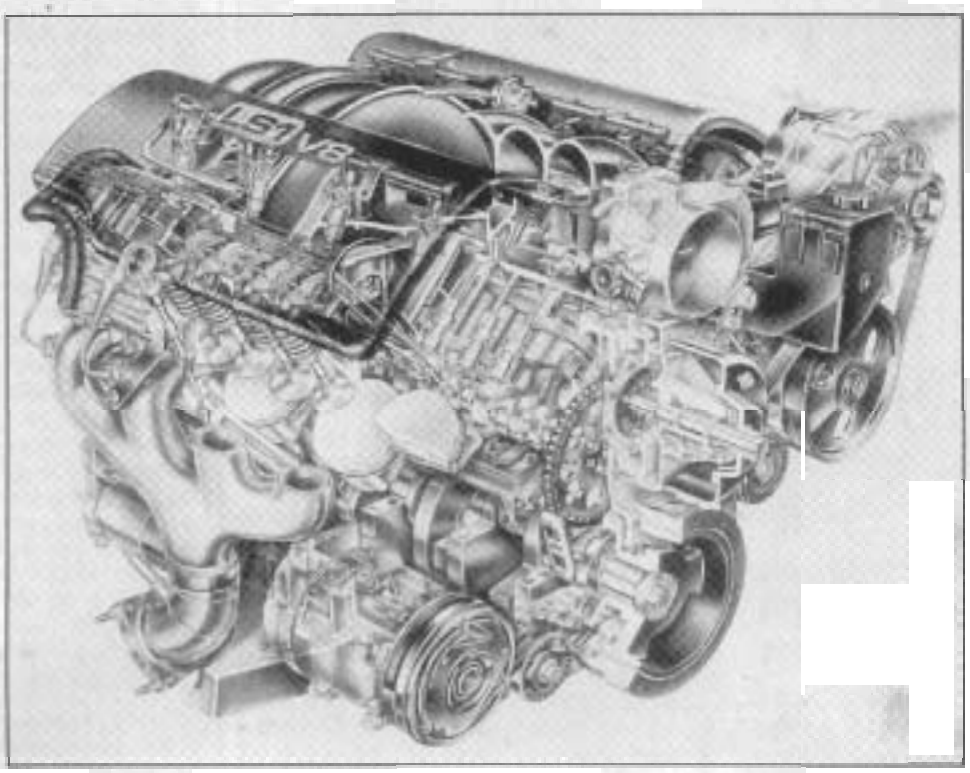
LS1 ENGINE KIT INSTALLATION GUIDE



LS1 Design and Development ■ Installation Notes ■ Engine Controls ■ Technical Information ■ Specifications

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LS1 INSTALLATION AND SERVICE INFORMATION

This publication provides general information on components and procedures that may be useful when installing or servicing LS1 Engine Kit PN 25534322. Topics include installation notes, support systems, electronic engine controls, recommended accessories, parts lists, and engine specifications.

The LS1 Engine Kit engine is based on the production Camaro/Firebird LS1 engine assembly. The kit may include exhaust manifolds, an automatic transmission flexplate, a wiring harness, and an ECM that will operate both the engine and an electronically controlled 4L60E automatic transmission. The LS1 engine assembly weighs approximately 390 pounds.

LS1 Engine Kit PN 25534322 includes exhaust manifolds, flexplate, wiring harness, and ECM. The assembly is shown here with recommended accessories described in this publication.

Due to the wide variety of vehicles in which LS1 engines can be installed, some procedures and recommendations may not apply to specific applications. This publication is **not** intended to replace comprehensive service manuals and parts catalogs which cover General Motors engines and components.

LS1 Engine Kit buyers should obtain a 1998 Camaro/Firebird Service Manual (GMP/98-F-3) before installing this engine. The Camaro/Firebird Service Manual contains important safety precautions, engine control diagnostics, mechanical repair procedures, wiring schematics, and other important information.

The toll-free telephone numbers for ordering General Motors service manuals are:

U.S. 1-800-551-4123
Canada 1-800-668-5539

Please read this entire publication before starting work to familiarize yourself with installation procedures. The information is orga-

IMPORTANT SAFETY NOTICE

This publication is intended to be used by experienced and knowledgeable mechanics. It does not cover basic vehicle preparation and assembly since it is assumed that the reader is already familiar with these procedures.

Observe all safety precautions and warnings in the applicable service manuals when installing or working on an LS1 Engine Kit in any vehicle. Wear eye protection and appropriate protective clothing. Support the vehicle securely with jackstands when working under or around it. Use only the proper tools. Exercise extreme caution when working with flammable, corrosive, and hazardous liquids and materials.

Some procedures require special equipment and skills. If you do not have the appropriate training, expertise, and tools to perform any part of this installation safely, this work should be done by a professional.

LEGAL AND EMISSIONS INFORMATION

This publication is intended to provide information about the LS1 Engine Kit assembly and related components. This manual also describes procedures and modifications that may be useful during the installation of an LS1 engine assembly. It is *not* intended to replace comprehensive service manuals and parts catalogs that cover GM engines and components. Rather, it is designed to provide supplemental information in areas of interest to knowledgeable do-it-yourself enthusiasts and mechanics.

This publication pertains to engines and vehicles which are used *off the public highways* except where specifically noted otherwise. Federal law restricts the removal or modification of any part of a federally required emission control system on motor vehicles. Further, many states have enacted laws which prohibit tampering with or modifying any required emission or noise control system. Vehicles which are not operated on public highways are generally exempt from most regulations, as are some special interest and pre-emission vehicles. The reader is strongly urged to check all applicable local and state laws.

Many of the parts described or listed in this manual are merchandised for *off-highway application only*, and are tagged with the Special Parts Notice reproduced here:

SPECIAL PARTS NOTICE

This part has been specifically designed for Off-Highway application *only*. Since the installation of this part may either impair your vehicle's emission control performance or be uncertified under current Motor Vehicle Safety Standards, it should not be installed in a vehicle used on any street or highway. Additionally, any such application could adversely affect the warranty coverage of such an on-street or highway vehicle.

The information contained in this publication is subject to change. General Motors also reserves the right to make changes at any time, without notice, in equipment, manufacturers, specifications, and materials, or to discontinue items.

The information in this publication is presented without any warranty. All the risk for its use is entirely assumed by the user. Specific component design, mechanical procedures, and the qualifications of individual readers are beyond the control of the publisher, and therefore the publisher disclaims all liability incurred in connection with the use of information contained in this publication.

nized by major component groups, such as Cooling System and Engine Controls. Planning ahead will make it easier to complete an LS1 engine installation successfully.

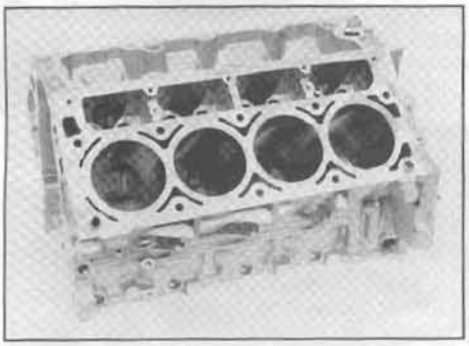
LS1 DEVELOPMENT AND DESIGN FEATURES

GM Powertrain introduced the LS1 engine, the successor to the legendary Chevrolet small-block V8, in the 1997 Corvette. The LS1 retains the original small-block's compact size, simplicity, and high specific output, but it is an entirely new engine that shares very few components with the first-generation small-block.

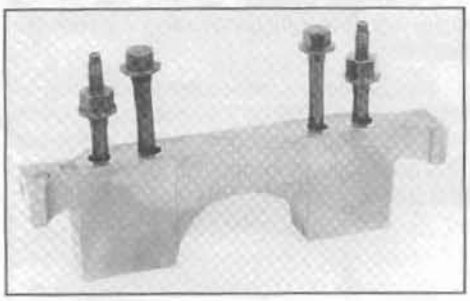
The 1997 Corvette LS1 engine was rated at 345 horsepower (at 5,600 rpm) and 350 lbs.-ft. torque (at 4,400 rpm). The LS1 was subsequently offered in 1998 Chevrolet Camaro Z28 and Pontiac Firebird models in 305 and 320-horsepower versions. The 2001 Corvette Z06 introduced a high-output 385-horsepower version designated LS6. The LS1 and its derivatives are members of a engine family that is now available in a wide range of GM vehicles and light trucks worldwide.

The LS1 displaces 5.7 liters (346 cubic inches) and retains the original small-block's 4.40" cylinder bore spacing. The LS1 differs from its predecessor in significant ways, including block material (cast iron vs. cast aluminum), cylinder bore diameter (4.00" vs. 3.90"), and crankshaft stroke (3.48" vs. 3.62").

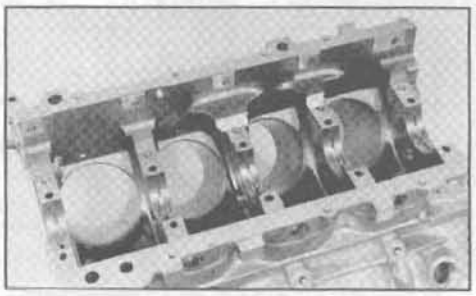
ENGINE BLOCK



The LS1 aluminum block features a deep-skirt design, with oil pan rails that extend below the crankshaft centerline to improve stiffness and rigidity. Each of the five main bearing caps is secured by six fasteners — four vertical bolts that screw into the main bearing bulkheads and two additional cross-bolts that anchor the caps to the sides of the block.



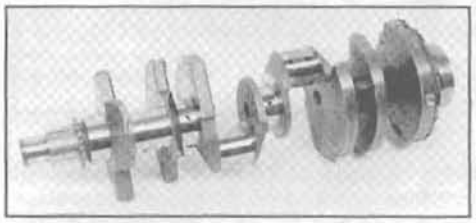
The cross-bolted main caps and deep-skirted crankcase minimize block distortion and bending under high loads. The increased block stiffness (compared to a conventional small-block) reduces noise and vibration.



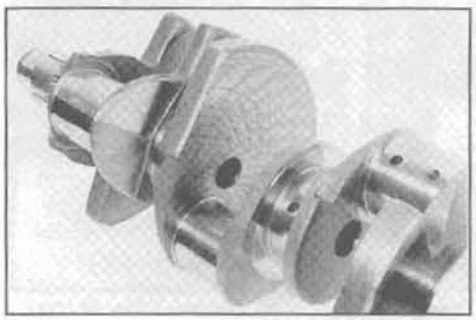
The LS1's dry cylinder liners are cast in place. Ribs on the liners' outer diameter anchor the sleeves securely in the block and expedite heat transfer to the surrounding aluminum and coolant passages.

The LS1 has four equally spaced head bolts around each cylinder. This four-bolt pattern minimizes bore distortion and permits the use of friction-reducing low-tension piston rings.

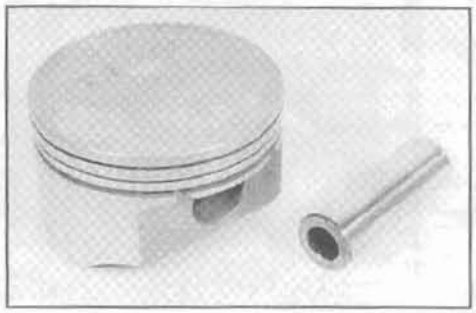
CRANKSHAFT



The LS1 crankshaft is nodular cast iron. Its journal fillets are rolled to improve durability. Hollow main bearing journals reduce the mass of the crankshaft assembly.

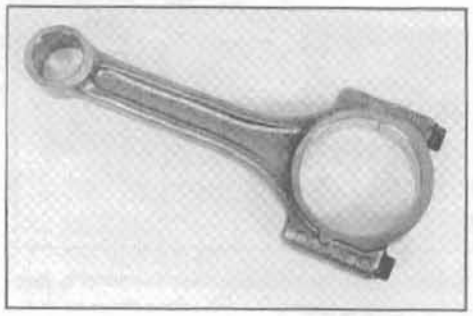


PISTONS



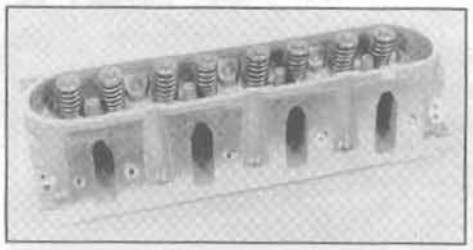
The LS1's shallow 15° valve angle and compact combustion chambers produce a 10:1 compression ratio with flat-top pistons. There is no dome or valve reliefs to impede flame travel across the cylinders.

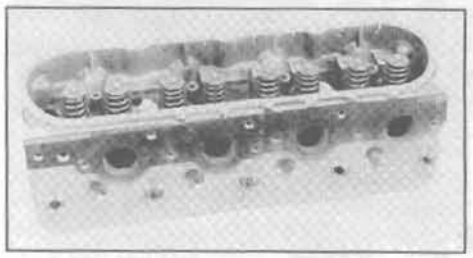
CONNECTING RODS



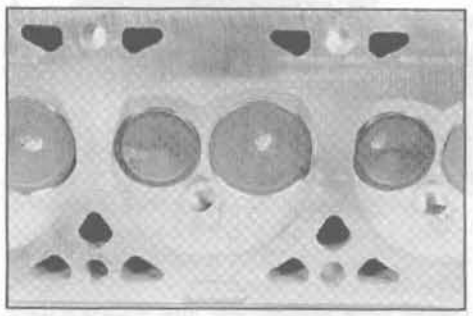
The LS1's connecting rods are forged powdered metal, a manufacturing process that produces rods that are very consistent and virtually identical. The powdered metal rods' "near net" shape minimizes variations in rod weight and balance. The rod bolts screw directly into the rod forks.

CYLINDER HEADS



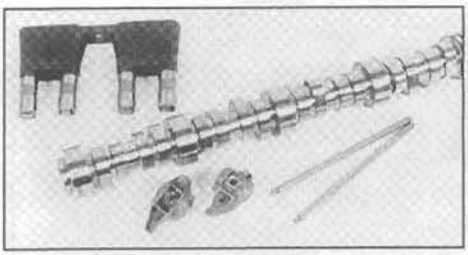


The LS1's cast-aluminum cylinder heads have evenly spaced, symmetrical intake and exhaust ports. The intake ports in the are tall and narrow, while the exhaust exits are oval. The cylinder head's rocker cover rail extends to the top of the valve springs to prevent oil leaks.



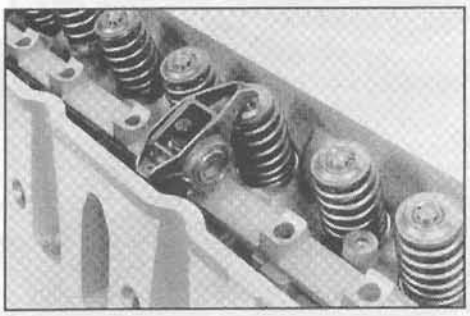
Shallow, heart-shaped combustion chambers minimize valve shrouding. Large squish areas opposite the centrally located spark plugs promote turbulence in the cylinders to improve combustion efficiency.

VALVETRAIN



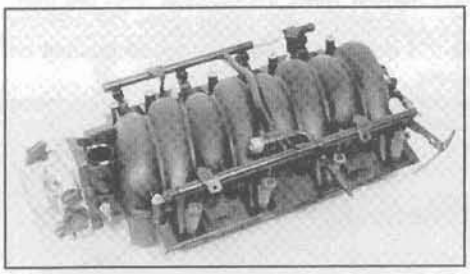
The LS1 hydraulic roller camshaft has large bearing journals and lobes to minimize torsional twisting and stress. The camshaft is hollow to reduce mass, and does not have an oil pump drive gear or fuel pump lobe. A notched ring at the rear of the camshaft triggers the camshaft position sensor.

The LS1's valves, pushrods and rocker arms are positioned in line to optimize the valvetrain geometry and reduce friction. Cast-steel roller rocker arms add stiffness to the LS1's valvetrain and enable high engine speeds.



Hydraulic roller lifters further reduce friction and wear compared to conventional flat tappets. Composite lifter guides align the roller lifters on the camshaft lobes. The LS1 valvetrain features lightweight valve spring retainers and beehive-shaped springs that enhance high-rpm performance.

INTAKE MANIFOLD



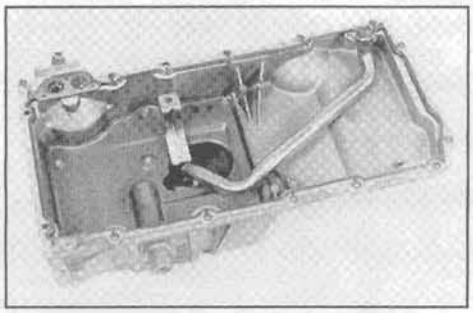
The LS1 uses a composite intake manifold that is lighter than a comparable aluminum casting. The manifold's smooth interior passages enhance airflow and insulate the intake charge from engine heat. The tuned intake runners and sequential fuel injection system produce a wide, flat power curve. A mass airflow sensor mounted at the front of the manifold provides accurate information on the amount of air entering the engine, which the Powertrain Control Module uses to determine the optimum fuel delivery.

LS1 CAMSHAFT SPECIFICATIONS

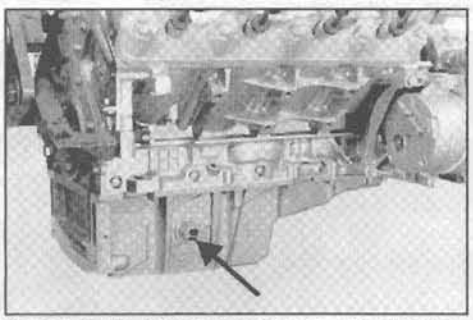
Year/Model	Part No.	Valve Lift (Int./Ex.)	Duration at .050" Lift	Centerline (Int./Ex.)	Lobe Separation
1997 Corvette	12554710	.472/.479"	202/210°	121/113°	117°
1998-99 Corvette*	12560964	.472.479"	202/210°	121/113°	117°
1998-2000 Camaro/Firebird	12560965	.500/.500"	201/212°	122/117°	119.5°
2000 Corvette	12560968	.500/.500"	201/212°	119/112°	115.5°
2001 Camaro/Firebird	12561721	.467/.479	199/210°	115/117°	116°

*Same as 1997 Corvette with different cam trigger wheel

OIL PAN

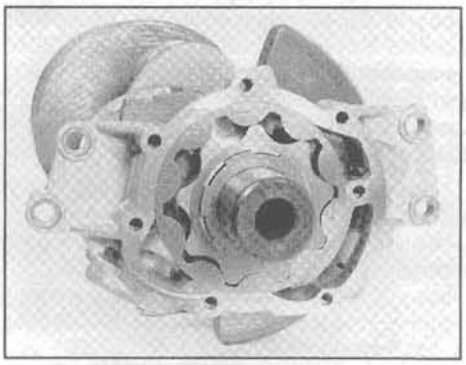


The LS1's production cast-aluminum wet-sump oil pan is designed to provide an uninterrupted supply of oil. Baffles and a windage tray ensure that the oil pump pickup is covered under high cornering loads. A molded O-ring gasket provides a leak-resistant seal against the block's extended oil pan rails.



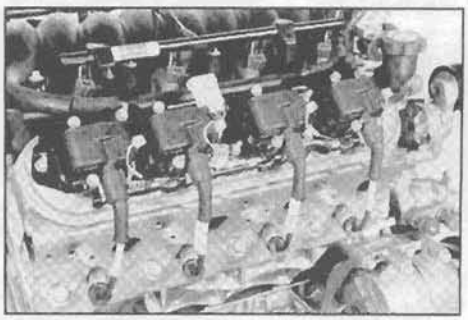
The cast-aluminum oil pan has a low oil level sensor; this sensor is not used with the LS1 Engine Kit wiring harness.

OIL PUMP



The LS1 incorporates a high-efficiency gerotor oil pump mounted at the front of the crankshaft. The crankshaft sprocket for the single-roller timing chain is incorporated in the oil pump drive.

IGNITION



Eight individual coils are mounted on the LS1's aluminum rocker covers to supply spark for each cylinder. Electronic spark timing signals for the coils are triggered by crankshaft and camshaft position sensors that provide highly accurate ignition timing and misfire detection.

The LS1 uses a revised firing order that differs from the original Chevrolet small-block. The LS1 firing sequence is 1-8-7-2-6-5-4-3. This revised firing order improves idle quality and reduces engine vibration.

INSTALLATION NOTES

Note: All fasteners used on LS1 engines are metric. Metric bolts must be used to attach all components (bellhousing, motor mounts, headers, etc.) to the engine.

As noted earlier, there are many differences between first-generation small-block V8 engines and the LS1 V8. Consequently components such as motor mounts, accessory drives, exhaust manifolds, water pumps, flywheels, etc. are not interchangeable. When installing an LS1 engine assembly in a vehicle not originally equipped with an LS1 engine, it will be necessary to adapt or fabricate various components for the cooling, fuel, electrical, and exhaust systems.

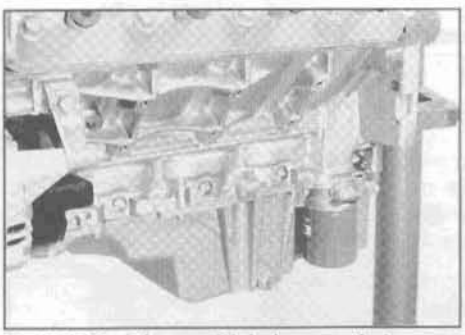
OPERATIONAL GUIDELINES

Recommended Oil Type: Mobil 1 10W-30

Recommended Fuel: Unleaded premium 91 octane (R+M/2)

Maximum Engine Speed: 6200 rpm (PCM controlled)

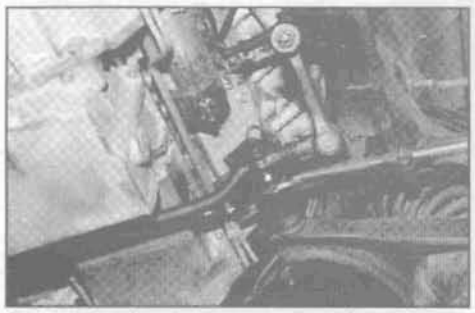
MOTOR MOUNTS



The LS1 block has multiple bosses that can be used for custom engine mounts.

The LS1 engine has unique motor mount fastener locations. Motor mount brackets can be fabricated to install the LS1 engine using the dimensions shown on the accompanying illustration.

In some installations, existing motor mounts can be adapted to the LS1 block using plates bolted to the LS1 mounting bosses as shown.



Conventional motor mounts are adapted to this LS1 block with fabricated plates.

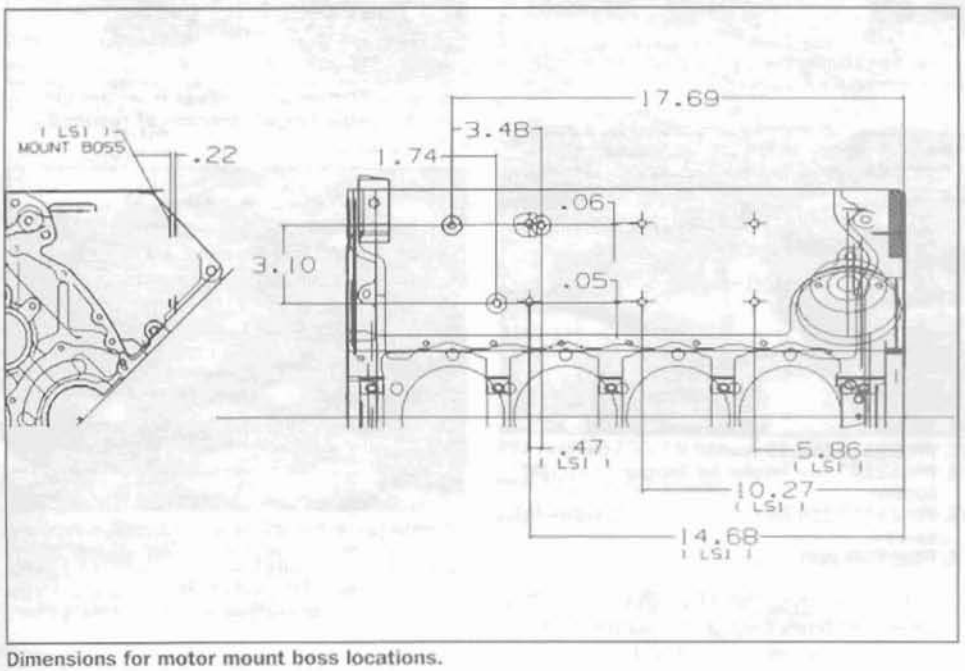
FLEXPLATE

"Dished" flexplate PN 12563136 (left) for 4L60E transmission and "flat" flexplate PN 12551367 (right) with 298mm bolt pattern for early 4L60, 700R4, THM 400 and THM 350 transmissions.

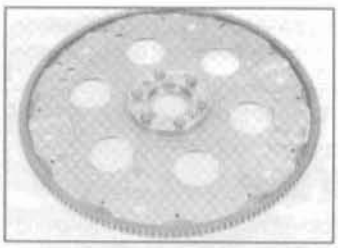
The LS1 Engine Kit assembly includes a Camaro/Firebird automatic transmission flexplate. The following 14" diameter automatic transmission flexplates can be used with LS1 engines:

PN 12563136 Flexplate, for 300mm bolt circle torque converter, originally used with Camaro/Firebird and C/K truck with 4L60E transmission. This flexplate is "dished" (see photo), and uses bolts PN 12553332.

PN 12551367 Flexplate, for 4L80E transmission or six-lug converter. This flexplate is flat, and requires a special spacer



Dimensions for motor mount boss locations.



Use crankshaft flange spacer and supplied bolts with flat flexplate.

(PN 12563532) and bolts (PN 12563533) included with the flexplate assembly. The spacer is installed between the flexplate and crankshaft flange. **Note:** This flexplate has a six-lug bolt pattern for use with THM 400 and 4L80 transmissions. The converter mounting holes must be modified for use with Gen 1 and Gen 2 converters with 298mm bolt patterns.

FLYWHEEL

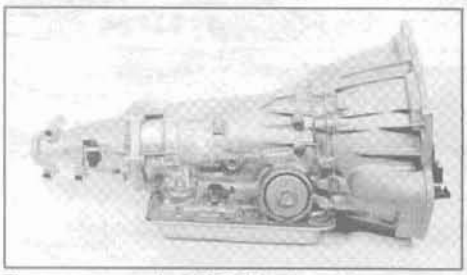
The LS1 crankshaft is .400" shorter relative to the bellhousing mounting flange than a small-block V8 crankshaft. A special pilot bearing (PN 12557583) is available which compensates for this difference and allows the use of a standard length transmission input shaft.

The following manual transmission flywheels can be used with LS1 engines. These flywheels use 11.7" (298mm) clutches.

PN 12562765 6-speed flywheel assembly

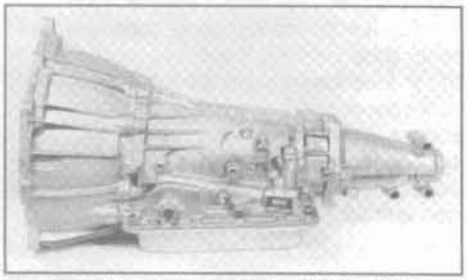
PN 12561680 Early-style 4-speed flywheel

AUTOMATIC TRANSMISSION



The recommended 4L60E automatic transmissions have provisions to mount a torque arm.

The wiring harness supplied with the LS1 Engine Kit is designed for a 4L60E automatic transmission. The 4L60E four-speed automatic overdrive transmission assembly has electronic control of shift points, shift feel, and torque converter lock-up. This automatic transmission assembly has a 3.06:1 first gear ratio for good acceleration and a .70:1 overdriven fourth for improved fuel economy.



The wiring harness supplied with the LS1 Engine Kit is designed for a 4L60E four-speed automatic overdrive transmission.

The following 4L60E automatic transmissions are recommended for use with LS1 engines:

PN 24210673 1998 Camaro/Firebird

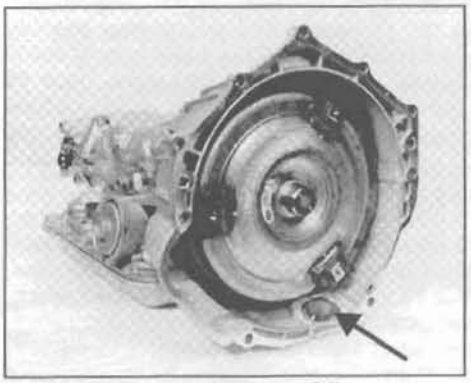
PN 24212631 1999 Camaro/Firebird

PN 24216077 2000 Camaro/Firebird

Use the following fasteners when installing a 4L60E transmission:

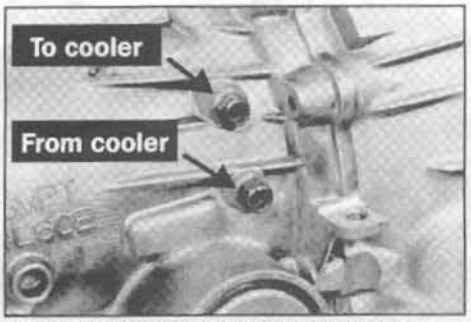
PN 11515767 Bellhousing bolts (8 req.)

PN 1261968 Converter bolts (3 req.)



The 4L60E transmission has a full bellhousing. Access the torque converter fasteners through the removable plug.

The 4L60E transmission has a full bellhousing. A removable cover in the bottom of the bellhousing provides access to the torque converter bolts. The tailshaft supplied with the recommended 4L60E transmissions has mounting provisions for a torque arm.



Install PN 8637742 fittings to convert to inverted flare cooler lines.

A transmission fluid cooler must be used with the 4L60E transmission. The upper fitting routes fluid out to the cooler; the lower fitting returns fluid to the transmission. To use inverted flare cooler lines, remove the quick-connect fittings supplied with the transmission and install PN 8637742 fittings.

The 4L60E transmission uses an electronic speedometer; there are no provisions for a mechanical speedometer drive. The PCM speedometer output (4,000 pulses per mile) is compatible with GM original equipment electronic speedometers. The speedometer calibration is for a 3.23:1 rear axle ratio and 813 tire revolutions per mile.

Vehicles with different axle/tire configurations require a conditioning device before the signal is sent to the speedometer head. These devices are available from aftermarket suppliers such as Jet. Autometer electric speedometer heads are compatible with the PCM output signal and can be calibrated for different axle ratios and tire diameters.

STARTER

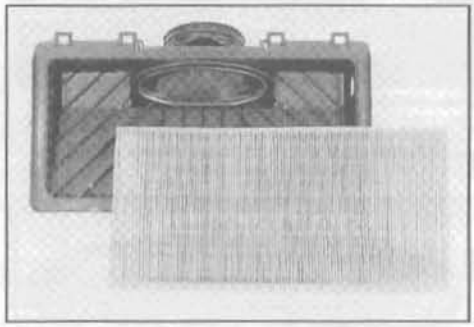
Use the following starter and fasteners for all LS1 engine installations:

PN 10465385 Starter

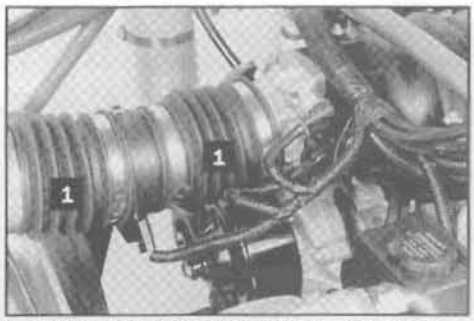
PN 12561848 Bolt, inner

PN 12561387 Bolt, outer

AIR FILTER AND INTAKE



A paper element low-restriction air cleaner should be used to protect the engine from excessive wear. In custom installations with adequate space, an air filter system can be fabricated using an air filter box (PN 25147318—lower and PN 25147318—upper) and element (PN 25042562) as shown. Use two air meter ducts (PN 25170358) and a length of 3.5" OD steel tubing to connect the air filter, mass airflow sensor (MAF), and throttle body as shown.



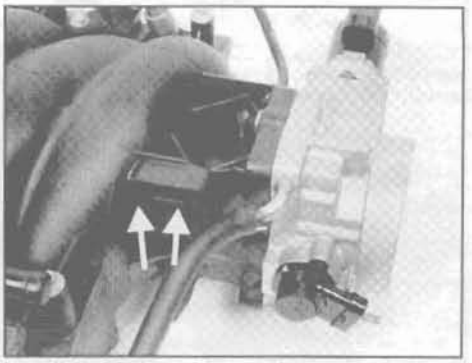
1. PN 25170358 Duct (straight) – trim to fit as required (two shown).

1. PN 25179711 Air meter
2. PN 12160244 Intake Air Temperature (IAT) sensor
3. PN 25147210 Duct (curved) – includes IAT sensor
4. Plug EGR port.

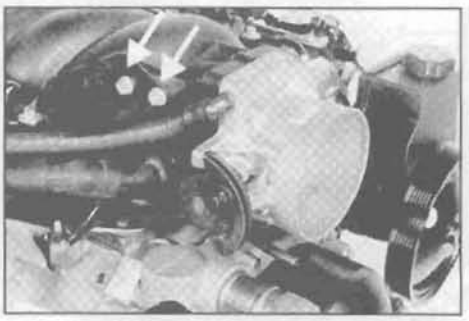
When installing the MAF, make sure that incoming air flows through the air meter in the direction of the arrows on the MAF housing. Plug the hole in the upper air filter box to prevent unfiltered air from being drawn into the induction system.

THROTTLE LINKAGE

The LS1 requires a cable throttle linkage. A production throttle cable (PN 12565559) can be modified to fit many chassis. Retain the original attachment that engages the cam on the throttle body.



Install ¼-20 thread inserts in manifold to mount throttle linkage bracket (if required).

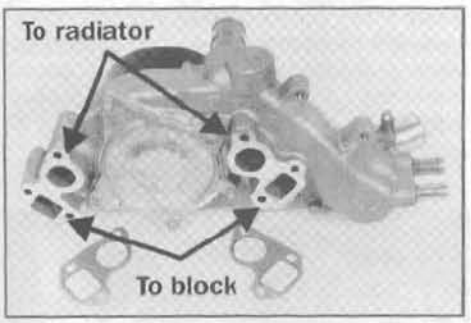


To mount a throttle bracket on the LS1 throttle body, enlarge the indicated mounting holes to .250" diameter and install ¼-20 Insta-Thread® thread inserts.

EXHAUST GAS RECIRCULATION (EGR)

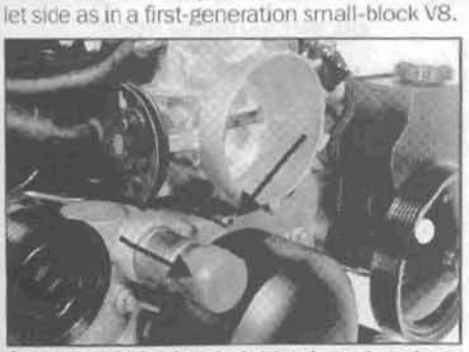
The LS1's intake manifold has provisions for exhaust gas recirculation (EGR) valve. Plug this hole using EGR plate PN 12558346.

COOLING SYSTEM



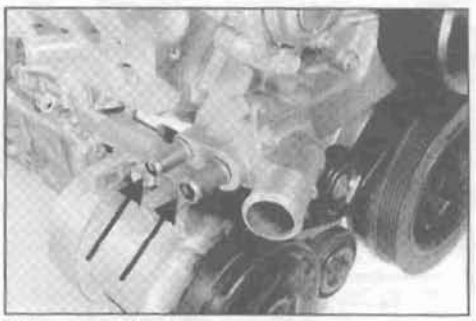
The LS1 V8 uses conventional coolant routing (not "reverse flow" cooling as used in Gen 2 LT1 engines). Coolant enters the block through the lower holes in the water pump and circulates around the cylinder barrels. Coolant is then routed through the cylinder heads and exits the block through the upper water pump holes. The pump then circulates the hot coolant through the radiator, where it is cooled and returned to the engine.

Note that the LS1's thermostat is on the suction side of the system rather than the outlet side as in a first-generation small-block V8.

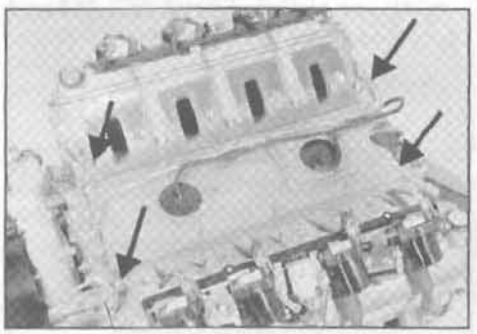


Connect cylinder head air bleeds and coolant return line to outlet radiator hose or return side of radiator. Cylinder head air bleeds must connect to fill bottle or highest point of cooling system above coolant level!

Connect a $^{5}/_{8}$" hose to the rear outlet the water pump and a $^{3}/_{4}$" return hose to the front inlet.



Water pump heater connections.



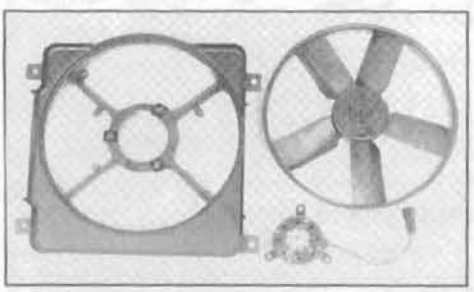
Note: Failure to connect the cylinder head air bleeds properly can result in an internal air lock and cause engine damage.

FILL TANK

A coolant fill tank must be mounted at the highest point of the cooling system. Water enters the engine through a hose connecting the tank and water pump inlet. Trapped air is purged from the system through bleed lines from the engine coolant manifold and the top of the radiator.

The fill tank can be plumbed to the water pump through the heater connection.

FAN



The LS1 engine requires an electric cooling fan. The following parts can be adapted for many custom fan installations:

PN 22115158 Shroud

PN 88890735 Motor

PN 22115157 Blade

PN 22062547 Screws (4 req.)

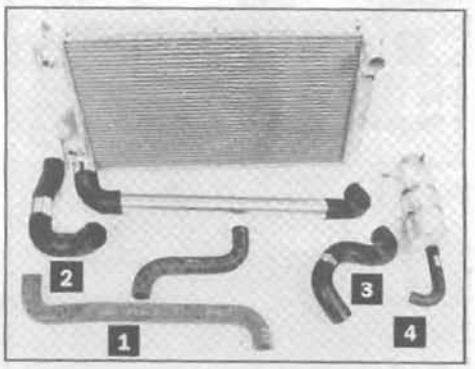
The fan must be mounted low enough to clear the air intake tube. If the fan extends below the radiator core, block the exposed part of the shroud to maximize airflow through the radiator.

Use relay **PN 14089936** to control the electric fan motor.

RADIATOR

The coolant flow through the radiator is from the inlet at the top right of the core to the outlet at the lower left.

The following molded hoses can be modified to plumb the cooling system in custom applications:



1. Upper radiator hose: 1998 Camaro/Firebird LS1, PN 10271554

2. Lower radiator outlet: Gates 20276

3. Water pump inlet: Gates 21997

4. Fill tank to water pump: Gates 20333

A transfer tube should be fabricated from aluminum tubing to adapt the $1^{3}/_{4}$" radiator outlet to the $1^{5}/_{8}$" water pump inlet.

FUEL SYSTEM

The LS1 fuel system operates at higher pressure than a conventional carburetor system. Use caution when assembling the fuel system and check all fittings and lines regularly for leaks. Use relay PN 14089936 to control the electric fuel pump.

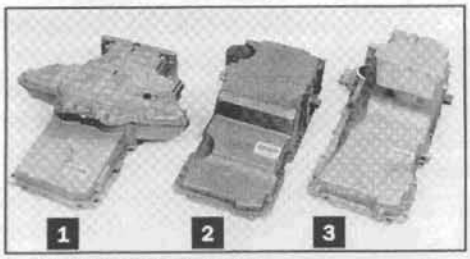
The LS1 fuel rail does not include a pressure regulator; it is designed to use an in-tank regulator. If you wish to use a conventional fuel system with return, use PN 12556705 fuel rail.

An electric fuel pump is required with the LS1 Engine Kit. The pump must be able to produce between 53 and 63 psi fuel pressure at idle. In-tank pump PN 25163473 is recommended.

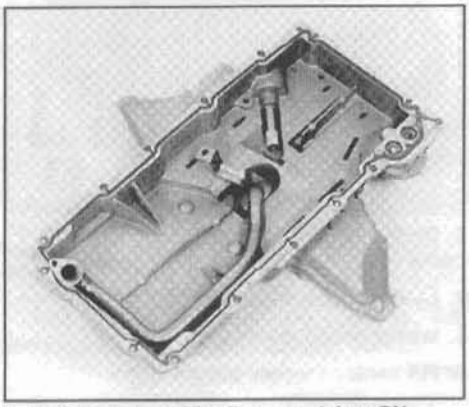
If you are converting a late-model vehicle that was originally equipped with an in-tank fuel pump, it may be possible to replace the original pump with a high-volume pump. If you are converting a vehicle that was originally equipped with a mechanical (engine-mounted) fuel pump, you must install a complete in-tank fuel pump kit.

LUBRICATION SYSTEM

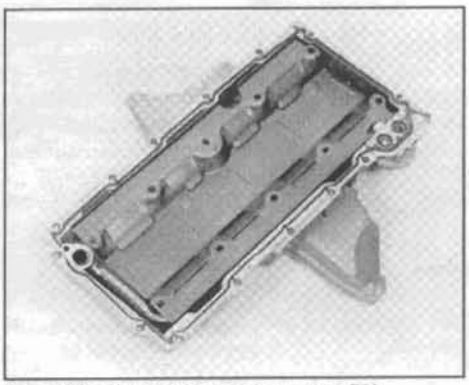
A 10W-30 synthetic oil is suitable for most operating conditions. Operation in extreme heat or cold may require oil with higher or lower viscosity respectively.



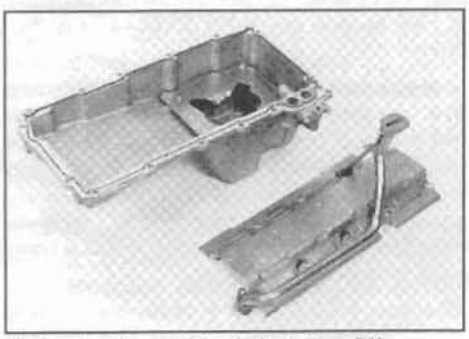
1. PN 12561828 Corvette
2. PN 12558762 Camaro/Firebird
3. PN 12560393 C/K Truck



Corvette oil pan with oil pump pickup PN 12558750.



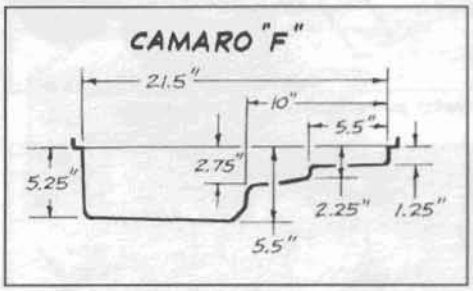
Corvette oil pan with windage tray PN 12558189.



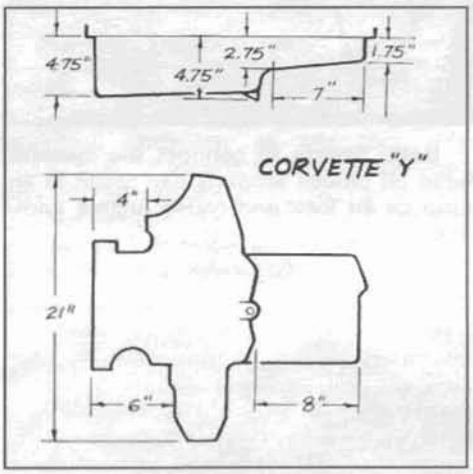
C/K truck oil pan with windage tray PN 12558268 and oil pump pickup PN 12563961.

The LS1 Engine Kit assembly uses a Camaro/Firebird oil pan. Other production pans are available for custom installations. These pans have various depths and configurations as shown in the accompanying photos. Note that each oil pan uses a specific windage tray and oil pump pickup. Capacities shown are with and without oil filter respectively.

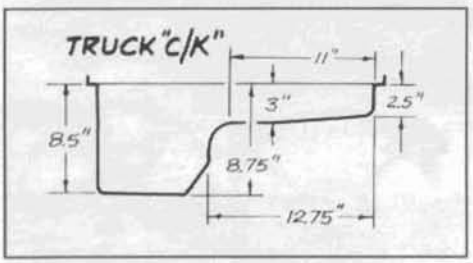
NOTE: All dimensions approximate; for reference use only.



PN 12558762 Camaro/Firebird (5/5.5 qts.)



PN 12561828 Corvette (6/6.5 qts.)



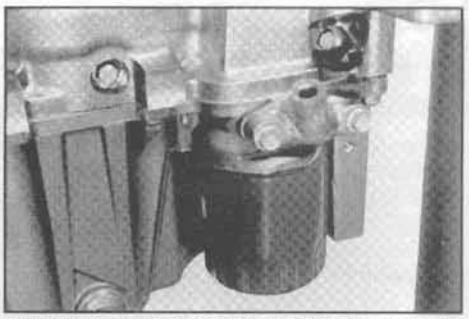
PN 12560393 C/K Truck (6/6.5 qts.)

Holden oil pan PN 12561541 (not shown) is a front-sump design that can be used in applications with rearward located engine crossmembers.

LS1 oil pan modified for custom installation.

It may be necessary to modify the oil pan for chassis and suspension clearance as shown in this LS1 installation in a 1955 Chevrolet. The pan sump was revised to clear the steering linkage and shortened for ground clearance. Note that the transmission bellhousing is attached to the structural oil pan casting with one bolt per side.

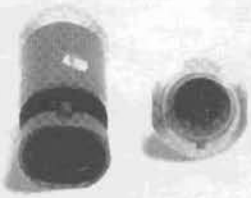
OIL FILTER



Drill and tap boss for aftermarket oil pressure gauge sender if required.

ACDelco oil filter PN PF44 is recommended for LS1 engines. If space permits, PN PF59 may be used to increase filter capacity.

OIL PRESSURE SENDER

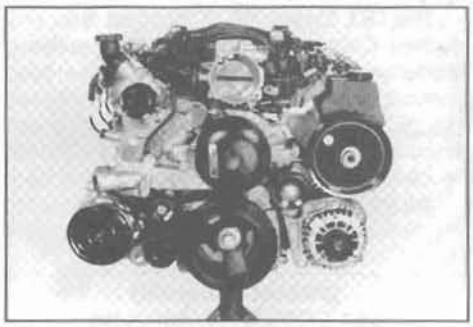


LS1 Engine Kits are supplied with two different types of oil pressure sending units — tall and short. If your engine is equipped with a short sender, it should be changed to the tall single-pin version. This sender is compatible with a production GM gauge (80 psi maximum). The signal from the oil pressure sender is not used by the PCM.

LS1 LUBRICATION SYSTEM COMPONENTS

Part No.	Application	Description
12551577	Camaro/ Firebird	Dipstick tube
12551581	Camaro/ Firebird	Dipstick
12558762	Camaro/ Firebird	Oil pan
12558253	Camaro/ Firebird	Windage tray
12558251	Camaro/ Firebird	Oil pump pickup
12563918	C/K Truck	Dipstick tube
12558684	C/K Truck	Dipstick
12560393	C/K Truck	Oil pan
12558268	C/K Truck	Windage tray
12563961	C/K Truck	Oil pump pickup
12556405	Corvette	Dipstick tube
12562468	Corvette/ Holden	Dipstick
12561828	Corvette	Oil pan
12558189	Corvette/ Holden	Windage tray
12558750	Corvette	Oil pump pickup
12561544	Holden	Dipstick tube
12561541	Holden	Oil pan
12572654	Holden	Oil pump pickup

ACCESSORIES

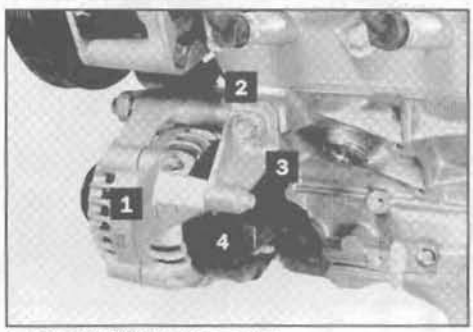


LS1 accessory drive system.

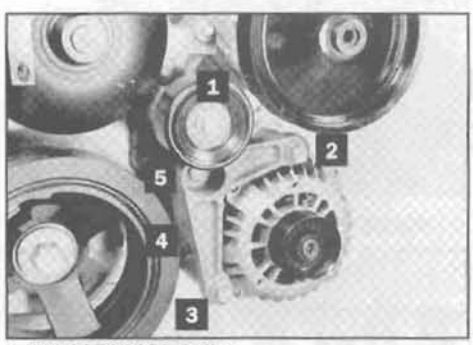
The LS1 Engine Kit does not include accessories such as an alternator, power steering pump, and air conditioning compressor. Production accessories and drive components can be used in many LS1 installations.

ALTERNATOR

The LS1 Engine Kit assembly does not include an alternator. The following components can be used:

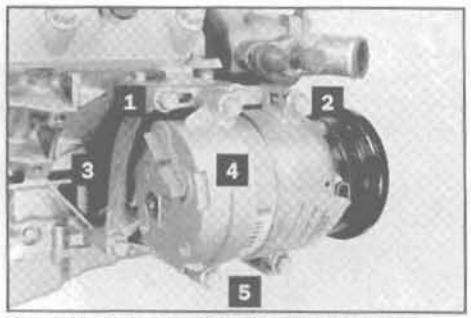


1. PN 10464402 Alternator
2. PN 11515767 Bolt
3. PN 12556915 Brace
4. PN 11509666 Bolt



1. PN 12564401 Pulley
2. PN 11516366 Bolt
3. PN 11516366 Bolt
4. PN 12563327 Bracket
5. PN 11516360 Bolt

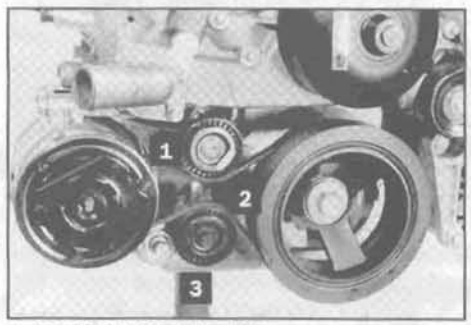
COMPRESSOR MOUNT



The following components can be used to mount an air conditioner compressor on an LS1 engine:

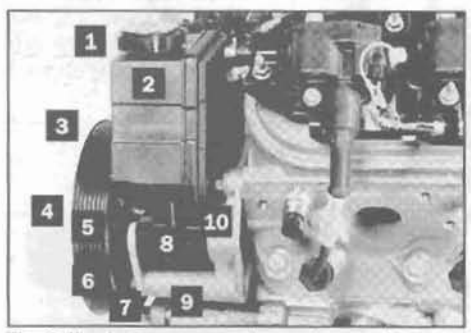
1. PN 11515771 Bolt (4 req.)
2. PN 11515771 Bolt (2 req.)
3. PN 12556677 Bracket
4. PN 1137028 Compressor
5. PN 11098341 Bolt (2 req.)

COMPRESSOR DRIVE



1. PN 12557335 Idler Pulley
2. PN 12569529 Belt
3. PN 12560345 Tensioner

POWER STEERING PUMP



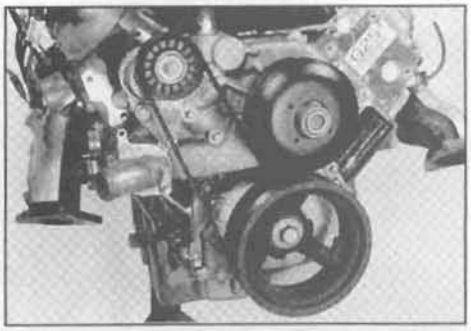
The following components can be used to mount a power steering pump on an LS1 engine:

1. PN 26040467 Cap
2. PN 26068934 Reservoir
3. PN 12569527 Belt
4. PN 12559885 Pulley
5. PN 14078896 Bolt (2 req.)
6. PN 12555693 Brace
7. PN 11515757 Bolt (2 req.)
8. PN 26068936 Pump
9. PN 12557331 Bracket
10. PN 11515767 Bolt (3 req.)

ACCESSORY DRIVE TENSIONER

1. PN 12560345 Tensioner
2. PN 11516356 Bolt (2 req.)

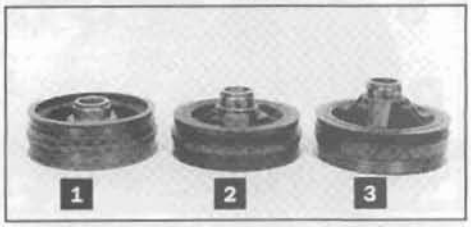
WATER PUMP DRIVE



A 18 x 1085mm short belt can be used in installations that require only a belt-driven water pump. Route the belt as shown around the tensioner and water pump pulley.

TORSIONAL DAMPER

The LS1 torsional damper also serves as the crankshaft pulley for the accessory drive. Crankshaft pulleys are available in different configurations to fit various installations. The dimensions shown are the approximate distances from the rear of the pulley to the round bosses on the front engine cover.



Dimensions shown are approximate distances from round bosses on front cover to rear of torsional damper pulley.

1. PN 12560115 Corvette (.600")

2. PN 12553118 Camaro/Firebird Damper (1.00")

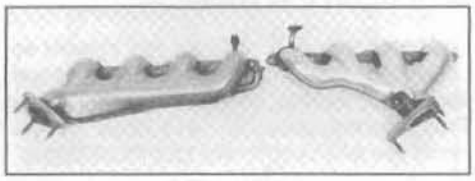
3. PN 12553112 C/K Truck (2.250")

The LS1 crankshaft damper retaining bolt is a "torque to yield" fastener. If it is ever necessary to replace the bolt, a new bolt should be installed; do not reuse a previously installed bolt. Tighten the new bolt to 110 ft.-lbs., then back off the bolt one turn. Retighten the bolt to 35 ft.-lbs. and then turn the bolt an additional 140°.

EXHAUST SYSTEM

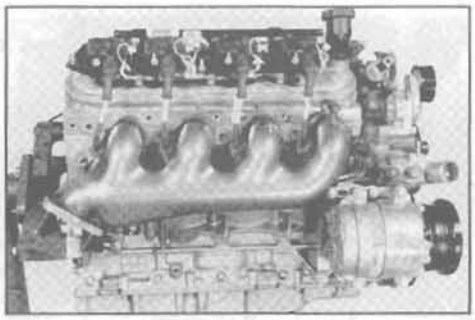
The LS1 Engine Kit is supplied with production Camaro/Firebird exhaust manifolds. Production LS1 exhaust manifolds for other applications can be adapted to custom installations. Note the differences in exhaust outlet locations and lengths. Part numbers listed are for cast-iron manifolds rather than the fabricated manifolds shown. In these instances, the overall designs of the manifolds are the same.

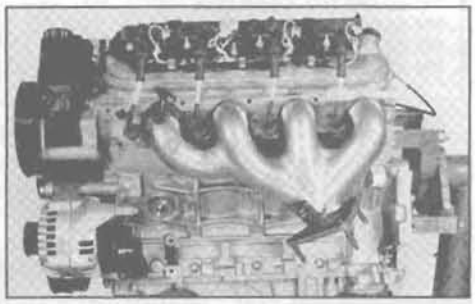
CAMARO/FIREBIRD LS1 EXHAUST MANIFOLDS



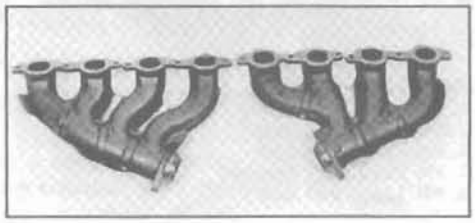
PN 12567706 Camaro/Firebird RH (w/o EGR boss)

PN 12559507 Camaro/Firebird LH



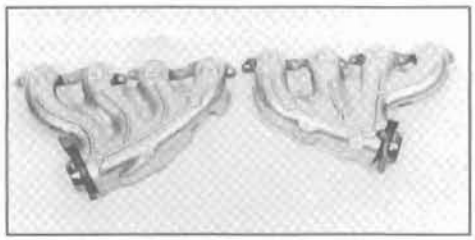


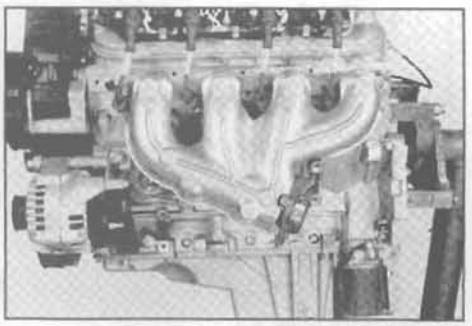
HOLDEN LS1 EXHAUST MANIFOLDS



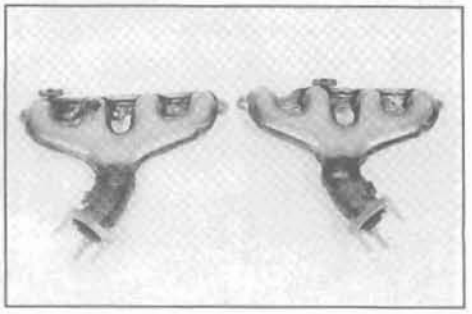
PN 12563278 Holden RH

PN 12563277 Holden LH



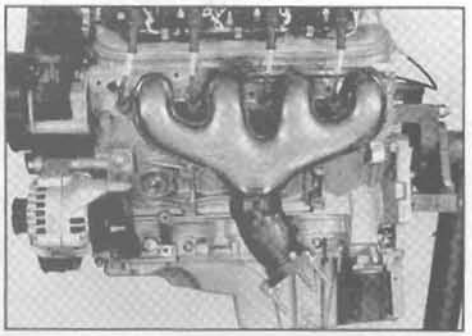


CORVETTE LS1 EXHAUST MANIFOLDS

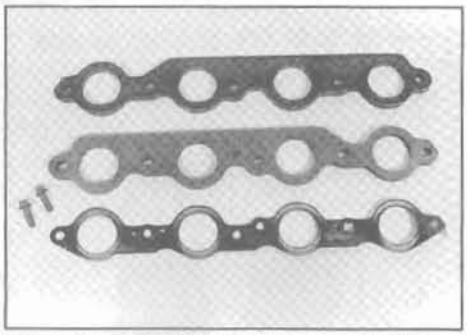


PN 12561256 Corvette RH

PN 12561255 Corvette LH



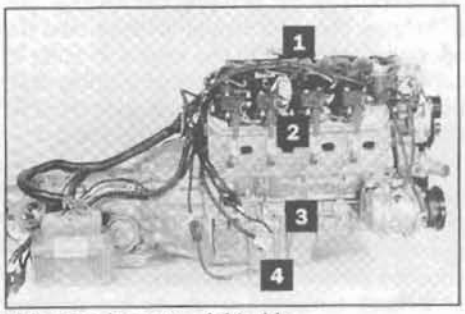
Header flanges for LS1 engines are available as PN 12480130 for custom-built exhaust systems. Production LS1 exhaust manifold gaskets (PN 12558573 – 2 req.) and metric fasteners (PN 12551187 – 12 req.) are recommended. These gaskets can be reused if in good condition.



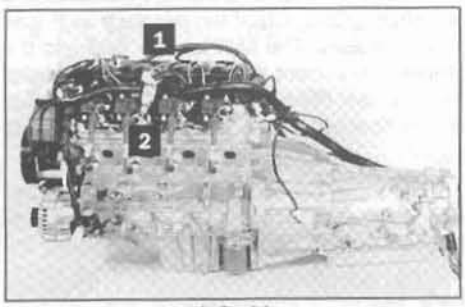
LS1 exhaust manifold gaskets and header flanges

ENGINE CONTROLS

ELECTRICAL SYSTEM



LS1 wiring harness, right side
1. Injectors 2,4, 6, 8
2. IC control bank 2 (RH)
3. Crank wire to starter
4. 12 volts to starter lug



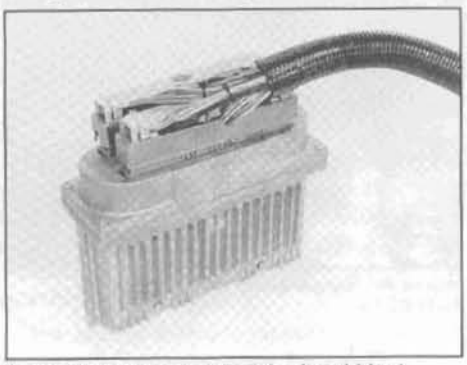
LS1 wiring harness, left side
1. Injectors 1, 3, 5, 7
2. IC control bank 1 (LH)

The following is an overview of the electronic engine controls used in the LS1 engine. For comprehensive information on the engine control system, including detailed explanations of Diagnostic Trouble Codes (DTC) and diagnostic procedures, refer to the 1998 Camaro/Firebird Service Manual. Toll-free telephone numbers for service manual ordering information are:

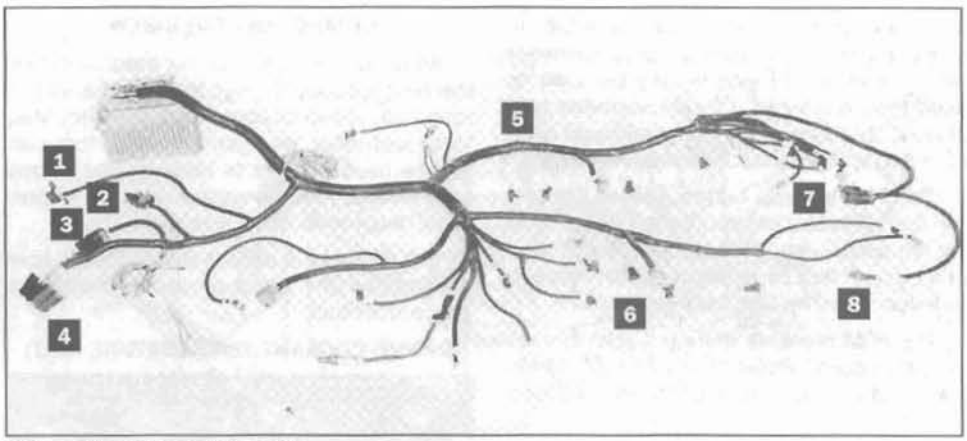
U.S. 1-800-551-4123
Canada 1-800-668-5539

SYSTEM OVERVIEW

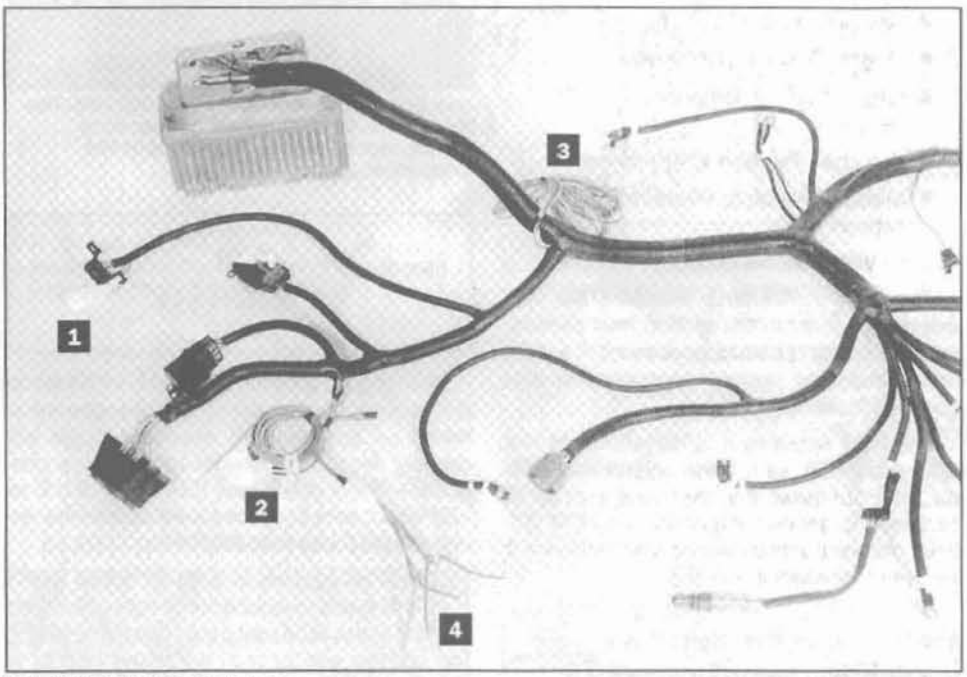
The Powertrain Control Module (PCM) is the "command center" of the LS1 engine. It controls the fuel metering system, ignition timing, and onboard diagnostics.



Note colors of connectors (red and blue) when connecting harness to PCM.



LS1 Engine Kit wiring harness
1. Data Link Connector (DLC) and Malfunction Indicator Lamp (MIL)
2. Fuel pump relay
3. A/C compressor relay
4. Fuse block
5. LH bank
6. RH bank
7. Fan relay
8. Fan connection



LS1 Engine Kit wiring harness
1. Data Link Connector (DLC) and Malfunction Indicator Lamp (MIL)
2. Fuel pump
   Blue = Fuel pump gauge
   Gray = Fuel pump power
   Black = Fuel pump ground
3. Gauge wiring
   Grn/Wht = Electric speedometer (optional)
   Pink = Voltmeter
   Pink = 12V to A/C switch
   Blue = Fuel gauge
   Dk Grn = Coolant temperature
   Tan = Oil pressure (for GM cluster only)
   Grn/Wht = A/C request
   White = Tachometer
   Pink/Purple = Torque converter clutch (TCC); open with brake pedal depressed
4. Ignition switch
   2 Red = Battery power (both to B+ input side of ignition switch; always hot)
   Purple = Crank to starter
   Pink = Switched 12V to fuse block

The PCM constantly monitors information from various sensors and controls the systems that affect vehicle performance. The PCM also performs the diagnostic function of the system and recognizes operational problems. The PCM alerts the driver to a problem through the Malfunction Indicator Lamp (MIL). When the PCM detects a malfunction, it stores a Diagnostic Trouble Code (DTC) in its memory. A stored DTC identifies a specific problem and helps the technician make the appropriate repair.

The PCM supplies either 5.0 or 12.0 volts to power various sensors and switches. This is done through resistances in the PCM. The resistance is so high that a test lamp will not

illuminate when connected to the circuit. In some cases, even an ordinary shop voltmeter will not give an accurate reading because its resistance is too low. A digital voltmeter with at least 10 megaohms input impedance is required to ensure accurate voltage readings.

The PCM controls output devices such as the fuel injectors, Idle Air Control (IAC), cooling fan relays, etc., by controlling the ground or the power feed circuit through transistors or a device called an Output Driver Module.

The PCM monitors the input components for circuit continuity and out-of-range values. The input components include the following sensors:

- Vehicle Speed Sensor (VSS)
- Mass Air Flow (MAF) sensor
- Intake Air Temperature (IAT) sensor
- Crankshaft Position (CKP) sensor
- Knock Sensor (KS)
- Throttle Position (TP) sensor
- Engine Coolant Temperature (ECT) sensor
- Camshaft Position (CMP) sensor
- Manifold Absolute Pressure (MAP) sensor

VOLTAGE REQUIREMENTS

The PCM continuously monitors the system voltage through the ignition feed circuits. Voltages below 8.0 volts or above 17.1 volts cause improper system operation and/or component damage.

The PCM operates in a default mode if a PCM voltage DTC sets. If the system voltage is low, the PCM raises the idle speed in order to increase the generator output. The PCM disables most outputs to protect the hardware if the system voltage is too high.

A scan tool will not display data if system voltage is outside this range.

WIRING HARNESS SERVICE

When repairing or servicing the engine control wiring harness, use wiring that has high temperature insulation. Remember that the engine control system operates at relatively low voltage and amperage levels, so make the best possible bond at all splices using rosin-core solder.

Repairing a connector requires complete replacement of the connector. Splice a new connector into the harness.

In order to prevent shorting between terminals, use care when probing a connector and when replacing terminals to prevent damage to the components. Always use jumper wire between connectors for circuit testing. Never probe through Weather-Pack seals.

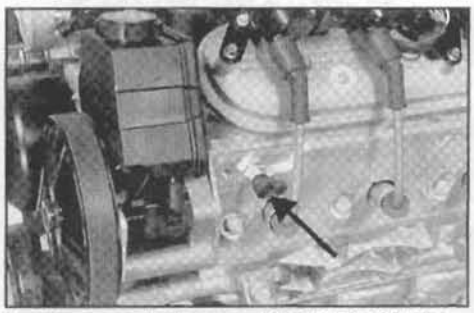
Open circuits are often difficult to locate by sight because oxidation or terminal misalignment are hidden by the connectors. Wiggling a connector on a sensor or in the wiring harness may temporarily correct an open circuit, but oxidized or loose connections may cause intermittent problems.

COMPONENT OVERVIEW

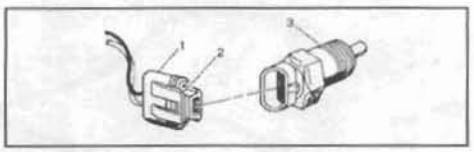
All of the sensors and the input switches can be diagnosed through the use of a Tech 2 scan tool. These tools are available from Mac Tools and other sources. The scan tool can also be used in order to compare the values for a normal running engine with the engine being diagnosed. (See note page 18.)

The following is a short description of how the sensors and switches can be diagnosed with a scan tool.

ENGINE COOLANT TEMPERATURE (ECT)



Use 3-pin coolant sensor PN 12551708. The third pin is for the coolant temperature gauge, and is only compatible with GM production gauges.



The engine coolant temperature sensor is a thermistor (a resistor which changes value based on temperature) mounted in the left cylinder head. Low coolant temperature produces a high resistance (100,000 ohms at -39° F) while high temperature causes low resistance (70 ohms at 266° F)

The PCM supplies a 5.0 volt signal to the engine coolant temperature sensor through a resistor in the PCM and measures the voltage. The voltage will be high when the engine is cold. The voltage will be low when the engine is hot. The PCM calculates the engine coolant temperature by measuring the voltage. The engine coolant temperature affects most systems the PCM controls.

The scan tool displays engine coolant temperature in degrees. The engine coolant temperature and intake air temperature should be close to each other if the engine has not been run for several hours.

The following DTCs set when the PCM detects a malfunction in the ECT sensor circuit:

- DTC P0117 ECT Sensor Circuit Low Voltage
- DTC P0118 ECT Sensor Circuit High Voltage
- DTC P0125 Excessive Time to Closed Loop
- DTC P1114 ECT Sensor Circuit Intermittent Low Voltage
- DTC P1115 ECT Sensor Circuit Intermittent High Voltage

MASS AIR FLOW (MAF) SENSOR

The Mass Air Flow (MAF) sensor measures the amount of air entering the engine. The PCM uses this information to determine the operating condition of the engine in order to control the fuel delivery. A large quantity of air indicates acceleration. A small quantity of air indicates deceleration or idle.

The MAF has a battery feed, ground, and a signal circuit. The MAF used on the LS1 Engine Kit is a hot wire type. The MAF output frequency is a function of the power required to keep the air flow sensing elements (hot wires) at a fixed temperature above the ambient temperature. Air flowing through the sensor cools the sensing elements. The amount of cooling is proportional to the amount of air flow. The MAF sensor requires a greater amount of current in order the maintain the hot wires at a constant temperature as the air flow increases. The MAF sensor converts the changes in current draw to a frequency signal read by the PCM. The PCM then calculates the air flow (grams per second) based on this signal.

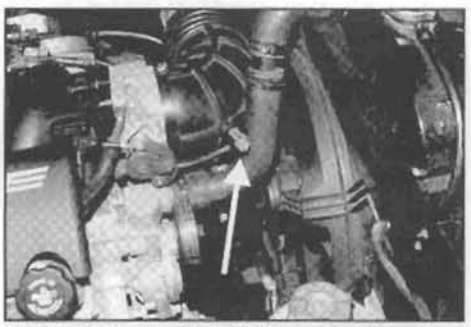
The PCM monitors the MAF sensor frequency. The PCM can determine if the sensor is stuck low, stuck high, or not providing the airflow expected for a given operating condition.

The scan tool reads the MAF value and displays it in grams per second (g/s). The MAF sensor displays between 9 g/s -14 g/s at idle on a fully warmed up engine. The MAF sensor values should change rather quickly on acceleration, but the MAF sensor values should remain fairly stable at any given RPM.

The following DTCs set when the PCM detects a malfunction in the MAF sensor circuit:

- DTC P0101 Mass Air Flow System Performance
- DTC P01 02 MAF Sensor Circuit Low Frequency
- DTC P0103 MAF Sensor Circuit High Frequency

INTAKE AIR TEMPERATURE (IAT) SENSOR



Intake Air Temperature (IAT) sensor PN 12160244

The Intake Air Temperature (IAT) sensor is integrated with the MAF sensor. The IAT is a thermistor which changes value based on the temperature of the air entering the engine. Low temperature produces a high resistance (100,000 ohms at -39° F). A high temperature causes low resistance (70 ohms at 266° F).

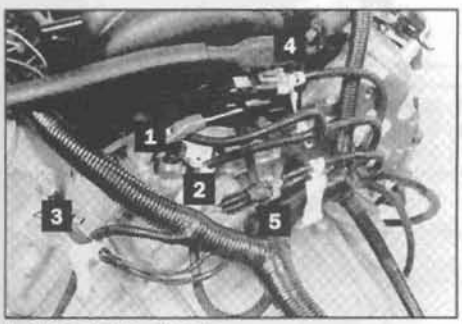
The PCM supplies a 5.0 volt signal to the sensor through a resistor in the PCM and measures the voltage. The voltage will be high when the incoming air is cold, and low when the air is hot. The PCM calculates the incoming air temperature by measuring the IAT voltage.

The IAT sensor signal is used to adjust spark timing according to incoming air density. The scan tool displays temperature of the air entering the engine, which should read close to ambient air temperature when the engine is cold. The temperature should rise as underhood temperature increases. If the engine has not been run for several hours, the IAT sensor temperature and engine coolant temperature should read close to each other.

The following DTCs set if the PCM detects a malfunction in the IAT sensor circuit:

- DTC P0112 IAT Sensor Circuit Low Voltage
- DTC P0113 IAT Sensor Circuit High Voltage
- DTC P1111 IAT Sensor CKT Intermittent High Voltage
- DTC P1112 IAT Sensor CKT Intermittent Low Voltage

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR



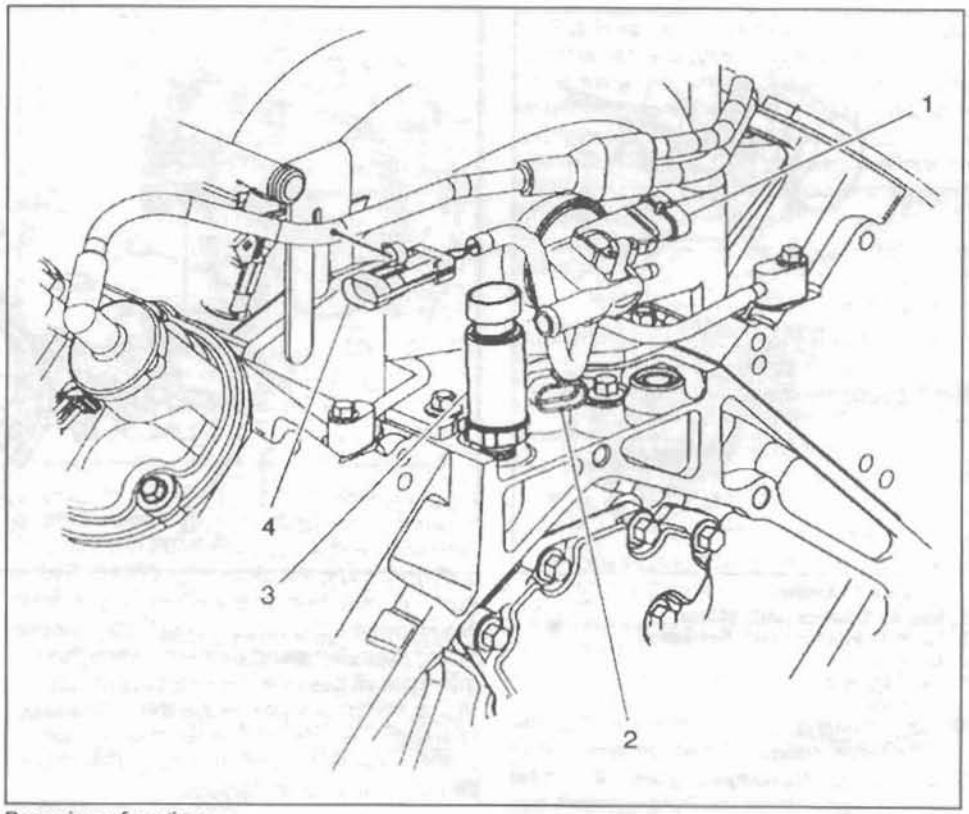
1. Oil pressure sensor
2. Camshaft Position (CMP) sensor
3. Ground lug to cylinder head
4. Manifold Absolute Pressure (MAP) sensor
5. Knock Sensor (KS)

The Manifold Absolute Pressure (MAP) sensor is mounted at the rear of the intake manifold. The MAP sensor measures the pressure changes inside the intake manifold, which is an indication of the engine load and speed, and converts this to a voltage output.

The MAP has a 5.0 volt reference, a ground, and a signal circuit. The MAP sensor contains a diaphragm which changes the resistance based on pressure. When the manifold pressure is low (high vacuum), the sensor output voltage is low. When the manifold pressure is high (high vacuum) the sensor output voltage is high.

The MAP is inversely proportional to what is measured on a vacuum gauge. The MAP sensor is used for the following:

- Altitude determination
- Ignition timing control
- Speed density fuel management default

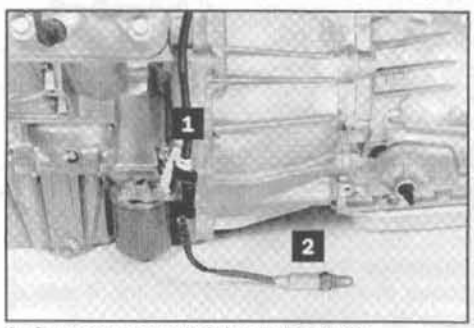


Rear view of engine:
1. Manifold Absolute Pressure (MAP) Sensor
2. Camshaft Position (CMP) Sensor
3. Oil Pressure Sensor
4. Connector to Knock Sensor (KS)

When the PCM detects a malfunction in the MAP sensor it sets the following DTCs:

- DTC P0107 MAP Sensor Circuit Low Voltage
- DTC P0108 MAP Sensor Circuit High Voltage

HEATED OXYGEN SENSORS (HO2S)



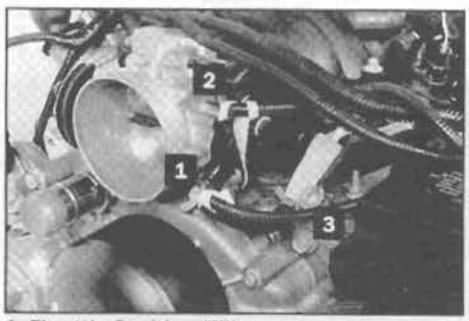
1. Oxygen sensor left bank (Bank 1)
2. Heated Oxygen Sensor (HO2S) PN 25312184

The Heated Oxygen Sensors are mounted in the exhaust system where they can monitor the oxygen content of the exhaust gas stream. The oxygen present in the exhaust gas reacts with the sensor to produce a voltage output. The oxygen senosr varies the voltage over a range from approximately 1000 mV when the exhaust is rich down to about 10 mV when the exhaust is lean.

The heated oxygen sensor voltage can be monitored with a scan tool. Install one Heated Oxygen Sensor (HO2S) in each header collector or exhaust pipe.

The PCM sets a DTC when the PCM detects an HO2S signal circuit that is too low or too high, or when the PCM detects no HO2S activity. The PCM also has the ability to detect HO2S response, switching, transition time, and incorrect ratio voltage problems. The PCM stores a DTC that indicates degraded HO2S performance if a HO2S response switching, transition time, or ratio problem is detected.

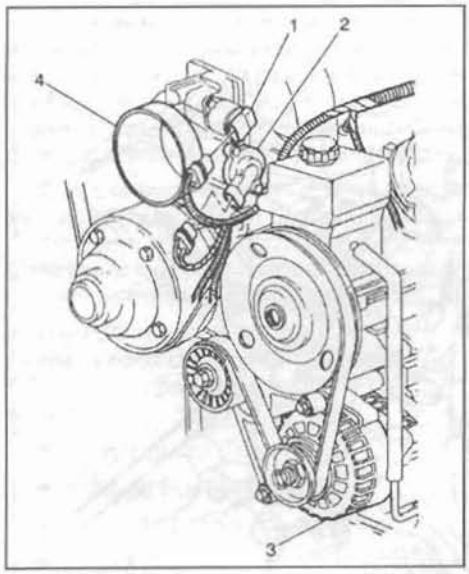
THROTTLE POSITION (TP) SENSOR



1. Throttle Position (TP) sensor
2. Idle Air Control (IAC) valve
3. Ground lug to power steering bracket

The Throttle Position (TP) sensor is a potentiometer. The TP sensor is connected to the throttle shaft on the left side of the throttle body. The TP sensor has a 5.0 volt reference, a ground, and a signal circuit.

The PCM calculates throttle position by monitoring the voltage on the signal line. The TP sensor signal changes as the throttle valve angle is changed (accelerator pedal moved). The TP sensor signal voltage is low at a closed throttle position (about 0.6 volt at idle). The



Front View of Engine:
1. Idle Air Control (IAC) Motor
2. Throttle Position (TP) Sensor
3. Generator
4. Throttle Body

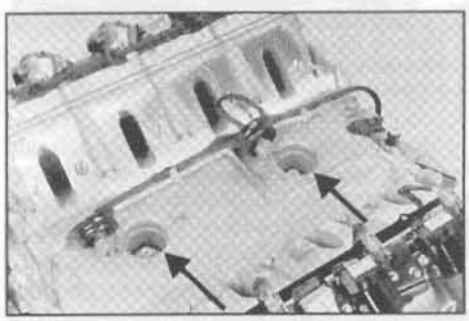
TP sensor signal voltage increases as the throttle valve opens so that at Wide Open Throttle (WOT), the output voltage should be above 4.0 volts. When the PCM senses a signal voltage higher than the normal operating range of the sensor, it sets a DTC.

The PCM calculates fuel delivery based on throttle valve angle (driver demand). A broken or loose TP sensor may cause intermittent bursts of fuel from an injector. This may cause an unstable idle because the PCM detects the throttle is moving.

The following DTCs set when the PCM detects a malfunction with the TP sensor circuits:

- DTC P0121 TP Sensor Circuit Insufficient Activity
- DTC P0122 TP Sensor Circuit Low Voltage
- DTC P0123 TP Sensor Circuit High Voltage
- DTC P1121 TP Sensor CKT Intermittent High Voltage
- DTC P1122 TP Sensor CKT Intermittent Low Voltage

KNOCK SENSORS (KS)



Detonation, sometimes called "spark knock," is caused by an uncontrolled explosion (burn) in the combustion chamber. This uncontrolled explosion could produce a flame front opposite that of the normal flame front produced by the spark plug. The rattling sound normally associated with detonation is the result of two or more opposing pressures (flame fronts) colliding within the combustion chamber. Though light detonation is sometimes considered normal, heavy detonation can result in engine damage.

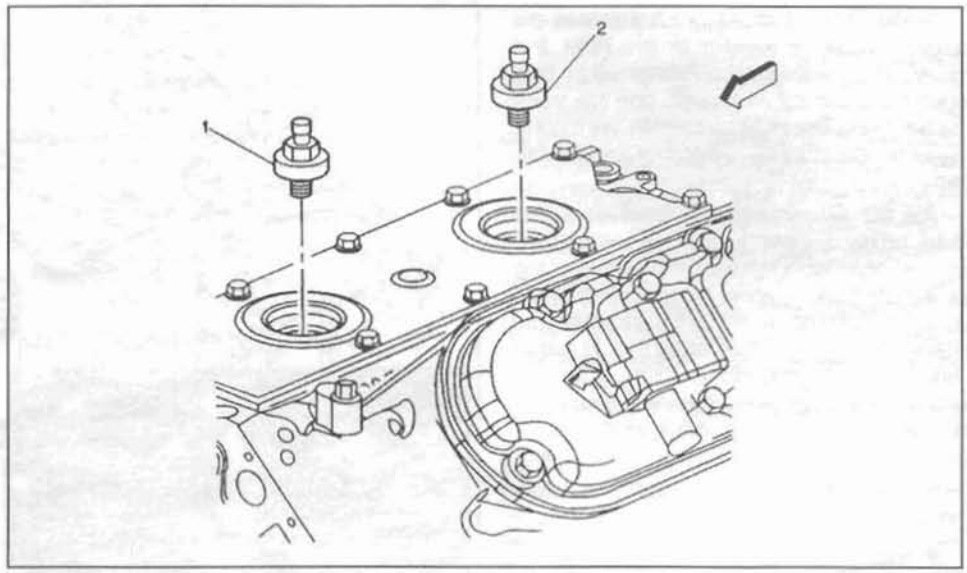
The LS1 Engine Kit uses a Knock Sensor (KS) system to control spark knock. This system is designed to retard spark timing up to 20° to reduce spark knock in the engine. This allows the engine to use maximum spark advance to improve performance and fuel economy.

The knock sensor system is used to detect engine detonation. The knock sensor(s) produce an AC voltage which is sent to the PCM. The PCM will retard the spark timing based on signals from the KS sensors. The amount of AC voltage produced by the sensors is determined by the amount of knock. The PCM then adjusts the Ignition Control (IC) to reduce the spark knock.

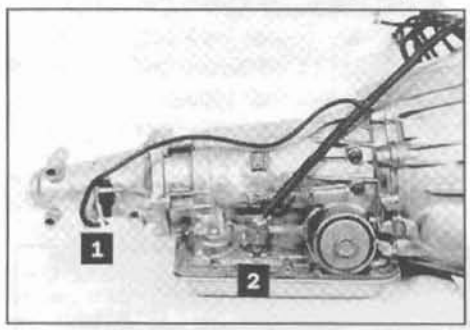
An operating engine produces a normal amount of mechanical vibration (noise). When the engine operates, the PCM learns the minimum and maximum frequency of the noise the engine produces. When the PCM determines that this frequency is less than or greater than the expected amount, it sets a knock sensor DTC.

The scan tool has several positions for diagnosing the KS circuit:

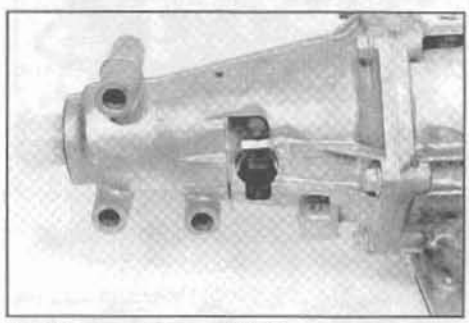
- "Knock Retard" indicates the amount of spark the PCM is removing from the IC spark advance in response to the signal from the knock sensors.
- "Spark" indicates the amount of spark advance being commanded by the PCM on the IC circuit.
- DTC P0325 indicates an internal PCM malfunction related to the KS system.
- DTCs P0327 and P0332 indicate that a Knock sensor or Knock sensor circuit is malfunctioning. If these DTCs are set, refer to applicable DTC table.



VEHICLE SPEED SENSOR (VSS)



1. Vehicle Speed Sensor (VSS)
2. Transmission connector

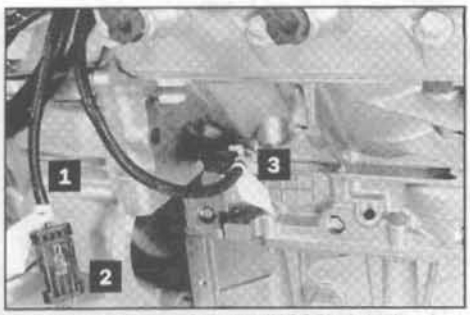


Vehicle Speed Sensor (VSS)

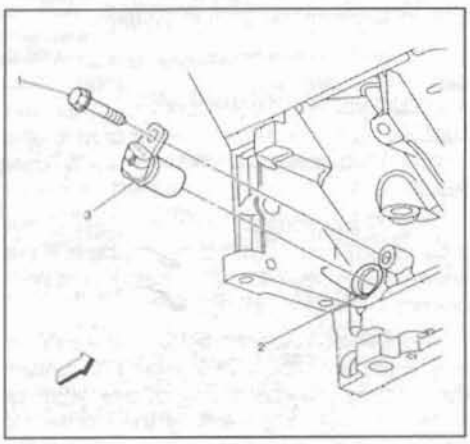
The VSS system is a pulse counter that informs the PCM how fast the vehicle is moving. The VSS system for the LS1 uses an inductive sensor mounted in the transmission tailshaft. As the vehicle speed increases, the VSS produces an AC voltage signal that also increases.

The VSS signals the PCM that the vehicle is still moving when the throttle is closed under deceleration. The PCM uses this information to prevent engine stalling and to insure proper operation of the Idle Air Control (IAC) valve and automatic transmission.

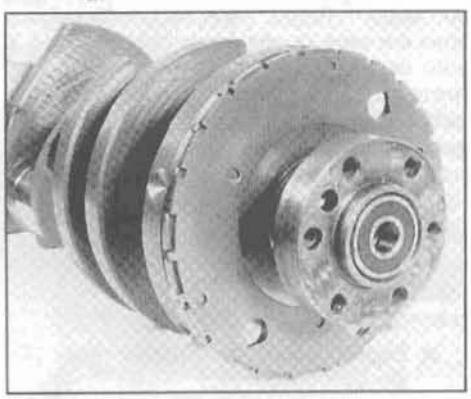
CRANKSHAFT POSITION (CKP) SENSOR



1. Heated Oxygen Sensor (HO2S) right bank (Bank 2)
2. Heated Oxygen Sensor (HO2S) PN 25312184
3. Crankshaft Position (CKP) sensor

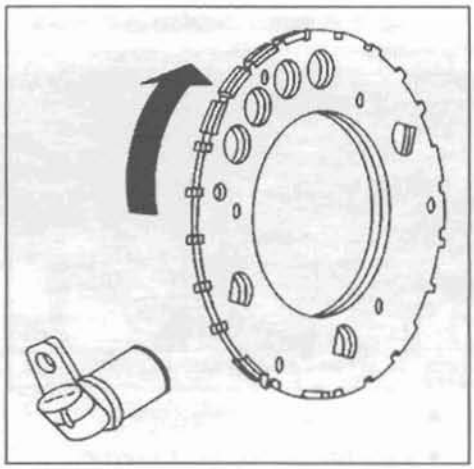


The Crankshaft Position Sensor is mounted in the right rear of the engine block behind the starter. The CKP sensor works in conjunction with a 24X reluctor wheel mounted on the rear of the crankshaft. The CKP sensor has B+ power supply, a ground, and a signal circuit.



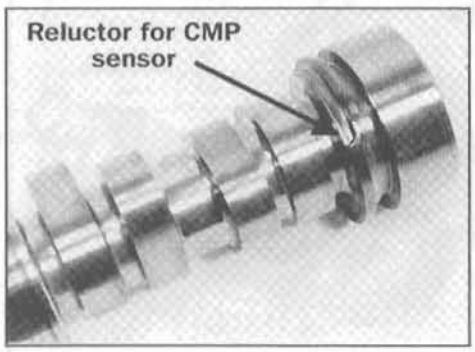
As the crankshaft rotates, the reluctor wheel teeth interrupt a magnetic field produced by a magnet inside the sensor. The sensor's internal circuitry detects this and produces a signal which the PCM reads. The PCM uses this signal to accurately measure crankshaft velocity.

A misfire causes a change in crankshaft speed. The PCM times the interval between each pulse and compares each new time interval with the previous one to determine when an excessive change in crankshaft speed has occurred. A certain amount of acceleration/deceleration between firing strokes is normal. If the crankshaft speed changes are greater than an expected amount, the PCM interprets this as a misfire. A DTC P0300 sets when the PCM detects a misfire.

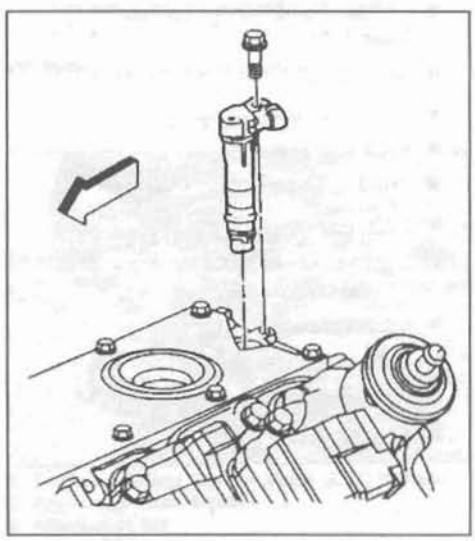


The PCM also monitors the CKP sensor signal circuit for malfunctions. The PCM sets a DTC P0335 or a DTC P0336 when the CKP sensor is out of the normal operating range.

CAMSHAFT POSITION (CMP) SENSOR



The Camshaft Position sensor is mounted through the top of the engine block at the rear of the valley cover and works in conjunction with a 1X reluctor wheel on the camshaft. The reluctor wheel is inside the engine immediately in front of the rear cam bearing. The PCM provides a 12 volt power supply to the CMP sensor as well as a ground and a signal circuit.

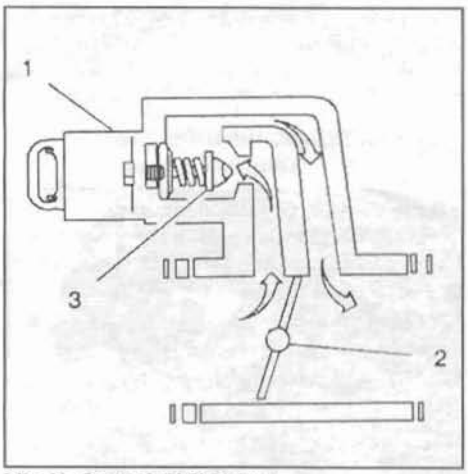


The PCM uses the Camshaft Position sensor in order to determine whether a cylinder is on a firing or exhaust stroke. The reluctor wheel interrupts a magnetic field produced by a magnet within the CMP sensor as the camshaft rotates. The CMP sensor's internal circuitry detects this and produces a signal which the PCM reads. The PCM uses this 1X signal in combination with the Crankshaft Position sensor 24X signal in order to determine the crankshaft position and stroke.

The PCM checks for a loss of Camshaft Position sensor signal. The PCM also monitors the CMP sensor signal circuit for malfunctions. The following DTCs set when the PCM detects a CMP sensor that is out of the normal operating range:

- DTC P0341 Camshaft Position Sensor (CMP) Circuit Performance
- DTC P0342 Camshaft Position Sensor (CMP) Circuit Low Voltage
- DTC P0343 Camshaft Position Sensor (CMP) Circuit High Voltage

IDLE AIR CONTROL (IAC) VALVE



Idle Air Control (IAC) Valve:
1. Idle Air Control Valve
2. Throttle Blade
3. IAC Valve Pintle

The Idle Air Control valve is a PCM-controlled stepper motor located on the throttle body. The stepper motor drives a valve pintle which protrudes into a passage that bypasses the throttle plates. The PCM commands the IAC valve pintle to extend to decrease the idle speed. The bypass air flow is reduced and the idle speed decreases as the pintle approaches its seat. (An orifice located between the throttle valves also supplies a constant amount of bypass air.) The PCM retracts the IAC valve pintle away from its seat to increase the idle speed. Retracting the valve pintle allows more air to bypass the throttle plates.

The PCM moves the IAC valve in small steps, called counts. These can be measured and displayed by a scan tool, which plugs into the Data Link Connector (DLC). The PCM calculates the proper position of the IAC valve during idle based on battery voltage, coolant temperature, engine load, and engine RPM. If the RPM drops below specification and the throttle valve is closed, the PCM senses a

near stall condition and calculates a new valve position in order to prevent stalling.

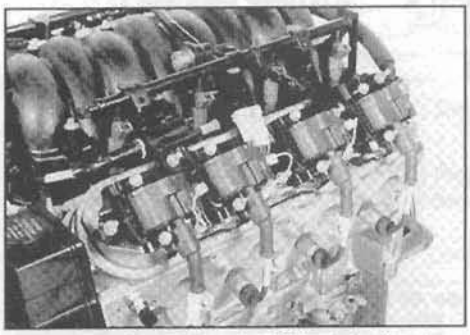
Engine idle speed is a function of total air flow into the engine. Idle speed is based on IAC valve pintle position + crankcase ventilation valve flow + throttle valve opening + bypass orifice air flow + calibrated vacuum loss through accessories.

Controlled idle speed is programmed into the PCM, which determines the correct IAC valve pintle position to maintain the desired idle speed for all engine operating conditions and loads.

The minimum idle air rate is set at the factory with a stop screw. This setting allows enough air flow by the throttle valves to cause the IAC valve pintle to be positioned a calibrated number of steps (counts), from the seat, during controlled idle operation. If the IAC valve is disconnected and reconnected with the engine running, the idle speed may be wrong. If this occurs, reset the IAC valve by depressing the accelerator pedal slightly, start and run the engine for five seconds, then turn the ignition OFF for ten seconds.

Note: Do not attempt to adjust engine idle speed by turning the screw on the right (passenger) side of the throttle body. Turning this screw can permanently damage the IAC.

ELECTRONIC IGNITION SYSTEM OVERVIEW

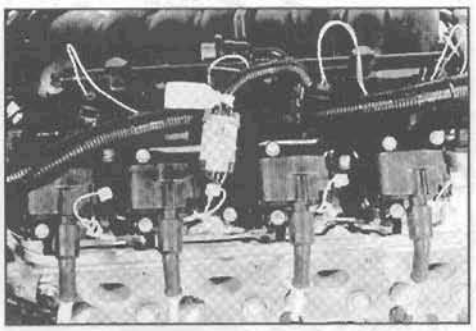


The LS1 Engine Kit has individual electronically controlled coil modules for each cylinder.

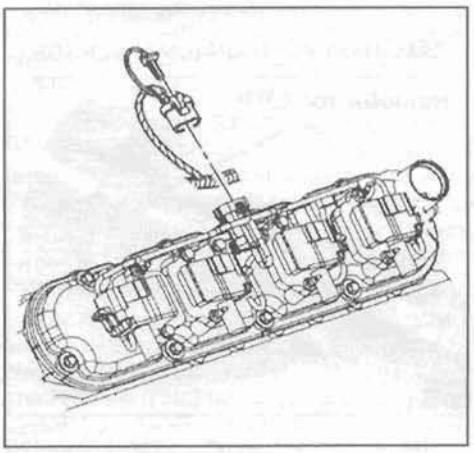
The LS1 Engine Kit's electronic ignition system controls combustion by providing a spark to ignite the compressed air/fuel mixture at the correct time. The PCM controls the spark advance of the ignition system to provide optimum engine performance and fuel economy.

The LS1 Engine Kit electronic ignition system does not use a conventional distributor and coil; rather, the ignition system has an individual coil/module for each cylinder. There are eight Ignition Control (IC) circuits, one per cylinder, that connect the PCM and the ignition coil/modules. Each ignition coil/module has a power feed, a chassis ground circuit, and a reference low circuit. The PCM causes a spark to occur by grounding the IC circuit, which signals the ignition module to trigger the ignition coil and fire the spark plug. Sequencing and timing are controlled by the PCM. The PCM sets a DTC when the IC circuit is out of range.

The ignition system consists of the following components/circuits:



- Eight ignition coils/modules
- Eight Ignition Control (IC) circuits
- Camshaft Position (CMP) sensor
- 1X Camshaft reluctor wheel
- Crankshaft Position (CKP) sensor
- 24X Crankshaft reluctor wheel
- Related connecting wires
- Powertrain Control Module (PCM)



The ignition feed circuits are fused separately for each bank of the engine. The two fuses also supply the injectors for that bank of the engine. Each coil/module is serviced separately.

To properly control ignition timing, the PCM relies on the following information:

- Engine load (manifold pressure or vacuum)
- Atmospheric (barometric) pressure
- Engine temperature
- Intake air temperature
- Crankshaft position
- Engine speed (RPM)

The Ignition Control (IC) system consists of the following components:

- Ignition coil/modules
- 24X crankshaft position sensor
- Powertrain Control Module (PCM)
- All connecting wires

The Ignition Control utilizes the following to control spark timing functions:

- 24X signal — The 24X crankshaft position sensor sends a signal to the PCM. The PCM uses this signal to determine crankshaft position. The PCM also utilizes this signal to trigger the fuel injectors.
- Ignition Control (IC) circuits — The PCM uses these circuits to trigger the ignition coil/modules. The PCM uses the crankshaft reference signal to calculate the amount of spark advance needed.

There are important considerations to point out when servicing the ignition system. The following information will help the technician in servicing the ignition system:

The ignition coils secondary voltage output capabilities are very high — more than 40,000 volts. Avoid body contact with ignition high voltage secondary components when the engine is running, or personal injury may result.

The 24X crankshaft position sensor is the most critical part of the ignition system. If the sensor is damaged so that pulses are not generated, the engine will not start.

Crankshaft position sensor clearance is very important. The sensor must not contact the rotating interrupter ring at any time, or sensor damage will result. If the interrupter ring is bent, the interrupter ring blades will destroy the sensor.

Ignition timing is not adjustable. There are no timing marks on the crankshaft balancer or timing chain cover.

Be careful not to damage the secondary ignition wires or boots when servicing the ignition system. Rotate each boot to dislodge it from the plug or coil tower before pulling it from either a spark plug or the ignition coil. Never pierce a secondary ignition wire or boot for any testing purposes. Future problems are guaranteed if pinpoints or test lights are pushed through the insulation for testing.

The PCM is responsible for maintaining proper spark and fuel injection timing for all operating conditions. The PCM monitors input signals from the following components in calculating Ignition Control (IC) spark timing:

- Engine Coolant Temperature (ECT) sensor
- Intake Air Temperature (IAT) sensor
- Mass Air Flow (MAF) sensor
- Throttle Position (TP) sensor
- Vehicle Speed Sensor (VSS)

An Ignition control circuit that is open or grounded will set an ignition control circuit DTC. If a fault occurs in the IC output circuit when the engine is running, the engine will experience a misfire. DTCs P0351 – P0358 will set when a malfunction is detected with an Ignition Control circuit. When an Ignition control DTC sets, the PCM will disable the injector for the appropriate cylinder.

The PCM uses information from the engine coolant temperature sensor in addition to RPM to calculate spark advance values as follows:

- High RPM = more advance
- Cold engine = more advance
- Low RPM = less advance
- Hot engine = less advance

Therefore, detonation could be caused by high resistance in the engine coolant temperature sensor circuit. Poor performance could be caused by low resistance in the engine coolant temperature sensor circuit.

If the engine cranks but will not run or immediately stalls, the "Engine Cranks But Will Not Run" diagnostic table must be used to determine if the failure is in the ignition system or the fuel system.

FUEL PUMP CONTROL CIRCUIT

When the ignition switch is turned to the ON position, the PCM activates the in-tank fuel pump. The fuel pump remains on as long as the PCM receives reference pulses from the electronic ignition system. If there are no reference pulses, the PCM turns the fuel pump off after less than one second.

The PCM controls the fuel pump relay by applying B+ to the control circuit via an internal switch called a driver. The primary purpose of the driver is to supply a voltage to the fuel pump relay.

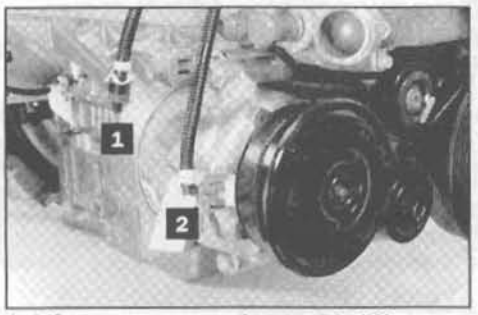
The driver has a fault line which the PCM monitors. When the PCM commands the fuel pump ON, the voltage of the control circuit should be high (near battery voltage). When the PCM commands the control circuit to the fuel pump OFF, the voltage should be low (near zero volts). The PCM sets a DTC when it detects the fuel pump control circuit is shorted to ground.

FAN CONTROL RELAY CIRCUIT

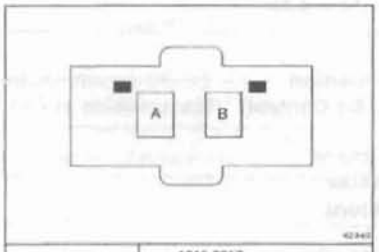
Ignition voltage is supplied directly to the cooling fan relay coil. The PCM controls the relay by grounding the control circuit via an internal switch called a driver. The primary function of the driver is to supply the ground for the controlled circuit. The engine cooling fan is turned on when coolant temperature reaches approximately
212° F.

Each driver has a fault line which the PCM monitors. When the PCM commands a component ON, the voltage of the control circuit should be low (near zero volts). When the PCM commands the control circuit to a component OFF, the voltage of the circuit should be high (near battery voltage). If the fault detection circuit senses a voltage other than what the PCM expects, a DTC is set.

AIR CONDITIONING COMPRESSOR



1. A/C pressure sensor (connect to PN 22601618)
2. A/C clutch connection



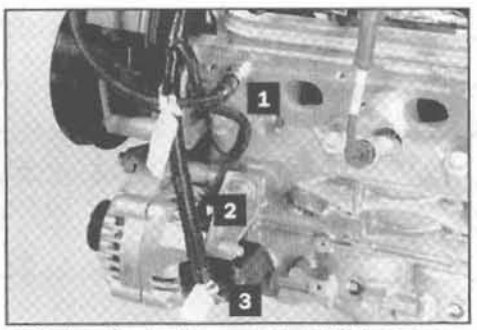
Connector Part Information		• 1216-2017 • 2 Way F Metri-Pack 150 Series (GRY)	
Pin	Wire Color	Circuit No.	Function
A	DK GRN	59	A/C Compressor Clutch Control
B	BLK	450	A/C Compressor Clutch Ground

A/C Compressor Clutch Control

Connector Part Information		• 1211-0192 • 3 Way M Metri-Pack 150 Series Pull To Seat (BLK)	
Pin	Wire Color	Circuit No.	Function
A	BLK	407	A/C Refrigerant Pressure Sensor Ground
B	GRY	474	A/C Refrigerant Pressure Sensor 5.0V Reference
C	RED/BLK	380	A/C Refrigerant Pressure Sensor Signal

A/C Refrigerant Pressure Sensor

ALTERNATOR



1. Engine Coolant Temperature (ECT) sensor
2. Alternator (flat 4-pin)
3. Alternator lug

TROUBLESHOOTING

General:

1. Fuel pressure should be between 53 and 63 psi at idle.

2. Check-engine light should be on (amber color) when ignition is turned on and should be off when the engine is running.

Engine will not crank:

Check for battery voltage (12 volts minimum) at the following locations:

1. Starter switch

2. Starter terminal

Engine cranks but will not start:

1. No (or low) fuel pressure. Check the following:

- There may be air in the fuel line or fuel rail which will require a minute to purge. Continue to crank the engine or open the fuel line at the fuel rail and check for fuel flow.
- Check that fuel filter is not plugged.
- The fuel pump relay will not stay energized unless the engine is cranking or running. To test the fuel pump, the relay can be bypassed as follows: Remove the connector from the fuel pump relay. Connect a jumper wire from the orange to the red wire. This will power the fuel pump.

2. Check-engine light should be on when ignition is on when engine is not running. If not, check the following:

- Ground wires on the back of the right side cylinder head must be tight.
- Check for battery voltage on both sides of ignition switch.
- The Tech 2 scan tool should show an ignition voltage of at least 12 volts.
- Both PCM harness connectors must be tight and in good condition.
- Check if any malfunction codes are set in the PCM.
- Burned out check-engine light. (This is an LED and is not easily replaced, but LEDs do not fail as easily as bulbs do).

3. Check for spark at the spark plugs

4. Check injectors for a signal

- Remove an injector connector and put a 6 to 12 volt test light across the connector. (A 6-volt test light will show up better in the daylight).
- Crank the engine. The light should blink.

Engine starts but runs rough:

1. If check-engine light is on, check the malfunction codes with a Tech 2 scan tool.

2. Fuel pressure must be at least 53 psi.

3. Bad sensor. Note that some sensor problems will not necessarily turn on the check-engine light.

- MAF: Engine idles but won't take the throttle. Disconnect the MAF sensor connector and blip the throttle. If the engine responds better, leave the connector off until a replacement MAF is installed.
- Throttle Position: Engine won't take the throttle and runs erratically. Shut off engine and turn on the ignition. While moving the throttle from closed to WOT, watch Throttle Position on the Tech 2. It should go linearly from 0% to 100%.
- Crank Sensor: If the sensor is not working correctly or the connector is faulty, the PCM will not detect the true engine rpm and will not properly fire the injectors or ignition coils. If the crank sensor is not working at all, the engine won't run. If the Tech 2 will shows the correct rpm, the crank sensor is working.

The engine runs fine until it reaches operating temperature, then it starts running rough. The spark plugs are black on one bank and clean on the other bank.:

1. Disconnect both oxygen sensors and bring the engine up to operating temperature. If the engine runs fine, then it is possible that the oxygen sensors are connected to the incorrect bank or side of the engine causing one bank to run rich and the other bank to run lean. Reverse the oxygen sensor connections and the fuel correction values should return to a normal, controllable range.

2. If using Tech 2 scanner, bring the engine up to operating temperature and check that the engine is operating in closed loop mode on the Tech 2. Observe Bank 1 and Bank 2 fuel correction values. If one bank is adding +25% fuel and the other is subtracting –25% fuel, this indicates that the oxygen sensors are connected to the incorrect bank or side of the engine causing one bank to run rich and the other bank to run lean. Reverse the oxygen sensor connections and the fuel correction values should return to a normal, controllable range.

When using a manual or non-electronic automatic transmission and the "Check Engine" light is always on:

The PCM calibration is designed for use with an electronic 4L60E automatic transmission. Operating with a non-electronic transmission will cause the Check Engine light to come on due to PCM trouble codes that are set because the PCM does not detect a 4L60E transmission. The engine will still operate, however problems may exist with the engine stalling when the vehicle is coasting to a stop. Whenever possible, retain the vehicle speed sensor input to the PCM to prevent this from occurring. Utilizing the 40-tooth sensor ring and sensor found on 1988-93 GM light-duty trucks with THM-400 and THM-700R4 transmissions will provide the proper signal to the PCM.

Typical readings on the Tech 2 at idle (Note: select 1998 model year, passenger car, 5.7 LS1, F-car, automatic transmission):

Engine Speed	650 rpm
ECT (Engine Coolant Temp)	180° F
IAT (Intake Air Temp)	80-100° F
Baro (Barometer)	90-100 kpa
MAP (Manifold Air Pressure)	45 kpa
MAF (Mass Air Flow)	6-10 g/s
IAC Position (Idle Air Control)	10-30 counts (auto transmission in Park)
TP Sensor (Throttle Position)	0%
Injector PWM – Bank 1	2.6
Injector PWM – Bank 2	2.6
CMP Sensor – Low to High	Should be counting up
CMP Sensor – High to Low	Should be counting up
Spark	15-23° (changing rapidly)
Knock Retard	0°
Vehicle Speed Sensor	0 mph
Ignition Signal	13-14 volts

SPECIFICATIONS

LS1 ENGINE SPECIFICATIONS	
GENERAL	
Displacement	5.7 liters (5665cc, 346ci)
Horsepower	310 @ 5200 rpm
Torque	340 lb.-ft. @ 4000 rpm
Compression Ratio	10.1:1
Bore x Stroke	3.90" x 3.62"
Firing Order	1-8-7-2-6-5-4-3
Redline	6200 rpm
CYLINDER BLOCK	
Material	319-T5 aluminum
Description	90° V, deep skirt with cast-in iron sleeves
Bore Spacing	4.40"
Deck Height	9.24"
Main Bearings	5
Thrust Bearing	Center bulkhead
Bearing Caps	4 vertical bolts, 2 cross bolts
CYLINDER HEADS	
Material	356-T6 aluminum
Description	Cross flow, wedge combustion chamber
Ports	Symmetrical, intake and exhaust
Chamber Volume	67.3 cc
Head Gasket	0.052" compressed
CRANKSHAFT	
Material	Cast nodular iron
Features	Undercut and rolled fillets
Crank Pin Diameter	2.10"
Main Bearing Diameter	2.56"
PISTONS	
Material	Cast aluminum
Description	Strutless, flat top
Compression Height	1.34"
Weight	15.5 oz.
INDUCTION SYSTEM	
Manifold	One-piece composite
Throttle Body	75.0 mm bore dia.

SPECIFICATIONS cont.

TORQUE SPECIFICATIONS	
FASTENER	TORQUE
Accessory Drive Belt Idler Pulley Bolt	37 ft.-lbs.
Accessory Drive Belt Tensioner Pulley Bolt	37 ft.-lbs.
Camshaft Sensor Bolt	18 ft.-lbs.
Crankshaft Damper Bolt	Tighten new bolt to 110 ft. lbs., then back off the bolt one turn. Retighten bolt to 35 ft.-lbs. and then turn the bolt an additional 140°.
Crankshaft Position Sensor Bolt	18 ft.-lbs.
Dry Sump Oil Pump Bolts	37 ft.-lbs.
Dry Sump Oil Pump Bracket Bolts	37 ft.-lbs.
Dry Sump Oil Pump Idle Pulley Bolt	37 ft.-lbs.
Dry Sump Oil Pump Tensioner Bolt	18 ft.-lbs.
Engine Block Coolant Drain Plugs	44 ft.-lbs.
Engine Bellhousing Bolts	37 ft.-lbs
Engine Flywheel Bolts (First Pass)	15 ft.-lbs.
Engine Flywheel Bolts (Second Pass)	37 ft.-lbs.
Engine Flywheel Bolts (Final Pass)	74 ft.-lbs.
Engine Mount Stud to Block	37 ft.-lbs.
Engine Mount to Block Bolts	37 ft.-lbs.
Exhaust Header Bolts (First Pass)	11 ft.-lbs.

TORQUE SPECIFICATIONS	
FASTENER	TORQUE
Exhaust Header Bolts (Final Pass)	18 ft.-lbs.
Fuel Injection Fuel Rail Bolts	89 in.-lbs.
Alternator Bracket Bolts	37 ft.-lbs.
Alternator Rear Bracket Bolts	18 ft.-lbs.
Ignition Coil Bolts	106 in.-lbs.
Ignition Coil Wire Harness Connector Bolts	106 in.-lbs.
Knock Sensors	15 ft.-lbs.
Oil Pressure Sensor	13 ft.-lbs.
Oxygen Sensor	31 ft.-lbs.
Power Steering Pump Bolts	18 ft.-lbs.
Power Steering Pump Brace Bolts	18 ft.-lbs.
Power Steering Pump Bracket Bolts	37 ft.-lbs.
Spark Plugs	12 ft.-lbs.
Throttle Body Bolts	106 in.-lbs.
Water Inlet Housing Bolts	11 ft.-lbs.
Water Pump Bolts (First Pass)	12 ft.-lbs.
Water Pump Bolts (Second Pass)	18 ft.-lbs.
Water Pump Pulley Bolts (First Pass)	89 in.-lbs.
Water Pump Pulley Bolts (Final Pass)	18 ft.-lbs.

DIAGNOSTIC TROUBLE CODES

DTC	DESCRIPTION
P0101	Mass Air Flow (MAF) System Performance
P0102	Mass Air Flow (MAF) Sensor Circuit Low Frequency
P0103	Mass Air Flow (MAF) Sensor Circuit High Frequency
P0107	Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage
P0108	Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage
P0112	Intake Air Temperature (IAT) Sensor Circuit Low Voltage
P0113	Intake Air Temperature (IAT) Sensor Circuit High Voltage
P0117	Engine Coolant Temperature (ECT) Sensor Low Voltage
P0118	Engine Coolant Temperature (ECT) Sensor High Voltage
P0121	TP Sensor Circuit Insufficient Activity
P0122	TP Sensor Circuit Low Voltage
P0123	TP Sensor Circuit High Voltage

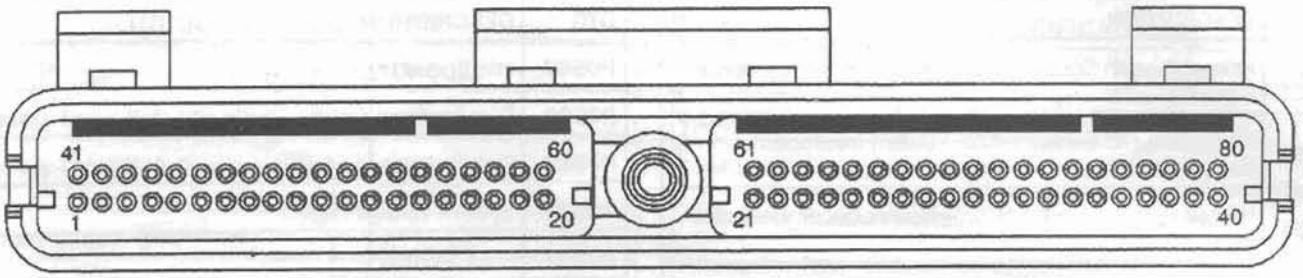
DTC	DESCRIPTION
P0125	Engine Coolant Temperature (ECT) Excessive Time To Closed Loop Fuel Control
P0131	Heated Oxygen Sensor (HO2S) Circuit Low Voltage Bank 1 Sensor 1
P0132	Heated Oxygen Sensor (HO2S) Circuit High Voltage Bank 1 Sensor 1
P0133	Heated Oxygen Sensor (HO2S) Slow Response Bank 1 Sensor 1
P0134	Heated Oxygen Sensor (HO2S) Circuit Insufficient Activity Bank 1 Sensor 1
P0135	Heated Oxygen Sensor (HO2S) Heater Circuit Bank 1 Sensor 1
P0151	Heated Oxygen Sensor (HO2S) Circuit Low Voltage Bank 2 Sensor 1
P0152	Heated Oxygen Sensor (HO2S) Circuit High Voltage Bank 2 Sensor 1

DIAGNOSTIC TROUBLE CODES cont.

DTC	DESCRIPTION
P0153	Heated Oxygen Sensor (HO2S) Slow Response Bank 2 Sensor 1
P0154	Heated Oxygen Sensor (HO2S) Circuit Insufficient Activity Bank 2 Sensor 1
P0155	Heated Oxygen Sensor (HO2S) Heater Circuit Bank 2 Sensor 1
P0171	Fuel Trim System Lean Bank 1
P0172	Fuel Trim System Rich Bank 1
P0174	Fuel Trim System Lean Bank 2
P0175	Fuel Trim System Rich Bank 2
P0230	Fuel Pump Control Circuit
P0300	Engine Misfire Detected
P0325	Knock Sensor (KS) Circuit
P0327	Knock Sensor (KS) Circuit Front
P0332	Knock Sensor (KS) Circuit Rear
P0335	CKP Sensor Circuit
P0336	CKP Sensor Circuit Performance
P0341	CMP Circuit Performance
P0342	CMP Sensor Circuit Low Voltage
P0343	CMP Sensor Circuit High Voltage
P0351	Ignition Control #1 Circuit
P0352	Ignition Control #2 Circuit
P0353	Ignition Control #3 Circuit
P0354	Ignition Control #4 Circuit
P0355	Ignition Control #5 Circuit
P0356	Ignition Control #6 Circuit
P0357	Ignition Control #7 Circuit
P0358	Ignition Control #8 Circuit
P0480	Fan Control Relay 1 Control Circuit
P0500	VSS Circuit (M/T)
P0506	Idle Speed Low

DTC	DESCRIPTION
P0507	Idle Speed High
P0530	Fuel Pressure Sensor Circuit
P0562	System Voltage Low
P0563	System Voltage High
P0601	PCM Memory
P0602	PCM Not Programmed
P0604	PCM RAM Performance
P0608	VSS Output Circuit
P0650	MIL Control Circuit
P0654	Engine Speed Output Circuit
P1111	Intake Air Temperature (IAT) Sensor Circuit Intermittent High Voltage
P1112	Intake Air Temperature (IAT) Sensor Circuit Intermittent Low Voltage
P1114	ECT Sensor Circuit Intermittent Low Voltage
P1115	ECT Sensor Circuit Intermittent High Voltage
P1121	TP Sensor CKT Intermittent High Voltage
P1122	TP Sensor CKT Intermittent Low Voltage
P1133	Heated Oxygen Sensor (HO2S) Insufficient Switching Bank 1 Sensor 1
P1134	Heated Oxygen Sensor (HO2S) Transition Time Ratio Bank 1 Sensor 1
P1153	Heated Oxygen Sensor (HO2S) Insufficient Switching Bank 2 Sensor 1
P1154	Heated Oxygen Sensor (HO2S) Transition Time Ratio Bank 2 Sensor 1
P1258	Engine Coolant Over Temperature-Fuel Disabled
P1336	CKP System Variation Not Learned
P1380	EB(T)CM DTC Detected – Rough Road Data Unusable
P1626	Theft Deterrent System Fuel Enable Circuit
P1635	5 Volt Reference #1 Circuit
P1639	5 Volt Reference #2 Circuit

PCM PIN-OUTS



PCM Pin-Outs							
#C1 Red Connector				#C2 Blue Connector			
ECM Term	Wire Color/Gauge	Wire Number	Function	ECM Term	Wire Color Gauge	Wire Number	Function
1				1			
2				2			
3				3	Tan	800	Serial Data (UART)
4	Brn/Wht 20	633	Cam Sensor	4	Red 18	631	Cam Sensor
5				5	Tan 20	1667	HO2S Bank 2
6				6	Tan/Wht 20	1653	HO2S Bank 1
7	Purple	400	VSS	7	Red/Blk 20	380	A/C Refrigerant Pressure Signal
8				8	Tan 20	472	Intake Air Temp
9	Pink/Blk 20	1746	Injector #3	9			
10				10			
11				11	Gray	23	Generator F-Terminal
12	Lt Blue/Blk 20	844	Injector #4	12	Dk Blue 20	417	TPS Sensor
13	Red/Wht 18	2122	ICM #2	13	Yel/Blk	1227	Transmission Fluid Temp Signal
14	Dk Grn	59	A/C Clutch	14	Orange/Blk	1057	Transmission Fluid Temp Ground
15	Blk/Wht 20	845	Injector #5	15			
16				16			
17				17			
18	Yel/Blk 20	846	Injector #6	18			
19				19	Pink 18	439	Ignition Feed
20				20	Orange 18	340B	PCM Battery Feed
21	Purple 20	719	Intake Air Temp	21	Black 16	451F	PCM Ground
22	Dk Blue	1225	Transmission Range Signal A	22	Yel/Blk 20	1868	Crank Sensor
23	Lt Grn/Blk 20	1745	Injector #2	23	Black 20	452	TPS
24	Blk 18	1704	PCM Ground	24	Black 18	1704	Sensor Ground Jumper
25	Pink/Blk	1224	Transmission Range Signal A	25	Brown 18	718	ECT Sensor Ground

PCM PIN-OUTS cont.

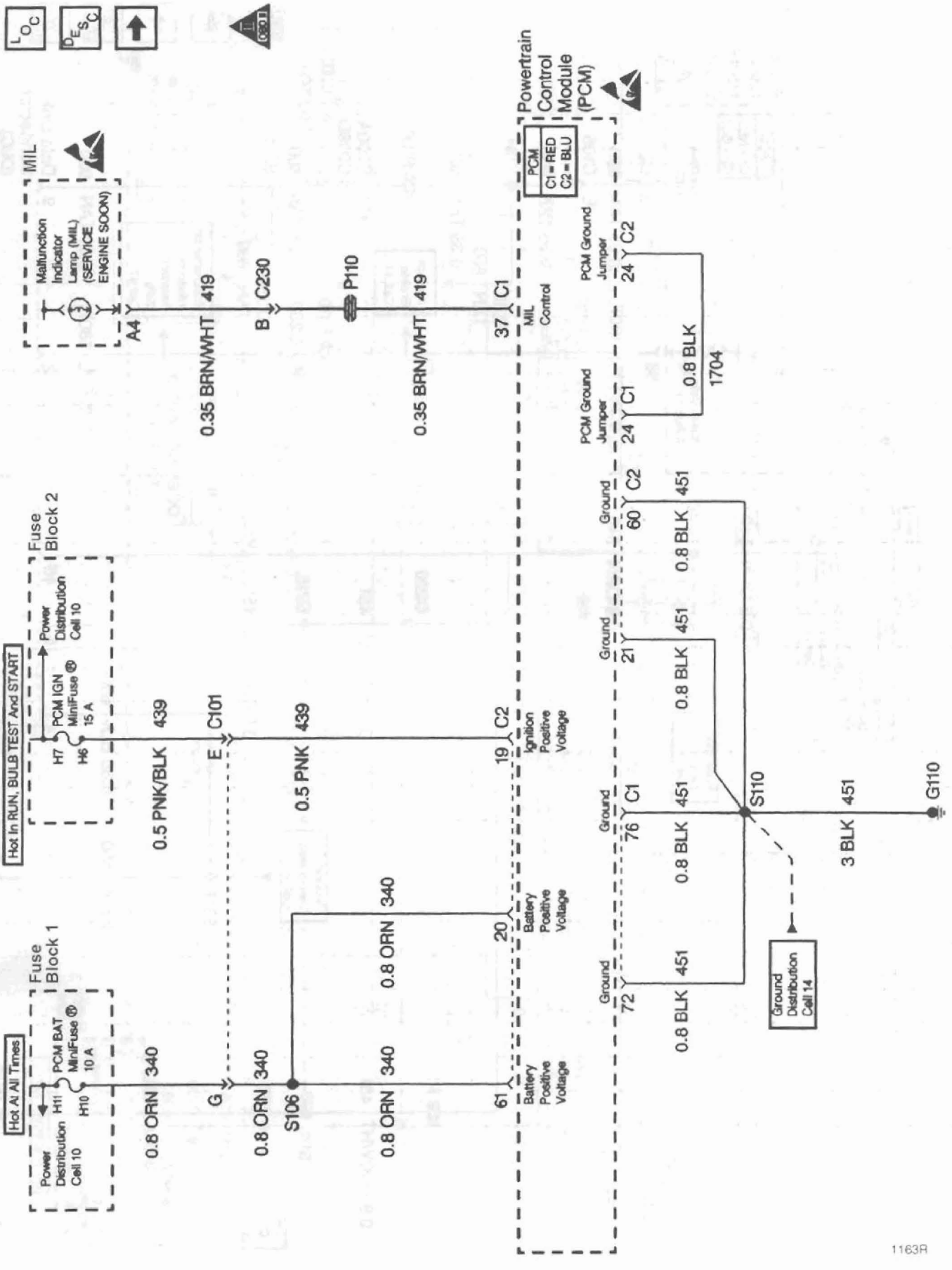
PCM Pin-Outs							
#C1 Red Connector				#C2 Blue Connector			
ECM Term	Wire Color/Gauge	Wire Number	Function	ECM Term	Wire Color Gauge	Wire Number	Function
26				26	Orn/Blk 20	469	MAP Sensor Ground
27	Red/Blk 20	877	Injector #7	27			
28				28			
29				29			
30				30			
31	Dk Blue/Wht 20	878	Injector #8	31			
32				32	Tan	422	TCC Solenoid Valve Control
33	Black 20	1744	Injector #1	33	Brn	418	TCC (PWM) Solenoid Valve Control
34	Grey or Wht	587 or 687	Skip Shift Solenoid Control (M/T) or 3-2 Shft Sol (A/T)	34			
35	Lt Grn	1222	1-2 Shft Sol	35	White 20	121C	Tach
36				36	Lt Blue/Wht	1229	Trans Fluid Pressure Control Solenoid Control Low
37	Brn/Wht 18	419	MIL Control	37	Dk Grn/Wht 18	465	Fuel Pump Relay Control
38				38			
39	Dk Grn/Wht	459	A/C Clutch Relay	39	Red/Blk	1228	Trans Fluid Pressure Control Solenoid Control High
40	Yellow	375 or 1223	Skip Shft Lamp (M/T) or Shft Sol B (A/T)	40			
41				41			
42				42			
43	Dk Green 18	335	Cooling Fan Relay	43	Gray 20	596	TPS
44	Yellow 20	573	Crank Sensor	44			
45				45			
46				46	Purple 20	1666	HO2S Bank 2
47	Dk Grn/Wht	762	A/C Request	47	Ppl/Wht 20	1665	HO2S Bank 1
48	Yellow 20	492	MAF	48	Lt Grn 20	432	MAP
49	Purple 18	2121	Bank 1 Ignition Control Module #1 (ICM)	49	Yellow 20	410	ECT Sensor
50				50			
51				51			
52	Ppl/Wht 18	2128	ICM #8	52			
53	Red 18	2127	ICM #7	53			

PCM PIN-OUTS cont.

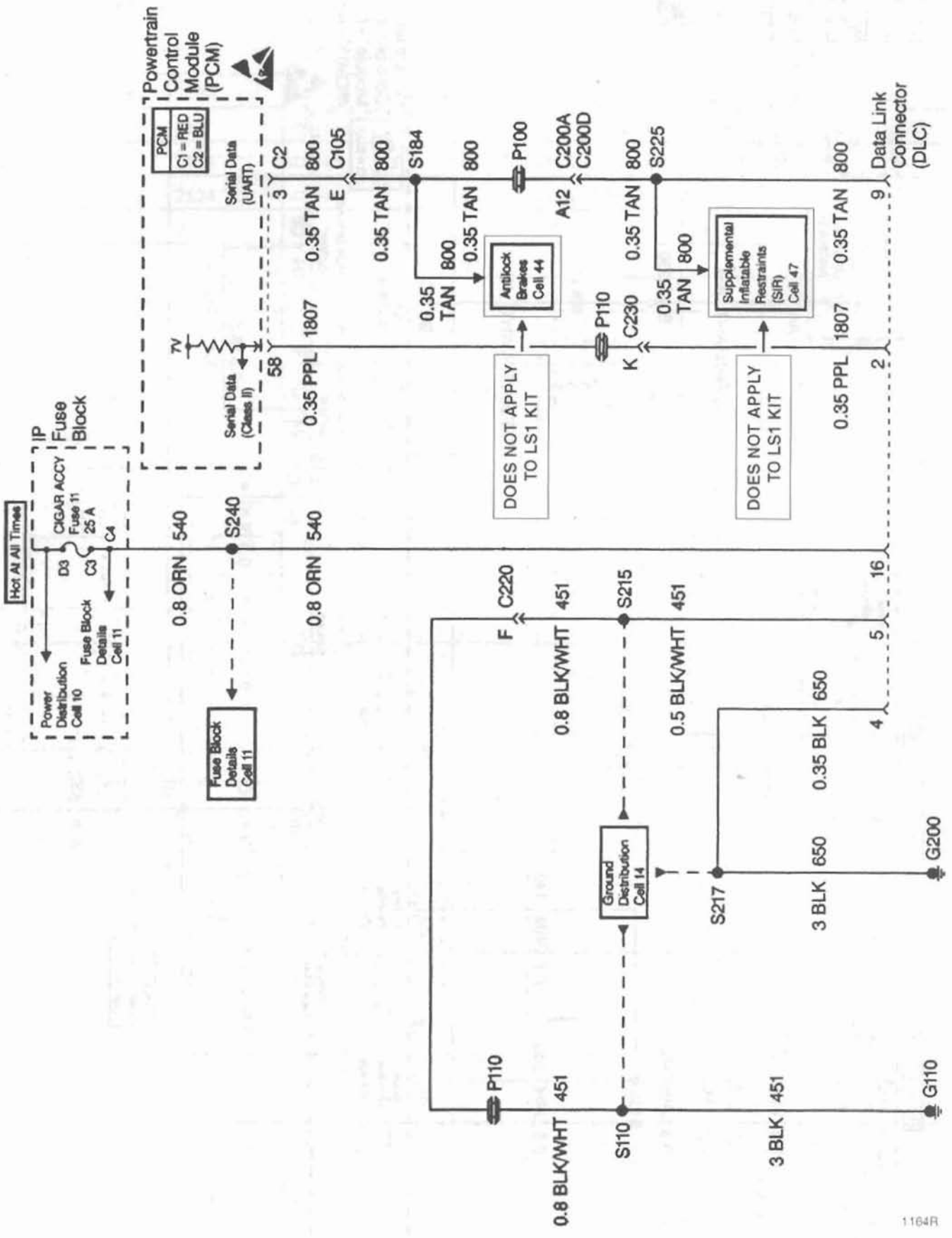
PCM Pin-Outs							
#C1 Red Connector				#C2 Blue Connector			
ECM Term	Wire Color/ Gauge	Wire Number	Function	ECM Term	Wire Color/ Gauge	Wire Number	Function
54	Lt Blu/Wht 18	2126	ICM #6	54	LT Grn/Blk 20	444	IAC Coil B Low
55	Dk Grn/Wht	817	VSS Output	55	Lt Blue/Blk 20	1748	IAC Coil A Low
56	Dk Grn 18	2125	ICM #5	56	Lt Blue/Wht 20	1747	IAC Coil A High
57	Dk Grn/Wht 18	2124	ICM #4	57	Lt Grn/Wht 20	1749	IAC Coil B High
58	Lt Blue 18	2123	ICM #3	58	Purple 20	1807	Serial Data (Class 2)
59	Brn/Wht 18	2130	Bank 2 ICM	59			
60	Brown 18	2129	Bank 1 ICM	60	Black 16	451G	PCM Ground
61	Red	1226	Transmission Range Signal	61	Orange 18	340C	PCM Battery Feed
62				62	Lt Grn 18	1867	Crank Sensor
63	Black 20	407	A/C Refrigerant Pressure Sensor Ground	63			
64				64	Gray 20	416	MAP
65				65			
66				66	Gray 20	474	A/C Refrigerant Pressure Sensor Signal
67				67			
68				68	Lt Blue 20	1876	Knock Sensor (KS) Rear
69				69	Dk Blue 20	496	Knock Sensor (KS) Front
70				70	Pink/Blk 20	632	Cam Sensor
71	Green	401	VSS Signal Low	71			
72	Black 16	451C	PCM Ground	72			
73				73			
74				74			
75				75			
76	Black 16	451C	PCM Ground	76			
77	Purple	420	TCC Brake Switch	77	Red	225	Generator L-Terminal
78				78			
79				79			
80				80			

ENGINE CONTROL SCHEMATICS

POWER, GROUND AND MIL

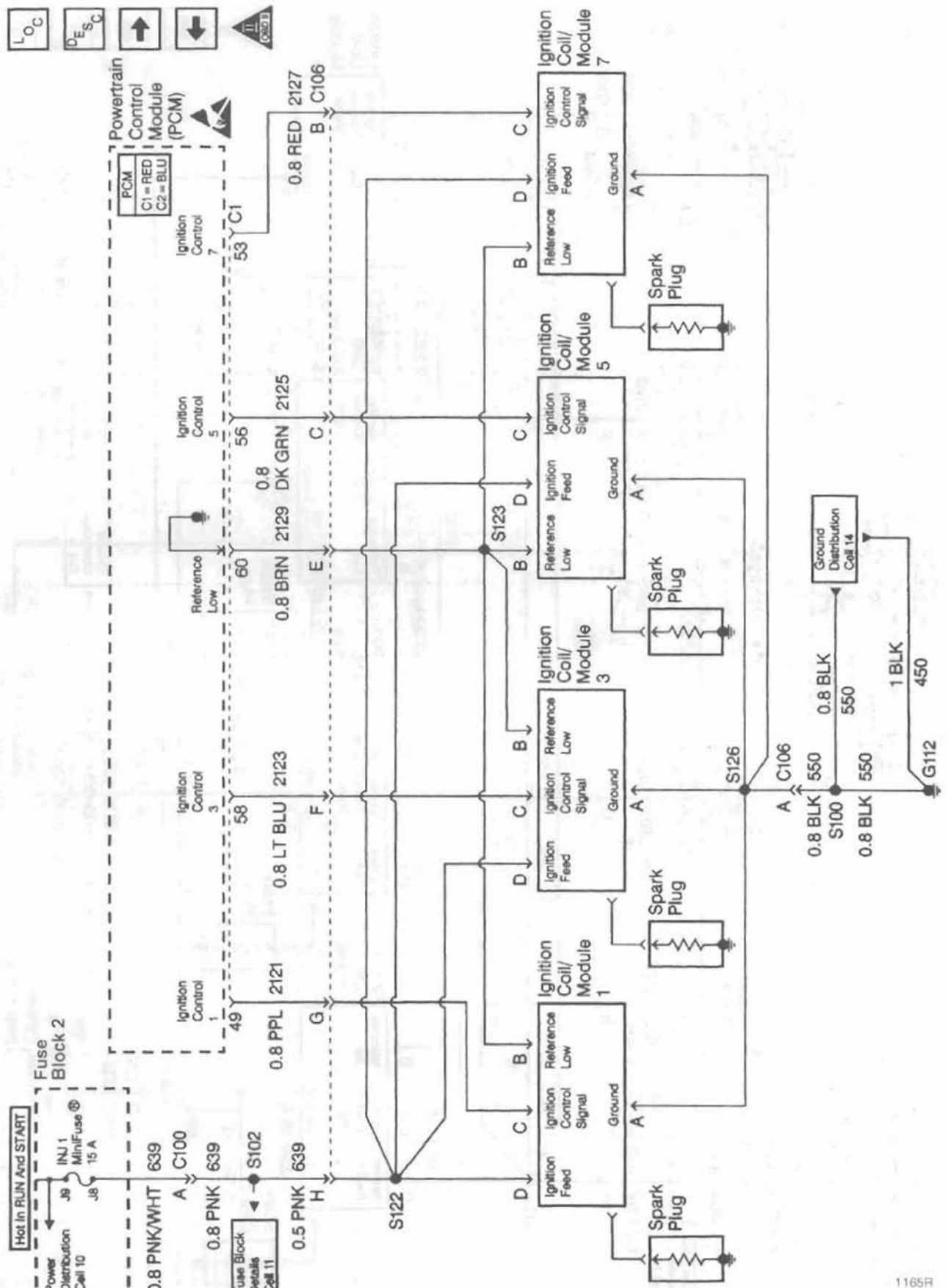


DATA LINK CONNECTOR (DLC)



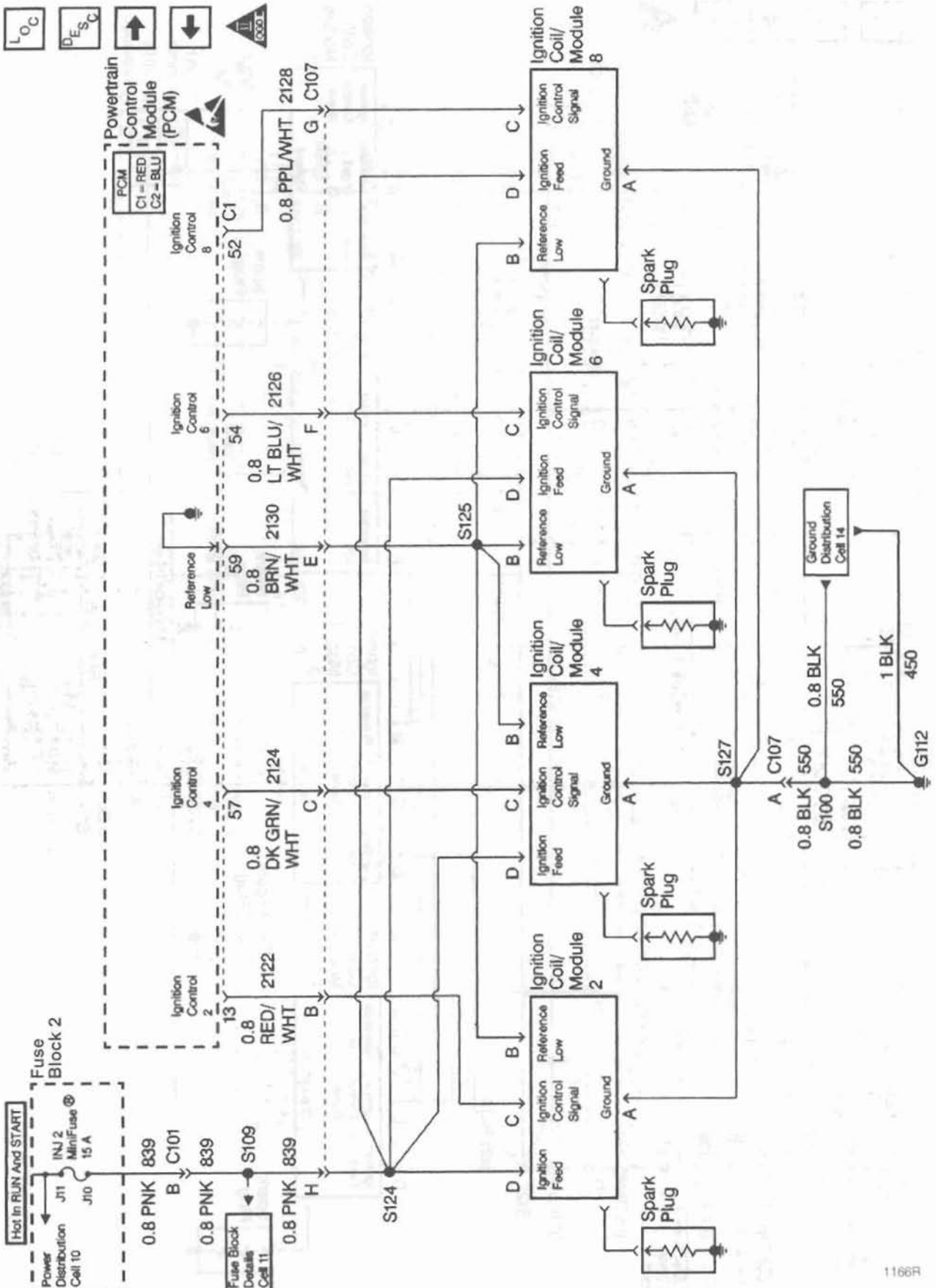
ENGINE CONTROL SCHEMATICS cont.

BANK 1 IGNITION COIL/MODULES



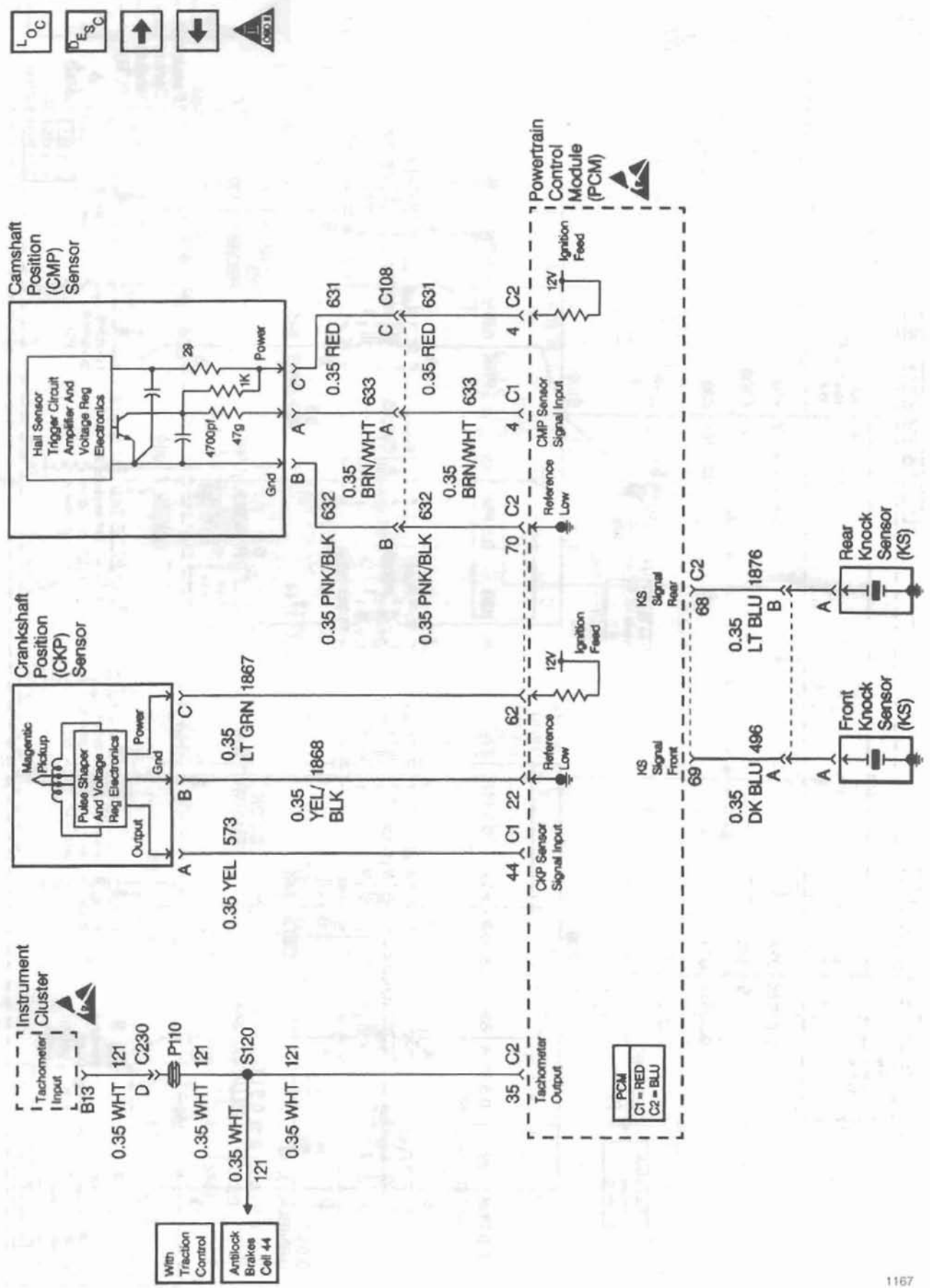
ENGINE CONTROL SCHEMATICS cont.

BANK 2 IGNITION COIL/MODULES



ENGINE CONTROL SCHEMATICS cont.

ENGINE SPEED OUTPUT, CKP AND CMP SENSORS



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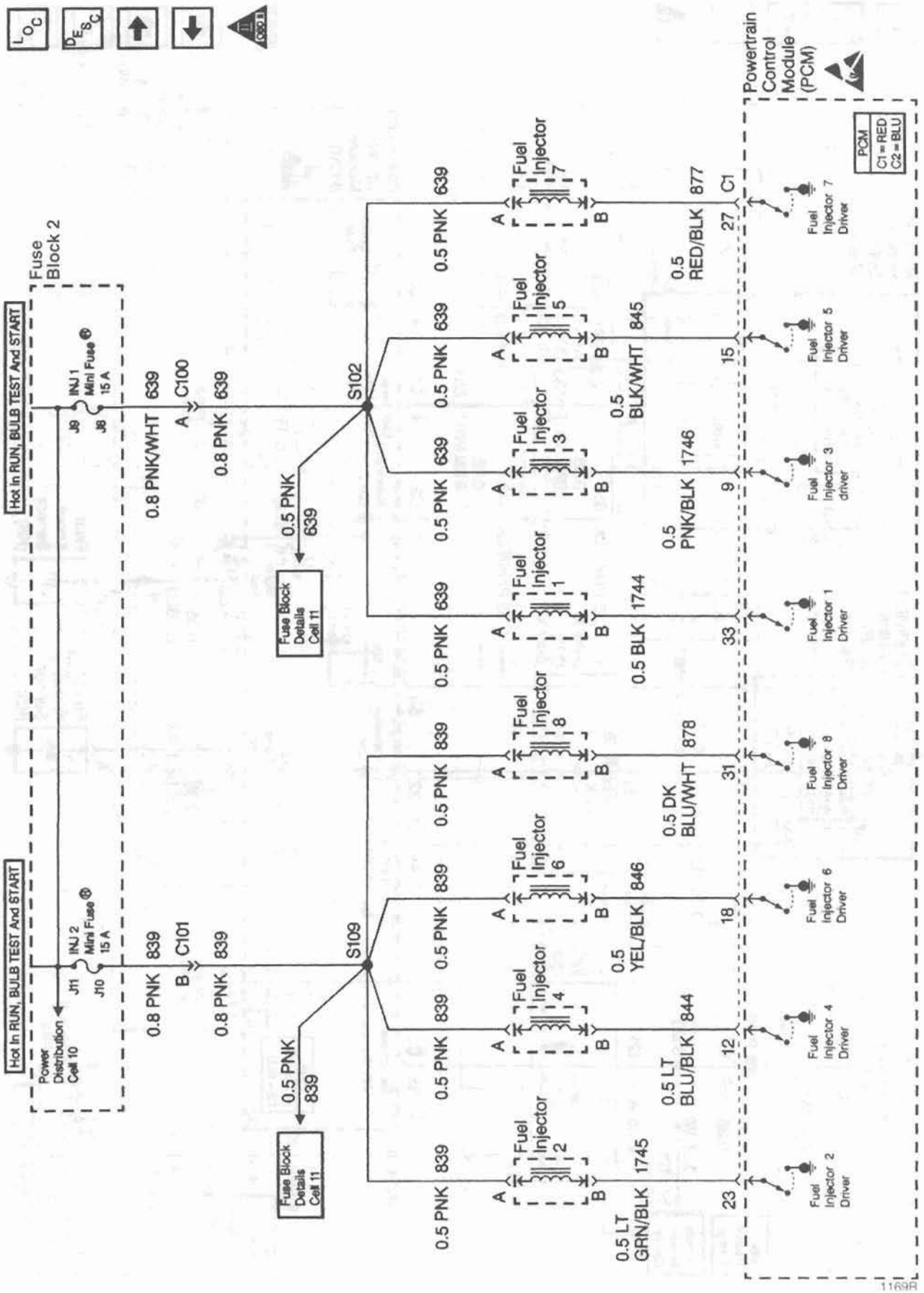
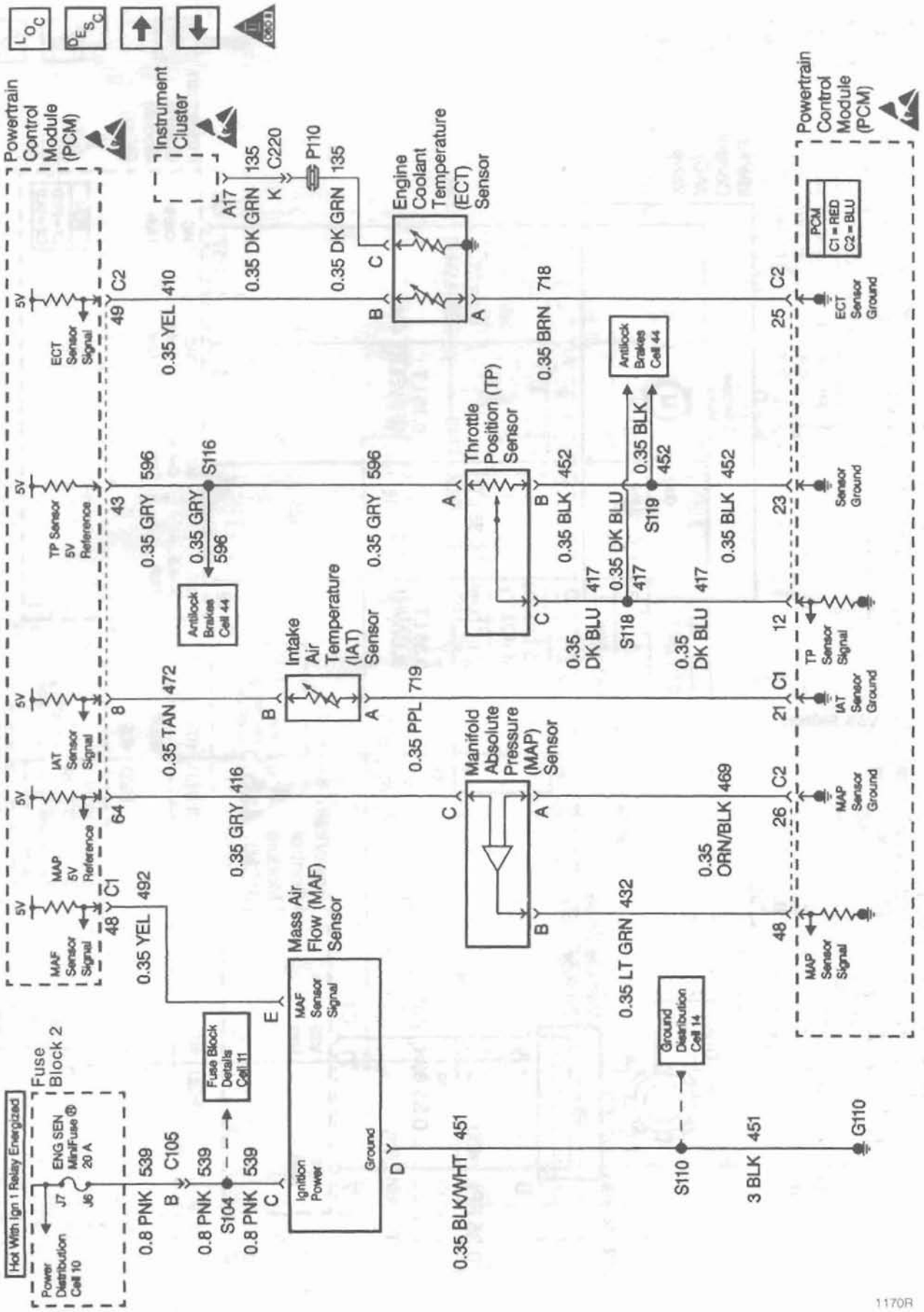
ENGINE CONTROL SCHEMATICS cont.

INJECTOR CIRCUITS



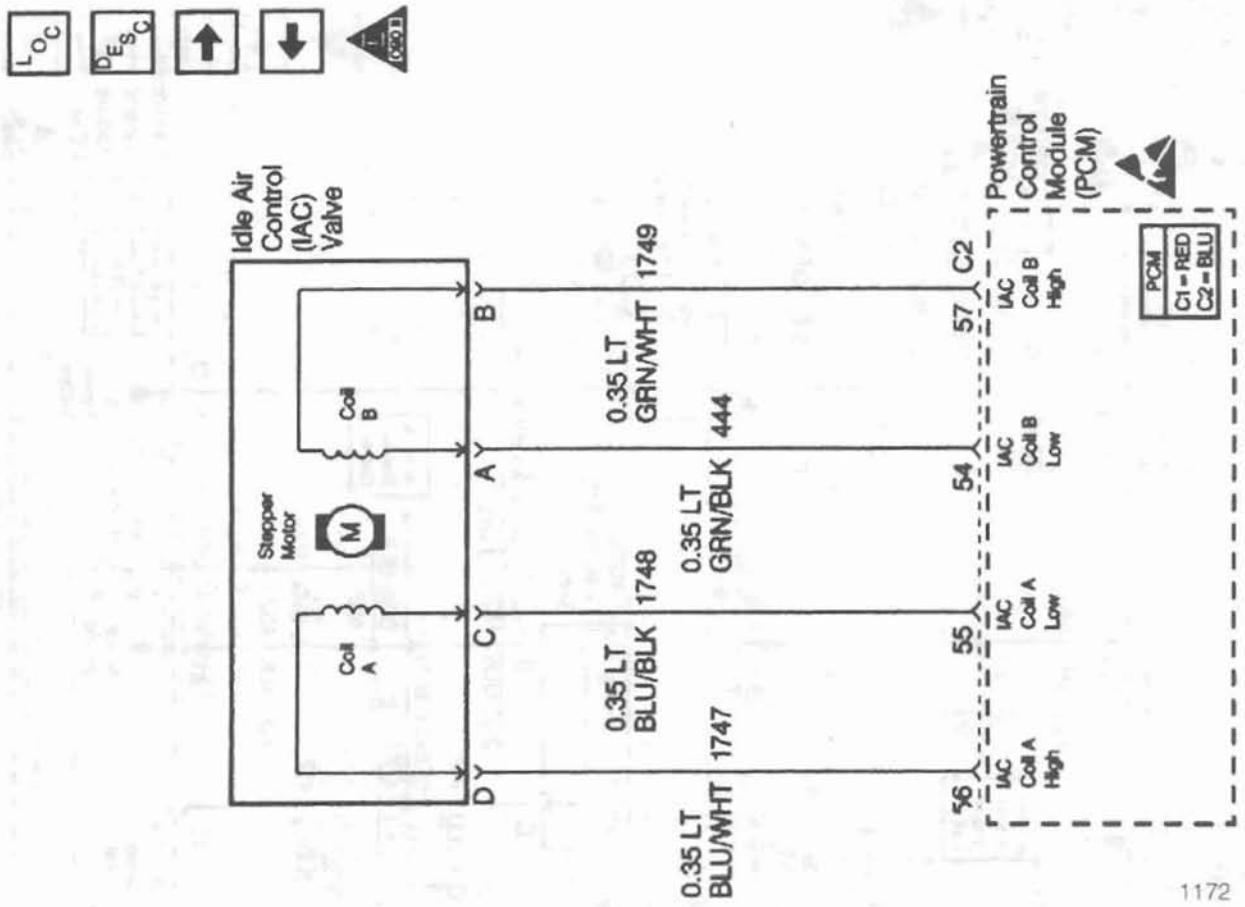
ENGINE CONTROL SCHEMATICS cont.

INFORMATION SENSORS



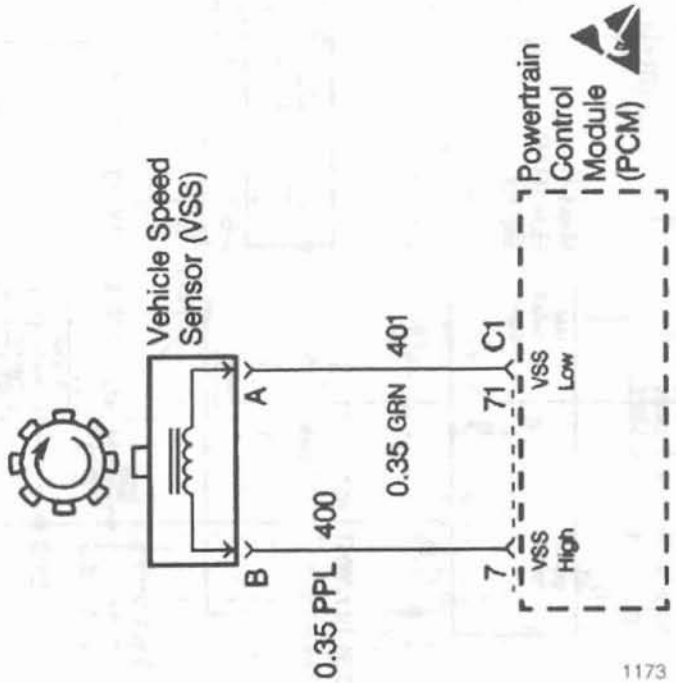
ENGINE CONTROL SCHEMATICS cont.

IAC

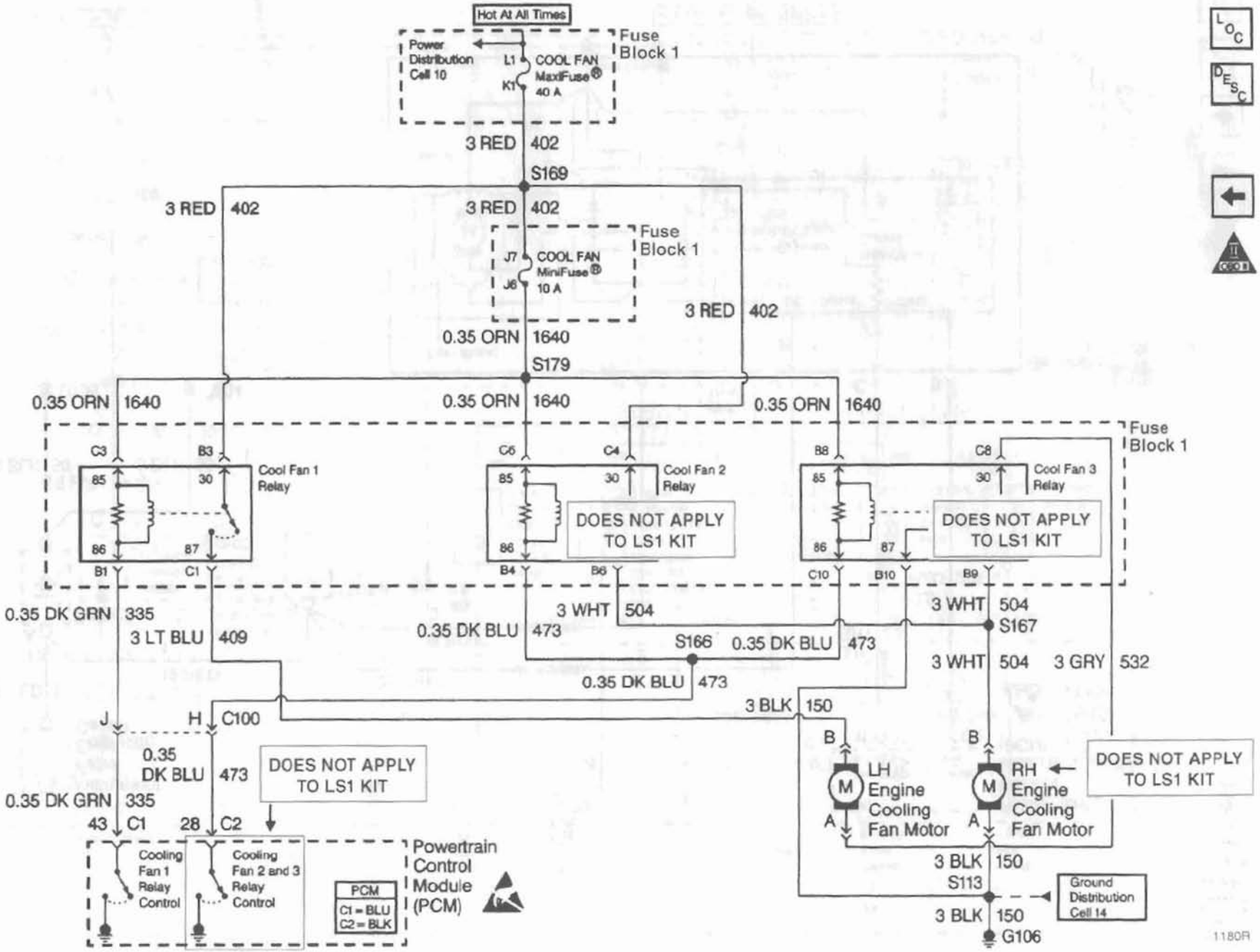


1172

VSS SIGNAL

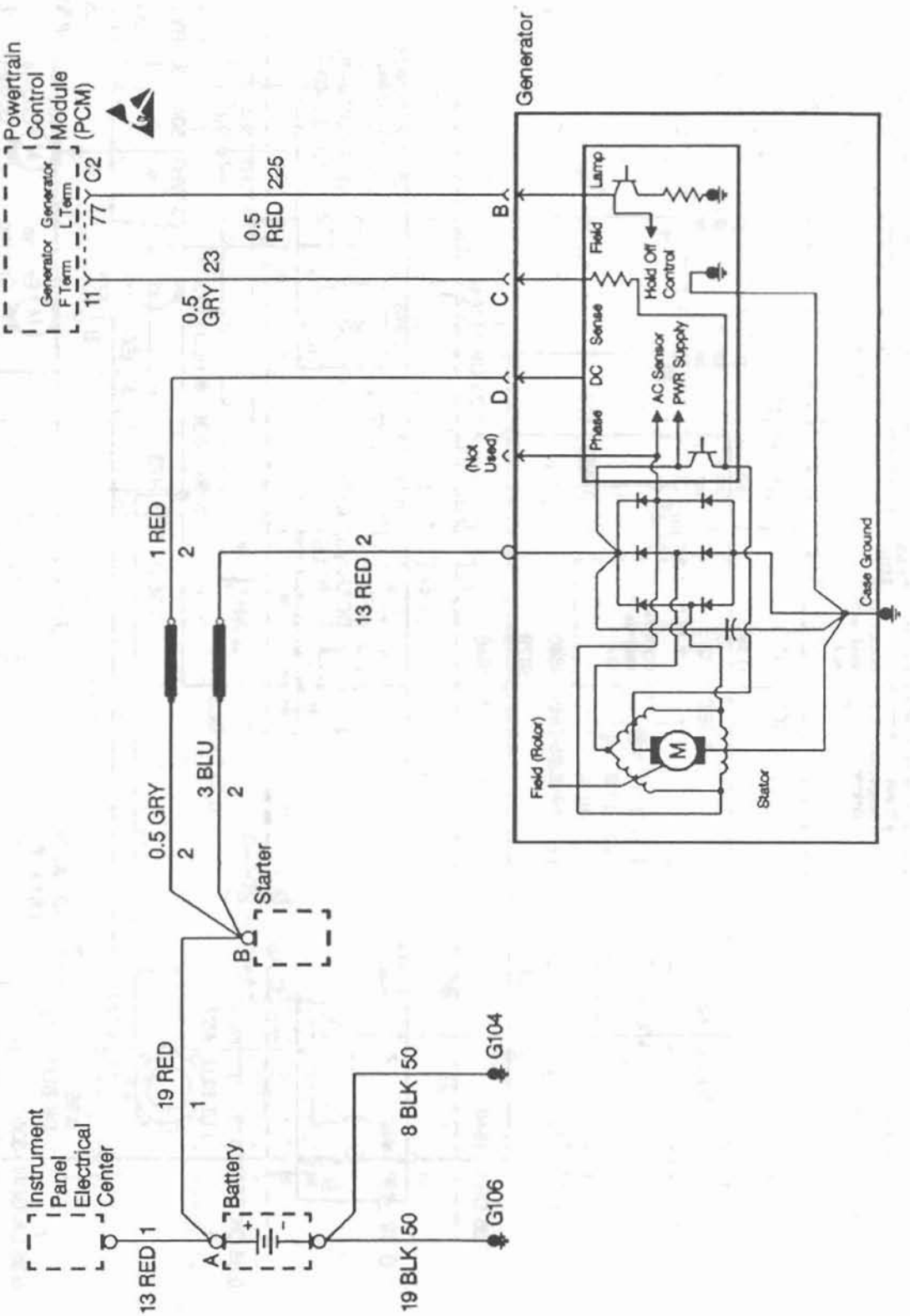


1173


Hot At All Times
Power Distribution Cell 10
L1
K1
COOL FAN MaxiFuse® 40 A
Fuse Block 1
3 RED 402
S169
J7
J6
COOL FAN MiniFuse® 10 A
0.35 ORN 1640
S179
C3
B3
C6
C4
B8
C8
85
30
86
87
Cool Fan 1 Relay
Cool Fan 2 Relay
Cool Fan 3 Relay
DOES NOT APPLY TO LS1 KIT
B1
C1
B4
B6
C10
B10
B9
0.35 DK GRN 335
3 LT BLU 409
3 WHT 504
0.35 DK BLU 473
S166
S167
3 GRY 532
3 BLK 150
J
H
C100
0.35 DK BLU 473
0.35 DK GRN 335
43
C1
28
C2
Cooling Fan 1 Relay Control
Cooling Fan 2 and 3 Relay Control
PCM
C1 = BLU
C2 = BLK
Powertrain Control Module (PCM)
B
A
M
LH Engine Cooling Fan Motor
RH Engine Cooling Fan Motor
S113
Ground Distribution Cell 14
G106
1180R

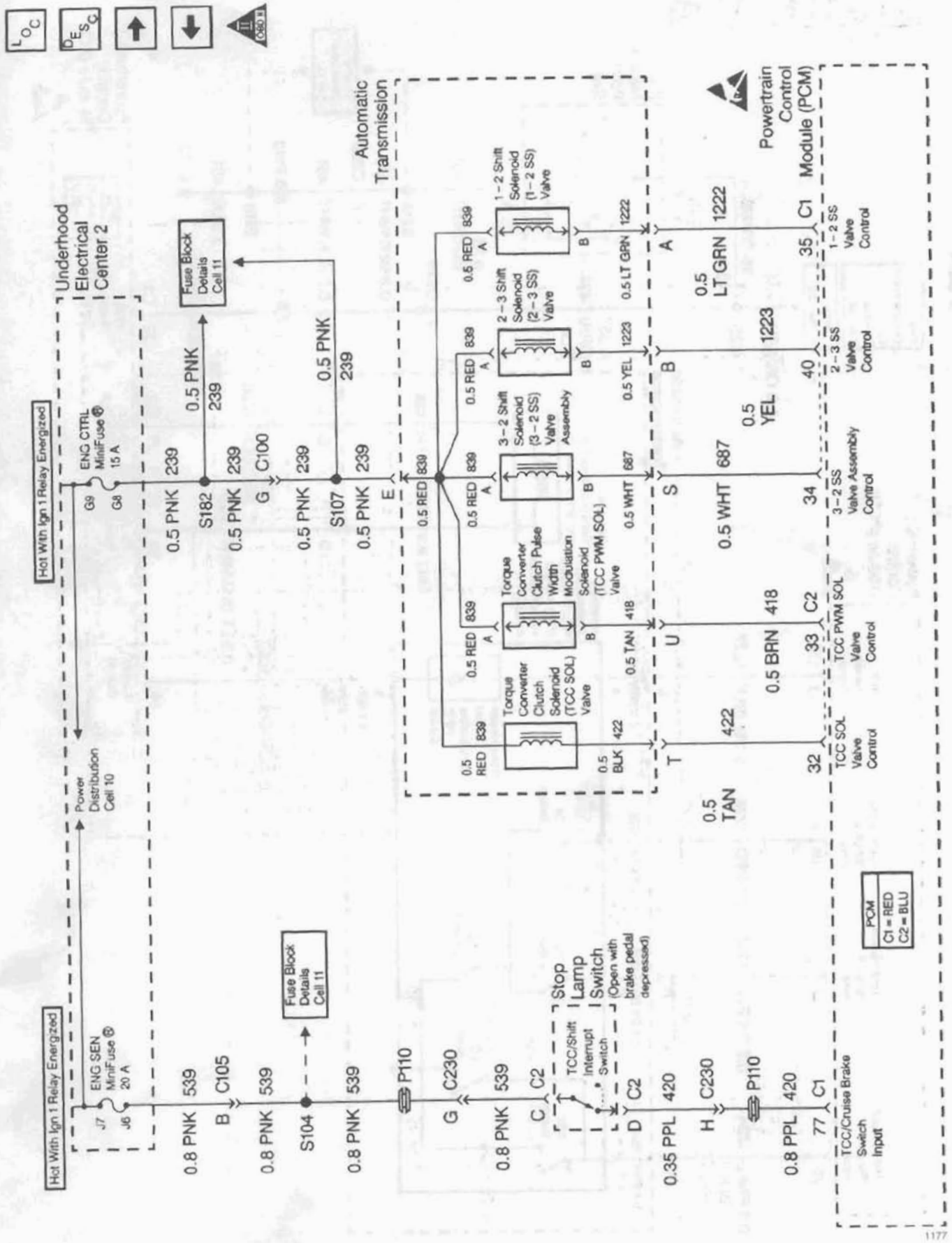
ENGINE CONTROL SCHEMATICS cont.

CHARGING SYSTEM



ENGINE CONTROL SCHEMATICS cont.

TRANSMISSION



TRANSMISSION