100 Engine–General

GENERAL

This section covers system descriptions and general information on engines and engine management systems. Also covered is basic engine troubleshooting.

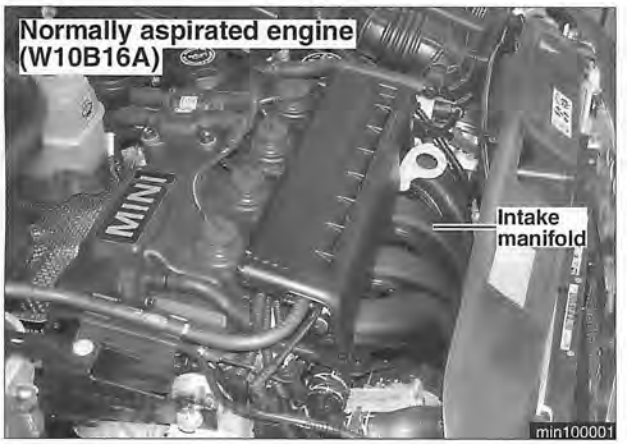
For specific repair procedures, refer to the appropriate repair group:

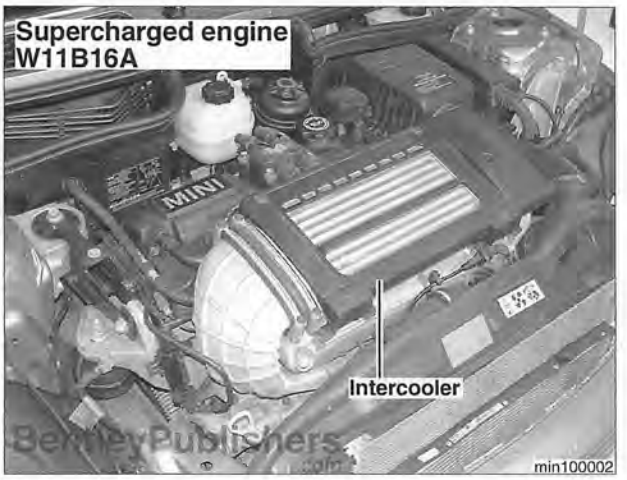
- **110 Engine Removal and Installation**
- **113 Cylinder Head Removal and Installation**
- **116 Cylinder Head and Valvetrain**
- **117 Camshaft Timing Chain**
- **119 Lubrication System**
- **120 Ignition System**
- **130 Fuel Injection**
- **170 Radiator and Cooling System**

MINI Cooper and MINI Cooper S cars are equipped with variants of a 4-cylinder engine, mounted transversely across the front of the car. See **Engine specifications** table.

Engine specifications

Model	Engine code, type	Displacement cc (cu. in.)	Engine management (DME)	Bore / stroke mm (in.)	Compression ratio	Torque lb-ft / rpm	Horsepower (SAE) / rpm
MINI Cooper							
2002 - 2006	W10B16A normally aspirated 4-cylinder	1598 (97.5)	Siemens EMS 2000	85.8 / 77 (3.38 / 3.03)	10.6 : 1	110 / 4500	115 / 6000
MINI Cooper S							
2002 - 2006	W11B16A supercharged 4-cylinder	1598 (97.5)	Siemens EMS 2000	85.8 / 77 (3.38 / 3.03)	8.3 : 1	155 / 4000	163 / 6000
MINI Cooper S with John Cooper Works (JCW) kit							
2003 - 2004	W11B16A supercharged 4-cylinder	1598 (97.5)	Siemens EMS 2000	85.8 / 77 (3.38 / 3.03)	n/a	177 / 4000	200 / 6950
2005 - 2006					n/a	181 / 4500	210 / 6950





Engine identifying features

The same engine, jointly developed by BMW Group and DaimlerChrysler, is used in both MINI versions. The main visual difference between the two is that the supercharged engine (Cooper S) is equipped with the supercharger on the lower right front of the engine and the intercooler housing on the top and front of the engine.

Engine Construction

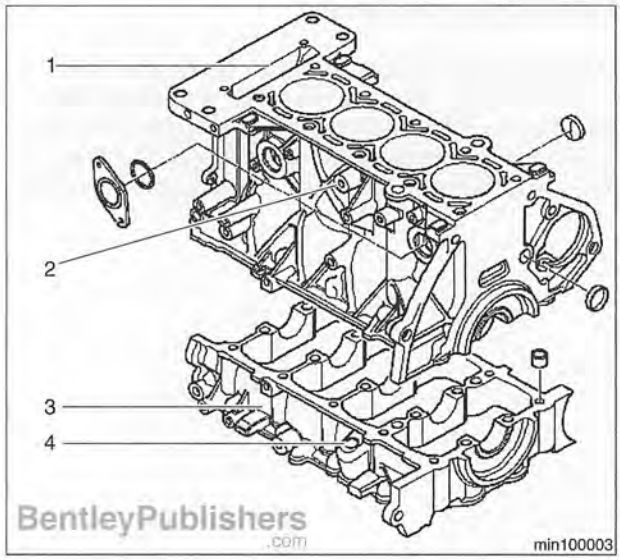
The engine block and bearing support ladder are constructed from cast iron with an aluminum alloy cylinder head. The oil pan is manufactured from aluminum alloy to reduce weight. Despite the iron block and bearing ladder, the engine is very light at 129.22 kg (285 lb). Main features of the engine include:

- 16 valves
- Single overhead chain driven camshaft
- Hydraulic lifters
- Engine drive belt with automatic tension adjustment
- Supercharger (Cooper S models)

Engine block

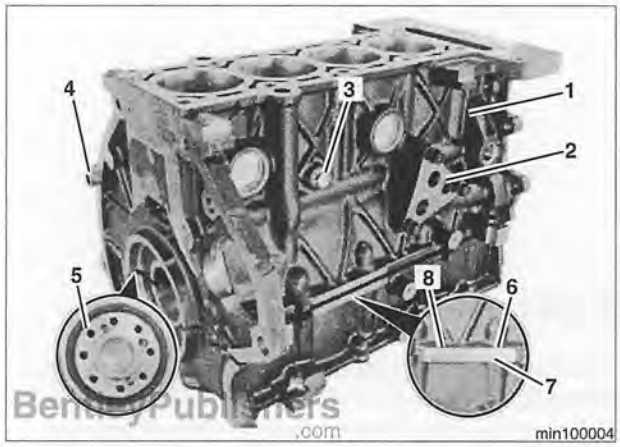
The engine block is manufactured in two halves from sand cast nodular iron. The top portion (main cylinder block) includes the cylinder bores and has provisions for five main bearing top shells. The lower portion (bearing support ladder) incorporates the lower main bearing shells and support for the rear main oil seal.

The engine block and ladder are machined as a matched pair and are not serviced as individual components. Three locating dowels are used to ensure perfect alignment between the bearing ladder and the engine block. A number is stamped on the engine block and the same number is stamped on the bearing ladder. This ensures that the matched pair of components remain together during engine assembly. The engine plant serial number is also stamped on the block.



Engine block and ladder, intake side (front of car):

1. Timing chain housing
2. Knock sensor location
3. Bearing support ladder
4. Dipstick tube location

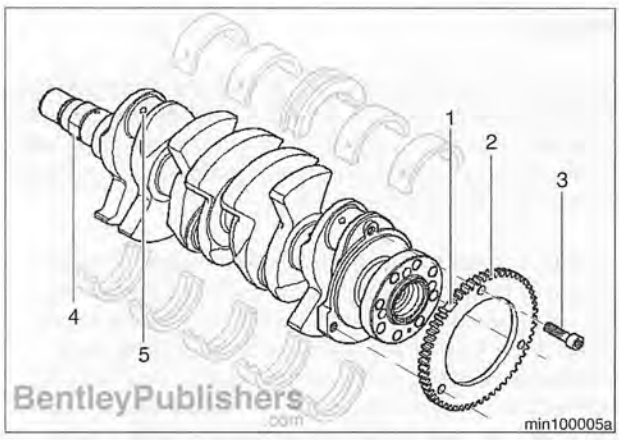


Engine block and ladder, exhaust side (bulkhead side):

1. Cylinder block
2. Oil filter mount
3. Cylinder block coolant drain plug
4. Clutch housing alignment dowels
5. Rear main oil seal
6. Block identification (matched to #7)
7. Ladder identification (matched to #6)
8. Engine serial number
   (Note: This is not the engine number)

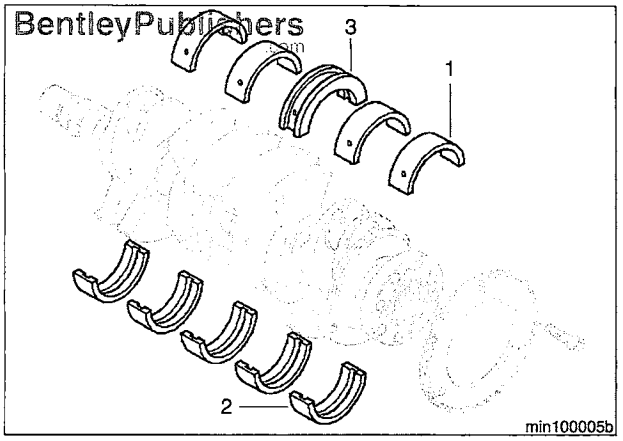
Crankshaft assembly

The MINI Cooper crankshaft is machined from nodular cast iron. The MINI Cooper S crankshaft is machined from forged steel. Both crankshafts provide a mounting point for the crankshaft sensor reluctor ring that is retained by three bolts. The drive for the oil pump is provided by machined flats towards the front of the crankshaft. The auxiliary drive belt pulley is a press fit on the crankshaft and retained by a bolt.



Crankshaft components:

1. Impulse wheel gap
2. Impulse wheel (reluctor)
3. Impulse wheel mounting bolt
4. Oil pump drive flat
5. Oil feed drilling



Crankshaft bearings

All MINI Cooper engines use five main bearings. Lubrication is supplied through holes in the upper shell directly from the main oil gallery.

1. Upper shell grooved to transport oil to lower shell
2. Lower shell located in bearing ladder
3. Thrust washer built into center upper main bearing shell to control crankshaft end float

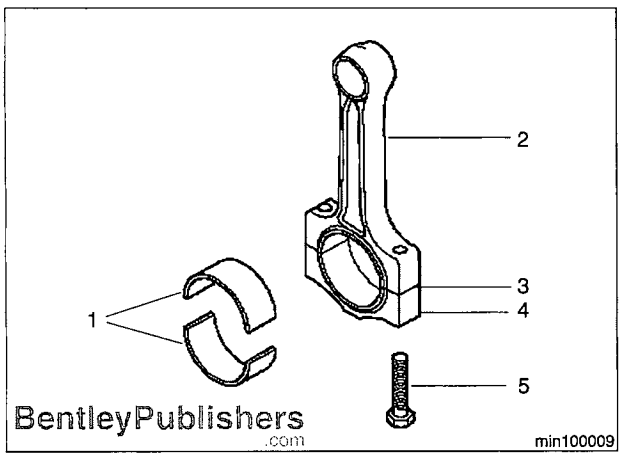
The connecting rod and main bearing shells are made of an aluminum base that is rolled onto a low carbon steel backing.

Connecting rods

MINI Cooper connecting rods are manufactured from non-coplanar powder metal. They are manufactured in one piece and then fractured across the big end journal.

MINI Cooper S connecting rods are manufactured from forged steel to provide additional strength. They are then fractured.

The big end bearings are of a conventional plain shell design, with oil supplied from a hole in the crankshaft.



1. Bearing shells
2. Connecting rod assembly
3. Fracture break
4. Big end cap
5. Connecting rod bolt

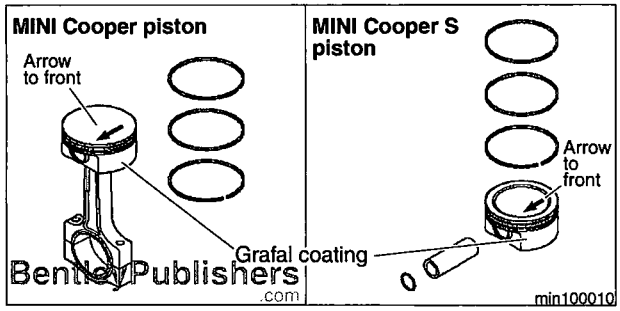
Fracture process

In the fracture splitting process, the connecting rod and big end bearing cap are designed to separate close to the theoretical center line with no loss of material. This is achieved by applying a load between the big end bearing cap and the connecting rod via a wedge in a split mandrel. The big end bore in the connecting rod is premachined with a notch introduced at the required joint plane to initiate the fracture. The separation is accurately determined by careful consideration of the geometry of the forging and material selection.

Fracturing of the connecting rod takes place immediately before the bolts are fitted and correctly tightened. This keeps the matching cap and connecting rod together for subsequent finish machining of the bore. The fractured surfaces form a unique multifaceted joint which provides a contact area much greater than that of a normally ground surface. The multifaceted joint also promotes precise mating between the big end cap and the connecting rod. No further machining of the faces is required, and no additional means of locating the big end bearing to connecting rod is necessary.

The main benefits of the fracturing process are:

- Reduction in manufacturing time and cost
- Each rod and bearing cap with a unique fracture, reducing the possibility of mismatched pairs
- Improved rod weight control



Pistons

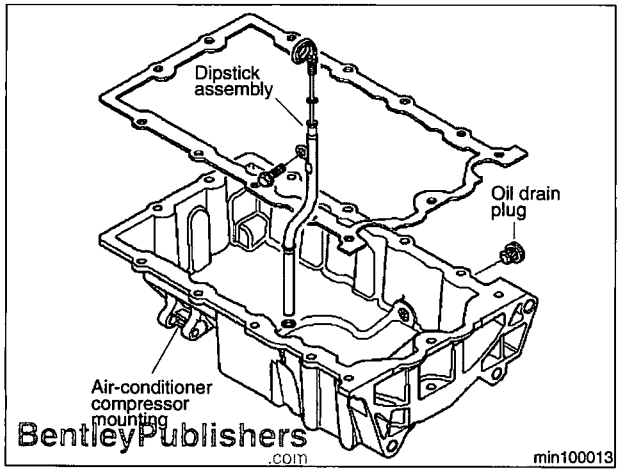
The pistons are of aluminum construction with a Grafal coating applied to the skirt to reduce noise, friction, and scuffing.

MINI Cooper pistons have flat tops.

MINI Cooper S has a concave piston top with a volume of 1.66 cc (0.1 cu. in.) to reduce the compression ratio.

Grafal coating

Grafal consists of a fine colloidal graphite which is bonded with resin. It is between 10 and 20 micrometers thick (0.010 - 0.020 mm / 0.0004 - 0.0008 in) and is applied by means of a printing process, followed by curing. Improved adhesion properties are achieved by a thin metallic phosphate layer or other proven methods which are applied prior to coating.



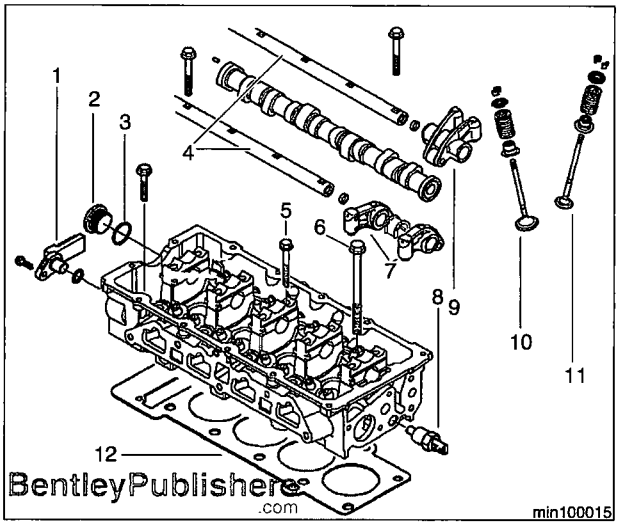
Oil pan

The oil pan is constructed of die cast aluminum. It is secured to the bearing ladder by 13 bolts.

The oil pan provides a mounting position for the air-conditioner compressor on the right side of the engine (viewed from the crankshaft pulley) and for the engine stabilizer on the left side of the engine.

The seal between the oil pan and bearing ladder has a washer fitted to each bolt location to prevent overtightening and distortion of the seal. A lip on the oil pan seal ensures correct location to the bearing ladder.

Oil pan removal and installation is covered in **119 Lubrication System**.



Cylinder head

The crossflow design cylinder head includes a single overhead camshaft, two rocker shafts and four valves per cylinder. The valves are arranged in two inline banks, the intake side facing towards the radiator, the exhaust facing towards the engine compartment rear bulkhead.

1. Camshaft pulse generator
2. Camshaft bore end-plug
3. Sealing O-ring
4. Rocker arm shafts
5. Camshaft bearing cap bolt (M8)
6. Cylinder head bolt (M10x150 mm)
7. Intake rocker arms
8. Coolant temperature sensor
9. Exhaust rocker arm
10. Intake valve assembly
11. Exhaust valve assembly
12. Cylinder head gasket

Cylinder head gasket

The multilayered steel head gasket is constructed from three layers of sheet metal. Four small rivets on the outer edge of the gasket hold the three layers together.

The head gasket contains an oil restrictor that controls the oil flow to the cylinder head. The standard thickness of the gasket is 0.65 mm (0.026 in). A thicker gasket, 0.95 mm (0.037 in) thick, is also available.

NOTE —
The gasket does not have any markings to indicate correct orientation. This is determined by visually lining up the location dowels and oil transfer gallery.

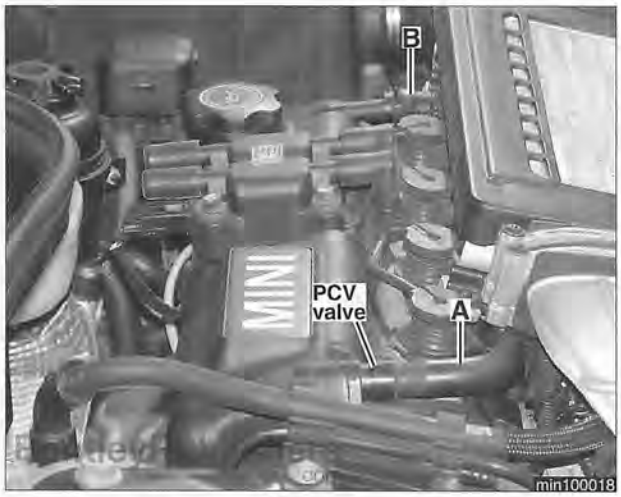
Cylinder head bolts

Discard a head bolt should there be any evidence of thinning at any point along its length. Replace with new.

For further information, see

- **113 Cylinder Head Removal and Installation**
- **116 Cylinder Head and Valvetrain**

Positive crankcase ventilation



The **PCV valve** in the valve cover has pipe **A** connecting it to the intake manifold. This connection is downstream of the throttle valve (high vacuum area).

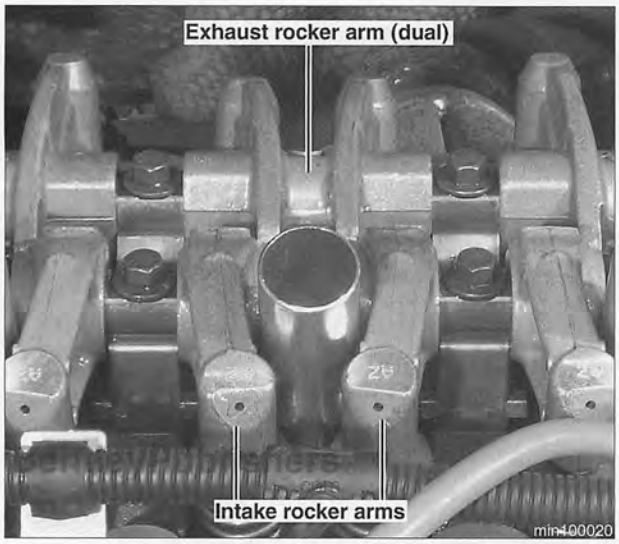
Breather pipe **B** connects the valve cover to the intake system rubber bellows between the air cleaner and throttle body. This connection is upstream of the throttle valve. Pipe B has no restrictions and allows air to travel in both directions depending on crankcase pressure.

Under normal driving conditions (negative crankcase pressure), air is drawn into the crankcase via pipe **B** and mixes with blow-by gases in the crankcase. The gases pass back up through the crankcase and reenter the valve cover. Negative pressure (vacuum) in the manifold is sufficient to open the PCV valve and allow the gases to enter the intake manifold downstream of the throttle valve through pipe **A** and be drawn into the combustion chambers.

When engine speed is high (positive crankcase pressure), the volume of blow-by gases may be too great for the PCV valve to handle alone. Vacuum in the intake manifold is also greatly reduced. Under these conditions blow-by gases also flow through pipe **B** and enter the air intake system upstream of the throttle valve, where they are drawn into the combustion chambers.

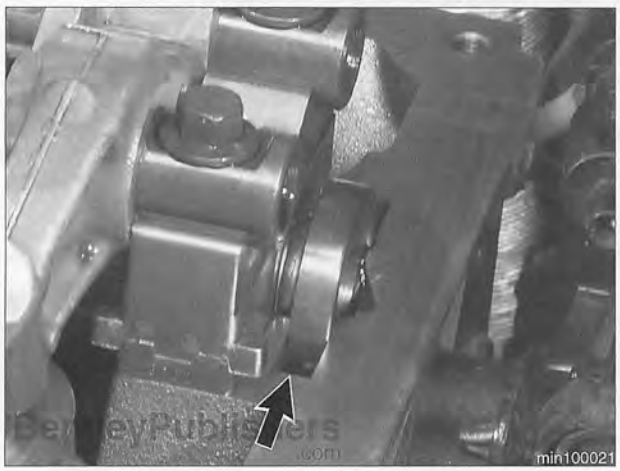
Valvetrain

Camshaft



The camshaft is machined from nodular iron. Nodular iron combines many advantages including good castability, excellent machinability, wear resistance, and weight savings. The camshaft consists of five bearing journals and three valve lift lobes per cylinder.

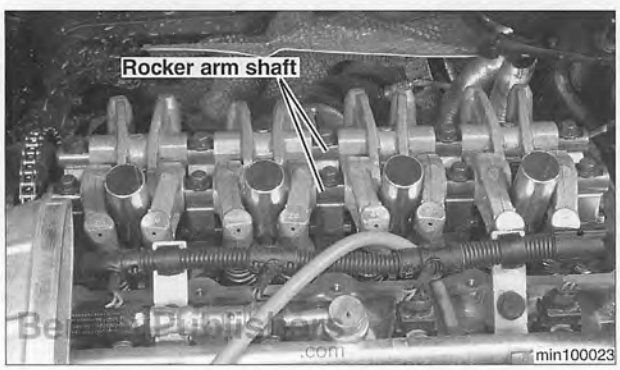
➢ The intake side uses one rocker arm per valve, while on the exhaust side a dual rocker arm operates both valves.



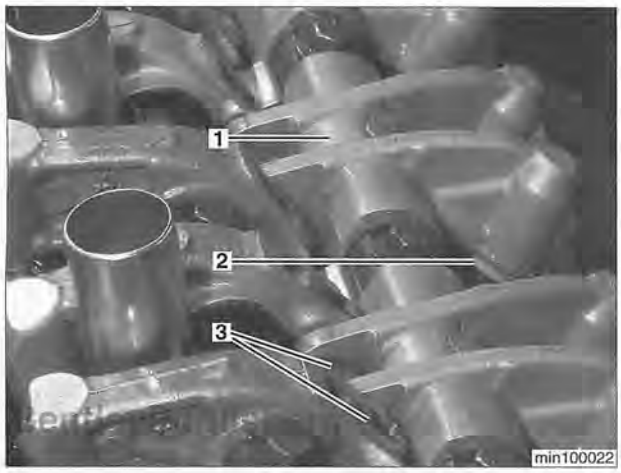
➢ A machined recess (**arrow**) in the cylinder head next to camshaft bearing cap 5 controls the camshaft end float.

– The camshaft for the normally aspirated model is identical to that in the supercharged engine.

Rocker arms and rocker shafts



➢ The rocker arm shafts are hollow to allow an oil supply to the hydraulic lifter mounted in the end of each rocker arm.



The valves are operated via rockers which pivot on the rocker arm shafts. Each rocker contacts the camshaft via a roller. At the other end of the rocker, a hydraulic valve lifter contacts the valve stem.

1. Rocker
2. Hydraulic lifter
3. Roller

Valves

Powder metal valve guides and seats are installed on both engine versions. Valves, springs and retainers are of conventional design.

Intake valves

The intake valves are made of carbon steel. The carbon content allows the valve to be hardened and tempered to increase strength and also to be locally hardened to improve wear resistance. The MINI Cooper S uses an upgraded material.

Intake valve seat inserts

Powder metal technology is used for valve seat inserts as the sintered part requires little or no machining and any number of material compositions can be developed to satisfy particular engine demands.

Exhaust valves

The exhaust valve specification is an austenitic steel, a particular type of steel with characteristics that are ideal for exhaust valve manufacture. The MINI Cooper S has upgraded exhaust valves.

Exhaust valve seat inserts

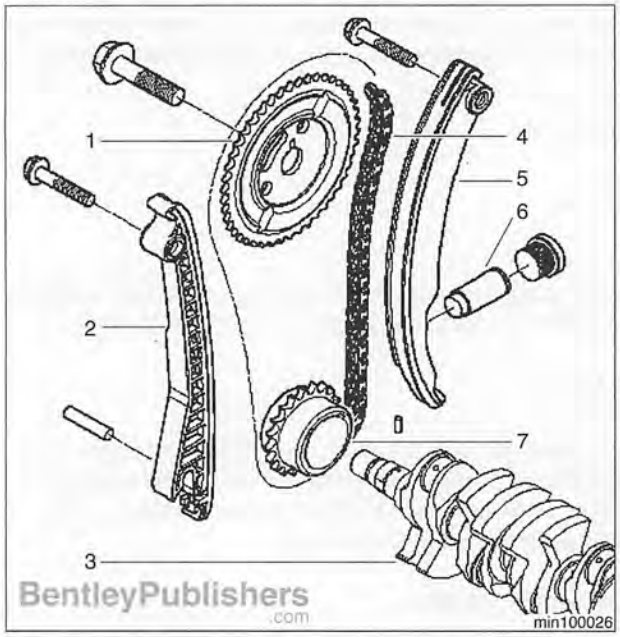
Many of the characteristics for the intake valve seat insert carry over to the exhaust valve seat insert. In addition, the exhaust valve seat uses what is known as grade J steel containing molybdenum and tungsten. This provide high heat hardness and increased resistance to indentation and wear.

Powder metal technology

A valve seat is produced from powdered metal by filling a rigid die with a blended powder and applying pressure. The pressure forces the powder particles to interlock, similar to a weld.

After being pressure formed, the parts are heated to 80% of the boiling point of the metal. The heat increases the bonds between the particles and further strengthens the part. To increase thermal conductivity the pores of the powder compact are infiltrated with copper during the sintering process.

See **116 Cylinder Head and Valvetrain** for repair information.

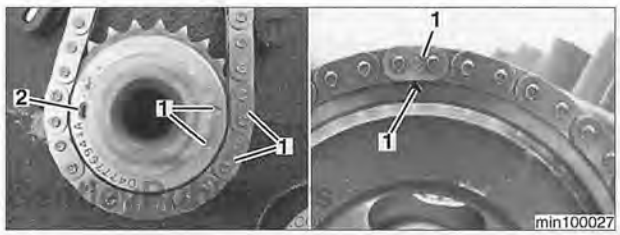


Timing chain

The camshaft sprocket is driven by a roller timing chain.

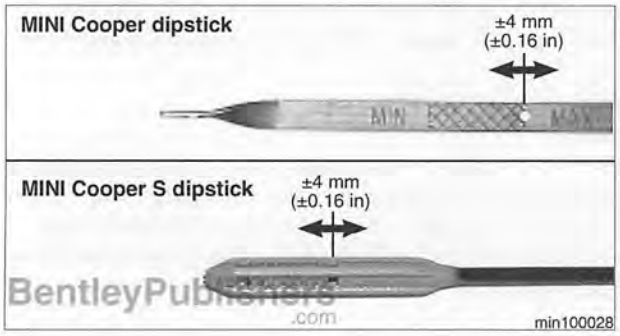
1. Camshaft sprocket
2. Fixed chain guide
3. Crankshaft
4. Timing chain
5. Semifloating chain guide
6. Chain tensioner
7. Crankshaft sprocket

There is a fixed chain guide on the intake side of the engine. The exhaust side has a semifloating guide that is spring-loaded and contains a self-ratcheting tensioner to retain the adjusted position. Engine oil pressure fine-tunes chain free play using a hydraulic tensioner.



1. Timing marks on crankshaft and camshaft sprockets
2. Copper colored links
3. Crankshaft sprocket locating pin

See **117 Camshaft Timing Chain** for repair information.



Lubrication system

The engine lubrication system is a full flow filtration pressure feed type.

The oil fill process at the factory allows for a tolerance of ±4 mm (±0.16 in) from the maximum mark on the dipstick. Oil level depends on oil temperature and length of time since the engine was last turned off.

See **119 Lubrication System** for repair information.

JOHN COOPER WORKS (JCW) KIT

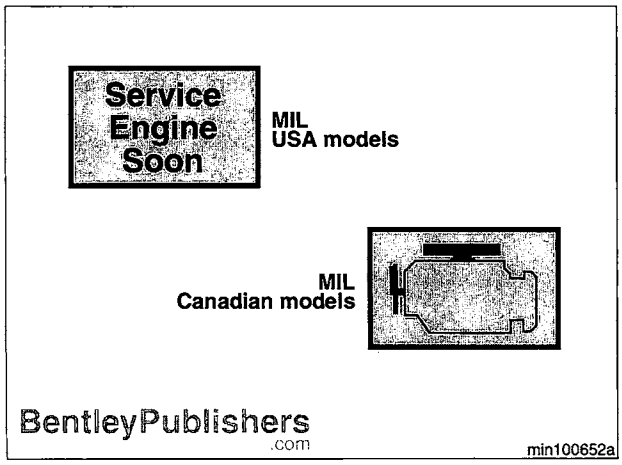
The John Cooper Works performance package was initially introduced to the U.S. market in April, 2003. Produced by the John Cooper Works Company of England, this package is sold through MINI dealers and is covered under MINI's comprehensive new car warranty. It is available as an add-on to MINI Cooper S models and can be retrofitted to earlier Cooper S models.

Engine performance is increased to 200 hp by utilizing a reconfigured cylinder head, uprated supercharger, special engine electronics and a performance exhaust.

Power was further increased to 210 hp in 2005 with the addition of a new air filter housing and special fuel injectors. The new JCW air filter housing has an extra intake flap to allow greater airflow at high revs (above 4500 rpm). This upgrade kit can be installed on engines that already have the earlier JCW kit.

DRIVEABILITY TROUBLESHOOTING

MINI Cooper vehicles are equipped with a sophisticated self-diagnostic engine management system. This system monitors and stores diagnostic fault information.



If the malfunction indicator light (MIL) comes on or flashes, it indicates that an emissions-related fault has occurred and that fault information is stored in memory within the ECM. In this situation, the first diagnostic test should be to connect a dedicated BMW scan tool and interrogate the fault memory.

The diagnostic capabilities of these systems have the potential to save hours of diagnostic time and prevent incorrect component replacement. See **OBD On Board Diagnostics**.

Two common causes of driveability problems are incorrect system voltage and bad grounds.

System voltage

Digital motor electronics (DME) requires that the system (battery) voltage be maintained within a narrow range. DC voltage levels beyond or below the operating range, or any A/C voltage in the electrical system can cause havoc. When troubleshooting an illuminated MIL, make sure the battery is fully charged and capable of delivering all its power to the electrical system. An undercharged battery can amplify A/C alternator output fluctuations.

To make a quick check of the battery charge, measure the voltage across the battery terminals with all cables attached and the ignition off. A fully charged battery will measure 12.6 volts or slightly more, compared to 12.15 volts for a battery with a 25% charge.

The DME system operates at low voltage and current levels, making it sensitive to small increases in resistance. The electrical system is routinely subjected to corrosion, vibration and wear, so faults or corrosion in the wiring harness and connectors are not uncommon. Check the battery terminals for corrosion or loose cable connec-

tions. See **121 Battery, Starter, Alternator** for additional information.

If a battery cable connection has no visible faults but is still suspect, measure the voltage drop across the connection. A large drop indicates excessive resistance, meaning that the connection is corroded, dirty, or damaged. Clean or repair the connection and retest.

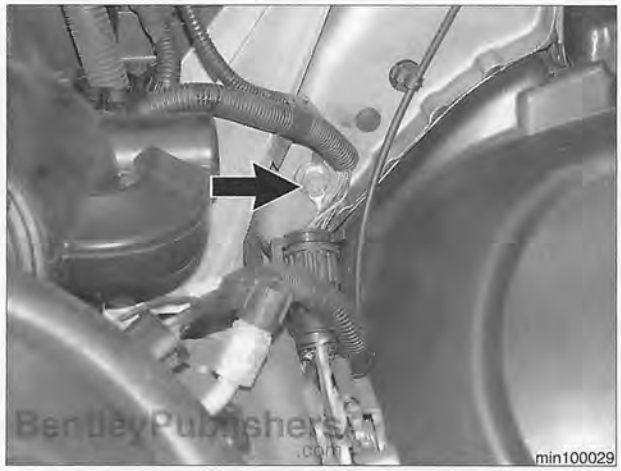
NOTE—
For instructions on conducting a voltage drop test and other general electrical troubleshooting information, see **600 Electrical System–General**.

Visually inspect all wiring, connectors, switches and fuses in the system. Loose or damaged connectors can cause intermittent problems, especially the small terminals in the engine control module (ECM) connectors. Disconnect the wiring harness connectors to check for corrosion, and use electrical cleaning spray to remove contaminants.

Main grounds

Good grounds are critical to proper DME operation. If a ground connection has no visible faults but is still suspect, measure the voltage drop across the connection. A large voltage drop means high resistance. Clean or repair the connection and retest.

The main grounds for the fuel and ignition circuits of the DME system are illustrated below. See **ECL Electrical Component Locations** for additional ground and component locations.



Grounds for engine management system (**arrow**) at left front strut tower.

Fuel pump ground (**arrow**) in left side of luggage compartment behind trim panel.

110 Engine Removal and Installation

GENERAL

Engine removal and installation for the Cooper and Cooper S are covered in this repair group. See **100 Engine–General** for engine details and engine codes.

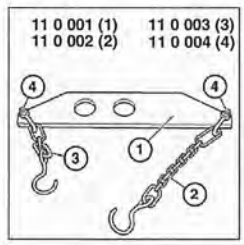
Cooper models are available with either a 5-speed manual transmission or an automatic Continuously Variable Transmission (CVT). Cooper S models are available with either a 6-speed manual transmission or an automatic (Agitronic) transmission. The engine and transmission are removed as a complete unit.

For additional procedures required during engine removal, refer to the following repair groups:

- **020 Maintenance**
- **121 Battery, Alternator, Starter**
- **170 Radiator and Cooling System**
- **180 Exhaust System**
- **230 Manual Transmission**
- **240 Automatic Transmission**
- **510 Bumpers, External Trim**

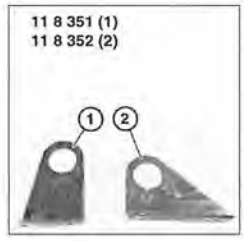
Special tools

Some special tools are required for engine removal and installation. Be sure to have the necessary equipment on hand before starting the job.

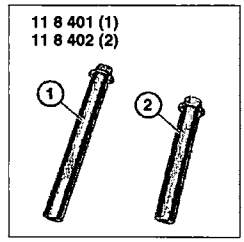


Engine hoisting harness
(BMW tool no. 11 0 000)

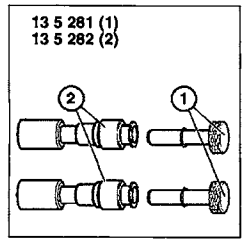
Engine lift attachment bracket (CVT)
(BMW tool no. 11 8 260)



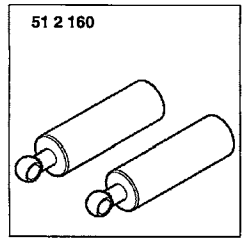
Engine lift attachment brackets
(BMW tool no. 11 8 350)



Modular front end extensions
(BMW tool no. 11 8 400)



Plugs for fuel lines and fittings
(BMW tool no. 13 5 280)



Service position hood prop extensions
(BMW tool no. 51 2 160)

CAUTION—

- *If the malfunction indicator light (MIL) is illuminated, see* **OBD On Board Diagnostics** *for DME fault code information.*
- *If other system faults have been detected, as indicated by an illuminated ABS, SRS or ASC/DSC warning light, see the appropriate repair group in this manual or an authorized BMW dealer for more information on fault codes.*

ENGINE REMOVAL AND INSTALLATION (COOPER)

> ***WARNING —***
> *Due to risk of personal injury, be sure the engine is cold before beginning the removal procedure.*

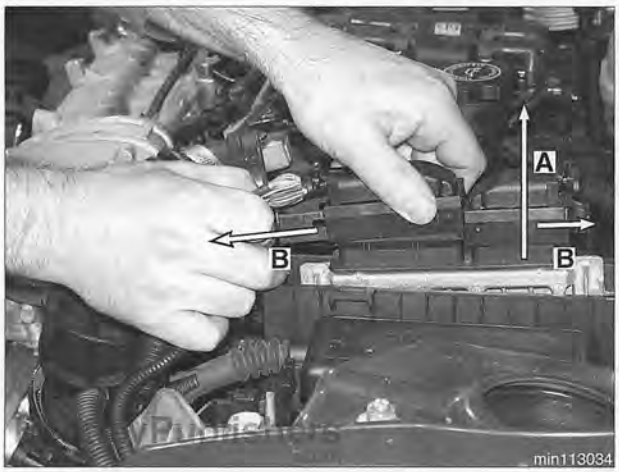
Protect painted surfaces before beginning the removal procedure. As an aid to installation, label all components, wires, and hoses before removing them. Do not reuse gaskets, O-rings or seals during reassembly.

Engine, removing and installing (Cooper)

– Remove battery box cover.

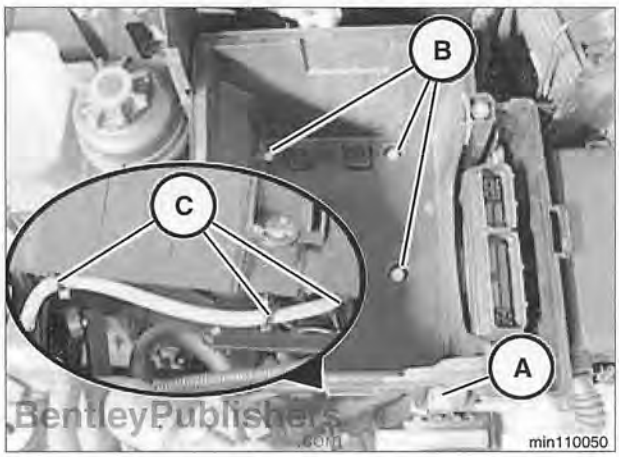
– Disconnect negative (-) cable from battery and remove battery. See **121 Battery, Starter, Alternator** for more information.

> ***CAUTION —***
> *Disconnecting the battery may erase fault code(s) stored in memory. Check for fault codes prior to disconnecting the battery cables.*



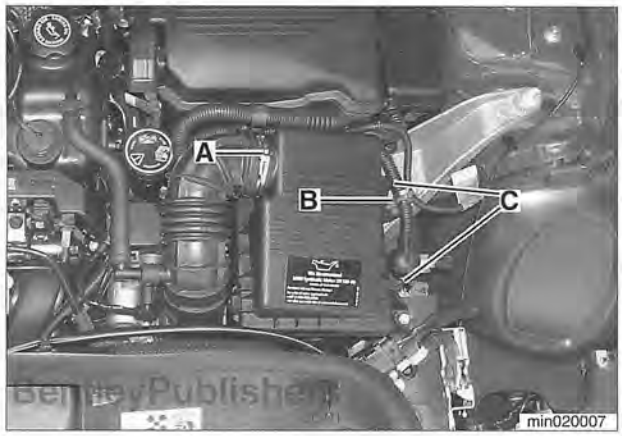
➢ Remove DME control module:

- Remove cover and lift DME control module upwards (**A**).
- Slide connector locking mechanisms (**B**) outward and disconnect control module connectors.



➢ Remove battery box:

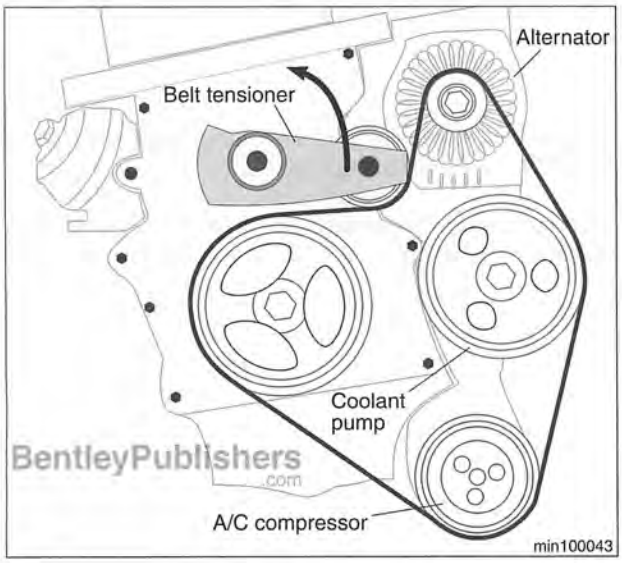
- Remove battery box retaining bolt (**A**).
- Release battery box clips (**B**).
- Disconnect harness clips (**C**) from bottom of battery box.



- Remove air filter and air filter housing:
  - Release hose clamp (**A**) and remove outlet duct from air filter housing.
  - Remove wire tie (**B**) if necessary.
  - Remove air filter retaining bolts (**C**).
- Remove air intake duct and remove air filter housing.
- Raise car and support in a safe manner. See **020 Maintenance** for more information.

> ***WARNING —***
> *Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

- Remove exhaust manifold with catalytic converter. See **180 Exhaust System**.
- Models with manual transmission: drain transmission oil. See **230 Manual Transmission**.
- Models with CVT: drain transmission oil. See **240 Automatic Transmission**.
- Remove drive shafts. See **310 Front Suspension, Drive Axles**.



- Make note of accessory belt layout.

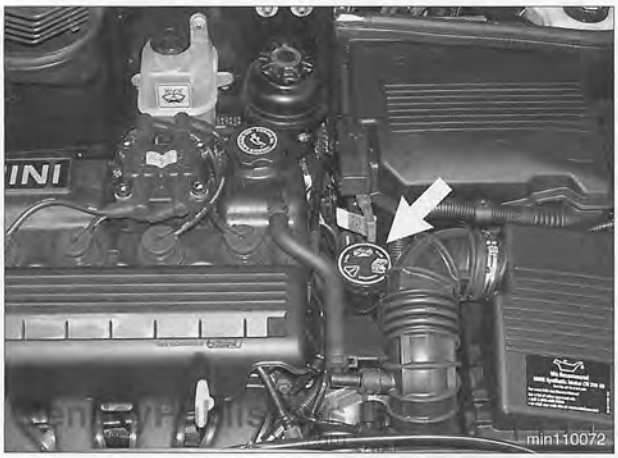
> ***NOTE —***
> *If belt is to be reused, mark direction of travel and reinstall belt in same direction of rotation.*

- Remove tank venting valve.
- Use special tool 11 8 390 to release accessory belt tension and special tool 11 8 280 to lock belt tensioner.

> ***CAUTION —***
> *Belt tensioner is under high tension. Check that lock pin is secure.*

- Remove accessory belt.

Engine Removal and Installation (Cooper)



➢ Drain coolant by first releasing pressure cap (**arrow**) on coolant expansion tank.

> ***WARNING—***
> *Cooling system is under high pressure when hot. Coolant may cause burns when hot. Allow engine to cool before opening cooling system.*

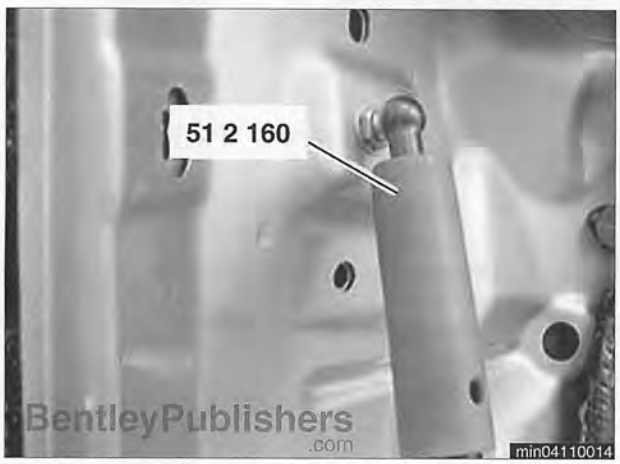
– Working from below, remove engine splash shield.

➢ Release clamp (**arrow**) and remove lower radiator hose.

– Allow coolant to drain into suitable catch pan.

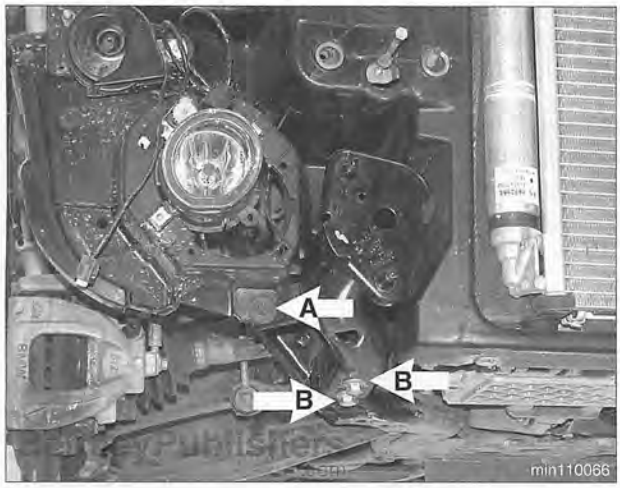
NOTE—
Save coolant and reuse, or dispose of properly.

> ***WARNING—***
> *Use extreme caution when draining and disposing of engine coolant. Coolant is poisonous and lethal to humans and pets. Pets are attracted to coolant because of its sweet smell and taste. Seek medical attention immediately if coolant is ingested.*



➢ For additional clearance, detach hood struts from hood and insert special tools (BMW 51 2 160) to support hood.

– Remove engine breather valve retaining bolt and remove engine breather valve from inspection cover.



- Working underneath car:
  - Remove bolt (**A**) holding crush tube to modular front end (MFE).
  - Remove bolts (**B**) holding crush tube to front subframe.

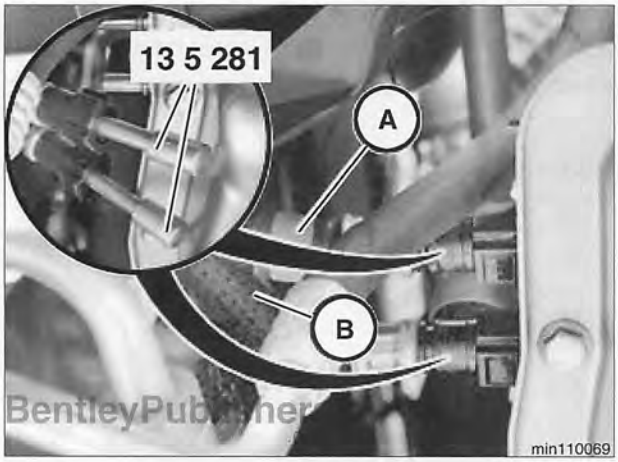
NOTE—
MFE removed in photo for purposes of illustration.

- Loosen modular front end. See **510 Exterior Trim, Bumpers** for more information.
  - Remove right front wheel housing liner.
  - Detach left front wheel housing liner from front bumper cover trim.
  - Remove front bumper cover trim.
  - Remove bumper.
  - Remove MFE mounting bolts. Install two 100 mm (4 in) M8 bolts (**arrow**) in left and right bumper support members. Slide modular front end forward, supported on long bolts.
  - Remove crush tubes.

CAUTION—
For ease of component alignment when reassembling front bumper assembly, do not loosen or remove bumper alignment bosses.

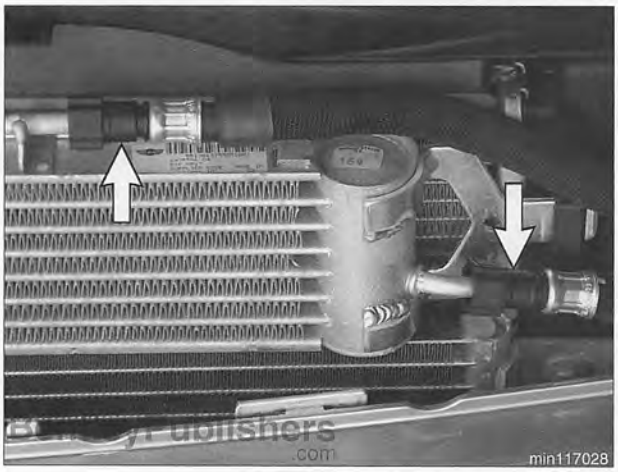
NOTE—
- *Cooper S engine is illustrated. Cooper engine layout is similar.*
- *If available, use BMW special tools 11 8 401 and 11 8 402 instead of long bolts to support MFE.*
- *Removal of MFE is a complicated job. It is covered in* **510 Exterior Trim, Bumpers**.

Engine Removal and Installation (Cooper)



➢ Models with CVT: disconnect oil cooler lines (**A**, **B**) from transmission and fit special tool (BMW 13 5 281) to plug lines.

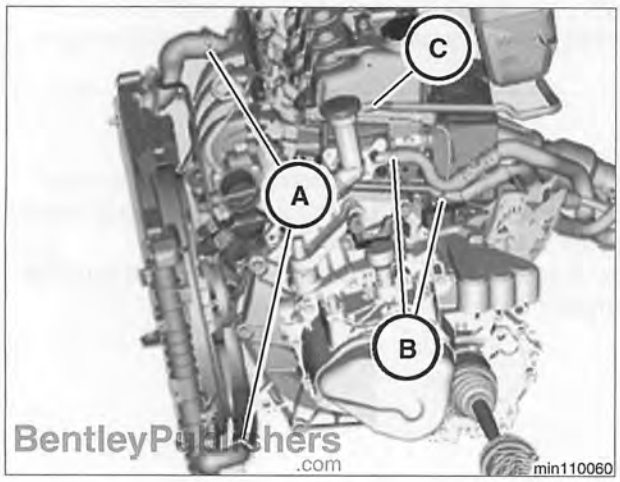
NOTE—
- *Oil cooler lines are color-coded green and black. Make note of routing and replace in same location.*
- *Be prepared to catch dripping transmission fluid.*



➢ Models with CVT: disconnect oil cooler lines (**arrows**) from oil cooler and fit special tool (BMW 13 5 282) to plug oil cooler fittings.

– Remove oil cooler lines.

NOTE—
Be prepared to catch dripping transmission fluid.



➢ Remove upper and lower radiator hoses (**A**).

– Remove heater hoses (**B**).

– Remove overflow hose (**C**).

➢ Unhook fuel injector electrical harness from fuel rail mounting brackets.

– Disconnect top fuel tank vent line and unclip at fuel rail.

WARNING—
If disconnecting fuel line from fuel rail, fuel will be expelled under pressure. Loosen fuel filler cap to release fuel tank pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hose, wrap a cloth around hose to absorb any leaking fuel. Plug all open fuel connections.

CAUTION—
Do not allow fuel to drip on alternator.

NOTE—
- *Follow the procedure below to avoid disconnecting the fuel hose from the fuel rail.*
- *If it becomes necessary to disconnect the fuel hose from the fuel rail, follow the procedure in* **130 Fuel Injection**. *Be sure to read the warnings and cautions regarding working with fuel.*

➢ Detach fuel rail from top of engine:
- Disconnect fuel injector electrical harness connectors (**A**).
- Working at fuel rail, unclip hoses and ducts. Cut wire ties as needed.
- Disconnect vacuum line at base of fuel pressure regulator (**B**).
- Remove fuel rail mounting bolts (**arrows**).

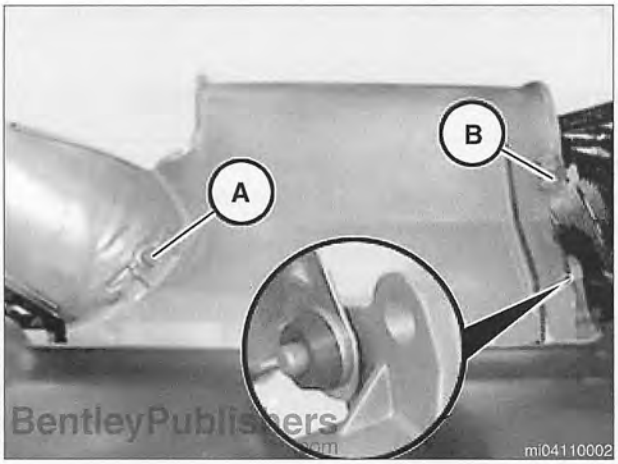
CAUTION—
Use compressed air to blow away accumulated debris at the base of each fuel injector.

– Remove fuel rail together with fuel injectors from intake manifold.
- Unclip fuel line from engine vibration damper bracket.
- Carefully fold fuel hose to right and rear of engine. Protect fuel rail and injectors by storing in plastic bag.

CAUTION—
Plug fuel injector bores in intake manifold.

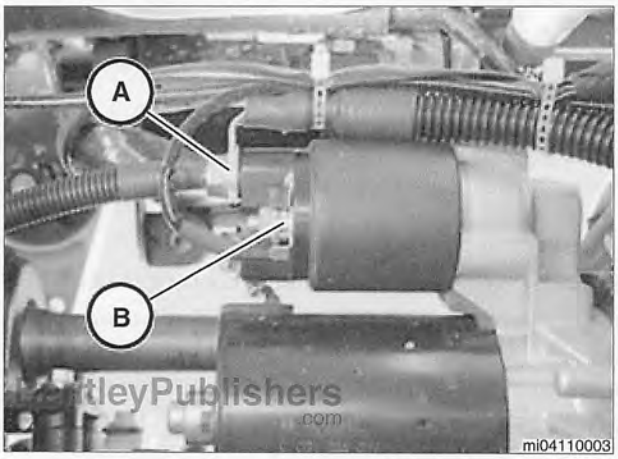
➢ Working at intake manifold, press locking ring down to detach brake booster vacuum line.

Engine Removal and Installation (Cooper)



➢ Working underneath car at back of engine, remove starter motor heat shield:

- Remove retaining bolt (**A**).
- Remove oxygen sensor from wire clip (**B**).

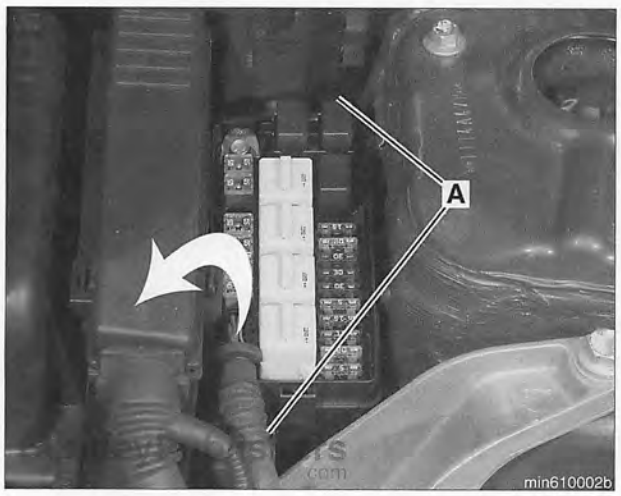


➢ Disconnect wires (**A**, **B**) at starter motor and unclip wire harness from frame. Make note of harness routing.

– Remove protective cover from underneath fuel injector rail.

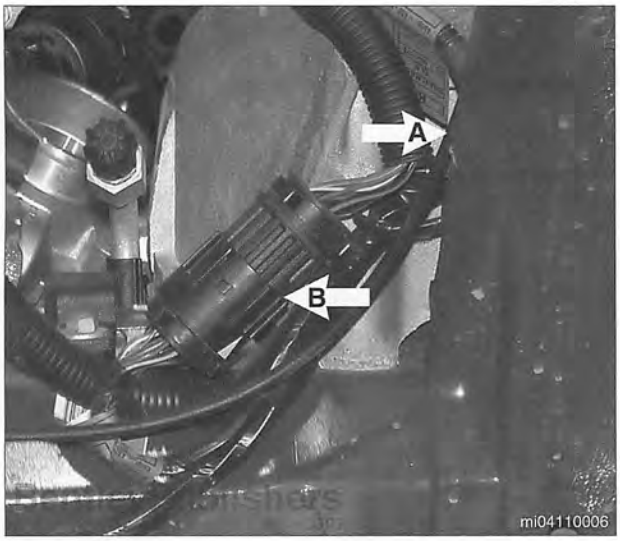
– Remove tank venting valve lower pipe from lower engine vibration damper.

– Remove ground wire from engine mounting bracket.



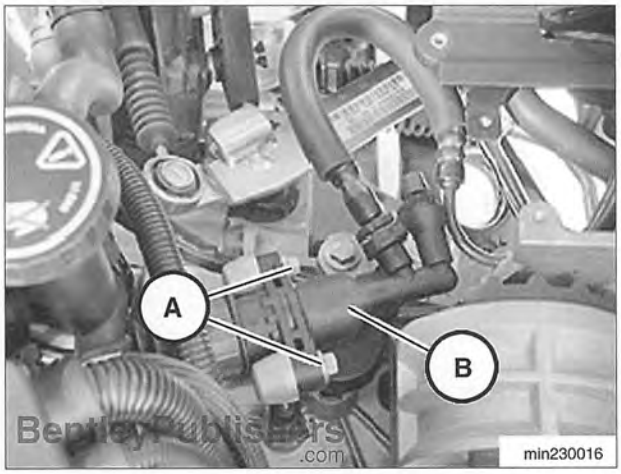
➢ Working in engine compartment on right side of engine:

- Remove cover to fuse and relay panel 3.
- Disconnect harness connector (**arrow**).
- Remove fuse panel retaining bolts (**A**) and move panel aside.



➤ Remove ground wire from left strut tower (**A**).

– Disconnect round engine harness connector (**B**) by twisting and pulling apart.

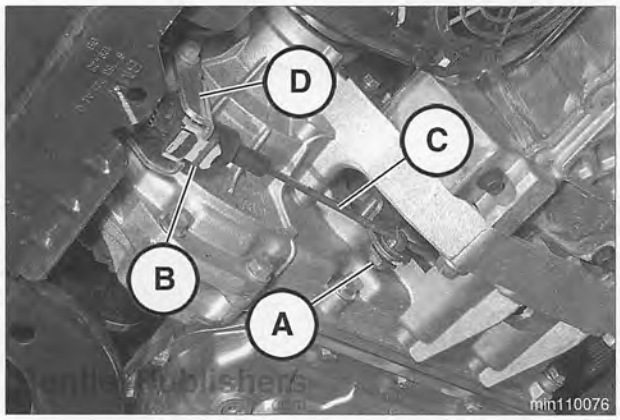


➤ Models with manual transmission: remove clutch slave cylinder retaining bolts (**A**) from top of transmission and remove clutch slave cylinder (**B**).

➤ Models with manual transmission: remove clips from gearshift cable bracket and remove gearshift cables from ball joints by carefully prying off with a pair of screwdrivers.

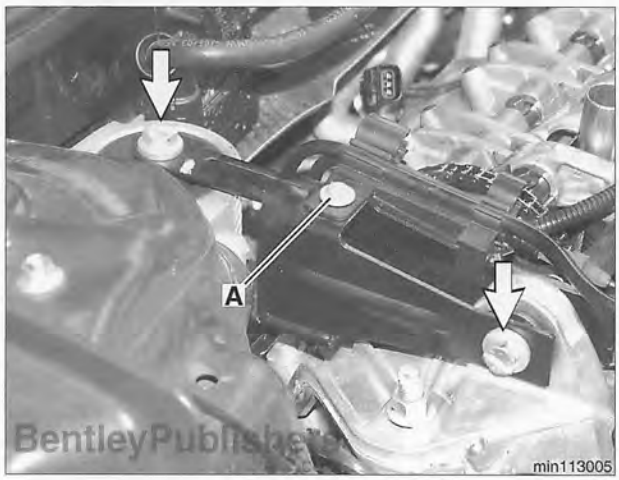
– Remove gearshift cable bracket bolts and remove gearshift bracket.

Engine Removal and Installation (Cooper)



➢ Models with CVT:
- Loosen transmission shift cable retaining nut (**A**).
- Squeeze cable retaining clip (**B**) and remove cable (**D**) from bracket (**C**).

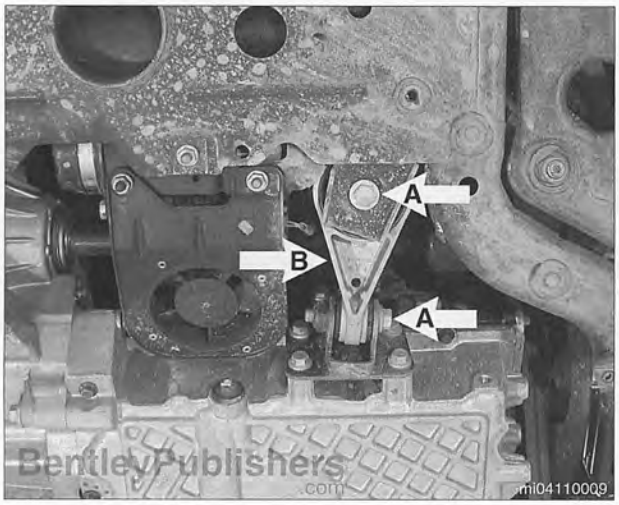
– Tie cable clear of engine compartment with stiff wire.



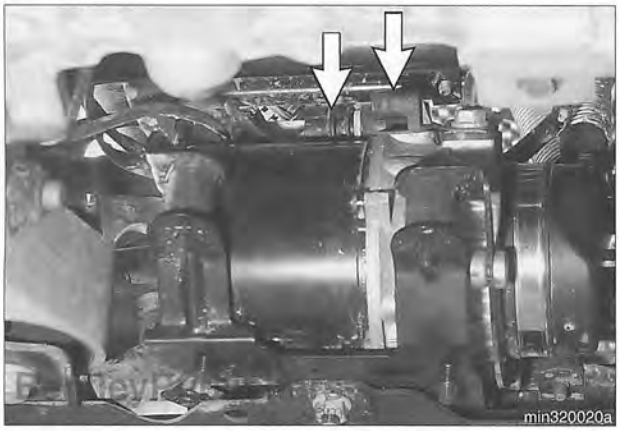
➢ Working on right side of engine, remove bolts from top engine vibration damper bracket (**arrows**), if applicable.

NOTE—
Later model vehicles may not have vibration damper bracket.

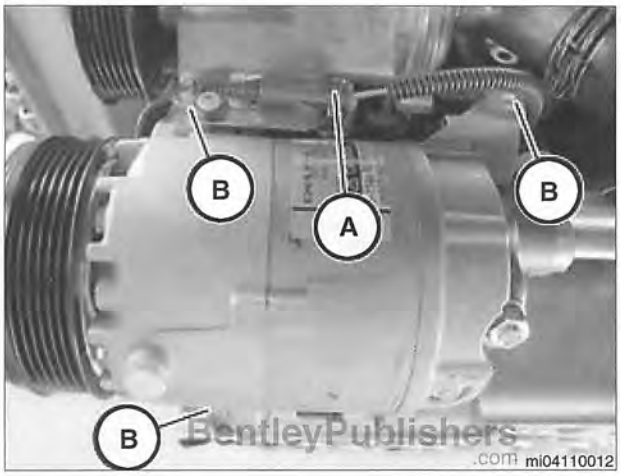
– Unclip hoses and remove plastic bracket (**A**).



➢ Working underneath car, remove lower engine vibration damper bracket bolts (**A**) and remove bracket (**B**).



➢ Working underneath car, disconnect electrohydraulic power steering (EHPS) pump electrical connectors (**arrows**) at steering rack at rear of engine oil pan.

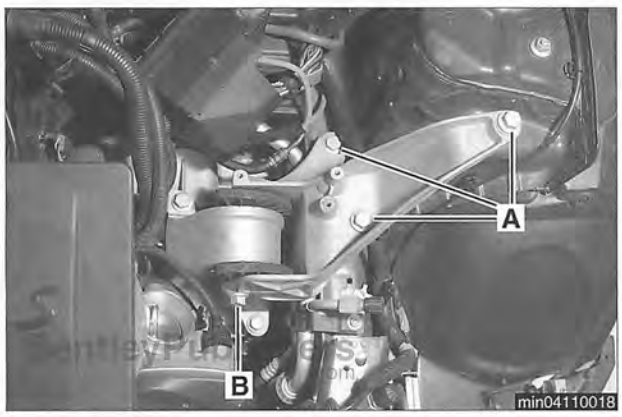


➢ Unbolt A/C compressor from engine pan on front of engine:

- Disconnect wiring harness (**A**).
- Remove compressor mounting bolts (**B**).
- Detach A/C high pressure line from engine block in order to allow compressor free movement. Do not detach high pressure line from compressor.

> ***CAUTION—***
> *A/C system does not need to be evacuated for this procedure. However, take care when removing the compressor to avoid personal injury or damage to the system.*

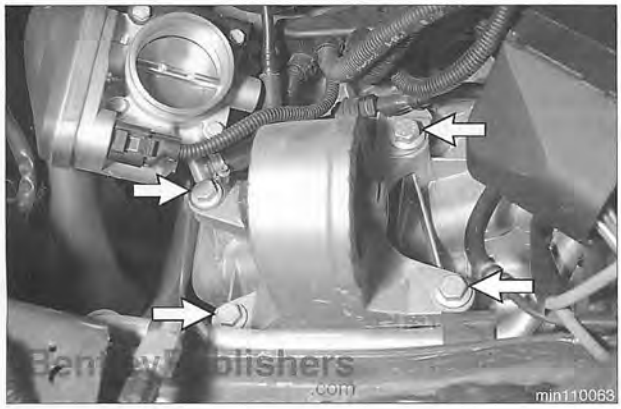
– Pull compressor away from engine oil pan and secure to MFE with stiff wire.



➢ Remove transmission upper mount bracket bolts (**A**).

> ***CAUTION—***
> *Support transmission from below with floor jack before removing bracket mounting bolts.*

– Remove transmission mount to bracket mounting nut and bolt (**B**). Remove bracket.



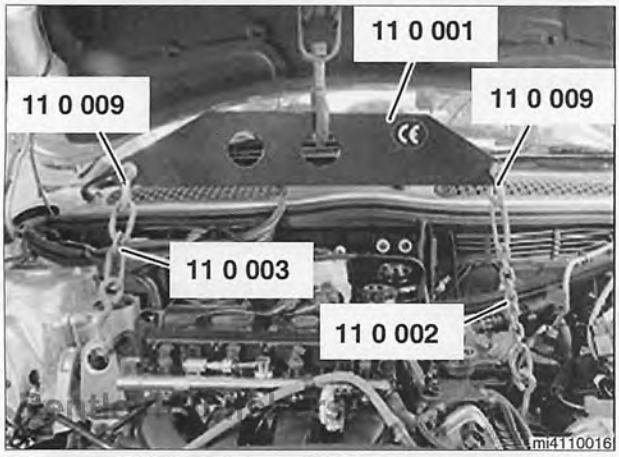
➢ Remove bolts (**arrows**) from transmission mount. Remove mount.

Engine Removal and Installation (Cooper)

➢ Models with manual transmission: Attach engine hoist bracket (BMW 11 8 352) to transmission.

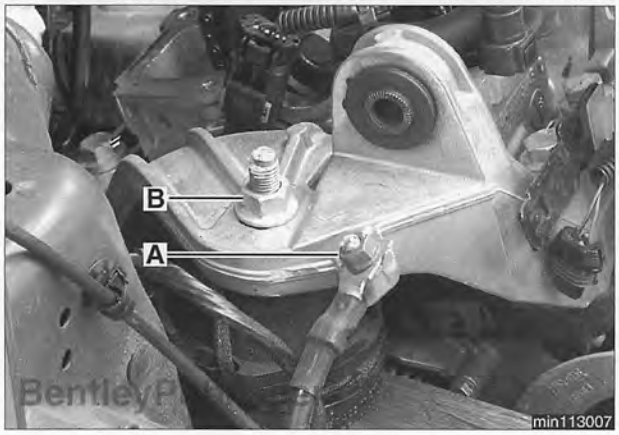
NOTE—
Models with CVT: Attach engine hoist bracket (BMW 11 8 260) to transmission.

➢ Attach engine hoist bracket (BMW 11 8 351) to front of engine.



➢ Attach engine hoisting harness (BMW 11 0 001, 11 0 002, 11 0 003, 11 0 009) to engine and transmission brackets and support firmly.

– Raise hoist slightly to remove load from engine and transmission mounts.



➢ Remove ground wire (**A**) from engine mount bracket and remove nut from hydraulic mount (**B**).

– Carefully remove engine, checking for any wiring, fuel lines or mechanical parts that might become snagged.

– Installation is reverse of removal, noting the following:
  - Replace all gaskets, O-rings and seals.
  - Models with manual transmission: Refill transmission and check all other fluid levels. See **020 Maintenance**.
  - Models with CVT: Refill transmission following procedure in **240 Automatic Transmission**. Check all other fluids.
  - Refill and bleed cooling system. See **170 Radiator and Cooling System**.
  - Check that engine accessory belt properly engages pulley grooves.

> ***CAUTION—***
> *Check accessory belt for cracks, coolant and oil residue. Replace if contaminated by oil.*

  - Install exhaust manifold using new gaskets. Use copper paste on threads. See **180 Exhaust System**.
  - After reattaching battery cables, initialize power windows by raising each window and keeping power window switch in raised position for about 5 seconds.

Tightening torques	
A/C compressor to engine pan mount	25 Nm (18 ft-lb)
Alternator lead to starter motor	14 Nm (10 ft-lb)
Crush tubes to front end	100 Nm (75 ft-lb)
Crush tubes to subframe	100 Nm (75 ft-lb)
CVT shift cable to gearshift lever	12 Nm (9 ft-lb)
Engine mount bracket to cylinder head	100 Nm (74 ft-lb)
Engine mount bracket to engine mount	68 Nm (50 ft-lb)
Engine mount to body	68 Nm (50 ft-lb)
Fusebox retaining bolts to chassis	5 Nm (4 ft-lb)
Gearshift cable bracket to transmission	22 Nm (16 ft-lb)
Ground wire to left strut tower	9 Nm (7 ft-lb)
Heat shield to starter motor	9 Nm (7 ft-lb)
Lower engine vibration damper to holder	100 Nm (74 ft-lb)
Lower engine vibration damper to oil pan	38 Nm (28 ft-lb)
Slave cylinder to bracket	24 Nm (18 ft-lb)
Top engine vibration damper bracket to body	100 Nm (74 ft-lb)
Top engine vibration damper bracket to engine	100 Nm (74 ft-lb)
Transmission mount bolts to gearbox	66 Nm (49 ft-lb)
Transmission mount bracket to transmission	38 Nm (28 ft-lb)
Transmission mount retaining bolt to upper bracket	66 Nm (49 ft-lb)
Wiring to starter solenoid	8 Nm (6 ft-lb)

ENGINE REMOVAL AND INSTALLATION (COOPER S)

WARNING—
Due to risk of personal injury, be sure the engine is cold before beginning the removal procedure.

Protect painted surfaces before beginning the removal procedure. As an aid to installation, label all components, wires, and hoses before removing them. Do not reuse gaskets, O-rings or seals during reassembly.

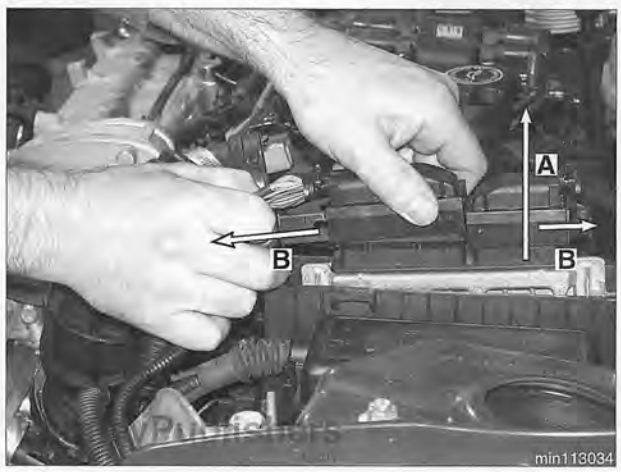
Engine, removing and installing (Cooper S)

– Working in luggage compartment, disconnect negative (-) cable from battery. See **121 Battery, Starter, Alternator** for more information.

CAUTION—
Disconnecting the battery may erase fault code(s) stored in memory. Check for fault codes prior to disconnecting the battery cables.

➤ Detach air filter housing from throttle housing:

- Pull up on battery positive connection point (Batt+) (**arrows**) to release from right side of air filter housing.
- Loosen or remove hose clamp (**A**) and detach outlet duct from air filter housing.
- Remove air filter housing retaining bolt (**B**).



➤ Remove DME control module:

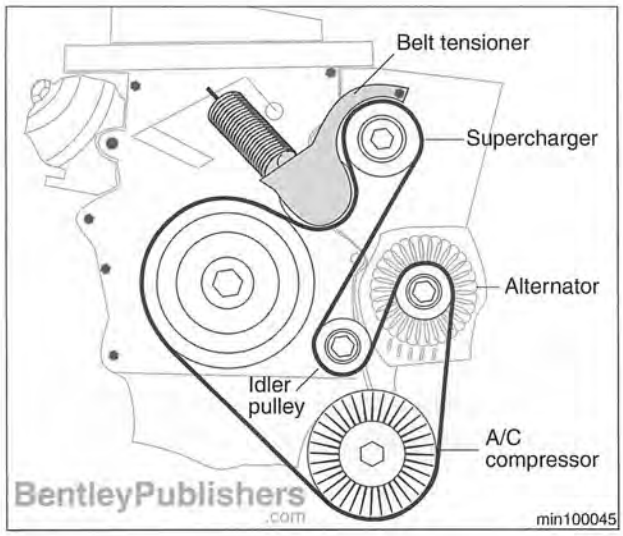
- Remove control module container cover and lift control unit upward (**A**).
- Pull connector locking sliders outward (**B**).
- Disconnect control module connectors.
- Place control module in safe storage location.

NOTE—
There are 2 control module harness connectors.

- Unclip air filter inlet duct from modular front end. Wriggle duct while pulling it toward front of car to detach from air filter housing.
- Remove air filter housing from engine compartment.
- Raise car and support in a safe manner. See **020 Maintenance** for more information.

> ***WARNING —***
> *Make sure the car is stable and well supported at all times. Usa a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

- Remove exhaust manifold with catalytic converter. See **180 Exhaust System**.
- Drain gearbox oil. See **230 Manual Transmission**.
- Remove drive shafts. See **310 Front Suspension, Drive Axles**.



- Make note of accessory belt layout.

> ***NOTE —***
> *If belt is to be reused, mark direction of travel and reinstall belt in same direction of rotation.*

- Remove tank venting valve.
- Use special tool 11 8 390 to release accessory belt tension and special tool 11 8 280 to lock belt tensioner.

> ***CAUTION —***
> *Belt tensioner is under high tension. Check that lock pin is secure.*

- Remove accessory belt.
- Remove intercooler. See **113 Cylinder Head Removal and Installation**.

- Drain coolant by first releasing pressure cap (**arrow**) on coolant expansion tank.

> ***WARNING —***
> *Cooling system under high pressure when hot. Coolant may cause burns when hot. Allow engine to cool before servicing cooling system.*

- Working from below, remove engine splash shield.

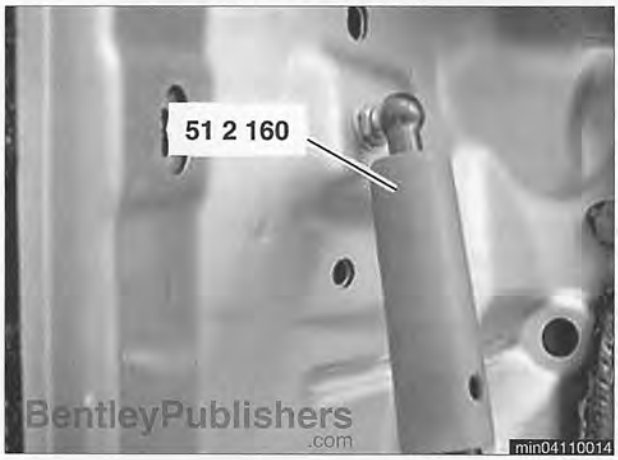
Engine Removal and Installation (Cooper S)

➢ Release clamp and remove lower radiator hose (**arrow**).

– Allow coolant to drain into suitable catch pan.

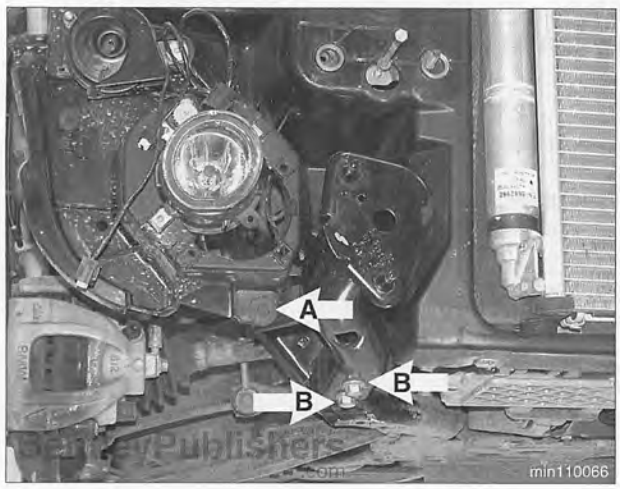
NOTE —
Save coolant and reuse, or dispose of properly.

> ***WARNING —***
> *Use extreme caution when draining and disposing of engine coolant. Coolant is poisonous and lethal to humans and pets. Pets are attracted to coolant because of its sweet smell and taste. Seek medical attention immediately if coolant is ingested.*



➢ For additional clearance, detach hood struts from hood and insert special tools (BMW 51 2 160) to support hood.

– Remove engine breather valve retaining bolt and remove engine breather valve from inspection cover.



➢ Working underneath car:

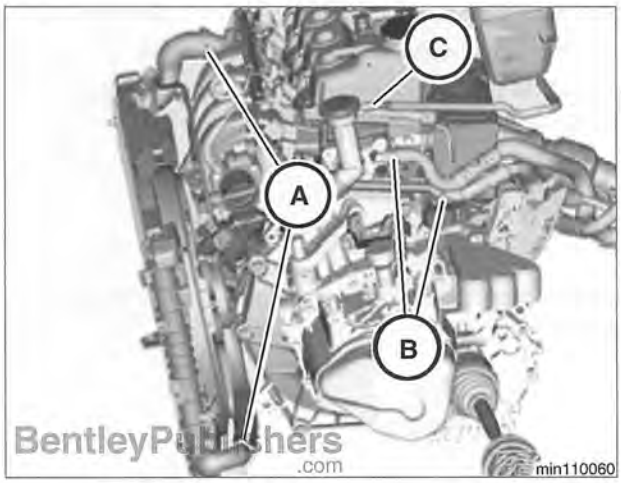
- Remove bolt (**A**) holding crush tube to modular front end (MFE).
- Remove bolts (**B**) holding crush tube to front subframe.

NOTE —
MFE removed in photo for purposes of illustration.

➤ Loosen modular front end. See **510 Exterior Trim, Bumpers** for more information.

- Remove right front wheel housing liner.
- Detach left front wheel housing liner from front bumper cover trim.
- Remove front bumper cover trim.
- Remove bumper.
- Detach radiator upper hose support clamp (**A**) from intake manifold.
- Remove MFE mounting bolts. Install two 100 mm (4 in) M8 bolts (**arrow**) in left and right bumper support members. Slide modular front end forward, supported on long bolts.
- Remove crush tubes.

CAUTION—
For ease of component alignment when reassembling front bumper assembly, do not loosen or remove bumper alignment bosses.



NOTE—

- *If available, use BMW special tools 11 8 401 and 11 8 402 instead of long bolts to support MFE.*
- *Removal of MFE is a complicated job. It is covered in* **510 Bumpers, External Trim**.

➤ Remove upper and lower radiator hoses (**A**).

– Remove heating hoses (**B**).

– Remove overflow hose (**C**).

NOTE—
Cooper coolant hose layout illustrated. Cooper S is similar.

➤ Unhook fuel injector electrical harness from fuel rail mounting brackets.

– Disconnect top fuel tank vent line and unclip at fuel rail.

WARNING—
If disconnecting fuel line from fuel rail, fuel will be expelled under pressure. Loosen fuel filler cap to release fuel tank pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hose, wrap a cloth around hose to absorb any leaking fuel. Plug all open fuel connections.

CAUTION—
Do not allow fuel to drip on alternator.

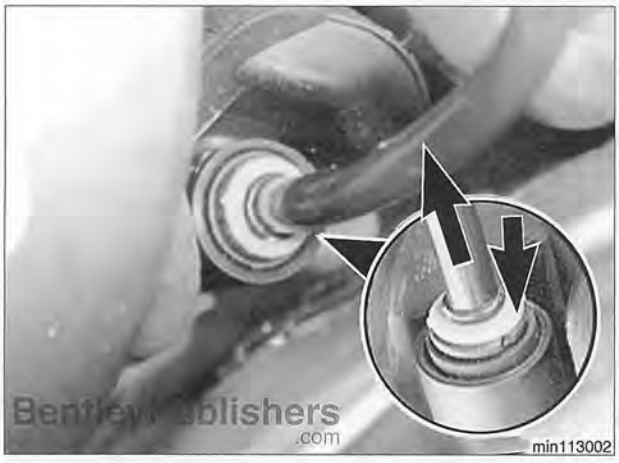
NOTE—
- *Follow the procedure below to avoid disconnecting the fuel hose from the fuel rail.*
- *If it becomes necessary to disconnect the fuel hose from the fuel rail, follow the procedure in* **130 Fuel Injection**. *Be sure to read the warnings and cautions regarding working with fuel.*

➢ Detach fuel rail from top of engine:
- Disconnect fuel injector electrical harness connectors (**A**).
- Working at fuel rail, unclip hoses and ducts. Cut wire ties as needed.
- Disconnect vacuum line at base of fuel pressure regulator (**B**).
- Remove fuel rail mounting bolts (**arrows**).

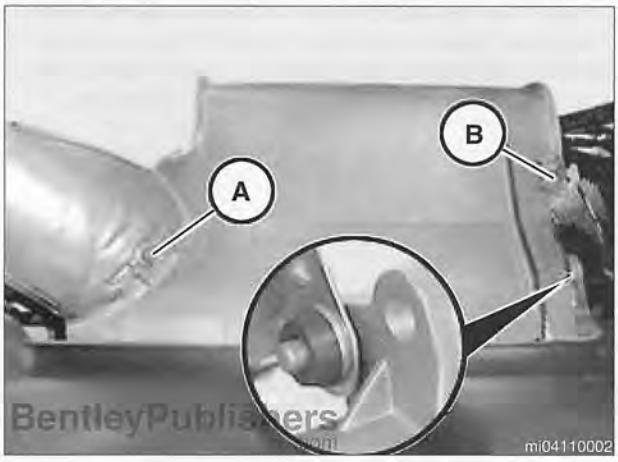
> ***CAUTION—***
> *Use compressed air to blow away accumulated debris at the base of each fuel injector.*

– Remove fuel rail together with fuel injectors from intake manifold.
- Unclip fuel line from engine vibration damper bracket.
- Carefully fold fuel hose to right and rear of engine. Protect fuel rail and injectors by storing in plastic bag.

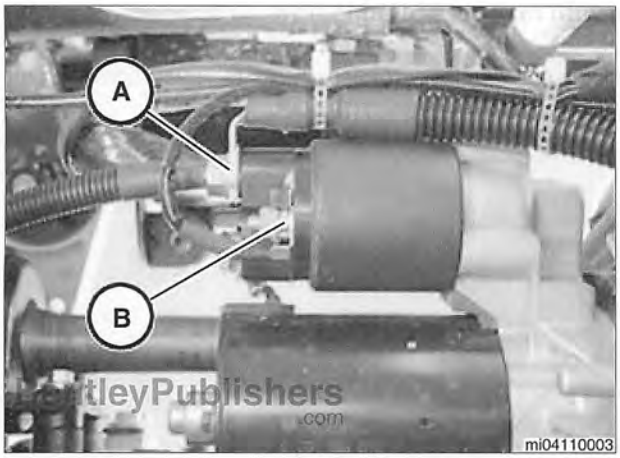
> ***CAUTION—***
> *Plug fuel injector bores in intake manifold.*



➢ Working at intake manifold, press locking ring down to detach brake booster vacuum line.



➢ Working underneath car at back of engine, remove starter motor heat shield:
- Remove retaining bolt (**A**).
- Remove oxygen sensor from wire clip (**B**).



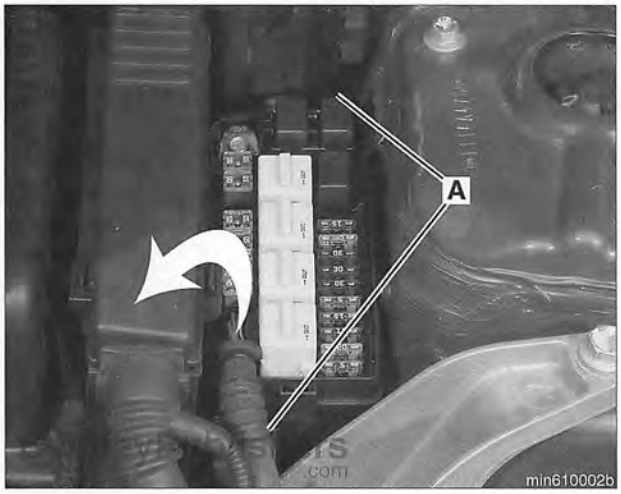
➤ Disconnect wires (**A**, **B**) at starter motor and unclip wire harness from frame (note harness routing).

– Remove protective cover from underneath fuel injector rail.

– Remove tank venting valve lower pipe from lower engine vibration damper bracket.

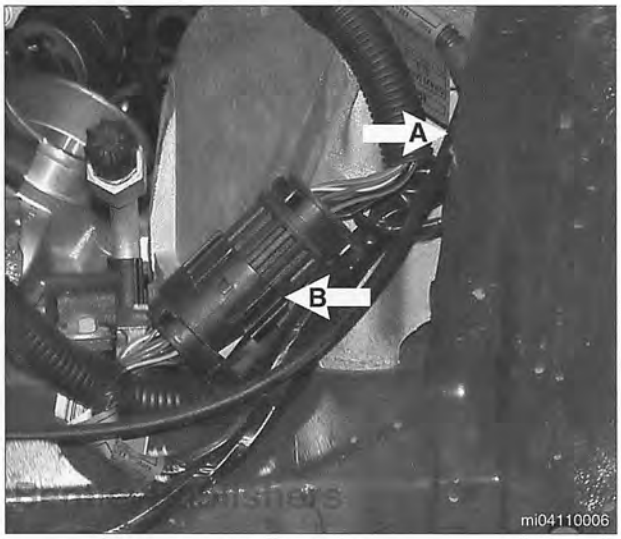
– Remove ground wire from engine mount bracket.

– On vehicles with automatic transmission, remove starter.



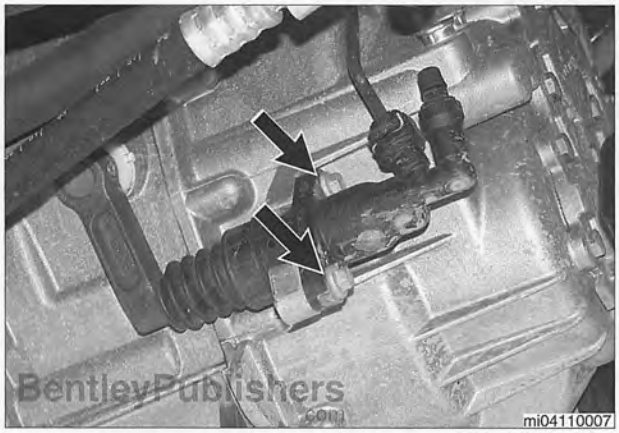
➤ Working in engine compartment on right side of engine:
- Remove cover to fuse and relay panel 3.
- Disconnect harness connector (**arrow**).

– Remove fuse panel retaining bolts (**A**) and move panel aside.



➤ Remove ground wire from left strut tower (**A**).

– Disconnect round engine harness connector (**B**) by twisting and pulling apart.

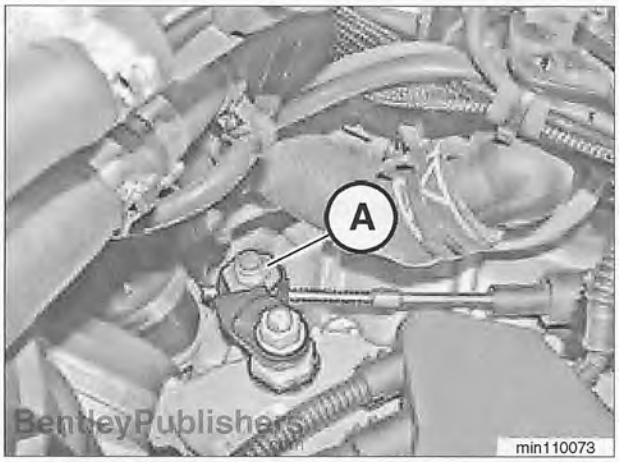


Vehicles with manual transmission

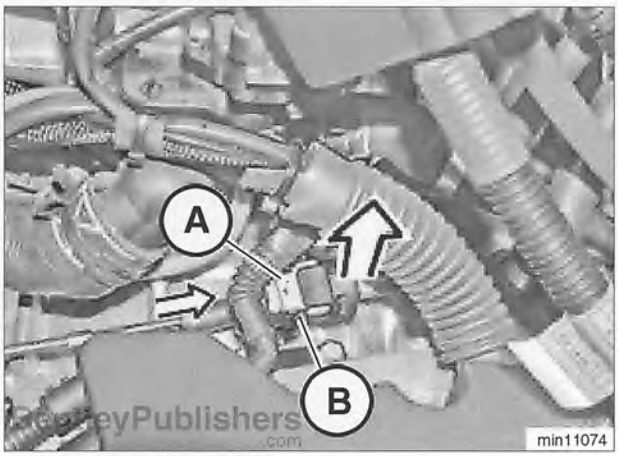
- Remove clutch slave cylinder retaining bolts (**arrows**) from front of transmission and remove clutch slave cylinder.

- Remove clips from gearshift cable bracket and remove gearshift cables from ball joints by carefully prying off with a pair of screwdrivers.
- Remove gearshift cable bracket bolts and remove gearshift bracket.

Vehicles with automatic transmission

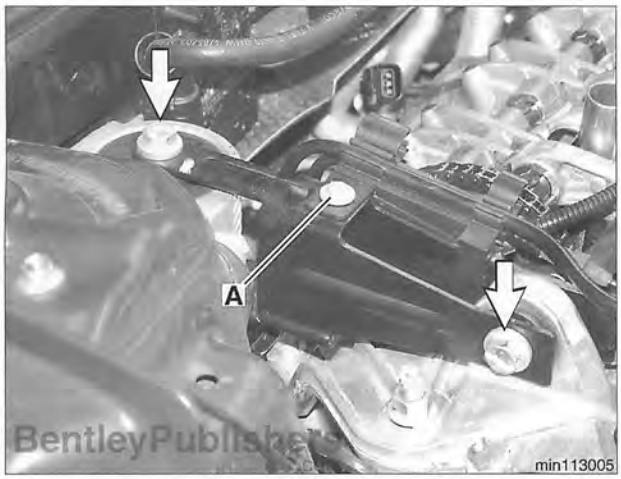


- Loosen lock nut (**A**) for gear selector cable and remove cable from bracket.



- Press retaining clip (**A**) together and remove +/– gear selector cable from bracket (**B**).

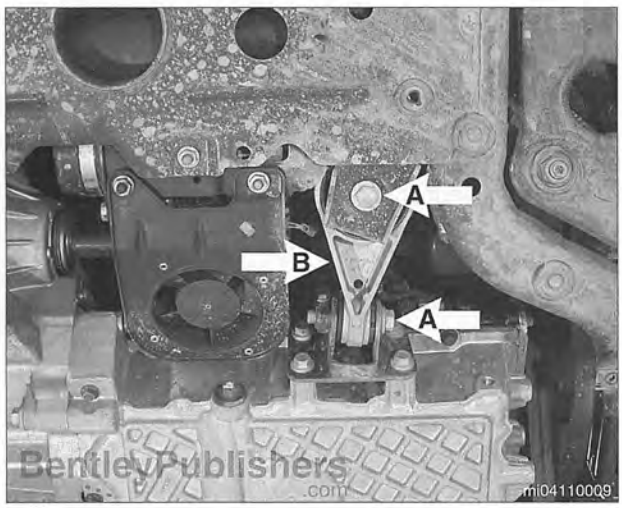
Continued for all vehicles



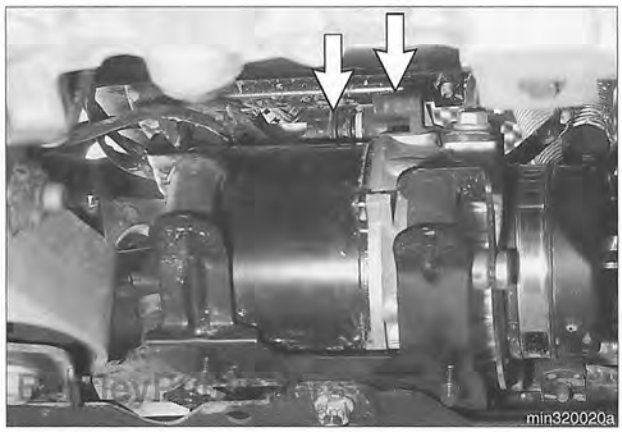
➢ Working on right side of engine, remove bolts from top engine vibration damper bracket (**arrows**), if applicable.

NOTE—
Later model vehicles may not have vibration damper bracket.

– Unclip hoses and remove plastic bracket (**A**).

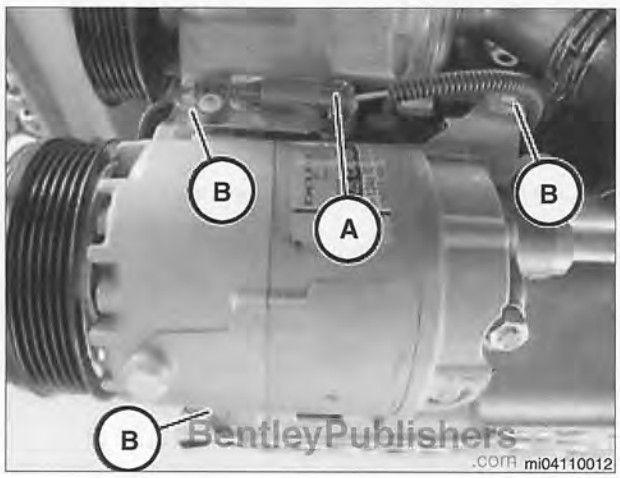


➢ Working underneath car, remove lower engine vibration damper bracket bolts (**A**) and remove bracket (**B**).



➢ Working underneath car, disconnect electrohydraulic power steering (EHPS) pump electrical connectors (**arrows**) at steering rack at rear of engine oil pan.

Engine Removal and Installation (Cooper S)

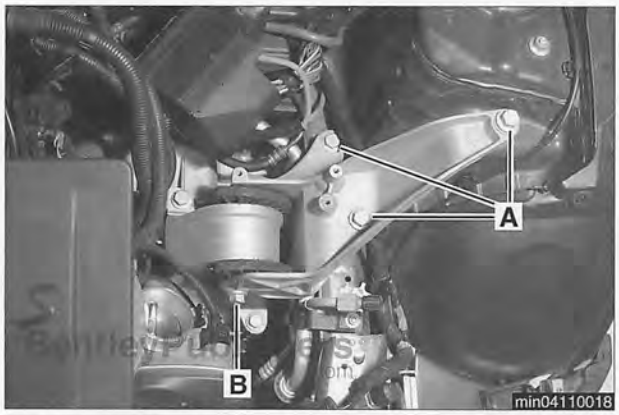


➤ Unbolt A/C compressor from engine pan on front of engine:

- Disconnect wiring harness (**A**).
- Remove compressor mounting bolts (**B**).
- Detach A/C high pressure line from engine block in order to allow compressor free movement. Do not detach high pressure line from compressor.

> ***CAUTION—***
> *A/C system does not need to be evacuated for this procedure. However, take care when removing the compressor to avoid personal injury or damage to the system.*

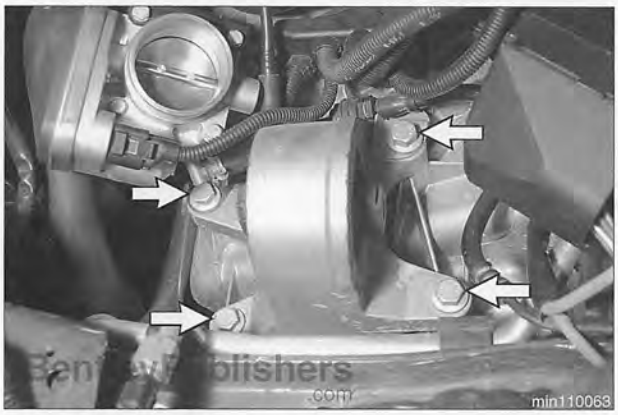
– Pull compressor away from engine oil pan and secure to MFE with stiff wire.



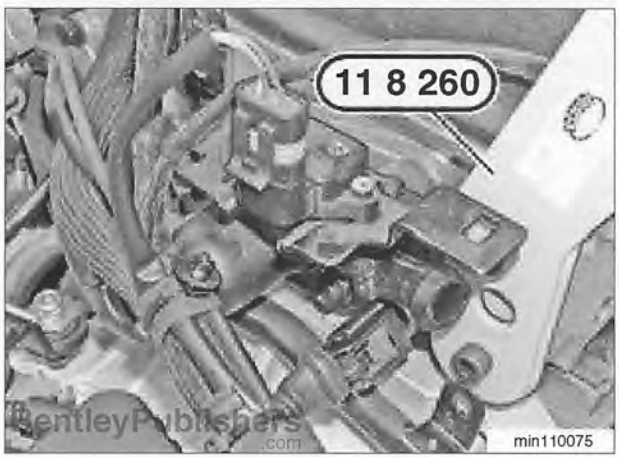
➤ Remove transmission upper mount bracket bolts (**A**).

> ***CAUTION—***
> *Support transmission from below with floor jack before removing bracket mounting bolts.*

– Remove transmission mount to bracket mounting nut and bolt (**B**). Remove bracket.

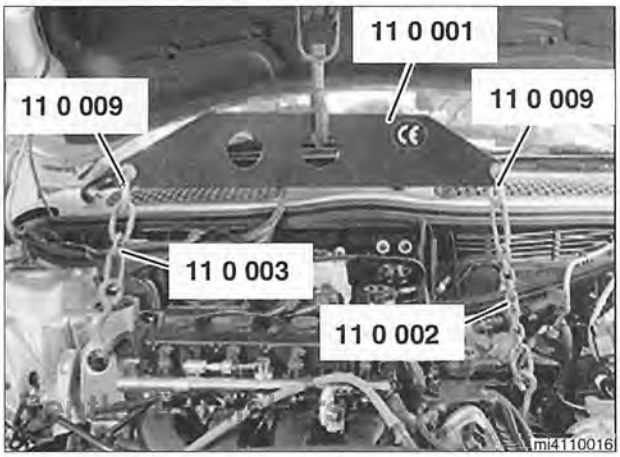


➤ Remove bolts (**arrows**) from transmission mount. Remove mount.



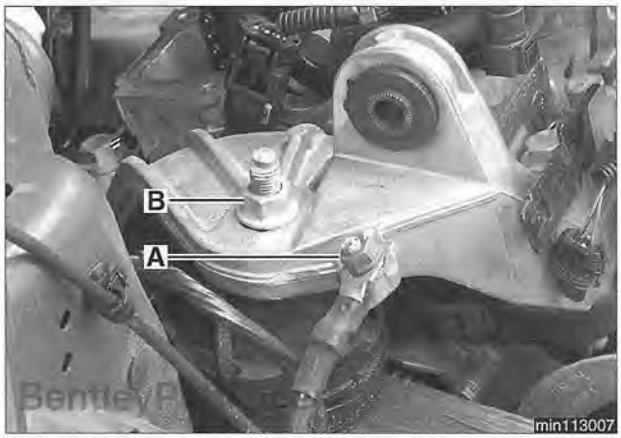
➤ Attach hoist bracket (BMW 11 8 260) to transmission.

➢ Attach hoist bracket (BMW 11 8 351) to front of engine.



➢ Attach engine hoisting harness (BMW 11 0 001, 11 0 002, 11 0 003, 11 0 009) to engine and transmission brackets and support firmly.

– Raise hoist slightly to remove load from engine and gearbox mounts.



➢ Remove ground wire (**A**) from engine mount bracket and remove nut from hydraulic mount (**B**).
- Early version shown, later is similar.

– Carefully raise engine out of car, checking for any wiring, fuel lines, or mechanical parts that might become snagged as engine is removed.

– Installation is reverse of removal, noting the following:
- Replace all gaskets, O-rings and seals.
- Refill transmission and check all other fluid levels. See **020 Maintenance**.
- Refill and bleed cooling system. See **170 Radiator and Cooling System**.
- Check that engine accessory belt properly engages pulley grooves.
- Install exhaust manifold using new gaskets. Use copper paste on threads. See **180 Exhaust System**.
- After reattaching battery cables, initialize power windows by raising each window and keeping power window switch in raised position for about 5 seconds.

Engine Removal and Installation (Cooper S)

CAUTION—
Check accessory belt for cracks, coolant and oil residue. Replace if contaminated by oil.

Tightening torques	
A/C compressor to engine pan mount	25 Nm (18 ft-lb)
Alternator lead to starter motor	14 Nm (10 ft-lb)
Crush tubes to front end	100 Nm (75 ft-lb)
Crush tubes to subframe	100 Nm (75 ft-lb)
Engine mount bracket to engine mount	68 Nm (50 ft-lb)
Engine mount bracket to transmission	38 Nm (28 ft-lb)
Engine mount to body	68 Nm (50 ft-lb)
Fusebox retaining bolts to chassis	5 Nm (4 ft-lb)
Gearshift cable bracket to manual transmission	22 Nm (16 ft-lb)
Gear selector cable to bracket on automatic transmission	12 Nm (9 ft-lb)
Ground wire to left strut tower	9 Nm (7 ft-lb)
Heat shield to starter motor	9 Nm (7 ft-lb)
Intercooler cover bracket to intercooler	9 Nm (7 ft-lb)
Intercooler cover to intercooler	9 Nm (7 ft-lb)
Lower engine vibration damper to holder	100 Nm (74 ft-lb)
Lower engine vibration damper to oil pan	38 Nm (28 ft-lb)
Mount bracket to cylinder head	100 Nm (74 ft-lb)
Slave cylinder to manual transmission bracket	24 Nm (18 ft-lb)
Starter to automatic transmission	82 Nm (60 ft-lb)
Throttle body to intake manifold	9 Nm (7 ft-lb)
Top engine vibration damper bracket to body	100 Nm (74 ft-lb)
Top engine vibration damper bracket to engine	100 Nm (74 ft-lb)
Transmission mount bolts to transmission	66 Nm (49 ft-lb)
Transmission mount retaining bolt to upper bracket	66 Nm (49 ft-lb)
Upper sealing ring bracket to lower bracket	9 Nm (7 ft-lb)
Wiring to starter solenoid	8 Nm (6 ft-lb)

113 Cylinder Head Removal and Installation

GENERAL

This repair group covers MINI cylinder head removal and installation as well as cylinder head / valve diagnosis procedures.

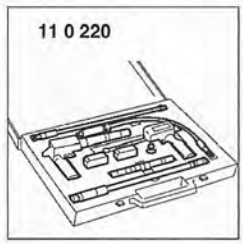
The information given in this repair group assumes that the engine is installed in the engine bay. For cylinder head and valvetrain reconditioning information, see **116 Cylinder Head and Valvetrain**.

NOTE —
If a head gasket problem is suspected, a compression test or leak-down test will usually detect the fault. See **Diagnostic Testing** *in this repair group.*

Special tools

Special service tools are required to properly remove and install the cylinder head. Read the entire procedure through before beginning the job.

- Torque angle measuring gauge (BMW special tool 00 9 120)



- Compression test kit (BMW special tool 11 0 220)

- Camshaft locking tool (BMW special tool 11 8 250)

- Engine block support tool (BMW special tool 11 8 370)

- Hydraulic engine mount removal and installation tool (BMW special tool 11 8 380)

- Modular front end supports (BMW special tool 11 8 400)

- Compression tester adapter (BMW special tool 11 8 490)

DIAGNOSTIC TESTING

Cylinder compression, checking

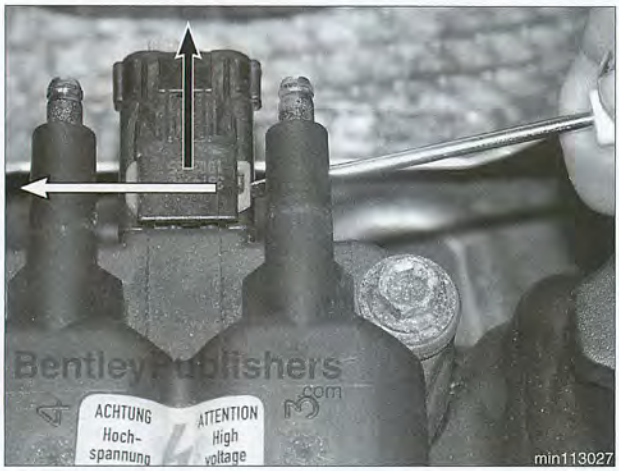
A compression gauge is needed to make a compression test. For an accurate test, the battery and starter must be capable of cranking the engine at least 300 rpm, and the engine should be at normal operating temperature.

NOTE—
Performing a compression test may cause a fault to set in the ECM and may illuminate the Malfunction Indicator Light (MIL). The light can only be turned out using either BMW special service scan tool or equivalent. Disconnecting the battery will not erase the fault memory or turn out the light. See **OBD On Board Diagnostics**.

– Use BMW service scan tool (DISplus, GT1, MoDiC) or equivalent to read out DME control module fault memory.

– Turn ignition OFF.

Diagnostic Testing



➤ Working at top of valve cover, disconnect electrical harness connector to ignition coil pack.

- Press securing clip in direction of **white arrow**.
- Pull off coil pack connector in direction of **black arrow**.

> ***WARNING —***
> - *The ignition system produces high voltages that can be fatal. Avoid contact with exposed terminals and use extreme caution when working on a car with the ignition switched on or the engine running.*
> - *Do not touch or disconnect ignition components while the engine is running or being cranked by the starter.*

➤ Pull up on each spark plug wire connector while gently twisting from side to side to remove. Label wires.

NOTE —
Cooper S engine is illustrated. Cooper engine layout is similar.

– Remove spark plugs from all cylinders.

NOTE —
Check spark plugs for oil deposits that may indicate poor cylinder sealing, then set them aside in order.

➤ Screw compression tester adapter (BMW special tool 11 8 490 or equivalent) into cylinder 1 spark plug thread tight enough to form a good seal. Attach compression gauge (BMW special tool 11 0 224 or equivalent).

– With parking brake set and clutch pressed to floor or transmission in PARK or NEUTRAL, crank engine with starter. Record highest value indicated by gauge.

NOTE —
- *The compression gauge reading should increase with each compression stroke and reach near its maximum reading in about 4 - 6 strokes.*
- *All cylinders should reach maximum compression in the same number of strokes. If a cylinder needs significantly more strokes to reach maximum compression, there is a problem.*

– Release pressure at compression gauge valve, then remove gauge from spark plug hole. Repeat test for each cylinder and compare results with values given in **Compression specifications** table.

Compression specifications	
Compression range Cooper Cooper S	 11.5 - 17.0 bar (167 - 247 psi) 9 - 13.5 bar (131 -196 psi)
Maximum difference between cylinders	0.5 bar (7 psi)

– Compression readings may be interpreted as follows:
  - Low compression in one cylinder indicates a poorly sealed combustion chamber.
  - Relatively even pressures that are below specification normally indicate worn piston rings and/or cylinder walls.
  - Erratic values tend to indicate valve leakage.
  - Dramatic differences between cylinders are often a sign of a failed head gasket, burned valve, or broken piston ring.

– If readings are within specifications, reinstall spark plugs.

NOTE—
Used spark plugs should be reinstalled in the same cylinder from which they were removed.

Tightening torque	
Spark plug to cylinder head	27 Nm (20 ft-lb)

– Remainder of installation is reverse of removal. Be sure to reattach coil pack electrical connector.

– Connect BMW service scan tool or equivalent and delete stored faults.

Wet compression test

To further help analyze the source of poor compression, a wet compression test is the next step.

– Repeat compression test, but this time squirt a teaspoon of oil into each cylinder. The oil will temporarily help seal between piston rings and cylinder wall, practically eliminating leakage past rings for a short time.

– If this test yields a higher reading than "dry" compression test, there is probably leakage between piston rings and cylinder walls, due either to wear or to broken piston rings.

– Little or no change in compression reading indicates other leakage, probably from valves.

Cylinder leak-down test

The most conclusive diagnosis of low compression symptoms requires a cylinder leak-down test. Using a special tester and compressed air, each cylinder, in turn, is pressurized. The rate at which the air leaks out of the cylinder, as well as where the air leaks out, can accurately pinpoint the magnitude and location of the leakage.

Before attempting any repair that requires major engine disassembly, use a leak-down test to confirm low compression.

Cylinder leak-down test equipment can be procured from an automotive parts and equipment supplier.

Cylinder Head Removal and Installation (Cooper)

Cylinder head removal and installation is a complicated job and requires special tools.

The job has been divided up into several procedures. Read the procedures before beginning the repair.

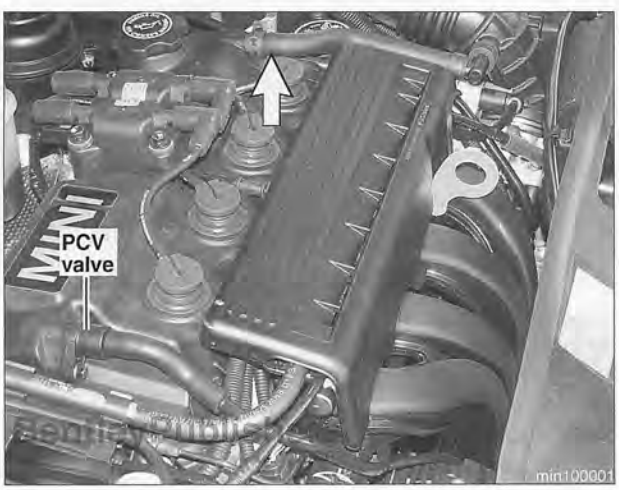
> ***WARNING —***
> *Due to risk of personal injury, be sure the engine is cold before beginning any of the procedures.*

> ***CAUTION —***
> *Cover all painted surfaces before beginning the removal procedure. As an aid to installation, label all components, wires, and hoses before removing them. Do not reuse gaskets, O-rings or seals during reassembly.*

Valve cover, removing and installing (Cooper)

– Make sure ignition is OFF.

➢ Working at top of engine, disconnect **PCV valve** and crankcase breather hose (**arrow**) from valve cover.



➢ Remove fuel rail cover:
- Squeeze locking tabs (**A**) to detach rear of cover.
- Tilt and pull cover forward until plastic clips (**arrows**) detach from fuel rail.

CAUTION—
Plastic clips can break easily.

➢ Pull up on spark plug wire connector while gently twisting from side to side.

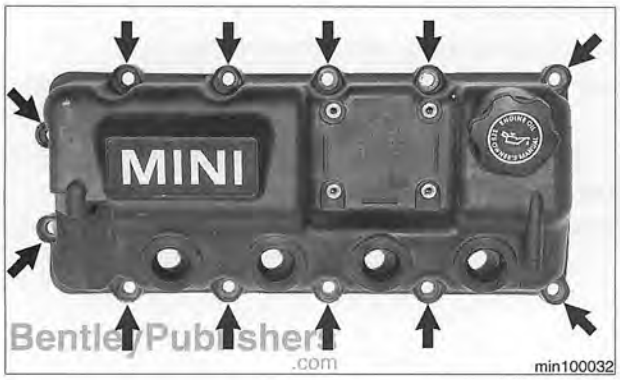
NOTE—
Cooper S engine is illustrated. Cooper engine layout is similar.

➢ Working at top of valve cover, disconnect electrical harness connector to ignition coil pack.
- Press securing clip in direction of **white arrow**.
- Pull off coil pack connector in direction of **black arrow**.

– Remove harness clips from valve cover bolts.

– Remove coil pack mounting bolts. Lift coil pack and spark plug wires off valve cover.

Cylinder Head Removal and Installation (Cooper)

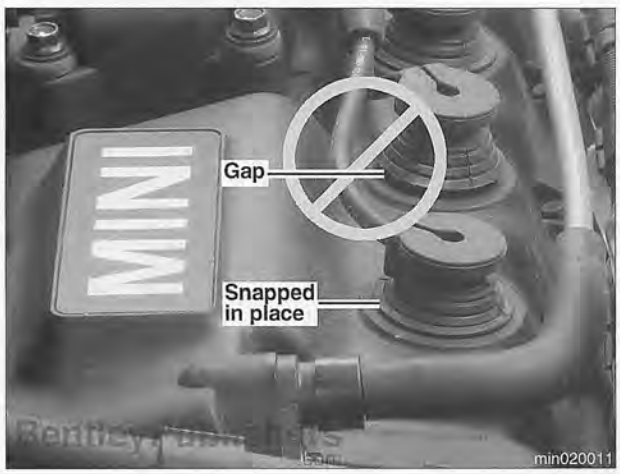


➢ Remove 12 valve cover bolts (**arrows**).

– Remove valve cover.

– Installation is reverse of removal. Note the following:
- Replace valve cover gasket.
- Replace spark plug hole sealing grommets in valve cover.
- Clean gasket mating faces. Coat lightly with oil.
- Replace valve cover mounting bolts or insulators if damaged.
- Tighten valve cover mounting bolts in sequence, from inside to outside.
- Inspect ignition coil pack insulators. Replace if damaged.

Tightening torques	
Ignition coil pack to valve cover (M6)	12 Nm (9 ft-lb)
Valve cover to cylinder head (M6)	12 Nm (9 ft-lb)

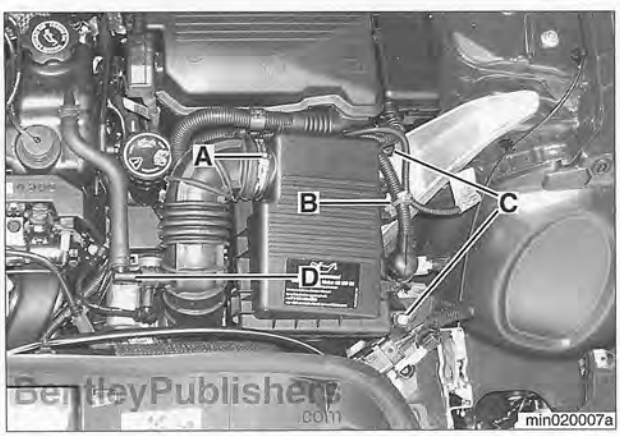


➢ When reinstalling ignition wires, make sure that they snap securely into place.

Intake manifold, removing and installing (Cooper)

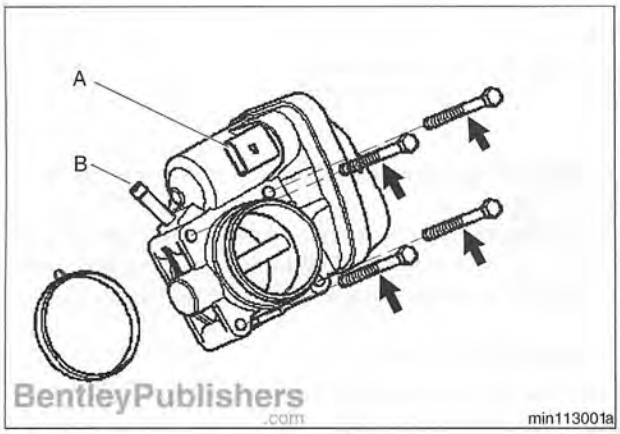
– Working in engine compartment, remove battery box cover. Disconnect negative (-) cable from battery. See **121 Battery, Starter, Alternator** for more information.

> ***CAUTION***—
> *Disconnecting the battery may erase fault code(s) stored in memory. Check for fault codes prior to disconnecting the battery cables.*

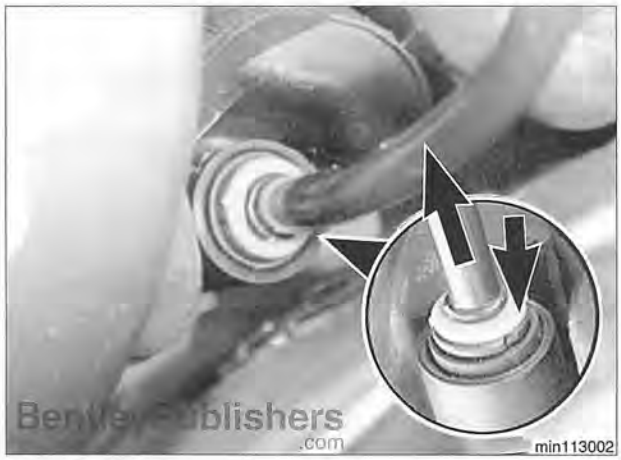


➢ Working at top of engine, loosen or remove air duct clamp (**A**). Detach air duct from air filter housing.
- Detach wire harness (**B**).
- Remove air filter housing mounting screws (**C**).
- Detach crankcase breather hose (**D**) from air duct.

– Remove complete air filter housing.



➢ Remove throttle valve assembly:
- Loosen or remove air duct clamp at throttle assembly. Detach air duct.
- Disconnect electrical harness connector (**A**).
- Detach fuel tank vent line (**B**).
- Loosen and remove throttle assembly mounting screws (**arrows**).
- Lift off throttle assembly.



➢ Working at intake manifold, press brake booster vacuum line locking ring downward to detach line from manifold.

– Working at top right of valve cover, remove hose from PCV valve.

➢ Remove fuel rail cover:
- Squeeze locking tabs (**A**) to detach rear of cover.
- Tilt and pull cover forward until plastic clips (**arrows**) detach from fuel rail.

> ***CAUTION—***
> *Plastic clips can break easily.*

– Detach electrical harness connector from intake air temperature / manifold absolute pressure (T-MAP) sensor.

– Detach knock sensor electrical harness connector from fuel rail wiring harness.

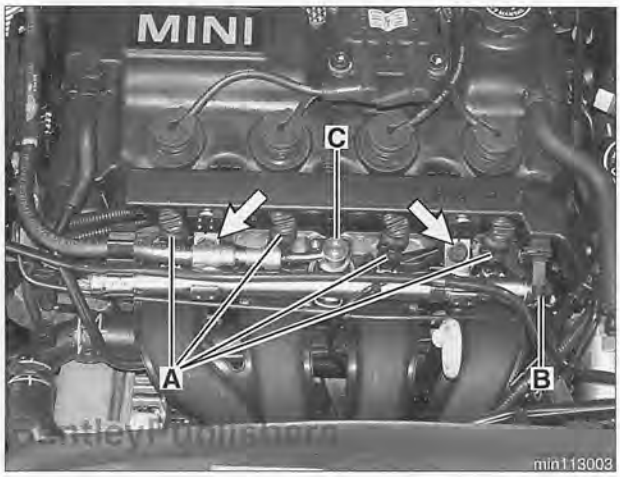
– Disconnect top fuel tank vent line and unclip at fuel rail.

> ***WARNING—***
> - *If disconnecting fuel line, fuel will be expelled under pressure. Loosen fuel filler cap to release tank pressure.*
> - *Do not smoke or work near heaters or other fire hazards.*
> - *Keep a fire extinguisher handy.*
> - *Before disconnecting fuel hose, wrap a cloth around hose to absorb any leaking fuel.*
> - *Plug all open fuel connections.*

Cylinder Head Removal and Installation (Cooper)

CAUTION—
Do not allow fuel to drip on alternator.

NOTE—
- *Follow the procedure below to avoid disconnecting the fuel hose from the fuel rail.*
- *If it becomes necessary to disconnect the fuel hose from the fuel rail, follow the procedure in* **130 Fuel Injection**. *Be sure to read the warnings and cautions regarding working with fuel.*



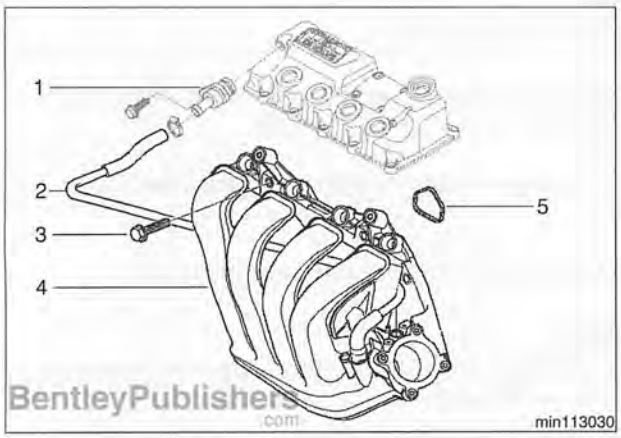
➤ Detach fuel rail from top of engine:
- Disconnect fuel injector electrical harness connectors (**A**).
- Disconnect harness connector (**B**).
- Remove cover from harness loom and swing harness out of way to left side of engine.
- Working at fuel rail, unclip hoses and ducts. Cut wire ties as needed.
- Disconnect vacuum line at base of fuel pressure regulator (**C**).
- Remove fuel rail mounting bolts (**arrows**).

CAUTION—
Use compressed air to blow away accumulated debris at the base of each fuel injector.

– Remove fuel rail together with fuel injectors from intake manifold.
- Unclip fuel line from engine vibration damper bracket.
- Carefully fold fuel hose to right and rear of engine. Protect fuel rail and injectors by storing in plastic bag.

CAUTION—
Plug fuel injector bores in intake manifold.

– Remove engine oil dipstick.



➤ Remove intake manifold mounting bolts in sequence, working from outside to inside. Remove manifold along with PCV valve hose.
1. PCV valve
2. PCV valve hose
3. Bolt, M8 x 35 mm
   -tighten to 26 Nm (19 ft-lb)
4. Intake manifold
5. Intake manifold profile gasket (always replace)

CAUTION—
Stuff clean rags in cylinder head intake ports.

– Unclip coolant line below manifold.

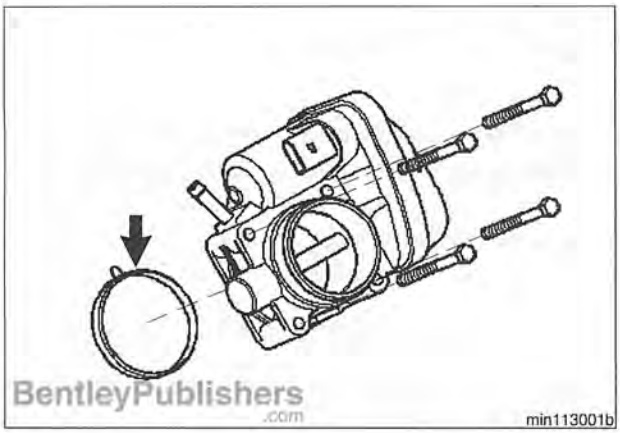
– When reinstalling intake manifold, replace intake manifold profile gaskets.

– Tighten down intake manifold mounting bolts in sequence, working from inside to outside.

Tightening torque	
Intake manifold to cylinder head (M8)	26 Nm (19 ft-lb)

– When reinstalling fuel rail, coat fuel injector sealing O-rings with anti-seize agent.

Tightening torque	
Fuel rail to intake manifold (M8)	25 Nm (18 ft-lb)



➤ When installing throttle valve assembly, replace sealing ring (**arrow**) between assembly and intake manifold.

Tightening torque	
Throttle valve assembly to intake manifold (M6)	9 Nm (7 ft-lb)

– Reinstall air filter housing.

Tightening torque	
Air filter housing to body (M6)	7 - 10 Nm (5 - 7 ft-lb)

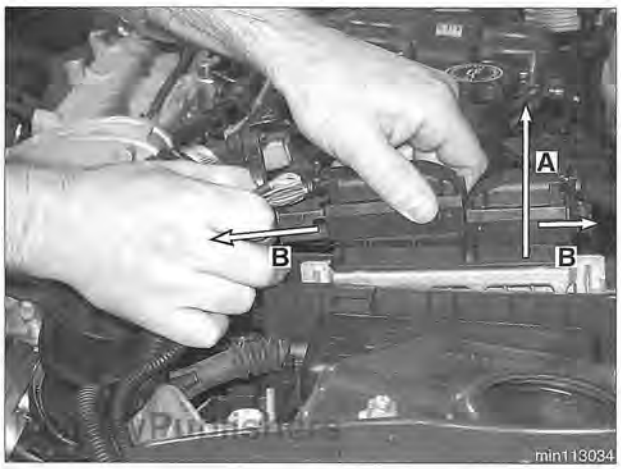
– Reattach air duct using new clamp.

NOTE—
If throttle valve assembly is replaced, be sure to reset DME control unit adaptation values using BMW scan tool.

Cylinder head, removing and installing (Cooper)

– Working in engine compartment, remove battery box cover and detach battery vent. Disconnect battery cables, starting with negative (-) cable. Remove battery See **121 Battery, Starter, Alternator** for more information.

CAUTION—
Disconnecting the battery may erase fault code(s) stored in memory. Check for fault codes prior to disconnecting the battery cables.



➤ Remove DME control module:

- Remove control module container cover and lift control unit upward (**A**).
- Pull connector locking sliders outward (**B**).
- Disconnect control module connectors.
- Place control module in safe storage location.

NOTE—
There are 2 control module harness connectors.

Cylinder Head Removal and Installation (Cooper)

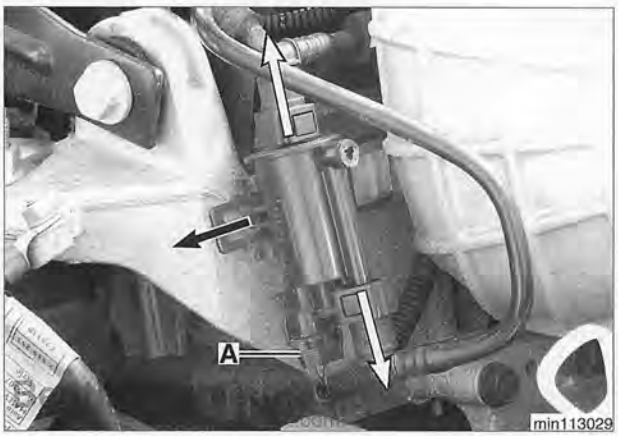
– Remove battery box:
  - Remove battery box retaining bolts.
  - Release battery box clips.
  - Disconnect harness clips from bottom of battery box.

– Drain coolant. Begin by releasing pressure at coolant filler cap. See **170 Cooling System**.

– Working at rear of cylinder head, loosen or remove heater hose clamps and detach heater hoses.

– Loosen or remove top radiator hose clamp at thermostat housing. Detach hose from housing.

– Remove right front wheel housing liner.



➢ Remove fuel tank vent valve.
  - Disconnect vent hoses (**white arrows**) via quick fit connectors.
  - Straighten retaining tab and slide vent valve off bracket (**black arrow**).
  - Remove electrical harness connector (**A**).

NOTE—
Cooper S engine is illustrated. Cooper engine layout is similar.

– Remove valve cover. See **Valve cover, removing and installing (Cooper)** in this repair group.

– Working in back of cylinder head, unbolt exhaust manifold from cylinder head:
  - Working underneath car, detach oxygen sensor harness connectors.
  - Detach exhaust system from exhaust manifold. See **180 Exhaust System**.

– Remove spark plugs.

– Remove dipstick.

– Remove intake manifold. See **Intake manifold, removing and installing (Cooper)** in this repair group.
  - Remove air filter housing.
  - Remove throttle assembly.
  - Detach brake booster vacuum line.
  - Remove fuel rail together with fuel injectors from intake manifold.
  - Unclip fuel line from engine vibration damper bracket.
  - Carefully fold fuel hose to right and rear of engine. Protect fuel rail and injectors by storing in plastic bag.

Cylinder Head Removal and Installation (Cooper)

WARNING—
- *If disconnecting fuel line, fuel will be expelled under pressure. Loosen fuel filler cap to release fuel tank pressure.*
- *Do not smoke or work near heaters or other fire hazards.*
- *Keep a fire extinguisher handy.*
- *Before disconnecting fuel hose, wrap a cloth around hose to absorb any leaking fuel.*
- *Plug all open fuel connections.*

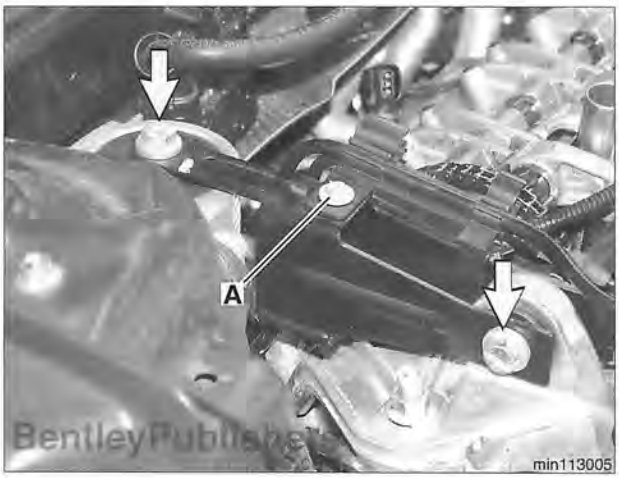
CAUTION—
Do not allow fuel to drip on alternator.

NOTE—
- *If the procedure for removing the fuel rail in* **Intake manifold, removing and installing (Cooper)** *is followed, there is no need to disconnect the fuel hose from the fuel rail.*
- *If it becomes necessary to disconnect the fuel hose from the fuel rail, follow the procedure in* **130 Fuel Injection**. *Be sure to read the warnings and cautions regarding working with fuel.*

– Disconnect coolant line from radiator filler neck to coolant expansion tank. This allows engine wiring harness to be routed around thermostat housing.

– Working to left of engine:
- Detach oxygen sensor harness connector.
- Remove oxygen sensor harness connector mounting bracket from cylinder head.
- Remove coolant distributor pipe mounting screw.
- Detach coolant temperature sensor harness connector.

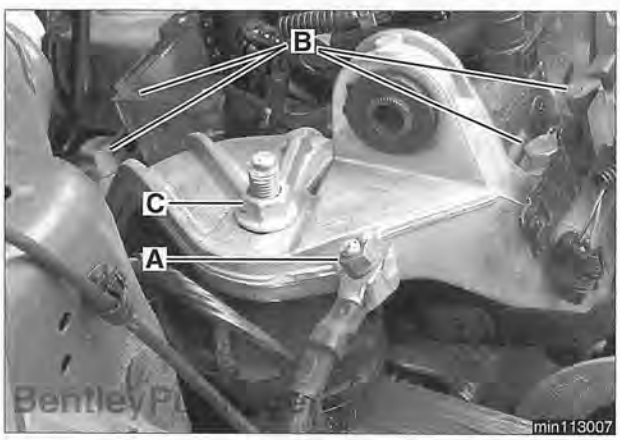
➢ Remove engine vibration damper bracket:
- Remove fuel line bracket mounting bolt (**A**). Detach any fuel lines still attached. Lift off bracket and set aside.
- Remove engine vibration damper bracket bolts (**arrows**).
- Remove bracket.



– Support engine under oil pan.

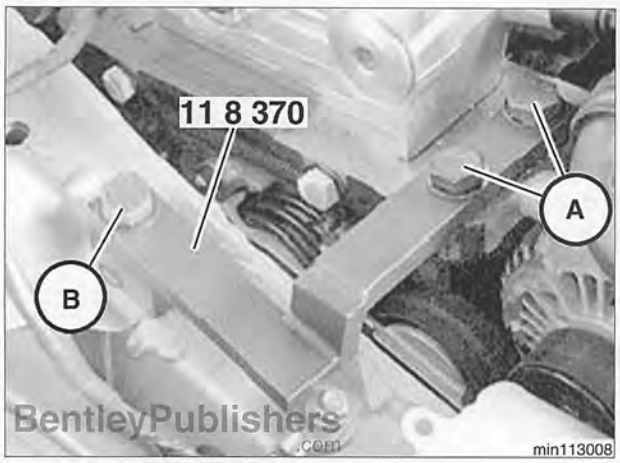
CAUTION—
To avoid damaging the oil pan, use a rubber pad on top of the engine supporting jack.

➢ Remove engine mounting bracket:
- Remove engine ground cable mounting nut (**A**) from bracket. Detach ground cable.
- Remove 4 engine mounting bolts (**B**) from engine block.
- Unscrew mounting nut (**C**) from hydraulic front engine mount stud. Lift off engine mount bracket.



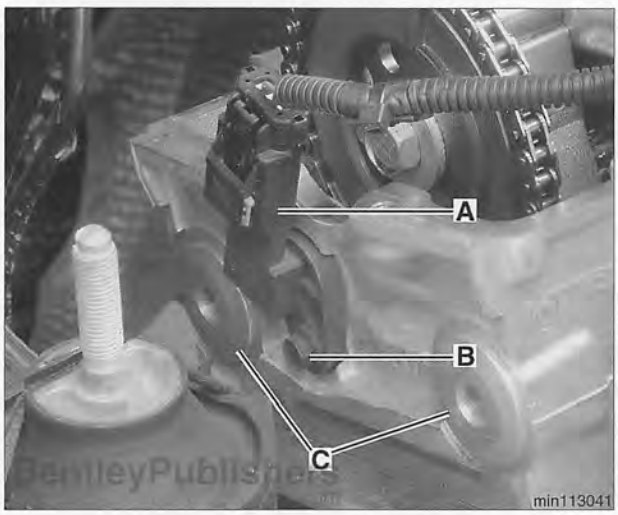
– Use special tool 11 8 380 to remove hydraulic engine mount. Counterhold Torx head mounting bolt from below.

Cylinder Head Removal and Installation (Cooper)



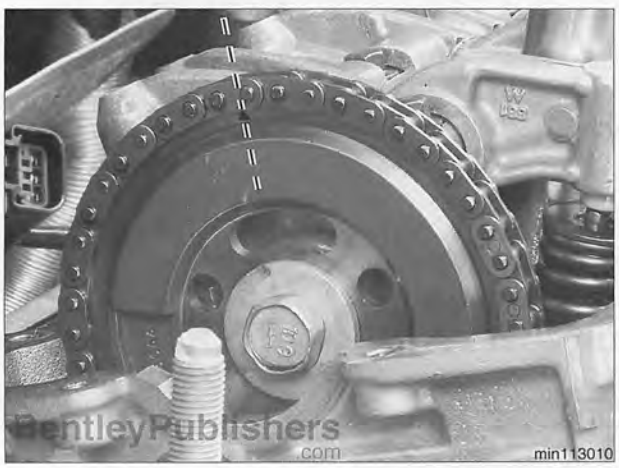
➤ Use BMW special tool 11 8 370 to support engine.

- Attach tool to cylinder head using engine mount bracket bolts (**A**).
- Use bolt (**B**) or long stud to secure tool to frame extension.
- Remove jack from underneath engine oil pan.



➤ Working at right end of cylinder head:

- Disconnect electrical harness connector (**A**) at camshaft position sensor.
- Remove sensor mounting bolt (**B**).
- Remove sensor from cylinder head.
- Remove threaded plugs (**C**) from cylinder head.



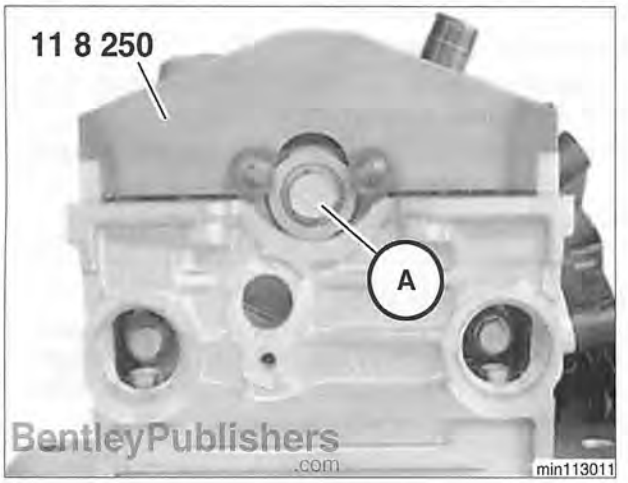
➤ Rotate crankshaft until triangular adjustment mark on camshaft sprocket (**dashed line**) is at 12 o'clock.

CAUTION —

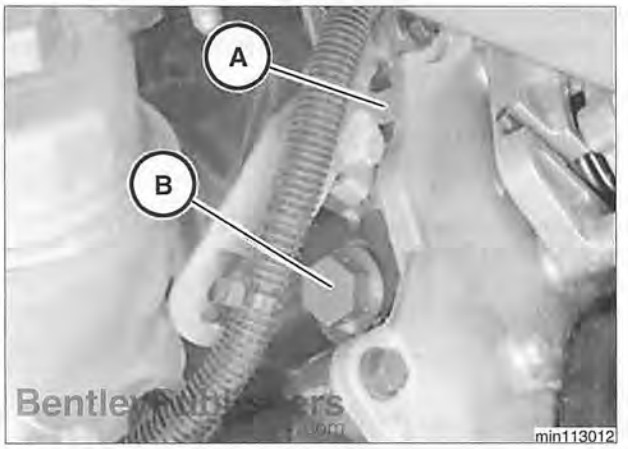
- *For ease of assembly, mark timing chain at triangular adjustment mark (**B**) with paint.*
- *Mark crankshaft vibration damper and timing case cover with paint.*

NOTE —

- *Because the engine is tilted slightly toward the back of the car, 12 o'clock on the camshaft sprocket and crankshaft vibration damper is NOT straight up and down.*
- *The brass-colored timing chain links are of no importance to the timing.*

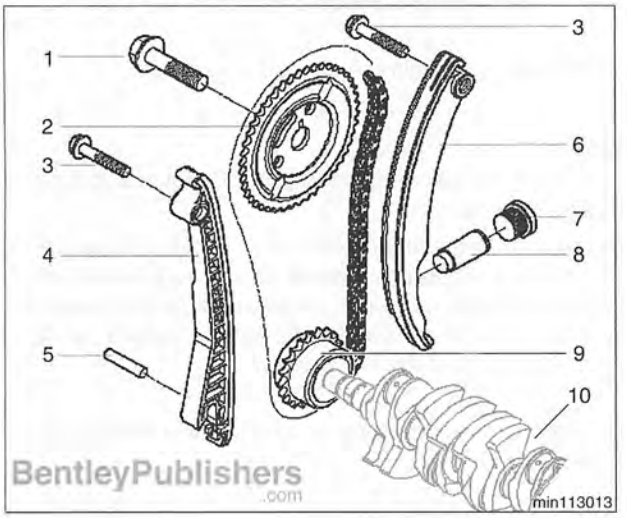


➢ Attach BMW special tool 11 8 250 to camshaft sprocket. Loosen but do not remove camshaft sprocket bolt (**A**).



➢ Working in back of engine block, remove wiring harness bracket (**A**).

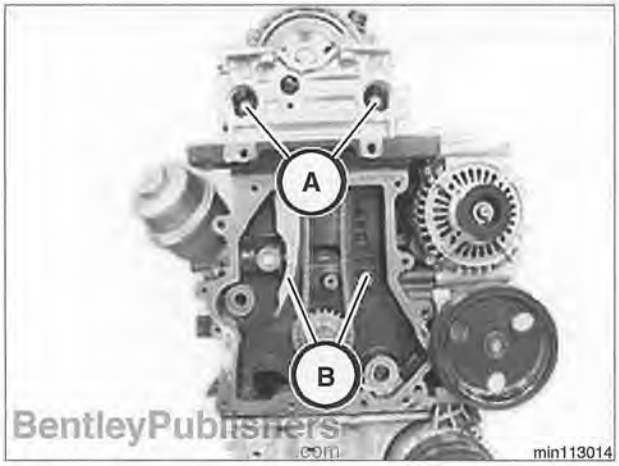
– Loosen and remove timing chain tensioner plug (**B**). Remove tensioner plunger from inside timing chain housing cover.



➢ Timing chain components:

1. Bolt, M12
   -tighten to 102 Nm (75 ft-lb)
2. Camshaft sprocket
3. Bolt, M8
   -tighten to 28 Nm (21 ft-lb)
4. Timing chain fixed guide
5. Stud
6. Timing chain tensioning guide
7. Timing chain tensioner plug with sealing O-ring
8. Timing chain tensioner plunger
9. Crankshaft sprocket
10. Crankshaft

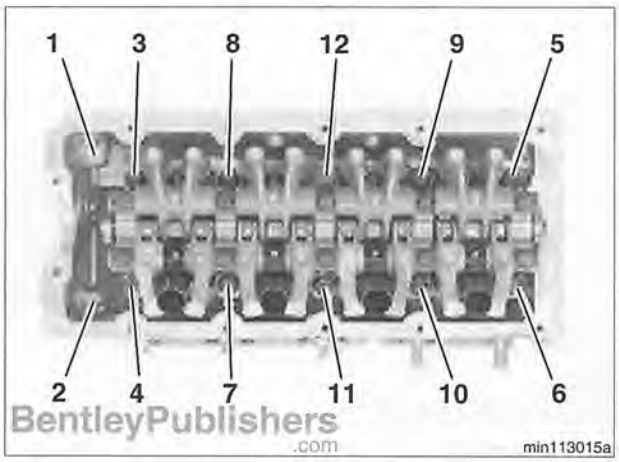
Cylinder Head Removal and Installation (Cooper)



➤ Detach timing chain from camshaft:
- Unscrew camshaft sprocket bolt.
- Remove camshaft sprocket from timing chain and secure timing chain to prevent it from dropping down.
- Remove timing chain fixed and tensioning guide mounting bolts (**A**).
- Pull timing chain guides (**B**) up out of timing chain housing.

> ***CAUTION—***
> *Do not rotate crankshaft. The timing chain cover is designed in such a way that the timing chain can remain on the crankshaft gear without gear teeth being skipped, as long as the crankshaft remains stationary.*

NOTE—
Timing chain housing cover does not need to be removed for this procedure. Illustration shows arrangement of chain guides inside housing.



➤ Remove cylinder head to timing chain housing mounting bolts **1** and **2**.

– Loosen and remove cylinder head bolts **3** to **12**, working from outside to inside. Discard bolts.

– Lift cylinder head off engine block.

> ***CAUTION—***
> *When placing cylinder head on work bench, do not rest on sealing surface. There is risk of damage to valves.*

– Clean cylinder head and engine block mating surfaces.

> ***CAUTION—***
> - *Multilayer steel cylinder head gasket (MLS) requires scratch-free sealing surfaces.*
> - *Do not use a metal scraper or wire brush to clean the aluminum cylinder head or pistons. If necessary, use a hard wooden or plastic scraper. Also available are abrasive discs to be used in conjunction with an electric drill. Be sure to use the correct disc for the type of metal being cleaned.*

– Use straight edge to check diagonal and horizontal surface evenness of cylinder head.

Cylinder head distortion specification	
Maximum warpage allowed	0.1 mm (0.004 in)

– Clean engine block oil ducts.

– Check aligning dowel sleeves in engine block for damage. Replace if necessary.

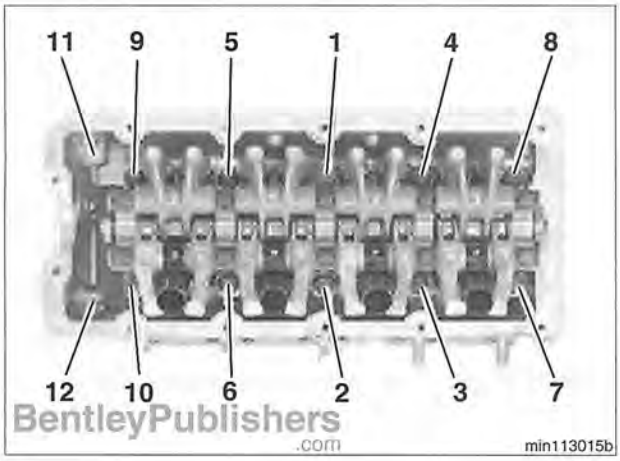
– Thoroughly clean oil and coolant out of cylinder head bolt tapped holes in engine block. If necessary, clean out holes with compressed air.

– Replace cylinder head gasket.

NOTE—
- *The standard thickness of the cylinder head gasket is 0.65 mm (0.026 in). A thicker one of 0.95 mm (0.037 in) is available.*
- *The gasket does not have any markings to indicate correct orientation. This is determined by visually lining up the location dowels and oil transfer gallery.*
- *Larger holes in head gasket slip over location dowels in engine block.*

– Reinstall cylinder head. Insert new cylinder head bolts.

CAUTION—
Do not wash off coating on new bolts.



➢ Tighten head bolts in sequence **1** to **10**, working from inside to outside.
- Head bolt are tightened in 2 stages.
- Final (stage 2) torque is applied with special tool 00 9 120 or equivalent protractor.

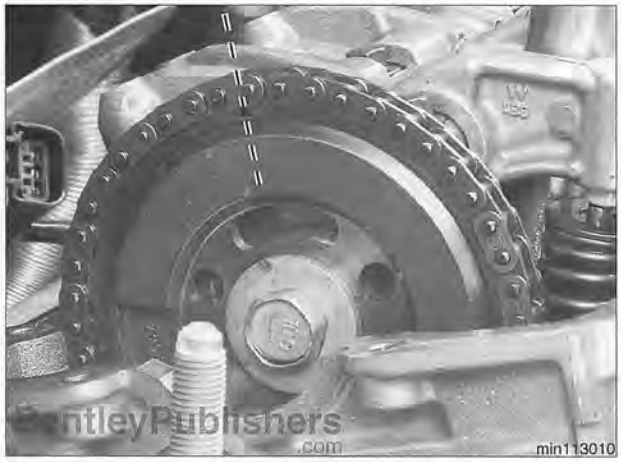
Tightening torque	
Cylinder head to engine block (use new)(M10): Stage 1 Stage 2	 40 Nm (30 ft-lb) rotate 90°

– Install and torque cylinder head to timing chain housing mounting bolts **11** and **12**.

Tightening torque	
Cylinder head to timing chain housing (M8)	28 Nm (21 ft-lb)

– Slide timing chain guides down into chain housing and reinstall mounting screws.

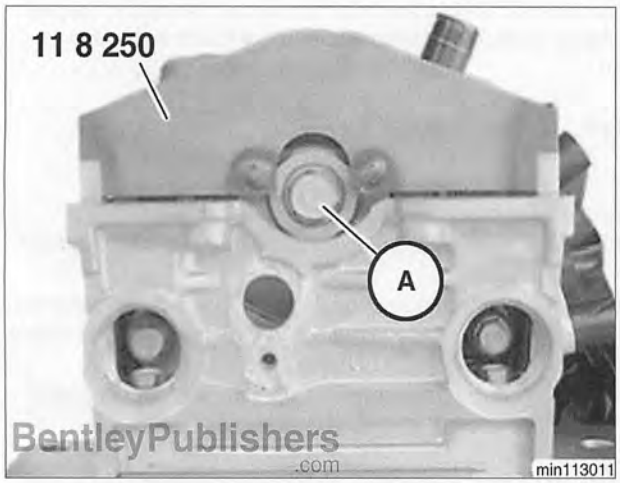
Tightening torque	
Timing chain guide to cylinder head (M8)	28 Nm (21 ft-lb)



➢ Place timing chain on camshaft sprocket. Use previously made paint mark to align sprocket and timing chain to each other.

– Place sprocket on camshaft and insert mounting bolt.

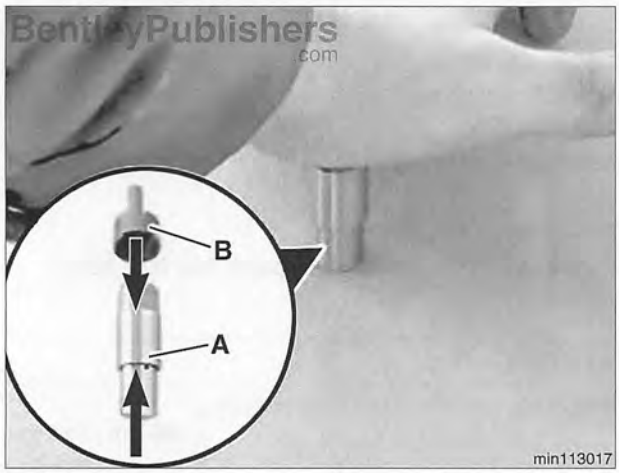
Cylinder Head Removal and Installation (Cooper)



➢ Attach BMW special tool 11 8 250 to camshaft sprocket. Torque camshaft sprocket bolt.

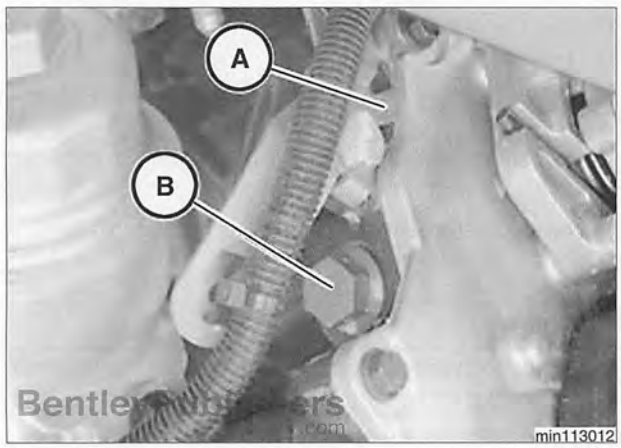
CAUTION—
Be careful not to damage timing chain during this step.

Tightening torque	
Camshaft sprocket to camshaft (M12)	102 Nm (75 ft-lb)



➢ Squeeze timing chain tensioner plunger into retracted position.

- Place plunger (**A**) on level surface.
- Remove plunger cap (**B**).
- Exert continuous hand pressure on plunger until it is completely compressed.
- Replace cap.

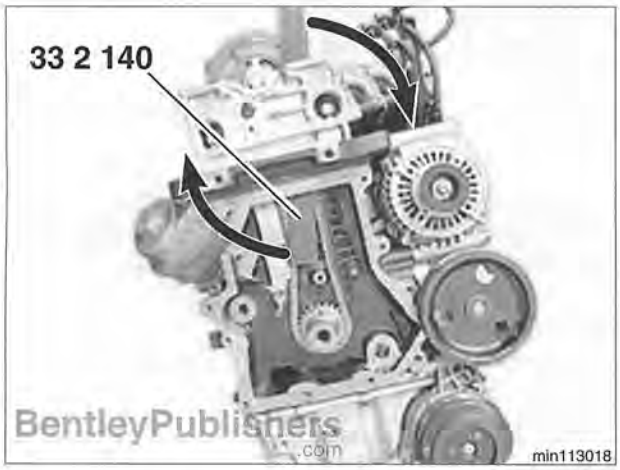


➢ Working in back of engine block, install timing chain tensioner plunger. Install tensioner plug (**B**).

Tightening torque	
Timing chain tensioner to engine block	63 Nm (46 ft-lb)

– Install wiring harness bracket in back of engine block (**A**).

Cylinder Head Removal and Installation (Cooper)



➢ Insert large prying bar (BMW special tool 33 2 140 or equivalent) into timing chain housing and lever clockwise. This releases timing chain tensioner plunger and tensions chain.

> ***CAUTION—***
> - *Do not lever directly at timing chain. Damage may result.*
> - *Make sure that the timing chain is properly positioned within the channel of the timing chain guides.*

– Continue to reassemble engine, paying attention to the following:
- Use new sealing washers when installing threaded plugs at front of cylinder head.
- Use new hose clamps, seals and gaskets, as necessary.
- Fill cooling system and check for leaks.
- Change engine oil if necessary.
- Check DME control module adaptations using BMW scan tool. Check for fault codes and clear and reset control module memory.

Tightening torques	
Air filter housing to body (M6)	7 - 10 Nm (5 - 7 ft-lb)
Battery box to body	8 Nm (6 ft-lb)
Battery cable (- or +) to battery (M6)	5 Nm (44 in-lb)
Battery securing strap to body (M6)	6 Nm (53 ft-lb)
Camshaft position sensor to cylinder head (M6)	9 Nm (7 ft-lb)
Engine front mounting bracket to top of engine block (M12)	100 Nm (74 ft-lb)
Engine splash shield to modular front end (M16 x 16 mm)	6 Nm (53 in-lb)
Exhaust manifold to cylinder head (M8)	24 Nm (18 ft-lb)
Hydraulic engine mount to body	100 Nm (74 ft-lb)
Hydraulic engine mount to body (replace Torx bolt): Initial torque Torque angle	 56 Nm (41 ft-lb) 90°
Hydraulic engine mount to engine mounting bracket	68 Nm (50 ft-lb)
Ignition coil pack to valve cover (M6)	12 Nm (9 ft-lb)
Intake manifold to cylinder head (M8)	26 Nm (19 ft-lb)
Sealing plug to cylinder head	18 Nm (13 ft-lb)
Spark plug to cylinder head	27 Nm (20 ft-lb)
Throttle valve assembly to intake manifold (M6)	9 Nm (7 ft-lb)
Upper engine vibration damper bracket to damper and to engine mounting bracket (M12)	100 Nm (74 ft-lb)
Valve cover to cylinder head (M6)	12 Nm (9 ft-lb)

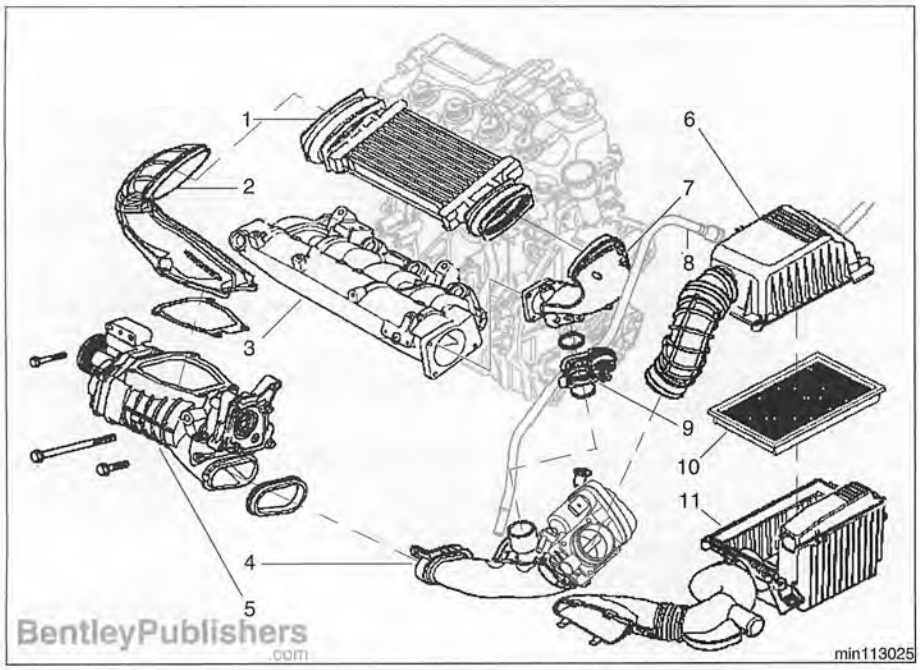
CYLINDER HEAD REMOVAL AND INSTALLATION (COOPER S)

Cylinder head removal and installation is a complicated job and requires special tools.

The job has been divided up into several procedures. Read the procedures before beginning the repair. If necessary, refer to **Cooper S air intake components** graphic for component locations.

> ***WARNING—***
> *Due to risk of personal injury, be sure the engine is cold before beginning any of the procedures.*

> ***CAUTION—***
> *Cover all painted surfaces before beginning the removal procedure. As an aid to installation, label all components, wires, and hoses before removing them. Do not reuse gaskets, O-rings or seals during reassembly.*



Cooper S air intake components

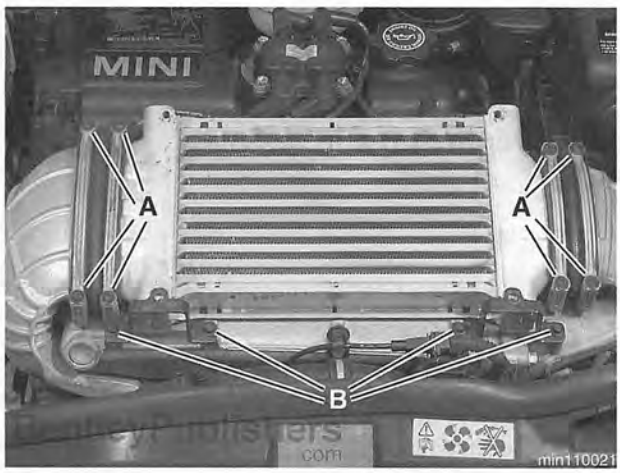
1. **Intercooler**
2. **Supercharger output air duct**
3. **Intake manifold**
4. **Supercharger intake air duct with throttle housing**
5. **Supercharger**
6. **Air filter cover**
7. **Intercooler output air duct**
8. **Brake booster vacuum hose**
9. **Air intake bypass valve**
10. **Air filter element**
11. **Air filter housing**

Intercooler, removing and installing

– Make sure ignition is OFF.

➢ Remove intercooler cover retaining screws (**arrows**). Remove cover.

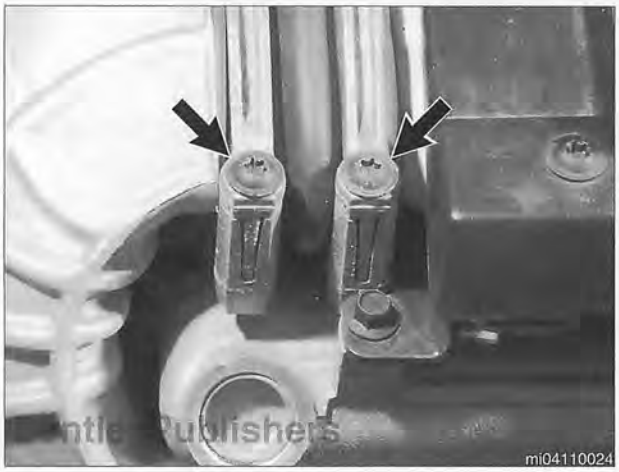
> ***CAUTION—***
> *Intercooler fins are easily damaged. Be careful working on or around intercooler. Use intercooler protector (BMW special tool 11 8 480) when working in the engine compartment.*



➢ Remove intercooler sealing bellows clamping bolts (**A**). Remove upper clamps.

– Remove intercooler cover mounting bracket bolts (**B**). Remove brackets.

➢ Detach sealing bellows and tilt intercooler to right to remove.



– Before reinstalling intercooler, check intercooler sealing bellows for splits or cracks. Replace if necessary.

➢ Note positioning of intercooler sealing bellows clamps with bolt heads (**arrows**) pointing up.

> ***CAUTION***—
> *Make sure sealing bellows are clean, dry and correctly located. Do not lubricate.*

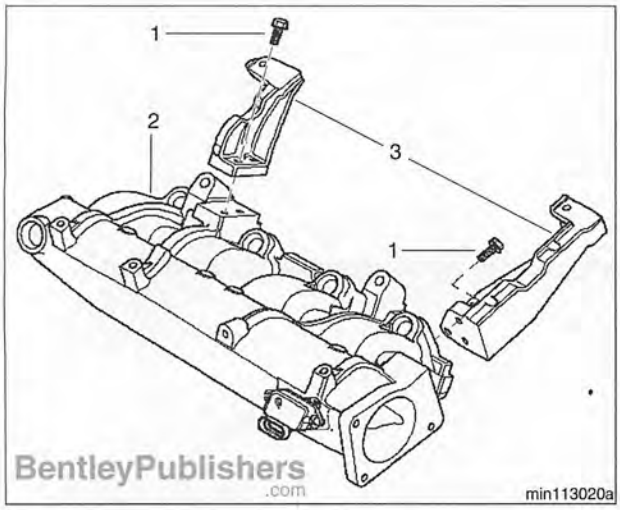
– Remainder of intercooler installation is reverse of removal.

Tightening torques	
Intercooler cover to intercooler	9 Nm (7 ft-lb)
Intercooler cover bracket to intercooler	9 Nm (7 ft-lb)
Upper sealing bellows clamp to lower clamp	9 Nm (7 ft-lb)

Valve cover, removing and installing (Cooper S)

– Make sure ignition is OFF.

– Remove intercooler. See **Intercooler, removing and installing** in this repair group.



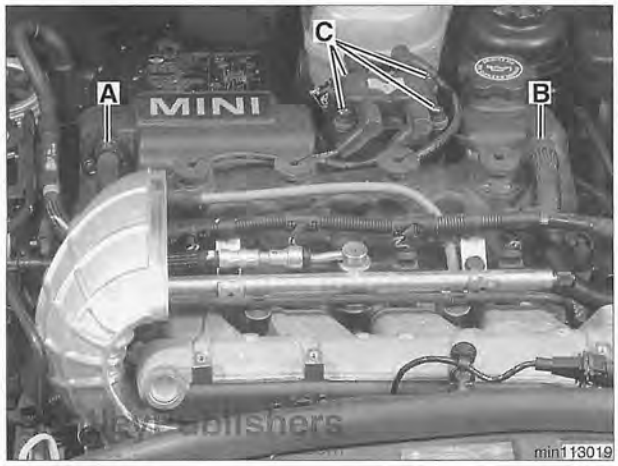
➢ Remove left and right intercooler bracket mounting bolts from intake manifold. Remove brackets.

1. Intercooler bracket mounting bolt, M6 -tighten to 9 Nm (7 ft-lb)
2. Intake manifold
3. Intercooler mounting brackets

➢ Working at top of valve cover, disconnect electrical harness connector to ignition coil pack.

- Press securing clip in direction of **white arrow**.
- Pull off coil pack connector in direction of **black arrow**.

Cylinder Head Removal and Installation (Cooper S)

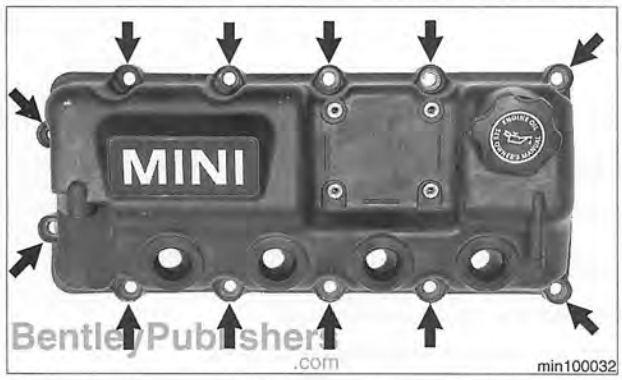


➢ Working at top of engine:
- Disconnect crankcase ventilation hoses (**A**, **B**).
- Remove coil pack mounting bolts (**C**).

➢ Pull up on each spark plug wire connector while gently twisting from side to side.

– Remove harness clips from valve cover studs.

– Remove coil pack and spark plug wires from valve cover.

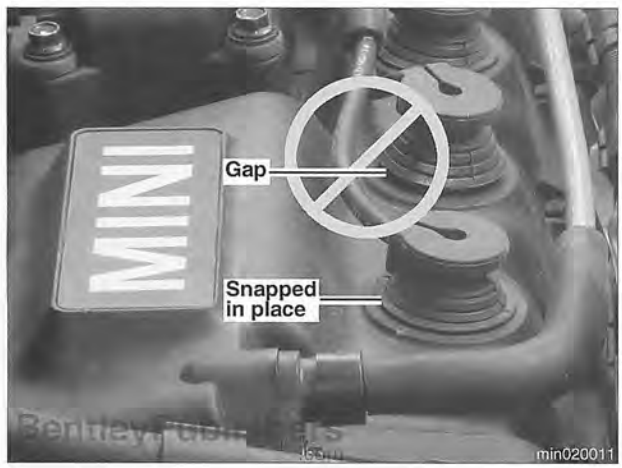


➢ Remove 12 valve cover bolts (**arrows**).

– Remove valve cover.

– Valve cover installation is reverse of removal. Note the following:
- Replace valve cover gasket.
- Replace spark plug hole sealing grommets in valve cover.
- Clean gasket mating faces. Coat lightly with oil.
- Replace valve cover mounting bolts or insulators if damaged.
- Tighten valve cover mounting bolts in sequence, from inside to outside.
- Inspect ignition coil pack insulators. Replace if damaged.

Tightening torques	
Valve cover to cylinder head (M6)	12 Nm (9 ft-lb)
Ignition coil pack to valve cover (M6)	12 Nm (9 ft-lb)



➢ When reinstalling ignition wires, make sure that they snap securely into place.

– Reinstall left and right intercooler brackets on intake manifold.

Tightening torque	
Intercooler bracket to intake manifold (M6)	9 Nm (7 ft-lb)

– Reinstall intercooler.

Intake manifold, removing and installing (Cooper S)

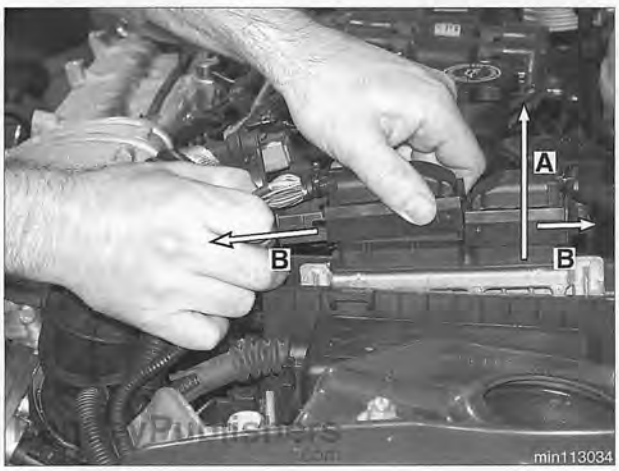
– Working in cargo compartment, lift floor trim cover. Disconnect negative (-) cable from battery. See **121 Battery, Starter, Alternator** for more information.

> ***CAUTION —***
> *Disconnecting the battery may erase fault code(s) stored in memory. Check for fault codes prior to disconnecting the battery cables.*

– Remove intercooler. See **Intercooler, removing and installing** in this repair group.

➤ Detach air filter housing from throttle housing:

- Pull up on battery positive connection point (Batt+) (**arrows**) to release from right side of air filter housing.
- Loosen or remove hose clamp (**A**) and detach outlet duct from air filter housing.
- Remove air filter housing retaining bolt (**B**).



➤ Remove DME control module:

- Remove control module container cover and lift control unit upward (**A**).
- Pull connector locking sliders outward (**B**).
- Disconnect control module connectors.
- Place control module in safe storage location.

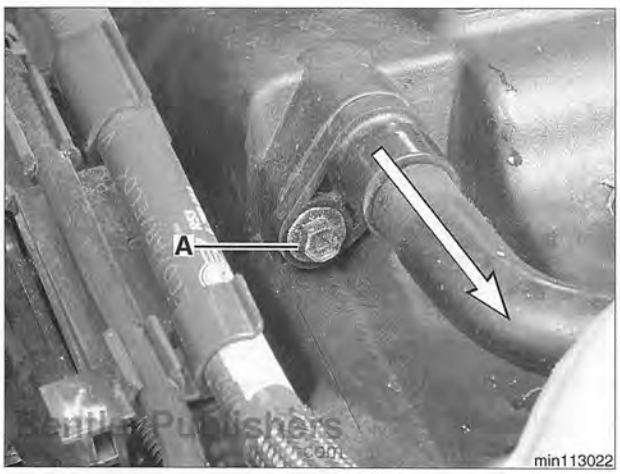
NOTE —
There are 2 control module harness connectors.

➢ Unclip air filter inlet duct from modular front end. Wriggle duct while pulling it toward front of car to detach from air filter housing.

– Remove air filter housing from engine compartment.

➢ Remove throttle valve assembly:

- Loosen or remove air duct clamp at throttle assembly. Detach air duct (**A**).
- Disconnect electrical harness connector (**B**).
- Detach fuel tank vent line (**B**).
- Loosen and remove throttle assembly mounting screws.
- Lift throttle assembly off supercharger intake duct.

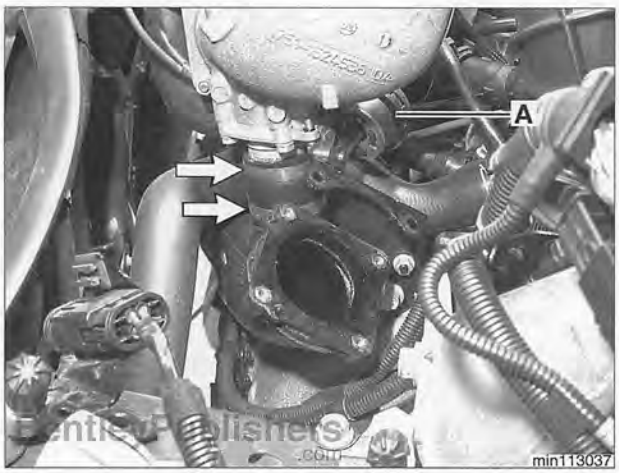


➢ Working at top right of valve cover, remove PCV valve and hose:

- Remove valve retaining screw (**arrow**).
- Pull valve out of valve cover.

– Detach crankcase ventilation hose from left end of valve cover.

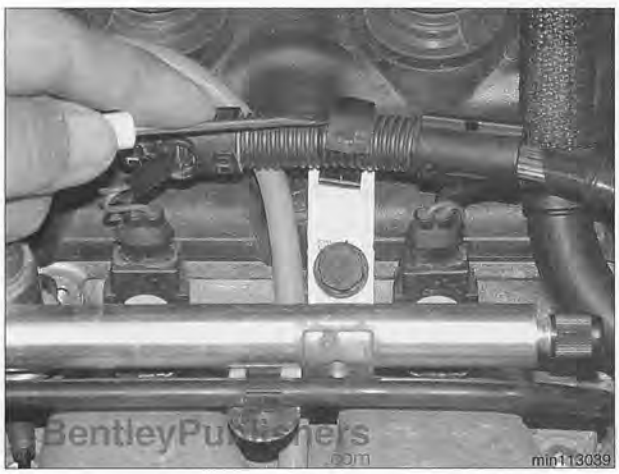
Cylinder Head Removal and Installation (Cooper S)



➤ Working below left end of intake manifold, loosen or remove hose clamps (**arrows**) from air intake bypass hose. Detach hose from air bypass valve (**A**).

– Detach knock sensor electrical harness connector from fuel rail wiring harness.

– Detach electrical harness connectors from intake manifold.



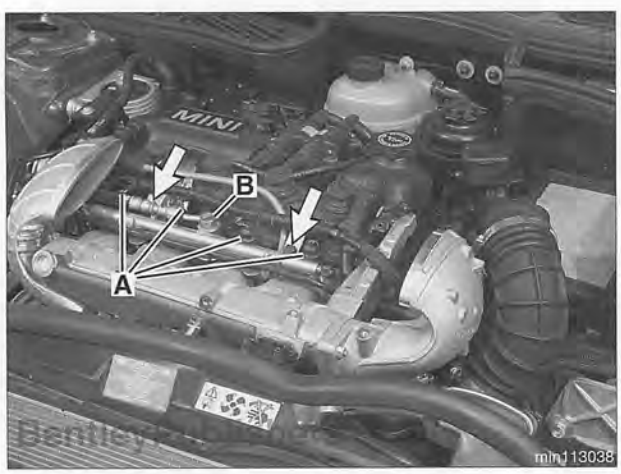
➤ Unhook fuel injector electrical harness from fuel rail mounting brackets.

– Disconnect top fuel tank vent line and unclip at fuel rail.

WARNING—
- *If disconnecting fuel line, fuel will be expelled under pressure. Loosen fuel filler cap to release fuel tank pressure.*
- *Do not smoke or work near heaters or other fire hazards.*
- *Keep a fire extinguisher handy.*
- *Before disconnecting fuel hose, wrap a cloth around hose to absorb any leaking fuel.*
- *Plug all open fuel connections.*

CAUTION—
Do not allow fuel to drip on alternator.

NOTE—
- *Follow the procedure below to avoid disconnecting the fuel hose from the fuel rail.*
- *If it becomes necessary to disconnect the fuel hose from the fuel rail, follow the procedure in* **130 Fuel Injection**. *Be sure to read the warnings and cautions regarding working with fuel.*



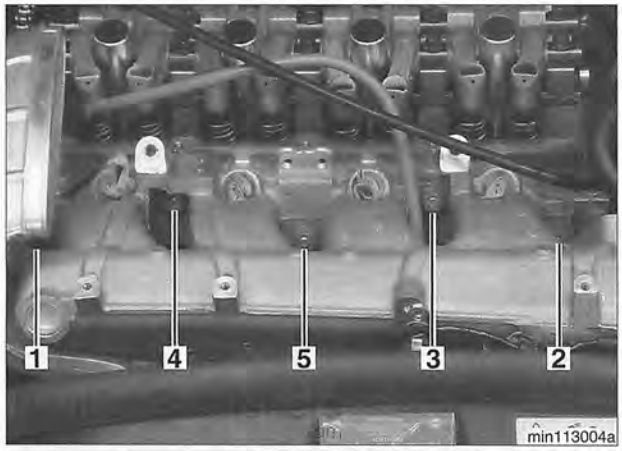
➤ Detach fuel rail from top of engine:
- Disconnect fuel injector electrical harness connectors (**A**).
- Working at fuel rail, unclip hoses and ducts. Cut wire ties as needed.
- Disconnect vacuum line at base of fuel pressure regulator (**B**).
- Remove fuel rail mounting bolts (**arrows**).

CAUTION—
Use compressed air to blow away accumulated debris at the base of each fuel injector.

– Remove fuel rail together with fuel injectors from intake manifold.
  - Unclip fuel line from engine vibration damper bracket.
  - Carefully fold fuel hose to right and rear of engine. Protect fuel rail and injectors by storing in plastic bag.

> ***CAUTION—***
> *Plug fuel injector bores in intake manifold.*

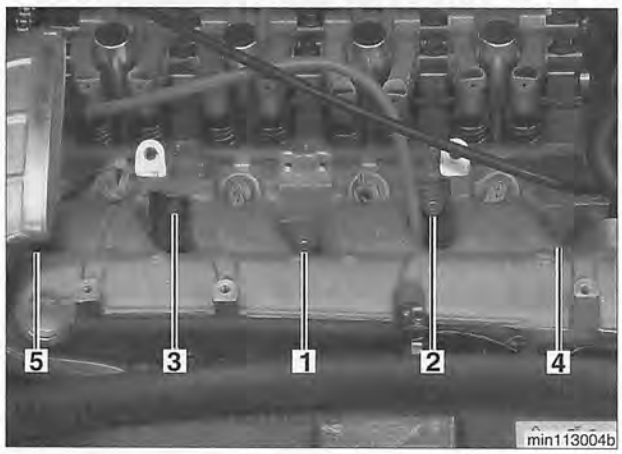
– Detach radiator upper hose support clamp from intake manifold.



➢ Remove intake manifold mounting nuts in sequence, working from outside to inside (**1** to **5**). Remove manifold.

> ***CAUTION—***
> *Stuff clean rags in cylinder head intake ports.*

– When reinstalling intake manifold, replace intake manifold gasket.

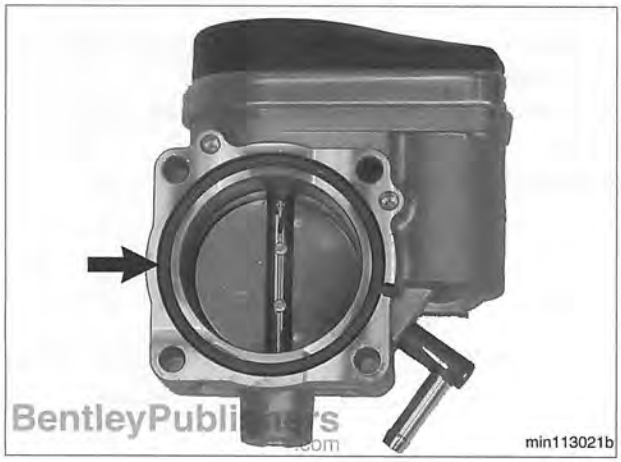


➢ Tighten down intake manifold mounting bolts in sequence, working from inside to outside (**1** - **5**).

Tightening torque	
Intake manifold to cylinder head (M8)	26 Nm (19 ft-lb)

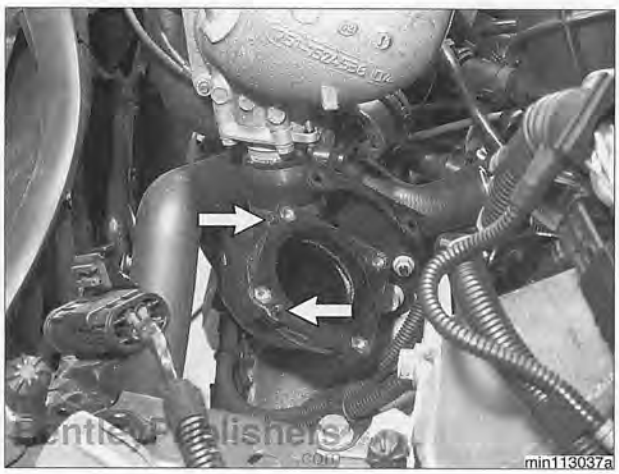
– When reinstalling fuel rail, coat fuel injector sealing O-rings with anti-seize agent.

Tightening torque	
Fuel rail to intake manifold (M8)	25 Nm (18 ft-lb)



➢ When reinstalling throttle valve assembly, replace sealing O-ring (**arrow**).

Cylinder Head Removal and Installation (Cooper S)



➤ Make sure locating pins (**arrows**) on supercharger intake duct align with corresponding bores on throttle valve assembly. Check locating pins for damage. Replace if necessary.

Tightening torque	
Throttle valve assembly to supercharger intake duct (M6)	9 Nm (7 ft-lb)

– Reinstall air filter housing.

Tightening torque	
Air filter housing to body (M6)	7 - 10 Nm (5 - 7 ft-lb)

– Reinstall ECM and attach connectors.

– Reattach air duct using new clamps.

– Reinstall intercooler.

NOTE—
If throttle valve assembly is replaced, be sure to reset DME control unit adaptation values using BMW scan tool.

Cylinder head, removing and installing (Cooper S)

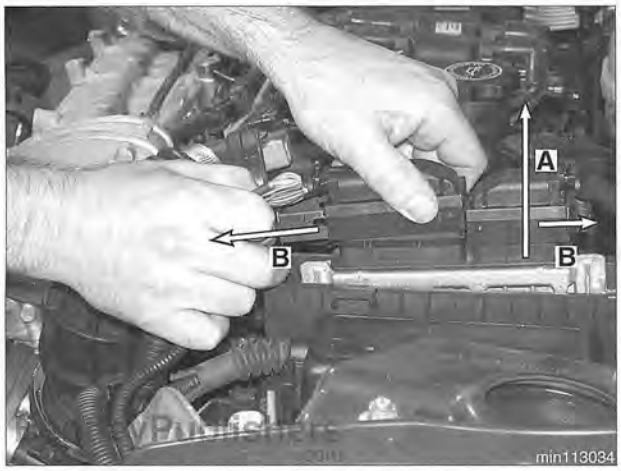
– Working in cargo compartment, lift floor trim cover. Disconnect negative (-) cable from battery. See **121 Battery, Starter, Alternator** for more information.

CAUTION—
Disconnecting the battery may erase fault code(s) stored in memory. Check for fault codes prior to disconnecting the battery cables.

– Remove intercooler. See **Intercooler, removing and installing** in this repair group.

➤ Detach air filter housing from throttle housing:

- Pull up on battery positive connection point (Batt+) (**arrows**) to release from right side of air filter housing.
- Loosen or remove hose clamp (**A**) and detach outlet duct from air filter housing.
- Remove air filter housing retaining bolt (**B**).



➢ Remove DME control module:

- Remove control module container cover and lift control unit upward (**A**).
- Pull connector locking sliders outward (**B**).
- Disconnect control module connectors.
- Place control module in safe storage location.

NOTE—
There are 2 control module harness connectors.

➢ Unclip air filter inlet duct from modular front end. Wriggle duct while pulling it toward front of car to detach from air filter housing.

– Remove air filter housing from engine compartment.

– Drain coolant. Begin by releasing pressure at coolant reservoir cap. See **170 Cooling System**.

➢ Loosen modular front end (MFE):

- Remove right front wheel housing liner.
- Detach left front wheel housing liner from front bumper cover trim.
- Remove front bumper cover trim.
- Remove bumper.
- Detach radiator upper hose support clamp (**A**) from intake manifold.
- Remove MFE mounting bolts. Install two 100 mm (4 in) M8 bolts (**arrow**) in left and right bumper support members. Slide MFE forward, supported on long bolts.

> ***CAUTION—***
> *For ease of component alignment when reassembling front bumper assembly, do not loosen or remove bumper alignment bosses.*

NOTE—

- *If available, use BMW special tools 11 8 401 and 11 8 402 instead of long bolts to support MFE.*
- *Removal of MFE is a complicated job. It is covered in* **510 Bumpers, External Trim**.

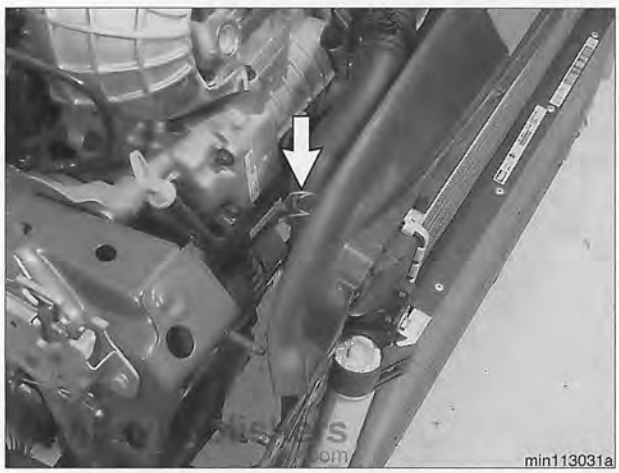
Cylinder Head Removal and Installation (Cooper S)

➢ Working below left side of engine compartment, loosen or remove lower radiator hose clamp (**arrow**). Detach hose from radiator.

– Allow coolant to drain into suitable catch pan.

NOTE—
Save coolant and reuse, or dispose of properly.

WARNING—
Use extreme caution when draining and disposing of engine coolant. Coolant is poisonous and lethal to humans and pets. Pets are attracted to coolant because of its sweet smell and taste. Seek medical attention immediately if coolant is ingested.

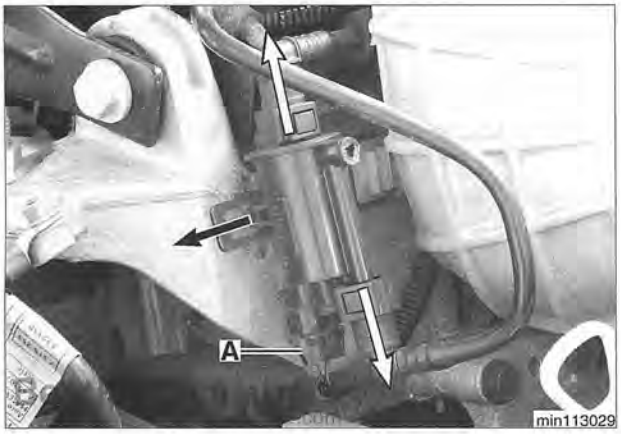


➢ Loosen or remove upper radiator hose clamp (**arrow**). Detach hose from radiator.

➢ Remove throttle valve assembly:

- Loosen or remove air duct clamp at throttle assembly. Detach air duct (**A**).
- Disconnect electrical harness connector (**B**).
- Detach fuel tank vent line (**C**).
- Loosen and remove throttle assembly mounting screws.
- Lift throttle assembly off supercharger intake duct.

– Remove valve cover. See **Valve cover, removing and installing (Cooper S)** in this repair group.



➢ Remove fuel tank vent valve.
- Disconnect vent hoses (**white arrows**) via quick fit connectors.
- Straighten retaining tab and slide vent valve off bracket (**black arrow**).
- Remove electrical harness connector (**A**).

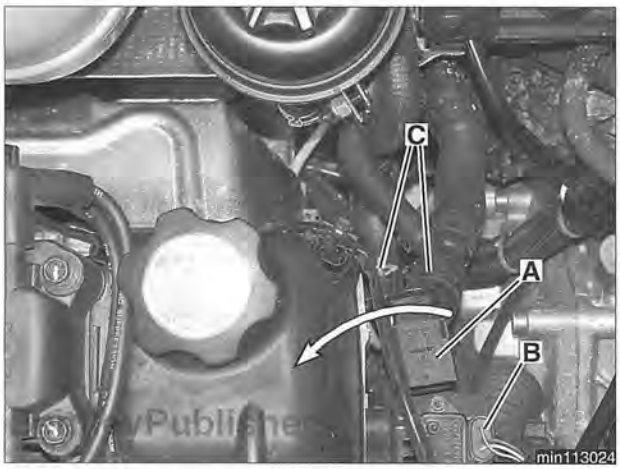
– Remove intake manifold. See **Intake manifold, removing and installing (Cooper S)** in this repair group.
- Detach brake booster vacuum line.
- Remove fuel rail together with fuel injectors from intake manifold.
- Unclip fuel line from engine vibration damper bracket.
- Carefully fold fuel hose to right and rear of engine. Protect fuel rail and injectors by storing in plastic bag.
- Unbolt and remove intake manifold.

WARNING—
- *If disconnecting fuel line, fuel will be expelled under pressure. Loosen fuel filler cap to release fuel tank pressure.*
- *Do not smoke or work near heaters or other fire hazards.*
- *Keep a fire extinguisher handy.*
- *Before disconnecting fuel hose, wrap a cloth around hose to absorb any leaking fuel.*
- *Plug all open fuel connections.*

CAUTION—
Do not allow fuel to drip on alternator.

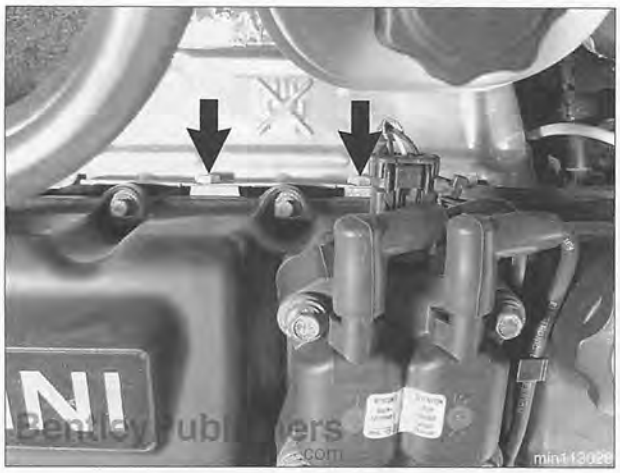
NOTE—
- *If the procedure for removing the fuel rail in* **Intake manifold, removing and installing (Cooper S)** *is followed, there is no need to disconnect the fuel hose from the fuel rail.*
- *If it becomes necessary to disconnect the fuel hose from the fuel rail, follow the procedure in* **130 Fuel Injection**. *Be sure to read the warnings and cautions regarding working with fuel.*

– Remove supercharger outlet pipe.



➢ Working at left end of cylinder head:
- Disconnect oxygen sensor connector (**A**). Twist in direction of **arrow** to detach from support bracket.
- Disconnect MAP sensor connector (**B**).
- Loosen coolant hose clamps (**C**) and detach hoses from coolant manifold.

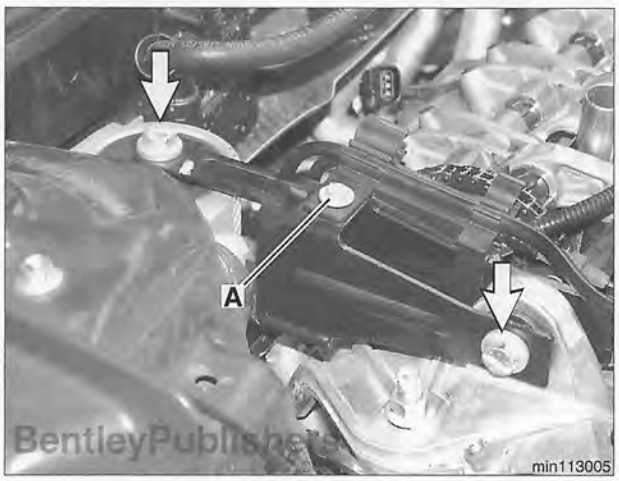
Cylinder Head Removal and Installation (Cooper S)



➢ Working in back of cylinder head, remove exhaust manifold heat shield fasteners (**arrows**).

– Unbolt exhaust manifold from cylinder head:
  - Working underneath car, detach oxygen sensor harness connectors.
  - Detach exhaust system from exhaust manifold. See **180 Exhaust System**.

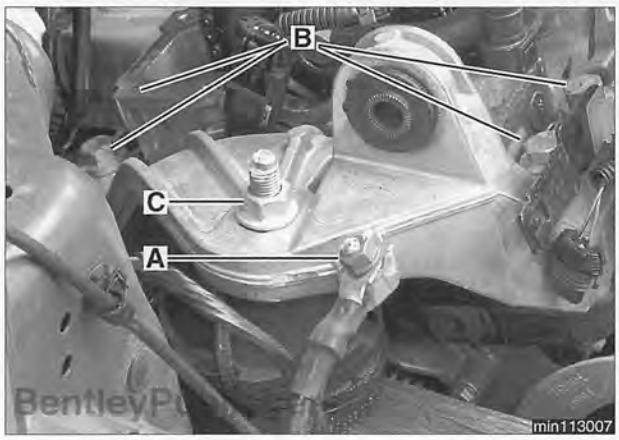
– Remove spark plugs.



➢ Remove engine vibration damper bracket:
  - Remove fuel line bracket mounting bolt (**A**). Detach any fuel lines still attached. Lift off bracket and set aside.
  - Remove engine vibration damper bracket bolts (**arrows**).
  - Remove bracket.

– Support engine under oil pan.

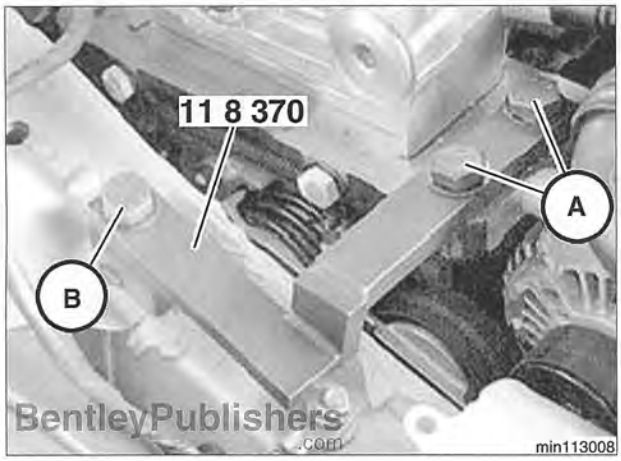
> ***CAUTION —***
> *To avoid damaging the oil pan, use a rubber pad on top of the engine supporting jack.*



➢ Remove engine mounting bracket:
  - Remove engine ground cable mounting nut (**A**) from bracket. Detach ground cable.
  - Remove 4 engine mounting bolts (**B**) from engine block.
  - Unscrew mounting nut (**C**) from hydraulic front engine mount stud. Lift off engine mount bracket.

– Use special tool 11 8 380 to remove hydraulic engine mount. Counterhold Torx head mounting bolt from below.

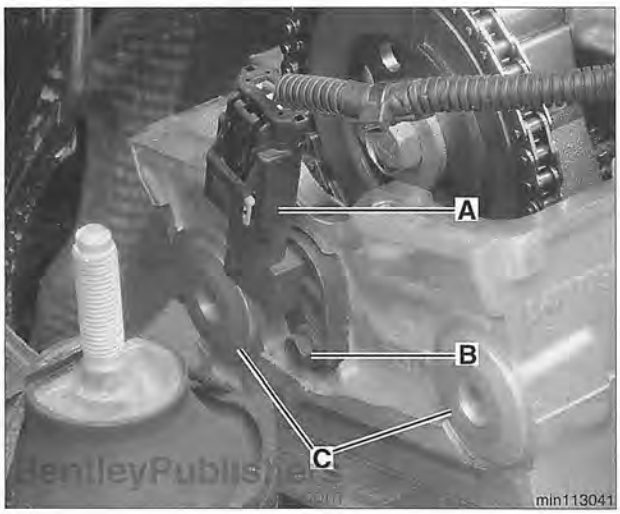
Cylinder Head Removal and Installation (Cooper S)



➢ Use BMW special tool 11 8 370 to support engine.

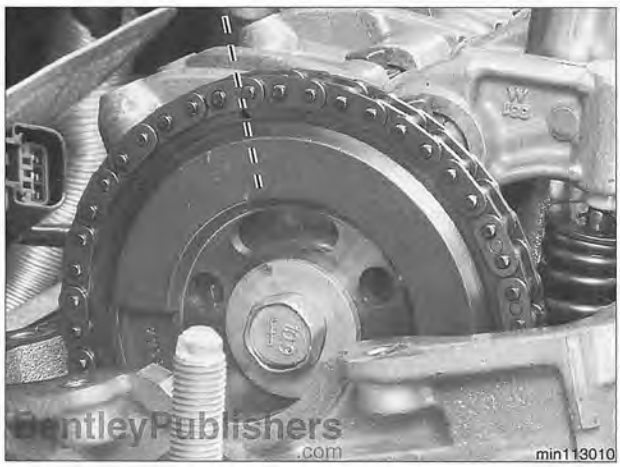
- Attach tool to cylinder head using engine mount bracket bolts (**A**).
- Use bolt (**B**) or long stud to secure tool to frame extension.

– Remove jack from underneath engine oil pan.



➢ Working at right end of cylinder head:

- Disconnect electrical harness connector (**A**) at camshaft position sensor.
- Remove sensor mounting bolt (**B**).
- Remove sensor from cylinder head.
- Remove threaded plugs (**C**) from cylinder head.



➢ Rotate crankshaft until triangular adjustment mark on camshaft sprocket (**dashed line**) is at 12 o'clock.

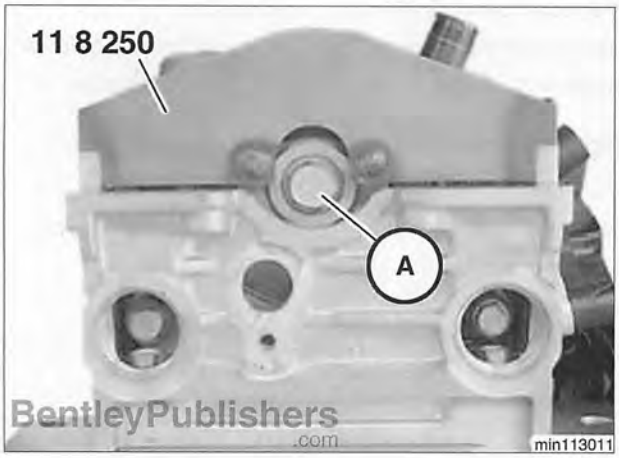
CAUTION—

- *For ease of assembly, mark timing chain at triangular adjustment mark (**B**) with paint.*
- *Mark crankshaft vibration damper and timing case cover with paint.*

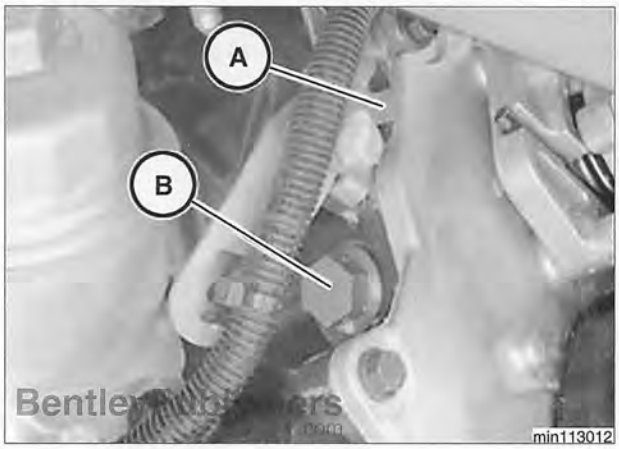
NOTE—

- *Because the engine is tilted slightly toward the back of the car, 12 o'clock on the camshaft sprocket and crankshaft vibration damper is NOT straight up and down.*
- *The brass-colored timing chain links are of no importance to the timing.*

Cylinder Head Removal and Installation (Cooper S)

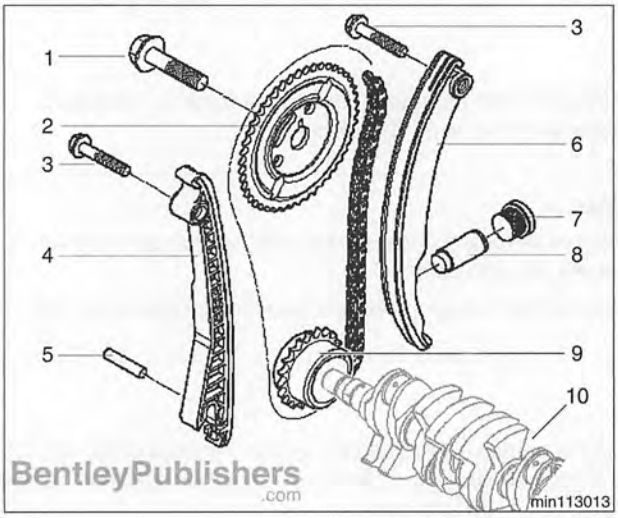


➢ Attach BMW special tool 11 8 250 to camshaft sprocket. Loosen but do not remove camshaft sprocket bolt (**A**).



➢ Working in back of engine block, remove wiring harness bracket (**A**).

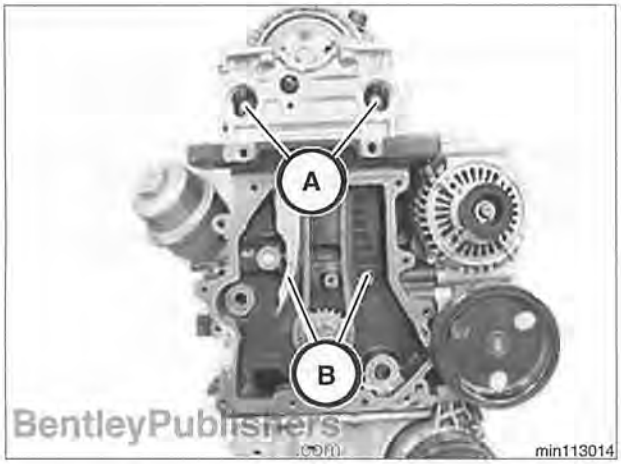
– Loosen and remove timing chain tensioner plug (**B**). Remove tensioner plunger from inside timing chain housing cover.



➢ Timing chain components:

1. Bolt, M12
   -tighten to 102 Nm (75 ft-lb)
2. Camshaft sprocket
3. Bolt, M8
   -tighten to 28 Nm (21 ft-lb)
4. Timing chain fixed guide
5. Stud
6. Timing chain tensioning guide
7. Timing chain tensioner plug with sealing O-ring
8. Timing chain tensioner plunger
9. Crankshaft sprocket
10. Crankshaft

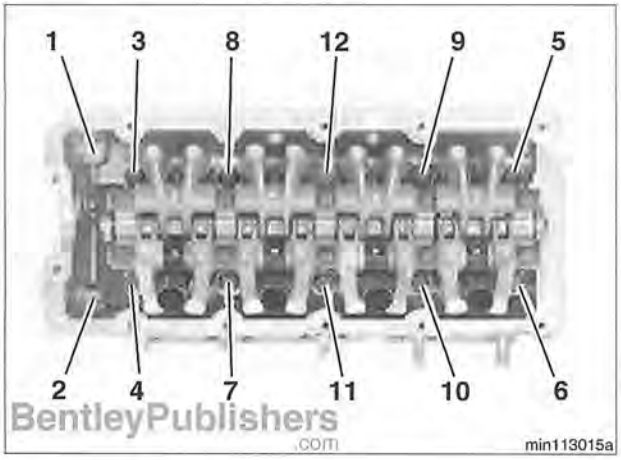
Cylinder Head Removal and Installation (Cooper S)



➤ Detach timing chain from camshaft:

- Unscrew camshaft sprocket bolt.
- Remove camshaft sprocket from timing chain and secure timing chain to prevent it from dropping down.
- Remove timing chain fixed and tensioning guide mounting bolts (**A** and **B**).
- Pull timing chain guides up out of timing chain housing.

> ***CAUTION—***
> *Do not rotate crankshaft. The timing chain cover is designed in such a way that the timing chain can remain on the crankshaft gear without gear teeth being skipped, as long as the crankshaft remains stationary.*



➤ Remove cylinder head to timing chain housing mounting bolts **1** and **2**.

– Loosen and remove cylinder head bolts **3** to **12**, working from outside to inside. Discard bolts.

– Lift cylinder head off engine block.

> ***CAUTION—***
> *When placing cylinder head on work bench, do not rest on sealing surface. There is risk of damage to valves.*

– Clean cylinder head and engine block mating surfaces.

> ***CAUTION—***
> - *Multilayer steel cylinder head gasket (MLS) requires scratch-free sealing surfaces.*
> - *Do not use a metal scraper or wire brush to clean the aluminum cylinder head or pistons. If necessary, use a hard wooden or plastic scraper. Also available are abrasive discs to be used in conjunction with an electric drill. Be sure to use the correct disc for the type of metal being cleaned.*

– Use straight edge to check diagonal and horizontal surface evenness of cylinder head.

Cylinder head distortion specification	
Maximum warpage allowed	0.1 mm (0.004 in)

– Clean engine block oil ducts.

– Check aligning dowel sleeves in engine block for damage. Replace if necessary.

– Thoroughly clean oil and coolant out of cylinder head bolt tapped holes in engine block. If necessary, clean out holes with compressed air.

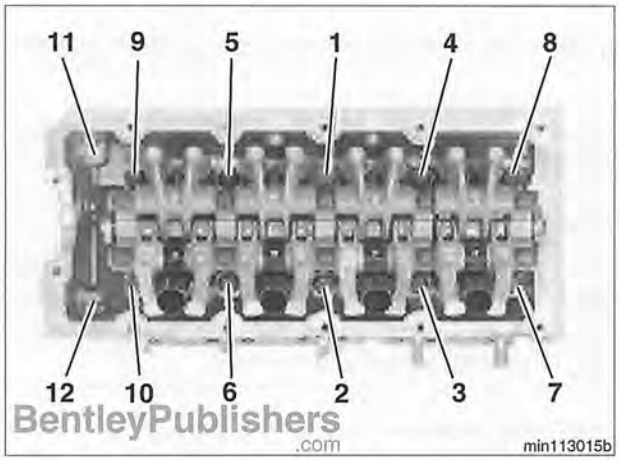
– Replace cylinder head gasket.

Cylinder Head Removal and Installation (Cooper S)

NOTE —
- *The standard thickness of the cylinder head gasket is 0.65 mm (0.026 in). A thicker one of 0.95 mm (0.037in) is available.*
- *The gasket does not have any markings to indicate correct orientation. This is determined by visually lining up the location dowels and oil transfer gallery.*
- *Larger holes in head gasket slip over location dowels in engine block.*

– Reinstall cylinder head. Insert new cylinder head bolts.

CAUTION —
Do not wash off coating on new bolts.



➢ Tighten head bolts in sequence **1** to **10**, working from inside to outside.
- Head bolt are tightened in 2 stages.
- Final (stage 2) torque is applied with special tool 00 9 120 or equivalent protractor.

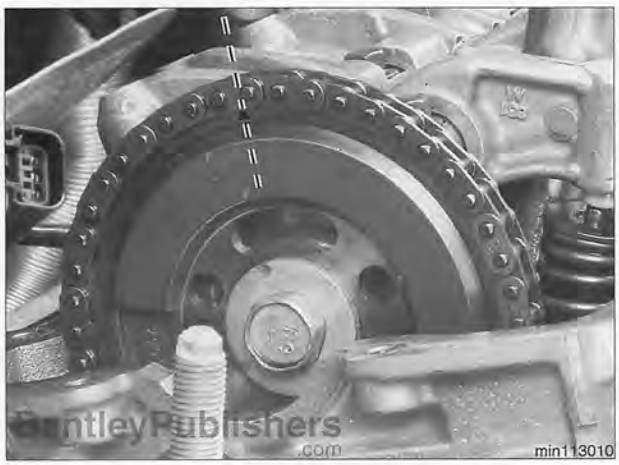
Tightening torque	
Cylinder head to engine block (use new)(M10): Stage 1 Stage 2	 40 Nm (30 ft-lb) rotate 90°

– Install and torque cylinder head to timing chain housing mounting bolts **11** and **12**.

Tightening torque	
Cylinder head to timing chain housing (M8)	28 Nm (21 ft-lb)

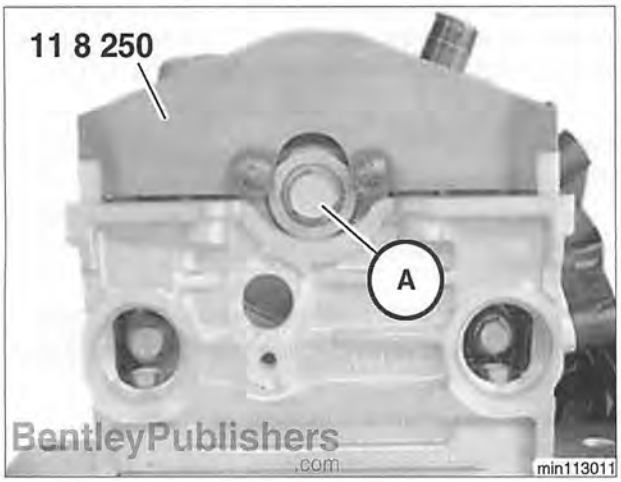
– Slide timing chain guides down into chain housing and reinstall mounting screws.

Tightening torque	
Timing chain guide to cylinder head (M8)	28 Nm (21 ft-lb)



➢ Place timing chain on camshaft sprocket. Use previously made paint mark to align sprocket and timing chain to each other.

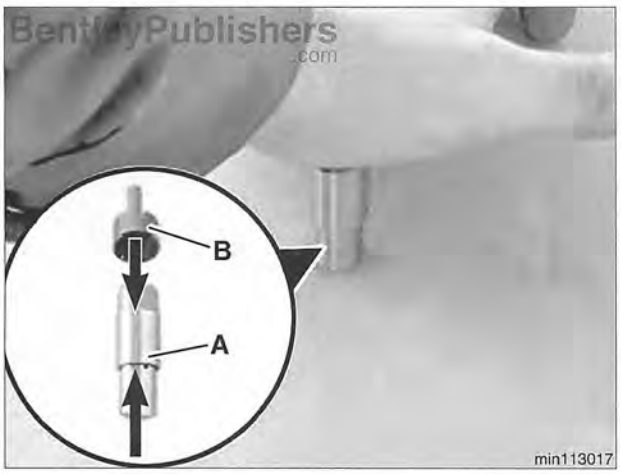
– Place sprocket on camshaft and insert mounting bolt.



➢ Attach BMW special tool 11 8 250 to camshaft sprocket. Torque camshaft sprocket bolt (**A**).

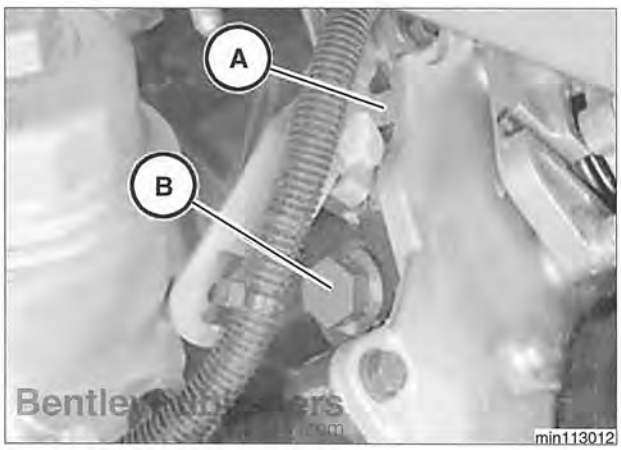
> ***CAUTION—***
> *Be careful not to damage timing chain during this step.*

Tightening torque	
Camshaft sprocket to camshaft (M12)	102 Nm (75 ft-lb)



➢ Squeeze timing chain tensioner plunger into retracted position.

- Place plunger (**A**) on level surface.
- Remove plunger cap (**B**).
- Exert continuous hand pressure on plunger until it is completely compressed.
- Replace cap.

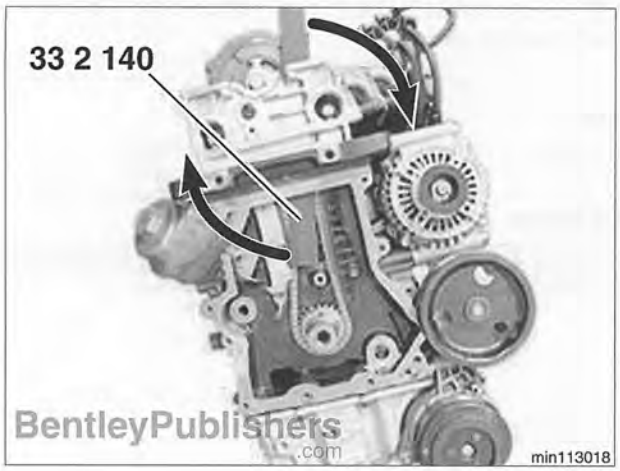


➢ Working in back of engine block, install timing chain tensioner plunger. Install tensioner plug (**B**).

Tightening torque	
Timing chain tensioner to engine block	63 Nm (46 ft-lb)

– Install wiring harness bracket in back of engine block (**A**).

Cylinder Head Removal and Installation (Cooper S)



➢ Insert large prying bar (BMW special tool 33 2 140 or equivalent) into timing chain housing and lever clockwise. This releases timing chain tensioner plunger and tensions chain.

CAUTION—
- *Do not lever directly at timing chain. Damage may result.*
- *Make sure that the timing chain is properly positioned within the channel of the timing chain guides.*

– Continue to reassemble engine, paying attention to the following:
- Use new sealing washers when installing threaded plugs at front of cylinder head.
- Use new hose clamps, seals and gaskets, as necessary.
- Fill cooling system and check for leaks.
- Fill engine with fresh oil.
- Check DME control module adaptations using diagnostic scan tool. Check for fault codes and clear and reset control module memory.

Tightening torques	
Air filter housing to body (M6)	7 - 10 Nm (5 - 7 ft-lb)
Battery cable (- or +) to battery (M6)	5 Nm (44 in-lb)
Camshaft position sensor to cylinder head (M6)	9 Nm (7 ft-lb)
Crush tube to subframe (M12 x 1.5 x 85 mm)	100 Nm (74 ft-lb)
Engine front mounting bracket to top of engine block (M12)	100 Nm (74 ft-lb)
Engine splash shield to modular front end (M6 x 16 mm)	6 Nm (53 in-lb)
Exhaust manifold to cylinder head (M8)	24 Nm (18 ft-lb)
Exhaust manifold heat shield to cylinder head (M8)	13 Nm (10 ft-lb)
Front bumper to crush tube or to bumper carrier (M8 x 30 mm)	22 Nm (16 ft-lb)
Front bumper to modular front end (M6 x 16 mm)	5 Nm (44 in-lb)
Hydraulic engine mount to body	100 Nm (74 ft-lb)
Hydraulic engine mount to body (replace bolt) Initial torque Torque angle	 56 Nm (41 ft-lb) 90°
Hydraulic engine mount to engine mounting bracket	68 Nm (50 ft-lb)
Ignition coil pack to valve cover (M6)	12 Nm (9 ft-lb)
Intake manifold to cylinder head (M8)	26 Nm (19 ft-lb)
Intercooler outlet pipe to intake manifold (M7)	16 Nm (12 ft-lb)
Modular front end to crush tube (M6)	5 Nm (44 in-lb)
Sealing plug to cylinder head	18 Nm (13 ft-lb)
Spark plug to cylinder head	27 Nm (20 ft-lb)
Supercharger outlet pipe to supercharger (M8)	25 Nm (18 ft--lb)
Throttle valve assembly to intake manifold (M6)	9 Nm (7 ft-lb)
Upper engine vibration damper bracket to damper or to engine mounting bracket (M12)	100 Nm (74 ft-lb)
Valve cover to cylinder head (M6)	12 Nm (9 ft-lb)

116 Cylinder Head and Valvetrain

GENERAL

This repair group covers cylinder head and valvetrain service and repair. The information given applies equally to Cooper and Cooper S.

NOTE —

- *For timing chain repair information, see* **117 Camshaft Timing Chain**.
- *If the cylinder head requires significant reconditioning work, a remanufactured cylinder head, available from an authorized MINI dealer, is a good alternative.*

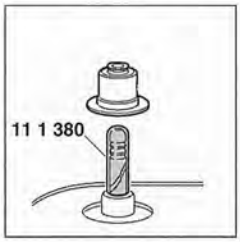
Special tools

Special service tools are required for most cylinder head service described in this repair group. Many of these tools are expensive and only available through an authorized MINI dealer. If the special tools are not available, have the cylinder head disassembled and removed by an authorized MINI dealer.

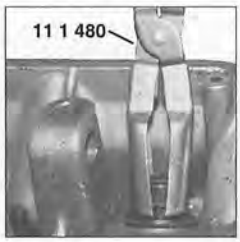
Be sure to read each procedure thoroughly before starting a job to determine which special tools and equipment will be necessary.

Most of the repairs to a cylinder head require precision machine work to specific tolerances. This type of work should be performed by an authorized MINI repair facility or an ASE certified machinist.

Valve seal installation drift
(BMW special tool 11 1 130)



Valve seal installation sleeve
(BMW special tool 11 1 380)



Valve seal removal tool
(BMW special tool 11 1 480)

Camshaft locking tool
(BMW special tool 11 8 250)

Engine block support tool
(BMW special tool 11 8 370)

Hydraulic engine mount removal and installation tool
(BMW special tool 11 8 380)

Valve removal and installation tool
(BMW special tool 11 8 420)

Cylinder head pressure testing jig
(BMW special tool 11 8 430)

Spark plug sleeve puller
(BMW special tool 11 8 500)

Cylinder head assembly stand
(BMW special tool 11 9 000)

Spark plug sleeve installer
(BMW special tool 12 1 210)

CYLINDER HEAD DISASSEMBLY

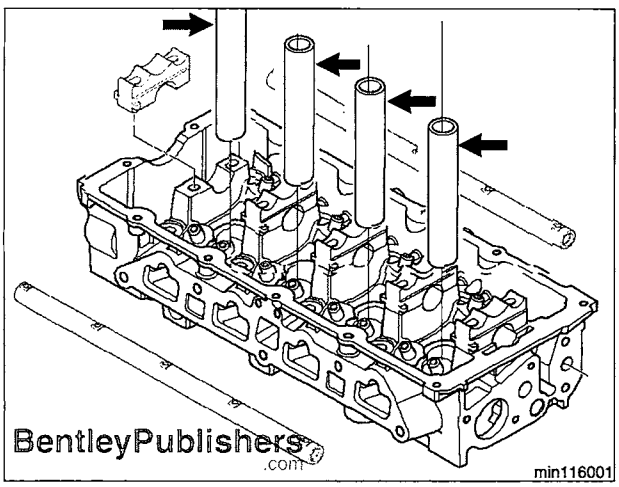
The procedures described here can be performed without removing the cylinder head from the engine.

Valves are actuated by hydraulic lifters which are integral with valve rocker arms. For information on removing rocker arms and hydraulic lifters, see **Rocker shafts and rocker arms, removing and installing** in this repair group.

WARNING—
Due to risk of personal injury, be sure the engine is cold before beginning any of the procedures.

CAUTION—
Cover all painted surfaces before beginning the repair procedure. As an aid to installation, label all components, wires, and hoses before removing them. Do not reuse gaskets, O-rings or seals during reassembly.

Spark plug sleeve, removing and installing



- Spark plug sleeves (**arrows**) are pressed into cylinder head.
- Remove valve cover. See **113 Cylinder Head Removal and Installation**.
- Remove spark plug.
- Fit special tool 11 8 500 to spark plug sleeve to be removed and lock in place. Attach slide hammer adapter to special tool and pull out spark plug sleeve.
- If spark plug sleeve is removed, always replace with new.
- Clean area around spark plug bore.
- Apply 3 mm (⅛ in) thick bead of Loctite® 277 sealing compound at distance of about 1 mm (0.04 in) from end of new spark plug sleeve.
- Screw special tool 12 1 212 or equivalent guide into spark plug hole.
- Carefully install spark plug sleeve:
  - Fit with special tool 12 1 211 or equivalent driver.
  - Drive spark plug sleeve into cylinder head bore.

NOTE—
Sleeve is installed correctly when special tool 12 1 211 makes contact with special tool 12 1 212.

- Assemble engine.

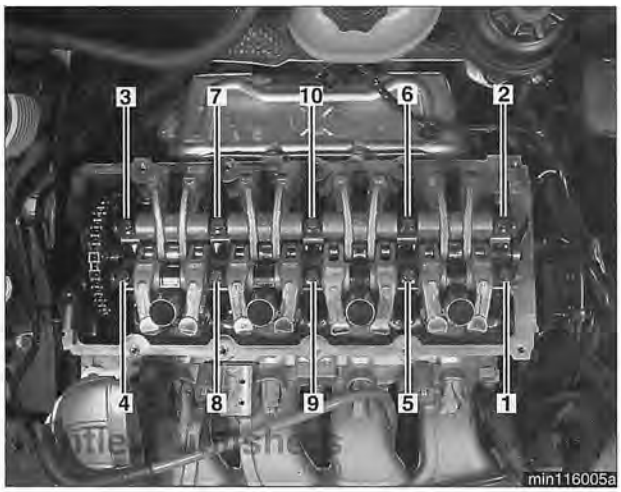
Tightening torques	
Spark plug to cylinder head	27 Nm (20 ft-lb)
Ignition coil pack to valve cover (M6)	12 Nm (9 ft-lb)
Valve cover to cylinder head (M6)	12 Nm (9 ft-lb)

Rocker arm shafts and rocker arms, removing and installing

– Disconnect negative (-) cable from battery. See **121 Battery, Starter, Alternator** for more information.

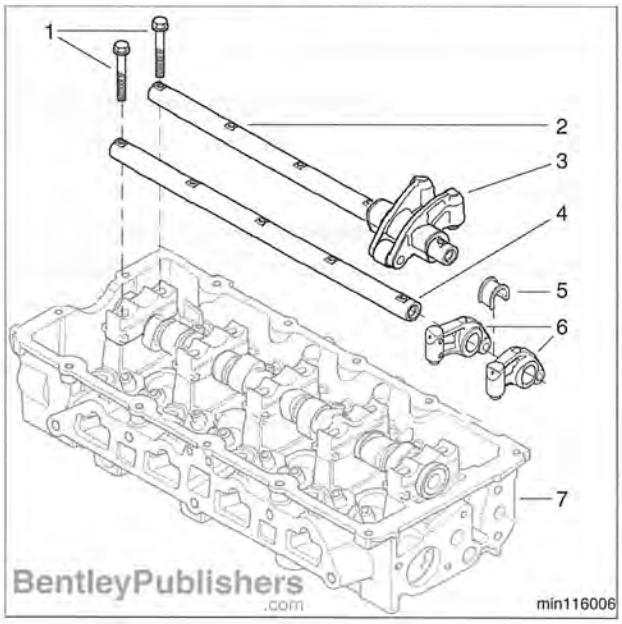
> ***CAUTION—***
> *Disconnecting the battery may erase fault code(s) stored in memory. Check for fault codes prior to disconnecting the battery cables.*

– Remove valve cover. See **113 Cylinder Head Removal and Installation.**



➤ Remove rocker arm shaft / camshaft bearing cap mounting bolts in sequence **1** to **10**, working from outside to inside.

> ***CAUTION—***
> *To avoid damaging the rocker arm shafts, loosen each rocker arm shaft / camshaft bearing cap bolt by one turn in the loosening sequence. Repeat until all bolts are free of tension.*



➤ Remove rocker arm shafts.
- Slide rocker arms off and replace if necessary.
- Note rocker arm spacers on intake rocker arm shaft.

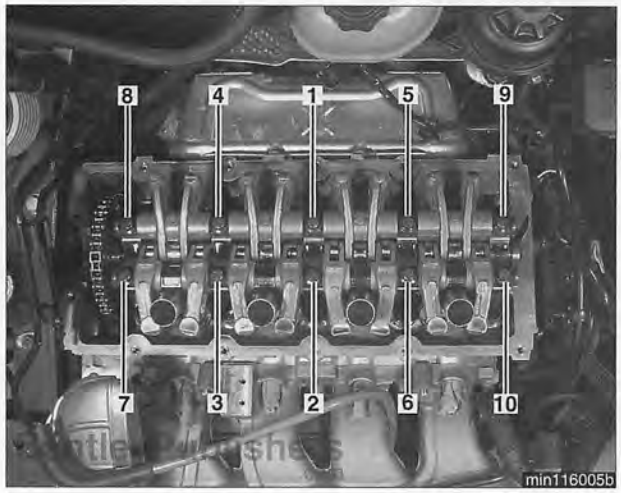
NOTE—
Intake and exhaust rocker arm shafts are not interchangeable. Note location of grooves on shafts.

1. Bolt, M8 x 65 mm
   - Tighten to 30 Nm (22 ft-lb)
2. Exhaust rocker arm shaft
3. Exhaust rocker arm (dual)
4. Intake rocker arm shaft
5. Spacer
6. Intake rocker arms
7. Cylinder head and camshaft

– If hydraulic valve lifter is defective, replace together with rocker arm.

– When reassembling rocker arms and rocker arm shafts, lubricate rolling area or rocker arm and shaft with clean engine oil.

– Before tightening rocker arm shaft / camshaft bearing cap bolts make sure bearing caps are correctly seated and rocker arms are in correct installation position.



– Initially, tighten all bolts hand-tight.

➢ Torque bolts in sequence **1** to **10**, working from inside to outside.

CAUTION—
To avoid damaging the rocker arm shafts, tighten each rocker arm shaft / camshaft bearing cap bolt by one turn in the tightening sequence. Repeat until all bolts are torqued properly.

Tightening torques	
Ignition coil pack to valve cover (M6)	12 Nm (9 ft-lb)
Rocker arm shaft / camshaft bearing cap to cylinder head (M8)	30 Nm (22 ft-lb)
Valve cover to cylinder head (M6)	12 Nm (9 ft-lb)

Camshaft, removing and installing

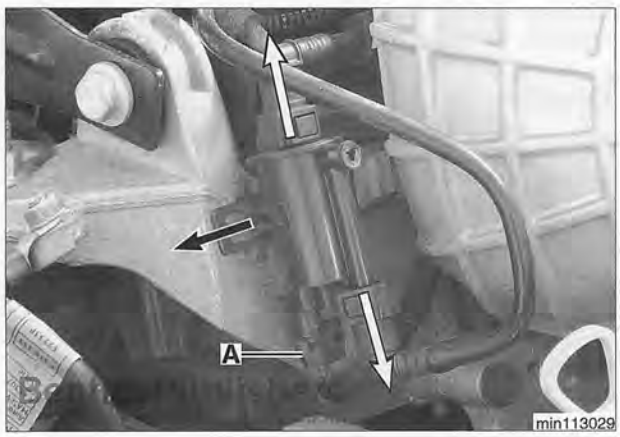
– Disconnect negative (-) cable from battery. See **121 Battery, Starter, Alternator** for more information.

CAUTION—
Disconnecting the battery may erase fault code(s) stored in memory. Check for fault codes prior to disconnecting the battery cables.

– Remove spark plugs.

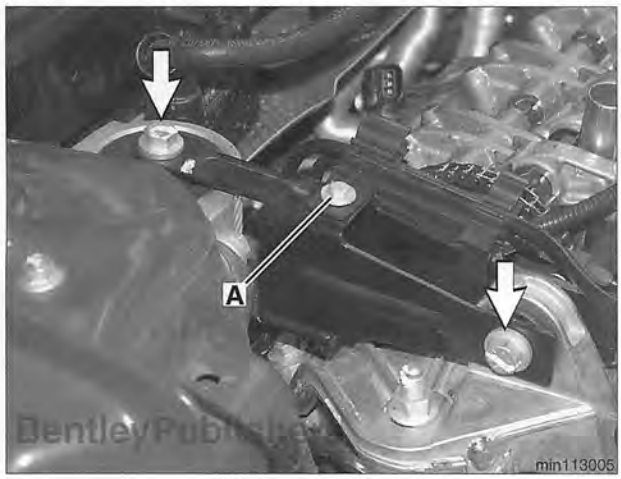
– Remove right front wheel housing liner.

– Remove valve cover. See **113 Cylinder Head Removal and Installation**.



➢ Remove fuel tank vent valve.
- Disconnect vent hoses (**white arrows**) via quick fit connectors.
- Straighten retaining tab and slide vent valve off bracket (**black arrow**).
- Disconnect electrical harness connector (**A**).

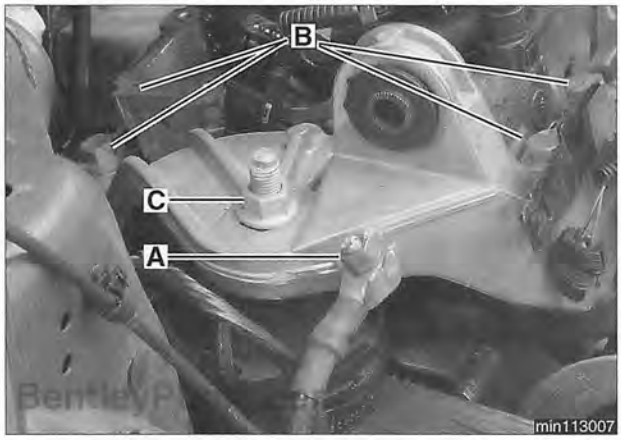
NOTE—
Cooper S engine compartment is illustrated. Cooper engine compartment is similar.



➢ Remove vibration damper bracket:
- Remove fuel line bracket mounting bolt (**A**). Detach any fuel lines still attached. Lift off bracket and set aside.
- Remove engine vibration damper bracket bolts (**arrows**).
- Remove bracket.

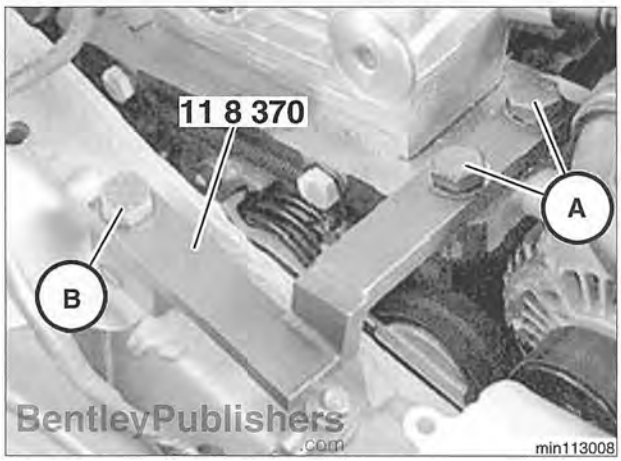
– Support engine under oil pan.

> ***CAUTION—***
> *To avoid damaging the oil pan, use a rubber pad on top of the engine supporting jack.*



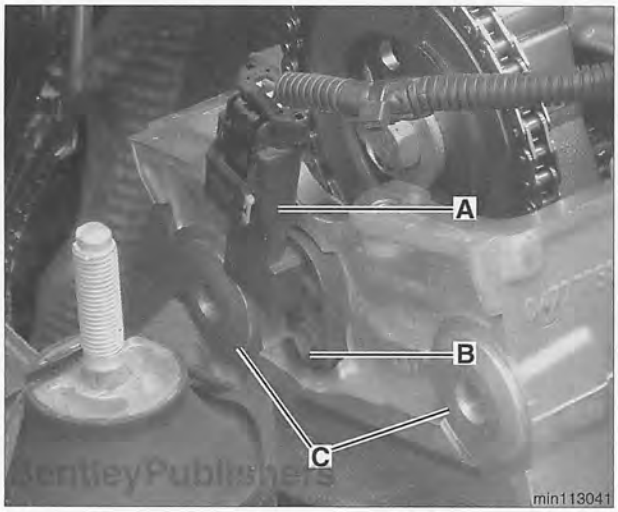
➢ Remove engine mounting bracket:
- Remove engine ground cable mounting nut (**A**) from bracket. Detach ground cable.
- Remove 4 engine mounting bolts (**B**) from engine block.
- Unscrew mounting nut (**C**) from hydraulic front engine mount stud. Lift off engine mount bracket.

– Use special tool 11 8 380 to remove hydraulic engine mount. Counterhold Torx head mounting bolt from below.

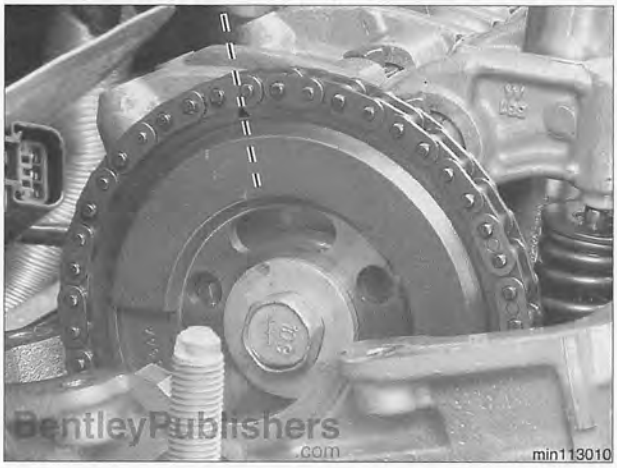


➢ Use BMW special tool 11 8 370 to support engine.
- Attach tool to cylinder head using engine mount bracket bolts (**A**).
- Use bolt (**B**) or long stud to secure tool to frame extension.
- Remove jack from underneath engine oil pan.

Cylinder Head Disassembly



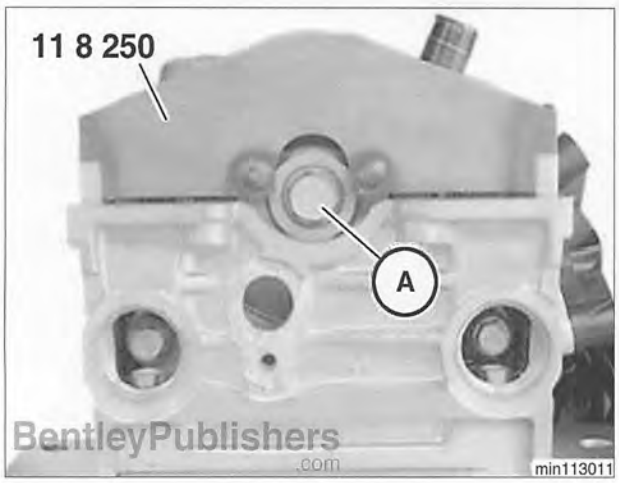
- Working at right end of cylinder head:
  - Disconnect electrical harness connector (**A**) at camshaft position sensor.
  - Remove sensor mounting bolt (**B**).
  - Remove sensor from cylinder head.
  - Remove threaded plugs (**C**) from cylinder head.



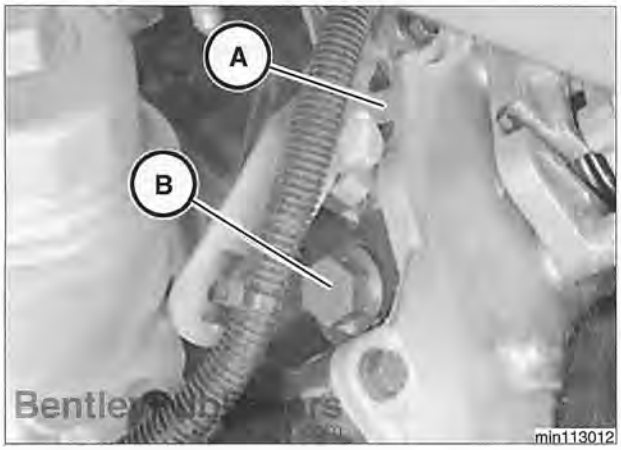
- Rotate crankshaft until triangular adjustment mark on camshaft sprocket (**dashed line**) is at 12 o'clock.

> ***CAUTION—***
> - *For ease of assembly, mark timing chain at triangular adjustment mark (**B**) with paint.*
> - *Mark crankshaft vibration damper and timing case cover with paint.*

NOTE—
- *Because the engine is tilted slightly toward the back of the car, 12 o'clock on the camshaft sprocket and crankshaft vibration damper is NOT straight up and down.*
- *The brass-colored timing chain links are of no importance to the timing.*



- Attach special tool 11 8 250 to camshaft sprocket. Loosen but do not remove camshaft sprocket bolt (**A**).



➢ Working in back of engine block, loosen and remove timing chain tensioner plug (**B**). Remove tensioner plunger from inside timing chain housing cover.

– Detach timing chain from camshaft:
- Unscrew camshaft sprocket bolt.
- Remove camshaft sprocket from timing chain and secure timing chain to prevent it from dropping down.

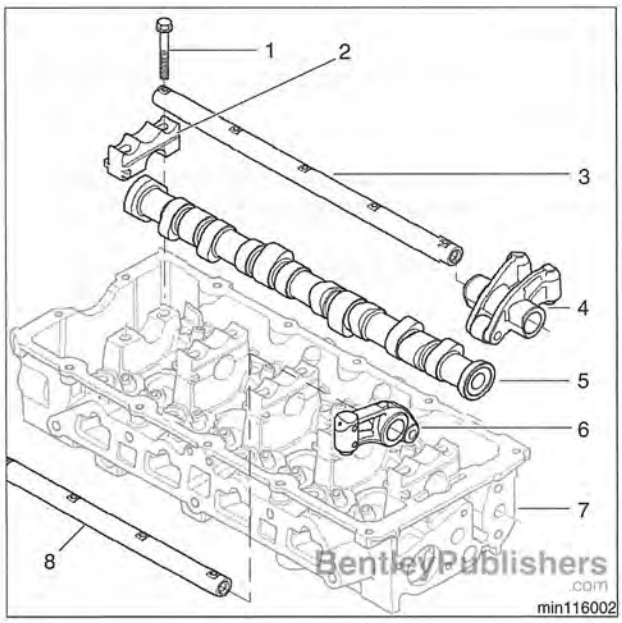
> ***CAUTION—***
> *Do not rotate crankshaft. The timing chain cover is designed in such a way that the timing chain can remain on the crankshaft gear without gear teeth being skipped, as long as the crankshaft remains stationary.*

➢ Use feeler gauge to measure axial play between end of camshaft and cylinder head.

Camshaft axial play (Cooper engine)	
Camshaft axial play	0.05 - 0.095 mm (0.0020 - 0.00374 in)
Wear limit	0.40 mm (0.0157 in)

– Remove rocker arm shafts. See **Rocker arm shafts and rocker arms, removing and installing** in this repair group.

> ***CAUTION—***
> - *Remove rocker arm shaft / camshaft bearing cap mounting bolts in sequence, working from outside to inside.*
> - *To avoid damaging the rocker arm shafts, loosen each rocker arm shaft / camshaft bearing cap bolt by one turn in the loosening sequence. Repeat until all bolts are free of tension.*

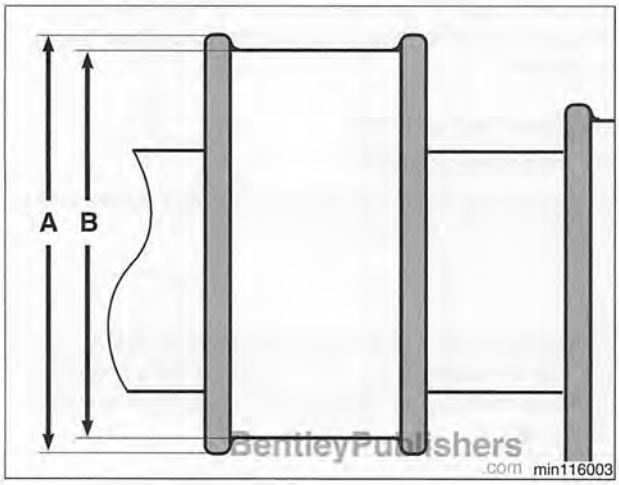


➢ Remove camshaft bearing caps and lift out camshaft.

> ***CAUTION—***
> *Note the alignment and numbering of the camshaft bearing caps. Be sure to replace each in original position and orientation.*

1. Bolt, M8 x 65 mm
   - Tighten to 30 Nm (22 ft-lb)
2. Camshaft bearing cap
3. Exhaust rocker arm shaft
4. Exhaust rocker arm (dual)
5. Camshaft
6. Intake rocker arm
7. Cylinder head
8. Intake rocker arm shaft

Cylinder Head Disassembly

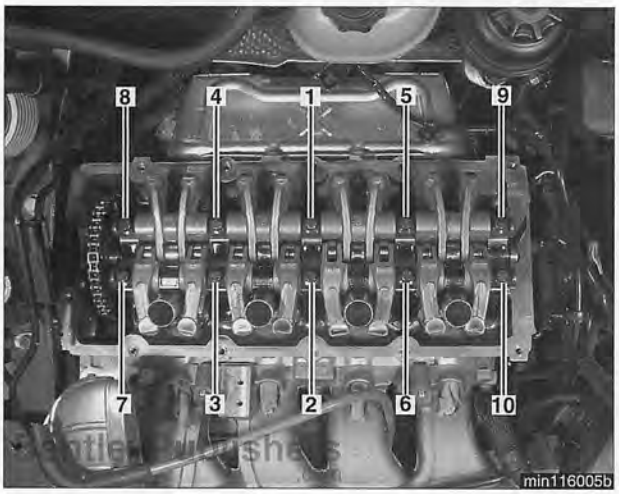


➢ Measure camshaft for wear at widest point of each cam lobe:
- Measure unworn area at edge of cam lobe (**A**).
- Measure worn area at center of lobe (**B**).
- Replace camshaft if difference between measurements **A** and **B** exceeds limit specified in table.

Camshaft runout (Cooper engine)	
Camshaft bearing diameter	25.290 - 25.309 mm (0.9957 - 0.9964 in)
Camshaft radial runout	0.053 - 0.093 mm (0.0021 - 0.0037 in)
Wear limit	0.12 mm (0.0047 in)

CAUTION—
If the camshaft is replaced because of wear or damage, also replace the rocker arms.

– When reinstalling camshaft, pay attention to the following:
- Lubricate camshaft bearing journals with clean engine oil.
- Install camshaft bearing caps in correct installation sequence and orientation.
- Lubricate rocker arm rolling area with clean engine oil.

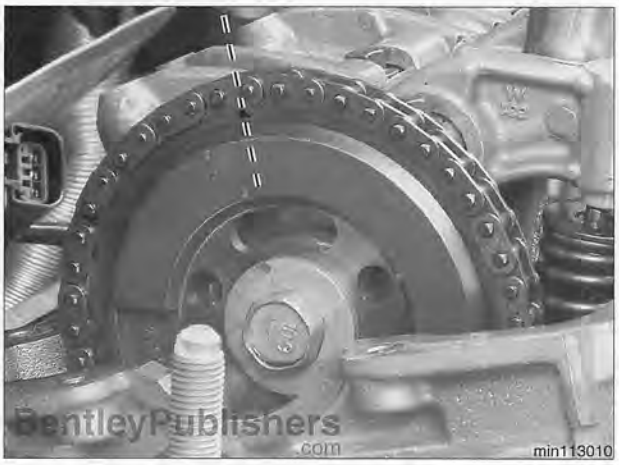


– Initially, tighten all rocker arm shaft / camshaft bearing cap bolts hand-tight.

➢ Torque bolts in sequence **1** to **10**, working from inside to outside.

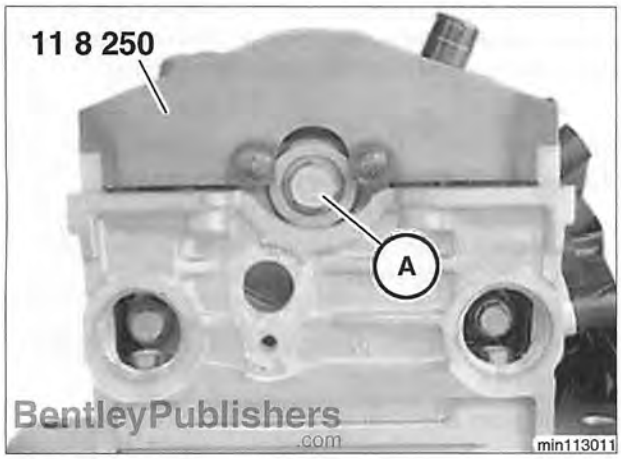
CAUTION—
To avoid damaging the rocker arm shafts, tighten each rocker arm shaft / camshaft bearing cap bolt by one turn in the tightening sequence. Repeat until all bolts are torqued properly.

Tightening torque	
Rocker arm shaft / camshaft bearing cap to cylinder head (M8)	30 Nm (22 ft-lb)



➢ Place timing chain on camshaft sprocket. Use previously made paint mark to align sprocket and timing chain to each other.

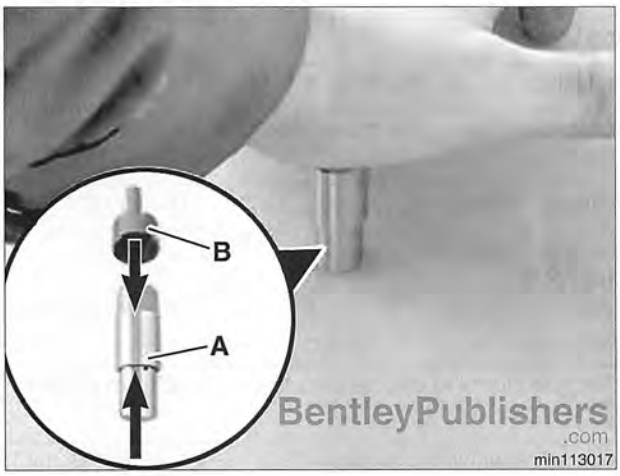
– Place sprocket on camshaft and insert mounting bolt.



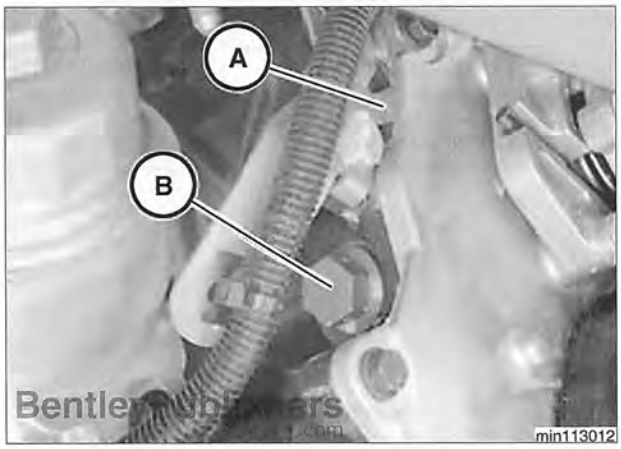
- Attach special tool 11 8 250 to camshaft sprocket. Torque camshaft sprocket bolt.

> ***CAUTION—***
> *Be careful not to damage timing chain during this step.*

Tightening torque	
Camshaft sprocket to camshaft (M12)	102 Nm (75 ft-lb)



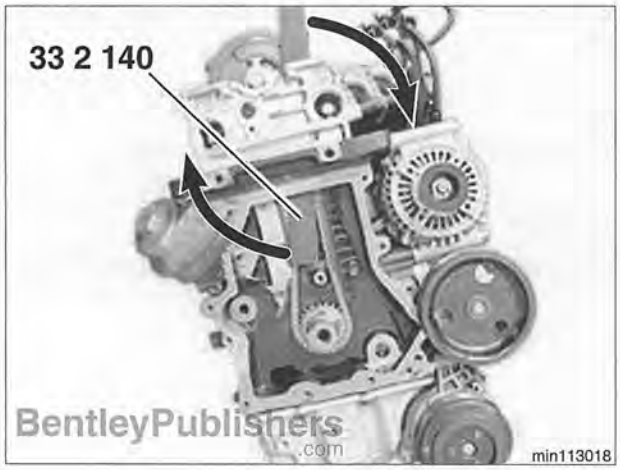
- Squeeze timing chain tensioner plunger into retracted position.
  - Place plunger (**A**) on level surface.
  - Remove plunger cap (**B**).
  - Exert continuous hand pressure on plunger until it is completely compressed.
  - Replace cap.



- Working in back of engine block, install timing chain tensioner plunger. Install tensioner plug (**B**).

Tightening torque	
Timing chain tensioner to engine block	63 Nm (46 ft-lb)

Cylinder Head Disassembly



➤ Insert large prying bar (BMW special tool 33 2 140 or equivalent) into timing chain housing and lever clockwise. This releases timing chain tensioner plunger and tensions chain.

CAUTION—
- *Do not lever directly at timing chain. Damage may result.*
- *Make sure that the timing chain is properly positioned within the channel of the timing chain guides.*

– Continue to reassemble engine, paying attention to the following:
- Change engine oil if necessary.
- Check for fault codes and clear and reset DME control module memory.

Tightening torques	
Camshaft position sensor to cylinder head (M6)	9 Nm (7 ft-lb)
Engine front mounting bracket to top of engine block (M12)	100 Nm (74 ft-lb)
Hydraulic engine mount to body	100 Nm (74 ft-lb)
Hydraulic engine mount to body (replace Torx bolt): Initial torque Torque angle	 56 Nm (41 ft-lb) 90°
Hydraulic engine mount to engine mounting bracket	68 Nm (50 ft-lb)
Ignition coil pack to valve cover (M6)	12 Nm (9 ft-lb)
Spark plug to cylinder head	27 Nm (20 ft-lb)
Upper engine vibration damper bracket to damper or to engine mounting bracket (M12)	100 Nm (74 ft-lb)
Valve cover to cylinder head (M6)	12 Nm (9 ft-lb)

CYLINDER HEAD SERVICE

The procedures described here are performed with the cylinder head off the engine and on the work bench.

Cylinder head removal and installation is described in **113 Cylinder Head Removal and Installation**.

Cylinder head, inspecting

- Remove rocker arm shafts and camshaft. See **Cylinder Head Disassembly** in this repair group.
- Check camshaft carrier bearing surfaces for warpage.
- Decarbonize and clean head before inspecting.
- Inspect disassembled and cleaned cylinder head for cracks.
  - Visually inspect cylinder head.
  - If a cracked cylinder head is suspected and no cracks are detected through visual inspection, have head further tested for cracks by authorized MINI dealer or ASE certified machinist.
  - Replace cracked cylinder head.
- Use straight edge to check diagonal and horizontal surface evenness of cylinder head.

Cylinder head distortion limits	
Maximum warpage	0.1 mm (0.004 in)

- Check valve guides and valve seats for wear before machining a warped head.
- Machine warped cylinder head.
  - Do not remove more than 0.3 mm (0.012 in.) of material.
  - If further machining is required, replace cylinder head.

NOTE —
- *Removing more than 0.3 mm (0.012 in.) will reduce the size of the combustion chamber and adversely affect engine performance.*
- *The standard thickness of the cylinder head gasket is 0.65 mm (0.026 in). A thicker one of 0.95 mm (0.037in) is available for machined heads.*

Valves, leak test

- Remove cylinder head. Disassemble rocker arm shafts and camshaft. See **Cylinder Head Disassembly** in this repair group.
- Install a spark plug in each cylinder.
- Place cylinder head on work bench with combustion chamber facing upward.
- Fill each combustion chamber with thin non-flammable liquid, such as parts cleaning fluid. After fifteen minutes, check level of fluid. If fluid level in any cylinder drops, that cylinder is not sealing properly.

Cylinder head, coolant leak test

- Remove and disassemble cylinder head. See **Cylinder Head Disassembly** in this repair group. Clean sealing surfaces.
- Place special tool 11 8 431 on sealing surface of cylinder head. Secure with special tool 11 8 433.
- Close off coolant opening with special tool 11 8 432.
- Connect compressed air supply to special tool 11 8 432. Set test pressure to 4.5 bar (65 psi).
- Immerse cylinder head in a water bath. Check for escaping bubbles.

NOTE—
If necessary, soften the bath water with a cleaning agent.

VALVES

The procedures described here are performed with the cylinder head off the engine and disassembled on the work bench.

Cylinder head removal and installation is described in **113 Cylinder Head Removal and Installation**. Also see **Cylinder Head Disassembly** in this repair group.

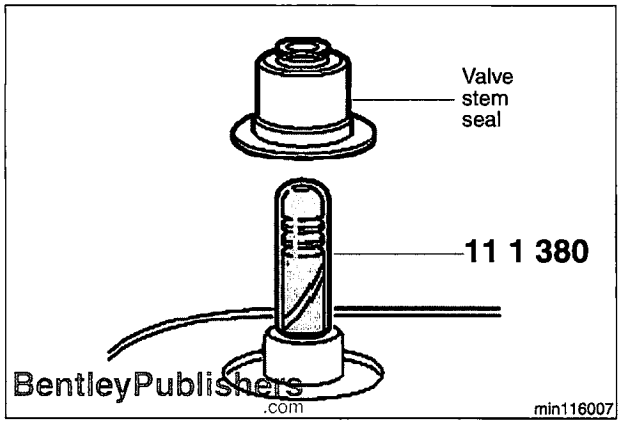
Valves, removing and installing

- Mount disassembled cylinder head on cylinder head assembly stand (special tool 11 9 000 or equivalent).
- Press down on valve springs with special tool 11 8 421 and remove valve spring keepers.
- Remove valve springs.
- Use special tool 11 1 480 to remove valve stem seals. Discard seals.
- Remove valves from bottom of cylinder head.

CAUTION—
Label each valve and valve spring assembly as it is removed so it can be installed in its original position.

- Valve dimension specifications are in **Table a**.
- When installing, lightly oil valve stem and valve stem seal.

NOTE—
- *Do not reuse valve stem oil seals. If valves are removed, use new valve stem oil seals.*
- *BMW special tools are available to remove the valve stem oil seals. As an alternative, standard valve seal removal tools are available from most automotive parts stores.*



➤ Use installation sleeve (special tool 11 1 380) over end of valve to prevent damage to valve stem seal.

– Press on valve stem seal with special installation drift 11 1 130 as far as it will go, until flush with surface of cylinder head.

– Install valve springs.

Table a. Valve specifications (Cooper only)	
Parameter	**Specification**
Valve length intake exhaust	 108.72 - 109.22 mm (4.280 - 4.300 in) 117.57 - 118.07 mm (4.629 - 4.648 in)
Valve stem dia.	5.934 - 5.952 mm (0.2336 - 0.2343 in)

NOTE—
Cooper S valve specifications were not available from MINI at time of publication. Contact your MINI dealer for more information.

Valve stem oil seals

The purpose of the valve stem oil seal is to prevent excess oil from entering the combustion chamber. The sign of faulty valve stem oil seals is excessive oil consumption and smoke from the exhaust immediately after starting and during deceleration.

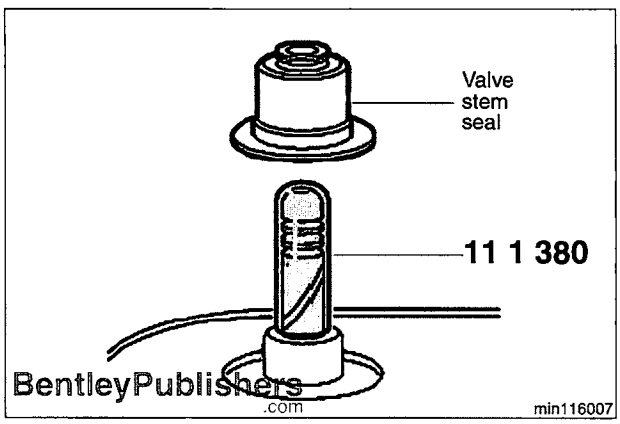
NOTE—
- *Do not reuse valve stem oil seals. If valves are removed, use new valve stem oil seals.*
- *BMW special tools are available to remove the valve stem oil seals. As an alternative, standard valve seal removal tools are available from most automotive parts stores.*

– Mount disassembled cylinder head on cylinder head assembly stand (special tool 11 9 000 or equivalent).

– Press down on valve springs with special tool 11 8 421 and remove valve keepers.

– Remove valve springs.

– Use special tool 11 1 480 to remove valve stem seals. Discard seals.

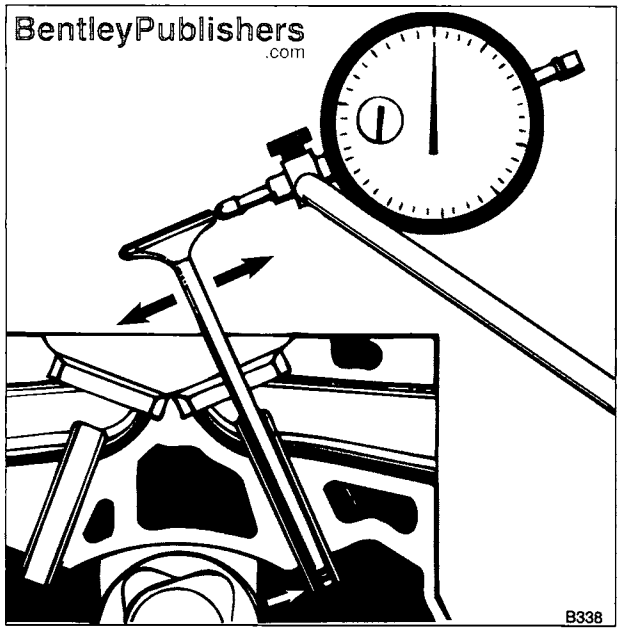


– When installing, lightly oil valve stem and valve stem seal.

➤ Use installation sleeve (special tool 11 1 380) over end of valve to prevent damage to valve stem seal.

– Press on valve stem seal with special installation drift 11 1 130 as far as it will go, until flush with surface of cylinder head.

– Install valve springs.



Valve guides

Check valve guides for wear using a new valve. Be sure to thoroughly inspect the cylinder head to ensure that it can be reused before reworking the guides.

Valve guide specifications are listed in **Table b.**

Table b. Valve guide specifications (Cooper only)	
Parameter	**Specification**
Valve guide inside diameter	5.975 - 6.000 mm (0.2352 - 0.2362 in)
Running clearance between valve and valve guide intake exhaust	 0.048 - 0.066 mm (0.0019 - 0.0026 in) 0.074 - 0.094 mm (0.0029 - 0.0037 in)
Maximum running clearance between valve and valve guide intake exhaust	 0.076 mm (0.0030 in) 0.101 mm (0.0040 in)
Valve guide wear, maximum (valve tilt clearance measured with new valve)	0.25 mm (0.0098 in)

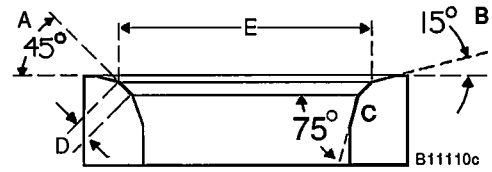
NOTE—
Cooper S valve guide specifications were not available from MINI at time of publication. Contact your MINI dealer for more information.

Valve seats

- Resurface valve seats whenever new valves or valve guides are installed. Special cutters are required to resurface seats.

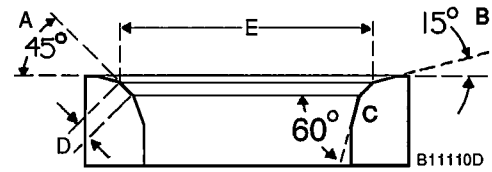
- Always check valves for leaks after reconditioning a valve seat as described above. **Table c** and **Table d** list valve seat dimensions.

Table c. Valve seat dimensions (Cooper)



Parameter	Specification
A Valve seat angle	45°
B Correction angle, outside	15°
C Correction angle, inside	75°
D Valve seat width intake exhaust	 1.15 - 1.48 mm (0.045 - 0.058 in) 1.47 - 1.80 mm (0.058 - 0.071 in)
E Valve seat outside dia. intake exhaust	 31.9 + 0.1 mm (1.256 + 0.004 in) 25.2 + 0.1 mm (0.992 + 0.004 in)

Table d. Valve seat dimensions (Cooper S)



Parameter	Specification
A Valve seat angle	45°
B Correction angle, outside	15°
C Correction angle, inside (not machineable)	60°
D Valve seat width intake or exhaust	 0.900 - 1.300 mm (0.035 - 0.051 in)
E Valve seat outside dia. intake exhaust	 30.000 mm (1.181 in) 23.000 mm (0.906 in)

Valve springs

– Check valve springs for fatigue:
  - Line up springs in a row.
  - Place straightedge across top of springs.
  - Replace any spring that is significantly shorter than others.

117 Camshaft Timing Chain

GENERAL

This repair group covers timing chain repair information. Timing chain components and operation are identical for Cooper and Cooper S engines.

The timing chain is lubricated by engine oil and does not require maintenance. A worn timing chain or sprockets can lead to noisy operation and erratic valve timing. A faulty tensioner can also cause timing chain noises.

Timing chain replacement is a complicated job. The job has been divided into several procedures. Be sure to read the procedures before beginning the repairs.

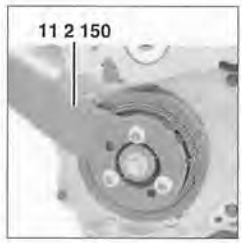
NOTE—
Front crankshaft seal replacement is covered in **119 Lubrication System**.

Special tools

Special service tools are needed to remove and disassemble the timing chain. Many of these tools are expensive and only available through an authorized MINI dealer.

Be sure to read each procedure thoroughly before starting a job to determine which special tools will be necessary.

- Gear puller
(BMW special tool 11 2 000)



- Crankshaft vibration damper holder (Cooper)
(BMW special tool 11 2 150)

- Crankshaft vibration damper installation tools
(BMW special tool 11 8 240)

Camshaft locking tool
(BMW special tool 11 8 250)

Crankshaft thread protector
(BMW special tool 11 8 270)

Gear puller jig for crankshaft chain sprocket
(BMW special tool 11 8 300)

Puller
(BMW special tool 11 8 310)

Crankshaft vibration damper counterholding studs
(BMW special tool 11 8 320)

Engine block support tool
(BMW special tool 11 8 370)

Hydraulic engine mount removal and installation tool
(BMW special tool 11 8 380)

General

Lever for relieving drive belt tension (Cooper)
(BMW tool no. 11 8 390)

Modular front end extensions
(BMW special tool 11 8 400)

Lever for relieving drive belt tension (Cooper S)
(BMW tool no. 11 8 410)

Drive belt tensioner locking tool
(BMW tool no. 11 8 280 for Cooper,
BMW tool no. 11 8 470 for Cooper S)

Crankshaft vibration damper puller (Cooper S)
(BMW tool no. 11 8 450)

Crankshaft vibration damper holder (Cooper S)
(BMW tool no. 11 8 460)

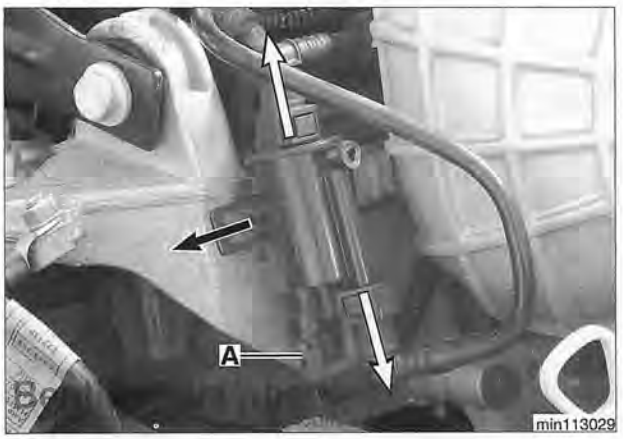
TIMING CHAIN HOUSING COVER

To access the timing chain, it is necessary to remove the timing chain housing cover.

WARNING—
Due to risk of personal injury, be sure the engine is cold before beginning any of the procedures.

CAUTION—
Cover all painted surfaces before beginning the removal procedure. As an aid to installation, label all components, wires, and hoses before removing them. Do not reuse gaskets, O-rings or seals during reassembly.

Crankshaft vibration damper, removing and installing (Cooper)



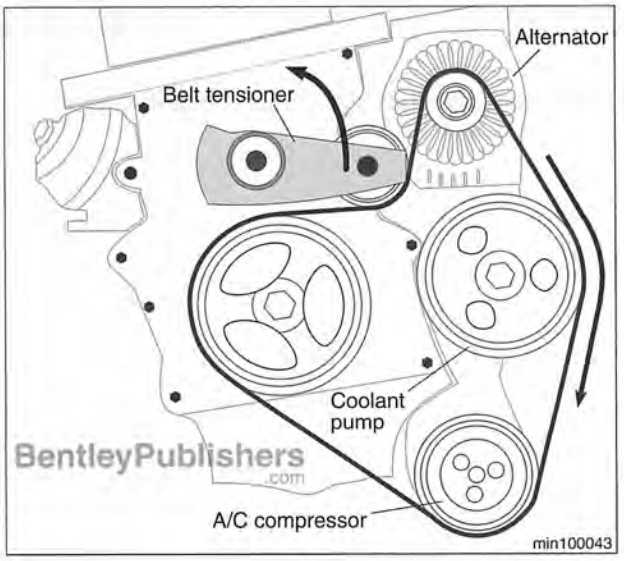
➤ Remove fuel tank vent valve.
- Disconnect vent hoses (**white arrows**) via quick fit connectors.
- Straighten retaining tab and slide vent valve off bracket (**black arrow**).
- Remove electrical harness connector (**A**).

NOTE—
Cooper S engine is illustrated. Cooper engine layout is similar.

– Remove splash shield under engine.

– Remove right front wheel.

– Remove right front wheel housing liner.

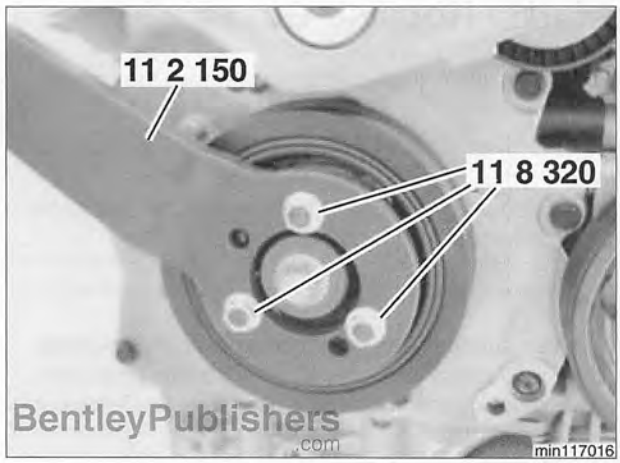


➤ Note engine drive belt layout. Then remove belt.
- Use special tool 11 8 390 to release drive belt tension.
- Use lock pin (special tool 11 8 280) to lock drive belt tensioner.
- Lift off drive belt.

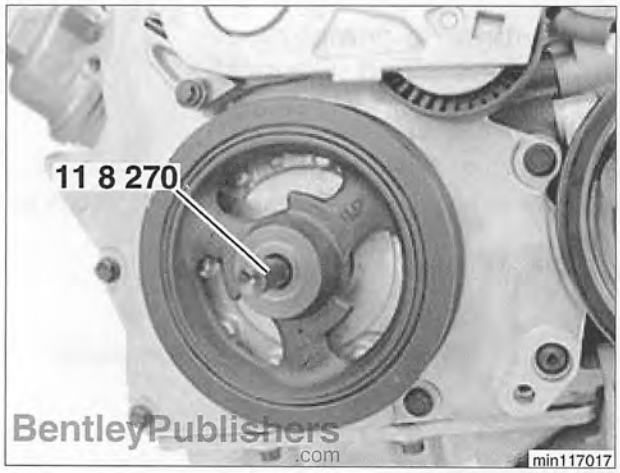
CAUTION—
- *Drive belt tensioner is under high tension. Check that lock pin is secure.*
- *Take care to avoid damage to paintwork.*

NOTE—
- *Drive belt removal and installation is covered in* **020 Maintenance**.
- *If drive belt is to be reused, mark direction of travel and reinstall drive belt in same direction of rotation.*

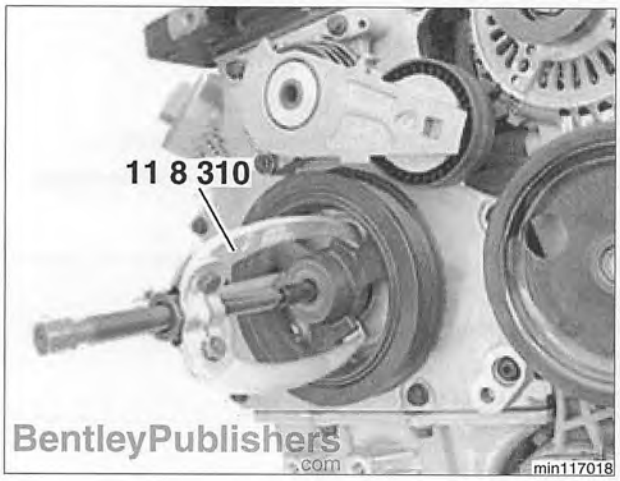
Timing Chain Housing Cover



➢ Fit counterholding studs (BMW special tools 11 8 320) to crankshaft vibration damper holder (BMW special tool 11 2 150). Counterhold vibration damper to loosen and remove retaining bolt.



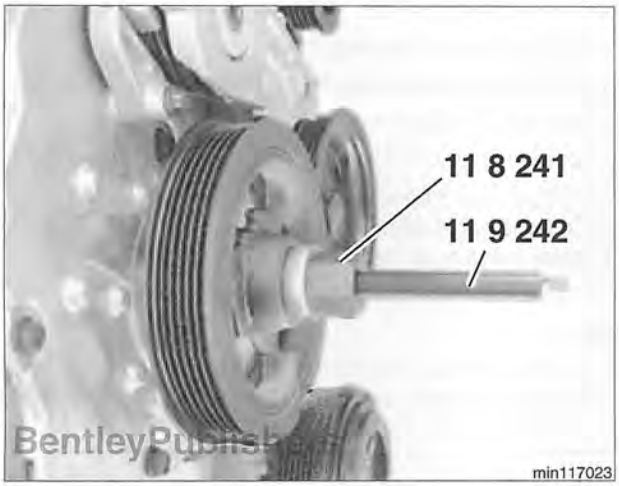
➢ Insert thread protector (BMW special tool 11 8 270) into crankshaft and tighten.



➢ Attach three-claw puller (BMW special tool 11 8 310 or equivalent) and remove vibration damper.

– Remove thread protector (BMW special tool 11 8 270) from crankshaft.

– To replace front crankshaft seal, see **119 Lubrication System**.



➤ Reinstall vibration damper using special tools 11 8 241 and 11 8 242:

- Install threaded stud 11 8 242 in crankshaft threads.
- Place vibration damper over end of crankshaft.
- Use deep 24 mm socket to tighten special tool 11 8 241 to pull vibration damper on crankshaft.

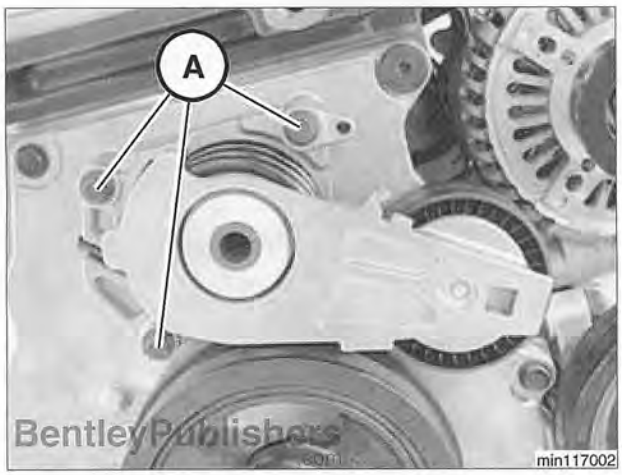
Tightening torque	
Vibration damper to crankshaft (use new M12 bolt)	115 Nm (85 ft-lb)

– Remainder of installation is reverse of removal.

- Replace drive belt if contaminated with oil.
- Check for fault codes and clear and reset DME control module memory.
- Start engine and check for leaks.

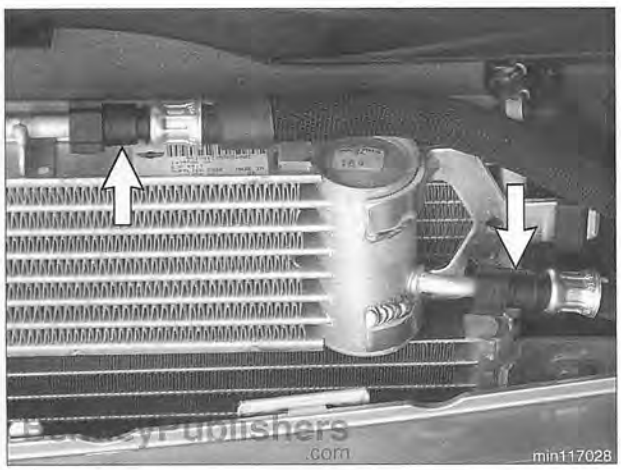
Timing chain housing cover, removing and installing (Cooper)

– Remove engine drive belt and crankshaft vibration damper. See **Crankshaft vibration damper, removing and installing (Cooper)** in this repair group.



➤ Remove belt tensioner retaining screws (**A**). Remove tensioner.

WARNING—
Do not release pretensioned spring.



➤ Models with CVT or automatic transmission: Disconnect transmission fluid lines (**arrows**) from cooler in front of radiator. Use BMW plugs 113 5 281 / 13 5 282 or equivalent to plug lines and connections.

NOTE—
Be prepared to catch dripping fluid.

Timing Chain Housing Cover

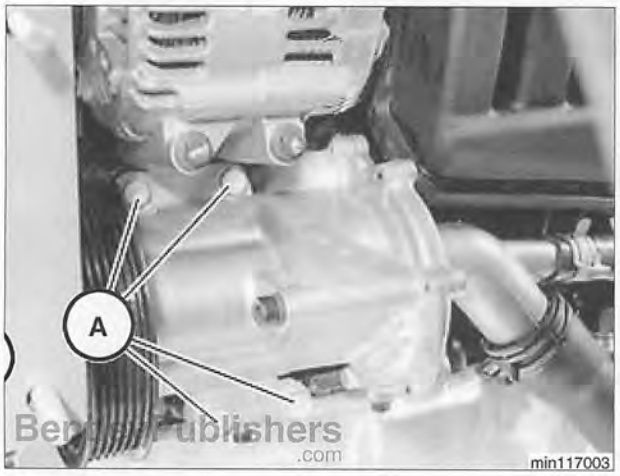
➤ Loosen modular front end (MFE):

- Remove right front wheel housing liner.
- Detach left front wheel housing liner from front bumper cover trim.
- Remove front bumper cover trim.
- Remove bumper.
- Remove MFE mounting bolts. Install two 100 mm (4 in) M8 bolts (**arrow**) in left and right bumper support members. Slide MFE forward, supported on long bolts.

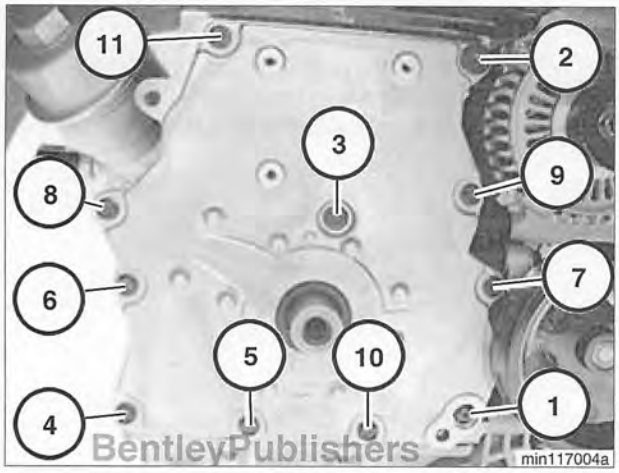
CAUTION—
For ease of component alignment when reassembling front bumper assembly, do not loosen or remove bumper alignment bosses.

NOTE—

- *Cooper S engine is illustrated. Cooper engine layout is similar.*
- *If available, use BMW special tools 11 8 401 and 11 8 402 instead of long bolts to support MFE.*
- *Removal of MFE is a complicated job. It is covered in* **510 Bumpers, External Trim**.

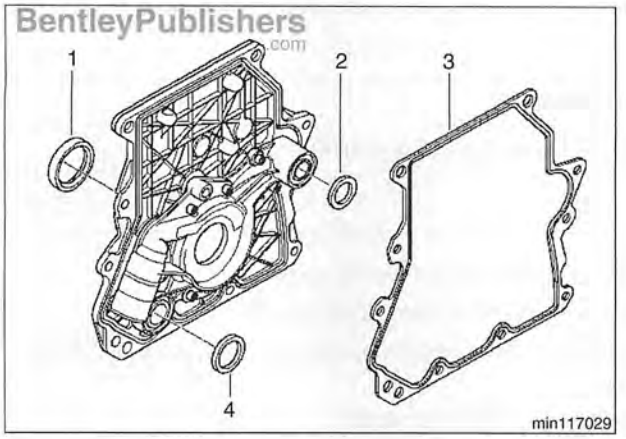


➤ Remove coolant pump mounting bolts (**A**) and shift coolant pump so that timing chain housing cover is unobstructed.

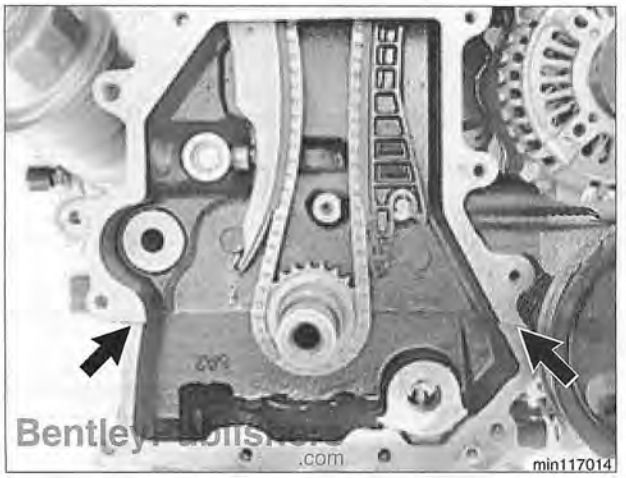


➤ Remove timing chain housing cover bolts in specified order (**1** to **11**).

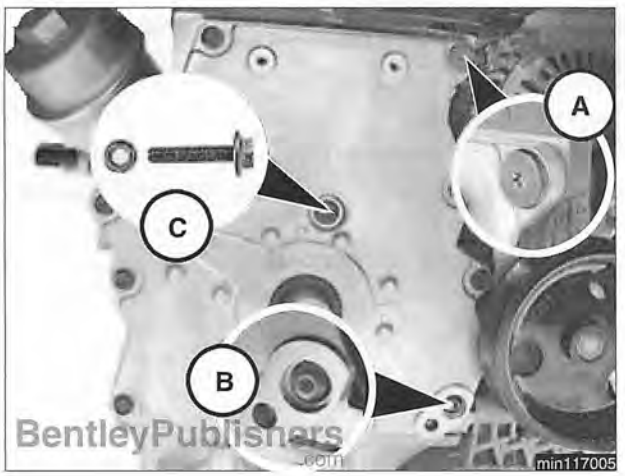
– Remove cover.



- Clean sealing surfaces on timing case cover and crankcase. Install new seals and gaskets:
  1. Crankshaft seal
  2. Oil pump outlet seal
  3. Timing chain housing cover sealing gasket
  4. Oil pump inlet seal



- Apply 3 mm (⅛ in) bead of Loctite® RTV 5999 sealer or equivalent to joint (**arrows**) between engine block and bearing ladder.

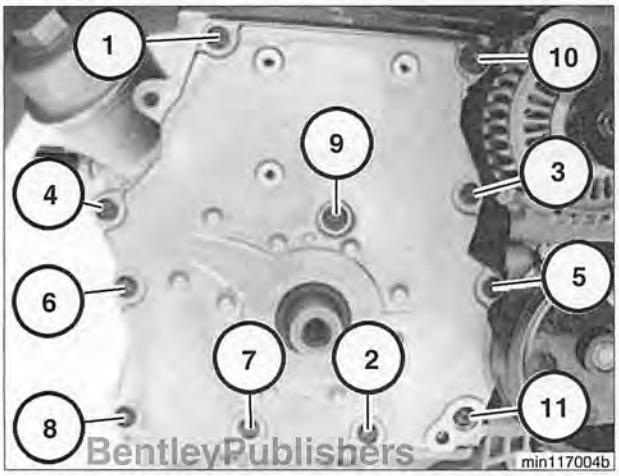


- Note location of Torx shoulder bolt (**A**), Torx round head bolt (**B**) and bolt with sealing O-ring (**C**).
  - Replace O-ring and lubricate with clean engine oil.

– Before timing housing cover installation, prime oil pump by filling with engine oil.

– While installing timing housing cover, align oil pump rotor flats with flats on crankshaft.

Timing Chain Housing Cover



➢ Tighten timing chain cover fasteners in specified order (**1** to **11**).

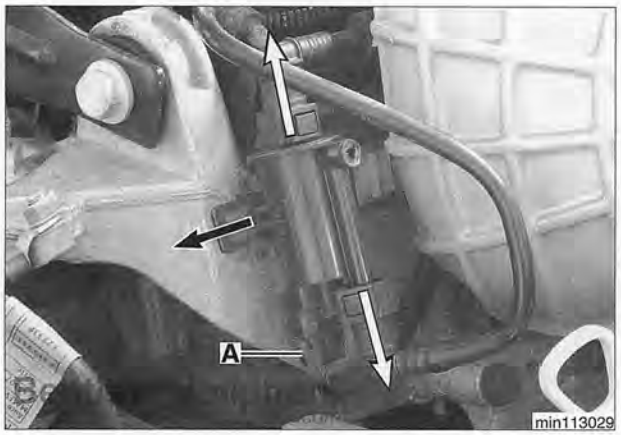
Tightening torques	
Timing chain housing cover to engine block M6 M8 oval head	 12 Nm (9 ft-lb) 18 Nm (13 ft-lb)

– Remainder of installation is reverse of removal.

- Replace drive belt if contaminated with oil.
- Check for fault codes and clear and reset DME control module memory.
- Start engine and check for leaks.

Tightening torques	
Coolant pump to engine block (M8)	30 Nm (22 ft-lb)
Crush tube to subframe (M12 x 1.5 x 85 mm)	100 Nm (74 ft-lb)
Drive belt tensioner to timing chain housing cover (M6)	9 Nm (7 ft-lb)
Front bumper to crush tube or to bumper carrier (M8 x 30 mm)	22 Nm (16 ft-lb)
Front bumper to modular front end (M6 x 16 mm)	5 Nm (44 in-lb)
Modular front end to crush tube (M6)	5 Nm (44 in-lb)

Crankshaft vibration damper, removing and installing (Cooper S)



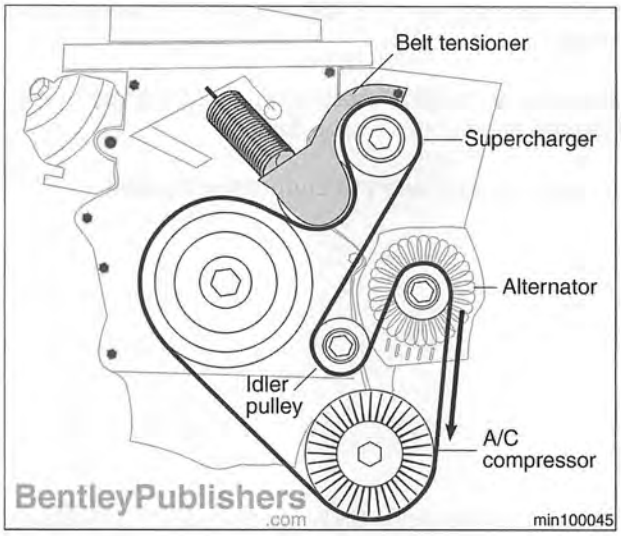
➢ Remove fuel tank vent valve.

- Disconnect vent hoses (**white arrows**) via quick fit connectors.
- Straighten retaining tab and slide vent valve off bracket (**black arrow**).
- Remove electrical harness connector (**A**).

– Remove splash shield under engine.

– Remove right front wheel.

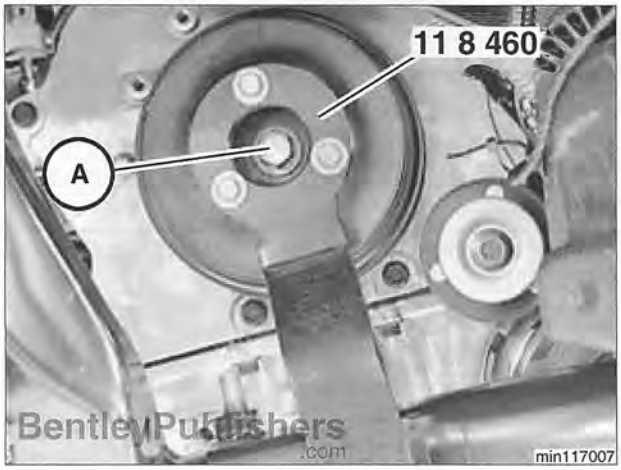
– Remove right front wheel housing liner.



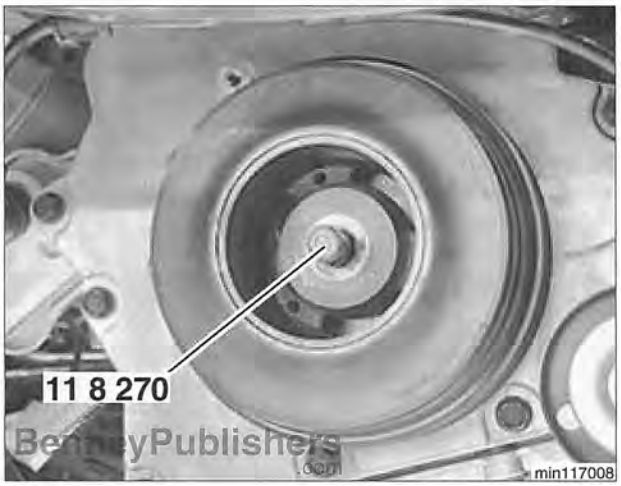
- Note engine drive belt layout. Then remove belt.
  - Use BMW special tool 11 8 410 to release drive belt tension.
  - Use lock pin (BMW special tool 11 8 470) to lock drive belt tensioner.
  - Lift off drive belt.

> ***CAUTION—***
> - *Drive belt tensioner is under high tension. Check that lock pin is secure.*
> - *Take care to avoid damage to paintwork.*

NOTE—
- *Drive belt removal and installation is covered in* **020 Maintenance**.
- *If drive belt is to be reused, mark direction of travel and reinstall drive belt in same direction of rotation.*



- Fit BMW special tool 11 8 460 to crankshaft vibration damper and remove mounting bolt (**A**).



- Insert thread protector (BMW special tool 11 8 270) into crankshaft and tighten.

Timing Chain Housing Cover

➢ Use puller (BMW special tool 11 8 450 or equivalent) to remove vibration damper.

– Remove thread protector (BMW special tool 11 8 270) from crankshaft and remove puller from vibration damper.

– To replace crankshaft seal, see **119 Lubrication System**.

➢ Reinstall vibration damper using BMW special tools 11 8 242 and 11 8 241:

- Install threaded stud (BMW special tool 11 8 242) in crankshaft threads.
- Place vibration damper over end of crankshaft.
- Use deep 24 mm socket to tighten BMW special tool 11 8 24. This presses vibration damper on crankshaft.

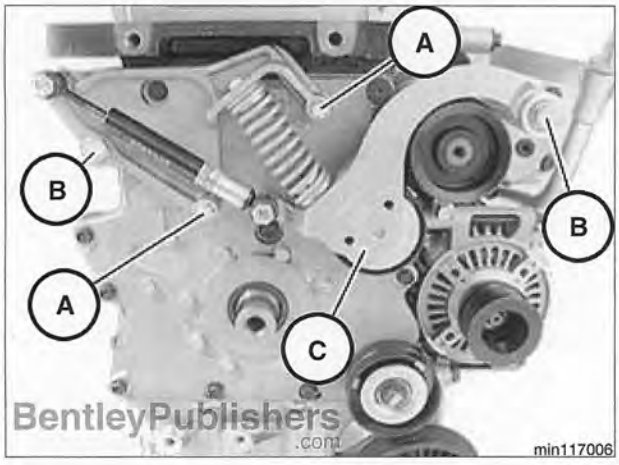
Tightening torque	
Vibration damper to crankshaft (use new M12 bolt)	115 Nm (85 ft-lb)

– Remainder of installation is reverse of removal.

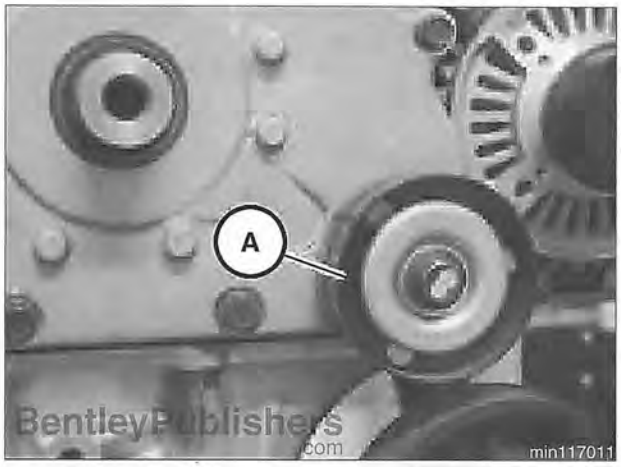
- Replace drive belt if contaminated with oil.
- Check for fault codes and clear and reset DME control module memory.
- Start engine and check for leaks.

Timing chain housing cover, removing and installing (Cooper S)

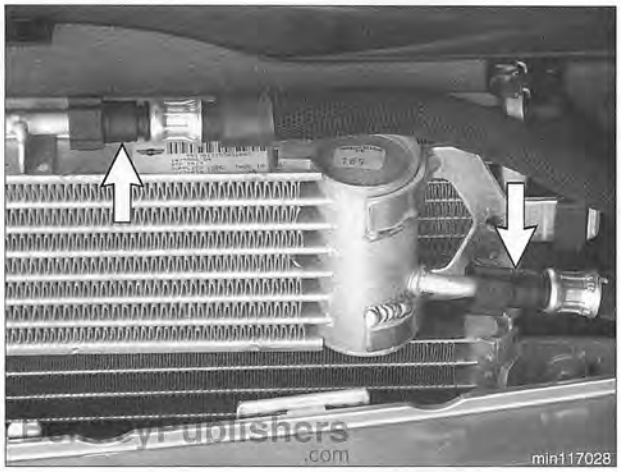
– Remove engine drive belt and crankshaft vibration damper. See **Crankshaft vibration damper, removing and installing (Cooper S)** in this repair group.



➢ Remove belt tensioner mounting bolts (**A** and **B**). Remove tensioner (**C**).



➤ Remove idler pulley (**A**) from timing chain cover.



➤ Models with CVT or automatic transmission: Disconnect transmission fluid lines (**arrows**) from cooler in front of radiator. Use BMW plugs 113 5 281 / 13 5 282 or equivalent to plug lines and connections.

NOTE—
Be prepared to catch dripping fluid.

➤ Loosen modular front end (MFE):

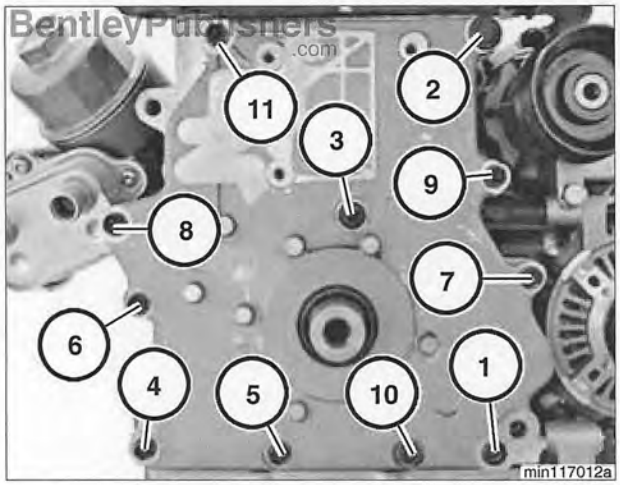
- Remove right front wheel housing liner.
- Detach left front wheel housing liner from front bumper cover trim.
- Remove front bumper cover trim.
- Remove bumper.
- Detach radiator upper hose support clamp (**A**) from intake manifold.
- Remove MFE mounting bolts. Install two 100 mm (4 in) M8 bolts (**arrow**) in left and right bumper support members. Slide MFE forward, supported on long bolts.

> ***CAUTION—***
> *For ease of component alignment when reassembling front bumper assembly, do not loosen or remove bumper alignment bosses.*

NOTE—

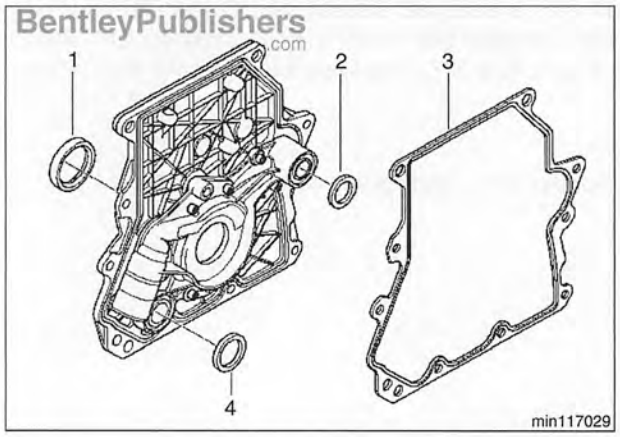
- *If available, use BMW special tools 11 8 401 and 11 8 402 instead of long bolts to support MFE.*
- *Removal of MFE is a complicated job. It is covered in* **510 Bumpers, External Trim**.

Timing Chain Housing Cover



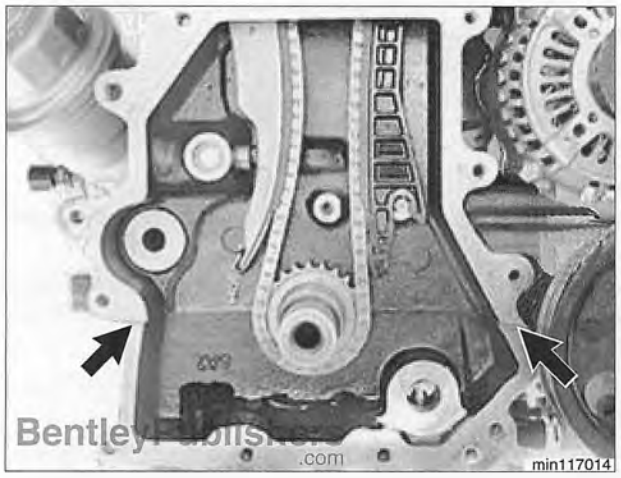
➢ Remove timing cover fasteners in specified order (**1** to **11**).

– Remove cover.

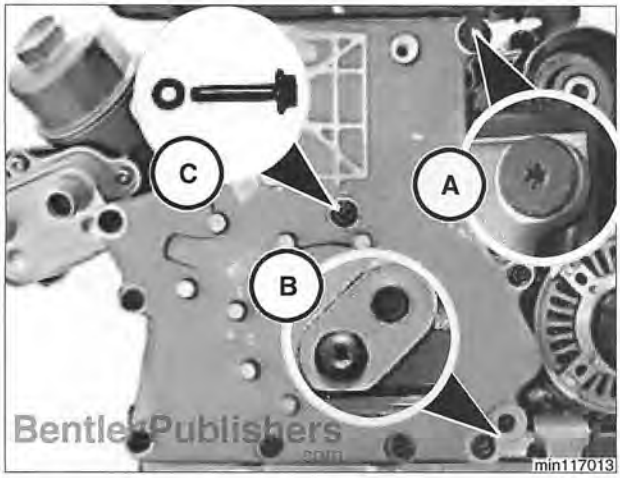


➢ Clean sealing surfaces on timing case cover and crankcase. Install new seals and gaskets:

1. Crankshaft seal
2. Oil pump outlet seal
3. Timing chain housing cover sealing gasket
4. Oil pump inlet seal



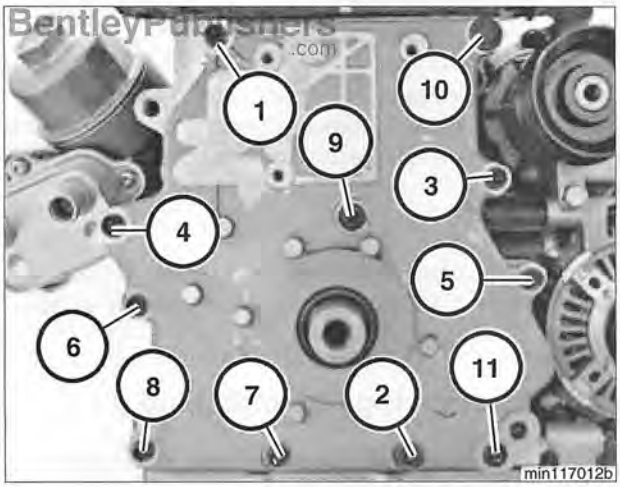
➢ Apply 3 mm (⅛ in) bead of Loctite® RTV 5999 sealer or equivalent to joint (**arrows**) between engine block and bearing ladder.



➢ Note location of Torx shoulder bolt (**A**), Torx round head bolt (**B**) and bolt with sealing O-ring (**C**).
- Replace sealing O-ring and lubricate with clean engine oil.

– Before timing housing cover installation, prime oil pump by filling with engine oil.

– While installing timing housing cover, align oil pump rotor flats with flats on crankshaft.

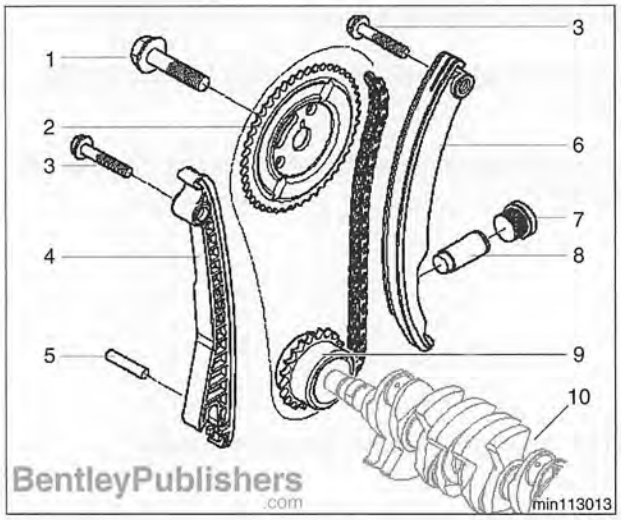


➢ Tighten timing chain cover fasteners in specified order (**1** to **11**).

Tightening torques	
Timing chain housing cover to engine block M6 M8 oval head	 12 Nm (9 ft-lb) 18 Nm (13 ft-lb)

– Remainder of installation is reverse of removal.
- Replace drive belt if contaminated with oil.
- Check for fault codes and clear and reset DME control module memory.
- Start engine and check for leaks.

Tightening torques	
Crush tube to subframe (M12 x 1.5 x 85 mm)	100 Nm (74 ft-lb)
Drive belt idler pulley to timing chain housing cover (M8)	45 Nm (33 ft-lb)
Drive belt tensioner to timing chain housing cover (M6)	9 Nm (7 ft-lb)
Drive belt tensioner to timing chain housing cover or to supercharger (M10)	45 Nm (33 ft-lb)
Front bumper to crush tube or to bumper carrier (M8 x 30 mm)	22 Nm (16 ft-lb)
Front bumper to modular front end (M6 x 16 mm)	5 Nm (44 in-lb)
Modular front end to crush tube (M6)	5 Nm (44 in-lb)



TIMING CHAIN

Timing chain components:

1. Bolt, M12
   - Tighten to 102 Nm (75 ft-lb)
2. Camshaft sprocket
3. Bolt, M8
   - Tighten to 28 Nm (21 ft-lb)
4. Timing chain fixed guide
5. Stud
6. Timing chain tensioning guide
7. Timing chain tensioner plug with sealing O-ring
8. Timing chain tensioner plunger
9. Crankshaft sprocket
10. Crankshaft

The timing chain incorporates three copper-coated links that are used to set valve timing. Both the crankshaft and camshaft sprockets incorporate timing marks which are used in conjunction with the copper-coated chain links.

NOTE—
The copper-coated links are used to set initial camshaft -to-crankshaft relative positions. They are not relevant to valve timing later on.

Timing chain, removing and installing

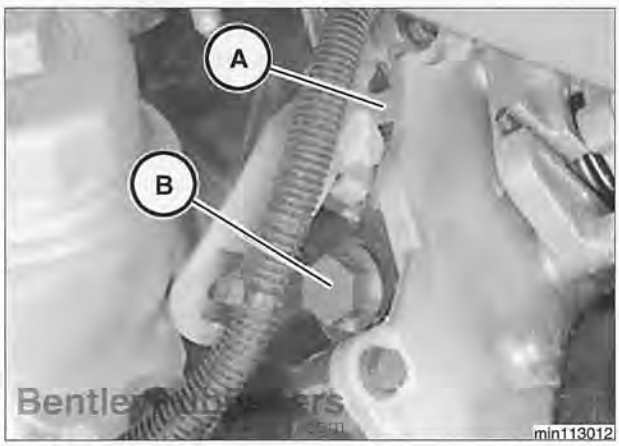
A gear puller and other special tools are necessary for this procedure. See **Special tools** in this repair group.

– Disconnect negative (-) cable from battery. See **121 Battery, Starter, Alternator** for more information.

> ***CAUTION***—
> *Disconnecting the battery may erase fault code(s) stored in memory. Check for fault codes prior to disconnecting the battery cables.*

– Unscrew all spark plugs.

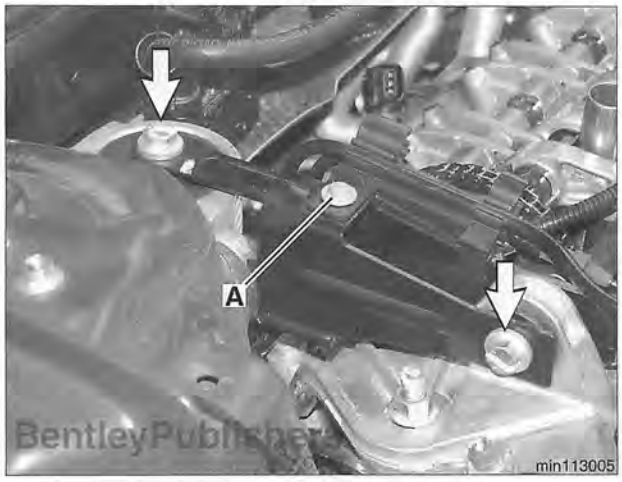
– Remove valve cover. See **113 Cylinder Head Removal and Installation**.



Working in back of engine block, loosen and remove timing chain tensioner plug (**B**). Remove tensioner plunger from inside timing chain housing cover.

– Cooper:
  - Remove crankshaft vibration damper. See **Crankshaft vibration damper, removing and installing (Cooper)** in this repair group.
  - Remove timing chain housing cover. See **Timing chain housing cover, removing and installing (Cooper)** in this repair group.

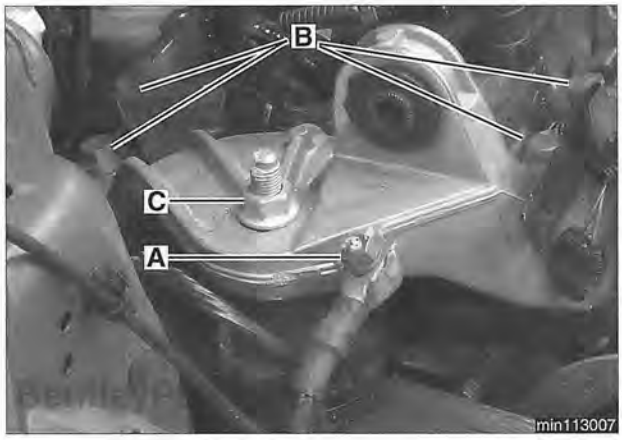
– Cooper S:
  - Remove crankshaft vibration damper. See **Crankshaft vibration damper, removing and installing (Cooper S)** in this repair group.
  - Remove timing chain housing cover. See **Timing chain housing cover, removing and installing (Cooper S)** in this repair group.



➢ Remove engine vibration damper bracket:
  - Remove fuel line bracket mounting bolt (**A**). Detach any fuel lines still attached. Lift off bracket and set aside.
  - Remove engine vibration damper bracket bolts (**arrows**).
  - Remove bracket.

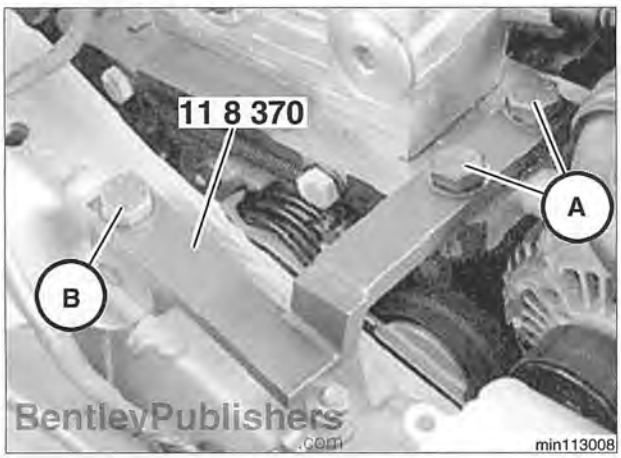
– Support engine under oil pan.

> ***CAUTION—***
> *To avoid damaging the oil pan, use a rubber pad on top of the engine supporting jack.*



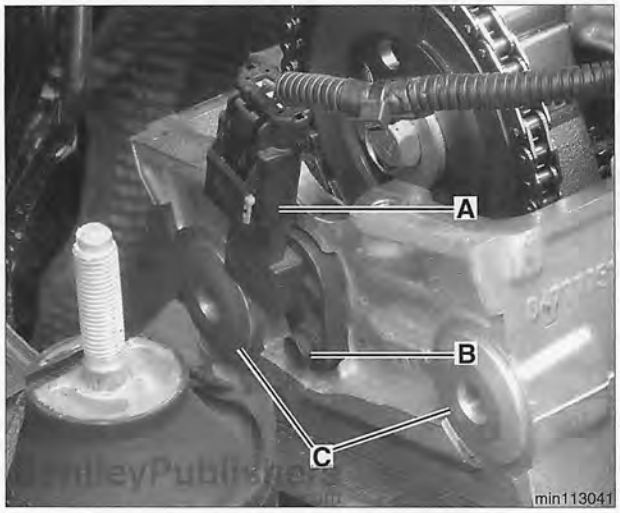
➢ Remove engine mounting bracket:
  - Remove engine ground cable mounting nut (**A**) from bracket. Detach ground cable.
  - Remove 4 engine mounting bolts (**B**) from engine block.
  - Unscrew mounting nut (**C**) from hydraulic front engine mount stud. Lift off engine mount bracket.

– Use BMW special tool 11 8 380 to remove hydraulic engine mount. Counterhold Torx head mounting bolt from below.



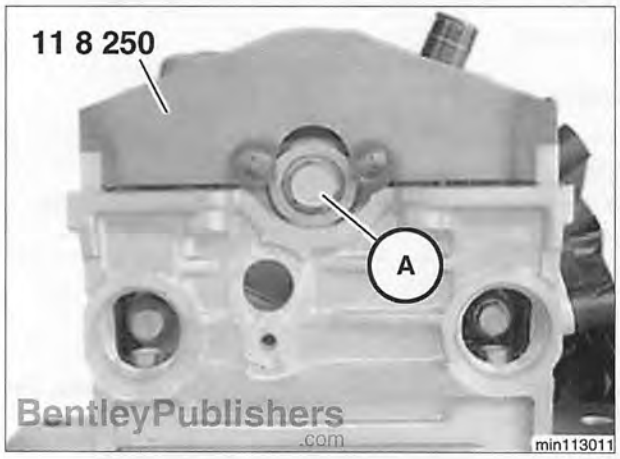
➢ Use BMW special tool 11 8 370 to support engine. Remove jack from underneath engine oil pan.
  - Insert bolts **A** in engine block.
  - Insert bolt **B** In hydraulic engine mount bolt hole.

Timing chain



➢ Working at right end of cylinder head:

- Disconnect electrical harness connector (**A**) at camshaft position sensor.
- Remove sensor mounting bolt (**B**).
- Remove sensor from cylinder head.
- Remove threaded plugs (**C**) from cylinder head.



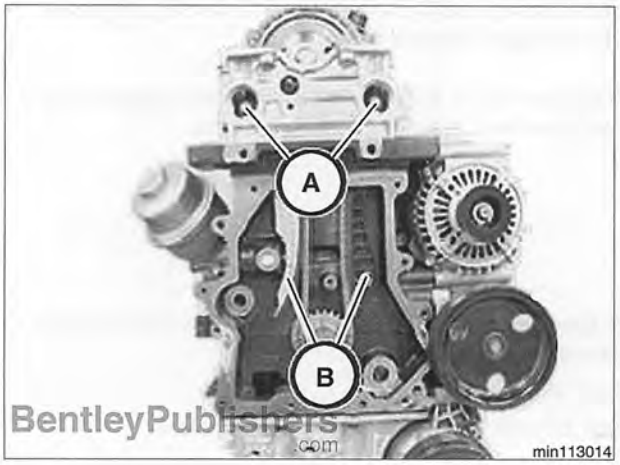
➢ Attach BMW special tool 11 8 250 to camshaft sprocket.

– Loosen and remove camshaft sprocket bolt (**A**).

– Remove camshaft sprocket and chain from camshaft.

– Remove camshaft sprocket from timing chain.

> ***CAUTION***—
> *Prevent timing chain from dropping into timing case.*



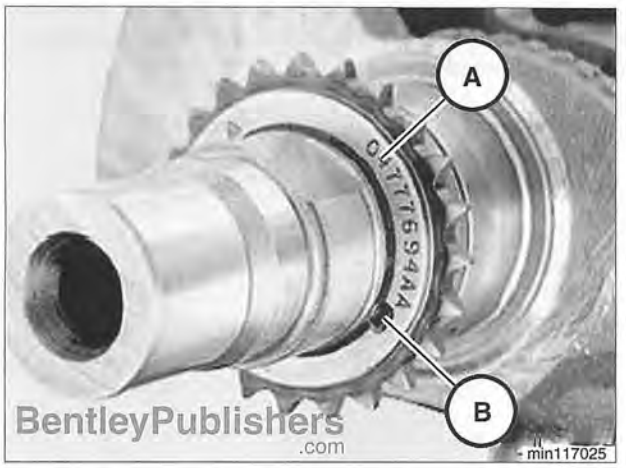
➢ Remove timing chain fixed and tensioning guide mounting bolts (**A** and **B**).

- Pull timing chain guides up out of timing chain housing.

– Remove chain from crankshaft sprocket.

NOTE—
If the timing chain is replaced, also replace the camshaft and crankshaft sprockets.

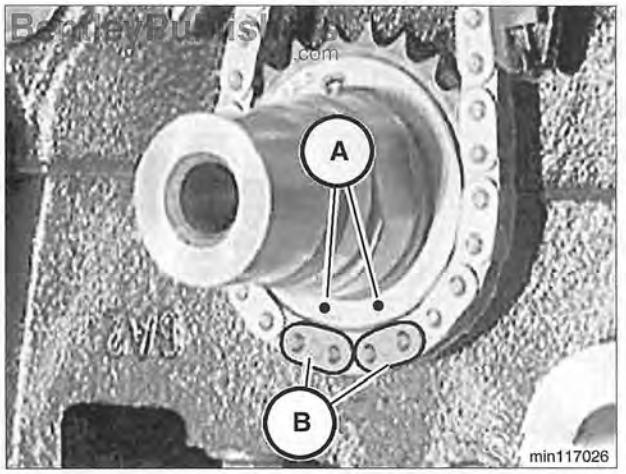
– Remove crankshaft sprocket using gear pulling jig (BMW special tool 11 8 300) together with gear puller (BMW special tool 11 2 000).



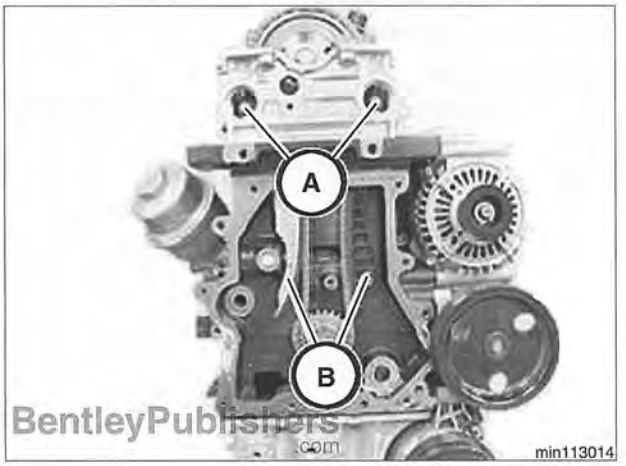
- Shrink-fit crankshaft sprocket (**A**) on crankshaft.
  - Note correct position of locating pin (**B**).
  - Use hotplate or oil bath to heat crankshaft sprocket to a maximum temperature of 150°C (302°F).
  - Slide sprocket on crankshaft as far as it will go.

> ***WARNING —***
> *Protect hands with heat-resistant gloves.*

> ***CAUTION —***
> *When heating the sprocket, do not exceed the specified temperature.*



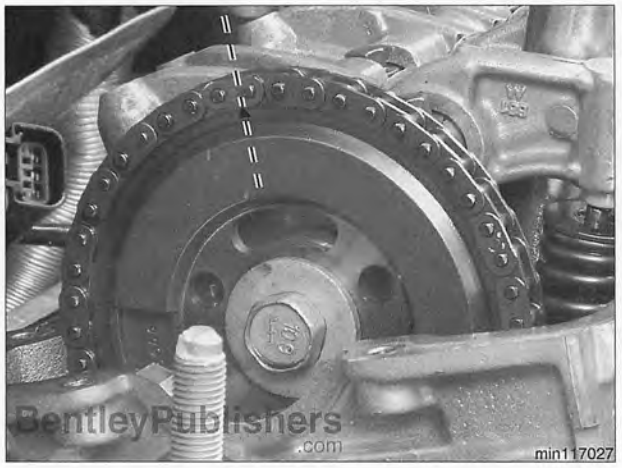
- Install timing chain on crankshaft sprocket. Make sure that crankshaft timing marks (**A**) line up with two copper-colored chain links (**B**).



- Reinstall timing chain fixed and tensioning guides.
  - Install tensioning guide mounting bolts (**arrows**).

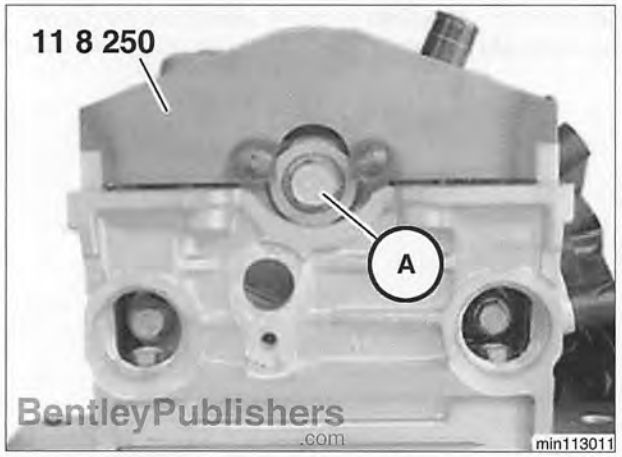
Tightening torque	
Timing chain guide to cylinder head (M8)	28 Nm (21 ft-lb)

Timing chain



➢ Place timing chain on camshaft sprocket. Make sure that triangular timing mark on camshaft sprocket is aligned with copper-colored timing chain link (**dashed line**).

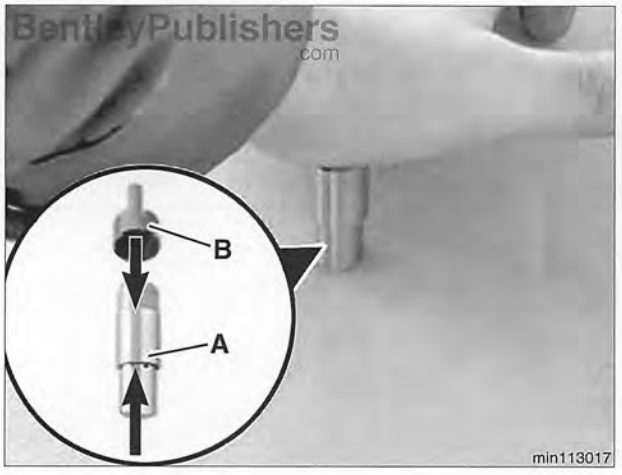
– Place sprocket on camshaft and insert mounting bolt.



➢ Attach BMW special tool 11 8 250 to camshaft sprocket. Torque camshaft sprocket bolt.

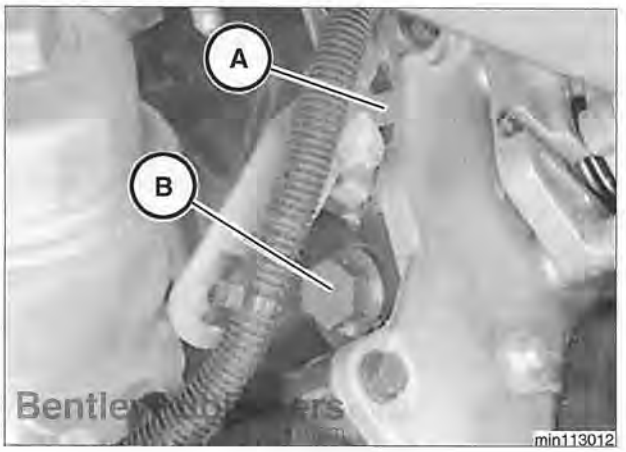
Tightening torque	
Camshaft sprocket to camshaft (M12)	102 Nm (75 ft-lb)

CAUTION—
Be careful not to damage timing chain during this step.



➢ Squeeze timing chain tensioner plunger into retracted position.

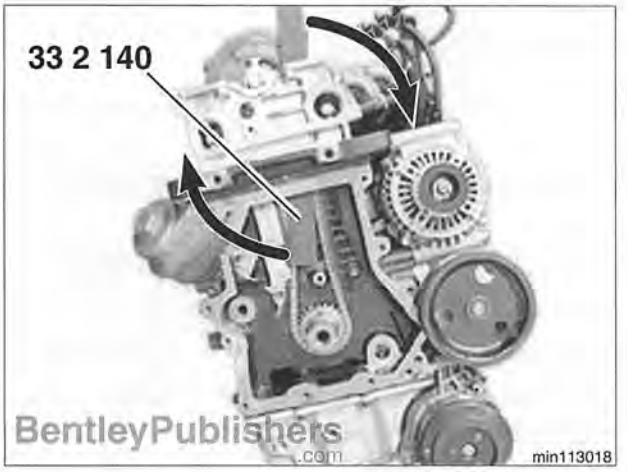
- Place plunger (**A**) on level surface.
- Remove plunger cap (**B**).
- Exert continuous hand pressure on plunger until it is completely compressed.
- Replace cap.



➢ Working in back of engine block, install timing chain tensioner plunger. Install tensioner plug (**B**).

Tightening torque	
Timing chain tensioner to engine block	63 Nm (46 ft-lb)

– If applicable: Install wiring harness bracket in back of engine block (**A**).



➢ Insert large prying bar (BMW special tool 33 2 140 or equivalent) into timing chain housing and turn clockwise. This releases timing chain tensioner plunger and tensions chain.

CAUTION—
- *Do not pry directly on timing chain. Damage may result.*
- *Make sure that the timing chain is properly positioned within the channels of the timing chain guides.*

– Reinstall timing chain housing cover, crankshaft vibration damper, alternator drive belt tensioner, and drive belt.

Tightening torques	
Drive belt idler pulley to timing chain housing cover (M8)	45 Nm (33 ft-lb)
Drive belt tensioner to timing chain housing cover (M6)	9 Nm (7 ft-lb)
Drive belt tensioner to timing chain housing cover or to supercharger (M10)	45 Nm (33 ft-lb)
Timing chain housing cover to engine block (M6)	12 Nm (9 ft-lb)
Timing chain housing cover to engine block (M8 oval head)	18 Nm (13 ft-lb)
Vibration damper to crankshaft (use new M12 bolt)	115 Nm (85 ft-lb)

– Continue to reassemble engine, paying attention to the following:
  - Use new sealing washers when installing threaded plugs at front of cylinder head.
  - Use new hose clamps, seals and gaskets, as necessary.
  - Check DME control module adaptations using diagnostic scan tool. Check for fault codes and clear and reset control module memory.

Tightening torques	
Battery cable (- or +) to battery (M6)	5 Nm (44 in-lb)
Camshaft position sensor to cylinder head (M6)	9 Nm (7 ft-lb)
Engine front mounting bracket to top of engine block (M12)	100 Nm (74 ft-lb)
Hydraulic engine mount to body	100 Nm (74 ft-lb)
Hydraulic engine mount to body (replace Torx bolt): Initial torque Torque angle	 56 Nm (41 ft-lb) 90°
Hydraulic engine mount to engine mounting bracket	68 Nm (50 ft-lb)
Ignition coil pack to valve cover (M6)	12 Nm (9 ft-lb)
Sealing plug to cylinder head	18 Nm (13 ft-lb)
Spark plug to cylinder head	27 Nm (20 ft-lb)
Upper engine vibration damper bracket to damper and to engine mounting bracket (M12)	100 Nm (74 ft-lb)
Valve cover to cylinder head (M6)	12 Nm (9 ft-lb)

119 Lubrication System

GENERAL

This repair group covers lubrication system troubleshooting as well as oil pan removal and oil pump replacement.

NOTE —
Oil change procedure and oil filter replacement are covered in **020 Maintenance**.

Special tools

Some special tools are required for servicing the lubrication system. Be sure to have the necessary equipment on hand before starting the job.

A standard oil pressure gauge may be used for measuring oil pressure.

- Handle for drift
(BMW tool no. 00 5 500)

- Slip sleeve for rear main seal
(BMW tool no. 11 8 220)

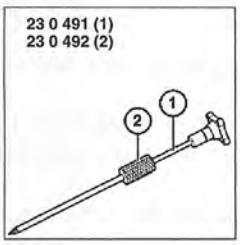
- Drift for rear main seal
(BMW tool no. 11 8 230)

- Crankshaft front seal insertion tool
(BMW tool no. 11 8 240)

Extraction tool for rear main seal
(BMW tool no. 11 8 290)

Oil pressure tool fitting
(BMW tool no. 11 8 360)

Modular front end extensions
(BMW tool no. 11 8 400)



Seal extractor
(BMW tool no. 490)

Engine lubrication

Oil pressure is generated by a gear-type pump located on the inside of the timing cover. The oil pump is driven directly off the front of the crankshaft. Servicing the oil pump requires removal of the timing cover. See **Table a** for oil recommendations and capacity.

Table a. Engine oil with filter change

Model	Approximate capacity	Oil specification
MINI Cooper MINI Cooper S	4.7 liters (4.5 US qt)	BMW Longlife-01 or BMW Longlife-98 ACEA A3

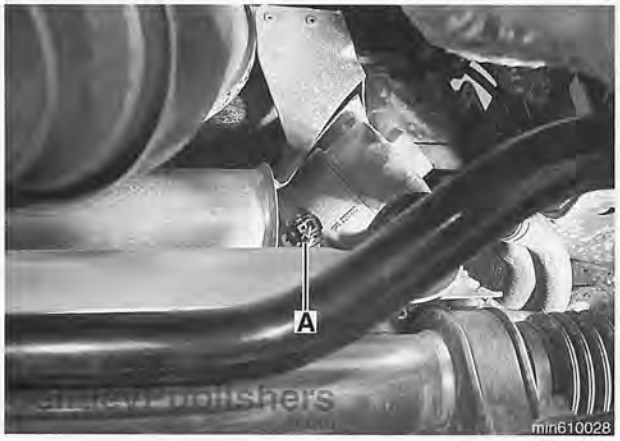
TROUBLESHOOTING

The oil pressure warning system consists of an oil pressure switch mounted on the oil filter housing and an instrument panel warning light. Other safety features include:

- A filter bypass to provide lubrication should the oil filter become clogged.
- An oil pressure relief valve installed in the oil pump housing to prevent excessive system pressure.

> ***CAUTION—***
> *If the red oil pressure light comes on while driving, always assume that oil pressure is low. Stop engine immediately and make arrangements to test oil pressure.*

Oil pressure, checking



➤ The oil pressure switch (**A**) is located at the base of the oil filter housing.

– Unscrew oil filter cover slowly to allow engine oil to drain back down into oil pan.

– Disconnect harness connector from oil pressure switch.

NOTE—
- *Thoroughly clean around the oil pressure switch before removing it.*
- *Be prepared to catch leaking oil with a shop towel.*

– Install threaded adapter with O-ring (BMW tool no. 11 8 360) (if necessary) and an oil pressure gauge in place of oil pressure switch.

– With gauge installed and filter cover retightened, start engine and allow to reach operating temperature. Check oil pressure. See **Table b**.

NOTE—
For the most accurate test results, the engine oil and filter should be new. The oil should be the correct grade.

Table b. Engine oil pressure	
At idle	0.25 bar (3.6 psi)
At 3000 RPM	1.7 - 5.5 bar (25 - 80 psi)

> ***CAUTION—***
> *If oil pressure is zero at idle, do not run engine at 3000 RPM.*

– Remove pressure gauge and reinstall pressure switch with new sealing washer.

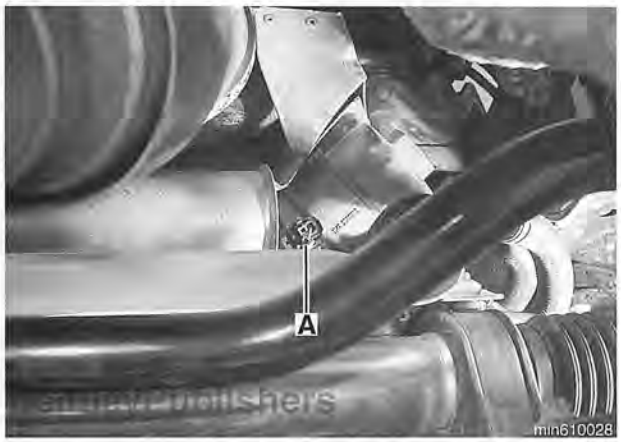
Tightening torque	
Oil pressure switch to oil filter housing	20 Nm (15 ft-lb)

If testing shows low oil pressure, one or more of the following conditions may be indicated:

- Worn or faulty oil pump or faulty pump pressure relief valve
- Worn or damaged engine bearings
- Severe engine wear

Any of these conditions indicate the need for major repairs.

Oil pressure warning system, testing



When the ignition is turned on, the oil pressure warning light comes on. When the engine is started and the oil pressure rises slightly, the oil pressure switch (**A**) contact opens and the warning light goes out. Make sure the oil level is correct before making tests.

– Turn ignition switch on.
  - Warning light on instrument panel must light.

– Remove connector from oil pressure switch.
  - Warning light on instrument panel must go out.

NOTE —
If the light does not go out, the wiring to the switch is most likely grounded somewhere between the switch terminal and the warning light. See **ELE Electrical Wiring Diagrams** *for electrical schematics.*

– If warning light does not light when ignition is on, remove connector from oil pressure switch and use a jumper wire to ground connector terminal to a clean metal surface. The oil pressure warning light should come on.

– If the warning light comes on, check the switch as described in the next step. If the warning light does not come on, the wiring to the instrument cluster or to the light itself is faulty.

– To test the switch, connect an ohmmeter between terminal in switch body and ground. With engine off, there should be continuity. With engine running, Oil pressure should open switch and there should be no continuity.

CAUTION —
Keep in mind that low oil pressure may be preventing the switch from turning the light out. If the light remains on while the engine is running, check the oil pressure as described earlier. Do not drive the car until the problem is corrected. The engine may be severely damaged.

Tightening torque	
Oil pressure switch to oil filter housing	20 Nm (15 ft-lb)

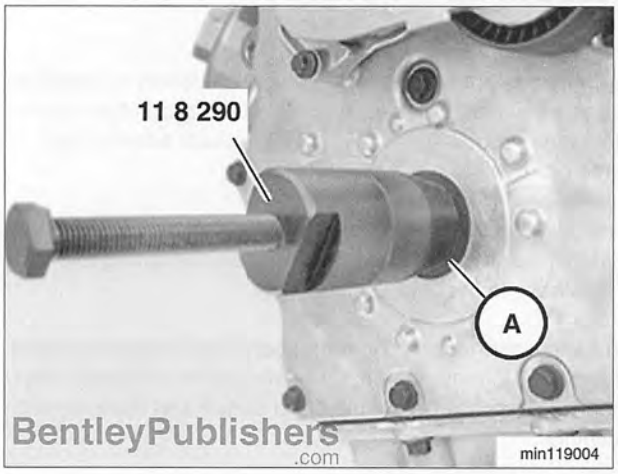
CRANKSHAFT SEAL

Crankshaft front seal, removing and installing

– Remove drive belt.

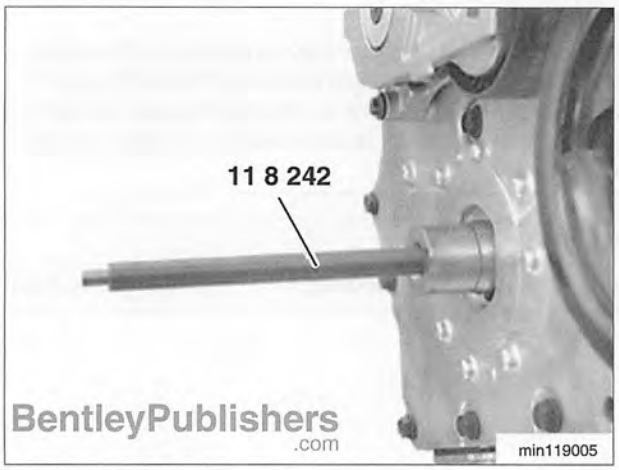
– Remove crankshaft vibration damper. See **117 Camshaft Timing Chain** for more information.

➢ Working at the timing cover, fit special tool (BMW 11 8 270) to crankshaft.



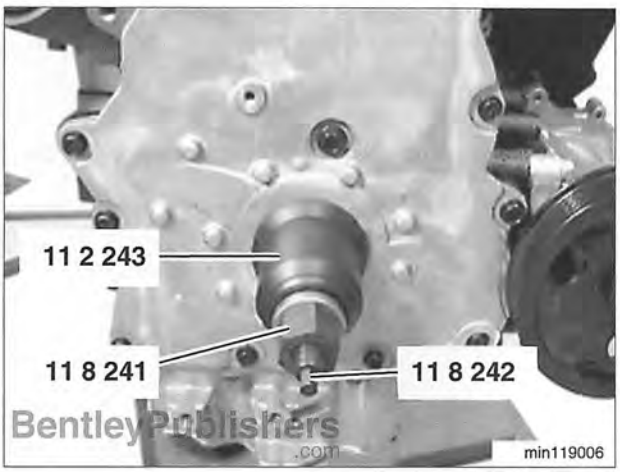
➢ Fit special tool (BMW 11 8 290) on crankshaft and screw in until it connects solidly with crankshaft seal.

– Remove crankshaft seal (**A**) by tightening bolt.



➢ To replace crankshaft seal, fit special tool (BMW 11 8 242) to crankshaft and tighten.

– Coat lip of new seal with oil.



➢ Using special tool (BMW 11 8 243) and (BMW 11 8 241) carefully install crankshaft seal until flush with timing case cover.

– Remainder of installation is reverse of removal.

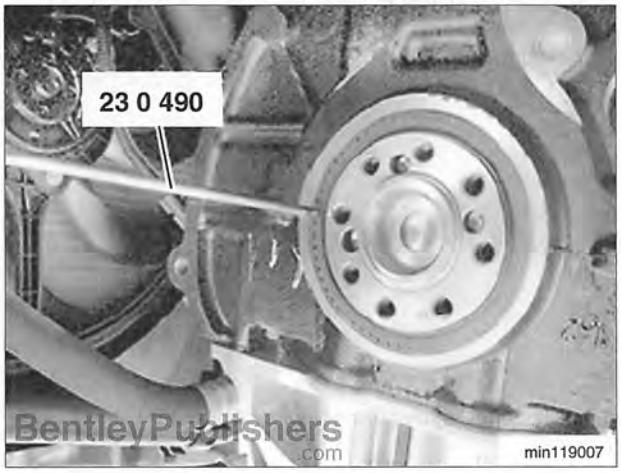
Crankshaft rear seal, removing and installing

Crankshaft rear main seal replacement requires removal of the transmission and flywheel.

– Remove transmission. See **230 Manual Transmission** or **240 Automatic Transmission**.

– Manual transmission models: Remove clutch pressure plate and disc. See **210 Clutch**.

– Remove flywheel. See **210 Clutch** or **240 Automatic Transmission**.



➢ Remove rear main seal with special tool (BMW 23 0 490).

– Clean seal surfaces on engine block and crankshaft.

➢ Fit special tool (BMW 11 8 220) over crankshaft and slide new seal over special tool.

➢ Use special tool (BMW 00 5 500) or suitable drift and special tool (BMW 11 8 230) to drive rear main seal flush with cylinder block.

> ***CAUTION —***
> *The seal is very delicate and must not be kinked or damaged. Do not touch seal lip with fingers.*

ENGINE OIL PAN

Oil pan, removing and installing

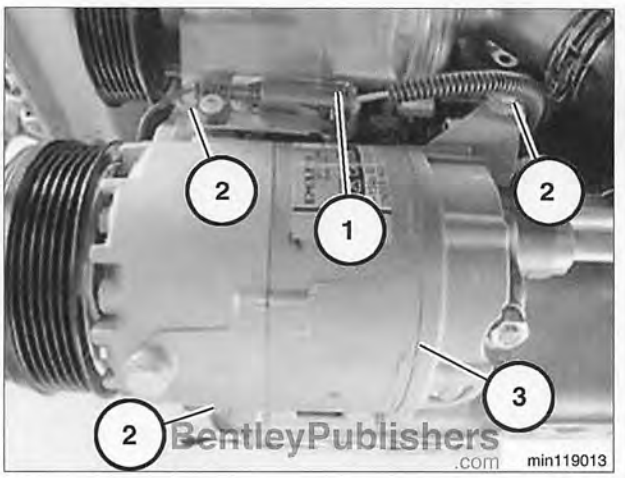
– Disconnect battery.

– Remove drive belt.

– Remove engine splash guard.

– Drain engine oil.

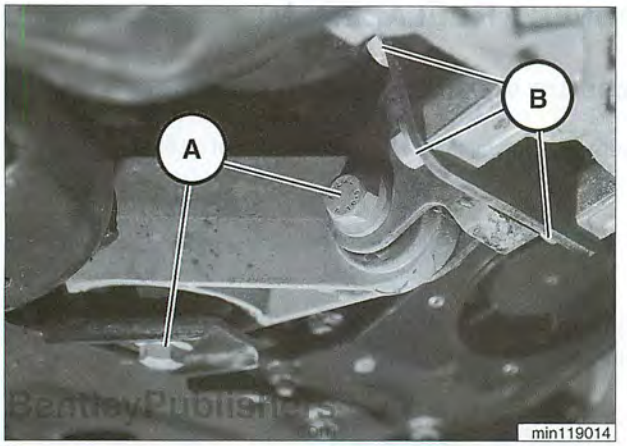
➢ Remove crush tubes and fit special tools (BMW 11 8 401 and 11 8 402) to extend front end way from chassis. See **110 Engine Removal and Installation**.



➢ Working at front of engine, disconnect wire connector (**1**) from A/C compressor.

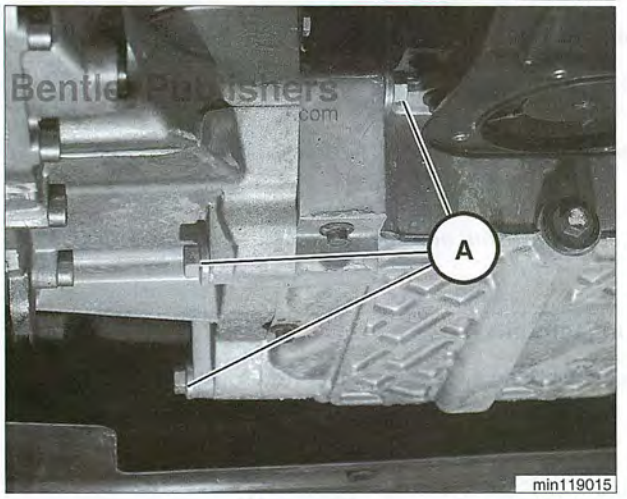
– Remove compressor retaining bolts (**2**) and secure compressor (**3**) to modular front end with stiff wire.

– Unclip A/C high pressure pipe from oil pan.



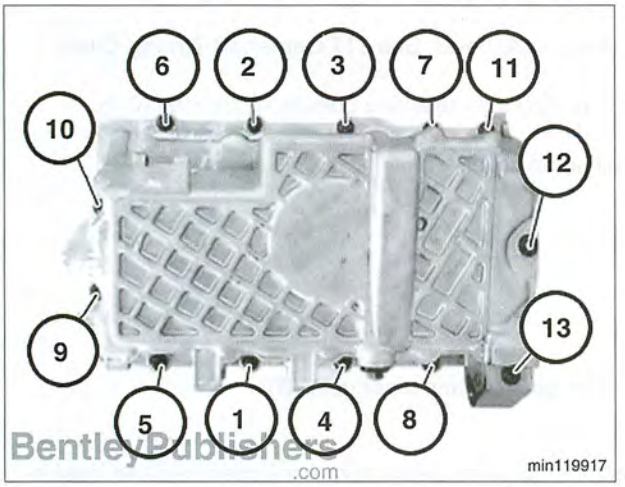
➢ Remove lower engine vibration damper bolts (**A**) and remove damper.

– Remove bracket retaining bolts (**B**) and remove bracket from oil pan.



➢ Remove transmission retaining bolts (**A**).

NOTE —
The two shorter bolts are installed in oil pan.



➢ Remove oil pan bolts in sequence (13 - 1) and remove pan.

– Clean surface of oil pan and cylinder block and check for surface damage.

– Installation is reverse of removal noting the following:
- Replace gasket.
- Tighten oil pan bolts in reverse sequence to removal (1-13).
- Replace engine oil and check for leaks.

Tightening torque	
Oil pan to cylinder block	31 Nm (23 ft-lb)

COMPONENT REPLACEMENT

Oil pressure warning switch, replacing

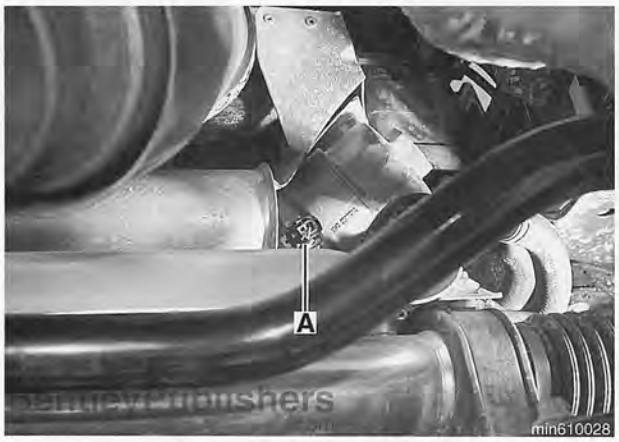
Oil pressure warning switch is located on side of oil filter housing.

– Remove right front wheel and fender lining to gain access to oil filter housing.

– Using a 36 mm socket, loosen oil filter housing cover slowly to allow oil to drain back into crankcase.

– Tighten oil cover.

Tightening torque	
Cover to oil filter housing	25 Nm (18 ft-lb)



➤ Disconnect electrical connector (**A**) and remove oil pressure switch.

NOTE—
Replace sealing washer anytime oil pressure warning switch is removed.

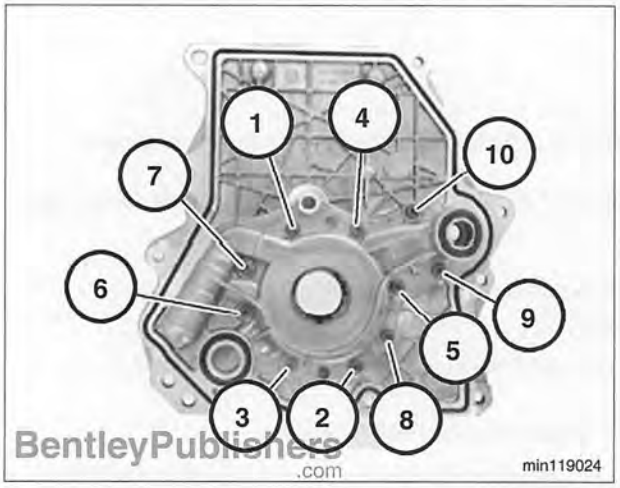
Tightening torque	
Oil pressure warning switch to oil filter housing	20 Nm (15 ft-lb)

Oil pump, removing and installing

– Remove timing case cover. See **117 Camshaft Timing Chain**.

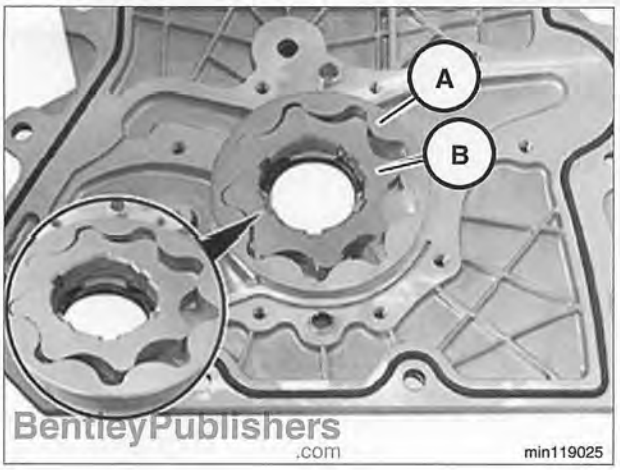
➤ Remove oil pump cover retaining bolts in sequence (10-1).

– Remove oil pump cover.



➤ Remove outer gear (**A**) and inner gear (**B**).

NOTE—
Outer and inner oil pump gears form a matched pair and must always be replaced as a set.



– Installation is reverse of removal noting the following:
- Tighten oil pump cover retaining bolts in reverse order (1-10).
- Replace timing cover and check for leaks.

Oil pressure relief valve, removing and installing

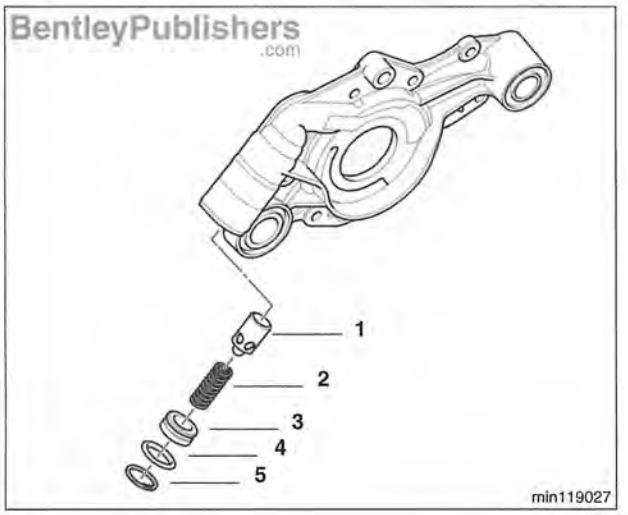
– Remove timing case cover. See **117 Camshaft Timing Chain**.

– Remove oil pump. See **Oil pump, removing and installing** in this repair group.

➤ Using a suitable drift, press down on valve spacer to remove load from circlip (**arrow**) and remove circlip.

> ***CAUTION—***
> *Relief valve is under strong spring pressure. Use care when removing.*

– Remove oil pressure relief valve.



➤ Replace relief valve components in the proper order:

1. Relief valve
2. Spring
3. Spacer
4. O-ring
5. Circlip

– Check oil pump housing and relief valve bore for scoring or damage before replacing.

120 Ignition System

GENERAL

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

When diagnosing engine management problems, including on-board diagnostics (OBD II) fault code analysis, also refer to these repair groups:

- **130 Fuel Injection**
- **ELE Electrical Wiring Diagrams**
- **OBD On Board Diagnostics**

Spark plug replacement is covered in **020 Maintenance**.

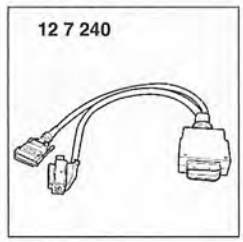
Special tools

Diagnosis and testing of the ignition system requires special test equipment. If you lack the necessary tools to perform a procedure, repairs are best left to an authorized MINI dealer or other qualified repair facility.

> ***CAUTION***—
> *Only use a digital multimeter for electrical tests.*

➤ LED test light
(Baum tool 1115)

➤ Automotive digital multimeter



➤ Test lead harness
(BMW special tool 12 7 240)

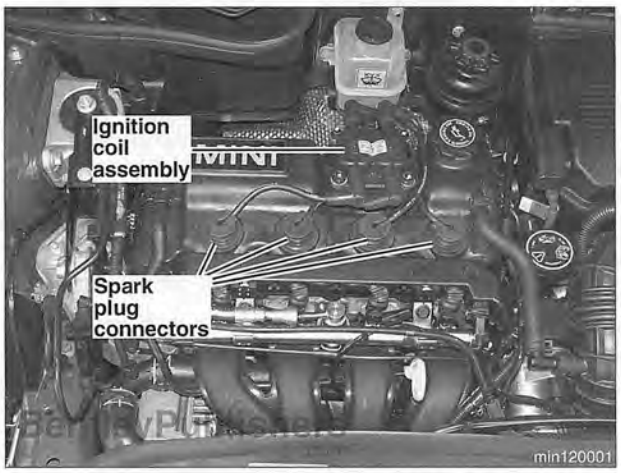
Engine management

The MINI engine use an advanced engine management system known as EMS2000. This system incorporates on-board diagnostics, fuel injection, ignition and other engine control functions into a single engine control module (ECM).

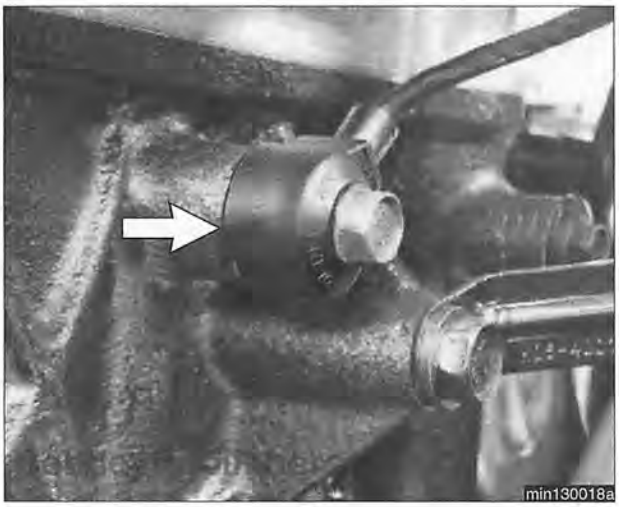
Second generation on-board diagnostics (OBD II) is incorporated into the engine management system. Use a BMW-specific or compatible scan tool to access diagnostic trouble codes (DTCs) and help pinpoint ignition and other engine management problems.

Additional information about DTCs and engine management system electronic system diagnosis is provided in **OBD On Board Diagnostics.**

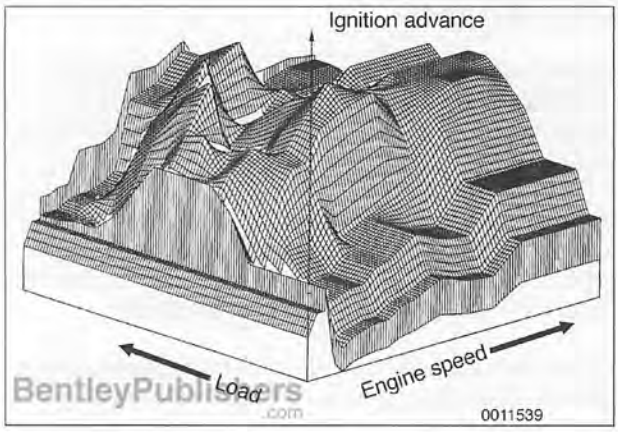
Ignition system



➤ The MINI engine uses a distributorless ignition system. There is no distributor cap or ignition rotor.



➤ A knock sensor (**arrow**) monitors the combustion chambers for engine-damaging knock. If engine knock is detected, the ignition timing is retarded by the ECM.



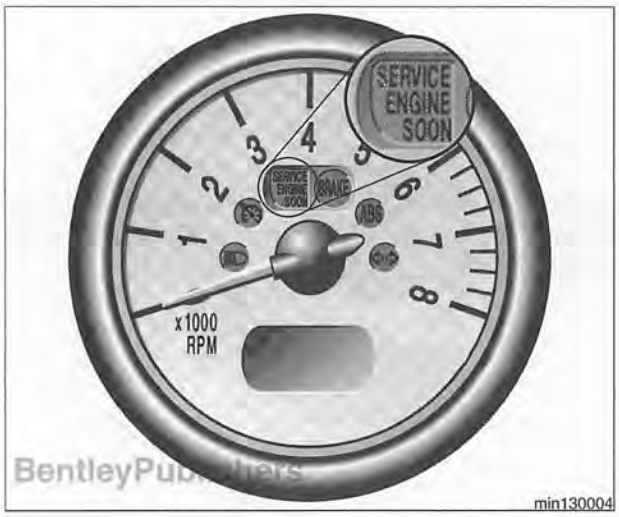
Ignition timing is electronically mapped and not adjustable. The ECM uses engine load, engine speed, coolant temperature, knock detection, and intake air temperature as the basic inputs for timing control. A three dimensional map similar to the one shown is digitally stored in the ECM.

The initial ignition point is determined by the crankshaft speed sensor during cranking. Once the engine is running, timing is continually adjusted based on operating conditions.

Troubleshooting

Troubleshooting ignition system faults should begin with an interrogation of the ECM fault memory. OBD II hardware and software monitors detect ignition system misfire and other related faults. When faults are detected, the ECM stores DTCs along with other pertinent fault information.

WARNING —
Ignition misfires can cause high hydrocarbon exhaust emissions and catalytic converter damage. For this reason, if a severe misfire is detected, the fuel injector will be turned off to the specific cylinder and the MIL will be illuminated. A misfire may also produce an overheated catalytic converter, which can be a fire hazard.



The malfunction indicator light (MIL) illuminates if an emissions related fault is detected. Additional OBD II information, including a DTC lookup table, can be found in **OBD On Board Diagnostics**.

NOTE —
In MINI models, the MIL reads "Service engine soon".

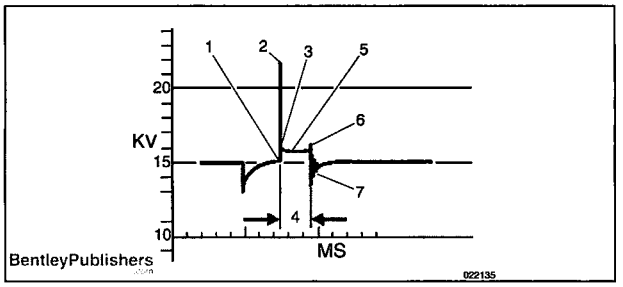
Oscilloscope diagnostic diagrams

One way to diagnose a faulty coil assembly is to use an oscilloscope to analyze spark quality with the engine running.

See **Table a** for a list of common ignition coil voltage faults and related causes.

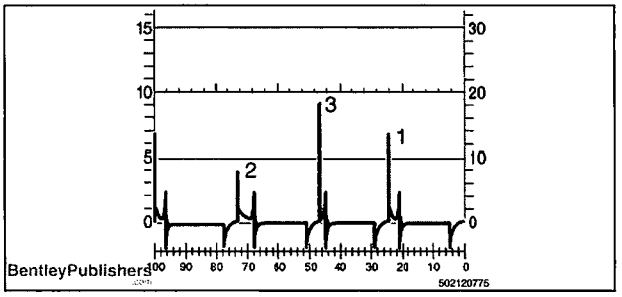
Table a. Ignition secondary voltage diagnostics

Test point	Secondary voltage low	Secondary voltage high
Spark plug electrode gap	Too small	Too big
Spark plug electrode condition		Worn/burnt
Spark plug electrode temperature	Too high	Too low
Engine compression	Too low	Too high
Spark plug wires		Faulty
Fuel air mixture		Too lean



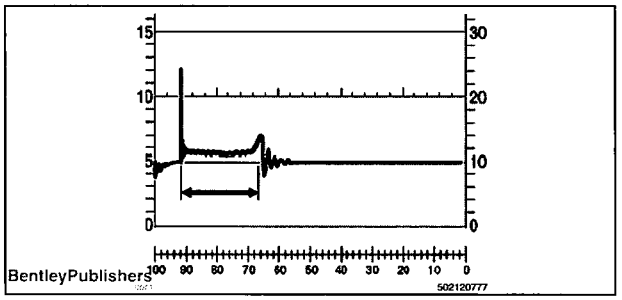
The illustration shows normal 'scope trace of spark at idle.

1. Start of ignition voltage peak
2. Level of ignition voltage
3. Level of combustion voltage
4. Period of combustion
5. Combustion curve characteristics
6. Start of decay process
7. Termination oscillations

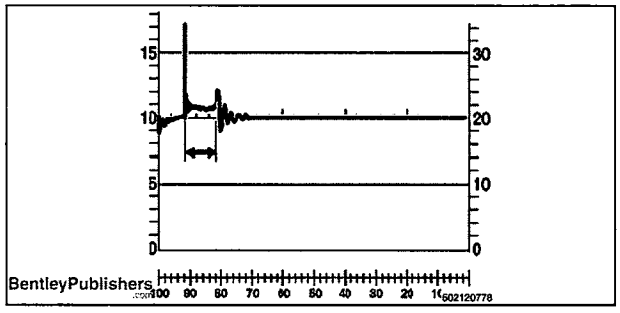


Ignition spark at idle speed.

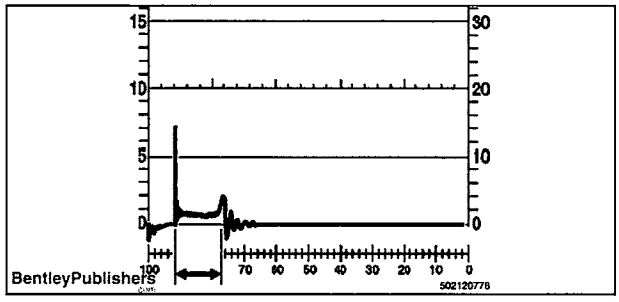
1. Normal ignition voltage peak indicates spark plug is good.
2. Low voltage peak indicates plug gap too narrow.
3. High voltage peak indicates plug gap too wide.



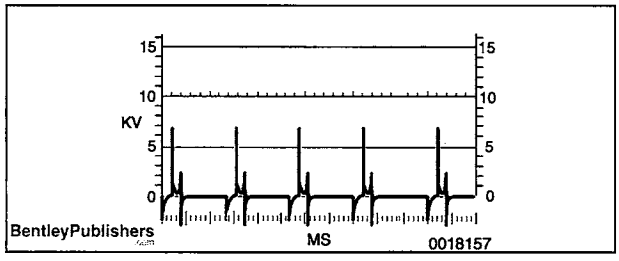
Long combustion period indicates spark plug gap too narrow.



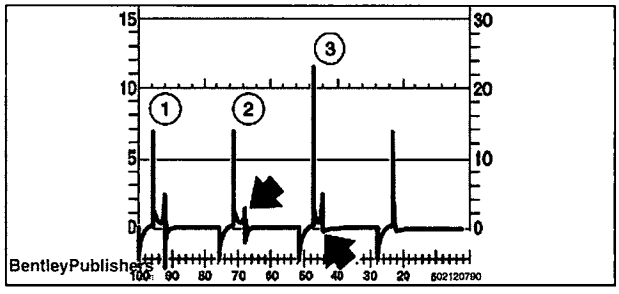
➤ Short combustion period indicates spark plug gap too wide.



➤ Normal combustion period at idle.

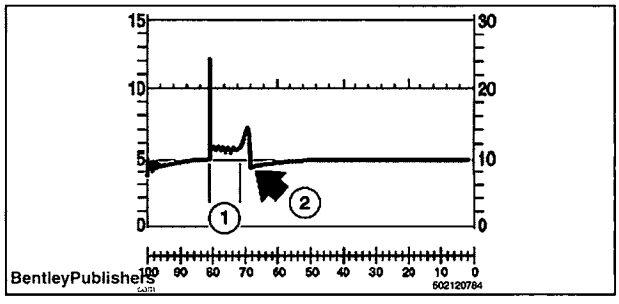


➤ Normal oscilloscope pattern for ignition system at idle.



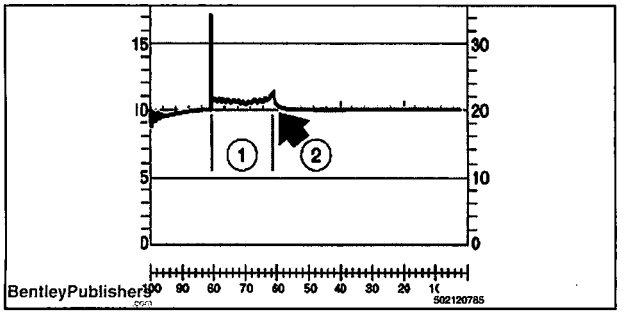
➤ Ignition voltage peaks at idle.

1. Normal ignition peaks.
2. Downward peak (**arrow**) is shortened (ignition coil is defective).
3. Downward peak (**arrow**) is missing completely (ignition coil is defective).

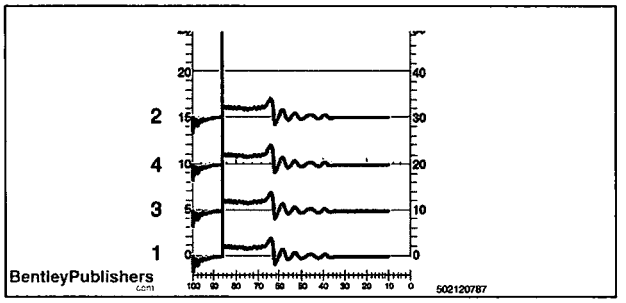


➤ Defective ignition coil.

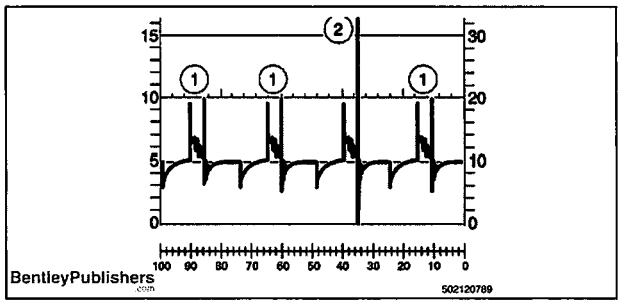
1. Short spark period.
2. Spark voltage line (**arrow**) is very slight.



- Defective ignition coil.
  1. Normal combustion period.
  2. Absence of spark voltage line (**arrow**).



- Normal secondary voltage patterns.



- Ignition voltage peaks in response to sudden acceleration load:
  1. Normal ignition pattern: Beginning of dying out pattern is not much higher than ignition voltage peak.
  2. Faulty ignition system: Beginning of dying out pattern considerably higher than ignition voltage peak. Possible causes:
     - Lean fuel mixture
     - Defective fuel injector
     - Low compression in cylinder

Warnings and cautions

The ignition system produces dangerous high voltage. In addition, sensitive electronic components can be damaged if proper precautions are not adhered to.

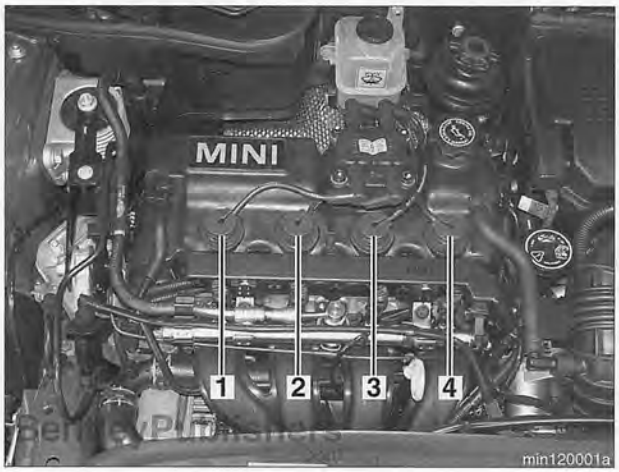
WARNING —

- *Do not touch or disconnect any cables from the coil assembly while the engine is running or being cranked by the starter.*
- *The ignition system produces high voltages that can be fatal. Avoid contact with exposed terminals. Use extreme caution when working on a car with the ignition switched on or the engine running.*
- *Connect and disconnect the DME system wiring and test equipment leads only when the ignition is OFF.*
- *Before operating the starter without starting the engine (for example when making a compression test) always disable the ignition. See* **Disabling ignition system** *in this repair group.*

CAUTION—
- *Connect or disconnect ignition system wires, multiple wire 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.*
- *Use a high impedance digital multimeter for all voltage and resistance tests. Use an LED test light 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 manufacturer.*

IGNITION SYSTEM SERVICE

Ignition firing order



Cylinder 1 is located at right (drive belt) end of engine.

Firing order	
Cooper, Cooper S	1-3-4-2

Disabling ignition system

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

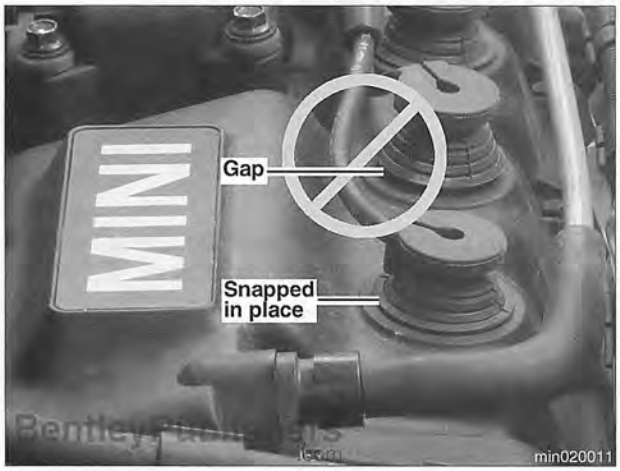
Working at top of valve cover, disconnect electrical harness connector to ignition coil assembly.
- Press securing clip in direction of **white arrow**.
- Pull off coil assembly connector in direction of **black arrow**.

Ignition wire, replacing

– Switch off ignition.

➤ Pull up on spark plug wire connector while gently twisting from side to side.

– Detach other end of wire from coil terminal.



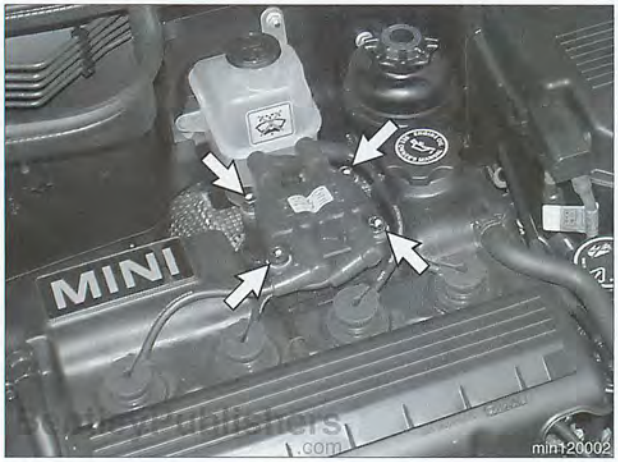
➤ When installing, make sure cable snaps securely into place at coil terminal and at spark plug opening in valve cover.

Ignition coil assembly, replacing

– Read out engine control module (ECM) fault memory. Then switch off ignition.

➤ Working at top of valve cover, disconnect electrical harness connector to ignition coil assembly.
- Press securing clip in direction of **white arrow**.
- Pull off coil assembly connector in direction of **black arrow**.

– Detach ignition cables from coil assembly.



➢ Unbolt coil assembly mounting bolts (**arrows**).

– When installing, check coil assembly insulating rubber spacers. Replace mounting bolts and spacers as necessary.

Tightening torque	
Ignition coil assembly to valve cover (M6)	12 Nm (9 ft-lb)

– Clear ECM fault memory.

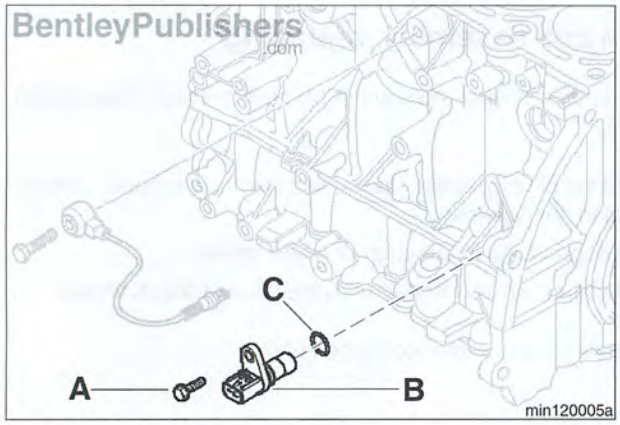
Crankshaft position sensor, replacing

– Read out engine control module (ECM) fault memory. Then switch off ignition.

– Cooper: Remove intake manifold. See **113 Cylinder Head Removal and Installation**.

– Cooper S: Remove front bumper and loosen modular front end. Pull assembly forward to gain access to front of crankcase.

NOTE —
Removal of modular front end is a complicated job. It is covered in **510 Bumpers, External Trim**.



➢ Working at crankshaft position sensor, in front of crankcase at clutch end of engine, unlock and detach electrical harness connector.

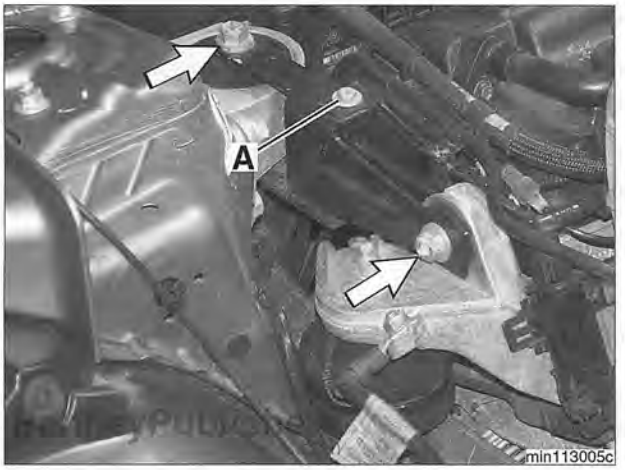
– Unscrew mounting bolt (**A**).

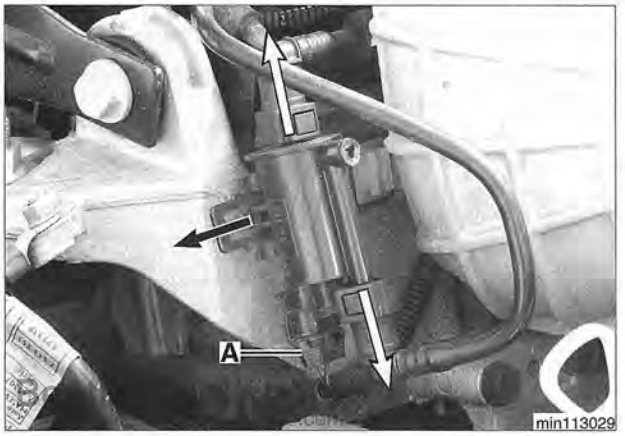
– Remove crankshaft sensor (**B**).

– When installing, replace sealing O-ring (**C**).

Tightening torque	
Crankshaft sensor to crankcase (M6)	9 Nm (7 ft-lb)

– After reassembling engine, clear ECM fault memory.





Camshaft position sensor, replacing

– Read out engine control module (ECM) fault memory.

– Switch off ignition.

➤ Remove engine vibration damper bracket:
- Remove fuel line bracket mounting bolt (**A**). Detach any fuel lines still attached. Lift off bracket and set aside.
- Remove engine vibration damper bracket bolts (**arrows**).
- Remove bracket.

➤ Remove fuel tank vent valve.
- Disconnect vent hoses (**white arrows**) via quick fit connectors.
- Straighten retaining tab and slide vent valve off bracket (**black arrow**).
- Remove electrical harness connector (**A**).

– Support engine under oil pan.

> ***CAUTION —***
> *To avoid damaging the oil pan, use a rubber pad on top of the engine supporting jack.*

– Remove right side engine mounting bracket:
- Remove engine ground cable mounting nut from bracket. Detach ground cable.
- Remove 4 engine mounting bolts from engine block.
- Unscrew mounting nut from hydraulic front engine mount stud. Lift off engine mount bracket.

➤ Working at right end of cylinder head, unlock and detach camshaft sensor electrical harness connector (**arrow**).

– Unscrew sensor mounting bolt and remove sensor.

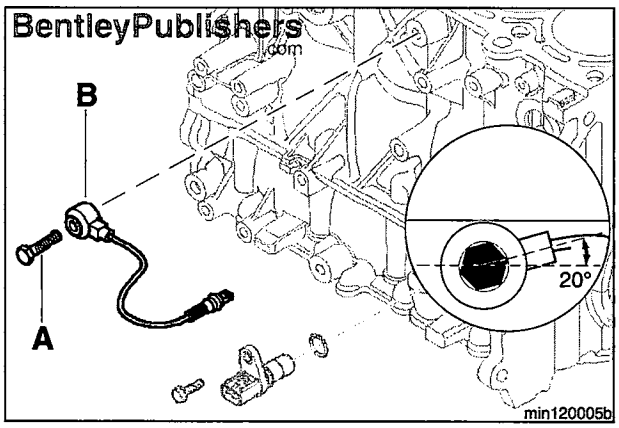
– When installing, lubricate sealing O-ring with antiseize paste.

Tightening torque	
Camshaft sensor to cylinder head (M6)	9 Nm (7 ft-lb)

– After reassembling engine, clear ECM fault memory.

Knock sensor, replacing

- Read out engine control module (ECM) fault memory. Then switch off ignition.
- Cooper: Remove intake manifold. See **113 Cylinder Head Removal and Installation**.
- Cooper S: Remove supercharger. See **130 Fuel Injection**.
- Working at center of engine block just below cylinder head seam, unlock and detach knock sensor electrical harness connector.



- Note knock sensor orientation before removal. Unscrew sensor mounting bolt (**A**) and remove sensor (**B**).
- When installing:
  - Clean knock sensor and crankcase contact surfaces.
  - Orient knock sensor in relation to engine block with tilt of 20° from horizontal. Refer to insert in illustration.

Tightening torque	
Knock sensor to crankcase (M8)	22 Nm (16 ft-lb)

- After reassembling engine, clear ECM fault memory.

121 Battery, Starter, Alternator

TABLES

GENERAL

This section covers battery, starter, alternator and associated components of the electrical system.

Troubleshooting information for these components is found in **Table a**. For additional electrical troubleshooting information, see **600 Electrical System - General**.

Special tools

Automotive digital multimeter

CAUTION—
Only use a digital multimeter when testing automotive electrical components.

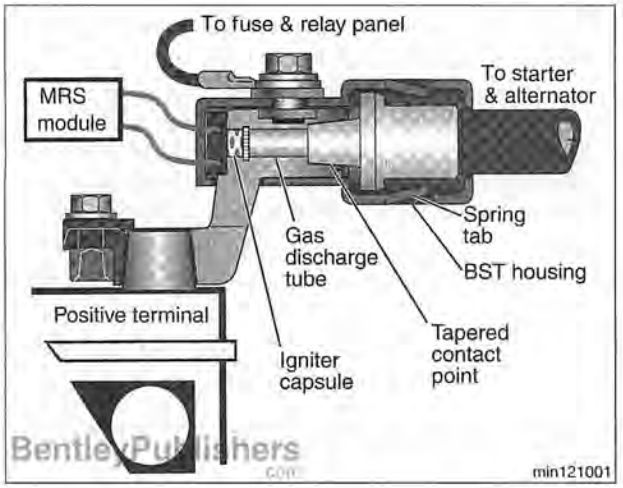
Electronic battery charger
(Deutronic DBL 1000-14)

Cigarette lighter trickle charger
(BMW special tool 61 2 410)

Engine electrical system

The alternator and starter are wired directly to the battery. To prevent accidental shorts that might blow a fuse or damage wires and electrical components, always disconnect the negative (-) battery lead before working on the electrical system.

Various versions of alternators, voltage regulators, starters, and batteries have been used in the MINI models covered by this manual. Replace components according to the original equipment specification. When in doubt, consult an authorized MINI parts department.



Battery safety terminal (BST)

In Cooper S models, due to battery location in the cargo compartment, a battery safety terminal (BST) is installed at the battery positive pole. This feature and a comprehensive electrical fusing system aim to minimize the danger of short circuits in case of a severe accident. To achieve this, the vehicle's electrical system is divided into the starter-alternator circuit and the vehicle system supply circuit:

- The vehicle system supply circuit is protected against short circuits by means of a fusible link.
- The starter and the alternator supply circuit, since it must carry very high current when the starter is engaged and is permanently subjected to voltage, is protected by BST.

The multiple restraint system (MRS) controls the BST. In case of an accident, the MRS control module fires the encapsulated pyrotechnic device in the BST, disconnecting power to the starter and alternator, but maintaining power to the exterior lights and interior of the vehicle.

Troubleshooting

Tests for individual electrical system components are described under different components in this repair group.
Table a gives some general troubleshooting ideas.

Table a. Battery, starter and alternator troubleshooting

Symptom	Probable cause	Corrective action
Engine does not crank.	Fault in immobilizer system (EWS).	Try another ignition key. If problem persists, contact your authorized dealer.
Engine cranks slowly or not at all, solenoid clicks when starter is operated.	Battery cables loose, dirty or corroded.	Clean or replace cables. See **020 Maintenance**.
	Battery discharged.	Charge battery and test. Replace if necessary.
	Battery to body ground cable loose, dirty or corroded.	Inspect ground cable. Clean, tighten or replace if necessary.
	Poor connection at starter motor terminal 30.	Check connections, test for voltage at starter. Test for voltage at neutral safety or clutch interlock switch.
	Starter motor or solenoid faulty.	Test starter.
Battery will not stay charged more than a few days.	Short circuit draining battery.	Test for excessive current drain with everything electrical off.
	Short driving trips and high electrical drain on charging system.	Evaluate driving style. Where possible, reduce electrical consumption when making short trips.
	Engine drive belt loose, worn, damaged.	Inspect or replace belt. See **020 Maintenance**.
	Battery faulty.	Test battery and replace if necessary.
	Battery cables loose, dirty or corroded.	Clean or replace cables. See **020 Maintenance**.
	Alternator or voltage regulator faulty.	Test alternator and voltage regulator.

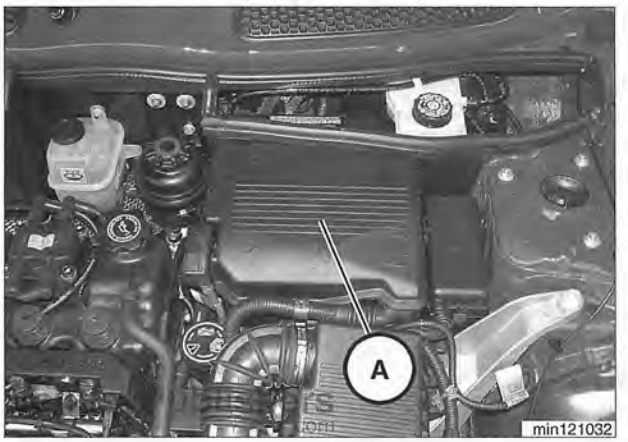
Warnings and cautions

WARNING—

- *Wear goggles, rubber gloves, and a rubber apron when working around the battery or battery acid (electrolyte).*
- *Battery acid contains sulfuric acid and can cause skin irritation and burning. If acid is spilled on your skin or clothing, flush the area at once with large quantities of water. If electrolyte gets into your eyes, flush them with large quantities of clean water for several minutes and call a physician.*
- *Batteries that are being charged or are fully charged give off explosive hydrogen gas. Keep sparks and open flames away. Do not smoke.*

CAUTION—

- *Only use a digital multimeter when testing automotive electrical components.*
- *If a repair procedure specifies disconnecting the battery, follow the instruction for safety reasons.*
- *Prior to disconnecting the battery, read the battery disconnection cautions in* **001 General Warnings and Cautions**.
- *Before disconnecting battery, switch ignition OFF. If the ignition is not turned off when the battery is disconnected, diagnostic troubles codes (DTCs) may be set in some electronic control modules.*
- *Disconnecting the battery cables may erase DTCs stored in ECM memory.*
- *Disconnecting the battery erases the radio presets. Therefore, note stored stations and restore them after connecting the battery.*
- *Stored settings of the on-board computer and clock will also be lost.*
- *Always disconnect the negative (–) battery cable first and reconnect it last. Cover the battery post with an insulating material whenever the cable is removed.*
- *Do not disconnect battery, alternator or starter wires while the engine is running.*
- *Never reverse the battery cables. Even a momentary wrong connection can damage the alternator and other electrical components.*
- *Do not depend on the color of insulation to tell battery positive and negative cables apart. Label cables before removing.*
- *After disconnecting battery, reinitialize power windows and electric sunroof. See* **512 Door Windows** *and* **540 Sunroof**.



BATTERY

MINI models are equipped with a 12-volt negative ground electrical system.

Cooper: Battery is located in left rear of engine compartment in an insulating box with a heat resistant cover (**A**).

Cooper S: Battery is located in center of cargo compartment, under a trim cover.

Battery capacity

Required battery capacity is determined by the amount of current consumed by the electrical system.

MINI batteries are rated by ampere-hours (Ah), determined by the average amount of current the battery can deliver over time without dropping below a specified voltage. Always replace the battery with one having the same or higher rating.

Battery capacity	
Cooper, Cooper S	55 Ah

Battery charging

Recharge discharged batteries using a battery charger. Prolonged charging causes electrolyte evaporation to a level that can damage the battery. It is best to use a low-current charger (6 amperes or less) to prevent battery damage caused by overheating.

Cooper S: When charging battery, connect positive charger cable to B+ terminal (**arrow**) in engine compartment. Connect negative cable to suitable exposed metal in engine compartment (such as engine or transmission mounting bracket).

– Before charging battery, test battery as described in **Battery open-circuit voltage test** in this repair group.
  - If voltage is 10 vdc or less, one or more cells may be faulty or battery may already be damaged.
  - In this case, remove battery from vehicle to recharge, because escaping battery gases could damage interior equipment and trim.
  - Remove battery cap covers and top up cells with distilled water. Leave caps off while charging.
  - Attempt to revive faulty cells with low charging current.

WARNING—
- *Hydrogen gas given off by the battery during charging is explosive. Do not smoke. Keep open flames away from the top of the battery, and prevent electrical sparks by turning off the battery charger before connecting or disconnecting it.*
- *When charging battery in the Cooper, make sure battery box cover is off.*
- *When charging battery in the Cooper S, make sure the cargo compartment door is open and battery trim cover in bottom of compartment is lifted up.*

CAUTION—
- *Battery electrolyte (sulfuric acid) can damage the car. If electrolyte is spilled, clean the area with a solution of baking soda and water.*
- *Always allow a frozen battery to thaw before attempting to recharge it.*
- *If a quick charger is used to charge the battery, disconnect battery from vehicle electrical system and remove. This prevents damage to paintwork and upholstery.*

Battery maintenance

Check battery acid level at least once a year. If necessary, top up with distilled water.

Electrical consumers require power supply from the battery even when the vehicle is not being driven. The battery also self-discharges. Battery self-discharging time is dependent on vehicle model and vehicle equipment.

If a long time passes without the battery being recharged, it will eventually result in concealed damage. This will in turn lead to early failure of the battery.

– If battery is connected to vehicle circuits: Recharge every 6 weeks.

– If battery is not connected to vehicle circuits: Recharge every 12 weeks.

– For vehicle in continual but light use, use cigarette lighter trickle charger, BMW special tool 61 2 410, to maintain optimum battery charge. This charger, with electronic circuitry for controlling voltage and current, switches charge voltage off at 13.8 vdc and back on again at 12.6 vdc. Charge current is no greater than 5.5 A.

Battery testing

Battery testing determines the state of battery charge. On conventional or low-maintenance batteries, the most common method of testing the battery is to check the specific gravity of the electrolyte using a hydrometer. Before testing the battery, check that the cables are tight and free of corrosion.

NOTE—
In several battery tests given below, it is assumed that the battery cell caps are removed. This is not possible in some "maintenance-free" batteries.

Hydrometer testing

Before hydrometer testing, load the battery with 15 amperes for one minute. If the battery is installed in the vehicle, this can be done by turning on the headlights without the engine running. The state of the battery charge based on specific gravity values are given in **Table b**.

The hydrometer indicates the specific gravity of the electrolyte. The more dense the concentration of sulfuric acid in the electrolyte, the higher the state of charge.

NOTE—
Electrolyte temperature affects hydrometer reading. Check the electrolyte temperature with a thermometer. Add 0.004 to the hydrometer reading for every 6° C (10° F) that the electrolyte is above 27° C (80° F). Subtract 0.004 from the reading for every 6° C (10° F) that the electrolyte is below 27° C (80° F).

Table b. Specific gravity of battery electrolyte at 27°C (80°F)

Specific gravity	State of charge
1.265	Fully charged
1.225	75% charged
1.190	50% charged
1.155	25% charged
1.120	Fully discharged

- If electrolyte specific gravity is at or above 1.225, but battery lacks power for starting, determine battery service condition with a load voltage test. See **Battery load voltage test** in this repair group.
- If average specific gravity of battery cells is below 1.225, recharge battery.
- After charging several hours, if electrolyte specific gravity remains low or battery lacks starting power, replace battery.

Battery open-circuit voltage test

➢ Before testing, load battery with 15 amperes for one minute with battery load-tester or turn on headlights for about one minute without engine running. Connect digital voltmeter across battery terminals. Open-circuit voltage levels are given in **Table c**.

– If open-circuit voltage is OK but battery still lacks power for starting, perform load voltage test.

– If open-circuit voltage is below 12.4 vdc, recharge battery and retest.

Table c. Open-circuit voltage and battery charge	
Open-circuit voltage	**State of charge**
12.6 vdc or more	Fully charged
12.4 vdc	75% charged
12.2 vdc	50% charged
11.7 vdc or less	Fully discharged

Battery load voltage test

– Disconnect battery cables before making test.

CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions in **001 General Warnings and Cautions**.

– Using battery load tester, apply high resistive load (approx. 200 amps) to battery terminals. Measure battery voltage.

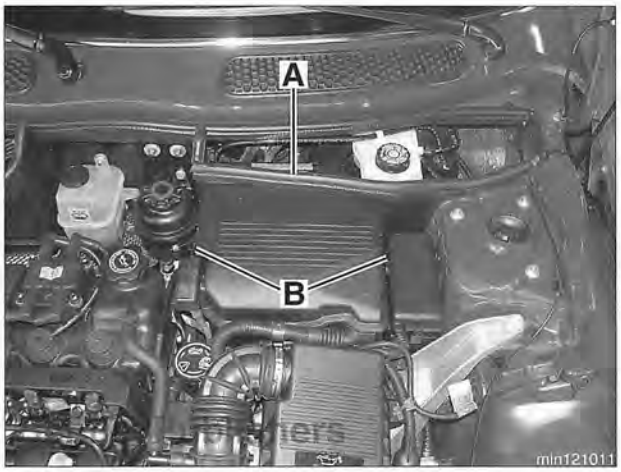
NOTE—
The battery should be fully charged for the most accurate results.

– Check results against data in **Table d**. Replace battery if voltage is below minimum.

Table d. Battery load test - minimum voltage	
Ambient temperature	**Voltage***
27°C (80°F)	9.6 vdc
16°C (60°F)	9.5 vdc
4°C (40°F)	9.3 vdc
-7°C (20°F)	8.9 vdc
-18°C (0°F)	8.5 vdc
*Measured after applying a 200 amp load for 15 seconds	

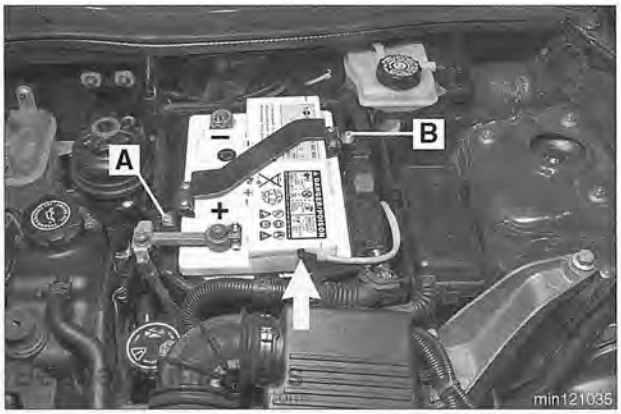
Battery, removing and installing (Cooper)

Cooper battery is in engine compartment, in insulated box.



➤ Working in engine compartment, pry off rubber seal (**A**).

– Release battery box cover clips (**B**) by pressing in. Remove cover.



➤ First disconnect negative (–) battery cable, then positive (+) cable.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions in* **001 General Warnings and Cautions**.

– Detach battery ventilation hose (**arrow**).

– Remove battery hold down retaining bolts (**A** and **B**). Remove hold down.

– Lift out battery.
- It may be helpful to use a battery carrying strap to lift battery out.

– When reinstalling, first connect positive (+) cable, then negative (–) cable. Ensure that both leads are positioned 90° to battery box and routed through recesses in battery box cover.

> ***CAUTION—***
> *Do not apply excessive force when fitting cover to box.*

Tightening torques	
Battery hold down to battery box (M6)	6 Nm (53 in-lb)
Battery terminal clamp (M6)	5 Nm (44 in-lb)

– Reattach ventilation hose.

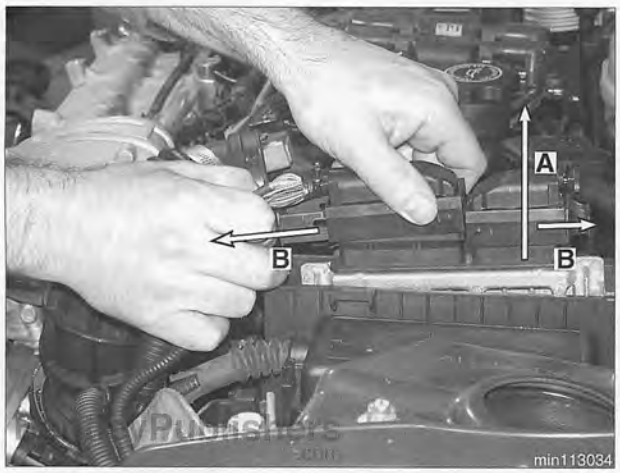
– Reinitialize power windows and electric sunroof. See **512 Door Windows** and **540 Sunroof**.

Battery box, removing and installing (Cooper)

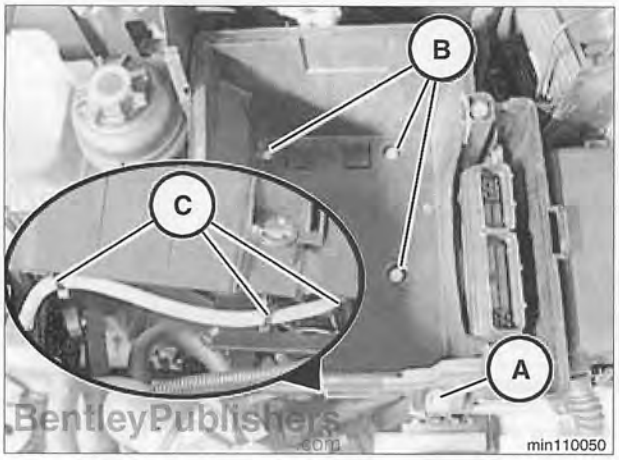
– Turn ignition off.

– Remove battery box cover and battery. See **Battery, removing and installing (Cooper)** in this repair group.

> ***CAUTION —***
> *Disconnecting the battery may erase fault code(s) stored in memory. Check for fault codes prior to disconnecting the battery cables.*



➤ Remove DME control module:
- Remove cover and lift DME control module upwards (**A**).
- Slide connector locking mechanisms (**B**) outward and disconnect control module connectors.



➤ Remove battery box:
- Remove battery box retaining bolt (**A**).
- Release battery box clips (**B**).
- Disconnect harness clips (**C**) from bottom of battery box.

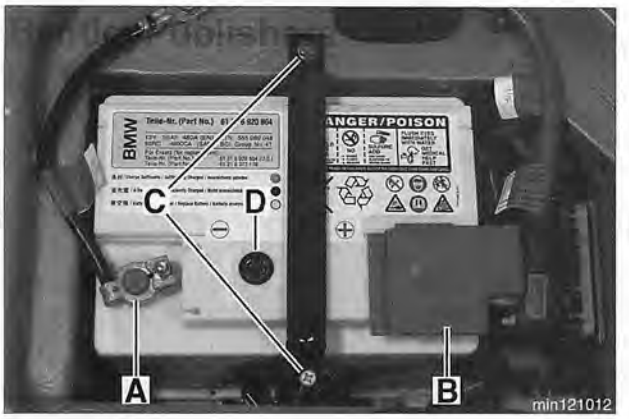
– Installation is reverse of removal.

Tightening torques	
Battery box to support bracket (M6 Torx)	8 Nm (6 ft-lb)
Battery hold down to battery box (M6)	6 Nm (53 in-lb)
Battery terminal clamp (M6)	5 Nm (44 in-lb)

Battery, removing and installing (Cooper S)

Cooper S battery is in center of cargo compartment, under floor trim panel.

– Working in cargo compartment, lift up floor trim.



➤ First disconnect negative (–) battery cable (**A**). Lift positive (+) terminal plastic cover (**B**), then disconnect positive (+) cable.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions in* **001 General Warnings and Cautions**.

– Detach battery ventilation hose.

– Remove battery hold down fasteners (**C**). Remove hold down.

– Lift out battery.

– When reinstalling, first connect positive (+) cable, then negative (–) cable.

Tightening torques	
Battery hold down to battery box (M6)	6 Nm (53 in-lb)
Battery terminal clamp (M6)	5 Nm (44 ft-lb)

– Make sure battery condition indicator (**D**) is visible next to battery hold down.

– Reattach ventilation hose.

– Reinitialize power windows and electric sunroof. See **512 Door Windows** and **540 Sunroof**.

Battery safety terminal (BST) replacement (Cooper S)

If BST has been triggered, investigate and correct cause prior to replacement. Read out and reset multiple restraint system (MRS) control module fault memory.

BST replacement requires replacement of one piece power supply cable to alternator and starter. This cable is routed through grommet in front of cargo compartment just ahead of battery, then underneath vehicle between rear exhaust heat shield and floor pan. It is then routed to left side of floor pan and on to engine compartment components including positive battery connection (B+).

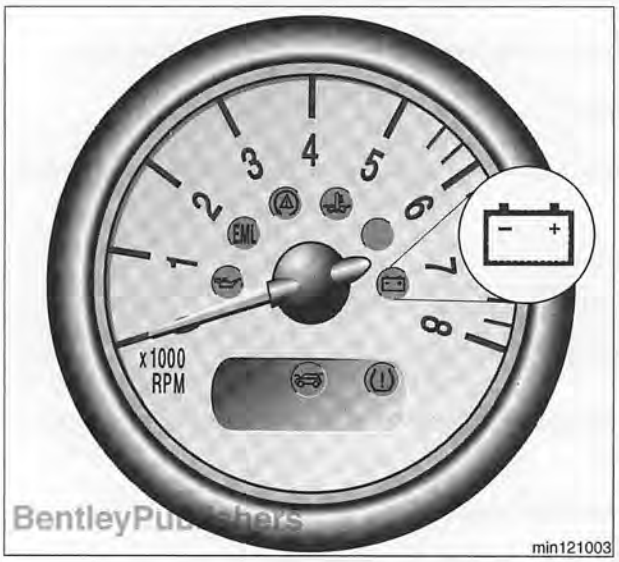
ALTERNATOR (GENERATOR)

The alternator assembly with integrated voltage regulator is bolted to the front of the engine block.

Depending on level of equipment, one of two different alternators have been fitted to MINI models covered by this manual.

Alternator output	
Normal output	105 amp
High output	120 amp

Charging system troubleshooting



The alternator is not connected to the battery warning light. Alternator faults are communicated to the engine control module (ECM) which illuminates the battery warning light if a charging system fault is detected.

Charging system diagnostics requires special test equipment. If the test equipment is not available, charging system fault diagnosis can be performed by an authorized MINI dealer or other qualified repair shop.

– Before checking alternator:

- Make sure battery is fully charged and capable of holding a charge.
- Check for clean and tight battery cables.
- Check ground cable running from negative (-) battery terminal to chassis and ground cable running from engine to chassis.
- Check engine drive belt condition and tension.

See **Table a** for general electrical component troubleshooting.

Charging system quick check

Use a digital multimeter to measure voltage across the battery terminals with key off and then again with engine running. Battery voltage should be about 12.6 volts with key off and between 13.5 and 14.5 volts with engine running.

NOTE —
The regulated voltage (engine running) should be between 13.2 and 14.5 volts, depending on temperature and operating conditions. If the voltage is higher than 14.8, the voltage regulator is most likely faulty.

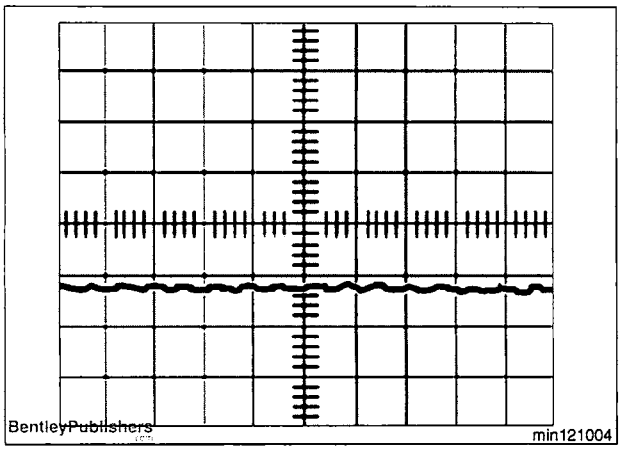
Charging system, checking

CAUTION—
- *Do not disconnect the battery while the engine is running. Damage to the alternator and/or engine electronic system may result.*
- *Only use high impedance electronic test equipment when testing charging system components.*

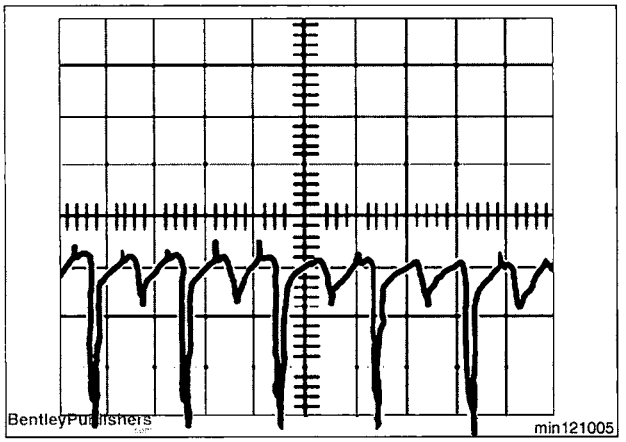
– Read out engine control module (ECM) fault memory.

– Connect BMW diagnostic scan tool or oscilloscope to check alternator function.

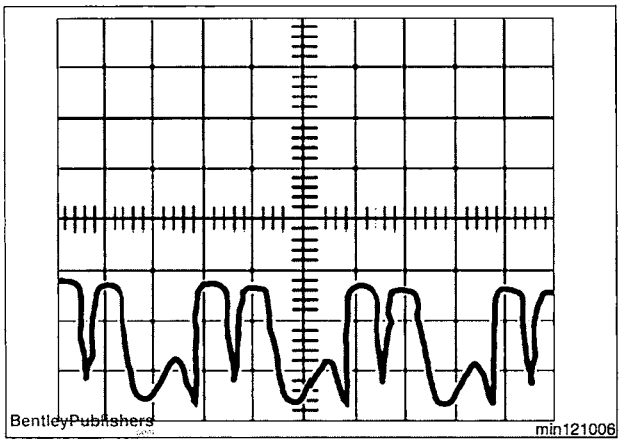
NOTE—
An alternator output pattern other than "normal" indicates that the alternator needs rebuilding or replacement.



➤ Normal alternator

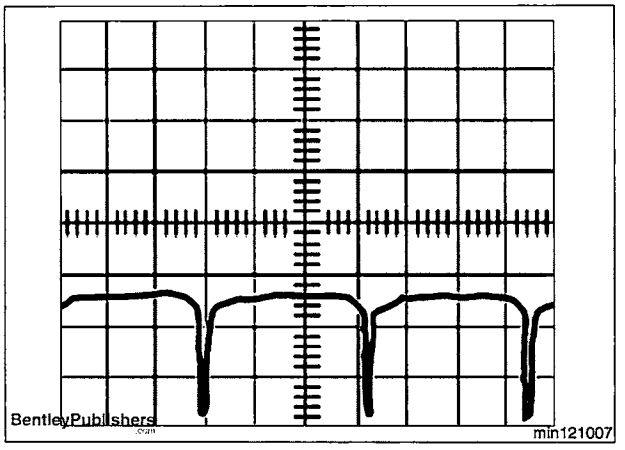


➤ One phase interrupted

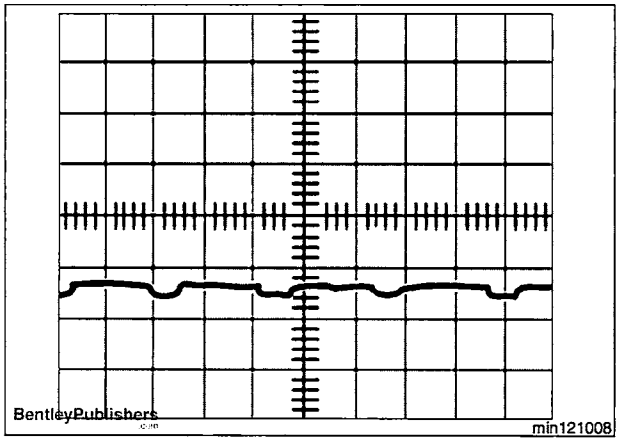


➤ Interturn fault

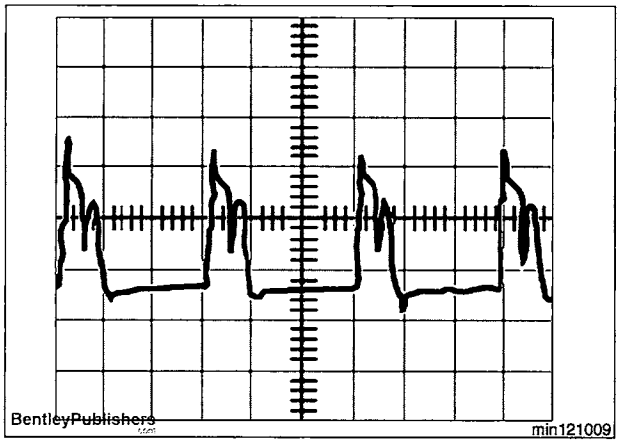
Alternator (Generator)



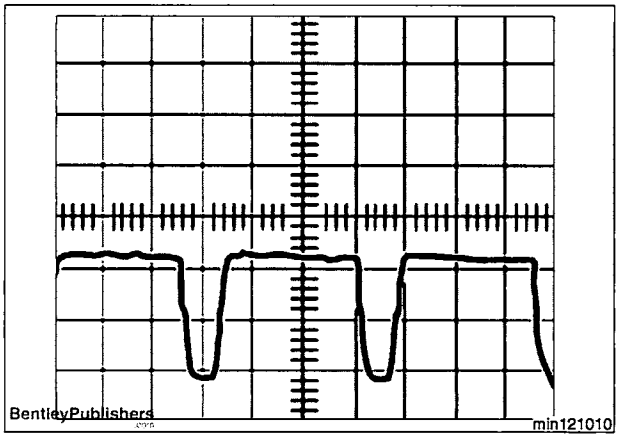
Open circuit in negative diode



Short circuit in positive diode



Open circuit in positive diode



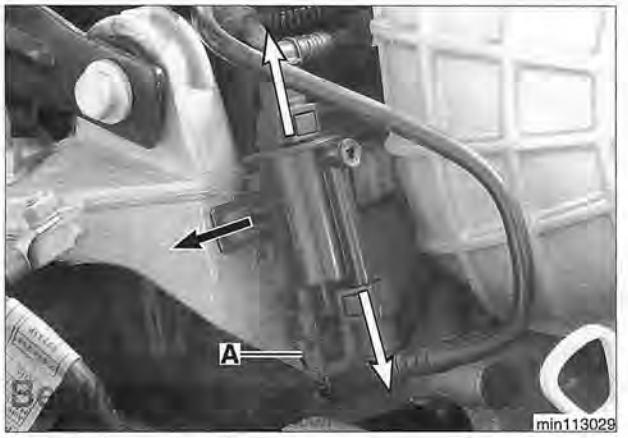
Open circuit in exciter diode

Alternator, removing and installing (Cooper)

– Read out engine control module (ECM) fault memory. Then switch off ignition.

– Disconnect battery.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions in* **001 General Warnings and Cautions**.



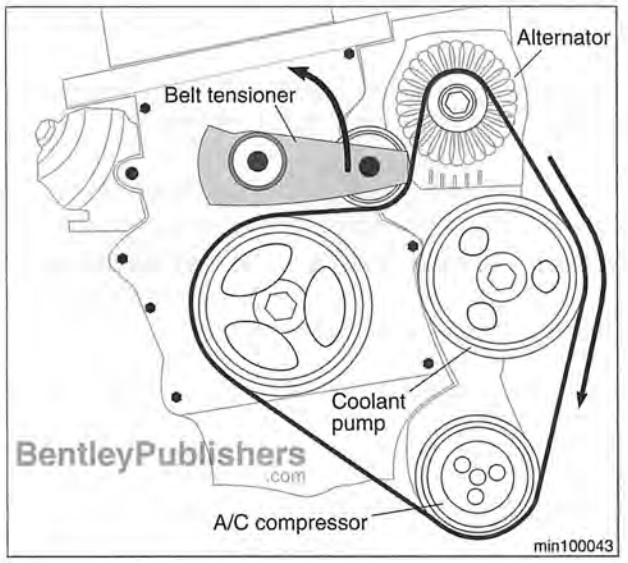
➢ Working at right side engine mount, remove fuel tank vent valve.
- Disconnect vent hoses (**white arrows**) quick fit connectors.
- Straighten retaining tab and slide vent valve off bracket (**black arrow**).
- Remove electrical harness connector (**A**).

NOTE—
Cooper S engine shown. Cooper is similar.

– Remove splash shield under engine.

– Remove right front wheel.

– Remove right front wheel housing liner.



➢ Note engine drive belt layout. Remove belt.
- Use special tool 11 8 390 to release drive belt tension.
- Use lock pin (special tool 11 8 280) to lock drive belt tensioner.
- Lift off drive belt.

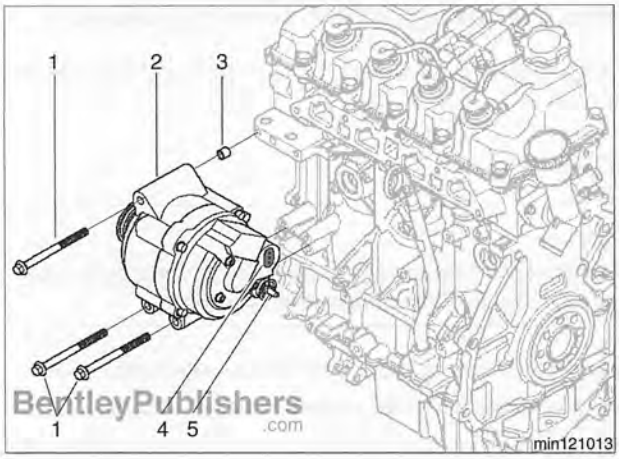
> ***CAUTION—***
> - *Drive belt tensioner is under high tension. Check that lock pin is secure.*
> - *Take care to avoid damage to paintwork.*

NOTE—
- *Drive belt removal and installation is covered in* **020 Maintenance**.
- *If drive belt is to be reused, mark direction of travel and reinstall drive belt in same direction of rotation.*

– Remove intake manifold. See **113 Cylinder Head Removal and Installation**.

– Disconnect alternator electrical harness connectors.

Alternator (Generator)



➤ Remove mounting bolts and remove alternator.

1. Bolt M8 x 100 mm
   - Tighten to 25 Nm (18 ft-lb)
2. Alternator
3. Spacer bushing
4. Regulator connector
5. B+ connector

– Installation is reverse of removal.

Tightening torques	
Alternator to engine block (M8)	25 Nm (18 ft-lb)
Alternator harness to alternator B+ connector (M6)	10 Nm (7 ft-lb)

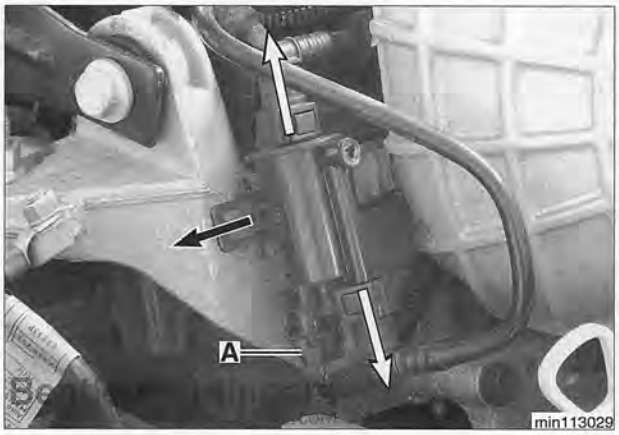
– After reassembling engine, clear ECM fault memory.

Alternator, removing and installing (Cooper S)

– Read out engine control module (ECM) fault memory. Then switch off ignition.

– Disconnect battery.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions in* **001 General Warnings and Cautions**.



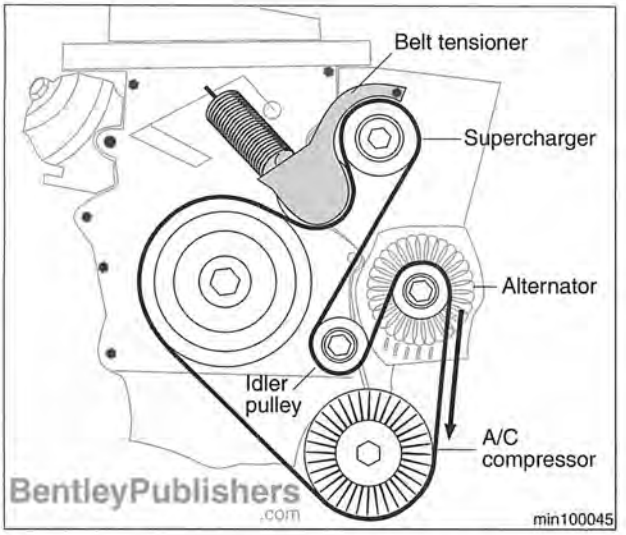
➤ Working at right side engine mount, remove fuel tank vent valve.

- Disconnect vent hoses (**white arrows**) quick fit connectors.
- Straighten retaining tab and slide vent valve off bracket (**black arrow**).
- Remove electrical harness connector (**A**).

– Remove splash shield under engine.

– Remove right front wheel.

– Remove right front wheel housing liner.



Note engine drive belt layout. Remove belt.

- Use special tool 11 8 410 to release drive belt tension.
- Use lock pin (special tool 11 8 470) to lock drive belt tensioner.
- Lift off drive belt.

CAUTION—

- *Drive belt tensioner is under high tension. Check that lock pin is secure.*
- *Take care to avoid damage to paintwork.*

NOTE—

- *Drive belt removal and installation is covered in* **020 Maintenance**.
- *If drive belt is to be reused, mark direction of travel and reinstall drive belt in same direction of rotation.*

Loosen modular front end:

- Detach front wheel housing liners from front bumper cover trim.
- Remove front bumper cover trim.
- Working underneath car, loosen and remove crush tubes that support modular front end to front subframe.
- Detach radiator upper hose support clamp (**A**) from intake manifold.
- Remove modular front end mounting bolts. Install two 100 mm (4 in) M8 bolts (**arrow**) in left and right bumper support members. Slide modular front end forward, supported on long bolts.

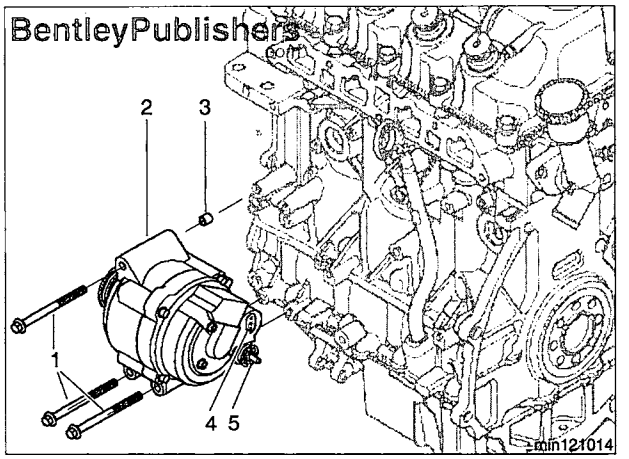
CAUTION—

For ease of component alignment when reassembling front bumper assembly, do not loosen or remove bumper alignment bosses.

NOTE—

- *If available, use BMW special tools 11 8 401 and 11 8 402 instead of long bolts to support modular front end.*
- *Removal of modular front end is a complicated job. It is covered in* **510 Exterior Trim, Bumpers**.

– Working underneath vehicle, disconnect alternator electrical harness connectors.



➤ Remove mounting bolts and remove alternator.

1. Bolt M8 x 100 mm
   -tighten to 25 Nm (18 ft-lb)
2. Alternator
3. Spacer bushing
4. Regulator connector
5. B+ connector

– Installation is reverse of removal.

Tightening torques	
Alternator to engine block (M8)	25 Nm (18 ft-lb)
Alternator harness to alternator B+ connector (M6)	10 Nm (7 ft-lb)

– After reassembling engine, clear ECM fault memory.

STARTER

Starter troubleshooting

Large wire at starter terminal 30 is direct battery voltage. Smaller wire at terminal 50 operates starter solenoid via ignition switch.

– If starter turns engine slowly when ignition is in START position:

- Check battery state of charge.
- Inspect starter wires, terminals and ground connections for good contact. In particular, make sure ground connections between battery, body and engine are completely clean and tight.
- If no faults are found, starter may be faulty.

– If starter fails to operate:

- Check EWS (drive-away protection system). Try another ignition key. If no faults can be found, have the EWS system checked using BMW scan tool equipment.
- Check clutch pedal operated starter lock-out switch or gear position switch (automatic).

NOTE—

- *A factory-installed drive-away protection system or EWS is used on MINI cars. This system prevents operation of the starter if a specially coded ignition key is not used.*
  See **515 Central Locking and Anti-theft**.
- *On automatic transmission cars, the transmission gear position switch signals EWS to prevent the engine from starting in gear positions other than PARK or NEUTRAL. See* **240 Automatic Transmission**.
- *On manual transmission cars, a starter immobilization switch at the clutch pedal is used to prevent the starter from operating unless the clutch pedal is pushed fully to the floor. See* **612 Switches**.

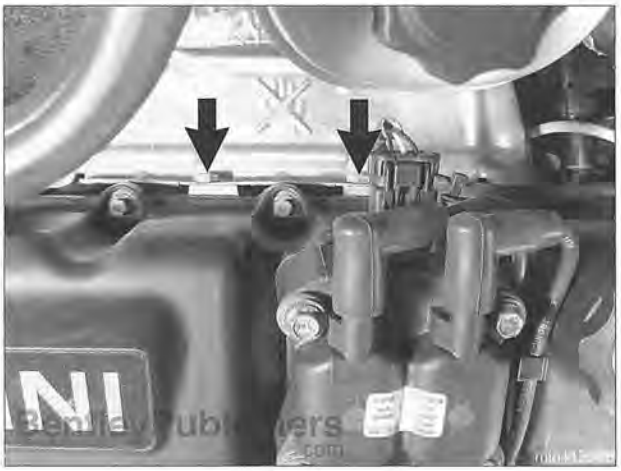
– Check for battery voltage at terminal 50 of starter motor with key in START position.
  - If voltage is not present, check wiring between ignition switch and starter terminal. Check EWS system and other inputs that disrupt input to starter. See **ELE Electrical Wiring Diagrams**.
  - If voltage is present and no other visible wiring faults can be found, problem is most likely in starter motor.

Starter, removing and installing

– Switch off ignition.

– Disconnect battery.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions in* **001 General Warnings and Cautions**.



➢ Working between engine and engine compartment rear bulkhead, remove exhaust manifold heat shield mounting bolts (**arrows**) and lift out heat shield.

– Remove exhaust manifold. See **180 Exhaust System**.

– Remove starter motor heat shield.

– Disconnect wires to starter.

– Remove starter mounting bolts and lift out starter.

– Installation is reverse of removal.

Tightening torques	
Exhaust manifold heat shield to cylinder head (M8)	13 Nm (10 ft-lb)
Exhaust manifold to cylinder head (M8)	24 Nm (18 ft-lb)
Starter heat shield to engine block (M6)	9 Nm (7 ft-lb)
Starter to transmission (M12)	85 Nm (63 ft-lb)
Terminal 30 to starter	14 Nm (10 ft-lb)
Terminal 50 to starter	8 Nm (6 ft-lb)

NOTE—
Route starter wires as they were before disassembly.

Starter solenoid, removing and installing

– Switch off ignition.

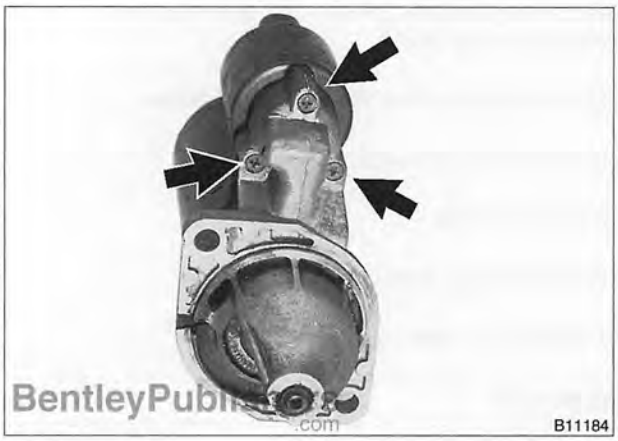
– Disconnect battery.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions in* **001 General Warnings and Cautions**.

– Remove starter. See **Starter, removing and installing** in this repair group.

– Disconnect field winding strap between starter motor and solenoid switch.

> ***NOTE—***
> *If the field winding strap is damaged or burned, a new or rebuilt starter motor is needed.*



➤ Remove solenoid switch mounting screws (**arrows**), and separate solenoid from starter.
- Unhook solenoid plunger from lever in starter drive.

– Installation is reverse of removal. Lubricate solenoid piston with light grease.

> ***CAUTION—***
> *When installing field winding strap to starter, position it so that it does not contact the starter body.*

Tightening torque	
Field strap to starter	13 Nm (10 ft-lb)

130 Fuel Injection

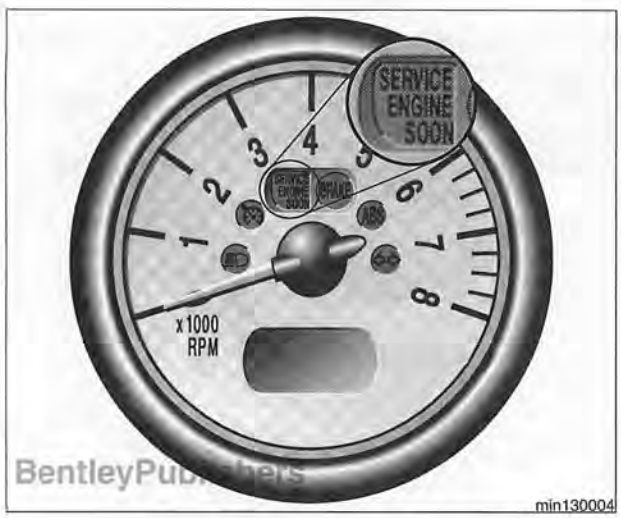
GENERAL

This repair group describes the Siemens EMS2000 engine management system used in MINI Cooper and Cooper S models. Fuel injection component replacement is included and pin assignments for the EMS2000 engine control module (ECM) are listed.

The engine management system and software interact with many vehicle systems. Related topics can be found in the following repair groups:

- **120 Ignition System**
- **160 Fuel Tank and Fuel Pump**
- **170 Radiator and Cooling System**
- **180 Exhaust System**
- **640 Heating and Air-conditioning**
- **OBD On Board Diagnostics**

Second generation on-board diagnostics (OBD II) software and hardware is incorporated in the engine management control systems. OBD II monitors components that influence exhaust and evaporative emissions. If a problem is detected, OBD II stores the associated diagnostic trouble code (DTC) and the conditions under which the fault occurred in the engine control module (ECM).



If vehicle emission levels exceed 1.5 times Federally mandated criteria, OBD II illuminates a malfunction indicator light (MIL) in the instrument cluster.

NOTE—
In MINI models, the MIL reads "Service engine soon".

When faults arise, or if the malfunction indicator lamp (MIL) is illuminated, begin troubleshooting by connecting BMW service tester DISplus, MoDiC, GT1 or equivalent scan tool. The capabilities of OBD II software has the potential to save hours of diagnostic time and to help avoid incorrect component replacement and possible damage to system components.

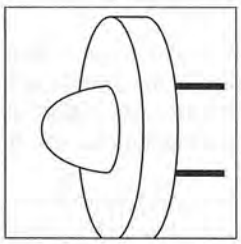
NOTE—
- *In addition to the MINI / BMW factory scan tools, Baum Tools, Snap-on, and Assenmacher Tool are specialized tool companies that may offer MINI-specific scan tools. Check with the tool manufacturer for availability.*
- *Generic OBD II scan tool software programs and handheld units are readily available. Though limited in capabilities compared to the factory tools, they are nonetheless powerful diagnostic devices which read live data streams, freeze-frame data and other valuable diagnostic information.*
- *A simple aftermarket DTC reader is available from Peake Research. This tool is capable of checking for DTCs as well as turning off the illuminated MIL.*

Special tools

Some special tools are needed to diagnose, repair or replace fuel injection system components. If you lack the necessary tools to perform a procedure, repairs are best left to an authorized MINI dealer or other qualified repair facility.

> ***CAUTION—***
> *Only use a digital multimeter for electrical tests.*

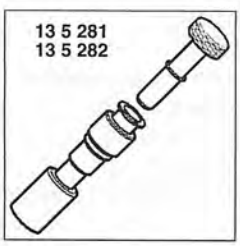
Digital multimeter



Low current test light ("noid")
(Baum Tools 1115a)

Modular front end supports
(BMW special tool 11 8 400)

Intercooler protective cover
(BMW special tool 11 8 480)



Fuel line plugs
(BMW special tools 13 5 281, 13 5 282)

Aftermarket scan tool

Factory scan tools
(BMW MoDiC and DISplus)

Engine management

The basic function of the EMS2000 engine management system is to produce smooth and efficient engine operation over varied driving conditions and engine loads. It also functions to monitor emissions systems and interfaces with other vehicle systems to enhance the driving experience.

Inputs from sensors, switches and monitoring devices are received by the engine management system (EMS) and processed. Using these inputs, the EMS makes operating decisions and outputs control signals to manage engine, transmission and emission operation.

Most communications among EMS components and with the rest of the vehicle occur over bus connections. See **600 Electrical System–General** for a schematic diagram of MINI bus network.

EMS inputs and outputs are listed in **Table a**.

Table a. EMS2000 inputs / outputs

Inputs	Outputs
Battery	Main relay
Main relay	Electronic throttle control (EDR)
Accelerator pedal sensor (PWG)	EDR warning LED
T-MAP sensor	Inertia switch
MAP sensor (Cooper S)	Fuel pump relay
Coolant temperature sensor	Fuel injectors
Electronic throttle control (EDR)	Ignition coils
Crankshaft sensor	Fuel leak detection system
Knock sensor	Purge valve
Camshaft sensor	Oxygen sensor heaters
Fuel leak detection system	Shift interlock relay
Oxygen sensors	Automatic transmission interface (GIU)
Brake light switch	A/C compressor
Clutch switch	Engine cooling fan
Transmission speed sensor	OBD II plug
Oil temperature sensor	Instrument cluster (IKE)
Alternator (generator)	
Immobilizer (EWS)	
Automatic transmission interface (GIU)	
ABS/DSC	
A/C pressure transducer	
Instrument cluster (IKE)	
Multifunction steering wheel (MFL)	

Engine control module (ECM)

The engine control module (ECM) is the center of the engine management system. It receives and processes all inputs and issues corresponding control commands.

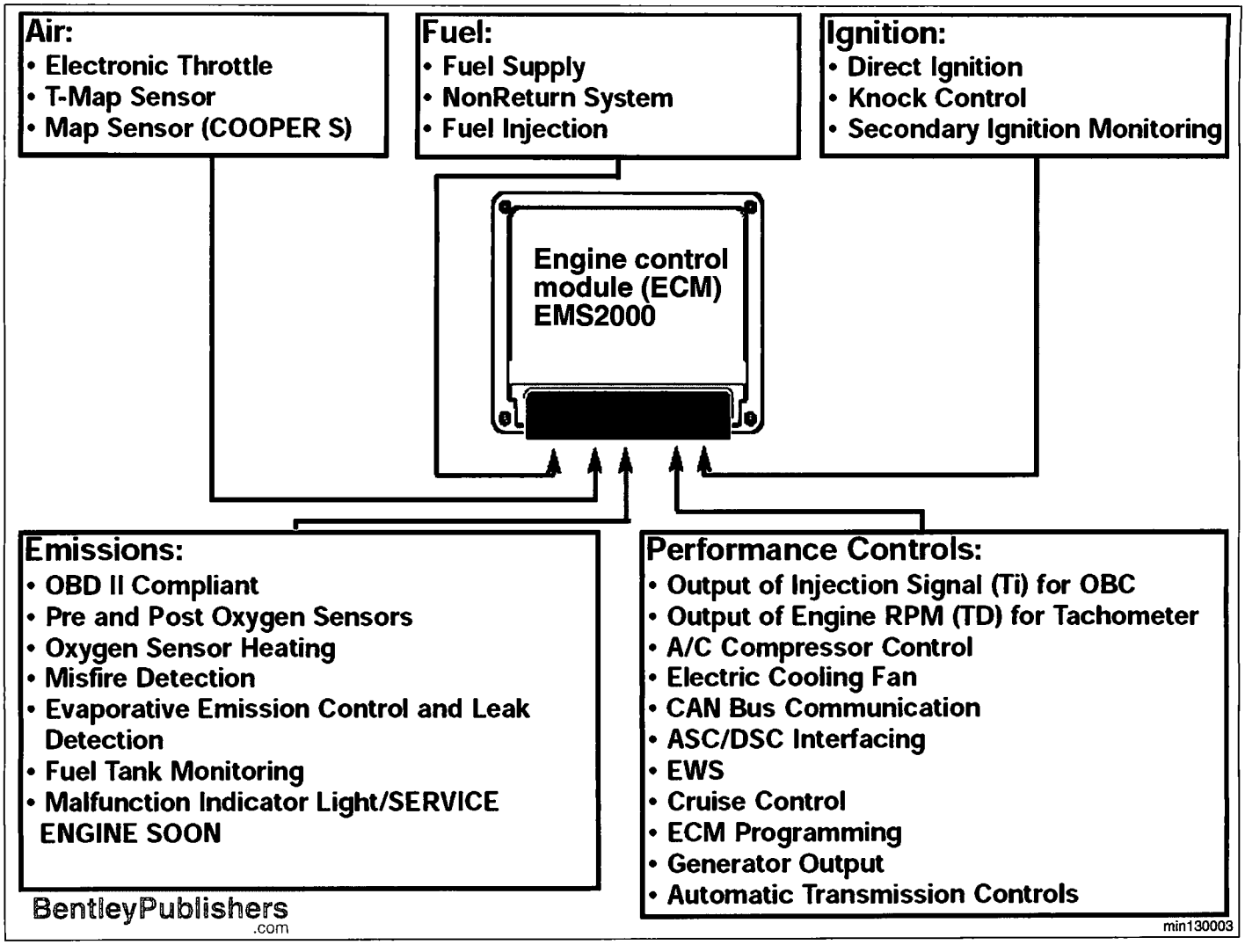
ECM location	
MINI Cooper	Left compartment of battery box next to engine compartment fuse and relay panel
MINI Cooper S	Left of air filter housing

In addition to engine controls, the ECM has direct control over the following systems:

- Drive by wire (DBW) throttle control
- Automatic transmission
- Cruise control
- Air-conditioning clutch relay
- Engine cooling fan relays

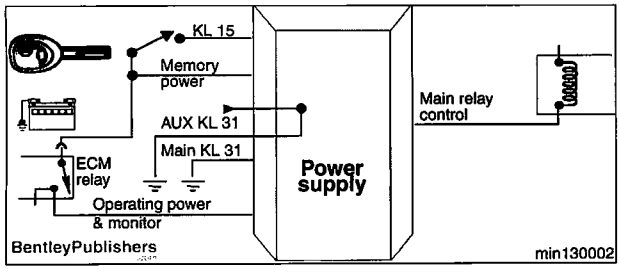
The ECM also has an interface with the following systems:

- Air-conditioning (IHKS/IHKA)
- Automatic stability control (ASC)
- Dynamic stability control (DSC)
- Immobilizer (EWS)



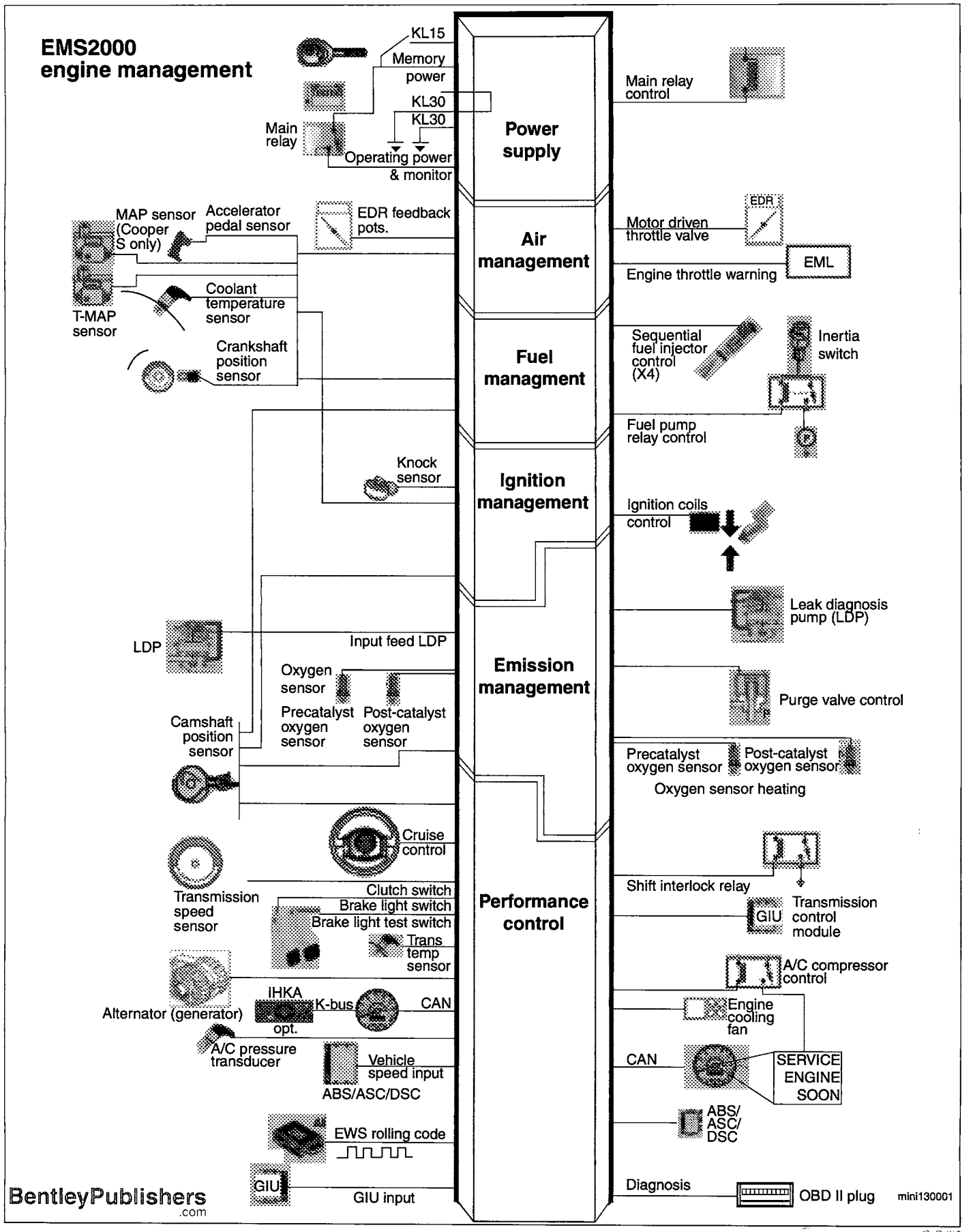
Principles of operation

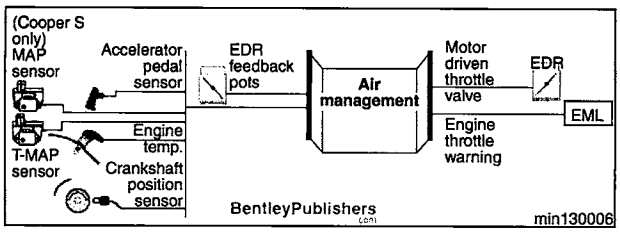
Power supply



When ignition switch is placed in KL15 (ignition ON) or KL50 (START) positions, fuse 34 is provided with power. Fuse 34 supplies wake up or ON signal to ECM. Upon receipt of ON signal, ECM supplies a ground signal to main relay. This energizes main relay, supplying operating power to engine compartment fuses and engine management components.

At this point the engine is ready to start.





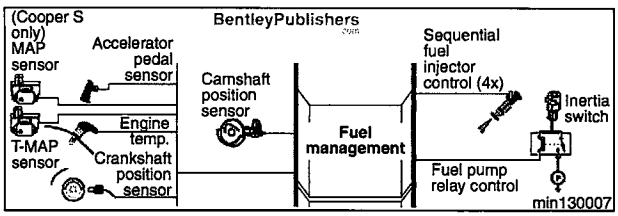
Air management

ECM detects that the engine is cranking via crankshaft sensor signal.

Accelerator pedal sensors (PWG) signal 0.5 vdc, indicating a request for idle. Feedback potentiometers in the electronic throttle control (EDR) are checked to confirm closed throttle valve position. Signals of 0.5 vdc from potentiometer 1 and 4.5 vdc from potentiometer 2 indicate that the throttle valve is in LL or idle position.

With engine cranking, ECM monitors input from T-MAP (and MAP sensor, if Cooper S). T-MAP output drops from 4 vdc (low vacuum) to 1 vdc (high vacuum).

Air volume and density are calculated from T-MAP sensor signal and intake air temperature.



Fuel management

When ECM detects engine revolutions, it provides ground signal to fuel pump relay.

Fuel pump relay is fused. In early models, fuel pump circuit is further protected by inertia switch. If inertia switch is not triggered (triggered = open) power is provided to fuel pump relay.

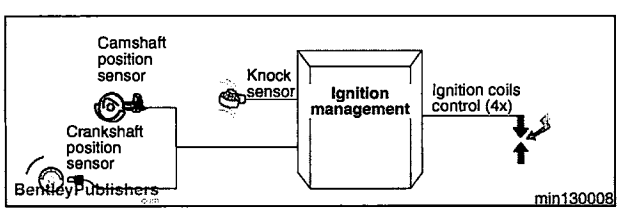
NOTE—
The inertia switch is eliminated and its functions are assigned to the multiple restraint system (MRS) control module.

Fuel pump is mounted in left side of saddle type fuel tank. When fuel pump receives power, it picks up fuel through fuel filter and passes it to right side tank.

Fuel at 3.5 bar (51 psi) is pumped to engine mounted fuel rail assembly. Fuel rail contains pressure regulator and damper to smooth out fluctuations in fuel pressure during high load situations.

Based on volume and density of air, engine load, engine rpm and temperature, the ECM calculates correct volume of fuel for injection.

The ECM monitors crankshaft and camshaft sensors to time fully sequential fuel injector pulses.

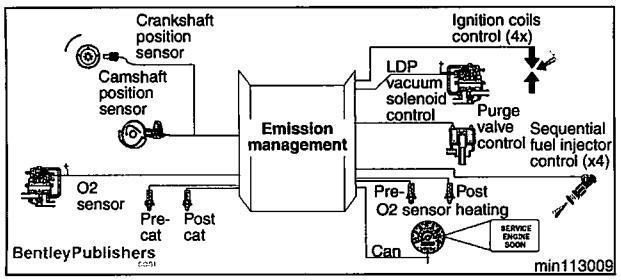


Ignition management

The ECM relies on previously analyzed sensor inputs to time ignition coil firing. As each cylinder approaches TDC, ECM grounds corresponding ignition output stage and fires ignition coil.

The ECM monitors knock sensors for variations in engine sound. If preignition knock is detected, ignition timing is retarded until the knocking stops.

Spark plugs introduce ignition energy into combustion chambers. High voltage arcs across air gap in spark plug, creating spark which ignites air/fuel mixture.



Emission management

Oxygen sensor heating. As soon as engine starts, pulse-width-modulated ground signal from ECM is supplied to oxygen sensor heaters. Duty cycle is increased to approximately 98% until oxygen sensors are fully heated. Afterwards duty cycle is varied to maintain sensor temperature. *Example:* During engine deceleration, duty cycle is increased to compensate for decrease in exhaust temperatures.

Once fully heated, oxygen sensors provide information about oxygen content in exhaust.

Pre-catalyst oxygen sensor. ECM adjusts injector ON-time based on input from pre-catalyst oxygen sensor. High voltage reading from pre-catalyst sensor indicates low oxygen content in exhaust (rich mixture). ECM reduces injector ON-time until voltage reading drops. Injector ON-time is then increased again. This oscillation is referred to as "closed loop".

Post-catalyst oxygen sensor. ECM monitors catalyst condition using post-catalyst oxygen sensor signal during closed loop operation. Oscillations in oxygen content, detected by precatalyst oxygen sensor, are dampened by oxygen storage capacity of catalyst. Normal post-catalyst sensor has fairly stable signal, indicating oxygen has been consumed.

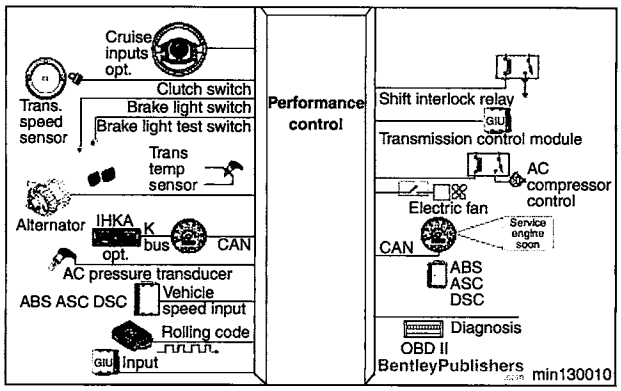
See **OBD On Board Diagnostics** for additional information on catalyst monitoring.

Evaporative emissions monitoring. ECM also monitors fuel tank evaporative losses via fuel tank leak diagnosis pump (LDP or DMTL).

Adaptation. ECM adapts to driving conditions in order to maintain a stoichiometric air / fuel ratio (14.7 : 1). It is capable of adapting to various environmental conditions encountered while the vehicle is in operation (changes in altitude, humidity, ambient temperature, fuel quality, etc.). These ECM adaptations can only make slight corrections and can not compensate for large changes which may be encountered as a result of incorrect airflow or incorrect fuel supply to engine.

Within allowed adaptation range, ECM modifies injection rate during these states of engine operation:

- During idle and low load mid range speeds (additive adaptation)
- During operation under normal load to higher load at higher engine speeds (multiplicative adaptation)



Performance controls

EWS Interface. ECM communicates with immobilizer (EWS) module prior to releasing injection and ignition.

Upon receiving correct rolling code from EWS, ECM allows fuel injectors and ignition coils to operate.

Automatic transmission control. As driver moves shift selector lever from PARK, ECM checks for brake pedal sensor signal before releasing shift interlock relay. Upon receiving a valid brake pedal sensor input, shift interlock relay is released and gear shift lever may be moved into DRIVE position.

ECM uses inputs from crankshaft sensor, transmission temperature sensor and transmission output speed sensor as well as gear shift lever switches to determine gear selection and programming. Instructions for gear control are transmitted from ECM through transmission control module (GIU) to transmission.

A/C compressor control. A request from the IHKS or IHKA is passed via the K-bus to the instrument cluster (IKE) and then over the CAN-bus to ECM. ECM checks signal from A/C pressure transducer and, if within range, activates compressor relay. ECM signals IHKS/IHKA that compressor is ON.

In response to compressor activation, ECM increases idle speed slightly to compensate for increased engine load.

Torque management. To prevent adversely affecting catalyst life or raising combustion chamber and piston temperatures, engine torque is changed by altering only ignition timing or throttle position.

Ignition timing can be altered rapidly and gives an instant torque change because under normal circumstances ECM always ensures that engine runs at peak efficiency.

Throttle position (airflow) change can increase or decease engine torque. If airflow is increased or decreased, ECM automatically maintains correct fuel mixture by balancing fuel input.

Unlike rapid torque change achieved by altering ignition, changes in throttle position take longer to achieve torque variation. Each system can demand either a slow or fast torque variation.

Torque control. EMS2000 can vary engine torque output in response to several conditions.

- Engine running demands. Torque variation is requested internally from within ECM to support the following:
  Idle control
  Catalyst 'light up' and overheat protection
  Limp home control
- Powertrain and chassis demands. Torque variation is requested externally from the following:
  Dynamic Stability Control (DSC)
  Automatic Stability Control + Traction Control (ASC)
  Automatic transmission (ECVT)
  Cruise control
- Driver demand.

Cruise control is integrated into EMS2000 because of drive-by-wire throttle operation:

- ECM controls vehicle speed by activation of electronic throttle valve (EDR).
- Clutch switch disengages cruise control to prevent over-revving during gear changes.
- Brake light switch and brake light test switch are input to ECM to disengage cruise control.

Cruise control functions are activated directly by multifunction (MFL) steering wheel signal to ECM. Individual buttons are digitally encoded in MFL switch and are input to ECM over a serial data wire.

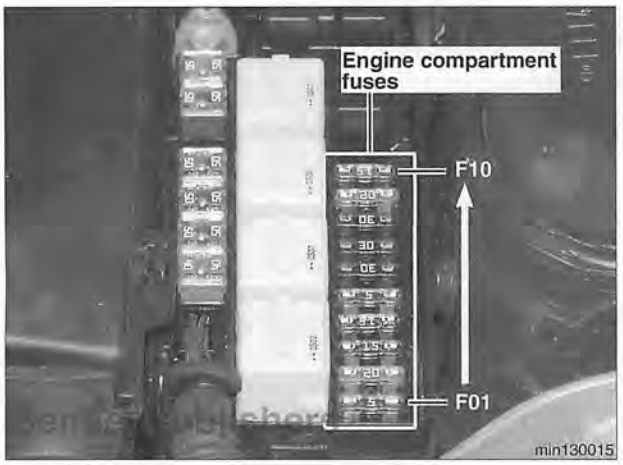
Road speed information for cruise control is supplied from DSC module via CAN-bus to ECM.

Engine cooling fan. ECM determines cooling fan operating speed based on engine coolant temperature sensor and A/C pressure transducer signals.

ECM reprogramming. EMS2000 control module reprogramming is possible. Be sure to confirm viability of software upgrades prior to attempting reprogramming. Failure to do this may result in a no-start condition.

System inputs

Power supply

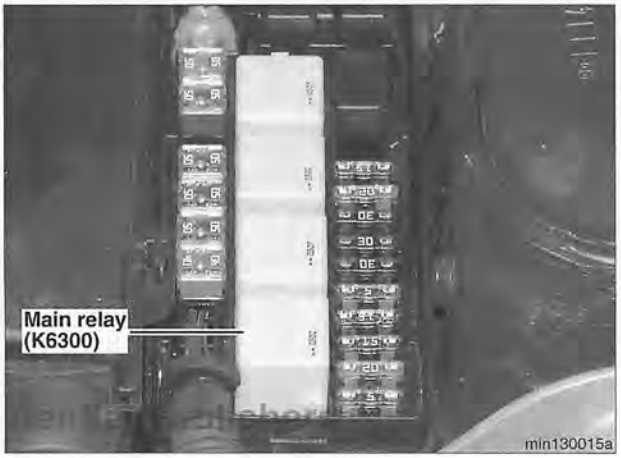


Battery power (KL30) is supplied through engine compartment fuse F01 to provide engine control module (ECM) memory with uninterrupted power.

Battery power (KL30) through engine compartment fuse F02 is provided by main relay to ECM.

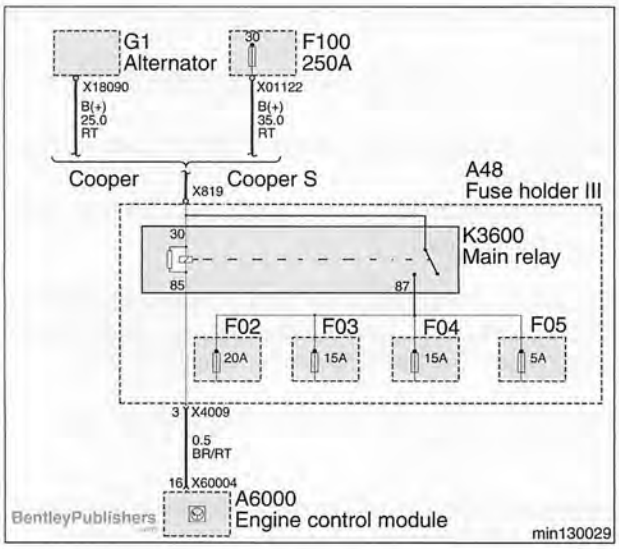
Battery positive pole (B+) is main supply of operating voltage to ECM. Battery voltage is monitored by ECM for fluctuations. ECM adjusts output functions to compensate for lower (6 vdc) or high (14 vdc) voltage values.

NOTE —
Based on available battery voltage, the ECM adjusts:
Fuel injection pulse width
Ignition system dwell



Main relay (K6300) is located in engine compartment fuse and relay panel.

General



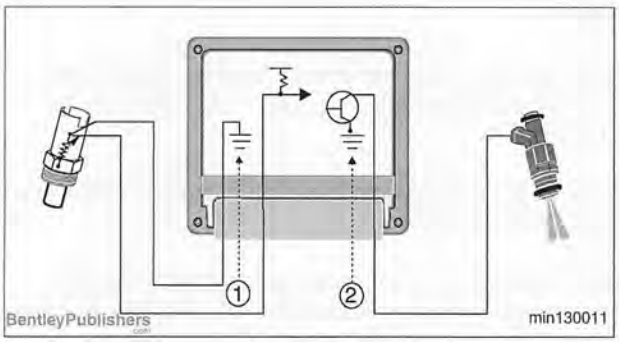
Main relay provides power to ECM and other system components. When ignition switch is in ON (KL15) or START (KL50) positions, fuse 34 supplies ON signal to ECM. Upon receipt of ON signal, ECM supplies ground signal to main relay. Ground signal energizes main relay, supplying operating power to following engine compartment fuses:

- F02: ECM, fuel injectors, crankshaft sensor, ignition coils
- F03: Camshaft sensor, oxygen sensor heaters, engine cooling fan, A/C compressor relay, purge system
- F04: Automatic transmission (CVT) controls
- F05: Engine cooling fan

Main relay supplies power to these components:

- ECM
- Fuel injectors
- Crankshaft sensor
- Ignition coils
- Fuel leakage detection pump (LDP or DMTL)
- Engine cooling fan
- Camshaft sensor
- Transmission control module (GIU)
- Oxygen sensor heaters

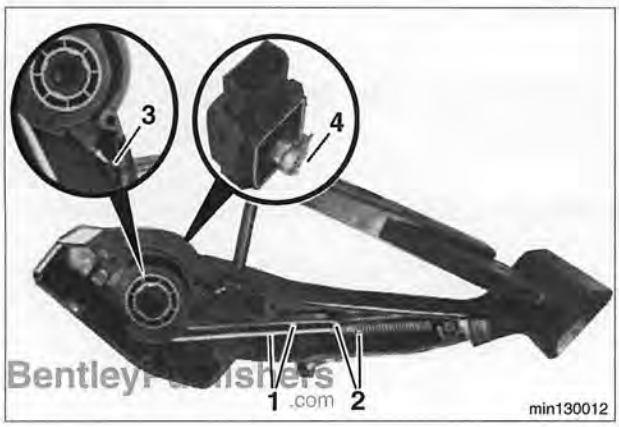
The main relay also protects system components in case of reversed battery polarity.



Grounds. Multiple ground points are supplied to complete current path through ECM.

1. Sensors are supplied with constant ground.
2. Components are activated via switched ground.

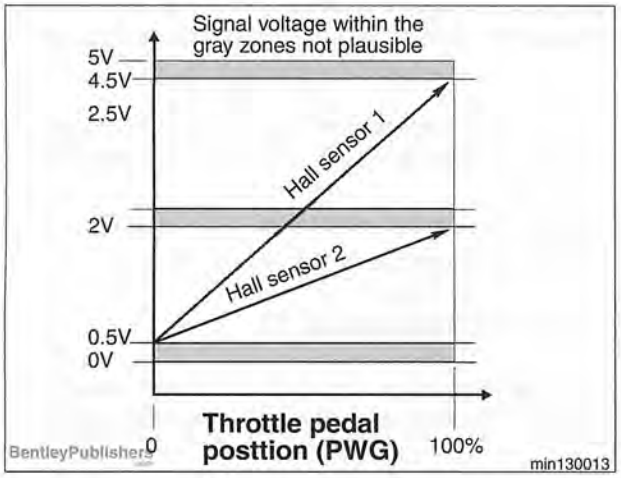
Accelerator pedal position sensor (PWG)



Accelerator pedal position sensor (PWG) is mounted in passenger compartment, clipped to bracket bolted to floor.

1. Twin cables
2. Return springs
3. Ball joint
4. Throttle potentiometer

PWG is monitored by ECM for input or speed requests. PWG uses two Hall sensors with different voltage characteristics and independent power supplies to detect driver input requests.



Hall sensors receive power (5 vdc) and ground from ECM and produce linear voltage signals as pedal is pressed from LL position (idle) to VL position (full throttle).

Hall sensor 1 range: 0.5 - 4.5 vdc, driver request

Hall sensor 2 range: 0.5 - 2.0 vdc, plausibility check

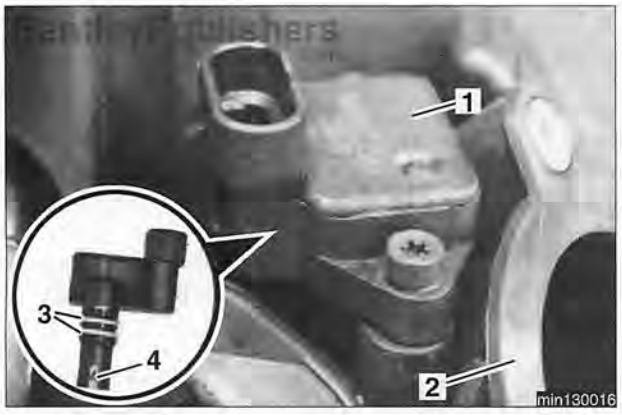
PWG is monitored by ECM for pedal angle position and rate of movement. As accelerator pedal is moved, rising voltage signals from Hall sensors request acceleration and determine rate of acceleration. ECM increases volume of fuel injected into engine, advances ignition timing and opens electronic throttle valve (EDR). Full throttle position indicates maximum acceleration to ECM. Full throttle also affects air conditioning compressor activation.

As accelerator pedal is released and returned to rest position by return springs, a decrease in voltage signals ECM to activate fuel shut off if RPM is above idle speed (coasting). Throttle valve closes, then opens just enough to maintain idle speed.

Sensor inputs

ECM uses input from T-MAP sensor (and MAP sensor if Cooper S), ECT sensor and throttle position potentiometers to calculate air volume consumed by engine. This calculated measurement is used by ECM to determine amount of fuel to be injected.

T-MAP sensor (Cooper)



Temperature and manifold absolute pressure (T-MAP) sensor is located in intake airstream next to electronic throttle valve housing (EDR).

1. T-MAP sensor
2. Throttle valve housing (EDR)
3. Sealing O-rings
4. Sensor tip

Manifold pressure sensor portion of T-MAP sensor is a piezoresistive pressure gauge that supplies analog input to ECM. Manifold pressure indicates engine load, used for internal engine control via ECM and for ASC/DSC (traction control). ECM uses manifold pressure signals to determine correct fuel delivery and ignition timing.

- Pressure sensor has maximum pressure range of 120 kpa (17.4 psi).
- At idle, manifold pressure is low (high vacuum). Sensor output voltage is 1 to 2 vdc.
- At higher engine speeds or wide-open throttle (WOT), manifold pressure is higher (low vacuum). Sensor output voltage is about 4 vdc.

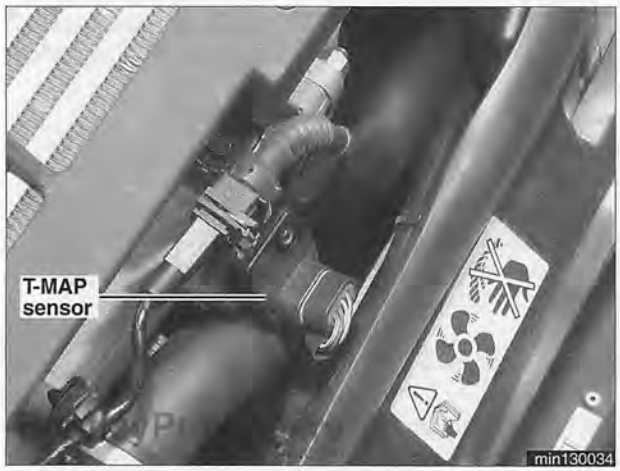
Air intake temperature sensor is built into T-MAP sensor. Sensor is a negative temperature coefficient (NTC) type, supplied 5 vdc by ECM.

Air temperature signal in conjunction with intake manifold pressure signal enable ECM to calculate volume of air being consumed by engine:

- At low intake air temperature, sensor resistance is high.
- At high intake air temperature, sensor resistance is low.

T-MAP and MAP sensors (Cooper S)

Pressure differential is measured across supercharger to determine manifold air density. Two sensors are fitted, one on either side of supercharger:



T-MAP sensor is fitted on manifold pressure side and has same hardware specification as Cooper T-MAP sensor, but maximum pressure range is 250 kpa (36.2 psi). This sensor is exposed to higher than atmospheric pressures as produced by supercharger.

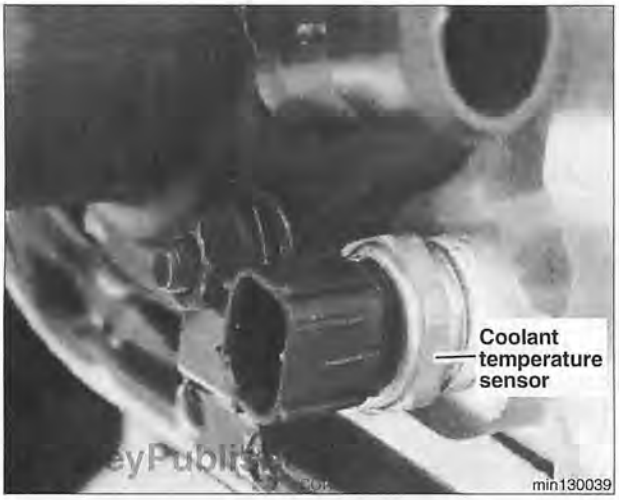
MAP sensor is fitted at left end of cylinder head. It is connected by vacuum line to supercharger supply duct and is not affected by supercharger air pressure. This sensor is same as Cooper T-MAP sensor but without temperature sensor.

Whenever ignition key is ON and ECM is supplied power from main relay without engine running, MAP sensor detects barometric pressure and provides a high voltage signal to ECM.

Once engine starts, MAP sensor measures absolute manifold pressure. This is barometric pressure minus vacuum created by operation of engine pistons. *Example:* If barometer is reading 1.5 bar (22 psi) at sea level and manifold vacuum is 1.0 bar (14.5 psi) at idle, manifold absolute pressure is 0.5 bar (7.3 psi).

ECM compares voltage from MAP sensor (ahead of supercharger) to voltage from T-MAP sensor (subject to increased pressures from supercharger) and calculates air volume drawn into engine.

Voltage reading of 0.6 - 1.5 vdc indicates high vacuum condition (idle or no load).Voltage reading of 4 vdc indicates low vacuum condition (full throttle).



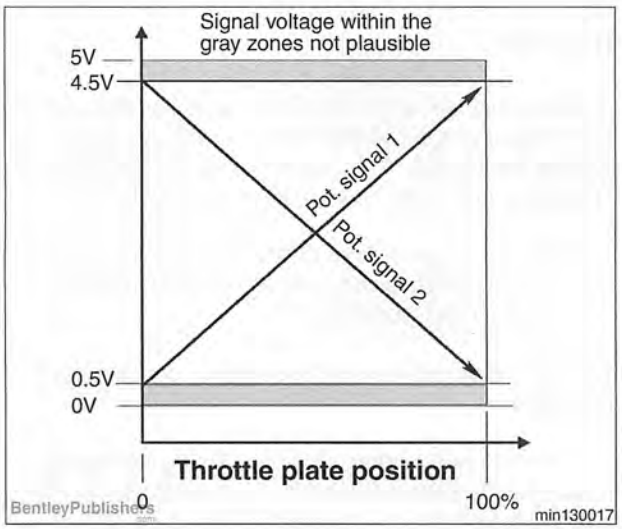
Engine coolant temperature (ECT) sensor

Engine coolant temperature (ECT) sensor is a negative temperature coefficient (NTC) thermistor located in coolant passage in cylinder head next to thermostat housing. Utilized to monitor engine coolant temperature, ECT sensor has two wires connected to ECM. ECT sensor signal is used for following functions:

- Fuel control and ignition timing
- Cooling fan speed
- Coolant temperature gauge in instrument cluster

A 5 vdc reference signal is supplied to ECT sensor by ECM.

- High voltage readings at ECM indicate high sensor resistance or low temperature.
- Low voltage readings indicate low sensor resistance or high temperature.

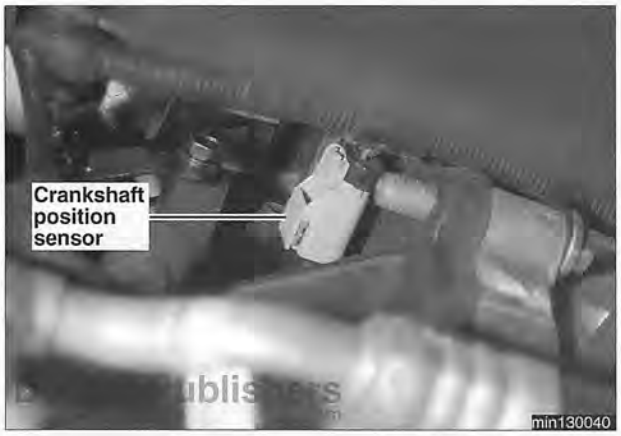


Throttle position feedback

Electronic throttle valve (EDR) position is monitored by two integrated potentiometers, providing feedback voltage signals to ECM for throttle and idle control functions.

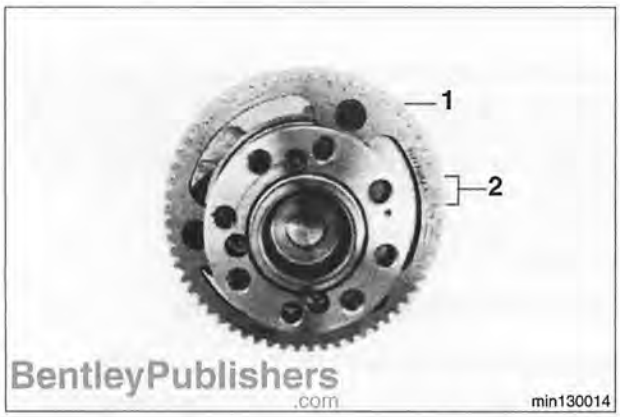
- Feedback potentiometer 1: Signal ranges from 0.5 vdc to 4.5 vdc.
- Feedback potentiometer 2: Signal ranges from 4.5 vdc to 0.5 vdc.

Potentiometer signal 1 is primary signal. Potentiometer signal 2 is used as a plausibility cross-check through total range of throttle plate movement. If there is an open or short in signal 1, signal 2 is used as a temporary substitute providing fail-safe operation. In this situation, faults are stored in ECM.



Crankshaft sensor

Crankshaft sensor, located at flywheel end and in front of crankcase, detects crankshaft speed and position and transmits this information to ECM. Crankshaft sensor is a Hall effect device providing digital electrical signal that is created as reluctor ring targets pass sensor.



Reluctor ring, bolted to end of crankshaft, is housed inside engine block.

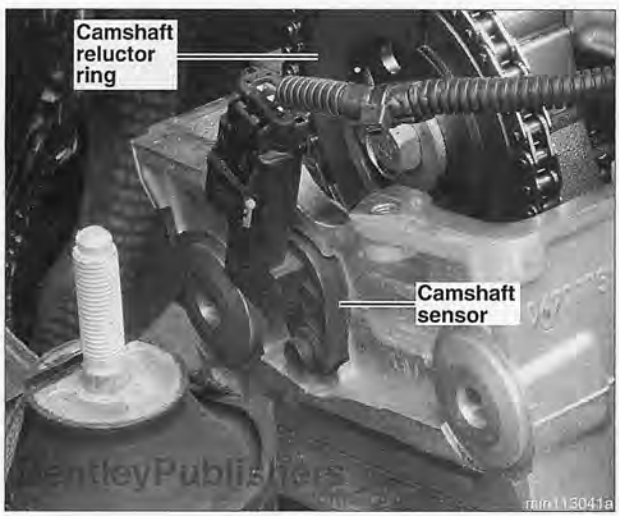
1. Reluctor ring
2. "Missing" teeth

Reluctor ring tooth pattern consists of 58 targets and a space of two missing teeth grouped together (6° tooth intervals). As engine rotates, sensor output enables ECM to determine crankshaft position and speed.

Missing reluctor ring teeth are essential for correct engine operation. They are used by ECM as angular reference point. This information is used in combination with information from camshaft sensor to determine correct timing for spark and fuel delivery.

Crankshaft position sensor signals ECM to start injection as well as providing information about engine operation. This input is used in combination with other inputs to determine engine load which increases / decreases injector pulse duration. Without crankshaft position sensor input, ECM does not activate injectors.

Camshaft sensor

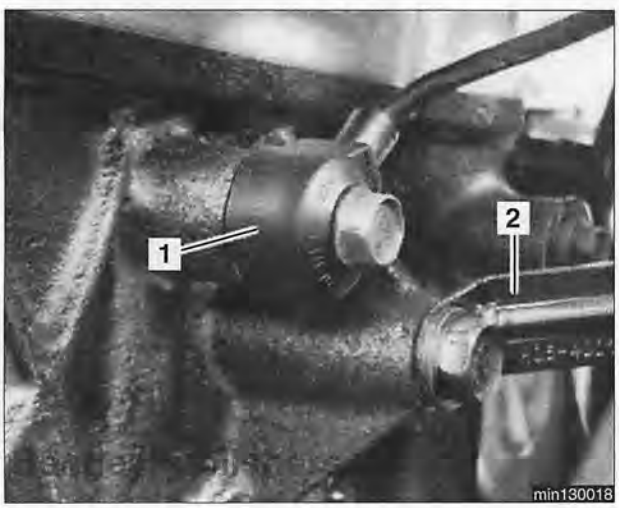


Camshaft sensor is located in front of cylinder head just below valve cover. Sensor reluctor ring is bolted to front of camshaft. Digital signal is provided by sensor in 0 - 5 vdc range. Sensor is Hall effect device which produces one pulse for each camshaft revolution.

Signal from camshaft sensor enables ECM to detect camshaft position in relation to crankshaft position. This allows ECM to synchronize fuel injector pulses and ignition spark.

Reluctor ring is half moon with a single "tooth" that extends over 180° of camshaft rotation.

Camshaft (cylinder ID) sensor affects injection timing (semisequential vs. full sequential). To accomplish this, ECM contains four final stage output transistors that activate injectors individually. Engine operates sufficiently on semisequential injection (two groups of two injector pulses), but more efficiently on full sequential injection (four individual injector pulses). If one fuel injector circuit is defective, engine can still operate on limited power from remaining fuel injector circuits.



Knock sensor

Knock sensor is bolted to front of crankcase just below intake manifold.

1. Knock sensor
2. Intake manifold support bracket

Knock sensor is a piezoelectric accelerometer producing voltage output proportional to mechanical vibration (knock) produced by engine caused by high pressure waves of uncontrolled spontaneous combustion of gasses in cylinder.

ECM control of engine timing based on knock sensor signal prevents detonation (pinging) from damaging engine. ECM response is cylinder selective.

Further information about knock sensor is in **120 Ignition System**.

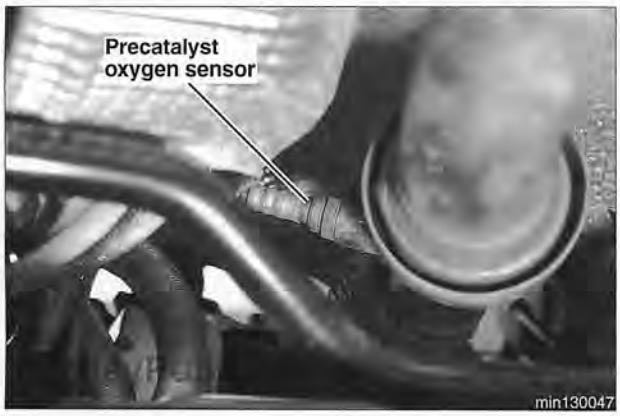
Fuel leakage diagnosis system (LDP or DMTL)

Clean air legislation in US demands on-board monitoring of fuel system sealing on all internal combustion engine vehicles. Leak diagnosis pump (LDP) system and other controls on fuel evaporative losses are described in **160 Fuel Tank and Fuel Pump**.

Oxygen sensors

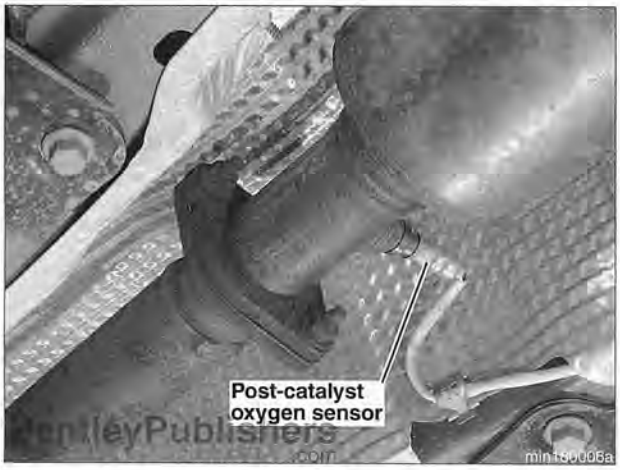
Cooper and Cooper S vehicles are equipped with two oxygen sensors each, one positioned upstream and the other downstream of catalyst.

Oxygen sensors are of zirconium dioxide type. They monitor exhaust gas oxygen content and signal ECM. This enables ECM to provide "closed loop" operation and maintain stoichiometric control of air/fuel ratio (14.7 : 1 air / fuel ratio by mass). This allows catalyst to work efficiently and reduce emissions of carbon monoxide (CO), hydrocarbons (HC) and oxides of nitrogen (NO_x) to acceptable levels.



Pre-catalyst oxygen sensor measures residual oxygen content of exhaust gas. Sensor is mounted in hot exhaust stream directly in front of catalytic converter. Sensor produces low voltage (0 - 1000 mv) proportional to exhaust oxygen content. Sensor output allows ECM to monitor air / fuel ratio. Sensor signal constantly changes due to combustion variations and normal exhaust pulsations. ECM monitors length of time sensor is in lean, rich (including time of rise and fall) and rest conditions.

Evaluation period of sensor is over a predefined number of oscillation cycles. This oscillation is efficient when oxygen sensor is hot (250° - 300°C or 480° - 570°F). For this reason, sensor contains heating element to reduce warm up time and retain heat during low engine speeds when exhaust is cooler.



Post-catalyst sensor is used to monitor catalyst performance. Post-catalyst oxygen sensor output is evaluated over course of several pre-catalyst sensor oscillations. During evaluation period, signal of post-catalyst sensor must remain within relatively constant high voltage range (700 - 800 mv) with a very slight fluctuation. If this signal is low in voltage or fluctuates rapidly, fault code is set for catalyst efficiency. MIL illuminates when OBD II limit criteria are triggered.

Brake light switch

Brake light switch is clipped to pedal cluster bracket above brake pedal.

Two separate Hall effect brake switch inputs into ECM allow redundant integrity checking. Main brake switch signal is used to control both cruise control and drive-by-wire systems.

If brake is applied, ECM suspends cruise control, but retains cruise target speed in memory.

Second switch is used in safety plausibility check. If at any time the two brake signals are inconsistent, a fault condition is assumed and any accelerator demand will result in no throttle change. Engine will remain at idle.

For more information on brake light switch, see **612 Switches**.

Clutch switch

Clutch switch module is clipped to clutch master cylinder above clutch pedal.

Clutch switch is Hall effect device used in manual transmission vehicles. Clutch switch signal to ECM is used as follows:

- Prevents starting of engine unless clutch pedal is pressed to floor.
- Suspends cruise control when clutch is operated.

For more information on clutch switch, see **612 Switches**.

Automatic transmission (CVT) sensors

CVT has a dedicated secondary speed sensor located in differential housing and a two wire temperature sensor in valve body, both connected to ECM.

For more information about automatic transmission control, see **240 Automatic Transmission**.

Alternator (generator)

Dedicated output from alternator is provided to ECM to determine electrical load on engine. When electrical loads are switched on, alternator is required to generate more electrical energy, which in turn creates greater load on engine. If alternator signal fails engine may exhibit poor idle speed stability as electrical loads are increased.

For more information on alternator, see **121 Battery, Starter, Alternator**.

Immobilizer (EWS)

ECM communicates with immobilizer system (EWS) to provide theft protection for vehicle.

On vehicles with automatic transmissions, there is a park / neutral inhibit signal that EWS control module receives directly from transmission. EWS allows engine to crank only if automatic transmission is in N or P position.

For more information on EWS system, see **515 Central Locking and Anti-Theft**.

Transmission control module (GIU)

Transmission control module (GIU) functions are as follows:

- Converts inputs from gear selector lever switches (and steering wheel switches if fitted) into CAN instructions for ECM.
- Illuminates LEDs to display transmission mode.
- Converts CAN instruction for ECM into electrical signals to drive transmission ratio control motor and clutch and secondary pressure solenoids.

For more information about GIU, see **240 Automatic Transmission**.

ABS/ASC/DSC

ECM receives road speed signals from ABS/ASC/DSC control module for cruise functions (if equipped) and maximum vehicle speed limiting. Road speed signals arrive at ECM over CAN-bus. Requests for torque modification are also received from ASC/DSC module over CAN-bus.

For more information about ABS/ASC/DSC, see **340 Brakes**.

A/C pressure transducer

Pressure transducer protects A/C system from extremes of system pressure. In conjunction with engine coolant temperature (ECT) sensor, transducer controls engine cooling fan speed. Transducer is fitted in high pressure/temperature line of refrigerant circuit, on AC pipe connecting condenser and thermostatic expansion valve, in left rear corner of engine compartment.

For more information about A/C system controls, see **640 Heating and Air-conditioning**.

Electronic instrument cluster (IKE)

Instrument cluster (IKE) communicates with ECM over CAN-bus. Low fuel level signal is passed to ECM for evaluation of misfires. IKE also transfers requests for the A/C compressor from IHKS/IHKA to the ECM. Any vehicle system not on CAN-bus that communicates with ECM does so through IKE.

For more information about IKE, see **620 Instruments**.

Multifunction steering wheel (MFL)

Vehicles equipped with cruise control have single wire digital communication system between multifunction steering wheel (MFL) and ECM. MFL transmits requests for cruise operation to ECM.

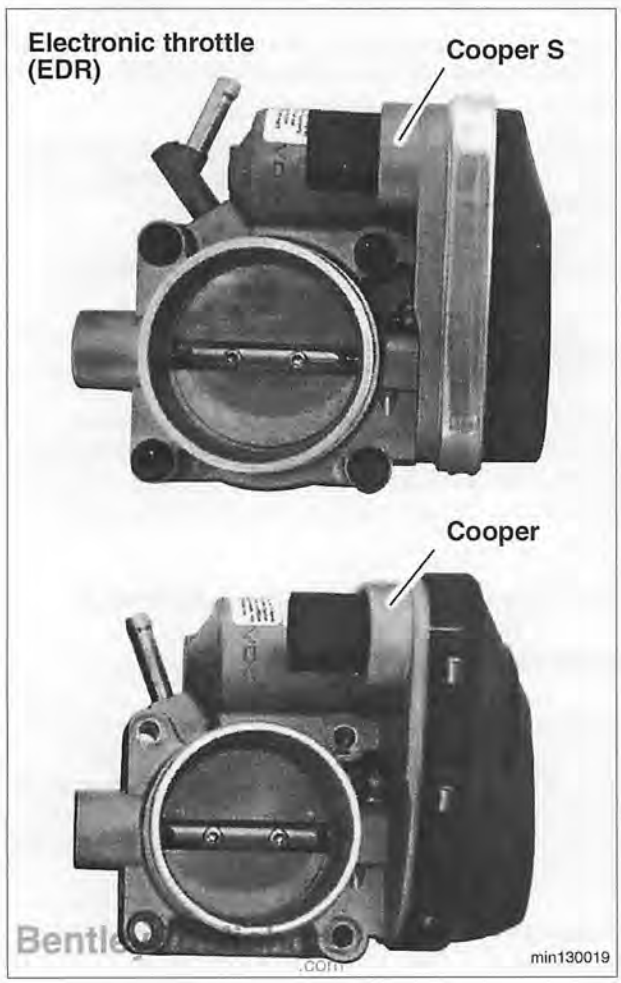
For more information about MFL, see **320 Steering and Wheel Alignment**.

System outputs

Main relay

Upon receiving wake up signal from ignition switch (switch ON or KL15) supplying power to fuse 34, engine control module (ECM) provides switched ground signal via pin 97 to main relay. This energizes main relay, providing operating power to ECM. Main relay output is monitored so that if relay is energized and power is not received by ECM, fault code is set.

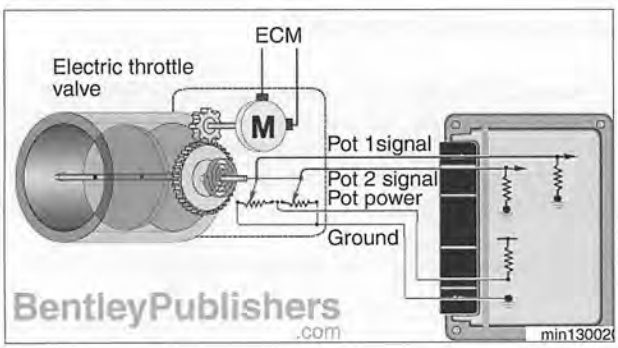
Electronic throttle control (EDR)



An electronic throttle (EDR) actuator is used to adjust engine load based on throttle position requests received by ECM from accelerator pedal position sensor. A DC motor electrically positions throttle plate from idle to full load. Two potentiometers, integrated in throttle housing, provide feedback on throttle plate position.

- MINI COOPER throttle body is 52 mm internal diameter.
- MINI COOPER S throttle body is 57 mm internal diameter.

EDR is operated by ECM for opening and closing of throttle based on accelerator pedal position, DSC intervention and cruise control function. EDR is a DC motor operating a gear-driven throttle plate. Variable duty-cycle fixed frequency signal is sent to EDR motor by ECM, which, to maintain throttle position, switches EDR signal polarity at rate of 600 Hz. Position and movement of throttle plates is confirmed through dual feedback potentiometers control functions.



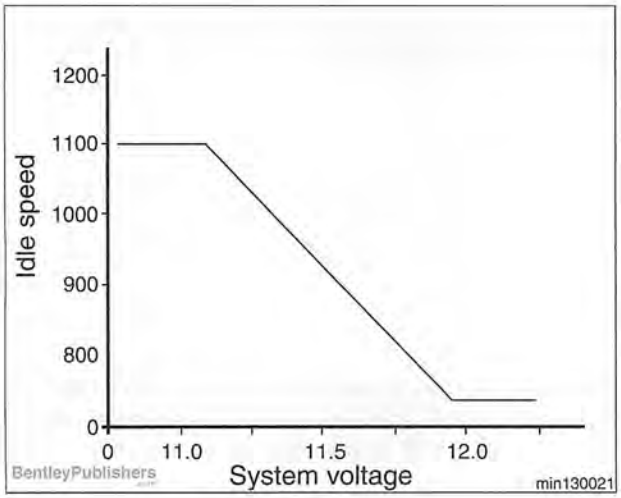
ECM provides power and ground for feedback potentiometers.

Idle speed control

Idle speed is controlled by ECM and EDR with no idle speed motor. For smooth driveability, engine speed remains constant when at idle no matter what varying loads may be. Engine idle does not fluctuate under following conditions:

- Engine cold start (increase in idle speed setting)
- Switching of different electrical loads (e.g. headlights, electrohydraulic steering)
- Air-conditioning compressor engagement

When there is a rapid change in electrical power demand on the alternator, there is corresponding rapid increase in alternator mechanical load upon engine. This has significant effect on idle speed stability. There is delay between electrical demand being made on alternator and mechanical demand on engine during which alternator transmits load change signal to ECM. This allows ECM to control throttle demand at idle to prevent flares and dips in engine speed.



Target idle speed setting for all MINI models is 750 rpm.

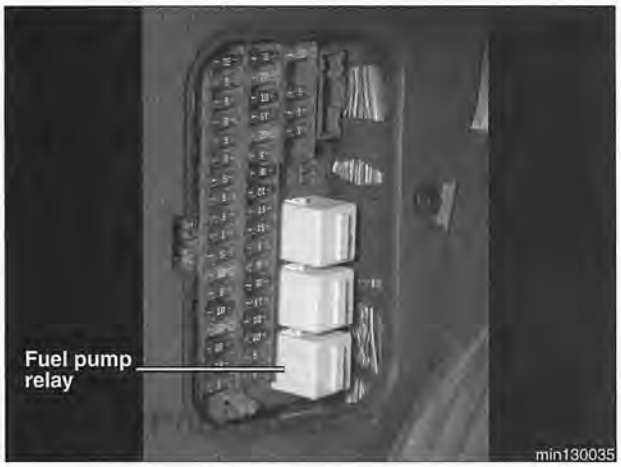
If system voltage decreases below minimum threshold (approx. 11 vdc), idle speed is increased to compensate with increased alternator output. Idle speed remains high for a period before returning to normal set point, when system voltage has recovered.

EML warning LED

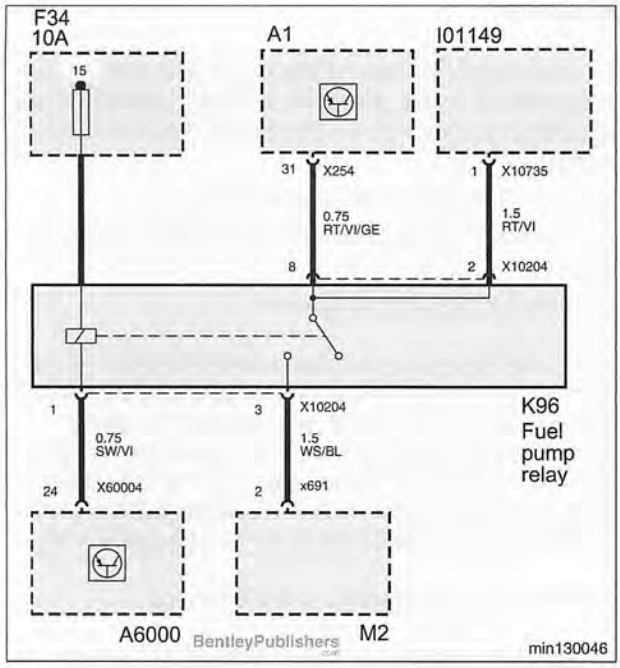
If the ECM detects an engine safety related fault, not emissions related, in ECM itself, EML warning light illuminates in instrument cluster (IKE). This fault could be caused by faulty throttle motor, defective transmission or a sticking throttle valve. EML warning LED is amber in color and is activated through CAN-bus message to IKE.

Fuel pump relay and inertia switch

Fuel pump relay is located in passenger compartment fuse and relay panel in left kick panel.



General

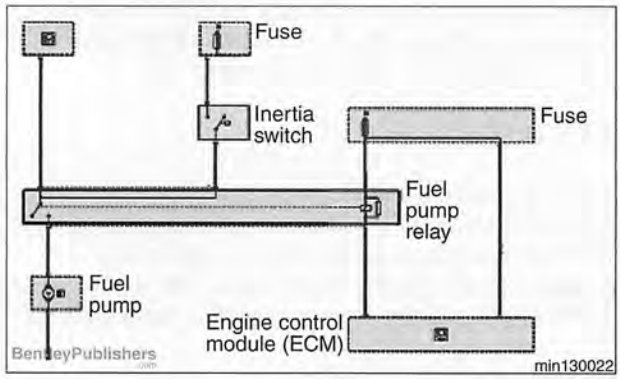


Fuel pump relay is normally open contact relay used to control fuel pump.

Pump is initially energized when ignition is switched ON. It remains energized for set time to pressurize fuel system. Relay remains energized if engine is detected to be running. Otherwise it is switched off after time delay.

Relay is switched OFF immediately if the engine has stopped. It is switched OFF after a time delay if ignition key is turned OFF.

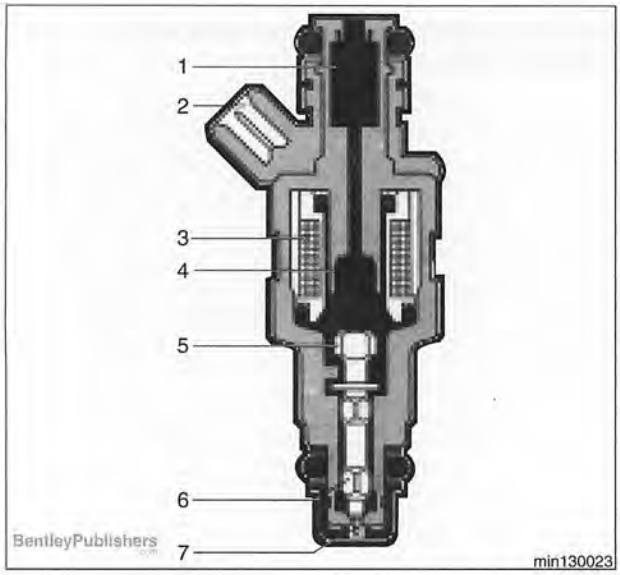
Relay gets its B+ feed from ignition switch through fuse F20 and is energized when ECM provides ground.



In early MINI models, an inertia switch is installed in the B+ line to relay between fuse and fuel pump relay. If vehicle undergoes an impact greater than 14 G, switch opens, interrupting power to relay.

If triggered, reset inertia switch manually.

Fuel Injectors

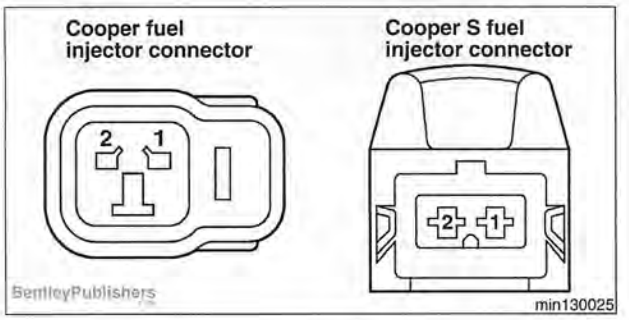


Fuel injectors are electronically controlled solenoid valves that provide precise metered and atomized fuel into engine intake ports.

1. Fuel Strainer
2. Electrical Connector
3. Solenoid Winding
4. Closing Spring
5. Solenoid Armature
6. Needle Valve
7. Pintle

Fuel is supplied from fuel rail to injector body. Fuel is channeled through injector body to needle valve and seat at tip of injector. Without electrical current, needle valve is sprung closed against seat.

There are two types of injectors used. Cooper uses an injector with 4 nozzles, while Cooper S uses an injector with a higher flow rate and 2 nozzles.



Injectors for both models are 62 mm in length and operate on fuel pressure of 3.5 Bar (51 psi). Electrical connectors are different for each type of injector, preventing accidental installation of wrong injector.

Fuel injectors receive voltage from main relay. ECM activates fuel injector by providing ground in pulses measured in milliseconds (ms). ECM varies pulse length to regulate air/fuel ratio (mixture).

Injection pulse length is regulated based on the following:

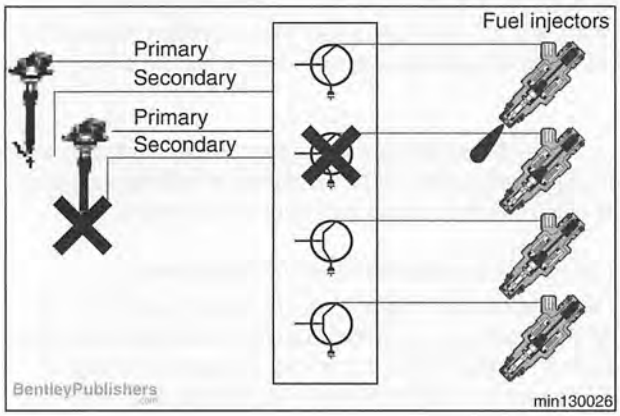
- **Battery voltage**. When cranking engine, battery voltage is low and ECM increases injector pulse duration to compensate for injector lag time. When engine is running and battery voltage is higher, ECM decreases pulse duration due to faster injector reaction time.
- **Cold starting** requires additional fuel to compensate for poor mixture and loss of fuel as it condenses on cold intake ports, valves and cylinder walls. Cold start fuel quantity is based on engine coolant temperature (ECT) sensor input during start up. As engine warms up, coolant temperature input allows ECM to adjust injection duration to compensate.
- **Idle**. With engine at idle, minimum injection is required. Additional fuel is added if ECM detects low engine rpm.
- **Acceleration**. As throttle is opened, ECM recognizes acceleration and increases fuel volume by increasing injection duration (acceleration enrichment).
- **Full throttle** position indicates maximum acceleration and ECM adds more fuel (full load enrichment).
- **Deceleration**. As throttle is closed, ECM decreases injection duration if engine rpm is above idle speed (coasting). This decreases fuel consumption and lowers emissions. When engine rpm approaches idle speed, injection duration is increased (cut-in) to prevent engine stalling. Cut-in rpm is dependent upon engine temperature and rate of deceleration.

Selective injector cut-out

ECM selectively deactivates injectors to control maximum engine rpm (regardless of vehicle speed). When engine speed reaches 6500 rpm, injectors are individually deactivated, as required, to protect engine from over-revving. As engine speed drops below 6500 rpm, normal injector activation is resumed.

> ***CAUTION—***
> *The injector cut-out feature does not protect the engine from driver error, such as forced over-revving from an improper manual transmission downshift.*

Maximum vehicle speed is also limited by ECM selectively deactivating injectors (regardless of engine rpm).



ECM will also protect catalytic converter by deactivating injectors if it detects a misfire because of ignition, injection or combustion fault(s).

Ignition system

ECM regulates ignition by calculating engine load based on a combination of inputs:

- Battery voltage
- Accelerator pedal position
- Calculated air volume and mass
- Engine coolant temperature
- Crankshaft and camshaft position
- Knock sensor

For more information on ignition coil, see **120 Ignition System**.

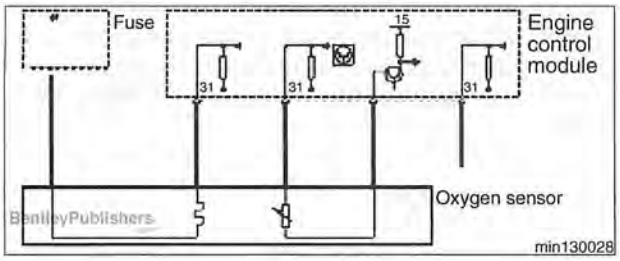
Evaporative emissions control

Evaporative emission purging is regulated by ECM via fuel tank vent valve (evaporative emission valve). This solenoid that regulates purge flow from active carbon canister into intake manifold. Main relay provides operating voltage, and ECM controls valve by regulating ground circuit.

For more information on evaporative emission controls, see **160 Fuel Tank and Fuel Pump**.

Oxygen sensor heating

Oxygen sensor efficiency is high when hot (250° - 300°C or 480° - 570°F). Oxygen sensor heater reduces warm-up time and maintains sensor temperature during low engine speed when exhaust temperature is cooler. OBD II requires monitoring of oxygen sensor heating.



Oxygen sensor heating circuits receive operating voltage from main relay when ignition is switched ON (KL15). Each heater is controlled through a separate final stage transistor by pulse-width modulated ground from engine control module (ECM) during cold start. This allows sensors to be brought up to operating temperature without thermal shock. Heating circuit duty cycle is then varied to maintain sensor heating.

When decelerating (closed throttle), ECM increases heating circuit duty cycle to compensate for decreased exhaust temperature.

Transmission control module (GIU)

ECM receives inputs from main automatic transmission sensors, communicates with transmission control module (GIU) to control transmission, accepts driver inputs, and provides information to driver via instrument cluster.

For more information about GIU, see **240 Automatic Transmission**.

A/C compressor control

ECM receives inputs from air-conditioning or climate control sensors, accepts driver inputs and controls operation of A/C compressor.

For more information about A/C system controls, see **640 Heating and Air-conditioning**.

Engine cooling fan

The engine cooling fan is controlled by ECM through a relay and relay pack at two different speeds: Low and High. In addition to maintaining coolant temperature, cooling fan is used to cool A/C refrigerant and, where applicable, CVT gearbox oil.

For more information about engine cooling fan controls, see **170 Radiator and Cooling System**.

OBD II plug

OBDII plug is behind cover above clutch pedal. Plug connection to ECM is through D-bus. This allows communication with scan tools (DISplus, GT1, MoDiC or equivalent), as well as emission related powertrain components.

Troubleshooting

Troubleshooting and fault diagnosis on the engine management system (EMS) is best performed using an electronic scan tool. However, it may be necessary to perform basic tests of EMS main components, fuel system or wiring.

Checking fuel delivery volume and fuel pressure is a fundamental part of troubleshooting and diagnosing the engine management system. Fuel pressure directly influences fuel delivery. Procedures for measuring fuel pressure and fuel volume are given in **160 Fuel Tank and Fuel Pump**.

Warnings and cautions

For personal safety, as well as the protection of sensitive electronic components, adhere to the following warnings and cautions.

WARNING —

- *Gasoline is highly flammable and its vapors are explosive. Do not smoke or work on a car near heaters or other fire hazards when diagnosing and repairing fuel system problems. Have a fire extinguisher available in case of an emergency.*
- *Renew fuel system hoses, clamps and O-rings any time they are removed.*
- *When working on an open fuel system, wear suitable hand protection, as prolonged contact with fuel can cause illnesses and skin disorders.*
- *The ignition system produces high voltages that can be fatal. Avoid contact with exposed terminals. Use extreme caution when working on a car with the ignition switched on or the engine running.*

CAUTION—
- *Disconnecting the battery may erase fault code(s) stored in memory. Check for fault codes prior to disconnecting the battery cables. Read the battery disconnection cautions in* **001 General Warnings and Cautions**.
- *Connect and disconnect the EMS system wiring and test equipment leads only when the ignition is switched off.*
- *Wait at least 5 minutes after turning off the ignition before removing the engine control module (ECM) connector. If the connector is removed before this time, residual power in the system relay may damage the control module.*
- *Fuel system cleaners and other chemical additives other than those specifically recommended by BMW may damage the catalytic converter, the oxygen sensor or other fuel supply components.*
- *Connect test equipment only as specified by BMW or the equipment maker.*
- *Only use a digital multimeter for electrical tests. Only use an LED test light for quick tests.*
- *Fuel system tests may set fault codes (DTCs) in the ECM and illuminate the MIL. After all testing tests is completed, access and clear DTC fault memory using a BMW compatible scan tool. See* **OBD On Board Diagnostics**.
- *Relay positions can vary. Be sure to confirm relay position by identifying the wiring in the socket using the wiring diagrams found at the rear of this manual.*

Component Replacement

The fuel pump is located inside the fuel tank. For replacement procedures, see **160 Fuel Tank and Fuel Pump**.

The fuel filter is a "lifetime" unit installed in the fuel tank. There is no routine interval or procedure for replacing the fuel filter.

Fuel rail and injectors, removing and installing

– Read out engine control module (ECM) fault memory. Then switch off ignition.

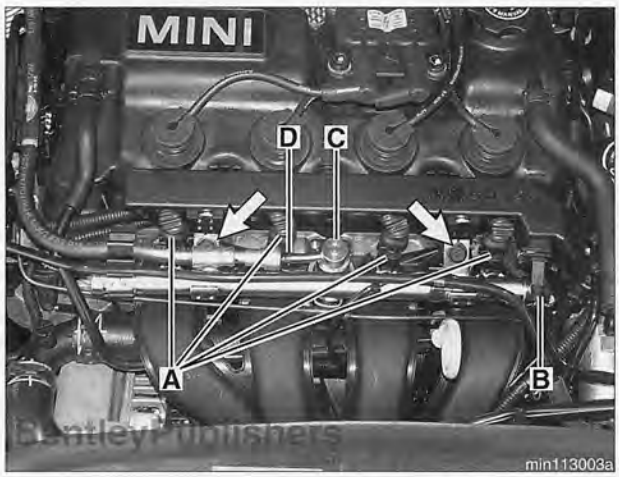
➢ Remove fuel rail cover:
- Squeeze locking tabs (**A**) to detach rear of cover.
- Tilt and pull cover forward until plastic clips (**arrows**) detach from fuel rail.

CAUTION—
Plastic clips can break easily.

Component Replacement

➤ Cooper S: Remove intercooler. See **113 Cylinder Head Removal and Installation** for complete procedure.

- Remove intercooler cover.
- Remove intercooler sealing bellows clamps and intercooler cover mounting brackets.
- Detach sealing bellows and tilt intercooler to remove.



➤ Detach fuel rail from top of engine:

- Disconnect fuel injector electrical harness connectors (**A**).
- Disconnect harness connector (**B**).
- Working at fuel rail, unclip hoses and ducts. Cut wire ties as needed.
- Disconnect vacuum line at base of fuel pressure regulator (**C**).
- Detach fuel supply line from clips. Unlock quick-connect coupling (**D**) on fuel supply line and detach from fuel pressure regulator. Use special tool 13 5 281to plug fuel line.
- Remove fuel rail mounting bolts (**arrows**).

WARNING —

- *When disconnecting fuel line, fuel will be expelled under pressure. Loosen fuel filler cap to release fuel tank pressure.*
- *Do not smoke or work near heaters or other fire hazards.*
- *Keep a fire extinguisher handy.*
- *Before disconnecting fuel hose, wrap a cloth around hose to absorb any leaking fuel.*
- *Plug all open fuel connections.*

CAUTION —

Do not allow fuel to drip on alternator.

NOTE —

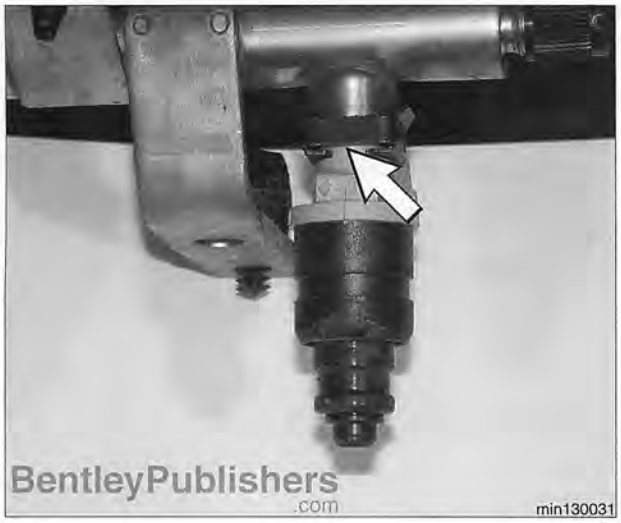
In illustration above, Cooper engine is shown. Cooper S fuel rail layout and connections are similar.

➤ Cooper S: Unhook fuel injector electrical harness from fuel rail mounting brackets.

– Remove fuel rail together with fuel injectors from intake manifold.

CAUTION —

- *Use compressed air to blow away accumulated debris at the base of each fuel injector before pulling out injectors.*
- *Plug fuel injector bores in intake manifold.*



➤ Remove retaining clip (**arrow**) of fuel injector and then remove fuel injector from fuel rail.

– Installation is reverse of removal.
- Coat fuel injector sealing O-rings with antiseize compound.
- Clear ECM fault memory.

Tightening torques	
Fuel rail to intake manifold (M8)	25 Nm (18 ft-lb)
Intercooler cover to intercooler	9 Nm (7 ft-lb)
Intercooler cover bracket to intercooler	9 Nm (7 ft-lb)
Upper sealing bellows clamp to lower clamp	9 Nm (7 ft-lb)

– Run engine and check for fuel leaks.

Fuel pressure regulator, removing and installing

– Switch off ignition.

– Remove fuel rail as described in this repair group.

➤ Remove pressure regulator retaining clip in direction of **arrow**. Twist pressure regulator and pull out of fuel rail housing to remove.

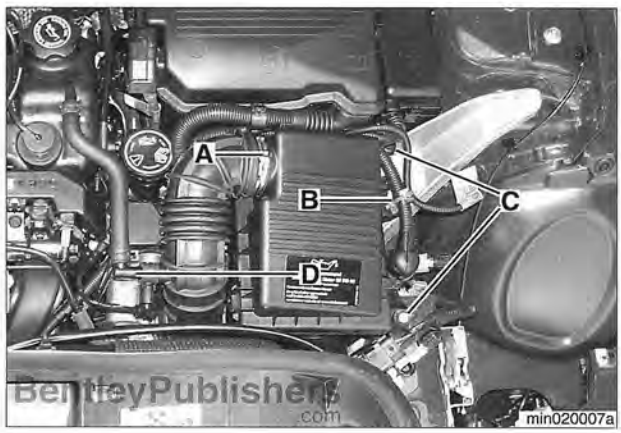
> ***CAUTION—***
> *After removing pressure regulator, make sure filter of regulator is not left behind in housing.*

– When reinstalling regulator, replace both sealing O-rings.

– Reinstall fuel rail. Coat fuel injector sealing O-rings with antiseize agent.

– Run engine and check for fuel leaks.

Air filter housing, removing and installing (Cooper)



➤ Working at top of engine, loosen or remove air duct clamp (**A**). Detach air duct from air filter housing.
- Detach wire harness (**B**).
- Remove air filter housing mounting screws (**C**).
- Detach crankcase breather hose (**D**) from air duct.

– Remove complete air filter housing.

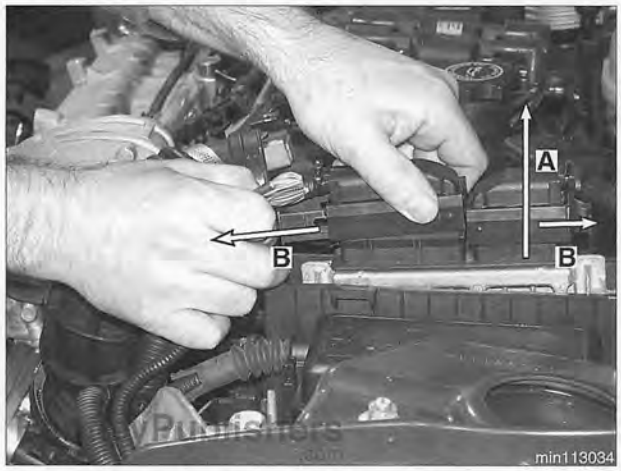
– When reinstalling, reattach air duct using new clamp.

Tightening torque	
Air filter housing to body (M6)	7 - 10 Nm (5 - 7 ft-lb)

Air filter housing, removing and installing (Cooper S)

Detach air filter housing from throttle housing:

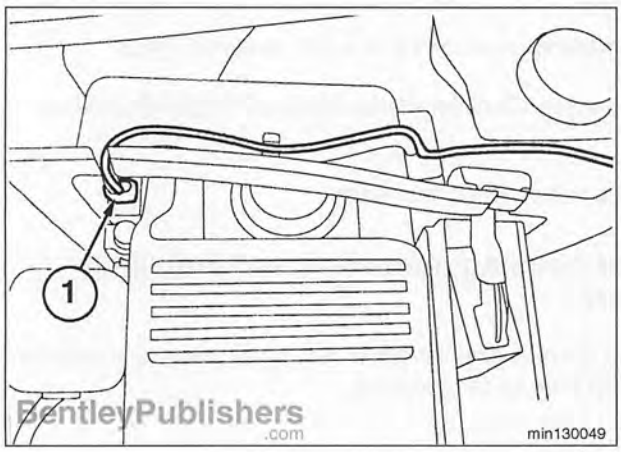
- Pull up on battery positive connection point (Batt+) (**arrows**) to release from right side of air filter housing.
- Loosen or remove hose clamp (**A**) and detach outlet duct from air filter housing.
- Remove air filter housing retaining bolt (**B**).



Remove DME control module:

- Remove control module container cover and lift control unit upward (**A**).
- Pull connector locking sliders outward (**B**).
- Disconnect control module connectors.
- Place control module in safe storage location.

NOTE—
There are 2 control module harness connectors.



For the John Cooper Works (JCW) air filter assembly, detach harness connector (**1**) and vacuum line near rear of filter assembly. For more JCW upgrade kit information, see **Air filter housing and upgrade kit (JCW)** in this repair group.

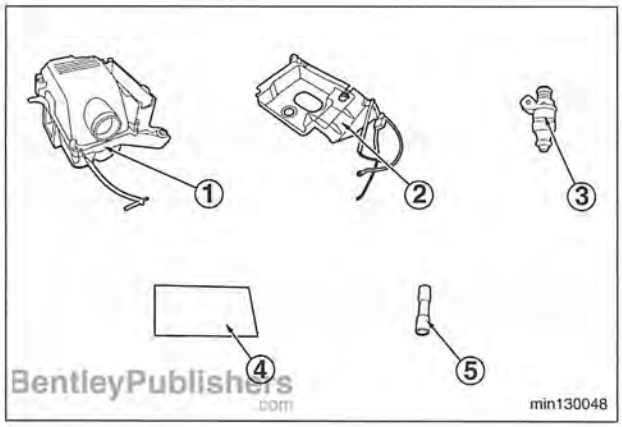
- Unclip air filter inlet duct from modular front end. Wriggle duct while pulling it toward front of car to detach from air filter housing.
- Remove air filter housing from engine compartment.
- When reinstalling, reattach air duct using new clamp.

Tightening torque	
Air filter housing to body (M6)	7 - 10 Nm (5 - 7 ft-lb)

- Reinstall ECM and attach connectors.

Air filter housing and upgrade kit (JCW)

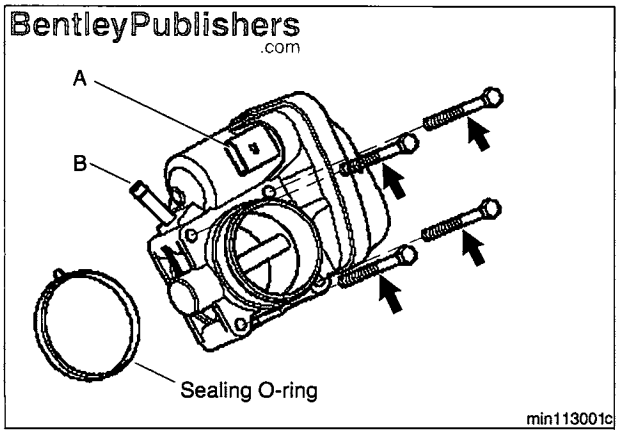
A special air filter assembly is available as part of the John Cooper Works (JCW) engine upgrade kit. This air filter assembly has an additional intake flap which opens at 4500 rpm to compliment the additional power demands of the modified JCW cylinder head, supercharger and engine management software.



The JCW upgrade kit includes the following components:

1. Air filter housing
2. Rear plenum partition with hole for additional air filter intake
3. Fuel injectors
4. Heat shield
5. Crimp connector

Installation of the JCW upgrade kit requires an update to the engine management software and should be done by an authorized MINI dealer.



Throttle housing (EDR), removing and installing (Cooper)

– Read out engine control module (ECM) fault memory. Then switch off ignition.

– Remove air filter housing. See **Air filter housing, removing and installing (Cooper)** in this repair group.

➢ Remove throttle housing:

- Loosen or remove air duct clamp at throttle assembly. Detach air duct.
- Disconnect electrical harness connector (**A**).
- Detach fuel tank vent line (**B**).
- Loosen and remove throttle assembly mounting screws (**arrows**).
- Lift off throttle assembly.

– When reinstalling, replace sealing O-ring.

Tightening torque	
Throttle housing to intake manifold (M6)	9 Nm (7 ft-lb)

– Reinstall air filter housing.

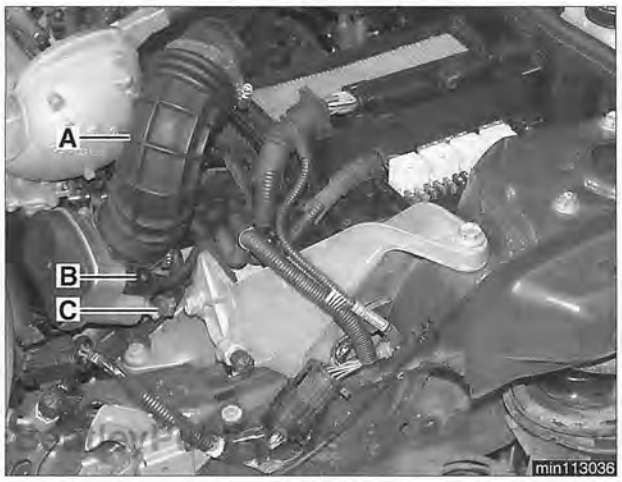
Tightening torque	
Air filter housing to body (M6)	7 - 10 Nm (5 - 7 ft-lb)

NOTE—
If throttle housing is replaced, be sure to reset DME control unit adaptation values using diagnostic scan tool.

Throttle housing (EDR), removing and installing (Cooper S)

– Read out engine control module (ECM) fault memory. Then switch off ignition.

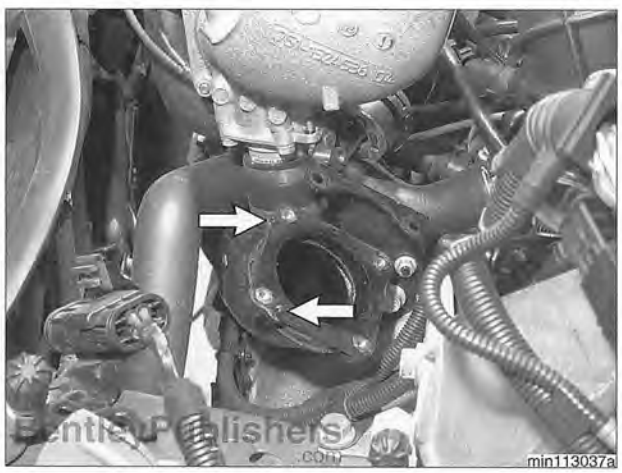
– Remove ECM and air filter housing. See **Air filter housing, removing and installing (Cooper S)** in this repair group.



➢ Remove throttle housing:

- Loosen or remove air duct clamp at throttle assembly. Detach air duct (**A**).
- Disconnect electrical harness connector (**B**).
- Detach fuel tank vent line (**C**).
- Loosen and remove throttle assembly mounting screws.
- Lift throttle assembly off supercharger intake duct.

➢ When reinstalling throttle housing, replace sealing O-ring (**arrow**).



➢ Make sure locating pins (**arrows**) on supercharger intake duct align with corresponding bores on throttle housing. Check locating pins for damage. Replace if necessary.

Tightening torque	
Throttle housing to supercharger intake duct (M6)	9 Nm (7 ft-lb)

– Reinstall air filter housing.

Tightening torque	
Air filter housing to body (M6)	7 - 10 Nm (5 - 7 ft-lb)

– Reattach air duct using new clamps.

NOTE —
If throttle housing is replaced, be sure to reset DME control unit adaptation values using diagnostic scan tool.

Supercharger oil service

Owing to the extreme heat and harsh operating conditions, it is a good idea to check the supercharger oil level on a regular basis. MINI does not specifically recommend a supercharger oil service and no oil is available through MINI parts.

The supercharger on the MINI is manufactured by Eaton. General Motors uses a similar Eaton supercharger and the GM supercharger oil (GM Part number **12345982**) can be substituted.

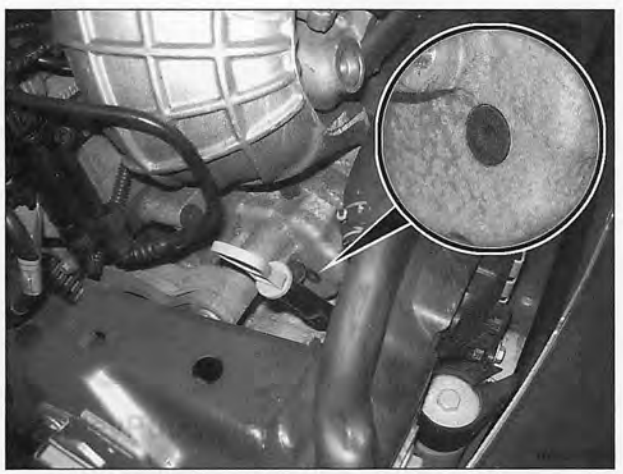
The supercharger has two oil reservoirs; one on the front of the supercharger below the drive pulley and one on the rear behind the water pump. Oil service for each is covered separately.

The reservoir fill plugs are difficult to access, and some disassembly is required to access the rear plug. A small diameter hose may help to facilitate topping off.

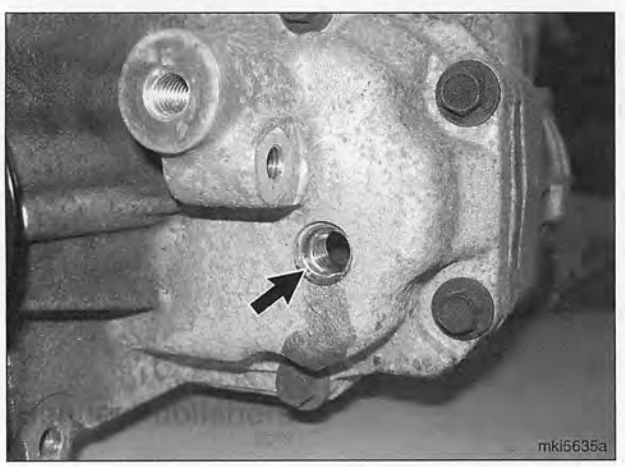
Supercharger front oil reservoir, adding oil (W11 engine)

– Remove engine oil dipstick tube.

➢ Using a 3/16 Allen wrench remove oil fill plug (**inset**).



➢ Fill reservoir with oil until it begins to run out (**arrow**).



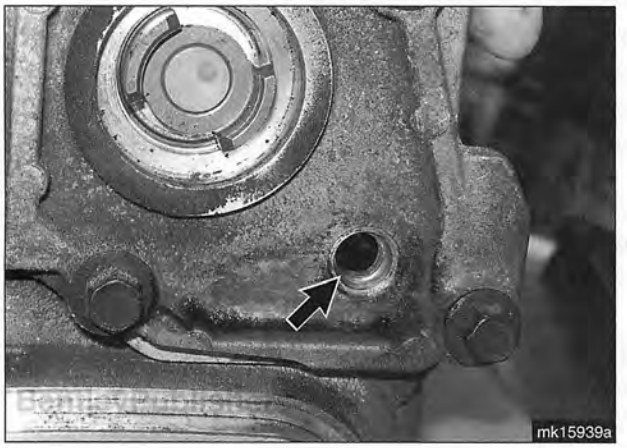
– Reinstall plug and tighten.

Supercharge rear oil reservoir, adding oil (W11 engine)

– Remove water pump. See **170 Radiator and Cooling System**.

➤ Using a 3/16 Allen wrench, remove oil fill plug (**arrow**).

NOTE —
- *Supercharger removed from vehicle for clarity*



➤ Fill reservoir with oil until it begins to run out (**arrow**).

– Reinstall plug and tighten.

Supercharger, removing and installing

– Working in cargo compartment, lift floor trim cover. Disconnect negative (–) cable from battery. See **121 Battery, Starter, Alternator** for more information.

> ***CAUTION—***
> *Disconnecting the battery may erase fault code(s) stored in memory. Check for fault codes prior to disconnecting the battery cables.*

– Remove intercooler. See **113 Cylinder Head Removal and Installation**.

– Remove throttle housing. See **Throttle housing, removing and installing (Cooper S)** in this repair group.

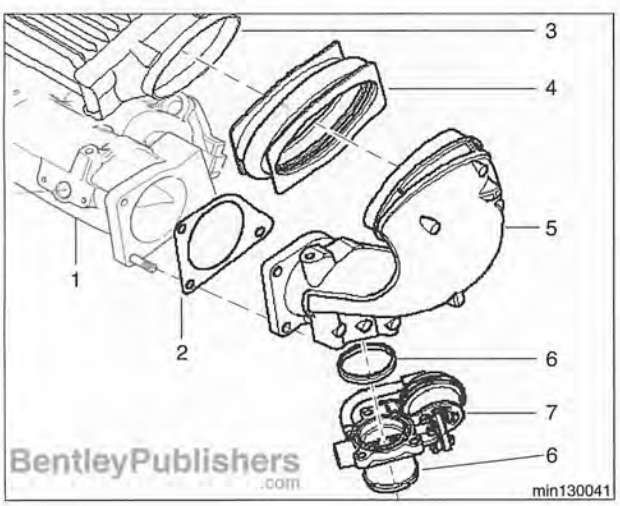
➢ Loosen modular front end (MFE):

- Remove right front wheel housing liner.
- Detach left front wheel housing liner from front bumper cover trim.
- Remove front bumper cover trim.
- Remove bumper.
- Detach radiator upper hose support clamp (**A**) from intake manifold.
- Remove MFE mounting bolts. Install two 100 mm (4 in) M8 bolts (**arrow**) in left and right bumper support members. Slide MFE forward, supported on long bolts.

> ***CAUTION—***
> *For ease of component alignment when reassembling front bumper assembly, do not loosen or remove bumper alignment bosses.*

NOTE—

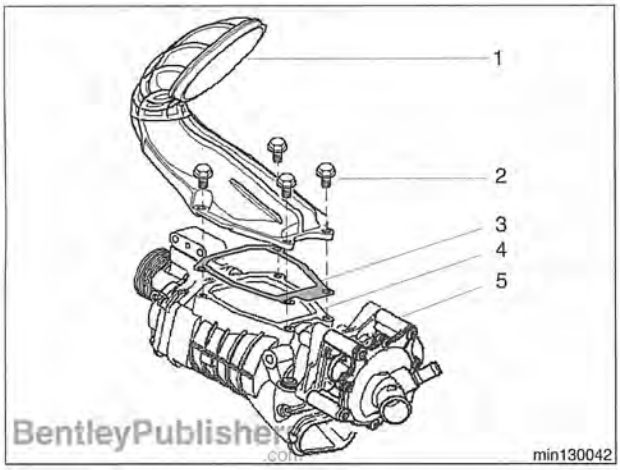
- *If available, use BMW special tools 11 8 401 and 11 8 402 instead of long bolts to support MFE.*
- *Removal of MFE is a complicated job. It is covered in* **510 Bumpers, External Trim**.



➢ Detach air intake bypass valve from intercooler output air duct. Remove air duct fasteners from intake manifold and remove duct.

1. Intake manifold
2. Gasket
3. Intercooler
4. Intercooler bellows
5. Intercooler output air duct
6. O-ring seal
7. Air intake bypass valve

– Remove intake manifold. See **113 Cylinder Head Removal and Installation**.



➢ Remove supercharger output air duct.

1. Supercharger output air duct
2. Bolt M8
   - Tighten to 25 Nm (18 ft-lb)
3. Gasket (always replace)
4. Supercharger
5. Coolant pump

– Remove engine accessory belt. See **020 Maintenance**.

NOTE —
Mark direction of belt travel. Reinstall drive belt in same direction of rotation.

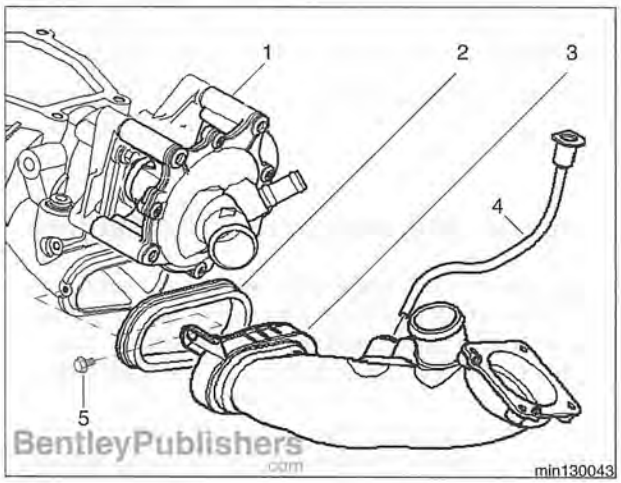
➢ Working below left side of engine compartment, loosen lower radiator hose clamp (**arrow**). Detach hose from radiator, allowing coolant to drain into suitable catch pan.

WARNING —
Due to risk of personal injury, be sure the engine is cold before opening any part of the cooling system or removing the coolant reservoir cap.

NOTE —
Save coolant and reuse, or dispose of properly.

WARNING —
Use caution when draining and disposing of engine coolant. Coolant is poisonous and lethal to humans and pets. Pets are attracted to coolant because of its sweet smell and taste. Seek medical attention immediately if coolant is ingested.

– Detach alternator electrical harness. Remove alternator mounting bolts. Remove alternator. See **121 Battery, Starter, Alternator**.

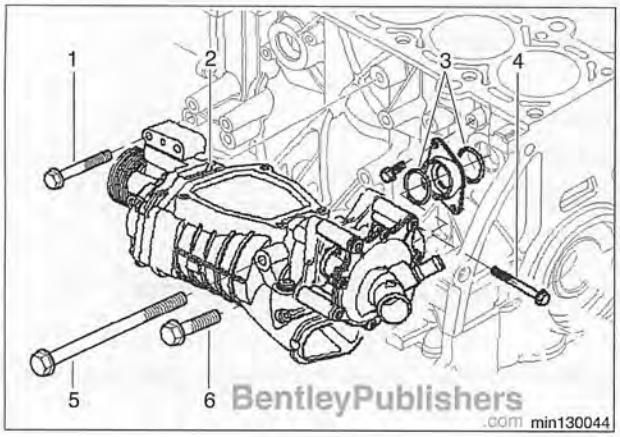


➢ Unclip vacuum lines from supercharger intake air duct. Remove duct from supercharger.

1. Supercharger-coolant pump assembly
2. Profile gasket
3. Supercharger intake air duct
4. Vacuum line
5. Bolt M6
   - Tighten to 9 Nm (7 ft-lb)

– Loosen clamps and detach coolant hoses from rear of coolant pump. Also, for better access, detach coolant hose from thermostat housing at left end of cylinder head.

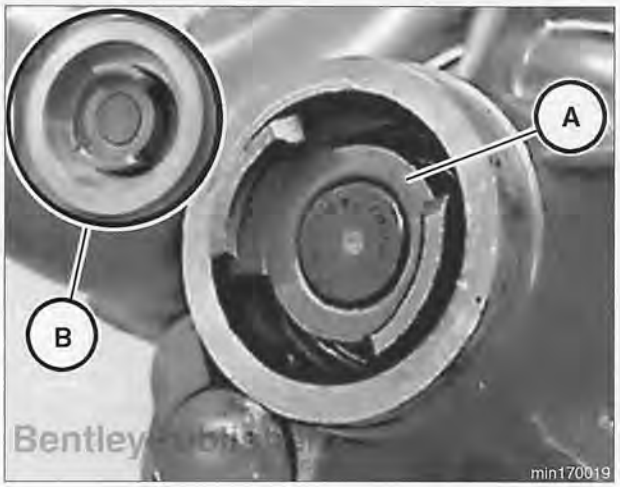
– Remove dipstick mounting bolt and move dipstick aside.



➢ Remove supercharger mounting bolts at engine block. Remove supercharger.

1. Bolt M8 x 60 mm
   - Tighten to 25 Nm (18 ft-lb)
2. Supercharger-coolant pump assembly
3. Coolant pump O-ring seals
4. Bolt M8 x 80 mm
   - Tighten to 30 Nm (22 ft-lb)
5. Bolt M10 x 150 mm
   - Tighten to 45 Nm (33 ft-lb)
6. Bolt M10 x 40 mm
   - Tighten to 45 Nm (33 ft-lb)

– With supercharger on workbench, remove coolant pump mounting bolts and separate coolant pump from supercharger.



➢ When reinstalling coolant pump, make sure pump shaft (**A**) is keyed correctly to supercharger shaft (**B**).

- Item **B** is shown in illustration at a smaller scale than item **A**.

Tightening torque	
Coolant pump to supercharger (M8)	30 Nm (22 ft-lb)

– Supercharger installation is opposite of removal. Note the following:

- Install new coolant pump sealing O-ring prior to placing supercharger-coolant pump assembly up against engine block.
- Fill and bleed cooling system. See **170 Radiator and Cooling System**. Run engine and check for leaks.

Tightening torques	
Alternator harness connector to alternator (M6)	10 Nm (7 ft-lb)
Alternator to engine block (M8)	25 Nm (18 ft-lb)
Intercooler outlet duct to intake manifold (M7)	16 Nm (12 ft-lb)
Supercharger outlet duct to supercharger (M8)	25 Nm (18 ft-lb)
Supercharger to engine block (M8)	25 Nm (18 ft-lb)
Supercharger to engine block (M10)	45 Nm (33 ft-lb)

Supercharger pulley, removing and installing

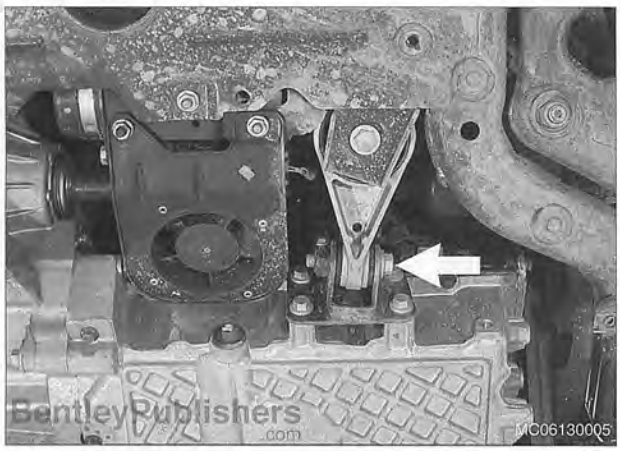
A common upgrade for the Cooper S is to replace the stock supercharger pulley with a smaller diameter aftermarket pulley. This allows the supercharger to spin faster and therefore provide more boost. This upgrade may void the manufacturer's vehicle warranty.

The procedure given here shows how to remove the stock pulley only. Installation for the various aftermarket pulleys will vary. Always follow manufacturer's installation instructions supplied with pulley.

To remove the stock pulley using a conventional gear puller, the engine must be lifted slightly and the accessory belt tensioner removed.

– Working in cargo compartment, lift floor trim cover. Disconnect negative (–) cable from battery. See **121 Battery, Starter, Alternator** for more information.

> ***CAUTION—***
> *Disconnecting the battery may erase fault code(s) stored in memory. Check for fault codes prior to disconnecting the battery cables.*



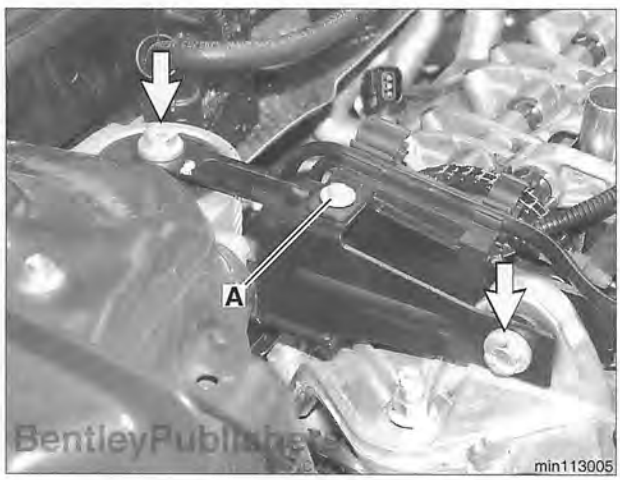
– Remove lower sound absorber panel under engine.

– Support weight of engine with hoist or floor jack.

NOTE—
- *Use wooden block or rubber pad under engine to prevent damage from floor jack.*
- *Use of two floor jacks on left and right sides of engine may make removal and installation of engine mounting bolts easier.*

➢ Working underneath car, remove lower engine vibration damper mounting bolt (**arrow**).

Vehicles through mid-2004

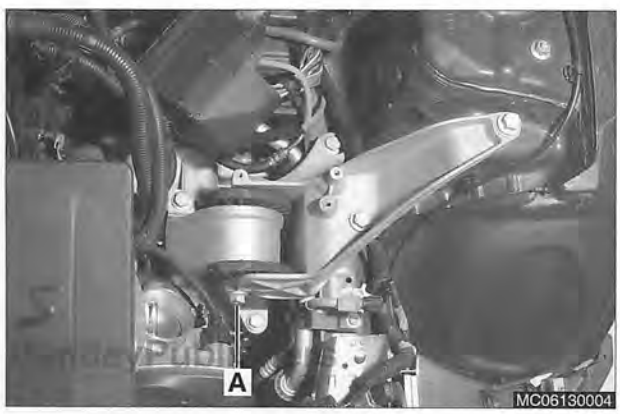


➢ Working on right side of engine, remove bolts from top engine vibration damper bracket (**arrows**), if applicable.

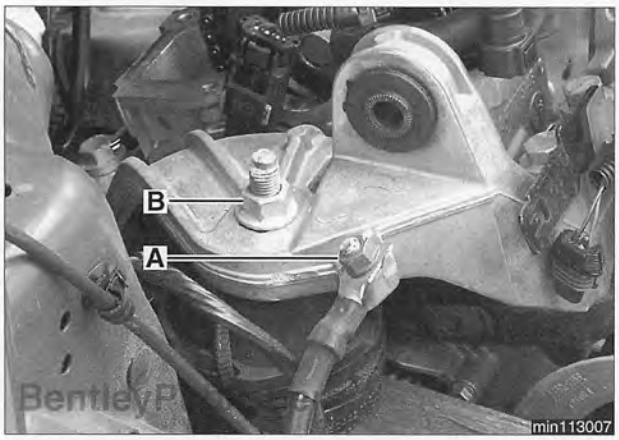
NOTE—
Later model vehicles may not have vibration damper bracket.

– Unclip hoses and remove plastic bracket (**A**).

Continued for all vehicles



➢ Remove left side engine mount bolt (**A**).



➢ Remove ground wire (**A**) from engine mount and mounting nut (**B**) from hydraulic mount.

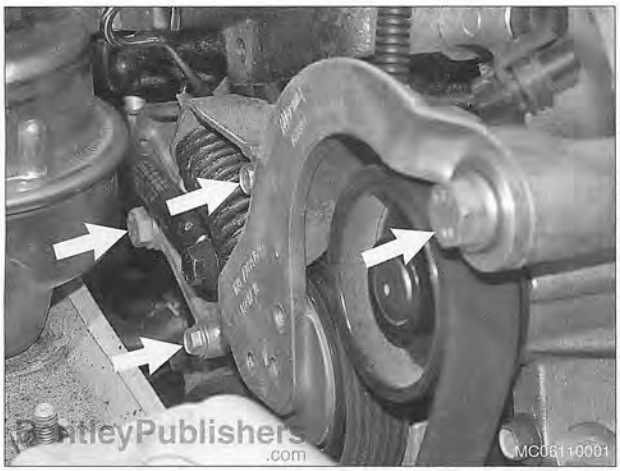
– Remove clamp bolt at top of radiator that holds wiring harness and radiator hose to intake manifold.

– Use hoist or floor jack to slowly lift engine enough to access accessory belt tensioner.
  - Make sure that coil pack plug, throttle body and power steering fan are not damaged while lifting engine.
  - Make sure hoses and wiring harnesses are not damaged while lifting engine.

➢ Use special tool 11 8 410 to release accessory belt tension.

➢ Use lock pin (**arrow**) (special tool 11 8 470, or equivalent) to lock belt tensioner.

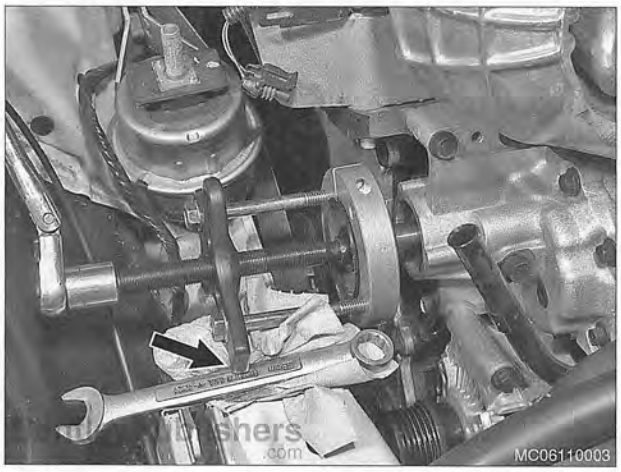
> ***CAUTION —***
> *Belt tensioner is under high tension. Check that lock pin is secure.*



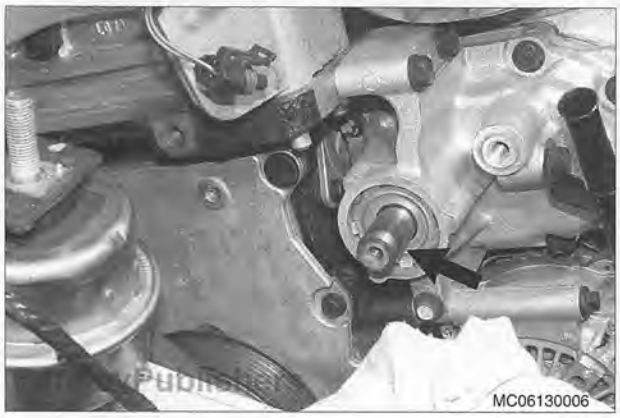
➢ Remove mounting bolts (**arrows**) for accessory belt tensioner.
- Note location of mounting bolts for correct installation later.

➢ Pry out top lip of center cap of supercharger pulley. Remove cap by unthreading it.

– Install a 10 mm (13mm head) bolt into the center of the pulley shaft to protect the internal threads from damage when using gear puller.



➢ Install collar around pulley and gear puller to collar. Remove pulley using gear puller.
- If necessary, block puller (open end wrench shown at **arrow**) from turning using suitable flat stock. Use a rag to protect painted surfaces.



➢ Clean pulley shaft (**arrow**) and follow manufacturer's instructions for installing new pulley.

– If re-installing old pulley, install in reverse order of removal. Tighten fasteners to specification.

Tightening torques	
Belt tensioner to crankcase	45 Nm (33 ft-lb)
Engine mount bracket to engine mount	68 Nm (50 ft-lb)
Engine mount bracket to transmission	38 Nm (28 ft-lb)
Engine mount to body	68 Nm (50 ft-lb)
Ground wire to engine support bracket	13.5 Nm (10 ft-lb)
Lower engine vibration damper to holder	100 Nm (74 ft-lb)
Top engine vibration damper bracket to body	100 Nm (74 ft-lb)
Top engine vibration damper bracket to engine	100 Nm (74 ft-lb)
Transmission mount bolts to transmission	66 Nm (49 ft-lb)
Transmission mount retaining bolt to upper bracket	66 Nm (49 ft-lb)

SENSOR REPLACEMENT

The manifold pressure sensors, air temperature sensor and coolant temperature sensor are among the most important components of the engine management system.

Testing of these components is generally best accomplished with a BMW or BMW-compatible diagnostic scan tool.

T-MAP sensor, replacing (Cooper)

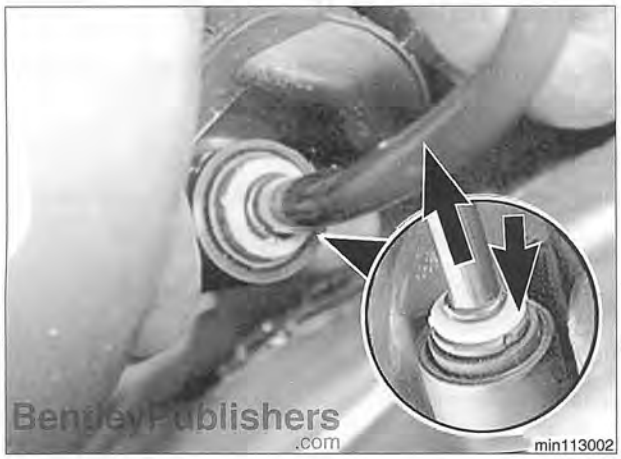
– Read out engine control module (ECM) fault memory. Then switch off ignition.

– Remove throttle housing. See **Throttle housing, removing and installing (Cooper)** in this repair group.

➢ Remove fuel rail cover:

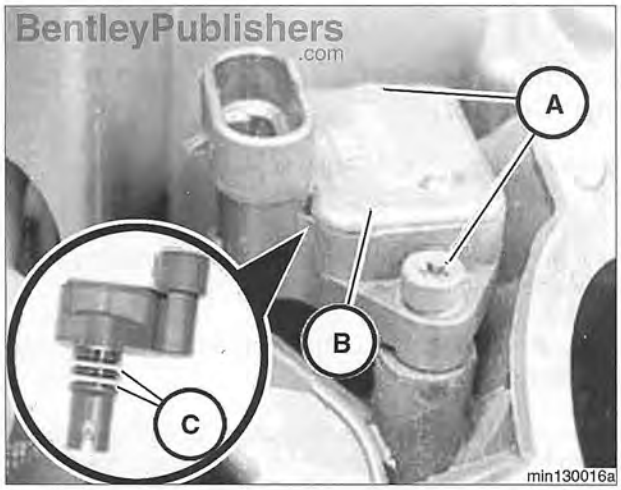
- Squeeze locking tabs (**A**) to detach rear of cover.
- Tilt and pull cover forward until plastic clips (**arrows**) detach from fuel rail.

CAUTION—
Plastic clips can break easily.



➢ Working at intake manifold, press brake booster vacuum line locking ring downward to detach line from manifold.

– Unlock electrical harness connector from sensor and detach.



➢ Release mounting screws (**A**) and remove T-MAP sensor (**B**).

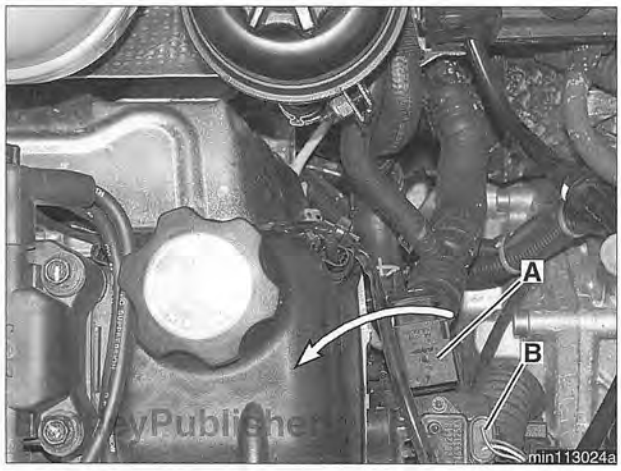
– When reinstalling, replace sealing O-rings (**C**).

Tightening torque	
T-MAP sensor to intake manifold	4 Nm (35 in-lb)

– Clear ECM fault memory.

MAP sensor, replacing (Cooper S)

– Read out engine control module (ECM) fault memory. Then switch off ignition.



➢ Working at left end of cylinder head:

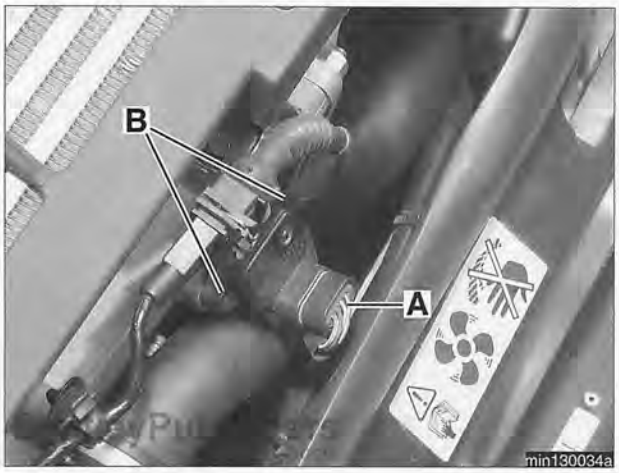
- Disconnect oxygen sensor connector (**A**). Twist in direction of **arrow** to detach from support bracket.
- Disconnect MAP sensor connector (**B**).

– Remove MAP sensor mounting screws and remove sensor.

– When reinstalling, replace sealing O-rings.

Tightening torque	
MAP sensor to bracket	3 Nm (28 in-lb)

– Clear ECM fault memory.



T-MAP sensor, replacing (Cooper S)

– Read out engine control module (ECM) fault memory. Then switch off ignition.

➢ Working at top left of intake manifold:
- Disconnect electrical harness connector (**A**) from T-MAP sensor.
- Remove sensor mounting screws (**B**). Remove sensor.

– When reinstalling, replace sealing O-rings.

Tightening torque	
T-MAP sensor to intake manifold	4 Nm (35 in-lb)

– Clear ECM fault memory.

Engine coolant temperature (ETC) sensor, replacing (Cooper)

– Read out engine control module (ECM) fault memory. Then switch off ignition.

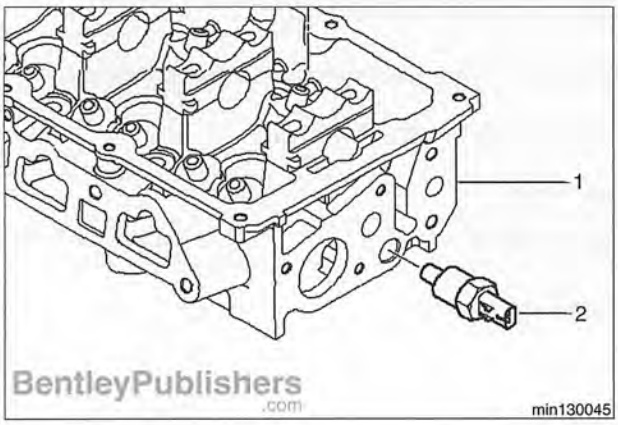
– Remove air filter housing. See **Air filter housing, removing and installing (Cooper)** in this repair group.

– Remove engine control module (ECM), battery and battery box. See **121 Battery, Starter, Alternator**.

➢ Working below left side of engine compartment, loosen lower radiator hose clamp (**arrow**). Detach hose from radiator and drain coolant down to below height of thermostat housing.

> ***WARNING —***
> *Due to risk of personal injury, be sure the engine is cold before opening any part of the cooling system or removing the coolant reservoir cap.*

– Working at left end of cylinder head, detach temperature sensor electrical harness connector.



➢ Remove coolant temperature sensor.
1. Cylinder head
2. Engine coolant temperature (ECT) sensor

– Install and torque new ECT sensor.

Tightening torque	
ECT sensor to cylinder head	17 Nm (13 ft-lb)

– Fill and bleed cooling system. See **170 Radiator and Cooling System**. Run engine and check for leaks. Clear ECM fault memory.

Engine coolant temperature (ETC) sensor, replacing (Cooper S)

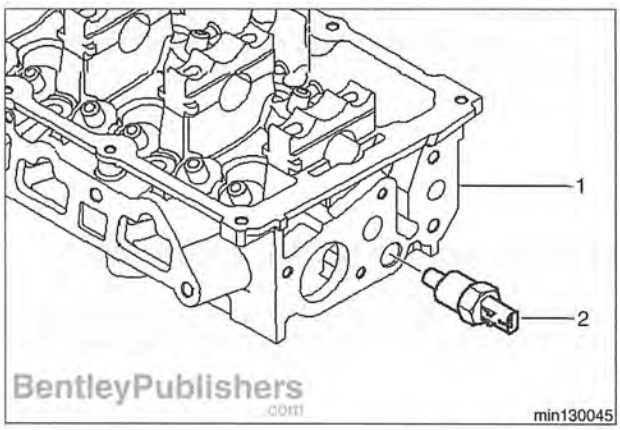
– Read out engine control module (ECM) fault memory. Then switch off ignition.

– Remove air filter housing. See **Air filter housing, removing and installing (Cooper S)** in this repair group.

➢ Working below left side of engine compartment, loosen lower radiator hose clamp (**arrow**). Detach hose from radiator and drain coolant down to below height of thermostat housing.

> ***WARNING —***
> *Due to risk of personal injury, be sure the engine is cold before opening any part of the cooling system or removing the coolant reservoir cap.*

– Working at left end of cylinder head, detach temperature sensor electrical harness connector.



➢ Remove coolant temperature sensor.
1. Cylinder head
2. Engine coolant temperature (ECT) sensor

– Install and torque new ECT sensor.

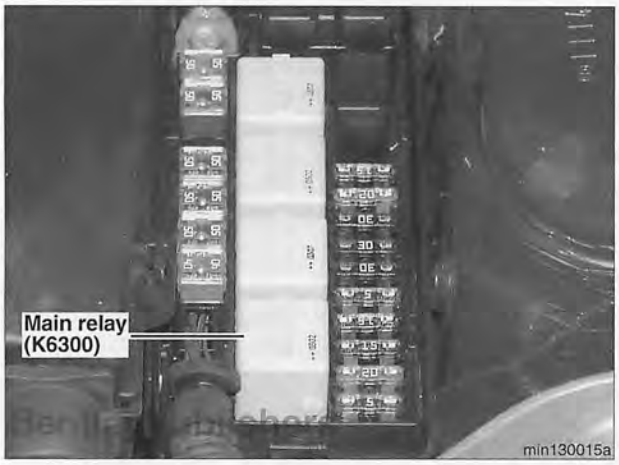
Tightening torque	
ECT sensor to cylinder head	17 Nm (13 ft-lb)

– Fill and bleed cooling system. See **170 Radiator and Cooling System**. Run engine and check for leaks.

– Clear ECM fault memory.

ELECTRICAL COMPONENTS

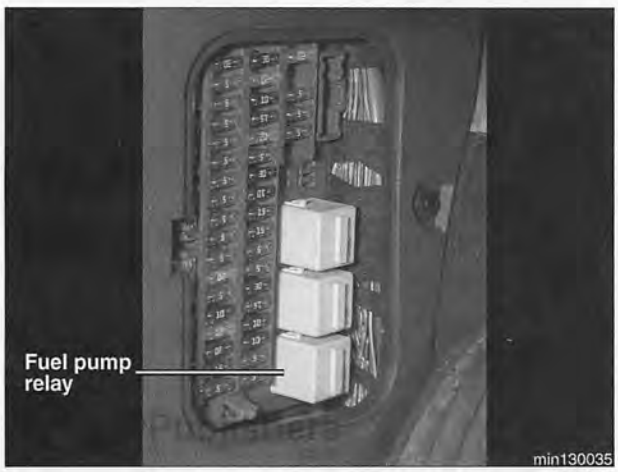
Main relay, accessing



Main relay (K6300) is located in engine compartment fuse and relay panel.

> ***CAUTION—***
> *Wait at least 5 minutes after turning off the ignition before removing the main relay. If the relay is removed before this time, a residual power surge may damage the engine control module (ECM).*

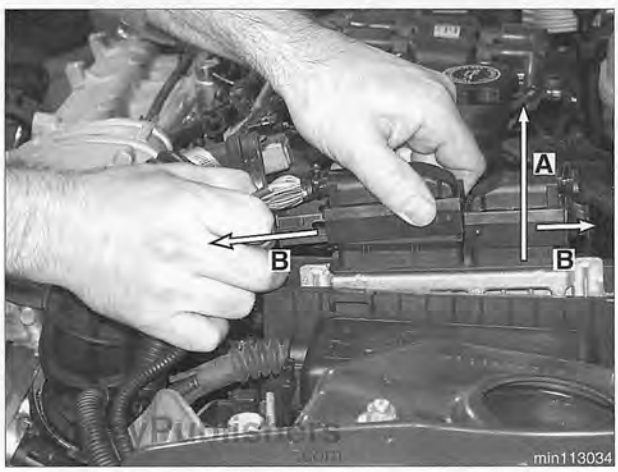
Fuel pump relay, accessing



Fuel pump relay is located in passenger compartment fuse and relay panel in left kick panel.

> ***CAUTION—***
> *Wait at least 5 minutes after turning off the ignition before removing the fuel pump relay. If the relay is removed before this time, residual power surge in the main relay may damage the engine control module (ECM).*

Engine control module (ECM), accessing

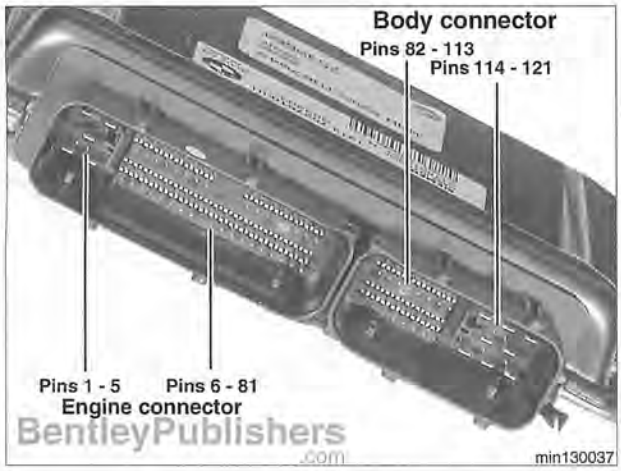


Engine control module (ECM) is located in engine compartment and shares a plastic housing with battery (Cooper) or air filter assembly (Cooper S).

Remove DME control module:

- Remove control module container cover and lift control unit upward (**A**).
- Pull connector locking sliders outward (**B**).
- Disconnect control module connectors.

NOTE—
There are 2 control module harness connectors.



ECM pin assignments

ECM electrical connector is a single molding split into two connectors.

- Engine connector (X6000): 81 pins
  Pins 1 - 5: load terminals
  Pins 6 - 81: signal terminals
- Body connector(X60004): 40 pins
  Pins 82 - 113: signal terminals
  Pins 114 - 121: load terminals

NOTE—

- *In wiring diagrams, the connector pins for X6000 and X60004 are each numbered starting at #1.*
- *In the molded housing of the ECM, the pins are numbered continuously from 1 to 121. Both pin numbering systems are shown in the pin assignment table for X60004. The wiring diagram pin numbers for X60004 are in the* **W.D. pin** *column of* **Table c.** *later in this repair group.*

ECM pin assignments are given in **Table b** and **Table c**. This information may be helpful when diagnosing faults to or from the ECM. If all inputs and wiring are OK but operational problems still exist, ECM itself may be faulty.

Generally, absence of voltage or continuity means there is a wiring or connector problem. Test results with incorrect values do not necessarily mean that a component is faulty.

- Check for loose, broken or corroded connections and wiring before replacing components.
- If results are still incorrect, check component itself.

For engine management system electrical schematics, see **ELE Electrical Wiring Diagrams**.

When making checks at ECM itself, use a breakout box to allow tests to be made with connectors attached to ECM. This also prevents damage to small terminals in connectors. As an alternative, separate harness connector housing so that electrical checks can be made from back of connector.

CAUTION—

- *Wait at least 5 minutes after turning off the ignition before removing the ECM connectors. If the ECM is disconnected before this time, residual power surge in the main relay may damage it.*
- *Always connect or disconnect the ECM connectors and meter probes with the ignition off.*

Table b. EMS2000 ECM pin assignments, connector X6000 (81-pin)			
Pin	**Signal**	**Function**	**Component**
1	not used		
2	not used		
3	Output	Signal, ignition coil 2-3	Plug connector, ignition coils X6150
5	Input	Oxygen sensor heater (precatalyst)	
6	Ground	Oxygen sensor (precatalyst)	
7	Ground	Knock sensor	
8	Input	Knock sensor	
9	Input	Oxygen sensor (precatalyst)	
10	Input	Throttle potentiometer 1	Throttle housing (EDR)
11	Input	Throttle potentiometer 2	Throttle housing (EDR)
12	Ground	Throttle position sensor	Throttle housing (EDR)
13	Output	Voltage supply, throttle position sensor	Throttle housing (EDR)
14	not used		
15	not used		
16	not used		
17	not used		
18	not used		
19	Output	Cyl. 4 fuel injector	
20	Output	Cyl. 2 fuel injector	
21	Output	Cyl. 1 fuel injector	
22	Output	Cyl. 3 fuel injector	
23	not used		
24	Output	Solenoid valve	Fuel tank ventilation valve
25	Input	Transmission fluid temperature sensor	Transmission control module (GIU)
26	Input	Engine coolant temperature sensor	
27	Input	Intake air temperature	T-MAP sensor
28	not used		
29	not used		
30	not used		
31	Input	T-MAP sensor	
32	not used		
33	not used		
34	not used		
35	not used		
36	not used		
37	not used		

Table b. EMS2000 ECM pin assignments, connector X6000 (81-pin)			
Pin	**Signal**	**Function**	**Component**
38	not used		
39	not used		
40	not used		
41	not used		
42	Input	Leakage diagnosis pump (LDP)	Engine plug connector I (X6011)
43	Input	Oxygen sensor heater (post-catalyst)	
44	not used		
45	Ground	Transmission fluid temperature sensor	Transmission control module (GIU)
46	Ground	Electronic ground, coolant temperature sensor	
47	Ground	T-MAP sensor	
48	Ground	Shield, knock sensor	
49	not used		
50	not used		
51	Output	Voltage supply, T-MAP sensor	
52	Input	Terminal 61	Alternator (generator)
53	Input	Engine cooling fan, camshaft sensor	
54	Input	Engine speed sensor signal	Transmission rpm sensor
55	Input	Crankshaft position sensor	
56	not used		
57	not used		
58	not used		
59	not used		
60	not used		
61	Ground	X6454	
62	Ground	X6454	
63	Output	Throttle valve	Throttle housing (EDR)
64	Output	Throttle valve	Throttle housing (EDR)
65	Output	Throttle valve	Throttle housing (EDR)
66	Output	Throttle valve	Throttle housing (EDR)
67	not used		
68	Input	Coolant outlet temperature	Coolant temperature sensor, radiator outlet
69	Ground	Coolant outlet temperature	Coolant temperature sensor, radiator outlet
70	not used		
71	Ground	Catalytic converter	
72	Input	Ground signal, engine cooling fan, camshaft sensor	
73	Input	Engine speed sensor signal ground	Transmission rpm sensor
74	Ground	Crankshaft position sensor	

Table b. EMS2000 ECM pin assignments, connector X6000 (81-pin)			
Pin	**Signal**	**Function**	**Component**
75	not used		
76	not used		
77	not used		
78	not used		
79	not used		
80	Ground	X6454	
81	Ground	X6454	

Table c. EMS2000 ECM pin assignments, connector X60004 (40-pin)				
W.D. pin	**ECM pin**	**Signal**	**Function**	**Component**
1	82	Output	Voltage supply, driver's wish sensor 1	Pedal position sensor
2	83	Output	Voltage supply, driver's wish sensor 2	Pedal position sensor
3	84	Not used		
4	85	Input	Signal, clutch pedal position switch	Clutch switch module
5	86	Output	Electronic ground, pedal position sensor 1	
6	87	Output	Electronic ground, pedal position sensor2	
7	88	Output	Activation, engine cooling fan	Relay, engine cooling fan
8	89	Not used		
9	90	Input	Pressure sensor signal, air-conditioning system	
10	91	Input	Pressure sensor signal, air-conditioning system	
11	92	Not used		
12	93	Input	Leakage diagnosis pump (LDP)	
13	94	Output	Compressor enable from main relay	A/C compressor
14	95	Output	Activation, engine cooling fan stage 2	Switch unit, 2-speed blower relay, fan, steering control module
15	96	Output	Gearshift lock	Shiftlock relay
16	97	Output	Activation, main relay (K6300)	
17	98	Input	Brake light	Brake light switch
18	99	Input	Brake light test signal	Brake light switch
19	100	Input	Electronic ground, A/C pressure sensor	Pressure sensor, A/C system
20	101	Output	Volute spring (I01002) speed signal	
21	102	Not used		
22	103	Not used		
23	104	Not used		
24	105	Input	Activation, fuel pump relay (K96)	
25	106	Input	Signal, immobilizer control module (EWS) (A836)	

Table c. EMS2000 ECM pin assignments, connector X60004 (40-pin)				
W.D. pin	**ECM pin**	**Signal**	**Function**	**Component**
26	107	Input	Pedal position sensor	
27	108	Input	Pedal position sensor	
28	109	Input	Oxygen sensor (post-catalyst)	
29	110	Input / output	CAN-bus high (X8090)	
30	111	Input / output	CAN-bus low (X8091)	
31	112	Ground	Oxygen sensor (post-catalyst)	
32	113	Input / output	OBDII diagnostic link connector (X19527)	
33	114	Ground	Ground	
34	115	Ground	Ground	
35	116	Not used		
36	117	Input / output	Diagnostic link connector (X9397)	
37	118	Output	Terminal 15 Fuse F34	
38	119	Not used		
39	120	Input	Terminal 87 Fuse F02	
40	121	Input	Terminal 30 Fuse F01	

160 Fuel Tank and Fuel Pump

GENERAL

This repair group covers service information for the fuel supply system. Information on the fuel injection system, EMS2000, is covered in **130 Fuel Injection**.

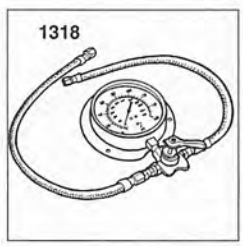
The fuel filter is a "lifetime" unit installed in the fuel tank. There is no routine interval or procedure for replacing the fuel filter.

Special tools

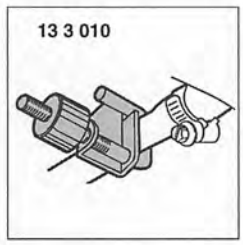
Some of the procedures in this group require the use of special tools.

- Intercooler protective cover
(BMW special tool 11 8 480)

- Fuel line adapter
(BMW special tool 13 1 130)



- Fuel pressure gauge
(Baum Tools 1318)



- Fuel line clamp
(BMW special tool 13 3 010)

- Fuel rail to pressure gauge adapter
(BMW special tool 13 5 220)

Fuel tank threaded collar spanner
(BMW special tool 16 1 022)

Parking brake cable removal pliers
(BMW special tool 34 6 310)

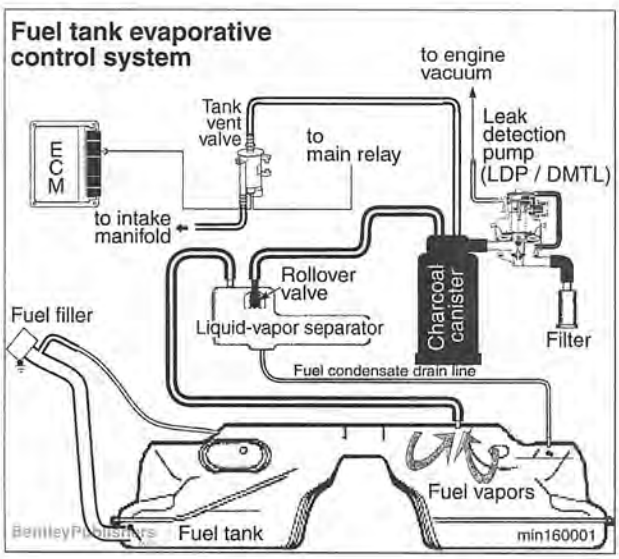
Fuel pump

The electric fuel pump is mounted in the fuel tank in tandem with the left side fuel level sender. The fuel pump delivers fuel at high pressure to the fuel injection system. A pressure regulator maintains system pressure.

NOTE—
Fuel pump removal procedures are given under **Fuel level sender (left side) and fuel pump, removing and installing** *in this repair group.*

Fuel tank evaporative control system

Evaporative control is designed to prevent fuel system evaporative losses from venting into the atmosphere. The components of this system allow control and monitoring of evaporative losses by the on-board diagnostic (OBD II) software incorporated into the engine control module (ECM).



The main components of the evaporative control system and their functions are as follows:

- **Liquid/vapor separator** acts as fuel overflow tank.
- **Activated charcoal canister** stores evaporated fuel.
- **Plumbing** ducts vapors from fuel tank to canister and from canister to intake manifold.
- **Fuel tank vent valve** is controlled by engine control module (ECM).
- **Leak detection pump (LDP or DMTL)** pressurizes fuel tank to monitor system leaks.

Evaporative system troubleshooting

Start troubleshooting and testing of evaporative system by accessing DTCs using a diagnostic scan tool (DISplus, GT1, MoDiC or equivalent).

The ECM sets a diagnostic trouble code (DTC) when it detects a leak in the evaporative system. The malfunction indicator light (MIL) is illuminated upon a second recurrence of the fault. See **OBD On-Board Diagnostics** for further details.

BMW recommends that an independent pressure test of the fuel system be conducted with a chemical leak detector to confirm the presence of the fuel system leak.

Warnings and cautions

Observe the following warnings and cautions when servicing the fuel system.

WARNING—

- *The fuel system is designed to retain pressure even when the ignition is off. When working with the fuel system, loosen the fuel lines slowly to allow residual fuel pressure to dissipate. Avoid spraying fuel. Use shop rags to capture leaking fuel.*
- *Before beginning any work on the fuel system, place a fire extinguisher in the vicinity of the work area.*
- *Fuel is highly flammable. When working around fuel, do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards.*
- *Always unscrew the fuel tank cap to release pressure in the tank before working on the tank or lines.*
- *Do not use a work light with an incandescent bulb near any fuel. Fuel may spray on the hot bulb, causing a fire.*
- *Make sure the work area is properly ventilated.*

CAUTION—
- *Prior to disconnecting the battery, read the battery disconnection cautions given in* **001 General Warnings and Cautions**.
- *Before making any electrical tests with the ignition turned on, disable the ignition system as described in* **120 Ignition System**. *Be sure the battery is disconnected when replacing components.*
- *To prevent damage to the ignition system or other engine management components, including the ECM, always connect and disconnect wires and test equipment with the ignition off.*
- *Cleanliness is essential when working with the fuel system. Thoroughly clean the fuel line unions before disconnecting any of the lines.*
- *Use only clean tools. Keep removed parts clean and sealed or covered with a clean, lint-free cloth, especially if completion of the repair is delayed.*
- *Do not move the car while the fuel system is open.*
- *Avoid using high pressure compressed air to blow out lines and components. High pressure can rupture internal seals and gaskets.*
- *Always replace seals, O-rings and hose clamps.*

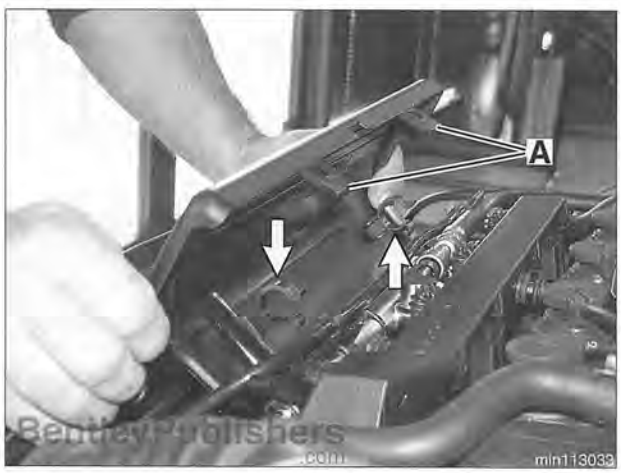
Fuel System Troubleshooting

Fuel pressure, testing (Cooper)

– Switch off ignition.

– If using DISplus: Connect BMW special tools 13 1 130 and 13 5 222 to scan tool pressure sensor adapter.

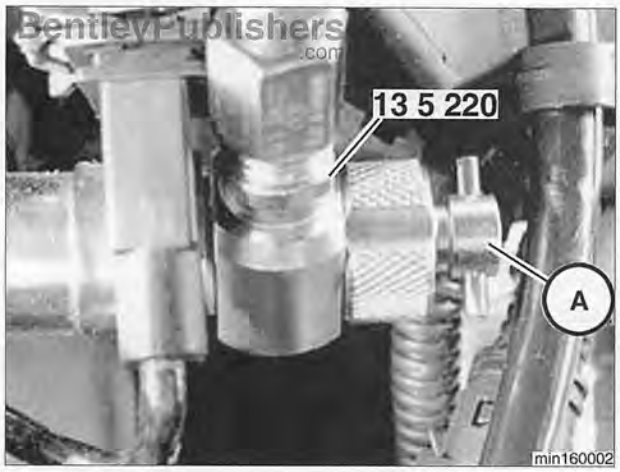
– If using pressure gauge: Attach BMW special tools 13 3 063 and 13 1 130 to gauge. (Both are flexible fuel hoses.)



➤ Remove fuel rail cover:
- Squeeze locking tabs (**A**) to detach rear of cover.
- Tilt and pull cover forward until plastic clips (**arrows**) detach from fuel rail.

CAUTION—
Plastic clips can break easily.

– Remove dust cap from end of fuel rail.



➤ Connect BMW special tool kit 13 5 220 (consisting of 13 5 221 and 13 5 222) to end of vehicle fuel rail and connect to pressure gauge or scan tool fuel pressure fitting.

- Make sure special tool sealing O-ring is correctly placed.
- Make sure non-return valve (**A**) on special tool is backed out so that fuel rail pressure release valve remains closed.

WARNING—
- *When working with fuel line, fuel may be expelled under pressure. Loosen fuel filler cap to release fuel tank pressure.*
- *Do not smoke or work near heaters or other fire hazards.*
- *Keep a fire extinguisher handy.*
- *Before disconnecting fuel hose, wrap a cloth around hose to absorb any leaking fuel.*
- *Plug all open fuel connections.*

– Start engine.

– Screw in non-return valve until pressure gauge indicates pressure.

CAUTION—
Do not screw in non-return valve up to mechanical stop. This could damage measuring valve in fuel rail.

Fuel pressure specification	
Cooper	3.0 ± 0.2 bar (43.5 ± 3 psi)

– Turn off engine.

Fuel pressure, testing (Cooper S)

– Switch off ignition.

– If using DISplus: Connect BMW special tools 13 1 130 and 13 5 222 to scan tool pressure sensor adapter.

– If using pressure gauge: Attach special tools BMW 13 3 063 and 13 1 130 to gauge. (Both are flexible fuel hoses.)

➤ Remove intercooler. See **113 Cylinder Head** for complete procedure.

- Remove intercooler cover.
- Remove intercooler sealing bellows clamps and intercooler cover mounting brackets.
- Detach sealing bellows and tilt intercooler to right to remove.

➤ Remove dust cap (**insert**) from end of fuel rail.

– Connect fuel pressure gauge or scan tool with adapters to end of fuel rail.

WARNING—
- *When working with fuel line, fuel may be expelled under pressure. Loosen fuel filler cap to release fuel tank pressure.*
- *Do not smoke or work near heaters or other fire hazards.*
- *Keep a fire extinguisher handy.*
- *Before disconnecting fuel hose, wrap a cloth around hose to absorb any leaking fuel.*
- *Plug all open fuel connections.*

– Reinstall intercooler and cover with protective shield (BMW special tool 11 8 480).

– Start engine and read off fuel pressure.

Fuel pressure specification	
Cooper S	3.5 ± 0.2 bar (50.8 ± 3 psi)

– Turn off engine.

Fuel Pump and Fuel Level Senders

MINI models use a two-lobed fuel tank. Each lobe of the tank has its own fuel level sending unit.

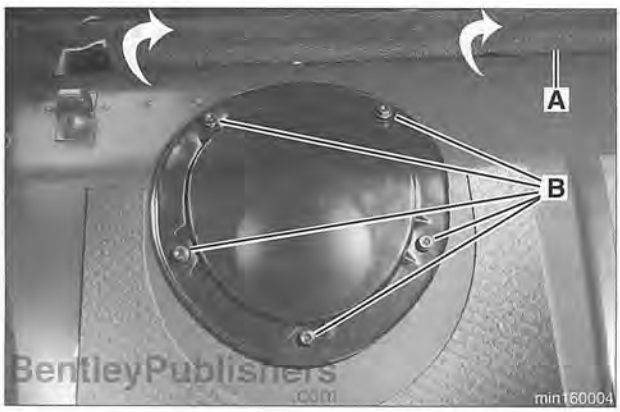
The left side fuel level sender is integrated with the fuel pump. The right side fuel sender is integrated with the fuel filter. Each sender has a float connected to a variable resistance wiper contact for fuel level. When replacing the tank unit assembly always replace hose clamps, gaskets and O-rings.

To equalize fuel level between the two tank lobes, a siphon pump is installed in the right lobe.

Fuel level sender (left side) and fuel pump, removing and installing

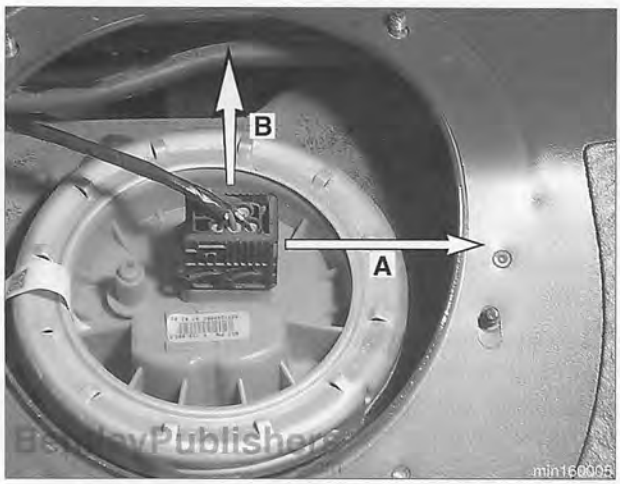
– Drain fuel tank. See **Fuel tank, draining** in this repair group.

– Remove rear seat cushion. See **520 Seats**.



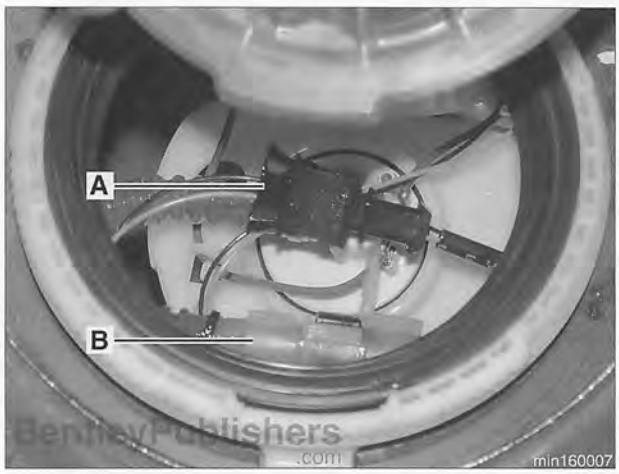
➤ Working under left rear seat:
- Roll trim (**A**) forward.
- Remove left fuel tank unit cover fasteners (**B**). Remove cover.

Fuel Pump and Fuel Level Senders



➢ Pull off fuel tank unit electrical harness connector:
- Slide connector lock in direction **A**.
- Pull off connector in direction **B**.

– Use fuel tank cap spanner, BMW special tool 16 1 020, to unscrew and remove fuel tank locking collar.



➢ Lift fuel pump / fuel level sender unit slightly and detach electrical harness connector (**A**) and fuel line (**B**).

– Carefully lift pump / sender unit out of tank.

> ***WARNING —***
> *Fuel may be spilled. Do not smoke or work near heaters or other fire hazards.*

➢ To reinstall:
- Use new sealing O-ring at tank collar.
- Reconnect harness connector and hose inside tank.
- Make sure fuel pump assembly locating lug engages tank recess. Then install locking collar.

Tightening torque	
Locking collar to fuel tank	35 Nm (26 ft-lb)

– Reconnect tank unit electrical harness.

– Fill fuel tank with at least 5 liters (1.5 gallons) of fuel. Then start engine and check for leaks.

> ***CAUTION —***
> *The fuel pump will be damaged if you run it without fuel.*

– Install access cover and tighten fasteners.

Tightening torque	
Fuel tank access cover to body (M6)	6 Nm (53 in-lb)

Fuel level sender (right side), removing and installing

– Drain fuel tank. See **Fuel tank, draining** in this repair group.

– Remove rear seat cushion. See **520 Seats**.

– Remove left side fuel tank unit. See **Fuel level sender (left side) and fuel pump, removing and installing** in this repair group.

➤ Working under left rear seat:

- Roll trim (**A**) forward.
- Remove left fuel tank unit cover fasteners (**B**). Remove cover.

➤ Squeeze plastic tabs on fuel line connector (**arrows**) to detach line from tank.

– Use fuel tank cap spanner, BMW special tool 16 1 020, to unscrew and remove fuel tank locking collar.

– Lift up sender unit slightly and disconnect line fastener. Lift sender unit and lines out of fuel tank.

> ***WARNING—***
> *Fuel may be spilled. Do not smoke or work near heaters or other fire hazards.*

➤ To reinstall:

- Use new sealing O-ring at tank collar.
- Reconnect fuel line inside tank.
- Make sure fuel level sender assembly locating lug engages tank recess. Then install locking collar.

Tightening torque	
Locking collar to fuel tank	35 Nm (26 ft-lb)

– Reconnect fuel hose.

– Fill fuel tank with at least 5 liters (1.5 gallons) of fuel. Then start engine and check for leaks.

> ***CAUTION—***
> *The fuel pump will be damaged if you run it without fuel.*

– Install access cover and tighten fasteners.

Tightening torque	
Fuel tank access cover to body (M6)	6 Nm (53 in-lb)

FUEL TANK AND FUEL LINES

The plastic fuel tank is mounted beneath the center of the car (underneath the rear seat). Mounted in the fuel tank are the fuel pump and fuel level sending units. Connecting lines for the evaporative emission control system and expansion tank are also attached to the tank.

Fuel tank capacity	
Cooper, Cooper S	
Fuel tank	50 liters (13.2 US gal)
Reserve capacity	8 liters (2.1 US gal)

Fuel tank, draining

Except for a small remainder, most of the fuel can be drawn off from the left and right tank halves via the fuel filler pipe. The residual amount is drawn off after removal of the left and right fuel tank units.

Drain fuel tank into a safe storage unit using an approved fuel pumping device.

WARNING—
- *Before draining tank, be sure that all hot components, such as the exhaust system, are completely cooled down.*
- *Fuel may be spilled. Do not smoke or work near heaters or other fire hazards.*

– Start engine and allow to run 10 - 15 seconds to fill fuel compensating siphon assembly. This will allow both lobes of fuel tank to be drawn off through fuel filler pipe.

– Disconnect negative (–) cable from battery.

CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Warnings and Cautions**.

– Remove fuel tank filler cap.

– Slide suction hose into filler neck about 90 cm (35 in), twisting as necessary. Withdraw fuel into storage unit.

– Remove left fuel sender. See **Fuel level sender (left side) and fuel pump, removing and installing** in this repair group.

– Remove right fuel sender. See **Fuel level sender (right side), removing and installing** in this repair group.

– Draw off residual fuel quantity through openings.

– If siphoning mechanism is faulty, drain left lobe via filler neck. Drain right tank lobe separately by removing sender cover and pumping fuel directly out of right lobe.

– Remove suction hose from tank filler neck carefully to avoid damaging filler neck baffle plate.

- After finishing repairs but before starting engine, fill fuel tank with at least 5 liters (1.5 gallons) of fuel.

> ***CAUTION—***
> *The fuel pump will be damaged if you run it without fuel.*

- After reconnecting battery, be sure to reinitialize power windows: Raise window and keep power window switch in raise position for about 5 seconds.

Fuel tank, removing and installing

- Drain fuel tank. See **Fuel tank, draining** in this repair group.

> ***WARNING—***
> - *Before draining tank, be sure that all hot components, such as the exhaust system, are completely cooled down.*
> - *Fuel may be spilled. Do not smoke or work near heaters or other fire hazards.*

- Disconnect negative (–) cable from battery.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given in* **001 General Warnings and Cautions.**

- Cooper S: Detach rear half of battery positive lead.
- Remove rear center console. See **513 Interior Trim.**
- Remove mounting bracket for rear center console.
- Disconnect parking brake cables at rear brake calipers. See **340 Brakes.**
- Remove rear seat. See **520 Seats.**
- Remove trim panels above fuel tank.
- Remove fuel tank unit covers. Disconnect wiring harness connector from left tank unit. Detach fuel line from right tank unit.
- Detach parking brake cables from parking brake lever. Use special tool 34 6 310 to squeeze cable tips and push out through bottom of car.
- Raise car and support in a safe manner.

> ***CAUTION—***
> *Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

– Remove rear exhaust from catalyst back. See **180 Exhaust System**.
  - Cooper S: Remove heat shield under battery box in rear.
  - Remove center body brace under exhaust pipe.
  - Remove exhaust.

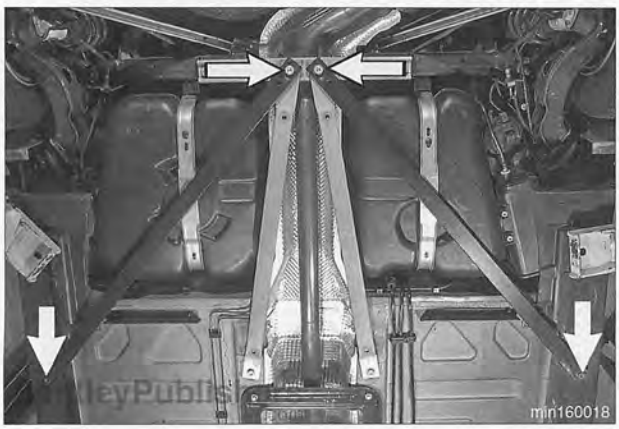
– Remove rear half of exhaust system heat shield.

– Remove left rear wheel and left rear wheel housing liner.

➢ Loosen hose clamp (**arrow**) and detach filler hose from fuel tank.

– Working above left rear wheel housing liner, disconnect vent hose from fuel filler pipe. See **Fuel filler pipe, removing and installing** in this repair group.

– Support fuel tank over a large area with a suitable lift.



➢ On convertible models, remove mounting bolts (**arrows**) and reinforcement supports.

➢ Remove fuel tank mounting bolts (**arrows**).

➤ Lower fuel tank and disconnect right vent line (**A**).

– Pull vent line through body.

– Carefully lower fuel tank, checking for any wiring, fuel lines or mechanical parts that might become snagged.

– Installation is reverse of removal:
  - Make sure lines and wiring harness are not trapped or crushed during installation.
  - Always use new seals, gaskets, O-rings, and hose clamps.
  - Inspect hoses and replace any that are chafed, dried out or cracked.
  - Inspect heat shield and replace if corroded.
  - Inspect rubber buffers and liners on fuel tank, support straps and on underside of body. Replace rubber parts that are hardened or damaged.

Tightening torques	
Fuel filler pipe to body (M6)	5 Nm (44 in-lb)
Fuel tank unit cover to body (M6)	6 Nm (53 in-lb)
Fuel tank to subframe and body (M8)	22 - 28 Nm (16 - 21 ft-lb)
Hose clamp 32 - 38 mm dia.	2.5 - 3.5 Nm (22 - 31 in-lb)

– After installation of fuel tank, prior to first engine start-up, check electrical resistance between filler pipe and wheel hub. To insure that filler pipe is correctly grounded, resistance should be no higher than approx. 0.65 Ω.

– After finishing repairs but before starting engine, fill fuel tank with at least 5 liters (1.5 gallons) of fuel.

> ***CAUTION—***
> *The fuel pump will be damaged if you run it without fuel.*

– After reconnecting battery, be sure to reinitialize power windows: Raise window and keep power window switch in raise position for about 5 seconds.

Fuel filler pipe, removing and installing

– Raise car and support in a safe manner.

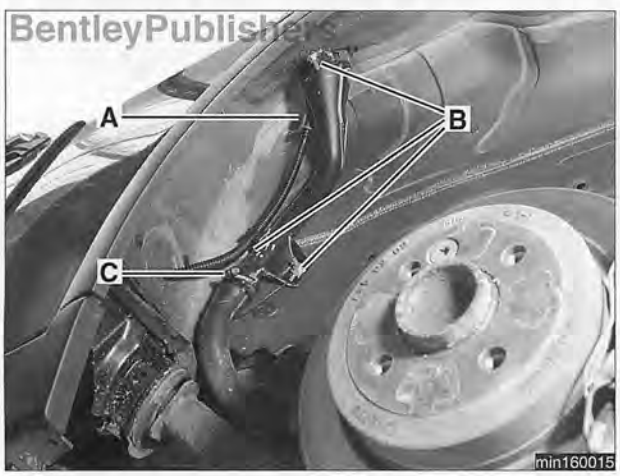
> ***CAUTION—***
> *Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

– Remove left rear wheel and left rear wheel housing liner.

➤ Loosen or cut hose clamp (**arrow**) and detach filler hose from fuel tank.

> ***WARNING—***
> *Fuel tank must be no more than half full; if necessary, draw off some fuel from fuel tank.*

– Unscrew fuel filler cap from fuel filler pipe.



➤ Detach filler neck assembly:

- Release quick-release fastener (**A**) and disconnect vent hose from filler pipe.
- Remove filler neck mounting nuts (**B**).
- Loosen or cut hose clamp (**C**) and separate filler neck from filler hose.

– Installation is reverse of removal:

- Make sure vent hose to fuel filler pipe and fuel filler pipe to body cutout are correctly sealed.
- Replace filler neck mounting nuts.

Tightening torques	
Fuel filler neck to body (M6)	5 Nm (44 in-lb)
Hose clamp 32 - 38 mm dia.	2.5 - 3.5 Nm (22 - 31 in-lb)
Wheel housing liner to fender	3 Nm (27 in-lb)
Wheel to wheel hub	120 ± 10 Nm (89 ± 7 ft-lb)

– After installation of fuel tank, prior to first engine start-up, check electrical resistance between filler pipe and wheel hub. To insure that filler pipe is correctly grounded, resistance should be no higher than approx. 0.65 Ω.

– After finishing repairs but before starting engine, fill fuel tank with at least 5 liters (1.5 gallons) of fuel.

> ***CAUTION—***
> *The fuel pump will be damaged if you run it without fuel.*

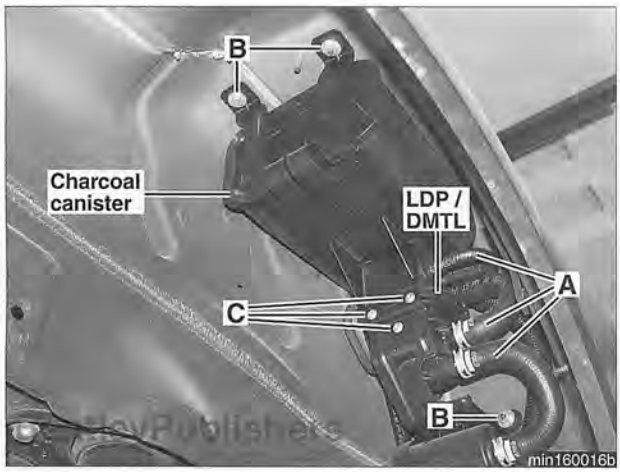
LDP / DMTL unit, removing and installing (2002-2004)

The fuel tank leakage diagnosis pump (LDP or DMTL) and the charcoal canister assembly are located behind the right rear wheel housing liner on 2002-2004 models.

– Raise car and support in a safe manner.

> ***CAUTION—***
> *Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

– Remove right rear wheel and right rear wheel housing liner.



➤ Working underneath right rear of car:

- Detach hoses (**A**) from charcoal canister and LDP / DMTL pump.
- Remove mounting nuts (**B**).
- Lower LDP / DTML pump and canister assembly.

> ***CAUTION—***
> *Lower assembly carefully to prevent damage to hoses.*

– Working at rear of canister:

- Detach electrical harness connector.
- Disconnect main breather hose from rear of canister.
- Detach vacuum line at quick disconnect.

– Remove canister and LDP / DMTL assembly complete with mounting bracket and place on work bench.

– Separate canister by prying away from mounting bracket.

– Remove LDP / DMTL mounting screws (**C**) and slide pump out of bracket.

– Installation is reverse of removal.

Tightening torques	
Wheel housing liner to fender	3 Nm (27 in-lb)
Wheel to wheel hub	120 ± 10 Nm (89 ± 7 ft-lb)

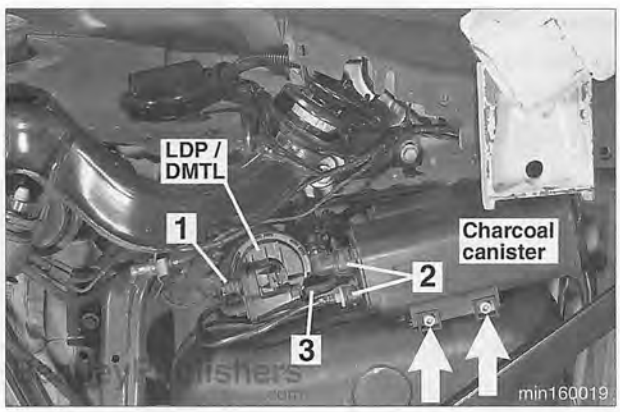
LDP / DMTL unit, removing and installing (2005-2006)

The fuel tank leakage diagnosis pump (LDP or DMTL) and the charcoal canister assembly are located under the right rear side of vehicle on 2005-2006 models.

– Raise car and support in a safe manner.

> ***CAUTION—***
> *Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

– Remove plastic underbody wind deflector at right rear corner.



➢ Working underneath right rear of car:

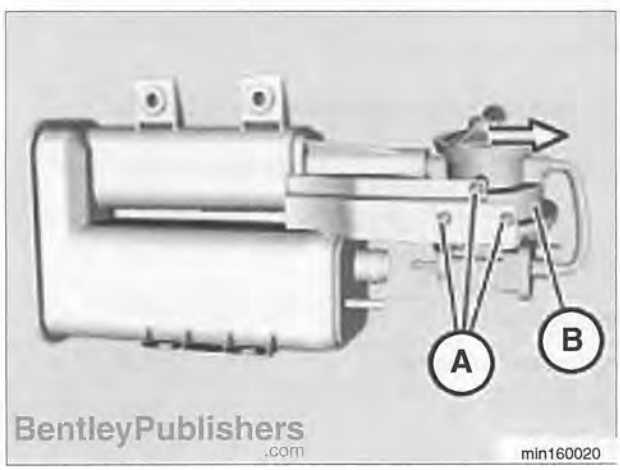
- Disconnect harness connector (**1**) from LDP / DTML pump.
- Detach hoses (**2**) from charcoal canister.
- Detach hose (**3**) from LDP / DTML pump.

– Remove mounting bolts (**arrows**).

– Lower LDP / DTML unit from upper fixtures and remove.

> ***CAUTION—***
> *Lower assembly carefully to prevent damage to hoses.*

– Place assembly on work bench.



➢ Remove LDP / DMTL (**B**) mounting screws (**A**) and slide pump out of bracket in direction of **arrow**.

– Installation is reverse of removal.

170 Radiator and Cooling System

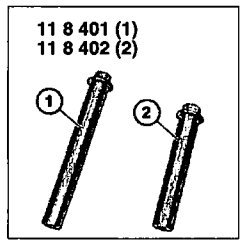
GENERAL

This section covers component repair information for the engine cooling system.

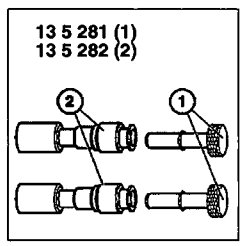
Heater core replacement is covered in **640 Heating and Air Conditioning**.

Special tools

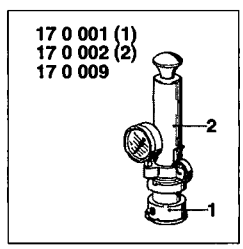
Special tools may be needed for some radiator and cooling system procedures.



- Modular front end extensions
(BMW tool no. 11 8 400)



- Plugs for fuel lines and fittings
(BMW tool no. 13 5 280)



- Cooling system pressure tester and adapters
(BMW tool no. 17 0 000)

Cooling system overview

Coolant pump

Cooper models use a coolant pump mounted to the front of the engine. Cooper S models use a pump mounted on the rear of the supercharger. These belt-driven pumps circulate coolant through the system whenever the engine is running.

Thermostat

All models use a conventional mechanical thermostat that relies on coolant temperature to operate. While coolant is cold, the thermostat remains closed, and circulating coolant bypasses the radiator for rapid engine warm up. At higher coolant temperature, the thermostat progressively opens to allow coolant flow through the radiator, thus controlling engine temperature.

Radiator and expansion tank

The radiator is a crossflow design. An expansion tank provides for coolant expansion at higher temperatures and easy monitoring of the coolant level.

Transmission fluid cooler

Models with Continuously Variable Transmission (CVT) have a transmission fluid cooler mounted to the front of the radiator. Lines from the CVT to the transmission cooler circulate transmission fluid for additional cooling. Airflow across the cooler is used to cool the transmission fluid.

Models with automatic transmission (Agitronic) have a small transmission fluid cooler mounted on the top of the transmission. Engine coolant lines run to the cooler to keep the transmission fluid cool. Engine coolant and transmission fluid are kept separate in the cooler.

Electric cooling fan

An electric cooling fan mounted behind the radiator operates at two speeds (low and high) depending on conditions. The fan is controlled by the ECM through two relays, a low speed relay and a high speed relay. The low speed relay is mounted in the engine compartment fuse box and is energized any time the fan is operating. The high speed relay is mounted on the fan housing in the relay pack. The relay pack contains the High speed relay and a voltage reducing resistor.

The cooling fan operates on low speed when the A/C is switched on and the system pressure reaches 8 bar.The fan switches to high speed should the AC system pressure rise above 18 bar. For the engine cooling system, the fan operates on low speed at 105°C (221°F). When the temperature drops to 101°C (214°F) the fan will switch off. The fan switches to high speed at 112°C (234°F) and remains on high until the system coolant temperature drops by 4°C (7°F) at which point the system reverts to low speed.

Engine coolant temperature sensor

The engine coolant temperature sensor is located in the cylinder head next to the thermostat housing. The sensor is a two wire type whose signal is sent to the ECM and used as input for the radiator fan, fuel control, ignition timing, and coolant temperature gauge.

Coolant temperature gauge

A dash mounted display incorporating a warning lamp illuminates at an engine temperature equal to or greater than 120°C (240°F). Engine temperature data is provided to the instrument cluster (IKE) by the engine control module (ECM) via the CAN-bus.

Warnings and cautions

Observe the following warnings and cautions when working on the cooling system.

***WARNING*—**
- *At normal operating temperature the cooling system is pressurized. Allow the system to cool as long as possible before opening (a minimum of one hour), then release the cap slowly to allow safe release of pressure.*
- *Releasing cooling system pressure lowers the coolant boiling point and the coolant may boil suddenly. Use heavy gloves and wear eye and face protection to guard against scalding.*
- *Use extreme care when draining and disposing of engine coolant. Coolant is poisonous and lethal to humans and pets. Pets are attracted to coolant because of its sweet smell and taste. Seek medical attention immediately if coolant is ingested.*

***CAUTION*—**
- *Avoid adding cold water to the coolant while the engine is hot or overheated. If it is necessary to add coolant to a hot system, do so only with the engine running and coolant pump turning.*
- *To avoid excess silicate gel precipitation in the cooling system and loss of cooling capacity, use BMW coolant or equivalent low silicate antifreeze.*
- *If oil enters the cooling system, the radiator, expansion tank and heating circuit must be flushed with cleaning agent.*
- *When working on the cooling system, cover the alternator to protect it against coolant drips.*
- *Prior to disconnecting the battery, read the battery disconnection cautions given in* **001 General Warnings and Cautions**.

TROUBLESHOOTING

Begin diagnosing cooling system problems with a thorough visual inspection. If no visual faults are found, check the engine control module (ECM) for stored diagnostic trouble codes (DTCs).

Common cooling system faults can be grouped into one of four categories:

- Cooling system leaks
- Poor coolant circulation
- Radiator cooling fan faults
- Electrical/electronic faults

Cooling system inspection

- Check condition of accessory drive belt.

- Check that accessory drive belt tensioner is functioning properly and that belt tension is correct.

- Check coolant hoses for cracks or softness. Check clamps for looseness. Check coolant level and check for evidence of coolant leaks.

- Check that radiator fins are not blocked with dirt or debris. Clean out radiator using low-pressure water or compressed air. Blow outward, from engine side out.

- To check coolant pump (Cooper):
  - Remove drive belt from coolant pump pulley. See **020 Maintenance**.
  - Firmly grasp opposite sides of pulley and check for play in all directions.
  - Spin pulley and check that shaft runs smoothly without play.

  NOTE—
  - *Cooper S: Coolant pump shaft is concealed within supercharger. Physical inspection is not possible.*
  - *Cooper: Coolant provides lubrication for the pump shaft, so an occasional drop of coolant from the pump is acceptable. If coolant drips steadily from the vent hole, replace the pump.*

- At normal engine operating temperature, cooling system is pressurized. This raises the boiling point of coolant. Leaks may prevent system from becoming pressurized. If visual evidence is inconclusive, pressure test cooling system. See **Cooling system pressure test** in this repair group.

- If cooling system is full of coolant and holds pressure:
  - Use an appropriate scan tool to interrogate the ECM for DTCs related to radiator fan or other cooling system components.
  - Check for loose or worn accessory drive belt.
  - Check for failed thermostat or coolant pump.
  - Check for clogged/plugged radiator or coolant passages.

Cooling system pressure test

A cooling system pressure tester is used to test for coolant leaks, including internal ones. Common sources of internal coolant leaks are a faulty cylinder head gasket, a cracked cylinder head, or a cracked engine block.

> ***WARNING—***
> *At normal operating temperature the cooling system is pressurized. Allow the system to cool before opening. Release the cap slowly to allow safe release of pressure.*

– With the engine cold, install pressure tester (BMW special tools 17 0 002/17 0 009 or equivalent) to radiator fill neck (Cooper) or expansion tank (Cooper S). Pressurize system to specification listed below.
  - Pressure should not drop more than 0.1 bar (1.45 psi) for at least two minutes.
  - If pressure drops rapidly and there is no sign of external leakage, cylinder head gasket may be faulty. Perform compression and leak-down tests. See **113 Cylinder Head Removal and Installation**.
  - Test radiator cap using pressure tester with correct adapter (BMW special tool 17 0 001 or equivalent). Replace faulty cap or cap gasket.

Cooling system test pressures	
Component	**Test pressure**
Radiator	1.5 bar (21.75 psi)
Radiator cap	0.95 - 1.24 bar (14 - 18 psi)

> ***CAUTION—***
> *Exceeding the specified test pressure could damage the radiator or other system components.*

Combustion chamber leak test

If you suspect that combustion chamber pressure is leaking into the cooling system past the cylinder head gasket, use an exhaust gas analyzer to test the vapors rising from the coolant at the expansion tank.

> ***CAUTION—***
> - *Use an extension tube above the reservoir neck to maintain distance between the top of the coolant and the gas analyzer nozzle. The gas analyzer is easily damaged if it is allowed to inhale liquid coolant.*
> - *While running engine to check for causes of overheating, observe coolant temperature carefully in order to avoid engine damage.*

Thermostat test

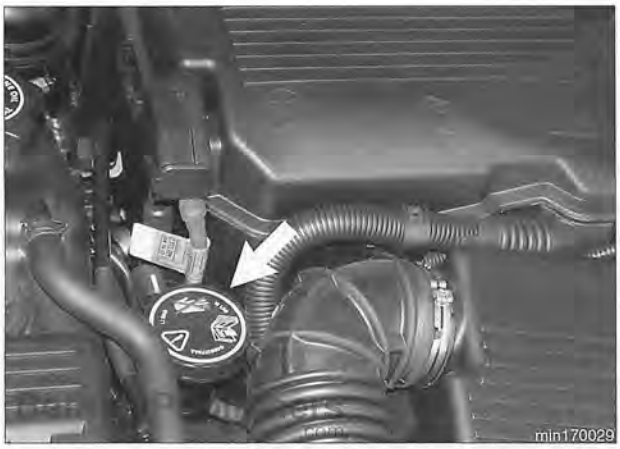
If the engine overheats or runs too cool and no other cooling system tests indicate trouble, the thermostat may be faulty.

COOLING SYSTEM SERVICE

Coolant, draining and filling

> ***WARNING —***
> *Allow the cooling system to cool before opening or draining the cooling system.*

Coolant, draining



➢ Unscrew pressure relief cap (**arrow**) from filler neck (Cooper), or expansion tank (Cooper S).

➢ Working underneath car, remove splash shield and disconnect lower radiator hose (**arrow**).

> ***WARNING —***
> *Use extreme care when draining and disposing of engine coolant. Coolant is poisonous and lethal to humans and pets.*

– Reattach lower radiator hose and tighten hose clamp.

– Reattach splash shield.

Coolant, filling

– Cooper: Working at left of engine, loosen vent screw in heating distribution pipe located in rear of thermostat housing.

➢ Loosen vent screw (**arrow**) in upper radiator hose.

NOTE —
Cooper engine is illustrated. Cooper S is similar.

– Add coolant at filler neck (Cooper), or expansion tank (Cooper S).

– Tighten vent screw(s) as soon as coolant begins to emerge.

– Cooper: Add coolant until level reaches inner ring of filler neck.
  - Replace pressure cap.
  - Fill overflow tank to MAX mark.

– Cooper S: Add coolant until level reaches MAX mark on expansion tank.

– Start engine and run at idle. Top off coolant to correct level until level stops dropping.

– Replace overflow cap or pressure cap and check system carefully for leaks.

NOTE—
- *Before filling system, turn on ignition and set heating controls to maximum temperature with fan on low.*
- *Add coolant slowly.*
- *Use only BMW approved coolant.*

Electric cooling fan, removing

WARNING—
Allow the cooling system to cool before opening or draining the cooling system.

Cooling fan and cooling fan cowl are removed as a unit.

– Remove radiator. See **Radiator, removing and installing** in this repair group.

– Unclip fan and fan cowl and slide off radiator.

Thermostat, removing and installing

WARNING—
Allow the cooling system to cool before opening or draining the cooling system.

The thermostat housing in the Cooper engine is part of the coolant filler neck at the rear of the engine. The Cooper S thermostat housing is in a similar location on the engine, but there is no filler neck at that location.

The illustrations used in this procedure are from a Cooper.

– Cooper: Remove battery and battery box. See **121 Battery, Starter, Alternator** for more information.

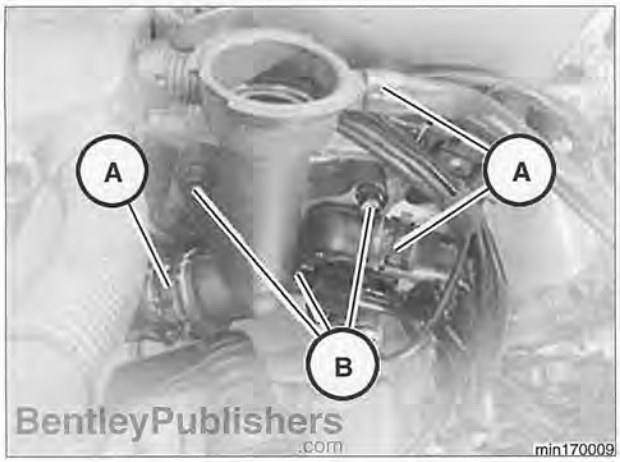
CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions in **001 General Warnings and Cautions**.

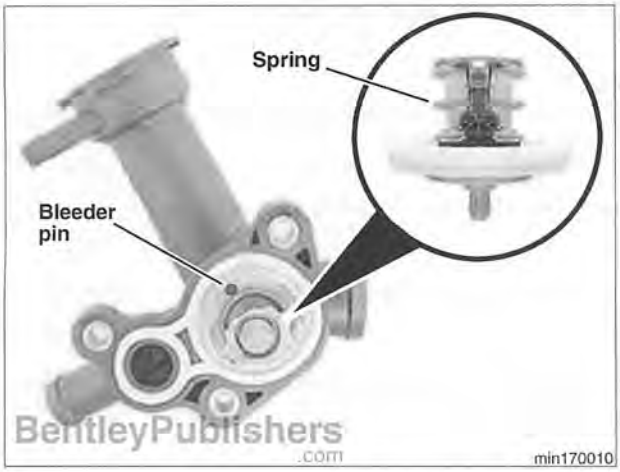
– Remove engine air intake duct and air filter housing. See **130 Fuel Injection** for more information.

– Drain coolant. See **Coolant, draining and filling** in this repair group.

➤ Working at left side of cylinder head, detach coolant hoses (**A**) from thermostat housing.

– Remove thermostat housing mounting bolts (**B**). Remove housing.





- Remove thermostat (**inset**) from housing and make sure housing and cylinder head mating surfaces are clean.
- When replacing thermostat make sure bleeder pin is positioned correctly and that spring side of thermostat is facing cylinder head.
- Replace thermostat and seal. Make sure aligning guides mate.
- Install housing to cylinder head.

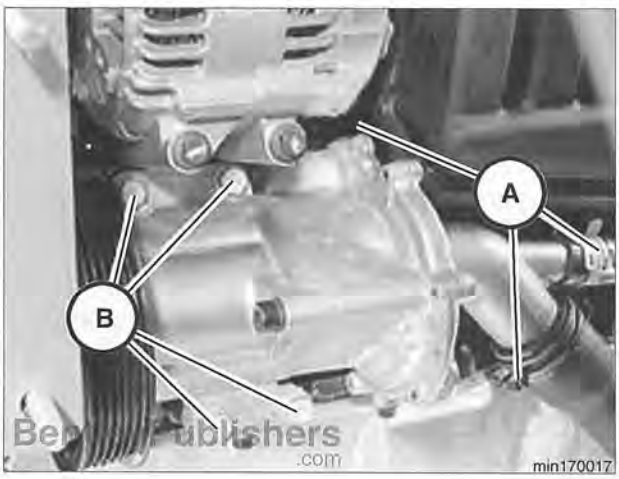
Tightening torque	
Thermostat housing to cylinder head	12 Nm (9 ft-lb)

- Remainder of installation is reverse of removal:
  - Fill and bleed cooling system. See **Coolant, draining and filling** in this repair group.
  - Check system for leaks.

Coolant pump, replacing (Cooper)

WARNING —
Allow the cooling system to cool before opening or draining the cooling system.

- Disconnect battery. See **121 Battery, Starter, Alternator** for more information.
- Drain coolant. See **Coolant, draining and filling** in this repair group.
- Remove alternator. See **121 Battery, Starter, Alternator** for more information.
- Slacken modular front end and pull forward to allow access to front of engine. See **510 Exterior Trim, Bumpers** for more information.



- Working at coolant pump:
  - Loosen or remove hose clamps (**A**) and remove hoses from coolant pump.
  - Remove mounting bolts (**B**) and remove coolant pump.
- Installation is reverse of removal:
  - Fill and bleed cooling system. See **Coolant, draining and filling** in this repair group.
  - Check system for leaks.

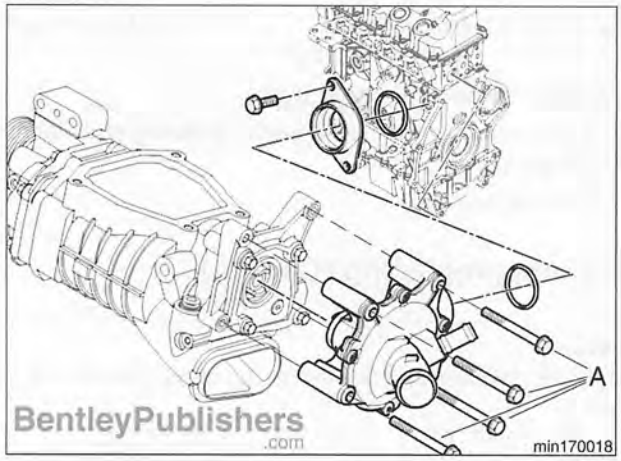
Tightening torque	
Coolant pump to crankcase (Cooper)	30 Nm (22 ft-lb)

Coolant pump, replacing (Cooper S)

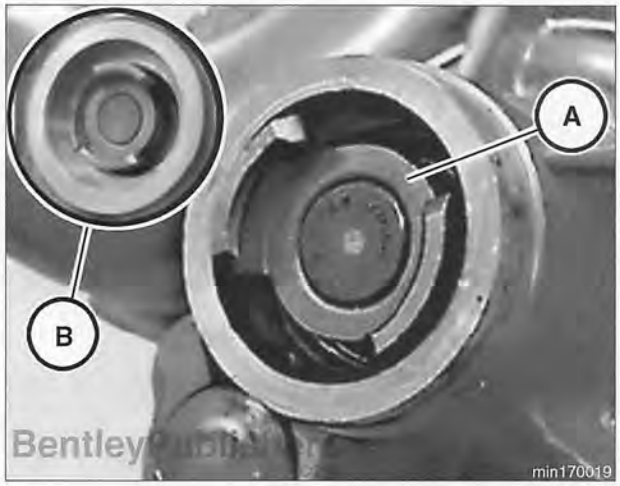
WARNING —
Allow the cooling system to cool before opening or draining the cooling system.

– Drain coolant. See **Coolant, draining and filling** in this repair group.

– Remove supercharger. See **130 Fuel Injection** for more information.



➤ Remove coolant pump retaining bolts (**A**) from rear of supercharger and remove coolant pump.



➤ To install, engage coolant pump drive (**A**) with supercharger drive (**B**). Install coolant pump to supercharger.

➤ Install new O-ring (**arrow**) to coolant pump outlet pipe. Lubricate O-ring with Syntheso Glep 1® or equivalent.

– Remainder of installation is reverse of removal:
- Fill and bleed cooling system. See **Coolant, draining and filling** in this repair group.
- Check system for leaks.

Tightening torque	
Coolant pump to supercharger (Cooper S)	25 Nm (18 ft-lb)

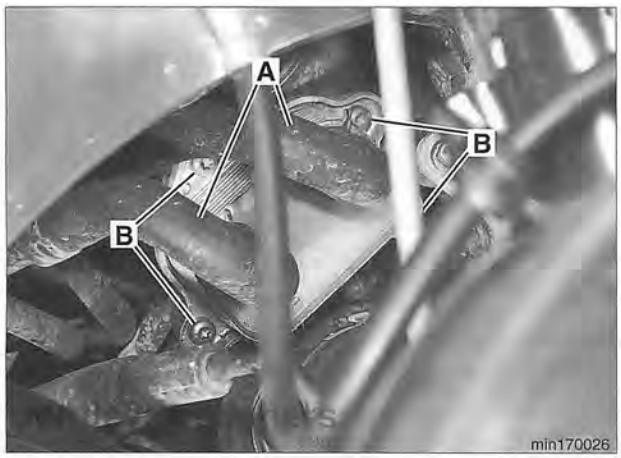
Engine oil cooler, removing and installing (Cooper S)

> ***WARNING —***
> *Allow the cooling system to cool before opening or draining the cooling system.*

The engine oil cooler is located on the right side of the engine compartment on the oil filter housing. Vehicles with automatic transmission (Agitronic) do not have an engine oil cooler.

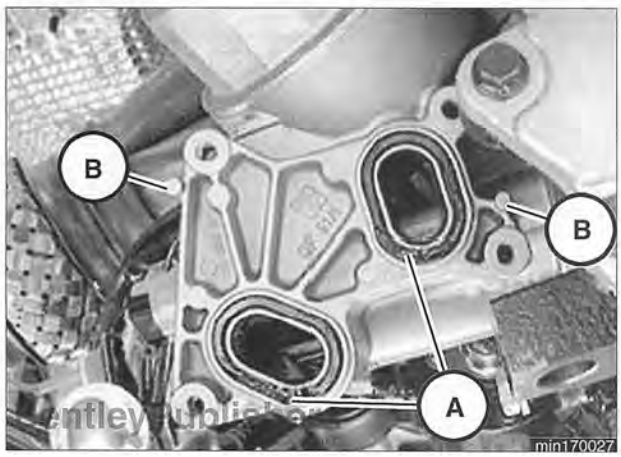
– Drain coolant. See **Coolant, draining and filling** in this repair group.

– Remove right front wheel.



➢ Working at rear of engine:

- Disconnect coolant hoses (**A**) at engine oil cooler. Be prepared to catch any coolant that escapes.
- Remove oil cooler mounting bolts (**B**) and remove oil cooler. Be prepared to catch any dripping oil.



➢ Before reinstalling:

- Remove sealing rings (**A**) and clean mating surfaces on cooler and oil filter housing.
- Install new sealing rings and refit oil cooler. Note cooler location lugs (**B**).

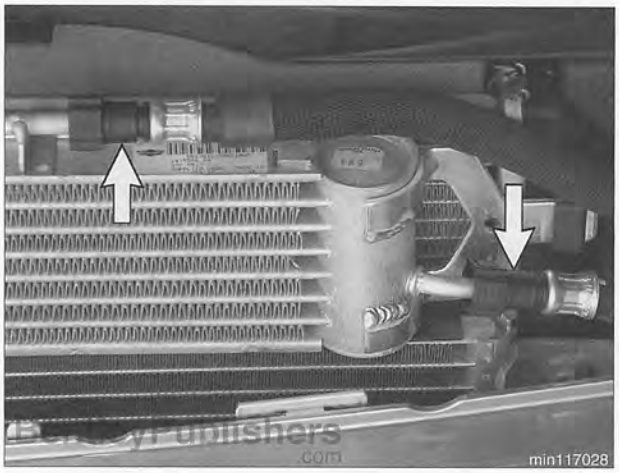
– Check engine oil level.

– Bleed and top-up cooling system.

Tightening torque	
Engine oil cooler to oil filter housing	12 Nm (9 ft-lb)

Transmission fluid cooler, removing and installing (CVT models)

> ***WARNING —***
> *Allow the cooling system to cool before opening or draining the cooling system.*



➤ Working in front of the radiator, disconnect pipes (**arrows**) from transmission cooler and use special tools (13 5 281 and 13 5 282) to seal cooler and lines. Be prepared to catch dripping transmission fluid.

➤ Remove transmission cooler mounting screw (**A**). Slide cooler (**arrow**) off mounting bracket to remove.

– Installation is reverse of removal. Check automatic transmission fluid level. See **240 Automatic Transmission**.

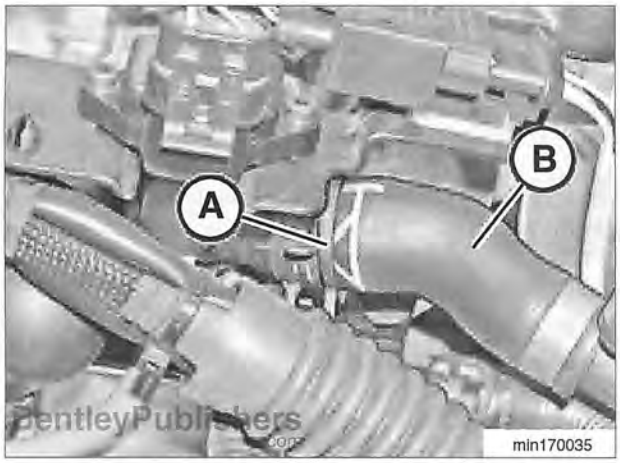
Tightening torque	
Transmission fluid cooler to radiator carrier	4 Nm (3 ft-lb)

Transmission fluid cooler, removing and installing (Agitronic models)

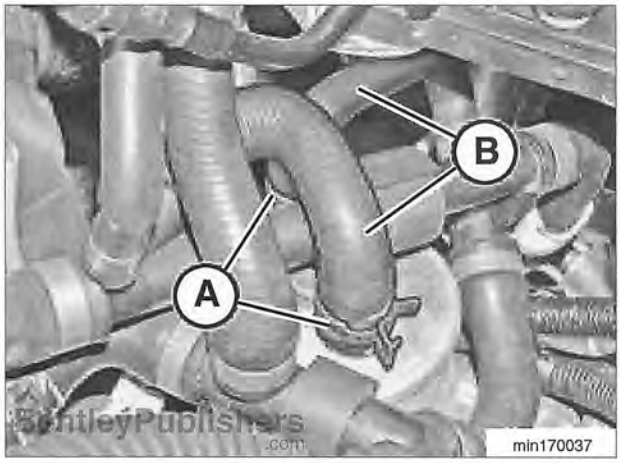
– Drain engine coolant as described in **Coolant, draining and filling** in this repair group.

> ***WARNING —***
> *Allow the cooling system to cool before opening or draining the cooling system.*

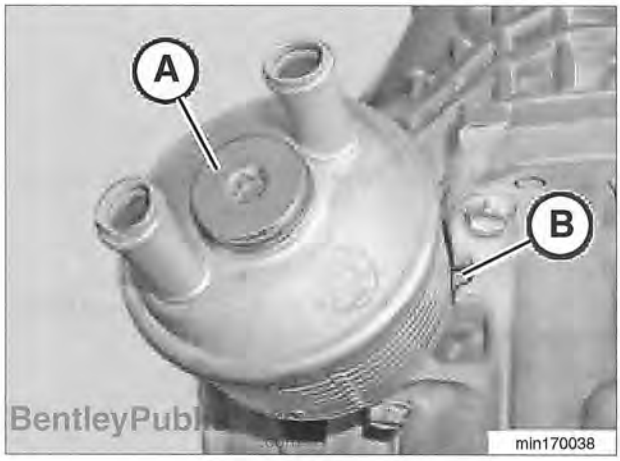
– Remove air filter assembly and inlet/outlet ducts, as necessary, to access transmission cooler. See **130 Fuel Injection**.



➢ Working on top of transmission, release hose clamp (**A**) and remove coolant hose (**B**).



➢ Release hose clamps (**A**) and detach coolant hosed (**B**) from transmission fluid cooler.



➢ Remove mounting bolt (**A**) and remove transmission fluid cooler.
- When installing, note position of locating lug (**B**).

– If re-using cooler, coat upper and lower O-ring seals with transmission fluid.

– Clean sealing contact surfaces on transmission before installing cooler.

– Installation is reverse of removal. Tighten cooler mounting bolt to specification.

Tightening torque	
Transmission fluid cooler to transmission	35 Nm (26 ft-lb)

– Check automatic transmission fluid level. See **240 Automatic Transmission**.

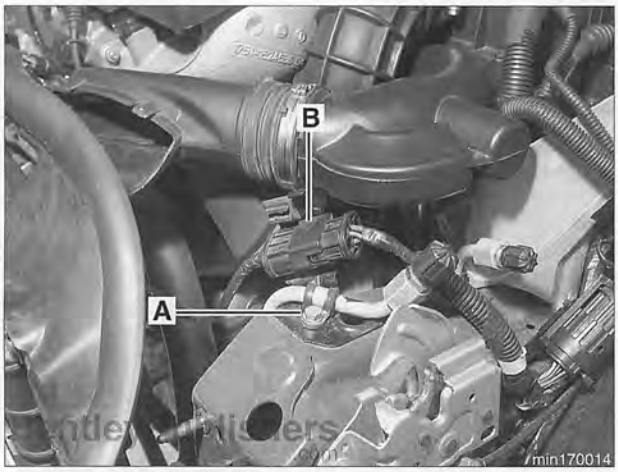
Radiator, removing and installing

WARNING —
Allow the cooling system to cool before opening or draining the cooling system.

– Drain coolant. See **Coolant, draining and filling** in this repair group.

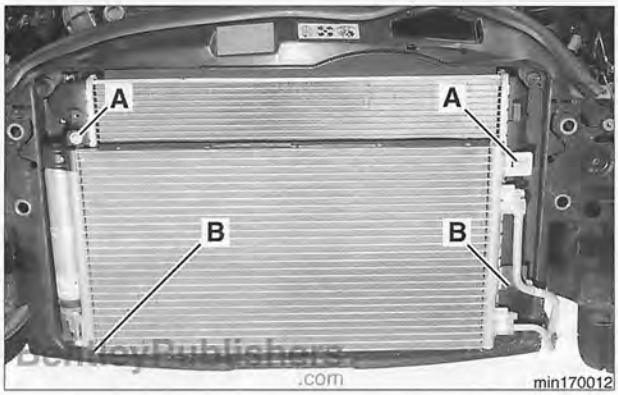
– Slacken modular front end and pull forward to allow access to radiator. See **510 Exterior Trim, Bumpers** for more information.

– CVT models: remove oil cooler. See **Transmission oil cooler, removing and installing (CVT models)** in this repair group.

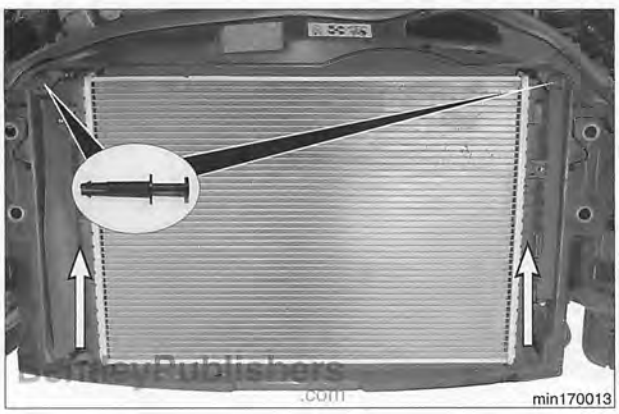


➢ Working at left frame extension, next to left engine hood latch:
- Remove refrigerant service fitting mounting bolt (**A**).
- Disconnect cooling fan electrical harness connector (**B**).

– Detach upper radiator hose.



➢ Remove air-conditioning condenser:
- Remove condenser mounting bolts (**A**).
- Carefully lift condenser out of retaining lugs (**B**). Support condenser and continue with radiator removal.

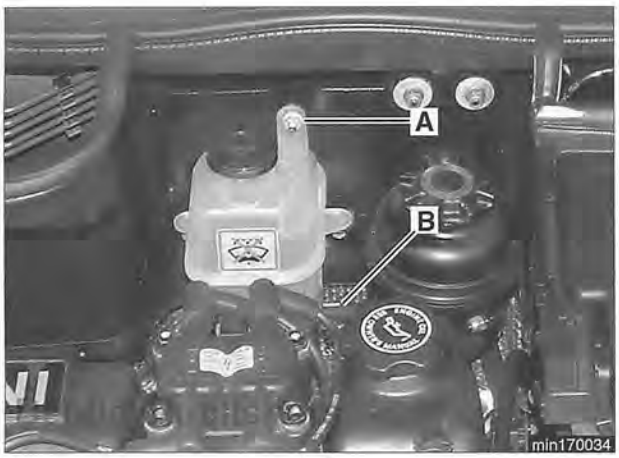


➢ Remove radiator retaining pins (**inset**). Lift radiator (**arrows**) to disengage from support lugs.

– Installation is reverse of removal. Remember to:
- Fill and bleed cooling system. See **Coolant, draining and filling** in this repair group.
- Check system for leaks.

Expansion tank, removing and installing

> ***WARNING —***
> *Allow the cooling system to cool before opening or draining the cooling system.*

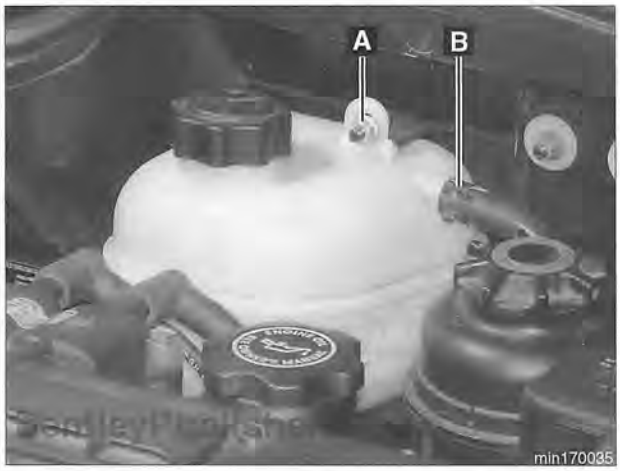


➢ Cooper: Remove expansion tank mounting nut (**A**).

– Detach hose (**B**) and lift expansion tank from mounting slots. Be prepared to catch any coolant that escapes.

– When replacing:
- Replace hose clamp(s).
- Fill and bleed cooling system. See **Coolant, draining and filling** in this repair group.
- Check system for leaks.

Tightening torque	
Expansion tank to bulkhead	5 Nm (4 ft-lb)



➢ Cooper S: Remove expansion tank mounting nut (**A**).

– Detach hose (**B**) from top of expansion tank.

– Lift tank out of mounting slots and remove hose from bottom of tank.

– Remove expansion tank. Be prepared to catch any coolant that escapes.

– When replacing:
- Replace hose clamp(s).
- Fill and bleed cooling system. See **Coolant, draining and filling** in this repair group.
- Check system for leaks.

Tightening torque	
Expansion tank to bulkhead	5 Nm (4 ft-lb)

180 Exhaust System

GENERAL

The exhaust system is designed to be maintenance free, although regular inspection is warranted due to the harsh operating conditions. Under normal conditions, the catalytic converter does not require replacement unless it is damaged.

EXHAUST SYSTEM

New fasteners, clamps, rubber mounts and gaskets should be used when replacing exhaust components. A liberal application of penetrating oil to the exhaust system nuts and bolts in advance may make removal easier.

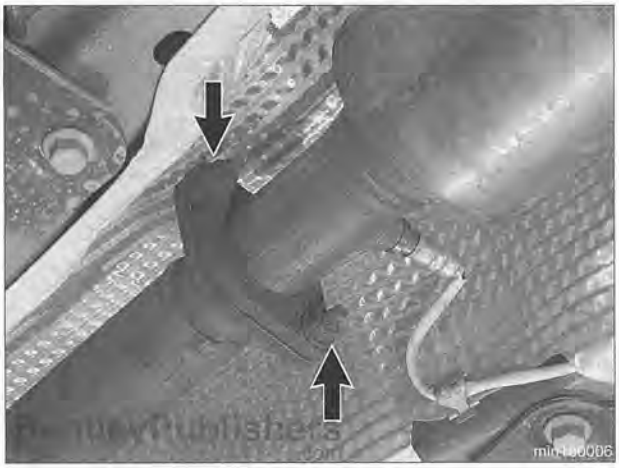
> ***WARNING —***
> • *The exhaust system and catalytic converter operate at very high temperatures. Allow components to cool before servicing. Wear protective gloves to prevent burns. Do not use flammable chemicals near a hot catalytic converter.*
>
> • *Corroded exhaust system components crumble easily and often have exposed sharp edges. To avoid injury, wear eye protection and heavy gloves when working with exhaust parts.*

Exhaust system, removing and installing

Removal and installation procedures given here are similar for all models. The removal of the exhaust system as a complete unit is recommended. Once the complete system is removed from the car it can be worked on more easily.

> ***WARNING —***
> *Exhaust gases are colorless, odorless, and very toxic. Run the engine only in a well-ventilated area. Immediately repair any leaks in the exhaust system or structural damage to the car body that might allow exhaust gases to enter the passenger compartment.*

> ***CAUTION —***
> *Use care not to drag or bang the oxygen sensors. Oxygen sensors can be easily ruined.*



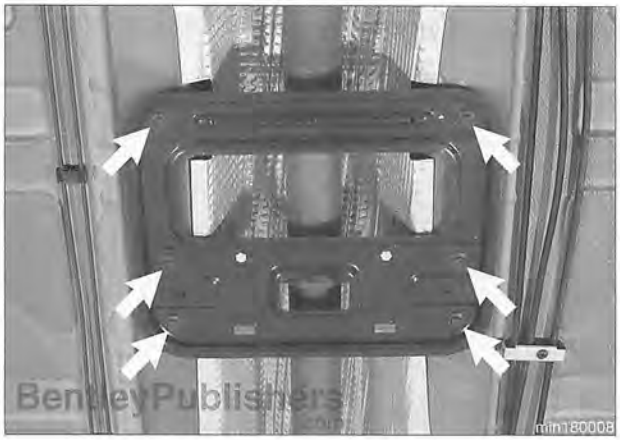
– With the exhaust system fully cold, raise and support car for access to exhaust system.

> ***WARNING —***
> *Do not work under a lifted car unless it is solidly supported on jack stands designed for that purpose. Never work under a car that is supported solely by a jack.*

➤ Remove fasteners (**arrows**) that join exhaust system to catalytic converter.

➢ Working at the muffler(s), remove bolts (**arrows**) from lower clamp.

NOTE—
Cooper S models: Remove shield attached to bottom of battery box.



➢ With an assistant supporting exhaust system, Remove bolts (**arrows**) from reinforcement plate.

– Carefully lower exhaust system out from under car.

– Installation is reverse of removal noting the following:
- Replace all nuts and bolts. Coat threads with copper paste.
- Replace gasket between exhaust and converter.
- Replace rubber mount rings.

Tightening torque	
Exhaust system to exhaust manifold (M10)	60 Nm (44 ft-lb)
Lower muffler clamp to upper clamp (M8)	15 Nm (11 ft-lb)
Reinforcement plate to body	14 Nm (10 ft-lb)

EXHAUST MANIFOLD

Exhaust manifold removal procedure is similar for all models. Always use new retaining nuts and gaskets when removing and installing the exhaust manifold.

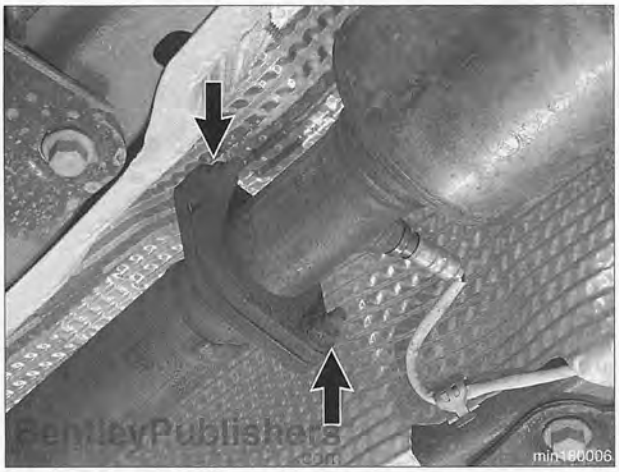
WARNING—
Exhaust gases are colorless, odorless, and very toxic. Run the engine only in a well-ventilated area. Immediately repair any leaks in the exhaust system or structural damage to the car body that might allow exhaust gases to enter the passenger compartment.

Exhaust manifold, removing and installing

– With the exhaust system fully cold, raise and support car for access to exhaust system.

WARNING—
Do not work under a lifted car unless it is solidly supported on jack stands designed for that purpose. Never work under a car that is supported solely by a jack.

Exhaust Manifold



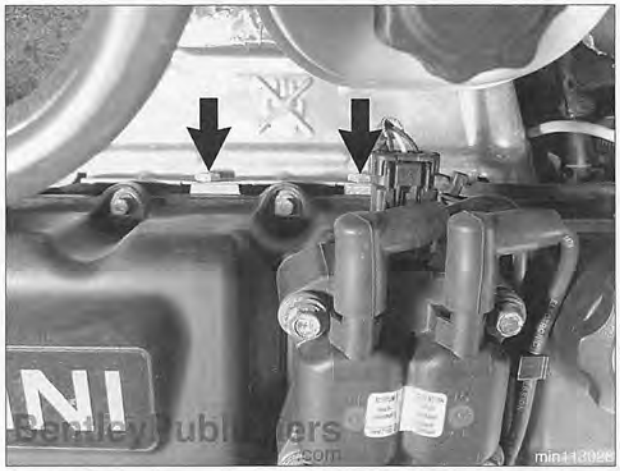
➢ Remove fasteners (**arrows**) that join exhaust system to catalytic converter.

NOTE —
Leave exhaust system suspended from body.

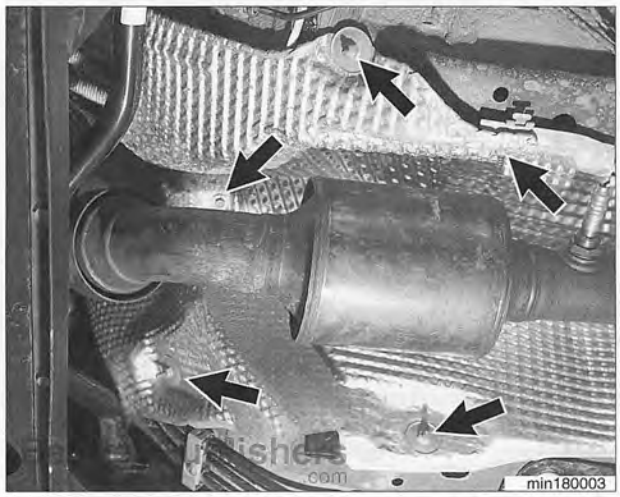
– Disconnect front and rear oxygen sensor electrical connectors.

NOTE —
Do not reverse oxygen sensor connectors. Label connectors to insure proper installation.

> ***CAUTION —***
> • *Use care not to drag or bang the oxygen sensors. Oxygen sensors can be easily ruined.*

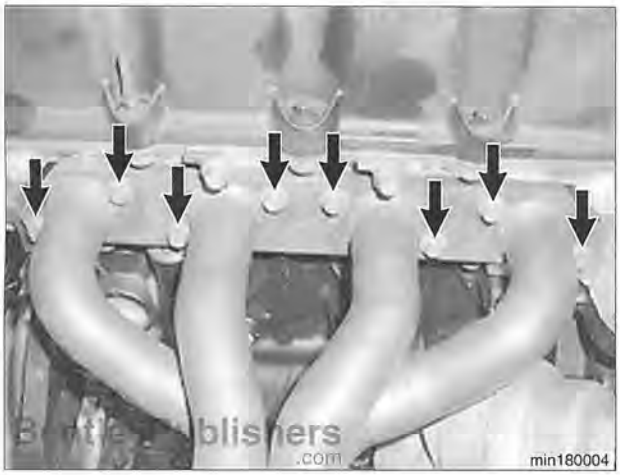


➢ Remove heat shield bolts (**arrows**) where shield attaches to cylinder head.



➢ Remove remaining bolts (**arrows**) holding heat shield to body and remove heat shield.

NOTE —
Note routing of oxygen sensor wiring.



➢ Remove exhaust manifold mounting bolts (**arrows**) from cylinder head. Remove exhaust manifold.

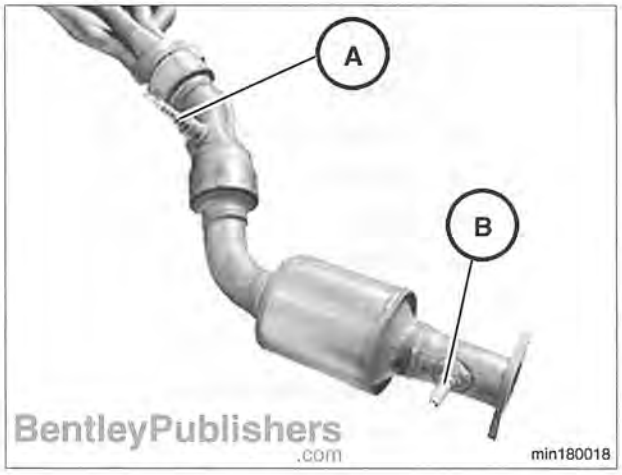
– Installation is reverse of removal noting the following:
- Replace all nuts and bolts.
- Clean mating surfaces of cylinder head and manifold.
- Coat exhaust system to exhaust manifold bolt threads with copper paste.
- Replace exhaust manifold gasket.

Tightening torque	
Exhaust manifold to cylinder head (M8)	24 Nm (18 ft-lb)
Exhaust system to exhaust manifold (M10)	60 Nm (44 ft-lb)
Heat shield to cylinder head (M8)	13 Nm (10 ft-lb)

OXYGEN SENSORS

Oxygen sensors are located in front of (pre-catalyst) and behind (post-catalyst) the catalytic converter. Oxygen sensor replacement is similar for all models.

Oxygen sensors, removing and installing



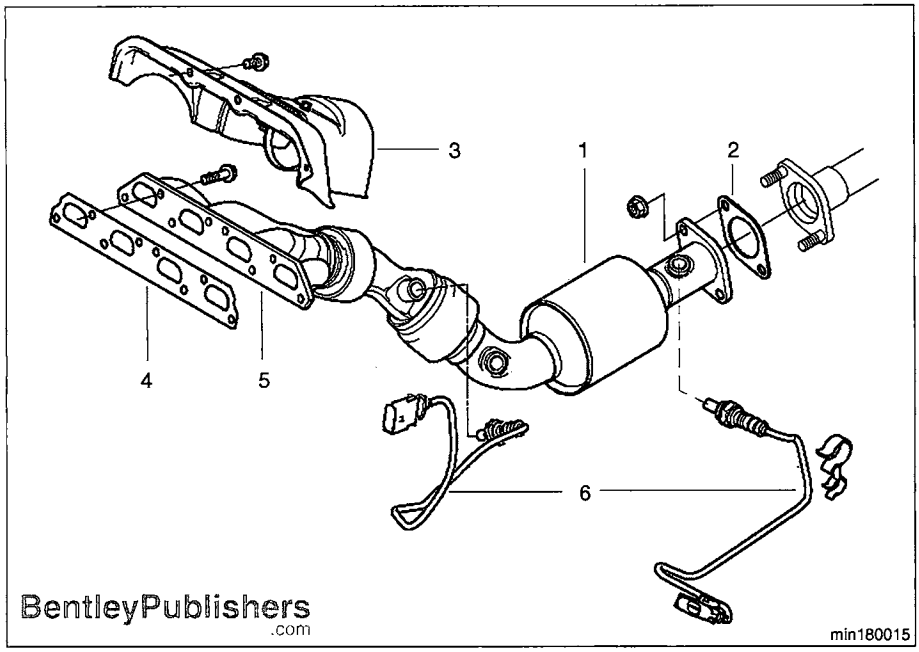
– Disconnect front and rear oxygen sensor electrical connectors.

➢ Remove front oxygen sensor (**A**) and rear oxygen sensor (**B**).

➢ To replace, use special tool (BMW tool no. 11 7 030) or equivalent to tighten oxygen sensor to proper torque. Installation is reverse of removal, noting the following:
- Oxygen sensors come pre-coated with anti-seize paste.
- Do not contaminate tip of sensor.

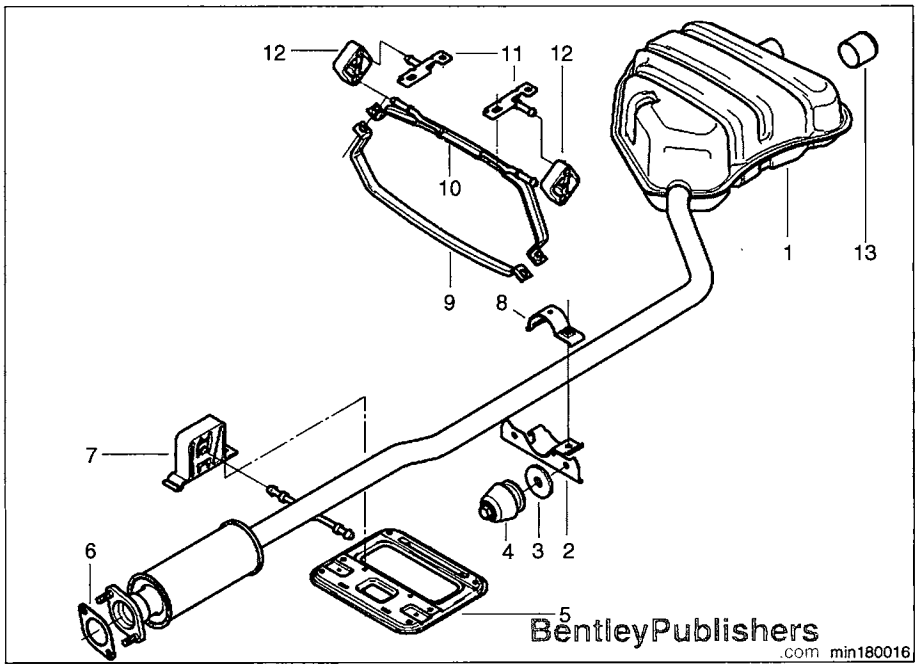
Tightening torque	
Oxygen sensors to exhaust	39 Nm (29 ft-lb)

EXHAUST SYSTEM DIAGRAMS



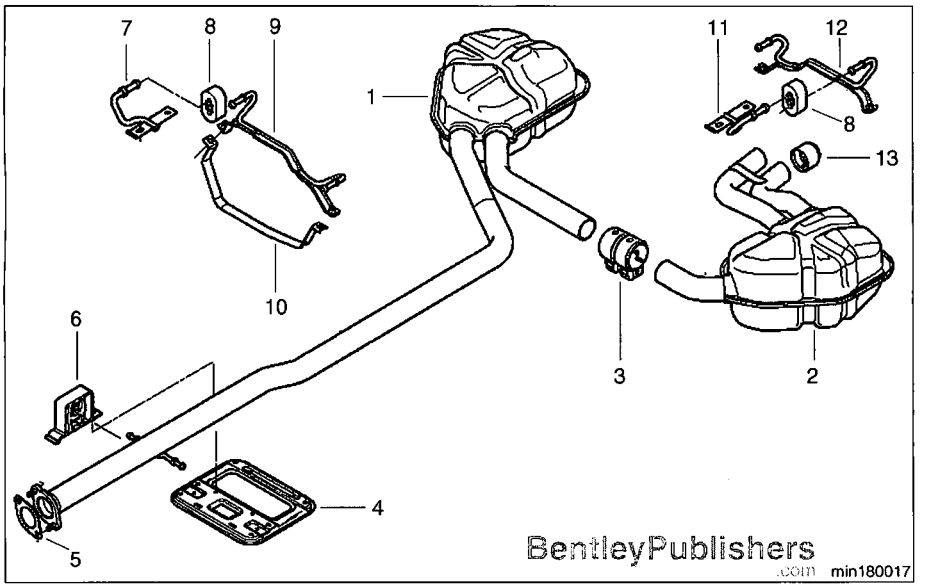
Exhaust manifold and catalytic converter (all models)

1. Catalytic converter
2. Gasket
3. Heat shield
4. Gasket
5. Exhaust manifold
6. Oxygen sensors



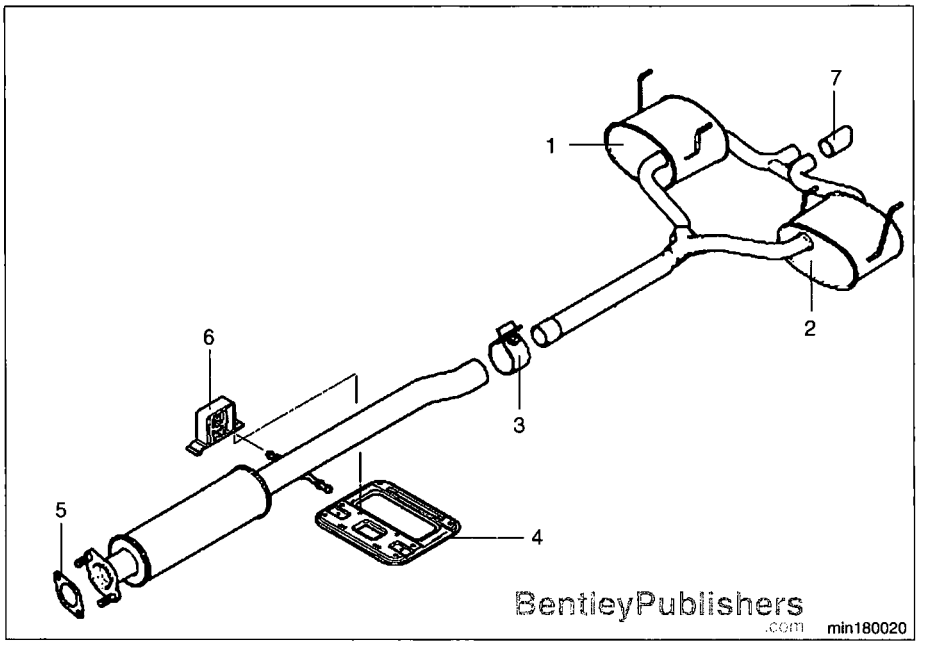
Cooper exhaust system

1. Muffler (rear)
2. Bracket
3. Washer
4. Vibration absorber
5. Support
6. Gasket
7. Rubber mounting
8. Bracket
9. Muffler clamp (lower)
10. Muffler clamp (upper)
11. Rear hanger
12. Rubber ring
13. Tailpipe extension



Cooper S exhaust system

1. **Right muffler**
2. **Left muffler**
3. **Connecting clamp**
4. **Support**
5. **Gasket**
6. **Rubber mounting**
7. **Hanger bracket**
8. **Rubber ring**
9. **Muffler clamp (upper right)**
10. **Muffler clamp (lower right)**
11. **Hanger bracket**
12. **Muffler clamp (upper left)**
13. **Tailpipe extension**



John Cooper Works exhaust system

1. **Right muffler**
2. **Left muffler**
3. **Connecting clamp**
4. **Support**
5. **Gasket**
6. **Rubber mounting**
7. **Tailpipe extension**