STARTING SYSTEMS

CONTENTS

DESCRIPTION AND OPERATION

STARTING SYSTEM

DESCRIPTION

An electrically operated engine starting system is standard factory-installed equipment on this model. The starting system is designed to provide the vehicle operator with a convenient, efficient and reliable means of cranking and starting the internal combustion engine used to power the vehicle and all of its accessory systems from within the safe and secure confines of the passenger compartment. See the owner's manual in the vehicle glove box for more information and instructions on the recommended use and operation of the factory-installed starting system.

NOTE: This group covers both Left-Hand Drive (LHD) and Right-Hand Drive (RHD) versions of this model. Whenever required and feasible, the RHD versions of affected vehicle components have been constructed as mirror-image of the LHD versions. While most of the illustrations used in this group represent only the LHD version, the diagnostic and service procedures outlined can generally be applied to either version. Exceptions to this rule have been clearly identified as LHD or RHD, if a special illustration or procedure is required.

The starting system consists of the following components:

- Battery
- Starter relay
- Starter motor (including an integral starter solenoid)
- Ignition switch
- Clutch pedal position switch (manual transmission)
- Park/neutral position switch (automatic transmission)
- Wire harnesses and connections (including the battery cables).

This group provides complete service information for the starter motor and the starter relay. Complete service information for the other starting system components can be located as follows:

- Refer to **Battery** in the proper section of Group 8A - Battery for complete service information for the battery.
- Refer to **Ignition Switch and Key Lock Cylinder** in the proper section of Group 8D - Ignition System for complete service information for the ignition switch.
- Refer to **Clutch Pedal Position Switch** in the proper section of Group 6 - Clutch for complete service information for the clutch pedal position switch.
- Refer to **Park/Neutral Position Switch** in the proper section of Group 21 - Transmission for complete service information for the park/neutral position switch.
- Refer to the proper section of **Group 8W - Wiring Diagrams** for complete service information and circuit diagrams for the starting system wiring components.

Group 8A covers the Battery, Group 8B covers the Starting Systems, and Group 8C covers the Charging System. We have separated these systems to make it easier to locate the information you are seeking within this Service Manual. However, when attempting to diagnose any of these systems, it is important that you keep their interdependency in mind.

The battery, starting, and charging systems in the vehicle operate with one another, and must be tested as a complete system. In order for the vehicle to start and charge properly, all of the components that are used in these systems must perform within specifications.

DESCRIPTION AND OPERATION (Continued)

The diagnostic procedures used in each of these groups include the most basic conventional diagnostic methods, to the more sophisticated On-Board Diagnostics (OBD) built into the Powertrain Control Module (PCM). Use of an induction-type milliampere ammeter, volt/ohmmeter, battery charger, carbon pile rheostat (load tester), and 12-volt test lamp may be required.

All OBD-sensed systems are monitored by the PCM. Each monitored circuit is assigned a Diagnostic Trouble Code (DTC). The PCM will store a DTC in electronic memory for any failure it detects. Refer to **On-Board Diagnostic Test For Charging System** in the Diagnosis and Testing section of Group 8C - Charging System for more information.

OPERATION

The starting system components form two separate circuits. A high-amperage feed circuit that feeds the starter motor between 150 and 350 amperes, and a low-amperage control circuit that operates on less than 20 amperes. The high-amperage feed circuit components include the battery, the battery cables, the contact disc portion of the starter solenoid, and the starter motor. The low-amperage control circuit components include the ignition switch, the clutch pedal position switch (manual transmission), the park/neutral position switch (automatic transmission), the starter relay, the electromagnetic windings of the starter solenoid, and the connecting wire harness components.

If the vehicle is equipped with a manual transmission, it has a clutch pedal position switch installed in series between the ignition switch and the coil battery terminal of the starter relay. This normally open switch prevents the starter relay from being energized when the ignition switch is turned to the momentary Start position, unless the clutch pedal is depressed. This feature prevents starter motor operation while the clutch disc and the flywheel are engaged. The starter relay coil ground terminal is always grounded on vehicles with a manual transmission.

If the vehicle is equipped with an automatic transmission, battery voltage is supplied through the low-amperage control circuit to the coil battery terminal of the starter relay when the ignition switch is turned to the momentary Start position. The park/neutral position switch is installed in series between the starter relay coil ground terminal and ground. This normally open switch prevents the starter relay from being energized and the starter motor from operating unless the automatic transmission gear selector is in the Neutral or Park positions.

When the starter relay coil is energized, the normally open relay contacts close. The relay contacts connect the relay common feed terminal to the relay normally open terminal. The closed relay contacts energize the starter solenoid coil windings.

The energized solenoid pull-in coil pulls in the solenoid plunger. The solenoid plunger pulls the shift lever in the starter motor. This engages the starter overrunning clutch and pinion gear with the starter ring gear on the manual transmission flywheel or on the automatic transmission torque converter drive plate.

As the solenoid plunger reaches the end of its travel, the solenoid contact disc completes the high-amperage starter feed circuit and energizes the solenoid plunger hold-in coil. Current now flows between the solenoid battery terminal and the starter motor, energizing the starter.

Once the engine starts, the overrunning clutch protects the starter motor from damage by allowing the starter pinion gear to spin faster than the pinion shaft. When the driver releases the ignition switch to the On position, the starter relay coil is de-energized. This causes the relay contacts to open. When the relay contacts open, the starter solenoid plunger hold-in coil is de-energized.

When the solenoid plunger hold-in coil is de-energized, the solenoid plunger return spring returns the plunger to its relaxed position. This causes the contact disc to open the starter feed circuit, and the shift lever to disengage the overrunning clutch and pinion gear from the starter ring gear.

Following are general descriptions of the major components in the starting system.

STARTER MOTOR

DESCRIPTION

The starter motors used for both the 2.5L and the 4.0L engines available in this model are not interchangeable. Both starter motors are mounted with two screws, but the 2.5L starter motor is mounted to the right rear corner of the engine block, while the 4.0L starter motor is mounted to the manual transmission clutch housing or automatic transmission torque converter housing on the right side of the engine.

Each of these starter motors incorporates several of the same features to create a reliable, efficient, compact, lightweight and powerful unit. The electric motors of both starters have four brushes contacting the motor commutator. The 2.5L starter motor uses four permanent magnets for the field poles, while the 4.0L starter motor features four electromagnetic field coils wound around four pole shoes. The 2.5L starter motor is rated at 1.2 kilowatts (about 1.6 horsepower) output at 12 volts, while the 4.0L starter

DESCRIPTION AND OPERATION (Continued)

motor is rated at 1.4 kilowatts (about 1.9 horsepower) output at 12 volts.

Both of these starter motors are serviced only as a unit with their starter solenoids, and cannot be repaired. If either component is faulty or damaged, the entire starter motor and starter solenoid unit must be replaced.

OPERATION

These starter motors are equipped with a planetary gear reduction (intermediate transmission) system. The planetary gear reduction system consists of a gear that is integral to the output end of the electric motor armature shaft that is in continual engagement with a larger gear that is splined to the input end of the starter pinion gear shaft. This feature makes it possible to reduce the dimensions of the starter. At the same time, it allows higher armature rotational speed and delivers increased torque through the starter pinion gear to the starter ring gear.

The starter motors for both engines are activated by an integral heavy duty starter solenoid switch mounted to the overrunning clutch housing. This electromechanical switch connects and disconnects the feed of battery voltage to the starter motor and actuates a shift fork that engages and disengages the starter pinion gear with the starter ring gear.

Both starter motors use an overrunning clutch and starter pinion gear unit to engage and drive a starter ring gear that is integral to the flywheel (manual transmission) or torque converter drive plate (automatic transmission) mounted on the rear crankshaft flange. Shims are available and can be used to adjust the 2.5L starter motor mounting position to correct for improper starter pinion gear to starter ring gear engagement.

STARTER RELAY

DESCRIPTION

The starter relay is an electromechanical device that switches battery current to the pull-in coil of the starter solenoid when the ignition switch is turned to the Start position. The starter relay is located in the Power Distribution Center (PDC), in the engine compartment. See the fuse and relay layout label affixed to the inside surface of the PDC cover for starter relay identification and location.

The starter relay is a International Standards Organization (ISO) relay. Relays conforming to the ISO specifications have common physical dimensions, current capacities, terminal patterns, and terminal functions.

The starter relay cannot be repaired or adjusted and, if faulty or damaged, it must be replaced.

OPERATION

The ISO relay consists of an electromagnetic coil, a resistor or diode, and three (two fixed and one movable) electrical contacts. The movable (common feed) relay contact is held against one of the fixed contacts (normally closed) by spring pressure. When the electromagnetic coil is energized, it draws the movable contact away from the normally closed fixed contact, and holds it against the other (normally open) fixed contact.

When the electromagnetic coil is de-energized, spring pressure returns the movable contact to the normally closed position. The resistor or diode is connected in parallel with the electromagnetic coil in the relay, and helps to dissipate voltage spikes that are produced when the coil is de-energized.

DIAGNOSIS AND TESTING

STARTING SYSTEM

DIAGNOSIS

The battery, starting, and charging systems operate with one another, and must be tested as a complete system. In order for the vehicle to start and charge properly, all of the components involved in these systems must perform within specifications.

Group 8A covers the Battery, Group 8B covers the Starting Systems, and Group 8C covers the Charging System. We have separated these systems to make it easier to locate the information you are seeking within this Service Manual. However, when attempting to diagnose any of these systems, it is important that you keep their interdependency in mind.

The diagnostic procedures used in these groups include the most basic conventional diagnostic methods, to the more sophisticated On-Board Diagnostics (OBD) built into the Powertrain Control Module (PCM). Use of an induction-type milliampere ammeter, volt/ohmmeter, battery charger, carbon pile rheostat (load tester), and 12-volt test lamp may be required.

All OBD-sensed systems are monitored by the PCM. Each monitored circuit is assigned a Diagnostic Trouble Code (DTC). The PCM will store a DTC in electronic memory for any failure it detects. Refer to **On-Board Diagnostic Test For Charging System** in the Diagnosis and Testing section of Group 8C - Charging System for more information.

DIAGNOSIS AND TESTING (Continued)

Starting System Diagnosis		
CONDITION	POSSIBLE CAUSE	CORRECTION
STARTER FAILS TO OPERATE.	1. Battery discharged or faulty. 2. Starting circuit wiring faulty. 3. Starter relay faulty. 4. Ignition switch faulty. 5. Clutch pedal position switch faulty. 6. Park/Neutral position switch faulty or misadjusted. 7. Starter solenoid faulty. 8. Starter motor faulty.	1. Refer to Battery in the Diagnosis and Testing section of Group 8A - Battery. Charge or replace the battery, if required. 2. Refer to Starting System in Group 8W - Wiring Diagrams. Test and repair the starter feed and/or control circuits, if required. 3. Refer to Starter Relay in the Diagnosis and Testing section of this group. Replace the starter relay, if required. 4. Refer to Ignition Switch and Key Lock Cylinder in the Diagnosis and Testing section of Group 8D - Ignition System. Replace the ignition switch, if required. 5. Refer to Clutch Pedal Position Switch in the Diagnosis and Testing section of Group 6 - Clutch. 6. Refer to Park/Neutral Position Switch in the Diagnosis and Testing section of Group 21 - Transmission. Replace the park/neutral position switch, if required. 7. Refer to Starter Motor in the Diagnosis and Testing section of this group. Replace the starter motor assembly, if required. 8. If all other starting system components and circuits test OK, replace the starter motor assembly.
STARTER ENGAGES, FAILS TO TURN ENGINE.	1. Battery discharged or faulty. 2. Starting circuit wiring faulty. 3. Starter motor faulty. 4. Engine seized.	1. Refer to Battery in the Diagnosis and Testing section of Group 8A - Battery. Charge or replace the battery, if required. 2. Refer to Starting System in Group 8W - Wiring Diagrams. Test and repair the starter feed and/or control circuits, if required. 3. If all other starting system components and circuits test OK, replace the starter motor assembly. 4. Refer to Engine Diagnosis in the Diagnosis and Testing section of Group 9 - Engine.
STARTER ENGAGES, SPINS OUT BEFORE ENGINE STARTS.	1. Starter ring gear faulty. 2. Starter motor faulty.	1. Refer to Starter Motor in the Removal and Installation section of this group. Remove the starter motor to inspect the starter ring gear. Replace the starter ring gear, if required. 2. If all other starting system components and circuits test OK, replace the starter motor assembly.
STARTER DOES NOT DISENGAGE.	1. Starter motor improperly installed. 2. Starter relay faulty. 3. Ignition switch faulty. 4. Starter motor faulty.	1. Refer to Starter Motor in the Removal and Installation section of this group. Tighten the starter mounting hardware to the correct tightness specifications. 2. Refer to Starter Relay in the Diagnosis and Testing section of this group. Replace the starter relay, if required. 3. Refer to Ignition Switch and Key Lock Cylinder in the Diagnosis and Testing section of Group 8D - Ignition System. Replace the ignition switch, if required. 4. If all other starting system components and circuits test OK, replace the starter motor assembly.

DIAGNOSIS AND TESTING (Continued)

INSPECTION

For complete circuit diagrams, refer to **Starting System** in the Contents of Group 8W - Wiring Diagrams. Before removing any unit from the starting system for repair or diagnosis, perform the following inspections:

WARNING: ON VEHICLES EQUIPPED WITH AIRBAGS, REFER TO GROUP 8M - PASSIVE RESTRAINT SYSTEMS BEFORE ATTEMPTING ANY STEERING WHEEL, STEERING COLUMN, OR INSTRUMENT PANEL COMPONENT DIAGNOSIS OR SERVICE. FAILURE TO TAKE THE PROPER PRECAUTIONS COULD RESULT IN ACCIDENTAL AIRBAG DEPLOYMENT AND POSSIBLE PERSONAL INJURY.

- **Battery** - Visually inspect the battery for indications of physical damage and loose or corroded cable connections. Determine the state-of-charge and cranking capacity of the battery. Charge or replace the battery, if required. Refer to **Battery** in the proper section of Group 8A - Battery for complete service information for the battery.
- **Ignition Switch** - Visually inspect the ignition switch for indications of physical damage and loose or corroded wire harness connections. Refer to **Ignition Switch and Key Lock Cylinder** in the proper section of Group 8D - Ignition System for complete service information for the ignition switch.
- **Clutch Pedal Position Switch** - If the vehicle is equipped with a manual transmission, visually inspect the clutch pedal position switch for indications of physical damage and loose or corroded wire harness connections. Refer to **Clutch Pedal Position Switch** in the proper section of Group 6 - Clutch for complete service information for the clutch pedal position switch.
- **Park/Neutral Position Switch** - If the vehicle is equipped with an automatic transmission, visually inspect the park/neutral position switch for indications of physical damage and loose or corroded wire harness connections. Refer to **Park/Neutral Position Switch** in the proper section of Group 21 - Transmission for complete service information for the park/neutral position switch.
- **Starter Relay** - Visually inspect the starter relay for indications of physical damage and loose or corroded wire harness connections.
- **Starter Motor** - Visually inspect the starter motor for indications of physical damage and loose or corroded wire harness connections.
- **Starter Solenoid** - Visually inspect the starter solenoid for indications of physical damage and loose or corroded wire harness connections.
- **Wiring** - Visually inspect the wire harnesses for damage. Repair or replace any faulty wiring, as required. Refer to the proper section of **Group 8W - Wiring Diagrams** for complete service information and circuit diagrams for the starting system wiring components.

TESTING

COLD CRANKING TEST

For complete circuit diagrams, refer to **Starting System** in the Contents of Group 8W - Wiring Diagrams. The battery must be fully-charged and load-tested before proceeding. Refer to **Battery** in the Diagnosis and Testing section of Group 8A - Battery for the procedures.

(1) Connect a suitable volt-ampere tester to the battery terminals (Fig. 1). See the instructions provided by the manufacturer of the volt-ampere tester being used.

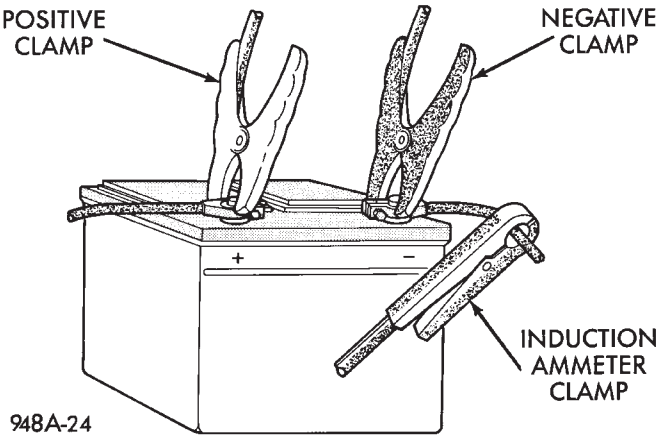


Fig. 1 Volts-Amps Tester Connections - Typical

(2) Fully engage the parking brake.

(3) If the vehicle is equipped with a manual transmission, place the gearshift selector lever in the Neutral position and block the clutch pedal in the fully depressed position. If the vehicle is equipped with an automatic transmission, place the gearshift selector lever in the Park position.

(4) Verify that all lamps and accessories are turned off.

(5) To prevent the engine from starting, remove the Automatic ShutDown (ASD) relay. The ASD relay is located in the Power Distribution Center (PDC), in the engine compartment. Refer to the fuse and relay layout label affixed to the underside of the PDC cover for ASD relay identification and location.

(6) Rotate and hold the ignition switch in the Start position. Note the cranking voltage and current (amperage) draw readings shown on the volt-ampere tester.

(a) If the voltage reads below 9.6 volts, refer to **Starter Motor** in the Diagnosis and Testing section of this group. If the starter motor is OK, refer

DIAGNOSIS AND TESTING (Continued)

to **Engine Diagnosis** in the Diagnosis and Testing section of Group 9 - Engine for further testing of the engine. If the starter motor is not OK, replace the faulty starter motor.

(b) If the voltage reads above 9.6 volts and the current (amperage) draw reads below specifications, refer to **Feed Circuit Test** in this section.

(c) If the voltage reads 12.5 volts or greater and the starter motor does not turn, refer to **Control Circuit Testing** in this section.

(d) If the voltage reads 12.5 volts or greater and the starter motor turns very slowly, refer to **Feed Circuit Test** in this section.

NOTE: A cold engine will increase the starter current (amperage) draw reading, and reduce the battery voltage reading.

FEED CIRCUIT TEST

The starter feed circuit test (voltage drop method) will determine if there is excessive resistance in the high-amperage feed circuit. For complete circuit diagrams, refer to **Starting System** in the Contents of Group 8W - Wiring Diagrams.

When performing these tests, it is important to remember that the voltage drop is giving an indication of the resistance between the two points at which the voltmeter probes are attached.

Example: When testing the resistance of the battery positive cable, touch the voltmeter leads to the battery positive cable clamp and the cable connector at the starter solenoid. If you probe the battery positive terminal post and the cable connector at the starter solenoid, you are reading the combined voltage drop in the battery positive cable clamp-to-terminal post connection and the battery positive cable.

The following operation will require a voltmeter accurate to 1/10 (0.10) volt. Before performing the tests, be certain that the following procedures are accomplished:

- Battery is fully-charged and load-tested. Refer to **Battery** in the Diagnosis and Testing section of Group 8A - Battery for the procedures.
- Fully engage the parking brake.
- If the vehicle is equipped with a manual transmission, place the gearshift selector lever in the Neutral position and block the clutch pedal in the fully depressed position. If the vehicle is equipped with an automatic transmission, place the gearshift selector lever in the Park position.
- Verify that all lamps and accessories are turned off.
- To prevent the engine from starting, remove the Automatic ShutDown (ASD) relay. The ASD relay is located in the Power Distribution Center (PDC), in the engine compartment. Refer to the fuse and relay layout label affixed to the underside of the PDC cover for ASD relay identification and location.

(1) Connect the positive lead of the voltmeter to the battery negative terminal post. Connect the negative lead of the voltmeter to the battery negative cable clamp (Fig. 2). Rotate and hold the ignition switch in the Start position. Observe the voltmeter. If voltage is detected, correct the poor contact between the cable clamp and the terminal post.

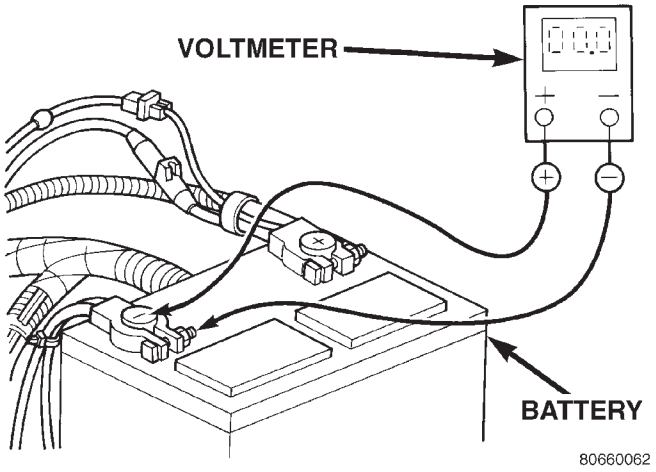


Fig. 2 Test Battery Negative Connection Resistance - Typical

(2) Connect the positive lead of the voltmeter to the battery positive terminal post. Connect the negative lead of the voltmeter to the battery positive cable clamp (Fig. 3). Rotate and hold the ignition switch in the Start position. Observe the voltmeter. If voltage is detected, correct the poor contact between the cable clamp and the terminal post.

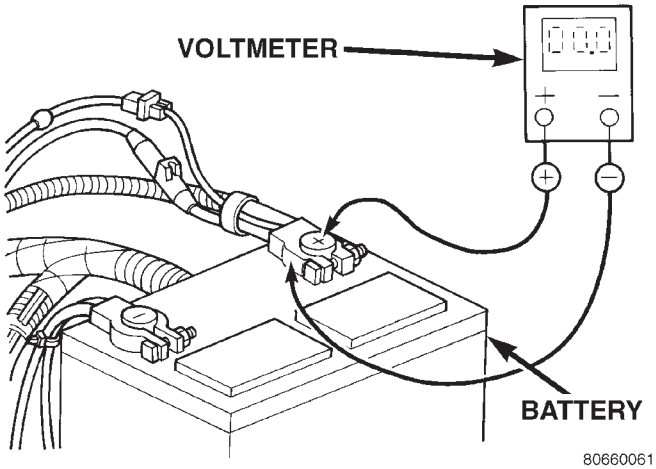


Fig. 3 Test Battery Positive Connection Resistance - Typical

(3) Connect the voltmeter to measure between the battery positive terminal post and the starter solenoid battery terminal stud (Fig. 4). Rotate and hold

DIAGNOSIS AND TESTING (Continued)

the ignition switch in the Start position. Observe the voltmeter. If the reading is above 0.2 volt, clean and tighten the battery cable connection at the solenoid. Repeat the test. If the reading is still above 0.2 volt, replace the faulty battery positive cable.

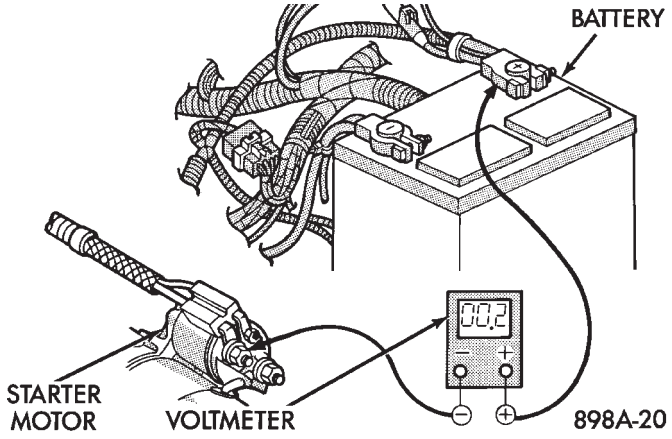


Fig. 4 Test Battery Positive Cable Resistance - Typical

(4) Connect the voltmeter to measure between the battery negative terminal post and a good clean ground on the engine block (Fig. 5). Rotate and hold the ignition switch in the Start position. Observe the voltmeter. If the reading is above 0.2 volt, clean and tighten the battery negative cable attachment on the engine block. Repeat the test. If the reading is still above 0.2 volt, replace the faulty battery negative cable.

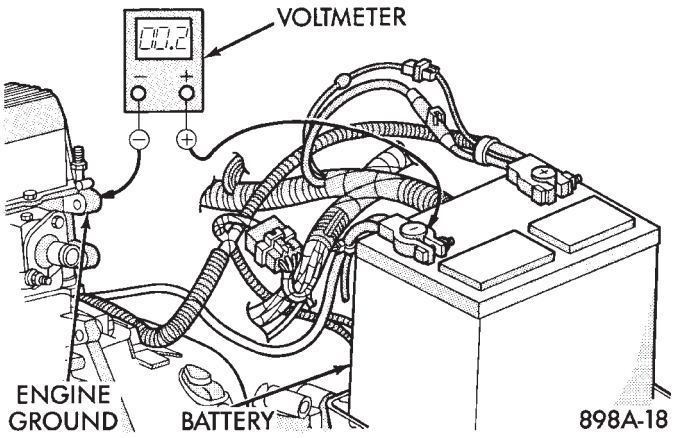


Fig. 5 Test Ground Circuit Resistance - Typical

(5) Connect the positive lead of the voltmeter to the starter housing. Connect the negative lead of the voltmeter to the battery negative terminal post (Fig. 6). Rotate and hold the ignition switch in the Start position. Observe the voltmeter. If the reading is above 0.2 volt, correct the poor starter to engine block ground contact.

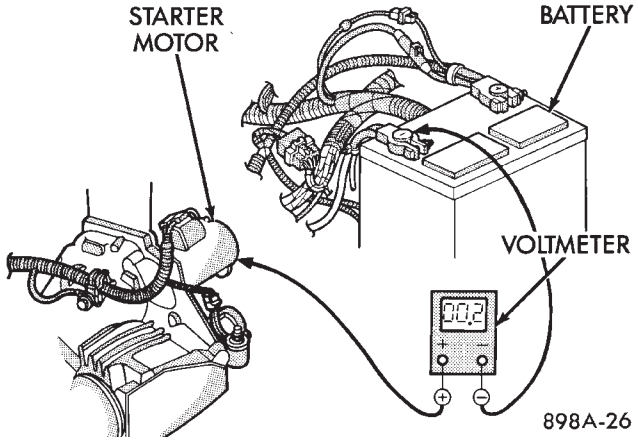


Fig. 6 Test Starter Ground - Typical

If the resistance tests detect no feed circuit problems, refer to **Starter Motor** in the Diagnosis and Testing section of this group.

CONTROL CIRCUIT TESTING

The starter control circuit components should be tested in the order in which they are listed, as follows:

- **Starter Relay** - Refer to **Starter Relay** in the Diagnosis and Testing section of this group for the procedures.
- **Starter Solenoid** - Refer to **Starter Motor** in the Diagnosis and Testing section of this group for the procedures.
- **Ignition Switch** - Refer to **Ignition Switch and Key Lock Cylinder** in the Diagnosis and Testing section of Group 8D - Ignition System for the procedures.
- **Clutch Pedal Position Switch** - If the vehicle is equipped with a manual transmission, refer to **Clutch Pedal Position Switch** in the Diagnosis and Testing section of Group 6 - Clutch for the procedures.
- **Park/Neutral Position Switch** - If the vehicle is equipped with an automatic transmission, refer to **Park/Neutral Position Switch** in the Diagnosis and Testing section of Group 21 - Transmission for the procedures.
- **Wire harnesses and connections** - Refer to **Starting System** in the Contents of Group 8W - Wiring Diagrams for complete circuit diagrams.

DIAGNOSIS AND TESTING (Continued)

STARTER MOTOR NOISE - 2.5L ENGINE

See the Starter Motor Noise Diagnosis chart (Fig. 7). If the complaint is similar to Conditions 1 and 2 in the chart, correction can be made by placing shims between the starter motor and the engine block using the following procedures:

(1) If the complaint is similar to Condition 1, the starter motor must be moved toward the starter ring gear by removing shims from both starter mounting pads on the engine block (Fig. 8). Refer to **Starter Motor** in the Removal and Installation section of this group for the procedures.

NOTE: The shim thickness is 0.381 mm (0.015 in.). These shims may be stacked if additional thickness is required.

(2) If the complaint is similar to Condition 2, the starter motor must be moved away from the starter ring gear. This is done by installing shim(s) across both starter mounting pads on the engine block. More than one shim may be required. Refer to **Starter Motor** in the Removal and Installation section of this group for the procedures.

NOTE: This is a condition that will generally cause broken starter (flywheel/torque converter drive plate) ring gear teeth or broken starter motor housings.

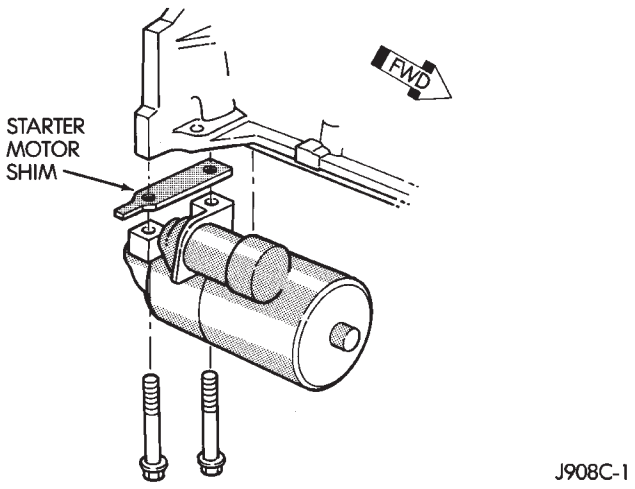


Fig. 8 Starter Motor Shim

STARTER MOTOR

Correct starter motor operation can be confirmed by performing the following free running bench test. This test can only be performed with the starter motor removed from the vehicle. Refer to **Starting System** in the Specifications section of this group for the starter motor specifications.

CONDITION	POSSIBLE CAUSE	CORRECTION
1. VERY HIGH FREQUENCY WHINE BEFORE ENGINE STARTS; ENGINE STARTS OK.	1. Excessive distance between pinion gear and flywheel/drive plate gear.	1. Move starter motor toward flywheel/drive plate by removing shim(s), if possible.
2. VERY HIGH FREQUENCY WHINE AFTER ENGINE STARTS WITH IGNITION KEY RELEASED. ENGINE STARTS OK.	2. Insufficient distance between starter motor pinion gear and flywheel/drive plate runout can cause noise to be intermittent.	2. Shim starter motor away from flywheel/drive plate. Inspect flywheel/drive plate for damage; bent, unusual wear, and excessive runout. Replace flywheel/drive plate as necessary.
3. A LOUD "WHOOP" AFTER ENGINE STARTS WHILE STARTER MOTOR IS ENGAGED.	3. Most probably cause is defective overrunning clutch.	3. Replace starter motor.
4. A "RUMBLE," "GROWL," OR "KNOCK" AS STARTER MOTOR COASTS TO STOP AFTER ENGINE STARTS.	4. Most probable cause is bent or unbalanced starter motor armature.	4. Replace starter motor.

NOTE: A high frequency whine during cranking is normal for this starter motor.

J958A-5

Fig. 7 Starter Motor Noise Diagnosis

DIAGNOSIS AND TESTING (Continued)

CAUTION: The 2.5L engine uses a permanent magnet starter. Permanent magnet starters are highly sensitive to hammering, shocks, external pressure and reverse polarity. This starter motor must never be clamped in a vise by the starter field frame. The starter should only be clamped by the mounting flange. Do not reverse the battery cable connections to this starter motor when testing. The permanent magnets may be damaged and the starter rendered unserviceable if it is subjected to any of these conditions.

(1) Remove the starter motor from the vehicle. Refer to **Starter Motor** in the Removal and Installation section of this group for the procedures.

(2) Mount the starter motor securely in a soft-jawed bench vise. The vise jaws should be clamped on the mounting flange of the starter motor. Never clamp on the starter motor by the field frame.

(3) Connect a suitable volt-ampere tester and a 12-volt battery to the starter motor in series, and set the ammeter to the 100 ampere scale. See the instructions provided by the manufacturer of the volt-ampere tester being used.

(4) Install a jumper wire from the solenoid terminal to the solenoid battery terminal. The starter motor should operate. If the starter motor fails to operate, replace the faulty starter motor assembly.

(5) Adjust the carbon pile load of the tester to obtain the free running test voltage. Refer to **Starting System** in the Specifications section of this group for the starter motor free running test voltage specifications.

(6) Note the reading on the ammeter and compare this reading to the free running test maximum amperage draw. Refer to **Starting System** in the Specifications section of this group for the starter motor free running test maximum amperage draw specifications.

(7) If the ammeter reading exceeds the maximum amperage draw specification, replace the faulty starter motor assembly.

STARTER SOLENOID

This test can only be performed with the starter motor removed from the vehicle.

(1) Remove the starter motor from the vehicle. Refer to **Starter Motor** in the Removal and Installation section of this group for the procedures.

(2) Disconnect the wire from the solenoid field coil terminal.

(3) Check for continuity between the solenoid terminal and the solenoid field coil terminal with a continuity tester (Fig. 9). There should be continuity. If OK, go to Step 4. If not OK, replace the faulty starter motor assembly.

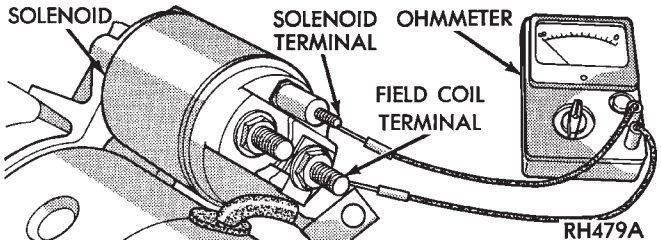


Fig. 9 Continuity Test Between Solenoid Terminal and Field Coil Terminal - Typical

(4) Check for continuity between the solenoid terminal and the solenoid case (Fig. 10). There should be continuity. If not OK, replace the faulty starter motor assembly.

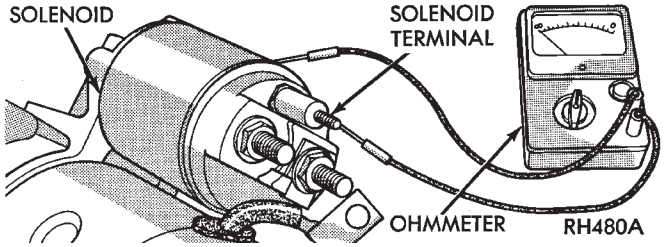


Fig. 10 Continuity Test Between Solenoid Terminal and Solenoid Case - Typical

STARTER RELAY

The starter relay (Fig. 11) is located in the Power Distribution Center (PDC), in the engine compartment. Refer to the fuse and relay layout label affixed to the underside of the PDC cover for starter relay identification and location. For complete circuit diagrams, refer to **Starting System** in the Contents of Group 8W - Wiring Diagrams.

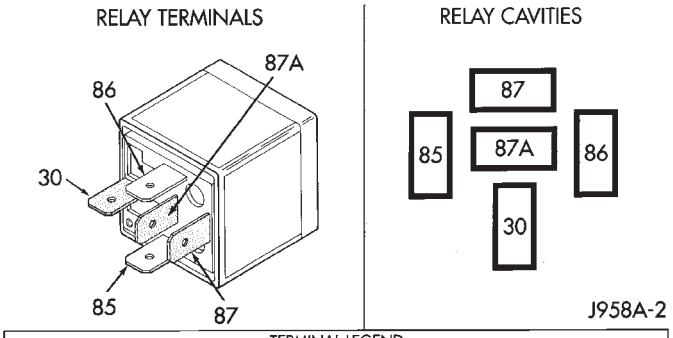
(1) Remove the starter relay from the PDC. Refer to **Starter Relay** in the Removal and Installation section of this group for the procedures.

(2) A relay in the de-energized position should have continuity between terminals 87A and 30, and no continuity between terminals 87 and 30. If OK, go to Step 3. If not OK, replace the faulty relay.

(3) Resistance between terminals 85 and 86 (electromagnet) should be 75 ± 5 ohms. If OK, go to Step 4. If not OK, replace the faulty relay.

DIAGNOSIS AND TESTING (Continued)

(4) Connect a battery to terminals 85 and 86. There should now be continuity between terminals 30 and 87, and no continuity between terminals 87A and 30. If OK, perform the Relay Circuit Test that follows. If not OK, replace the faulty relay.



TERMINAL LEGEND	
NUMBER	IDENTIFICATION
30	COMMON FEED
85	COIL GROUND
86	COIL BATTERY
87	NORMALLY OPEN
87A	NORMALLY CLOSED

Fig. 11 Starter Relay

RELAY CIRCUIT TEST

(1) The relay common feed terminal cavity (30) is connected to battery voltage and should be hot at all times. If OK, go to Step 2. If not OK, repair the open circuit to the fuse in the PDC as required.

(2) The relay normally closed terminal (87A) is connected to terminal 30 in the de-energized position, but is not used for this application. Go to Step 3.

(3) The relay normally open terminal (87) is connected to the common feed terminal (30) in the energized position. This terminal supplies battery voltage to the starter solenoid field coils. There should be continuity between the cavity for relay terminal 87 and the starter solenoid terminal at all times. If OK, go to Step 4. If not OK, repair the open circuit to the starter solenoid as required.

(4) The coil battery terminal (86) is connected to the electromagnet in the relay. It is energized when the ignition switch is held in the Start position. On vehicles with a manual transmission, the clutch pedal must be fully depressed for this test. Check for battery voltage at the cavity for relay terminal 86 with the ignition switch in the Start position, and no voltage when the ignition switch is released to the On position. If OK, go to Step 5. If not OK with an automatic transmission, check for an open or short circuit to the ignition switch and repair, if required. If the circuit to the ignition switch is OK, refer to **Ignition Switch and Key Lock Cylinder** in the Diagnosis and Testing section of Group 8D - Ignition System for testing of the ignition switch. If not OK with a manual transmission, check the circuit between the relay and the clutch pedal position switch for an open or a short. If the circuit is OK, refer to **Clutch Pedal Position Switch** in the Diagnosis and Testing section of Group 6 - Clutch for testing of the switch.

(5) The coil ground terminal (85) is connected to the electromagnet in the relay. On vehicles with a manual transmission, it is grounded at all times. On vehicles with an automatic transmission, it is grounded through the park/neutral position switch only when the gearshift selector lever is in the Park or Neutral positions. Check for continuity to ground at the cavity for relay terminal 85. If not OK with a manual transmission, repair the circuit to ground as required. If not OK with an automatic transmission, check for an open or short circuit to the park/neutral position switch and repair, if required. If the circuit to the park/neutral position switch is OK, refer to **Park/Neutral Position Switch** in the Diagnosis and Testing section of Group 21 - Transmission for testing of the park/neutral position switch.

REMOVAL AND INSTALLATION

STARTER MOTOR

REMOVAL

2.5L ENGINE

(1) Disconnect and isolate the battery negative cable.

(2) Raise and support the vehicle.

(3) While supporting the starter motor with one hand, use the other hand to remove the two screws that secure the starter motor to the engine block (Fig. 12).

(4) Lower the starter motor from the engine block far enough to access and remove the nut that secures the battery cable eyelet to the solenoid battery terminal (Fig. 13). Always support the starter motor during this process, do not let the starter motor hang from the wire harness.

(5) Remove the battery cable eyelet from the solenoid battery terminal. Always support the starter motor during this process, do not let the starter motor hang from the wire harness.

(6) Disconnect the solenoid terminal wire harness connector from the connector receptacle on the starter solenoid. Always support the starter motor during this process, do not let the starter motor hang from the wire harness.

(7) Remove the starter motor from the engine compartment.

4.0L ENGINE

(1) Disconnect and isolate the battery negative cable.

(2) Raise and support the vehicle.

REMOVAL AND INSTALLATION (Continued)

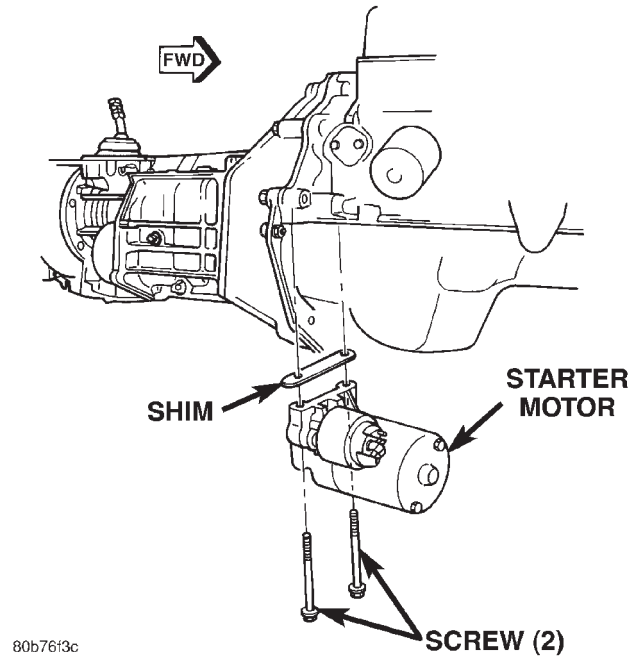


Fig. 12 Starter Motor Remove/Install - 2.5L Engine

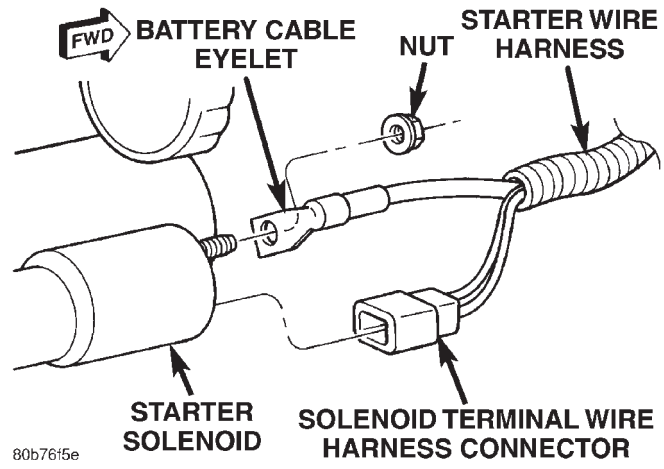


Fig. 13 Starter Wire Harness Remove/Install

(3) Remove the lower (forward facing) mounting screw from the starter motor (Fig. 14).

(4) While supporting the starter motor with one hand, use the other hand to remove the upper (rear facing) mounting screw from the starter motor.

(5) Lower the starter motor from the front of the transmission clutch housing or torque converter housing far enough to access and remove the nut that secures the battery cable eyelet to the solenoid battery terminal (Fig. 13). Always support the starter motor during this process, do not let the starter motor hang from the wire harness.

(6) Remove the battery cable eyelet from the solenoid battery terminal. Always support the starter motor during this process, do not let the starter motor hang from the wire harness.

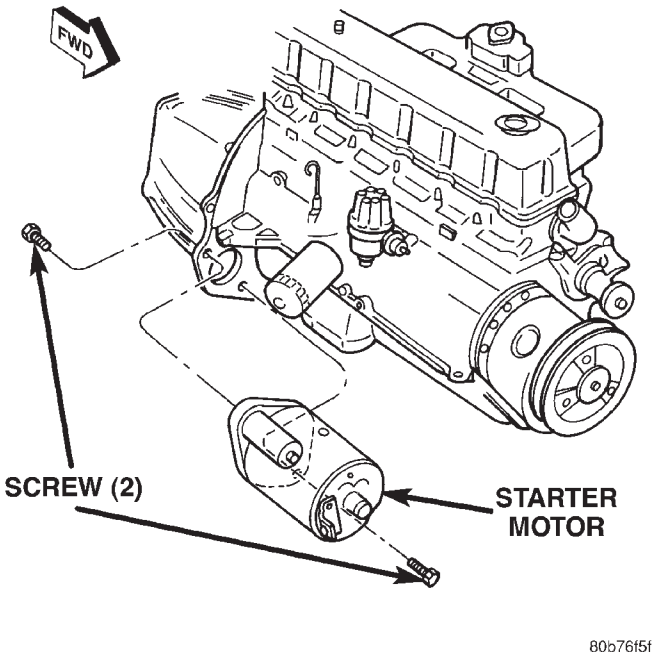


Fig. 14 Starter Motor Remove/Install - 4.0L Engine

(7) Disconnect the solenoid terminal wire harness connector from the connector receptacle on the starter solenoid. Always support the starter motor during this process, do not let the starter motor hang from the wire harness.

(8) Remove the starter motor from the engine compartment.

INSTALLATION

2.5L ENGINE

(1) Position the starter motor in the engine compartment.

(2) Reconnect the solenoid terminal wire harness connector to the connector receptacle on the starter solenoid. Always support the starter motor during this process, do not let the starter motor hang from the wire harness.

(3) Install the battery cable eyelet onto the solenoid battery terminal. Always support the starter motor during this process, do not let the starter motor hang from the wire harness.

(4) Install and tighten the nut that secures the battery cable eyelet to the solenoid battery terminal. Tighten the nut to 10 N·m (90 in. lbs.). Always support the starter motor during this process, do not let the starter motor hang from the wire harness.

(5) Position the starter motor and any starter motor shims that were removed to the engine block and loosely install both of the mounting screws.

REMOVAL AND INSTALLATION (Continued)

NOTE: Shim thickness available is 0.381 mm (0.015 in.). Refer to Starter Motor Noise - 2.5L Engine in the Diagnosis and Testing section of this group for more information.

(6) Tighten both of the starter motor mounting screws. Tighten the screws to 45 N·m (33 ft. lbs.).
(7) Lower the vehicle.
(8) Reconnect the battery negative cable.

4.0L ENGINE

(1) Position the starter motor in the engine compartment.
(2) Reconnect the solenoid terminal wire harness connector to the connector receptacle on the starter solenoid. Always support the starter motor during this process, do not let the starter motor hang from the wire harness.
(3) Install the battery cable eyelet onto the solenoid battery terminal. Always support the starter motor during this process, do not let the starter motor hang from the wire harness.
(4) Install and tighten the nut that secures the battery cable eyelet to the solenoid battery terminal. Tighten the nut to 10 N·m (90 in. lbs.). Always support the starter motor during this process, do not let the starter motor hang from the wire harness.
(5) Position the starter motor to the front of the transmission clutch housing or torque converter housing and loosely install both the upper and lower mounting screws.
(6) Tighten the lower (forward facing) starter motor mounting screw. Tighten the screw to 47 N·m (35 ft. lbs.).
(7) Tighten the upper (rearward facing) starter motor mounting screw. Tighten the screw to 41 N·m (30 ft. lbs.).
(8) Lower the vehicle.
(9) Reconnect the battery negative cable.

STARTER RELAY

REMOVAL

(1) Disconnect and isolate the battery negative cable.
(2) Remove the cover from the Power Distribution Center (PDC) (Fig. 15).

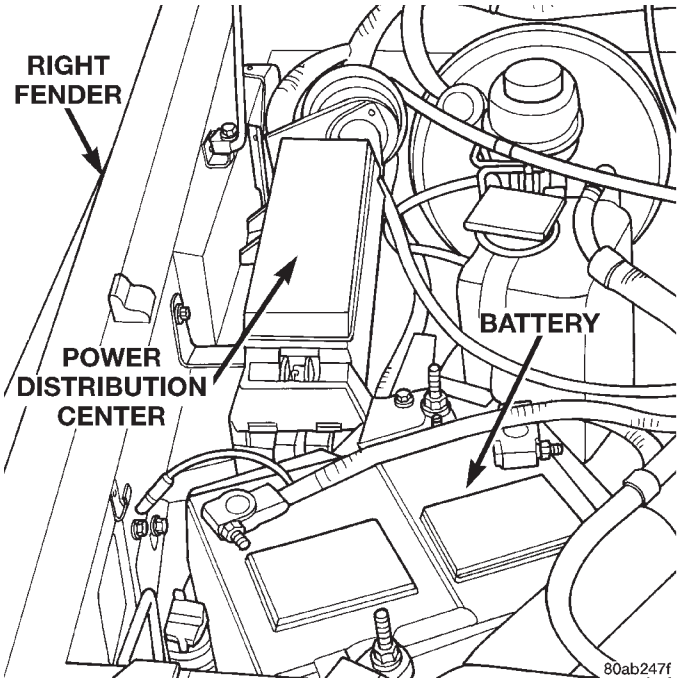


Fig. 15 Power Distribution Center

(3) Refer to the fuse and relay layout label affixed to the underside of the PDC cover for starter relay identification and location.
(4) Remove the starter relay from the PDC.

INSTALLATION

(1) Refer to the fuse and relay layout label affixed to the underside of the PDC cover for the proper starter relay location.
(2) Position the starter relay in the proper receptacle in the PDC.
(3) Align the starter relay terminals with the terminal cavities in the PDC receptacle.
(4) Push down firmly on the starter relay until the terminals are fully seated in the terminal cavities in the PDC receptacle.
(5) Install the cover onto the PDC.
(6) Connect the battery negative cable.

SPECIFICATIONS

STARTING SYSTEM

Starter Motor and Solenoid	
Manufacturer	Mitsubishi
Engine Application	2.5L, 4.0L
Power Rating	2.5L - 1.2 Kilowatt (1.6 Horsepower) 4.0L - 1.4 Kilowatt (1.9 Horsepower)
Voltage	12 Volts
Number of Fields	4
Number of Poles	4
Number of Brushes	4
Drive Type	Planetary Gear Reduction
Free Running Test Voltage	11.2 Volts
Free Running Test Maximum Amperage Draw	90 Amperes
Free Running Test Minimum Speed	2.5L - 2600 rpm 4.0L - 2500 rpm
Solenoid Closing Maximum Voltage Required	7.8 Volts
*Cranking Amperage Draw Test	2.5L - 130 Amperes 4.0L - 160 Amperes
*Test at operating temperature. Cold engine, tight (new) engine, or heavy oil will increase starter amperage draw.	