

120 Ignition System

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GENERAL

This repair group covers troubleshooting and testing of the ignition specific components of the DME engine management system. Additional DME troubleshooting and testing is covered in **130 Fuel Injection**.

The DME engine management system (also known as Motronic) controls both the fuel and the ignition functions via an electronic control module (ECM). Various versions of DME are used on the cars covered by this manual.

NOTE—

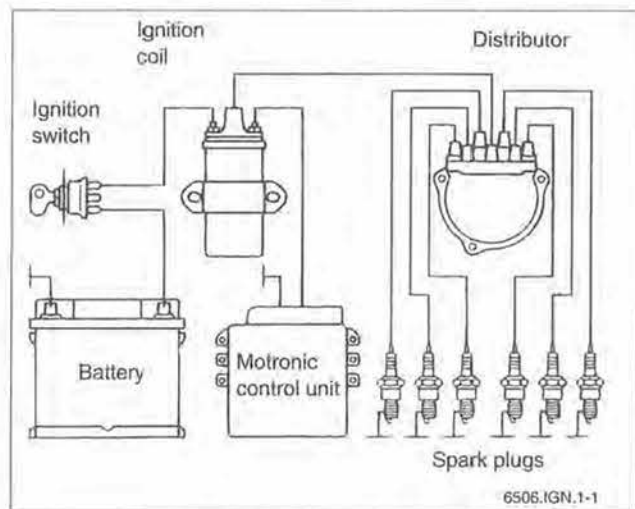
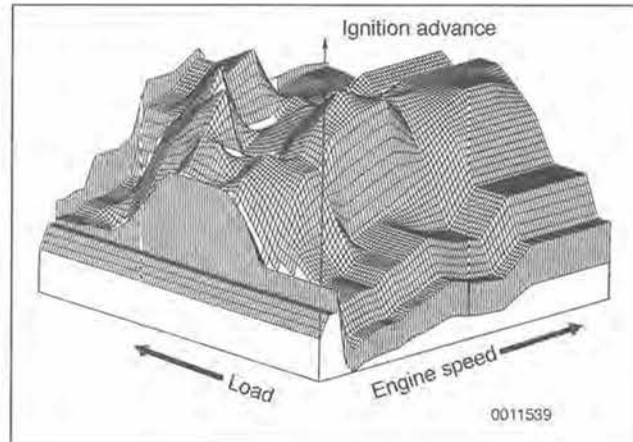
- The M70 (V12) engine uses two separate engine management systems. This includes two DME modules, two mass air flow sensors, two oxygen sensors, two crankshaft position sensors, etc. In essence, the V12 engine is managed as two 6-cylinder engines.
- Spark plug replacement is covered in **020 Maintenance**.
- Information in this repair group labeled "Motronic" or "DME" applies to all versions, unless specifically noted otherwise.

DME Engine Management Systems

- 735i/iL (M30 engine) DME 1.3
- 740i/iL (M60 engine) DME 3.3
- 750iL (M70 engine)
1988-1990 DME 1.2
- 1991-1994 DME 1.7

Ignition timing is electronically controlled and not adjustable. The DME control module uses engine load, engine speed,

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coolant temperature, and intake air temperature as the basic inputs for timing control. On cars with DME 3.3 (M60 engine), knock detection is also an input to the DME control module.

◀ Motronic ignition characteristic map.

The initial ignition point is determined by the crankshaft position/rpm sensor during cranking. Once the engine is running, timing is continually adjusted based on operating conditions. A DME ignition characteristic map is digitally stored in the Motronic control module.

WARNING —

The ignition system is a high-energy system operating in a dangerous voltage range that could prove to be fatal if exposed terminals or live parts are contacted. Use extreme caution when working on a car with the ignition on or the engine running.

◀ Distributor ignition system (DME 1.3 system).

M30 and M70 engines use a distributor ignition system. A distributor cap is mounted to the front of each cylinder head. The ignition rotor is driven directly off the front of each camshaft. The only function the distributor serves is to distribute high voltage to the spark plugs. There are no adjustments that can be made.

On M60 engine, a direct ignition system is used—there is no distributor cap or ignition rotor. Individual coils are mounted directly above each spark plug. Each coil can be selectively controlled by the DME control module on a cylinder-by-cylinder basis.

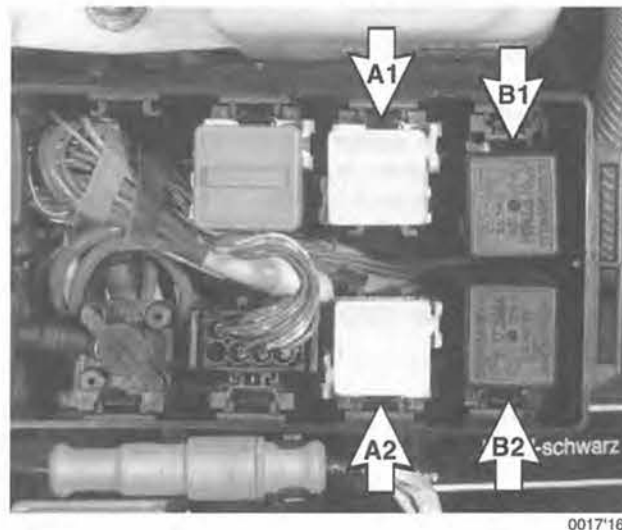
Disabling ignition system

The ignition system operates in a lethal voltage range and should therefore be disabled any time service or repair work is being done on the engine that requires the ignition to be switched on.



➤ Main DME relay (A) and fuel pump relay (B) in right rear of engine compartment (E-Box). M30 engine shown. Relay positions on M60 engine are similar.

- The DME engine management system can be disabled by removing the DME main relay. Relays locations vary depending on engine application.



➤ Main DME relays (A1, A2) and fuel pump relays (B1, B2) in auxiliary relay panel II, ahead of right front strut tower, in 750iL.

Warnings and cautions

The DME system contains sensitive electronic components. To protect the system and for general safety, the following warnings and cautions should be observed during ignition system troubleshooting, maintenance, or repair work.

WARNING—

- Do not touch or disconnect any of the high tension cables at the coil, distributor, or spark plugs while the engine is running or being cranked by the starter. Fatal voltages are present.
- Before operating the starter without starting the engine (for example when making a compression test) always disable the ignition. See **Disabling Ignition System**.

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CAUTION—

- Connect or disconnect ignition system wires, multiple connectors, and ignition test equipment leads only while the ignition is off. Switch multimeter functions or measurement ranges only with the test probes disconnected.
- On M30 or M70 engines, do not disconnect terminal 4 (center terminal) from the coil or remove the distributor cap to disable the ignition.
- Do not disconnect the battery while the engine is running.
- Many of the tests of ignition system components require the use of high-impedance test equipment to prevent damage to the electrical components. A high impedance digital multimeter should be used for all voltage and resistance tests. An LED test light should be used in place of an incandescent-type test lamp.
- Do not connect test instruments with a 12-volt supply to terminal 15 (+) of the ignition coil. The voltage backflow can damage the DME control module. In general, make test connections only as specified by BMW, as described in this manual, or as described by the instrument's manufacturer.

TROUBLESHOOTING

Poor driveability may have a variety of causes. The fault may lie with the ignition system, the fuel system, parts of the emission control system, or a combination of the three. Because of the interrelated functions of these systems and their effects on each other, it is often difficult to know where to begin looking for problems. For this reason, effective troubleshooting should always begin with an interrogation of the On-Board Diagnostic (OBD) system. See **100 Engine—General**.

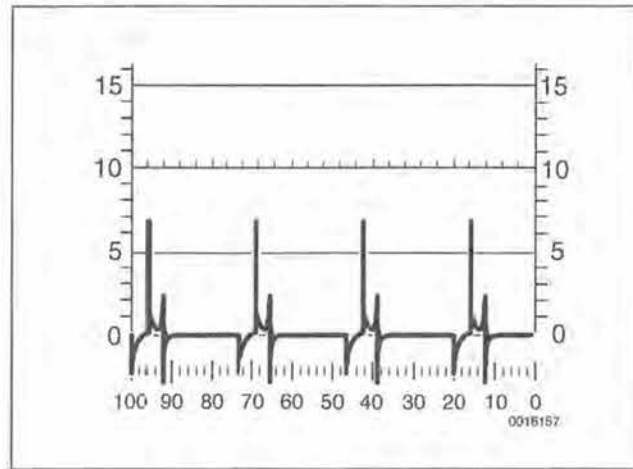
Basic troubleshooting principles

An engine that starts and runs indicates that the ignition system is fundamentally working—delivering voltage to the spark plugs. A hard-starting or poor-running engine, however, may indicate a problem with how well the spark is delivered. Faulty or worn ignition components, such as old spark plugs, may be the cause of reduced spark intensity and inefficient combustion.

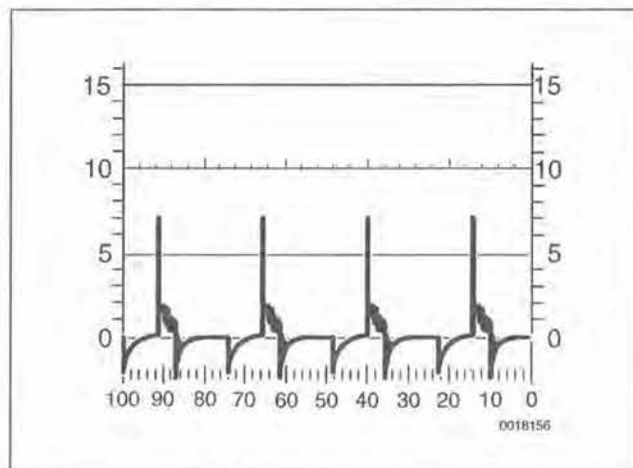
WARNING—

Inefficient combustion (rich air/fuel mixture) can cause the catalytic converter to overheat and plug. An overheated catalytic converter can also be a fire hazard.

- The most effective way to diagnose a faulty coil on a car that is running is to use an oscilloscope to analyze spark quality.



Scope trace at idle (4-cylinder engine shown—voltage spike values are lower than actual).



Scope trace at elevated engine speed (approx. 2,000 rpm).

Table a lists common ignition coil voltage faults and the related cause.

NOTE—

Note the length of sparking period and the up-down voltage attenuations. A short sparking period and/or an irregular/low voltage attenuations usually indicates a faulty coil.

Table a. Ignition Coil Diagnostics

	Ignition voltage low	Ignition voltage high
Spark plug electrode gap	too small	too big
Spark plug electrode condition	new/correct	worn/burnt
Spark plug electrode temperature	too high	too low
Engine compression	too low	too high
Spark plug wire(s)	—	faulty
Fuel air mixture	correct	too lean

Checking for spark (M30/M70 engine only)

On engines with distributor ignition, the most fundamental step in troubleshooting a no-start condition is to determine if the spark plugs are making spark. The battery should be fully charged when making the test.

NOTE—

On M60 engine with individual coils, checking for spark is difficult. Try removing the plugs and inspecting for differences between them. Note that late DME systems, the fuel injector will be electrically disabled if a faulty coil is detected.

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- Turn ignition off. Remove connector from spark plug. Connect plug wire to known good spark plug, preferably a new plug.

WARNING—

Do not hold the spark plug or its connector, even if using insulated pliers. The ignition system is a high-energy system operating in a dangerous voltage range which could prove to be fatal if exposed terminals or live parts are contacted.

- Position plug so that outer electrode is grounded on engine.

CAUTION—

Any test set-up other than the one described above may cause damage or inconclusive tests.

- While a helper briefly actuates starter, look and/or listen for spark.

NOTE—

- On M70 engine, be sure to check the spark on both sides of the engine. The M70 engine uses two independent DME systems, one for each bank of cylinders.
- A bright blue spark indicates a good spark. A yellow-orange spark indicates a weak spark. Test the coil, the spark plug wires, the distributor cap and rotor and replace any faulty components found (where applicable). If there is no spark, begin by testing the crankshaft position/rpm sensor.

WARNING—

If ignition system failure is not the problem, the engine may start during this test. Be prepared to turn off the ignition immediately. Running the engine with a spark plug wire disconnected may damage the catalytic converter.

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Ignition components, testing (M30/M70 engine)

The following procedures checks the ignition coil(s), the distributor caps, and the rotor(s) on M30 and M70 engines.

- Connect a voltmeter between terminal **15 (+)** of ignition coil and ground. Turn ignition on and check for voltage.
- If battery voltage is not present, check wire between terminal 15 and ignition switch. See **Electrical Wiring Diagrams**.

CAUTION—

The wiring to terminal 15 (+) of the coil (via the ignition switch) is not fused. Use care when testing this circuit.

- Label and remove wiring from coil. Use a digital multimeter to test coil primary and secondary circuits. Resistance values are listed in **Table b**.

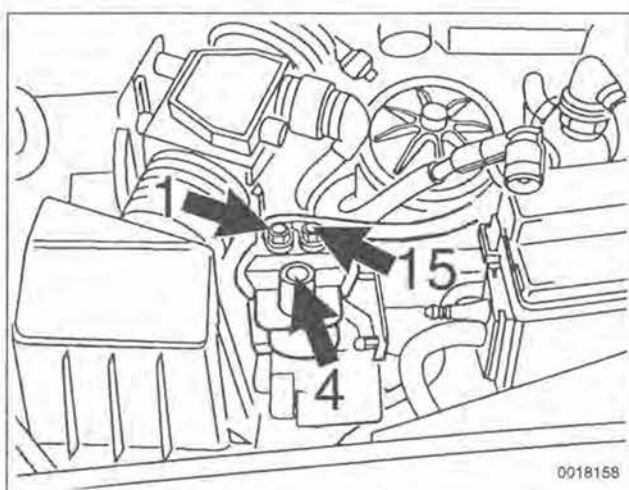


**Table b. Ignition System Resistance Specifications
(M30/M70 engine)**

Components	Terminals	Resistance
Coil primary		
Coil code no. 2051118335	1 (–) and 15 (+)	0.50 Ω
Coil code no. 20510171101	1 (–) and 15 (+)	0.37 Ω
Coil secondary		
Coil code no. 2051118335	15 (+) and 4 (ctr.)	6.0 k Ω
Coil code no. 20510171101	15 (+) and 4 (ctr.)	9.0 k Ω
Spark plug ends	–	5.0 $\pm$ 10% k Ω
Shielded plugs	–	1.0 $\pm$ 20% k Ω
Spark plug wires	–	0 Ω (approx.)
Rotor	–	1.1 $\pm$ 10% k Ω

NOTE—

Note that two types of coils are installed, depending on model year. Identify the coil code number on the coil when making the tests.

- Inspect coil housing for hairline cracks or leaks. Replace the coil if any faults are found.
- Check resistance of spark plug end connectors and individual wires. Wires or connectors with high resistance should be replaced. Check for corrosion at connections. Resistance values are listed in **Table b**.
- Remove distributor cap and check condition of ignition rotor. See **Table b** for rotor resistance values.
- Check resistance of removed distributor cap between tower and matching contact inside cap. Resistance should be nearly zero ohms.
- Replace any faulty components found.

NOTE—

- *On models with DME 1.3, a failed engine control module can sometimes damage the ignition coil. Be sure to check the ignition coil anytime a faulty DME 1.3 control module is replaced and a no-start condition still exists.*
- *Spark plug wire ends are available individually through an authorized BMW dealer parts department.*

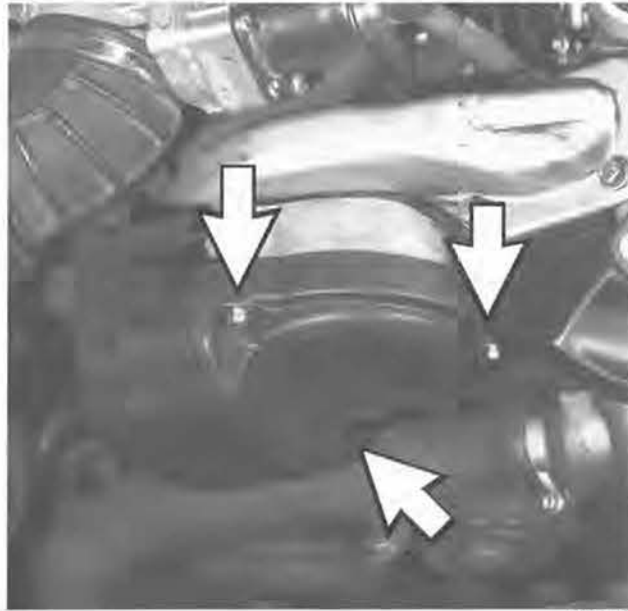
Ignition components, replacing (M30/M70 engine)

BMW does not specify a replacement interval for the distributor cap and rotor. Worn and corroded contacts or poor insulation that allows the spark to short to ground are the primary reasons for replacement of these components.

Each spark plug wire leads from a specific terminal on the distributor cap to a specific spark plug. A cylinder number label should be attached to each spark plug wire.

NOTE—

To facilitate easier removal of the cap and rotor, first remove the radiator cooling fan and fan shroud. See 170 Radiator and Cooling System.



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Distributor cap mounting screws (arrows). (M70 right side)

- The distributor cap is held in place with three screws. Carefully remove the plastic shield from the cap and then loosen the captive screws. Leave the spark plug wires in the old cap. Mount the new cap and tighten the screws. Change over one wire at a time from the old cap to the new one.
- To remove the rotor mounting screws use a 3mm allen wrench. Installation of the rotor and cap is the reverse of removal. Do not over tighten the rotor mounting screws.

Tightening Torque

- Ignition rotor to rotor adaptor 2.8 ± 0.2 Nm (25 ± 1.8 in-lb)

NOTE—

The inductive pickup (cylinder identification sensor) on the spark plug wire is used to sequence the fuel injectors. See 130 Fuel Injection.

Ignition coil, testing (M60 engine)

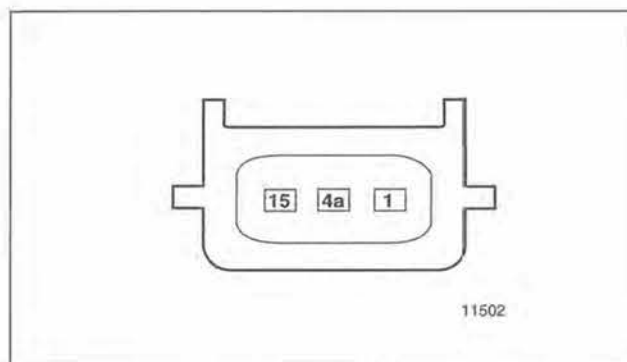
- Remove plastic engine cover(s) from top of engine by prying off nut covers and removing cover mounting nuts.

Disconnect harness connector from coil.

- Connect digital voltmeter between terminal 15 (+) in harness connector and terminal 4a (ground). Turn ignition on and check for battery voltage.
- If battery voltage is not present, check wire between terminal 15 and ignition switch. Check for continuity to ground at terminal 4a. See Electrical Wiring Diagrams.

CAUTION—

The wiring to terminal 15 of the coil (via the ignition switch) is not fuse protected. Use care when testing this circuit.



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- Turn ignition off.
- Use digital multimeter to test coil primary. Resistance values are listed in **Table c.**

Table c. Ignition Coil Resistance (M60 engine)

	Terminals	Resistance
Coil primary	1 (–) and 15 (+)	0.8 Ω (approx.)
Coil secondary	—	—

- Remove coil and inspect coil housing for hairline cracks or leaking casting material. Replace coil if any faults are found.

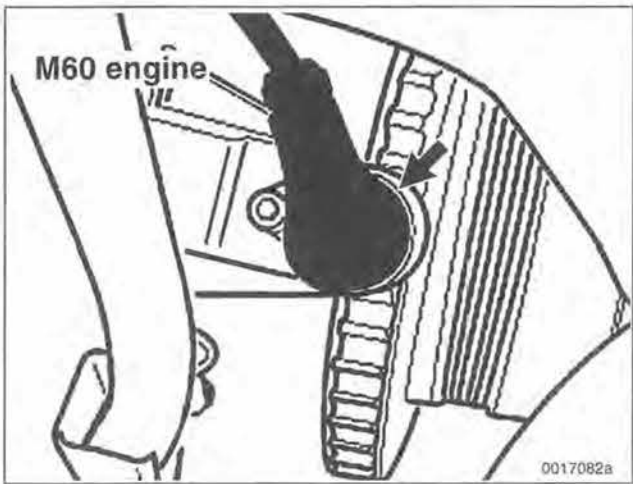
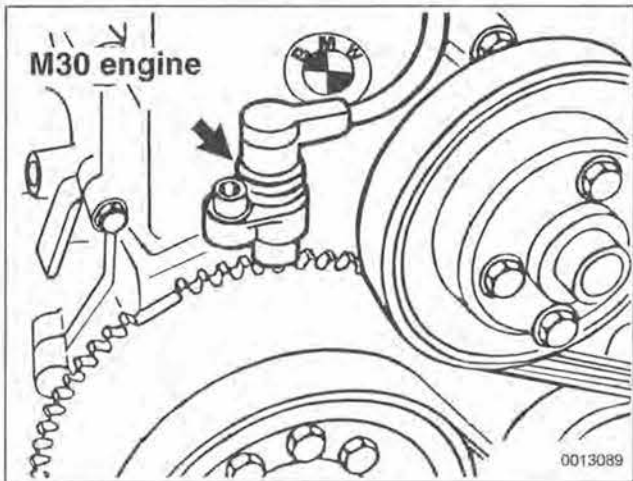
NOTE —
On "May and Christe" manufactured coils, check carefully for thermal stress cracks or signs of leaking casting material. If any of these faults are found, the coil should be replaced before it causes damage to the DME ECM.

Crankshaft position/rpm sensor, testing and replacing

If the engine control module (ECM) does not receive a crankshaft position signal during cranking, engine will not start.

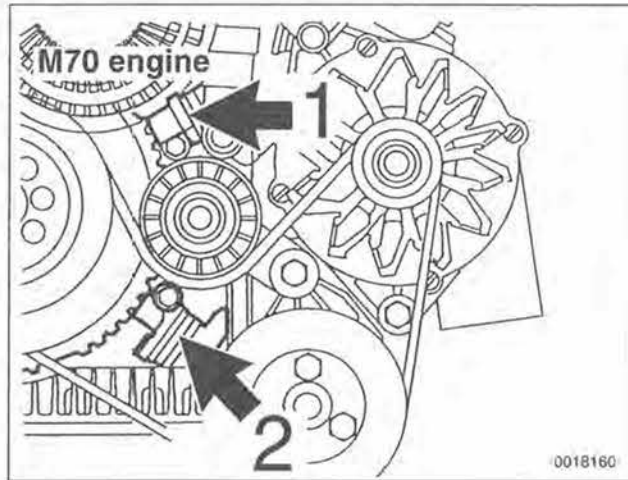
- Engine speed is calculated from rate at which wheel's teeth pass the sensor.
- Crankshaft position is determined by missing-teeth gap on pulse wheel.

➤ Crankshaft position/rpm sensor (**arrow**) is mounted at front of M30 engine cover and reads the toothed vibration dampener wheel.

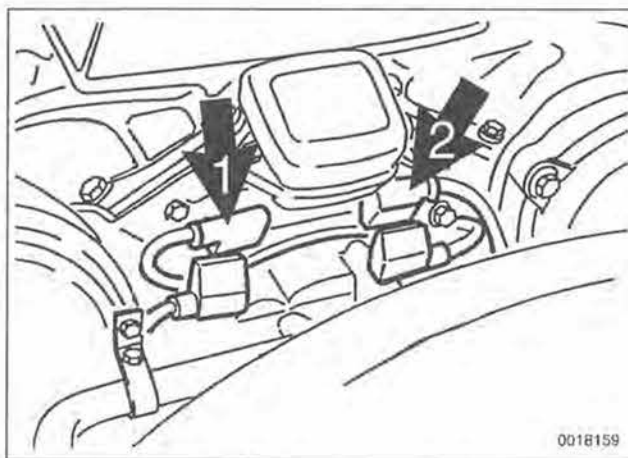


➤ Crankshaft position/rpm sensor (**arrow**) mounted at front of M60 engine.

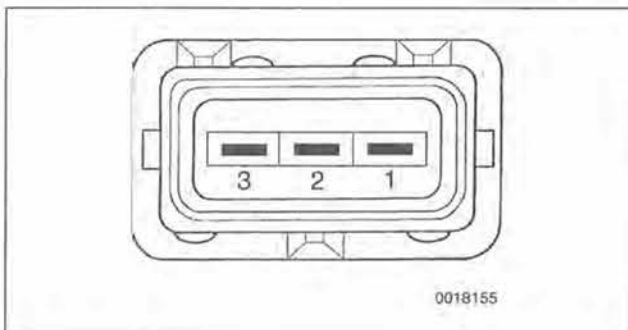
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- Crankshaft position/rpm sensors on M70 engine (arrows) mounted on front timing chain cover. Upper sensor is for DME 1, lower sensor is for DME 2.



- Disconnect crankshaft position/rpm sensor harness connectors on M70 engine for right bank (1) and left bank (2) of cylinders.



- Using digital multimeter, check resistance between terminals 1 and 2 in crankshaft position/rpm sensor connector.

Crankshaft Position/rpm Sensor Specifications

- Coil resistance (approx.) @ 20°C
M30/M70 engine 540 ± 10% Ω
M60 engine 1280 ± 10% Ω
- Air gap (sensor distance from toothed wheel) 1.0 ± 0.3 mm (0.04 ± 0.01 in.)

- If resistance is not correct, sensor is faulty and should be replaced.

NOTE—

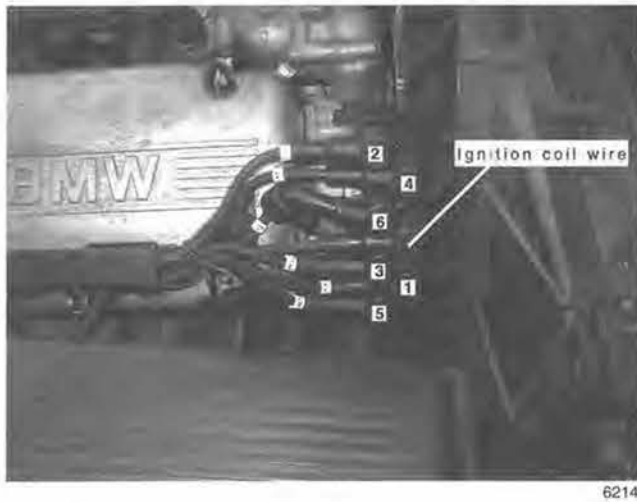
If the sensor resistance is correct, it does not mean the DME is receiving the signal from the pulse sensor. Make a dynamic test using a scope or a digital voltmeter (VAC) at terminals 15 and 1 while cranking the engine. An AC voltage indicates the sensor is functioning.

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- On M30 or M60 engine: To replace a faulty sensor, remove sensor mounting bolt using a 5 mm hex wrench.
 - Cut wire ties as necessary to remove electrical harness connector.
 - When installing new sensor, be sure wiring is rerouted in the same orientation.
 - Secure sensor to mounting bracket and use new wire ties on electrical harness.
- On M70 engine: When replacing DME 2 sensor (cyl. 7-12), components listed below must be unbolted to gain access to lower sensor.
 - Once all components have been unbolted and carefully set aside, rotate crank pulley/vibration damper so that gap in toothed wheel aligns with sensor mounting bolt.
 - Remove bolt and sensor.
 - Remove alternator cooling duct.
 - Remove power steering pump pulley.
 - Remove power steering pump mounting bracket and pump.

Tightening Torque

- Crankshaft position/rpm sensor to mounting bracket 7 ± 1 Nm (62 ± 9 in-lb)



Ignition firing order

- ◀ Spark plug wires correctly installed in distributor cap (M30 engine).
 - On M30 and M70 engine, spark plug wires must be installed so that spark plugs fire in a specified order.
 - The rotor turns in a clockwise direction when viewed from the front with the cap removed.

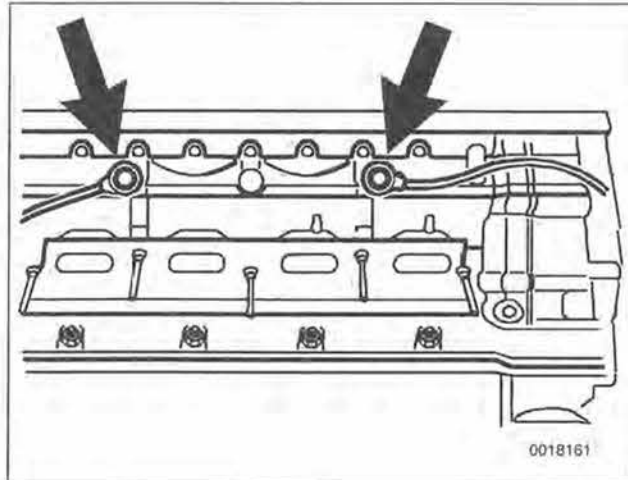
NOTE—

- On M70 engine: When replacing the spark plug wires in the left distributor cap (cyl. 7-12), note that position 1 on the cap corresponds to cylinder no. 7 and position 2 on the cap corresponds to cylinder no. 8, and so on.
- On 6-cylinder engine, cylinder no. 1 is at the front of the engine.
- On 8-cylinder and 12-cylinder engines, cylinder no. 1 is at the front of the engine on the right (passenger side) cylinder head.

Ignition Firing Order

- M30 engine 1-5-3-6-2-4
- M60 engine 1-5-4-8-6-3-7-2
- M70 engine 1-7-5-11-3-9-6-12-2-8-4-10

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Knock sensors (M60 engine)

Four knock sensors, 2 per cylinder per bank, are used on DME 3.3 engine management systems.

- Knock sensors are bolted to cylinder block (arrows) and monitor combustion chamber for engine-damaging knock.
- If knock is detected, the ignition point is retarded accordingly via DME control module.
- Access to knock sensor requires removal of intake manifold.

NOTE—

- On M60 engine, intake manifold removal procedures are described as part of cylinder head removal in 113 Cylinder Head Removal and Installation.
- Knock sensor function is monitored by the On-Board Diagnostic (OBD) system. If a knock sensor is determined to be faulty, an appropriate diagnostic trouble code (DTC) may be stored in memory. See 100 Engine-General for information on retrieving DTCs.

CAUTION—

Do not interchange knock sensor harness connectors. Serious engine damage may result if the sensors are monitoring the wrong cylinders. If the connectors need to be removed, be sure to label them before disconnecting.

Tightening Torque

- Knock sensor to cylinder block 20 Nm (15 ft-lb)

IGNITION SYSTEM CIRCUIT SCHEMATICS

The wiring schematics that follow cover DME ignition system electrical diagrams for 6- and 8-cylinder engines. For 12-cylinder ignition system, including all other additional electrical circuits, see **Electrical Wiring Diagrams**.

WARNING—

Do not touch or disconnect any of the high tension cables from the coil, distributor, or spark plugs while the engine is running or being cranked by the starter. Fatal voltages are present.

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