

120 Ignition System

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GENERAL

This repair group covers repair and component replacement information for the ignition system.

NOTE —

- Spark plug replacement is covered in **020 Maintenance Program**.
- For fuel related troubleshooting and testing, see **130 Fuel Injection**.

All engines covered by this manual use an advanced engine management system. The engine management system incorporates on-board diagnostics, fuel injection, ignition and other advanced engine control functions.

Table a. Engine Management System Variants

Engine code	System
4-cylinder M42 (1.8 l) M44 (1.9 l)	Bosch DME M1.7 Bosch DME M5.2 (OBD II)
6-cylinder M50 1992 (2.5 l) 1993-1995 (2.5 l) M52 1996-1998 (2.8 l) 1998 (2.5 l) S50US (3.0 l) S52US (3.2 l)	Bosch DME M3.1 Bosch DME M3.3.1 Siemens MS 41.1 (OBD II) Siemens MS 41.1 (OBD II) Bosch DME M3.3.1 Siemens MS 41.1 (OBD II)

Troubleshooting and testing of the engine management system should be carried out using the BMW specialized service tester (scan tool).

All engines use a distributorless ignition system with individual ignition coils for each cylinder. There is no distributor cap or ignition rotor. Each coil can be selectively controlled by the engine control module on a cylinder-by-cylinder basis. On later systems, knock sensors are used to monitor and control ignition knock (ping) and adjust timing accordingly.

Ignition timing is electronically controlled and not adjustable. The engine control module (ECM) uses engine load, engine speed, coolant temperature, and intake air temperature as the basic inputs for timing control. Knock detection is also an input to the control module, where applicable.

NOTE —

All engines covered by this manual, with the exception of the 1992 M50, incorporate knock sensors as part of the engine management system.

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 characteristic ignition map is shown in Fig. 1. A map similar to the one shown is digitally stored in the engine control module.

GENERAL

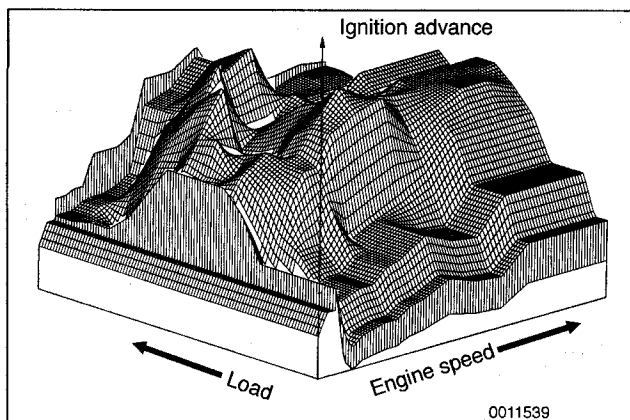


Fig. 1. Ignition characteristic map.

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.

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.

The engine management system can be disabled by removing the main relay. The relay is located in the power distribution box in the left rear of the engine compartment. See Fig. 2.

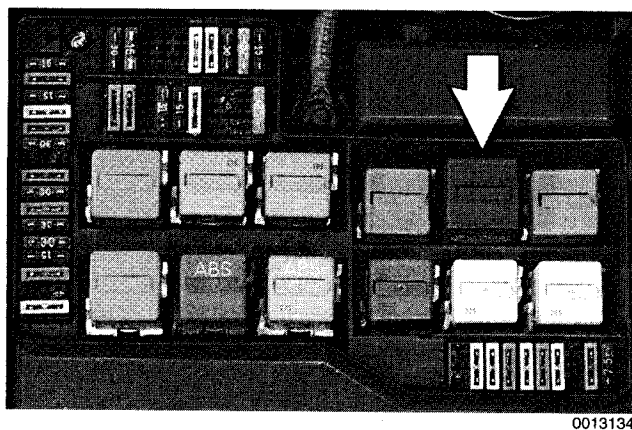


Fig. 2. Main system relay (arrow) in power distribution box (left rear of engine compartment).

CAUTION —

Relay locations may vary. Use care when identifying relays. The main relay has a large (4 or 6 mm²) red wire at terminal 30 and at Terminal 86 in the relay socket. Terminal 87 has a large (4 mm²) red/white wire. See 610 Electrical Component Locations.

Warnings and Cautions

The engine management 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 coils 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.

CAUTION —

- Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.
- Do not attempt to disable the ignition by either removing the coil from the spark plugs (6-cylinder engines) or disconnecting the coil wires from the plugs (4-cylinder engines).
- 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.
- 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.
- In general, make test connections only as specified by BMW, as described in this manual, or as described by the instrument's manufacturer.

IGNITION SYSTEM DIAGNOSTICS

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 these interrelated functions 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. The OBD system detects certain emissions-related engine management malfunctions. When faults are detected, the OBD system stores a Diagnostic Trouble Code (DTC) in the system ECM. In addition, the Check Engine warning light will come on if an emissions-related fault is detected.

Two generations of OBD are used on the cars covered by this manual. See **100 Engine-General** for OBD information.

On-Board Diagnostics

- 1992-1995 models OBD I
- 1996 and later models OBD II

NOTE —

- On cars with OBD II, specialized OBD II scan tool equipment must be used to access DTCs, either using the BMW special tool or a "generic" OBD II scan tool.
- The OBD II fault memory (including an illuminated Check Engine light) can only be reset using the special scan tool. Removing the connector from the ECM or disconnecting the battery will not erase the fault memory.

Basic Troubleshooting Principles

An engine that starts and runs indicates the ignition system is fundamentally working—delivering voltage to at least some of the spark plugs. A hard-starting or poor-running engine, however, may indicate ignition coil problems, cracked or deteriorated spark plug wires (4-cylinder engines only), and worn or fouled spark plugs.

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.

IGNITION SYSTEM SERVICE

On 4-cylinder engines, an ignition coil pack is mounted to the passenger side strut tower in the engine compartment. The coil pack integrates 4 individual coils.

On 6-cylinder engines, an ignition coil is located directly above each spark plug.

Checking for Spark

WARNING —

If a spark test is done incorrectly, damage to the engine control module (ECM) or the ignition coil(s) may result.

Checking for spark is difficult on engines with distributorless ignition systems.

Try removing the plugs and inspecting for differences between them. A poor-firing plug may be wet with fuel and/or black and sooty, but not always. If a coil is not operating, the engine management system will electrically disable the fuel injector to that cylinder. The key is to look for differences between cylinders.

Ignition coil, testing and replacing (4-cylinder engine)

1. Disconnect main harness connector from coils:
 - On M42 engine, remove plastic covering from coils and disconnect individual harness connectors.
 - On M44 engine, disconnect main harness connector at end of coil pack. See Fig. 3.

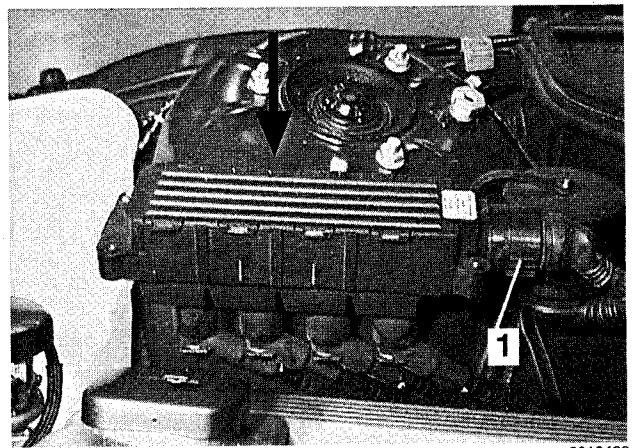


Fig. 3. Ignition coil pack for M44 engine (arrow). Coil harness connector shown at 1.

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2. Check for battery voltage to coils. If voltage is not present, check wire between terminal 15 and ignition switch. See **Electrical Wiring Diagrams**.
- On M42 engine, connect digital multimeter between terminal 15(+) in each harness connector and ground. See Fig. 4.
- On M44 engine, connect voltmeter between terminal 2 (15+) in connector and ground. Turn ignition on and check for voltage. See Fig. 5.

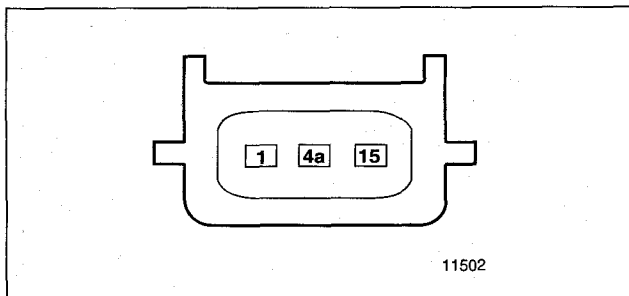


Fig. 4. Ignition coil harness connector terminal identification for M42 engine.

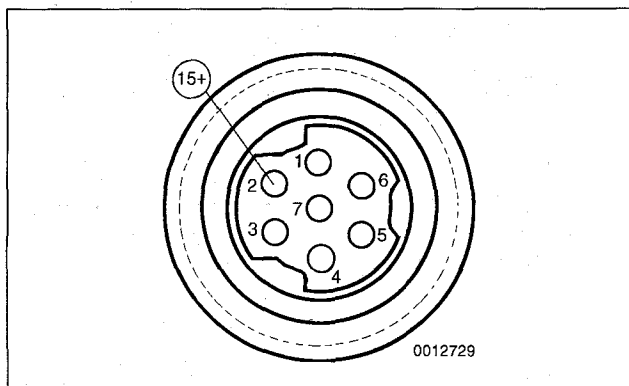


Fig. 5. Ignition coil harness connector terminal identification for M44 engine.

CAUTION —

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

3. Turn ignition off.
4. Use a digital multimeter to test coil primary resistance.
 - On M42 engine, use **Table b** as a guide to check coil resistance. Make checks at each harness connector.
 - On M44 engine, use **Table c** as a guide to check coil primary resistance.
5. Inspect coil housing for hairline cracks or leaking casting material. See Fig. 7. A leaky ignition coil may indicate a faulty ECM (engine control module). Check the ECM before installing a new coil.

Table b. Ignition Coil Resistance (M42 Engine)

	Terminals (refer to Fig. 4.)	Resistance
Coil primary	1 (-) and 15 (+)	0.4-0.8 ohms
Coil secondary	N.A.	N.A.

Table c. Ignition Coil Resistance (M44 Engine)

	Terminals (refer to Fig. 5.)	Resistance
Coil #1 primary	1 (-) and 2 (+)	0.4-0.8 ohms
Coil #2 primary	6 (-) and 2 (+)	0.4-0.8 ohms
Coil #3 primary	7 (-) and 2 (+)	0.4-0.8 ohms
Coil #4 primary	5 (-) and 2 (+)	0.4-0.8 ohms
Coil secondary	N.A.	N.A.

NOTE —

If a single coil is faulty on M44 engines, the complete coil pack will have to be replaced.

Ignition coil, testing and replacing (6-cylinder engine)

CAUTION —

Use a digital multimeter for the following tests.

1. Remove plastic engine covers from top of engine by prying off nut covers and removing cover mounting nuts. See **113 Cylinder Head Removal and Installation**.
2. Disconnect harness connector from coil. Connect multimeter between terminal 15 (+) in connector and ground. See Fig. 6.
3. Turn ignition on and check for battery voltage.
 - If battery voltage is not present, check wire between terminal 15 and ignition switch. See **Electrical Wiring Diagrams**.

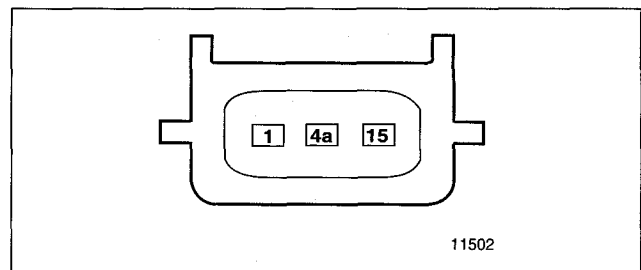


Fig. 6. Ignition coil harness connector terminal identification for 6-cylinder engine.

CAUTION —

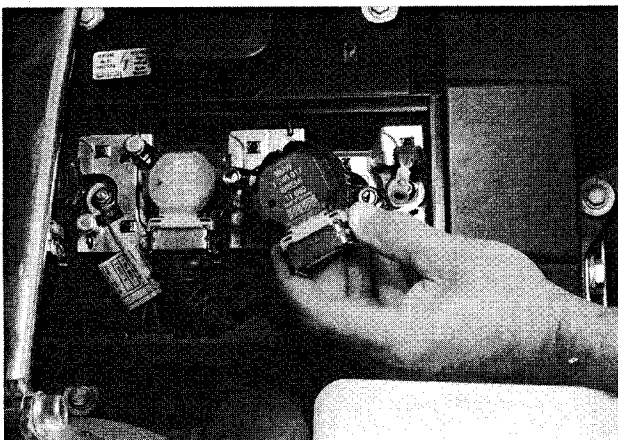
The wiring to terminal 15 (+) of the coil (via the ignition switch) is not fuse protected. Use care when testing this circuit.

4. Turn ignition off.
5. Use a multimeter to test coil primary resistance at coil terminals. See **Table d.**

Table d. Ignition Coil Resistance (6-cylinder Engine)

	Terminals (refer to Fig. 4.)	Resistance
Coil primary	1 (-) and 15 (+)	0.4-0.8 ohms
Coil secondary	N.A.	N.A.

6. Remove coil and inspect coil housing for hairline cracks or leaking casting material. See Fig. 7. A leaky ignition coil may indicate a faulty engine control module (ECM). Check ECM before installing a new coil.



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Fig. 7. Ignition coil being removed on 6-cylinder engine (M52 engine shown).

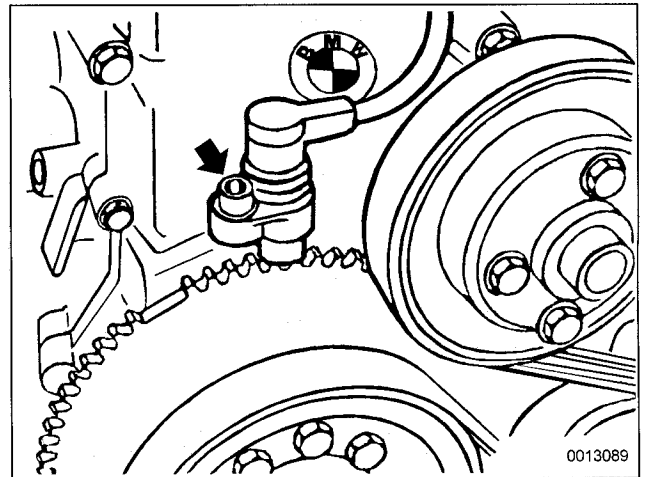
CAUTION —

- Note location of coil ground straps before coil removal; reinstall in the same location.
- When replacing ignition coils, ensure that the replacement coil(s) are from the same manufacturer containing the same part/code numbers. If individual coils with the correct specifications are not available, all coils should be replaced.

Crankshaft Position/rpm Sensor

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

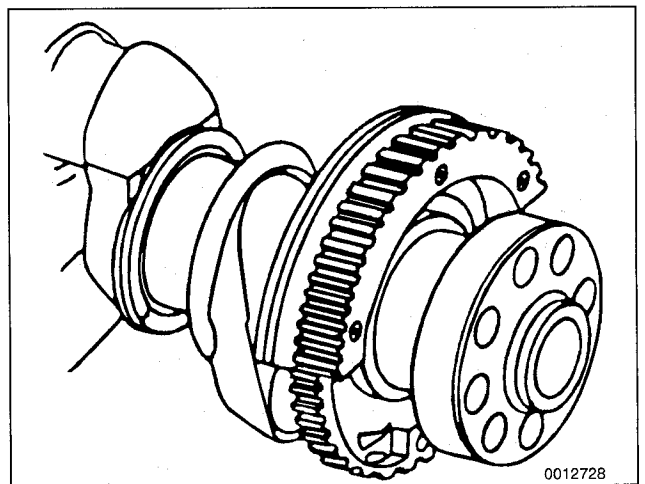
On 1992-1995 (pre-OBD II) cars, the crankshaft position/rpm sensor is mounted on the front engine cover and reads the toothed vibration dampener wheel. See Fig. 8.



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Fig. 8. Crankshaft position/rpm sensor mounted at front of engine on 1992-1995 cars. (arrow).

On 1996 and later cars (OBD II compliant), the crankshaft position/rpm sensor is mounted in the left rear side of the cylinder block. The sensor reads a toothed wheel mounted to the end of the crankshaft. See Fig. 9.



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Fig. 9. Crankshaft position/rpm sensor toothed wheel mounted to rear of crankshaft OBD II compliant cars. The sensor is mounted in the left rear side of the cylinder block.

Crankshaft position/rpm sensor, testing and replacing (front mounted)

1. Disconnect sensor harness connector.
2. Using a digital multimeter, check resistance between terminals 1 and 2 in connector. See Fig. 10.

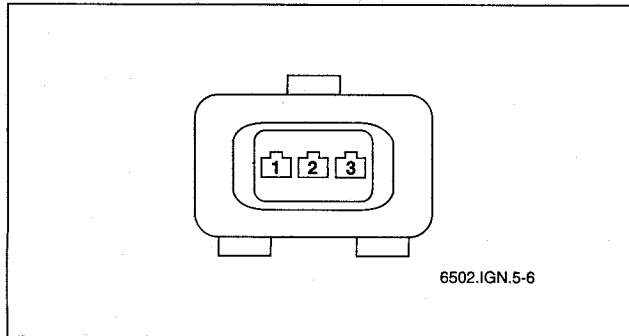


Fig. 10. Crankshaft position/rpm sensor connector.

Crankshaft position/rpm sensor specifications

- Coil resistance (approx.)
terminals 1 and 2 $1280 \pm 10\%$ ohms
- Air gap (sensor distance from toothed wheel) 1.0 ± 0.3 mm (0.04 ± 0.01 in.)

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

NOTE —

When installing the new sensor, be sure the wiring is rerouted in the same orientation. Secure the sensor using new wire ties.

Tightening Torque

- Crankshaft position/rpm sensor to mounting bracket 5 ± 1 Nm (62 ± 9 in-lb)

Crankshaft position/rpm sensor, replacing (rear mounted)

1. Disconnect sensor harness connector.
2. Locate sensor on rear left side of cylinder block. Remove sensor mounting bolt and remove sensor from cylinder block.

3. Installation is reverse of removal. Use a new O-ring when installing sensor. Be sure wiring is rerouted in same orientation. Secure sensor using new wire ties.

NOTE —

It may be easier to remove the sensor working from the underside of the vehicle.

Camshaft Position (CMP) Sensor

The camshaft position (CMP) sensor is used by the engine management system for sequential fuel injection and knock control.

Camshaft position (CMP) sensor, replacing (4-cylinder engine)

1. Remove CMP sensor from top timing cover, just above coolant thermostat housing. See Fig. 11.

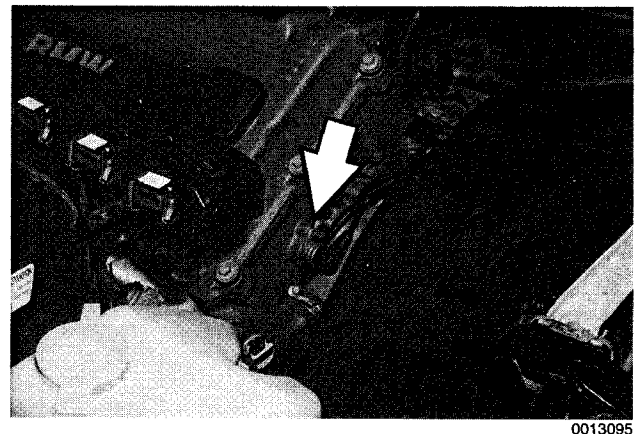


Fig. 11. Camshaft position sensor mounting bolt (arrow). M42 engine shown.

2. On M42 engines to 9/93: Disconnect CMP harness plug just above oil filter housing.
3. On M42 from 9/93 and all M44 engines: Remove upper intake manifold as described in **113 Cylinder Head Removal and Installation**. Then unplug CMP sensor harness connector below manifold.
4. Installation is reverse of removal. Use a new O-ring when installing sensor. Be sure wiring is rerouted in same orientation.

Camshaft position (CMP) sensor, replacing (6-cylinder engine)

1. Remove plastic cover from above fuel injectors.
2. Disconnect harness connector from VANOS solenoid and unscrew solenoid from VANOS control unit. Remove oil supply line from VANOS control unit. See 117 **Camshaft Timing Chain**.
3. Remove camshaft position (CMP) sensor from left front of cylinder head, next to top of oil filter housing.
4. Disconnect CMP sensor harness from under intake manifold.
5. Installation is reverse of removal. Use a new O-ring when installing sensor. Be sure wiring is rerouted in same orientation.

Tightening Torques

- CMP sensor to cylinder head 5 Nm (3.5 ft-lb)
- VANOS oil supply pipe to VANOS control unit 32 Nm (24 ft-lb)
- VANOS solenoid to VANOS control unit 30 Nm (22 ft-lb)

Knock sensors, replacing

Knock sensors are used on engines with Bosch DME M1.7, Bosch DME M3.3.1, Bosch DME M5.2, and Siemens MS 41.1 engine management systems. The knock sensors are bolted to the left side of the cylinder block and monitor the combustion chamber for engine-damaging knock. If engine knock is detected, the ignition point is retarded accordingly via the engine control module.

On 6-cylinder engines, the knock sensors are accessible after removing the intake manifold. On 4-cylinder engines, the upper section of the intake manifold should be removed to access the sensors. See Fig. 12.

Intake manifold removal and installation procedures are covered in 113 **Cylinder Head Removal and Installation**.

CAUTION —

- Label knock sensor harness connectors before disconnecting them. The connectors must not be interchanged. Engine damage may result if the sensors are monitoring the wrong cylinders.
- Note the installed angle of the knock sensor on the block before removing it. Reinstall the sensor in the same position. Be sure to use a torque wrench when tightening the sensor mounting bolt.

NOTE —

- On M52 engines, a single harness connects the two sensors to the main harness connector. The shorter cable lead is for the knock sensor for cylinders 4, 5, and 6.
- Clean contact surface on engine block before installing knock sensors.

Tightening Torque

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

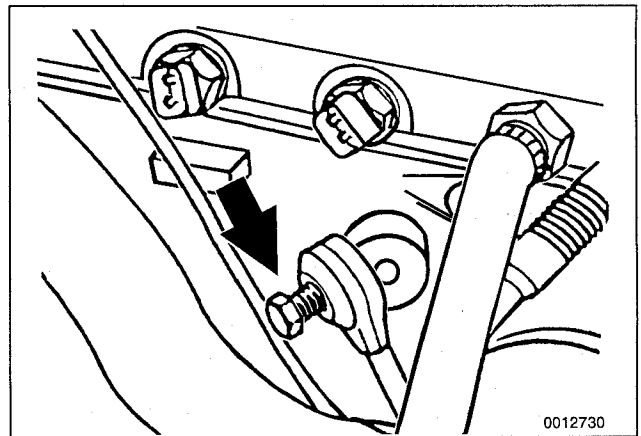


Fig. 12. Knock sensor mounting bolt on front left side of cylinder block.

NOTE —

Knock sensor function is monitored by the On-Board Diagnostic system. If a knock sensor is detected to be faulty, an appropriate diagnostic trouble code (DTC) may be stored in memory. See 100 **Engine-General** for information on retrieving DTCs.

Ignition Firing Order

NOTE —

- Cylinder no. 1 is at the front of the engine.

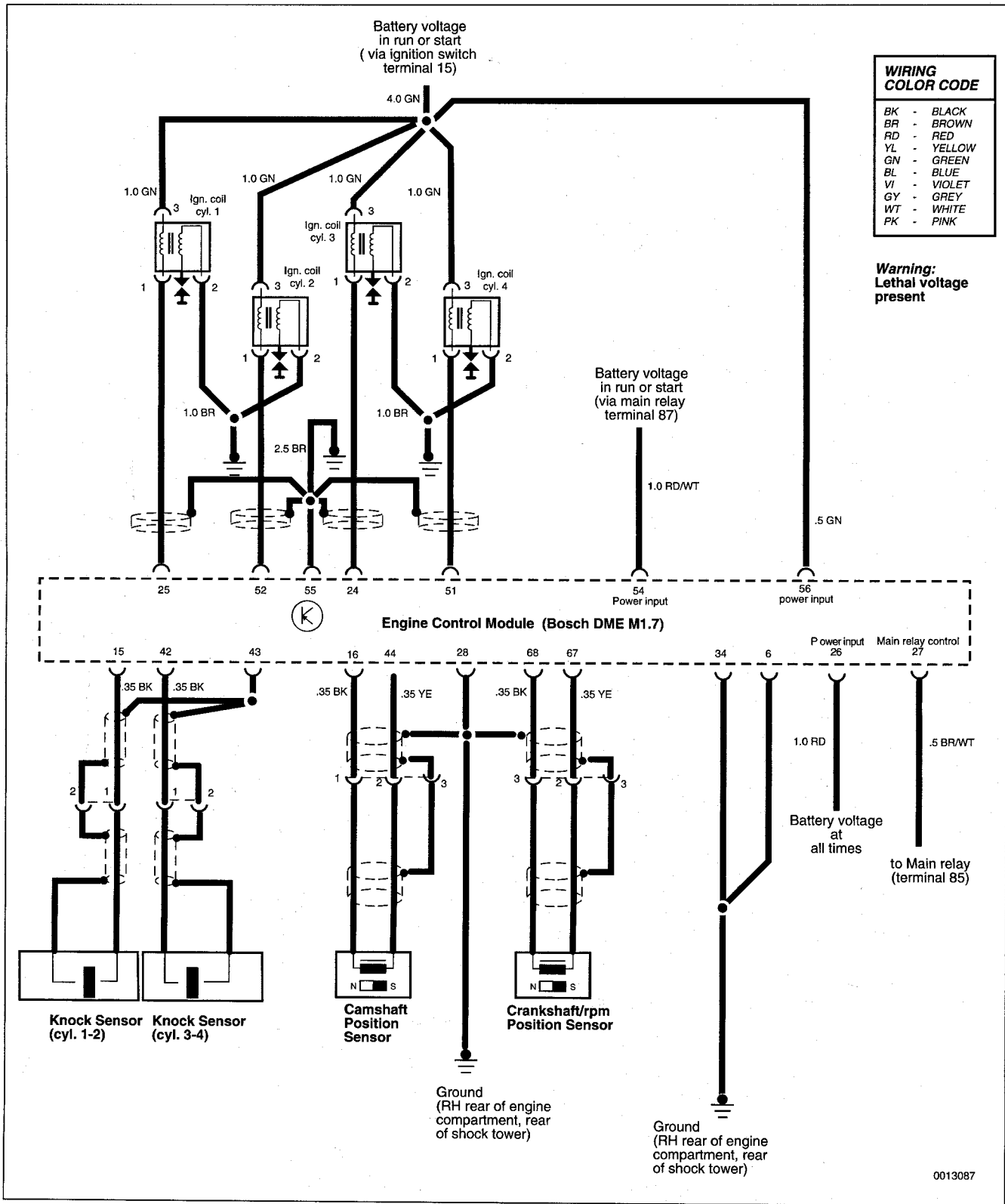
Ignition Firing Order

- 4-cylinder engines 1-3-4-2
- 6-cylinder engines 1-5-3-6-2-4

IGNITION SYSTEM SCHEMATICS

Fig. 13 through Fig. 17 show ignition system schematics used on the engines covered by this manual.

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WIRING COLOR CODE	
BK	- BLACK
BR	- BROWN
RD	- RED
YL	- YELLOW
GN	- GREEN
BL	- BLUE
VI	- VIOLET
GY	- GREY
WT	- WHITE
PK	- PINK

Warning:
Lethal voltage present

Fig. 13. Bosch DME M1.7 ignition system circuit for M42 engine.

IGNITION SYSTEM SCHEMATICS

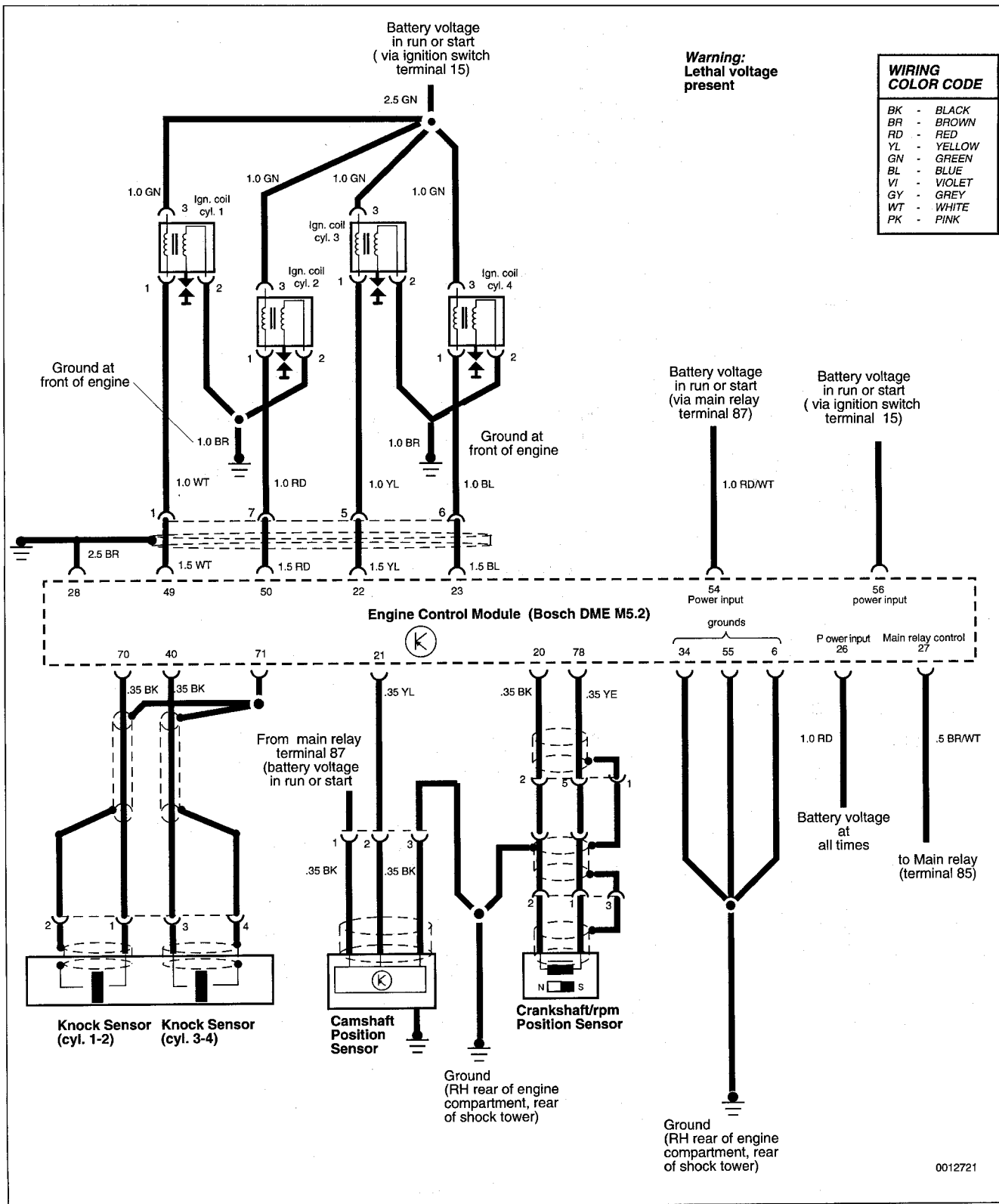


Fig. 14. Bosch DME M5.2 ignition system circuit for M44 engine.

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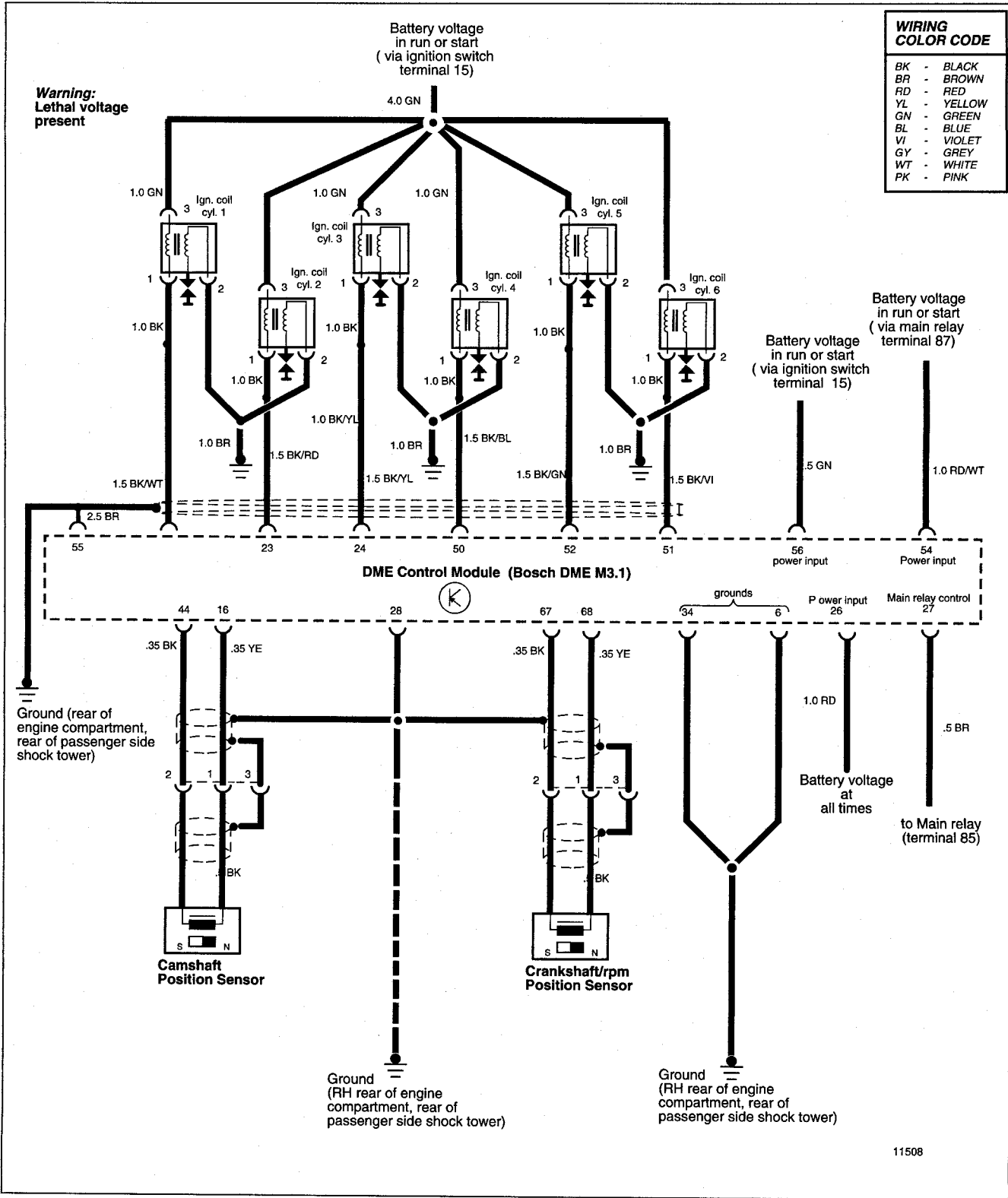


Fig. 15. Bosch DME M3.1 used on 1992 M50 engines (without VANOS).

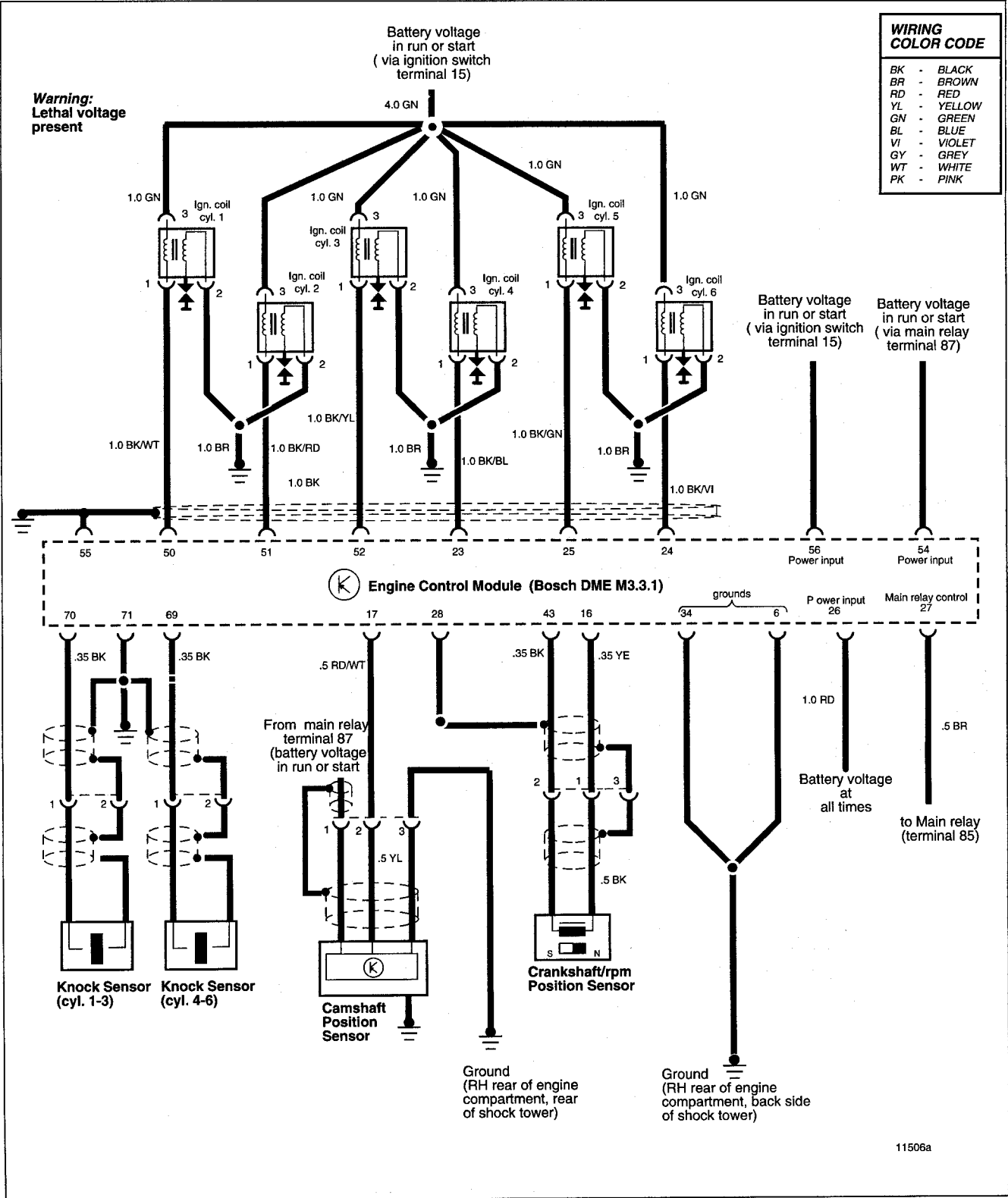


Fig. 16. Bosch DME M3.3.1 ignition system circuit for 1993-1995 M50 engines with VANOS.

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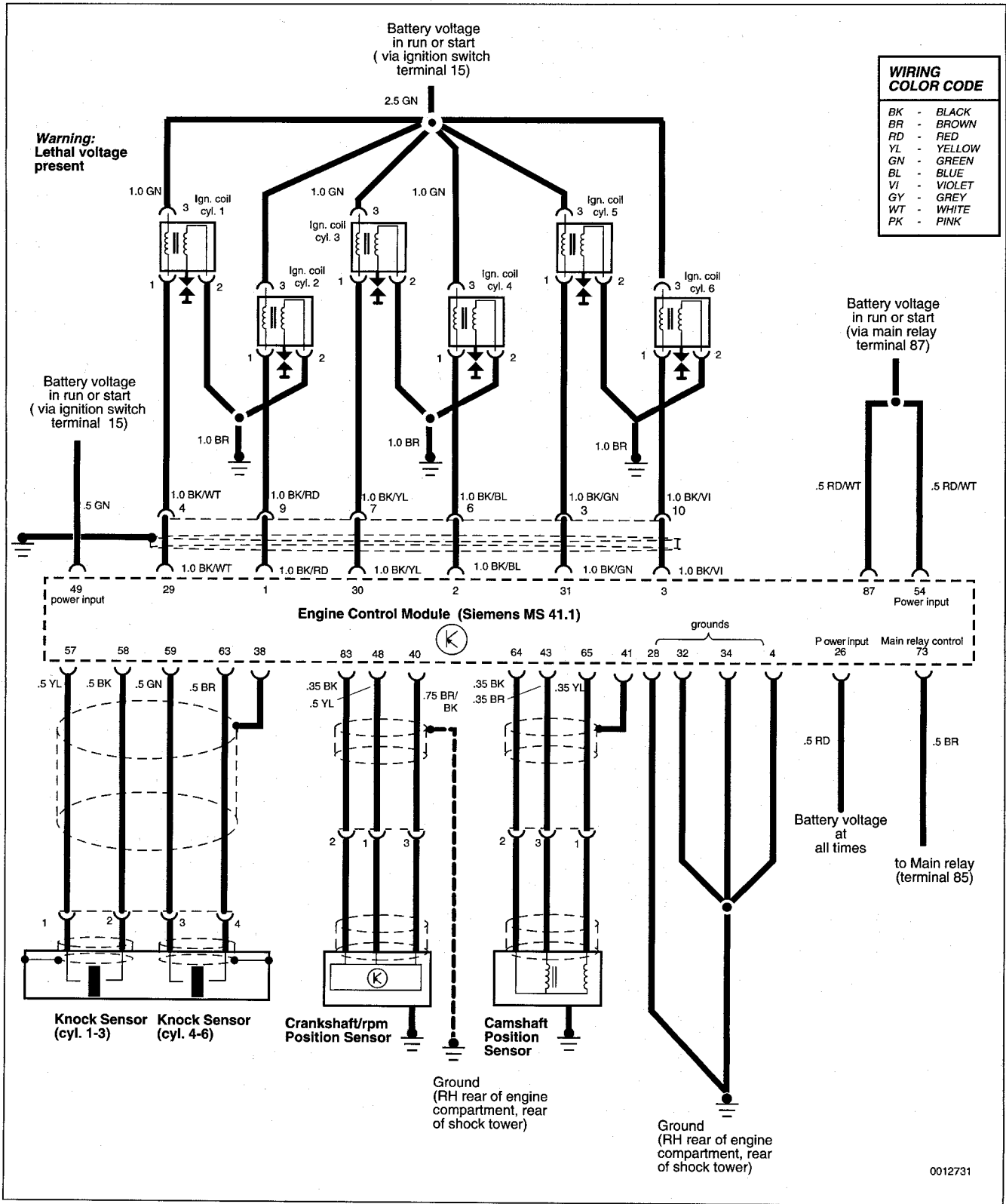


Fig. 17. Siemens MS 41.1 ignition system used on 1996 and later 6-cylinder engines.

