

SECTION 6D

ENGINE ELECTRICAL

CAUTION: This vehicle is equipped with Supplemental Inflatable Restraint (SIR). Refer to CAUTIONS in Section 9J under "ON-VEHICLE SERVICE" and the SIR Component and Wiring Location view in Section 9J before performing service on or around SIR components or wiring. Failure to follow CAUTIONS could result in possible air bag deployment, personal injury, or otherwise unneeded SIR system repairs.

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GENERAL DESCRIPTION

The engine electrical system includes the storage battery assembly, ignition (primary and secondary), starter motor assembly (and related wiring) and the

generator assembly (and related wiring). To diagnose and troubleshoot system faults, refer to SECTION 8A for wiring diagrams, component locations and system checks.

When a fault is traced to a particular component, refer to that component's section of the service manual.

SECTION 6D1

BATTERY

CAUTION: This vehicle is equipped with Supplemental Inflatable Restraint (SIR). Refer to CAUTIONS in Section 9J under "ON-VEHICLE SERVICE" and the SIR Component and Wiring Location view in Section 9J before performing service on or around SIR components or wiring. Failure to follow CAUTIONS could result in possible air bag deployment, personal injury, or otherwise unneeded SIR system repairs.

CAUTION: Before removing or installing any electrical unit, or when a tool or equipment could easily come in contact with "live" exposed electrical terminals, disconnect the battery negative cable assembly to help prevent personal injury and/or damage to the vehicle or components. Unless instructed otherwise, the ignition switch must be in the "OFF" or "LOCK" position.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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CAUTION: All battery assemblies generate hydrogen gas which is extremely flammable. If ignited by a spark or flame, the gas may explode violently, causing spraying of acid, fragmentation of the battery assembly and possible severe personal injuries. Wear approved eye protection. Battery assembly fluid is corrosive acid. Flush any contacted area with water immediately and thoroughly.

GENERAL DESCRIPTION

BATTERY ASSEMBLY

Figures 1 and 2

The maintenance-free battery assembly is standard on all vehicles. See "Specifications" in this section for battery assembly usage applications. There are no vent plugs in the cover. The battery assembly is completely sealed except for two small vent holes in the sides. These vent holes allow the small amount of gas produced in the battery assembly to escape.

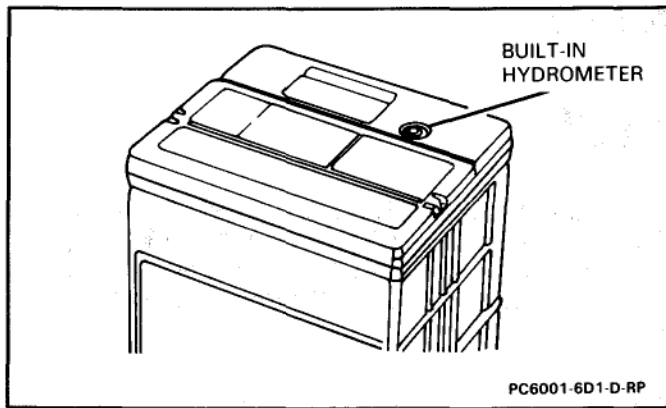


Figure 1 - Maintenance-Free Battery Assembly

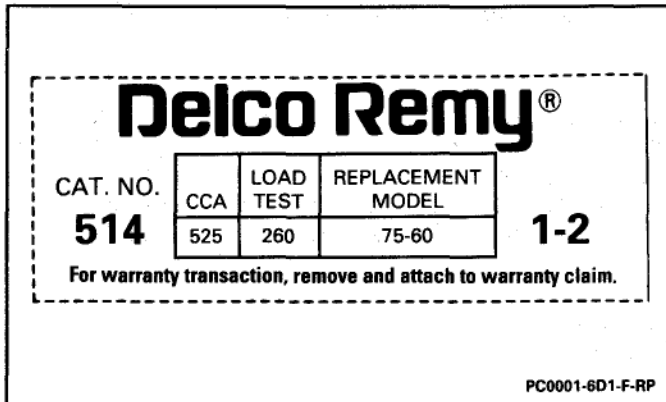


Figure 2 - Battery Assembly Label

The battery assembly has three major functions in the electrical system: first, it provides a source of energy for cranking the engine; second, it acts as a voltage stabilizer for the electrical system; and third, it provides energy for a limited time when the electrical load exceeds the output of the generator assembly.

The battery assembly specifications label contains important information for servicing the battery assembly. This information includes test rating and both original equipment and recommended replacement part numbers. Refer to "Specifications" at the end of this section.

BATTERY ASSEMBLY RATINGS

A battery assembly has two ratings: (1) a reserve capacity rating and (2) a cold cranking amperage rating at -18°C (0°F). When replacing the battery assembly, use these two ratings as a guide in selecting a replacement. For the catalog number of a replacement battery assembly with ratings similar to the original battery assembly, refer to "Specifications" at the end of this section.

Reserve Capacity

The "Reserve Capacity" is an estimate of the maximum length of time it is possible to travel at night with minimum electrical load and no generator assembly output.

Expressed in minutes, it is the approximate time the fully-charged battery assembly can support a 25-amp load without the battery assembly terminal voltage dropping below 10.5 volts at 27°C (80°F).

Cold Cranking Amps

The cold cranking amperage (CCA) test is expressed at a battery temperature of -18°C (0°F). The current rating is the minimum amperage which must be maintained by the battery assembly for 30 seconds, at the specified temperature, while meeting a minimum voltage requirement of 7.2 volts. This rating is a measure of cold cranking capacity.

COMMON CAUSES OF FAILURE

The battery assembly is not designed to last indefinitely; however, with proper care, it will provide many years of service.

If the battery assembly tests "good," but fails to perform satisfactorily in service for no apparent reason, the following are some of the more important factors that may point to the cause of trouble:

1. Vehicle accessories are left on overnight.
2. Slow average driving speeds for short periods.
3. The vehicle's electrical load being more than the generator assembly output, particularly with the addition of aftermarket equipment.
4. Conditions in the charging system such as electrical shorts, slipping serpentine belt, faulty generator assembly, or generator voltage regulator.
5. Battery assembly abuse, including failure to keep the battery assembly terminals clean and tight, or loose battery assembly hold-down. See "Battery Assembly Replacement" in this section for torque specifications.
6. Mechanical conditions in the electrical system, such as shorted or pinched wires.
7. Extended storage of vehicles.
8. Extended cranking periods due to plug fouling.
9. Incorrect interpretation of the hydrometer.
10. Insufficient ampere-hour charge rate for a discharged battery assembly.
11. Continuous current draw on the battery assembly through excessive parasitic drain.

ELECTROLYTE FREEZING

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

As long as the green dot is visible in the hydrometer, the freezing point of the battery will be somewhere below -32°C (-25°F).

The higher the state of charge, the lower the freezing point. A fully charged battery will not freeze until the temperature gets below -65°C (-85°F).

BATTERY TRAY ASSEMBLY AND HOLD-DOWN RETAINER

The battery tray assembly and hold-down retainer should be clean and free from corrosion before installing the battery assembly.

The battery tray assembly should be in a sound condition so that it will hold the battery assembly securely and keep it level. Make certain there are no parts in the battery tray assembly before installing battery assembly.

To prevent the battery assembly from shaking in its battery tray assembly, the hold-down retainers should be tight, but not overtight.

BATTERY ASSEMBLY PROTECTION DURING VEHICLE STORAGE

Today's vehicles have many high technology electronic devices which result in very small but continuous current drains on the battery assemblies, commonly referred to as "parasitic loads." Vehicles that are not used for an extended period of time may develop an extremely discharged and/or permanently damaged battery assembly resulting from parasitic loads.

Any battery assembly discharged by parasitic loading and then allowed to stand in this condition for a period of time may not accept recharge. However, if properly recharged, most battery assemblies will return to a good usable condition.

An extremely discharged battery assembly can freeze at temperatures as high as -7°C (20°F) causing permanent damage. Permanent damage to a discharged battery assembly can also be accelerated by high temperatures.

To prevent this condition, the battery negative cable assembly should be disconnected on vehicles which are not going to be in service within a 30-day period, beginning from the time the vehicle is shipped. If this is not possible, battery assemblies should be recharged periodically (every 20-45 days) until the green dot of the built-in hydrometer is visible.

BUILT-IN HYDROMETER

Figure 3

The maintenance-free battery assembly has a built-in temperature compensated hydrometer in the top of the battery assembly. This hydrometer is used with the following diagnostic procedure.

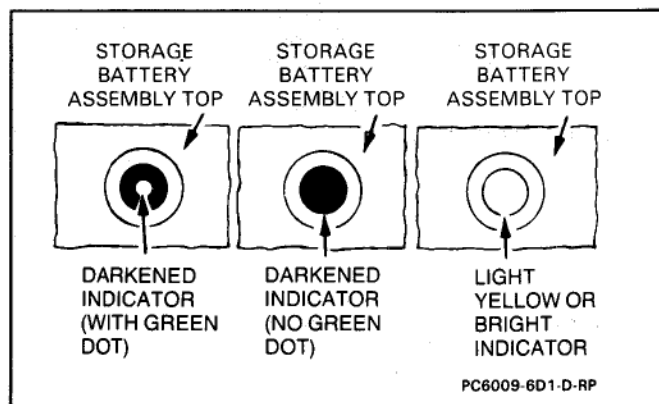


Figure 3 - Built-In Hydrometer

When observing the hydrometer, make sure that the battery assembly has a clean top. A light may be required in some poorly-lit areas. Tap the hydrometer lightly on top to dislodge any air bubbles that might cause a false indication.

Under normal operation, two indications can be observed.

1. GREEN DOT VISIBLE

Any green appearance is interpreted as a "green dot" and the battery assembly is ready for testing.

2. DARK; GREEN DOT NOT VISIBLE

If there is cranking complaint, the battery assembly should be tested as described in the "Diagnosis" in this section. The charging and electrical systems 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, or excessive tipping. When finding a battery assembly in this condition it 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 assembly, the battery assembly should be replaced.

DIAGNOSIS

BATTERY ASSEMBLY TESTING

Figures 3, 4 and 5

The following procedure should be used for testing battery assemblies:

1. VISUAL INSPECTION

Check for obvious damage, such as a cracked or broken case or cover that could permit loss of electrolyte. If obvious damage is noted, replace the battery assembly. Determine the cause of damage and correct as needed. If not, proceed to step 2.

2. HYDROMETER CHECK (Figure 3).

- GREEN DOT VISIBLE – Go to step 3.
- DARK; GREEN DOT NOT VISIBLE.

Charge the battery assembly as outlined under "Charging Procedure" in this section and proceed to step 3.

3. LOAD TEST

Load testing requires using battery assembly side terminal adapters to ensure good connection (Figure 4). Do not load test a frozen battery assembly

- A. Connect a voltmeter and a battery assembly load tester across the battery assembly terminals.
- B. Apply a 300-amp load for 15 seconds to remove surface charge from the battery assembly.

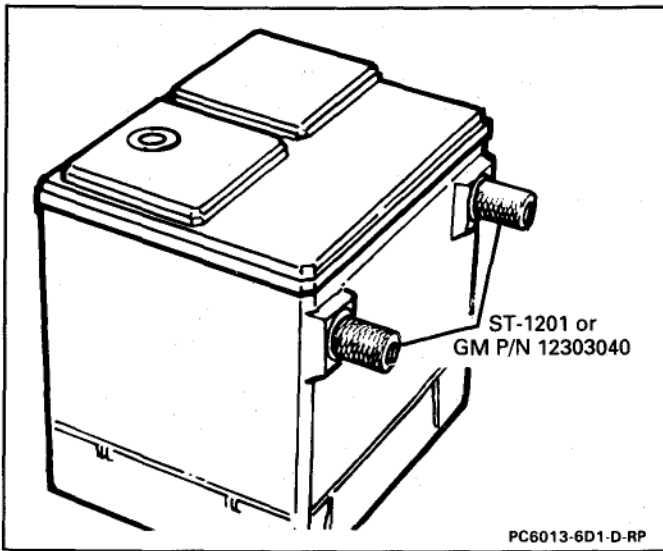


Figure 4 – Battery Assembly Side Terminal Adapters

ESTIMATED TEMPERATURE	MINIMUM VOLTAGE
21°C (70°F)	9.6
10°C (50°F)	9.4
0°C (32°F)	9.1
-10°C (14°F)	8.8
-18°C (0°F)	8.5
BELOW: -18°C (0°F)	8.0

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Figure 5 – Battery Assembly Voltage Drop Temperature

- C. Wait 15 seconds to let the battery assembly recover. Apply load specified on the battery assembly label or in "Specifications" at the end of this section. Read voltage after 15 seconds, then remove load.
- D. If voltage does not drop below the minimum listed in Figure 5, the battery assembly is good and should be returned to service. The battery assembly temperature must be estimated by feel and by the temperature the battery assembly has been exposed to for the past few hours.
- E. If voltage drops below the minimum listed, replace the battery assembly.

BATTERY ASSEMBLY ELECTRICAL DRAIN

Battery assembly electrical drain is a small amount of current required by specific control modules that is needed to retain system memory and system monitoring. Too much electrical drain, however, can cause an extremely discharged and/or permanently damaged battery assembly. To test the battery assembly electrical drain, refer to "Parasitic Load Test" in this section.

Parasitic Load Test

Figures 6 and 7

Tool Required:

J 38758 Parasitic Draw Test Switch

If the battery assembly discharges while the vehicle sits for a few hours or days, the vehicle should be diagnosed for parasitic loads. Simple connection of an ammeter in series with the battery assembly may not find the cause as the condition may not show up when power is restored unless that particular component is repeatedly cycled. Parasitic loads can be diagnosed using either of the procedures below, but use of the special tool as described in the first procedure is recommended.

NOTICE: Parasitic draw test switch should never be turned to "OFF" position with engine running or damage could occur to attached ammeter or vehicle electrical system.

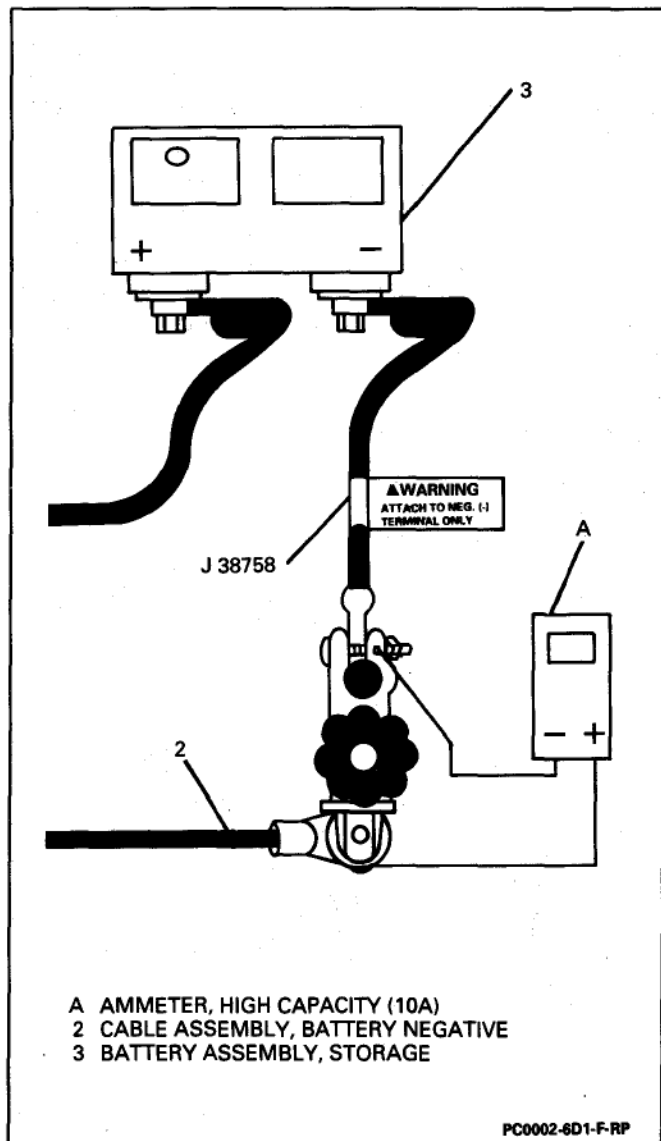


Figure 6 – Use of Parasitic Draw Test Switch

1993 COMPONENT PARASITIC LOADS (mA)

Component	Approximate Parasitic Draw
PASS-Key II®	2
Voltage Regulator in Generator Assembly	1
HVAC Control Head	
Before 2.5 hour timeout	15
After 2.5 hour timeout*	5
ECM	5-10
Radio Control Head	5

*After specified timeout period elapses, component switches from "AWAKE" to "ASLEEP" mode.

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Figure 7 – Component Parasitic Loads

- Turn test switch knob to "OFF" position.
CAUTION: Refer to "Caution" under "Disconnecting the Battery Negative Cable Assembly" in Section 0A.
- Remove battery negative cable assembly.
- Install parasitic draw test switch male (cable) end to negative battery terminal.
- Install battery negative cable assembly to female end of test switch tool.
- Turn test switch tool knob to "ON" position.
- Road test vehicle while activating all accessories (radio, A/C, etc.).
- Turn ignition switch to "LOCK" position and remove ignition key.
- Set ammeter to 10-amp scale and connect to terminals on test switch tool with alligator clips. Use of 10-amp scale may prevent damage to meter.
- Turn test switch tool knob to "OFF" position to allow current to flow through ammeter.
- Check current reading. Allow time for reading to stabilize. Verify that retained accessory power (RAP) is off. If current reading is at or below two amps, turn test tool knob to "ON" position (to maintain continuity in electrical system) and switch to a lower scale for a more accurate reading, or install a more accurate meter, if necessary. Turn test tool knob to "OFF." If current reading is above 25 milliamps, refer to components parasitic load chart (Figure 7) for specific current loads and micro-processor "time-outs" for modules in "awake" and "asleep" states. Total reading below 20 milliamps is normal, and a reading below 25 milliamps is acceptable. A zero reading indicates a problem with meter, scale being used, or connection.
- If current draw is above specifications listed in component parasitic load chart, remove system maxifuses and circuit breakers one at a time until

current draw returns to a value less than or equal to specifications listed. This should be done while monitoring ammeter so that a disruption of drain will be evident. Perform steps 9 and 10 each time a fuse is removed. Refer to SECTION 8A for specific circuit schematics. Total readings in the hundreds of milliamps may suggest grounded wires, sticking relays, or small lamps remaining lit.

Important

- Always turn test switch tool knob to "ON" position before removing each fuse to maintain continuity in electrical system and to avoid damaging ammeter due to accidental overloading (i.e., opening door). Do not turn switch to "OFF" while engine is running.
- When cause of excessive current draw has been located and repaired, repeat steps 9 and 10 to verify the repair. Then turn test tool to "OFF," remove tool, and reconnect battery negative cable assembly to battery assembly negative terminal.

Tighten

- Negative cable assembly to 15 N•m (11 lb. ft.).

Alternate Parasitic Load Test

Figures 4, 7 and 8

The following alternate procedure may be used when testing for parasitic load if J 38758 is not available.

CAUTION: Refer to "Caution" under "Disconnecting the Battery Negative Cable Assembly" in SECTION 0A.

- Disconnect battery negative cable assembly.
- Install a battery side terminal adapter, AC Delco P/N ST-1201 or GM P/N 12303040 or equivalent, in negative terminal of battery (See Figure 4).

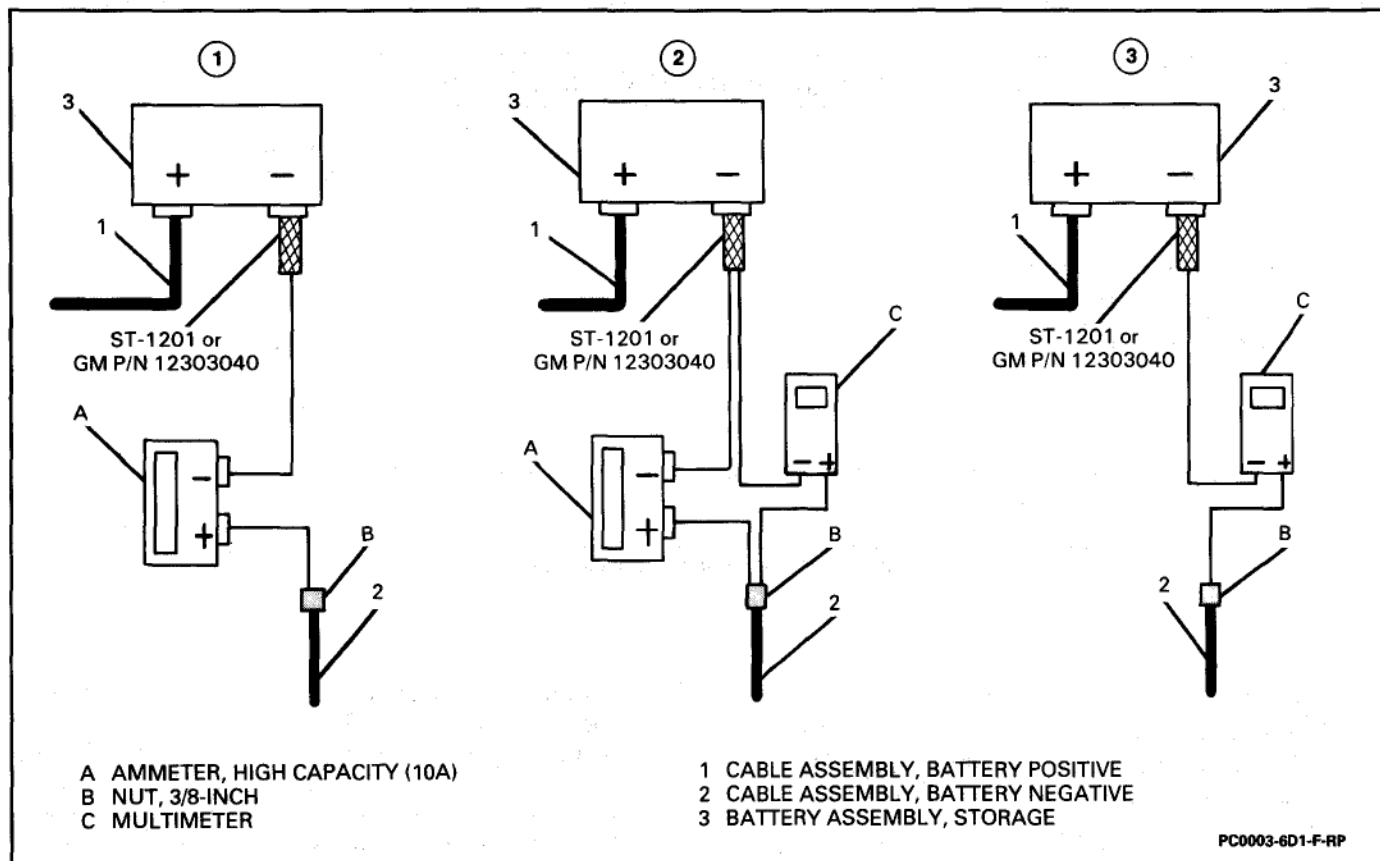


Figure 8 – Alternate Parasitic Load Diagnosis Procedure

3. Install other battery side terminal adapter or a 3/8-inch nut with standard threads (16 UNC) on battery negative cable assembly to assure a good electrical contact with metal face on cable for testing (add a washer behind nut if nut does not contact firmly). Yellow or black finish nuts are generally non-conductive and should not be used.
4. With all lights, accessories, retained accessory power (RAP), and ignition switch off, connect a high capacity ammeter (at least 10 amps) from battery negative cable assembly to side terminal adapter. This high capacity ammeter is connected to verify whether or not a high current draw is occurring at a constant rate. It is this type of high current draw which will blow the fuse in lower capacity ammeters.

NOTICE: If a high capacity ammeter is not available, install a section of heavy wire (preferably battery cable section) between existing battery negative cable assembly and side terminal adapter. Allow time for initial draw to occur or check for reduced current with an inductive ammeter (current clamp) and proceed to step 5.

5. With high capacity ammeter or battery cable section still connected, connect digital multimeter, set on 2000 mA dc range, in parallel with high reading ammeter.
6. Disconnect high capacity ammeter and take reading with digital multimeter.

If current draw is above specifications listed in component parasitic load chart, remove system fuses and mini-breakers one at a time until current draw returns to a value less than or equal to specifications listed. This should be done while monitoring ammeter so that a disruption of drain will be evident. Refer to Figure 7 for approximate parasitic loads for various vehicle components. Set ammeter on maximum scale when pulling fuses to avoid damage. Refer to SECTION 8A for specific circuit schematics.

7. When cause of excessive draw has been located and repaired, repeat step 6 to verify the repair. Reconnect battery negative cable assembly to battery assembly negative terminal.



Tighten

- Negative cable assembly to 15 N•m (11 lb. ft.).

ON-VEHICLE SERVICE

BATTERY ASSEMBLY CHARGING

NOTICE: Always disconnect the negative cable assembly when charging a battery assembly or electronic components may be damaged.

When it is necessary to charge the battery assembly, follow these basic rules:

1. Do not charge battery assembly if hydrometer is clear or light yellow. Replace battery assembly.

2. If the battery assembly feels hot (52°C (125°F) or higher), or if electrolyte violently gasses or spews through the vent holes, discontinue charging or reduce charging rate.
3. Do not charge a battery assembly if it seems to be frozen.

Charging Procedure

Tool Required:

A/C Delco P/N ST-1201 or GM P/N 12303040

Battery Side Terminal Adapters (Pair)

1. Battery assemblies with green hydrometer dot showing do not require charging unless they have just been discharged (such as in cranking vehicle).
2. When charging battery assembly with side terminals, install adapter kit (AC Delco P/N ST-1201 or GM P/N 12303040 or equivalent). Refer to Figure 4.

The adapter should be snugged up against the battery assembly terminals to keep resistance between the adapter and the battery assembly terminal to a minimum. Recommended battery assembly side terminal adapter torque is $15\text{ N}\cdot\text{m}$ (11 lb. ft.).

3. Make sure all battery charger connections are clean and tight.
4. For best results, battery assemblies should be charged while electrolyte and plates are at room temperature. A battery assembly that is extremely cold may not accept current for several hours after starting battery charger.
5. Charge battery assembly until green dot of built-in hydrometer appears. Refer to "Charging Time Required" in this section. Battery assembly should be checked every half-hour while charging. Tap the hydrometer lightly on top to dislodge any air bubbles that might cause a false indication.
6. After charging, battery assembly should be tested. Refer to "Diagnosis" in this section.

Charging Time Required

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

- **Size of Battery Assembly** – A completely discharged large heavy-duty battery assembly requires more than twice the recharging as a completely discharged small passenger vehicle battery assembly.
- **Temperature** – A longer time will be needed to charge any battery assembly at -18°C (0°F) than at 27°C (80°F). When a fast battery charger is connected to a cold battery assembly the current accepted by the battery assembly will be very low at first, then in time, the battery assembly will accept a higher rate as the battery assembly warms.
- **Battery Charger Capacity** – A battery charger which can supply only five amps will require a much longer period of charging than a battery charger that can supply 30 amps or more.

- **State-of-Charge** – A completely discharged battery assembly requires more than twice as much charge as a half-charged battery assembly. Because the electrolyte is nearly pure water and a poor conductor in a completely discharged battery assembly, the current accepted by the battery assembly is very low at first. Later, as the charging current causes the electrolyte acid content to increase, the charging current will also increase.

CHARGING A VERY LOW OR COMPLETELY DISCHARGED BATTERY ASSEMBLY

The following procedure should be used to recharge a very low or completely discharged battery assembly.

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

1. Measure voltage at battery assembly terminals with an accurate voltmeter. If below 11 volts, the charge current will be very low and it could take some time before it accepts a current in excess of a few milliamps. Such low current may be detectable on ammeter available in the field.
2. Set battery charger on high setting.
3. Some chargers feature polarity protection circuitry which prevents charging unless the battery charger leads are connected to the battery terminals correctly. A completely discharged battery assembly may not have enough voltage to activate this circuitry even though battery charger leads are connected properly, making it appear that the battery assembly will not accept charging current. Therefore, follow the specific charger manufacturer's instructions telling how to bypass or override the circuitry so that the charger will turn on and charge a low-voltage battery assembly.
4. Battery chargers vary in the amount of voltage and current they provide. The time required for the battery assembly to accept measurable charge current at various voltages may be as follows:

CHARGING VOLTAGE	HOURS
16.0 or more	Up to 4 Hours
14.0 – 15.9	Up to 8 Hours
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 assembly should be replaced.

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

5. It is important to remember that a completely discharged battery assembly 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 (RC) rating of the battery assembly as the number of ampere hours of charge will usually bring the green dot into view. For reserve capacity refer to "Specifications" in this section. If battery assembly is rated at 75 RC minutes, it would usually be completely recharged as follows:

10 ampere charge $\times$ 7 1/2 hours = 75 AH

or

25 ampere charge $\times$ 3 hours = 75 AH, etc.

- It is recommended that any battery assembly recharged by this procedure be LOAD TESTED to establish serviceability. Refer to "Battery Assembly Testing" in this section.

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

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

Both auxiliary battery assembly and discharged battery assembly should be treated carefully when using jumper cables.

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 assembly explosion, battery assembly acid, or electrical burns; and/or (2) damage to electronic components of either vehicle.

Never expose battery assembly to open flame or electric spark – battery assemblies generate a gas which is flammable and explosive. Remove rings, watches, and other jewelry. Wear approved eye protection.

Do not allow battery assembly fluid to contact eyes, skin, fabrics, or painted surfaces – battery assembly 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 battery assembly positive terminal (or metal in contact with it) and any other metal on the vehicle, because a short circuit could occur.

- Set parking brake lever assembly and place automatic transmission assembly in "PARK." Turn off the ignition, lamps and all other electrical loads.
- Check the built-in hydrometer. If it is clear or light yellow, replace the battery assembly.

NOTICE: Do not jump start a vehicle with charging equipment unless the equipment is specifically designed for jump starting. Using improper equipment can cause serious damage to the electrical system or electronic parts.

- Attach the end of one jumper cable to the auxiliary battery assembly positive terminal and the other end of the same cable to the positive terminal of the junction block assembly.

Do not permit vehicles to touch each other as this could cause a ground connection and counteract the benefits of this procedure.

CAUTION: To prevent sparking and possibly explosion of battery gases, do not connect jumper cable directly to the battery negative terminal of the dead battery assembly.

- Attach one end of the remaining negative cable to the auxiliary battery assembly negative terminal, and the other end to a solid engine ground (such as the compressor assembly bracket or power steering pump bracket assembly) at least 46 cm (18 inches) from the battery assembly of the vehicle being started.
- Start the engine of the vehicle that is providing the jump start and turn off electrical accessories. Then start the engine of the vehicle with the discharged battery assembly.
- Reverse these directions exactly when removing the jumper cables. The negative cable must first be disconnected from the engine that was jump started.

BATTERY TRAY ASSEMBLY REPLACEMENT

The battery tray is part of the coolant recovery reservoir assembly. Refer to Section 6B for replacement.

BATTERY ASSEMBLY REPLACEMENT

Figure 9



Remove or Disconnect

CAUTION: Refer to "Caution" under "Disconnecting the Battery Negative Cable Assembly" in Section OA.

- Negative cable assembly (2) from battery assembly negative terminal.
- Positive cable assembly (1) from battery assembly positive terminal.
- Battery hold-down retainer bolt/screw (5) and battery hold-down retainer (9).
- Battery assembly (3).



Install or Connect

NOTICE: See "Notice" on page 6D1-1 of this section.

- Battery assembly (3).
- Battery hold-down retainer (9) and battery hold-down retainer bolt/screw (5).



Tighten

- Battery hold-down retainer bolt/screw (5) to 18 N•m (13 lb. ft.).
- Positive cable assembly (1) to battery assembly positive terminal.



Tighten

- Positive cable assembly (1) to 15 N•m (11 lb. ft.).

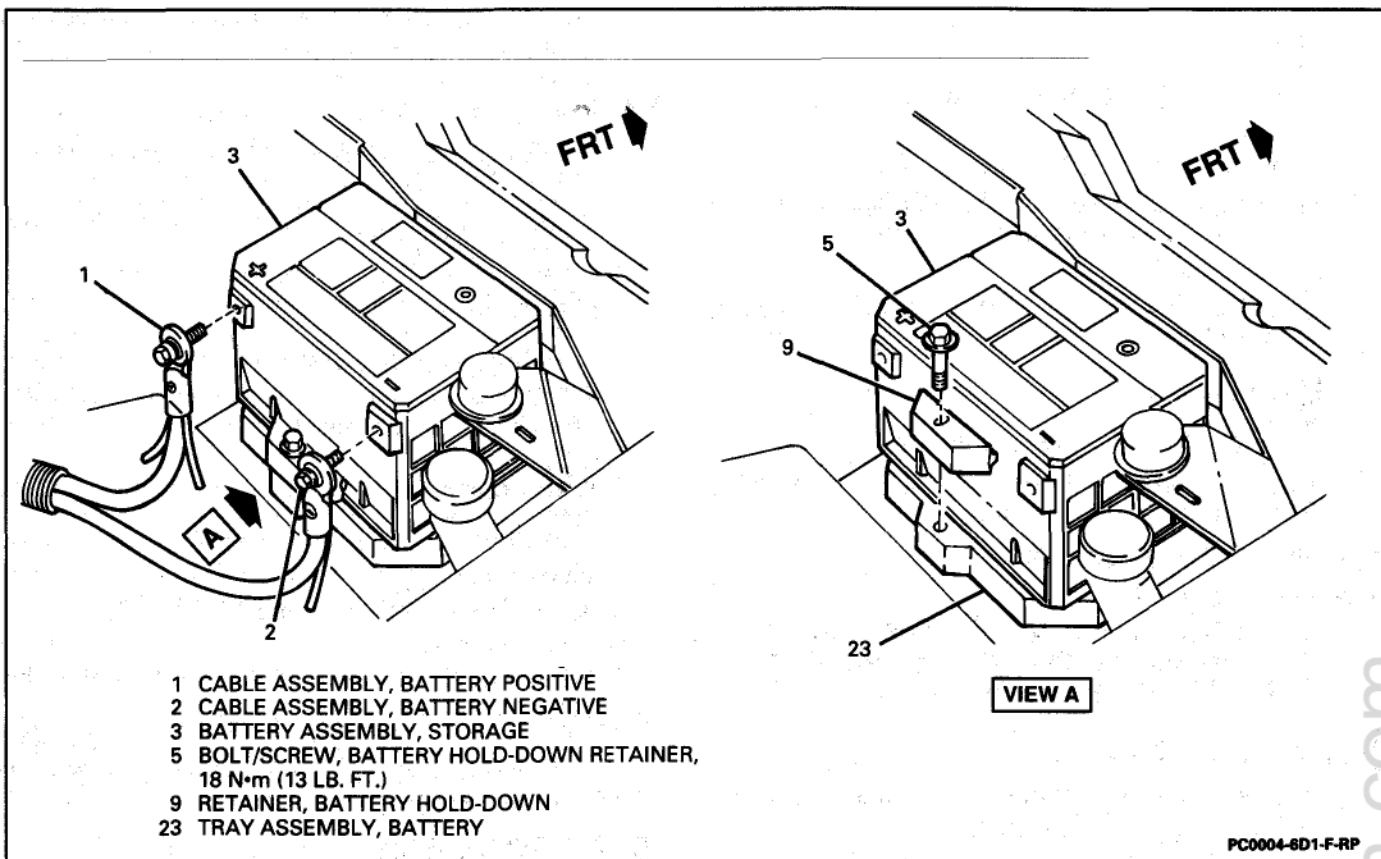


Figure 9 - Battery Assembly

4. Negative cable assembly (2) to battery assembly negative terminal.

**Tighten**

- Negative cable assembly (2) to 15 N·m (11 lb. ft.).

BATTERY CABLE ASSEMBLY REPLACEMENT AND ROUTING

Whenever battery cable assemblies are replaced, always be certain to use a replacement battery cable assembly that is the same type and length. Some positive cable assemblies have additional feed wires attached to them and some negative cable assemblies have additional ground straps attached.

Always be certain when replacing a battery cable assembly to route it the same as the one being replaced.

Negative Cable Assembly

Figures 10 and 11

**Remove or Disconnect**

CAUTION: Refer to "Caution" under "Disconnecting the Battery Negative Cable Assembly" in Section 0A.

1. Battery assembly. Refer to "Battery Assembly Replacement" in this section.
2. Nut (8) and negative cable assembly (2) from stud (7) on wheelhouse assembly.

3. Raise and suitably support vehicle. Refer to SECTION 0A.

4. Using a standard screwdriver, pop open cable assembly clip (16) and remove negative cable assembly (2).

5. Negative cable assembly (2) from engine block.

- On 3.4L L32 engines, negative cable assembly (2) is connected to engine block by a stud threaded into engine block just behind crankshaft pulley assembly. Remove nut (10) and then remove negative cable assembly (2).
- On 5.7L LT1 engines, negative cable assembly (2) is connected to the engine block by either a stud (13) or nut (10) just behind the air conditioning compressor assembly. Remove stud (13) or nut (10) and negative cable assembly (2).

**Install or Connect**

NOTICE: See "Notice" on page 6D1-1 of this section

1. Negative cable assembly (2) to engine block.
 - On 3.4L L32 engines, connect negative cable assembly (2) and nut (10) to engine block stud just behind crankshaft pulley.
 - On 5.7L LT1 engines, connect negative cable assembly (2) and either stud (13) or nut (10) to engine block just behind air conditioning compressor assembly.

 Tighten

- Nut (10) to 22 N•m (16 lb. ft.).
or
 - Stud (13) to 33 N•m (24 lb. ft.).
2. Place negative cable assembly (2) back into cable assembly clip (16) and snap clip closed.
 3. Lower vehicle.
 4. Negative cable assembly (2) and nut (8) to stud (7) on wheelhouse assembly.

 Tighten

- Nut (8) to 5.5 N•m (49 lb. in.).
5. Battery assembly. Refer to "Battery Assembly Replacement" in this section.

Positive Cable Assembly**Figures 10 and 11**

CAUTION: Refer to "Caution" under "Disconnecting the Battery Negative Cable Assembly" in Section 0A.

 Remove or Disconnect

1. Battery assembly. Refer to "Battery Assembly Replacement" in this section.
2. Positive cable assembly (1) from junction block.
 - A. Open junction block cover (4).
 - B. Remove nut (6) from stud (14).
 - C. Remove positive cable assembly (1) from stud (14).
3. Positive cable assembly (1) from generator assembly (21).
 - A. Move boot covering connection and slide out of way.
 - B. Remove positive cable assembly (1).
 - On 3.4L L32 engines, positive cable assembly (1) is connected to generator assembly (21) with nut (18). Remove nut (18) and positive cable assembly (1).
 - On 5.7L LT1 engines, positive cable assembly (1) is connected to generator assembly (21) with bolt/screw (20). Remove bolt/screw (20) and positive cable assembly (1).
4. Raise and suitably support vehicle. Refer to SECTION 0A.
5. Using a standard screwdriver, pop open cable assembly clip (16) and remove positive cable assembly (1).
6. Bolt/screw (11) securing positive cable assembly (1) and clip (17) to engine mount bracket.
7. Nut (12) and positive cable assembly (1) from starter solenoid switch (19).

NOTICE: Before installing positive cable assembly to starter solenoid switch, be sure solenoid terminal is secure in cap by tightening terminal nut next to cap. If terminal is not tight in solenoid cap, the cap

may be damaged during installation of positive cable assembly and cause starter to fail later.

 Install or Connect

NOTICE: See "Notice" on page 6D1-1 of this section.

1. Positive cable assembly (1) and nut (12) to starter solenoid switch (19).

 Tighten

- Nut (12) to 9.5 N•m (84 lb. in.).
2. Bolt/screw (11) and clip (17) securing positive cable assembly to engine mount bracket.

 Tighten

- Bolt/screw (11) to 10 N•m (89 lb. in.).
3. Place positive cable assembly (1) back into cable assembly clip (16) and snap clip (16) closed.
 4. Lower vehicle.
 5. Positive cable assembly (1) to generator assembly (21).
 - On 3.4L L32 engines, positive cable assembly (1) is connected to the generator assembly (21) with nut (18).

 Tighten

- Nut (18) to 10 N•m (89 lb. in.).
- On 5.7L LT1 engines, positive cable assembly (1) is connected to generator assembly (21) with bolt/screw (20).

 Tighten

- Bolt/screw (20) to 15 N•m (11 lb. ft.).
6. Carefully slide boot over positive cable assembly (1) and generator assembly (21) connection.
 7. Positive cable assembly (1) to junction block.
 - A. Place positive cable assembly (1) and nut (6) on stud (14).

 Tighten

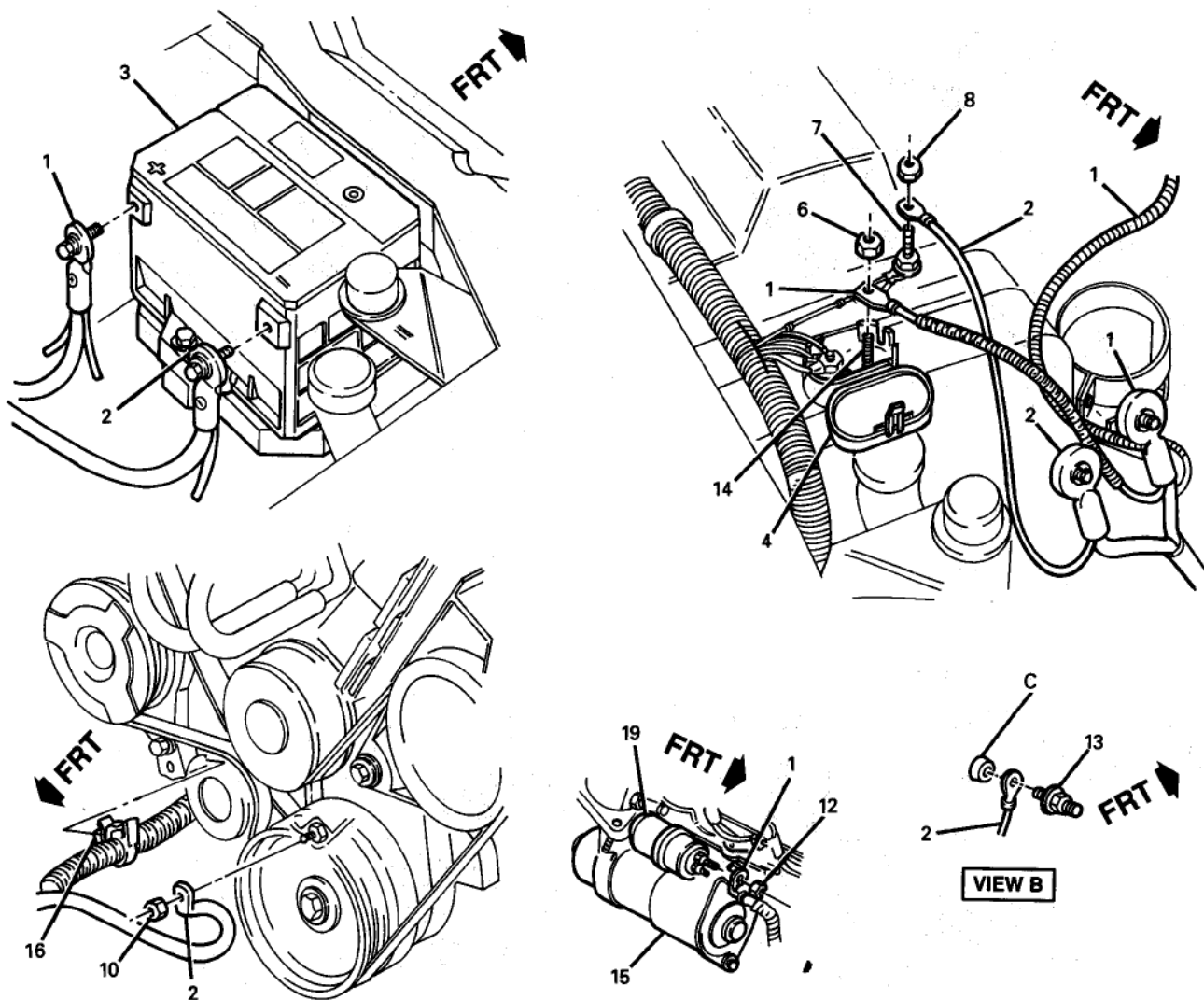
- Nut (6) to 2.0 N•m (18 lb. in.).
 - B. Close junction block cover (4).
8. Battery assembly. Refer to "Battery Assembly Replacement" in this section.
 - Route positive cable assembly between heater hoses as shown in Figure 11.

GROUND STRAPS

Additional ground straps are used to connect the body and frame to the engine and transmission. Always connect all ground straps to ensure a good ground path to the battery assembly from all electrical components

CHARGING EQUIPMENT

A battery charger that is considered sufficient is usually capable of a 16-volt output. When choosing



- A 3.4L L32 ENGINE
 B 5.7L LT1 ENGINE
 C BLOCK, ENGINE
 1 CABLE ASSEMBLY, BATTERY POSITIVE
 2 CABLE ASSEMBLY, BATTERY NEGATIVE
 3 BATTERY ASSEMBLY, STORAGE
 4 COVER, JUNCTION BLOCK
 6 NUT, BATTERY POSITIVE CABLE-TO-JUNCTION BLOCK, 2.0 N·m (18 LB. IN.)
 7 STUD, GROUND
 8 NUT, BATTERY NEGATIVE CABLE GROUND, 5.5 N·m (49 LB. IN.)
 10 NUT, BATTERY NEGATIVE CABLE-TO-ENGINE BLOCK GROUND, 22 N·m (16 LB. FT.)
 11 BOLT/SCREW, BATTERY POSITIVE AND NEGATIVE CABLE ASSEMBLY CLIP, 10 N·m (89 LB. IN.)
 12 NUT, BATTERY POSITIVE CABLE, 9.5 N·m (84 LB. IN.)
 13 STUD, BATTERY NEGATIVE CABLE-TO-ENGINE BLOCK GROUND, 33 N·m (24 LB. FT.)
 14 STUD, JUNCTION BLOCK POSITIVE TERMINAL
 15 MOTOR ASSEMBLY, STARTER
 16 CLIP, CABLE ASSEMBLY
 17 CLIP, CABLE ASSEMBLY
 19 SWITCH, STARTER SOLENOID

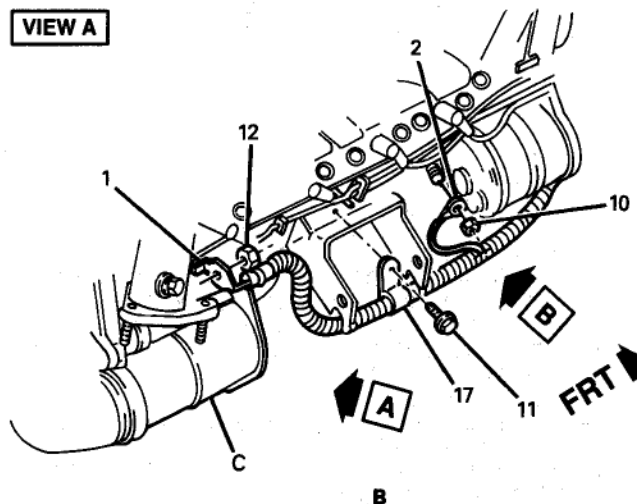
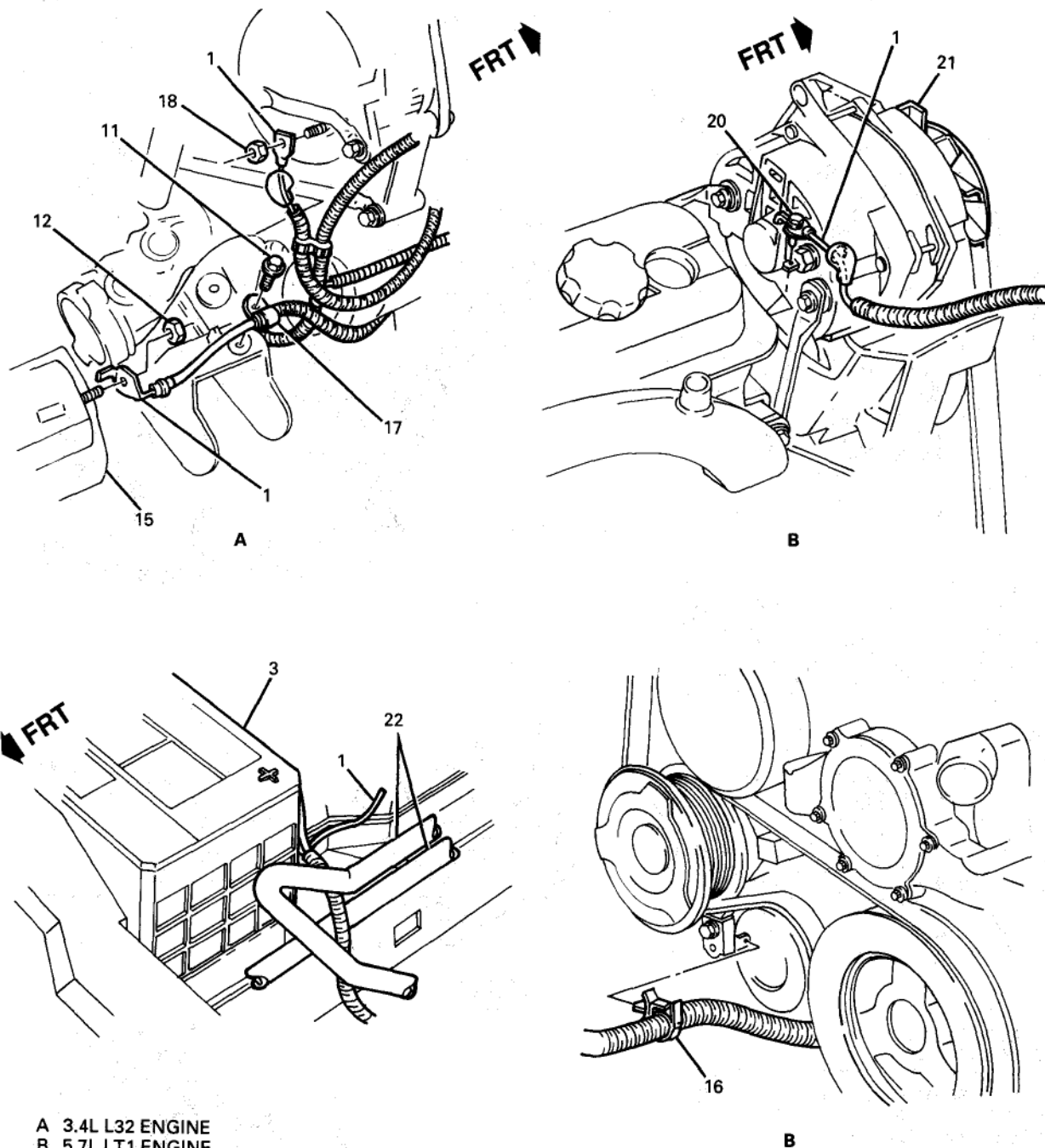


Figure 10 – Battery Cable Assemblies Routing (1 of 2)



- A 3.4L L32 ENGINE
 B 5.7L LT1 ENGINE
 1 CABLE ASSEMBLY, BATTERY POSITIVE
 3 BATTERY ASSEMBLY, STORAGE
 11 BOLT/SCREW, BATTERY POSITIVE AND NEGATIVE CABLE ASSEMBLY CLIP, 10 N·m (89 LB. IN.)
 12 NUT, BATTERY POSITIVE CABLE, 9.5 N·m (84 LB. IN.)
 15 MOTOR ASSEMBLY, STARTER
 16 CLIP, CABLE ASSEMBLY
 17 CLIP, CABLE ASSEMBLY
 18 NUT, ENGINE WIRING HARNESS GENERATOR LEAD, 10 N·m (89 LB. IN.)
 20 BOLT/SCREW, ENGINE WIRING HARNESS GENERATOR LEAD, 15 N·m (11 LB. FT.)
 21 GENERATOR ASSEMBLY
 22 HOSE ASSEMBLY, HEATER INLET/OUTLET

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Figure 11 – Battery Cable Assemblies Routing (2 of 2)

a charger, the following items should be considered essential:

1. A 16-volt minimum output.
2. To prevent overcharging, the unit should have a timer (1 to 2 hours) or a voltage regulator that would regulate a maximum of 18 volts, or have an automatic shut-off feature at full charge.
3. Ammeter or charging rate meter.

4. An automatic polarity protector.

Some equipment that is available includes the AC Delco MP2101-07, Associated No. 6001, the Sun 720, or equivalent. Very few chargers have sensitive low-voltage meters, therefore, separate voltmeters may be necessary.

A suitable load tester such as the Sun VAT-40 (or equivalent) is available and is a very useful tool to properly diagnose battery assembly problems.

SPECIFICATIONS

BATTERY ASSEMBLY USAGE

STORAGE BATTERY ASSEMBLY USAGE CHART

CATALOG NUMBER	TEST LOAD AMPS	COLD CRANKING AMPS*	RESERVE CAPACITY MINUTES**	REPLACEMENT NUMBER
514 (Std. LT1, L32)	260	525	90	75-60

*Cold Cranking = Amperage available for 30 seconds of engine cranking at -18°C (0°F).

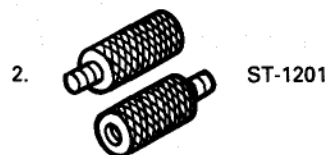
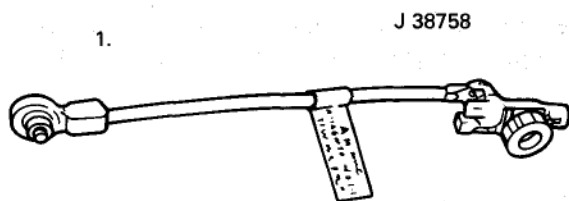
**Reserve Capacity = The approximate time in minutes a storage battery assembly can support a 25 amp load without the terminal voltage dropping below 10.5 volts at 27°C (80°F) in the event of a charging system failure.

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FASTENER TIGHTENING SPECIFICATIONS

Battery Hold-Down Retainer Bolt/Screw	18 N•m (13 lb. ft.)
Battery Negative Cable Assembly-to-Battery Assembly	15 N•m (11 lb. ft.)
Battery Negative Cable Ground Body-to-Nut	5.5 N•m (49 lb. in.)
Battery Negative Cable-to-Engine Block Nut	22 N•m (16 lb. ft.)
Battery Negative Cable-to-Engine Block Stud	33 N•m (24 lb. ft.)
Battery Positive and Negative Cable Retainer Bolt/Screw	10 N•m (89 lb. in.)
Battery Positive Cable Assembly-to-Battery Assembly	15 N•m (11 lb. ft.)
Battery Positive Cable-to-Generator Bolt/Screw	15 N•m (11 lb. ft.)
Battery Positive Cable-to-Generator Nut	10 N•m (89 lb. in.)
Battery Positive Cable-to-Junction Block Nut	2.0 N•m (18 lb. in.)
Battery Positive Cable-to-Starter Solenoid Switch Nut	9.5 N•m (84 lb. in.)

SPECIAL TOOLS



1. PARASITIC DRAW TEST SWITCH
2. BATTERY SIDE TERMINAL ADAPTERS (PAIR)

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SECTION 6D2

CRANKING SYSTEM

CAUTION: This vehicle is equipped with Supplemental Inflatable Restraint (SIR). Refer to CAUTIONS in Section 9J under "ON-VEHICLE SERVICE" and the SIR Component and Wiring Location view in Section 9J before performing service on or around SIR components or wiring. Failure to follow CAUTIONS could result in possible air bag deployment, personal injury, or otherwise unneeded SIR system repairs.

CAUTION: Before removing or installing any electrical unit, or when a tool or equipment could easily come in contact with "live" exposed electrical terminals, disconnect the battery negative cable assembly to help prevent personal injury and/or damage to the vehicle or components. Unless instructed otherwise, the ignition switch must be in the "OFF" or "LOCK" position.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

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GENERAL DESCRIPTION

CRANKING CIRCUIT

The cranking circuit consists of the battery assembly, starter motor assembly, ignition switch, control circuits, starter enable relay and related electrical wiring; these components are connected electrically. Refer to SECTION 8A for a complete electromechanical schematic.

STARTER MOTOR ASSEMBLY

Figure 1

When the ignition switch is moved to the start position, battery voltage is applied to the PASS-Key II® decoder module and resistance is read at this time. If proper resistance is recognized and vehicle is in "PARK" or "NEUTRAL," then the PASS-Key II® decoder module will energize the starter enable relay. The starter enable

relay will send battery voltage to the starter solenoid switch. The starter solenoid switch will move the starter shift lever, causing the starter drive pinion to engage the flywheel ring gear. After engagement, the starter solenoid switch will close the main contacts, which results in cranking of the engine. When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened, at which time the solenoid switch plunger spring causes the pinion to disengage. To prevent excessive overrun, the ignition switch should be opened immediately when the engine starts.

DIAGNOSIS

Before removing any unit in a cranking circuit for repair, perform the diagnostic procedures recommended in Figures 2, 3 and 4, and in SECTION 8A. Then check the following items:

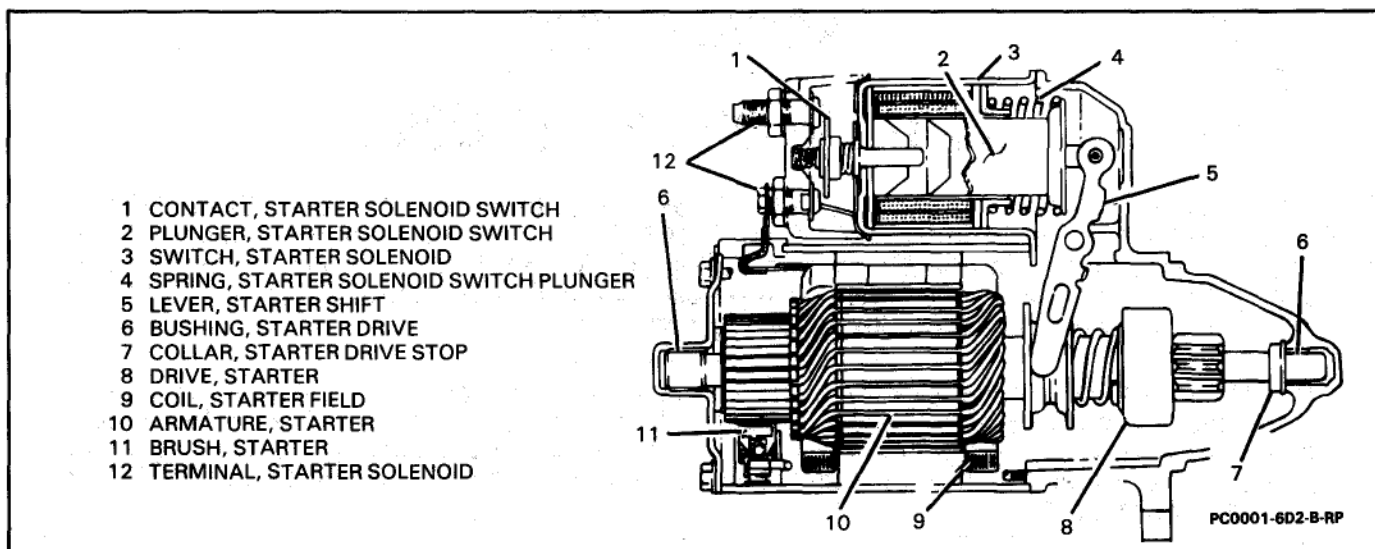


Figure 1 - Starter Motor Assembly (Typical)

Battery Assembly: Determine condition of battery assembly. Follow testing procedure outlined in SECTION 6D1.

Wiring: Inspect wiring for damage. Inspect all connections to starter motor assembly, solenoid switch, ignition switch, and battery assembly, including all ground connections. Clean and tighten all connections as required.

Ignition Switch and Control Circuits: Inspect all switches and relays to determine condition.

Cranking or Slow Cranking: If engine assembly does not crank, or cranks slowly, follow diagnostic procedure in Figures 2, 3 and 4, and in SECTION 8A. If faulty starter motor assembly is diagnosed, remove starter motor assembly and follow test procedures.

Starter Motor Assembly Noise: Correct starter motor assembly noise using the following procedure:

1. Refer to Figure 4 to determine problem.
2. Shims are not installed during vehicle assembly. However if complaint is similar to problem 1 or 2 in Figure 4, correct "shimming" as follows:
 - For starter motor assembly noise during cranking, add one 0.38 mm (0.015 inch) single shim (13 or 18) to outer bolt/screw only. Refer to Figure 5.
 - For high-pitched whine after engine assembly fires, add 0.38 mm (0.015 inch) double shims (14 or 19) until noise disappears. Number of shims should not exceed 1.14 mm (0.045 inch).

Starter Motor Assembly: General diagnosis is part of starter motor assembly testing procedure. If battery assembly, wiring and switches are in satisfactory condition, engine assembly is functioning properly, and problem has been traced to starter motor assembly, remove starter motor assembly (refer to "Starter Motor Assembly Replacement" in this section) and proceed to "Unit Repair" in this section.

NOTICE: Never operate the starter motor assembly 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 starter motor assembly.

ON-VEHICLE SERVICE

LUBRICATION

Starter motor assemblies do not require lubrication except during overhaul. When the starter motor assembly is taken apart for any reason, lubricate only as described under "PG-250 Starter Motor Assembly" or "SD210 Starter Motor Assembly" in this section.

STARTER MOTOR ASSEMBLY REPLACEMENT

Figures 5 and 6

 Remove or Disconnect

 Important

- This vehicle was designed for starter mounting without shims. However if single shims (13 or 18) or double shims (14 or 19) have been added to correct a noise or engagement condition, they should be reinstalled in their original location to ensure proper pinion-to-flywheel assembly engagement. Refer to Figure 6.

CAUTION: See "Caution" on page 6D2-1 of this section.

1. Battery negative cable assembly.
2. Raise and suitably support vehicle. Refer to SECTION 0A.
3. Exhaust crossover pipe at the manifolds. Refer to SECTION 6F.
4. Two starter mounting bolts/screws (16 and 17 or 21) and lower starter motor assembly (15 or 20).

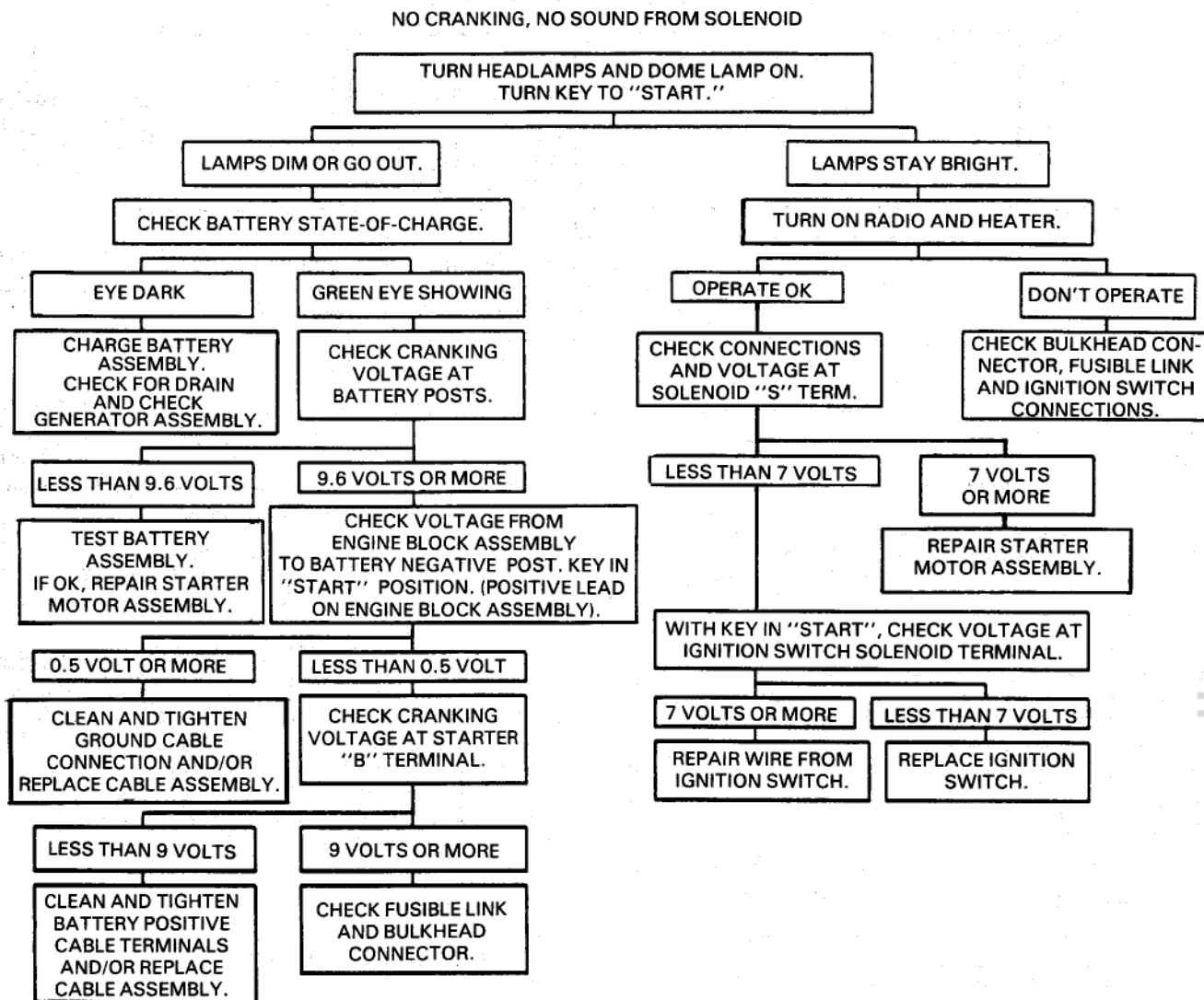
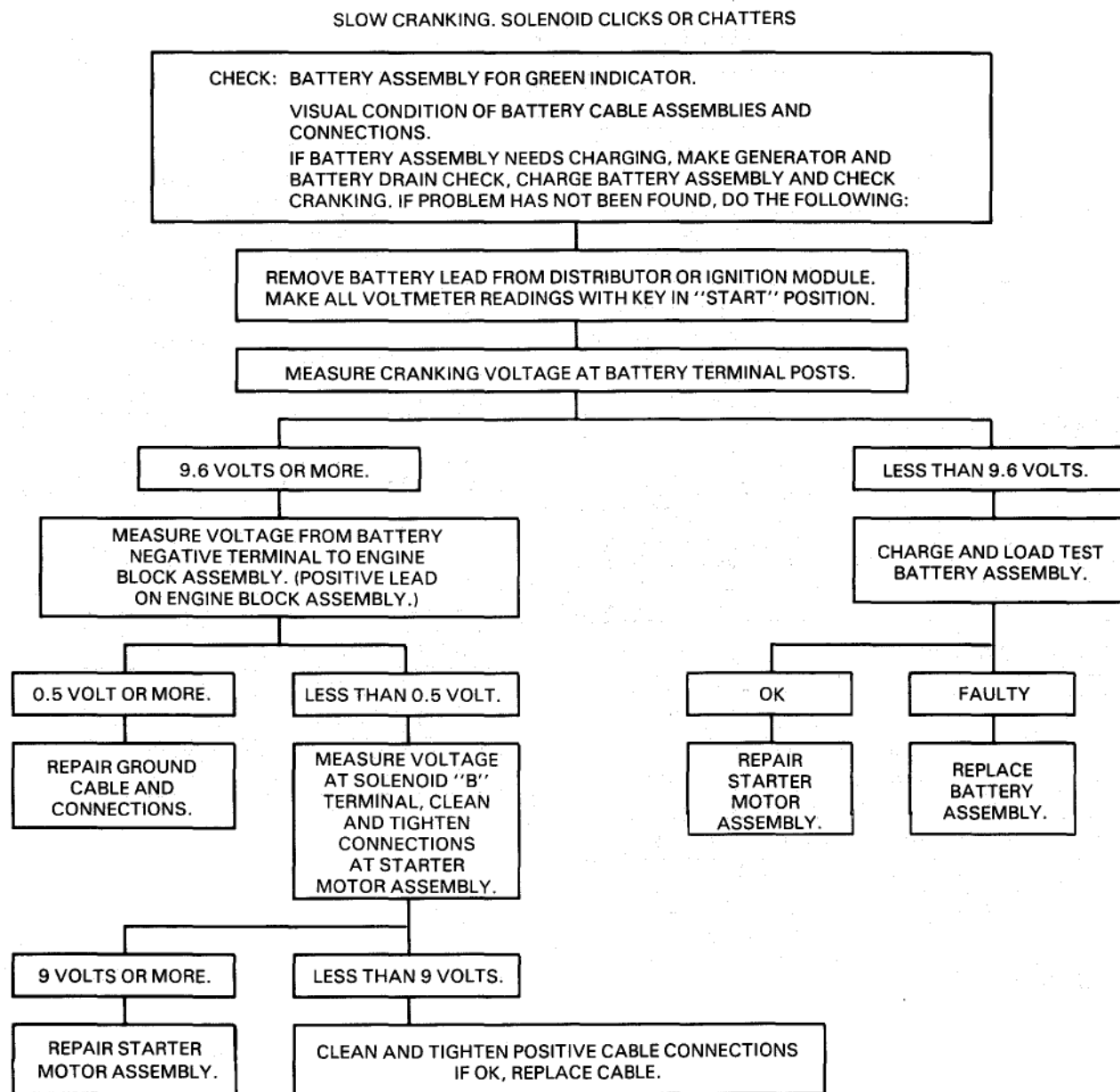


Figure 2 – Electrical System General Diagnosis (1 of 2)



THIS PROCEDURE IS DESIGNED FOR USE ON
ENGINE AND BATTERY ASSEMBLIES
AT ROOM OR NORMAL OPERATING TEMPERATURES.
IT ALSO ASSUMES THERE ARE NO ENGINE ASSEMBLY
DEFECTS WHICH WOULD CAUSE CRANKING PROBLEMS.
TO USE IT UNDER OTHER CONDITIONS MIGHT RESULT
IN AN IMPROPER DIAGNOSIS.

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

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Figure 4 – Starter Motor Assembly Noise Diagnosis

- Electrical leads from starter motor assembly (15 or 20).

- Note position of wires before disconnecting.

- Starter motor assembly (15 or 20).

Install or Connect

NOTICE: See "Notice" on page 6D2-1 of this section.

NOTICE: Before attaching electrical leads, tighten inner nuts on the solenoid terminals. If the nuts are not tight, solenoid cap may be damaged during installation of leads. Tighten inner nut of "BAT" terminal to 9 N•m (80 lb. in.) on both PG-250 and SD210 starter motor assemblies.

- Electrical leads to starter motor assembly (15 or 20).

Tighten

- Starter solenoid switch "BAT" terminal outer nut to 9 N•m (80 lb. in.).
- Starter solenoid switch "S" terminal nut to 2.5 N•m (22 lb. in.).

- Starter motor assembly (15 or 20) to engine assembly.

- Bolts/screws (16 and 17 or 21).

Tighten

- Bolts/screws (16 and 17 or 21) to 47 N•m (35 lb. ft.).

Measure

- Pinion-to-flywheel clearance (see Figure 6). Add shims (13 and 14 or 18 and 19) if necessary.

- Exhaust crossover pipe to the manifolds. Refer to SECTION 6F.

- Lower vehicle.

- Battery negative cable assembly.

Tighten

- Battery negative cable assembly to 15 N•m (11 lb. ft.).

UNIT REPAIR

STARTER SOLENOID SWITCH REPLACEMENT

5.7L LT1 Engine

Figure 7

When a "no crank and no sound" starter motor assembly condition exists, check solenoid switch (23) before disassembling starter motor assembly. Solenoid switch (23) can be checked without removal. Refer to "Cleaning, Inspection and Testing" in this section. Solenoid switch (23) must be replaced with drive housing (36). For removal and installation procedures, refer to "PG-250 Starter Motor Assembly Disassembly" and "PG-250 Starter Motor Assembly" in this section.

3.4L L32 Engine

Figure 8

Remove or Disconnect

- Starter solenoid switch nut (61).
- Field lead from solenoid switch "M" terminal.
- Nuts (62) and solenoid switch heat shield (71).
- Starter solenoid switch clamp bolts/screws (63) and clamp (66).
- Starter solenoid switch (56).

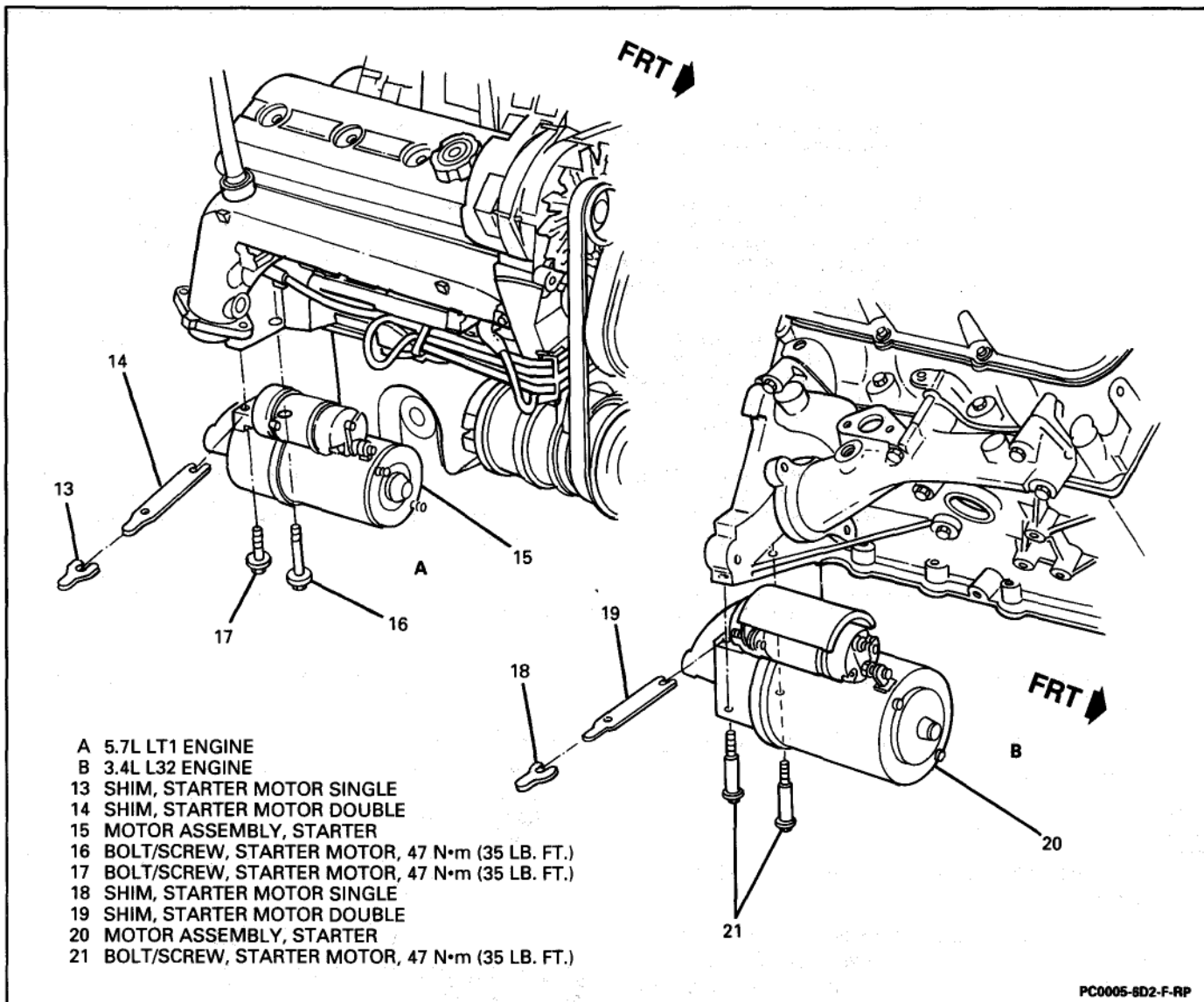


Figure 5 – Mounting Starter Motor Assembly

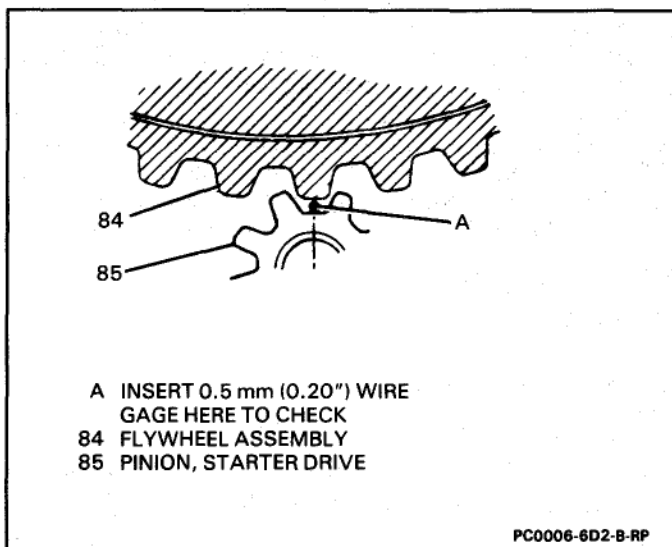


Figure 6 – Flywheel Assembly-to-Pinion Clearance



Install or Connect

NOTICE: See "Notice" on page 6D2-1 of this section.

1. Starter solenoid switch (56).
2. Clamp (66) and starter solenoid switch clamp bolts/screws (63).



Tighten

- Starter solenoid switch clamp bolts/screws (63) to 11 N•m (97 lb. in.).
3. Solenoid switch heat shield (71) and nuts (62).



Tighten

- Nuts (62) to 8 N•m (71 lb. in.).

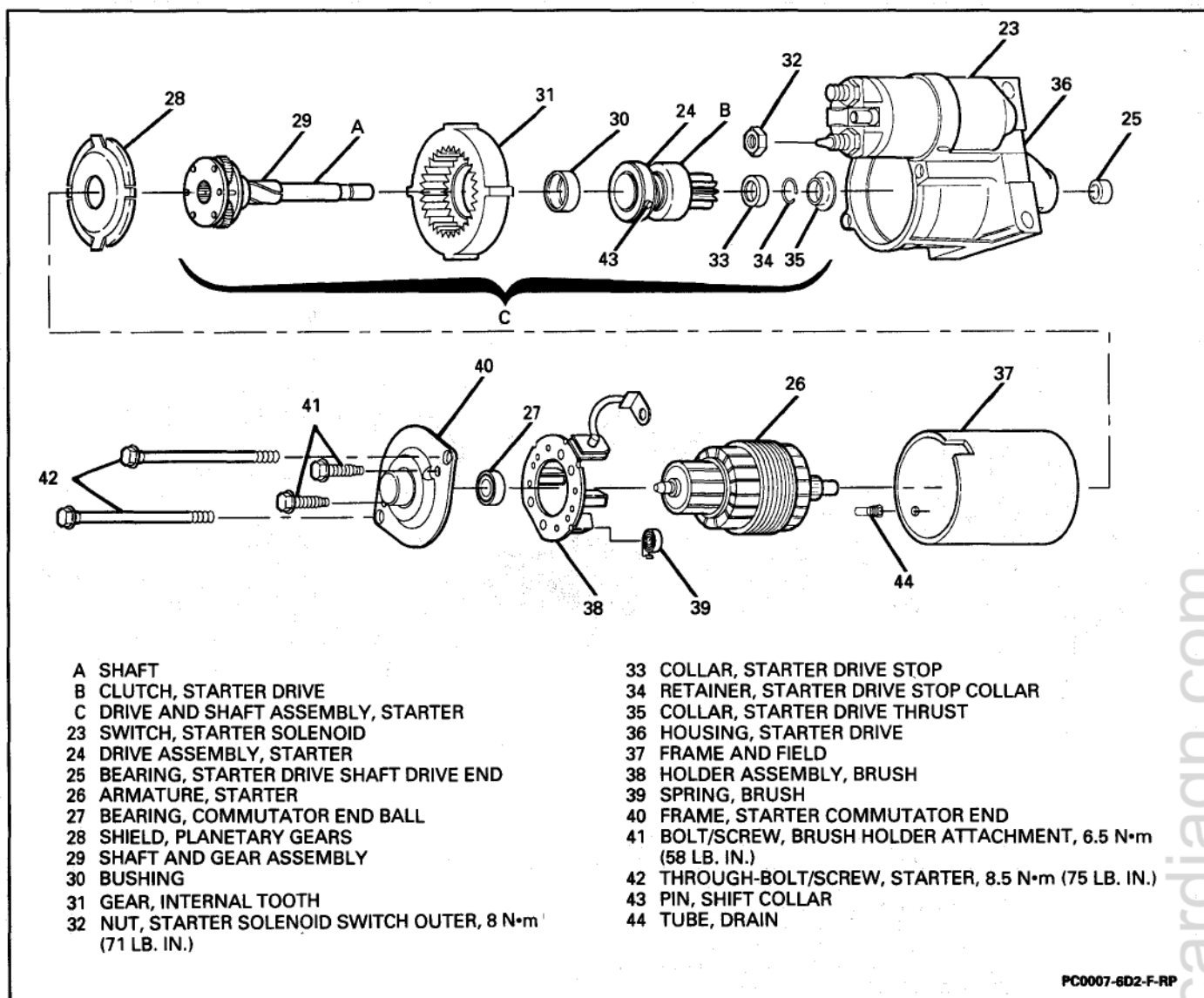


Figure 7 – PG-250 Starter Motor Assembly Disassembled View

NOTICE: Before attaching field lead, tighten inner nut on the solenoid switch “M” terminal. If inner nut is not tight, solenoid cap may be damaged during installation of outer nut. Tighten inner nut on the solenoid switch “M” terminal to 9 N•m (80 lb. in.).

4. Field lead to solenoid switch “M” terminal.
5. Starter solenoid switch outer nut (61).



Tighten

- Starter solenoid switch outer nut (61) to 10 N•m (89 lb. in.).

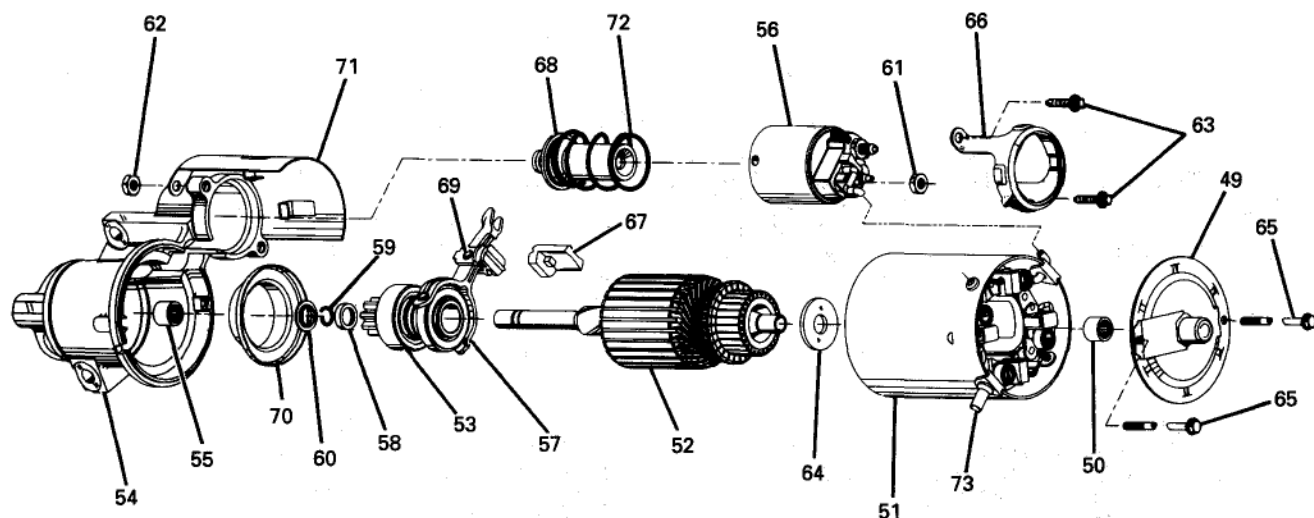
NO-LOAD TEST

Figure 9

With carbon pile “OFF,” make connections as shown in Figure 9. Close the switch, adjust carbon pile to obtain 10 volts, and compare the RPM, current and voltage readings with “Specifications” listed at the end of this section.

Make disconnections only with the switch open. Use the test results as follows:

1. Rated current draw and no-load speed indicates normal starter motor assembly condition.
2. Low free speed and high current draw indicates:
 - Too much friction. This can be caused by tight, dirty or worn bearings, or bent armature shaft allowing armature to drag.
 - Shorted armature. This can be further checked on growler after disassembly.
 - Grounded armature or fields. Check further after disassembly.
3. Failure to operate with high current draw indicates:
 - Direct ground in terminal or fields.
 - “Frozen” bearings (this should have been determined by hand turning armature).
4. Failure to operate with no current draw indicates:
 - Open field circuit. After disassembly inspect internal connections and tracing circuit with test lamp.



- 49 FRAME, STARTER COMMUTATOR END
- 50 BEARING, STARTER ARMATURE COMMUTATOR END
- 51 FRAME KIT, STARTER WITH FIELD
- 52 ARMATURE, STARTER
- 53 DRIVE ASSEMBLY, STARTER
- 54 HOUSING, STARTER DRIVE
- 55 BEARING, STARTER DRIVE SHAFT DRIVE END
- 56 SWITCH, STARTER SOLENOID
- 57 LEVER, STARTER SHIFT
- 58 COLLAR, STARTER DRIVE STOP
- 59 RETAINER, STARTER DRIVE STOP COLLAR
- 60 COLLAR, STARTER DRIVE THRUST
- 61 NUT, STARTER SOLENOID SWITCH OUTER,
10 N·m (89 LB. IN.)
- 62 NUT, STARTER MOTOR ASSEMBLY HEAT SHEILD,
8 N·m (71 LB. IN.)
- 63 BOLT/SCREW, STARTER SOLENOID SWITCH CLAMP,
11 N·m (97 LB. IN.)
- 64 WASHER, STARTER ARMATURE BRAKE COMMUTATOR
END
- 65 BOLT/SCREW, COMMUTATOR END FRAME,
8.5 N·m (75 LB. IN.)
- 66 CLAMP, STARTER SOLENOID SWITCH
- 67 PLUG, STARTER SHIFT LEVER RETAINER
- 68 PLUNGER, STARTER SOLENOID SWITCH
- 69 RETAINER, STARTER SHIFT LEVER
- 70 SHIELD, STARTER DRIVE HOUSING
- 71 SHIELD, STARTER MOTOR ASSEMBLY HEAT
- 72 SPRING, STARTER SOLENOID SWITCH PLUNGER
- 73 TUBE, STARTER DRAIN

Figure 8 – SD210 Starter Motor Assembly Disassembled View

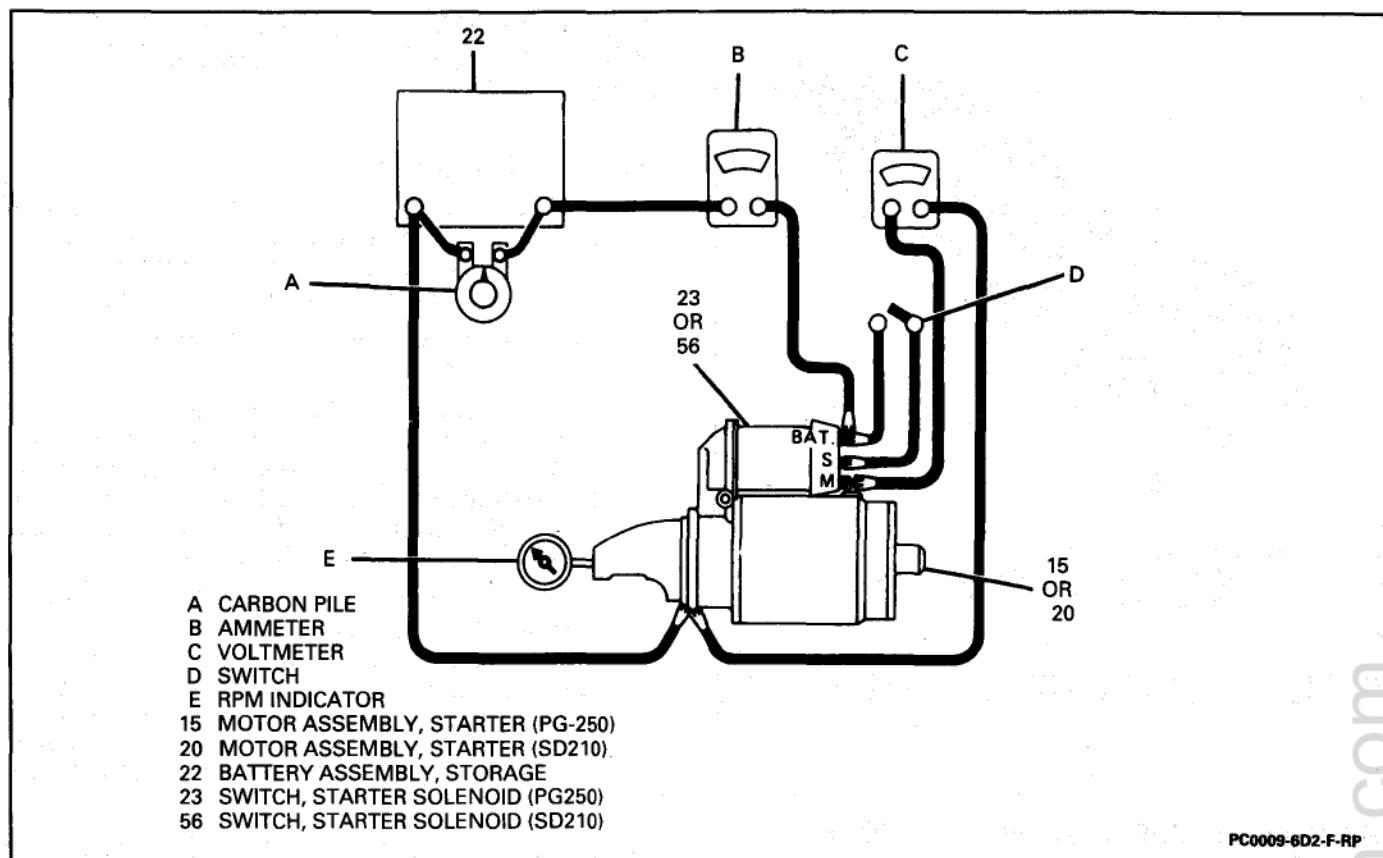


Figure 9 - No-Load Test

- Open armature coils. Inspect commutator for badly burned bars after disassembly.
 - Broken brush springs, worn brushes, high insulation between commutator bars or other causes which would prevent good contact between brushes and commutator.
- Low no-load speed and low current draw indicates:
 - High internal resistance due to poor connections, defective leads, dirty commutator and causes listed above under number 4.
 - High free speed and high current draw usually indicate shorted fields. If shorted fields are suspected, replace field coil assembly. Also check for shorted armature, using growler.

PG-250 STARTER MOTOR ASSEMBLY DISASSEMBLY

Figures 7 and 10

Tool Required:

J 28509-A Counter Gear Bearing Remover



Disassemble

- Field lead from solenoid switch terminal by removing nut (32).
- Through-bolts/screws (42).
- Bolts/screws (41) and end frame (40) from starter motor assembly. Brush holder assembly (38) and bearing (27) remain on armature (26).

CAUTION: Magnets in frame and field have strong attraction to armature. Keep fingers clear of pinch points to avoid personal injury.

- Armature (26) from frame and field (37).
 - Frame and field (37) and shield (28) from housing (36).
 - Bearing (27) from armature (26), using J 28509.
 - Bearing (27) is press-fit over shaft.
- NOTICE:** Before removing brush holder assembly, lift each brush spring and rest against side of brush; this prevents brush damage or contamination when brush holder assembly is pulled off of commutator.
- Brush holder assembly (38) from armature (26).
 - Slightly separate shaft and gear assembly (29) and drive assembly (24) from housing (36) and use a screwdriver to pry plastic shift lever off of pins (43).
 - Shaft and gear assembly (29) and drive assembly (24) from housing (36).
 - Collar (35) from shaft.
 - Slide deep socket over shaft and tap socket to drive collar (33) off of retainer (34).
 - Retainer (34), collar (33) and drive assembly (24) from shaft.
 - Gear (31) and bushing (30) from shaft and gear assembly (29). Bushing (30) is press-fit into gear (31), and should only be removed if damaged.

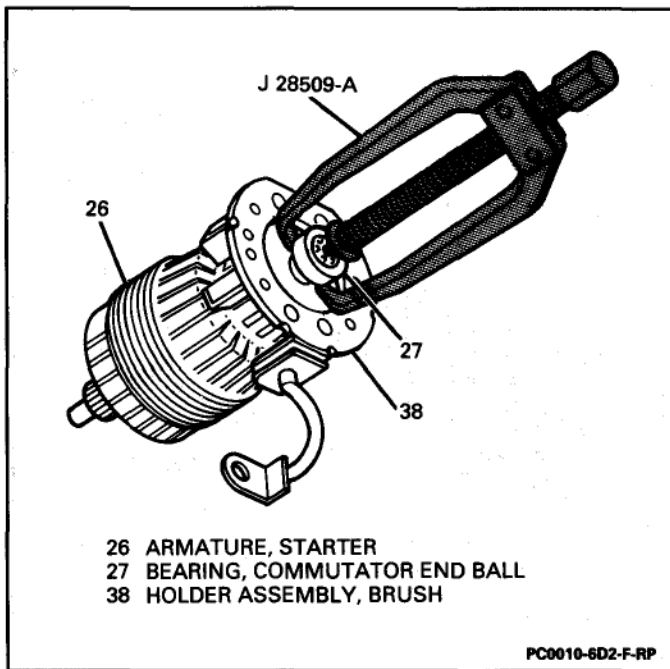


Figure 10 – Removing Commutator End Ball Bearing

SD210 STARTER MOTOR ASSEMBLY DISASSEMBLY

Figure 8



Disassemble

1. Nuts (62) and heat shield (71), if equipped, from clamp bolts/screws (63).
2. Nut (61) and field lead from solenoid switch (56).
3. Clamp bolts/screws (63) and solenoid switch (56) with clamp (66) from drive housing (54).
4. Bolts/screws (65) from starter motor assembly.
5. Commutator end frame (49), brake washer (64), and frame kit (51) from armature (52) and drive housing (54).
6. Plug (67) from drive housing (54).
7. Armature (52) with drive assembly (53), shift lever (57), plunger (68), and return spring (72) from drive housing (54).
8. Return spring (72) from plunger (68).
9. Plunger (68) from shift lever (57).
10. Shift lever (57) from drive housing (54) by spreading lever arms slightly to disengage.
11. Thrust collar (60) from armature shaft.
12. Retainer (59) by pushing pinion stop collar (58) off of retainer (59) and sliding it off of armature shaft.
 - Discard retainer (59).
13. Pinion stop collar (58) and drive assembly (53) from armature shaft.

CLEANING, INSPECTION AND TESTING (PG-250 AND SD210 STARTER MOTOR ASSEMBLIES)

Figures 7 through 14

NOTICE: Do not use grease dissolving solvents for cleaning the overrunning clutch or armature. Solvents dissolve the grease packed in the clutch and damage armature and field coil insulation.

1. Clean all starter motor assembly parts. Wipe parts with a clean shop cloth.
2. Test drive assembly (24 or 53) action. Pinion should turn freely in overrunning direction. Check pinion teeth for chipping, cracking or excessive wear. Replace drive assembly (24 or 53) if necessary. Badly chipped pinion teeth may indicate chipped teeth on ring gear; replace if necessary.
3. On SD210 starter motor assembly, check drive assembly (53) for slipping by leaving drive assembly (53) attached to armature (52). Wrap armature (52) with shop towel and clamp in vice. Using 12-point deep socket and torque wrench, put socket on pinion and turn counterclockwise. Drive should not slip up to 68 N•m (50 lb. ft.) of torque. If it does, replace drive assembly (53).
4. Starter drive assembly (24 or 53) requires no lubrication; however, drive assembly (24 or 53) should be wiped clean.
5. Inspect armature commutator. If commutator is dirty, clean with 400 grit polishing cloth. If commutator is rough, replace armature (26 or 52). Do not undercut or turn commutators. Inspect points where armature conductors join commutator bars to make sure they have good connection. Burned commutator bar is usually evidence of poor connection.
6. Inspect brushes and brush holder assemblies. When brushes appear excessively worn when compared to new brushes they should be replaced. Make sure brush holder assemblies are clean and brushes are not binding in brush holder assemblies. Full brush surface should ride on commutator to give proper performance.
 - Check to ensure that brush springs are giving firm contact between brushes and commutator. When brush springs are distorted or discolored, they should be replaced.
 - On PG-250 starter motor assembly, brush holder (38) and springs (39) are available as separate items.
 - On SD210 starter motor assembly, all brush and brush holder parts are part of the frame kit (51).
7. If test equipment is available:
 - A. Check armature (26 or 52) for short circuits by placing on growler and holding hacksaw blade over armature core while armature is rotated. If saw blade vibrates, armature (26 or 52) is shorted. Replace armature (26 or 52).

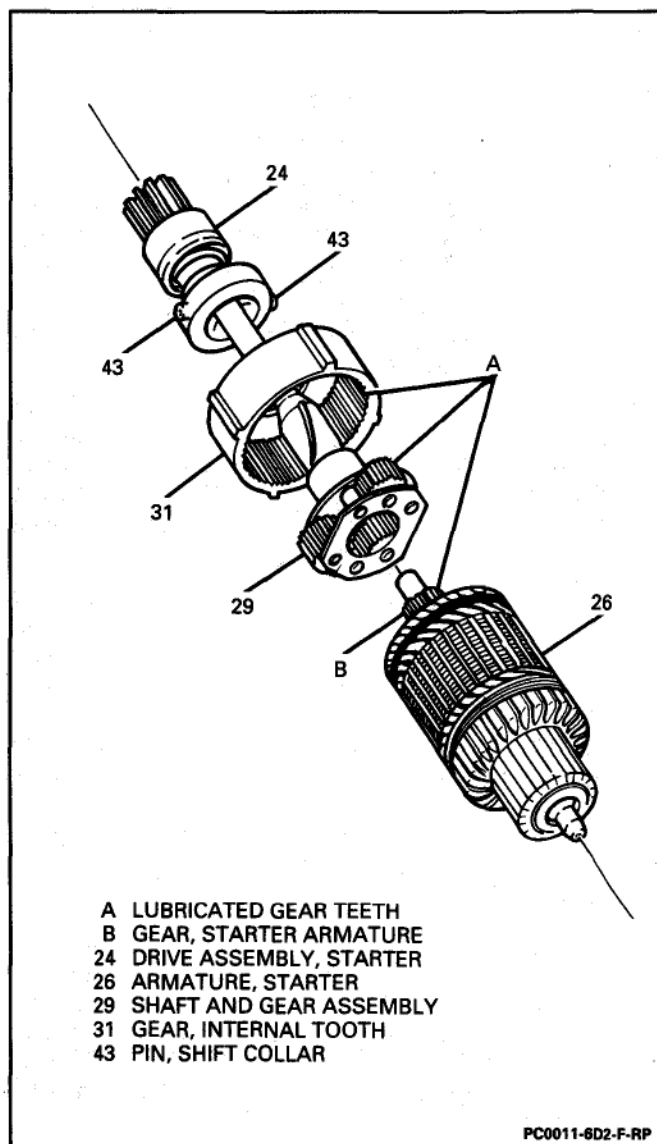


Figure 11 – Starter Armature and Starter Drive Assembly

- B. On SD210 starter motor assembly, check field windings by using self-powered test lamp. Place one lead on field lead terminal and other lead on one insulated brush. If lamp fails to light, series coil is open and will require repair or replacement. Perform this test for each insulated brush to check brush and lead continuity (Figure 12).
- C. On SD210 starter motor assembly, using self-powered test lamp, place one lead on grounded brush holder assembly and other lead on either insulated brush. If lamp lights, grounded series coil is indicated and frame kit (51) must be replaced (Figure 13).
- D. Check armature (26 or 52) for grounds using a self-powered test lamp. Place one lead on commutator and other lead on armature core or shaft. If lamp lights, armature (26 or 52) is grounded and must be replaced.

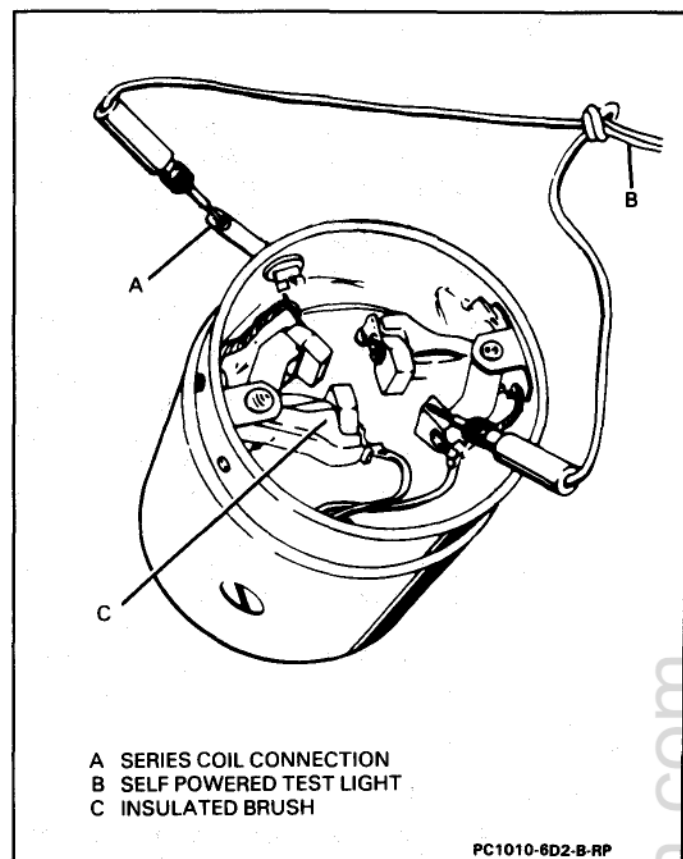


Figure 12 – Testing Series Coil for Open

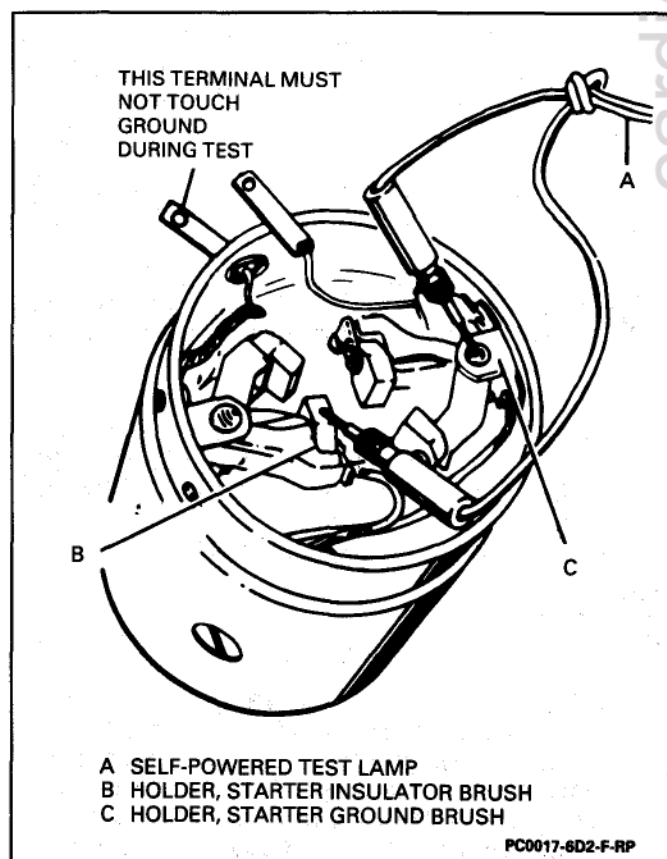


Figure 13 – Testing Series Coil for Ground

E. Check current draw of solenoid windings as follows:

- If solenoid switch (23 or 56) is not removed from starter motor assembly, field lead must be removed from "M" terminal on solenoid switch (23 or 56) before making these tests. Complete tests in minimum of time to prevent overheating of solenoid switch (23 or 56).
- To check hold-in winding, connect ammeter in series with 12-volt battery and "S" terminal on solenoid switch (23 or 56). Connect voltmeter to "S" terminal and to ground. Connect carbon pile across battery. Adjust voltage to 10 volts and note ammeter reading. Reading should be 10 to 20 amperes.
- To check both windings, connect as for previous test. Ground solenoid "M" terminal. Adjust voltage to 10 volts and note ammeter reading. Reading should be 60 to 85 amperes.

Important

- 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 switch (23 or 56) and the solenoid switch (23 or 56) should be replaced. No or low current draw readings that are under specifications indicate excessive resistance. A zero reading indicates an open circuit. Check connections, then replace solenoid switch (23 or 56) if necessary.

8. On SD210 starter, solenoid switch (56) is serviced as an assembly. On PG-250 starter, solenoid switch (23) and drive housing (36) are serviced as an assembly.

Checking Pinion Clearance (PG-250 and SD210 Starter Motor Assemblies)

Figure 15

NOTICE: When the starter motor assembly has been disassembled or the solenoid switch has been replaced, it is necessary to check the pinion clearance. Starter motor assembly may not engage properly if pinion clearance is incorrect.

Measure

- Pinion clearance as follows:

CAUTION: Keep fingers, tools, and other objects away from opening in drive housing while making electrical connections during this procedure. The strong shifting action of the solenoid switch could cause personal injury or damage as the drive pinion moves into cranking position.

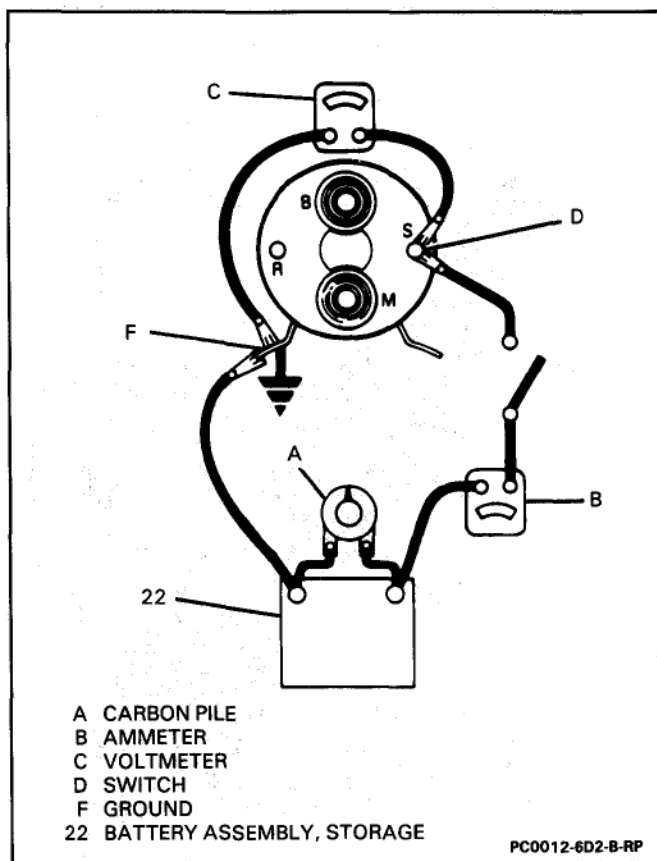


Figure 14 - Testing Solenoid Windings

- Secure starter motor assembly in vise or equivalent fixture so that opening in drive housing is accessible for measurement.
- Disconnect field lead from solenoid switch "M" terminal and insulate it carefully.
- Connect one 12-volt battery lead to solenoid switch "S" terminal and the other to starter frame.
- Flash jumper lead momentarily from solenoid switch "M" terminal to starter frame. This will shift pinion into cranking position and it will remain so until battery is disconnected.
- Push pinion back as far as possible to take up any movement, and check clearance with feeler gage. Clearance should be 0.25 mm to 4.06 mm (0.010 inch to 0.160 inch).
- Means for adjusting pinion clearance is not provided on starter motor assembly. If clearance does not fall within limits, check for improper installation and replace all worn parts.
- Disconnect 12-volt battery leads from solenoid switch "S" terminal and starter frame.
- Reconnect field lead. Refer to "Starter Motor Assembly PG-250" or "Starter Motor Assembly SD210" in this section.

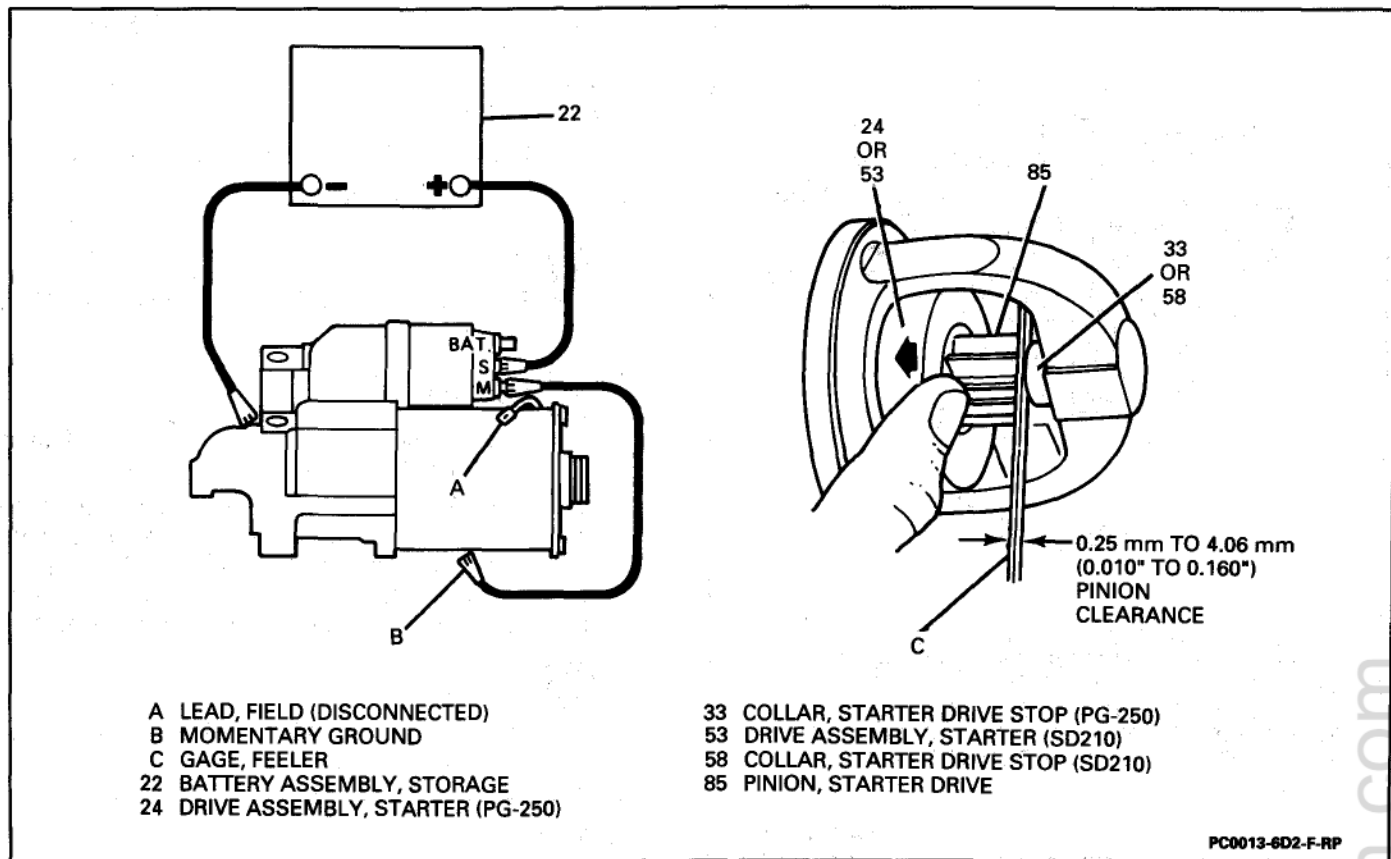


Figure 15 – Electrical Connections and Checking Pinion Clearance

PG-250 STARTER MOTOR ASSEMBLY

Figures 7, 11, 16 and 17

Inspect

- Bushing (30), bearing (25), shaft and gear assembly (29) and bearing (27). When dry, bushing (30), and shaft and gear assembly (29) may be lightly lubricated with GM lubricant 10497186 or equivalent. Bearings (25 and 27) are permanently lubricated – do not add lubricant. If dry, replace the bearings (25 and 27). Replace bushing or bearings when damaged.

Assemble

NOTICE: See “Notice” on page 6D2-1 of this section.

1. Bearing (25) to drive housing (36). Press bearing (25) to 0.35 mm (0.014 inch) below face of casing. Refer to Figure 17.
2. Lubricate gear (31), planetary gear of the shaft and gear assembly (29), and armature shaft gear teeth lightly with GM lubricant 10497186 or equivalent. Refer to Figure 11.
3. Gear (31) and drive assembly (24) over shaft and gear assembly (29) with pinion away from armature (26).
4. Collar (33) onto shaft.

5. New retainer (34) into groove on shaft. Do not reuse old retainer (34).
6. Collar (35) to end of shaft with flange toward retainer (34). Use pliers as shown in Figure 16 to snap collar (33) over retainer (34).
7. Drive assembly (24) and shaft and gear assembly (29) into housing (36).
 - Use screwdriver to gently guide shift lever over pins (43) on drive assembly (24).
8. Shield (28) and frame and field (37) into housing (36).

Inspect

- Brushes. Replace if damaged or excessively worn.
9. Brush holder assembly (38) onto armature (26).
 - Release brushes onto commutator by sliding springs to ends of brushes.
 10. Bearing (27) onto armature (26) by pressing on inner race until bearing (27) rests against shoulder on armature shaft.
- CAUTION: Magnets in frame and field have strong attraction to armature. Keep fingers clear of pinch points to avoid personal injury.**
11. Armature (26) to frame and field (37).

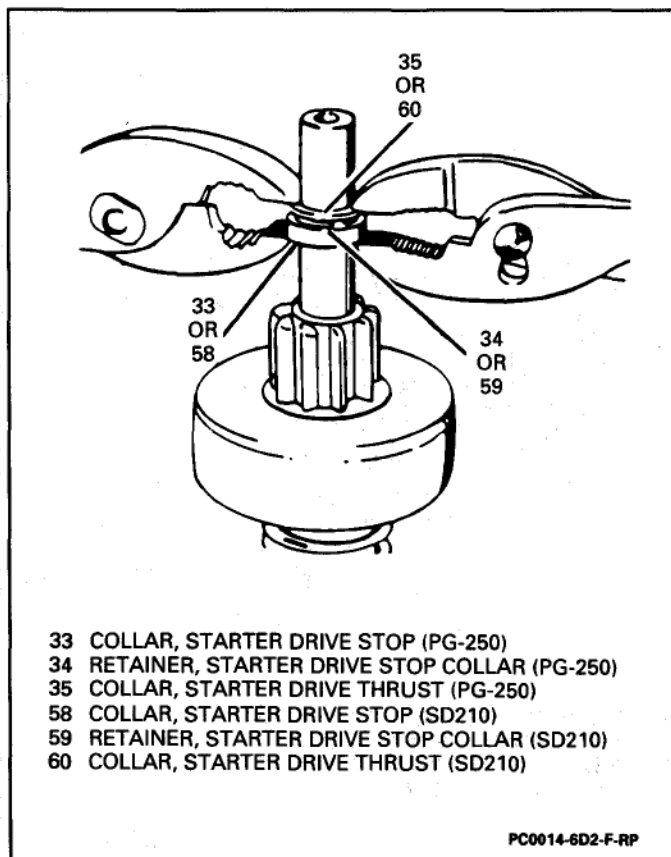


Figure 16 – Installing Pinion Stop Collar

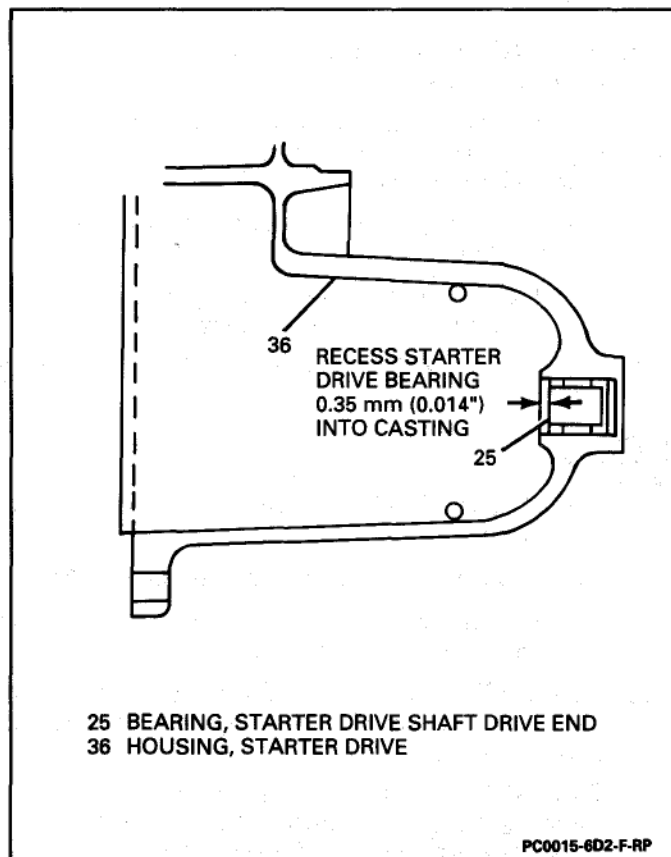


Figure 17 – Starter Drive Shaft Drive End Bearing

12. End frame (40) to brush holder assembly (38) using bolts/screws (41).

**Tighten**

- Bolts/screws (41) to 6.5 N•m (58 lb. in.)

13. Through-bolts/screws (42).

**Tighten**

- Through-bolts/screws (42) to 8.5 N•m (75 lb. in.).

**Measure**

- Pinion clearance. Refer to "Checking Pinion Clearance" in this section.

NOTICE: When installing electrical connections to starter motor assembly, the inner nut on the solenoid switch "M" terminal must be tightened before field lead is installed. If inner nut is not tight, cap may be damaged during installation of electrical connector.

**Tighten**

- Starter solenoid switch "M" terminal inside nut to 9 N•m (80 lb. in.).

14. Field lead to solenoid switch "M" terminal.

15. Nut (32).

**Tighten**

- Nut (32) to 8 N•m (71 lb. in.).

SD210 STARTER MOTOR ASSEMBLY**Figures 8 and 16****Assemble**

NOTICE: See "Notice" on page 6D2-1 of this section.

1. Drive assembly (53) onto armature shaft.
2. Pinion stop collar (58) onto armature shaft with flat side toward drive assembly (53).
3. New retainer (59) onto armature shaft and slide it down shaft until seated in shaft groove.
4. Thrust collar (60) onto armature shaft with flange toward retainer (59).

- Use two sets of pliers and squeeze pinion stop collar (58) and thrust collar (60) to snap pinion stop collar (58) onto retainer (59).

**Inspect**

- End bearing (55). If bearing (55) has no lubrication visible or appears damaged, replace bearing (55).
- Press bearing (55) from drive housing (54) and then press in new bearing (55) until recessed 1.6 mm (1/16 inch) into drive housing casting. Bearing (55) is pre-lubricated and no additional lubrication is needed.

5. Shift lever (57) to drive assembly (53) by spreading arms slightly.
6. Plunger (68) to other end of shift lever (57) by snapping into place.
7. Armature shaft into end bearing (55) while sliding lever retainer (69) into slot in drive housing (54).
8. Plug (67) into slot in drive housing (54).
9. Return spring (72) over plunger (68).
10. Solenoid switch (56) with clamp (66) to drive housing (54).
 - Align motor terminal and solenoid switch (56) with field lead.
11. Clamp bolts/screws (63).

**Tighten**

- Clamp bolts/screws (63) to 11 N•m (97 lb. in.).

**Clean**

- Contact surface of frame kit brushes and armature commutator with soft cloth.

12. Frame kit (51) onto armature (52) and drive housing (54) by pushing in and holding brushes and aligning notch in frame kit (51) with locator on drive housing (54). When in place, release brushes and make sure they move freely and contact commutator.

**Inspect**

- Bearing (50) in commutator end frame (49). If bearing (50) has no visible lubrication or

appears damaged, press in a new bearing (50) until recessed 2 mm (0.08 inch) into commutator end frame (49). Bearing (50) is pre-lubricated and no additional lubrication is needed.

13. Washer (64) onto armature shaft.
14. Commutator end frame (49) onto armature shaft and seat into frame kit (51).
15. Identification tag over bolt/screw hole in commutator end frame (49) with fluted end around bearing well.
16. Bolts/screws (65) to starter motor assembly.

**Tighten**

- Bolts/screws (65) to 8.5 N•m (75 lb. in.).

NOTICE: Before attaching electrical leads, tighten inner nuts on solenoid switch terminals. If nuts are not tight, solenoid cap may be damaged during installation of leads. Tighten inner nuts on "S" terminal to 2.5 N•m (22 lb. in.). Tighten inner nut at "BAT" terminal to 10 N•m (89 lb. in.).

17. Nut (61) to solenoid switch (56).

**Tighten**

- Nut (61) to 10 N•m (89 lb. in.).

18. Heat shield (71) and nuts (62) onto protruding ends of clamp bolts/screws (63).

**Tighten**

- Nuts (62) to 8 N•m (71 lb. in.).

SPECIFICATIONS

STARTER MOTOR ASSEMBLY USAGE CHART

3.4L L32 Engine

Starter Type	SD210
No-Load Test at 10 Volts	
Amps-Minimum	45
Amps-Maximum	75
RPM at Drive Pinion	
Minimum	6,000
Maximum	11,000
Starter Solenoid Switch	
Hold-in Windings at 10 Volts	10-20 Amps
Both Windings at 10 Volts	60-85 Amps

5.7L LT1 Engine

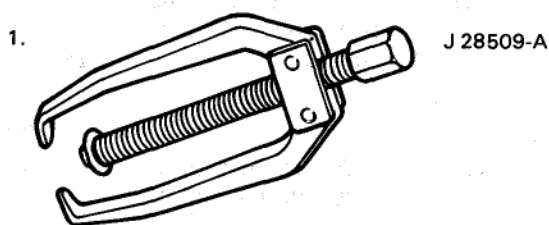
Starter Type	PG-250
No-Load Test at 10 volts	
Current	65-95 Amps
Starter Drive Pinion Speed	2750-3250 RPM
Starter Solenoid Switch	
Hold-in Windings at 10 Volts	10-20 Amps
Both Windings at 10 Volts	60-85 Amps

FASTENER TIGHTENING SPECIFICATIONS

Battery Negative Cable Assembly	15 N•m (11 lb. ft.)
Starter Motor Assembly Heat Shield Nut	8 N•m (71 lb. in.)
Starter Motor Bolt/Screw	47 N•m (35 lb. ft.)
Starter Motor Brush Holder Bolt/Screw (PG-250)	6.5 N•m (58 lb. in.)
Starter Motor Commutator End Frame Bolt/Screw	8.5 N•m (75 lb. in.)
Starter Solenoid Switch "BAT" Terminal Inner Nut	9 N•m (80 lb. in.)
Starter Solenoid Switch "BAT" Terminal Outer Nut	9 N•m (80 lb. in.)
Starter Solenoid Switch Clamp Bolt/Screw	11 N•m (97 lb. in.)
Starter Solenoid Switch Inner Nut	9 N•m (80 lb. in.)
Starter Solenoid Switch Outer Nut (PG-250)	8 N•m (71 lb. in.)
Starter Solenoid Switch Outer Nut (SD210)	10 N•m (89 lb. in.)
Starter Solenoid Switch "S" Terminal Nut	2.5 N•m (22 lb. in.)
Starter Through-Bolt/Screw (PG-250)	8.5 N•m (75 lb. in.)

GENERAL SPECIFICATIONS

Pinion Clearance 0.25 mm to 4.06 mm (0.010" to 0.160")

SPECIAL TOOLS

1. COUNTER GEAR BEARING REMOVER

PC6016-6D2-D-RP

SECTION 6D3

CHARGING SYSTEM

CAUTION: This vehicle is equipped with Supplemental Inflatable Restraint (SIR). Refer to CAUTIONS in Section 9J under "ON-VEHICLE SERVICE" and the SIR Component and Wiring Location view in SECTION 9J before performing service on or around SIR components or wiring. Failure to follow CAUTIONS could result in possible air bag deployment, personal injury, or otherwise unneeded SIR system repairs.

CAUTION: Before removing or installing any electrical unit, or when a tool or equipment could easily come in contact with "live" exposed electrical terminals, disconnect the battery negative cable to help prevent personal injury and/or damage to the vehicle or components. Unless instructed otherwise, the ignition switch must be in the "OFF" or "LOCK" position.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

CHARGING CIRCUIT

Refer to SECTION 8A for operation and additional charging circuit diagnosis.

CS-130 AND CS-144 GENERATOR ASSEMBLIES

The charging system generator assemblies use a built-in voltage regulator with fault detection, a stator, rectifier bridge, and rotor with slip rings and brushes. A conventional pulley and fan is used to cool the slip ring end frame, rectifier bridge and voltage regulator.

These generator assemblies use only two connections – battery positive and "L" terminal, in addition to the ground path through the generator bracket. Use of "P," "I" and "S" terminals is optional. The "P" terminal is connected to the stator and may be connected externally to a tachometer or other device. The "I" terminal can be connected directly to battery voltage to power the genera-

tor assemblies instead of, or in addition to, the "L" terminal which must be stepped down. The "S" terminal may be connected to an external voltage source, such as voltage near the battery assembly, for voltage control. If the "S" terminal is not used, internal generator voltage is used for control.

The voltmeter reads battery voltage when the engine is not running and reads charging system voltage when the engine is running. The normal indication is between 11 volts and 16 volts.

The regulator voltage setting varies with temperature and limits system voltage by controlling rotor field current. While the field current is "on," this regulator actually switches rotor field current on and off at a fixed frequency of about 400 cycles per second to help control radio noise. By varying the overall on-off time, correct average field current for proper system voltage control can be obtained. At high speeds, the on-time may be 10 percent and the off-time 90 percent. At low speeds, with high electrical loads, on-off time may be 90 percent and 10 percent respectively.

DIAGNOSIS

CS GENERATOR ASSEMBLY ON-VEHICLE CHECK

Tool Required:

J 39200 Digital Multimeter

When the CS charging system is operating normally, the voltmeter will read between 11 volts and 16 volts when the engine is running. If the voltmeter operates abnormally, or if an undercharged or overcharged battery assembly condition occurs, the following procedure may be used to diagnose the charging system. Remember that an undercharged battery assembly is often caused by accessories being left on overnight, or by a hood or instrument panel compartment lamp that stays on.

Noise from a generator assembly may be caused by a loose drive pulley, loose mounting bolts/screws, worn or dirty bearings, faulty diode or faulty stator. A magnetic whining noise may be heard from vehicles equipped with the CS-130 alternator. This is a normal condition.

To avoid damage to the electrical equipment, always observe the following precautions:

- Do not reverse connections to generator assembly.
- Do not short across or ground any of the terminals in charging circuit, except as directed by instructions.
- NEVER disconnect generator "BAT" terminal with generator assembly operating.
- When connecting charger or booster battery assembly to battery assembly, refer to SECTION 6D1.
- In some vehicles, voltmeter may be used instead of indicator lamp. In this case, steps 1 through 4 pertaining to faulty indicator lamp operation, should be omitted from troubleshooting procedure.
- Do not attempt to disassemble CS-130 generator assembly. Damage to generator assembly could result.

Trouble in the charging system will show up as one or more of the following conditions:

- Faulty voltmeter operation.
- Undercharged battery assembly, as evidenced by slow cranking or dark hydrometer.
- Overcharged battery assembly, as evidenced by spewing of electrolyte from vents or a yellow hydrometer.

To diagnose the CS-130 or CS-144 charging system, use the following procedure:



Important

- Only the CS-144 generator assembly may be repaired.

1. Visually check serpentine drive belt and wiring.
2. Battery assembly undercharged or overcharged (voltage lower than 11 volts or higher than 16 volts).
 - A. Detach wiring harness connector from generator assembly.
 - B. With ignition switch "ON" and engine assembly not running, connect J 39200 as voltmeter from ground to "L" terminal in wiring harness

connector. Connect to "F" or "I" terminal for gage equipped vehicles. At least one terminal should have battery voltage.

- C. Zero volts indicates open circuit between terminal and battery assembly. Correct as required.
- D. Reconnect harness connector to generator assembly.

CAUTION: Disconnect battery negative cable assembly before installing or removing a series-type ammeter at generator battery terminal.

CAUTION: See "Caution" on page 6D3-1 of this section.

- E. Install ammeter at generator output terminal. With load off, install carbon pile load test across battery terminals. Start engine assembly and run at 2500 rpm. Make sure this is done at ambient temperature.
- F. Measure voltage across battery assembly, using J 39200. If voltage is above 16 volts, replace or repair generator assembly.
- G. Turn on accessories and load battery assembly with carbon pile to obtain maximum generator assembly output. Maintain voltage at 13 volts or above. Use ammeter to check amperage. Compare output to ampere rating in "Specifications" at the end of this section.
 - If within 15 amps of rated output, generator assembly is OK.
 - If not within 15 amps of rated output, repair or replace generator assembly.

CS GENERATOR ASSEMBLY BENCH CHECK

Figure 1

Tool Required:

J 39200 Digital Multimeter

The following bench check may be used to simulate operation on a vehicle. Use the bench check to verify operation of a CS-144 generator assembly that has been repaired.

1. Mount generator assembly in suitable test stand according to test stand manufacturer's instructions. Test stand must be capable of driving generator assembly at 6,500 rpm.
2. Make connections as shown in Figure 1. Be sure carbon pile is turned off. Ground polarity of generator assembly and battery assembly must be same. Battery assembly must be fully charged. Use a 30-500 ohm resistor between battery assembly and "L" terminal of generator assembly.
3. Slowly increase generator assembly speed and observe voltage using J 39200.

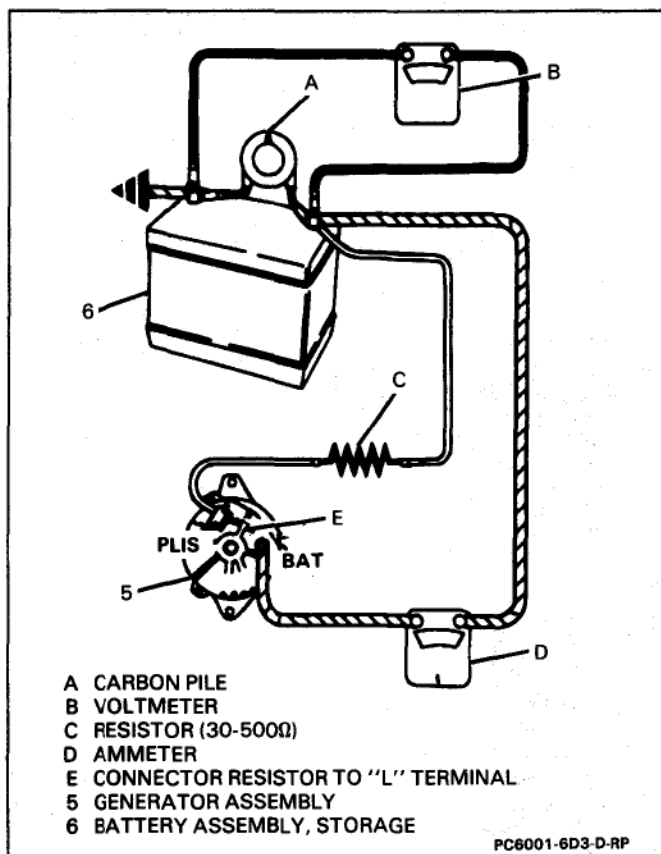


Figure 1 - Generator Assembly Bench Check

Important

- The battery assembly must be fully charged when making this test.
 - The engine must be run at 2500 rpm and at ambient temperature.
4. If voltage is uncontrolled and increases above 16 volts, repair or replace generator assembly.
 5. If voltage is below 16 volts, increase speed and connect and adjust carbon pile to obtain maximum amperage output. Maintain voltage above 13 volts.
 6. Use ammeter to check amperage. If output is within 15 amps of rated output, generator assembly is good.
 7. If output is not within 15 amps of rated output, repair or replace generator assembly.

Important

- Only the CS-144 generator assembly may be repaired.

ON-VEHICLE SERVICE

The CS generator assembly does not require periodic lubrication. The rotor shaft is mounted on permanently lubricated bearings. At periodic intervals, check mounting bolts/screws for tightness and check serpentine drive belt tension. Refer to SECTION 6A2A or 6A3A.

The charging system could be equipped with two different CS-144 generators. The reason for this is the

CS-144 124-amp generator is being replaced by the CS-144 140-amp generator. The differences between the two are as follows:

- The CS-144 124-amp generator (part number 10480131) is equipped with a metal fan mounted at the front of the generator and a bolt used to attach the battery positive cable assembly to the generator "BAT" terminal.
- The CS-144 140-amp generator (part number 10480111) is equipped with a plastic and metal fan mounted at the front of the generator and uses a stud and nut to attach the battery positive cable assembly to the "BAT" terminal.

GENERATOR ASSEMBLY REPLACEMENT

CS-130 105-AMP Generator Assembly (3.4L L32 Engine)

Figure 2

Remove or Disconnect

CAUTION: See "Caution" on page 6D3-1 of this section.

1. Battery negative cable assembly from battery terminal.
2. Serpentine drive belt. Refer to SECTION 6A2A or 6A3A.
3. Battery positive cable assembly from generator "BAT" terminal.
4. Electrical connector from generator assembly (5).
5. Nuts (2 and 25) and bolt/screw (21).
6. Generator rear inner brace (1).
7. Bolts/screws (9 and 17).
8. Generator assembly (5) from accessory mounting bracket (7).

Install or Connect

NOTICE: See "Notice" on page 6D3-1 of this section.

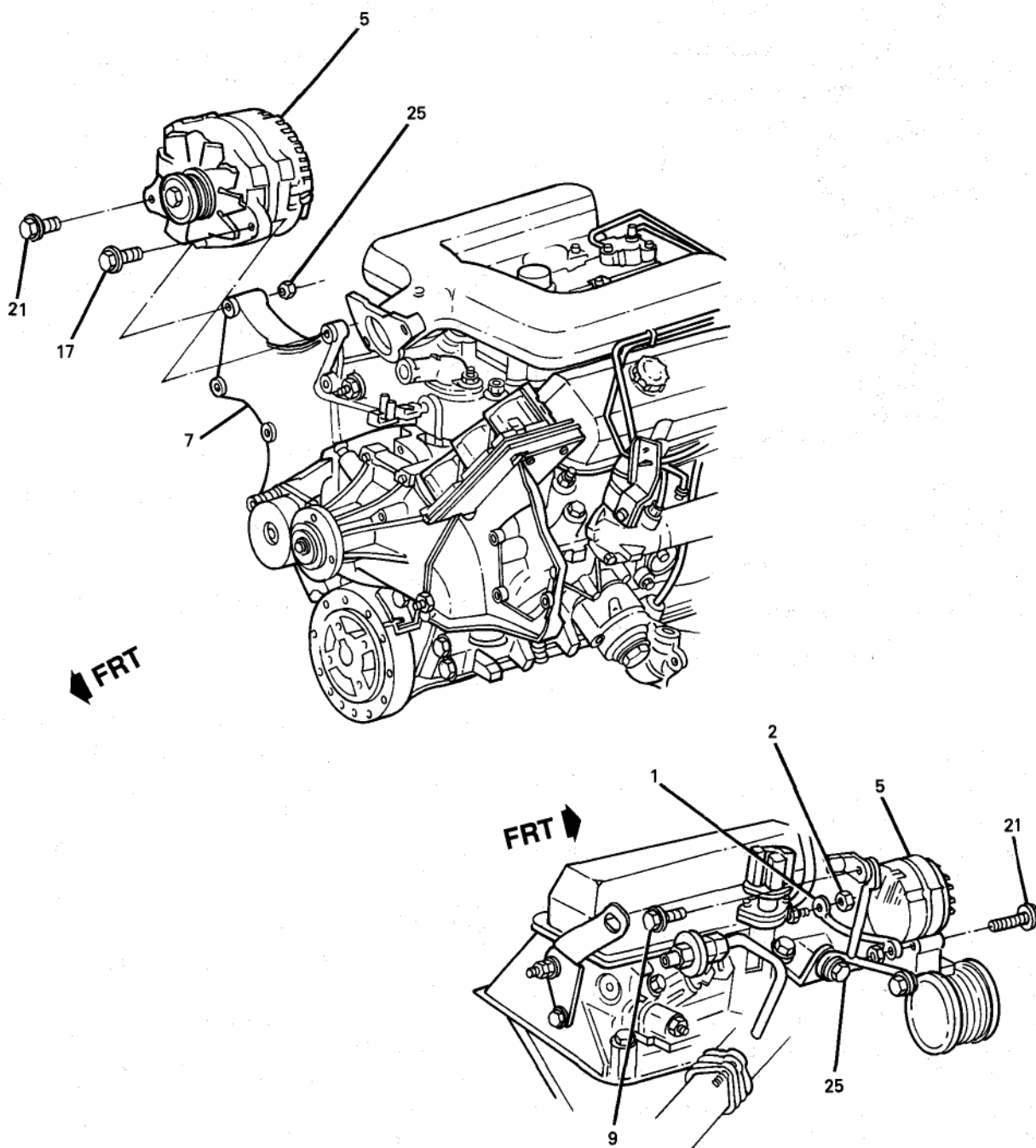
1. Generator assembly (5) to accessory mounting bracket (7).
2. Bolts/screws (9 and 17).

Tighten

- Bolt/screw (9) to 25 N•m (18 lb. ft.).
 - Bolt/screw (17) to 50 N•m (37 lb. ft.).
3. Generator rear inner brace (1).
 4. Nuts (2 and 25) and bolt/screw (21).

Tighten

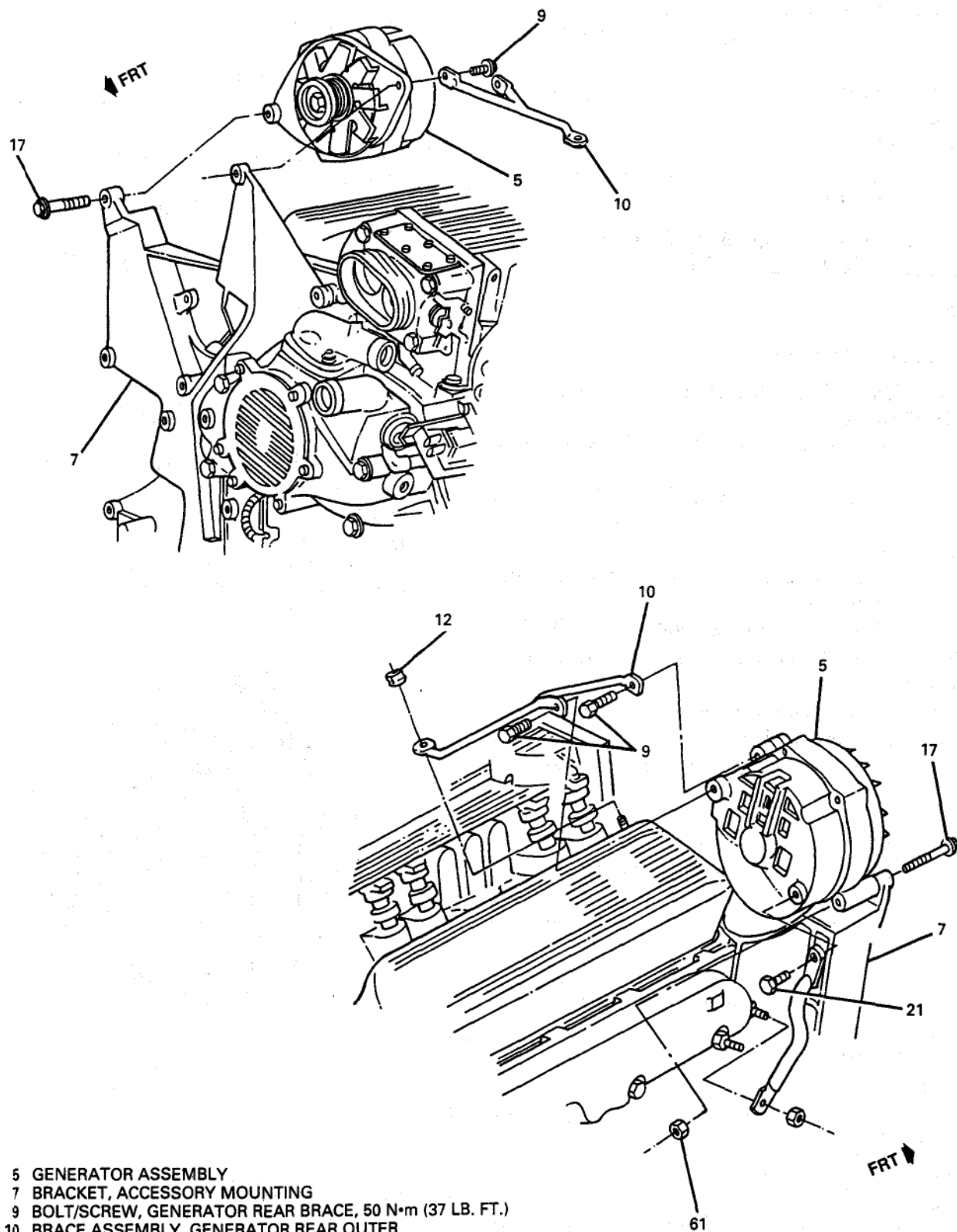
- Nut (2) to 25 N•m (18 lb. ft.).
 - Nut (25) to 50 N•m (37 lb. ft.).
 - Bolt/screw (21) to 50 N•m (37 lb. ft.).
5. Electrical connector to generator assembly (5).
 6. Battery positive cable assembly to generator "BAT" terminal.



- 1 BRACE, GENERATOR REAR INNER
- 2 NUT, GENERATOR BRACE, 25 N•m (18 LB. FT.)
- 5 GENERATOR ASSEMBLY
- 7 BRACKET, ACCESSORY MOUNTING
- 9 BOLT/SCREW, GENERATOR REAR BRACE, 25 N•m (18 LB. FT.)
- 17 BOLT/SCREW, GENERATOR, 50 N•m (37 LB. FT.)
- 21 BOLT/SCREW, GENERATOR, 50 N•m (37 LB. FT.)
- 25 NUT, GENERATOR, 50 N•m (37 LB. FT.)

PC0001-6D3-F-RP

Figure 2 – CS-130 105-Amp Generator Assembly Mounting (3.4L L32 Engine)



RC0001-6D3-F-RP

Figure 3 – CS-144 Generator Assembly Mounting (5.7L LT1 Engine) (Typical)

**Tighten**

- Cable nut to 14 N•m (124 lb. in.).
7. Serpentine drive belt. Refer to SECTION 6A2A or 6A3A.
 8. Battery negative cable assembly to battery terminal.

**Tighten**

- Battery negative cable bolt/screw to 15 N•m (11 lb. ft.).

CS-144 124-Amp or 140-Amp Generator Assembly (5.7L LT1 Engine)

Figure 3

**Remove or Disconnect**

CAUTION: See "Caution" on page 6D3-1 of this section.

1. Battery negative cable assembly from battery terminal.
2. Serpentine drive belt. Refer to SECTION 6A2A or 6A3A.
3. Lower vehicle.
4. Battery positive cable assembly from generator "BAT" terminal.
5. Electrical connector from generator assembly (5).
6. Bolts/screws (9, 17 and 21) and nut (61) at generator assembly (5).
7. Nut (12) at generator rear outer brace (10).
8. Generator rear outer brace (10).
9. Generator assembly (5) from accessory mounting bracket (7).

**Install or Connect**

NOTICE: See "Notice" on page 6D3-1 of this section.

1. Generator assembly (5) to accessory mounting bracket (7).
2. Generator rear outer brace (10).
3. Nut (12) at generator rear outer brace (10).

**Tighten**

- Nut (12) to 33 N•m (24 lb. ft.).

4. Bolts/screws (9, 17 and 21) and nut (61) at generator assembly (5).

**Tighten**

- Bolts/screws (9 and 17) to 50 N•m (37 lb. ft.).
- Bolt/screw (21) to 25 N•m (18 lb. ft.).

5. Electrical connector to generator assembly (5).

6. Battery positive cable assembly to generator "BAT" terminal.

**Tighten**

- Cable bolt/screw to 14 N•m (124 lb. in.), if equipped with 124-amp alternator.
- Cable nut to 20 N•m (15 lb. ft.), if equipped with 140-amp alternator.

7. Raise and suitably support vehicle. Refer to SECTION 0A.
8. Serpentine drive belt. Refer to SECTION 6A2A or 6A3A.
9. Battery negative cable assembly to battery terminal.

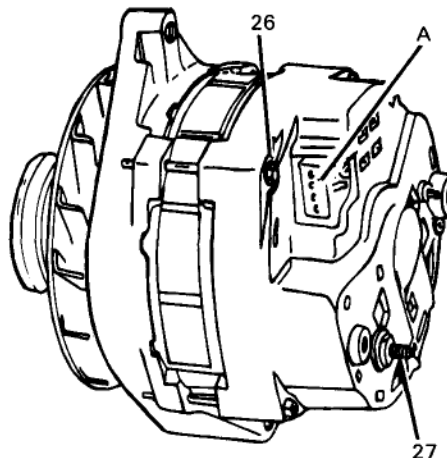
**Tighten**

- Battery negative cable bolt/screw to 15 N•m (11 lb. ft.).

UNIT REPAIR

CS-130 105-AMP GENERATOR ASSEMBLY (3.4L L32 Engine)

NOTICE: Do not attempt to disassemble a CS-130 generator assembly. Damage to the generator assembly could result. The CS-130 generator assembly is replaced as a complete assembly.



A "P" "L" "I" "S" TERMINALS
26 THROUGH-BOLT/SCREW, GENERATOR
27 TERMINAL, GENERATOR BATTERY

PC6003-6D3-D-RP

Figure 4 – Generator Through-Bolt/Screw Location

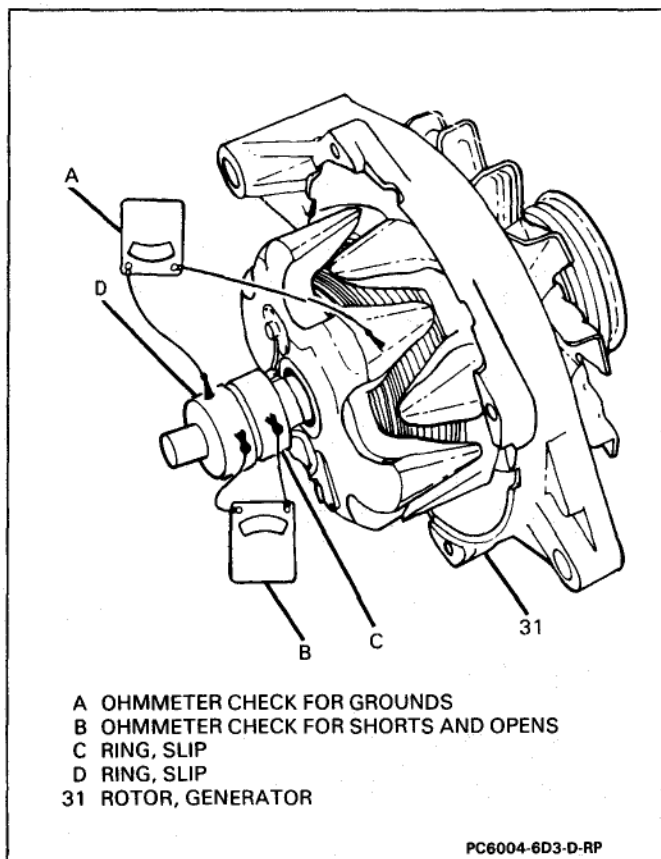


Figure 5 – Testing Generator Rotor

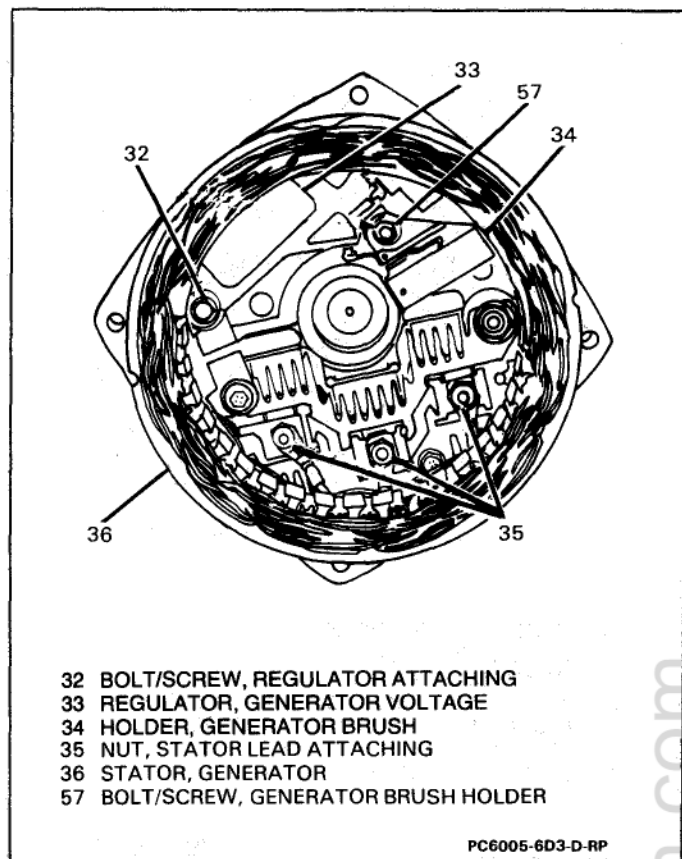


Figure 6 – Generator Slip Ring End Frame View

CS-144 124-AMP OR 140-AMP GENERATOR DISASSEMBLY, TEST AND REASSEMBLY (5.7L LT1 Engine)

Figures 4 through 12

Disassemble

1. Make scribe marks on slip ring end frame (43) and drive end frame (59) to ease reassembly.
2. Through-bolts/screws (26) and separate slip ring end frame (43) and drive end frame (59).
3. End frame bearing (28) from rotor shaft.

Measure

- Rotor (31) for grounds, opens and shorts (Figure 5).

Important

- Test should be performed at approximately 21°C (70°F). A different temperature may result in inaccurate ohmmeter readings.
 - A. Connect ohmmeter to slip ring and clean metal grounding surface on frame of rotor (31) to check for grounds.
 - Ohmmeter should read infinity (open). If not, replace rotor (31).
 - B. Connect ohmmeter to both slip rings to check for shorts and opens.

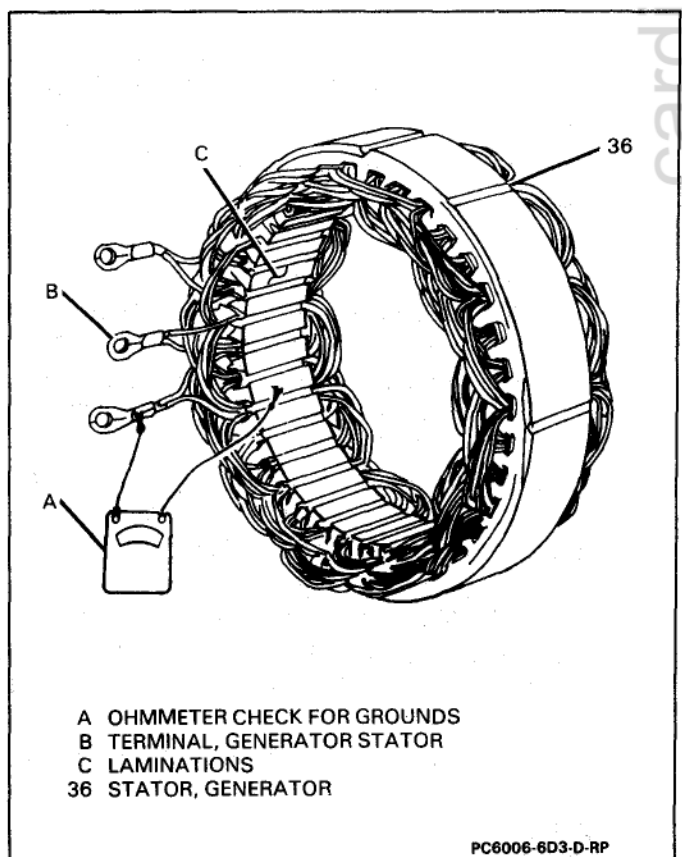


Figure 7 – Testing Generator Stator

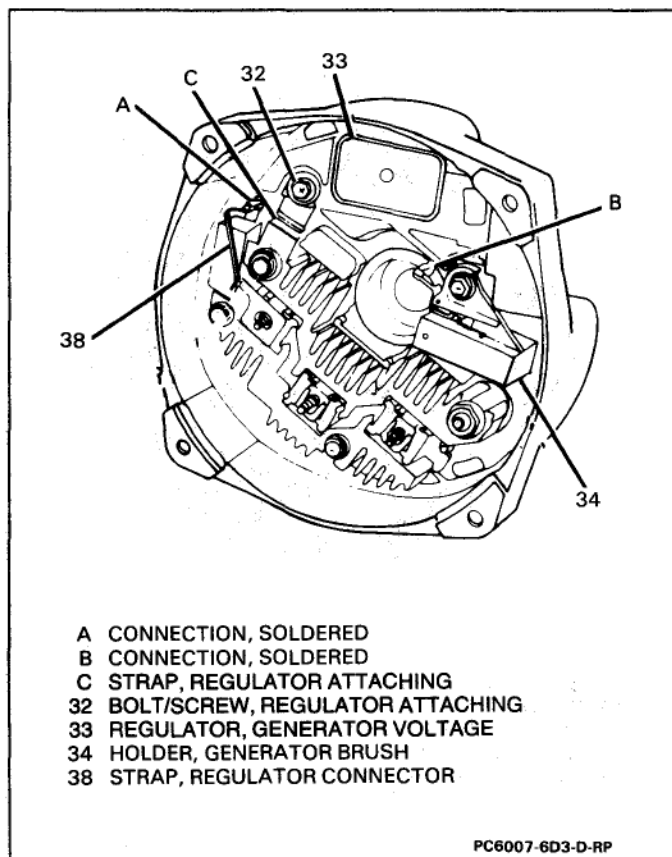


Figure 8 – Removing Generator Voltage Regulator and Generator Brush Holder

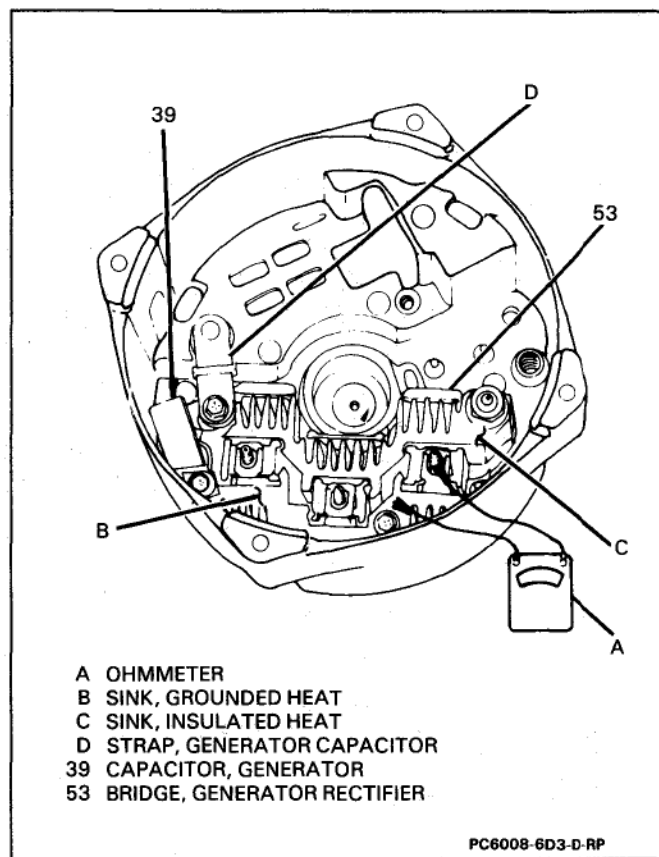


Figure 9 – Testing Generator Rectifier Bridge

- Ohmmeter should read 1.7 to 2.1 ohms. If not, replace rotor (31).

- Nuts (35).
- Stator (36) from slip ring end frame (43).

**Measure**

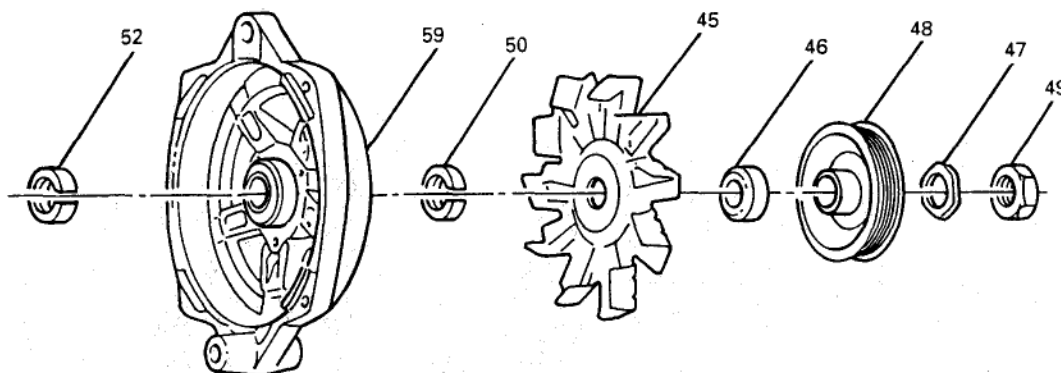
- Stator (36) for grounds (Figure 7).
 - Connect ohmmeter to stator terminal and to clean metal ground on laminations.
 - If ohmmeter reading is low, replace stator (36). Stator (36) cannot be checked for opens and shorts with ohmmeter.
- Unsolder connections at connector strap (38) and brush holder (34) to voltage regulator (33).
- Bolt/screw (32) and bolt/screw (57).
- Voltage regulator (33) and brush holder (34) with dust shield (60) from slip ring end frame (43).
 - Tap plastic retaining pin from dust shield retaining clip. Be sure to keep pin for reassembly.
- Brushes (41) and dust shield (60) from brush holder (34).

**Clean**

- Brushes (41) with soft, dry cloth.

**Measure**

- Rectifier bridge (53) for continuity (Figure 9).
 - Connect ohmmeter to grounded heat sink and flat metal clip at rectifier bridge (53).
 - Reverse leads. One reading should be high (open) and one low (continuity). If both readings are the same, replace rectifier bridge (53).
 - Repeat test between grounded heat sink and clips at two other bridge terminals.
 - Repeat test between insulated heat sink and at bridge terminals.
- Capacitor (39) and rectifier bridge (53).
- Washers (55) and bolts/screws (56 and 58).
- Bearing (28) from slip ring end frame (43) by pushing through to inside.
- Nut (49), using hex wrench to hold rotor shaft.
- Washer (47), pulley (48), fan collar (46), fan (45) and outside collar (50).
- Rotor (31) from drive end frame (59).
- Inside collar (52) from rotor (31).



- 45 FAN, GENERATOR
 46 COLLAR, GENERATOR ROTOR DRIVE END FAN
 47 WASHER, GENERATOR ROTOR SHAFT DRIVE END
 48 PULLEY, GENERATOR
 49 NUT, GENERATOR ROTOR SHAFT DRIVE END,
 100 N·m (75 LB. FT.)

- 50 COLLAR, GENERATOR ROTOR DRIVE END BEARING OUTSIDE
 52 COLLAR, GENERATOR ROTOR DRIVE END BEARING INSIDE
 59 FRAME, GENERATOR ROTOR DRIVE END BEARING

RC0002-6D3-F-RP

Figure 10 – Generator Rotor Drive End Bearing

**Assemble**

NOTICE: See “Notice” on page 6D3-1 of this section.

1. Inside collar (52) onto rotor (31).
2. Rotor (31) to drive end frame (59).
3. Outside collar (50), fan (45), fan collar (46), pulley (48) and washer (47) onto rotor shaft.
4. Nut (49).

**Tighten**

- Nut (49) to 100 N·m (75 lb. ft.).
5. Bearing (28) into slip ring end frame (43) from outside, until flush with outside shoulder of slip ring end frame (43).
 6. Slip ring end frame electrical components.

**Important**

- Installation of the slip ring end frame electrical components must be done in the following order to insure proper operation of the unit. Assembly in any other manner will result in either no output from generator assembly (5) or a direct internal ground in the generator assembly (5).

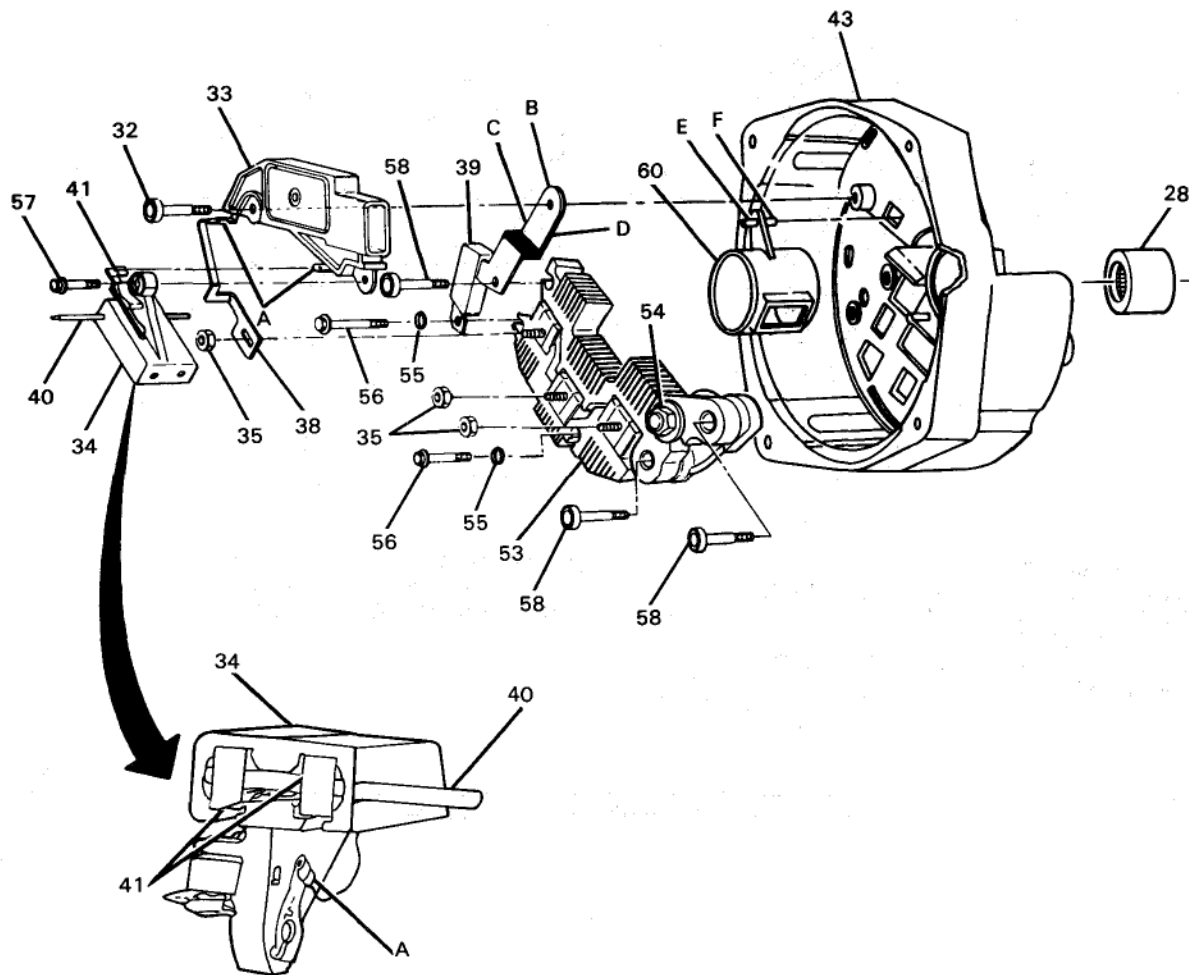
- A. Rectifier bridge (53).
- B. Capacitor (39).
- C. Washers (55).
- D. Bolts/screws (56 and 58).

**Important**

- The capacitor (39) has an insulator material on one side which must rest against the drive end frame (59) (ground).
 - The capacitor/rectifier bridge insulated attaching bolt/screw (58) must be installed in the proper hole, attaching the capacitor strap and rectifier bridge (53) to the slip ring end frame (43).
- E. Brushes (41) into brush holder (34) with retaining pin (40).
 - F. Dust shield (60) onto brush holder (34).
 - G. Voltage regulator (33), and brush holder (34) with dust shield (60), brushes (41) and retaining pin (40) installed into slip ring end frame (43).

**Important**

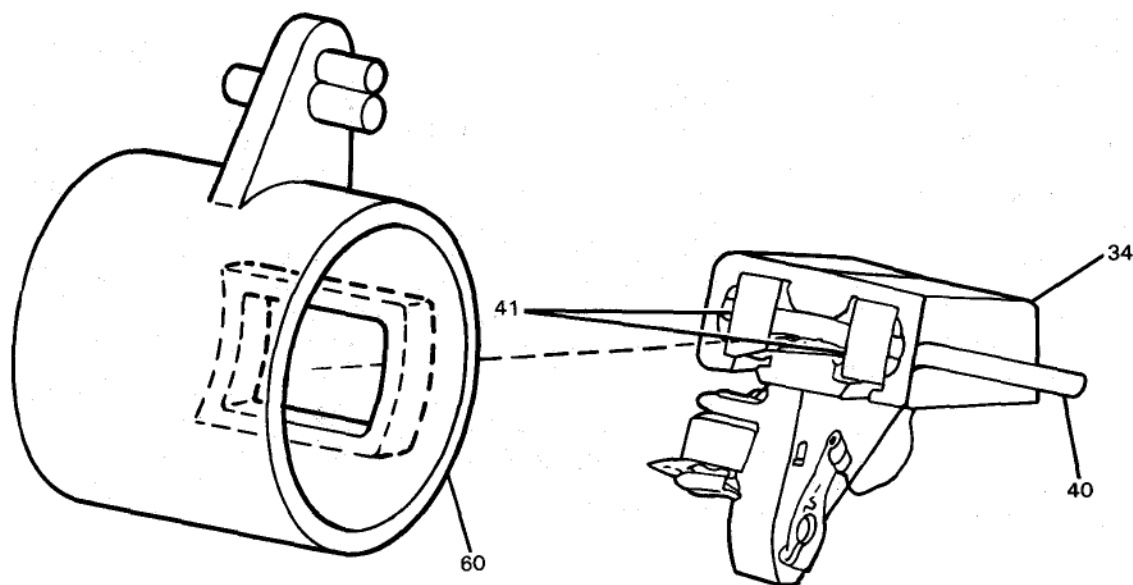
- The metal side of the capacitor strap must be against the regulator connection.



- A CLIPS, SOLDER
- B STRAP, GENERATOR CAPACITOR
- C METAL SIDE
- D INSULATED SIDE
- E PIN, PLASTIC RETAINING
- F CLIP, DUST SHIELD RETAINING
- 28 BEARING, GENERATOR ROTOR SLIP RING END FRAME
- 32 BOLT/SCREW, REGULATOR ATTACHING
- 33 REGULATOR, GENERATOR VOLTAGE
- 34 HOLDER, GENERATOR BRUSH
- 35 NUT, STATOR LEAD ATTACHING
- 38 STRAP, REGULATOR CONNECTOR
- 39 CAPACITOR, GENERATOR
- 40 PIN, BRUSH RETAINING
- 41 BRUSH, GENERATOR
- 43 FRAME, GENERATOR SLIP RING END
- 53 BRIDGE, GENERATOR RECTIFIER
- 54 NUT, GENERATOR BATTERY TERMINAL
- 55 WASHER, GENERATOR RECTIFIER BRIDGE
- 56 BOLT/SCREW, GENERATOR RECTIFIER BRIDGE
- 57 BOLT/SCREW, GENERATOR BRUSH HOLDER
- 58 BOLT/SCREW, GENERATOR CAPACITOR/RECTIFIER
- BRIDGE
- INSULATED ATTACHING
- 60 SHIELD, DUST

PC1010-6D3-B-RP

Figure 11 – Generator Slip Ring End Frame Components



- 34 HOLDER, GENERATOR BRUSH
 40 PIN, BRUSH RETAINING
 41 BRUSH, GENERATOR
 60 SHIELD, DUST

PC6009-6D3-D-RP

Figure 12 – Generator Brushes Retained in Generator Brush Holder

- H. Tap plastic retaining pin on dust shield (60) into retaining clip.

- Be sure brush retaining pin (40) goes through access hole to outside of slip ring end frame (43) for removal after generator is assembled.

- I. Bolt/screw (32) and bolt/screw (57).

- J. Connector strap (38) to voltage regulator solder clip, and brush holder connection to other voltage regulator solder clip.

- Crimp and solder voltage regulator solder clip connections.

NOTICE: Avoid excessive heat when soldering connections, as this can cause voltage regulator damage.

- K. Stator (36), placing stator terminals over rectifier bridge terminals.

- L. Nuts (35).

- M. Slip ring end frame (43) and drive end frame (59), noting scribe marks.

- N. Slip ring end bearing outer race into bearing well in slip ring end frame casting.

- O. Through-bolts/screws (26).

- P. Remove retaining pin (40) to release brushes (41) against slip rings.

SPECIFICATIONS

GENERATOR ASSEMBLY USAGE CHART

ENGINE	EQUIPMENT	MODEL	PART NUMBER	RATED AMPERES
3.4L L32	ALL	CS-130		105
5.7L LT1	ALL	CS-144	10480131	124
5.7L LT1	ALL	CS-144	10480111	140

FASTENER TIGHTENING SPECIFICATIONS

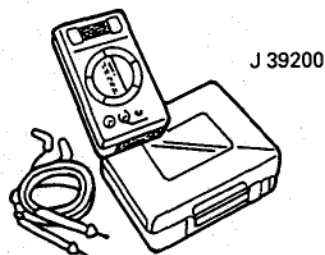
CS-130 105-Amp Generator Assembly (3.4L L32 Engine)

Battery Negative Cable Assembly-to-Battery Terminal	15 N•m (11 lb. ft.)
Battery Positive Cable Assembly-to-Generator Nut	14 N•m (124 lb. in.)
Generator-to-Accessory Mounting Bracket Bolt/Screw (Lower)	50 N•m (37 lb. ft.)
Generator-to-Accessory Mounting Bracket Bolt/Screw (Upper)	50 N•m (37 lb. ft.)
Generator-to-Generator Brace Bolt/Screw	25 N•m (18 lb. ft.)
Generator-to-Generator Brace Nut (Lower)	50 N•m (37 lb. ft.)
Generator-to-Generator Brace Nut (Upper)	25 N•m (18 lb. ft.)

CS-144 124-Amp or 140-Amp Generator Assembly (5.7L LT1 Engine)

Battery Negative Cable Assembly-to-Battery Terminal	15 N•m (11 lb. ft.)
Battery Positive Cable Assembly-to-Generator Bolt/Screw	14 N•m (124 lb. in.)
Battery Positive Cable Assembly-to-Generator Nut	20 N•m (15 lb. ft.)
Generator Outer Brace Mounting Nut	33 N•m (24 lb. ft.)
Generator Rotor Shaft Drive End Nut	100 N•m (75 lb. ft.)
Generator-to-Accessory Mounting Bracket Bolt/Screw (Lower)	50 N•m (37 lb. ft.)
Generator-to-Accessory Mounting Bracket Bolt/Screw (Upper)	50 N•m (37 lb. ft.)
Generator-to-Generator Lower Brace Bolt/Screw	25 N•m (18 lb. ft.)
Generator-to-Generator Upper Brace Bolt/Screw	50 N•m (37 lb. ft.)

SPECIAL TOOLS



1 DIGITAL MULTIMETER

RC0003-6D3-F-RP

SECTION 6D4

IGNITION SYSTEM

CAUTION: Before removing or installing any electrical unit or when a tool or equipment could easily come in contact with "live" exposed electrical terminals, disconnect the negative battery cable to help prevent personal injury and/or damage to the vehicle or components. Unless instructed otherwise, the ignition switch must be in the "OFF" or "LOCK" position.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

The ignition 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 powertrain control module (PCM) controls distributor spark advance (timing) with an ignition control system.

IGNITION SYSTEM (5.7L LT1 ENGINE)

The 5.7L LT1 engine ignition system consists of a distributor assembly, control circuits for ignition timing in the powertrain control module (PCM), a separate ignition coil/ignition control module assembly, primary and secondary wiring, and the spark plugs. All ignition timing is controlled by the PCM; there is no "bypass" mode built into the ignition control module as in other ignition systems.

The distributor assembly is mounted directly to the camshaft assembly next to the water pump assembly. It directs the spark from the ignition coil assembly to the proper spark plug secondary wire through a rotor. The secondary output connectors in the distributor cap are each connected to an individual spark plug. The connectors in the cap are arranged for convenience in routing spark plug wire harness assemblies. The corresponding cylinder number is molded into the distributor cap next to each output connector.

The distributor assembly also contains a signal disk and two optical camshaft position (CMP) sensor assemblies that provide signals to the PCM for timing control. One CMP sensor assembly senses 360 equally-spaced slots in the signal disk to provide 720 signals per camshaft revolution for high-resolution timing control. The other CMP sensor assembly senses eight disk slots of variable length, providing a low-resolution signal that tells the PCM which spark plug is being fired. Power for the optical CMP sensor assemblies, a system ground, and the two

CMP sensor assembly signals are transferred between the PCM and the distributor assembly through a shielded harness connected to the four-terminal connector on the distributor.

The ignition system supplies two timing inputs to the PCM, a high resolution signal (360 pulses per one camshaft revolution) and a low resolution signal (eight pulses per one camshaft revolution). The PCM can determine if one of the timing inputs is not being received by comparing the two inputs. If the PCM detects one timing pulse without detecting the other timing pulse, diagnostic trouble code 16 will set.

The reference signals toggle between 0 and 5 volts as the camshaft assembly turns. Therefore, an open, a short to voltage, a short to ground, or a defective sensor inside the distributor assembly can prevent the voltage from pulsing at the PCM.

The ignition coil/ignition control module assembly provides spark to the distributor assembly, timed by signals from the PCM. Power (B+) for the ignition coil primary circuit and the ignition control module is supplied by the ignition switch. The PCM combines the camshaft position information supplied by the distributor with other system parameters and calculates the required spark advance and coil dwell. The PCM signals the ignition control module, which turns on the primary current to the ignition coil by grounding the primary circuit, and then turns it off by removing the ground. When the primary current flow stops, high voltage induced in the ignition coil secondary winding becomes the spark voltage for the spark plug. The spark voltage is delivered to the distributor assembly through the coil output (secondary) wire, and then directed to the proper spark plug connector by the distributor rotor.

IGNITION SYSTEM (3.4L L32 ENGINE)

The 3.4L L32 engine ignition system uses a "waste spark" method of spark distribution. Each cylinder is paired with its opposing cylinder in the firing order, so that one cylinder on compression fires simultaneously with its opposing cylinder on exhaust. Since the cylinder on the exhaust requires very little of the available voltage to fire its plug, most of the voltage is used to fire the cylinder on compression. The process reverses when the cylinders reverse roles. There are three coils for this electronic ignition (EI) system.

Components of the EI system include an ignition coil, ignition coil module, 3X signal crankshaft position sensor assembly, camshaft position sensor assembly, 24X signal crankshaft position sensor assembly, crankshaft reluctor ring, crankshaft balancer assembly with interrupter rings, and the PCM. The coil pack consists of three separate, interchangeable, ignition coils. The ignition coil module is located above the power steering pump assembly and is connected to the PCM. The ignition coil module controls the primary circuit to the coils, turning them on and off.

This system also uses a magnetic crankshaft position sensor assembly which protrudes into the engine block, within approximately 1.27 mm (0.050 inch) of the crankshaft reluctor. The reluctor is a special wheel cast on the crankshaft assembly that has seven machined slots, six of

which are equally spaced (60 degrees apart). The seventh slot is spaced 10 degrees from one of the other slots. As the reluctor rotates with the crankshaft, the slots change the magnetic field of the crankshaft position sensor assembly, causing an induced voltage pulse.

By counting the time between pulses, the ignition control module can recognize the pulse of the seventh slot (sync pulse). Based on this sync pulse, the ignition control module sends the reference signal to the PCM to calculate crankshaft position (used to fire coils in correct sequence) and engine speed.

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

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

For further information refer to SECTION 6E3.

Camshaft Position Sensor Assembly (3.4L L32 Engine)

The camshaft position sensor assembly is located on the engine block behind the water pump assembly near the lower intake manifold assembly.

The camshaft position sensor assembly is used for timing the injectors for sequential injection. This sensor is a hall-effect type switch. Refer to SECTION 6E3 for more information.

24X Signal Crankshaft Position Sensor Assembly (3.4L L32 Engine)

The 24X signal crankshaft position sensor assembly is mounted to the engine front cover assembly and is partially behind the crankshaft balancer assembly. This sensor reads 24 notches in the crankshaft balancer assembly for crankshaft position and is used for ignition control during engine cranking and improved idle control. The ECM uses the 24X signal crankshaft position sensor assembly to improve spark accuracy at speeds below 1200 rpm, and influence fuel delivery at speeds below 2000 rpm. This is a hall-effect sensor. For additional information, refer to SECTION 6E3.

3X Signal Crankshaft Position Sensor Assembly (3.4L L32 Engine)

The 3X signal crankshaft position sensor assembly inserts through the right side of the engine block at mid-engine, near the crankshaft reluctor ring. Notches in the crankshaft reluctor ring trigger the magnetic pickup sensor to provide timing information to the PCM. This is also a hall-effect sensor. For additional information, refer to SECTION 6E3.

SPARK PLUG WIRE HARNESS ASSEMBLY

The spark plug wire harness assemblies used with both ignition systems use carbon impregnated cord conductors, encased in 8 mm (5/16-inch) diameter silicone jackets. The silicone jackets withstand very high temperatures and also provide excellent insulation for the high

voltage of the system. Silicone spark plug boots form a tight seal to the spark plugs.

SPARK PLUGS

Figure 1

Resistor type, tapered seat spark plugs are used on all engine assemblies. No gasket is used on these tapered-seat spark plugs. Refer to SECTION 0B for spark plug type and gap size. When replacing spark plugs, use only the type specified.

Normal service is assumed to be a mixture of idling, slow speed, and high speed driving. Occasional or intermittent high-speed driving is needed for good spark plug performance. It gives increased combustion heat, burning away carbon or oxides that have built up from frequent idling, or continual stop-and-go driving.

Spark plugs are protected by insulating nipples made of special heat-resistant materials, which cover the spark plug terminals and extend downward over a portion of the plug insulators. These nipples prevent flash-over, which causes engine misfiring. Do not mistake corona discharge for flash-over, or a shorted insulator. Corona is a steady blue light appearing around the insulator, just above the shell crimp. It is the visible evidence of a high-tension field and has no effect on ignition performance. Usually it can be detected only in darkness. This discharge may repel dust particles, leaving a clear ring on the insulator just above the shell. This ring is sometimes mistakenly regarded as evidence that combustion gases have blown out between shell and insulator.

IGNITION SWITCH

The mechanical key and lock cylinder ignition switch is located in the steering column assembly on the right-hand side, just below the steering wheel. The electrical switching portion of the assembly is separate from the key and lock cylinder. However, both are synchronized and work in conjunction through the action of the actuator rod assembly.

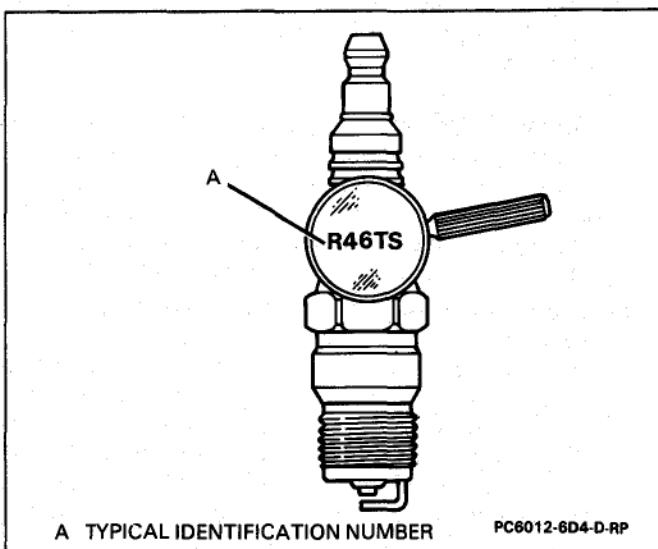


Figure 1 – Spark Plug Identification

For a complete explanation of the key and lock cylinder, and the actuator rod assembly, refer to SECTION 3F or SECTION 3F5B. For electrical switching information, refer to SECTION 8A.

KNOCK SENSOR SYSTEM

The knock sensor system retards the spark advance when detonation occurs. Further information is found in SECTION 6E3.

IGNITION TIMING

The base timing is preset when the engine is manufactured, no adjustment is possible. Timing advance and retard are accomplished through the PCM with ignition control and knock sensor systems.

DIAGNOSIS

IGNITION SYSTEM

Diagnosis for the ignition system is in SECTION 6E3.

SPARK PLUGS

Worn or dirty spark plugs may give satisfactory operation at idling speed, but frequently fail at higher rpm. Faulty spark plugs may cause poor fuel economy, power loss, loss of speed, hard starting and generally poor engine performance. Follow the scheduled maintenance services recommendations given in SECTION 0B, to assure satisfactory spark plug performance.

Normal spark plug operation will result in brown to grayish-tan deposits appearing on the portion of the spark plug that projects into the cylinder area. A small amount of red-brown, yellow, and white powdery material may also be present on the insulator tip around the center electrode. These deposits are normal combustion by-products of fuels and lubricating oils with additives. Some electrode wear will also occur.

Engine assemblies which are not running properly are often referred to as "misfiring." This means the ignition spark is not igniting the fuel/air mixture at the proper time. While other ignition and fuel system causes must also be considered, possible causes include spark plug conditions which allow the spark voltage to reach ground in some other manner than by jumping across the air gap at the tip of the spark plug, leaving the fuel/air mixture unburned. Refer to SECTION 6E3. Misfiring may also occur when the tip of the spark plug becomes overheated and ignites the mixture before the spark jumps. This is referred to as "pre-ignition."

Spark plug misfiring may be indicated in a number of ways: poor fuel economy, power loss, loss of speed, hard starting, and/or generally poor engine performance. Worn or dirty plugs may give satisfactory operation at idling speed, but will misfire under other operating conditions. Spark plugs may also misfire due to fouling, excessive gap, or a cracked or broken insulator. Should misfiring occur before the recommended replacement interval, locate and correct the cause.

Carbon fouling of the spark plug is indicated by dry, black carbon (soot) deposits on the portion of the spark plug in the cylinder. Excessive idling and slow speeds

under light engine loads can keep the spark plug temperatures so low that these deposits are not burned off. Over-rich fuel mixtures or poor ignition system output may also be the cause. Refer to SECTION 6E for diagnosis.

Oil fouling of the spark plug is indicated by wet oily deposits on the portion of the spark plug in the cylinder, usually with little electrode wear. This may be caused by oil getting past worn piston rings. This condition also may occur during break-in of new or newly overhauled engine assemblies.

Deposit fouling of the spark plug occurs when the normal red-brown, yellow or white deposits of combustion by-products become sufficient to cause misfiring. In some cases, these deposits may melt and form a shiny glaze on the insulator around the center electrode. If the fouling is found in only one or two cylinders, valve stem clearances or intake valve seals may be allowing excess lubricating oil to enter the cylinder, particularly if the deposits are heavier on the side of the spark plug that was facing the intake valve.

Excessive gap means that the air space between the center and side electrodes at the bottom of the spark plug is too wide for consistent firing. This may be due to improper gap adjustment or to excessive wear of the electrodes during use. A check of the gap size and comparison to the gap specified for the vehicle in SECTION 0B, will tell if the gap is too wide. Excessive gap wear can be an indication of continuous operation at high speeds or with high engine loads, causing the spark plug to run too hot. Another possible cause is an excessively lean fuel mixture.

Low or high spark plug installation torque or improper seating can result in the spark plug running too hot and cause excessive gap wear. The plug and cylinder head seats must be in good contact for proper heat transfer and spark plug cooling. Dirty or damaged threads in the head or on the spark plug can keep it from seating even though the proper torque is applied. Once spark plugs are properly seated, tighten to torque shown under "Specifications" in this section. Low torque may result in poor contact of seats due to a loose spark plug. Over-tightening may cause spark plug shell to be stretched and also result in poor contact between seats. In extreme cases, exhaust blow-by and damage beyond simple gap wear may occur.

Cracked or broken insulators may be the result of improper installation, damage during spark plug regapping, or heat shock to the insulator material. Upper insulators can be broken when a poorly fitting tool is used during installation or removal, or when the spark plug is hit from the outside. Cracks in the upper insulator may be inside the shell and not visible. Also, the breakage may not cause problems until oil or moisture penetrates the crack later.

A broken or cracked lower insulator tip (around the center electrode) may result from damage during regapping or from "heat shock" (spark plug suddenly operating too hot).

Damage during regapping can happen if the gapping tool is pushed against the center electrode or the insulator around it, causing the insulator to crack. When regapping

a spark plug, make the adjustment by only bending the side electrode, keeping the tool clear of other parts.

"Heat shock" breakage in the lower insulator tip generally occurs during severe engine operating conditions (high speeds or heavy loading) and may be caused by over-advanced timing or low grade fuels. Heat shock refers to a rapid increase in the tip temperature that causes the insulator material to crack.

Spark plugs with less than the recommended amount of service can sometimes be cleaned and regapped, then returned to service. However, if there is any doubt about the serviceability of a spark plug, replace it. Spark plugs with cracked or broken insulators should always be replaced.

SPARK PLUG WIRE HARNESS ASSEMBLY

Spark plug wire harness assemblies can be checked by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wire.

ON-VEHICLE SERVICE

SERVICE PRECAUTIONS

- Allow engine assembly to cool before removing spark plugs. Attempting to remove spark plugs from a hot engine assembly may cause spark plugs to seize, causing damage to cylinder head threads.
- Clean spark plug recess area before removing spark plug. Failure to do so can result in engine damage due to dirt or foreign material entering cylinder head assembly, or in contamination of cylinder head threads. Contaminated threads may prevent proper seating of new spark plug.
- Do not install spark plugs that are either "hotter" or "colder" than the heat range specified for the vehicle. Refer to SECTION 0B, for spark plug usage information. Today's technology requires a specific spark plug heat range for each engine type. Installing spark plugs of any other heat range can severely damage the engine assembly.
- When disconnecting connectors, do not use a screwdriver or other tool to release the locking tab, as it may break.
- Care should be exercised when connecting a timing light or other pick-up equipment. Do not force anything between the boots and wiring, or through the silicone jackets. Connections should be made in parallel using an adapter. The tachometer terminal must never be allowed to touch ground, as damage to the PCM and/or ignition coil assembly can result.
- The material used to construct spark plug wires is very soft. This wire will withstand more heat and carry a higher voltage, but chaffing and cutting become easier. The spark plug wires must be routed correctly to prevent chaffing or cutting. See "Spark Plug Wire Harness Assembly Replacement" in the following procedure, for routing. When removing a spark plug wire from a spark plug, twist the boot on the spark plug one-half turn while pulling on the boot.

SPARK PLUG WIRE HARNESS ASSEMBLY REPLACEMENT

Figures 2 and 3

NOTICE: The boots should be twisted one-half turn while removing. Do not pull on the wires to remove them from the spark plugs. Pull on the boots, or use a tool designed for this purpose.

When replacing spark plug wire harness assemblies (secondary wiring), route the wires correctly and through the proper retainers. Failure to route the wires properly can lead to radio ignition noise and crossfiring of the spark plugs, or shorting of the leads to ground.

For location and routing of the spark plug wire harness assemblies refer to Figures 2 and 3. Note the positions and locations of wires, retainers, studs, etc. for ease of installation.

SPARK PLUGS

Figures 2 and 3

CAUTION: If you smoke while handling coated spark plugs, wear gloves to prevent transfer of the coating to cigarettes and subsequent burning of the coating. Wash hands after installing spark plugs.

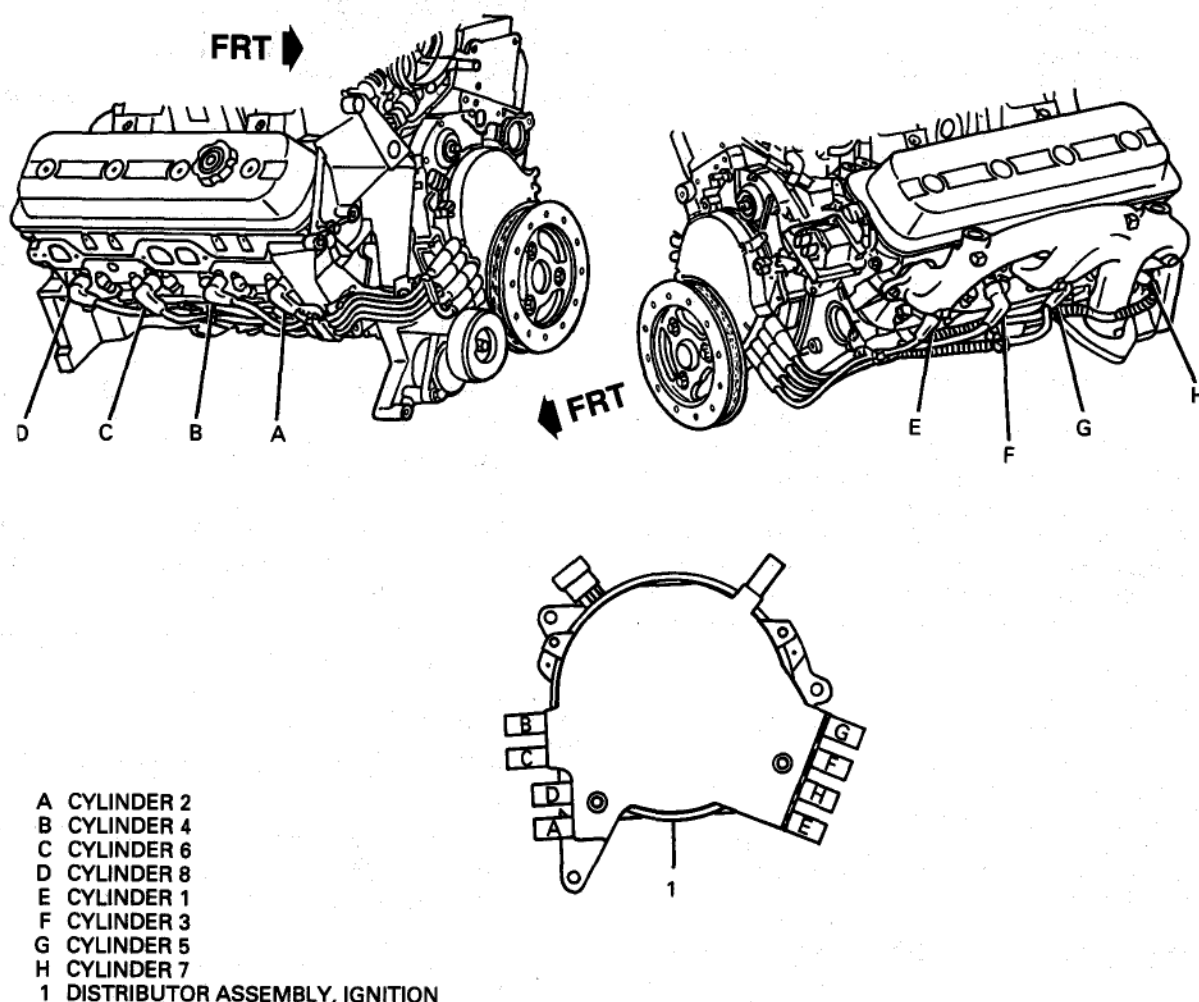


Remove or Disconnect

1. Be sure ignition switch is in "OFF" or "LOCK" position.

NOTICE: The boots should be twisted one-half turn while removing. Do not pull on the wires to remove them from the spark plugs. Pull on the boots, or use a tool designed for this purpose.

2. Spark plug wire harness assembly from spark plugs.
 - Note positions of wires before removing.



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Figure 2 – Spark Plug Wire Harness Assembly Routing (5.7L LT1 Engine)

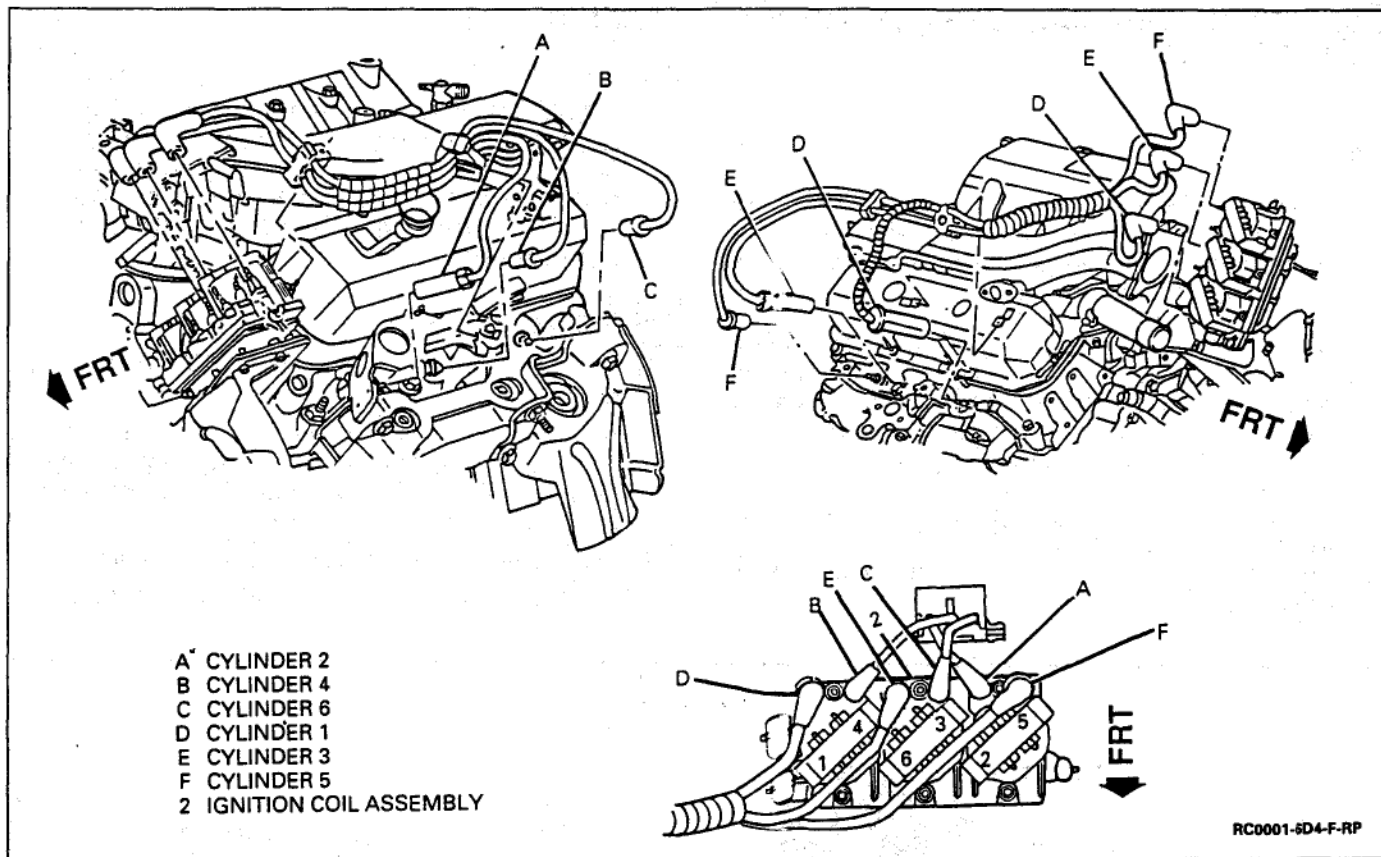


Figure 3 - Spark Plug Wire Harness Assembly Routing (3.4L L32 Engine)

Important

- Clean dirt and debris from spark plug recess areas.

3. Spark plugs from cylinder head assemblies.

Install or Connect

NOTICE: Be sure spark plugs thread smoothly into cylinder head assemblies and are fully seated. Cross-threading or failing to fully seat spark plugs can cause overheating of spark plugs, exhaust blow-by, or thread damage. Follow recommended torque specifications carefully. Over or under-tightening can also cause severe damage to cylinder head assemblies or spark plugs.

1. Spark plugs to cylinder head assemblies.

Tighten

- Spark plugs to 15 N•m (11 lb. ft.).
2. Spark plug wire harness assemblies, routed properly as note during removal.

DISTRIBUTOR (5.7L LT1 ENGINE)

Figure 4

Remove or Disconnect

1. Be sure ignition switch is in "OFF" or "LOCK" position.

2. Water pump assembly. Refer to SECTION 6B.
3. Crankshaft balancer assembly. Refer to SECTION 6A3A.
4. Spark plug wire harness assemblies from distributor assembly (1).
5. Four-terminal PCM connector from distributor assembly (1).
6. Distributor bolts/screws (3).
7. Distributor assembly (1).

A. Pull distributor assembly forward until driveshaft (4) disengages from end of camshaft assembly.

B. Mark top surface of driveshaft (4), for alignment during installation.

Install or Connect

NOTICE: See "Notice" on page 6D4-1 of this section.

1. Distributor driveshaft (4) into distributor assembly (1), if removed.
 - Turn driveshaft (4) until alignment mark made during removal is on top.
2. Distributor assembly (1) into position with driveshaft (4) in end of camshaft assembly.
3. Distributor bolts/screws (3).

Tighten

- Bolts/screws (3) to 11 N•m (97 lb. in.).

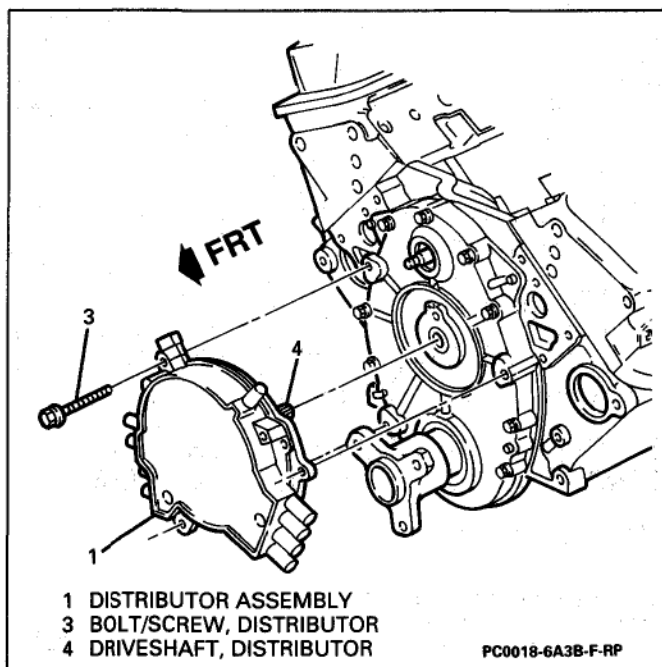


Figure 4 - Distributor Assembly (5.7L LT1 Engine)

4. Four-terminal PCM connector to distributor assembly (1).
5. Spark plug wire harness assemblies to distributor assembly (1).
6. Crankshaft balancer assembly. Refer to SECTION 6A3A.
7. Water pump assembly. Refer to SECTION 6B.

IGNITION COIL ASSEMBLY (5.7L LT1 ENGINE)

Figure 5

Remove or Disconnect

1. Be sure ignition switch is in "OFF" or "LOCK" position.
2. Four-terminal PCM connector at ignition coil module.
3. Ignition coil wiring connectors.
4. Ignition coil harness.
5. Bolt/screw (6).
6. Stud (5).
7. Ignition coil assembly (8).

- Do not wipe silicone grease from bottom of ignition coil assembly (8) if it is to be reinstalled.

Install or Connect

NOTICE: See "Notice" on page 6D4-1 of this section.

NOTICE: If a new ignition coil assembly is to be installed, a package of silicone grease will be included in the box. This grease is necessary for ignition coil assembly cooling.

1. Spread silicone grease on metal mounting face of ignition coil bracket (14) if necessary, and position ignition coil assembly (8) to cylinder head assembly.
2. Stud (5).

Tighten

- Stud (5) to 25 N•m (18 lb. ft.).

3. Bolt/screw (6).

Tighten

- Bolt/screw (6) to 25 N•m (18 lb. ft.).

4. Ignition coil harness.
5. Ignition coil wiring connectors.
6. Four-terminal PCM connector to ignition coil module.

IGNITION COIL ASSEMBLY (3.4L L32 ENGINE)

Figure 6

Remove or Disconnect

1. Be sure ignition switch is in "OFF" or "LOCK" position.
2. Spark plug wire harness assembly from ignition coil assembly (2).
3. Electrical connectors.
4. Nuts (16).
5. Ignition coil assembly (2).

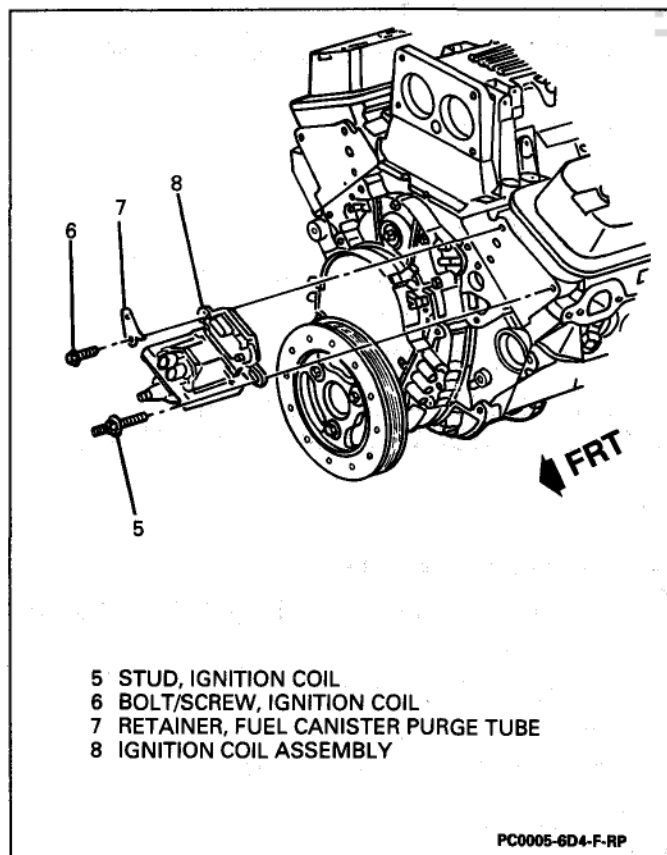


Figure 5 - Ignition Coil Assembly (5.7L LT1 Engine)

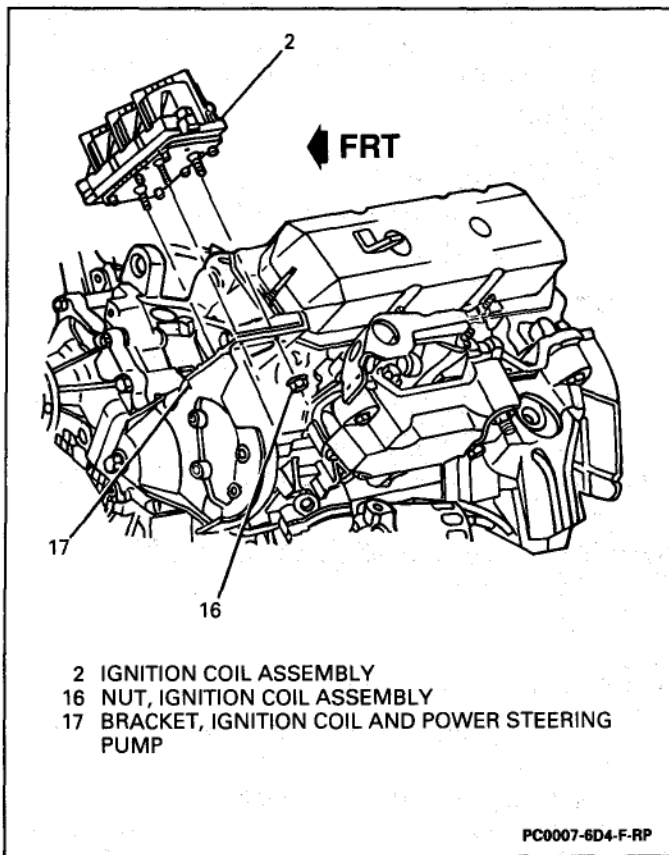


Figure 6 – Ignition Coil Assembly (3.4L L32 Engine)

Install or Connect

NOTICE: See “Notice” on page 6D4-1 of this section.

1. Ignition coil assembly (2).
2. Nuts (16).

Tighten

- Nuts (16) to 10 N•m (89 lb. in.).
3. Electrical connectors.
 4. Spark plug wire harness assembly.

3X SIGNAL CRANKSHAFT POSITION SENSOR ASSEMBLY (3.4L L32 ENGINE)

Figure 7

Remove or Disconnect

1. Be sure ignition switch is in “OFF” or “LOCK” position.
2. Sensor electrical connector.
3. Bolt/screw (26).
4. Sensor assembly (25) from engine block.

Inspect

- Sensor O-ring for wear, cracks or leakage. Replace if necessary.

Install or Connect

NOTICE: See “Notice” on page 6D4-1 of this section.

1. Lubricate sensor O-ring with engine oil.
2. Sensor assembly (25) to the engine block.
3. Bolt/screw (26).

Tighten

- Bolt/screw (26) to 10 N•m (89 lb. in.).
4. Sensor electrical connector.

24X SIGNAL CRANKSHAFT POSITION SENSOR ASSEMBLY (3.4L L32 ENGINE)

Figure 7

Remove or Disconnect

1. Be sure ignition switch is in “OFF” or “LOCK” position.
2. Crankshaft balancer assembly. Refer to SECTION 6A2A.
3. Bolts/screws (24).
4. Sensor (23).

Install or Connect

NOTICE: See “Notice” on page 6D4-1 of this section.

1. Sensor (23).
2. Bolts/screws (24).

Tighten

- Bolts/screws (24) to 1.9 N•m (17 lb. in.).
3. Crankshaft balancer assembly. Refer to SECTION 6A2A.

CAMSHAFT POSITION SENSOR ASSEMBLY (3.4L L32 ENGINE)

Figure 7

Remove or Disconnect

1. Be sure ignition switch is in “OFF” or “LOCK” position.
2. Electrical connector from sensor assembly (27).
3. Bolt/screw (28).

NOTICE: Be careful not to damage sensor assembly when prying at its base during removal.

4. Sensor assembly (27) using a small-bladed screwdriver to gently pry between sensor assembly (27) and engine block.
 - Pry from alternate sides to loosen sensor assembly (27) in its mounting boss.

Inspect

- Sensor O-rings for wear, cracks or leakage. Replace if necessary.

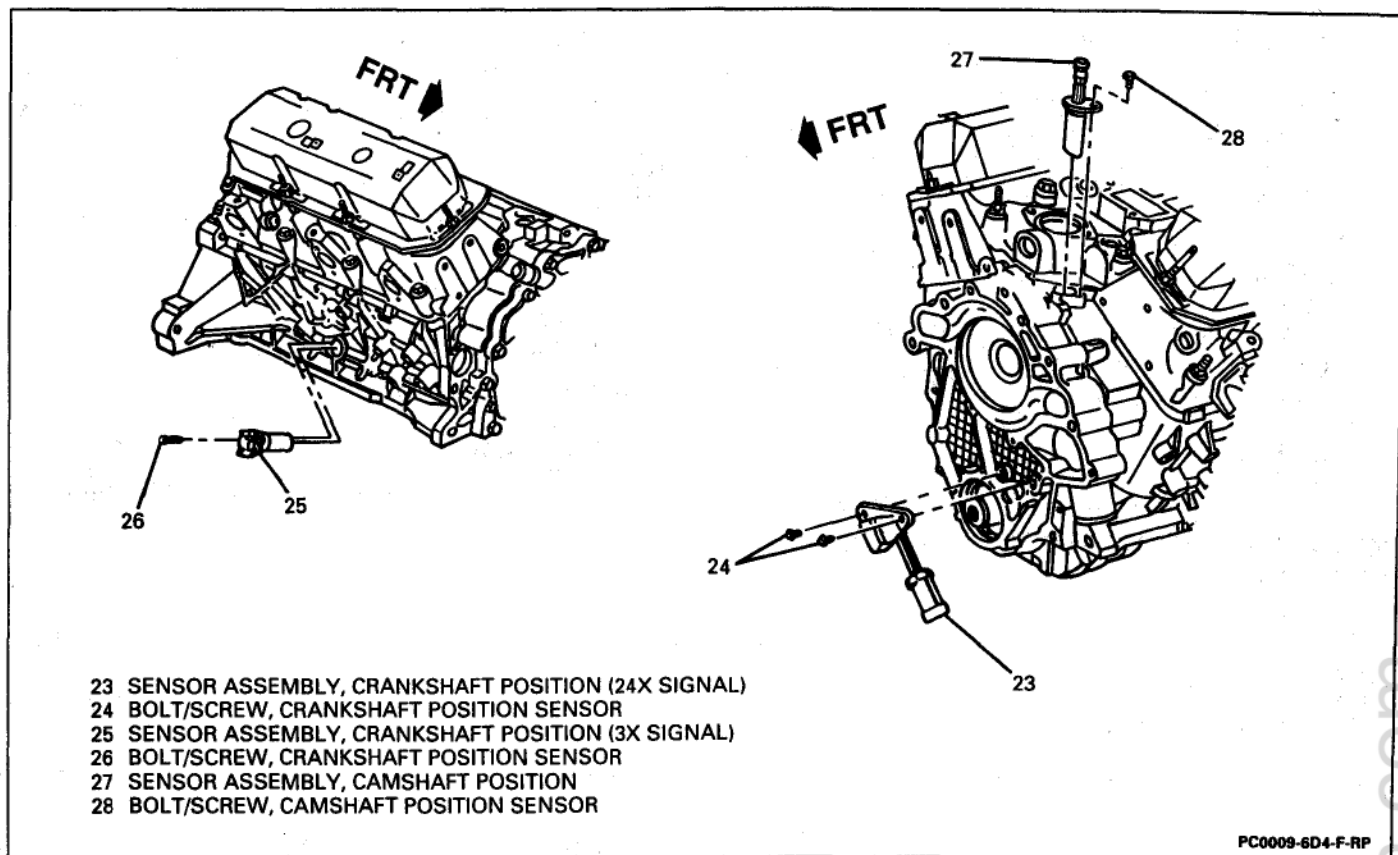


Figure 7 – Crankshaft and Camshaft Position Sensor Assemblies (3.4L L32 Engine)

Install or Connect

NOTICE: See “Notice” on page 6D4-1 of this section.

1. Lubricate sensor O-rings with engine oil.
2. Sensor (27) in engine block.
3. Bolt/screw (28).

Tighten

- Bolt/screw (28) to 1.9 N•m (17 lb. in.).
4. Sensor electrical connector.

UNIT REPAIR

IGNITION COIL AND IGNITION COIL MODULE (5.7L LT1 ENGINE)

Figure 8

Disassemble

1. Coil (10) from brackets (13 and 14) by drilling out rivets (9).
2. Bolts/screws (12).
3. Ignition coil module (11).

Assemble

NOTICE: See “Notice” on page 6D4-1 of this section.

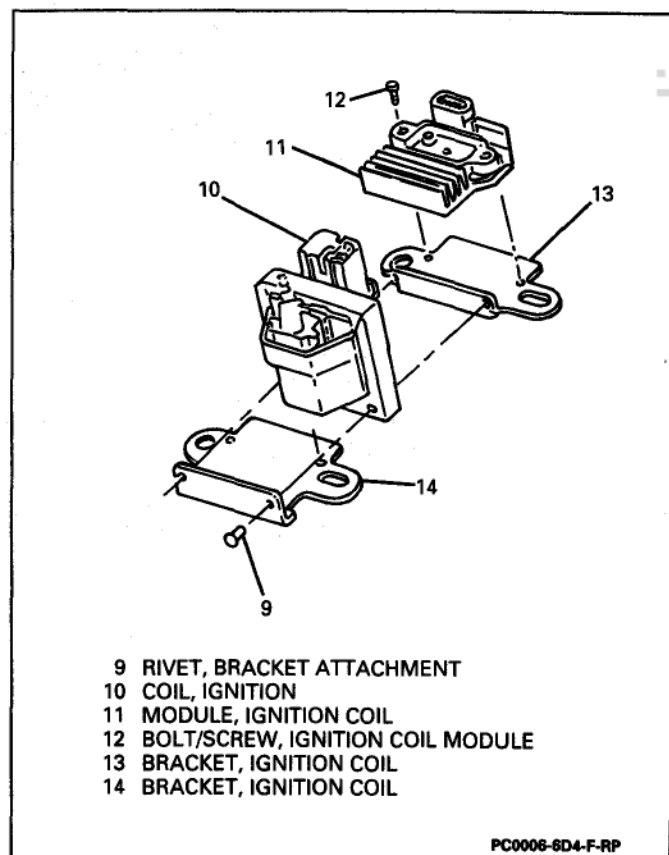


Figure 8 – Ignition Coil and Ignition Coil Module (5.7L LT1 Engine)

NOTICE: A package of silicone grease is included with a new ignition coil module. This grease is necessary for ignition coil module cooling.

1. Spread silicone grease on metal face of ignition coil module (11) and on bracket (13) where it seats, and position ignition coil module (11) to bracket (13).
2. Bolts/screws (12).

Tighten

- Bolts/screws (12) to 1.7 N•m (15 lb. in.).
3. Coil (10) to brackets (13 and 14) using bolts/screws provided with replacement coil (10).

Tighten

- Bolts/screws to 2.8 N•m (25 lb. in.).

IGNITION COIL ASSEMBLY (3.4L L32 ENGINE)

Figure 9

Disassemble

1. Bolts/screws (22).

2. Ignition coils (18).
3. Seals (19).
4. Module (20) from bracket (21).

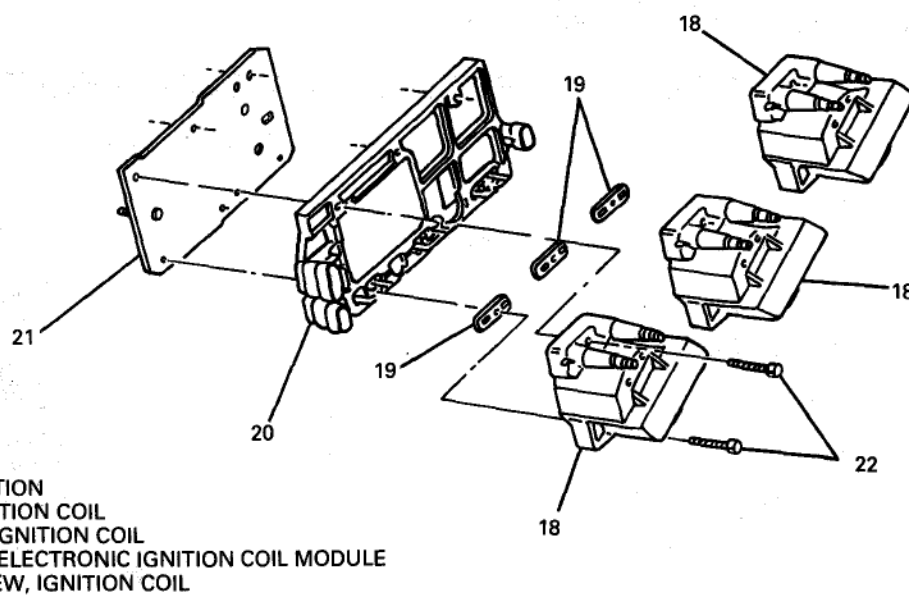
Assemble

NOTICE: See "Notice" on page 6D4-1 of this section.

1. Module (20) to bracket (21).
2. Seals (19).
3. Ignition coils (18).
4. Bolts/screws (22).

Tighten

- Bolts/screws (22) to 4.5 N•m (40 lb. in.).



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Figure 9 – Ignition Coils and Ignition Coil Module (3.4L L32 Engine)

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Camshaft Position Sensor Assembly Bolt/Screw (3.4L L32 Engine)	1.9 N•m (17 lb. in.)
Distributor Bolt/Screw (5.7L LT1 Engine)	11 N•m (97 lb. in.)
Ignition Coil Assembly Bolt/Screw (3.4L L32 Engine)	4.5 N•m (40 lb. in.)
Ignition Coil Assembly Bolt/Screw (5.7L LT1 Engine)	25 N•m (18 lb. ft.)
Ignition Coil Assembly Nut (3.4L L32 Engine)	10 N•m (89 lb. in.)
Ignition Coil Assembly Stud (5.7L LT1 Engine)	25 N•m (18 lb. ft.)
Ignition Coil Bolt/Screw (5.7L LT1 Engine)	2.8 N•m (25 lb. in.)
Ignition Coil Module Bolt/Screw (5.7L LT1 Engine)	1.7 N•m (15 lb. in.)
Spark Plugs	15 N•m (11 lb. ft.)
3X Signal Crankshaft Position Sensor Assembly Bolt/Screw (3.4L L32 Engine)	10 N•m (89 lb. in.)
24X Signal Crankshaft Position Sensor Assembly Bolt/Screw (3.4L L32 Engine)	1.9 N•m (17 lb. in.)

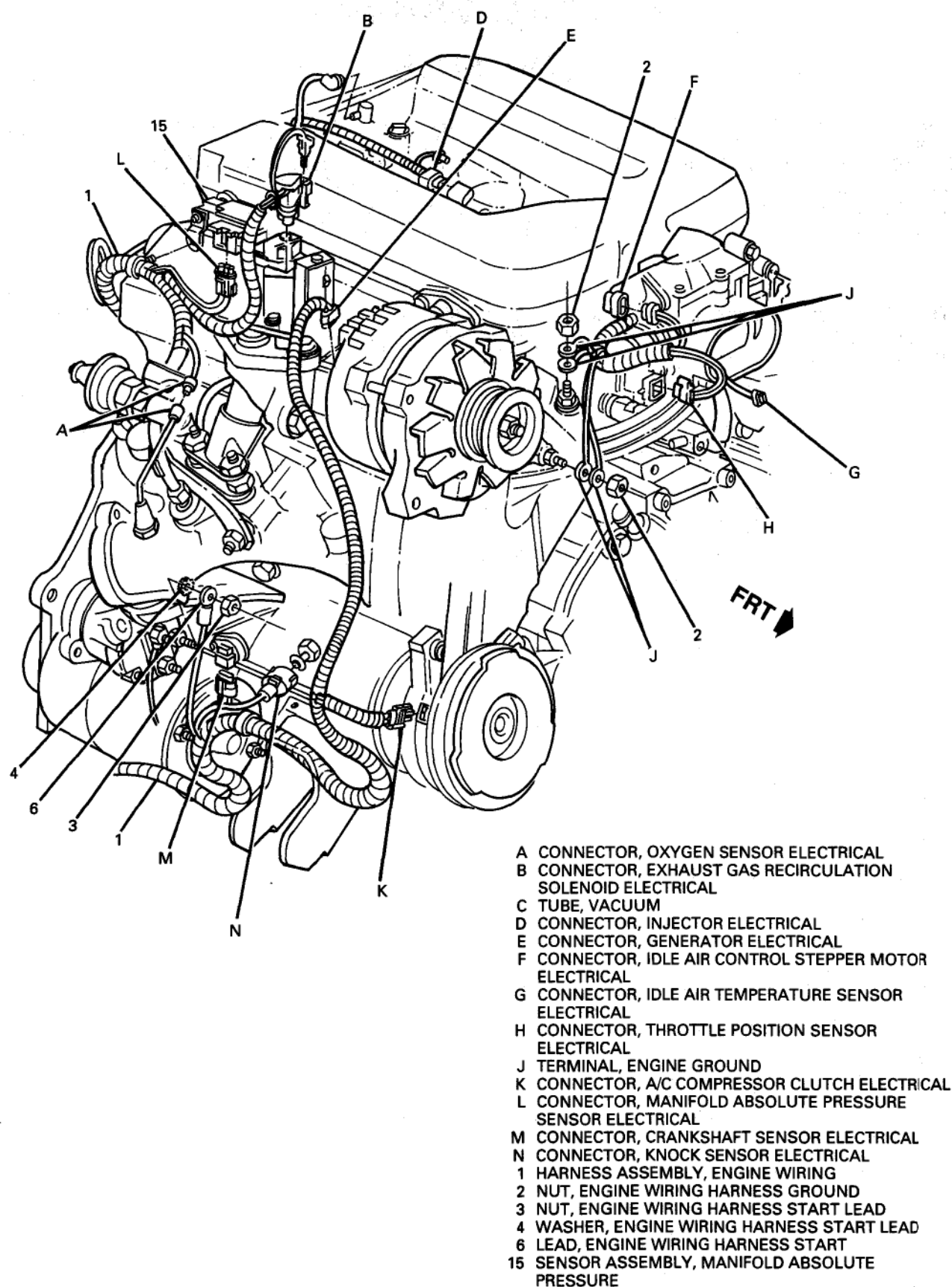
SECTION 6D5

ENGINE WIRING

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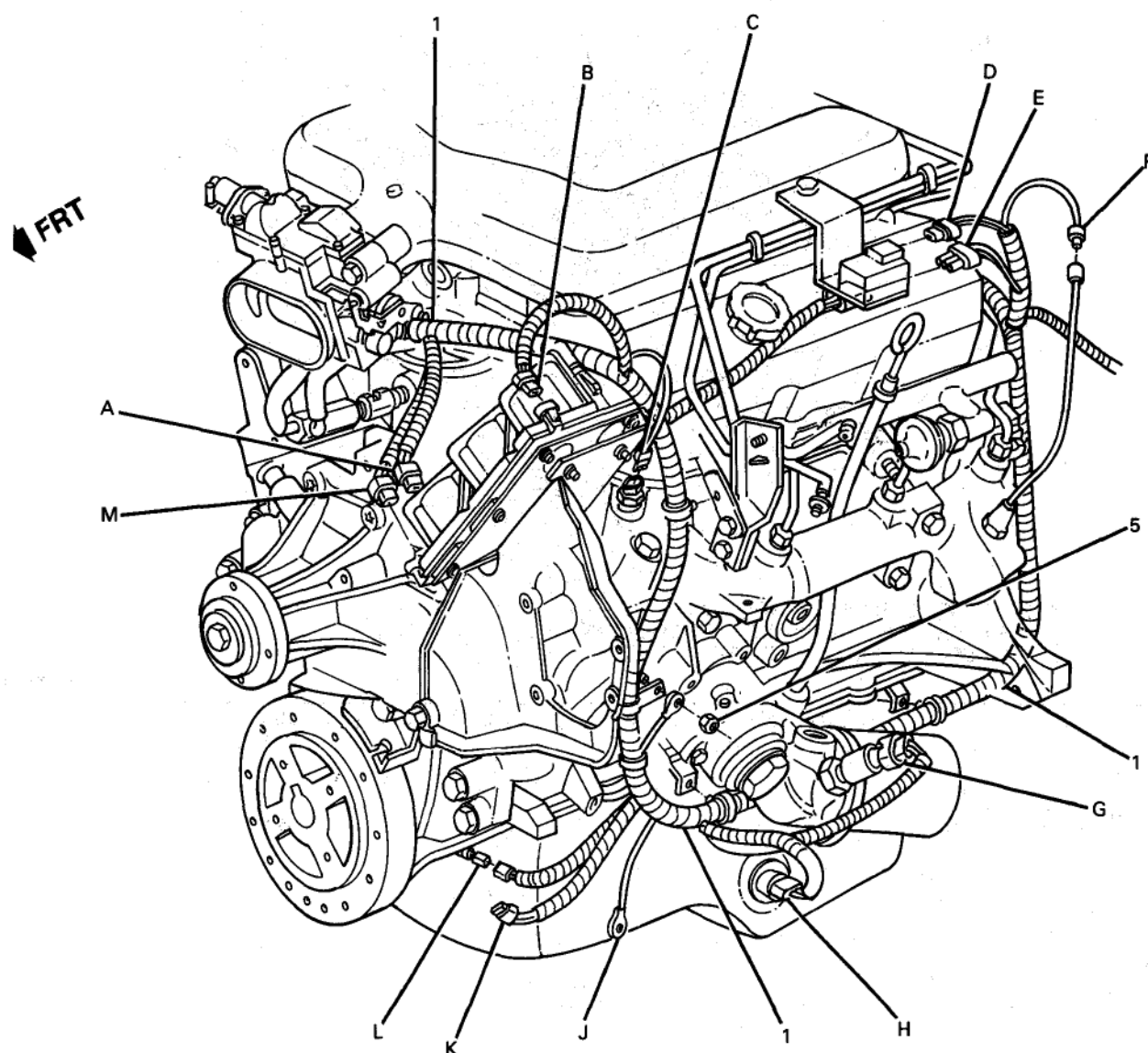
Right-Hand Side Engine Wiring Harness Assembly (3.4L L32)	6D5-2	Right-Hand Side Engine Wiring Harness Assembly (5.7L LT1)	6D5-5
Left-Hand Side Engine Wiring Harness Assembly (3.4L L32)	6D5-3	Left-Hand Side Engine Wiring Harness Assembly (5.7L LT1)	6D5-6
Rear View Engine Wiring Harness Assembly (3.4L L32)	6D5-4	Transmission Engine Wiring Harness Assembly (All)	6D5-7

The following figures illustrate engine wiring harness routing and the various electrical/electronic components that have terminal connectors attached to them. In the illustration legends, the connectors are identified with the component name that completes their connection. Refer to SECTION 8A for detailed diagnostics.



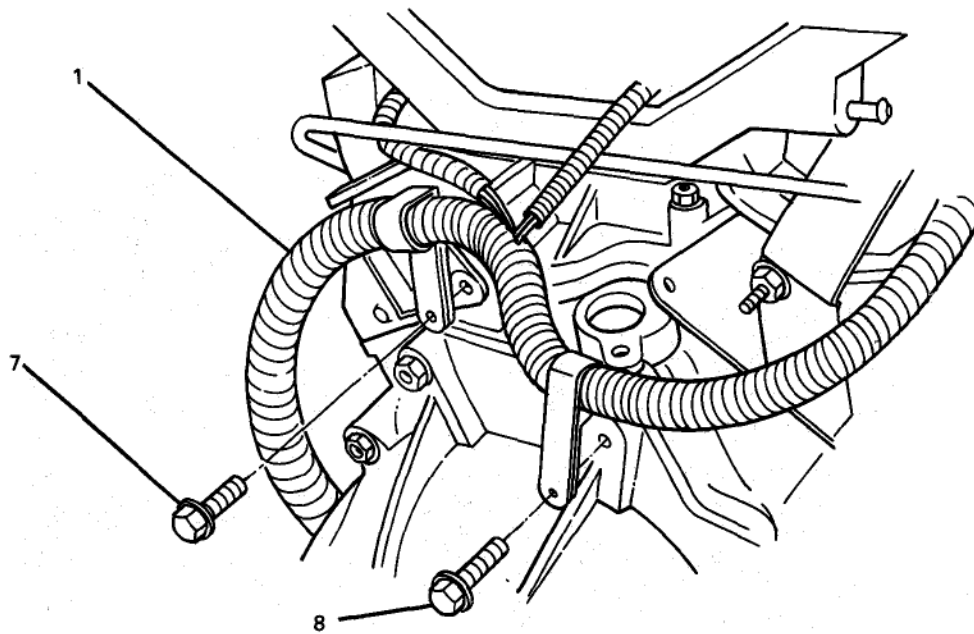
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Figure 1 – Right-Hand Side Engine Wiring Harness Assembly (3.4L L32)



- A CONNECTOR, DISTRIBUTOR SENSOR INPUT/OUTPUT ELECTRICAL
- B CONNECTOR, DISTRIBUTOR POWER INPUT ELECTRICAL
- C CONNECTOR, ENGINE COOLANT TEMPERATURE GAGE SENSOR ELECTRICAL
- D CONNECTOR, CANISTER PURGE SOLENOID VALVE ELECTRICAL
- E CONNECTOR, CAMSHAFT POSITION SENSOR ELECTRICAL
- F CONNECTOR, OXYGEN SENSOR ELECTRICAL
- G CONNECTOR, OIL PRESSURE SENSOR ELECTRICAL
- H CONNECTOR, OIL LEVEL SENSOR ELECTRICAL
- J STRAP, RIGHT FRONT GROUND
- K CONNECTOR, POWER STEERING PRESSURE SWITCH ELECTRICAL
- L CONNECTOR, CRANKSHAFT POSITION SENSOR ELECTRICAL
- M CONNECTOR, CRANK SENSOR INPUT ELECTRICAL
- 1 HARNESS ASSEMBLY, ENGINE WIRING
- 5 NUT, ENGINE WIRING HARNESS CLAMP

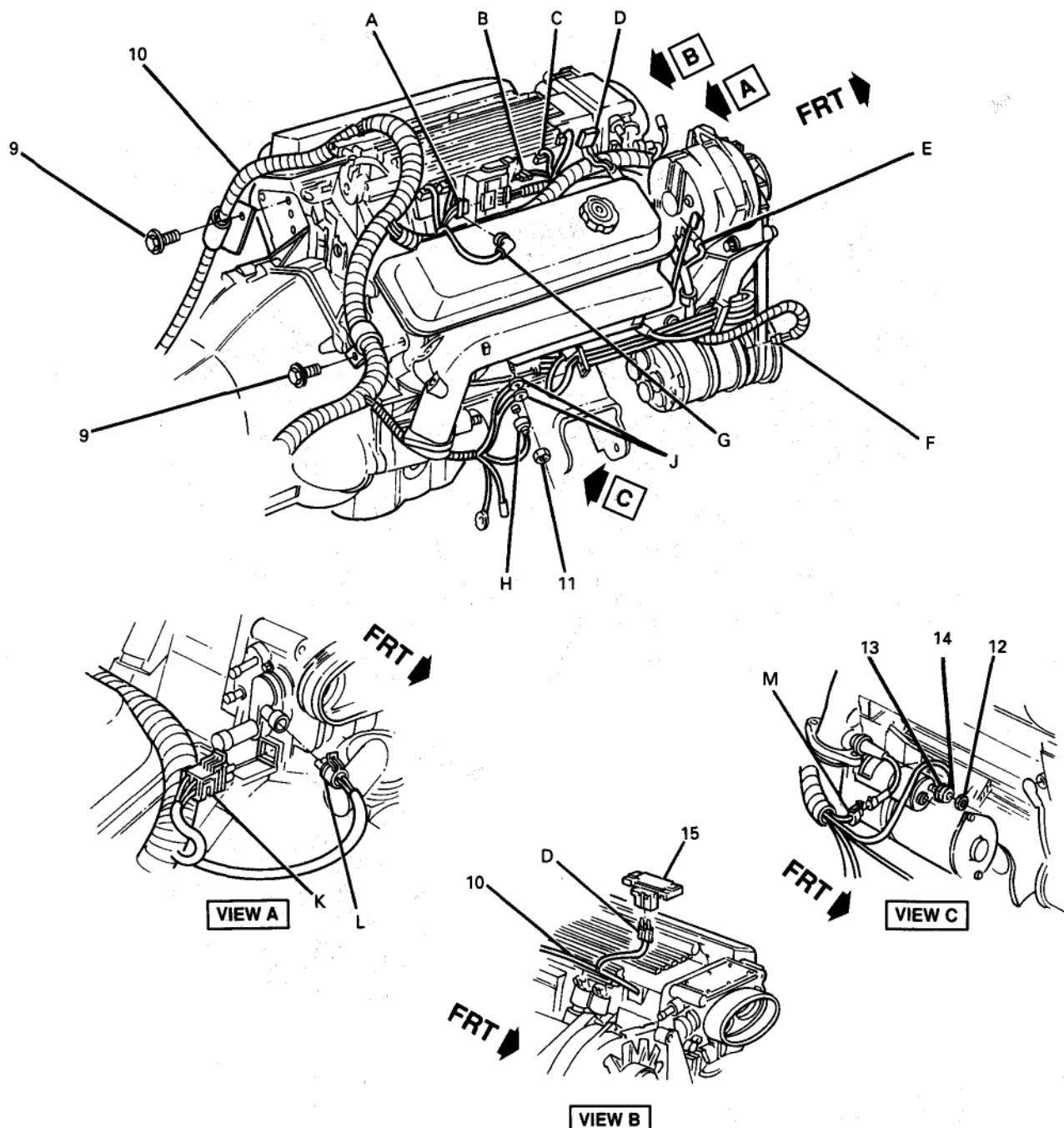
Figure 2 – Left-Hand Side Engine Wiring Harness Assembly (3.4L L32)



- 1 HARNESS ASSEMBLY, ENGINE WIRING
- 7 BOLT/SCREW, ENGINE WIRING HARNESS CLAMP
- 8 BOLT/SCREW, FLYWHEEL HOUSING

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Figure 3 – Rear View Engine Wiring Harness Assembly (3.4L L32)

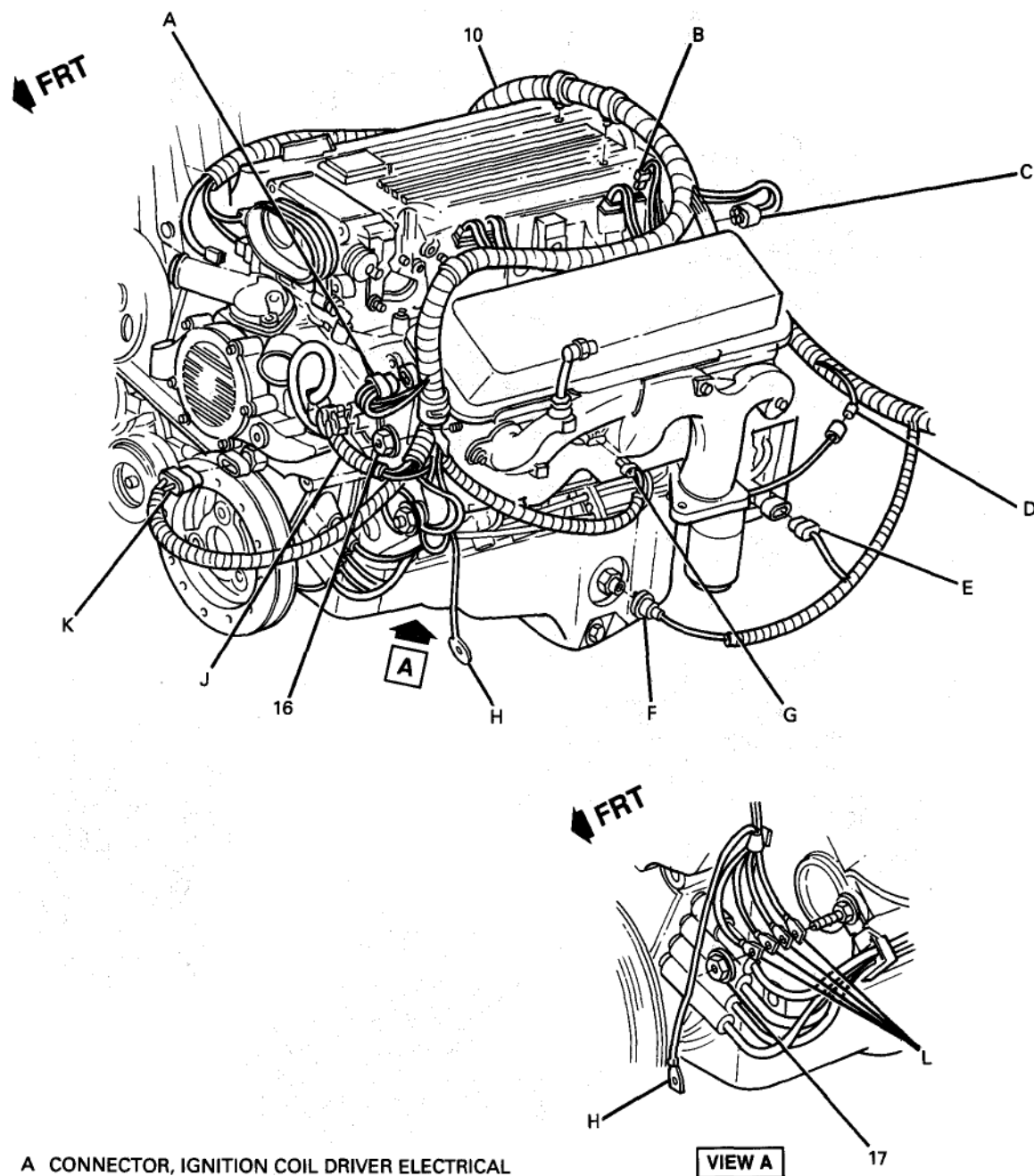


- A CONNECTOR, IGNITION DISTRIBUTOR ELECTRICAL
- B CONNECTOR, CANISTER PURGE SOLENOID VALVE ELECTRICAL
- C CONNECTOR, INJECTOR ELECTRICAL
- D CONNECTOR, MANIFOLD ABSOLUTE PRESSURE SENSOR ELECTRICAL
- E CONNECTOR, GENERATOR ELECTRICAL
- F CONNECTOR, A/C COMPRESSOR CLUTCH ELECTRICAL
- G TUBE, VACUUM
- H CONNECTOR, KNOCK SENSOR ELECTRICAL
- J TERMINAL, ENGINE GROUND
- K CONNECTOR, IDLE AIR CONTROL STEPPER MOTOR ELECTRICAL

VIEW B

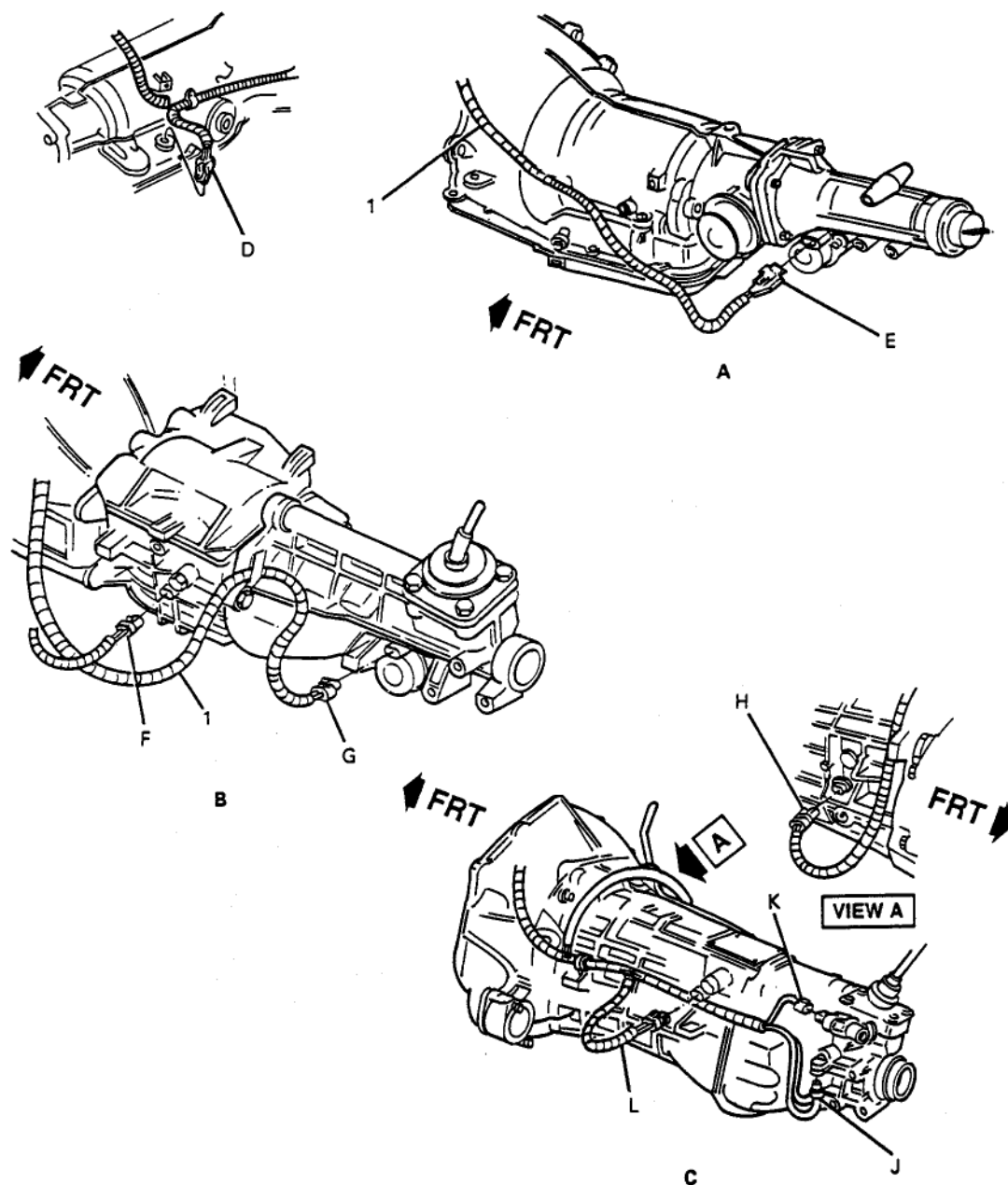
- L CONNECTOR, THROTTLE POSITION SENSOR ELECTRICAL
- M CONNECTOR, OXYGEN SENSOR ELECTRICAL
- 9 BOLT/SCREW, ENGINE WIRING HARNESS CLAMP
- 10 HARNESS ASSEMBLY, ENGINE WIRING
- 11 NUT, ENGINE WIRING HARNESS GROUND
- 12 NUT, ENGINE WIRING HARNESS START LEAD
- 13 WASHER, ENGINE WIRING HARNESS START LEAD
- 14 LEAD, ENGINE WIRING HARNESS START
- 15 SENSOR ASSEMBLY, MANIFOLD ABSOLUTE PRESSURE

Figure 4 – Right-Hand Side Engine Wiring Harness Assembly (5.7L LT1)



- A CONNECTOR, IGNITION COIL DRIVER ELECTRICAL
- B CONNECTOR, INJECTOR ELECTRICAL
- C CONNECTOR, EXHAUST GAS RECIRCULATION SOLENOID VALVE ELECTRICAL
- D CONNECTOR, OXYGEN SENSOR ELECTRICAL
- E CONNECTOR, OIL PRESSURE SENSOR ELECTRICAL
- F CONNECTOR, OIL LEVEL SENSOR ELECTRICAL
- G CONNECTOR, ENGINE COOLANT TEMPERATURE GAGE SENSOR ELECTRICAL
- H STRAP, RIGHT FRONT GROUND
- J CONNECTOR, IGNITION COIL ELECTRICAL
- K CONNECTOR, ENGINE COOLANT TEMPERATURE SENSOR ELECTRICAL
- L TERMINAL, GROUND
- 10 HARNESS ASSEMBLY, ENGINE WIRING
- 16 NUT, ENGINE WIRING HARNESS CLAMP
- 17 NUT, ENGINE WIRING HARNESS GROUND

Figure 5 – Left-Hand Side Engine Wiring Harness Assembly (5.7L LT1)



- A TRANSMISSION ASSEMBLY, AUTOMATIC (MD8)
- B TRANSMISSION ASSEMBLY, MANUAL (5-SPEED M49)
- C TRANSMISSION ASSEMBLY, MANUAL (6-SPEED MM6)
- D CONNECTOR, ELECTRONIC SWITCH
- E CONNECTOR, VEHICLE SPEED SENSOR ELECTRICAL
- F CONNECTOR, BACKUP SWITCH ELECTRICAL
- G CONNECTOR, VEHICLE SPEED SENSOR ELECTRICAL
- H CONNECTOR, BACKUP SWITCH ELECTRICAL
- J CONNECTOR, VEHICLE SPEED SENSOR ELECTRICAL
- K CONNECTOR, REVERSE LOCKOUT SOLENOID ELECTRICAL
- L CONNECTOR, SKIP SHIFT SOLENOID
- 1 HARNESS ASSEMBLY, ENGINE WIRING

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Figure 6 – Transmission Engine Wiring Harness Assembly (All)

