INSTRUMENT PANEL OIL WARNING LAMP "ON" AT IDLE

1. Oil cooler, or oil or cooler line restricted. Remove restrictions in cooler or cooler line.
2. Oil pump pressure low. See oil pump repair procedures in Section 6A.

ENGINE COMPRESSION TEST

COMPRESSION TEST

Important

- Disconnect the **"BAT."** terminal from the HEI distributor or ignition module.

To determine if the valves or pistons are at fault, a test should be made to determine the cylinder compression pressure. When checking cylinder compression, the throttle and choke should be open, all spark plugs removed, and the battery at or near full charge. The lowest reading cylinder should not be less than 70% of the highest and no cylinder reading should be less than 689 kPa (100 PSI).

This should be done with four **"puffs"** per cylinder.

Normal – Compression builds up quickly and evenly to specified compression on each cylinder.

Piston Rings – Compression low on first stroke, tends to build up on following strokes, but does not reach normal. Improves considerably with addition of oil.

Valves – Low on first stroke, does not tend to build up on following strokes. Does not improve much with addition of oil.

Use approximately three squirts from a plunger type oiler.

SECTION 6A2

2.8 LITER V-6 VIN CODE S RPO (LB8)

CONTENTS

GENERAL DESCRIPTION

CYLINDER BLOCK

The cylinder block is made of alloy cast iron and has 6 cylinders arranged in a "V" shape with 3 cylinders in each bank. The cylinder banks are set at a 60° angle from each other.

The right bank cylinders are 1, 3, 5. Cylinders 2, 4, 6 are on the left bank.

Four main bearings support the crankshaft which is retained by bearing caps that are machined with the block for proper alignment and clearances.

CYLINDER HEAD

The cast alloy iron cylinder heads have individual intake and exhaust ports for each cylinder. Valve guides are integral, and rocker arms are retained on individual threaded studs.

CRANKSHAFT AND BEARINGS

The crankshaft is cast nodular iron with deep rolled fillets on all six crankpins and two center main journals. Four steel backed aluminum bearings are used, with #3 bearing being the end-thrust bearing.

CAMSHAFT AND DRIVE

The camshaft is cast alloy iron with tapered 13. 2mm wide lobes, offset from the lifters and tapered to provide positive valve lifter rotation. The camshaft is supported by four journals and includes a distributor/oil pump drive gear, and fuel pump eccentric.

A 3/8" pitch chain drives the camshaft through a hardened sintered iron sprocket. The crankshaft sprocket is also hardened sintered iron, and is pressed onto the nose of the crankshaft. A rubber snubber is used to dampen chain motion.

PISTONS AND CONNECTING RODS

The pistons are cast aluminum with steel struts using two compression rings and one coil control ring. The piston pin is offset 1.5mm towards the major thrust side. This allows a gradual change in thrust pressure against the cylinder wall as the piston travels its path. Pins are chromium steel and have a floating fit in the pistons. They are retained in the connecting rods by a press fit.

Connecting rods are made of forged steel. Full pressure lubrication is directed to the connecting rods by drilled oil passages from the adjacent main bearing journal.

VALVE TRAIN

A very simple ball pivot-type train is used. Motion is transmitted from the camshaft through the hydraulic lifter and push rod to the rocker arm. The rocker arm pivots on its ball and transmits the camshaft motion to the valve. The rocker arm ball locates on a stud, threaded into the head, and is retained by a nut. The push rod is located by a guide plate held under the rocker arm stud, assuring that the rocker arm operates in the plane of the valve.

INTAKE MANIFOLD

The intake manifold is a three piece cast aluminum unit. It centrally supports a fuel rail with 6 fuel injectors.

EXHAUST MANIFOLDS

The exhaust manifolds are cast nodular iron.

ENGINE LUBRICATION (FIGURES 6A2-1 THRU 6A2-4)

Full pressure lubrication, through a full flow oil filter is furnished by a gear type oil pump. Oil is drawn up through the pick up screen and tube and passed through the pump to the oil filter.

The oil filter is a full flow paper element unit. An oil filter by-pass is used to ensure adequate oil supply should the filter develope excessive pressure drop. The by-pass is designed to open at 69-83 kPa.

From the filter, oil is routed to the main oil gallery, rifle drilled above the camshaft to the left of the camshaft centerline. This gallery supplies the left bank hydraulic lifters with oil.

From the left gallery oil is directed, by means of interesting passages to the camshaft bearings and right oil gallery.

The hydraulic lifters pump oil up through the push rods to the rocker arms. Oil draining back from the rocker arms is directed, by cast dams which are part of the crankcase casting, to supply the camshaft lobes.

The passages supplying oil to the camshaft bearings also supply the crankshaft main bearings through intersecting vertical drilled holes. Oil from the crankshaft main bearings is supplied to the connecting rod bearings by means of intersecting passages drilled in the crankshaft.

Oil also drains past specific hydraulic lifter flats to oil camshaft lobes directly.

The front cam bearing has a .25mm deep slot on its outside diameter to supply oil to the cam sprocket thrust face.

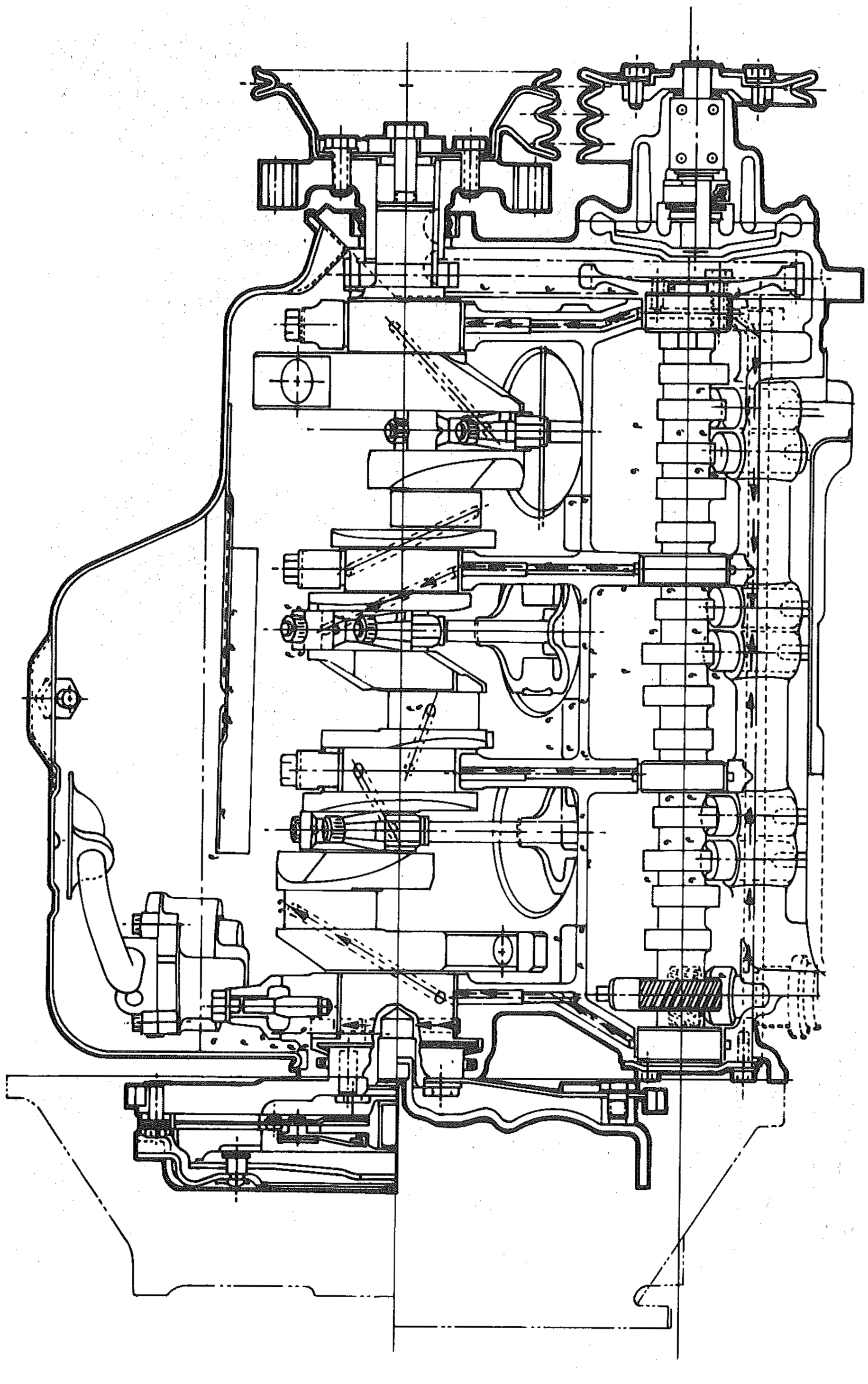


Figure 6A2-1 Engine Lubrication (1 of 4)

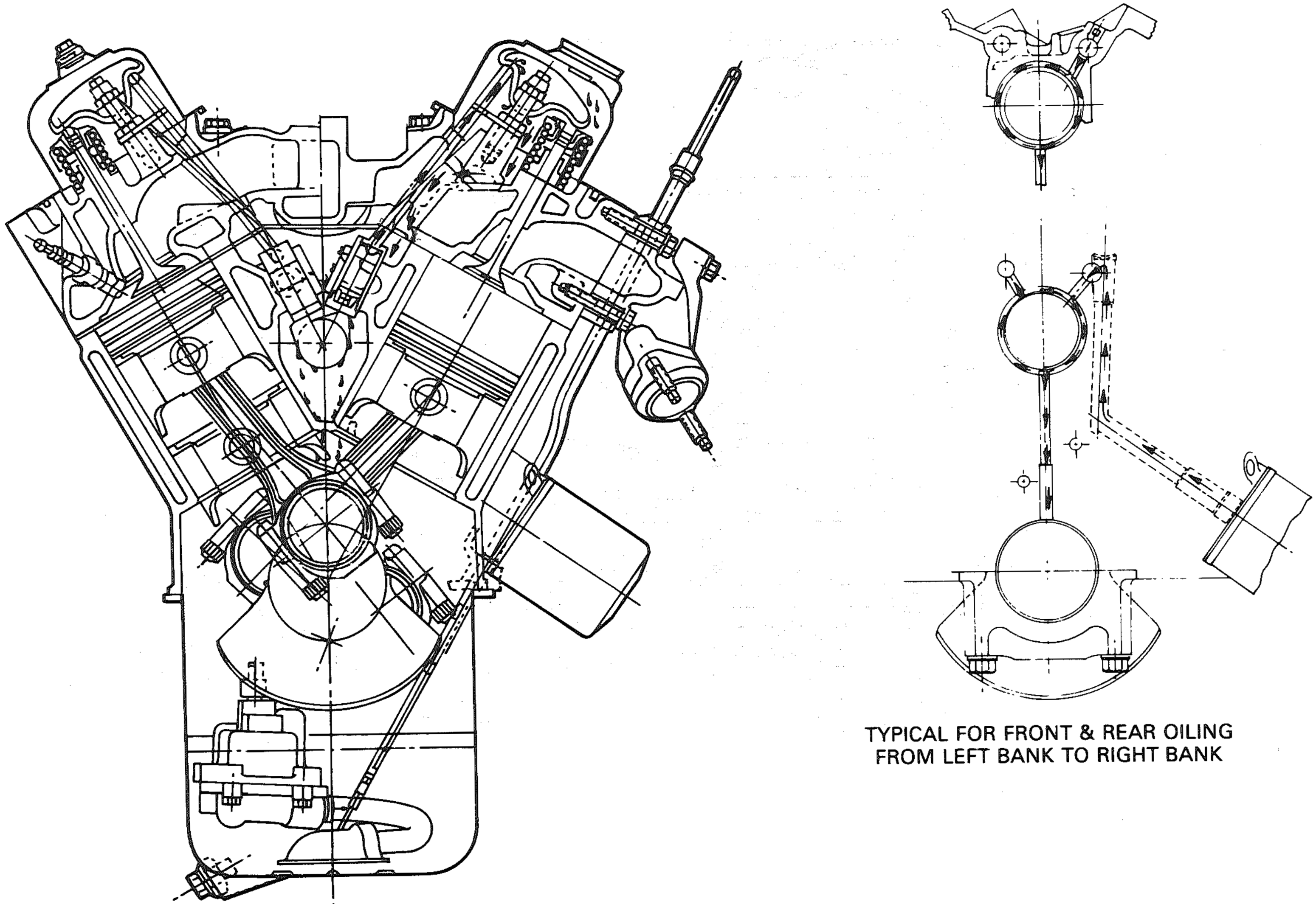


Figure 6A2-2 Engine Lubrication (2 of 4)

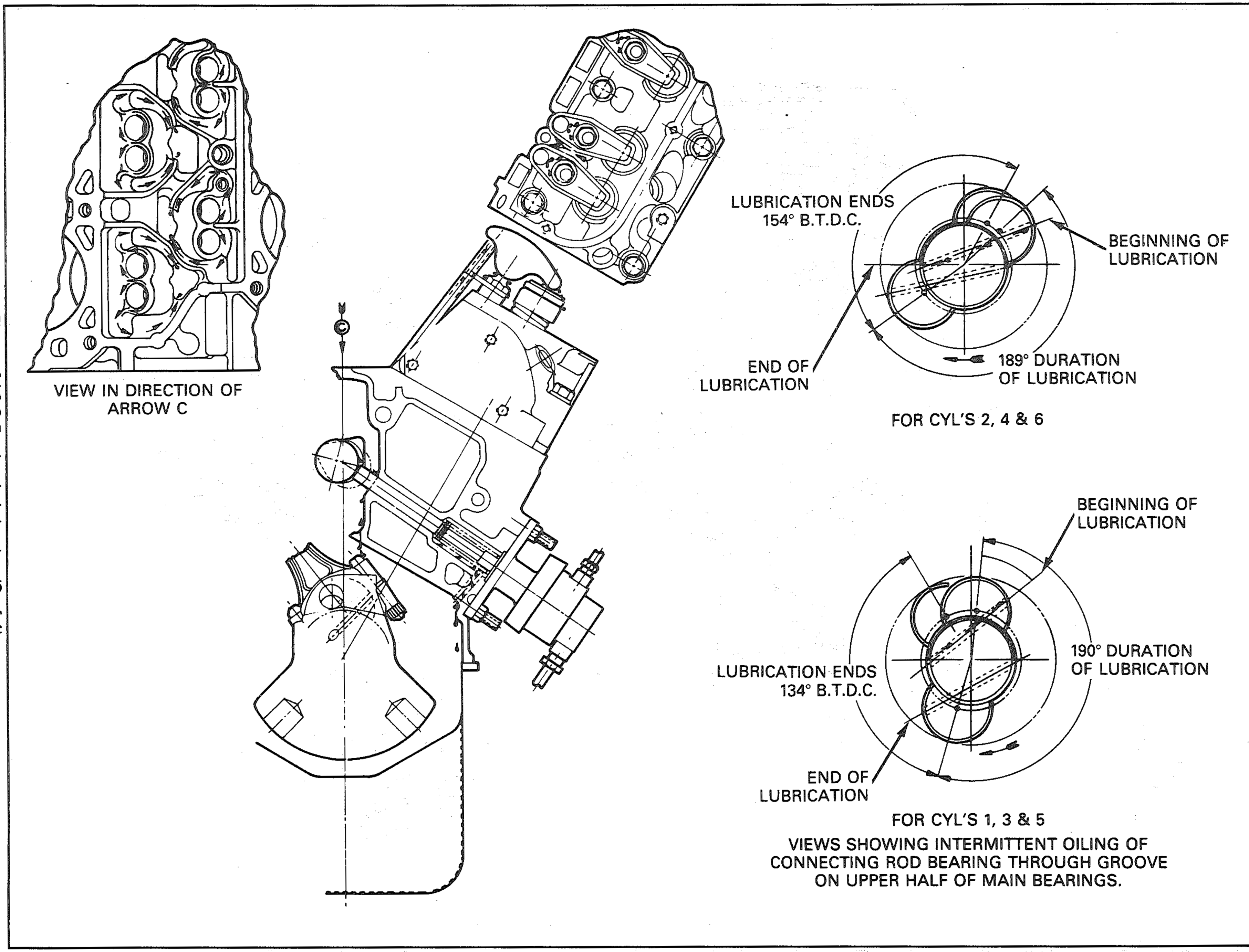


Figure 6A2-3 Engine Lubrication (3 of 4)

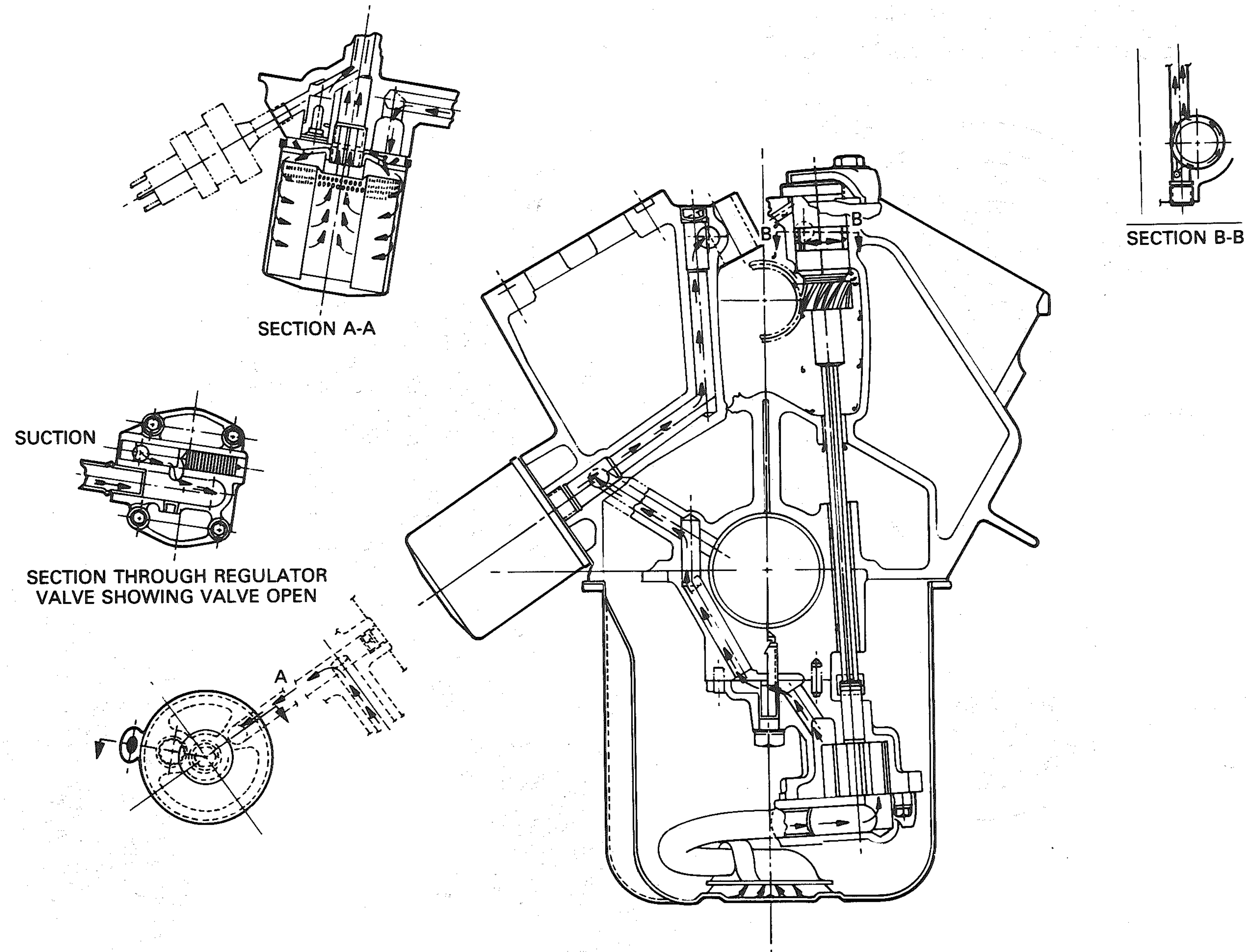


Figure 6A2-4 Engine Lubrication (4 of 4)

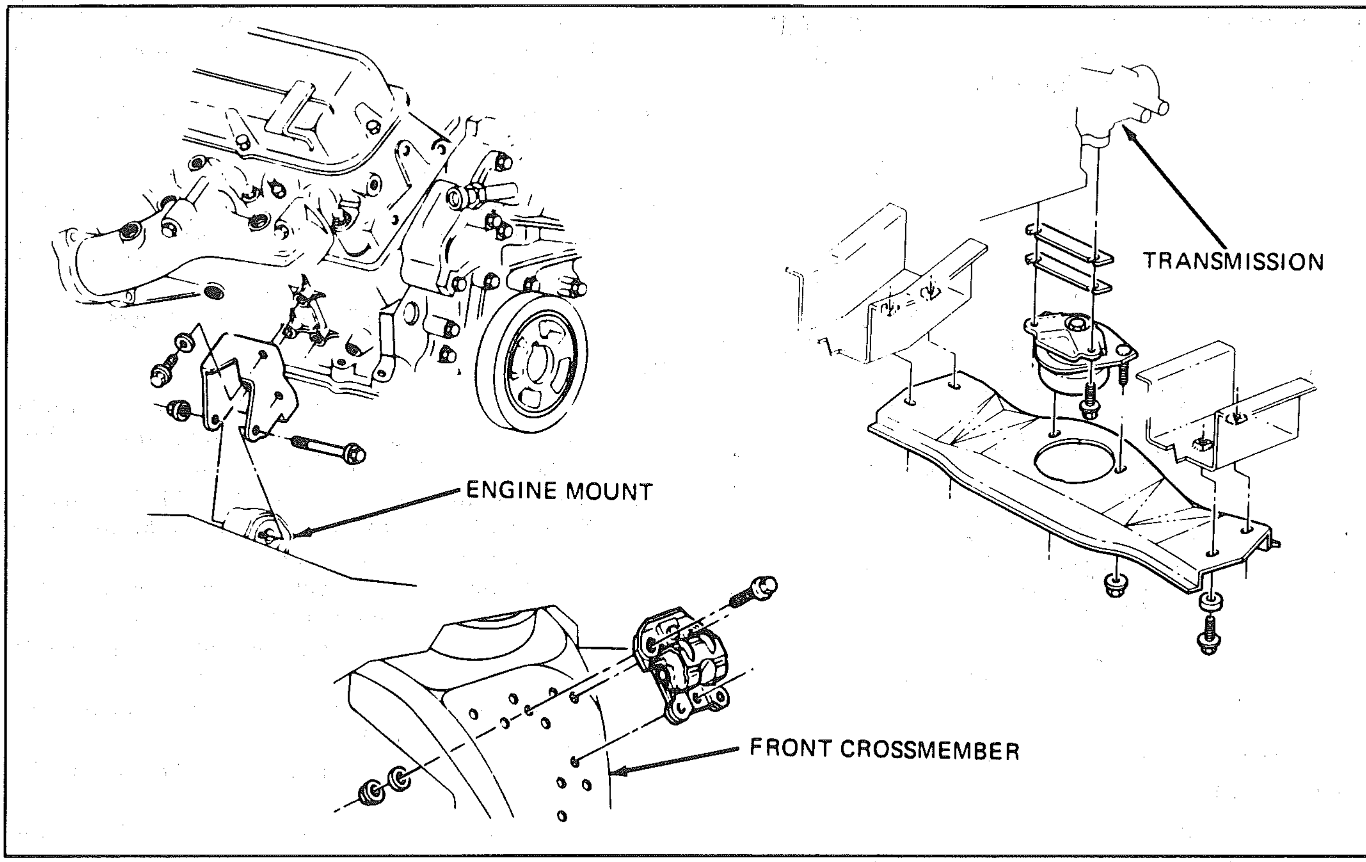


Figure 6A2-5 Engine Mounting

ON-VEHICLE SERVICE

POWERTRAIN MOUNTS

Engine mounts (Figure 6A2-5) are the nonadjustable type and seldom require service. Broken or deteriorated mounts should be replaced immediately, because of the added strain placed on other mounts and drive line components.

Checking Engine Mounts

Front Mount

Raise the engine to remove weight from the mounts and to place a slight tension in the rubber. Observe both mounts while raising engine. If an engine mount exhibits:

a. Hard rubber surface covered with heat check cracks;
b. Rubber separated from a metal plate of the mount;
c. Rubber split through center, replace the mount. If there is relative movement between a metal plate of the mount and its attaching points, lower the engine on the mounts and tighten the screws or nuts attaching the mount to the engine, frame, or bracket.

Rear Mount

Raise the vehicle on a hoist. Push up and pull down on the transmission tailshaft while observing the transmission mount. If the rubber separates from the metal plate of the mount or if the tailshaft moves up but not down (mount bottomed out), replace the mount. If there is relative movement between a metal plate of the mount and its attaching point, tighten the screws or nuts attaching the mount to the transmission or crossmember.

Front Mount Replacement

1. Disconnect battery.
2. Remove top half of fan shroud.
3. Raise vehicle.
4. Remove mount through bolt.
5. Raise front of engine and remove mount-to-engine bolts and remove mount.

NOTICE: Raise engine only enough for sufficient clearance. Check for interference between rear of engine and cowl panel which could cause distributor damage.

6. Replace mount to engine and lower engine into place.
7. Install retaining bolt and torque all bolts to specifications.

Rear Mount Replacement

1. Disconnect battery.
2. Raise vehicle.
3. Remove mount and support nuts.
4. Raise transmission.
5. Remove mount.

6. Install new mount.
7. Lower transmission.
8. Torque nuts to specifications.

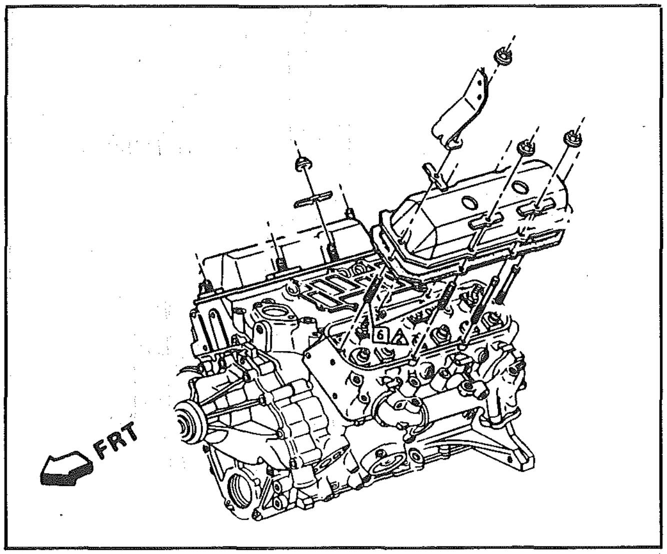


Figure 6A2-6 Rocker Arm Cover

ROCKER ARM COVER

Removal (Left)

1. Disconnect battery.
2. Disconnect air management hose (manual transmission only).
3. Remove plenum and runners and disconnect throttle body per Section 6E3.
4. Remove A/C bracket.
5. Remove rocker cover reinforcements and nuts.
6. Remove cover. If cover adheres to cylinder head, shear off by bumping end of rocker arm cover with palm of hand or rubber mallet. If cover still will not come loose, CAREFULLY pry until loose. DO NOT DISTORT SEALING FLANGE. It may be necessary to remove the two spark plug wire harness studs in order to get the rocker cover past the windshield wiper motor.

Installation (Left)

1. Clean sealing surface on cylinder head, intake manifold and rocker cover. Make sure sealing flange or rocker cover is not bent.
2. Place a 3mm diameter (1/8") dot of RTV sealant, #1052917 or equivalent, at the intake manifold and cylinder head splitline.
3. Install rocker cover gasket over studs in the manifold and cylinder head.
4. Install the reinforcements and nuts and torque to 8-20 N·m (6-14 ft. lbs.).
5. Install the plenum and runners and connect the throttle body as per Section 6E3.
6. Connect air management hose (manual transmission only).
7. Install A/C bracket.
8. Connect battery.

Removal (Right)

1. Disconnect battery.
2. Remove EGR valve transfer tube from plenum.
3. Remove coil and coil mounting bracket from cylinder head.
4. Remove plenum and runners and disconnect throttle body per Section 6E3.
5. Remove rocker cover retainers and nuts.
6. Remove cover. If cover adheres to cylinder head, shear off by bumping end of rocker cover with palm of hand or rubber mallet. If cover still does not come loose, CAREFULLY pry until loose. DO NOT DISTORT SEALING FLANGE.

Installation (Right)

1. Clean sealing surface on cylinder head, intake manifold, and rocker cover. Make sure sealing flange or rocker cover is not bent.
2. Place a 3mm diameter (1/8") dot of RTV sealant, #1052917 or equivalent, at the intake manifold and cylinder head splitline.
3. Install rocker cover gasket over studs in the manifold and cylinder head.
4. Install the load spreaders and nuts and torque to 90 in. lbs.
5. Install plenum and runners and connect throttle body per Section 6E3.
6. Install coil and coil mounting bracket at cylinder head.
7. Install EGR valve and transfer tube at plenum.
8. Connect battery.

NOTE APPLY A SMOOTH CONTINUOUS BEAD APPROX 2.0-3.0 WIDE AND 3.0-5.0 THICK ON BOTH SURFACES. BEAD CONFIGURATION MUST INSURE COMPLETE SEALING OF WATER AND OIL. SURFACE MUST BE FREE OF OIL AND DIRT TO INSURE ADEQUATE SEAL.

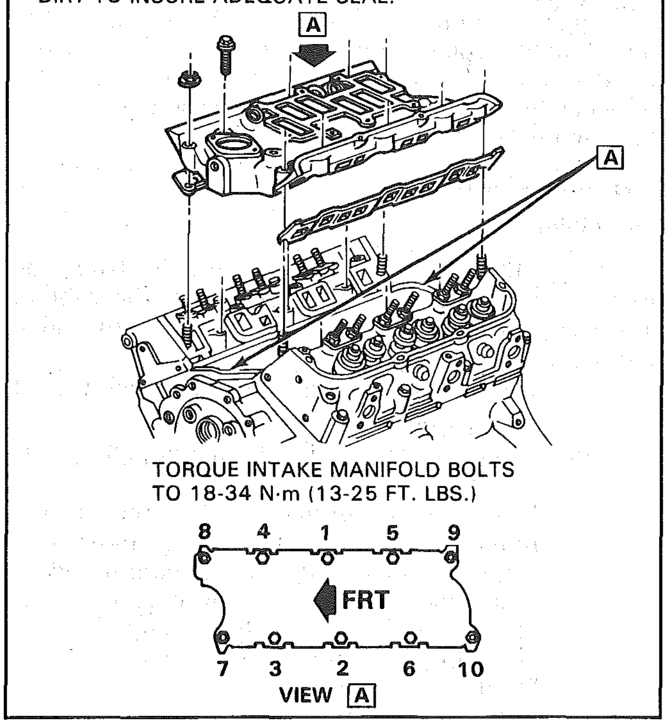


Figure 6A2-7 Intake Manifold

INTAKE MANIFOLD (FIGURE 6A2-7)

Removal

1. Disconnect battery.
2. Remove air cleaner.
3. Drain coolant.
4. Refer to Section 6E3 for removal of the following PFI sub-assemblies.
   - Plenum
   - Fuel Rail
   - Runner
5. Disconnect spark plug wires at spark plugs.
6. Disconnect wires at coil.
7. Remove distributor cap and spark plug wires.
8. Mark distributor position and remove hold down bracket.
9. Remove distributor.
10. Remove air management hose, manual transmission only.
11. Disconnect emission canister hoses. Remove pipe bracket (front left valve cover).
12. Remove left valve cover.
13. Remove air management bracket, manual transmission only.
14. Remove right valve cover.
15. Remove upper radiator hose.
16. Disconnect heater hose.
17. Disconnect coolant switches.
18. Remove manifold bolts.
19. Remove manifold. Discard manifold gaskets and remove loose RTV from front and rear ridges of cylinder case.

Installation

When installing intake gaskets, notice that the gaskets are marked Right Side and Left Side (carbureted only). Use them only as indicated to maintain designed efficiency of this engine.

1. Make sure that no oil or water is present on surface when new RTV is applied. Place a 5mm diameter (3/16") bead of RTV, #1052917 or equivalent, on each ridge.
2. Install new intake gaskets on cylinder heads. Hold in place by extending ridge RTV bead up 6mm onto the gasket ends. The new intake gaskets will have to be cut, where indicated, to install behind push rods. Cut only those areas that are necessary.
3. Install intake manifold on engine. Make sure areas between case ridges and intake are completely sealed.
4. Install manifold retaining bolts and nuts and torque in the sequence shown in Figure 6A2-7.
5. Install heater and radiator hose to manifold.
6. Install rocker covers as previously outlined.
7. Connect coolant switches.
8. Install air management bracket.
9. Install pipe bracket (front left rocker cover).
10. Install distributor, distributor cap and retaining nut. Do not tighten.
11. Refer to Section 6E3 for installation of PFI sub-assemblies removed.
12. Connect necessary wires and hoses.
13. Fill cooling system with the proper mixture of ethylene glycol anti-freeze and water. Do not install radiator cap.
14. Start engine, set intitial timing. After set, torque distibutor hold down clamp bolt to 34 N·m (25 lb. ft.). Recheck timing after torquing bolt.
15. Let engine run until radiator upper hose becomes hot (thermostat open).
16. With engine idling, add coolant to radiator, if necessary, until level reaches bottom of filler neck.
17. Install radiator cap, making sure arrows on cap line up with overflow tube.

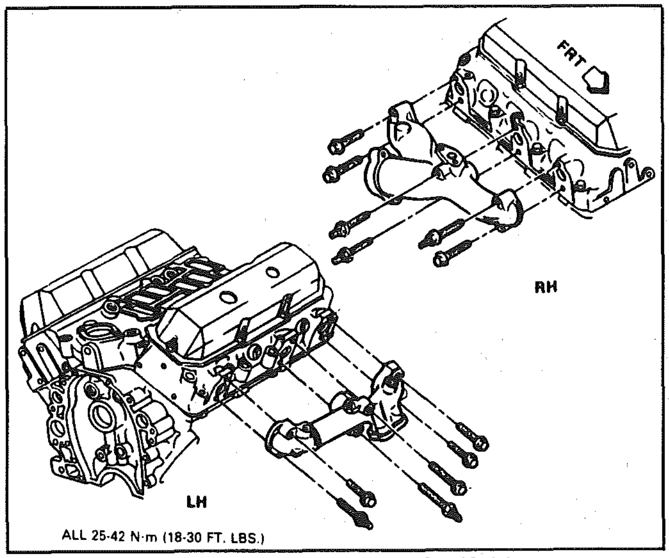


Figure 6A2-8 Exhaust Manifold

EXHAUST MANIFOLD (FIGURE 6A2-8)

Removal (Left)

1. Disconnect battery.
2. Raise vehicle.
3. Disconnect exhaust pipe.
4. Remove (4) rear manifold bolts and (1) nut.
5. Lower vehicle.
6. Disconnect air management, hoses and wires.
7. Remove power steering and fuel line bracket.
8. Remove manifold.

Installation (Left)

1. Clean mating surfaces on manifold and head, then install manifold in position and install bolts.
2. Torque manifold bolts to 34 N·m (25 ft. lbs.).
3. Install power steering bracket.
4. Raise vehicle.
5. Install exhaust pipe.
6. Lower vehicle.
7. Connect battery.

Removal (Right)

1. Disconnect battery.
2. Raise vehicle.
3. Disconnect exhaust pipe.
4. Lower vehicle.

5. Remove air management valve from A.I.R. pump.
6. Remove alternator bracket.
7. Remove exhaust manifold bolts.
8. Disconnect air management hose.
9. Remove manifold.

Installation (Right)

1. Clean mating surfaces on manifold and head, then install manifold in position and install bolts.
2. Torque manifold bolts to 34 N·m (25 ft. lbs.).
3. Attach air management hose.
4. Raise vehicle.
5. Install exhaust pipes.
6. Lower vehicle.
7. Install alternator bracket.
8. Install air management valve.
7. Connect battery.

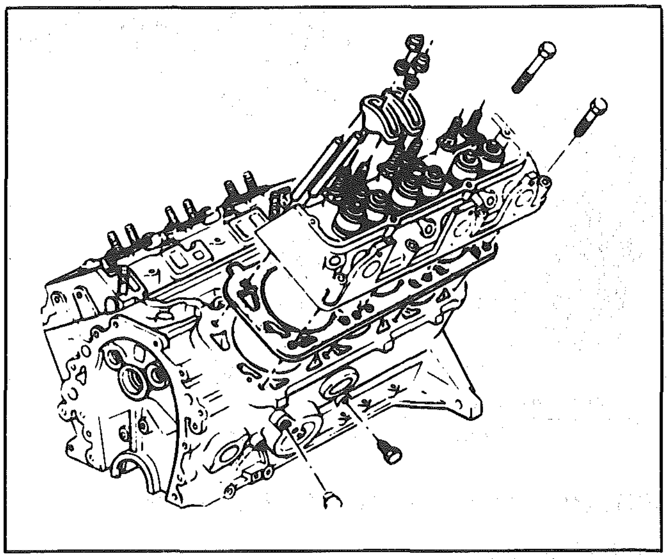


Figure 6A2-9 Rocker Arm and Push Rods

ROCKER ARM AND PUSH ROD (FIGURE 6A2-9)

Removal

1. Remove rocker arm cover as previously outlined.
2. Remove rocker arm nuts, rocker arm balls, rocker arms and push rods. Place components in a rack so they can be reinstalled in the same location.

Installation and Adjustment

Whenever new rocker arms and/or rocker arm balls are being installed, coat bearing surfaces of rocker arms and rocker balls with a thin even coating of "Molykote" or its equivalent.

1. Install push rods. Be sure push rods seat in lifter.
2. Install rocker arms, rocker arm balls and rocker arm nuts. Tighten rocker arm nuts until all lash is eliminated.
3. Adjust valves when lifter is on base circle of camshaft lobe as follows:
   a. Crank engine until mark on torsional damper lines up with "O" mark on the timing tab. The engine should also be in the #1 firing position. This may be determined

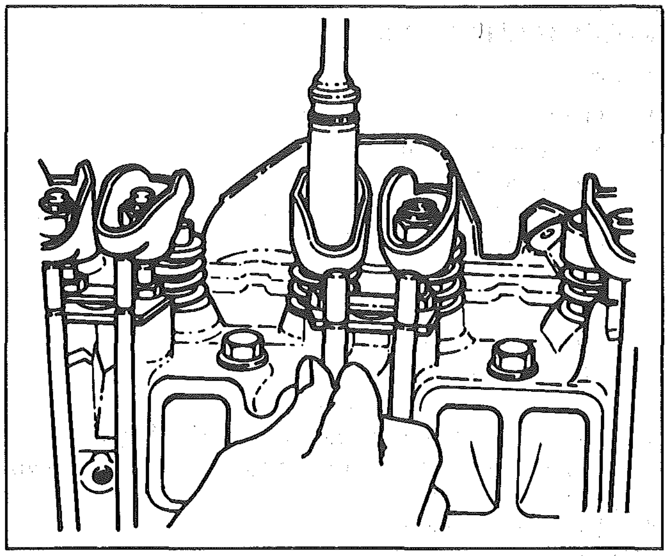


Figure 6A2-10 Adjusting Valve Lash

   by placing fingers on the #1 rocker arms as the mark on the damper comes near the "O" mark. If the valves are not moving, the engine is in the #1 firing position. If the valves move as the mark comes up to the timing tab, the engine is in the #4 firing position and should be rotated one revolution to reach the #1 position.
   b. With the engine in the #1 firing position, the following valves may be adjusted.
   Exhaust 1, 2, 3
   Intake 1, 5, 6
   c. Back out adjusting nut until lash is felt at the push rod, then turn in adjusting nut until all lash is removed (Figure 6A2-10). (This can be determined by rotating push rod while turning adjusting nut). When lash has been removed, turn adjusting nut in 1-1/2 additional turns (to center lifter plunger).
   d. Crank the engine one revolution until the timing tab "O" mark and torsional damper mark are again in alignment. This is the #4 firing position. With the engine in this position, the following valves may be adjusted:
   Exhaust 4, 5, 6
   Intake 2, 3, 4
4. Install rocker arm covers as previously outlined.
5. Start engine and check timing and idle speed.

VALVE MECHANISM

Valve Stem Oil Seal and/or Valve Spring (Figure 6A2-12)

Removal

1. Remove rocker arm cover as previously outlined.
2. Remove spark plug, rocker arm and push rod on the cylinder(s) to be serviced.
3. Install air line adapter Tool J-23590 to spark plug port and apply compressed air to hold the valves in place.

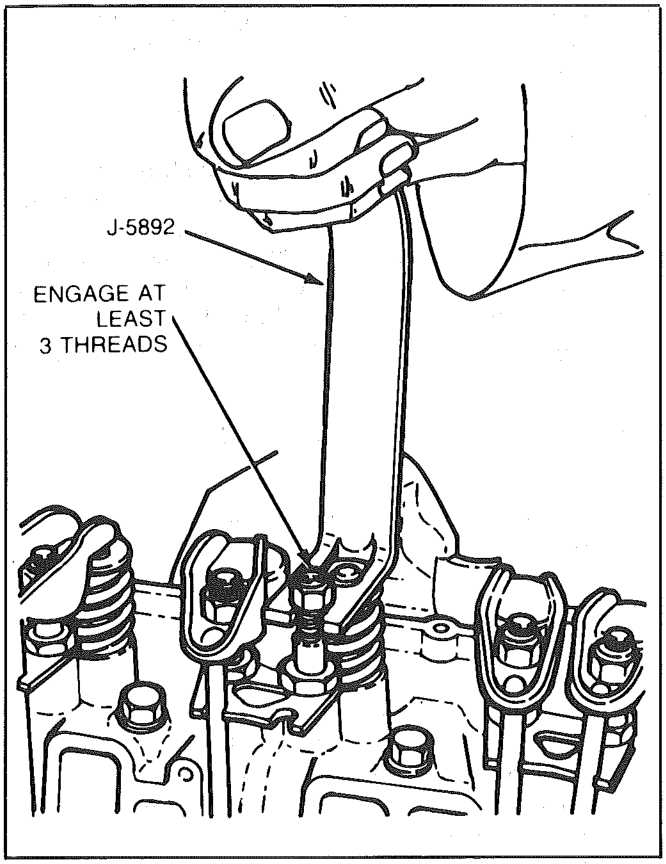


Figure 6A2-11 Depressing Valve Spring

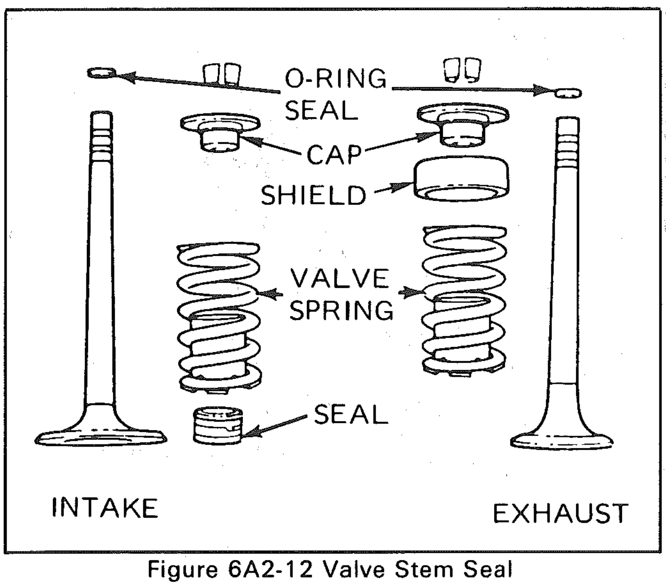


Figure 6A2-12 Valve Stem Seal

4. Using Tool J-5892 to compress the valve spring, remove the valve locks, valve cap, oil shedder (exhaust only) and valve spring and damper (Figure 6A2-11).
5. Remove the valve stem oil seal.

Installation

1. Set the valve spring and damper around the valve guide boss.
2. Install a valve stem seal over the valve stem and valve guide base inlet only.
3. Drop an oil shedder and valve rotator over the exhaust and a valve spring cap over the valve spring.
4. Using Tool J-5892, compress the valve spring.
5. Install the square cut "O" ring around the valve stem in the lower groove, making sure it is not twisted.
6. Insert valve stem key locks and release tool.

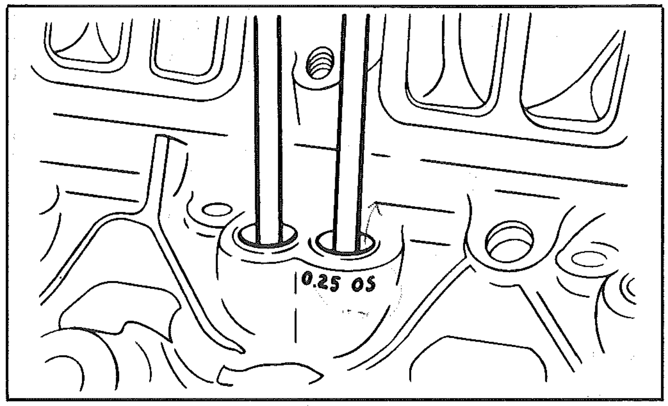


Figure 6A2-13 Oversize Lifter Marking

Valve Lifters (6A2-14)

Hydraulic valve lifters very seldom require attention. The lifters are extremely simple in design, readjustments are not necessary, and servicing of the lifters requires only that care and cleanliness be exercised in the handling of parts. Valve lifters should be kept in order so they may be reinstalled in their original position. Some engines will have both standard and .010" oversize valve lifters.

The cylinder case will be marked, where the O.S. lifters are used, with a dab of white paint and 0.25 (mm) O.S. stamped on the lifter boss (Figure 6A2-13).

If for any reason, the lifters are removed, it is important that all lifters be reinstalled in their original location. If replacement is necessary, lifters with a narrow flat along the lower 3/4 of the length should be used. This provides additional area to the cam lobe and lifter surfaces.

Removal

1. Remove rocker arm covers and intake manifold as previously outlined.
2. Remove rocker arm nuts, rocker arm balls, rocker arms and push rods. Place components in a rack so they can be reinstalled in the same location.
3. Remove lifters.

Installation

1. Install valve lifters. Whenever new valve lifters are being installed, coat foot of valve lifters with "Molykote" or its equivalent. Make sure lifter foot is convex.

   Lifter foot is very slightly convex. It can be detected by holding a good straight edge to the surface and looking into a light source.
2. Install intake manifold as previously outlined.
3. Install and adjust valve mechanism as previously outlined.

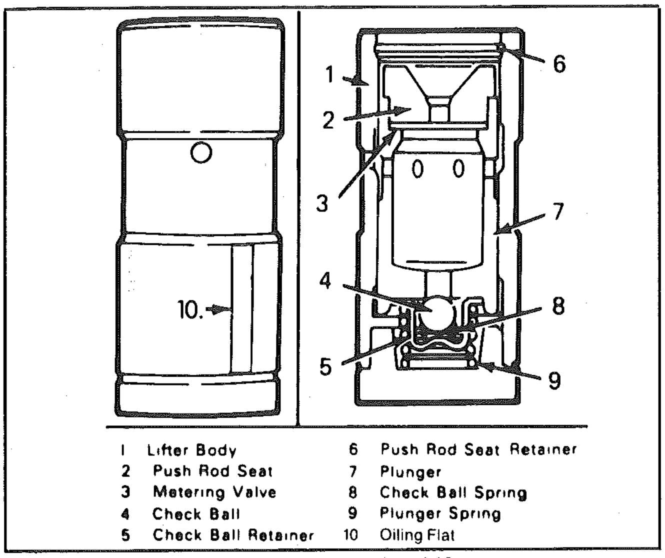


Figure 6A2-14 Valve Lifter

Disassembly

1. Hold the plunger down with a push rod, and using the blade of a small screw driver, remove the push rod seat retainer.
2. Remove the push rod seat and metering valve.
3. Remove the plunger, ball check valve assembly and the plunger spring.
4. Remove the ball check valve and spring by prying the ball retainer loose from the plunger with the blade of a small screw driver.

Cleaning and Inspection

Thoroughly clean all parts in cleaning solvent, and inspect them carefully. If any parts are damaged or worn, the entire lifter assembly should be replaced. If the lifter body wall is scuffed or worn, inspect the cylinder block lifter bore. If the bottom of the lifter is scuffed or worn, inspect the camshaft lobe. If the push rod seat is scuffed or worn, inspect the push rod. An additive containing EP lube, such as EOS, should always be added to crankcase oil for run-in when any new camshaft or lifters are installed. All damaged or worn lifters should be replaced. For proper lifter rotation during engine operation, lifter foot must be convex.

Assembly

1. Place the check ball on small hole in bottom of the plunger.
2. Insert check ball spring on seat in ball retainer and place retainer over ball so that spring rests on the ball. Carefully press the retainer into position in plunger with the blade of a small screw driver.
3. Place the plunger spring over the ball retainer and slide the lifter body over the spring and plunger, being careful to line up the oil feed holes in the lifter body and plunger.
4. Fill the assembly with SAE 10 oil, then insert the end of a 1/8" drift pin into the plunger and press down solid. Do not attempt to force or pump the plunger. At this point, oil holes in the lifter body and plunger assembly will be aligned.
5. Insert a 1/16" drift pin through both oil holes to hold the plunger down against the lifter spring tension.
6. Remove the 1/8" drift pin, refill assembly with SAE 10 oil.
7. Install the metering valve and push rod seat.
8. Install the push rod seat retainer, press down on the push rod seat and remove the 1/16" drift pin from the oil holes. The lifter is now completely assembled, filled with oil and ready for installation. Before installing lifters, coat the bottom of the lifter with "Molykote" or its equivalent.

CYLINDER HEAD (FIGURE 6A2-15)

Removal (Left)

1. Remove intake manifold as previously outlined.
2. Raise vehicle.
3. Drain engine block.
4. Disconnect exhaust pipe.
5. Remove dipstick tube attachment.
6. Lower vehicle.
7. Remove serpentine belt.
8. Remove A/C compressor and lay aside.
9. Remove P/S pump and lay aside.
10. Loosen rocker arm until able to remove push rod.
11. Remove head bolts.
12. Remove head.

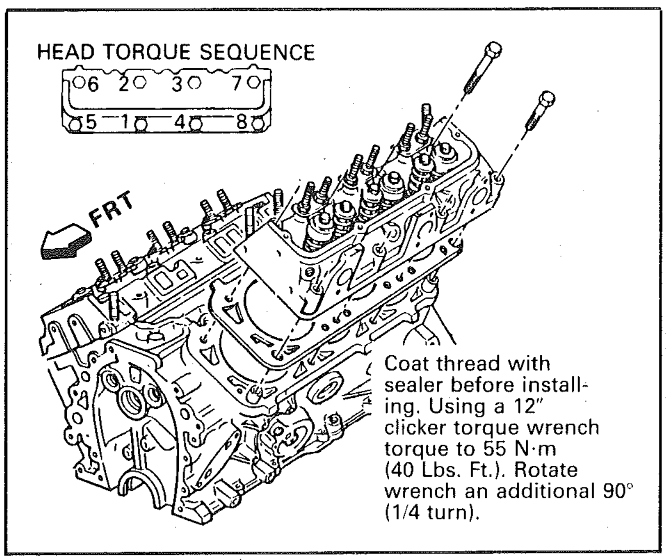


Figure 6A2-15 Cylinder Head Installation

Installation (Left)

The gasket surfaces on both head and cylinder case deck must be clean of any foreign matter and free of nicks of heavy scratches. Cylinder bolt threads in the case and threads on the cylinder head bolts must be clean. Dirt will affect bolt torque.

1. Place the gasket in position, over the dowel pins, with the note "This Side Up" showing.
2. Install cylinder head.
3. Coat cylinder head bolt threads with sealer, #1052080 or equivalent, and install bolts.

Torque bolts as shown in Figure 6A2-15.

4. Install push rods and loosely retain with rocker arms. Make sure lower ends of pushrods are in lifter seats.
5. Install intake manifold.
6. Raise vehicle.
7. Install dipstick tube bracket.
8. Connect exhaust pipe to exhaust manifold flange.
9. Lower vehicle.
10. Adjust valve lash as previously outlined.
11. Continue following intake manifold installation for build up.

Removal (Right)

1. Remove intake manifold as previously outlined.
2. Raise vehicle.
3. Disconnect exhaust pipe.
4. Drain engine block.
5. Lower vehicle.
6. Loosen rocker arms until able to remove push rod.
7. Remove serpentine belt.
8. Remove tensioner.
9. Remove A.I.R. bracket.
10. Remove generator bracket.
11. Remove head bolts.
12. Remove head.

Installation (Right)

The gasket surfaces on both the head and cylinder case deck must be clean of any foreign matter and free of nicks of heavy scratches. Cylinder bolt threads in the case and threads on the cylinder head bolts must be clean. Dirt will affect bolt torque.

1. Place the gasket in position, over the dowel pins, with the note "This Side Up" showing.
2. Install cylinder head.
3. Coat cylinder head bolt threads with sealer, #1052080 or equivalent, and install bolts. Torque bolts as shown in (Figure 6A2-15).
4. Install push rods and loosely retain with rocker arms. Make sure lower ends of push rods are in lifter seats.
5. Install intake manifold.
6. Raise vehicle.
7. Install exhaust pipe to exhaust manifold flange.
8. Lower vehicle.
9. Adjust valve lash as previously outlined.
10. Install AIR bracket.
11. Install tensioner.
12. Install generator bracket.
13. Continue following intake manifold installation for build up.

Disassembly

1. With cylinder head removed, remove rocker arm nuts, balls and rocker arms (if not previously done).
2. Using tool J-8062, compress the valve springs and remove valve keys. Release the compressor tool and remove spring caps, oil shedders, springs and damper assemblies, then remove oil seals.
3. Remove valves from cylinder head and place them in a rack so they can be installed in their original positions.

Cleaning and Inspection

1. Clean all carbon from combustion chambers and valve ports using 'tool J-8089.
2. Thoroughly clean valve guides using J-8101.
3. Clean all carbon and sludge from push rods, rocker arms and push rod guides.
4. Clean valve stems and heads on a buffing wheel.
5. Clean carbon deposits from head gasket mating surface.
6. Inspect cylinder head for cracks in the exhaust ports, combustion chambers, or external cracks to the water jacket.
7. Inspect the valves for burned heads, cracked faces or damaged stems.

NOTICE: Excessive valve stem to bore clearance will cause high oil consumption and may cause valve breakage. Insufficient clearance will result in noise and sticky functioning of the valve and disturb engine smoothness.

8. Measure valve stem clearance as follows:
   a. Clamp a dial indicator on one side of the cylinder head. Locate the indicator so that movement of the valve stem from side to side (crosswise to the head) will cause direct movement of the indicator stem. The indicator stem must contact the side of the valve stem just above the guide.
   b. Drop the valve head 1.5mm off the valve seat.
   c. Move the stem of the valve from side to side, using light pressure, to obtain a clearance reading. If clearance exceeds specifications, it will be necessary to ream valve guides for oversize valves. Service valves are available in std., 089, .394 and .775mm O.S. sizes.
9. Check valve spring tension with tool J-8056, spring tester. Springs should be compressed to the specified height and checked against the specifications chart. Springs should be replaced if not within 44 N (10 lbs.) of the specified load (without dampers).
10. Inspect rocker arm studs for wear or damage.

ROCKER ARM STUDS

Cylinder heads use threaded rocker arm studs. Rocker arm studs that have damaged threads should be replaced with new studs. If, for some reason, the threads in the head are damaged or stripped, the head can be retapped, and a helical type insert added. If such an insert is not available, the head should be replaced.

VALVE GUIDES

Valves with oversize stems are available in .089, .394 and .775mm over sizes. To ream the valve guide bores for oversize valves use tool J-5330-1, 2 or 3, respectively.

VALVE SEATS

Reconditioning the valve seats is very important, because the seating of the valves must be perfect for the engine to deliver the power and performance designed into it.

Another important factor is the cooling of the valve heads. Good contact between each valve and its seat in the head is imperative to insure that the heat in the valve head will be properly carried away.

Several different types of equipment are available for reseating valve seats. The recommendations of the manufacturer of the equipment being used should be carefully followed to attain proper results.

VALVES

Valves that are pitted can be refaced, to the proper angle, insuring correct relation between the head and stem, on a valve refacing machine. Valve stems which show excessive wear, or valves that are warped excessively should be replaced. When a valve head which is warped excessively is refaced, a knife edge will be ground on part or all of the valve head due to the amount of metal that must be removed to completely reface the valve. Knife edges lead to breakage, burning or preignition due to heat localizing on this knife edge. If the edge of the valve head is less than .8mm thick after grinding, replace the valve.

Several different types of equipment are available for refacing valves. The recommendations of the manufacturer of the equipment being used should be carefully followed to attain the proper results.

Assembly

1. Insert a valve in the proper port.
2. Install a valve stem seal over the valve stem and valve guide base inlet only.
3. Drop an oil shedder and valve rotator over the exhaust and a valve spring cap over the valve spring.
4. Using tool J-8062 compress the valve spring.
5. Install the square cut "O" ring around the valve stem in the lower groove, making sure it is not twisted.
6. Insert valve, stem key locks and release tool.
7. Install the valve locks and release the compressor tool making sure that the locks seat properly in the upper groove of the valve stem. Grease may be used to hold the locks in place while releasing the compressor tool.
8. Install the remaining valves.
9. Check each valve stem oil seal by placing valve stem leak detector, tool J-23994, over the end of the valve stem and against the cap. Operate the vacuum pump and make sure no air leaks pass the seal.
10. Check the installed height of the valve springs, using a narrow thin scale. Measure from the top of the spring damper "feet" to the bottom inside of the oil shedder exhaust and from the top of the spring damper "feet" to the bottom of the valve

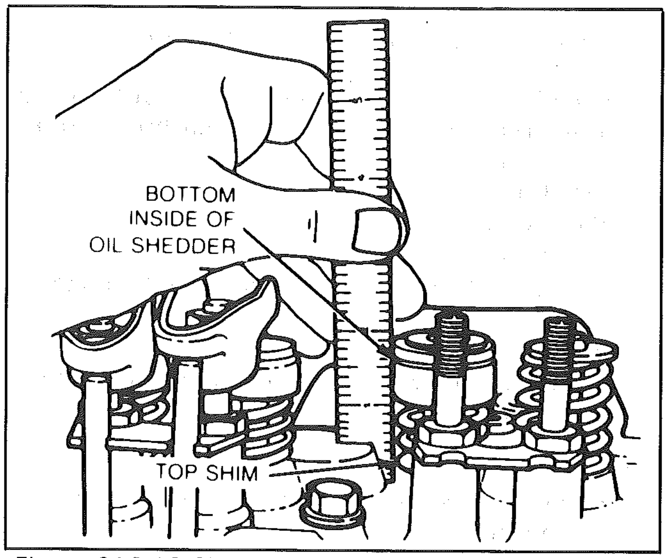


Figure 6A2-16 Checking Valve Spring Installed Height

cap for intake. If this is found to exceed the specified height, install valve spring seat shim approximately .75mm thick. At no time should the spring be shimmed to give an installed height under the minumum specified of 40mm.

TORSIONAL DAMPER

NOTICE: The inertial weight section of the torsional damper is assembled to the hub with a rubber sleeve. The removal and installation procedures (with proper tools) must be followed or movement of the inertia weight section the hub will destroy the tuning of the torsional damper and the engine timing reference.

Removal

1. Disconnect battery negative cable at battery.
2. Remove serpentine drive belt.
3. Raise vehicle.
4. Remove drive pulley and remove damper retaining bolt.
5. Install Tool J-23523 on damper and then turning puller screw, remove damper.

Installation

1. Coat front cover seal contact area (on damper) with engine oil.
2. Place damper in position over key on crankshaft.
3. Pull damper onto crankshaft as follows:
   a. Install Tool J-29113 into crankshaft so that at least 6mm of thread engagement is obtained.
   b. Pull damper into position and remove tool from damper.
4. Install drive pulley and damper retaining bolts. Torque to specifications.
5. Lower vehicle.
6. Install serpentine belt.
7. Connect battery negative cable.

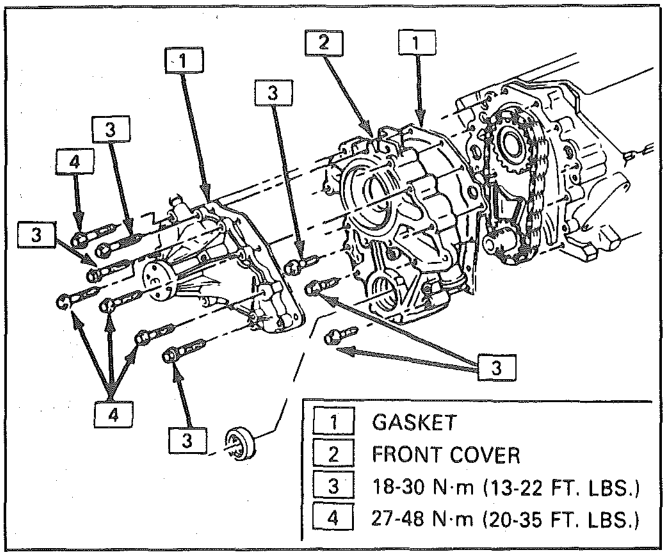


Figure 6A2-17 Water Pump/Front Cover Orientation

CRANKCASE FRONT COVER

Removal

1. Raise engine.
2. Remove oil pan.
3. Lower vehicle.
4. Remove water pump as outlined in Section 6B.
5. If A/C equipped, remove compressor from mounting bracket and lay aside. Then remove compressor mounting bracket.
6. Remove torsional damper as previously outlined.
7. Disconnect lower radiator hose at front cover and heater hose at water pump.
8. Remove remaining front cover bolts and remove cover.

Installation

1. Install new gasket. When installing new gasket, be sure sealing surfaces are clean. Care should be taken not to damage sealing surfaces.
2. Place front cover on the engine, install stud bolt and bolts, install water pump as outlined in Section 6B, install retaining bolts and nut and torque to specifications.
3. Connect lower radiator hose to front cover. Torque clamps to 3.5 N·m (30 lb. in.).
4. Install torsional damper as previously outlined.
5. Install water pump as outlined in Section 6B.
6. If A/C equipped, install compressor mounting bracket and install compressor.
7. Raise vehicle.
8. Inspect oil pan gasket replace if necessary.
9. Install oil pan.
10. Lower vehicle.
11. Install serpentine belt.
12. Fill cooling system. Leave radiator cap off.
13. Connect battery negative cable and start engine.
14. Run engine until upper radiator hose becomes hot (thermostat open).
15. Check coolant level and add as necessary.
16. Install radiator cap, making sure arrows on cap line up with overflow tube.

OIL SEAL (FRONT COVER)

Replacement

With Cover Removed

1. With cover removed, pry oil seal out of cover from the front with a large screw driver.
2. Install new seal so that open end of the seal is toward the inside of cover and drive it into position with Tool J-23042. Support cover at seal area. Pre-lube seal with engine oil prior to installation of torsional damper.

With Cover Installed

1. With torsional damper removed, pry seal out of cover from the front with a large screw driver, being careful not to damage the surface on the crankshaft.
2. Install new seal so that open end of seal is toward the inside of cover and drive it into position with Tool J-23042.

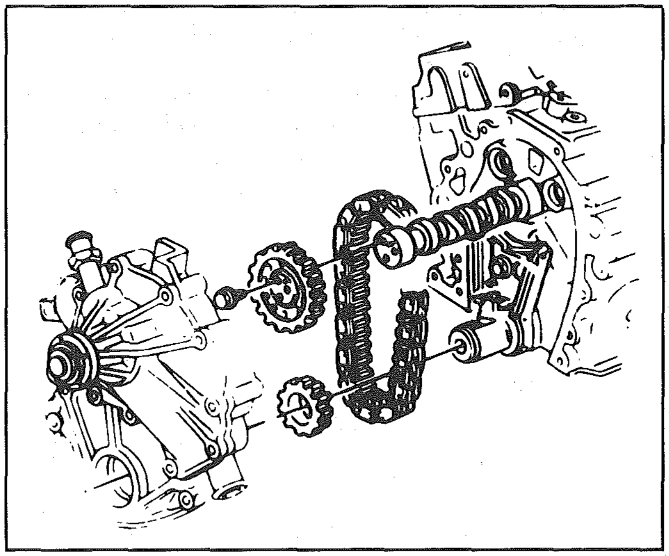


Figure 6A2-18 Timing Chain and Sprockets

TIMING CHAIN AND SPROCKET

Removal

1. Remove crankcase front cover as previously outlined.
2. Place #1 piston at top dead center with the marks on the camshaft and crankshaft sprockets aligned (#4 firing).
3. Remove camshaft sprocket bolts and remove camshaft sprocket and chain (Figure 6A2-18). Sprocket is a light fit on camshaft. If sprocket does not come off easily, a light blow on the lower edge of the sprocket (with a plastic mallet) should dislodge the sprocket.

Installation

1. Install timing chain on camshaft sprocket, lube thrust surface with Molykote or its equivalent. Hold the sprocket vertically with the chain hanging down and align the marks on the camshaft and crankshaft sprockets. (Refer to Figure 6A2-19).

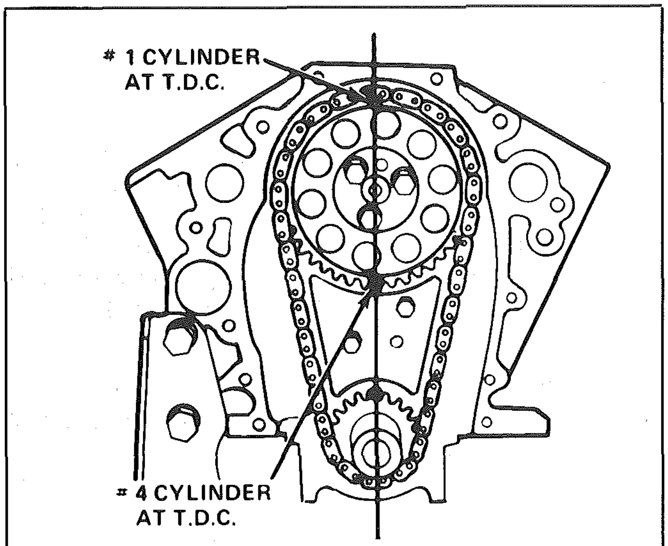


Figure 6A2-19 Camshaft Timing

2. Align dowel in camshaft with dowel hole in camshaft sprocket, then install sprocket on camshaft.
3. Draw the camshaft sprocket onto camshaft using the mounting bolts. Torque to specifications.
4. Lubricate timing chain with engine oil.
5. Install crankcase front cover as previously outlined.

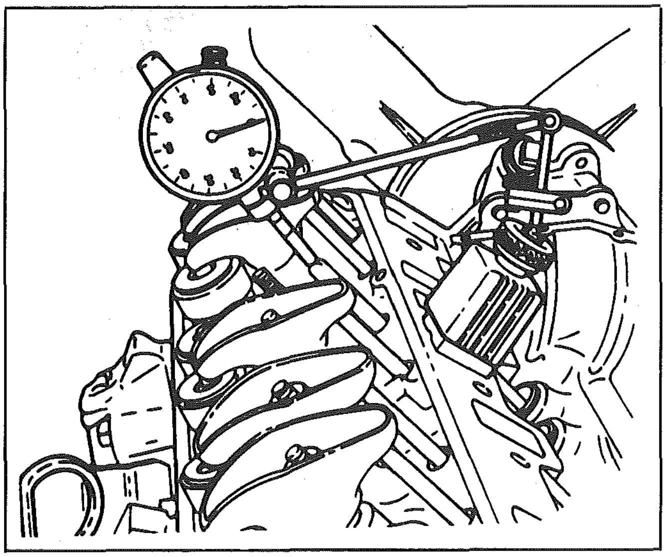


Figure 6A2-20 Measuring Camshaft Lobe Lift

CAMSHAFT

Measuring Lobe Lift Procedure is similar to that used for checking valve timing. If improper valve operation is indicated, measure the lift of each push rod in consecutive order and record the readings.

1. Remove the valve mechanism, as previously outlined.
2. Position indicator with ball socket adapater (Tool J-8520) on push rod. Make sure push rod is in the lifter socket.
3. Rotate the crankshaft slowly in the direction of rotation until the lifter is on the heel of the cam lobe. At this point, the push rod is in its lowest position.
4. Set the dial indicator on zero, then rotate the crankshaft slowly, or attach an auxiliary starter switch and "bump" the engine over, until the push rod is in the fully raised position (Figure 6A2-20).

   CAUTION: Whenever the engine is cranked remotely at the starter, with a special jumper cable or other means, the distributor primary lead must be disconnected from the coil to prevent electrical shock.
5. Compare the total lift recorded from the dial indicator with the specifications.
6. If camshaft readings for all lobes are within specifications, remove dial indicator assembly.
7. Install and adjust valve mechanism, as previously outlined.

Removal

1. Remove valve lifters as previously outlined.
2. Remove crankcase front cover as previously outlined.
3. Remove fuel pump and push rod.
4. Remove timing chain and sprocket as previously outlined.
5. Remove camshaft.

NOTICE: All camshaft journals are the same diameter and care must be exercised in removing camshaft to avoid damage to bearings.

Inspection

The camshaft bearing journals should be measured with a micrometer for an out-of-round condition. If the journals exceed .025mm out-of-round, the camshaft should be replaced.

Installation

Whenever a new camshaft is installed, coat camshaft lobes with GM E.O.S. or equivalent.

Whenever a new camshaft is installed, install new oil, new filter and replacement of all valve lifters is recommended to insure durability of the camshaft lobes and lifter feet.

1. Lubricate camshaft journals with engine oil and install camshaft.
2. Install timing chain, as previously outlined.
3. Install fuel pump push rod and fuel pump.
4. Install crankcase cover, as previously outlined.
5. Install lifters, as previously outlined.
6. Complete build up of engine.

CAMSHAFT BEARINGS

Removal

Camshaft bearings can be replaced while engine is disassembled for overhaul or without complete disassembly of the engine. To replace bearings without complete disassembly remove the camshaft and crankshaft leaving cylinder heads attached and pistons in place. Before removing crankshaft, tape threads of

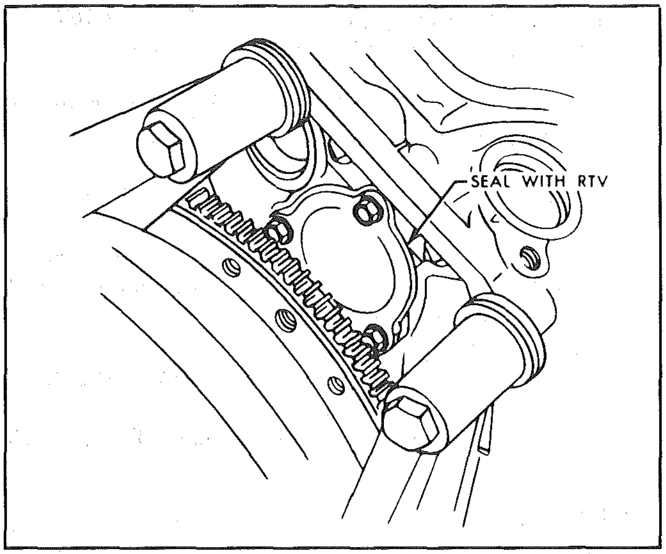


Figure 6A2-21 Camshaft Rear Cover

connecting rod bolts to prevent damage to crankshaft. Fasten connecting rods against sides of engine so they will not be in the way while replacing camshaft bearings.

1. With camshaft and crankshaft removed, remove camshaft rear cover from cylinder block (Figure 6A2-21).
2. Using Tool J-6098, with nut and thrust washer installed to end of threads, index pilot in camshaft front bearing and install puller screw through pilot.
3. Install remover and installer tool with shoulder toward bearing, making sure a sufficient amount of threads are engaged.
4. Using two wrenches, hold puller screw while turning nut. When bearing has been pulled from bore, remove remover and installer tool and bearing from puller screw.
5. Remove remaining bearings (except front and rear) in the same manner. It will be necessary to index pilot in camshaft rear bearing to remove the rear intermediate bearing.
6. Assemble remover and installer tool on driver handle and remove camshaft front and rear bearings by driving towards center of cylinder block.

Installation

1. Assemble remover and installer tool on driver handle and install camshaft bearings.
2. Using Tool Set J-6098, with nut then thrust washer installed to end of threads, index pilot in camshaft bearing and install puller screw through pilot.
3. Index camshaft bearing in bore with oil hole aligned at 2:30 o'clock on rear and intermediate bearing. Front bearing has oil holes at 1:00 o'clock and 2:30.
4. Using two wrenches, hold puller screw while turning nut. After bearing has been pulled into bore, remove the remover and installer tool from puller screw and check alignment of oil hole in camshaft bearing.
5. Install remaining bearings in the same manner.
6. Install the camshaft rear cover after applying a fresh 3mm diameter (1/8") bead of RTV, #1052917 or equivalent. Apply RTV or equivalent on engine block in machined groove. Sealant must be wet to touch when bolts are torqued.

NOTICE: Prior to rear cover installation check that the sealing surfaces on the cover and block are clean or free of oil. Be sure that all loose RTV is removed. Make sure that old RTV is removed from block groove and blind attaching holes.

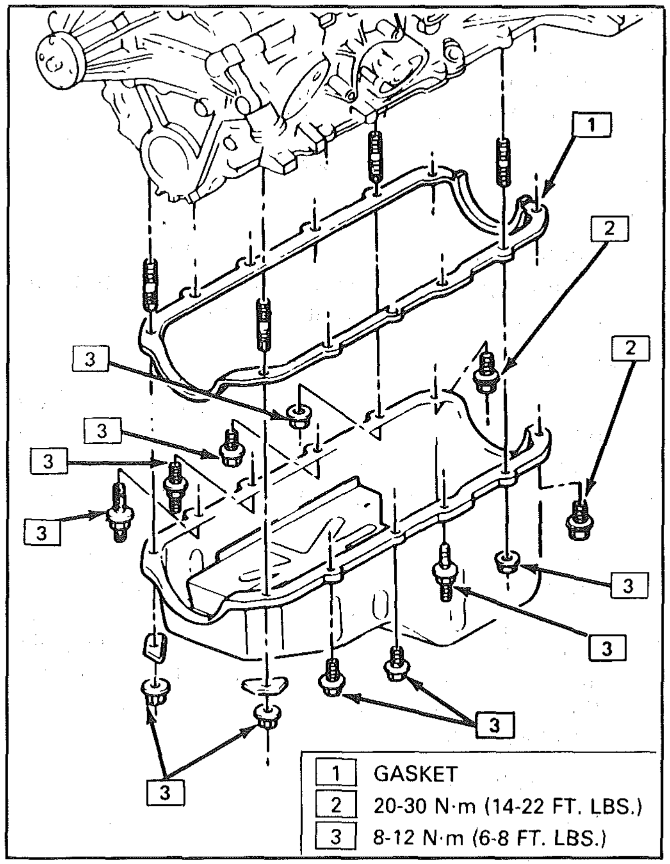


Figure 6A2-22 Oil Pan

OIL PAN (FIGURE 6A2-22)

Removal

1. Disconnect battery negative cable.
2. Remove air cleaner.
3. Remove distributor cap and lay aside.
4. Remove upper half of fan shroud.
5. Raise vehicle.
6. Drain engine oil.
7. Remove converter dust cover.
8. Remove exhaust pipe at manifolds.
9. Remove starter bolts and lay starter aside.
10. Remove motor mount through bolts.
11. Remove oil pan bolts.
12. Install jack and raise engine.
13. Remove oil pan.

Installation

1. Clean sealing surfaces on cylinder case and oil pan.
2. Install gasket and attach retaining bolts.
3. Remove jack and lower engine.
4. Install motor mount through bolts.
5. Install starter.
6. Install exhaust pipes.
7. Install converter dust cover.
8. Lower vehicle.
9. Install fan shroud.
10. Install distributor cap.
11. Refill crankcase.
12. Install air cleaner.
13. Connect battery.
14. Start engine, check for leaks.

OIL PUMP (FIGURE 6A2-22)

Removal

1. Remove oil pan as previously outlined.
2. Remove pump to rear main bearing cap bolt and remove pump and extension shaft.

Disassembly

1. Remove the pump cover attaching bolts and the pump cover. Mark gear teeth so they may be reassembled with the same teeth indexing.
2. Remove the idler gear and the drive gear and shaft from the pump body.
3. Remove the pressure regulator valve retaining pin pressure regulator spring and valve.
4. If the pickup screen and pipe assembly need replacing, mount the pump in a soft-jawed vise and extract pipe from pump cover. Do not disturb the pickup screen on the pipe. This is serviced as an assembly.

Cleaning and Inspection

1. Wash all parts in cleaning solvent and dry with compressed air.
2. Inspect the pump body and cover for cracks or excessive wear.
3. Inspect pump gears for damage or excessive wear. The pump gears and body are not serviced separately. If the pump gears or body are damaged or worn, replacement of the entire oil pump assembly is necessary.
4. Check the drive gear shaft for looseness in the pump body.
5. Inspect inside of pump cover for wear that would permit oil to leak past the ends of the gears.
6. Inspect the pickup screen and pipe assembly for damage to screen or pipe.
7. Check the pressure regulator valve for fit.

Assembly

1. If the pickup screen and pipe assembly was removed, it should be replaced with a new part. Loss of press fit condition could result in an air leak and loss of oil pressure. Mount the pump in a soft-jawed vise, apply sealer to outside diameter of swaged end of pipe, and using Tool J-8369 tap the pipe in place with a plastic hammer.

NOTICE: Be careful of twisting, shearing or collapsing pipe while installing in pump.

2. Install the pressure regulator valve and related parts.
3. Install the drive gear and shaft in the pump body.
4. Install the idler gear in the pump body in the original orientation.
5. Install cover gasket.
6. Install the pump cover and torque attaching screws to specifications.
7. Turn drive shaft by hand to check for smooth operation.

Installation

1. Assemble pump and extension shaft with retainer to rear main bearing cap, aligning top end of hexagon extension shaft with hexagon socket lower end of distributor drive gear.
2. Install pump to rear bearing cap bolt and torque to specifications.
3. Install oil pan as previously outlined.

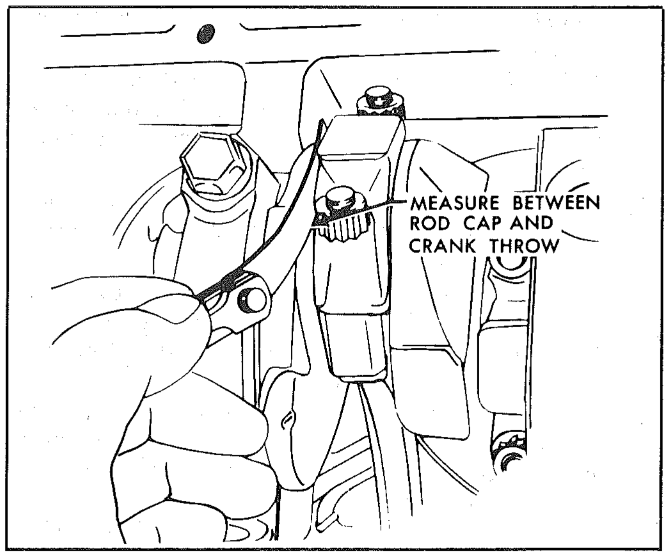


Figure 6A2-23 Measuring Connecting Rod Side Clearance

CONNECTING ROD BEARINGS

Connecting rod bearings are of the precision insert type and do not utilize shims for adjustment. DO NOT FILE RODS OR ROD CAPS. If clearances are found to be excessive, a new bearing will be required. Service bearings are available in standard size and .013mm and .026mm undersize for use with new and used standard size crankshafts.

Inspection and Replacement

1. With oil pan and oil pump removed, remove the connecting rod cap and bearing.
2. Inspect the bearing for evidence of wear or damage. (Bearings showing the above should not be reinstalled.)
3. Wipe both upper and lower bearing shells and crankpin clean of oil.

4. Measure the crankpin for out-of-round or taper with a micrometer. If not within specifications, replace or recondition the crankshaft. If within specifications and a new bearing is to be installed, measure the maximum diameter of the crankpin, to determine new bearing size required.
5. If within specifications, measure new or used bearing clearance with Plastigage or its equivalent.

NOTICE: If a bearing is being fitted to an out-of-round crankpin, be sure to fit to the maximum diameter of the crankpin. If the bearing is fitted to the minimum diameter and the crankpin is out-of-round .025mm interference between the bearing and crankpin will result in a rapid bearing failure.

   a. Place a piece of gaging plastic the full width of the crankpin as contacted by the bearing (parallel to the crankshaft).
   b. Install the bearing in the connecting rod and cap.
   c. Install the rod cap and evenly torque nuts to specifications. Do not turn the crankshaft with gaging plastic installed.
   d. Remove the rod cap and using the scale on the gaging plastic envelope, measure the gaging plastic width at the widest point.
6. If the clearance exceeds specifications, select a new, correct size, bearing and remeasure the clearance.

   If clearance cannot be brought to within specifications, the crankpin will have to be ground undersize. If the crankpin is already at maximum undersize, replace crankshaft.
7. Coat the bearing surface with oil, install the rod cap and torque nuts to 50 N·m (37 lb. ft.).
8. When all connecting rod bearings have been installed tap each rod lightly (parallel to the crankpin) to make sure they have clearance.
9. Measure all connecting rod side clearances (see specifications) between the rod cap and crankshaft throw (Figure 6A2-23).

MAIN BEARINGS (FIGURE 6A2-24)

Main bearings are of the precision insert type and do not utilize shims for adjustment. If clearances are found to be excessive, a new bearing, both upper and lower halves, will be required. Service bearings are available in standard size and undersize.

Selective fitting of both rod and main bearing inserts is necessary in production in order to obtain close tolerances. For this reason you may find one half of a standard insert with one half of a .016mm undersize insert which will decrease the clearance .008mm from using a full standard bearing.

Inspection

In general, the lower half of the bearing (except #1 bearing) shows a greater wear and the most distress from fatigue. If upon inspection, the lower half is suitable for use, it can be assumed that the upper half

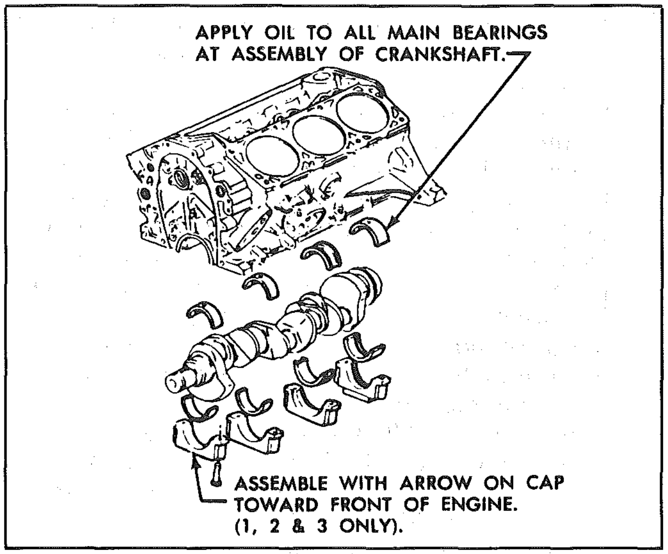


Figure 6A2-24 Main Bearings

is also satisfactory. Of the lower half shows evidence of wear or damage, both upper and lower halves should be replaced. Never replace one half without replacing the other half.

Checking Clearance

To obtain the most accurate results with "Plastigage", (or its equivalent), a wax-like plastic material which will compress evenly between the bearing and journal surfaces without damaging either surface, certain precautions should be observed.

If the engine is out of the vehicle and upside down, the crankshaft will rest on the upper bearings and the total clearance can be measured between the lower bearing and journal. If the engine is to remain in the vehicle, the crankshaft should be supported both front and rear to remove the clearance from the upper bearing. The toal clearance can then be measured between the lower bearing and journal. When checking #1 main bearing, loosen accessory drive belts so as to prevent tapered reading with plastic gage.

NOTICE: To assure the proper seating of the crankshaft, all bearing cap bolts should be at their specified torque. In addition, prior to checking the bearing fit, the surface of the crankshaft journal and bearing should be wiped clean of oil.

1. With the oil pan and oil pump removed, and starting with the rear main bearing, remove bearing cap and wipe oil from journal and bearing cap.
2. Place a piece of gaging plastic the full width of the bearing (parallel to the crankshaft) on the journal. Do not rotate the crankshaft while the gaging plastic is between the bearing and journal.
3. Install the bearing cap and evenly torque the retaining bolts to 95 N·m (70 lb. ft.). Bearing cap MUST be torqued to specification in order to assure proper reading. Variations in torque affect the compression of the plastic gage.

4. Remove bearing cap. The flattened gaging plastic will be found adhering to either the bearing shell or journal.
5. On the edge of gaging plastic envelope, there is a graduated scale which is correlated in thousandths of a millimetre. Without removing the gaging plastic, measure its compressed width (at the widest point) with the graduations on the gaging plastic envelope. Normally, main bearing journals wear evenly and are not out-of-round. However, if a bearing is being fitted to an out-of-round (.025mm max.), be sure to fit to the maximum diameter of the journal: If the bearing is fitted to the minimum diameter and the journal is out-of-round .025mm, interference between the bearing and journal will result in rapid bearing failure. If the flattened gaging plastic tapers toward the middle or ends, there is a difference in clearance indicating taper, low spot or other irregularity of the bearing or journal. Be sure to measure the journal with a micrometer if the flattened gaging plastic indicates more than .025mm difference.
6. If the bearing clearance is within specifications, the bearing insert is satisfactory. If the clearance is not within specifications, replace the insert. Always replace both upper and lower inserts as a unit.
7. A standard, .016mm and .032mm undersize bearing may produce the proper clearance. If not, it will be necessary to regrind the crankshaft journal for use with the next undersize bearing. After selecting new bearing, recheck clearance.
8. Proceed to the next bearing. After all bearings have been checked rotate the crankshaft to see that there is no excessive drag.
9. Measure crankshaft end play (see specifications) by forcing the crankshaft to the extreme front position. Measure at the front end of the #3 main bearing with a feeler gage (Figure 6A2-25).
10. Install a new rear main bearing oil seal in the cylinder block and main bearing cap.

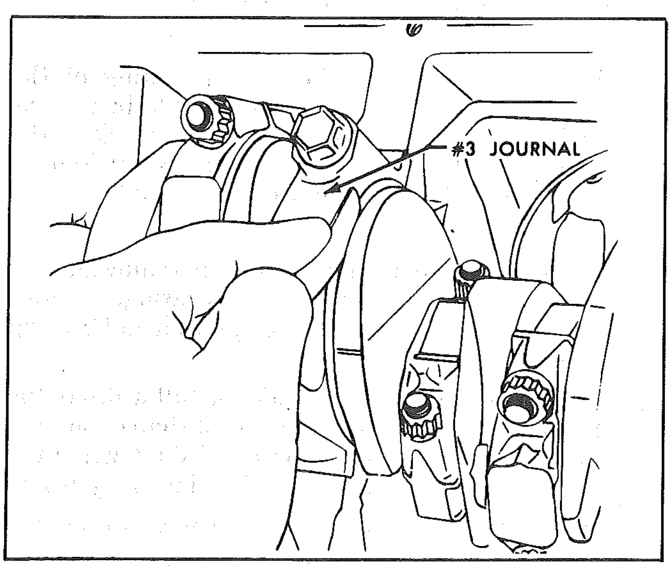


Figure 6A2-25 Measuring Crankshaft End Play

Replacement

Main bearings may be replaced with or without removing the crankshaft.

With Crankshaft Removal

1. Remove and inspect the crankshaft.
2. Remove the main bearings from the cylinder block and main bearing caps.
3. Coat bearing surfaces of new, correct size, main bearings with oil and install in the cylinder block and main bearing caps.
4. Install the crankshaft.

Without Crankshaft Removal

1. With oil pan, oil pump and spark plugs removed, remove cap on main bearing requiring replacement and remove bearing from cap.
2. Install a main bearing removing and installing tool in oil hole in crankshaft journal. If such a tool is not available, a cotter pin may be bent as required to do the job.
3. Rotate the crankshaft clockwise as viewed from the front of engine. This will roll upper bearing out of block.
4. Oil new selected size upper bearing and insert plain (unnotched) end between crankshaft and indented or notched side of block. Rotate the bearing into place and remove tool from oil hole in crankshaft journal. Inspect for burrs at oil hole, remove if required.
5. Oil new lower bearing and install in bearing cap.
6. Install main bearing cap with arrows pointing toward front of engine.
7. Torque all main bearing caps, EXCEPT THE #3 MAIN CAP, to 95 N·m (70 lb. ft.). Torque #3 main bearing cap to 15 N·m (11 lb. ft.) then tap end of crankshaft, first rearward then forward with a lead hammer. This will line up rear main bearing and crankshaft thrust surfaces. Retorque all main bearing caps to 95 N·m (70 lb. ft.).

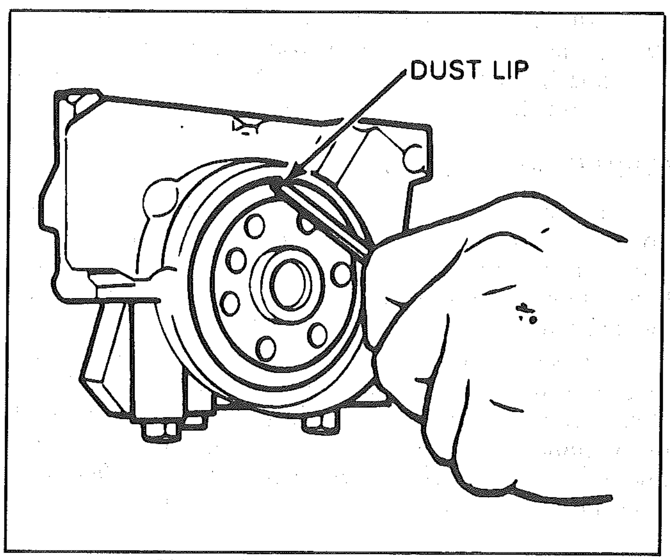


Figure 6A2-26 Removing Seal

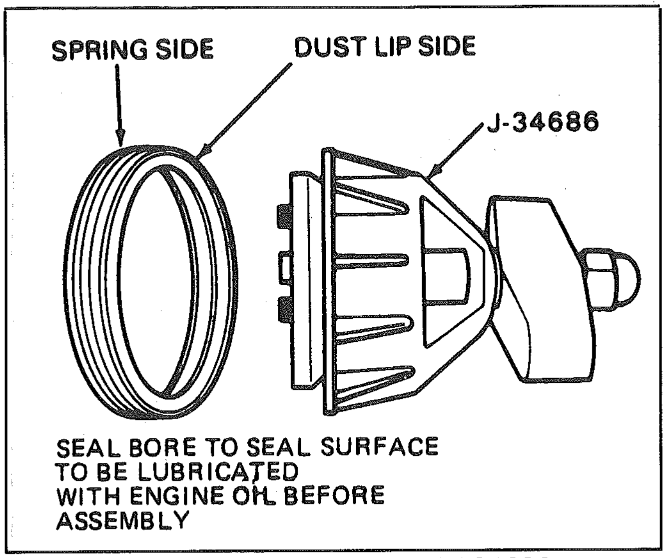


Figure 6A2-27 Seal and Tool J-34686

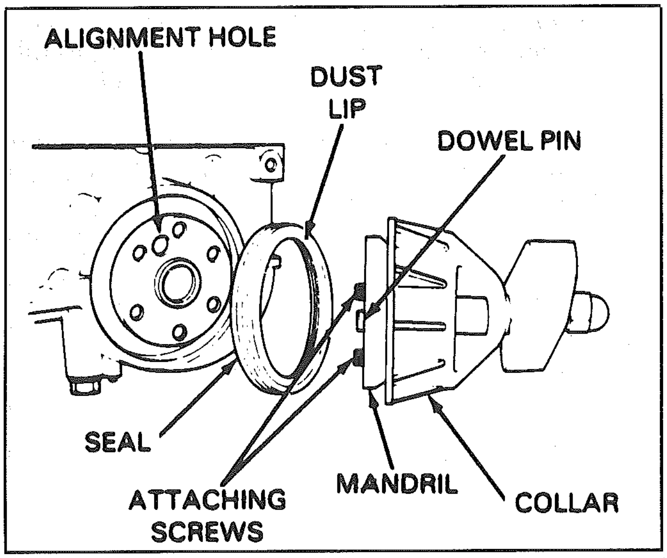


Figure 6A2-28 Installing Seal

OIL SEAL - REAR MAIN

Repair

1. Remove transmission.
2. Remove flexplate.
3. Old seal, insert a screwdriver or similar tool through the dust lip at an angle as shown in Figure 6A2-26. Pry seal out by moving handle of tool towards the end of the crankshaft. Repeat as required around the seal until seal is removed. **CARE MUST BE TAKEN NOT TO DAMAGE THE CRANKSHAFT O.D. SURFACE WITH THE PRY TOOL.**
4. Check the I.D. of bore for knicks or burrs and correct as required. Inspect crankshaft for burrs or knicks on surface which contacts seal. Repair or replace crankshaft as required.
5. Install new seal using Tool J-34686, Figure 6A2-27.
6. Apply a light coat of oil to I.D. of new seal and install over mandril, slide the seal on the mandril until the dust lip (back of seal) bottoms squarely against collar of tool, Figure 6A2-28.
7. Align dowel pin of tool with dowel pin hole in crankshaft and attach tool to crankshaft by hand or torque attaching screw to 2-5 ft. lbs.
8. Turn "T" handle of tool so that collar pushes seal into the bore, turn handle until the collar is tight against the case. This will insure that the seal is seated properly.
9. Loosen the "T" handle of the tool until it comes to a stop. This will insure that the collar will be in the proper position for installing a new seal. Remove attaching screws.
10. Check seal, making sure seal is seated squarely in the bore.
11. Install flywheel.
12. Install transmission.
13. Start engine, check for leaks.

PISTONS, RINGS AND CONNECTING RODS

Removal

1. Remove cylinder heads.
2. Examine the cylinder bores above the ring tavel. If bores are worn so that a shoulder or ridge exists at the top of the cylinder, remove the ridges with a ridge reamer to avoid damaging rings or cracking ring lands in pistons during removal.
3. Use a silver pencil or quick drying paint to mark the cylinder number on all pistons, connecting rods and caps. Starting at the front end of the crankcase the cylinders in the right bank are numbered 1-3-5 and those in the left bank are number 2-4-6.
4. Remove rod bearing cap and bearing.
5. Install guide hose over threads of rod bolts. This is to prevent damage to bearing journal and rod bolt threads.
6. Remove rod and piston assembly through the top of the cylinder bore.

Disassembly

1. Remove compression rings and oil ring.
2. Install piston and connecting rod assembly on fixture and support J-24086-20 and place in an arbor press. Press pin out of connecting rod.

Inspection

1. Inspect cylinder walls for scoring, roughtness, or ridges which indicate excessive wear. Check cylinder bores for taper and out-of-round with an accurate cylinder gage at top, middle and bottom of bore, both parallel at right angles to the cylinder bores at any point may be measured with an inside micrometer or setting the cylinder gage dial at "O" and measuring across the gage contact points with outside micrometer while the gage is at same "O" setting.
2. If a cylinder bore is moderately rough or slightly scored but is not out-of-round or tapered, it is usually possible to remedy the situation by honing the bore to fit a standard service piston since standard service pistons are high limit production pistons. If cylinder bore is very rough or deeply scored, however, it may be necessary to

rebore the cylinder to fit an oversize piston in order to insure satisfactory results.

3. If cylinder bore is tapered 0.1mm or more or is out-of-round 0.1mm or more, it is advisable to rebore for the smallest possible oversize piston and rings. Below these limits, the cylinder bore can be trued up with honing.
4. Clean carbon from piston surfaces and under side of piston heads. Clean carbon from ring grooves with suitable tool and remove any gum or varnish from piston skirts with suitable solvent.
5. Carefully examine pistons for rough or scored surfaces; cracks in skirt or head; cracked or broken ring lands; chipped or uneven wearing pistons would cause rings to seat improperly or have excessive clearance in ring grooves. Damaged or faulty pistons should be replaced. The pistons are cam ground, which means that the diameter at a right angle to the wrist pin is greater than the diameter parallel to the wrist pin. When a piston is checked for size, it must be done at points 90° to the piston pin. The piston should be checked (for fitting purposes) in a plane through the piston pin centerline.
6. Inspect surfaces of wrist pins and check for wear by measuring worn or unworn surfaces with micrometers. Occasionally pins will be found tight due to gum or varnish deposits. This may be corrected by removing the deposit with a suitable solvent. If piston bosses are worn out-of-round or oversize, the piston and pin assembly must be replaced. Oversize pins are not practical due to the pin being a press fit in the connecting rod. Piston pins must fit the piston with an easy finger push at 70°F (21°C) (.0065 to .0091mm clearance).
7. Examine all piston rings for scores, chips or cracks. Check compression rings for tension by comparing with new rings. Check gap of compression rings by placing rings in bore at bottom of ring travel. Measure gap with feeler gage. Gap should be between 0.25mm and 0. 50mm. If gaps are excessive (over 0.50mm) it indicates the rings have worn considerably and should be replaced. Bore wear should be checked before rings are replaced, .125mm bore wear will result in .39mm increase in ring gap.

Assembly

There is a machined hole or a cast notch in the top of all pistons to facilitate proper installation. The piston assemblies should always be installed with the hole toward the front of the engine (Figure 6A2-29).

1. Lubricate piston pin holes in piston and connecting rod light with engine oil.
2. Position conncecting rod in its respective piston. Hold in place with piston pin guide and piston pin. Place assembly on fixture and support assembly J-24086-20.
3. Press the piston pin into the piston and connecting rod.

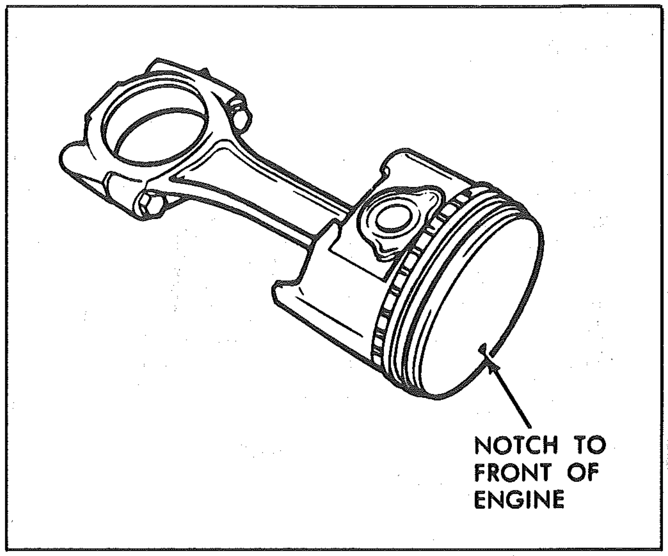


Figure 6A2-29 Piston

NOTICE: After installer hub bottoms on support assembly, do not exceed 5000 psi pressure, as this could cause structural damage to the tool.

4. Remove piston and connecting rod assembly from tool and check piston pin for freedom of movement on piston.

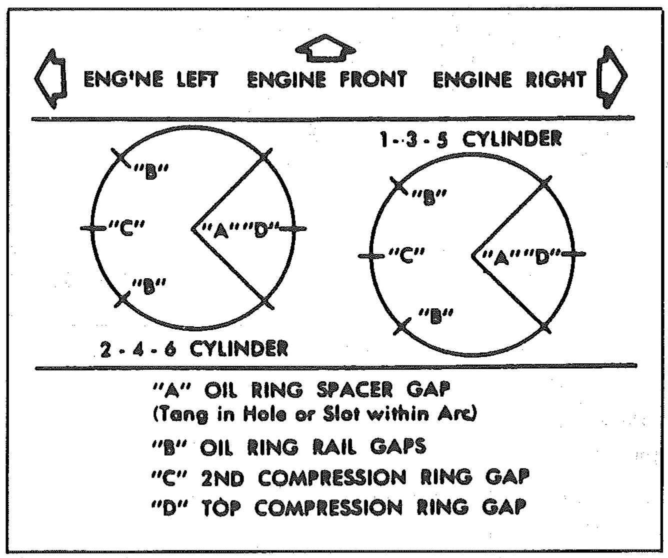


Figure 6A2-30 Ring Gap Locations

Installation

Cylinder bores must be clean before piston installation. This may be accomplished with a hot water and detergent wash or with a light honing as necessary. After cleaning, the bores should be swabbed several times with light engine oil and a clean dry cloth.

1. Lubricate connecting rod bearings and install in rods and rod caps.
2. Lightly coat pistons, rings and cylinder walls with light engine oil.
3. With bearing caps removed, install guide hose over connecting rod bolts. These guide hoses protect the crankpin journal from damage during installation of connecting rod and piston assembly.

4. Make sure the gap in the oil ring rails are in "up" position toward center of engine and the gaps of the compression rings are positioned as shown in Figure 6A2-30.
5. Install each connecting rod and piston assembly in its respective bore. Install with connecting rod bearing tang slots on side opposite camshaft. Use Tool J-8037 or J-8910 to compress the rings. Guide the connecting rod into place on the crankshaft journal.
   Use a hammer handle and light blows to install the piston into the bore. Hold the ring compressor firmly against the cylinder block until all piston rings have entered the cylinder bore.
6. Install the bearing caps and torque nuts to specifications. If bearing replacement is required refer to "Connecting Rod Bearings".
   Be sure to install new pistons in the same cylinders for which they were fitted, and used pistons in the same cylinder from which they were removed. Each connecting rod and bearing cap should be marked, beginning at the front of the engine.
   On V-6 engines, 1,3 and 5 are in the right bank and 2, 4 and 6 are in the left bank. The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.

2.8 LITER V-6
SERVICE PISTONS

TYPE	CODE	SIZE
STD.	S4	89.001-89.014
	S5	89.014-89.027
HI LIMIT	S6	89.027-89.040
	S7	89.040-89.053
.50 O. S.	1	89.501-89.514
	2	89.514-89.527
	3	89.527-89.540
	4	89.540-89.553
1.0 O. S.	1	90.001-90.014
	2	90.014-90.027
	3	90.027-90.040
	4	90.040-90.053

NOTE: All dimensions are in millimetres.

Figure 6A2-31 Service Pistons

HONING OR REBORING CYLINDERS (FIGURE 6A2-32)

If one or more cylinder bores are rough, scored or worn beyond limits, it will be necessary to smooth or true up such bores to fit new pistons.

If relatively few bores require correction, it will not be necessary to rebore all cylinders to the same oversize in order to maintain engine balance. All

HONED SURFACE

1. Cross Hatch Angle 20° - 32°
2. Uniformly Cut in Both Directions
3. Clean Cut Not Sharp Free of Torn and Folded Metal
4. Micro Ave. 10-20 Micro In. (0.25-0.30 micrometers) Range 10-15 micro in. (0.25-0.38 micrometers)
5. Cross Hatch Ave. .0004"-.0006" Wide Range .0002"-.0009"
6. Cross Hatch Ave. .00015"-.00025" Deep Range .0001"-.0003"
7. Plateau to be 1/2 to 2/3 of Surface
8. Free of Burnish or Glaze
9. Free of Imbedded Particles

Figure 6A2-32 Honing Specifications

oversize service pistons (Figure 6A2-31) are held to the same weights as standard size pistons.

No attempt should be made to cut down oversize pistons to fit cylinder bores as this will destroy the surface treatment and affect the weight. The smallest possible oversize service pistons should be used and the cylinder bores should be honed to size for proper clearances.

Before the honing or reboring operation is started, measure all new pistons with micrometer contacting at points exactly 90 degrees from piston pin centerline then select the smallest piston for the first fitting. The slight variation usually found beween pistons in a set may provide for correction in case the first piston is fitted too free.

If wear at top of cylinder does not exceed 0.10 mm on the diameter or exceed 0.10mm out-of-round, honing is recommended for truing the bore. If wear or out-of-round exceeds these limits, the bore should be trued up with a boring bar of the fly cutter type, then finish honed.

When reboring cylinders, all crankshaft bearing caps must be in place and tightened to proper torque to avoid distortion of bores in final assembly. Always be sure the crankshaft is out of the way of the boring cutter when boring each cylinder. When taking the final cut with boring bar, leave .025mm on the diameter for finish honing to give the required clearance specified.

When honing cylinders, use clean sharps tones of proper grade for the amount of metal to be removed, in accordance with instructions of the hone manufacturer. Dull or dirty stones cut unevenly and generate excessive heat. When using coarse or medium grade stones use care to leave sufficient metal so that all stone marks may be removed with the fine stones used for finishing to provide proper clearance.

It is of the greatest importance that refinished cylinder bores are trued up to have not over .02mm out-of-round or taper. Each bore must be final honed to remove all stone or cutter marks and provide a smooth surface. During final honing, each piston must be fitted individually to the bore in which it will be installed and should be marked to insure correct installation.

After final honing and before the piston is checked for fit, each cylinder bore must be thoroughly washed to remove all traces of abrasives and then dried thoroughly. The dry bore should then be brushed clean with a power-driven fibre brush. If all traces of the abrasives are not removed, rapid wear of new pistons and rings will result.

FITTING PISTONS

1. Remove all rings from pistons which will be fitted. It is not necessary to separate rods from pistons. If an excess amount of varnish or carbon appears as a ridge at the top of the cylinder, remove by scraping or sanding.
2. Wipe bores and pistons clean, removing oil or other foreign material. Select a piston-rod assembly for the bore to be fitted (or piston and pin if a new piston is being fitted) and position down into the bore with the top of piston down. The piston should fall free by its own weight through the bore when when the bottom of the piston skirt is 12 to 25mm from top of block.

   Caution must be used to insure piston is not damaged when it "falls" through the cylinder. If it does not, the piston fit is too tight and another piston should be selected until the piston will slide freely through the bore without any force being applied. Mark piston and bore for proper assembly.
3. After a piston has been slected, which will slide freely through a bore, it must be determined if piston fit will be too loose. This is done by placing a .060 mm feeler gage for used pistons and a .050 mm feeler gage for new pistons at least 150mm long and not over 12mm wide, down into the same bore with selected piston while holding feeler to top of the bore.

   Position selected piston and feeler down into the bore until the bottom of the skirt is again 12 to 25 mm from top of block, being sure that the feeler gage is 90° from the pin. If the piston hangs on the feeler gage and does not fall free, it indicates that the piston is correctly fitted to that respective bore. Mark both piston and bore before going to the next bore. If the piston fell free during this check with the .060mm feeler gage (.050mm feeler gage for new pistons) then that particular piston is too small for the bore and a larger diameter piston will be required.

   When checking more than one bore, it is very possible that what may be a piston too small for one bore will be a correct fit in another.

PISTON RINGS

When new piston rings are installed without reboring cylinders, the glazed cylinder walls should be slightly dulled, but without increasing the bore diameter, by means of the finest grade of stones in a cylinder hone.

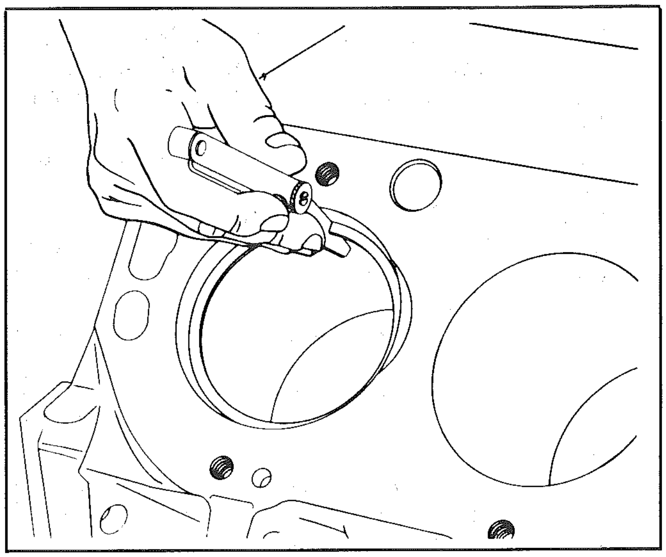


Figure 6A2-33 Measuring Ring Gap

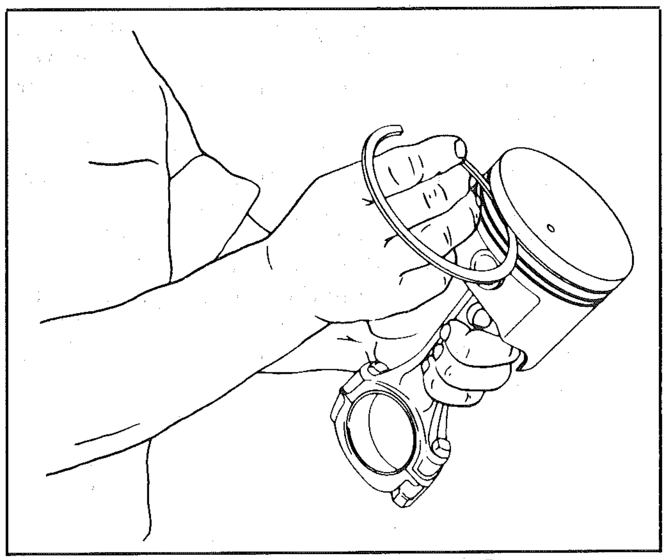


Figure 6A2-34 Checking Ring In Groove

New piston rings must be checked for clearance in piston grooves and for gap in cylinder bores. The cylinder bores and piston grooves must be clean, dry and free of carbon and burrs.

With rings installed, check clearance in grooves by inserting feeler gages between each ring and its lower land because any wear that occurs forms a step at inner portion of the lower land.

If the piston grooves have worn to the extent that relatively high steps exist on the lower lands, the piston should be replaced because the steps will interfere with the operation of new rings and the ring clearances will be excessive. Piston rings are not furnished in oversize widths to compensate for ring groove wear.

All compression rings are marked on the upper side of the ring. When installing compression rings, make sure the marked side is toward the top of the piston. The top ring is treated with molybdenum for maximum life.

The oil control rings are of three piece type, consisting of two segments (rails) and a spacer.

Fitting

1. Select rings comparable in size to the piston being used.
2. Slip the compression ring in the cylinder bore; then press the ring down into the cylinder bore about 6mm above ring travel. Be sure ring is square with cylinder wall.
3. Measure the space or gap between the ends of the ring with a feeler gage (Figure 6A2-33).
4. If the gap between the ends of the ring is below specifications, remove the ring and try another for fit.
5. Fit each compression ring to the cylinder in which it is going to be used.
6. If the pistons have not been cleaned and inspected as previously outlined, do so.
7. Slip the outer surface of the top and second compression ring into the respective piston ring groove and roll the ring entirely around the groove (Figure 6A2-34). If binding occurs at any point, the cause should be determined. If there is a ring groove, remove by dressing with a fine cut file. If the binding is caused by a distorted ring, check a new ring.

Installation

1. Install oil ring spacer in groove being sure ends are butted and not overlapped.
2. Hold spacer ends butted and install lower steel oil ring rail.
3. Install upper steel oil ring rail with gap staggered.
4. Flex the oil ring assembly to make sure ring is free. If binding occurs, the cause should be detemined. If caused by ring groove, remove by dressing groove with a fine cut file. If binding is caused by a distorted ring, check a new ring.
5. Install second compression ring. Stagger gap from other rings.
6. Install top compression ring with gap properly located.

ENGINE ASSEMBLY

Removal

1. Disconnect battery.
2. Remove air cleaner.
3. Remove hood.
4. Drain radiator.
5. Remove lower radiator hose.
6. Remove upper fan shroud.
7. Remove upper radiator hose and coolant recovery hose.
8. Remove transmission cooler lines.
9. Remove radiator.
10. Remove fan assembly.
11. Remove heater hoses.
12. Disconnect carburetor linkage, includes cruise control detent cable.
13. Remove vacuum brake booster line.
14. Remove distributor cap and lay wiring aside.
15. Disconnect necessary wires and hoses.
16. Remove power steering pump and lay aside.
17. Raise vehicle.
18. Remove exhaust pipes at exhaust manifold.
19. Remove dust cover.
20. Remove converter bolts.
21. Disconnect starter wires.
22. Remove bell housing bolts.
23. Remove motor mount through bolts.
24. Disconnect fuel lines at fuel pump.
25. Lower vehicle.
26. Support transmission.
27. Remove A.I.R./Converter pipes bracket.
28. Remove engine, include removing wire from bracket at rear left of engine.

Installation

1. Position engine assembly in vehicle.
2. Attach motor mount to engine brackets and lower engine in place.
3. Remove engine lifting device.
4. Remove transmission floor jack.
5. Raise vehicle on hoist.
6. Install mount "through" bolts. Torque to specifications.
7. Install bell housing bolts. Torque to specifications.
8. On vehicles with automatic transmission, install converter to flywheel attaching bolts. Torque to specifications.
9. Install flywheel splash shield of conveter housing cover as applicable. Torque attaching bolts to specifications.
10. Install starter wires.
11. Connect fuel lines.
12. Connect exhaust pipe at manifold.
13. Lower vehicle on hoist.
14. Reinstall power steering pump, if so equipped.
15. Connect necessary wires and hoses.
16. Install radiator and fan shroud and reconnect radiator and heater hoses.
17. Fill cooling system.
18. Fill crankcase with oil. See owner's manual for specifications.
19. Install air cleaner.
20. Install hood.
21. Connect battery cables.

NOTICE: To avoid possible arcing of battery, connect positive battery cable first.

22. Start engine, check for leaks and check timing.

CRANKSHAFT

The crankshaft can be removed while the engine is dissassembled for overhaul, as previously outlined or without complete disassembly.

Removal

1. With the engine removed from the vehicle, remove the clutch assembly (if equipped) and flywheel. Mount engine in stand and clamp securely.

2. Remove the spark plugs.
3. Remove crankshaft pulley and torsional damper.
4. Remove oil pan and oil pump.
5. Remove water pump, crankcase front cover, camshaft sprocket and timing chain.
6. Check the connecting rod caps for cylinder number identification. If necessary mark them.
7. Remove the connecting rod caps and push the pistons to top of bores.
8. Remove main bearing caps and lift crankshaft out of cylinder block.
9. Remove rear main bearing oil seal and main bearings from cylinder block and main bearing caps.

Cleaning and Inspection

1. Wash crankshaft in solvent and dry with compressed air.
2. Measure dimensions of main bearing journals and crankpins with a micrometer for out-of-round, taper or undersize (See Specifications).
3. Check crankshaft for run-out by supporting at the front and rear main bearings journals in "V" blocks and check at the front and rear intermediate journals with a dial indicator (See Specifications).
4. Replace or recondition the crankshaft if out of specifications.

Installation

1. Install rear main bearing oil seal in cylinder block and rear bearing cap grooves.
2. Lubricate seal with engine oil. Keep oil off parting line surface.
3. Install main bearings in cylinder block and main bearing caps then lubricate bearing surface with engine oil.
4. Install crankshaft, being careful not to damage bearing surfaces.
5. Recheck bearing clearances using plastigage.
6. Apply a thin coat of anaerobic sealant #1052357 or equivalent to rear of the block mating surface or corresponding surface or rear main cap only. Do not allow sealer on crankshaft or seal.
7. Install main bearing caps with arrow pointing toward front of engine.
8. Torque all except #3 main bearing cap bolts to specifications. Torque #3 main bearing cap bolts to 14-16 N·m (10-12 lbs. ft.) then tap end of crankshaft, first rearward then forward with a lead hammer. This will line up rear main bearing and crankshaft thrust surfaces. Retorque all main bearing cap bolts to specifications.
9. Measure crankshaft end play with a feeler gage. Force crankshaft forward and measure clearance between the front of the #3 main bearing and crankshaft thrust surface.
10. Install flywheel and torque to specifications.

SPROCKET OR GEAR REPLACEMENT

Remove crankshaft sprocket using Tool J-5825, install using Tool J-5590.

GENERAL DATA

TYPE	60° V-6
DISPLACEMENT	2.8 Liter
RPO	LB8
BORE	89
STROKE	76
COMPRESSION RATIO	8.9:1
FIRING ORDER	1-2-3-4-5-6

Cylinder Bore

DIAMETER	88.992-88.070
OUT OF ROUND	.02 Max.
TAPER-THRUST SIDE	.02 Max.

Piston

CLEARANCE	.017-.043

Piston Ring

COMPRESSION
- Groove Clearance
  - Top .... .030-.070
  - Second .... .040-.095
- Gap
  - Top .... .25-.50
  - Second .... .25-.50

OIL
- Groove Clearance .... .0199 Max.
- Gap 0.51-1.40

Piston Pin

- DIAMETER 22.9937-23.0015
- CLEARANCE .... .0065-.0091
- FIT IN ROD .... .0187-.0515 Press

Camshaft

LIFT
- Intake 6.67
- Exhaust 6.94

JOURNAL DIAMETER 47.44-47.49
JOURNAL CLEARANCE .... .026-.101

Crankshaft

MAIN JOURNAL
- Diameter All 67.241-67.265mm
- Taper .... .005 Max.
- Out of Round .... .005 Max.

MAIN BEARING CLEARANCE .... .041-.081
MAIN THRUST BEARING CLEARANCE .... .054-.084
CRANKSHAFT END PLAY .... .06-.21mm
CRANK PIN
- Diameter 50.784-50.758
- Taper .... .005 Max.
- Out of Round .... .005 Max.

ROD BEARING CLEARANCE .... .035-.095
ROD SIDE CLEARANCE .... .16-.44

Valve System

LIFTER .... Hydraulic
ROCKER ARM RATIO 1.5:1
VALVE LASH .... 1-1/2 Turns From Zero Lash
FACE ANGLE .... 45°
SEAT ANGLE .... 46°
SEAT RUNOUT .... .05°
SEAT WIDTH
- Intake 1.25-1.50
- Exhaust 1.60-1.90

STEM CLEARANCE .... .026-.068
VALVE SPRING
- Free Length 48.5
- Pressure N·m
  - Closed .... 391 @ 40
  - Open .... 867 @ 30
- Installed Height 40

DAMPER
- Free Length 47.2

Approx. # of Coils 4

SPECIFICATIONS

Camshaft Sprocket	20-35 N·m, 15-25 ft. lbs.
Camshaft Rear Cover	8-12 N·m, 6-9 ft. lbs.
Connecting Rod Caps	46-60 N·m, 34-45 ft. lbs.
Torsional Damper	90-115 N·m, 67-85 ft. lbs.
Dist. Hold Down Bolt	27-41 N·m, 20-31 ft. lbs.
Exhaust Manifold	25-42 N·m, 19-31 ft. lbs.
Water Pump	
M8x1.25x70.0	18-30 N·m, 13-22 ft. lbs.
M10x1.5x75.0	27-48 N·m, 20-35 ft. lbs.
Thermostat Housing	18-24 N·m, 13-18 ft. lbs.
Inlet Manifold Lower	18-34 N·m, 13-25 ft. lbs.
Inlet Manifold Center	20-30 N·m (15-22 ft. lbs.)
Timing Chain Damper	18-24 N·m, 14-19 ft. lbs.
Rocker Arm Nut	6-14 N·m, 5-11 ft. lbs.
Rocker Arm Covers	8-20 N·m, 7-15 ft. lbs.
Spark Plugs	9.5-20.3 N·m, 7-15 ft. lbs.
Oil Pan	
M8x1.25x14.0	20-30 N·m, 15-22 ft. lbs.
M6x1x16.0	8-12 N·m, 6-9 ft. lbs.
Main Bearing Caps	85-112 N·m, 63-83 ft. lbs.
Oil Pump	35-47 N·m, 25-35 ft. lbs.

SECTION 6A3

5.0 LITER V8 VIN CODE E (L03)
5.0 LITER V8 VIN CODE F (LB9)
5.7 LITER V8 VIN CODE 8 (L98)

CONTENTS

GENERAL DESCRIPTION

CYLINDER BLOCK

The cylinder block is made of cast iron and has 8 cylinders arranged in a "V" shape with 4 cylinders in each bank. 5 main bearings support the crankshaft which is retained by bearing caps that are machined with the block for proper alignment and clearances. Cylinders are completely encircled by coolant jackets.

CYLINDER HEAD

The cast iron cylinder heads feature individual intake and exhaust ports for each cylinder. Valve guides are integral, and rocker arms are retained on individual pressed studs.

CRANKSHAFT AND BEARINGS

The crankshaft is cast nodular iron and is supported by five main bearings #5 is the end thrust bearing.

Main bearings are lubricated from oil holes which intersect the camshaft bearings. The camshaft bearings are fed oil by the main oil gallery which is rifle drilled down the center of the block, above the camshaft. Two additional oil galleries are on either side of the main oil gallery to provide an oil supply for the hydraulic lifters.

CAMSHAFT AND DRIVE

The cast iron camshaft is supported by 5 bearings and is chain driven. A steel crankshaft sprocket drives the timing chain which in turn drives the camshaft through a cast iron sprocket.

Cam lobes are ground, hardened and tapered with the high side toward the rear. This, coupled with a spherical face on the lifter, causes the valve lifters to rotate.

Camshaft bearings are lubricated through oil holes which intersect the main oil gallery. The main oil gallery is rifle drilled down the center of the block, above the camshaft.

PISTONS AND CONNECTING RODS

The pistons are made of cast aluminum alloy using two compression rings and one oil control ring. Piston pins are offset 1/16" (1.6mm) toward the thrust side (right hand side) to provide a gradual change in thrust pressure against the cylinder wall as the piston travels its path. Pins are Chromium steel and have a floating fit in the pistons They are retained in the connecting rods by a press fit. Connecting rods are made of forged steel. Full pressure lubrication is directed to the connecting rods by drilled oil passages from the adjacent main bearing journal.

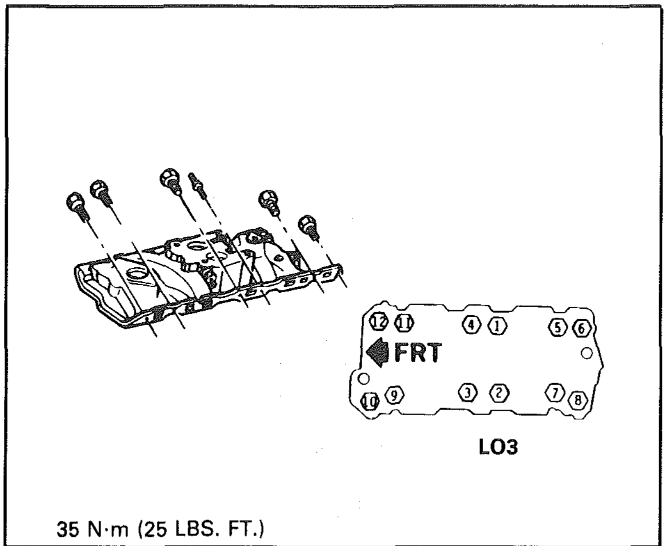


Fig. 6A3-4 Intake Manifold Installation (LO3)

INTAKE MANIFOLD

Removal (TBI)

1. Disconnect battery negative cable.
2. Drain radiator and remove air cleaner.
3. Disconnect:
   - Radiator upper hose and heater hose at manifold.
   - TBI linkage.
   - Fuel lines
   - Spark plug wires (right side).
   - Necessary wires and hoses.
4. Remove distributor cap and mark rotor position with chalk, then remove distributor.
5. Remove (as required) air compressor and brackets and cruise control servo and bracket.
6. Remove generator upper mounting bracket.
7. Remove EGR solenoids and bracket.
8. Remove vacuum brake line.
9. Remove manifold attaching bolts, then remove manifold, discard gaskets.
10. If manifold is to be replaced, transfer:
    - TBI attaching bolts, where applicable.
    - Thermostat with housing (use new gasket or RTV, as applicable).
    - EGR Valve (use new gasket), where applicable.
    - Necessary switches and fittings.

Installation

1. Clean gasket and seal surfaces on manifold, block, and cylinder heads with degreaser. Remove all RTV that is loose or will cause installation interference.
2. Install gaskets on cylinder heads and place a 3/16" (5mm) bead of RTV, #1052917 or equivalent, on the front and rear ridges of the cylinder case. Extend the bead 1/2" (13mm) up each cylinder head to seal and retain the manifold side gaskets. Use sealer at water passages.
3. Install manifold and torque bolts to specifications in the sequence outlined in fig. 4.
4. Install (if removed) air compressor and bracket, and cruise control servo and bracket.
5. Install distributor, positioning rotor at chalk mark, then install distributor cap.
6. Install generator upper mounting bracket.
7. Install vacuum brake line.
8. Install EGR solenoid and bracket.
9. Connect:
   - Fuel lines
   - Accelerator linkage at carburetor.
   - Disconnected wires and hoses.
   - Battery negative cable at battery.
10. Install air cleaner.
11. Fill with coolant, start engine, adjust ignition timing
    and check for leaks.

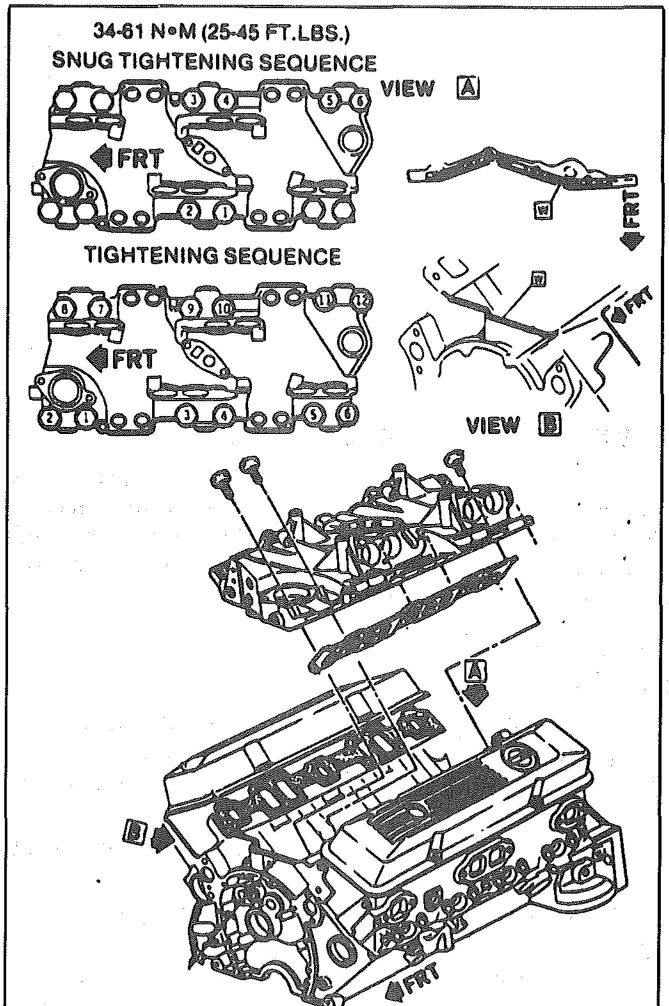


Figure 6A3-4a Intake Manifold Installation (PFI)

Removal (PFI)

1. Disconnect the negative battery cable.
2. Drain the cooling system.

3. Disconnect accelerator T.V. and cruise cables.
4. Remove air intake duct.
5. Disconnect coolant hoses at throttle body.
6. Disconnect wires at throttle body.
7. Disconnect vacuum and breather hoses at throttle body.
8. Remove throttle body from plenum.
9. Remove distributor shield.
10. Disconnect brake vacuum hoses at plenum.
11. Disconnect vacuum hoses at plenum.
12. Refer to Section 6E3 for removal of:
    - Plenum
    - Fuel Rail
    - Cold Start Injector
    - Runners
13. Remove distributor.
14. Disconnect EGR solenoid.
15. Disconnect all electrical wires that would interfere.
16. Remove intake manifold bolts.
17. Remove intake manifold.

Installation

1. Clean all seal surfaces.
2. Install gaskets and place a 3/16 inch 5 (mm) bead of RTV, No. 1052917 or equivalent,on the front and rear ridges of the cylinder case. Extend the bead 1/2 inch (13mm) up each cylinder head to seal and retain the manifold side gaskets and install intake manifold.
3. Torque manifold bolts to specified torque.
4. Reconnect electrical and vacuum wires.
5. Install distributor.
6. Refer to Section 6E3 for installation of:
    - Plenum
    - Fuel Rail
    - Cold Start Injectors
    - Runners
7. Vacuum hoses at plenum.
8. Install distributor shield.
9. Install throttle body and related parts.
10. Fill cooling system.
11. Reconnect battery cable.
12. Start engine and look for leaks.

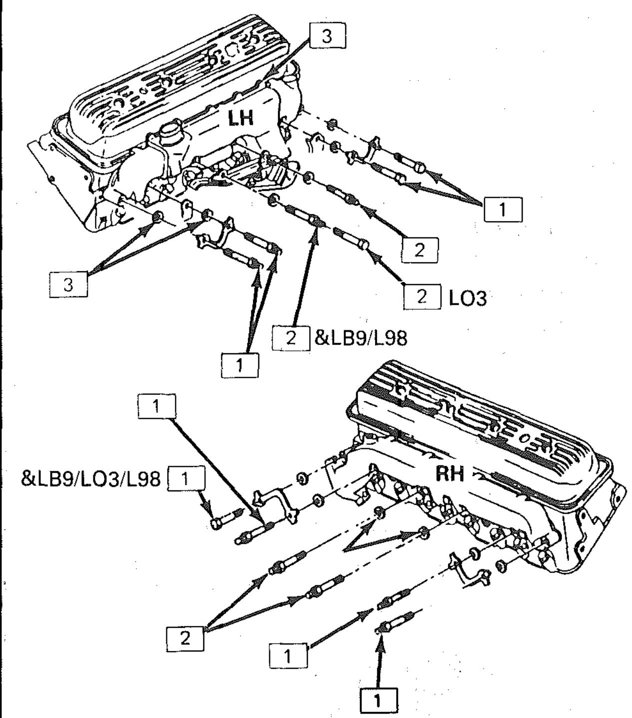
DIPSTICK TUBE

Removal

1. Disconnect battery negative cable to prevent possible contact of the dipstick tube with the battery terminal on starter during removal.
2. Remove bolt attaching bracket to engine and remove tube (loose fit).

Installation

1. Clean tube and apply sealant #1052080 or equivalent, around tube 1/2" below bead.
2. Insert tube in block and rotate into position.
3. Install bolt (with starter brace on top of tube bracket) and connect battery cable.



1 19-35 N·m (14-26 FT. LBS.)
2 27-43 N·m (20-32 FT. LBS.)
3 HEAT STOVE (LO3)

Fig. 6A3-5 Exhaust Manifold Installation

EXHAUST MANIFOLD

Removal (Right Side)

1. Disconnect battery negative cable.
2. Disconnect spark plug wires.
3. Disconnect A.I.R. hoses.
4. Remove air management valve.
5. Raise vehicle.
6. Remove exhaust pipe nuts.
7. Lower vehicle.
8. Remove manifold bolts.
9. Remove exhaust manifold.

Installation

1. Clean mating surfaces on manifold and head, then install manifold in position and install bolts finger tight.
2. Torque bolts to specifications.
3. Reverse removal procedures.

Removal (Left Side)

1. Disconnect battery negative cable.
2. Disconnect spark plug wires.
3. Disconnect A.I.R. hoses.
4. If equipped with A/C, remove compressor and lay aside.
5. Remove power steering pump and lay aside.
6. Loosen brackets.
7. Remove rear A/C and power steering adjusting bracket.
8. Remove lower power steering adjusting bracket.
9. Raise vehicle.

10. Remove exhaust pipe nuts.
11. Lower vehicle.
12. Remove manifold bolts.
13. Remove manifold.

Installation

1. Clean mating surfaces on manifold and head, then install manifold in position and install bolts finger tight.
2. Torque bolts to specifications.
3. Reverse removal procedures.
4. Adjust necessary drive belts.

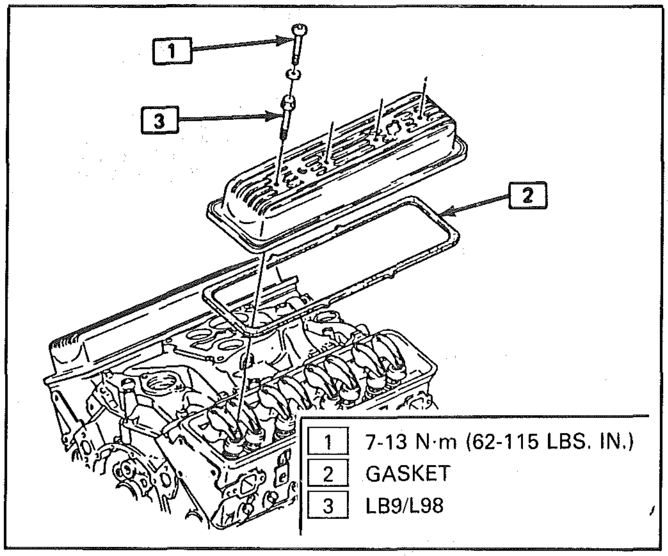


Fig. 6A3-6 Rocker Arm Cover

ROCKER ARM COVER (FIG. 6A3-6)

Removal (Right Side)

1. Disconnect battery negative cable.
2. Remove air cleaner if equipped.
3. Disconnect air management hoses.
4. Disconnect wires and hoses.
   - EGR solenoid.
   - Alternator
5. Remove EGR solenoid.
6. Remove air management valve bracket and move aside.
7. Remove air management tubes.
8. Remove cover bolts.
9. Remove cover.

NOTICE: If cover adheres to cylinder head, shear off by bumping end of rocker arm cover with a block of wood and a rubber mallet. If cover still will not come loose, CAREFULLY pry until loose. DO NOT DISTORT SEALING FLANGE.

Removal (Left Side)

1. Disconnect battery negative cable.
2. Remove air cleaner if equipped.
3. Remove power brake booster line.
4. Disconnect A.I.R. hoses.
5. Disconnect PCV and move wire harness.
6. Remove cover bolts.
7. Remove cover.

NOTICE: If cover adheres to cylinder head, shear off by bumping end of rocker arm cover with a block of wood and a rubber mallet. If cover still will not come loose, CAREFULLY pry until loose. DO NOT DISTORT SEALING FLANGE.

Installation

1. Clean gasket surface on cylinder head and rocker arm cover.
2. Inspect rocker arm cover for damage or distortion and replace cover if necessary.
3. Install a new gasket.
4. Reverse removal procedures.
5. Start engine and check for leaks.

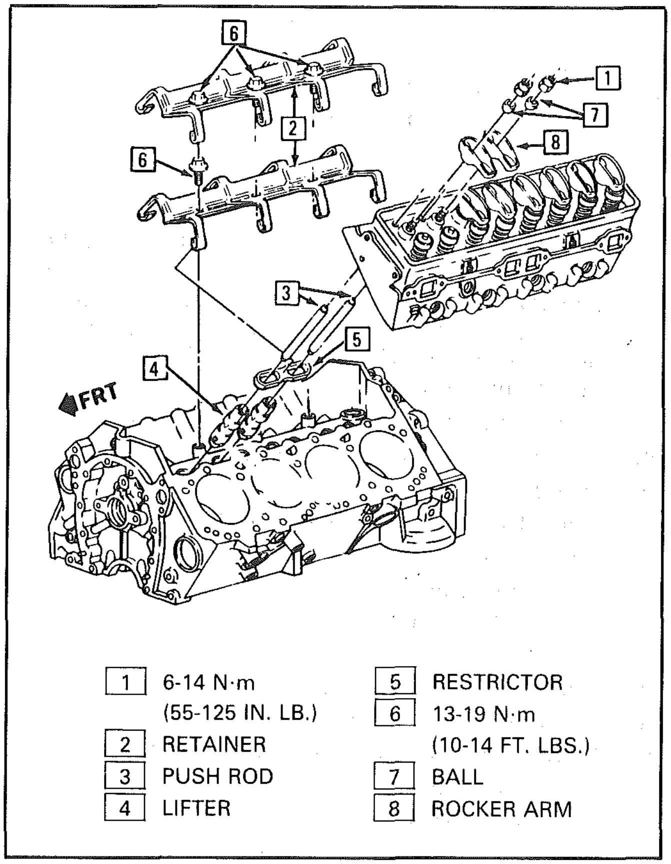


Fig. 6A3-7 Rocker Arm and Pushrods

ROCKER ARM AND PUSHRODS

Removal

1. Remove rocker arm covers as previously outlined.
2. Remove rocker arm nuts, rocker arm balls, rocker arms and push rods. Place rocker arms, rocker arm balls and push rods in a rack to they may be reinstalled in the same locations.

Installation and Adjustment

- Whenever new rocker arms and/or rocker arm balls are being installed, coat bearing surfaces of rocker arms and rocker arm balls with "Molykote" or its equivalent.

1. Install push rods. Be sure push rods seat in lifter socket.
2. Install rocker arms, rocker arm balls and rocker arm nuts. Tighten rocker arm nuts until all lash is eliminated.
3. Adjust valves when lifter is on base circle of camshaft lobe as follows:
   a. Crank engine until mark on torsional damper lines up with center or "O" mark on the timing tab fastened to the crankcase front cover and the engine is in the #1 firing position. This may be determined by placing fingers on the #1 valve as the mark on the damper comes near the "O" mark on the crankcase front cover. If the valves are not moving, the engine is in the #1 firing position. If the valves move as the mark comes up to the timing tab, the engine is in #6 firing position and should be turned over one more time to reach the #1 position.
   b. With the engine in the #1 firing position as just determined, the following valves may be adjusted:
   - Exhaust--1, 3, 4, 8
   - Intake--1, 2, 5, 7

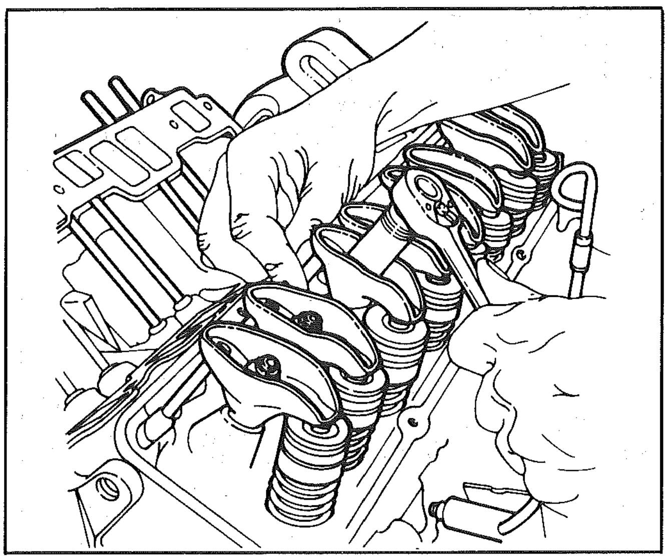


Fig. 6A3-8 Valve Adjustment - Typical

   c. Back out adjusting nut until lash is felt at the push rod then turn in adjusting nut until all lash is removed. This can be determined by rotating push rod while turning adjusting nut (fig. 6A3-8). When play has been removed, turn adjusting nut 1+1/4 in additional turn (to center lifter plunger).
   d. Crank the engine one revolution until the pointer "O" mark and torsional damper mark are again in alignment. This is #6 firing position. With the engine in this position the following valves may be adjusted.
   - Exhaust--2, 5, 6, 7
   - ntake--3, 4, 6, 8
4. Install rocker arm covers as previously outlined.
5. Start engine and adjust carburetor idle speed, if needed.

VALVE STEM OIL SEAL AND/OR VALVE SPRING (6A3-9)

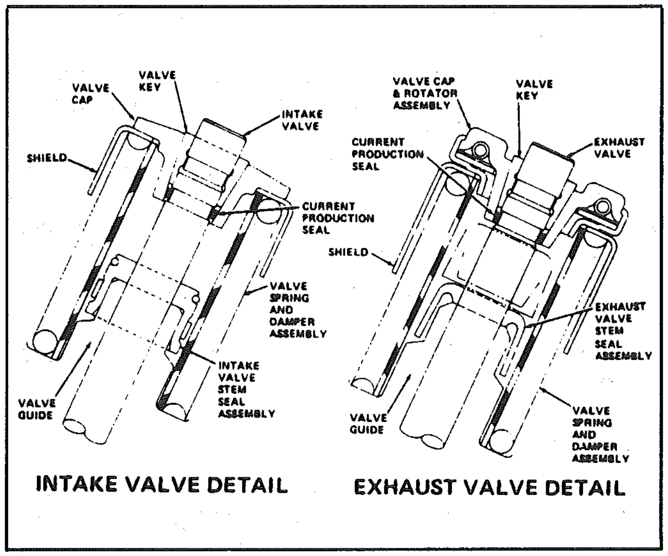


Fig. 6A3-9 Valve Seals

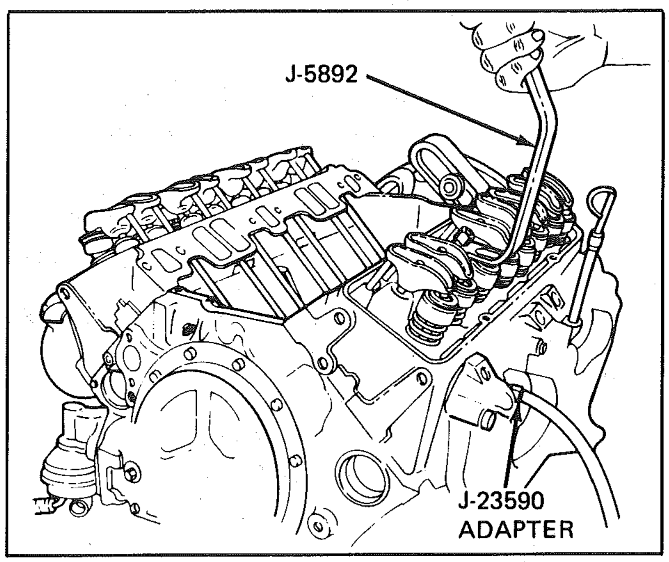


Fig. 6A3-10 Compressing Valve Spring

Removal

1. Remove rocker arm cover as previously outlined.
2. Remove spark plug, rocker arm and push rod on the cylinder(s) to be serviced.
3. Install air line adapter Tool J-23590 to spark plug port and apply compressed air to hold the valves in place.
4. Using Tool J-5892 to compress the valve spring, remove the valve locks, valve cap and valve spring and damper (fig. 6A3-10).
5. Remove the valve stem or head oil seal.

Installation

1. Install valve stem seal over valve stem and seat against head.
2. Set the valve spring and damper, oil shedder and valve cap in place. Compress the spring with Tool J-5892 and install oil seal in the lower groove of the stem, making sure the seal is flat and not twisted. A light coat of oil on the seal will help prevent twisting.
3. Install the valve locks and release the compressor tool making sure the locks seat properly in the upper groove of the valve stem. Grease may be used to hold the locks in place while releasing the compressor tool.
4. Using tool J-23994, apply vacuum to the valve cap to make sure no air leaks past the seal.
5. Install spark plug and torque to 22 lb. ft. (30N·m).
6. Install and adjust valve mechanism as previously outlined.

VALVE LIFTERS

Hydraulic valve lifters very seldom require attention. The lifters are extremely simple in design, readjustments are not necessary, and servicing of the lifters requires only that care and cleanliness be exercised in the handling of parts.

Valve Lifter Diagnosis

1. Momentarily Noisy When Car is Started:
   This condition is normal. Oil drains from the lifters which are holding the valves open when the engine is not running. It will take a few seconds for the lifter to fill after the engine is started.
2. Intermittently Noisy On Idle Only. Disappearing When Engine Speed is Increased:
   Intermittent clicking may be an indication of a pitted check valve ball, or it may be caused by dirt.
   Correction: Clean the lifter and inspect. If check valve ball is defective, replace lifter.
3. Noisy At Slow Idle Or With Hot Oil, Quiet With Cold Oil Or As Engine Speed Is Increased:
   High leak down rate. Replace suspect lifter.
4. Noisy At High Car Speeds And Quiet At Low Speeds:
   a. High oil level - Oil level above the "Full" mark allows crankshaft counterweights to churn the oil into foam. When foam is pumped into the lifters, they will become noisy since a solid column of oil is required for proper operation. Correction: Drain oil intil proper level is obtained.
   b. Low oil level - Oil level below the "Add" mark allows the pump to pump air at high speeds which results in noisy lifters. Correction: Fill until proper oil level is obtained.
   c. Oil pan bent on bottom or pump screen cocked or loose, replace or repair as necessary.
5. Noisy At Idle Becoming Louder As Engine Speed Is Increased To 1500 rpm:
   This noise is not connected with lifter malfunction. It becomes most noticeable in the car at 10 to 15 mph "1" (Low) range, or 30 to 35 mph "D" (Drive) range and is best described as a hashy sound. At slow idle, it may be entirely gone or appear as a light ticking noise in one or more valves. It is caused by one or more of the following:
   a. Badly worn or scuffed valve tip and rocker arm pad.
   b. Excessive valve stem to guide clearance.
   c. Excessive valve seat runout.
   d. Off square valve spring.
   e. Excessive valve face runout.
   f. Valve spring damper clicking on rotator.

Removal

1. Remove intake manifold as previously outlined.
2. Remove valve mechanism as previously outlined.
3. Remove valve lifter retainer.
4. Remvoe valve lifter restrictor.
5. Remove valve lifters (Fig. 6A3-7). Place valve lifters in a rack so that they may be reinstalled in the same location.

Installation

1. Coat roller of valve lifters with "Molykote" or its equivalent and install valve lifters.
2. Install valve lifter restrictor.
3. Install valve lifter retainer.
4. Install intake manifold as previously outlined.
5. Install and adjust valve mechanism as outlined.

Disassembly

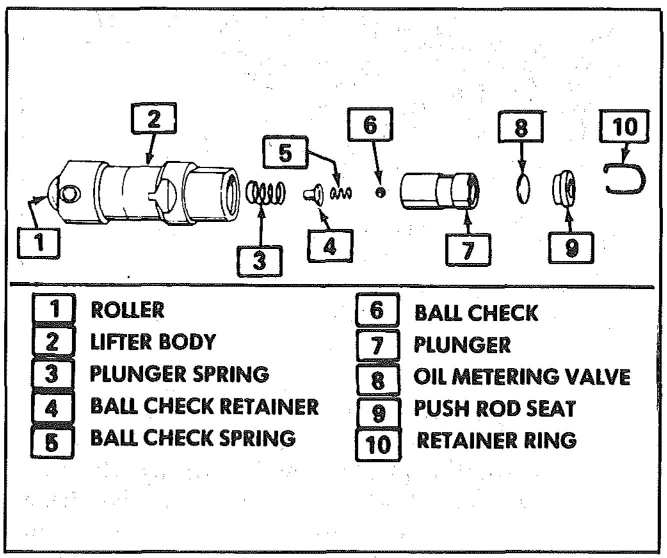


Fig. 6A3-11 Hydraulic Valve Lifter

1. Hold the plunger down with a push rod, and using the blade of a small screw driver, remove the push rod seat retainer.
2. Remove the push rod seat and metering valve (fig. 6A3-11).

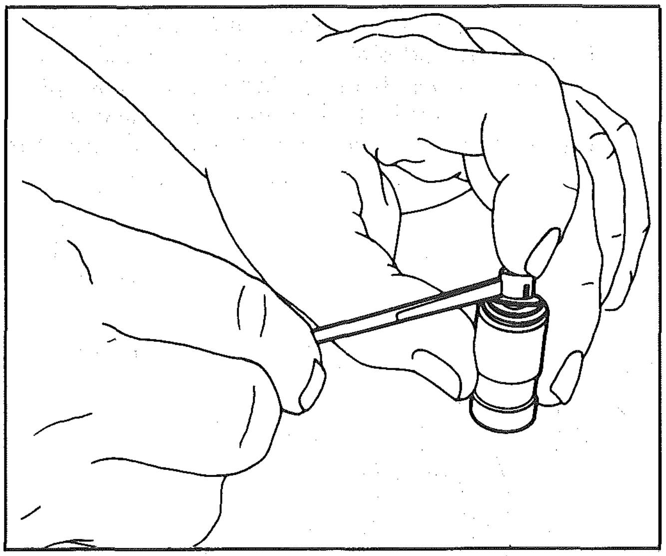


Fig. 6A3-12 Removing Ball Check Valve Typical

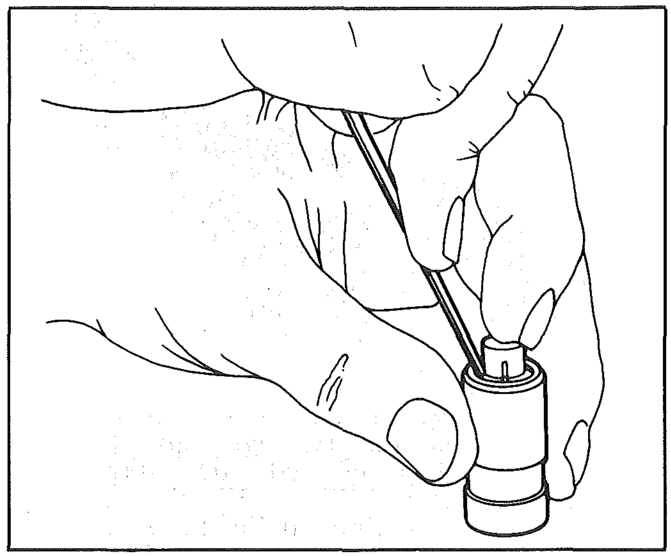


Fig. 6A3-13 Installing Ball Check Valve Typical

3. Remove the plunger, ball check valve assembly and the plunger spring.
4. Remove the ball check valve and spring by prying the ball retainer loose from the plunger with the blade of a small screw driver (fig. 6A3-12).

Cleaning and Inspection

Thoroughly clean all parts in cleaning solvent, and inspect them carefully. If any parts are damaged or worn, the entire lifter assembly should be replaced.

1. Lifter body for:
   - Wear
   - Scuffing. Also inspect the bore in the cylinder block.
   - Flat spot on the bottom. If the bottom is worn flat or grooved, replace the lifter. Also inspect the camshaft lobe.
2. Roller for:
   - Freedom of movement. Replace the lifter if it binds or roughness can be felt.
   - Excessive looseness in the roller bearings. Replace lifter if necessary.
   - Flat spots. Replace the lifter, if worn.
   - Pitting, replace the lifter if pitted.
3. Pushrod seat. If worn, inspect the pushrod. Replace the pushrod, if worn.

Assembly

1. Place the check ball on small hole in bottom of the plunger.
2. Insert check ball spring on seat in ball retainer and place retainer over ball so that spring rests on the ball. Carefully press the retainer into position in plunger with the blade of a small screw driver (fig. 6A3-13).
3. Place the plunger spring over the ball retainer and slide the lifter body over the spring and plunger, being careful to line up the oil feed holes in the lifter body and plunger.
4. Fill the assembly with SAE 10 oil, then insert the end of a 1/8" (3mm) drift pin into the plunger and press down solid. Do not attempt to force or pump the plunger. At this point, oil holes in the lifter body and plunger assembly will be aligned (fig. 15).

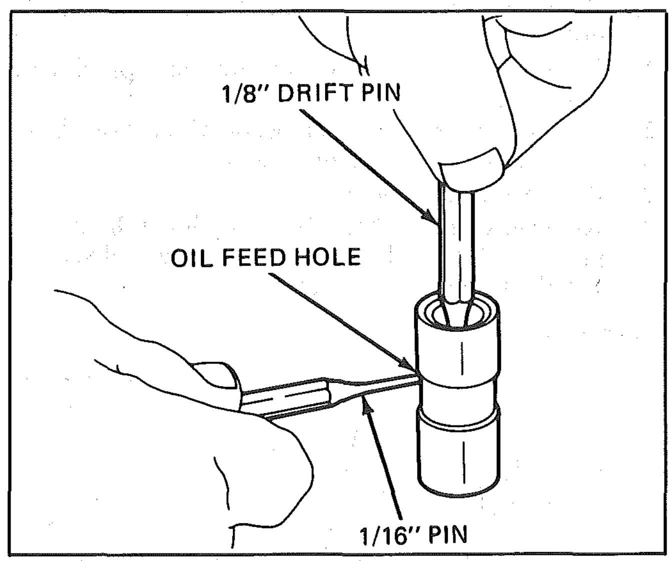


Fig. 6A3-14 Assembling Hydraulic Lifter Typical

5. Insert a 1/16" drift pin through both oil holes to hold the plunger down against the lifter spring tension (fig. 6A3-14).
6. Remove the 1/8" drift pin, refill assembly with SAE 10 oil.
7. Install the metering valve and push rod seat (fig. 6A3-11).
8. Install the push rod seat retainer, press down on the push rod seat and remove the 1/16" drift pin from the oil holes. The lifter is now completely assembled, filled with oil and ready for installation. Before installing lifters, coat the bottom of the lifter with "Molykote" or its equivalent.

CYLINDER HEAD ASSEMBLY (FIG. 6A3-15)

Removal

1. Remove intake manifold as previously outlined.

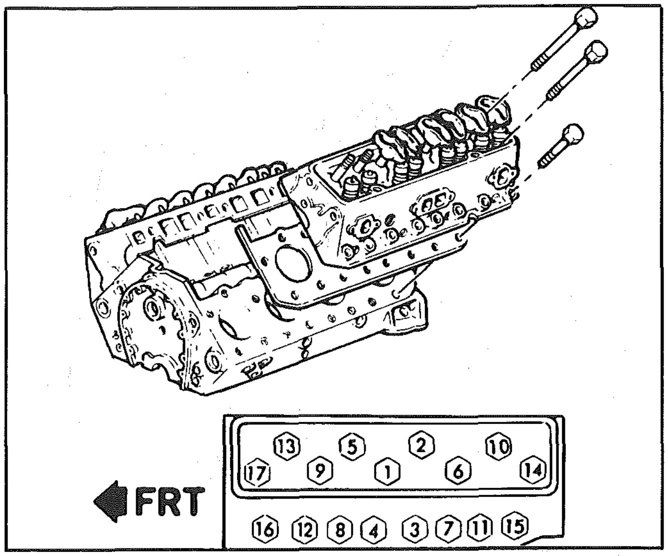


Fig. 6A3-15 Cylinder Head

2. Remove generator lower mounting bolt and lay unit aside.
3. Remove exhaust manifolds as previously outlined.
4. Remove rocker arm covers as previously outlined.
5. Remove valve mechanism as previously outlined.
6. Drain cylinder block of coolant.
7. Remove diverter valve.
8. Remove cylinder head bolts, cylinder head and gasket. Place cylinder head on two blocks of wood to prevent damage.

Disassembly

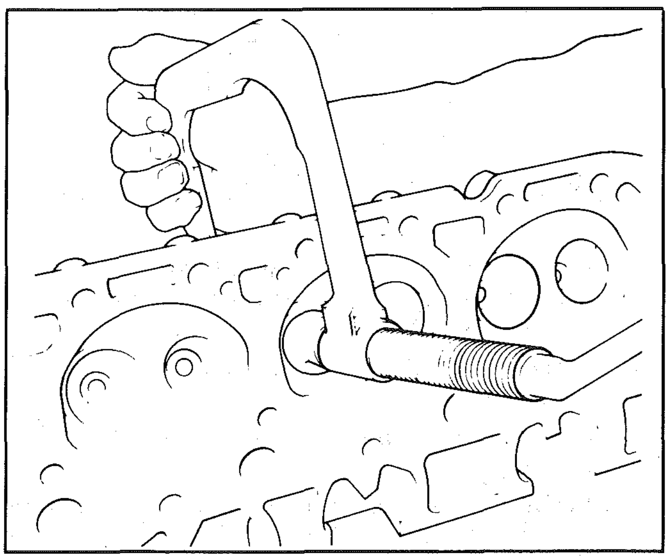


Fig. 6A3-16 Compressing Valve Spring-Typical

1. With cylinder head removed, remove valve rocker arm nuts, balls and rocker arms (if not previously done).

2. Using Tool J-8062, compress the valve springs (fig. 6A3-16) and remove valve keys. Release the compressor tool and remove rotators or spring caps, oil shedders, springs and spring damper, then remove oil seals and valve spring shims.
3. Remove valves from cylinder head and place them in a rack in their proper sequence so that they can be assembled in their original positions.

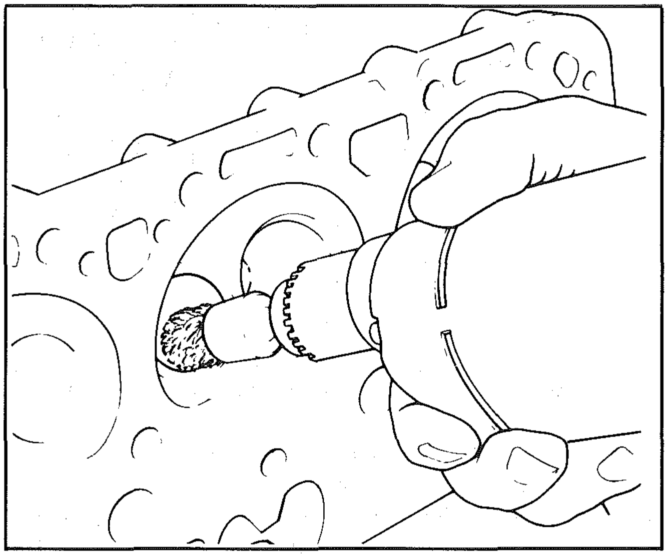


Fig. 6A3-17 Cleaning Combustion Chambers-Typical

Cleaning

1. Clean all carbon from combustion chambers and valve ports using Tool J-8089 (fig. 6A3-17).
2. Thoroughly clean the valve guides using Tool J-8101.
3. Clean all carbon and sludge from push rods, rocker arms and push rod guides.
4. Clean valve stems and heads on a buffing wheel.
5. Clean carbon deposits from head gasket mating surface.

Inspection

1. Inspect the cylinder head for cracks in the exhaust ports, combustion chambers, or external cracks to the water chamber.
2. Inspect the valves for burned heads, cracked faces or damaged stems.
   - Excessive valve stem to bore clearance will cause excessive oil consumption and may cause valve breakage. Insufficient clearance will result in noisy and sticky functioning of the valve and disturb engine smoothness.
3. Measure valve stem clearance (Fig. 6A3-19) as follows:
   a. Clamp a dial indicator on one side of the cylinder head rocker arm cover gasket rail.
   b. Locate the indicator so that movement of the valve stem from side to side (crosswise to the head) will cause a direct movement of the indicator stem. The indicator stem must contact the side of the valve stem just above the valve guide.
   c. Drop the valve head about 1/16" (1.6mm) off the valve seat.
   d. Move the stem of the valve from side to side using light pressure to obtain a clearance

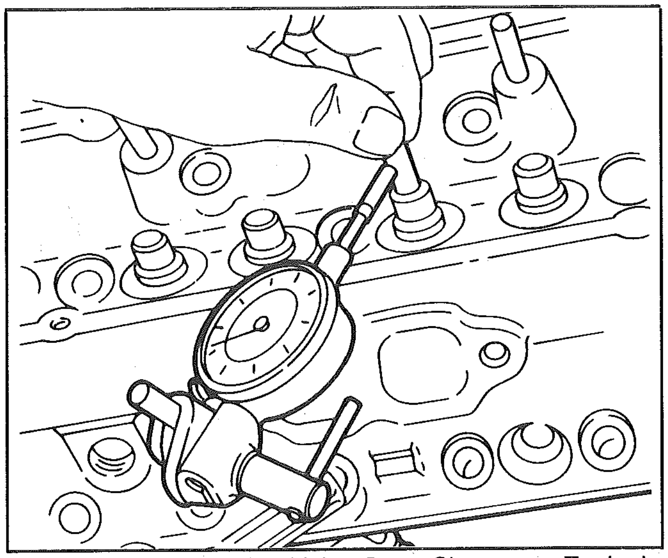


Fig. 6A3-18 Measuring Valve Stem Clearances-Typical

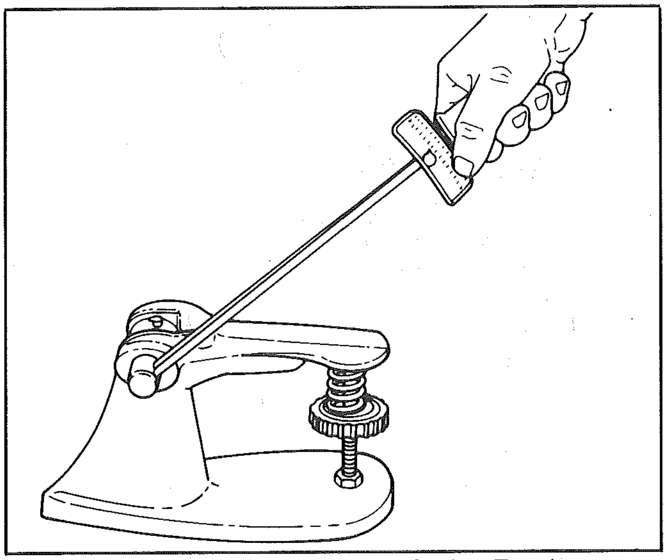


Fig. 6A3-19 Checking Valve Spring Tension

reading. If clearance exceeds specifications, it will be necessary to ream valve guides for oversize valves.

- Service valves are available in standard, .003", .015" and .030" oversize.

4. Check valve spring tension with Tool J-8056 spring tester (fig. 6A3-19). Springs should be compressed to the specified height and checked against the specifications chart. Springs should be replaced if not within 10 lbs. (44 N) of the specified load (without dampers).
5. Inspect rocker arm studs for wear of damage.

Assembly

1. Insert a valve in the proper port.
2. Assemble the valve spring and related parts as follows:
   a. Set the valve spring shim, valve spring (with damper), oil shedder and valve cap or rotator in place.
   b. Compress the spring with Tool J-8062.
   c. Install oil seal in the lower groove of the stem, making sure that the seal is flat and not twisted.
   d. Install the valve locks and release the compressor tool making sure that the locks seat properly in the upper groove of the valve stem. Grease may be used to hold the locks in place while releasing the compressor tools.

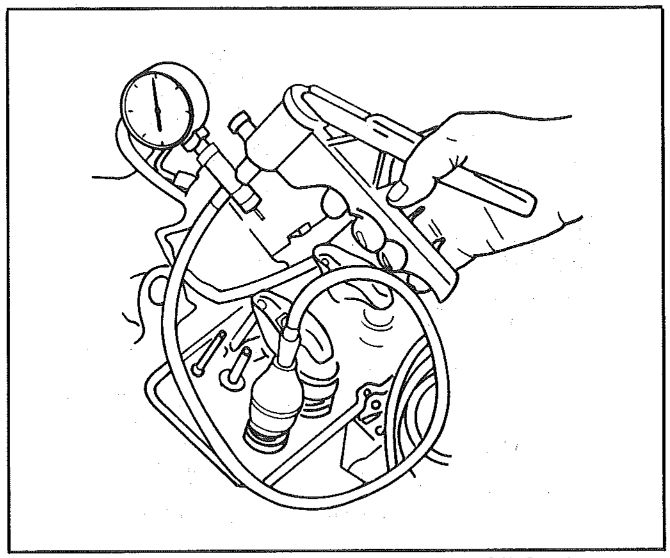


Fig. 6A3-20 Checking Valve Stem Oil Seals

3. Install the remaining valves.
4. Check each valve stem oil seal by placing Valve Seal Leak Detector (Toool J-23994) over the end of the valve stem and against the cap. Operate the vacuum pump and make sure no air leaks past the seal (fig. 6A3-20).

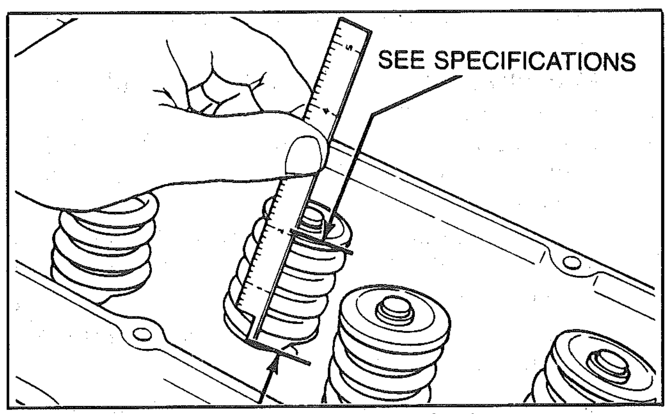


Fig. 6A3-21 Cutaway Scale

5. Check the installed height of the valve springs, using a narrow thin scale. A cutaway scale will help (fig. 6A3-21). Measure from the top of the shim or the spring seat to the top of the oil shedder. If this is found to exceed the specified height, install a valve spring seat shim approximately 1/16" (1.6mm) thick. At no time should the spring be shimmed to give an installed height under the minimum specified.

Installation

- The gasket surfaces on both the head and the block must be clean of any foreign matter and free of nicks or heavy scratches. Cylinder bolt threads in the block and threads on the cylinder head bolts must be clean as dirt will affect bolt torque.

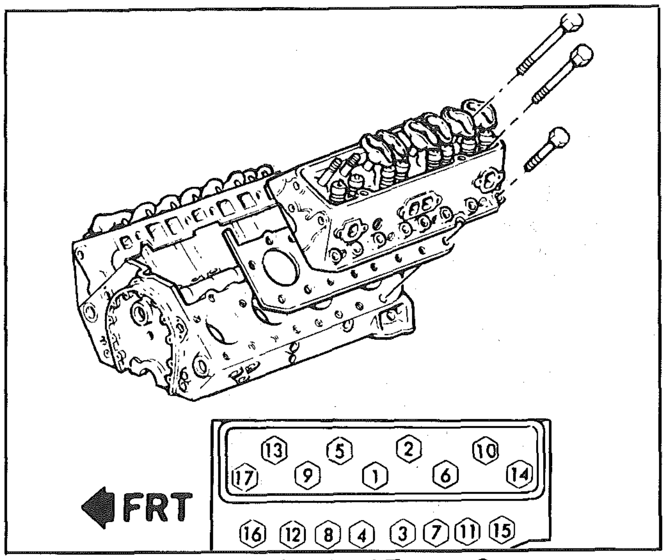


Fig. 6A3-22 Cylinder Head Torque Sequence

1. On engines using a STEEL gasket, coat both sides of a new gasket with a good sealer. Spread the sealer thin and even. One method of applying the sealer that will assure the proper coat is with the use of a paint roller. Too much sealer may hold the gasket away from the head or block.
   - Use no sealer on engines using a composition STEEL ASBESTOS gasket.
2. Place the gasket in position over the dowel pins with the bead up.
3. Carefully guide the cylinder head into place over the dowel pins and gasket.
4. Coat threads of cylinder head bolts with sealing compound, #1052080 or equivalent, and install bolts finger tight.
5. Tighten each cylinder head bolt a little at a time until the specified torque is reached (fig. 6A3-22).
6. Install exhaust manifolds as previously outlined.
7. Install rocker arm covers as previously outlined.
8. Install diverter valve.
9. Install intake manifold as previously outlined.
10. Install and adjust valve mechanism as previously outlined.

ROCKER ARM STUDS

Replacement

Rocker arm studs that have damaged threads or are loose in cylinder heads should be replaced with new studs available in .003" and .013" oversize. Studs may be installed after reaming the holes as follows:

1. Remove old stud by placing Tool J-5802-1 over the stud, installing nut and flat washer and removing stud by turning nut (fig. 6A3-23).

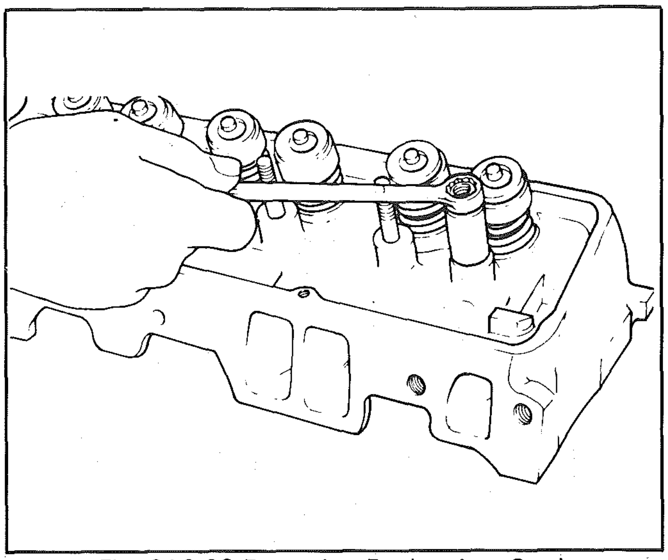


Fig. 6A3-23 Removing Rocker Arm Stud

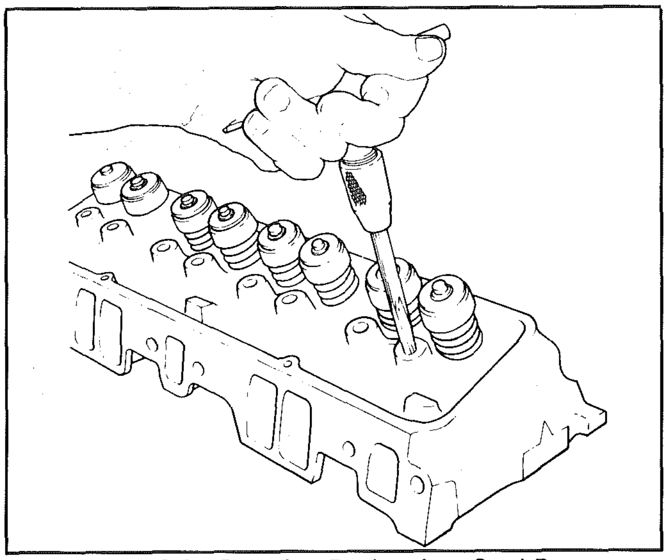


Fig. 6A3-24 Reaming Rocker Arm Stud Bore

2. Ream hole for oversize stud using Tool J-5715 for .003" oversize or Tool J-6036 for .013" oversize (fig. 6A3-24).

NOTICE: Do not attempt to install an oversize stud without reaming stud hole as this could damage the head casting.

3. Coat press-fit area of stud with hypoid axle lubricant. Install new stud, using Tool J-6880 as a guide. Gage should bottom on head (fig. 6A3-25).

VALVE GUIDE BORES

Valves with oversize stems are available (see specifications). To ream the valve guide bores for oversize valves use Tool Set J-5830.

VALVE SEATS

Reconditioning the valve seats is very important, because the seating of the valves must be perfect for the

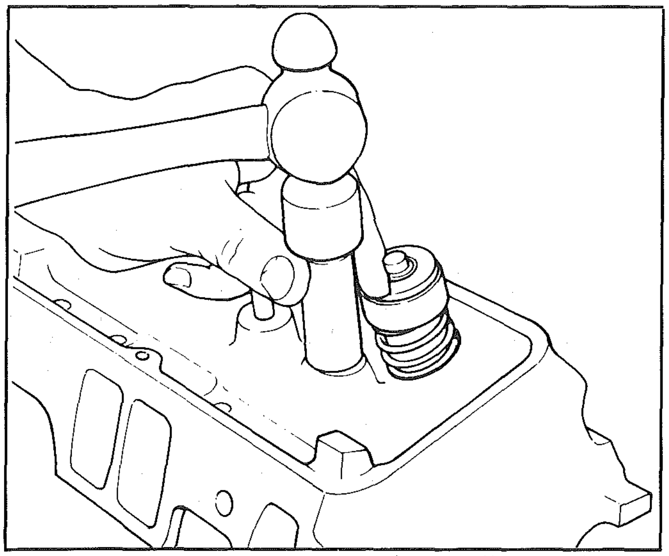


Fig. 6A3-25 Installing Rocker Arm Stud

engine to deliver the power and performance built into it.

Another important factor is the cooling of the valve heads. Good contact between each valve and its seat in the head is imperative to insure that the heat in the valve head will be properly carried away.

Several different types of equipment are available for reseating valves seats. The recommendations of the manufacturer of the equipment being used should be carefully followed to attain proper results.

Regardless of what type of equipment is used, however, it is essential that valve guide bores be free from carbon or dirt to ensure proper centering of pilot in the guide. Valve seats should be concentric to within .002" total indicator reading.

VALVES

Valves that are pitted can be refaced to the proper angle, insuring correct relation between the head and stem on a valve refacing mechanism. Valve stems which show excessive wear, or valves that are warped excessively should be replaced. When a valve head which is warped excessively is refaced, a knife edge will be ground on part or all of the valve head due to the amount of metal that must be removed to completely reface. Knife edges lead to breakage, burning or pre-ignition due to heat localizing on this knife edge. If the edge of the valve head is less than 1/32" (.08mm) thick after grinding, replace the valve. Several different types of equipment are available for refacing valves. The recommendation of the manufacturer of the equipment being used should be carefully followed to attain proper results.

TORSIONAL DAMPER

Removal

1. Remove drive belts and pulley.
2. Raise vehicle.
3. Remove crankshaft pulley, then remove damper retaining bolt.
4. Install Tool J-23523 on damper then, turning puller screw, remove damper.

Installation

NOTICE: The inertial weight section of the torsional damper is assembled to the hub with a rubber type material. The installation procedures (with proper tool) must be followed or movement of the inertia weight section on the hub will destroy the tuning of the torsional damper.

1. Inspect the cover seal contact area surface (on damper) for damage or grooving and coat front cover seal with engine oil.
2. Place damper in position over key on crankshaft.
3. Pull damper onto crankshaft as follows:
   a. Install appropriate threaded end of Tool J-23523 into crankshaft. Install tool in crankshaft so that at least 1/2" (13mm) of thread engagement is obtained.

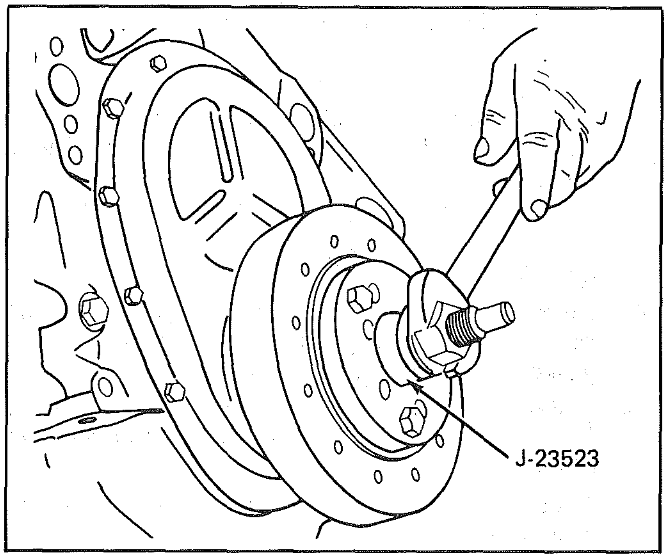


Fig. 6A3-26 Installing Torsional Damper

   b. Install plate, thrust bearing and nut to complete tool installation.
   c. Pull damper into position as shown in Figure 6A3-26.
   d. Remove tool from crankshaft then install damper retaining bolt and torque to specifications.
4. Install crankshaft pulley.
5. Lower vehicle.
6. Install drive belts and adjust to specifications.

CRANKCASE FRONT COVER (FIG. 6A3-27)

Removal

1. Remove torsional damper as previously outlined.
2. Remove oil pan.
3. Remove water pump as outlined in Section 6B.
4. Remove crankcase front cover attaching screws and remove front cover and gasket, then discard gasket.

Installation

1. Clean gasket surface on block and crankcase front cover.

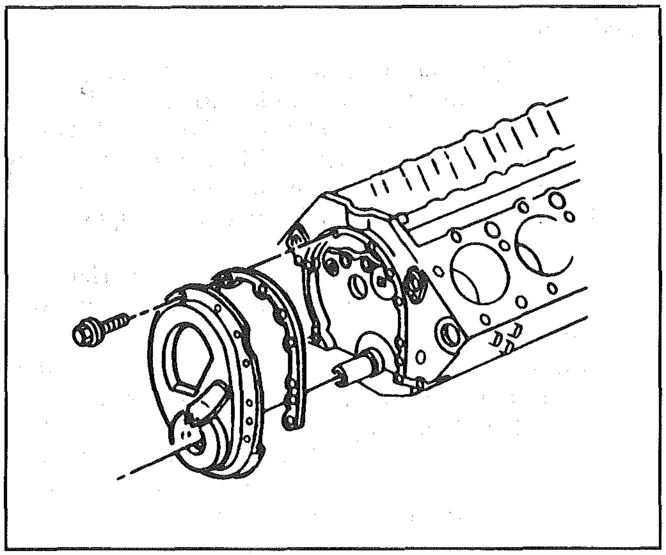


Fig. 6A3-27 Crankcase Front Cover

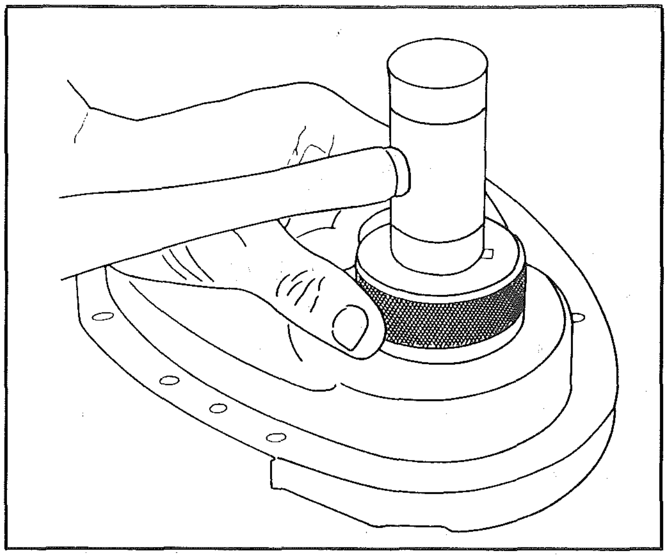


Fig. 6A3-28 Installing Oil Seal-Cover Removed

2. Use a sharp knife or other suitable cutting tool to remove any excess oil pan gasket material that may be protruding at the oil to engine block junction.
3. Apply a 1/8" (3mm) bead of RTV, #1052917 or equivalent, to the joint formed at the oil pan and cylinder block.
4. Inspect the cover for damage or distortion and replace if necessary. Coat the cover gasket with gasket sealant and place in position on cover.
5. Install cover-to-oil pan seal, lightly coat bottom of seal with engine oil, and position cover over crankshaft end.
6. Loosely install the cover-to-block upper attaching screws.
7. Tighten screws alternately and evenly while pressing downward on cover so that dowels in block are aligned with corresponding holes in cover. Position cover so that dowels enter holes in cover without binding. Do not force cover over dowels so that cover flange or holes are distorted.
8. Install remaining cover screws and torque to specifications.
9. Install torsional damper and water pump as previously outlined.
10. Install oil pan.

OIL SEAL (FRONT COVER)

Replacement

With Cover Removed

1. With cover removed, pry oil seal out of cover from the front with a large screwdriver. Be careful not to damage the cover while removing seal.
2. Install new seal so that open end of the seal is toward the inside of cover and drive it into position with Tool J-23042 (Fig. 6A3-28). Support rear of cover at seal area.

With Cover Installed

1. With torsional damper removed, pry seal out of cover from the front with a large screw driver. Be careful not to damage the surface on the crankshaft.
2. Install new seal so that open end of seal is toward the inside of cover and drive it into position with Tool J-23042. Care should be taken to avoid damaging the cover.

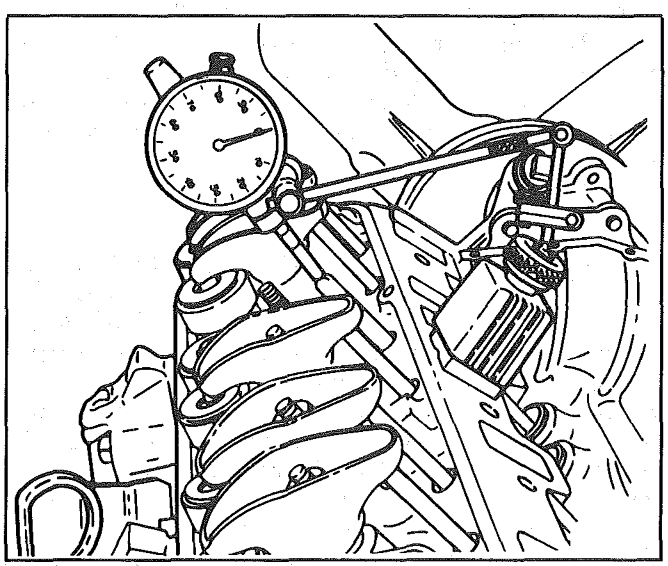


Fig. 6A3-29 Measuring Camshaft Lobe Lift

CAMSHAFT

Measuring Lobe Lift

1. Remove the valve mechanism as previously outlined.
2. Position indicator with ball socket adapter (Tool J-8520) on push rod (Fig. 6A3-29). Make sure push rod is in the lifter socket.
3. Rotate the crankshaft slowly in the direction of rotation until the lifter is on the heel of the cam lobe. At this point, the push rod will be in its lowest position.

4. Set dial indicator on zero, then rotate the crankshaft slowly, or attach an auxiliary starter switch and "bump" the engine over, until the push rod is fully raised position.
   - Whenever the engine is cranked remotely at the started, with a special jumper cable or other means, the distributor primary lead should be disconnected from the distributor (coil).
5. Compare the total lift recorded from the dial indicator with specifications.
6. If camshaft readings for all lobes are within specifications, remove dial indicator assembly.
7. Install and adjust valve mechanism as outlined.

Removal

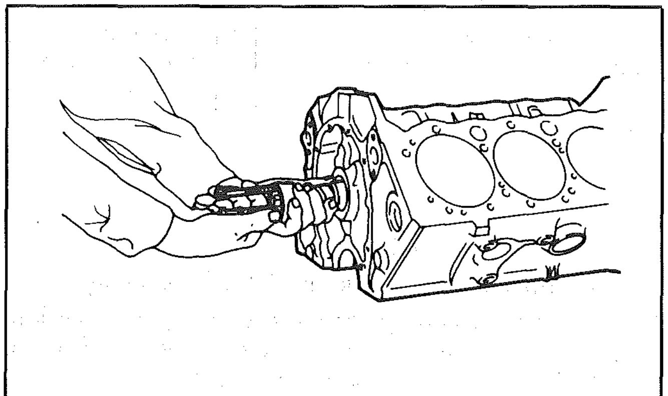


Fig. 6A3-30 Removing Camshaft

1. Remove valve lifters as previously outlined.
2. Remove crankcase front cover as previously outlined.
3. Remove grille.
4. Remove fuel pump push rod as outlined in Section 6C.
5. Complete camshaft removal as follows:
   - Sprocket is a light fit on camshaft. If sprocket does not come off easily a light blow on the lower edge of the sprocket (with a plastic mallet) should dislodge the sprocket.
6. Install two 5/16" - 18 x 4" bolts in camshaft bolt holes then remove camshaft (fig. 6A3-30).

NOTICE: All camshaft journals are the same diameter and care must be used in removing camshaft to avoid damage to bearings.

Inspection

The camshaft bearing journals should be measured with a micrometer for an out-of-round condition. If the journals exceed .001" out-of-round, the camshaft should be replaced.

Installation

When a new camshaft is installed coat camshaft lobes with "Molykote" or its equivalent. When a new camshaft is installed, replacement of all valve lifters is recommended to insure durability of the camshaft lobes and lifter feet.

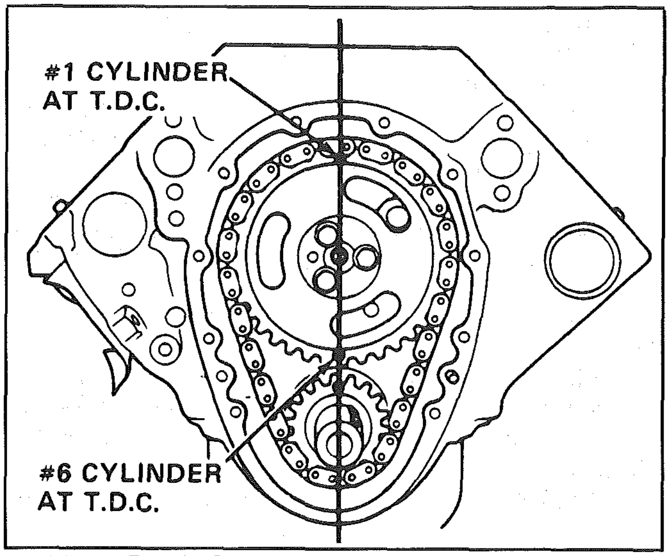


Fig. 6A3-31 Aligning Timing Marks

1. Lubricate camshaft journals with engine oil and install camshaft.
2. Install timing chain on camshaft sprocket. Hold the sprocket vertically with the chain hanging down and align marks on camshaft and crankshaft sprockets. (Refer to fig. 6A3-31).
3. Align dowel in camshaft with dowel hole in camshaft sprocket then install sprocket on camshaft.
4. Draw the camshaft sprocket onto camshaft using the mounting bolts. Torque to specifications.
5. Lubricate timing chain with engine oil.
6. Install fuel pump push rod as outlined in Section 6C.
7. Install grille.
8. Install crankcase front cover as previously outlined.
9. Install valve lifters as previously outlined.

CAMSHAFT BEARINGS

Removal

Camshaft bearings can be replaced with engine completely or partially disassembled. To replace bearings without complete disassembly remove the camshaft and crankshaft leaving cylinder heads attached and pistons in place. Before removing crankshaft, tape threads of connecting rod bolts to prevent damage to crankshaft. Fasten connecting rods against sides of engine so they will not be in the way while replacing camshaft bearings.

1. With camshaft and crankshaft removed, drive camshaft rear plug from cylinder block.
2. Using Tool J-6098, with nut and thrust washer installed to end of threads, index pilot in camshaft front bearing and install puller screw through pilot.
3. Install remover and installer tool with shoulder toward bearing, making sure a sufficient amount of threads are engaged.
4. Using two wrenches, hold puller screw while turning nut. When bearing has been pulled from

bore, remove remover and installer tool and bearing from puller screw.

5. Remove remaining bearings (except front and rear) in the same manner. It will be necessary to index pilot in camshaft rear bearing to remove the rear intermediate bearing.
6. Assemble remover and installer tool on driver handle and remove camshaft front and rear bearings by driving towards center of cylinder block.

Installation

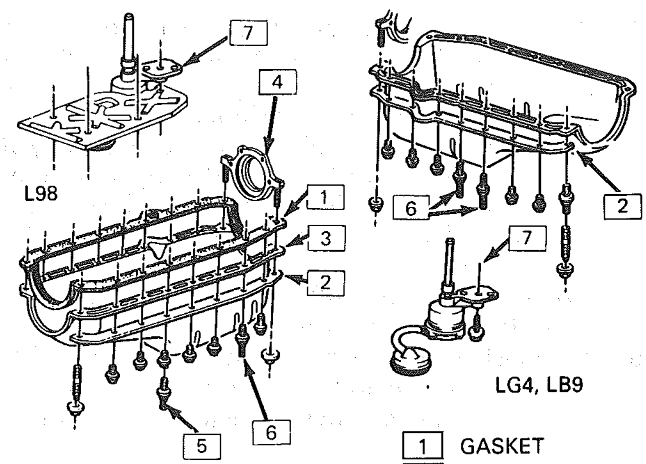
The camshaft front and rear bearings should be installed first. These bearings will act as guides for the pilot and center the remaining bearings being pulled into place.

1. Assemble remover and installer tool on driver handle and install camshaft front and rear bearings by driving towards center of cylinder block.
2. Using Tool Set J-6098, with nut then thrust washer installed to end of threads, index pilot in camshaft front bearing and install puller screw through pilot.
3. Index camshaft bearing in bore (with oil hole aligned as outlined below), then install remover and installer tool on puller screw with shoulder toward bearing.
   - Number one cam bearing oil hole must be positioned so that oil holes are equidistant from 6 o'clock position.
   - Number two through number four bearing oil holes must be positioned at 5 o'clock position (toward left side of engine and at a position even with bottom of cylinder bore).
   - Number five bearing oil hole must be in 12 o'clock position.
4. Using two wrenches, hold puller screw while turning nut. After bearing has been pulled into bore, remove the remover and installer tool from puller screw and check alignment of oil hole in camshaft bearing.
5. Install remaining bearings in the same manner. It will be necessary to index pilot in the camshaft rear bearing to install the rear intermediate bearing.
6. Coat new camshaft rear plug O.D. with #1052080 sealant, or equivalent, and install flush to 1/32" (.80mm) deep.

OIL PAN

Removal

1. Disconnect battery negative cable.
2. Remove fan shroud.
3. Remove air cleaner and lay aside if equipped.
4. Remove distributor cap and lay aside.
5. Raise vehicle.
6. Drain crankcase.
7. Disconnect exhaust pipe at manifold.
8. Disconnect AIR pipe clamp.
9. Disconnect converter hanger bolts and allow exhaust to hang down.



ENGINE OIL PRESSURE 10 LBS. MINIMUM AT 500 RPM AND 30-55 LBS. AT 2000 RPM.
OIL FILTER BY-PASS VALVE OPERATES AT 9- TO 11 LBS. PRESSURE.

1 GASKET
2 REINFORCEMENT
3 OIL PAN
4 RETAINER
5 STUD (LB9, L98)
6 STUD (L98)
7 OIL PUMP

Fig. 6A3-32 Oil Pan

10. Remove front starter brace.
11. Remove starter bolts and let starter hang.
12. On vehicles equipped with manual transmission, it may be necessary to remove the oil filter in order to remove the inspection cover.
13. Remove inspection cover.
14. Remove engine mount through bolts.
15. Remove oil pan bolts.
16. Raise engine.
17. Rotate crankshaft to position throws so as not to block pan removal.
18. Remove oil pan.

Installation

1. Clean sealing surfaces on cylinder case and oil pan.
2. Check oil pan gasket for damage and replace if necessary.
3. Apply a small amount of 1052751, or equivalent, to front and rear corners of oil pan.

NOTICE: Only a small amount of sealant is required. Excessive amounts of sealant may cause a problem with proper sealing of oil pan.

4. Reverse removal procedures.

OIL PUMP

Removal

1. Remove oil pan as previously outlined.
2. Remove pump to rear main bearing cap bolt and remove pump and extension shaft.

Disassembly (Figure 6A3-33)

1. Remove the pump cover attaching screws and the pump cover.

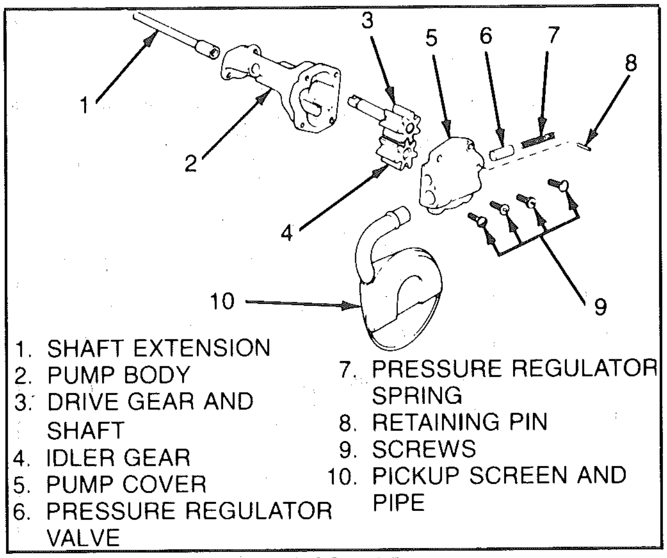


Fig. 6A3-33 Oil Pump

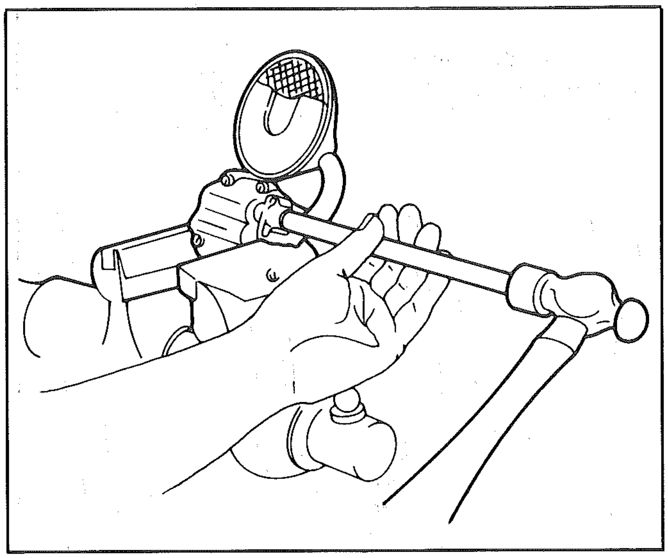


Fig. 6A3-34 Installing Screen

2. Mark gear teeth so they may be reassembled with the same teeth indexing. Remove the idler gear and the drive gear and shaft from the pump body.
3. Remove the pressure regulator valve retaining pin, pressure regulator valve and related parts.
4. If the pickup screen and pipe assembly need replacing, mount the pump in a soft-jawed vise and extract pipe from pump. Do not disturb the pickup screen on the pipe. This is serviced as an assembly.

Cleaning and Inspection

1. Wash all parts in cleaning solvent and dry with compressed air.
2. Inspect the pump body and cover for cracks or excessive wear.
3. Inspect pump gears for damage or excessive wear.
   - The pump gears and body are not serviced separately. If the pump gears or body are damaged or worn, replacement of the entire oil pump assembly is necessary.
4. Check the drive gear shaft for looseness in the pump body.
5. Inspect inside of pump cover for wear that would permit oil to leak past the ends of the gears.
6. Inspect the pickup screen and pipe assembly for damage to screen, pipe or relief grommet.
7. Check the pressure regulator valve for fit.

Assembly (Figure 6A3-33)

1. If the pickup screen and pipe assembly was removed, it should be replaced with a new part. Loss of press fit condition could result in an air leak and loss of oil pressure. Mount the pump in a soft-jawed vise, apply sealer to end of pipe, and using Tool J-8369 (fig. 6A3-34) tap the pipe in place with a plastic hammer.

NOTICE: Be careful of twisting, shearing or collapsing pipe while installing in pump.

2. Install the pressure regulator valve and related parts.
3. Install the drive gear and shaft in the pump body.
4. Install the idler gear in the pump body with the smooth side of gear towards pump cover opening.
5. Install the pump cover and torque attaching screws to specifications.
6. Turn drive shaft by hand to check for smooth operation.

Installation

1. Assemble pump and extension shaft to rear main bearing cap, aligning slot on top end of extension shaft with drive tang on lower end of distributor drive shaft.
2. Install pump to rear bearing cap bolt and torque to specifications.
3. Install oil pan previously outlined.

CONNECTING ROD BEARINGS

Connecting rod bearings are of the precision insert type and do not utilize shims for adjustment. DO NOT FILE RODS OR ROD CAPS. If clearances are found to be excessive a new bearing will be required. Service bearings are available in standard size and .001" and .002" undersize for use with new and used standard size crankshafts, and in .010" and .020" undersize for use with reconditioned crankshafts.

On removing a connecting rod cap, it is possible to find a .010" undersize bearing. These are used in manufacturing for selective fitting.

Inspection and Replacement

1. With oil pan and oil pump removed, remove the connecting rod cap and bearing.

   Before removal of connecting rod cap, mark the side of the rod and cap with the cylinder number to assure matched reassembly of rod and cap.
2. Inspect the bearing for evidence of wear or damage. (Bearings showing the above should not be installed.)
3. Wipe both upper and lower bearing shells and crankpin clean of oil.

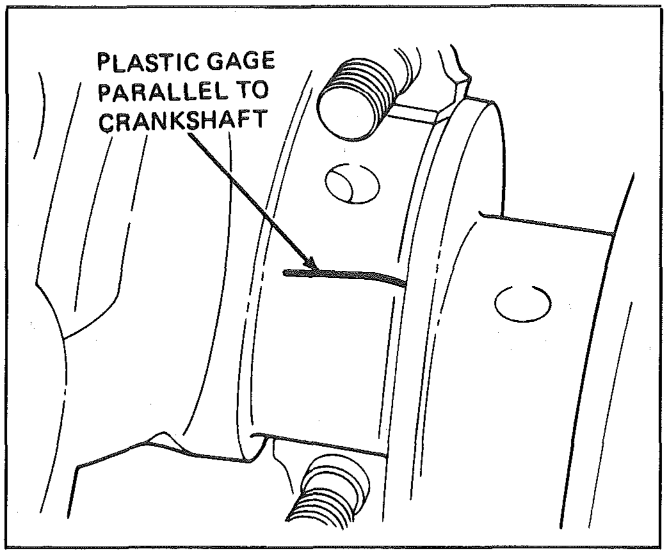


Fig. 6A3-35 Gaging Plastic On Crankpin-Typical

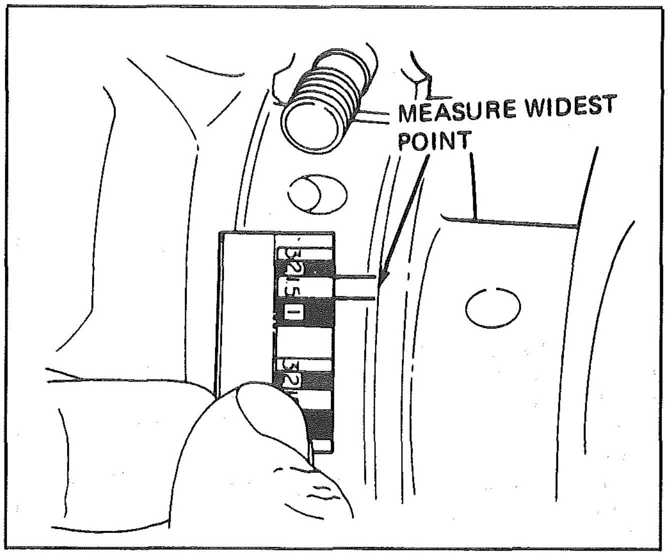


Fig. 6A3-36 Measuring Gaging Plastic-Typical

4. Measure the crankpin for out-of-round or taper with a micrometer. If not within specifications replace or recondition the crankshaft. If within specifications and a new bearing is to be installed, measure the maximum diameter of the crankpin to determine new bearing size required.
5. If within specifications measure new or used bearing clearances with Plastigage or its equivalent.

   If a bearing is being fitted to an out-of-round crankpin, be sure to fit to the maximum diameter of the crankpin. If the bearing is fitted to the minimum diameter and the crankpin is out-of-round .001" interference between the bearing and crankpin will result in rapid bearing failure.

   a. Place a piece of gaging plastic, the length of the bearing (parallel to the crankshaft), on the crankpin or bearing surface (fig. 6A3-35). Plastic gage should be positioned in the middle of the bearing shell. (Bearings are eccentric and false readings could occur if placed elsewhere).
   b. Install the bearing in the connecting rod and cap.
   c. Install the bearing cap and evenly torque nuts to specifications.

NOTICE: Do not turn the crankshaft with the gaging plastic installed.

   d. Remove the bearing cap and using the scale on the gaging plastic envelope, measure the gaging plastic width at the widest point (fig. 6A3-36).
6. If the clearance exceeds specifications, select a new, correct size, bearing and remeasure the clearance.

   Be sure to check what size bearing is being removed in order to determine proper replacement size bearing. If clearance cannot be brought to within specifications, the crankpin will have to be ground undersize. If the crankpin is already at maximum undersize, replace crankshaft.
7. Coat the bearing surface with oil, install the rod cap and torque nuts to specifications.
8. When all connecting rod bearings have been installed tap each rod lightly (parallel to the crankpin) to make sure they have clearance.
9. Measure all connecting rod side clearances (see specifications) between connecting rod caps (fig. 6A3-37).

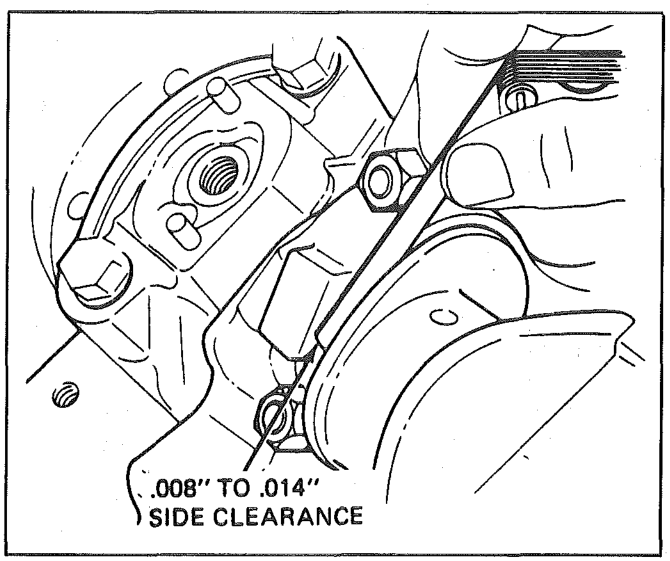


Fig. 6A3-37 Measuring Connecting Rod Side Clearance-Typical

MAIN BEARINGS (FIG. 6A3-38)

Main bearings are of the precision insert type and do not utilize shims for adjustment. If clearances are found to be excessive, a new bearing, both upper and lower halves, will be required. Service bearings are available in standard size and .001", .002", .009", .010" and .020" undersize.

Selective fitting of both rod and main bearing inserts is necessary in production in order to obtain close tolerances. For this reason you may find one half

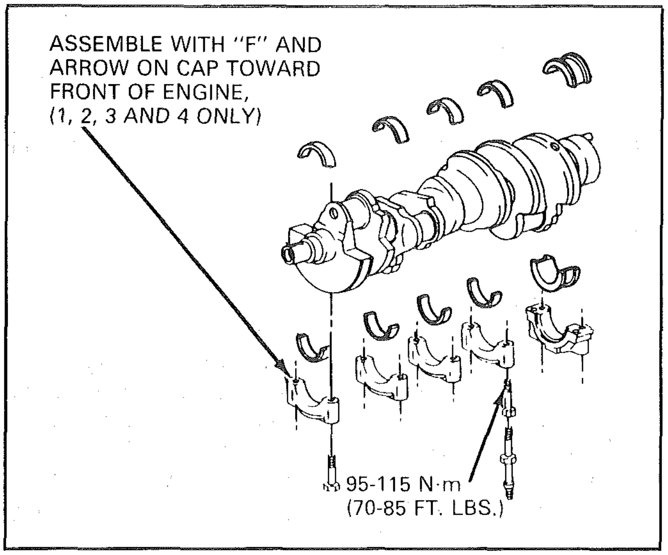


Fig. 6A3-38 Main Bearings

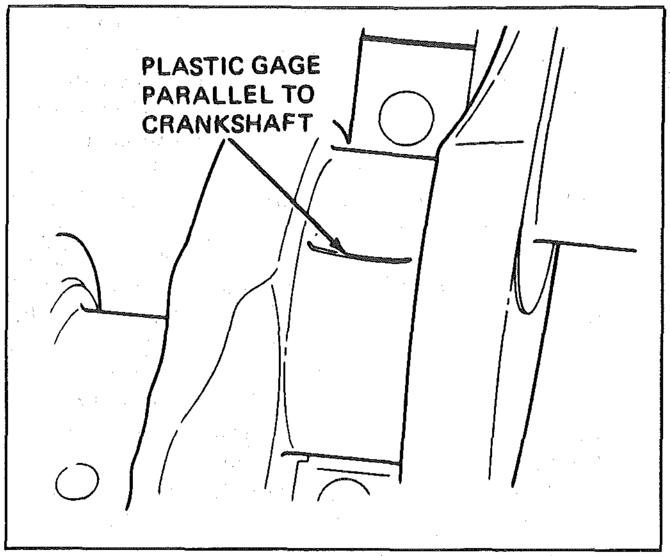


Fig. 6A3-39 Gaging Plastic on Journal-Typical

of a standard insert with one half of a .001" undersize insert which will decrease the clearance .0005" from using a full standard bearing.

When a production crankshaft cannot be precision fitted by this method, it is then ground .009" undersize **ON ONLY THOSE MAIN JOURNALS THAT CANNOT BE PROPERLY FITTED. ALL JOURNALS WILL NOT NECESSARILY BE GROUND.** A .009" undersize bearing and .010" undersize bearing may be used for precision fitting in the same manner as previously described.

If, for any reason, main bearing caps are replaced, shimming may be necessary. Laminated shims for each cap are available for service. Shim requirement will be determined by bearing clearance.

Inspection

In general, the lower half of the bearing (except #1 bearing) shows a greater wear and the most distress from fatigue. If upon inspection the lower half is suitable for use, it can be assumed that the upper half is also satisfactory. If the lower half shows evidence of wear or damage, both upper and lower halves should be replaced. Never replace one half without replacing the other half.

Checking Clearance

To obtain the most accurate results with "Plastigage", (or its equivalent) a wax-like plastic material which will compress evenly between the bearing and journal surfaces without damaging either surface, certain precautions should be observed.

If the engine is out of the vehicle and upside down, the crankshaft will rest on the upper bearings and the total clearance can be measured between the lower bearing and journal. If the engine is to remain in the vehicle, the crankshaft must be supported upward to remove any clearance from the upper bearing. The total clearance can then be measured between the lower bearing and journal.

To assure the proper seating of the crankshaft, all bearing cap bolts should be at their specified torque. In addition, preparatory to checking fit of bearings, the surface of the crankshaft journal and bearing should be wiped clean of oil.

1. With the oil pan and oil pump removed, and starting with the rear main bearing, remove bearing cap and wipe oil from journal and bearing cap.
2. Place a piece of gaging plastic the full width of the bearing (parallel to the crankshaft) on the journal (fig. 6A3-39).

NOTICE: Do not rotate the crankshaft while the gaging plastic is between the bearing and journal.

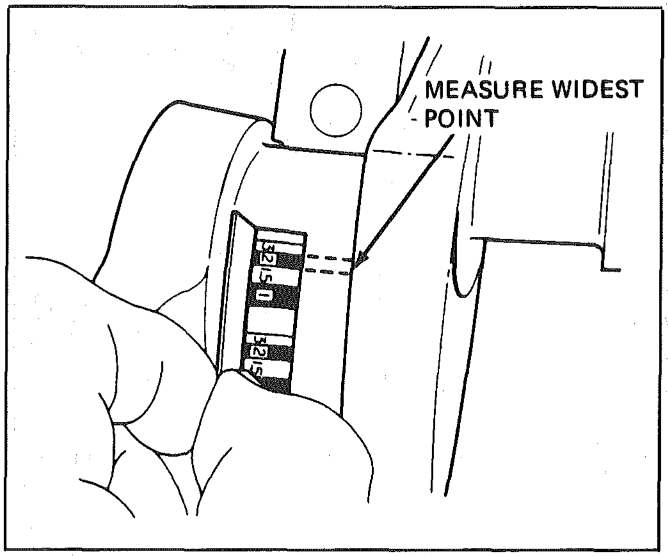


Fig. 6A3-40 Measuring Gaging Plastic-Typical

3. Install the bearing cap and evenly torque the retaining bolts to specifications. Bearing cap MUST be torqued to specification in order to assure proper reading. Variations in torque affect the compression of the plastic gage.

4. Remove bearing cap. The flattened gaging plastic will be found adhering to either the bearing shell or journal.

5. On the edge of gaging plastic envelope there is a graduated scale which is correlated in thousandths of an inch. Without removing the gaging plastic, measure its compressed width (at the widest point) with the graduations on the gaging plastic envelope (fig. 6A3-40).
   Normally main bearing journals wear evenly and are not out-of-round. However, if a bearing is being fitted to an out-of-round journal (.001" max.), be sure to fit to the maximum diameter of the journal: If the bearing is fitted to the minimum diameter and the journal is out-of-round .001", interference between the bearing and journal will result in rapid bearing failure. If the flattened gaging plastic tapers toward the middle or ends, there is a difference in clearance indicating taper, low spot or other irregularity of the bearing or journal. Be sure to measure the journal with a micrometer if the flattened gaging plastic indicates more than .001" difference.
6. If the bearing clearance is within specifications, the bearing insert is satisfactory. If the clearance is not within specifications, replace the insert. Always replace both upper and lower inserts as a unit.
   If a new bearing cap is being installed and clearance is less than .001", inspect for burrs or nicks; if none are found then install shims as required.

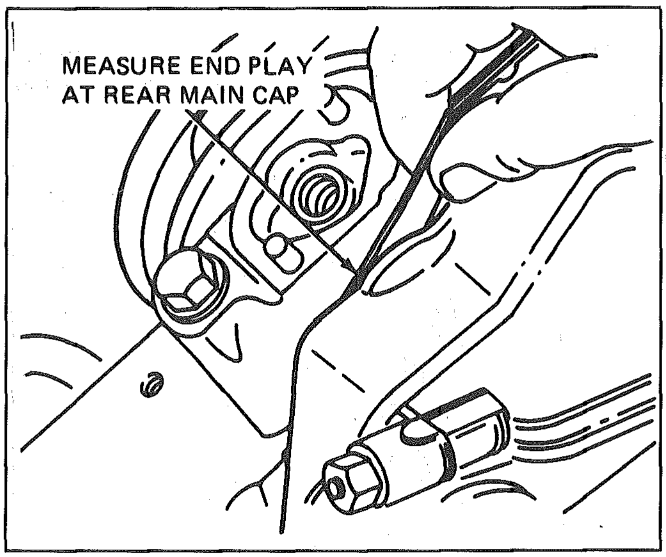


Fig. 6A3-41 Measuring Crankshaft End Play - Typical

7. A standard, .001" or .002" undersize bearing may produce the proper clearance. If not, it will be necessary to regrind the crankshaft journal for use with the next undersize bearing.
   After selecting new bearing, recheck clearance.
8. Proceed to the next bearing. After all bearings have been checked rotate the crankshaft to see that there is no excessive drag.
   When checking # 1 main bearing, loosen accessory drive belts so as to prevent tapered reading with plastic gage.
9. Measure crankshaft end play (see specifications) by forcing the crankshaft to the extreme front position. Measure at the front end of the rear main bearing with a feeler gage (fig. 6A3-41).
10. Install a new rear main bearing oil seal in the cylinder block and main bearing cap.

Replacement

Main bearings may be replaced with or without removing the crankshaft.

NOTICE: Some production engines may come with rear main bearings with the distance between thrust faces .008" wider than the standard size. The crankshaft will be identified by .008" stamped on the rear counterweight. If the rear main bearings are replaced, they must have the proper distance between thrust faces to ensure correct crankshaft end play.

With Crankshaft Removal

1. Remove and inspect the crankshaft.
2. Remove the main bearings from the cylinder block and main bearing caps.
3. Coat bearing surfaces of new, correct size, main bearings with oil and install in the cylinder block and main bearing caps.
4. Install the crankshaft.

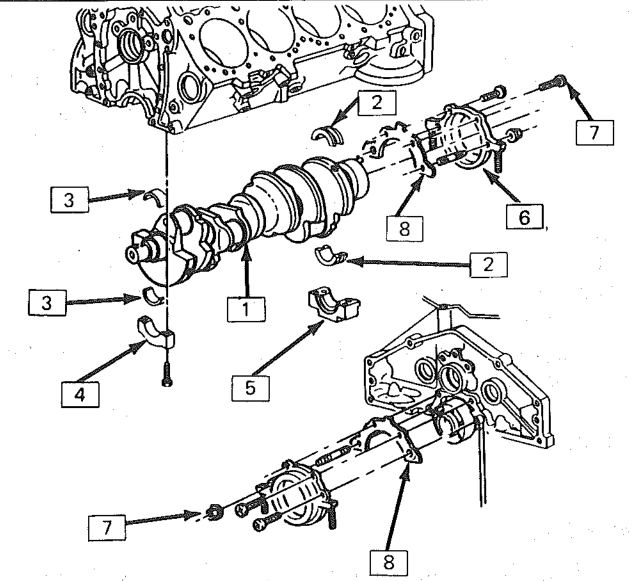
Without Crankshaft Removal

1. With oil pan, oil pump and spark plugs removed, remove cap on main bearing requiring replacement and remove bearing from cap.
2. Install a main bearing removing and installing tool in oil hole in crankshaft journal. If such a tool is not available, a cotter pin may be bent as required to do the job.
3. Rotate the crankshaft clockwise as viewed from the front of engine. This will roll upper bearing out of block.
4. Oil new selected size upper bearing and insert plain (unnotched) end between crankshaft and indented or notched side of block.
   Rotate the bearing into place and remove tool from oil hole in crankshaft journal.
5. Oil new lower bearing and install in bearing cap.
6. Install main bearing cap with arrows pointing toward front of engine.
7. Torque all main bearing caps, EXCEPT THE REAR MAIN CAP, to specifications. Torque rear main bearing cap to 10-12 lb. ft. (14-16N·m) then tap end of crankshaft, first rearward then forward with a lead hammer. This will line up rear main bearing and crankshaft thrust surfaces. Retorque all main bearing caps to specifications.

REAR MAIN SEAL

Removal

1. Remove transmission as outlined in Section 7.
2. Using notches provided in retainer, pry out seal with a screwdriver (Figure 6A4-43).



1. CRANKSHAFT
2. THRUST BEARING
3. MAIN BEARING
4. BEARING CAP
5. REAR MAIN BEARING CAP
6. RETAINER
7. 13-16 N·m (120-150 IN. LBS.)
8. GASKET

Figure 6A3-42 Crankshaft Oil Seal-Rear Main

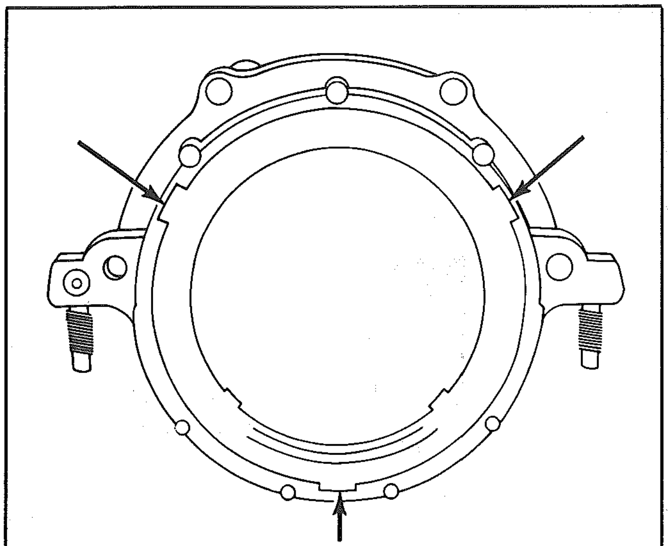


Figure 6A3-43 Seal Removal

NOTICE: Care should be taken when removing the seal so as not to nick crankshaft sealing surface.

Installation

1. Lubricate the I.D. and O.D. of new seal with engine oil.
2. Install seal on tool J-35621 (Figure 6A4-44).
3. Thread screws into rear of crankshaft. Tighten screws with a screwdriver snugly, this is to insure that the seal will be installed squarely over the crankshaft.

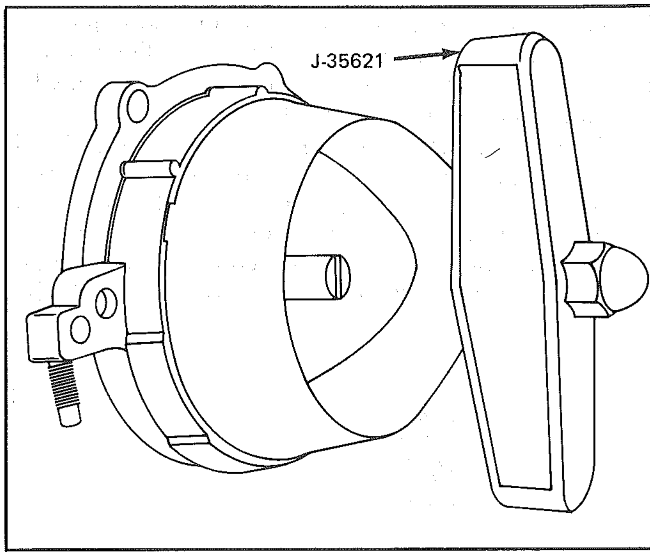


Figure 6A3-44 Seal Installation

4. Tighten the wing nut until it bottoms.
5. Remove tool from crankshaft.
6. Install transmission.

REAR MAIN SEAL RETAINER/GASKET

Removal

1. Remove oil pan bolts and lower oil pan.
2. Remove transmission as outlined in Section 7.
3. Remove retainer and seal assembly.
4. Remove gasket.

Installation

Whenever the retainer is removed, a new retainer gasket and rear main seal must be installed.

1. Clean mating surfaces of case and retainer assembly.
2. (Install new gasket on studs in engine case. It is not necessary to use any type of sealant to retain gasket in place.
3. (Install retainer to case bolts, torque bolts to 10-13 N·m (90-120 in. lbs.).
4. Install transmission.
5. Inspect oil pan gasket for damage. Replace gasket if necessary.
6. Apply a small amount of 1052751 or equivalent to front and rear corners of oil pan.

NOTICE: Only a small amount of sealant is required. Excessive amounts of sealant may cause a problem with proper sealing of oil pan.

7. Install oil pan bolts (Figure 6A4-32).
8. Install rear main seal using tool J-35621 as previously outlined.

CONNECTING ROD AND PISTON ASSEMBLIES

Removal

1. Remove oil pan, oil pump and cylinder head as previously outlined.
2. For the cylinder being serviced, turn crankshaft until piston is at the bottom of the stroke. Place a cloth on top of the piston.

3. Use a ridge reamer to remove any ridge and/or deposits from the upper end of the cylinder bore.
4. Turn crankshaft until piston is at top of stroke and remove cloth and cuttings.
5. Remove connecting rod cap and install Tool J-5239 (3/8") on studs. Push connecting rod and piston assembly out of top of cylinder block. It will be necessary to turn the crankshaft slightly to disconnectt some of the connecting rod and piston assemblies and push them out of the cylinder.

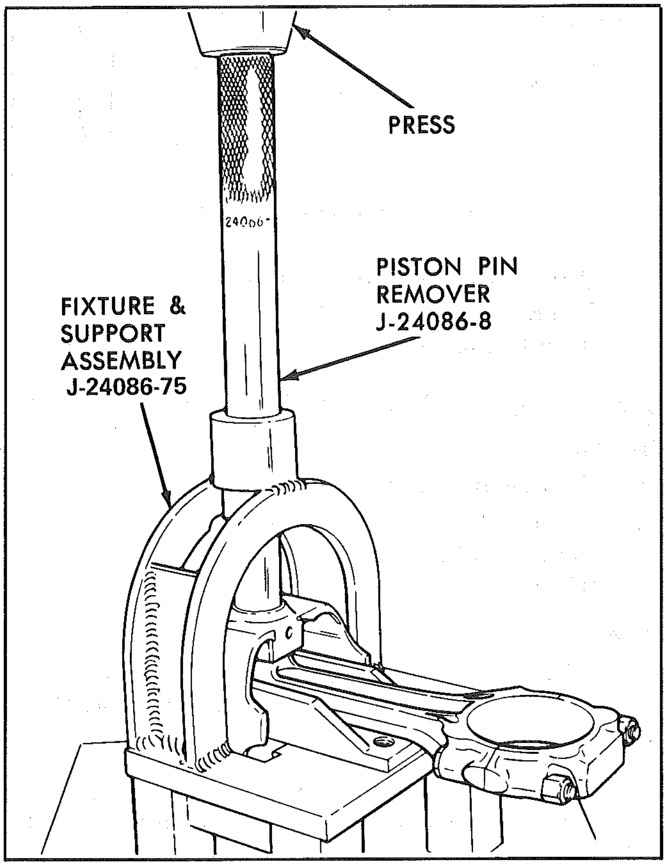


Fig. 6A3-45 Removing Piston Pin

Disassembly

1. Remove connecting rod bearings from connecting rods and caps. If bearings are being reused, place them in a rack so they may be reinstalled in their original rod and cap.
2. Remove piston rings by expanding and sliding them off the pistons.
3. Place connecting rod and piston assembly on Tool J-24086-20. Using an arbor press and piston pin remover, J-24086-8, press the piston pin out of connecting rod and piston (Fig. 6A3-45).

Cleaning and Inspection

Connecting Rods

Wash connecting rods in cleaning solvent and dry with compressed air. Check for twisted or bent rods and inspect for nicks or cracks. Replace connecting rods that are damaged.

Pistons

Clean varnish from piston skirts and pins with a cleaning solvent. DO NOT WIRE BRUSH ANY PART OF THE PISTON. Clean the ring grooves with a groove cleaner and make sure oil ring holes and slots are clean.

Inspect the piston for cracked ring lands, skirts or pin bosses, wavy or worn ring lands, scuffed or damaged skirts, eroded areas at top of the piston. Replace pistons that are damaged or show signs of excessive wear.

Inspect the grooves for nicks or burrs that might cause the rings to hang up.

Measure piston skirt (across center line of piston pin) and check clearance.

Piston Pins

The piston pin clearance is designed to maintain adequate clearance under all engine operating conditions. Because of this, the piston and piston pin are a matched set and not serviced separately.

Inspect piston pin bores and piston pins for wear. Piston pin bores and piston pins must be free of varnish or scuffing when being measured. The piston pin should be measured with a micrometer and the piston pin bore should be measured with a dial bore gage or an inside micrometer. If clearance is in excess of the .001" wear limit, the piston and piston pin assembly should be replaced.

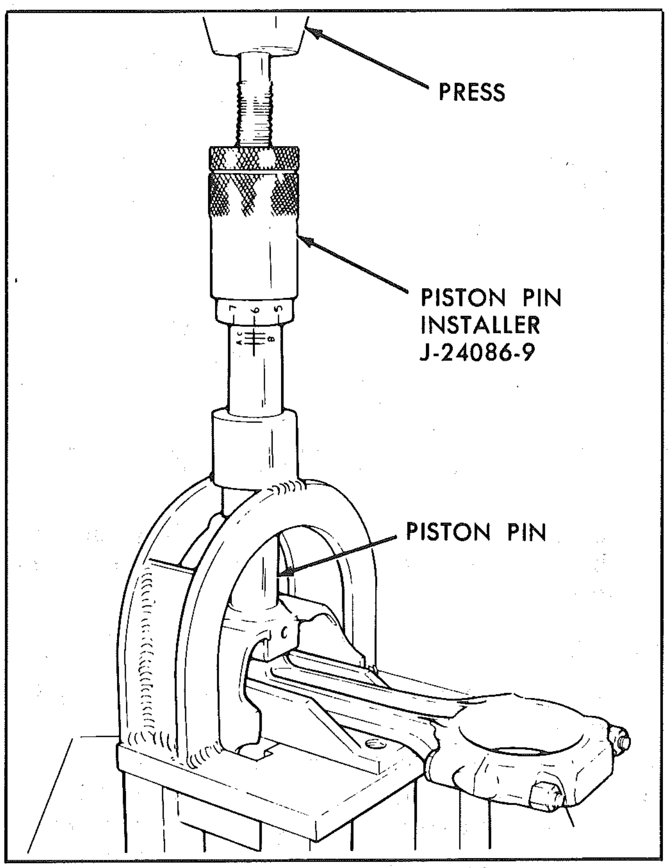


Fig. 6A3-46 Installing Piston Pin

Assembly

1. Lubricate piston pin holes in piston and connecting rod to facilitate installation of pin.
2. Place connecting rod in piston and hold in place with piston pin guide and piston pin. Place assembly on fixture and support assembly.
3. Using piston pin installer, J-24086-9, press the piston pin into the piston and connecting rod (Fig. 6A3-46).

   NOTICE: After installer hub bottoms on support assembly, do not exceed 5000 psi pressure, as this could cause structural damage to the tool.
4. Remove piston and connecting rod assembly from tool and check piston for freedom of movement on piston pin.

Piston Rings

All compression rings are marked on the upper side of the ring. When installing compression rings, make sure the MARKED SIDE IS TOWARD THE TOP OF THE PISTON. The top ring is chrome faced, or treated with molybdenum for maximum life. The second compression ring is a tapered face acting as both a compression and oil control ring.

The oil control rings are of three piece type, consisting of two segments (rails) and a spacer.

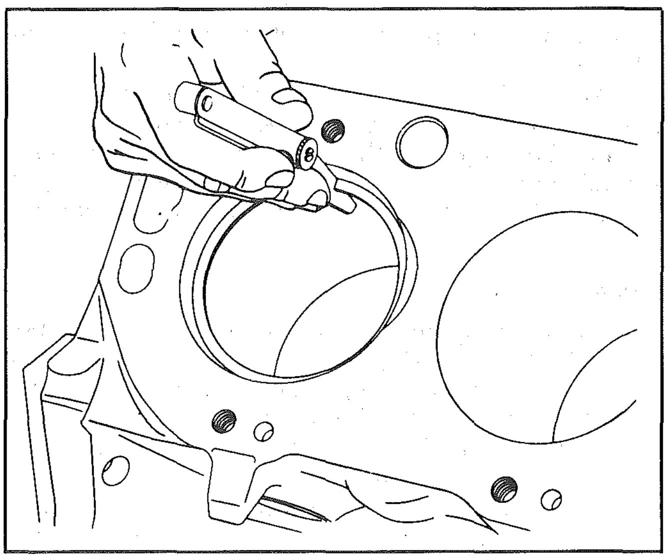


Fig. 6A3-47 Measuring Ring Gap

1. Select rings comparable in size to the piston being used.
2. Slip the compression ring in the cylinder bore; then press the ring down into the cylinder bore about 1/4" (6.5mm) (above ring travel). Be sure ring is square with cylinder wall.
3. Measure the space or gap between the ends of the ring with a feeler gage (Fig. 6A3-47).
4. If the gap between the ends of the ring is below specifications, remove the ring and try another for fit.
5. Fit each compression ring to the cylinder in which it is going to be used.
6. If the pistons have not been cleaned and inspected as previously outlined, do so.

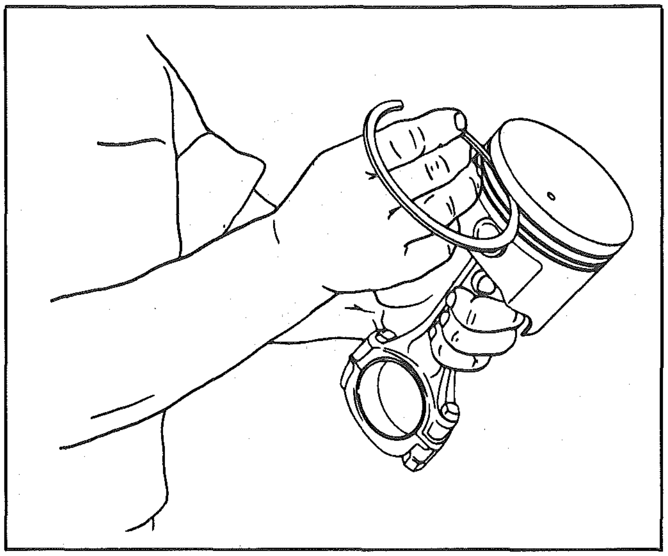


Fig. 6A3-48 Checking Ring in Groove

7. Slip the outer surface of the top and second compression ring into the respective piston ring groove and roll the ring entirely around the groove (Fig. 6A3-48) to make sure that the ring is free. If binding occurs at any point, the cause should be determined. If binding is caused by ring groove, correct by dressing with a fine cut file. If the binding is caused by a distorted ring, check a new ring.
8. Install piston rings as follows:
   a. Install oil ring spacer in groove and insert anti-rotation tang (where applicable) in drilled hole.
   b. Hold spacer ends butted and install lower steel oil ring rail with gap properly located.
   c. Install upper steel oil ring rail with gap properly located.
   d. Flex the oil ring assembly to make sure ring is free. If binding occurs at any point the cause should be determined. If binding is caused by ring groove, correct by dressing groove with a fine cut file. If binding is caused by a distorted ring, check a new ring.
   e. Install second compression ring (manufacturer mark up) with gaps properly located.
   f. Install top compression ring (manufacturer mark up) with gap properly located.
9. Proper clearance of the piston ring in its piston ring groove is very important to provide proper ring action and reduce wear. Therefore, when fitting new rings, the clearances between the surfaces of the ring and groove should be measured (Fig. 6A3-49). (See Specifications).

Installation

Cylinder bores must be clean before piston installation. This may be accomplished with a hot water and detergent wash or with a light honing as necessary. After cleaning, the bores should be swabbed several times with light engine oil and a clean dry cloth.

1. Lubricate connecting rod bearings and install in rods and rod caps.

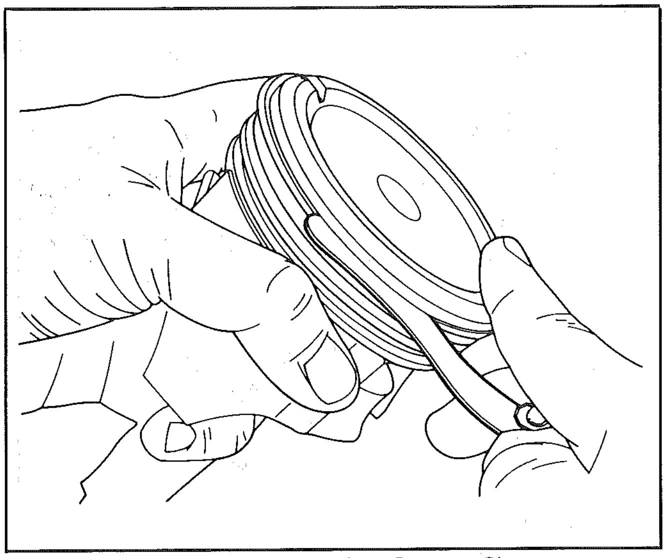


Fig. 6A3-49 Measuring Ring Groove Clearance

2. Lightly coat pistons, rings and cylinder walls with light engine oil.
3. With bearing caps removed, install Tool J-5239 (3/8") on connecting rod bolts.
4. Install each connecting rod and piston assembly in its respective bore. Install with connecting rod bearing tang slots on side opposite camshaft. Use Tool J-8037 to compress the rings. Guide the connecting rod into place on the crankshaft journal with Tool J-5239 (3/8"). Use a hammer handle and light blows to install the piston into the bore. Hold the ring compressor firmly against the cylinder block until all piston rings have entered the cylinder bore.
5. Remove Tool J-5239.
6. Install the bearing caps and torque nuts to specifications.

Be sure to install new pistons in the cylinders for which they were fitted, and used pistons in the cylinder from which they were removed. Each connecting rod and bearing cap should be marked, beginning at the front of the engine. 1,3,5 and 7 in the left bank and, 2 4, 6 and 8 in the right bank. The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.

CYLINDER BLOCK

Cleaning and Inspection

1. Wash cylinder block thoroughly in cleaning solvent and clean all gasket surfaces.
2. Remove oil gallery plugs and clean all oil passages.
3. Clean and inspect coolant passages in the cylinder block.
4. Inspect the cylinder block for cracks in the cylinder walls, coolant jacket, valve lifter bores and main bearing webs.
5. Measure the cylinder walls for taper, out-of-round or excessive ridge at top of ring travel. This should be done with a dial indicator. Set the gage so that the thrust pin must be forced in about 1/4" (6.5mm) to enter gage in cylinder bore. Center gage in cylinder and turn dial to "0". Carefully work gage up and down cylinder to determine taper and turn it to different points around cylinder wall to determine the out-of-round condition. If cylinders were found to exceed specifications, honing or boring will be necessary.

Conditioning

The performance of the following operation is contingent upon engine condition at time of repair.

If the cylinder block inspection indicated that the block was suitable for continued use except for out-of-round or tapered cylinders, they can be conditioned by honing or boring.

If the cylinders were found to have less than .005" (.13mm) taper or wear, they can be conditioned with a hone and fitted with the high limit standard size piston. A cylinder bore of less then .005" (.13mm) wear or taper may not entirely clean up when fitted to a high limit piston. If it is desired to entirely clean up the bore in these cases, it will be necessary to rebore for an oversize piston. If more than .005" (.13mm) taper or wear, they should be bored and honed to the smallest oversize that will permit complete resurfacing of all cylinders.

When pistons are being fitted and honing is not necessary, cylinder bores may be cleaned with a hot water and detergent wash. After cleaning, the cylinder bores should be swabbed several times with light engine oil and a clean cloth and then wiped with a clean dry cloth.

Boring

1. Before using any type boring bar, the top of the cylinder block should be filed to remove any dirt or burrs. This is very important. If not checked, the boring bar may be tilted which would result in the rebored cylinder wall not being at right angles to the crankshaft.
2. The piston to be fitted should be measured with a micrometer, measuring at the center of the piston skirt and at right angles to the piston pin. The cylinder should be bored to the same diameter as the piston and honed to give the specified clearance.
3. The instructions furnished by the manufacturer of the equipment being used should be carefully followed.

Honing

1. When cylinders are to be honed, follow the hone manufacturer's recommendations for the use of the hone and cleaning and lubrication during honing.
2. Occasionally during the honing operation, the cylinder bore should be thoroughly cleaned and the piston selected for the individual cylinder checked for correct fit.

3. When finish honing a cylinder bore to fit a piston, the hone should be moved up and down at a sufficient speed to obtain very fine uniform surface finish marks in a cross-hatch pattern of approximately 45° to 65° included angle. The finish marks should be clean but not sharp, free from imbedded particles and torn or folded metal.
4. Permanently mark the piston for the cylinder to which it has been fitted and proceed to hone cylinders and fit the remaining pistons.

NOTICE: Handle the pistons with care and do not attempt to force them through the cylinder until the cylinder has been honed to correct size as this type piston can be distorted through careless handling.

5. Thoroughly clean the bores with hot water and detergent. Scrub well with a stiff bristle brush and rinse thoroughly with hot water. It is extremely essential that a good cleaning operation be performed. If any of the abrasive material is allowed to remain in the cylinder bores, it will rapidly wear the new rings and cylinder bores in addition to the bearings lubricated by the contaminated oil, the bores should be swabbed and then wiped with a clean dry cloth. Cylinder should not be cleaned with kerosene or gasoline. Clean the remainder of the cylinder block to remove the excess material spread during the honing operation.

Piston Selection

1. Check USED piston to cylinder bore clearance as follows:
   a. Measure the "Cylinder Bore Diameter" with a telescope gage "2-1/2″ (64mm) from top of cylinder bore").
   b. Measure the "Piston Diameter" (at skirt across center line of piston pin).
   c. Subtract piston diameter from cylinder bore diameter to determine "Piston to Bore Clearance".
   d. Determine if piston to bore clearance is in the acceptable range.
2. If used piston is not acceptable, check Piston Size Chart and determine if a new piston can be selected to fit cylinder bore within the acceptable range.
3. If cylinder bore must be reconditioned, measure new piston diameter (across center line of piston pin) then hone cylinder bore to correct clearance (preferable range).
4. Mark the piston to identify the cylinder for which it was fitted.

OIL FILTER BYPASS VALVE

Inspection and Replacement

With the oil filter removed, check the spring and fibre valve for operation. Inspect for a cracked or broken valve. If replacement is necessary, the oil filter adapter and bypass valve assembly must be replaced as an assembly. Clean valve chamber in cylinder block thoroughly. Torque retaining screws to specifications.

ENGINE ASSEMBLY

Removal

1. Disconnect battery.
2. Remove air cleaner.
3. Remove hood.
4. Drain radiator.
5. Remove lower radiator hose.
6. Remove upper fan shroud.
7. Remove upper radiator hose and coolant recovery hose.
8. Remove transmission cooler lines.
9. Remove radiator.
10. Remove fan assembly.
11. Remove heater hoses.
12. Disconnect carburetor linkage, includes cruise control detent cable.
13. Remove vacuum brake booster line.
14. Remove distributor cap and lay wiring aside.
15. Disconnect necessary wires and hoses.
16. Remove power steering pump and lay aside.
17. Raise vehicle.
18. Remove exhaust pipes at exhaust manifold.
19. Remove dust cover.
20. Remove converter bolts.
21. Disconnect starter wires.
22. Remove bell housing bolts.
23. Remove motor mount through bolts.
24. Disconnect fuel lines at fuel pump.
25. Lower vehicle.
26. Support transmission.
27. Remove A.I.R./Converter pipe bracket.
28. Remove engine, include removing wire from bracket at rear left of engine.

Installation

1. Position engine assembly in vehicle.
2. Attach motor mount to engine brackets and lower engine in place.
3. Remove engine lifting device.
4. Remove transmission floor jack.
5. Raise vehicle on hoist.
6. Install mount "through" bolts. Torque to specifications.
7. Install bell housing bolts. Torque to specifications.
8. On vehicles with automatic transmissions, install converter to flywheel attaching bolts. Torque to specifications.
9. Install flywheel splash shield of converter housing cover as applicable. Torque attaching bolts to specifications.
10. Install starter wires.
11. Connect fuel lines.
12. Connect exhaust pipe at manifold.
13. Lower vehicle on hoist.
14. Reinstall power steering pump, if so equipped.
15. Connect necessary wires and hoses.

16. Install radiator and fan shroud and reconnect radiator and heater hoses.
17. Fill cooling system.
18. Fill crankcase with oil. See owner's manual for specifications.
19. Install air cleaner.
20. Install hood.
21. Connect battery cables.

NOTICE: To avoid possible arcing of battery, connect positive battery cable first.

22. Start engine, check for leaks and check timing.

CRANKSHAFT

The crankshaft can be removed while the engine is disassembled for overhaul, as previously outlined, or without complete disassembly.

Removal

1. With the engine removed from the vehicle and the transmission and/or clutch housing removed from the engine, mount engine in stand and clamp securely.
2. Remove the oil dip stick and oil dip stick tube, (if applicable).
3. Remove the starting motor, clutch assembly (if equipped) and flywheel.
4. Remove the spark plugs.
5. Remove crankshaft pulley and torsional damper.
6. Remove oil pan and oil pump.
7. Remove crankcase front cover, and if so equipped, remove timing chain and camshaft sprocket.
8. Check the connecting rod caps for cylinder number identification. If necessary, mark them.
9. Remove the connecting rod caps and push the pistons to top of bores.
10. Remove main bearing caps and lift crankshaft out of cylinder block.
11. Remove rear main bearing oil seal and main bearings from cylinder block and main bearing caps.

Cleaning and Inspection

1. Wash crankshaft in solvent and dry with compressed air.
2. Measure dimensions of main bearing journals and crankpins with a micrometer for out-of-round, taper or undersize. (See Specifications.)
3. Check crankshaft for run-out by supporting at the front and rear main bearings journals in "V" blocks and check at the front and rear intermediate journals with a dial indicator. (See Specifications.)
4. Replace or recondition the crankshaft if out of specifications.

SPROCKET OR GEAR REPLACEMENT

- Remove crankshaft sprocket using Tool J-5825, install using Tool J-5590.

Installation

1. Install rear main bearing oil seal in cylinder block and rear main bearing cap grooves. Install with lip of seal toward front of engine. Where seal has two lips install lip with helix towards front of engine.
2. Lubricate lips of seal with engine oil. Keep oil off parting line surface.
3. Install main bearings in cylinder block and main bearing caps then lubricate bearing surface with engine oil.
4. Install crankshaft, being careful not to damage bearing surfaces.
5. Recheck bearing clearances using plastigage.
6. Apply a thin coat of brush-on type oil sealing compound to block mating surface and corresponding surface of cap only. Do not allow sealant on crankshaft or seal.
7. Install main bearing caps with arrows pointing toward front of engine.
8. Torque all except rear main bearing cap bolts to specifications. Torque rear main bearing cap bolts to 10-12 lbs. ft. (14-16 N·m)then tap end of crankshaft, first rearward then forward with a lead hammer. This will line up rear main bearing and crankshaft thrust surfaces. Retorque all main bearing cap bolts to specifications.
9. Measure crankshaft end play with a feeler gage. Force crankshaft forward and measure clearance between the front of the rear main bearing and the crankshaft thrust surface.
10. Install flywheel and torque to specifications. A wood block placed between the crankshaft and cylinder block will prevent crankshaft from rotating.
    - Align dowel hole in flywheel with dowel hole in crankshaft. On vehicles equipped with automatic transmissions, install flywheel with the converter attaching pads towards transmission.

GENERAL DATA

TYPE	90° V-8
DISPLACEMENT	305 Cu. In., 350 Cu. In.
LITER (VIN)	**5.0, (E), (F), 5.7 (8)**
RPO	**L03, LB9, L98**
BORE	3.736, 4.000
STROKE	3.480, 3.480
COMPRESSION RATIO	**9.3:1, 9.3:1, 9.5:1**
FIRING ORDER	1-8-4-3-6-5-7-2

Cylinder Bore

DIAMETER 3.7350-4.7385, (L98) 3.9995-4.0025
OUT-OF-ROUND
- Production .... .0010 Max.
- Service .... .0020 Max.

TAPER
- Production Thrust Side .... .0005 Max.
- Production Relief Side .... .0010 Max.
- Service .... .0010 Max.

Piston

CLEARANCE
- Production .... .0007-.0017
- Service .... .0027 Max.

Piston Ring

COMPRESSION
- Groove Clearance
  - Production 1st .... .0012-.0032
  - Production 2nd .... .0012-.0032
  - Service .... Hi Limit Production + .001
- Gap
  - Production 1st .... .010-.020
  - Production 2nd .... .010-.025
  - Service .... Hi Limit Production + .010

OIL
- Groove Clearance
  - Production .... .002-.007
  - Service .... Hi Limit Production + .001
- Gap
  - Production .... .015-.055
  - Service .... Hi Limit Production + .010

Piston Pin

DIAMETER .... .9270-.9273
CLEARANCE
- Production .... .00025-.00035
- Service .... .001 Max.

FIT IN ROD .... .0008-.0016 Interference

Crankshaft

MAIN JOURNAL
- Diameter
  - Front 2.4484-2.4493
  - Intermediate 2.4481-2.4490
  - Rear 2.4479-2.4488
- Taper
  - Production .... .0002 Max.
  - Service .... .0010 Max.
- Out-Of-Round
  - Production .... .0002 Max.
  - Service .... .0010 Max.

MAIN BEARING CLEARANCE
- Production
  - Front .... .0008-.0020
  - Intermediate .... .0011-.0032

Rear	.0017-.0032
Service	
Front	.001-.0015
Intermediate	.001-.0020
Rear	.0025-.0030
CRANKSHAFT END PLAY	.002-.006
CRANKPIN	
Diameter	2.0986-2.0998
Taper	
Production	.0005 Max., (L98) .0003 Max.
Service	.001 Max.
Out-Of-Round	
Production	.0002
Service	.001 Max.
ROD BEARING CLEARANCE	
Production	.0018-.0039, (L98), 0013-.0035
Service	.002-.0030, (L98) .0035 Max.
ROD SIDE CLEARANCE	.008-.014, (L98) .006-.014

Camshaft

LOBE LIFT ± .002	
Intake	.234, .269, (L98) .273
Exhaust	.257, .276, (L98) .282
JOURNAL DIAMETER	1.8682-1.8692
CAMSHAFT END PLAY	.004-.012

VALVE SYSTEM

LIFTER	Hydraulic
ROCKER ARM RATIO	1.50:1
VALVE LASH	
Intake	One Turn Down
Exhaust	From Zero Lash
FACE ANGLE	45°
SEAT ANGLE	46°
SEAT RUNOUT	.002 Max.
SEAT WIDTH	
Intake	1/32-1/16
Exhaust	1/16-3/32
STEM CLEARANCE	
Production	
Intake	.0010-.0027
Exhaust	.0010-.0027
Service	Hi Limit Production + .001 Intake + .002 Exhaust
VALVE SPRING	
Free Length	2.03
Pressure Lbs. @ In.	
Closed	76-84 @ 1.70 INT., 1.61 EXH.
Open	194-206 @ 1.25 INT., 1.16 EXH.
Installed Height	1-23/32 INT., 1-19/32 EXH.
DAMPER	
Free Length	1.86
Approx. # of Coils	4

TORQUE SPECIFICATIONS

Main Bearing Caps	85-115 N·m, 63-85 ft. lbs.
Cylinder Head Bolts	81-102 N·m, 60-75 ft. lbs.
Flywheel Bolts	85-115 N·m, 63-85 ft. lbs.
Connecting Rod Caps	57-64 N·m, 42-47 ft. lbs.
Oil Pan	
Stud 5/16-18x1.44	10 in. lbs. minimum
Stud Nut	17-28 N·m, 150-250 in. lbs.
1/4-20x.56	8-14 N·m, 72-130 in. lbs.
Stud 1/4-20x.50x.56	8-14 N·m, 72-130 in. lbs.
Oil Pump to Case	81-95 N·m, 60-70 ft. lbs.
Front Cover	8-14 N·m, 69-130 in. lbs.
Water Pump	34-47 N·m, 25-35 ft. lbs.
Thermostat Housing	
T.P.I.	27-40 N·m, 20-30 ft. lbs.
Intake Manifold	
Carbureted	34-61 N·m, 25-45 ft. lbs.
T.P.I.	34-61 N·m, 25-45 ft. lbs.
Exhaust Manifold	
Outer 4 bolts	19-35 N·m, 14-26 ft. lbs.
Inner 2 bolts	27-43 N·m, 20-32 ft. lbs.
Camshaft Sprocket	17-31 N·m, 13-23 ft. lbs.
Rocker Arm Nuts	6-14 N·m, 55-125 in. lbs.
Rocker Arm Covers	7-12 N·m, 62-115 in. lbs.
Distributor Hold Down Bolt	27-47 N·m, 20-35 ft. lbs.

3. The vehicle's electrical load is more than the generator output, particularly with the addition of aftermarket equipment.
4. Defects in the charging system such as electrical shorts, slipping fan belt, faulty generator, or faulty voltage regulator.
5. Battery abuse, including failure to keep the battery cable terminals clean and tight, or loose battery hold-down. See "Service Procedures" for torque specifications.
6. Mechanical problems in the electrical system, such as shorted or pinched wires.

Electrolyte Freezing

The freezing point of electrolyte depends on its specific gravity. Since freezing may ruin a battery, it should be protected against freezing by keeping it in a charged condition.

Carrier and Hold-Down

The battery carrier and hold-down clamp should be clean and free from corrosion before installing battery.

The carrier should be in sound condition, to hold the battery securely and keep it level. Make certain there are no parts in the carrier before installing battery.

To prevent the battery from shaking in its carrier, the hold-down bolts should be tight, but not overtightened.

Built-In Hydrometer

The sealed battery has a built-in, temperature compensated hydrometer in the top of the battery. This hydrometer is to be used with the following diagnostic procedure.

When observing the hydrometer, make sure that the battery has a clean top. A light may be required, if the lighting is poor.

Under normal operation, two indications can be observed (see Fig. 4).

1. GREEN DOT VISIBLE
   Any green appearance is interpreted as a "green dot" and the battery is ready for testing.
2. DARK; GREEN DOT NOT VISIBLE
   If there is a cranking complaint, the battery should be tested as described in the "Diagnosis" section. The charging and electrical system should also be checked at this time.

Occasionally, a third condition may appear:

3. CLEAR OR LIGHT YELLOW
   This means the fluid level is below the bottom of the hydrometer. This may have been caused by excessive or prolonged charging, a broken case, excessive tipping, or normal battery wearout. Finding a battery in this condition may indicate high charging voltages caused by a faulty charging system. Therefore, the charging and electrical systems may need to be checked. If a cranking complaint exists and is caused by the battery, it should be replaced.

DIAGNOSIS

BATTERY

1. VISUAL INSPECTION
   Check for obvious damage, such as cracked or broken case or cover, that could permit loss of electrolyte. If obvious damage is noted, replace the battery. Determine cause of damage and correct as needed. If not, proceed to step 2.
2. HYDROMETER CHECK
   a. GREEN DOT VISIBLE - Go To Step 3
   b. DARK; GREEN DOT NOT VISIBLE - Charge the battery as outlined under "Charging Procedure" section and proceed to Step 3.
3. LOAD TEST
   Load testing may require use of battery side terminal adapters to insure good connections (see Fig. 2).
   a. Connect a voltmeter and a battery load tester across the battery terminals.

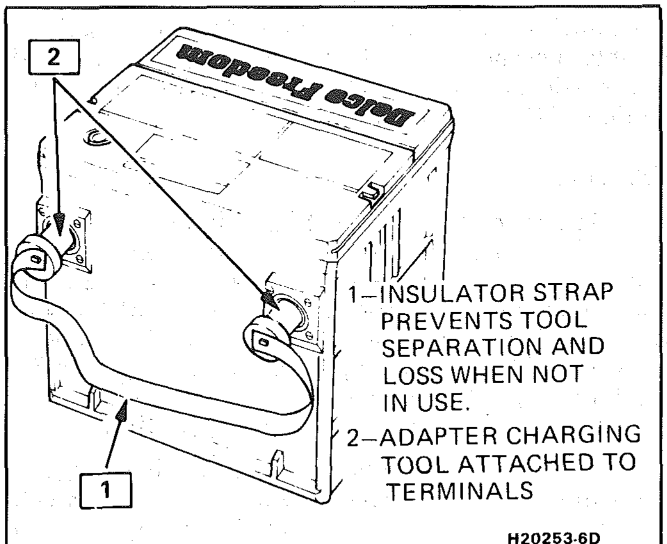


Fig. 2 Side Terminal Battery Adapters

   b. Apply 300 ampere load for 15 seconds to remove surface charge from the battery. Remove load.
   c. Wait 15 seconds to let battery recover and apply specified load from specifications. Read voltage after 15 seconds, then remove load.
   d. If voltage does not drop below the minimum listed in Fig. 3, the battery is good and should be returned to service. If voltage is less than minimum listed, replace battery. (The battery temperature must be estimated by feel and by the temperature the battery has been exposed to for the preceding few hours.)

SERVICE PROCEDURES

BATTERY CHARGING

When it is necessary to charge the battery, the following basic rules must be followed:

ESTIMATED TEMPERATURE	MINIMUM VOLTAGE
70° F. (21° C.)	9.6
50° F. (10° C.)	9.4
30° F. (0° C.)	9.1
15° F. (−10° C.)	8.8
0° F. (−18° C.)	8.5
0° F. (BELOW: −18° C.)	8.0

520011-6D

Fig. 3 Minimum Voltage

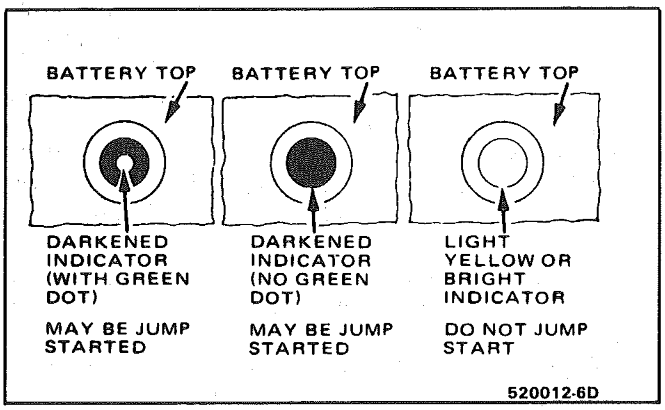


Fig. 4 Built-In Hydrometer

1. Do not charge battery if hydrometer is clear or light yellow. Replace battery.
2. If the battery feels hot 52°C (125°F), or if violent gassing or spewing of electrolyte through the vent holes occurs, discontinue charging or reduce charging rate.

Charging Procedure

1. Batteries with green dot showing do not require charging unless they have just been discharged (such as in cranking vehicle).
2. When charging sealed-terminal batteries out of vehicle, install adapter kit (AC Delco part number ST-1201 or GM part number 1846855, or equivalent). (Refer to Fig. 2.) Post-type batteries need no adapters.
3. Make sure all charger connections are clean and tight.
4. For best results, batteries should be charged while electrolyte and plates are at room temperature. A battery that is extremely cold may not accept current for several hours after starting charger.
5. Charge battery until green dot appears (see "Charging Time Required"). Battery should be checked every half-hour while charging. Tipping or shaking battery may be necessary to make green dot appear.
6. After charging, battery should be load tested as outlined in BATTERY DIAGNOSIS.

Charging Time Required:

The time required to charge a battery will vary depending upon the following factors:

- **Size of Battery** - A completely discharged large heavy-duty battery requires more than twice the recharging as a completely discharged small passenger car battery.
- **Temperature** - A longer time will be needed to charge any battery at 0°F than at 80°F. When a fast charger is connected to a cold battery, the current accepted by the battery will be very low at first. Then, in time, the battery will accept a higher rate as the battery warms.
- **Charger Capacity** - A charger which can supply only five amperes will require a much longer period of charging than a charger that can supply 30 amperes or more.
- **State-Of-Charge** - A completely discharged battery requires more than twice as much charge as a one-half charged battery. Because the electrolyte is nearly pure water and a poor conductor in a completely discharged battery, the current accepted by the battery is very low at first. Later, as the charging current causes the electrolyte acid content to increase, the charging current will likewise increase.

CHARGING A COMPLETELY DISCHARGED BATTERY (OFF THE VEHICLE)

The following procedure should be used to recharge a completely discharged battery:

Unless the procedure is properly followed, a perfectly good battery may be needlessly replaced.

1. Measure voltage at battery terminals with an accurate voltmeter. If below 10 volts, the charge current will be very low and it could take some time before it accepts current in excess of a few milliamperes.

   Such low current may not be detectable on ammeters available in the field.
2. Set battery charger on high setting.
3. Some chargers feature polarity protection circuitry, which prevents charging unless the charger leads are connected to the battery terminals correctly. A completely discharged battery may not have enough voltage to activate this circuitry, even though leads are connected properly, making it appear that the battery will not accept charging current. Therefore, follow the specific charger manufacturer's instruction telling how to bypass or override the circuitry so that the charger will turn on and charge a low-voltage battery.
4. Battery chargers vary in the amount of voltage and current they provide. The time required for the battery to accept measurable charger current at various voltages may be as follows:

VOLTAGE	HOURS
A. 16.0 or more	Up to 4 Hours
B. 14.0 - 15.9	Up to 8 Hours
C. 13.9 or less	Up to 16 Hours

If the charge current is still not measurable at the end of the above charging times, the battery should be replaced.

If the charge current is measurable during the charging time, the battery is considered to be good and charging should be completed in the normal manner.

5. It is important to remember that a completely discharged battery must be recharged for a sufficient number of ampere hours (AH) to restore it to a usable state. As a general rule of thumb, using the reserve capacity rating (RC) of the battery as the number of ampere hours of charge will usually bring the green dot into view.

   For example, if battery is rated at 75 RC minutes, it would be completely recharged as follows:

   10 ampere charge x 7-1/2 hours = 75 AH

   or

   25 ampere charge x 3 hours = 75 AH, etc.

6. It is recommended that any battery recharged by this procedure be **LOAD TESTED** to establish serviceability.

JUMP STARTING IN CASE OF EMERGENCY WITH AUXILIARY (BOOSTER) BATTERY

NOTICE: Do not push or tow the vehicle to start. Damage to the emission system, or to other parts of the vehicle may result.

Both booster and discharged battery should be treated carefully when using jumper cables. Follow the procedure outlined below, being careful not to cause sparks:

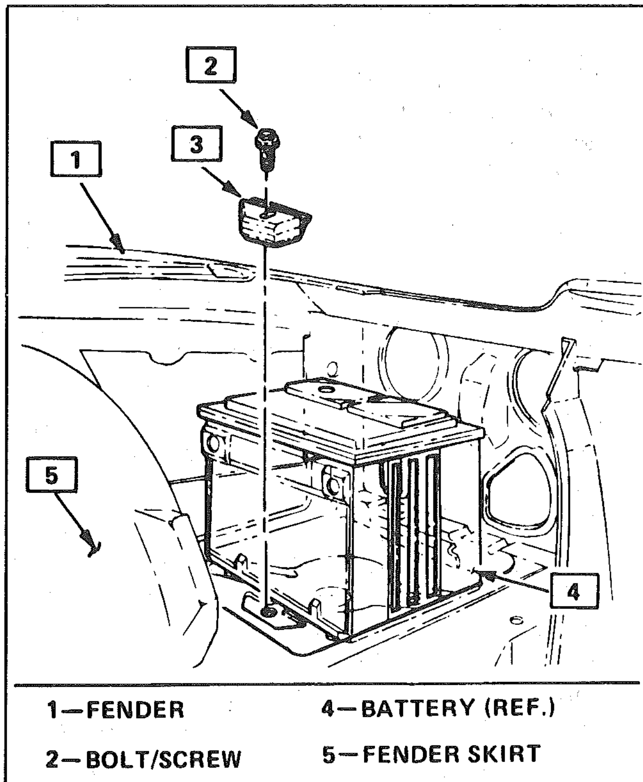
CAUTION: Departure from these conditions or the procedure below could result in: (1) Serious personal injury (particularly to eyes) or property damage from such causes as battery explosion, battery acid, or electrical burns; and/or (2) damage to electronic components of either vehicle.

Never expose battery to open flame or electric spark - batteries generate a gas which is flammable and explosive.

Remove rings, watches, and other jewelry. Wear approved eye protection.

Do not allow battery fluid to contact eyes, skin, fabrics, or painted surfaces - fluid is a corrosive acid. Flush any contacted area with water immediately and thoroughly. Be careful that metal tools or jumper cables do not contact the positive battery terminal (or metal in contact with it) and any other metal on the car, because a short circuit could occur. Batteries should always be kept out of the reach of children.

1. Set parking brake and place automatic transmission in "PARK" (NEUTRAL for manual transmission.) **Turn off the ignition, turn off lights, and all other electrical loads.**
2. Check the built-in hydrometer. If it is clear or light yellow, replace the battery.
3. Attach the end of one jumper cable to the positive terminal of the booster battery and the other end of the same cable to the positive terminal of the discharged battery. Do not permit vehicles to touch each other as this could cause a ground connection and counteract the benefits of this procedure. (Use 12-volt battery only to jump start the engine).
4. Attach one end of the remaining negative cable to the negative terminal of the booster battery, and the other end to a solid engine ground (such as A/C compresser bracket or generator mounting bracket) at least 18 inches from the battery of the vehicle being started (DO NOT CONNECT DIRECTLY TO THE NEGATIVE TERMINAL OF THE DEAD BATTERY).
5. Start the engine of the vehicle that is providing the jump start and turn off electrical accessories. Then start the engine in the car with the discharged battery.
6. Reverse these directions exactly when removing the jumper cables. The negative cable must be disconnected from the engine that was jump started first.



1—FENDER
2—BOLT/SCREW
3—RETAINER
4—BATTERY (REF.)
5—FENDER SKIRT

520028-6D

Fig. 5 Battery Hold-Down (Typical)

ON-CAR SERVICE

BATTERY

Remove or Disconnect

1. Negative cable.
2. Positive cable.
3. Retainer screw and retainer.
4. Battery.

Install or Connect

1. Battery.
2. Retainer and retainer screw - 17 N·m (13 lb.ft.).
3. Positive cable - 17 N·m (13 lb.ft.).
4. Negative cable - 17 N·m (13 lb.ft.).

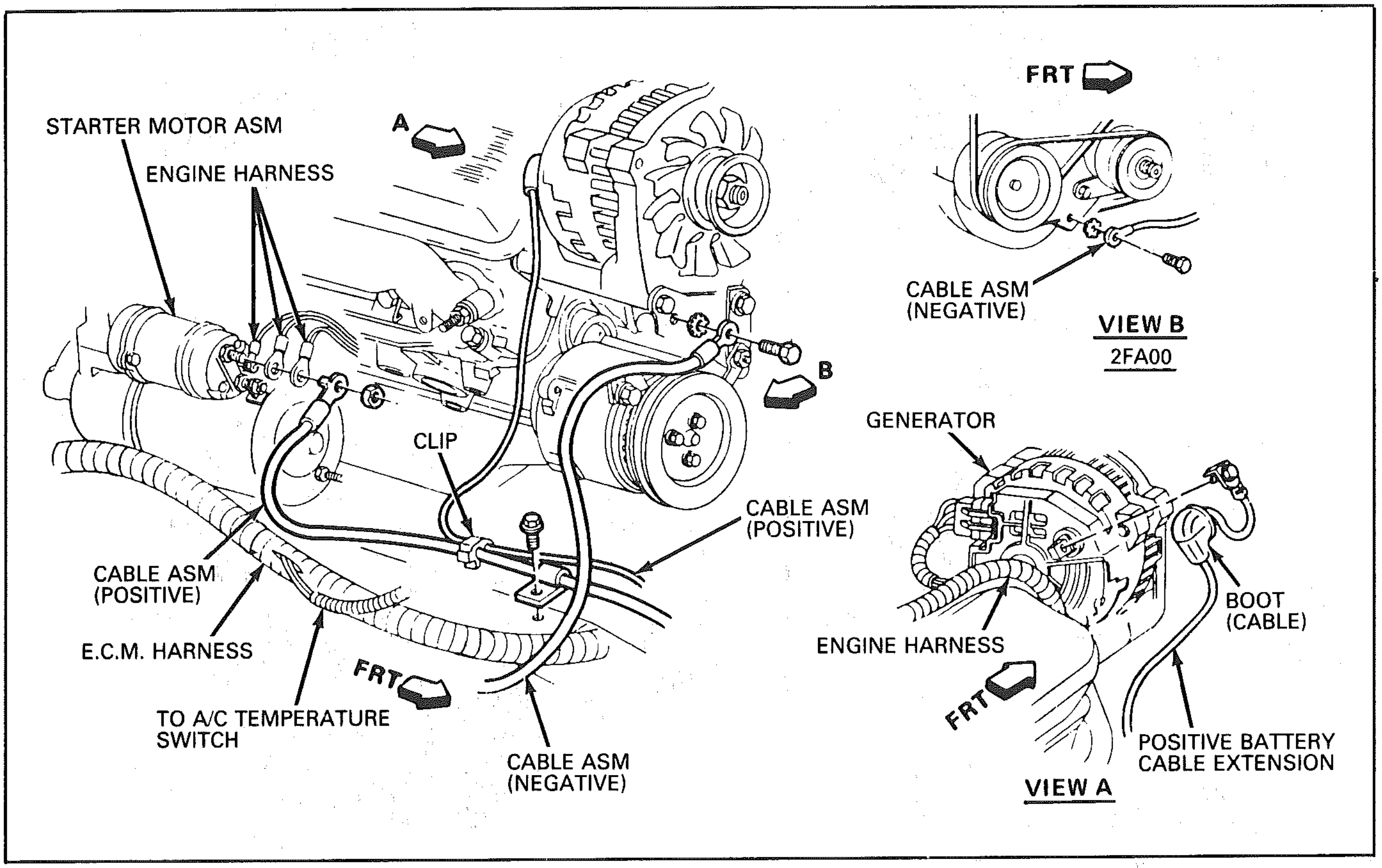


Figure 600 Battery Cable Routing LB9/L98

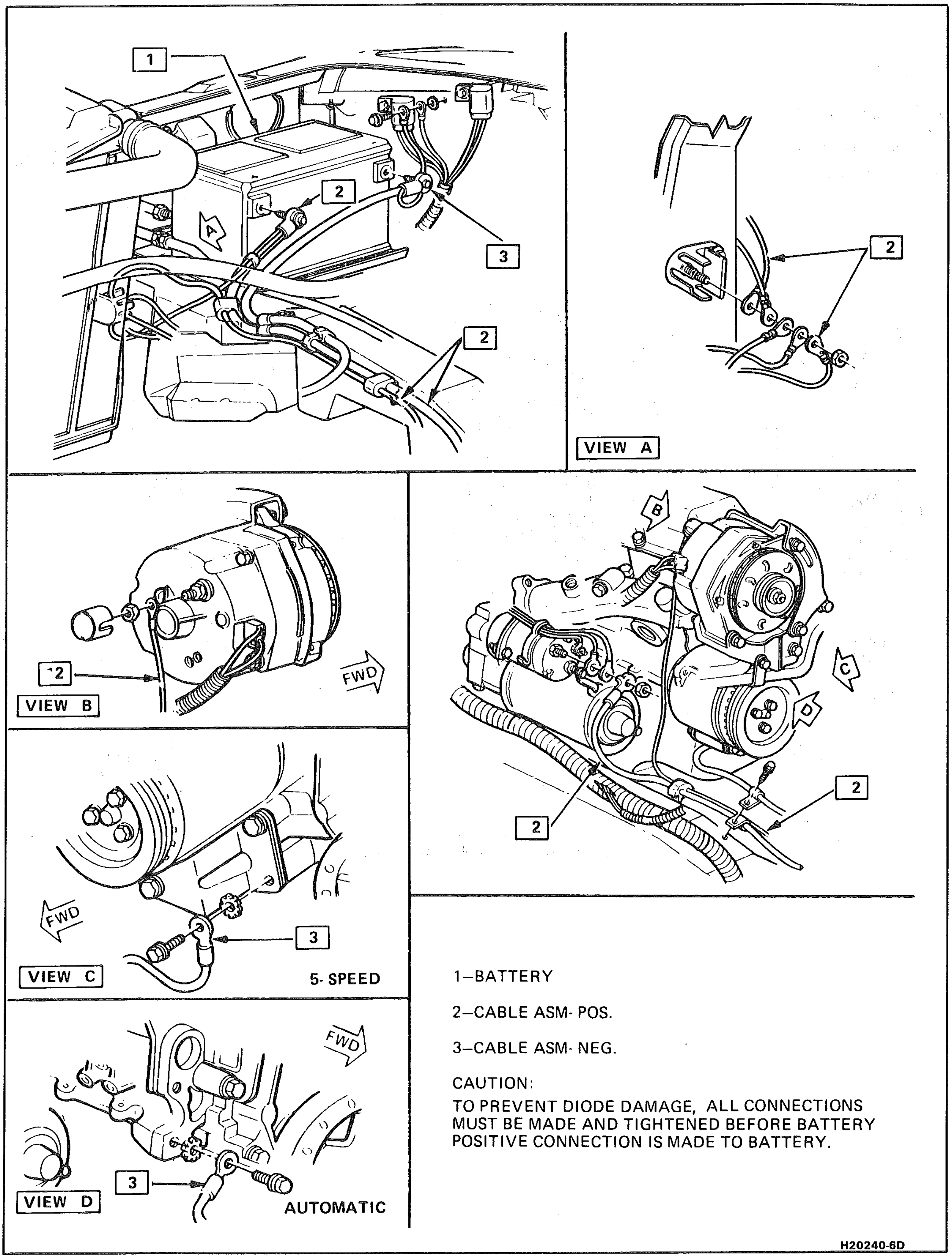


Fig. 601 Battery Cables (LB8)

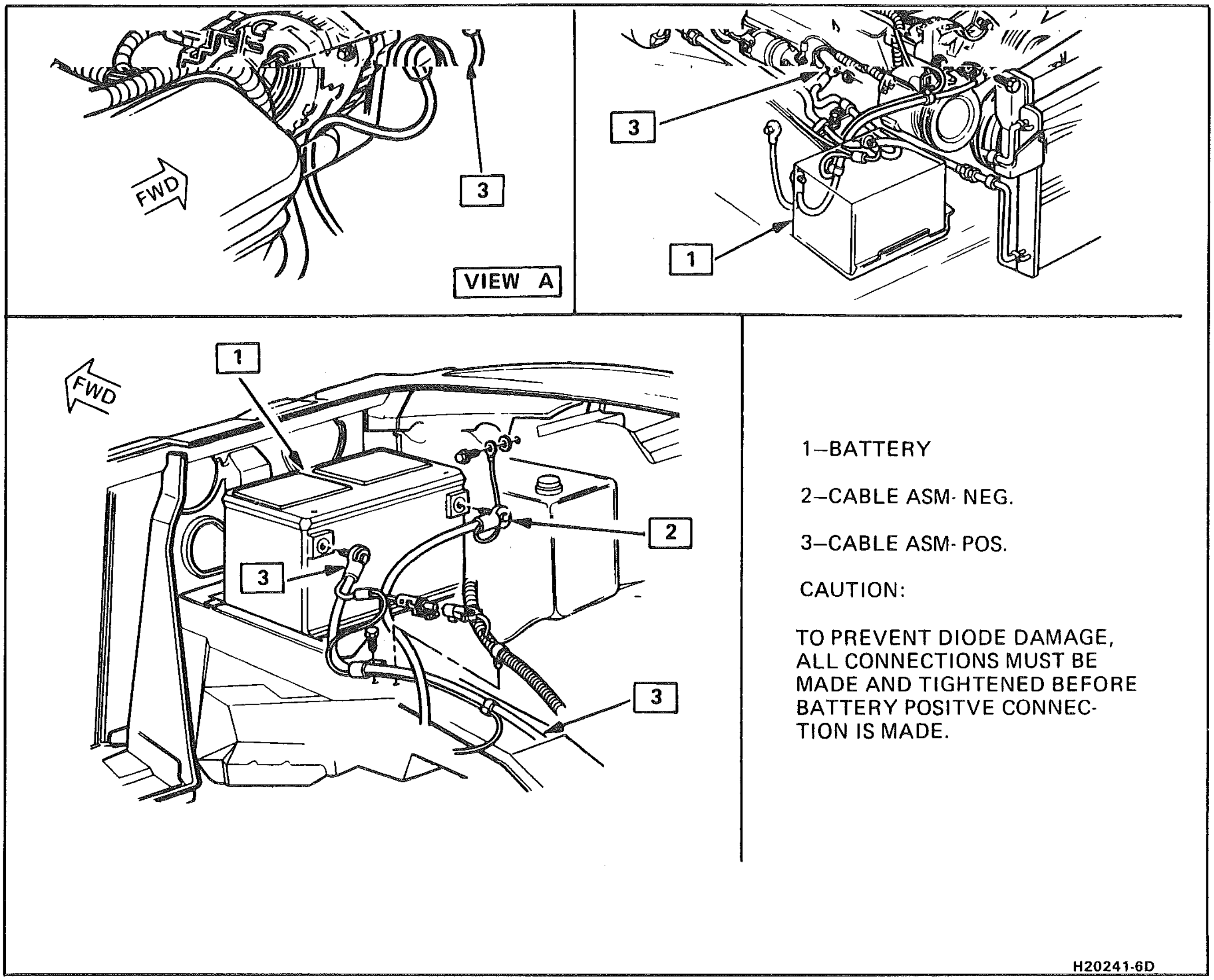


Fig. 602 Battery Cables (LB9/LG4)

SPECIFICATIONS

ENGINE	BATTERY/FUNCTION	REPLACEMENT
LB8/LO3	1981730-STD CCA 525 RC(MIN)90 Load Test 260 Amps	730
	1981731-HD CCA 570 RC(MIN)90 Load Test 280 AMPS	731
LB9	**1981600-STD** **CCA 525** **RC(MIN)75** **Load Test 260 Amps**	**600**
	1981731-HD **CCA 570** **RC(MIN)90** **Load Test 280 AMPS**	**731**
L98	1981601 CCA 630 RC(MIN)90 Load Test 310 AMPS	601

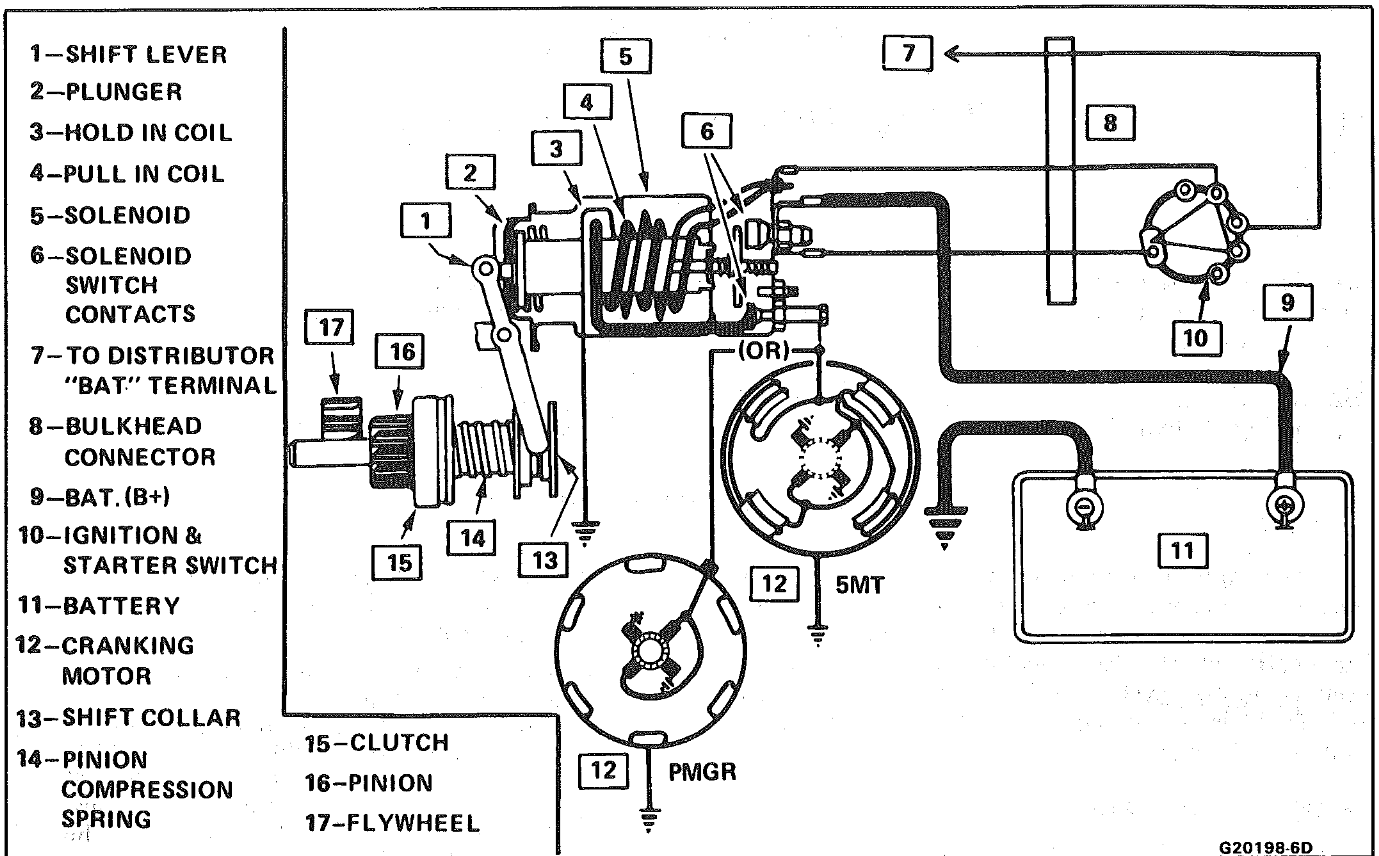


Fig. 1 Cranking Circuit - 5MT or PMGR

	PROBLEM	CAUSE
1.	HIGH PITCHED WHINE DURING CRANKING (BEFORE ENGINE FIRES) BUT ENGINE CRANKS AND FIRES OKAY.	DISTANCE TOO GREAT BETWEEN STARTER PINION AND FLYWHEEL.
2.	HIGH PITCHED "WHINE" AFTER ENGINE FIRES, AS KEY IS BEING RELEASED. ENGINE CRANKS AND FIRES OKAY. THIS INTERMITTENT COMPLAINT IS OFTEN DIAGNOSED AS "STARTER HANG-IN" OR "SOLENOID WEAK."	DISTANCE TOO SMALL BETWEEN STARTER PINION AND FLYWHEEL. FLYWHEEL RUNOUT CONTRIBUTES TO THE INTERMITTENT NATURE.
3.	A LOUD "WHOOP" AFTER THE ENGINE FIRES BUT WHILE THE STARTER IS STILL HELD ENGAGED. SOUNDS LIKE A SIREN IF THE ENGINE IS REVVED WHILE STARTER IS ENGAGED.	MOST PROBABLE CAUSE IS A DEFECTIVE CLUTCH. A NEW CLUTCH WILL OFTEN CORRECT THIS PROBLEM.
4.	A "RUMBLE", "GROWL" OR (IN SEVERE CASES) A "KNOCK" AS THE STARTER IS COASTING DOWN TO A STOP AFTER STARTING THE ENGINE.	MOST PROBABLE CAUSE IS A BENT OR UNBALANCED STARTER ARMATURE. A NEW ARMATURE WILL OFTEN CORRECT THIS PROBLEM.

520026-6D

Fig. 2 Starter Motor Noise Diagnosis

location will decrease the clearance by approximately .3mm (.010").

If normal starter shims are not available, they can be improvised from plain washers or other suitable material.

Starter Motor: If the battery, wiring and switches are in satisfactory condition, and the engine is known to be functioning properly, remove the motor and follow the procedures shown in Starter Motor Disassembly, Test and Reassembly (Unit Repair).

Never operate the cranking motor more than 30 seconds at a time without pausing to allow it to cool for at least two minutes. Overheating, caused by excessive cranking, will seriously damage the cranking motor.

Corning 33 Medium or equivalent, on the shaft underneath the overrunning clutch assembly.

2. Avoid excessive lubrication.

STARTER

Use the following procedure to remove the starter:

1. Disconnect negative battery lead at battery.
2. Raise car.
3. Remove starter braces, shields, etc., that may be in the way.
4. Remove two starter motor to engine bolts, and allow starter to drop down.
5. Remove solenoid wires and battery cable and remove starter.
6. To replace, reverse the above procedure. Ensure that any shims removed are replaced.

SOLENOID

Use the following procedure to remove the solenoid from the starter:

1. Disconnect field strap.
2. Remove solenoid to drive housing attaching screws, motor terminal bolt, and remove solenoid by twisting.
3. Replace by reversing above procedures.

OVERRUNNING CLUTCH

1. Test overrunning clutch action. The pinion should turn freely in the overrunning direction. Check pinion teeth to see that they have not been chipped, cracked or excessively worn. Replace assembly if necessary. Badly chipped pinion teeth may indicate chipped teeth on the ring gear. This should be checked under such conditions and replaced if necessary.
2. Check the overrunning clutch for slipping by leaving the clutch attached to the armature. Wrap the armature with a shop towel and clamp the armature in a vise. Using a 12-point deep socket and torque wrench, put the socket on the clutch and turn counterclockwise. The clutch should not slip up to 68 N·m (50 ft. lb.) of torque. If it does, replace the clutch.

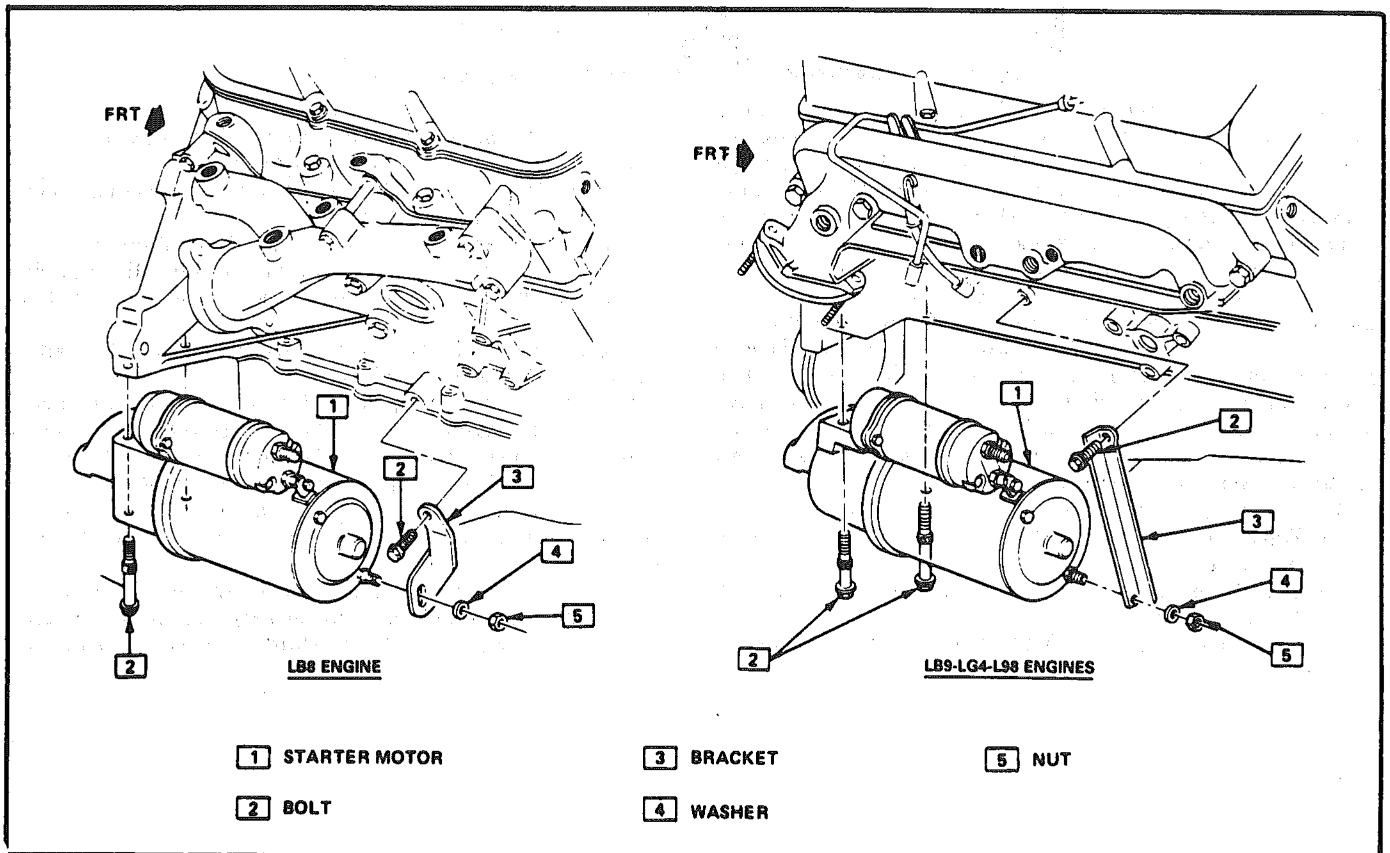
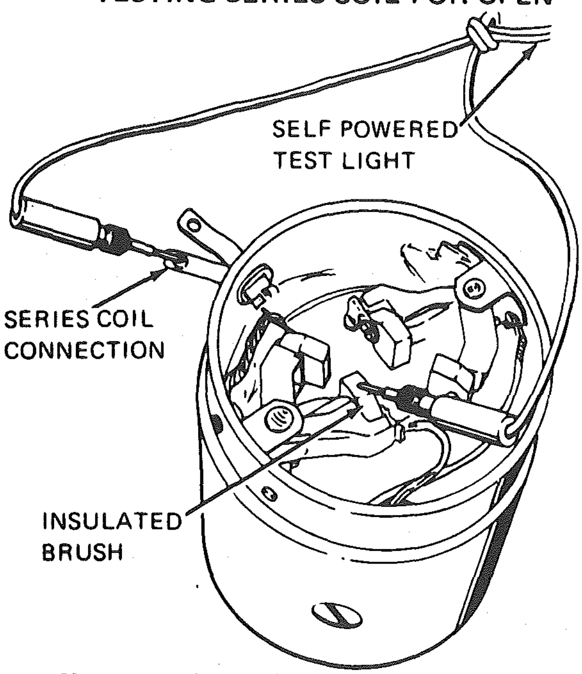


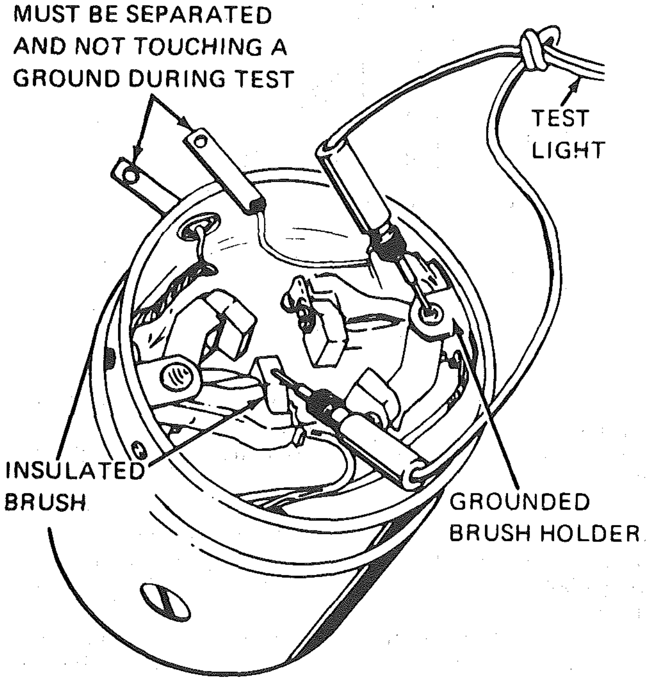
Fig. 602A--Starter Motor Mounting

TESTING SERIES COIL FOR OPEN



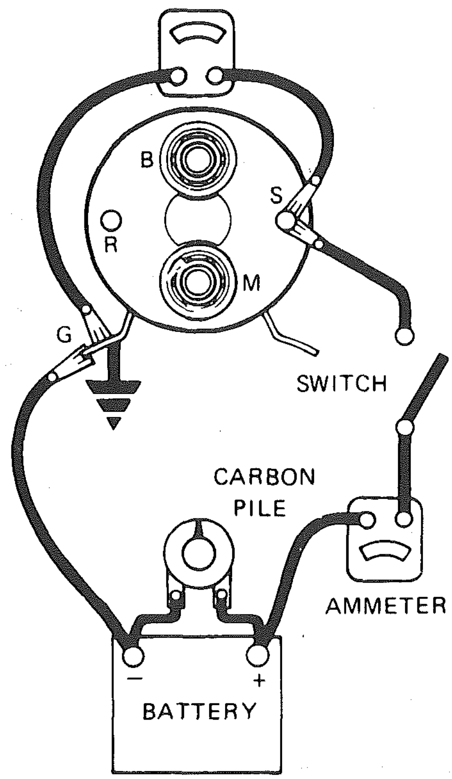
c. Using a test lamp, place one lead on the series coil terminal and the other lead on the insulated brush. If the lamp fails to light, the series coil is open and will require repair or replacement. This test should be made from each insulated brush to check brush and lead continuity.

TESTING SERIES COIL FOR GROUND



d. On starters with shunt coil, separtate series and shunt coil strap terminals during this test. Do not let strap terminals touch case or other ground. Using a test lamp place one lead on the grounded brush holder and the other lead on either insulated brush. If the lamp lights, a grounded series coil is indicated and must be repaired or replaced.

TESTING SOLENOID WINDINGS



e. Check the current draw of the solenoid winding as follows:

If solenoid is not removed from starting motor, the connector strap terminals must be removed from the terminal on the solenoid before making these tests. Complete tests in a minimum of time to prevent overheating of the solenoid.

To check hold-in winding, connect an ammeter in series with 12-volt battery and the "switch" terminal on the solenoid. Connect a voltmeter to the "switch" terminal and to ground. Connect carbon pile across battery. Adjust the voltage to 10 volts and note the ammeter reading. It should be 13 to 19 amperes for all starting motors.

To check both windings, connect as for previous test. Ground the solenoid motor terminal. Adjust the voltage to 10 volts and note the ammeter reading. It should be 59 to 79 amperes for all starting motors.

NOTE: Current will decrease as windings heat up.

Current draw readings that are over specifications indicate shorted turns or a ground in the windings of the solenoid and the solenoid should be replaced. Current draw readings that are under specifications indicate excessive resistance. No reading indicates an open circuit. Check connections then replace solenoid if necessary.

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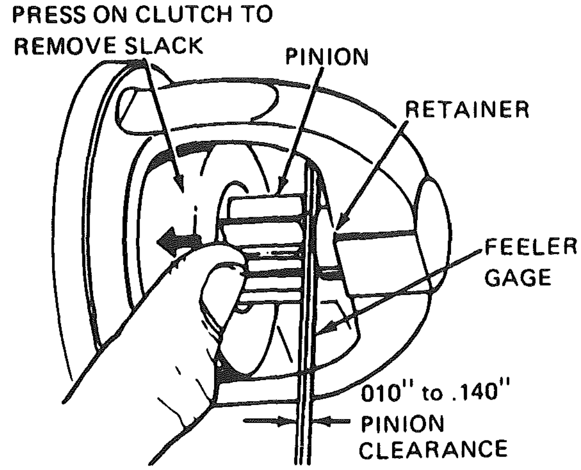
Fig. 606 Starter Motor Disassembly, Test and Reassembly 4 of 6

CHECKING PINION CLEARANCE



When the starter motor has been disassembled or the solenoid has been replaced, it is necessary to check the pinion clearance. Pinion clearance must be correct to prevent the buttons on the shift lever yoke from rubbing on the clutch collar during cranking.

31. Disconnect the motor field coil connector from the solenoid motor terminal and insulate it carefully.

32. Connect one 12 volt battery lead to the solenoid switch terminal and the other to the starter frame.

33. Flash a jumper lead momentarily from the solenoid motor terminal to the starter frame. This will shift the pinion into cranking position and it will remain so until the battery is disconnected.

34. Push the pinion back as far as possible to take up any movement, and check the clearance with a feeler gage. The clearance should be .010" to .140".

Means for adjusting pinion clearance is not provided on the starter motor. If the clearance does not fall within limits, check for improper installation and replace all worn parts.

520047-6D

Fig. 608 Starter Motor Disassembly, Test and Reassembly 6 of 6

SPECIFICATIONS

Engine (RPO/VIN)	2.8L-V6-LB8-S	5.0L-V8-LB9-F	5.0L-V8-LB9-F
Starter	5MT-1998524	10MT-1998580 (Auto Trans)	5MT-1998527 (Manual Trans)
—No Load Test @10V	Min. 50A Max. 75A 6000 rpm - 11,900 rpm	Min. 70A Max. 110A 6500 rpm - 10,700 rpm	Min. 52A Max. 76A 6000 rpm - 12,000 rpm
Solenoid			
—Hold-in Windings @10V	13-19A	13-19A	13-19A
—Pull-in Windings @5V	23-30A	23-30A	23-30A
Engine (RPO/VIN)	5.0L-V8-LO3-E	5.0L-V8-LO3-E	5.7L-V8-B2L-8
Starter	10MT-1998580 (Auto Trans)	5MT-1998527 (Manual Trans)	10MT-1998591
—No Load Test @10V	Min. 70A Max. 110A 6500 rpm - 10,700 rpm	Min. 52A Max. 76A 6000 rpm - 12,000 rpm	Min. 70A Max. 110A 6500 rpm - 10,700 rpm
Solenoid			
—Hold-in Windings @10V	13-19A	13-19A	13-19A
—Pull-in Windings @5V	23-30A	23-30A	23-30A

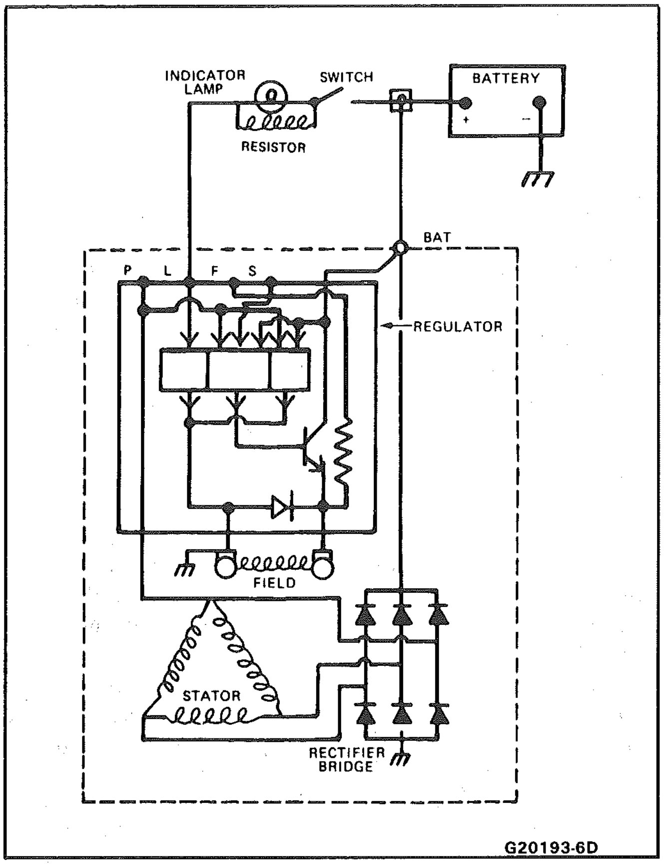


Fig. 1F CS Charging System Wiring Diagram

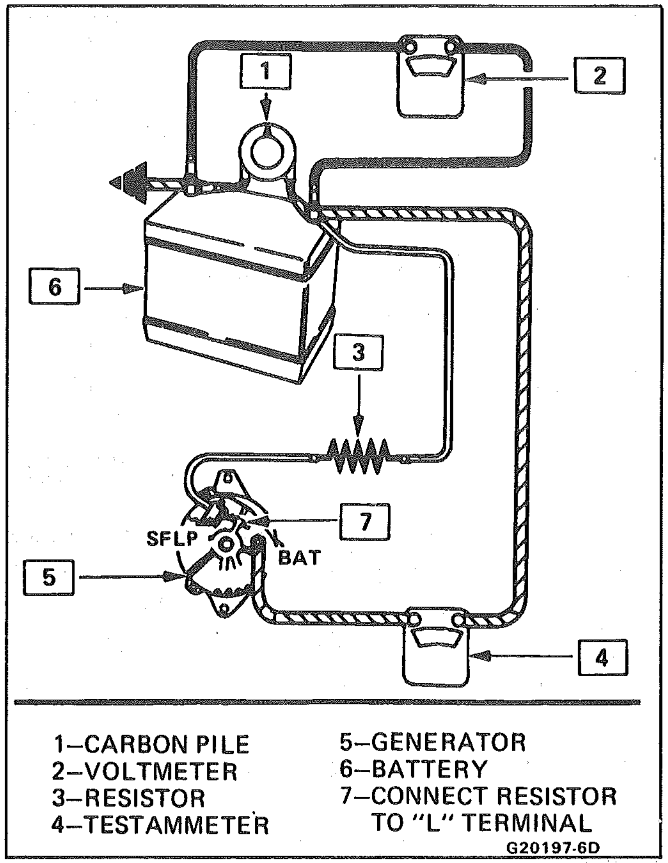


Fig. 1H Generator Bench Check - CS

4. If voltage is below 16.0 volts, increase speed and adjust carbon pile to obtain maximum amperage output. Maintain voltage above 13.0 volts.
5. If output is within 15 amperes of rated output, generator is good.
6. If output is not within 15 amperes of rated output, generator is defective and requires repair.

ON-CAR SERVICE

a spark plug wire from a spark plug, twist the boot on the spark plug and pull **on the boot** to remove the wire, or use a special tool designed to remove spark plug boots.

Remove or Disconnect

1. Ignition switch battery feed wire and tachometer lead (if equipped) from distributor cap. Also release the coil connectors from the cap. (DO NOT use a screwdriver or tool to release the locking tabs.)
2. Distributor cap by turning four screws counterclockwise. Move cap out of the way.
3. Four-terminal ECM harness from distributor.
4. If necessary, remove secondary wires from cap, release wiring harness latches and remove wiring harness retainer. The spark plug wire numbers are indicated on the retainer.
5. Distributor clamp screw and hold-down clamp.
6. Note position of rotor, then pull distributor up until rotor just stops turning counterclockwise and again note position of rotor.
   - To insure correct timing of the distributor, the distributor must be INSTALLED with the rotor correctly positioned as noted.

If the engine was accidentally cranked after the distributor was removed, the following procedure can be used for installing:

1. Remove No. 1 spark plug.
2. Place finger over No. 1 spark plug hole and crank engine slowly until compression is felt.
3. Align timing mark on pulley to "0" on engine timing indicator.
4. Turn rotor to point between No. 1 and No. 8 spark plug towers on distributor cap on V8 engines, between No. 1 and No. 6 on V6 engines, and No. 1 and No. 4 on 4 cylinder engines.
5. Install distributor and connect ignition feed wire.
6. Install distributor cap and spark plug wires.
7. Check engine timing (see Set Ignition Timing).

Install or Connect

1. Insert distributor, positioning rotor as removed.
2. Distributor hold-down clamp and screw.
3. Wiring harness retainer and secondary wires, if removed.
4. ECM harness connector.
5. Distributor cap.
6. Coil connectors.
7. Battery wire and tachometer lead, if equipped.

Module

It is not necessary to remove the distributor from car.

Remove or Disconnect

1. Distributor cap and rotor.
2. Two module attaching screws, and lift module up.
3. Leads from module. (Observe color code on leads as these cannot be interchanged.)
4. Do not wipe grease from module, or distributor base, if same module is to be replaced.

Install or Connect

NOTICE: If a new module is to be installed, a package of silicone grease will be included with it. Spread the grease on the metal face of the module and on the distributor base where the module seats. This grease is necessary for module cooling.

1. Module.
2. Module leads (observe color code).
3. Attaching screws to module.
4. Rotor.
5. Cap.

Pick-Up Coil

1. Remove distributor from car and follow instructions in Unit Repair, as applicable.

Rotor

Fig. 1

1. Remove distributor cap.
2. The rotor is retained by two screws and is provided with a slot which fits over a square lug, so that the rotor can be installed in only one position.

Integral Ignition Coil

Fig. 1

Remove or Disconnect

1. Distributor cap.
2. Three coil cover attaching screws, and lift off cover.
3. Coil attaching screws and lift ignition coil and leads from cap.

Install or Connect

1. Coil and attaching screws.
2. Coil leads.
3. Coil cover and attaching screws.

Capacitor

Fig. 1

The capacitor is part of the coil wire harness assembly. Since the capacitor is used only for radio noise suppression, it will seldom need replacement.

Remove or Disconnect

1. Distributor cap and rotor.
2. Capacitor attaching screw and unplug connector from module. It may help to loosen the module.

Install or Connect

1. Plug into module.
2. Capacitor and hold-down screw (be sure ground lead is under screw).

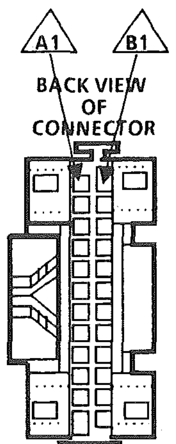
FUEL INJECTION ECM CONNECTOR IDENTIFICATION

This ECM voltage chart is for use with a digital voltmeter to further aid in diagnosis. The voltages you get may vary due to low battery charge or other reasons, but they should be very close.

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

● Engine at operating temperature ● Engine idling in closed loop (for "Engine Run" column)
● Test terminal not grounded ● ALDL tool not installed

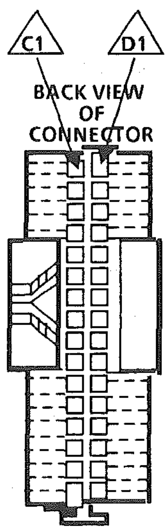
Note	VOLTAGE KEY "ON"	VOLTAGE ENG. RUN	CIRCUIT	PIN	WIRE COLOR
2	0	B+	FUEL PUMP RELAY CONTROL	A1	DK GRN/ WHT
			NOT USED	A2	
	0	B+	CANISTER PURGE CONTROL	A3	DK GRN/ YEL
	B+	B+	EGR CONTROL SOL.	A4	GRY
	0	B+	"SERVICE ENGINE SOON" CONTROL	A5	BRN/ WHT
	B+	B+	IGN (ECM)	A6	PNK/ BLK
	B+	B+	A/T SHIFT LIGHT TCC CONTROL	A7	TAN/ BLK
	2-5 VARYING	2-5	SERIAL DATA	A8	ORN
	5	5	DIAG. TERM.	A9	WHT/ BLK
1	0 OR 12	0 OR 12	SPEED SENSOR SIGNAL	A10	BRN
	0	0	COOLANT AND MAT TPS GROUND	A11	BLK
	0	0	SYSTEM GROUND	A12	BLK/ WHT



24 PIN A-B CONNECTOR

WIRE COLOR	PIN	CIRCUIT	VOLTAGE KEY "ON"	VOLTAGE ENG. RUN	Note
ORN	B1	BATT.12.VOLTS	B+	B+	
TAN/WHT	B2	FUEL PUMP SIGNAL	0	B+	4
BLK/ RED	B3	IGNITION GROUND	0	0	
	B4	NOT USED			
PPL/ WHT	B5	DISTRIBUTOR REFERENCE HIGH	0	1.3	
PPL	B6	VATS	5	5	
BLK	B7	ESC SIGNAL	9.2	9.3	
LT BLU	B8	A/C SIGNAL OFF / ON	0 / B+	0 / B+	
	B9	NOT USED			
ORN/ BLK	B10	PARK/NEUTRAL SW.SIGNAL (A/T)	0	0	6
	B11	NOT USED			
	B12	NOT USED			

Note	VOLTAGE KEY "ON"	VOLTAGE ENG. RUN	CIRCUIT	PIN	WIRE COLOR
	B+	B+	A.I.R. DIVERT SOLENOID	C1	BLK/ PNK
	B+	B+	A.I.R. SWITCH SOLENOID	C2	BRN
	NOT USEABLE		IAC "B" LO	C3	LT GRN/ BLK
	NOT USEABLE		IAC "B" HI	C4	LT GRN/ WHT
	NOT USEABLE		IAC "A" HI	C5	LT BLU/ WHT
	NOT USEABLE		IAC "A" LO	C6	LT BLU BLK
	0	0	4 TH GEAR	C7	LT BLU
	B+	B+	PSPS	C8	LT BLU
7	0	0	CRANK DISCRETE	C9	PPL/ WHT
5	1.6	1.6	COOLANT TEMP. SIGNAL	C10	YEL
3	4.75	1.1	MAP SIGNAL	C11	LT GRN
	2.5	2.5	MAT	C12	TAN
	.7	.7	TPS SIGNAL	C13	DK BLU
	5	5	TPS 5 VOLT REFERENCE	C14	GRY
			NOT USED	C15	
	B+	B+	BATTERY	C16	ORN



32 PIN C-D CONNECTOR

WIRE COLOR	PIN	CIRCUIT	VOLTAGE KEY "ON"	VOLTAGE ENG. RUN	Note
BLK/ WHT	D1	SYSTEM GROUND	0	0	
PPL	D2	MAP GROUND	0	0	
	D3	NOT USED			
WHT	D4	EST CONTROL	0	1.3	
TAN/ BLK	D5	BYPASS	0	4.75	
TAN	D6	GRN'D. (O_2)	0	0	
PPL	D7	02 SENSOR SIGNAL	3.5	1.9	3
	D8	NOT USED			
	D9	NOT USED			
	D10	NOT USED			
	D11	NOT USED			
	D12	NOT USED			
	D13	NOT USED			
LT GRN	D14	INJECTOR B	B+	B+	
	D15	NOT USED			
LT BLU	D16	INJECTOR A	B+	B+	

1 Varies from .60 to battery voltage, depending on position of drive wheels.
2 12 V for first two seconds.
3 Varies.
4 12V when fuel pump is running.
5 Varies with temperature.
6 Reads battery voltage in gear.
7 12 volts, when engine is cranking.

ENGINE 5.0 L

6-10-87
8S 4588-6E

Figure A-5 - ECM Connector Terminal End View 5.0L (VIN E)

BLANK

DIAGNOSTIC CIRCUIT CHECK

The Diagnostic Circuit Check is an organized approach to identifying a problem created by an electronic engine control system malfunction. It must be the starting point for any driveability complaint diagnosis, because it directs the service technician to the next logical step in diagnosing the complaint.

The "Scan Data" listed in the table may be used for comparison, after completing the diagnostic circuit check and finding the on-board diagnostics functioning properly and no trouble codes displayed. The "Typical Values" are an average of display values recorded from normally operating vehicles and are intended to represent what a normally functioning system would typically display.

A "SCAN" TOOL THAT DISPLAYS FAULTY DATA SHOULD NOT BE USED, AND THE PROBLEM SHOULD BE REPORTED TO THE MANUFACTURER. THE USE OF A FAULTY "SCAN" CAN RESULT IN MISDIAGNOSIS AND UNNECESSARY PARTS REPLACEMENT.

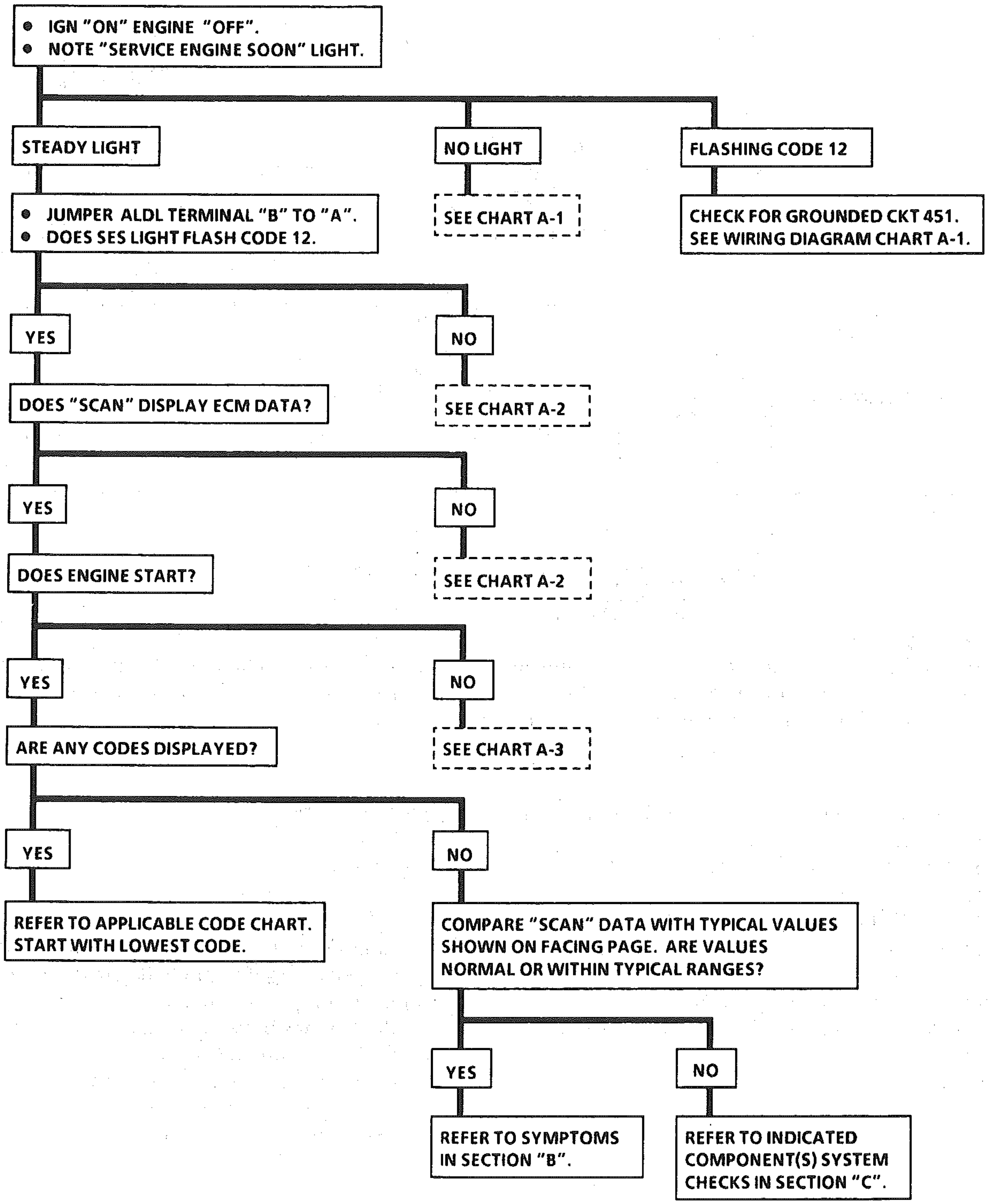
Only the parameters listed below are used in this manual for diagnosis. If a "Scan" tool reads other parameters, the values are not recommended by General Motors for use in diagnosis. For more description on the values and use of the "Scan" to diagnosis ECM inputs, refer to the applicable diagnosis section in Section "C". If all values are within the range illustrated, refer to "Symptoms" in Section "B".

"SCAN" DATA

Idle / Upper Radiator Hose Hot / Closed Throttle / Park or Neutral / Closed Loop / Acc. off

"SCAN" Position	Units Displayed	Typical Data Value
Coolant Temp.	C°	85° - 105°
TPS	Volts	.4 - 1.25
MAP	Volts	1 - 2 (depends on Vac. & Baro pressure)
INT (Integrator)	Counts	Varies
BLM (Block Learn)	Counts	118 - 138
IAC	Counts (steps)	1 - 50
RPM	RPM	1000 ± 75 RPM (depends on temperature)
O_2	Volts	.001 - 999 and varies
Open/Closed Loop	Open/Closed	Closed Loop (may go open with extended idle)
A/C Request	Yes/No	No (yes, with A/C requested)
P/N Switch	P/N and RDL	Park/Neutral (P/N)
TCC	On/Off	Off/ (on, with TCC commanded)
VSS	MPH	0
Battery	Volts	13.5 - 14.5
Air Switch	Normal/Divert	Normal
Air Divert	Converter/Port	Converter
Knock Signal	Yes/No	No
4th Gear	Yes/No	No (Yes, if in 4th Gear)
MAT Temp.	C°	10° - 90° (Depends on Under Hood Temp.).
Power Steering Pressure Switch	Normal/Hi Pressure	Normal

DIAGNOSTIC CIRCUIT CHECK
5.0L (VIN E) "F" SERIES (TBI)



4-22-87
• 7S 3227-6E

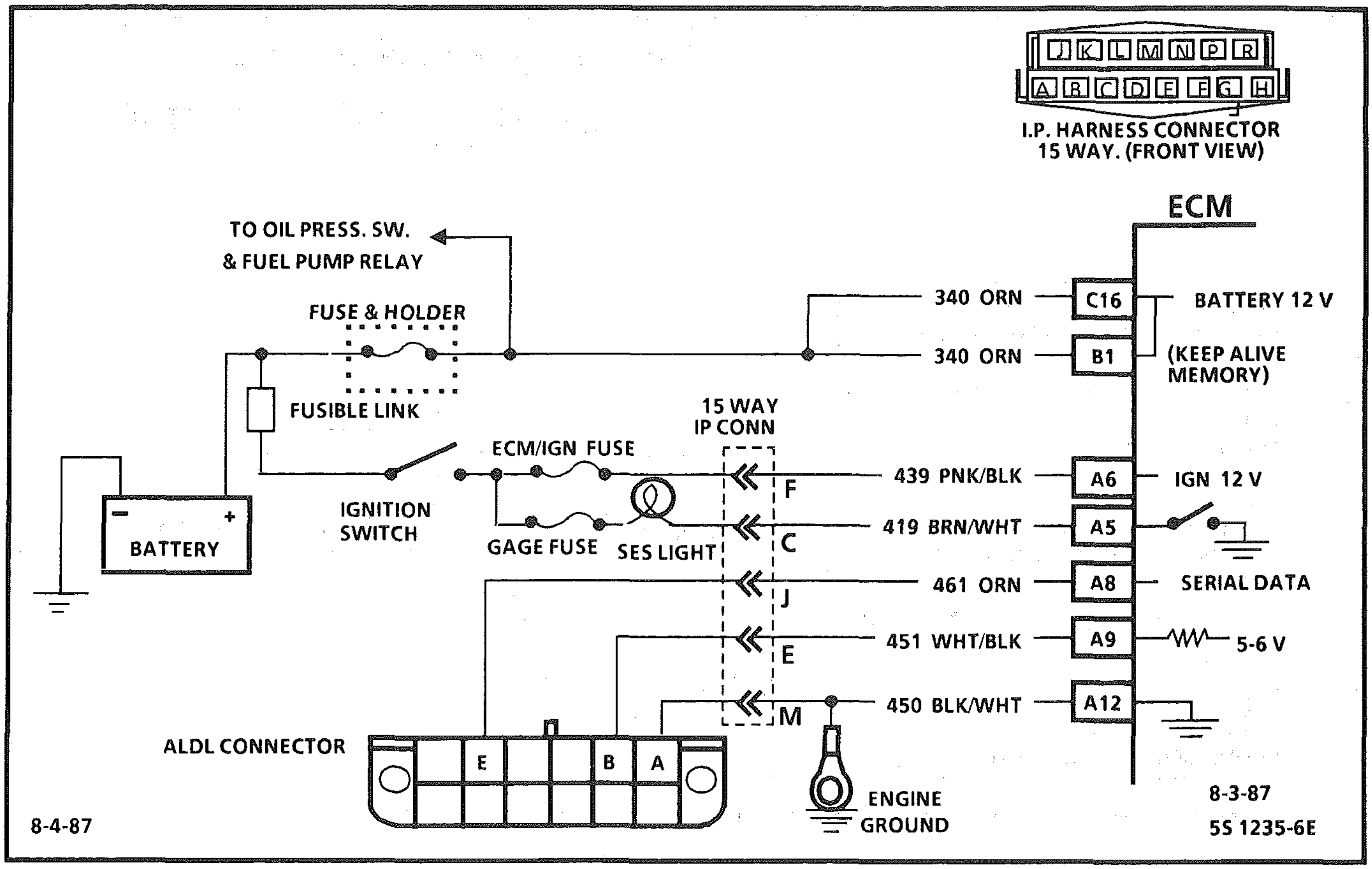


CHART A-1

NO "SERVICE ENGINE SOON" LIGHT
5.0L (VIN E) "F" SERIES (TBI)

Circuit Description:

There should always be a steady "Service Engine Soon" light, when the ignition is "ON" and engine stopped. Battery is supplied directly to the light bulb. The electronic control module (ECM) will control the light and turn it "ON" by providing a ground path through CKT 419 to the ECM.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Battery feed CKT 340 is protected by a 20amp in-line fuse. If this fuse was blown, refer to wiring diagram on the facing page of Code 54.
2. Using a test light connected to 12 volts, probe each of the system ground circuits to be sure a good ground is present. See ECM terminal end view in front of this section for ECM pin locations of ground circuits.

Diagnostic Aids:

Engine runs ok, check:

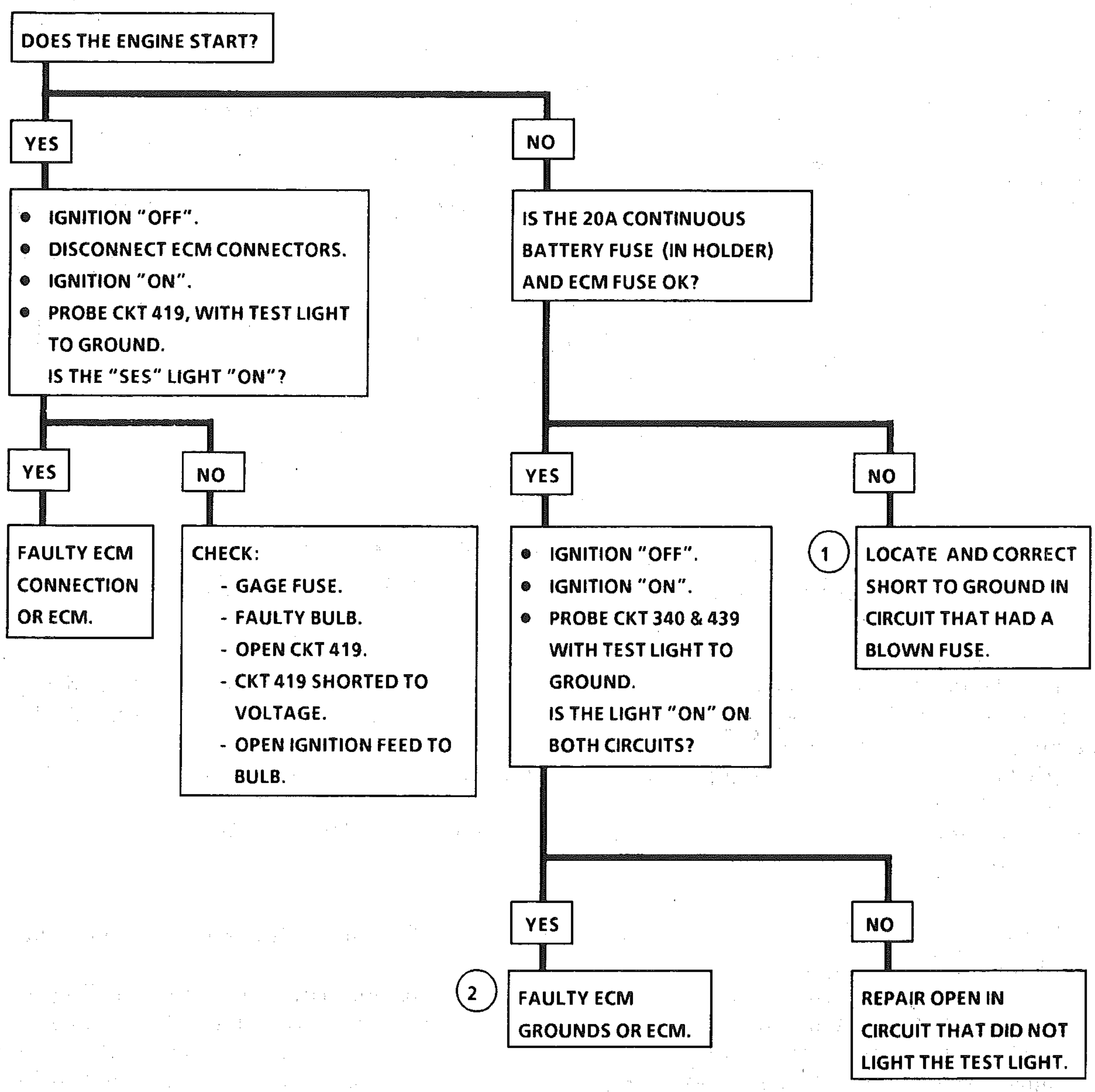
- Faulty light bulb
- CKT 419 open
- Gage fuse blown. This will result in no oil, or generator lights, seat belt reminder, etc.

Engine cranks, but will not run.

- Continuous battery - fuse or fusible link open.
- ECM ignition fuse open.
- Battery CKT 340 to ECM open.
- Ignition CKT 439 to ECM open.
- Poor connection to ECM.

CHART A-1

NO "SERVICE ENGINE SOON" LIGHT 5.0L (VIN E) "F" SERIES (TBI)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

7-21-87
7S 3185-6E

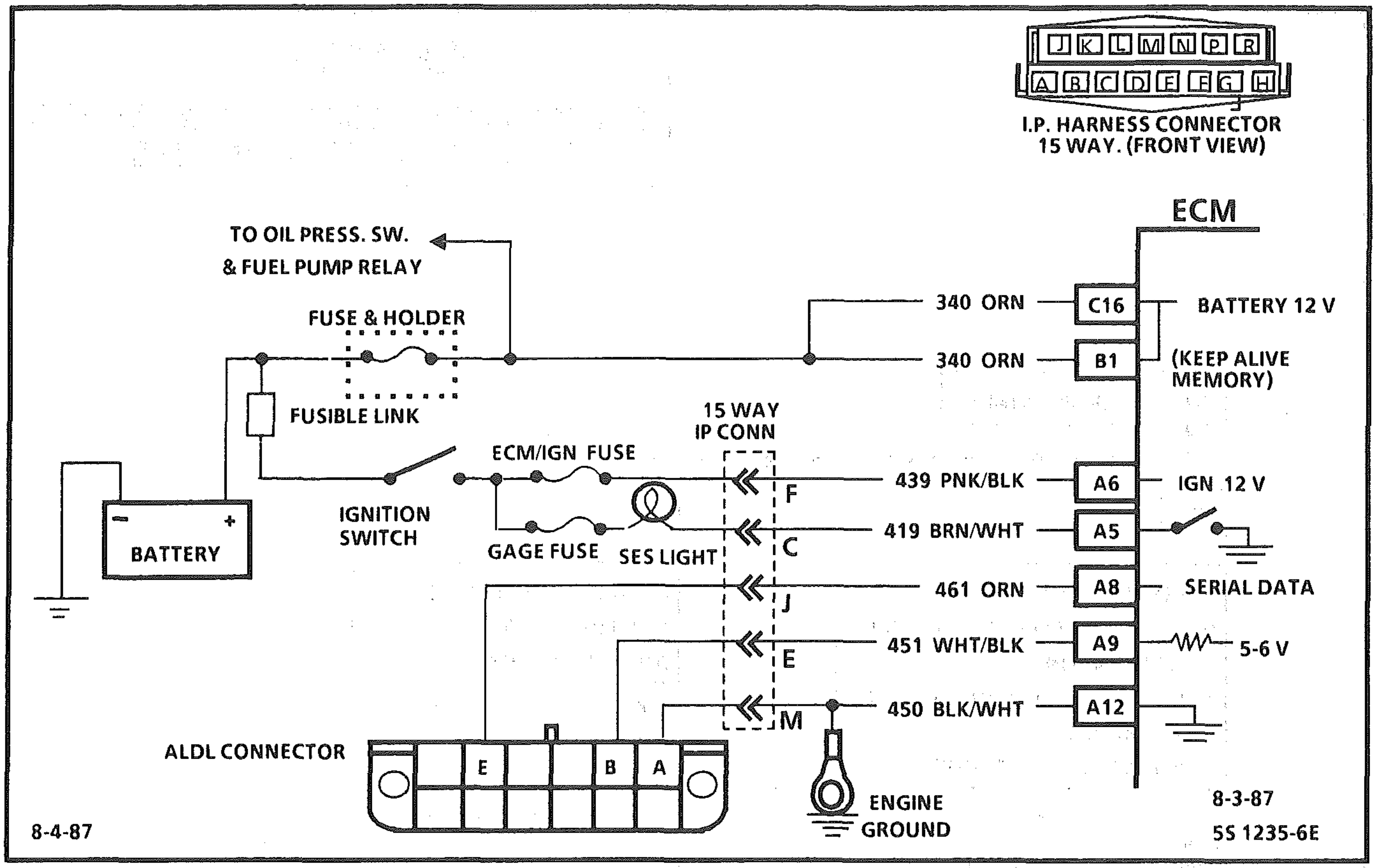


CHART A-2

NO ALDL DATA OR WON'T FLASH CODE 12
"SERVICE ENGINE SOON" LIGHT "ON" STEADY
5.0L (VIN E) "F" SERIES (TBI)

Circuit Description:

There should always be a steady "Service Engine Soon" light, when the ignition is "ON" and engine stopped. Battery is supplied directly to the light bulb. The electronic control module (ECM) will turn the light "ON" by grounding CKT 419 at the ECM.

With the diagnostic terminal grounded, the light should flash a Code 12, followed by any trouble code(s) stored in memory.

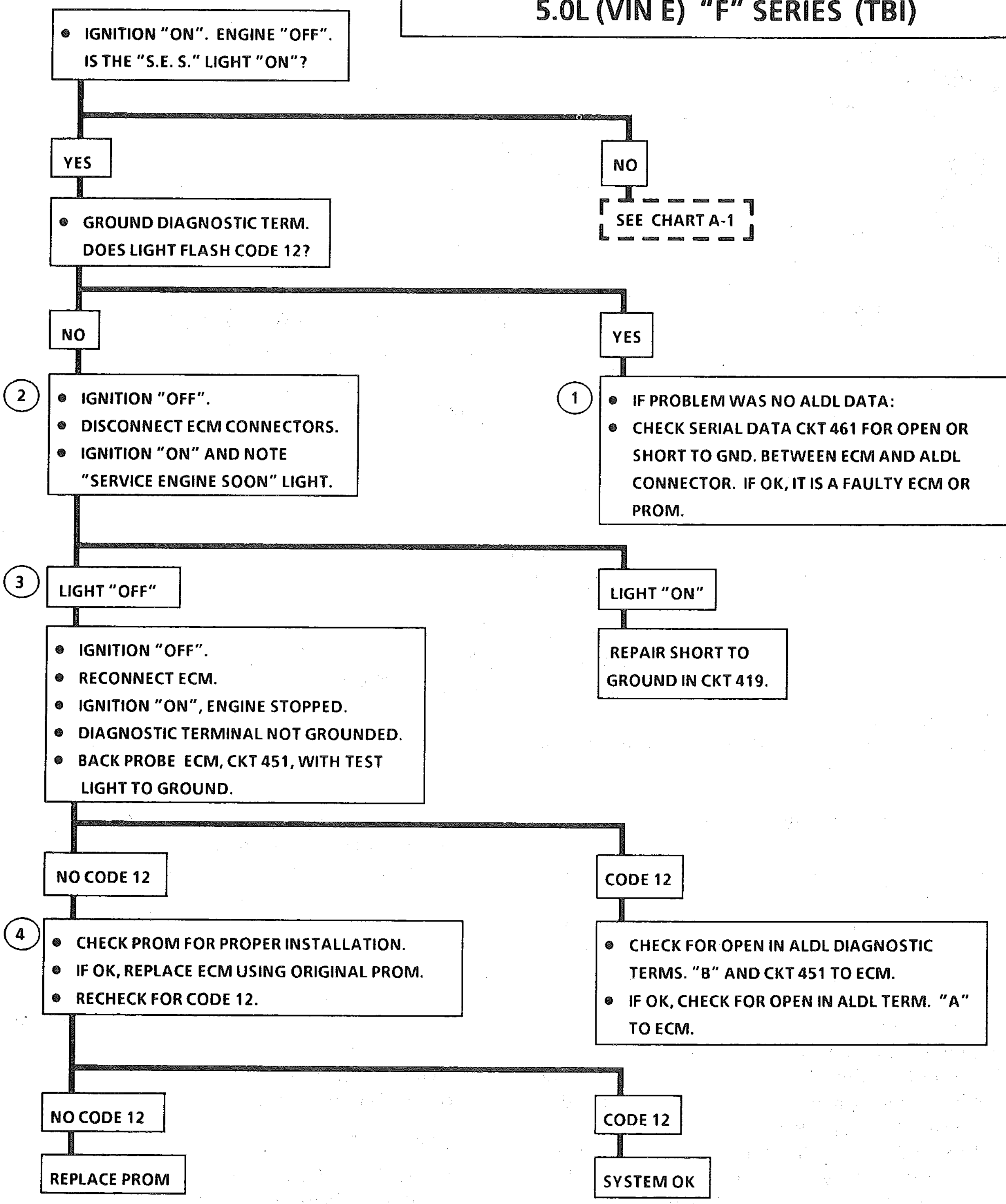
A steady light suggests a short to ground in the light control CKT 419, or an open in diagnostic CKT 451.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. If there is a problem with the ECM that causes a "Scan" tool to not read serial data, then the ECM should not flash a Code 12. If Code 12 does flash, be sure that the "Scan" tool is working properly on another vehicle. If the "Scan" is functioning properly and CKT 461 is OK, the PROM or ECM may be at fault for the NO ALDL symptom.
2. If the light goes "OFF" when the ECM connector is disconnected, then CKT 419 is not shorted to ground.
3. This step will check for an open diagnostic CKT 451.
4. At this point, the "Service Engine Soon" light wiring is OK. The problem is a faulty ECM or PROM. If Code 12 does not flash, the ECM should be replaced using the original PROM. Replace the PROM only after trying an ECM, as a defective PROM is an unlikely cause of the problem.

CHART A-2

NO ALDL DATA OR WON'T FLASH CODE 12 "SERVICE ENGINE SOON" LIGHT "ON" STEADY 5.0L (VIN E) "F" SERIES (TBI)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

6-16-87
7S 3341-6E

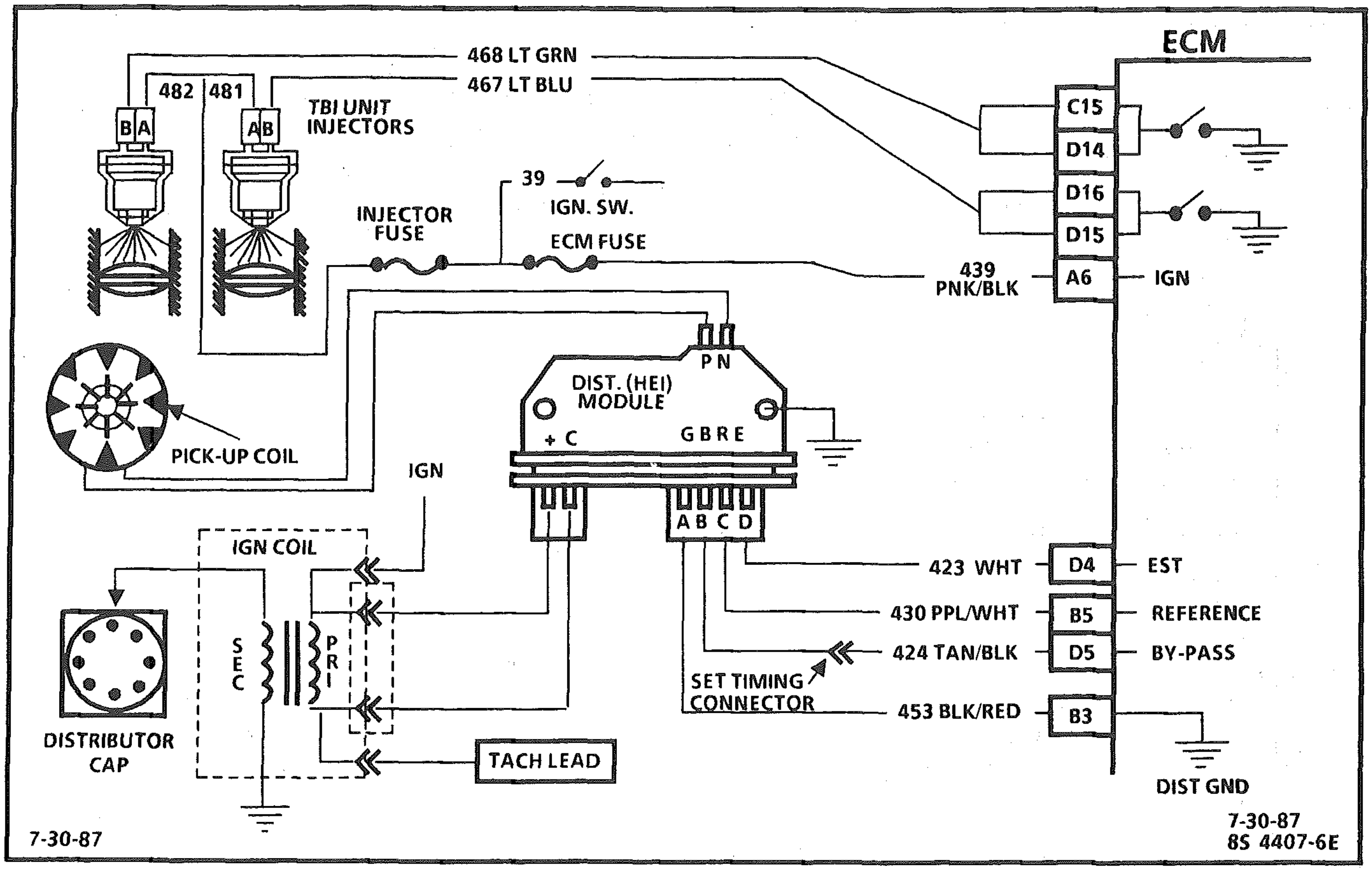


CHART A-3

(Page 1 of 2)
ENGINE CRANKS BUT WILL NOT RUN
5.0L (VIN E) "F" SERIES (TBI)

Circuit Description:

This chart assumes that battery condition and engine cranking speed are OK, and there is adequate fuel in the tank.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. A "Service Engine Soon" light "ON" is a basic test to determine if there is a 12 volt supply and ignition 12 volts to ECM. No ALDL may be due to an ECM problem and CHART A-2 will diagnose the ECM. If TPS is over 2.5 volts, the engine may be in the clear flood mode, which will cause starting problems.
2. No spark may be caused by one of several components related to the ignition system. CHART C-4 will address all problems related to the causes of a no spark condition.
3. Fuel spray from the injector(s) indicates that fuel is available. However, the engine could be severely flooded due to too much fuel.
4. While cranking engine, there should be no fuel spray with injector disconnected. Replace an injector if it sprays fuel or drips like a leaking water faucet.
5. The fuel pressure will drop after the fuel pump stops running due to a controlled bleed in the fuel system. Use of the fuel pressure gage will determine if fuel system pressure is enough for the engine to start and run. The key may have to be cycled 2 or more times for accurate reading.
6. No fuel spray from injector indicates a faulty fuel system or no ECM control of injector.
7. This test will determine if the ignition module is not generating the reference pulse if the wiring or ECM is at fault. By touching and removing a test light to 12 volts on CKT 430, a reference pulse should be generated. If injector test light blinks, the ECM and wiring are OK.

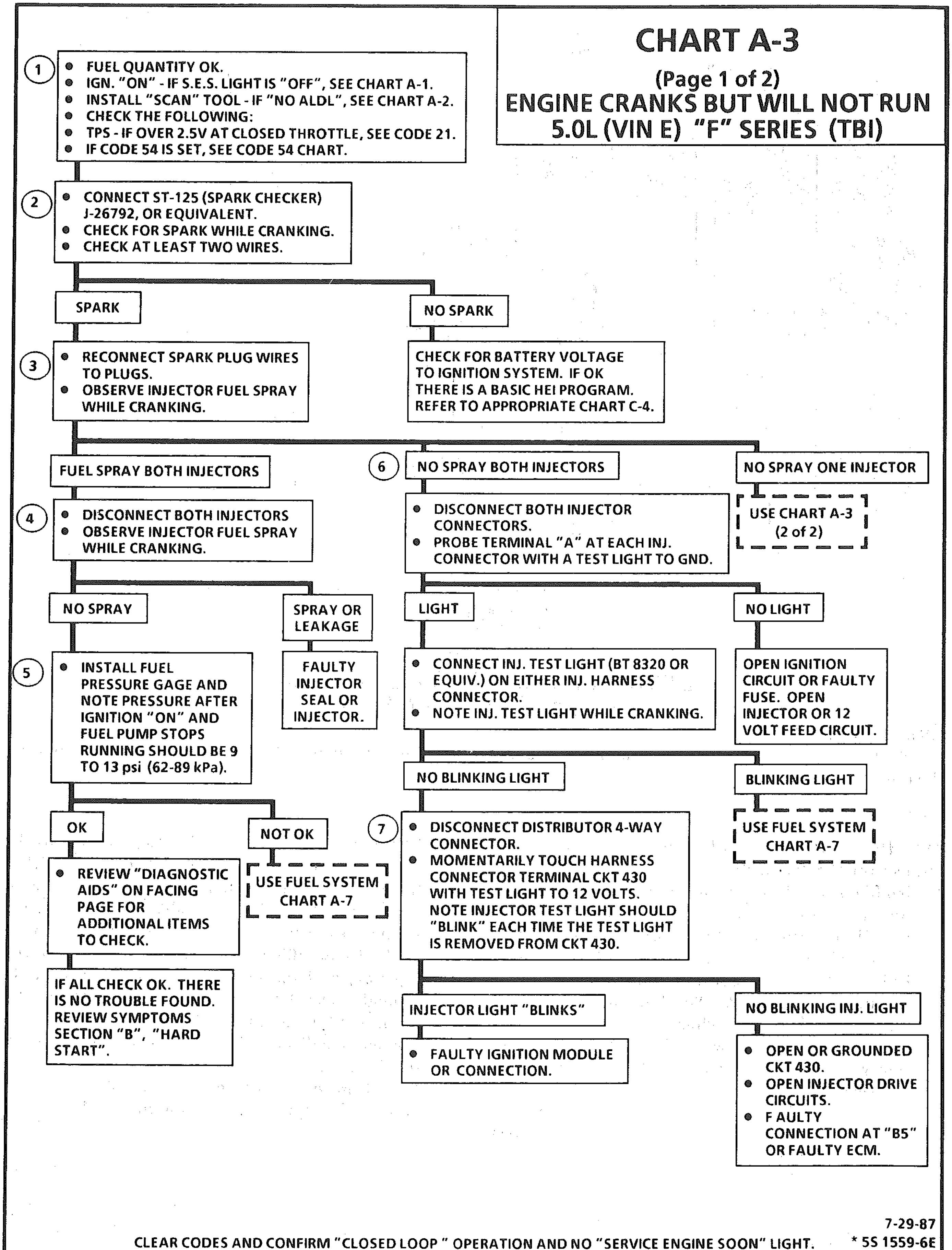
Diagnost Aids:

- Water or foreign material can cause a no start during freezing weather.
- An EGR sticking open can cause a low air/fuel ratio during cranking.
- Fuel pressure: Low fuel pressure can result in a very lean air/fuel ratio. See CHART A-7.
- A grounded CKT 423 (EST) may cause a "No-Start" or a "Start then Stall" condition.

CHART A-3

(Page 1 of 2)

ENGINE CRANKS BUT WILL NOT RUN 5.0L (VIN E) "F" SERIES (TBI)



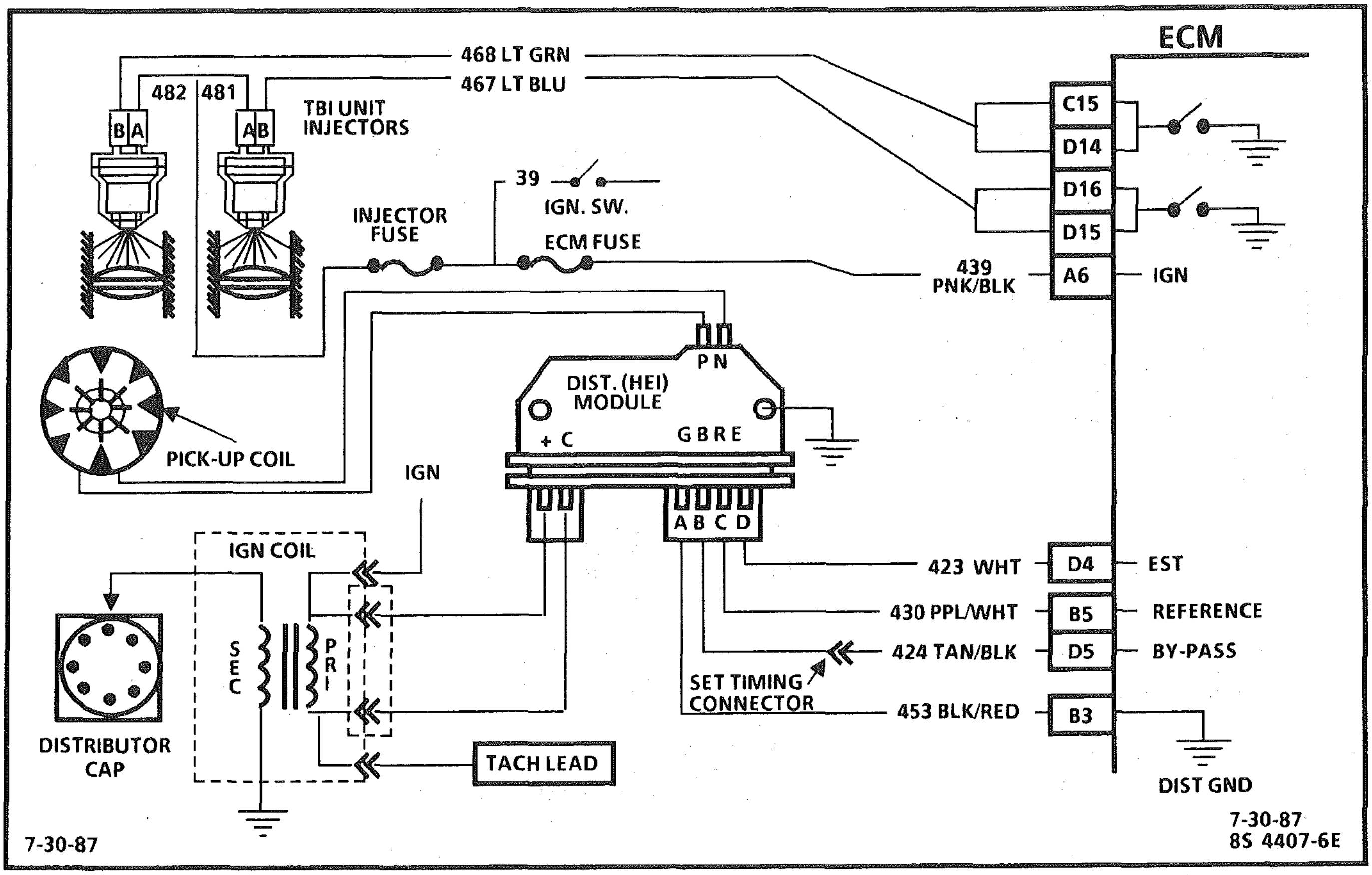


CHART A-3

(Page 2 of 2)
ENGINE CRANKS BUT WILL NOT RUN
5.0L (VIN E) "F" SERIES (TBI)

Circuit Description:

This chart assumes that battery condition and engine cranking speed are OK, and there is adequate fuel in the tank.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

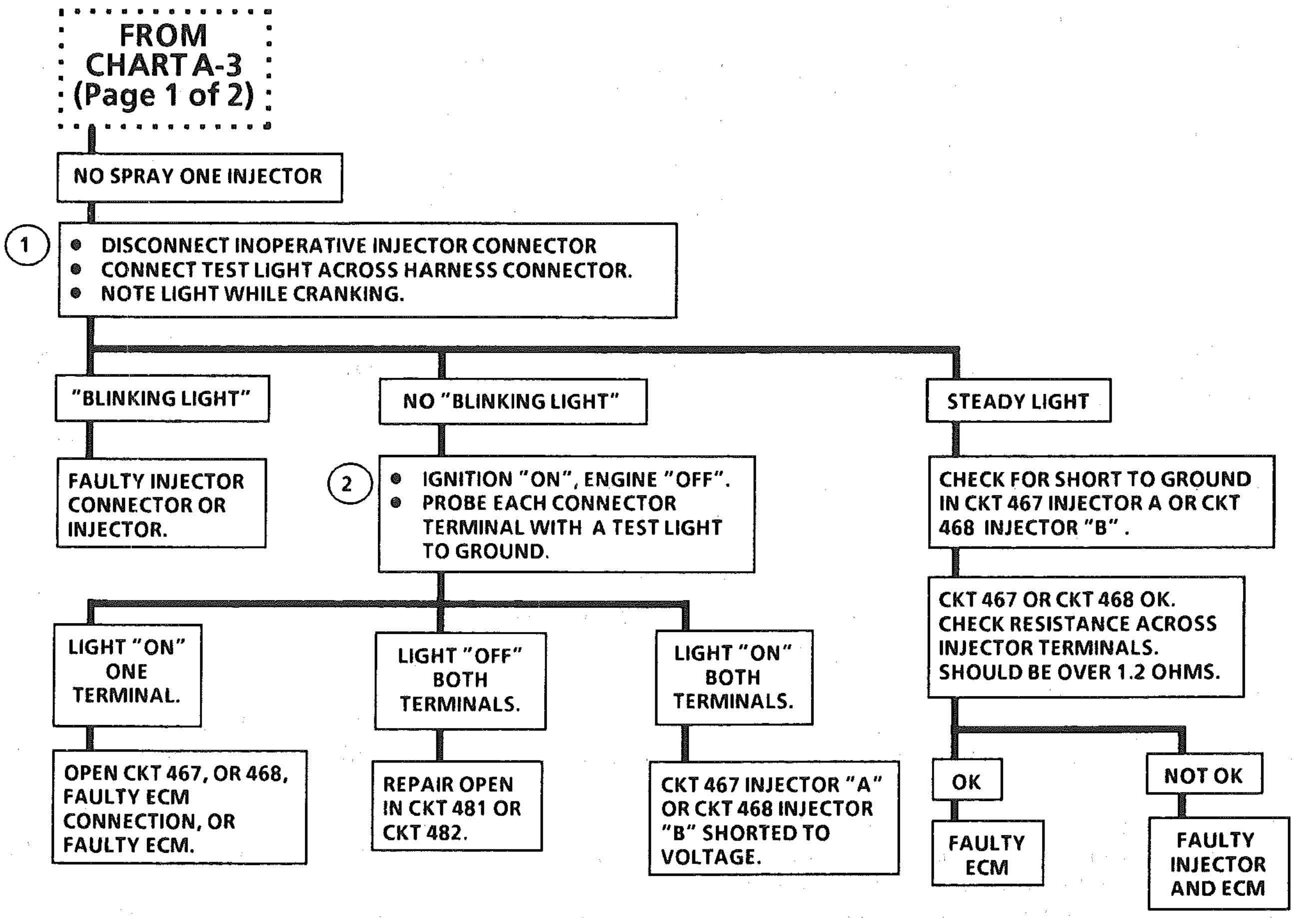
1. No fuel spray from one injector indicates a faulty fuel injector or no ECM control of injector. If the test light "blinks" while cranking, then ECM control should be considered OK. Be sure test light makes good contact between connector terminals during test. The light may be a little dim when "blinking". This is due to current draw of the test light. How bright it "blinks" is not important. However, the test light should be a BT 8320 or equivalent.
2. CKTs 481 and 482 supply ignition voltage to the injectors. Probe each connector terminal with a test light to ground. There should be a light on at one terminal. If the test light confirms ignition voltage at the connector, the ECM injector control CKT 467 or 468 may be open. Reconnect the injector, and using a test light connected to ground, check for a light at the applicable ECM connector terminal ("D14" or "D16"). A light at this point indicates that the injector drive circuit involved is OK.

   If an ECM repeat failure has occurred, the injector is shorted. Replace the injector and ECM.

CHART A-3

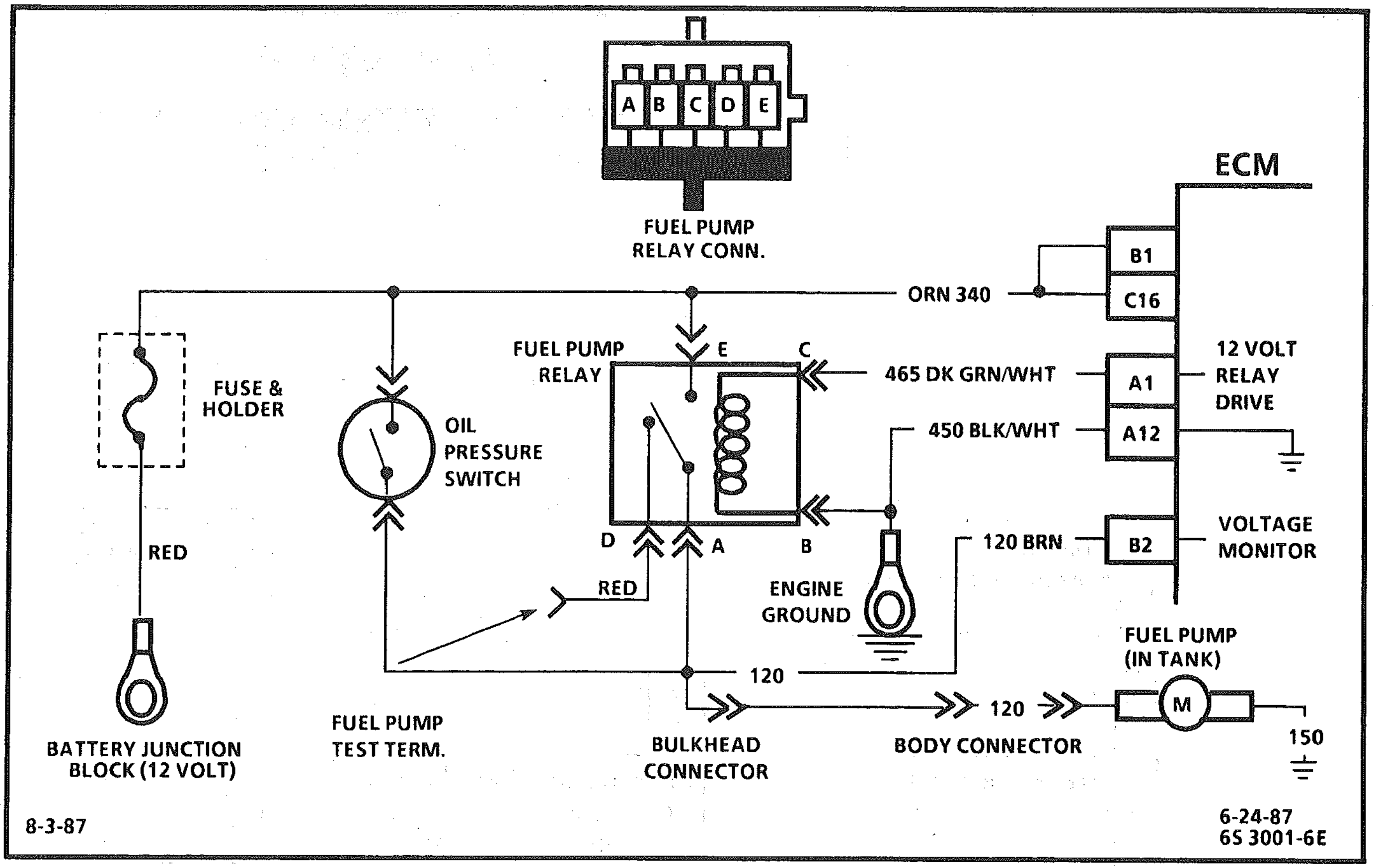
(Page 2 of 2)

ENGINE CRANKS BUT WILL NOT RUN
5.0L (VIN E) "F" SERIES (TBI)



CLEAR CODES AND CONFIRM "CLOSED LOOP " OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

7-29-87
* 5S 1561-6E



CODE 54

FUEL PUMP CIRCUIT
(LOW VOLTAGE)
5.0L (VIN E) "F" SERIES (TBI)

Circuit Description:

When the ignition switch is turned "ON", the electronic control module (ECM) will activate the fuel pump relay and run the in-tank fuel pump. The fuel pump will operate as long as the engine is cranking or running, and the ECM is receiving ignition reference pulses.

If there are no reference pulses, the ECM will shut "OFF" the fuel pump within 2 seconds after key "ON".

Should the fuel pump relay, or the 12 volt relay drive from the ECM fail, the fuel pump will be run through an oil pressure switch back-up circuit.

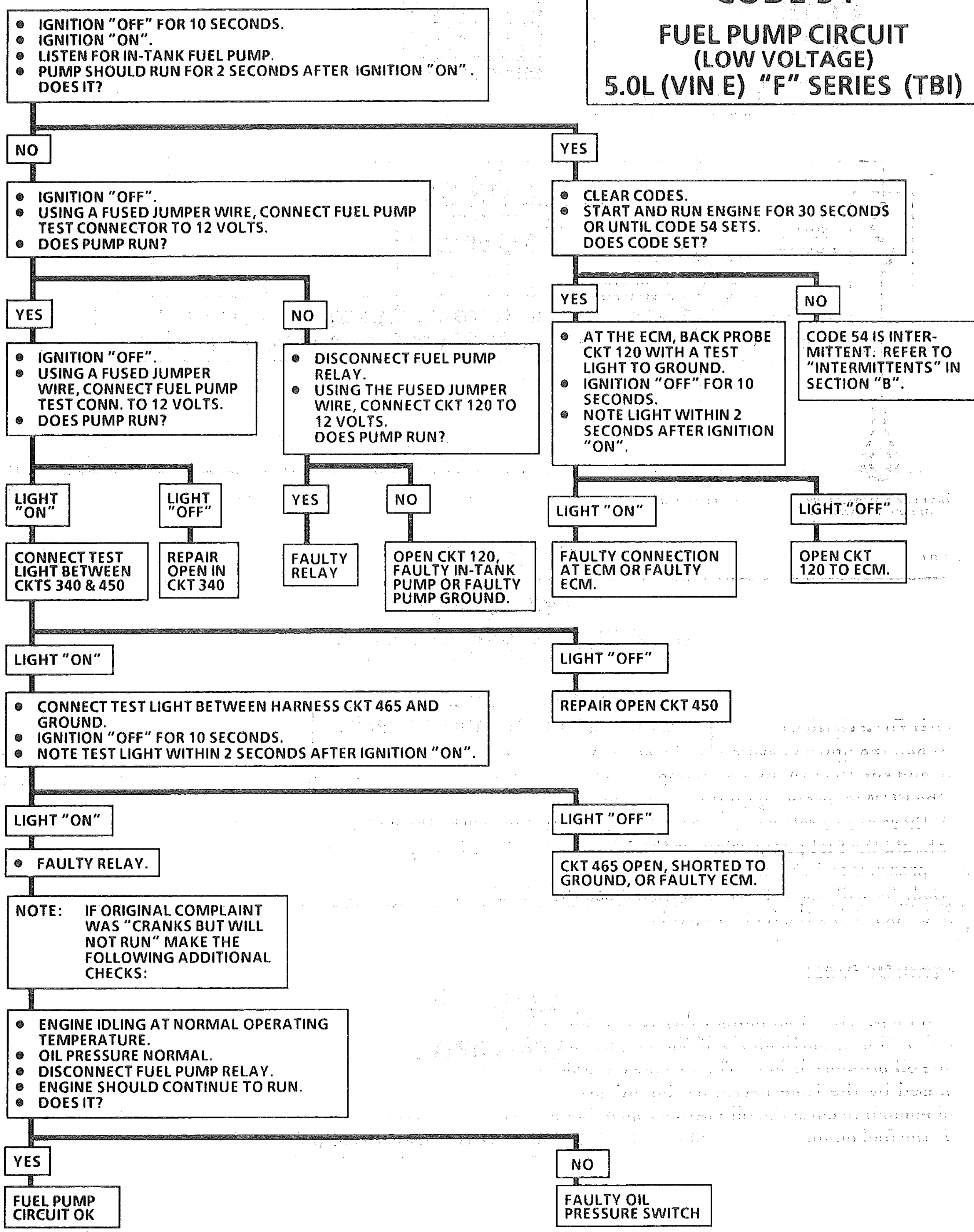
Code 54 will set if the ECM does not see the 12 volts signal at terminal "B2" during the 2 seconds that the ECM is energizing the fuel pump relay.

Diagnostic Aids:

An inoperative fuel pump relay can result in long cranking times, particularly if the engine is cold or engine oil pressure is low. The extended crank period is caused by the time necessary for oil pressure to build enough to close the oil pressure switch and turn "ON" the fuel pump.

CODE 54

FUEL PUMP CIRCUIT (LOW VOLTAGE) 5.0L (VIN E) "F" SERIES (TBI)



7-16-87
*7S 3155-6E

CODE 51
CODE 52
CODE 55

5.0L (VIN E) "F" SERIES (TBI)

CODE 51

PROM ERROR

CHECK THAT ALL PINS ARE FULLY INSERTED IN THE SOCKET. IF OK , REPLACE PROM ,CLEAR MEMORY, AND RECHECK. IF CODE 51 REAPPEARS, REPLACE ECM.

CODE 52

CALPAK ERROR
(FAULTY OR INCORRECT CALPAK)

INSTALL MISSING OR FAULTY CALPAK .

CODE 55

ECM ERROR

REPLACE ELECTRONIC CONTROL MODULE (ECM).

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

6-26-87
4S 1212-6E

DIAGNOSIS

Since the ECM can have a failure which may effect only one circuit, following the diagnostic procedures in this section can reliably tell when a failure has occurred in the ECM. Also, a Code 55 in dicates a failure of the ECM.

If a diagnostic chart indicates that the ECM connections or ECM is the cause of a problem,and the ECM is replaced, but does not correct the problem, one of the following may be the reason:

- There is a problem with the ECM terminal connections. - The diagnostic chart will say "ECM Connections or ECM". The terminals may have to be removed from the connector in order to check them properly.
- The ECM or PROM is not correct for the application. - The incorrect ECM or PROM may cause a malfunction and may or may not set a code.
- The problem is intermittent. - This means that the problem is not present at the time the system is being checked. In this case, refer to the "Symptoms" portion of the manual and make a careful physical inspection of all portions of the system involved.
- Shorted solenoid, relay coil, or harness. - Solenoids and relays are turned "ON" and "OFF" by the ECM, using internal electronic switches called "Drivers".

A shorted solenoid, relay coil, or harness in a GMP4 computer will not damage the ECM, but will cause the circuit and controlled component to be inoperative. When the circuit fault is not present or has been repaired, the "Quad-Driver" will again operate in a normal manner due to it's fault protected design. If a fault has been repaired in a circuit controlled by a "Quad-Driver", the original ECM should be reinstalled and the circuit checked for proper operation. ECM replacement will not be necessary if the repaired circuit or component now operates correctly.

J34636 or BT8405 testers or equivalent provide a fast, accurate means of checking for a shorted coil or a short to battery voltage.

- The PROM may be faulty. - Although the PROM rarely fails,it operates as part of the ECM. Therefore, it could be the cause of the problem. Substitute a known good PROM.
- The replacement ECM may be faulty. - After the ECM is replaced, the system should be rechecked for proper operation. If the diagnostic chart again indicates the ECM is the problem, substitute a known good ECM. Although this is a rare condition, it could happen.

The components or circuits and the codes or charts, related to them are:

- Code 55 indicates a failure of the ECM.
- PROM - Code 51.
- Coolant Temperature Sensor - CHARTS 14 - 15.
- MAP sensor - CHART 33 or 34. To check the sensor with no code set, use CHART C-1D.
- TPS - CHARTS 21 or 22.
- P/N switch - CHART C-1A
- Crank Signal - CHART C-1B
- O_2 Sensor - CHARTS 13, 44, 45.
- VSS - CHART 24 and in TCC System.
- Distributor - CHART 42 and in EST system.
- Distributor - Chart and in the EST system.

ECM

A faulty ECM will be determined in the diagnostic charts, or by a Code 55.

PROM

An incorrect or faulty PROM, which is part of the ECM, may set a Code 51.

ECM INPUTS

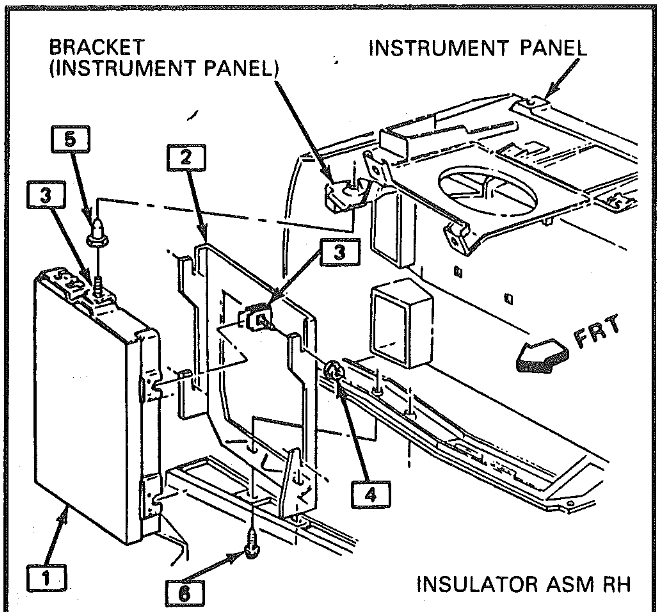
All of the sensors and input switches can be diagnosed by the use of a "Scan" tool. Following is a short description of how the sensors and switches can be diagnosed by the use of "a Scan" tool. The "Scan" tool can also by used to compare the values for a normal running engine with the engine you're diagnosing.

Coolant Temperature Sensor

A "Scan" tool displays engine temp. in degrees centigrade. After the engine is started, the temperature should rise steadily to about 90°C, then stabilize when thermostat opens. A fault in the coolant sensor circuit should set a Code 14 or 15. The code charts also contain a chart to check for sensor resistance values relative to temperature.

MAT Sensor

A "Scan" tool displays temperature of the air entering the engine and should read close ambient air temperature, when engine is cold, and rise as underhood temperature increases. If the engine has not been run for several hours (overnight), the MAT sensor temperature and coolant temperature should read close to each other.



1 MODULE ASM ECM (TBI)
2 BRACKET
3 BOLT/SCREW (5)
4 NUT (4) 4.7-7.0 N·m (3.3-5.1 LBS. FT.)
5 NUT
6 BOLT/SCREW (2) 2.2-3.4 N·m (1.6-2.5 LBS. FT.)

8S 4427-6E

Figure C1-9 - ECM Mounting

NOTICE: To prevent internal ECM damage, the ignition must be "OFF" when disconnecting or reconnecting power to ECM (for example, battery cable, ECM pigtail, ECM fuse, jumper cables, etc.).

Remove or Disconnect

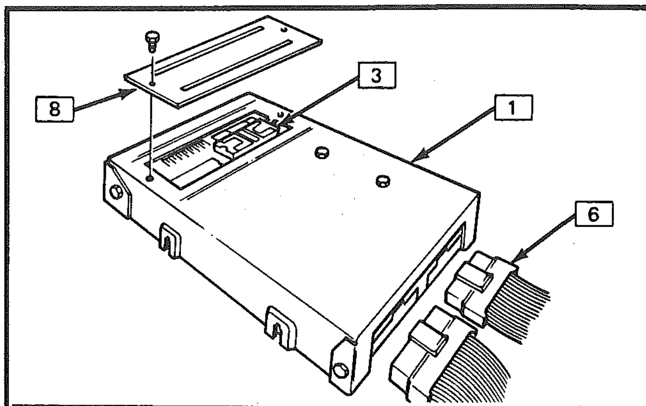
1. Negative battery cable.
2. Right hand hush panel.
3. Connectors to ECM.
4. ECM.
5. PROM from ECM.

Install or Connect

1. Old PROM in new ECM.
2. ECM into car.
3. Connectors.
4. Hush panel.
5. Negative battery cable.

PROM

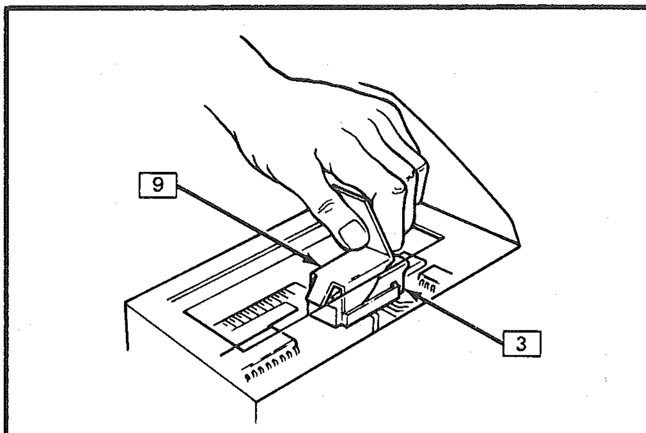
Code 51 indicates a faulty PROM, bent pins, or incorrect installation.



1 ECM
3 PROM CARRIER
6 ECM HARNESS CONNECTORS TO ECM
8 PROM ACCESS COVER

4S 0463-6E

Figure C1-10 PROM Access Cover



3 PROM CARRIER
9 PROM REMOVAL TOOL

4S 0464-6E

Figure C1-11 PROM Removal Tool

Important

It is possible to install a PROM backward. If the PROM is installed backward and the ignition key turned to "ON," the PROM circuitry will be destroyed, requiring PROM replacement.

Important

The ignition should always be off when installing or removing the ECM connectors.

Remove or Disconnect

1. Connectors from ECM.
2. ECM mounting hardware.
3. ECM from passenger compartment.
4. Prom access cover (see Figure C1-10).
5. Remove PROM assembly

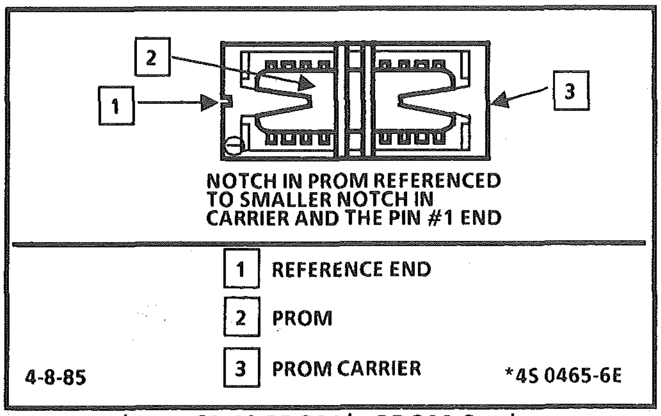


Figure C1-12 PROM in PROM Carrier

Important

Using the rocker-type PROM removal tool, engage one end of the PROM carrier with the hook end of the tool (see Figure C1-11). Press on the vertical bar end of the tool and rock the engaged end of the PROM carrier up as far as possible. Engage the opposite end of the PROM carrier in the same manner and rock this end up as far as possible. Repeat this process until the PROM carrier and PROM are free of the PROM socket. The PROM carrier with PROM in it should lift off of the PROM socket easily. PROM carrier should only be removed by using the pictured PROM removal tool. Other methods could cause damage to the PROM or PROM socket.

Remove or Disconnect

1. New PROM carrier in PROM socket.

Inspect

1. New PROM for same part number as old or updated number per service bulletin.

Important

Do not remove PROM from carrier to check PROM number.

2. For correct reference of PROM in carrier, see Figure C1-12.

Important

Small notch of carrier should be aligned with small notch in socket. Press on PROM carrier until it is firmly seated in the socket. Do not press on PROM; only the carrier.

2. Access cover on ECM.
3. ECM in passenger compartment.
4. Connectors to ECM.

Functional Check

1. Turn ignition "ON".
2. Enter diagnostics (see Diagnostic Circuit Check for procedure).
   A. Allow Code 12 to flash four times to verify that no other codes are present. This indicates the PROM is installed properly.
   B. If trouble Code 51 occurs or if the "Service Engine Soon" light is "ON" constantly with no codes, the PROM is not fully seated, installed backwards, has bent pins, or is defective.
      - If not fully seated, press firmly on PROM carrier.
      - If it is necessary to remove the PROM, follow instructions in steps "A" and "B".
      - If installed backwards, REPLACE THE PROM.
   - If pins bend, remove PROM, straighten pins, and reinstall. If bent pins break or crack during straightening, discard PROM and replace it.

NOTICE: Any time the PROM is installed backward and the ignition switch turned "ON", the PROM is destroyed.

CALPAK

Remove or Disconnect

1. Remove ECM access cover.
2. Remove CALPAK (Figure C1-13) using removal tool shown. Grasp the CALPAK carrier at the narrow end only. Gently rock the carrier from end to end while applying a firm upward force.

Inspect

3. Inspect reference end of the CALPAK carrier and carefully set aside. Do not remove CALPAK from the carrier to confirm CALPAK correctness. Notch in CALPAK referenced to smaller notch in carrier and the (1).

Install or Connect

4. Install CALPAK. If a service CALPAK is being installed, make sure it has the same part number as the removed CALPAK. Do not press on the CALPAK - only the carrier.
   Small notch of the carrier must be aligned with small notch in socket. Press on CALPAK carrier until it is firmly seated in the socket.
5. Install ECM access cover.
6. Install ECM in passenger compartment and perform a "Diagnostic Circuit Check" to confirm proper installation.

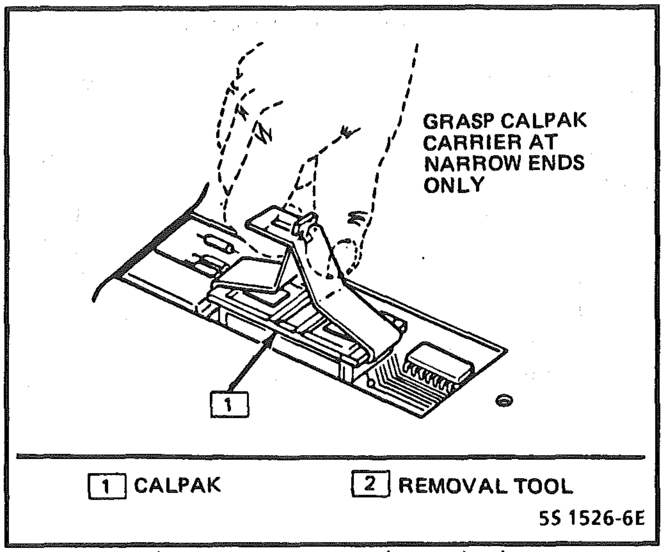


Figure C1-13 Removing Calpak

COOLANT SENSOR

NOTICE: Care must be taken when handling coolant sensor. Damage to coolant sensor will affect proper operation of the Fuel Injection system.

Remove or Disconnect

1. Negative battery cable.
2. Electrical connector.
3. Carefully back out coolant sensor.

Install or Connect

1. Sensor in engine.
2. Electrical connector.
3. Negative battery cable.

MAT Sensor

Remove or Disconnect

1. Negative battery cable.
2. Electrical connector.
3. Carefully back out sensor.

Install or Connect

1. Coat threads only with sealant, P/N 1052080 or equivalent.
2. Sensor in engine.
3. Electrical connector.
4. negative battery cable.

MAP SENSOR

Other than checking for loose hoses and electrical connections the only service possible is unit replacement if diagnosis shows sensor to be faulty.

OXYGEN SENSOR

NOTICE: The oxygen sensor uses a permanently attached pigtail and connector. This pigtail should not be removed from the oxygen sensor. Damage or removal of the pigtail or connector could affect proper operation of the oxygen sensor.

Important

Take care when handling the oxygen sensor (Figure C1-14). The in-line electrical connector and louvered end must be kept free of grease, dirt or other contaminants. Also, avoid using cleaning solvents of any type. Do not drop or roughly handle the oxygen sensor.

Remove or Disconnect

1. Negative battery cable.
2. Electrical connector.
3. Carefully back out oxygen sensor.

The oxygen sensor may be difficult to remove when engine temperature is below 48°C (120°F). Excessive force may damage threads in exhaust manifold or exhaust pipe.

1. Negative battery cable.
2. Electrical connector.
3. Carefully back out Oxygen Sensor.

Install or Connect

Important

A special anti-seize compound is used on the oxygen sensor threads. The compound consists of a liquid graphite and glass beads. The graphite will tend to burn away, but the glass beads will remain, making the sensor easier to remove.

New or service sensors will already have the compound applied to the threads. If a sensor is removed from an engine, and, if for any reason it is to be reinstalled, the threads must have anti-seize compound applied before reinstallation.

1. Coat threads of oxygen sensor with anti-seize compound P/N 3613695 or equivalent if necessary.
2. Sensor, and torque to 41 N·M (30 ft. lbs.).
3. Electrical connector.
4. Negative battery cable.

THROTTLE POSITION SENSOR (TPS)

Remove or Disconnect

1 Air cleaner.
2 Electrical connector.
3 Two TPS attaching screws, lockwashers and retainers.
4. Sensor.

Install or Connect

1. With throttle valve in the normal closed idle position, install throttle position sensor on throttle body assembly, making sure TPS pickup lever is located ABOVE tang on throttle actuator lever.
2. Retainers and two TPS screws and lockwashers using a thread locking compound on the screws. Use loctite 262, GM part No. 1052624, or equivalent. Tighten screws.
3. Connector.
4. Air cleaner.

PARK/NEUTRAL SWITCH

See Section 8A for location of park/neutral switch. On-Car Service and Adjustment Procedures are also listed there.

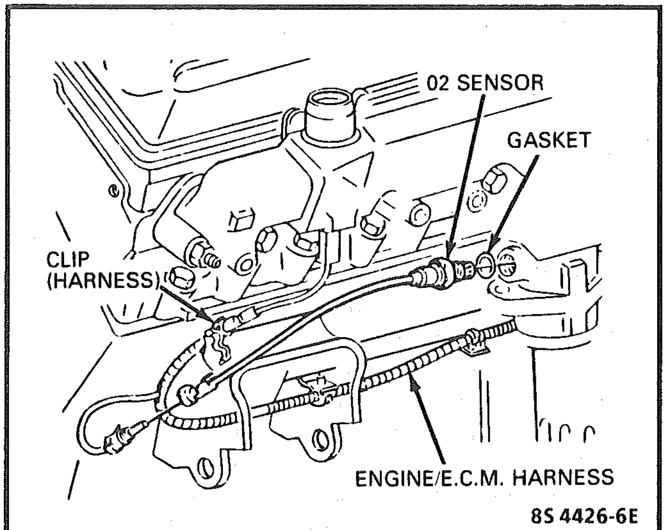


Figure C1-14 Oxygen Sensor

PARTS INFORMATION

PART NAME	GROUP
Controller, ECM	3.670
Calibrator, PROM	3.670
Sensor, Coolant Temp.	3.682
MAT Sensor	3.682
Sensor, Exhaust Oxygen	3.682
Sensor, MAP	3.682
Sensor Kit, Throttle Position	3.764
Switch, Neu Saf and Backing LP	2.698

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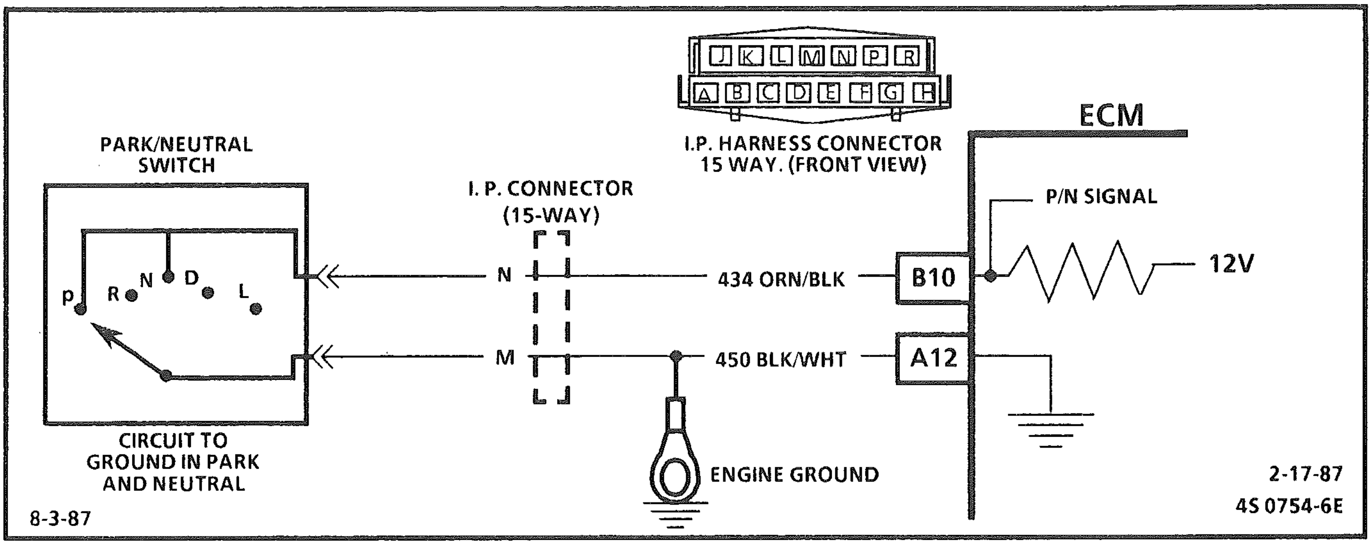


CHART C-1A

PARK/NEUTRAL SWITCH DIAGNOSIS
(AUTO TRANSMISSION ONLY)
5.0L (VIN E) "F" SERIES (TBI)

Circuit Description:

The park/neutral switch contacts are a part of the neutral start switch, and are closed to ground in park or neutral and open in drive ranges.

The ECM supplies ignition voltage through a current limiting resistor to CKT 434 and senses a closed switch when the voltage on CKT 434 drops to less than one volt.

The ECM uses the P/N signal as one of the inputs to control:

Idle air control
VSS diagnostics
EGR

If CKT 434 indicates P/N (grounded), while in drive range, the EGR would be inoperative, resulting in possible detonation.

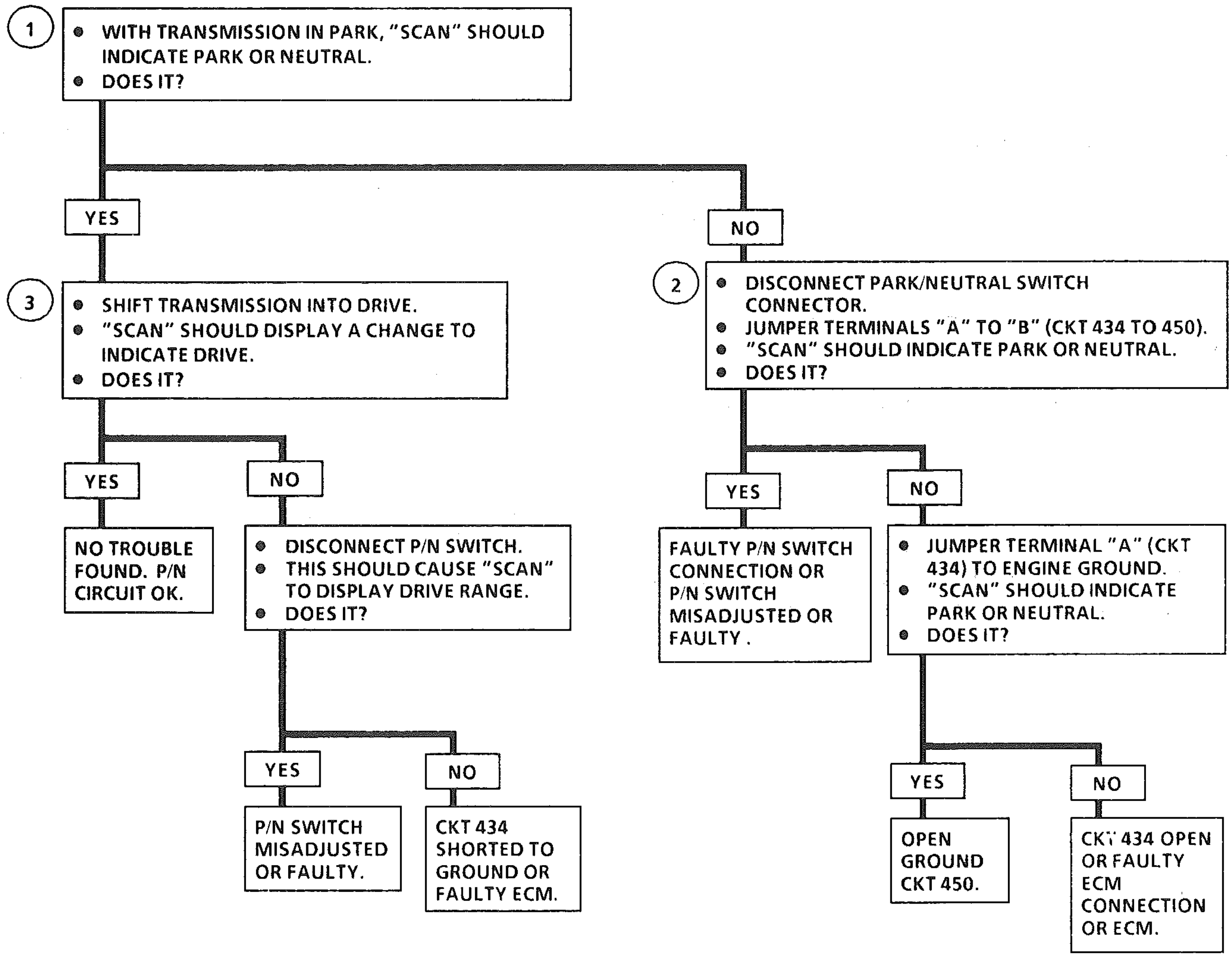
If CKT 434 always indicates drive (open), a drop in the idle may exist when the gear selector is moved into drive range.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Checks for a closed switch to ground in park position. Different makes of "Scan" tools will read P/N differently. Refer to "Operators Manual" for type of display used for a specific tool.
2. Checks for an open switch in drive range.
3. Be sure "Scan" tool indicates drive, even while wiggling shifter to test for an intermittent or misadjusted switch in drive range.

CHART C-1A

PARK/NEUTRAL SWITCH DIAGNOSIS
(AUTO TRANSMISSION ONLY)
5.0L (VIN E) "F" SERIES (TBI)



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*7S 3161-6E

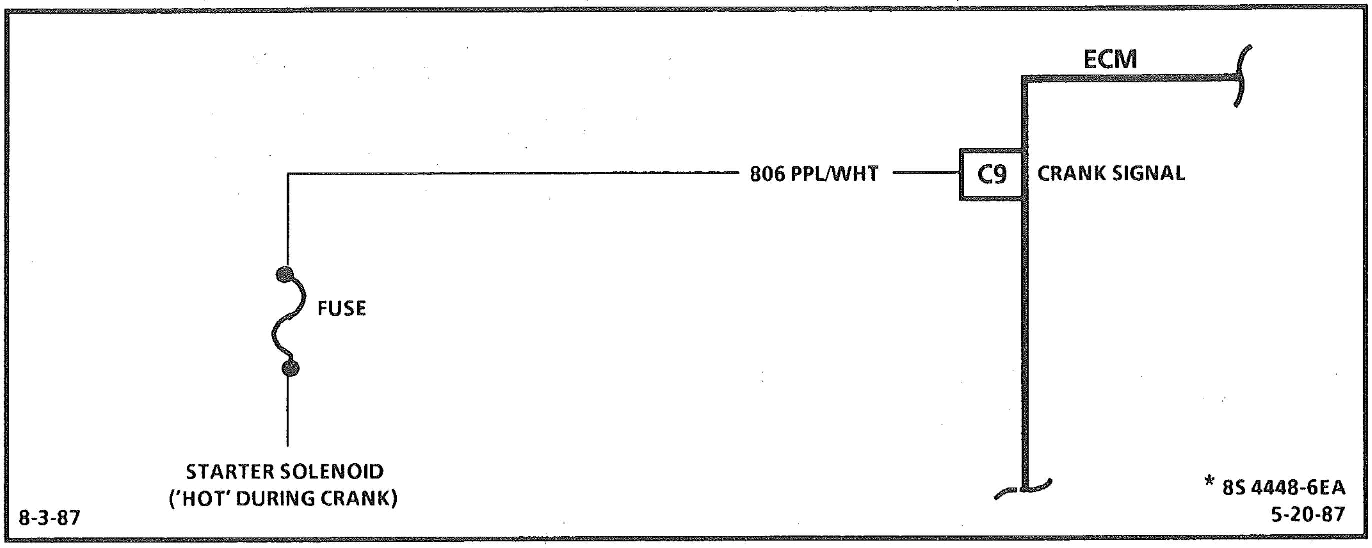


CHART C-1B

CRANK SIGNAL
5.0L (VIN E) "F" SERIES (TBI)

Circuit Description:

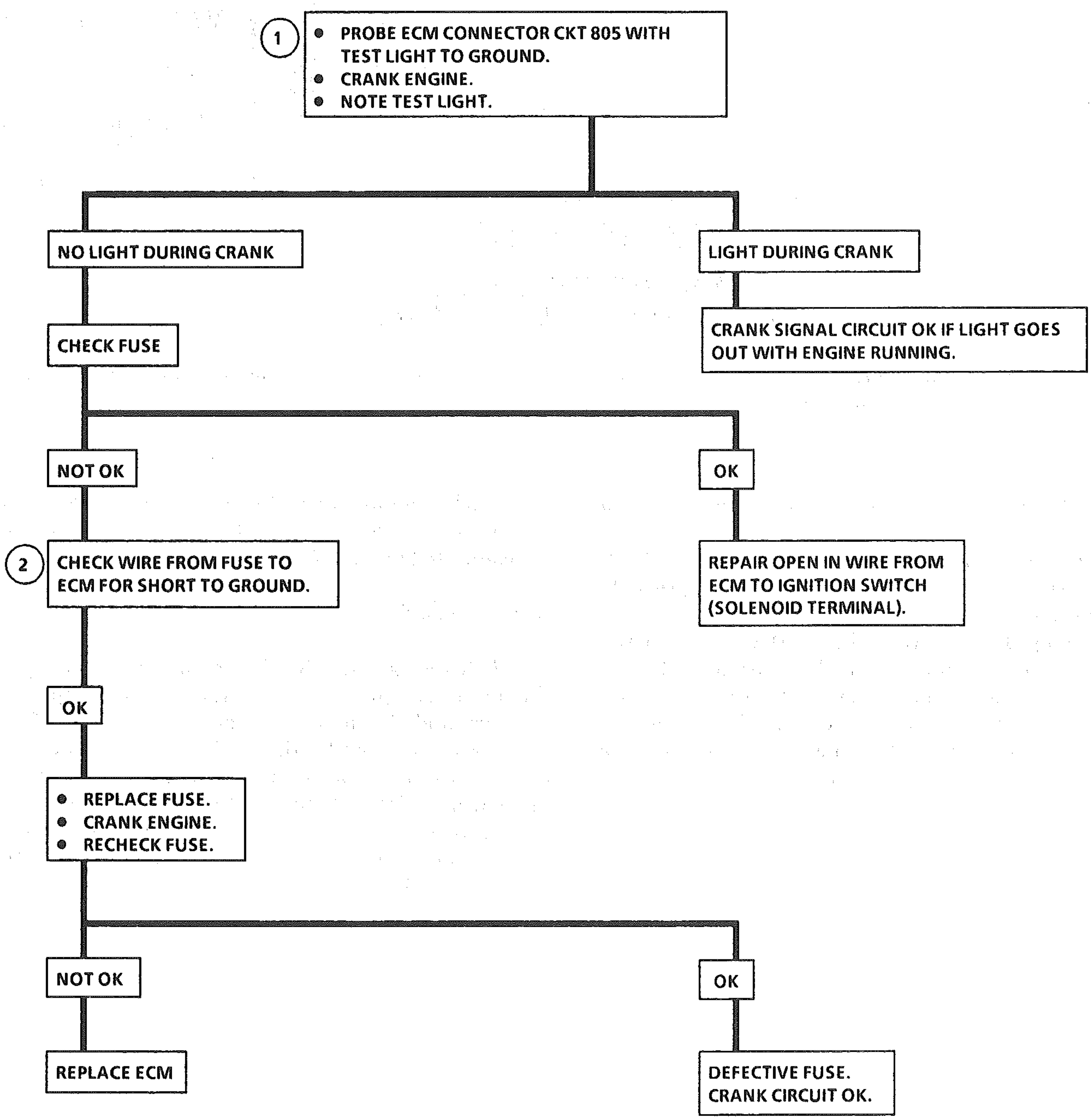
Crank signal is a 12 volts signal to the ECM during cranking to allow enrichment and cancel diagnostics until engine is running and 12 volts is no longer on circuit.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Checks for normal (cranking) voltage to terminal "C9" of ECM. Test light should be "ON" during cranking.
2. Checks to determine if source of blown fuse was a faulty ECM.

CHART C-1B

CRANK SIGNAL
5.0L (VIN E) "F" SERIES (TBI)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

7-28-87
4S 0820-6E

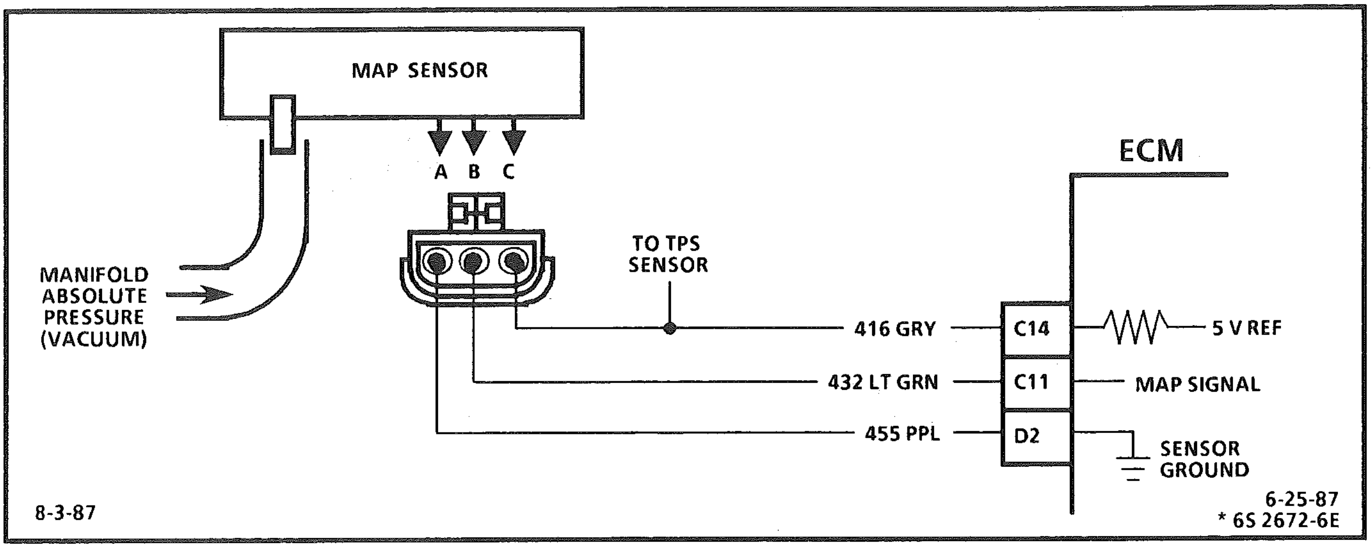


CHART C-1D

MAP OUTPUT CHECK
5.0L (VIN E) "F" SERIES (TBI)

Circuit Description:

The manifold absolute pressure sensor (MAP) measures manifold pressure (vacuum) and sends that signal to the ECM. The ECM uses this information for fuel and spark control.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Checks MAP sensor output voltage to the ECM. This voltage, without engine running, represents a barometer reading to the ECM.
2. Applying 34 kPa (10 inches Hg) vacuum to the MAP sensor should cause the voltage to be 1.2 volts less than the voltage at Step 1. Upon applying vacuum to the sensor, the change in voltage should be instantaneous. A slow voltage change indicates a faulty sensor.
3. Check vacuum hose to sensor for leaking or restriction. Be sure no other vacuum devices are connected to the MAP hose.

Diagnostic Aids:

With the ignition "ON" and the engine stopped, the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of vehicle altitude and is referred to as BARO. Comparison of this BARO reading with a known good vehicle with the same sensor is a good way to check accuracy of a "suspect" sensor. Reading should be the same, ± .4 volt.

CHART C-1D

MAP OUTPUT CHECK
5.0L (VIN E) "F" SERIES (TBI)

1. • IGNITION "ON", ENGINE STOPPED.
"SCAN" TOOL SHOULD INDICATE A VOLTAGE WITHIN THE VALUES SHOWN IN THE CHART BELOW.

NOT OK → REPLACE SENSOR

OK ↓

2. • DISCONNECT VACUUM HOSE AT MAP SENSOR AND PLUG HOSE
• CONNECT A HAND VACUUM PUMP TO MAP SENSOR
• START ENGINE
• APPLY 34 kPa (10") OF VACUUM AND NOTE VOLTAGE CHANGE. (VOLTAGE SHOULD BE 1.2 - 2.3 VOLTS LESS THAN STEP 1.)

NOT OK → CHECK SENSOR CONNECTION, IF OK, REPLACE SENSOR.

OK ↓

3. NO TROUBLE FOUND. CHECK MAP HOSE FOR LEAKAGE OR RESTRICTION. BE SURE THIS HOSE SUPPLIES VACUUM TO MAP SENSOR ONLY.

ALTITUDE Meters	ALTITUDE Feet	VOLTAGE RANGE
Below 305	Below 1,000	3.8---5.5V
305--- 610	1,000--2,000	3.6---5.3V
610--- 914	2,000--3,000	3.5---5.1V
914--1219	3,000--4,000	3.3---5.0V
1219--1524	4,000--5,000	3.2---4.8V
1524--1829	5,000--6,000	3.0---4.6V
1829--2133	6,000--7,000	2.9---4.5V
2133--2438	7,000--8,000	2.8---4.3V
2438--2743	8,000--9,000	2.6---4.2V
2743--3048	9,000--10,000	2.5---4.0V

LOW ALTITUDE = HIGH PRESSURE = HIGH VOLTAGE

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

5-27-87
*7S 3162-6EA

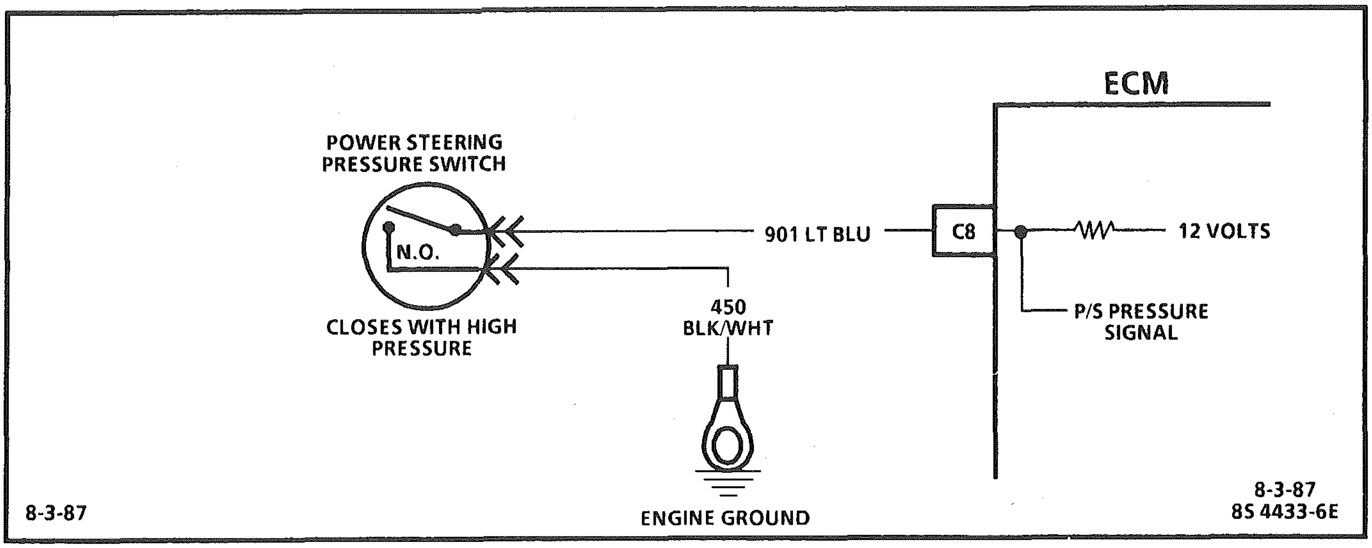


CHART C-1E

POWER STEERING PRESSURE SWITCH (PSPS) DIAGNOSIS
5.0L (VIN E) "F" SERIES (TBI)

Circuit Description:

The power steering pressure switch is normally open to ground, and CKT 901 will be near the battery voltage.

Turning the steering wheel increases power steering oil pressure and its load on an idling engine. The pressure switch will close before the load can cause an idle problem.

Closing the switch causes CKT 901 to read less than 1 volt and the ECM will increase the idle air rate and de-energize the A/C relay.

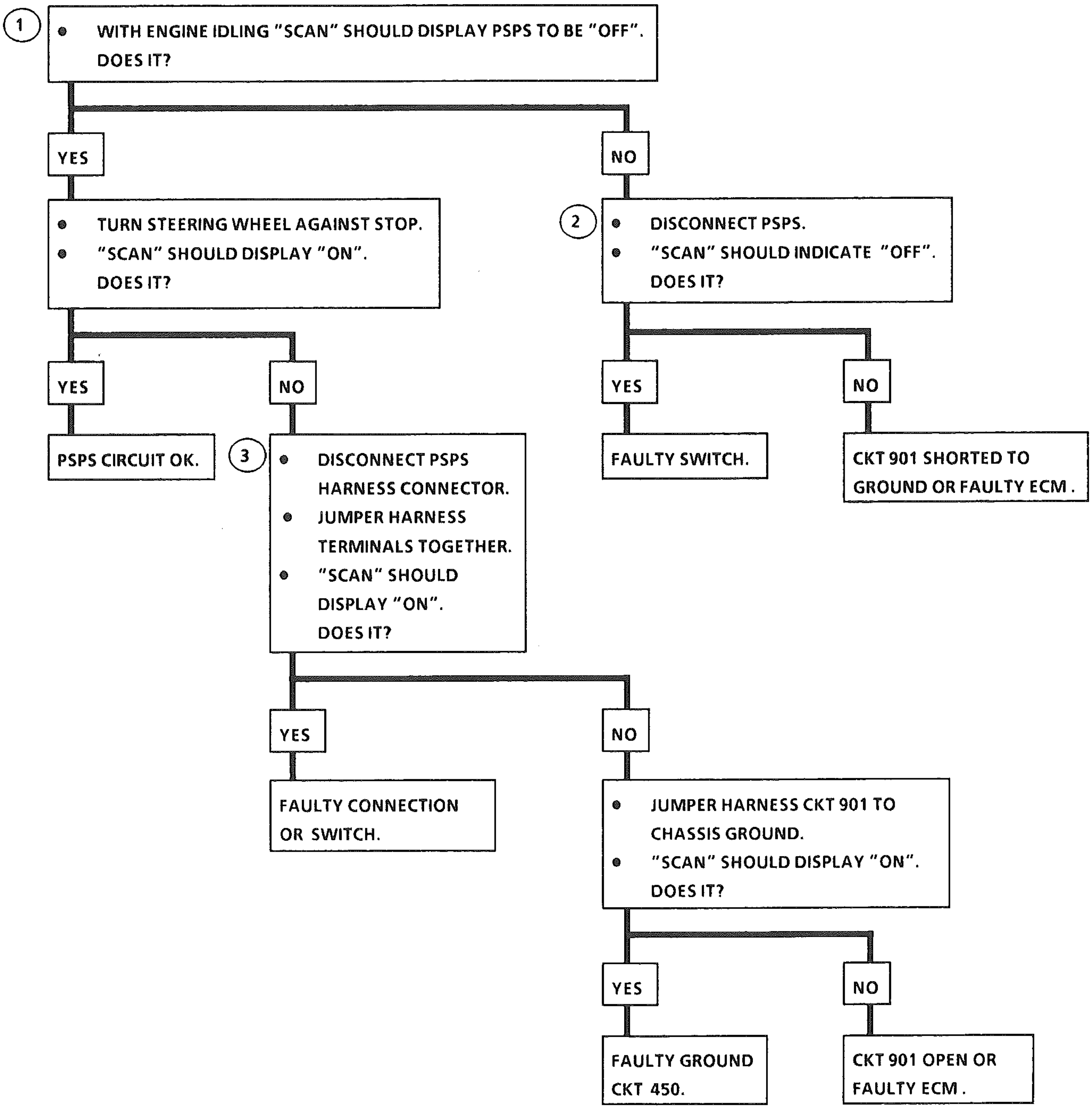
- A pressure switch that will not close, or an open CKT 901 or 450, may cause the engine to stop when power steering loads are high.
- A switch that will not open, or a CKT 901 shorted to ground, may affect idle quality, and will cause the A/C relay to be de-energized.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Different makes of "Scan" tools may display the state of this switch in different ways. Refer to "Scan" tool upgrading to determine how this input is indicated.
2. Checks to determine if CKT 901 is shorted to ground.
3. This should simulate a closed switch.

CHART C-1E

POWER STEERING PRESSURE SWITCH (PSPS) DIAGNOSIS 5.0L (VIN E) "F" SERIES (TBI)



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CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

* 7S 3163

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1.5:1 at -36°C (-33°F) to 14.7:1, at 94°C (201°F) running temperature.

The ECM controls the amount of fuel delivered in the starting mode by changing how long the injector is turned "ON" and "OFF". This is done by "pulsing" the injector for very short times.

Clear Flood Mode

If the engine floods, clear it by pushing the accelerator pedal down all the way. The ECM then pulses the injector at a 20:1 air/fuel ratio, and holds this injector rate as long as the throttle stays wide open, and the engine is below 600 rpm. If the throttle position becomes less than 80%, the ECM returns to the starting mode.

Run Mode

The run mode has two conditions called "Open Loop" and "Closed Loop."

Open Loop

When the engine is first started, and it is above 400 rpm, the system goes into "Open Loop" operation. In "Open Loop," the ECM ignores the signal from the (O_2) sensor, and calculates the air/fuel ratio based on inputs from the coolant temperature and MAP sensors.

The system stays in "Open Loop" until the following conditions are met:

1. The O_2 sensor has varying voltage output, showing that it is hot enough to operate properly. (This depends on temperature.)
2. The coolant temperature sensor is above a specified temperature.
3. A specific amount of time has elapsed after starting the engine.

Closed Loop

The specific values for the above conditions vary with different engines, and are stored in the programmable read only memory (PROM). When these conditions are met, the system goes into "Closed Loop" operation. In "Closed Loop," the ECM calculates the air/fuel ratio (injector on-time) based on the signal from the O_2 sensor. This allows the air/fuel ratio to stay very close to 14.7:1.

Acceleration Mode

The ECM looks at rapid changes in throttle position and manifold pressure, and provides extra fuel.

Deceleration Mode

When deceleration occurs, the fuel remaining in the intake manifold can cause excessive emissions and backfiring. Again, the ECM looks at changes in throttle position and manifold pressure and reduces the amount of fuel. When deceleration is very fast, the ECM can cut off fuel completely for short periods.

Battery Voltage Correction Mode

When battery voltage is low, the ECM can compensate for a weak spark delivered by the distributor by:

- Increasing injector on time of fuel delivered;
- Increasing the idle rpm.

Fuel Cutoff Mode

No fuel is delivered by the injectors when the ignition is "OFF". This prevents dieseling. Also, fuel is not delivered if no reference pulses are seen from the distributor, which means the engine is not running. **Fuel cutoff also occurs at high engine rpm, to protect internal engine components from damage.**

FUEL CONTROL SYSTEM COMPONENTS

The fuel control system consists of the following:

- Throttle body injection (TBI) unit
- Fuel pump
- Fuel pump relay.

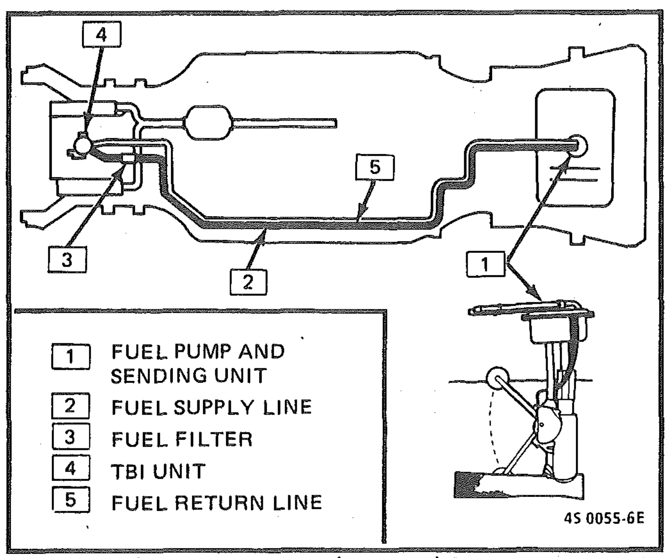


Figure C2-2 - Fuel Control System

BASIC SYSTEM OPERATION

The fuel control system (Figure C2-2) has an electric fuel pump, located in the fuel tank with the gage sending unit, which pumps fuel to the TBI through the fuel supply line, then through an in-line fuel filter. The pump is designed to provide pressurized fuel at about 125 kPa (18 psi). A pressure regulator in the TBI keeps fuel available to the injectors at a constant pressure between 62 and 90 kPa (9 and 13 psi). Fuel in excess of injector need is returned to the fuel tank by a separate line.

The ECM controls the injectors that are located in the fuel meter body assembly of the TBI. The injectors deliver fuel in one of several modes, described above.

In order to properly control the fuel supply, the fuel pump is operated by the ECM through the fuel pump relay and oil pressure switch (see "Fuel Pump Electrical Circuit").

THROTTLE BODY INJECTION (TBI) UNIT

The Model 220 unit (Figure C2-3) consists of three major casting assemblies:

1. A fuel meter cover with:
   - A pressure regulator
2. A fuel meter body with:
   - Two fuel injectors
3. A throttle body with:
   - Two throttle valves
   - An idle air control (IAC) valve
   - A throttle position sensor (TPS).

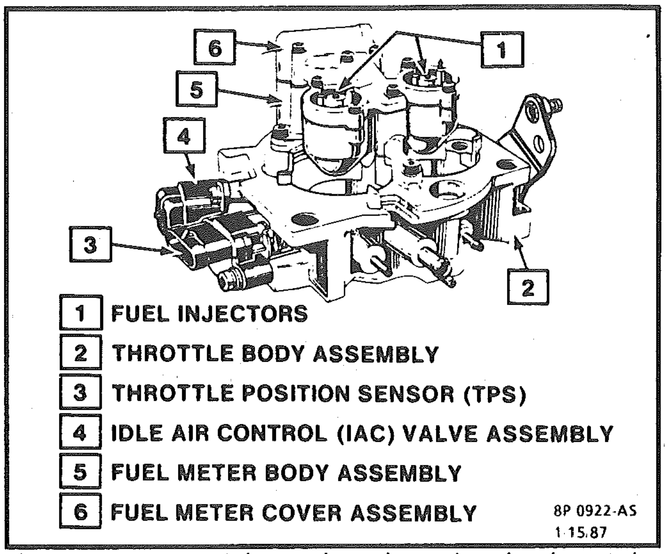


Figure C2-3 - Model 220 Throttle Body Injection Unit

Fuel Injectors

Fuel injectors (Figure C2-4) are solenoid-operated devices controlled by the ECM. The ECM turns on the solenoid, which lifts a normally closed ball valve off a seat. Fuel, under pressure, is injected in a conical spray pattern at the walls of the throttle body bore above the throttle valve. The fuel which is not used by the injectors passes through the pressure regulator before being returned to the fuel tank.

A fuel injector which does not open may cause a no-start condition. An injector which is stuck partly open will cause a loss of pressure after setting, so long crank times would be noticed. Also, dieseling could occur because some fuel would be delivered to the engine after the key is turned "OFF."

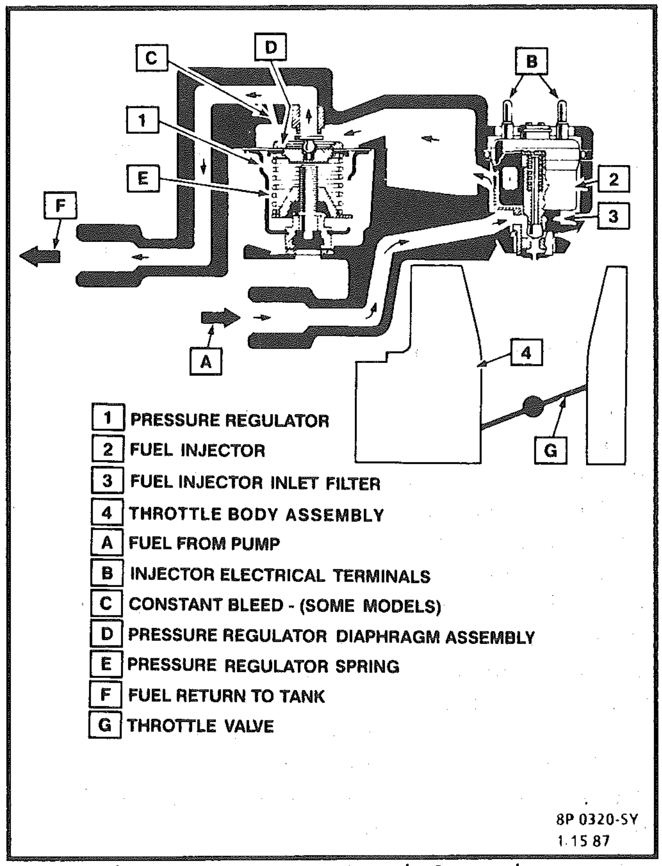


Figure C2-4 - TBI 220 Unit Operation

Pressure Regulator

The pressure regulator (see Figure C2-4) is a diaphragm-operated relief valve with injector pressure on one side and air cleaner pressure on the other. The function of the regulator is to maintain a constant pressure at the injectors at all times, by controlling the flow in the return line (by means of a calibrated bypass).

The pressure regulator is serviced as part of the fuel meter cover and should not be disasembled.

If the pressure regulator in the TBI supplies pressure which is too low (below 62 kPa or 9 psi), poor performance could result. If the pressure is too high, excess emissions and unpleasant exhaust odor may result.

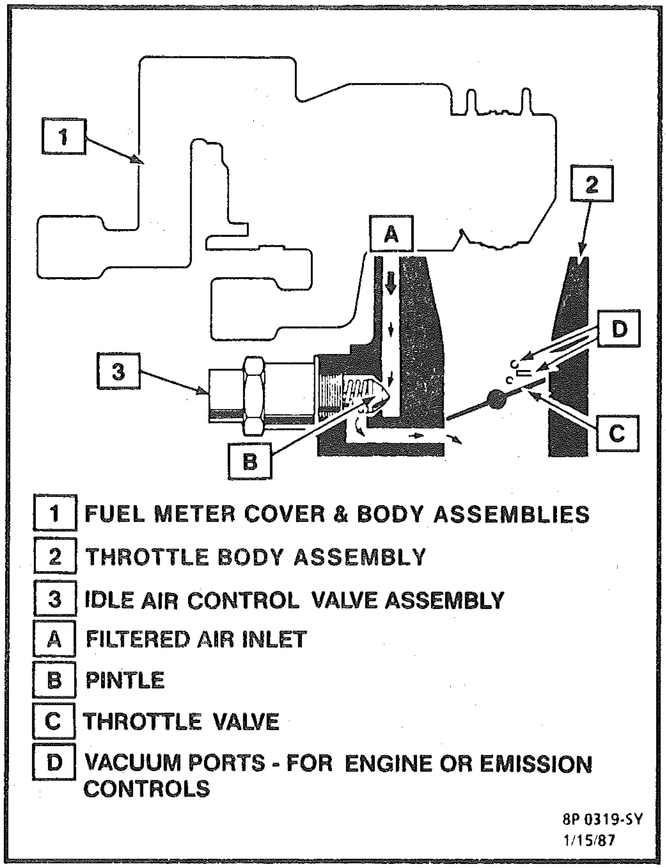


Figure C2-5 - Idle Air Contol System

Idle Air Control (IAC) Valve

The purpose of the idle air control (IAC) valve , is to control engine idle speed, and prevent stalls due to changes in engine load (see Figure C2-5) .

The IAC valve, mounted on the throttle body, controls bypass air around the throttle valve. By moving a conical valve IN (to decrease air flow) or OUT (to increase air flow), a controlled amount of air can move around the throttle valve. If rpm is too low, more air is bypassed around the throttle valve to increase rpm. If rpm is too high, less air is bypassed around the throttle valve to decrease rpm.

The IAC valve moves in small steps called "Counts," and can be monitored by a "Scan" tool which plugs into the assembly line data link (ALDL) connector

During idle, the proper position of the IAC valve is calculated by the ECM based on battery voltage, coolant temperature, engine load, and engine rpm. If the rpm drops below a specified rpm, and the throttle valve is closed, the ECM senses a near stall condition. The ECM will then calculate a new IAC valve position to prevent stalls .

If the IAC valve is disconnected or connected with the engine running, the idle rpm may be wrong. In this case, the IAC valve may be reset by turning the ignition switch "ON" and "OFF" one time.

The IAC valve affects only the idle characteristics of the engine. If it is open fully, too much air will be

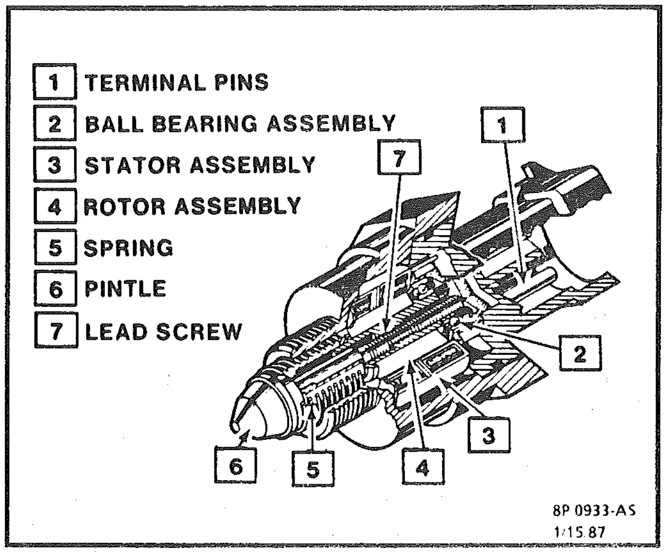


Figure C2-6 - Idle Air Control (IAC) Valve

allowed to the manifold and idle speed will be high. If it is stuck closed, too little air will be allowed in the manifold, and idle speed will be too low. If it is stuck part way open, the idle may be rough, and will not respond to engine load changes.

On 4.3L (VIN Z) V6, LB4 engines, for "B" and "G" cars, the valve is thread mounted, with a dual taper,10 mm diameter pintle (Figure C2-6). If replacement is necessary, use only an IAC valve with the correct part number and appropriate pintle shape and diameter.

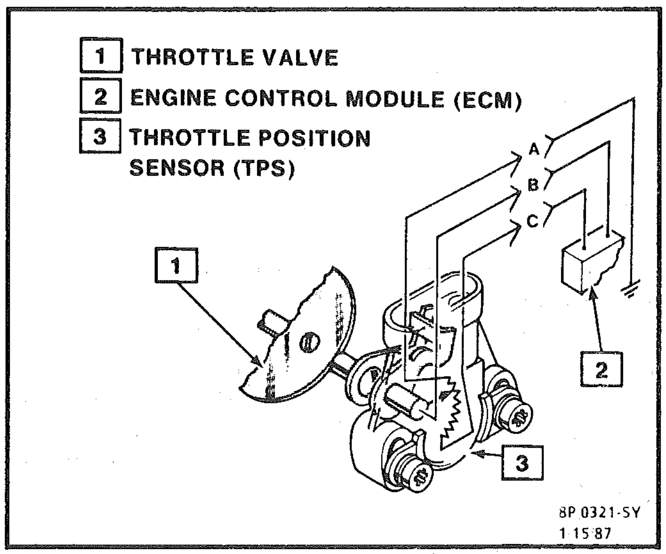


Figure C2-7 - Throttle Position Sensor

Throttle Position Sensor (TPS)

The throttle position sensor (TPS), is mounted on the side of the throttle body opposite the throttle lever assembly. Its function is to sense the current throttle valve position and relay that information to the ECM (Figure C2-7). Knowledge of throttle position allows the ECM to generate the required injector control signals (base pulse). If the TPS senses a wide open throttle, a voltage signal indicating this condition is sent to the ECM. The ECM then increases the injector base pulse width, permitting increased fuel flow.

As the throttle valve rotates in response to movement of the accelerator pedal, the throttle shaft transfers this rotational movement to the TPS. A potentiometer (variable resistor) within the TPS assembly changes its resistance (and voltage drop) in proportion to throttle movement.

By applying a reference voltage (5.0 volts) to the TPS input, a varying voltage (reflecting throttle position) is available at the TPS output. For example, approximately 2.5 volts results from a 50% throttle valve opening (depending on TPS calibration). The voltage output from the TPS assembly is routed to the ECM for use in determining throttle position.

FUEL PUMP

The fuel pump is a turbine type, low pressure electric pump, mounted in the fuel tank. Fuel is pumped at a positive pressure (above 62 kPa or 9 psi) from the fuel pump through the in-line filter to the pressure regulator in the TBI assembly. Excess fuel is returned to the fuel tank through the fuel return line.

The fuel pump is attached to the fuel gage sender assembly. A fuel strainer is attached to the fuel pump inlet line and prevents dirt particles from entering the fuel line and tends to separate water from the fuel.

Vapor lock problems are reduced when using an electric pump because the fuel is pushed from the tank under pressure rather than being pulled under vacuum, a condition that produces vapor.

An inoperative fuel pump would cause a no start condition. A fuel pump which does not provide enough pressure can result in poor performance. (See "Fuel System Pressure Test" procedure).

FUEL PUMP ELECTRICAL CIRCUIT

When the key is first turned "ON" without the engine running, the ECM turns the fuel pump relay "ON" for two seconds. This builds up the fuel pressure quickly. If the engine is not started within two seconds, the ECM shuts the fuel pump "OFF" and waits until the engine starts. As soon as the engine is cranked, the ECM turns the relay "ON" and runs the fuel pump.

As a backup system to the fuel pump relay, the fuel pump can also be turned on by the oil pressure switch. The oil pressure sender has two circuits internally. One operates the oil pressure indicator or gage in the instrument cluster, and the other is anormally open switch which closes when oil pressure reaches about 28 kPa (4 psi). If the fuel pump relay fails, the oil pressure switch will run the fuel pump.

An inoperative fuel pump relay can result in long cranking times, particularly if the engine is cold. The oil pressure switch will turn on the fuel pump as soon as oil pressure reaches about 28 kPa (4 psi).

DIAGNOSIS

FUEL CONTROL

Always start with the "Diagnostic Circuit Check" in Section "6E2-A". This will reduce diagnosis time and prevents unnecessary replacement of parts. The information in this check will direct diagnosis concerning "Engine Cranks But Won't Run" and the "Fuel Control System," Section "6E2-C2", including diagnosis of an injector, pressure regulator, fuel pump, fuel pump relay, and oil pressure switch.

Idle Air Control (IAC) Valve

A "Scan" tool reads IAC position in steps, called "Counts." "0" steps indicates the ECM is commanding the IAC to be driven in, to a fully seated position (minimum idle air). The higher the number steps, the more idle air being allowed to pass by the IAC valve.

Refer to CHART C-2C for information to diagnose the function of the IAC valve.

Drivability

Refer to Section "B" for driveability symptoms related to the fuel control.

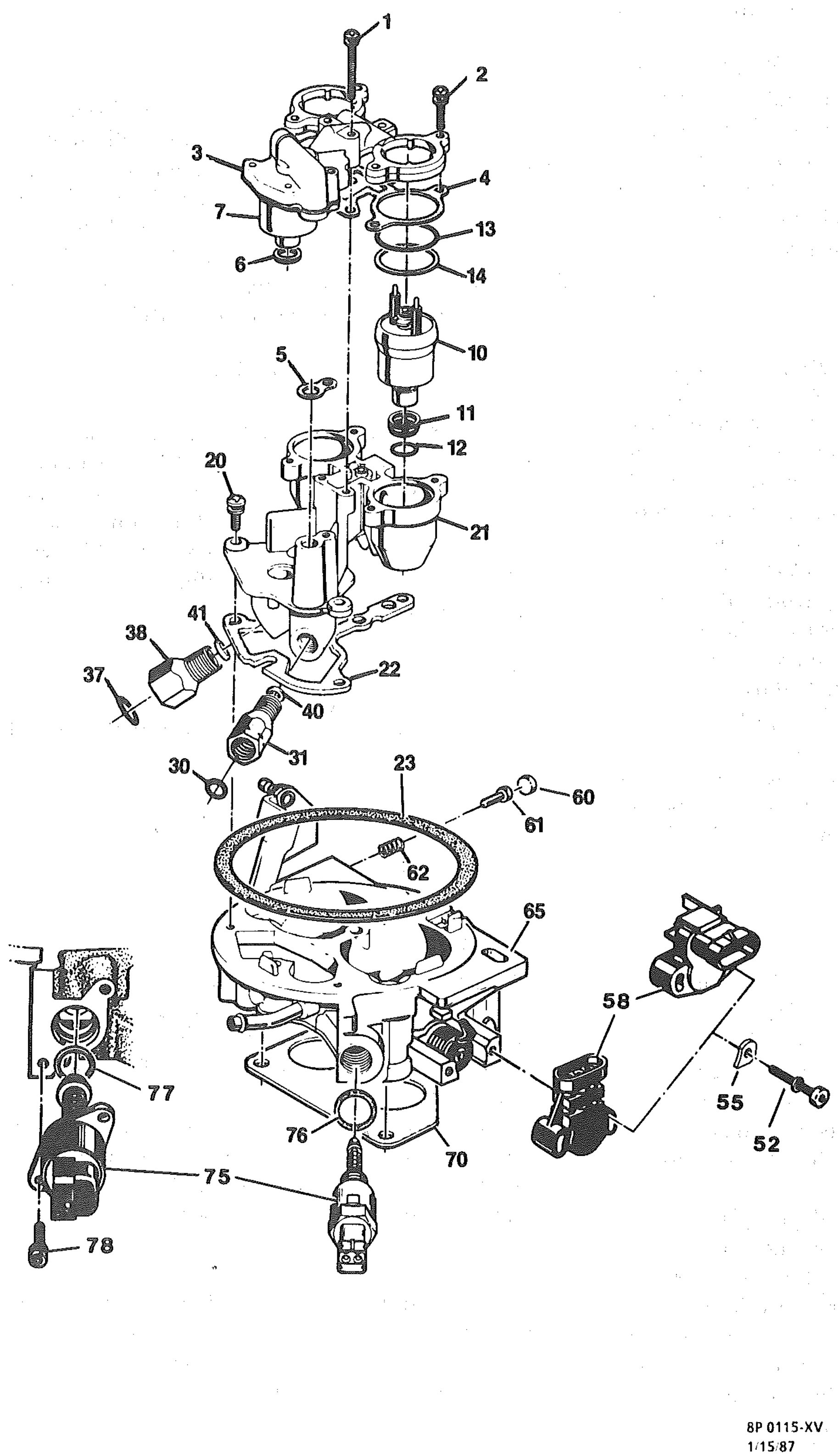
ON-VEHICLE SERVICE

GENERAL SERVICE INFORMATION

CAUTION:

- **To prevent personal injury or damage to the vehicle as the result of an accidental start, disconnect and reconnect the negative battery cable before and after service is performed.**
- **Also, catch any fuel that leaks out when disconnecting the fuel lines, by covering the fittings with a shop cloth. Place the cloth in an approved container when work is complete.**

The TBI unit repair procedures cover component replacement with the unit on the vehicle. However, throttle body replacement requires that the complete unit be removed from the engine.



PARTS IDENTIFICATION
Model 220 TBI

1 Screw Assembly - Fuel Meter Cover Attaching - Long
2 Screw Assembly - Fuel Meter Cover Attaching - Short
3 Fuel Meter Cover Assembly
4 Gasket - Fuel Meter Cover
5 Gasket - Fuel Meter Outlet
6 Seal - Pressure Regulator
7 Pressure Regulator
10 Injector - Fuel
11 Filter - Fuel Injector Inlet
12 O-ring - Fuel Injector - Lower
13 O-ring - Fuel Injector - Upper
14 Washer - Fuel Injector
20 Screw Assembly - Fuel Meter Body - Throttle Body Attaching
21 Fuel Meter Body Assembly
22 Gasket - Throttle Body to Fuel Meter Body
23 Gasket - Air Cleaner
30 O-ring - Fuel Return Line
31 Nut - Fuel Outlet
37 O-ring - Fuel Inlet Line
38 Nut - Fuel Inlet
40 Gasket - Fuel Outlet Nut
41 Gasket - Fuel Inlet Nut
52 Screw Assembly - TPS Attaching
55 Retainer - TPS Attaching Screw
58 Sensor - Throttle Position
60 Plug - Idle Stop Screw
61 Screw Assembly - Idle Stop
62 Spring - Idle Stop Screw
65 Throttle Body Assembly
70 Gasket - Flange
75 Valve Assembly - Idle Air Control
76 Gasket - Idle Air Control Valve Assembly
77 O-Ring - IACV
78 Screw Assembly - IACV Attaching

Figure C2-8 - Model 220 TBI Parts Identification

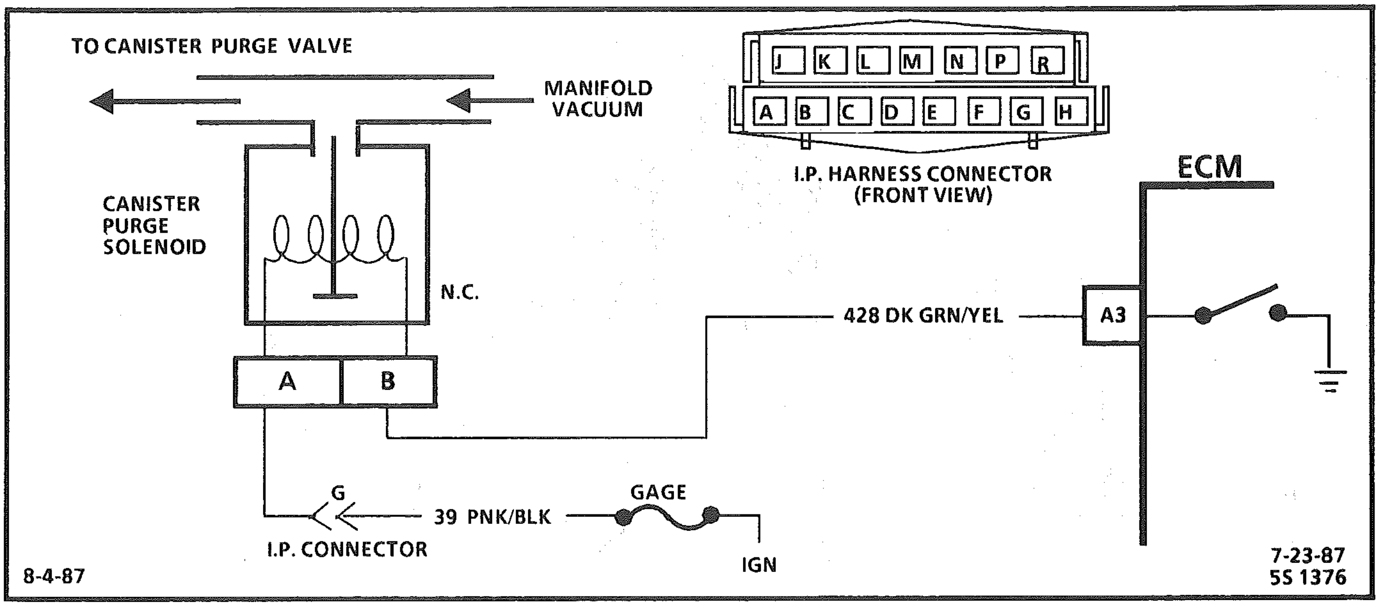


CHART C-3

CANISTER PURGE VALVE CHECK
5.0L (VIN E) "F" SERIES (TBI)

Circuit Description:

Canister purge is controlled by a solenoid that allows manifold vacuum to purge the canister when energized. The ECM supplies a ground to energize the solenoid (purge "ON").

If the following conditions are met with the engine running, the purge solenoid is energized (purge "ON").

- Engine run time after start more than 1 min.
- Coolant temperature above 80°C.
- Vehicle speed above 5 mph.
- Throttle off idle. TPS signal about .75 volt.

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Checks to see if the solenoid is opened or closed. The solenoid is energized in this step so it should be open.
2. Completes functional check, by grounding test terminal. This should, normally, de-energize the solenoid and allow the vacuum to drop (purge "ON").
3. Checks for a complete circuit. Normally, there is battery voltage on CKT 39, and the ECM provides a ground on CKT 428. A shorted solenoid could cause an open circuit in the ECM.

Diagnostic Aids:

Normal operation of the canister purge solenoid is described as follows:

With ignition "ON", engine stopped, diagnostic terminal ungrounded, the purge solenoid will be energized.

With ignition "ON", engine "OFF", diagnostic terminal grounded, the purge solenoid will be de-energized.

CHART C-3

CANISTER PURGE VALVE CHECK
5.0L (VIN E) "F" SERIES (TBI)

1
- IGNITION "ON". ENGINE STOPPED.
- GROUND DIAGNOSTIC TERMINAL.
- DISCONNECT VACUUM HOSES FROM PURGE SOLENOID.
- AT THE SOLENOID, APPLY 10" Hg OR (34 kPa) OF VACUUM TO THE THROTTLE BODY SIDE OF PURGE SOLENOID.

ABLE TO GET 10" Hg OR 34 kPa OF VACUUM.

2
- UNGROUND DIAGNOSTIC TERMINAL.
- NOTE VACUUM.

NO DROP

3
- DISCONNECT PURGE SOLENOID.
- CONNECT A TEST LIGHT BETWEEN HARNESS CONNECTOR TERMINALS.

NO LIGHT

- PROBE EACH HARNESS CONNECTOR TERMINAL WITH A TEST LIGHT TO GROUND.

LIGHT "ON" ONE TERMINAL.

OPEN CKT 428. FAULTY CONNECTION OR FAULTY ECM.

LIGHT BOTH TERMINALS.

REPAIR SHORT TO VOLTAGE IN CKT 428 .

NO LIGHT

CHECK FOR OPEN CKT 39.

LIGHT

FAULTY SOLENOID CONNECTOR OR SOLENOID.

DROPS

NO TROUBLE FOUND.

UNABLE TO GET 10" Hg OR 34 kPa OF VACUUM .

- DISCONNECT SOLENOID.
- PROBE CKT 428 WITH A TEST LIGHT TO 12 VOLTS..

LIGHT "ON"

CKT 428 SHORTED TO GROUND OR FAULTY ECM.

LIGHT "OFF"

FAULTY SOLENOID

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT

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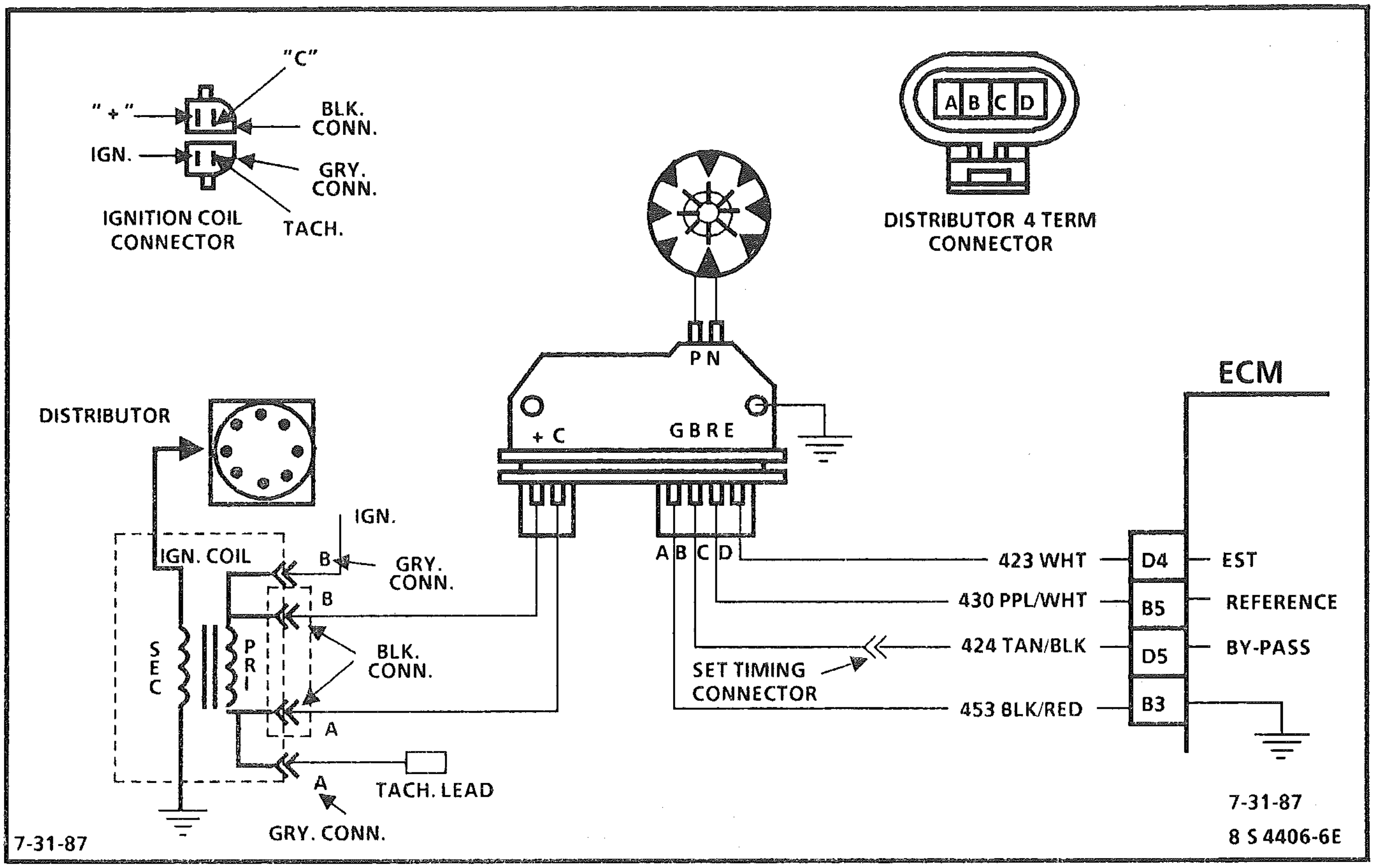

CHART C-4

IGNITION SYSTEM CHECK
(REMOTE COIL/SEALED MODULE CONNECTOR DISTRIBUTOR)
5.0L (VIN E) "F" SERIES (TBI)

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Two wires are checked, to ensure that an open is not present in a spark plug wire.

1A. If spark occurs with EST connector disconnected, pick-up coil output is too low for EST operation.

2. A spark indicates the problem must be the distributor cap or rotor.

3. Normally, there should be battery voltage at the "C" and "+" terminals. Low voltage would indicate an open or a high resistance circuit from the distributor to the coil or ignition switch. If "C" term. voltage was low, but "+" term. voltage is 10 volts or more, circuit from "C" term. to Ign. coil or ignition coil primary winding is open.

4. Checks for a shorted module or grounded circuit from the ignition coil to the module. The distributor module should be turned "OFF", so normal voltage should be about 12 volts.
   If the module is turned "ON", the voltage would be low, but above 1 volt. This could cause the ignition coil to fail from excessive heat.
   With an open ignition coil primary winding, a small amount of voltage will leak through the module from the "Bat." to the tach terminal.

5. Applying a voltage (1.5 to 8 volts) to module terminal "P" should turn the module "ON" and the tach. term. voltage should drop to about 7-9 volts. This test will determine whether the module or coil is faulty or if the pick-up coil is not generating the proper signal to turn the module "ON". This test can be performed by using a DC battery with a rating of 1.5 to 8 volts. The use of the test light is mainly to allow the "P" terminal to be probed more easily. Some digital multi-meters can also be used to trigger the module by selecting ohms, usually the diode position. In this position the meter may have a voltage across it's terminals which can be used to trigger the module. The voltage in the ohm's position can be checked by using a second meter or by checking the manufacture's specification of the tool being used.

6. This should turn "OFF" the module and cause a spark. If no spark occurs, the fault is most likely in the ignition coil because most module problems would have been found before this point in the procedure. A module tester could determine which is at fault.

CHART C-4
IGNITION SYSTEM CHECK (REMOTE COIL / SEALED MODULE CONNECTOR DISTRIBUTOR) 5.0L (VIN E) "F" SERIES (TBI)

(1)
- Perform Diagnostic Circuit Check before proceeding with this test. (If a tachometer is connected to the Tach term., disconnect it before proceeding with the test).
- Check spark at plug with spark tester J-26792 or equivalent (ST-125) while cranking (if no spark on one wire, check a second wire) A few sparks and then nothing is considered no spark.

No Spark → (1A)

Spark → Check fuel,spark plugs, etc. See section "B" symptoms.

(1A)
- Disconnect 4 term. distributor connector and check for spark.

No spark → (2)

Spark → Replace pick-up coil

(2)
- Check for spark at coil wire with tester while cranking. (Leave spark tester connected to coil wire for Steps 3-6).

No Spark → (3)

Spark → Inspect cap for water, cracks, etc. If OK, replace rotor.

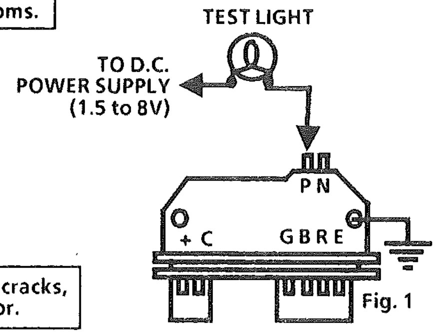

Fig. 1

(3)
- Disconnect distributor 2 term. "C / + " connector.
- Ignition switch "on", Engine stopped.
- Check volts at " + " and "C" term's. of dist. harn. conn.

Both term's. 10 volts or more → (4)

Both term's. under 10 volts → Repair wire from module " + " term. to "B" term. of black Ign. coil connector or primary ckt. to ign. sw.

Under 10 volts "C" term. only → Check for open or gnd. in ckt. from "C" term. to ign. coil. If Ckt. is OK, fault is. ign. coil or conn..

(4)
- Reconnect dist. 2 term. conn.
- With ign. "ON", check voltage from tach. term. to gnd. (term. may be taped back in harness).

Over10 volts →
- Connect test light from tach. term. to ground.
- Crank engine and observe light.

Light on steady → (5)

Light blinks → Replace ignition coil and recheck for spark with spark tester. If still no spark, re-install original coil and replace dist. module..

Under 1 volt → Repair open tach. lead or conn and repeat test #4.

1 to 10 volts → Replace module and check for spark from coil as in Step 6.

Spark → System OK

No Spark → Replace ign. coil, it too is faulty

(5)
- Disconnect distributor 4 term. connector.
- Remove dist. cap.
- Disconnect pick-up coil connector from module.
- Connect voltmeter from tach. term. to ground.
- Ignition on.
- Insulate a test light probe to 1/4" from tip and note voltage, as test light is momentarily connected from a voltage source (1.5 to 8V) to module term. "P". (Fig. 1).

Voltage drops → (6)

No drop in voltage → Check module ground. If OK, replace module.

(6)
- Check for spark from coil wire with spark tester as test light is removed from module term.

No Spark →
- If no module tester (J24642) is available; Replace ign. coil and repeat Step 5.
  - No Spark → Ign. coil removed is OK, reinstall coil and check coil wire from dist. cap. if OK, replace dist. module.
  - Spark → System OK
- If module tester (J24642) is available: test module
  - OK → Check coil wire from cap to coil. If OK, replace coil.
  - Not OK → Replace module

Spark →
- Is rotating pole piece still magnetized?
  - Yes → Check pick-up coil or conns. (Coil resistance should be 500-1500 ohms and not grounded).
  - No → Replace pole piece and shaft assy.

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SECTION C5
ELECTRONIC SPARK CONTROL (ESC) SYSTEM

CONTENTS

GENERAL DESCRIPTION

PURPOSE

To control spark knock, an electronic spark control (ESC) system has been added. 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 driveability and fuel economy.

Varying octane levels in today's gasoline can cause detonation in high performance engines. Detonation is called spark knock.

OPERATION

The ESC system has two major components:

- ESC Module
- ESC Knock Sensor

The sensor is mounted in the engine block near the cylinders, or in the intake manifold at the rear of the engine. When the ESC knock sensor detects abnormal vibration (spark knocking) in the engine, it produced a voltage that is received by the ESC module. As long as the ESC module sees no voltage from the knock sensor (knock not present), it sends a signal voltage (8 to 10 volts) to the ECM and the ECM provides normal spark advance.

When the module detects voltage from the knock sensor (knock present), it turns "OFF" the signal to the ECM and the voltage at terminal B7 goes to 0 volts. The ECM then retards EST to reduce spark knock.

DIAGNOSIS

RESULTS OF INCORRECT ESC OPERATION

Loss of the ESC knock sensor signal or loss of ground at ESC module would cause the signal to the ECM to remain high. This condition would cause the ECM to control EST, as if no spark knocking were happening. No retard would occur, and spark knocking could become severe under heavy engine load conditions.

Loss of the ESC signal to the ECM would cause the ECM to constantly retard EST. This could result in sluggish performance and cause a Code 43 to set.

A "Scan" tool will read knock signal in A/D counts. When detonation is detected, knock signal counts will increment, as long as knock is present. "Scan" tools will indicate knock being present either by showing A/D counts, or displaying Yes (knock present), or No (knock not present). If Code 43 is present, use that chart to diagnose system. If no code is present and ESC system is suspected, use CHART C-5.

ON-CAR SERVICE

ESC KNOCK SENSOR

See Figure C5-1.

←→ Remove or Disconnect

1. Negative battery cable.
2. ESC wiring harness connector from ESC sensor.
3. ESC sensor from engine block.

→← Install or Connect

1. ESC sensor into engine block. Apply thread sealer, such as soft tape, to the ESC sensor threads.
2. ESC wiring harness connector to the ESC sensor.
3. Negative battery cable.

ESC MODULE

Refer to Figure C5-1.

←→ Remove or Disconnect

1. ESC module connector.
2. Attaching screws.
3. ESC module.

Install or Connect

1. ESC module.
2. Attaching screws.
3. ESC module connector.

PARTS INFORMATION

PART NAME	GROUP
Sensor, ESC Knock	2.383
Module, Elek Spark Cont	2.383

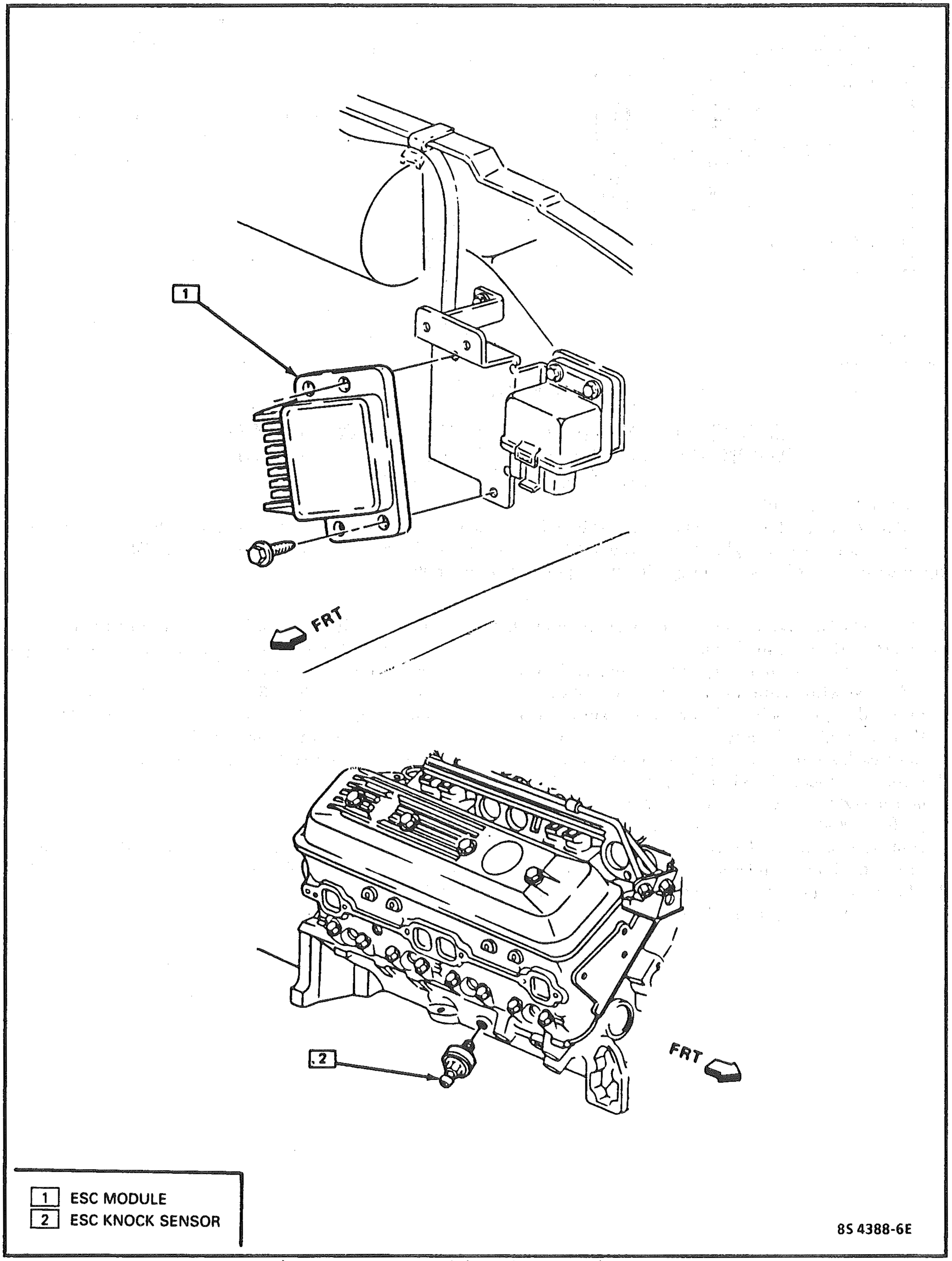

Figure C5-1 - ESC Module and ESC Knock Sensor

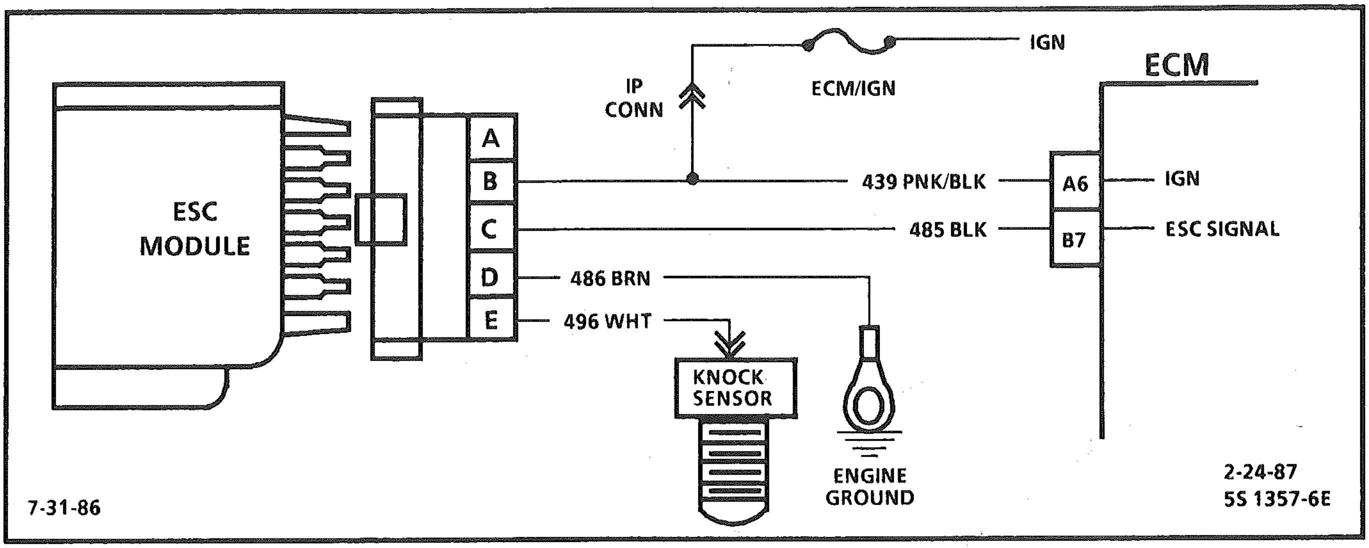

CHART C-5

ELECTRONIC SPARK CONTROL (ESC) SYSTEM CHECK
(ENGINE KNOCK, POOR PERFORMANCE, OR POOR ECONOMY)
5.0L (VIN E) "F" SERIES (TBI)

Circuit Description:

Electronic spark control is accomplished with a module that sends a voltage signal to the ECM. As the knock sensor detects engine knock, the voltage from the ESC module to the ECM is shut "OFF" and this signals the ECM to retard timing, if engine rpm is over about 900.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. If a Code 43 is not set, but a knock signal is indicated while running at 1500 rpm, listen for an internal engine noise. Under a no load condition, there should not be any detonation, and if knock is indicated, an internal engine problem may exist.
2. Usually a knock signal can be generated by tapping on the right exhaust manifold. This test can also be performed at idle. Test number 1 was run at 1500 rpm, to determine if a constant knock signal was present, which would affect engine performance.
3. This tests whether the knock signal is due to the sensor, a basic engine problem, or the ESC module.
4. If the module ground circuit is faulty, the ESC module will not function correctly. The test light should light indicating the ground circuit is OK.
5. Contacting CKT 496, with a test light to 12 volts, should generate a knock signal to determine whether the knock sensor is faulty, or the ESC module can't recognize a knock signal.

Diagnostic Aids:

If the ESC system checks OK, but detonation is the complaint, refer to Detonation/Spark knock in Section "B".

CHART C-5

ELECTRONIC SPARK CONTROL (ESC) SYSTEM CHECK
(ENGINE KNOCK, POOR PERFORMANCE, OR POOR ECONOMY)
5.0L (VIN E) "F" SERIES (TBI)

THIS CHART SHOULD BE USED AFTER ALL OTHER CAUSES OF SPARK KNOCK HAVE BEEN CHECKED. I.E., TIMING, EGR, ENGINE TEMPERATURE OR EXCESSIVE ENGINE NOISE,ETC. IF CODE 43 IS SET, USE THAT CHART FIRST.

(1)
- IF A CODE 43 WAS SET USE THAT CHART FIRST. THIS CHART ASSUMES CODE 43 IS NOT PRESENT.
- "SCAN" TOOL SET ON KNOCK SIGNAL.
- ENGINE RUNNING AT ABOUT 1500 RPM.
- IS THERE A KNOCK SIGNAL INDICATED?

NO

(2)
- ENGINE RUNNING AT 1500 RPM.
- TAP ENGINE BLOCK IN AREA OF KNOCK SENSOR.
- DOES "SCAN" INDICATE A KNOCK SIGNAL WHILE TAPPING ON ENGINE?

YES

(3)
- DISCONNECT KNOCK SENSOR.
- REPEAT TEST.
- IS THERE A KNOCK SIGNAL INDICATED?

YES

CHECK FOR ROUTING OF WIRE FROM KNOCK SENSOR TO ESC MODULE FOR PICKING UP FALSE KNOCK SIGNALS FROM AN ADJACENT WIRE. REROUTE AS NECESSARY. IF ROUTING IS CORRECT, REPLACE ESC MODULE.

NO

INTERNAL ENGINE KNOCK OR FAULTY SENSOR.

NO

(4)
- DISCONNECT ESC MODULE.
- PROBE HARNESS TERMINAL "D" (CKT 486) WITH A TEST LIGHT TO 12 V.

YES

ESC SYSTEM OK. REVIEW "DIAGNOSTIC AIDS" ON FACING PAGE.

LIGHT "ON"

(5)
- RECONNECT ESC MODULE.
- DISCONNECT KNOCK SENSOR.
- ENGINE IDLING.
- MOMENTARILY TOUCH KNOCK SENSOR HARNESS (CKT 496) WITH A TEST LIGHT TO 12V.
- EACH TIME THE TEST LIGHT CONTACTS CKT 496, A KNOCK SIGNAL SHOULD BE GENERATED.
- IS A KNOCK SIGNAL INDICATED WITH "SCAN"?

LIGHT "OFF"

REPAIR OPEN GROUND CKT 486.

YES

FAULTY CONNECTION AT SENSOR OR FAULTY KNOCK SENSOR.

NO

CKT 496 OPEN, SHORTED TO GROUND, FAULTY CONNECTION AT ESC MODULE, OR FAULTY ESC MODULE.

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SECTION C6

AIR INJECTION REACTION (A.I.R.) SYSTEM

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The A.I.R. system helps reduce hydrocarbon (HC), carbon monoxide (CO), and oxides of nitrogen (NO_x) exhaust emissions. It also heats up the catalytic converter quickly on engine start-up so conversion of exhaust gases can occur sooner.

A Dual bed converter is used. It consists of a three way catalyst (which controls all three emissions) in series with a two way catalyst (which controls only HC and CO) both are in one housing. A pipe between the two converters allows air to be injected into the second (two way) converter to increase its efficiency to further control HC and CO (Figure C6-1).

As shown in Figure C6-1, air can be directed to:

- A divert silencer.
- Exhaust ports; or
- Catalytic converter.

OPERATION

The system (Figure C6-1) includes:

- <u>An Air Pump</u>
  The air pump is driven by a belt on the front of the engine and supplies the air to the system. Intake air passes through a centrifugal filter fan at the front of the pump; where foreign materials are separated from the air by centrifugal force.
- <u>A Control Valve</u>
  Air flows from the pump through an ECM controlled valve (called a control valve) through check valves to either the exhaust ports or the converter.
- <u>Check Valves</u>
  The check valves prevent back flow of exhaust into the pump in the event of an exhaust backfire or pump drive belt failure.
- <u>Necessary Plumbing</u>

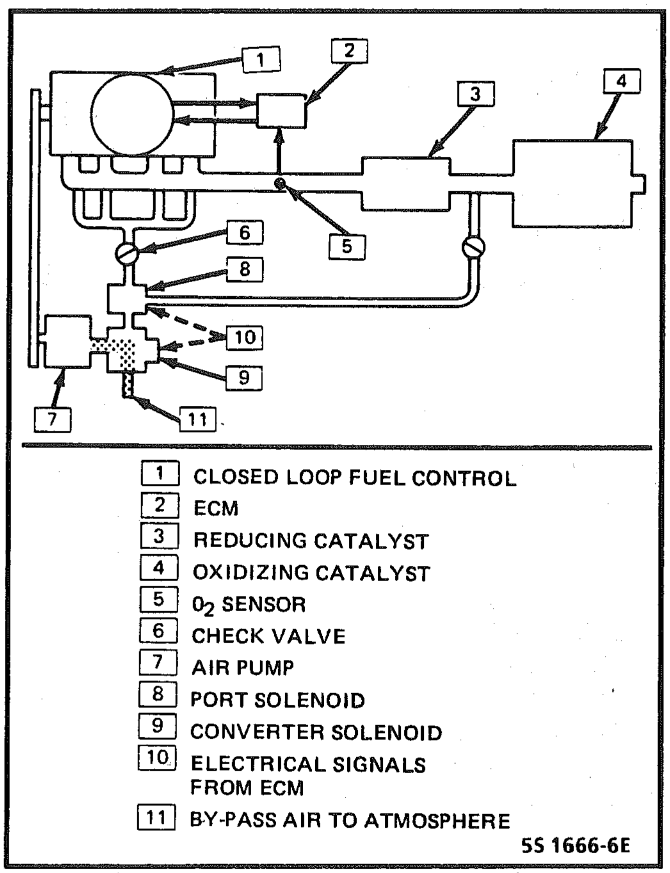

Figure C6-1 - A.I.R. System Operation

AIR CONTROL PEDES VALVE

Pressure Operated Electric Divert / Electric Air Switching (PEDES) valve is used on this engine. The diverting and switching functions are electronically controlled by the ECM, which grounds to complete the circuit and energize the solenoid. Self-generated pressure from the A.I.R. pump is used to operate the valve, which is completely independent of manifold vacuum.

Air enters the body of the valve from the pump. Air pressure builds against the control valve and for:

- Cold Mode - The port solenoid is energized which in turn opens the port valve and allows flow to the exhaust ports.
- Warm Mode - The port solenoid is de-energized and the converter solenoid energized which closes the port valve and keeps the converter valve seated, thus forcing flow past the converter valve and to the converter.
- Divert Mode - Both solenoids are de-energized which opens the converter valve, allowing air to take the path of least resistance, i.e., out the divert / relief tube to atmosphere.

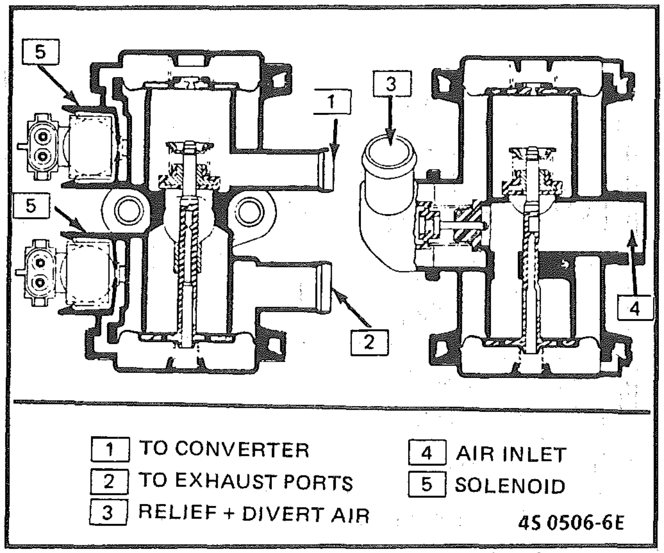

Figure C6-2 - A.I.R. System Control Valve

Air is diverted to the atmosphere under the following conditions:

- Rich operation.
- When the ECM recognizes a problem and sets the "Service Engine Soon" light.
- During deceleration.
- During high RPM operation when air pressure is greater than the setting for the internal relief valve.

RESULTS OF INCORRECT OPERATION

If no air (oxygen) flow enters the exhaust stream at the exhaust ports, HC and CO emission levels will be too high.

Air flowing to the exhaust ports at all times could increase temperature of the converter.

Air flowing at all times to the catalytic converter may cause converter overheating during rich operation.

Electrical failure (open circuit) of the control valve will divert air flow overboard at all times. Air will flow to the converter at all times if an open circuit occurs to the switching valve (converter solenoid).

Mechanical failures in the valves could cause the air to flow incorrectly to the exhaust ports or the converter.

DIAGNOSIS

The diagnosis of the AIR system is covered in CHART C-6 at the end of this section.

OPERATIONAL CHECKS

Air Pump

The air pump is a positive displacement vane type which is permanently lubricated and requires no periodic maintenance.

Accelerate engine to approximately 1500 rpm's and observe air flow from hose(s). If air flow increases as engine is accelerated, pump is operating satisfactorily. If air flow does not increase or is not present, proceed as follows:

Inspect

1. For proper drive belt tension.
2. For a leaky pressure relief valve. Air may be heard leaking with the pump running.

NOTICE: If the engine or underhood compartment is to be cleaned with steam or high-pressure detergent, the centrifugal filter fan should be masked off to prevent liquids from entering the pump (see Fig. C6B-3).

NOTICE: The AIR System is not completely noiseless. Under normal conditions, noise rises in pitch as engine speed increases.

Inspect

3. For a seized Air Injection Pump.
4. Hoses, tubes and all connections for leaks and proper routing.
5. For air flow from control/switching valve.
6. AIR injection pump for proper mounting and bolt torque.
7. If no irregularities exist and the AIR injection pump noise is still excessive, remove and replace pump.

CAUTION: **Do Not Oil A.I.R. Pump**

Hoses and Pipes

Inspect

1. Hose or pipe for deterioration or holes.
2. All hoses or pipe connections, and clamp tightness.
3. Hose or pipe routing. Interference may cause wear.
4. If a leak is suspected on the pressure side of the system or if a hose or pipe has been disconnected on the pressure side, the connections should be checked for leaks with a soapy water solution. With the pump running, bubbles will form if a leak exists.

Check Valve

Inspect

1. A check valve should be inspected whenever the hose is disconnected form a check valve or whenever check valve failure is suspected. (A pump that had become inoperative and had shown indications of having exhaust gases in the pump would indicate check valve failure).
2. Blow through the check valve (toward the cylinder head) then attempt to suck back through the check valve. Flow should only be in one direction(toward the exhaust manifold). Replace valve which does not operate properly.

ON-CAR SERVICE

DRIVE BELT

Remove or Disconnect

1. Inspect drive belt for wear, cracks or deterioration and replace if required. When installing new belt, it must be seated and fully secured in grooves of all belt driven components.

AIR INJECTION PUMP

Remove or Disconnect

1. Hold pump pulley from turning by compressing drive belt, then loosen pump pulley bolts.
2. Drive belt and pulley.
3. Hoses, vacuum, and electrical connections from Air Injection Control valve.
4. Air pump mounting bolts, and pump assembly (See Figure C6-3).

Install or Connect

1. Air pump assembly, and tighten mounting bolts.
2. Spacer and pump pulley against centrifugal filter fan.
3. Pump pulley bolts and tighten equally to 13 N·m (10 lb. ft).
4. Check air injection system for proper operation (see Chart C-6).

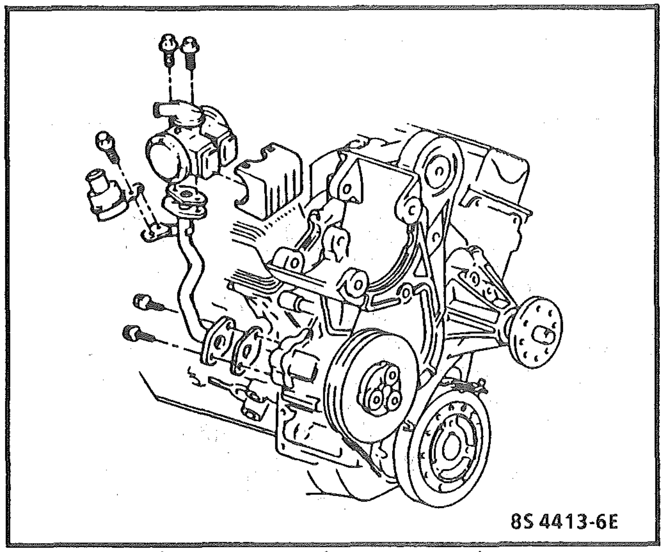

Figure C6-3 - Air Pump Service

AIR INJECTION CONTROL (PEDES) VALVE

Remove or Disconnect

1. Battery ground cable.
2. Adapter bolts (See Figure C6-4).
3. Air outlet hoses from valve.
4. Splash guard / cover
5. Electrical connectors and vacuum hoses from valve.
6. Control valve.

Install or Connect

1. Control valve.
2. Electrical connectors.
3. Splash guard / cover
4. Air hoses to valve.
5. Battery ground cable.
6. Check system operation (see CHART C-6).

AIR INJECTION CHECK VALVE

Remove or Disconnect

1. Release clamp and disconnect air hoses from check valve.
2. Unscrew check valve from air injection pipe.

Install or Connect

1. Screw check valve onto air injection pipe. 23 N · m (17 lb. ft.).
2. Position air hoses on check valve and secure with clamp.

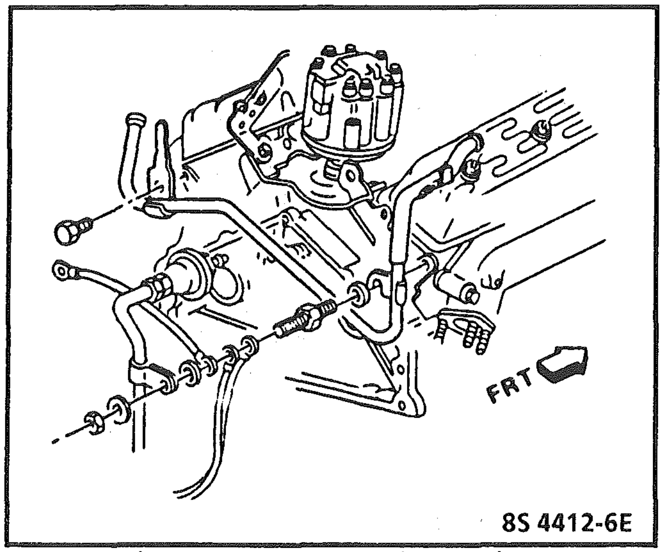

Figure C6-4 - PEDES Valve Service

PARTS INFORMATION

PART NAME	GROUP
Adapter, AIR Inj Cont Vlv	3.671
Brace, AIR Inj Pump	3.655
Bracket, AIR Inj Pump	3.655
Gasket, AIR Inj Dvtr Vlv El	3.671
Harness, AIR Inj Cont Vlv Vac	3.675
Hose, AIR Inj Cont Vlv	3.675
Hose, AIR Inj Cont Vlv Dvtr	3.675
Hose, Ctltc Conv AIR Inj Chk Vlv	3.675
Pipe, AIR Inj Ctltc Conv Chk Vlv	3.690
Pipe, Ctltc Conv AIR Inj	3.675
Pulley, AIR Inj Pump	3.650
Pump, AIR Inj	3.660
Silencer AIR Inj Cont Vlv	3.660
Support, AIR Inj Pump	3.660
Valve, AIR Inj Cont	3.670
Valve, AIR Inj Eng Chk	3.670
Valve, Ctltc Conv AIR Inj Chk	3.670

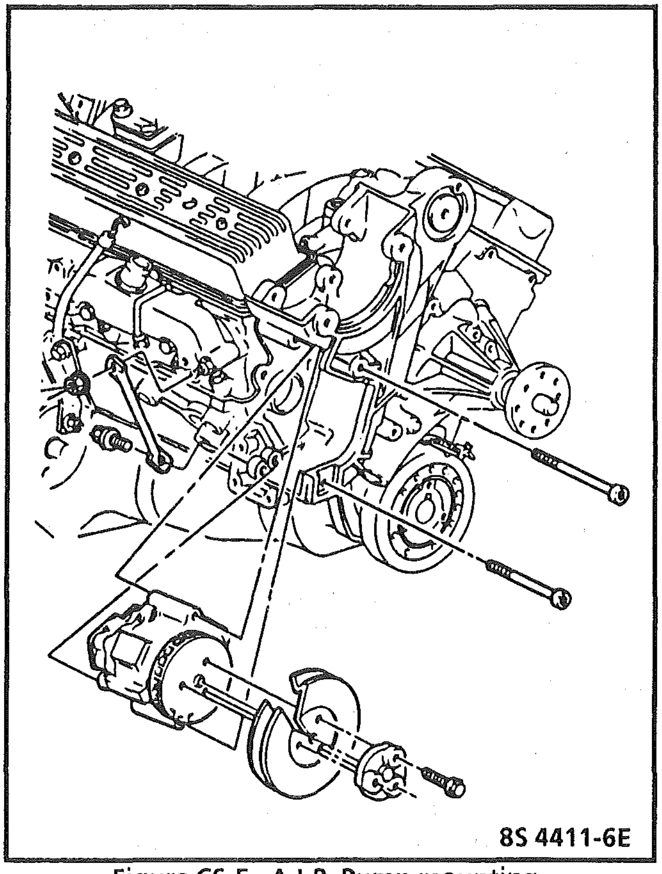

Figure C6-5 - A.I.R. Pump mounting

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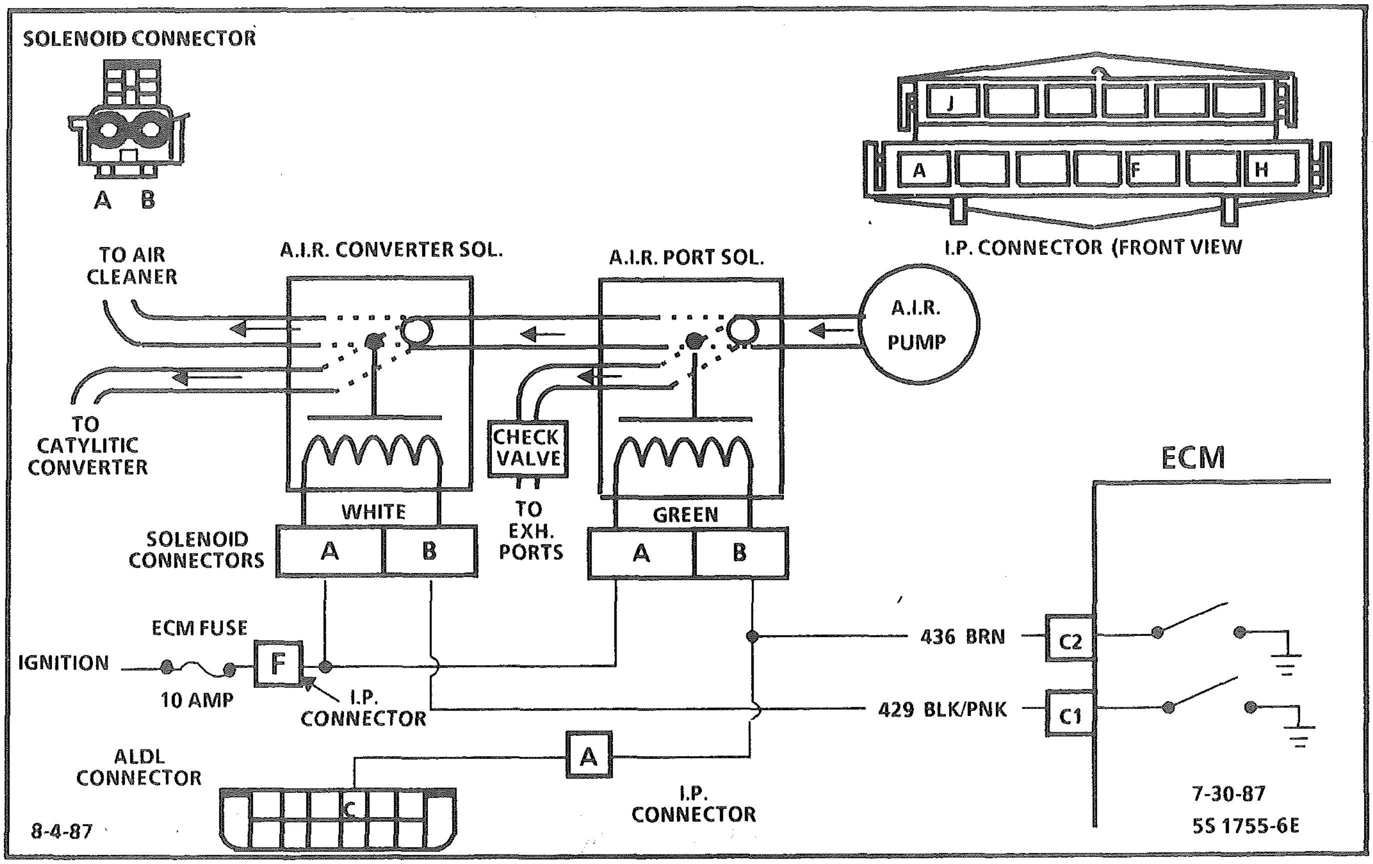


CHART C-6

AIR MANAGEMENT CHECK - PEDES VALVE
(PRESSURE OPERATED ELECTRIC DIVERT/ELECTRIC SWITCHING)
5.0L (VIN E) "F" SERIES (TBI)

Circuit Description:

Air management is controlled by a port valve and a converter valve, each with an ECM controlled vacuum solenoid. When the solenoid is grounded by the ECM, AIR pressure will activate the valve and allow pump air to be directed as follows:

Neither solenoid grounded by the ECM - Air pump air diverted to atmosphere. Converter solenoid grounded by the ECM - Air pump air to converter.

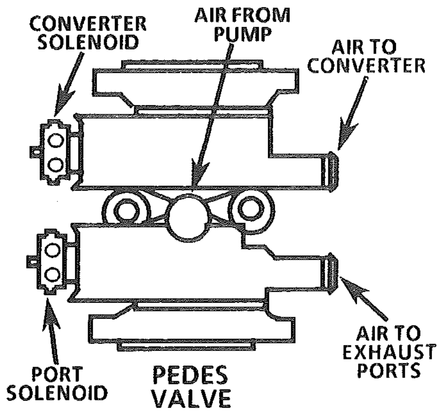
Port solenoid grounded by the ECM - Air pump air to exhaust ports.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. This is a system functional check. Air is directed to ports during "Open Loop" and all engine start in "Open Loop" even on a warm engine. Since the air to the ports time is very short on some engines, prepare to observe port air prior to engine start up. On some engines, this can be done by squeezing a hose. On others, steel pipes have to be disconnected.
2. This should normally set a Code 22. When any code is set, the ECM opens the ground to the air control valve and allows air to divert. This checks for ECM response to a fault. A ground in the control valve circuit to the ECM would prevent divert action.
3. This checks for a grounded circuit to the ECM. Test light "OFF" is normal and would indicate the circuit is not grounded.
4. Checks for an open in the solenoid control circuits. Grounding the test terminal should ground both solenoid circuits. Normally, the test light should be "ON" which indicates the problem is not in the ECM or wiring but at the solenoid connections or valve itself.
5. Checks for a grounded switching valve circuit. Test light "OFF" would indicate the circuit is normal and fault is in the valve.

CHART C-6

AIR MANAGEMENT CHECK - PEDES VALVE
(PRESSURE OPERATED ELECTRIC DIVERT/ELECTRIC SWITCHING)
5.0L (VIN E) "F" SERIES (TBI)



(1)
- "DIAGNOSTIC" TERMINAL UNGROUNDED.
- START ENGINE, RUNNING AT PART THROTTLE, BELOW 2000 RPM, AIR SHOULD BE FELT AT OUTLET TO EXHAUST PORTS DURING "OPEN LOOP" OPERATION (FROM 6 SECONDS TO 3 MINUTES ON WARM ENGINE DEPENDING ON APPLICATION) AND SWITCH TO CONVERTER WHEN SYSTEM GOES "CLOSED LOOP".

OK

(2)
- DISCONNECT TPS CONNECTOR AT IDLE AND AIR SHOULD DIVERT TO ATMOSPHERE AFTER A FEW SECONDS.

NO DIVERT

(3)
- IGNITION "ON", ENGINE STOPPED.
- DISCONNECT CONVERTER SOLENOID ELECT. CONNECTOR AND CONNECT TEST LIGHT BETWEEN HARNESS CONNECTOR TERMINALS
- NOTE LIGHT.

LIGHT "ON"

CHECK CKT 429 FOR SHORT TO GROUND. IF NOT GROUNDED, IT IS A FAULTY ECM.

LIGHT "OFF"

REPLACE PEDES VALVE.

OK

NO TROUBLE FOUND. CLEAR MEMORY AND REVIEW SYMPTOMS SECTION "B".

PORT THEN DIVERT ONLY

(4)
- IGNITION "ON", ENGINE STOPPED
- GROUND "DIAGNOSTIC" TERMINAL
- DISCONNECT CONVERTER VALVE SOLENOID
- CONNECT TEST LIGHT BETWEEN HARNESS CONNECTOR TERMINALS AND NOTE LIGHT.

LIGHT "OFF"

- CONNECT TEST LIGHT BETWEEN CKT 39 AND GROUND.

LIGHT "OFF"

OPEN CKT 39

LIGHT "ON"

OPEN IN CKT 429. FAULTY ECM CONNECTION OR ECM.

LIGHT "ON"

FAULT IS CONVERTER VALVE SOLENOID, CONNECTION, OR VALVE.

CONSTANT PORT OR CONVERTER AIR

(5)
- IGNITION "ON", ENGINE STOPPED.
- "DIAGNOSTIC" TERMINAL NOT GROUNDED.
- DISCONNECT PORT VALVE SOLENOID
- CONNECT TEST LIGHT BETWEEN HARNESS CONNECTOR TERMINALS AND NOTE LIGHT.

LIGHT "OFF"

- GROUND "DIAGNOSTIC" TERMINAL.
- NOTE TEST LIGHT.

LIGHT "OFF"

- CONNECT TEST LIGHT BETWEEN CKT 39 AND GROUND.

LIGHT "OFF"

REPAIR OPEN CKT 39

LIGHT "ON"

OPEN CKT 436. FAULTY CONNECTION OR ECM.

LIGHT "ON"

FAULTY CONNECTION AT PORT SOLENOID OR FAULTY PEDES VALVE.

LIGHT "ON"

GROUNDED CKT 436 OR FAULTY ECM.

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SECTION C7

EXHAUST GAS RECIRCULATION (EGR) SYSTEM

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The EGR system is used to lower NO_X (oxides of nitrogen) emission levels caused by high combustion temperatures. It does this by decreasing combustion temperature.

The main element of the system is an EGR valve operated by vacuum, and mounted on the intake manifold.

The EGR valve feeds small amounts of exhaust gas back into the combustion chamber as shown in Figure C7-1.

OPERATION

The EGR valve is opened by manifold vacuum regulated by an ECM controlled solenoid to let exhaust gas flow into the intake manifold. The exhaust gas then moves with the air/fuel mixture into the combustion chamber. If too much exhaust gas enters, combustion will not occur. For this reason, very little exhaust gas is allowed to pass through the valve, especially at idle. The EGR valve is usually open during warm engine operation and when the vehicle is above idle speed.

EGR CONTROL

The EGR vacuum control has a vacuum solenoid that uses "pulse width modulation". This means the ECM turns the solenoid "ON" and "OFF" many times a second and varies the amount of "ON" time ("pulse width") to vary the amount of EGR.

The ECM uses information from the following sensors to regulate the EGR solenoid:

- Coolant Temperature
- Throttle Position (TPS)
- P / N Switch

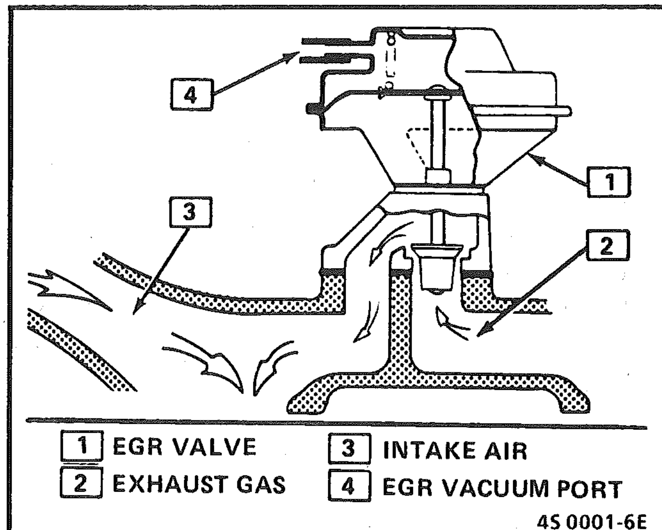

Figure C7-1 - Exhaust Gas Recirculation

During cold operation and at idle, the solenoid circuit is not grounded by the ECM. This blocks vacuum to the EGR valve.

A system malfunction should trigger a "Service Engine Soon" light, and set a Code 32. For more information see Code CHART 32.

NEGATIVE BACKPRESSURE VALVE

The valve used on this engine is a negative backpressure valve. It varies the amount of exhaust gas flow into the manifold depending on manifold vacuum and variations in exhaust backpressure.

The diaphragm on this valve (shown in Figure C7-2) has an internal vacuum bleed hole which is held closed by a small spring when there is no exhaust backpressure. The amount of vacuum to the valve is controlled by the ECM controlling a solenoid.

Engine vacuum opens the EGR valve against the pressure of a large spring. When manifold vacuum combines with negative exhaust backpressure, the vacuum bleed hole opens and the EGR valve closes

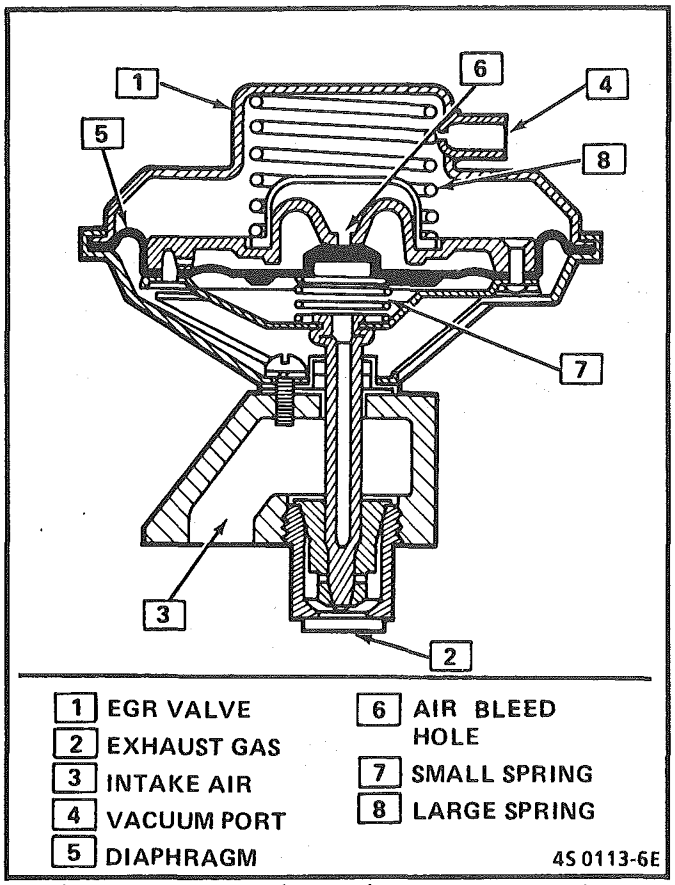

Figure C7-2 - Negative Backpressure EGR Valve

EGR VALVE IDENTIFICATION

- Negative backpressure EGR valves will have an "N" stamped on the top side of the valve after the part number (Figure C7-3).
- Positive backpressure EGR valves will have a "P" stamped on the top side of the valve, after the part number.
- Port EGR valves have no identification stamped after the part number.

When replacing an EGR valve, always check for correct part number in the parts catalog or supplemental bulletin.

RESULTS OF INCORRECT OPERATION

Too much EGR flow (at idle, cruise, or cold operation) and may result in any of the following conditions:

- Engine stops after cold start.
- Engine stops at idle after deceleration.
- Car surges during cruise.
- Rough idle.

Too little or no EGR flow allows combustion temperatures to get too high during acceleration and load conditions. This could causes:

- Spark knock (detonation).
- Engine overheating.
- Emission test failure.

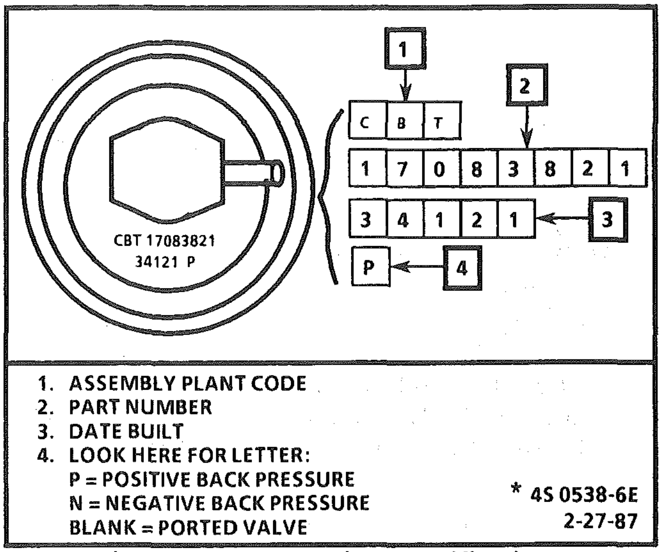

Figure C7-3 - EGR Valve Identification

DIAGNOSIS

Diagnosis of the ECM controlled EGR system on the 5.0L is covered in CHART C-7 at the end of this section. If the vehicle has a stored Code 32 see that chart first.

ON-CAR SERVICE

EGR VALVE

Remove or Disconnect

1. Air cleaner.
2. EGR valve vacuum hose at valve.
3. Bolts.
4. EGR valve from manifold.

EGR Manifold Passage

Inspect

If EGR passages in the inlet manifold indicate excessive build-up of deposits, the passages should be cleaned. Care should be taken to ensure that all loose particles are completely removed to prevent them from clogging the EGR valve or from being ingested into the engine.

Clean

1. With a wire wheel, buff the exhaust deposits from the mounting surface and around the valve.
2. Look for exhaust deposits in the valve outlet. Remove deposit build-up with a screwdriver.
3. Clean mounting surfaces of intake manifold and valve assembly.

Install or Connect

1. EGR valve on intake manifold using new gasket.
2. Bolts and tighten to 22 N · m (16 lb. ft.).
3. Vacuum hose to valve.
4. Air cleaner.

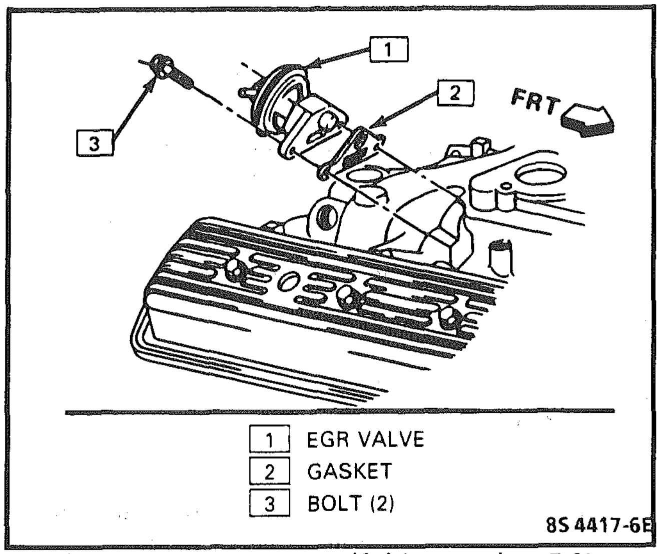

Figure C7-4 - EGR to Manifold Mounting 5.0L

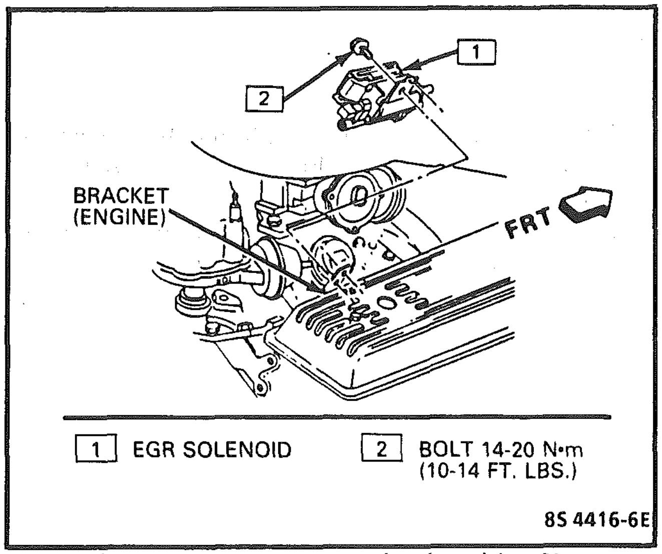

Figure C7-5 - EGR Control Solenoid 5.0L

EGR CONTROL SOLENOID

Remove or Disconnect

1. Negative battery cable.
2. Air cleaner.
3. Electrical connector at solenoid, (Figure C7-4)
4. Vacuum hoses.
5. Nut and solenoid.

Install or Connect

1. Solenoid and bracket. Tighten nut to 24 N · m (17 lb. ft.).
2. Vacuum hoses.
3. Electrical connector.
4. Air cleaner.
5. Negative battery cable.

PARTS INFORMATION

PART NAME	GROUP
Valve, EGR	3.670
Solenoid, EGR Cont Vlv Rly	3.670
Gasket, EGR Valve	3.680

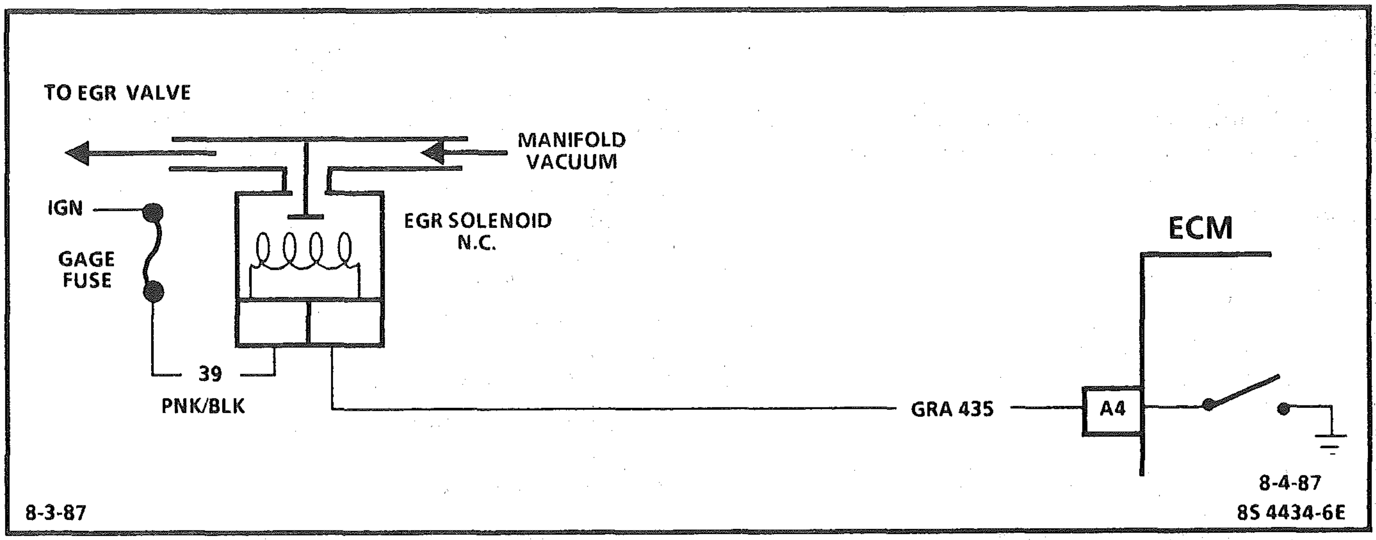

CHART C-7

EXHAUST GAS RECIRULATION (EGR) CHECK 5.0L (VIN E) "F" SERIES (TBI)

Circuit Description:

The ECM operates a solenoid to control the exhaust gas recirculation (EGR) valve. This solenoid is normally closed. By providing a ground path, the ECM energizes the solenoid which then allows vacuum to pass to the EGR valve. The ECM control of the EGR is based on the following inputs:

- Engine coolant temperature - above 25°C.
- TPS - off idle
- MAP

If Code 24 is stored, use that chart first.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Checks for solenoid stuck open.
2. Checks for solenoid always being energized.
3. Grounding test terminal will energize the solenoid and vacuum will drop.
4. Negative backpressure valve should hold vacuum with engine "OFF".
5. When engine is started, exhaust backpressure should cause vacuum to bleed off and valve to fully close.
6. 5.0L engines have a manifold vacuum source which should have at least 7 hg at idle.

CHART C-7
EXHAUST GAS RECIRCULATION (EGR) CHECK
5.0L (VIN E) "F" SERIES (TBI)

BEFORE USING THIS CHART, CHECK FOR MANIFOLD VACUUM TO EGR SOLENOID, ALSO CHECK HOSES FOR LEAKS OR RESTRICTIONS. SHOULD BE AT LEAST (7") HG VACUUM AT 2000 RPM.

1
- DISCONNECT EGR SOLENOID VACUUM HARNESS.
- ROTATE HARNESS AND REINSTALL ONLY THE EGR VALVE SIDE,
- IGNITION "ON", ENGINE STOPPED.
- GROUND DIAGNOSTIC TERMINAL.
- INSTALL A HAND HELD VACUUM PUMP WITH GAGE TO MANIFOLD SIDE OF EGR SOLENOID.
- APPLY VACUUM AND OBSERVE EGR VALVE DIAPHRAGM.
- VALVE SHOULD MOVE.

DOES IT?

YES

2
- UNGROUND DIAGNOSTIC TERMINAL.
- VACUUM SHOULD BLEED OFF AND VALVE SHOULD CLOSE.

DOES IT?

YES

4
- IGNITION "OFF"
- CONNECT A VACUUM PUMP TO EGR VALVE.
- USING A MIRROR, OBSERVE EGR DIAPHRAGM WHILE APPLYING VACUUM.
- DIAPHRAGM SHOULD MOVE FREELY AND HOLD VACUUM FOR AT LEAST 20 SECONDS.

DOES IT?

YES

5
- APPLY 10" Hg VACUUM TO EGR VALVE.
- START ENGINE AND IMMEDIATELY OBSERVE VACUUM GAGE ON VACUUM PUMP.
- VALVE IS GOOD IF DIAPHRAGM HAS MOVED TO SEATED POSITION (VALVE CLOSED) AND VACUUM DROPPED WHILE STARTING ENGINE.

VACUUM DROPPED

6
BE SURE VACUUM HOSE BETWEEN SOLENOID AND EGR VALVE IS OK. (NO LEAKS OR RESTRICTIONS) IF NO PROBLEM IS FOUND, THE EGR CIRCUIT IS OK.

NO VACUUM DROP

- REMOVE EGR VALVE.
- CHECK PASSAGES FOR BEING PLUGGED.

IF NOT PLUGGED, REPLACE VALVE,

NO (from 4)

REPLACE EGR VALVE.

NO (from 2)

- DISCONNECT SOLENOID ELECTRICAL CONNECTOR. DOES VACUUM BLEED OFF?

YES

CKT 435 SHORTED TO GROUND OR FAULTY ECM.

NO

REPLACE SOLENOID

NO (from 1)

- CONNECT VACUUM PUMP TO EGR VALVE SIDE OF HARNESS.
- APPLY VACUUM AND OBSERVE VALVE.
- VALVE SHOULD MOVE.

DOES IT?

NO

- FAULTY VACUUM HOSE TO EGR VALVE OR FAULTY VALVE.

YES

3
- DISCONNECT EGR ELECTRICAL CONNECTOR.
- CONNECT TEST LIGHT BETWEEN HARNESS CONNECTOR TERMINALS.
- IGNITION "ON", ENGINE "OFF".
- TEST LIGHT SHOULD LIGHT.

DOES IT?

YES

FAULTY SOLENOID CONNECTION OR FAULTY SOLENOID.

NO

CONNECT TEST LIGHT BETWEEN HARNESS TERMINAL "A" AND GROUND.

NO LIGHT

REPAIR OPEN CKT 39.

LIGHT

REPAIR OPEN CKT 435. IF NOT OPEN, IT IS A FAULTY ECM.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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SECTION C8

TRANSMISSION CONVERTER CLUTCH (TCC) SYSTEM

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The transmission converter clutch (TCC) system is designed to eliminate power loss by the converter (slippage) thus increasing fuel economy. By locking the converter clutch, a more effective coupling to the flywheel is achieved. The converter clutch is operated by an ECM controlled solenoid.

OPERATION

Engagement of the TCC is accomplished by a solenoid operated valve within the transmission. The solenoid is activated when an internal switch in the ECM is grounded. Although the ECM may command the TCC "ON", the converter clutch will not apply until internal transmission fluid pressure requirements are met. See Section "7A".

Before the ECM activates the TCC apply solenoid, several inputs must be monitored:

- Vehicle Speed. Must be above a certain value before the TCC can be applied.
- Coolant Temperature. The engine coolant temperature must be above a certain value before the TCC can be applied.
- Throttle Position Sensor. After the TCC is applied, during low engine load condition, the ECM uses the information from the TPS to release the clutch when the car is accelerating or decelerating at a certain rate.

CIRCUIT DESCRIPTION

The 12 volt power supply for the solenoid in the transmission is provided through a normally closed switch located on the brake pedal linkage. When the brake pedal is depressed (switch open), the power supply to the TCC solenoid is interrupted and the TCC is disengaged regardless of any other conditions.

When the brake pedal is not depressed (switch closed), battery voltage will be fed to the TCC solenoid. If the ECM has determined that conditions are correct, the circuit from the TCC solenoid will be completed to ground through the ECM and the TCC solenoid will be activated.

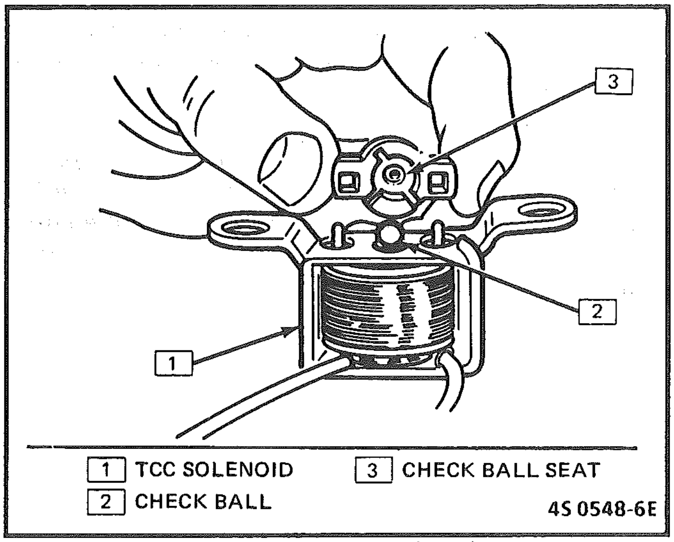

Figure C8-1 - TCC Solenoid

Some transmission use other internal switches in addition to the TCC solenoid.

- 700-R4. transmissions normally use a 4th gear switch to send a signal to the ECM telling it when the transmission is in 4th gear. The ECM uses this information to vary the conditions under which the clutch applies or releases. However, the transmission does not have to be in 4th gear in order for the ECM to turn the clutch "ON"

RESULTS OF INCORRECT TCC OPERATION

An engine stall will result if the converter clutch remains applied at all times.

If the converter clutch does not apply, fuel economy may be lower than expected.

The transmission converter clutch (TCC) system has different operating characteristics than an automatic transmission without TCC. If the driver complains of a "chuggle" or "surge" condition, the car should be road tested and compared to a similar car to see if a real problem exists. Another TCC complaint may be a downshift felt when going up a grade, especially with cruise control. This may not be a downshift, but a clutch disengagement due to the change in TPS to maintain cruising speed. The Owner's Manual section on TCC operation should be reviewed with the driver.

DIAGNOSIS

The diagnosis of the TCC system is covered in CHART C-8. If the ECM detects a problem in the VSS system, a Code 24 should set. In this case see Code 24 Chart.

If the ECM doesn't switch the TCC "ON" when driving, but will turn it "ON" when the "test" terminal is grounded with ignition "ON" and engine stopped, the sensors such as coolant, speed, and throttle position should be checked.

ON-CAR SERVICE

- See Section "7" for TCC Solenoid.
- See Section "8B" for VSS (IP mounted) and brake system.

PARTS INFORMATION

PART NAME	GROUP
Sensor, VSS	9.761
Solenoid, TCC	4.122

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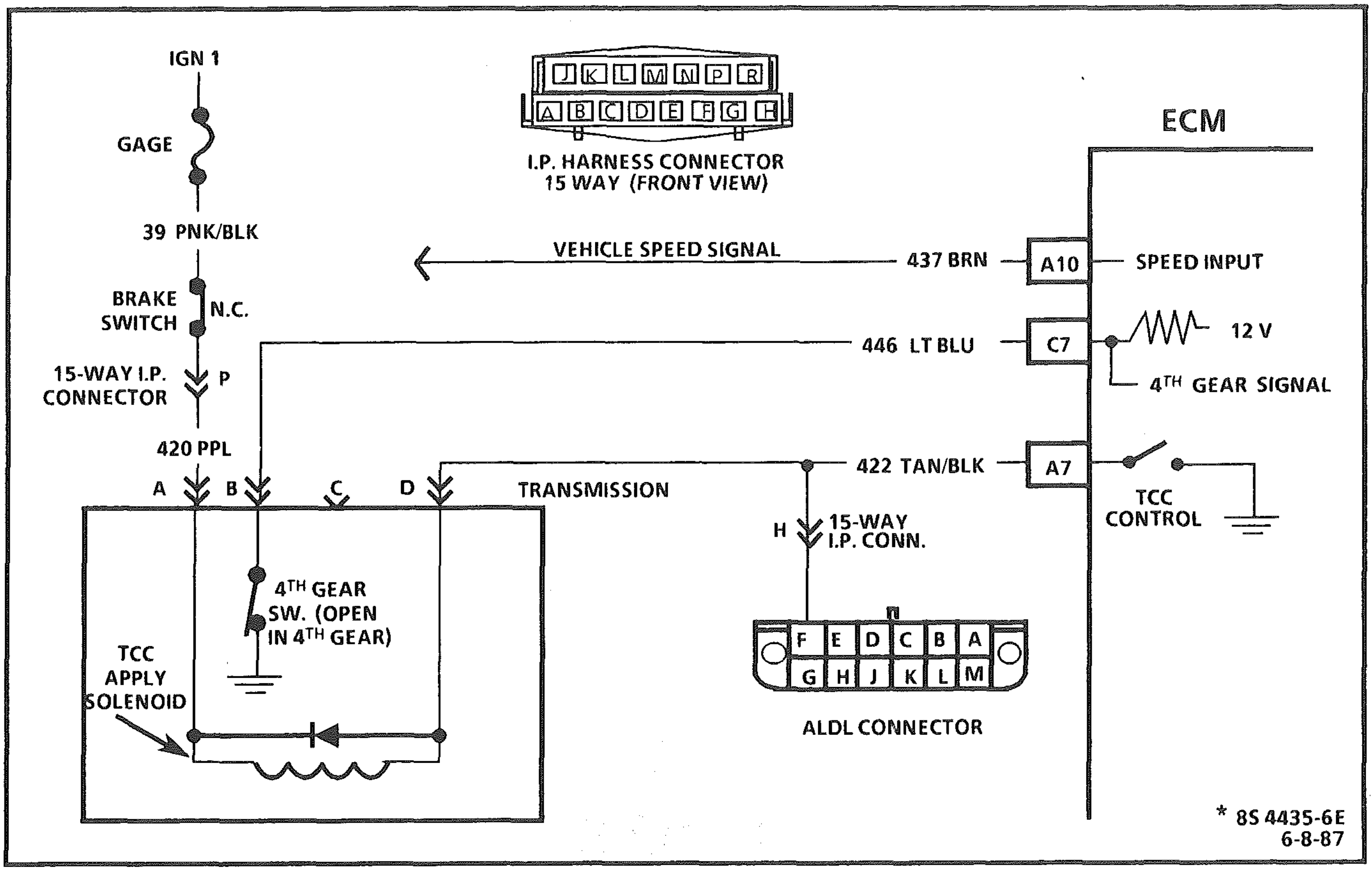


CHART C-8A

TRANSMISSION CONVERTER CLUTCH (TCC)
ELECTRICAL DIAGNOSIS
(Page 1 of 2)
5.0L (VIN E) "F" SERIES (TBI)

Circuit Description:

The purpose of the automatic transmission torque converter clutch is to eliminate the power loss of the torque converter, when the vehicle is in a cruise condition. This allows the convenience of the automatic transmission and the fuel economy of a manual transmission.

Fused battery ignition is supplied to the TCC solenoid through the brake switch. the ECM will engage TCC by grounding CKT 422 to energize the solenoid.

TCC will engage when:

- Vehicle speed above 24 mph
- Engine at normal operating temperature (above 70°C, 156°F)
- Throttle position sensor output not changing, indicating a steady road speed
- Brake switch closed

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

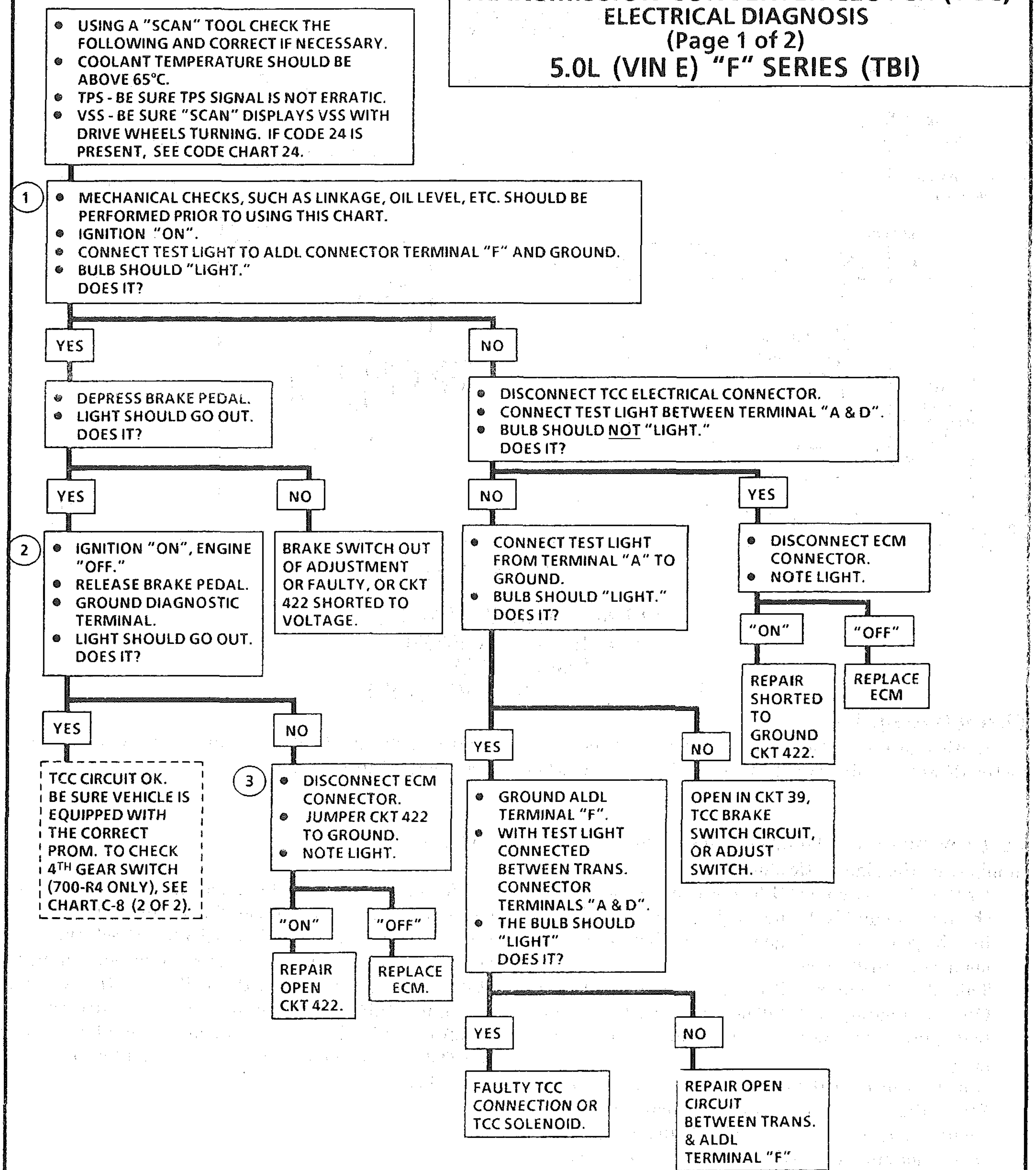
1. Confirms 12 volt supply as well as continuity of TCC circuit.
2. Grounding the diagnostic terminal with engine "OFF", should energize the capability of the ECM to control the solenoid.
3. Solenoid coil resistance must measure more than 20 ohms. Less resistance will cause early failure of the ECM "Driver". Using an ohmmeter, check the solenoid coil resistance of all ECM controlled solenoids and relays before installing a replacement ECM. Replace any solenoid or relay that measures less than 20 ohms.

Diagnostic Aids:

An engine coolant thermostat that is stuck open or opens at too low a temperature, may result in an inoperative TCC.

CHART C-8A

TRANSMISSION CONVERTER CLUTCH (TCC)
ELECTRICAL DIAGNOSIS
(Page 1 of 2)
5.0L (VIN E) "F" SERIES (TBI)



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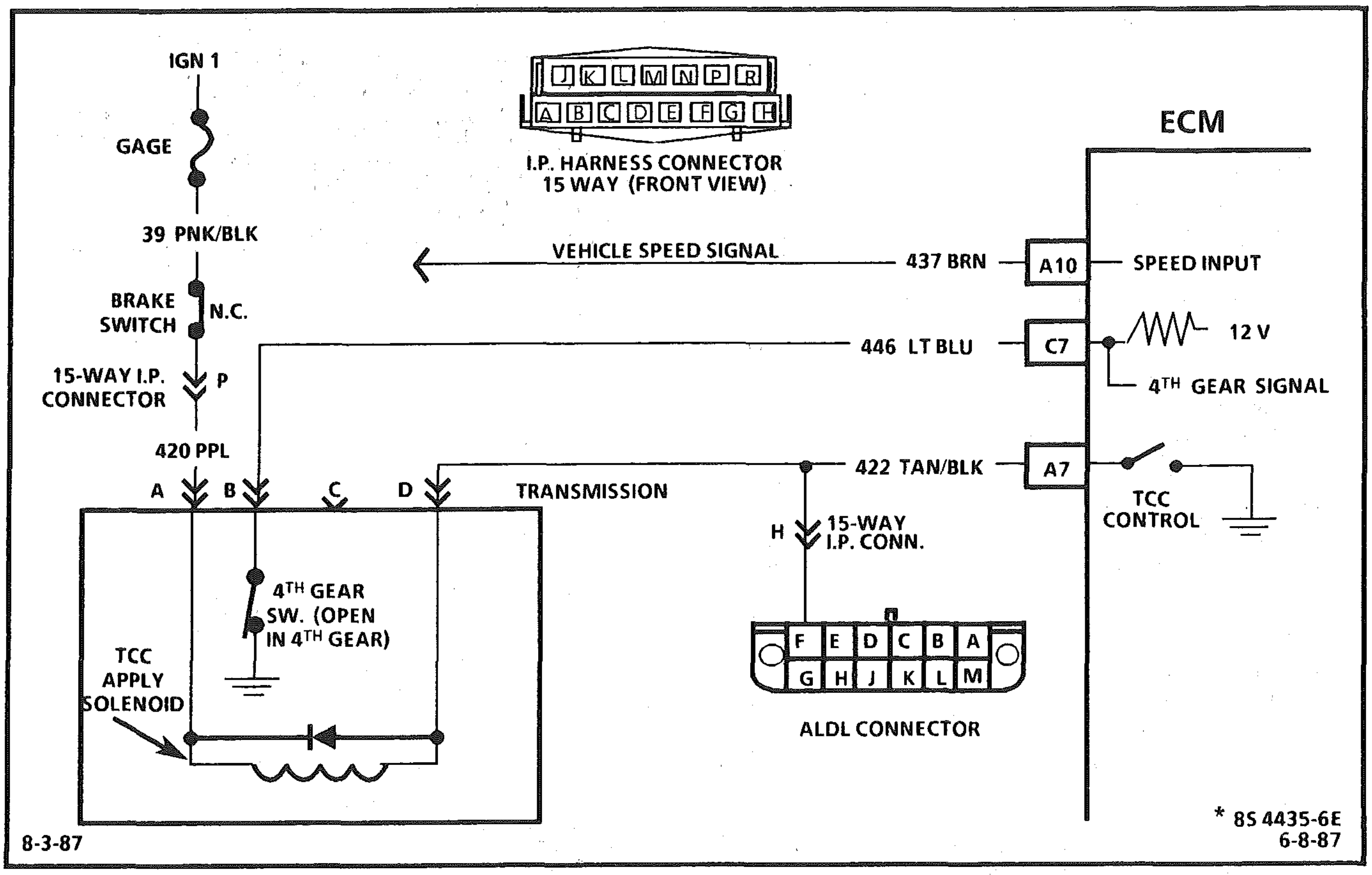

CHART C-8A

700-4R TRANSMISSION
ELECTRICAL DIAGNOSIS
(Page 2 of 2)
5.0L (VIN E) "F" SERIES (TBI)

Circuit Description:

A 4th gear switch (mounted in the trans.) opens when the trans. shifts into 4th gear, and this switch is used by the ECM to modify TCC lock and unlock points, when in a 4-3 downshift maneuver.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Unless the switch or CKT 446 is open the "Scan" should display "NO", indicating the trans. is not in 4th gear. The 4th gear switch should only be open while in 4th gear.
2. This step determines if the ECM and wiring are OK. Grounding CKT 446 should cause the "Scan" to display "NO", indicating the trans. is not in 4th gear.
3. Checks the operation of the 4th gear switch. When the trans. shifts into 4th gear the switch should open and the "Scan" should display "YES".
4. Disconnecting the TCC connector simulates an open switch to determine if CKT 446 is shorted to ground or the problem is in the transmission.

Diagnostic Aids:

A road test may be necessary to verify the customer complaint. If the "Scan" indicates TCC is turning "ON" and "OFF" erratically, check the state of the 4th gear switch to be sure it is not changing states under a steady throttle position. If the switch is changing states, check connections and wire routing carefully. Also if the 4th gear switch is always open the TCC may engage as soon as sufficient oil pressure is reached.

CHART C-8A

700-4R TRANSMISSION
ELECTRICAL DIAGNOSIS
(Page 2 of 2)
5.0L (VIN E) "F" SERIES (TBI)

CHECKS MADE ON THIS PAGE WILL NOT PREVENT THE TCC FROM WORKING, BUT WILL AFFECT ENGAGEMENT OR DISENGAGEMENT POINTS.

1
- IGNITION "ON", ENGINE "OFF".
- DOES "SCAN" INDICATE TRANS. IS IN 4TH GEAR?

NO

3
- RAISE DRIVE WHEELS
- SHIFT VEHICLE INTO OVERDRIVE
- INCREASE SPEED SLOWLY UNTIL TRANS. SHIFTS INTO 4TH GEAR.
- DOES "SCAN" INDICATE TRANS. IS IN 4TH GEAR?

YES

4TH GEAR SWITCH OK. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

NO

4
- IGNITION "ON" ENGINE "OFF"
- DISCONNECT TRANS. ELECTRICAL CONNECTOR
- DOES "SCAN" INDICATE TRANS. IS IN 4TH GEAR?

YES

WIRE GROUNDED INTERNALLY IN TRANS. OR FAULTY 4TH GEAR SWITCH.

NO

CKT 446 SHORTED TO GROUND OR FAULTY ECM.

YES

2
- DISCONNECT TCC ELECTRICAL CONNECTOR.
- JUMPER HARNESS TERMINAL "B" (CKT 446) TO GROUND.
- DOES "SCAN" INDICATE TRANS. IS IN 4TH GEAR?

NO

FAULTY CONNECTION OR 4TH GEAR SWITCH.

YES

OPEN CKT 446, FAULTY CONNECTION OR FAULTY ECM.

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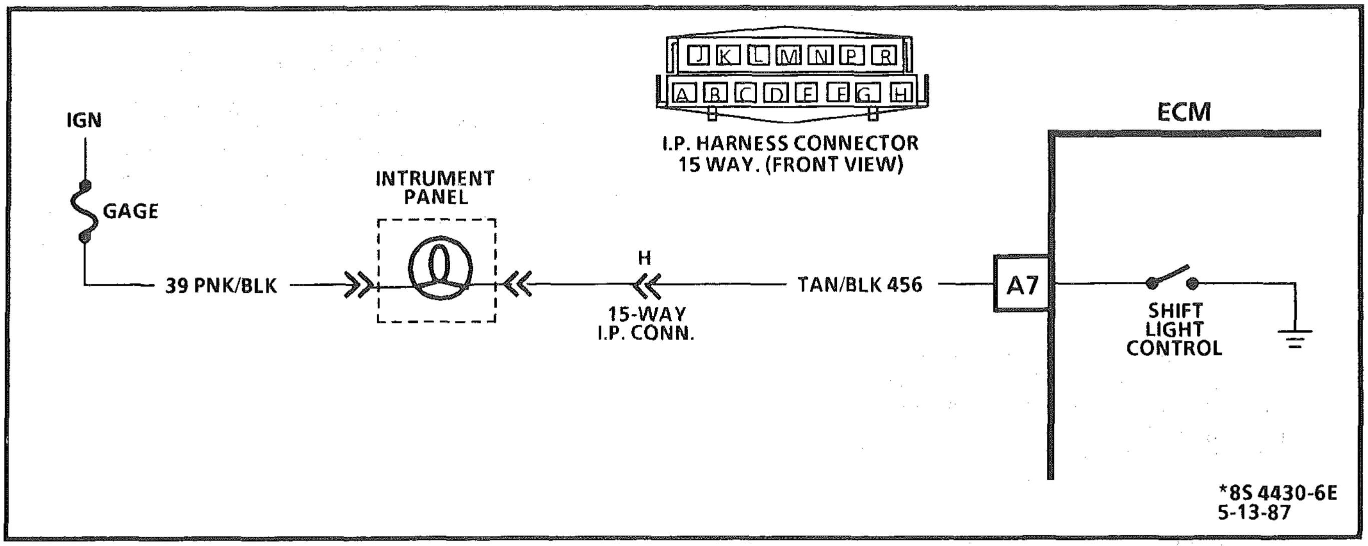


CHART C-8B

MANUAL TRANSMISSION (M/T)
SHIFT LIGHT CHECK
5.0L (VIN E) "F" SERIES (TBI)

Circuit Description:

The shift indicates the best transmission shift point for maximum fuel economy. The light is controlled by the ECM and is turned "ON" by grounding CKT 456.

The ECM uses information from the following inputs to control the shift light:

- Coolant temperature
- TPS
- VSS
- RPM

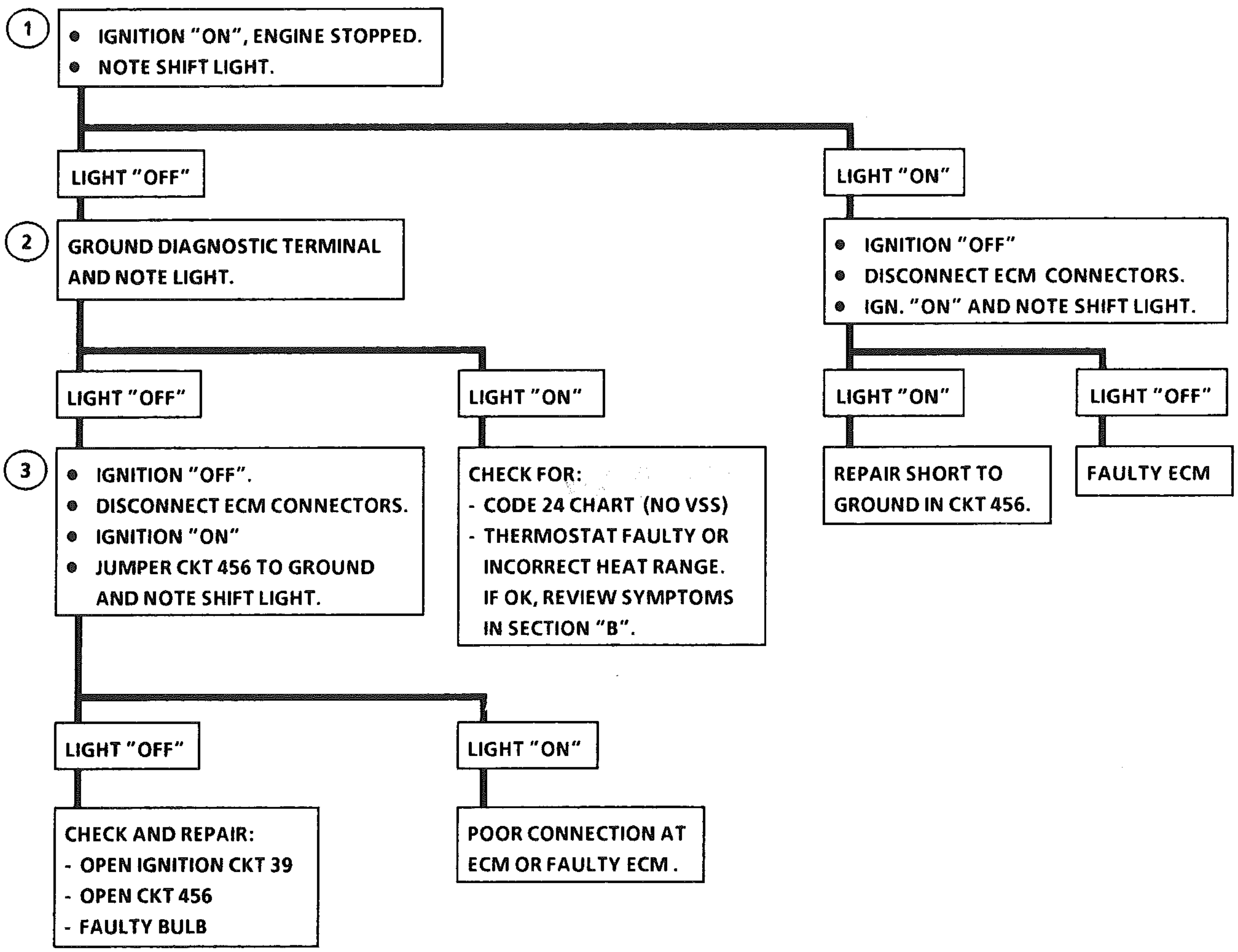
The ECM uses the measured rpm and the vehicle speed to calculate what gear the vehicle is in. It is this calculation that determines when the shift light should be turned on.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. This should not turn "ON" the shift light. If the light is "ON", there is a short to ground in CKT 456 wiring, or a fault in the ECM.
2. When the diagnostic terminal is grounded, the ECM should ground CKT 456, and the shift light should come on.
3. This checks the shift light circuit up to the ECM connector. If the shift light illuminates, then the ECM connector is faulty, or the ECM does not have the ability to ground the circuit.

CHART C-8B

MANUAL TRANSMISSION (M/T) SHIFT LIGHT CHECK 5.0L (VIN E) "F" SERIES (TBI)



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SECTION C13

POSITIVE CRANKCASE VENTILATION (PCV)

CONTENTS

GENERAL DESCRIPTION

A positive crankcase ventilation (PCV) system is used to consume crankcase vapors in the combustion process instead of venting to atmosphere. Fresh air from the air cleaner is supplied to the crankcase, mixed with blow-by gases and then passed through a positive crankcase ventilation (PCV) valve into the intake manifold (Figure C13-2).

The primary control is through the PCV valve which meters the flow at a rate depending on manifold vacuum.

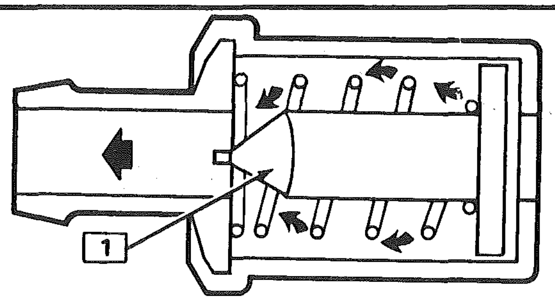


Figure C13-1 - PCV Valve Cross Section

To maintain idle quality, the PCV valve restricts the flow when intake manifold vacuum is high. If abnormal operating conditions arise, the system is designed to allow excessive amounts of blow-by gases to back flow through the crankcase vent tube into the air cleaner to be consumed by normal combustion.

- A leaking valve or hose would cause:
  - Rough idle.
  - Stalling.
  - High idle speed.

DIAGNOSIS

If an engine is idling rough, check for a clogged PCV valve or plugged hose. Replace as required. Use the following procedure:

1. Remove PCV valve from rocker arm cover.
2. Run the engine at idle.

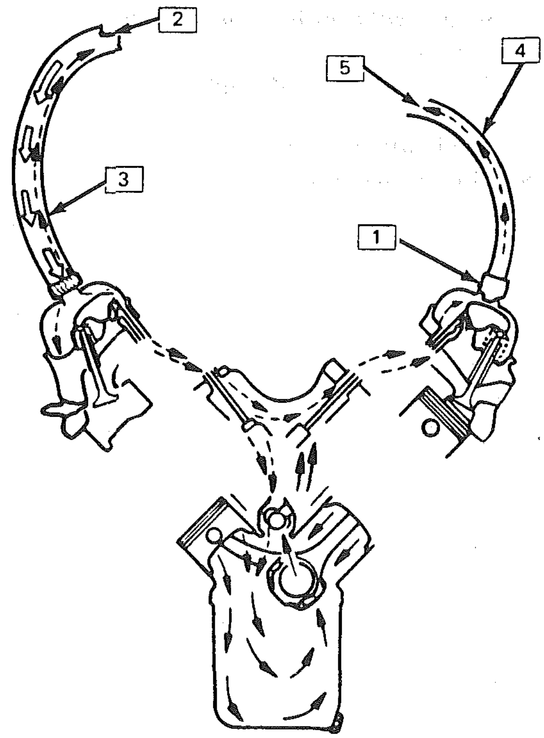


Figure C13-2 - PCV-Flow

3. Place your thumb over end of valve to check for vacuum. If there is no vacuum at valve, check for plugged hoses or manifold port, or PCV valve. Replace plugged or deteriorated hoses.
4. Turn "OFF" the engine and remove PCV valve. Shake valve and listen for the rattle of check needle inside the valve. If valve does not rattle, replace valve.

With this system, any blow-by in excess of the system capacity (from a badly-worn engine, sustained heavy load, etc.) is exhausted into the air cleaner and is drawn into the engine.

Proper operation of the PCV System is dependent upon a sealed engine. If oil sludging or dilution is noted, and the PCV System is functioning properly, check engine for possible cause and correct to ensure that system will function as intended.

Results of Incorrect PCV Operation

- A plugged valve or hose may cause:
  - Rough idle.
  - Stalling or slow idle speed.
  - Oil leaks.
  - Oil in air cleaner.
  - Sludge in engine.

ON-CAR SERVICE

An engine which is operated without any crankcase ventilation can be damaged. Therefore, it is important to replace the PCV valve and air cleaner breather at intervals shown in Section "0B".

Periodically, inspect the hoses and clamps and replace any showing signs of deterioration.

PARTS INFORMATION

PART NAME	GROUP
Air Cleaner	3.402
Valve Asm, C/Case Vent	1.745

SECTION C14

THERMOSTATIC AIR CLEANER (THERMAC)

CONTENTS

GENERAL DESCRIPTION

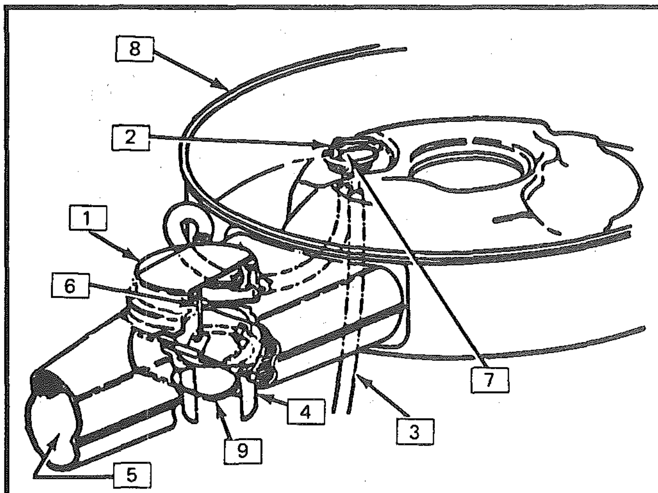
PURPOSE

A heated intake air system is used to give good driveability under varying climatic conditions. By having a uniform inlet air temperature, the fuel system can be calibrated to reduce exhaust emissions and to eliminate throttle valve icing.

OPERATION

The THERMAC air cleaner operates by heated air and manifold vacuum (Figure C14-1). Air can enter the air cleaner from outside the engine compartment or from a heat stove built around the exhaust manifold. A vacuum diaphram motor, built into the air cleaner snorkel, moves a damper door, to admit hot air from the exhaust manifold, outside air, or a combination of both. Inside the air cleaner is a temperature sensor that reacts to air intake temperature and controls the amount of vacuum going to the motor.

- Hot Air Delivery Mode. When the temperature is below 86°F (30°C), the sensor allows vacuum to the motor and the damper door will be up, shuting off outside air and allowing only heated air from the exhaust manifold to enter the air cleaner.
- Outside Air Delivery Mode. When the temperature is above 55°C (131°F), the damper door drops down and only outside air enters the air cleaner.
- Regulating Mode. Between 30°C (86°F) and 55°C (131°F) the damper door allows both heated and outside air to enter the air cleaner.



1 VACUUM DIAPHRAGM MOTOR
2 TEMPERATURE SENSOR
3 VACUUM HOSE (TO MANIFOLD VACUUM)
4 HEAT STOVE DUCT
5 SNORKEL
6 LINKAGE
7 AIR BLEED VALVE
8 AIR CLEANER ASM.
9 DAMPER DOOR

4S 0648-6E

Figure C14-1 - THERMAC Air Cleaner - Typical

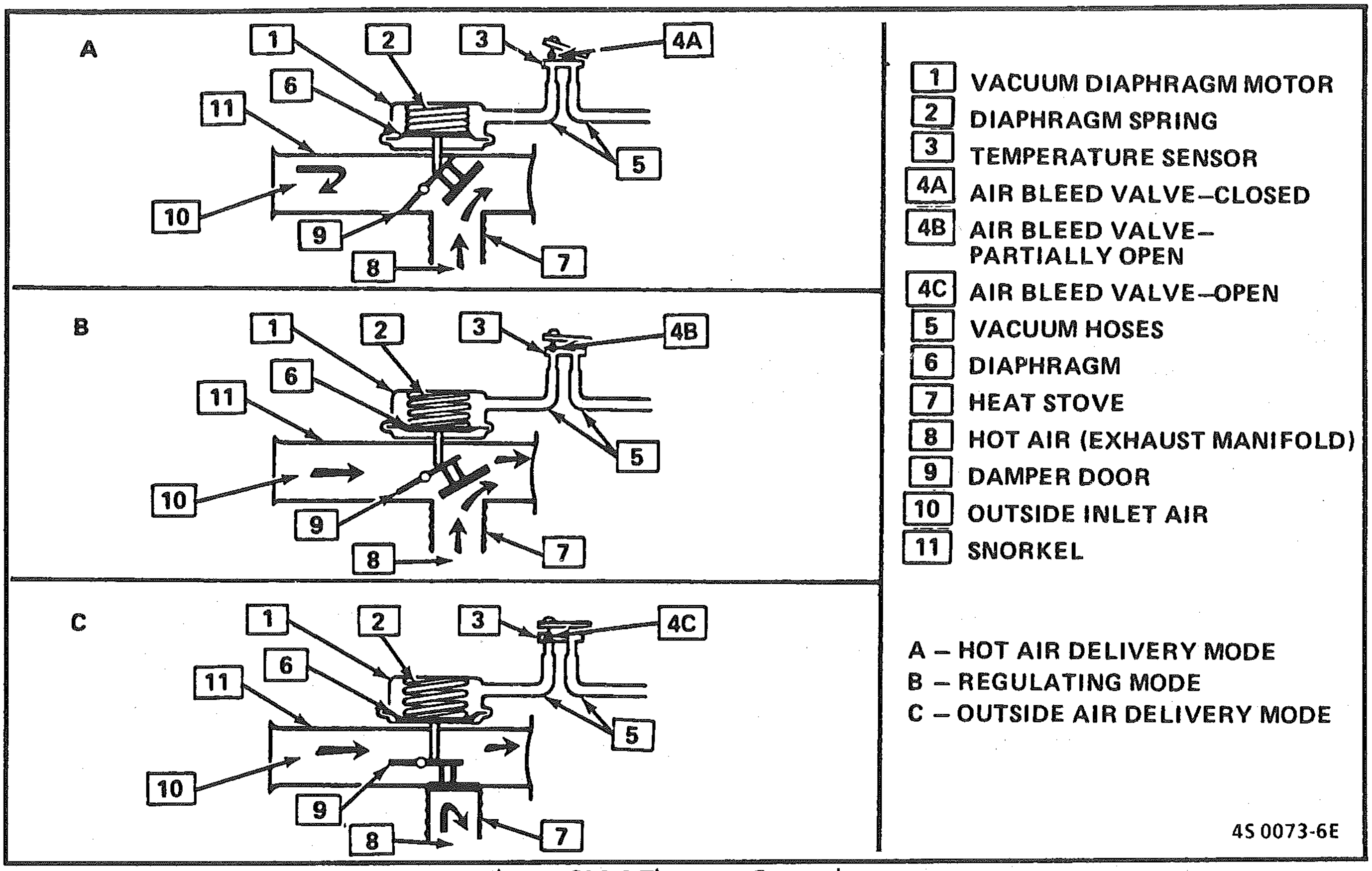


Figure C14-2 Thermac Operation

DIAGNOSIS

RESULTS OF INCORRECT THERMAC OPERAITON

Hesitation during warm-up can be caused by:

- Heat stove tube disconnected.
- Vacuum diaphram motor inoperative (open to snorkel).
- No manifold vacuum.
- Damper door does not move.
- Missing air cleaner to carburetor seal.
- Missing air cleaner cover seal or loose cover.
- Loose air cleaner.

Spark Knock, Lack of power, sluggish, or spongy, on a hot engine can be caused by:

- Damper door does not open to outside air.
- Temperature sensor doesn't bleed off vacuum.

THERMAC AIR CLEANER CHECK

1. Inspect system to be sure all hoses and heat stove tube are connected. Check for kinked, plugged or deteriorated hoses.
2. Check for presence and condition of air cleaner to carburetor gasket seal.
3. With air cleaner assembly installed, damper door should be open to outside air.
4. Start engine. Watch damper door in air cleaner snorkel. When engine is first started, damper door should move and close off outside air.
   As air cleaner warms up, damper door should open slowly to outside air.
5. If the air cleaner fails to operate as described above, perform vacuum motor check. If it operates, the door may not be moving at the right temperature. If the driveability problem is during warm-up, make the temperature sensor check below.

VACUUM MOTOR CHECK

1. With engine "OFF", disconnect vacuum hose at vacuum diaphragm motor.
2. Apply at least 23 kPa (7in.Hg.) of vacuum to the vacuum diaphragm motor. Damper door should completely block off to outside air when vacuum is applied. If not, check to see if linkage is hooked up correctly.
3. With vacuum still applied, trap vacuum in vacuum diaphragm motor by bending hose.
   Damper door should remain closed. If not, replace vacuum diaphragm motor assembly. (Failure of the vacuum diaphragm motor assembly is more

likely to be caused from binding linkage or a corroded snorkel than from a failed diaphragm. This should be checked first, before replacing the diaphragm.)

4. If vacuum motor checks OK, check vacuum hoses and connections. If OK, replace the temperature sensor.

TEMPERATURE SENSOR CHECK

1. Start test with air cleaner temperature below 30°C (86°F). If engine has been run recently, remove air cleaner cover and place thermometer as close as possible to the sensor. Let air cleaner cool until thermometer reads below 30°C (86°F) about 5 to 10 minutes. Reinstall air cleaner on engine and continue to Step 2.
2. Start and idle engine. Damper door should move to close off outside air immediately if engine is cool enough. When damper door starts to open the snorkel passage (in a few minutes), remove air cleaner cover and read thermometer. It must read about 55°C (131°F).
3. If the damper door is not open to outside air at temperature indicated, temperature sensor is malfunctioning and must be replaced.

ON-CAR SERVICE

AIR CLEANER ELEMENT

Remove or Disconnect

1. Air cleaner cover.
2. Old element.

Install or Connect

1. New element.
2. Air cleaner cover. Do not over-torque nuts (install finger- tight).

VACUUM DIAPHRAGM MOTOR

Remove or Disconnect

1. Air cleaner.
2. Vacuum hose from motor.
3. Drill out the two spot welds initially with a 1. 6mm (1/16") drill, then enlarge as required to remove the retaining strap. Do not damage the snorkel tube.
4. Motor retaining strap.
5. Lift up motor, cocking it to one side to unhook the motor linkage at the control damper assembly.

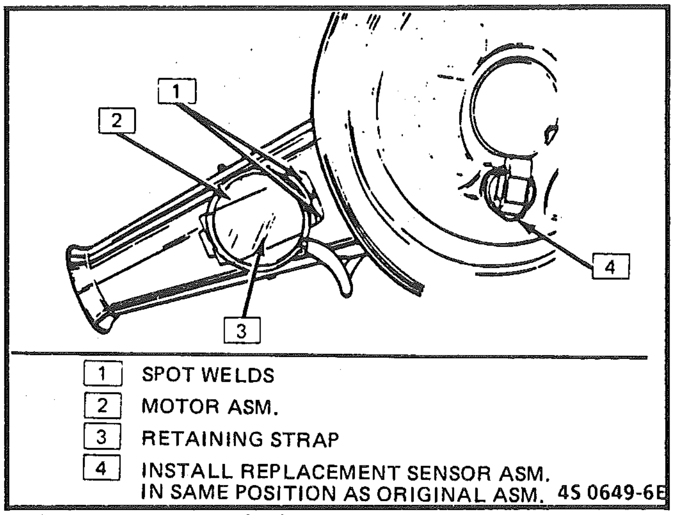


Figure C14-3 - Replacing THERMAC Vacuum Motor

Install or Connect

1. Drill a 2.8mm (7/64") hole in snorkel tube at center of vacuum motor retaining strap.
2. Vacuum motor linkage into control damper assembly.
3. Use the motor retaining strap and sheet metal screw provided in the motor service package to secure motor to the snorkel tube. Make sure the screw does not interfere with the operation of the damper assembly. Shorten screw if required.
4. Vacuum hose to motor and install air cleaner.

SENSOR

Remove or Disconnect

1. Air cleaner.
2. Hoses at sensor.
3. Pry up tabs on sensor retaining clip. Remove clip and sensor from air cleaner. Note position of sensor for installation.

Install or Connect

1. Sensor and gasket assembly in original position.
2. Retainer clip on hose connectors.
3. Vacuum hoses and air cleaner on engine.

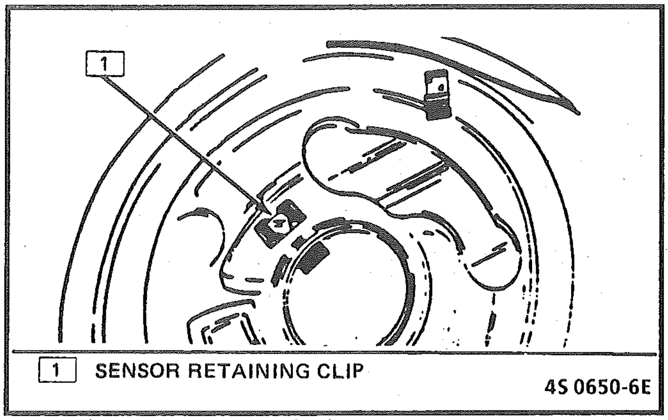


Figure C14-4 - Replacing THERMAC Sensor

PARTS INFORMATION

PART NAME	GROUP
Sensor, A/C	3.415
Motor, A/CVac Diaph	3.415

FUNCTIONAL CHECKS/ DIAGNOSTIC CHARTS
2.8L (VIN S)

SECTION C - COMPONENT SYSTEMS
2.8L (VIN S)

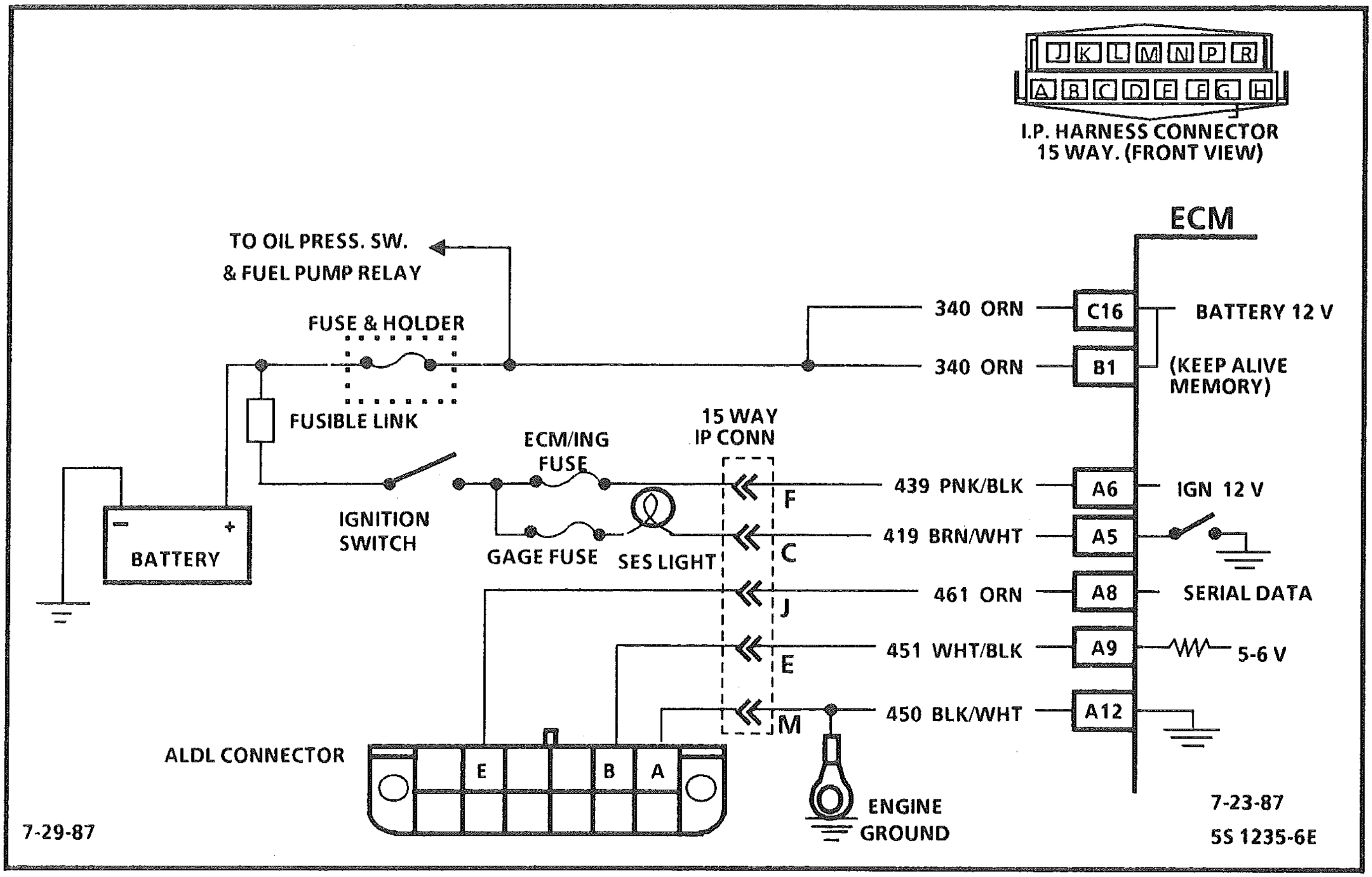


CHART A-1

NO "SERVICE ENGINE SOON" LIGHT
2.8L (VIN S) "F" SERIES (PORT)

Circuit Description:

There should always be a steady "Service Engine Soon" light when the ignition is "ON" and engine stopped. Battery is supplied directly to the light bulb. The electronic control module (ECM) will control the light and turn it "ON" by providing a ground path through CKT 419 to the ECM.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. If the fuse in holder is blown refer to facing page of Code 54 for complete circuit.
2. Using a test light connected to 12 volts probe each of the system ground circuits to be sure a good ground is present. See ECM terminal end view in front of this section for ECM pin locations of ground circuits.

Diagnostic Aids:

Engine runs OK, check:

- Faulty light bulb.
- CKT 419 open.
- Gage fuse blown. This will result in no oil or generator lights, seat belt reminder, etc.

Engine cranks but will not run.

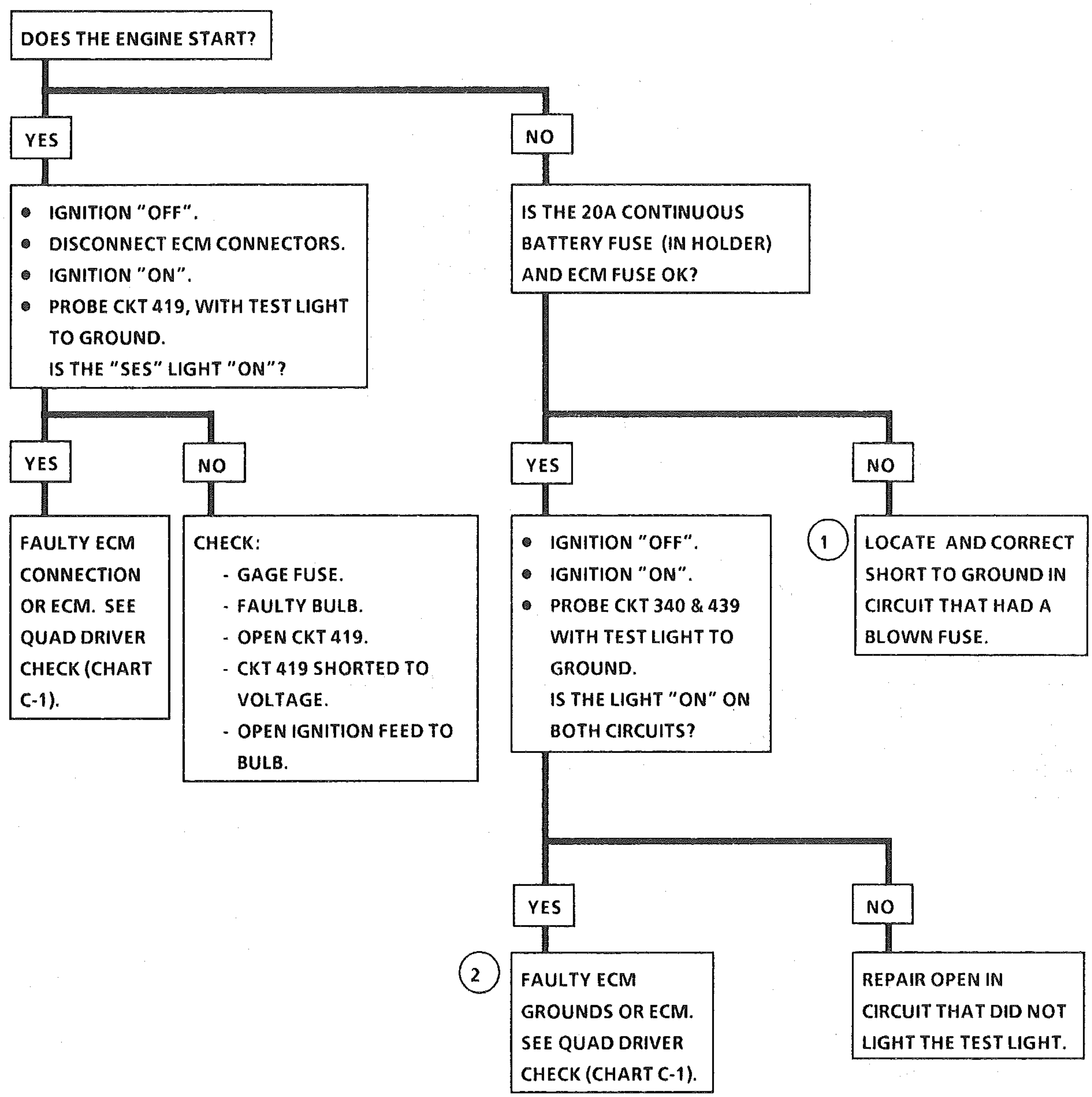
- Continuous battery - fuse or fusible link open.
- ECM ignition fuse open.
- Battery CKT 340 to ECM open.
- Ignition CKT 439 to ECM open.
- Poor connection to ECM.

Solenoids and relays are turned "ON" and "OFF" by the ECM, using internal electronic switches called "drivers". Each driver is part of a group of four called "Quad-Drivers". Failure of one driver can damage any other driver in the set. Solenoid and relay coil resistance must measure more than 20 ohms. Less resistance will cause early failure of the ECM "driver".

Before replacing ECM, be sure to check the coil resistance of all solenoids and relays controlled by the ECM. See ECM wiring diagram for the solenoid(s) and relay(s) and the coil terminal identification.

CHART A-1

NO "SERVICE ENGINE SOON" LIGHT 2.8L (VIN S) "F" SERIES (PORT)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

7-23-87
8S 4694-6E

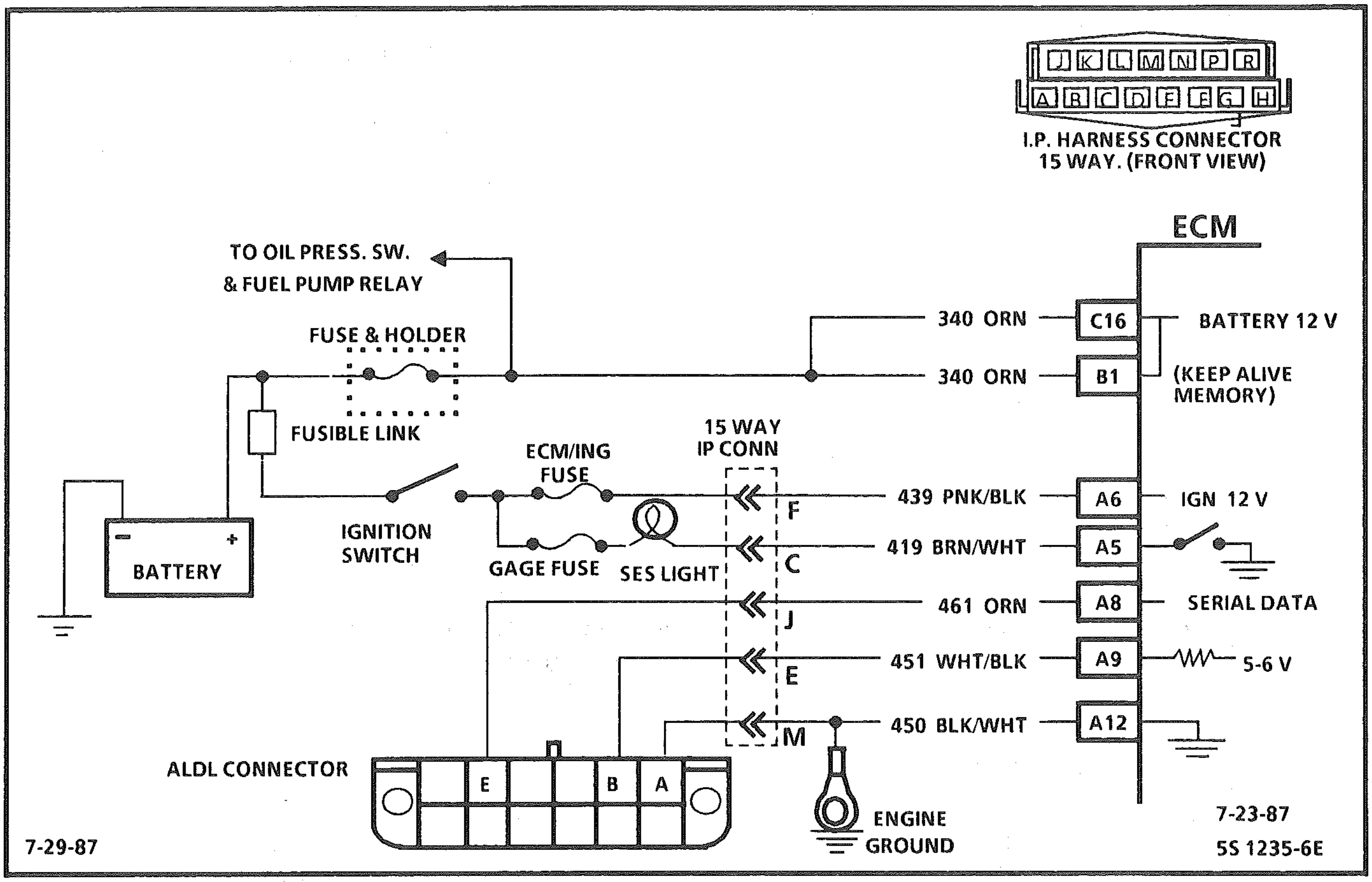


CHART A-2

NO ALDL OR WON'T FLASH CODE 12 "SERVICE ENGINE SOON" LIGHT "ON" STEADY 2.8L (VIN S) "F" SERIES (PORT)

Circuit Description:

There should always be a steady "Service Engine Soon" light when the ignition is "ON" and engine stopped. Battery ignition voltage is supplied to the light bulb. The electronic control module (ECM) will turn the light "ON" by grounding CKT 419 at the ECM.

With the diagnostic terminal grounded, the light should flash a Code 12, followed by any trouble code(s) stored in memory.

A steady light suggests a short to ground in the light control CKT 419, or an open in diagnostic CKT 451.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. If there is a problem with the ECM that causes a "Scan" tool to not read serial data, the ECM should not flash a Code 12. If Code 12 is flashing check for CKT 451 short to ground. If Code 12 does flash be sure that the "Scan" tool is working properly on another vehicle. If the "Scan" is functioning properly and CKT 461 is OK the PROM or ECM may be at fault for the NO ALDL symptom.
2. If the light goes "OFF" when the ECM connector is disconnected, CKT 419 is not shorted to ground.
3. This step will check for an open diagnostic CKT 451.
4. At this point the "Service Engine Soon" light wiring is OK. The problem is a faulty ECM or PROM. If Code 12 does not flash, the ECM should be replaced using the original PROM. Replace the PROM only after trying an ECM, as a defective PROM is an unlikely cause of the problem.

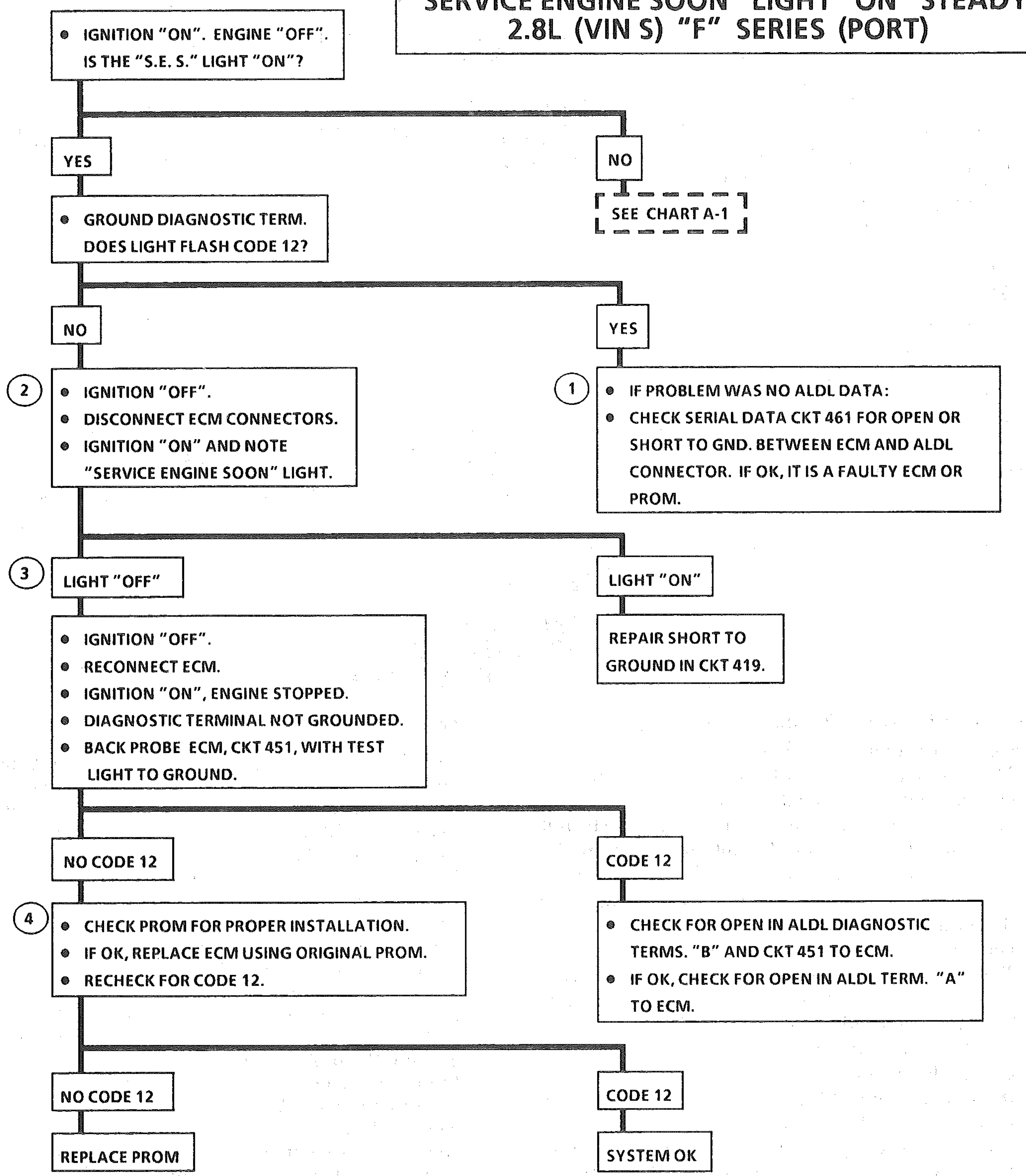
Diagnostic Aids:

Solenoids and relays are turned "ON" or "OFF" by the ECM using internal electronic switches called "drivers". Each driver is part of a group of four called "Quad-Drivers". Failure of one driver can damage any other driver in the set.

Before replacing ECM, be sure to check the coil resistance of all solenoids and relays controlled by the ECM. See ECM wiring diagram for the solenoid(s) and relay(s) and the coil terminal identification.

CHART A-2

NO ALDL DATA OR WON'T FLASH CODE 12 "SERVICE ENGINE SOON" LIGHT "ON" STEADY 2.8L (VIN S) "F" SERIES (PORT)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

6-16-87

7S 3341-6E

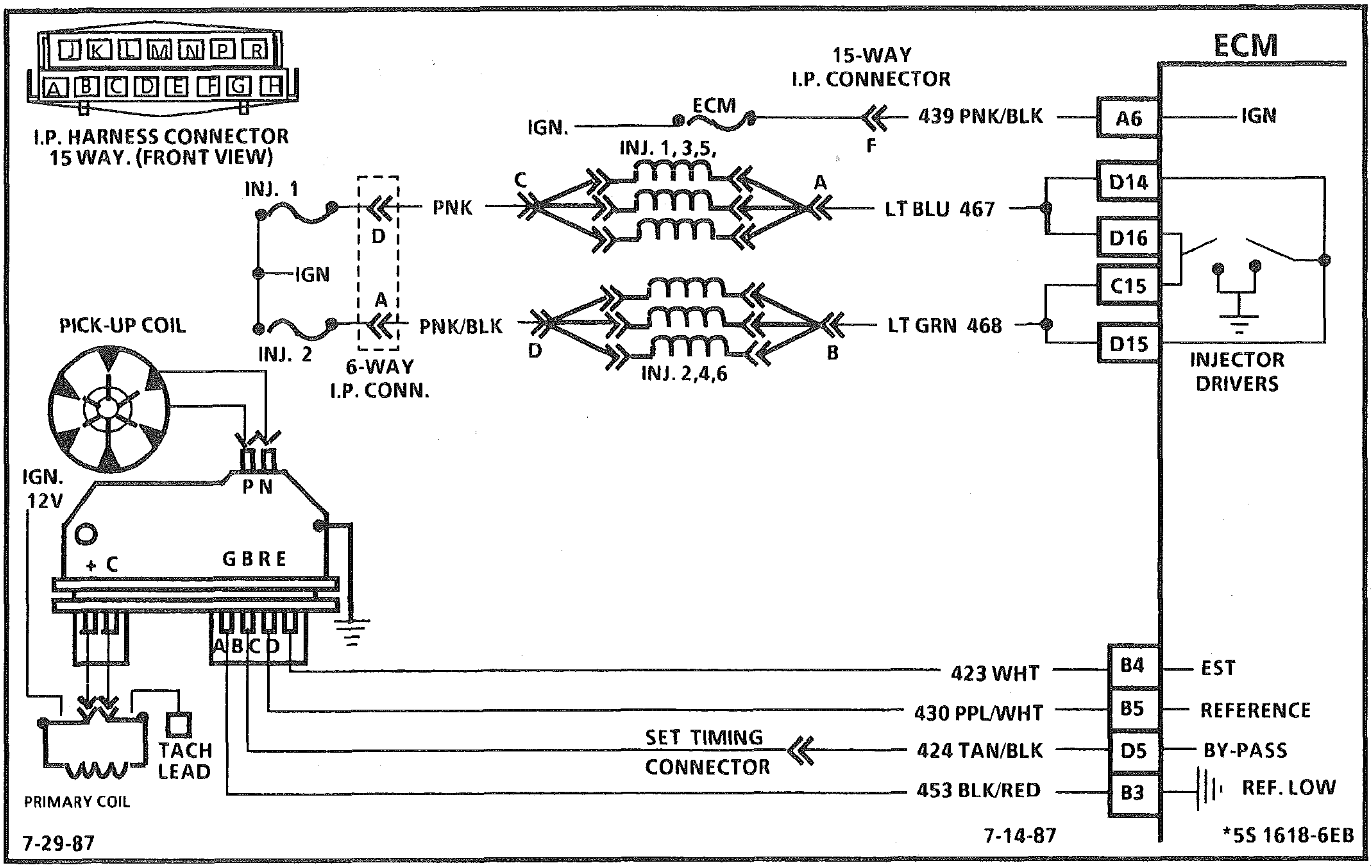


CHART A-3

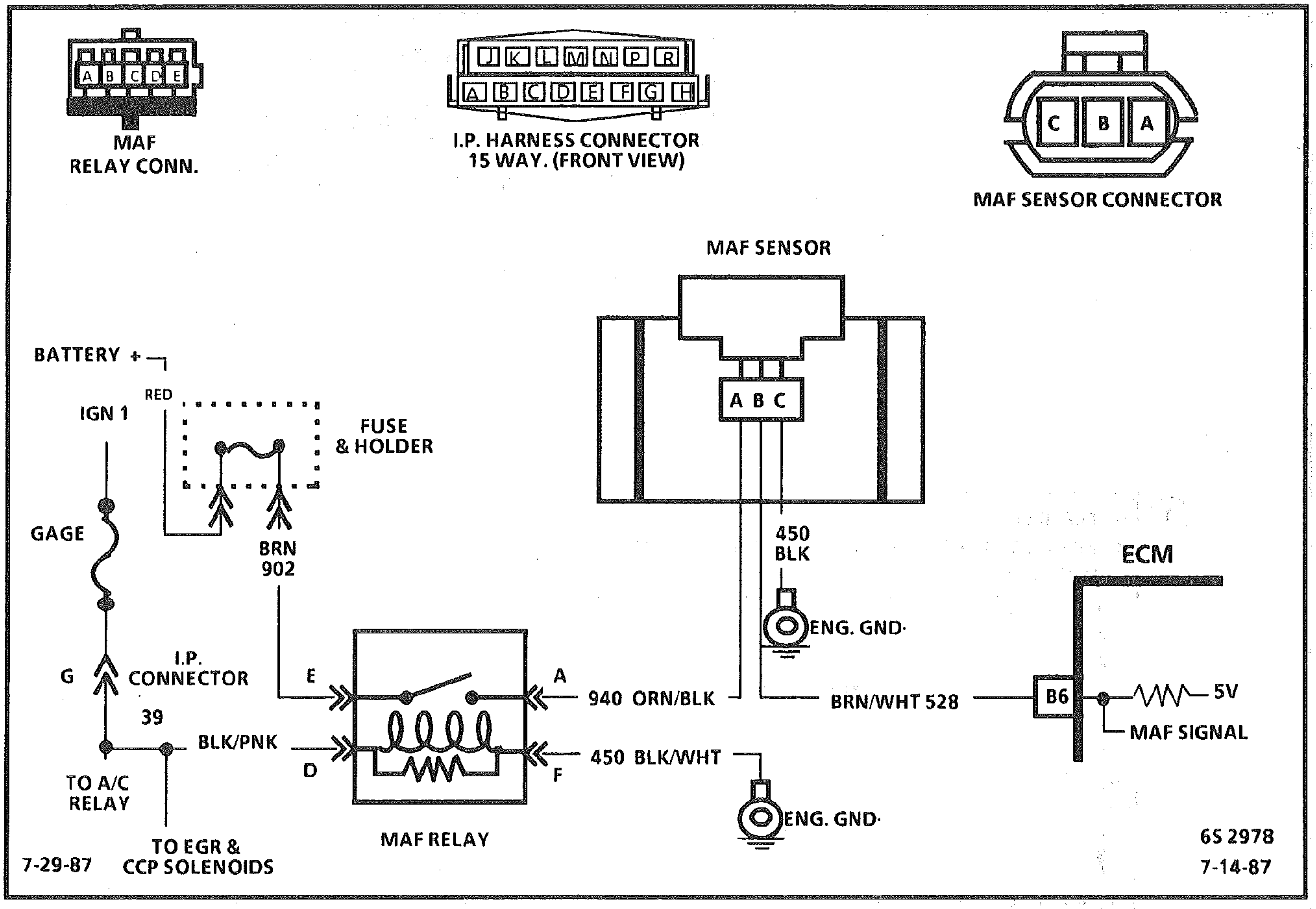
(Page 1 of 2)
ENGINE CRANKS BUT WON'T RUN
2.8L (VIN S) "F" SERIES (PORT)

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. This chart assumes that battery condition and engine cranking speed are OK, and there is adequate fuel in the tank. If engine starts but immediately stalls, see "Symptoms", Section "B" (Hard Start). A "Service Engine Soon" light "ON" is a basic check for ignition and battery supply to the electronic control module (ECM).
2. No spark indicates a basic HEI problem.
3. This test will determine if the ECM is receiving the reference signal and controlling the injectors. This test could also be performed at the 4-way injector connector by using a test light between terminals "A" and "D".
   If the test light "blinks" while cranking, then ECM control should be considered OK. How bright the test light "blinks" is not important. However, the test light should be a J-34730-2 or equivalent.
4. Use pressure gage J-34730-1. Wrap a shop towel around the fuel pressure tap to absorb any small amount of fuel leakage that may occur when installing the gage.

Diagnostic Aids:

- An EGR valve sticking open can cause a low air/fuel ratio during cranking. Unless engine enters "Clear Flood" at the first indication of a flooding condition, it can result in a no start.
- Check for fouled plugs:
- If the TPS is sticking or binding in the wide open throttle position, the ECM will be in the "Clear Flood" mode.
- A defective cold start circuit or water in fuel line can cause a no start in cold weather. To check cold start circuit: See CHART A-9.
- A defective MAF sensor may cause a no start or a stall after start. To determine if the sensor is causing the problem, disconnect it. The ECM will then use a default value for the sensor, and if the condition is corrected and the connections are OK, replace the sensor.
- Also check that injectors on both sides of engine will cause a test light to "blink". Checking of two injectors on each bank in this manner will locate a shorted injector.
  If above are all OK, refer to "Symptoms" in Section "B" "Hard Start".
- Also check that injectors are not open or shorted. Injector resistance should be greater than ohms.



CODE 34

MASS AIR FLOW (MAF) SENSOR CIRCUIT
(GM/SEC LOW)
2.8L (VIN S) "F" SERIES (PORT)

Circuit Description:

The MAF sensor measures the flow of air entering the engine. The sensor produces a frequency output between 32 and 150 hertz (3gm/sec to 150gm/sec). A large quantity (high frequency) indicates acceleration, and a small quantity (low frequency) indicates deceleration or idle. This information is used by the ECM for fuel control and is converted by a "SCAN" tool to read out the air flow in grams per second. A normal reading is about 4-7 grams per second at idle and increase with rpm.

The MAF sensor is powered up by the MAF sensor relay and the sensor should have power supplied to it anytime the ignition is "ON".

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 34 will set if:
   - Engine running
   - MAF sensor disconnected, faulty relay, or MAF signal circuit shorted to ground.

     OR
   - Air flow less than 2 grams per second (low frequency).

   A loose or damaged air duct can set Code 34.

   This test checks to see if ECM recognizes a problem. A light "OFF" at this point indicates an intermittent problem.
2. Checks to see if 5 volt reference signal from ECM is at MAF sensor harness connector.
3. Checks for 12 volt supply to MAF sensor.
4. Checks for open in 12 volt supply to relay.

Diagnostic Aids:

The "Scan" tool is not of much use in diagnosing this code because when the code sets gm/sec will be displaying the default value. However, the "Scan" may be useful in comparing the signal of a problem vehicle with that of a known good running one.

Check for loose or damaged air duct.

Inspect sensor and relay connections as an open will result in a Code 34.

Refer to "Intermittents" in Section "B".

CODE 34

MASS AIR FLOW (MAF) SENSOR CIRCUIT (GM/SEC LOW) 2.8L (VIN S) "F" SERIES (PORT)

1
- CHECK FOR LOOSE OR DAMAGED AIR DUCT BETWEEN MAF SENSOR AND THROTTLE BODY.
- CLEAR CODES.
- START AND IDLE ENGINE FOR 1 MINUTE OR UNTIL CODE 34 SETS.
  DOES CODE SET?

- NO: CODE 34 IS INTERMITTENT. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.
- YES:

2
- IGNITION "OFF".
- DISCONNECT MAF SENSOR ELECTRICAL CONNECTOR.
- IGNITION "ON", ENGINE STOPPED.
- CONNECT VOLTMETER BETWEEN HARNESS CONNECTOR TERMINAL "B" (CKT 528) AND GROUND.
- SHOULD READ 4-6 VOLTS.
  DOES IT?

- NO:
  - LESS THAN 4 VOLTS: CKT 528 OPEN, SHORTED TO GROUND, OR FAULTY ECM.
  - OVER 6 VOLTS: CKT 528 SHORTED TO VOLTAGE OR FAULTY ECM.
- YES: CONNECT TEST LIGHT BETWEEN HARNESS CONNECTOR TERMINALS "A" AND "C".
  - LIGHT "ON": FAULTY MAF SENSOR CONNECTION OR SENSOR.
  - LIGHT "OFF":

3 CONNECT TEST LIGHT BETWEEN HARNESS CONNECTOR TERMINAL "A" AND CHASSIS GROUND.

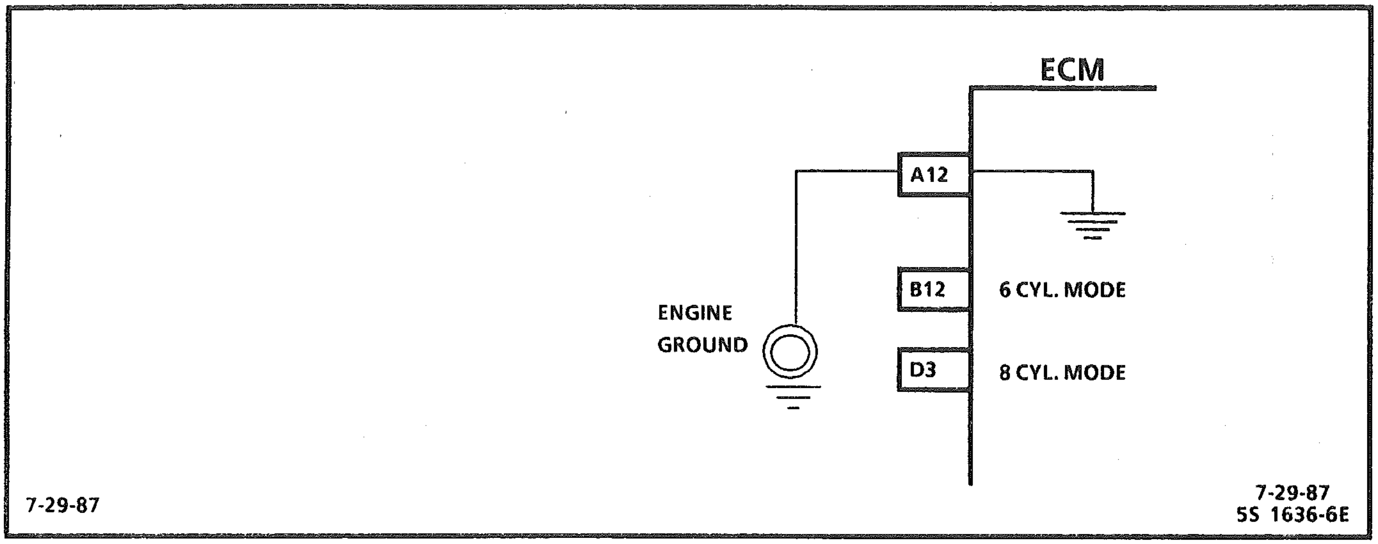
- LIGHT "ON": OPEN CKT 450
- LIGHT "OFF":

4
- DISCONNECT MAF RELAY, IGNITION "ON".
- CONNECT A TEST LIGHT BETWEEN TERMINAL "A" AND GND AND TERMINAL "C" AND GND.

- NO LIGHT ON ONE OR BOTH: REPAIR OPEN IN CIRCUIT THAT DID NOT LIGHT.
- LIGHT ON BOTH: CONNECT TEST LIGHT BETWEEN TERMINALS "A" AND "B" (GND).
  - LIGHT "OFF": REPAIR OPEN GROUND WIRE 450.
  - LIGHT "ON": CKT 940 OPEN SHORTED TO GROUNDD., OR THE MAF RELAY IS FAULTY.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

7-29-87
5S 1635-6E



CODE 41

CYLINDER SELECT ERROR
2.8L (VIN S) "F" SERIES (PORT)

Circuit Description:

Due to the ECM being used for different engines, it is necessary for the engine application to be selected. This is done by leaving "B12" and "D3" open for a six cylinder engine.

A Code 41 will set if the reference pulses are not equal to a value selected within the PROM when engine rpm's are below 2000. This code may set if the incorrect PROM is installed into the ECM.

CODE 41

CYLINDER SELECT ERROR
2.8L (VIN S) "F" SERIES (PORT)

- IGNITION "OFF", CLEAR CODES.
- START ENGINE AND IDLE FOR I MINUTE OR UNTIL CODE 41 SETS.
- DOES CODE 41 SET?

YES

- THERE SHOULD BE NO WIRES CONNECTED TO ECM TERMINALS "B12" OR "D3".

OK

- CHECK FOR CORRECT PROM.
- IF FOUND TO BE THE CORRECT PROM, THE ECM IS FAULTY.

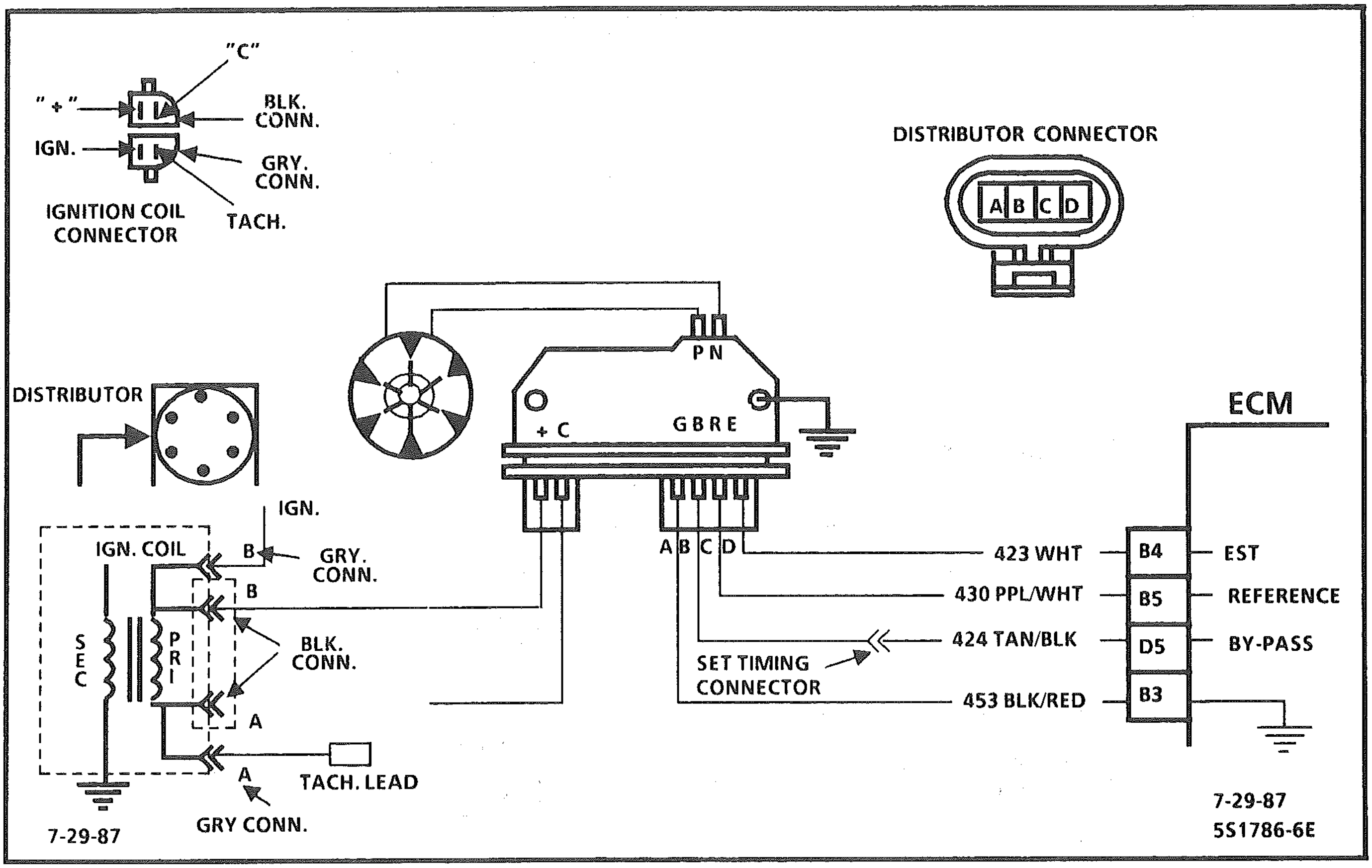
NOT OK

DISCONNECT WIRES FROM CONNECTOR.

NO

CODE 41 IS INTERMITTENT. IF NO OTHER CODES WERE STORED, REFER TO "INTERMITTENTS" IN SECTION "B".

7-29-87
5S 1637-6E



CODE 42

ELECTRONIC SPARK TIMING (EST) FAULT
2.8L (VIN S) "F" SERIES (PORT)

Circuit Description:

When the system is running on the ignition module, that is, no voltage on the bypass line, the ignition module grounds the EST signal. The ECM expects to see no voltage on the EST Line during this condition. If it sees a voltage, it sets Code 42 and will not go into the EST mode.

When the rpm for EST is reached (about 400 rpm), and bypass voltage applied, the EST should on longer be grounded in the ignition module so the EST voltage should be varying.

If the bypass line is open or grounded, the ignition module will not switch to EST mode so the EST voltage will be low and Code 42 will be set.

If the EST line is grounded, the ignition module will switch to EST, but because the line is grounded there will be no EST signal. A Code 42 will be set.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 42 means the ECM has seen an open or short to ground in the EST or bypass circuits. This test confirms Code 42 and that the fault causing the code is present.
2. Checks for a normal EST ground path through the ignition module. An EST CKT 423 shorted to ground will also read less than 500 ohms; however, this will be checked later.
3. As the test light voltage touches CKT 424, the module should switch causing the ohmmeter to "overrange" if the meter is in the 1000-2000 ohms position. Selecting the 10-20,000 ohms position will indicate above 5000 ohms. The important thing is that the module "switched".
4. The module did not switch and this step checks for:
   - EST CKT 423 shorted to ground.
   - Bypass CKT 424 open.
   - Faulty ignition module connection or module.
5. Confirms that Code 42 is a faulty ECM and not an intermittent in CKTs 423 or 424.

Diagnostic Aids:

The "Scan" tool does not have any ability to help diagnose a Code 42 problem.

A PROM not fully seated in the ECM can result in a Code 42.

Refer to "Intermittents" in Section "B".

CODE 42

ELECTRONIC SPARK TIMING (EST) FAULT 2.8L (VIN S) "F" SERIES (PORT)

1
- CLEAR CODES.
- IDLE ENGINE FOR 1 MINUTE OR UNTIL CODE 42 SETS.

DOES CODE 42 SET?

YES

2
- IGNITION "OFF".
- DISCONNECT ECM CONNECTORS.
- IGNITION "ON".
- OHMMETER SELECTOR SWITCH IN THE 1000 TO 2000 OHMS RANGE.
- PROBE ECM HARNESS CONNECTOR CKT 423 WITH AN OHMMETER TO GROUND.

IT SHOULD READ LESS THAN 500 OHMS.
DOES IT?

NO

CODE 42 INTERMITTENT. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

YES

- PROBE ECM HARNESS CONNECTOR CKT 424 WITH A TEST LIGHT TO 12 VOLTS AND NOTE LIGHT.

NO

OPEN CKT 423, FAULTY CONNECTION OR FAULTY IGNITION MODULE.

LIGHT "OFF"

3
- WITH OHMMETER STILL CONNECTED TO ECM HARNESS CKT 423 AND GROUND. AGAIN PROBE ECM HARNESS CKT 424 WITH THE TEST LIGHT CONNECTED TO 12 VOLTS. (AS TEST LIGHT CONTACTS CKT 424, RESISTANCE SHOULD SWITCH FROM UNDER 500 TO OVER 5,000 OHMS,)

DOES IT?

LIGHT "ON"

- DISCONNECT IGNITION MODULE 4-WAY CONNECTOR.

LIGHT "ON"

CKT 424 SHORTED TO GROUND.

LIGHT "OFF"

FAULTY IGNITION MODULE.

NO

4
- DISCONNECT DIST. 4-WAY CONNECTOR . NOTE OHMMETER THAT IS STILL CONNECTED TO CKT 423 AND GROUND. RESISTANCE SHOULD HAVE GONE HIGH (OPEN CIRCUIT) .

DOES IT?

YES

CKT 424 OPEN, FAULTY CONNECTIONS OR FAULTY IGNITION MODULE.

NO

CKT 423 SHORTED TO GROUND.

YES

5
- RECONNECT ECM AND IDLE ENGINE FOR ONE MINUTE OR UNTIL CODE 42 SETS.

DOES CODE SET?

YES

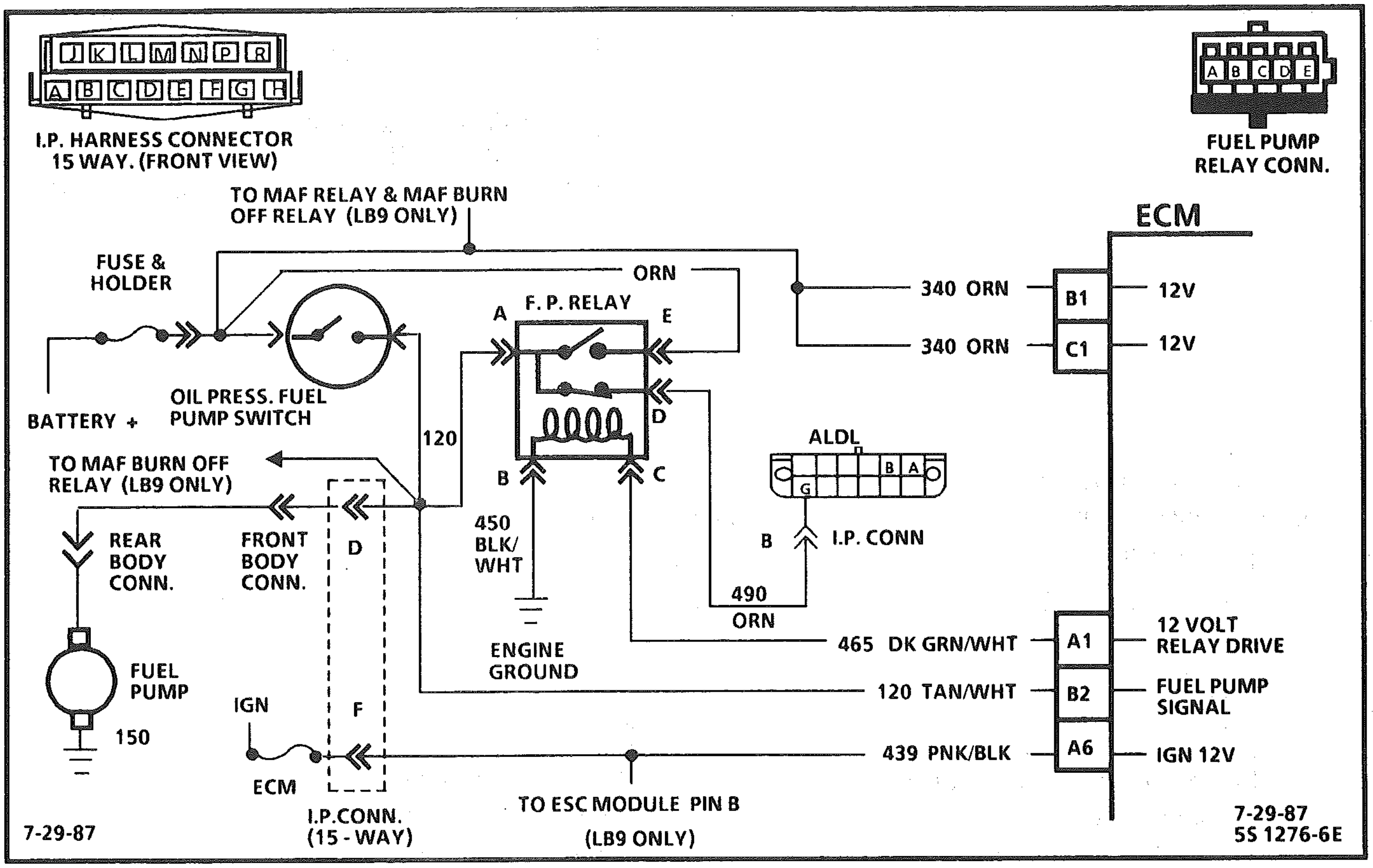
FAULTY ECM

NO

CODE 42 INTERMITTENT. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

2-12-87
* 7S 3291-6E



CODE 54

FUEL PUMP CIRCUIT
(LOW VOLTAGE)
2.8L (VIN S) "F" SERIES (PORT)

Circuit Description:

The status of the fuel pump CKT 120 is monitored by the ECM at terminal "B2", and is used to compensate fuel delivery based on system voltage. This signal is also used to store a trouble code if the fuel pump relay is defective or fuel pump voltage is lost while the engine is running. There should be about 12 volts on CKT 120 for 2 seconds after the ignition is turned or any time references pulses are being received by the ECM.

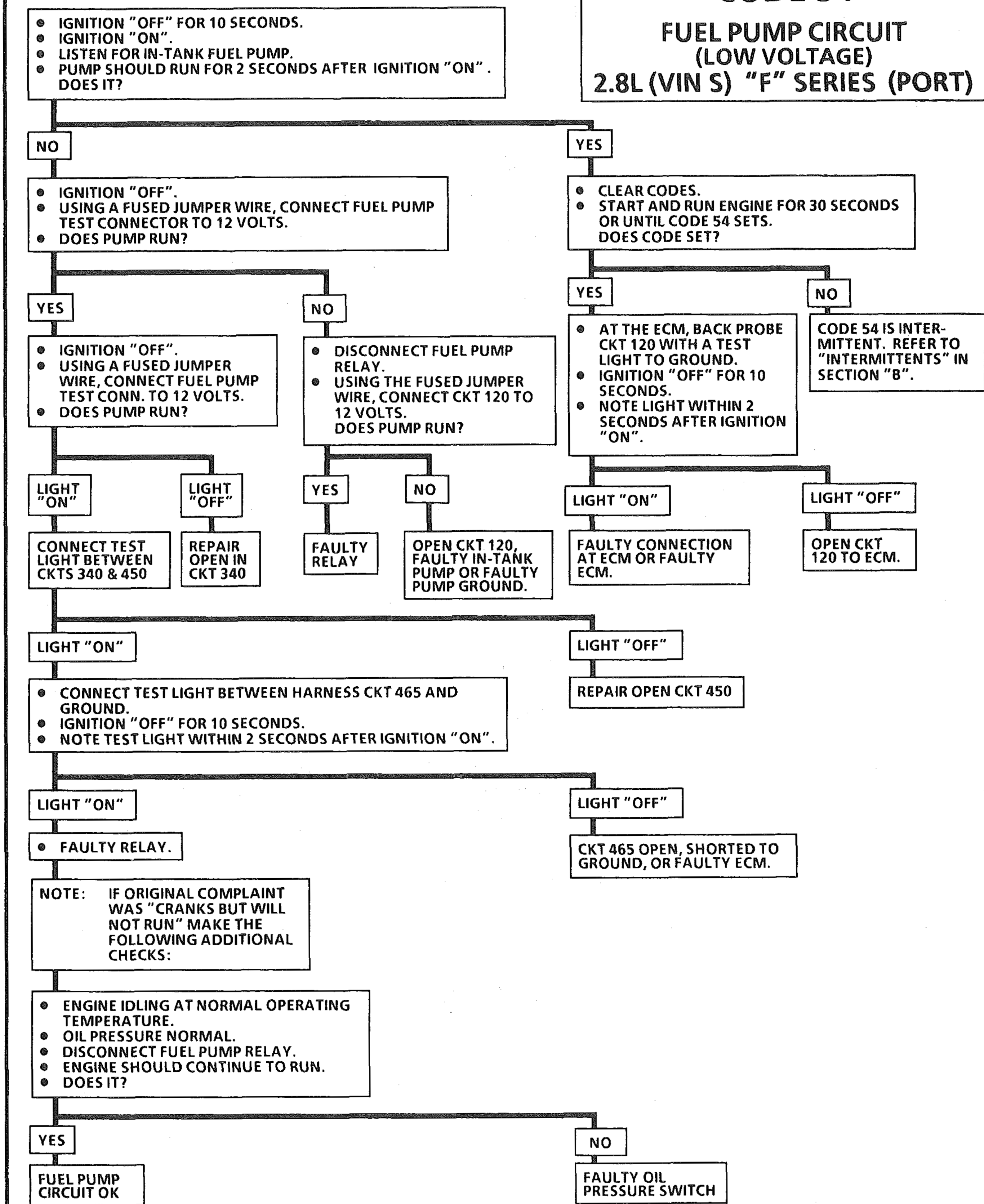
Diagnostic Aids:

Code 54 will set if the voltage at terminal "B2" is less than 2 volts for 1.5 seconds since the last reference pulse was received. This will help in detecting a faulty relay, causing extended crank time and the code will help the diagnosis of an engine that "CRANKS BUT WILL NOT RUN".

If a fault is detected during start-up the "Service Engine Soon" light will stay "ON" until the ignition is cycled off. However, if the voltage is detected below 2 volts with the engine running the light will only remain on while the condition exists.

CODE 54

FUEL PUMP CIRCUIT (LOW VOLTAGE) 2.8L (VIN S) "F" SERIES (PORT)



7-16-87
*7S 3155-6E

Park/Neutral Switch (Auto Only)

The Park/Neutral (P/N) switch indicates to the ECM when the transmission is in Park or Neutral. This information is used for the TCC and the IAC valve operation.

Important

Vehicle should not be driven with Park/Neutral switch disconnected as idle quality will be affected and a possible false Code 24 (VSS).

See Section "8A" for more information on the P/N switch, which is part of the neutral/start and backup light switch assembly.

A/C "On" Signal

This signal tells the ECM that the A/C selector Switch is turned on, and that the pressure cycling switch is closed. The ECM uses this to adjust the idle Speed when the air conditioning is working.

If this signal is not available to the ECM, idle may be rough, especially when the A/C compressor cycles. The voltage at ECM terminal "B8" should equal battery voltage when A/C is requested and the pressure cycling switch is closed.

The signal at B8 will cause the ECM to turn on the A/C clutch by energizing the A/C relay.

Distributor Reference Signal

The distributor sends a signal to the ECM to tell it both engine RPM and crankshaft position. See EST System for further information.

DIAGNOSIS

To read the codes, use a "Scan" tool or ground the diagnostic terminal with the engine not running and the ignition on. The "Service Engine Soon" light will flash Code 12 three times and then flash each code stored in memory three times. All codes stored in memory would have been read when Code 12 was flashed again. No new codes can be stored when in the Diagnostics Mode (diagnostics lead grounded). This eliminates confusion while the system is being worked on.

To clear the codes from memory:

- Ignition off
- Remove fuse located in a weather proof holder located near the battery for 30 seconds.

Since the ECM can have a failure which may effect only one circuit, following the Diagnostic Procedures in this section will determine which circuit has a problem and where it is.

If a diagnostic chart indicates that the ECM connections or ECM is the cause of a problem and the ECM is replaced, but does not correct the problem, one of the following may be the reason:

- <u>There is a problem with the ECM terminal connections</u>. - The diagnostic chart will say "ECM connections or ECM. The terminals may have to be removed from the connector in order to check them properly.
- <u>The ECM or PROM is not correct for the application</u>. - The incorrect components may cause a malfunction and may or may not set a code.
- <u>The problem is intermittent</u>. - This means that the problem is not present at the time the system is being checked. In this case, refer to the "Symptoms" portion of the manual and make a careful physical inspection of all portions of the system involved.
- <u>Shorted solenoid, relay coil, or harness</u>. - Solenoids and relays are turned "ON" and "OFF" by the ECM,using internal electronic switches called "Drivers". Each driver is part of a group of four called "Quad-drivers". Failure of one driver can damage any other driver in the set. Solenoid and relay coil resistance must measure more than 20 ohms. Less resistance will cause early failure of the ECM "driver". A shorted solenoid, relay coil, or harness, with a GMP4 computer, will not damage the ECM, but will cause the component to be inoperative.

  Before replacing an ECM, be sure to check the coil resistance of all solenoids and relays controlled by the ECM. See ECM wiring diagram for the solenoid(s) and relay(s) and the coil terminal identification.

  J34636 or BT 8405 testers or equivalent provide a fast, accurate means of checking for a shorted coil or a short to battery voltage.
- <u>The PROM may be faulty</u>. - Although these rarely fail, it operates as part of the ECM. Therefore, it could be the cause of the problem. Substitute a known good PROM.
- <u>The replacement ECM may be faulty</u>. - After the ECM is replaced, the system should be rechecked for proper operation. If the diagnostic chart again indicates the ECM is the problem, substitute a known good ECM. Although this is a rare condition, it could happen.

ECM

A faulty ECM will be determined in the diagnostic charts or by a Code 55.

PROM

A faulty PROM may result in a Code 51.

Important

When replacing the production ECM with a service ECM (controller), it is important to transfer the Broadcast code and production ECM number to the service ECM label. Please do not record on ECM cover. This will allow positive identification of ECM parts throughout the service life of the vehicle.

Important

To prevent internal ECM damage, the ignition must be "OFF" when disconnecting or reconnecting power to ECM (for example, battery cable, ECM pigtail, ECM fuse, jumper cables, etc.).

ECM AND COMPONENTS REPLACEMENT PROM OR ECM

Code 51 indicates a faulty PROM, possibly caused by bent pins, or incorrect installation.

Important

It is possible to install a PROM backwards. If the PROM is installed backwards and the ignition key turned to "ON," the PROM circuitry will be destroyed, requiring PROM replacement.

NOTICE: The ignition should always be off when installing or removing the ECM connectors or internal components.

Remove or Disconnect

1. Negative battery cable.
2. Right hand hush panel.
3. Connectors from ECM.
4. ECM mounting hardware.
5. ECM from passenger compartment.
6. ECM access cover (see Figure C1-6).
7. Remove PROM assembly.

Important

Using the rocker-type PROM removal tool, engage one end of the PROM carrier with the hook end of the tool (see Figure C1-8). Press on the vertical bar end of the tool and rock the engaged end of the PROM carrier up as far as possible. Engage the opposite end of the PROM carrier in the same manner and rock this end up as far as possible. Repeat this process until the PROM carrier and PROM are free of the PROM socket. The PROM carrier with PROM in it Should lift off of the PROM socket easily. PROM carrier should only be removed by using the pictured PROM removal tool. Other methods could cause damage to the PROM or PROM socket.

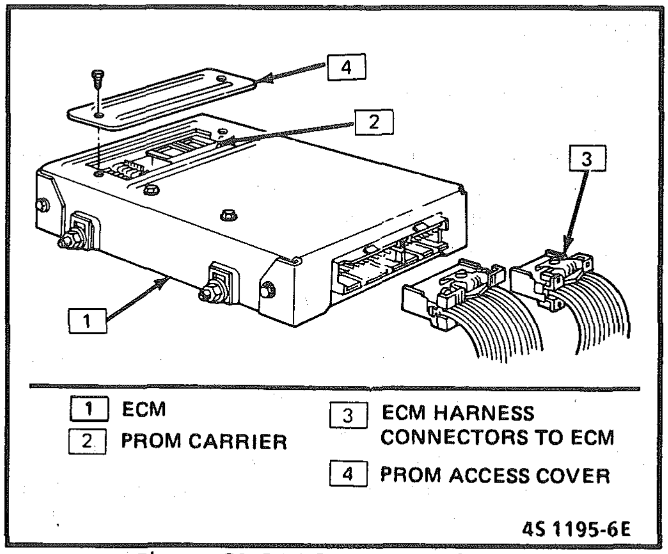


Figure C1-6 PROM Access Cover

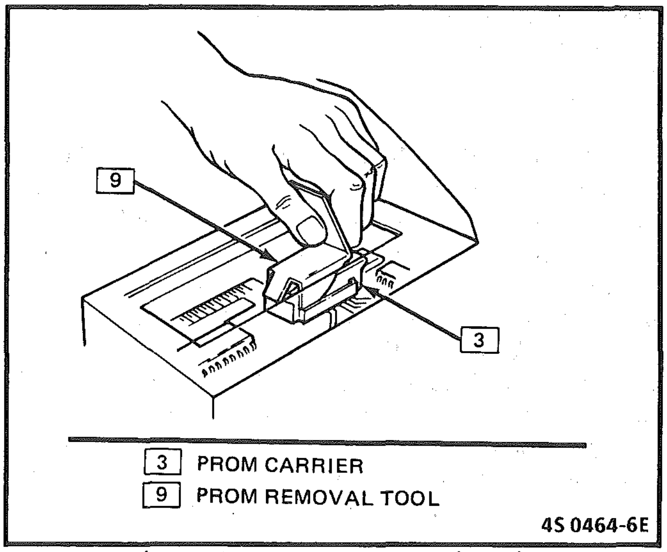


Figure C1-7 PROM Removal Tool

Inspect

1. New PROM for same part number as old.

Important

Do not remove PROM from carrier to check PROM number

2. For correct reference of PROM in carrier, Figure C1-8.
3. CALPAK Assembly

Using the removal tool, pictured in Figure C1-9, grasp the carrier at the narrow ends. Gently rock the carrier from end to end while applying a firm upward force and remove the CALPAK and carrier. Use of unapproved CALPAK removal tools or methods will cause damage to the CALPAK or CALPAK socket.

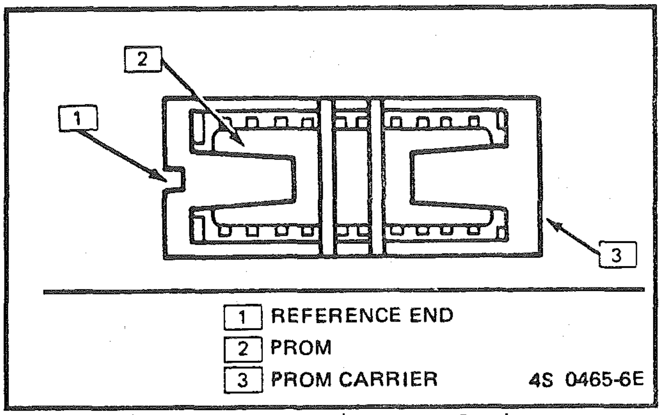


Figure C1-8 PROM in PROM Carrier

Install or Connect

1. New PROM carrier in PROM socket.
2. CALPAK in CALPAK socket.

Important

Small notch of carrier should be aligned with small notch in socket. Press on PROM carrier until it is firmly seated in the socket. Do not press on PROM; only the carrier.

3. Access cover on ECM.
4. ECM in passenger compartment.
5. Connectors to ECM.

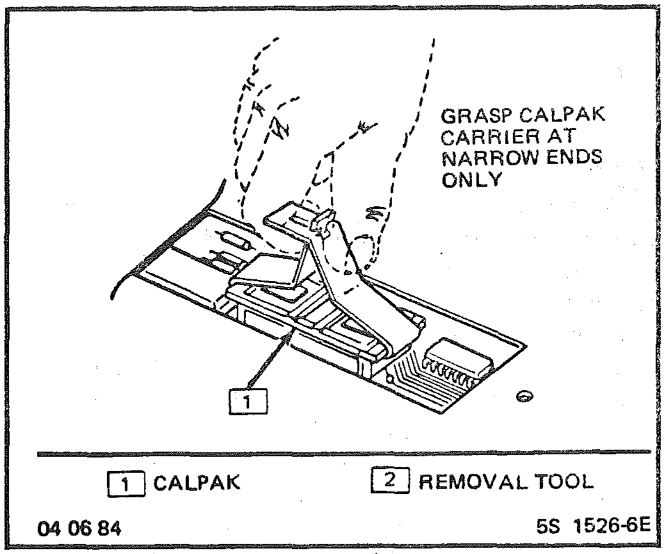


Figure C1-9 Removing CALPAK

Functional Check

1. Turn ignition on.
2. Enter diagnostics (see Diagnostic Circuit Check for procedure).
   A. Code 12 should flash at least four times. (No other codes present). This indicates the PROM and CALPAK is installed properly.
   B. If Trouble Code 51 occurs or if the "Service Engine Soon" light is on constantly with no codes, the PROM is not fully seated, installed backwards, has bent pins, or is defective. If Code 52 occurs, the CALPAK is not fully seated, installed backwards, has bent pins, or is defective.
      - If not fully seated, press firmly on PROM or CALPAK carrier.
      - If it is necessary to remove the PROM or CALPAK, follow instructions in steps "A" and "B".
      - If installed backwards, REPLACE THE PROM. The CALPAK may be removed and reinstalled correctly.
      - If pins bend, remove PROM or CALPAK, straighten pins, and reinstall. If bent pins break or crack during straightening, discard PROM or CALPAK and replace it.

Important

Any time the PROM in installed backwards and the ignition switch turned "ON," the PROM is destroyed.

CALPAK see figure C1-9 or refer to step 3 of PROM and ECM replacement.

COOLANT SENSOR

NOTICE: Care must be taken when handling coolant sensor. Damage to coolant sensor will affect proper operation of the Fuel Injection system.

Remove or Disconnect

1. Negative battery cable.
2. Electrical connector.
3. Carefully back out coolant sensor.

Install or Connect

1. Sensor in engine.
2. Electrical connector.
3. Negative battery cable.

MAF SENSOR

Replacement of the MAF sensor is shown in Figure C1-10. When replacing the MAF sensor, replace clamps with special screw type clamps (Service Part).

MAF SENSOR POWER & BURN-OFF RELAY

Refer to Figure C1-11 for relay location. The MAF power relay is to the right of the radiator.

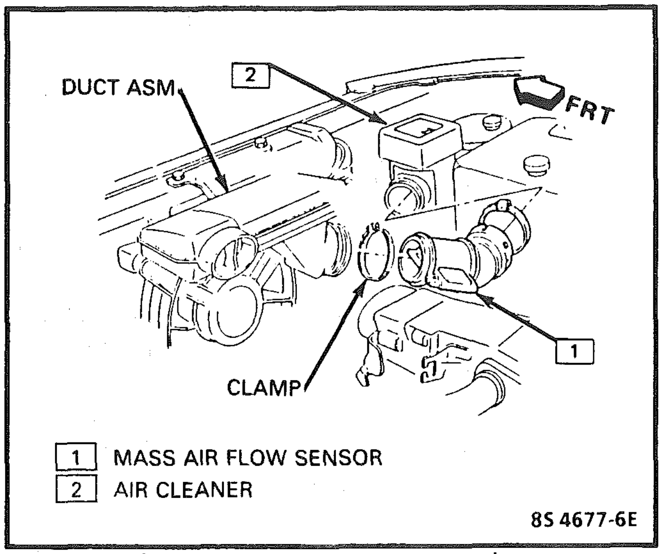


Figure C1-10 MAF Sensor Service

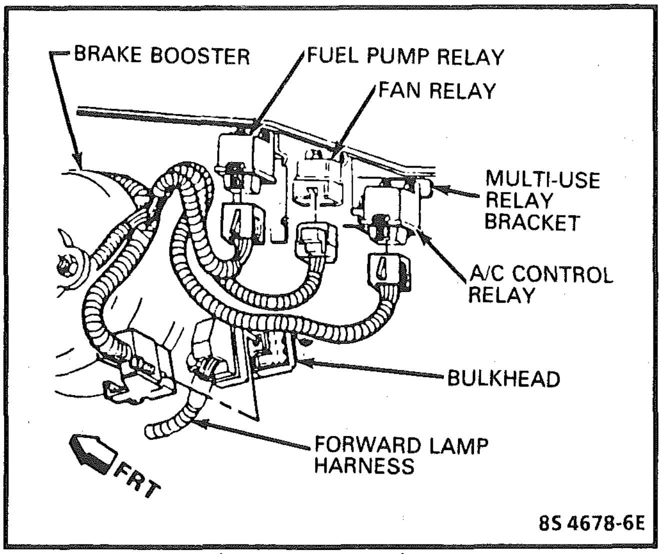


Figure C1-11 Relays

OXYGEN SENSOR

NOTICE: The oxygen sensor uses a permanently attached pigtail and connector. This pigtail should not be removed from the oxygen sensor. Damage or removal of the pigtail or connector could affect proper operation of the oxygen sensor.

Important

Take care when handling the oxygen sensor. The in-line electrical connector and louvered end must be kept free of grease, dirt or other contaminants. Also, avoid using cleaning solvents of any type. Do not drop or roughly handle the oxygen sensor.

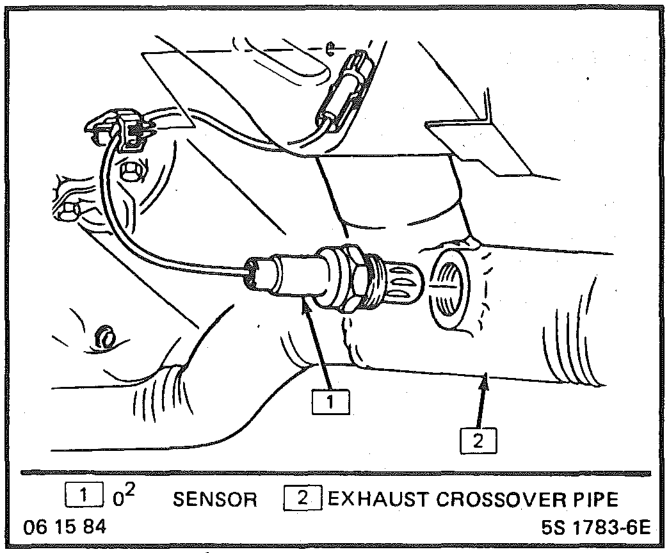


Figure C1-12 O_2 Sensor

Remove or Disconnect

The oxygen sensor may be difficult to remove when engine temperature is below 48°C (120°F).

Excessive force may damage threads in exhaust manifold or exhaust pipe.

1. Negative battery cable.
2. Electrical connector.
   The vehicle should be raised on hoist because the O_2 sensor is mounted behind the exhaust Y-pipe.
3. Carefully back out Oxygen Sensor.

Install or Connect

Important

A special anti-seize compound is used on the oxygen sensor threads. The compound consists of a liquid graphite and glass beads. The graphite will burn away, but the glass beads will remain, making the sensor easier to remove.

New or service sensors will already have the compound applied to the threads. If a sensor is removed from an engine, and, if for any reason it is to be reinstalled, the threads must have anti-seize compound applied before reinstallation.

1. Coat threads of oxygen sensor with anti-seize compound P/N 5613695 or equivalent if necessary.
2. Sensor, and torque to 41 N-m (30 ft. lbs.).
3. Electrical connector.
4. Negative battery cable.

Throttle Position Sensor (TPS)

Remove or Disconnect

1. Electrical connector.
2. Two TPS attaching screws and retainers.
3. Sensor.

Install or Connect

1. With throttle valve in the normal closed idle position, install throttle position sensor on throttle body assembly, making sure TPS pickup lever lines up with tang on throttle actuator lever. (See Figure C1-13)
2. Retainers and two TPS screws.

DO NOT tighten screws until TPS is adjusted.

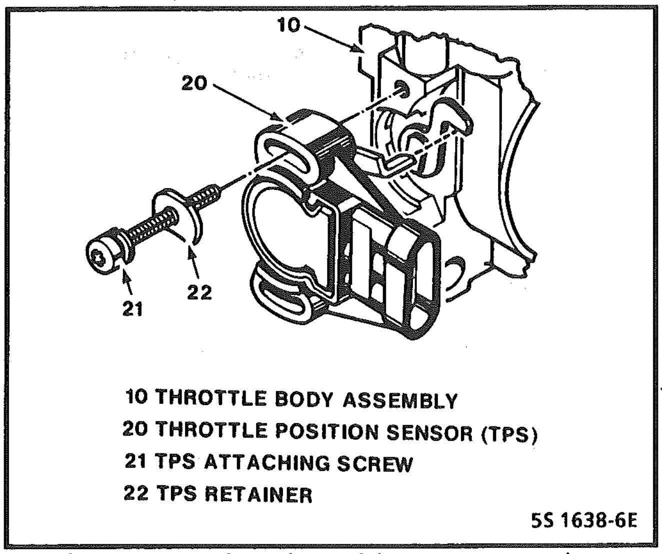


Figure C1-13 Throttle Position Sensor Service

Adjust

1. Install "Scan" tool and select TPS.
2. With ignition "ON," adjust TPS to obtain;
   - .55 volts ± 0.1 volts
3. Tighten screws, then recheck reading to insure that adjustment has not changed.

PARK/NEUTRAL SWITCH

See Section "8A" for location of Park/Neutral Switch. On-Car Service and Adjustment Procedures are also listed there.

PARTS INFORMATION

PART NAME	GROUP
Controller, ECM	3.670
Calibrator, PROM (Mem-Cal)	3.670
Sensor, Coolant Temp	3.682
Sensor, Exhaust Oxygen	3.682
Sensor, Manifold Air Temp (MAT)	3.682
Sensor, Mass Air Flow (MAF)	3.682
Relay - MAF Burn-off	3.682
Relay - MAF Power	3.682
Sensor, Throttle Position: Part of Sensor Kit, Throttle Position	3.440
Sensor, Vehicle Speed	3.682

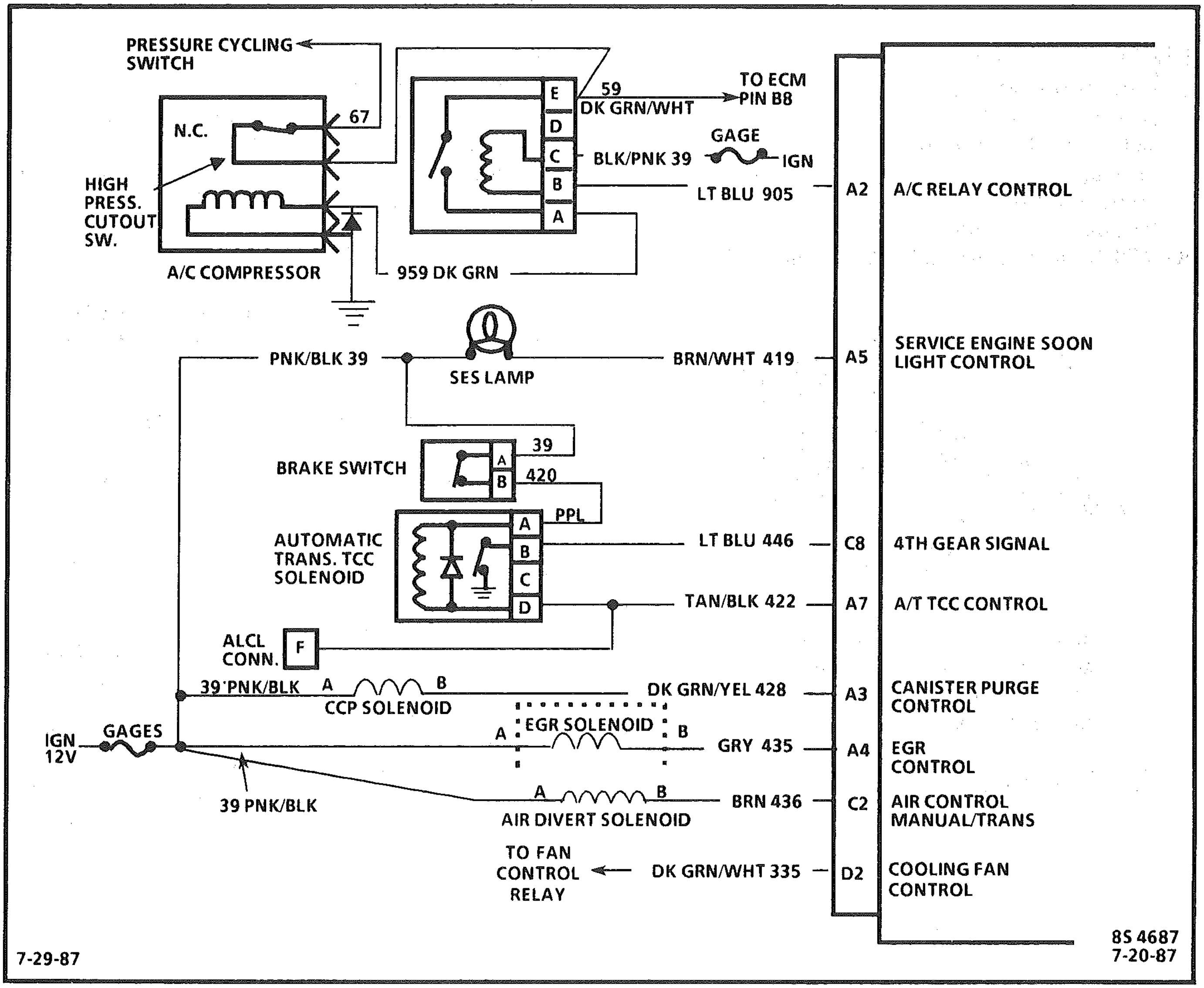


CHART C-1

ECM QDR CHECK
2.8L (VIN S) "F" SERIES (PORT)

ECM Quad Driver (QDR) Check

The ECM uses an integrated circuit (IC) called a quad driver (QDR) in place of separate transistors to turn "ON" or "OFF" different circuits controlled by the ECM. Each QDR has four separate outputs that can independently turn "ON" or "OFF" four different circuits.

ECM service part number 1227302, used with this engine, does not have fault protection, therefor, a single faulty circuit many time causes all four QDR outputs to be inoperative or "ON" all the time. A failed QDR usually results in either a shorted or open ECM output. Because of the increased current flow, two QDR outputs are used to drive the TCC solenoid.

Refer to the ECM QDR check procedure on the facing page. This check will not test all ECM functions, but it will determine if a specific circuit has caused a specific QDR to fail in the ECM.

A faulty circuit is the largest cause of a failed QDR, therefore, the check procedure should be used whenever ECM replacement is indicated, especially if the removed ECM exhibits characteristics of a damaged QDR such as:

- SES light with no code stored.
- Engine will not start and/or ECM will not flash Code 12.
- Flickering, intermittent, or dim SES light.
- Output, such as TCC circuit, is inoperative or "ON" at all times.
- Engine misfires, surges or stalls.
- "Scan" tool is erratic or inoperative.

CHART C-1

ECM QDR CHECK
2.8L (VIN S) "F" SERIES (PORT)

USE THIS CHECK PROCEDURE ONLY AFTER OTHER DIAGNOSTIC CHARTS , IN THIS SERVICE MANUAL HAVE DETERMINED THAT THERE WAS AN ECM FAILURE.

- REMOVE THE ECM FROM THE VEHICLE.

- REFER TO LIST BELOW OF THE ECM TERMINALS WHICH ARE QDR OUTPUTS.
- USING THE 100/200 K OHM SCALE ON DVM*, MEASURE RESISTANCE BETWEEN THE ECM CASE AND EACH ECM TERMINAL LISTED, BLACK (NEG.) LEAD TO CASE AND RED (POS.) LEAD TO ECM TERMINAL.
- ALL TERMINALS LISTED SHOULD HAVE RESISTANCE OF 50K OHMS OR MORE.
- DO THEY?

NO

THE PRIOR TEST HAS DETERMINED THAT A QDR IN THE ECM HAS BEEN DAMAGED. IT IS MOST IMPORTANT TO LOCATE AND REPAIR THE CIRCUIT OR COMPONENT THAT CAUSED THE DAMAGE. FAILURE TO DO SO WILL RESULT IN ANOTHER FAILURE OF THE NEWLY REPLACED ECM. ANY TERMINAL WITH LESS THAN 50K OHMS RESISTANCE IS CONNECTED TO A DEFECTIVE QDR. THE ECM TERMINAL WITH THE LOWEST RESISTANCE WAS CONNECTED TO THE VEHICLE CIRCUIT MOST LIKELY TO HAVE CAUSED THE QDR FAILURE.

- DISCONNECT THE COMPONENT IN THAT VEHICLE CIRCUIT AND CHECK FOR A SHORT TO VOLTAGE. IF THE CIRCUIT IS NOT SHORTED TO VOLTAGE, REPLACE THE COMPONENT IN THAT CIRCUIT AND THE ECM.

YES

- KEY "ON", ENGINE NOT RUNNING.
- USE A FUSED AMMETER CAPABLE OF MEASURING AT LEAST 2 AMPS (J-34029-A OR EQUIVALENT).
- CONNECT ONE LEAD OF THE AMMETER TO CHASSIS GROUND.
- CONNECT THE REMAINING LEAD TO EACH VEHICLE CIRCUIT WHICH WAS LISTED ABOVE.
- MEASURE SUSTAINED CURRENT FLOW THROUGH EACH CIRCUIT FOR 2 MINUTES EACH (IN MOST CASES, THE TCC SOLENOID CANNOT BE EASILY TESTED FOR CURRENT DRAW).
- NOTE AMPERAGE.

IF A CIRCUIT(S) HAS MORE THAN 0.75 AMPS CURRENT DRAW.

- CHECK FOR A SHORT TO VOLTAGE IN EXCESSIVE CURRENT DRAW CIRCUIT.
- IF NO SHORT TO VOLTAGE, REPLACE RELATED SOLENOID OR RELAY.

IF NO CIRCUIT HAS MORE THAN 0.75 AMPS CURRENT DRAW.

- REPLACE ECM

ECM# 1227302

QDR NUMBER	ECM OUTPUT TERMINAL	CIRCUIT
1	A2	A/C RELAY CONTROL
	A4	EGR CONTROL
	A5	SES LIGHT
2	A3	CANNISTER PURGE SOL.
	D2	COOLANT FAN RELAY
3	A7	SHIFT LIGHT M/T TCC CONTROL A/T
	C2	AIR DIVERT SOLENOID

*** USE DVM J-34029-A OR EQUIVALENT**

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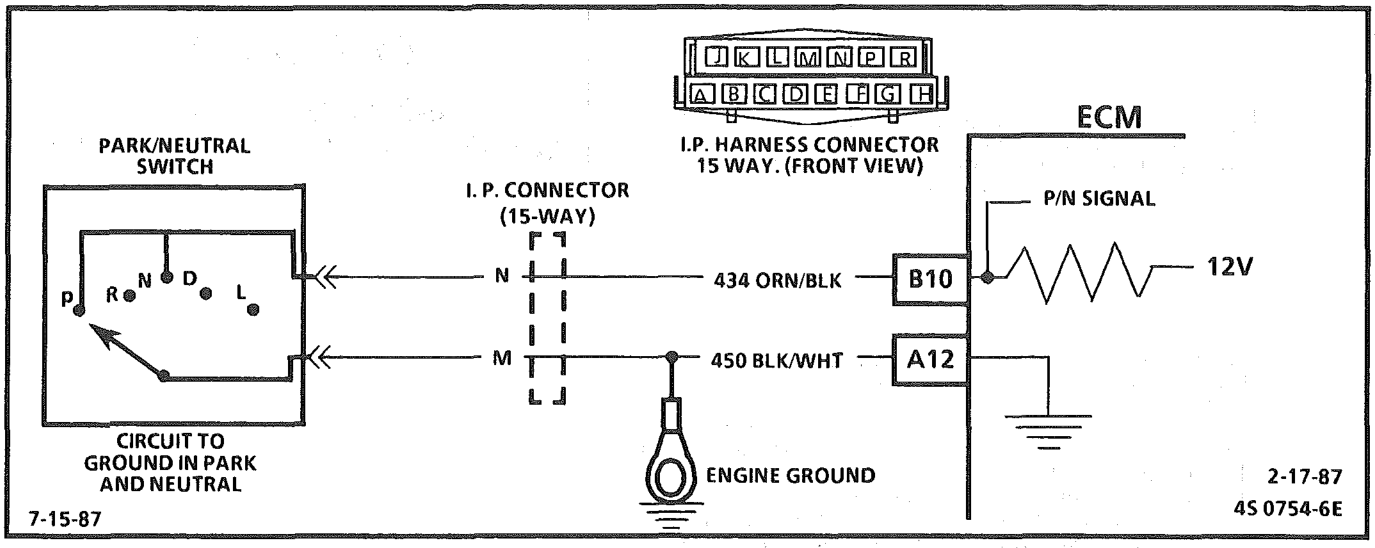

CHART C-1A

PARK/NEUTRAL SWITCH
2.8L (VIN S) "F" SERIES (PORT)

Circuit Description:

The Park/Neutral Switch contacts are a part of the Neutral Start switch, and are closed to ground in park or neutral and open in drive ranges.

The ECM supplies ignition voltage, through a current limiting resistor, to CKT 434 and senses a closed switch, when the voltage on CKT 434 drops to less than one volt.

The ECM uses the P/N signal as one of the inputs to control:

Idle Air Control
VSS Diagnostics
EGR

If CKT 434 indicates P/N (grounded), while in drive range, the EGR would be inoperative, resulting in possible detonation.

If CKT 434 always indicates drive (open), a drop in the idle may exist when the gear selector is moved into drive range.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Checks for a closed switch to ground in park position. Different makes of "Scan" tools will read P/N differently. Refer to operator's manual for type of display used for a specific tool.
2. Checks for an open switch in drive range.
3. Be sure "Scan" indicates drive, even while wiggling shifter to test for an intermittent or misadjusted switch in drive range.

CHART C-1A

PARK/NEUTRAL SWITCH
2.8L (VIN S) "F" SERIES (PORT)

1
- WITH TRANSMISSION IN PARK, "SCAN" SHOULD INDICATE PARK OR NEUTRAL.
- DOES IT?

YES

3
- SHIFT TRANSMISSION INTO DRIVE.
- "SCAN" SHOULD DISPLAY A CHANGE TO INDICATE DRIVE.
- DOES IT?

YES

NO TROUBLE FOUND. P/N CIRCUIT OK.

NO

- DISCONNECT P/N SWITCH.
- THIS SHOULD CAUSE "SCAN" TO DISPLAY DRIVE RANGE.
- DOES IT?

YES

P/N SWITCH MISADJUSTED OR FAULTY.

NO

CKT 434 SHORTED TO GROUND OR FAULTY ECM.

NO

2
- DISCONNECT PARK/NEUTRAL SWITCH CONNECTOR.
- JUMPER TERMINALS "A" TO "B" (CKT 434 TO 450).
- "SCAN" SHOULD INDICATE PARK OR NEUTRAL.
- DOES IT?

YES

FAULTY P/N SWITCH CONNECTION OR P/N SWITCH MISADJUSTED OR FAULTY .

NO

- JUMPER TERMINAL "A" (CKT 434) TO ENGINE GROUND.
- "SCAN" SHOULD INDICATE PARK OR NEUTRAL.
- DOES IT?

YES

OPEN GROUND CKT 450.

NO

CKT 434 OPEN OR FAULTY ECM CONNECTION OR ECM.

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*7S 3161-6E

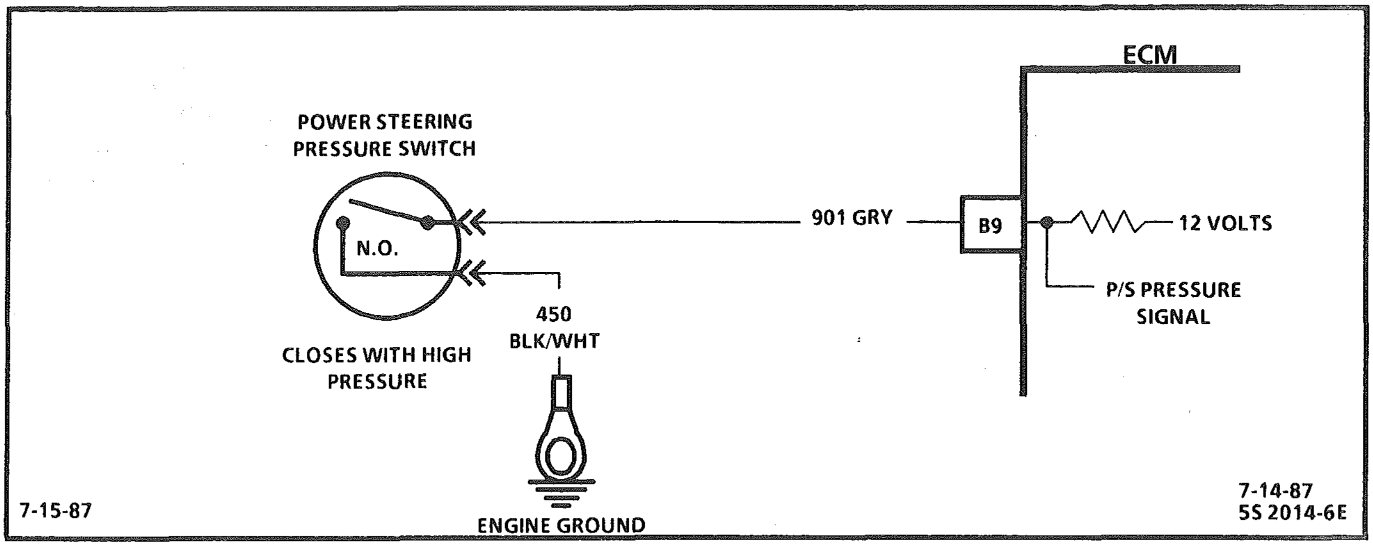


CHART C-1E

POWER STEERING PRESSURE SWITCH
2.8L (VIN S) "F" SERIES (PORT)

Circuit Description:

The power steering pressure switch is normally open to ground, and CKT 901 will be near the battery voltage.

Turning the steering wheel increases power steering oil pressure and its load on an idling engine. The pressure switch will close before the load can cause an idle problem.

Closing the switch causes CKT 901 to read less than 1 volt. The ECM will increase the idle air rate and disengage the A/C relay.

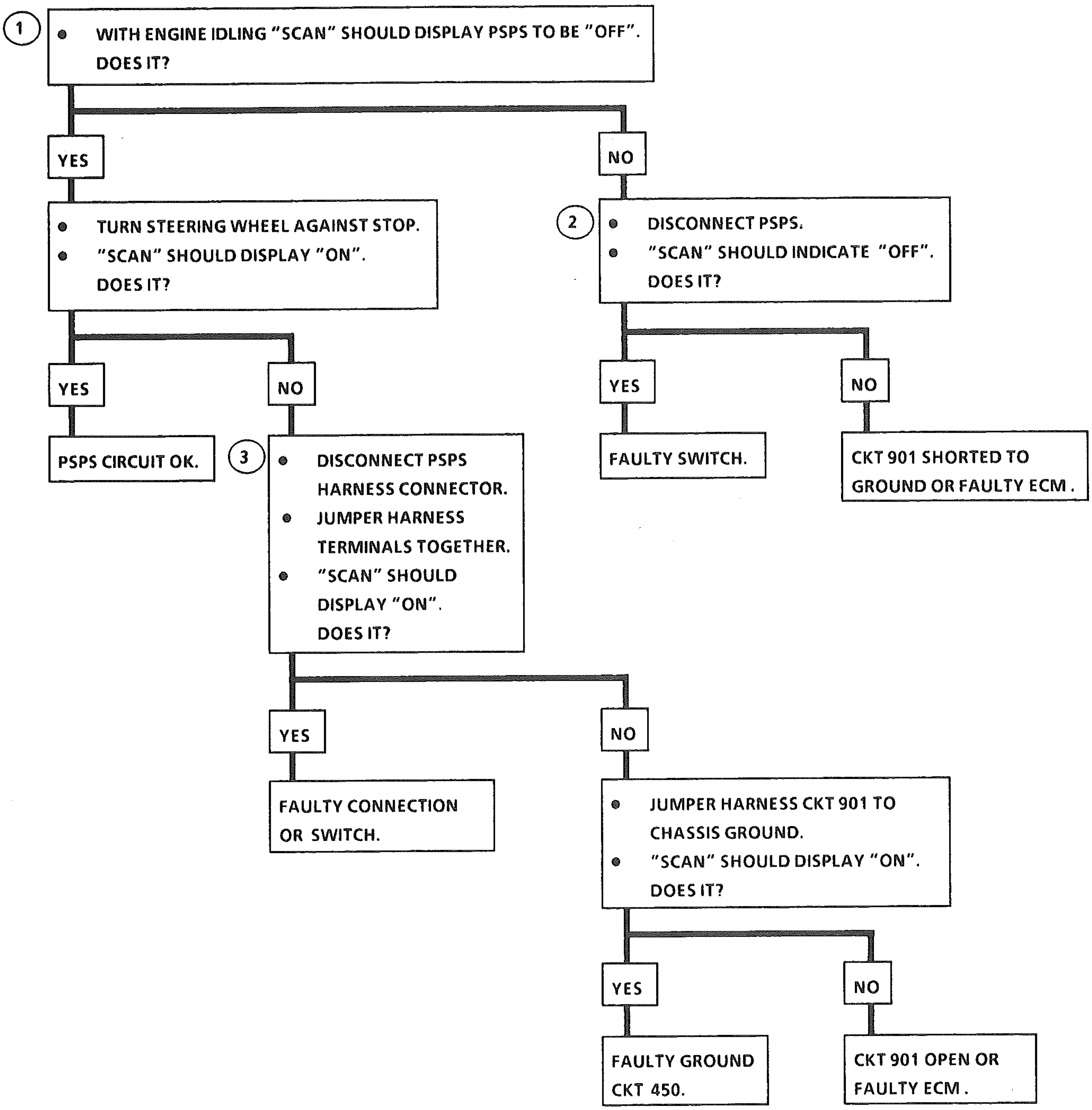
- A pressure switch that will not close, or an open CKT 901 or 450, may cause the engine to stop when power steering loads are high.
- A switch that will not open, or a CKT 901 shorted to ground, may affect idle quality and will cause the A/C relay to be de-energized.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Different makes of "Scan" tools may display the state of this switch in different ways. Refer to "Scan" tool operator's manual to determine how this input is indicated.
2. Checks to determine if CKT 901 is shorted to ground.
3. This should simulate a closed switch.

CHART C-1E

POWER STEERING PRESSURE SWITCH 2.8L (VIN S) "F" SERIES (PORT)



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CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

* 7S 3163

BLANK

SECTION C2

FUEL CONTROL SYSTEM

CONTENTS

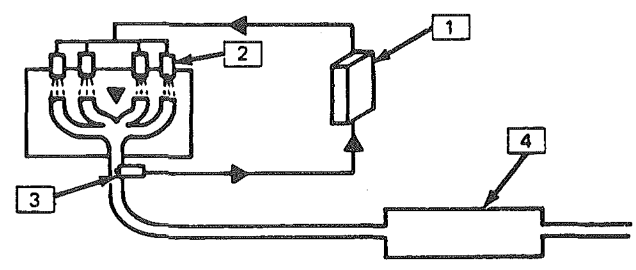
GENERAL DESCRIPTION

PURPOSE

The basic function of the fuel control system is to control fuel delivery to the engine.

Fuel is delivered to the engine by individual fuel injectors mounted in the intake manifold near each cylinder.

The main control sensor is the oxygen (O_2) sensor, which is located in the exhaust manifold. The O_2 sensor tells the ECM how much oxygen is in the exhaust gas, and the ECM changes the air/fuel ratio to the engine by controlling the fuel injectors. The best mixture to minimize exhaust emissions is 14.7 to 1, which allows the catalytic converter to operate the most efficiently. Because of the constant measuring and adjusting of the air/fuel ratio, the fuel injection system is called a "Closed Loop" system (shown in Figure C2-1).



1 ELECTRONIC CONTROL MODULE (ECM)
2 FUEL INJECTORS
3 EXHAUST OXYGEN O_2 SENSOR
4 CATALYTIC CONVERTER

4S 0997-6E

Figure C2-1 Closed Loop System

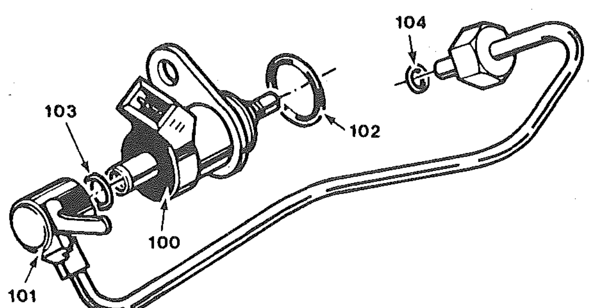
MODES OF OPERATION

The ECM looks at voltages from several sensors to determine how much fuel to give the engine. The fuel is delivered under one of several conditions, called "modes". All the modes are controlled by the ECM, and are described below.

Starting Mode

When the ignition is first turned "ON," the ECM will turn "ON" the fuel pump relay for two seconds, and the fuel pump will build up pressure. The ECM then checks the coolant temperature sensor, throttle position sensor, and determines the proper air/fuel ratio for starting. This ranges from 1.5 : 1 at -36°C (-33°F) to 14.7 : 1 at 94°C (201°F). The ECM controls the amount of fuel delivered in the STARTING mode by changing how long the injectors are pulsed "ON".

The cold start valve (Figure C2-2) not controlled by the ECM is used to provide additional fuel during the starting mode to improve cold start-ups. This circuit is important when the engine coolant temperature is very low because the other injectors would not be pulsed "ON" long enough to provide the needed amount of fuel to start. The cold start valve is somewhat different from the other injectors in that it causes the fuel to be vaporized for a better combustible mixture.



100 VALVE - COLD START
101 TUBE AND BODY ASSEMBLY
102 O-RING SEAL - VALVE
103 O-RING SEAL - BODY
104 O-RING SEAL - TUBE

5S 1446-6E

Figure C2-2 Cold Start Valve

The circuit is activated only in the crank mode. The power is supplied directly from the starter solenoid and is protected by the crank fuse. The system is controlled by a cold start fuel injection switch which provides a ground path for the valve during cranking whenever engine coolant is below 35° C (95°F).

The cold start fuel injection switch contains a bimetal switch which opens the circuit at specified coolant temperature. This bimetal is also heated by the winding in the switch which would allow the valve to stay "ON" 8 seconds at -20°C or below. The time the switch stays closed varies inversely with coolant temperature. In other words, as the coolant temperature goes up the maximum cold start valve "ON" time goes down.

Clear Flood Mode

If the engine floods, clear it by pushing the accelerator pedal down all the way. The ECM then will turn "OFF" the fuel to the injectors. The ECM holds this injector rate as long as the throttle stays wide open, and the engine rpm is below 600. If the throttle position becomes less than 80%, the ECM returns to the STARTING mode.

Run Mode

The RUN mode has two conditions called "Open Loop" and "Closed Loop".

When the engine is first started, and rpm is above 400 rpm, the system goes into "Open Loop" operation. In "Open Loop," the ECM will ignore the signal from the oxygen (O_2) sensor, and calculate the air/fuel ratio based on inputs from the coolant and MAF sensors.

The system will stay in "Open Loop" until the following conditions are met:

1. The O_2 sensor has varying voltage output, showing that it is hot enough to operate properly. (This depends on temperature.)
2. The coolant sensor is above a specified temperature about 25°C (77°F).
3. A specific amount of time has elapsed after starting the engine.

The specific values for the above conditions vary with different engines, and are stored in the PROM or Mem-Cal. When these conditions are met, the system goes into "Closed Loop" operation. In "Closed Loop", the ECM will calculate the air/fuel ratio (injector on-time) based on the signal from the O_2 sensor. This allows the air/fuel ratio to stay very close to 14.7:1.

Acceleration Mode

The ECM looks at rapid changes in throttle position and air flow, and provides extra fuel.

Deceleration Mode

The ECM looks at changes in throttle position and air flow to reduce the amount of fuel. When deceleration is very fast, the ECM can cut off fuel completely for short periods.

Battery Voltage Correction Mode

When battery voltage is low, the ECM can compensate for the weak spark delivered by the distributor by:

- Increasing the amount of fuel delivered;
- Increasing the idle rpm; and
- Increasing ignition dwell time.

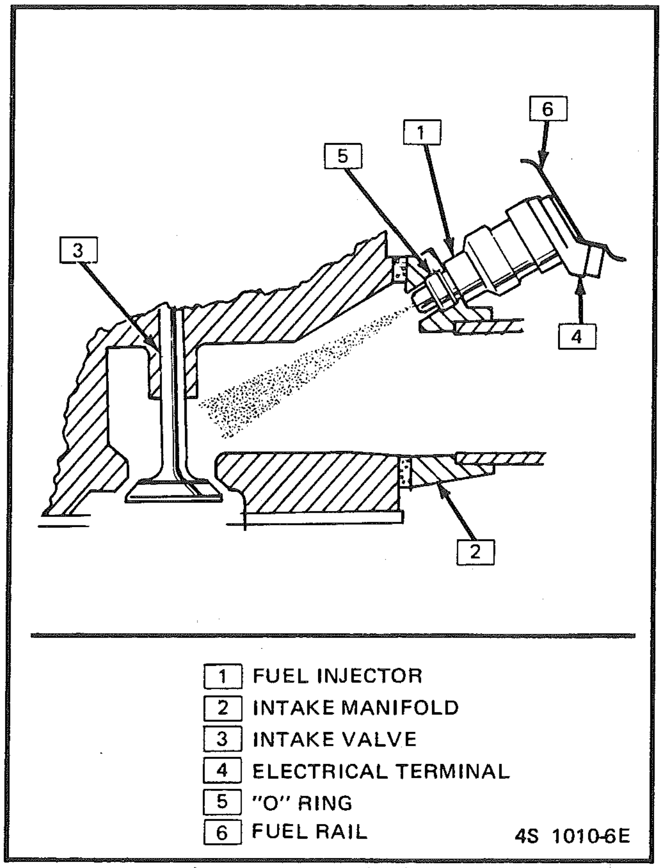


Figure C2-4 Fuel Injector

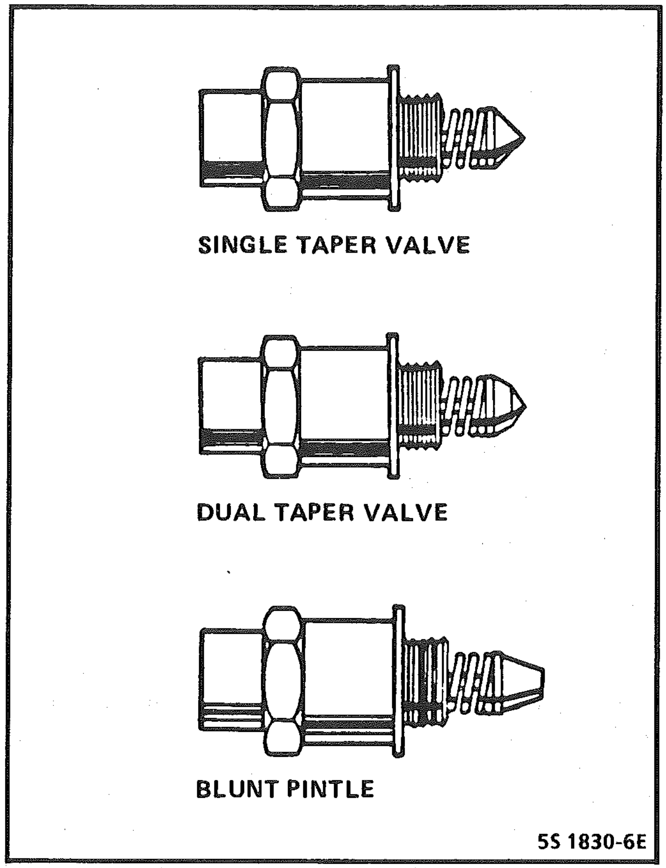


Figure C2-5 IAC Valve Designs

The pressure regulator is mounted on the fuel rail, and is replaced as an assembly.

If the pressure is too low, poor performance could result. If the pressure is too high, excessive odor and a Code 45 may result. CHART A-7 has information on diagnosing fuel pressure conditions.

IDLE AIR CONTROL (IAC) VALVE

The purpose of the idle air control (IAC) valve (shown in Figure C2-5), is to control engine idle speed, while preventing stalls due to changes in engine load.

The IAC valve, mounted in the throttle body, controls bypass air around the throttle valve. By moving a conical valve IN (to decrease air flow) or OUT (to increase air flow), a controlled amount of air can move around the throttle plate. If rpm is too low, more air is bypassed around the throttle valve to increase rpm. If rpm is too high, less air is bypassed around the throttle valve to decrease rpm.

The IAC valve moves in small steps called "counts," which can be measured by some test equipment which plugs into the ALDL.

During idle, the proper position of the IAC valve is calculated by the ECM based on battery voltage, coolant temperature, engine load, and engine rpm. If the rpm drops below a specified rpm, and the throttle plate is closed, the ECM senses a near stall condition. The ECM will then calculate a new valve position to prevent stalls.

If the IAC valve is disconnected and reconnected with the engine running, the idle rpm may be wrong. In this case, the IAC can be reset by starting the engine momentarily and then turning the ignition "OFF".

Different designs are used for the IAC valve. Be sure to use the correct design when replacement is required.

The IAC valve affects only the idle characteristics of the vehicle. If it is open fully, too much air will be allowed into the manifold and idle speed will be high. If it is stuck closed, too little air will be allowed in the manifold, and idle speed will be too low. If it is stuck part way open, the idle may be rough, and will not respond to engine load changes.

FUEL PUMP ELECTRICAL CIRCUIT

When the ignition is first turned "ON" without the engine running, the ECM will turn the fuel pump relay "ON" for two seconds. This builds up the fuel pressure quickly. If the engine is not started within two seconds, the ECM will shut the fuel pump "OFF" and wait until the engine starts. As soon as the engine is cranked, the ECM will turn the relay "ON" and run the fuel pump.

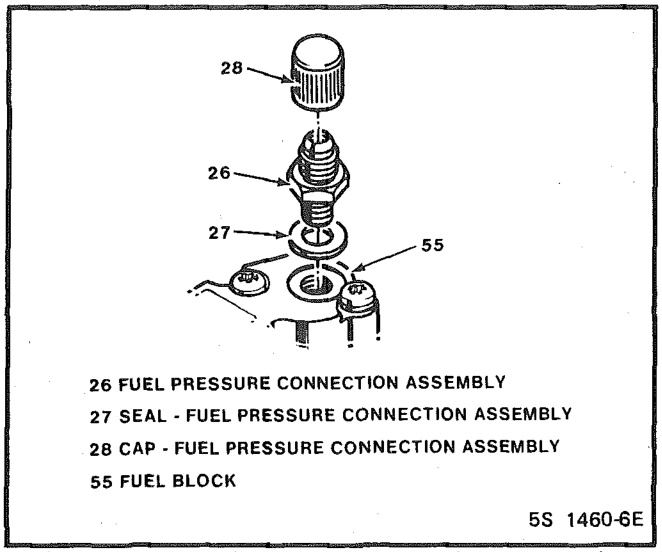


Figure C2-10 Fuel Pressure Connection Assembly

FUEL BLOCK AND SEAL
Figure C2-11

Remove or Disconnect

1. Negative battery terminal.
2. Engine components above fuel block.

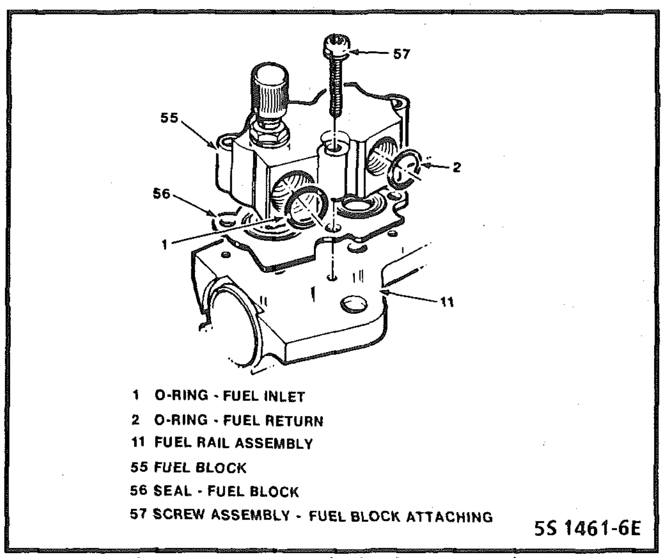


Figure C2-11 Fuel Block Assembly

Clean

- Fuel block (55) and adjacent fuel line connections with AC Delco X-30A or equivalent.

3. Fuel inlet and return lines, and O-ring seals (1) and (2).
   - Discard O-ring seals.
4. Fuel block attaching screw assemblies (57).
5. Fuel block (55) and seal (56). Discard seal.

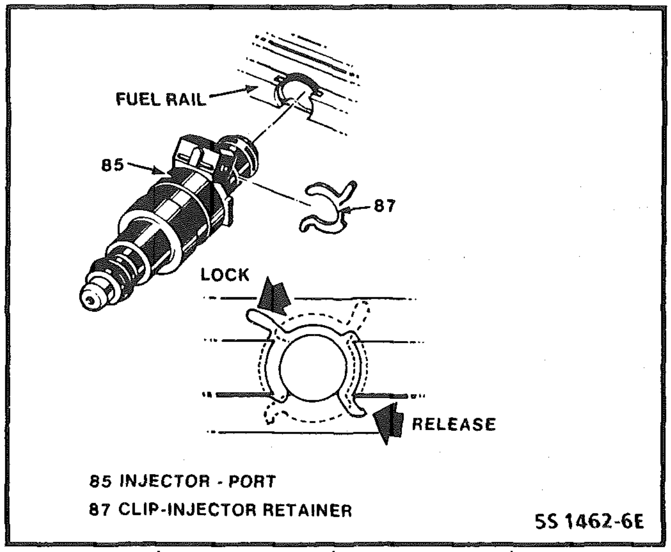


Figure C2-12 Injector Removal

Clean

- Sealing surfaces of fuel block and fuel rail assembly to ensure a good seal.

Install or Connect

1. New fuel block seal (56) on fuel rail assembly (11).
2. Fuel block (55) on seal.
3. Fuel block attaching screw assemblies (57).

Tighten

- Attaching screw assemblies to 5.0 Nm (44.0 in. lbs.)

4. New O-ring seals (1) and (2) on fuel inlet and return lines.
5. Fuel inlet and return lines.
6. Battery negative terminal.

Inspect

- Energize fuel pump and check for fuel leaks.

FUEL INJECTORS

Each port injector is located and held in position by a retainer clip that must be rotated to release and/or lock the injector in place, as shown in Figure C2-12.

Port Injectors with Injector Retaining Clips

Remove or Disconnect

1. Rotate injector retaining clip(s) (87) to unlocked position.
2. Port injectors (85).

Inspect

- All injector O-ring seals (86).
  - Replace if damaged.

Assemble

- New O-ring seals (86) as required, on port injectors (85).

Install or Connect

1. Lubricate all injector O-ring seals with engine oil.
2. Port injectors to fuel rail and pressure regulator assembly (11).
3. Rotate injector retainer clips (87) to locking position (Figure C2-12).

Fuel Pressure Regulator

Important

The pressure regulator is factory adjusted and is not serviceable. Do not attempt to remove the regulator from the fuel rail.

PORT INJECTORS

Each port injector is located and held in position by a retainer clip that must be rotated to release and/or lock the injector in place, as shown in Figure C2-13.

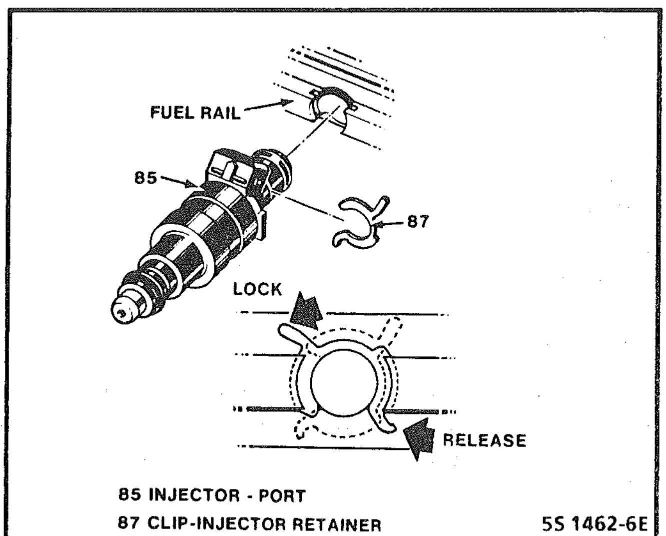


Figure C2-13 Port Injector with Injector Retainer Clip

Remove or Disconnect

1. Rotate injector retaining clip(s) (87) to unlocked position.
2. Injectors (85).

Inspect

- All injector O-ring seals (86).
  - Replace if damaged.

Assemble

- New O-ring seals (86) as required, on injectors (85).

Install or Connect

1. Lubricate all injector O-ring seals with engine oil.
2. Injectors to fuel rail and pressure regulator assembly (11).
3. Rotate injector retainer clips (87) to locking position (Figure C2-13).

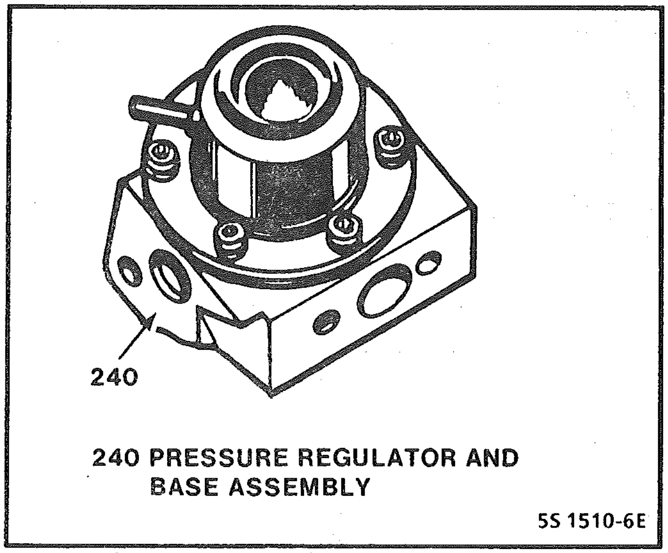


Figure C2-14 Fuel Pressure Regulator

PRESSURE REGULATOR
Figure C2-14

Important

The pressure regulator is factory adjusted and is not serviceable. Do not attempt to remove regulator cover.

Remove or Disconnect

1. Front crossover tube retainer attaching screw assembly (235) and crossover tube retainer (234).
2. Retainer to base screw assembly (273) and rear crossover tube retainer (270)
3. Separate the left hand fuel rail and plug assembly (200) from the right hand fuel rail and tube assembly (220).
4. Bracket to rail attaching screw assembly (256), bracket to base attaching screw assembly (258) and the pressure regulator and base assembly bracket (255).
5. Rear bracket attaching study assembly (222).
6. Base to right hand rail screw assembly (275).

7. Pressure regulator and base assembly (240) from right hand rail assembly (220).
8. Rotate the regulator and base assembly to remove from the fuel outlet tube.
9. Base to rail connector (250).

Important

When removing O-Ring seals, note locations and sizes, to assure correct replacement and re-assembly.

10. O-Ring seals:
    - Connector (252).
    - Fuel outlet tube (224).
    - Rear crossover tube (267).
    - Front crossover tube (232).

Install or Connect

1. Lubricate with engine oil, and install O-Ring seals:
    - Connector (252).
    - Fuel outlet tube (224).
    - Rear crossover tube (267).
    - Front crossover tube (232).
2. Base to rail connector (250) in pressure regulator and base assembly (240).
3. Regulator and base assembly on fuel outlet tube.
4. Rotate the regulator and base assembly to install base to rail connector (250) into right hand rail assembly.
5. Base to right hand rail screw assembly (275).
6. Pressure regulator and base assembly bracket (255), bracket to base attaching screw assembly (258) and bracket to rail attaching screw assembly (256).
7. Rear bracket attaching study assembly (222).
8. Left hand rail and plug assembly (200), with front and rear crossover tubes (230) and 265), to right hand rail and tube assembly (220).
9. Rear crossover tube retainer (270) and retainer to base screw assembly (273).
10. Front crossover tube retainer (234) and retainer attaching screw assembly (235).

COLD START FUEL INJECTION SWITCH

Remove or Disconnect

1. Connector.
2. Switch.

Install or Connect

1. Switch.
2. Connector.

THROTTLE BODY (Figure C2-15)

Remove or Disconnect

1. Air inlet duct.
2. IAC and TPS connectors.
3. Vacuum lines.
4. Coolant hoses (2).
5. Throttle, TV and cruise control cables.
6. Throttle body retaining bolts.

Install or Connect

1. Reverse procedure to reinstall.
2. Refill radiator with lost coolant.

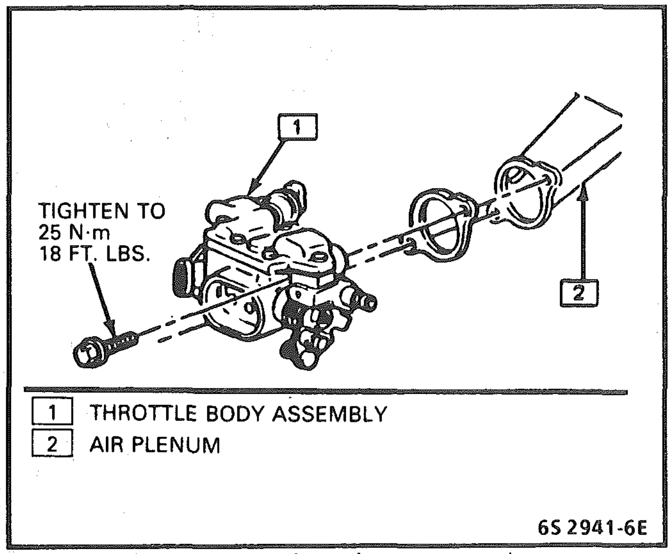


Figure C2-15 Throttle Body Service

THROTTLE BODY SERVICE IDENTIFICATION

An eight digit identification number is stamped on the throttle body casting next to the coolant cover, as shown in Figure C2-16. Refer to this model identification number if servicing or part replacement is required.

Names of component parts will be found on the numbered list that accompanies the exploded view (Figure C2-17). Numbers used to identify parts in the exploded views also are used to identify the same parts in other illustrations of this manual.

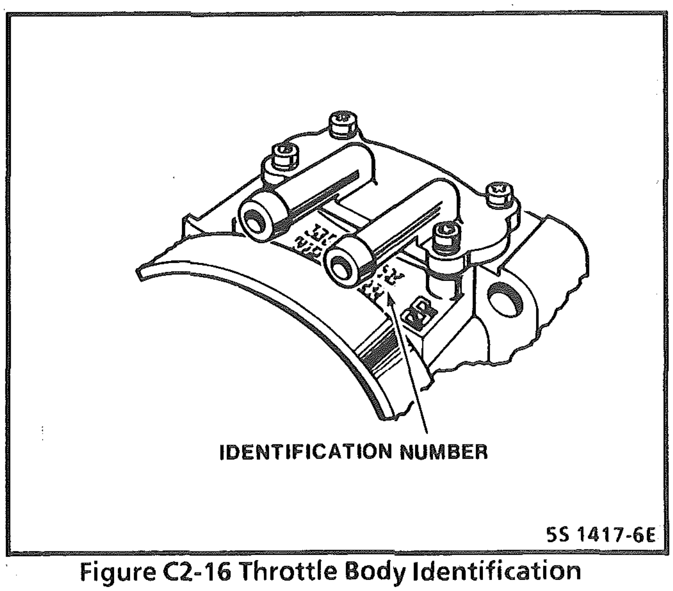


Figure C2-16 Throttle Body Identification

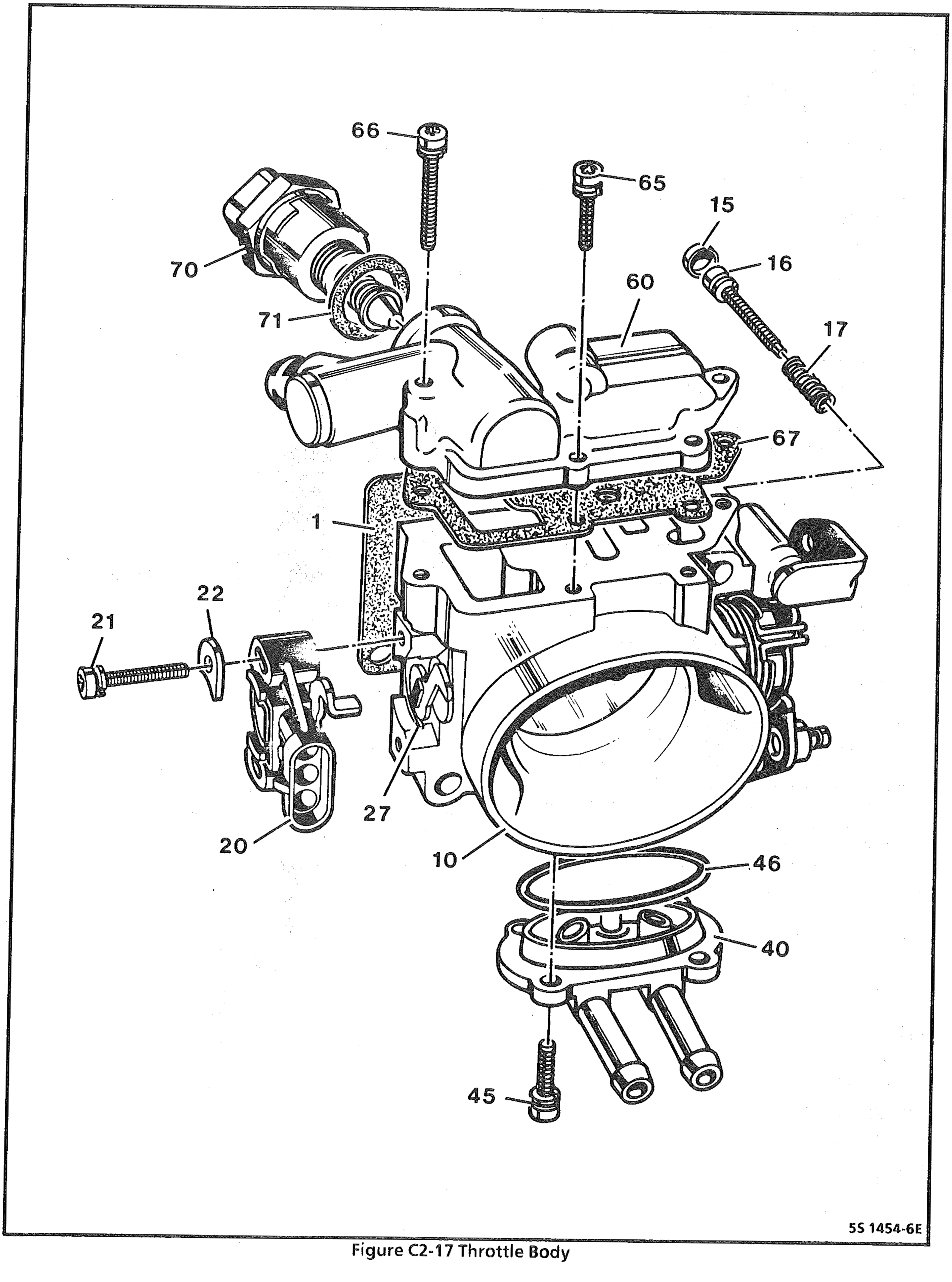


Figure C2-17 Throttle Body

PARTS INFORMATION

PART NAME	PART #
Throttle Body Assembly	10
Plug - Idle Stop Screw	15
Screw Assembly - Idle Stop	16
Spring - Idle Stop Screw	17
Sensor - Throttle Position (TPS)	20
Screw Assembly - TPS Attaching	21
Retainer - TPS Attaching Screw	22
Cover - Coolant Cavity	40
Screw Assembly - Coolant Cover Attaching	45
O-Ring - Coolant Cover to Throttle Body	46
Idle Air/Vacuum Signal Housing Assembly	60
Screw Assembly - Idle Air/Vacuum Signal Assembly	65
Screw Assembly - Idle Air/Vacuum Signal Assembly	66
Gasket - Idle Air/Vacuum Signal Assembly	67
Valve Assembly - Idle Air Control (IAC)	70
Gasket - IAC Valve Assembly	71

MINIMUM IDLE SPEED ADJUSTMENT

The idle stop screw (16), used to regulate minimum idle speed of the engine, is adjusted at the factory, then is covered with a plug (15) to discourage unnecessary readjustment. However, if it is necessary to gain access to the idle stop screw assembly, proceed as shown in Figure C2-18.

Adjust

1. Pierce the idle stop screw plug (15) with an awl, and apply leverage to remove it.
2. Adjust idle stop screw assembly (16) as required.
3. With IAC motor connected, ground diagnostic lead.
4. Turn "ON" ignition, do not start engine. Wait at least 30 seconds.
5. With ignition "ON," disconnect IAC electrical connector.
6. Start engine and allow to go "Closed Loop".
7. Remove ground from diagnostic terminal.
8. Adjust idle stop screw to 550 rpm in drive, 650 rpm in neutral on manual transmission vehicles.
9. Turn ignition "OFF" and reconnect connector at IAC motor.
10. Do not adjust TPS unless setting is outside of 0.35-0.67 limits. If adjustment is required, see procedure in Section "6E3-C1".
11. Start engine and inspect for proper idle operation.

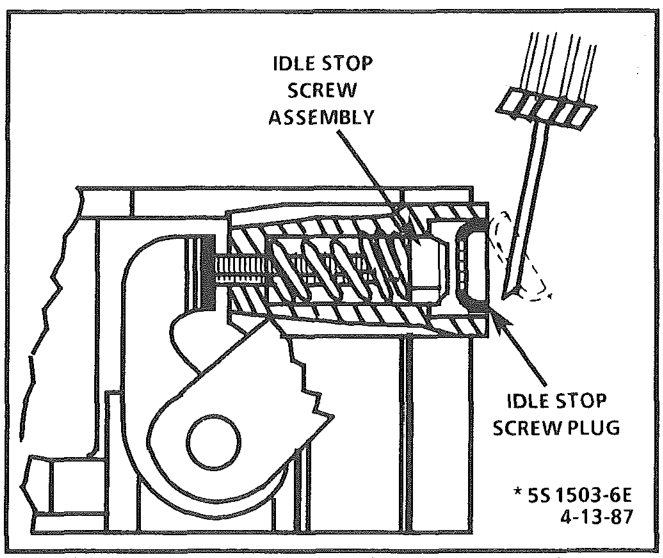


Figure C2-18 Removing Idle Stop Screw Plug

UNIT REPAIR PROCEDURES

The unit repair procedures cover component replacement with the unit on the vehicle. However, throttle body replacement requires that the complete unit be removed from the engine. If removed, it may be placed on a holding fixture, such as J-9789-118, BT-3553, or equivalent, to prevent damage to the throttle valve.

Cleaning and Inspection

Throttle body parts, except as noted below, may be cleaned in a cold immersion-type cleaner such as AC Delco X-55 or equivalent.

NOTICE: The throttle position sensor (TPS), idle air control (IAC) valve, throttle body with cover and seals or gaskets in place, should NOT be soaked in liquid solvent or cleaner, as they may be damaged. If TPS or IAC valve is still mounted in the throttle body, do not immerse throttle body.

1. Clean all metal parts throughly and blow dry with shop air. Be sure all air passages are free of burrs and dirt.
2. Inspect mating casting surfaces for damage that could affect gasket sealing.

IDLE AIR CONTROL VALVE ASSEMBLY AND GASKET (Figure C2-19)

Remove or Disconnect

1. Electrical connector at idle air control valve assembly (70).
2. IAC valve assembly from idle air/vacuum signal housing assembly (60).
3. IAC valve assembly gasket (71) and discard.

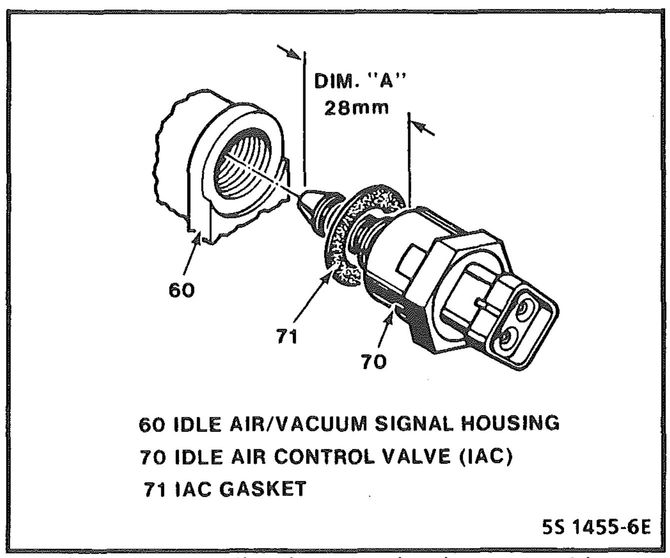


Figure C2-19 Idle Air Control Valve Assembly

NOTICE: Before installing new idle air control valve assembly, the position of its pintle MUST be checked. If pintle is extended too far, damage to the assembly may occur.

Measure

- Distance from gasket mounting surface of IAC valve assembly (70) to tip of pintle, Dimension "A" in Figure C2-19.

Adjust

If distance is greater that 28 mm (1 1/8 in.), reduce it as follows:

a. If IAC valve assembly has a "collar" around electrical connector end, use firm hand pressure on pintle to retract it. (A slight side-to-side motion may help.)

b. If IAC valve assembly has "no collar", compress pintle-retaining spring toward body of the IAC and try to turn pintle clockwise.
   - If pintle will turn, continue turning until 28mm (1 1/8 in.) is reached. Return spring to original position, with straight part of spring end lined up with flat surface under the pintle head.
   - If pintle will not turn, use firm hand pressure to retract it.

Install or Connect

1. New IAC valve assembly gasket (71) on IAC valve assembly (70).
2. IAC valve assembly in idle air/vacuum signal housing assembly (60).

Tighten

- IAC valve assembly to 18N·m (13 ft. lbs.), with wrench on hex surface only.

3. Electrical connector at IAC valve assembly (70).

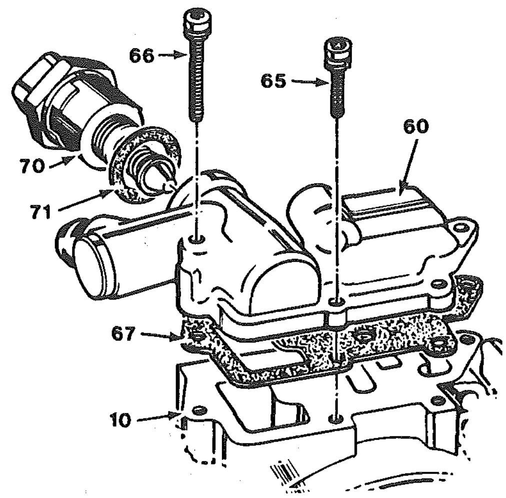
Important

No physical adjustment is made to the IAC assembly after installation. IAC resetting occurs after reinstallation on the vehicle, and is reset after the engine is started and then the ignition turned off.

IDLE AIR / VACUUM SIGNAL HOUSING ASSEMBLY (With IAC Removed) (Figure C2-20)

Remove or Disconnect

1. Idle air/vacuum signal assembly attaching screw assemblies (65) and (66).
2. Idle air/vacuum signal housing assembly (60).
3. Idle air/vacuum signal assembly gasket (67).



10 THROTTLE BODY ASSEMBLY
60 IDLE AIR/VACUUM SIGNAL HOUSING ASSY
65 SCREW ASSY - IDLE AIR/VACUUM SIGNAL HOUSING ASSY.
66 SCREW ASSY - IDLE AIR/VACUUM SIGNAL HOUSING ASSY
67 GASKET - IDLE AIR VACUUM SIGNAL ASSY
70 VALVE ASSY - IDLE AIR CONTROL (IAC)
71 GASKET - IAC VALVE ASSY

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Figure C2-20 Idle Air/Vacuum Signal Housing Assembly

Tighten

- Attaching screw assemblies (starting in center and moving outward) to 3.0 N·m (27.0 in. lbs.).

COOLANT CAVITY COVER AND O-RING (Figure C2-21)

Remove or Disconnect

1. Coolant cover attaching screw assemblies (45).
2. Coolant cavity cover (40).
3. Coolant cover to throttle body O-ring (46).

Clean

- O-ring surface of coolant cavity cover.

Inspect

- Gasket and O-ring surfaces, for damage and corrosion which might effect sealing.

Install and Connect

1. Lubricate coolant cover to throttle body O-ring (46) with ethylene glycol antifreeze.
2. O-ring in throttle body assembly (10).
3. Coolant cavity cover.
4. Coolant cover attaching screw assemblies (45), applying pressure against throttle body (10).

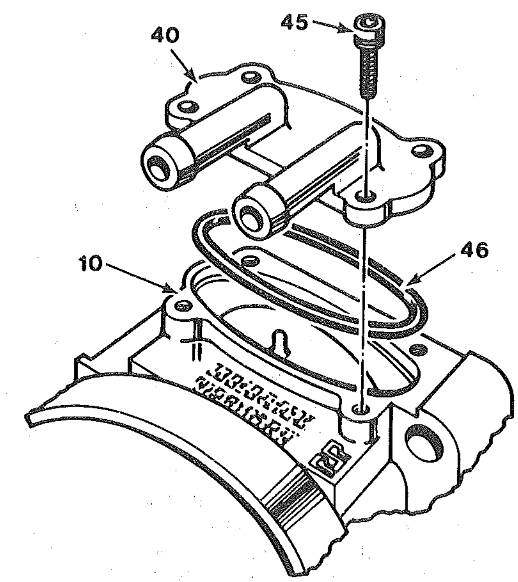


Figure C2-21 Coolant Cavity Cover Assembly

Tighten

- Screw assemblies to 3.0 Nm (27.0 in. lbs.).

IDLE AIR CONTROL/COOLANT COVER ASSEMBLY

With Throttle Body Removed From Engine (Figure C2-22)

Remove or Disconnect

1. Idle air control (IAC) valve assembly (70) from IACV/coolant cover assembly. (See "Idle Air Control valve and Gasket" section.)
2. IACV cover assembly to throttle body screw assemblies (62).
3. Cover assembly (61).
4. Cover assembly to throttle body gasket (63).

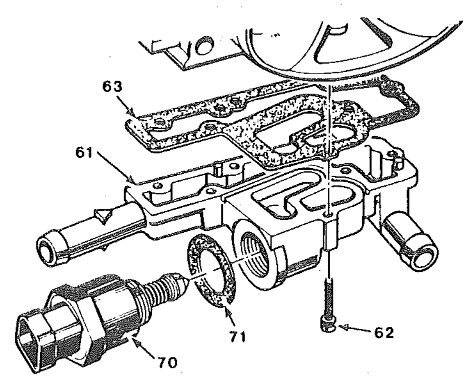


Figure C2-22 Idle Air control/Coolant Cover Assembly

REINSTALLATION

Clean

- Throttle body gasket mounting surface to ensure a good seal.
- Sealing surface for damage that could prevent sealing properly or cause coolant leak.

Install and Connect

1. New IACV/coolant cover assembly to throttle body gasket (63).
2. IACV/coolant cover assembly (61).
3. IACV cover assembly to throttle body screw assemblies (62).

Tighten

- Screw assemblies to 3.0 N·m (27.0 in. lbs.).

4. IAC valve assembly (70). (See "Idle Air Control Valve and Gasket" section.)

NOTICE: Before installing the IAC valve assembly the position of its pintle MUST be checked. If pintle is extended too far, damage to the assembly may occur. (See "Idle Air Control Valve and Gasket" section.)

FUEL PUMP RELAY

The fuel pump relay is mounted in the engine compartment (see Figure C2-23). Other than checking for loose connectors, the only service possible is replacement.

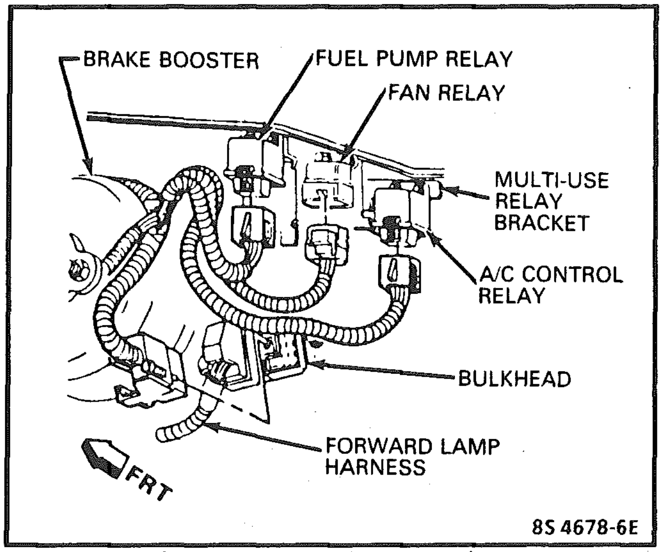


Figure C2-23 Fuel Pump Relay

OIL PRESSURE SWITCH

The oil pressure switch is mounted as shown in Figure C2-24.

Remove or Disconnect

1. Electrical Connector.
2. Oil Pressure Switch.

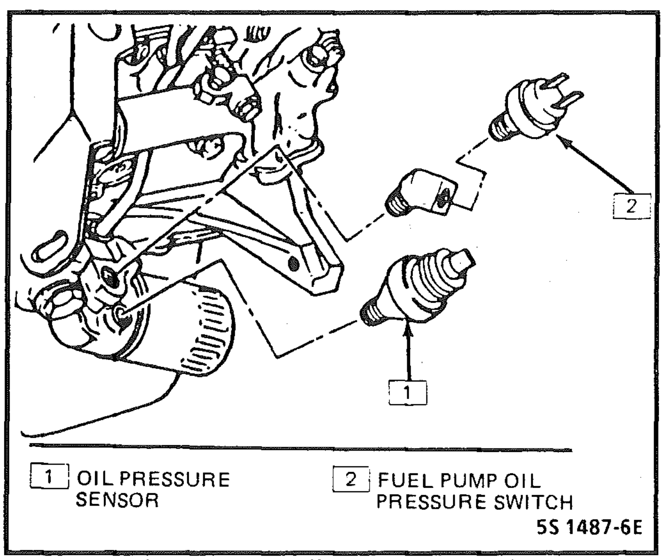


Figure C2-24 Oil Pressure Switch

Install or Connect

1. Make sure fittings (41) are properly aligned to allow switch installation.
2. Oil Pressure Switch.
3. Electrical Connector.

PARTS INFORMATION

PART NAME	GROUP
Injector, fuel	3.300
Pump, Fuel (In-Tank)	3.900
Relay, Fuel Pump	3.900
Switch, Oil Pressure	1.800
Valve Asm, Idle Air Control : Part Of Control Kit, Idle Air Valve	3.820
Regulator, Fuel Pressure	3.164
Rail, Fuel Feed	3.330

CHART C-2A

INJECTOR BALANCE TEST

The injector balance tester is a tool used to turn the injector on for a precise amount of time, thus spraying a measured amount of fuel into the manifold. This causes a drop in fuel rail pressure that we can record and compare between each injector. All injectors should have the same amount of pressure drop (± 10 kpa). Any injector with a pressure drop that is 10 kpa (or more) greater or less than the average drop of the other injectors should be considered faulty and replaced.

STEP 1

Engine "cool down" period (10 minutes) is necessary to avoid irregular readings due to "Hot Soak" fuel boiling. With ignition "OFF" connect fuel gauge J347301 or equivalent to fuel pressure tap. Wrap a shop towel around fitting while connecting gage to avoid fuel spillage.

Disconnect harness connectors at all injectors, and connect injector tester J-34730-3, or equivalent, to one injector. On Turbo equipped engines, use adaptor harness furnished with injector tester to energize injectors that are not accessible. Follow manufacturers instructions for use of adaptor harness. Ignition must be "OFF" at least 10 seconds to complete ECM shutdown cycle. Fuel pump should run about 2 seconds after ignition is turned "ON". At this point, insert clear tubing attached to vent valve into a suitable container and bleed air from gauge and hose to insure accurate gauge operation. Repeat this step until all air is bled from gauge.

STEP 2

Turn ignition "OFF" for 10 seconds and then "ON" again to get fuel pressure to its maximum. Record this initial pressure reading. Energize tester one time and note pressure drop at its lowest point (Disregard any slight pressure increase after drop hits low point.). By subtracting this second pressure reading from the initial pressure, we have the actual amount of injector pressure drop.

STEP 3

Repeat step 2 on each injector and compare the amount of drop. Usually, good injectors will have virtually the same drop. Retest any injector that has a pressure difference of 10kPa, either more or less than the average of the other injectors on the engine. Replace any injector that also fails the retest. If the pressure drop of all injectors is within 10kPa of this average, the injectors appear to be flowing properly. Reconnect them and review "Symptoms," Section "B".

NOTE: ***The entire test should <u>not</u> be repeated more than once without running the engine to prevent flooding. (This includes any retest on faulty injectors).***

CHART C-2A

INJECTOR BALANCE TEST 2.8L (VIN S) "F" SERIES (PORT)

NOTE: If injectors are suspected of being dirty, they should be cleaned using an approved tool and procedure prior to performing this test. The fuel pressure test in Section A, Chart A-7, should be completed prior to this test.

Step 1. If engine is at operating temperature, allow a 10 minute "cool down" period then connect fuel pressure gauge and injector tester.

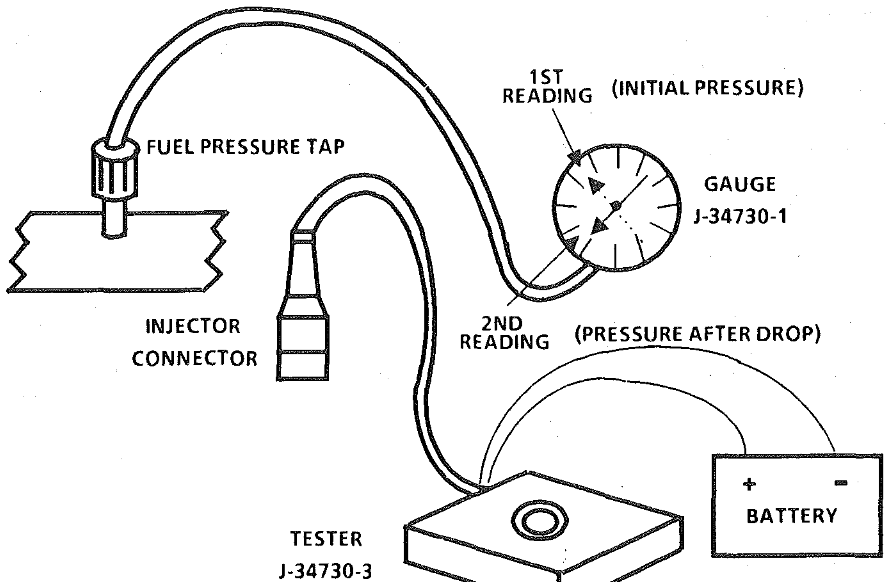
1. Ignition "OFF".
2. Connect fuel pressure gauge and injector tester.
3. Ignition "ON".
4. Bleed off air in gauge. Repeat until all air is bled from gauge.

Step 2. Run test:

1. Ignition "OFF" for 10 seconds.
2. Ignition "ON". Record gauge pressure. (Pressure must hold steady, if not see the Fuel System diagnosis, Chart A-7, in Section A).
3. Turn injector on, by depressing button on injector tester, and note pressure at the instant the gauge needle stops.

Step 3.

1. Repeat step 2 on all injectors and record pressure drop on each. Retest injectors that appear faulty (Any injectors that have a 10 kPa difference, either more or less, in pressure from the average). If no problem is found, review Symptoms Section B.



— EXAMPLE —

CYLINDER	1	2	3	4	5	6
1ST READING	225	225	225	225	225	225
2ND READING	100	100	100	90	100	115
AMOUNT OF DROP	125	125	125	135	125	110
	OK	OK	OK	FAULTY, RICH (TOO MUCH) (FUEL DROP)	OK	FAULTY, LEAN (TOO LITTLE) (FUEL DROP)

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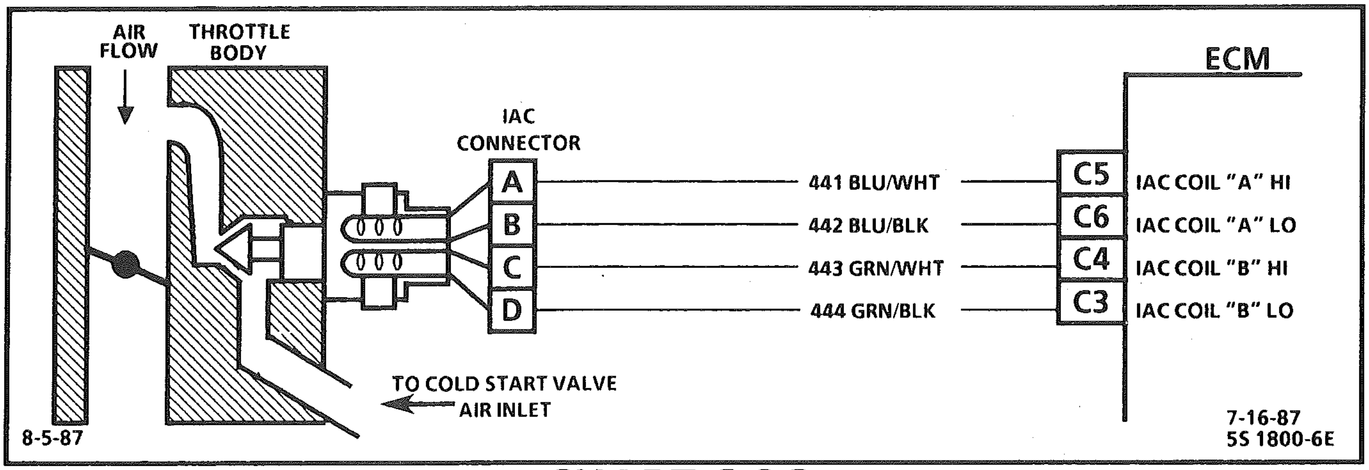


CHART C-2C
IDLE AIR CONTROL
2.8L (VIN S) "F" SERIES (PORT)

Circuit Description:

The ECM will control engine idle speed by moving the IAC valve to control air flow around the throttle plate. It does this by sending voltage pulses to the proper motor winding for each IAC motor. This will cause the motor shaft and valve to move in or out of the motor a given distance for each pulse received. ECM pulses are referred to as "counts".

- To increase idle speed - ECM will send enough counts to retract the IAC valve and allow more air to flow through the idle air passage and bypass the throttle plate until idle speed reaches the proper RPM. This will increase the ECM counts.
- To decrease idle speed - ECM will send enough counts to extend the IAC valve and reduce air flow through the idle passage around the throttle plate. This will reduce the ECM counts.

Each time the engine is started and then the ignition is turned "OFF" the ECM will reset the IAC valve. This is done by sending enough counts to seat the valve. The fully seated valve is the ECM reference zero. A given number of counts are then issued to open the valve, and normal ECM control of IAC will begin from this point. The number of counts are then calculated by the ECM. This is how the ECM knows what the motor position is for a given idle speed.

The ECM uses the following information to control idle speed.

- Battery voltage
- Engine Speed
- Coolant Temperature
- A/C clutch signal
- Throttle Position Sensor

Don't apply battery voltage across the IAC motor terminals. It will permanently damage the IAC motor windings.

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Continue with test even if engine will not idle. If idle is too low, "Scan" will display 80 or more counts, or steps. If idle is high it will display "0" counts.
   Occasionally an erratic or unstable idle may occur. Engine speed may vary 200 rpm or more up and down. Disconnect IAC. If the condition is unchanged, the IAC is not at fault. There is a system problem. Proceed to diagnostic aids below.
2. When the engine was stopped, the IAC valve retracted (more air) to a fixed "Park" position for increased air flow and idle speed during the next engine start. A "Scan" will display 140 or more counts.
3. Be sure to disconnect the IAC valve prior to this test. The test light will confirm the ECM signals by a steady or flashing light on all circuits.
4. There is a remote possibility that one of the CKTs is shorted to voltage which would have been indicated by a steady light. Disconnect ECM and turn the Ignition "ON" and probe terminals to check for this condition.

Diagnostic Aids:

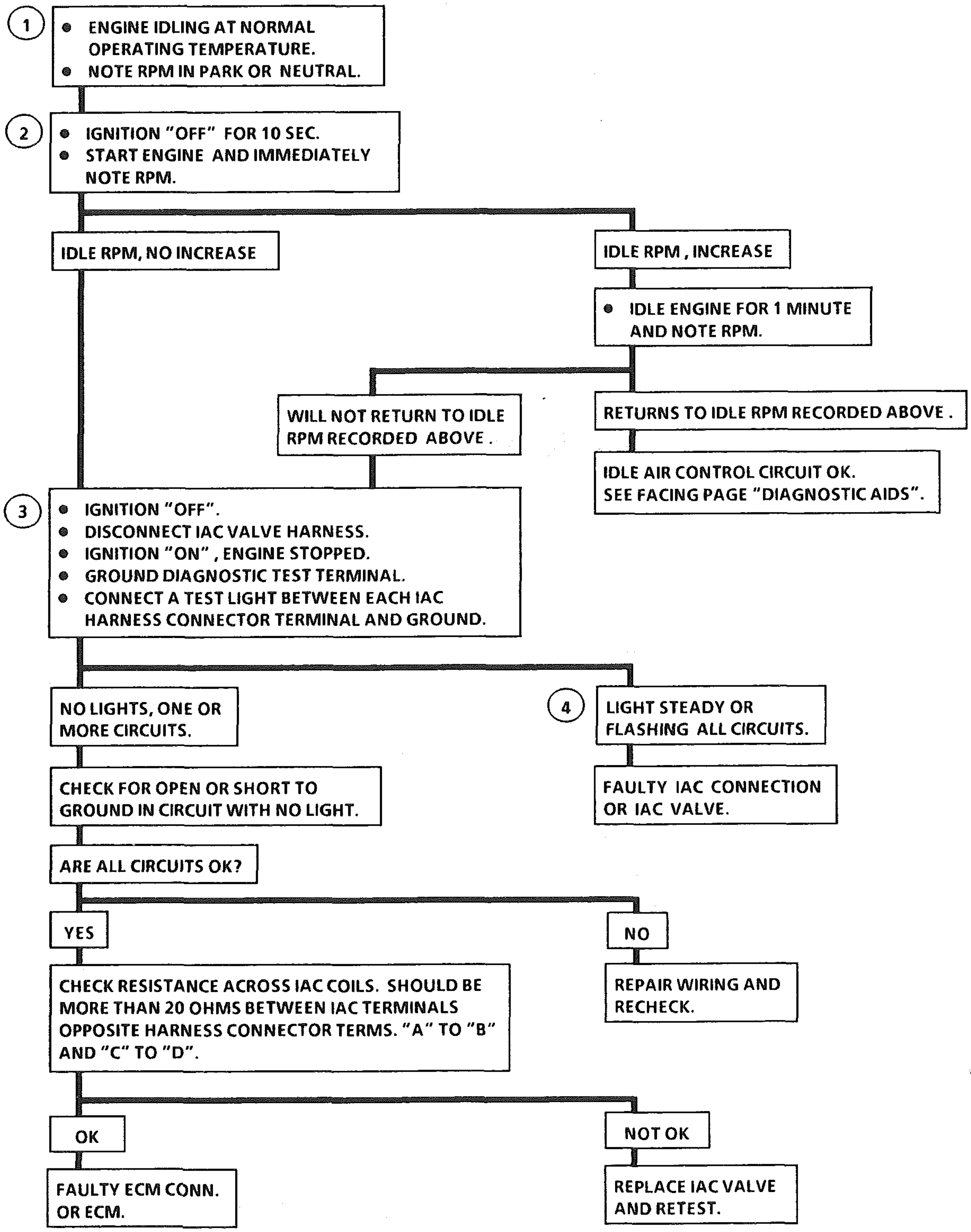
Engine idle speed can be adversely affected by the following:

- Park/Neutral Switch - If ECM thinks the car is always in neutral, then idle will not be controlled to the specified rpm when in drive range.
- Leaking injector(s) will cause fuel imbalance and poor idle quality due to excess fuel. See CHART A-7.
- Vacuum or crankcase leaks can affect idle.
- When the throttle shaft or throttle position sensor is binding or sticking in an open throttle position, the ECM does not know if the vehicle has stopped and does not control idle.
- Check AIR management system for intermittent air to ports while in "Closed Loop".
- In addition to electrical control of EGR, be sure to examine the EGR valve for proper seating.
- Faulty battery cables can result in voltage variations. The ECM will try to compensate, which results in erratic idle speeds.
- The ECM will compensate for A/C compressor clutch loads. Loss of this signal would be most apparent in neutral.
- Contaminated fuel can adversely affect idle.
- Perform injector balance test CHART C-2A.

If all OK, refer to "Rough, Unstable, Incorrect Idle or Stalling" "Symptoms" in Section "B".

CHART C-2C

IDLE AIR CONTROL
2.8L (VIN S) "F" SERIES (PORT)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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BLANK

SECTION C3

EVAPORATIVE EMISSION CONTROL SYSTEM (EECS)

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The basic Evaporative Emission Control System (EECS) used on all vehicles is the charcoal canister storage method. This method transfers fuel vapor from the fuel tank to an activated carbon (charcoal) storage device (canister) to hold the vapors when the vehicle is not operating. When the engine is running, the fuel vapor is purged from the carbon element by intake air flow and consumed in the normal combustion process.

VAPOR CANISTER

The canister used on these engines has a diaphragm operated purge valve and a solenoid to control purge (See Figure C3-1). When the engine is running, ported manifold vacuum is supplied to the top of the purge valve (Control Vacuum Signal) which lifts the valve diaphragm and opens the valve when the throttle is above a specified opening. The lower tube on the purge valve (PCV tube) is connected to the solenoid valve.

EVAPORATIVE EMISSION SYSTEM

Under cold engine or idle conditions, the solenoid is turned "ON" by the ECM, which closes the purge passage preventing canister purge. The ECM turns "OFF" the solenoid valve and allows purge when the following occur:

- The engine is warm.
- After the engine has been running a specified length of time.
- The vehicle is above a specified road speed.
- Throttle valve is past a specified opening.

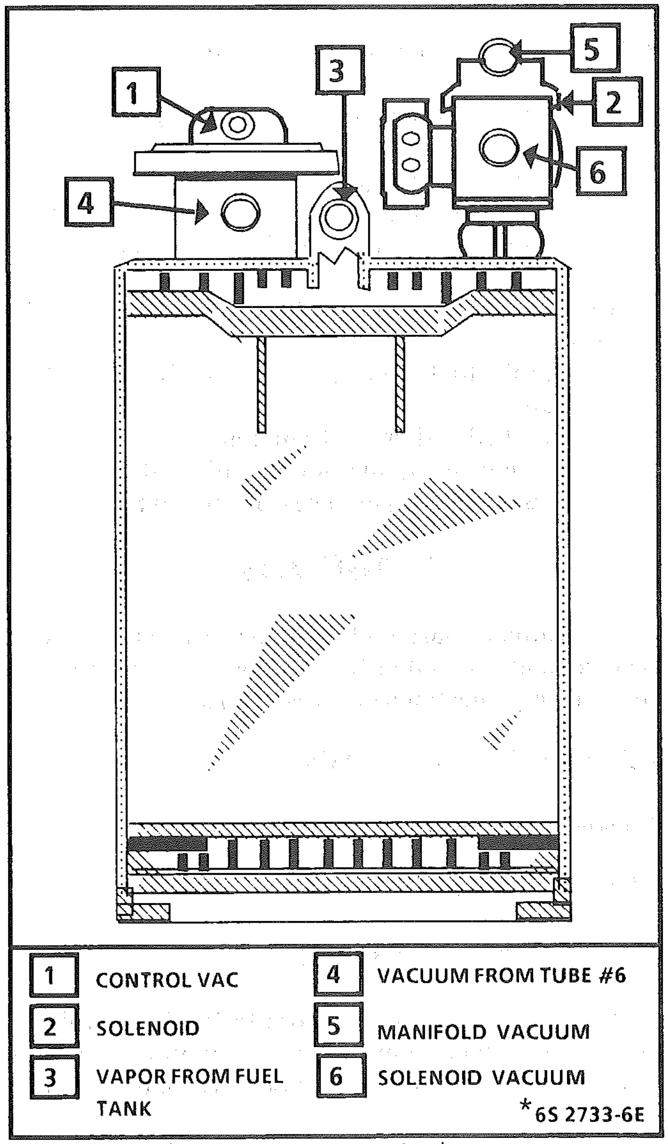


Figure C3-1 - Vapor Canister With Non-Encapsulated Solenoid

The "CONTROL VAC" tube on the purge valve of the canister is connected to a ported vacuum source. When the engine is above idle speed, sufficient vacuum is available to open the purge valve diaphragm. Vapors are purge through the solenoid to the combustion chamber.

This system also has a Tank Pressure Control Valve to control the flow of vapors to the canister.

TANK PRESSURE CONTROL VALVE

The Fuel Tank Pressure Control Valve (Figure C3-3) is located near the canister and is connected to the fuel tank vapor line. When the engine is running, manifold vacuum is supplied to the control vacuum tube and the valve is opened allowing fuel vapors too vent to the canister. When the engine is "OFF", the valve closes and vapors tend to remain in the tank.

RESULTS OF INCORRECT OPERATION

Poor idle, stalling and poor driveability can be caused by:

- Inoperative purge solenoid
- Damaged canister
- Hoses split, cracked and, or not connected to the proper tubes.

Evidence of fuel loss or fuel vapor odor can be caused by:

- Liquid fuel leaking from fuel lines, or fuel pump.
- Cracked or damaged canister
- Disconnected, misrouted, kinked, deteriorated or damaged vapor hoses, or control hoses.

DIAGNOSIS

The canister purge solenoid operation is covered in the charts at the end of this section. A failure in the solenoid or connections may result in a Code 26.

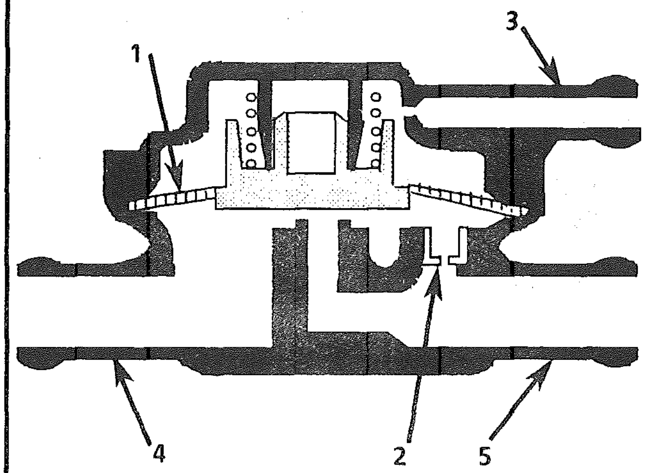
VISUAL CHECK OF CANISTER

Cracked or damaged , replace canister.

FUNCTIONAL TEST

Vapor Canister Purge Valve

Apply a short length of hose to the lower tube of purge valve, and atempt to blow through it. Little or no air should pass into the canister. (A small amount



1 DIAPHRAGM
2 VENT RESTRICTION
3 CONTROL VACUUM TUBE
4 TUBE TO FUEL TANK
5 TUBE TO CANISTER

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Figure C3-3 Fuel Tank Pressure Control Valve

of air will pass if the canister has a constant purge hole).

With hand vacuum pump, apply vacuum (15"Hg. or 51 kPa) through the control valve tube (upper tube). The diaphragm should hold vacuum for at least 20 seconds. If not the canister must be replaced. If the diaphragm holds vacuum, again try to blow through the hose connected to the lower tube while vacuum is still being applied. An increased flow of air should be observed. If not, the canister must be replaced.

Tank Pressure Control Valve

With a hand vacuum pump apply vacuum (15" or 51 kPa) to the control vacuum tube. The diaphragm should hold vacuum for at least 20 seconds. If it does not hold vacuum the diaphragm is leaking and the valve must be replaced.

With the vacuum still applied to the control vacuum tube, apply a short hose to the valve's tank tube side, blow into the tube. You should feel the air pass through the valve. If the air does not pass through, the valve should be replaced.

ON-CAR SERVICE

FUEL VAPOR CANISTER

Remove or Disconnect

1. Hoses from canister. Mark hoses to install on new canister.
2. Canister.

Install or Connect

1. Canister as removed.
2. Hoses. Make sure connections are correct.

FUEL VAPOR CANISTER SOLENOID

Remove or Disconnect

1. Negative battery cable.
2. Electrical connector and hoses from solenoid.
3. Solenoid.

Install or Connect

1. Hoses and electrical connector on solenoid.
2. Solenoid, cover, and bolt.
3. Negative battery cable

CANISTER HOSES

Refer to Vehicle Emission Control Information Label for routing of canister hoses.

PARTS INFORMATION

PART NAME	GROUP
Canister, Fuel Vapor	3.130
Solenoid, Fuel Vapor Canister	3.140
Valve, Fuel Tank Pressure Control	3.140

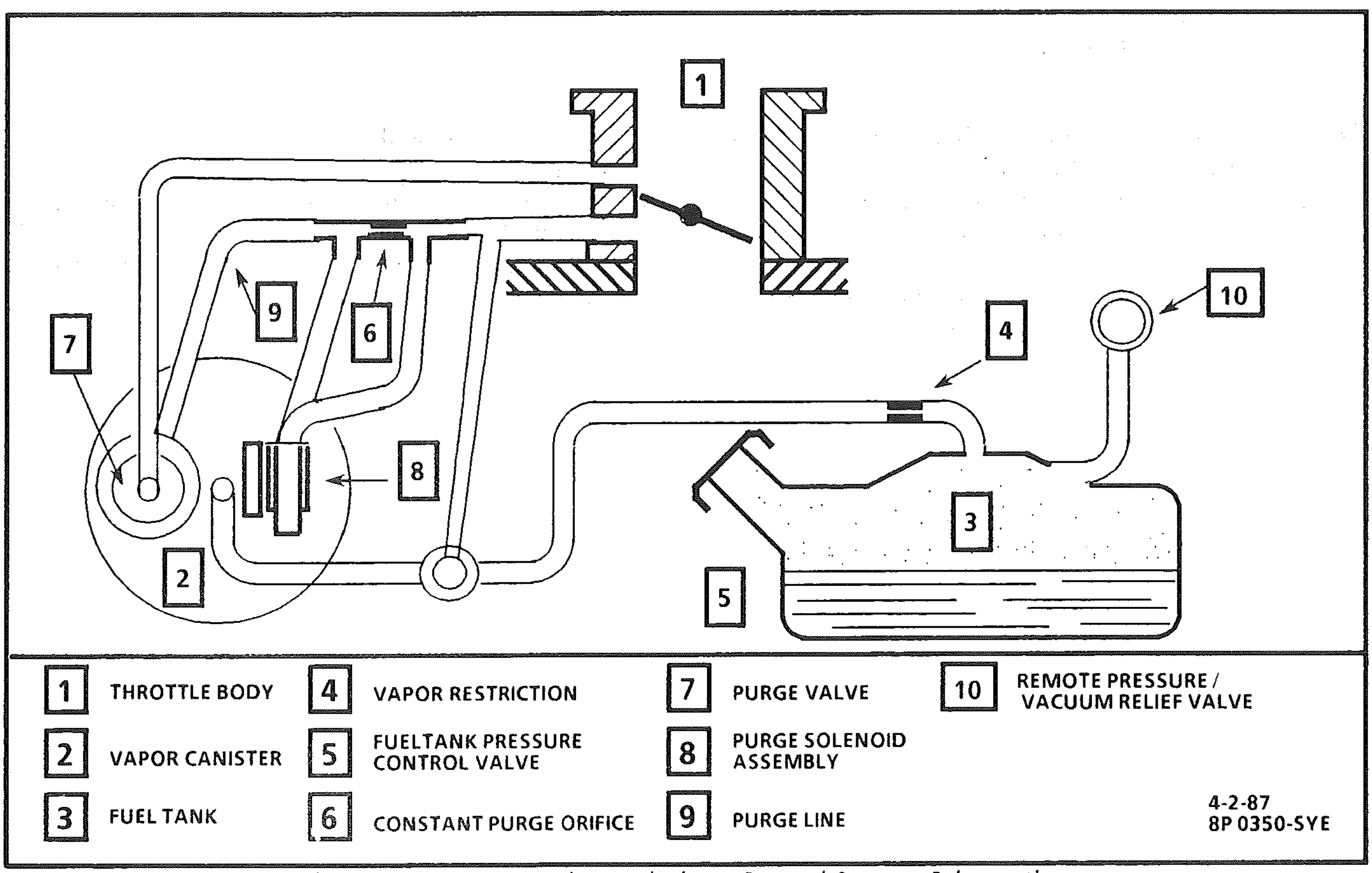


Figure C3-4 - Evaporative Emissions Control System Schematic

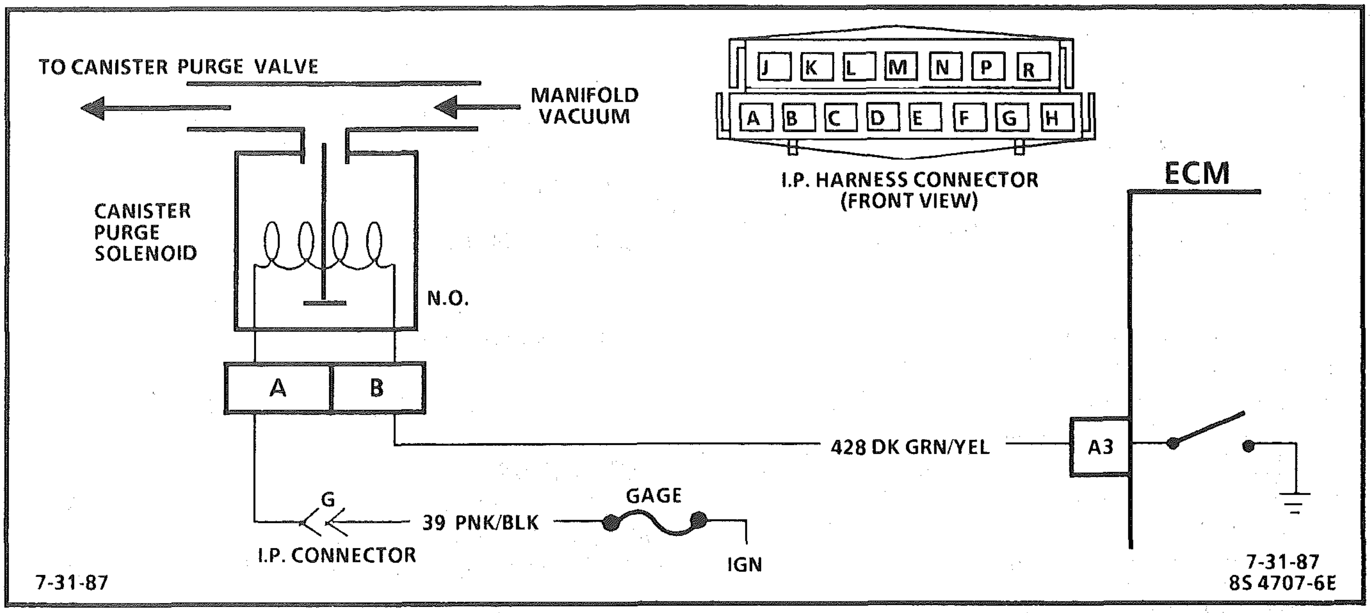


CHART C-3

CANISTER PURGE VALVE CHECK
2.8L (VIN S) "F" SERIES (PORT)

Circuit Description:

Canister purge is controlled by a solenoid that allows manifold vacuum to purge the canister when de-energized. The ECM supplies a ground to energize the solenoid (purge "OFF").

If the diagnostic test terminal is ungrounded with the engine stopped or the following is met with the engine running, the purge solenoid is de-energized (purge "ON").

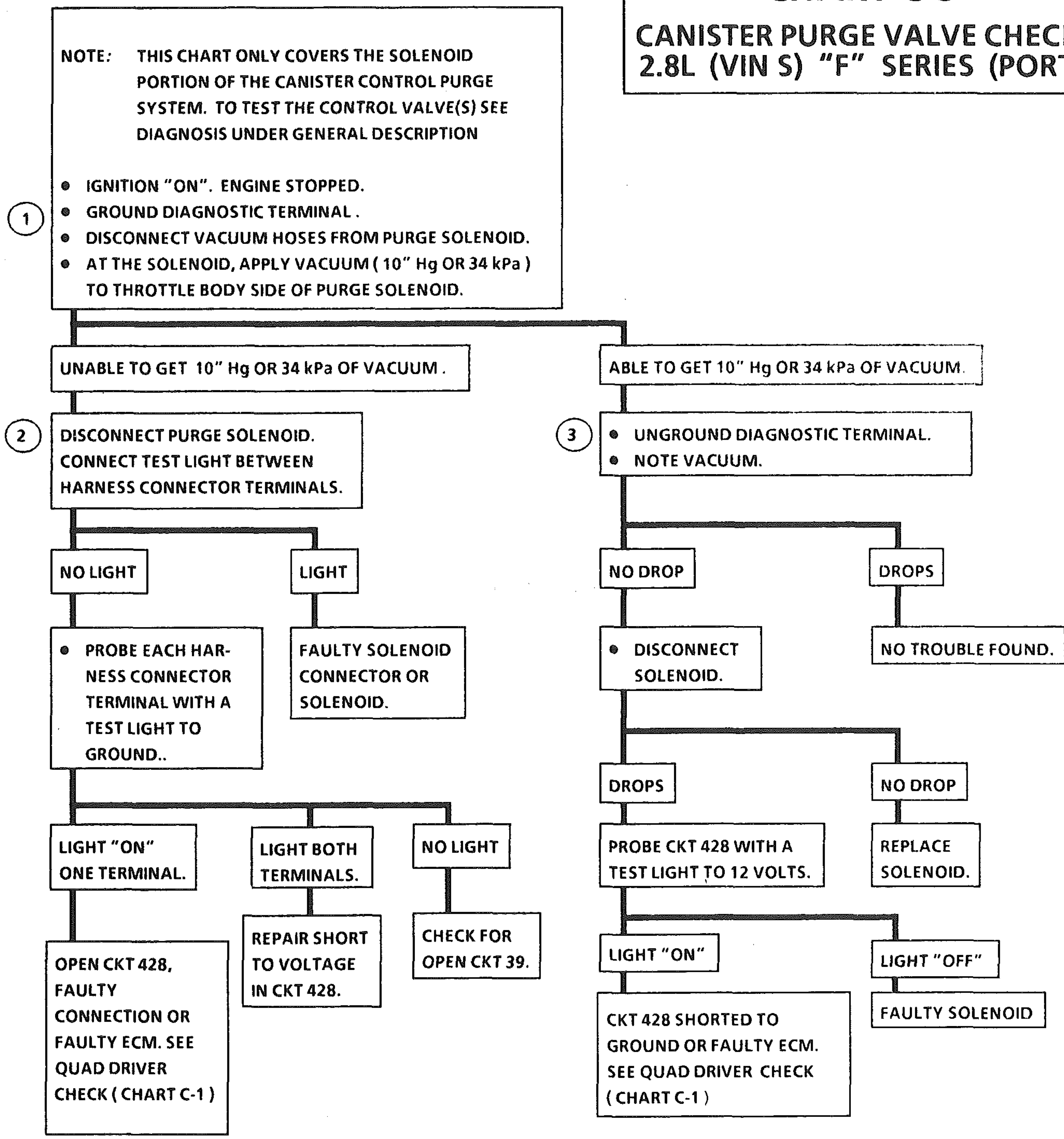
- Engine run time after start more than 1 minute.
- Coolant temperature above 75°C.
- Vehicle speed above 15 mph.
- Throttle off idle.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Checks to see if the solenoid is opened or close. The solenoid is normally energized in this step; so it should be closed.
2. Checks for a complete circuit. Normally there is ignition voltage on CKT 39 and the ECM provides a ground on CKT 428. A shorted solenoid could cause an open circuit in the ECM.
3. Completes functional check by ungrounding test terminal. This should normally de-energize the solenoid and allow the vacuum to drop (purge "ON").

CHART C-3

CANISTER PURGE VALVE CHECK 2.8L (VIN S) "F" SERIES (PORT)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT

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SECTION C4

IGNITION SYSTEM / EST

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The High Energy Ignition (HEI) system controls fuel combustion by providing a spark to ignite the compressed air/fuel mixture at the correct time. To provide improved engine performance, fuel economy, and control of exhaust emissions, the ECM controls distributor spark advance (timing) with the Electronic Spark Timing (EST) system.

Only the Electronic Spark Timing (EST) system will be described here. Additional information on the HEI system is found in Section "6D".

To properly control ignition/combustion timing the ECM needs to know:

- Crankshaft position
- Engine speed (rpm)
- Mass Air Flow
- Engine temperature

OPERATION

The EST system consists of the distributor module, ECM, and connecting wires. The connector terminals are lettered as shown in Figure C4-1 for the 2.8L.

These circuits perform the following functions:

- Distributor reference (CKT 430).

This provides the ECM with rpm and crankshaft position information. If the wire becomes open or grounded the engine will not run, because the ECM will not operate the injectors. If the engine cranks but won't run, see CHART A-3.

- Reference ground (CKT 453).

This wire is grounded in the distributor and makes sure the ground circuit has no voltage drop which could affect performance. If it is open, it may cause poor performance.

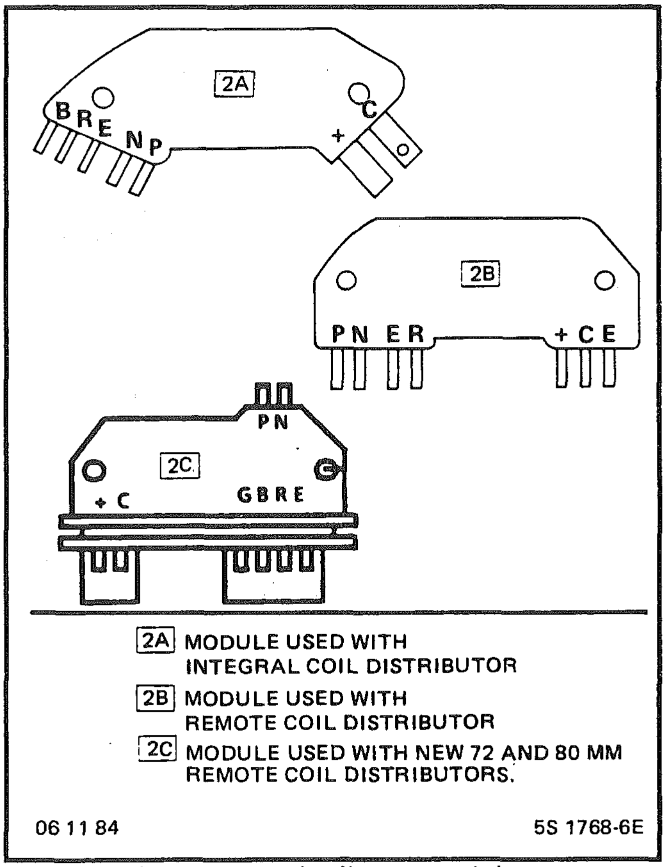

Figure C4-1 Distributor Modules

- By-Pass (CKT 424).

At about 400 rpm, the ECM applies 5 volts to this circuit to switch spark timing control from the HEI module to the ECM. The wire goes through a connector between the 4 wire connector and the ECM. This is disconnected to the set base timing. An open or grounded bypass circuit will set a Code 42 and the engine will run at base timing, plus a small amount of advance built into the HEI module.

- EST (CKT 423).

This circuit triggers the HEI module. The ECM does not know what the actual timing is, but it does know when it gets the reference signal. It then advances or retards the spark from that point. Therefore, if the base timing is set incorrectly, the entire spark curve will be incorrect.

RESULTS OF INCORRECT OPERATION

An open or ground in the EST circuit will set a Code 42 and cause the engine to run on the HEI module timing. This will cause reduced performance and poor fuel economy.

The ECM uses information from the MAF and coolant sensors in addition to rpm to calculate spark advance as follows:

- Cold engine = more spark advance.
- Engine under minimum load based on rpm and low amount of air flow- more spark advance.
- Hot engine = less spark advance.
- Engine under heavy load based on rpm and high amount of air flow- less spark advance.

DIAGNOSIS

The description, operation, and diagnosis of the HEI system are found in Section "6D" of this manual.

CODE 12

Code 12 is used during the Diagnostic Circuit Check procedure to test the code display ability of the ECM. This code indicates that the ECM is not receiving the engine rpm (REFERENCE) signal. This occurs with the ignition key "ON" and the engine not running.

The "Reference" signal also triggers the fuel injection system. Without the "Reference" signal the engine cannot run.

ON-CAR SERVICE

SETTING TIMING

The initial base timing is set by disconnecting the timing connector, located near the blower motor. Refer to Emission Control Information Label for procedure. This will cause Code 42 to store in the code memory of the ECM. The memory must be cleared after setting timing.

How Code 42 Is Determined

When the system is running on the HEI module, that is no voltage on the bypass line, the HEI module grounds the EST signal. The ECM expects to see no voltage on the EST line during this condition. If it sees a voltage, it sets code 42 and will not go into the EST mode.

When the rpm for EST is reached (about 400 rpm) the ECM applies 5 volts to the bypass line and the EST should no longer be grounded in the HEI module so the EST voltage should be varying.

If the bypass line is open or grounded, the HEI module will not switch to EST mode so the EST voltage will be low and Code 42 will be set. Refer to Section "6D" for on vehicle service.

PARTS INFORMATION

PART NAME	GROUP
Controller, ECM (Remanufactured)	3.670
Distributor	2.361
Module, Distr	2.383
Coil, Distr	2.170

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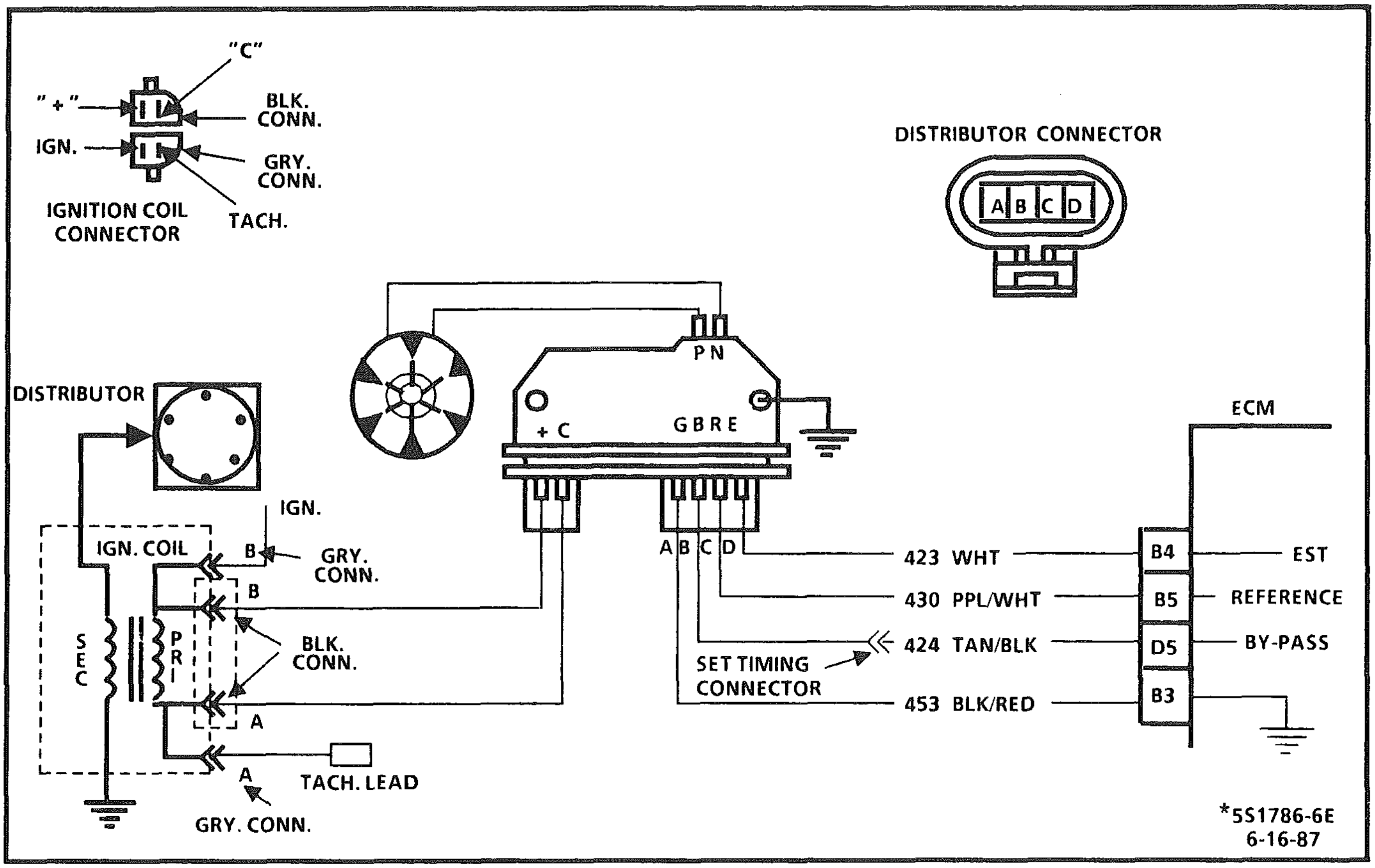

CHART C-4A

IGNITION SYSTEM CHECK
(REMOTE COIL / SEALED MODULE CONNECTOR DISTRIBUTOR)
2.8L (VIN S) "F" SERIES (PORT)

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Two wires are checked, to ensure that an open is not present in a spark plug wire.

1A. If spark occurs with EST connector disconnected, pick-up coil output is too low for EST operation.

2. A spark indicates the problem must be the distributor cap or rotor.

3. Normally, there should be battery voltage at the "C" and "+" terminals. Low voltage would indicate an open or a high resistance circuit from the distributor to the coil or ignition switch. If "C" term. voltage was low, but "+" term. voltage is 10 volts or more, circuit from "C" term. to Ign. coil or ignition coil primary winding is open.

4. Checks for a shorted module or grounded circuit from the ignition coil to the module. The distributor module should be turned "OFF", so normal voltage should be about 12 volts.
   If the module is turned "ON", the voltage would be low, but above 1 volt. This could cause the ignition coil to fail from excessive heat.
   With an open ignition coil primary winding, a small amount of voltage will leak through the module from the "Bat." to the tach terminal.

5. Applying a voltage (1.5 to 8V) to module terminal "P" should turn the module "ON" and the tach. term. voltage should drop to about 7-9 volts. This test will determine whether the module or coil is faulty or if the pick-up coil is not generating the proper signal to turn the module "ON". This test can be performed by using a DC battery with a rating of 1.5 to 8 volts. The use of the test light is mainly to allow the "P" terminal to be probed more easily.
   Some digital multi-meters can also be used to trigger the module by selecting ohms, usually the diode position. In this position the meter may have a voltage across it's terminals which can be used to trigger the module. The voltage in the ohm's position can be checked by using a second meter or by checking the manufacture's specification of the tool being used.

6. This should turn "OFF" the module and cause a spark. If no spark occurs, the fault is most likely in the ignition coil because most module problems would have been found before this point in the procedure. A module tester could determine which is at fault.

CHART C-4A
IGNITION SYSTEM CHECK
(REMOTE COIL / SEALED MODULE CONNECTOR DISTRIBUTOR)
2.8L (VIN S) "F" SERIES (PORT)

1
- Perform Diagnostic Circuit Check before proceeding with this test. (If a tachometer is connected to the Tach term., disconnect it before proceeding with the test).
- Check spark at plug with spark tester J-26792 or equivalent (ST-125) while cranking (if no spark on one wire, check a second wire) A few sparks and then nothing is considered no spark.

Spark: Check fuel, spark plugs, etc. See section "B" symptoms.

No Spark:

1A
- Disconnect 4 term. distributor connector and check for spark.

Spark: Replace pick-up coil

No spark:

2
- Check for spark at coil wire with tester while cranking. (Leave spark tester connected to coil wire for Steps 3-6).

Spark: Inspect cap for water, cracks, etc. If OK, replace rotor.

No Spark:

3
- Disconnect distributor 2 term. "C / +" connector.
- Ignition switch "on", Engine stopped.
- Check volts at "+" and "C" term's. of dist. harn. conn.

Both term's. under 10 volts: Repair wire from module "+" term. to "B" term. of black Ign. coil connector or primary ckt. to ign. sw.

Under 10 volts "C" term. only: Check for open or gnd. in ckt. from "C" term. to ign. coil. If Ckt. is OK, fault is. ign. coil or conn..

Both term's. 10 volts or more:

4
- Reconnect dist. 2 term. conn.
- With ign. "ON", check voltage from tach. term. to gnd. (term. may be taped back in harness).

Under 1 volt: Repair open tach. lead or conn and repeat test #4.

1 to 10 volts: Replace module and check for spark from coil as in Step 6.
- **Spark:** System OK
- **No Spark:** Replace ign. coil, it too is faulty

Over10 volts:
- Connect test light from tach. term. to ground.
- Crank engine and observe light.

Light blinks: Replace ignition coil and recheck for spark with spark tester. If still no spark, re-install original coil and replace dist. module..

Light on steady:

5
- Disconnect distributor 4 term. connector.
- Remove dist. cap.
- Disconnect pick-up coil connector from module.
- Connect voltmeter from tach. term. to ground.
- Ignition on.
- Insulate a test light probe to 1/4" from tip and note voltage, as test light is momentarily connected from a voltage source (1.5 to 8V) to module term. "P". (Fig. 1).

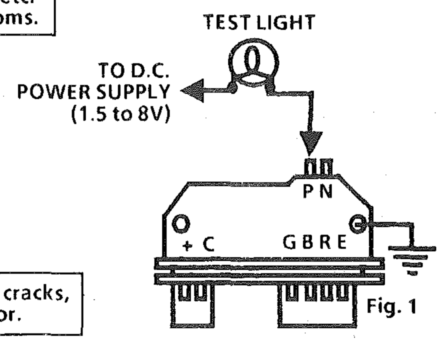

Fig. 1

No drop in voltage: Check module ground. If OK, replace module.

Voltage drops:

6
- Check for spark from coil wire with spark tester as test light is removed from module term.

No Spark:
- If no module tester (J24642) is available; Replace ign. coil and repeat Step 5.
  - **No Spark:** Ign. coil removed is OK, reinstall coil and check coil wire from dist. cap. if OK, replace dist. module.
  - **Spark:** System OK
- If module tester (J24642) is available: test module
  - **OK:** Check coil wire from cap to coil. If OK, replace coil.
  - **Not OK:** Replace module

Spark:
- Is rotating pole piece still magnetized?
  - **Yes:** Check pick-up coil or conns. (Coil resistance should be 500-1500 ohms and not grounded).
  - **No:** Replace pole piece and shaft assy.

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SECTION C6
AIR INJECTION REACTION (A.I.R.) SYSTEM
MANUAL TRANSMISSION ONLY

CONTENTS

GENERAL DESCRIPTION

PURPOSE

These systems are used to reduce carbon monoxide (CO), hydrocarbon (HC) and oxides of nitrogen (NO_x) emissions. They also heat up the catalytic converter quickly "ON" engine start-up so conversion of exhaust gases will start quickly.

A.I.R. PUMP OPERATION

The system (Figure C6-1) includes:

- An Air Pump
  The air pump is driven by a belt on the front of the engine and supplies the air to the system. Intake air passes through a centrifugal filter fan at the front of the pump; where foreign materials are separated from the air by centrifugal force.
- A Control Valve
  Air flows from the pump through an ECM controlled valve (called a control valve) through check valves to either the exhaust ports or the silencer (overboard).
- Check Valves
  The check valves prevent back flow of exhaust into the pump in the event of an exhaust backfire or pump drive belt failure.
- Necessary Plumbing

AIR CONTROL

Electric Air Control Valve (EAC)

The electric air control valve combines electronic control with the normal diverter valve function. This valve can be electronically controlled to provide divert air under any driving mode.

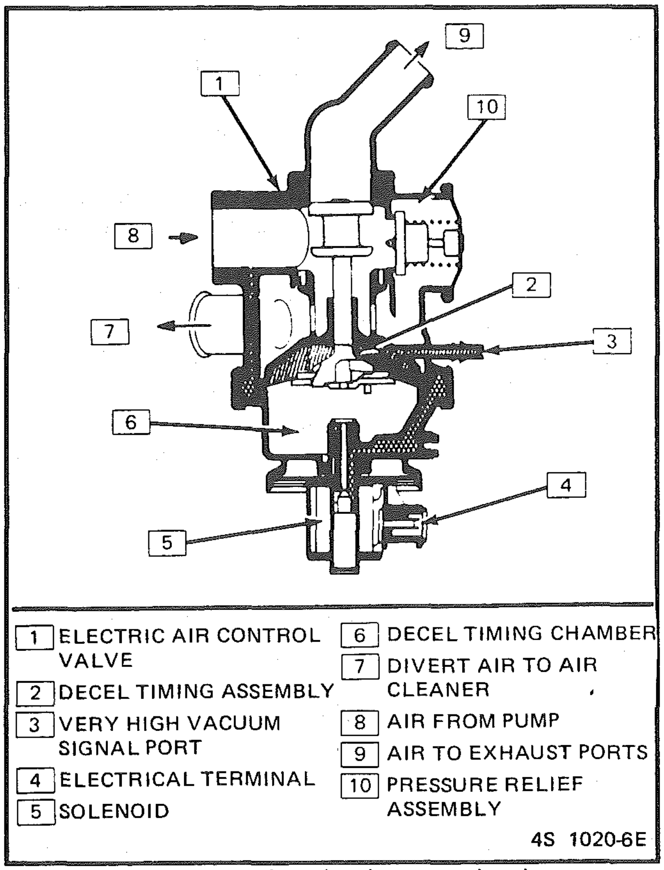


Figure C6-1 - Electric Air Control Valve

When the solenoid is energized, the valve will perform like a standardized diverter valve. Air from the air pump is directed to the exhaust ports, unless there is a great sudden rise in manifold vacuum due to throttle deceleration.

When the solenoid is de-energized, the pressurized air from the air pump is allowed to enter the decel timing chamber. This places sufficient pressure on the metering valve diaphragm to overcome spring tension, closing the valve,causing air to divert to the silencer.

At higher engine speeds, excess air is exhausted to the silencer through the pressure relief valve. (Figure C6-1)

Deceleration Valve

To help prevent backfiring during high vacuum conditions a deceleration (gulp) valve is used to allow air to flow into the intake manifold (shown in Figure C6-2). This air enters the air/fuel mixture to lean the rich condition created by high vacuum when the throttle valve closes on deceleration.

The vacuum draws the deceleration valve diaphragm down and opens the valve allowing air inlet duct to flow into the intake manifold.

RESULTS OF INCORRECT OPERATION

- If no air (oxygen) flow enters the exhaust stream at the exhaust ports, HC and CO emission levels will be too high.
- Air flowing to the exhaust ports at all times could cause a rich ECM command and increased temperature of the converter. This may also cause a Code 44 due to oxygen being pumped passed the oxygen sensor. There should be no air going to the exhaust ports while operating in the closed loop mode.

DIAGNOSIS

The diagnosis of the AIR system is covered in CHART C-6 at the end of this section.

OPERATIONAL CHECKS

A.I.R. Pump

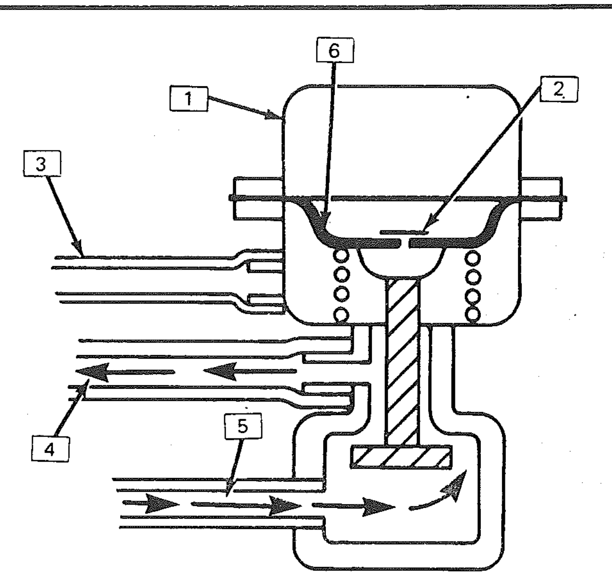
1. The air pump is a positive displacement vane type which is permanently lubricated and requires no periodic maintenance.

Accelerate engine to approximately 1500 rpm's and observe air flow from hose(s). If air flow increases as engine is accelerated, pump is operating satisfactorily. If air flow does not increase or is not present, proceed as follows:

Inspect

For proper drive belt tension.

2. For a leaky pressure relief valve. Air may be heard leaking with the pump running.



1 DECELERATION VALVE
2 VACUUM BLEED VALVE
3 MANIFOLD VACUUM
4 DECELERATION AIR TO INTAKE MANIFOLD
5 FILTERED AIR FROM INTAKE DUCT
6 DIAPHRAGM

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Figure C6-2 - Deceleration Valve

NOTICE: If the engine or underhood compartment is to be cleaned with steam or high-pressure detergent, the centrifugal filter fan should be masked "OFF" to prevent liquids from entering the pump.

Inspect

3. For a seized Air Injection Pump.
4. Hoses, tubes and all connections for leaks and proper routing.
5. For air flow from control/switching valve.
6. AIR injection pump for proper mounting and bolt torque.
7. If no irregularities exist and the AIR injection pump noise is still excessive, remove and replace pump.

CAUTION: **Do Not Oil Air Pump**

Hoses and Pipes

Inspect

1. Hose or pipe for deterioration or holes.
2. All hoses or pipe connections, and clamp tightness.
3. Hose or pipe routing. Interference may cause wear.

4. If a leak is suspected on the pressure side of the system or if a hose or pipe has been disconnected on the pressure side, the connections should be checked for leaks with a soapy water solution. With the pump running, bubbles will form if a leak exists.

Deceleration Valve

1. Connect tachometer, start engine and allow idle to stabilize.
2. With the engine running at specified idle speed, remove the small deceleration valve signal hose from the manifold vacuum source.
3. Reconnect the signal hose and listen for air flow through the ventilation pipe and into the deceleration valve. There should also be a noticeable speed drop when the signal hose is reconnected.
4. If the air flow does not continue for at least one second or the engine speed does not drop noticeably, check the deceleration valve hoses for restrictions or leaks.
5. If no restrictions or leaks are found, replace the deceleration valve.

Check Valve

Inspect

1. A check valve should be inspected whenever the hose is disconnected form a check valve or whenever check valve failure is suspected. (A pump that had become inoperative and had shown indications of having exhaust gases in the pump would indicate check valve failure).
2. Blow through the check valve (toward the exhaust manifold) then attempt to suck back through the check valve. Flow should only be in one direction(toward the exhaust manifold). Replace valve which does not operate properly.

ON-CAR SERVICE

DRIVE BELT

Remove or Disconnect

1. Inspect drive belt for ware, cracks or deterioration and replace if required. When installing new belt, it must be seated and fully secured in grooves of A/C compressor, AIR pump, generator, and crankshaft pulleys.

A.I.R. PUMP

Remove or Disconnect

1. Hold pump pulley from turning by compressing drive belt, then loosen pump pulley bolts.
2. Loosen bolt, holding pump to mounting brackets, release tension on drive belts.
3. Move belts out of the way, then remove pump hoses, vacuum and electrical connections, and control valve.
4. Pulley, then pump.
5. If required, insert needle nose pliers and pull filter fan from hub.

Install or Connect

1. Air pump assembly, and tighten mounting bolts.
2. Hoses, vacuum and electrical connections, and control valve.
3. New filter fan on pump hub.
4. Spacer and pump pulley against centrifugal filter fan.
5. Pump pulley bolts and tighten equally to 13 N·m (10 lb. ft.). This will compress the centrifugal filter fan onto the pump hole. Do not drive filter fan on with a hammer. A slight amount of interference with the housing bore is normal. After a new filter fan has been installed, it may squeal upon initial operation or until O.D. sealing lip has worn in. This may require a short period of pump operation at various engine speeds.
6. Pump drive belt and adjust.
7. Check air injection system for proper operation (see CHART C-6)

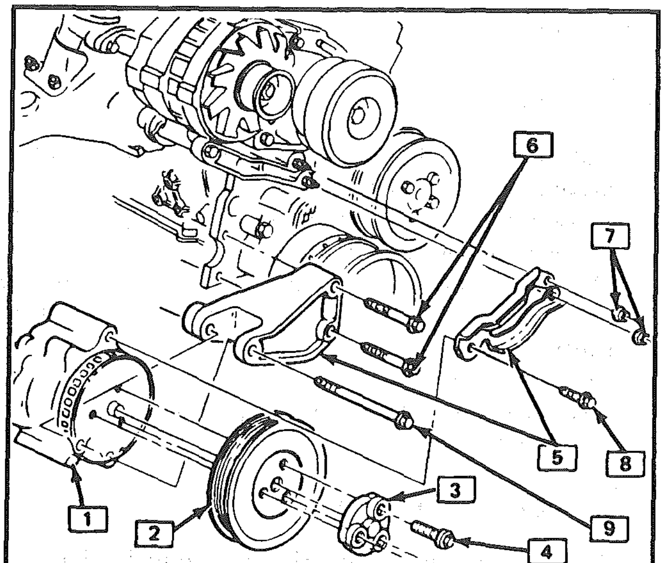
AIR CONTROL VALVE

Remove or Disconnect

1. Battery ground cable.
2. Adapter bolts (See Figure C6-3).
3. Air outlet hoses from valve.
4. Adapter.
5. Electrical connectors and vacuum hoses from valve.
6. Control valve.

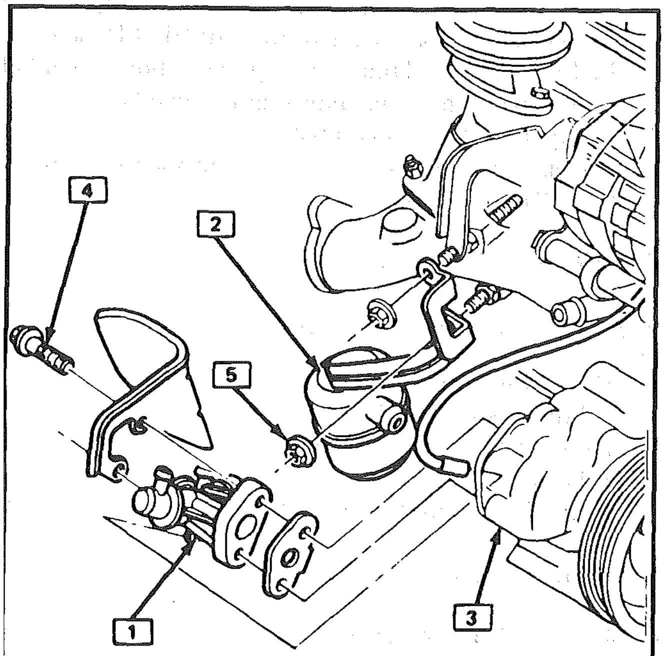
Install or Connect

1. Control valve.
2. Electrical connectors and vacuum hoses.
3. Adapter.
4. Air hoses to valve.
5. Adapter bolts to pump.
6. Battery ground cable.
7. Check system operation (see CHART C-6).



1 A.I.R. PUMP ASM
2 PULLEY
3 SPACER
4 PULLEY BOLT 27 N·m (20 FT. LBS.)
5 BRACKETS (UPPER AND LOWER)
6 BOLTS (2) 80 N·m (60 FT. LBS.)
7 NUTS (2) 50 N·m (36 FT. LBS.)
8 UPPER PUMP BOLT 35 N·m (26 FT. LBS.)
9 LOWER PUMP BOLT 35 N·m (26 FT. LBS.) 7S 3317-6E

Figure C6-3 - Air Pump Mounting



1 CONTROL VALVE
2 DIVERT SILENCER
3 A.I.R. PUMP ASM
4 BOLT (2) 16 N·m (12 FT. LBS.)
5 NUTS (2) 24 N·m (18 FT. LBS.) 7S 3315-6E

Figure C6-4 - Control Valve Service

CHECK VALVE

Remove or Disconnect

1. Any parts required for access.
2. Release clamp and disconnect air hoses from check valve.
3. Unscrew check valve from air injection pipe.

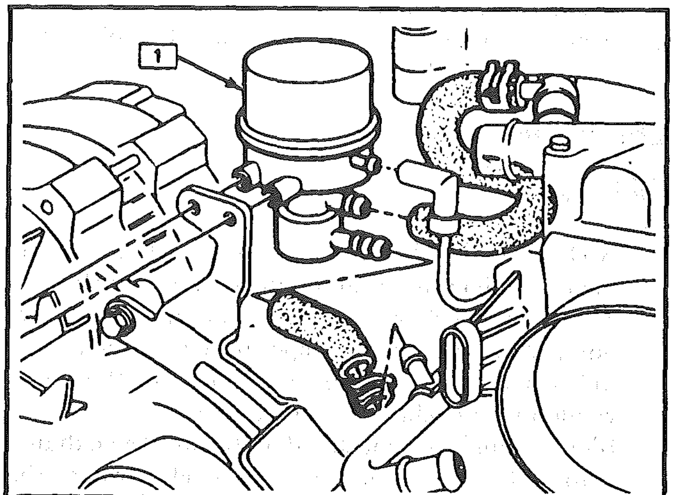
Install or Connect

1. Screw check valve onto air injection pipe.
2. Position air hoses on check valve and secure with clamp.
3. Any parts removed for access.

DECELERATION VALVE

Remove or Disconnect

1. Vacuum hoses from valve.
2. Screws securing valve to engine bracket.
3. Deceleration valve.



1 DECELERATION VALVE ASM 7S 3316-6E

Figure C6-5 - Control Valve Service

Install or Connect

1. Deceleration valve.
2. Screws securing valve to engine bracket.
3. Vacuum hoses to valve.

PARTS INFORMATION

PART NAME	GROUP
Bracket, AIR Inj Pump Supt (RR)	3.655
Bracket, AIR Inj Pump (Frt)	3.655
Bracket, Dclr Vlv	3.671
Gasket, AIR Cont Vlv	3.671
Hose, AIR Inj Cont Vlv	3.675
Hose, C/case Vent Pipe to Dclr Vlv	3.675
Pipe, AIR Inj Ctltc Conv Chk Vlv	3.690
Pipe, AIR Inj Cont Vlv	3.675
Pulley, AIR Inj Pump	3.650
Pump, AIR Inj	3.660
Silencer, AIR Inj Cont Vlv	3.675
Valve, AIR Inj Cont	3.670
Valve, AIR Inj Eng Chk	3.670
Valve, Dclr	3.670

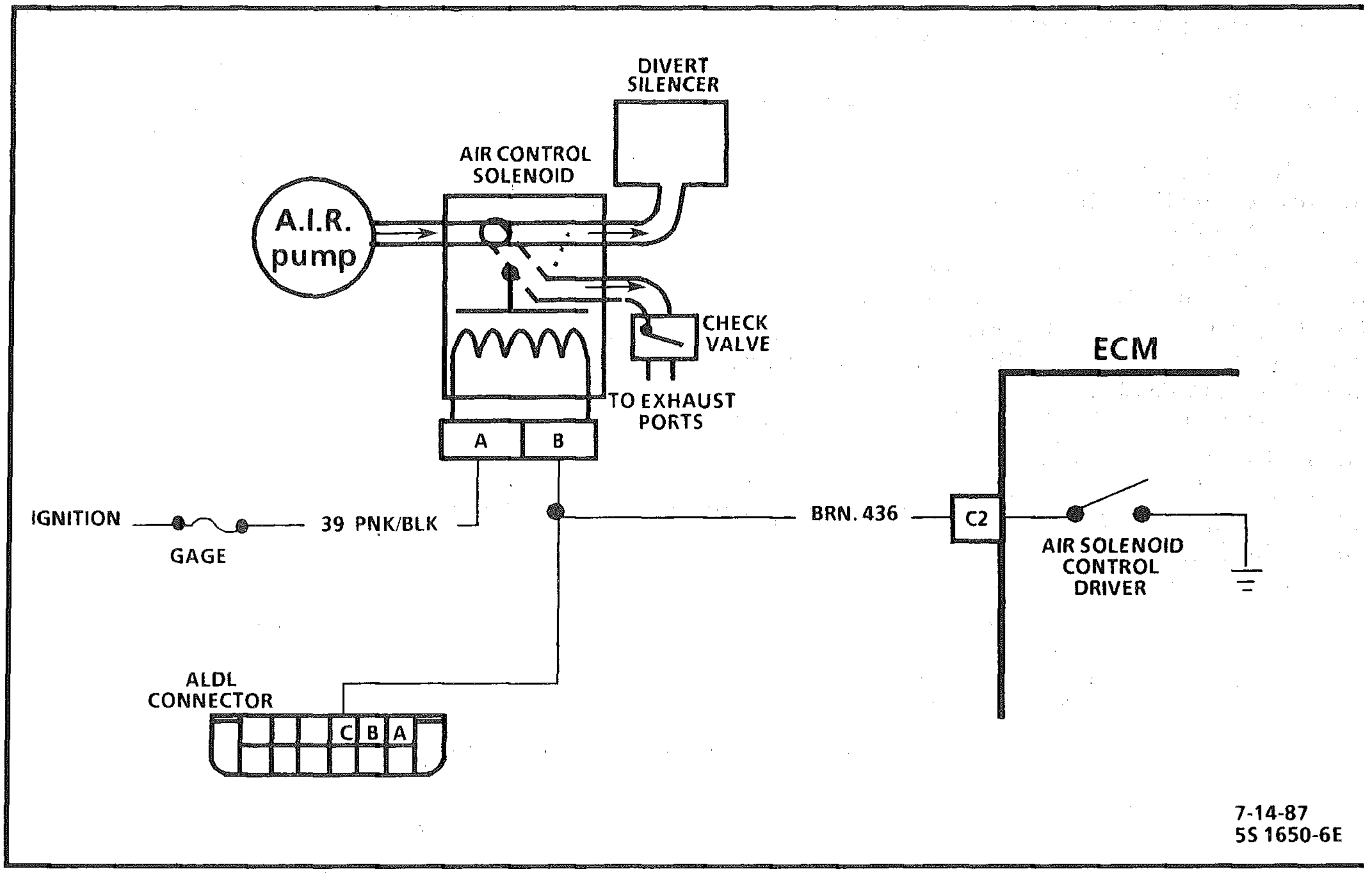


CHART C-6

ELECTRIC CONTROL (DIVERT)
(MANUAL TRANSMISSION)
2.8L (VIN S) "F" SERIES (PORT)

Circuit Description:

This system uses a single bed converter and Air Management is controlled by an Air Control Valve (divert valve).

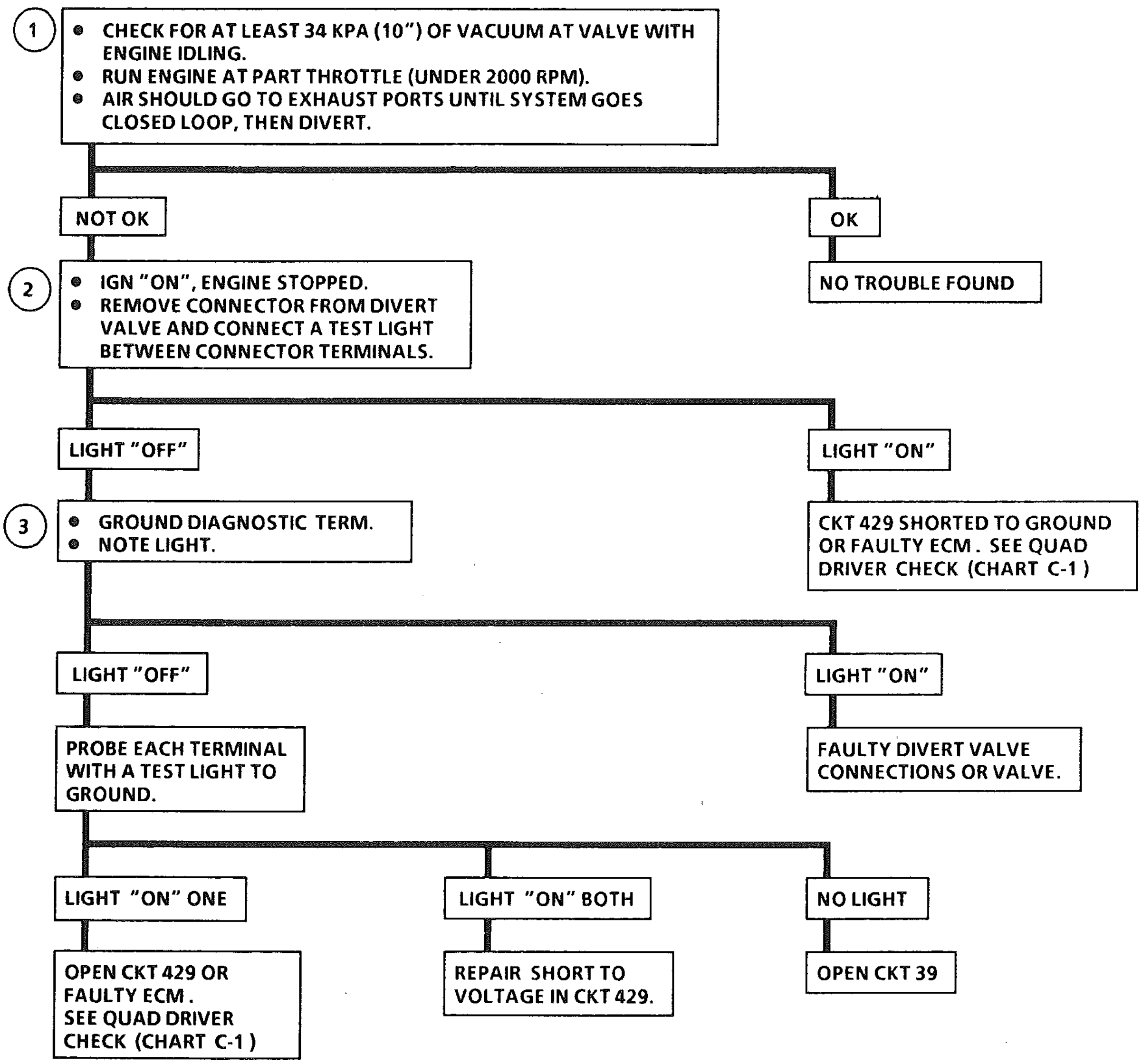
When grounded by the ECM, the solenoid causes the valve to direct air to the exhaust ports. When de-energized air diverts to the atmosphere, air will go to the ports provided the valve has a ground to the ECM and good manifold vacuum.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. This is a system performance test. When vehicle goes to closed loop, air will switch from the ports to divert.
2. Tests for a grounded electric divert circuit. Normal system light will be "OFF".
3. Checks for an open control circuit. Grounding test terminal will energize the solenoid if ECM and circuits are normal. In this step, if test light is "ON", circuits are normal and faulty is in valve connections or valve.

CHART C-6

ELECTRIC CONTROL (DIVERT)
(MANUAL TRANSMISSION)
2.8L (VIN S) "F" SERIES (PORT)



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SECTION C7

EXHAUST GAS RECIRCULATION (EGR) SYSTEM

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The EGR system is used to lower NO_X (oxides of nitrogen) emission levels caused by high combustion temperature. It does this by decreasing combustion temperature.

The main element of the system is the EGR valve operated by vacuum and mounted "ON" the intake manifold.

The EGR valve feeds small amounts of exhaust gas back into the combustion chamber as shown in Figure C7-1.

OPERATION

The EGR valve is opened by vacuum to let exhaust gas flow into the intake manifold. The exhaust gas then moves with the air/fuel mixture into the combustion chamber. If too much exhaust gas enters, combustion will not occur. For this reason, very little exhaust gas is allowed to pass through the valve, especially at idle. The EGR valve is usually open during warm engine operation and when the vehicle is above idle speed.

The amount of exhaust gas recirculated is controlled by variations in vacuum and the EGR vacuum control solenoid.

ELECTRONIC VACUUM REGULATOR VALVE

The Electronic Vacuum Regulator Valve (EVRV) uses "pulse width modulation" to control EGR flow. This means the ECM turns the solenoid "ON" and "OFF many times a second and varies the amount of "ON" time ("pulse width") to vary the amount of EGR.

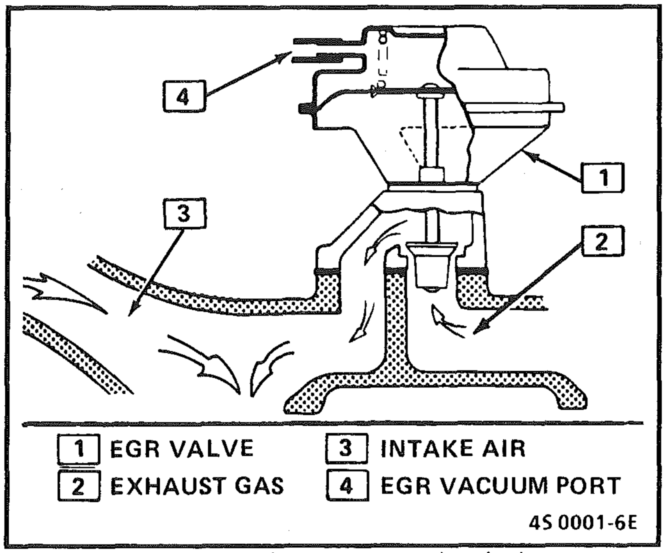


Figure C7-1 Exhaust Gas Recirculation

The ECM uses information from the following sensors to enable the EVRV:

- Throttle position sensor (TPS)
- P/N Switch
- Manifold absolute temperature (MAT)

The ECM uses information from the following sensors to regulate the EVRV:

- Engine Load
- Coolant Temperature
- Distributor (rpm Signal)
- Torque Converter Clutch (TCC)

A diagnostic switch is part of the control and monitors vacuum to the EGR valve. This switch will trigger a "Service Engine Soon" light, and set a Code 32 in the event of a vacuum circuit failure.

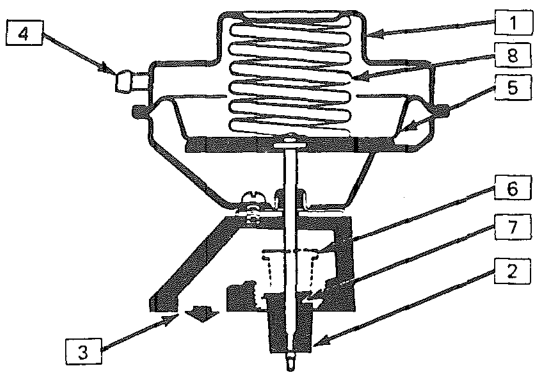


Figure C7-2 - Port EGR Valve

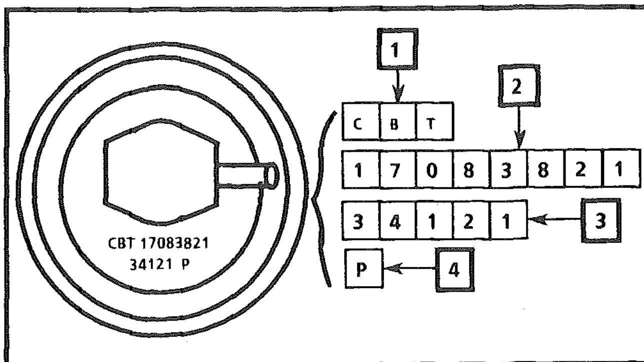


Figure C7-4 - EGR Valve Identification

PORT EGR VALVE

The port EGR valve (Figure C7-2) is controlled by a flexible diaphragm which is spring loaded to hold the valve closed. Ported vacuum applied to the top side of the diaphragm overcomes the spring pressure and opens the valve in the exhaust gas port. This allows exhaust gas to be pulled into the intake manifold and enter the engine cylinders.

EGR VALVE IDENTIFICATION

- Negative backpressure EGR valves will have an "N" stamped on the top side of the valve after the part number (Figure C7-4).
- Positive backpressure EGR valves will have a "P" stamped on the top side of the valve, after the part number.
- Port EGR valves have no identification stamped after the part number.

When replacing an EGR valve, always check for correct part number in the parts catalog or supplemental bulletin.

RESULTS OF INCORRECT OPERATION

Too much EGR flow tends to weaken combustion, causing the engine to run roughly or stop. With too much EGR flow at idle, cruise, or cold operation, any of the following conditions may happen:

- Engine stops after cold start.
- Engine stops at idle after deceleration.
- Car surges during cruise.
- Rough idle.

If the EGR valve should stay open all of the time, the engine may not idle.

Too little or no EGR flow allows combustion temperatures to get too high during acceleration and load conditions. This could cause:

- Spark knock (detonation).
- Engine overheating.
- Emission test failure.

DIAGNOSIS

Diagnosis of the EGR system is covered in CHART C-7 for the 2.8L at the end of this section.

ON-CAR SERVICE

EGR VALVE

Remove or Disconnect

1. Vacuum line
2. Bolts
3. EGR valve

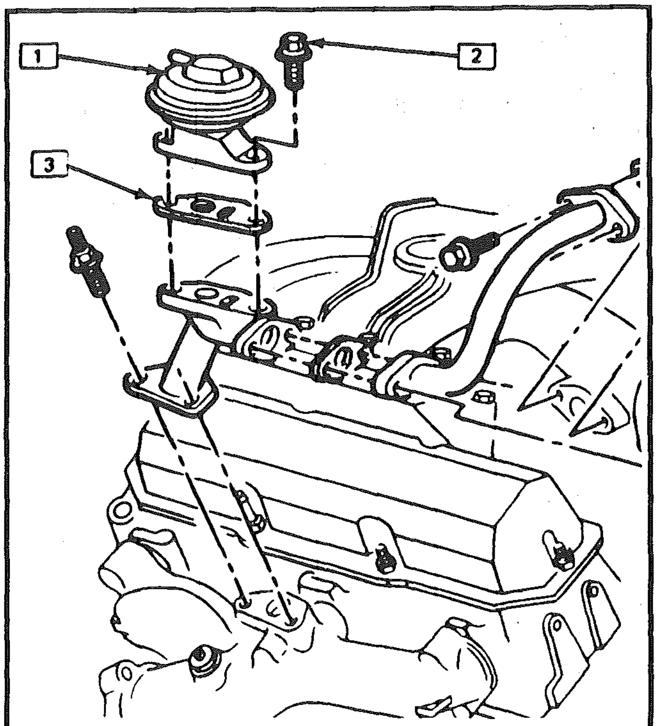
Install or Connect

1. EGR valve
2. Bolts
3. Vacuum line

EGR Manifold Passage

Inspect

If EGR passages in the inlet manifold indicate excessive build-up of deposits, the passages should be cleaned. Care should be taken to ensure that all loose particles are completely removed to prevent them from clogging the EGR valve or from being ingested into the engine.



1 EGR VALVE
2 BOLTS (2) 31 N·m (23 FT. LBS.)
3 GASKET

7S 3320-6E

Figure C7-5 - EGR to Manifold Mounting

Do not wash EGR valve in solvents or degreaser-- permanent damage to valve diaphragm may result. Also sand blasting of the valve is not recommended, since this can affect the operation of the valve.

Clean

1. With a wire wheel, buff the exhaust deposits from the mounting surface and around the valve.
2. Look for exhaust deposits in the valve outlet. Remove deposit build-up with a screwdriver.
3. Clean mounting surfaces of intake manifold and valve assembly.

EGR Manifold Passage

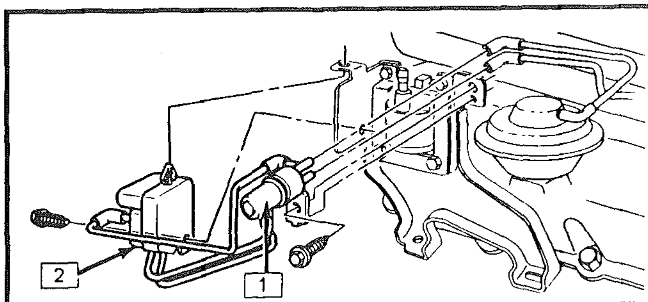
Inspect

If EGR passages in the inlet manifold indicate excessive build-up of deposits, the passages should be cleaned. Care should be taken to ensure that all loose particles are completely removed to prevent them from clogging the EGR valve or from being ingested into the engine.

Do not wash EGR valve in solvents or degreaser-- permanent damage to valve diaphragm may result. Also, sand blasting of the valve is not recommended since this can affect the operation of the valve.

Clean

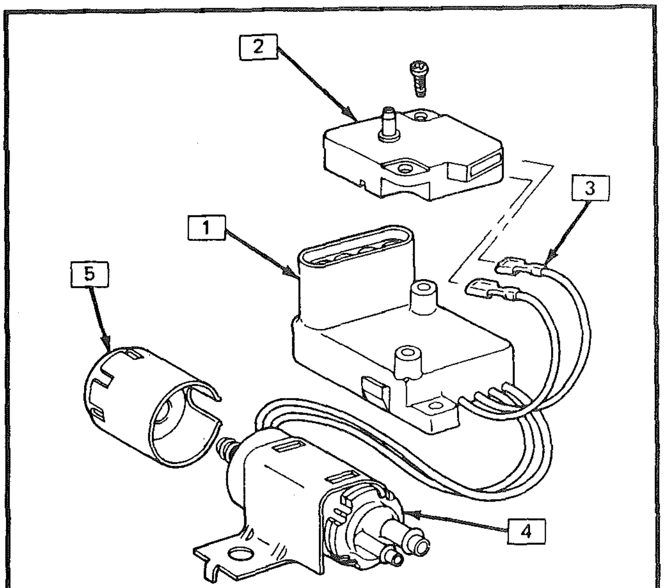
1. With a wire wheel, buff the exhaust deposits from the mounting surface and around the valve.
2. Look for exhaust deposits in the valve outlet. Remove deposit build-up with a screwdriver.
3. Clean mounting surfaces of intake manifold and valve assembly.



1 EGR CONTROL SOLENOID
2 EGR DIAGNOSTIC VACUUM SWITCH

05 24 84 5S 1488-6E

Figure C7-6 - EGR Control Solenoid



1 EGR VACUUM CONTROL ASSEMBLY BASE
2 EGR VACUUM DIAGNOSTIC SWITCH
3 DIAGNOSTIC SWITCH CONNECTORS
4 EGR SOLENOID
5 FILTER

4S 1182-6EA

Figure C7-7 - EGR Vacuum Control Assembly

ELECTRONIC VACUUM REGULATOR VALVE

Remove or Disconnect

1. Negative battery cable.
2. Electrical connector at regulator valve
3. Vacuum hoses.
4. Nut and regulator valve.

Install or Connect

1. Regulator valve and bracket, tighten nut to 24 N · m (17 lb. ft.).
2. Vacuum hoses
3. Electrical connector
4. Negative battery cable

EVRV FILTER REPLACEMENT

The EVRV filter should be replaced every 30, 000 miles.

1. Grasp and pull filter "OFF" with a rocking motion.
2. Push new filter "ON", making sure cut-out for wires is properly aligned.

PARTS INFORMATION

PARTS NAME	GROUP
Valve, EGR	3.670
Gasket, EGR Valve	3.680
Control, EGR Vacuum	3.670

BLANK

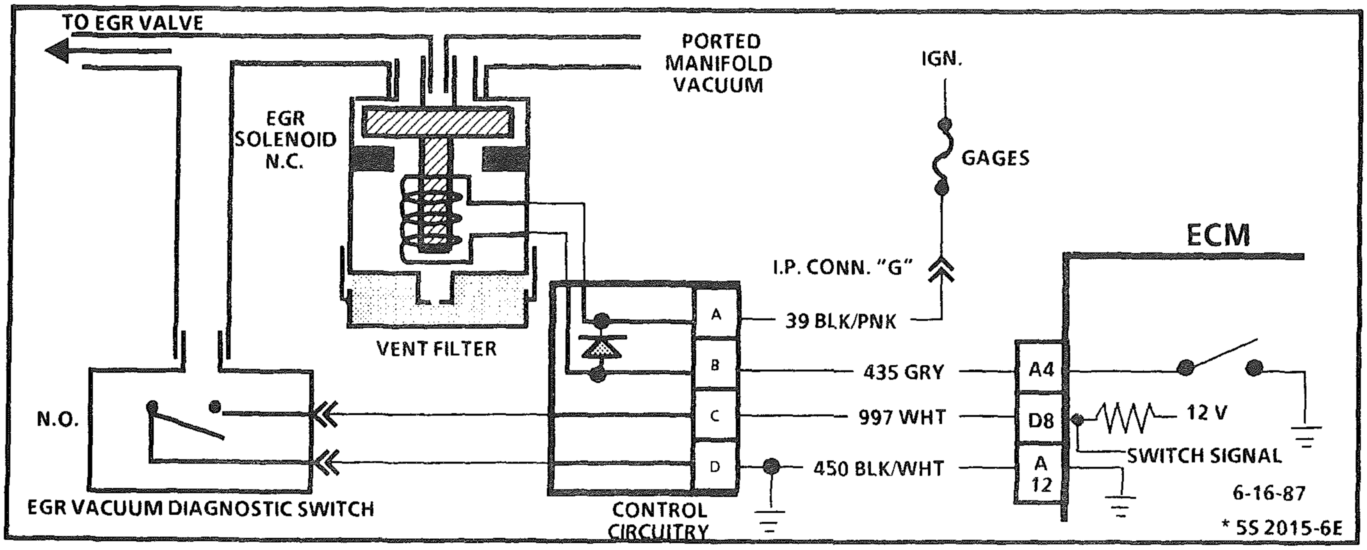


CHART C-7

EXHAUST GAS RECIRCULATION CHECK
2.8L (VIN S) "F" SERIES (PORT)

Circuit Description:

The EGR valve is controlled by a normally closed solenoid (allow a vacuum to pass when energized). The ECM energizes the solenoid to turn the EGR "ON", and monitors vacuum to the EGR with the EGR diagnostic switch. Code 32 will detect a faulty solenoid, vacuum switch or vacuum supply. CHART C-7 checks for plugged EGR passages, a sticking EGR valve, or a stuck open solenoid.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. With the ignition "ON" engine stopped, the solenoid should not be energized and vacuum should not pass to the EGR valve.
2. Grounding the diagnostic terminal will energize the solenoid and allow vacuum to pass to valve.
3. Checks for pluged EGR passages. If passages are plugged, the engine may have severe detonation on acceleration.
4. The EGR solenoid will not be energized in Park or Neutral. This test will determine if the Park/Neutral switch input is being received by the ECM.

CHART C-7

EXHAUST GAS RECIRCULATION CHECK 2.8L (VIN S) "F" SERIES (PORT)

ASSUMES NO CODE 32 IS STORED

1
- DISCONNECT EGR SOLENOID VACUUM HARNESS.
- ROTATE HARNESS AND REINSTALL ONLY THE EGR VALVE SIDE.
- CHECK PORTED VACUUM SOURCE TO SOLENOID (IF NOT OK, REPAIR).
- INSTALL A HAND HELD VACUUM PUMP WITH GAGE ON MANIFOLD SIDE OF EGR SOLENOID.
- IGNITION "ON", ENGINE STOPPED.
- DIAGNOSTIC TERMINAL NOT GROUNDED.
- APPLY VACUUM.
- OSBSERVE EGR VALVE.
- VALVE SHOULD NOT MOVE.

VALVE DOES NOT MOVE

2
- GROUND DIAGNOSTIC TERMINAL.
- REPEAT TEST.

VALVE MOVES

3
- START AND IDLE ENGINE.
- LIFT UP ON EGR VALVE AND OBSERVE IDLE.

IDLE ROUGHENS

4
- RECONNECT EGR SOLENOID.
- CONNECT VACUUM GAGE TO VACUUM HARNESS AT EGR VALVE,
- ENGINE AT NORMAL OPERATING TEMP.
- IN DRIVE (AUTOMATIC TRANS.)
- HOLD BRAKES AND ACCELERATE MOMENTARILY UP TO ABOUT 1800 RPM.
- OBSERVE GAGE
- SHOULD HAVE OVER 2" VACUUM BUT LESS THAN 10".

OK

NO TROUBLE FOUND. EGR SYSTEM OK.

NOT OK

OVER 10" VACUUM

REPLACE EGR FILTER.

NO VACUUM OR LESS THAN 2".

IF THERE ARE NO RESTRICTIONS IN VACUUM LINES, PERFORM P/N SWITCH CHECK. CHART C-1A A/T ONLY.

NO CHANGE

- REMOVE EGR VALVE.
- CHECK PASSAGES FOR BEING PLUGGED. IF NOT PLUGGED REPLACE EGR VALVE.

VALVE DOES NOT MOVE

REPLACE EGR VALVE.

VALVE MOVES

- DISCONNECT EGR SOLENOID ELECTRICAL CONNECTOR.
- REPEAT TEST.

VALVE MOVES

REPLACE SOLENOID.

VALVE DOES NOT MOVE

CHECK CKT 435 FOR SHORT TO GROUND. IF NOT SHORTED, IT IS A FAULTY ECM. SEE ECM QUAD DRIVER CHECK (CHART C-1).

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

7-31-87
8S 4696-6E

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SECTION C8

TRANSMISSION CONVERTER CLUTCH (TCC) SYSTEM AND MANUAL TRANSMISSION SHIFT LIGHT

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The transmission converter clutch (TCC) system uses a solenoid operated valve in the automatic transmission to couple the engine flywheel to the output shaft of the transmission thru the torque converter. This reduces the slippage losses in the converter, which increases fuel economy.

OPERATION

For the converter clutch to apply, two conditions must be met:

- Internal transmission fluid pressure must be correct. For information on internal transmission operation, see Section "7A". This section will cover only the electrical operation of the TCC system.
- The ECM grounds a switch internally to turn on a solenoid in the transmission. This moves a check ball, which will allow the converter clutch to apply, if the hydraulic pressure is correct, as described above.

The ECM controls the TCC apply solenoid by looking at several sensors:

- Speedo Buffer Sensor (also called vehicle speed sensor (VSS). Speed must be above a certain value before the clutch can apply.
- Coolant Temperature Sensor. Engine must be warmed up before clutch can apply about 65°C (149°F).
- Throttle position sensor (TPS). After the converter clutch applies, the ECM uses the information from the TPS to release the clutch when the car is accelerating or decelerating at a certain rate.
- The brake switch is also part of the TCC circuit as it will remove battery voltage to the TCC solenoid when the brake pedal is depressed.
- Gear Select Switch. The 4th gear switch is used to send a signal to the ECM telling it when the transmission is in 4th gear. The ECM uses this information to vary the conditions under which the clutch applies or releases. However, the transmission does not have to be in fourth gear in order for the ECM to turn the clutch on.

If the converter clutch is applied at all times, the engine will stall immediately, just as in a manual transmission with the clutch applied.

If the converter clutch does not apply, fuel ecomony may be lower than expected. If the vehicle speed sensor fails, the TCC will not apply. If the 4th gear switch does not operate, the TCC may not apply at the right time.

DIAGNOSIS

The diagnosis of the TCC system is covered in CHART C-8 . If the ECM detects a problem in the system, a Code 24 should set. In this case see Code 24 CHART.

SHIFT LIGHT (M/T) DESCRIPTION

The purpose of the shift light is to provide a display which indicates the optimum fuel economy point for up shifting the manual transmission based on engine speed and load. The display is a lamp on the instrument panel. Activation of the ECM driver turns the lamp on.

DIAGNOSIS

The shift light circuit can be checked using CHART C-8C.

ON-CAR SERVICE

- See Section "8B" if the shift light bulb needs replacement.
- See Section "6E" to repair wiring problem.
- See Section "6C" if ECM is to be replaced.

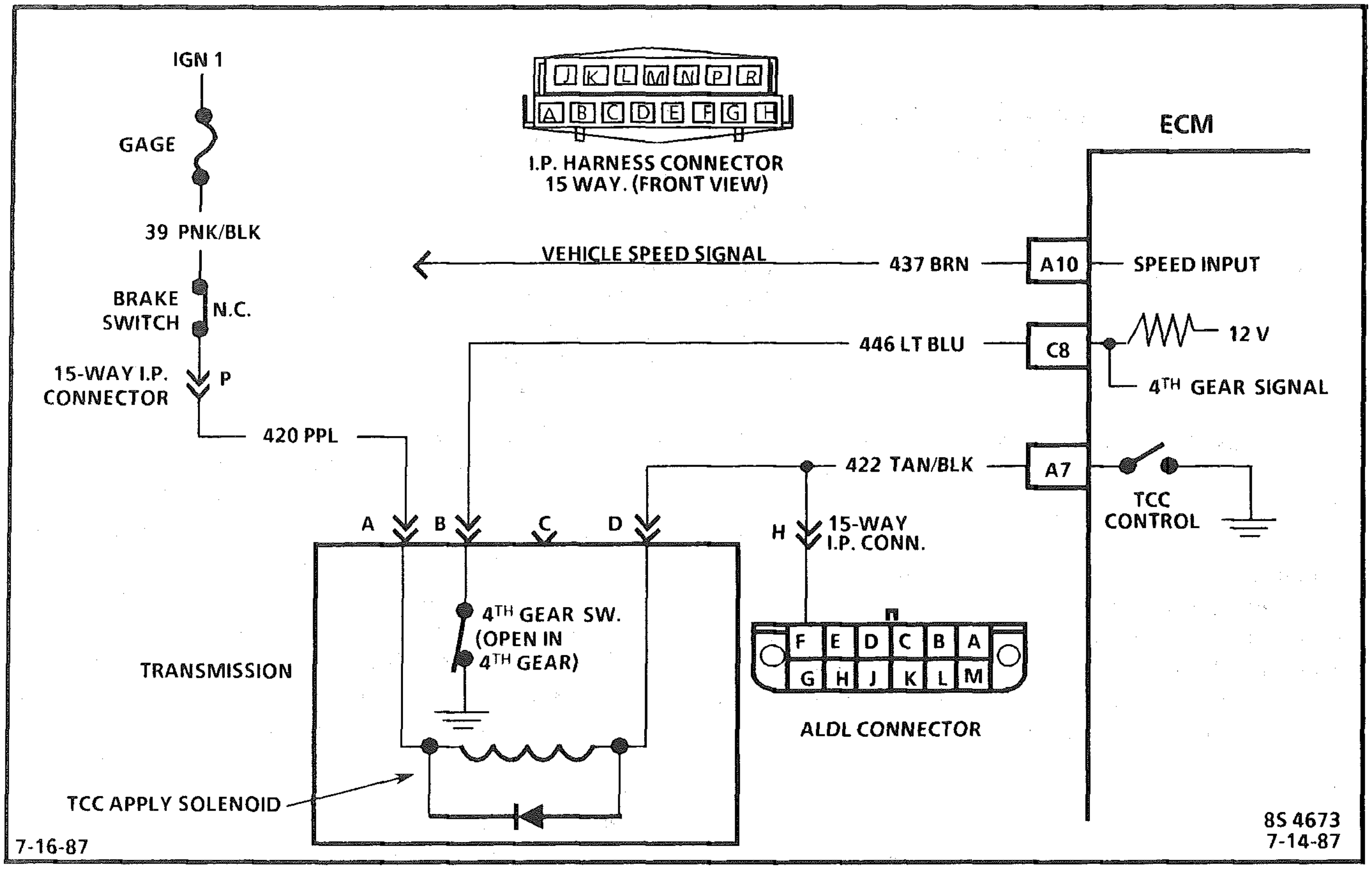


CHART C-8

(Page 1 of 2)
AUTOMATIC TRANSMISSION CONVERTER CLUTCH (TCC)
2.8L (VIN S) "F" SERIES (PORT)

Circuit Description:

The purpose of the automatic transmission torque converter clutch feature is to eliminate the power loss of the torque converter stage when the vehicle is in a cruise condition. This allows the convenience of the automatic transmission and the fuel economy of a manual transmission. The heart of the system is a solenoid located inside the automatic transmission which is controlled by the ECM.

When the solenoid coil is activated ("ON"), the torque converter clutch is applied which results in straight through mechanical coupling from the engine to transmission. When the transmission solenoid is deactivated, the torque converter clutch is released which allows the torque converter to operate in the conventional manner (fluidic coupling between engine and transmission).

The ECM turns "ON" the TCC when coolant temperature is above 65°C (149°F), TPS not changing, and vehicle speed above a specified value.

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. When a test light is connected from ALDL terminal "F" to ground, a test light "ON" indicates battery voltage is OK and the TCC solenoid is disengaged.
2. When the diagnostic terminal is grounded, the ECM should energize the TCC solenoid and the test light should go out.

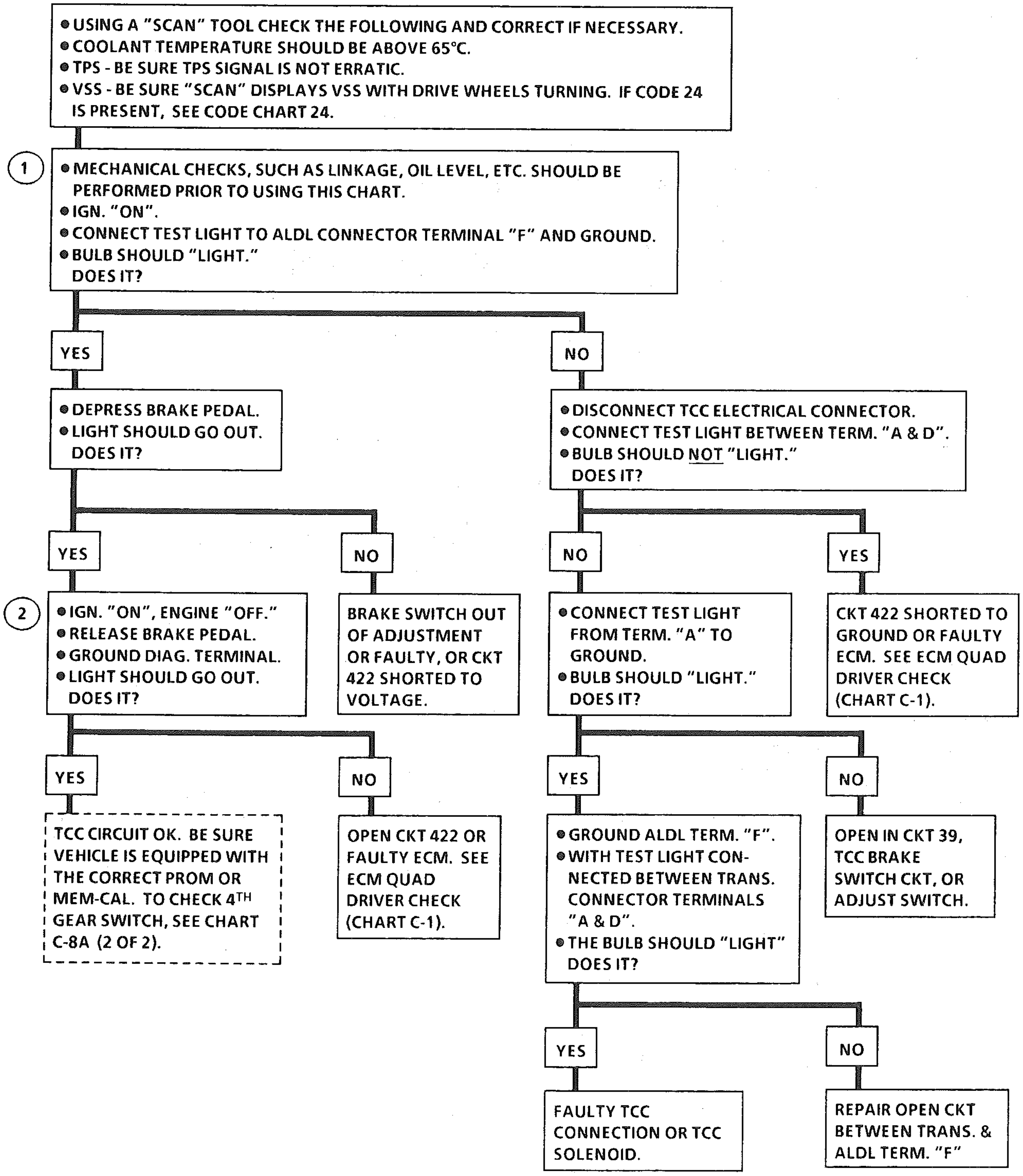
Diagnostic Aids:

A "Scan" tool only indicates when the ECM has turned "ON" the TCC driver (grounded CKT 422), but this does not confirm that the TCC has engaged. To determine if TCC is functioning properly, engine rpm should decrease when the "Scan" indicates the TCC driver has turned "ON". To determine if the 4th gear switch is functioning properly, perform the checks in CHART C-8A (Page 2 of 2). The switches will not prevent TCC from functioning but will affect TCC lock and unlock points. If the 4th gear switch CKT is always open the TCC may engage as soon as sufficient oil pressure is reached.

CHART C-8

(Page 1 of 2)

AUTOMATIC TRANSMISSION CONVERTER CLUTCH (TCC) 2.8L (VIN S) "F" SERIES (PORT)



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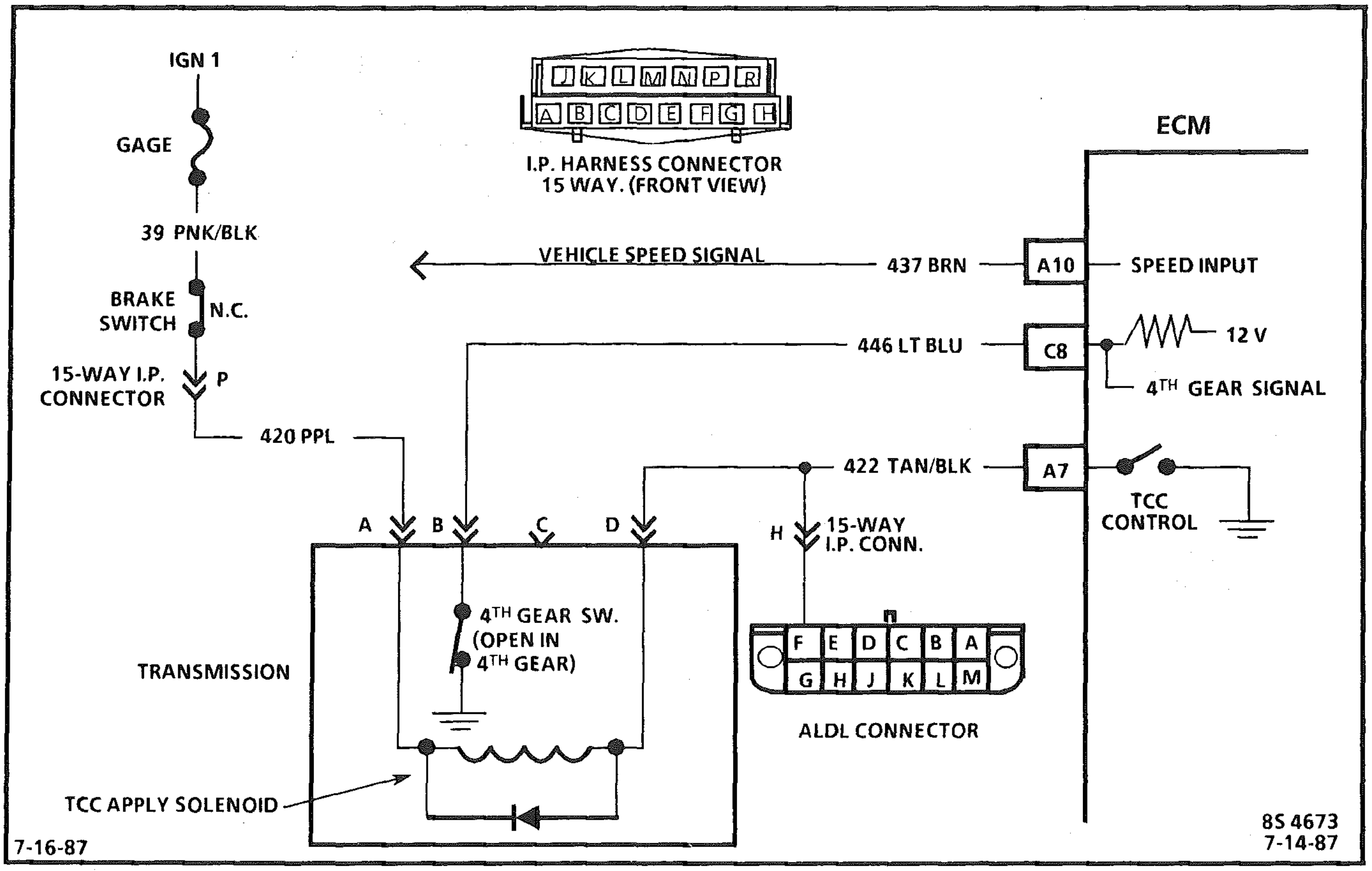


CHART C-8

(Page 2 of 2)
AUTOMATIC TRANSMISSION CONVERTER CLUTCH (TCC)
2.8L (VIN S) "F" SERIES (PORT)

Circuit Description:

A 4th gear switch (mounted in the trans.) opens when the trans. shifts into 4th gear, and this switch is used by the ECM to modify TCC lock and unlock points, when in a 4-3 downshift maneuver.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Unless the switch or CKT 446 is open the "Scan" should display "NO," indicating the trans. is not in 4th gear. The 4th gear switch should only be open while in 4th gear.
2. This step determines if the ECM and wiring are OK. Grounding CKT 446 should cause the "Scan" to display "NO," indicating the trans. is not in 4th gear.
3. Checks the operation of the 4th gear switch. When the trans. shifts into 4th gear the switch should open and the "Scan" should display "YES".
4. Disconnecting the TCC conne tor simulates an open switch to determine if CKT 446 is shorted to ground or the problem is in the transmission.

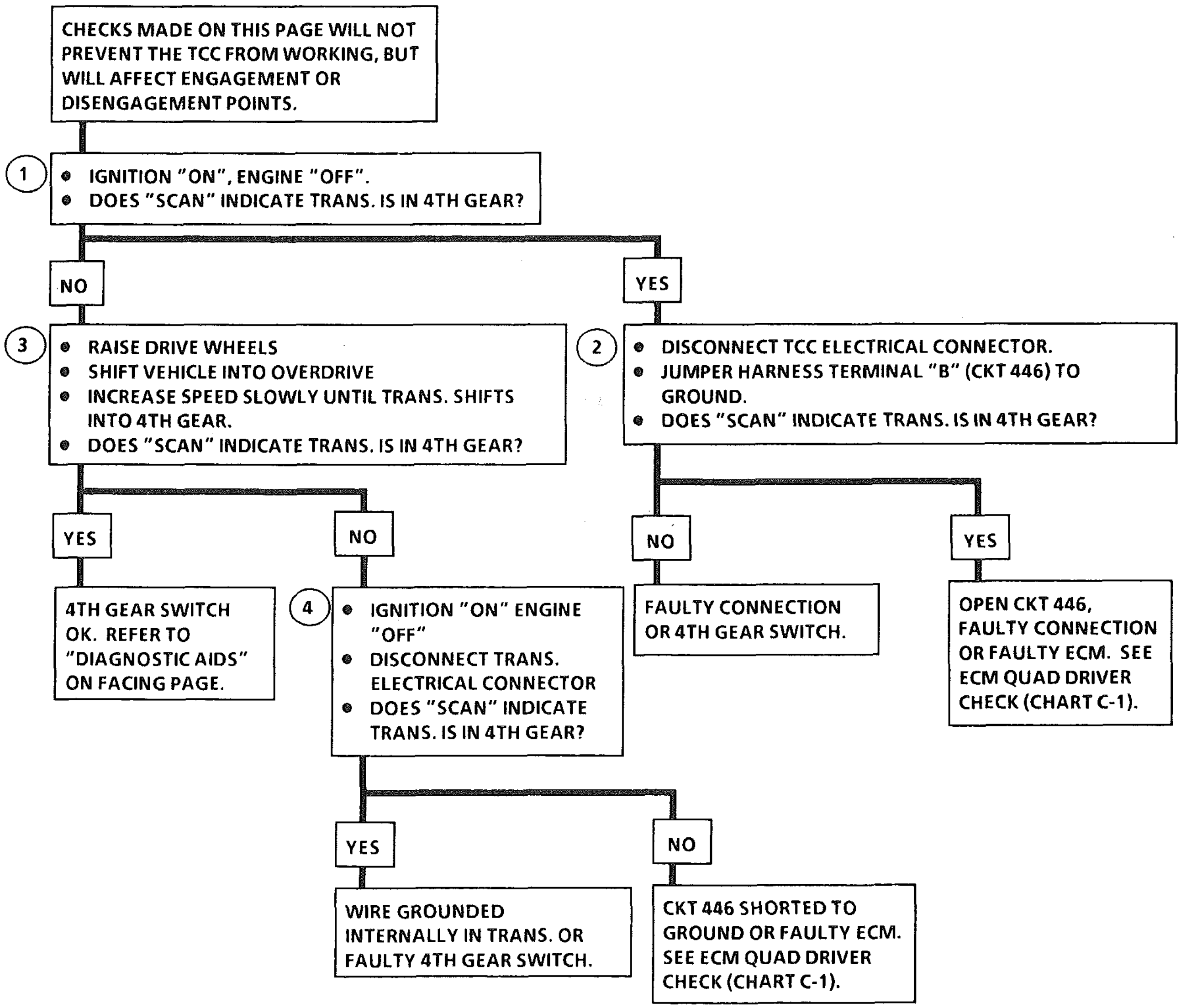
Diagnostic Aids:

A road test may be necessary to verify the customer complaint. If the "Scan" indicates TCC is turning "ON" and "OFF" erratically, check the state of the 4th gear switch to be sure it is not changing states under a steady throttle position. If the switch is changing states, check connections and wire routing carefully. Also if the 4th gear switch is always open the TCC may engage as soon as sufficient oil pressure is reached.

CHART C-8

(Page 2 of 2)

AUTOMATIC TRANSMISSION CONVERTER CLUTCH (TCC) 2.8L (VIN S) "F" SERIES (PORT)



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8S 4680-6E

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SECTION C10

ECM CONTROLLED AIR CONDITIONING

CONTENTS

GENERAL DESCRIPTION

In order to improve idle quality and wide open throttle performance, the A/C compressor is controlled by the ECM.

There are two different types of A/C systems used in GM vehicles. One is referred to as C.C.O.T. (cycling clutch orifice tube), which uses a fixed displacement compressor. The other type of system uses a compressor with a variable displacement, and is referred to as the V-5 type system. The V-5 type meets A/C requirements without cycling. For descriptions of both types, and an explanation of the components used, refer to Section "1B" of the service manual.

OPERATION

The 2.8L engine uses the C.C.O.T. type A/C system, and is controlled by the ECM. When A/C is requested, 12V power is supplied to the pressure cycling switch and to the A/C power relay. The ECM controls the A/C clutch by energizing the A/C control relay. This allows the ECM to increase idle speed before turning on A/C to improve idle quality.

The high pressure cut-out switch (normally closed) opens when head pressure gets too high. This disables the A/C clutch, before damage can occur to the system. This switch opens, when pressure is greater than about 440 psi (3034 kPa).

See CHART C-10 for diagnosis and wiring diagram of the electrical portion of the A/C circuit.

DIAGNOSIS

CHART C-10 should be used for diagnosing the electrical portion of the A/C circuit. Section "1B" should be used for diagnosing the refrigerant portion of the system.

The "Scan" tool will be used in diagnosing the system, as it has the ability to read the A/C request input to the ECM, as well as displaying when the ECM has commanded the A/C clutch "ON".

ON-CAR SERVICE

For removal and replacement procedures of A/C components, refer to Section "1" of the service manual.

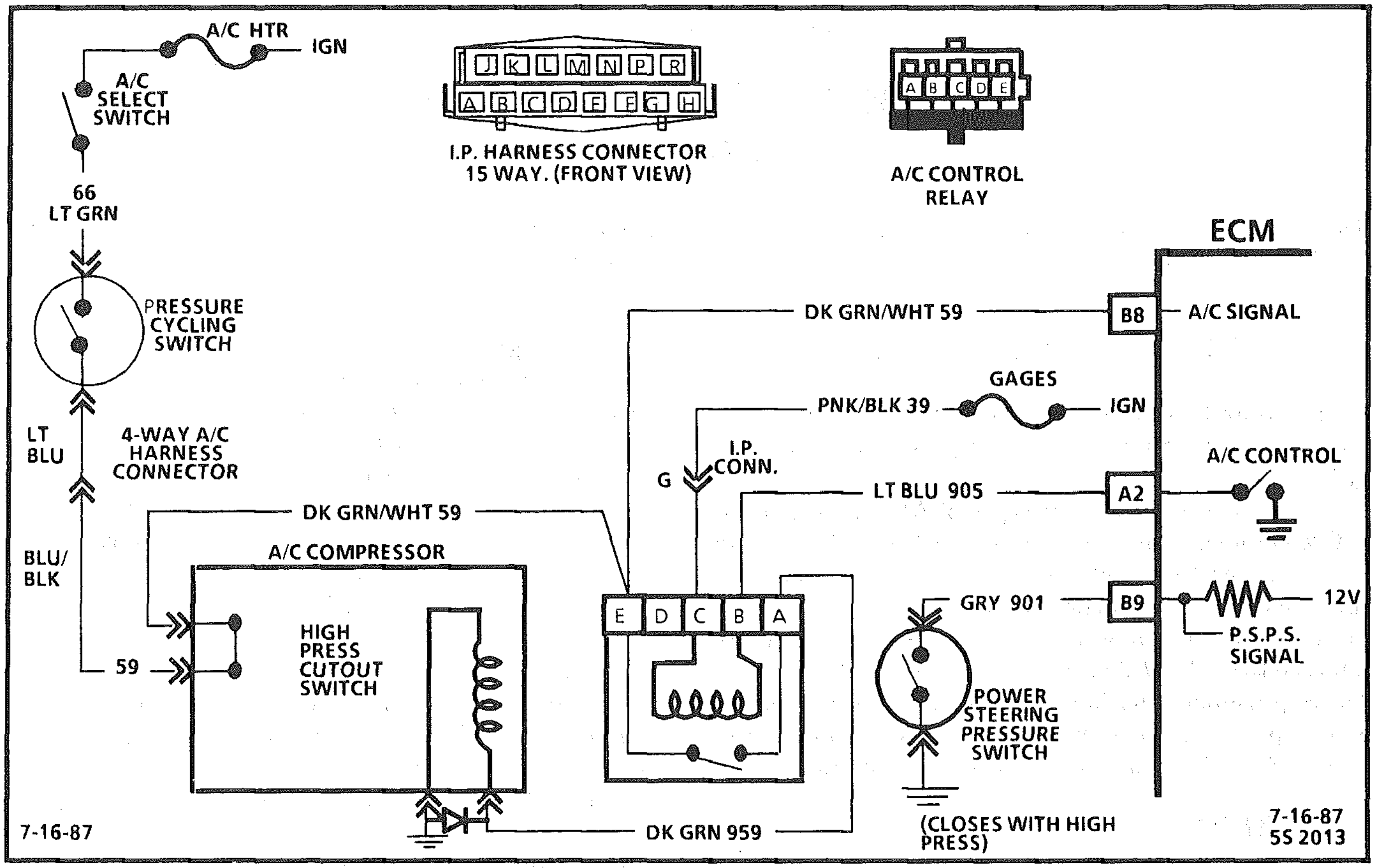


CHART C-10

A/C CLUTCH CONTROL 2.8L (VIN S) "F" SERIES (PORT)

Circuit Description:

ECM control of the A/C clutch improves idle quality and performance by:

- Delaying clutch apply until the idle air rate is increased.
- Releasing clutch when idle speed is too low or during high power steering loads.
- Releasing clutch at wide open throttle.
- smooths cycling of the compressor by providing additional fuel at the instant clutch is applied.

Voltage is supplied to the A/C Clutch Control relay on CKT 59 by the A/C Control Switch. This same voltage is supplied as a signal to ECM pin B8. After a time delay of about 1/2 second the ECM will ground terminal "A2," CKT 905, and close the A/C relay contacts.

When relay is energized battery voltage from CKT 59 is supplied to the A/C clutch through the relay and CKT 959.

Test Description:

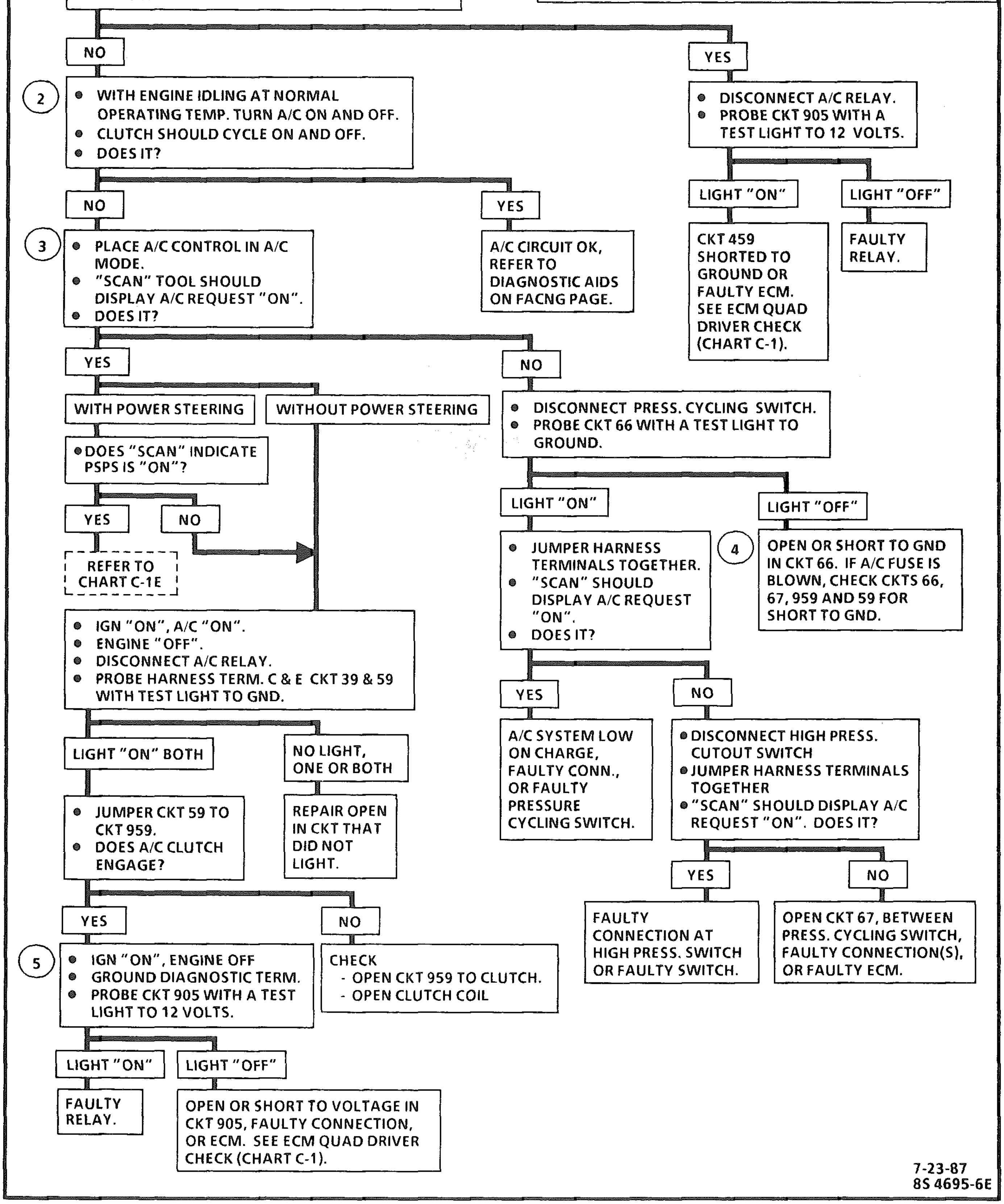
Numbers below refer to circled numbers on the diagnostic chart.

1. The ECM will only energize the A/C relay, when the engine is running. This test will determine if the relay, or CKT 905, is faulty.
2. In order for the clutch to properly be engaged, the pressure cycling switch must be closed to provide 12 volts to the relay, and the high pressure switch must be closed, so the A/C request (12 volts) will be present at the ECM.
3. Determines if the signal is reaching the ECM on CKT 59 from the A/C control panel. Signal should only be present when the A/C mode or defrost mode has been selected.
4. A short to ground in any part of the A/C request circuit, CKT 67 to the relay CKT 59, CKT 959 to the A/C clutch, or the A/C clutch, could be the cause of the blown fuse.
5. With the ignition "ON" and the diagnostic terminal grounded, the ECM should be grounding CKT 905 which should cause the test light to be "ON".

Diagnostic Aids:

If complaint was insufficient cooling, the problem may be caused by an inoperative cooling fan. The engine cooling fan should turn "ON," when A/C is "ON" and A/C head pressure exceeds about 233 psi. If not, see CHART C-12 for diagnosing the cooling fan.

CHART C-10
A/C CLUTCH CONTROL 2.8L (VIN S) "F" SERIES (PORT)



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SECTION C12

COOLING FAN CONTROL

CONTENTS

GENERAL DESCRIPTION

The fan is used for engine and A/C condenser cooling but the fan only operates under certain conditions.

OPERATION

The electric cooling fan on this engine is controlled by the ECM. The ECM will ground the cooling fan relay, which turns on the fan, when the following conditions are met.

- Coolant temperature sensor signal indicating a temperature greater than 106°C (222°F).
- Or: A/C head pressure greater than about 200 psi and vehicle speed less than 40 mph.
- When the cooling fan is turned on, it will stay on for a minimum time of 15 seconds on the 2.8L.
- The 2.8L also uses an override switch which will also turn on the cooling fan if the ECM fails.

DIAGNOSIS

The following charts will diagnose the ECM controlled cooling fan.

PARTS INFORMATION

PART NAME	GROUP
Fan, Engine	1.055
Motor, Fan	1.055
Relay, Engine Fan	1.055

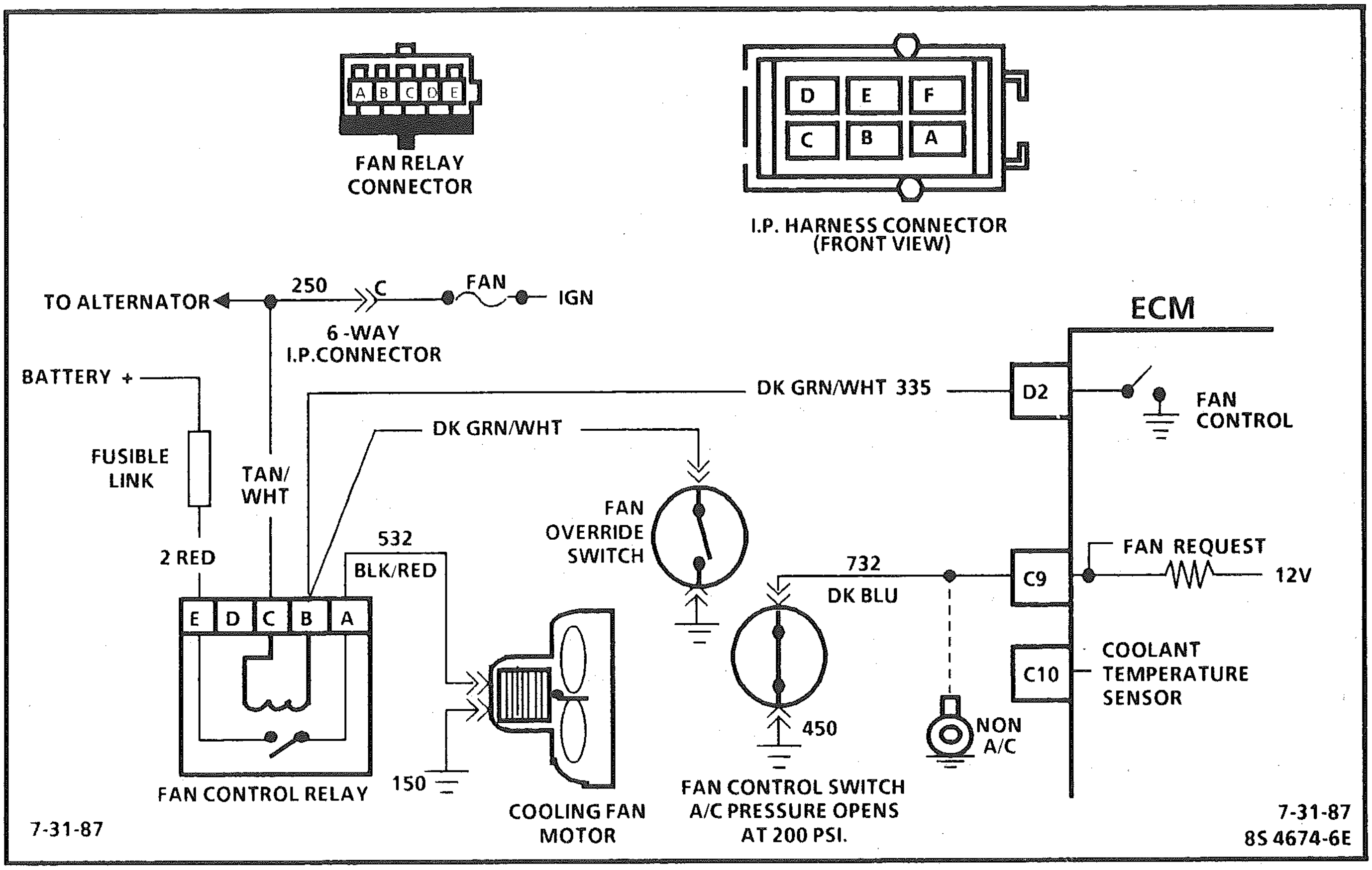


CHART C-12

(Page 1 of 2)

COOLING FAN CONTROL CIRCUIT
2.8L (VIN S) "F" SERIES (PORT)

Circuit Description:

The electric cooling fan is controlled by the ECM, based on inputs from the coolant temperature sensor, the A/C fan control switch, and vehicle speed. The ECM controls the fan by grounding CKT 335, which energizes the fan control relay. Battery voltage is then supplied to the fan motor.

The ECM grounds CKT 335, when coolant temp. is over about 106°C (223°F), or when A/C has been requested, and the fan control switch opens with high A/C pressure, about 200 psi (1380 kPa). Once the ECM turns the relay "ON", it will keep it "ON" for a minimum of 30 seconds, or until vehicle speed exceeds 70 mph.

Also, if Code 14 or 15 sets, or the ECM is in throttle body back up, the fan will run at all times.

On a vehicle not equipped with A/C, CKT 732 is jumpered to ground so that the fan does not run at all times.

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. With the diagnostic terminal grounded, the cooling fan control driver will close, which should energize the fan control relay.
2. If the A/C fan control switch or circuit is open, the fan would run whenever the engine is running.
3. With A/C clutch engaged, the A/C fan control switch should open, when A/C high pressure exceeds about 200 psi (1380 kPa). This signal should cause the ECM to energize the fan control relay.

Diagnostic Aids:

If the owner complained of an overheating problem, it must be determined if the complaint was due to an actual boilover, or the hot light, or temperature gage indicated over heating.

If the gage, or light, indicates overheating, but no boilover is detected, the gage circuit should be checked. The gage accuracy can, also, be checked by comparing the coolant sensor reading using a "Scan" tool and comparing its reading with the gage reading.

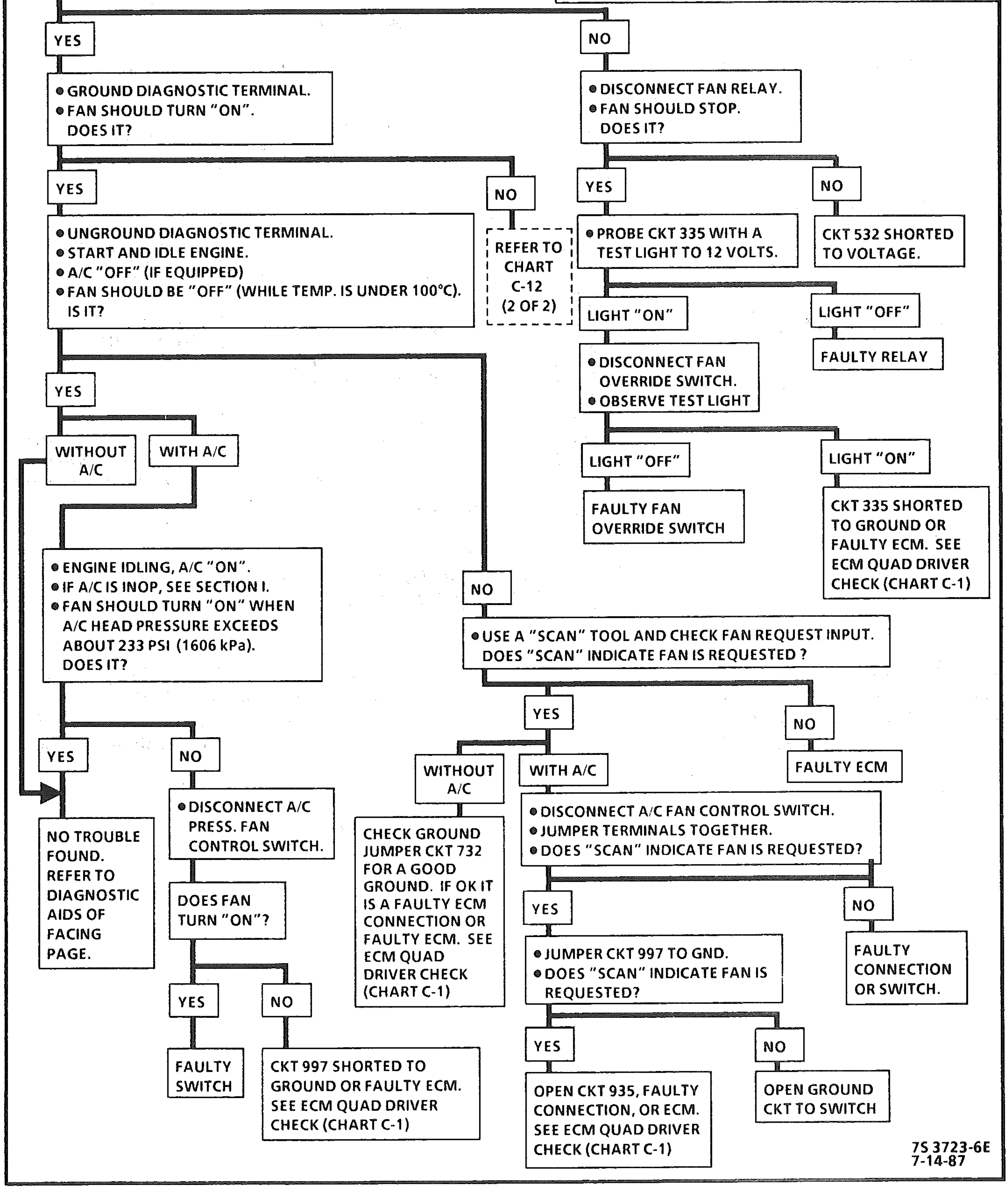
If the engine is actually overheating, and the gage indicates overheating, but the cooling fan is not coming "ON", the coolant sensor has probably shifted out of calibration and should be replaced.

If the engine is overheating, and the cooling fan is "ON", the cooling system should be checked.

CHART C-12

(Page 1 of 2)

COOLING FAN CONTROL CIRCUIT 2.8L (VIN S) "F" SERIES (PORT)



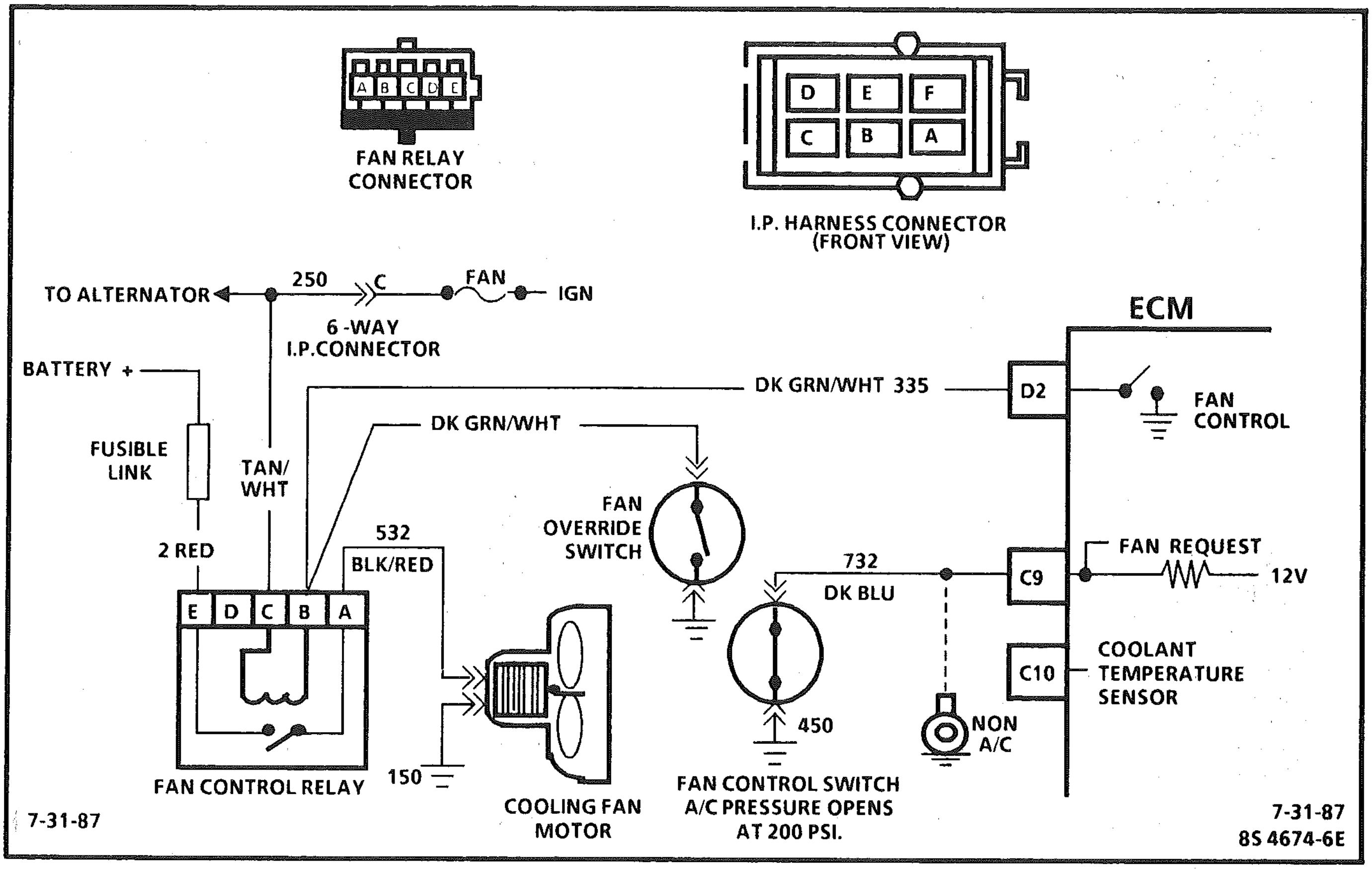


CHART C-12

(Page 2 of 2)
COOLING FAN CONTROL CIRCUIT
2.8L (VIN S) "F" SERIES (PORT)

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. 12 volts should be available to both terminal "E" & "C", when the ignition is "ON".
2. This test checks the ability of the ECM to ground CKT 335. The SES light should also be flashing, at this point. If it isn't flashing, see CHART A-2.
3. If the fan does not turn "ON", at this point, CKT 936 or CKT 150 is open, or the cooling fan motor is faulty.

CHART C-12

(Page 2 of 2)

COOLING FAN CONTROL CIRCUIT 2.8L (VIN S) "F" SERIES (PORT)

FROM CHART C-12 (1 OF 2)

1
- DISCONNECT FAN CONTROL RELAY.
- IGNITION "ON", ENGINE STOPPED.
- PROBE "A" AND "D" HARNESS TERMINALS WITH A TEST LIGHT CONNECTED TO GROUND.

LIGHT "ON" BOTH

2
- DIAGNOSTIC TERMINAL GROUNDED.
- PROBE CKT 335 WITH A TEST LIGHT CONNECTED TO 12 VOLTS.

LIGHT "ON"

3
- JUMPER HARNESS TERMINALS "A" AND "E" TOGETHER USING A FUSED JUMPER.
- FAN SHOULD RUN. DOES IT?

NO

- WITH "A-E" STILL JUMPERED, CONNECT A TEST LIGHT ACROSS THE COOLING FAN MOTOR HARNESS CONNECTOR TERMINALS.

LIGHT "OFF"

- PROBE EACH TERMINAL WITH A TEST LIGHT CONNECTED TO GROUND.

LIGHT "ON" ONE

OPEN IN GROUND CKT 150

LIGHT "OFF"

REPAIR OPEN IN CKT BETWEEN RELAY AND COOLING FAN MOTOR.

LIGHT "ON"

FAULTY MOTOR

YES

FAULTY RELAY OR RELAY CONNECTION

LIGHT "OFF"

OPEN OR SHORT TO VOLTAGE IN CKT 335, FAULTY CONNECTION AT ECM OR A FAULTY ECM.

NO LIGHT "ON" ONE OR BOTH

REPAIR OPEN OR SHORT TO GROUND IN CIRCUIT THAT DID NOT LIGHT.

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SECTION C13

POSITIVE CRANKCASE VENTILATION (PCV)

CONTENTS

GENERAL DESCRIPTION

A "closed" crankcase ventilation (PCV) system is used to provide more complete scavenging of crankcase vapors. Fresh air from the air cleaner is supplied to the crankcase, mixed with blow-by gases and then passed through a positive crankcase ventilation (PCV) valve into the intake manifold (Figure C13-1).

The primary control is through the PCV valve (Figure C13-2) which meters the flow at a rate depending on manifold vacuum.

To maintain idle quality, the PCV valve restricts the flow when intake manifold vacuum is high. If abnormal operating conditions arise, the system is designed to allow excessive amounts of blow-by gases to back flow through the crankcase vent tube into the engine air inlet to be consumed by normal combustion.

RESULTS OF INCORRECT OPERATION

A plugged valve or hose may cause:
- Rough idle.
- Stalling or slow idle speed.
- Oil leaks.
- Sludge in engine.

A leaking valve or hose would cause:
- Rough idle.
- Stalling.
- High idle speed.

DIAGNOSIS

FUNCTIONAL CHECK OF PCV VALVE

If an engine is idling rough, check for a clogged PCV valve or plugged hose. Replace as required. Use the following procedure:

1. Remove PCV valve from rocker arm cover.
2. Run the engine at idle.
3. Place your thumb over end of valve to check for vacuum. If there is no vacuum at valve, check for plugged hoses or manifold port, or PCV valve. Replace plugged or deteriorated hoses.
4. Turn "OFF" the engine and remove PCV valve. Shake valve and listen for the rattle of check needle inside the valve. If valve does not rattle, replace valve.

With this system, any blow-by in excess of the system capacity (from a badly-worn engine, sustained heavy load, etc.) is exhausted into the air cleaner and is drawn into the engine.

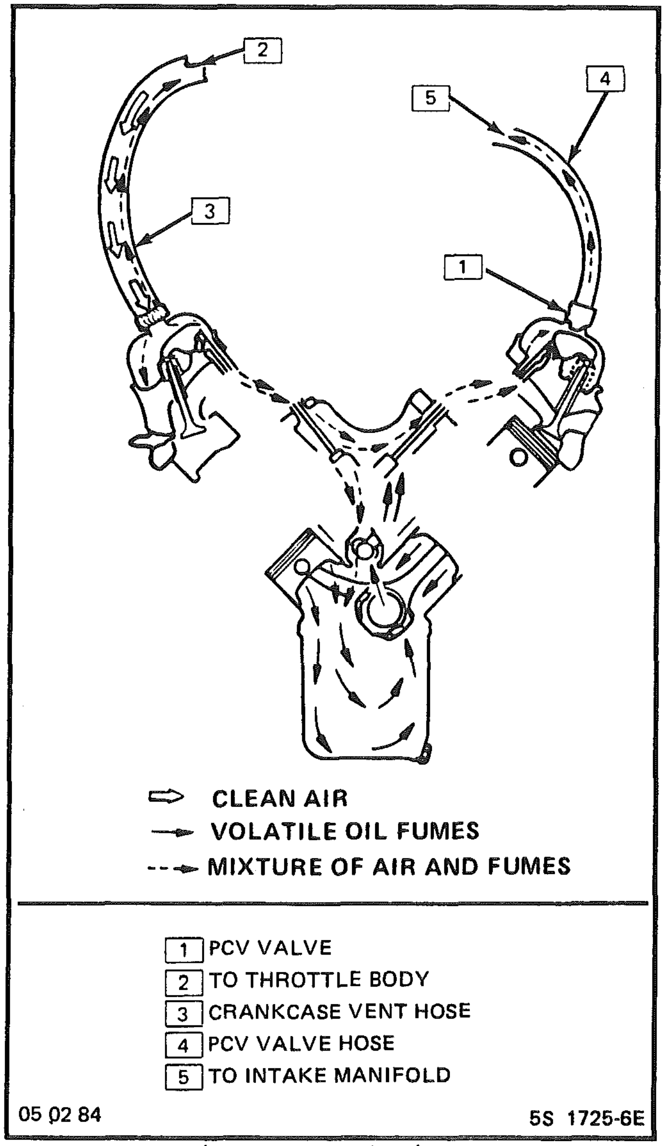


Figure C13-1 PCV Flow

Proper operation of the PCV System is dependent upon a sealed engine. If oil sludging or dilution is noted, and the PCV System is functioning properly, check engine for possible cause and correct to ensure that system will function as intended.

4S 0068-6E

Figure C13-2 PCV Valve Cross Section

ON-CAR SERVICE

An engine which is operated without any crankcase ventilation can be damaged. Therefore, it is important to replace the PCV valve at intervals shown in Section "OB".

Periodically, inspect the hoses and clamps and replace any showing signs of deterioration.

PARTS INFORMATION

PART NAME	GROUP
Air Cleaner	3.402
Valve Asm, C/Case Vent	1.745
Tube, C/Case Vent	1.762
Hose, C/Case Vent V1v	1.762
Breather, A/C and Sil	3.410

PORT FUEL INJECTION ECM CONNECTOR IDENTIFICATION

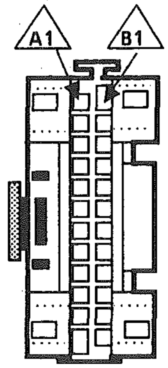
This ECM voltage chart is for use with a digital voltmeter to further aid in diagnosis. The voltages you get may vary due to low battery charge or other reasons, but they should be very close.
B + in Chart refers to system voltage.

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

● Engine at operating temperature ● Engine idling in "Closed Loop" (for "Engine Run" column) in park or neutral ● Test terminal not grounded ● "Scan" tool not installed

	VOLTAGE KEY "ON"	VOLTAGE ENG. RUN	CIRCUIT	PIN	WIRE COLOR
3	0*	B +	FUEL PUMP RELAY	A1	GRN/ WHT
	B +	B +	AIR SWITCH SOLENOID	A2	BRN
	B +	B +	CANISTER PURGE SOLENOID	A3	GRN/ YEL
	B +	1∇	EGR SOLENOID	A4	GRY
	1∇	B +	"SERVICE ENGINE SOON" LIGHT	A5	BRN/ WHT
	B +	B +	IGNITION	A6	PNK/ BLK
	B +	B +	M/T SHIFT LIGHT A/T TCC CONTROL	A7	TAN/ BLK
	2-5 varies	2-5 varies	SERIAL DATA	A8	ORN
	5	5	DIAG. TERM.	A9	WHT/ BLK
1			SPEED SENSOR SIGNAL	A10	BRN
	0*	0*	MAF SENSOR GROUND	A11	BLK/ PNK
	0*	0*	ECM GROUND	A12	BLK/ WHT

BACK VIEW OF CONNECTOR

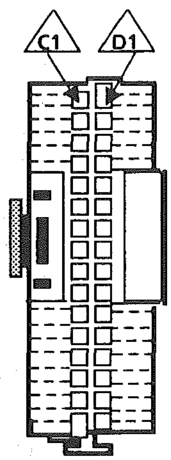


24 PIN A-B CONNECTOR

WIRE COLOR	PIN	CIRCUIT	VOLTAGE KEY "ON"	VOLTAGE ENG. RUN	
ORN	B1	CONTINUOUS BATTERY VOLTAGE	B +	B +	
TAN/ WHT	B2	FUEL PUMP SIGNAL	0*	B +	3
BLK/ RED	B3	IGNITION GROUND	0*	0*	
	B4	NOT USED			
PPL/ WHT	B5	DISTRIBUTOR REFERENCE	0*	1.3	
PPL	B6	VATS	2.5	2.5	
BLK	B7	ESC SIGNAL	9.2	9.3	
GRN	B8	A/C SIGNAL (OFF) (ON)	0* B +	0* B +	
	B9	NOT USED			
ORN/ BLK	B10	PARK/NEUTRAL P/N SW.SIGNAL (A/T) D	0* B +	0* B +	
	B11	NOT USED			
DK GRN	B12	MAF SENSOR SIGNAL	2.5	.4-1	2

	KEY "ON"	ENG. RUN	CIRCUIT	PIN	WIRE COLOR
	B +	B +	FAN RELAY	C1	DK GRN/ WHT
	B +	1∇	AIR CONTROL SOLENOID	C2	BLK/ PNK
	NOT USEABLE		IAC "B" LO	C3	LT GRN/ BLK
	NOT USEABLE		IAC "B" HI	C4	LT GRN/ WHT
	NOT USEABLE		IAC "A" HI	C5	LT BLU WHT
	NOT USEABLE		IAC "A" LO	C6	LT BLU BLK
			NOT USED	C7	
	0*	0*	4TH GR. SIG. (A/T)	C8	DK GRN
			NOT USED	C9	
4	1.7	1.7	COOLANT TEMP. SIGNAL	C10	YEL
			NOT USED	C11	
4	2.0	2.0	MAT SIGNAL	C12	TAN
	.54V ± .08V	.54V ± .08V	TPS SIGNAL	C13	DK BLU
	5	5	TPS 5 VOLT REFERENCE	C14	GRY
	B +	B +	EGR DIAG.SWITCH	C15	DK GRN
	B +	B +	CONTINUOUS BATTERY VOLTAGE	C16	ORN

BACK VIEW OF CONNECTOR



32 PIN C-D CONNECTOR

WIRE COLOR	PIN	CIRCUIT	KEY "ON"	ENG. RUN	
BLK/ WHT	D1	ECM GROUND	0*	0*	
BLK	D2	TPS,CTS,MAT SENSOR GROUND	0*	0*	
BLK/ WHT	D3	ECM GROUND	0*	0*	
WHT	D4	EST	0*	1.3	
TAN/ BLK	D5	BYPASS	0*	4.75	
TAN	D6	O_2 GROUND	0*	0*	
PPL	D7	O_2 SENSOR SIGNAL	.35-.55	.01-.99	2
	D8	NOT USED			
	D9	NOT USED			
BLK/ WHT	D10	ECM GROUND	0*	0*	
GRA	D11	A/C PRESSURE FAN SWITCH	B +	B +	
BLK	D12	MAF BURN-OFF RELAY	B +	B +	
	D13	NOT USED			
	D14	NOT USED			
BLK/PNK	D15	INJ.1,3,5,7.	B +	B +	
BLK/GRN	D16	INJ.2,4,6,8.	B +	B +	

∇ Less than 1 volt.
* Less than .5 volts.
1. Varies from .60 to battery voltage depending on position of drive wheels.
2. Varies.
3. 12V First two seconds.
4. Varies with temperature.

ENGINE: 5.0L LB9
5.7L L98

CARLINE: F

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* 8S 4276-6E

Figure A-6 - ECM Connector Terminal End View - 5.0L (VIN F) & 5.7L (VIN 8) "F" Series

DIAGNOSTIC CIRCUIT CHECK

The Diagnostic Circuit Check is an organized approach to identifying a problem created by an Electronic Engine Control System malfunction. It must be the starting point for any driveability complaint diagnosis, because it directs the Service Technician to the next logical step in diagnosing the complaint.

The "Scan Data" listed in the table may be used for comparison, after completing the Diagnostic Circuit Check and finding the on-board diagnostics functioning properly and no trouble codes displayed. The "Typical Values" are an average of display values recorded from normally operating vehicles and are intended to represent what a normally functioning system would typically display.

A "SCAN" TOOL THAT DISPLAYS FAULTY DATA SHOULD NOT BE USED, AND THE PROBLEM SHOULD BE REPORTED TO THE MANUFACTURER. THE USE OF A FAULTY "SCAN" CAN RESULT IN MISDIAGNOSIS AND UNNECESSARY PARTS REPLACEMENT.

Only the parameters listed below are used in this manual for diagnosing. If a "Scan" reads other parameters, the values are not recommended by General Motors for use in diagnosing. For more description on the values and use of the "Scan" to diagnosis ECM inputs, refer to the applicable diagnosis section in Section C. If all values are within the range illustrated, refer to symptoms in Section B.

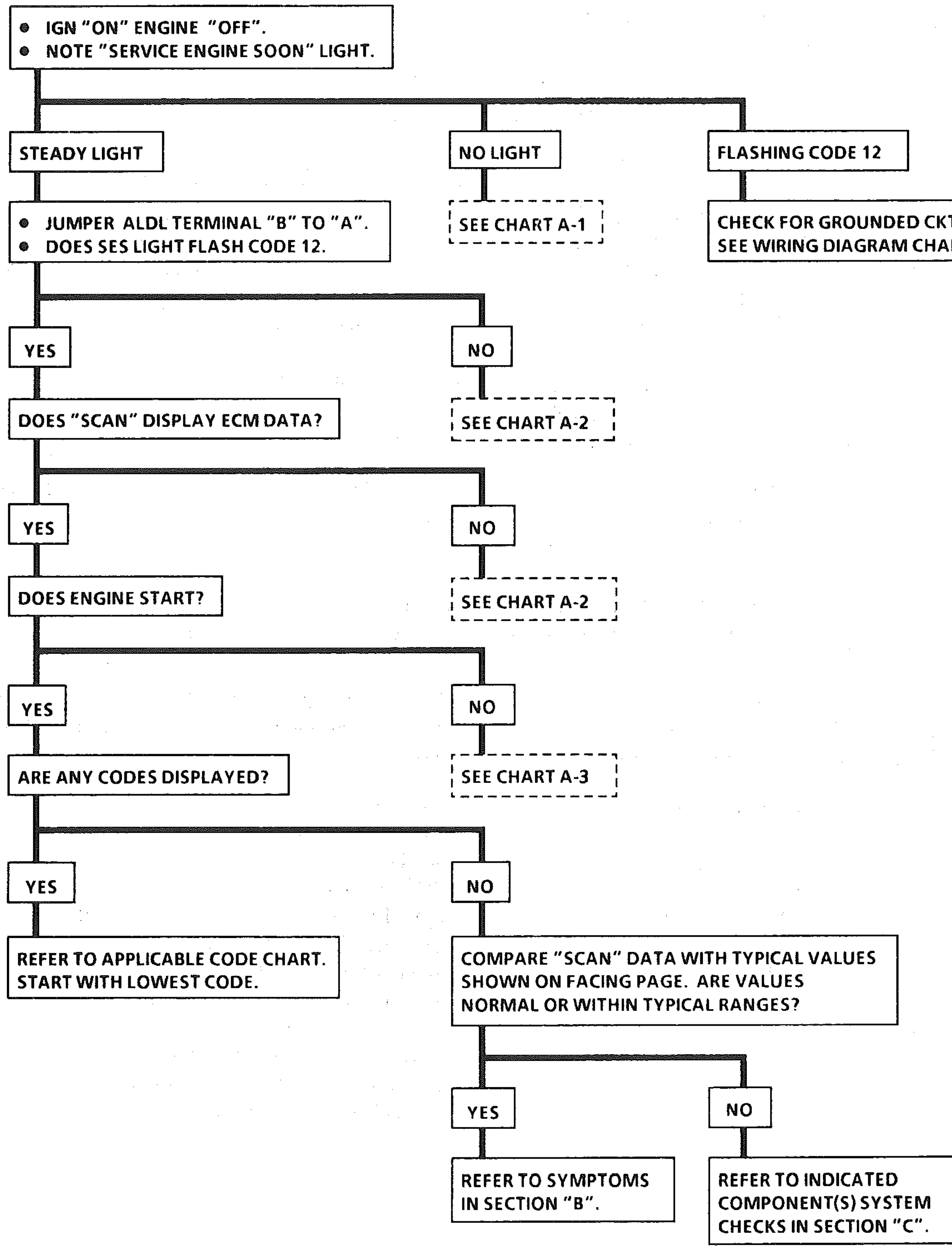
"SCAN" DATA

Idle / Upper Radiator Hose Hot / Closed Throttle / Park or Neutral / Closed Loop / Acc. off

"SCAN" Position	Units Displayed	Typical Data Value
Desired RPM	RPM	ECM idle command (varies with temp.)
RPM	RPM	± 100 RPM from desired RPM (± 50 in drive)
Coolant Temp.	C°	85° - 105°
MAT Temp.	C°	10° - 90° (depends on underhood temp.)
MAF	Gm/Sec	4 - 7
Air Flow	Gm/Sec	4 - 7
BPW (base pulse width)	M/Sec	1 - 4 and varying
O_2	Volts	1-1000 and varying
TPS	Volts	.46 - .62
IAC	Counts (steps)	5 - 50
INT (Integrator)	Counts	Varies
BLM (Block Learn)	Counts	118 - 138
Open/Closed Loop	Open/Closed	Closed Loop (may go open with extended idle)
BLM Cell	Cell Number	0 or 1 (depends on Air Flow & RPM)
VSS	MPH	0
TCC	On/Off	Off/ (on with TCC commanded)
Battery	Volts	13.5 - 14.5
PPSW	Volts	13.5 - 14.5
LV8	Counts	30 - 60
Knock Retard	Degrees of Retard	0
Spark Advance	# of Degrees	Varies
P/N Switch	P/N and RDL	Park/Neutral (P/N)
A.I.R. Control	Normal/Divert	Normal
A.I.R. Switch	Port/Converter	Converter
A/C Request	Yes/No	No (yes, with A/C requested)
Fan Request	Yes/No	No (yes, with A/C high pressure)
EGRDC	0 - 100%	0 at idle
EGR Diagnostic	On/Off	off
Fan	On/Off	Off (below 108°C)
CCP duty cycle	0 - 100%	0
Knock Signal	Yes/No	No (yes, when knock is detected)
Shift Light (M/T)	On/Off	Off
4th Gear	Yes/No	No (yes, when in 4th gear)

DIAGNOSTIC CIRCUIT CHECK

5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)



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• 7S 3227-6E

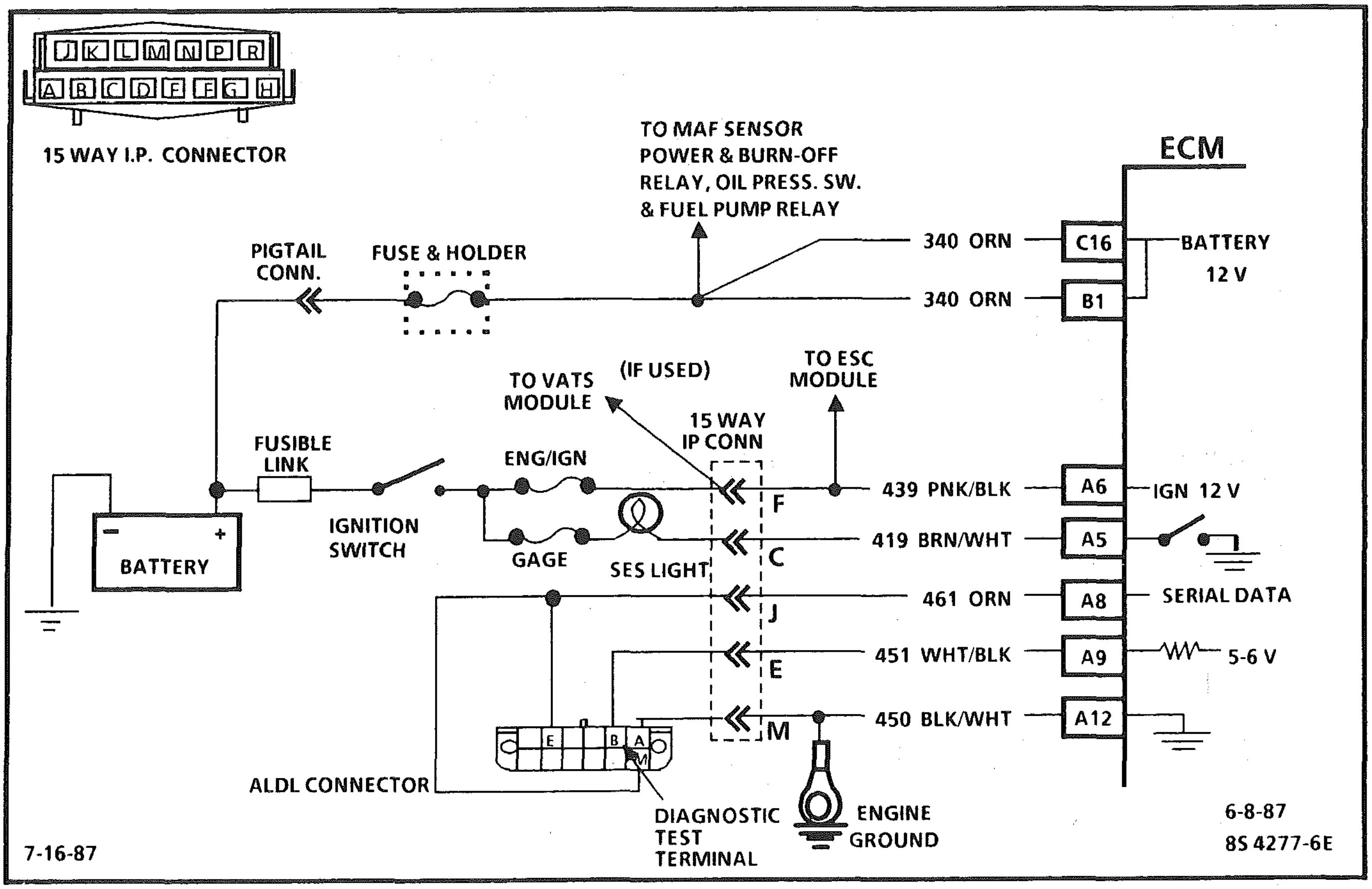


CHART A - 1

NO "SERVICE ENGINE SOON" LIGHT
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

Circuit Description:

There should always be a steady "Service Engine Soon" light when the ignition is "ON" and engine stopped. Ignition voltage is supplied directly to the light bulb. The electronic control module (ECM) will control the light and turn it "ON" by providing a ground path through CKT 419 to the ECM.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. If the fuse in holder is blown, refer to facing page of Code 54 for complete circuit.
2. Using a test light connected to 12 volts probe each of the system ground circuits to be sure a good ground is present. Refer to the ECM terminal end view in front of this section for ECM pin locations of ground circuits.

Diagnostic Aids:

Engine runs OK, check:

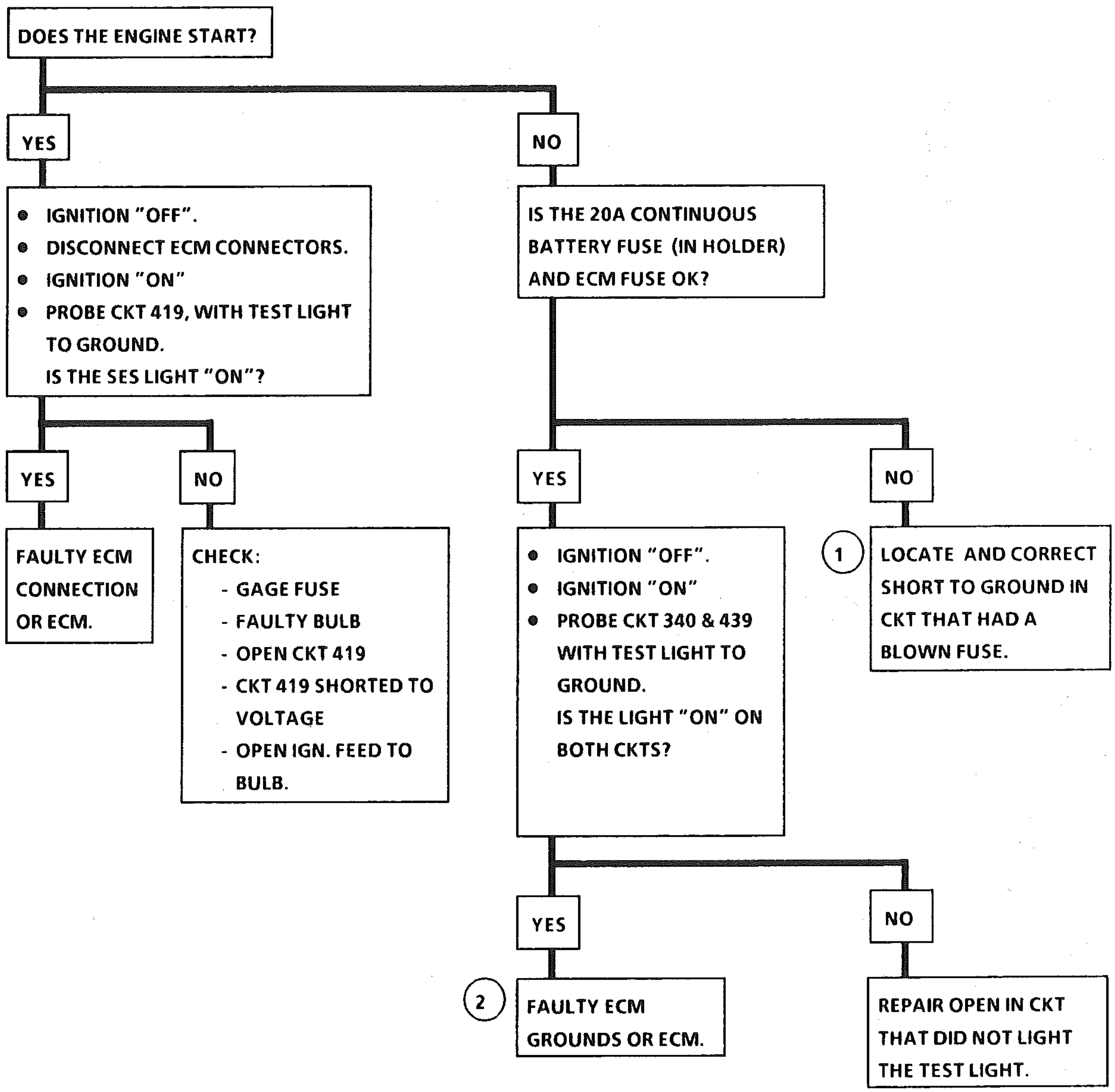
- Faulty light bulb.
- CKT 419 open.
- Gage fuse blown. This will result in no oil or generator lights, seat belt reminder, etc.

Engine cranks but will not run, check:

- Continuous battery - fuse or fusible link open.
- ECM ignition fuse open.
- Battery CKT 340 to ECM open.
- Ignition CKT 439 to ECM open.
- Poor connection to ECM.

CHART A-1

NO "SERVICE ENGINE SOON" LIGHT
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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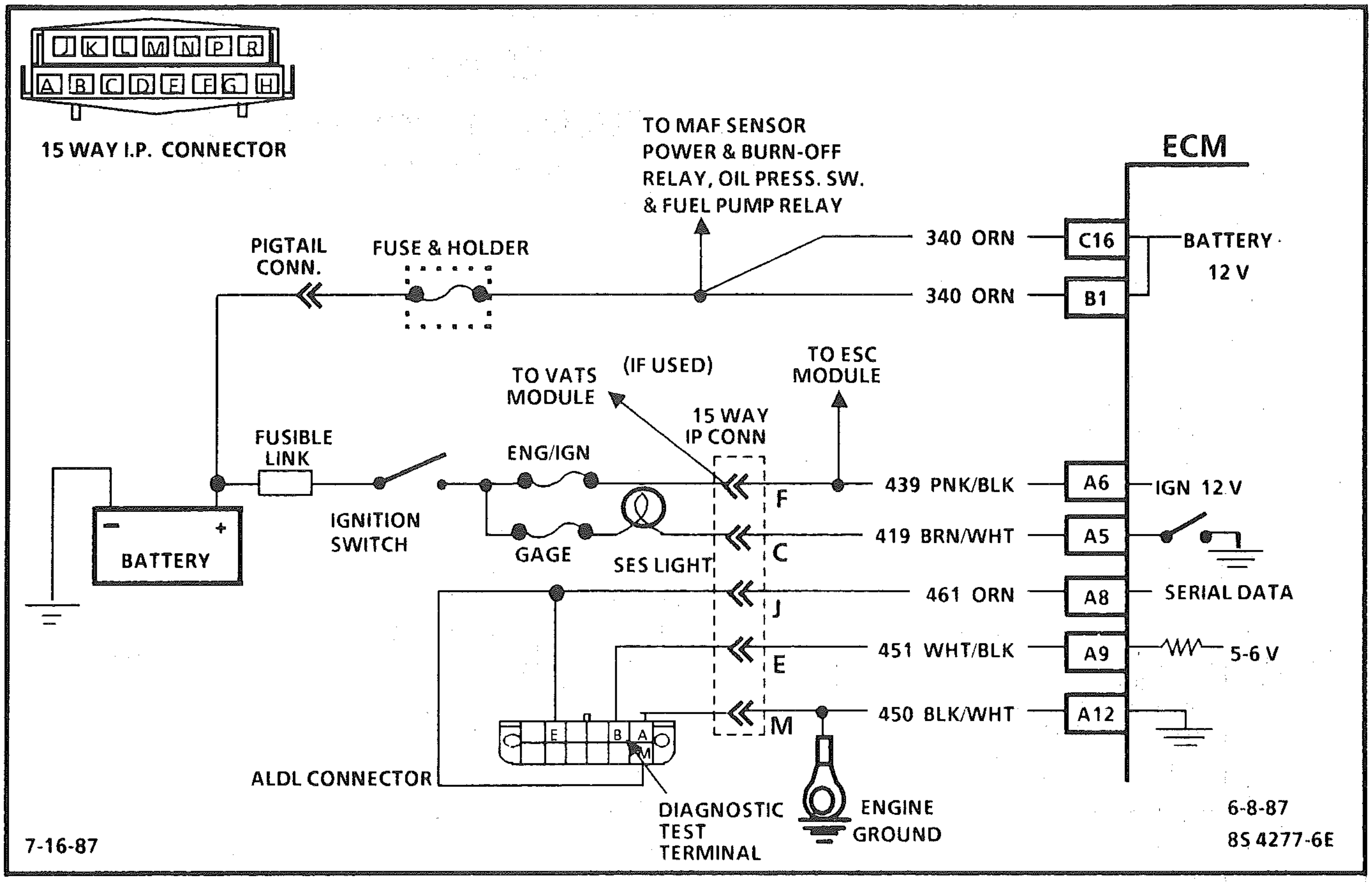


CHART A-2

NO ALDL DATA OR WON'T FLASH CODE 12 "SERVICE ENGINE SOON" LIGHT "ON" STEADY 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

Circuit Description:

There should always be a steady "Service Engine Soon" light when the ignition is "ON" and engine stopped. Ignition voltage is supplied to the light bulb. The electronic control module (ECM) will turn the light "ON" by grounding CKT 419 at the ECM.

With the diagnostic terminal grounded, the light should flash a Code 12, followed by any trouble code(s) stored in memory.

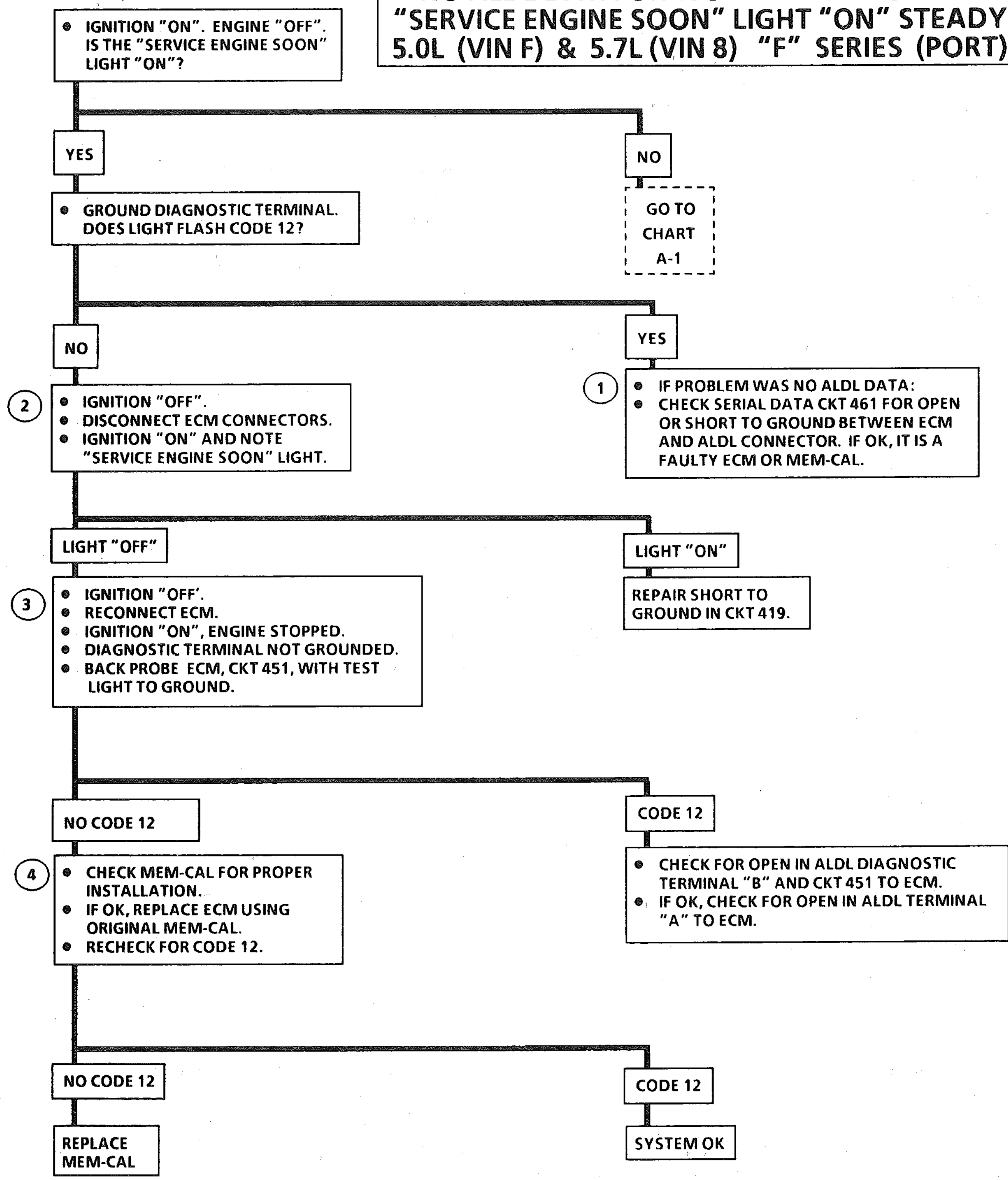
A steady light suggests a short to ground in the light control CKT 419, or an open in diagnostic CKT 451.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. If there is a problem with the ECM that causes a "Scan" tool to not read Serial data, the ECM should not flash a Code 12. If Code 12 is flashing check for CKT 451 short to ground. If Code 12 does flash be sure that the "Scan" tool is working properly on another vehicle. If the "Scan" is functioning properly and CKT 461 is OK, the Mem-Cal or ECM may be at fault for the NO ALDL symptom.
2. If the light goes "OFF" when the ECM connector is disconnected, CKT 419 is not shorted to ground.
3. This step will check for an open diagnostic CKT 451.
4. At this point the "Service Engine Soon" light wiring is OK. The problem is a faulty ECM or Mem-Cal. If Code 12 does not flash, the ECM should be replaced using the original Mem-Cal. Replace the Mem-Cal only after trying an ECM, as a defective Mem-Cal is an unlikely cause of the problem.

CHART A-2

NO ALDL DATA OR WON'T FLASH CODE 12
"SERVICE ENGINE SOON" LIGHT "ON" STEADY
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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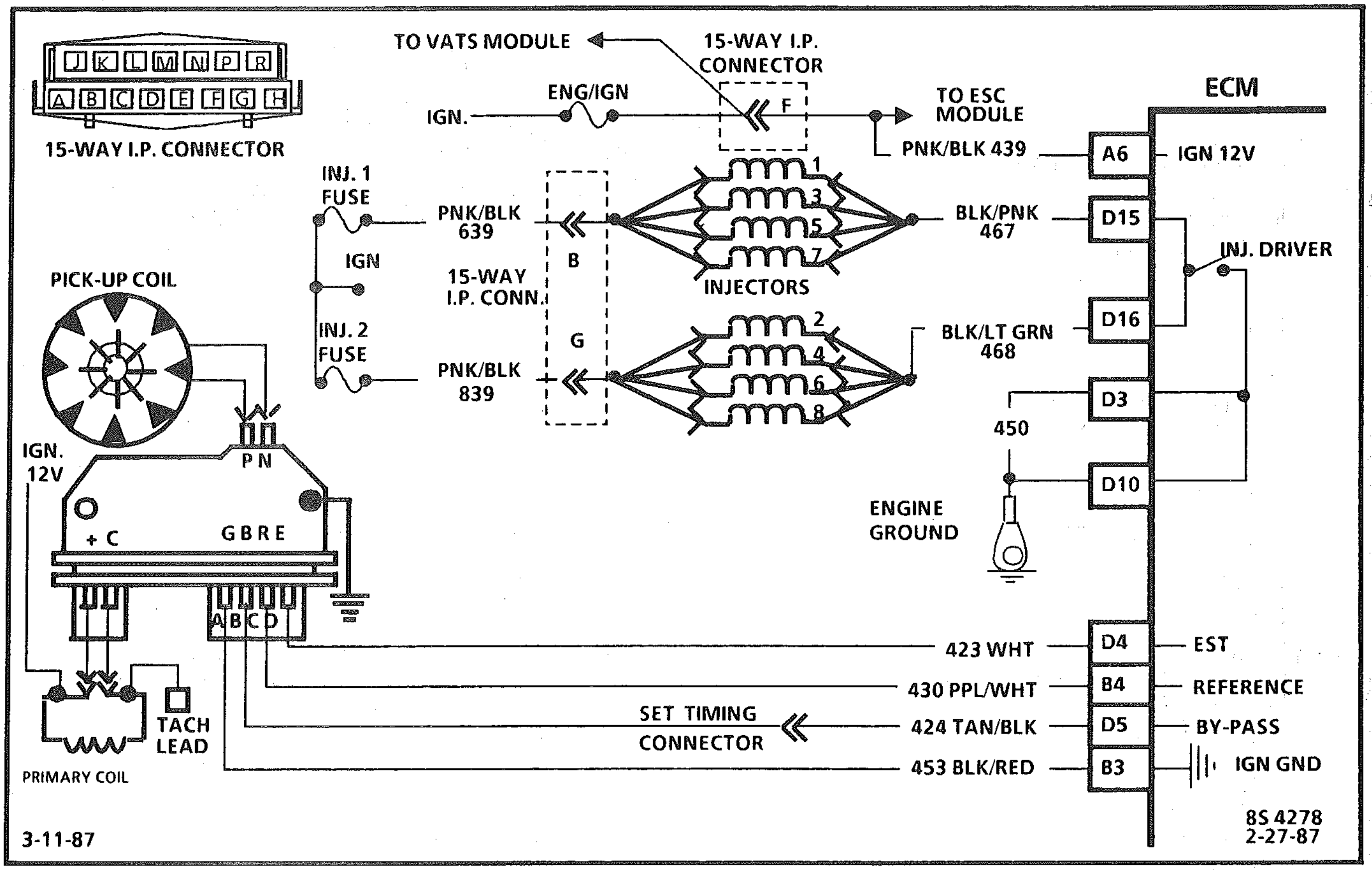

CHART A-3

(Page 1 of 2)
ENGINE CRANKS BUT WON'T RUN
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

Circuit Description:

This chart assumes that battery condition and engine cranking speed are OK, and there is adequate fuel in the tank.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. A "Service Engine Soon" light "ON" is a basic test to determine if there is a 12 volt supply and ignition 12 volts to ECM. No ALDL may be due to an ECM problem and CHART A-2 will diagnose the ECM. If TPS is over 2.5 volts the engine may be in the clear flood mode which will cause starting problems. The engine will not start without reference pulses and therefore the "Scan" should read rpm (reference) during crank.
2. No spark may be caused by one of several components related to the Ignition System. CHART C-4 will address all problems related to the causes of a no spark condition.
3. The test light should blink, indicating the ECM is controlling the injectors ok. How bright the light blinks is not important. However, the test light should be a J-34730-3 or equivalent.
4. Use fuel pressure gage J-34730-1 or equivalent. Wrap a shop towel around the fuel pressure tap to absorb any small amount of fuel leakage that may occur when installing the gage.

Diagnostic Aids:

- An EGR valve sticking open can cause a low air/fuel ratio during cranking. Unless engine enters "Clear Flood" at the first indication of a flooding condition, it can result in a no start.
- Check for fouled plugs.
- A defective cold start circuit or water in fuel line can cause a no start in cold weather. See CHART A-9.
- A defective MAF Sensor may cause a no start or a stall after start. To determine if the sensor is causing the problem, disconnect it. The ECM will then use a default value for the sensor, and if the condition is corrected and the connections are OK, replace the sensor.
- Also check that injectors on both sides of engine will cause a test light to "blink". If not OK, check injector fuses.

If above are all OK, refer to "Symptoms" in Section "B", Hard Start.

CHART A-3

(Page 1 of 2)
ENGINE CRANKS BUT WON'T RUN
5.0L (VIN F) & 5.7L (VIN 8)
"F" SERIES (PORT)

1
- FUEL QUANTITY OK.
- IGNITION "ON". IF "SERVICE ENGINE SOON" LIGHT IS "OFF", USE CHART A-1.
- INSTALL "SCAN" TOOL. IF "NO ALDL", USE CHART A-2.

CHECK THE FOLLOWING:
- IF A CODE 46 OR 54 IS SET, REFER TO APPLICABLE CHART.
- TPS - IF OVER 2.5 VOLTS AT CLOSED THROTTLE, USE THE CODE 21 CHART.

IS RPM IDICATED DURING CRANKING?

YES
- USING A ST-125 (SPARK CHECKER), J-26792 OR EQUIVALENT, CHECK FOR SPARK WHILE CRANKING (CHECK TWO WIRES)

IS SPARK PRESENT?

YES

3
- DISCONNECT ONE INJECTOR
- CONNECT TEST LIGHT J-34730-2 OR EQUIVALENT TO INJECTOR HARNEES CONNECTOR.
- CHECK FOR BLINKING LIGHT WHILE CRANKING.

BLINKING LIGHT

4
- IGNITION "OFF".
- INSTALL FUEL PRESSURE GAGE AND NOTE PRESSURE AFTER IGNITION "ON".

SHOULD BE 32-47 psi (220-325 kPa)

OK
- REVIEW THE "DIAGNOSTIC AIDS" ON FACING PAGE FOR ADDITIONAL ITEMS TO CHECK. IF ALL ARE OK, EFI SYSTEM IS OK.

REFER TO "HARD START "IN SECTION "B".

NOT OK

USE CHART A-7

NO BLINKING LIGHT

USE CHART A-3 (2 OF 2)

NO

2 BASIC HEI PROBLEM. REFER TO CHART C-4

NO
- USING A ST-125 (SPARK CHECKER), J-26792 OR EQUIVALENT, CHECK FOR SPARK WHILE CRANKING (CHECK TWO WIRES)

IS SPARK PRESENT?

YES
- IGNITION "OFF".
- DISCONNECT DISTRIBUTOR 4-WAY CONNECTOR.
- IGNITION "ON".
- MOMENTARILY TOUCH HARNESS CONNECTOR TERMINAL (CKT 430) WITH A TEST LIGHT TO 12 VOLTS.
- "SCAN" SHOULD INDICATE RPM WHEN TEST IS PERFORMED.

DOES IT?

YES
- FAULTY CONNECTION OR IGNITION MODULE.

NO

CKT 430 OPEN, SHORTED TO GROUND, OR FAULTY ECM.

NO

2 CHECK FOR BATTERY VOLTAGE TO IGNITION SYSTEM. IF OK, THERE IS A BASIC HEI PROBLEM. REFER TO CHART C-4.

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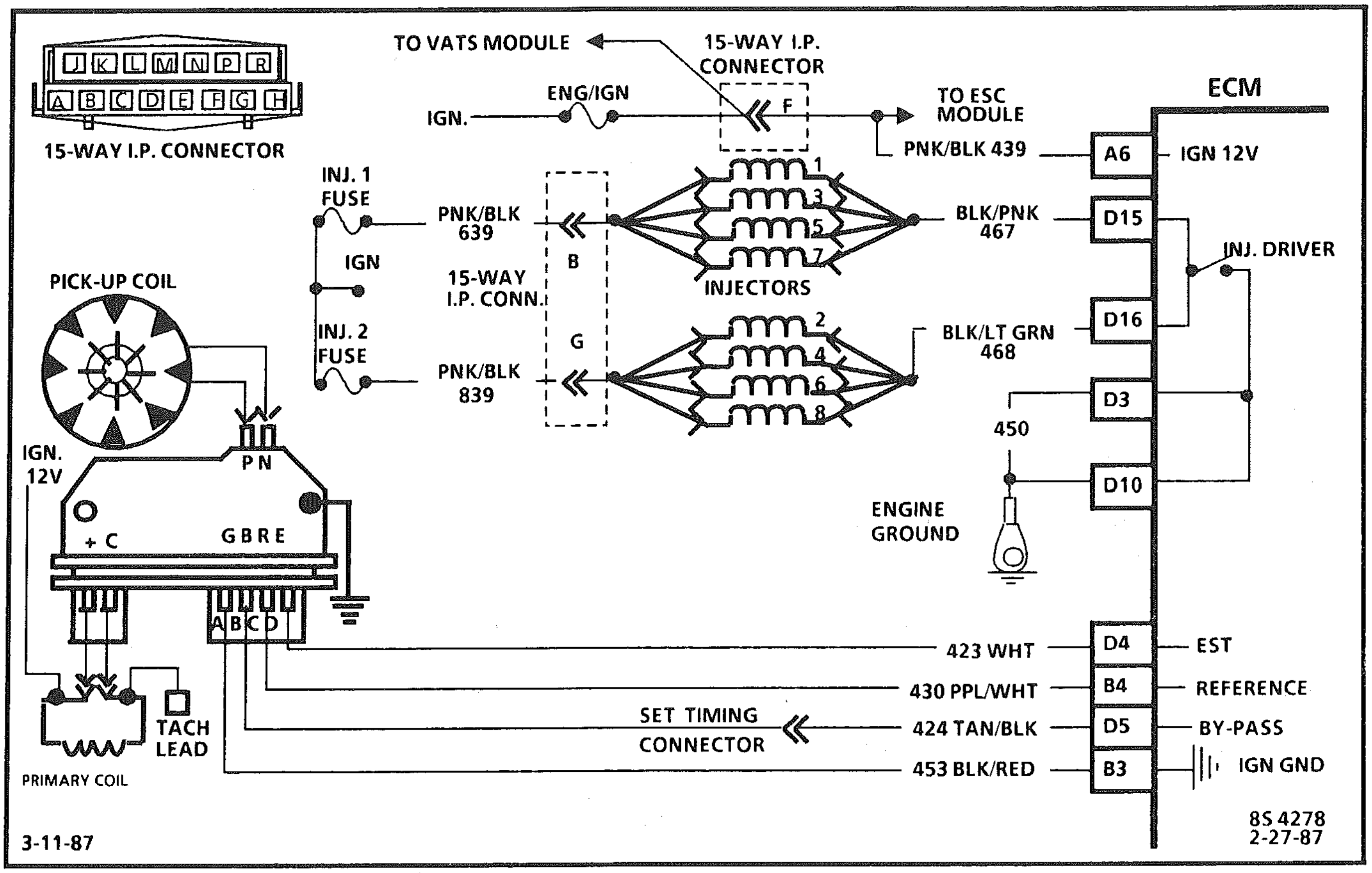


CHART A-3

(Page 2 of 2)
ENGINE CRANKS BUT WON'T RUN
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Checks for 12 volt supply to injectors. Due to the injectors wired in parallel there should be a light "ON" on both terminals.
2. Checks continuity of CKT 467 and 468.
3. All checks made to this point would indicate that the ECM is at fault. However, there is a possibility of CKT 467 or 468 being shorted to a voltage source either in the engine harness or in the injector harness.

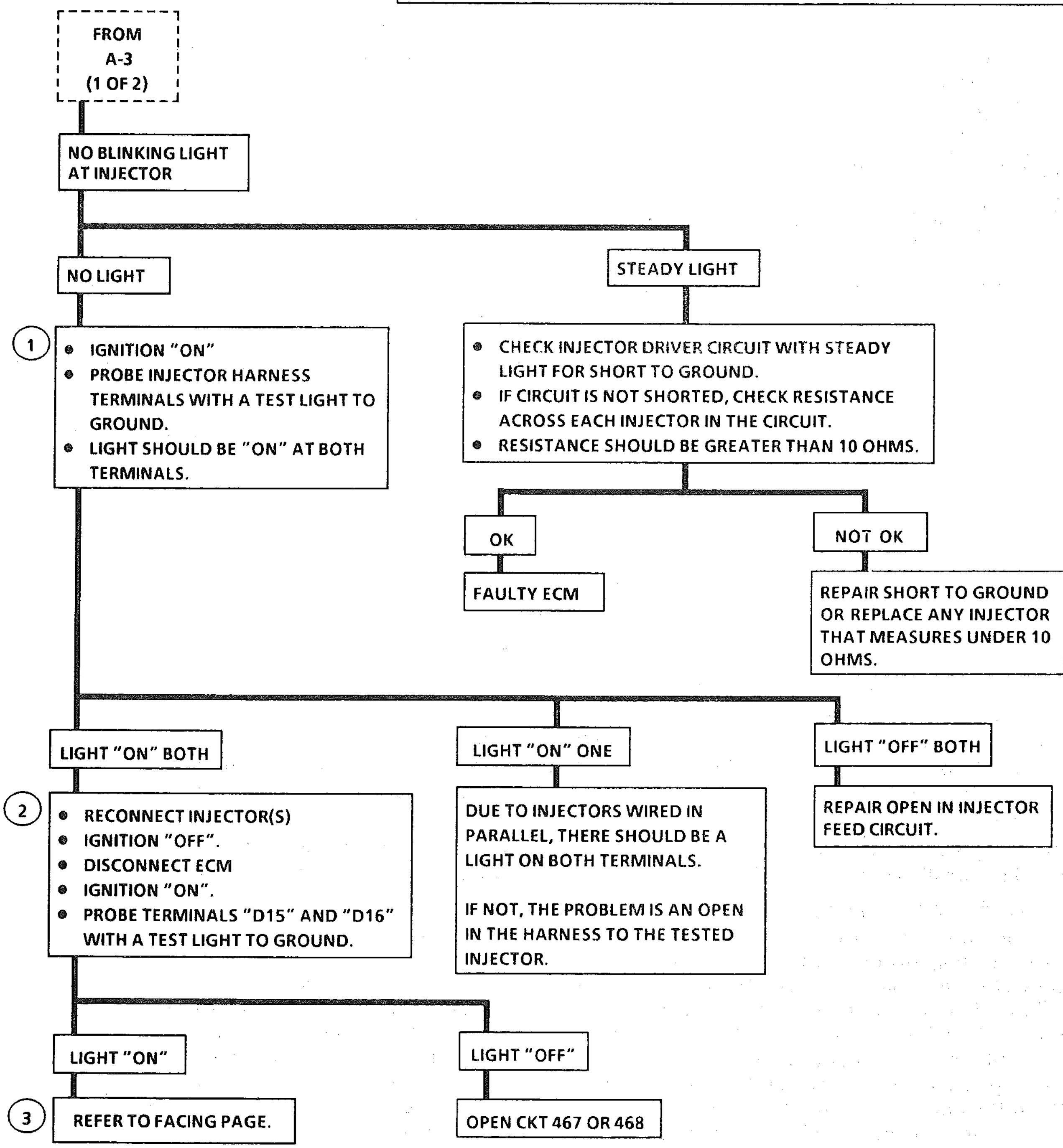
To test for this condition:

- Disconnect all injectors
- Ignition "ON".
- Probe CKTs 467 and 468 on the ECM side of injector harness with a test light connected to ground. (Test one injector harness on each side of engine). There should be no light. If light is "on" repair short to voltage.
- If OK, check the resistance of the injectors.
- Should be 10 ohms or more.
- Check injector harness connector. Be sure terminals are not backed out of connector and contacting each other.
- If all OK, replace ECM.

CHART A-3

(Page 2 of 2)

ENGINE CRANKS BUT WON'T RUN
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)



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* 7S 3284-6E

See Section "8A" for more information on the P/N switch, which is part of the neutral/start and backup light switch assembly.

A/C "ON" Signal

This signal tells the ECM that the A/C selector switch is turned "ON", and that the pressure cycling switch is closed. The ECM uses this to adjust the idle speed when the air conditioning is working.

If this signal is not available to the ECM, idle may be rough, especially when the A/C compressor cycles. The voltage at ECM terminal "B8" should equal battery voltage on a C60 system and about 5 volts on a C68 option, when A/C is requested and the pressure cycling switch is closed.

Distributor Reference Signal

The distributor sends a signal to the ECM to tell it both engine rpm and crankshaft position. See ignition system Section "C4" for further information.

DIAGNOSIS

To read the codes, use a "Scan" tool or ground the diagnostic terminal with the engine not running and the ignition "ON". The "Service Engine Soon" light will flash Code 12 three times and then flash each code stored in memory three times. All codes stored in memory would have been read when Code 12 was flashed again. No new codes can be stored when in the diagnostics mode (diagnostics lead grounded). This eliminates confusion while the system is being worked on.

To clear the codes from memory:

- Ignition "OFF".
- Disconnect battery pigtail, located near the battery, for 30 seconds.

Since the ECM can have a failure which may affect only one circuit, following the diagnostic procedures in this section will determine which circuit has a problem and where it is.

If a diagnostic chart indicates that the ECM connections or ECM is the cause of a problem,and the ECM is replaced, but does not correct the problem, one of the following may be the reason:

- <u>There is a problem with the ECM terminal connections</u>. - The diagnostic chart will say ECM connections or ECM. The terminals may have to be removed from the connector in order to check them properly.
- <u>The ECM, or Mem-Cal is not correct for the application</u>. - The incorrect components may cause a malfunction and may or may not set a code.
- <u>The problem is intermittent</u>. - This means that the problem is not present at the time the system is being checked.

  In this case, refer to the "Symptoms" portion of the manual and make a careful physical inspection of all portions of the system involved.
- <u>Shorted solenoid, relay coil, or harness</u>. - Solenoids and relays are turned "ON" and "OFF" by the ECM, using internal electronic switches called "Drivers".

  A shorted solenoid, relay coil, or harness in a GMP4 computer will not damage the ECM, but will cause the circuit and controlled component to be inoperative. When the circuit fault is not present or has been repaired, the "Quad-Driver" will again operate in a normal manner due to it's fault protected design. If a fault has been repaired in a circuit controlled by a "Quad-Driver", the original ECM should be reinstalled and the circuit checked for proper operation. ECM replacement will not be necessary if the repaired circuit or component now operates correctly.

  J34636 or BT 8405 testers or equivalent provide a fast, accurate means of checking for a shorted coil or a short to battery voltage.
- <u>The Mem-Cal may be faulty</u>. - Although these rarely fail, it operates as part of the ECM. Therefore, it could be the cause of the problem. Substitute a known good Mem-Cal.
- <u>The replacement ECM may be faulty</u> - After the ECM is replaced, the system should be rechecked for proper operation. If the diagnostic chart again indicates the ECM is the problem, substitute a known good ECM. Although this is a rare condition, it could happen.

ECM

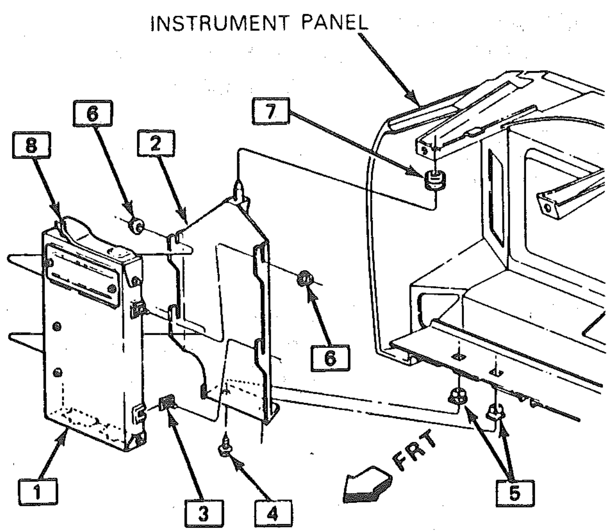
A faulty ECM will be determined in the diagnostic charts.

MEM-CAL

An incorrect or faulty Mem-Cal, which is part of the ECM, may set a Code 41 or 52. Also, be sure Mem-Cal is fully seated and latched in the socket.

ECM INPUTS

All of the sensors and input switches can be diagnosed by the use of a "Scan" tool. Following is a short description of how the sensors and switches can be diagnosed by the use of a "Scan" tool. The "Scan" can also be used to compare the values for a normal running engine with the engine you're diagnosing.



1	MODULE ASM ECM (PFI)
2	BRACKET
3	BOLT/SCREW (4)
4	BOLT/SCREW (2) 4.7-7.0 N·m (3.3-5.1 LBS. FT.)
5	BOLT/SCREW RETAINER (2)
6	NUT (4) 4.7-7.0 N·m (3.3-5.1 LBS. FT.)
7	SPACER
8	COVER ECM

8S 4667-6E

Figure C1-7 - ECM LOCATION

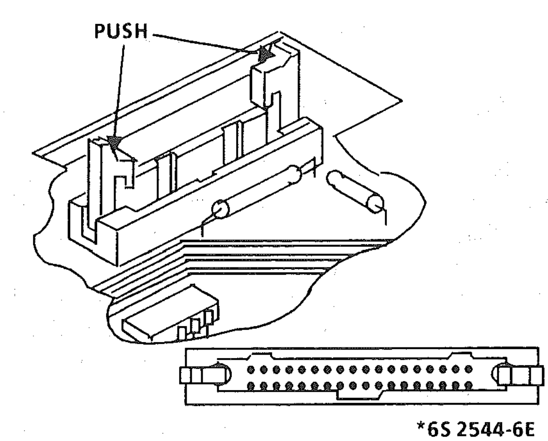


Figure C1-8 - Mem/Cal Unit Socket

Please do not record on ECM cover. This will allow positive identification of ECM parts throughout the service life of the vehicle.

Important

To prevent internal ECM damage, the ignition must be "OFF", when disconnecting or reconnecting power to ECM (for example, battery cable, ECM pigtail, ECM fuse, jumper cables, etc.).

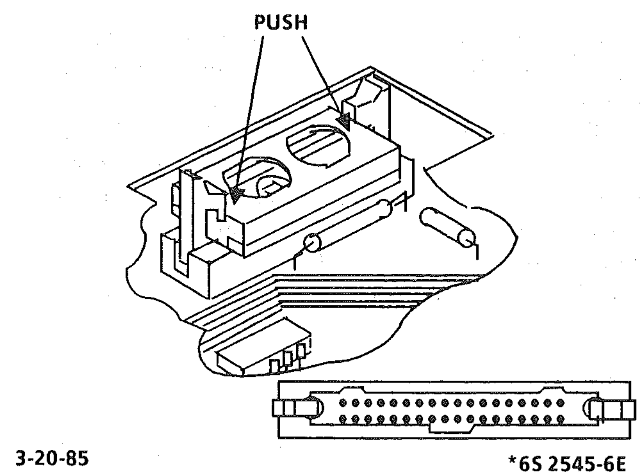


Figure C1-9 - Mem/Cal Unit Installation

ECM OR MEM-CAL REPLACEMENT FIGURE C1-7

Remove or Disconnect

1. Negative battery cable.
2. Right hand hush panel.
3. Connectors from ECM.
4. ECM mounting hardware.
5. ECM from passenger compartment.
6. ECM access cover. (Figure C1-1).
7. Mem-Cal removal. (Figure C1-8).

Important

Replacement ECM is supplied without a Mem-Cal, so care should be used when removing it from the defective ECM because it will be reused in the new ECM.

Using two fingers, push both retaining clips back away from the Mem-Cal. At the same time, grasp it at both ends and lift it up out of the socket. Do not remove the cover of the Mem-Cal. Use of unapproved Mem-Cal removal methods may cause damage to the Mem-Cal or socket.

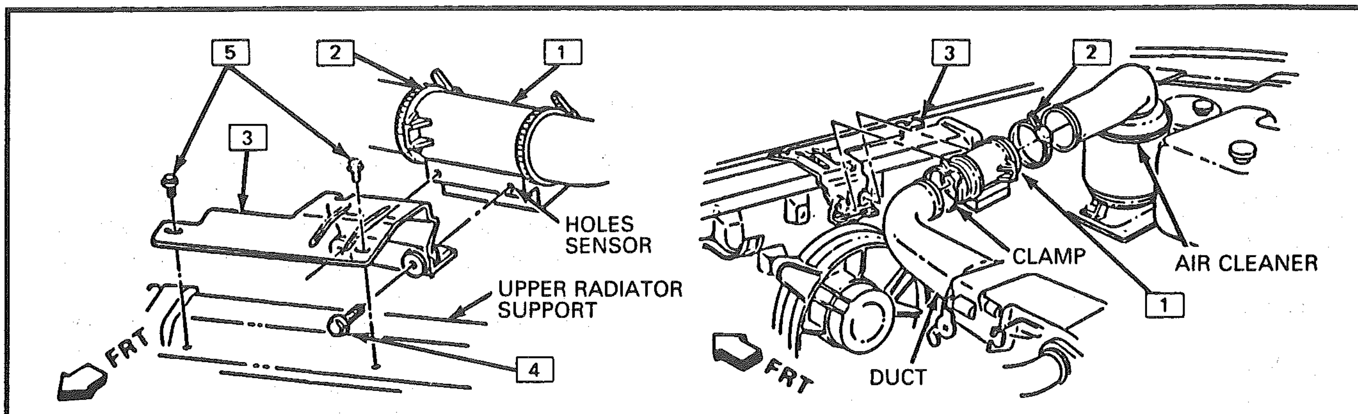
Inspect

For alignment notches of the Mem-Cal and carefully set it aside. Do not open the Mem-Cal.

IF ECM IS BEING REPLACED:

Remove or Disconnect

1. New ECM from its packaging and check the service number to make sure it is the same as the defective ECM.
2. Access Cover.



1 MAF SENSOR ASM
2 CLAMP ASM 1.4-2.0 N·m (1-1.4 LBS. FT.)
3 BRACKET MAF SENSOR
4 BOLT/SCREW (2)
5 BOLT/SCREW (2)

8S 4686-6E

Figure C1-10 MAF Sensor Service

Install or Connect (Figure C1-9)

1. Mem-Cal in Mem-Cal socket.

Important

Press only on the ends of the Mem-Cal.
Small notches in the Mem-Cal must be aligned with the small notches in the Mem-Cal socket. Press on the ends of the Mem-Cal until the retaining clips snap into the ends of the Mem-Cal. Do not press on the middle of the Mem-Cal, only on the ends.

2. Access cover on ECM.
3. ECM in passenger compartment.
4. Connectors to ECM.
5. Right hand hush panel.
6. Negative battery cable.

Functional Check

1. Turn ignition "ON".
2. Enter diagnostics.
   A. Allow Code 12 to flash four times to verify no other codes are present.
   This indicates the Mem-Cal is installed properly and the ECM is functioning.
   B. If trouble Code 51 occurs, or if the "Service Engine Soon" light is "ON" constantly with no codes, the Mem-Cal is not fully seated or is defective.
   - If not fully seated, press firmly on the ends of the Mem-Cal.
   - If it is necessary to remove the Mem-Cal, follow the previous removal instructions.

COOLANT SENSOR

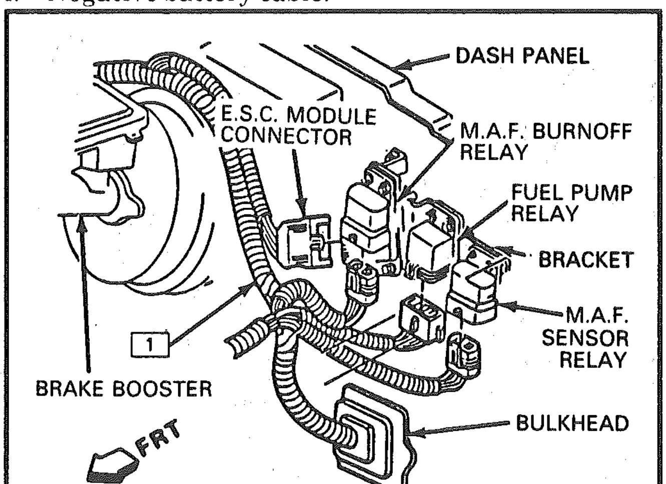
NOTICE: Care must be taken when handling coolant sensor. Damage to coolant sensor will affect proper operation of the fuel injection system.

Remove or Disconnect

1. Negative battery cable.
2. Air inlet duct.
3. Electrical connector.
4. Carefully back out coolant sensor.

Install or Connect

1. Sensor in engine.
2. Electrical connector.
3. Air inlet tube.
4. Negative battery cable.



1 ENGINE HARNESS ASM

8S 4689-6E

Figure C1-11 Relays

MAF SENSOR

Replacement of the MAF sensor is shown in Figure C1-10.

MAF SENSOR POWER & BURN-OFF RELAY

Refer to Figure C1-11 for relay location

OXYGEN SENSOR (Figure C1-12)

NOTICE: The oxygen sensor uses a permanently attached pigtail and connector. This pigtail should not be removed from the oxygen sensor. Damage or removal of the pigtail or connector could affect proper operation of the oxygen sensor.

Important

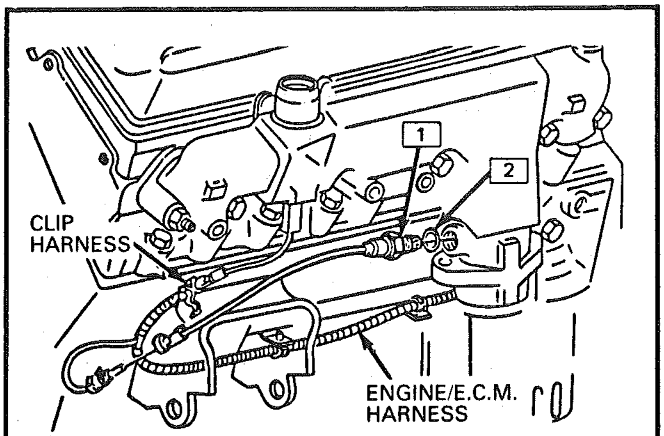
Take care when handling the oxygen sensor. The in-line electrical connector and louvered end must be kept free of grease, dirt, or other contaminants. Also, avoid using cleaning solvents of any type. Do not drop or roughly handle the oxygen sensor.

Remove or Disconnect

The oxygen sensor may be difficult to remove when engine temperature is below 48°C (120°F).

Excessive force may damage threads in exhaust manifold or exhaust pipe.

1. Negative battery cable.
2. Electrical connector.
3. Carefully back out oxygen sensor.



1 OXYGEN SENSOR 38-46 N·m (28-33 LBS. FT.)
2 GASKET
8S 4688-6E

Figure C1-12 - O_2 Sensor

Install or Connect

Important

A special anti-seize compound is used on the oxygen sensor threads. The compound consists of a liquid graphite and glass beads. The graphite will burn away, but the glass beads will remain, making the sensor easier to remove.

New, or service, sensors will already have the compound applied to the threads. If a sensor is removed from an engine, and, if for any reason it is to be reinstalled, the threads must have anti-seize compound applied before reinstallation.

1. Coat threads of oxygen sensor with anti-seize compound P/N 5613695, or equivalent, if necessary.
2. Sensor, and torque to 41 N•m (30 ft. lbs.).
3. Electrical connector.
4. Negative battery cable.

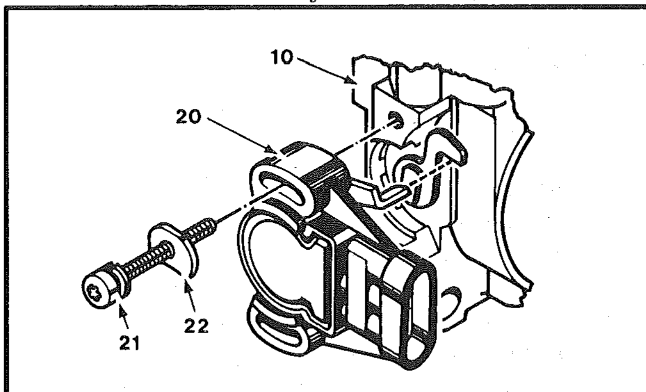
THROTTLE POSITION SENSOR (TPS).

Remove or Disconnect

1 Electrical connector.
2. Two TPS attaching screws and retainers.
3. Sensor.

Install or Connect

1. With throttle valve in the normal closed idle position, install throttle position sensor on throttle body assembly, making sure TPS pickup lever lines up with tang on throttle actuator lever. (See Figure C1-13)
2. Retainers and two TPS screws. DO NOT tighten screws until TPS is adjusted.



10 THROTTLE BODY ASSEMBLY
20 THROTTLE POSITION SENSOR (TPS)
21 TPS ATTACHING SCREW
22 TPS RETAINER
5S 1638-6E

Figure C1-13 - Throttle Position Sensor Service

Adjust

1. Install "Scan" tool or 3 jumper wires.
2. With ignition "ON", adjust TPS to obtain .54 volts ± .08 volts.
3. Tighten screws, then recheck reading to insure adjustment has not changed.

PARK/NEUTRAL SWITCH

See Section "8A" for location of park/neutral switch. On-car service and adjustment procedures are also listed there.

PARTS INFORMATION

PART NAME	GROUP
Controller, ECM	3.670
Memory Calibration Unit, Mem/Cal	3.670
Sensor, Coolant Temp	3.682
Sensor, Exhaust Oxygen	3.682
Sensor, Manif Air Temp (MAT)	3.682
Sensor, Mass Air Flow (MAF)	3.682
Relay - MAF Burn-Off	3.682
Relay - MAF Power	3.682
Sensor, Throttle Position: Part of	
Sensor Kit, Throttle Position	3.440
Sensor, Vehicle Speed	3.682

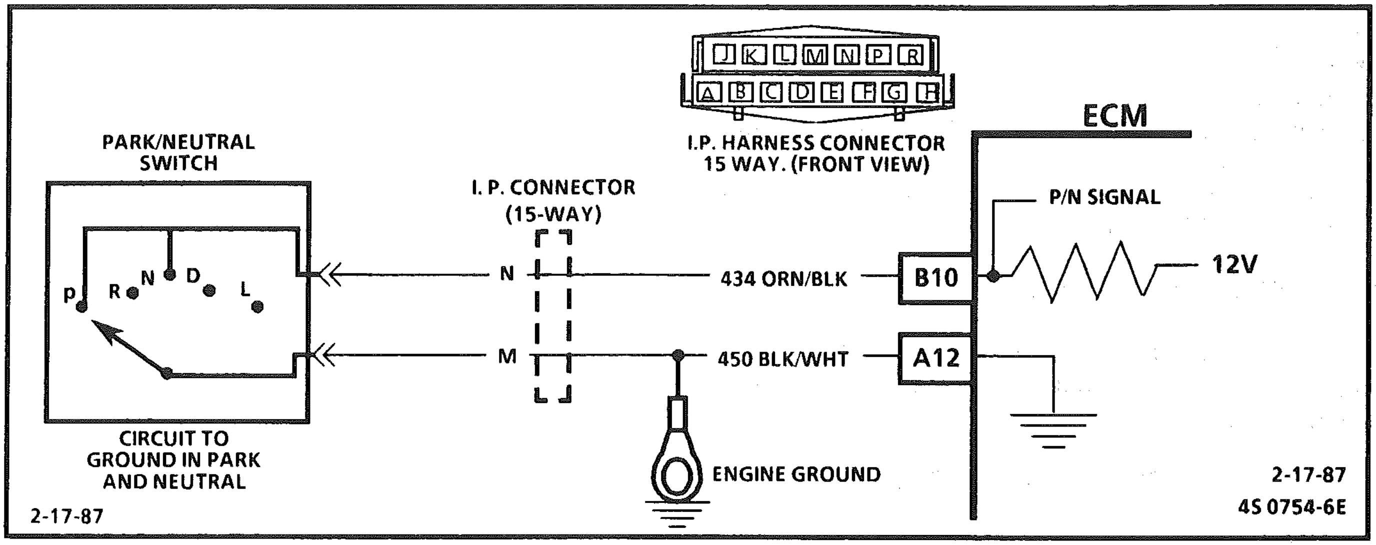


CHART C-1

PARK/NEUTRAL SWITCH DIAGNOSIS
(AUTO TRANSMISSION ONLY)
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

Circuit Description:

The park/neutral switch contacts are a part of the neutral start switch, and are closed to ground in park or neutral and open in drive ranges.

The ECM supplies ignition voltage through a current limiting resistor to CKT 434 and senses a closed switch when the voltage on CKT 434 drops to less than one volt.

The ECM uses the P/N signal as one of the inputs to control:

Idle air control
VSS diagnostics
EGR

If CKT 434 indicates P/N (grounded), while in drive range, the EGR would be inoperative, resulting in possible detonation.

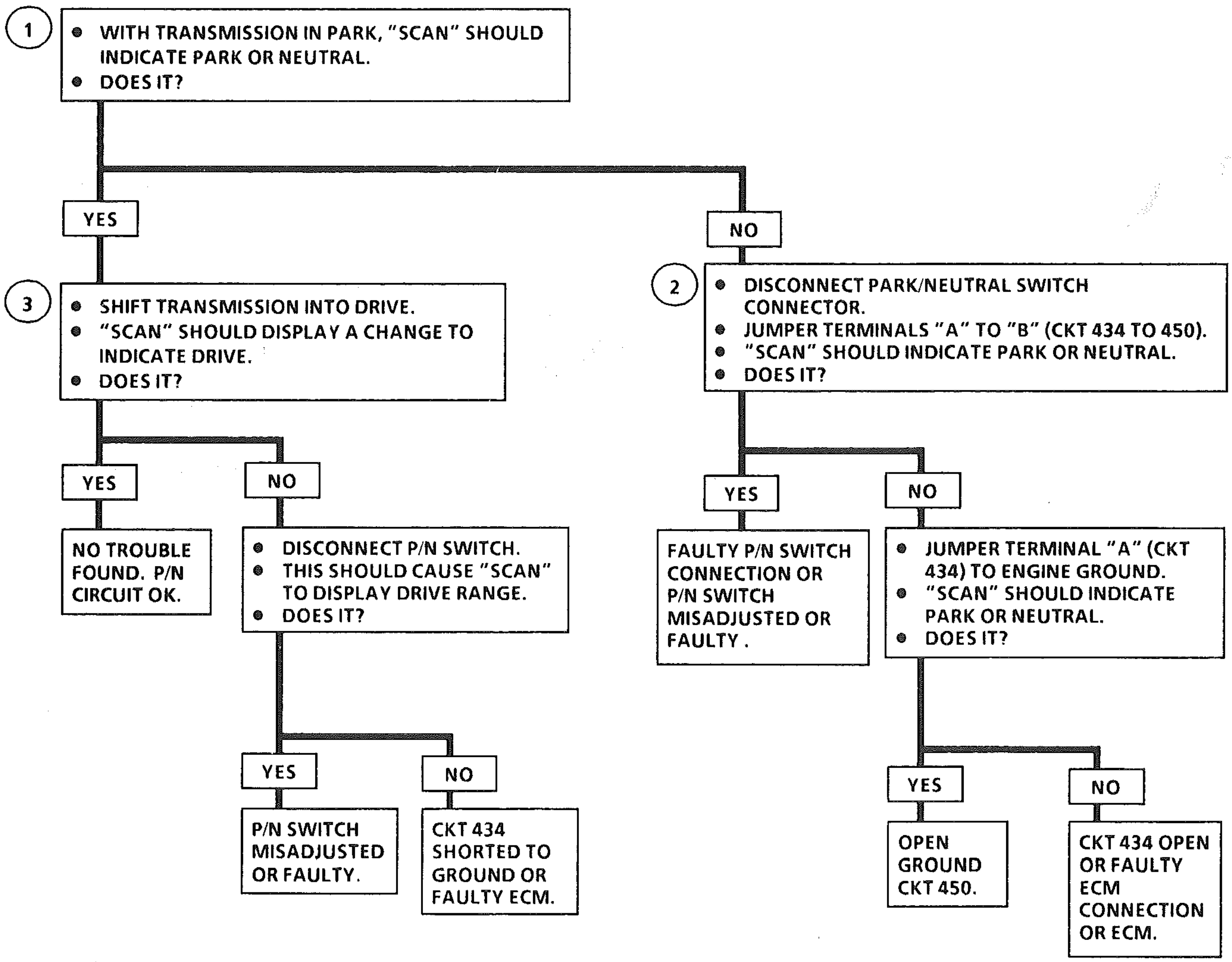
If CKT 434 always indicates drive (open), a drop in the idle may exist when the gear selector is moved into drive range.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Checks for a closed switch to ground in park position. Different makes of "Scan" tools will read P/N differently. Refer to "Operators Manual" for type of display used for a specific tool.
2. Checks for an open switch in drive range.
3. Be sure "Scan" indicates drive, even while wiggling shifter to test for an intermittent or misadjusted switch in drive range.

CHART C-1

PARK/NEUTRAL SWITCH DIAGNOSIS
(AUTO TRANSMISSION ONLY)
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)



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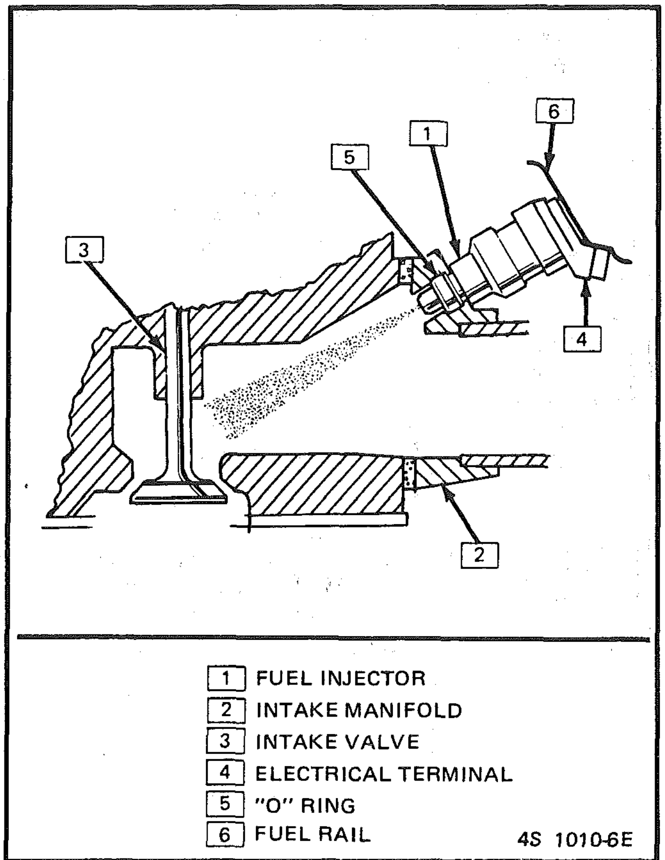

Figure C2-4 Fuel Injector

Pressure Regulator

The pressure regulator is a diaphragm-operated relief valve with injector pressure on one side and manifold pressure on the other. The function of the regulator is to maintain a constant pressure at the injector at all times. The pressure regulator compensates for engine load by increasing fuel pressure when it sees low engine vacuum.

The pressure regulator is mounted on the fuel rail, and is serviced separately.

If the pressure is too low, poor performance could result. If the pressure is too high, excessive odor and a Code 45 may result. CHART A-7 has information on diagnosing fuel pressure conditions.

Idle Air Control (IAC) Valve

The purpose of the idle air control (IAC) valve (shown in Figure C2-5) is to control engine idle speed, while preventing stalls due to changes in engine load.

The IAC valve, mounted in the throttle body, controls bypass air around the throttle valve. By moving a conical valve IN (to decrease air flow) or OUT (to increase air flow), a controlled amount of air can move around the throttle plate. If rpm is too low, more air is bypassed around the throttle valve to increase rpm. If rpm is too high, less air is bypassed around the throttle valve to decrease rpm.

The IAC valve moves in small steps called "counts", which can be monitored by a "Scan" tool.

During idle, the proper position of the IAC valve is calculated by the ECM based on battery voltage, coolant temperature, and engine rpm. If the rpm drops below a specified rpm, and the throttle plate is closed, the ECM senses a near stall condition. The ECM will then calculate a new valve position to prevent stalls.

If the IAC valve is disconnected and reconnected with the engine running, the idle rpm may be wrong. In this case, the IAC valve can be reset by starting the engine momentarily and then turning the ignition "OFF".

When servicing the IAC, it should only be disconnected or connected with the ignition "OFF". This will keep from having to reset the IAC.

The IAC valve affects only the idle characteristics of the vehicle. If it is open fully, too much air will be allowed into the manifold and idle speed will be high. If it is stuck closed, too little air will be allowed in the manifold, and idle speed will be too low. If it is stuck part way open, the idle may be rough, and will not respond to engine load changes.

Different designs are used for the IAC valve. Be sure to use the correct design when replacement is required.

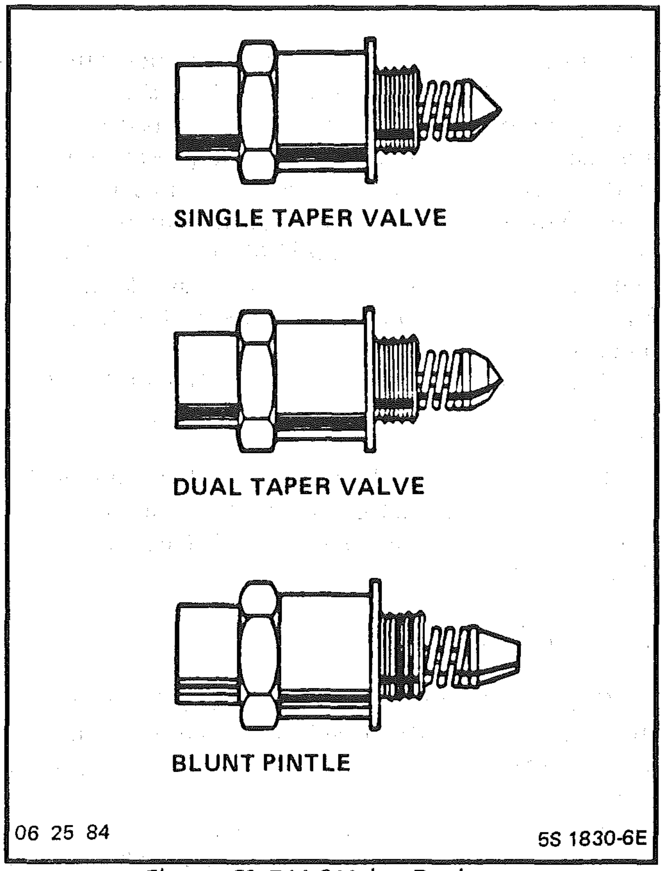

Figure C2-5 IAC Valve Designs

2. Cold start valve (100) onto tube and body assembly.
   - Screw in until valve bottoms, then back off until hole in mounting lug on valve will be aligned properly with hole in fuel rail when mounted.
   - Bend tang over cold start valve to lock it in position.

Clean

- Areas around valve and connection with AC Delco X-30A or equivalent.

Install or Connect

1. Cold start (100) valve in intake manifold.
2. Cold start valve retaining bolt.

Tighten

- Retaining bolt to 27 N•m (20 ft. lbs.).

3. PVC hose.
4. Tube and body assembly (101) at fitting on fuel rail.

Tighten

- Nut on fitting to 27 N•m (20 ft. lbs.).

6. Brake booster line.
6. Electrical connector on cold start valve (100).
7. Negative battery cable.

Inspect

- Energize fuel pump and inspect for leaks.

8. Intake manifold plenum, per previous instructions.

FUEL RAIL SERVICE
FIGURE C2-9
PARTS INFORMATION

PART NAME	PART #
O-ring - Fuel Inlet Line	1
O-ring - Fuel Return Line	2
Assembly - Fuel Pressure Connection	26
Seal - Fuel Pressure Connection	27
Cap - Fuel Pressure Connection	28
Injector - Port	85
Seal - O-Ring - Injector	86
Clip - Injector Retainer	87
Valve - Cold Start	100
Assembly - Tube & Body 101 Seal - O-ring Valve	102
Seal - O-Ring - Body	103
Seal - O-Ring - Tube	104
Assembly - Fuel Rail & Plug (LH)	200
Assembly - Fuel Rail & Plug (RH)	220
Stud Assembly - Rear Bracket Attaching	222
Seal - O-Ring - Fuel Outlet Tube	224
Tube - Front Crossover	230
Seal - O-Ring - Fuel Crossover Tube	232
Retainer - Crossover Tube	234
Screw Assembly - Retainer Attaching	235
Assembly - Pressure Regulator and Base	240
Seal - O-Ring - Connector	252
Connector - Base to Rail	250
Bracket - Pressure Regulator & Base Assembly	255
Screw Assembly - Bracket to rail Attaching	256
Screw Assembly - Bracket to Base Attaching	258
Tube - Rear Crossover	265
Seal - O-Ring - Crossover Tube	267
Retainer - Rear Crossover Tube	270
Screw Assembly - Retainer to LH Rail	271
Screw Assembly - Retainer to Base	273
Screw Assembly - Base to RH Rail	275

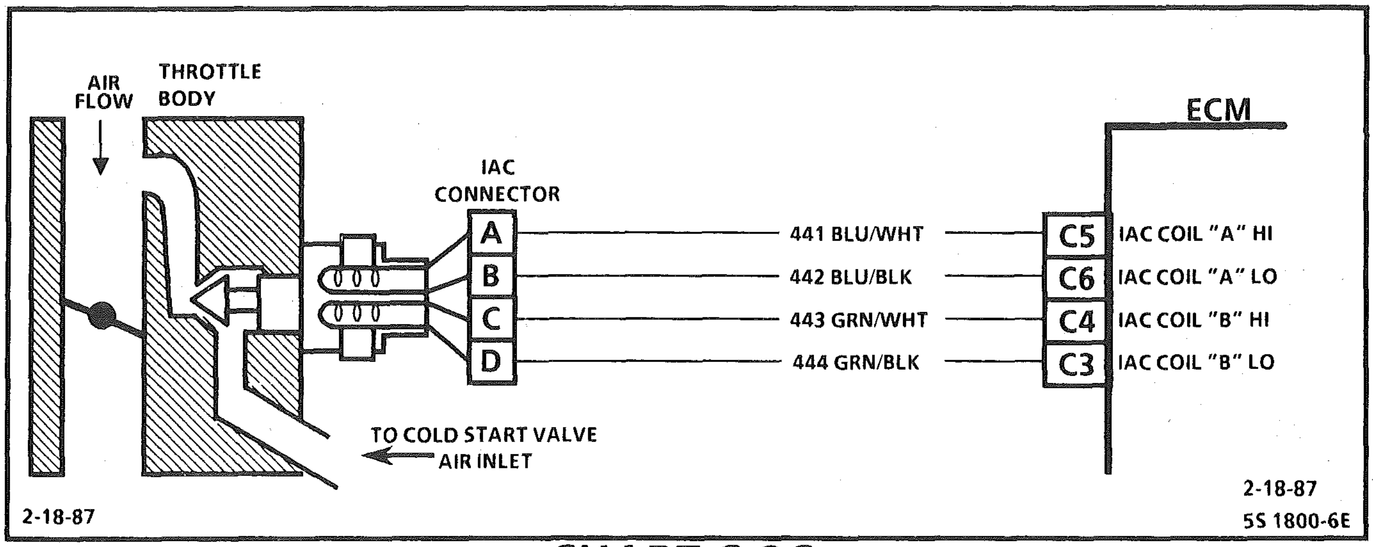

CHART C-2C
IDLE AIR CONTROL (IAC) SYSTEM CHECK
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

Circuit Description:

The ECM will control engine idle speed by moving the IAC valve to control air flow around the throttle plates. It does this by sending voltage pulses to the proper motor winding for each IAC motor. This will cause the motor shaft and valve to move "IN" or "OUT" of the motor a given distance for each pulse received. ECM pulses are referred to as "counts".

- To increase idle speed - ECM will send enough counts to retract the IAC valve and allow more air to flow through the idle air passage and bypass the throttle plates until idle speed reaches the proper rpm. This will increase the ECM counts.
- To decrease idle speed - ECM will send enough counts to extend the IAC valve and reduce air flow through the idle passage around the throttle plates. This will reduce the ECM counts.

Each time the engine is started and then the ignition is turned "OFF", the ECM will reset the IAC valve. This is done by sending enough counts to seat the valve. The fully seated valve is the ECM reference zero. A given number of counts are then issued to open the valve, and normal ECM control of IAC will begin from this point. The number of counts are then calculated by the ECM. This is how the ECM knows what the motor position is for a given idle speed.

The ECM uses the following information to control idle speed.

- Battery voltage
- Engine speed
- Coolant temperature
- Throttle position sensor
- P/N switch
- A/C clutch signal

Don't apply battery voltage across the IAC motor terminals. It will permanently damage the IAC motor windings.

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Continue with test, even if engine will not idle. If idle is too low, "Scan" will display 80 or more counts, or steps. If idle is high, it will display "0" counts.
   Occasionally an erratic or unstable idle may occur. Engine speed may vary 200 rpm or more up and down. Disconnect IAC. If the condition is unchanged, the IAC is not at fault. There is a system problem. Proceed to "Diagnostic Aids" below.
2. When the engine was stopped, the IAC valve retracted (more air) to a fixed "Park" position for increased air flow and idle speed during the next engine start. A "Scan" will display 140 or more counts.
3. Be sure to disconnect the IAC valve prior to this test. The test light will confirm the ECM signals by a steady or flashing light on all circuits.
4. There is a remote possibility that one of the circuits is shorted to voltage which would have been indicated by a steady light. Disconnect ECM and turn the ignition "ON" and probe terminals to check for this condition.

Diagnostic Aids:

Engine idle speed can be adversely affected by the following:

- Park/Neutral switch - If ECM thinks the car is always in neutral, then idle will not be controlled to the specified rpm when in drive range.
- Leaking injector(s) will cause fuel imbalance and poor idle quality due to excess fuel. See CHT. A-7.
- Vacuum or crankcase leaks can affect idle.
- When the throttle shaft or throttle position sensor is binding or sticking in an open throttle position, the ECM does not know if the vehicle has stopped and does not control idle.
- Check A.I.R. management system for intermittent air to ports while in "Closed Loop".
- In addition to electrical control of EGR, be sure to examine the EGR valve for proper seating.
- Faulty battery cables can result in voltage variations. The ECM will try to compensate, which results in erratic idle speeds.
- The ECM will compensate for A/C compressor clutch loads. Loss of the A/C request signal would be most apparent in neutral.
- Contaminated fuel can adversely affect idle.
- Perform injector balance test CHART C-2A.

If all OK, refer to "Rough, Unstable, Incorrect Idle or Stalling" symptoms in Section "B".

CHART C-2C

IDLE AIR CONTROL (IAC)SYSTEM CHECK
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

(1)
- ENGINE IDLING AT NORMAL OPERATING TEMPERATURE.
- NOTE RPM IN PARK OR NEUTRAL.

(2)
- IGNITION "OFF" FOR 10 SEC.
- START ENGINE AND IMMEDIATELY NOTE RPM.

IDLE RPM, NO INCREASE

IDLE RPM , INCREASE

- IDLE ENGINE FOR 1 MINUTE AND NOTE RPM.

WILL NOT RETURN TO IDLE RPM RECORDED ABOVE .

RETURNS TO IDLE RPM RECORDED ABOVE .

IDLE AIR CONTROL CIRCUIT OK.
SEE FACING PAGE "DIAGNOSTIC AIDS".

(3)
- IGNITION "OFF".
- DISCONNECT IAC VALVE HARNESS.
- IGNITION "ON" , ENGINE STOPPED.
- GROUND DIAGNOSTIC TEST TERMINAL.
- CONNECT A TEST LIGHT BETWEEN EACH IAC HARNESS CONNECTOR TERMINAL AND GROUND.

NO LIGHTS, ONE OR MORE CIRCUITS.

CHECK FOR OPEN OR SHORT TO GROUND IN CIRCUIT WITH NO LIGHT.

ARE ALL CIRCUITS OK?

YES

CHECK RESISTANCE ACROSS IAC COILS. SHOULD BE MORE THAN 20 OHMS BETWEEN IAC TERMINALS OPPOSITE HARNESS CONNECTOR TERMS. "A" TO "B" AND "C" TO "D".

OK

FAULTY ECM CONN. OR ECM.

NOT OK

REPLACE IAC VALVE AND RETEST.

NO

REPAIR WIRING AND RECHECK.

(4) LIGHT STEADY OR FLASHING ALL CIRCUITS.

FAULTY IAC CONNECTION OR IAC VALVE.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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SECTION C3

EVAPORATIVE EMISSION CONTROL SYSTEM (EECS)

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The basic evaporative emission control system (EECS) used on all vehicles is the charcoal canister storage method. This method transfers fuel vapor from the fuel tank to an activated carbon (charcoal) storage device (canister) to hold the vapors when the vehicle is not operating. When the engine is running, the fuel vapor is purged from the carbon element by intake air flow and consumed in the normal combustion process.

VAPOR CANISTER

Gasoline vapors from the fuel tank flow into the tube labeled tank. Any liquid fuel goes into a reservoir in the bottom of the canister to protect the integrity of the carbon bed above (Figure C3-1). These vapors are absorbed into the carbon. The canister is purged when the engine is running above idle speed. Ambient air is allowed into the canister through the air tube in the top. The air mixes with the vapor and the mixture is drawn into the intake manifold.

EVAPORATIVE EMISSION SYSTEM

The canister is equipped with a normally closed solenoid to control canister purge. The ECM operates the solenoid which controls vacuum to the purge valve in the charcoal canister. Under cold engine or idle conditions, the solenoid is turned "OFF" by the ECM, which closes the solenoid and blocks vacuum to the canister purge valve.

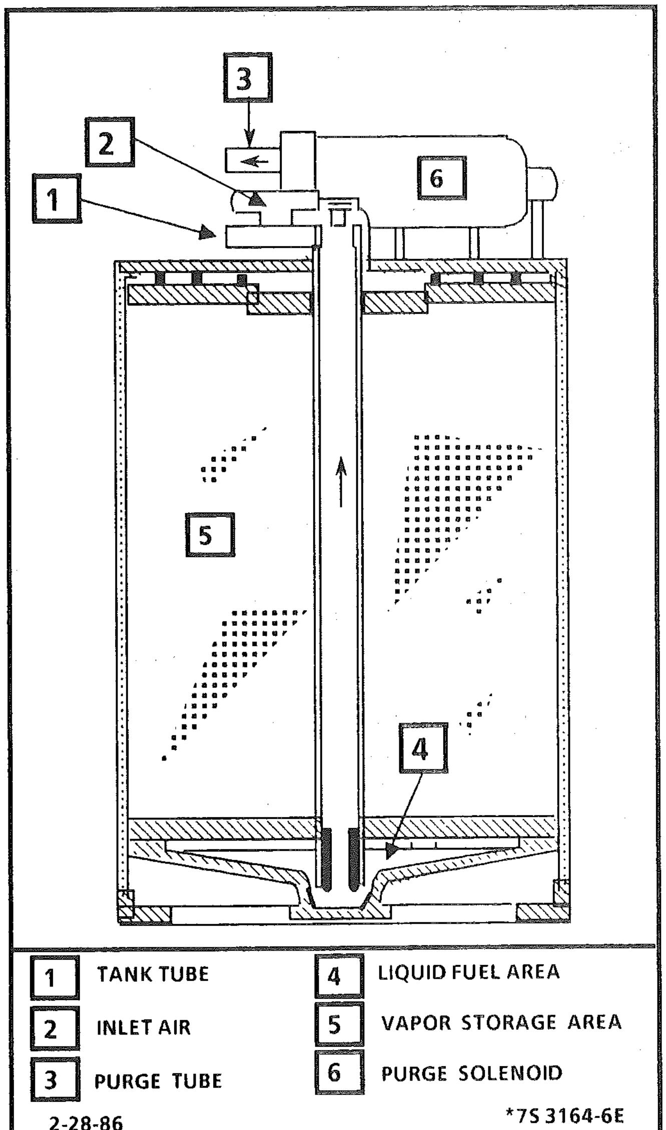


Figure C3-1 - Inverted Function Vapor Canister - With Encapsulated Purge Solenoid

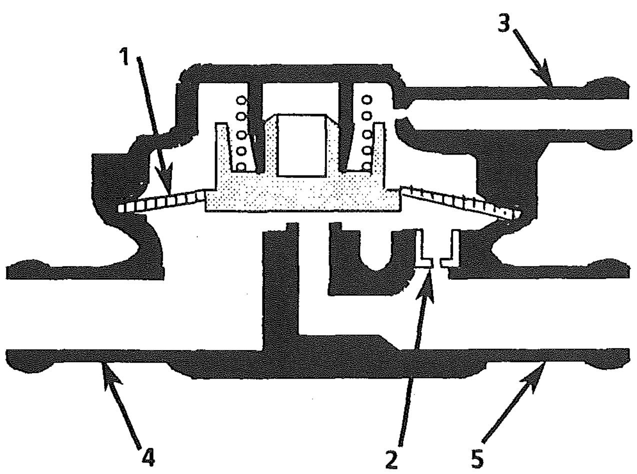
The ECM turns "ON" the solenoid valve and allows purge when:

- Above a specified road speed.
- Engine is warm
- After the engine has been running a specified time.
- Above a specified throttle opening.

This is an ECM feedback system that increases purge until the ECM senses a rich condition from the O_2 sensor. The purge is then regulated until the ECM no longer receives a rich signal from the O_2 sensor. This system uses an in-tank pressure control valve to control the flow of vapors from the fuel tank to the canister.

IN-TANK PRESSURE CONTROL VALVE

The in-tank pressure control valve, a combination roll-over, integral pressure and vacuum relief valve, is located with the fuel sending unit in the fuel tank. When vapor pressure in the tank exceeds 1" Hg (5 kPa) the valve opens and allows vapors to vent to the canister and then be purged. When the tank pressure drops below the opening point of the valve it will close, keeping vapors in the fuel tank. The valve provides vacuum relief to protect against vacuum build up in the fuel tank and roll-over protection to prevent liquid fuel from entering the canister during normal driving maneuvers.



1 DIAPHRAGM
2 VENT RESTRICTION
3 CONTROL VACUUM TUBE
4 TUBE TO FUEL TANK
5 TUBE TO CANISTER

10-1-85
*6S 2971-6E

Figure C3-2 Fuel Tank Pressure Control Valve

RESULTS OF INCORRECT OPERATION

Poor idle, stalling and poor driveability can be caused by:

- Inoperative purge solenoid
- Damaged canister
- Hoses split, cracked and, or not connected to the proper tubes.

Evidence of fuel loss or fuel vapor odor can be caused by:

- Liquid fuel leaking from fuel lines.
- Cracked or damaged canister
- Disconnected, misrouted, kinked, deteriorated or damaged vapor hoses, or control hoses.

DIAGNOSIS

The canister purge solenoid operation is covered in the charts at the end of this section.

VISUAL CHECK OF CANISTER

Cracked or damaged , replace canister.

FUNCTIONAL TEST

Vapor Canister Purge Valve

Apply a short length of hose to the lower tube of purge valve, and atempt to blow through it. Little or no air should pass into the canister. (A small amount of air will pass if the canister has a constant purge hole).

With hand vacuum pump, apply vacuum (15" Hg or 51 kPa) through the control valve tube (upper tube). The diaphragm should hold vacuum for at least 20 seconds. If not the canister must be replaced. If the diaphragm holds vacuum, again try to blow through the hose connected to the lower tube while vacuum is still being applied. An increased flow of air should be observed. If not, the canister must be replaced.

Tank Pressure Control Valve

With a hand vacuum pump apply vacuum (15" or 51 kPa) to the control vacuum tube. The diaphragm should hold vacuum for at least 20 seconds. If it does not hold vacuum the diaphragm is leaking and the valve must be replaced.

With the vacuum still applied to the control vacuum tube, apply a short hose to the valve's tank tube side, blow into the tube. You should feel the air pass through the valve. If the air does not pass through, the valve should be replaced.

ON-CAR SERVICE

FUEL VAPOR CANISTER

Remove or Disconnect

1. Hoses from canister. Mark hoses to install on new canister.
2. Canister.

Install or Connect

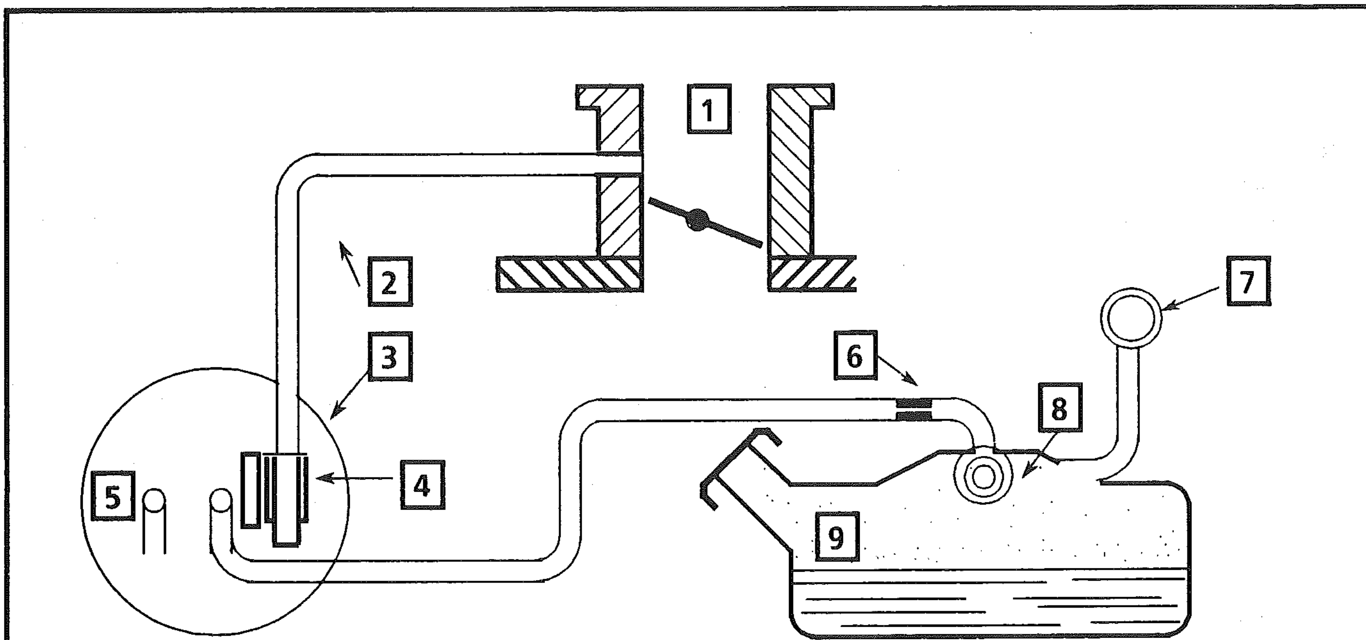
1. Canister as removed.
2. Hoses. Make sure connections are correct.

CANISTER HOSES

Refer to Vehicle Emission Control Information Label for routing of canister hoses.

PARTS INFORMATION

PART NAME	GROUP
Canister, Fuel Vapor	3.130
Solenoid, Fuel Vapor Canister	3.140
Valve, Fuel Tank Pressure Control	3.140



1	THROTTLE BODY	4	PURGE SOLENOID ASSEMBLY	7	REMOTE PRESSURE / VACUUM RELIEF VALVE
2	PURGE LINE	5	AIR INLET	8	IN-TANK PRESSURE CONTROL VALVE
3	VAPOR CANISTER	6	VAPOR RESTRICTION	9	FUEL TANK

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Figure C3-3 - Evaporative Emissions Control System Schematic

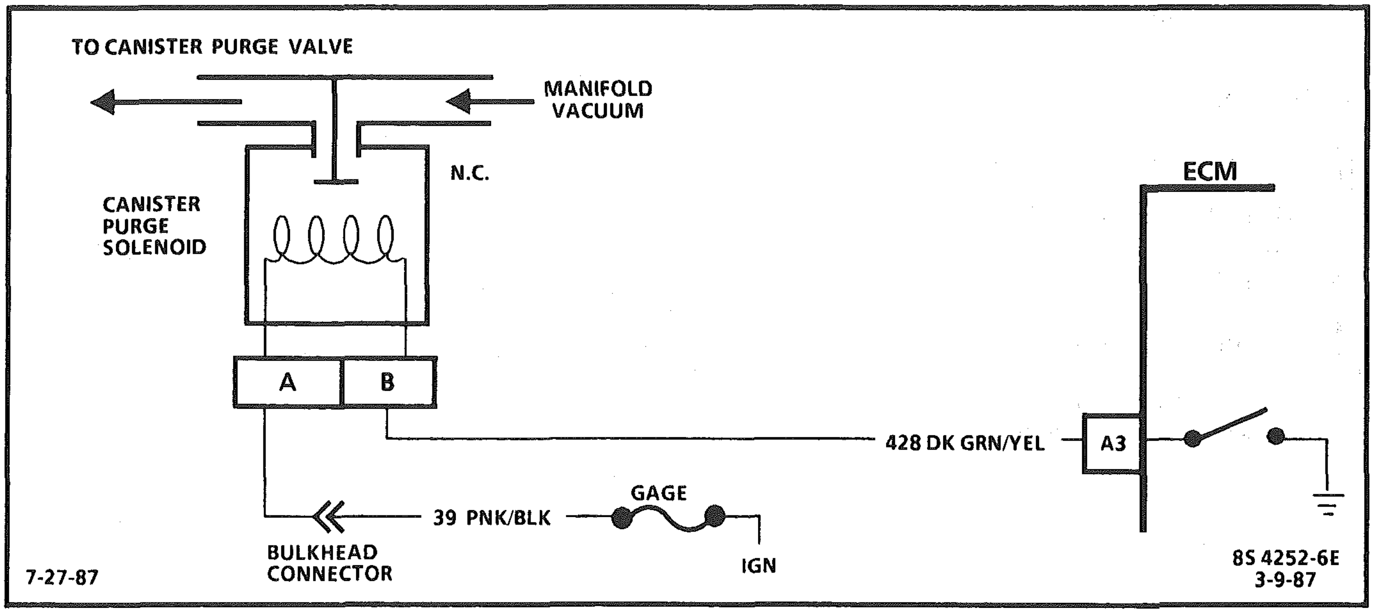


CHART C-3

CANISTER PURGE SOLENOID CHECK
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

Circuit Description:

Canister purge is controlled by a solenoid that allows manifold vacuum to purge the canister when de-energized. The ECM supplies a ground to energize the solenoid (purge "ON").

If the diagnostic test terminal is grounded, with the engine stopped, or the following conditions are met with the engine running, the purge solenoid will be energized (purge "ON").

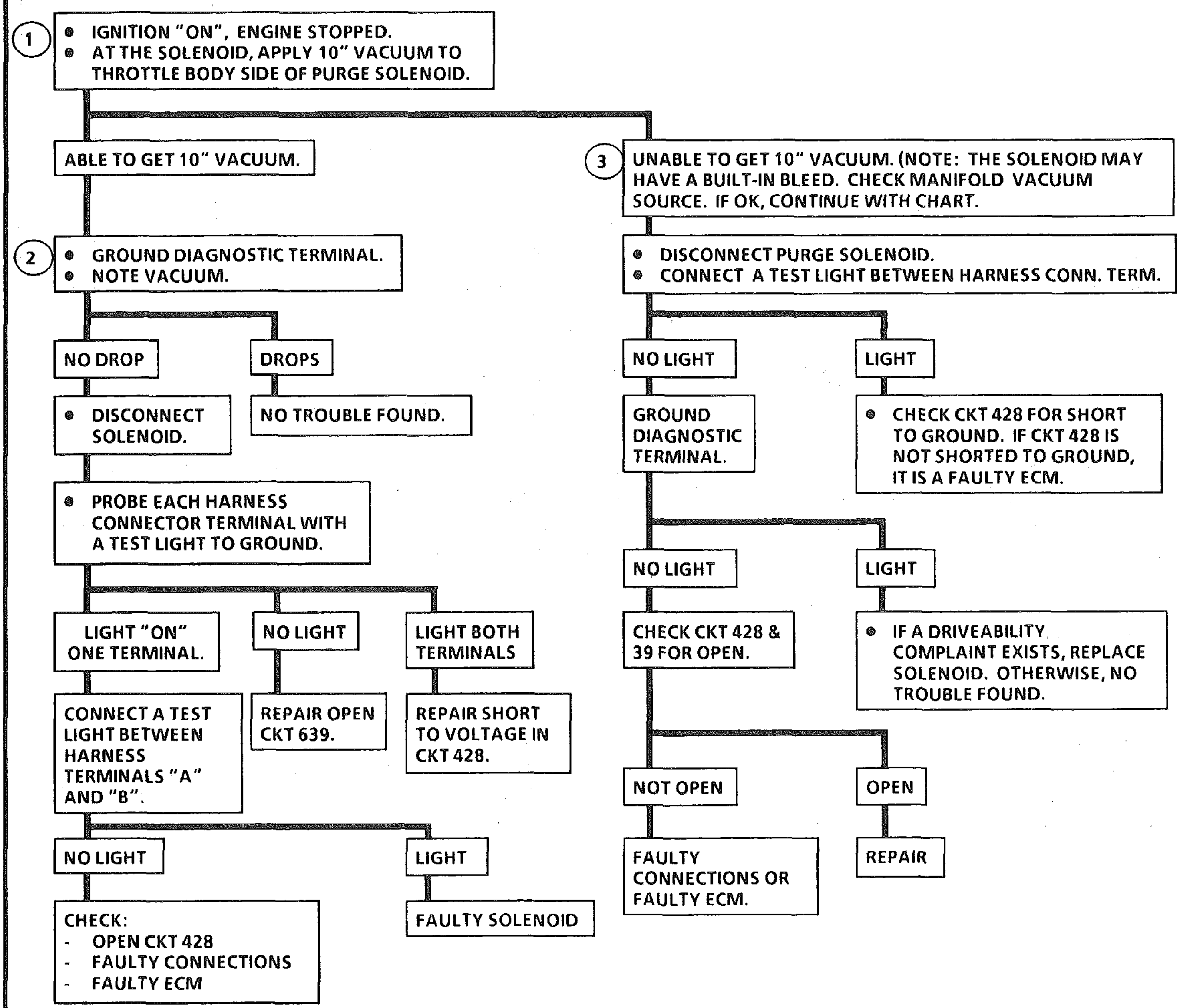
- Engine run time after start more than 1 minute.
- Coolant temperature above 75°C.
- Vehicle speed above 15 mph.
- Throttle position is above idle.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. The external vacuum source must be applied to the purge solenoid at the canister.
2. Grounding the diagnostic terminal will energize the solenoid and allow vacuum to pass.
3. Some solenoids may have a large enough bleed built into them to appear to be operating incorrectly.

CHART C-3

CANISTER PURGE SOLENOID CHECK
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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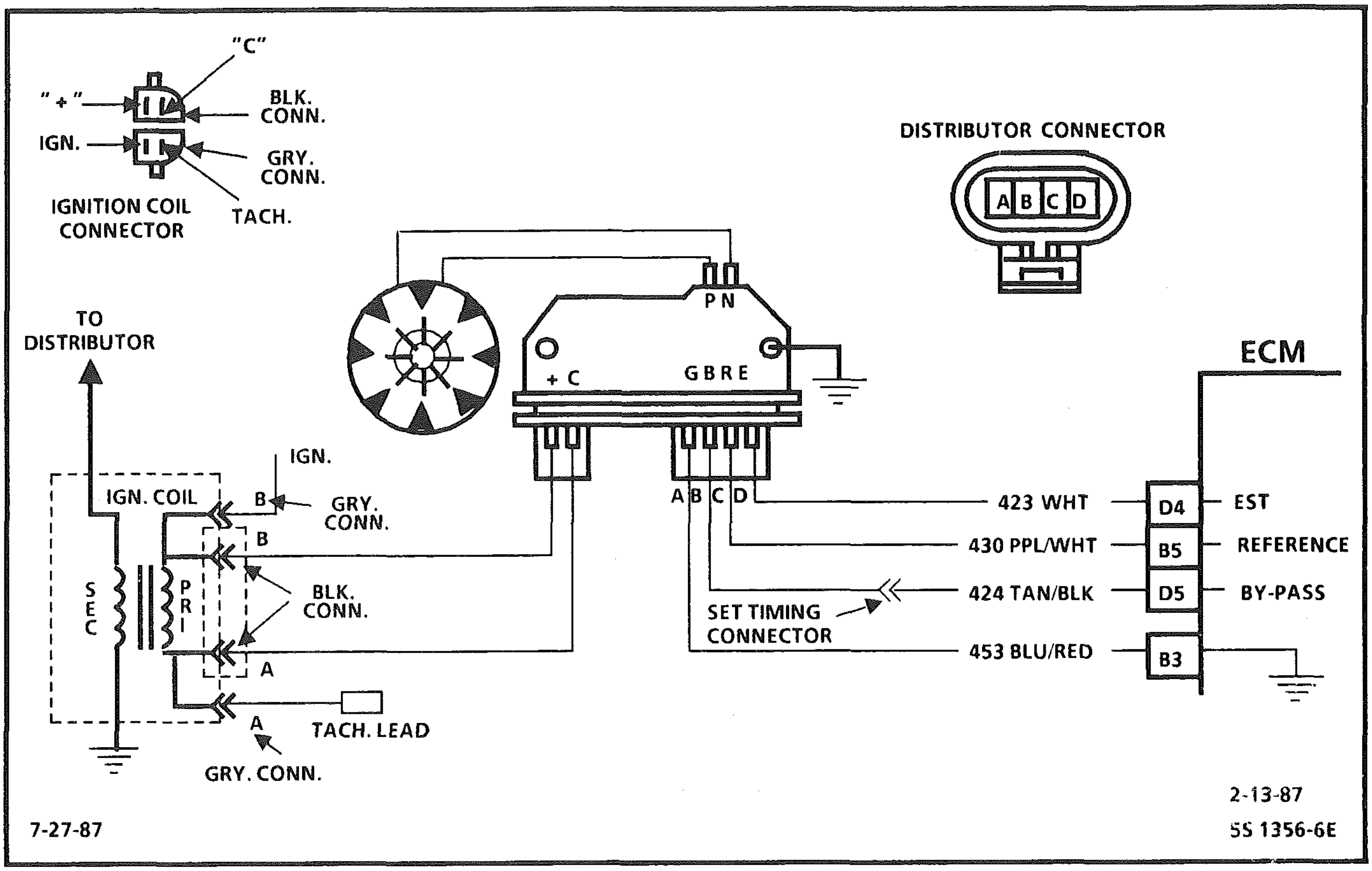

CHART C-4

IGNITION SYSTEM CHECK
(INTEGRAL COIL)
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Checks for proper output from the ignition system. The spark tester requires a minimum of 25,000 volts to fire. This check can be used in case of an ignition miss because the system may provide enough voltage to run the engine but not enough to fire a spark plug under heavy load.

1A. If spark occurs with EST connector disconnected, pick-up coil output is too low for EST operation.

2. Normal reading during cranking is about 8-10 volts.
3. Checks for a shorted module or grounded circuit from the ignition coil to the module. The distributor module should be turned "OFF", so normal voltage should be about 12 volts. If the module is turned "ON", the voltage would be low, but above 1 volt. This could cause the ignition coil to fail from excessive heat. With an open ignition coil primary winding, a small mount of voltage will leak through the module from the battery to the tach. terminal.
4. Checks the voltage output with the pick-up coil triggering the module. A spark indicates that the ignition system has sufficient output, however, intermittent no-starts or poor performance could be the result of incorrect polarity between the ignition coil and the pick-up coil.
   The color of the pick-up coil connector has to be yellow, if one of the ignition coil leads is yellow. If the ignition coil has a white lead, any pick-up coil connector color, except yellow, is OK.
5. Checks for an open module or circuit to it. 12 volts applied to the module "P" terminal should turn the module "ON" and the voltage should drop to about 7-9 volts.
6. This should turn "OFF" the module and cause a spark. If no spark occurs, the fault is most likely in the ignition coil, because most module problems would have been found before this point in the procedure. A module tester could determine which is at fault.

CHART C-4
IGNITION SYSTEM CHECK
(INTEGRAL COIL)
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

(1)
- Perform Diagnostic Circuit Check before proceeding with this test. (If a tachometer is connected to the Tach term., disconnect it before proceeding with the test).
- Check spark at plug with spark tester J-26792 or equivalent (ST-125) while cranking (if no spark on one wire, check a second wire) A few sparks and then nothing is considered no spark.

No Spark → (1A)

Spark → Check fuel, spark plugs, etc. See section "B" symptoms.

(1A)
- Disconnect 4 term. distributor connector and check for spark.

No spark → (2)

Spark → Replace pick-up coil

(2)
- Check for spark at coil wire with tester while cranking. (Leave spark tester connected to coil wire for Steps 3-6).

No Spark → (3)

Spark → Inspect cap for water, cracks, etc. If OK, replace rotor.

(3)
- Disconnect distributor 2 term. "C / +" connector.
- Ignition switch "on", Engine stopped.
- Check volts at "+" and "C" term's. of dist. harn. conn.

Both term's. 10 volts or more → (4)

Both term's. under 10 volts → Repair wire from module "+" term. to "B" term. of black Ign. coil connector or primary ckt. to ign. sw.

Under 10 volts "C" term. only → Check for open or gnd. in ckt. from "C" term. to ign. coil. If Ckt. is OK, fault is. ign. coil or conn..

(4)
- Reconnect dist. 2 term. conn.
- With ign. "ON", check voltage from tach. term. to gnd. (term. may be taped back in harness).

Over10 volts →
- Connect test light from tach. term. to ground.
- Crank engine and observe light.

  Light on steady → (5)

  Light blinks → Replace ignition coil and recheck for spark with spark tester. If still no spark, re-install original coil and replace dist. module..

Under 1 volt → Repair open tach. lead or conn and repeat test #4.

1 to 10 volts → Replace module and check for spark from coil as in Step 6.
- Spark → System OK
- No Spark → Replace ign. coil, it too is faulty

(5)
- Disconnect distributor 4 term. connector.
- Remove dist. cap.
- Disconnect pick-up coil connector from module.
- Connect voltmeter from tach. term. to ground.
- Ignition on.
- Insulate a test light probe to 1/4" from tip and note voltage, as test light is momentarily connected from a voltage source (1.5 to 8V) to module term. "P". (Fig. 1).

Voltage drops → (6)

No drop in voltage → Check module ground. If OK, replace module.

(6)
- Check for spark from coil wire with spark tester as test light is removed from module term.

No Spark →
- If no module tester (J24642) is available; Replace ign. coil and repeat Step 5.
  - No Spark → Ign. coil removed is OK, reinstall coil and check coil wire from dist. cap. if OK, replace dist. module.
  - Spark → System OK
- If module tester (J24642) is available: test module
  - OK → Check coil wire from cap to coil. If OK, replace coil.
  - Not OK → Replace module

Spark →
- Is rotating pole piece still magnetized?
  - Yes → Check pick-up coil or conns. (Coil resistance should be 500-1500 ohms and not grounded).
  - No → Replace pole piece and shaft assy.

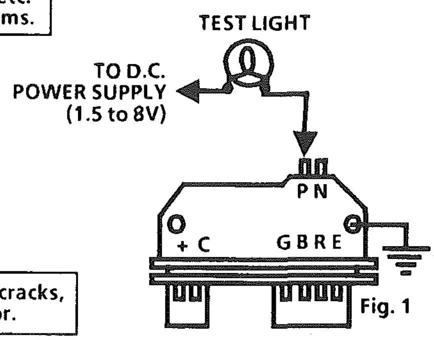

Fig. 1

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SECTION C5

ELECTRONIC SPARK CONTROL (ESC) SYSTEM

CONTENTS

GENERAL DESCRIPTION

PURPOSE

Varying octane levels in today's gasoline can cause detonation in high performance engines. Detonation is sometimes called spark knock.

To control spark knock, an electronic spark control (ESC) system has been added. This system is designed to retard spark timing up to 20°, if necessary, to reduce spark knock in the engine. This allows the engine to use maximum spark advance to improve driveability and fuel economy.

GENERAL DESCRIPTION

The ESC system has two major components:

- ESC module
- ESC knock sensor

The ESC knock sensor detects abnormal vibration (spark knocking) in the engine. The sensor is mounted in the engine block near the cylinders. The ESC module receives the knock sensor information and sends a signal to the ECM. The ECM then adjusts the electronic spark timing (EST) to reduce spark knocking.

The ESC module sends a voltage signal (8 to 10 volts) to the ECM when NO spark knock is detected by the knock sensor, and the ECM provides normal spark advance.

When the knock sensor detects spark knock, the module turns "OFF" CKT 485 to the ECM. The ECM then retards EST to reduce spark knock.

Loss of the ESC knock sensor signal or loss of ground at ESC module terminal "D" would cause the signal on CKT 485 to the ECM to remain high. This condition would cause the ECM to control EST as if no spark knock was occuring. No retard would occur, and spark knock could become severe under heavy engine load conditions. This condition should, however, cause a Code 43 to set.

Loss of the ESC signal to the ECM would cause the ECM to constantly retard EST. This will result in sluggish performance and set a Code 43.

DIAGNOSIS

Code 43 indicates that the ECM terminal "B7" is receiving less than 6 volts for a 4 second period with the engine running. This is CKT 485, which normally provides a 8 to 10 volt signal from the ESC module to the ECM. See Code 43 CHART for diagnosis if the code is present.

When no Code 43 is present but the ESC system is a potential cause of excessive spark knock, see CHART C-5 which follows.

ON-CAR SERVICE

ESC SENSOR

Remove or Disconnect

1. Negative battery cable.
2. Raise car.
3. ESC wiring harness connector from ESC sensor.
4. ESC sensor from engine block.

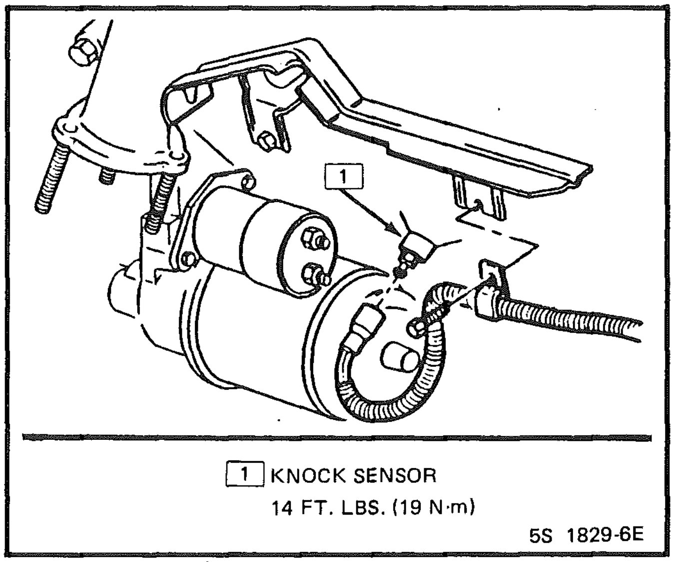

Figure C5-1 ESC Sensor

Install or Connect

1. ESC sensor into engine block.
   - Tighten to 14 ft. lbs. (19 N·m).
2. ESC wiring harness connector to the ESC sensor.
3. Lower car.
4. Negative battery cable.

ESC MODULE AND BRACKET

Refer to Figure C5-2 for ESC module replacement.

PARTS INFORMATION

PART NAME	GROUP
Bracket, Elek Spark Cont Mdl	2.383
Module, Elek Spark Cont	2.383
Sensor, ESC Knock	2.383
Shield, Elek Spark Cont Knock	2.383

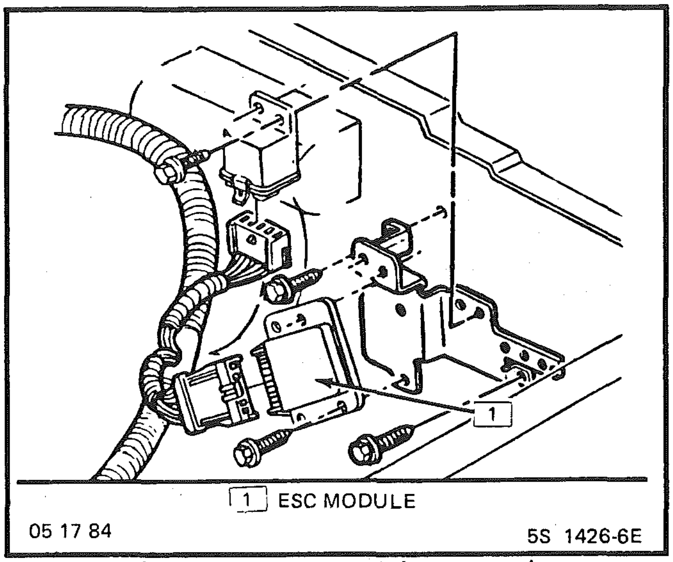

Figure C5-2 ESC Module Removal

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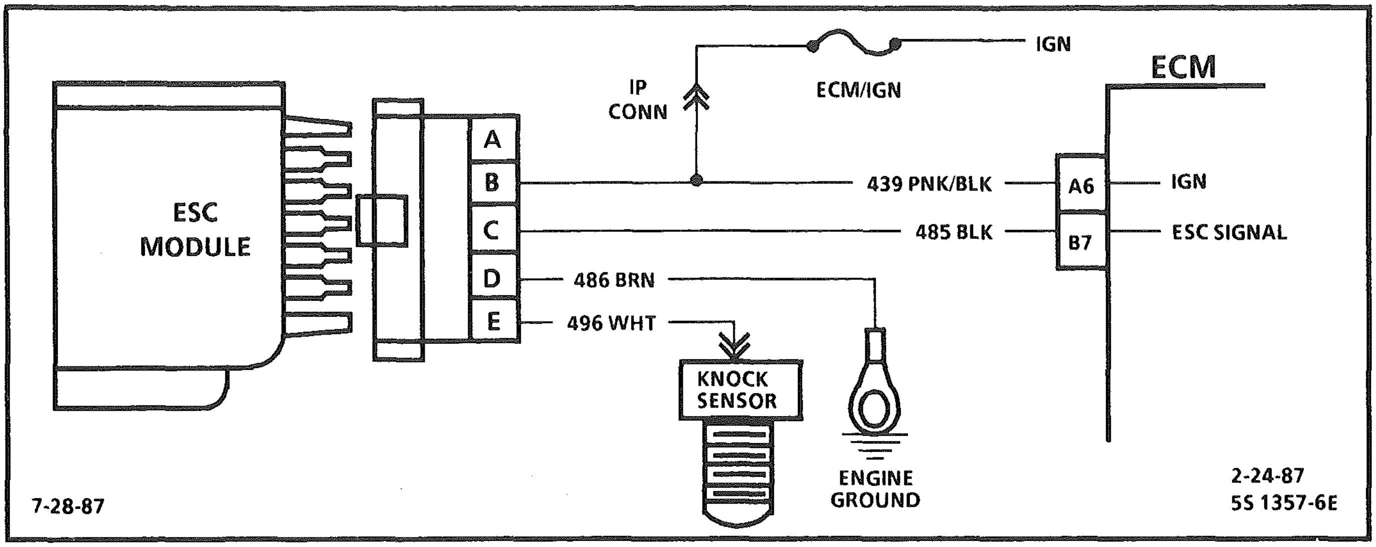

CHART C-5

ELECTRONIC SPARK CONTROL
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

Circuit Description:

Electronic spark control is accomplished with a module that sends a voltage signal to the ECM. As the knock sensor detects engine knock, the voltage from the ESC module to the ECM is shut "OFF" and this signals the ECM to retard timing, if engine rpm is over about 900.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. If a Code 43 is not set, but a knock signal is indicated while running at 1500 rpm, listen for an internal engine noise. Under a no load condition, there should not be any detonation, and if knock is indicated, an internal engine problem may exist.
2. Usually a knock signal can be generated by tapping on the right exhaust manifold. This test can also be performed at idle. Test number 1 was run at 1500 rpm to determine if a constant knock signal was present, which would affect engine performance.
3. This tests whether the knock signal is due to the sensor, a basic engine problem, or the ESC module.
4. If the module ground circuit is faulty, the ESC module will not function correctly. The test light should light indicating the ground circuit is OK.
5. Contacting CKT 496, with a test light to 12 volts, should generate a knock signal to determine whether the knock sensor is faulty, or the ESC module can't recognize a knock signal.

Diagnostic Aids:

"Scan" tools have two positions to diagnose the ESC system. The knock signal can be monitored to see if the knock sensor is detecting a knock condition and if the ESC module is functioning, knock signal should display "YES", whenever detonation is present. The knock retard position on the "Scan" displays the amount of spark retard the ECM is commanding. The ECM can retard the timing up to 20 degrees.

If the ESC system checks OK, but detonation is the complaint, refer to "Detonation/Spark Knock" in Section "B".

CHART C-5

ELECTRONIC SPARK CONTROL
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

THIS CHART SHOULD BE USED AFTER ALL OTHER CAUSES OF SPARK KNOCK HAVE BEEN CHECKED. I.E., TIMING, EGR, ENGINE TEMPERATURE OR EXCESSIVE ENGINE NOISE,ETC. IF CODE 43 IS SET, USE THAT CHART FIRST.

1
- IF A CODE 43 WAS SET USE THAT CHART FIRST. THIS CHART ASSUMES CODE 43 IS NOT PRESENT.
- "SCAN" TOOL SET ON KNOCK SIGNAL.
- ENGINE RUNNING AT ABOUT 1500 RPM.
- IS THERE A KNOCK SIGNAL INDICATED?

NO

2
- ENGINE RUNNING AT 1500 RPM.
- TAP ENGINE BLOCK IN AREA OF KNOCK SENSOR.
- DOES "SCAN" INDICATE A KNOCK SIGNAL WHILE TAPPING ON ENGINE?

YES

3
- DISCONNECT KNOCK SENSOR.
- REPEAT TEST.
- IS THERE A KNOCK SIGNAL INDICATED?

YES

CHECK FOR ROUTING OF WIRE FROM KNOCK SENSOR TO ESC MODULE FOR PICKING UP FALSE KNOCK SIGNALS FROM AN ADJACENT WIRE. REROUTE AS NECESSARY. IF ROUTING IS CORRECT, REPLACE ESC MODULE.

NO

INTERNAL ENGINE KNOCK OR FAULTY SENSOR.

NO

4
- DISCONNECT ESC MODULE.
- PROBE HARNESS TERMINAL "D" (CKT 486) WITH A TEST LIGHT TO 12 V.

YES

ESC SYSTEM OK.

LIGHT "ON"

5
- RECONNECT ESC MODULE.
- DISCONNECT KNOCK SENSOR.
- ENGINE IDLING.
- MOMENTARILY TOUCH KNOCK SENSOR HARNESS (CKT 496) WITH A TEST LIGHT TO 12V.
- EACH TIME THE TEST LIGHT CONTACTS CKT 496, A KNOCK SIGNAL SHOULD BE GENERATED.
- IS A KNOCK SIGNAL INDICATED WITH "SCAN"?

YES

FAULTY CONNECTION AT SENSOR OR FAULTY KNOCK SENSOR.

NO

CKT 496 OPEN, SHORTED TO GROUND, FAULTY CONNECTION AT ESC MODULE, OR FAULTY ESC MODULE.

LIGHT "OFF"

REPAIR OPEN GROUND CKT 486.

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SECTION C6

AIR INJECTION REACTION (A.I.R.) SYSTEM

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The A.I.R. system helps reduce hydrocarbon (HC), carbon monoxide (CO), and oxides of nitrogen (NO_x) exhaust emissions. It also heats up the catalytic converter quickly on engine start-up so conversion of exhaust gases can occur sooner.

A dual bed converter is used. It consists of a three way catalyst (which controls all three emissions) in series with a two way catalyst (which controls only HC and CO) both are in one housing. A pipe between the two converters allows air to be injected into the second (two way) converter to increase its efficiency to further control HC and CO (Figure C6-1).

As shown in Figure C6-1, air can be directed to:

- A divert silencer.
- Exhaust ports; or
- Catalytic converter.

OPERATION

The system (Figure C6-1) includes:

- An Air Pump
  The air pump is driven by a belt on the front of the engine and supplies the air to the system. Intake air passes through a centrifugal filter fan at the front of the pump; where foreign materials are separated from the air by centrifugal force.
- A Control Valve (PEDES)
  Air flows from the pump through an ECM controlled valve (called a PEDES valve) through check valves to either the exhaust ports or the converter.
- Check Valves
  The check valves prevent back flow of exhaust into the pump in the event of an exhaust backfire or pump drive belt failure.
- Necessary Plumbing

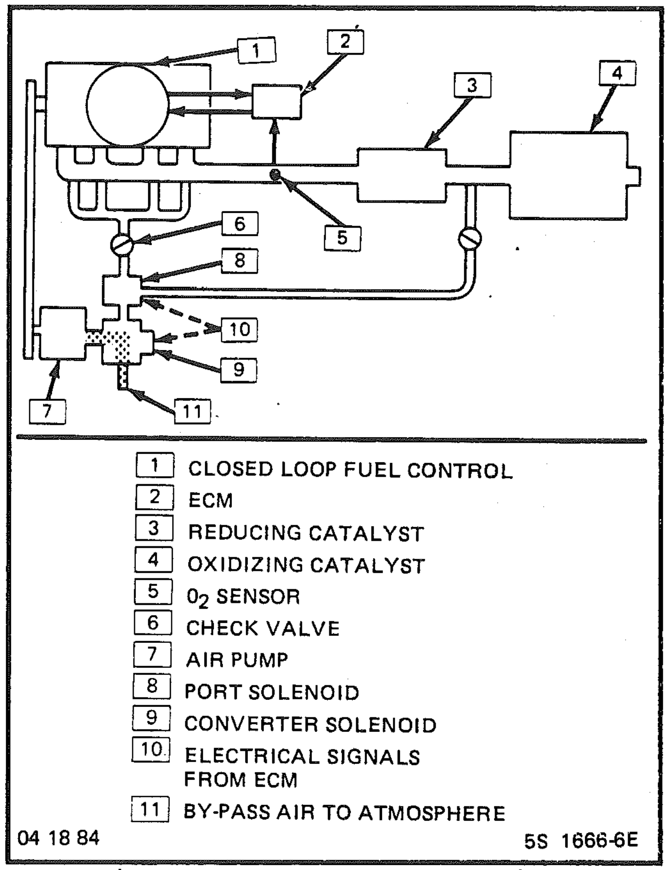

Figure C6-1 - A.I.R. System Operation

AIR CONTROL PEDES VALVE

Pressure operated electric divert/electric air switching (PEDES) valves are used on these engines. The diverting and switching functions are electronically controlled by the ECM,which grounds to complete the circuit and energize the solenoid. Self-generated pressure from the A.I.R. pump is used to operate the valve, which is completely independent of manifold vacuum.

Air enters the body of the valve from the pump. Air pressure builds against the control valve and for:

- Cold Mode - The port solenoid is energized which in turn opens the port valve and allows flow to the exhaust ports.
- Warm Mode - The port solenoid is de-energized and the converter solenoid energized which closes the port valve and keeps the converter valve seated, thus forcing flow past the converter valve and to the converter.
- Divert Mode - Both solenoids are de-energized which opens the converter valve, allowing air to take the path of least resistance, i.e., out the divert/relief tube to atmosphere.

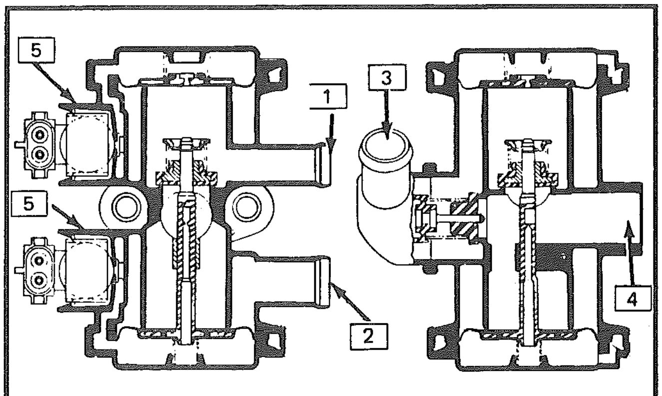

Figure C6-2 - A.I.R. System Control Valve

Air is diverted to the atmosphere under the following conditions:

- Rich operation.
- When the ECM recognizes a problem and sets a trouble code.
- During deceleration.
- During high rpm operation when air pressure is greater than the setting for the internal relief valve.

RESULTS OF INCORRECT OPERATION

If no air (oxygen) flow enters the exhaust stream at the exhaust ports, HC and CO emission levels will be too high.

Air flowing to the exhaust ports at all times could increase temperature of the converter.

Air flowing at all times to the catalytic converter may cause converter overheating during rich operation.

Mechanical failures in the valves could cause the air to flow incorrectly to the exhaust ports or the converter.

Electrical failure (open circuit) of the control valve will divert air flow overboard at all times. Air will flow to the converter at all times if an open circuit occurs to the switching valve (converter solenoid).

DIAGNOSIS

The diagnosis of the AIR system is covered in CHART C-6 at the end of this section.

OPERATIONAL CHECKS

Air Pump

The air pump is a positive displacement vane type which is permanently lubricated and requires no periodic maintenance.

Accelerate engine to approximately 1500 rpm's and observe air flow from hose(s). If air flow increases as engine is accelerated, pump is operating satisfactorily. If air flow does not increase or is not present, proceed as follows:

Inspect

1. For proper drive belt tension.
2. For a leaky pressure relief valve. Air may be heard leaking with the pump running.

NOTICE: If the engine or underhood compartment is to be cleaned with steam or high-pressure detergent, the centrifugal filter fan should be masked off to prevent liquids from entering the pump (see Figure C6-3).

NOTICE: The AIR system is not completely noiseless. Under normal conditions, noise rises in pitch as engine speed increases. To determine if excessive noise is the fault of the air injection reactor system, operate the engine with the pump drive belt removed. If excessive noise does not exist with the belt removed proceed as follows:

Inspect

3. For a seized air injection pump.
4. Hoses, tubes and all connections for leaks and proper routing.
5. For air flow from control/switching valve.
6. AIR injection pump for proper mounting and bolt torque.
7. If no irregularities exist and the AIR injection pump noise is still excessive, remove and replace pump.

CAUTION: **Do Not Oil Pump**

Hoses and Pipes

Inspect

1. Hose or pipe for deterioration or holes.
2. All hoses or pipe connections, and clamp tightness.
3. Hose or pipe routing. Interference may cause wear.
4. If a leak is suspected on the pressure side of the system or if a hose or pipe has been disconnected on the pressure side, the connections should be checked for leaks with a soapy water solution. With the pump running, bubbles will form if a leak exists.

Check Valve

Inspect

1. A check valve should be inspected whenever the hose is disconnected from a check valve or whenever check valve failure is suspected. (A pump that had become inoperative and had shown indications of having exhaust gases in the pump would indicate check valve failure).
2. Blow through the check valve (toward the cylinder head) then attempt to suck back through the check valve. Flow should only be in one direction(toward the exhaust manifold). Replace valve which does not operate properly.

ON-CAR SERVICE

DRIVE BELT

Remove or Disconnect

1. Inspect drive belt for wear, cracks or deterioration and replace if required. When installing a new belt, it must be seated and fully secured in grooves of all belt driven components.

AIR INJECTION PUMP

Remove or Disconnect

1. Hold pump pulley from turning by compressing drive belt, then loosen pump pulley bolts.
2. Drive belt and pulley.
3. Hoses, vacuum, and electrical connections from air injection control valve.
4. Air pump mounting bolts, and pump assembly (See Figure C6-3).

Install or Connect

1. Air pump assembly, and tighten mounting bolts.
2. Spacer and pump pulley against centrifugal filter fan.
3. Pump pulley bolts and tighten equally to 13 N·m (10 lb. ft).
4. Check air injection system for proper operation (see CHART C-6).

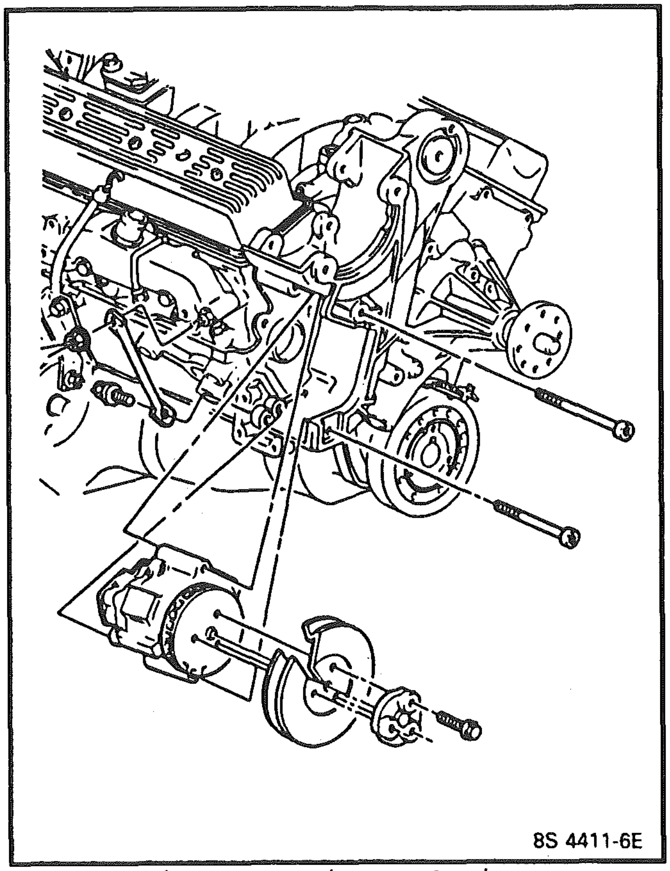

Figure C6-3 - Air Pump Service

AIR INJECTION CONTROL (PEDES) VALVE

Remove or Disconnect

1. Battery ground cable.
2. Adapter bolts (See Figure C6-4).
3. Air outlet hoses from valve.
4. Splash guard/cover
5. Electrical connectors and vacuum hoses from valve.
6. Control valve.

Install or Connect

1. Control valve.
2. Electrical connectors.
3. Splash guard/cover.
4. Air hoses to valve.
5. Battery ground cable.
6. Check system operation (see CHART C-6).

AIR INJECTION CHECK VALVE

Remove or Disconnect

1. Release clamp and disconnect air hoses from check valve.
2. Unscrew check valve from air injection pipe.

Install or Connect

1. Screw check valve onto air injection pipe. 23 N·m (17 lb. ft.).
2. Position air hoses on check valve and secure with clamp.

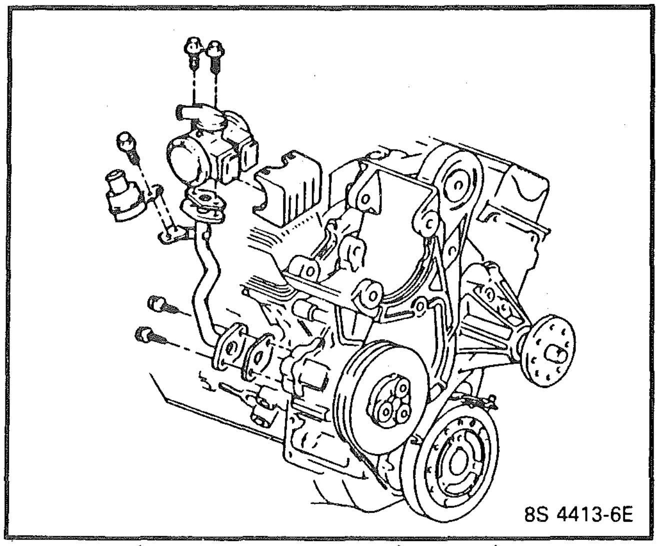

Figure C6-4 - PEDES Valve Service

PARTS INFORMATION

PART NAME	GROUP
Adapter, AIR Inj Cont Vlv	3.671
Brace, AIR Inj Pump	3.655
Bracket, AIR Inj Pump	3.655
Gasket, AIR Inj Dvtr Vlv El	3.671
Harness, AIR Inj Cont Vlv Vac	3.675
Hose, AIR Inj Cont Vlv	3.675
Hose, AIR Inj Cont Vlv Dvtr	3.675
Hose, Ctltc Conv AIR Inj Chk Vlv	3.675
Pipe, AIR Inj Ctltc Conv Chk Vlv	3.690
Pipe, Ctltc Conv AIR Inj	3.675
Pulley, AIR Inj Pump	3.650
Pump, AIR Inj	3.660
Silencer AIR Inj Cont Vlv	3.660
Support, AIR Inj Pump	3.660
Valve, AIR Inj Cont	3.670
Valve, AIR Inj Eng Chk	3.670
Valve, Ctltc Conv AIR Inj Chk	3.670

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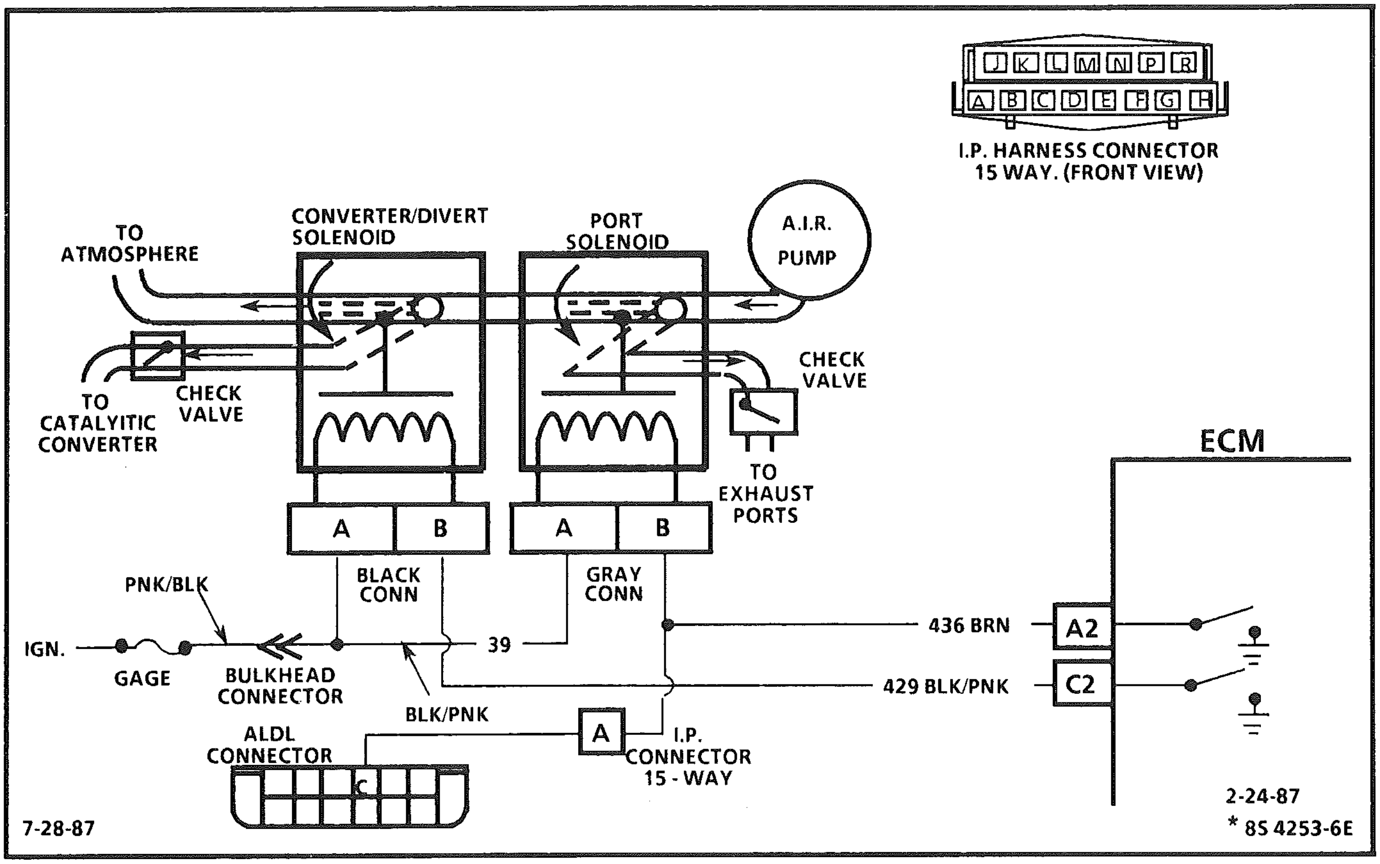


CHART C-6

AIR MANAGEMENT CHECK (PEDES)
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

Circuit Description:

Air management is controlled by a pressure operated port valve and a converter valve, each with an ECM controlled solenoid. When the solenoid is grounded by the ECM, AIR pressure will activate the valve and allow pump air to be directed as follows:

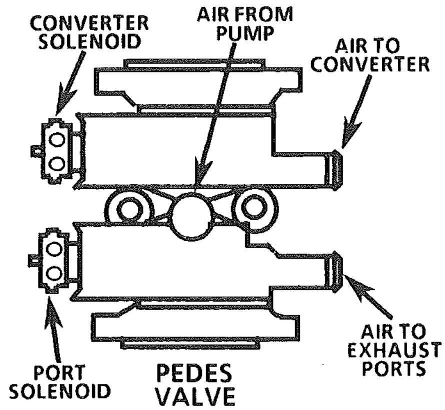
- Cold Mode - The port solenoid is energized which in turn opens the port valve and allows flow to the exhaust ports.
- Warm Mode - The port solenoid is de-energized and the converter solenoid energized which closes the port valve and keeps the converter valve seated, thus forcing flow past the converter valve and to the converter.
- Divert Mode - Both solenoids are de-energized, which opens the converter valve, allowing air to take the path of least resistnance, i.e., out the divert/relief tube to atmosphere.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. This is a system functional check. Air is directed to ports during "Open Loop" and all engines start in "Open Loop" even on a warm engine. Since the air to the ports may be very short, prepare to observe port air prior to engine start up. This can be done by squeezing a hose.
2. This should normally set a Code 22. When any code is set, the ECM opens the ground to the converter solenoid and allows air to divert. This checks for ECM response to a fault. A ground in the control valve circuit to the ECM would prevent divert action.
3. This checks for a grounded circuit to the ECM. Test light "OFF" is normal and would indicate the circuit is not grounded.
4. Checks for an open in the solenoid control circuits. Grounding the test terminal should ground both solenoid circuits. Normally, the test light should be "ON", which indicates the problem is not in the ECM or wiring but at the solenoid connections or valve itself.
5. Checks for a grounded solenoid circuit. Test light "OFF" would indicate the circuit is normal and fault is in the valve.

CHART C-6B

AIR MANAGEMENT CHECK (PEDES)
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)



(1)
- "DIAGNOSTIC" TERMINAL UNGROUNDED.
- START ENGINE, RUNNING AT PART THROTTLE, BELOW 2000 RPM, AIR SHOULD BE FELT AT OUTLET TO EXHAUST PORTS DURING "OPEN LOOP" OPERATION (FROM 6 SECONDS TO 3 MINUTES ON WARM ENGINE DEPENDING ON APPLICATION) AND SWITCH TO CONVERTER WHEN SYSTEM GOES "CLOSED LOOP".

OK

(2)
- DISCONNECT TPS CONNECTOR AT IDLE AND AIR SHOULD DIVERT TO ATMOSPHERE AFTER A FEW SECONDS.

NO DIVERT

(3)
- IGNITION "ON", ENGINE STOPPED.
- DISCONNECT CONVERTER SOLENOID ELECT. CONNECTOR (BLACK CONNECTOR) AND CONNECT TEST LIGHT BETWEEN HARNESS CONNECTOR TERMINALS
- NOTE LIGHT.

LIGHT "ON"

CHECK CKT 429 FOR SHORT TO GROUND. IF NOT GROUNDED, IT IS A FAULTY ECM.

LIGHT "OFF"

REPLACE PEDES VALVE.

OK

NO TROUBLE FOUND. CLEAR MEMORY AND REVIEW SYMPTOMS SECTION "B".

PORT THEN DIVERT ONLY

(4)
- IGNITION "ON", ENGINE STOPPED.
- GROUND "DIAGNOSTIC" TERMINAL.
- DISCONNECT CONVERTER VALVE SOLENOID (BLACK CONNECTOR).
- CONNECT TEST LIGHT BETWEEN HARNESS CONNECTOR TERMINALS AND NOTE LIGHT.

LIGHT "OFF"

- CONNECT TEST LIGHT BETWEEN CKT 39 AND GROUND.

LIGHT "OFF"

OPEN CKT 39

LIGHT "ON"

OPEN IN CKT 429. FAULTY ECM CONNECTION OR ECM.

LIGHT "ON"

FAULT IS CONVERTER VALVE SOLENOID, CONNECTION, OR VALVE.

CONSTANT PORT OR CONVERTER AIR

(5)
- IGNITION "ON", ENGINE STOPPED.
- "DIAGNOSTIC " TERMINAL NOT GROUNDED.
- DISCONNECT PORT VALVE SOLENOID (GRAY CONNECTOR).
- CONNECT TEST LIGHT BETWEEN HARNESS CONNECTOR TERMINALS AND NOTE LIGHT.

LIGHT "OFF"

- GROUND "DIAGNOSTIC" TERMINAL.
- NOTE TEST LIGHT.

LIGHT "OFF"

- CONNECT TEST LIGHT BETWEEN CKT 39 AND GROUND.

LIGHT "OFF"

REPAIR OPEN CKT 39

LIGHT "ON"

OPEN CKT 436. FAULTY CONNECTION OR ECM.

LIGHT "ON"

FAULTY CONNECTION AT PORT SOLENOID OR FAULTY PEDES VALVE.

LIGHT "ON"

GROUNDED CKT 436 OR FAULTY ECM.

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SECTION C7

EXHAUST GAS RECIRCULATION (EGR) SYSTEM

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The EGR system is used to lower NO_x (oxides of nitrogen) emission levels caused by high combustion temperature. It does this by decreasing combustion temperature.

The main element of the system is the EGR valve operated by vacuum and mounted on the intake manifold.

The EGR valve feeds small amounts of exhaust gas back into the combustion chamber as shown in Figure C7-1.

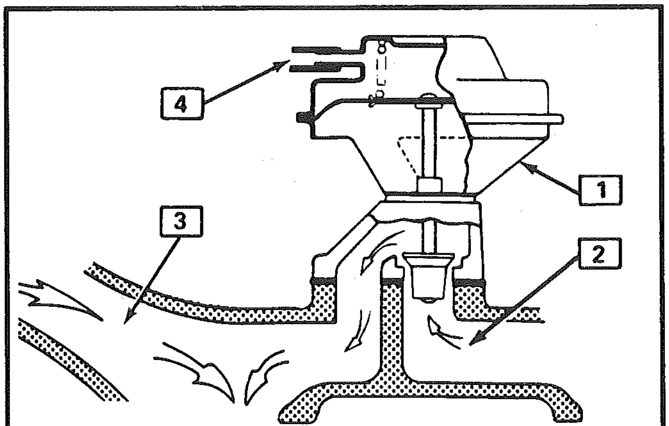


Figure C7-1 Exhaust Gas Recirculation

OPERATION

The EGR valve is opened by vacuum to let exhaust gas flow into the intake manifold. The exhaust gas then moves with the air/fuel mixture into the combustion chamber. If too much exhaust gas enters, combustion will not occur. For this reason, very little exhaust gas is allowed to pass through the valve, especially at idle. The EGR valve is usually open during warm engine operation and when the vehicle is above idle speed.

The amount of exhaust gas recirculated is controlled by variations in vacuum and the EGR vacuum control solenoid.

EGR CONTROL

The EGR vacuum control has a vacuum solenoid that uses "pulse width modulation". This means the ECM turns the solenoid "ON" and "OFF" many times a second and varies the amount of "ON" time ("pulse width") to vary the amount of EGR.

A diagnostic switch is part of the control and monitors vacuum to the EGR valve. This switch will trigger a "Service Engine Soon" light, and set a Code 32 in the event of a vacuum circuit failure.

During cold operation and at idle, the solenoid circuit is not grounded by the ECM. This blocks vacuum to the EGR valve.

Grounding the ALDL diagnostic "test" terminal, with the ignition "ON" and the engine not running, will energize the solenoid and block vacuum to the EGR valve.

NEGATIVE BACKPRESSURE EGR VALVE

The valve on this engine is called a negative backpressure valve. It varies the amount of exhaust gas flow into the manifold depending on manifold vacuum and variations in exhaust backpressure.

The diaphragm on this valve (shown in Figure C7-2) has an internal vacuum bleed hole which is held closed by a small spring when there is no exhaust backpressure. The amount of vacuum to the valve is controlled by the ECM controlling a solenoid.

Engine vacuum opens the EGR valve against the pressure of a large spring. When manifold vacuum combines with negative exhaust backpressure, the vacuum bleed hole opens and the EGR valve closes.

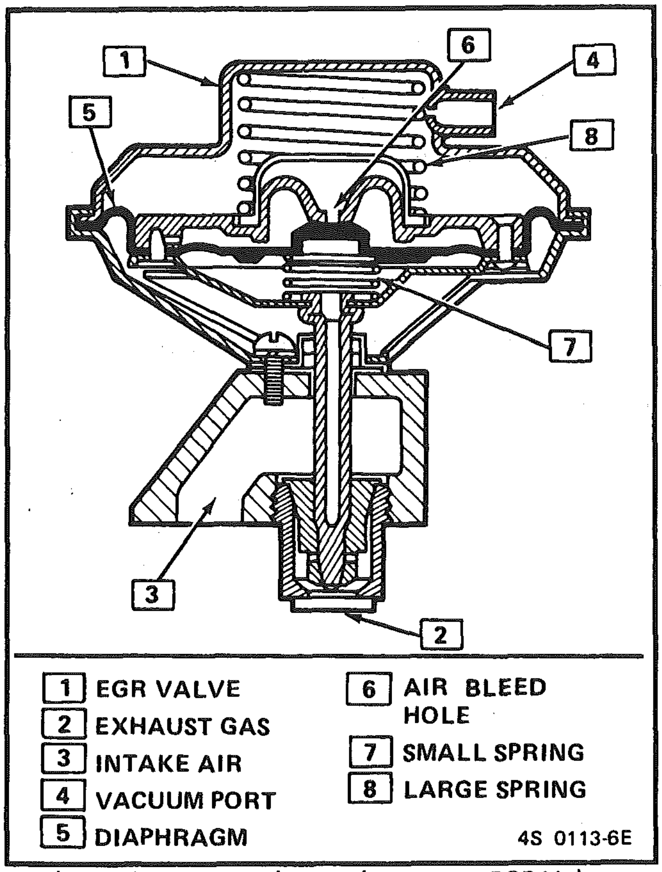


Figure C7-2 - Negative Backpressure EGR Valve

EGR VALVE IDENTIFICATION

- Negative backpressure EGR valves will have an "N" stamped on the top side of the valve after the part number (Figure C7-3).
- Positive backpressure EGR valves will have a "P" stamped on the top side of the valve, after the part number.
- Port EGR valves have no identification stamped after the part number.

When replacing an EGR valve, always check for correct part number in the parts catalog or supplemental bulletin.

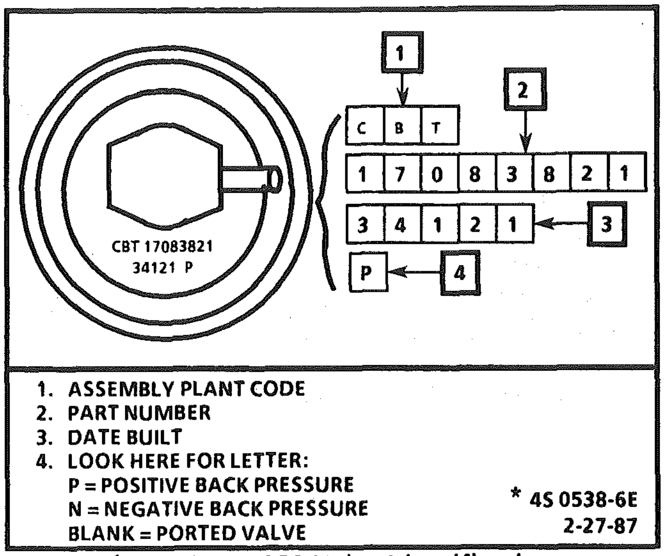


Figure C7-3 - EGR Valve Identification

RESULTS OF INCORRECT OPERATION

Too much EGR flow tends to weaken combustion, causing the engine to run roughly or stop. With too much EGR flow at idle, cruise, or cold operation, any of the following conditions may happen:

- Engine stops after cold start.
- Engine stops at idle after deceleration.
- Car surges during cruise.
- Rough idle.

If the EGR valve should stay open all of the time, the engine may not idle.

Too little or no EGR flow allows combustion temperatures to get too high during acceleration and load conditions. This could cause:

- Spark knock (detonation).
- Engine overheating.
- Emission test failure.

DIAGNOSIS

Diagnosis of the EGR system is covered in CHART C-7 at the end of this section.

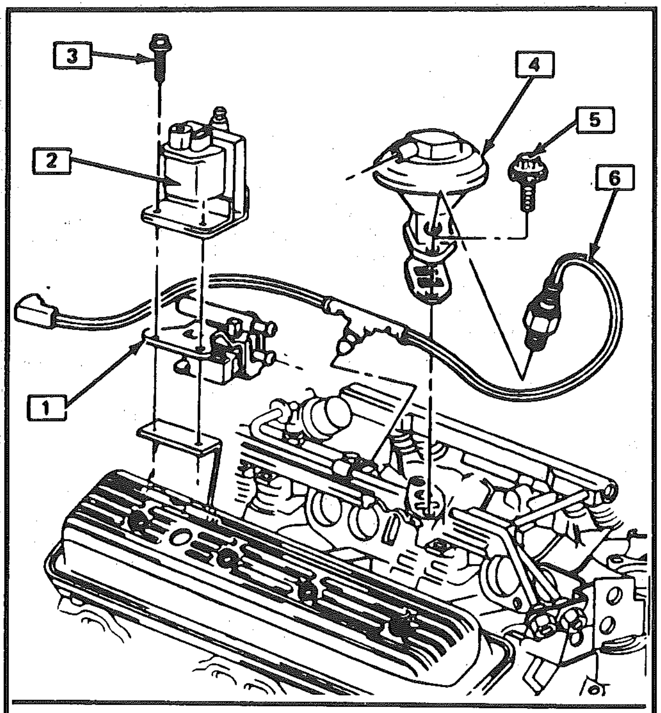
EGR VALVE

Remove or Disconnect

1. Plenum (See Plenum R&R).
2. Vacuum line.
3. Retaining bolts.
4. EGR valve.

Install or Connect

1. Reinstall valve or replacement EGR valve on intake manifold using new gasket.
2. Bolts and tighten to 18 N·m (14 lb. ft.).
3. Vacuum line to valve.
4. Plenum.



1	EGR SOLENOID	4	EGR VALVE
2	COIL	5	BOLTS (2)
3	BOLT (2) 21 N·m (16 FT. LBS.)	6	EGR DIAG TEMP SWITCH 12 N·m (105 IN. LBS.)

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Figure C7-4 - EGR and Solenoid Service

EGR Manifold Passage

Inspect

If EGR passages in the inlet manifold indicate excessive build-up of deposits, the passages should be cleaned. Care should be taken to ensure that all loose particles are completely removed to prevent them from clogging the EGR valve or from being ingested into the engine.

Do not wash EGR valve in solvents or degreaser--permanent damage to valve diaphragm may result. Also, sand blasting of the valve is not recommended since this can affect the operation of the valve.

Clean

1. With a wire wheel, buff the exhaust deposits from the mounting surface and around the valve.
2. Look for exhaust deposits in the valve outlet. Remove deposit build-up with a screwdriver.
3. Clean mounting surfaces of intake manifold and valve assembly.

EGR CONTROL SOLENOID

Remove or Disconnect

1. Negative battery cable.
2. Electrical connector at solenoid
3. Vacuum hoses.
4. Nut and solenoid.

Install or Connect

1. Solenoid and bracket, tighten nut to 24 N·m (17 lb. ft.).
2. Vacuum hoses.
3. Electrical connector.
4. Negative battery cable.

PARTS INFORMATION

PARTS NAME	GROUP
Control, EGR Vacuum	3.670
Gasket, EGR Valve	3.680
Valve, EGR	3.670

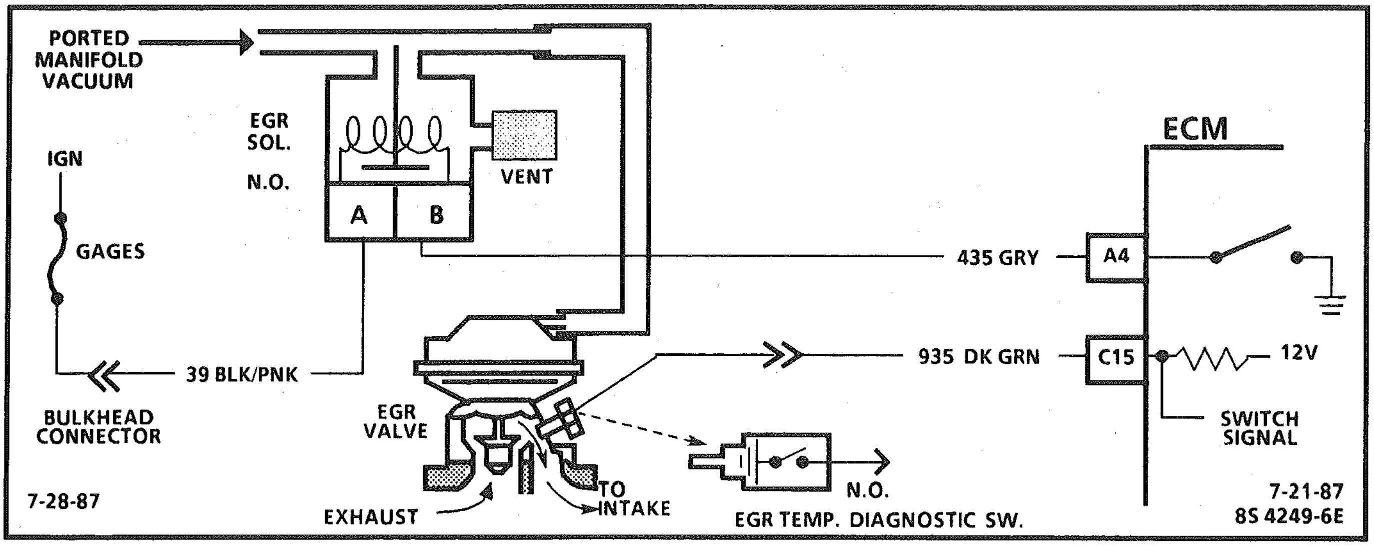


CHART C-7

EXHAUST GAS RECIRCULATION CHECK
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

Circuit Description:

The exhaust gas recirculation (EGR) valve is controlled by a normally open pulse width modulated (PWM) solenoid. The ECM turns the solenoid "OFF" to allow vacuum to pass to the EGR and turns the solenoid "ON" to prohibit EGR operation. When EGR is commanded, the solenoid is turned "ON" and "OFF" many times a second (duty cycle).

The duty cycle is calculated by the ECM based on information from the coolant, MAT, TPS, and MAF sensors. Also, engine rpm's and the P/N switch input affect EGR. There should be no EGR when in park or neutral, TPS below a calibrated value or TPS indicating WOT.

With the ignition "ON" and engine stopped, the EGR solenoid is de-energized. The solenoid, however, should be energized if the diagnostic terminal is grounded with the ignition "ON" and engine not running.

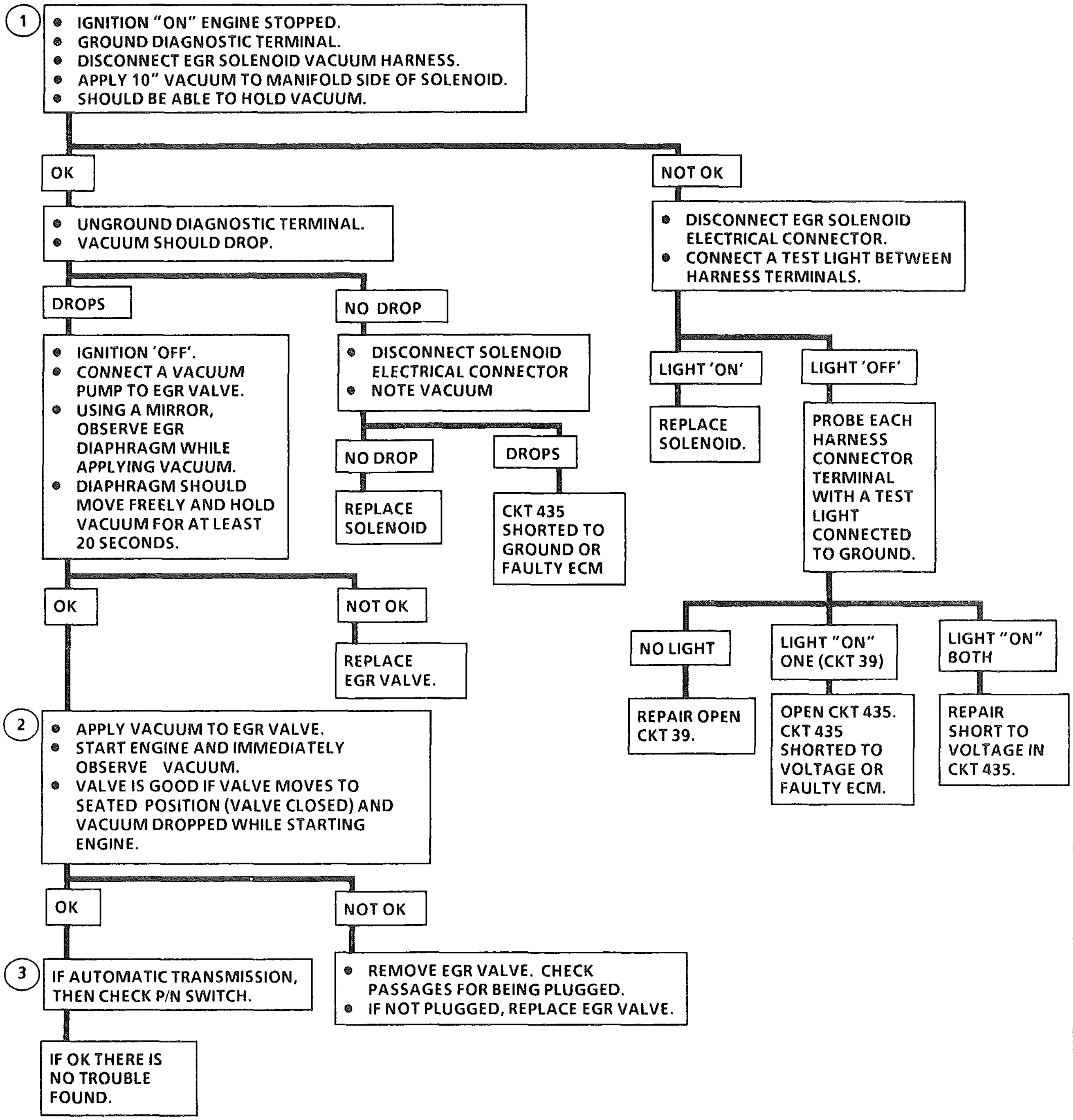
Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. This will test the solenoid value to determine if it is capable of closing off the manifold vacuum from the EGR valve. The vacuum may bleed off slowly but this should not be considered a fault.
2. As soon as back pressure is available at the EGR valve, the bleed portion in the valve should open and cause the valve to go to its heated position.
3. The EGR will be inoperative if the P/N switch is misadjusted or faulty. Use "Scan" tool and check P/N switch. Refer to CHART C-1.

BEFORE USING THIS CHART, CHECK FOR PORTED VACUUM TO EGR SOLENOID, ALSO CHECK HOSES FOR LEAKS OR RESTRICTIONS. SHOULD BE AT LEAST 7" HG VACUUM AT 2000 RPM.
THIS CHART ASSUMES THERE IS NO CODE 32.

CHART C-7

EXHAUST GAS RECIRCULATION CHECK 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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SECTION C8

TRANSMISSION CONVERTER CLUTCH (TCC) SYSTEM AND MANUAL TRANSMISSION SHIFT LIGHT 5.0L ONLY

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The transmission converter clutch (TCC) system uses a solenoid operated valve in the automatic transmission to couple the engine flywheel to the output shaft of the transmission thru the torque converter. This reduces the slippage losses in the converter, which increases fuel economy.

OPERATION

For the converter clutch to apply, two conditions must be met:

- Internal transmission fluid pressure must be correct. For information on internal transmission operation, see Section "7A". This section will cover only the electrical operation of the TCC system.
- The ECM grounds a switch internally to turn "ON" a solenoid in the transmission. This moves a check ball, which will allow the converter clutch to apply, if the hydraulic pressure is correct, as described above.

The ECM controls the TCC apply solenoid by looking at several sensors:

- Speedo Buffer Sensor (also called Vehicle Speed Sensor (VSS) Speed must be above a certain value before the clutch can apply.
- Coolant Temperature Sensor Engine must be warmed up before clutch can apply about 65° C (149°F).
- Throttle Position Sensor (TPS) After the converter clutch applies, the ECM uses the information from the TPS to release the clutch when the car is accelerating or decelerating at a certain rate.
- The brake switch is also part of the TCC circuit as it will remove battery voltage to the TCC solenoid when the brake pedal is depressed.
- Gear Select Switch The 4th gear switch is used to send a signal to the ECM telling it when the transmission is in 4th gear.

The ECM uses this information to vary the conditions under which the clutch applies or releases. However, the transmission does not have to be in fourth gear in order for the ECM to turn the clutch "ON".

If the converter clutch is applied at all times, the engine will stall immediately, just as in a manual transmission with the clutch applied.

If the converter clutch does not apply, fuel ecomony may be lower than expected. If the vehicle speed sensor fails, the TCC will not apply. If the 4th gear switch does not operate, the TCC may not apply at the right time.

DIAGNOSIS

The diagnosis of the TCC system is covered in CHART C-8A. If the ECM detects a problem in the system, a Code 24 should set. In this case, see Code 24 CHART.

SHIFT LIGHT (M/T) DESCRIPTION

The purpose of the shift light is to provide a display which indicates the optimum fuel economy point for up shifting the manual transmission based on engine speed and load. The display is a lamp on the instrument panel. Activation of the ECM driver turns the lamp "ON".

DIAGNOSIS

The shift light circuit can be checked using CHART C-8B.

ON-CAR SERVICE

- See Section "8B" if the shift light bulb needs replacement.
- See Section "6E" to repair wiring problem.
- See Section "C-1" if ECM is to be replaced.

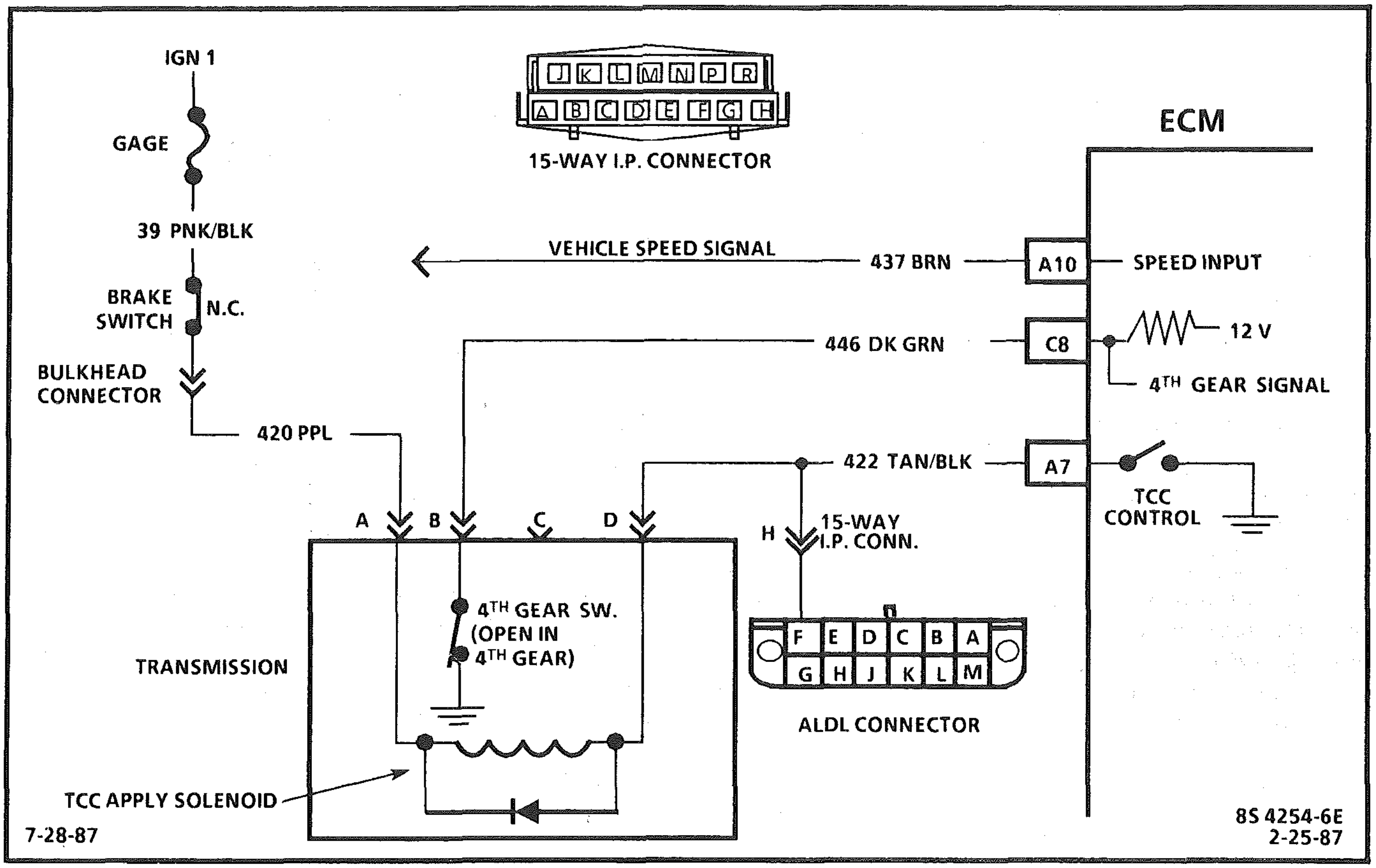

CHART C-8A

(Page 1 of 2)
AUTOMATIC TRANSMISSION CONVERTER CLUTCH (TCC)
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

Circuit Description:

The purpose of the automatic transmission torque converter clutch feature is to eliminate the power loss of the torque converter stage when the vehicle is in a cruise condition. This allows the convenience of the automatic transmission and the fuel economy of a manual transmission. The heart of the system is a solenoid located inside the automatic transmission which is controlled by the ECM.

When the solenoid coil is activated ("ON"), the torque converter clutch is applied which results in straight through mechanical coupling from the engine to transmission. When the transmission solenoid is deactivated, the torque converter clutch is released, which allows the torque converter to operate in the conventional manner (fluidic coupling between engine and transmission).

The ECM turns "ON" the TCC when coolant temperature is above 65° C (149° F), TPS not changing ,and vehicle speed above a specified value.

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. When a test light is connected from ALDL terminal "F" to ground, a test light "ON" indicates battery voltage is OK and the TCC solenoid is disengaged.
2. When the diagnostic terminal is grounded, the ECM should energize the TCC solenoid and the test light should go out.

Diagnostic Aids:

A "Scan" tool only indicates when the ECM has turned "ON" the TCC driver (grounded CKT 422) but this does not confirm that the TCC has engaged. To determine if TCC is functioning properly, engine rpm should decrease when the "Scan" indicates the TCC driver has turned "ON". To determine if the 4th gear switch is functioning properly, perform the checks in CHART C-8A (Page 2 of 2). The switches will not prevent TCC from functioning but will affect TCC lock and unlock points. If the 4th gear switch circuit is always open, the TCC may engage as soon as sufficient oil pressure is reached.

CHART C-8A

(Page 1 of 2)
AUTOMATIC TRANSMISSION CONVERTER CLUTCH (TCC)
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

- USING A "SCAN" TOOL CHECK THE FOLLOWING AND CORRECT IF NECESSARY.
- COOLANT TEMPERATURE SHOULD BE ABOVE 65°C.
- TPS - BE SURE TPS SIGNAL IS NOT ERRATIC.
- VSS - BE SURE "SCAN" DISPLAYS VSS WITH DRIVE WHEELS TURNING. IF CODE 24 IS PRESENT, SEE CODE CHART 24.

1
- MECHANICAL CHECKS, SUCH AS LINKAGE, OIL LEVEL, ETC. SHOULD BE PERFORMED PRIOR TO USING THIS CHART.
- IGNITION "ON".
- CONNECT TEST LIGHT TO ALDL CONNECTOR TERMINAL "F" AND GROUND.
- BULB SHOULD LIGHT.

DOES IT?

YES

- DEPRESS BRAKE PEDAL.
- LIGHT SHOULD GO OUT.

DOES IT?

- **YES**

  2
  - IGNITION "ON", ENGINE "OFF."
  - RELEASE BRAKE PEDAL.
  - GROUND DIAGNOSTIC TERMINAL.
  - LIGHT SHOULD GO OUT.

  DOES IT?

  - **YES**: TCC CIRCUIT OK. BE SURE VEHICLE IS EQUIPPED WITH THE CORRECT PROM OR MEM-CAL. TO CHECK 4TH GEAR SWITCH, SEE CHART C-8A (2 OF 2).
  - **NO**: OPEN CKT 422 OR FAULTY ECM.

- **NO**: BRAKE SWITCH OUT OF ADJUSTMENT OR FAULTY, OR CKT 422 SHORTED TO VOLTAGE.

NO

- DISCONNECT TCC ELECTRICAL CONNECTOR.
- CONNECT TEST LIGHT BETWEEN TERM. "A & D".
- BULB SHOULD NOT LIGHT.

DOES IT?

- **NO**

  - CONNECT TEST LIGHT FROM TERM. "A" TO GROUND.
  - BULB SHOULD LIGHT.

  DOES IT?

  - **YES**

    - GROUND ALDL TERM. "F".
    - WITH TEST LIGHT CON-NECTED BETWEEN TRANS. CONNECTOR TERMINALS "A & D".
    - THE BULB SHOULD "LIGHT"

    DOES IT?

    - **YES**: FAULTY TCC CONNECTION OR TCC SOLENOID.
    - **NO**: REPAIR OPEN CIRCUIT BETWEEN TRANS. & ALDL TERM. "F".

  - **NO**: OPEN IN CKT 39, TCC BRAKE SWITCH CIRCUIT, OR ADJUST SWITCH.

- **YES**: CKT 422 SHORTED TO GROUND OR FAULTY ECM.

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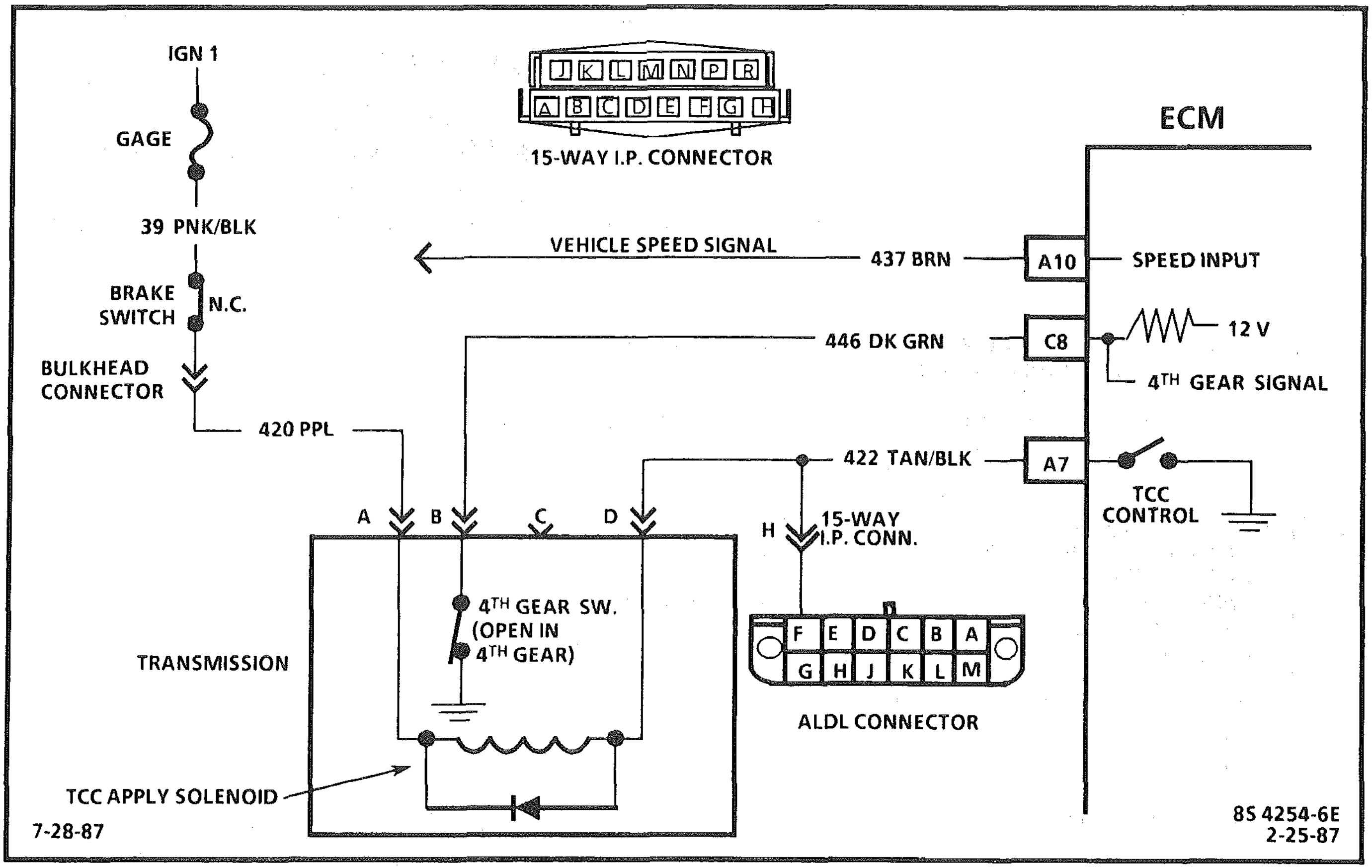

CHART C-8A

(Page 2 of 2)

TRANSMISSION CONVERTER CLUTCH (TCC) ELECTRICAL DIAGNOSIS 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

Circuit Description:

A 4th gear switch (mounted in the trans.) opens when the trans. shifts into 4th gear, and this switch is used by the ECM to modify TCC lock and unlock points, when in a 4-3 downshift maneuver.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Unless the switch or CKT 446 is open, the "Scan" should display "NO", indicating the trans. is not in 4th gear. The 4th gear switch should only be open while in 4th gear.
2. This step determines if the ECM and wiring are OK. Grounding CKT 446 should cause the "Scan" to display "NO", indicating the trans. is not in 4th gear.
3. Checks the operation of the 4th gear switch. When the trans. shifts into 4th gear the switch should open and the "Scan" should display "YES".
4. Disconnecting the TCC connector simulates an open switch to determine if CKT 446 is shorted to ground or the problem is in the transmission.

Diagnostic Aids:

A road test may be necessary to verify the customer complaint. If the "Scan" indicates TCC is turning "ON" and "OFF" erratically, check the state of the 4th gear switch to be sure it is not changing states under a steady throttle position. If the switch is changing states, check connections and wire routing carefully. Also, if the 4th gear switch is always open the TCC may engage as soon as sufficient oil pressure is reached.

CHART C-8A

(Page 2 of 2)
TRANSMISSION CONVERTER CLUTCH (TCC) ELECTRICAL DIAGNOSIS
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

CHECKS MADE ON THIS PAGE WILL NOT PREVENT THE TCC FROM WORKING, BUT WILL AFFECT ENGAGEMENT OR DISENGAGEMENT POINTS.

1
- IGNITION "ON", ENGINE "OFF".
- DOES "SCAN" INDICATE TRANS. IS IN 4TH GEAR?

NO

3
- RAISE DRIVE WHEELS
- SHIFT VEHICLE INTO OVERDRIVE
- INCREASE SPEED SLOWLY UNTIL TRANS. SHIFTS INTO 4TH GEAR.
- DOES "SCAN" INDICATE TRANS. IS IN 4TH GEAR?

YES

4TH GEAR SWITCH OK. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

NO

4
- IGNITION "ON" ENGINE "OFF"
- DISCONNECT TRANS. ELECTRICAL CONNECTOR
- DOES "SCAN" INDICATE TRANS. IS IN 4TH GEAR?

YES

WIRE GROUNDED INTERNALLY IN TRANS. OR FAULTY 4TH GEAR SWITCH.

NO

CKT 446 SHORTED TO GROUND OR FAULTY ECM.

YES

2
- DISCONNECT TCC ELECTRICAL CONNECTOR.
- JUMPER HARNESS TERMINAL "B" (CKT 446) TO GROUND.
- DOES "SCAN" INDICATE TRANS. IS IN 4TH GEAR?

NO

FAULTY CONNECTION OR 4TH GEAR SWITCH.

YES

OPEN CKT 446, FAULTY CONNECTION OR FAULTY ECM.

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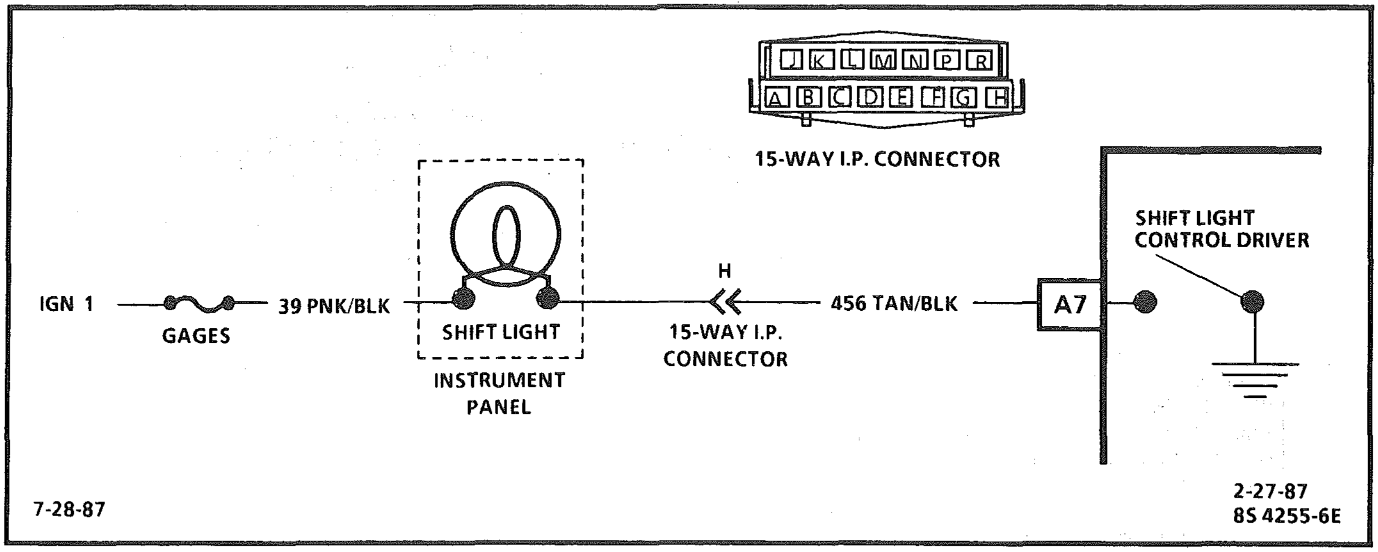


CHART C-8B

M/T SHIFT LIGHT CHECK
5.0L (VIN F) "F" SERIES (PORT)

Circuit Description:

The shift light indicates the best transmission shift point for maximum fuel economy. The light is controlled by the ECM and is turned "ON" by grounding CKT 456.

The ECM uses information from the following inputs to control the shift light:

- Coolant temperature
- TPS
- VSS
- rpm

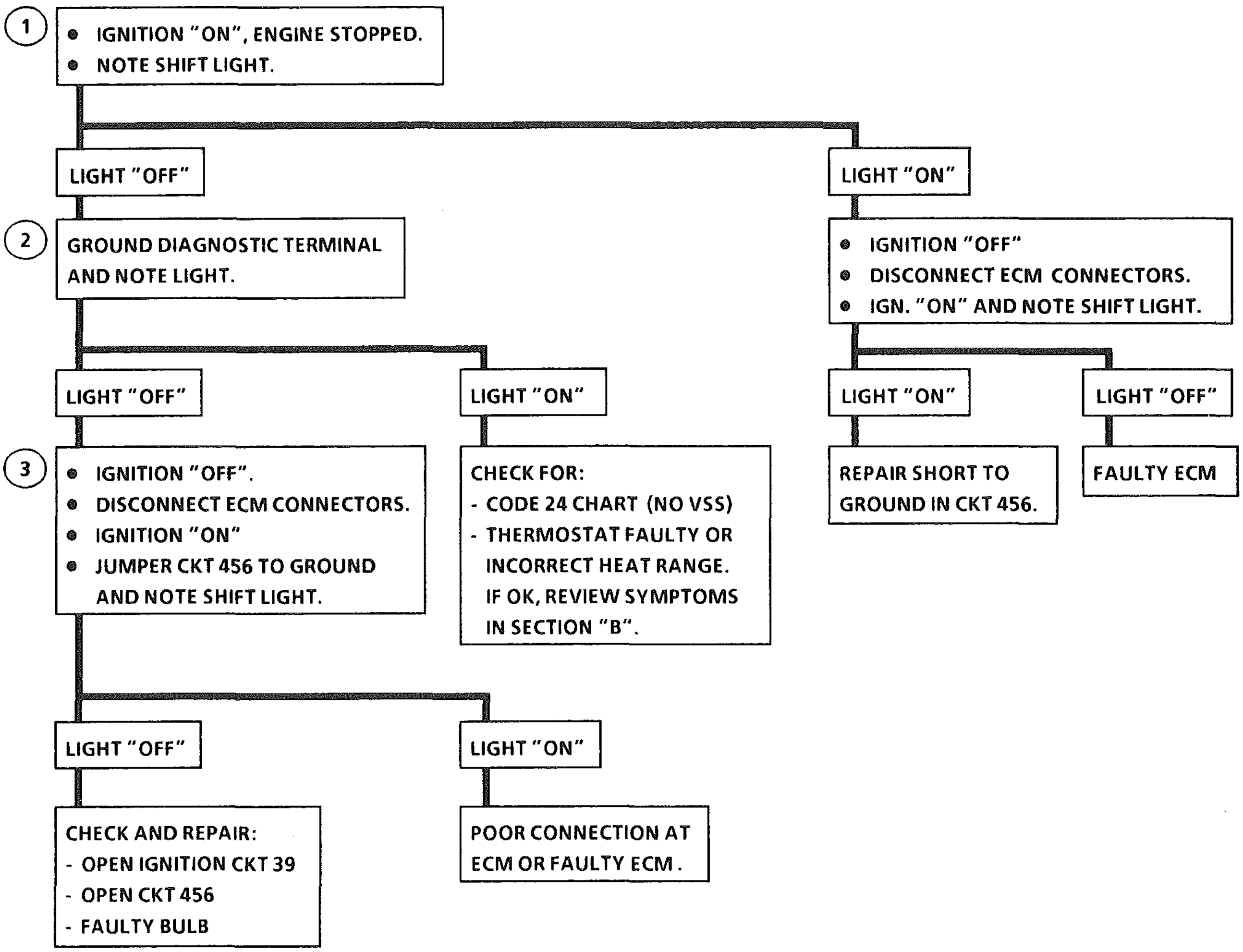
The ECM uses the measured rpm and the vehicle speed to calculate what gear the vehicle is in. It's this calculation that determines when the shift light should be turned "ON".

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. This should not turn "ON" the shift light. If the light is "ON", there is a short to ground in CKT 456 wiring or a fault in the ECM.
2. When the diagnostic terminal is grounded, the ECM should ground CKT 456 and the shift light should come "ON".
3. This checks the shift light circuit up to the ECM connector. If the shift light illuminates, then the ECM connector is faulty or the ECM does not have the ability to ground the circuit.

CHART C-8B

M/T SHIFT LIGHT CHECK
5.0L (VIN F) "F" SERIES (PORT)



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SECTION C12

COOLING FAN CONTROL

CONTENTS

GENERAL DESCRIPTION

The fan is used for engine and A/C condenser cooling but the fan only operates under certain conditions.

OPERATION

The electric cooling fan on this engine is controlled by the ECM. The ECM will ground the cooling fan relay, which turns "ON" the fan, when the following conditions are met.

- Coolant temperature sensor signal indicating a temperature greater than 106°C (222°F).
- A/C head pressure greater than 233 psi and vehicle speed less than 40 mph.
- When the cooling fan is turned "ON", it will stay "ON" for a minimum time of 15 seconds.

DIAGNOSIS

The following charts will diagnose the ECM controlled cooling fan.

Use Section "8A" to diagnose the secondary cooling fan.

ON-CAR SERVICE

Cooling system component replacement can be found in Section "6B".

PARTS INFORMATION

PART NAME	GROUP
Fan, Engine	1.055
Motor, Fan	1.055
Relay, Engine Fan	1.055

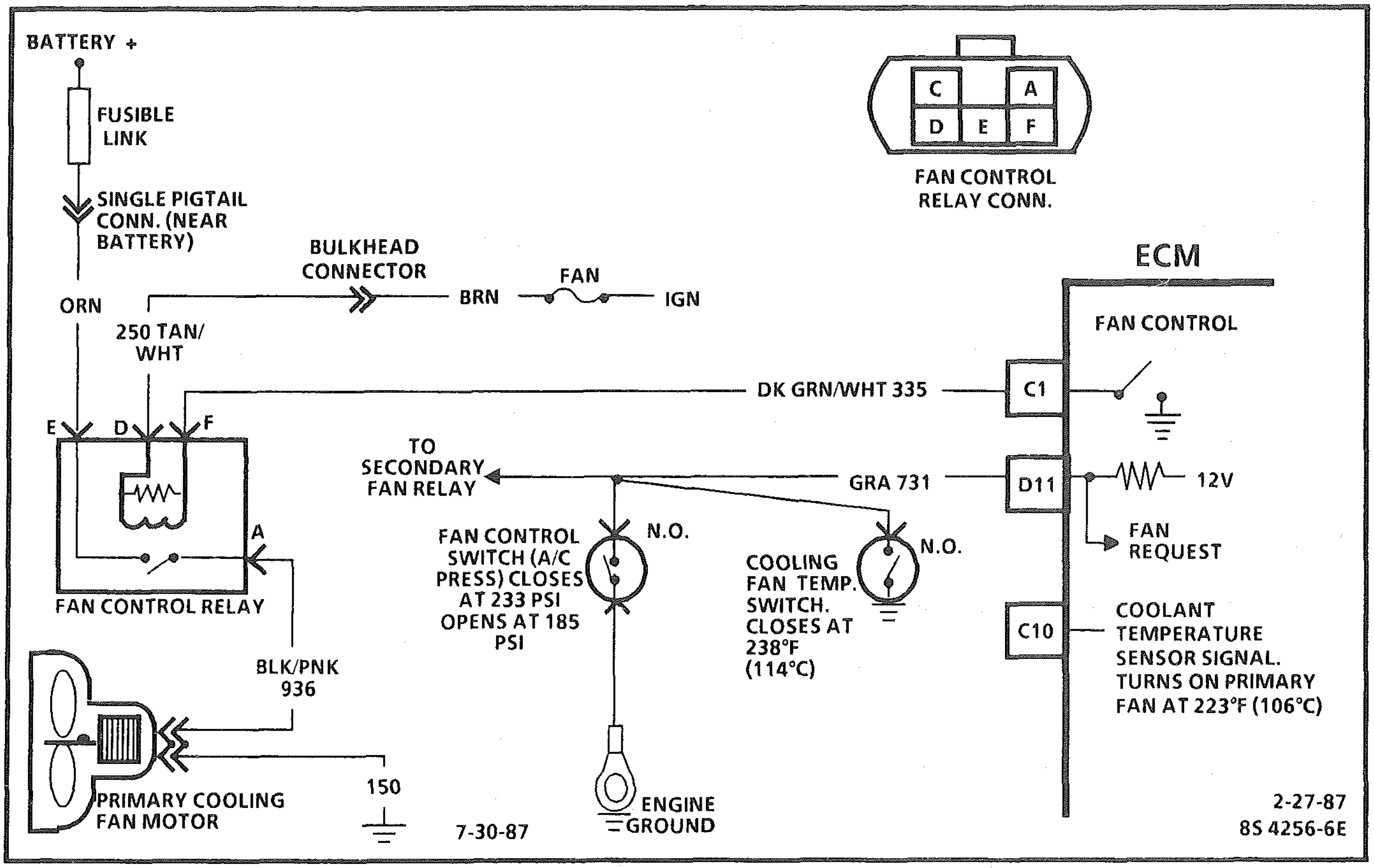


CHART C-12

(Page 1 of 2)
COOLING FAN CONTROL CIRCUIT
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

Circuit Description:

- The primary cooling fan is totally controlled by the ECM based on inputs from the coolant sensor and fan control switch. The fan should run, if coolant temperature is greater than 106°C (223°F).
- Battery voltage is supplied to the fan relay on terminal "E" and ignition voltage to terminal "D".
- Grounding CKT 335 (relay terminal "F") will energize the relay and supply battery voltage to the fan motor. Once the fan relay is energized by the ECM, it will remain "ON" for a minimum of 15 seconds.
- The ECM will remove the ground to CKT 335 if vehicle speed is over 40 mph unless the engine is overheating.
- The fan control switch, mounted in the A/C high pressure line, will close when head pressure exceeds 233 psi (1600 kPa) and this input causes the ECM to ground CKT 335.
- If a Code 14 or 15 sets, or if the ECM is operating in the fuel back-up mode, the ECM will turn "ON" the cooling fan.

Diagnostic Aids:

If the owner complained of an overheating problem, it must be determined if the complaint was due to an actual boil over or the hot light or temperature gage indicated overheating.

If the gate or light indicates overheating, but no boilover is detected, the gage circuit should be checked. The gage accuracy can also be checked by comparing the coolant sensor reading using a "Scan" tool and comparing its reading with the gage reading.

If the engine is actually overheating and the gage indicates overheating, but the cooling fan is not coming "ON", the coolant sensor has probably shifted out of calibration and should be replaced.

If the engine is overheating, and the cooling fan is "ON", the cooling system should be checked.

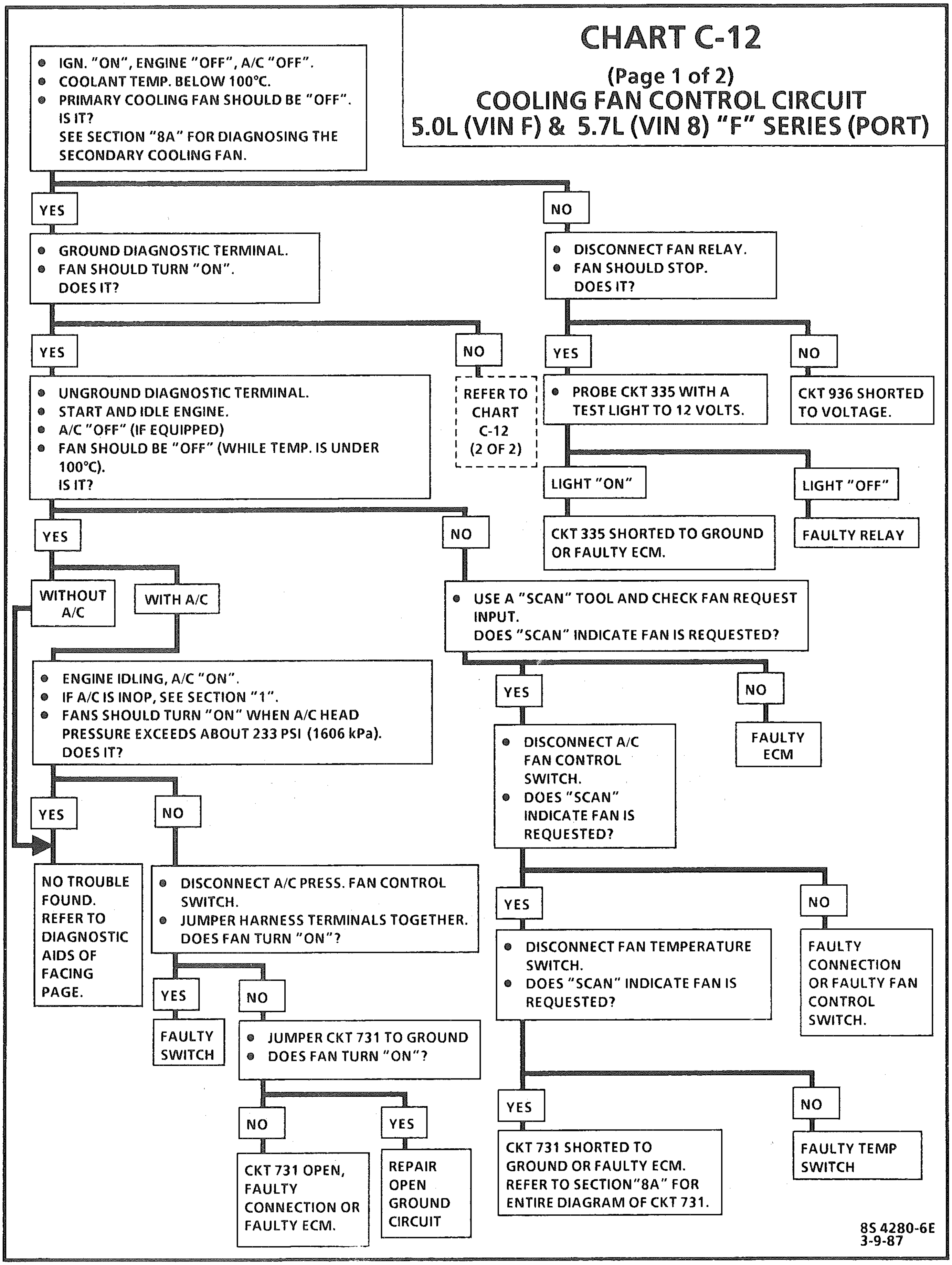


CHART C-12
(Page 1 of 2)
COOLING FAN CONTROL CIRCUIT
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)
• IGN. "ON", ENGINE "OFF", A/C "OFF".
• COOLANT TEMP. BELOW 100°C.
• PRIMARY COOLING FAN SHOULD BE "OFF". IS IT?
SEE SECTION "8A" FOR DIAGNOSING THE SECONDARY COOLING FAN.
YES
• GROUND DIAGNOSTIC TERMINAL.
• FAN SHOULD TURN "ON". DOES IT?
YES
• UNGROUND DIAGNOSTIC TERMINAL.
• START AND IDLE ENGINE.
• A/C "OFF" (IF EQUIPPED)
• FAN SHOULD BE "OFF" (WHILE TEMP. IS UNDER 100°C). IS IT?
YES
WITHOUT A/C
WITH A/C
• ENGINE IDLING, A/C "ON".
• IF A/C IS INOP, SEE SECTION "1".
• FANS SHOULD TURN "ON" WHEN A/C HEAD PRESSURE EXCEEDS ABOUT 233 PSI (1606 kPa). DOES IT?
YES
NO TROUBLE FOUND. REFER TO DIAGNOSTIC AIDS OF FACING PAGE.
NO
• DISCONNECT A/C PRESS. FAN CONTROL SWITCH.
• JUMPER HARNESS TERMINALS TOGETHER. DOES FAN TURN "ON"?
YES
FAULTY SWITCH
NO
• JUMPER CKT 731 TO GROUND
• DOES FAN TURN "ON"?
NO
CKT 731 OPEN, FAULTY CONNECTION OR FAULTY ECM.
YES
REPAIR OPEN GROUND CIRCUIT
NO
REFER TO CHART C-12 (2 OF 2)
NO
• USE A "SCAN" TOOL AND CHECK FAN REQUEST INPUT. DOES "SCAN" INDICATE FAN IS REQUESTED?
YES
• DISCONNECT A/C FAN CONTROL SWITCH.
• DOES "SCAN" INDICATE FAN IS REQUESTED?
YES
• DISCONNECT FAN TEMPERATURE SWITCH.
• DOES "SCAN" INDICATE FAN IS REQUESTED?
YES
CKT 731 SHORTED TO GROUND OR FAULTY ECM. REFER TO SECTION "8A" FOR ENTIRE DIAGRAM OF CKT 731.
NO
FAULTY TEMP SWITCH
NO
FAULTY CONNECTION OR FAULTY FAN CONTROL SWITCH.
NO
FAULTY ECM
NO
• DISCONNECT FAN RELAY.
• FAN SHOULD STOP. DOES IT?
YES
• PROBE CKT 335 WITH A TEST LIGHT TO 12 VOLTS.
LIGHT "ON"
CKT 335 SHORTED TO GROUND OR FAULTY ECM.
LIGHT "OFF"
FAULTY RELAY
NO
CKT 936 SHORTED TO VOLTAGE.
8S 4280-6E
3-9-87

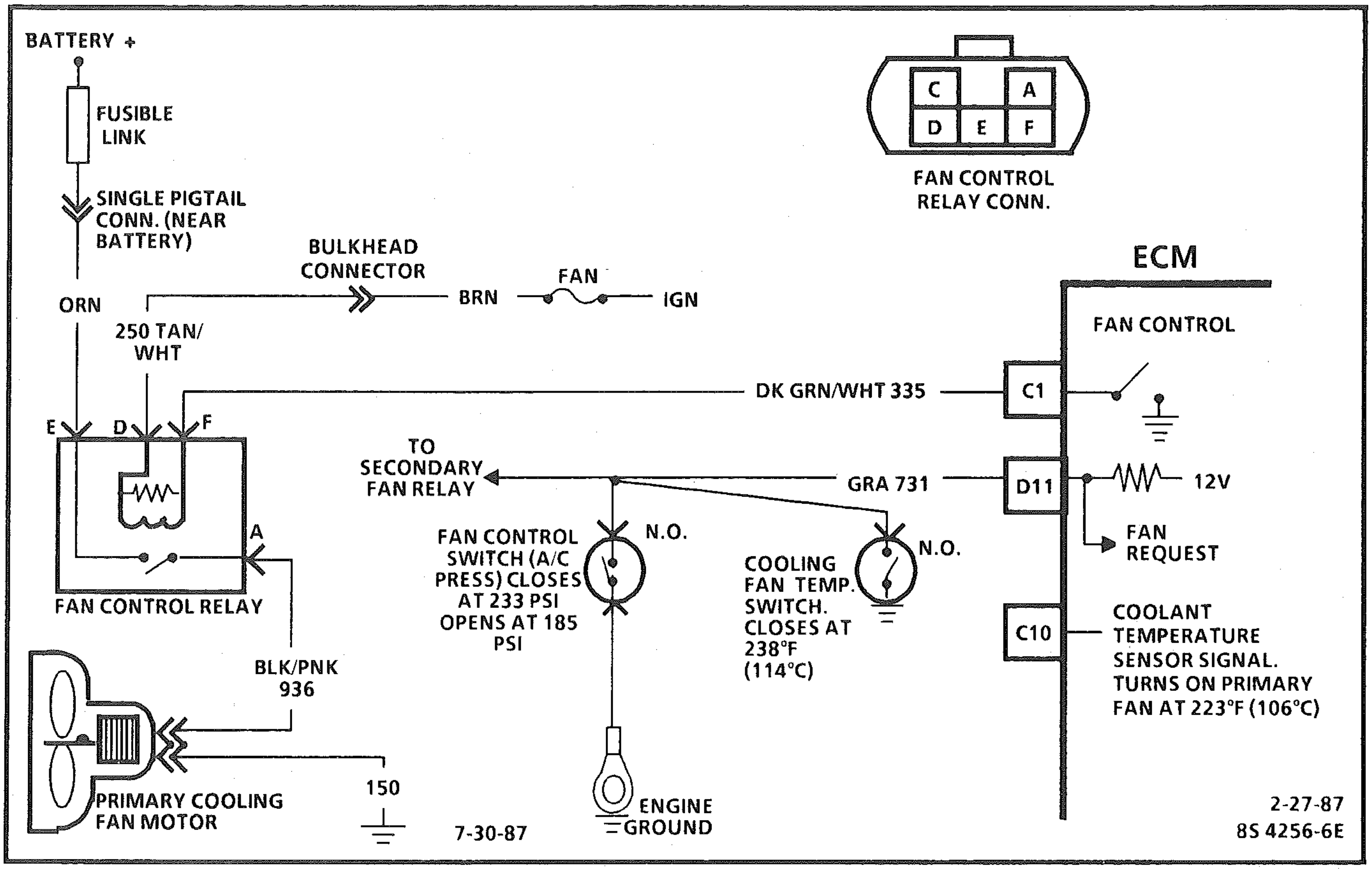


CHART C-12

(Page 2 of 2)
COOLING FAN CONTROL CIRCUIT
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

Circuit Description:

- The primary cooling fan is totally controlled by the ECM based on inputs from the coolant sensor and fan control switch. The fan should run, if coolant temperature is greater than 106°C (223°F).
- Battery voltage is supplied to the fan relay on terminal "E" and ignition voltage to terminal "D".
- Grounding CKT 335 (relay terminal "F") will energize the relay and supply battery voltage to the fan motor. Once the fan relay is energized by the ECM, it will remain "ON" for a minimum of 15 seconds.
- The ECM will remove the ground to CKT 335 if vehicle speed is over 40 mph unless the engine is overheating.
- The fan control switch, mounted in the A/C high pressure line, will close when head pressure exceeds 233 psi (1600 kPa) and this input causes the ECM to ground CKT 335.
- If a Code 14 or 15 sets, or if the ECM is operating in the fuel back-up mode, the ECM will turn "ON" the cooling fan.

Diagnostic Aids:

If the owner complained of an overheating problem, it must be determined if the complaint was due to an actual boil over or the hot light or temperature gage indicated overheating.

If the gate or light indicates overheating, but no boilover is detected, the gage circuit should be checked. The gage accuracy can also be checked by comparing the coolant sensor reading using a "Scan" tool and comparing its reading with the gage reading.

If the engine is actually overheating and the gage indicates overheating, but the cooling fan is not coming "ON", the coolant sensor has probably shifted out of calibration and should be replaced.

If the engine is overheating, and the cooling fan is "ON", the cooling system should be checked.

CHART C-12

(Page 2 of 2)

COOLING FAN CONTROL CIRCUIT
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

FROM CHART C-12 (1 OF 2)

- DISCONNECT FAN CONTROL RELAY.
- IGNITION "ON", ENGINE STOPPED.
- PROBE "D" AND "E" HARNESS TERMINALS WITH A TEST LIGHT CONNECTED TO GROUND.

LIGHT "ON" BOTH

- DIAGNOSTIC TERMINAL GROUNDED.
- PROBE CKT 335 WITH A TEST LIGHT CONNECTED TO 12 VOLTS.

  LIGHT "ON"

  - JUMPER HARNESS TERMINALS "A" AND "E" TOGETHER USING A FUSED JUMPER.
  - FAN SHOULD RUN. DOES IT?

    YES

    FAULTY RELAY

    NO

    - WITH "A-E" STILL JUMPERED, CONNECT A TEST LIGHT ACROSS THE COOLING FAN MOTOR HARNESS CONNECTOR TERMINALS.

      LIGHT "OFF"

      - PROBE EACH TERMINAL WITH A TEST LIGHT CONNECTED TO GROUND.

        LIGHT "ON" ONE

        OPEN IN GROUND CKT 150.

        LIGHT "OFF"

        REPAIR OPEN IN CKT 936.

      LIGHT "ON"

      FAULTY MOTOR

  LIGHT "OFF"

  OPEN OR SHORT TO VOLTAGE IN CKT 335, FAULTY CONNECTION AT ECM OR A FAULTY ECM.

LIGHT "OFF" ONE OR BOTH

REPAIR OPEN OR SHORT TO GROUND IN CIRCUIT THAT DID NOT LIGHT.

05-06-87

7S 3330-6E

BLANK

SECTION C13

POSITIVE CRANKCASE VENTILATION (PCV)

CONTENTS

GENERAL DESCRIPTION

A "closed" crankcase ventilation (PCV) system is used to provide more complete scavenging of crankcase vapors. Fresh air from the air cleaner is supplied to the crankcase, mixed with blow-by gases and then passed through a positive crankcase ventilation (PCV) valve into the intake manifold (Figure C13-1).

The primary control is through the PCV valve (Figure C13-2) which meters the flow at a rate depending on manifold vacuum.

To maintain idle quality, the PCV valve restricts the flow when intake manifold vacuum is high. If abnormal operating conditions arise, the system is designed to allow excessive amounts of blow-by gases to back flow through the crankcase vent tube into the engine air inlet to be consumed by normal combustion.

RESULTS OF INCORRECT OPERATION

A plugged valve or hose may cause:

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

A leaking valve or hose would cause:

- Rough idle.
- Stalling.
- High idle speed.

DIAGNOSIS

FUNCTIONAL CHECK OF PCV VALVE

If an engine is idling rough, check for a clogged PCV valve or plugged hose. Replace as required. Use the following procedure:

1. Remove PCV valve from rocker arm cover.
2. Run the engine at idle.
3. Place your thumb over end of valve to check for vacuum. If there is no vacuum at valve, check for plugged hoses or manifold port, or PCV valve. Replace plugged or deteriorated hoses.
4. Turn "OFF" the engine and remove PCV valve. Shake valve and listen for the rattle of check needle inside the valve. If valve does not rattle, replace valve.

With this system, any blow-by in excess of the system capacity (from a badly-worn engine, sustained heavy load, etc.) is exhausted into the air cleaner and is drawn into the engine.

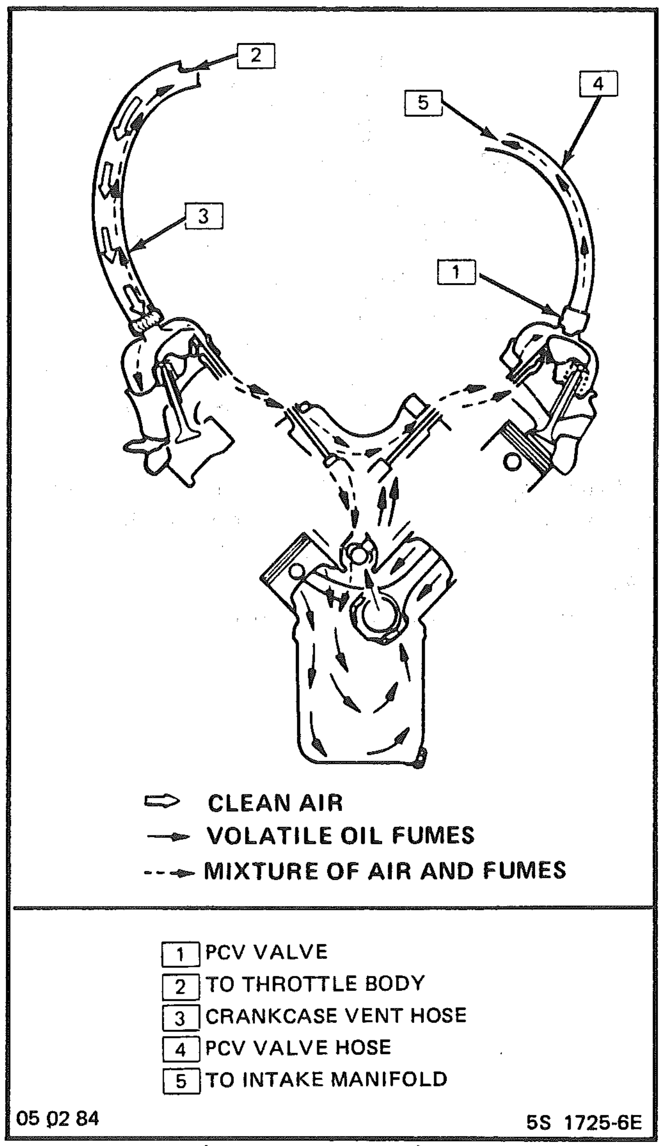


Figure C13-1 PCV Flow

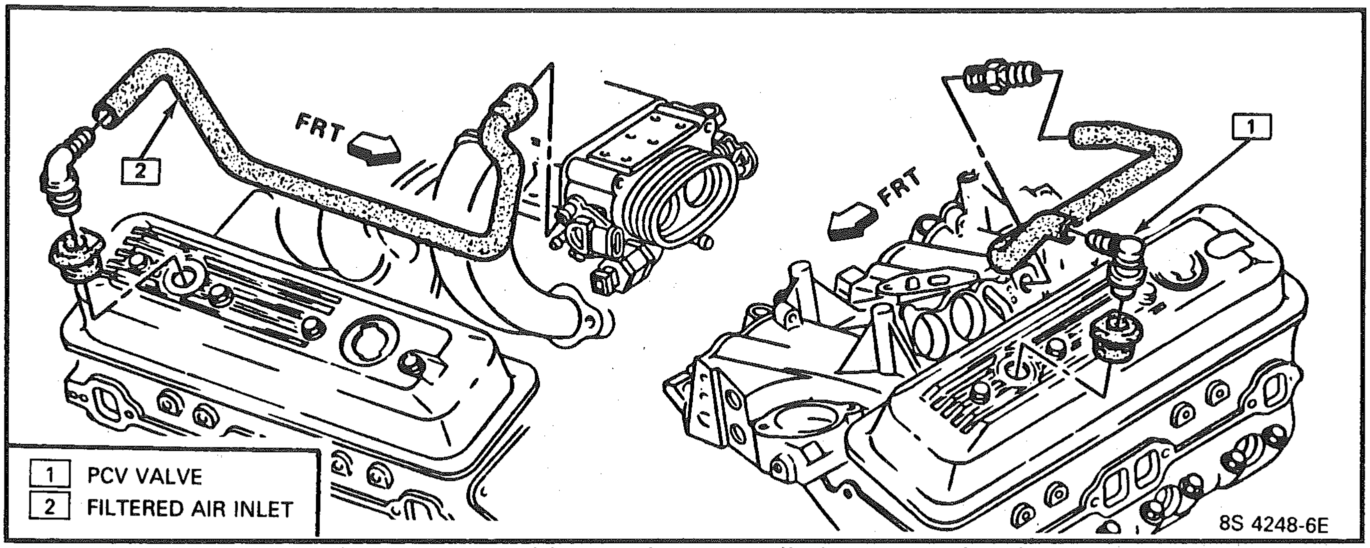


Figure C13-3 Positive Crankcase Ventilation System (5.7L)

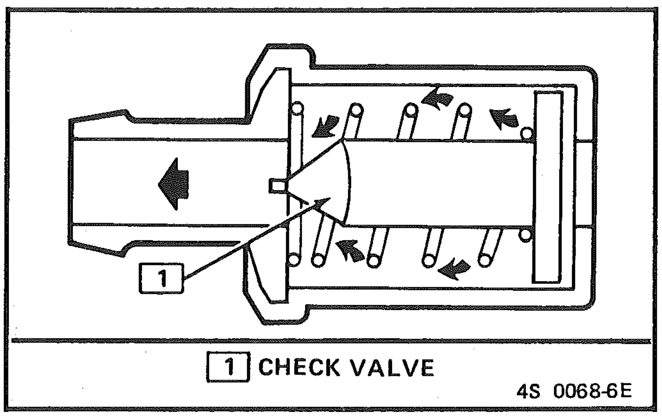


Figure C13-2 PCV Valve Cross Section

Proper operation of the PCV system is dependent upon a sealed engine. If oil sludging or dilution is noted, and the PCV system is functioning properly, check engine for possible cause and correct to ensure that system will function as intended.

ON-CAR SERVICE

An engine which is operated without any crankcase ventilation can be damaged. Therefore, it is important to replace the PCV valve at intervals shown in Section "OB".

Periodically, inspect the hoses and clamps and replace any showing signs of deterioration.

PARTS INFORMATION

PART NAME	GROUP
Air Cleaner	3.402
Breather, A/C and Sil	3.410
Hose, C/Case Vent Vlv	1.762
Tube, C/Case Vent	1.762
Valve Asm, C/Case Vent	1.745

Park/Neutral Switch

The indication in this mode may vary with manufacturer so the type of reading for a particular tool should be checked in the operator's manual. The important thing is that the the reading changes state (switches) when the gear selector is moved from park/neutral to drive or reverse.

Torque Convertor Clutch (TCC)

In this position, the tool will indicate when the TCC has been commanded by the ECM to turn "ON". This does not necessarily mean that the clutch was engaged but only that the ECM grounded the circuit internally. The best way to determine if the clutch has engaged is to monitor engine rpm when the TCC comes "ON".

EGR (Duty Cycle)

The EGR system uses a valve to feed a small amount of exhaust gas back into the intake manifold to control formation of NO_x. Like all ECM outputs, the "Scan" tool only indicates that the ECM has commanded the function, and does not indicate that the function has really happened.

EGR Position

This indicates the position of the EGR pintle.

Integrator and Block Learn

Normal readings for these positions are around 128. If higher, it indicates that the ECM is adding fuel to the base fuel calculation because the system is lean, and if the numbers are below 128, the ECM is taking out fuel from the base calculation because the system is rich. The integrator gives short term corrective action, while the block learn portion (which is a long term correction) will only change if the integrator has seen a condition which lasts for a calibrated period of time.

Block Learn Multiplier (BLM) Cell - or - Block Learn Memory (BLM)

There are up to sixteen different cells, corresponding to ranges of rpm and engine load (indicated by MAF or MAP signals), and other conditions, such as A/C or P/N switch "ON" or "OFF", etc. The ECM learns how much adjustment is needed in each cell, and retains it in memory, so that the adjustment will immediately be made when the engine operates in that cell (or rpm/load range). This parameter will display what cell the ECM is currently using for the fuel calculation.

IAC (Idle Air Control)

This system is used to control engine idle speed to the desired rpm, for different operating conditions. In this mode, the numbers will indicate the position to which the ECM has moved the valve pintle. The ECM moves the IAC in counts, or steps, and the number of these counts are displayed on a "Scan" tool.

Desired RPM

This indicates the rpm to which the ECM is trying to control the idle.

Shift Light

This displays "yes" when the ECM is commanding the shift light to turn "ON".

PPSW (Pump Prime Switch)

This is the voltage on the fuel pump feed circuit. The ECM will adjust fuel injector base pulse width from this voltage value rather than from battery voltage.

A/C Request

The state of the A/C signal line to the ECM is shown. It should read "yes" whenever the A/C is requested.

A/C Clutch

"ON" is displayed when the ECM has commanded the A/C clutch "ON".

Knock Retard

This indicates the number of degrees the ECM is retarding the electronic spark timing (EST).

Knock Signal

This displays a "yes" when knock is detected by the ECM, and a "no" when knock is not detected.

Battery Voltage

This displays the battery voltage detected at the ECM ignition input.

Fan

"ON" is displayed when the cooling fan has been commanded "ON".

CCP (Carbon Canister Purge)

This displays "ON" when the canister purge solenoid is commanding purge. Some display duty cycle from 0-100%.

2nd Gear

This displays the state of the 2nd gear switch. Yes = 2nd gear applied. It remains applied in 3rd and 4th gears.

3rd Gear

This displays the state of the 3rd gear switch. Yes = 3rd gear applied. It remains applied in 4th gear.

4th Gear

This displays the state of the 4th gear switch. Yes = 4th gear applied.

Fan Request

State of the A/C fan control switch is displayed. It should read "yes" when fan is requested. Some engines may display the state of the 2nd fan, if used.

Power Steering Pressure Switch

This reading displays the state of switch, and may vary with the tool used, and the type of switch installed on the vehicle. The important thing is that the reading changes state (switches) when the steering is moved against the stops.

SECTION B - DRIVEABILITY SYMPTOMS

Always start with Section "A" "Diagnostic Circuit Check" before proceeding to the driveability symptoms or an emissions test failure. Section "A" checks the ECM, which may cause the driveability problem. A definition of each symptom is included. This will then lead to the most probable causes of the driveability problem.

SECTION C - COMPONENT SYSTEMS

There are many component systems that are used to control fuel and emissions. Section "C" introduces each component system or control with a general description, diagnosis, and on-vehicle service.

Each of the Section "C" diagnosis sections contain information on how the "Scan" tool can be used for diagnosing a particular component when a trouble code has not been set. (example: Section "C1" under diagnosis will explain how the "Scan" tool can be used for diagnosis as well as what the normal readings would be for the ECM sensors.)

Electronic Control Module (ECM)

This section describes the ECM and the information sensors in the system. Figure 4 shows the operating conditions which the ECM may sense and the systems that the ECM may control. (See specific engines to determine which are applicable to that engine.)

Fuel Control System

The ECM controls the air/fuel delivery to the combustion chamber by controlling the fuel flow through the injector(s).

Electric Fuel Pump (In-tank)

The in-tank fuel pump is controlled by the ECM. When ignition is turned "ON", the pump will run for 2 seconds, then stop unless the ECM is receiving ignition pulses, as when cranking or running.

Evaporative Emission Control

This system has a canister which stores fuel vapor from the fuel tank. The fuel vapor is removed from the canister and consumed in the normal combustion process when the engine is running. This system is used on all engines and may or may not be controlled by the ECM.

Electronic Spark Timing (EST)

This system is controlled by the ECM, which controls spark advance (timing), and is used on all engines.

Electronic Spark Control (ESC)

This system uses a knock sensor in connection with the ECM to control spark timing, to allow the engine to have maximum spark advance without spark knock. This improves driveability and fuel economy, but will retard spark if detonation (spark knock) is detected.

Air Injection Reaction (A.I.R.)

The system provides additional oxygen to the exhaust gases to continue the combustion process. The system also supplies additional air to the catalytic converter under certain conditions. The A.I.R. system is not on all engines.

Early Fuel Evaporation (EFE)

The EFE system heats the engine induction system electrically or with exhaust gas during cold and MPH) for abbreviations used in this Section, but all types are acceptable.

A/F - AIR/FUEL (A/F RATIO)

A.I.R. - AIR INJECTOR REACTION SYSTEM - Air flow from pump is directed into engine exhaust manifold and/or converter to reduce exhaust emissions.

ALDL - ASSEMBLY LINE DIAGNOSTIC LINK - Used at assembly to evaluate Computer Command Control, and for service to flash the "Service Engine Soon" light if there are trouble codes. It also is used by "Scan" tools to obtain ECM serial data.

BARO - BAROMETRIC ABSOLUTE PRESSURE SENSOR - Reads atmospheric pressure.

B + - Battery Positive Terminal (12 Volts) or system voltage with the engine running (approximately 13.8 v.)

CALPAK - A device used with fuel injection to allow fuel delivery in the event of a PROM or ECM malfunction.

CALIBRATOR - (PROM) - An electronic component that can be specifically programmed to meet engine operating requirements for a specific vehicle model. It plugs into the Engine Control Module (ECM).

CCC - COMPUTER COMMAND CONTROL - has an electronic control module to control air/fuel and emission systems.

CLCC - CLOSED LOOP CARBURETOR CONTROL - Used to describe oxygen sensor to ECM to M/C solenoid circuit operation.

C³I - Computer Controlled Coil Ignition. Produces the ignition spark without the aid of an ignition distributor.

CCP - CONTROLLED CANISTER PURGE - ECM controlled solenoid valve that permits manifold vacuum to purge the evaporative emissions from the charcoal canister.

CID - CUBIC INCH DISPLACEMENT - Used to describe engine size.

C/L OR C/LOOP - "CLOSED LOOP" - Describes ECM fuel control when using oxygen sensor information.

COOLANT TEMPERATURE SENSOR - Device that senses the engine coolant temperature, and passes that information to the engine control module.

CONV. - CATALYTIC CONVERTER, THREE-WAY - EXHAUST CONVERTER. Containing platinum and palladium to speed up conversion of HC and CO, and rhodium to accelerate conversion of NO_x.

CO - CARBON MONOXIDE - One of the pollutants found in engine exhaust.

CV - CRANKCASE VENTILATION - Prevents fumes in crankcase from passing into the atmosphere, by drawing them into the intake manifold and burning them in the the combustion process.

DIAGNOSTIC CODE - Pair of numbers obtained from flashing "Service Engine Soon" light or displaying on a "Scan" tool. This code can be used to determine the system malfunction.

DIAGNOSTIC TERM. - Lead of ALDL Connector which is grounded to get a Trouble Code. It is grounded with the engine running to enter the "Field Service Mode".

DIS - Direct Ignition System. Produces the ignition spark without the aid of an ignition distributor.

DVM (10 Meg.) - Digital Voltmeter with 10 Million ohms resistance - used for measurement in electronic systems.

DWELL - The amount of time (recorded on a dwell meter in degrees of crankshaft rotation) that current passes through a closed switch; for example, ignition contact points or internal switch in an electronic control module.

EAC - ELECTRIC AIR CONTROL - Used on A.I.R. system to direct air flow to air switching valve or to atmosphere.

EAS - ELECTRIC AIR SWITCHING - used to direct air flow to catalytic converter or exhaust ports of the engine.

ECM - ENGINE CONTROL MODULE (ELECTRONIC) - A metal case (located in passenger compartment) containing electronic circuitry which electrically controls and monitors air/fuel and emission systems on computer command control, and turns "ON" the "Service Engine Soon" light when a malfunction occurs in the system.

EFI - ELECTRONIC FUEL INJECTION - Computer Command Control using throttle body fuel injection.

EGR - EXHAUST GAS RECIRCULATION - Method of reducing NO_x emission levels by causing exhaust gas to be added to air/fuel mixture in combustion chamber, thus cooling combustion.

EECS - EVAPORATIVE EMISSIONS CONTROL SYSTEM - Used to prevent gasoline vapors in the fuel tank from entering the atmosphere.

EFE - EARLY FUEL EVAPORATION - Method of warming the intake manifold during cold engine operation. Provides efficient air/fuel mixing.

ENERGIZE/DE-ENERGIZE - When current is passed through a coil (energized) such as the canister purge solenoid, the plunger is pulled into the solenoid.

When the voltage to the solenoid is turned off, (de-energized), a spring raises the plunger.

ESC - ELECTRONIC SPARK CONTROL - Used to sense detonation and retard spark advance when detonation occurs.

EST - ELECTRONIC SPARK TIMING - ECM controlled timing of ignition spark.

EVRV - ELECTRONIC VACUUM REGULATOR VALVE - Controls EGR vacuum.

FED - FEDERAL - Vehicle/Engine available in all states except California.

GROUND - The negative (-) side of the battery. Also could be a wire (conductor) shorted to ground.

HC - HYDROCARBONS - One of the pollutants found in engine exhaust.

HIGH IMPEDANCE VOLTMETER - Has high opposition to the flow of electrical current. Good for reading circuits with low current flow, such as found in electronic systems because it allows tests to be made without affecting the circuit.

HEI - HIGH ENERGY IGNITION - A distributor that uses an electronic module and pick-up coil in place of contact points.

Hg - MERCURY - A calibration material used as a standard for vacuum measurement.

IAC - IDLE AIR CONTROL - A valve installed in the throttle body of fuel injected systems and controlled by the ECM to regulate idle speed.

IDEAL MIXTURE - The air/fuel ratio which provides the best performance, while maintaining maximum conversion of exhaust emissions. Typically it is 14.7:1.

IDI - INTEGRATED DIRECT IGNITION - Produces the ignition spark without the aid of an ignition distributor or spark plug wires.

IDLE AIR BLEED VALVE - Controls the amount of air let into the idle fuel mixture prior to the mixture entering the carburetor idle system, when the M/C solenoid is energized.

IGN - IGNITION

ILC - IDLE LOAD COMPENSATOR - Device used to control throttle angle during long deceleration, such as coasting down a long grade; it extends at wide open throttle position or to prevent engine stalls at idle.

INPUTS - Information from sources (such as coolant temperature sensors, exhaust oxygen sensor, etc.) to the ECM that indicate how the systems are performing.

INTERMITTENT - Occurs now and then; not continuously. In electrical circuits, refers to occasional open, short, or ground.

I.P. - INSTRUMENT PANEL

ISC - IDLE SPEED CONTROL - Regulates throttle valve position to control idle speed. Idle speed is controlled by the ECM and is not adjustable.

KM/HR - KILOMETER PER HOUR - A metric unit measuring speed needed to travel distance of one kilometer (1000 meters) in one hour.

L - LITER - A metric unit of capacity.

L4 - FOUR CYLINDER IN-LINE ENGINE

MAF - MASS AIR FLOW - Sensor which measures the amount of air entering the engine.

MALFUNCTION - A problem that causes the system to operate incorrectly. Typical malfunctions are wiring harness opens or shorts, failed sensors or circuit components.

MANIFOLD VACUUM SENSOR - Indicates vacuum in the intake manifold by measuring the pressure in intake manifold in relation to barometric pressure. It is also called a differential pressure sensor because it measures the difference between the two pressures. It puts out a voltage which is highest when the vacuum is highest. The maximum voltage is between 4 and 5 volts.

MAP - MANIFOLD ABSOLUTE PRESSURE SENSOR - Reads pressure changes in intake manifold with reference to zero pressure. It puts out a voltage which is highest when the pressure is highest. The maximum voltage is between 4 and 5 volts.

MAT - Manifold Air Temperature Sensor. Measures temperature of air in the intake manifold.

M/C - MIXTURE CONTROL

MEM-CAL - MEMORY CALIBRATOR - Contains specific calibrations to meet the requirements of a specific engine.

MFI - MULTIPORT FUEL INJECTION - Individual injectors for each cylinder are mounted in the intake manifold. The injectors are fired in groups rather than individually.

MIXTURE CONTROL (M/C) SOLENOID - Device, installed in carburetor, to regulate the air/fuel ratio.

MODE - A particular state of operation.

MPH - MILES PER HOUR - A unit measuring speed needed to travel distance of one mile (5280 feet) in one hour.

N.C. - NORMALLY CLOSED - State of relay contacts or solenoid plunger when no voltage is applied.

N·m - NEWTON METER (Torque) - A metric unit describing force.

INTRODUCTION

Power Distribution

The Power Distribution schematic shows the wiring from the Battery and Generator to the Starter Solenoid, Fuse Block, Ignition Switch and Light Switch. The first component after a Fusible Link is also shown. In certain instances, the first component after a Fuse Block fuse and Light Switch is also shown.

The Power Distribution schematic refers to Fuse Block Details and Light Switch Details schematics. By using these three (3) schematics, power distribution wiring can be followed from the Battery and Generator to the first component after a Fusible Link, Fuse and Light Switch. The ability to follow the power distribution wiring to the first component in each circuit is extremely helpful in locating short circuits which cause fusible links and fuses to open.

Figure 5 is a sample Power Distribution schematic. It shows how voltage is applied from the positive Battery terminal to the various circuits on the car. For example, Battery voltage is applied to the Starter Solenoid, Fusible Link D, the RED wire and connector C100 to Fuse 1 and Fuse 2 in the Fuse Block and the Light Switch in the LH Pod. These fuses are said to be "Hot At All Times", since Battery voltage is always applied to them.

Notice that Battery voltage is also applied to Fusible Link F and the RED wire to the Coolant Fan Relay.

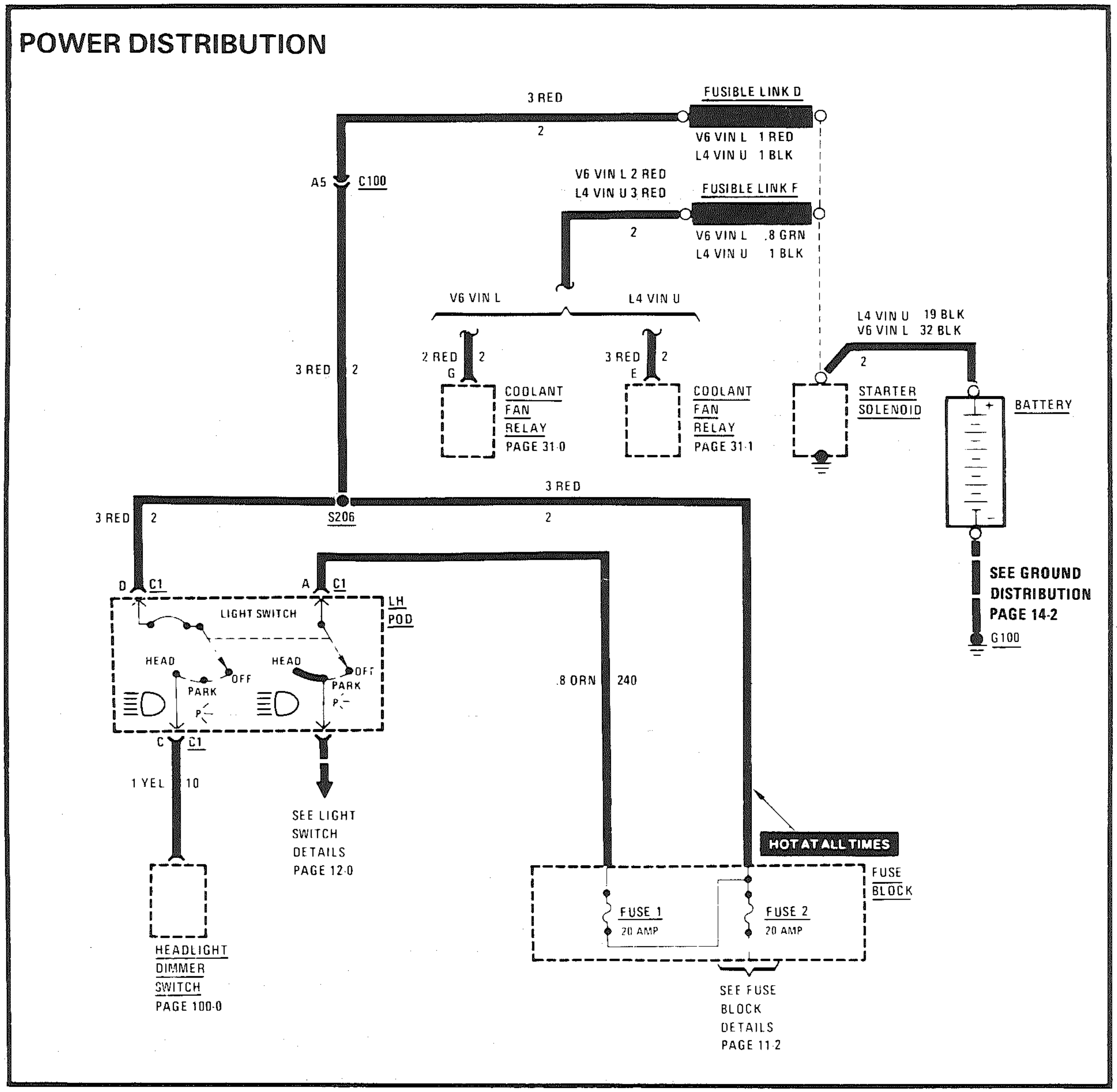


Figure 5 - Typical Power Distribution Schematic

Fuse Block Details

The Fuse Block Details schematic, see figure 6, shows all the wiring between a fuse and the components connected to the output of the fuse. In certain instances where space permits, this detail is shown on the Power Distribution schematic. The Fuse Block Details schematic is extremely helpful in locating a short circuit that causes a fuse to open.

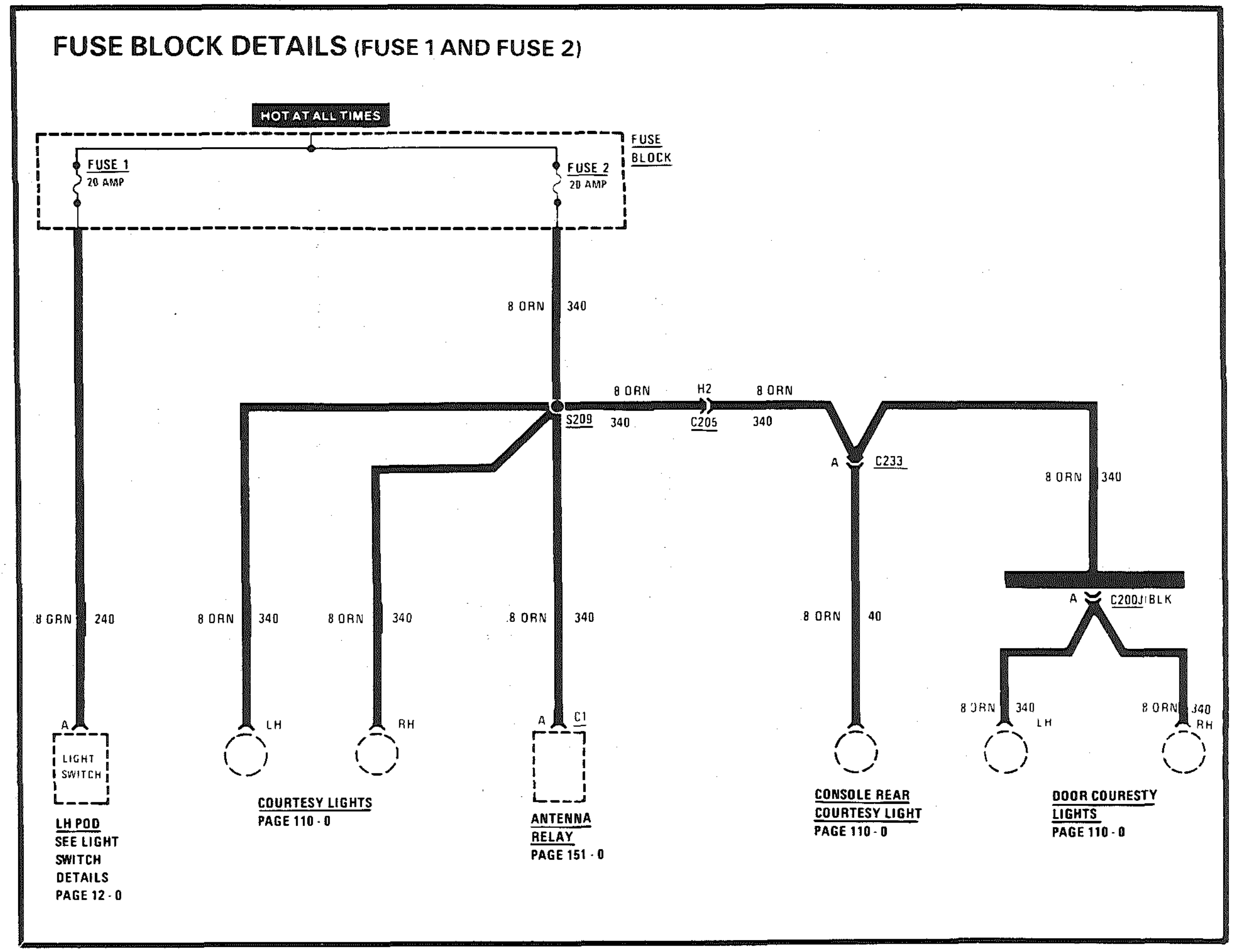


Figure 6 - Typical Fuse Block Details Schematic

INTRODUCTION

Light Switch Details

The Light Switch Details schematic, see figure 7, shows the wiring between the Light Switch and the components connected to the output of the Light Switch. In certain instances where space permits, some of this detail may be shown on the Power Distribution schematic. The Light Switch Details schematic helps you understand the many wires that come from the Light Switch. This schematic is also helpful in locating a short circuit that causes the fuse ahead of the Light Switch to open.

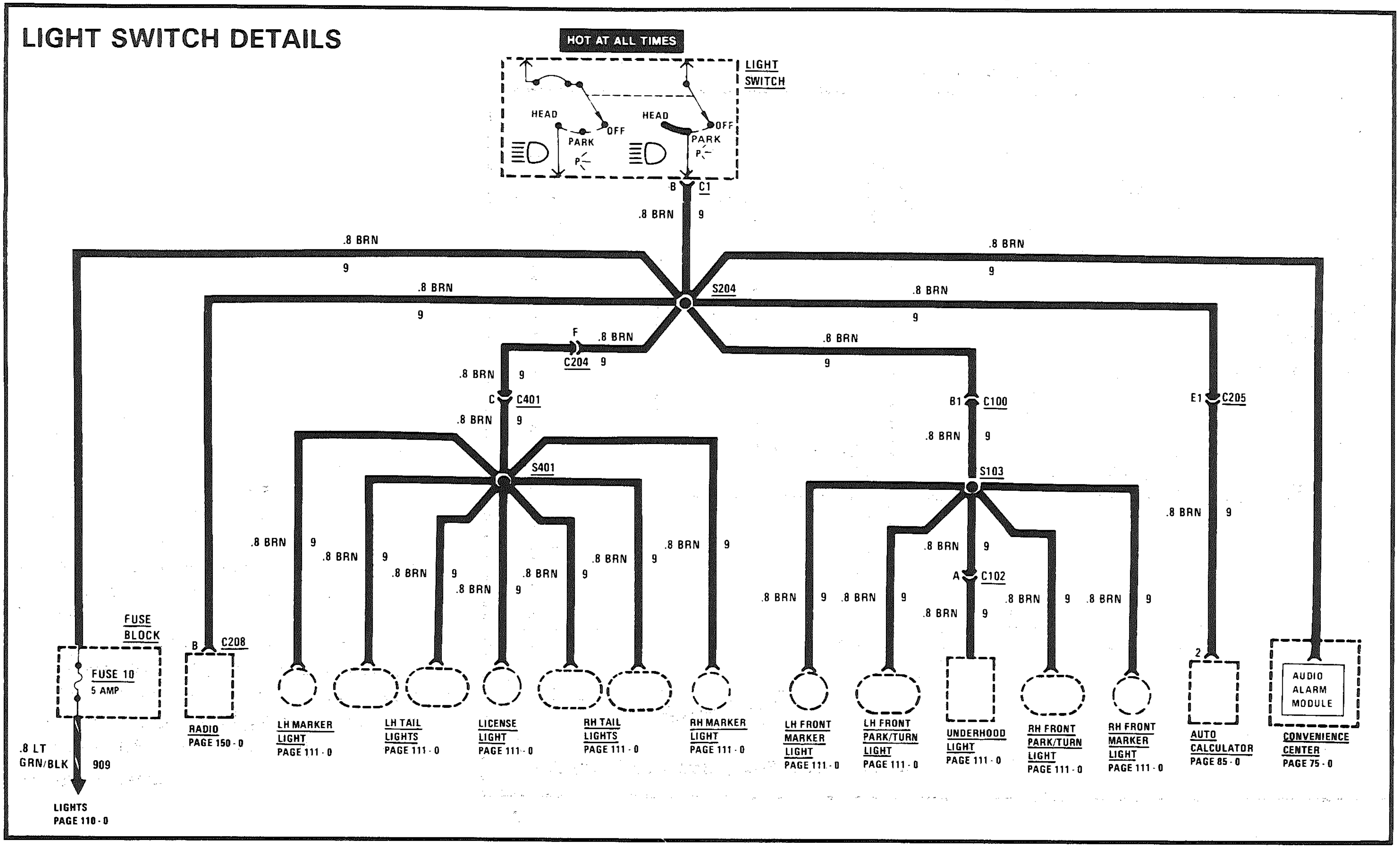


Figure 7 - Typical Light Switch Details Schematic

Ground Distribution

Figure 8 is a sample Ground Distribution schematic for the Headlights. It shows exactly which components share each ground. This information can often be a time-saver when troubleshooting ground circuits.

For example, if both Headlights and the Park/Turn Light on one side are all out, you could suspect an open in their common ground wire or the ground connection itself. On the other hand, if one of the lights works, you know that the ground and the wire up to the splice are good. You have learned this just by inspecting the schematic and knowing the vehicle's symptoms. No actual work on the lighting system was needed.

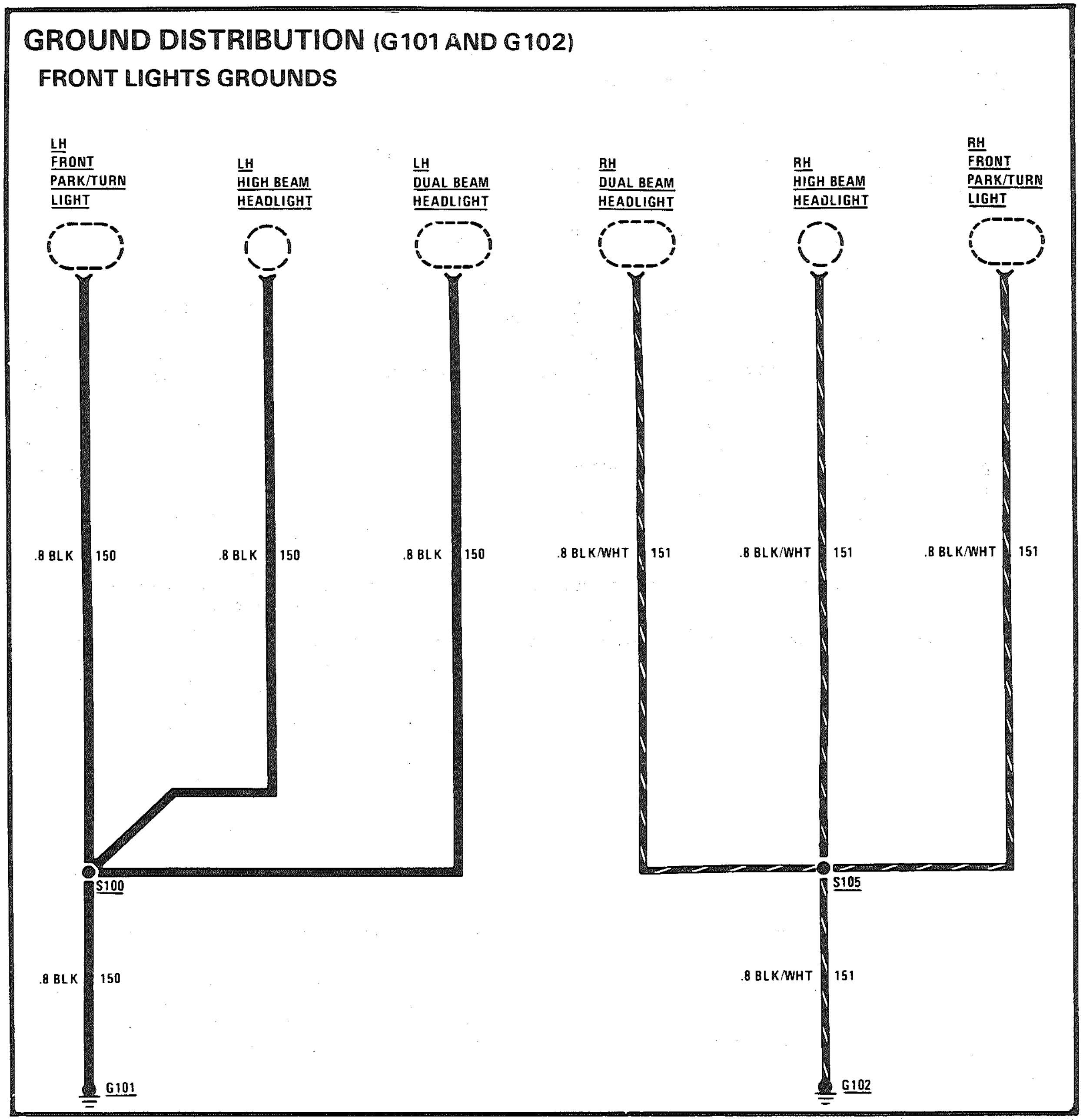
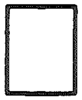
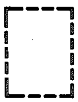


Figure 8 - Typical Ground Distribution Schematic

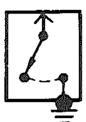
SYMBOLS



ENTIRE COMPONENT SHOWN

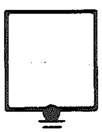


PART OF A COMPONENT SHOWN



NAME OF COMPONENT

DETAILS ABOUT COMPONENT OR ITS OPERATION



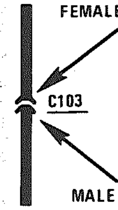
COMPONENT CASE IS DIRECTLY ATTACHED TO METAL PART OF CAR (GROUNDED)

WIRE IS ATTACHED TO METAL PART OF CAR (GROUNDED)

GROUND IS NUMBERED FOR REFERENCE ON COMPONENT LOCATION TABLE

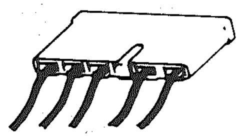
WIRE IS INDIRECTLY CONNECTED TO GROUND

WIRE MAY HAVE ONE OR MORE SPLICES BEFORE IT IS GROUNDED

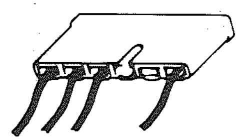


CONNECTOR REFERENCE NUMBER FOR COMPONENT LOCATION TABLE

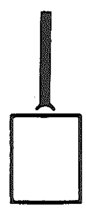
TABLE ALSO SHOWS TOTAL NUMBER OF TERMINALS POSSIBLE: C103 (6 CAVITIES)



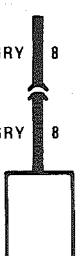
5 CAVITY CONNECTOR (5 OUT OF 5 CAVITIES ARE USED)



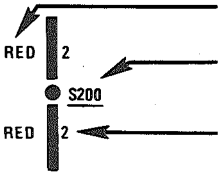
5 CAVITY CONNECTOR (4 OUT OF 5 CAVITIES ARE USED)



CONNECTOR ATTACHED TO COMPONENT



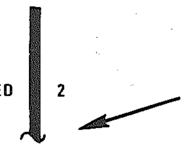
CONNECTOR ON COMPONENT LEAD (PIGTAIL)



INSULATION COLOR IS BOTH SHOWN AND LABELED

SPLICES ARE SHOWN AND NUMBERED

CIRCUIT NUMBER IS SHOWN TO HELP IN TRACING CIRCUITS



A WAVY LINE MEANS A WIRE IS TO BE CONTINUED

WIRE INSULATION IS ONE COLOR WITH ANOTHER COLOR STRIPE (RED WITH YELLOW)

WIRE SIZE AND INSULATION COLOR ARE LABELED

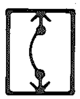
TO GENERATOR PAGE 30-0

CURRENT PATH IS CONTINUED AS LABELED. THE ARROW SHOWS THE DIRECTION OF CURRENT FLOW AND IS REPEATED WHERE CURRENT PATH CONTINUES.

LIGHTS: TURN/HAZARD/STOP

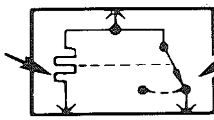
A WIRE WHICH CONNECTS TO ANOTHER CIRCUIT. THE WIRE IS SHOWN AGAIN ON THAT CIRCUIT.

SYMBOLS

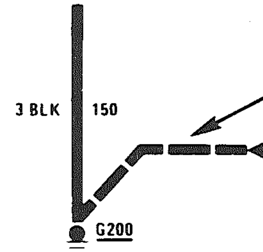


CIRCUIT BREAKER

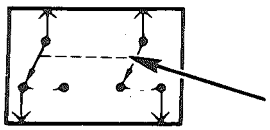
HEATING ELEMENT



HEAT-ACTUATED CONTACT

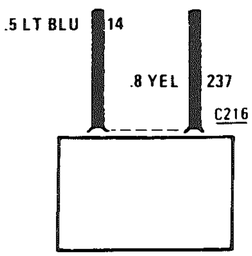


INDICATES THAT THE CIRCUITRY IS NOT SHOWN IN COMPLETE DETAIL BUT IS COMPLETE IN THE INDICATED CELL



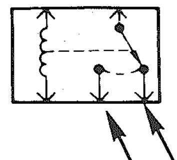
SWITCH CONTACTS THAT MOVE TOGETHER

DASHED LINE SHOWS A MECHANICAL CONNECTION BETWEEN SWITCH CONTACTS



TWO TERMINALS IN THE SAME CONNECTOR

DASHED LINE SHOWS A PHYSICAL CONNECTION BETWEEN PARTS (SAME CONNECTOR)

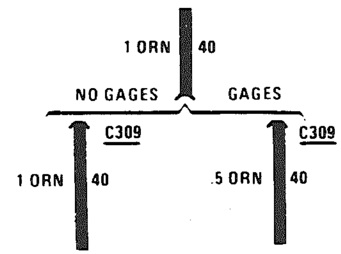


RELAY SHOWN WITH NO CURRENT FLOWING THROUGH COIL

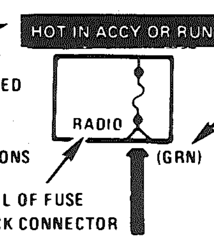
NORMALLY CLOSED CONTACT

NORMALLY OPEN CONTACT

WHEN CURRENT FLOWS THROUGH COIL, CONTACT MOVES TO NORMALLY OPEN POSITION



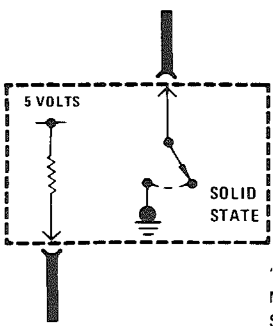
WIRE CHOICES FOR OPTIONS OR DIFFERENT MODELS ARE SHOWN AND LABELED



COLOR OF FUSE BLOCK CONNECTOR

INDICATES THAT POWER IS SUPPLIED WITH IGNITION SWITCH IN ACCY AND RUN POSITIONS

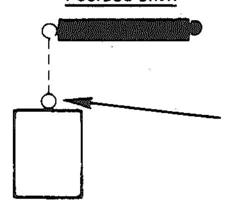
LABEL OF FUSE BLOCK CONNECTOR CAVITY



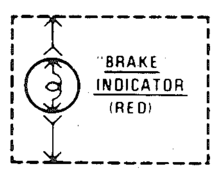
ELECTRONIC CONTROL MODULE (ECM) SOLID STATE

"SOLID STATE" IDENTIFIES MODULE AS ELECTRONIC. SIMPLIFIED COMPONENTS WITHIN THE MODULE SHOW HOW EACH CIRCUIT IS COMPLETED. DO NOT MEASURE RESISTANCE OF CIRCUITS INSIDE SOLID STATE MODULES.

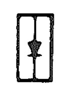
FUSIBLE LINK



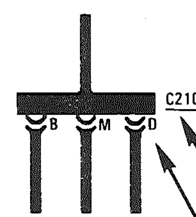
FUSIBLE LINK CONNECTS TO SCREW TERMINAL, SHOWN SEPARATED



AN INDICATOR WHICH DISPLAYS THE LIGHTED WORD "BRAKE"



DIODE
CURRENT CAN FLOW ONLY IN THE DIRECTION OF THE ARROW

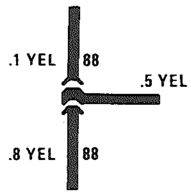


3 CONNECTORS ARE SHOWN CONNECTED TOGETHER AT A JUNCTION BLOCK. FOURTH WIRE IS SOLDERED TO COMMON CONNECTION ON BLOCK.

CONNECTOR NUMBER

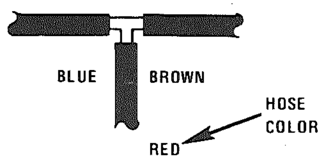
LETTERS FOR EACH CAVITY

SYMBOLS

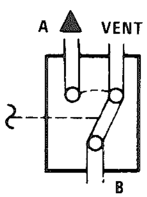


3 WIRES ARE SHOWN CONNECTED TOGETHER WITH A PIGGYBACK CONNECTOR

VACUUM JUNCTION



VACUUM SOURCE

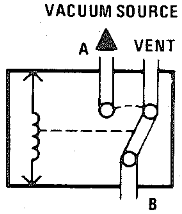


MECHANICAL VACUUM VALVE

WHEN THE VALVE IS IN THE " AT REST " POSITION, PORT B IS VENTED. THE VACUUM AT PORT A HAS NO EFFECT.

WHEN THE VALVE IS MOVED TO THE "OPERATED" POSITION VACUUM FROM PORT A IS CONNECTED TO PORT B

VACUUM SOURCE

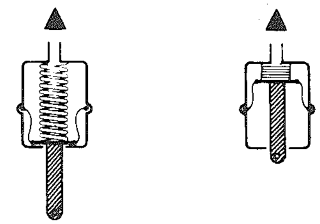


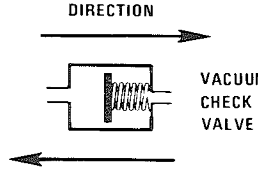
SOLENOID VACUUM VALVE

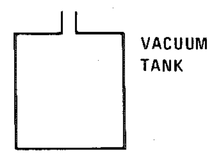
THE SOLENOID VACUUM VALVE USES THE SOLENOID TO MOVE THE VALVE

Vacuum motors operate like electrical solenoids, mechanically pushing or pulling a shaft between two fixed positions. When vacuum is applied, the shaft is pulled in. When no vacuum is applied, the shaft is pushed all the way out by a spring.

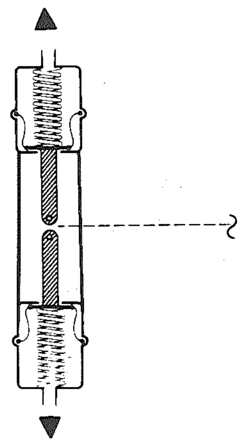
SINGLE DIAPHRAGM MOTOR





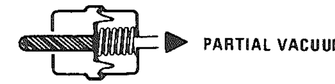


DOUBLE DIAPHRAGM MOTOR



Double diaphragm motors can be operated by vacuum in two directions. When there is no vacuum, the motor is in the center "at rest" position.

SERVO MOTOR



Some vacuum motors such as the servo motor in the Cruise Control can position the actuating arm at any position between fully extended and fully retracted. The servo is operated by a control valve that applies varying amounts of vacuum to the motor. The higher the vacuum level, the greater the retraction of the motor arm. Servo motors work like the two position motors; the only difference is in the way the vacuum is applied. Servo motors are generally larger and provide a calibrated control.

TROUBLESHOOTING PROCEDURES

The following four-step troubleshooting procedure is recommended:

Step 1: Check the problem.

Perform a System Check to be sure you understand what's wrong. Don't waste time fixing part of the problem! Do not begin disassembly or testing until you have narrowed down the possible causes.

Step 2: Read the Electrical Schematic.

Study the schematic. Read the Circuit Operation text if you do not understand how the circuit *should* work. Check circuits that share wiring with the problem circuit. The names of circuits that share the same fuse, ground, switch, etc., are included on each electrical schematic. (Shared circuits are also shown on Power Distribution, Ground Distribution, Fuse Block Details, and Light Switch pages.) Try to operate the shared circuits. If the shared circuits work, then the shared wiring is OK. The cause must be within the wiring used only by the problem circuit. If several circuits fail at the same time, chances are the power (fuse) or ground circuit is faulty.

Step 3: Find the Cause and Repair.

- Narrow down the possible causes.
- Use the Troubleshooting Hints.
- Make the necessary measurements as given in the System Diagnosis.
- Before you replace a component, check power, signal, and ground wires at the component harness connector. If these are OK, the component must be bad.

Step 4: Test the Repair

Repeat the System Check to be sure you have fixed the whole problem.

Example

A customer brings in a car and says that the high beams do not work.

Step 1: Perform a System Check on the Headlights Circuit. You may discover that both low beams operate. In "Hi," you may notice that the High Beam Indicator comes on, but neither high beam operates.

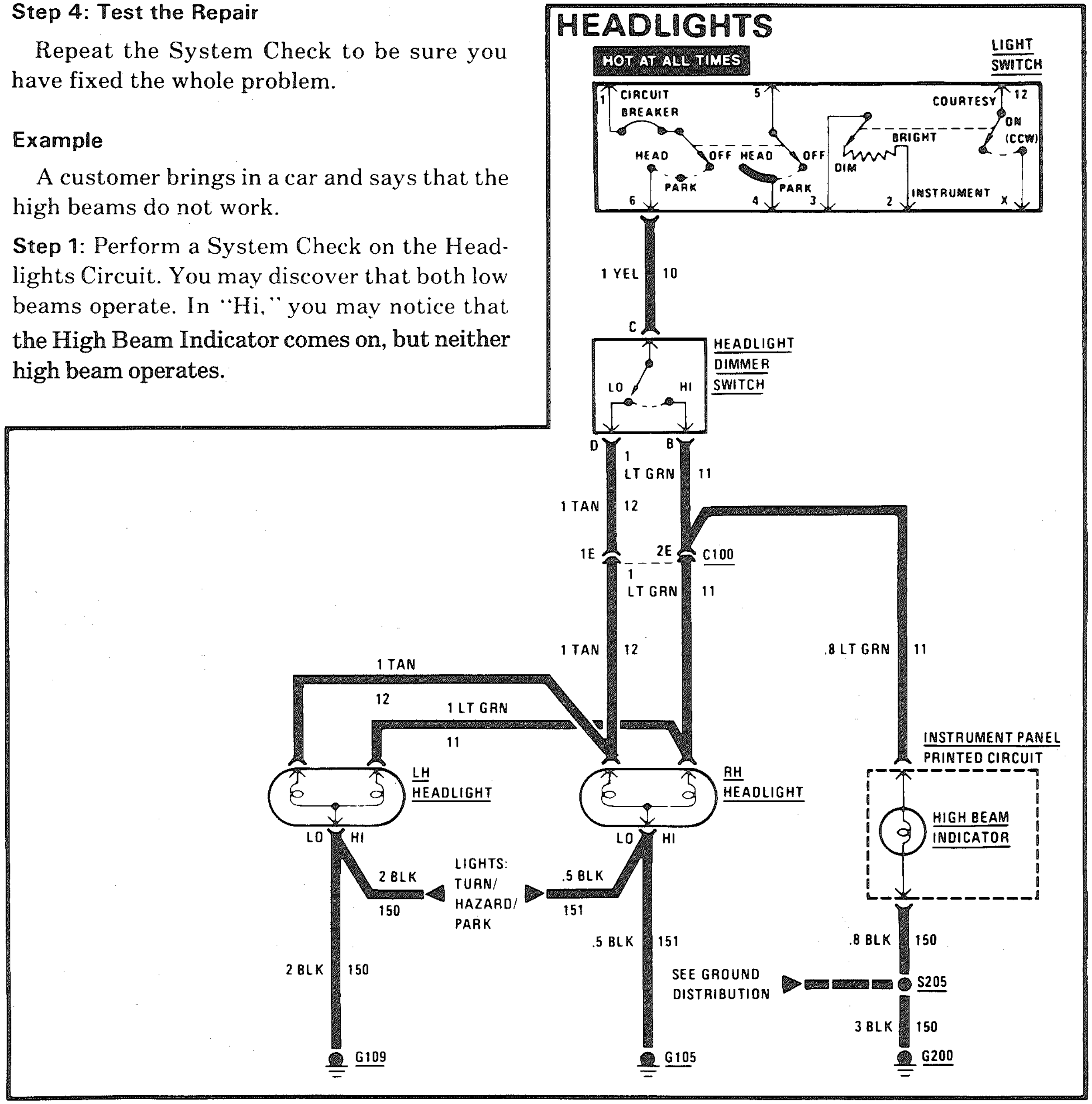


Figure 9 - Typical Headlights Schematic

Step 2: Read the Headlights electrical schematic, see figure 9. This is the step that will save you time and labor. Remember, it is essential to understand how a circuit *should* work, before trying to figure out why it doesn't.

After you understand how the circuit should operate, read the schematic again, this time keeping in mind what you have learned by operating the circuit.

Since both low beams work, you know that the Light Switch, the YEL wire, the Lo contacts of the Headlight Dimmer Switch, terminal 1E of C100, the TAN wires, and grounds G105 and G109 are all good.

Furthermore, since you saw that the High Beam Indicator came on when the Headlight Dimmer Switch was moved to Hi, you know that the Hi contacts of the dimmer switch and the LT GRN wire between the dimmer switch and C100 are good.

At this point, you could test for voltage at the RH Headlight with the dimmer switch in Hi. However, it is extremely unlikely that the high beam filaments have burned out in *both* headlights, or that *both* headlight connections are bad. The cause must be a bad connection at C100, or a break in the LT GRN wire between C100 and the RH Headlight.

You have quickly narrowed the possible causes down to one specific area, and have *done* absolutely *no* work on the car itself.

Step 3: Find the cause and repair it. Using the Component Location List and the corresponding figure, you can quickly find C100 and the LT GRN wire, locate the exact trouble point, and make the repair.

Step 4: Check the repair by performing a system check on the Headlights circuit. This, of course, means making sure that both high beams, both low beams, and the High Beam Indicator are all working.

Now suppose that the symptoms were different. You may have operated the Headlights and found that the low beams were working, but neither the high beams nor the High Beam Indicator were working. Looking at the schematic, you might conclude the following.

It is unlikely that both high beam filaments and the High Beam Indicator have all burned out at once. The cause is probably the dimmer switch or its connector.

TROUBLESHOOTING TOOLS

Electrical troubleshooting requires the use of common electrical test equipment.

TEST LIGHT/VOLTMETER

Use a test light to check for voltage. A Test Light (BT-7905 or equivalent) is made up of a 12-Volt light bulb with a pair of leads attached. After grounding one lead, touch the other lead to various points along the circuit where voltage should be present. When the bulb goes on, there is voltage at the point being tested.

A voltmeter can be used instead of a test light. While a test light shows whether or not voltage is present, a voltmeter indicates how much voltage is present.

An increasing number of circuits include solid state control modules. One example is the Electronic Control Module (ECM) used with Computer Command Control and Electronic Fuel Injection. Voltages in these circuits should be tested only with a 10-megohm or higher impedance digital voltmeter or multimeter (J-29125 or equivalent). Never use a test light on circuits that contain solid state components, since damage to these components may result.

When testing for voltage or continuity at a connection, you do not have to separate the two halves of the connector. Unless you are testing a "weather-pack" connector, you should probe the connector from the back. Always check both sides of the connector. An accumulation of dirt and corrosion between contact surfaces is sometimes a cause of electrical problems.

CONNECTOR TEST ADAPTERS

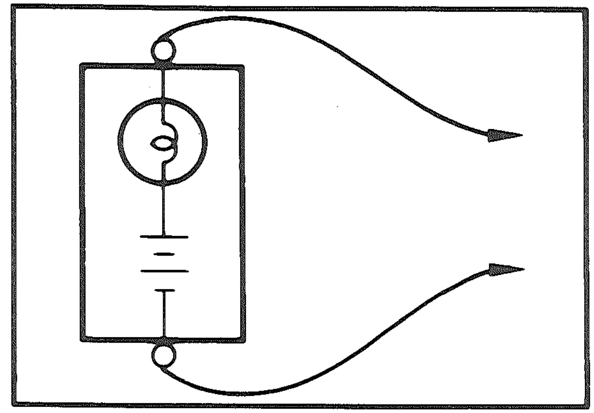
A connector Adapter Kit is available (J35616) for making tests and measurements at separated connectors. This kit contains an assortment of probes which mate with many of the types of connectors you will see. Avoid using paper clips and other substitutes since they can damage terminals and cause incorrect measurements.

SELF-POWERED TEST LIGHT

Use a self-powered test light (J-21008 or equivalent) to check for continuity. This tool is made up of a light bulb, battery, and two leads. If the leads are touched together, the bulb will go on.

A self-powered test light is used only on an unpowered circuit. First disconnect the car's Battery, or remove the fuse which feeds the circuit you're working on. Select two specific points along the circuit through which there should be continuity. Connect one lead of the self-powered test light to each point. If there is continuity, the test light's circuit will be completed and the bulb will go on.

Never use a self-powered test light on circuits that contain solid state components, since damage to these components may result.



Self-Powered Test Light

OHMMETER

An ohmmeter can be used instead of a self-powered test light. The ohmmeter shows how much resistance there is between two points along a circuit. Low resistance means good continuity.

Circuits which include any solid state control modules, such as the Electronic Control Module (ECM), should be tested only with a 10-megohm or higher impedance digital multimeter (J-29125 or equivalent).

When measuring resistance with a digital multimeter, the vehicle Battery should be disconnected. This will prevent incorrect readings. Digital meters apply such a small voltage to measure resistance that the presence of voltages can upset a resistance reading.

Diodes and solid state components in a circuit can cause an ohmmeter to give a false reading. To find out if a component is affecting a measurement, take a reading once, reverse the leads and take a second reading. If the readings differ, the solid state component is affecting the measurement.

FUSED JUMPER WIRE

A fused jumper is available (J-36169 or equivalent) with small clamp connectors providing adaptation to most connectors without damage. This fused jumper wire is supplied with a 20 amp fuse which may not be suitable for some circuits. Do not use a fuse with a higher rating than the fuse that protects the circuit being tested.

CAUTION: Do not use fused jumper wire in any instance to substitute for inputs or outputs at the ECM (Electronic Control Module), BCM (Body Control Module), or any microprocessor device.

SHORT FINDER

Short Finders are available (J-8681 or equivalent) to locate hidden shorts to ground. The short finder creates a pulsing magnetic field in the shorted circuit and shows you the location of the short through body trim or sheet metal.

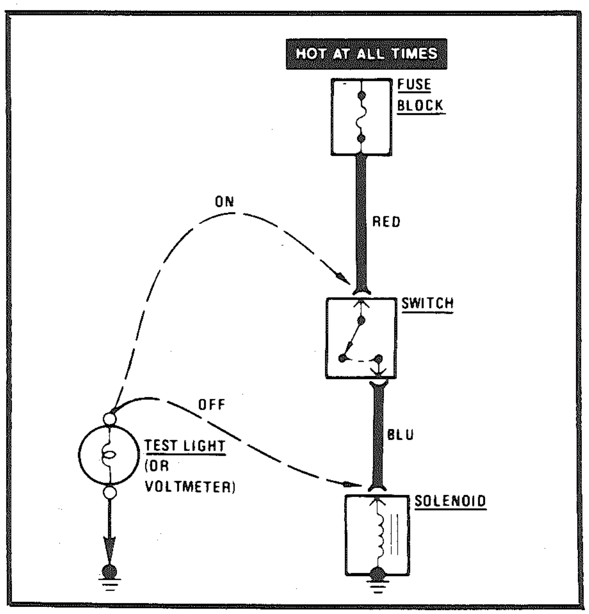
FUSE TESTER

A simple tester that indicates a blown fuse is available (J-34764 or equivalent). To check a fuse the tester is applied directly to the fuse in the fuse block. Two probes contact the fuse. The probes are either placed into the slots of a flat fuse or to the metal ends of a glass fuse. With power on, a red LED in the tester lights if the fuse is open. The handle of the tester is a tool for removing either type of fuse.

TROUBLESHOOTING TESTS

TESTING FOR VOLTAGE

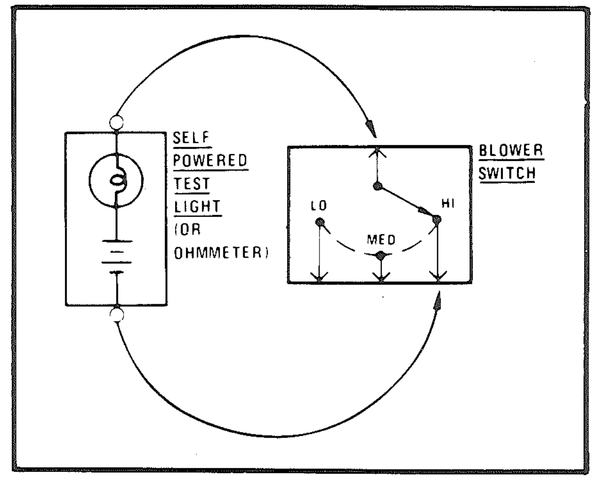
1. Connect one lead of a test light to a known good ground. If you are using a voltmeter, be sure it is the voltmeter's negative lead that you have connected to ground.
2. Connect the other lead of the test light or voltmeter to a selected test point (connector or terminal).
3. If the test light glows, there is voltage present. If you are using a voltmeter, note the voltage reading. It should be within one volt of measured Battery voltage. A loss of more than one volt indicates a problem.



Voltage Check

TESTING FOR CONTINUITY

1. Disconnect the car battery.
2. Connect one lead of a self-powered test light or ohmmeter to one end of the part of the circuit you wish to test.
3. Connect the other lead to the other end of the circuit.
4. If the self-powered test light glows, there is continuity. If you are using an ohmmeter, low or no resistance means good continuity.



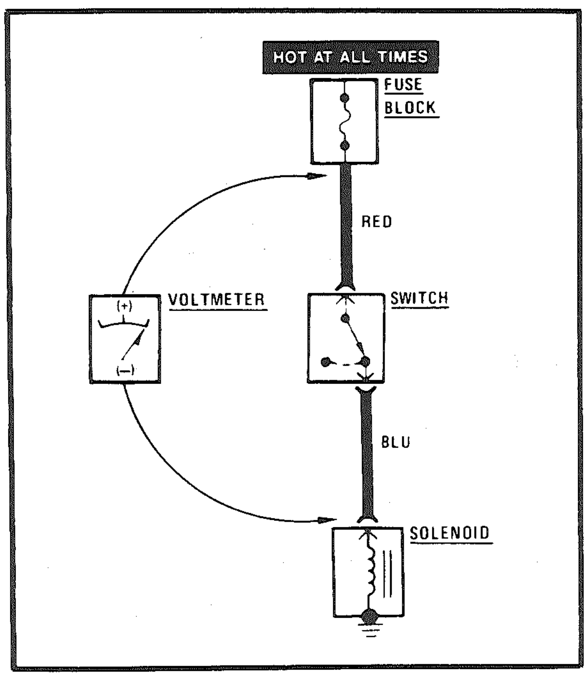
Continuity Check Through A Switch

TROUBLESHOOTING TESTS

TESTING FOR VOLTAGE DROP

This test checks for voltage being lost along a wire, or through a connection or switch.

1. Connect the positive lead of a voltmeter to the end of the wire (or to one side of the connection or switch) which is closer to the Battery.
2. Connect the negative lead to the other end of the wire (or the other side of the connection or switch).
3. Operate the circuit.
4. The voltmeter will show the difference in voltage between the two points. A difference (or drop) of more than one volt indicates a problem.

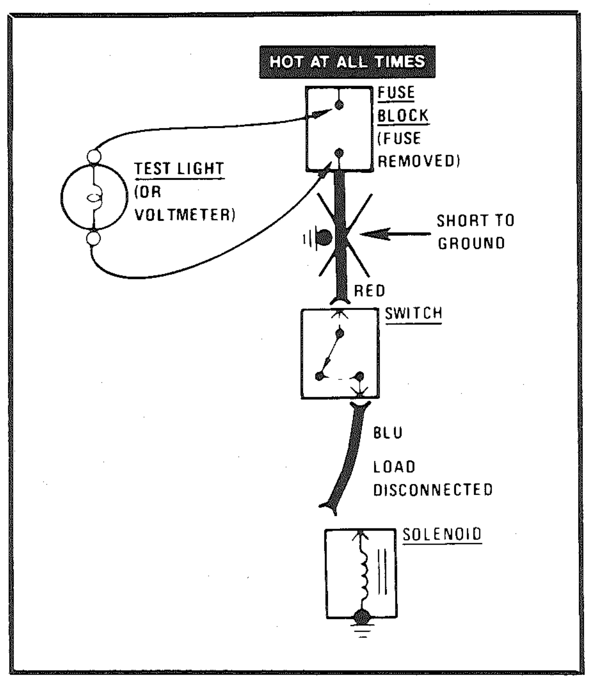


Voltage Drop Test

TESTING FOR SHORT TO GROUND

With a Test Light or Voltmeter

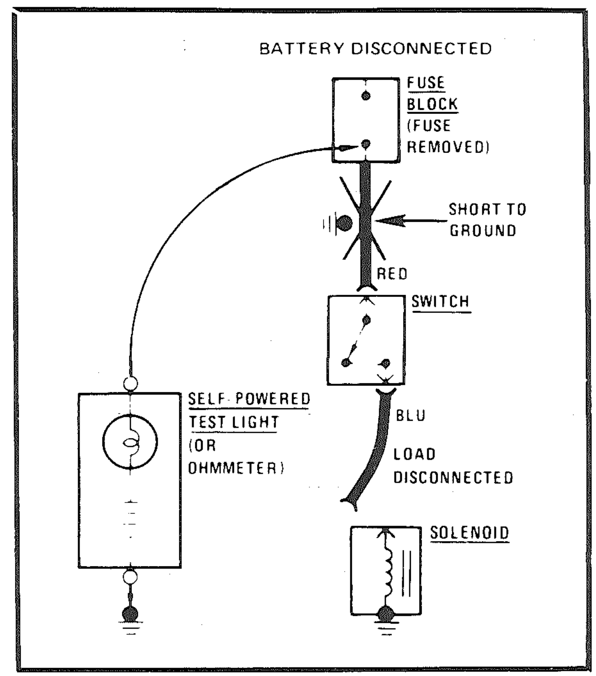
1. Remove the blown fuse and disconnect the load.
2. Connect a test light or voltmeter across the fuse terminals (be sure that the fuse is powered).
3. Beginning near the fuse block, wiggle the harness from side to side. Continue this at convenient points (about 6 inches apart) while watching the test light or voltmeter.
4. When the test light glows, or the voltmeter registers, there is a short to ground in the wiring near that point.



Testing For Short With Test Light or Voltmeter

With a Self-Powered Test Light or Ohmmeter

1. Remove the blown fuse and disconnect the battery and load.
2. Connect one lead of a self-powered test light or ohmmeter to the fuse terminal on the load side.
3. Connect the other lead to a known good ground.
4. **Beginning near the fuse block, wiggle the harness from side to side. Continue this at convenient points (about 6 inches apart) while watching the self-powered test light or ohmmeter.**
5. When the self-powered test light glows, or the ohmmeter registers, there is a short to ground in the wiring near that point.



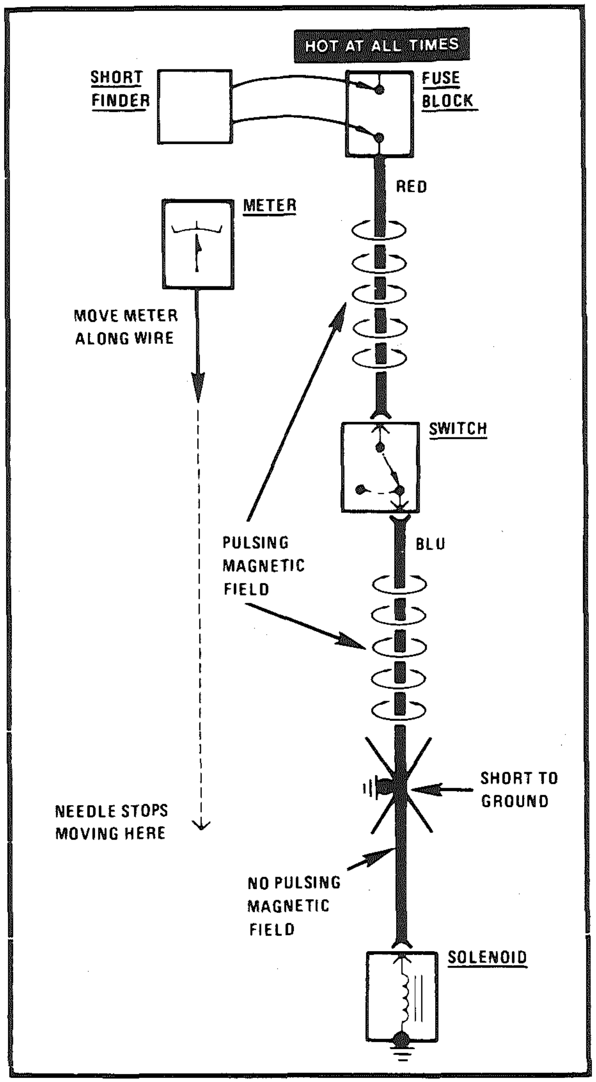
Testing For Short With Self-Powered Test Light or Ohmmeter

With a Short Finder

1. Remove the blown fuse, leaving the Battery connected.
2. Connect the Short Finder across the fuse terminals.
3. Close all switches in series with the circuit you are troubleshooting.
4. Operate the Short Finder. The Short Finder will pulse current to the short. This creates a pulsing magnetic field surrounding the circuit wiring between the fuse block and the short.
5. Beginning at the fuse block, slowly move the Short Finder meter along the circuit wiring. The meter will show current pulses through sheet metal and body trim. As long as the meter is between the fuse block and the short, the needle will move with each current pulse. When you have moved the meter past the point of the short, the needle will stop moving. Examine the wiring in that area for the short to ground.

Fuses Powering Several Loads

1. Find the schematic in Fuse Block Details (8A-11) for the fuse that has blown.
2. Open the first connector or switch leading from the fuse to each load.
3. Replace the fuse.
   - If the fuse blows, the short is in the wiring leading to the first connector or switch. Use a test light, meter, or short finder as described above.
   - If fuse does not blow, go to next step.
4. Close each connector or switch until the fuse blows, to find which circuit the short is in. Connect test lamp, meter, or short finder at the connector to the suspect circuit (disconnected) rather than at the fuse terminals.



Finding Short With Short Finder

PROPER JUMP STARTING PROCEDURES

With the use of electronic components (such as solid-state radios, electronic control modules, and others) becoming more wide-spread each model year, the potential for damage caused by improper jump starts increases. The following guidelines are presented to reduce the likelihood of such damage.

JUMP START ONLY IF BUILT-IN HYDROMETER "EYE" ON BATTERY IS DARK. If the "eye" is clear or yellow, do not attempt to jump start. If the "eye" is green, the Battery is charged and does not require a jump start. Both the booster and the discharged Battery should be treated carefully when using jumper cables.

CAUTION: Do not expose the Battery to open flame or sparks. Serious personal injury, particularly to the eyes, may result from a Battery explosion, Battery acid, or electrical burns.

- The Ignition Switch must be in OFF when connecting or disconnecting the jumper cables.
- All accessories, including the Radio, should be turned off before jump starting.
- Cable polarity must be correct. Component damage can occur if the polarity is reversed, even if only briefly.
- Connect the positive jumper cable first, then connect the negative cable to the engine ground (not the negative terminal of the dead Battery).

ELECTRICAL REPAIRS

This section provides instruction in the following repairs:

- Circuit Protection
- Typical Electrical Repairs
- Splicing Copper Wire
- Splicing Aluminum Wire
- Splicing Twisted Shielded Cable
- Repairing Connectors (Except Weather Pack®) and
- Repairing Weather Pack® (Environmental) Connectors

Note: After any electrical repair is made, always test the circuit by operating the devices in the circuit. This confirms not only that the repair is correct, but also that the cause of the complaint was correctly identified.

CIRCUIT PROTECTION

All electrical circuits are protected against excessive loads which might occur because of shorts or overloads in the wiring system. Such protection is provided by a fuse, circuit breaker, or fusible link.

Fuses

The most common method of automotive wiring circuit protection is the fuse. Whenever there is an excessive amount of current flowing through a circuit the fusible element will melt and create an open or incomplete circuit (see Figure 1). Fuses are a "one time" protection device and must be replaced each time the circuit is overloaded.

Auto-fuses are color coded. The standardized color identification and ratings are shown in Figure 2.

For service replacement, non-color coded fuses of the same respective current rating can be used. The current rating of each fuse is molded into its head.

To determine whether or not an auto-fuse is blown, remove the suspect fuse and examine the element in the fuse for a break, (see Figure 1). If the element is broken, replace the fuse with one of equal current rating.

There are, however, additional specific circuits with in-line fuses. In-line fuses are located within the individual wiring harness. They are usually housed in spring-loaded, twist-type receptacles.

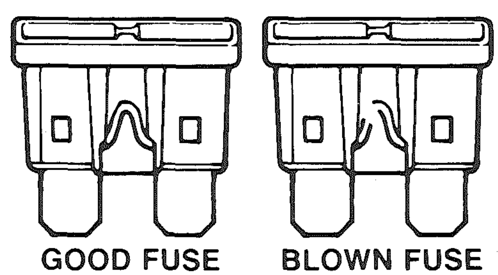


Figure 1 - Sample Fuses

CURRENT RATING (AMPERES)	COLOR
3	VIOLET
5	TAN
7.5	BROWN
10	RED
15	BLUE
20	YELLOW
25	WHITE
30	GREEN

Figure 2 - Fuse Rating And Color

Circuit Breakers

A circuit breaker is a protective device designed to open the circuit when a current load is in excess of rated breaker capacity. If there is a short or other type of overload condition in the circuit, the excessive current will open the circuit between the circuit breaker terminals. The circuit breaker will remain open until the trouble is found and corrected. The circuit breaker will close automatically when the excessive current is removed. The condition of a circuit breaker may be verified by removing it from the circuit and checking the resistance. A good circuit breaker will have less than 1 ohm resistance between the two terminals.

Fusible Links

In addition to circuit breakers and fuses, some circuits use fusible links to protect the wiring. Like fuses, fusible links are "one time" protection devices that will melt and create an open circuit (see Figure 3).

Not all fusible link open circuits can be detected by observation. Always inspect that there is Battery voltage past the fusible link to verify continuity.

Fusible links are used instead of a fuse in wiring circuits that are not normally fused, such as the ignition circuit. Each fusible link is four wire-gauge sizes smaller than the cable it is designed to protect. Links are marked on the insulation with wire-gauge size because the heavy insulation makes the link appear to be a heavier gauge than it actually is. The same wire size fusible link must be used when replacing a blown fusible link.

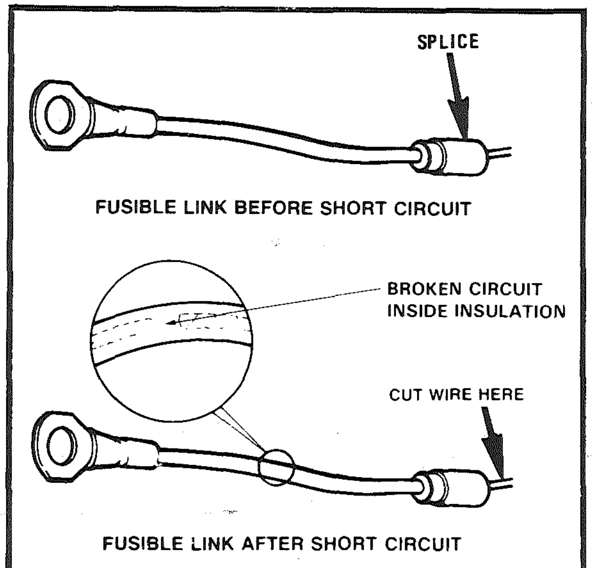


Figure 3 - Good And Damaged Fusible Links

Fusible links are available with two types of insulation: Hypalon® and Silicone/GXL (SIL/GXL). Service fusible links made with SIL/GXL may be used to replace either Hypalon® or SIL/GXL fusible links. Service fusible links made with Hypalon® may only be used to replace Hypalon® fusible links. To determine the fusible link type: nick the insulation of the blown fusible link with a knife. SIL/GXL will have a white inner core under the outer color. Hypalon® insulation is one color. Service fusible links are available in many lengths. Choose the shortest length that is suitable. If the fusible link is to be cut from a spool, NEVER make a fusible link longer than 228 mm (9 in).

CAUTION: Fusible links cut longer than 228 mm (9 in) will not provide sufficient overload protection.

To replace a damaged fusible link, cut it off beyond the splice. Replace with a repair link. When connecting the repair link, strip wire and use staking-type pliers to crimp the splice securely in two places (see Figure 4). For more details on splicing procedures see Splicing Copper Wire.

To replace a damaged fusible link which feeds two harness wires, cut them both off beyond the splice. Use two repair links, one spliced to each harness wire (see Figure 5).

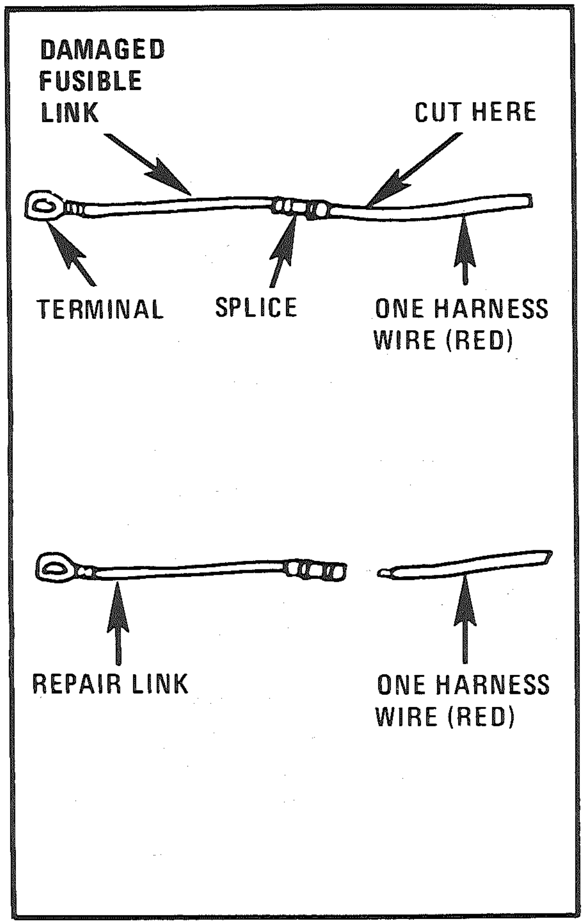


Figure 4 - Single Wire Feed Fusible Link

TYPICAL ELECTRICAL REPAIRS

An open circuit is an incomplete circuit. Power cannot reach the load or reach ground. If a circuit is open, active components do not energize. A short circuit is an unwanted connection between one part of the circuit and either ground or another part of the circuit. A **short circuit causes a fuse to blow or a circuit breaker to open.**

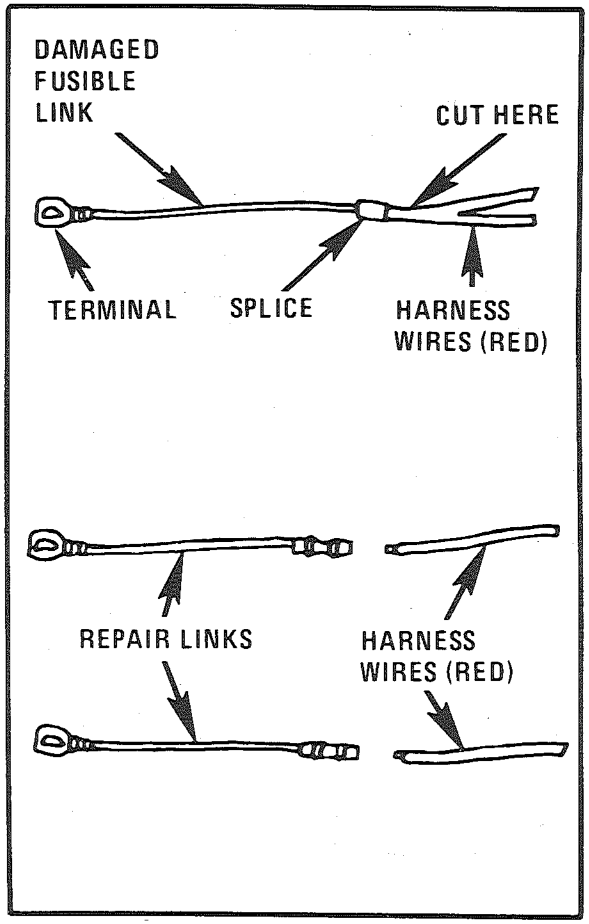


Figure 5 - Double Wire Feed Fusible Link

Short Circuits Caused by Damaged Wire Insulation

—Locate the damaged wire.

—Find and correct the cause of the wire insulation damage.

—For minor damage, tape over the wire. If damage is more extensive, replace the faulty segment of the wire. (Refer to the splicing instructions for copper, aluminum, or shielded cable for the correct splicing procedure.)

SPLICING COPPER WIRE

Step One: Open the Harness

If the harness is taped, remove the tape. To avoid wire insulation damage, use a sewing "seam ripper" to cut open the harness (available from sewing supply stores).

If the harness has a black plastic conduit, simply pull out the desired wire. Note that aluminum wire is enclosed in brown conduit. Refer to Splicing Aluminum Wire if necessary.

Step Two: Cut the Wire

Begin by cutting as little wire off the harness as possible. You may need the extra length of wire later if you decide to cut more wire off to change the location of a splice. You may have to adjust splice locations to make certain that each splice is at least 40mm (1 1/2") away from other splices, harness branches, or connectors.

Step Three: Strip the Insulation

When replacing a wire, use a wire of the same size as the original wire or larger. The schematics list wire size in metric units. The following table (see Figure 6) shows the commercial (AWG) wire sizes that can be used to replace each metric wire size. Each AWG size is either equal to or larger than the equivalent metric size.

METRIC WIRE SIZES	AWG SIZES
.22	24
.35	22
.5	20
.8	18
1.0	16
2.0	14
3.0	12
5.0	10
8.0	8
13.0	6
19.0	4
32.0	2

Figure 6 - Wire Size Conversion Table

To find the correct wire size either find the wire on the schematic page and convert the metric size to the AWG size, or use an AWG wire gage.

If you aren't sure of the wire size, start with the largest opening in your wire stripper and work down until you get a clean strip of the insulation. Be careful to avoid nicking or cutting any of the wires.

Check the stripped wire for nicks or cut strands. If the wire is damaged, repeat the procedure on a new section of wire. The two stripped wire ends should be equal in length.

Step Four: Crimp the Wires

Select the proper clip to secure the splice. To determine the proper clip size for the wire being spliced, follow the directions included with your clips. Select the correct anvil on the crimper. (On most crimpers your choice is limited to either a small or large anvil.) Overlap the two stripped wire ends and hold them between your thumb and forefinger as shown in Figure 7. Then, center the splice clip under the stripped wires and hold it in place.

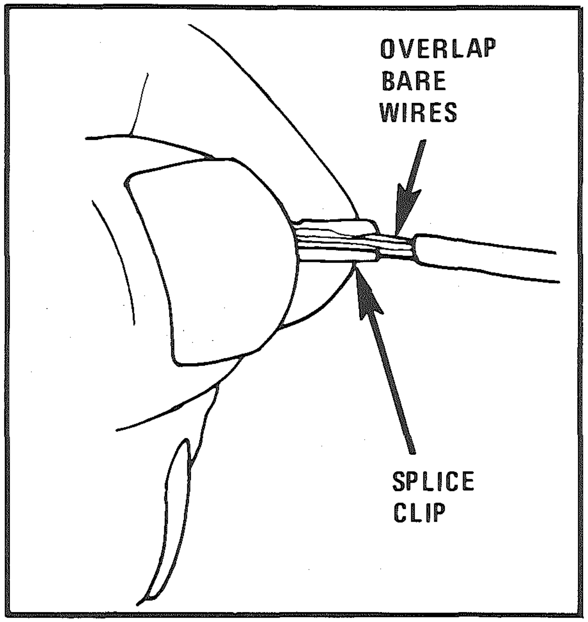


Figure 7 - Centering The Splice Clip

—Open the crimping tool to its full width and rest one handle on a firm flat surface.
—Center the back of the splice clip on the proper anvil and close the crimping tool to the point where the former touches the wings of the clip.
—Make sure that the clip and wires are still in the correct position. Then, apply steady pressure until the crimping tool closes (see Figure 8).

Before crimping the ends of the clip, be sure that:

—The wires extend beyond the clip in each direction.
—No strands of wire are cut loose, and
—No insulation is caught under the clip.

Crimp the splice again, once on each end. Do not let the crimping tool extend beyond the edge of the clip or you may damage or nick the wires (see Figure 9).

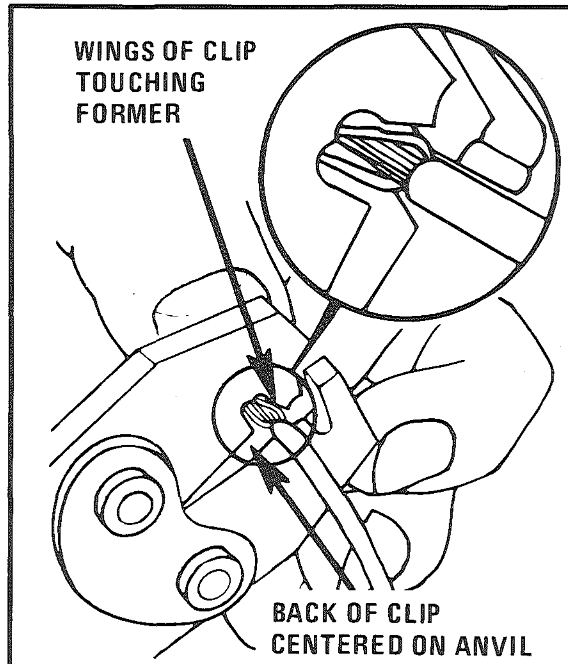


Figure 8 - Crimping The Splice Clip

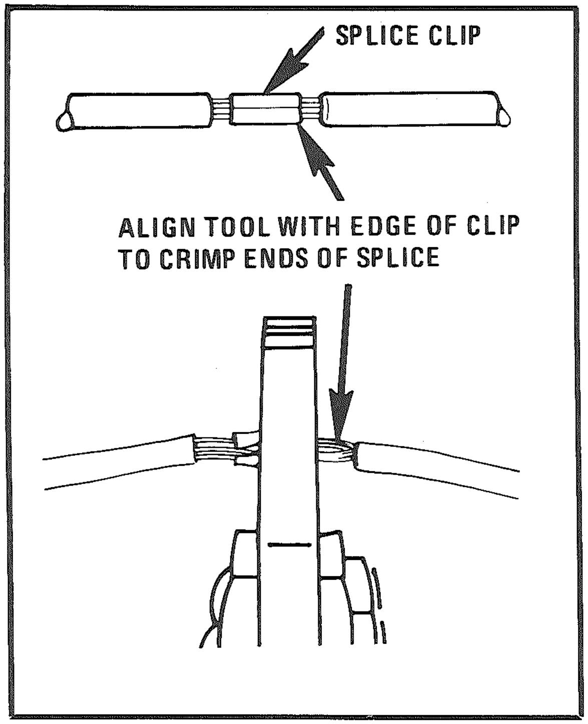


Figure 9 - Completing The Crimp

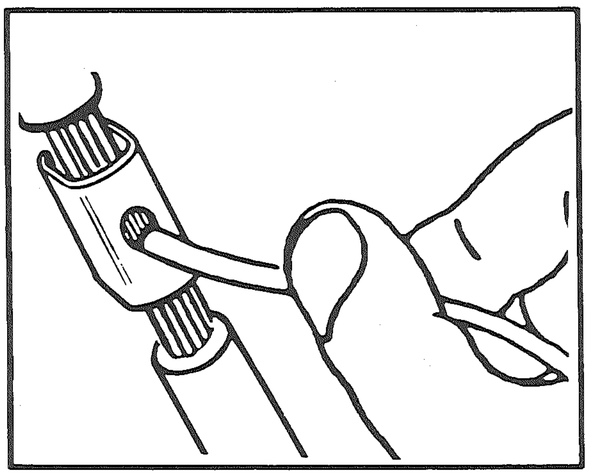


Figure 10 - Applying The Solder

Step Five: Solder

Apply 60/40 rosin core solder to the opening in the back of the clip (see Figure 10). Follow the manufacturer's instructions for the solder equipment you are using.

Step Six: Tape the Splice

Center and roll the splicing tape. The tape should cover the entire splice. Roll on enough tape to duplicate the thickness of the insulation on the existing wires. Do not flag the tape. Flagged tape may not provide enough insulation, and the flagged ends will tangle with the other wires in the harness (see Figure 11).

If the wire does not belong in a conduit or other harness covering, tape the wire again. Use a winding motion to cover the first piece of tape (see Figure 12).

SPLICING ALUMINUM WIRE

General Motors cars have a front body wiring harness made of 2.0 metric and 1.0 metric (14 and 16 gauge) insulated solid cable aluminum wires. These wires are enclosed in a brown solid plastic conduit from behind the instrument panel to the rear of the car..

A special repair kit (1684873-GR.2.530-KIT-ALUM-WIRE TERMINAL REPAIR) is available to help make repairs on aluminum wires. This kit contains materials and instructions that can be used either to splice wire or crimp on new terminals. The kit includes the following parts:

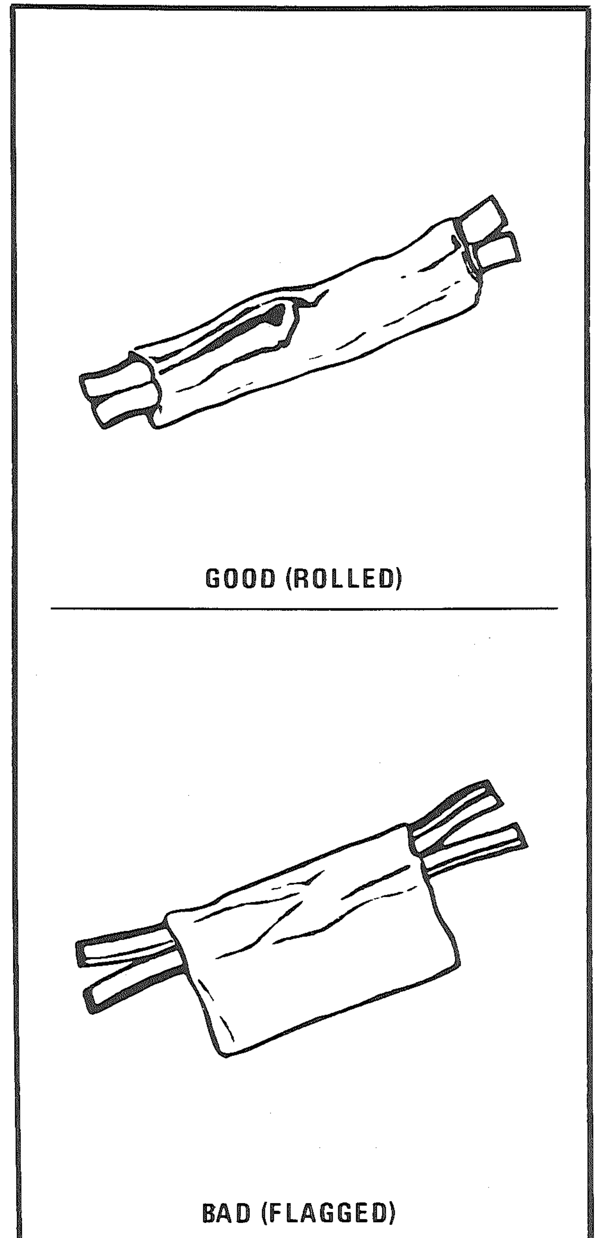


Figure 11 - Proper First Taping

Figure 12 - Proper Second Taping

- Small cylindrical metal splice clips.
- A plastic tube of petroleum jelly.
- Ten 2.0 metric (14 gauge) DK GRN leads: 150mm (6") long with terminals.
- Ten 1.0 metric (16 gauge) BRN leads:150 mm (6") long with terminals.

Use of the special materials in this kit will help prevent galvanic corrosion. Galvanic corrosion causes increased resistance between the terminal and wire, or the splice clip and wire, or both. Increased resistance would affect the operation of the electrical components in the repaired circuit.

Step One: Open the Harness

Because the harness has a solid plastic conduit, simply cut the conduit open with diagonal cutters and pull out the desired wire. Be careful not to damage any of the wires when cutting open the conduit.

Step Two: Cut the Wire

Begin by cutting as little wire off the harness as possible. You may need the extra length of wire later if you decide to cut more wire off to change the location of a splice. You may have to adjust splice locations to make certain that each splice is at least 40mm (1 1/2") away from the other splices, harness branches, or connectors.

Step Three: Strip the Insulation

When replacing a wire or lead, use a wire of the same size as the original wire, or larger. Look up the metric wire size on the schematic and select the proper-sized leads from the special repair kit. Remember that the wires in this harness can only be one of two sizes-2.0 metric or 1.0 metric (14 or 16 gauge).

Use wire strippers of the proper gauge to strip approximately 6mm (1/4") of insulation from each wire end.

When stripping the outer jacket from the aluminum wire core, be careful not to nick or damage the core. A damaged core will weaken the assembly at this point.

Step Four: Coating the Splice/Terminal

To prevent corrosion, apply a generous coating of petroleum jelly to the splice area. If you are replacing a lead, also thoroughly coat the terminal crimp area and aluminum core with petroleum jelly. Both areas are shown in Figure 13 and identified with the letter "A."

Step Five: Crimp the Wires

- Select the proper-sized splice clip (follow the instructions included in the special repair kit).
- Place one wire end in each end of the splice clip.
- Crimp the clip firmly to the wire using 10" slip joint pliers. Do NOT solder the splice (see Figure 14).
- Repeat this procedure for the second wire or lead in the splice clip.

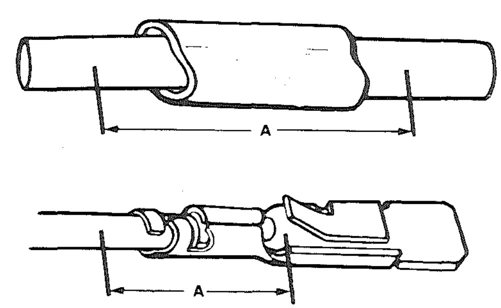


Figure 13 - Where To Apply Petroleum Jelly

Step Six: Tape Splice/Insert Terminal

Tape over both the splice clip and the petroleum jelly to seal out moisture and insulate the splice (see Figure 15). If you have replaced a lead, do not tape over the terminal crimp area but insert the lead into the connector body.

SPLICING TWISTED/ SHIELDED CABLE

Twisted/shielded cable is sometimes used to protect wiring from electrical noise (stray signals). For example, two-conductor cable of this construction is used between the ECM and the distributor. See Figure 16 for a breakdown of twisted/shielded cable construction.

Step One: Remove Outer Jacket

Remove the outer jacket and discard it. Be careful to avoid cutting into the drain wire or the mylar tape.

Step Two: Unwrap the Tape

Unwrap the aluminum/mylar tape, but do not remove it. The tape will be used to rewrap the twisted conductors after the splices have been made.

Step Three: Prepare the Splice

Untwist the conductors. Then, prepare the splice by following the splicing instructions for copper wire presented earlier. Remember to stagger splices to avoid shorts (see Figure 17).

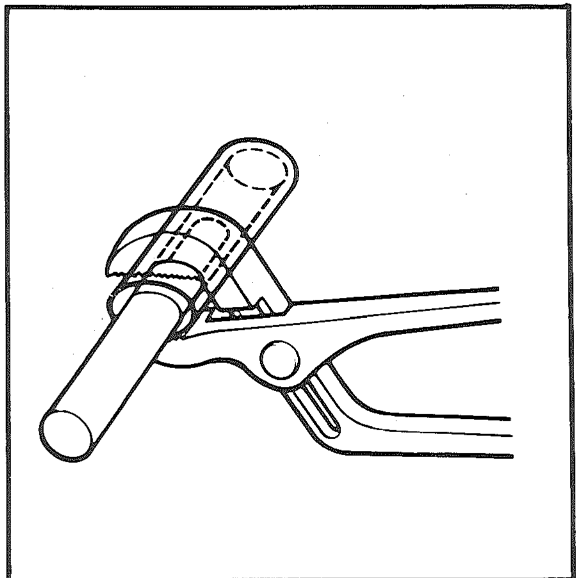


Figure 14 - Crimping The First Half Of The Splice Clip (Aluminum Wire)

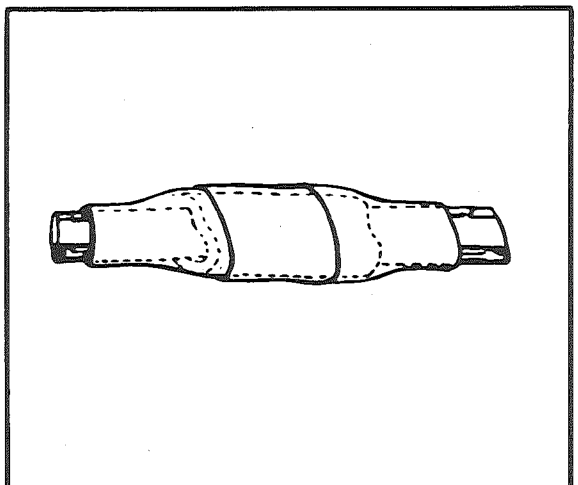


Figure 15 - The Tape Covers The Splice Clip And The Petroleum Jelly To Seal And Insulate

Step Four: Re-Assemble the Cable

After you have spliced and taped each wire, rewrap the conductors with the mylar tape. Be careful to avoid wrapping the drain wire in the tape.

Next, splice the drain wire following the splicing instructions for copper wire. Then, wrap the drain wire around the conductors and mylar tape (see Figure 18).

Step Five: Tape the Cable

Tape over the entire cable using a winding motion (see Figure 19). This tape will replace the section of the jacket you removed to make the repair.

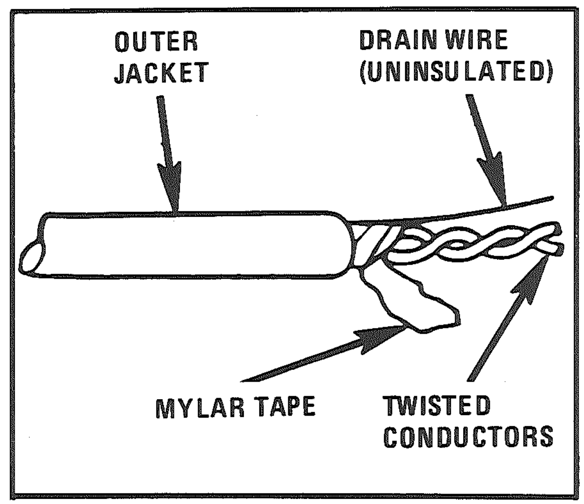


Figure 16 - Twisted/Shielded Cable

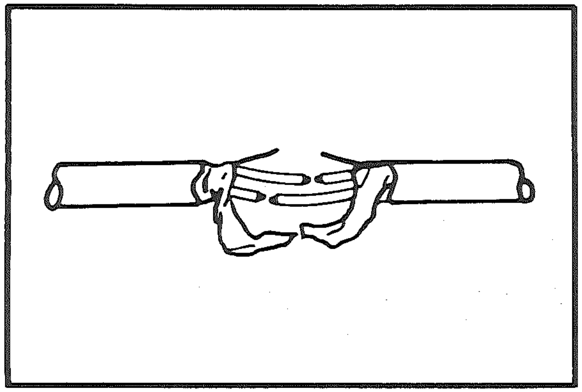


Figure 17 - The Untwisted Conductors

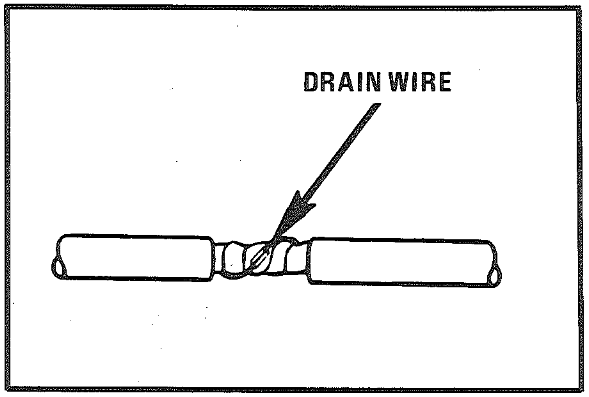


Figure 18 - The Re-Assembled Cable

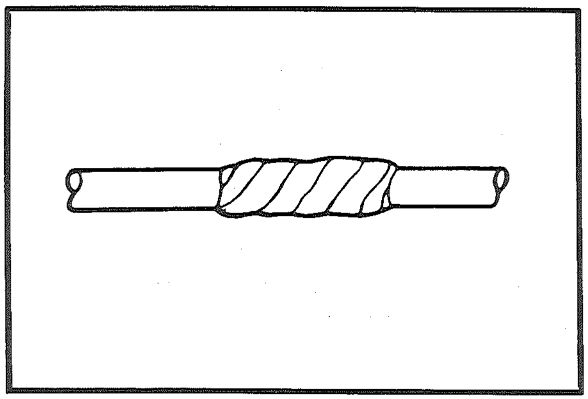


Figure 19 - Proper Taping

REPAIRING CONNECTORS

(Except Weather Pack® and Metri-Pack Series 150 Pull-to-Seat Type)

The following general repair procedures can be used for High Density, Printed Circuit and Bulkhead connectors. Prior to starting any repairs, separate connector halves and remove any terminal covers or retainers.

Instruction in the disassembly, repair, and assembly of connectors follows. Consult the figures for details on each specific type of connector. The instruction is divided into steps. Only perform those steps necessary to make the repair.

Step One: Remove the Lead

Depress the terminal locking tang using the proper size pick.

CAUTION: Do not place fingers or other parts of the body next to or around the back of the connector. If too much force is used, the pick and terminal both could be pushed out the back of the connector and cause injury.

—Place the pick between the locking tang of the terminal and the plastic of the connector body.
—Ease the lead back enough to release the locking tang.
—Pull the pick out.
—Gently pull the lead out of the back of the connector body.

Step Two: Re-Form the Locking Tang

If the lead and terminal are in good condition, reform the locking tang:

—Hold the lead firmly to prevent the splice between the terminal and the wire from flexing.
—Use the pick to bend the locking tang back into its original shape. Also check to see that the remainder of the terminal is still in its original shape.

Step Three: Make the Repair

When you make a repair, use the correct types of terminals and wires.

—Attach a new wire or a new terminal using the procedures in Splicing Copper Wire or Splicing Aluminum Wire.

Step Four: Insert the Lead

Before inserting the lead, make certain that the terminal is correctly shaped. Be careful to insert terminals in their proper locations.

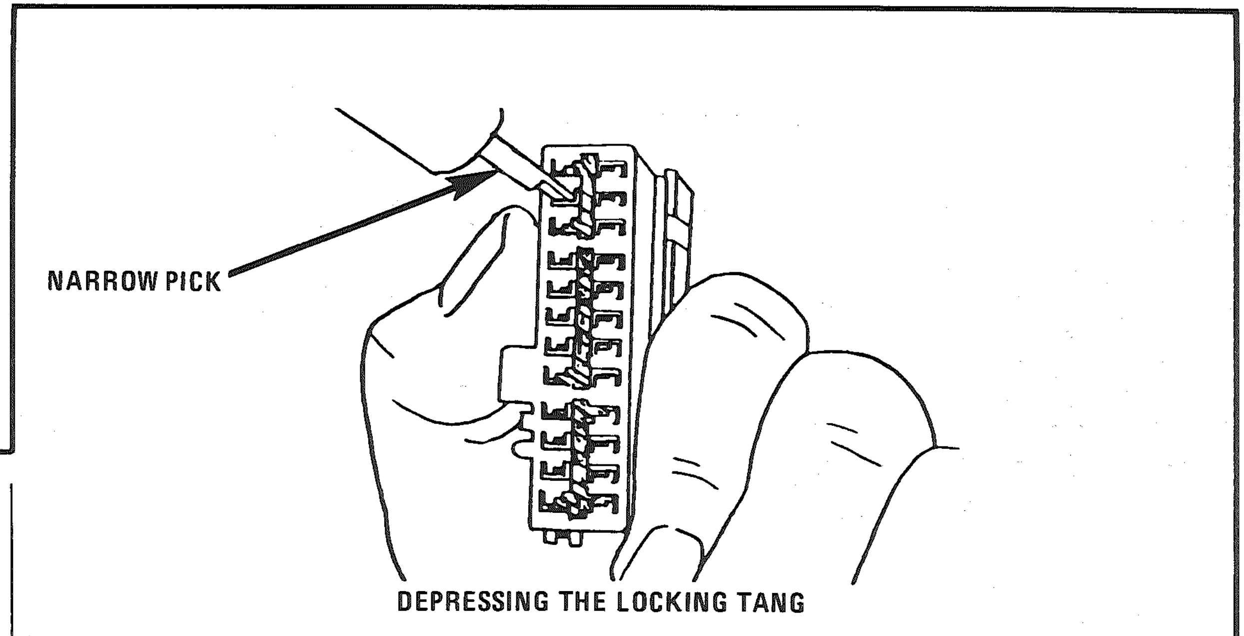
—Gently insert the lead from the back.

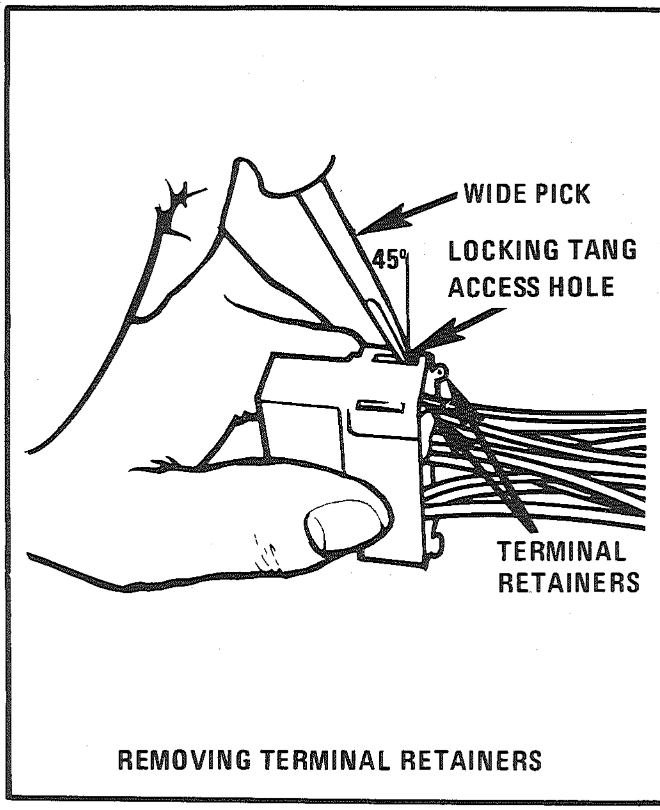
The terminal should stop or "catch" about halfway through the connector body.

Note: With bulkhead connectors, in many cavities it is possible for the terminal to be inserted in two ways. Be sure it is inserted in the same direction as it was removed, or to mate correctly with the facing terminal.

—Push back and forth gently on the lead to be sure the terminal is held in place in both directions. If the terminal easily pushes or pulls out, review Step Two: "Re-Form the Locking Tang."

Before mating the connector halves replace any terminal covers or retainers that were removed, and apply grease to prevent corrosion.





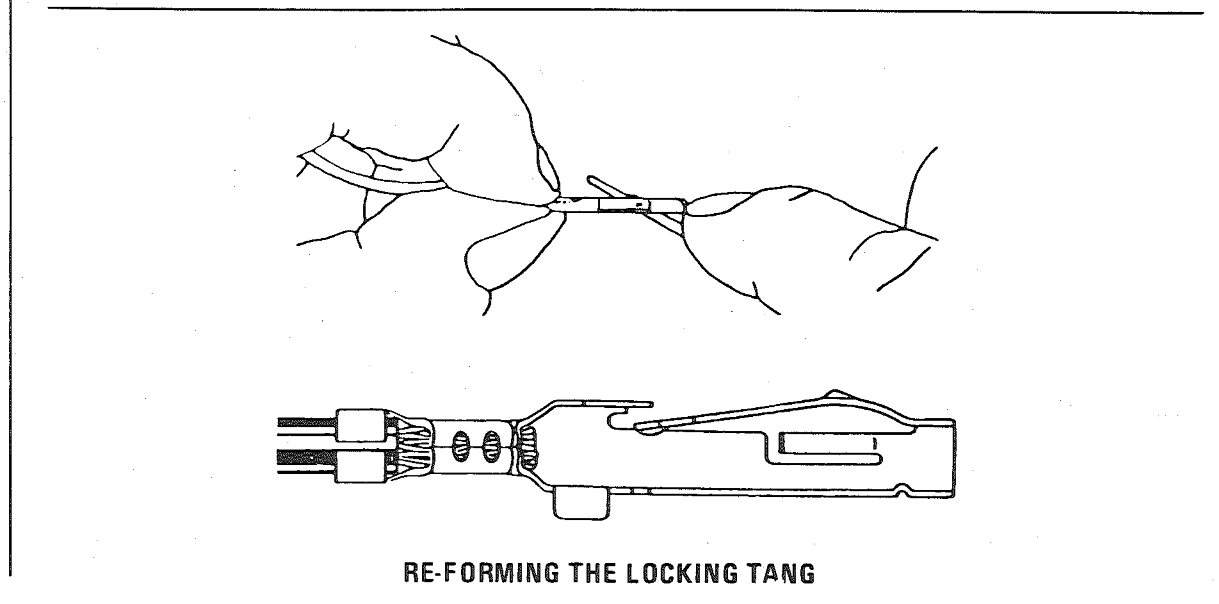


Figure 20 - High Density Connectors

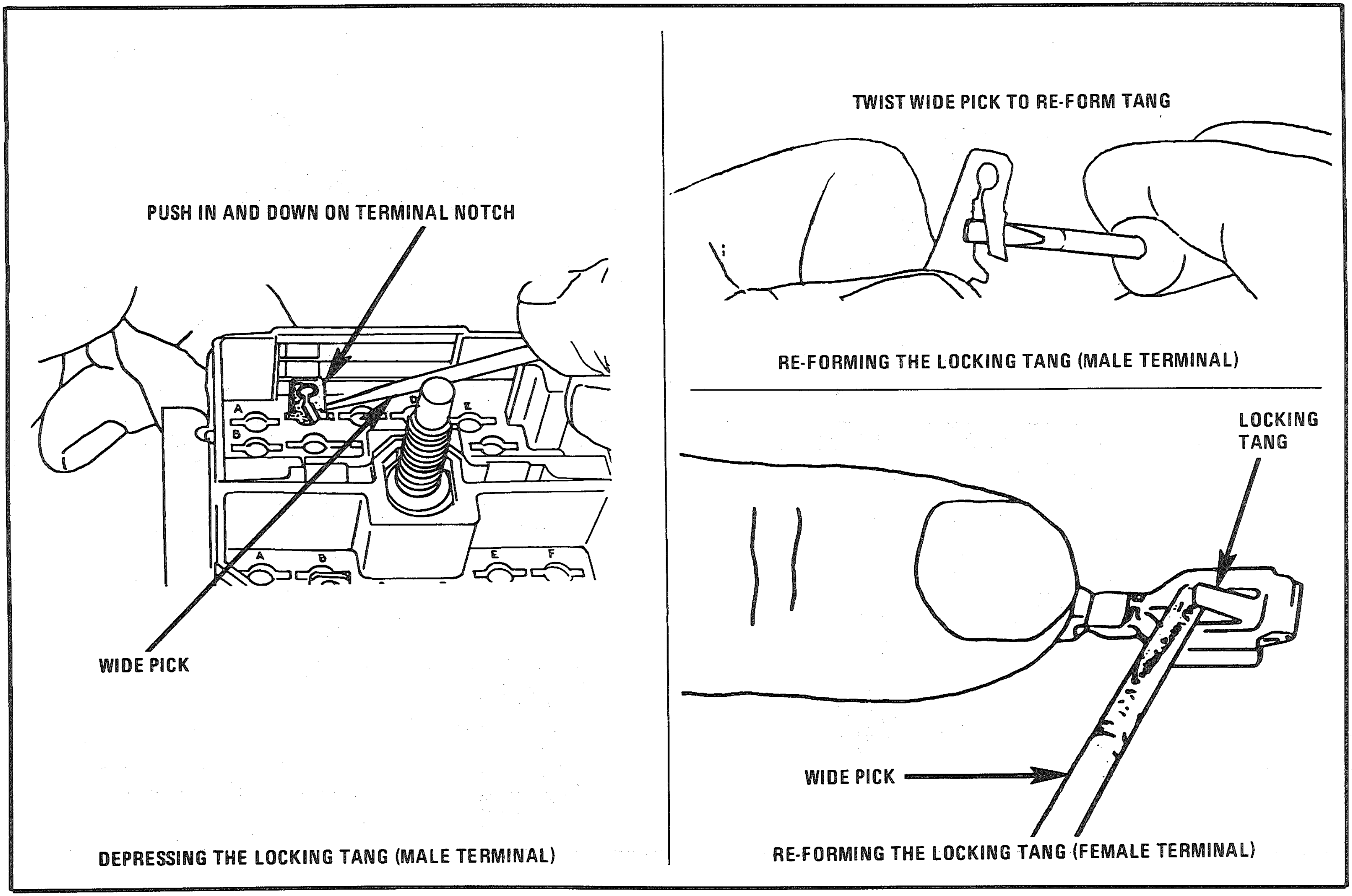


Figure 21 - Bulkhead Type Connectors

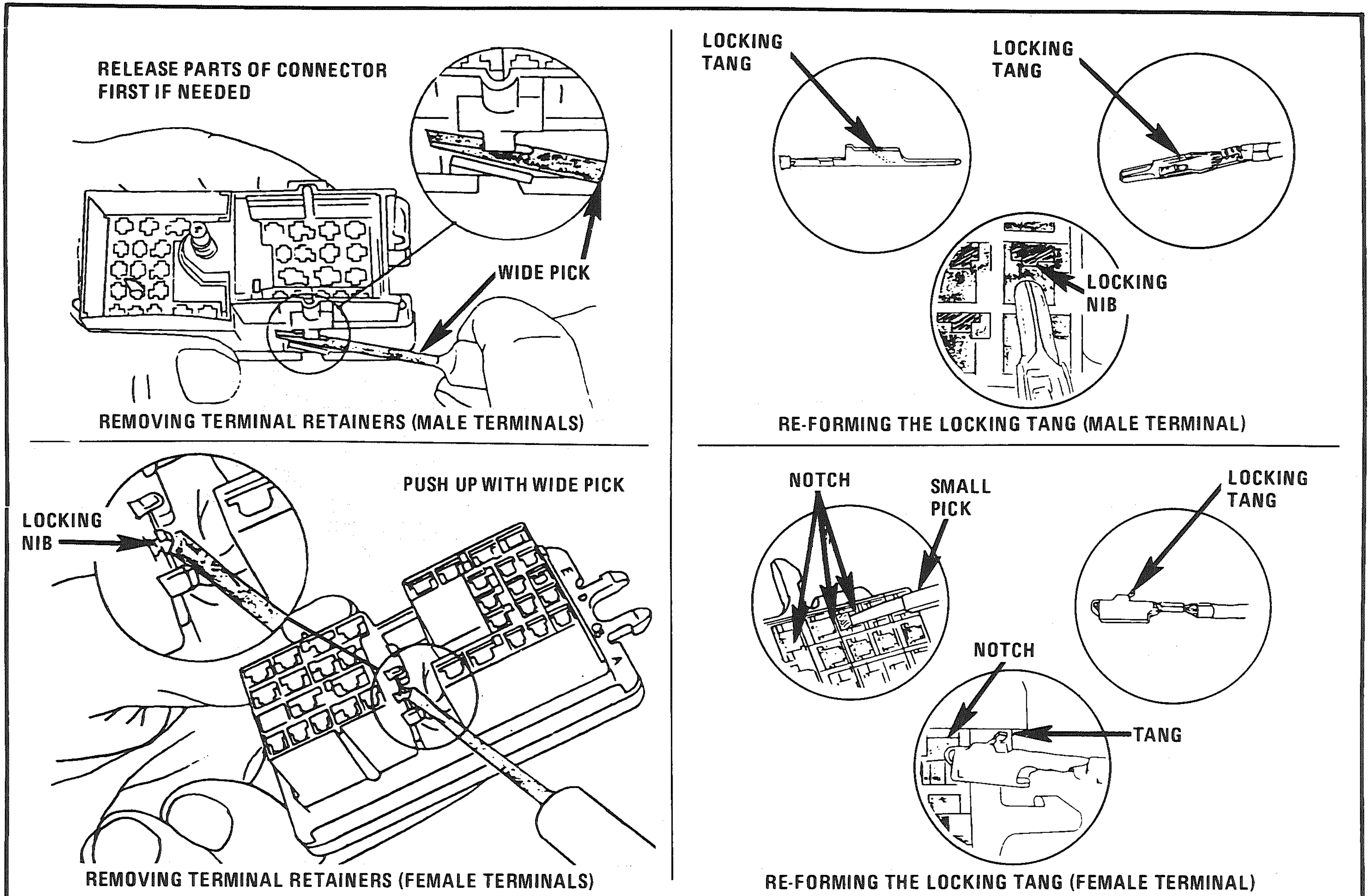


Figure 22 - Metri-pack Type Connectors — Push-To-Seat Type

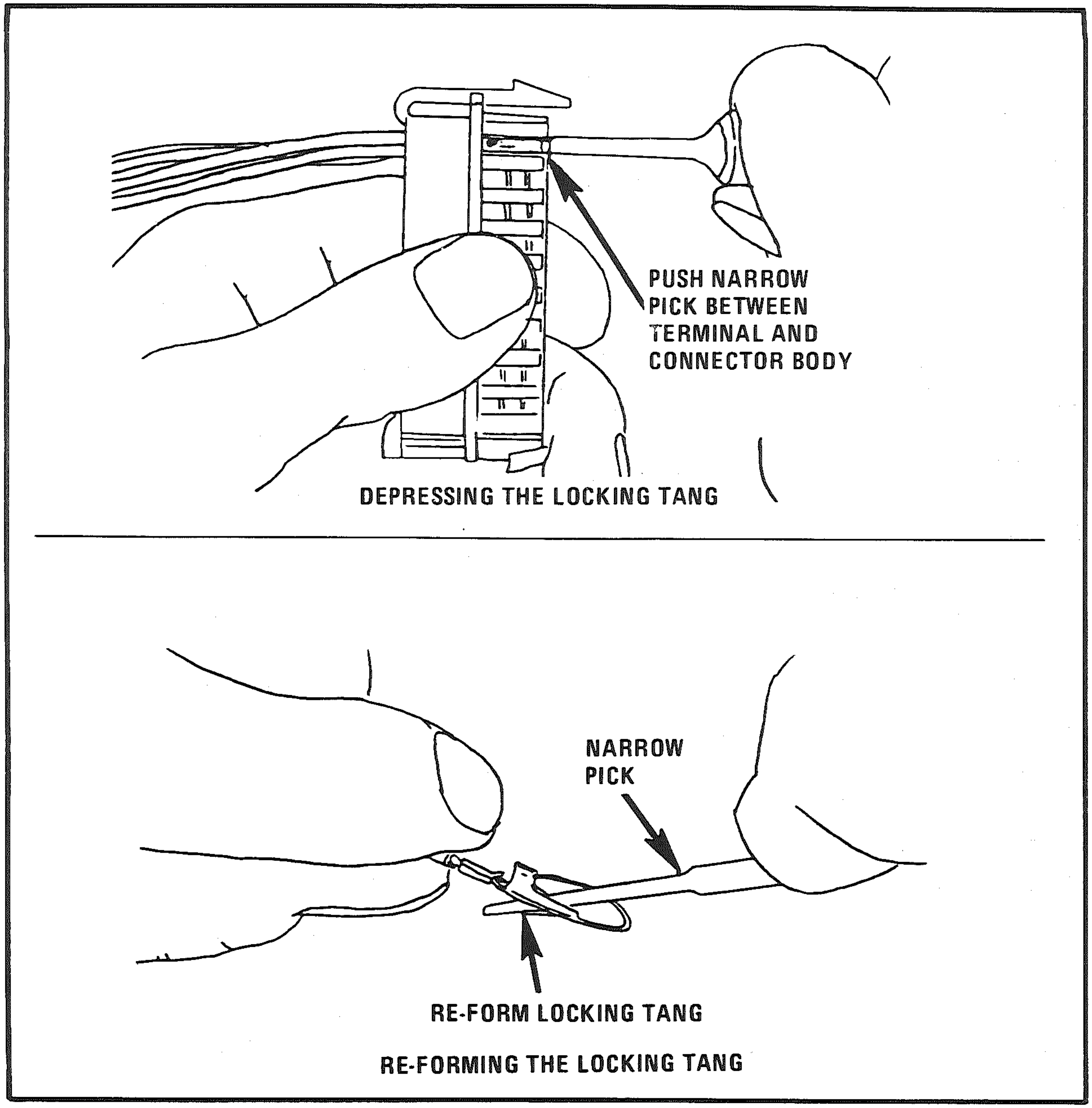


Figure 23 - Printed Circuit Type Connectors

REPAIRING WEATHER PACK® (Environmental) CONNECTORS

Weather Pack® or weatherproof connectors provide environmental protection on certain electrical circuits. This protection consists of a moisture-proof rubber flexible seal between the two connector halves and rubber cable seals attached to each terminal. The terminals and the cable seals are secured by a hinged secondary lock on small Weather Pack® connectors and by plastic terminal retainers on large Weather Pack® connectors.

If a Weather Pack® connector requires repair, do not replace the Weather Pack® parts with other types of connectors and temrinals. Also, do not omit either the large seal or the cable seals when making a repair.

Instruction in the disassemly, repair, and assembly of both small and large Weather Pack® connectors follows. The instruction is divided into steps. Only perform those steps necessary to make the repair.

Step One: Separate the Connector Halves

To separate a large connector, unscrew the bolt in the center of the connector body. Then pull the two halves apart. To separate a small connector, simply pull up on the primary lock and simultaneously pull the two halves apart.

Step Two: Remove the Terminal Retainer(s) (Large Connectors)/Open the Secondary Locks (Small Connectors)

To remove a terminal retainer, press a wide pick at a 45° angle against the locking nib (see Figure 24). Push the nib up as far as possible. Then, pull the retainer out.

To open the secondary locks on small connectors, flip down the lock hinges as shown in Figure 25.

Step Three: Remove the Lead

Depress the terminal locking tangs using a Weather Pack™ pick(J28742-A or the equivalent):

- —Push the hollow cylinder of the pick into the terminal cavity from the front until it stops (see Figures 26 and 27).The pick should surround the terminal (see Figure 28 for drawings of locking tangs).
- —Pull the pick out.
- —Gently pull the lead out of the back of the connector body.

Note that the male connector body half contains female terminals and the female half houses male terminals.

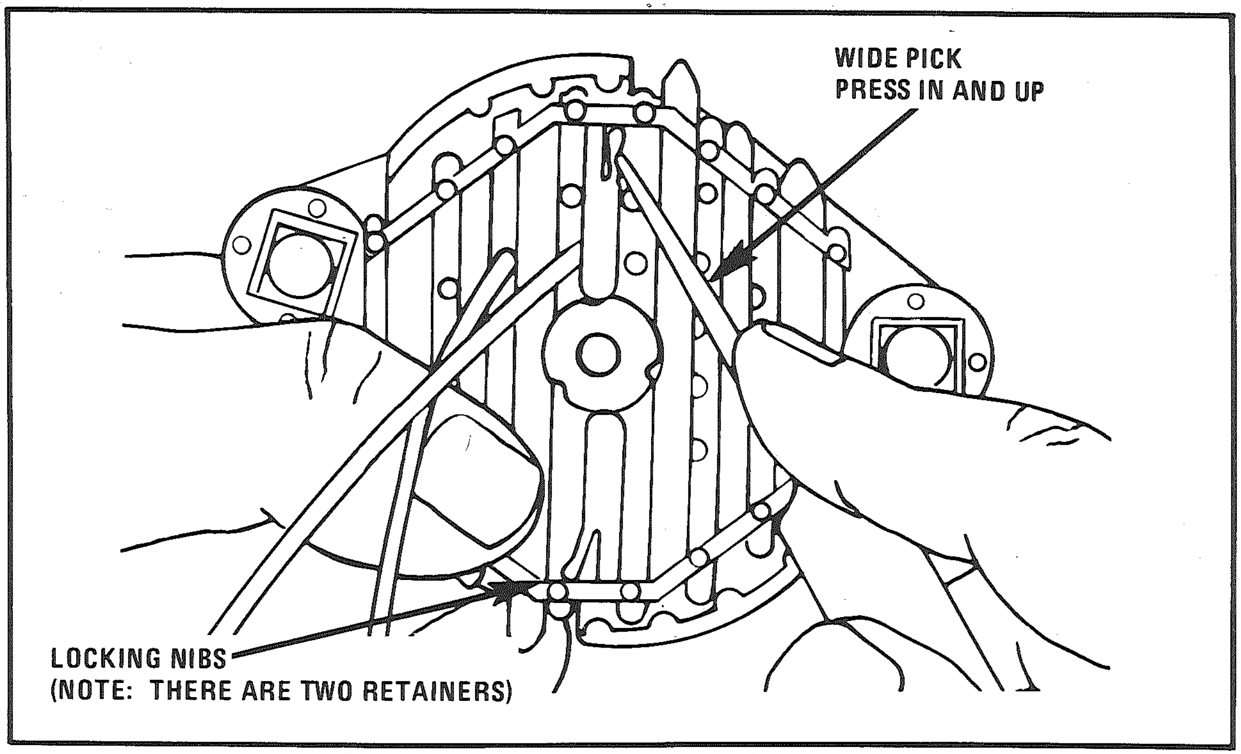


Figure 24 - Releasing the Terminal Retainers (Large Connectors)

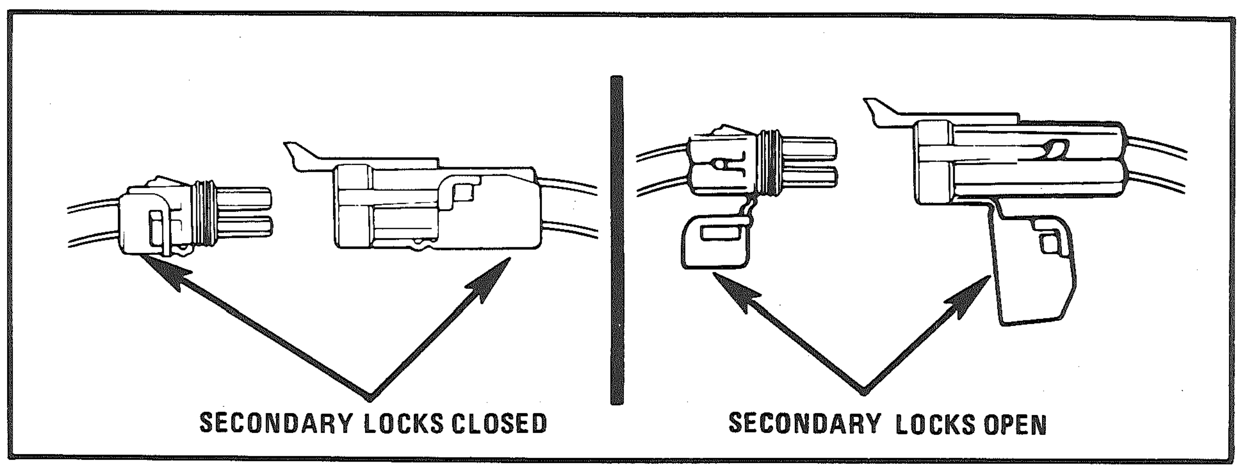


Figure 25 - Opening the Secondary Locks (Small Connectors)

Step Four: Re-Form the Locking Tang

If the lead and terminal are in good condition, re-form the locking tang.

- —Hold the lead firmly to prevent the splice between the terminal and the wire from flexing.
- —Use the pick (J28742-A or the equivalent) to bend the locking tang back into its original shape (see Figure 28). Also, check to see that the remainder of the terminal is still in its original shape. (See Step Six for instruction in inserting the lead.)

Step Five: Make the Repair

When you make a repair, use the correct types of terminals, wires, and seals.

To add a new lead, cut the wire and crimp and solder on the Weather Pack® lead assembly (see Figure 29) using rosin core solder. (Follow the instructions for splicing wire outlined earlier in this section for a review of splicing procedures.)

If Weather Pack® lead assemblies are not available, splice a new terminal and cable seal onto the existing wire.

- —Cut the wire immediately behind the cable seal.
- —Slip the new cable seal onto the wire and push it back out of the way.
- —Strip 5.0mm (3/16") of insulation from the wire.

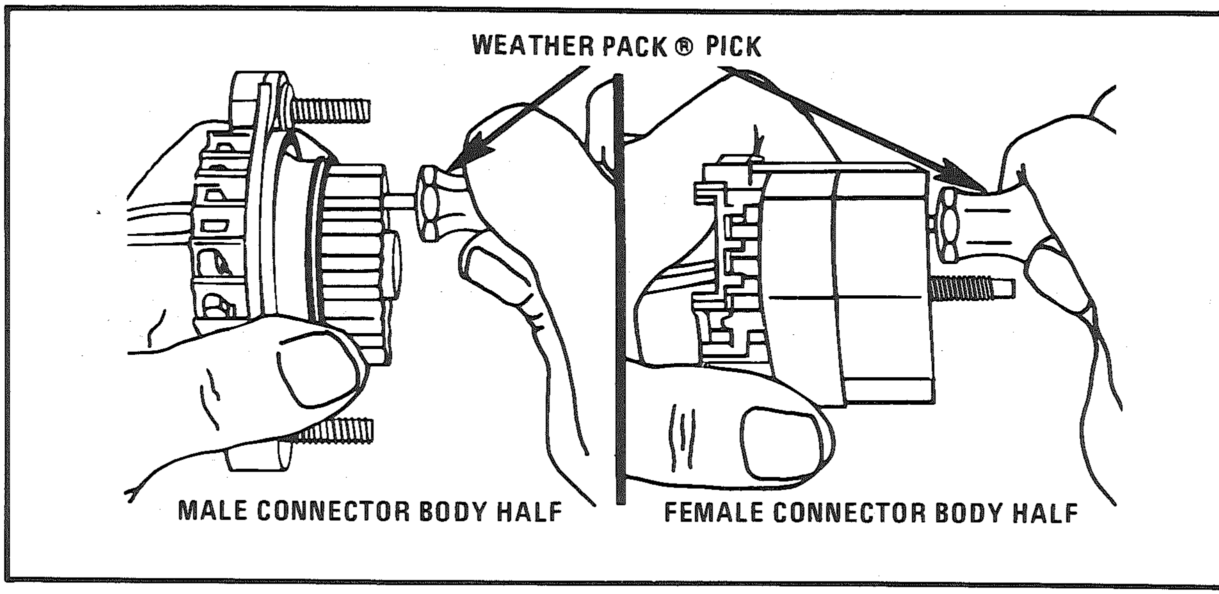


Figure 26 - Releasing The Terminal Locking Tangs (Large Connector)

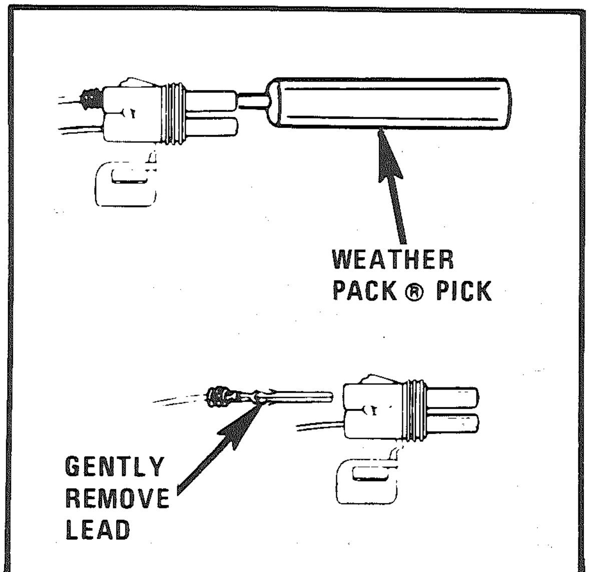


Figure 27 - Releasing The Terminal Locking Tangs (Small Connectors)

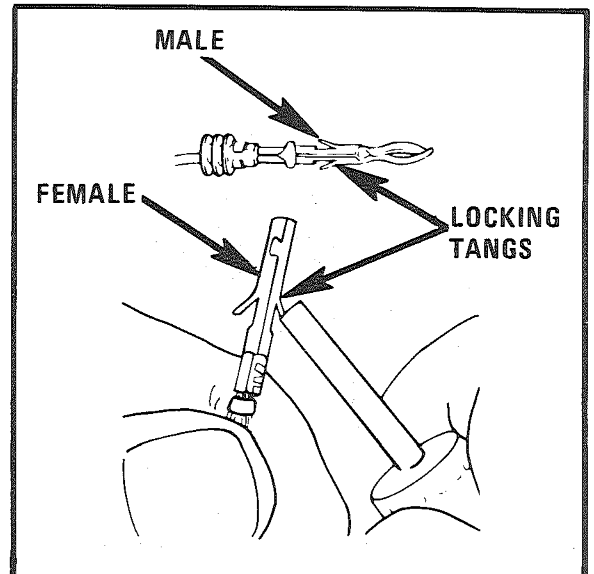


Figure 28 - Re-Forming The Locking Tang

—Crimp the new terminal over the copper strands (core crimp) as shown in Figure 30. (Use a standard crimping tool, number J25563 in the Kent-Moore catalog.)
—Solder with rosin core solder.
—Move the cable seal to edge of the insulation.
—Crimp the grips at the end of the terminal around the cable seal and insulated wire as shown in Figure 30 (insulation crimp). Apply light pressure for this crimp.

Remember to use the proper types of terminals and seals for this repair.

Step Six: Insert the Lead

Before inserting the lead, make certain that the terminal is correctly shaped (see Figure 28). Then, gently insert the lead from the back. The terminal should stop or "catch" about halfway through the connector body. Gently push back and forth on the lead to be sure the terminal is held in place in both directions. If the terminal easily pushes or pulls out, review Step Four: "Re-Form the Locking Tang."

Be careful to insert leads in their proper locations.

Step Seven: Replace the Terminal Retainer(s) (Large Connectors)/Secondary Locks (Small Connectors)

Replace the terminal retainers by slipping the retainer halves into the connector body (as shown in Figure 31).

To close the secondary locks on small connectors, flip the hinges back to their original positions (see Figure 32).

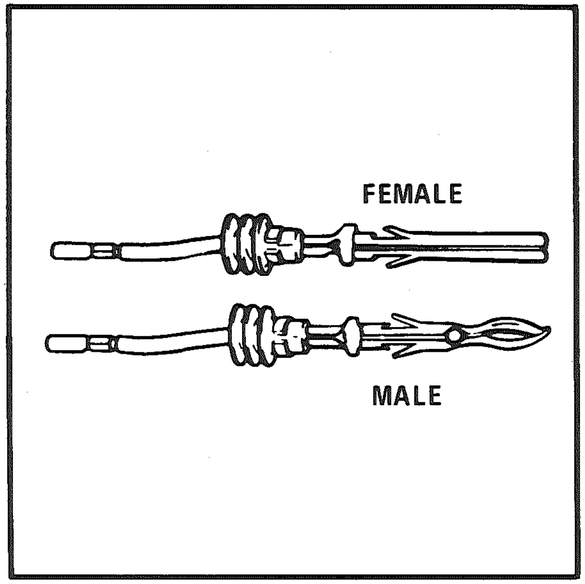


Figure 29 - Lead Assemblies

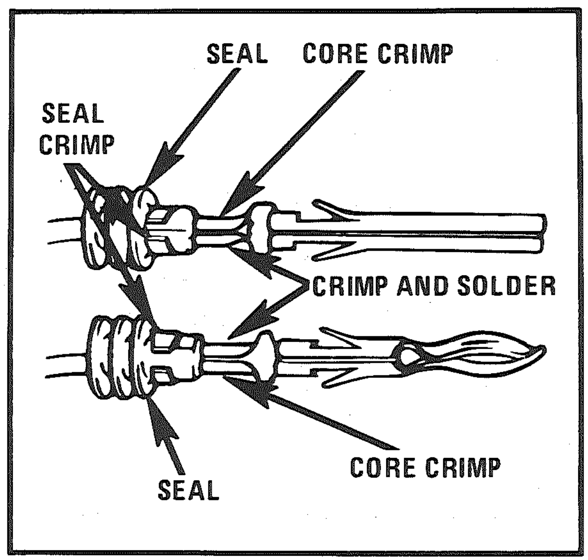


Figure 30 - Replacing The Terminal

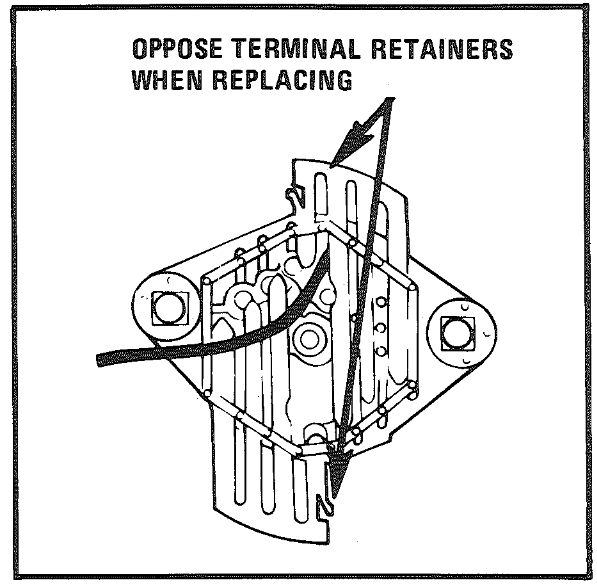


Figure 31 - Replacing The Terminal Retainers (Large Connectors)

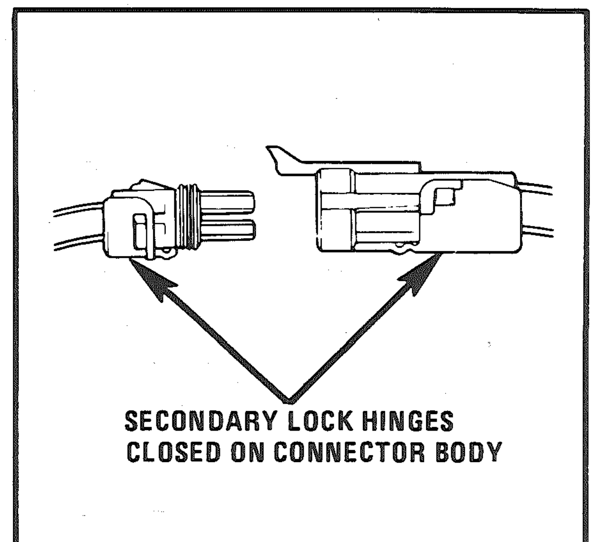


Figure 32 - Closing The Secondary Locks

REPAIRING METRI-PACK SERIES 150 CONNECTORS
(Pull-to-Seat Type)

Metri-Pack connectors are used to connect various sensors such as the cam, crankshaft and coolant sensors to primary harnesses in the engine compartment. The Metri-Pack connector consists of three parts (see Figure 35): a Pull to Seat type terminal, a connector body and a rubber seal which is inserted in the back of the connector body to provide environmental protection.

Do not replace the Metri-Pack parts with parts of other types of connectors and terminals or omit the environmental seals when repairing Metri-Pack connectors.

Repair instructions are divided into two steps, connector disassembly and terminal removal and connector assembly and terminal insertion. (Refer to figures 33 to 36)

Step One: Connector Disassembly and Terminal Removal

Insert tool BT-8446 or J35689 into the connector (Figure 33). Pull back on the wire slightly, pry up the locking tang and then push the wire through the front of the connector. If the terminal will be reused, reshape the locking tang.

Step 2: Connector Assembly and Terminal Insertion

Insert the wire through the seal and the connector body (Figure 35). Crimp the terminal to the stripped wire. Pull the wire and the terminal back through the connector body until it locks in place (Figure 36).

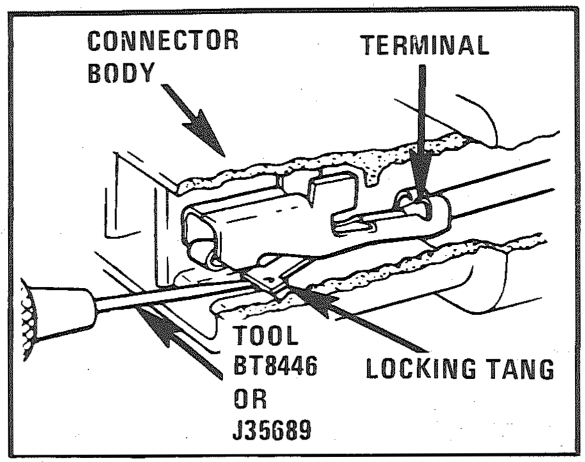


Figure 33 - Terminal Removal From Connector Body

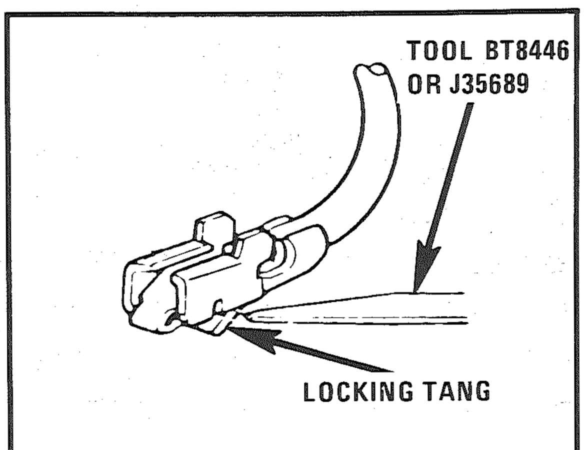


Figure 34 - Reforming The Locking Tang

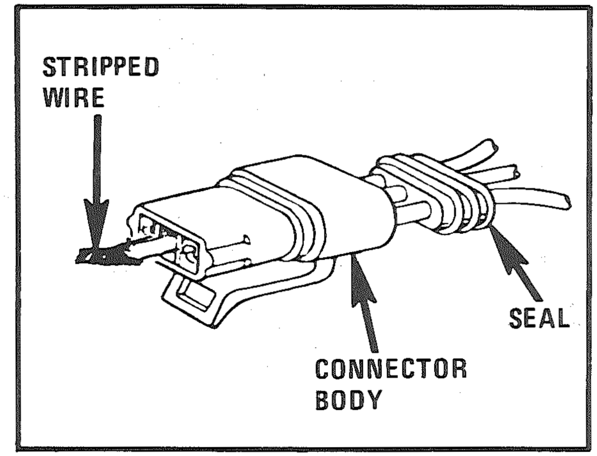


Figure 35 - Connector Reassembly

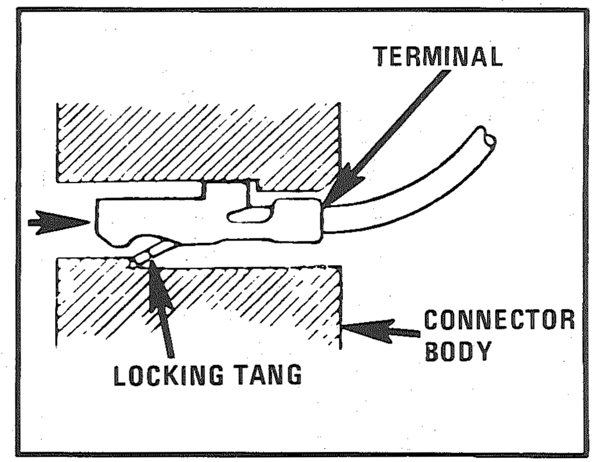
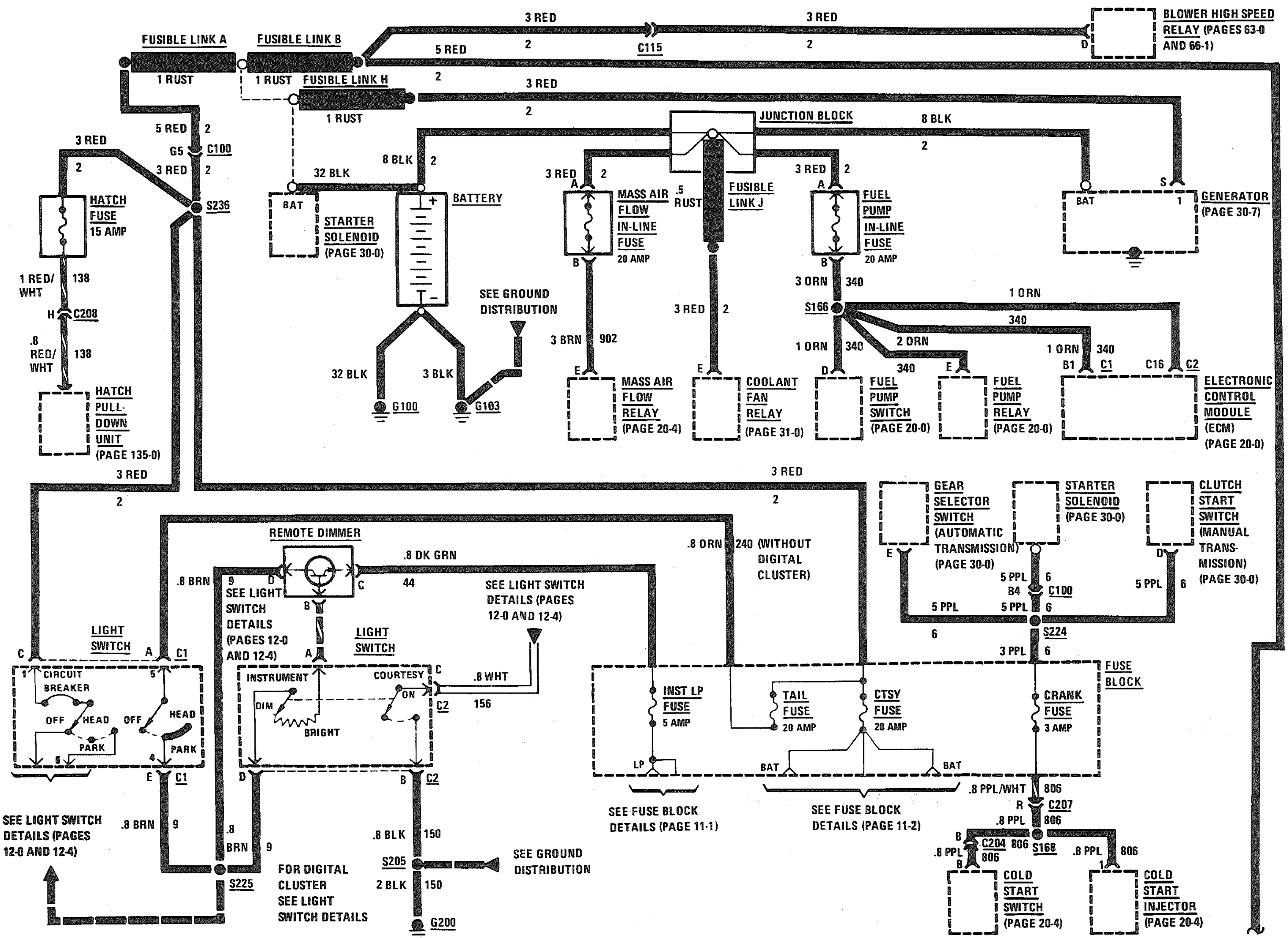
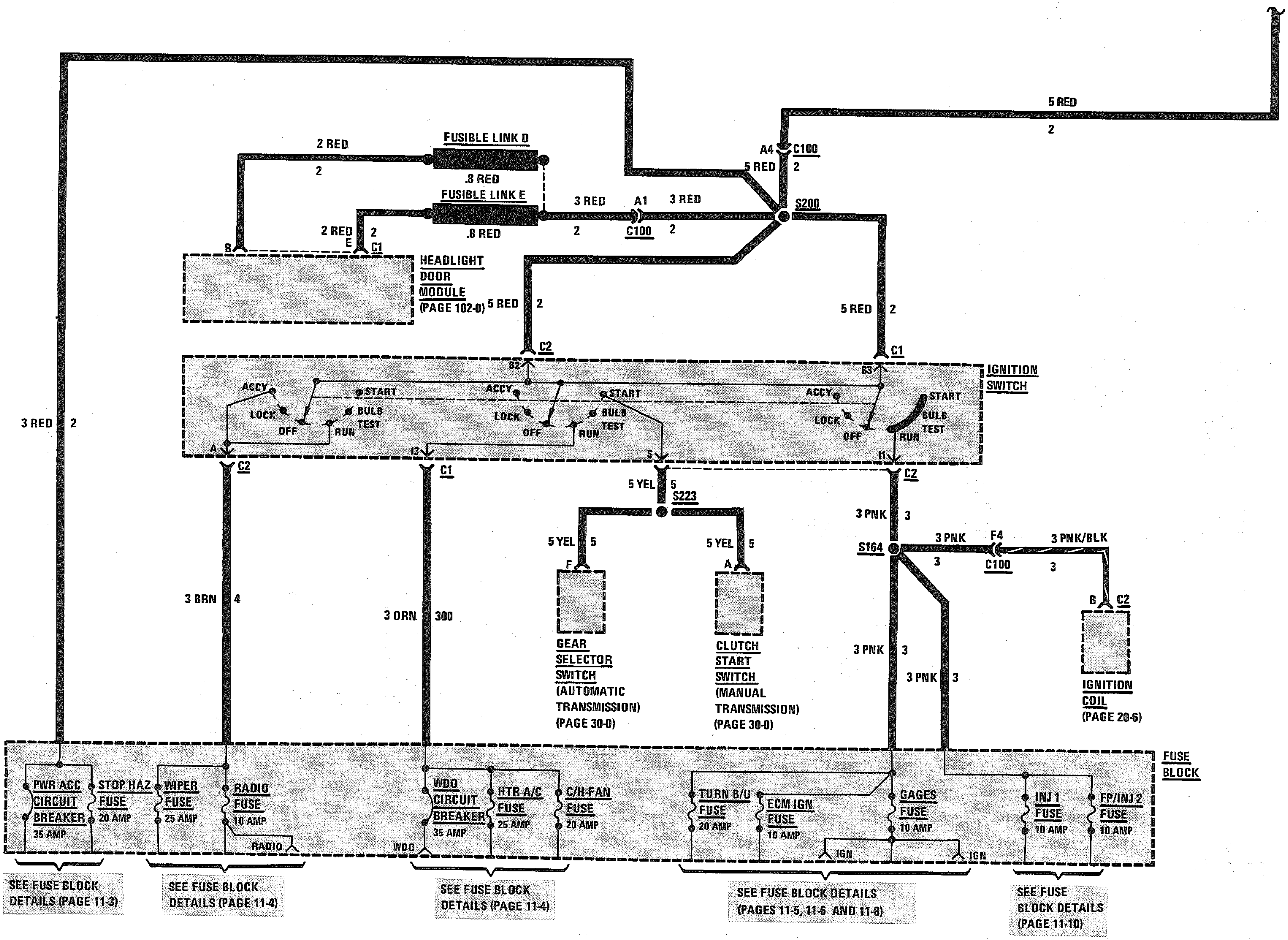


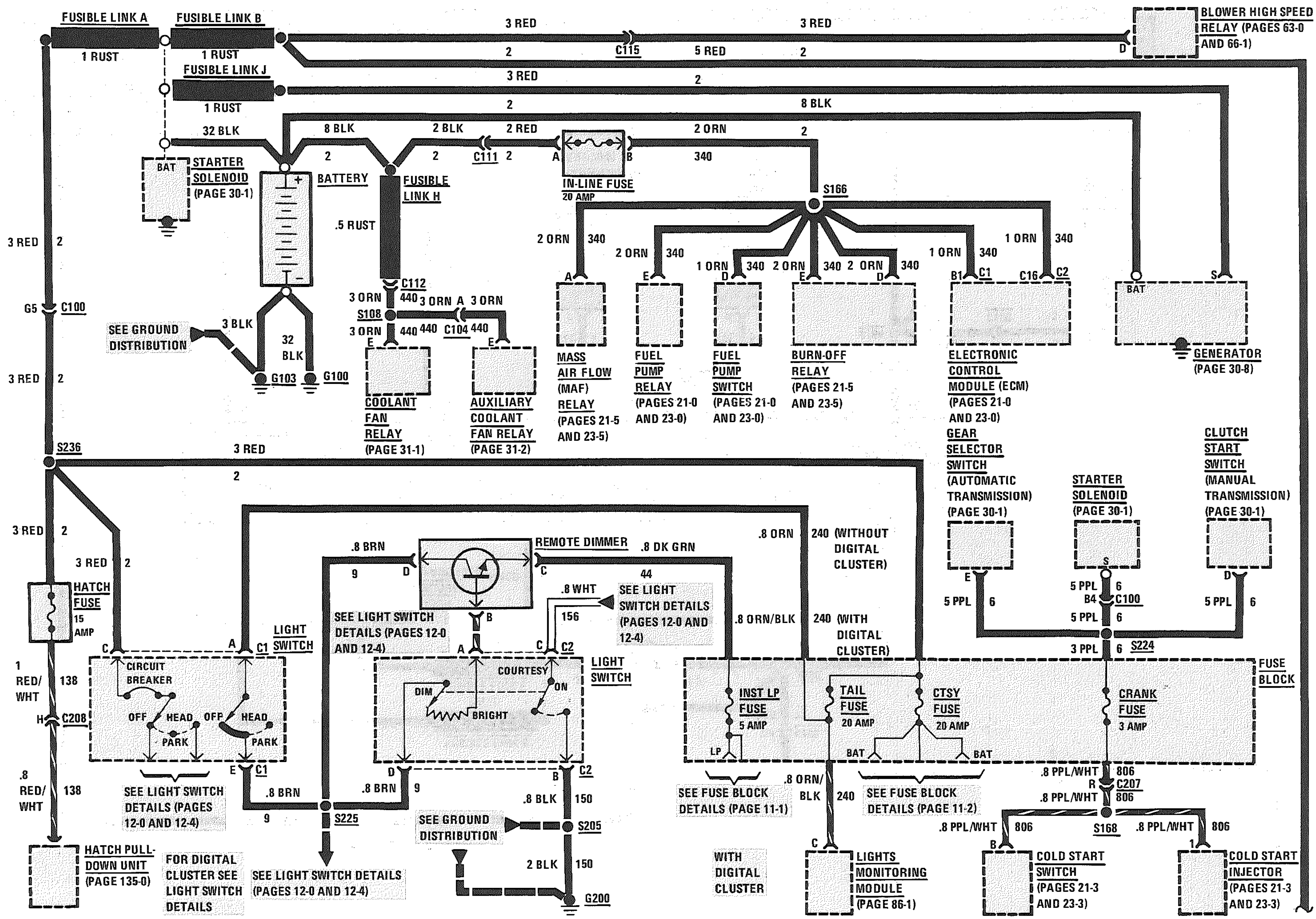
Figure 36 - Terminal Reinsertion

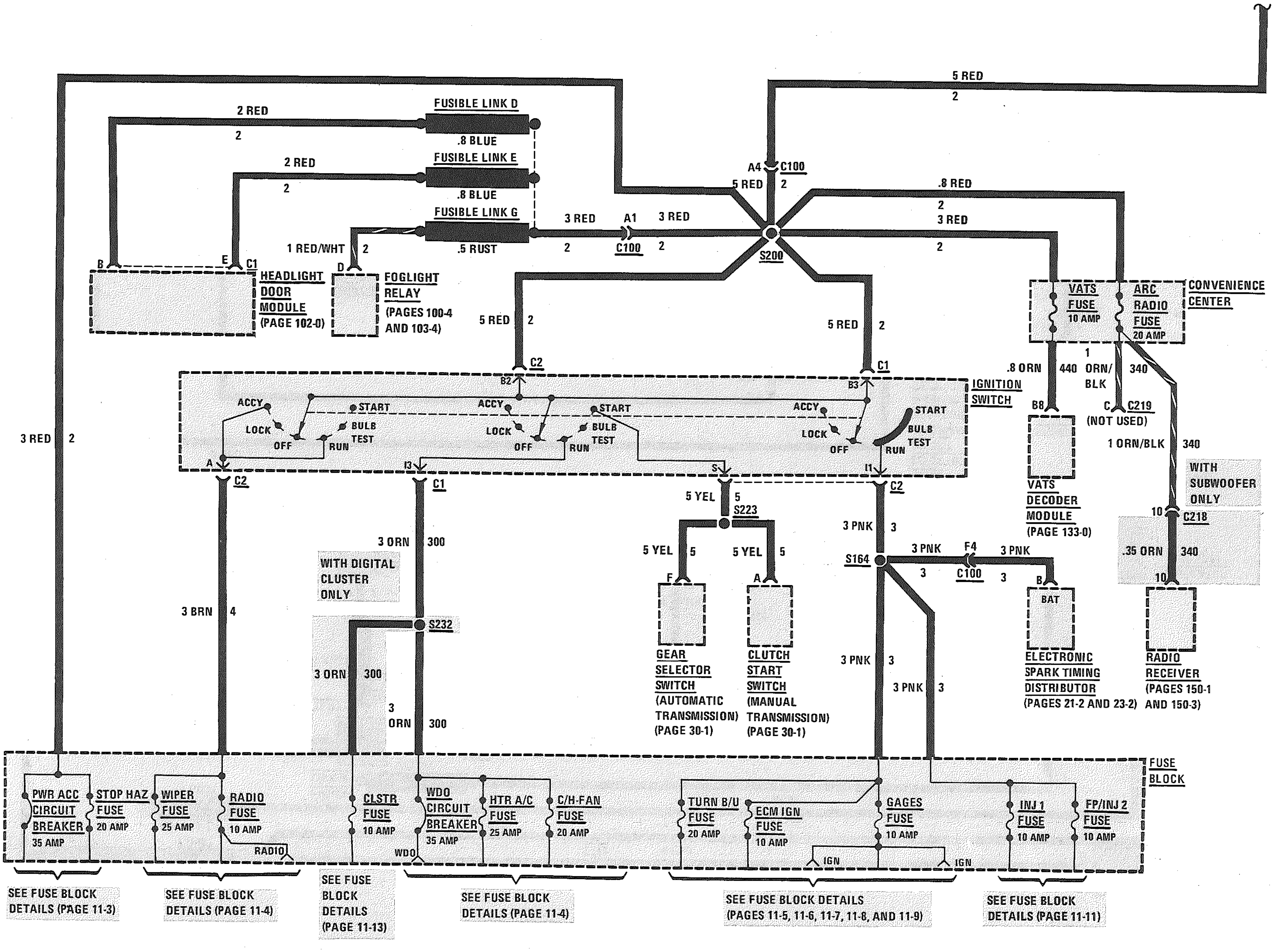
POWER DISTRIBUTION: V6 VIN S




5 RED
2
A4
C100
5 RED
2
2 RED
2
FUSIBLE LINK D
.8 RED
FUSIBLE LINK E
.8 RED
3 RED
A1
3 RED
2
C100
2
S200
2 RED
2
E
C1
B
HEADLIGHT DOOR MODULE (PAGE 102-0)
5 RED
2
5 RED
2
C2
B2
C1
B3
IGNITION SWITCH
ACCY
START
LOCK
BULB TEST
OFF
RUN
3 RED
2
A
C2
I3
C1
S
I1
C2
5 YEL
5
S223
5 YEL
5
5 YEL
5
F
A
GEAR SELECTOR SWITCH (AUTOMATIC TRANSMISSION) (PAGE 30-0)
CLUTCH START SWITCH (MANUAL TRANSMISSION) (PAGE 30-0)
3 PNK
3
S164
3 PNK
F4
C100
3
3 PNK/BLK
3
B
C2
IGNITION COIL (PAGE 20-6)
3 BRN
4
3 ORN
300
3 PNK
3
3 PNK
3
FUSE BLOCK
PWR ACC CIRCUIT BREAKER 35 AMP
STOP HAZ FUSE 20 AMP
WIPER FUSE 25 AMP
RADIO FUSE 10 AMP
RADIO
WDO
WDO CIRCUIT BREAKER 35 AMP
HTR A/C FUSE 25 AMP
C/H-FAN FUSE 20 AMP
TURN B/U FUSE 20 AMP
ECM IGN FUSE 10 AMP
GAGES FUSE 10 AMP
IGN
IGN
INJ 1 FUSE 10 AMP
FP/INJ 2 FUSE 10 AMP
SEE FUSE BLOCK DETAILS (PAGE 11-3)
SEE FUSE BLOCK DETAILS (PAGE 11-4)
SEE FUSE BLOCK DETAILS (PAGE 11-4)
SEE FUSE BLOCK DETAILS (PAGES 11-5, 11-6 AND 11-8)
SEE FUSE BLOCK DETAILS (PAGE 11-10)

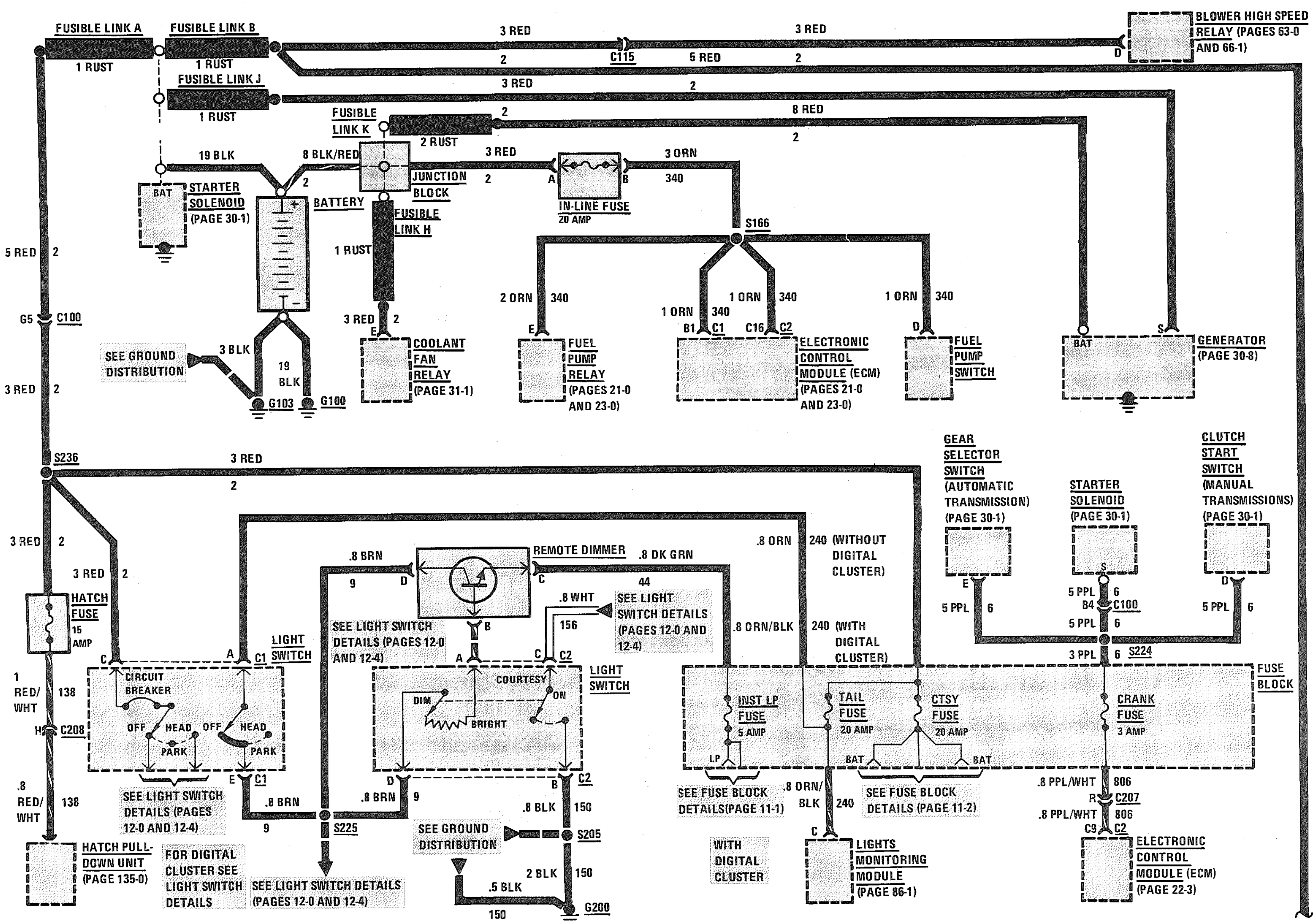
POWER DISTRIBUTION: V8 VIN F, V8 VIN 8

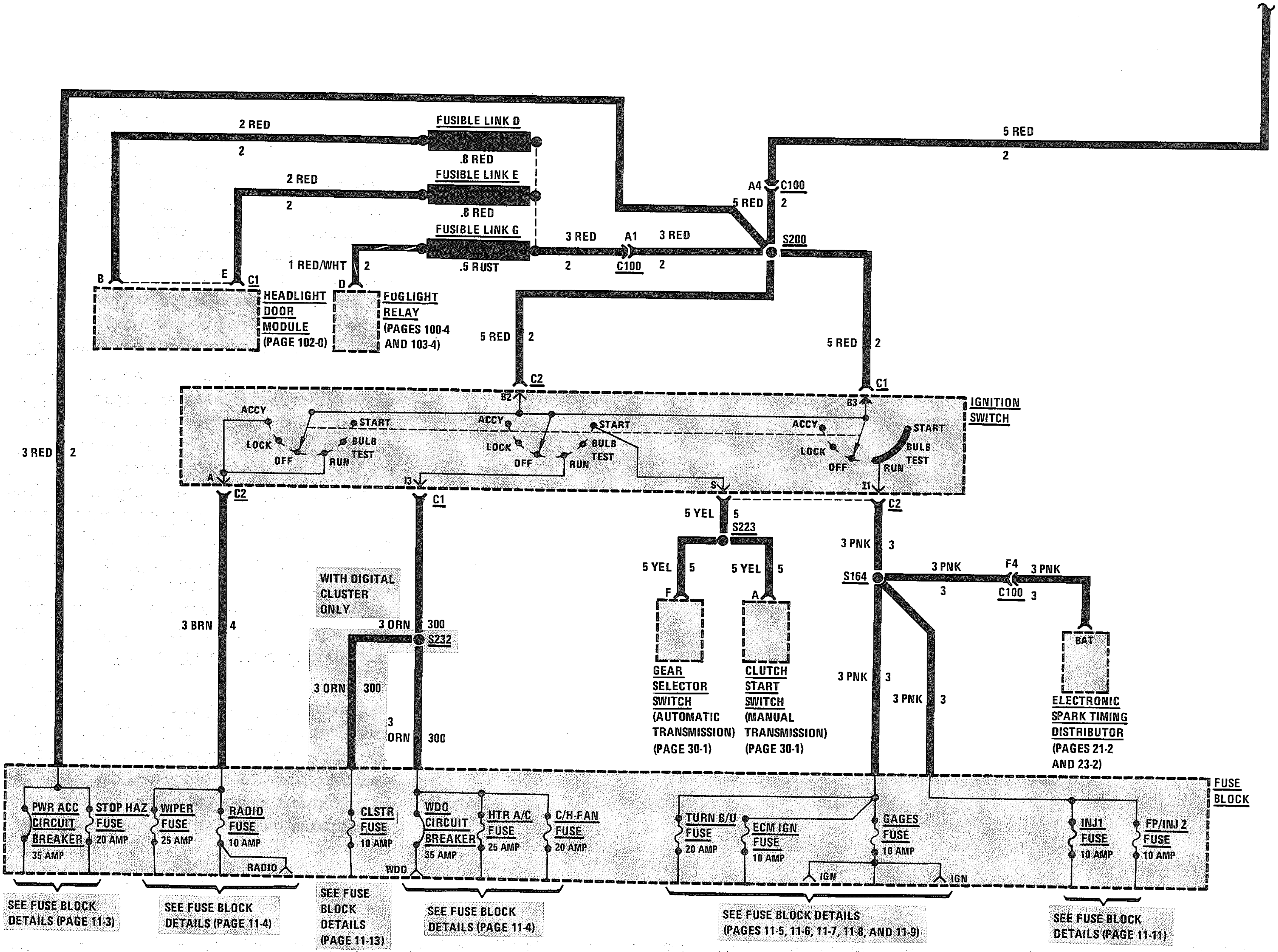




FUSIBLE LINK D
2 RED
2
.8 BLUE
FUSIBLE LINK E
2 RED
2
.8 BLUE
FUSIBLE LINK G
1 RED/WHT
2
.5 RUST
3 RED
A1
3 RED
C100
5 RED
2
A4
C100
5 RED
2
.8 RED
2
3 RED
2
S200
HEADLIGHT DOOR MODULE (PAGE 102-0)
B
E
C1
D
FOGLIGHT RELAY (PAGES 100-4 AND 103-4)
5 RED
5 RED
C2
C1
B2
B3
IGNITION SWITCH
ACCY
LOCK
OFF
RUN
START
BULB TEST
A
C2
I3
C1
S
I1
C2
CONVENIENCE CENTER
VATS FUSE 10 AMP
ARC RADIO FUSE 20 AMP
.8 ORN
440
1 ORN/BLK
340
B8
C
C219
(NOT USED)
VATS DECODER MODULE (PAGE 133-0)
1 ORN/BLK
340
WITH SUBWOOFER ONLY
10
C218
.35 ORN
340
RADIO RECEIVER (PAGES 150-1 AND 150-3)
3 RED
3 BRN
4
3 ORN
300
WITH DIGITAL CLUSTER ONLY
S232
3 ORN
300
3 ORN
300
5 YEL
5
S223
5 YEL
5
F
GEAR SELECTOR SWITCH (AUTOMATIC TRANSMISSION) (PAGE 30-1)
A
CLUTCH START SWITCH (MANUAL TRANSMISSION) (PAGE 30-1)
3 PNK
3
S164
3 PNK
F4
C100
3 PNK
B
BAT
ELECTRONIC SPARK TIMING DISTRIBUTOR (PAGES 21-2 AND 23-2)
3 PNK
3
3 PNK
3
FUSE BLOCK
PWR ACC CIRCUIT BREAKER 35 AMP
STOP HAZ FUSE 20 AMP
WIPER FUSE 25 AMP
RADIO FUSE 10 AMP
RADIO
CLSTR FUSE 10 AMP
WDO CIRCUIT BREAKER 35 AMP
WDO
HTR A/C FUSE 25 AMP
C/H-FAN FUSE 20 AMP
TURN B/U FUSE 20 AMP
ECM IGN FUSE 10 AMP
IGN
GAGES FUSE 10 AMP
IGN
INJ 1 FUSE 10 AMP
FP/INJ 2 FUSE 10 AMP
SEE FUSE BLOCK DETAILS (PAGE 11-3)
SEE FUSE BLOCK DETAILS (PAGE 11-4)
SEE FUSE BLOCK DETAILS (PAGE 11-13)
SEE FUSE BLOCK DETAILS (PAGE 11-4)
SEE FUSE BLOCK DETAILS (PAGES 11-5, 11-6, 11-7, 11-8, AND 11-9)
SEE FUSE BLOCK DETAILS (PAGE 11-11)

POWER DISTRIBUTION: V8 VIN E




FUSIBLE LINK D
2 RED
2
.8 RED
FUSIBLE LINK E
2 RED
2
.8 RED
FUSIBLE LINK G
1 RED/WHT
2
.5 RUST
3 RED
A1
3 RED
2
C100
2
5 RED
2
A4
C100
5 RED
2
S200
B
E
C1
HEADLIGHT DOOR MODULE (PAGE 102-0)
D
FOGLIGHT RELAY (PAGES 100-4 AND 103-4)
5 RED
2
5 RED
2
C2
C1
B2
B3
IGNITION SWITCH
ACCY
START
LOCK
OFF
RUN
BULB TEST
A
I3
S
I1
3 RED
2
C2
C1
C2
5 YEL
5
S223
5 YEL
5
5 YEL
5
F
A
GEAR SELECTOR SWITCH (AUTOMATIC TRANSMISSION) (PAGE 30-1)
CLUTCH START SWITCH (MANUAL TRANSMISSION) (PAGE 30-1)
3 PNK
3
S164
3 PNK
3
F4
3 PNK
C100
3
BAT
ELECTRONIC SPARK TIMING DISTRIBUTOR (PAGES 21-2 AND 23-2)
3 PNK
3
3 PNK
3
WITH DIGITAL CLUSTER ONLY
3 BRN
4
3 ORN
300
S232
3 ORN
300
3 ORN
300
FUSE BLOCK
PWR ACC CIRCUIT BREAKER 35 AMP
STOP HAZ FUSE 20 AMP
WIPER FUSE 25 AMP
RADIO FUSE 10 AMP
RADIO
CLSTR FUSE 10 AMP
WDO
WDO CIRCUIT BREAKER 35 AMP
HTR A/C FUSE 25 AMP
C/H-FAN FUSE 20 AMP
TURN B/U FUSE 20 AMP
ECM IGN FUSE 10 AMP
GAGES FUSE 10 AMP
IGN
IGN
INJ1 FUSE 10 AMP
FP/INJ 2 FUSE 10 AMP
SEE FUSE BLOCK DETAILS (PAGE 11-3)
SEE FUSE BLOCK DETAILS (PAGE 11-4)
SEE FUSE BLOCK DETAILS (PAGE 11-13)
SEE FUSE BLOCK DETAILS (PAGE 11-4)
SEE FUSE BLOCK DETAILS (PAGES 11-5, 11-6, 11-7, 11-8, AND 11-9)
SEE FUSE BLOCK DETAILS (PAGE 11-11)

POWER DISTRIBUTION

CIRCUIT OPERATION

Electrical power for the car is provided by the Generator when the engine is running. The schematic diagram shows how each circuit gets its power. For more details about the Generator, and connections to the Battery and Starter, see Starter and Charging System, Section 8A-30.

The car's Power Distribution System consists of Fusible Links, Fuses, Circuit Breakers, the Light Switch and the Ignition Switch. Fusible Links are short pieces of wire to which they supply power. They are covered with a special high-temperature insulation. When conducting a high current, the Fusible Link will melt and stop current flow. They are designed to protect the car's electrical system from electrical shorts where it is not protected by the Circuit Breakers and Fuses. See Fuse Block Details and Light Switch Details for complete wiring to the first component in each circuit.

The Ignition Switch has six positions, five of which have detents. The BULB TEST position is after the RUN position and just before the START position. BULB TEST does not have a detent. As shown in the schematic, circuits which are supplied from the Ignition Switch are On (Hot) for different switch positions. Individual schematics show their fuses supplied from headings such as "Hot In Run." The heading corresponds to the Ignition Switch position in which power is On.

COMPONENT LOCATION

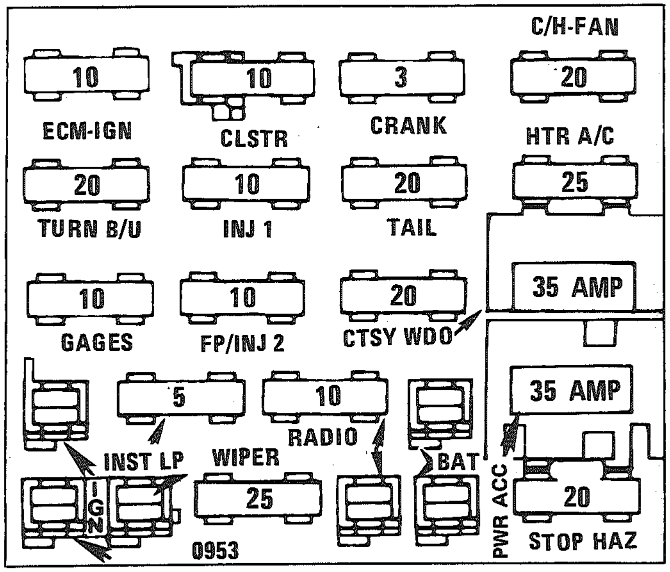
Component	Location	Page-Figure
Auxiliary Coolant Fan Relay	RH front side of engine compartment	201- 5-A
Blower High Speed Relay	RH front of dash, near Blower Motor	201-14-A
Burn-Off Relay	LH rear corner of engine compartment, on relay bracket	201- 7-A
Clutch Start Switch	Above clutch pedal, on clutch pedal support	
Cold Start Injector (VIN F) (VIN 8)	Top LH side of engine	201- 7-A
Cold Start Injector (VIN S)	Top LH rear of engine	201- 0-C
Cold Start Switch (VIN F) (VIN 8)	Top center of engine	201- 8-C
Cold Start Switch (VIN S)	Top of engine	
Convenience Center	Behind I/P, to right of steering column	201-10-A
Coolant Fan Relay (VIN E)	LH rear corner of engine compartment, on relay bracket	201- 3-A
Coolant Fan Relay (VIN F) (VIN 8)	Front of engine compartment, RH side of radiator support	201- 5-A
Coolant Fan Relay (VIN S)	LH rear corner of engine compartment, on relay bracket	201- 0-A
Electronic Control Module (ECM)	Behind RH side of I/P	201-12-B
Electronic Spark Timing (EST) Distributor (VIN E)	Top rear of engine	201- 3-A
Electronic Spark Timing (EST) Distributor (VIN F) (VIN 8)	Top rear of engine	201- 5-A
Fog Light Relay	LH front of engine compartment, on fender	201-16-A
Fuel Pump In-Line Fuse	RH side of engine compartment, on inner fender panel	201- 1-A
Fuel Pump Relay (VIN E)	LH rear corner of engine compartment, on relay bracket	201- 3-A
Fuel Pump Relay (VIN F) (VIN 8)	LH rear corner of engine compartment, on relay bracket	201- 7-A
Fuel Pump Relay (VIN S)	LH rear corner of engine compartment, on relay bracket	201- 0-A
Fuel Pump Switch (VIN E)	Lower LH rear of engine	201- 3-A
Fuel Pump Switch (VIN F) (VIN 8)	Lower LH side of engine	201- 8-A
Fuel Pump Switch (VIN S)	Lower LH side of engine	201- 0-A
Fuse Block	Behind LH side of I/P, below light switch	201-10-A
Fusible Link A (VIN E)	Lower RH side of engine, at Starter Solenoid	201- 2-A
Fusible Link A (VIN F) (VIN 8)	Lower RH side of engine, at Starter Solenoid	201- 6-B

COMPONENT LOCATION

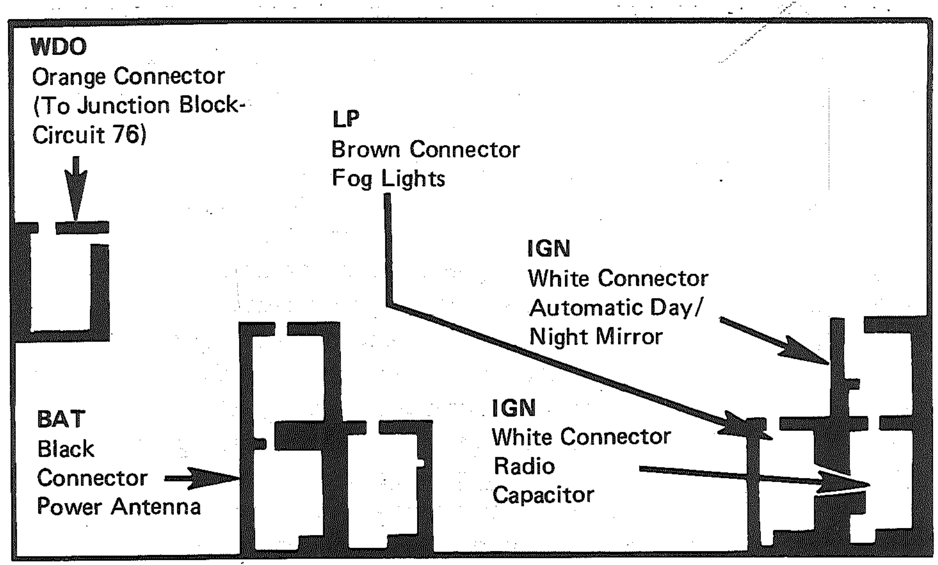
Component	Location	Page-Figure
Fusible Link A (VIN S)	Lower RH side of engine, at Starter Solenoid	201- 1-A
Fusible Link B (VIN E)	Lower RH side of engine, at Starter Solenoid	201- 2-A
Fusible Link B (VIN F) (VIN 8)	Lower RH side of engine, at Starter Solenoid	201- 6-B
Fusible Link B (VIN S)	Lower RH side of engine, at Starter Solenoid	201- 1-A
Fusible Link D	Front lights harness, near LH side of dash	201-16-A
Fusible Link E	Front lights harness, near LH side of dash	201-16-A
Fusible Link G	Front lights harness, near LH side of dash	201-16-A
Fusible Link H (VIN E)	RH front of engine compartment, at Junction Block	201- 3-B
Fusible Link H (VIN F) (VIN 8)	LH front of engine compartment, behind battery	201- 5-C
Fusible Link H (VIN S)	Lower RH side of engine, at Starter Solenoid	201- 1-A
Fusible Link J (VIN E)	Lower RH side of engine, at Starter Solenoid	201- 2-A
Fusible Link J (VIN F) (VIN 8)	Lower RH side of engine, at Starter Solenoid	201- 6-B
Fusible Link J (VIN S)	RH side of radiator support, at Junction Block	201- 1-A
Fusible Link K	RH front of engine compartment, at Junction Block	201- 3-B
Gear Selector Switch	In console, at base of gear selector	201-11-E
Hatch Fuse	Attached to side of Fuse Block	
Hatch Pull-Down Unit	Center of end panel, in cargo compartment	201-17-B
Headlight Door Module	LH front of dash	201-16-A
Ignition Coil (VIN S)	Rear RH side of engine	201- 1-A
Ignition Switch	Behind I/P, on top side of steering column	201- 9-A
In-Line Fuse (VIN F)(VIN 8)	On LH side of radiator support, forward of battery	201- 5-C
Junction Block	RH front of engine compartment, behind headlight	201- 1-A
Lights Monitoring Module	Behind I/P, at base of steering column	
Mass Air Flow (MAF) Relay (VIN F) (VIN 8)	LH rear corner of engine compartment, on relay bracket	201- 7-A
Mass Air Flow (MAF) Relay (VIN S)	Front of engine compartment, on RH side of radiator bracket	201- 1-A
Mass Air Flow In-Line Fuse	RH side of engine compartment, on inner fender panel	201- 1-A
Remote Dimmer	RH side of steering column, on I/P retainer	201-10-A
Starter Solenoid (VIN E)	Lower RH side of engine	201- 2-A
Starter Solenoid (VIN F) (VIN 8)	Lower RH side of engine	201- 6-B

COMPONENT LOCATION

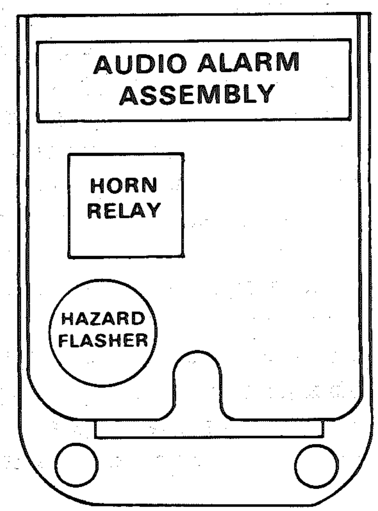
Component	Location	Page-Figure
Starter Solenoid (VIN S)	Lower RH side of engine	201- 1-A
VATS Decoder Module	Behind LH side of I/P, above steering column	
C100 (42 cavities)	LH front of dash, left of brake master cylinder	201- 0-A
C104 (6 cavities)	Front of engine compartment, RH side of radiator	201- 5-A
C111 (1 cavity)	Behind battery, near positive battery cable	201- 7-A
C115 (1 cavity)	Center front of dash	201-14-A
C204 (4 cavities)	Above LH rear corner of engine	201- 0-A
C207 (15 cavities)	Behind RH side of I/P, near ECM	201-13-A
C208 (8 cavities)	Behind LH side of rear seat	201-17-C
C218	Behind center of I/P	201-12-A
C219 (6 cavities)	Behind RH side of I/P, near Subwoofer Amplifier	201-13-B
G100 (VIN E)	RH front of engine	201- 4-B
G100 (VIN F) (VIN 8)	Lower LH front of engine	201- 8-B
G100 (VIN S)	Lower LH front of engine	201- 1-B
G103 (Except VIN E)	On radiator support, behind LH headlights	201-16-A
G200	Behind I/P, left of steering column	201-10-A
S108	Engine harness, lower RH side of engine	201- 5-A
S164	I/P harness, above Fuse Block	201-10-A
S166 (VIN E)	Engine harness, above rear of engine	201- 3-C
S166 (VIN F) (VIN 8)	Engine harness, above LH rear of engine	201- 7-A
S166 (VIN S)	Engine harness, lower RH side of engine	201- 1-A
S168 (VIN F) (VIN 8)	Engine harness, RH front of dash	201- 6-A
S168 (VIN S)	Engine harness, top rear of engine	201- 1-C
S200	I/P harness, behind LH side of I/P	201-10-A
S205	I/P harness, behind instrument cluster	201-10-A
S223	I/P harness, above Fuse Block	201- 9-A
S224	I/P harness, near LH shroud	
S225	I/P harness, behind instrument cluster	201-10-A
S232	I/P harness, behind LH side of I/P, above Fuse Block	201-10-A
S236	I/P harness, below light switch	201-10-A



FRONT VIEW OF
FUSE BLOCK

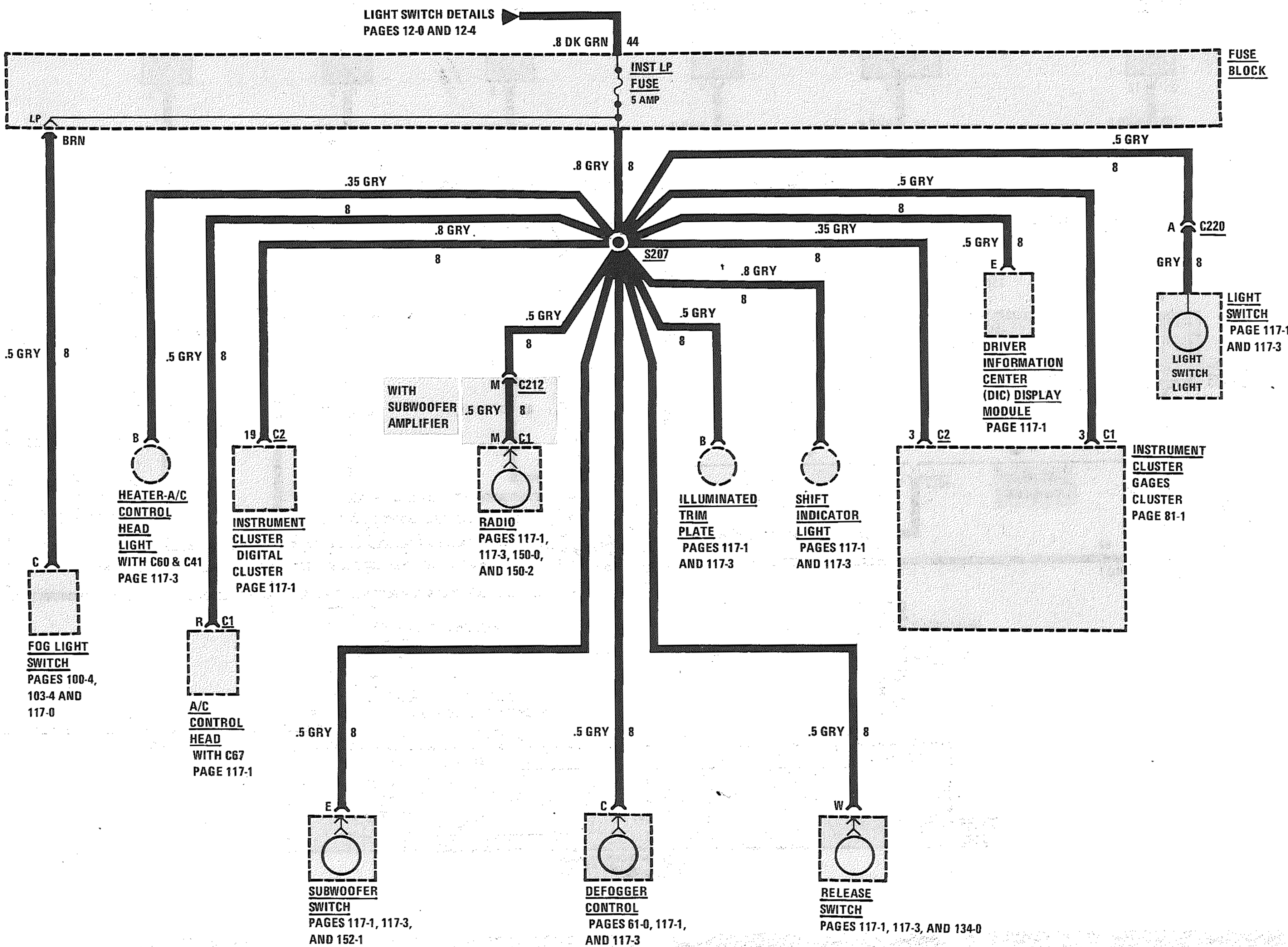


REAR VIEW OF FUSE BLOCK
Cavity and Connector Locations

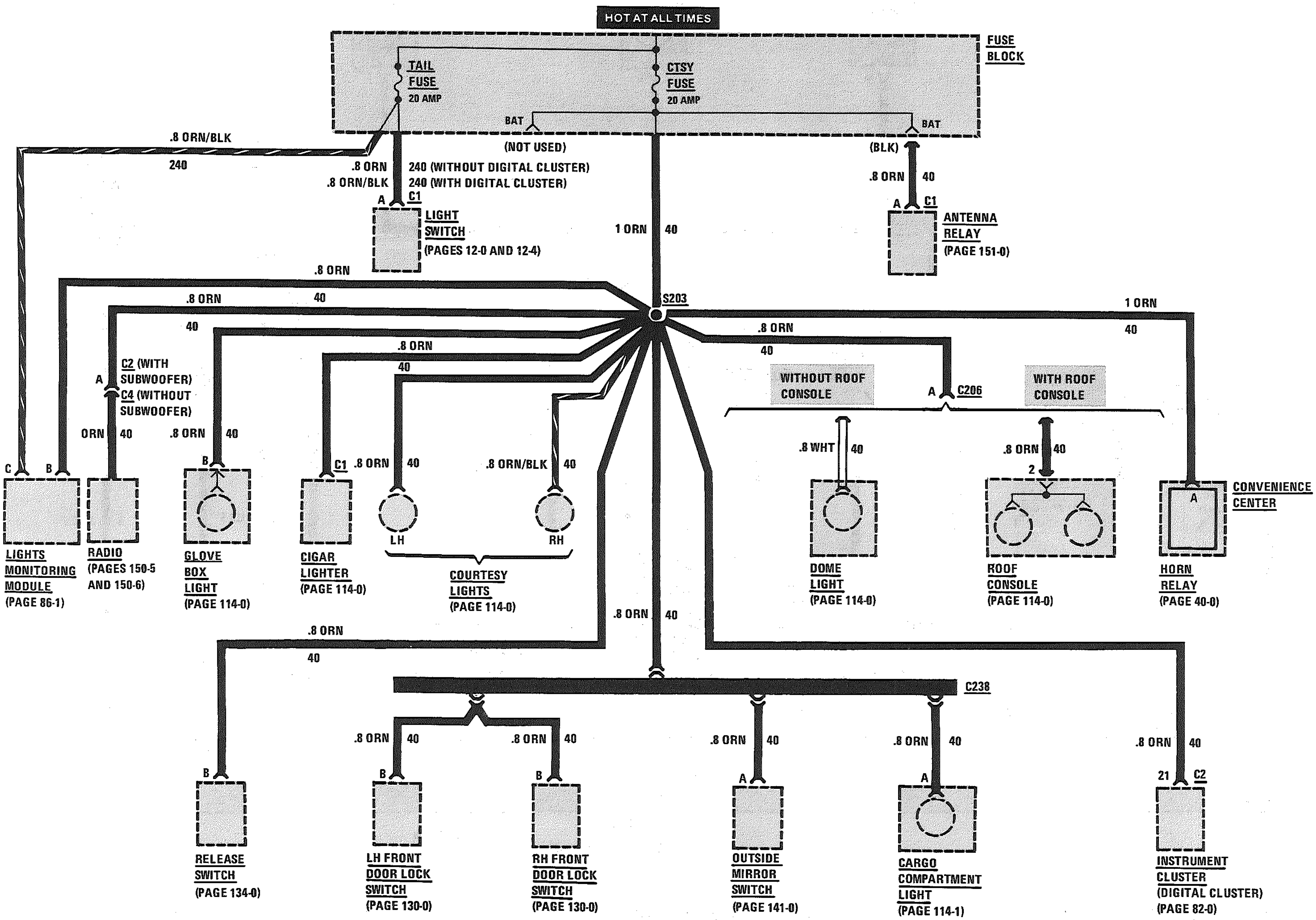


CONVENIENCE CENTER

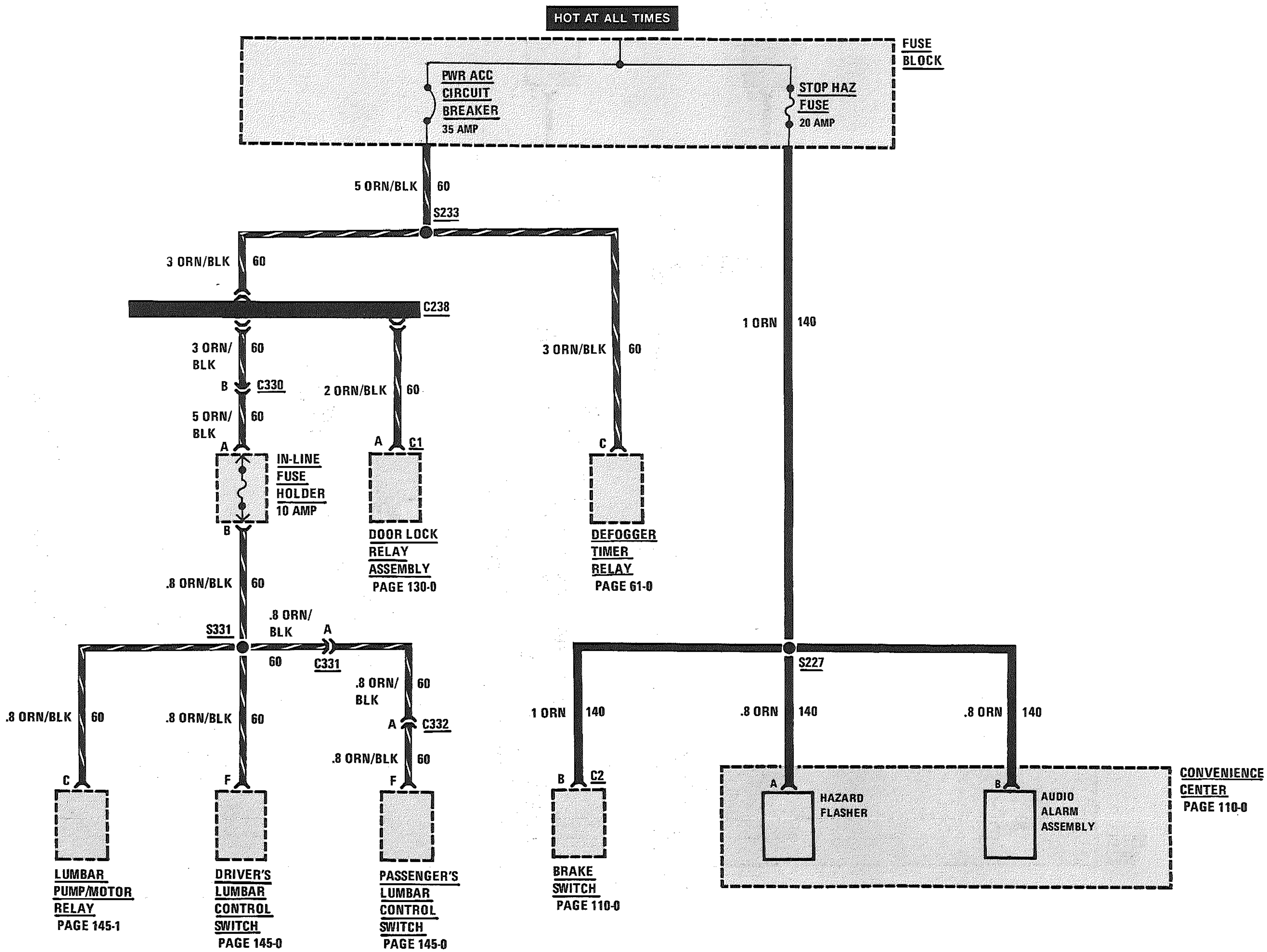
FUSE BLOCK DETAILS: INST LP FUSE



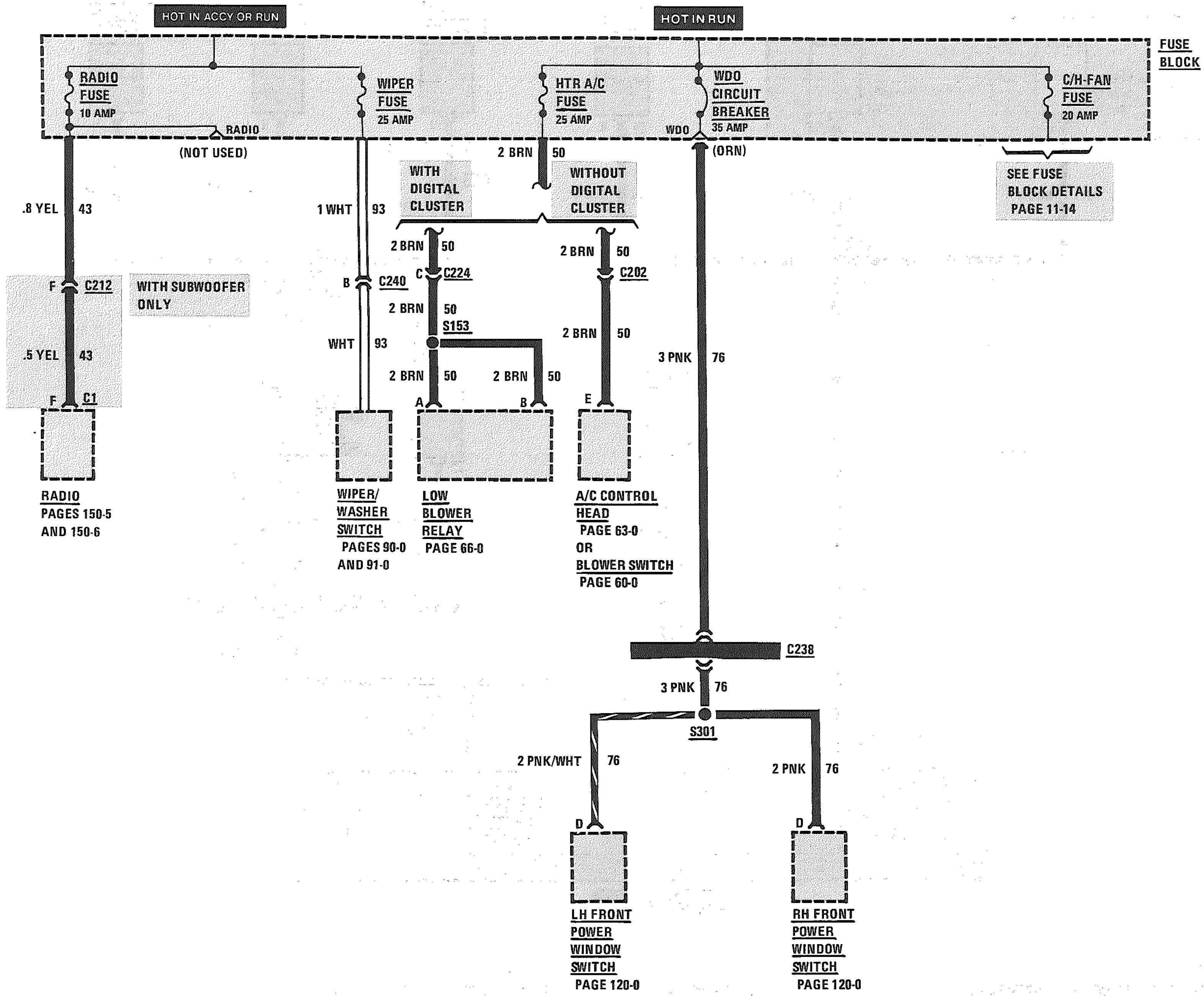
FUSE BLOCK DETAILS: CTSY FUSE AND TAIL FUSE



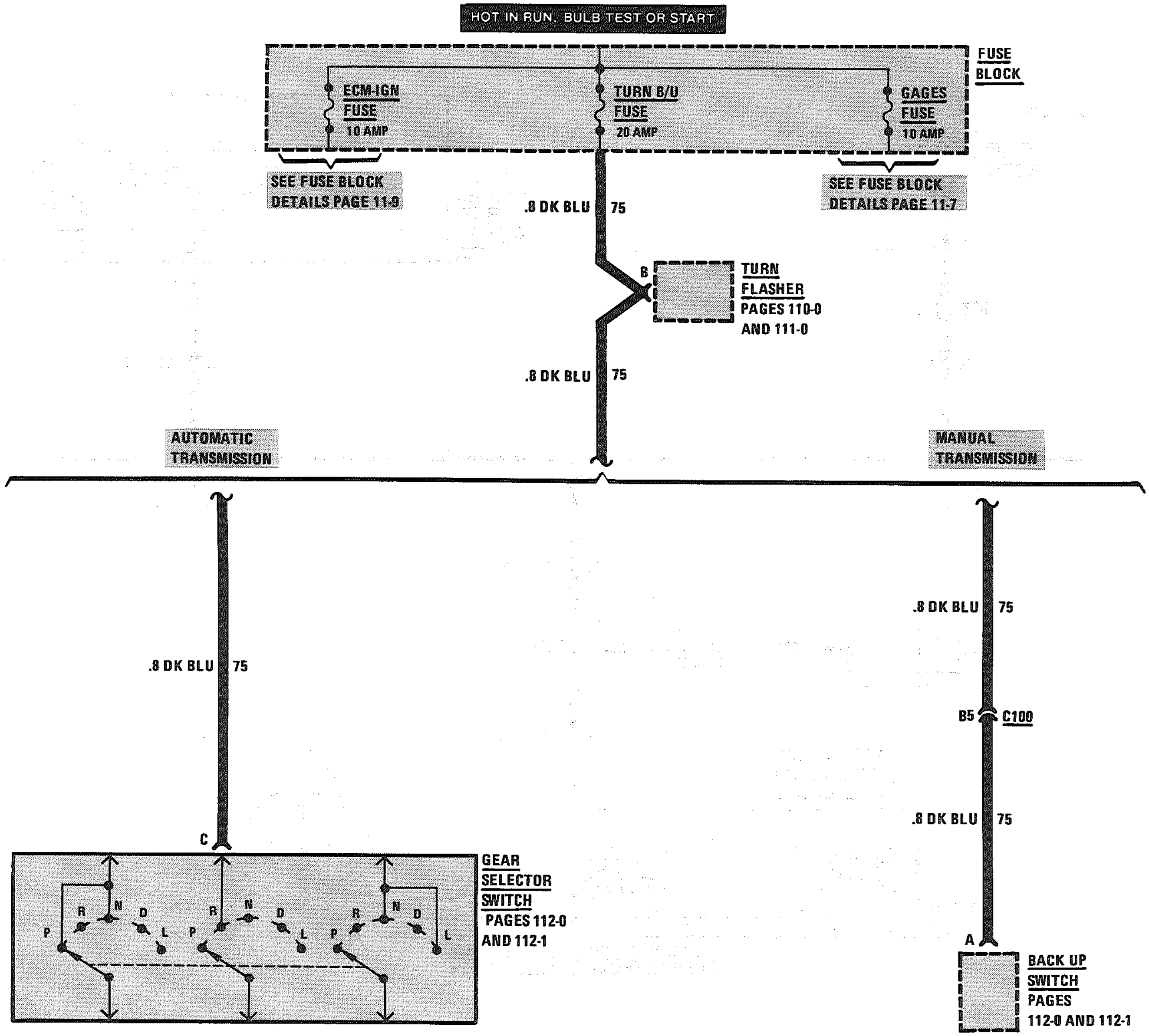
FUSE BLOCK DETAILS: PWR ACC CIRCUIT BREAKER AND STOP HAZ FUSE



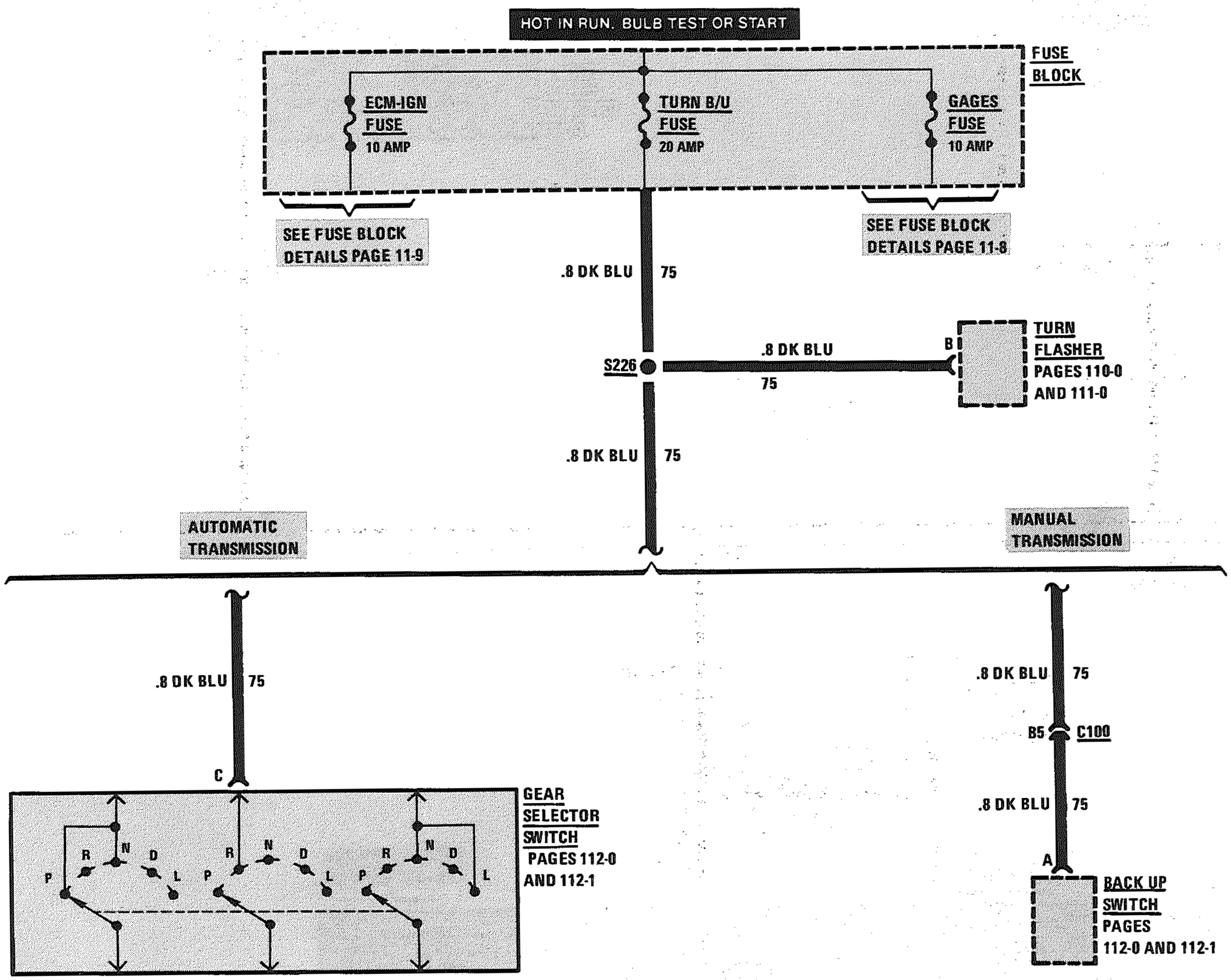
FUSE BLOCK DETAILS: WDO CIRCUIT BREAKER, HTR A/C FUSE, RADIO FUSE, AND WIPER FUSE



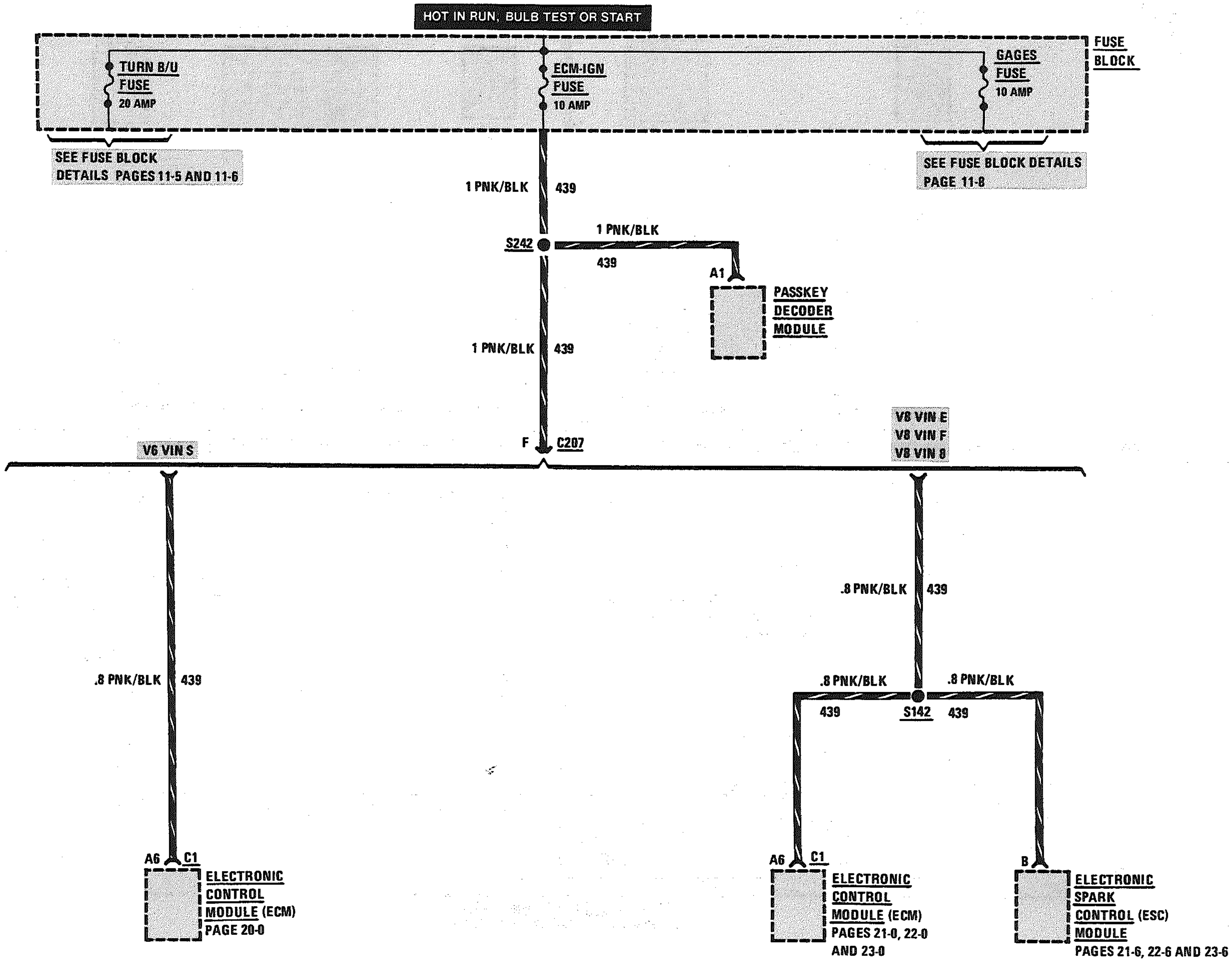
FUSE BLOCK DETAILS: TURN B/U FUSE
WITH DIGITAL CLUSTER



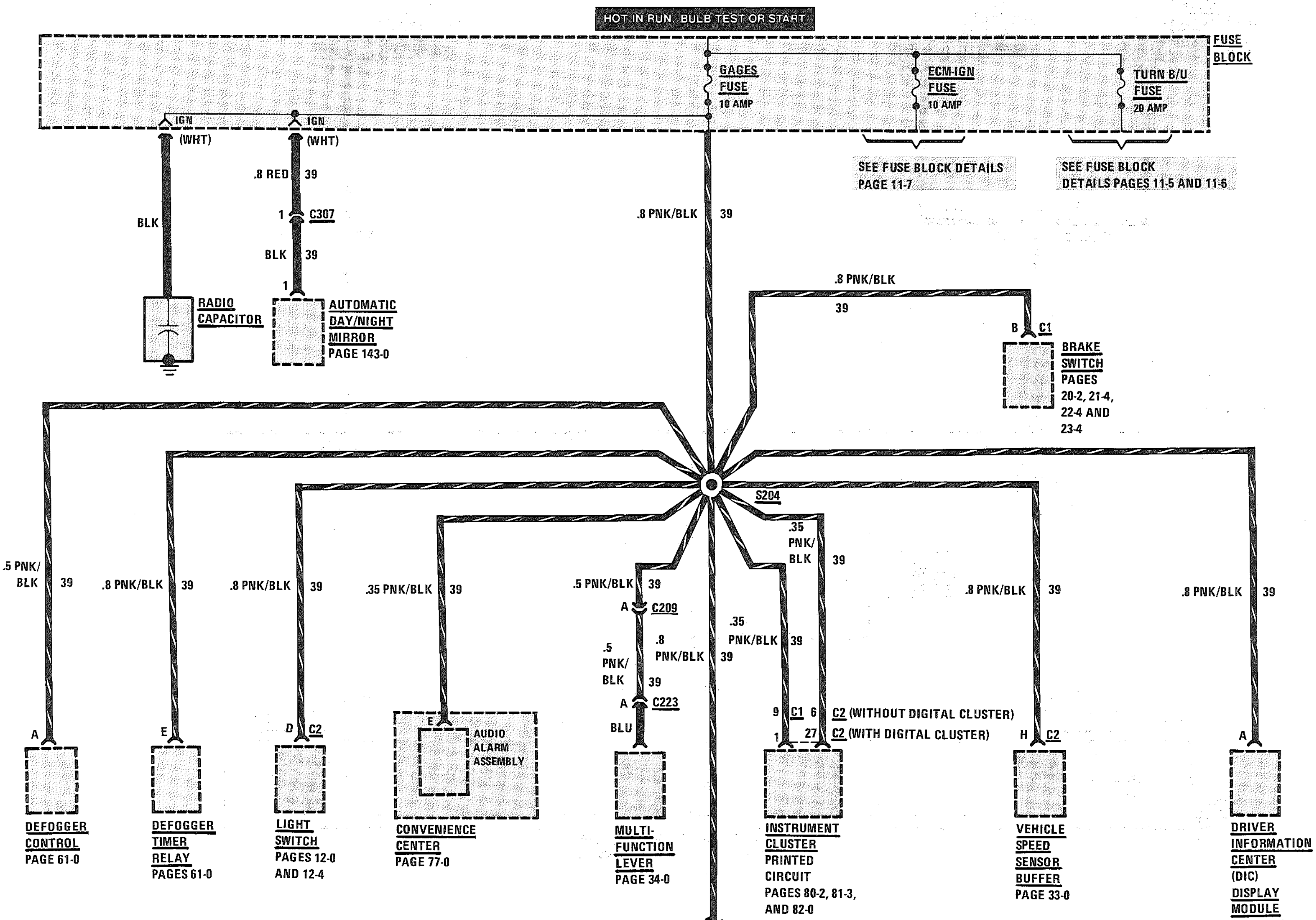
FUSE BLOCK DETAILS: TURN B/U FUSE
WITHOUT DIGITAL CLUSTER

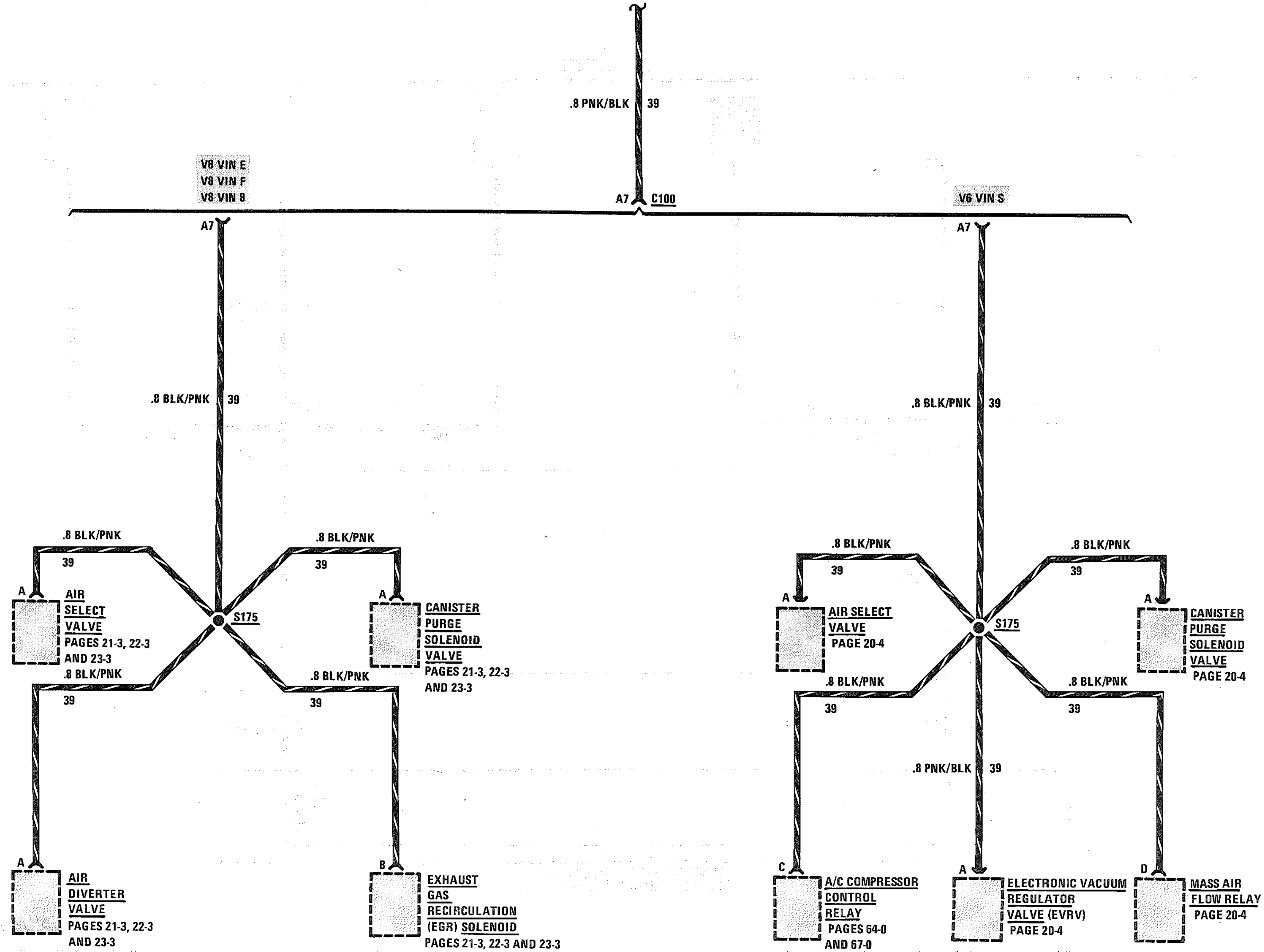


FUSE BLOCK DETAILS: ECM-IGN FUSE

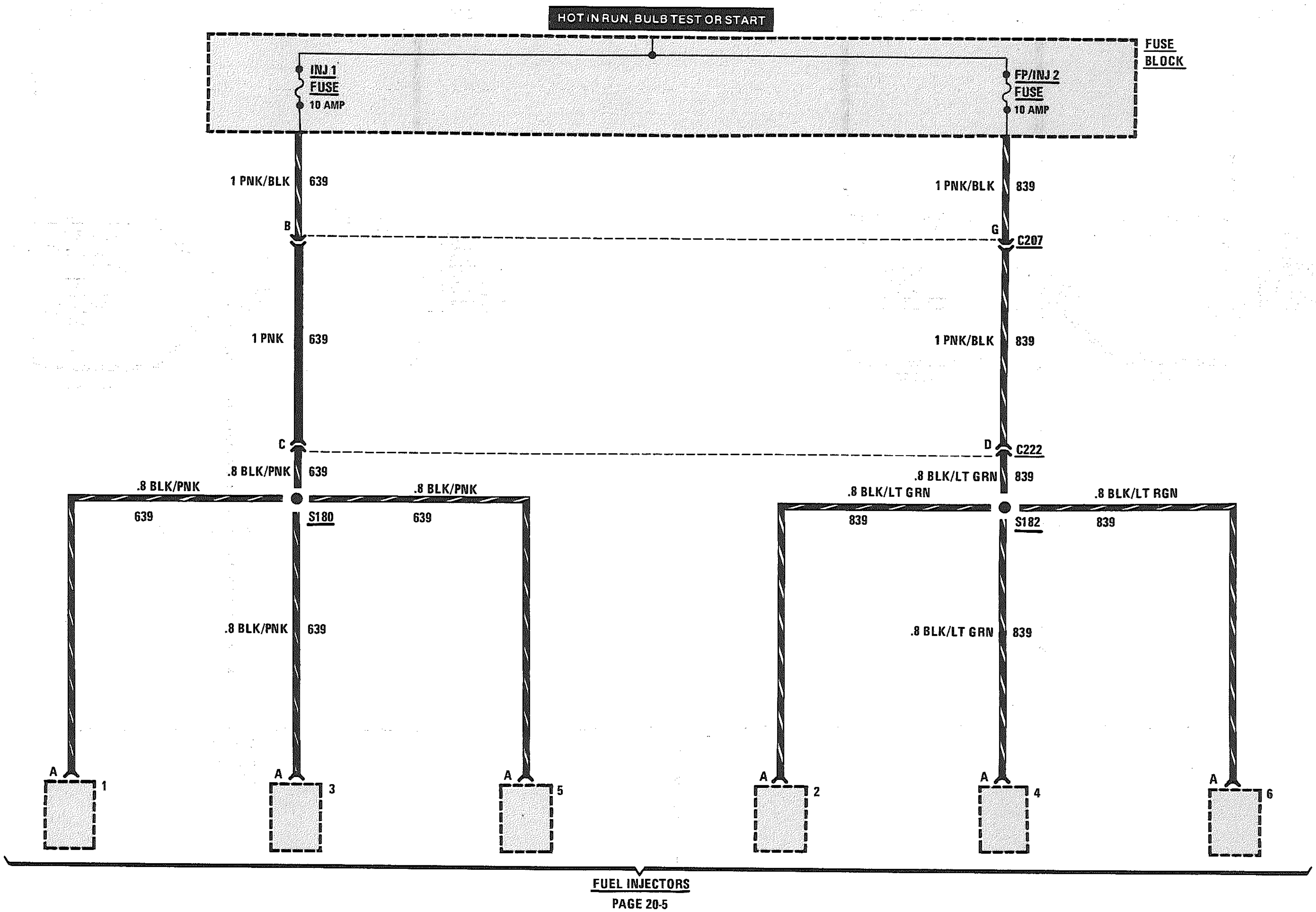


FUSE BLOCK DETAILS: GAGES FUSE

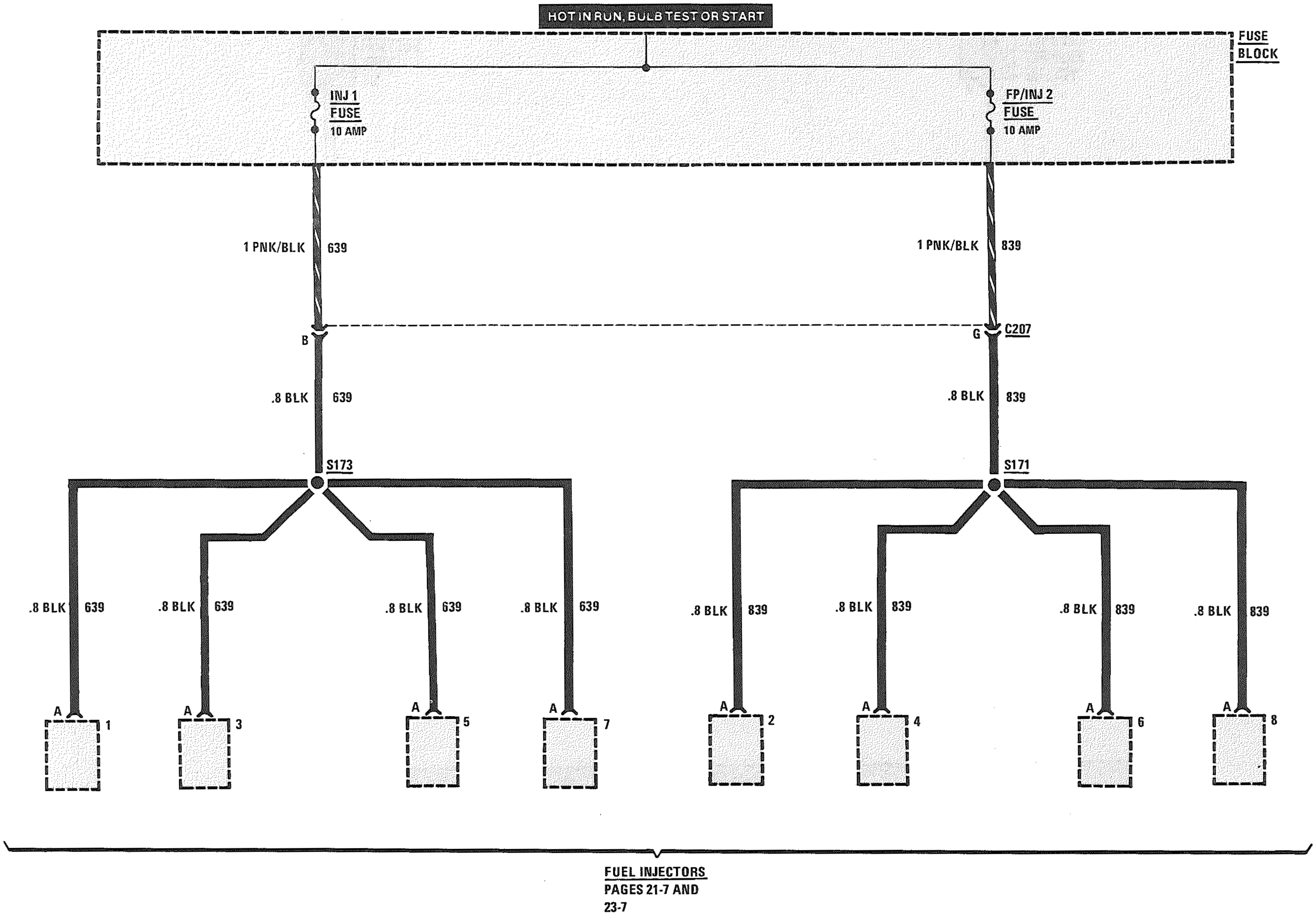



.8 PNK/BLK 39
V8 VIN E
V8 VIN F
V8 VIN 8
A7
C100
V6 VIN S
A7
A7
.8 BLK/PNK 39
.8 BLK/PNK 39
.8 BLK/PNK
39
.8 BLK/PNK
39
A
AIR SELECT VALVE
PAGES 21-3, 22-3 AND 23-3
S175
A
CANISTER PURGE SOLENOID VALVE
PAGES 21-3, 22-3 AND 23-3
.8 BLK/PNK
39
.8 BLK/PNK
39
A
AIR DIVERTER VALVE
PAGES 21-3, 22-3 AND 23-3
B
EXHAUST GAS RECIRCULATION (EGR) SOLENOID
PAGES 21-3, 22-3 AND 23-3
.8 BLK/PNK
39
.8 BLK/PNK
39
A
AIR SELECT VALVE
PAGE 20-4
S175
A
CANISTER PURGE SOLENOID VALVE
PAGE 20-4
.8 BLK/PNK
39
.8 BLK/PNK
39
.8 PNK/BLK 39
C
A/C COMPRESSOR CONTROL RELAY
PAGES 64-0 AND 67-0
A
ELECTRONIC VACUUM REGULATOR VALVE (EVRV)
PAGE 20-4
D
MASS AIR FLOW RELAY
PAGE 20-4

FUSE BLOCK DETAILS: INJ 1 FUSE AND FP/INJ 2 FUSE
V6 VIN S

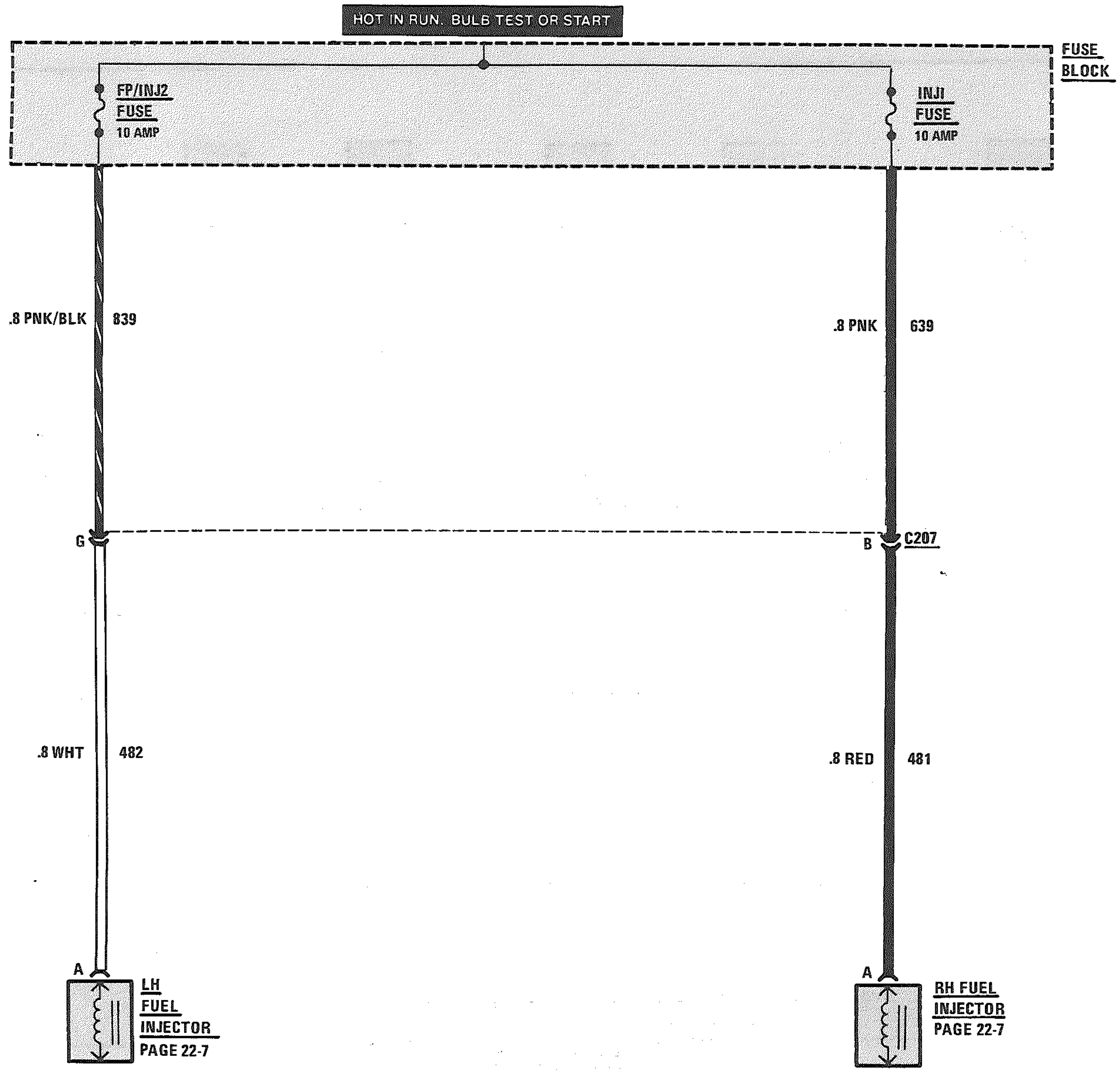


FUSE BLOCK DETAILS: INJ 1 FUSE AND FP/INJ 2 FUSE
V8 VIN F AND V8 VIN 8

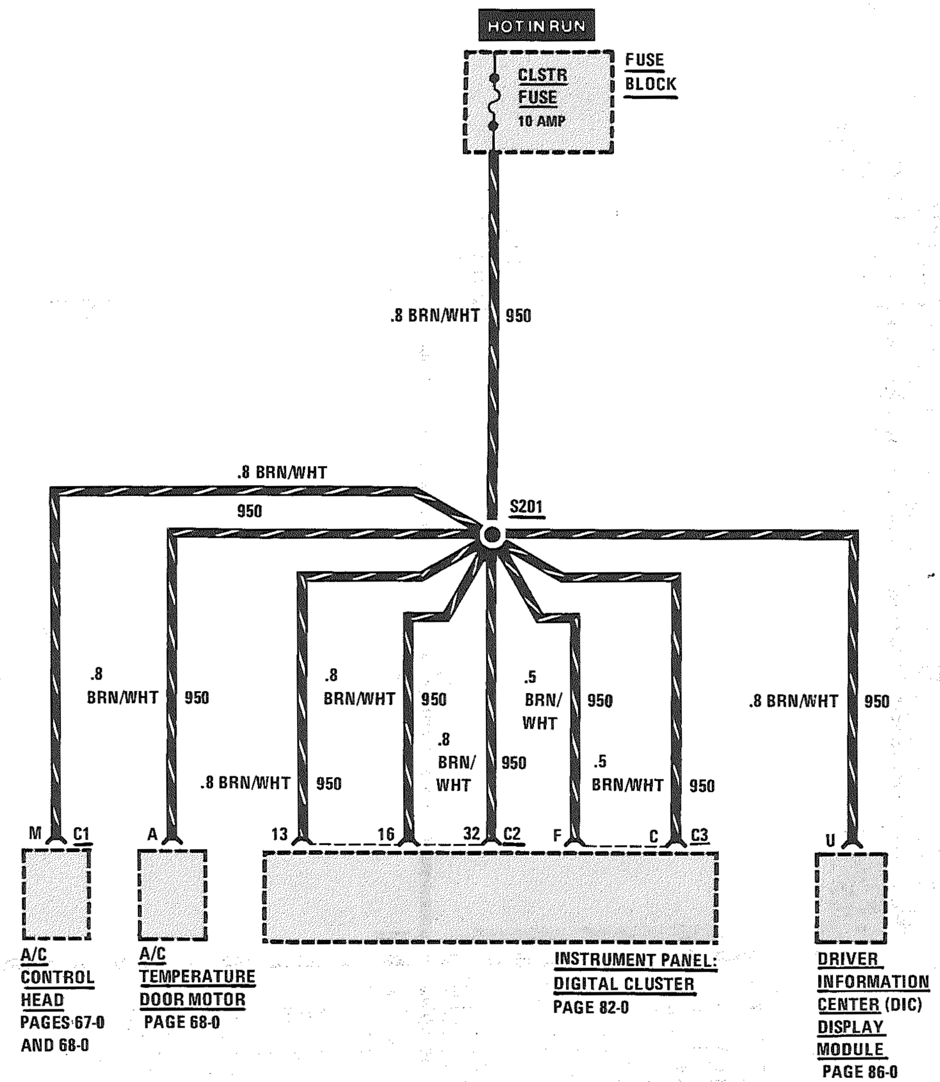


FUSE BLOCK DETAILS: INJ 1 FUSE AND FP/INJ 2 FUSE

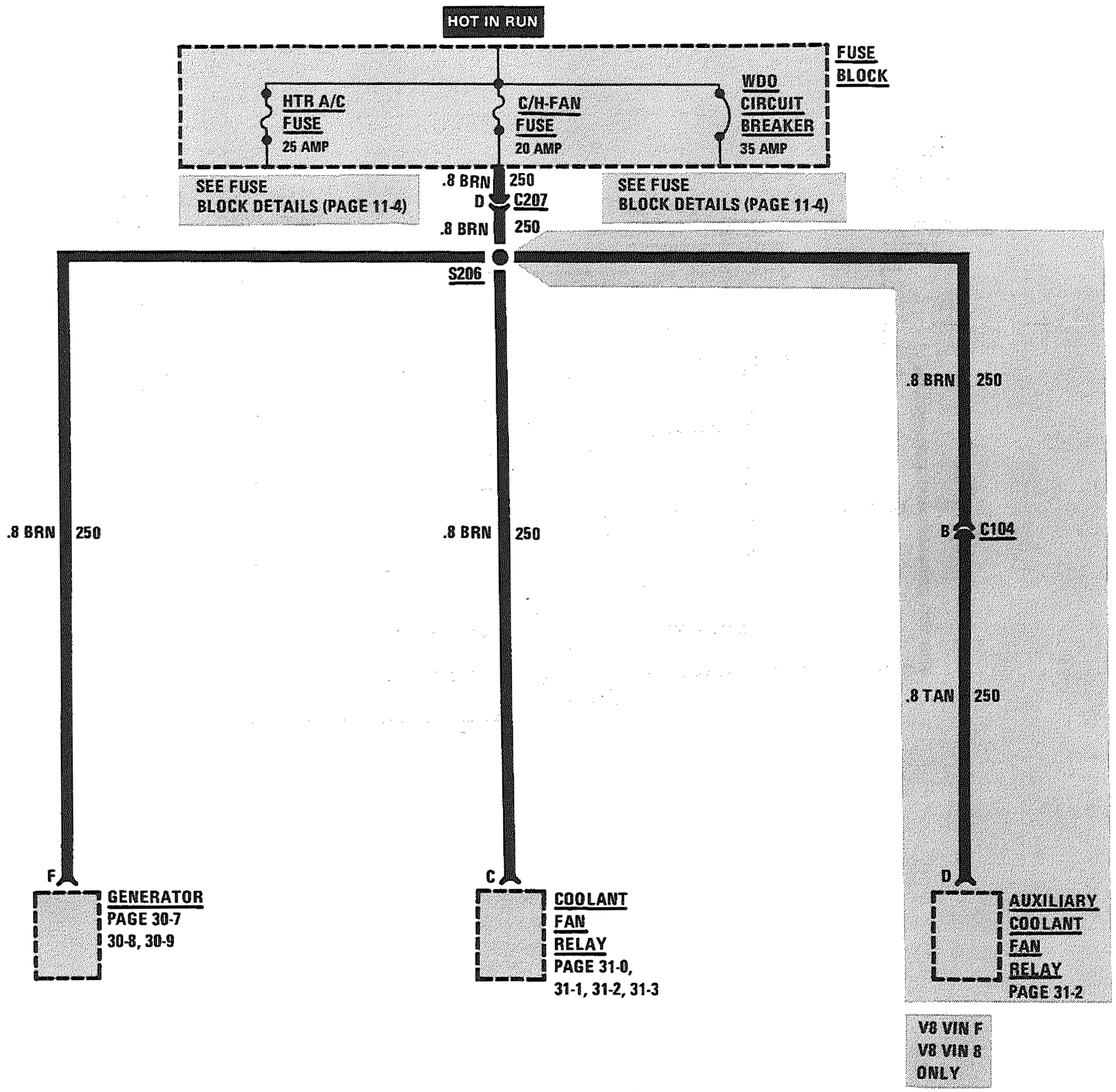
V8 VIN E



FUSE BLOCK DETAILS: CLSTR FUSE

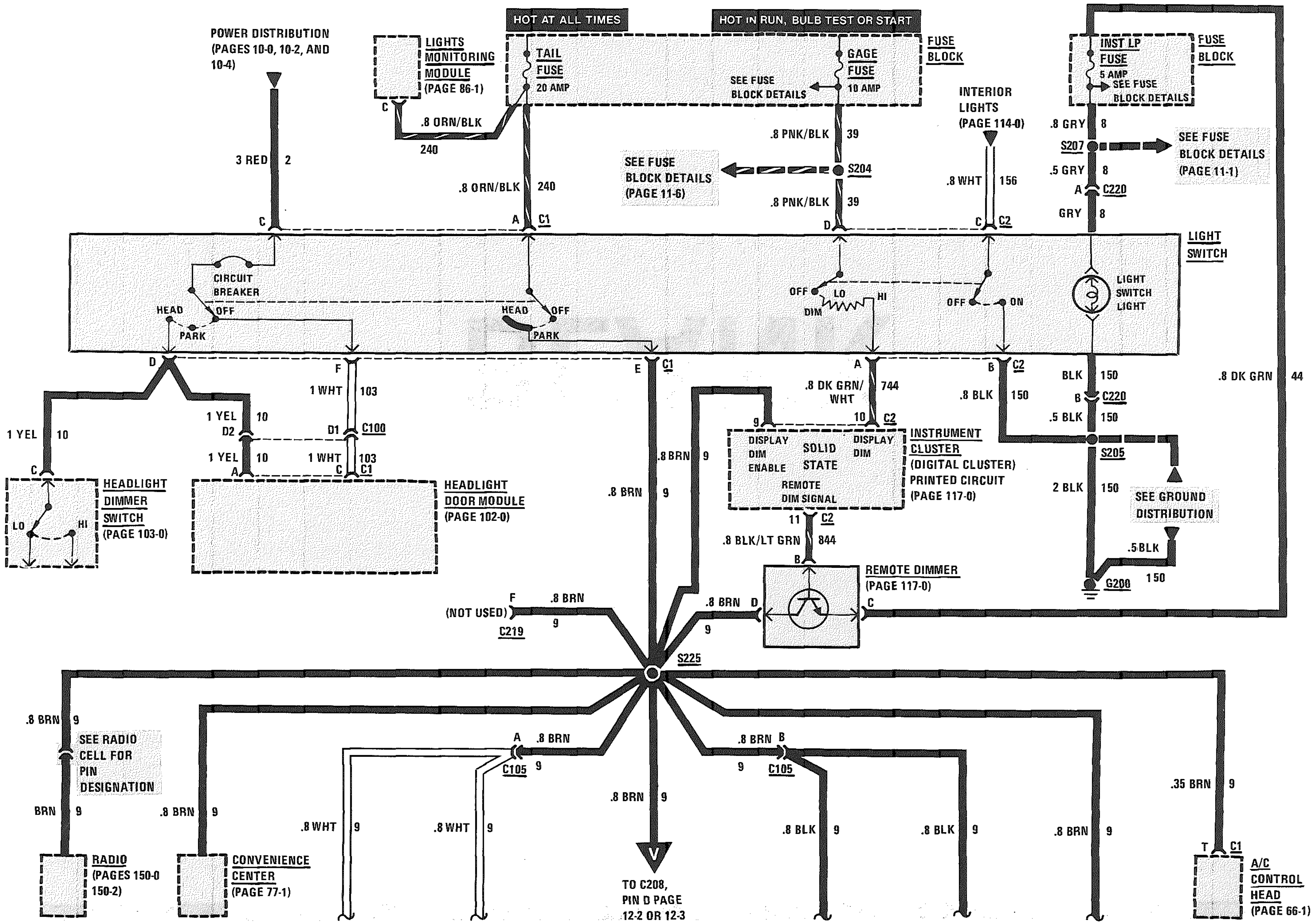


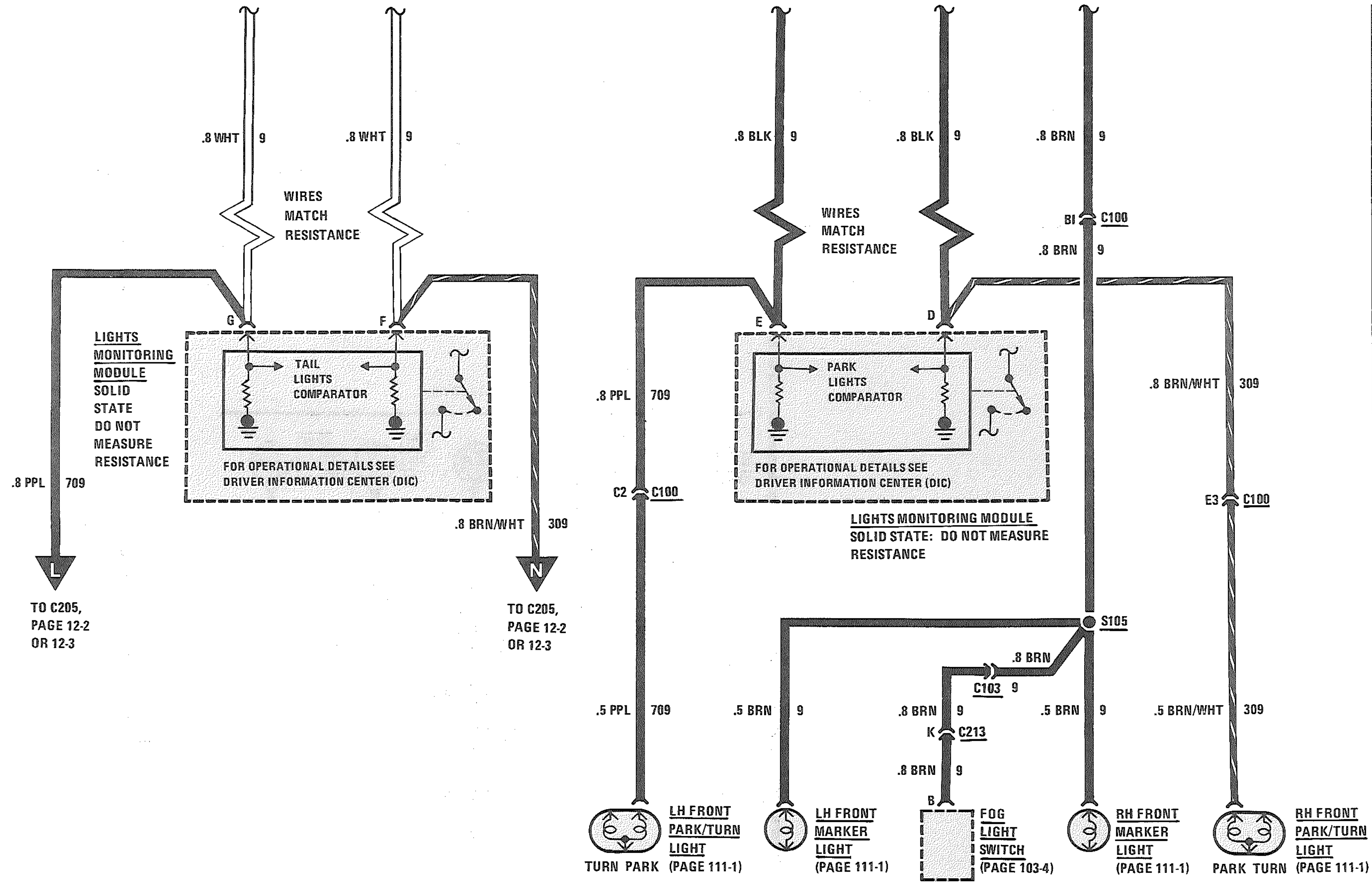
FUSE BLOCK DETAILS: C/H FAN FUSE



BLANK

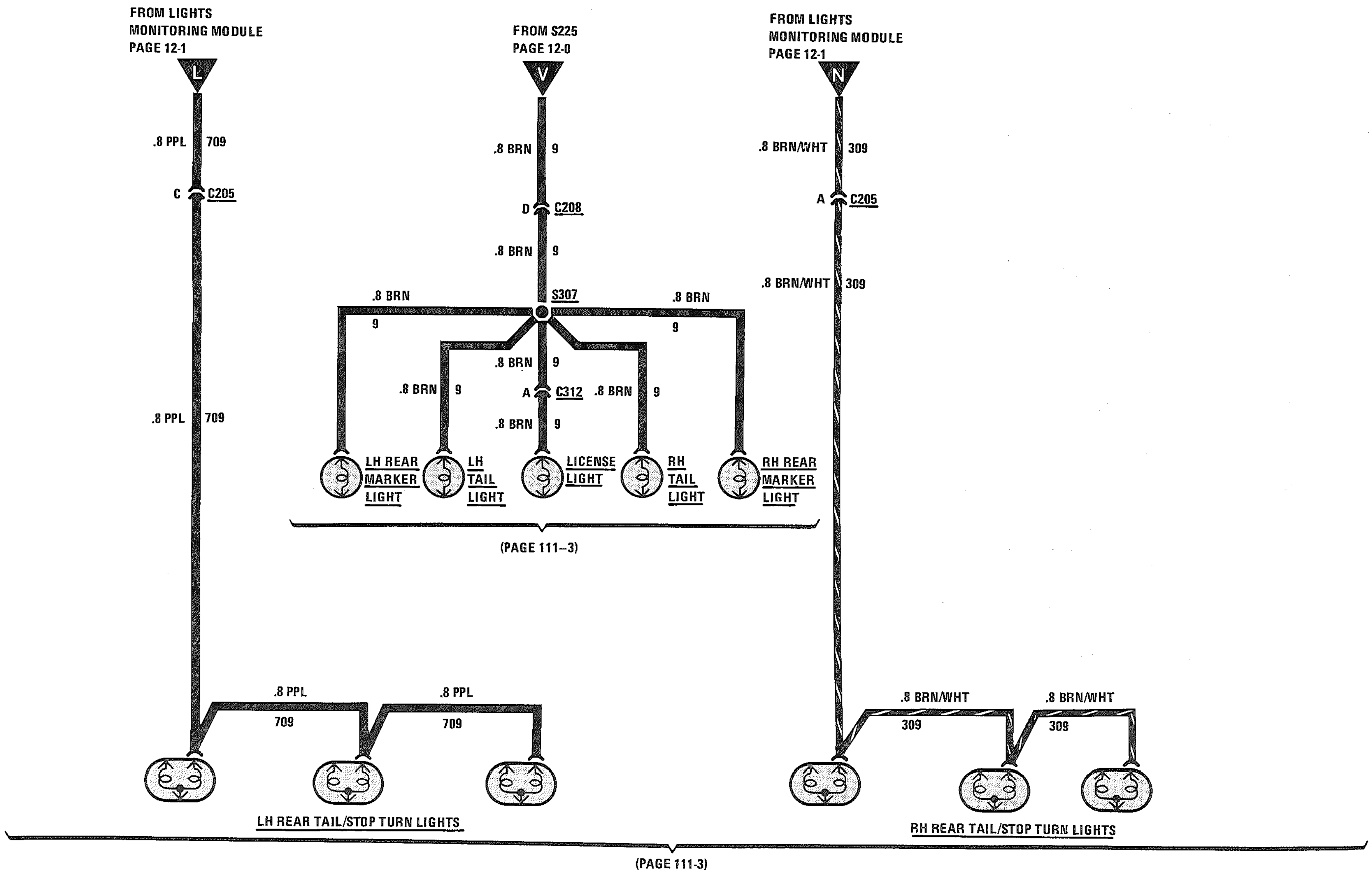
LIGHT SWITCH DETAILS: WITH DIGITAL CLUSTER



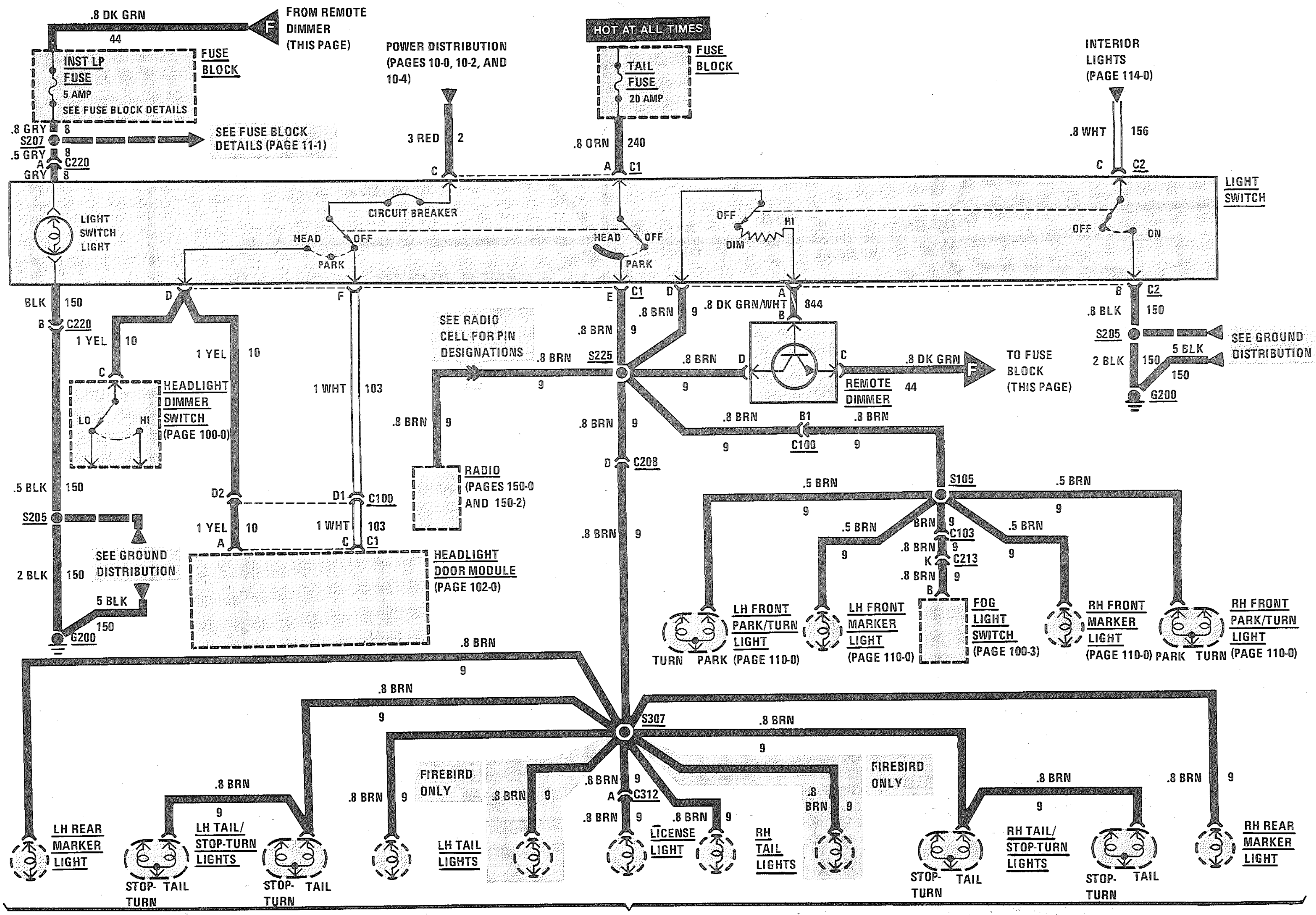


.8 WHT 9
.8 WHT 9
WIRES MATCH RESISTANCE
G
F
LIGHTS MONITORING MODULE SOLID STATE DO NOT MEASURE RESISTANCE
TAIL LIGHTS COMPARATOR
FOR OPERATIONAL DETAILS SEE DRIVER INFORMATION CENTER (DIC)
.8 PPL 709
.8 BRN/WHT 309
L
N
TO C205, PAGE 12-2 OR 12-3
TO C205, PAGE 12-2 OR 12-3
.8 BLK 9
.8 BLK 9
.8 BRN 9
WIRES MATCH RESISTANCE
B1 C100
.8 BRN 9
E
D
PARK LIGHTS COMPARATOR
FOR OPERATIONAL DETAILS SEE DRIVER INFORMATION CENTER (DIC)
LIGHTS MONITORING MODULE
SOLID STATE: DO NOT MEASURE RESISTANCE
.8 PPL 709
C2 C100
.8 BRN/WHT 309
E3 C100
S105
.8 BRN
C103 9
.5 PPL 709
.5 BRN 9
.8 BRN 9
K C213
.8 BRN 9
.5 BRN 9
.5 BRN/WHT 309
B
LH FRONT PARK/TURN LIGHT (PAGE 111-1)
TURN PARK
LH FRONT MARKER LIGHT (PAGE 111-1)
FOG LIGHT SWITCH (PAGE 103-4)
RH FRONT MARKER LIGHT (PAGE 111-1)
RH FRONT PARK/TURN LIGHT (PAGE 111-1)
PARK TURN

LIGHT SWITCH DETAILS: WITH DIGITAL CLUSTER



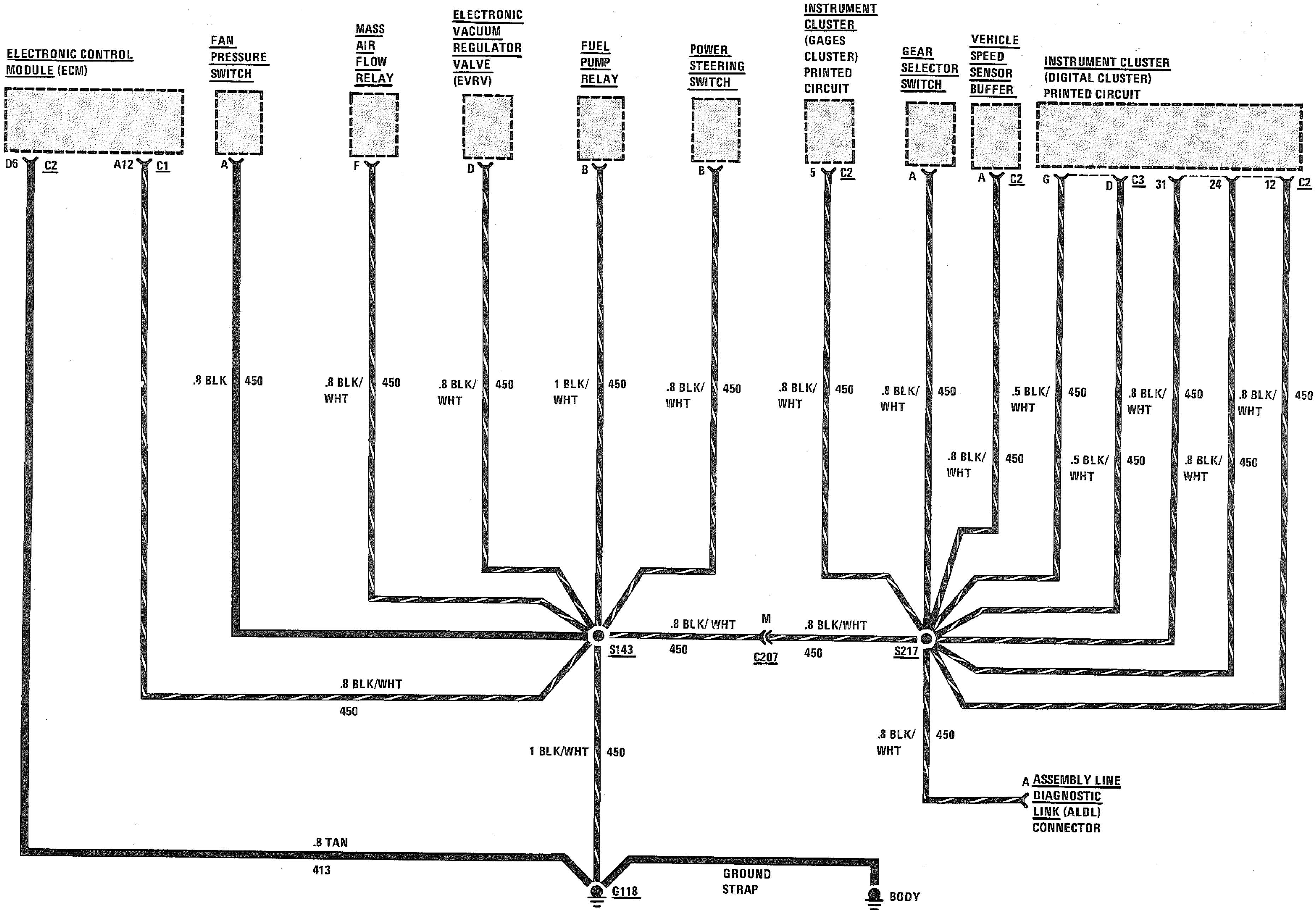
LIGHT SWITCH DETAILS: WITHOUT DIGITAL CLUSTER



(PAGE 110-3) TRANS AM;(PAGE 110-4) FIREBIRD

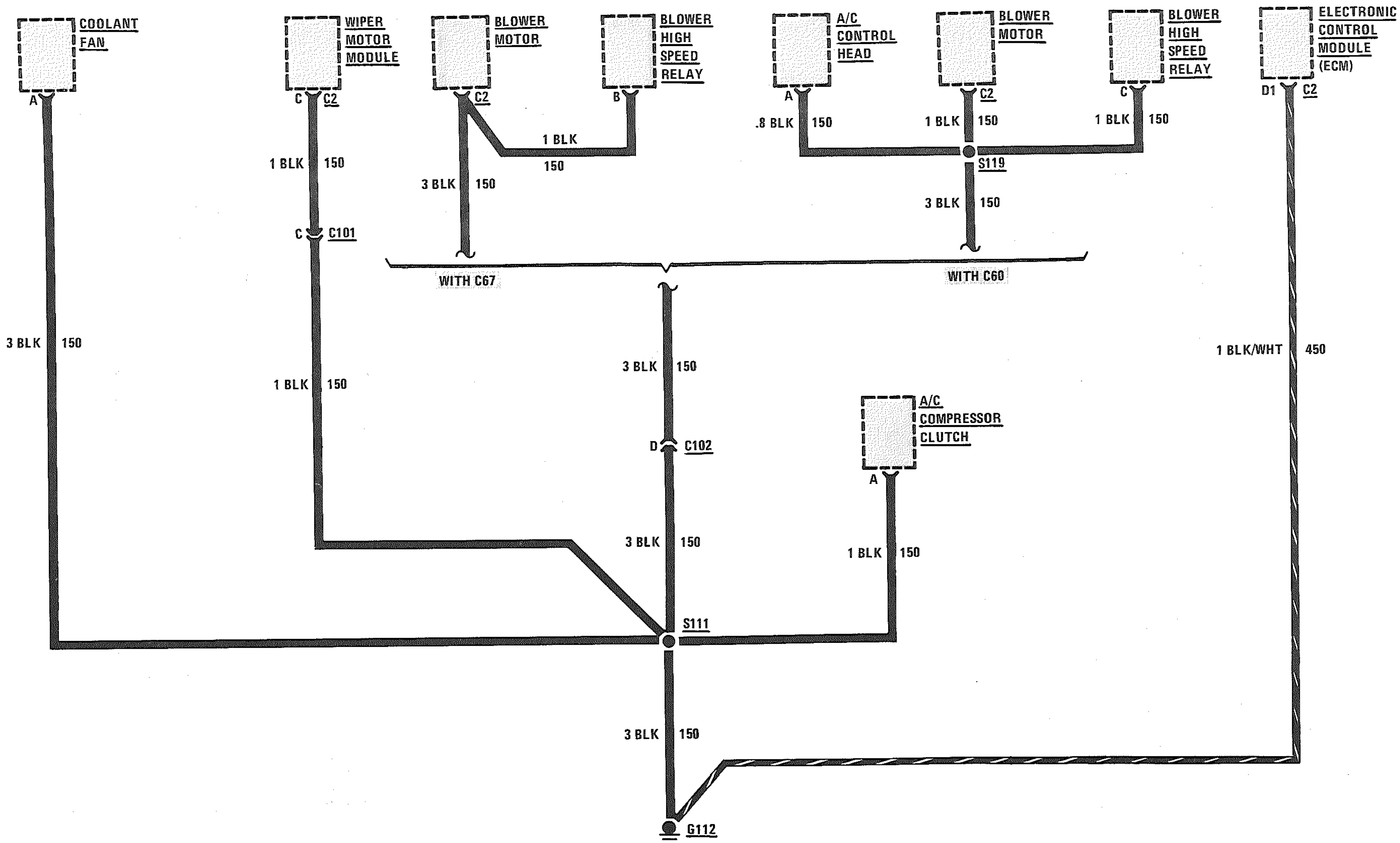
GROUND DISTRIBUTION: G118

ENGINE GROUND, V6 VIN S



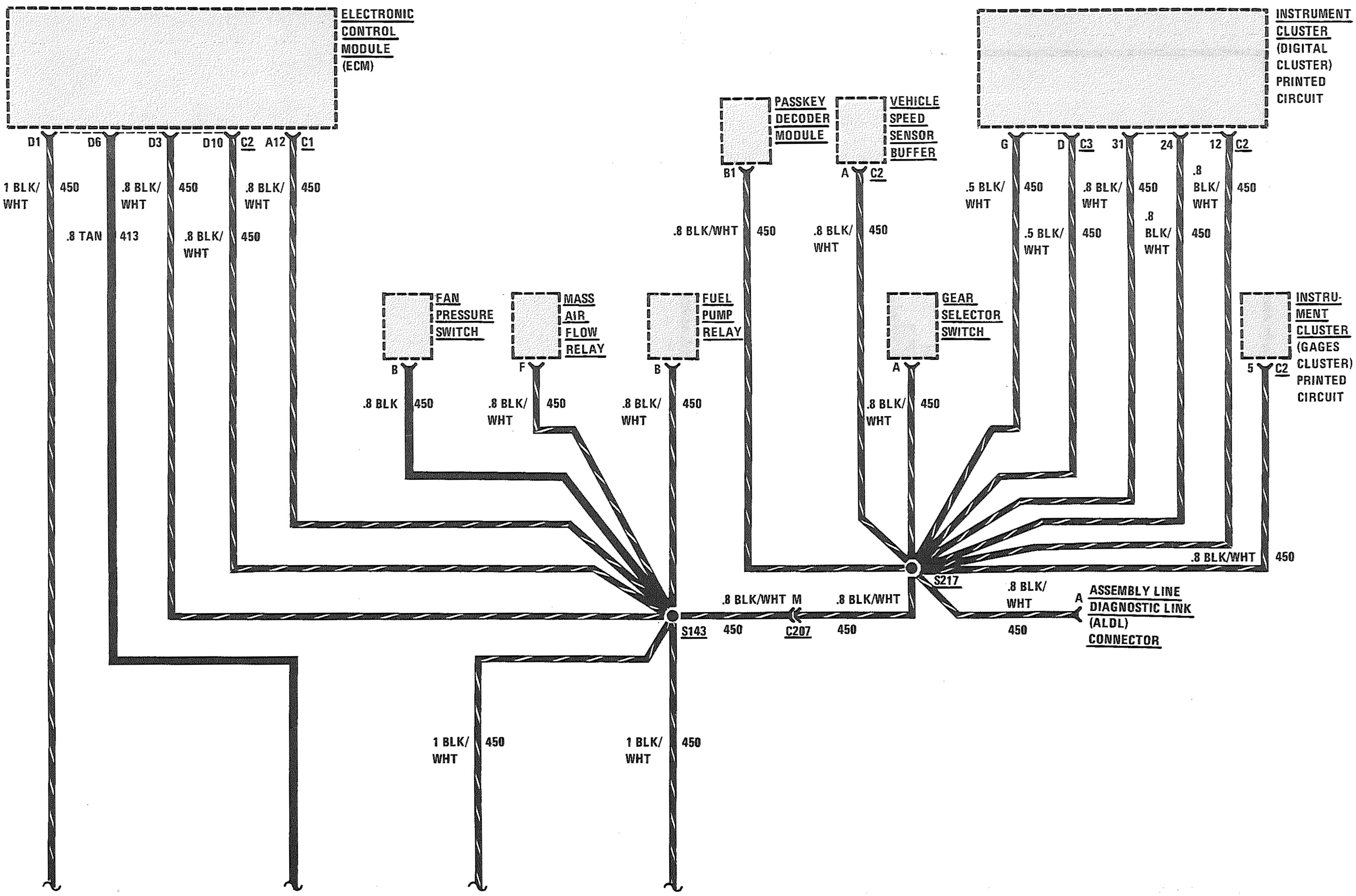
GROUND DISTRIBUTION: G112

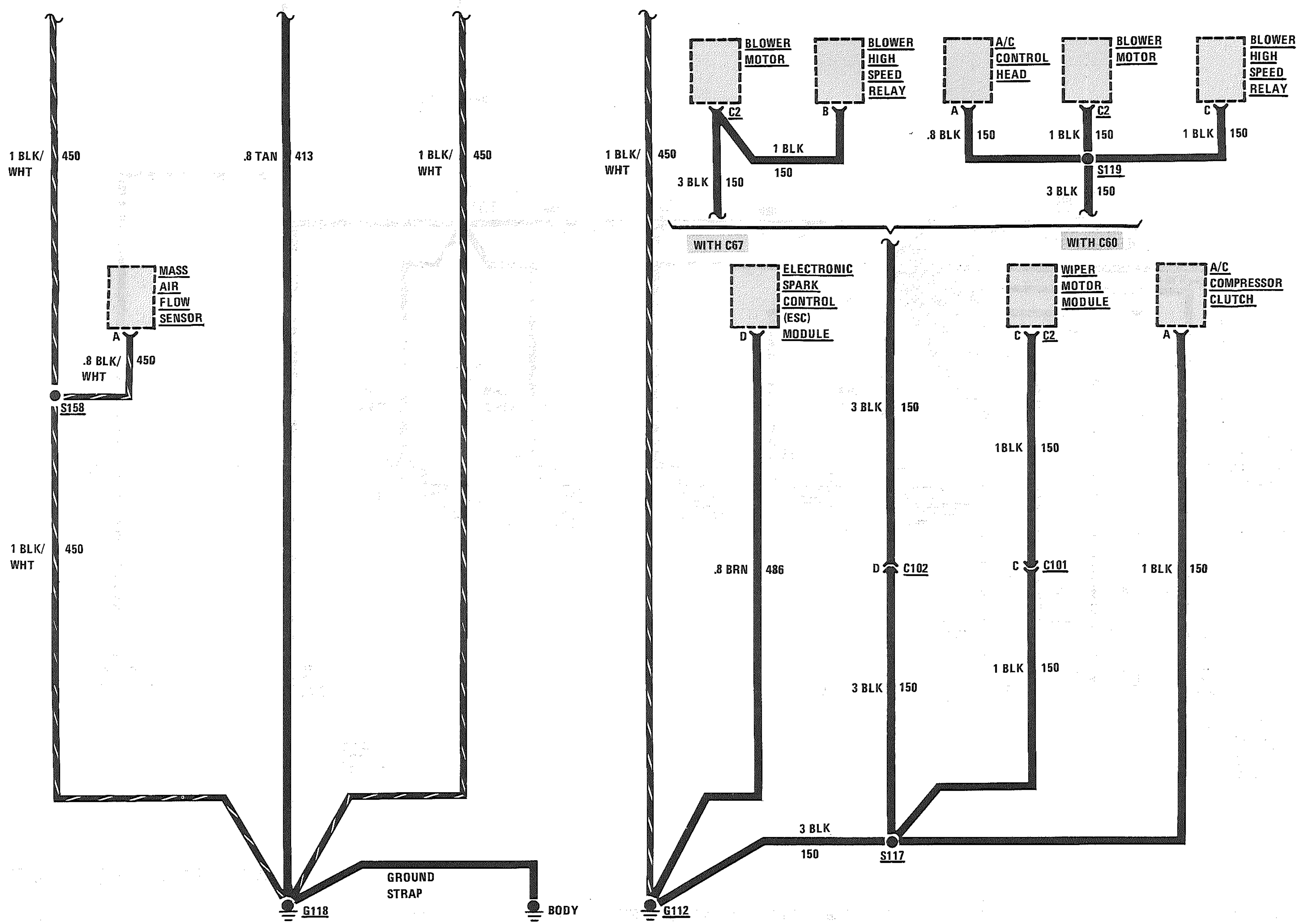
ENGINE GROUND, V6 VIN S



GROUND DISTRIBUTION: G112 AND G118

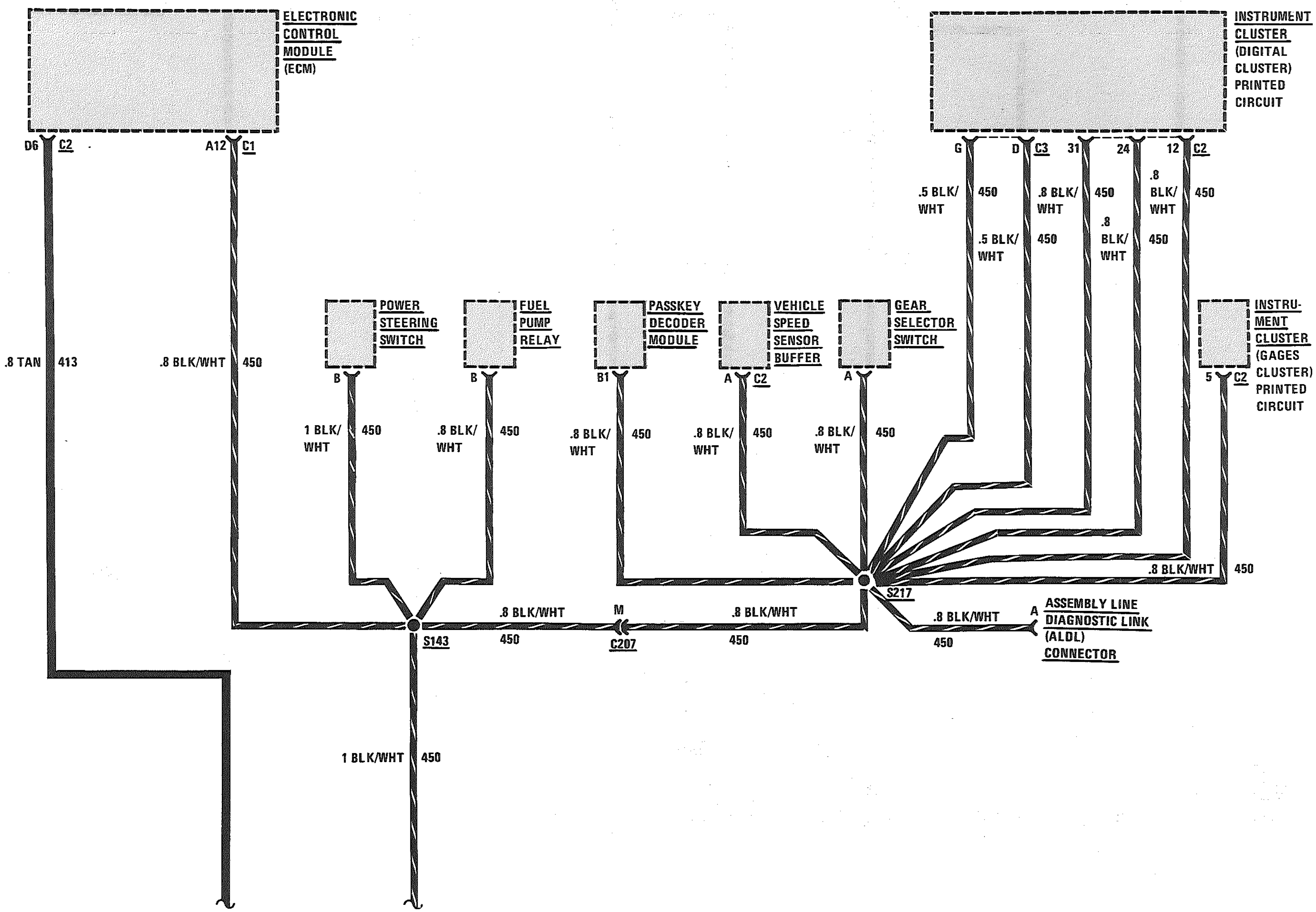
ENGINE GROUNDS, V8 VIN F AND V8 VIN 8

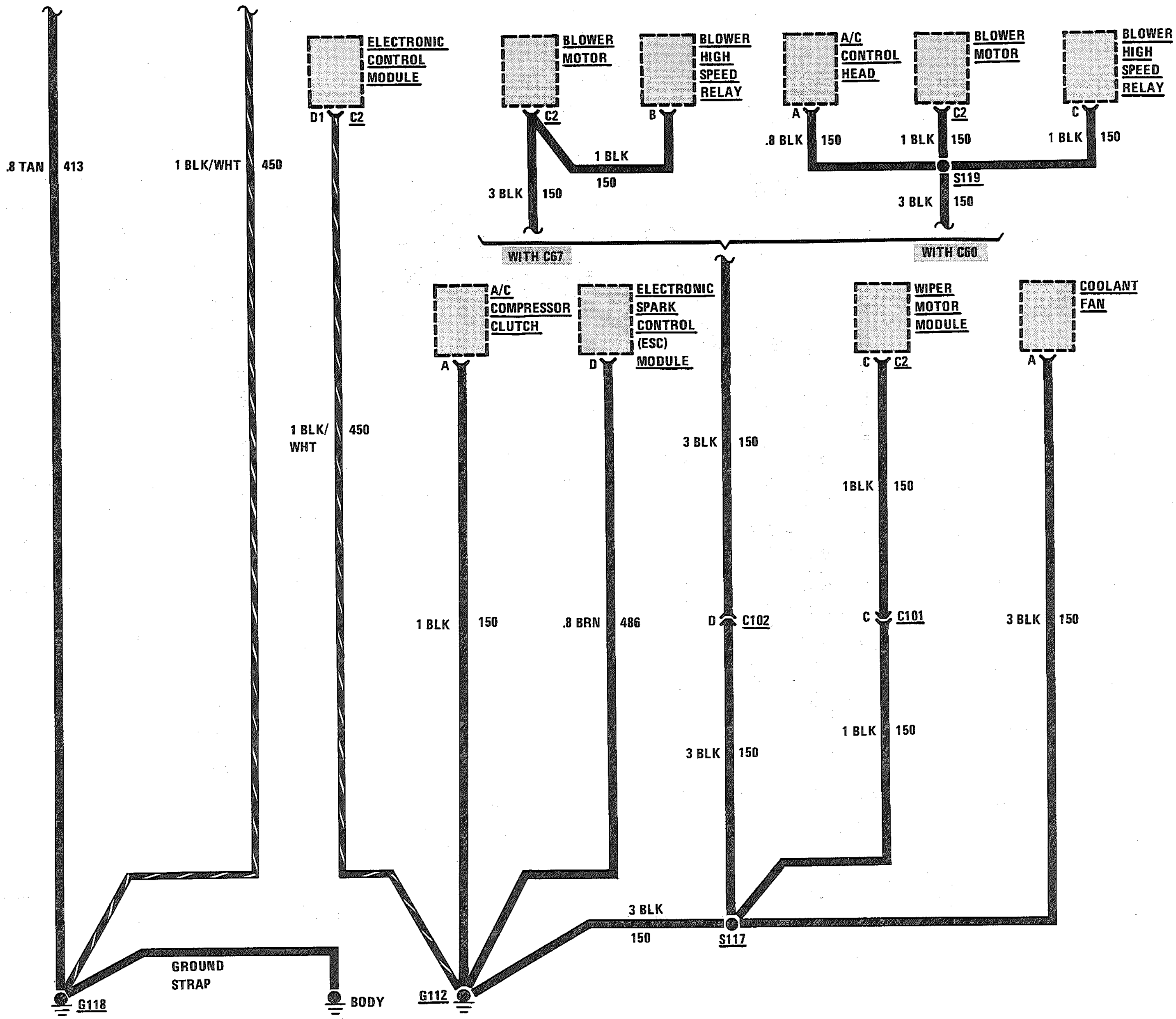



1 BLK/
WHT
450
.8 TAN
413
1 BLK/
WHT
450
1 BLK/
WHT
450
MASS
AIR
FLOW
SENSOR
A
.8 BLK/
WHT
450
S158
1 BLK/
WHT
450
GROUND
STRAP
G118
BODY
BLOWER
MOTOR
C2
BLOWER
HIGH
SPEED
RELAY
B
1 BLK
150
3 BLK
150
A/C
CONTROL
HEAD
A
.8 BLK
150
BLOWER
MOTOR
C2
1 BLK
150
BLOWER
HIGH
SPEED
RELAY
C
1 BLK
150
S119
3 BLK
150
WITH C67
WITH C60
ELECTRONIC
SPARK
CONTROL
(ESC)
MODULE
D
.8 BRN
486
3 BLK
150
D
C102
3 BLK
150
WIPER
MOTOR
MODULE
C
C2
1BLK
150
C
C101
1 BLK
150
A/C
COMPRESSOR
CLUTCH
A
1 BLK
150
3 BLK
150
S117
G112

GROUND DISTRIBUTION: G112 AND G118

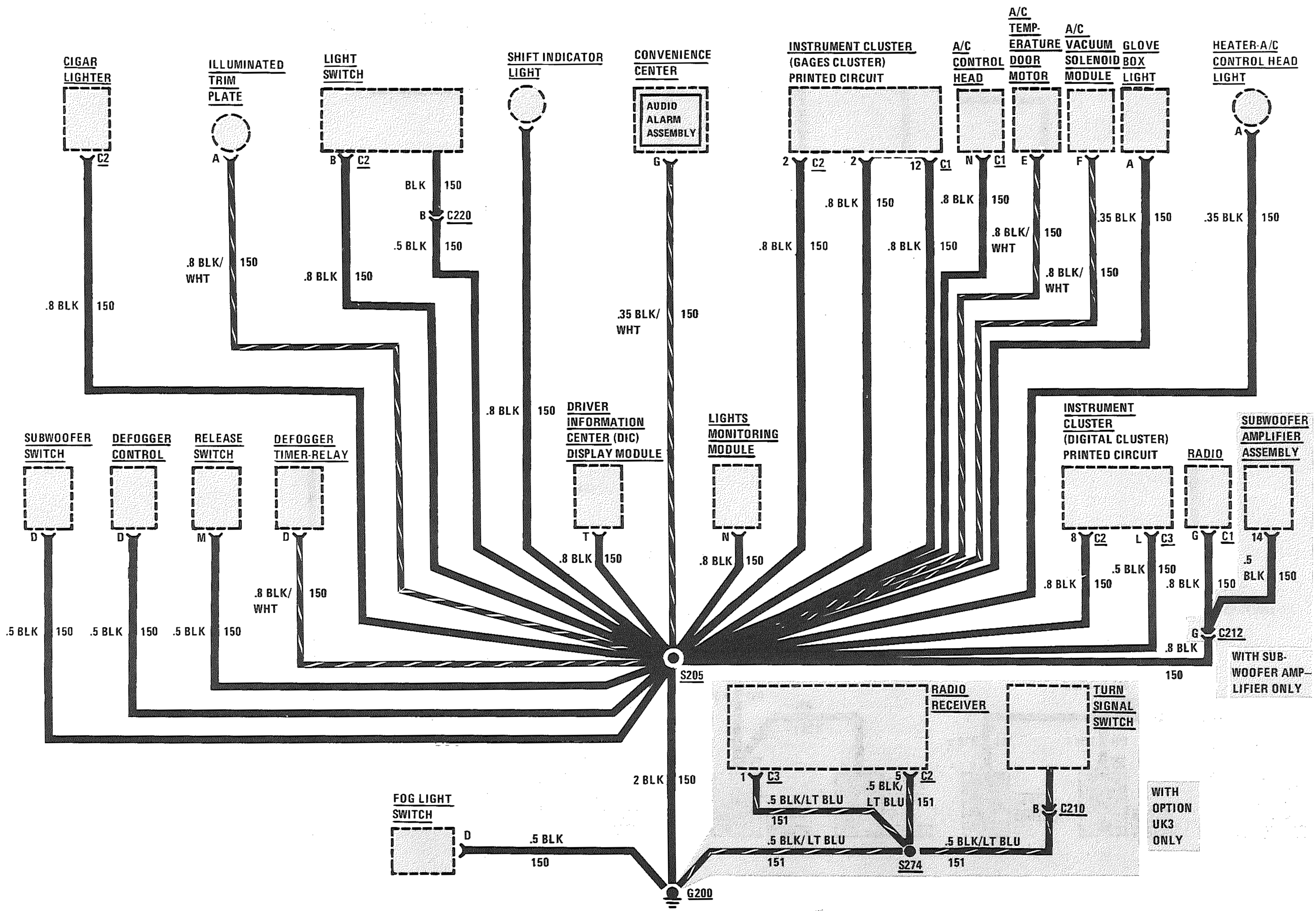
ENGINE GROUNDS, V8 VIN E



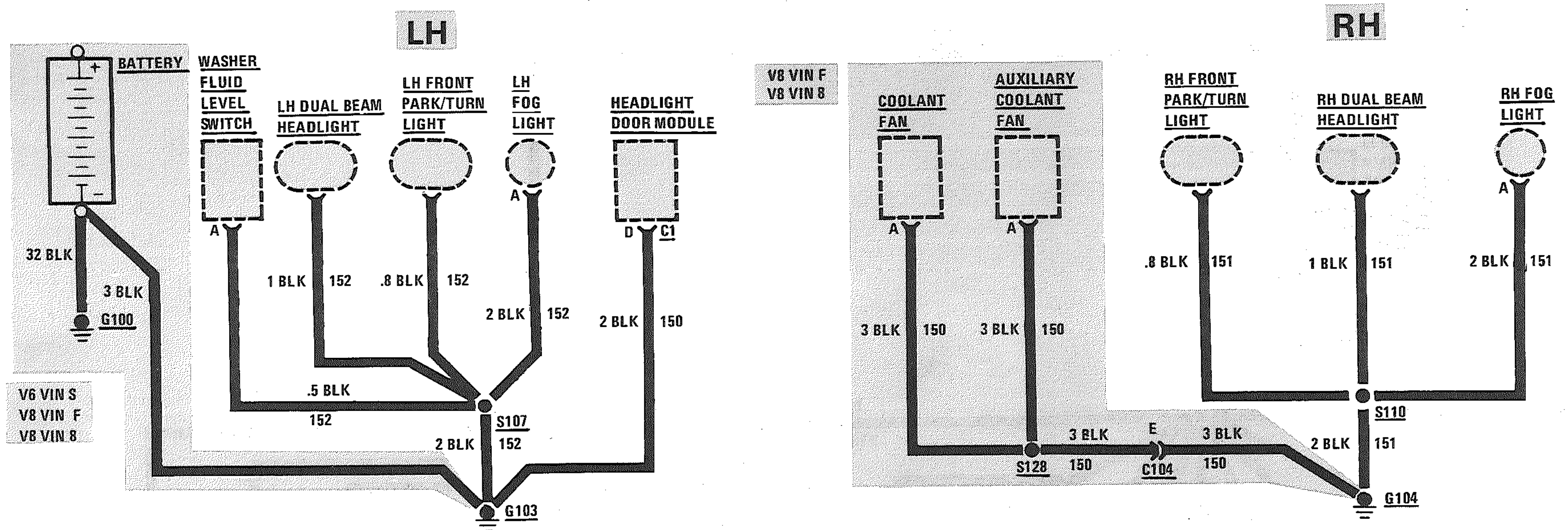

ELECTRONIC CONTROL MODULE
BLOWER MOTOR
BLOWER HIGH SPEED RELAY
A/C CONTROL HEAD
BLOWER MOTOR
BLOWER HIGH SPEED RELAY
D1
C2
B
A
C
.8 TAN 413
1 BLK/WHT 450
1 BLK 150
3 BLK 150
.8 BLK 150
1 BLK 150
1 BLK 150
S119
3 BLK 150
WITH C67
WITH C60
A/C COMPRESSOR CLUTCH
ELECTRONIC SPARK CONTROL (ESC) MODULE
WIPER MOTOR MODULE
COOLANT FAN
A
D
C
C2
A
1 BLK/ WHT 450
3 BLK 150
1BLK 150
1 BLK 150
.8 BRN 486
D C102
C C101
3 BLK 150
1 BLK 150
3 BLK 150
3 BLK 150
S117
GROUND STRAP
G118
BODY
G112

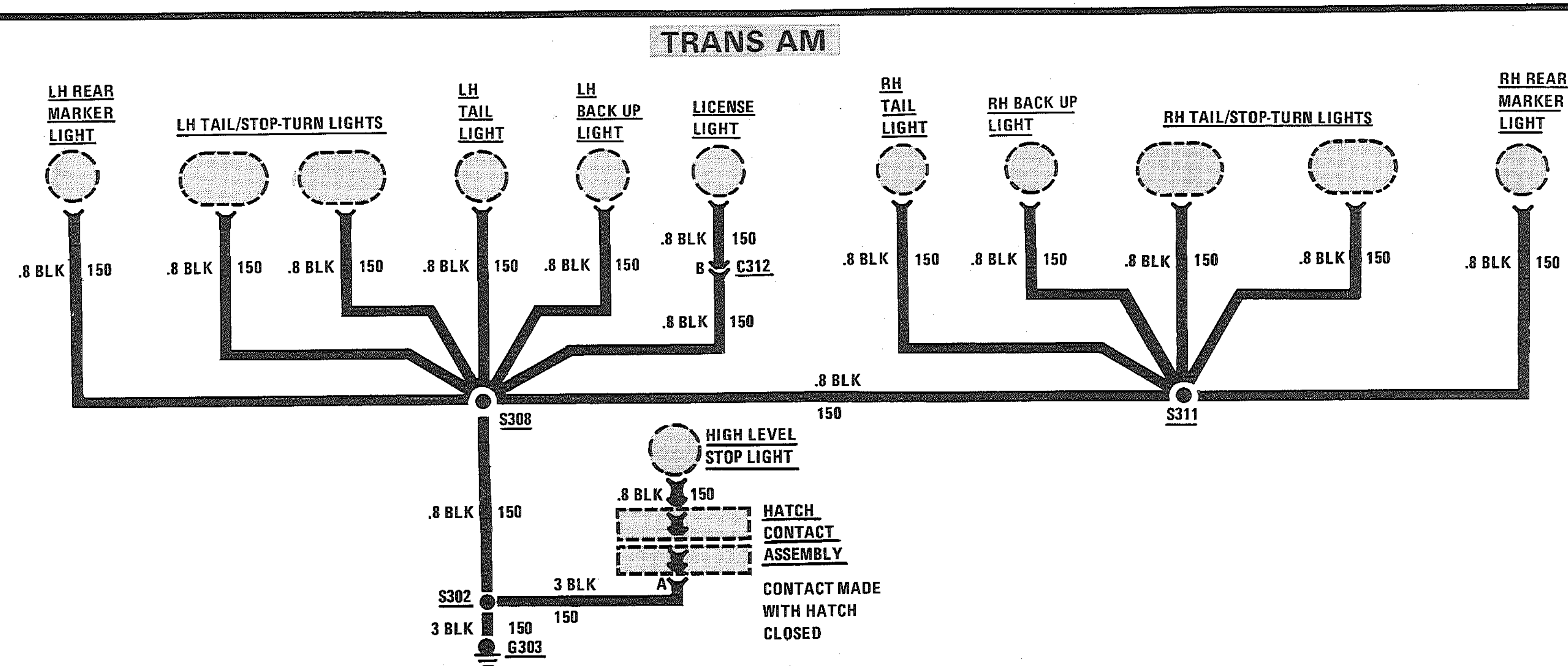
GROUND DISTRIBUTION: G200

INSTRUMENT CLUSTER

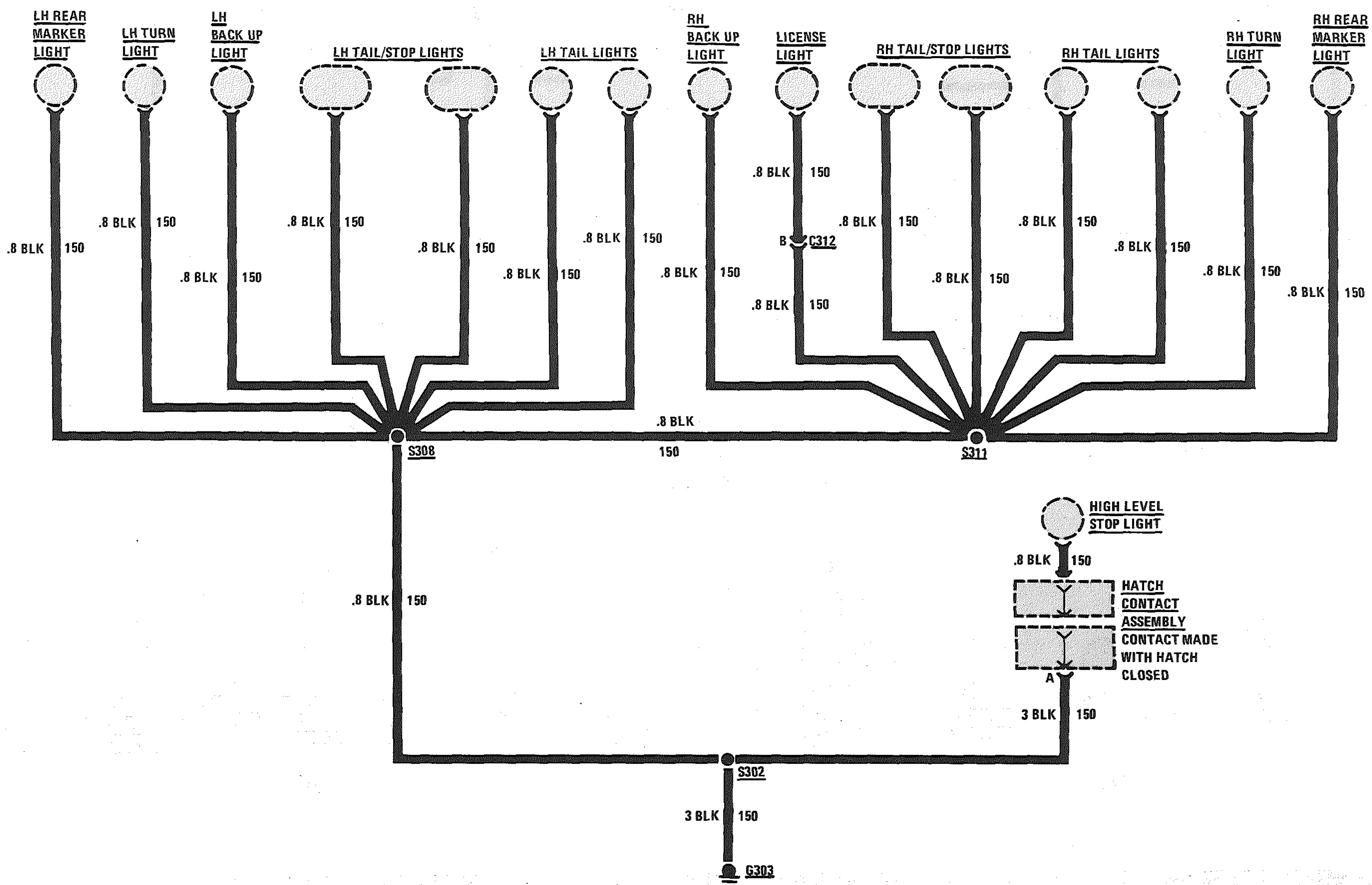


GROUND DISTRIBUTION: G103, G104, G303





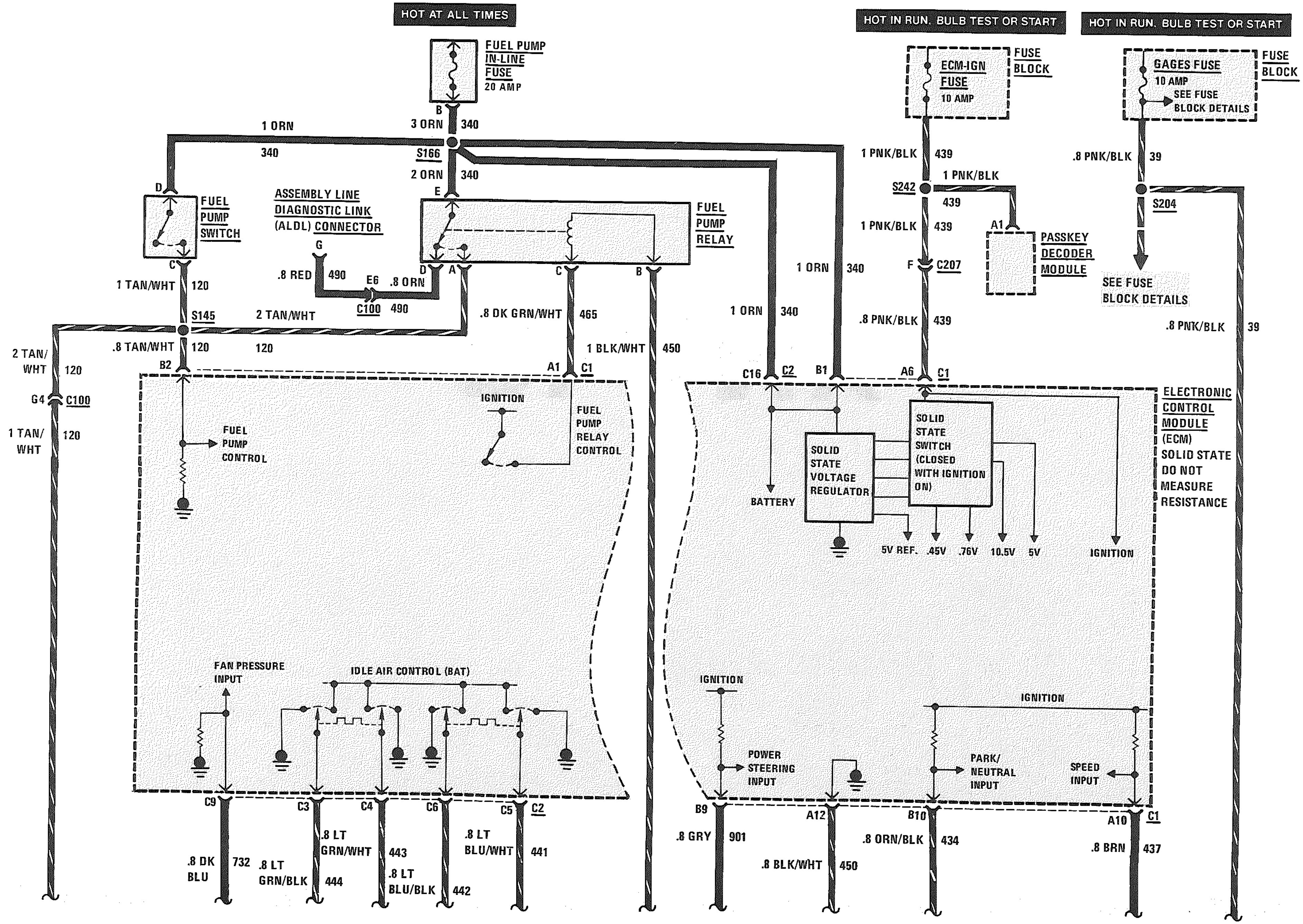
FIREBIRD

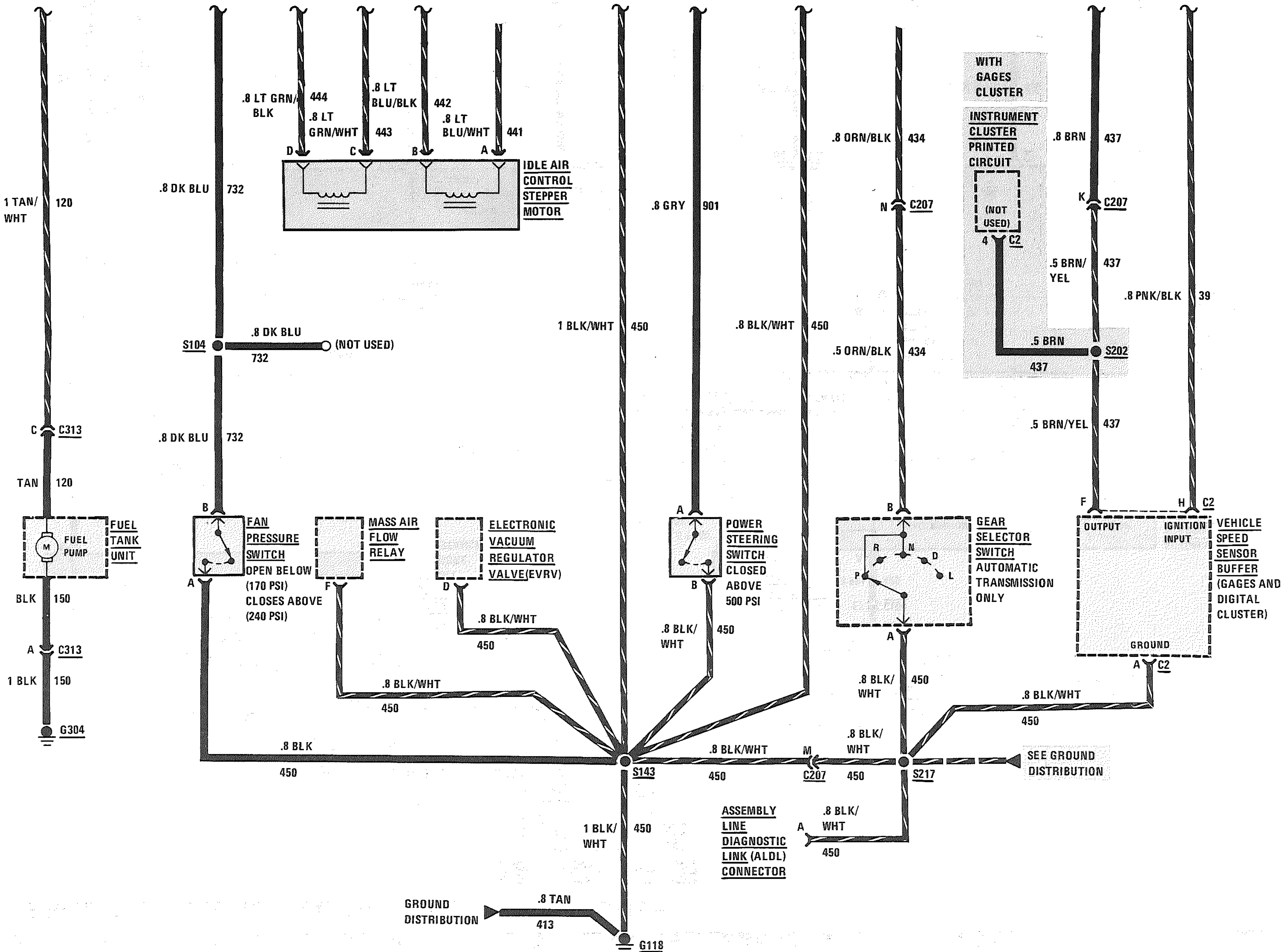

LH REAR MARKER LIGHT
LH TURN LIGHT
LH BACK UP LIGHT
LH TAIL/STOP LIGHTS
LH TAIL LIGHTS
RH BACK UP LIGHT
LICENSE LIGHT
RH TAIL/STOP LIGHTS
RH TAIL LIGHTS
RH TURN LIGHT
RH REAR MARKER LIGHT
.8 BLK 150
B C312
S308
S311
HIGH LEVEL STOP LIGHT
HATCH CONTACT ASSEMBLY
CONTACT MADE WITH HATCH CLOSED
A
3 BLK 150
S302
G303

BLANK

MULTI-PORT FUEL INJECTION: V6 VIN S

IDLE SPEED CONTROL, FUEL CONTROL, AND VEHICLE DATA SENSORS

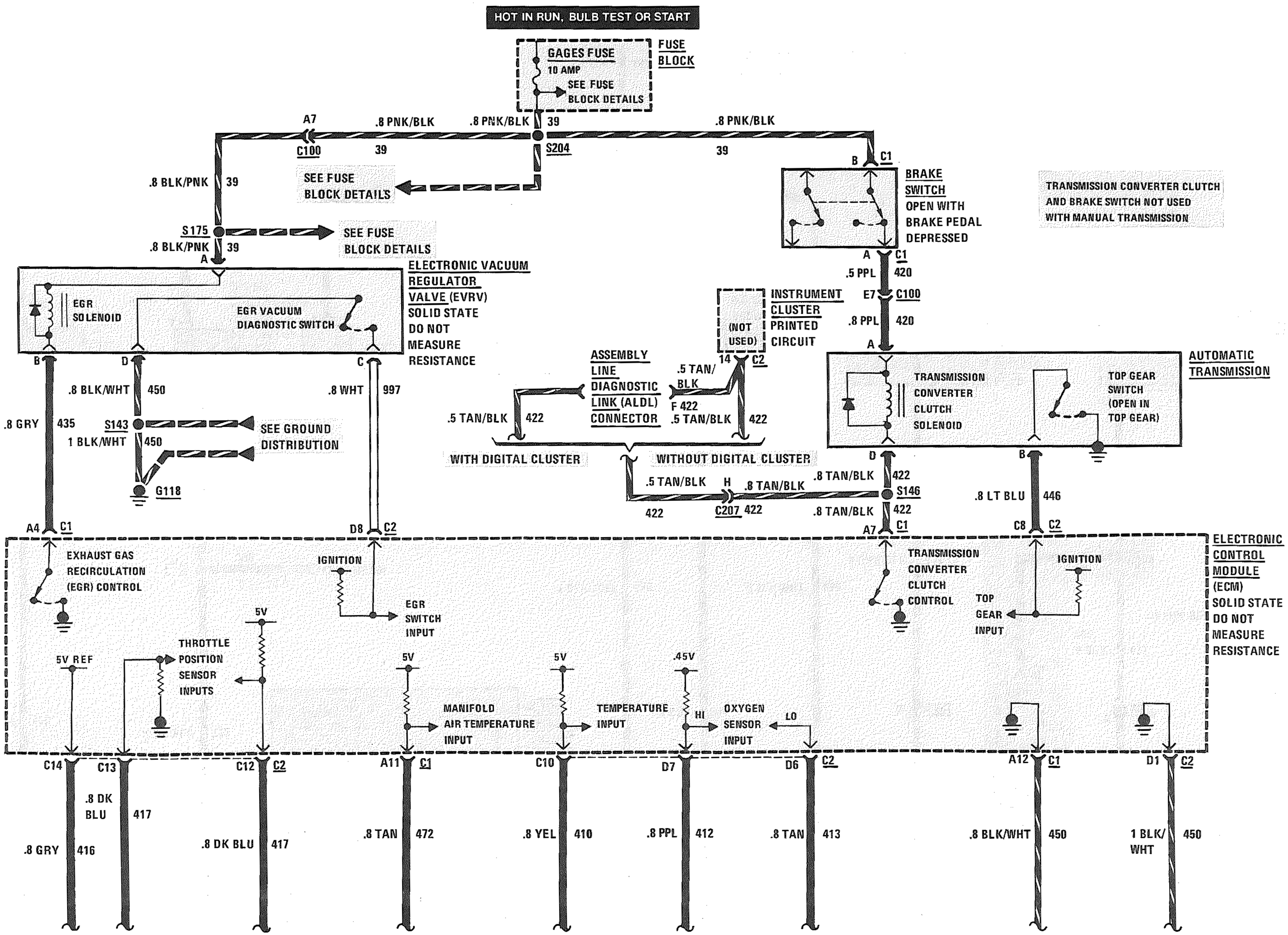


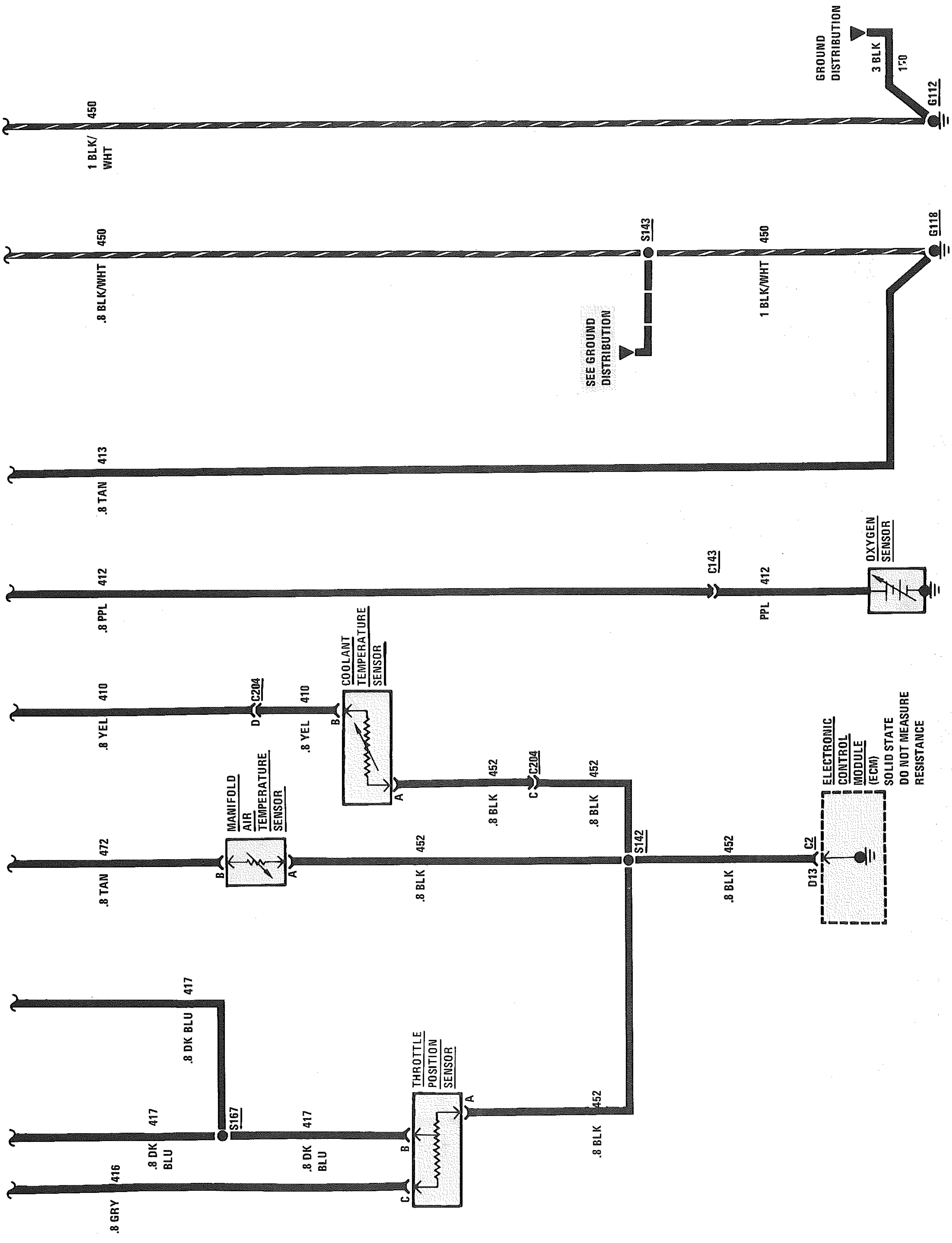


1 TAN/ WHT 120
C C313
TAN 120
FUEL PUMP
FUEL TANK UNIT
BLK 150
A C313
1 BLK 150
G304
.8 DK BLU 732
S104
.8 DK BLU
732
(NOT USED)
.8 DK BLU 732
.8 LT GRN/ BLK 444
.8 LT GRN/WHT 443
.8 LT BLU/BLK 442
.8 LT BLU/WHT 441
D C B A
IDLE AIR CONTROL STEPPER MOTOR
B
A
FAN PRESSURE SWITCH
OPEN BELOW (170 PSI)
CLOSES ABOVE (240 PSI)
F
MASS AIR FLOW RELAY
D
ELECTRONIC VACUUM REGULATOR VALVE(EVRV)
.8 BLK/WHT
450
.8 BLK/WHT
450
.8 BLK
450
1 BLK/WHT 450
.8 GRY 901
A
B
POWER STEERING SWITCH
CLOSED ABOVE 500 PSI
.8 BLK/ WHT 450
.8 BLK/WHT 450
S143
.8 BLK/WHT
450
M
C207
1 BLK/ WHT 450
GROUND DISTRIBUTION
.8 TAN
413
G118
.8 ORN/BLK 434
N C207
.5 ORN/BLK 434
B
A
GEAR SELECTOR SWITCH
AUTOMATIC TRANSMISSION ONLY
R N D P L
.8 BLK/ WHT 450
.8 BLK/ WHT
450
S217
SEE GROUND DISTRIBUTION
ASSEMBLY LINE DIAGNOSTIC LINK (ALDL) CONNECTOR
A
.8 BLK/ WHT
450
WITH GAGES CLUSTER
INSTRUMENT CLUSTER PRINTED CIRCUIT
(NOT USED)
4 C2
.8 BRN 437
K C207
.5 BRN/ YEL 437
.5 BRN
437
S202
.5 BRN/YEL 437
.8 PNK/BLK 39
F
H C2
OUTPUT
IGNITION INPUT
GROUND
VEHICLE SPEED SENSOR BUFFER (GAGES AND DIGITAL CLUSTER)
A C2
.8 BLK/WHT
450

MULTI-PORT FUEL INJECTION: V6 VIN S

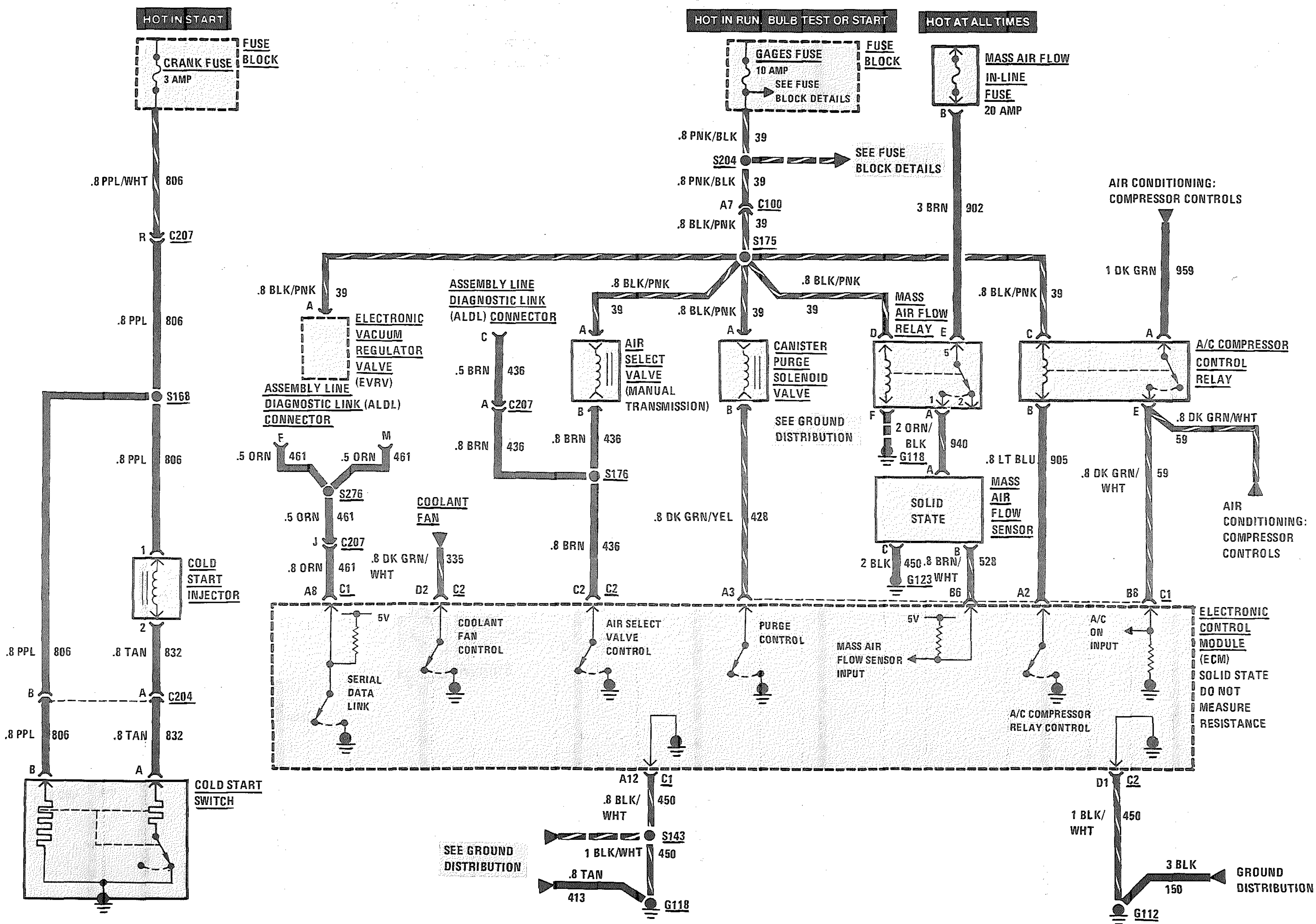
ENGINE DATA SENSORS, TRANSMISSION CONVERTER CLUTCH




GROUND DISTRIBUTION
3 BLK
150
G112
450
1 BLK/ WHT
450
.8 BLK/WHT
S143
SEE GROUND DISTRIBUTION
450
1 BLK/WHT
G118
413
.8 TAN
412
.8 PPL
C143
412
PPL
OXYGEN SENSOR
410
.8 YEL
C204
D
410
.8 YEL
B
COOLANT TEMPERATURE SENSOR
A
452
.8 BLK
C
C204
452
.8 BLK
ELECTRONIC CONTROL MODULE (ECM)
SOLID STATE DO NOT MEASURE RESISTANCE
MANIFOLD AIR TEMPERATURE SENSOR
472
.8 TAN
B
A
452
.8 BLK
S142
452
.8 BLK
C2
D13
417
.8 DK BLU
THROTTLE POSITION SENSOR
A
452
.8 BLK
417
.8 DK BLU
S167
417
.8 DK BLU
B
416
.8 GRY
C

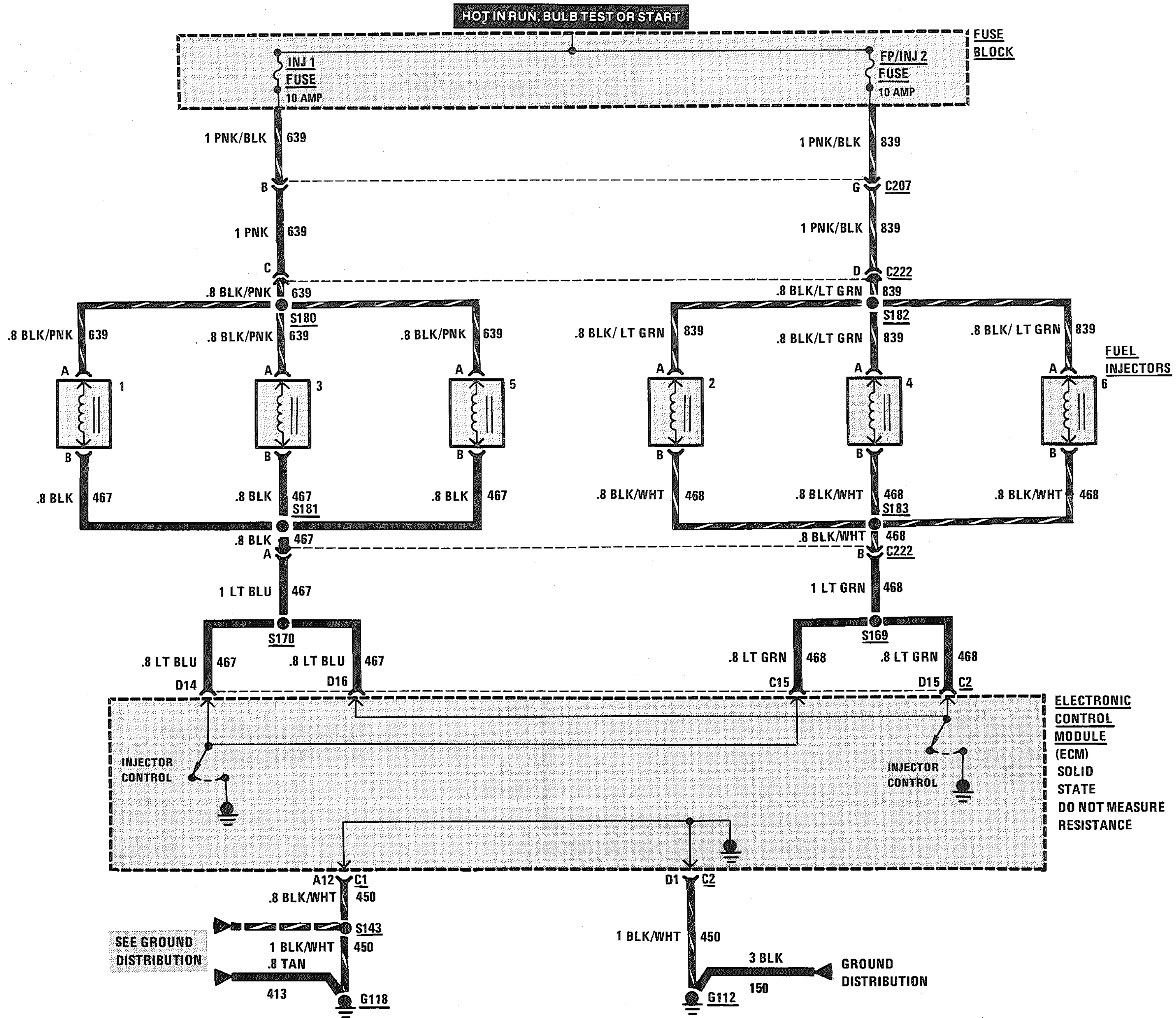
MULTI-PORT FUEL INJECTION: V6 VIN S

COLD START, EMISSION CONTROL, AND MASS AIR FLOW SENSOR



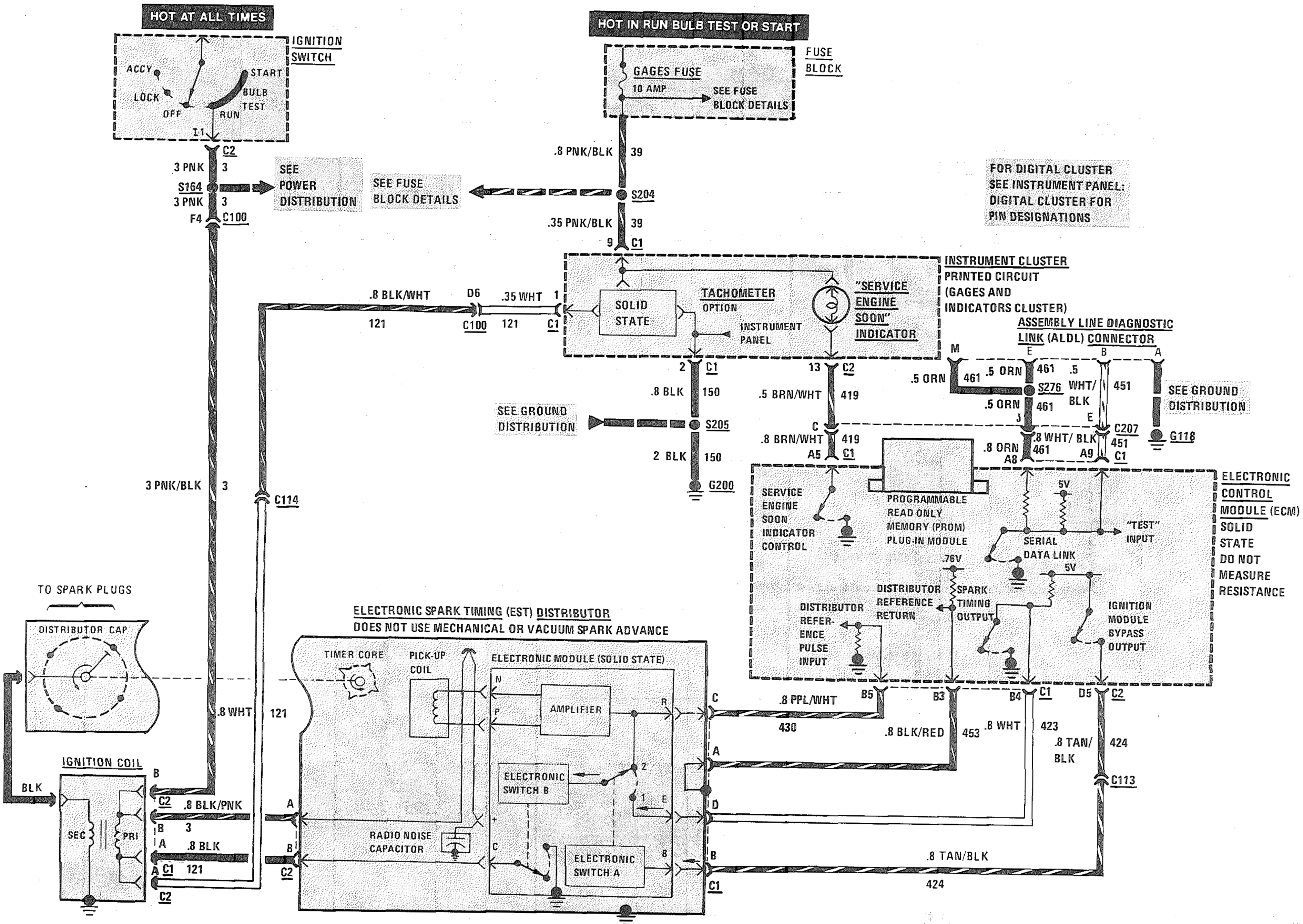
MULTI-PORT FUEL INJECTION: V6 VIN S

FUEL INJECTORS



MULTI-PORT FUEL INJECTION: V6 VIN S

IGNITION, SERVICE ENGINE SOON INDICATOR, AND TACHOMETER



COMPONENT LOCATION

Component	Location	Page-Figure
A/C Compressor Control Relay	LH rear corner of engine compartment, on relay bracket	201- 0-A
AIR Select Valve (VIN S)	Lower RH side of engine, behind AIR pump	
Assembly Line Diagnostic Link (ALDL) Connector	On bottom of I/P hush panel, to right of steering column	
Brake Switch	Above brake pedal, on brake pedal support	201- 9-A
Canister Purge Solenoid Valve (VIN S)	Lower RH front corner of engine compartment	201- 1-A
Cold Start Injector (VIN S)	Top LH rear of engine	201- 0-C
Cold Start Switch (VIN S)	Top of engine	
Coolant Temperature Sensor (VIN S)	Top LH front of intake manifold	201- 0-A
Electronic Control Module (ECM)	Behind RH side of I/P	201-12-B
Electronic Spark Timing (EST) Distributor (VIN S)	Top rear of engine	201- 1-C
Electronic Vacuum Regulator Valve (EVRV)	Top RH rear of engine	201- 1-A
Fan Pressure Switch (VIN S)	Lower RH front of engine compartment, on A/C line	201- 1-A
Fuel Injectors	Top of engine, at each intake cylinder	
Fuel Pump In-Line Fuse	RH side of engine compartment, on inner fender panel	201- 1-A
Fuel Pump Relay (VIN S)	LH rear corner of engine compartment, on relay bracket	201- 0-A
Fuel Pump Switch (VIN S)	Lower LH side of engine	201- 0-A
Fuel Tank Unit	Top center of fuel tank	201- 9-C
Fuse Block	Behind LH side of I/P, below light switch	201-10-A
Gear Selector Switch	In console, at base of gear selector	201-11-E
Idle Air Control Stepper Motor (VIN S)	Top center of engine	201- 1-A
Ignition Coil (VIN S)	Rear RH side of engine	201- 1-A
Ignition Switch	Behind I/P, on top side of steering column	201- 9-A
Manifold Air Temperature (MAT) Sensor (VIN S)	RH front of engine compartment, on air cleaner assembly	201- 1-A

COMPONENT LOCATION

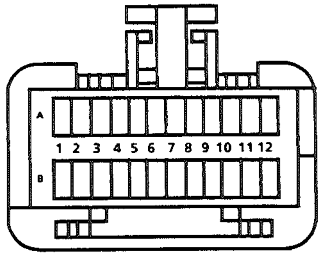
		Page-Figure
Mass Air Flow (MAF) Relay (VIN S)	Front of engine compartment, on RH side of radiator bracket	201- 1-A
Mass Air Flow (MAF) Sensor (VIN S)	Front of engine compartment, on rear of air cleaner	201- 1-A
Mass Air Flow In-Line Fuse	RH side of engine compartment, on inner fender panel	201- 1-A
Oxygen Sensor (VIN S)	Lower RH rear of engine, on exhaust manifold	201- 1-A
Power Steering Switch	Lower LH front corner of engine compartment, on steering unit	201- 0-A
Throttle Position Sensor (VIN S)	Top center of engine	201- 1-A
Vehicle Speed Sensor Buffer	Behind RH side of I/P, near ECM	201-13-A
C100 (42 cavities)	LH front of dash, left of brake master cylinder	201- 0-A
C113 (1 cavity) (VIN S)	Taped to engine harness, RH front of dash	201- 1-A
C114 (1 cavity) (VIN S)	Taped to engine harness, above rear of engine	201- 1-A
C143 (1 cavity) (VIN S)	Lower rear RH side of engine	201- 1-A
C204 (4 cavities)	Above LH rear corner of engine	201- 0-A
C207 (15 cavities)	Behind RH side of I/P, near ECM	201-13-A
C222 (4 cavities)	Top front of engine	201- 0-A
C313 (3 cavities)	Below center of back seat	201- 9-C
G112 (VIN S)	Rear of LH cylinder head	201- 0-C
G118 (VIN S)	Rear of RH cylinder head	201- 1-C
G123	RH front corner of engine compartment, on inner fender panel	201- 1-A
G200	Behind I/P, left of steering column	201-10-A
G304	Under rear seat, on support bracket	
S104 (VIN S)	Engine harness, lower RH side of engine	201- 1-A
S142 (VIN S)	Engine harness, lower RH side of engine	201- 1-A
S143 (VIN S)	Engine harness, center front of dash	201- 1-A
S145 (VIN S)	Engine harness, above rear of engine	201- 1-A
S146 (VIN S)	Engine harness, behind RH side of I/P	
S164	I/P harness, above Fuse Block	201-10-A
S166 (VIN S)	Engine harness, lower RH side of engine	201- 1-A
S167	Engine harness, behind RH side of I/P	
S168 (VIN S)	Engine harness, top rear of engine	201- 1-C
S169	Engine harness, behind RH side of I/P	
S170	Engine harness, behind RH side of I/P	

COMPONENT LOCATION

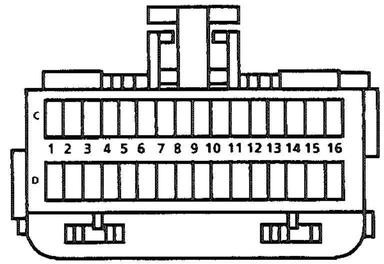
Component	Location	Page-Figure
S175 (VIN S)	Engine harness, lower LH front of dash	201- 0-A
S176 (VIN S)	Engine harness, behind RH side of I/P	
S180 (VIN S)	Injector harness, top of engine	
S181	Injector harness, top of engine	
S182	Injector harness, top of engine	
S183	Injector harness, top of engine	
S202	I/P harness, behind RH side of I/P	201-13-A
S204	I/P harness, behind instrument cluster	201-10-A
S205	I/P harness, behind instrument cluster	201-10-A
S217	I/P harness, behind center of I/P	201-10-A
S242	I/P harness, behind RH side of I/P	201-13-A
S276	I/P harness, behind RH side of I/P	201-13-A
S346	Speaker harness, behind RH side of rear seat	201- 9-B

MULTI-PORT FUEL INJECTION: V6 VIN S

ELECTRONIC CONTROL MODULE CONNECTORS



C1 BLK



C2 BLK

ELECTRONIC CONTROL MODULE (ECM)

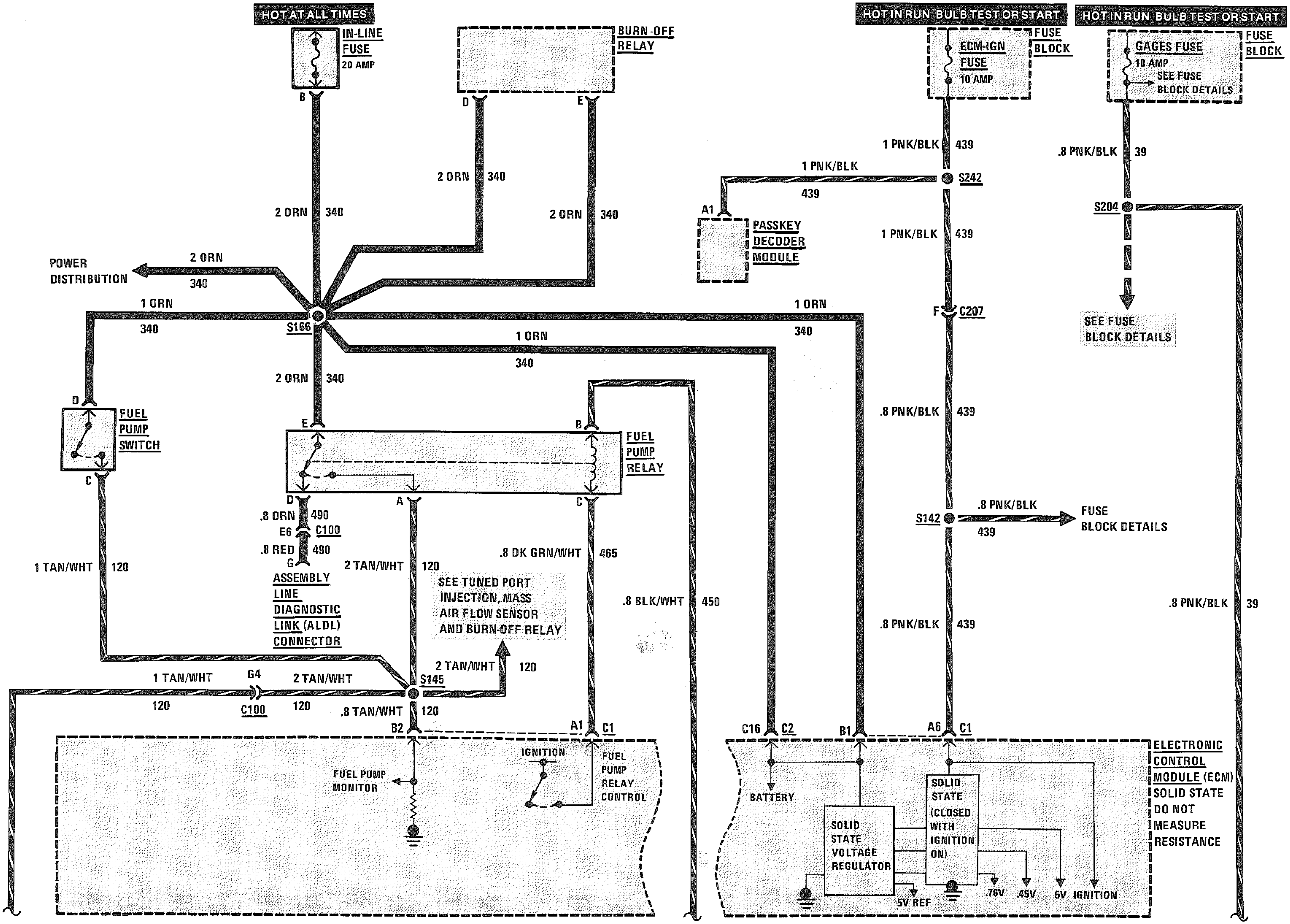
Cavity	Wire Color Socket Half	Circuit Number	Circuit Function
A1	DK GRN/WHT	465	Fuel Pump Relay Control
A2	LT BLU	905	A/C Compressor Relay Control
A3	DK GRN/YEL	428	Canister Purge Solenoid Valve Control
A4	GRY	435	Exhaust Gas Recirculation Solenoid Control
A5	BRN/WHT	419	"Service Engine Soon" Indicator Control
A6	PNK/BLK	439	Ignition
A7	TAN/BLK	422(Auto) 456(Man)	TCC Control (Auto) Shift Indicator Control (Man)
A8	ORN	461	Serial Data Link
A9	WHT/BLK	451	Diagnostic "Test" Input
A10	BRN	437	Speed Input
A11	TAN	472	Manifold Air Temperature Sensor Input
A12	BLK/WHT	450	Ground
B1	ORN	340	Battery
B2	TAN/WHT	120	Fuel Pump Control
B3	BLK/RED	453	Distributor Reference Pulse: LO
B4	WHT	423	Spark Timing Output
B5	PPL/WHT	430	Distributor Reference Pulse Input: HI
B6	BRN/WHT	528	Mass Air Flow Sensor Input
B7	–	–	Not Used
B8	DK GRN/WHT	59	A/C On Input
B9	GRY	901	Power Steering Input
B10	ORN/BLK	434	Park/Neutral Input
B11	–	–	Not Used
B12	–	–	Not Used
C1	–	–	Not Used
C2	BRN	436	Air Select Valve Control

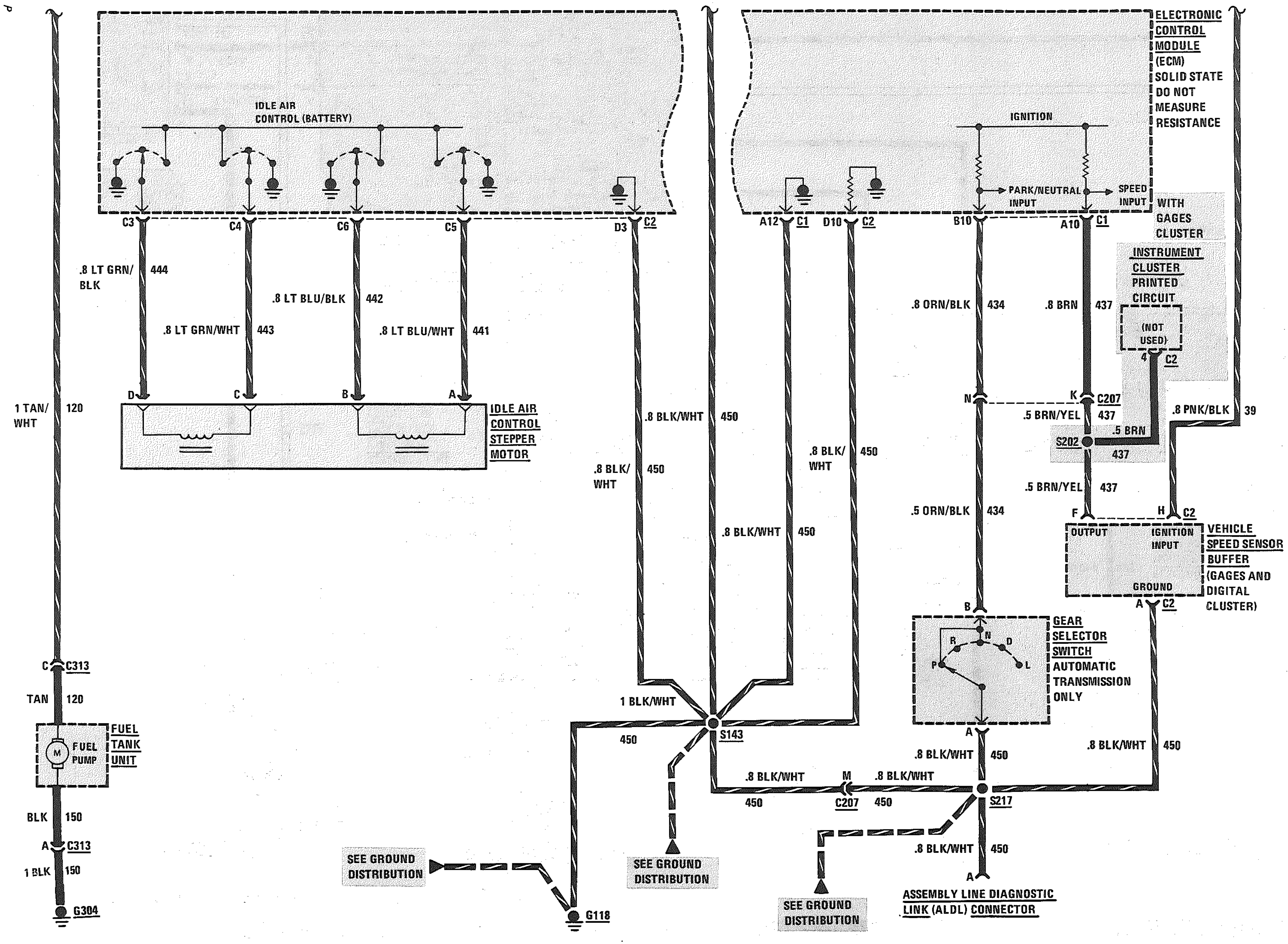
Cavity	Wire Color Socket Half	Circuit Number	Circuit Function
C5	LT BLU/WHT	441	Idle Air Control A HI
C6	LT BLU/BLK	442	Idle Air Control A LO
C7	–	–	Not Used
C8	LT BLU	446	Top Gear Input
C9	DK BLU	732	Fan Pressure Switch Input
C10	YEL	410	Coolant Temperature Sensor Input
C11	–	–	Not Used
C12	DK BLU	417	Throttle Position Sensor Input
C13	DK BLU	417	Throttle Position Sensor Input
C14	GRY	416	5 Volt Reference
C15	LT GRN	468	Connected to D14
C16	ORN	340	Battery
D1	BLK/WHT	450	Ground
D2	DK GRN/WHT	335	Fan Control Output
D3	–	–	Not Used
D4	–	–	Not Used
D5	TAN/BLK	424	Ignition Module Bypass Output
D6	TAN	413	Oxygen Sensor Input: LO
D7	PPL	412	Oxygen Sensor Input: HI
D8	WHT	397	Evrv Control
D9	–	–	Not Used
D10	–	–	Not Used
D11	–	–	Not Used
D12	–	–	Not Used
D13	BLK	452	Ground
D14	LT BLU	467	Fuel Injector Control
D15	LT GRN	468	Fuel Injector Control
D16	LT BLU	467	Connected to D15

BLANK

TUNED PORT INJECTION: V8 VIN F

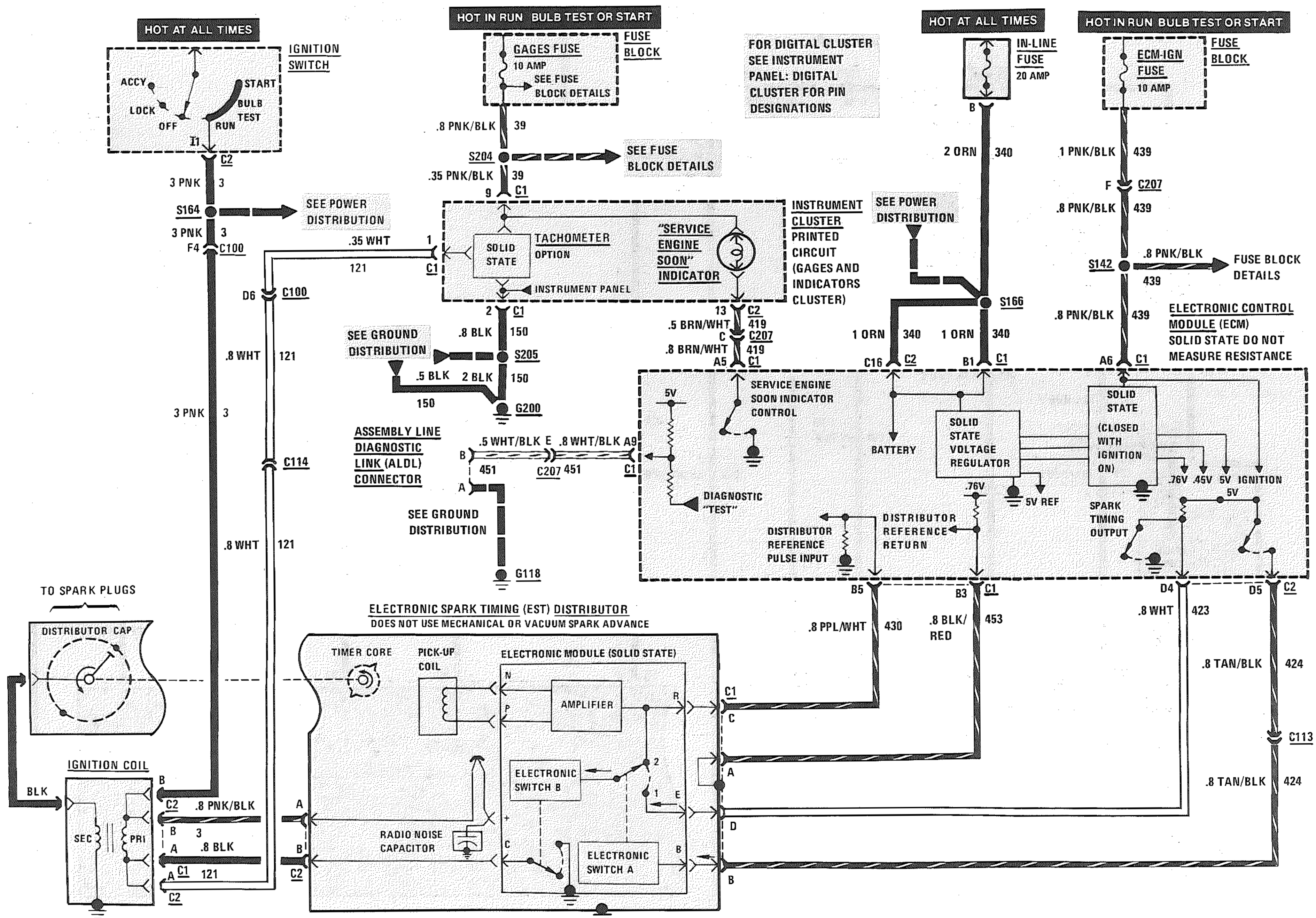
IDLE SPEED CONTROL, FUEL CONTROL, AND VEHICLE DATA SENSORS



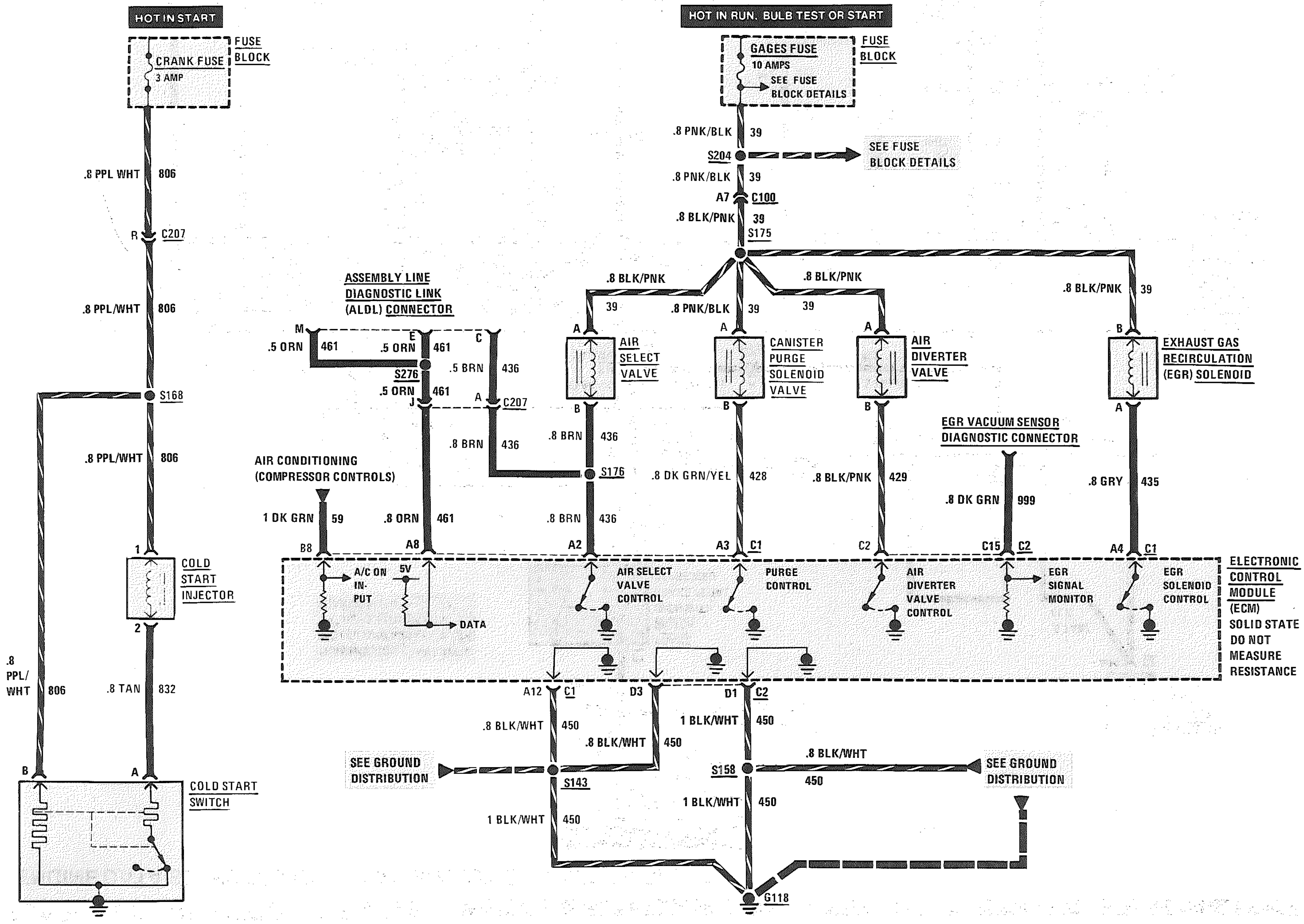

ELECTRONIC CONTROL MODULE (ECM) SOLID STATE DO NOT MEASURE RESISTANCE
IDLE AIR CONTROL (BATTERY)
IGNITION
PARK/NEUTRAL INPUT
SPEED INPUT
WITH GAGES CLUSTER
C3
C4
C6
C5
D3 C2
A12 C1
D10 C2
B10
A10 C1
.8 LT GRN/ BLK 444
.8 LT GRN/WHT 443
.8 LT BLU/BLK 442
.8 LT BLU/WHT 441
D
C
B
A
IDLE AIR CONTROL STEPPER MOTOR
1 TAN/ WHT 120
.8 BLK/WHT 450
.8 BLK/ WHT 450
.8 BLK/ WHT 450
.8 BLK/WHT 450
.8 ORN/BLK 434
.8 BRN 437
INSTRUMENT CLUSTER PRINTED CIRCUIT
(NOT USED)
4 C2
N
K C207
.5 BRN/YEL 437
.5 BRN
S202
437
.8 PNK/BLK 39
.5 BRN/YEL 437
.5 ORN/BLK 434
F
H C2
OUTPUT
IGNITION INPUT
GROUND
A C2
VEHICLE SPEED SENSOR BUFFER (GAGES AND DIGITAL CLUSTER)
B
GEAR SELECTOR SWITCH AUTOMATIC TRANSMISSION ONLY
R N D
P L
A
C C313
TAN 120
FUEL PUMP
M
FUEL TANK UNIT
BLK 150
A C313
1 BLK 150
G304
1 BLK/WHT
450
S143
.8 BLK/WHT 450
.8 BLK/WHT
M
.8 BLK/WHT
450
C207
450
S217
.8 BLK/WHT 450
.8 BLK/WHT 450
SEE GROUND DISTRIBUTION
G118
SEE GROUND DISTRIBUTION
SEE GROUND DISTRIBUTION
A
ASSEMBLY LINE DIAGNOSTIC LINK (ALDL) CONNECTOR

TUNED PORT INJECTION: V8 VIN F

IGNITION, SERVICE ENGINE SOON INDICATOR AND TACHOMETER

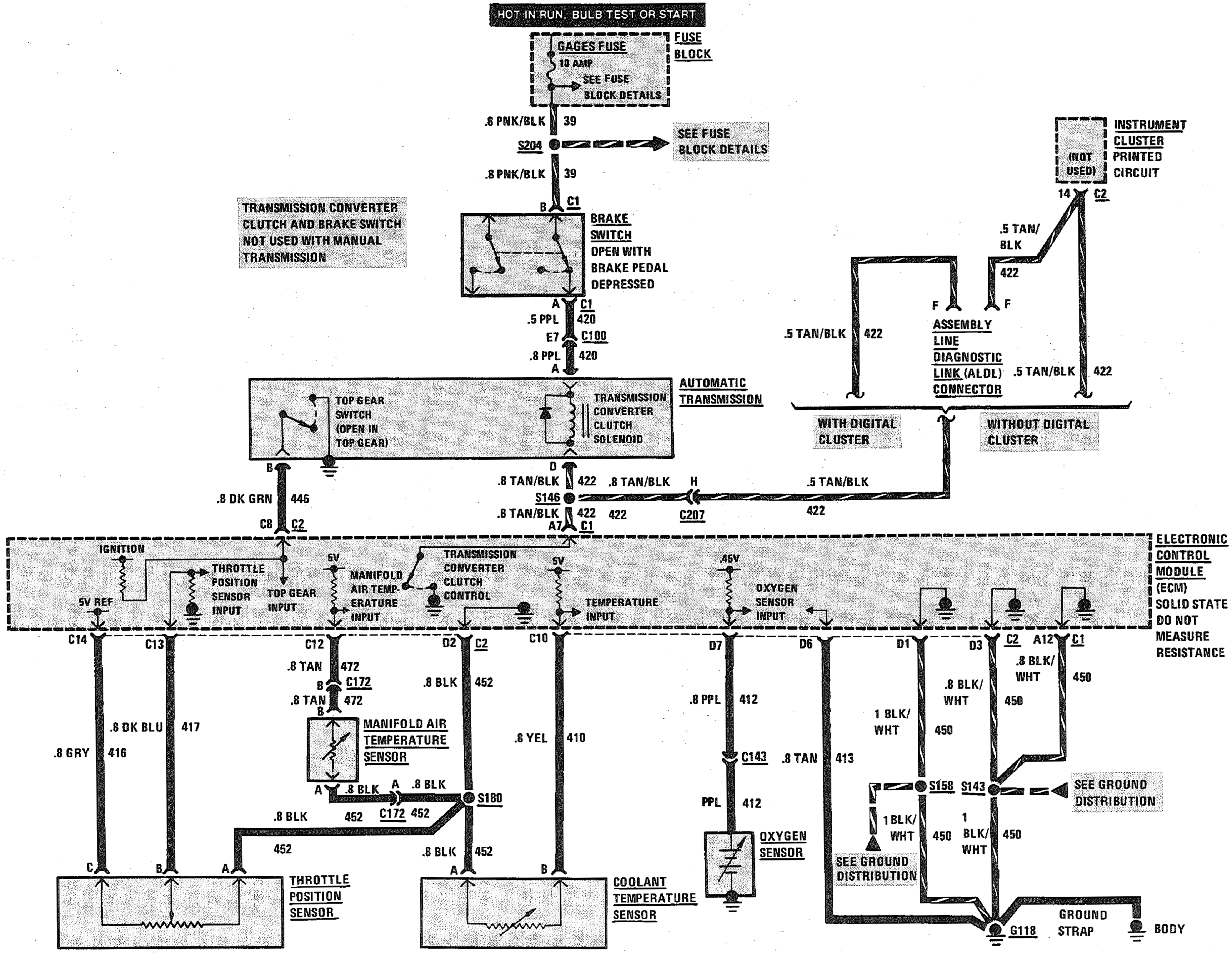


TUNED PORT INJECTION: V8 VIN F
COLD START AND EMISSION CONTROL



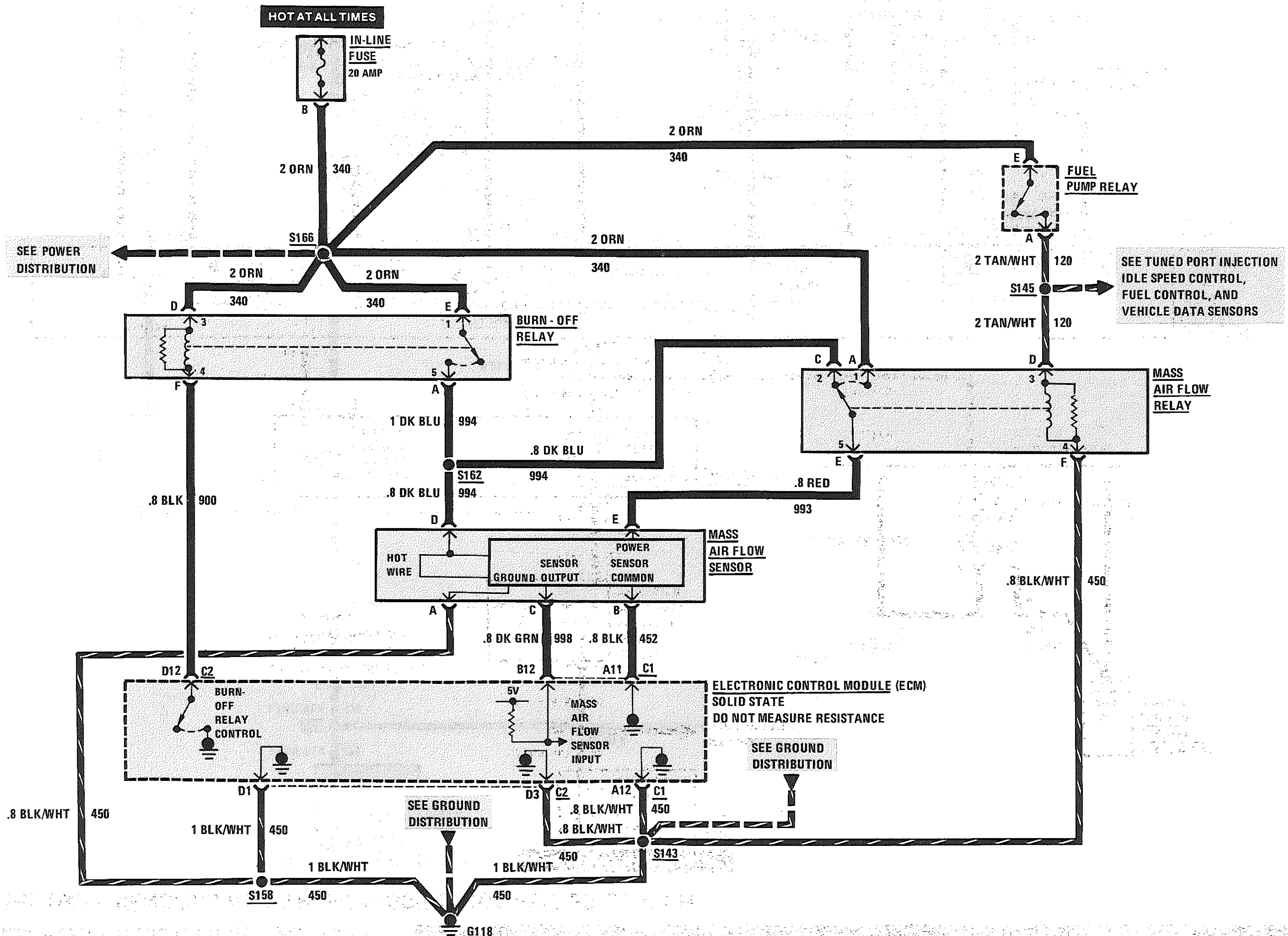
TUNED PORT INJECTION: V8 VIN F

ENGINE DATA SENSORS AND TRANSMISSION CONVERTER CLUTCH



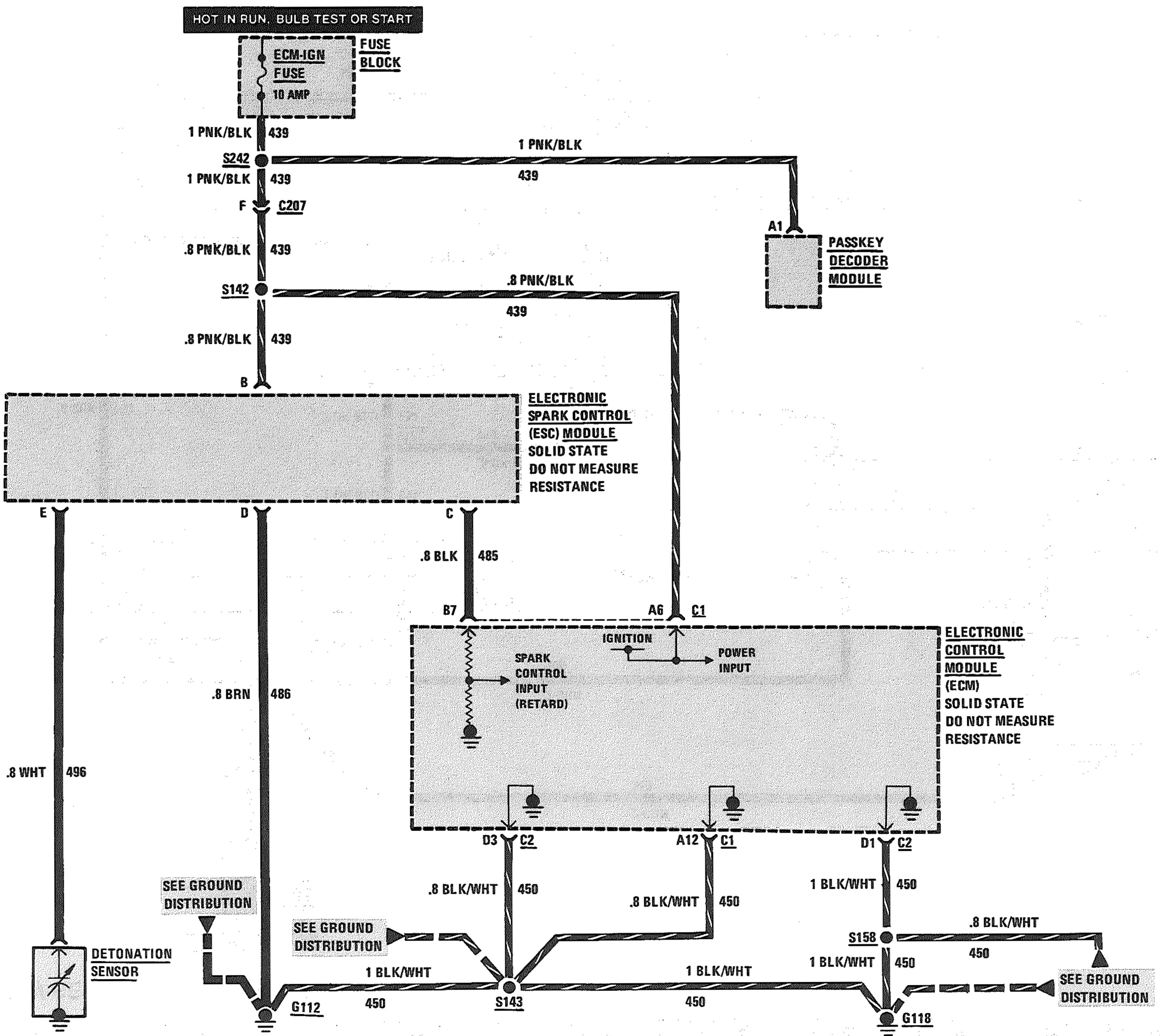
TUNED PORT INJECTION: V8 VIN F

MASS AIR FLOW SENSOR AND BURN-OFF RELAY



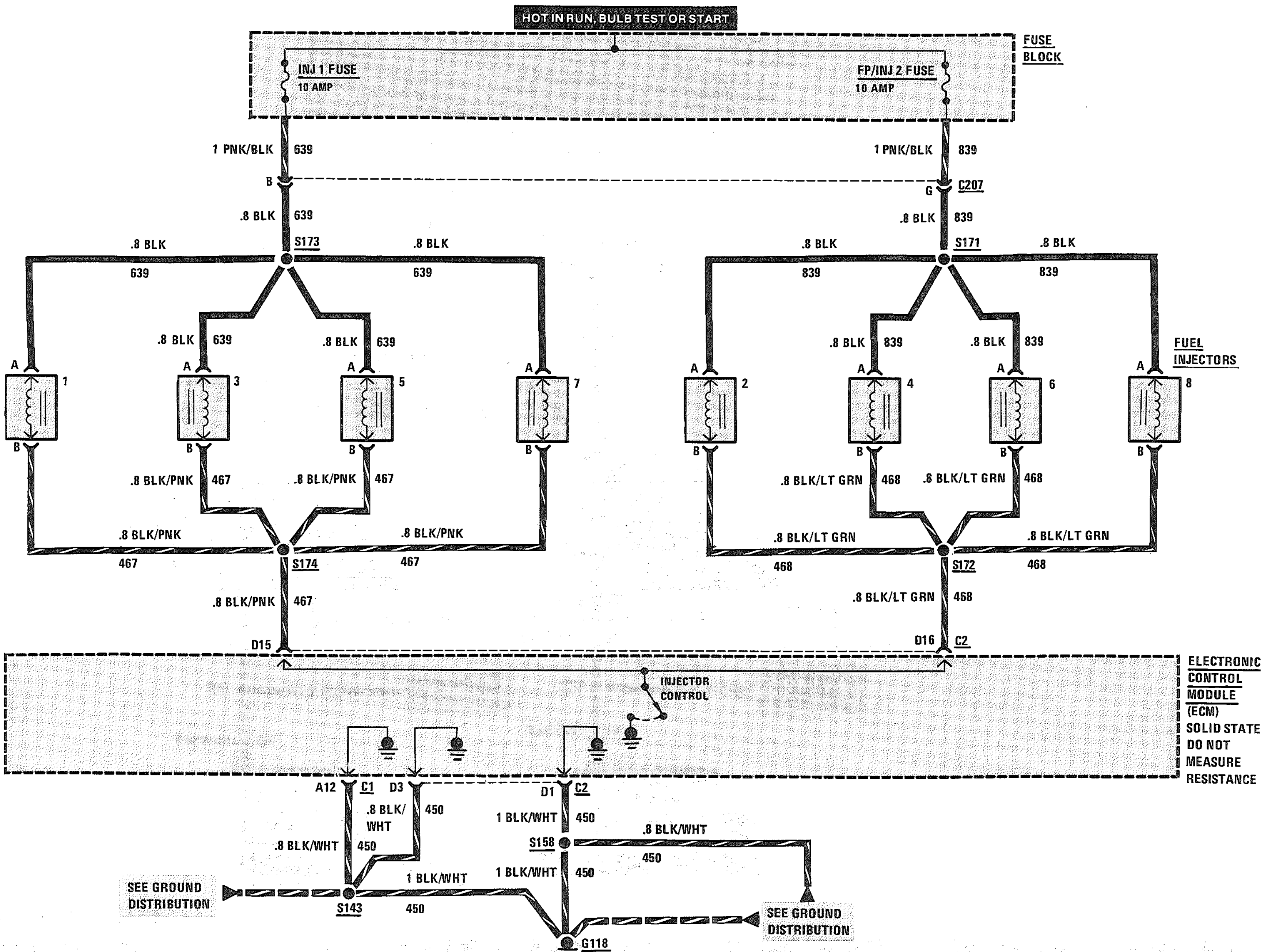
TUNED PORT INJECTION: V8 VIN F

SPARK CONTROL

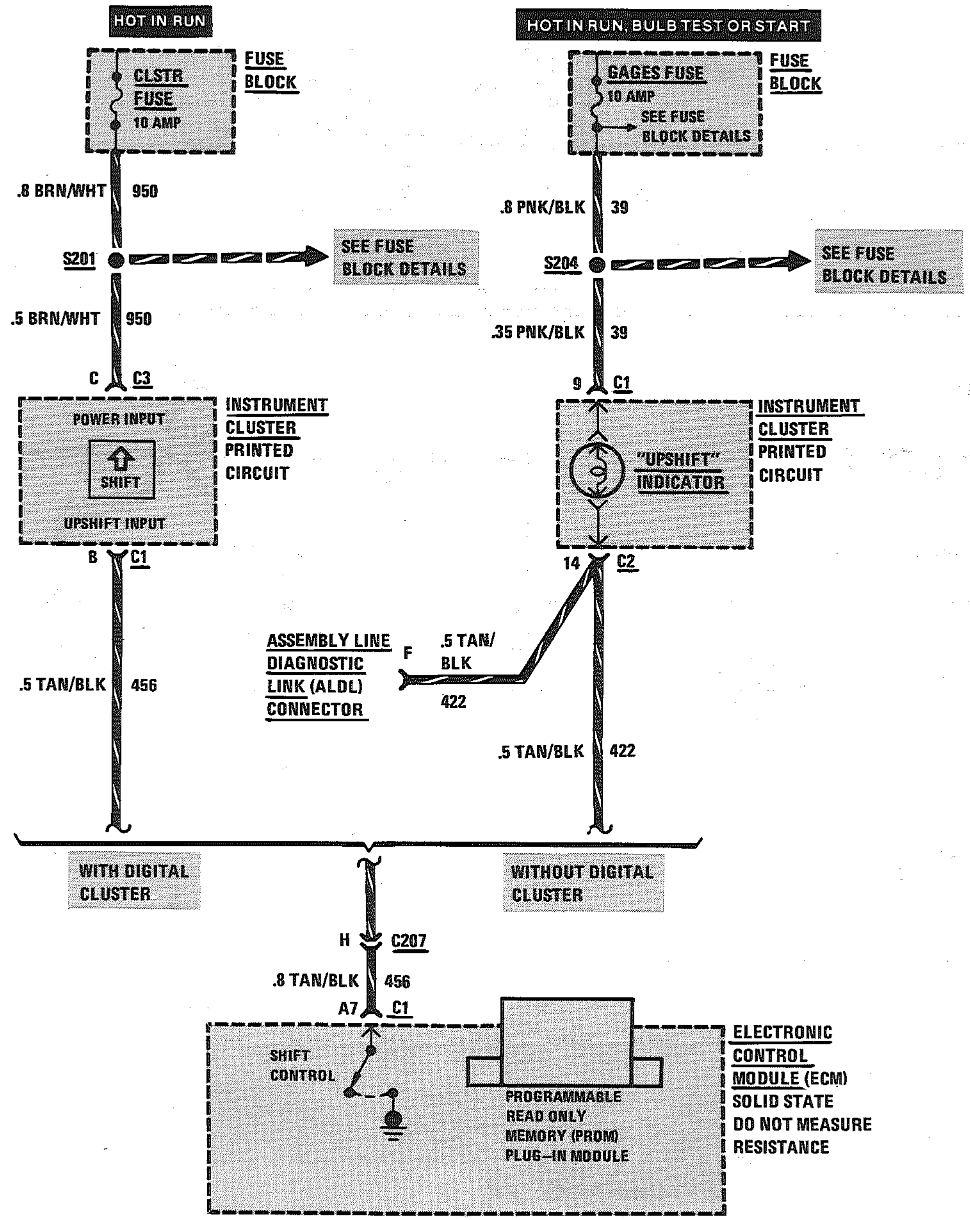


TUNED PORT INJECTION: V8 VIN F

FUEL INJECTORS



TUNED PORT INJECTION: V8 VIN F
UPSHIFT INDICATOR



COMPONENT LOCATION

Component	Location	Page-Figure
AIR Diverter Valve (VIN F) (VIN 8)	RH front of engine, on valve cover	201- 6-A
AIR Select Valve (VIN F) (VIN 8)	RH front of engine, on valve cover	201- 6-A
Assembly Line Diagnostic Link (ALDL) Connector	On bottom of I/P hush panel, to right of steering column	
Brake Switch	Above brake pedal, on brake pedal support	201- 9-A
Burn-Off Relay	LH rear corner of engine compartment, on relay bracket	201- 7-A
Canister Purge Solenoid Valve (VIN F) (VIN 8)	Lower RH front corner of engine compartment	201- 5-A
Cold Start Injector (VIN F) (VIN 8)	Top LH side of engine	201- 7-A
Cold Start Switch (VIN F) (VIN 8)	Top center of engine	201- 8-C
Coolant Temperature Sensor (VIN F) (VIN 8)	Top LH front of engine	201- 8-C
Detonation Sensor (VIN F) (VIN 8)	Lower RH side of engine, above Starter Solenoid	201- 5-A
EGR Vacuum Sensor Diagnostic Connector	Top rear of engine	201- 4-E
Electronic Control Module (ECM)	Behind RH side of I/P	201-12-B
Electronic Spark Control (ESC) Module (VIN F) (VIN 8)	LH rear corner of engine compartment, on relay bracket	201- 7-A
Electronic Spark Timing (EST) Distributor (VIN F) (VIN 8)	Top rear of engine	201- 5-A
Exhaust Gas Recirculation (EGR) Solenoid (VIN F) (VIN 8)	Top RH rear of intake manifold	201- 5-A
Fuel Injectors	Top of engine, at each intake cylinder	
Fuel Pump Relay (VIN F) (VIN 8)	LH rear corner of engine compartment, on relay bracket	201- 7-A
Fuel Pump Switch (VIN F) (VIN 8)	Lower LH side of engine	201- 8-A
Fuel Tank Unit	Top center of fuel tank	201- 9-C
Fuse Block	Behind LH side of I/P, below light switch	201-10-A
Gear Selector Switch	In console, at base of gear selector	201-11-E
Idle Air Control Stepper Motor (VIN F) (VIN 8)	Top LH front of engine	201- 8-C
Ignition Coil (VIN F)(VIN 8)	RH rear side of engine	201- 7-B
Ignition Switch	Behind I/P, on top side of steering column	201- 9-A

COMPONENT LOCATION

Component	Location	Page-Figure
In-Line Fuse (VIN F)(VIN 8)	On LH side of radiator support, forward of battery	201- 5-C
Manifold Air Temperature (MAT) Sensor (VIN F) (VIN 8)	Top of intake manifold	
Mass Air Flow (MAF) Relay (VIN F) (VIN 8)	LH rear corner of engine compartment, on relay bracket	201- 7-A
Mass Air Flow (MAF) Sensor (VIN F) (VIN 8)	Front of engine compartment, on rear of air cleaner	201- 5-A
Oxygen Sensor (VIN F) (VIN 8)	Lower LH side of engine, on exhaust manifold	
Throttle Position Sensor (VIN F) (VIN 8)	Top center of engine	201- 8-C
Vehicle Speed Sensor Buffer	Behind RH side of I/P, near ECM	201-13-A
C100 (42 cavities)	LH front of dash, left of brake master cylinder	201- 0-A
C113 (1 cavity) (VIN F) (VIN 8)	Taped to engine harness, RH front of dash	201- 5-A
C114 (1 cavity) (VIN F) (VIN 8)	Taped to engine harness, above rear of engine	201- 7-B
C143 (1 cavity) (VIN F) (VIN 8)	Lower LH side of engine, below exhaust manifold	201- 8-A
C172 (2 cavities)	Top rear of engine	201- 4-E
C207 (15 cavities)	Behind RH side of I/P, near ECM	201-13-A
C313 (3 cavities)	Below center of back seat	201- 9-C
G112 (VIN F) (VIN 8)	Rear of LH cylinder head	201- 7-C
G118 (VIN F) (VIN 8)	Rear of RH cylinder head	201- 5-A
G200	Behind I/P, left of steering column	201-10-A
G304	Under rear seat, on support bracket	
S142 (VIN F) (VIN 8)	Engine harness, behind RH side of I/P	
S143 (VIN F) (VIN 8)	Engine harness, RH front of dash	201- 6-A
S145 (VIN F) (VIN 8)	Engine harness, above LH rear of engine	201- 7-A
S146 (VIN F) (VIN 8)	Engine harness, behind RH side of I/P	
S158	Engine harness, behind RH side of I/P	
S162	Engine harness, LH rear corner of engine compartment	201- 7-A
S164	I/P harness, above Fuse Block	201-10-A
S166 (VIN F) (VIN 8)	Engine harness, above LH rear of engine	201- 7-A
S168 (VIN F) (VIN 8)	Engine harness, RH front of dash	201- 6-A
S171	Engine harness, RH front of dash	201- 6-A

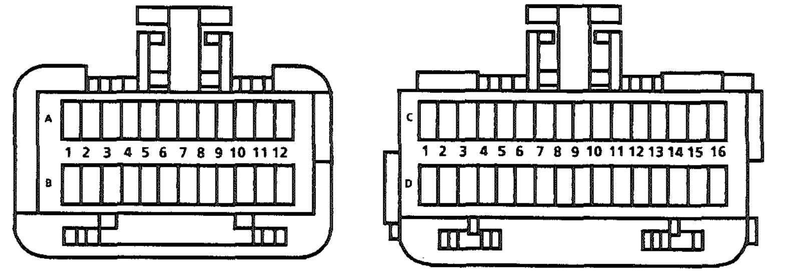
COMPONENT LOCATION

		Page-Figure
S172 (VIN F) (VIN 8)	Engine harness, RH front of dash	201- 6-A
S173	Engine harness, top center rear of engine	201- 7-A
S174 (VIN F) (VIN 8)	Engine harness, top center rear of engine	201- 7-A
S175 (VIN F) (VIN 8)	Engine harness, above LH rear of engine	201- 7-A
S176 (VIN F) (VIN 8)	Engine harness, behind RH side of I/P	
S180 (VIN F) (VIN 8)	Engine harness, above RH rear of engine	201- 7-B
S201	I/P harness, behind instrument cluster	201-10-A
S202	I/P harness, behind RH side of I/P	201-13-A
S204	I/P harness, behind instrument cluster	201-10-A
S205	I/P harness, behind instrument cluster	201-10-A
S217	I/P harness, behind center of I/P	201-10-A
S242	I/P harness, behind RH side of I/P	201-13-A
S276	I/P harness, behind RH side of I/P	201-13-A

TUNED PORT INJECTION: V8 VIN F

ELECTRONIC CONTROL MODULE CONNECTORS

ELECTRONIC CONTROL MODULE (ECM)



C1 BLK

C2 BLK

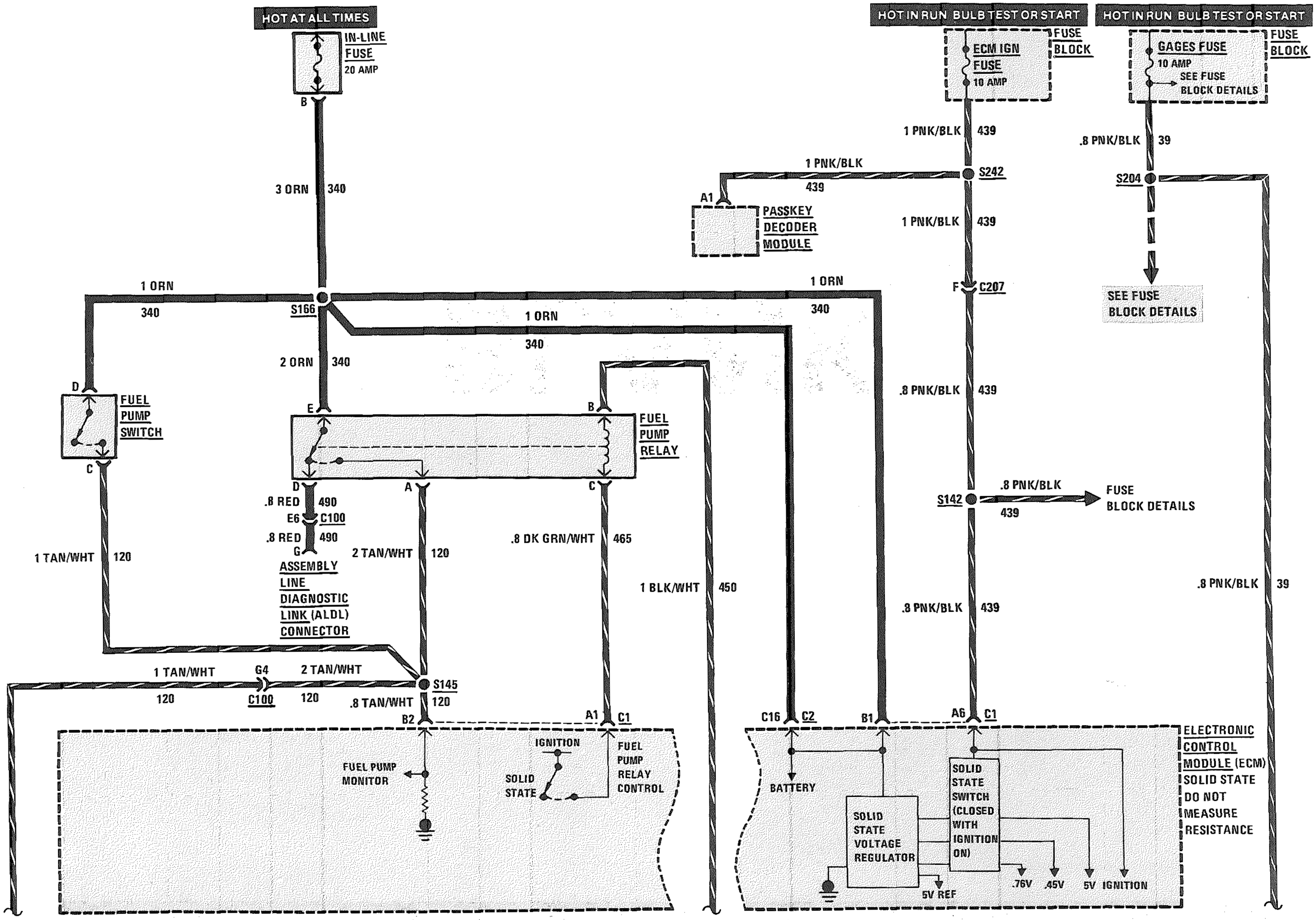
CAVITY	WIRE COLOR SOCKET HALF	CIRCUIT NUMBER	CIRCUIT FUNCTION
A1	DK GRN/WHT	465	Fuel Pump Relay Control
A2	BRN	436	Air Select Valve Control
A3	DK GRN/YEL	428	Canister Purge Solenold Valve Control
A4	GRY	435	Exhaust Gas Recirculation Solenold Control
A5	BRN/WHT	419	"Service Engine Soon" Indicator Control
A6	PNK/BLK	439	Ignition
A7	TAN/BLK	422(Auto) 456 (Manual)	TCC Control (auto) Shift Indicator Control (manual)
A8	ORN	461	Data
A9	WHT/BLK	451	Diagnostic "Test" Input
A10	BRN	437	Speed Input
A11	BLK	452	Ground
A12	BLK/WHT	450	Ground
B1	ORN	340	Battery
B2	TAN/WHT	120	Fuel Pump Control
B3	BLK/RED	453	Distributor Reference Pulse Input:LO
B4	—	—	Not Used
B5	PPL/WHT	430	Distributor Reference Pulse Input:HI
B6	PPL	963	Theft Deterrent
B7	BLK	485	Electronic Spark Control Input (Retard)
B8	DK GRN	59	A/C On Input
B9			Not Used
B10	ORN/BLK	434	Park/Neutral Input
B11	—	—	Not Used
B12	DK GRN	998	Mass Air Flow Sensor Input
C1	DK GRN/WHT	335	Fan Control Output
C2	BLK/PNK	429	Air Diverter Valve Control
C3	LT GRN/BLK	444	Idle Air Control B LO
C4	LT GRN/WHT	443	Idle Air Control B HI

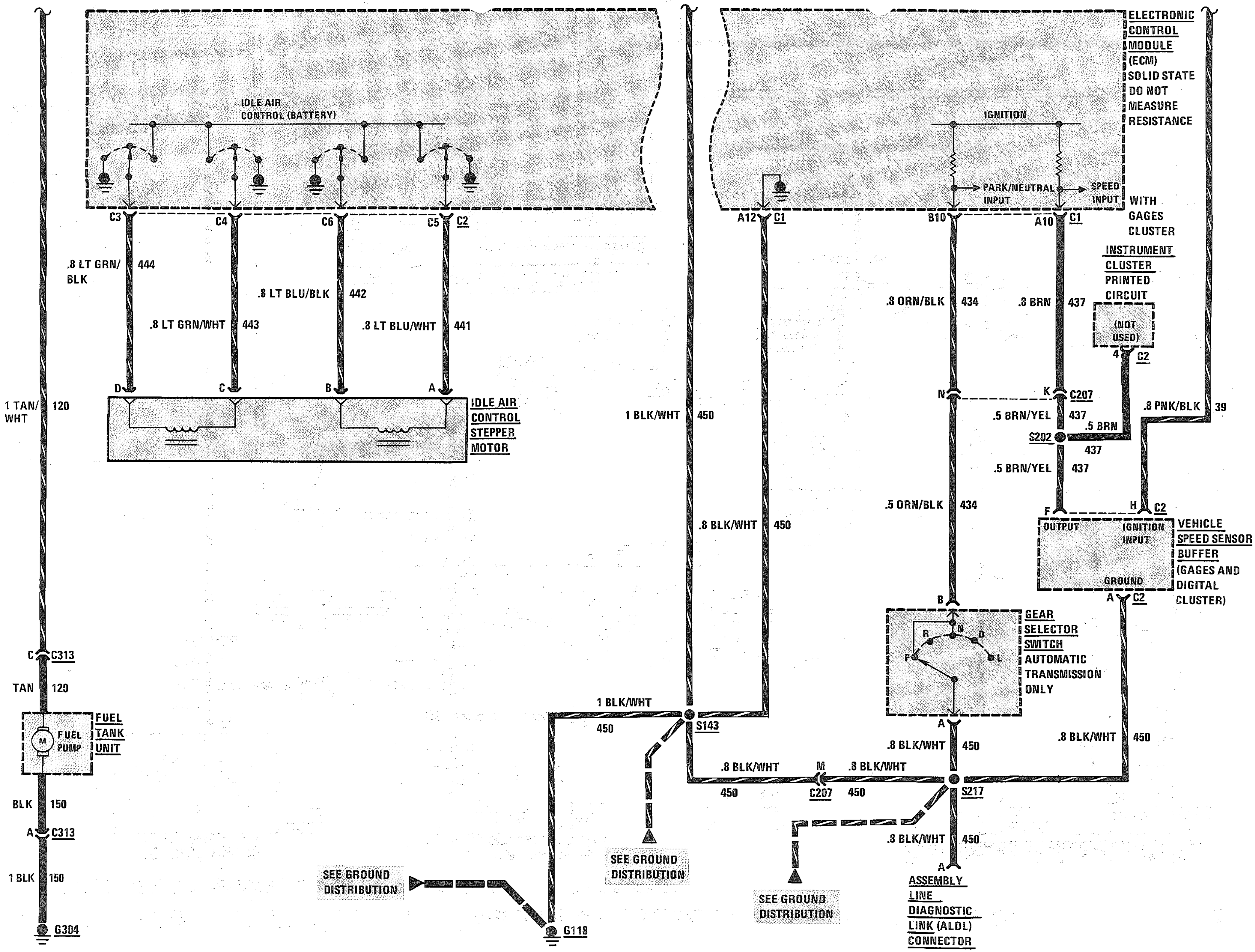
CAVITY	WIRE COLOR SOCKET HALF	CIRCUIT NUMBER	CIRCUIT FUNCTION
C5	LT BLU/WHT	441	Idle Air Control A HI
C6	LT BLU/BLK	442	Idle Air Control A LO
C7	—	—	Not Used
C8	DK GRN	446	Top Gear Input
C9	—	—	Not Used
C10	YEL	410	Coolant Temperature Sensor Input
C11	—	—	Not Used
C12	TAN	472	Manifold Air Temperature Sensor Input
C13	DK BLU	417	Throttle Position Sensor Input
C14	GRY	416	5 Volt Reference
C15	DK GRN	999	EGR Vacuum Sensor Signal
C16	ORN	340	Battery
D1	BLK/WHT	450	Ground
D2	BLK	452	Ground
D3	BLK/WHT	450	Ground
D4	WHT	423	Spark Timing Output
D5	TAN/BLK	424	Ignition Module Bypass Output
D6	TAN	413	Oxygen Sensor Ground
D7	PPL	412	Oxygen Sensor Input
D8	—	—	Not Used
D9	—	—	Not Used
D10	BLK/WHT	450	Ground
D11	GRY	731	Fan Pressure Switch Input
D12	BLK	900	Burn-Off Relay Control
D13	—	—	Not Used
D14	—	—	Not Used
D15	BLK/PNK	467	Fuel Injector Control
D16	BLK/LT GRN	467	Fuel Injector Control

BLANK

THROTTLE BODY INJECTION: V8 VIN E

IDLE SPEED CONTROL, FUEL CONTROL, AND VEHICLE DATA SENSORS

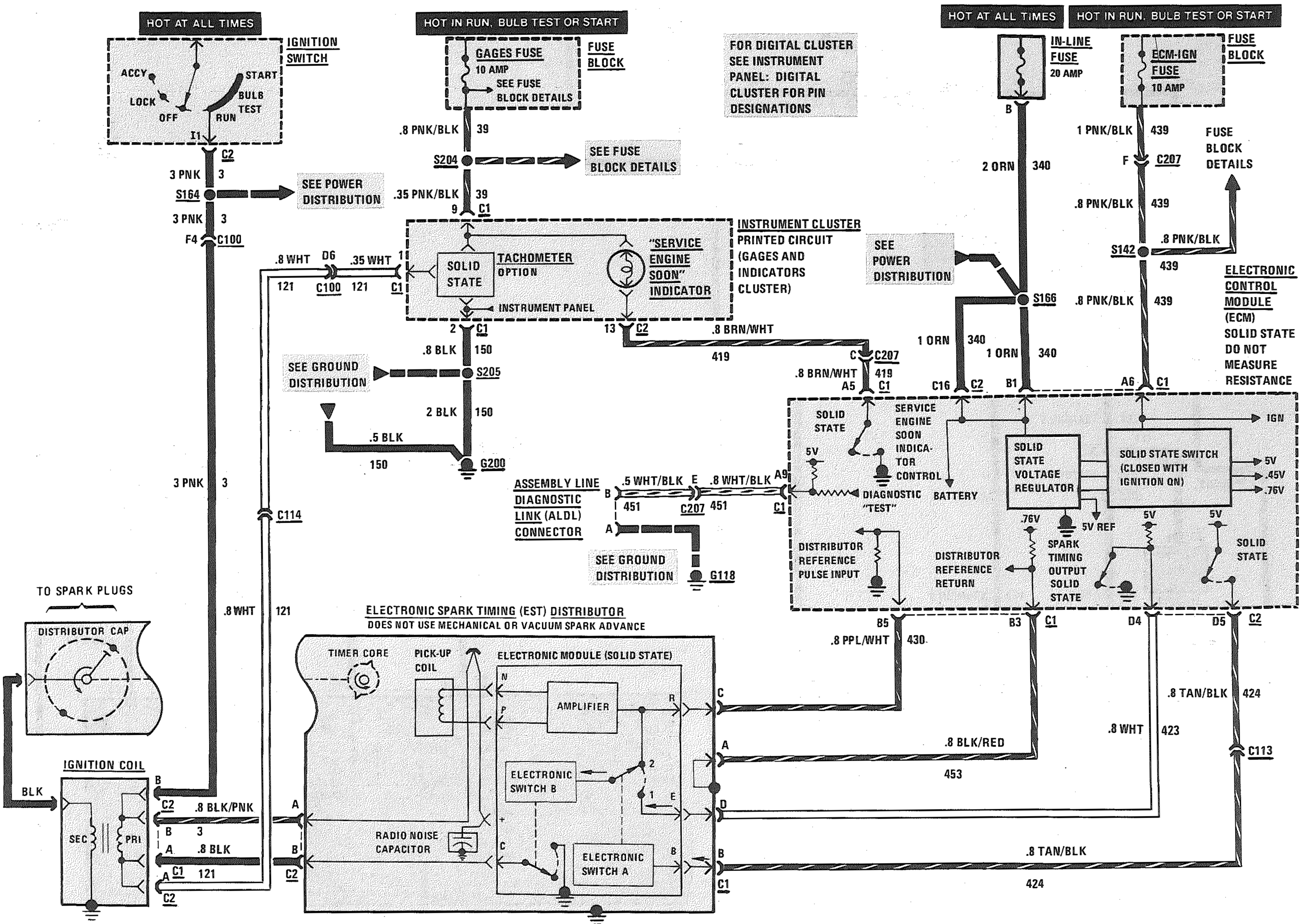




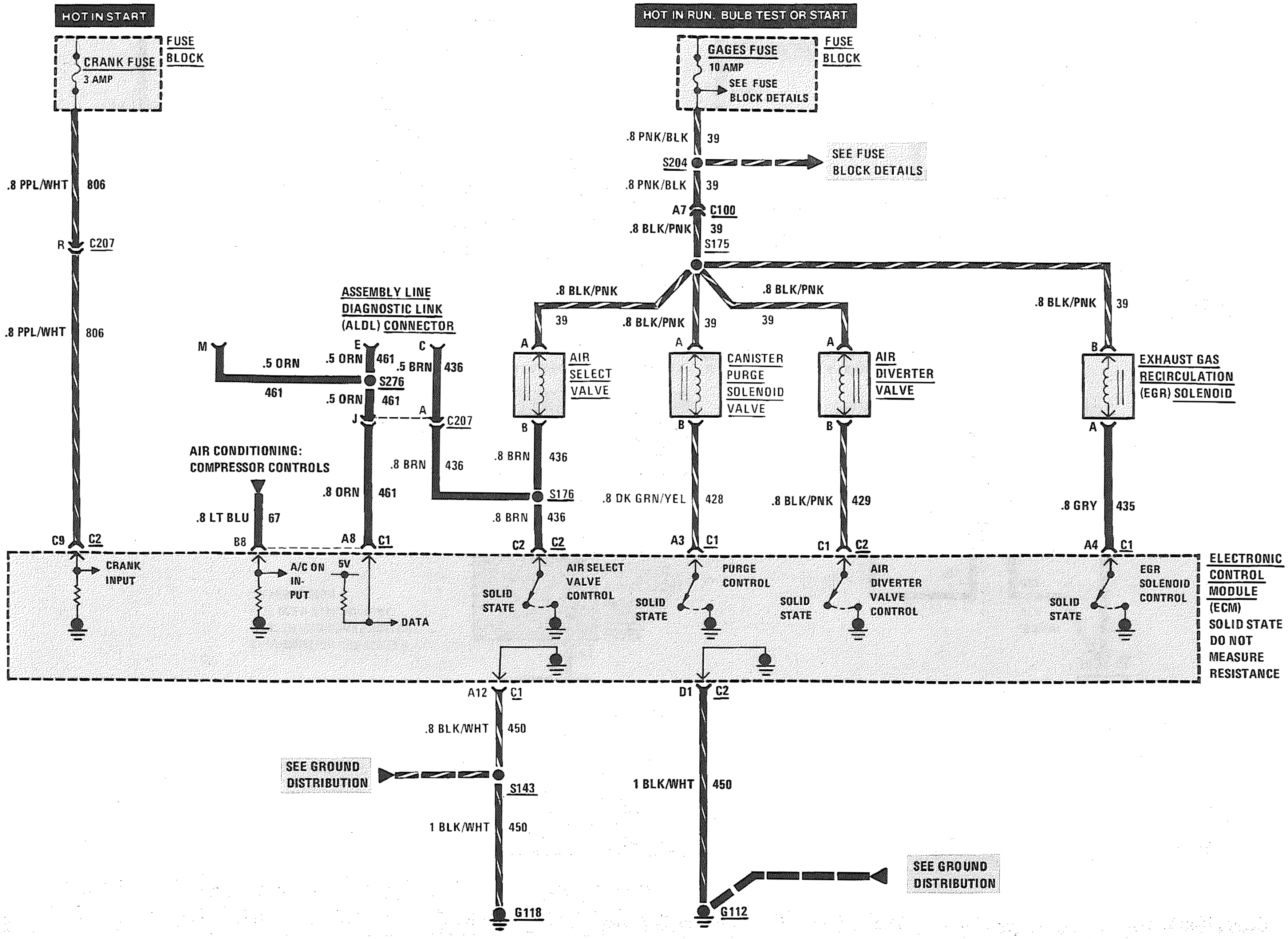
ELECTRONIC CONTROL MODULE (ECM) SOLID STATE DO NOT MEASURE RESISTANCE
IDLE AIR CONTROL (BATTERY)
IGNITION
PARK/NEUTRAL INPUT
SPEED INPUT
WITH GAGES CLUSTER
C3
C4
C6
C5
C2
A12
C1
B10
A10
C1
.8 LT GRN/BLK 444
.8 LT GRN/WHT 443
.8 LT BLU/BLK 442
.8 LT BLU/WHT 441
D
C
B
A
IDLE AIR CONTROL STEPPER MOTOR
1 TAN/WHT 120
C C313
TAN 120
FUEL TANK UNIT
FUEL PUMP
M
BLK 150
A C313
1 BLK 150
G304
1 BLK/WHT 450
.8 BLK/WHT 450
1 BLK/WHT
450
S143
SEE GROUND DISTRIBUTION
SEE GROUND DISTRIBUTION
G118
.8 ORN/BLK 434
.8 BRN 437
INSTRUMENT CLUSTER PRINTED CIRCUIT
(NOT USED)
4 C2
N
K C207
.5 BRN/YEL 437
.5 BRN
S202
437
.5 BRN/YEL 437
.8 PNK/BLK 39
.5 ORN/BLK 434
F
H C2
OUTPUT
IGNITION INPUT
GROUND
VEHICLE SPEED SENSOR BUFFER (GAGES AND DIGITAL CLUSTER)
A C2
B
GEAR SELECTOR SWITCH AUTOMATIC TRANSMISSION ONLY
R N D
P L
A
.8 BLK/WHT 450
.8 BLK/WHT 450
.8 BLK/WHT
M
.8 BLK/WHT
450
C207
450
S217
SEE GROUND DISTRIBUTION
.8 BLK/WHT 450
A
ASSEMBLY LINE DIAGNOSTIC LINK (ALDL) CONNECTOR

THROTTLE BODY INJECTION: V8 VIN E

IGNITION, SERVICE ENGINE SOON INDICATOR, AND TACHOMETER

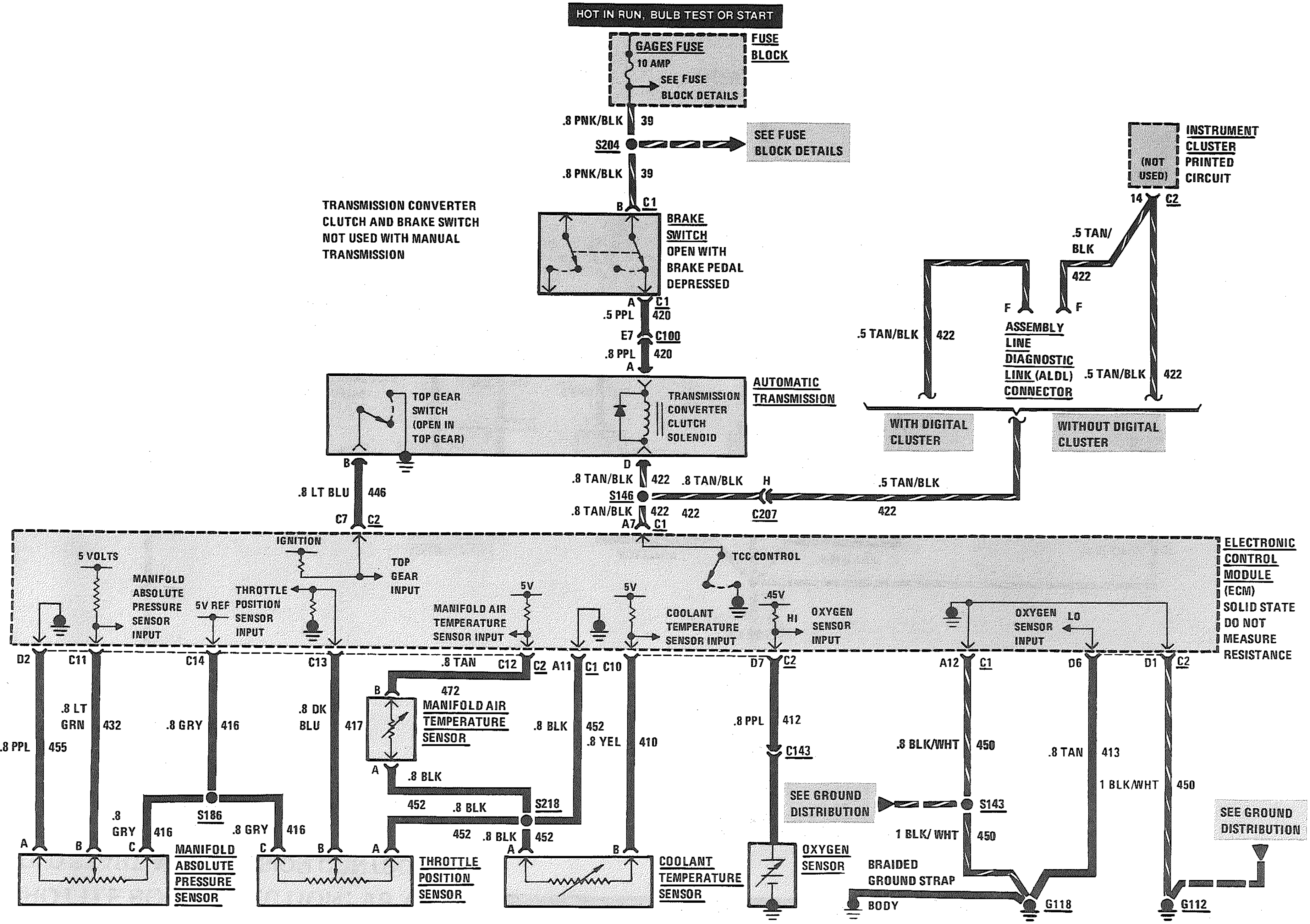


THROTTLE BODY INJECTION: V8 VIN E
COLD START AND EMISSION CONTROL



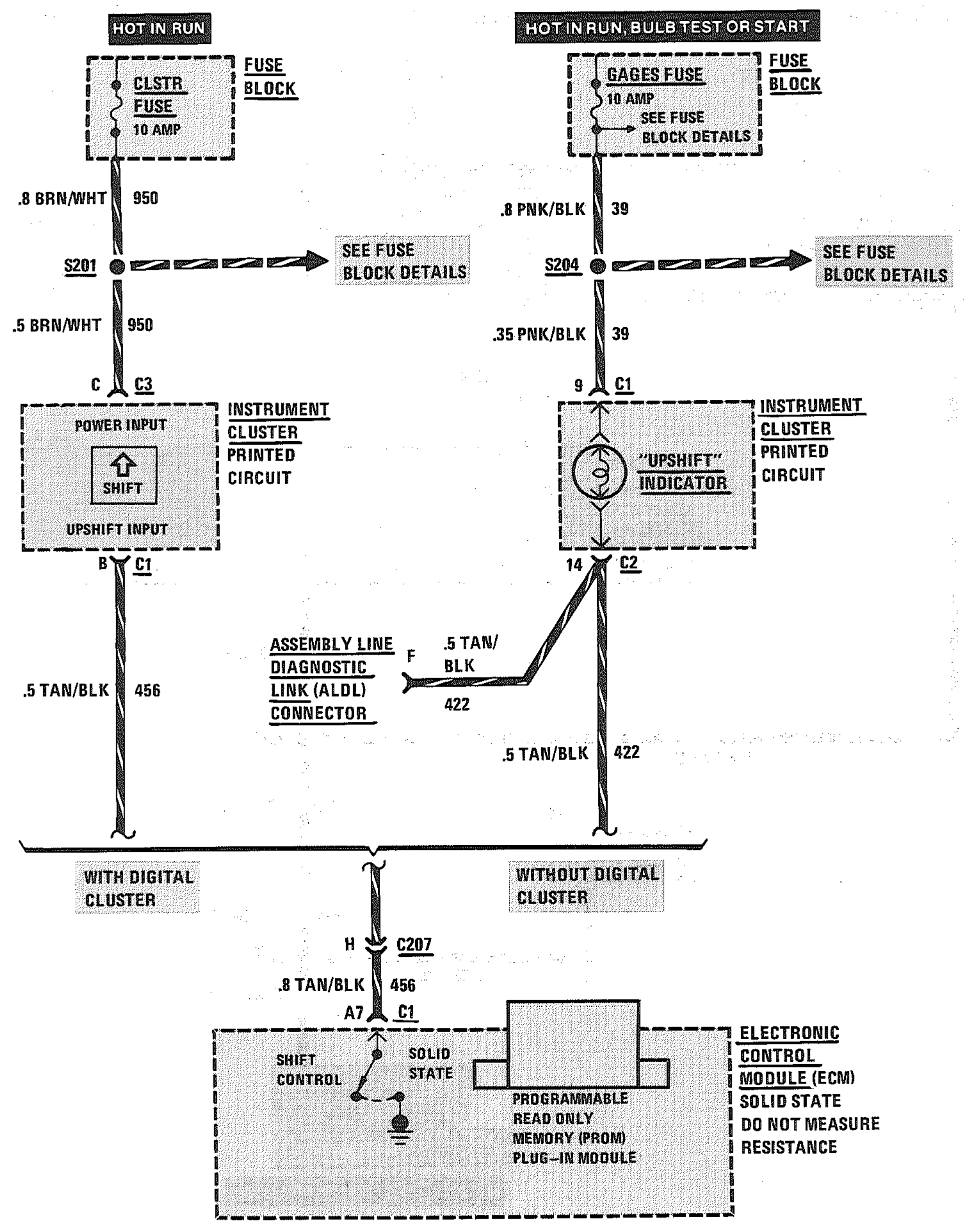
THROTTLE BODY INJECTION: V8 VIN E

ENGINE DATA SENSORS AND TRANSMISSION CONVERTER CLUTCH



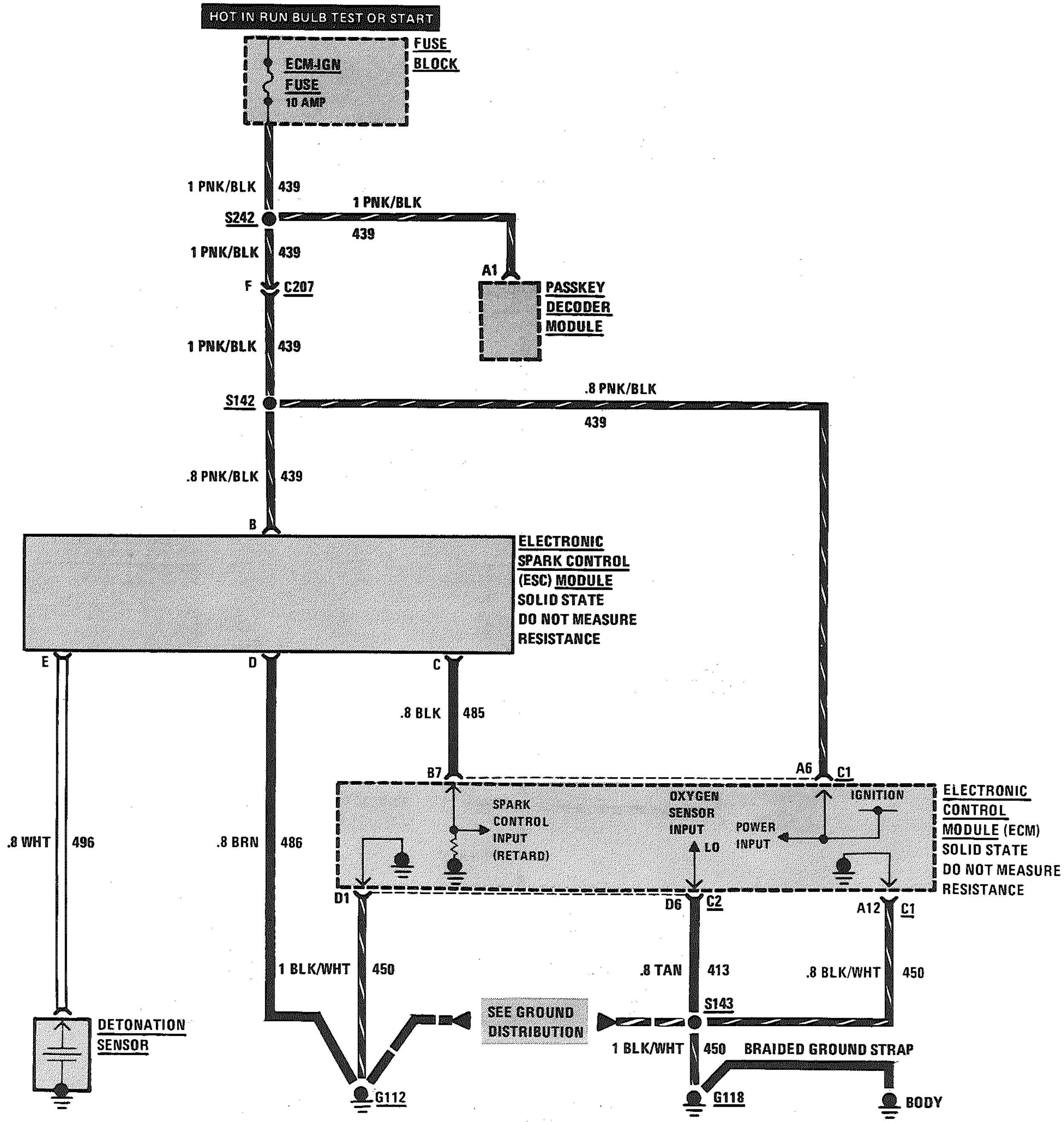
THROTTLE BODY INJECTION: V8 VIN E

UPSHIFT INDICATOR



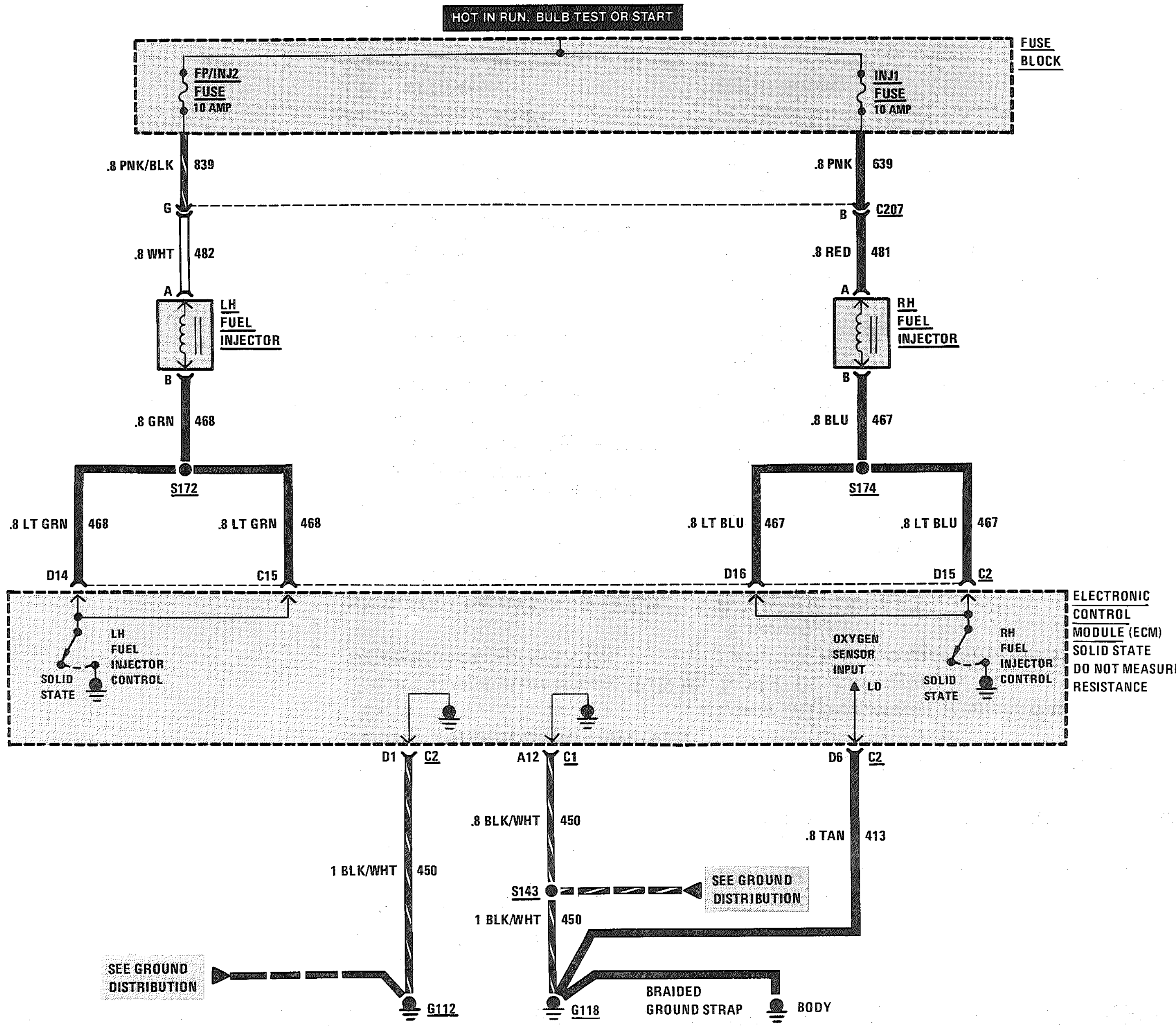
THROTTLE BODY INJECTION: V8 VIN E

SPARK CONTROL



THROTTLE BODY INJECTION: V8 VIN E

FUEL INJECTORS



COMPONENT LOCATION

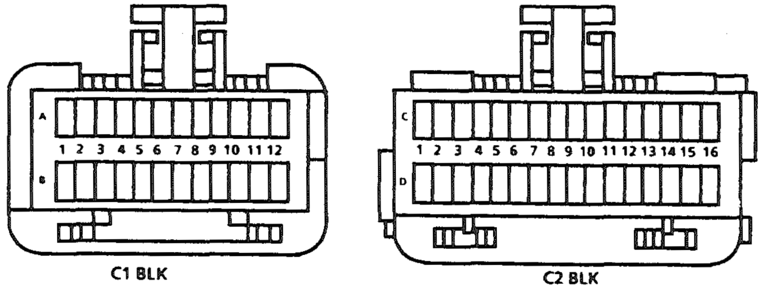
Component	Location	Page-Figure
AIR Diverter Valve (VIN E)	RH front of engine	201- 2-A
AIR Select Valve (VIN E)	RH front of engine	201- 2-A
Assembly Line Diagnostic Link (ALDL) Connector	On bottom of I/P hush panel, to right of steering column	
Brake Switch	Above brake pedal, on brake pedal support	201- 9-A
Canister Purge Solenoid Valve (VIN E)	Lower LH front corner of engine compartment	201- 2-A
Coolant Temperature Sensor (VIN E)	Top LH front of engine	201- 4-D
Detonation Sensor (VIN E)	Lower RH side of engine, ahead of Starter Solenoid	201- 4-C
Electronic Control Module (ECM)	Behind RH side of I/P	201-12-B
Electronic Spark Control (ESC) Module (VIN E)	LH rear corner of engine compartment, on relay bracket	201- 2-A
Electronic Spark Timing (EST) Distributor (VIN E)	Top rear of engine	201- 3-A
Exhaust Gas Recirculation (EGR) Solenoid (VIN E)	Top RH rear of intake manifold	201- 4-A
Fuel Pump Relay (VIN E)	LH rear corner of engine compartment, on relay bracket	201- 3-A
Fuel Pump Switch (VIN E)	Lower LH rear of engine	201- 3-A
Fuel Tank Unit	Top center of fuel tank	201- 9-C
Fuse Block	Behind LH side of I/P, below light switch	201-10-A
Gear Selector Switch	In console, at base of gear selector	201-11-E
Idle Air Control Stepper Motor (VIN E)	Top center of engine	201- 2-A
Ignition Coil (VIN E)	Top center rear of engine	201- 4-A
Ignition Switch	Behind I/P, on top side of steering column	201- 9-A
In-Line Fuse (VIN E)	RH inner fender panel by battery	201- 3-B
LH Fuel Injector	Top of throttle body	201- 4-A
Manifold Absolute Pressure (MAP) Sensor	RH front of dash	201- 2-A
Manifold Air Temperature (MAT) Sensor (VIN E)	Top RH rear of engine	201- 4-A
Oxygen Sensor (VIN E)	Lower LH side of engine, on exhaust manifold	
RH Fuel Injector	Top of throttle body	201- 4-A

COMPONENT LOCATION

		Page-Figure
Throttle Position Sensor (VIN E)	Top center of engine	201- 4-A
Vehicle Speed Sensor Buffer	Behind RH side of I/P, near ECM	201-13-A
C100 (42 cavities)	LH front of dash, left of brake master cylinder	201- 0-A
C113 (1 cavity) (VIN E)	Taped to engine harness, RH front of dash	201- 2-A
C114 (1 cavity) (VIN E)	Taped to engine harness, above rear of engine	
C143 (1 cavity) (VIN E)	Lower LH side of engine	201- 3-A
C207 (15 cavities)	Behind RH side of I/P, near ECM	201-13-A
C313 (3 cavities)	Below center of back seat	201- 9-C
G112 (VIN E)	Rear of LH cylinder head	201- 3-C
G118 (VIN E)	Rear of RH cylinder head	201- 5-B
G200	Behind I/P, left of steering column	201-10-A
G304	Under rear seat, on support bracket	
S142 (VIN E)	Engine harness, behind RH side of I/P	
S143 (VIN E)	Engine harness, RH front of dash	201- 2-A
S145 (VIN E)	Engine harness, above rear of engine	201- 3-C
S146 (VIN E)	Engine harness, behind RH side of I/P	
S164	I/P harness, above Fuse Block	201-10-A
S166 (VIN E)	Engine harness, above rear of engine	201- 3-C
S172 (VIN E)	Engine harness, RH front of dash	201- 2-A
S174 (VIN E)	Engine harness, RH front of dash	201- 2-A
S175 (VIN E)	Engine harness, above LH rear of engine	201- 3-A
S176 (VIN E)	Engine harness, behind RH side of I/P	
S186	Engine harness, RH front of dash	201- 2-A
S201	I/P harness, behind instrument cluster	201-10-A
S202	I/P harness, behind RH side of I/P	201-13-A
S204	I/P harness, behind instrument cluster	201-10-A
S205	I/P harness, behind instrument cluster	201-10-A
S217	I/P harness, behind center of I/P	201-10-A
S218	Engine harness, lower RH corner of engine compartment	201- 2-A
S242	I/P harness, behind RH side of I/P	201-13-A
S276	I/P harness, behind RH side of I/P	201-13-A

THROTTLE BODY INJECTION: V8 VIN E

ELECTRONIC CONTROL MODULE CONNECTORS



ELECTRONIC CONTROL MODULE (ECM)

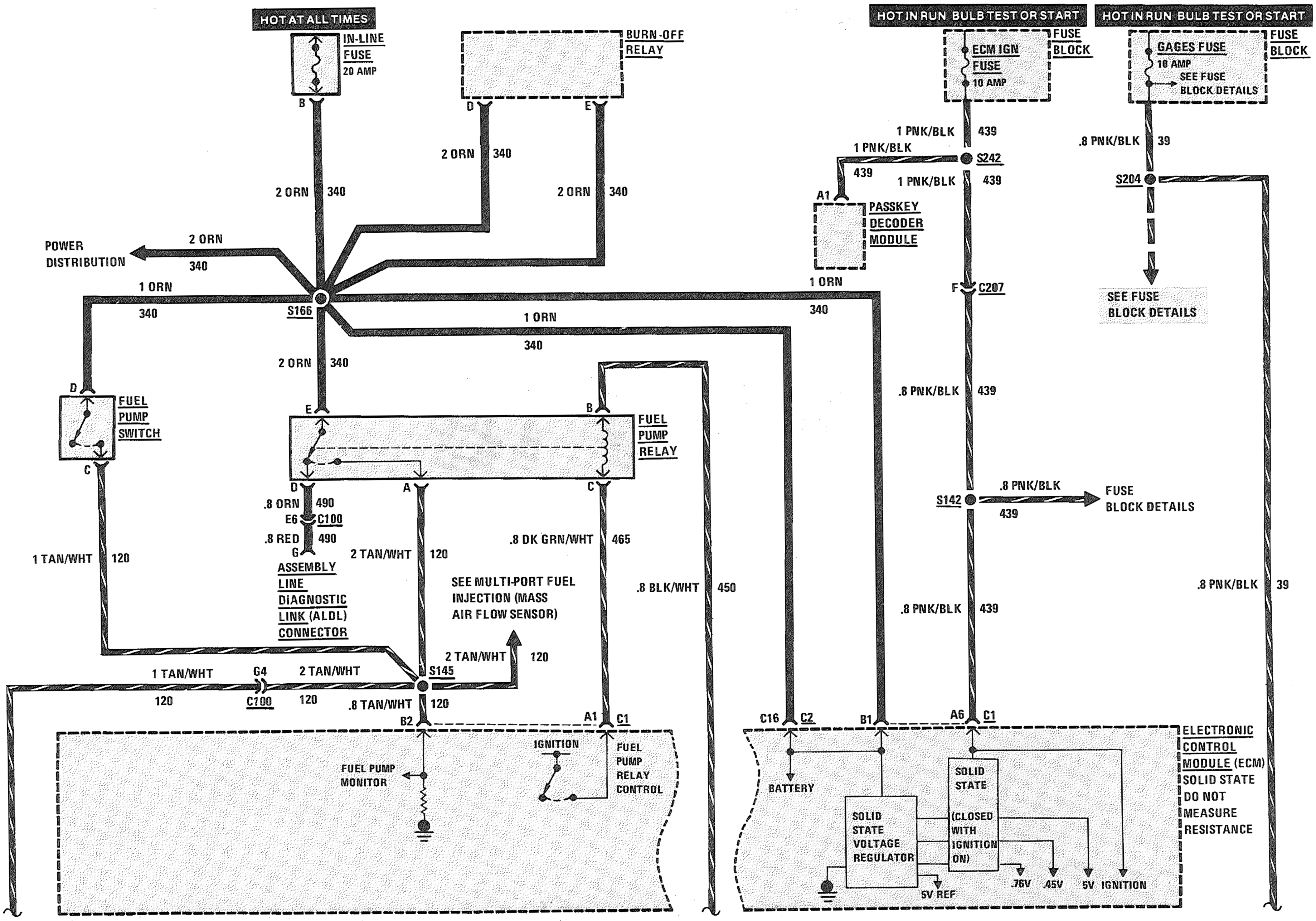
CAVITY	WIRE COLOR SOCKET HALF	CIRCUIT NUMBER	CIRCUIT FUNCTION
A1	DK GRN/WHT	465	FUEL PUMP RELAY CONTROL
A2	–	–	NOT USED
A3	DK GRN/YEL	428	CANISTER PURGE SOLENOID VALVE CONTROL
A4	GRY	435	EXHAUST GAS RECIRCULATION SOLENOID CONTROL
A5	BRN/WHT	419	"SERVICE ENGINE SOON" INDICATOR CONTROL
A6	PNK/BLK	439	IGNITION
A7	TAN/BLK	422 (AUTO) 456 (MAN)	TCC CONTROL (AUTO) SHIFT INDICATOR CONTROL (MAN)
A8	ORN	461	SERIAL DATA LINK
A9	WHT/BLK	451	DIAGNOSTIC "TEST" INPUT
A10	BRN	437	SPEED INPUT
A11	BLK	452	GROUND
A12	BLK/WHT	450	GROUND
B1	ORN	340	BATTERY
B2	TAN/WHT	120	FUEL PUMP CONTROL
B3	BLK/RED	453	DISTRIBUTOR REFERENCE PULSE INPUT: LO
B4	–	–	NOT USED
B5	PPL/WHT	430	DISTRIBUTOR REFERENCE PULSE INPUT: HI
B6	–	–	NOT USED
B7	BLK	485	ELECTRONIC SPARK CONTROL INPUT (RETARD)
B8	LT BLU	67	A/C ON INPUT
B9	–	–	NOT USED
B10	ORN/BLK	434	PARK/NEUTRAL INPUT
B11	–	–	NOT USED
B12	–	–	NOT USED
C1	BLK/PNK	429	AIR DIVERTER VALVE CONTROL
C2	BRN	436	AIR SELECT VALVE CONTROL
C3	LT GRN/BLK	444	IDLE AIR CONTROL B LO
C4	LT GRN/WHT	443	IDLE AIR CONTROL B HI

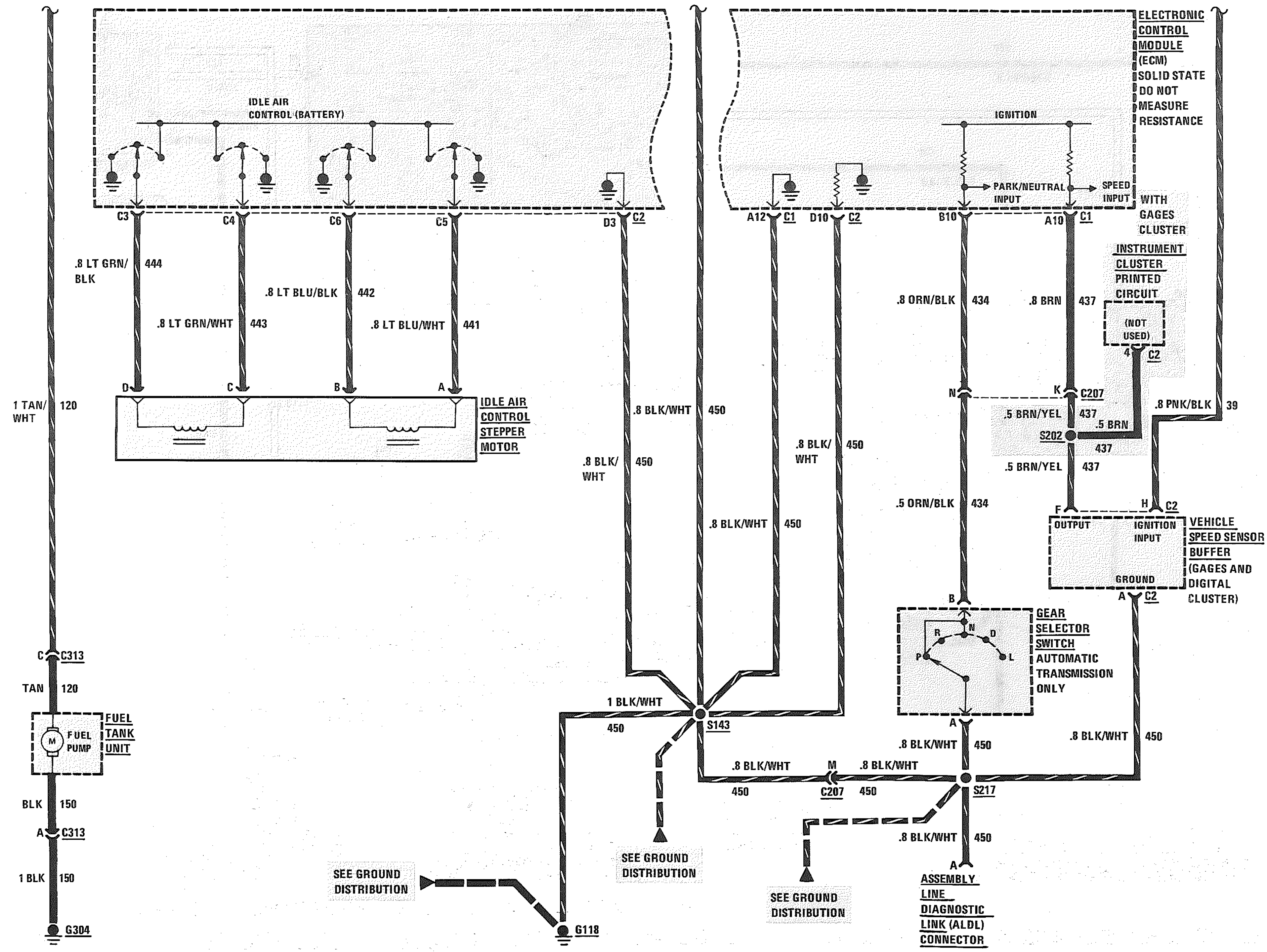
CAVITY	WIRE COLOR SOCKET HALF	CIRCUIT NUMBER	CIRCUIT FUNCTION
C5	LT BLU/WHT	441	IDLE AIR CONTROL A HI
C6	LT BLU/BLK	442	IDLE AIR CONTROL A LO
C7	LT BLU	446	TOP GEAR INPUT
C8	LT BLU	901	POWER STEERING INPUT
C9	PPL/WHT	806	CRANK INPUT
C10	YEL	410	COOLANT TEMPERATURE SENSOR INPUT
C11	LT GRN	432	MANIFOLD ABSOLUTE PRESSURE SENSOR INPUT
C12	TAN	472	MANIFOLD AIR TEMPERATURE SENSOR INPUT
C13	DK BLU	417	THROTTLE POSITION SENSOR INPUT
C14	GRY	416	5 VOLT REFERENCE
C15	LT GRN	468	CONNECTED TO D14
C16	ORN	340	BATTERY
D1	BLK/WHT	450	GROUND
D2	PPL	455	GROUND
D3	–	–	NOT USED
D4	WHT	423	SPARK TIMING OUTPUT
D5	TAN/BLK	424	IGNITION MODULE BYPASS OUTPUT
D6	TAN	413	OXYGEN SENSOR INPUT: LO
D7	PPL	412	OXYGEN SENSOR INPUT
D8	–	–	NOT USED
D9	–	–	NOT USED
D10	–	–	NOT USED
D11	–	–	NOT USED
D12	–	–	NOT USED
D13	–	–	NOT USED
D14	LT GRN	468	LH FUEL INJECTOR CONTROL
D15	LT BLU	467	RH FUEL INJECTOR CONTROL
D16	LT BLU	467	CONNECTED TO D15

BLANK

MULTI-PORT FUEL INJECTION: V8 VIN 8

IDLE SPEED CONTROL, FUEL CONTROL, AND VEHICLE DATA SENSORS

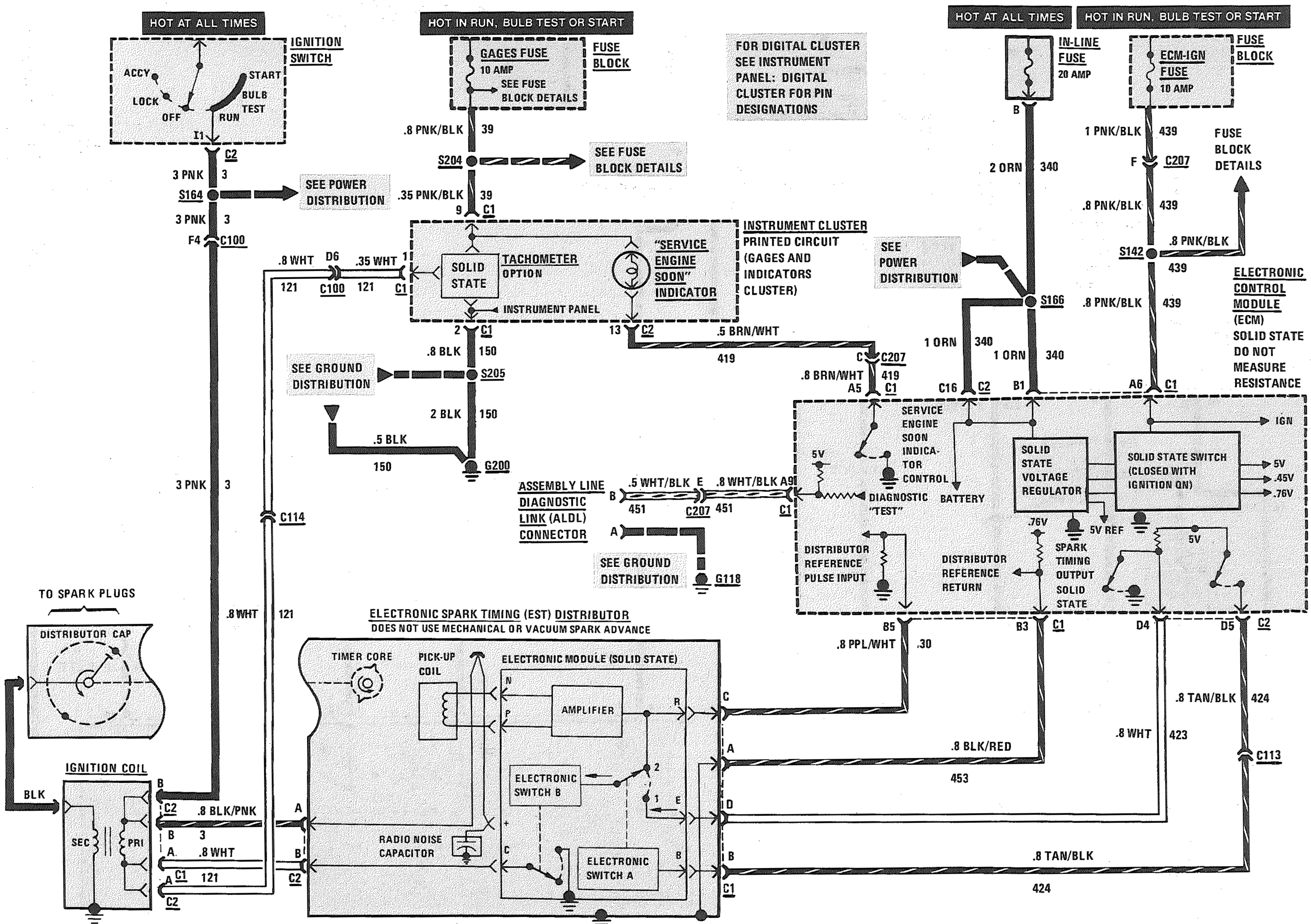




ELECTRONIC CONTROL MODULE (ECM) SOLID STATE DO NOT MEASURE RESISTANCE
IDLE AIR CONTROL (BATTERY)
IGNITION
PARK/NEUTRAL INPUT
SPEED INPUT
WITH GAGES CLUSTER
C3
C4
C6
C5
D3 C2
A12 C1
D10 C2
B10
A10 C1
.8 LT GRN/BLK 444
.8 LT GRN/WHT 443
.8 LT BLU/BLK 442
.8 LT BLU/WHT 441
IDLE AIR CONTROL STEPPER MOTOR
1 TAN/WHT 120
.8 BLK/WHT 450
.8 BLK/WHT 450
.8 BLK/WHT 450
.8 BLK/WHT 450
.8 ORN/BLK 434
.8 BRN 437
INSTRUMENT CLUSTER PRINTED CIRCUIT
(NOT USED)
4 C2
N
K C207
.5 BRN/YEL 437
.5 BRN
S202
437
.5 BRN/YEL 437
.8 PNK/BLK 39
.5 ORN/BLK 434
F
H C2
OUTPUT
IGNITION INPUT
GROUND
A C2
VEHICLE SPEED SENSOR BUFFER (GAGES AND DIGITAL CLUSTER)
B
GEAR SELECTOR SWITCH AUTOMATIC TRANSMISSION ONLY
R N D P L
A
C C313
TAN 120
FUEL TANK UNIT
FUEL PUMP
BLK 150
A C313
1 BLK 150
G304
1 BLK/WHT
450
S143
.8 BLK/WHT 450
M
C207
.8 BLK/WHT 450
S217
.8 BLK/WHT 450
.8 BLK/WHT 450
.8 BLK/WHT 450
A
ASSEMBLY LINE DIAGNOSTIC LINK (ALDL) CONNECTOR
SEE GROUND DISTRIBUTION
SEE GROUND DISTRIBUTION
SEE GROUND DISTRIBUTION
G118

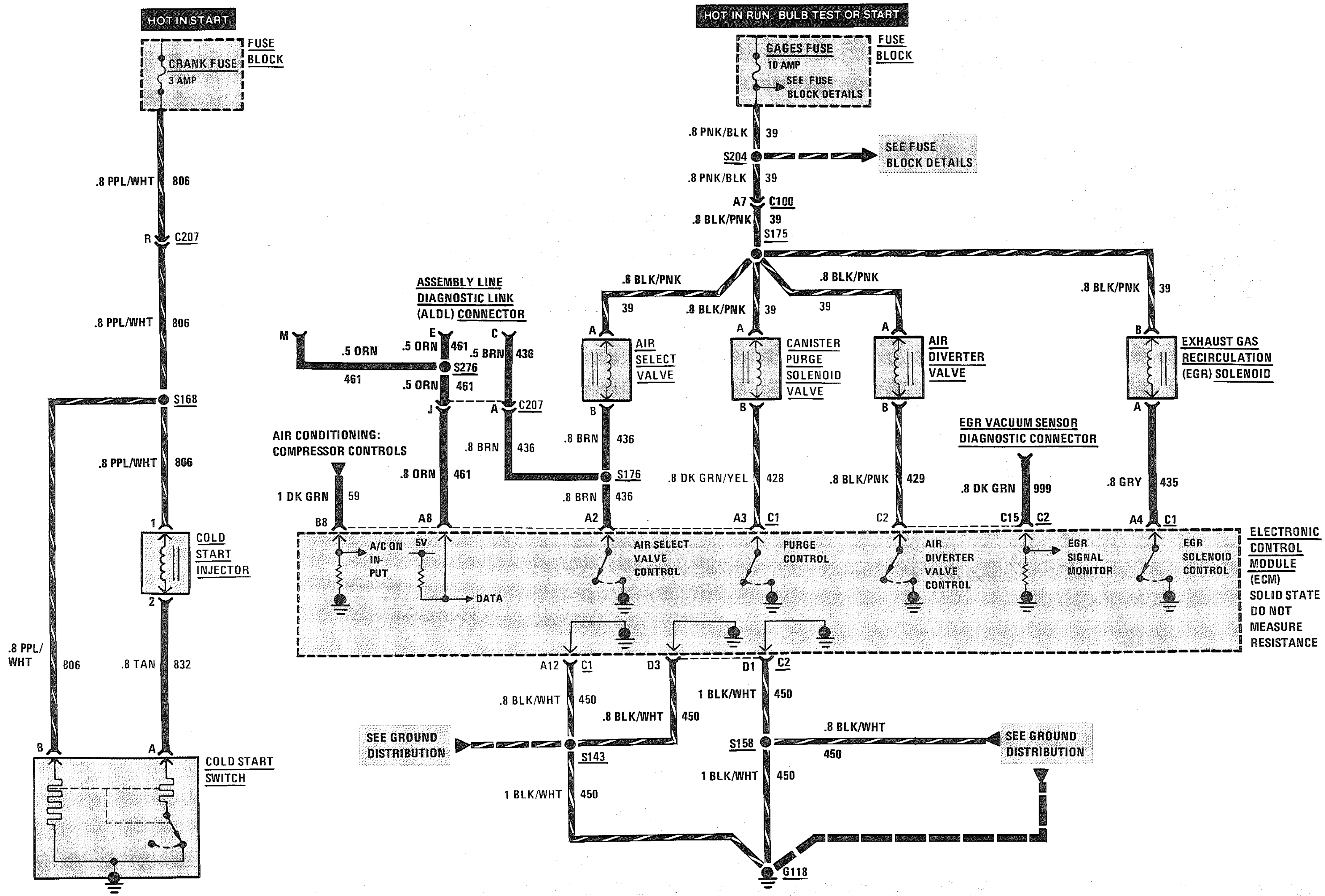
MULTI-PORT FUEL INJECTION: V8 VIN 8

IGNITION, SERVICE ENGINE SOON INDICATOR, AND TACHOMETER



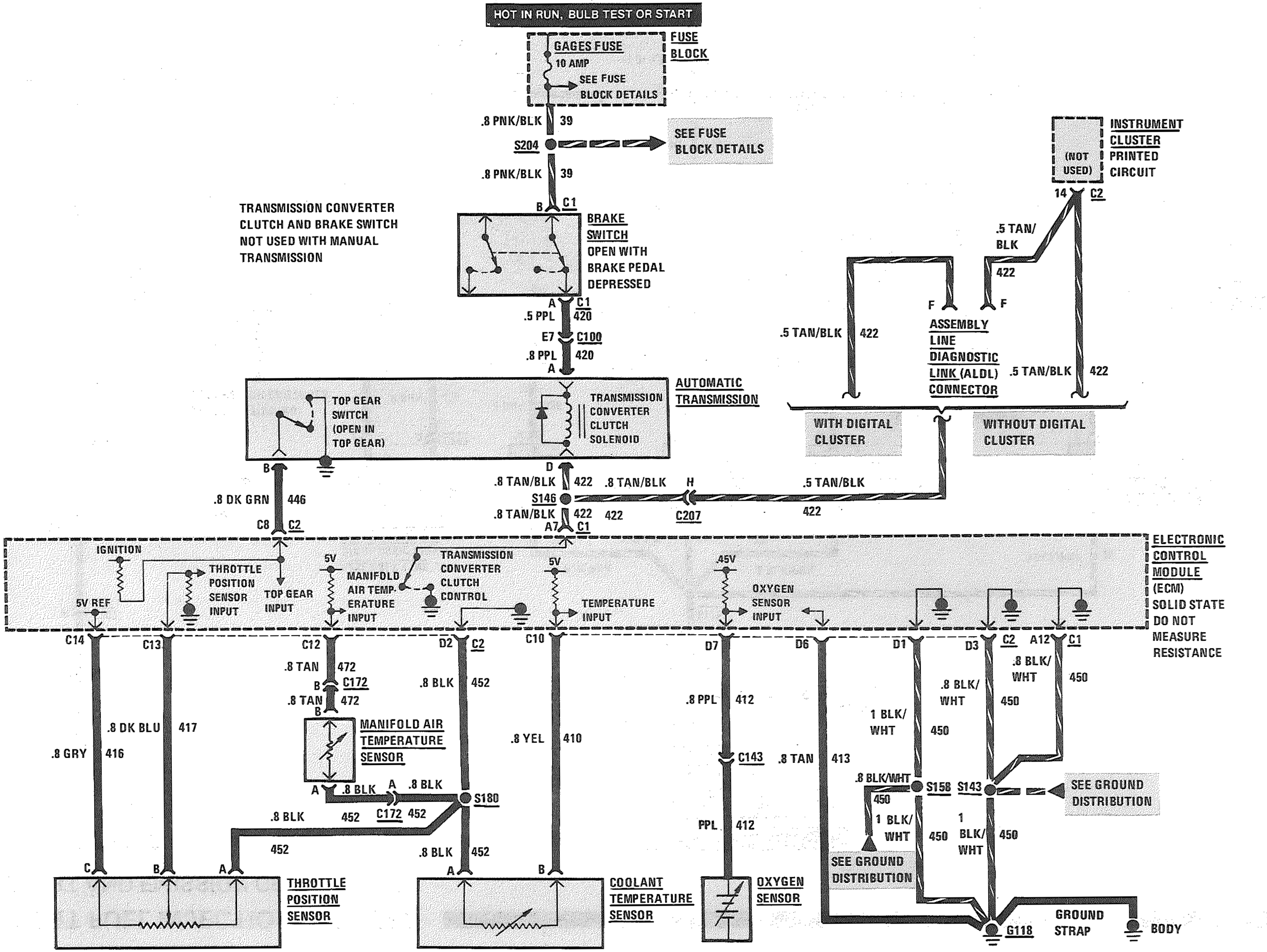
MULTI-PORT FUEL INJECTION: V8 VIN 8

COLD START AND EMISSION CONTROL



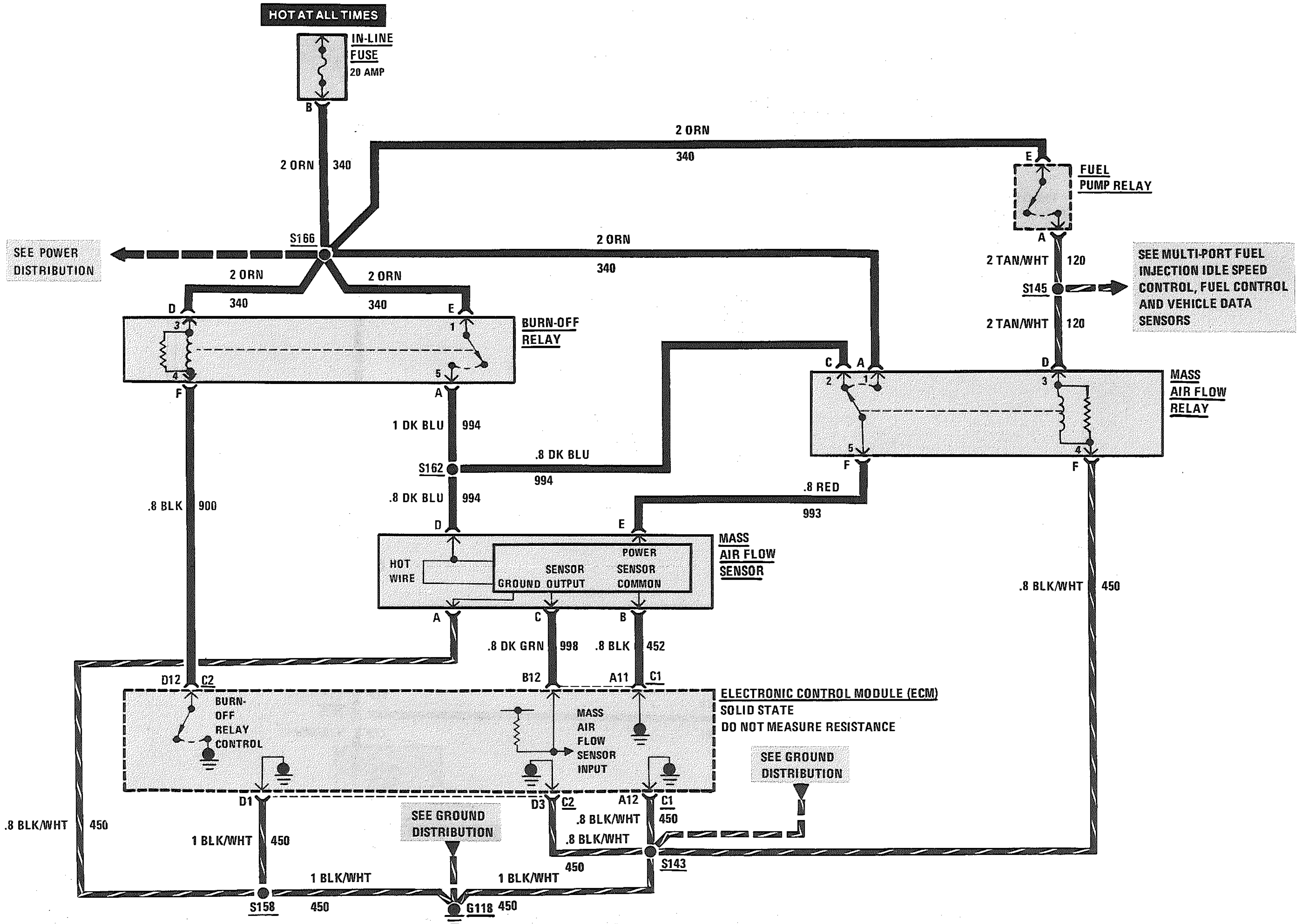
MULTI-PORT FUEL INJECTION: V8 VIN 8

ENGINE DATA SENSORS AND TRANSMISSION CONVERTER CLUTCH



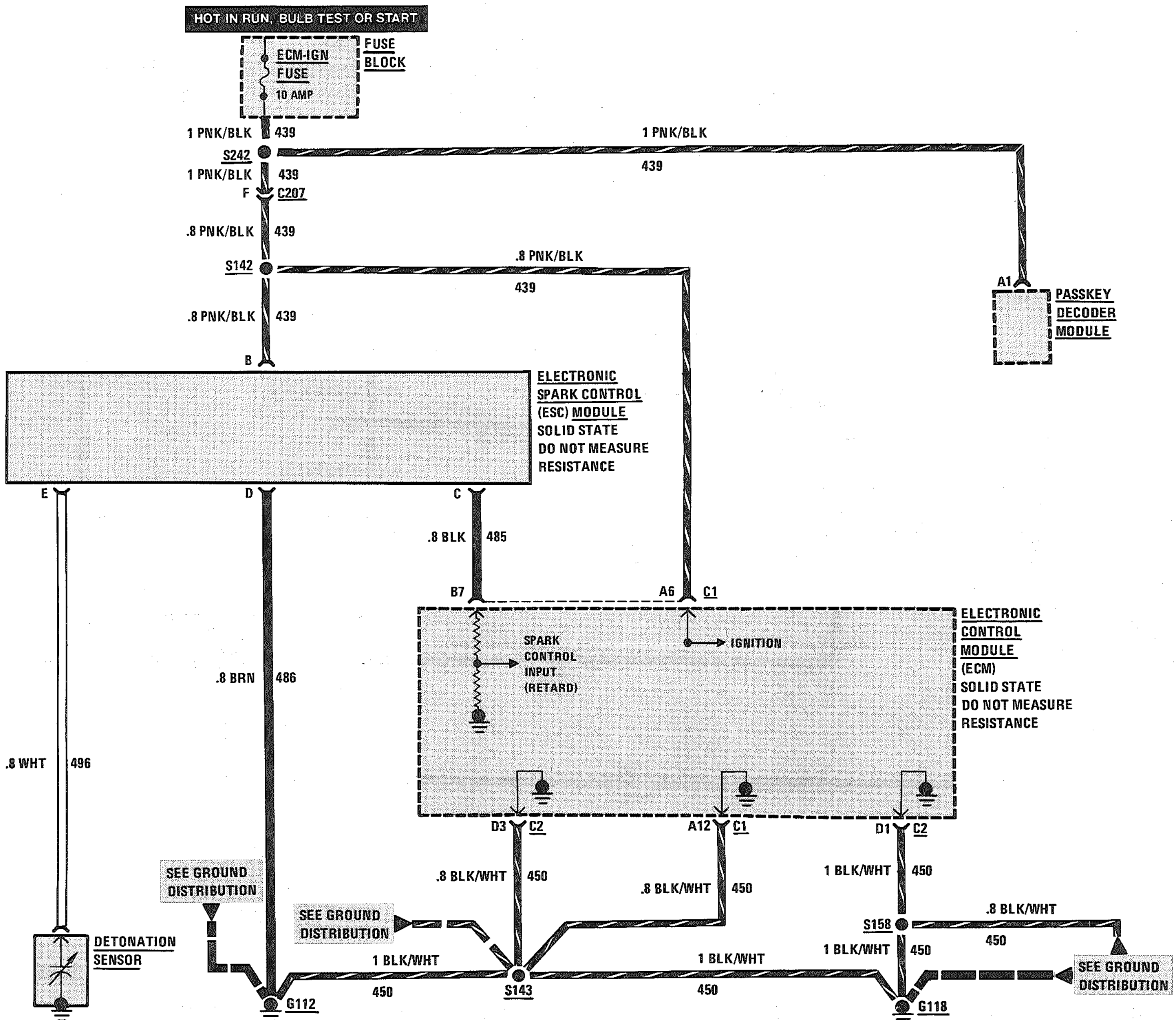
MULTI-PORT FUEL INJECTION: V8 VIN 8

MASS AIR FLOW SENSOR AND BURN-OFF RELAY

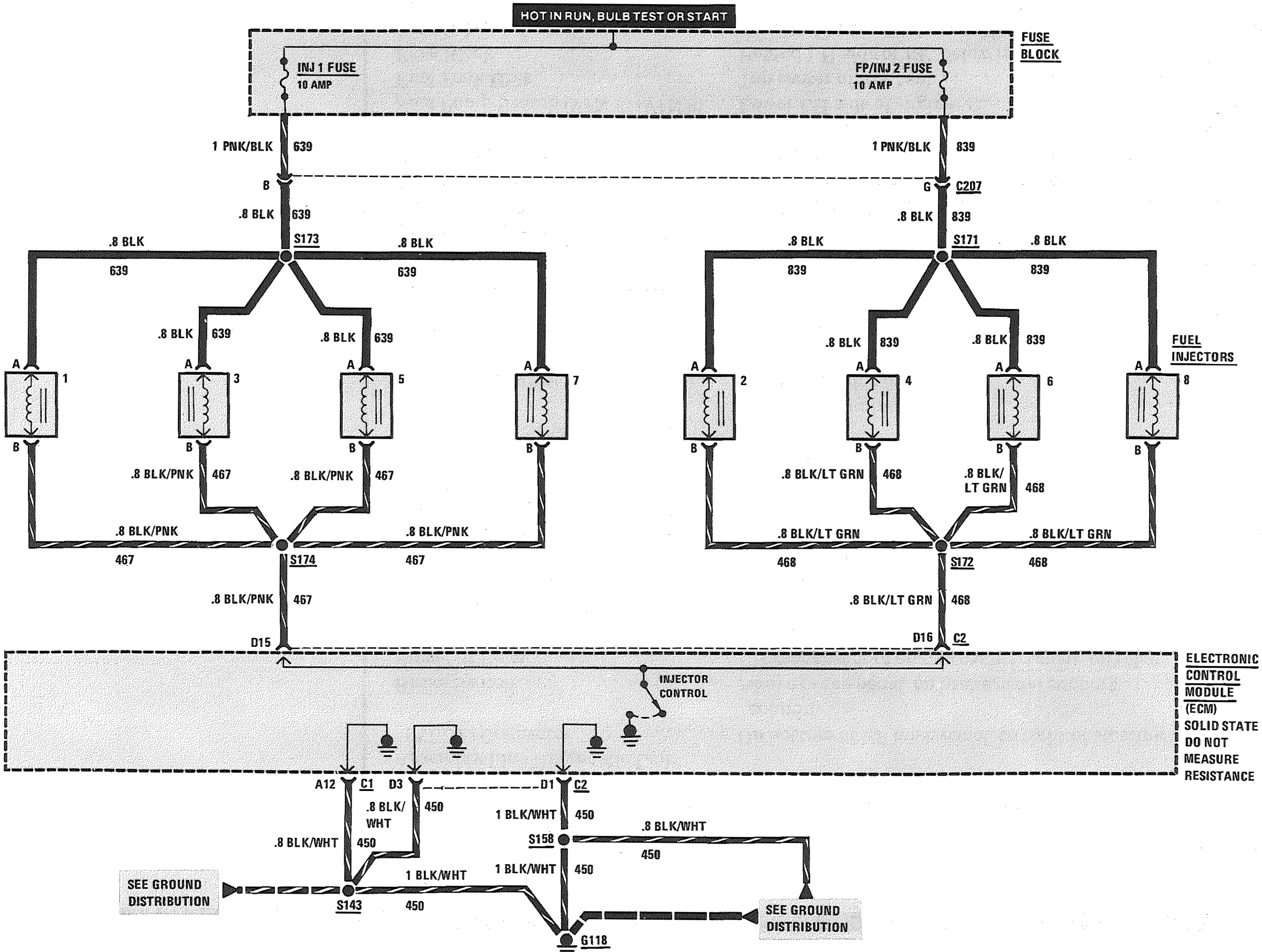


MULTI-PORT FUEL INJECTION: V8 VIN 8

SPARK CONTROL



MULTI-PORT FUEL INJECTION: V8 VIN 8
FUEL INJECTORS



COMPONENT LOCATION

Component	Location	Page-Figure
AIR Diverter Valve (VIN F) (VIN 8)	RH front of engine, on valve cover	201- 6-A
AIR Select Valve (VIN F) (VIN 8)	RH front of engine, on valve cover	201- 6-A
Assembly Line Diagnostic Link (ALDL) Connector	On bottom of I/P hush panel, to right of steering column	
Brake Switch	Above brake pedal, on brake pedal support	201- 9-A
Burn-Off Relay	LH rear corner of engine compartment, on relay bracket	201- 7-A
Canister Purge Solenoid Valve (VIN F) (VIN 8)	Lower RH front corner of engine compartment	201- 5-A
Cold Start Injector (VIN F) (VIN 8)	Top LH side of engine	201- 7-A
Cold Start Switch (VIN F) (VIN 8)	Top center of engine	201- 8-C
Coolant Temperature Sensor (VIN F) (VIN 8)	Top LH front of engine	201- 8-C
Detonation Sensor (VIN F) (VIN 8)	Lower RH side of engine, above Starter Solenoid	201- 5-A
EGR Vacuum Sensor Diagnostic Connector	Top rear of engine	201- 4-E
Electronic Control Module (ECM)	Behind RH side of I/P	201-12-B
Electronic Spark Control (ESC) Module (VIN F) (VIN 8)	LH rear corner of engine compartment, on relay bracket	201- 7-A
Electronic Spark Timing (EST) Distributor (VIN F) (VIN 8)	Top rear of engine	201- 5-A
Exhaust Gas Recirculation (EGR) Solenoid (VIN F) (VIN 8)	Top RH rear of intake manifold	201- 5-A
Fuel Injectors	Top of engine, at each intake cylinder	
Fuel Pump Relay (VIN F) (VIN 8)	LH rear corner of engine compartment, on relay bracket	201- 7-A
Fuel Pump Switch (VIN F) (VIN 8)	Lower LH side of engine	201- 8-A
Fuel Tank Unit	Top center of fuel tank	201- 9-C
Fuse Block	Behind LH side of I/P, below light switch	201-10-A
Gear Selector Switch	In console, at base of gear selector	201-11-E
Idle Air Control Stepper Motor (VIN F) (VIN 8)	Top LH front of engine	201- 8-C
Ignition Coil (VIN F)(VIN 8)	RH rear side of engine	201- 7-B
Ignition Switch	Behind I/P, on top side of steering column	201- 9-A
In-Line Fuse (VIN F)(VIN 8)	On LH side of radiator support, forward of battery	201- 5-C

COMPONENT LOCATION

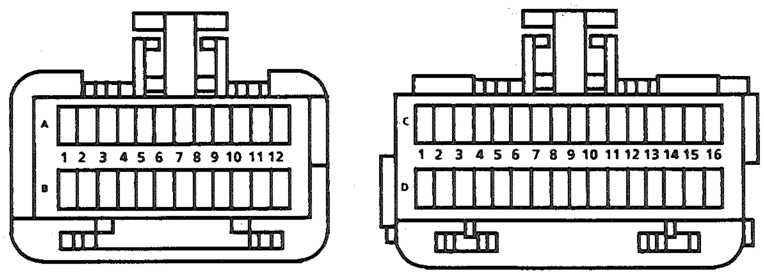
Component	Location	Page-Figure
Manifold Air Temperature (MAT) Sensor (VIN F) (VIN 8)	Top of intake manifold	
Mass Air Flow (MAF) Relay (VIN F) (VIN 8)	LH rear corner of engine compartment, on relay bracket	201- 7-A
Mass Air Flow (MAF) Sensor (VIN F) (VIN 8)	Front of engine compartment, on rear of air cleaner	201- 5-A
Oxygen Sensor (VIN F) (VIN 8)	Lower LH side of engine, on exhaust manifold	
Throttle Position Sensor (VIN F) (VIN 8)	Top center of engine	201- 8-C
Vehicle Speed Sensor Buffer	Behind RH side of I/P, near ECM	201-13-A
C100 (42 cavities)	LH front of dash, left of brake master cylinder	201- 0-A
C113 (1 cavity) (VIN F) (VIN 8)	Taped to engine harness, RH front of dash	201- 5-A
C114 (1 cavity) (VIN F) (VIN 8)	Taped to engine harness, above rear of engine	201- 7-B
C143 (1 cavity) (VIN F) (VIN 8)	Lower LH side of engine, below exhaust manifold	201- 8-A
C172 (2 cavities)	Top rear of engine	201- 4-E
C207 (15 cavities)	Behind RH side of I/P, near ECM	201-13-A
C313 (3 cavities)	Below center of back seat	201- 9-C
G112 (VIN F) (VIN 8)	Rear of LH cylinder head	201- 7-C
G118 (VIN F) (VIN 8)	Rear of RH cylinder head	201- 5-A
G200	Behind I/P, left of steering column	201-10-A
G304	Under rear seat, on support bracket	
S142 (VIN F) (VIN 8)	Engine harness, behind RH side of I/P	
S143 (VIN F) (VIN 8)	Engine harness, RH front of dash	201- 6-A
S145 (VIN F) (VIN 8)	Engine harness, above LH rear of engine	201- 7-A
S146 (VIN F) (VIN 8)	Engine harness, behind RH side of I/P	
S158	Engine harness, behind RH side of I/P	
S162	Engine harness, LH rear corner of engine compartment	201- 7-A
S164	I/P harness, above Fuse Block	201-10-A
S166 (VIN F) (VIN 8)	Engine harness, above LH rear of engine	201- 7-A
S168 (VIN F) (VIN 8)	Engine harness, RH front of dash	201- 6-A
S171	Engine harness, RH front of dash	201- 6-A
S172 (VIN F) (VIN 8)	Engine harness, RH front of dash	201- 6-A

COMPONENT LOCATION

		Page-Figure
S205	I/P harness, behind instrument cluster	201-10-A
S217	I/P harness, behind center of I/P	201-10-A
S242	I/P harness, behind RH side of I/P	201-13-A
S276	I/P harness, behind RH side of I/P	201-13-A
S173	Engine harness, top center rear of engine	201- 7-A
S174 (VIN F) (VIN 8)	Engine harness, top center rear of engine	201- 7-A
S175 (VIN F) (VIN 8)	Engine harness, above LH rear of engine	201- 7-A
S176 (VIN F) (VIN 8)	Engine harness, behind RH side of I/P	
S180 (VIN F) (VIN 8)	Engine harness, above RH rear of engine	201- 7-B
S202	I/P harness, behind RH side of I/P	201-13-A
S204	I/P harness, behind instrument cluster	201-10-A

MULTI-PORT FUEL INJECTION: V8 VIN 8

ELECTRONIC CONTROL MODULE CONNECTORS



C1 BLK ELECTRONIC CONTROL MODULE (ECM) C2 BLK

V00005.1

CAVITY	WIRE COLOR SOCKET HALF	CIRCUIT NUMBER	CIRCUIT FUNCTION
A1	DK GRN/WHT	465	FUEL PUMP RELAY CONTROL
A2	BRN	436	AIR SELECT VALVE CONTROL
A3	DK GRN/YEL	428	CANISTER PURGE SOLENOID VALVE CONTROL
A4	GRY	435	EXHAUST GAS RECIRCULATION SOLENOID CONTROL
A5	BRN/WHT	419	"SERVICE ENGINE SOON" INDICATOR CONTROL
A6	PNK/BLK	439	IGNITION
A7	TAN/BLK	422	TCC CONTROL
A8	ORN	461	DATA
A9	WHT/BLK	451	DIAGNOSTIC "TEST" INPUT
A10	BRN	437	SPEED INPUT
A11	BLK	452	GROUND
A12	BLK/WHT	450	GROUND
B1	ORN	340	BATTERY
B2	TAN/WHT	120	FUEL PUMP CONTROL
B3	BLK/RED	453	DISTRIBUTOR REFERENCE PULSE INPUT: LO
B4	–	–	NOT USED
B5	PPL/WHT	430	DISTRIBUTOR REFERENCE PULSE INPUT: HI
B6	PPL	963	THEFT DETERRENT
B7	BLK	485	ELECTRONIC SPARK CONTROL INPUT (RETARD)
B8	DK GRN	59	A/C ON INPUT
B9	–	–	NOT USED
B10	ORN/BLK	434	PARK/NEUTRAL INPUT
B11	–	–	NOT USED
B12	DK GRN	998	MASS AIR FLOW SENSOR INPUT
C1	DK GRN/WHT	335	FAN CONTROL OUTPUT
C2	BLK/PNK	429	AIR DIVERTER VALVE CONTROL
C3	LT GRN/BLK	444	IDLE AIR CONTROL B LO
C4	LT GRN/WHT	443	IDLE AIR CONTROL B HI

CAVITY	WIRE COLOR SOCKET HALF	CIRCUIT NUMBER	CIRCUIT FUNCTION
C5	LT BLU/WHT	441	IDLE AIR CONTROL A HI
C6	LT BLU/BLK	442	IDLE AIR CONTROL A LO
C7	–	–	NOT USED
C8	DK GRN	446	TOP GEAR INPUT
C9	–	–	NOT USED
C10	YEL	410	COOLANT TEMPERATURE SENSOR INPUT
C11	–	–	NOT USED
C12	TAN	472	MANIFOLD AIR TEMPERATURE SENSOR INPUT
C13	DK BLU	417	THROTTLE POSITION SENSOR INPUT
C14	GRY	416	5 VOLT REFERENCE
C15	DK GRN	999	EGR VACUUM SENSOR SIGNAL
C16	ORN	340	BATTERY
D1	BLK/WHT	450	GROUND
D2	BLK	452	GROUND
D3	BLK/WHT	450	GROUND
D4	WHT	423	SPARK TIMING OUTPUT
D5	TAN/BLK	424	IGNITION MODULE BYPASS OUTPUT
D6	TAN	413	OXYGEN SENSOR GROUND
D7	PPL	412	OXYGEN SENSOR INPUT
D8	–	–	NOT USED
D9	–	–	NOT USED
D10	BLK/WHT	450	GROUND
D11	GRY	731	FAN PRESSURE SWITCH INPUT
D12	BLK	900	BURN-OFF RELAY CONTROL
D13	–	–	NOT USED
D14	–	–	NOT USED
D15	BLK/PNK	467	FUEL INJECTOR CONTROL
D16	BLK/LT GRN	468	FUEL INJECTOR CONTROL

TROUBLESHOOTING HINTS

STARTER

- **Try the following checks before doing the System Diagnosis.**

1. Check the hydrometer eye that is built into the vehicle Battery before troubleshooting the Starter System.
   - Green eye - Battery is charged.
   - Dark eye - Battery is discharged. Recharge Battery.
   - Clear or yellow eye - Battery fluid is low. Replace Battery.
2. Check that the Starter Solenoid terminals S and B and battery connections are clean and tight.
3. Check that grounds G100 and G103 are clean and tight.

- **Go to System Diagnosis for diagnostic tests.**

SYSTEM DIAGNOSIS

STARTER

NOTE: The following tests are designed for engines and batteries at normal operating temperatures and assumes that there are no engine symptoms which could cause a no start condition. To use the tests under other conditions could result in misdiagnosis.

- **Diagnostic steps for the symptoms listed in the following table are listed after the table.**

COMPONENT LOCATION

Component	Location	Page-Figure
Clutch Start Switch	Above clutch pedal, on clutch pedal support	
Fusible Link A (VIN E)	Lower RH side of engine, at Starter Solenoid	201- 2-A
Fusible Link A (VIN F) (VIN 8)	Lower RH side of engine, at Starter Solenoid	201- 6-B
Fusible Link A (VIN S)	Lower RH side of engine, at Starter Solenoid	201- 1-A
Fusible Link B (VIN E)	Lower RH side of engine, at Starter Solenoid	201- 2-A
Fusible Link B (VIN F) (VIN 8)	Lower RH side of engine, at Starter Solenoid	201- 6-B
Fusible Link B (VIN S)	Lower RH side of engine, at Starter Solenoid	201- 1-A
Fusible Link H (VIN E)	RH front of engine compartment, at Junction Block	201- 3-B
Fusible Link H (VIN F) (VIN 8)	LH front of engine compartment, behind battery	201- 5-C
Fusible Link H (VIN S)	Lower RH side of engine, at Starter Solenoid	201- 1-A
Fusible Link J (VIN E)	Lower RH side of engine, at Starter Solenoid	201- 2-A
Fusible Link J (VIN F) (VIN 8)	Lower RH side of engine, at Starter Solenoid	201- 6-B
Fusible Link K	RH front of engine compartment, at Junction Block	201- 3-B
Gear Selector Switch	In console, at base of gear selector	201-11-E
Ignition Switch	Behind I/P, on top side of steering column	201- 9-A
In-Line Fuse (VIN E)	RH inner fender panel by battery	201- 3-B
In-Line Fuse (VIN F)(VIN 8)	On LH side of radiator support, forward of battery	201- 5-C
Junction Block	RH front of engine compartment, behind headlight	201- 1-A
Starter Solenoid (VIN E)	Lower RH side of engine	201- 2-A
Starter Solenoid (VIN F) (VIN 8)	Lower RH side of engine	201- 6-B
Starter Solenoid (VIN S)	Lower RH side of engine	201- 1-A
C100 (42 cavities)	LH front of dash, left of brake master cylinder	201- 0-A
C111 (1 cavity)	Behind battery, near positive battery cable	201- 7-A
C112 (1 cavity)	Behind battery, near positive battery cable	201- 7-A
G100 (VIN E)	RH front of engine	201- 4-B
G100 (VIN F) (VIN 8)	Lower LH front of engine.	201- 8-B
G100 (VIN S)	Lower LH front of engine.	201- 1-B
G103 (Except VIN E)	On radiator support, behind LH headlights	201-16-A
G103 (VIN E)	RH inner fender panel, near battery	201- 3-B
S200	I/P harness, behind LH side of I/P	201-10-A

SYMPTOM TABLE

A:	Engine does not crank and Starter Solenoid does not click
B:	Starter Solenoid clicks, but engine does not crank or cranks slowly

A: ENGINE DOES NOT CRANK AND STARTER SOLENOID DOES NOT CLICK (TABLE 1)

Measure: VOLTAGE
At: STARTER SOLENOID
Conditions:
- Ignition Switch: START
- Gear Selector: PARK (Automatic Transmission)
- Clutch: DEPRESSED (Manual Transmission)

Measure Between	Correct Voltage	For Diagnosis
S (PPL) & Ground	Battery	See 1
S (PPL) & Starter Motor mounting bolts	Battery	See 2

- If all the voltages are correct, replace the Starter Solenoid. Refer to Section 6D for replacement procedures.

1. Go to Table 2 (Automatic Transmission) or Table 3 (Manual Tranmission).
2. Clean the Starter Motor mounting bolts and Starter Motor. Scrape off any excess paint, rust or dirt.

COMPONENT LOCATION

		Page-Figure
S223	I/P harness, above Fuse Block	201- 9-A
S224	I/P harness, near LH shroud	

A: ENGINE DOES NOT CRANK AND STARTER SOLENOID DOES NOT CLICK (TABLE 2—AUTOMATIC TRANSMISSION)

Measure: VOLTAGE
At: GEAR SELECTOR SWITCH CONNECTOR (Disconnected)
Condition:
- Ignition Switch: START

Measure Between	Correct Voltage	For Diagnosis
F (YEL) & Ground	Battery	See 1

- If voltage is correct, go to Table 4.

1. Go to Table 6.

A: ENGINE DOES NOT CRANK AND STARTER SOLENOID DOES NOT CLICK (TABLE 3—MANUAL TRANSMISSION)

Measure: VOLTAGE
At: CLUTCH START SWITCH CONNECTOR (Disconnected)
Condition:
- Ignition Switch: START

Measure Between	Correct Result	For Diagnosis
A (YEL) & Ground	Battery	See 1

- If voltage is correct, go to Table 5.

1. Go to Table 6.

A: ENGINE DOES NOT CRANK AND STARTER SOLENOID DOES NOT CLICK (TABLE 4—AUTOMATIC TRANSMISSION)

Connect: FUSED JUMPER
At: GEAR SELECTOR SWITCH CONNECTOR (Disconnected)
Condition:
- Ignition Switch: START

Jumper Between	Correct Result	For Diagnosis
F (YEL) & E (PPL)	Engine cranks	See 1

- If engine cranks, replace Gear Selector Switch. Check Gear Selector Switch adjustment before replacing with new switch.

1. Check/repair PPL (6) wire for an open.

A: ENGINE DOES NOT CRANK AND STARTER SOLENOID DOES NOT CLICK (TABLE 5—MANUAL TRANSMISSION)

Connect: FUSED JUMPER
At: CLUTCH SWITCH CONNECTOR (Disconnected)
Condition:
- Ignition Switch: START

Jumper Between	Correct Result	For Diagnosis
A (YEL) & D (PPL) wires	Engine cranks	See 1

- If the engine cranks, check/replace the Clutch Start Switch.

1. Check/repair PPL (6) wire for an open.

A: ENGINE DOES NOT CRANK AND STARTER SOLENOID DOES NOT CLICK (TABLE 6)

Measure: VOLTAGE
At: IGNITION SWITCH CONNECTORS C1 & C2 (Connected)

Measure Between	Correct Result	For Diagnosis
B2 (RED) & Ground	Battery	See 1
B3 (RED) & Ground	Battery	See 1
• Turn the Ignition Switch to START		
S (YEL) & Ground	Battery	See 2

- If all the voltages are correct, check/repair YEL (5) wire for an open (see schematic).

1. Check RED (2) wire and Fusible Link B (see schematic).
2. Replace Ignition Switch.

B: STARTER SOLENOID CLICKS BUT ENGINE DOES NOT CRANK OR CRANKS SLOWLY (TABLE 1)

Measure: VOLTAGE
At: BATTERY TERMINALS
Conditions:
- Battery fully charged
- Fuses INJ1 and FP/INJ 2: REMOVED
- Ignition Switch: START
- Engine being cranked

Measure Between	Correct Voltage	For Diagnosis
Positive & Negative Battery Terminals	Greater than 9.5 volts	See 1

- If the voltage is correct, go to Table 2.

1. Refer to Section 6D for Battery Load Test. Remove Starter Assembly for repairs if the Battery is OK.

B: STARTER SOLENOID CLICKS BUT ENGINE DOES NOT CRANK OR CRANKS SLOWLY (TABLE 2)

Measure: VOLTAGE
At: BATTERY CABLES
Conditions:
- Battery fully charged
- Fuses INJ1 and FP/INJ 2: REMOVED
- Ignition Switch: START
- Engine being cranked

Measure Between	Correct Voltage	For Diagnosis
Negative Battery Terminal & Engine Block	Less than .5 volts	See 1
Positive Battery Terminal & Starter Solenoid Terminal B	Less than .5 volts	See 2

- If both voltages are correct, remove the Starter Assembly for repairs. Refer to Section 6D.

1. Replace negative battery cable.
2. Replace positive battery cable.

CIRCUIT OPERATION

STARTER

When the Ignition Switch is moved to the START position with the Gear Selector Switch in PARK or NEUTRAL (automatic transmission) or the Clutch Start Switch closed (manual transmission), battery voltage is applied to the Starter Solenoid. Both solenoid windings are energized. The circuit through the Pull-In Winding is completed to ground through the Starter Motor. The windings work together magnetically to pull in and hold in the Plunger. The Plunger moves the Shift Lever. This action causes the Drive Assembly to rotate as it engages the Flywheel Gear on the engine. At the same time, the Plunger also closes the Solenoid Switch contacts in the Starter Solenoid. Full battery voltage is applied directly to the Starter Motor and it cranks the engine.

As soon as the Solenoid Switch contacts close, current no longer flows through the Pull-In Winding since battery voltage is applied to both ends of the winding. The Hold-In Winding remains energized and its magnetic field is strong enough to hold the Plunger, Shift Lever, Drive Assembly, and Solenoid Switch contacts in place to continue cranking the engine.

When the Ignition Switch is released from the START position, battery voltage is removed from the PPL wire and the junction of the two windings. Current flows from the motor contacts, through both windings, to ground at the end of the Hold-In Winding. However, the direction of current flow through the Pull-In Winding is now opposite to the direction of current flow when the winding was first energized. The magnetic fields of the Pull-In and Hold-In Windings now oppose one another. This action of the windings, with the help of the Return Spring, causes the starter Drive Assembly to disengage and Solenoid Switch contacts open, the Starter Circuit is turned off.

TROUBLESHOOTING HINTS

CHARGING

- **Try the following checks before doing the System Diagnosis.**

1. Check the hydrometer eye that is built into the vehicle Battery before troubleshooting the Charging System.
   - Green eye - Battery is charged.
   - Dark eye - Battery is discharged. Recharge Battery.
   - Clear or yellow eye - Battery fluid is low. Replace Battery.
2. Check the Generator Belt.
3. Check that the Starter Solenoid terminal B and battery connections are clean and tight.
4. Check that the Generator connector is tight and that the Generator battery terminal is clean and tight.
5. Check the vehicle voltmeter (if equipped) to assure accurate voltage readings.
6. Check the GAGES Fuse. This check can be done by observing the BRAKE Warning Indicator with the Ignition Switch in RUN and the Park Brake applied.
7. Check the C/H-FAN Fuse.

- **Go to System Diagnosis for diagnostic tests.**

COMPONENT LOCATION

Component	Location	Page-Figure
Coolant Fan Relay (VIN E)	LH rear corner of engine compartment, on relay bracket	201- 3-A
Coolant Fan Relay (VIN F) (VIN 8)	Front of engine compartment, RH side of radiator support	201- 5-A
Coolant Fan Relay (VIN S)	LH rear corner of engine compartment, on relay bracket	201- 0-A
Fuel Pump In-Line Fuse	RH side of engine compartment, on inner fender panel	201- 1-A
Fuse Block	Behind LH side of I/P, below light switch	201-10-A
Fusible Link H (VIN E)	RH front of engine compartment, at Junction Block	201- 3-B
Fusible Link H (VIN S)	Lower RH side of engine, at Starter Solenoid	201- 1-A
Fusible Link J (VIN E)	Lower RH side of engine, at Starter Solenoid	201- 2-A
Fusible Link J (VIN F) (VIN 8)	Lower RH side of engine, at Starter Solenoid	201- 6-B
Fusible Link J (VIN S)	RH side of radiator support, at Junction Block	201- 1-A
Fusible Link K	RH front of engine compartment, at Junction Block	201- 3-B
In-Line Fuse (VIN E)	RH inner fender panel by battery	201- 3-B
In-Line Fuse (VIN F)(VIN 8)	On LH side of radiator support, forward of battery	201- 5-C
Junction Block	RH front of engine compartment, behind headlight	201- 1-A
Mass Air Flow In-Line Fuse	RH side of engine compartment, on inner fender panel	201- 1-A
Starter Solenoid (VIN E)	Lower RH side of engine	201- 2-A
Starter Solenoid (VIN F) (VIN 8)	Lower RH side of engine	201- 6-B
Starter Solenoid (VIN S)	Lower RH side of engine	201- 1-A
C100 (42 cavities)	LH front of dash, left of brake master cylinder	201- 0-A
C207 (15 cavities)	Behind RH side of I/P, near ECM	201-13-A
G100 (VIN E)	RH front of engine	201- 4-B
G100 (VIN F) (VIN 8)	Lower LH front of engine	201- 8-B
G100 (VIN S)	Lower LH front of engine	201- 1-B
G103 (Except VIN E)	On radiator support, behind LH headlights	201-16-A
G103 (VIN E)	RH inner fender panel, near battery	201- 3-B
S204	I/P harness, behind instrument cluster	201-10-A
S206 (VIN E)	Engine harness, RH front of dash	201- 2-A

(Continued on facing page)

SYSTEM DIAGNOSIS

CHARGING

- Do the tests below if the Battery is under-charged or overcharged or if the vehicle voltmeter shows less than 12 volts or more than 16 volts with the engine running at fast idle.

GENERATOR TEST (TABLE 1)

Measure: VOLTAGE
At: GENERATOR BATTERY TERMINAL AND GENERATOR CONNECTOR (Disconnected)
Conditions
- Ignition Switch: RUN

Measure Between	Correct Result	For Diagnosis
L (BRN) & Ground	Battery	See 1
F (BRN) & Ground (see schematic)	Battery	See 2
S (RED) & Ground	Battery	See 3
Battery Terminal & Ground	Battery	See 4

(Continued in next column)

COMPONENT LOCATION

		Page-Figure
S206 (VIN F)(VIN 8)	Engine harness, top center rear of engine	201- 7-A
S206 (VIN S)	Engine harness, above rear of engine	201- 1-A

(Continued from previous column)

- If all voltages are correct, reconnect the connector and go to Table 2.

1. Check GAGES Fuse, BRN (25) wire, PNK/BLK (39) wire and the Instrument Cluster Printed Circuit for an open or short to ground.
2. Check C/H-FAN FUSE and the BRN (250) wire for an open or short to ground (see schematic).
3. Check RED (2) wire and Fusible Link (see schematic) for an open or short to ground.
4. Check wiring from the battery positive terminal of the Generator (see schematic).

GENERATOR TEST (TABLE 2)

Measure: VOLTAGE
At: GENERATOR
Conditions:
- Generator Connector: CONNECTED
- All accessories: OFF
- Engine running at fast idle

Measure Between	Correct Result	For Diagnosis
Battery terminal & Ground	Less than 16 volts	See 1

- If the voltage is correct, perform a Generator Load Test. Refer to Section 6D. Perform a Battery Load Test if the Generator is good. Refer to Section 6D.

1. Repair/replace Generator. Refer to Section 6D.

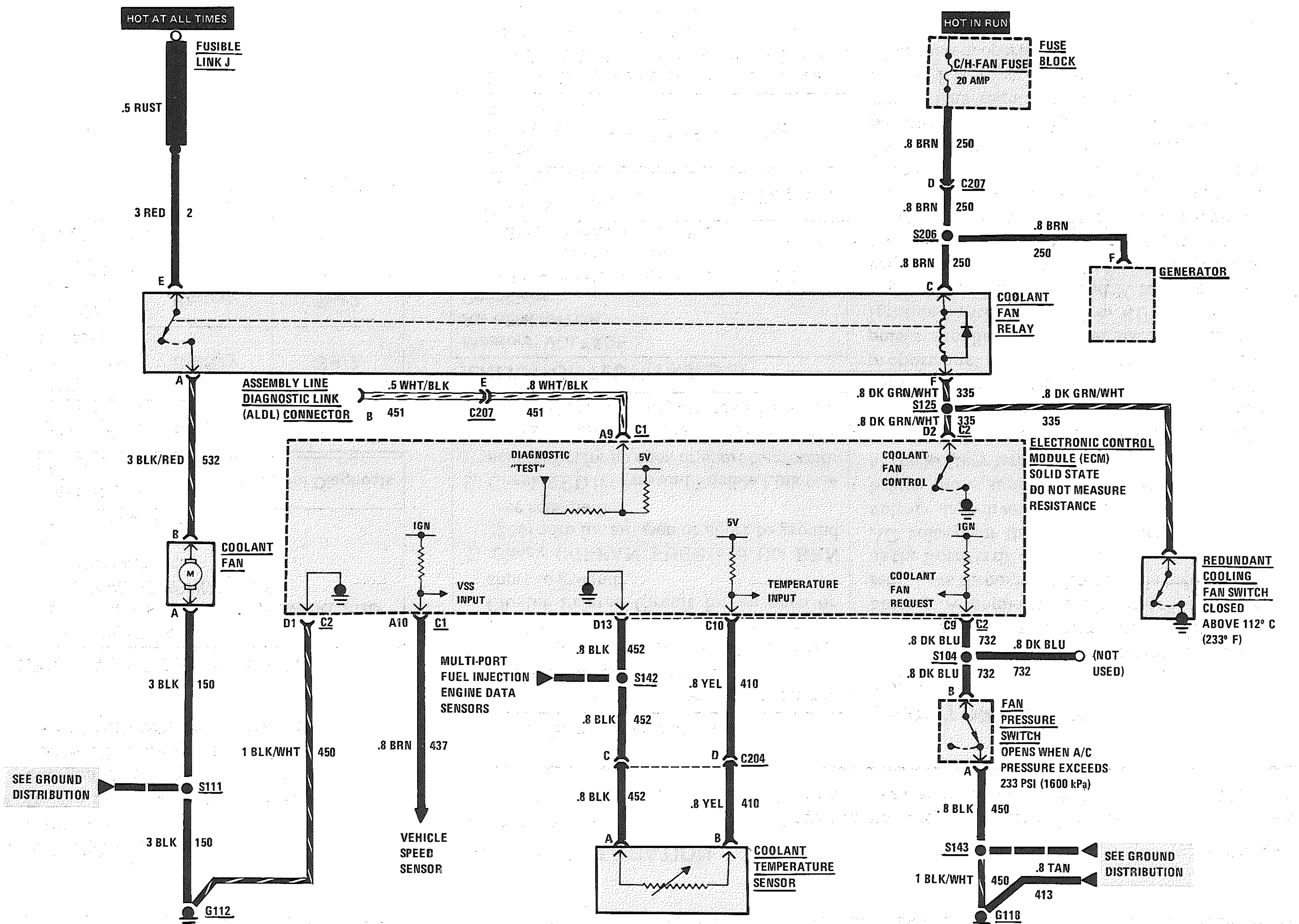
CIRCUIT OPERATION

CHARGING

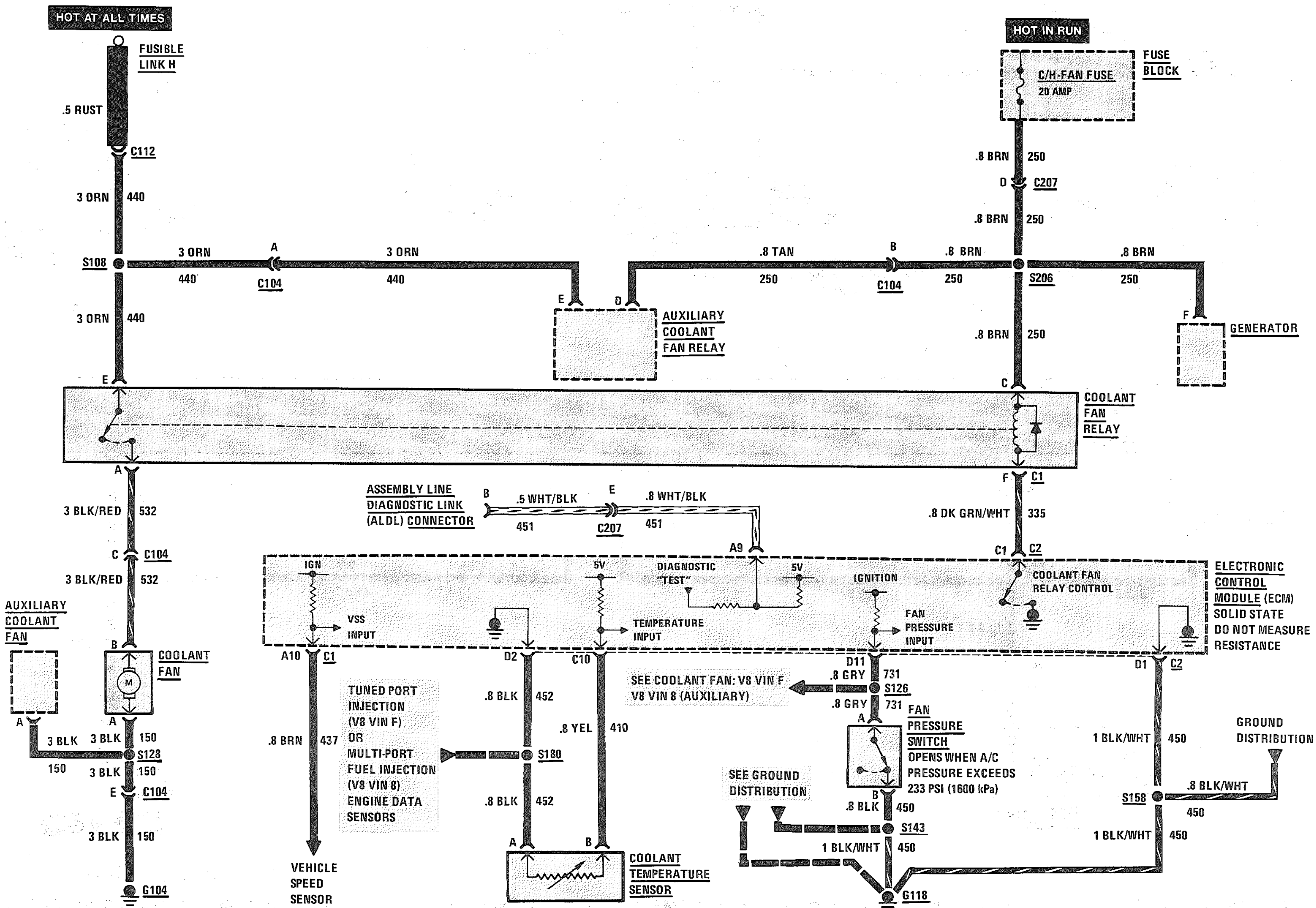
The Generator provides voltage to operate the car's electrical system and to charge its battery. A magnetic field is created when current flows through the Rotor. This field rotates as the Rotor is driven by the engine, creating an AC voltage in the Stator windings. The AC voltage is converted to DC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

The Generator's Regulator uses digital techniques to supply the Rotor current and thereby control the output voltage. The Rotor current is proportional to the width of the electrical pulses supplied by the Regulator. When the Ignition Switch is placed in RUN, voltage is supplied to terminals L and F, turning on the Regulator. Narrow width pulses are supplied to the Rotor, creating a weak magnetic field. When the engine is started, the Regulator senses Generator rotation by detecting AC voltage at the stator through an internal wire. Once the engine is running, the Regulator varies the field current by controlling the pulse width. This regulates the Generator output voltage for proper battery charging and electrical system operation.

COOLANT FAN: V6 VIN S

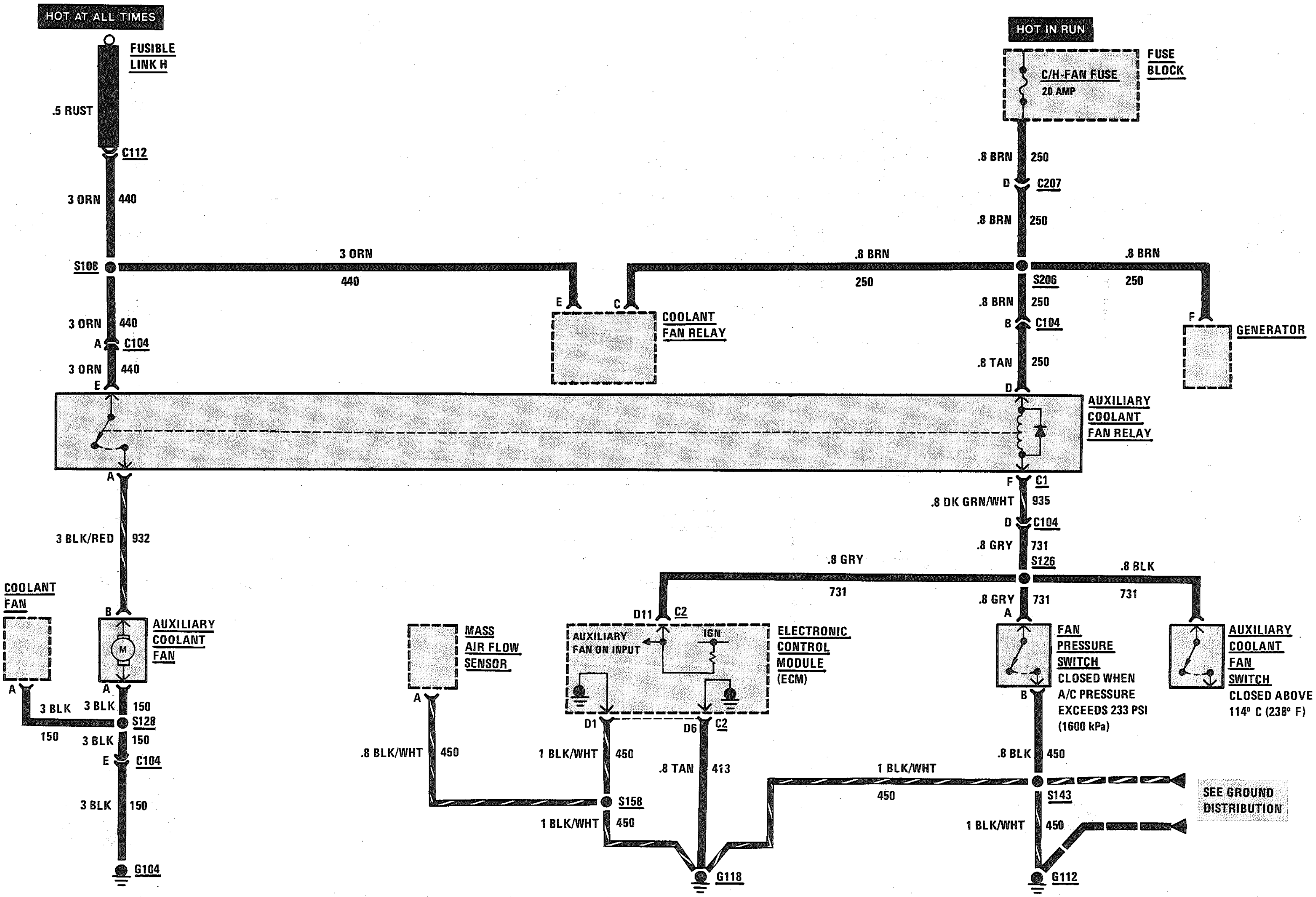


COOLANT FAN: V8 VIN F, V8 VIN 8

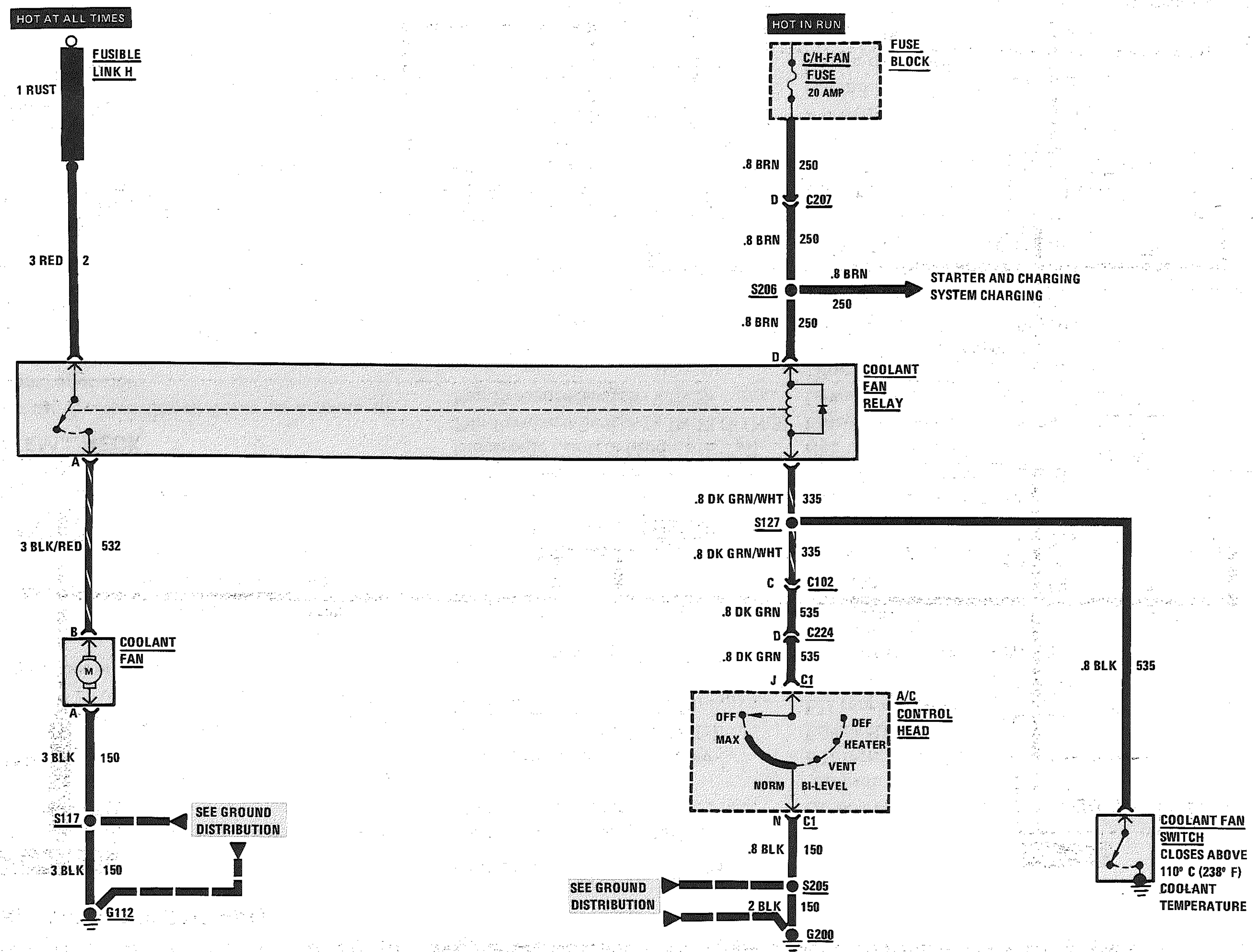


COOLANT FAN: V8 VIN F, V8 VIN 8

AUXILIARY COOLANT FAN



COOLANT FAN: V8 VIN E



TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Check.**

1. Check the C/H-FAN Fuse if the Coolant Fan does not run.
2. Check that ground G112 (V6 VIN S), G117 (V8 VIN E) or G104 (V8 VIN F and V8 VIN 8) is clean and tight.
3. Check the Fusible Link (see schematic).
4. If the Coolant Fan runs with the Ignition Switch OFF, replace the Coolant Fan Relay.

- **Go to System Check for a guide to normal operation.**
- **Go to System Diagnosis for diagnostic tests.**

SYSTEM CHECK

- **Use the System Check Table as a guide to normal operation.**

SYSTEM CHECK TABLE

ACTION	NORMAL RESULT
With the engine cold and idling, turn the A/C Selector to NORM (if equipped with A/C)	VIN E: Coolant Fan turns on VIN S, VIN F & VIN 8: Coolant Fan (and Auxiliary Coolant Fan-if equipped) turns on when A/C Control Head Pressure exceeds 233 psi (1600 kPa)

(Continued on next page)

COMPONENT LOCATION

		Page-Figure
Assembly Line Diagnostic Link (ALDL) Connector	On bottom of I/P hush panel, to right of steering column	
Auxiliary Coolant Fan Relay	RH front side of engine compartment	201- 5-A
Auxiliary Coolant Fan Switch	Lower RH rear of engine	201- 6-A
Coolant Fan Relay (VIN E)	LH rear corner of engine compartment, on relay bracket	201- 3-A
Coolant Fan Relay (VIN F) (VIN 8)	Front of engine compartment, RH side of radiator support	201- 5-A
Coolant Fan Relay (VIN S)	LH rear corner of engine compartment, on relay bracket	201- 0-A
Coolant Fan Switch	Lower RH rear of engine, above starter solenoid	201- 4-A
Coolant Temperature Sensor (VIN F) (VIN 8)	Top LH front of engine	201- 8-C
Coolant Temperature Sensor (VIN S)	Top LH front of intake manifold	201- 0-A
Electronic Control Module (ECM)	Behind RH side of I/P	201-12-B
Fan Pressure Switch (VIN F) (VIN 8)	Lower RH side of engine, on A/C line	201- 5-A
Fan Pressure Switch (VIN S)	Lower RH front of engine compartment, on A/C line	201- 1-A
Fuse Block	Behind LH side of I/P, below light switch	201-10-A
Fusible Link H (VIN E)	RH front of engine compartment, at Junction Block	201- 3-B
Fusible Link H (VIN F) (VIN 8)	LH front of engine compartment, behind battery	201- 5-C
Fusible Link J (VIN S)	RH side of radiator support, at Junction Block	201- 1-A
Redundant Cooling Fan Switch	Top RH rear of engine	201- 1-C
C102 (4 cavities)	Center front of dash	201-14-A
C104 (6 cavities)	Front of engine compartment, RH side of radiator	201- 5-A
C204 (4 cavities)	Above LH rear corner of engine	201- 0-A
C207 (15 cavities)	Behind RH side of I/P, near ECM	201-13-A
C224 (6 cavities)	Center of I/P, behind A/C control	201-14-B
G104	On radiator support, behind RH headlights	201-16-A
G112 (VIN E)	Rear of LH cylinder head	201- 3-C
G112 (VIN S)	Rear of LH cylinder head	201- 0-C
G118 (VIN F) (VIN 8)	Rear of RH cylinder head	201- 5-A
G118 (VIN S)	Rear of RH cylinder head	201- 1-C

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With the engine coolant below operating temperature, move the A/C Selector to OFF	VIN E: Coolant Fan turns off VIN S, VIN F & VIN 8: Coolant Fan (and Auxiliary Coolant Fan-if equipped) turns off when A/C Control Head Pressure falls below 233 psi (1600 kPa)
With the engine warm, run the engine at a fast idle for several minutes	Coolant Fan (and Auxiliary Coolant Fan-if equipped) turns on before the Coolant Temperature Indicator in the Instrument Panel lights or before the Coolant Temperature Gage needle indicates hot
Turn the Ignition Switch to off	Coolant Fan (and Auxiliary Coolant Fan-if equipped) turns off

- **Refer to System Diagnosis when a result is not normal.**

SYSTEM DIAGNOSIS

V6 VIN S

- **Do the tests listed for your symptom in the Symptom Table below.**
- **Tests follow the Symptom Table.**

COMPONENT LOCATION

		Page-Figure
G200	Behind I/P, left of steering column	201-10-A
S104 (VIN S)	Engine harness, lower RH side of engine	201- 1-A
S108	Engine harness, lower RH side of engine	201- 5-A
S111	Engine harness, RH rear of engine compartment	201- 1-A
S126	Engine harness, RH rear corner of engine compartment	201- 5-A
S127	Engine harness, RH front of dash	201- 2-A
S128	Cooling Fan harness, RH front corner of engine compartment	201- 6-A
S142 (VIN S)	Engine harness, lower RH side of engine	201- 1-A
S143 (VIN F) (VIN 8)	Engine harness, RH front of dash	201- 6-A
S143 (VIN S)	Engine harness, center front of dash	201- 1-A
S158	Engine harness, behind RH side of I/P	
S205	I/P harness, behind instrument cluster	201-10-A
S206 (VIN E)	Engine harness, RH front of dash	201- 2-A
S206 (VIN F)(VIN 8)	Engine harness, top center rear of engine	201- 7-A
S206 (VIN S)	Engine harness, above rear of engine	201- 1-A

SYMPTOM TABLE

SYMPTOM	FOR DIAGNOSIS
Coolant Fan does not run at all	Do Test A
Coolant Fan does not run with engine hot but does run with the A/C on	Do Test B
Coolant Fan runs at all times with the engine cool and the A/C off	Do Test C

(Continued on next page)

COOLANT FAN

A: COOLANT FAN OPEN TEST (TABLE 1)

Connect: FUSED JUMPER
At: ALDL CONNECTOR
Condition:
- **Ignition Switch: RUN**

Connect Between	Correct Result	For Diagnosis
B & Ground	Coolant Fan runs	See 1

- If the result is correct, go to section 6E for ECM diagnosis.

1. Go to Table 2

A: COOLANT FAN OPEN TEST (TABLE 2)

Connect: FUSED JUMPER
At: COOLANT FAN RELAY CONNECTOR (Connected)
Condition:
- **Ignition Switch: RUN**

Jumper Between	Correct Result	For Diagnosis
F (DK GRN/ WHT) & Ground	Coolant Fan runs	See 1

- If the Coolant Fan runs, check the DK GRN/WHT (335) wire for an open. If the wire is OK, go to section 6E for ECM diagnosis.

1. Go to Table 3.

A: COOLANT FAN OPEN TEST (TABLE 3)

Connect: TEST LAMP
At: COOLANT FAN RELAY CONNECTOR (Disconnected)
Condition:
- **Ignition Switch: RUN**

Connect Between	Correct Result	For Diagnosis
C (BRN) & Ground	Test Lamp lights	See 1
E (RED) & Ground	Test Lamp lights	See 2

- If the results are correct, go to Table 4.

1. Check C/H-FAN Fuse and BRN (250) wire for open.
2. Check Fusible Link J and RED (2) wire for opens.

A: COOLANT FAN OPEN TEST (TABLE 4)

Connect: FUSED JUMPER
At: COOLANT FAN RELAY CONNECTOR (Disconnected)

Jumper Between	Correct Result	For Diagnosis
E (RED) & A (BLK/RED)	Coolant Fan runs	See 1

- If the Coolant Fan runs, replace the Coolant Fan Relay.

1. Leave fused jumper in place and go to Table 5.

A: COOLANT FAN OPEN TEST (TABLE 5)

Connect: TEST LAMP
At: COOLANT FAN CONNECTOR (Disconnected)
Condition:
- **Fused jumper from Table 4 connected**

Connect Between	Correct Result	For Diagnosis
B (BLK/RED) & Ground	Test Lamp lights	See 1
B (BLK/RED) & A (BLK)	Test Lamp lights	See 2

- If the results are correct, replace the Coolant Fan.

1. Check BLK/RED (532) wire for an open.
2. Check BLK (150) wire for an open.

B: COOLANT FAN SWITCH TEST

Connect: FUSED JUMPER
At; REDUNDANT COOLING FAN SWITCH CONNECTOR (Disconnected)
Condition:
- **Ignition Switch: RUN**

Jumper Between	Correct Result	For Diagnosis
DK GRN/ WHT & Ground	Coolant Fan runs	See 1

- If the Coolant Fan runs, replace the Redundant Cooling Fan Switch, then refer to Section 6E for ECM diagnosis.

1. Check the DK GRN/WHT (335) wire for an open (see schematic).

C: COOLANT FAN SHORT TEST

1. With the Ignition Switch in RUN, remove the Redundant Cooling Fan Switch connector.

- If the Coolant Fan does not turn off, go to Step 2.
- If the Coolant Fan turns off, replace the Redundant Cooling Fan Switch.

2. Remove the C/H-FAN Fuse.

- If the Coolant Fan turns off, check the DK GRN/WHT (335) wires for a short to ground. Refer to Section 6E for ECM diagnosis if the wires are OK.
- If the Coolant Fan does not turn off, replace the Coolant Fan Relay.

SYSTEM DIAGNOSIS

V8 VIN F AND V8 VIN 8

- **Do the tests listed for your symptom in the Symptom Table below.**
- **Tests follow the Symptom Table.**

SYMPTOM TABLE

SYMPTOM	FOR DIAGNOSIS
Coolant Fan does not run at all	Do Test A
Coolant Fan runs at all times with the A/C off and engine cool	Do Test B
Auxiliary Coolant Fan does not run at all	Do Test C
Auxiliary Coolant Fan runs at all times with A/C off and the engine cool	Do Test D

(Continued in next column)

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A: COOLANT FAN OPEN TEST (TABLE 1)

Connect: FUSED JUMPER
At: ALDL CONNECTOR
Condition:
- **Ignition Switch: RUN**

Connect Between	Correct Result	For Diagnosis
B & Ground	Coolant Fan runs	See 1

- If the result is correct, go to Section 6E for ECM diagnosis.

1. Go to Table 2.

A: COOLANT FAN OPEN TEST (TABLE 2)

Connect: FUSED JUMPER
At: COOLANT FAN RELAY CONNECTOR (Connected)
Condition:
- **Ignition Switch: RUN**

Jumper Between	Correct Result	For Diagnosis
F (DK GRN/ WHT) & Ground	Coolant Fan runs	See 1

(Continued in next column)

(Continued from previous column)

- If the Coolant Fan runs, check the DK GRN/WHT (335) wire for an open. If wire is OK, go to Section 6E for ECM diagnosis.

1. Go to Table 3.

A: COOLANT FAN OPEN TEST (TABLE 3)

Connect: TEST LAMP
At: COOLANT FAN RELAY CONNECTOR (Disconnected)
Condition:
- **Ignition Switch: RUN**

Connect Between	Correct Result	For Diagnosis
C (BRN) & Ground	Test Lamp lights	See 1
E (ORN) & Ground	Test Lamp lights	See 2

- If the results are correct, go to Table 4.

1. Check C/H-FAN Fuse and BRN (250) wire for opens.
2. Check Fusible Link H and ORN (440) wire for opens.

(Continued on next page)

COOLANT FAN

A: COOLANT FAN OPEN TEST (TABLE 4)

Connect: FUSED JUMPER
At: COOLANT FAN RELAY CONNECTOR (Disconnected)

Jumper Between	Correct Result	For Diagnosis
E (ORN) & A (BLK/RED)	Coolant Fan runs	See 1

- If the Coolant Fan runs, replace the Coolant Fan Relay.

1. Leave fused jumper in place and go to Table 5.

A: COOLANT FAN OPEN TEST (TABLE 5)

Connect: TEST LAMP
At: COOLANT FAN CONNECTOR (Disconnected)
Condition:
- Fused jumper in place from Table 4

Connect Between	Correct Result	For Diagnosis
B (BLK/RED) & Ground	Test Lamp lights	See 1
B (BLK/RED) & A (BLK)	Test Lamp lights	See 2

- If the results are correct, replace the Coolant Fan.

1. Check BLK/RED (532) wire for an open.
2. Check BLK (150) wire for an open.

B: COOLANT FAN SHORT TEST

With the Ignition Switch in RUN, remove the C/H-FAN Fuse.

- If the Coolant Fan turns off, check the DK GRN/WHT (335) wire for a short to ground. If the wire is OK, refer to Section 6E for ECM diagnosis.
- If the Coolant Fan does not turn off, replace the Coolant Fan Relay.

C: AUXILIARY COOLANT FAN OPEN TEST (TABLE 1)

Connect: FUSED JUMPER
At: AUXILIARY COOLANT FAN RELAY CONNECTOR (Connected)
Condition:
- Ignition Switch: RUN

Jumper Between	Correct Result	For Diagnosis
F (DK GRN/ WHT) & Ground	Auxiliary Coolant Fan runs	See 1

- If the Auxiliary Coolant Fan runs, check the DK GRN/WHT (935) and GRY (731) wires for opens. If wires are good, check switches.

1. Go to Table 2.

C: AUXILIARY COOLANT FAN OPEN TEST (TABLE 2)

Connect: TEST LAMP
At: AUXILIARY COOLANT FAN RELAY CONNECTOR (Disconnected)
Condition:
- Ignition Switch: RUN

Connect Between	Correct Result	For Diagnosis
D (ORN) & Ground	Test Lamp lights	See 1
E (ORN) & Ground	Test Lamp lights	See 2

- If the results are correct, go to Table 3.

1. Check ORN (440) and BRN (250) wires for opens.
2. Check ORN (440) wires for opens.

C: AUXILIARY COOLANT FAN OPEN TEST (TABLE 3)

Connect: FUSED JUMPER
At: AUXILIARY COOLANT FAN RELAY CONNECTOR (Disconnected)

Jumper Between	Correct Result	For Diagnosis
E (ORN) & A (BLK/RED)	Auxiliary Coolant Fan runs	See 1

- If the Auxiliary Coolant Fan runs, replace the Auxiliary Coolant Fan Relay.

1. Leave fused jumper in place and go to Table 5.

C: AUXILIARY COOLANT FAN OPEN TEST (TABLE 4)

Connect: TEST LAMP
At: AUXILIARY COOLANT FAN CONNECTOR (Disconnected)
Condition:
- Fused jumper in place from Table 4

Connect Between	Correct Result	For Diagnosis
B (BLK/RED) & Ground	Test Lamp lights	See 1
B (BLK/RED) & A (BLK)	Test Lamp lights	See 2

- If the results are correct, replace the Auxiliary Coolant Fan.

1. Check BLK/RED (932) wire for an open.
2. Check BLK (150) wire for an open.

D: AUXILIARY COOLANT FAN SHORT TEST

1. With the Ignition Switch in RUN, disconnect the Auxiliary Coolant Fan Switch.
- If the Auxiliary Coolant Fan does not turn off, go to Step 2.
- If the Auxiliary Coolant Fan turns off, replace the Auxiliary Coolant Fan Switch.
2. Disconnect the Fan Pressure Switch.
- If the Auxiliary Coolant Fan does not turn off, go to Step 3.
- If the Auxiliary Coolant Fan turns off, replace the Fan Pressure Switch.
3. Remove the C/H-FAN Fuse.
- If the Auxiliary Coolant Fan does not turn off, replace the Auxiliary Coolant Fan Relay.
- If the Auxiliary Coolant Fan turns off, check the DK GRN/WHT (935) and GRY (731) wires for a short to ground.

SYSTEM DIAGNOSIS

V8 VIN E

- **Do the tests listed for your symptom in the Symptom Table below.**
- **Tests follow the Symptom Table.**

SYMPTOM TABLE

SYMPTOM	FOR DIAGNOSIS
Coolant Fan does not run with engine hot and the A/C on	Do Test A
Coolant Fan does not run with engine hot but does run with the A/C on	Do Test B
Coolant Fan does not run with the A/C on but does run with the engine hot	Do Test C
Coolant Fan runs at all times with A/C off and engine cool	Do Test D

A: COOLANT FAN OPEN TEST (TABLE 1)

Connect: FUSED JUMPER
At: COOLANT FAN RELAY CONNECTOR (Connected)
Condition:
- Ignition Switch: RUN

Jumper Between	Correct Result	For Diagnosis
F (DK GRN) & Ground	Coolant Fan runs	See 1

- If the Coolant Fan runs, check the DK GRN (335) wire for an open.

1. Go to Table 2.

A: COOLANT FAN OPEN TEST (TABLE 2)

Connect: TEST LAMP
At: COOLANT FAN RELAY CONNECTOR (Disconnected)
Condition:
- Ignition Switch: RUN

Connect Between	Correct Result	For Diagnosis
D (BRN) & Ground	Test Lamp lights	See 1
E (RED) & Ground	Test Lamp lights	See 2

- If the results are correct, go to Table 3.

1. Check C/H-FAN Fuse and BRN (250) wire for opens.
2. Check Fusible Link H and RED (2) wire for opens.

(Continued on next page)

A: COOLANT FAN OPEN TEST (TABLE 3)

Connect: FUSED JUMPER
At: COOLANT FAN RELAY CONNECTOR
(Disconnected)

Jumper Between	Correct Result	For Diagnosis
E (RED) & A (BLK/RED)	Coolant Fan runs	See 1

- If the Coolant Fan runs, replace the Coolant Fan Relay.

1. Leave fused jumper in place and go to Table 4.

A: COOLANT FAN OPEN TEST (TABLE 4)

Connect: TEST LAMP
At: COOLANT FAN CONNECTOR
(Disconnected)
Condition:
- Fused jumper in place from Table 3.

Connect Between	Correct Result	For Diagnosis
B (BLK/RED) & Ground	Test Lamp lights	See 1
B (BLK/RED) & A (BLK)	Test Lamp lights	See 2

- If the results are correct, replace the Coolant Fan.

1. Check BLK/RED (532) wire for an open.
2. Check BLK (150) wire for an open.

B: COOLANT FAN SWITCH TEST

Connect: FUSED JUMPER
At: COOLANT FAN SWITCH CONNECTOR
(Disconnected)
Condition:
- Ignition Switch: RUN

Jumper Between	Correct Result	For Diagnosis
BLK & Ground	Coolant Fan runs	See 1

- If the Coolant Fan runs replace the Coolant Fan switch.

1. Check BLK (335) wire for an open (see schematic).

C: A/C CONTROL HEAD TEST

Connect: FUSED JUMPER
At: A/C CONTROL HEAD CONNECTOR C1
(Disconnected)
Condition:
- Ignition Switch: RUN

Jumper Between	Correct Result	For Diagnosis
J (DK GRN) & Ground	Coolant Fan runs	See 1
J (DK GRN) & N (BLK)	Coolant Fan runs	See 2

- If the results are correct, replace the A/C Control Head.

1. Check DK GRN/WHT (335) and DK GRN (535) wires for an open (see schematic).
2. Check BLK (150) wire for an open (see schematic).

D: COOLANT FAN SHORT TEST

1. With the Ignition Switch in RUN, remove the Coolant Fan Switch.
   - If the fan continues to run, go to step 2.
   - If the fan turns off, replace the Coolant Fan Switch.
2. Remove the C/H-FAN Fuse.
   - If the fan turns off, go to step 3.
   - If the fan continues to run, replace the Coolant Fan Relay.
3. Disconnect the A/C Control Head and reconnect C/H-FAN Fuse.
   - If the fan continues to run, check the DK GRN/WHT (335) and BLK (335) wires for a short to ground.
   - If the fan turns off, replace the A/C Control Head.

CIRCUIT OPERATION

V6 VIN S, V8 VIN F and V8 VIN 8

The Coolant Fan is controlled by the Electronic Control Module (ECM). In the V6 VIN S, the Coolant Fan is also controlled by the Redundant Cooling Fan Switch. When the ECM grounds the 335 circuit, the Coolant Fan Relay is energized and battery voltage is applied to the Coolant Fan. If the ECM fails (V6 VIN S), the Redundant Cooling Fan Switch will ground the 335 circuit and energize the Coolant Fan Relay. The ECM will ground the Coolant Fan Relay when the Coolant Temperature Sensor indicates the coolant temperature is greater than 106 °C (222 °F) or when the A/C Control Head pressure is greater than 233 psi (1600 kPa) and the vehicle speed is less than 40 mph.

COOLANT FAN

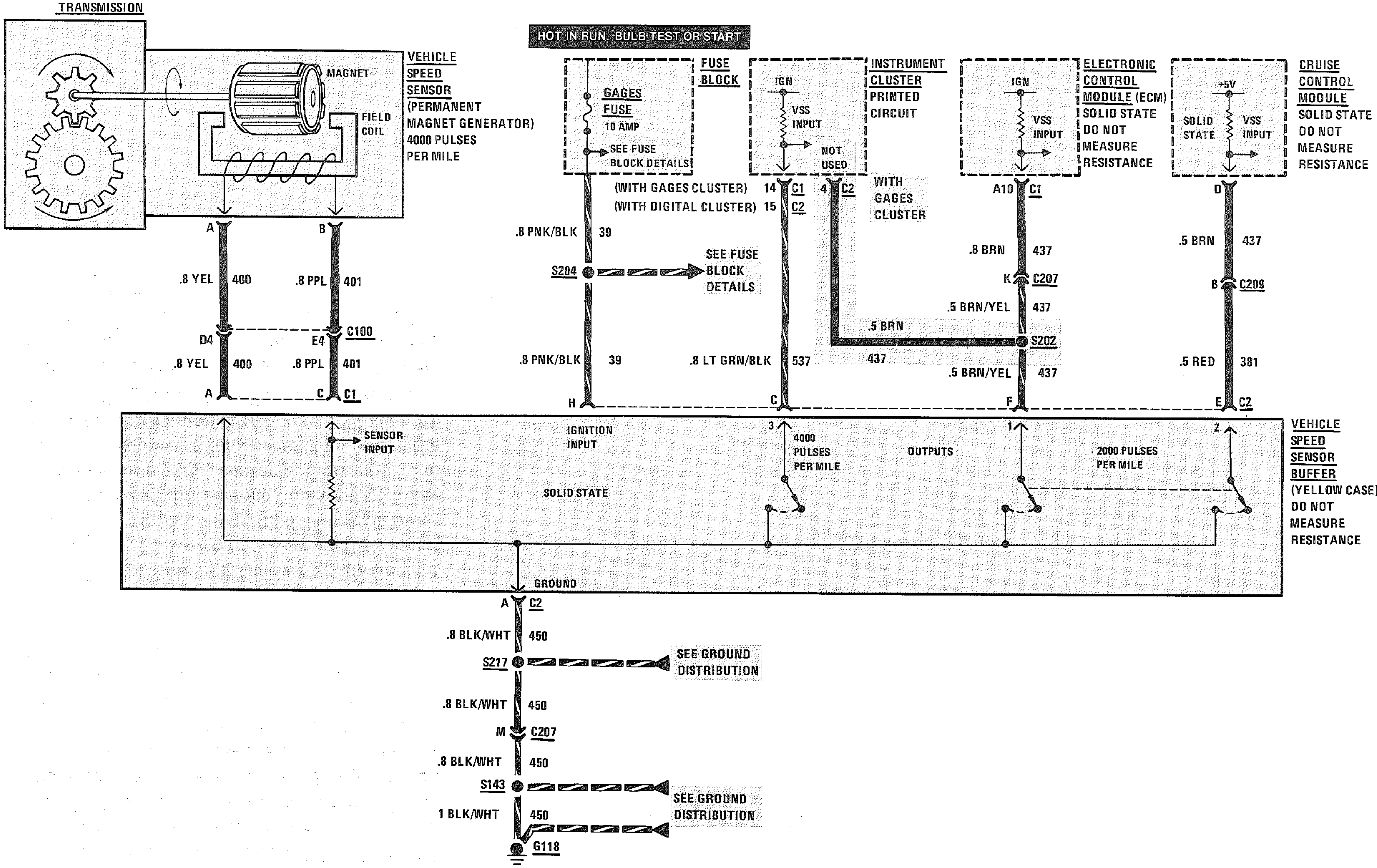
The Auxiliary Coolant Fan (V8 VIN F and V8 VIN 8) is controlled by the Fan Pressure Switch and the Auxiliary Coolant Fan Switch. If one of these switches closes, the Auxiliary Coolant Fan Relay is energized and the Auxiliary Coolant Fan is turned on. When a switch is closed, terminal D11 of ECM connector C2 is grounded. This tells the ECM that the Auxiliary Coolant Fan should be on.

V8 VIN E

The Coolant Fan is activated by the Coolant Fan Switch. The switch closes when the coolant temperature is over 110 °C (238 °F) completing a path to ground through the Coolant Fan Relay windings. The relay contacts then close and voltage is applied to the Coolant Fan. When the coolant temperature drops to 101 °C (214 °F), the switch opens and the Coolant Fan stops.

In A/C equipped vehicles, the A/C Control Head completes a path to ground for the Coolant Fan Relay. Voltage is then applied to the Coolant Fan.

VEHICLE SPEED SENSOR: PERMANENT MAGNET GENERATOR



VEHICLE SPEED SENSOR

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Diagnosis.**

1. Check the Gages Fuse by observing the Brake Indicator when applying the Parking Brake with the Ignition Switch in RUN (engine not running).
2. Check ground G118.
3. If only the Speedometer or only the Odometer does not work, replace the suspect item.

- **Go to System Diagnosis for diagnostic tests.**

SYSTEM DIAGNOSIS

- **Do the tests listed for your symptom in the Symptom Table below.**
- **Tests follow the Symptom Table.**

COMPONENT LOCATION

Component	Location	Page-Figure
Cruise Control Module	Behind RH side of I/P	201-11-A
Electronic Control Module (ECM)	Behind RH side of I/P	201-12-B
Fuse Block	Behind LH side of I/P, below light switch	201-10-A
Vehicle Speed Sensor	Lower LH rear of transmission	201- 8-D
Vehicle Speed Sensor Buffer	Behind RH side of I/P, near ECM	201-13-A
C100 (42 cavities)	LH front of dash, left of brake master cylinder	201- 0-A
C207 (15 cavities)	Behind RH side of I/P, near ECM	201-13-A
C209 (2 cavities)	Behind RH side of I/P, left of Cruise Control Module	201-11-A
G118 (VIN E)	Rear of RH cylinder head	201- 5-B
G118 (VIN F) (VIN 8)	Rear of RH cylinder head	201- 5-A
G118 (VIN S)	Rear of RH cylinder head	201- 1-C
S143 (VIN E)	Engine harness, RH front of dash	201- 2-A
S143 (VIN F) (VIN 8)	Engine harness, RH front of dash	201- 6-A
S143 (VIN S)	Engine harness, center front of dash	201- 1-A
S202	I/P harness, behind RH side of I/P	201-13-A
S204	I/P harness, behind instrument cluster	201-10-A
S217	I/P harness, behind center of I/P	201-10-A

SYMPTOM TABLE

SYMPTOM	FOR DIAGNOSIS
Speedometer does not operate properly, ECM Code 24 is not set	Do Test B
ECM Code 24 is set, Speedometer is good	Do Test C See Section 6E of Service Manual
Speedometer does not operate properly, and ECM Code 24 is set	Do Test A
Cruise Control does not operate properly, ECM Code 24 is not set	Do Test D

- **If your symptom is not listed in the Symptom Table, perform all the tests.**

VEHICLE SPEED SENSOR

A: VEHICLE SPEED SENSOR BUFFER TEST (TABLE 1)

Measure: VOLTAGE
At: VEHICLE SPEED SENSOR BUFFER CONNECTOR C2 (Disconnected)
Condition:
- Ignition Switch: RUN

Measure Between	Correct Voltage	For Diagnosis
H (PNK/BLK) & Ground	Battery	See 1
H (PNK/BLK) & A (BLK/WHT)	Battery	See 2

- If both voltages are correct, go to Table 2.

1. Check/repair PNK/BLK (39) wire for an open (see schematic).
2. Check/repair BLK/WHT (450) wire for an open (see schematic). Check that ground G118 is clean and tight.

A: VEHICLE SPEED SENSOR BUFFER TEST (TABLE 2)

Measure: AC VOLTAGE
At: VEHICLE SPEED SENSOR BUFFER CONNECTOR C1 (Connected)
Conditions:
- Ignition Switch: RUN
- Gear Selector: NEUTRAL
- Turn drive wheels by hand while making measurement

Measure Between	Correct AC Voltage	For Diagnosis
A (YEL) & C (PPL)	1 volt AC to 5 volts AC	See 1

- If the voltage is correct, replace the Vehicle Speed Sensor Buffer.

1. Check/repair the YEL (400) and PPL (401) wires (see schematic). Replace Vehicle Speed Sensor if both wires are OK, and connector C100 is correctly mated.

B: INSTRUMENT CLUSTER INPUT TEST

Measure: VOLTAGE
At: VEHICLE SPEED SENSOR BUFFER CONNECTOR C2 (Disconnected)
Condition:
- Ignition Switch: RUN

Measure Between	Correct Voltage	For Diagnosis
C (LT GRN/BLK) & Ground	Battery	See 1

- Vehicle Speed Sensor Buffer: CONNECTED
- Gear Selector: NEUTRAL
- Turn drive wheels by hand while making measurement

Measure Between	Correct Voltage	For Diagnosis
C (LT GRN/BLK) & Ground	Varying from less than 1 volt to more than 4 volts	See 2

- If voltages are correct, repair/replace Speedometer/Instrument Cluster.

1. Check LT GRN/BLK (537) wire for open or short to ground. If OK, repair/replace Instrument Cluster after verifying power inputs to Cluster (see Section 8A-81 or 82).
2. Replace Vehicle Speed Sensor Buffer.

C: ECM INPUT TEST

Measure: VOLTAGE
At: VEHICLE SPEED SENSOR BUFFER CONNECTOR C2 (Disconnected)
Condition:
- Ignition Switch: RUN

Measure Between	Correct Voltage	For Diagnosis
F (BRN/YEL) & Ground	Battery	See 1

- Vehicle Speed Sensor Buffer: CONNECTED
- Gear Selector: NEUTRAL
- Turn drive wheels by hand while making measurement

Measure Between	Correct Voltage	For Diagnosis
F (BRN/YEL) & Ground	Varying from less than 1 volt to more than 4 volts	See 2

- If voltages are correct, refer to Section 6E for further diagnosis.

1. Check BRN and BRN/YEL (437) wires for an open or short to ground. Also check that connections are good. If OK, replace ECM.
2. Replace Vehicle Speed Sensor Buffer.

D: CRUISE CONTROL INPUT TEST

Measure: VOLTAGE
At: VEHICLE SPEED SENSOR BUFFER CONNECTOR C2 (Disconnected)
Conditions:
- Ignition Switch: RUN
- Cruise Switch: ON

Measure Between	Correct Voltage	For Diagnosis
E (RED) & Ground	5 volts	See 1

- Vehicle Speed Sensor Buffer: CONNECTED
- Gear Selector: NEUTRAL
- Turn drive wheels by hand while making measurement

Measure Between	Correct Voltage	For Diagnosis
E (RED) & Ground	Varying from less than 1 volt to more than 2.5 volts	See 2

- If voltages are correct, refer to Cruise Control, Section 8A-34 for further diagnosis. If Section 8A-34 refers you back to this section (Vehicle Speed Sensor, 8A-33), replace Cruise Control Module.

1. Check RED (381) wire for open or short to ground. If wire is good, replace Cruise Control Module.
2. Replace Vehicle Speed Sensor Buffer.

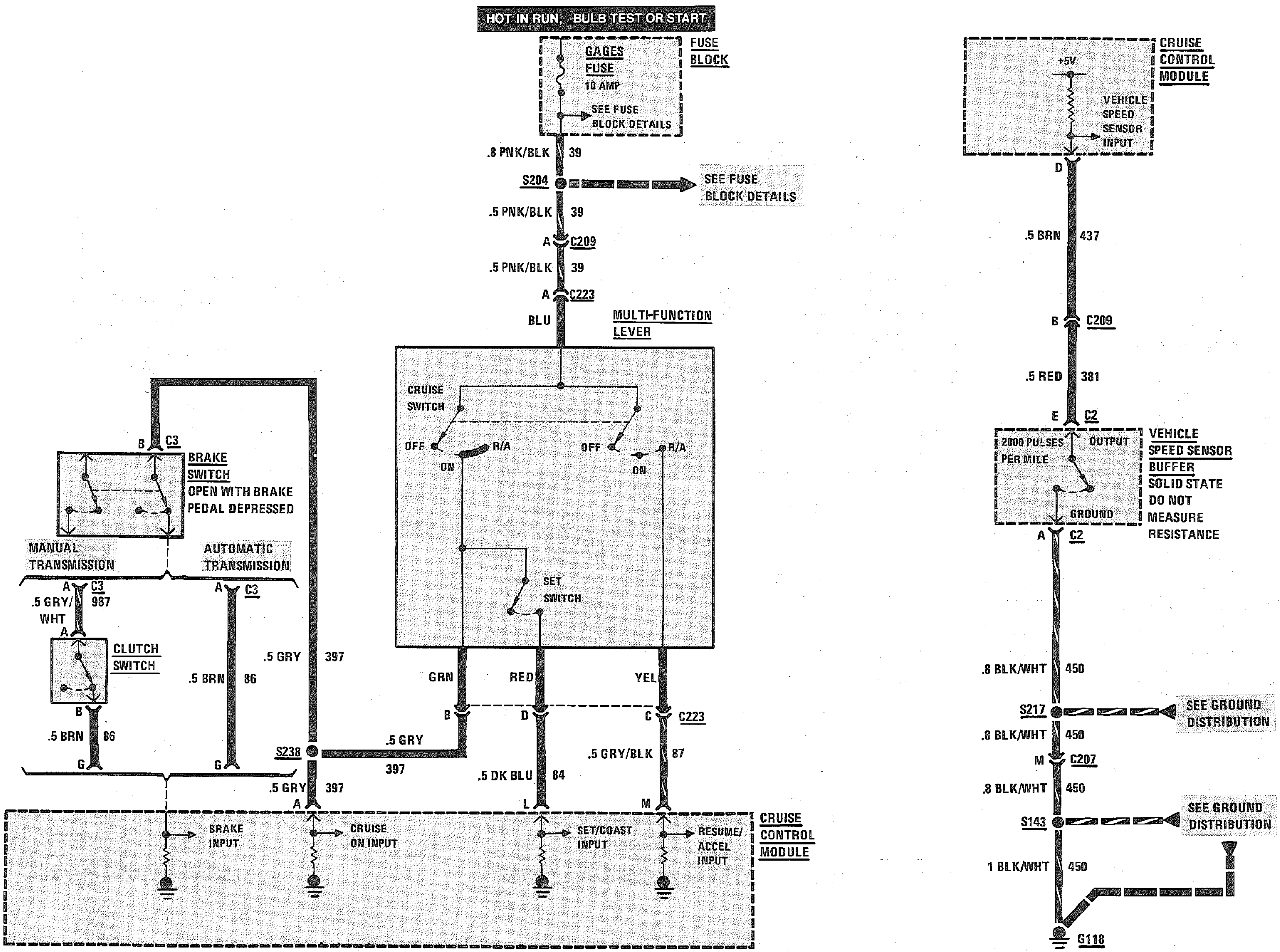
CIRCUIT OPERATION

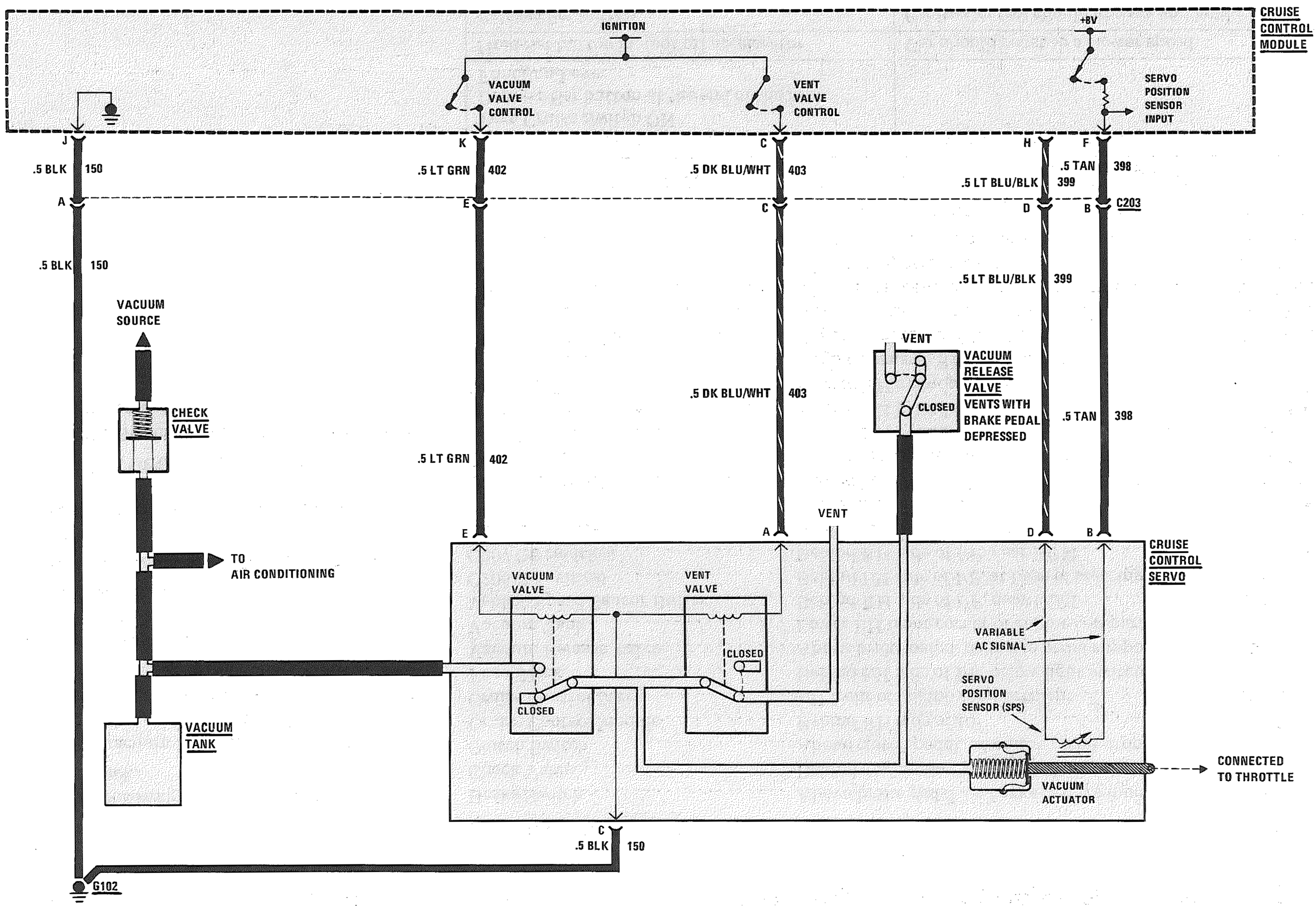
The Vehicle Speed Sensor (VSS) generates a signal that indicates the speed of the vehicle. This signal is processed by the solid state Vehicle Speed Sensor Buffer to supply inputs to the Electronic Control Module (ECM), the Cruise Control Module and the Speedometer.

The Vehicle Speed Sensor is mounted in the Transmission. A magnet rotates near a coil, producing voltage pulses in the coil. The frequency of the AC voltage coming from this coil depends on the vehicle speed. As the speed increases, so does the number of voltage pulses per second.

The Vehicle Speed Sensor Buffer takes the sensor/voltage pulses from the sensor and uses them to close three solid state output switches. Each output terminal is switched to ground at a rate that is proportional to the speed of the car. The sensor generates 4000 pulses per mile (ppm). The Speedometer is switched at a frequency of 4000 ppm. The ECM and the Cruise Control use a lower frequency, 2000 pulses per mile. Their output pulses are operated by a circuit after it has divided the sensor frequency by two.

CRUISE CONTROL




CRUISE CONTROL MODULE
IGNITION
+8V
VACUUM VALVE CONTROL
VENT VALVE CONTROL
SERVO POSITION SENSOR INPUT
J
K
C
H
F
.5 BLK 150
.5 LT GRN 402
.5 DK BLU/WHT 403
.5 LT BLU/BLK 399
.5 TAN 398
A
E
C
D
B
C203
VACUUM SOURCE
CHECK VALVE
TO AIR CONDITIONING
VACUUM TANK
VENT
VACUUM RELEASE VALVE
VENTS WITH BRAKE PEDAL DEPRESSED
CLOSED
CRUISE CONTROL SERVO
VACUUM VALVE
VENT VALVE
CLOSED
VARIABLE AC SIGNAL
SERVO POSITION SENSOR (SPS)
VACUUM ACTUATOR
CONNECTED TO THROTTLE
G102

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Check.**

1. Check vacuum hose for leaks, kinks, and/or restrictions. Also check Cruise Control Servo linkage. Refer to Section 9 for vacuum hose routing and servo linkage adjustments.
2. If the system works except for the Tap-Up and Tap-Down functions, replace the Cruise Control Module.

- **Go to System Check for a guide to normal operation.**
- **Go to System Diagnosis for diagnostic tests.**

SYSTEM CHECK (ROAD TEST)

- **Use the System Check Table as a guide to normal operation.**

COMPONENT LOCATION

Component	Location	Page-Figure
Brake Switch	Above brake pedal, on brake pedal support	201- 9-A
Check Valve	Behind engine, to right of master brake cylinder	201-15-A
Clutch Switch	Above clutch pedal, on clutch pedal support	201-10-B
Cruise Control Module	Behind RH side of I/P	201-11-A
Cruise Control Servo	LH front of engine compartment	201-15-A
Fuse Block	Behind LH side of I/P, below light switch	201-10-A
Vacuum Release Valve	Above brake pedal, on brake pedal support	201-10-B
Vacuum Tank	Lower LH front corner of engine compartment	201-15-A
Vehicle Speed Sensor Buffer	Behind RH side of I/P, near ECM	201-13-A
C203 (6 cavities)	Behind LH side of I/P, at base of steering column	201-11-A
C207 (15 cavities)	Behind RH side of I/P, near ECM	201-13-A
C209 (2 cavities)	Behind RH side of I/P, left of Cruise Control Module	201-11-A
C223 (4 cavities)	Behind LH side of I/P, at base of steering column	201-11-A
G102	LH rear corner of engine compartment	201-15-A
G118 (VIN E)	Rear of RH cylinder head	201- 5-B
G118 (VIN F) (VIN 8)	Rear of RH cylinder head	201- 5-A
G118 (VIN S)	Rear of RH cylinder head	201- 1-C
S143 (VIN E)	Engine harness, RH front of dash	201- 2-A
S143 (VIN F) (VIN 8)	Engine harness, RH front of dash	201- 6-A
S143 (VIN S)	Engine harness, center front of dash	201- 1-A
S204	I/P harness, behind instrument cluster	201-10-A
S217	I/P harness, behind center of I/P	201-10-A
S238	Cruise control harness, near Brake Switch	201-11-A

SYSTEM CHECK TABLE

ACTION	CORRECT RESULT
Drive car faster that 25 mph Turn Cruise Switch ON Depress Set button at the end of the Multi-Function Lever	Car should maintain speed
Hold Set button in, foot off accelerator	Car should coast to a slower speed
Release Set button	Cruise Control should engage and hold a slower speed, if the new speed remains above 25 mph
Slide Cruise Switch to R/A and hold it there	Car should accelerate

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Release Cruise Switch back to ON	Car should hold new faster speed
Tap brake pedal	Car should coast slower (Cruise disengages)
Slide Cruise Control Switch momentarily to R/A	Car should accelerate to former set speed
While cruising, accelerate, then remove foot from accelerator	Car should coast back to set speed
While cruising, tap Cruise Switch to R/A	Car should increase 1 mph for each tap, up to ten taps, then system must be reset to a new speed
While cruising, tap Set button	Car speed should decrease by 1 mph for each tap until 25 mph is reached when Cruise Control will not operate
Slide Cruise Switch to OFF	Cruise Control turns off

- **Refer to System Diagnosis when a result is not normal.**

SYSTEM DIAGNOSIS

- **Use the Isolation Test below to choose the proper diagnostic tests.**
- **Tests follow the Isolation Test.**
- **Note: Do not press both the SET and R/A Switches at the same time while the engine is running. If the Quick Checker displays a short light, release the switches immediately. Shorts can damage the Quick Checker.**

ISOLATION TEST

Connect: QUICK CHECKER (J-34185, SPECMO QC-3 OR EQUIVALENT) or VOLT-OHMMETER
At: CRUISE CONTROL MODULE CONNECTOR (Disconnected)
Conditions:
- **Ignition Switch: RUN**
- **Test with Quick Checker (J-34185 or equivalent) or Digital Meter**

Test	Condition	With Quick Checker, Correct Response	Without Quick Checker, Using a Digital Meter			For Different Response, Do Test:
			Meter Range	Connector Terminals	Correct Response	
1	Cruise Switch OFF	—	200 ohms	J & Ground	0 ohms	B
		All Lights Off	20 VDC	A & J	0 volts	A
			20 VDC	M & J	0 volts	

(ISOLATION TEST continued on next page)

(ISOLATION TEST continued from previous page)

Test	Condition	With Quick Checker, Correct Response	Without Quick Checker, Using a Digital Meter			For Different Response, Do Test
			Meter Range	Connector Terminals	Correct Response	
2	Cruise Switch ON	ON/OFF Light On	20 VDC	A & J	Battery voltage	B
		BRK Light On	20 VDC	G & J	Battery voltage	C
		VENT Light On	200 ohms	C & J	30 to 55 ohms	D
		VAC Light On	200 ohms	K & J	30 to 55 ohms	E
		SPS Light On	200 ohms	F & H	15 to 25 ohms	F
		RA Light Off	20 VDC	M & J	0 volts	A
		SC Light Off	20 VDC	L & J	0 volts	A
3	Cruise Switch ON, Set Switch pressed	SC Light On	20 VDC	L & J	Battery voltage	G
		VAC & SHORT Lights Off	200 ohms	K & J	30 to 55 ohms	H
4	Cruise Switch in R/A	ON/OFF Light On	20 VDC	A & J	Battery voltage	A
		RA Light On	20 VDC	M & J	Battery voltage	I
		VENT & SHORT Lights Off	200 ohms	C & J	30 to 55 ohms	J
5	Cruise Switch ON, drive wheels turned by hand	VSS Light flashes On and Off	20 VDC	A & D	Pulses between approximately battery voltage and less than 7 volts	K, L
6	Run engine for one minute, then turn it off. With Ignition Switch in RUN, and holding Cruise Switch in R/A, press Set Switch, wait for Servo to pull in and release Set Switch	Vacuum holds the servo all the way in	Connect fused jumper from C to M and from K to L before operating switches		Vacuum holds the servo all the way in	M
7	Quick Checker not connected	—	200 ohms	F & J	Over range	N

• If all the responses were correct, replace Cruise Control Module and check for proper operation.

TEST A: CRUISE SWITCH SHORT

Check for shorts to voltage in the wires to terminals G (BRN), A (GRY), M (GRY/BLK), L (DK BLU) of the Module (see schematic).

- If the wires are good, replace the Multi-Function Lever.

TEST B: POWER CIRCUIT OPEN

1. Check the GAGES Fuse.
2. Check that terminal J (BLK) is grounded.
3. Disconnect connector C235 and check for battery voltage at terminal A of the socket half with Ignition in RUN.

- If battery voltage is missing, check/repair PNK/BLK (239) wire.

4. Check continuity between terminals A (BLU) and B (GRN) of the pin half of connector C223 with the Cruise Switch ON.

- If the Switch is open, replace the Multi-Function Lever.

5. Check for an open in GRY (397) wire between terminal B of connector C223 and terminal A of the module connector.

TEST C: BRK CIRCUIT OPEN

1. Check for an open Brake Switch or Clutch Switch (see schematic)
2. Check for an open in the GRY (397) wire, BRN (86) wire or GRY/WHT (987) wire.

TEST D: VENT CIRCUIT OPEN

If you measured less than 30 ohms, perform Test J. Otherwise, remove the connector from the Cruise Control Servo. Measure the resistance between terminals A and C of the Servo.

- If it is greater than 55 ohms, replace the Servo.
- If it is less than 55 ohms, check for an open DK BLU/WHT (403) wire between terminal C of the Module and terminal A of the Servo. Check that terminal C (BLK) of the Servo connector is grounded (see schematic).

TEST E: VAC CIRCUIT OPEN

If you measured less than 30 ohms, perform Test H. Otherwise, remove the connector from the Cruise Control Servo. Measure the resistance between terminals E and C of the Servo.

- If it is more than 55 ohms, replace the Servo.
- If it is less than 55 ohms, check for an open in the LT GRN (402) wire between terminal K of the Module and terminal E of the Servo. Check that terminal C (BLK) of the Servo Connector is grounded (see schematic).

TEST F: SPS CIRCUIT OPEN

If you measured less than 15 ohms, perform Test N. Otherwise, remove the connector from the Cruise Control Servo. Measure the resistance between terminals B and D of the Servo.

- If it is more than 25 ohms, replace the Servo.
- If it is less than 25 ohms, check for an open in the LT BLU/BLK (399) wire between terminals H of the Module and terminal D of the Servo. Check for an open in the TAN (398) wire between terminal F of the Module and terminal B of the Servo.

TEST G: SC CIRCUIT OPEN

Disconnect C223 and check the switch continuity between terminals B (GRN) and D (RED) of the pin half with the Set Switch pressed.

- If the Switch is open, replace the Multi-Function Lever.
- If the switch is not open, check for an open in the DK BLU (84) wire between terminal D of connector C223 and terminal L of the Module.

TEST H: VAC CIRCUIT SHORT

Remove the connector from the Servo and measure resistance between terminals C and E of the Servo.

- If it is less than 30 ohms, replace the Servo.
- If it is 30 ohms or more, check for a short to ground in the LT GRN wire from terminal K of the Module to terminal E of the Servo.

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TEST I: R/A CIRCUIT OPEN

Disconnect C223 and check switch continuity between terminals A (BLU) and C (YEL) of the pin half of the Cruise Switch in R/A.

- If the switch is open, replace the Multi-Function Lever.
- If the switch is not open, check for an open in the GRY/BLK (87) wire between terminal C of connector C223 at terminal M of the Module.

TEST J: VENT CIRCUIT SHORT

Remove the connector from the Servo and measure resistance between terminals A and C of the Servo.

- If it is less than 30 ohms, replace the Servo.
- If it is 30 ohms or more, check for a short to ground in the DK BLU/WHT wire from terminal C of the Module to terminal A of the Servo.

TEST K: VSS CIRCUIT OPEN

If the VSS light does not come on, or the voltage between terminals A (GRY) and D (BRN) remains less than 7 volts, check for an open in the BRN (437) wire or the RED (381) wire from the Vehicle Speed Sensor Buffer. Refer to page 33-0 for diagnosis of Vehicle Speed Sensor.

TEST L: VSS CIRCUIT SHORT

If the VSS lights does not go off or Battery voltage remains between terminals A (GRY) and D (BRN), check for a short to ground on the BRN (437) wire or the RED (381) wire from the Vehicle Speed Sensor Buffer. Refer to page 33-0 for diagnosis of Vehicle Speed Sensor.

TEST M: VACUUM SYSTEM

1. Check for a blocked or leaking vacuum source.
2. If the vacuum source is good, plug the Vacuum Release Port and repeat Test 6 of the Isolation Test.

- If the vacuum now holds the throttle open, replace or repair the Vacuum Release Valve or the hose to it.
- If the test still fails, replace the Cruise Control Servo.

TEST N: SPS CIRCUIT SHORT

Disconnect the Cruise Control Servo connector and repeat Test 7 of the Isolation Test.

- If the resistance is now over range, replace the Cruise Control Servo.
- If the resistance is still low, find and repair the short in the TAN wire from terminal F of the Cruise Control Module to terminal B of the Cruise Control Servo.

CIRCUIT OPERATION

The Cruise Control System operates a mechanical linkage to the throttle by means of a Vacuum Motor. This is a diaphragm moved by a vacuum applied to one side. A solenoid operated valve connects the Vacuum Motor to a Vacuum Tank. Another solenoid valve vents the vacuum to reduce the suction. The Cruise Control Module controls the Vacuum Motor and the throttle by pulsing these solenoid valves on and off.

One input to the Module is the vehicle speed. This input comes from the Vehicle Speed Sensor. If the actual speed signal is different from the speed that was set into and remembered by the Module, the Module generates pulses to change the vacuum and return the vehicle to the set speed. The Vehicle Speed Sensor is mounted on the Transmission. Other inputs to the Module are from the Cruise Switch and the Set Switch. A disengage input to the Module comes from a switch on the brake pedal. A seperate vacuum shut down of the Cruise Control comes from the Vacuum Release Valve on the brake pedal.

The two outputs of the Cruise Control Module operate the coils of the Vacuum Valve and the Vent Valve. Both valves are located in the Cruise Control Servo. These valves move the throttle be means of the Vacuum Motor. The Servo Position Sensor (SPS) coil senses the position and motion of the Vacuum Motor. It feeds this information back to the Module to provide smooth acceleration while the vehicle is in Cruise Control.