

INTRODUCTION

The ignition system includes components and wiring necessary to create and distribute a high voltage (up to 40,000 volts or more) and send to the spark plug. A high-voltage arc occurs across the gap of a spark plug inside the combustion chamber. The spark raises the temperature of the air-fuel mixture and starts the combustion process inside the cylinder.

Electronic Ignition (EI) is the term specified by the SAE for an ignition system that does not use a distributor . Types of EI systems include:

- Waste-spark system . This type of system uses one ignition coil to fire the spark plugs for two cylinders at the same time. Figure 1.
- Coil-on-plug system . This type of system uses a single ignition coil for each cylinder with the coil placed above or near the spark plug. Figure 2.

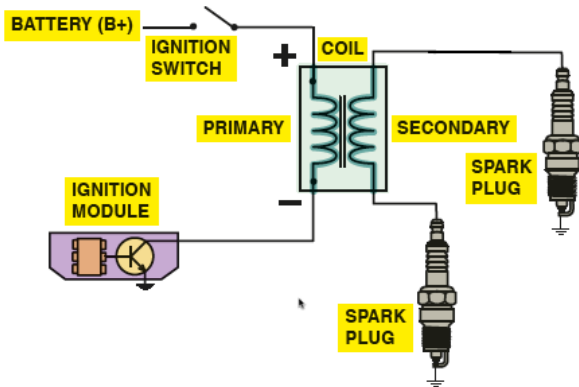


Figure 1. Waste spark system.

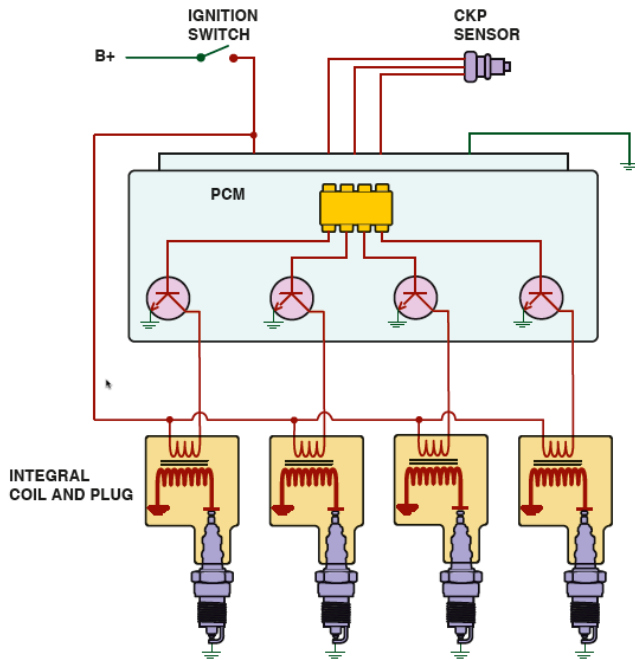


Figure 12. A coil-on-plug ignition system.

For any ignition system to function, the primary current must be turned on to charge the coil and off to allow the coil to discharge, creating a high-voltage spark. This turning on and off of the primary circuit is called switching. The unit that does the switching is an electronic switch, such as a power transistor. This power transistor can be located in the ignition control module or the powertrain module (PCM).

The device that signals the switching of the coil on and off in most instances, is called the trigger. A trigger is typically a pickup coil in some distributor-type ignitions or a crankshaft position (CKP) sensor in non-distributor systems. Figure 3.

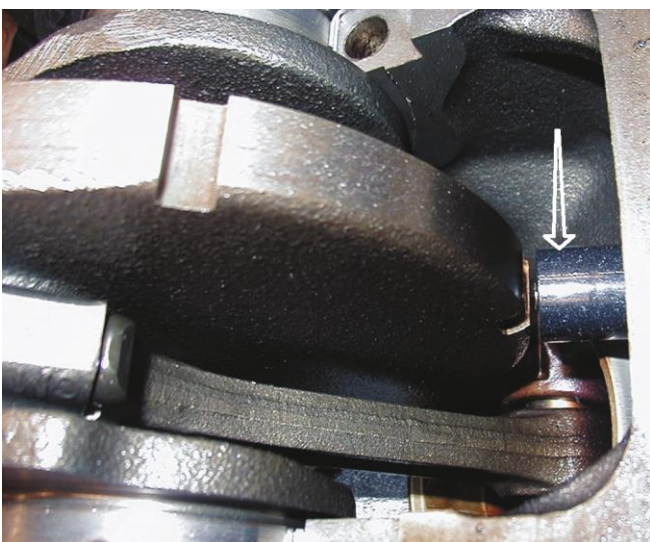


Figure 3. CKP sensor (arrow).

Spark plugs are manufactured from ceramic insulators inside a steel shell. The threads of the shell are rolled, and a seat is formed to create a gas-tight seal with the cylinder head. Most spark plugs include a

resistor in the center electrode, which helps to reduce electromagnetic noise or radiation from the ignition system. Figure 3.

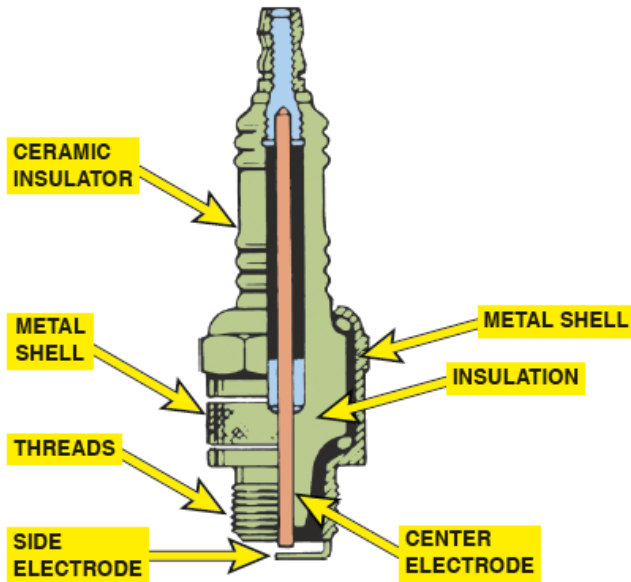


Figure 3. Parts of a spark plug.

ASE TEST TOPICS

1. Diagnose ignition system-related problems such as: no starting, hard starting, engine misfire, poor driveability, spark knock, power loss, poor mileage, and emissions problems; determine root cause.

In the event of a no-start condition, the first step should be to check for secondary voltage out of the ignition coil to the spark plugs. Remove the spark plug wire from the spark plug, install a spark tester, and crank the engine. A good coil and ignition system should produce a blue spark at the spark tester. Figure 4.



Figure 4. Spark tester.

A basic step in the diagnosis process is to perform a thorough visual inspection of the ignition system, including the following:

A8-B. Ignition System Diagnosis and Repair

- Check all spark plug wires for proper routing. All plug wires should be in the factory wiring separator and be clear of any metallic object that could cause damage to the insulation and cause a short-to-ground fault.
- Check that all spark plug wires are securely attached to the spark plugs and to the distributor cap or ignition coil(s).
- Remove the spark plugs and check for excessive wear or other visible faults. Replace if needed.
- On COP systems remove the coils and check the connecting boot for cracks, carbon tracks, or corrosion. Figure 5.



Figure 5. Check the COP coil for arcing or corrosion.

If accessible, check the crankshaft position sensor for the correct resistance and AC voltage output using a DMM. Figure 6.



Figure 6. Measuring CKP sensor resistance.

2. Interpret ignition system-related diagnostic trouble codes (DTCs); determine needed action.

A scan tool is required to retrieve DTCs from an OBD-II vehicle. Every OBD-II scan tool will be able to read all generic Society of Automotive Engineers (SAE) DTCs from any vehicle. OBD alphanumeric DTCs follow a specific format. Figure 7.

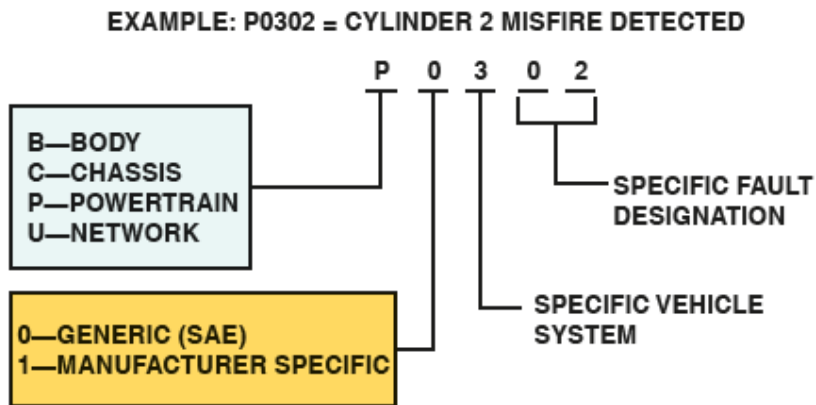


Figure 7. OBD-II DTC identification format.

The diagnostic trouble codes (DTCs) are grouped into major categories, depending on the location of the fault on the system involved. The number in the hundredth position indicates the specific vehicle system or subgroup that failed. Ignition system-related DTCs are in the P0300 group. Some examples are:

- P0300 Random/Multiple Cylinder Misfire Detected
- P0315 Crankshaft Position System Variation Not Learned
- P0325 Knock Sensor 1 Circuit (Bank 2 or Single Sensor)
- P0350 Ignition Coil Primary/Secondary Circuit Malfunction
- P0390 Camshaft Position Sensor B Circuit (Bank 2)

3. Inspect, test, service, repair, or replace ignition system primary circuit wiring and components.

The ignition components that regulate the current in the coil primary winding by turning it on and off are known collectively as the primary ignition circuit. When the primary circuit is carrying current, the secondary circuit is off. When the primary circuit is turned off, the secondary circuit has high voltage. These components of the primary circuit should be inspected:

1. Battery
2. Ignition switch
3. Primary windings of coil
4. Pickup coil (crankshaft position sensor)
5. Ignition module (igniter)

4. Inspect, test, service, repair, or replace ignition system secondary circuit wiring and components.

A8-B. Ignition System Diagnosis and Repair

The components necessary to create and distribute the high voltage produced in the secondary windings of the coil are called the secondary ignition circuit. Figures 8 and 9.

Components of the secondary ignition circuit that should be inspected are:

1. Secondary windings of coil
2. Distributor cap and rotor (if the vehicle is so equipped)
3. Spark plug wires
4. Spark plugs

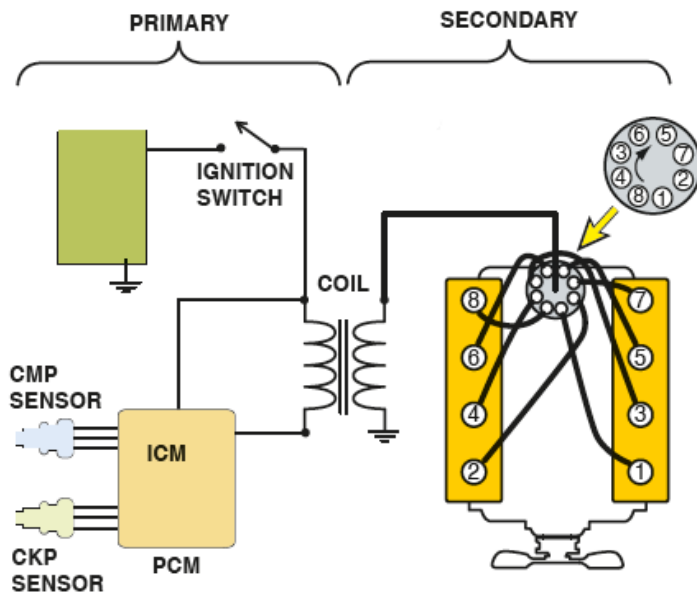


Figure 8. Distributor-type ignition system.

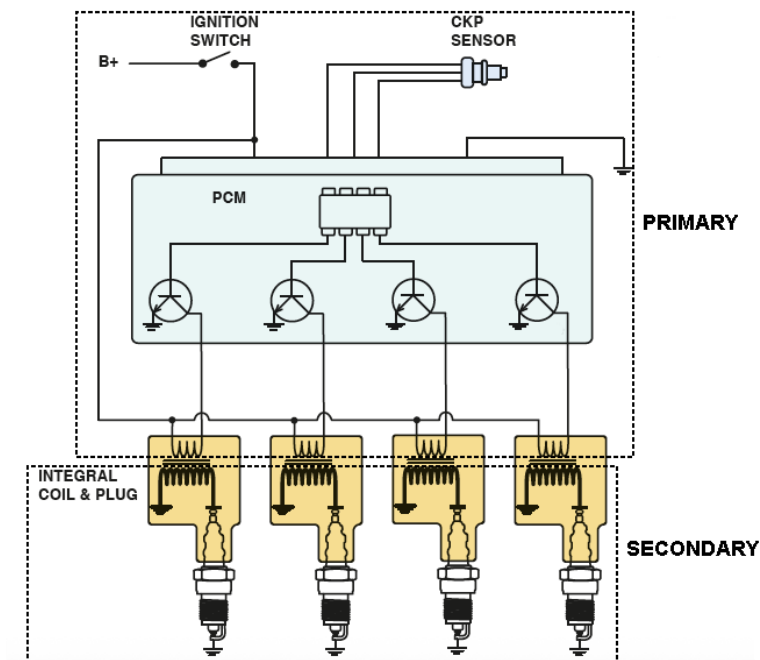


Figure 9. Coil-on-plug ignition system.

Spark plug wires should be visually inspected for cuts or defective insulation. Faulty spark plug wire insulation can cause hard starting or no starting in rainy or damp weather conditions. Check all spark plug wires with an ohmmeter for proper resistance. Good spark plug wires should measure less than 10,000 ohms per foot of length. Figure 10.

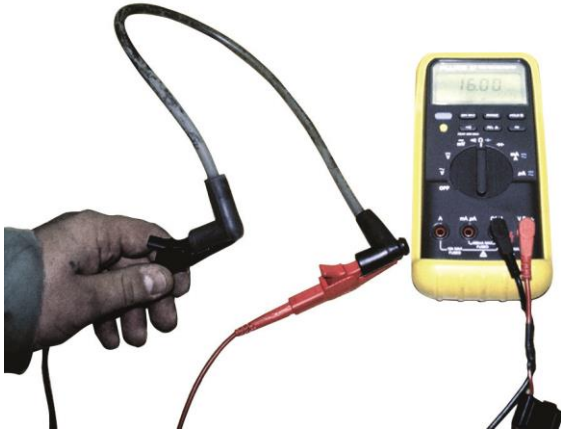


Figure 10. Checking spark plug wire resistance.

5. Inspect, test, and replace ignition coil(s).

If an ignition coil is suspected of being defective, an ohmmeter check can be performed to test the resistance of the primary and secondary windings inside the coil. This works on distributor coils and waste-spark coils. Figure 11.

Primary resistance. Measure the resistance between the positive terminal and the negative terminal of the ignition coil. Most coils will give a reading between less than 1 and 3 ohms.

Secondary resistance. Measure the resistance between either the primary terminal and the secondary coil tower or between the secondary towers. The normal resistance of most coils ranges between 6,000 and 30,000 ohms.

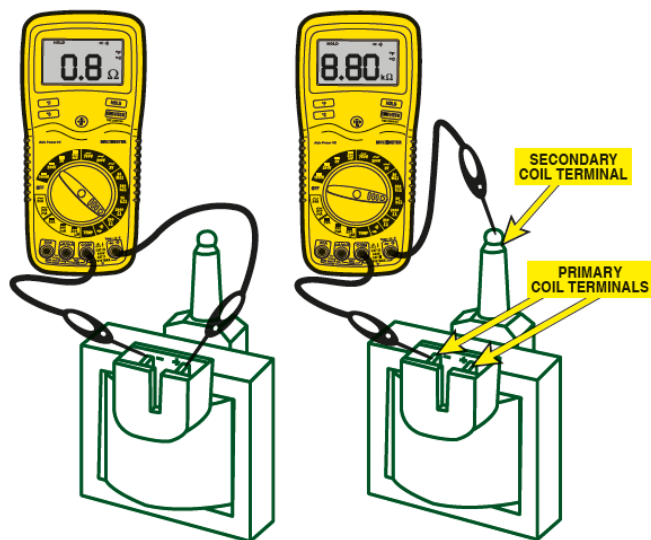


Figure 11. Measuring ignition coil resistance.

Coil-on-plug ignition coils. A two-wire COP ignition coil uses the vehicle computer to control the firing of the ignition coil. The two wires include the ignition voltage feed and the pulse ground wire, which is controlled by the computer. These can be measured using the ohmmeter.

A three wire COP design includes an ignition module at each coil. The three wires include ignition voltage, ground, and pulse from the computer to the built-in ignition module. This type should be diagnosed using the scan tool or a scope.

6. Inspect, test, and replace ignition system sensors; adjust as necessary.

Ignition system sensors are checked for poor connections and wiring by visual inspection. The easiest way to check sensor operation is with a scan tool; the CKP sensor is the primary sensor for RPM, and this can be verified in the scan tool data.

If accessible, the magnetic crankshaft position (CKP) sensor can be tested using a digital meter set to read ohms or AC volts. Figure 12.

- Resistance. Usually between 150 and 1,500 ohms but check service information for the exact specifications.
- AC voltage output. The CKP sensor also can be tested for proper voltage output. During cranking, most pickup coils should produce a minimum of 0.25-volt AC.



Figure 12. Checking CKP sensor resistance.

7. Inspect, test, and/or replace ignition control module (ICM) and/or powertrain/engine control module (PCM/ECM); program, reprogram, code, initialize, and/or setup as needed.

When a sensor or PCM is replaced there is usually a requirement that reprogramming or a setup procedure is needed to complete the repair. In addition, in states with emission testing, the vehicle must be driven to the point that all of the OBD-II monitors have run to completion.

Module reprogramming consists of downloading new calibrations from the manufacturer into the PCM's electronically erasable programmable read only memory (EEPROM). After loading the new calibrations there are usually instructions for re-learning some engine sensors, such as the CKP and CMP sensors.