08 mm	0.042 in
Spark Plug Torque	18 N·m	13 lb ft
Spark Plug Type	GM P/N 12569190	

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Accelerator Pedal Position (APP) Sensor Mounting Nut	9 N·m	80 lb in
Air Cleaner Assembly Bolt	10 N·m	89 lb in
Air Cleaner Assembly Nut	15 N·m	11 lb ft
Air Cleaner Outlet Duct Clamp	6 N·m	53 lb in
Air Cleaner Resonator Bolt	6 N·m	53 lb in
Air Cleaner Resonator Outlet Duct Clamp	6 N·m	53 lb in
Camshaft Position (CMP) Actuator Solenoid Valve Bolt	10 N·m	89 lb in
Camshaft Position (CMP) Sensor Bolt	10 N·m	89 lb in
Crankshaft Position (CKP) Sensor Bolt	10 N·m	89 lb in
Engine Coolant Temperature (ECT) Sensor	14 N·m	124 lb in
Evaporative Emission (EVAP) Canister Bolt	25 N·m	18 lb ft
Evaporative Emission (EVAP) Canister Purge Solenoid Valve Bolt	10 N·m	89 lb in
Fuel Filler Hose Clamp	2.5 N·m	22 lb in
Fuel Filler Hose Ground Strap Bolt	9 N·m	80 lb in
Fuel Filler Hose Screw	2 N·m	18 lb in
Fuel Pressure Regulator Screw	8 N·m	71 lb in
Fuel Rail Bolt	10 N·m	89 lb in
Fuel Tank Strap Bolt	32 N·m	24 lb ft
Heated Oxygen Sensor (HO2S)	42 N·m	31 lb ft
Ignition Coil Bolt	10 N·m	89 lb in
Knock Sensor (KS) Bolt	25 N·m	18 lb ft
Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor Screw	2.25 N·m	20 lb in
Spark Plug	18 N·m	13 lb ft
Throttle Control Module Bolt	10 N·m	89 lb in

Fuel System Specifications

See fuel system specifications above.

Exhaust System

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Catalytic Converter Nut	50 N·m	37 lb ft
Exhaust Manifold Bolt		
First Pass	20 N·m	15 lb ft
Second Pass	20 N·m	15 lb ft
Final Pass	20 N·m	15 lb ft
Exhaust Manifold Heat Shield Nut	10 N·m	89 lb in
Heat Shield Nut	9 N·m	80 lb in
Leaf Spring Bolt and Nut	85 N·m	63 lb ft
Lower Shock Absorber Bolt and Nut	95 N·m	70 lb ft
Muffler Nut	45 N·m	33 lb ft
Transmission Filler Tube Bracket Nut	12.5 N·m	111 lb in

Exhaust System Description

Important

Use of non-OEM parts may cause driveability concerns.

The exhaust system carries exhaust gases, treated by the catalytic converter, through a resonator, if applicable and into the exhaust muffler where exhaust noise is lessened.

In order to secure the exhaust pipe to the exhaust manifold, a flange and seal-joint coupling is utilized. The exhaust system may utilize a slip-joint coupling design with a clamp and a U-bolt or a flange connection with a gasket.

Exhaust hangers and rubber insulators help to support the weight of the exhaust pipe along with insulating any exhaust system vibration, rattle, or noise.

Exhaust hangers also space the exhaust system away from the underbody of the vehicle and allows the exhaust system to expand as the exhaust system warms up.

Exhaust heat shields are used to protect the body and other components from damage due to the heat from the exhaust system.

The exhaust system may be comprised of the following components:

- Exhaust manifold
- Exhaust pipes
- Catalytic converters
- Exhaust muffler
- Exhaust resonator, if equipped
- Exhaust tail pipe, if equipped
- Exhaust hangers
- Exhaust heat shields

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/Transaxle Description and Operation

Manual Transmission –Aisin AR5

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Backup Lamp Switch	44 N·m	32 lb ft
Control Lever Boot Screw	2.5 N·m	22 lb in
Drain Plug	37 N·m	27 lb ft
Fill Plug	37 N·m	27 lb ft
Fuel Hose/Pipe Brackets Nut	20 N·m	15 lb ft
Input Shaft Bearing Retainer Bolt	17 N·m	13 lb ft
Shift Lever Assembly Bolt	20 N·m	15 lb ft
Transmission Mount Bolt	60 N·m	44 lb ft
Transmission Mount Nut	57 N·m	42 lb ft
Transmission Mounting Bolt	50 N·m	37 lb ft
Vehicle Speed Sensor (VSS)	17 N·m	13 lb ft

Lubrication Specifications

Application	Specification	
	Metric	English
API AI-A or GL-3 SAE 75W-90 GM P/N 89021806 (Canadian P/N 89021807)	RWD: 2.2 liters 4WD: 2.3 liters	RWD: 2.3 quarts 4WD: 2.4 quarts

Description

The Aisin AR5 is a 5 speed transmission with 5th gear being an overdrive ratio. All gear positions are synchronized. There are two versions of the AR5, RWD and 4WD. The operation is the same for both transmissions. The differences are the RWD has a longer extension housing and output shaft. In addition, the RWD has a speed reluctor wheel on the output shaft for the vehicle speed sensor. The transmission uses 4 aluminum housings. The clutch housing is removable. Roller ball bearings support the input shaft, countershaft, and output shaft. No shimming is required. For proper set up, select thickness retaining rings are used. All of the speed gears use needle bearings. The AR5 uses a special 75W-90 transmission fluid. Lubrication to the input and output shafts are by splash. An oil receiver at the rear of the countershaft lubricates the 5th gear synchronizer and bearing. On the RWD transmission, an oil trough delivers transmission fluid to the rear bushing.

Hydraulic Clutch

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Clutch Actuator Cylinder Bolt	8 N·m	71 lb in
Clutch Pedal Assembly Nut	20 N·m	15 lb ft
Clutch Pressure Plate Bolt		
First Pass	20 N·m	15 lb ft
Final Pass	45 degrees	

Sealers and Lubricants

Application	Type of Material	GM Part Number	
		United States	Canada
Clutch Hydraulic Fluid	DOT 3 Hydraulic Fluid	12345347	992667

Hydraulic Clutch Description

The S/T model vehicle uses two different clutch variations.

2.8L (LK5) Clutch

The 2.8L clutch system is described as the following:

- Size - 232 mm (9 in)
- Clutch pressure plate - Diaphragm spring plate, non-self adjusting
- Clutch disc - Damper spring style
- Hydraulic system

3.5L (L52) Clutch

The 3.5L clutch system is described as the following:

- Size - 265 mm (10.4 in)
- Clutch pressure plate - Diaphragm spring plate, non-self adjusting
- Clutch disc - Damper spring style
- Hydraulic system

Clutch System Components

Clutch Pedal

The clutch pedal, mounted on the engine cowl, is designed to compress the clutch hydraulic fluid with little driver effort. The pedal swivels on bushings. The clutch master cylinder pushrod connects to a pin on the pedal. A spring, located inside of the clutch master cylinder, returns the pedal to the correct position after depressing.

Clutch Master Cylinder

The reservoir, which is part of the master cylinder, supplies the fluid at the front of the master cylinder through the center feed port. The center feed port allows the flow of fluid from the reservoir to the cylinder when the pedal is in the complete returned position. The master cylinder uses a spring to return the piston to the clutch engagement position. When the clutch pedal is depressed, the piston moves forward in the cylinder, compressing the fluid. The compressed fluid travels through a hose to the clutch actuator cylinder. A bleeder screw is located at the clutch actuator cylinder for bleeding the hydraulic system.

Clutch Actuator Cylinder and Release Bearing

The clutch control actuator cylinder disengages the clutch, using the pressurized fluid from the clutch master cylinder. The clutch control actuator cylinder is fastened to the front of the transmission. The clutch release bearing is attached to the control actuator cylinder. The control actuator cylinder has a piston, which has seals that slide on the housing assembly. There is a spring between the piston and the housing to keep the piston at the extended position, allowing the release bearing to be in constant contact with the pressure plate fingers. The movement of the piston, by the pressurized fluid, pushes the release bearing against the tips of the clutch pressure plate fingers, to disengage the clutch.

As the clutch wears, the piston, or release bearing, moves towards the transmission. The piston is at the furthest position from the transmission with a new clutch.

The clutch control actuator cylinder has a bleeder, for bleeding the air out of the hydraulic system.

Ball bearings enable the release bearing to turn, while applying pressure to the pressure plate fingers. Using an angular contract style bearing allows the release bearing to be in constant contact with the pressure plate fingers.

Pressure Plate Assembly

The diaphragm spring clutch consists of a pressure plate, a diaphragm spring, a pivot ring, drive straps, and a cover. When the release bearing contacts the tips of the diaphragm spring fingers, it moves them toward the flywheel. The outside diameter of the diaphragm spring pivots on a pivot ring inside the cover. This action lifts the pressure plate off the flywheel through the drive straps, which connect the cover to the pressure plate. As the clutch wears, there is an increase in pedal effort.

Clutch Disc

The clutch disc, or driven member, is a critical component in the service life of the clutch system. The disc provides smooth engagement and dampens engine vibrations. Mounted to the transmission input shaft, between the flywheel and the clutch pressure plate, the disc slides on the input shaft forward and backward. The disc is splined to the input shaft and cannot rotate without rotating the input shaft. The critical parts of the clutch disc are the hub flange and the torsion springs. The hub flange is located between the cover plate and a retainer plate and splined to fit the input shaft. The torsion springs, in the damper assembly, smooth the engagement and dampen vibrations. Friction material is riveted to numerous components, called marcels, or cushion segments. Waves in marcels soften engagement.

Flywheel

Bolted to the end of the crankshaft, the flywheel provides the mounting surface for the clutch. During engagement, the disc is clamped against the flywheel by the pressure plate. The flywheel acts as a heat sink, dissipating heat and moving it away from the clutch pressure plate and disc friction material. The flywheel must provide a smooth, flat surface in order for the clutch to operate properly.

Pilot Bearing/Bushing

A pilot bearing, or bushing, is located in the end of the crankshaft. The pilot bearing supports the end of the input shaft and centers the disc on the flywheel. The pilot bearing is a sintered bronze bushing. A small, and relatively inexpensive component, the pilot bearing or bushing should always be replaced during clutch installation. The variety of conditions caused by a worn or defective bearing or bushing is not worth the risk of having to remove the bell housing and transmission to replace this small part.

Clutch Pedal Reserve

In order for the clutch to be completely disengaged and allow proper shifting of the transmission, clutch pedal reserve is required. Clutch pedal reserve is the movement of the pedal from the down stop, or the floor, to where the clutch begins transmitting torque; it should be a minimum of 25 mm (1 in). Inspect for clutch pedal reserve by depressing the clutch pedal. Allow the clutch disc to quit spinning, and let up on the clutch pedal while listening for the clutch disc to start spinning. The distance the pedal moved from the floor, before the clutch disc started to spin, is the pedal reserve.

In order to determine if the clutch is properly releasing and the hydraulic system is functioning properly:

- Depress the clutch pedal fully to disengage the clutch.
- Shift into a low gear, either 1st or reverse.
- Slowly shift out of the gear, only to disengage the synchronizer sleeve from the speed gear engagement teeth.
- Let up on the pedal, to engage the clutch.
- Depress the clutch pedal and shift back into gear.

If the clutch pedal is releasing properly, you should be able to engage the gear without grinding after 4-5 seconds, which is the time for the clutch disc to quit spinning.

Automatic Transmission - 4L60-E/4L65-E

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Accumulator Cover to Case Bolt	8.0-14.0 N·m	6-10 lb ft
Case Extension to Case Bolt	42.0-48.0 N·m	31-35 lb ft
Case Extension to Case Bolt (4WD Shipping)	11.2-22.6 N·m	8.3-16.7 lb ft
Control Lever Nut	20 N·m	15 lb ft
Converter Cover Bolt	10 N·m	89 lb in
Converter Housing to Case Screw	65.0-75.0 N·m	48-55 lb ft
Cooler Pipe Connector	35.0-41.0 N·m	26-30 lb ft
Detent Spring to Valve Body Bolt	20.0-27.0 N·m	15-20 lb ft
Engine Wiring Harness Retainer to Transmission Screw	9 N·m	80 lb in
Filler Tube Nut	12.5 N·m	111 lb in
Floorshift Control Bolt	10 N·m	89 lb in
Forward Accumulator Cover to Valve Body Bolt	8.0-14.0 N·m	6-10 lb ft
Fuel Hose Pipe Bracket Nut	20 N·m	15 lb ft
Heat Shield to Transmission Bolt	17 N·m	13 lb ft
Line Pressure Plug	8.0-14.0 N·m	6-10 lb ft
Manual Shaft to Inside Detent Lever Nut	27.0-34.0 N·m	20-25 lb ft
Negative Battery Cable Bolt	15 N·m	11 lb ft
Oil Level Indicator Bolt	47 N·m	35 lb ft
Oil Pan to Transmission Case Bolt	11 N·m	97 lb in
Oil Passage Cover to Case Bolt	8-14.0 N·m	6-10 lb ft
Park Brake Bracket to Case Bolt	27.0-34.0 N·m	20-25 lb ft
Park/Neutral Back Up Switch Bolt	27 N·m	20 lb ft
Park/Neutral Position Switch Screw	3 N·m	27 lb in
Plate to Case Bolt (Shipping)	27.0-34.0 N·m	20-25 lb ft
Plate to Converter Bolt (Shipping)	27.0-34.0 N·m	20-25 lb ft
Pressure Control Solenoid Bracket to Valve Body Bolt	8.0-14.0 N·m	6-10 lb ft
Pump Assembly to Case Bolt	26.0-32.0 N·m	19-24 lb ft
Pump Cover to Pump Body Bolt	20.0-27.0 N·m	15-20 lb ft
Shift Cable Grommet Screw	1.7 N·m	15 lb in
Shift Control Cable Attachment	20 N·m	15 lb ft
Speed Sensor Retainer Bolt	10.5-13.5 N·m	7.7-10 lb ft
TCC Solenoid Assembly to Case Bolt	8.0-14.0 N·m	6-10 lb ft
Torque Converter Bolt	60 N·m	44 lb ft
Transmission Fluid Pressure Manual Valve Position Switch to Valve Body Bolt	8.0-14.0 N·m	6-10 lb ft
Transmission Mount to Transmission Bolt	60 N·m	44 lb ft
Transmission Mount to Transmission Support Nut	57 N·m	42 lb ft
Transmission Mounting Bolt	50 N·m	37 lb ft
Transmission Oil Cooler Pipe Fitting	35.0-41.0 N·m	26-30 lb ft
Transmission Oil Pan to Case Bolt	9.5-13.8 N·m	7-10 lb ft
Transmission Range Selector Cable Bracket Bolt	25 N·m	18 lb ft
Transmission to Engine Bolt	47 N·m	35 lb ft
Valve Body to Case Bolt	8.0-14.0 N·m	6-10 lb ft

Transmission General Specifications

Transmission General Specifications (4L60-E)	Hydra-matic 4L60-E
RPO Codes	M30
Production Location	Toledo, Ohio Romulus, MI Ramos Arizpe, Mexico
Vehicle Platform (Engine/Transmission) Usage	S/T
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
Torque Converter Size - Diameter of Torque Converter Turbine	245 mm 258 mm
Pressure Taps	Line Pressure
Transmission Fluid Type	DEXRON® III
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, OD, D, 2, 1 P, R, N, OD, 3, 2, 1
Case Material	Die Cast Aluminum
Transmission Weight Dry - Approximate	245 mm Converter 65.4 kg (144.30 lbs) 258 mm Converter 79.9 kg (176.6 lbs)
Transmission Weight Wet - Approximate	245 mm Converter 72.4 kg (159.55 lbs) 258 mm Converter 89.2 kg (197.7 lbs)
Maximum Trailer Towing Capacity	6,130 kg (13,500 lbs)
Maximum Gross Vehicle Weight (GVW)	3,900 kg (8,600 lbs)

Fluid Capacity Specifications

Application	Specification	
	Metric	English
Pan Removal	4.7 L	5 qts
Overhaul	10.6 L	11 qts
245 mm Torque Converter Approximate Fluid Capacity Dry Fill	8.3 L	8.8 qts
258 mm Torque Converter Approximate Fluid Capacity Dry Fill	8.8 L	9.3 qts

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

Transmission Adapt Function

The 4L60-E transmission utilizes a line pressure control system during upshifts to compensate for the normal wear of transmission components. By adjusting the line pressure, the PCM can maintain acceptable transmission shift times. This process is known as "adaptive learning" or "shift adapts" and is similar to the closed loop fuel control system used for the engine.

In order for the PCM to perform a "shift adapt," it must first identify if an upshift is acceptable to analyze. For example, upshifts that occur during cycling of the A/C compressor or under extreme throttle changes could cause the PCM to incorrectly adjust line pressure. When an upshift is initiated, a number of contingencies, such as throttle position, transmission temperature, and vehicle speed, are checked in order to determine if the actual shift time is valid to compare to a calibrated desired shift time. If all the contingencies are met during the entire shift, then the shift is considered valid and the adapt function may be utilized if necessary.

Once an adaptable shift is identified, the PCM compares the actual shift time to the desired shift time and calculates the difference between them. This difference is known as the shift error. The actual shift time is determined from the time that the PCM commands the shift to the start of the engine RPM drop initiated by the shift. If the actual shift time is longer than the calibrated desired shift time, a soft feel or slow engagement, then the PCM decreases current to the pressure control (PC) solenoid in order to increase line pressure for the next, same, upshift under identical conditions. If the actual shift time is shorter than the calibrated desired shift time, a firm engagement, then the PCM increases current to the PC solenoid in order to decrease line pressure for the next, same, upshift under identical conditions.

The purpose of the adapt function is to automatically compensate the shift quality for the various vehicle shift control systems. It is a continuous process that will help to maintain optimal shift quality throughout the life of the vehicle.

Automatic Transmission Shift Lock Control Description

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

- The automatic transmission shift lock control solenoid
- The body control module (BCM)
- The powertrain control module (PCM)

The body control module (BCM) controls the voltage supply circuit of the shift lock control solenoid. The following conditions must be met before the BCM will supply battery voltage to the shift lock control solenoid:

- The ignition is in the ON position.
- The powertrain control module (PCM) sends a class 2 message to the BCM indicating the transmission is in the PARK position.
- The PCM receives a brake applied input from the brake light switch and sends a class 2 message to the BCM indicating the brakes are not applied.

With the above conditions met, the BCM supplies battery voltage to the shift lock control solenoid. The solenoid is permanently grounded and therefore energizes, locking the shift lever in the PARK position. When the brake pedal is depressed the PCM send a class 2 message to the BCM indicating the brakes are applied. The BCM turns off the battery voltage supply to the shift lock control solenoid. This de-energizes the shift lock control solenoid releasing the mechanical lock, allowing the driver to move the shift lever out of the PARK position. With the shift lever out of the PARK position the PCM sends a class 2 message to the BCM and no voltage is applied to the shift lock control solenoid.

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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^3	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^2	Square Foot/Feet
sq in, in^2	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/s²	0.3048	m/s²
In/s²	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/m²

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

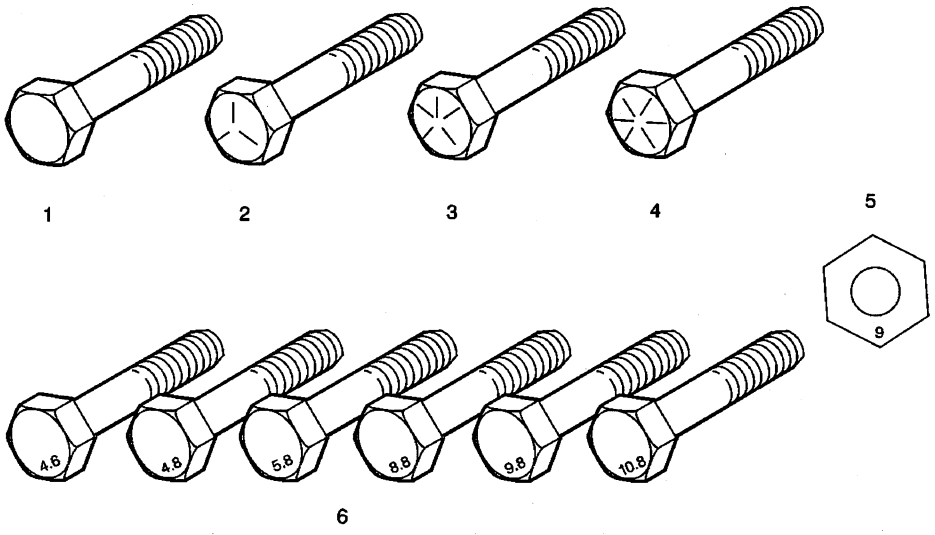
Metric Fasteners

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

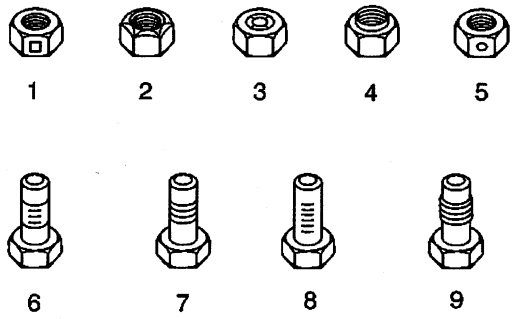
These fasteners accomplish the thread interface by a designed distortion or deformation in the fastener.

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