IGNITION SYSTEM

TABLE OF CONTENTS

DESCRIPTION AND OPERATION

IGNITION SYSTEM

DESCRIPTION

The system's three main components are the coil pack, crankshaft position sensor, and camshaft position sensor.

OPERATION

Basic ignition timing is not adjustable. The Powertrain Control Module (PCM) determines spark advance. The 2.0L engines use a fixed ignition timing system. The distributorless electronic ignition system is referred to as the Direct Ignition System (DIS).

SPARK PLUGS

The 2.0L engines uses resistor spark plugs. For spark plug identification and specifications, Refer to the Specifications section at the end of this group.

Remove the spark plugs and examine them for burned electrodes and fouled, cracked or broken porcelain insulators. Keep plugs arranged in the order in which they were removed from the engine. An isolated plug displaying an abnormal condition indicates that a problem exists in the corresponding cylinder.

Spark plugs that have low mileage may be cleaned and reused if not otherwise defective. Refer to the Spark Plug Condition section of this group. After cleaning, file the center electrode flat with a small point file or jewelers file. Adjust the gap between the electrodes (Fig. 1) to the dimensions specified in the chart at the end of this section by bending the ground electrode (just above the attachment weld) with the appropriate tool.

Never apply any force between the electrode or damage to the center electrode assembly will result.

Always tighten spark plugs to the specified torque. Over tightening can cause distortion and damage. Tighten spark plugs to 28 N·m (20 ft. lbs.) torque.

SPARK PLUG CABLES

Spark plug cables are sometimes referred to as secondary ignition wires. The wires transfer electrical current from the coil pack to individual spark plugs at each cylinder. The resistor type, nonmetallic spark plug cables provide suppression of radio frequency emissions from the ignition system.

Check the spark plug cable connections for good contact at the coil and spark plugs. Terminals should be fully seated. The nipples and spark plug covers should be in good condition. Nipples should fit tightly on the coil. Spark plug boot should completely cover the spark plug hole in the cylinder head cover. Install the boot until the terminal snaps over the spark plug. A snap must be felt to ensure the spark plug cable terminal engaged the spark plug.

DESCRIPTION AND OPERATION (Continued)

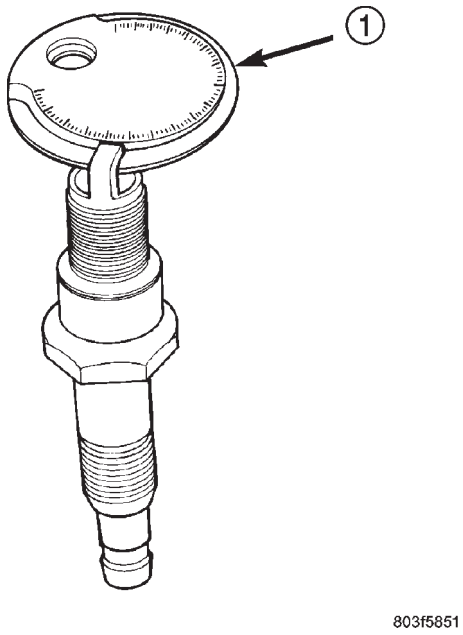


Fig. 1 Checking Spark Plug Electrode Gap

1 – TAPER GAUGE

Loose cable connections will corrode, increase resistance and permit water to enter the coil towers. These conditions can cause ignition malfunction. Plastic clips in various locations protect the cables from damage. When the cables are replaced the clips must be used to prevent damage to the cables, and should be rotated about 30° below the horizontal.

ELECTRONIC IGNITION COILS

DESCRIPTION

The coil pack consists of 2 coils molded together. The coil pack is mounted on the valve cover (Fig. 2).

OPERATION

WARNING: THE DIRECT IGNITION SYSTEM GENERATES APPROXIMATELY 40,000 VOLTS. PERSONAL INJURY COULD RESULT FROM CONTACT WITH THIS SYSTEM.

High tension leads route to each cylinder from the coil. The coil fires two spark plugs every power stroke. One plug is the cylinder under compression, the other cylinder fires on the exhaust stroke. Coil number one fires cylinders 1 and 4. Coil number two fires cylinders 2 and 3. The PCM determines which of the coils to charge and fire at the correct time.

The Auto Shutdown (ASD) relay provides battery voltage to the ignition coil. The PCM provides a ground contact (circuit) for energizing the coil. When the PCM breaks the contact, the energy in the coil primary transfers to the secondary causing the spark. The PCM will de-energize the ASD relay if it does not receive the crankshaft position sensor and camshaft position sensor inputs. Refer to Auto Shutdown (ASD) Relay—PCM Output, in this section for relay operation.

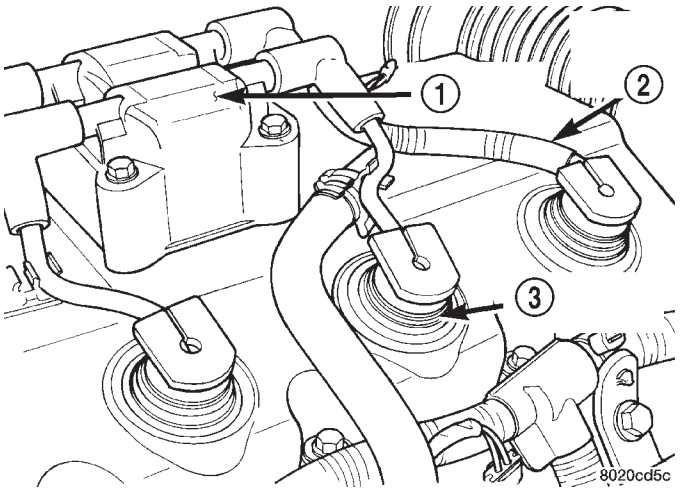


Fig. 2 Ignition Coil Pack

1 – IGNITION COILS
2 – SPARK PLUG CABLE
3 – SPARK PLUG INSULATOR

AUTOMATIC SHUTDOWN RELAY

DESCRIPTION

The ASD relay is located in the PDC (Fig. 3). The inside top of the PDC cover has label showing relay and fuse identification.

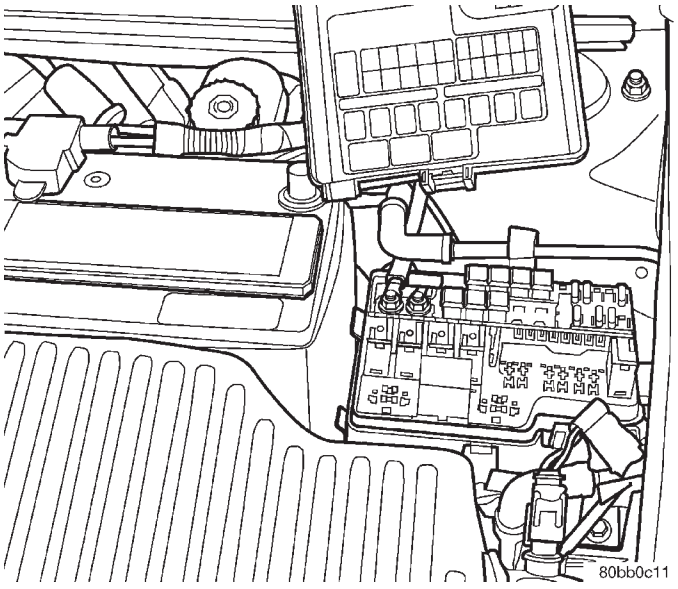


Fig. 3 Power Distribution Center (PDC)

DESCRIPTION AND OPERATION (Continued)

OPERATION

The Automatic Shutdown (ASD) relay supplies battery voltage to the fuel injectors, electronic ignition coil and the heating elements in the oxygen sensors.

A buss bar in the Power Distribution Center (PDC) supplies voltage to the solenoid side and contact side of the relay. The fuse also protects the power circuit for the fuel pump relay and pump. The fuse is located in the PDC. Refer to the Wiring Diagrams for circuit information.

The PCM controls the ASD relay by switching the ground path for the solenoid side of the relay on and off. The PCM turns the ground path off when the ignition switch is in the Off position. When the ignition switch is in On or Start, the PCM monitors the crankshaft and camshaft position sensor signals to determine engine speed and ignition timing (coil dwell). If the PCM does not receive crankshaft and camshaft position sensor signals when the ignition switch is in the Run position, it will de-energize the ASD relay.

CRANKSHAFT POSITION SENSOR—PCM INPUT

DESCRIPTION

The crankshaft position sensor mounts to the engine block behind the generator, just above the oil filter (Fig. 4).

The PCM uses the Crankshaft Position sensor to calculate the following:

- Engine RPM

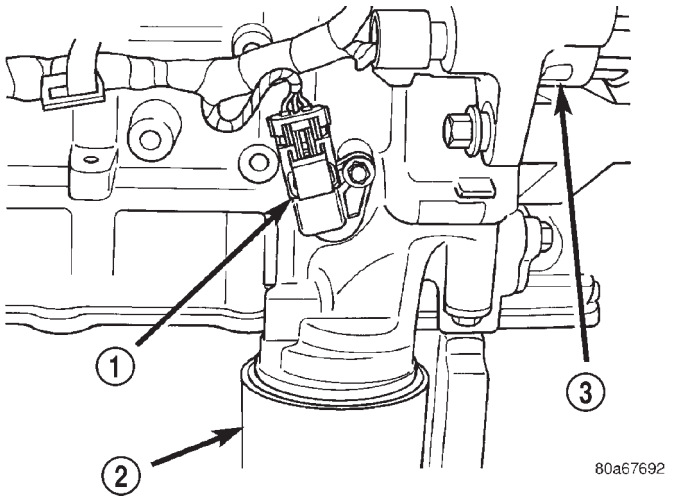


Fig. 4 Crankshaft Position Sensor

1 – CRANKSHAFT POSITION SENSOR
2 – OIL FILTER
3 – GENERATOR

- TDC number 1 and 4
- Ignition coil synchronization
- Injector synchronization
- Camshaft-to-crankshaft misalignment (Timing belt skipped 1 tooth or more diagnostic trouble code).

OPERATION

The Crankshaft Position (CKP) sensor is a Hall-effect sensor. The second crankshaft counterweight has two sets of four timing reference notches including a 60 degree signature notch (Fig. 5).

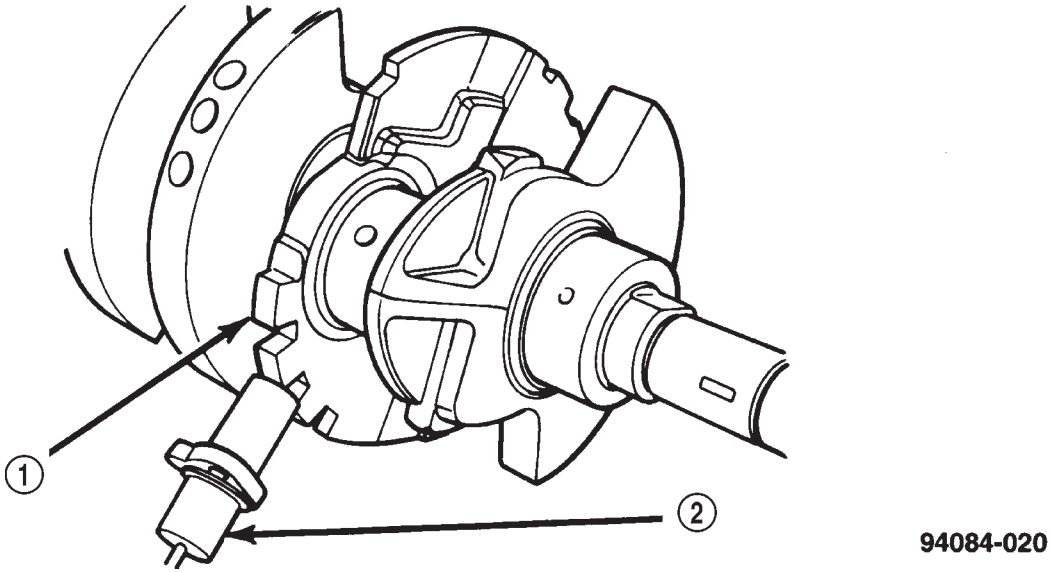


Fig. 5 Timing Reference Notches

1 – MACHINED NOTCHES
2 – CRANKSHAFT POSITION SENSOR

DESCRIPTION AND OPERATION (Continued)

The PCM sends approximately 8 volts to the Hall-effect sensor. This voltage is required to operate the Hall-effect chip and the electronics inside the sensor. A ground for the sensor is provided through the sensor return circuit. The input to the PCM occurs on a 5 volt output reference circuit.

The notches generate pulses from high to low in the crankshaft position sensor output voltage. When a metal portion of the counterweight aligns with the crankshaft position sensor, the sensor output voltage goes low (less than 0.5 volts). When a notch aligns with the sensor, voltage goes high (5.0 volts). As a group of notches pass under the sensor, the output voltage switches from low (metal) to high (notch) then back to low.

If available, an oscilloscope can display the square wave patterns of each voltage pulses. From the width of the output voltage pulses, the PCM calculates engine speed. The width of the pulses represent the amount of time the output voltage stays high before switching back to low. The period of time the sensor output voltage stays high before switching back to low is referred to as pulse width. The faster the engine is operating, the smaller the pulse width on the oscilloscope.

By counting the pulses and referencing the pulse from the 60 degree signature notch, the PCM calculates crankshaft angle (position). In each group of timing reference notches, the first notch represents 69 degrees before top dead center (BTDC). The second notch represents 49 degrees BTDC. The third notch represents 29 degrees. The last notch in each set represents 9 degrees before top dead center (TDC).

The timing reference notches are machined at 20° increments. From the voltage pulse width the PCM tells the difference between the timing reference notches and the 60 degree signature notch. The 60 degree signature notch produces a longer pulse width than the smaller timing reference notches. If the camshaft position sensor input switches from high to low when the 60 degree signature notch passes under the crankshaft position sensor, the PCM knows cylinder number one is the next cylinder at TDC.

CAMSHAFT POSITION SENSOR—PCM INPUT

DESCRIPTION

The camshaft position sensor attaches to the rear of the cylinder head. The PCM determines fuel injection synchronization and cylinder identification from inputs provided by the camshaft position sensor (Fig. 6) and crankshaft position sensor. From the two inputs, the PCM determines crankshaft position.

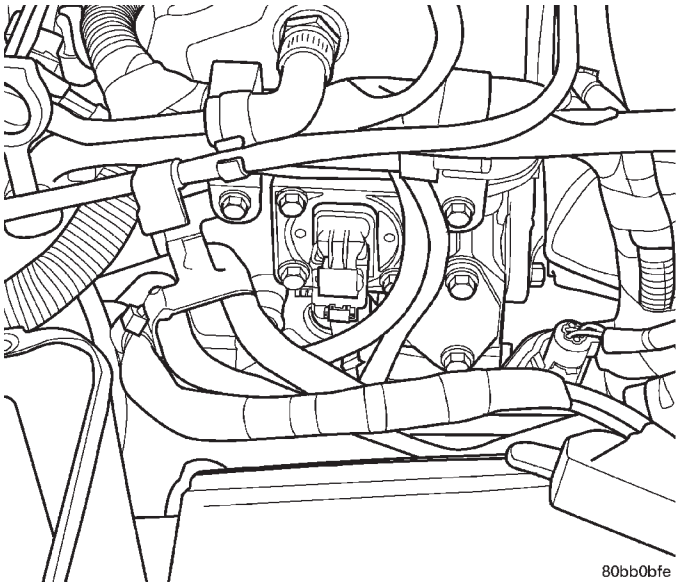


Fig. 6 Camshaft Position Sensor—SOHC

OPERATION

The PCM sends approximately 8 volts to the hall affect sensor. This voltage is required to operate the hall effect chip and the electronics inside the sensor. A ground for the sensor is provided through the sensor return circuit. The input to the PCM occurs on a 5 volt output reference circuit.

A target magnet attaches to the rear of the camshaft and indexes to the correct position. The target magnet has four different poles arranged in an asymmetrical pattern (Fig. 7). As the target magnet rotates, the camshaft position sensor senses the change in polarity (Fig. 8). The sensor output switch switches from high (5.0 volts) to low (0.5 volts) as the target magnet rotates. When the north pole of the target magnet passes under the sensor, the output switches high. The sensor output switches low when the south pole of the target magnet passes underneath.

The sensor also acts as a thrust plate to control camshaft endplay.

DESCRIPTION AND OPERATION (Continued)

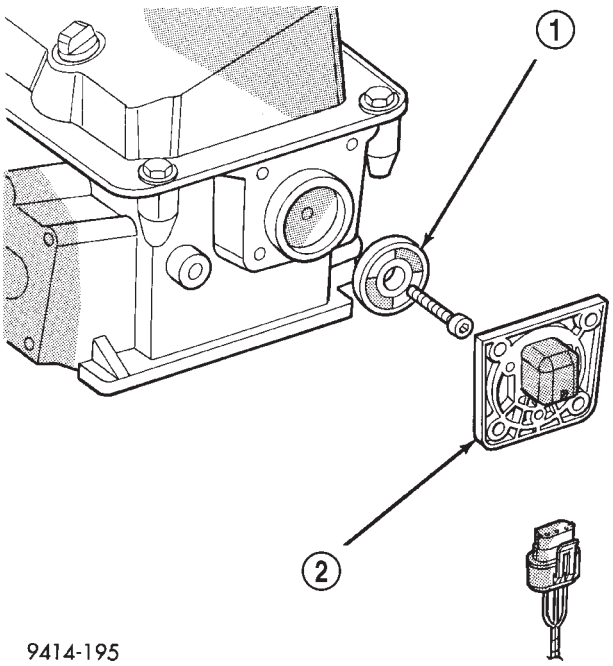


Fig. 7 Target Magnet—Typical

1 – CAM MAGNET/TARGET
2 – CAMSHAFT POSITION SENSOR

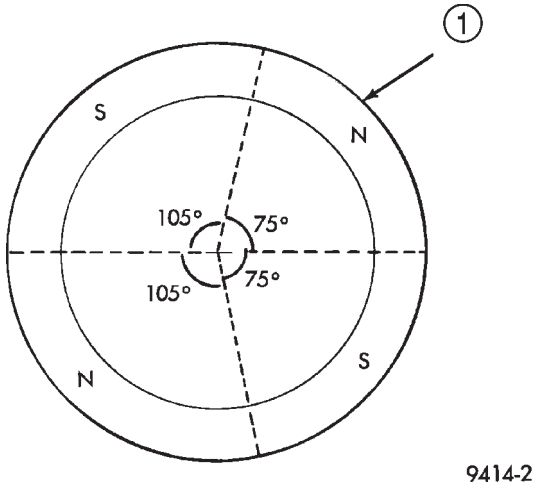


Fig. 8 Target Magnet Polarity

1 – TARGET MAGNET

KNOCK SENSOR

DESCRIPTION

The knock sensor threads into the cylinder block.

OPERATION

When the knock sensor detects a knock in one of the cylinders, it sends an input signal to the PCM. In response, the PCM retards ignition timing for all cylinders by a scheduled amount.

Knock sensors contain a piezoelectric material which constantly vibrates and sends an input voltage (signal) to the PCM while the engine operates. As the intensity of the crystal's vibration increases, the knock sensor output voltage also increases.

NOTE: Over or under tightening affects knock sensor performance, possibly causing improper spark control.

IGNITION SWITCH

In the RUN position, the ignition switch connects power from the Power Distribution Center (PDC) to a fuse in the fuse block, back to a bus bar in the PDC. The bus bar feeds circuits for the Powertrain Control Module (PCM), Proportional purge solenoid, EGR solenoid, and ABS system. The bus bar in the PDC feeds the coil side of the radiator fan relay, A/C compressor clutch relay, and the fuel pump relay. It also feeds the Airbag Control Module (ACM)

LOCK KEY CYLINDER

DESCRIPTION

The lock cylinder is inserted in the end of the housing opposite the ignition switch.

OPERATION

The ignition key rotates the cylinder to 5 different detents (Fig. 9) :

- Accessory
- Off (lock)
- Unlock
- On/Run
- Start

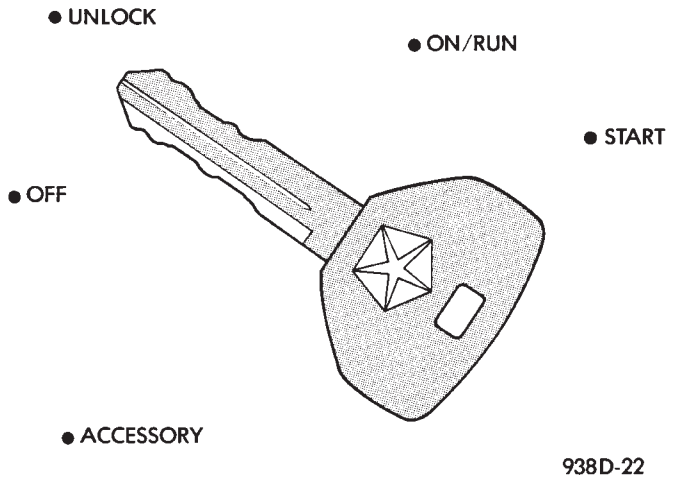


Fig. 9 Ignition Lock Cylinder Detents

DESCRIPTION AND OPERATION (Continued)

IGNITION INTERLOCK

OPERATION

All vehicles equipped with automatic transaxles have an interlock system. The system prevents shifting the vehicle out of Park unless the ignition lock cylinder is in the Off, Run or Start position. In addition, the operator cannot rotate the key to the lock position unless the shifter is in the park position. On vehicles equipped with floor shift refer to the - Transaxle for Automatic Transmission Shifter/Ignition Interlock.

REMOVAL AND INSTALLATION

SPARK PLUG SERVICE

Failure to route the cables properly could cause the radio to reproduce ignition noise, cross ignition of the spark plugs or short circuit the cables to ground.

REMOVAL

REMOVE CABLES FROM COIL FIRST.

Always remove the spark plug cable by grasping the top of the spark plug insulator, turning the boot 1/2 turn and pulling straight up in a steady motion.

(1) Remove the spark plug using a quality socket with a rubber or foam insert.

(2) Inspect the spark plug condition.

INSTALLATION

(1) To avoid cross threading, start the spark plug into the cylinder head by hand.

(2) Tighten spark plugs to 28 N·m (20 ft. lbs.) torque.

(3) Install spark plug insulators over spark plugs. Ensure the top of the spark plug insulator covers the upper end of the spark plug tube.

Reconnect to coil.

SPARK PLUG CABLE SERVICE

Failure to route the cables properly could cause the radio to reproduce ignition noise, cross ignition of the spark plugs or short circuit the cables to ground.

REMOVAL

Remove spark plug cable from coil first.

Always remove the spark plug cable by grasping the top of the spark plug insulator, turning the boot 1/2 turn and pulling straight up in a steady motion.

INSTALLATION

Install spark plug insulators over spark plugs. Ensure the top of the spark plug insulator covers the upper end of the spark plug tube. The connect the other end to coil pack. Be sure that dual plastic clip holds the cables off of the valve cover.

IGNITION COIL

The electronic ignition coil pack attaches directly to the valve cover (Fig. 11).

REMOVAL

(1) Disconnect electrical connector from coil pack (Fig. 10).

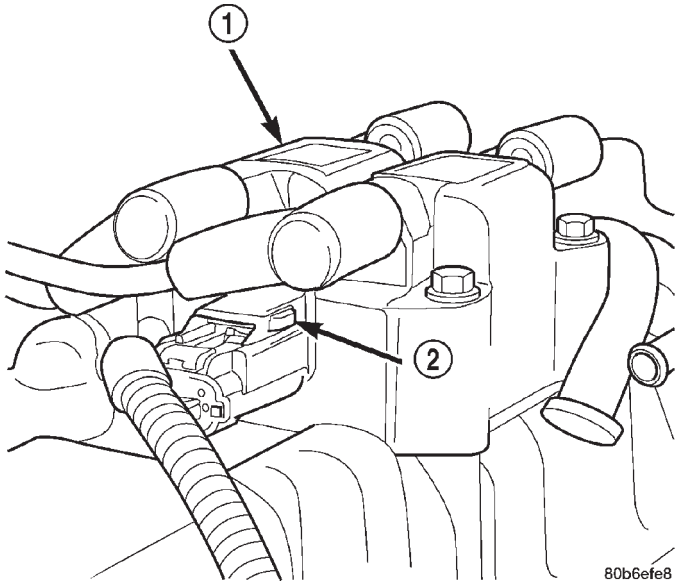


Fig. 10 Electronic Ignition Coil Connector

1 – COIL
2 – LOCKING TAB

(2) Remove coil pack mounting bolts.

(3) Remove coil pack.

INSTALLATION

(1) Install coil pack on valve cover.

(2) Transfer spark plug cables to new coil pack. The coil pack towers are numbered with the cylinder identification. Be sure the ignition cables snap onto the towers.

AUTOMATIC SHUTDOWN RELAY

The relay is located in the Power Distribution Center (PDC) (Fig. 12). The PDC is located next to the battery in the engine compartment. For the location of the relay within the PDC, refer to the PDC cover for location. Check electrical terminals for corrosion and repair as necessary.

CAMSHAFT POSITION SENSOR

The camshaft position sensor is mounted to the rear of the cylinder head (Fig. 13).

REMOVAL AND INSTALLATION (Continued)

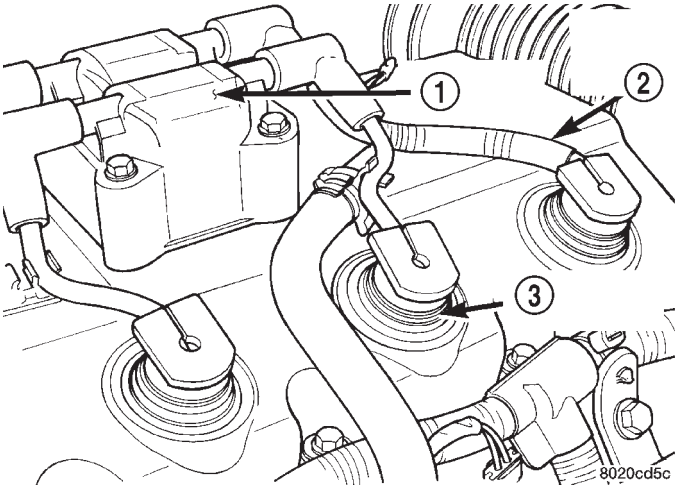


Fig. 11 Electronic Ignition Coil Pack

1 – IGNITION COILS
2 – SPARK PLUG CABLE
3 – SPARK PLUG INSULATOR

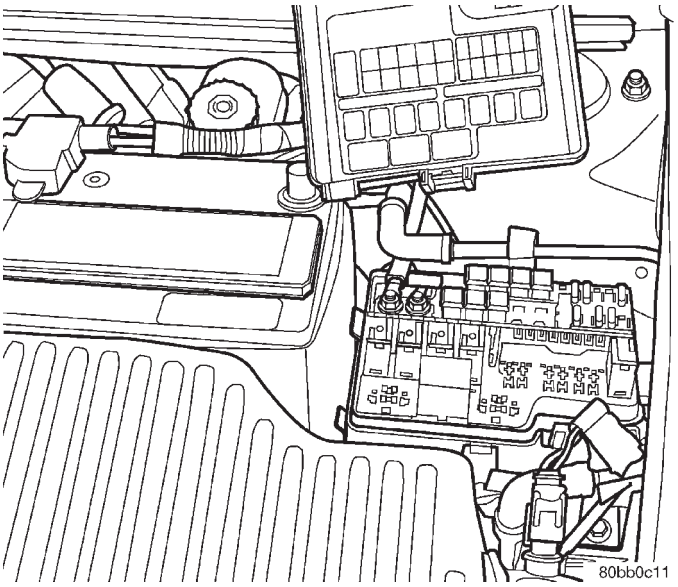


Fig. 12 Power Distribution Center (PDC)

REMOVAL

(1) Remove brake booster hose and electrical connector from holders on end of cylinder head cover and reposition.

(2) Disconnect electrical connectors from camshaft position sensor.

(3) Remove camshaft position sensor mounting screws. Remove sensor.

(4) Loosen screw attaching target magnet to rear of camshaft (Fig. 14).

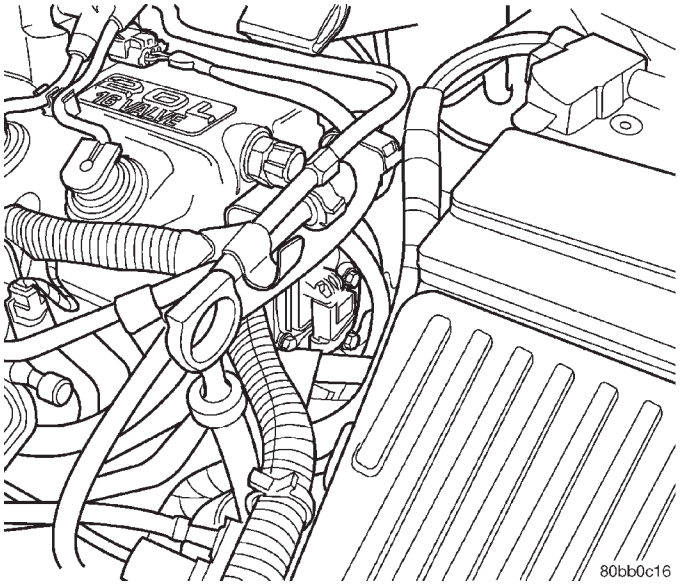


Fig. 13 Camshaft Position Sensor Location

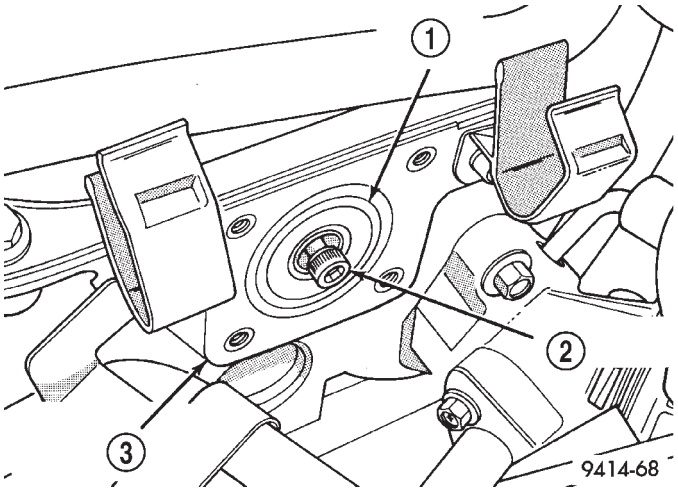


Fig. 14 Target Magnet Removal/Installation

1 – TARGET MAGNET
2 – MOUNTING BOLT
3 – REAR OF CYLINDER HEAD

INSTALLATION

The target magnet has two locating dowels that fit into machined locating holes in end of the camshaft.

(1) Install target magnet in end of camshaft. Tighten mounting screw to 3.4 N·m (30 in. lbs.) torque.

(2) Install camshaft position sensor. Tighten sensor mounting screws to 9 N·m (80 in. lbs.) torque.

(3) Place brake booster hose and electrical harness in holders on end of valve cover.

(4) Attach electrical connectors to camshaft position sensor.

REMOVAL AND INSTALLATION (Continued)

CRANKSHAFT POSITION SENSOR

The crankshaft position sensor mounts to the engine block behind the generator, just above the oil filter (Fig. 15).

REMOVAL

(1) Disconnect electrical connector from crankshaft position sensor.

(2) Remove sensor mounting screw. Remove sensor.

INSTALLATION

(1) Install sensor. Install sensor mounting screw and tighten.

(2) Connect electrical connector to crankshaft position sensor.

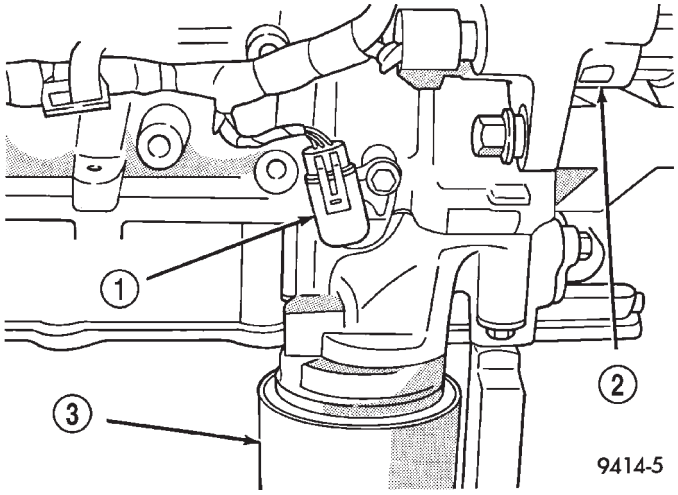


Fig. 15 Crankshaft Position Sensor

1 – CRANKSHAFT POSITION SENSOR
2 – GENERATOR
3 – OIL FILTER

KNOCK SENSOR

The knock sensor threads into the side of the cylinder block in front of the starter (Fig. 16).

REMOVAL

(1) Disconnect electrical connector from knock sensor.

(2) Use a crow foot socket to remove the knock sensors.

INSTALLATION

(1) Install knock sensor. Tighten knock sensor to 10 N·m (7 ft. lbs.) torque. **Over or under tightening effects knock sensor performance, possibly causing improper spark control.**

(2) Attach electrical connector to knock sensor.

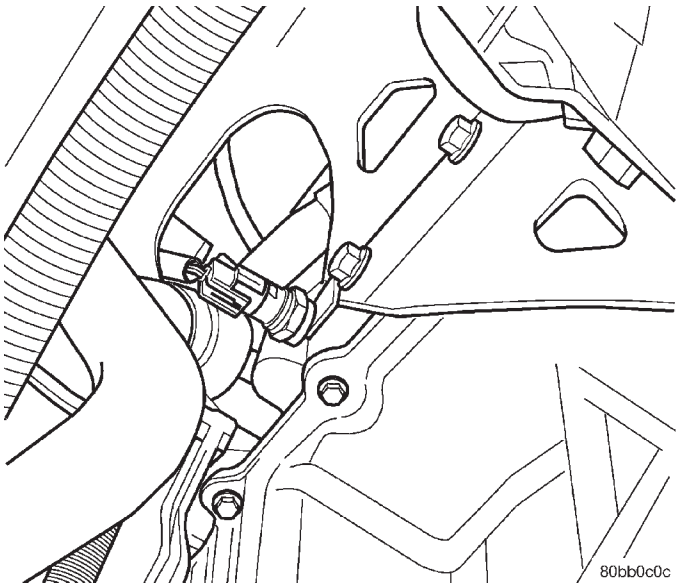


Fig. 16 Knock Sensor

IGNITION SWITCH

The ignition switch attaches to the lock cylinder housing on the end opposite the lock cylinder (Fig. 17). For ignition switch terminal and circuit identification, refer to the Wiring Diagrams sections.

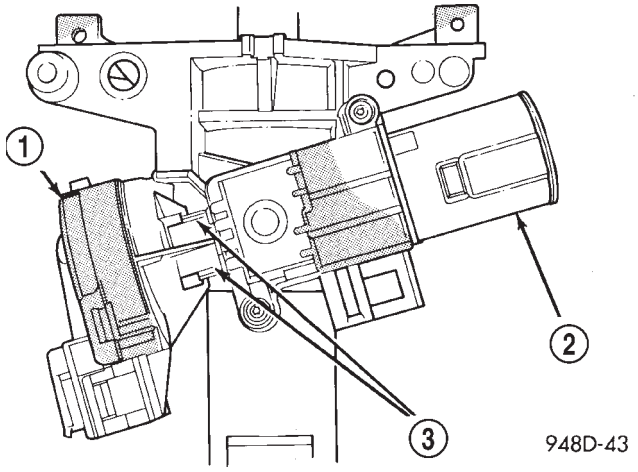


Fig. 17 Ignition Switch—Viewed From Below Column

1 – IGNITION SWITCH
2 – LOCK CYLINDER HOUSING
3 – RETAINING TABS

REMOVAL

(1) Disconnect negative cable from battery.

(2) Place key cylinder in RUN position. Through the hole in the lower shroud, depress lock cylinder retaining tab and remove key cylinder (Fig. 18).

(3) Remove upper and lower shrouds from steering column.

REMOVAL AND INSTALLATION (Continued)

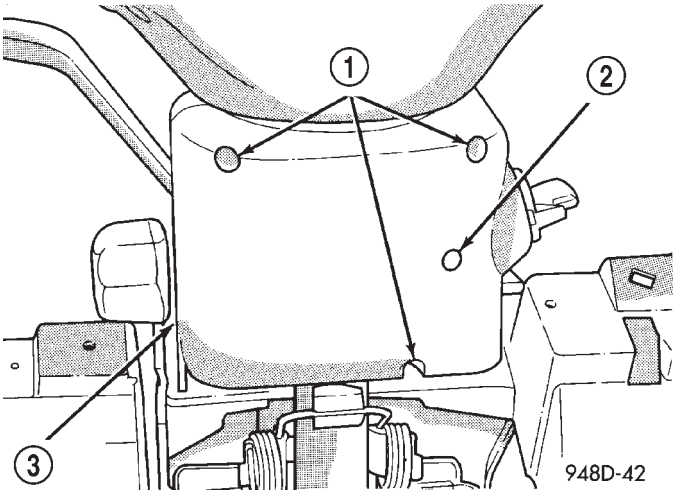


Fig. 18 Steering Column Shrouds

1 – SCREW ACCESS HOLE
2 – TAB ACCESS HOLE
3 – LOWER SHROUD

(4) Disconnect electrical connectors from ignition switch.

(5) Remove ignition switch mounting screw (Fig. 19) with a #10 Torx® bit.

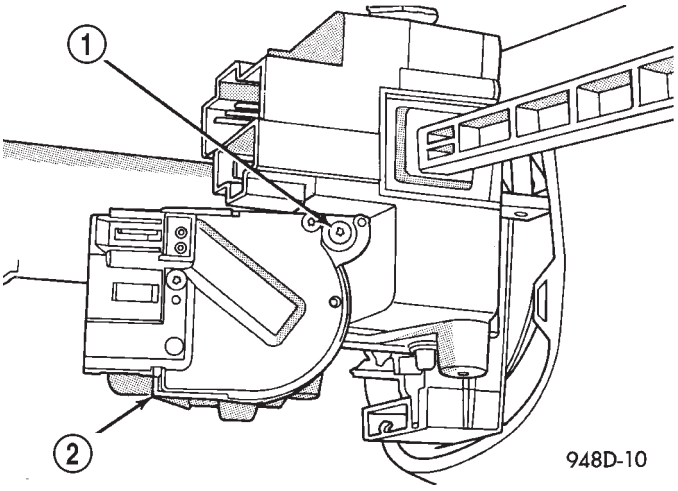


Fig. 19 Ignition Switch Mounting Screw

1 – MOUNTING SCREW
2 – IGNITION SWITCH

(6) Depress retaining tabs (Fig. 20) and pull ignition switch from steering column.

INSTALLATION

(1) Ensure the ignition switch is in the RUN position and the actuator shaft in the lock housing is in the RUN position.

(2) Carefully install the ignition switch. The switch will snap over the retaining tabs (Fig. 21). Install mounting screw (Fig. 19).

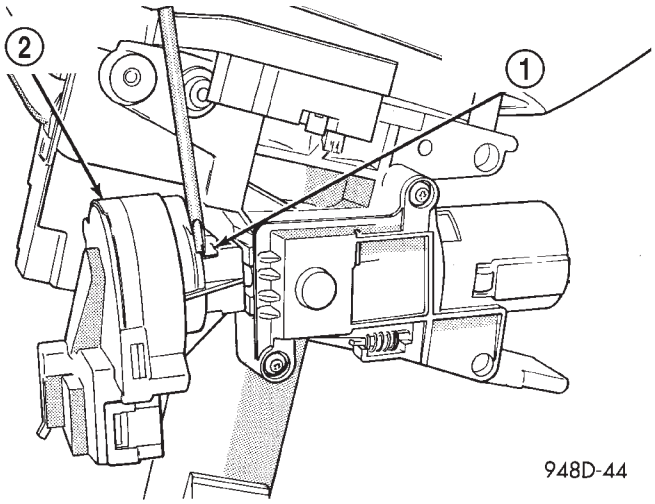


Fig. 20 Removing Ignition Switch

1 – DEPRESS RETAINING TABS
2 – IGNITION SWITCH

(3) Install electrical connectors to ignition switch.

(4) Install upper and lower shrouds.

(5) Install key cylinder (cylinder retaining tab will depress only in the RUN position).

(6) Connect negative cable to battery.

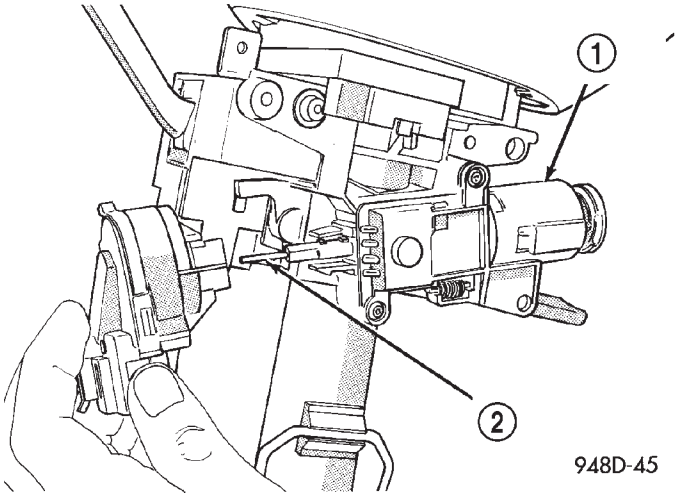


Fig. 21 Ignition Switch Installation

1 – LOCK CYLINDER HOUSING
2 – SHAFT

(7) Check for proper operation of ignition switch and key-in warning switch.

LOCK KEY CYLINDER

The lock cylinder is inserted in the end of the housing opposite the ignition switch. The ignition key rotates the cylinder to 5 different detentes (Fig. 22) :

- Accessory
- Off (lock)
- Unlock

REMOVAL AND INSTALLATION (Continued)

- On/Run
- Start

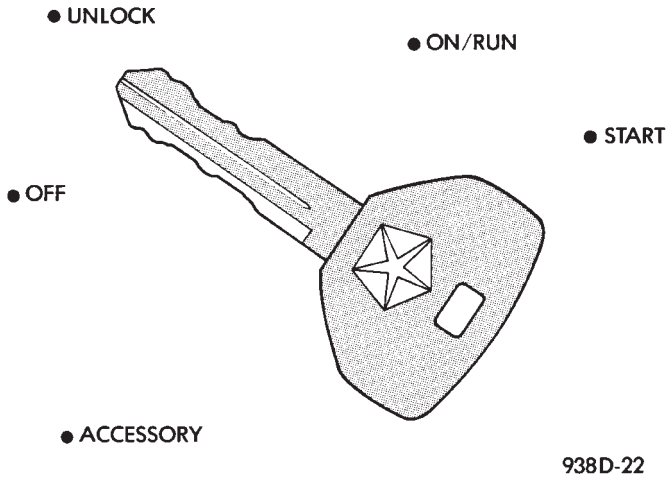


Fig. 22 Ignition Lock Cylinder Detentes

REMOVAL

(1) Disconnect negative cable from battery.

(2) Place key cylinder in RUN position. Through the hole in the lower shroud, depress lock cylinder retaining tab and remove key cylinder.

INSTALLATION

(1) Install key in lock cylinder. Turn key to run position (retaining tab on lock cylinder can be depressed).

(2) The shaft at the end of the lock cylinder aligns with the socket in the end of the housing. To align the socket with the lock cylinder, ensure the socket is in the Run position (Fig. 23).

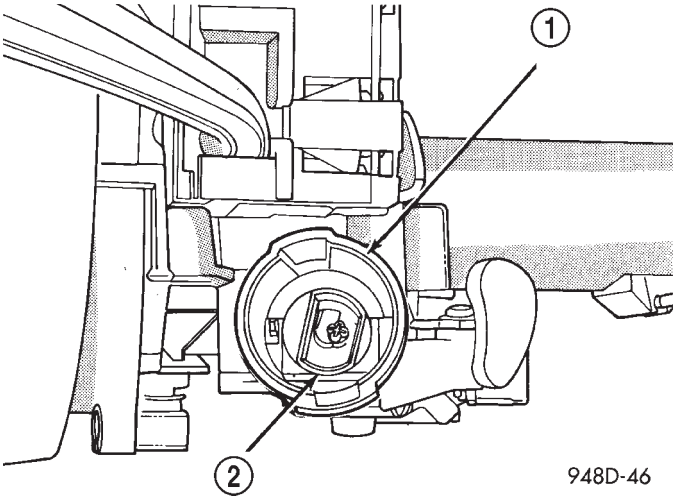


Fig. 23 Socket in Lock Cylinder Housing

1 – LOCK CYLINDER HOUSING
2 – SOCKET

(3) Align the lock cylinder with the grooves in the housing. Slide the lock cylinder into the housing until the tab sticks through the opening in the housing.

(4) Turn the key to the Off position. Remove the key.

(5) Connect negative cable to battery.

IGNITION INTERLOCK

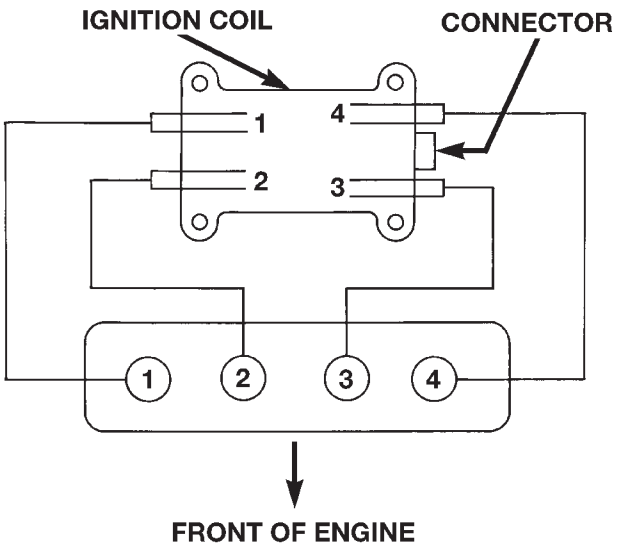
Refer to the Transaxle section for Shifter/Ignition Interlock Service.

SPECIFICATIONS

VECI LABEL

Always use the information found on the Vehicle Emission Control Information (VECI) label. The VECI label is located in the engine compartment.

FIRING ORDER—2.0L



FIRING ORDER 1-3-4-2 8008a549

SPECIFICATIONS (Continued)

TORQUE SPECIFICATION

DESCRIPTION	TORQUE
Camshaft Position Sensor Screw	9 N·m (80 in. lbs.)
SOHC Cam Magnet/Target	3.4 N·m (30 in. lbs.)
Crankshaft Position Sensor Screw	9 N·m (80 in. lbs.)
Coolant Temp. Sensor	18.6 N·m (165 in. lbs.)
Ignition Coil to Cyl. Head	11.9 N·m (105 in. lbs.)
Knock Sensor	10 N·m (90 in. lbs.)
MAP/IAT Sensor Plastic Manifold	2 N·m (20 in. lbs.)
Spark Plugs	28 N·m (20 ft. lbs.)

SPARK PLUG CABLE RESISTANCE—SOHC

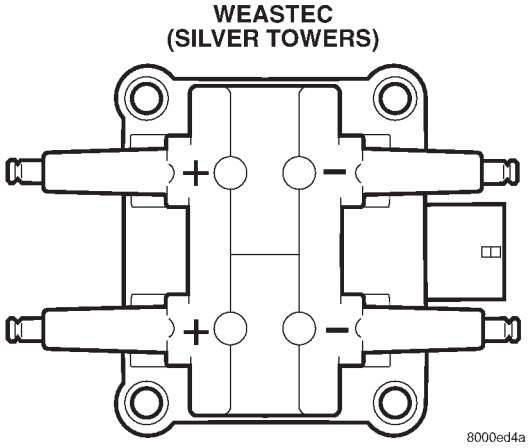
CABLE	RESISTANCE
#1,#4	3500 ohms— 4900 ohms
#2,#3	2950 ohms— 4100 ohms

SPARK PLUG

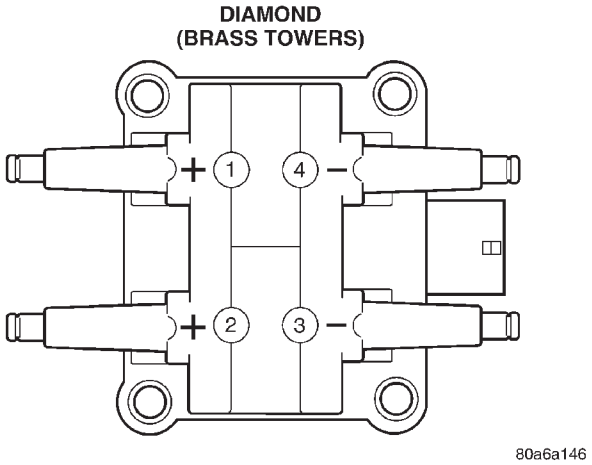
Engine	Spark Plug	Gap	Thread Size
2.0L	RC9YC	0.033 TO 0.038	14mm (3/4 in.) reach

IGNITION COIL

Coil Manufacture	Primary Resistance at 21°C-27°C (70°F-80°F)	Secondary Resistance at 21°C-27°C (70°F-80°F)
Weastec (Steel Towers)	0.45 to 0.65 Ohms	11,500 to 13,500 Ohms
Diamond (copper towers)	0.53 to 0.65 Ohms	10,900 to 14,700 Ohms



Coil Polarity



Coil Polarity