

# **BMW**

# **5 Series**

**(E39)**



**Service Manual**  
**525i, 528i, 530i, 540i**  
**Sedan, Sport Wagon**  
**1997, 1998, 1999, 2000, 2001, 2002**



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Do not use this manual unless you are familiar with basic automotive repair procedures and safe workshop practices. This manual illustrates the workshop procedures required for most service work. It is not a substitute for full and up-to-date information from the vehicle manufacturer or for proper training as an automotive technician. Note that it is not possible for us to anticipate all of the ways or conditions under which vehicles may be serviced or to provide cautions as to all of the possible hazards that may result.

The vehicle manufacturer will continue to issue service information updates and parts retrofits after the editorial closing of this manual. Some of these updates and retrofits will apply to procedures and specifications in this manual. We regret that we cannot supply updates to purchasers of this manual.

We have endeavored to ensure the accuracy of the information in this manual. Please note, however, that considering the vast quantity and the complexity of the service information involved, we cannot warrant the accuracy or completeness of the information contained in this manual.

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Your common sense and good judgment are crucial to safe and successful service work. Read procedures through before starting them. Think about whether the condition of your car, your level of mechanical skill, or your level of reading comprehension might result in or contribute in some way to an occurrence which might cause you injury, damage your car, or result in an unsafe repair. If you have doubts for these or other reasons about your ability to perform safe repair work on your car, have the work done at an authorized BMW dealer or other qualified shop.

Part numbers listed in this manual are for identification purposes only, not for ordering. Always check with your authorized BMW dealer to verify part numbers and availability before beginning service work that may require new parts.

Before attempting any work on your BMW, read the 001 General Warnings and Cautions, and any WARNING or CAUTION that accompanies a procedure in the service manual. Review the WARNINGS and CAUTIONS each time you prepare to work on your BMW.

Special tools required to perform certain service operations are identified in the manual and are recommended for use. Use of tools other than those recommended in this service manual may be detrimental to the car's safe operation as well as the safety of the person servicing the car.

Copies of this manual may be purchased from most automotive accessories and parts dealers specializing in BMW automobiles, from selected booksellers, or directly from the publisher.

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You are now in **Volume 1**

Foreword ..... v  
 Index..... rear of manual

**0 General, Maintenance**

001 General Warnings and Cautions  
 002 Vehicle Identification and VIN Decoder  
 010 General  
 020 Maintenance

**1 Engine**

100 Engine-General  
 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  
 121 Battery, Starter, Alternator  
 130 Fuel Injection  
 160 Fuel Tank and Fuel Pump  
 170 Radiator and Cooling System  
 180 Exhaust System

**2 Transmission**

200 Transmission-General  
 210 Clutch  
 230 Manual Transmission  
 240 Automatic Transmission  
 250 Gearshift Linkage  
 260 Driveshaft

**3 Suspension, Steering and Brakes**

300 Suspension, Steering and Brakes-General  
 310 Front Suspension  
 320 Steering and Wheel Alignment  
 330 Rear Suspension  
 331 Final Drive  
 340 Brakes

**4 Body**

400 Body-General  
 410 Fenders, Engine Hood  
 411 Doors  
 412 Trunk Lid, Tailgate

**5 Body Equipment**

510 Exterior Trim, Bumpers  
 512 Door Windows  
 513 Interior Trim  
 515 Central Locking and Anti-Theft  
 520 Seats  
 540 Sunroof

**7 Equipment and Accessories**

720 Seat Belts  
 721 Airbag System (SRS)

**OBD**

On-Board Diagnostics

Volume 1

Foreword ..... v  
 Index..... rear of manual

**6 Electrical System**

600 Electrical System-General  
 610 Electrical Component Locations  
 611 Wipers and Washers  
 612 Switches  
 620 Instruments  
 630 Lights  
 640 Heating and Air Conditioning  
 650 Radio

**ELE**

Electrical Wiring Diagrams

Volume 2

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# Foreword

For the BMW owner with basic mechanical skills and for independent auto service professionals, this manual includes many of the specifications and procedures that were available to an authorized BMW dealer service department as this manual went to press. The BMW owner with no intention of working on his or her car will find that owning and referring to this manual makes it possible to be better informed and to more knowledgeably discuss repairs with a professional automotive technician.

If you are a BMW owner intending to do maintenance and repair work, make sure you have screwdrivers, a set of metric wrenches and sockets and metric Allen and Torx wrenches, since these basic hand tools are needed for most of the work described in this manual. Many procedures also require a torque wrench to ensure that fasteners are tightened properly and in accordance with specifications. Additional information on basic tools and other tips are in **010 General**. In some cases, the text refers to special tools that are recommended or required to accomplish adjustments or repairs. These tools are usually identified by their BMW special tool number and illustrated.

## Disclaimer

We have endeavored to ensure the accuracy of the information in this manual. When the vast array of data presented in the manual is taken into account, however, no claim to infallibility can be made. We therefore cannot be responsible for the result of any errors that may have crept into the text. Please also read the **Important Safety Notice** on the copyright page at the beginning of this book.

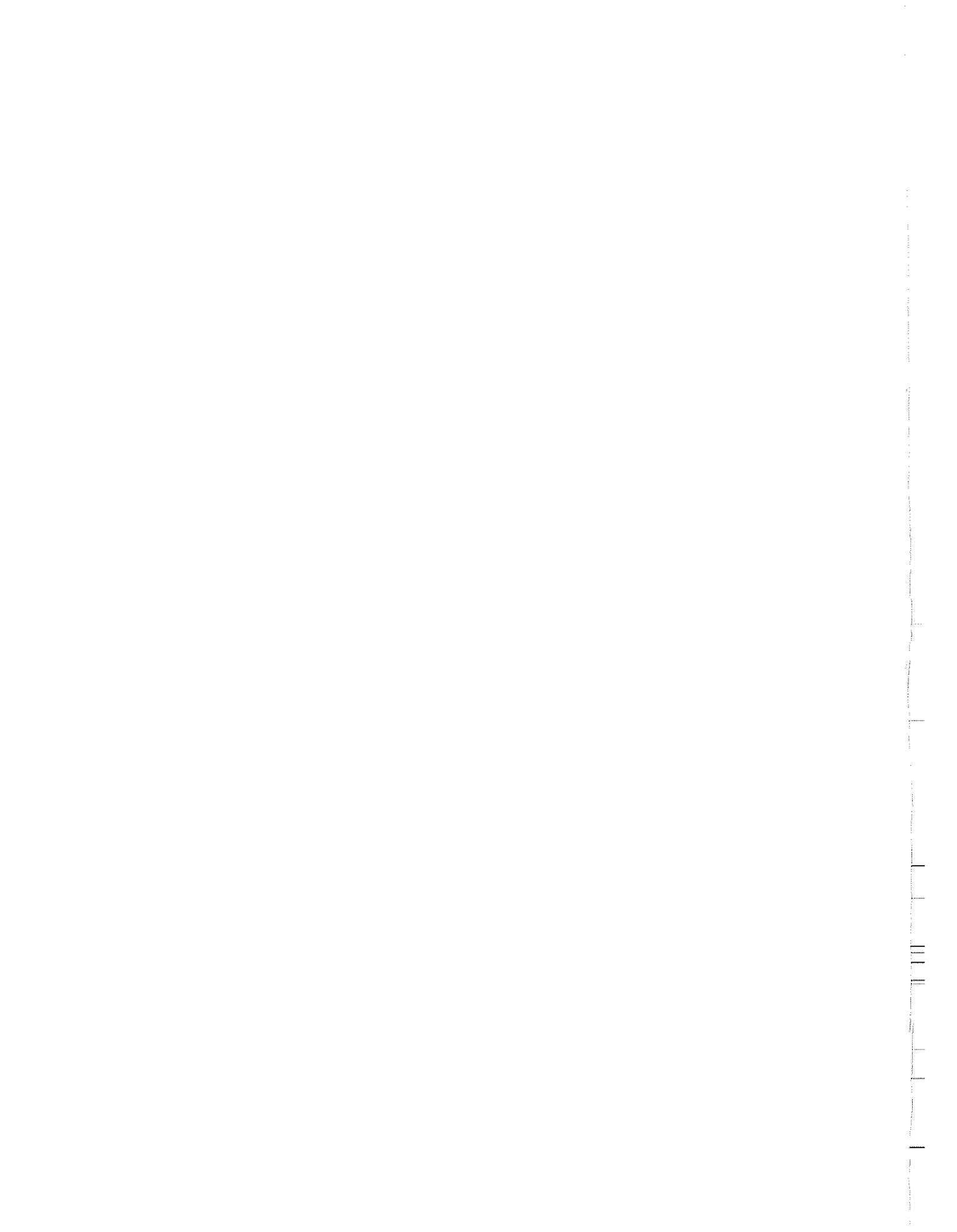
Prior to starting a repair procedure, read the procedure, **001 General Warnings and Cautions** and the warnings and cautions that accompany the procedure. Reading a procedure before beginning work will help you determine in advance the need for specific skills, identify hazards, prepare for appropriate capture and handling of hazardous materials, and the need for particular tools and replacement parts such as gaskets.

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BMW offers extensive warranties, especially on components of the fuel delivery and emission control systems. Therefore, before deciding to repair a BMW that may be covered wholly or in part by any warranties issued by BMW of North America, LLC, consult your authorized BMW dealer. You may find that the dealer can make the repair either free or at minimum cost. Regardless of its age, or whether it is under warranty, your BMW is both an easy car to service and an easy car to get serviced. So if at any time a repair is needed that you feel is too difficult to do yourself, a trained BMW technician is ready to do the job for you.

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# 001 General Warnings and Cautions

**PLEASE READ THESE WARNINGS AND CAUTIONS  
BEFORE PROCEEDING WITH MAINTENANCE AND REPAIR WORK.**

## **WARNINGS—**

See also **CAUTIONS**

- Some repairs may be beyond your capability. If you lack the skills, tools and equipment, or a suitable workplace for any procedure described in this manual, we suggest you leave such repairs to an authorized BMW dealer service department or other qualified shop.
- Do not reuse any fasteners that are worn or deformed. Many fasteners are designed to be used only once and become unreliable and may fail when used a second time. This includes, but is not limited to, nuts, bolts, washers, self-locking nuts or bolts, circlips and cotter pins. Always replace these fasteners with new parts.
- Never work under a lifted car unless it is solidly supported on stands designed for the purpose. Do not support a car on cinder blocks, hollow tiles or other props that may crumble under continuous load. Never work under a car that is supported solely by a jack. Never work under the car while the engine is running.
- If you are going to work under a car on the ground, make sure that the ground is level. Block the wheels to keep the car from rolling. Disconnect the battery negative (–) terminal to prevent others from starting the car while you are under it.
- Never run the engine unless the work area is well ventilated. Carbon monoxide kills.
- Rings, bracelets and other jewelry should be removed so that they cannot cause electrical shorts, get caught in running machinery, or be crushed by heavy parts.
- Tie long hair behind your head. Do not wear a necktie, a scarf, loose clothing, or a necklace when you work near machine tools or running engines. If your hair, clothing, or jewelry were to get caught in the machinery, severe injury could result.
- Do not attempt to work on your car if you do not feel well. You increase the danger of injury to yourself and others if you are tired, upset or have taken medication or any other substance that may keep you from being fully alert.
- Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the car. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel, vapors or oil.
- Catch draining fuel, oil, or brake fluid in suitable containers. Do not use food or beverage containers that might mislead someone into drinking from them. Store flammable fluids away from fire hazards. Wipe up spills at once, but do not store the oily rags, which can ignite and burn spontaneously.
- Always observe good workshop practices. Wear goggles when you operate machine tools or work with battery acid. Gloves or other protective clothing should be worn whenever the job requires working with harmful substances.
- Greases, lubricants and other automotive chemicals contain toxic substances, many of which are absorbed directly through the skin. Read the manufacturer's instructions and warnings carefully. Use hand and eye protection. Avoid direct skin contact.
- Disconnect the battery negative (–) terminal whenever you work on the fuel system or the electrical system. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.
- Friction materials (such as brake pads or shoes or clutch discs) contain asbestos fibers or other friction materials. Do not create dust by grinding, sanding, or by cleaning with compressed air. Avoid breathing dust. Breathing any friction material dust can lead to serious diseases and may result in death.
- Batteries give off explosive hydrogen gas during charging. Keep sparks, lighted matches and open flame away from the top of the battery. If hydrogen gas escaping from the cap vents is ignited, it will ignite gas trapped in the cells and cause the battery to explode.
- Connect and disconnect battery cables, jumper cables or a battery charger only with the ignition switched off. Do not disconnect the battery while the engine is running.
- Do not quick-charge the battery (for boost starting) for longer than one minute. Wait at least one minute before boosting the battery a second time.
- Do not allow battery charging voltage to exceed 16.5 volts. If the battery begins producing gas or boiling violently, reduce the charging rate. Boosting a sulfated battery at a high charging rate can cause an explosion.

*Continued on next page*

## General Warnings and Cautions

### WARNINGS (continued)

- The air conditioning system is filled with chemical refrigerant, which is hazardous. The A/C system should be serviced only by *trained technicians using approved refrigerant recovery/recycling equipment, trained in related safety precautions, and familiar with regulations governing the discharging and disposal of automotive chemical refrigerants.*
- Do not expose any part of the A/C system to high temperatures such as open flame. Excessive heat will increase system pressure and may cause the system to burst.
- Some aerosol tire inflators are highly flammable. Be extremely cautious when repairing a tire that may have been inflated using an aerosol tire inflator. Keep sparks, open flame or other sources of ignition away from the tire repair area. Inflate and deflate the tire at least four times before breaking the bead from the rim. Completely remove the tire from the rim before attempting any repair.
- Cars covered by this manual are equipped with a supplemental restraint system (SRS), that automatically deploys airbags and pyrotechnic seat belt tensioners in the event of a frontal or side impact. These are explosive devices. Handled improperly or without adequate safeguards, they can be accidentally activated and cause serious injury.
- The ignition system produces high voltages that can be fatal. Avoid contact with exposed terminals and use extreme care when working on a car with the engine running or the ignition switched on.
- Place jack stands only at locations specified by the manufacturer. The vehicle lifting jack supplied with the vehicle is intended for tire changes only. A heavy duty floor jack should be used to lift vehicle before installing jack stands. See **010 General**.
- Battery acid (electrolyte) can cause severe burns. Flush contact area with water, seek medical attention.
- Aerosol cleaners and solvents may contain hazardous or deadly vapors and are highly flammable. Use only in a well ventilated area. Do not use on hot surfaces (engines, brakes, etc.).
- Do not remove coolant reservoir or radiator cap with the engine hot. Danger of burns and engine damage.
- Before starting a job, make certain that you have all the necessary tools and parts on hand. Read all the instructions thoroughly, and do not attempt shortcuts. Use tools appropriate to the work and use only replacement parts meeting BMW specifications.
- Use pneumatic and electric tools only to loosen threaded parts and fasteners. Never use these tools to tighten fasteners, especially on light alloy parts. Always use a torque wrench to tighten fasteners to the tightening torque specification listed.
- Be mindful of the environment and ecology. Before you drain the crankcase, find out the proper way to dispose of the oil. Do not pour oil onto the ground, down a drain, or into a stream, pond or lake. Dispose of waste in accordance with Federal, State and Local laws.
- The control module for the anti-lock brake system (ABS) cannot withstand temperatures from a paint-drying booth or a heat lamp in excess of 203° F (95° C) and should not be subjected to temperatures in excess of 185° F (85° C) for more than two hours.
- Before doing any electrical welding on cars equipped with ABS, disconnect the battery negative (-) terminal (ground strap) and the ABS control module connector.
- Always make sure ignition is off before disconnecting battery.
- Label battery cables before disconnecting. On some models, battery cables are not color coded.
- Disconnecting the battery may erase fault code(s) stored in control module memory. Using special BMW diagnostic equipment, check for fault codes prior to disconnecting the battery cables. If the malfunction indicator light (MIL) is illuminated, see **OBD On-Board Diagnostics**. This light is identified as the Check Engine light (1997-2000 models) or Service Engine Soon light (2001 and later models). If any other system faults have been detected (indicated by an illuminated warning light), see an authorized BMW dealer.
- If a normal or rapid charger is used to charge battery, the battery must be disconnected and removed from the vehicle in order to avoid damaging the vehicle.
- Do not quick-charge the battery (for boost starting) for longer than one minute. Wait at least one minute before boosting the battery a second time.
- Connect and disconnect a battery charger only with the battery charger switched off.
- Sealed or "maintenance free" batteries should be slow-charged only, at an amperage rate that is approximately 10% of the battery's ampere-hour (Ah) rating.
- Do not allow battery charging voltage to exceed 16.5 volts. If the battery begins producing gas or boiling violently, reduce the charging rate. Boosting a sulfated battery at a high charging rate can cause an explosion.

### CAUTIONS—

#### See also **WARNINGS**

- If you lack the skills, tools and equipment, or a suitable workshop for any procedure described in this manual, leave such repairs to an authorized BMW dealer or other qualified shop.
- BMW is constantly improving its cars and sometimes these changes, both in parts and specifications, are made applicable to earlier models. Therefore, part numbers listed in this manual are for reference only. Always check with your authorized BMW dealer parts department for the latest information.



# 002 Vehicle Identification and VIN Decoder

## Vehicle Identification Number (VIN), decoding

Some of the information in this manual applies only to cars of a particular model year or range of years. For example, 1999 refers to the 1999 model year but does not necessarily match the calendar year in which the car was manufactured or sold. To be sure of the model year of a particular car, check the Vehicle Identification Number (VIN) on the car.

The VIN is a unique sequence of 17 characters assigned by BMW to identify each individual car. When decoded, the VIN tells the country and year of manufacture; make, model and serial number; assembly plant and some equipment specifications.

The BMW VIN is on a plate mounted on top of the dashboard, on the driver's side where the number can be seen through the windshield. The 10th character is the model year code. The letters I, O, Q and U are not used for model year designation. Examples: X for 1999, Y for 2000, 1 for 2001, 2 for 2002, etc. The table below explains some of the codes in the VIN for 1997 through 2002 BMW E39 5 Series BMWs covered by this manual.

Sample VIN: **WBA DE63 20WB W61389**  
 position 1 2 3 4 5 6 7 8 9 10 11 12-17

VIN position	Description	Decoding information	
1 - 3	Country of manufacture	WBA WBS	BMW, AG. Munich, Germany BMW Motorsport, GmbH, Munich, Germany
4	Line	D	525i (2001 - 2003) 528i (2000-2003), 530i, 540i
5	Series	D E J M N P R T	525i (2001 - 2002), 528i (1997 - 2000) M5, 530i, 540i (1997 - 1998) 525i Wagon 528i (1999 - 2000) 540i Sedan (1999 - 2003) 540i wagon (2001) 528i wagon (1999 - 2000) 540i wagon (2002 - 2003) 525i sedan (2002 - 2003), 530i (2001 - 2003)
6	Body type / engine type	6,4 5,3	Automatic Manual
7	Vehicle type	3, 4, 7	Passenger vehicle
8	Restraint system	0 1 2 3 4	Manual belts Manual belts with dual airbags Manual belts with advanced airbags Manual belts with driver & passenger airbags Manual belts with advanced passenger & driver airbags
9	Check digit		0 - 9 or X, calculated by NHTSA
10	Model year	V W X Y 1 2 3	1997 1998 1999 2000 2001 2002 2003
11	Assembly plant	A, F, K B, C, D, G E, J, P	Munich, Germany Dingolfing, Germany Regensburg, Germany
12-17	Serial number		Sequential production number for specific vehicle





# 010 General

<b>General</b> .....	010-2	<b>Service</b> .....	010-13
<b>How to Use this Manual</b> .....	010-2	<b>Tools</b> .....	010-13
Warnings, cautions and notes .....	010-3	Basic tool requirements .....	010-14
<b>Getting Started</b> .....	010-5	Jack stands .....	010-16
Safety .....	010-5	Oil change equipment .....	010-16
Lifting the car .....	010-5	Torque wrench .....	010-17
Raising car .....	010-5	Digital multimeter .....	010-17
Working under car .....	010-6	BMW special tools .....	010-18
<b>Advice for the Beginner</b> .....	010-7	<b>Emergencies</b> .....	010-18
Planning ahead .....	010-7	Changing a tire .....	010-18
Workshop practices .....	010-7	Jump starting .....	010-19
Non-reusable fasteners .....	010-7	Indicator and warning lights .....	010-19
Tightening fasteners .....	010-8	Towing .....	010-20
Gaskets and seals .....	010-9	Spare parts kit .....	010-21
Electrical testing .....	010-10		
Wire repairs .....	010-10		
<b>Buying Parts</b> .....	010-11		
Genuine BMW parts .....	010-11		
Non-returnable parts .....	010-11		
Information you need to know .....	010-12		

## GENERAL

This section is intended to help the do-it-yourselfer get started. Tips on workshop practices, basic tools, and a quick reference guide to emergencies can be found here.

### **WARNING—**

- *Do not use this manual unless you are familiar with basic automotive repair procedures and safe workshop practices.*
- *This manual illustrates the workshop procedures required for most service work; it is not a substitute for full and up-to-date information from the vehicle manufacturer or for proper training as an automotive technician.*
- *Note that it is not possible to anticipate all of the ways or conditions under which vehicles may be serviced or to provide cautions as to all of the possible hazards that may result.*

## HOW TO USE THIS MANUAL

### **WARNING—**

*Your common sense and good judgement are crucial to safe and successful service work. Read procedures through before starting them. Think about whether the condition of your car, your level of mechanical skill, or your level of reading comprehension might result in or contribute in some way to an occurrence that might cause you injury, damage your car, or result in an unsafe repair. If you have doubts for these or other reasons about your ability to perform safe repair work on your car, have the work done at an authorized BMW dealer or other qualified shop.*

The manual is divided into ten sections:

- 0 GENERAL, MAINTENANCE
- 1 ENGINE
- 2 TRANSMISSION
- 3 SUSPENSION, STEERING AND BRAKES
- 4 BODY
- 5 BODY EQUIPMENT
- 6 ELECTRICAL SYSTEM
- 7 EQUIPMENT AND ACCESSORIES
- ELE ELECTRICAL WIRING DIAGRAMS
- OBD ON-BOARD DIAGNOSTICS

0 GENERAL, MAINTENANCE covers general vehicle information (**010 General**) as well as the recommended maintenance schedules and service procedures to perform BMW scheduled maintenance work (**020 Maintenance**).

The next seven sections (1 through 7) are repair based and organized by three digit repair groups. Most major sections begin with a GENERAL repair group, e.g. **100 Engine-General**. These "00" (double zero) groups contain descriptive theory of operation and system troubleshooting information. The remainder of the repair groups within a section contain the service and repair information. The last two sections contain detailed electrical wiring schematics and OBD II scan tool and diagnostic information.

## Warnings, cautions and notes

Throughout this manual are many passages with the headings WARNING, CAUTION, or NOTE. These very important headings have different meanings.

### **WARNING—**

*The text under this heading warns of unsafe practices that are very likely to cause injury, either by direct threat to the person(s) performing the work or by increased risk of accident or mechanical failure while driving.*

### **CAUTION—**

*A CAUTION calls attention to important precautions to be observed during the repair work that will help prevent accidentally damaging the car or its parts.*

### **NOTE—**

*A NOTE contains helpful information, tips that will help in doing a better job and completing it more easily.*

Please read every WARNING, CAUTION, AND NOTE in **001 General Warnings and Cautions** and as they appear in repair procedures. They are very important. Read them before you begin any maintenance or repair job.

**WARNING—**

- *Never run the engine in the work area unless it is well-ventilated. The exhaust should be vented to the outside. Carbon monoxide (CO) in exhaust kills.*
- *Remove all neckties, scarfs, loose clothing, or jewelry when working near a running engine or power tools. Tuck in shirts. Tie long hair and secure it under a cap. Severe injury can result from these things being caught in rotating parts.*
- *Remove rings, watches, and bracelets. Aside from the dangers of moving parts, metallic jewelry conducts electricity and may cause shorts, sparks, burns, or damage to the electrical system when accidentally contacting the battery or other electrical terminals.*
- *Disconnect the battery negative (-) cable whenever working on or near the fuel system or anything that is electrically powered. Accidental electrical contact may damage the electrical system or cause a fire.*
- *Fuel is highly flammable. When working around fuel, do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.*
- *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 the residual pressure to dissipate gradually. Take precautions to avoid spraying fuel.*
- *Illuminate the work area adequately and safely. Use a portable safety light for working inside or under the car. A fluorescent type light is best because it gives off less heat. If using a light with a normal incandescent bulb, use rough service bulbs to avoid breakage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.*
- *Keep sparks, lighted matches, and any open flame away from the top of the battery. Hydrogen gas emitted by the battery is highly flammable. Any nearby source of ignition may cause the battery to explode.*
- *Never lay tools or parts in the engine compartment or on top of the battery. They may fall into confined spaces and be difficult to retrieve, become caught in belts or other rotating parts when the engine is started, or cause electrical shorts and damage to the electrical system.*

## GETTING STARTED

Much of the necessary maintenance and minor repair that an automobile will need can be done with ordinary tools. Below you'll find important information on how to work safely, a discussion of what tools will be needed and how to use them.

### Safety

Although an automobile presents many hazards, common sense and good equipment can help ensure safety. Many accidents happen because of carelessness. Pay attention and stick to the safety rules in this manual.

### Lifting the car

- ◀ The proper jacking points should be used to raise the car safely and avoid damage. The jack supplied with the car can only be used at the four side points (arrows) just behind the front wheels or just in front of the rear wheels.



#### **WARNING—**

- *Never work under a lifted car unless it is solidly supported on jack stands that are intended for that purpose.*
- *When raising the car using a floor jack or hydraulic lift, carefully position the jack pad to prevent damaging the car body.*
- *Watch the jack closely. Make sure it stays stable and does not shift or tilt. As the car is raised, it may roll slightly and the jack may shift.*

### Raising car

- Park car on flat, level surface.
- If changing a tire, loosen lug bolts before raising car. See **Changing a tire.**
- ◀ Place jack into position. Make sure jack is resting on flat, solid surface. Use a board or other support to provide a firm surface for jack, if necessary.
- Raise car slowly while constantly checking position of jack and car.
- Once car is raised, block wheel that is opposite and farthest from jack to prevent car from unexpectedly rolling.



**WARNING—**

- Do not rely on the transmission or the parking brake to keep the car from rolling. They are not a substitute for positively blocking the opposite wheel.
- Never work under a car that is supported only by a jack. Use jack stands designed to support the car. See **Tools**.

**Working under car**

- Disconnect negative (-) cable from battery so that car cannot be started. Let others know what you will be doing.

**CAUTION—**

Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.

- Raise car slowly as described above.
- Use at least two jack stands to support car. Use jack stands designed for the purpose of supporting a car. See **Tools**.

**WARNING—**

- A jack is a temporary lifting device and should not be used alone to support the car while you are under it.
- Do not use wood, concrete blocks, or bricks to support a car. Wood may split. Blocks and bricks, while strong, are not designed for that kind of load, and may break or collapse.

- Place jack stands on firm, solid surface. If necessary, use a flat board or similar solid object to provide a firm footing.
- Lower car slowly until its weight is fully supported by jack stands. Watch to make sure that the jack stands do not tip or lean as the car settles on them.
- Observe all jacking precautions again when raising car to remove jack stands.

## ADVICE FOR THE BEGINNER

The tips that follow are general advice to help the do-it-yourself BMW owner perform repairs and maintenance tasks more easily and more professionally.

### Planning ahead

Know what the whole job requires before starting. Read the procedure thoroughly, from beginning to end, in order to know just what to expect and what parts will have to be replaced.

### Workshop practices

Keeping things organized, neat, and clean is essential to doing a good job. When working under the hood, fender covers will protect the finish from scratches and other damage. Make sure the car finish is clean so that dirt under the cover does not scratch the finish.

Any repair job will be less troublesome if the parts are clean. For cleaning old parts, there are many solvents and parts cleaners commercially available.

For cleaning parts prior to assembly, commercially available aerosol cans of parts cleaner or brake cleaner are handy to use, and the cleaner will evaporate completely.

#### **WARNING —**

*Most solvents used for cleaning parts are highly flammable as well as toxic, especially in aerosol form. Use with extreme care. Do not smoke. Do not use these products indoors or near any source of heat, sparks or flame.*

### Non reusable fasteners

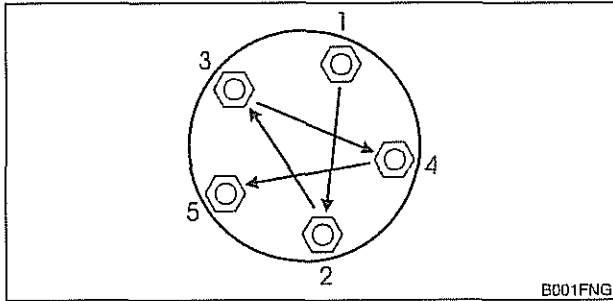
Many fasteners used on the cars covered by this manual must be replaced with new ones once they are removed. These include but are not limited to: bolts, nuts (self-locking, nylock, etc.), roll pins, clips and washers. Genuine BMW parts should be the only replacement parts used for this purpose.

Some bolts are designed to stretch during assembly and are permanently altered, rendering them unreliable once removed. These are known as torque-to-yield fasteners. Always replace fasteners where instructed to do so. Failure to replace these fasteners could cause personal injury or vehicle damage. See an authorized BMW dealer for applications and ordering information.

## Tightening fasteners

When tightening the bolts or nuts on a component, it is always good practice to tighten the bolts gradually and evenly to avoid misalignment or over-stressing any one portion of the component. For components sealed with gaskets, this method helps to ensure that the gasket will seal properly.

- ◀ Where there are several fasteners, tighten them in a sequence alternating between opposite sides of the component. Repeat the sequence until all the bolts are evenly tightened to the proper specification.



For some repairs a specific tightening sequence is necessary, or particular order of assembly is required. Such special conditions are noted in the text, and the necessary sequence is described or illustrated. Where no specific torque is listed, **Table a: General bolt tightening torques in Nm (max. permissible)** can be used as a general guide for tightening fasteners.

### WARNING —

**Table a: General bolt tightening torques in Nm (max. permissible)** is a general reference only. The values listed in the table are not intended to be used as a substitute for torques specifically called out in the text or in manufacturer's information.

### NOTE —

- Metric bolt classes or grades are marked on the bolt head.
- Do not confuse wrench size with bolt diameter. For a listing of the common wrenches used on various bolt diameters, see **Basic tool requirements**.



**Table a. General bolt tightening torques in Nm  
(max. permissible)**

Bolt Class (according to DIN 267)						
Bolt diameter	5.6	5.8	6.8	8.8	10.9	12.9
M5	2.5	3.5	4.5	6	8	10
M6	4.5	6	7.5	10	14	17
M8	11	15	18	24	34	40
M10	23	30	36	47	66	79
M12	39	52	62	82	115	140
M14	62	82	98	130	180	220
M16	94	126	150	200	280	340
M18	130	174	210	280	390	470

## Gaskets and seals

Gaskets are designed to crush and become thinner as the mating parts are bolted together. Once a gasket has been used, it is no longer capable of making as good a seal as when new, and is much more likely to leak. For this reason, gaskets should not be reused.

Some gaskets and seals are directional. Make sure that these are installed correctly. In places where a shaft must pass through a housing, flexible lip seals are used to keep the lubricating oil or grease from leaking out past the rotating shaft. Seals should never be reused once they have been removed. When removing a seal, be careful not to damage the metal surfaces.

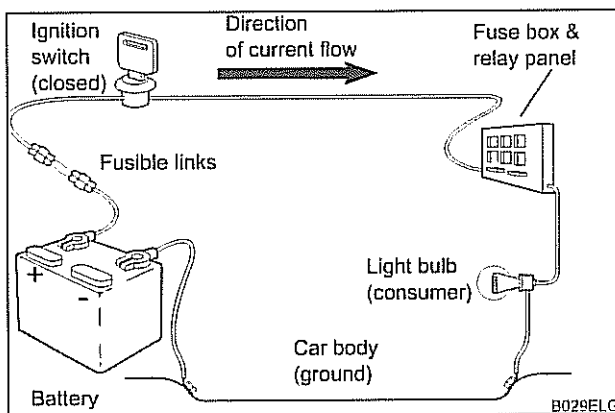
The key to seal installation is to get the seal in straight without damaging it. Use a seal driver that is the same diameter as the seal housing to gently and evenly install into place. If a proper size seal driver is not available, a socket of the right size will do.

Some seals are directional and special installation instructions apply. Make sure a seal is installed with the lip facing the correct way. Note the installation direction of the old seal before removing it.

## Electrical testing

Many electrical problems can be understood and solved with only a little fundamental knowledge of how electrical circuits function.

Electrical current only flows in a complete circuit. To operate, every electrical device in the car requires a complete circuit including a voltage source and a path to ground. The positive (+) side of the battery is the original voltage source, and ground is any return path to the negative (-) side of the battery, whether through the wiring harness or the car body. Except for portions of the charging system, all electrical current in the car is direct current (DC) and flows from positive (+) to negative (-).



Switches are used to turn components on or off by completing or interrupting the circuit. A switch is "open" when the circuit is interrupted, and "closed" when the circuit is completed. See **600 Electrical System—General** for electrical troubleshooting.

## Wire repairs

Repairs to a wiring harness require special care to make the repair permanent. The wire ends must be clean. If frayed or otherwise damaged, cut off the end and remove enough insulation to complete the repair. If the wire is too short, splice in a new piece of wire of the same size and make two connections.

Use connectors that are designed for the purpose. Crimped on or soldered-on connectors are best. Crimp connectors and special crimping pliers are widely available. If soldering, use needle nose pliers to hold the wire near the solder joint and create a "heat dam". This keeps the heat and the solder from traveling up the wire. Always use a solder made specifically for electrical work (rosin core).

### NOTE —

*Twisting wires together to make a repair is not recommended. Corrosion and vibration will eventually spoil the connection and may lead to irreparable damage to sensitive electronic components.*

Insulate the finished connection. Electronics stores can supply heat-shrinkable insulating tubing that can be placed on to the wire before connecting, slid over the finished joint, and shrunk to a tight fit with a heat gun or hair dryer. The next best alternative is electrical tape. Make sure the wire is clean and free of solder flux or other contamination. Wrap the joint tightly to seal out moisture. See **600 Electrical System—General** for more information.

## BUYING PARTS

Many of the maintenance and repair tasks in this manual call for the installation of new parts, or the use of new gaskets and other materials when reinstalling parts. Most often, the parts that will be needed should be on hand before beginning the job. Read the introductory text and the complete procedure to determine which parts will be needed.

### **NOTE—**

*For some bigger jobs, partial disassembly and inspection is required to determine a complete parts list. Read the procedure carefully and, if necessary, make other arrangements to get the necessary parts while your car is disassembled.*

### **Genuine BMW parts**

Genuine BMW replacement parts from an authorized BMW dealer are designed and manufactured to the same high standards as the original parts. They will be the correct material, manufactured to same specifications, and guaranteed to fit and work as intended. Most genuine BMW parts carry a limited warranty.

Many independent repair shops make a point of using genuine BMW parts, even though they may at times be more expensive than parts from other sources. They know the value of doing the job right with the right parts. Parts from other sources can be as good as BMW parts, particularly if manufactured by one of BMW's original equipment suppliers, but it is often difficult to know.

BMW is constantly updating and improving their cars, often making improvements during a given model year. BMW may recommend a newer, improved part as a replacement, and your authorized dealer's parts department will know about it and provide it. The BMW parts organization is best equipped to deal with your BMW parts needs.

### **Non returnable parts**

Some parts cannot be returned, even for credit. The best example is electrical parts, which are almost universally considered non returnable. Buy electrical parts carefully, and be as sure as possible that a replacement is needed, especially for expensive parts such as electronic control units. It may be wise to let an authorized BMW dealer or other qualified shop confirm your diagnosis before replacing an expensive non returnable part.

## Information you need to know

### Model

When ordering parts it is important that you know the correct model designation for your car. Models covered in this E39 manual are the 525i, 528i, 530i, 540i in Sedan and Station Wagon body styles.

### Model year

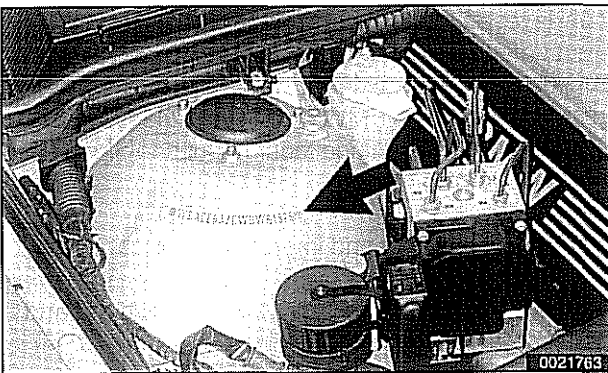
This is not necessarily the same as date of manufacture or date of sale. A 1999 model may have been manufactured in late 1998, and perhaps not sold until early 2000. It is still a 1999 model. Model years covered by this manual are 1997 to 2002.

### Date of manufacture

This information is necessary when ordering replacement parts or determining if any of the warranty recalls are applicable to your car. The label on the driver's door below the door latch will specify the month and year that the car was built.

### Vehicle Identification Number (VIN)

- This is a combination of letters and numbers that identify the particular car. The VIN appears on the state registration document, and on the car itself. One location is on the right front strut tower in the engine compartment (**arrow**), another in the lower left corner of the windshield.



### Engine code

5 Series car covered in this manual are powered by 6 and 8 cylinder engines. For information on engine codes and engine applications, see **100 Engine-General**.

### Transmission code

The transmission type with its identifying code may be important when buying clutch parts, seals, gaskets, and other transmission-related parts. For information on transmission codes and applications, see **200 Transmission-General**.

## SERVICE

BMW dealers are uniquely qualified to provide service for BMW cars. Their authorized relationship with the large BMW service organization means that they have access to special tools and equipment, together with the latest and most accurate repair information.

The BMW dealer's service technicians are highly trained and very capable. Authorized BMW dealers are committed to supporting the BMW product. On the other hand, there are many independent shops that provide quality repair work. Checking with other BMW owners for recommendations on service facilities is good way to learn of reputable BMW shops in your area.

## TOOLS

Most maintenance can be accomplished with a small selection of tools. Tools range in quality from inexpensive junk, which may break at first use, to very expensive and well-made tools for the professional. The best tools for most do-it-yourself BMW owners lie somewhere in between.

Many reputable tool manufacturers offer good quality, moderately priced tools with a lifetime guarantee. These are your best buy. They cost a little more, but they are good quality tools that will do what is expected of them. Sears' Craftsman® line is one such source of good quality tools.

Some of the repairs covered in this manual require the use of special tools, such as a custom puller or specialized electrical test equipment. These special tools are called out in the text and can be purchased through an authorized BMW dealer. As an alternative, some special tools mentioned may be purchased from the following tool manufacturers and/or distributors:

### Specialty tool suppliers

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Assenmacher Specialty Tools  
6440 Odell Place  
Boulder, CO 80301  
303-530-2424  
sales@asttool.com  
<http://www.asttool.com>

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Baum Tools Unlimited, Inc.  
P.O. Box 5867  
Sarasota, FL 34277-5867  
800-848-6657  
sales@baumtools.com  
<http://www.baumtools.com>

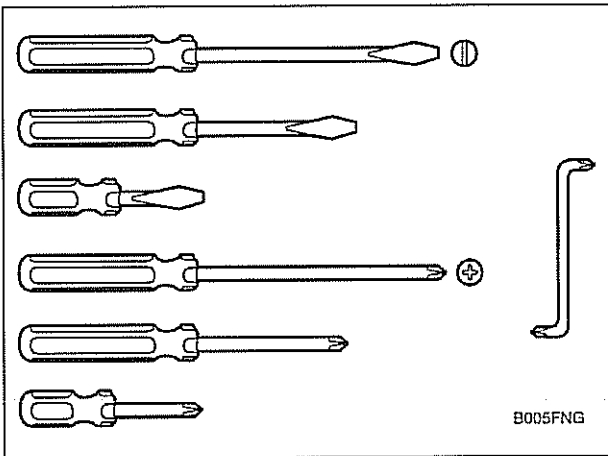
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**Specialty tool suppliers**

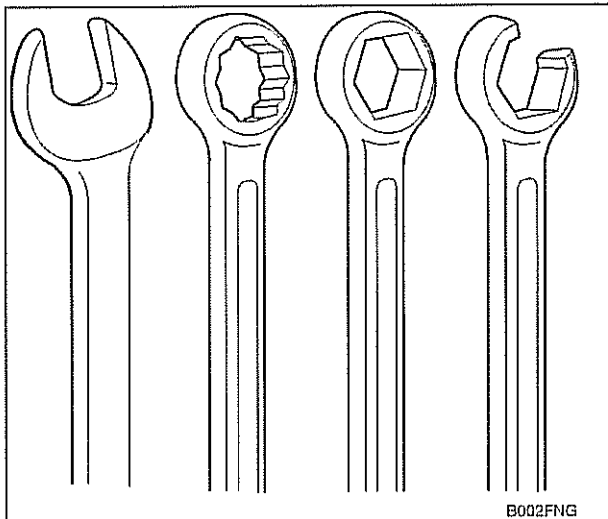
Peake Research, Automotive Products Division  
 P.O. Box 28776  
 San Jose, CA 95159  
 408-369-0406  
 support@peakeresearch.com  
 http://www.peakeresearch.com

**Basic tool requirements**

The basic hand tools described below can be used to accomplish most of the simple maintenance and repair tasks.

**Screwdrivers**

- ◀ The common flat-blade type, Phillips type, and Torx® type screwdrivers will handle almost all screws used on BMWs. Two or three different sizes of each type will be required, since a screwdriver of the wrong size will damage the screw head.

**Wrenches**

- ◀ Wrenches come in different styles, including open-end, 12 point box-end, 6 point box-end and flare nut. The basic open-end wrench is the most widely used, but grips on only two sides. The box-end wrench has better grip on all six sides of a nut or bolt.

A 12 point box-end can loosen a nut or bolt where there is less room for movement, while a 6 point box-end provides better grip. For hex fasteners on fluid lines, like brake lines and fuel lines, a flare-nut wrench offers the advantages of a box-end wrench with a slot that allows it to fit over the line.

The combination wrench is the most universal. It has one open-end and one box-end. 10 mm and 13 mm wrenches are the most common sizes needed. A more complete set of wrenches would include 6 mm through 19 mm sizes.

## Sockets

Sockets are used with a ratchet handle for speed and convenience and can be combined with extensions and universal joints (swivels) to reach fasteners more easily. The most common socket drive sizes are 1/4 inch, 3/8 inch and 1/2 inch.

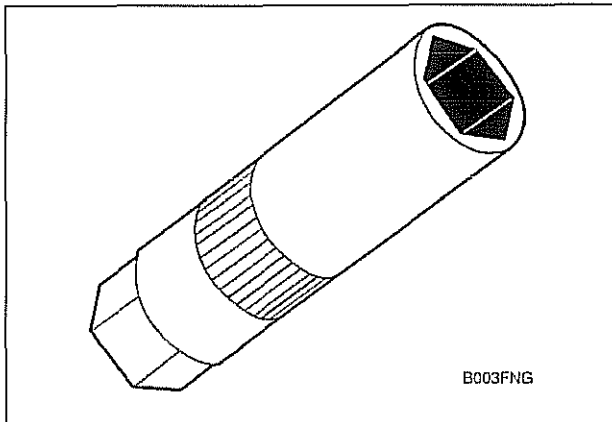
Sockets come in 6 point and 12 point styles. The 6 point offers a better grip on tight nuts and bolts. 6 mm to 19 mm sockets are the most needed sizes. Below is a list of typical bolt diameters and the corresponding wrench sizes.

### Common bolt diameters and wrench sizes

M5	8 mm
M6	10 mm
M8	12 mm or 13 mm
M10	17 mm
M12	19 mm
M14	22 mm

### Spark plug socket

- ▶ A 5/8" deep-well socket for spark plugs includes a rubber insert to both protect the spark plug from damage and grip it for easier removal.

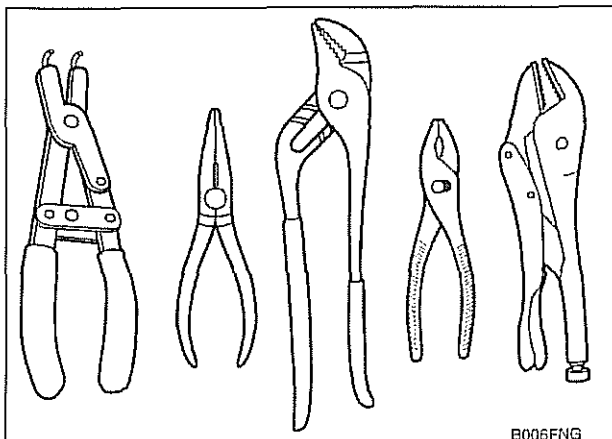


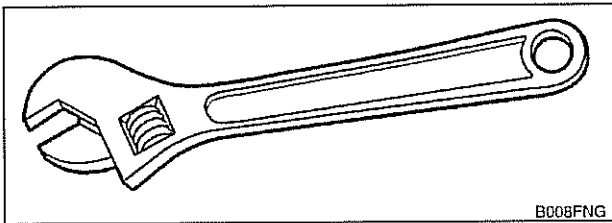
### Pliers

- ▶ There are many types of pliers including snap-ring, needle-nose, adjustable-joint, slip-joint (Channel-lock®), and locking (Vise-Grip®) most of which are used for holding irregular objects, bending, or crimping. Some have special applications.

Needlenose pliers are used for gripping small and poorly accessible objects, and are useful for wiring and other electrical work. Locking pliers such as the Vise-Grip® are useful because of their tight grip.

Snap-ring and circlip pliers with special tipped jaws are used to remove and install snap-rings or circlips. Channel-lock® or water pump pliers have adjustable jaws that can be quickly changed to match the size of the object being held to give greater leverage.

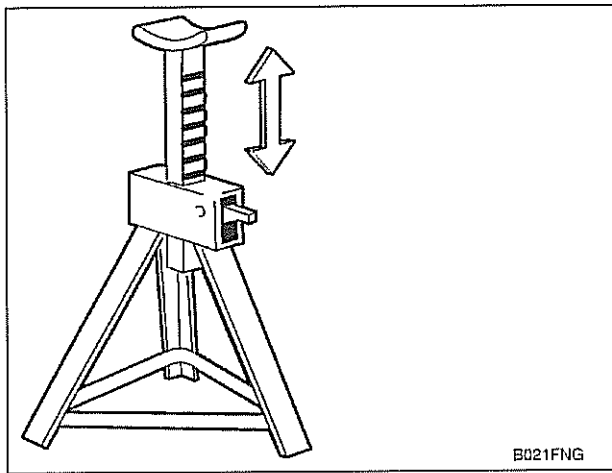




- ◀ An adjustable wrench can be a useful addition to a small tool kit. It can substitute in a pinch if two wrenches of the same size are needed to remove a nut and bolt. Use extra care with adjustable wrenches, as they tend to loosen, slip, and damage fasteners.

Compared to a wrench of the correct size, an adjustable wrench is always second best. They should only be used when the correct size wrench is not available. Choose one of average size range, about 6 to 8 inches in length.

### Jack stands



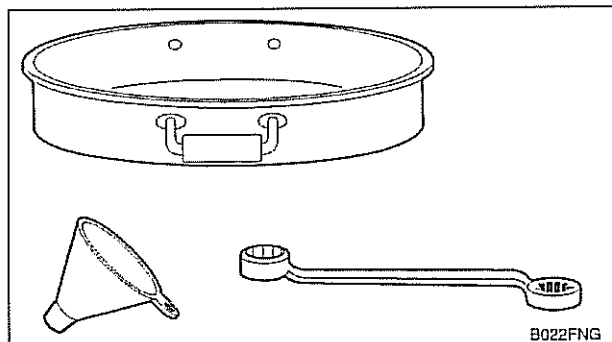
- ◀ Strong jack stands are extremely important for any work that is done under the car. Use only jack stands that are designed for the purpose. Blocks of wood, concrete, bricks, etc. are not safe or suitable substitutes.

#### **WARNING—**

*A jack should be used only to raise the vehicle, not to support the car for a long period. Always use jack stands to support a raised vehicle.*

Jack stands are available in several styles. The best ones are made of heavy material for strength, have a wide base for stability, and are equipped to positively lock in their raised position. Get the best ones available.

### Oil change equipment



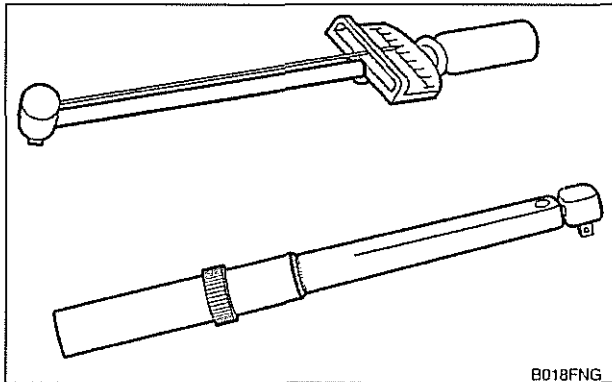
- ◀ Changing engine oil requires a 17 mm socket or wrench to loosen and tighten the drain plug and a drain pan (at least 8 quart capacity). A wide, low drain pan will fit more easily under the car. Use a funnel to pour the new oil into the engine.

BMW engines use an oil filter canister with a disposable filter cartridge insert. A 36 mm socket or wrench is required to remove the oil filter canister cover. See **020 Maintenance** for oil change instructions.



## Torque wrench

A torque wrench is used to precisely tighten threaded fasteners to a predetermined value. Many of the repair procedures in this manual include BMW-specified torque values in Newton-meters (Nm) and the equivalent values in foot-pounds (ft-lb).



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- Several types of torque wrenches are available. An inexpensive beam-type (top) is adequate but must be read visually. A ratchet-type (bottom) can be preset to indicate (click) when the torque value has been reached. They all do the same job, but offer different convenience features at different prices. The most convenient ones have a built-in ratchet, and can be preset to indicate when a specific torque value has been reached. Follow the wrench manufacturer's directions for use to achieve the greatest accuracy.

A torque wrench with a range up to about 150 Nm (110 ft-lb) has adequate capacity for most of the repairs covered in this manual. For recommended torque values of 10 Nm or below, the English system equivalent is given in inch-pounds (in-lb). These small values may be most easily reached using a torque wrench calibrated in inch-pounds. To convert inch-pounds to foot-pounds, divide by 12.

## Digital multimeter

- Many of the electrical tests in this manual call for the measurement of resistance (ohms) or voltage values. For safe and accurate tests of sensitive electronic component and systems, a multimeter or digital volt/ohm meter (DVOM) with high input impedance (at least 10,000 $\Omega$ ) should be used. Some meters have automotive functions such as dwell and pulse width that are useful for troubleshooting ignition and fuel injection problems.

### CAUTION—

Vehicle electronic systems may be damaged by the high current draw of a test light with a normal incandescent bulb. As a general rule, use a high impedance digital multimeter or an LED test light for all electrical testing.



001223

## BMW special tools

Many repairs covered in this manual call for the use of BMW special tools. Many of the BMW special tools mentioned in this manual are simply the best thing to use to do the job correctly. In these cases, the tool is identified with a BMW part number. See your authorized BMW dealer parts department for information on how to order special tools.

There are some jobs for which expensive special tools are essential, and not a cost-effective purchase for a one time repair by the do-it-yourself owner. This manual includes such repairs for the benefit of those with the necessary experience and access to tools. For the do-it-yourselfer, the need for special tools is noted in the text, and whether or not BMW dealer service is recommended.

## EMERGENCIES

### Changing a tire

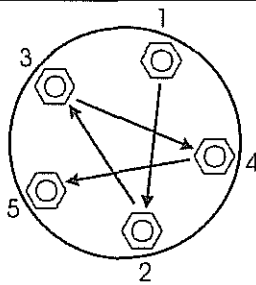
- Stop car on as flat a surface as possible, in a place where you can be easily seen by other drivers. Avoid stopping just over the crest of a hill.

#### **WARNING—**

*If a tire goes flat while driving, pull well off the road. Changing a tire on a busy street or highway is very dangerous. If necessary, drive a short distance on the flat tire to get to a safe place. It is much better to ruin a tire or rim than to risk being hit.*

- Turn on emergency flashers, and set out flares or emergency markers well behind car. Chock wheel (wheel chock located in trunk) diagonally opposite to the one being changed. Passengers should get out of car and stand well away from road.
- Take jack and tools from tool area beneath trunk mat. Remove spare tire from tire storage tray.
- Loosen wheel bolts while car is on ground, but leave them a little snug.
- Place jack in lifting point nearest wheel being changed. Use a board to provide a firm footing for jack if ground is soft. Raise car only far enough so that the wheel is fully off ground and then remove wheel nuts and wheel.
- Install spare wheel. Install wheel nuts and tighten them hand tight using lug nut wrench.





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- ⚠ Lower car. With all wheels on ground, fully tighten nuts in a crisscross pattern. Torque wheel nuts when installing wheel. Check inflation pressure of spare tire.

#### Tightening torque

Wheel to wheel hub	120 Nm (89 ft-lb)
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## Jump starting

Cars with discharged or dead batteries can be jump-started using the good battery from another car. See owner's manual for proper instruction on jump starting. When jump-starting the engine, always note the following warnings.

#### **WARNING —**

- *Battery acid (electrolyte) can cause severe burns, and will damage the car, clothing, and you. If electrolyte is spilled, wash the surface with large quantities of water. If it gets into eyes, flush them with water for several minutes and call a doctor.*
- *Batteries produce explosive and noxious gasses. Keeps sparks and flames away. Do not smoke near batteries.*
- *Do not jump-start the engine if you suspect that the battery is frozen. Trapped gas may explode. Allow the battery to thaw first.*
- *Do not quick-charge the battery (for boost starting) for longer than one minute, and do not exceed 16.5 volts at the battery with the boosting cables attached. Wait at least one minute before boosting the battery a second time.*

## Indicator and warning lights

Many vehicle systems are self-monitored for faults while driving. Generally, a red warning lamp that comes on during driving should be considered serious. If you cannot immediately determine the seriousness of the warning light, stop the vehicle in a safe place and turn the engine off as soon as possible. Consult the owner's manual for additional information on the warning lamp and the recommended action.

If the Malfunction Indicator Lamp (MIL) (Check Engine or Service Engine Soon warning light) comes on or flashes, it indicates that an emissions-related fault has occurred. Faults such as a bad oxygen sensor or a dead fuel injector can cause the exhaust or evaporative emissions to exceed a specified limit. When these limits are exceeded, the MIL will be turned on. The engine can be safely driven with the light on, although the emission systems should be checked as soon as possible. See **OBD On-Board Diagnostics** for

more information on the Check Engine Light and the on-board diagnostic system.

## Towing

The cars covered by this manual should be towed with a tow truck using wheel lift or flat bed equipment. Do not tow the car on all four wheels except for very short distances to move it to a safe place.

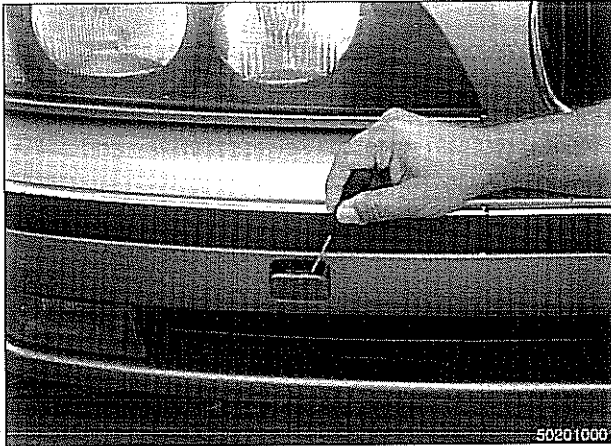
### CAUTION—

*Do not tow with sling-type equipment. The front spoilers and bumper covers may sustain damage.*

- To access threaded towing eye socket, pry open trim on front or rear bumper.

### NOTE—

*A towing eye is provided in the luggage compartment tool kit. The towing eye can be screwed into the front or rear bumper.*



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- Install towing eye into threaded hole.

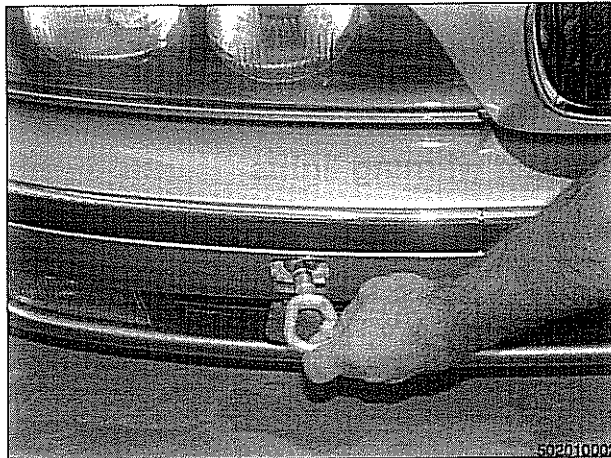
- Standard transmission: Do not tow with rear wheels on ground unless absolutely necessary.
- Automatic transmission: Have rear wheels placed on dollies, or use flat bed truck. Use towing eye for winching vehicle on flat bed.

### CAUTION—

*Automatic transmission fluid (ATF) does not circulate when the car is towed. Severe transmission damage may result.*

### NOTE—

- Be sure transmission fluid has been topped off before starting tow.
- Always tow car with transmission lever in N (neutral).
- ATF draining and filling is covered in **240 Automatic Transmission**. Be sure to read the filling and draining procedure, as special service equipment is required to check the fluid level.



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## Spare parts kit

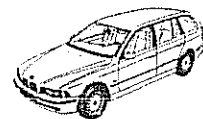
Carrying a basic set of spare parts can prevent a minor breakdown from turning into a major repair annoyance. The list below is a good place to start.

### Spare parts kit - basic

- Polyribbed drive belt(s)
- BMW engine oil: one or two quarts
- BMW engine coolant: 1 gallon of premixed 50/50 BMW anti-freeze and water
- Fuse assortment: 7.5A, 10A, 15A, 20A, 30A, 50A
- Radiator hoses: upper and lower

### Spare parts kit - additional contents

- Exterior lighting bulbs: headlight, brake light, turn signal, and taillight
- Wiper blades or blade inserts
- Brake fluid: new, unopened bottle, DOT 4 specification
- Main relay for DME system





# 020 Maintenance

<b>General</b> . . . . .	020-2	Parking brake, checking . . . . .	020-25
Special tools . . . . .	020-2	Clutch fluid, checking . . . . .	020-26
Service Interval Indicator (SII) . . . . .	020-3	Differential oil level, checking . . . . .	020-26
Service Interval Indicator (SII), resetting . . . . .	020-3	Drive axle joint (CV joint) boots, inspecting . . . . .	020-27
Inspection I, Inspection II . . . . .	020-5	Exhaust system, inspecting . . . . .	020-27
<b>Maintenance Tables</b> . . . . .	020-6	Fuel filter, replacing . . . . .	020-27
<b>Fluid and Lubricant Specifications</b> . . . . .	020-9	Fuel tank and fuel lines, inspecting . . . . .	020-28
Fluids and lubricants . . . . .	020-10	Suspension, front, inspecting . . . . .	020-29
<b>Engine Oil Service</b> . . . . .	020-11	Suspension, rear, inspecting . . . . .	020-29
Engine oil, checking level . . . . .	020-12	Tires, checking inflation pressure . . . . .	020-29
Engine oil and filter, changing . . . . .	020-13	Tires, rotating . . . . .	020-29
<b>Engine Compartment Maintenance</b> . . . . .	020-14	Transmission service, automatic . . . . .	020-29
Accelerator and linkage . . . . .	020-14	Transmission service, manual . . . . .	020-30
Air filter, replacing . . . . .	020-14	Transmission fluid, checking and filling (manual transmission) . . . . .	020-30
Cooling system service . . . . .	020-15	Wheels, aligning . . . . .	020-30
Engine drive belt service . . . . .	020-16	<b>Body and Interior Maintenance</b> . . . . .	020-31
Idle speed . . . . .	020-19	Body and hinges, lubricating . . . . .	020-31
Catalytic converter and oxygen sensors . . . . .	020-19	Exterior washing . . . . .	020-31
Power steering fluid, checking level . . . . .	020-20	Interior care . . . . .	020-31
Spark plugs . . . . .	020-20	Leather upholstery and trim . . . . .	020-31
Spark plugs, replacing . . . . .	020-21	Polishing . . . . .	020-32
Interior ventilation microfilter, replacing . . . . .	020-22	Seat belts . . . . .	020-32
<b>Other Mechanical Maintenance</b> . . . . .	020-22	Special cleaning . . . . .	020-32
Battery, checking, cleaning, and replacing . . . . .	020-22	Washing chassis . . . . .	020-32
Brake fluid, replacing . . . . .	020-24	Waxing . . . . .	020-32
Brake pad / rotor wear, checking . . . . .	020-24	Windshield wiper blade maintenance . . . . .	020-33
Brake system, inspecting . . . . .	020-25		

## GENERAL

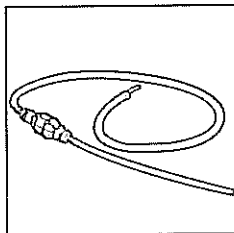
The information given in this repair group includes the routine checks and maintenance steps that are both required by BMW under the terms of the vehicle warranty protection and recommended by BMW to ensure long and reliable vehicle operation.

### NOTE—

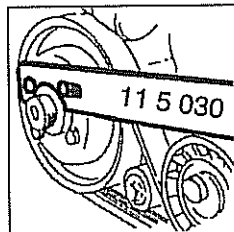
*Aside from keeping your car in the best possible condition, proper maintenance plays a role in maintaining full protection under BMW's new car warranty coverage. If in doubt about the terms and conditions of your car's warranty, an authorized BMW dealer should be able to explain them to you.*

## Special tools

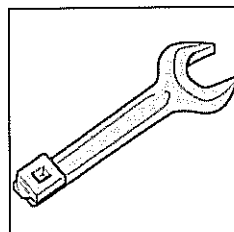
Some special tools are required for performing engine maintenance tasks. Be sure to have the necessary equipment on hand before starting any job.



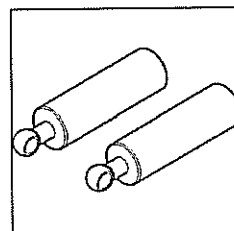
- ◀ Hand pump for manual transmission lifetime oil  
(Tool No. BMW 002 080)



- ◀ Cooling fan counterhold wrench  
(Tool No. BMW 11 5 030)



- ◀ Cooling fan wrench  
(Tool No. BMW 11 5 040)



- ◀ Service position hood props  
(Tool No. BMW 51 2 160)

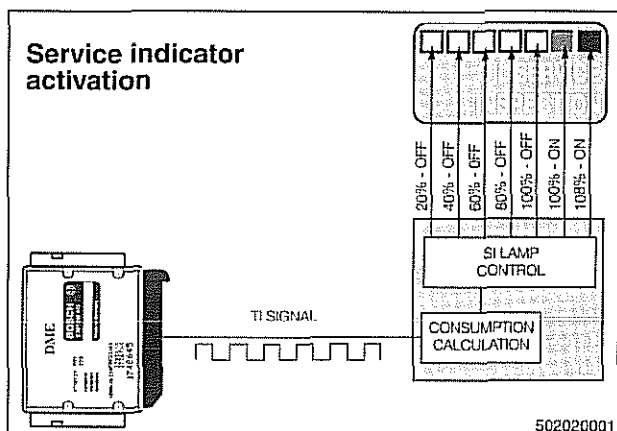


## Service Interval Indicator (SII)

The BMW Service Interval Indicator (SII) notifies the driver when oil change and other service is required. The SII displays the phrase "OIL SERVICE" or "INSPECTION" and 7 light emitting diodes (LEDs) in the instrument cluster: 5 green, one yellow and one red.

For the 1997 and later 5 Series, BMW introduced an oil change interval based on fuel consumption. The advantages of this system are:

- Fuel consumption is an accurate method of determining engine load and the need for service.
- The processing electronics are simple.
- Resetting of indicator before the scheduled time will not affect the time to the next service.



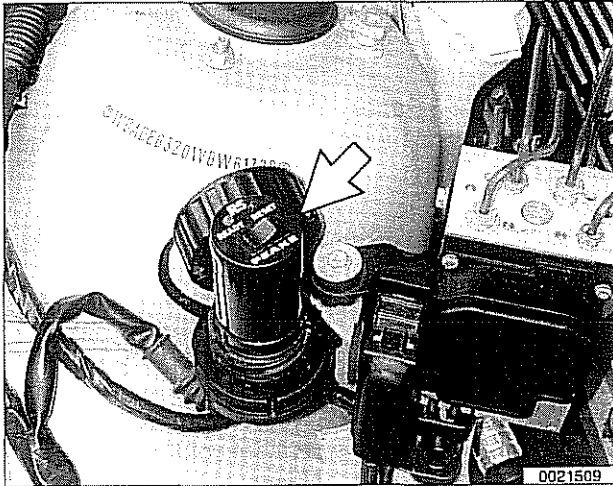
◀ The SII is programmed to measure a set volume of consumed fuel. This volume varies between models, dependent on vehicle and engine size. The SII control unit receives a signal from the engine control module (ECM) when the vehicle is in use. As 20% of the programmed fuel volume is consumed, one of the green LEDs will go out. Each successive 20% of fuel consumption will cause the next LED to go out until 100% of the measured volume has been consumed. At this point the yellow LED will come on, indicating that service is due. When 108% of the measured volume has been consumed, the red LED will illuminate, indicating that service is overdue.

## Service Interval Indicator (SII), resetting

After the specified maintenance has been carried out, the SII memory should be reset.

### NOTE—

For reference, the BMW oil service requirements are approximately equivalent to the maintenance that other European manufacturers specify at intervals with a maximum of every 15,000 miles or 12 months.



### 1997 to 2000 models

1997 to 2000 models are equipped with a data link connector (DLC) plug in the right side engine compartment:

- ◀ Reset SII using BMW service and scan tool (DISPlus or MoD-iC, GT1) or a specialty tool from another manufacturer. Plug tool (arrow) into DLC.

#### **CAUTION—**

*Follow the manufacturer's directions when resetting the SII. If the reset procedures are done incorrectly, the tool or the electronic Service Interval Indicator may be damaged.*

Aftermarket reset tools that can reset all models with the DLC can be purchased from one of the following suppliers:

#### **Specialty tool suppliers**

Assenmacher Specialty Tools  
6440 Odell Place  
Boulder, CO 80301  
303-530-2424  
sales@asttool.com  
<http://www.asttool.com>

Baum Tools Unlimited, Inc.  
P.O. Box 5867  
Sarasota, FL 34277-5867  
800-848-6657  
sales@baumtools.com  
<http://www.baumtools.com>

Peake Research, Automotive Products Division  
P.O. Box 28776  
San Jose, CA 95159  
408-369-0406  
support@peakeresearch.com  
<http://www.peakeresearch.com>

### 2001 and later models

On vehicles without the data link connector (DLC) in the engine compartment (2001 and later cars), the reset tool can not be used. Instead, the SII can be reset with the trip odometer reset button in the instrument cluster.

- Make sure ignition key is in OFF position.
- Press and hold trip odometer button in instrument cluster, and turn ignition key to ACCESSORY position.
- Keep button pressed for approximately 5 seconds until either of following appear in display: OIL SERVICE or INSPECTION, with RESET.
- Press button again and hold for approximately 5 seconds until RESET flashes.

- Service due is shown with RESET if the measured consumption limit has been reached and resetting is possible. If RESET is not shown, the minimum limit has not been reached and resetting is not possible.
- While display is flashing, press button briefly to reset SII.
- After display has shown new interval, the following will appear in display for approximately 2 seconds: END SIA.

**NOTE—**

- *The system can only be reset again after the vehicle has been driven approximately 50 to 75 miles (consumes at least 2.5 gallons of fuel). If the display shows RESET when resetting, the minimum driving distance has been fulfilled and the system can be reset again.*
- *It is possible to interrupt and end the reset procedure by changing the position of the ignition key.*

## Inspection I, Inspection II

The Service Interval Indicator (SII) signals the need for maintenance and inspection. There are two sets of inspection requirements, alternating throughout a car's maintenance history. If the last inspection interval was Inspection I, the next inspection interval (following an oil service) will be Inspection II, the next after that will be Inspection I, and so on.

Inspection I tasks are listed in **Table b. Inspection I Service**. Inspection II includes most of the tasks from Inspection I with additional Inspection II tasks. A complete listing of Inspection II tasks is in **Table c. Inspection II Service**.

**NOTE—**

*For reference, the BMW Inspection I and Inspection II requirements are approximately equivalent to the maintenance requirements that other European manufacturers specify. Inspection I is normally due at intervals with a maximum of 30,000 miles or 24 months. Inspection II is normally due at intervals with a maximum of 60,000 miles or 48 months.*

## MAINTENANCE TABLES

The intervals for most tasks listed in the maintenance tables below are determined by the SII.

### NOTE—

*BMW is constantly upgrading recommended maintenance procedures and requirements. The information contained here is as accurate as possible at the time of publication. If there is any doubt about what procedures apply to a specific model or year, or what intervals should be followed, remember that an authorized BMW dealer has the latest information on factory-recommended maintenance.*

Except where noted, the maintenance items listed apply to all models and model years covered by this manual. The number in the "additional repair information" column refers to the repair group in this manual where additional information can be found.

**Table a. Oil Service**

	Tools Required	New parts required	Warm engine required	Dealer service recommended	Additional repair information
<b>Engine compartment maintenance</b>					
Change oil and oil filter	*	*	*		020
Reset Service Interval Indicator (SII)	*				020
Replace interior ventilation microfilter		*			020
<b>Under car maintenance</b>					
Check overall thickness of front and rear brake pads. If replacement is necessary: Examine brake disc surface. Clean brake pad contact points in calipers. Grease wheel centering hubs. Check thickness of parking brake linings only when replacing rear brake pads. Check operation of parking brake and adjust as necessary.	*				340
Check and adjust tire pressures, including spare	*				020

**Table b. Inspection I Service**

	Tools Required	New parts required	Warm engine required	Dealer service recommended	Additional repair information
<b>Undercar maintenance</b>					
Change oil and oil filter.	*	*	*		020
Check engine drive belt condition					020

Table b. Inspection I Service (continued)

	Tools Required	New parts required	Warm engine required	Dealer service recommended	Additional repair information
Check transmission and differential for external leaks.	*				230/240
Check CV joint boots for damage or leaks.					331
Visually check fuel tank, fuel lines, and connections for leaks.					160
Check condition, position, and mounting of exhaust system. Visually check and adjust if necessary.					180
Check power steering system for leaks. Check power steering fluid level and adjust if necessary.					320
Check steering rack/box and tie rods for tightness. Check condition of front axle joints, steering linkage, and steering shaft joints.	*				320
Check overall thickness of front and rear brake pads using BMW special tool. If replacement is necessary: Examine brake disc surface. Clean brake pad contact points in calipers. Grease wheel centering hubs. Check thickness of parking brake linings only when replacing rear brake shoes. Check operation of parking brake and adjust as necessary.	*				340
Check front control arm bushings for damage or wear.					310
Check brake system connections and lines for leaks, damage, and incorrect positioning					340
Check parking brake actuator. Adjust if necessary	*				340
Check all tire pressure (including spare) and correct if necessary. Check condition of tires (outer tread surface), tread wear pattern; in case of uneven wear, perform wheel alignment.	*				020
Inspect entire body according to terms of rust perforation limited warranty. (Must be performed at least every two years).					
Read out on-board diagnostic (OBD II) fault codes.	*				100 / 130 / OBD
Check engine coolant system / heater hose connections for leaks. Check coolant level and antifreeze protection level. Add coolant as necessary.					170

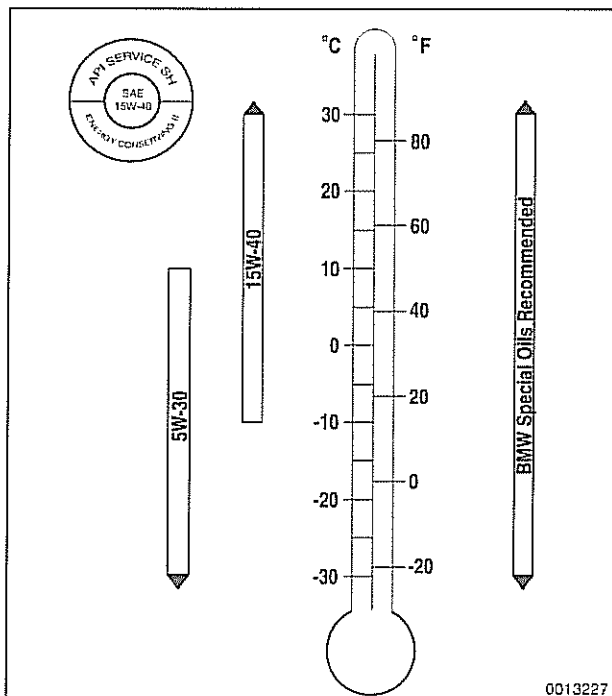
<b>Maintenance</b>
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Table b. Inspection I Service (continued)

	Tools Required	New parts required	Warm engine required	Dealer service recommended	Additional repair information
Check windshield washer fluid level and antifreeze protection. Add washer fluid as necessary.					611
Replace ventilation microfilter. (Note: reduce replacement intervals in dusty operation conditions)		*			020
Reset Service Interval Indicator (SII).	*				020
<b>Body/electrical</b>					
Check battery state of charge	*				121
Check operation of: headlights, parking lights, back-up lights, license plate lights, interior lights, glove box illumination, engine compartment light, trunk light, turn signals, emergency flashers, stop lights.					630
Check operation of horn and headlight dimmer switch					630
Check wipers and windshield washer system Check aim of washer jets and adjust if necessary.					611
Check condition and function of seat belts.					720
Visually examine all airbag units for torn covers, obvious damage or attachment of decals, decorations or accessories.					721
Check central locking system and double lock.					515
Replace batteries for alarm remote control in all master keys.	*	*			515
Check operation and condition of all door, hood, and trunk latches.					410/515
Check air conditioner operation.					640
Check heater, air conditioner blower, and rear window defogger operation.					640
Check all warning/indicator lights, check control.					620
Check operation of rear view mirrors.					
<b>Road test</b>					
Check braking performance, steering, heating and air conditioner operation.					
Check manual transmission and clutch operation or automatic transmission operation.					

Table c. Inspection II Service

	Tools required	New parts required	Warm engine required	Dealer service recommended	Additional repair information
<b>Engine compartment maintenance</b>					
Replace air filter element. (Note: reduce replacement intervals in dusty operating conditions).		*			020
<b>Brake system maintenance</b>					
Replace brake fluid every 2 years (time interval begins from vehicle production date).	*	*		*	340
<b>Cooling system service</b>					
Replace coolant every 3 years (time interval begins from vehicle production date).	*	*			170
<b>Oxygen sensor service</b>					
Replace oxygen sensor every 160,000 km (100,000 miles).	*	*			180
<b>Spark plug service</b>					
Spark plugs: M52 / M62 engine: Replace every 60,000 km (48,000 miles). M52 TU / M54 / M62 TU engine: Replace every 160,000 km (100,000 miles).	*	*			020



## FLUID AND LUBRICANT SPECIFICATIONS

- Engine oil viscosity (SAE grade) vs. operating temperature range for the BMW engines covered in this manual.

Fluid and lubricant capacities and specifications are listed below. See **Fluids and lubricants**.

### **WARNING** —

*The use of fluids that do not meet BMW's specifications may impair performance and reliability, and may void warranty coverage.*

## Fluids and lubricants

Table d. Engine oil with filter change

Fluid	Approximate capacity	Specification
6-cylinder models	6.5 liters (6.9 US qt)	1997 – 1998 15W-40 mineral oil BMW part no. 07 510 017 868
V-8 models	7.5 liters (7.9 US qt)	1999 and later 5W-30 synthetic oil BMW part no. 07 51 0 017 866

Table e. Manual transmission oil

Fluid	Approximate capacity	Specification
Getrag S5D 250G	1.1 liters (1.2 US quarts)	BMW part no. 83 22 9 408 942 (MTF-LT-1)
ZF S5D 320Z	1.3 liters (1.4 US quarts)	
Getrag S6S 420G	1.9 liters (2.0 US quarts)	

Table f. Automatic transmission fluid (ATF)

Lifetime fluid (drain and refill)

(Additional fluid required when installing dry torque converter)

Transmission	Approximate capacity	Specification
A5S 310Z	Total volume: 7.8 liter (8.2 US qt) Oil change volume: 3.3 liter (3.5 US qt)	BMW 83 22 9 407 807 (Exxon LT 71141) or BMW 83 22 0 024 359 (Texaco ETL 8072B or Shell LA2634)
A5S 360R A5S 390R	Total volume: 9.0 liter (9.5 US qt) Oil change volume: 4.0 liter (4.2 US qt)	
A5S 440Z	Total volume: 9.7 liter (10.2 US qt) Oil change volume: 4.0 liter (4.2 US qt)	



**Table g. Differential oil**

(Lifetime fluid; no fluid change required)

Differential	Approximate capacity (initial fill)	Specification
G	1.6 liter (1.7 US qt)	BMW SAF-XO synthetic oil
188 Compact	1.0 liter (1.1 US qt)	
220 / 215 Compact	1.4 liter (1.5 US qt)	

**Table h. Engine Coolant**

Year, model	Approximate capacity	Specification
1997: 6-cylinder V-8	9.9 liter (10.5 US qt) 11.4 liter (12.0 US qt)	50% mixture of BMW phosphate / nitrite free antifreeze and water
1998 – 2002: 6-cylinder V-8	10.5 liter (11.1 US qt) 12.0 liter (12.7 US qt)	
1997 – 2002 with latent heater: V-8	13.5 liter	

**Table i. Brake fluid**

Brake system fluid	BMW high performance, DOT 4
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## ENGINE OIL SERVICE

With the introduction of synthetic oil and extended oil change intervals, a new oil filter with improved filter paper design was introduced. The new filter paper resists deterioration caused by high oil temperatures over an extended time.

Use BMW specified oil to top off the engine oil level between oil changes, BMW recommends the following engine oils:

**Table j. Engine Oil Specification**

Years	Oil description	BMW part no.
1997 – 1998	BMW HP 15W-40 mineral oil	07 510 017 868
1999 and later	BMW HP 5W-30 synthetic oil	07 51 0 017 866

**NOTE—**

- Castrol supplies the mineral and synthetic oil recommended by BMW.
- BMW High Performance synthetic oil may be used in all E39 models, regardless of year.
- The use of engine oil additives is not recommended when using BMW High Performance synthetic engine oil.
- BMW is constantly upgrading recommended maintenance procedures and requirements. The information contained here is as accurate as possible at the time of publication. If there is any doubt about what procedures apply to a specific model or model year, or what intervals should be followed, remember that an authorized BMW dealer has the latest information on factory-recommended maintenance.

**CAUTION—**

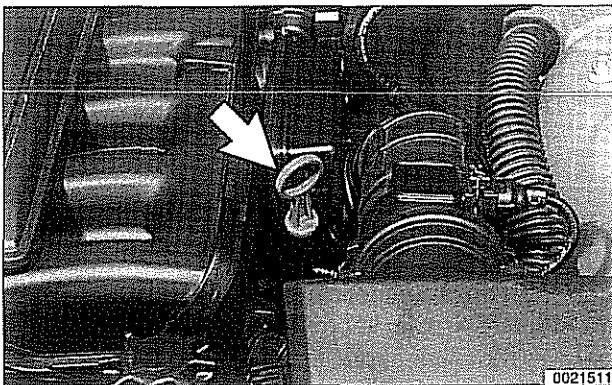
- In the case of cars that accumulate very low mileage per year, BMW recommends that the engine oil should be changed once a year at a minimum, regardless of whether mineral or synthetic based oil is used.
- In the interest of engine longevity, use half the recommended engine oil change interval.

**Engine oil, checking level**

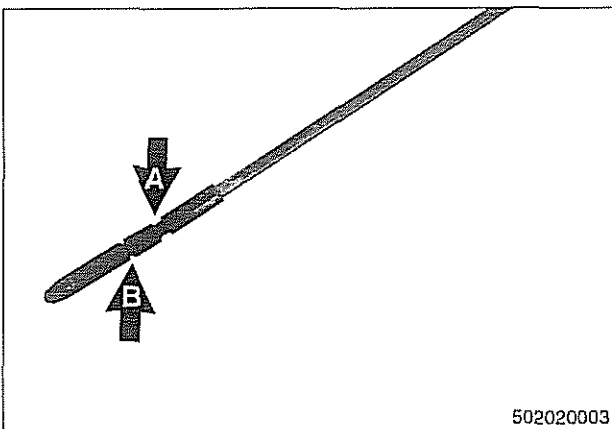
↙ Engine oil level is checked with a dipstick (arrow) in the engine block (6-cylinder oil dipstick shown, V-8 dipstick is similar).

- Check oil level with car on level surface, after engine has been stopped for at least a few minutes.
- Check level by pulling out dipstick and wiping it clean. Reinsert it all the way and withdraw it again.

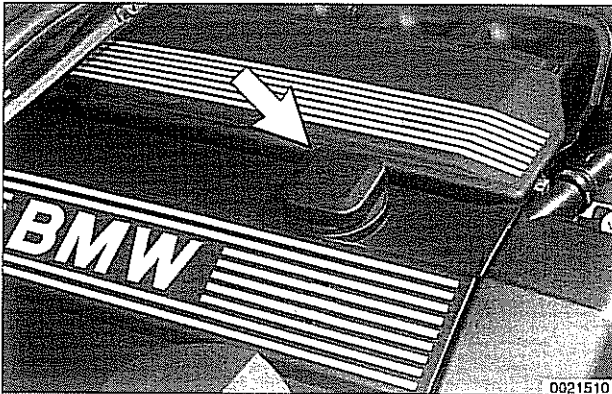
↙ Oil level is correct if it is between two marks (A and B) near end of dipstick.



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- If oil level is low, add oil by removing oil filler cap (arrow) on top of cylinder head (6-cylinder oil cap shown, V-8 is similar).
- Add only amount needed to bring oil level to upper mark on dipstick, using an oil of correct viscosity and grade.

### Engine oil and filter, changing

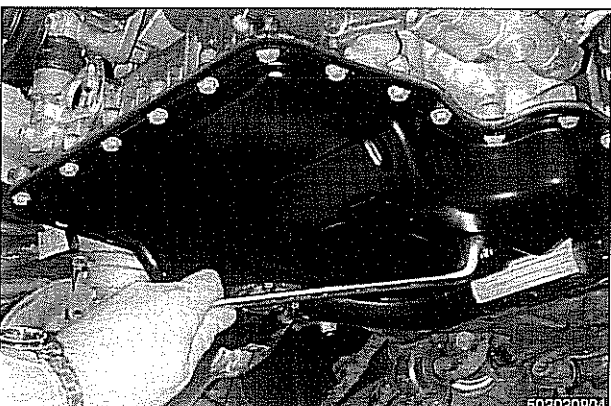
A complete oil change requires new oil, a new filter insert kit, and a new drain plug sealing washer. The tools needed, a 17 mm drain plug socket or box wrench, a 36 mm socket or wrench, and a drain pan (8 - 10 US qt. capacity), are described in **010 General**.

#### NOTE —

*If using a "fast lube" service facility for oil changes, make sure the technician hand-starts and torques the engine oil drain plug using hand-tools. Power tools can strip the threads of the plug and the oil pan.*



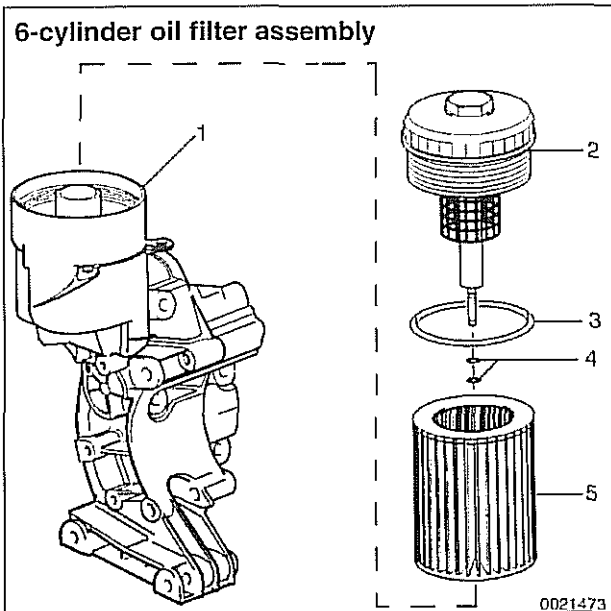
- Run engine for a few minutes to warm engine oil. Shut engine off.
- With car on level ground, place drain pan under oil drain plug.
- Using a 36 mm socket, loosen and remove oil filter housing cover (arrow). Remove filter cartridge and discard any O-rings (V-8 engine oil filter housing shown, 6-cylinder oil filter housing is similar).



- Using a socket or box wrench, loosen drain plug at oil drain pan. Remove plug by hand and let oil drain into pan (V-8 engine oil drain plug shown, 6-cylinder drain plug is similar).

#### WARNING —

*Pull the loose plug away from the hole quickly to avoid being scalded by hot oil. It will run out quickly when the plug is removed. If possible, use gloves to protect your hands.*



- When oil flow has diminished to an occasional drip, reinstall *drain plug with a new metal sealing washer and torque plug.*

#### Tightening torque

Engine oil drain plug to oil pan	25 Nm (18 ft-lb)
----------------------------------	------------------

- ◀ Working at oil filter housing (1):

- Lubricate and install new oil filter O-rings (3, 4).
- Install a new filter cartridge (5).
- Install and tighten housing cover (2).
- 6-cylinder oil filter assembly shown, V-8 is similar.

#### Tightening torque

Cover to oil filter housing	25 Nm (18 ft-lb)
-----------------------------	------------------

- Refill crankcase with oil. Approximate oil capacity is listed in **Table d. Engine oil with filter change.** Use dipstick to *check correct oil level.*
- Start engine and check that oil pressure warning light immediately goes out.
- Allow engine to run for a few minutes to circulate new oil, then check for leaks at drain plug and oil filter. Stop engine and re-check oil level.

## ENGINE COMPARTMENT MAINTENANCE

The section describes other routine maintenance done in the engine compartment. Information on engine oil service is given earlier in this group.

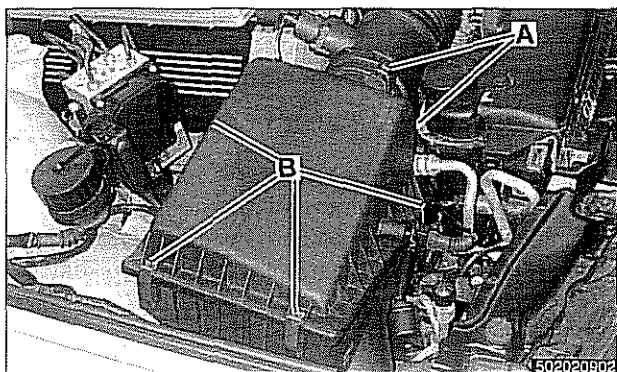
For these procedures, it is not necessary for the car to be *raised and supported off the ground.*

### Accelerator and linkage

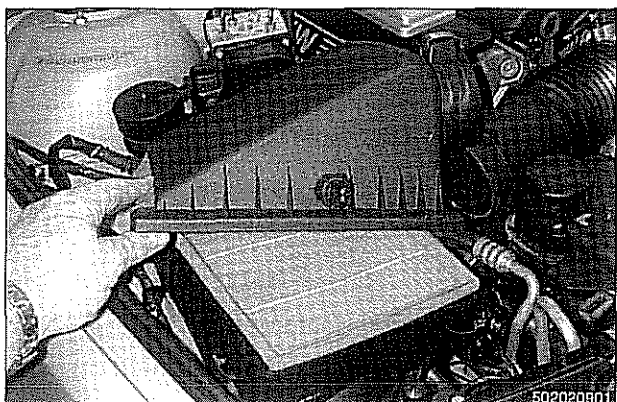
The accelerator and linkage at the throttle housing should be lubricated periodically. Use a general purpose oil on the joints and bearings of the linkage. Use a multipurpose grease on the bearing points of the throttle plate.

### Air filter, replacing

The specified replacement intervals for the air filter are based on normal use. If the car is operated primarily in dusty conditions, the air filter should be serviced more frequently.



- Release mass air flow sensor clips (A).
- Release upper air filter housing clips (B).



- Lift air filter upper housing, and remove filter element.

**NOTE—**

*V-8 engine air filter assembly shown in illustration. 6-cylinder air filter assembly is similar but located at the left front of the engine compartment.*

- On installation, install O-ring for mass air flow sensor into retaining clips in air filter upper housing.
- Replace air filter and upper air filter housing, and attach upper air filter housing clips.

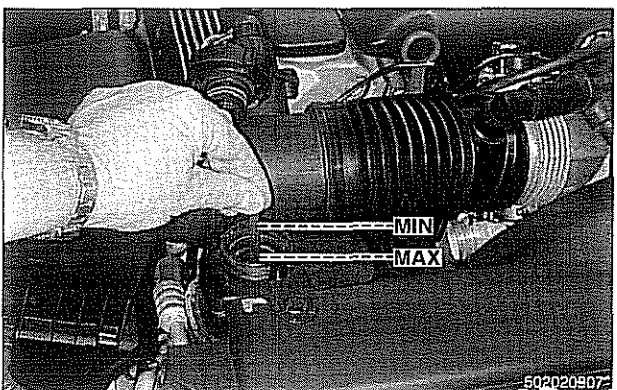
## Cooling system, checking

Antifreeze raises the boiling point and lowers the freezing point of the coolant. BMW recommends engine coolant that is a 50 / 50 mixture of distilled water and ethylene glycol-based antifreeze.

Routine cooling system maintenance consists of maintaining the coolant level and inspecting hoses. Because the coolant's anticorrosion and antifreeze additives gradually lose their effectiveness, replacement of the coolant every three years is recommended.

**CAUTION—**

*Use only BMW approved phosphate-free antifreeze when filling the cooling system. Use of antifreeze containing phosphates is harmful to the cooling system.*

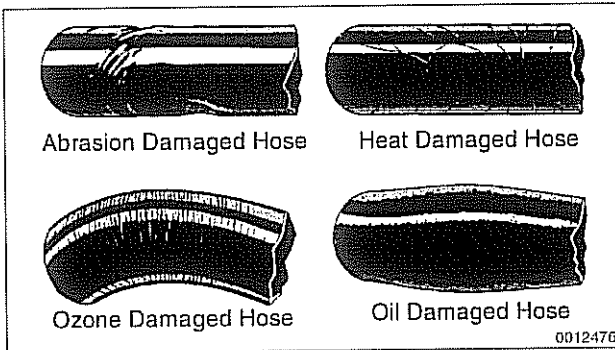


- Float in radiator tank indicates coolant level. Inspect while coolant is cold.
- When upper mark on float is level with top of filler neck, coolant is at minimum allowable level.
- When lower mark on float is level with top of filler neck, coolant is at maximum level.

Hose connections should be tight and dry. Coolant seepage at clamped connection indicates either that hose clamp is

loose, hose is damaged, or connection is dirty or corroded. Dried coolant has a chalky appearance. Hoses should be firm and springy. Replace any hose that is cracked, has become soft and limp, or has been contaminated by oil.

As a preventive measure, replacement of the cooling system hoses every four years is recommended. The illustration shows examples of damage to coolant hoses. Any of these conditions is cause for replacement (illustration courtesy of Gates Rubber Company, Inc.).



## Engine drive belt, replacing

Drive belts and pulleys transfer power from the engine crankshaft to various accessories. E39 models use two polyribbed (serpentine) belts:

- The outer belt turns the A/C compressor.
- The inner, longer belt turns the alternator (generator), coolant pump and power steering pump.

Inspect drive belts with the engine off. If the belt shows signs of wear, cracking, glazing, or missing sections, it should be replaced immediately. To reduce the chance of belt failure while driving, replacement of the belts every four years is recommended.

### **WARNING—**

Observe care when replacing belts. Personal injury could result if a tensioner springs back into position uncontrolled.

### **CAUTION—**

Mark drive belt rotation direction if removing and reusing an old belt.

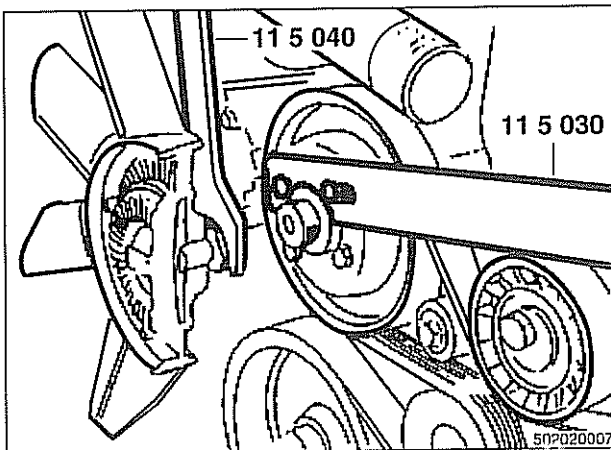
### **NOTE—**

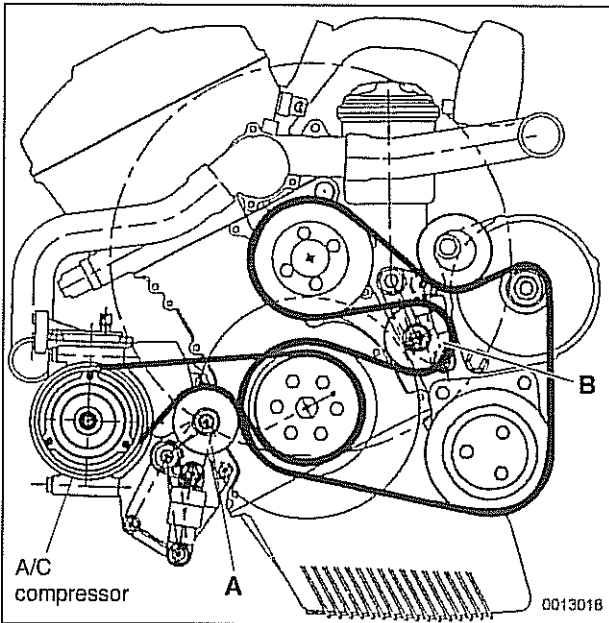
When belts are replaced with new ones, store the old set in the trunk for emergency use.

All models, use BMW special tools 11 5 030 and 11 5 040 to loosen and remove cooling fan and clutch from coolant pump.

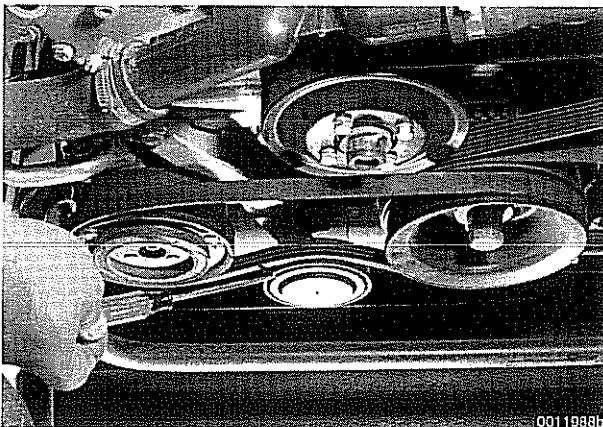
### **NOTE—**

- 32 mm cooling fan nut has left-hand threads.
- If necessary, remove fan cowl from radiator.

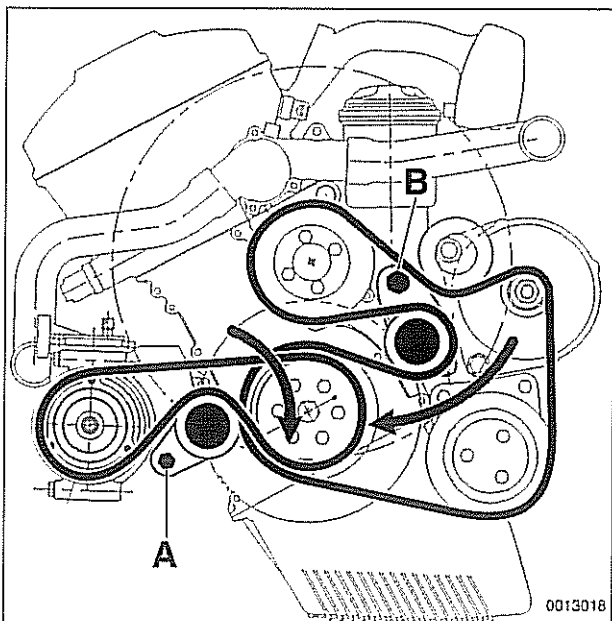




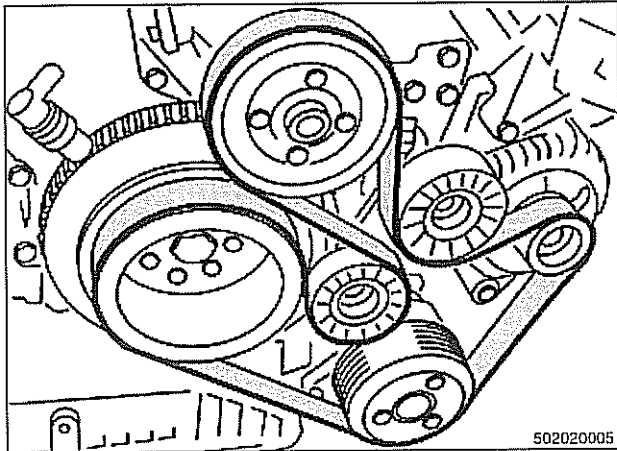
- ⚠ 6-cylinder engine with hydraulic belt tensioners.
- Use long-handled wrench to turn A/C belt tensioner (A) clockwise. Remove A/C belt.
  - Similarly, turn main engine drive belt tensioner (B) clockwise and remove belt.



- ⚠ Some models have a dust cover over belt tensioner release lug, which must be pried off prior to removing belt.



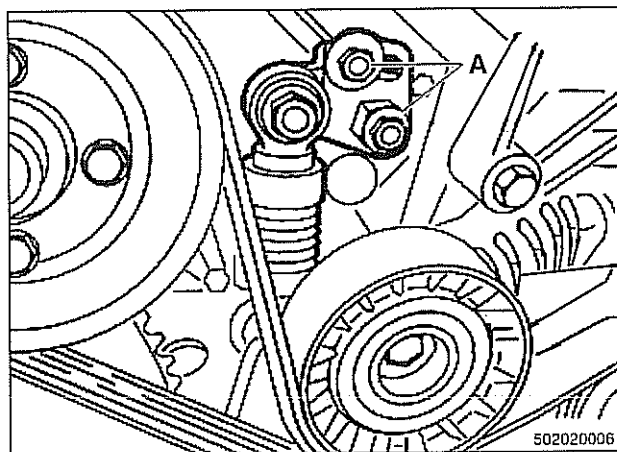
- ⚠ 6-cylinder engine with spring-loaded belt tensioners.
- Use long-handled wrench to turn A/C belt tensioner release lug (A) clockwise (against spring tension). Remove A/C belt.
  - Similarly, turn main engine drive belt tensioner lug (B) clockwise and remove belt.



◀ V-8 engine drive belt diagram (A/C belt not shown).

**NOTE—**

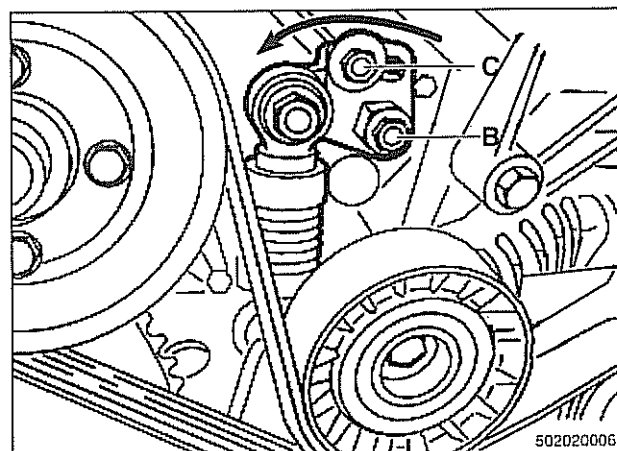
Two types of belt tensioners are used on the V-8 engines. The tensioner shown in this procedure is for cars built up to 8/97. The later style tensioner is similar.



◀ V-8 engine tensioner.

- Loosen fasteners(A) to relieve belt tension.

— Remove drive belt.



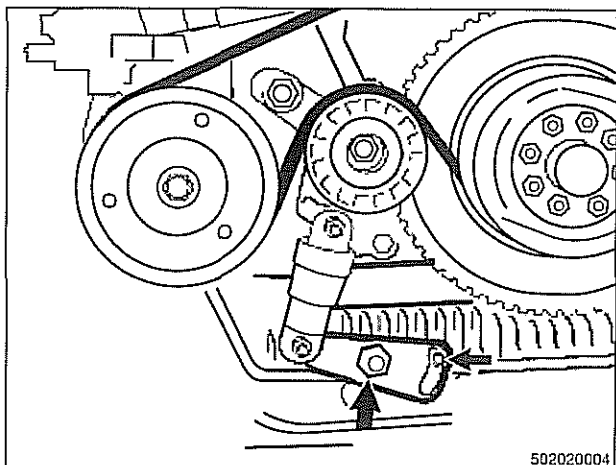
◀ When reinstalling belt, check that it is correctly positioned on belt pulleys.

- With bolts (B and C) finger tight, pretension adjuster by turning hex counterclockwise (arrow) to stop.
- Tighten mounting bolts.

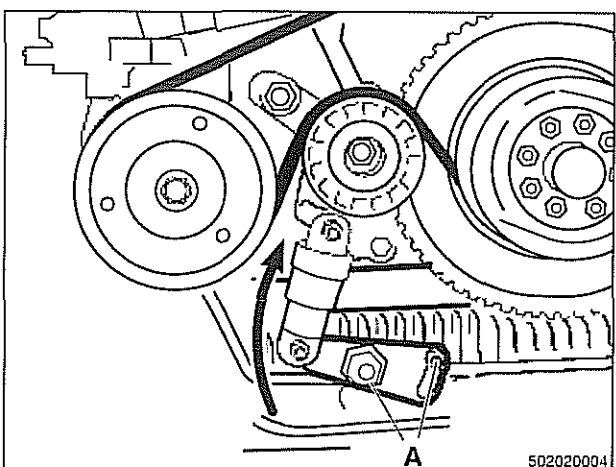
**NOTE—**

On 8/97 and later tensioner, turn hex on tensioner plate to align lower plate mounting bolt.





- ◀ Remove A/C compressor belt:
- Loosen tensioner mounting fasteners (arrows).
  - Swing tensioner down to remove belt.



- ◀ To reinstall compressor belt:
- Route belt over pulleys.
  - Pretension belt by turning adjuster clockwise (arrow) to stop.
  - Tighten tensioner mounting bolts (A).

#### Tightening torques

Fan clutch to coolant pump (left- hand thread)	
with BMW tool 11 5 040	30 Nm (22 ft-lb)
without BMW tool 11 5 040	40 Nm (29 ft-lb)
Tensioner to engine block	
8.8 grade	22 Nm (16 ft-lb)
10.9 grade (liquid-cooled alternator)	30 Nm (22 ft-lb)

### Idle speed

Engine idle speed can change due to a number of factors, including normal wear. The idle speed is electronically adaptive and not adjustable. See **130 Fuel Injection** for more information.

### Catalytic converter and oxygen sensors

OBD II enhanced emission standards require the engine control module (ECM) to monitor the oxygen content in the exhaust with oxygen sensors placed before and after the catalytic converter. This allows for tighter control of tail pipe emissions and also allows the ECM to diagnose converter problems. If the ECM detects that catalytic converter or oxygen sensor efficiency has degraded past a certain preprogrammed limit, it will turn on the malfunction indicator light (MIL), and store a diagnostic trouble code (DTC) in the ECM. See **OBD On-Board Diagnostics** for more information on OBD II systems.

Replacement of oxygen sensors at the specified intervals ensures that the engine and emission control system will

continue to operate as designed. Extending the replacement interval may void the emission control warranty coverage. See **180 Exhaust System** for information on replacing the oxygen sensors.

#### Tightening torque

Oxygen sensor to exhaust manifold	50 Nm (37 ft-lb)
-----------------------------------	------------------

#### NOTE —

A special socket for replacing the oxygen sensor is available from most automotive parts stores. The socket has a groove cut down one side to allow the sensor to be installed without damaging the wire harness.

### Power steering fluid, checking level

The power steering system is permanently filled and does not have a drain. Routinely adding ATF is not required unless the system is leaking.

◀ To check power steering fluid level in fluid reservoir:

- Park car on level ground with engine off.
- Level is correct if it is between **MIN** and **MAX** marks on dipstick.
- If level is below **MIN** mark, add fluid to reservoir to bring level up.
- Hand-tighten reservoir cap.

#### Power steering fluid

Dexron III® ATF or equivalent

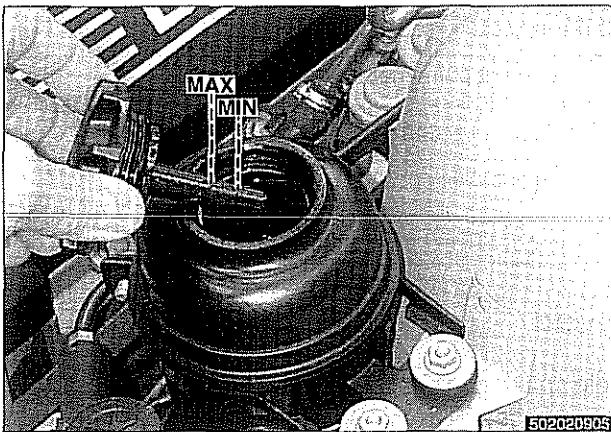
### Spark plugs

E39 models through model year 1998 were equipped with spark plugs with two electrodes. These are gapped to 0.7 mm (0.028 in) by the manufacturer and are not adjustable.

Starting with 1999 models, long life spark plugs with 3 or four electrodes were used. These can be retroactively fitted to earlier models. The recommended spark plug replacement interval for these is 100,000 miles. The electrode gap in these spark plugs is not adjustable.

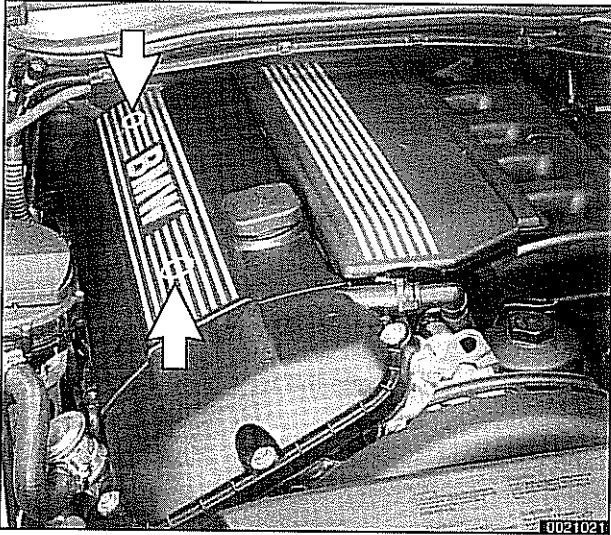
#### Spark plug applications

M52	Bosch F8LDCR
M52 TU, M54	Bosch FGR7DQP or NGK BKR6EQUP
M62 to 7/97	Bosch F7LDCR or NGK BKR6EK
M62 from 7/97	Bosch F9LDCR
M62 TU	Bosch FGR7DQP or NGK BKR6EQUP



## Spark plugs, replacing

E39 engines use a coil-over-spark plug configuration, with one ignition coil above each spark plug. Spark plugs should be removed only after the engine has cooled.



- ◀ Remove engine cover(s) over ignition coils:
  - Remove acoustic cover over fuel injectors / intake manifold.
  - 6-cylinder engine: Remove oil filler cap.
  - Remove plastic trim covers (**arrows**).
  - Remove cover hold-down bolts. Remove coil cover(s)
  - 6-cylinder engine: Temporarily reinstall oil filler cap to keep out contaminants.



- ◀ Remove ignition coil grounding harnesses (**arrows**). 6-cylinder coils shown, V-8 engine is similar.



- ◀ Remove ignition coils:
  - Pull up on spring clips to disconnect ignition coil harness connectors.
  - Remove coil mounting bolts. Pull coils up and off spark plugs.
- Remove spark plugs.

- Installation is reverse of removal, bearing in mind the following:
  - Lightly lubricate new spark plug threads with copper-based anti-seize compound.
  - Thread plugs into cylinder head by hand to prevent cross-threading.
  - Be sure to reinstall and tighten coil grounds.

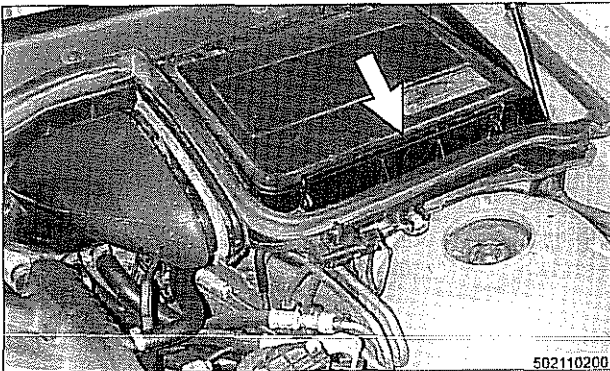
#### Tightening torque

Spark plug to cylinder head	25 Nm (18 ft-lb)
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### Interior ventilation microfilter, replacing

Two interior ventilation microfilters are used, one on each side of the engine compartment at the fire wall.

- ▲ To replace the microfilter, unclip the wire fastener and remove the cover.
  - Lift out the filter, and replace. Left side shown; right is similar.
  - Replace cover and clip wire fastener to retain cover.



## OTHER MECHANICAL MAINTENANCE

### Battery, checking, cleaning, and replacing

The battery is located in the right side of the luggage compartment. Simple maintenance of the battery and its terminal connections will ensure maximum starting performance, especially in winter when colder temperatures reduce battery power.

Battery cables should be tight. The terminals, cable clamps and battery case should be free of the white deposits that indicate corrosion and acid salts. Even a thin layer of dust containing conductive acid salts can cause battery discharge.

- To remove battery corrosion:
  - Disconnect battery cables. Disconnect negative (-) cable first.
  - Remove battery from trunk.
  - Clean terminal posts and cable clamps with a wire brush.
  - Clean main chassis ground terminal next to battery. Corrosion can be washed away with a baking soda and water solution that will neutralize acid.
  - Reinstall battery and reconnect cable clamps, positive (+) cable first.
  - Lightly coat outside of terminals, hold down screws, and clamps with petroleum jelly, grease, or a commercial battery terminal corrosion inhibitor.

**WARNING—**

Battery acid is extremely dangerous. Take care to keep it from contacting eyes, skin, or clothing. Wear eye protection. Extinguish all smoking materials and do not work near any open flames.

**CAUTION—**

Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.

**NOTE—**

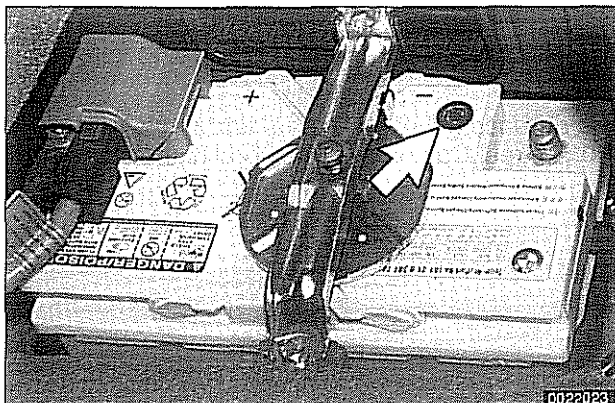
The original equipment battery in E39 models is maintenance free. The original electrolyte will normally last the entire service life of the battery under moderate climate conditions.

Battery electrolyte should be maintained at the correct level just above the battery plates and their separators. The correct level is approximately 5 mm ( $\frac{1}{4}$  in.) above the top of battery plates or to the top of the indicator marks (if applicable). The battery plates and the indicator marks can be seen once the filler caps are removed. If the electrolyte level is low, replenish it by adding distilled water only.

◀ The original equipment BMW battery is equipped with a built-in hydrometer "magic eye" (arrow). Battery condition is determined by the color of the eye:

- Green: Adequate charge
- Black: Inadequate charge, recharge
- Yellow: Defective battery, replace

Batteries are rated by ampere hours (Ah), the number of hours a specific current drain can be sustained before complete discharge, or by cold cranking amps (CCA), the number of amps available to crank the engine in cold weather condi-



tions. In general, replacement batteries should always be rated equal or higher than the original battery.

The battery is held in place by a single hand screw and plate. A secure battery hold-down is important in order to prevent vibrations and road shock from damaging the battery.

**CAUTION—**

*Prior to disconnecting the battery, read the battery disconnection cautions given in 001 General Cautions and Warnings.*

**NOTE—**

- Always disconnect the negative (–) cable first, and connect it last. While changing the battery, clean away any corrosion in or around the battery tray.
- More battery and charging system information is in 121 Battery, Alternator, Starter.

## Brake fluid, replacing

Brake fluid absorbs moisture easily, and moisture in the fluid affects brake performance and reliability. This is why BMW strictly recommends replacing the brake fluid every two years. When replacing or adding brake fluid, use only new fluid from previously unopened containers. Do not use brake fluid that has been bled from the system, even if it is brand new. Use only DOT 4 brake fluid.

**NOTE—**

See 340 Brakes for brake fluid flushing procedures.

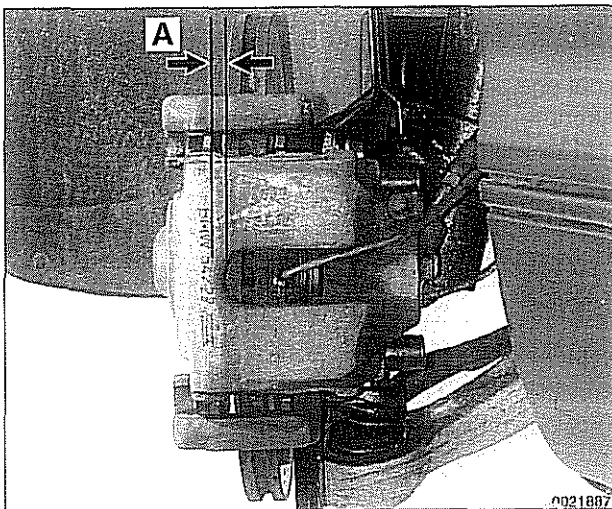
## Brake pad / rotor wear, checking

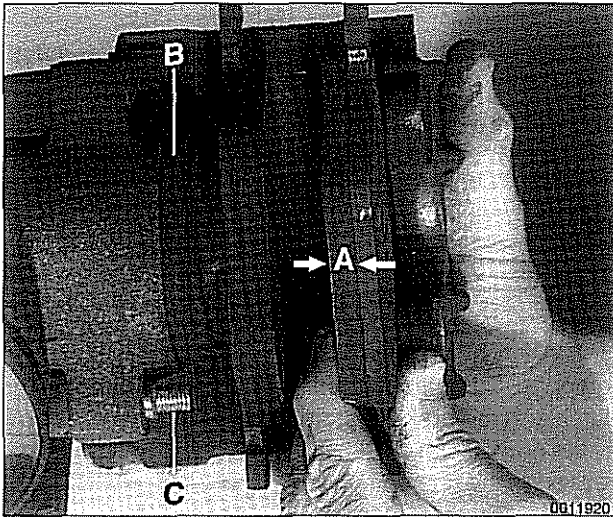
Disc brakes are fitted at all four wheels. Although the brakes are equipped with a brake pad warning system, the system only monitors one wheel per axle. Pad thickness should be checked whenever wheels are off or brake work is being done.



Disc brake pad wear can be checked through opening in caliper:

- Measure distance (A) of brake pad “ear” to brake rotor. See 340 Brakes. Compare to specification below.





◀ Unbolt caliper from steering arm to properly inspect:

- Brake pad thickness (A)
- Brake rotor
- Condition of caliper seal (B)
- Condition of caliper slider bolts (C)

**NOTE**—

*Brake caliper removal and installation procedures are given in 340 Brakes.*

**Brake pad lining minimum thickness**

Dimension A	3.0 mm (0.12 in)
-------------	------------------

### Brake system, inspecting

Routine maintenance of the brake system includes maintaining the brake fluid in the reservoir, checking brake pads for wear, checking parking brake function, and inspecting the system for fluid leaks or other damage:

- Check that brake hoses are correctly routed to avoid chafing or kinking.
- Inspect unions and brake calipers for signs of fluid leaks.
- Inspect rigid lines for corrosion, dents, or other damage.
- Inspect flexible hoses for cracking.
- Replace faulty hoses or lines as described in **340 Brakes**.

**WARNING**—

*Incorrect installation or overtightening hoses, lines, and unions may cause chafing or leakage. This can lead to partial or complete brake system failure.*

### Parking brake, checking

The parking brake system is independent of the main braking system and may require periodic adjustment depending on use. Adjust the parking brake if the brake lever can be pulled up more than 8 clicks. Check that the cable moves freely. A description of the parking brake and parking brake adjustment can be found in **340 Brakes**.

**NOTE—**

The parking brake may lose some of its effectiveness if it is not used frequently. This is due to corrosion build-up on the parking brake drum. To remove corrosion, apply the parking brake just until it begins to grip, then pull the lever up one more stop (click). Drive the car approximately 400 meters (1,300 ft.) and release the brake. To recheck the adjustment of the parking brake see **340 Brakes**.

**Clutch fluid, checking**

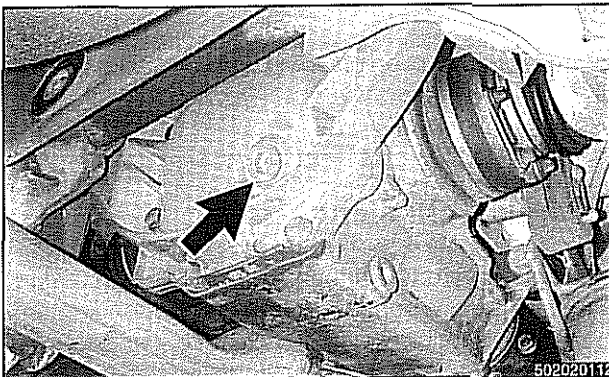
In cars equipped with manual transmission and clutch, the hydraulic clutch and the brake system share the same reservoir and the same brake fluid. Clutch fluid level and brake fluid level are checked at the same time.

**NOTE—**

- See **340 Brakes** for more information.
- See **210 Clutch** for information on the clutch and the hydraulic clutch operating system.

**Differential oil level, checking**

The E39 differential is filled with lifetime oil that ordinarily does not need to be changed. BMW recommends using only a specially formulated synthetic gear oil (SAF-XO) that is available through an authorized BMW dealer parts department. For additional information on this lubricant and any other lubricants that may be compatible, contact an authorized BMW dealer service department.



◀ Check rear differential oil level at filler plug (arrow).

- Check lubricant level with car on a level surface:
  - Level is correct when fluid just reaches edge of filler hole.
  - If necessary, top up fluid.
  - Replace filler plug sealing ring.
  - Install and tighten oil filler plug when oil level is correct.

**NOTE—**

- Use either a 14 mm or 17 mm Allen socket to remove the drain plug.
- If the car is raised in the air, it should be level when checking or filling final drive fluid level.

**Tightening torque**

Filler plug to final drive housing	70 Nm (52 ft-lb)
------------------------------------	------------------



## Drive axle joint (CV joint) boots, inspecting

CV joint protective boots must be closely inspected for cracks and any other damage that will allow contaminants to get into the joint. If the rubber boots fail, the water and dirt that enter the joint will quickly damage it.

### NOTE—

Replacement of the CV joint boots and inspection of the joints are described in **331 Final Drive**.

## Exhaust system, inspecting

Exhaust system life varies widely according to driving habits and environmental conditions. If short-distance driving predominates, the moisture and condensation in the system will not fully dry out. This will lead to early corrosion damage and more frequent replacement.

➤ Scheduled maintenance of the exhaust system is limited to inspection:

- Check to see that all the hangers (arrow) are in place and properly supporting the system and that the system does not strike the body.
- Check for restrictions due to dents or kinks.
- Check for weakness or perforation due to rust.

### NOTE—

Alignment of the system and the location of the hangers are described in **180 Exhaust System**.



## Fuel filter, replacing

The fuel filter is located beneath the center of the car, approximately under the driver's seat. A protective cover must be removed to access the filter.

➤ Fuel filter for M62 engine (arrow)

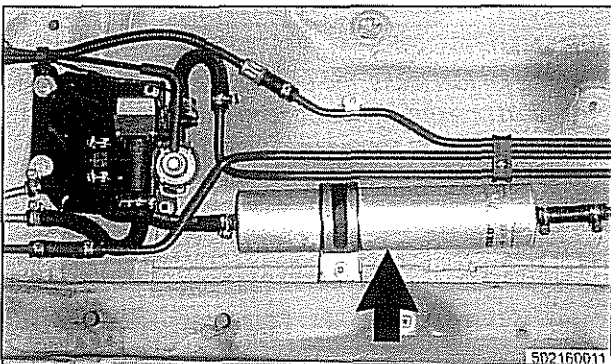
- Disconnect battery negative (-) cable.

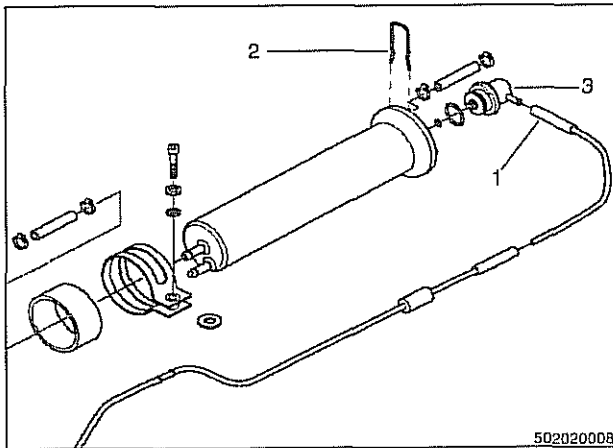
### CAUTION—

Disconnecting the battery cables may erase fault codes stored in engine control module memory.

### WARNING—

Fuel will be expelled forcibly when the filter is removed. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy.





- When replacing fuel filter:
  - Use appropriate hose clamping device to clamp off filter inlet and outlet hoses to lessen fuel spillage.
  - Loosen center clamping bracket and hose clamps on either end of filter.
  - Note arrow or markings indicating direction of flow on new filter.
  - Install new filter using new hose clamps.
- Drain fuel filter from inlet side into a container and inspect drained fuel. Check for rust, moisture and contamination.

◀ If fuel filter is equipped with fuel pressure regulator:

- Remove vacuum hose (1).
- Pull out locking clip (2).
- Remove fuel pressure regulator (3).
- Install pressure regulator in new filter.

**CAUTION—**

- Clean thoroughly around the filter connections before removing them.
- After assembly, check filter connections carefully for leaks before installing cover.

**NOTE—**

Additional information about the fuel filter assembly is in **160 Fuel Tank and Fuel Pump**.

## Fuel tank and fuel lines, inspecting

Inspect the fuel tank, fuel lines, and fuel system for damage or leaks. Check for fuel leaks in the engine compartment or fuel odors in the passenger compartment. Check for any evaporative emissions hoses that may have become disconnected, checking carefully at charcoal canister and evaporative emissions purge system. See **130 Fuel Injection** and **160 Fuel Tank and Fuel Pump** for component locations and additional information.

**WARNING—**

When checking for fuel leaks, the engine must be cold. A hot exhaust manifold or exhaust system could cause the fuel to ignite or explode causing serious personal injury. Ventilate the work area and clean up spilled fuel immediately.

## Suspension, front, inspecting

Inspection of the front suspension and steering includes a check of all moving parts for wear and excessive play. Inspect ball joint and tie-rod rubber seals and boots for cracks or tears that could allow the entry of dirt, water, and other contaminants. See **310 Front Suspension**.

## Suspension, rear, inspecting

Differential and rear drive axle service consists of checking and changing the gear oil, inspecting for leaks, and checking the drive axle CV joint boots for damage.

The areas where leaks are most likely to occur are around the drive shaft and drive axle mounting flanges. For more information on identifying oil leaks and their causes, see **330 Rear Suspension** and **331 Final Drive**.

## Tires, checking inflation pressure

Correct tire pressures are important to handling and stability, fuel economy, and tire wear. Tire pressures change with temperature. Pressures should be checked often during seasonal temperature changes. Correct inflation pressures can be found on the driver's door pillar and in the owner's manual. Note that tire pressures should be higher when the car is more heavily loaded.

### **WARNING**—

*Do not inflate any tire to a pressure higher than the tire's maximum inflation pressure listed on the sidewall. Use care when adding air to warm tires. Warm tire pressures can increase as much as 4 psi (0.3 bar) over their cold pressures.*

## Tires, rotating

BMW does not recommend tire rotation. Due to the car's suspension design, the front tires begin to wear first at the outer shoulder and the rear tires begin to wear first at the middle of the tread or inner shoulder. Rotating the tires may adversely affect road handling and tire grip.

## Transmission service, automatic

The automatic transmissions installed in E39 models are filled with special automatic transmission fluid. The transmission lubricant type can be found on the "type-plate" on the side of the transmission. The recommended lubricants are listed earlier in this repair group. See **Fluids and Lubricants**. If in doubt, consult an authorized BMW dealer for alternate

fluid use and the most-up-to-date information regarding transmission operating fluids.

The automatic transmission is not equipped with a dipstick. Therefore, checking the ATF level is an involved procedure which includes measuring and maintaining a specified ATF temperature during the checking procedure.

For more complete ATF service information, including checking ATF level and ATF filter replacement procedures, see **240 Automatic Transmission**.

### Transmission service, manual

Manual transmission service consists of inspecting for leaks and checking the fluid. Evidence of transmission leaks is likely to be seen around the driveshaft mounting flange and at the bottom of the bellhousing.

#### NOTE —

For more information on identifying oil leaks and their causes, see **230 Manual Transmission** and **210 Clutch**.

### Transmission fluid, checking and filling (manual transmission)

The manual transmission installed in the E39 models is filled with a special lifetime fluid (MTF-LT-1). This oil ordinarily does not need to be changed.

- ▲ Check manual transmission oil level at transmission filler plug (A). Make sure car is on level surface.

#### NOTE —

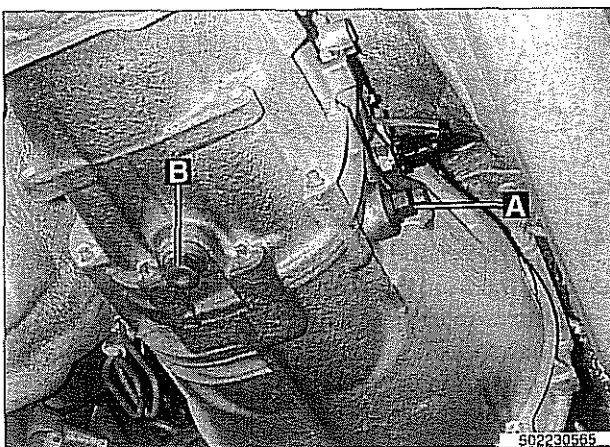
Transmission fluid level checking and replacement procedures are covered in **230 Manual Transmission**.

### Wheels, aligning

BMW recommends checking the front and rear alignment once a year and whenever new tires are installed.

#### NOTE —

See **320 Steering and Wheel Alignment** for a more detailed discussion of alignment requirements and specifications.



## BODY AND INTERIOR MAINTENANCE

### Body and hinges, lubricating

Door locks and lock cylinders can be lubricated with an oil that contains graphite.

Body and door hinges, hood latch and door check rods should be lubricated with SAE 30 or SAE 40 engine oil. Lubricate seat runners with multipurpose grease. Do not apply any oil to rubber parts. If door weather-strips are sticking, lubricate them with silicone spray or talcum powder. The hood release cable should be lubricated as well.

The use of winter lock deicer sprays should be kept to an absolute minimum, as the alcohol in the deicer will wash the grease out of the lock assemblies and may cause locks to corrode internally or to become difficult to operate.

### Exterior washing

The longer dirt is left on the paint, the greater the risk of damaging the glossy finish, either by scratching or by the chemical effect dirt particles may have on the painted surface.

Do not wash the car in direct sunlight. If the engine hood is warm, allow it to cool. Beads of water not only leave spots when dried rapidly by the sun or heat from the engine, but also can act as small magnifying glasses and burn spots into the finish. Wash the car with a mixture of lukewarm water and a car wash product. Rinse using plenty of clear water. Wipe the body dry with a soft cloth towel or chamois to prevent water-spotting.

### Interior care

Dirt spots can usually be removed with lukewarm soapy water or a dry foam cleaner. Use spot remover for grease and oil spots. Do not pour the liquid directly on the carpet or fabric, but dampen a clean cloth and rub carefully, starting at the edge of the spot and working inward. Do not use gasoline, naphtha, or other flammable substances.

### Leather upholstery and trim

Leather upholstery and trim should be periodically cleaned using a slightly damp cotton or wool cloth. The idea is to get rid of the dirt in the creases and pores that can cause brittleness and premature aging. On heavily soiled areas, use a mild detergent (such as Woolite®) or other specially formulated leather cleaners. Dry the trim and upholstery completely

using a soft cloth. Regular use of a good quality leather conditioner will reduce drying and cracking of the leather.

## Polishing

Use paint polish only if the finish assumes a dull look after long service. Polish can be used to remove tar spots and tar-nish, but afterwards a coat of wax should be applied to protect the clean finish. Do not use abrasive polish or cleaners on aluminum trim or accessories.

## Seat belts

Dirt and other abrasive particles will damage seat belt webbing. If it is necessary to clean seat belts, use a mild soap solution. Bleach and other strong cleaning agents may weaken the belt webbing and should be avoided.

### **WARNING** —

*Do not clean the seat belt webbing using dry cleaning or other chemicals. Allow wet belts to dry before allowing them to retract.*

The condition of the belt webbing and the function of the retractor mechanisms should be inspected. See **720 Seat Belts** for seat belt inspection information.

## Special cleaning

Tar spots can be removed with a bug and tar remover. Never use gasoline, kerosene, nail polish remover, or other unsuitable solvents. Insect spots also respond to tar remover. A bit of baking soda dissolved in the wash water will facilitate their removal. This method can also be used to remove tree sap spots.

## Washing chassis

Periodic washing of the underside of the car, especially in winter, will help prevent accumulation of road salt and rust. The best time to wash the underside is just after the car has been driven in wet conditions. Spray the chassis with a powerful jet of water. Commercial or self-service car washes may not be best for this, as they may recycle the salt-contaminated water.

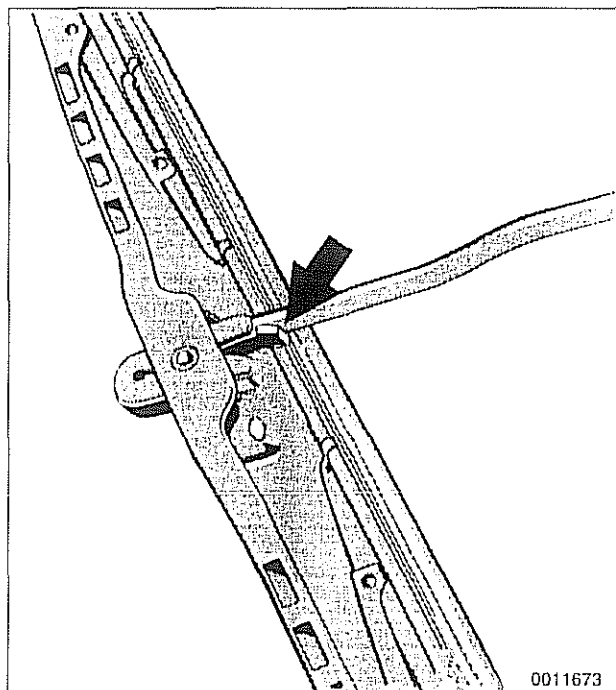
## Waxing

For a long-lasting, protective, and glossy finish, apply a hard wax after the car has been washed and dried. Use carnauba or synthetic based products. Waxing is not needed after every washing. You can tell when waxing is required by look-

ing at the finish when it is wet. If the water coats the paint in smooth sheets instead of forming beads that roll off, a new coat of wax is needed. Wax should not be applied to black trim pieces, rubber, or other plastic parts.

### Windshield wiper blade maintenance

Common problems with the windshield wipers include streaking or sheeting, water drops after wiping, and blade chatter. Streaking is usually caused when wiper blades are coated with road film or car wash wax. Clean the blades using soapy water. If cleaning the blades does not cure the problem, they should be replaced. BMW recommends replacing the wiper blades twice a year, before and after the cold season.



- To replace wiper blade, depress retaining tab (arrow) and slide blade out of arm.
- Check tension spring that forces wiper against glass. Replace wiper arm if spring tension is weak.

Drops that remain behind after wiping are caused by oil, road film, or diesel exhaust coating the windshield. Use an alcohol or ammonia solution or a nonabrasive cleanser to clean the windshield.

Wiper blade chatter may be caused by dirty or worn blades, by a dirty windshield, or by bent or twisted wiper arms. Clean the blades and windshield as described above. Adjust the wiper arm so that there is even pressure along the blade, and so that the blade is perpendicular to the windshield at rest. Lubricate the wiper linkage with a light oil. The linkage is located under the hood on the driver's side. If the problem persists, the blades are excessively aged or worn and should be replaced. See **611 Wipers and Washers** for more information.







# 100 Engine-General

**General** ..... 100-2  
Engine identifying features ..... 100-3

**Driveability Troubleshooting** ..... 100-4  
System voltage ..... 100-5  
Main grounds ..... 100-5

## 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

E39 models are fitted with a variant of either an inline 6-cylinder or a V-8 engine. See **Table a**.

**Table a. Engine specifications**

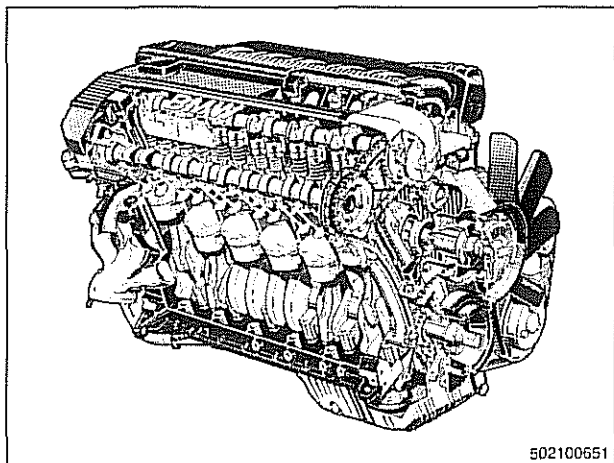
Model	Engine code, type	Displacement cc (cu. in.)	Engine management	Bore, Stroke mm (in.)	Compression ratio	Torque lb-ft / rpm	Horsepower (SAE) / rpm
528i 1997 - 1998	M52 6-cylinder	2793 (170.4)	Siemens MS 41.1	84 (3.307) 84 (3.307)	10.2 : 1	206 / 3,950	190 / 5,300
528i 1999 - 2000	M52 TU 6-cylinder	2793 (170.4)	Siemens MS 42.0	84 (3.307) 84 (3.307)	10.2 : 1	206 / 3,950	193 / 5,500
525i 2001 - 2002	M54 6-cylinder	2494 (152.2)	Siemens MS 43.0	84 (3.307) 75 (2.953)	10.5 : 1	175 / 3,500	184 / 6,000
530i 2001 - 2002	M54 6-cylinder	2979 (181.8)	Siemens MS 43.0	84 (3.307) 89.6 (3.528)	10.2 : 1	214 / 3,500	225 / 5,900
540i 1997	M62 V-8	4398 (268.4)	Bosch M 5.2	82.7 (3.26) 92 (3.62)	10.0 : 1	310 / 3,900	282 / 5,700
540i 1998	M62 V-8	4398 (268.4)	Bosch M 5.2.1	82.7 (3.26) 92 (3.62)	10.0 : 1	310 / 3,900	282 / 5,700
540i 1999 - 2002	M62 TU V-8	4398 (268.4)	Bosch ME 7.2	82.7 (3.26) 92 (3.62)	10.0 : 1	324 / 3,600	282 / 5,400

## Engine identifying features

- ▶ The M52 engine (MY97-98 528i) used a single on-off variable intake valve timing system (called VANOS). The cylinder block is cast iron and the cylinder head is aluminum. The engine management system is Siemens MS 41.1 and features NGK-type (0-5 volt) oxygen sensors.

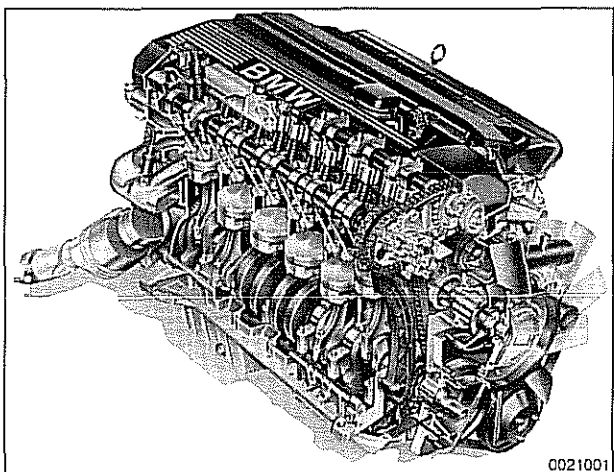
### NOTE—

*VANOS is an acronym based on the German words Variable Nockenwellen Steuerung (variable camshaft timing).*



502100651

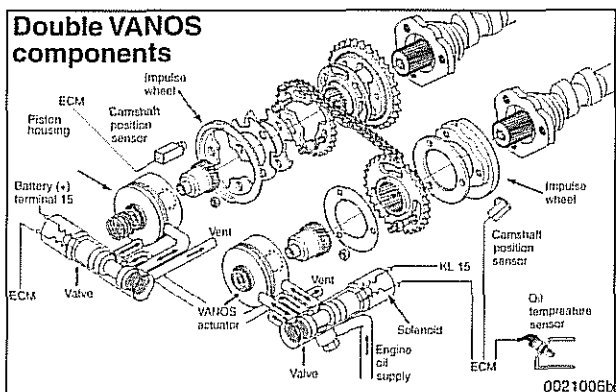
- ▶ The M52 TU engine (MY99-00 528i) and the M54 engines (MY01-02 525i/530i) are fitted with double VANOS. The engine blocks are constructed of aluminum alloy with cast iron cylinder sleeves.



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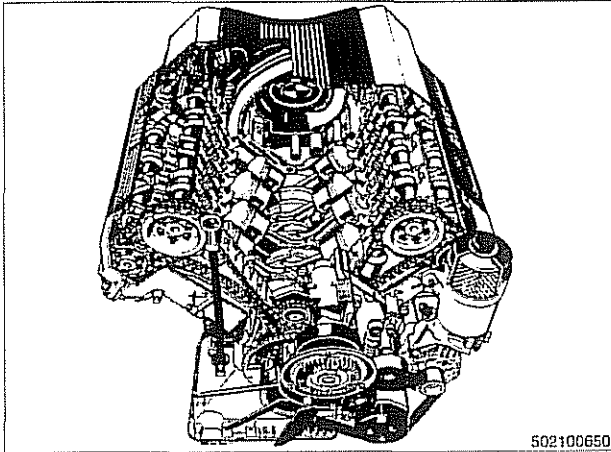
- ▶ The double VANOS (variable camshaft control) system incorporates true variable control of both the intake and exhaust camshafts, as compared to the single VANOS system on the M52 engine (on/off control of the intake camshaft only).

The M54 engines use a fully electronic throttle control (drive by wire). There is no accelerator cable connecting the throttle pedal to the throttle housing in these cars.



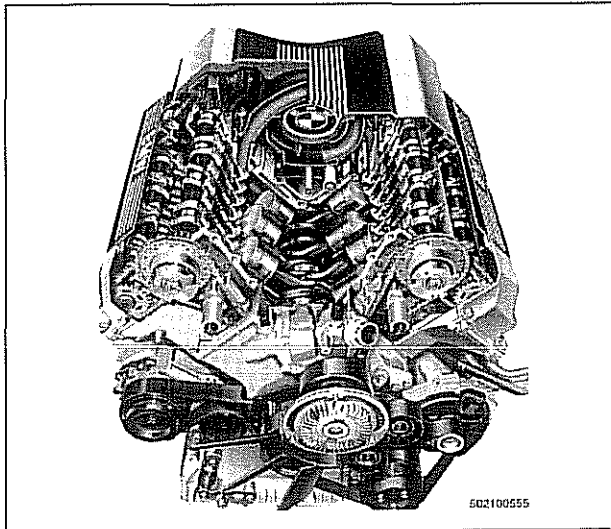
0021006b

## Engine-General



- The M62 90° V8 engine uses four valves per cylinder, double overhead camshafts and light alloy cylinder head and cylinder block engine construction.

On 1997 and 1998 540i models, Bosch engine management systems are utilized. **Table a** lists engine management system applications.



- For the 1999 model year, the M62 TU VANOS engine was introduced to the 540i models. This engine is primarily a carry-over from the earlier M62 engine, but contains many unique identifying components and technology:

- Variable camshaft timing (VANOS) for the intake valves.
- Bosch ME 7.2 engine management system with electronic throttle control. There is no accelerator cable connecting the throttle pedal to the throttle housing in these cars.
- Compact water-cooled generator (alternator).

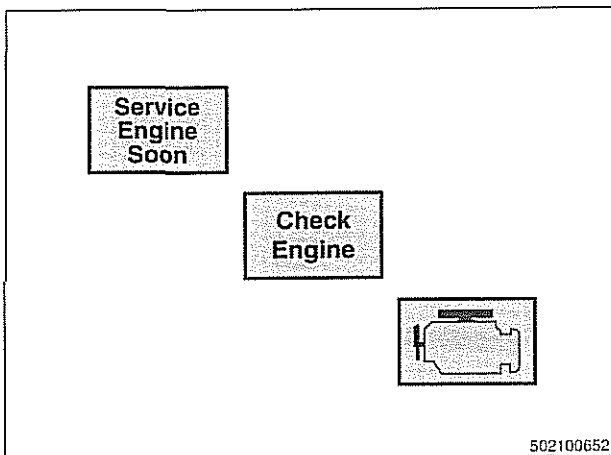
## DRIVEABILITY TROUBLESHOOTING

E39 vehicles are equipped with sophisticated self-diagnostic engine management systems. These systems monitor and store diagnostic fault information. If the malfunction indicator lamp (MIL) illuminates, the first diagnostic test should be to connect a dedicated scan tool for BMW automobiles and interrogate the fault memory.

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.

- The MIL in E39 cars displays one of these warning graphics in the instrument cluster.

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 of DC voltage. 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 ripple.

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 connections. 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—**

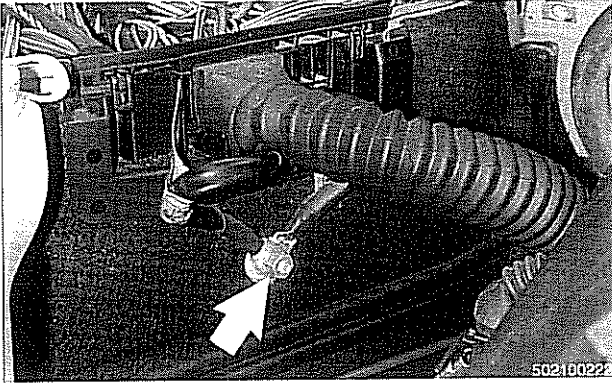
*For instructions on conducting a voltage drop test and other general electrical troubleshooting information, see **600 Electrical System—General**.*

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 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.

**Engine-General**

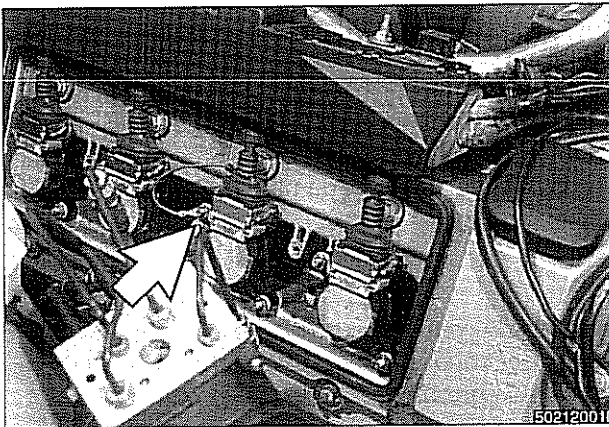


The main grounds for the fuel and ignition circuits of the DME system are illustrated below; see **610 Electrical Component Locations** for additional ground and component locations.

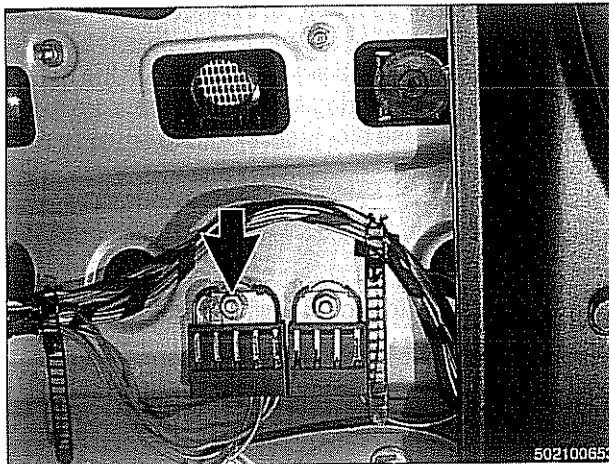
- ◀ Ground for engine management system in right rear of engine compartment on E-box bulkhead (**arrow**).



- ◀ 6-cylinder models: Grounds for ignition coils (**arrows**).



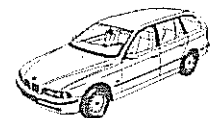
- ◀ V-8 models: Grounds for ignition coils, at cylinders 3 (**arrow**) and 7.



- ◀ Fuel pump ground (**arrow**) below right tail light in luggage compartment.

**NOTE—**

Ground location for sedan shown, wagon models may differ.



# 110 Engine Removal and Installation

<b>General</b> .....	110-2	<b>Engine, Removal and Installation</b>	
Special tools .....	110-2	<b>(V-8 models)</b> .....	110-16
<b>Engine, Removal and Installation</b>			
<b>(6-cylinder)</b> .....	110-3		

## GENERAL

Engine removal and installation are covered in this repair group.

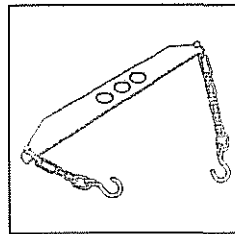
See **100 Engine—General** for engine identification details and engine codes.

Transmission removal is required for all models before the engine can be removed. This is best accomplished with the car raised on an automotive lift. For additional procedures required during engine removal, refer to the following repair groups:

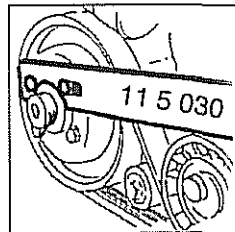
- **020 Maintenance**
- **121 Battery, Alternator, Starter**
- **170 Radiator and Cooling System**
- **180 Exhaust System**
- **230 Manual Transmission**
- **240 Automatic Transmission**
- **410 Fenders, Engine Hood**

## Special tools

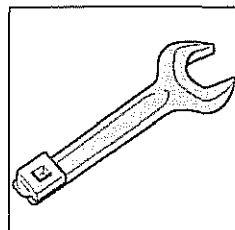
Some special tools are required for engine removal and installation. Be sure to have the necessary equipment on hand before starting the job.



- ◀ Engine lifting tool  
(Tool No. BMW 11 0 000)

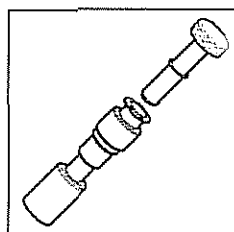


- ◀ Cooling fan counterhold tool  
(Tool No. BMW 11 5 030)

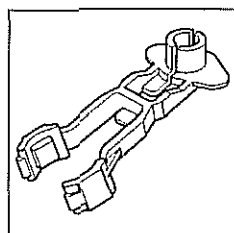


- ◀ Cooling fan wrench  
(Tool No. BMW 11 5 040)





- ◀ Fuel line plugs  
(Tool No. BMW 13 5 281 / 13 5 282)



- ◀ Fuel line removal tool  
(Tool No. BMW 16 1 050)

**CAUTION—**

- Disconnecting the battery may erase fault code(s) stored in memory. Check for fault codes prior to disconnecting the battery cables.
- If the MIL (Malfunction Indicator Light, also may be called "Check Engine" or "Service Engine Soon" light) 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 (6-CYLINDER)

**NOTE—**

- Engine removal procedures are similar for all 6-cylinder models. When differences exist, they are noted at the beginning of each step. Engine are referred to by engine code. See **100 Engine-General** for engine code and application information.
- Be sure to 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.
- The intake manifold must be removed on 6-cylinder models before the engine can be removed.

**WARNING—**

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

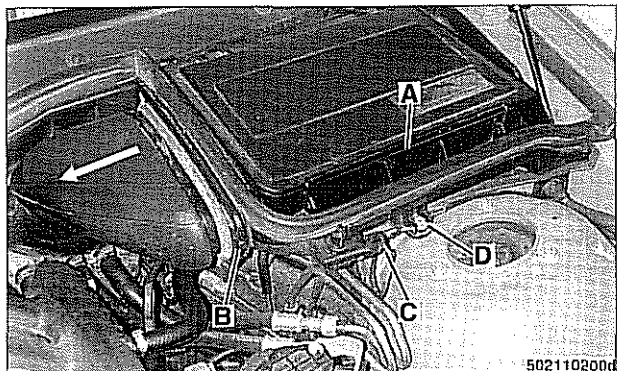
## Engine Removal and Installation

- Disconnect negative (–) cable from battery.

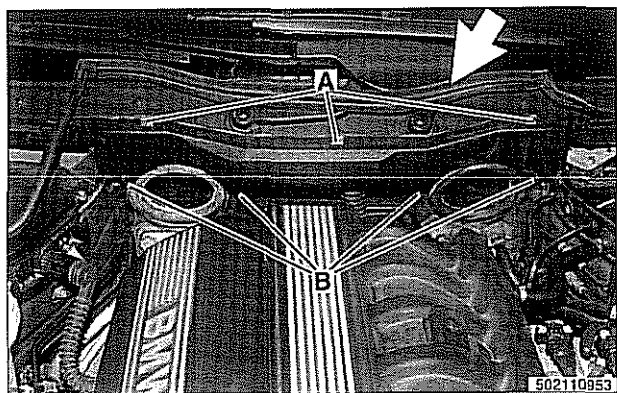
### CAUTION—

Prior to disconnecting the battery, read the battery disconnection cautions in 001 *General Cautions and Warnings*.

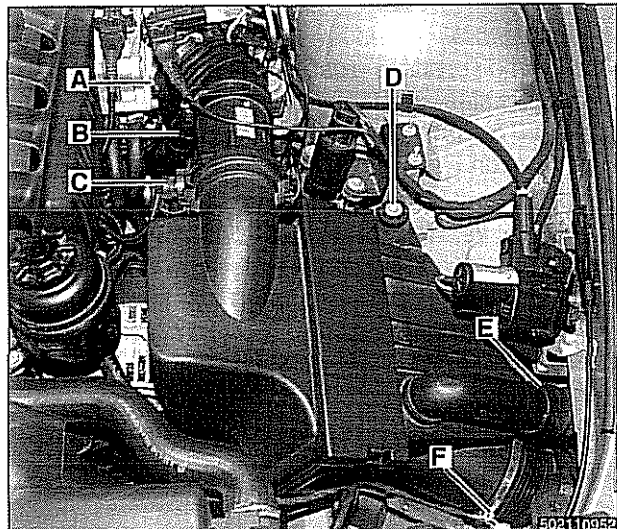
- Remove engine hood, or place in service position. See 410 *Fenders, Engine Hood*.



- Remove left and right interior ventilation ducts (left side shown):
  - Release ventilation filter cover latch (A) and remove cover.
  - Release plastic locking tab (B) or release locking tabs on top of duct (later models).
  - Rotate duct counterclockwise to unlock from bulkhead and remove (arrow).
  - Disconnect electrical harness from hood switch (C).
  - Release spring lock (D).
  - Slide filter housing away from inner fender to remove.
  - Removal of right side ventilation duct is similar.

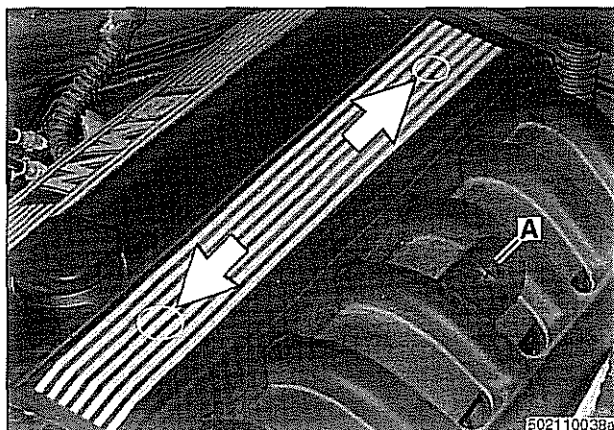


- Remove rear bulkhead panel:
  - Remove rubber sealing gasket (arrow).
  - Remove 3 mounting clips (A).
  - Remove 4 retaining screws (B).
  - Lift off panel.

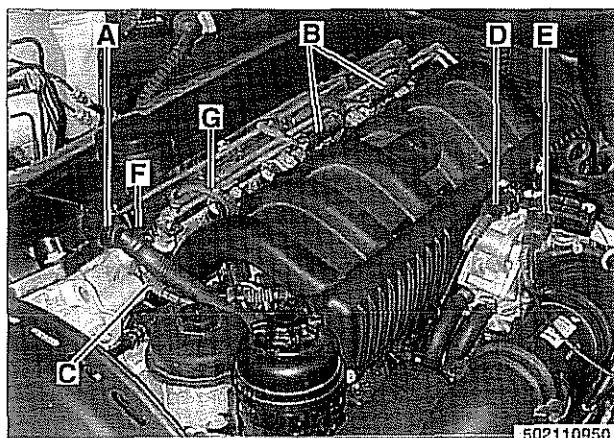


- Remove complete air filter housing:
  - Loosen intake duct hose clamp (A) at throttle assembly.
  - Loosen clamp and remove idle control line from intake duct (B) and (where applicable) disconnect idle speed control valve electrical harness connector.
  - Disconnect harness connector (C) from mass air flow sensor.
  - Remove air filter housing mounting screw (D).
  - Disconnect vent tube (E).
  - Loosen air intake duct clamp (F).
  - Carefully lift air filter housing out of engine bay.

## Engine Removal and Installation



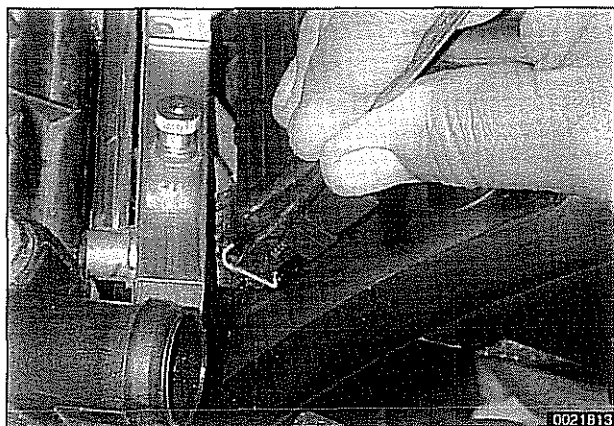
- ◀ Remove positive battery cable and intake manifold cover:
  - Remove protective cover from positive (+) jump start post (A).
  - Loosen and remove battery lead mounting nut.
  - Remove lead and push down through intake manifold.
  - Remove trim covers (arrows) from fuel injector cover.
  - Remove cover hold down bolts and lift off cover.



- ◀ Working above engine, disconnect the following:
  - Vent line from cylinder head cover (A).
  - M52 engine: Oxygen sensor connectors (B).
  - Electrical harness connector from intake camshaft VANOS solenoid valve (C).
  - M52 engine: Disconnect electrical harness connectors at throttle valve position switch (D), ASC valve position switch (E), fuel injector harness (F) and vent valve (G).

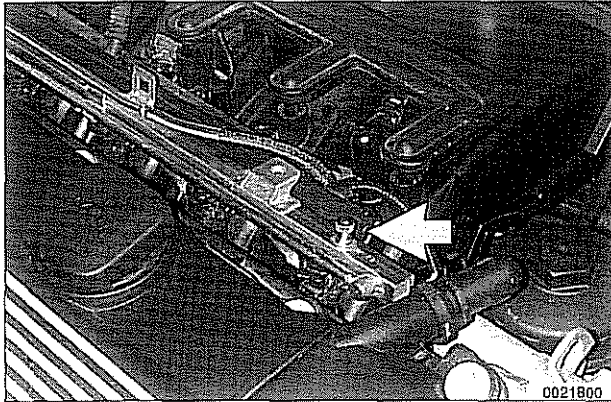
### CAUTION—

*Be sure to mark oxygen sensor harness connectors so that they can be reassembled correctly. Do not interchange connectors.*



- ◀ M52 TU, M54 engine: Disconnect fuel injector electrical connectors from injectors.
  - Use small screwdriver to pry one corner of wire lock clip on fuel injector 1 connector.
  - Repeat for all injectors.
  - Lift off connector loom and lay aside.

## Engine Removal and Installation



- Where applicable, remove schrader valve cap (**arrow**) from air connection on fuel rail. Using a tire chuck, blow fuel back through feed line using a brief burst of compressed air (maximum of 3 bar or 43.5 psi).

### **WARNING —**

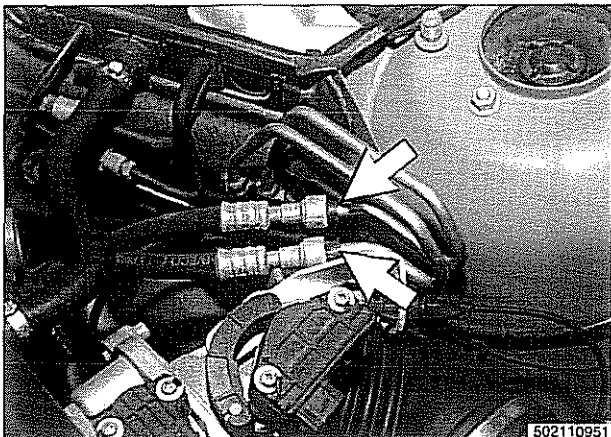
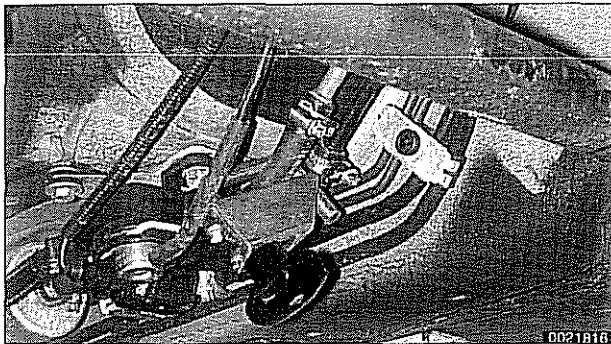
- Fuel in fuel line is under pressure (approx. 3 - 5 bar or 45 - 75 psi) and may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Catch and dispose of escaped fuel. Plug all open fuel lines.
- Always unscrew the fuel tank cap to release pressure in the tank before working on the tank or lines.

- Raise car and support in a safe manner.

### **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.

- Working underneath car, remove protective engine splash guard.
- Working beneath car (on left side under driver seat), remove fuel filter cover and clamp fuel hose(s).



- Disconnect fuel lines by sliding locking collar in (**arrows**) and pulling line apart.

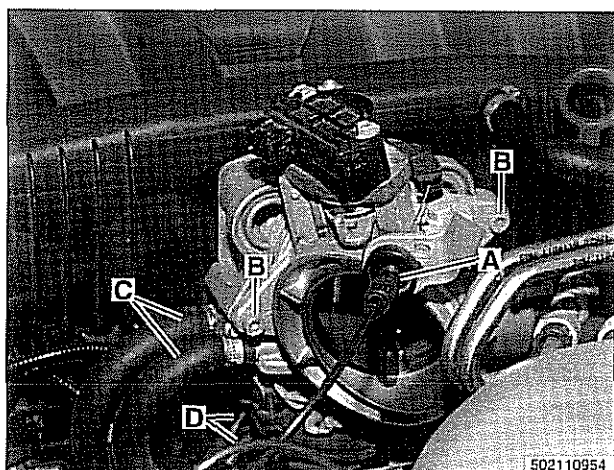
## Engine Removal and Installation

### NOTE —

BMW uses three styles of fuel line connections; a one-time single use clamp, a locking fitting that uses special tool 16 1 050 to release, and a quick release sleeve (arrow) that disconnects the line when depressed.

### WARNING —

Fuel may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Plug all open fuel lines.

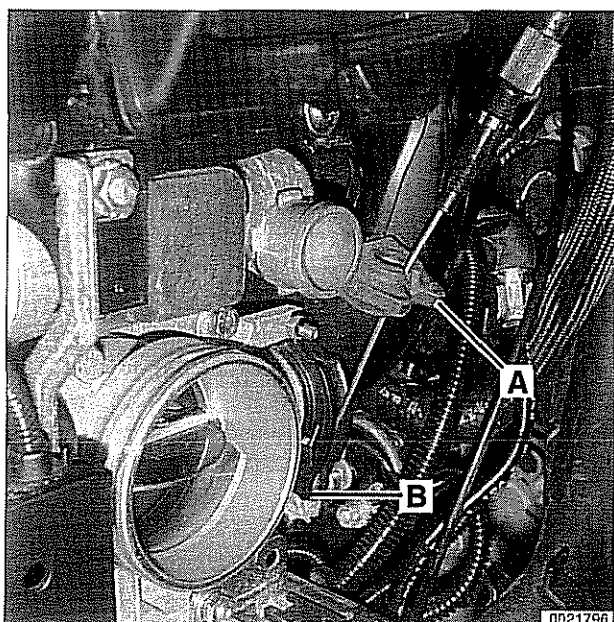


◀ M52 engine: Remove throttle valve and ASC throttle assemblies.

- Disconnect ASC throttle cable (A).
- Remove ASC throttle housing mounting fasteners (B).
- Clamp off, disconnect, and plug coolant hoses (C).
- Disconnect throttle and cruise control cables (D).
- Remove throttle housing mounting hardware and throttle valve.

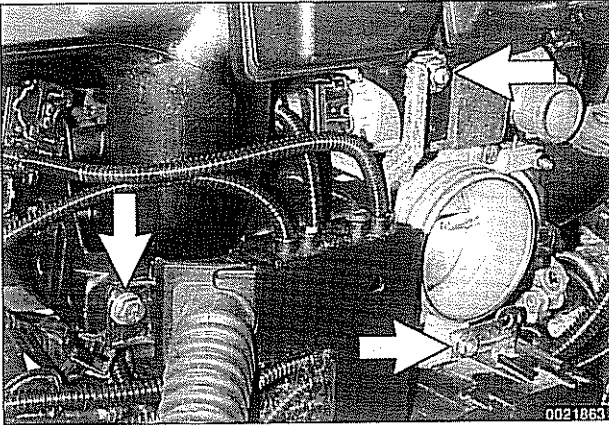
### NOTE —

M52 TU, M54 engine: Throttle body is removed with intake manifold.



◀ M52 TU engine: Pull throttle cable out of rubber retainer (A) and unlock ball end of cable (B) from throttle actuator.

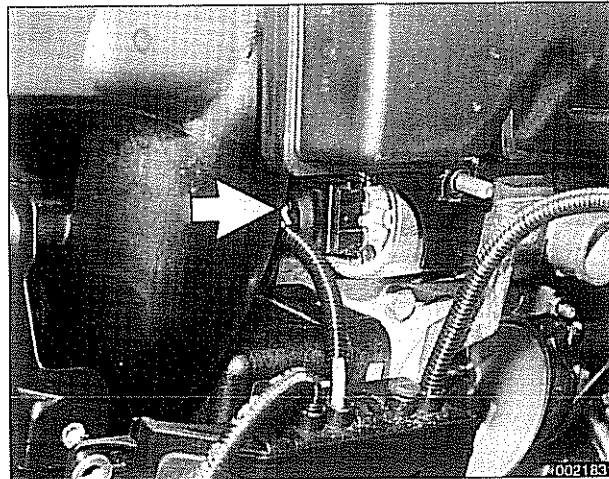
## Engine Removal and Installation



- ◀ M52 TU, M54 engine: Remove fasteners (**arrows**) retaining wiring harness conduit to throttle body.



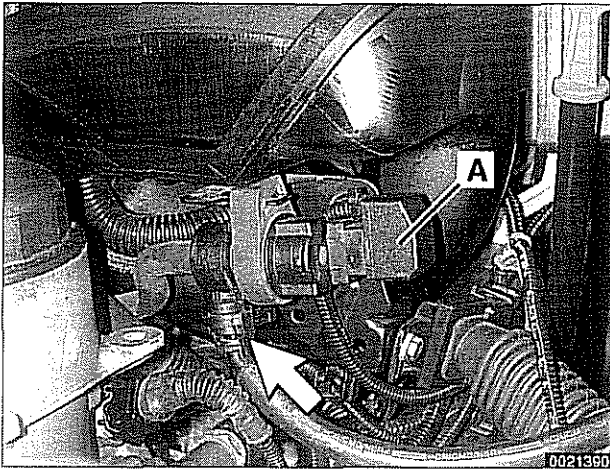
- ◀ M52 TU, M54 engine: Working at throttle housing, rotate harness plug (**arrow**) counterclockwise and remove.



- ◀ M52 TU, M54 engine: Disconnect electrical harness connector at idle speed control valve (**arrow**), directly above throttle valve.

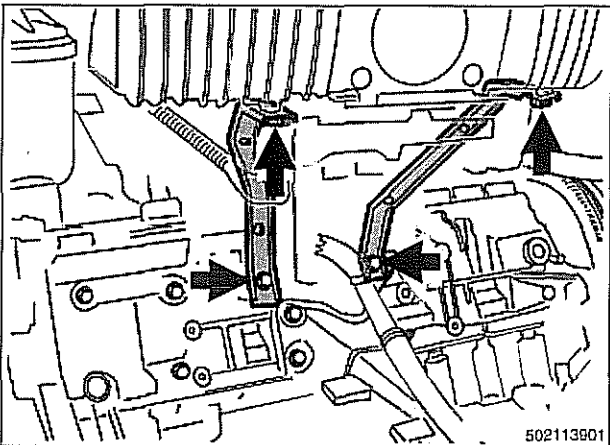


## Engine Removal and Installation

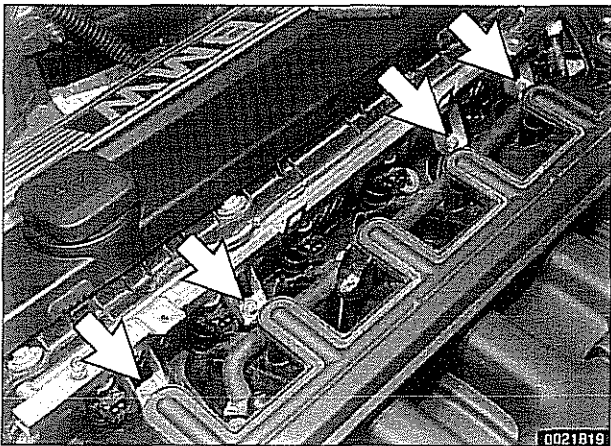


◀ M52 TU, M54 engine: Disconnect electrical harness connector at fuel tank venting valve (A). Disconnect vent hose at fitting (arrow).

- Working under intake manifold, disconnect the following:
  - Engine oil dipstick tube support.
  - Oil separator return line from dipstick tube.
  - Intake air temperature sensor electrical harness connector (underside of intake manifold near throttle body).
  - M52 TU, M54 engine: Resonance valve electrical harness connector.
  - M52 engine: Fuel tank vent line and harness.



◀ Working underneath car, remove lower intake manifold support mounting bolts (arrows).



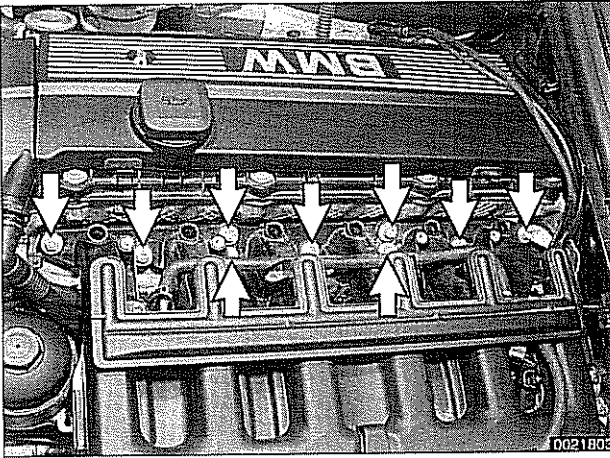
◀ M52 TU, M54 engine: Remove fuel rail mounting bolts (arrows):

- Carefully pry fuel rail off manifold.
- Separate fuel line support bracket at rear of intake manifold.

**NOTE**—

- M52 TU engine shown. M54 engine is similar.
- M52 engine: Fuel rail is removed with intake manifold.

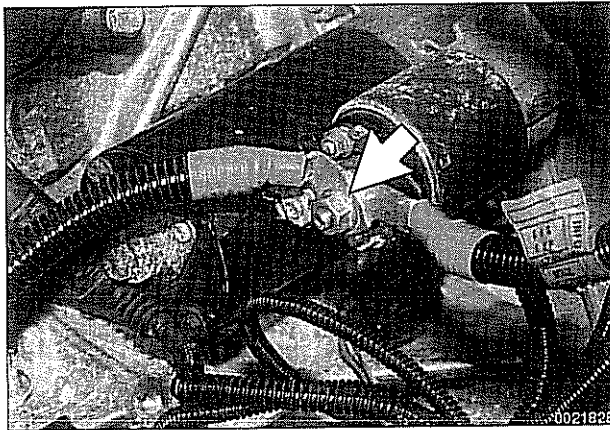
## Engine Removal and Installation



- ◀ Remove intake manifold mounting hardware (arrows).

**NOTE—**

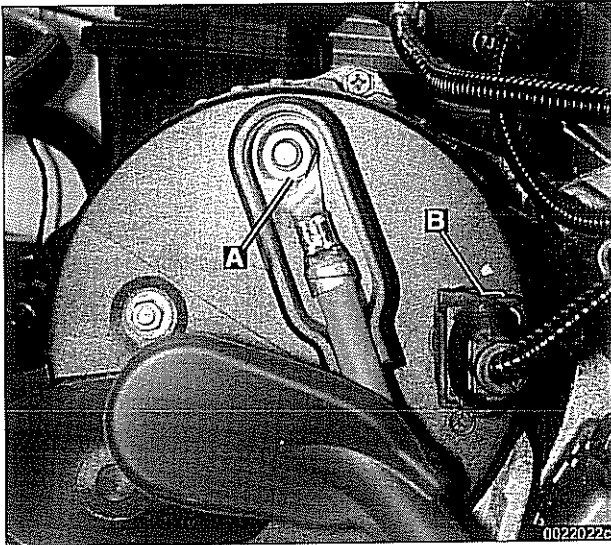
*M52 TU engine shown. M52 and M54 engines are similar.*



- ◀ Lift up manifold just enough to remove positive cables from starter motor terminal 50 (arrow).
- Remove intake manifold from cylinder head while carefully checking for electrical connections, tie wraps, and hoses.

**CAUTION—**

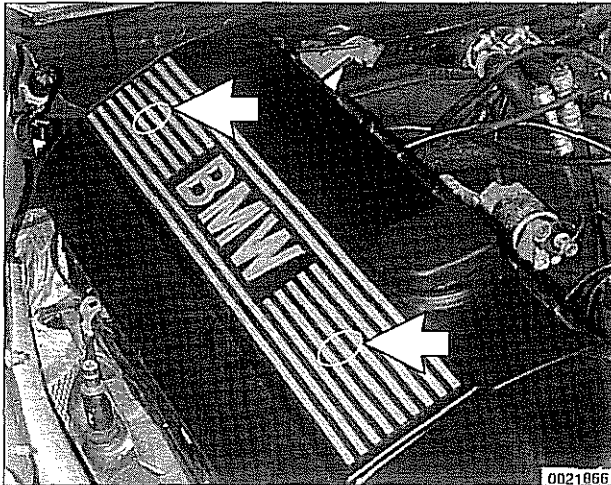
*Stuff clean rags into open intake ports to prevent any parts from falling into the engine intake.*



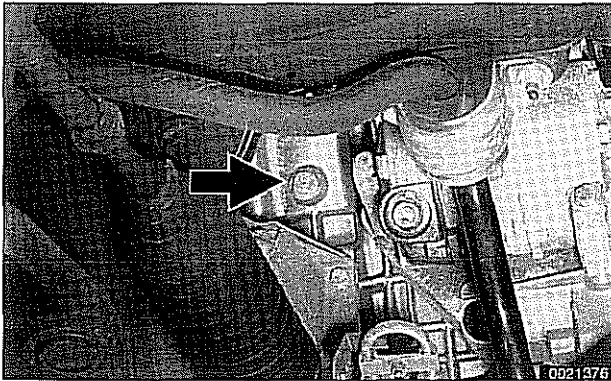
- ◀ Remove fastener (A) and harness connector (B) from alternator.



## Engine Removal and Installation



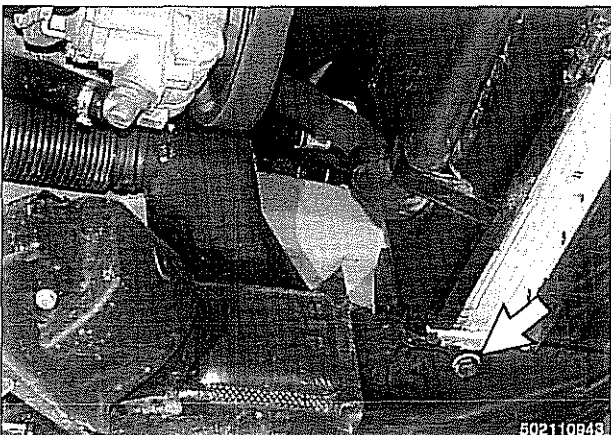
- Remove cylinder head top cover:
  - Remove plastic trim caps (**arrows**).
  - Remove cover retaining fasteners and lift off cover.
- Remove alternator cooling tube.



- Drain engine coolant and remove coolant hoses:
  - Remove expansion tank cap on coolant reservoir.
  - Place a 3 gallon pail beneath engine to capture coolant.
  - Remove coolant drain plug located on exhaust side of cylinder 2 of engine block (**arrow**).

**NOTE** —

*Drain plug for M52 TU and M54 engine shown. Plug for M52 located between cylinders 4 and 5.*



- Drain radiator by removing plastic drain plug (**arrow**) from bottom of radiator.

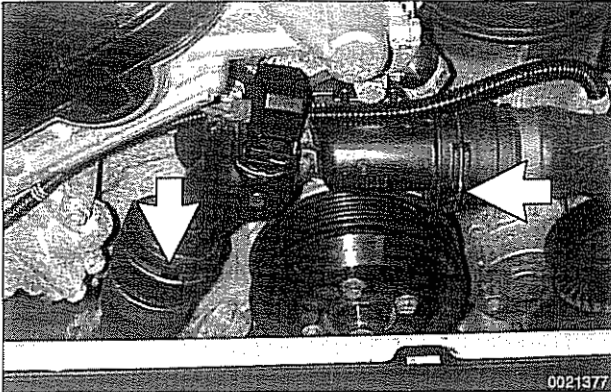
**WARNING** —

*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.*

**NOTE** —

*Catch and dispose of drained coolant according to local, state, and federal laws.*

## Engine Removal and Installation



- Remove hoses from thermostat housing by releasing locks (**arrows**). If applicable, detach electrical harness connector for thermostat housing.

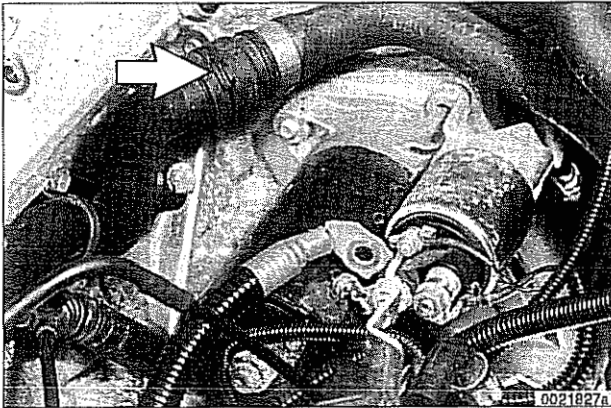
**NOTE—**

*Two different types of hose fasteners are used on the E39 car; lock clamp type as shown above or standard band clamps.*

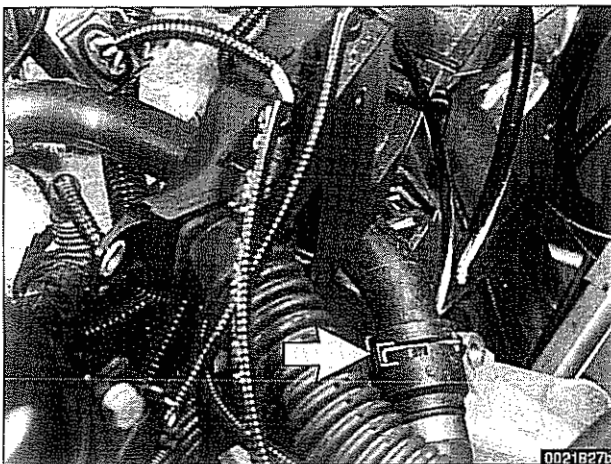
- On vehicles equipped with mechanical cooling fan: Remove belt-driven cooling fan and radiator as described in **170 Radiator and Cooling System**.

**CAUTION—**

*32 mm radiator fan mounting nut has left hand threads.*

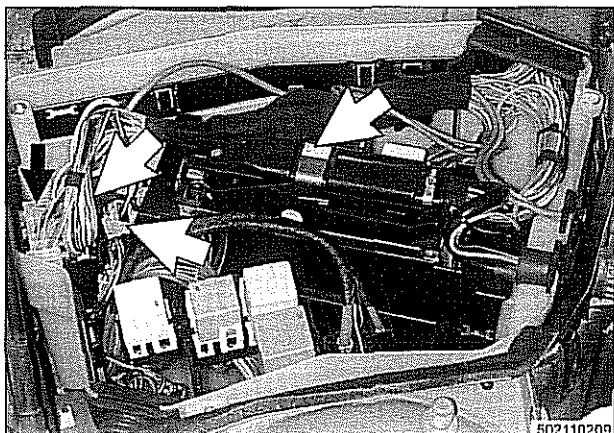


- Disconnect coolant hose (**arrow**) at rear left side of engine above starter.



- Disconnect coolant hose (**arrow**) at front left side of engine mount.
- Unbolt power steering fluid reservoir and pull aside without detaching hoses. Secure to fender with cord or stiff wire.

## Engine Removal and Installation



◀ Working at E-box at right rear of engine compartment:

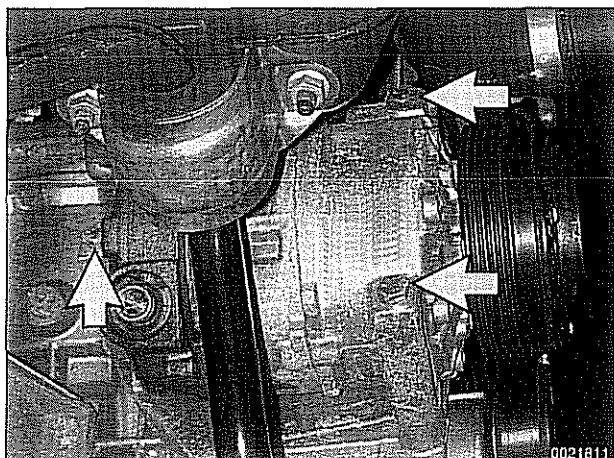
- Disconnect engine electrical harness connectors (arrows).
- Lift off harness looms and lay over engine.

- Remove polyribbed drive belts. Mark direction of rotation if belts will be reused. See **020 Maintenance**.
- Remove exhaust system and transmission from car. See **180 Exhaust System**, **230 Manual Transmission** or **240 Automatic Transmission**.

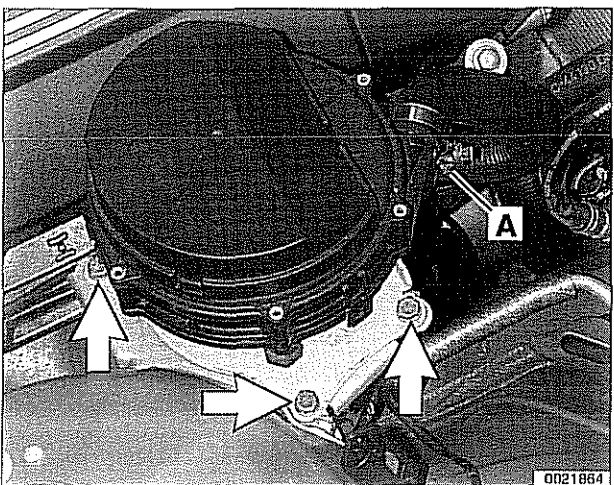
**NOTE—**

*Detach automatic transmission cooler lines from radiator, remove brackets holding lines to side of engine, and store lines in a clean environment.*

- Remove power steering pump:
  - If necessary, remove steering pump pulley.
  - Remove front and rear pump mounting bolts.
  - Suspend pump from body using stiff wire.



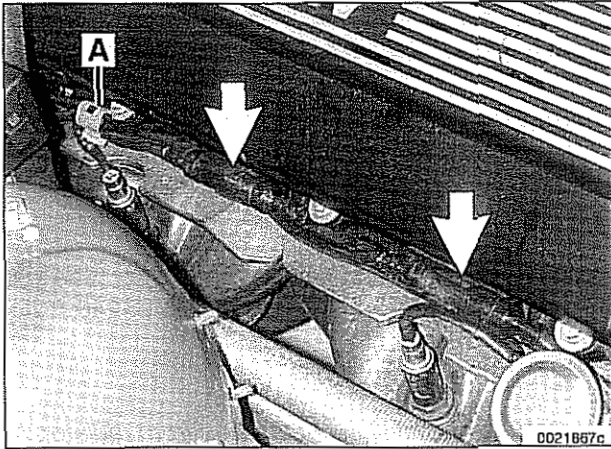
◀ Remove A/C compressor mounting bolts (arrows) and A/C compressor from its mounting bracket without disconnecting, distorting, or deforming any refrigerant lines. Suspend from body using stiff wire.



◀ If applicable, remove secondary air pump:

- Remove hose at one-way valve (A).
- Remove bolts at support bracket on strut tower (arrows).
- Disconnect electrical harness from bottom of secondary air pump.
- Remove bracket from strut tower.

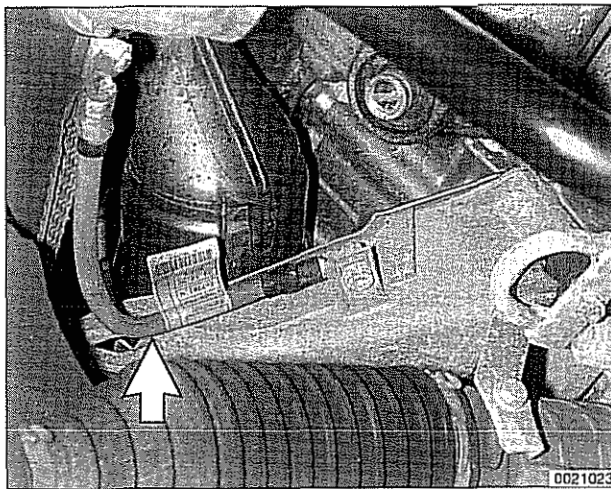
## Engine Removal and Installation



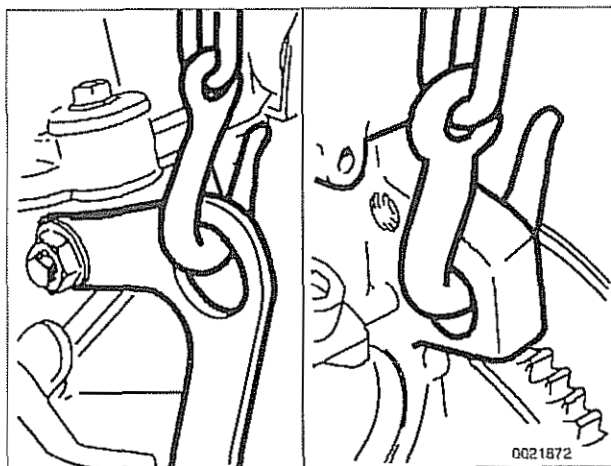
- M52 TU, M54 engine: Separate oxygen sensor electrical harness connectors (**arrows**) and mounting clip (**A**) on right side of engine.

### CAUTION—

*Be sure to mark oxygen sensor connectors so that they can be assembled correctly. Do not interchange connectors.*



- Remove chassis ground strap (**arrow**) at right engine mounting pedestal.



- Install an engine lifting device (BMW 11 0 000 or equivalent) to the front and rear engine supports and raise engine until its weight is supported. Detach left and right engine mounts.
- 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.
  - Use new fuel injector seals.
  - Check that engine drive belts properly engage pulley grooves.
  - Inspect O-ring seal between mass air flow sensor and air filter housing. To facilitate reassembly, coat seal with acid-free grease.
  - Change engine oil and filter and check all other fluid levels. See **020 Maintenance**.
  - Refill and bleed cooling system. See **170 Radiator and Cooling System**.

**CAUTION—**

*When reattaching throttle assembly harness connector, connector is fully tightened when arrows on connector and plug line up.*

**Tightening torques**

Coolant drain plug to cylinder block	25 Nm (18 ft-lb)
Engine mount to subframe (M10)	45 Nm (33 ft-lb)
Exhaust manifold to cylinder head	
M6	10 Nm (89 in-lb)
M7 or M8	20 Nm (15 ft-lb)
Intake manifold to cylinder head	
M7	15 Nm (11 ft-lb)
M8	22 Nm (16 ft-lb)
Radiator cooling fan to coolant pump	40 Nm (30 ft-lb)
Radiator drain screw to radiator	2.5 Nm (22 in-lb)

## ENGINE, REMOVAL AND INSTALLATION (V-8 MODELS)

### NOTE—

- Engine removal procedures are similar for all V-8 models. When differences exist, they are noted at the beginning of each step. Engine are referred to by engine code. If necessary, See **100 Engine-General** for engine code and application information.
- Be sure to 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.

### WARNING—

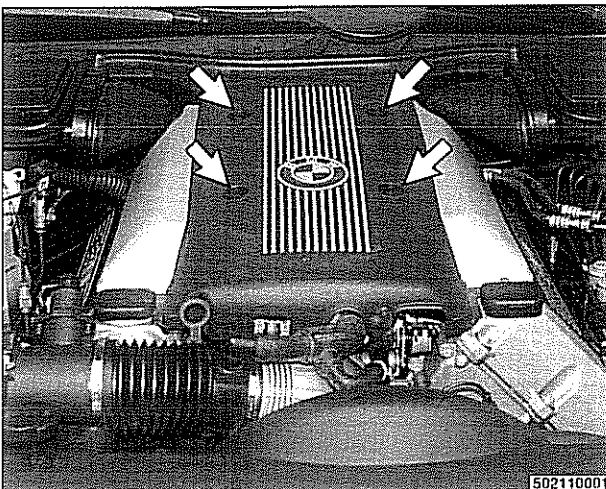
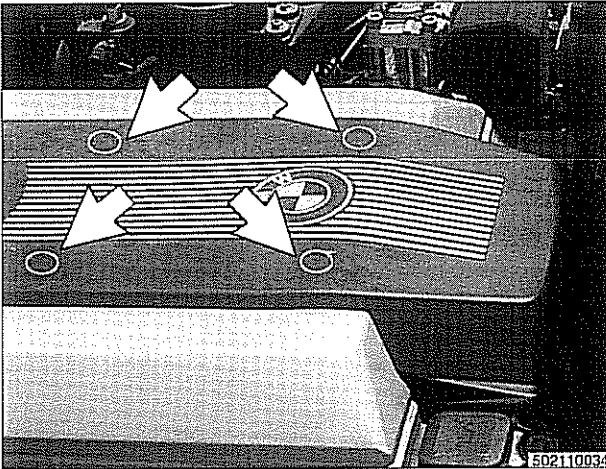
Due to risk of personal injury, be sure the engine is cold before beginning the removal procedure.

- Disconnect negative (–) cable from battery.

### CAUTION—

Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.

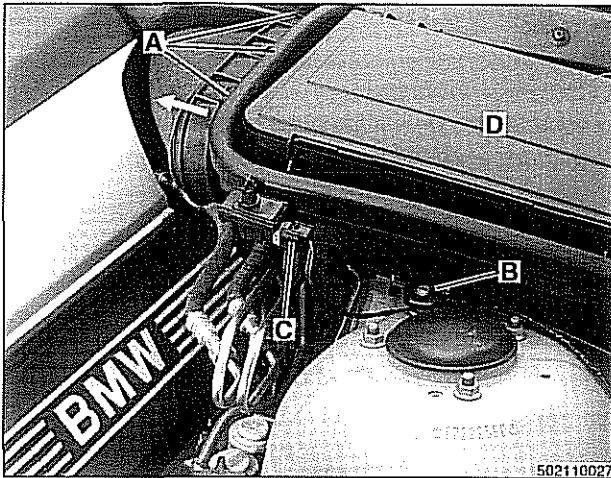
- Remove engine hood or place hood in service position. See **410 Fenders, Engine Hood**.



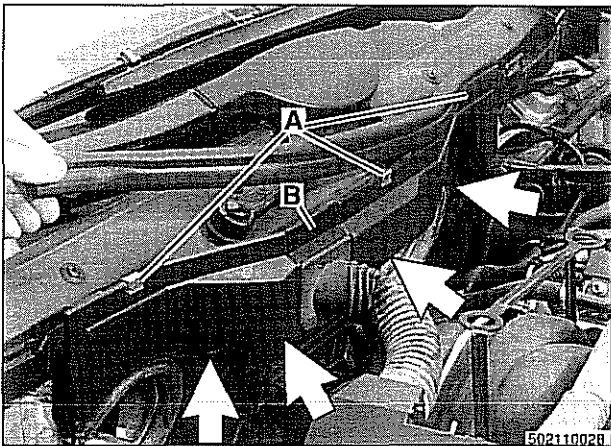
- ◀ Remove intake manifold cover, version 1:
  - Remove plastic trim caps (**arrows**).
  - Remove cover mounting fasteners and lift off cover.
- ◀ Remove intake manifold cover, version 2:
  - Press down on locking pins (**arrows**) to release locks.
  - Lift cover straight up to remove.



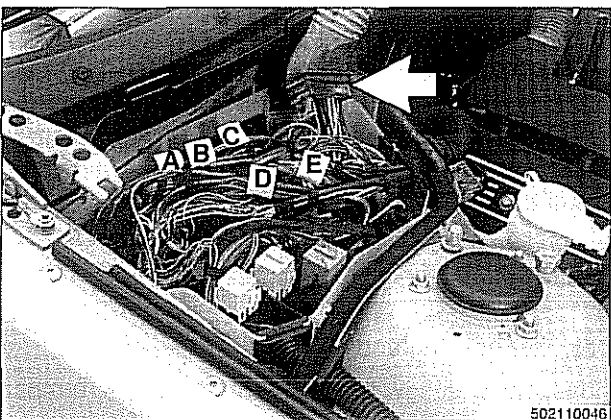
## Engine Removal and Installation



- Remove left interior ventilation duct:
- Release duct locking tabs (A). Early models: release locking strap.
  - Rotate duct inward (arrow) to detach.
  - Release spring lock (B) to unlock ventilation housing.
  - Disconnect electrical harness connector from hood switch (C).
  - Release locking clip and remove ventilation filter cover (D).
  - Slide air housing away from inner fender to remove.
  - Removal of right side ventilation duct is similar.



- Remove rear engine compartment bulkhead panel:
- Remove rubber sealing strip.
  - Remove 3 mounting clips (A).
  - Remove harness supporting clip (B).
  - Unlock panel retainers (arrows).
  - Lift out panel.

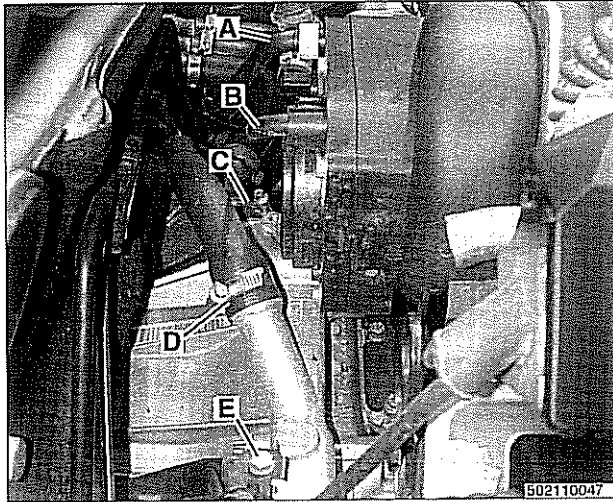


- Separate engine wiring harness (arrow) from electrical box at right side of engine compartment:
- Remove E-box cover.
  - Disconnect electrical harness connectors leading from engine wiring harness (arrow). Connectors are labelled (A, B, C, D, E) for locating purposes.
  - Lay engine harness on top of engine.
- Drain engine coolant from engine block and radiator. See **170 Radiator and Cooling System**.
- Remove drain plugs from right and left side of engine block (between cylinders 2/3 and 6/7).
  - After coolant has drained, reinstall drain plugs using new sealing washers.
  - Drain radiator and reinstall drain plug.

### Tightening torques

Coolant drain plug to cylinder block (M14)	25 Nm (18 ft-lb)
Radiator drain screw to radiator	2.5 Nm (22 in-lb)

## Engine Removal and Installation



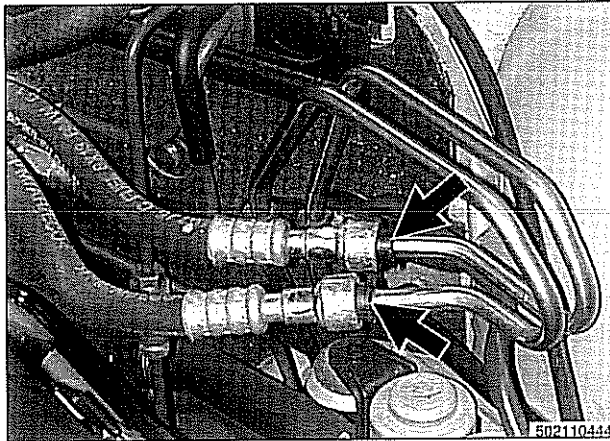
### WARNING —

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.

- ▶ Working at rear of intake manifold:
  - Disconnect brake booster vacuum line (A).
  - Disconnect fuel tank vent line (B).
  - Disconnect hoses (C and D) at coolant manifold.
  - Remove transmission harness support (E).
- Remove oil filter housing assembly from fender:
  - Remove oil filter housing mounting fasteners.
  - Use stiff wire to secure oil filter housing to engine.

### NOTE —

Do not disconnect oil lines from filter housing.



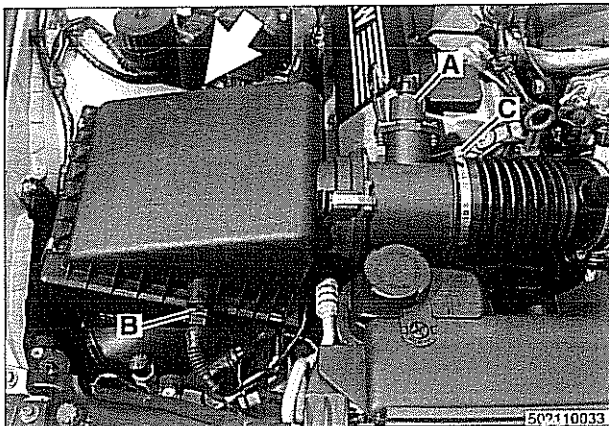
- ▶ Disconnect supply and return fuel lines (where applicable) at or near fuel rail. Plug open fuel lines.

### NOTE —

BMW uses three styles of fuel line connections; a single use clamp, a locking fitting that uses special tool 16 1 050 to release, and a quick release sleeve (arrows) that disconnects the line when depressed.

### WARNING —

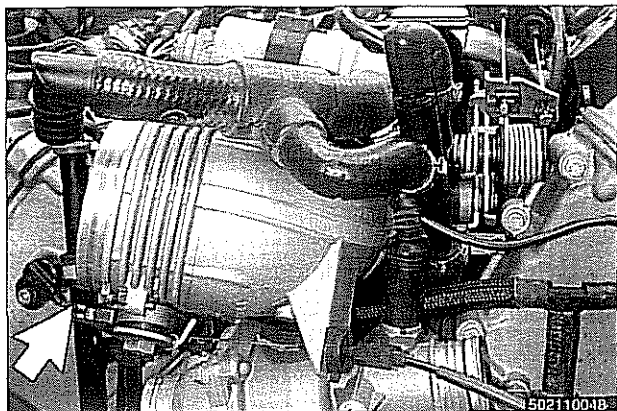
- Fuel in fuel line is under pressure (approx. 3 - 5 bar or 45 - 75 psi) and may be expelled. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Catch and dispose of escaped fuel. Plug all open fuel lines.
- Always unscrew the fuel tank cap to release pressure in the tank before working on the tank or lines.



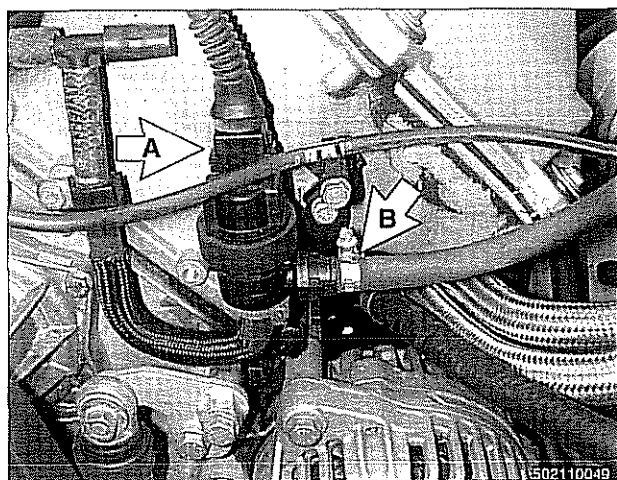
- ▶ Remove air filter housing and mass air flow sensor:
  - Disconnect mass air flow sensor (A) and intake air temperature sensor (B) electrical harness connectors.
  - Remove air filter housing mounting fastener (arrow).
  - Loosen intake hose clamp (C).
  - M62 engine: Remove hose at idle air stabilizer.
  - Remove air filter housing with mass air flow sensor.
  - Remove intake hose from throttle body.



## Engine Removal and Installation



- M62 engine, remove ASC throttle body.
  - Disconnect electrical harness from throttle position sensor.
  - Disconnect ASC actuator cable (arrow).
  - Remove mounting fasteners and remove throttle body.



- On front of left side cylinder head, disconnect electrical harness connector (A), and remove and plug fuel tank vent valve vacuum line (B).
- Raise car and support in a safe manner.

### CAUTION—

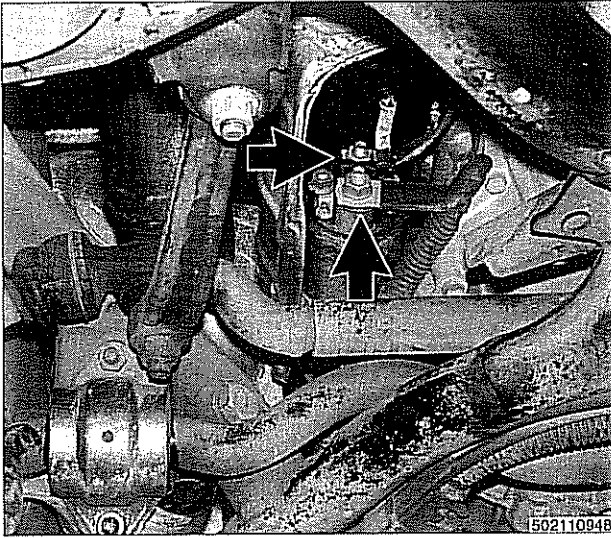
*Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

- Working beneath car:
  - Remove engine splash shield.
  - Remove right and left heat shield from front suspension subframe.



- Working underneath engine compartment, disconnect ground cable on right side engine mount (arrow).

## Engine Removal and Installation

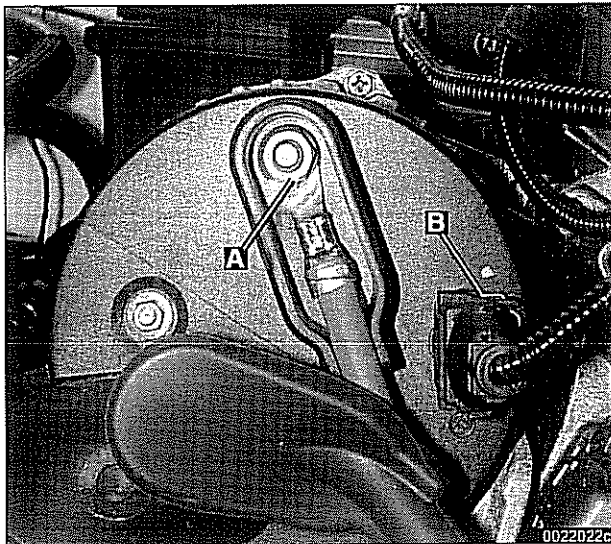


Working at right side of transmission bellhousing, disconnect electrical harness connections (**arrows**) from starter. Remove starter retaining bolts and remove starter from transmission mount.

- M62 TU engine: Disconnect electrical harness connector for right oxygen sensor from retaining clip and remove retaining clip from transmission.

Working underneath engine compartment at left side:

- Unclip positive battery cable from oil pan.
- Remove alternator cooling duct.



M62 engine: Remove fastener **A** and plug connector **B** from alternator.

M62 TU engine: Remove electrical harness connectors from front of water cooled alternator.

Remove exhaust system and transmission. See **180 Exhaust System** and **230 Manual Transmission** or **240 Automatic Transmission**.

Working at front of engine:

- Remove upper and lower hoses from radiator.
- Disconnect expansion tank hose from coolant pump.

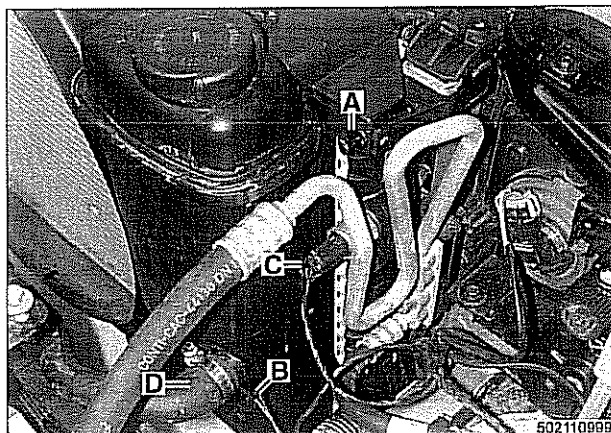
Remove belt-driven cooling fan:

- Counterhold fan with special tool 11 5 050.
- Turn fan mounting nut (32 mm) clockwise (left hand threads) to loosen.
- Rotate fan clockwise to remove.

Remove cooling fan shroud:

- Disconnect electrical connectors from coolant level sensor (**B**) and coolant temperature sensor (**C**).
- Remove expansion rivets (**A**) from each side of shroud.
- Remove coolant hose (**D**).
- Slide fan shroud with expansion tank up. Remove radiator overflow tube from spout of expansion tank. Remove radiator fan shroud with expansion tank.

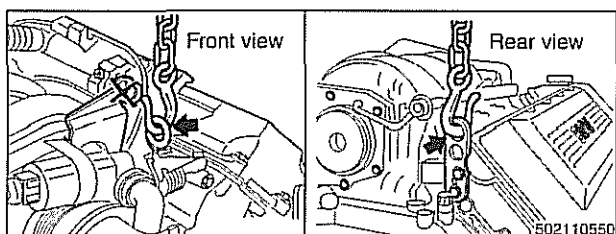
Remove radiator. See **170 Radiator and Cooling System**.



## Engine Removal and Installation



- ◀ Remove polyribbed A/C compressor belt:
  - Mark direction of belt travel if belts are to be reused.
  - Loosen bolts (A).
  - Turn adjusting lug (B) clockwise to release belt tension.
- Working beneath car, remove power steering pump and air conditioner compressor. Suspend from body using stiff wire.
- Remove exhaust manifolds. See **180 Exhaust System**.



- ◀ Install engine lifting device (BMW 11 0 000 or equivalent) to front and rear engine supports and raise engine until its weight is supported. Detach engine mounts.
  - Watch carefully for hoses and electrical wires that might snag.
- Installation is reverse of removal:
  - Replace all gaskets, O-rings and seals.
  - V-8 engine mounts have two sets of mounting holes. E39 cars use front most mounting holes.
  - On cars with automatic transmission, use new O-rings at ATF cooler lines.
  - Use new alignment sleeves when installing transmission.
  - Be sure engine drive belts properly engage pulley grooves. When installing belt, preload tensioner to stop (toward belt), then tighten tensioner clamping nut.
  - Install front exhaust pipes using new gaskets and copper paste and new mounting hardware. See **180 Exhaust System**.
  - Change engine oil and filter. Check all other fluid levels as described in **020 Maintenance**.
  - Refill and bleed cooling system as described in **170 Radiator and Cooling System**.

### CAUTION—

*Do not interchange knock sensor harness connectors. Serious engine damage may result.*

## Engine Removal and Installation

### Tightening torques

ATF cooler lines to radiator (use new O-rings)	
M18 cap nut	20 Nm (15 ft-lb)
M22 cap nut	22 Nm (17 ft-lb)
Coolant drain plug to cylinder block (M14)	25 Nm (18 ft-lb)
Engine mount to engine bracket or subframe (M10)	47 Nm (35 ft-lb)
Exhaust flange nuts (8 mm)	25 Nm (18 ft-lb)
Radiator cooling fan to coolant pump (left-hand threads)	40 Nm (30 ft-lb)
Radiator drain screw to radiator	2.5 Nm (22 in-lb)
Wiring to alternator (M8 nut)	13 Nm (9.5 ft-lb)



# 113 Cylinder Head Removal and Installation

<b>General</b> .....	113-2	<b>Double VANOS Timing</b>	
Special tools .....	113-2	<b>Chain Components</b> .....	113-46
<b>Diagnostic Testing</b> .....	113-5	Double VANOS timing chain components,	
Cylinder compression, checking .....	113-5	installing, M52 TU and M54 engines .....	113-46
Wet compression test .....	113-7	<b>Cylinder Head Removal and Installation</b>	
Cylinder leak-down test .....	113-8	<b>(M62 Engine)</b> .....	113-56
<b>Cylinder Head Removal and Installation</b>		Intake manifold, removal and installation,	
<b>(M52 Engine)</b> .....	113-8	M62 engine .....	113-66
Cylinder head, removing, M52 engine .....	113-8	Left cylinder head, removing,	
Cylinder head, installing, M52 engine .....	113-17	M62 engine .....	113-61
<b>Cylinder Head Removal and Installation</b>		Left cylinder head, installing,	
<b>(M52 TU and M54 Engines)</b> .....	113-22	M62 engine .....	113-66
Cylinder head, removing, M52 TU		Right cylinder head, removing,	
and M54 engines .....	113-22	M62 engine .....	113-72
Cylinder head, installing, M52 TU		Right cylinder head, installing,	
and M54 engine .....	113-39	M62 engine .....	113-77

## GENERAL

This group covers cylinder head removal and installation as well as cylinder head/valve diagnostic procedures.

In the procedures in this repair group, engines are referred to by engine code. If necessary, see **100 Engine-General** for engine code and application information.

The information given in this repair group assumes that the engine is installed in the engine bay. On the 6-cylinder engines, the VANOS control unit must be removed in order to remove the cylinder head from the engine block. On M52 TU and M54 engines, camshafts must be removed from the cylinder head before the head is removed.

The cylinder head removal and installation procedures for the M62 V-8 are also included, but the procedures for the M62 TU V-8 with VANOS are not provided.

For cylinder head and valvetrain reconditioning information, see **116 Cylinder Head and Valvetrain**.

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

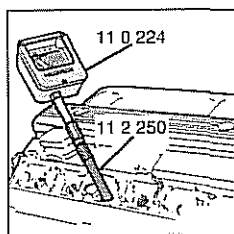
- **020 Maintenance**
- **116 Cylinder Head and Valvetrain**
- **117 Camshaft Timing Chain**
- **170 Radiator and Cooling System**
- **610 Component locations**

### NOTE—

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

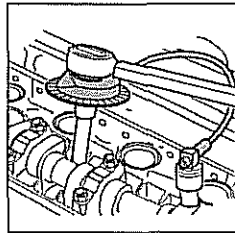
## Special tools

Special BMW service tools are required to properly remove and install the cylinder head on engines covered by this manual. The special tools are used to time the valvetrain to the crankshaft, and to remove the VANOS control unit, the camshafts and the Torx (E12) head bolts. Read the entire procedure through before beginning the job.

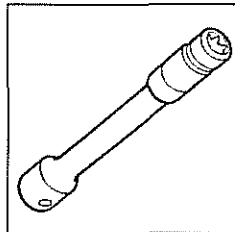


◀ Compression gauge  
(Tool No. BMW 11 0 224/11 2 250)

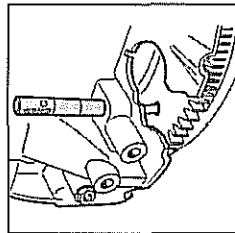
## Cylinder Head Removal and Installation



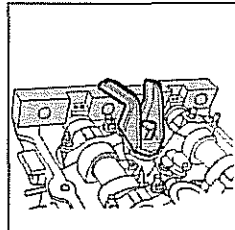
- Rotary angle torque dial gauge  
(Tool No. BMW 11 2 250/00 9 120)



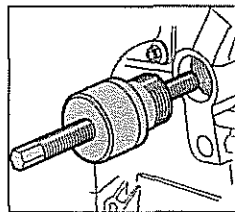
- E12 Torx socket for cylinder head bolts  
(Tool No. BMW 11 2 250)



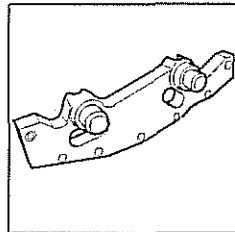
- Crankshaft locking tool  
(Tool No. BMW 11 2 300)



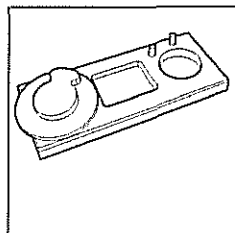
- Camshaft locking tool set, 6-cylinder  
(Tool No. BMW 11 3 240)



- Timing chain adjustable tension setup tool, 6-cylinder  
(Tool No. BMW 11 4 220)

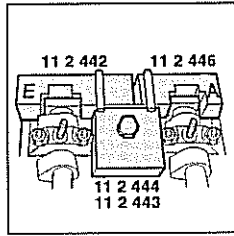


- Double VANOS adjustment plate  
(Tool No. BMW 11 6 150)

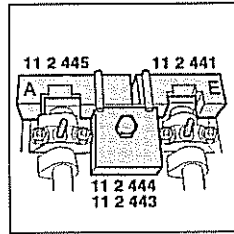


- Secondary sprocket setup tool for double VANOS  
(Tool No. BMW 11 6 180)

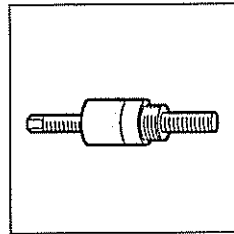
**Cylinder Head Removal and Installation**



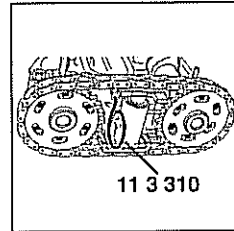
◀ Camshaft locking tools (cyl. 5–8), V-8  
(Tool No. BMW 11 2 442/11 2 446/11 2 443/11 2 444)



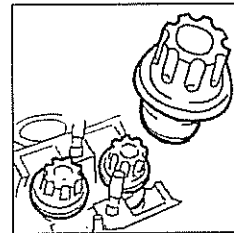
◀ Camshaft locking tools (cyl. 1–4), V-8  
(Tool No. BMW 11 2 445/11 2 441/11 2 443/11 2 444)



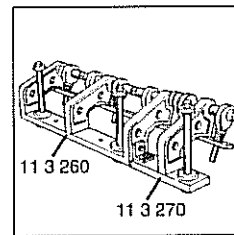
◀ Timing chain adjustable tension setup tool, V-8  
(Tool No. BMW 11 3 390)



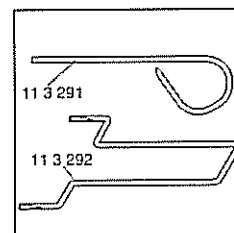
◀ Secondary timing chain tensioner locking pin, V-8  
(Tool No. BMW 11 3 310)



◀ Hydraulic lifter securing plugs  
(Tool No. BMW 11 3 250)

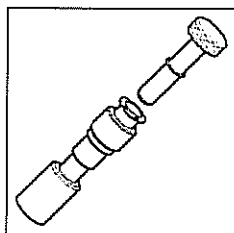


◀ Camshaft bearing cap tensioner (6-cylinder)  
for camshaft removal and installation  
(Tool No. BMW 11 3 260/11 3 270)

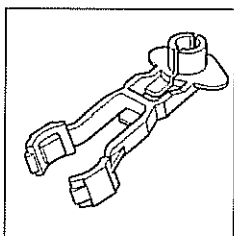


◀ Secondary timing chain tensioner lock set  
(Tool No. BMW 11 3 291/11 3 292)

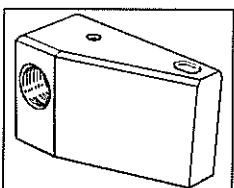




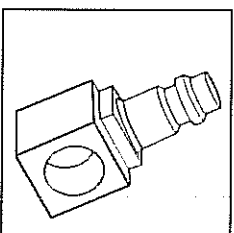
- ▶ Fuel line plugs  
(Tool No. BMW 13 5 281/13 5 282)



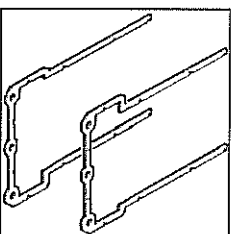
- ▶ Fuel line removal tool for quick-disconnect fittings  
(Tool No. BMW 16 1 050)



- ▶ Tensioning bracket (V-8)  
(Tool No. BMW 11 7 380)



- ▶ Compressed air fitting for testing VANOS operation  
(Tool No. BMW 11 3 450)



- ▶ Upper timing cover installation tool set, V-8  
(Tool No. BMW 11 1 410)

## DIAGNOSTIC TESTING

### Cylinder compression, checking

A compression gauge is needed to make a compression test. For 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 tools or an equivalent aftermarket scan tool. Disconnecting the battery will not erase the fault memory or turn out the light. See **OBD On-Board Diagnostics**.*

## Cylinder Head Removal and Installation

- Disable ignition system by removing DME main relay. See **610 Component Locations** for relay location.

### 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.*

### CAUTION—

*Failure to remove the DME main relay or attempting to disable the fuel and ignition systems by other methods may result in damage to the engine control module (ECM).*



- Remove plastic cylinder head cover(s).
- Pull up on spring clips to disconnect ignition coil harness connectors at each cylinder.
- Remove coil grounding straps.

### CAUTION—

*Note location of all grounds. Failure to reinstall grounds can result in permanent damage to engine control module or ignition system components.*

- Remove coils.
- Remove spark plugs from all cylinders.

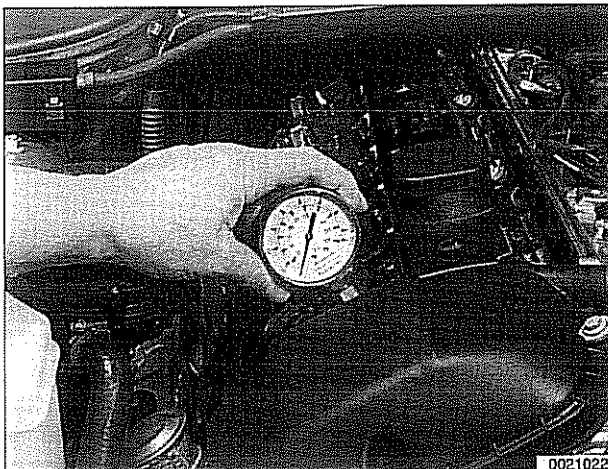
### NOTE—

*Check the spark plugs for oil deposits that may indicate poor cylinder sealing, then set them aside in order. Used spark plugs should be reinstalled in the same cylinder from which they were removed.*

- Install compression gauge in first cylinder spark plug hole, tight enough to form a good seal.
- With parking brake set, transmission in PARK or NEUTRAL, and accelerator pedal pressed to floor, 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.*



## Cylinder Head Removal and Installation

- 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 **Table a**.

**Table a. Compression testing specifications**

Minimum compression	
6-cylinder	10–11 bar (142–156 psi)
V-8	12–14 bar (174–203 psi)
Maximum difference between cylinders (all engines)	
	0.5 bar (7 psi)

- Compression readings may be interpreted as follows:
  - Low compression 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 and ignition coils.

**NOTE** —

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

**Tightening torque**

Spark plug to cylinder head	25 Nm (18 ft-lb)
Ignition coils to cylinder head	10 Nm (7.5 ft-lb)

- Remainder of installation is reverse of removal. Be sure to re-install all wires disconnected during test, especially ground wires at coils and cylinder head cover (where applicable).

### Wet compression test

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

- Repeat compression test, 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 HEAD REMOVAL AND INSTALLATION (M52 ENGINE)

### **WARNING—**

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

Cylinder head removal and installation is a time consuming repair procedure requiring multiple special service tools. Read the entire procedure before beginning the repair.

This procedure includes the following steps:

- Cylinder head, removing, M52 engine
- Cylinder head, installing, M52 engine

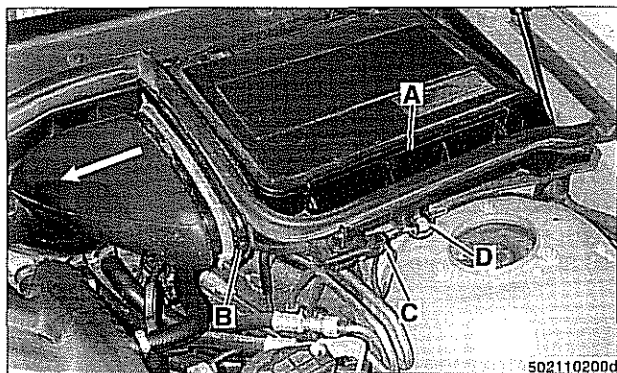
### Cylinder head, removing, M52 engine

- Disconnect negative (–) cable from battery in luggage compartment.

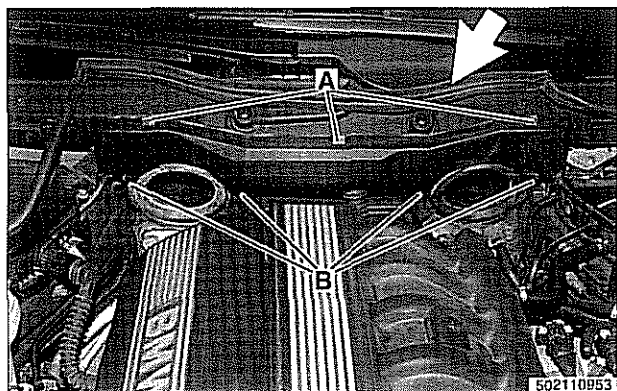
### **CAUTION—**

*Prior to disconnecting the battery, read the battery disconnection cautions in 001 General Cautions and Warnings.*

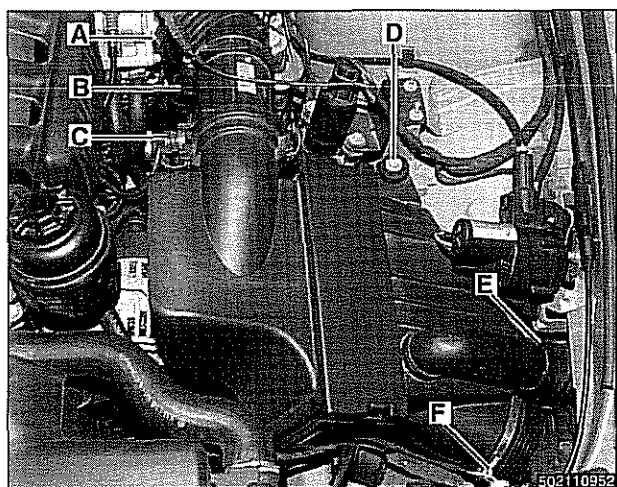
## Cylinder Head Removal and Installation



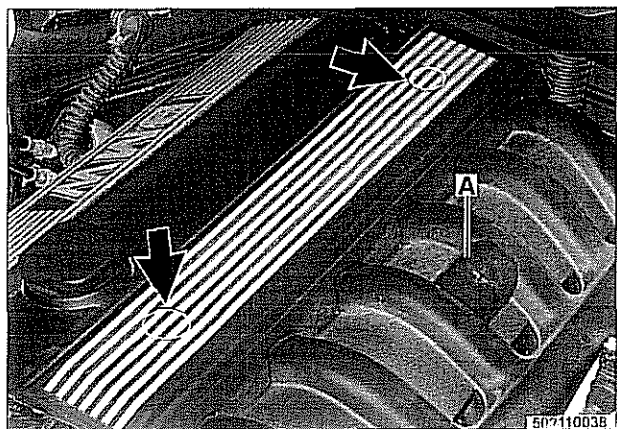
- Remove left and right interior ventilation ducts (left shown):
  - Release ventilation filter cover latch (A) and remove cover.
  - Release plastic locking tab (B) or release locking tabs on top of duct (later models).
  - Rotate duct counterclockwise to unlock from bulkhead and remove (arrow).
  - Disconnect electrical connector from hood switch (C).
  - Release spring lock (D).
  - Slide filter housing away from inner fender to remove.
  - Removal of right side ventilation duct is similar.



- Remove rear bulkhead panel:
  - Remove rubber sealing gasket (arrow).
  - Remove 3 mounting clips (A).
  - Remove 4 retaining screws (B).
  - Lift out panel.

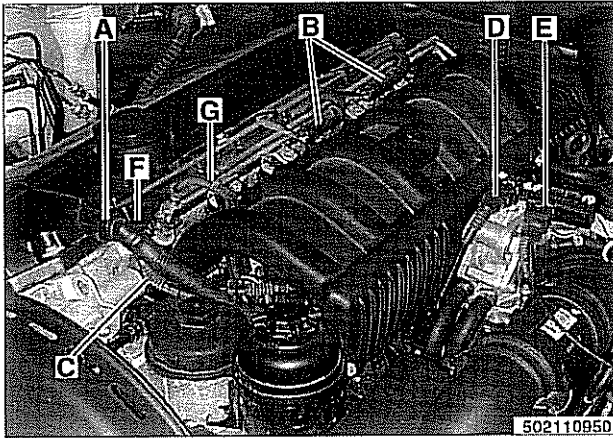


- Remove complete air filter housing:
  - Loosen intake duct hose clamp (A) at throttle assembly.
  - Loosen clamp and remove idle control hose from intake duct (B) and disconnect idle speed control valve electrical harness connector.
  - Disconnect electrical harness connector (C) from mass air flow sensor.
  - Remove air filter housing mounting screw (D).
  - Disconnect vent tube (E).
  - Loosen air intake duct clamp (F).
  - Carefully lift air filter housing out of engine bay.



- Remove positive battery cable and intake manifold cover:
  - Remove protective cover from positive (+) jumper post (A).
  - Loosen and remove battery lead mounting nut.
  - Remove battery lead and push down through intake manifold.
  - Remove trim caps (arrows) from fuel injector cover.
  - Remove cover hold down fasteners and lift off cover.

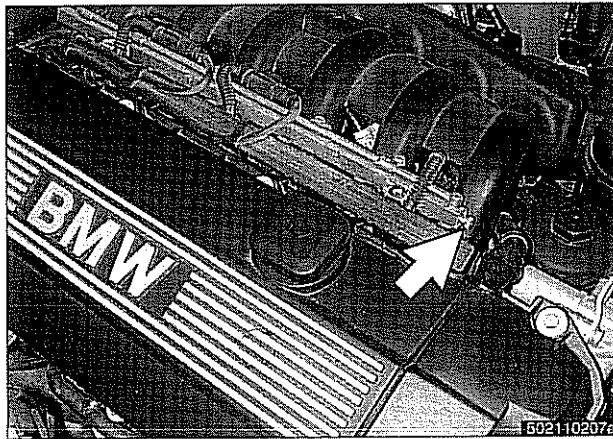
## Cylinder Head Removal and Installation



- Working above engine, disconnect the following:
- Vent line from cylinder head cover (A).
  - Oxygen sensor connectors (B).
  - Electrical harness connector from VANOS solenoid valve (C).
  - Electrical harness connectors at throttle valve position switch (D), ASC valve position switch (E), fuel injector harness (F) and vent valve (G).

### CAUTION—

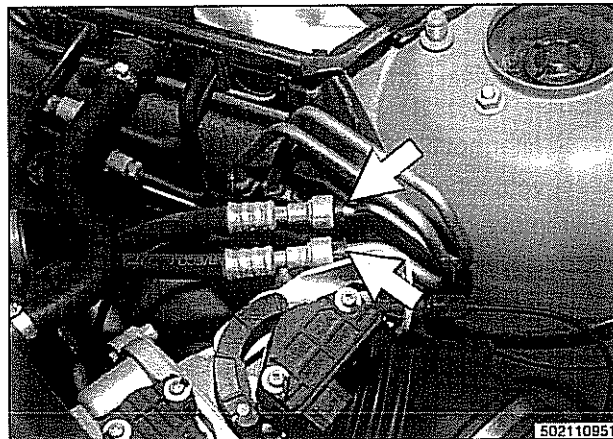
Be sure to mark oxygen sensor harness connectors so that they can be reassembled correctly. Do not interchange connectors.



- Where applicable, remove schrader valve cap (arrow) from air connection on fuel rail. Using a tire chuck, blow fuel back through feed line using a brief burst of compressed air (maximum of 3 bar or 43.5 psi).

### WARNING—

- Fuel in fuel line is under pressure (approx. 3 - 5 bar or 45 - 75 psi) and may be expelled. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Catch and dispose of escaped fuel. Plug open fuel lines.
- Always unscrew the fuel tank cap to release pressure in the tank before working on the tank or lines.

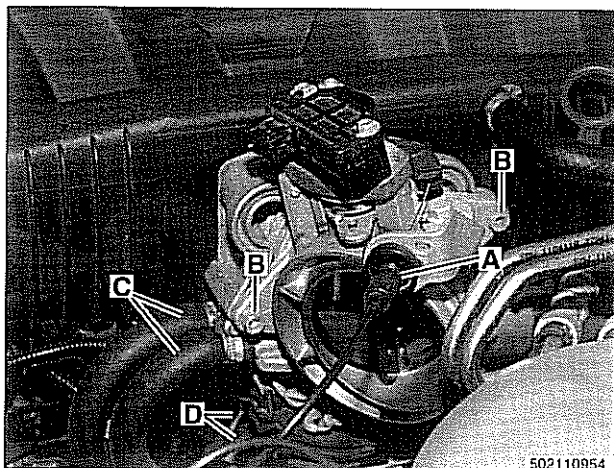


- Disconnect fuel lines by sliding locking collar in (arrows) and pulling lines apart.

### NOTE—

BMW uses three styles of fuel line connections; a one-time use clamp; a locking fitting that uses BMW special tool 16 1 050 to release; and a quick release sleeve (above) that disconnects the line when depressed.

## Cylinder Head Removal and Installation



Remove intake throttle valve and ASC throttle assemblies:

- Disconnect ASC throttle cable (A).
- Remove ASC throttle housing mounting fasteners (B).

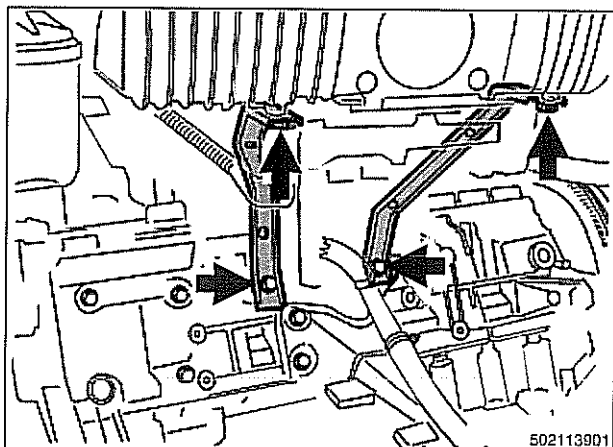
**NOTE—**

*It is not necessary to disconnect coolant hoses (C) or bowden cables (D).*

- Remove intake throttle housing mounting hardware, pull throttle housing off intake manifold, and set aside.
- Working under intake manifold, disconnect the following:
- Engine oil dipstick tube support.
  - Oil separator return line from dipstick tube.
  - Intake air temperature sensor electrical harness connector (underside of intake manifold near throttle body).
  - Fuel tank vent line and electrical harness at canister vent valve.

Remove lower intake manifold supports (arrows).

- Disconnect coolant line retaining bracket at cylinder block.



Remove manifold mounting hardware (arrows).

- Remove intake manifold from cylinder head while carefully checking for electrical connections or hoses.

**NOTE—**

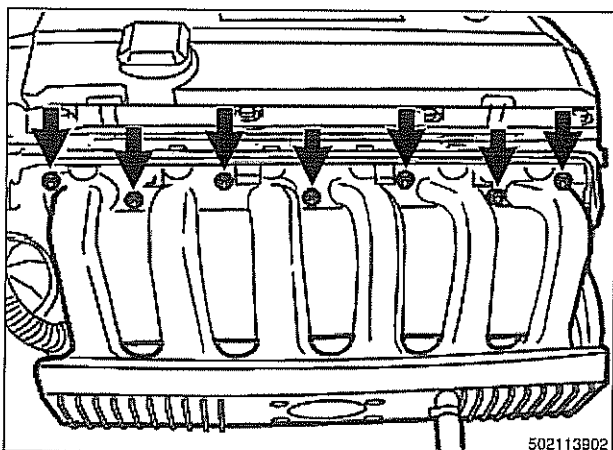
*Fuel rail is removed with intake manifold.*

**CAUTION—**

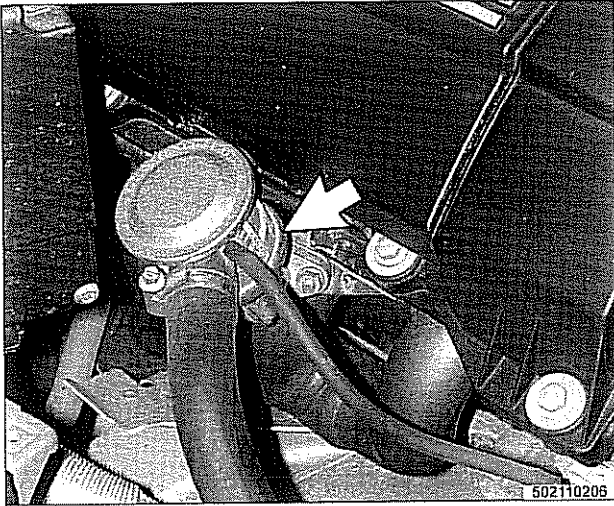
*Stuff clean rags into open intake ports to prevent any parts from falling into the engine intake.*

- Drain cooling system (engine block and radiator), then remove radiator cooling fan and fan shroud. See **170 Radiator and Cooling System**.

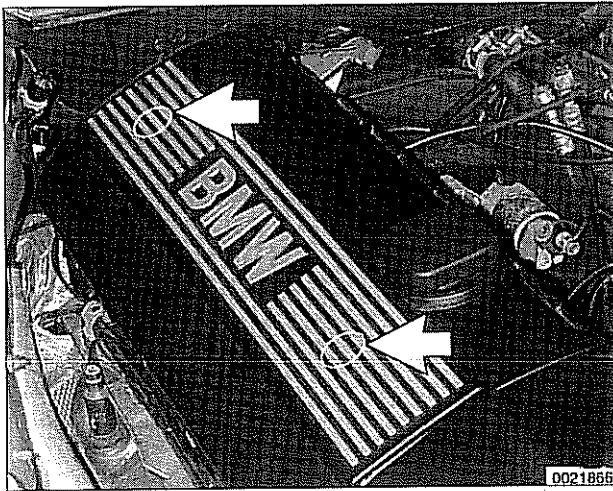
- Disconnect coolant hoses from thermostat housing.



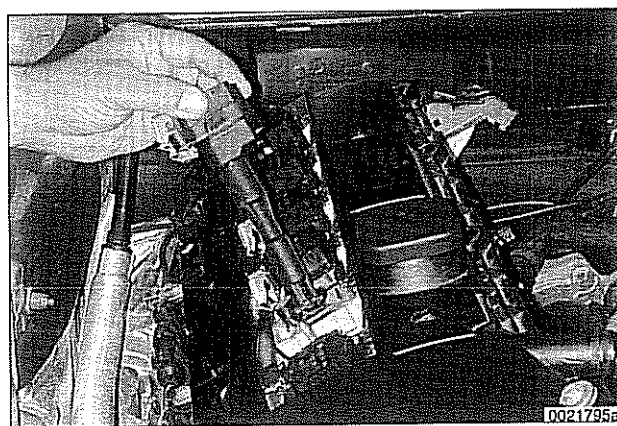
## Cylinder Head Removal and Installation



- ◀ Remove secondary air injection check valve (arrow).



- ◀ Remove cylinder head top cover:
  - Remove plastic trim caps (arrows).
  - Remove engine oil filler cap.
  - Remove cover hold down fasteners and lift off cover.



- ◀ Remove ignition coils:
  - Disconnect ignition coil harness connectors.
  - Remove coil mounting fasteners.
  - Remove coils.
  - Remove ground straps.

**NOTE —**

*Make note of ground wire at mounting studs arrangement during removal.*

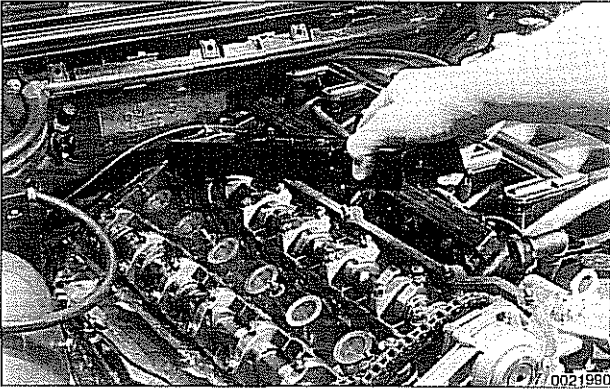
- Remove spark plugs.
- Remove cylinder head cover mounting fasteners and remove cylinder head cover.

**NOTE —**

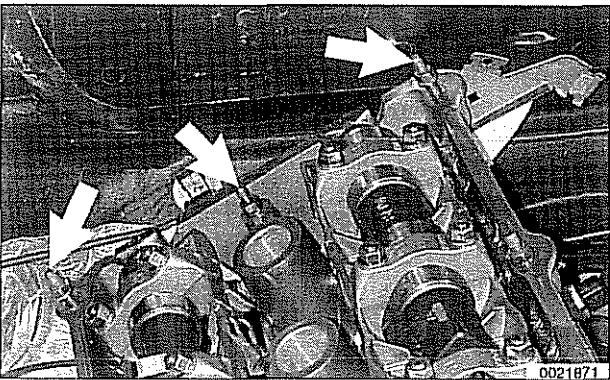
*The cylinder head cover mounting bolt insulators and gaskets should be reinstalled in their original locations. Make note of their arrangement during removal.*



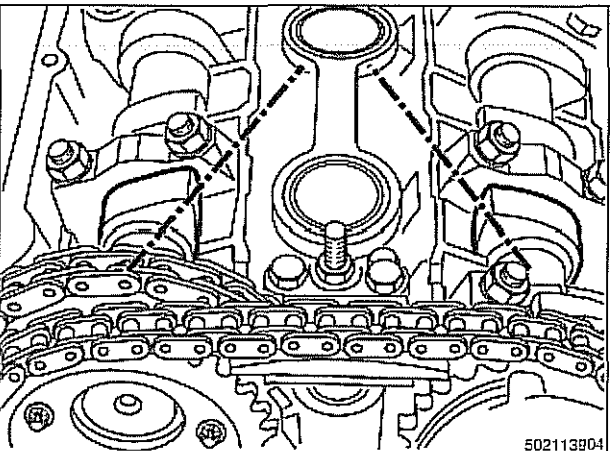
## Cylinder Head Removal and Installation



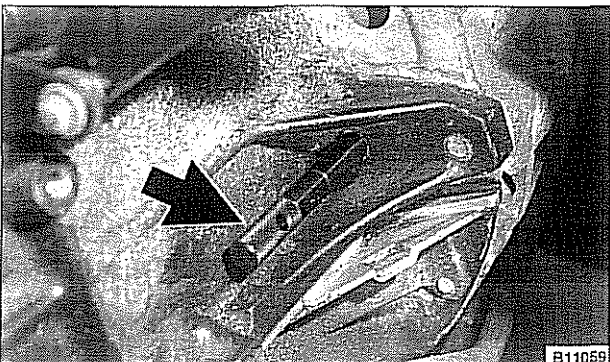
- Remove oil baffle cover from above intake camshaft.



- Unscrew and remove three cylinder head cover studs (arrows) at rear of cylinder head.

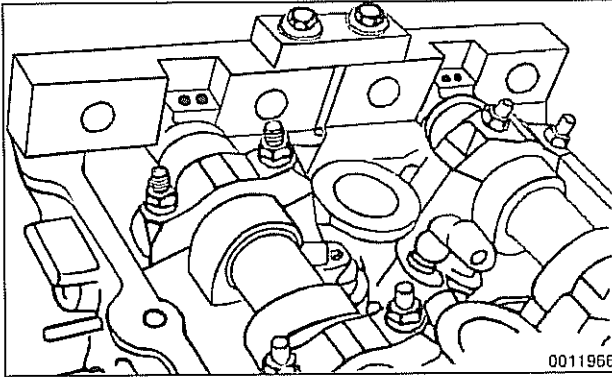


- Set engine to approximate top dead center (TDC) by turning crankshaft bolt in direction of rotation (clockwise when viewed from front of engine) until camshaft lobes for cylinder 1 face each other (**dotted lines**) and arrows on camshaft sprockets face up.
- Set engine to TDC by aligning "OIT" mark of vibration damper with boss cast on lower timing chain cover.

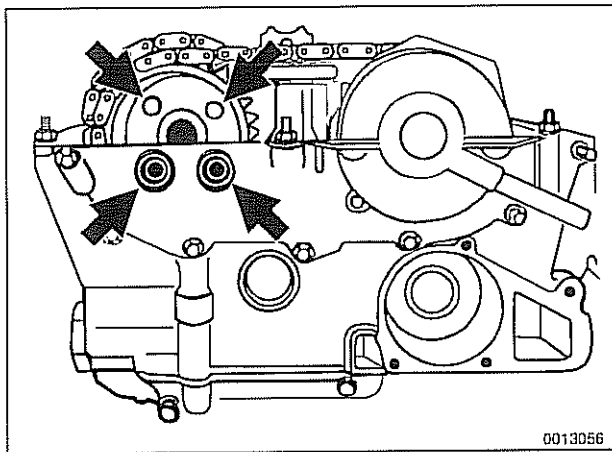


- Lock crankshaft at TDC:
  - Remove sealing plug from bore on lower left side of engine block below starter. Secure crankshaft in TDC position with BMW special tool 11 2 300.

## Cylinder Head Removal and Installation



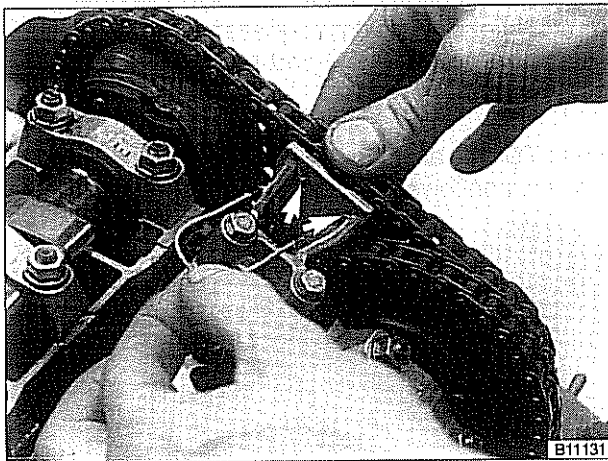
- Secure camshafts in TDC position using BMW special tool set 11 3 240.



- Remove access plugs from VANOS control unit in front of exhaust camshaft sprocket.
  - Remove 4 bolts (arrows) from exhaust camshaft sprocket (Torx E10).

**CAUTION—**

*Hold the camshaft stationary (at hex on camshaft) when loosening or tightening sprocket mounting fasteners.*



- Press down on secondary chain tensioner and lock into place using BMW special tool 11 3 292 or a similar size pin.

**NOTE—**

*Some tensioners may have a single hole for special tool.*

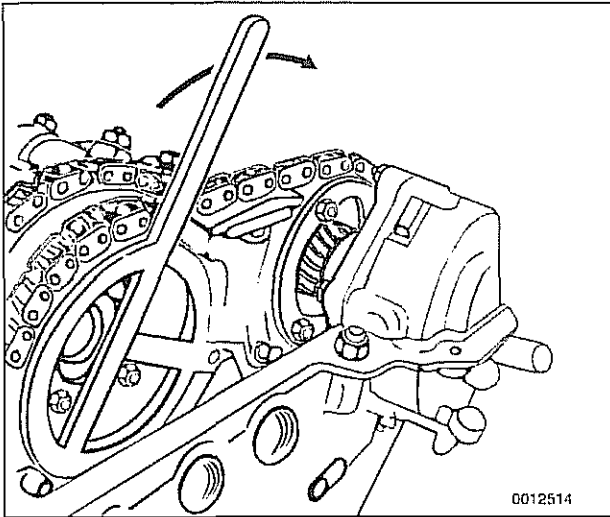
- Remove secondary chain tensioner.
- Disconnect harness connector and oil line fitting from bottom of VANOS control unit.

**NOTE—**

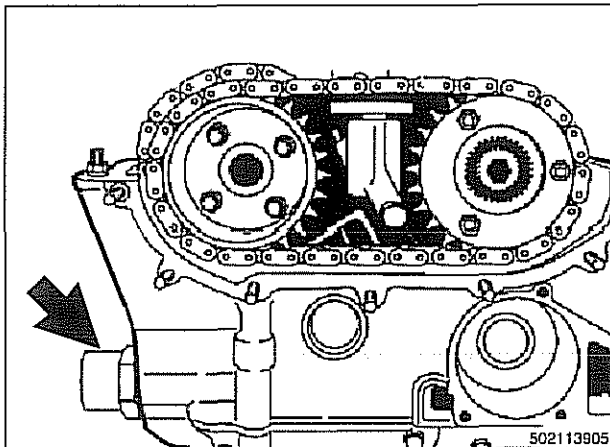
*Wrap the VANOS oil line fitting with a shop rag to absorb leaking oil.*

- Remove VANOS control unit mounting nuts and bolt at front of cylinder head.

## Cylinder Head Removal and Installation



- Use a spanner tool to rotate exhaust sprocket until stop on intake sprocket is contacted.
- Slide VANOS control unit forward to remove.

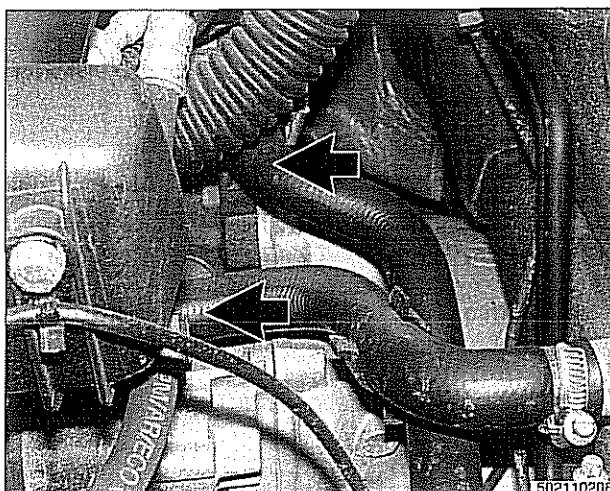


- Remove primary chain tensioner (arrow).

**WARNING—**

*Remove tensioner slowly — it is under spring pressure.*

- Working at the intake side of cylinder 1:
  - Detach electrical harness connector for camshaft position sensor and remove sensor.
  - Detach electrical harness connector for coolant temperature sensor.
- Remove exhaust manifolds. Discard nuts. See **180 Exhaust System**.



- Disconnect heating system hoses (arrows) from back of cylinder head.

## Cylinder Head Removal and Installation

- Remove secondary timing chain and sprockets:
  - Remove mounting nuts from front of intake camshaft sprocket. Remove and label shim.

### CAUTION—

*Hold the camshaft stationary (at hex on camshaft) when loosening or tightening sprocket mounting fasteners.*

- Remove mounting nuts from front of exhaust camshaft sprocket and remove and label thrust washer.

### NOTE—

*Where applicable, make note of thrust washer positions. The thicker (0.4 mm) washer is mounted outermost.*

- Remove secondary sprockets together with camshaft timing chain from front of camshafts.

### CAUTION—

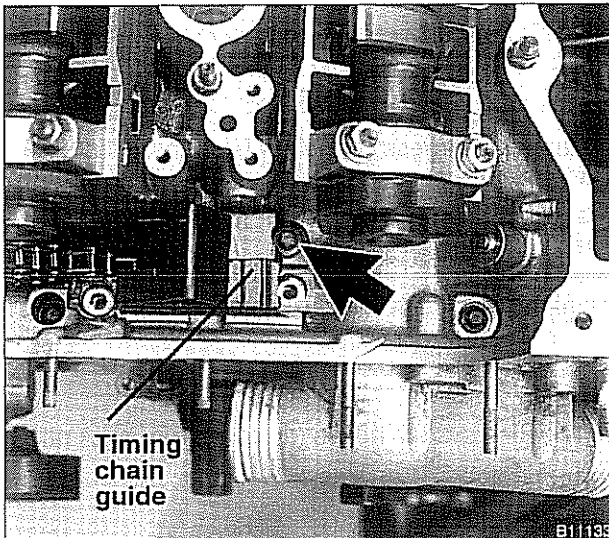
*The camshafts must be locked in the TDC position using the special service tool as described earlier. The arrows on the sprockets should not be used to accurately set the engine to TDC. The tool holds the camshafts parallel to each other and perpendicular to the cylinder head cover gasket surface.*

### NOTE—

*Do not remove the sprockets from the chain unless these parts are being replaced. Wire tie each sprocket to the chain to keep the sprockets timed to each other.*

### CAUTION—

*The crankshaft must not be allowed to rotate once the camshaft timing chain is removed. The pistons can contact the valves.*



- ⚡ Unscrew timing chain guide and remove.

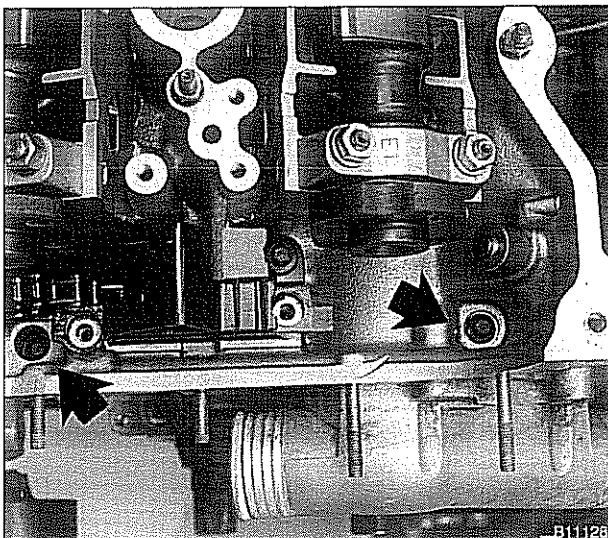
- Lift off primary sprocket with chain.
  - Secure chain with wire to prevent chain from dropping into lower timing cover.

- ⚡ Unscrew timing case cover to cylinder head bolts (arrows).

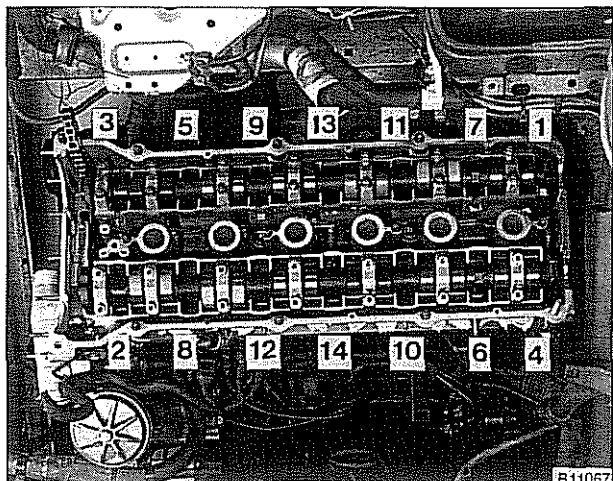
### NOTE—

*Photo shows timing chain guide in place; it should first be removed as described previously.*

- Remove crankshaft locking tool (BMW special tool 11 2 300). Using the crankshaft vibration damper bolt, turn engine opposite of normal direction of rotation (counterclockwise as viewed from the front) approximately 30°. This prevents accidental contact between valves and pistons during installation.



## Cylinder Head Removal and Installation



### ◀ Cylinder head bolt loosening sequence.

- Using BMW special tool 11 2 250 or an equivalent tool, loosen cylinder head bolts in sequence. Discard head bolts.
- Separate the cylinder head from the block and remove head. Evaluate head as described in 116 Cylinder Head and Valvetrain.

### Cylinder head, installing, M52 engine

If the camshafts were removed and installed while the cylinder head was off, a minimum waiting time is required after installing the camshafts. When the camshafts are removed, the hydraulic lifters can expand. This expansion can cause increased valve lift when the camshafts are bolted down, resulting in open valves.

#### Camshaft installation waiting times

68° F (20° C) and higher	4 minutes
50-68° F (10-20° C)	11 minutes
32-50° F (0-10° C)	30 minutes

- Clean cylinder head and gasket surfaces of cylinder block and all timing chain covers.

#### **CAUTION—**

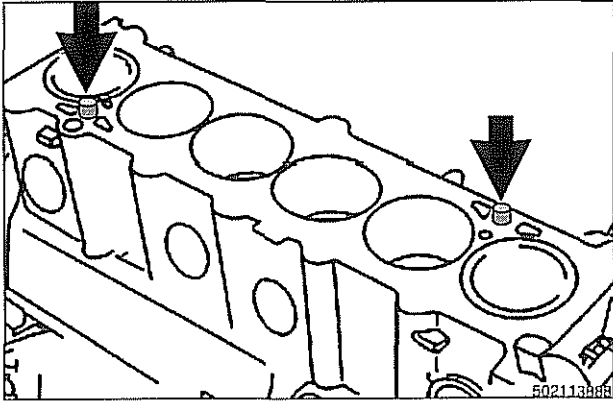
*Do not use a metal scraper or wire brush to clean the aluminum cylinder head or pistons. If necessary, use a hard wooden or plastic scraper. Also available are abrasive discs to be used in conjunction with an electric drill. Be sure to use the correct disc for the type of metal being cleaned.*

- Remove all debris and fluids from bolt holes and clean with a thread chaser.
- Check gasket surface of cylinder head and cylinder block for warp using a straight edge.

#### **NOTE—**

*If the cylinder head has been machined, a special 0.3 mm thicker gasket should be installed. The thicker gasket is available from an authorized BMW dealer.*

## Cylinder Head Removal and Installation



- ⚠ Check that two locating dowels are correctly positioned in block and are not damaged.
- Apply permanently elastic sealing compound Three Bond 1209 @ to joints where cylinder block joins timing case cover.
- Place new cylinder head gasket on cylinder block.

**NOTE—**

The word "OBEN" or "TOP", printed on the gasket, should face up. The cylinder head gasket will fit correctly in only one orientation.

- With camshafts locked in TDC position with BMW special tools as described during cylinder head removal, set cylinder head in position, guiding primary chain through cylinder head opening.

**NOTE—**

- The camshafts must be locked in the TDC position at the rear of the cylinder head with BMW special tool 11 3 240 before installing the cylinder head.
- Make sure the crankshaft, which had been rotated approximately 30° opposite the direction of engine rotation, is still in that position before lowering the cylinder head into position.

- Lightly lubricate new cylinder head bolts. Loosely install bolts and their washers, then thread them in until they are finger tight.

**NOTE—**

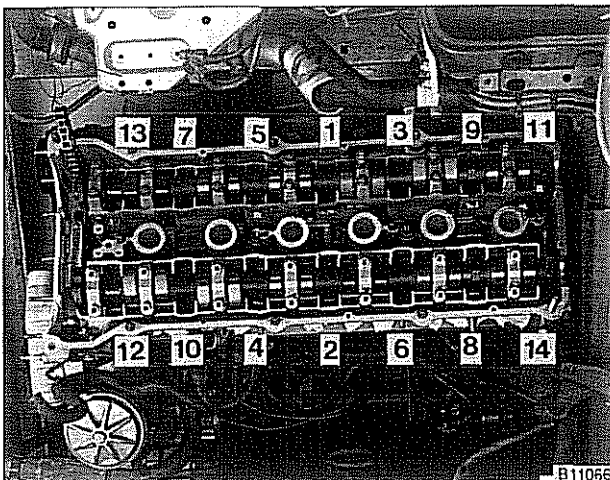
- Torx-type cylinder head bolts should not be reused. They are stretch-type bolts and must always be replaced whenever loosened.
- Check that all washers for the cylinder head bolts are in place before installing the bolts. Some of the washers may be staked to the cylinder head.

**CAUTION—**

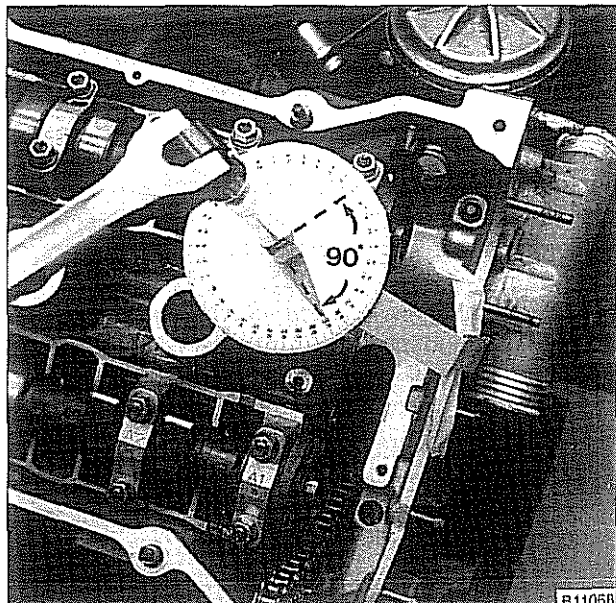
Cylinder head bolts for a cast iron engine block are different length and require different tightening torque than bolts for an aluminum cylinder block engines (95 mm versus 110 mm bolts).

- Install cylinder head-to-lower timing chain cover bolts finger tight.

- ⚠ Tighten cylinder head bolts in correct sequence to initial torque value.



## Cylinder Head Removal and Installation



- Use BMW tool 11 2 110 or torque angle gauge to tighten cylinder head bolts in sequence to stage 2 and 3.

### Tightening torques

Cylinder head to cast iron block	
Stage 1	30 Nm (22 ft-lb)
Stage 2	+90°
Stage 3	-90°
Cylinder head to aluminum block	
Stage 1	40 Nm (30 ft-lb)
Stage 2	+90°
Stage 3	-90°

- Tighten cylinder head-to-lower timing chain cover bolts.

### Tightening torques

Cylinder head to lower timing chain cover	10 Nm (89 in-lb)
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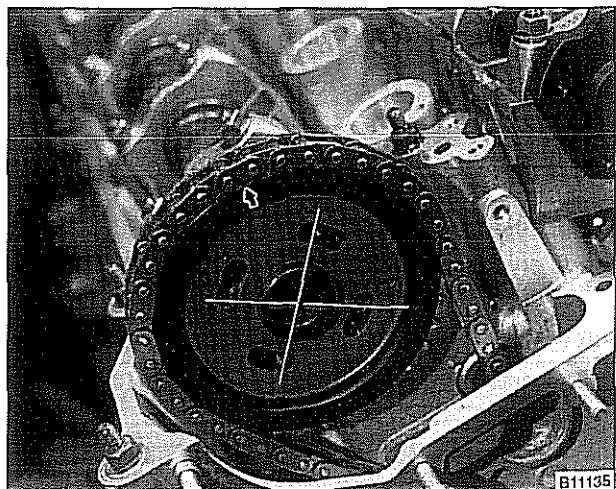
- Inspect secondary chain guide rail and tensioner rail for grooves caused by chain contact. Replace any part that is worn.

### NOTE—

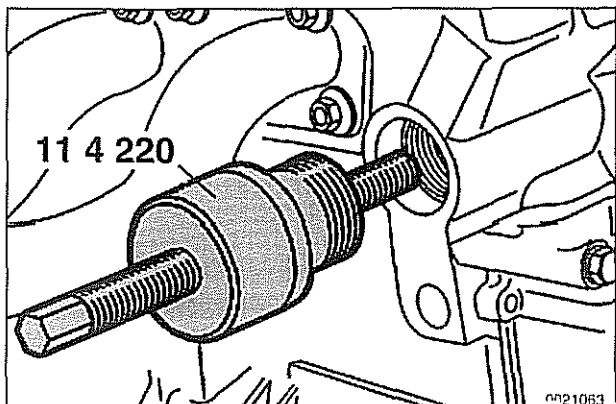
- Inspect timing chain sprockets. Sprockets that have worn or missing teeth should be replaced.
- If any of the sprockets are being replaced due to wear, the chain should also be replaced.
- If the crankshaft sprocket requires replacement, the oil pump drive sprocket and chain must be removed as described under **119 Lubrication System**.

### CAUTION—

The procedure outlined below assumes that the camshafts and the crankshaft are locked in the TDC position with special tools.



- Mount primary timing chain sprocket to primary chain so that arrow on sprocket faces up. Mount sprocket to camshaft so that tapped holes in camshaft are on left side of elongated holes in sprocket.



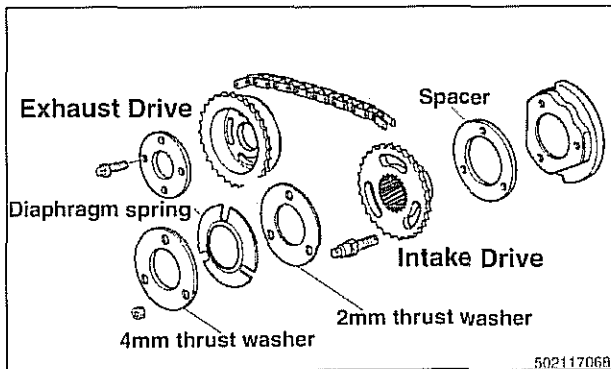
- Install BMW special tool 11 4 220 into primary timing chain tensioner sleeve. Thread center spindle in finger tight until slack is removed from chain.

## Cylinder Head Removal and Installation

### NOTE—

BMW special tool 11 4 220 is an adjustable primary chain tensioner and simulates the function of the hydraulic tensioner.

- Check that elongated holes in primary sprocket are now centered to bolt holes in camshaft and chain is free of slack. If not, reposition sprocket to chain and reinstall.
- Install secondary timing chain guide and secondary chain tensioner. Tighten mounting bolts (tensioner remains locked down for now using BMW special tool 11 3 292).
- Install cylinder identification trigger plate to front of intake camshaft with studs.
- Install spacer to front of intake camshaft.
- Install secondary chain sprockets and chain as an assembly so that arrows on sprockets are pointing up. Center mounting holes in sprockets to bolt holes in camshafts.
- Install thrust washers and diaphragm spring to intake cam sprocket.
- Install shim and torx bolts to exhaust camshaft. Tighten finger tight; do not torque down.
- Tighten intake sprocket nuts.



### CAUTION—

Hold the camshaft stationary (at hex on camshaft) when loosening or tightening sprocket mounting bolts and studs.

### Tightening torque

Intake sprocket nuts to studs	10 ± 1 Nm (89 ± 9 in-lb)
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- Turn crankshaft approx. 30° in direction of rotation to bring engine to TDC. Lock crankshaft in TDC position with BMW special tool 11 2 300.

### CAUTION—

The camshafts and crankshaft must be locked in the TDC position using BMW special tools 11 2 300 and 11 3 240. If the camshafts and crankshaft are not at TDC, the valves can contact the pistons.



## Cylinder Head Removal and Installation

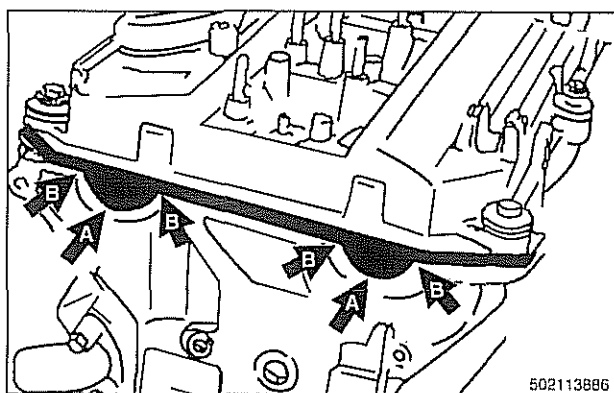
### NOTE—

Be sure the secondary timing chain tensioner is locked down and the exhaust camshaft mounting bolts are loose before proceeding.

- Install VANOS control unit. See VANOS control unit, installing (M52 engine) in **117 Camshaft Timing Chain**.

### CAUTION—

Incorrect installation of the VANOS control may result in damage to the engine valvetrain.



- Install exhaust manifolds using new gaskets and nuts. Coat manifold studs with copper paste prior to installing nuts.
- ▲ Install intake camshaft cover and cylinder head cover.
  - Check for correct seating of half-moon seals (A) in back of cylinder head cover.
  - Use a small amount of Three Bond 1209® or equivalent sealant at corners (B) of half-moon cutouts.
  - Seat gasket and seal corners in front of cylinder head at VANOS unit.
- Installation of remaining parts is reverse of removal, noting the following:
  - Reinstall electrical harness connectors for oil pressure switch and coolant temperature sensor before installing intake manifold.
  - Refill cooling system as described in **170 Radiator and Cooling System**.
  - Change engine oil and filter as described in **020 Maintenance**.
  - If necessary, adjust accelerator cable.
  - Reconnect battery last.

### Tightening Torques

VANOS oil line	32 Nm (24 ft-lb)
VANOS solenoid to control unit	30 Nm (22 ft-lb)
Coolant drain plug to cylinder block	25 Nm (18 ft-lb)
Cylinder head cover to cylinder head (M6 bolts)	10 Nm (89 in-lb)
Intake manifold to cylinder head	15 Nm (11 ft-lb)
Radiator cooling fan to coolant pump	40 Nm (30 ft-lb)
Radiator drain screw to radiator	2.5 Nm (22 in-lb)

## CYLINDER HEAD REMOVAL AND INSTALLATION (M52 TU AND M54 ENGINES)

### WARNING—

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

Cylinder head removal and installation is a time consuming repair procedure requiring multiple special service tools. Read the entire procedure before beginning the repair.

This topic includes the following procedures:

- Cylinder head, removing, M52 TU and M54 engines
- Cylinder head, installing, M52 TU and M54 engines

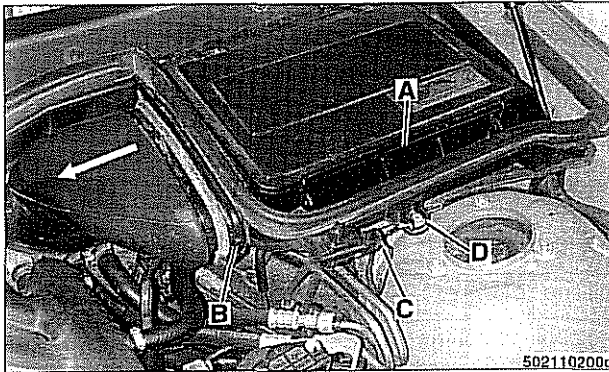
### Cylinder head, removing, M52 TU and M54 engines

Allow engine to cool before beginning this procedure.

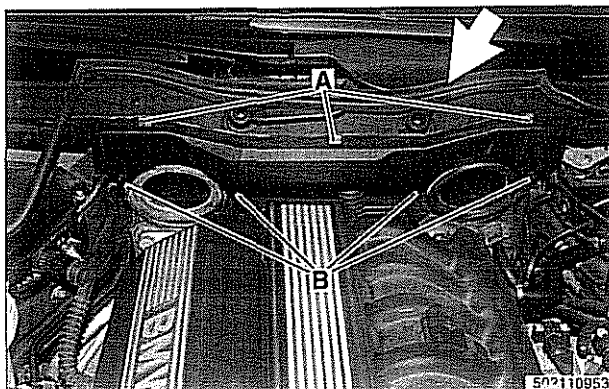
- Disconnect negative (–) cable from battery.

### CAUTION—

Prior to disconnecting the battery, read the battery disconnection cautions in 001 **General Cautions and Warnings**.

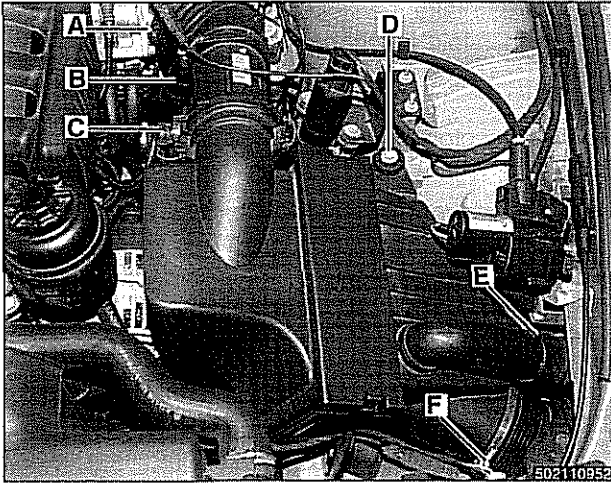


- Remove left and right interior ventilation ducts (left side shown):
  - Release ventilation filter cover latch (A) and remove cover.
  - Release plastic locking tab (B) or release locking tabs on top of duct (later models).
  - Turn duct counterclockwise to unlock from bulkhead and remove (arrow).
  - Disconnect electrical harness from hood switch (C).
  - Release spring lock fastener (D).
  - Slide filter housing away from inner fender to remove.
  - Removal of right side ventilation duct is similar.

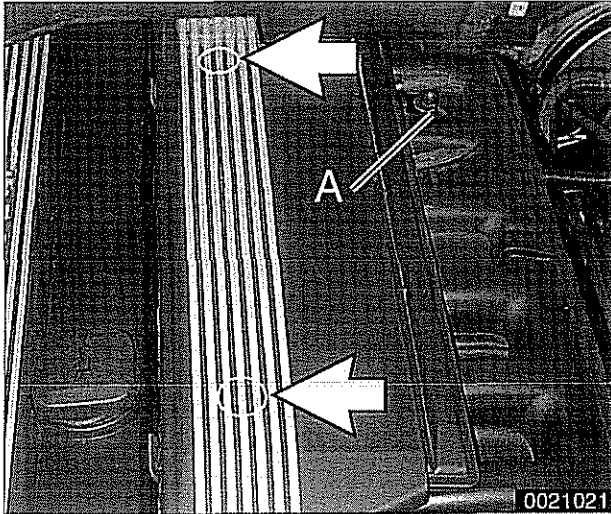


- Remove rear bulkhead panel:
  - Lift off rubber sealing gasket (arrow).
  - Remove 3 mounting clips (A).
  - Remove 4 retaining screws (B).
  - Lift off panel.

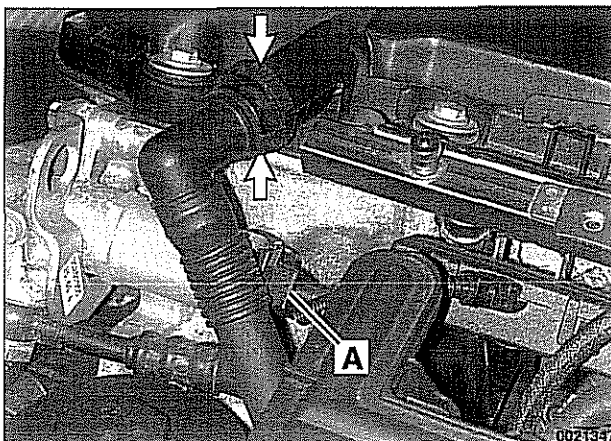
## Cylinder Head Removal and Installation



- Remove complete air filter housing assembly with mass air flow sensor:
- Loosen intake duct hose clamp (A) at throttle assembly.
  - Loosen clamp and remove idle control line from intake duct (B) and disconnect idle speed control valve electrical harness connector.
  - Disconnect electrical harness connector (C) from mass air flow sensor.
  - Remove air filter housing mounting screw (D).
  - Disconnect vent tube (E).
  - Loosen air intake duct clamp (F).
  - Carefully lift air filter housing, mass air flow sensor, and intake duct hose out of engine bay.



- Disconnect positive battery cable and remove intake manifold cover:
- Remove protective cover from positive (+) jumper post.
  - Loosen and remove battery lead mounting nut (A).
  - Remove lead and push down through intake manifold.
  - Remove trim covers (arrows) from fuel injector cover.
  - Remove cover hold down fasteners and lift off cover.



- Working above engine, disconnect the following:
- Vent line from cylinder head cover. To remove, pinch clips (arrows).
  - Electrical harness connector from VANOS solenoid valve (A).
- Remove oxygen sensors and exhaust manifolds. See 180 Exhaust System.

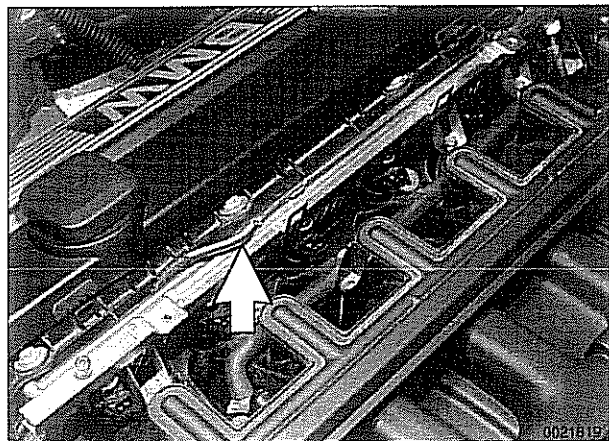
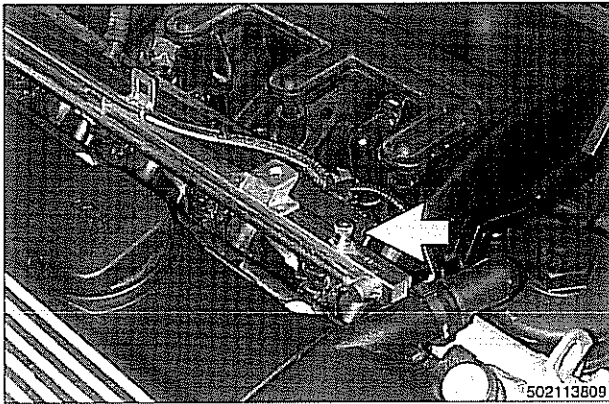
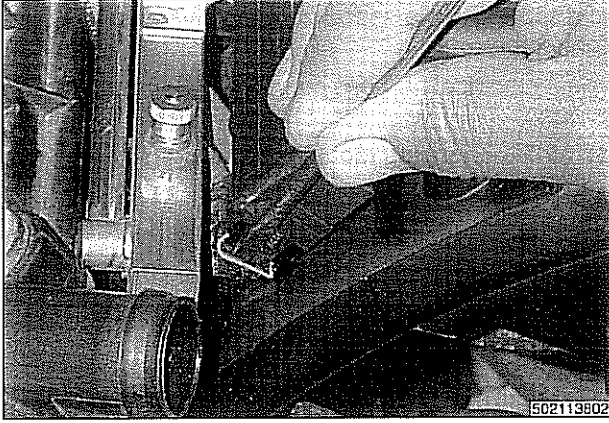
### CAUTION—

- Remove oxygen sensors before removing exhaust manifold to prevent damage.
- Label oxygen sensor harness connectors so that they can be reassembled correctly. Do not interchange connectors.

### NOTE—

Front exhaust manifold must be removed before rear manifold.

## Cylinder Head Removal and Installation



- Working at side of intake manifold near left strut tower, disconnect intake manifold resonance valve electrical harness connector.
- Disconnect fuel injector electrical harness connectors from injectors.
  - Use small screwdriver to pry out wire lock clip on fuel injector 1 connector.
  - Repeat for remaining injectors.
  - Release harness conduit fasteners from injector rail.
  - Disconnect intake air temperature sensor electrical harness connection (between intake runners for cylinders 3 and 4).
  - Lift off connector assembly and lay aside.
- Where applicable, remove schrader valve cap (**arrow**) from fuel rail. Using a tire chuck, blow fuel back through feed line using a brief burst of compressed air (maximum of 3 bar or 43.5 psi).

### WARNING —

- Fuel is under pressure (approx. 3 - 5 bar or 45 - 75 psi) and may be expelled. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Catch and dispose of escaped fuel. Plug all open fuel lines.
- Always unscrew the fuel tank cap to release pressure in the tank before working on the tank or lines.

- Disconnect manifold vacuum line (**arrow**).

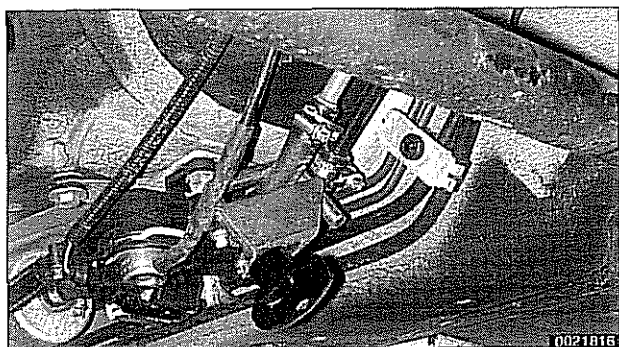
- Raise car and support in a safe manner.

### 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 protective engine splash guard from below engine.

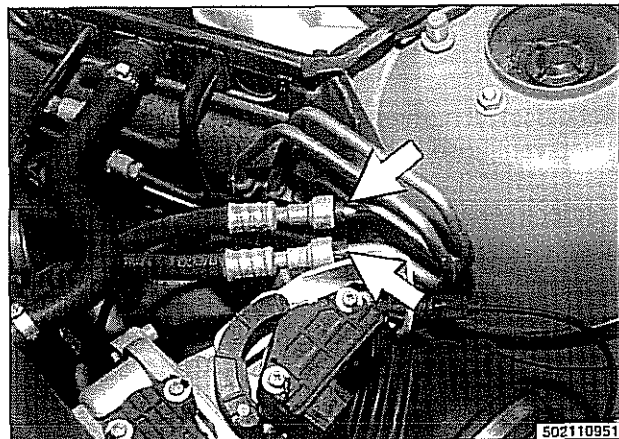
## Cylinder Head Removal and Installation



- Working beneath car (on left side under driver seat), remove fuel filter cover and clamp off fuel hose(s).

**NOTE—**

*M54 engines use a single fuel line to the non-return fuel rail.*



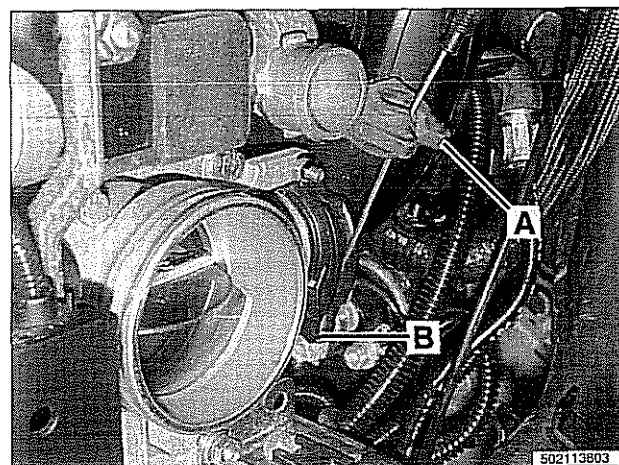
- Disconnect fuel lines by pressing in on spring lock (arrows).

**CAUTION—**

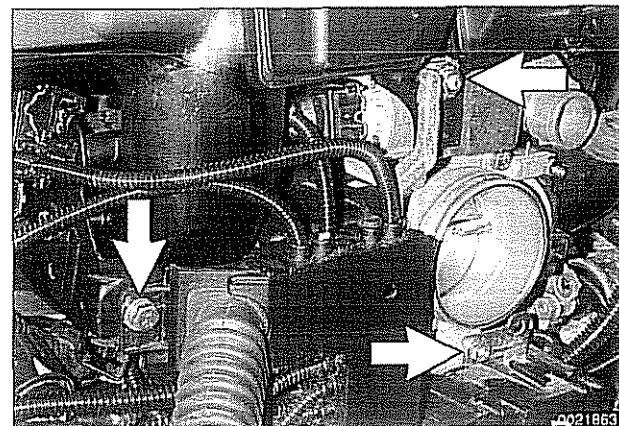
*Fuel may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Plug all open fuel lines.*

**NOTE—**

*BMW uses various styles of line connections; a one-time band clamp; a self-locking connector (that use BMW special tool 16 1 050 to release); and a quick release connector (above).*

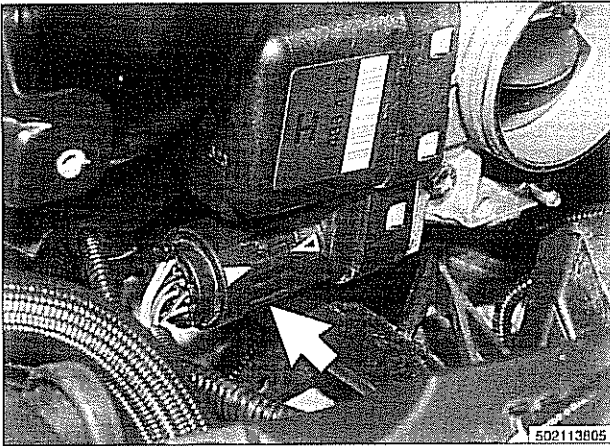


- M52 TU engine: Pull throttle cable out of rubber retainer (A) and unhook ball end of cable (B) from throttle actuator.

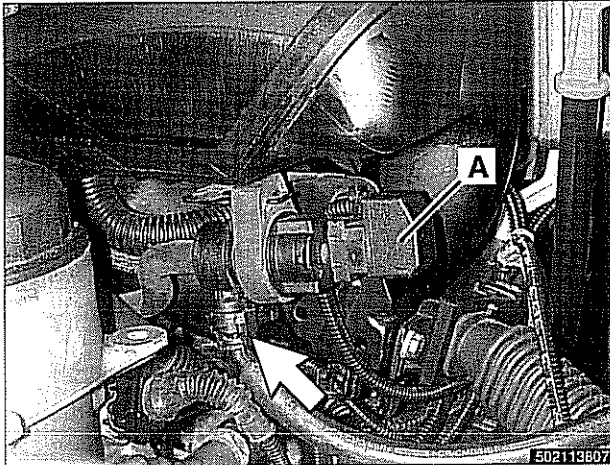


- Remove fasteners retaining wiring harness at throttle body and support bracket (arrows).

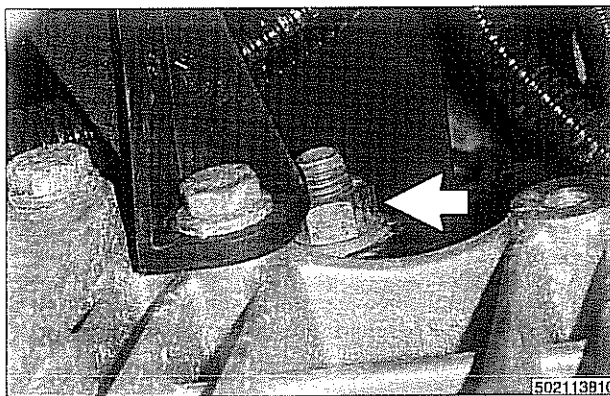
## Cylinder Head Removal and Installation



- Working at throttle housing, unscrew and disconnect electrical harness plug (arrow).



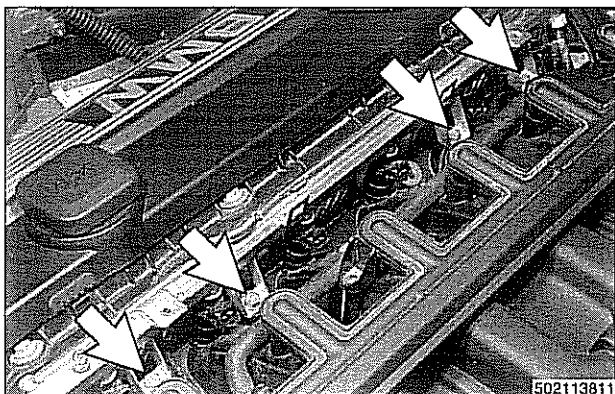
- Disconnect electrical harness connector at fuel tank venting valve (A) and vent hose at quick disconnect fitting (arrow).
- Working under intake manifold, disconnect the following:
  - Engine oil dipstick tube support.
  - Oil separator return line from dipstick tube.
  - Knock sensor harness connector from support.



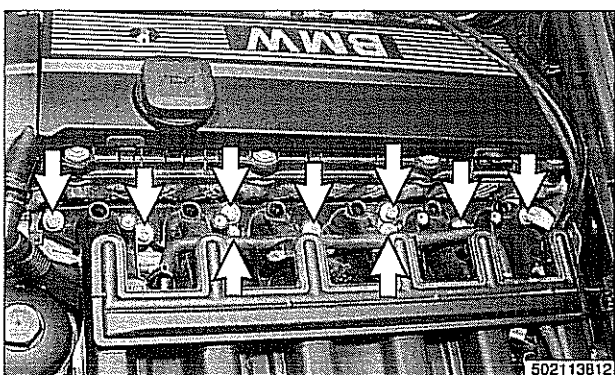
- Working underneath car, remove intake manifold support mounting nut (arrow), located adjacent to left engine mount.



## Cylinder Head Removal and Installation



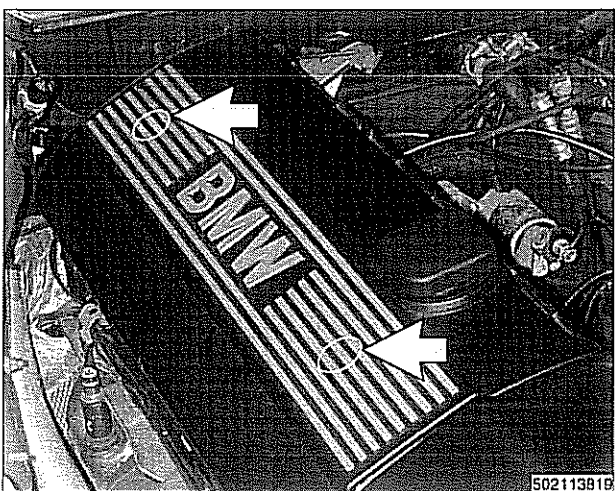
- Remove fuel rail mounting bolts (**arrows**):
  - Carefully pry fuel rail off manifold.
  - Separate fuel line support bracket at rear of intake manifold.
  - Guide fuel line(s) out of rear of engine compartment while lifting fuel rail out.



- Remove intake manifold mounting hardware (**arrows**).
- Remove intake manifold from cylinder head while carefully checking for electrical connections or hoses.

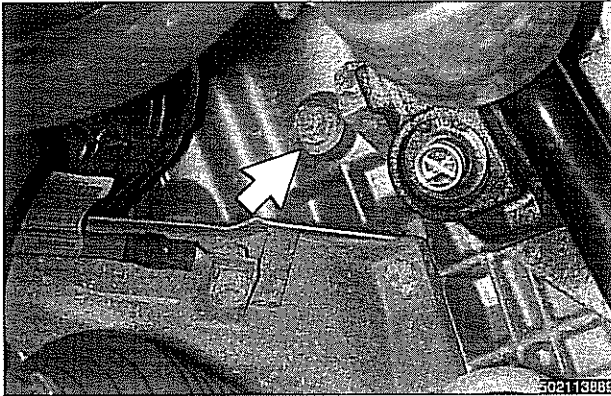
**CAUTION—**

*Stuff clean rags into open intake ports to prevent any parts from falling into the engine intake.*

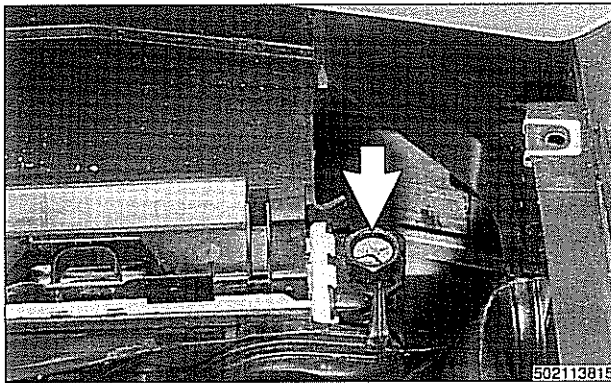


- Remove cylinder head top cover:
  - Remove plastic trim caps (**arrows**).
  - Remove cover hold down fasteners and lift off cover.

## Cylinder Head Removal and Installation



- Drain engine coolant and remove coolant hoses:
  - Remove expansion tank cap on radiator.
  - Place a 3 gallon pail beneath engine to capture coolant.
  - Remove coolant drain plug (**arrow**) located on exhaust side of cylinder 2 of engine block.



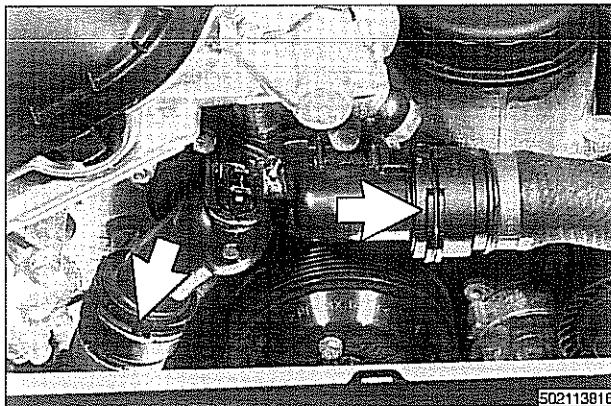
- Drain radiator into a 3 gallon pail by removing plastic drain plug (**arrow**) completely.

### **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.*

### **NOTE—**

*Catch and dispose of drained coolant according to local, state, and federal laws.*

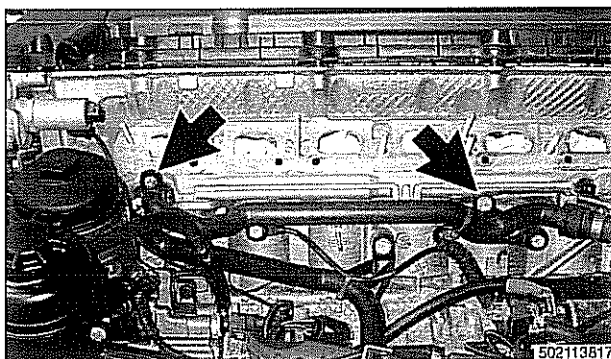


- Remove thermostat housing:
  - Disconnect electrical harness connector at thermostat housing.
  - Remove hoses from thermostat housing by releasing locks (**arrows**).
  - Unbolt (4 bolts) and remove thermostat housing.

- On vehicles equipped with mechanical cooling fan: Remove belt-driven cooling fan and radiator shroud as described in **170 Radiator and Cooling System**.

### **CAUTION—**

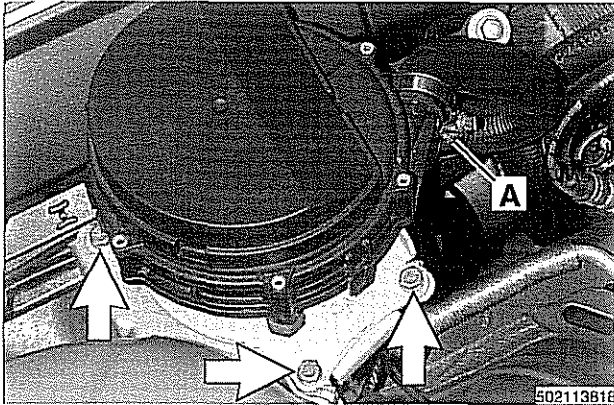
*32 mm radiator fan mounting nut has left hand threads.*



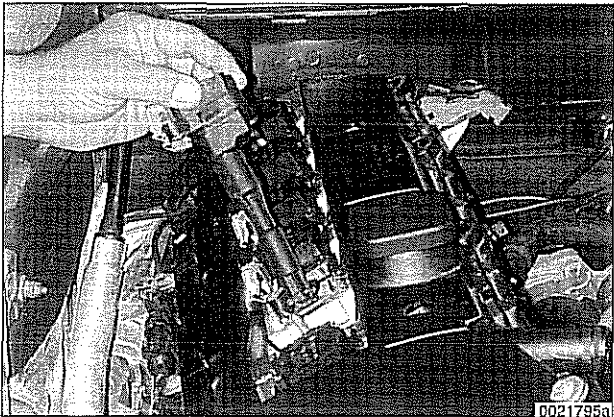
- Remove fasteners (**arrows**) from heater bypass tube. Pull tube out of cylinder head and set to side, leaving heater hose connected.
- Unbolt power steering fluid reservoir and pull aside without disconnecting hoses. Secure to fender with cord or stiff wire.



## Cylinder Head Removal and Installation



- ◀ If applicable, remove secondary air injection pump:
  - Disconnect hose at one-way valve (A).
  - Remove bolts at support bracket on strut tower (arrows).
  - Disconnect electrical harness from bottom of secondary air injection pump.
  - Remove mounting bracket from strut tower.



- ◀ Remove ignition coils:
  - Disconnect ignition coil harness connectors.
  - Remove coil mounting fasteners.
  - Remove coils.
  - Remove ground straps.

### CAUTION—

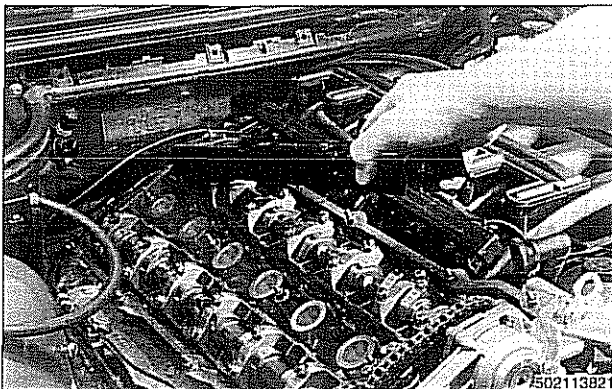
*Note location of all ground wires. Failure to reinstall grounds can result in permanent damage to engine control module or ignition system components.*

- Set coil harness to side of engine compartment.
- Remove cylinder head cover mounting fasteners and remove cylinder head cover.

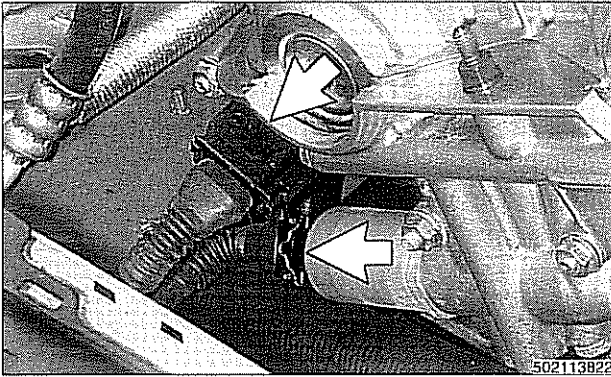
### NOTE—

*The cylinder head cover mounting bolt insulators and gaskets should be reinstalled in their original locations. Make note of their arrangement during removal.*

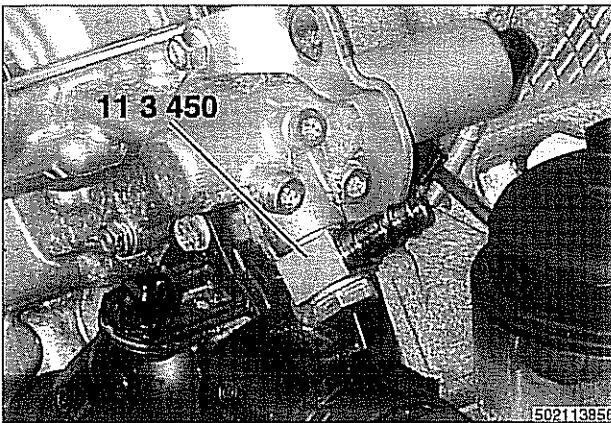
- Remove spark plugs.
- ◀ Remove oil baffle cover from above intake camshaft.



## Cylinder Head Removal and Installation



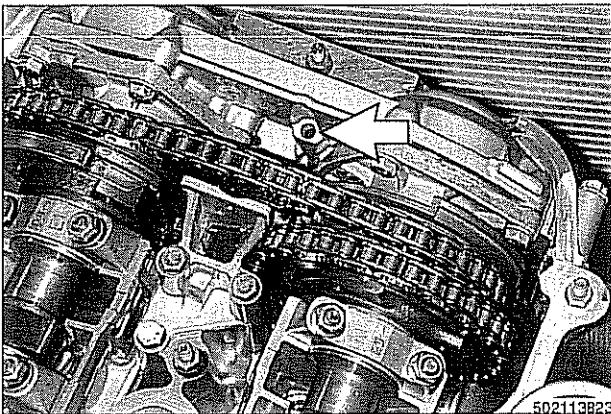
- Disconnect electrical harness connections at exhaust camshaft position sensor and exhaust camshaft VANOS control valve (arrows).



- Remove banjo bolt from VANOS unit oil pressure line. Use banjo bolt to attach BMW special tool 11 3 450 (compressed air fitting) to VANOS control unit.

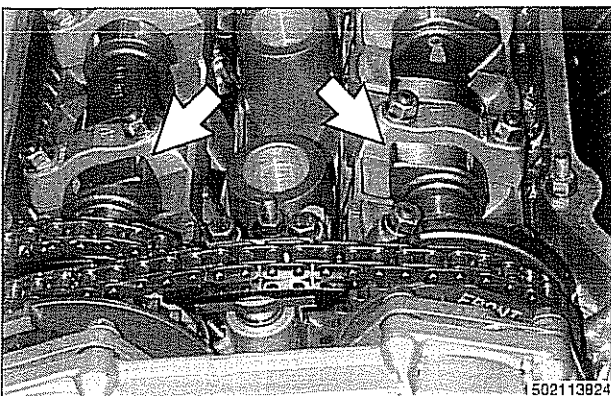
**CAUTION—**

*Oil will drain from pressure line. Have a drain container and rags ready. Do not allow oil to run onto drive belts.*



- Cover oil hole (arrow) in VANOS unit with shop towel to capture oil which will spray when compressed air is applied.

- Connect compressed air line to air fitting. Apply air pressure set to 2–8 bar (30–115 psi).

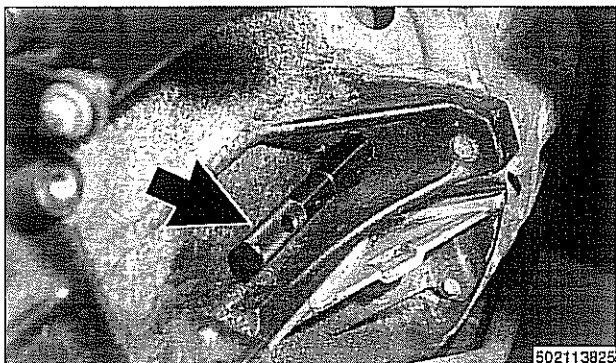


- With compressed air line connected, rotate engine at vibration damper in direction of rotation (clockwise) at least twice, until cylinder 1 intake and exhaust camshaft lobes face each other (arrows) in the top dead center (TDC) position for cylinder 1.

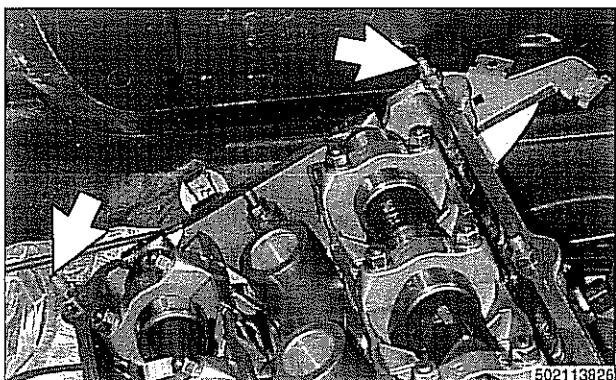
**CAUTION—**

*Do not rotate engine counterclockwise to reach the top dead center position. If engine rotated beyond top dead center, complete another two complete rotations.*

## Cylinder Head Removal and Installation



- Remove sealing plug from special tool bore on lower left side of engine block near flywheel. Secure crankshaft in TDC position with BMW special tool 11 2 300 (arrow).

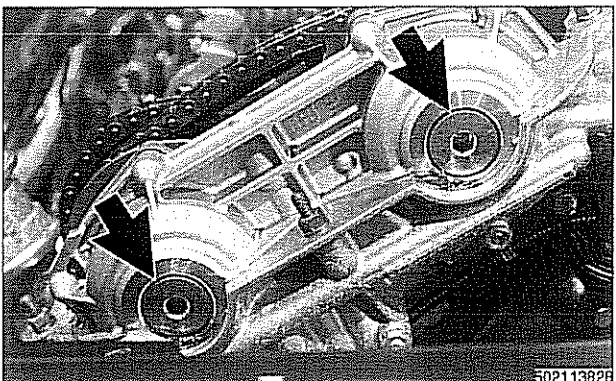


- Unscrew and remove two cylinder head cover studs (arrows) at rear of cylinder head.



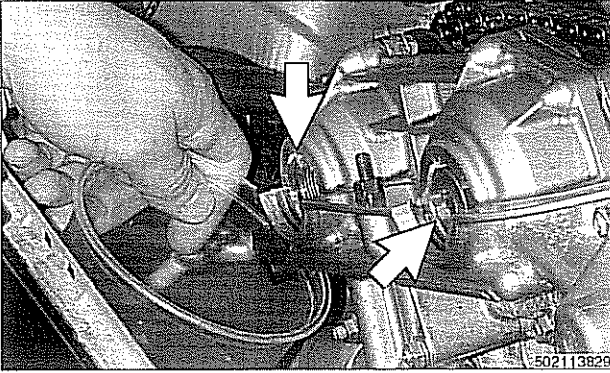
- Secure camshafts in TDC position using BMW special tool set 11 3 240.

- Disconnect compressed air line, leaving compressed air fitting attached to VANOS unit.

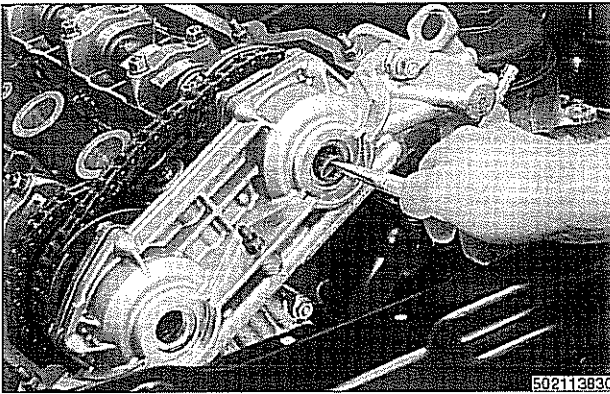


- Unscrew sealing plugs (arrows) from VANOS unit.

## Cylinder Head Removal and Installation



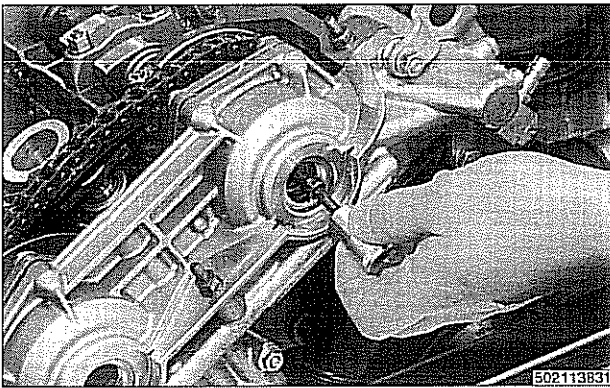
- Oil will drain from plugs (arrows) when removed. Have a container and rags ready. Do not allow oil to run onto drive belts.



- Pull sealing caps straight out of VANOS unit using short nose pliers.

**NOTE—**

*Additional oil may drain from VANOS unit.*

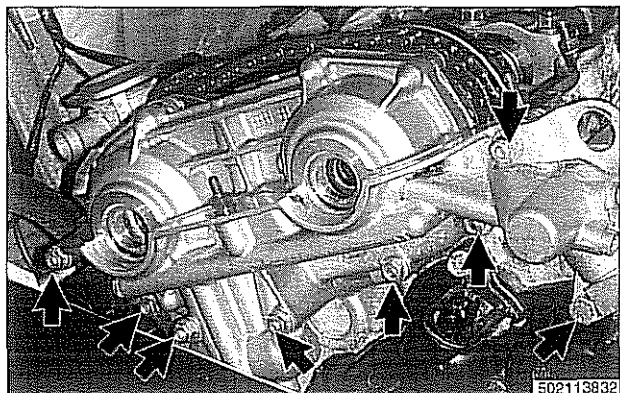


- Remove set screws (left-hand thread) on ends of intake and exhaust camshafts.

**CAUTION—**

*Set screws have left-hand threads. Loosen in clockwise direction.*

## Cylinder Head Removal and Installation



- Remove VANOS unit:
- Remove engine lifting eye.
  - Remove VANOS mounting nuts (arrows) and pull VANOS unit and metal gasket off.

**CAUTION—**

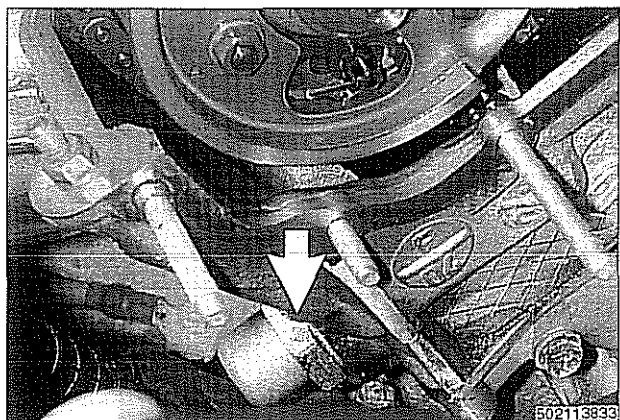
*Do not crank the engine with VANOS unit removed. Piston/valve interference may result.*

**NOTE—**

*The VANOS unit will contain a small quantity of oil. Place shop towel to catch oil as unit is removed or tilted.*

**CAUTION—**

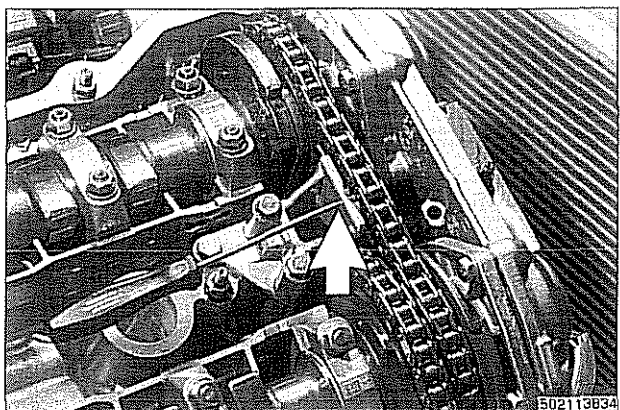
*If the VANOS adjustment unit is replaced, or if operations are completed that may change the timing of the camshafts, the camshaft timing must be checked. See 117 Camshaft Timing Chain.*



- Remove primary camshaft chain tensioner cylinder (arrow).

**CAUTION—**

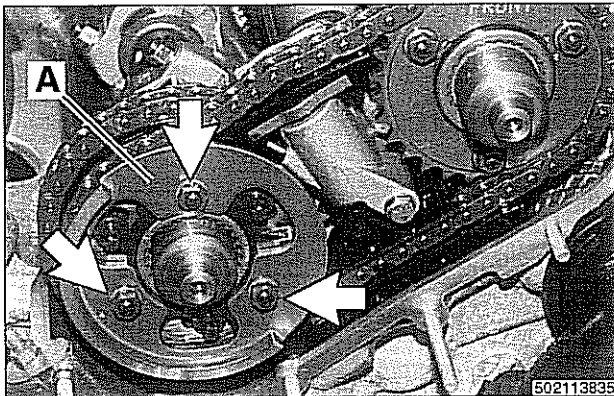
*Primary camshaft chain tensioner is under spring pressure.*



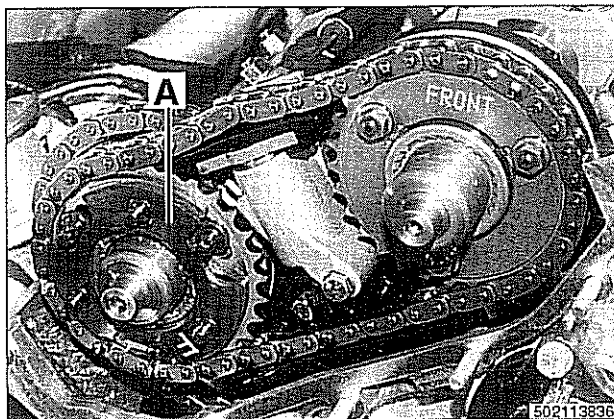
- Press down on secondary chain tensioner and lock into place using BMW special tool 11 3 291, or a thin drift or pin.



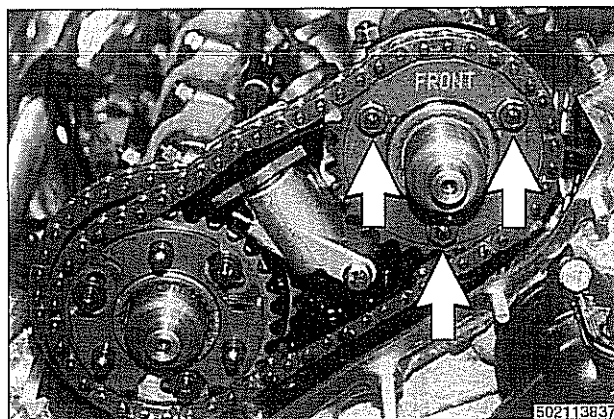
## Cylinder Head Removal and Installation



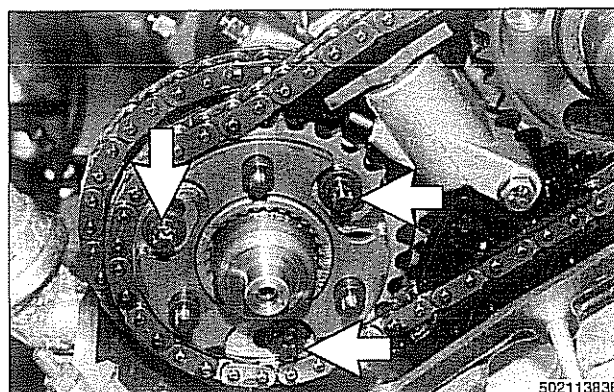
- Remove exhaust camshaft impulse wheel mounting nuts (arrows). Remove impulse wheel (A).



- Remove spring plate (A).

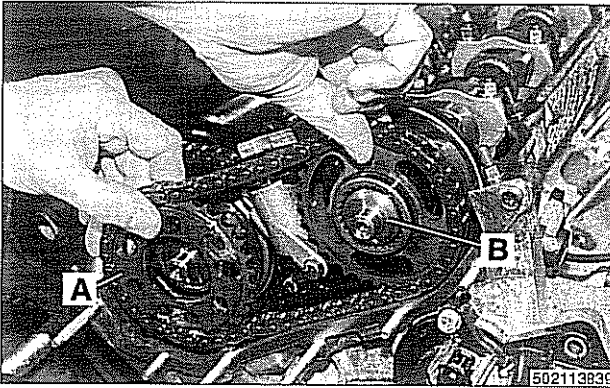


- Remove intake camshaft sprocket mounting nuts (arrows) and remove spring plate (labelled **FRONT**).



- Remove torx screws from exhaust camshaft sprocket (arrows).

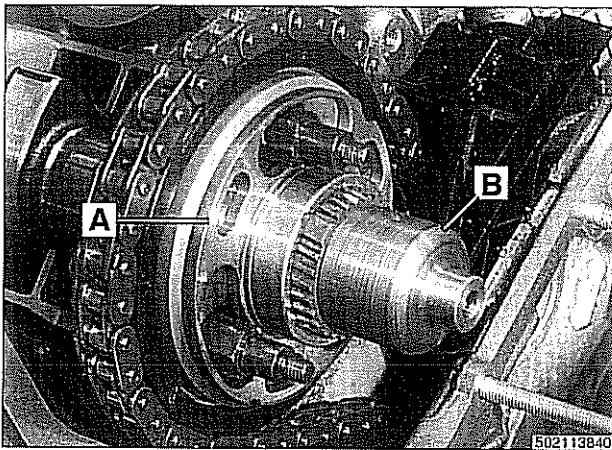
## Cylinder Head Removal and Installation



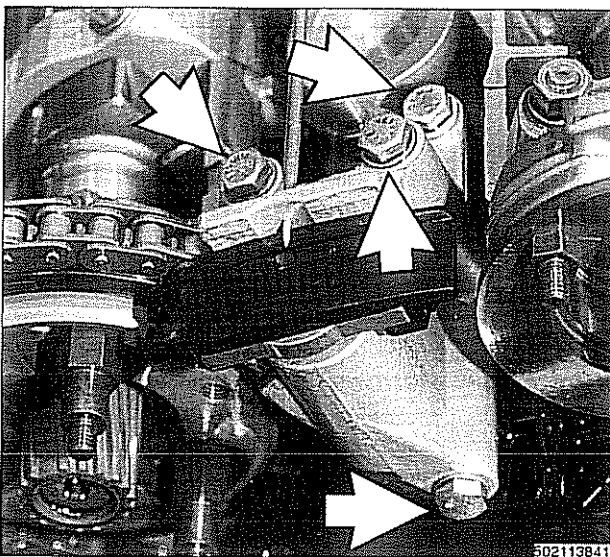
- ⚡ Lift off exhaust and intake sprockets together with secondary chain, thrust spacer (A), and splined shaft (B).

### CAUTION—

*Splined shafts share the same part number for both intake and exhaust camshafts. Used splined shafts must be reinstalled in their original positions.*

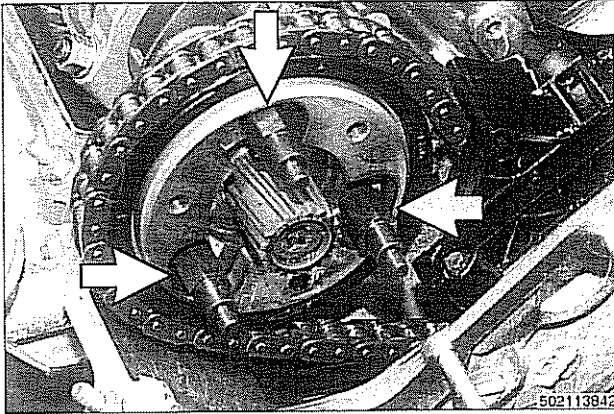


- ⚡ Remove exhaust camshaft splined sleeve (A) and shaft (B).

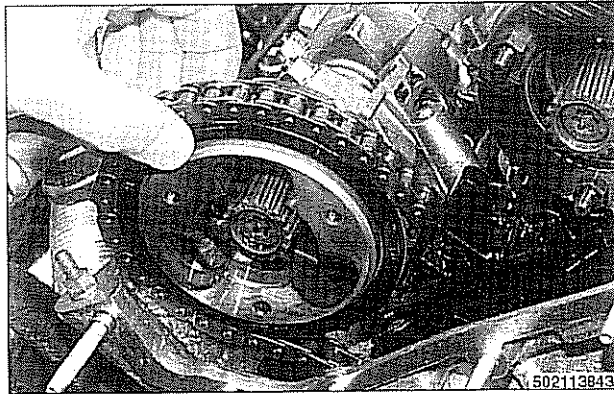


- ⚡ Remove secondary chain tensioner mounting bolts (arrows) and remove tensioner with retaining pin in place.

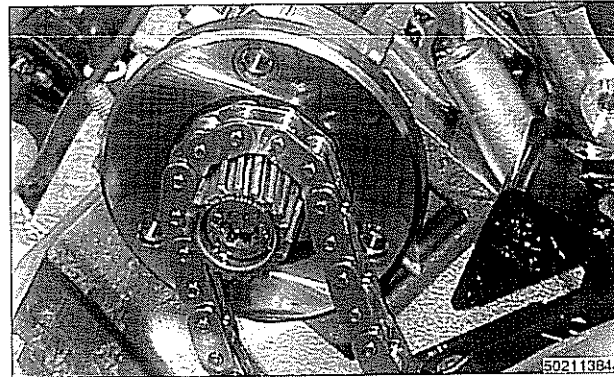
**Cylinder Head Removal and Installation**



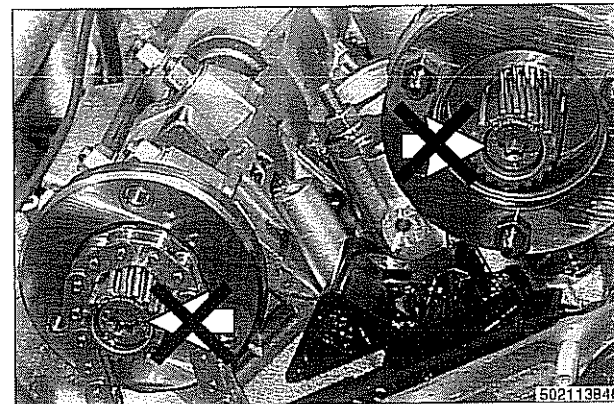
Remove sprocket mounting studs (arrows) from exhaust camshaft.



Lift primary chain sprocket off exhaust camshaft. Remove sprocket from chain.



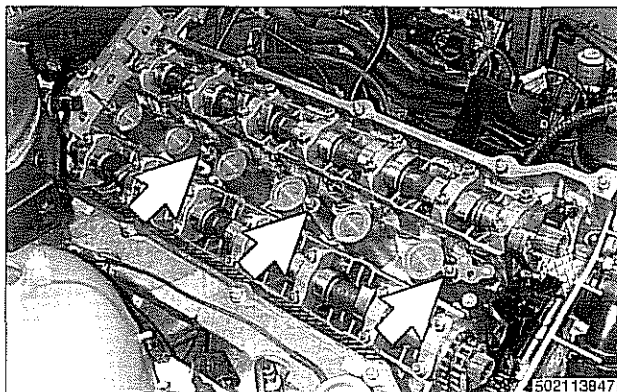
Place timing chain on end of exhaust camshaft.



Spline retaining screws (arrows) should not be removed from camshaft.

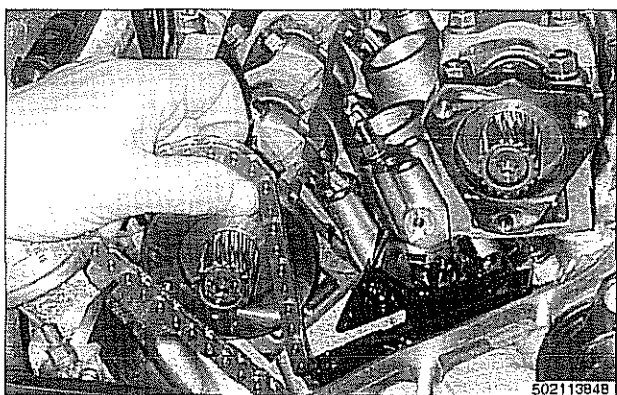


## Cylinder Head Removal and Installation



➤ Remove cylinder head cover mounting studs (**arrows**) from center of cylinder head.

— Remove crankshaft locking tool from transmission bell housing.

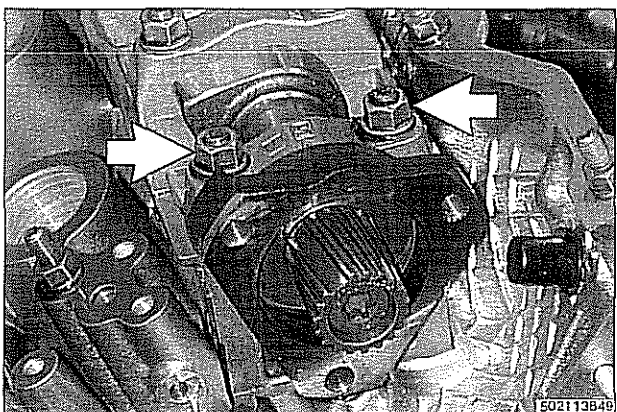


➤ Lift primary chain and hold under tension, then rotate engine at vibration damper in opposite direction of normal rotation (counterclockwise) approximately 30°.

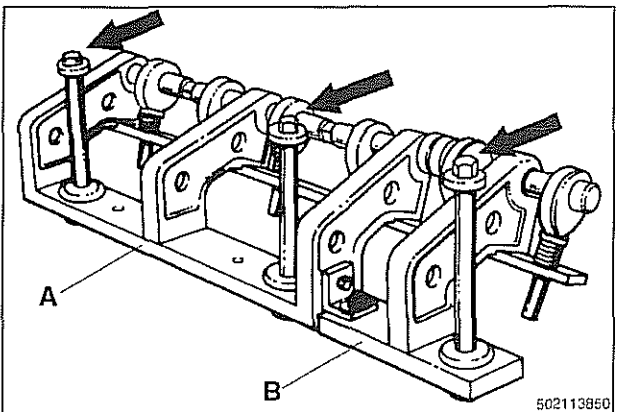
### CAUTION—

*By turning crankshaft 30°, pistons are moved away from top dead center, to prevent possible valve interference to pistons during camshaft servicing.*

— Remove camshaft locking tools (BMW special tool set 11 3 240) from rear of cylinder head.



➤ Remove camshaft bearing cap 1 on intake camshaft.

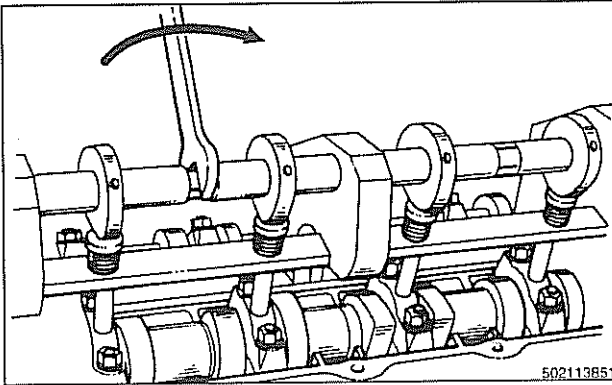


➤ Fit BMW special tools 11 3 260 (**A**) and 11 3 270 (**B**) to cylinder head and screw long bolts (**arrows**) into spark plug threads. Tensioning pins on tool will align with the bearing caps on the intake camshaft.

### CAUTION—

*Do not over torque bolts into spark plug holes.*

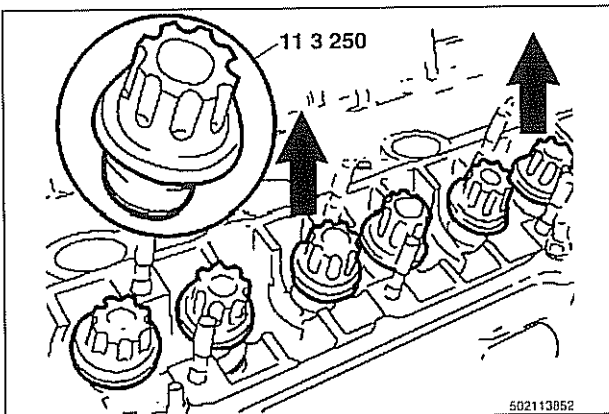
## Cylinder Head Removal and Installation



➤ Turn eccentric shaft of special tool to pretension intake camshaft bearing caps. Remove nuts on all intake camshaft bearing caps.

— Slowly release tension on eccentric shaft and remove BMW special tools. Remove bearing caps and set aside in order. Remove camshaft and store safely.

— Repeat procedure for exhaust camshaft.



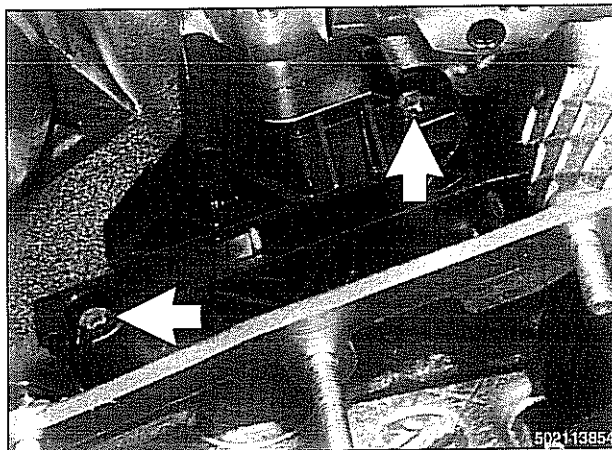
➤ Secure hydraulic lifters in lifter bores using BMW special tool 11 3 250, or remove lifters using a magnetic pick-up tool. With lifters secure or removed, lift out camshaft bearing carriers from cylinder head.

### CAUTION—

- Use care to not let hydraulic lifters fall out as camshaft carrier is removed.
- Hydraulic lifters should be stored in an upright position.
- Used hydraulic lifters must be reinstalled into their original lifter bores.

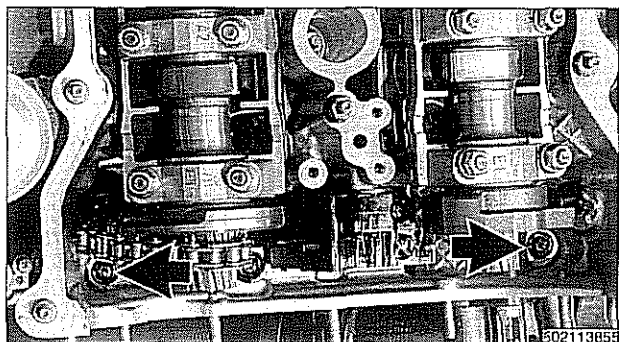


➤ Remove intake camshaft position sensor (arrow) from side of cylinder head.

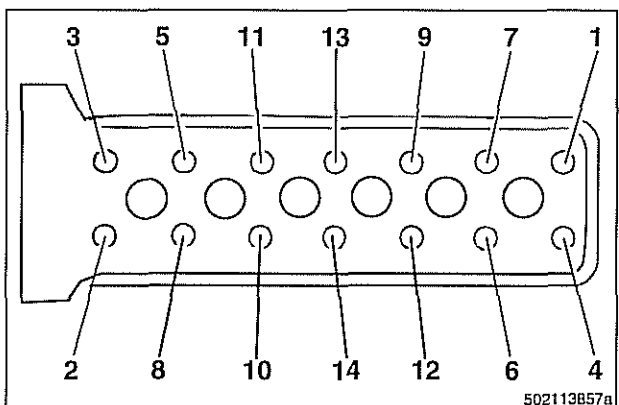


➤ Remove secondary chain lower guide bolts (arrow). Remove chain guide.

## Cylinder Head Removal and Installation



- Remove bolts (arrows) holding timing chain cover to cylinder head. (Photo shows camshafts and camshaft bearing caps in place).



- Using BMW special tool 11 2 250 or equivalent, loosen cylinder head bolts in several stages, in sequence shown. Discard head bolts.

### NOTE—

BMW special tool 11 2 250 is a thin-walled Torx E12 socket with an extended reach. The cylinder head bolts are recessed into the head below the camshaft towers with little working space.

- Lift off cylinder head. Refer to **116 Cylinder Head and Valvetrain** for cylinder head reconditioning information.

## Cylinder head, installing, M52 TU and M54 engines

Clean cylinder head and gasket surfaces of cylinder block and all timing chain covers.

### CAUTION—

Remove foreign matter and liquid from bolt holes. Trapped oil or coolant in bolt holes can cause damage to block.

### CAUTION—

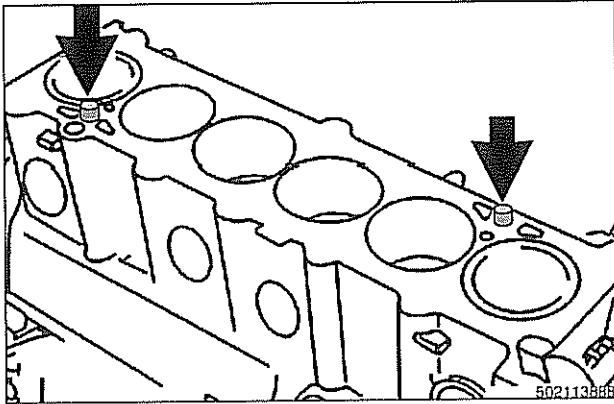
Do not use a metal scraper or wire brush to clean the aluminum cylinder head or pistons. If necessary, use a hard wooden or plastic scraper. Also available are abrasive discs to be used in conjunction with an electric drill. Be sure to use the correct disc for the type of metal being cleaned.

Evaluate cylinder head as shown in **116 Cylinder Head and Valvetrain**.

### NOTE—

- If the cylinder head has been machined, a special 0.3 mm (0.011 in.) thicker gasket should be installed. The thicker gasket is available from an authorized BMW dealer and should be marked accordingly.
- Cylinder head and valve specifications are covered in **116 Cylinder Head and Valvetrain**.

## Cylinder Head Removal and Installation



Lubricate camshafts, camshaft carriers, bearing caps, hydraulic lifters, friction washers, splined shafts and spline hubs with assembly lubricant before installation.

◀ Check that two cylinder head aligning sleeves (arrows) are correctly positioned in block and are not damaged.

– Apply elastic sealing compound Three Bond 1209® to corner joints on cylinder block to timing chain cover.

– Place new cylinder head gasket on cylinder block.

### NOTE—

The word "OBEN" or "TOP", printed on the gasket, should face up. The cylinder head gasket will fit correctly in only one orientation.

– Set cylinder head in position, guiding primary chain through cylinder head opening.

### CAUTION—

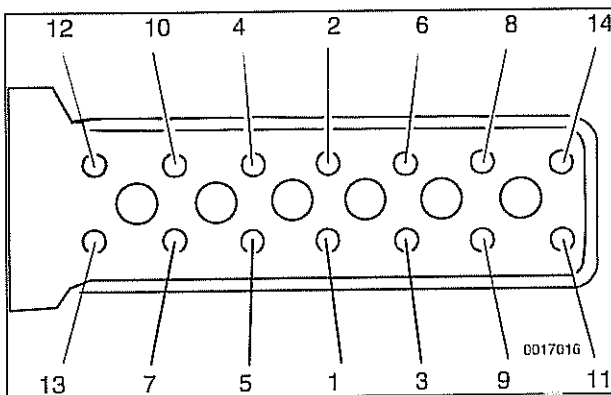
Make sure the crankshaft, which had been rotated approximately 30° opposite the direction of engine rotation from TDC, is still in that position before lowering the cylinder head into position. All pistons must be out of TDC position to prevent valve/piston interference when the camshafts are installed.

– Lightly lubricate new cylinder head bolts and washers with oil. Install bolts and washers finger tight. Install cylinder head to lower timing chain cover bolts finger tight.

### NOTE—

- Cylinder head bolts should not be reused. They are stretch-type bolts and must be replaced whenever loosened.
- Aluminum cylinder blocks use different length cylinder head bolts and torque values than cast iron blocks.
- Check that all washers for the head bolts are in place before installing the bolts. Some of the washers may be staked to the cylinder head.

◀ Tighten cylinder head bolts in correct sequence (1–14).



### CAUTION—

The bolts should be tightened in three stages as listed below. The final stages require the use of a BMW special tool 11 2 110 or a suitable protractor to tighten the bolts to a specified torque angle.

## Cylinder Head Removal and Installation

- Secure cylinder head bolts by torquing an additional 90° each for Stage 2 and 3.

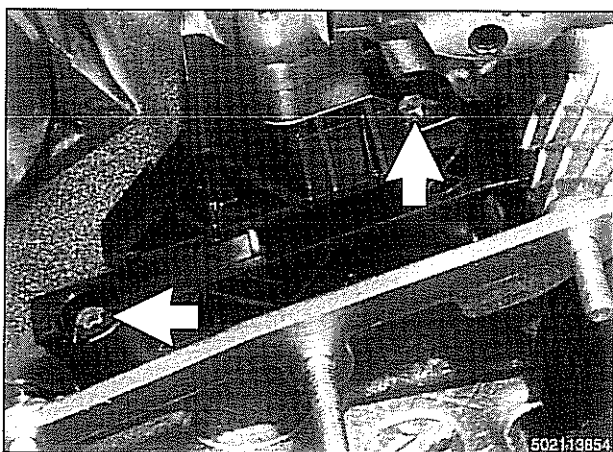
### Tightening torques

Cylinder head to engine block  
(aluminum block)

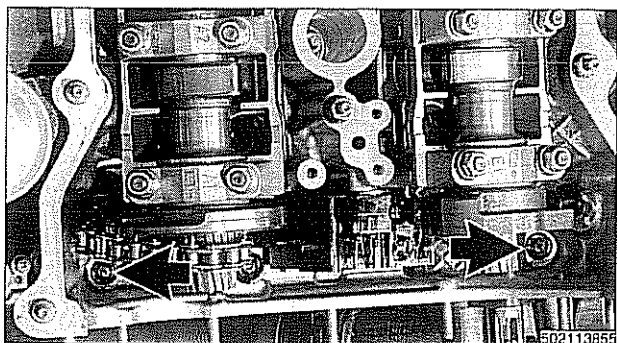
Stage 1	40 Nm (30 ft-lb)
Stage 2	+90°
Stage 3	-90°



- Install intake camshaft position sensor (arrow).



- Install lower secondary chain guide. Tighten torx bolts to specifications. The bolt on the intake camshaft side is long and extends into the engine block.

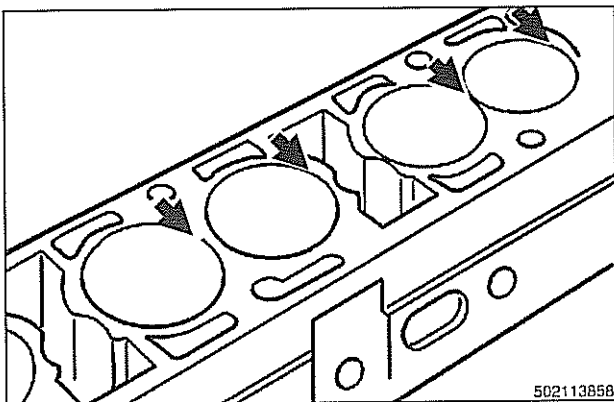


- Install and tighten cylinder head-to-lower timing chain cover bolts (arrows). (Photo shows camshafts in place).

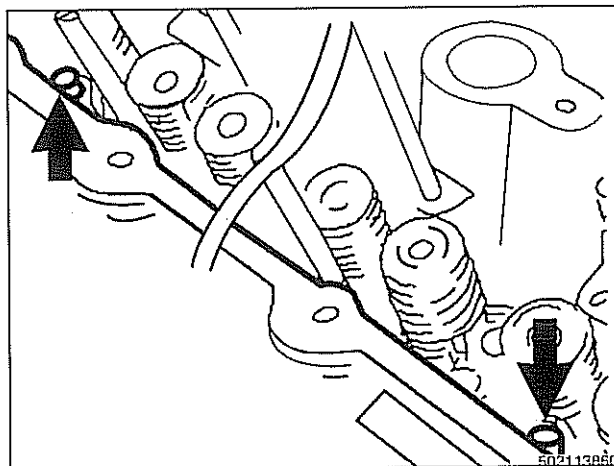
### Tightening torque

Secondary chain guide to cylinder head	10 Nm (89 in-lb)
Cylinder head to lower timing chain cover	
M6	10 Nm (89 in-lb)
M7	15 Nm (11 ft-lb)

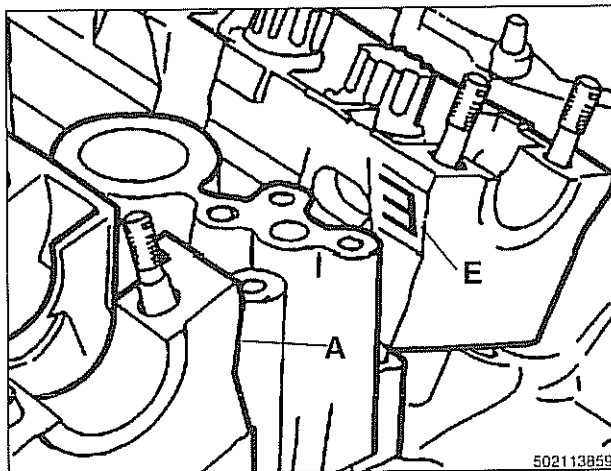
## Cylinder Head Removal and Installation



- Before installing camshaft carriers, examine bearing points (arrows) on hydraulic lifter bores for signs of wear.

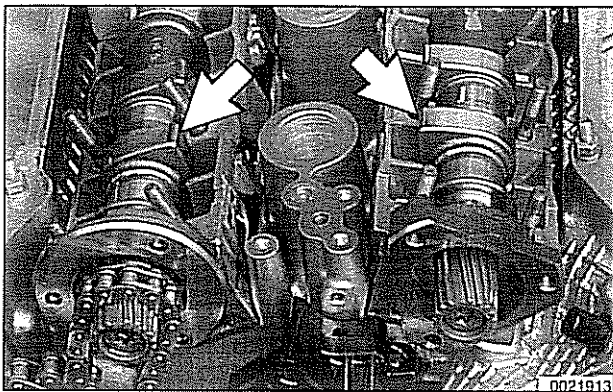


- Center camshaft carrier with hydraulic lifters on pins (arrows) at bearing positions 2 and 7.



- Note marks on carriers: (E) for intake side and (A) for exhaust side.
- Lift timing chain and put exhaust cam onto exhaust camshaft carrier. Place intake camshaft on camshaft carrier.

## Cylinder Head Removal and Installation

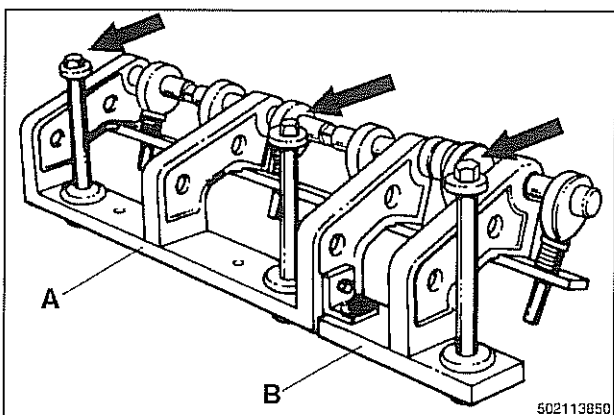


- Rotate camshafts until intake and exhaust lobes for cylinder 1 face each other (**arrows**).

### CAUTION—

Be sure that crankshaft is still positioned at least 30° away from TDC.

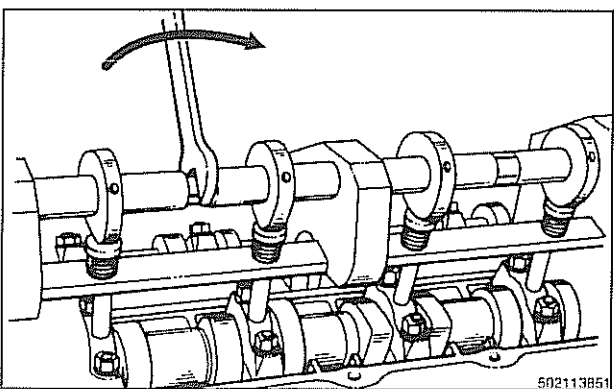
- Place bearing caps on cams, but do not install retaining nuts.



- Fit BMW special tool 11 3 260 (**A**) and 11 3 270 (**B**) to cylinder head over intake camshaft and screw long bolts (**arrows**) into spark plug threads.

### CAUTION—

Do not overtighten bolts in spark plug holes.



- Turn eccentric shaft of special tool to pretension bearing caps. Install and torque nuts on intake camshaft bearing caps.

### Tightening torque

Camshaft bearing cap to cylinder head (M7)	14 Nm (10 ft-lb)
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- Release tension on eccentric shaft and remove BMW special tools 11 3 260/270.
- Repeat procedure for exhaust camshaft.

### CAUTION—

After the camshafts are installed, a minimum waiting time is required for the hydraulic lifters to "bleed down" before bringing the crankshaft and piston back to top dead center. When the camshafts are removed, the hydraulic lifters can expand. This expansion can cause increased valve lift when the camshafts are bolted down, possibly resulting in piston interference.

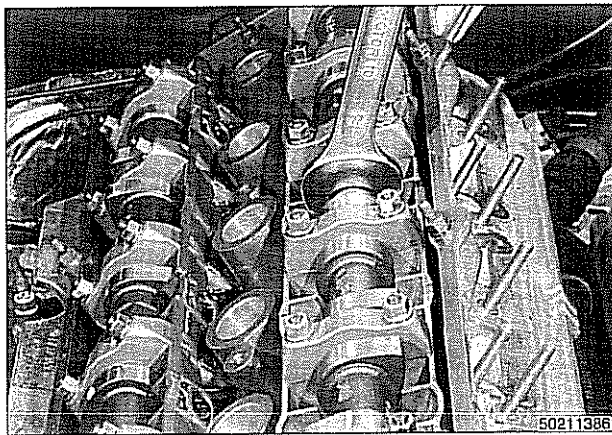
### Crankshaft / valve timing waiting times

68° F (20° C) and higher	4 minutes
50 – 68° F (10 – 20° C)	11 minutes
32 – 50° F (0 – 10° C)	30 minutes

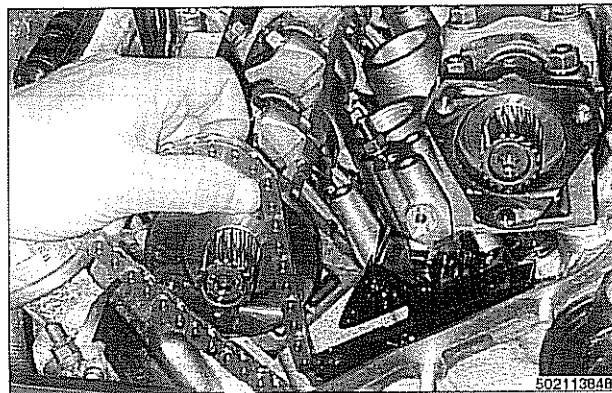
## Cylinder Head Removal and Installation



- Secure camshafts in TDC position using BMW special tool set 11 3 240.

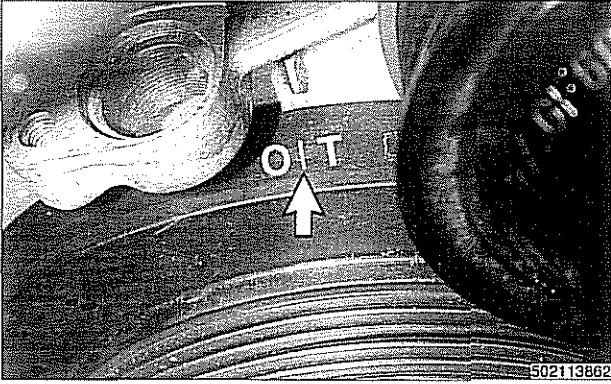


- In necessary, turn camshaft slightly so that special tools are squarely seated on cylinder head.

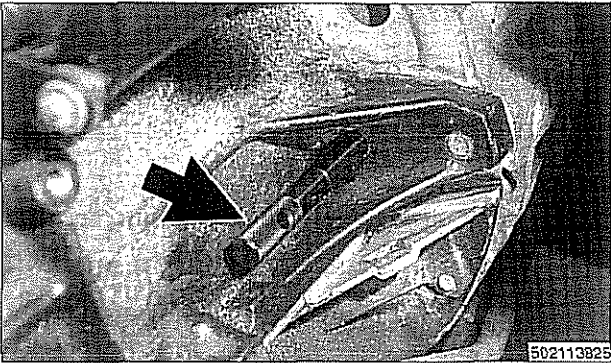


- Lift timing chain and hold under tension.



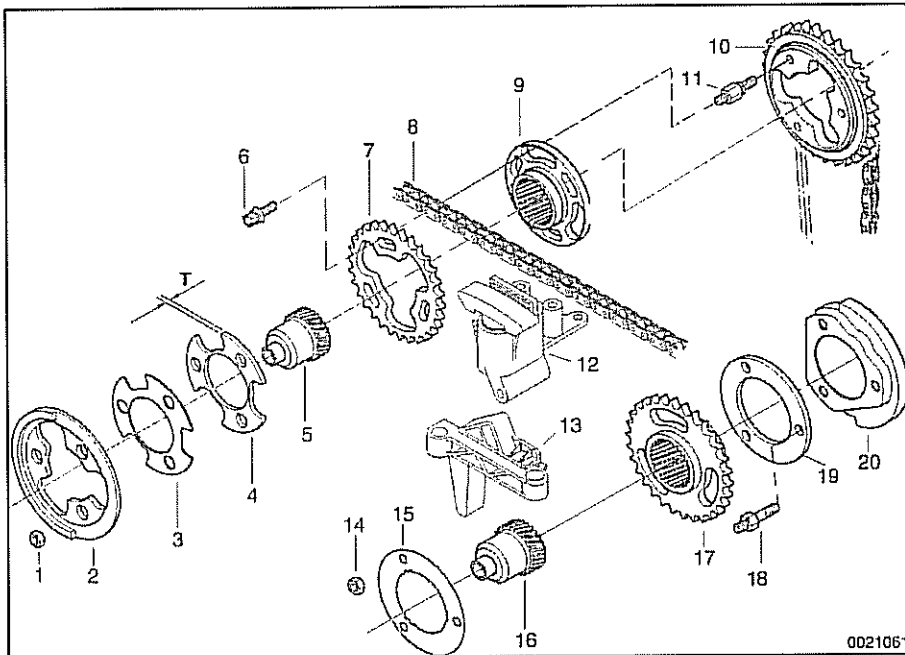
**Cylinder Head Removal and Installation**

- While maintaining tension on timing chain, rotate crankshaft at vibration damper from 30° before TDC in direction of rotation (clockwise) until number 1 cylinder is at TDC position with line between the **OIT** (arrow) on front pulley lined up with boss on lower timing chain cover.



- Secure crankshaft in TDC position with BMW special tool 11 2 300 (arrow).

## Cylinder Head Removal and Installation

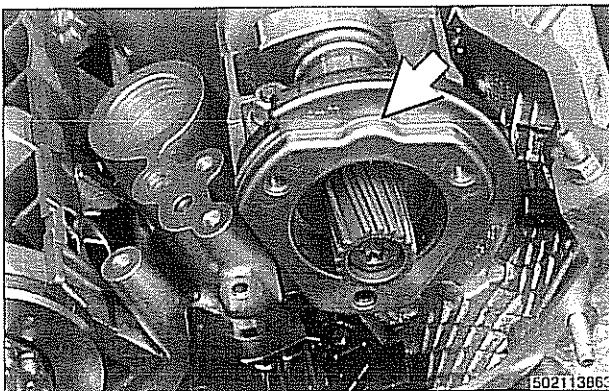


### Double VANOS Timing Chain Components

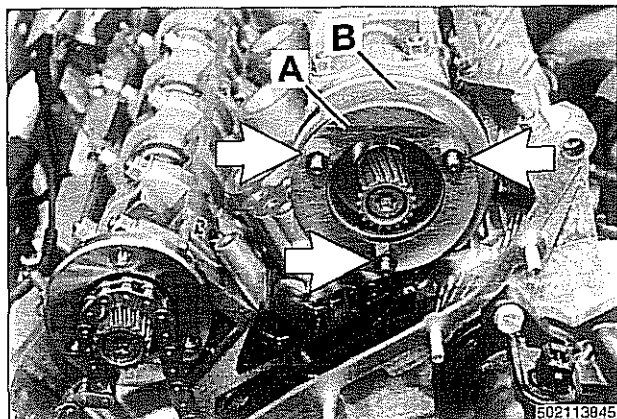
1. Impulse wheel mounting nut
2. Exhaust camshaft impulse wheel
3. Spring plate, exhaust
4. Thrust spacer (T = 3.5 mm)
5. Splined shaft
6. Torx screw
7. Exhaust camshaft secondary sprocket
8. Secondary timing chain
9. Splined sleeve
10. Primary sprocket
11. Threaded locating stud
12. Secondary chain tensioner
13. Secondary chain lower guide
14. Sprocket mounting nut
15. Spring plate, intake
16. Splined shaft
17. Intake camshaft sprocket
18. Locating stud
19. Thrust spacer
20. Intake camshaft impulse wheel

### Double VANOS timing chain components, installing, M52 TU and M54 engines

- Slide impulse wheel on intake camshaft, aligning boss with raised portion on camshaft (arrow).



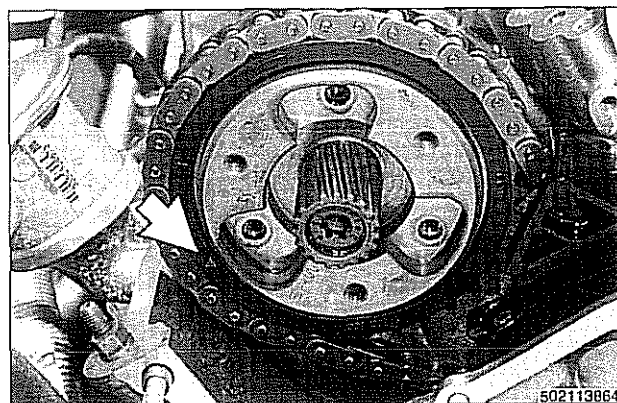
## Cylinder Head Removal and Installation



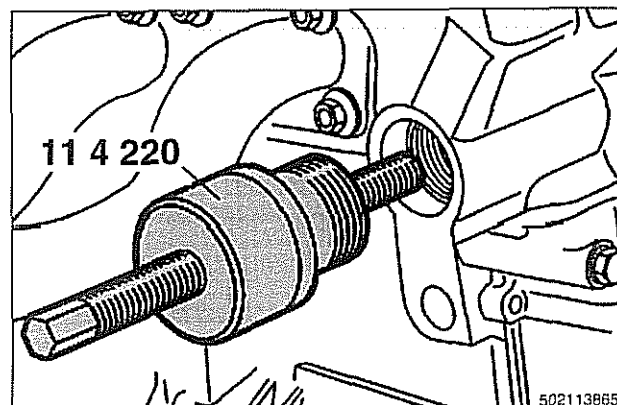
- Fit thrust spacer (A) to intake camshaft (B) and tighten down with threaded locating studs. Place longer threaded end of studs into camshaft (arrows).

### Tightening torque

Impulse wheel studs to intake camshaft)	20 Nm (15 ft-lb)
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- Fit primary sprocket to primary timing chain and install on exhaust camshaft so that pointer on sprocket (arrow) lines up with cylinder head sealing surface.

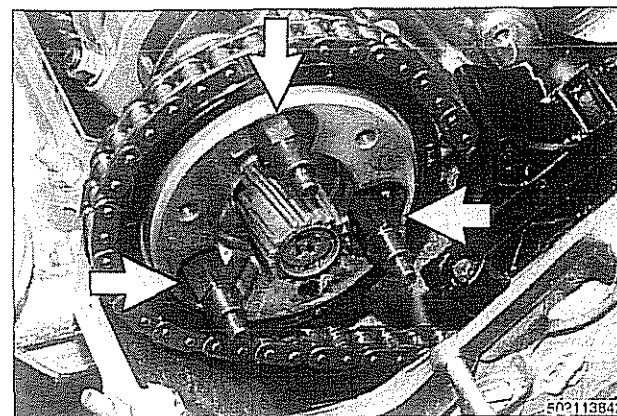


- Insert BMW special tool 11 4 220 into timing chain tensioner bore and bring center spindle into contact with tensioning rail. Tighten until slack is removed, but do not pretension timing chain.

### NOTE —

BMW special tool 11 4 220 is an adjustable primary chain tensioner and simulates the function of the tensioner.

- Recheck arrow on primary sprocket is aligned with upper edge of cylinder head. Reposition sprocket if necessary.

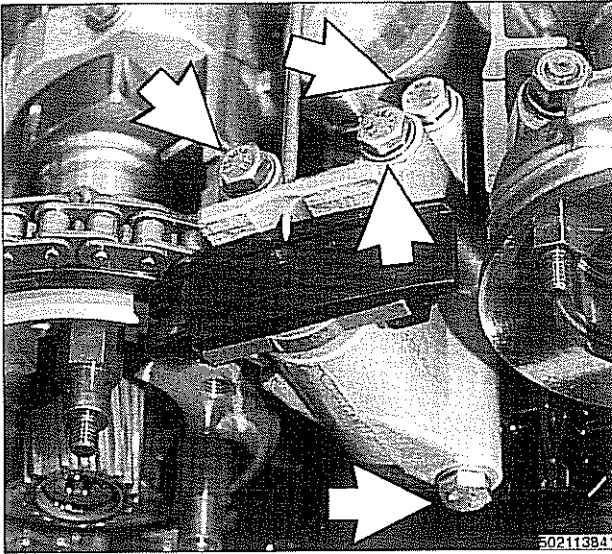


- Insert and tighten down threaded locating studs (arrows) in end of exhaust camshaft. Note installed position of studs.

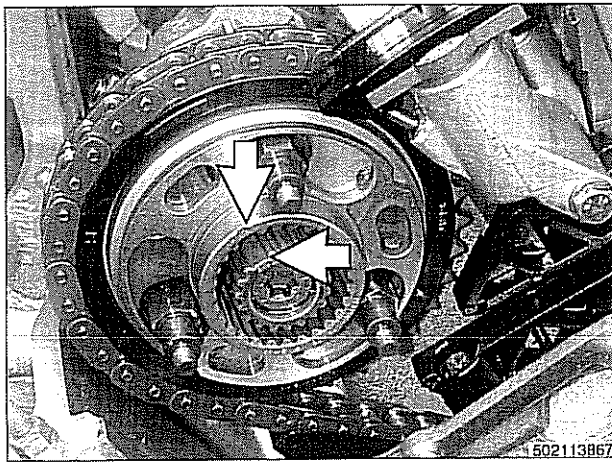
### Tightening torques

Exhaust camshaft locating stud	20 Nm (15 ft-lb)
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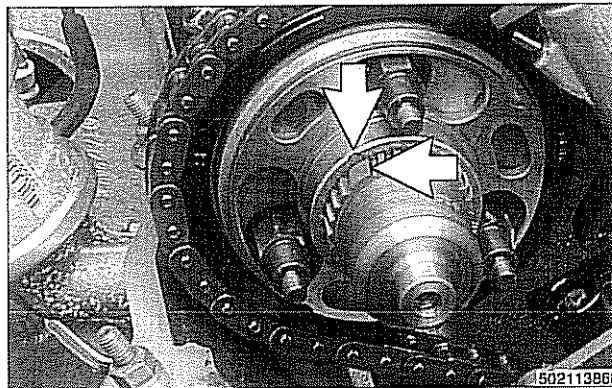
## Cylinder Head Removal and Installation



- Install secondary chain tensioner on cylinder head (**arrows**). Keep tensioner compressed using BMW special tool 11 3 291 or suitable pin.

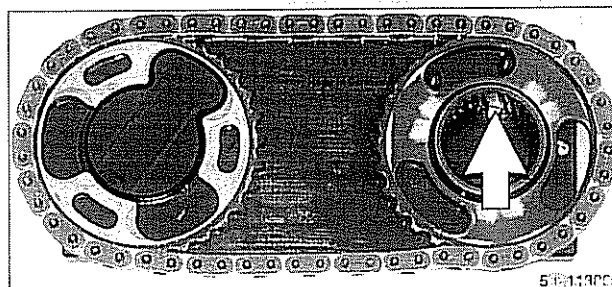


- Install exhaust camshaft splined sleeve. Confirm that gap in sleeve splines aligns with corresponding gap in camshaft splines (**arrows**).



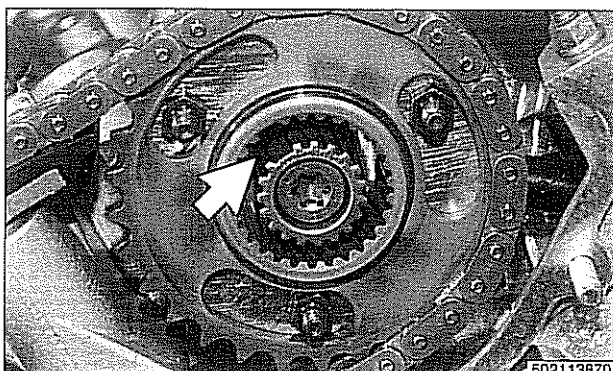
- Slide splined shaft onto exhaust camshaft. Be sure that locating tooth of shaft fits into spline gaps of camshaft and splined sleeve (**arrows**).

- Push splined shaft in further to rotate splined sleeve until the three threaded holes in primary chain sprocket are centered in the small slots of the splined sleeve.



- Place intake and exhaust sprockets in BMW special tool 11 6 180. Position spline gap on intake sprocket (**arrow**) as shown and place secondary chain on sprockets.

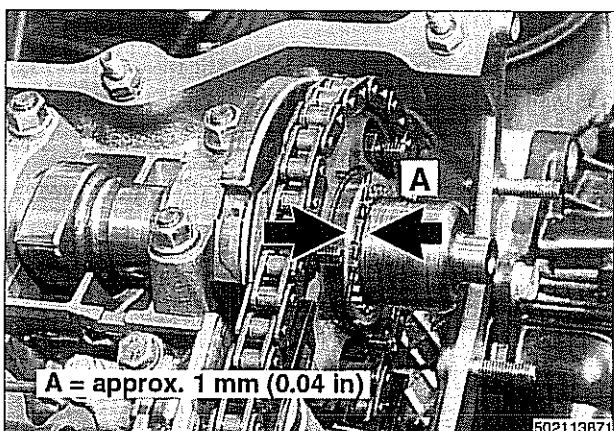
## Cylinder Head Removal and Installation



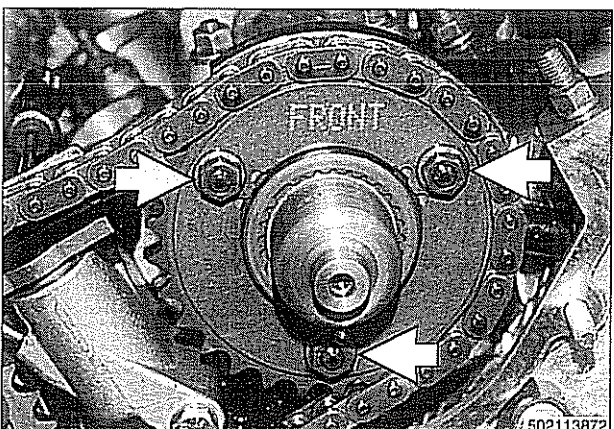
- Remove chain and sprockets from tool and slide sprockets on camshafts. Confirm that gap in intake sprocket splines lines up with corresponding gap in camshaft splines (arrow).

### CAUTION—

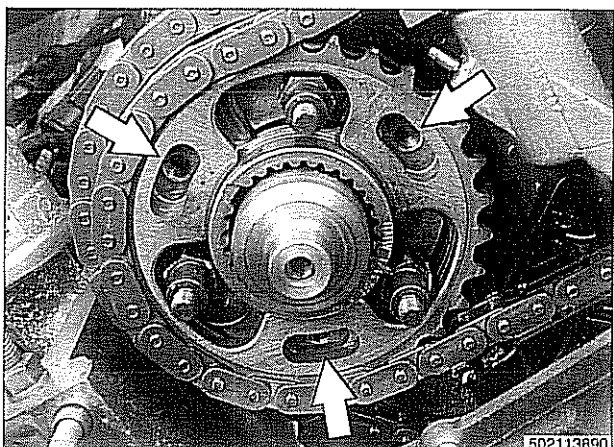
Do not alter position of sprockets with respect to chain when removing from special tool 11 6 180.



- Align locating tooth of splined shaft with gaps on camshaft and sprocket. Slide splined shaft onto intake camshaft until approx. 1 mm (0.04 in) of splines (arrows) are visible.

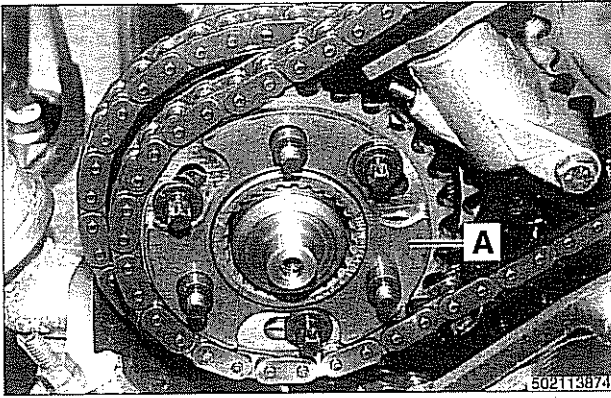


- Install intake camshaft spring plate so that **FRONT** mark is visible. Install mounting nuts (arrows) finger tight.

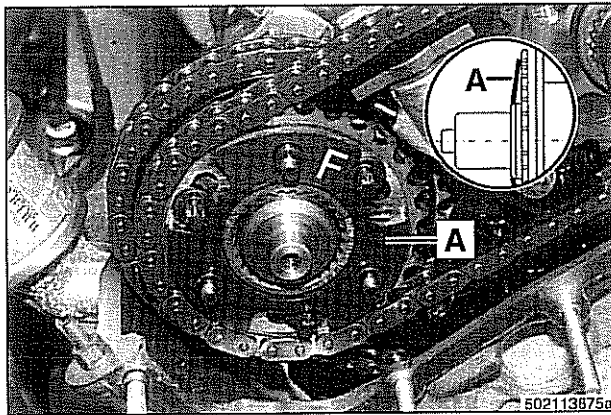


- Insert sprocket mounting bolts (arrows) on exhaust side camshaft assembly.
  - Initially tighten to approx. 5 Nm (44 in-lb) and then back off by half a turn.

## Cylinder Head Removal and Installation



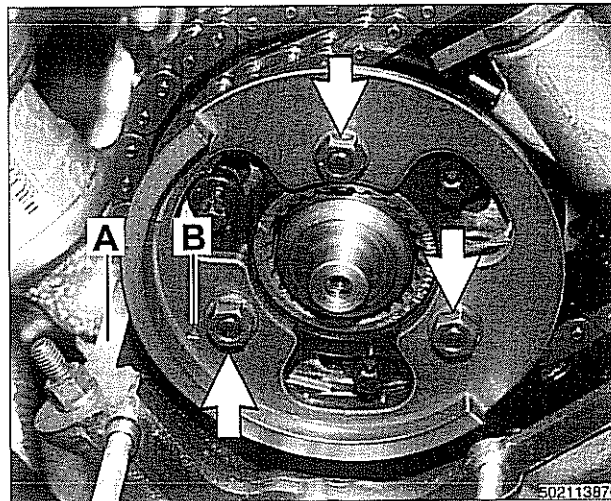
- Fit thrust spacer (A) on exhaust camshaft.



- Install spring plate (A) to exhaust camshaft. Make sure that (F) mark is visible.

**NOTE—**

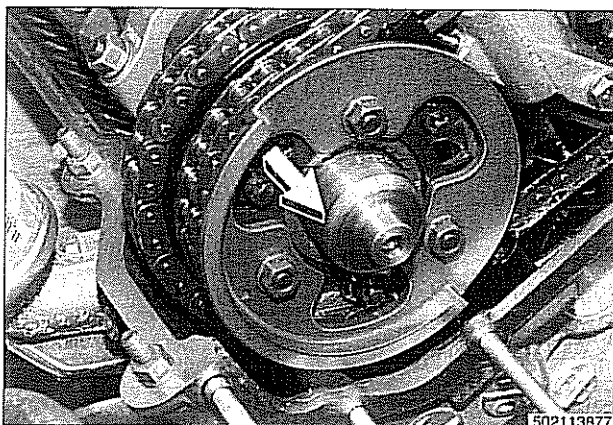
*If F mark is no longer visible, install spring plate as shown in inset.*



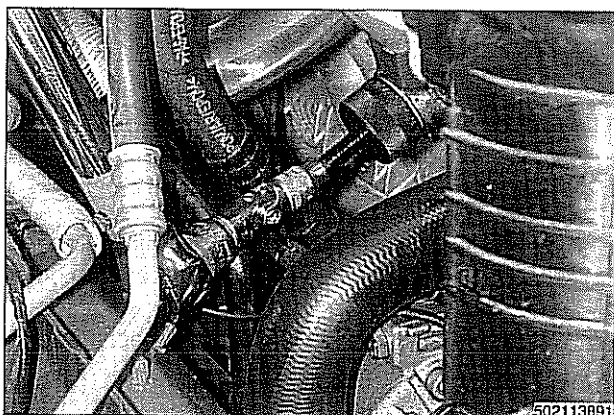
- Install exhaust camshaft impulse wheel, aligning pointer (B) with top edge of cylinder head (A). Install mounting nuts (arrows) finger tight.



## Cylinder Head Removal and Installation



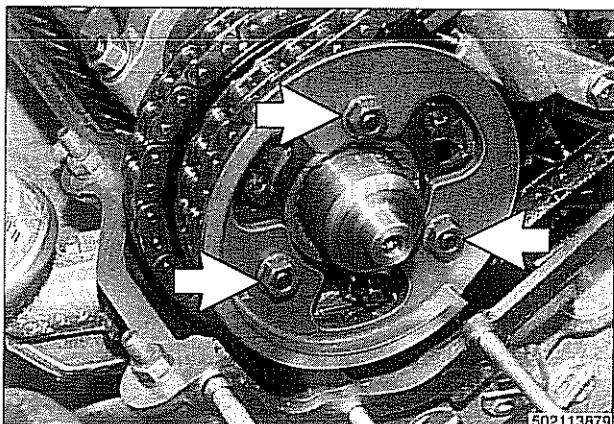
- ⚡ Pull out exhaust camshaft splined shaft to stop.
- Press down on secondary chain tensioner and remove tensioner lock-down tool.



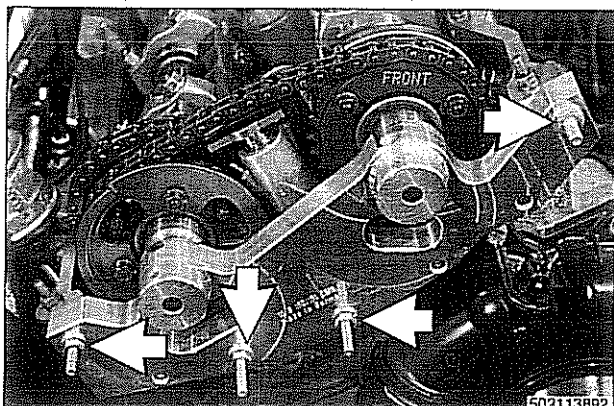
- ⚡ Preload primary chain:
  - Tighten adjusting screw on BMW special tool 11 4 220 to specified torque.

### Tightening torque

Primary chain tensioner preload	0.7 Nm (6 in-lb)
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- ⚡ Preload exhaust camshaft spring plate by pressing on impulse wheel while tightening mounting nuts (**arrows**) finger tight.

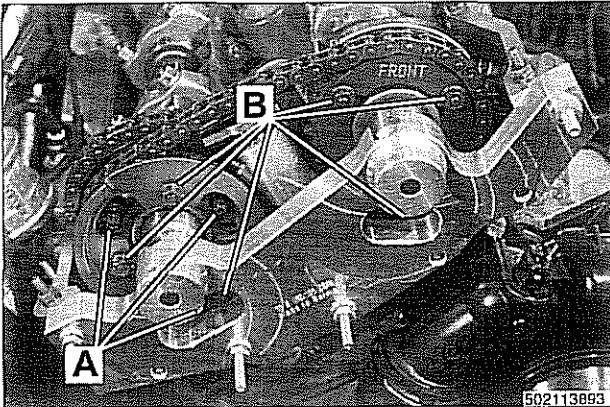


- ⚡ Install BMW special tool 11 6 150 (VANOS setup bracket) to front of cylinder head timing case. Install nuts (**arrows**) finger tight, then tighten down uniformly until special tool is in full contact with cylinder head.

### CAUTION—

*Make sure all gasket material is removed from face of cylinder head. Clean sealing face and keep free of oil. If any foreign material is present on the sealing surface, the camshaft timing will be incorrect.*

## Cylinder Head Removal and Installation

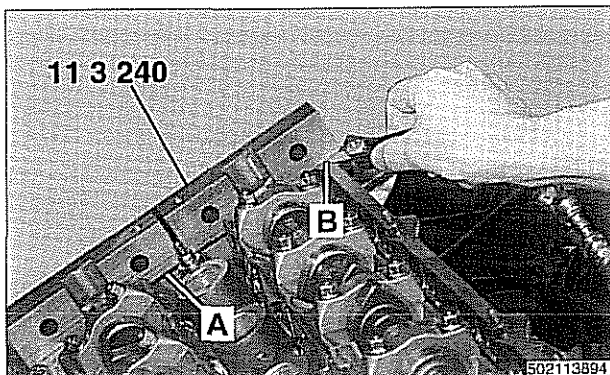
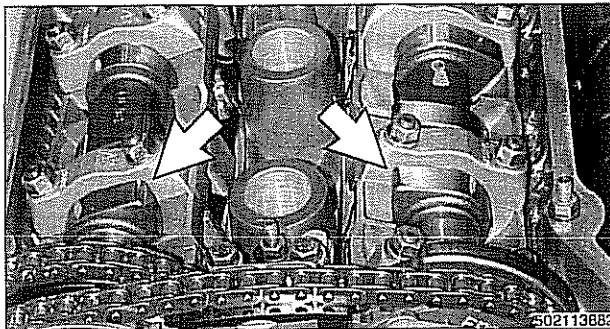


- Secure camshaft sprockets and impulse wheels:
  - Tighten mounting screws (A) on exhaust camshaft impulse wheel to approx. 5 Nm (44 in-lb).
  - Tighten mounting nuts (B) on exhaust and intake sprocket assemblies to approx. 5 Nm (44 in-lb).
  - Torque down mounting screws (A) and nuts (B) to final specifications.

### Tightening torques

Sprocket assembly to camshaft initial torque	5 Nm (44 in-lb)
Sprocket assembly wheel to camshaft M7 torx screws (A)	20 Nm (15 ft-lb)
M6 mounting nuts (B)	10 Nm (8 ft-lb)

- Remove crankshaft locking tool from transmission bell housing so that crankshaft is no longer secured in TDC position.
- Remove camshaft locking tools from cylinder head.
- Turn engine over twice in direction of rotation until cylinder 1 intake and exhaust camshaft lobes (arrows) face each other.
- Secure crankshaft in TDC position with BMW special tool 11 2 300.



- Place BMW special tool set 11 3 240 over camshafts and measure clearances.

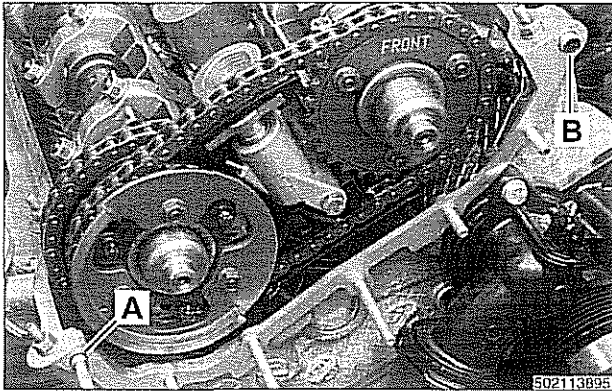
### CAUTION—

- If the exhaust side of the tool (A) is not flush with the head, camshaft timing is incorrect. Reset camshaft timing as described in **117 Camshaft Timing Chain**.
- Due to flexible sprocket design, VANOS unit tolerances and play in the VANOS splines, when the camshaft timing is set correctly, the intake side of special tool 11 3 240 (B) may be up to 1 mm (0.04 in.) above the surface of the cylinder head. This is normal. Reassemble engine. Otherwise, reset camshaft timing as described in **117 Camshaft Timing Chain**.

- Remove BMW special tool 11 6 150 from front of cylinder head.



## Cylinder Head Removal and Installation



- ◀ Clean contact edges of cylinder head face and VANOS unit and apply a thin coat of permanently elastic Three Bond 1209 ® or equivalent to surfaces.

### CAUTION—

- Check locating dowel (A) and dowel sleeve (B) at top of cylinder head for damage or incorrect installation.
- Make sure all gasket material is removed from face of cylinder head. Clean sealing face and keep free of oil. If any foreign material is present on the sealing surface, the camshaft timing will be incorrect.

- Install new steel gasket to front of cylinder head and install VANOS unit.

### NOTE—

If VANOS control unit is being replaced, be sure to check and adjust camshaft timing as described in **117 Camshaft Timing Chain**.

- Reinstall engine lifting eye.

### Tightening torque

VANOS unit to cylinder head

M6 nut	10 Nm (89 in-lb)
M7 nut	14 Nm (10 ft-lb)

- Reconnect electrical harness connectors to camshaft position sensors and VANOS solenoid valves.

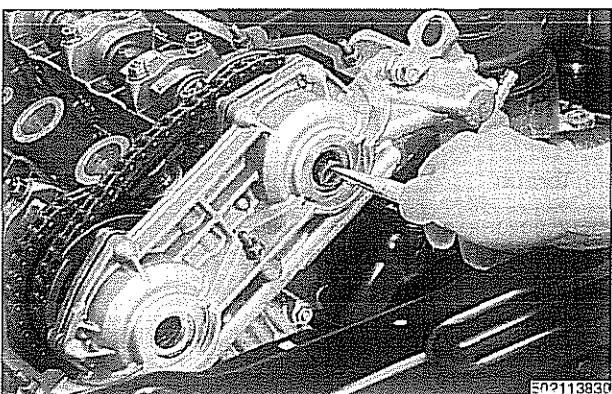
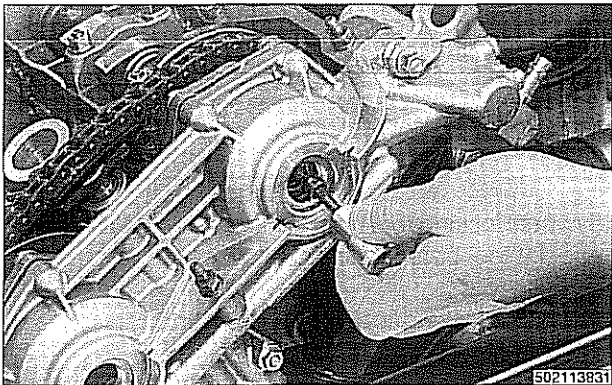
- ◀ Insert and tighten down VANOS hydraulic piston set screws in splined shafts on intake and exhaust camshafts.

### CAUTION—

Set screws have left hand thread. Tighten counterclockwise.

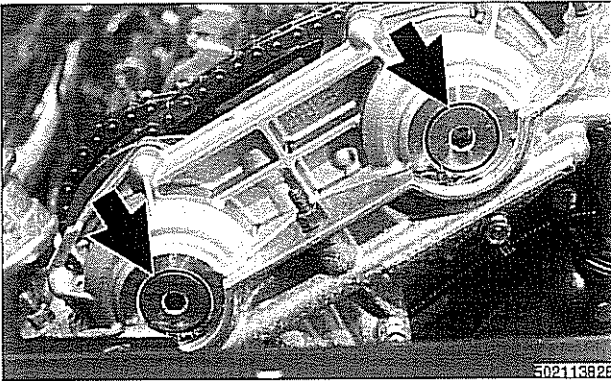
### Tightening torque

Hydraulic piston to splined shaft	10 Nm (89 in-lb)
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- ◀ Replace sealing caps inside VANOS unit with short needle nose pliers.

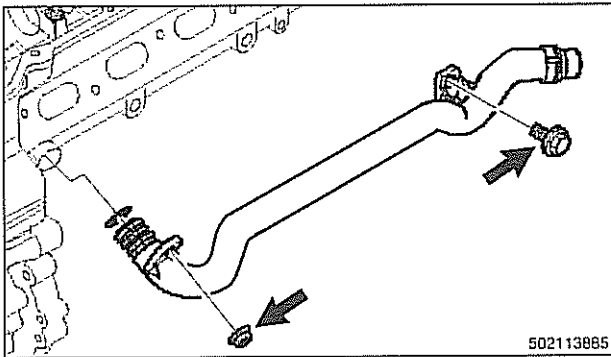
## Cylinder Head Removal and Installation



- Insert and secure VANOS sealing plugs (**arrows**) with new sealing O-rings.

### Tightening torque

Sealing plug to VANOS	50 Nm (37 ft-lb)
-----------------------	------------------



- Install coolant pipe fasteners at base of cylinder head and tighten fasteners (**arrows**).

### NOTE —

Use new sealing O-ring on coolant pipe.

- Install VANOS oil line banjo bolt with new seals. Attach oil line to VANOS unit.

### Tightening torque

Oil line to VANOS unit (banjo bolt)	32 Nm (24 ft-lb)
--	------------------

- Remove adjustable timing chain tensioner tool and reinstall chain tensioner.

### Tightening torque

Primary chain tensioner cylinder to cylinder head	70 Nm (52 ft-lb)
--	------------------

- Remove flywheel locking tool from transmission bell housing. Replace special tool bore sealing plug.

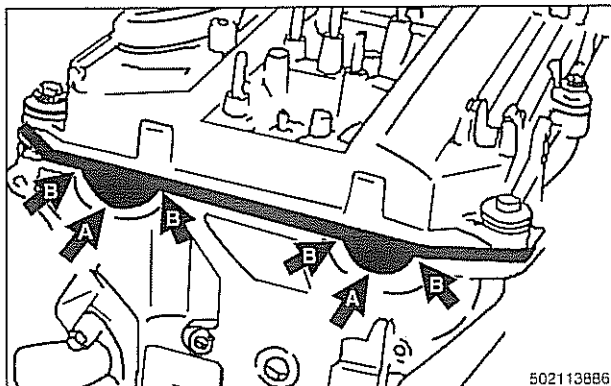
- Remove camshaft locking tools from cylinder head.

- Install intake camshaft cover and cylinder head cover.

- Check for correct seating of half-moon seals (**A**) in back of cylinder head cover.
- Use a small amount of Three Bond 1209® or equivalent sealant at corners (**B**) of half-moon cutouts.
- Seat gasket and seal corners in front of cylinder head at VANOS unit.

### Tightening torque

Cylinder head cover to cylinder head (M6)	10 Nm (89 in-lb)
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## Cylinder Head Removal and Installation

- Install exhaust manifolds using new gaskets and nuts. Coat manifold studs with copper paste prior to installing nuts.

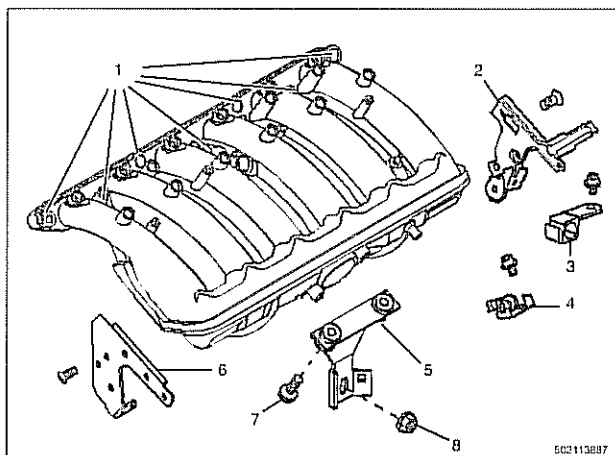
### Tightening torque

Exhaust manifold to cylinder head (M7)	20 Nm (15 ft-lb)
--	------------------

- Install electrical harness connectors for oil pressure sender and coolant temperature sensor before installing intake manifold.

### Install intake manifold:

1. Manifold mounting nuts: tighten to 15 Nm (11 ft-lb)
2. Fuel pipe bracket
3. Fuel pipe bracket
4. Vacuum pump bracket
5. Manifold mounting bracket
6. Tank venting valve bracket
7. Mounting bracket to manifold bolt (M6)
8. Mounting bracket to cylinder block nut (M10), tighten to 47 Nm (33 ft-lb)



- Intake manifold installation is reverse of removal, noting the following:
  - Use new fuel injector seals.
  - Carefully check intake manifold gasket and replace if necessary.
  - Inspect O-ring seal between mass air flow sensor and air filter housing. To facilitate reassembly, coat seal with acid-free grease.
  - Use new fuel injector seals.
  - Carefully check intake manifold gasket and replace if necessary.

### CAUTION—

When reattaching throttle assembly harness connector, connector is fully tightened when arrows on connector and plug line up.

### Tightening torque

Intake manifold to cylinder head (M7)	15 Nm (11 ft-lb)
Mounting bracket to cylinder block (M10)	47 Nm (33 ft-lb)
Mounting bracket to intake manifold (M6)	10 Nm (89 in-lb)

## Cylinder Head Removal and Installation

- Installation of the remaining parts is reverse or removal, noting the following:
  - Refill cooling system as described in **170 Radiator and Cooling System**.
  - Change engine oil and filter as described in **020 Maintenance**.
  - If necessary, adjust accelerator cable.
  - Reconnect battery.

### **CAUTION—**

*To prevent damaging the engine electronic systems, install all ground wire previously removed, including the ground wires for the ignition coils.*

### Tightening torque

Coolant drain plug to cylinder block	25 Nm (18 ft-lb)
Radiator cooling fan to coolant pump	40 Nm (30 ft-lb)
Radiator drain screw to radiator	2.5 Nm (22 in-lb)
Spark plug to cylinder head	25 Nm (18 ft-lb)

## CYLINDER HEAD REMOVAL AND INSTALLATION (M62 ENGINE)

This procedure covers cylinder head removal and installation for the M62 V-8 engine. Procedures for the M62 TU VANOS engine are not covered in this manual.

Intake manifold, left cylinder head, and right cylinder head removal and installation are written as separate procedures. The intake manifold must be removed before the cylinder heads can be removed.

### **WARNING—**

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

Cylinder head removal and installation requires multiple special service tools. Read the entire procedure before beginning the repair.

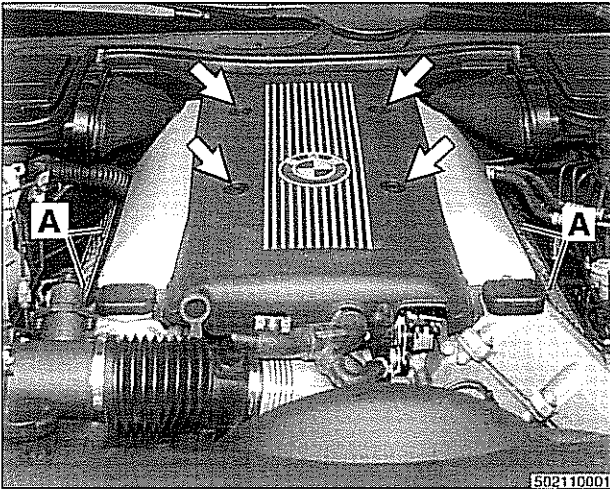
### Intake manifold, removal and installation, M62 engine

- Disconnect negative (-) battery cable.

### **CAUTION—**

*Prior to disconnecting the battery, read the battery disconnection cautions in **001 General Cautions and Warnings**.*

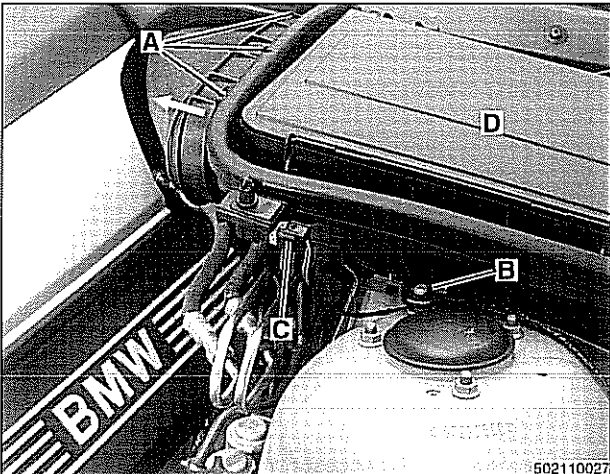
## Cylinder Head Removal and Installation



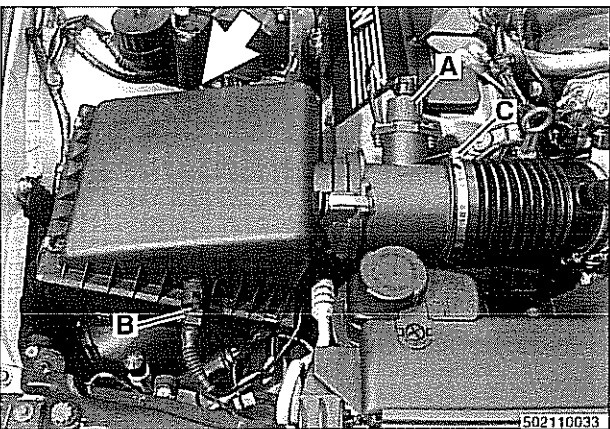
- Remove top engine cover by releasing quick release fasteners (**arrows**) by pressing down.

### NOTE—

Earlier models may have an engine cover with pry off caps and fasteners in place of quick release fasteners.

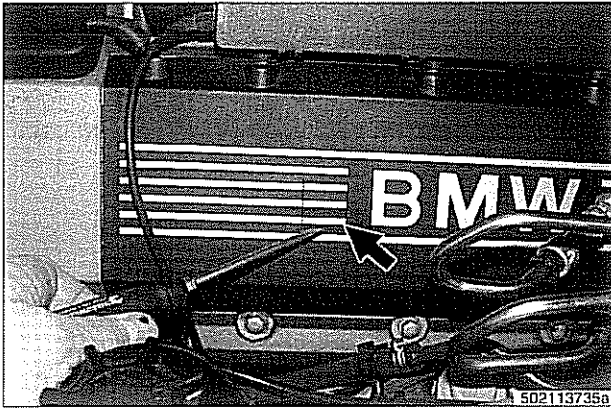


- Remove left and right interior ventilation ducts (left side shown):
  - Release locking tabs (**A**) or locking strap (early models, not shown).
  - Release spring lock (**B**).
  - Rotate duct inward (**arrow**) to remove.
  - Disconnect electrical harness from hood light switch (**C**).
  - Release locking clip and remove ventilation housing cover (**D**).
  - Lift out housing from inner fender.
  - Removal of right side ventilation housing is similar.

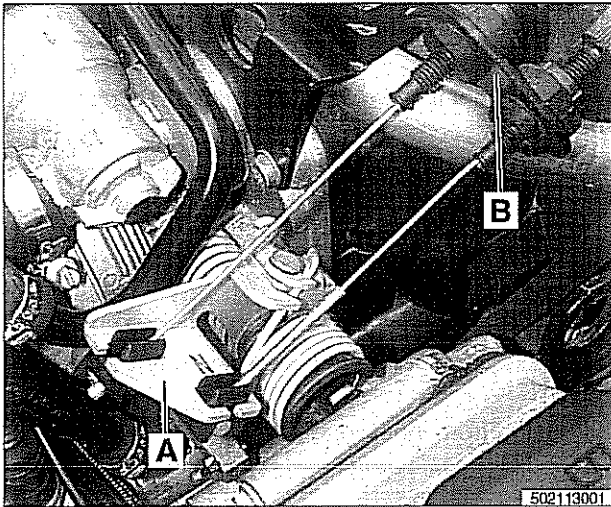


- Air filter housing assembly, removing:
  - Disconnect electrical harness connectors from mass air flow sensor (**A**) and temperature sensor (**B**).
  - Loosen hose clamp (**C**).
  - Remove filter housing mounting fastener (**arrow**) and remove filter housing with mass air flow sensor.

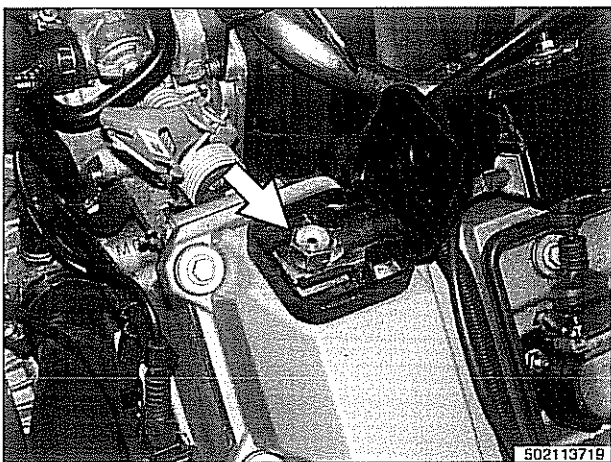
## Cylinder Head Removal and Installation



- ⚡ Pry out ignition coil cover trim caps, remove fasteners and covers from left and right sides.

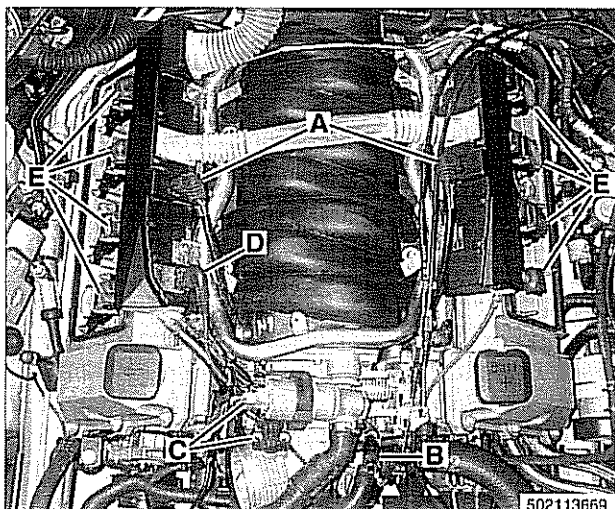


- ⚡ Disconnect throttle cables from throttle shaft (A) and remove cables from support bracket (B).

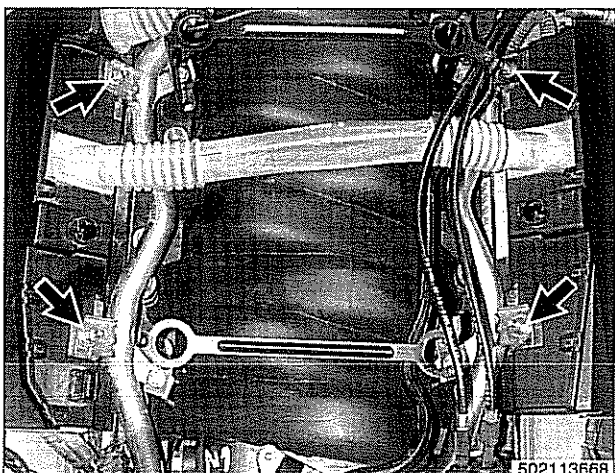


- ⚡ Disconnect cable from jump start post (arrow) on left cylinder head cover.

## Cylinder Head Removal and Installation



- ⚡ Disconnect the following electrical harness connectors:
- Knock sensors (A).
  - Thermostat (B).
  - Throttle position sensor and idle valve (C).
  - Camshaft position sensor (D).
  - Ignition coils (E).



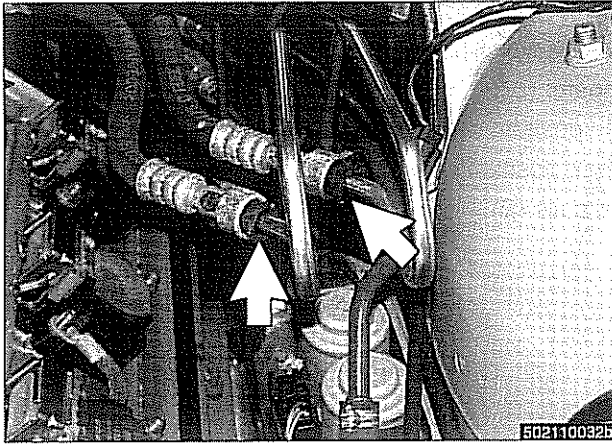
- ⚡ Remove mounting nuts (arrows) from wiring harness ducts.



- ⚡ Release fuel injector connectors by releasing spring clip (arrow) on each injector.
- Lift up and remove electrical ducts and set to one side.



## Cylinder Head Removal and Installation



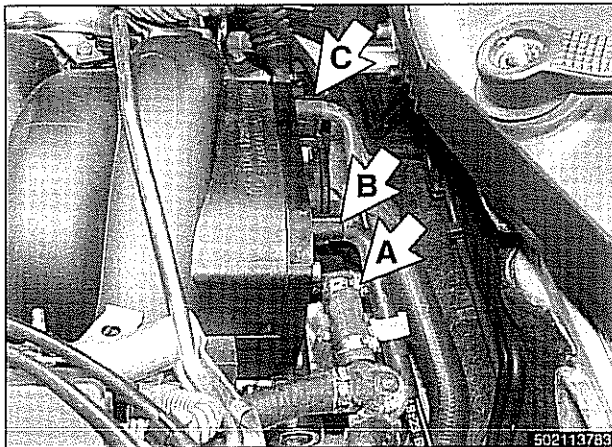
- Label and disconnect fuel lines from fuel rail by pressing locking sleeves (arrows) in to release lines.

### NOTE—

BMW uses three styles of fuel line connections; a single use clamp; a locking fitting that uses special tool 16 1 050 to release; and a quick release sleeve (arrow) that disconnects the line when depressed.

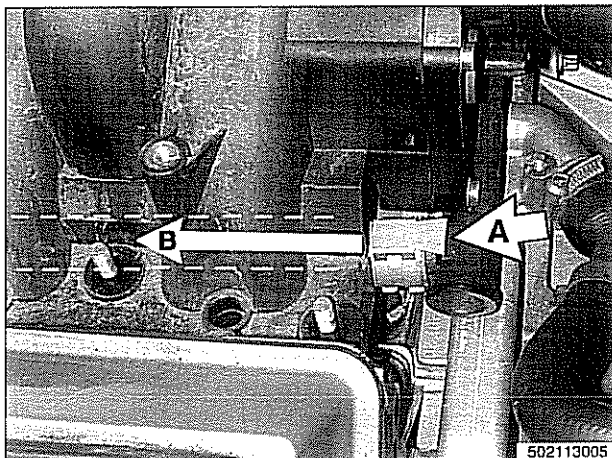
### CAUTION—

- Fuel may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb leaking fuel. Plug all open fuel lines.
- Always unscrew fuel tank cap to release pressure in tank before removing fuel lines.



- Cap fuel lines and fuel rail inlets.

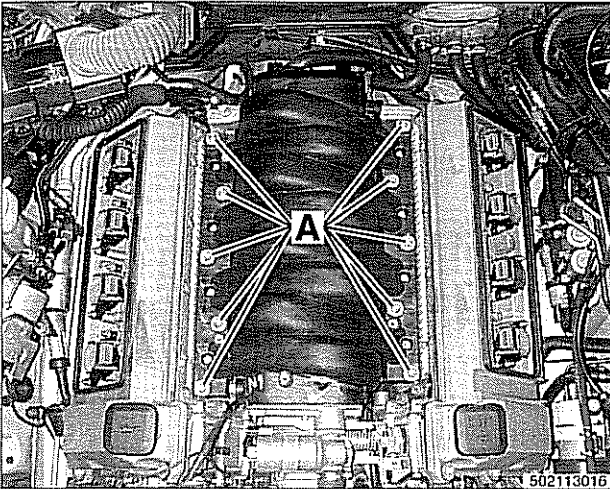
- Disconnect vacuum lines (A, B and C) from rear of intake manifold.



- Working at rear of intake manifold, disconnect crankcase ventilation valve from pipe by prying up on lock (A) and sliding tube forward (B).



## Cylinder Head Removal and Installation



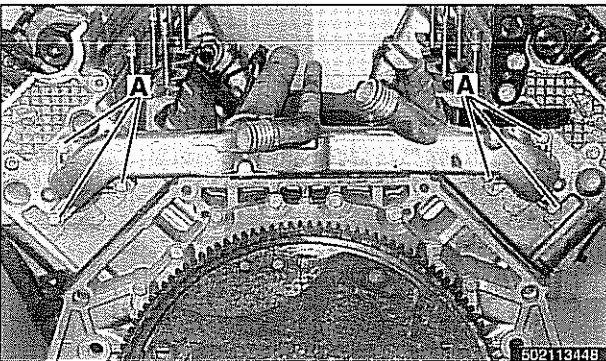
- ◀ Remove intake manifold fasteners (A).
- Carefully lift intake manifold off engine while checking that all hoses and harnesses have been disconnected.

### Left cylinder head, removing, M62 engine

- Remove intake manifold as described earlier.
- Remove left side exhaust manifold. See **180 Exhaust System**.
- Drain engine coolant, then remove viscous clutch cooling fan. See **170 Radiator and Cooling System**.

#### **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.*

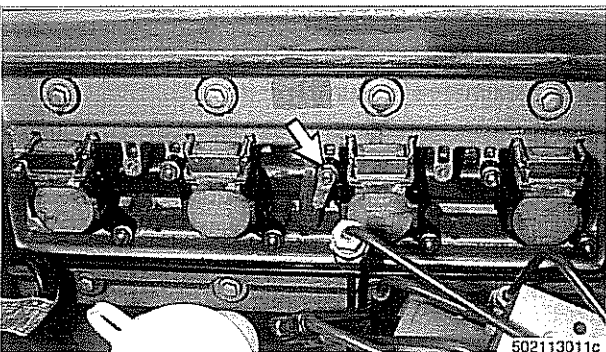


- ◀ Remove coolant manifold mounting fasteners and carefully remove manifold.

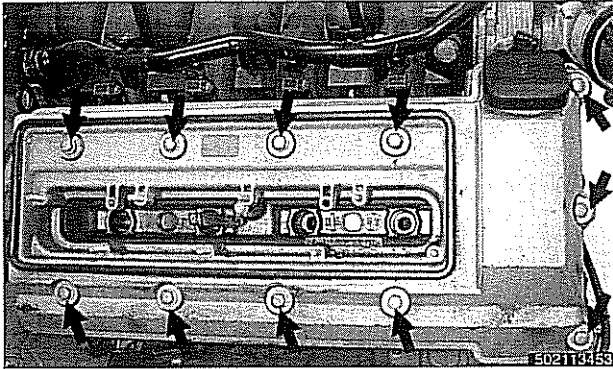
#### **NOTE**—

*Engine shown removed from engine bay.*

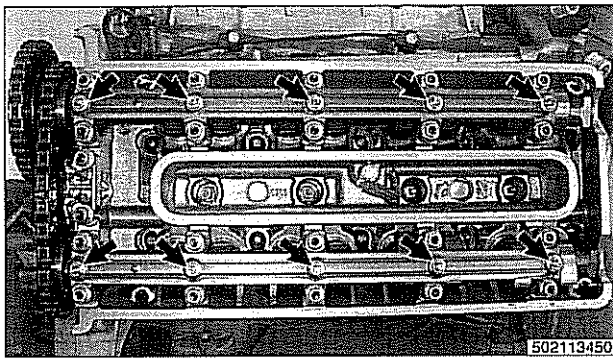
- ◀ Remove ignition coil fasteners and coils (noting location of ground strap).
- Remove spark plugs.



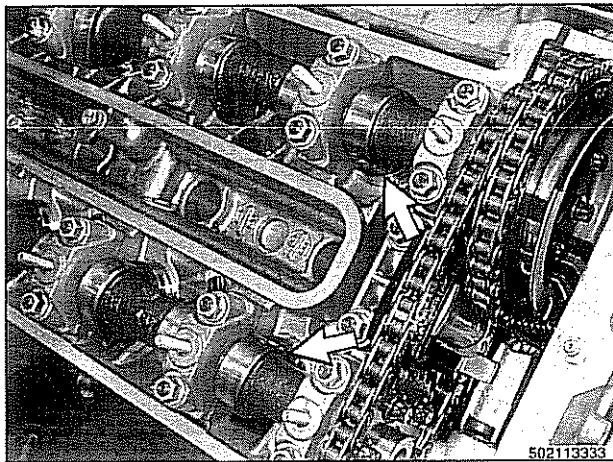
## Cylinder Head Removal and Installation



- Remove cylinder head cover fasteners (**arrows**) and remove covers from left and right cylinder heads.



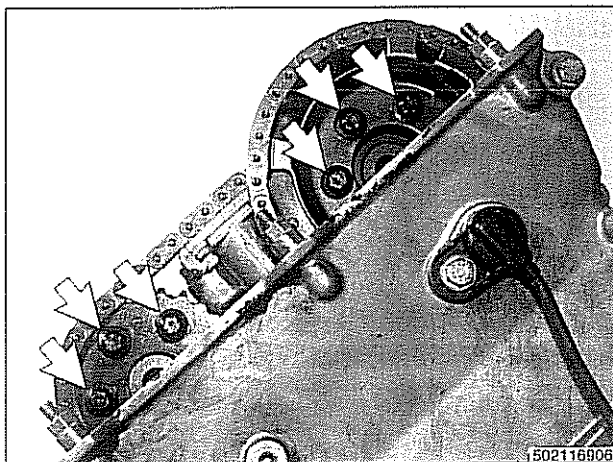
- Remove oil distribution tubes from camshaft bearing caps from left and right cylinder heads.



- Using crankshaft center bolt, turn crankshaft clockwise until number one cylinder (passenger side front cylinder) is in TDC overlap position (**arrow**).

### NOTE —

Number one cylinder is at valve overlap when both the intake and exhaust valves are starting to open (camshaft lobes facing down).

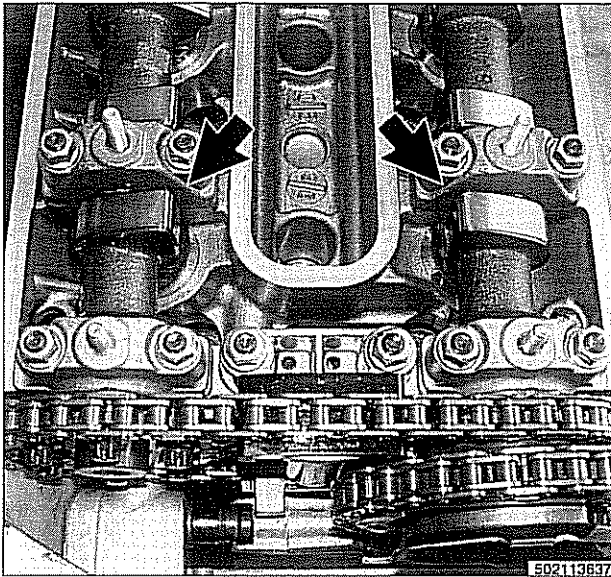


- Working at right cylinder head, loosen three accessible camshaft sprocket fasteners (**arrows**) on both intake and exhaust camshafts approximately  $\frac{1}{2}$  turn.

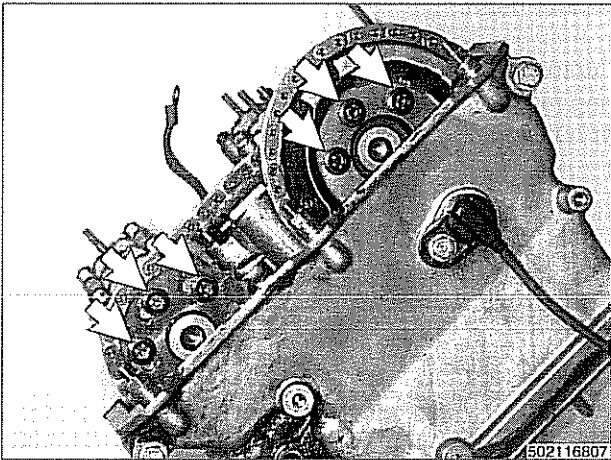
### CAUTION —

To prevent valve to piston contact when loosening camshaft sprocket fasteners, counterhold camshaft with 27 mm open-end wrench. If necessary, grind outer side of wrench jaws to prevent damaging cylinder head.

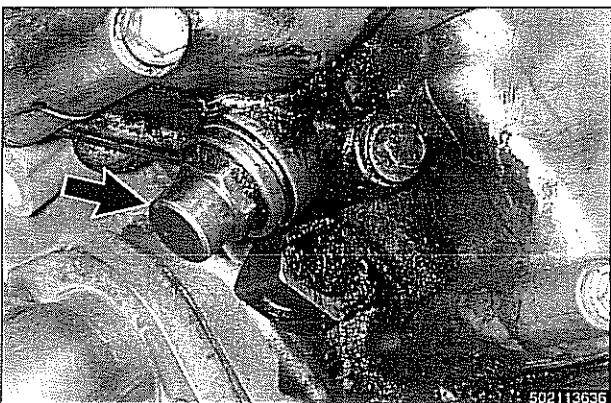
## Cylinder Head Removal and Installation



- Rotate crankshaft vibration damper to TDC position. Right head camshaft lobes for number one cylinder should be in position shown (arrows).

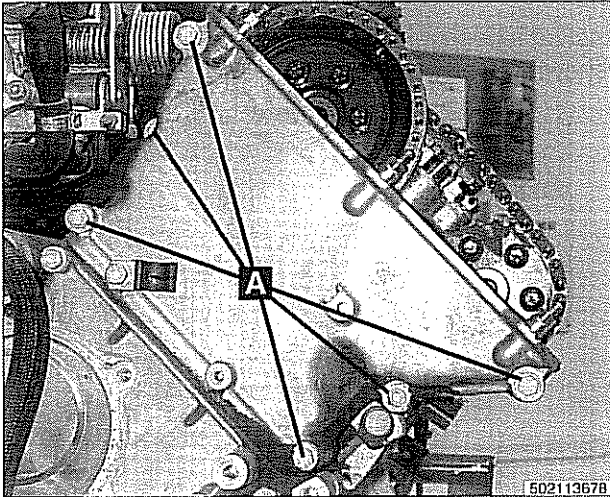


- Working at right cylinder head (passengers side) loosen remaining sprocket fasteners (arrows) on both intake and exhaust camshafts approximately  $\frac{1}{2}$  turn.

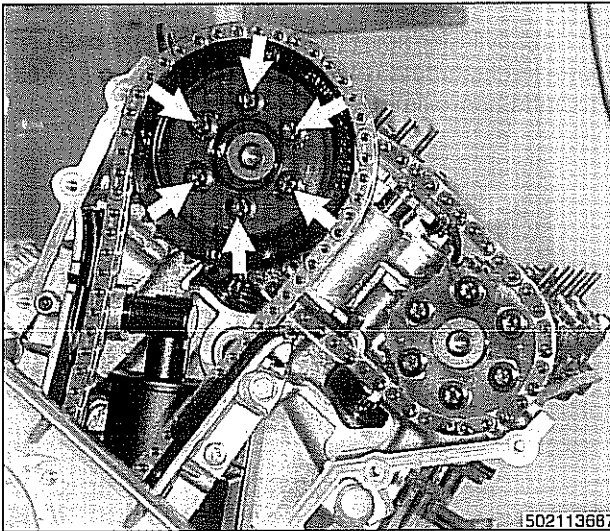


- Loosen and remove primary timing chain tensioner (arrow) from upper timing chain cover on right head.

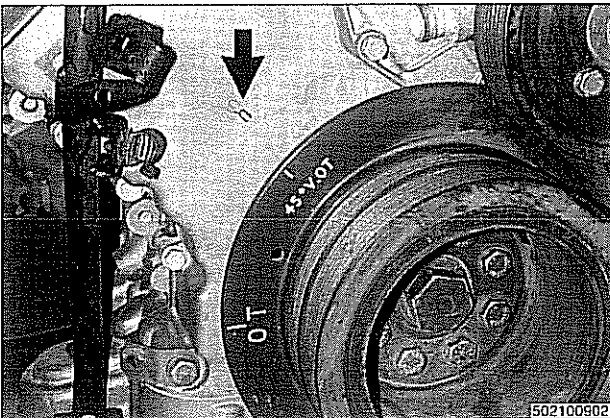
## Cylinder Head Removal and Installation



- Remove upper timing chain cover fasteners (A) and cover from left cylinder head.

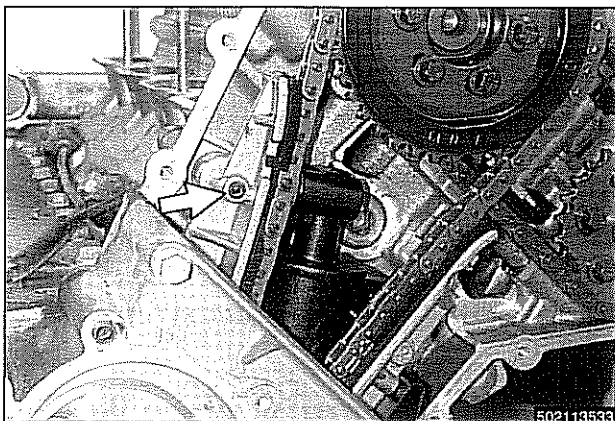


- Remove fasteners from intake camshaft sprocket (arrows) on left cylinder head.
- Remove primary timing chain sprocket and suspend timing chain using mechanics wire to prevent chain from dropping into lower housing.



- Turn crankshaft counterclockwise until 45° mark on crankshaft is aligned with boss on front timing chain cover (arrow).

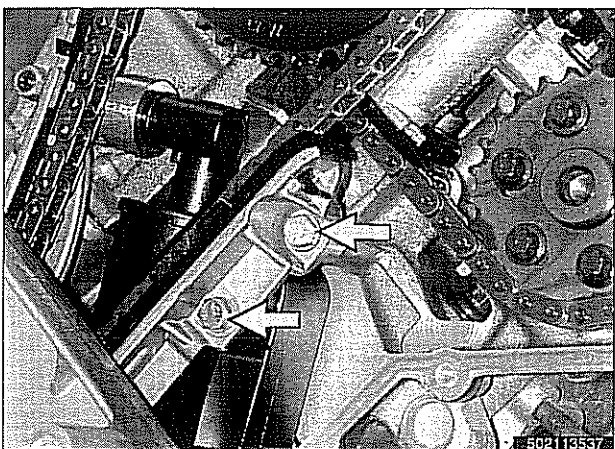
## Cylinder Head Removal and Installation



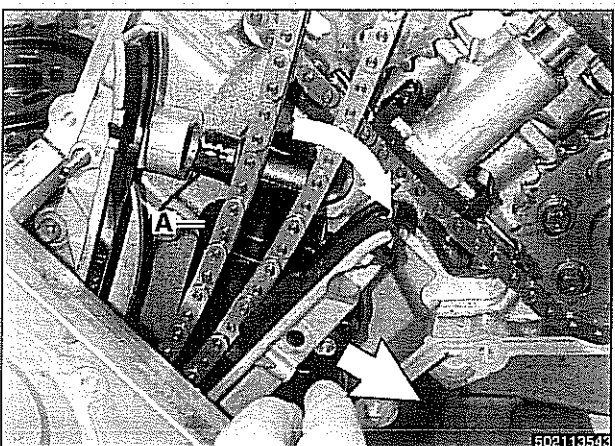
- Loosen chain rail set screw (arrow) 3 full turns (do not remove).

**NOTE—**

Allen screw secures crankcase vent tube in cylinder head.



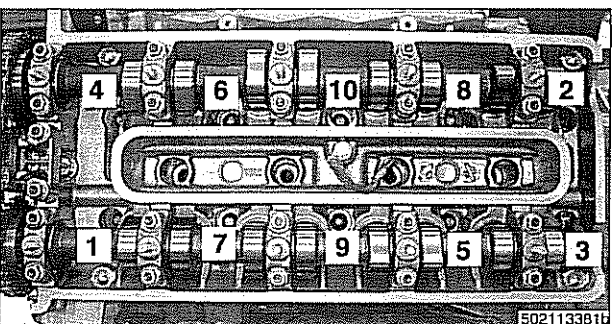
- Loosen and remove chain guide rail fasteners (arrow).



- Slide oil separator (A) out of crankcase vent connecting bracket (arrows).

**CAUTION—**

When removing the cylinder head carefully press oil separator outwards.



- Loosen cylinder head bolts in sequence 1–10 as shown (arrows) and discard used head bolts.

- Lift cylinder head off engine block while pressing out on oil separator.

**CAUTION—**

Be careful not to damage oil separator while removing cylinder head.

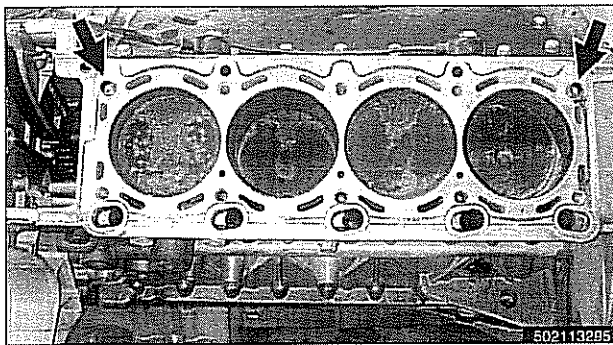


## Cylinder Head Removal and Installation

- Evaluate cylinder head as described in 116 Cylinder head and valvetrain.

### Left cylinder head, installing, M62 engine

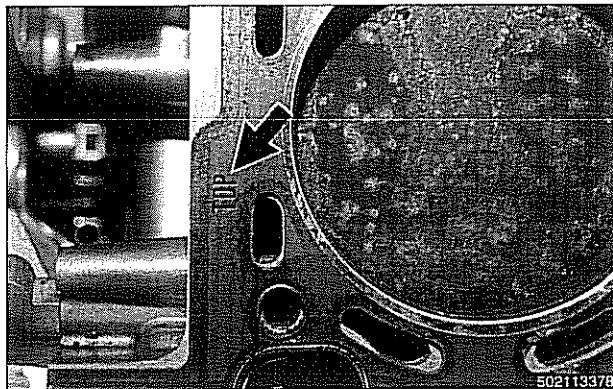
- Clean cylinder head and block sealing surfaces of gasket debris, making sure no debris drops into coolant or oil passages.
- Clean cylinder head bolt holes and check condition of threads.
- ↙ Check cylinder head locator sleeves (arrows) for damage.



#### CAUTION—

*If the cylinder head has been machined, a special 0.3 mm thicker gasket should be installed. The thicker gasket is available through an authorized BMW dealer and should be marked accordingly.*

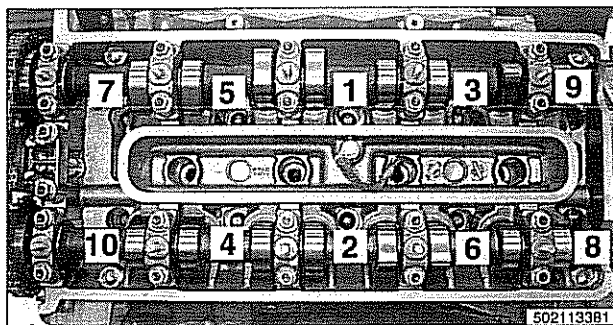
- Place new cylinder head gasket over locating sleeve on block.
- ↙ The word "OBEN" or "TOP" (arrow) printed on the gasket, must face up.
- Set left side cylinder head in position on cylinder block while pressing oil separator outward.



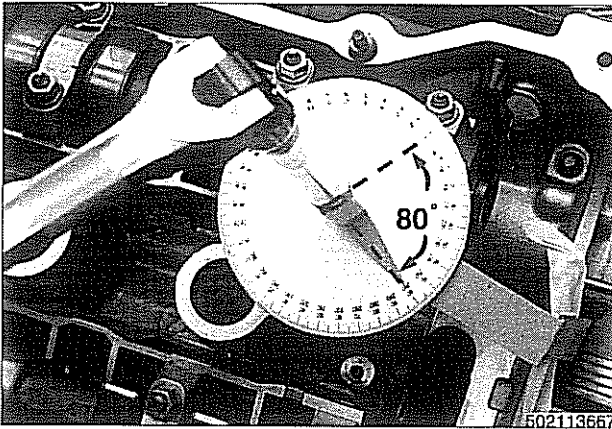
#### CAUTION—

*Make sure the crankshaft, which had been rotated approximately 45° opposite the direction of engine rotation from TDC, is still in that position before installing the cylinder head. All pistons must be out of TDC position to prevent valve/piston contact.*

- Install new cylinder head bolts and washers finger tight. Be sure not to remove coating from new cylinder head bolts.
- ↙ Tighten cylinder head bolts in correct sequence (1-10) to stage 1 torque values.



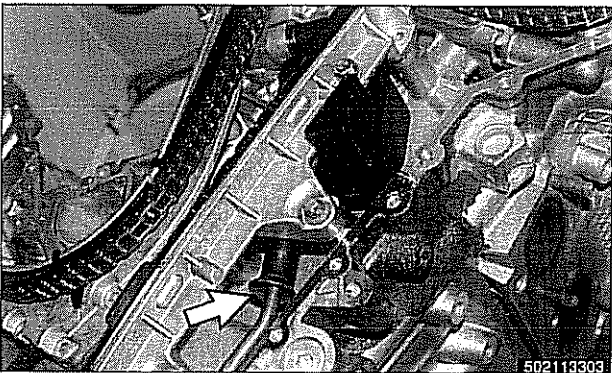
## Cylinder Head Removal and Installation



- Using a torque angle gauge, tighten cylinder head bolts to specified torque angle in stages 2 and 3.

### Tightening torques

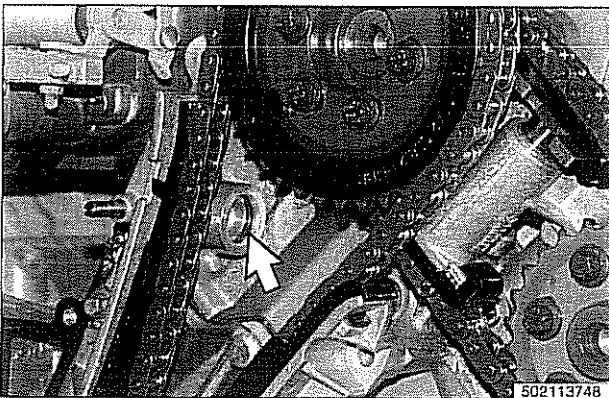
Stage I	30 Nm (22 ft-lb)
Stage II	+80°
Stage III	+80°



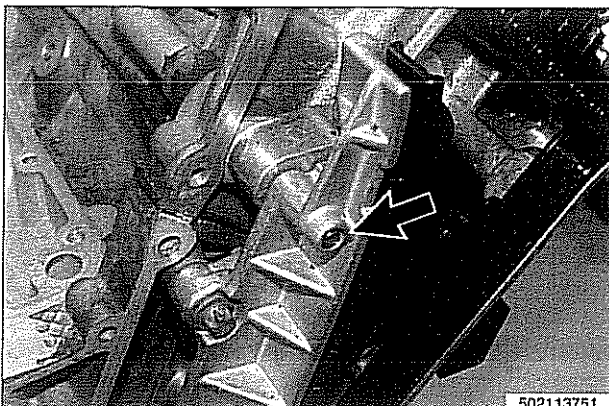
- If possible, confirm oil return pipe at bottom of separator is correctly seated (arrow).

### NOTE—

*Photo shows lower timing case cover removed.*



- Remove old O-ring and install new O-ring (arrow) in angle section.
- Press oil separator into angle section and install guide rail retaining screws.

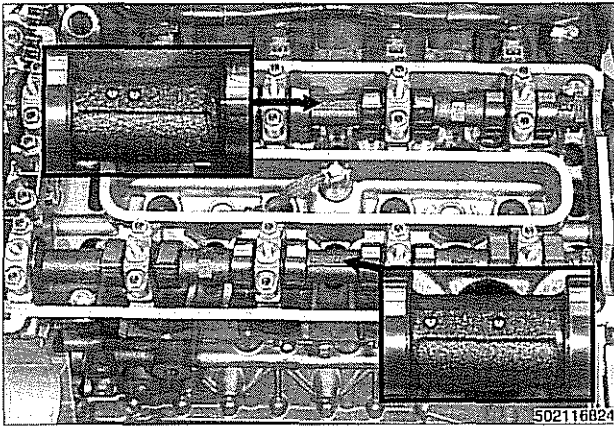


- Tighten allen screw (arrow) just until it makes contact with crankcase vent tube angle section without play.

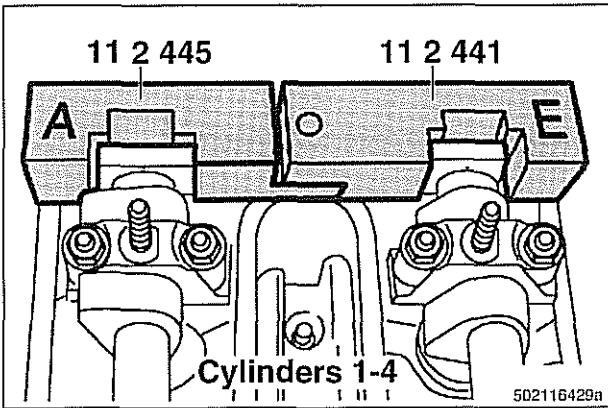
### NOTE—

*Allen screw secures crankcase vent tube in place. Do not torque down.*

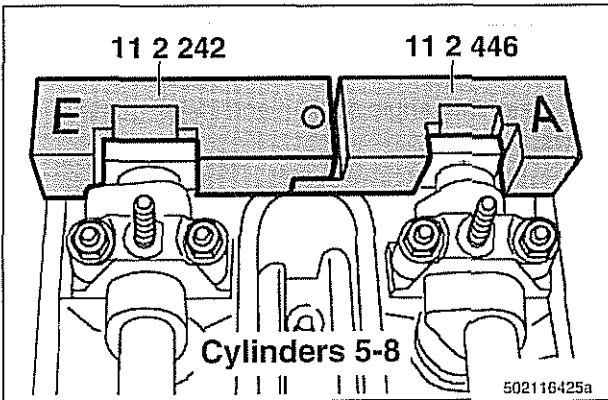
**Cylinder Head Removal and Installation**



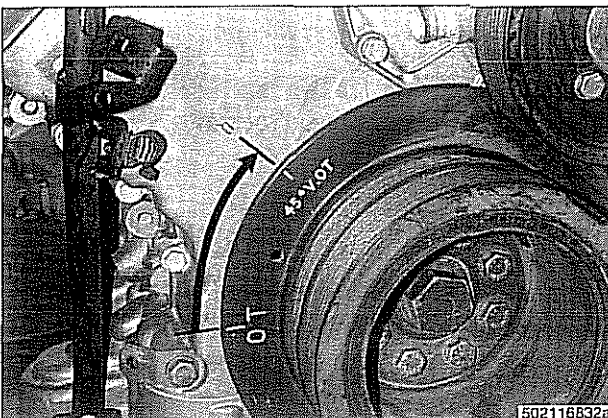
➤ Using BMW special tool 11 3 430, or a 27 mm open-ended wrench, rotate camshafts to cylinder 1 TDC position (until markings point upwards).



➤ Install camshaft locking tool set (BMW special tool set 11 2 440) on right cylinder head (cylinders 1–4). Fit on cylinder head without gaps.



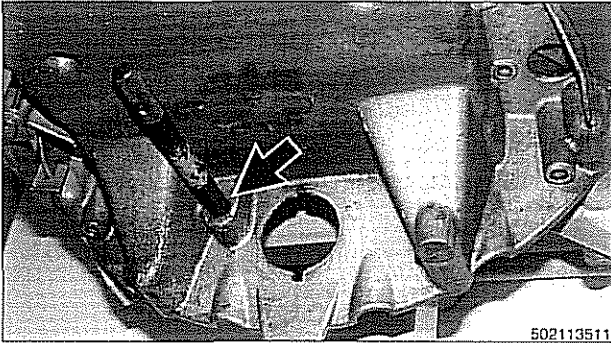
➤ Install camshaft locking tool set (BMW special tool set 11 2 440) on left cylinder head (cylinder head 5–8). Fit on cylinder head without gaps.



➤ Using crankshaft center bolt, rotate engine clockwise from the 45° mark to TDC position (OIT aligns with casting mark on cylinder block).



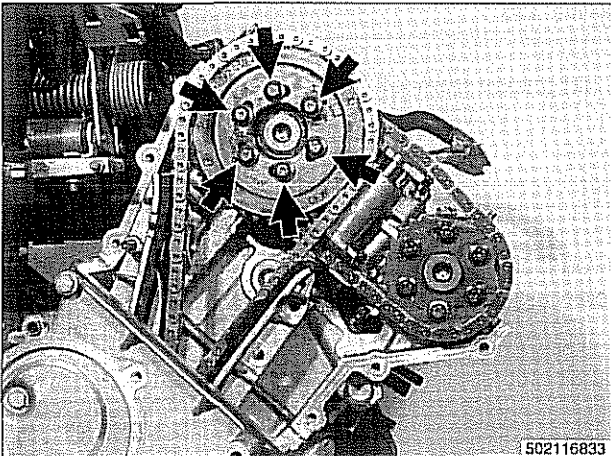
## Cylinder Head Removal and Installation



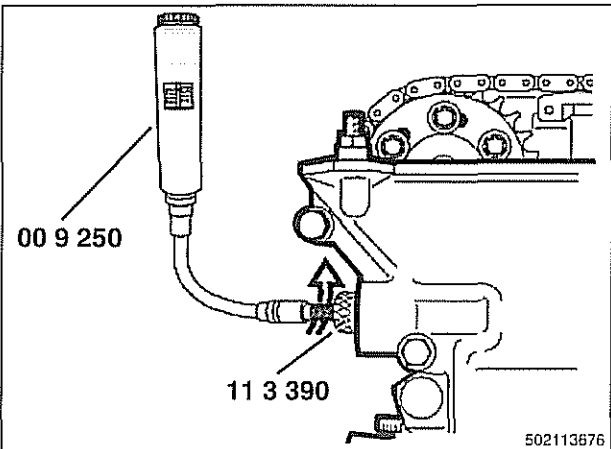
- ◀ Lock crankshaft in TDC position with BMW special tool 11 3 200 (arrow).

**NOTE—**

Boss for special tool 11 3 200 located at rear of engine oil pan.



- ◀ Working at left cylinder head (driver's side) fit primary sprocket and chain to camshaft flange, centering threaded bores.
  - Insert bolts (arrows) and hand tighten.



- ◀ Install BMW special tool 11 3 390 into right timing case cover.
  - Using BMW special tool 00 9 250, tighten adjusting screw on 11 3 390 to 0.7 Nm (6.3 in-lb).

**NOTE—**

BMW special tool 00 9 250 is a flexible shaft torque wrench.

- Tighten sprocket retaining bolts in the following order:
  - All bolts on left cylinder head exhaust camshaft
  - 3 accessible bolts on right cylinder head exhaust camshaft
  - All bolts on left cylinder head intake camshaft
  - 3 accessible bolts on right cylinder head intake camshaft

**Tightening torques**

Sprocket bolts to camshaft flange	15 Nm (11 ft-lb)
-----------------------------------	------------------

- Remove camshaft and crankshaft locking tools from engine.
- Using crankshaft center bolt, turn engine clockwise to access remaining sprocket retaining bolts of right cylinder head camshafts. Tighten remaining bolts.

**Tightening torques**

Sprocket bolts to camshaft flange	15 Nm (11 ft-lb)
-----------------------------------	------------------

## Cylinder Head Removal and Installation

- Remove adjustable timing chain tensioner tool from timing case cover and install primary timing chain tensioner with new sealing washer.

### Tightening torque

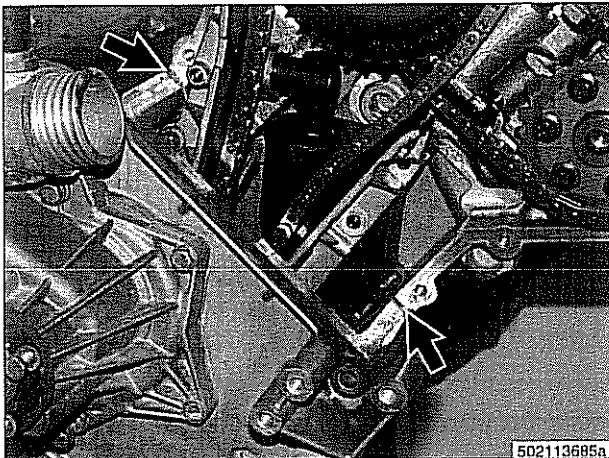
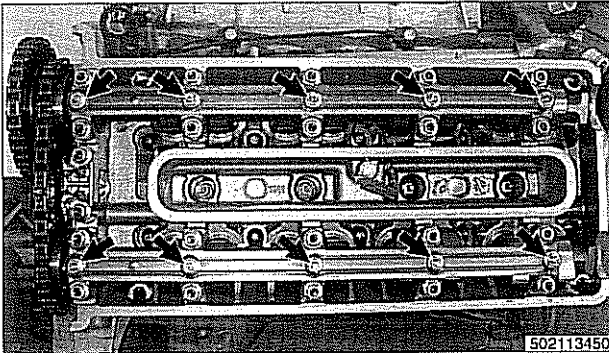
Chain tensioner cylinder to timing cover	65 Nm (48 ft-lb)
--	------------------

- Install oil supply lines and mounting nuts (**arrows**) to both heads.

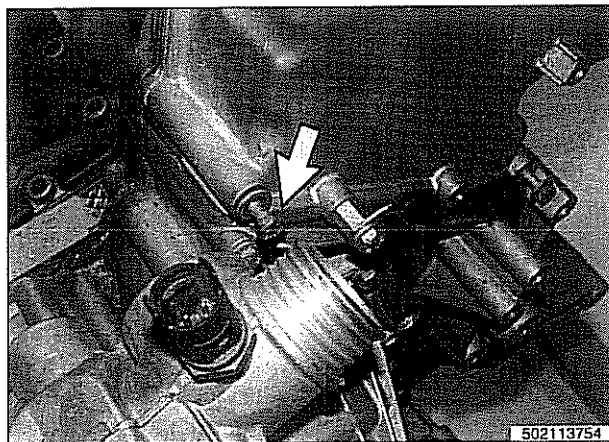
### Tightening torque

Oil supply line nuts	10 Nm (7.5 ft-lb)
----------------------	-------------------

- Remove old gasket from left timing cover, and clean gasket surface.



- Apply Three Bond 1209 ® sealant to joint between cylinder head and timing cover (**arrows**).

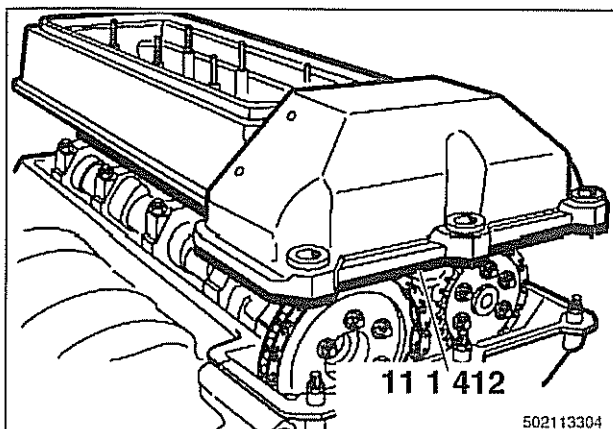


- Using a new gasket, install left timing cover with lower inner fastener inserted in cover (**arrow**). Position cover in place and tighten cover fasteners finger tight.

### NOTE—

*It is not possible to install lower inner fastener after cover is in place.*

## Cylinder Head Removal and Installation



- Remove left cylinder head cover gasket and install spacing tool (BMW 11 1 412) in place of gasket.

- Install left cylinder head cover fasteners and tighten uniformly in  $\frac{1}{2}$  turn steps.

### Tightening torque

Cylinder head cover nuts	10 Nm (7.5 ft-lb)
--------------------------	-------------------

- Tighten left upper timing cover retaining bolts in two passes.

### Tightening torque

Timing chain cover to head	10 Nm (7.5 ft-lb)
----------------------------	-------------------

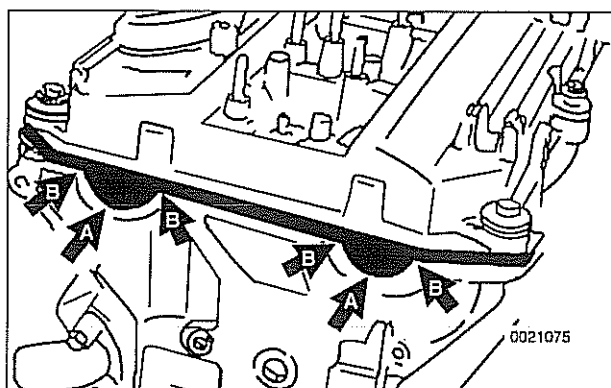
- Remove left cylinder head cover and BMW special tool 11 4 412.

- Reinstall cylinder head covers to left and right cylinder heads using new gaskets.

- Check for correct seating of half-moon seals (A) in back of cylinder head cover.
- Use a small amount of Three Bond 1209® or equivalent sealer at corners (B) of half-moon cutouts.

- Install left cylinder head cover fasteners and tighten uniformly in  $\frac{1}{2}$  turn steps.

- Install exhaust manifolds using new gaskets and fasteners. See **180 Exhaust System**.



## Cylinder Head Removal and Installation

- Remainder of installation is reverse of removal, noting the following:
  - Use new gaskets when mounting intake manifold. Tighten nuts finger tight first, then torque to specification in stages working diagonally from center out.
  - Be sure to reinstall ignition coil ground straps at cylinders no. 3 and no. 7. See **120 Ignition System**.
  - Reinstall cooling fan and shroud. See **170 Radiator and Cooling System**.
  - Refill and bleed cooling system as described in **170 Radiator and Cooling System**.
  - Change engine oil and filter as described in **020 Maintenance**.

### CAUTION—

*To prevent damaging engine electrical systems, be sure to install all ground wires previously removed.*

### Tightening torques

Camshaft sprocket to camshaft	15 Nm (11 ft-lb)
Coolant manifold to cylinder head	10 Nm (7.5 ft-lb)
Cylinder head cover nuts	10 Nm (7.5 ft-lb)
Exhaust manifold to head	22 Nm (17 ft-lb)
Engine mounts to subframe	42 Nm (30 ft-lb)
Spark plugs to cylinder head	22 Nm (17 ft-lb)

## Right cylinder head, removing, M62 engine

- Remove left side exhaust manifold. See **180 Exhaust System**.
- Remove intake manifold. See **Intake manifold, removal and installation, M62 engine**.
- Drain engine coolant. See **170 Radiator and Cooling System**.

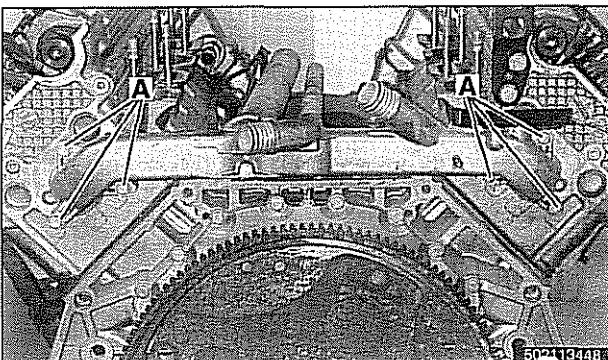
### WARNING—

*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.*

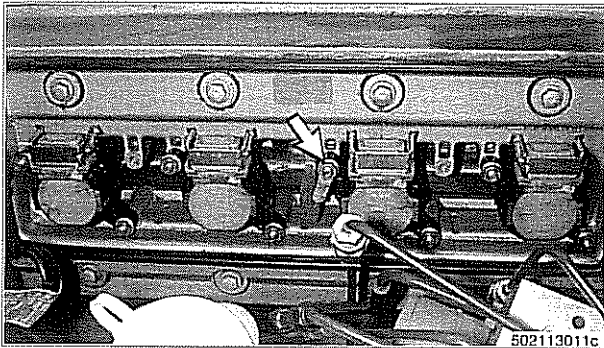
- Remove engine coolant manifold mounting fasteners and carefully remove manifold.

### NOTE—

*Engine is shown removed for clarity.*

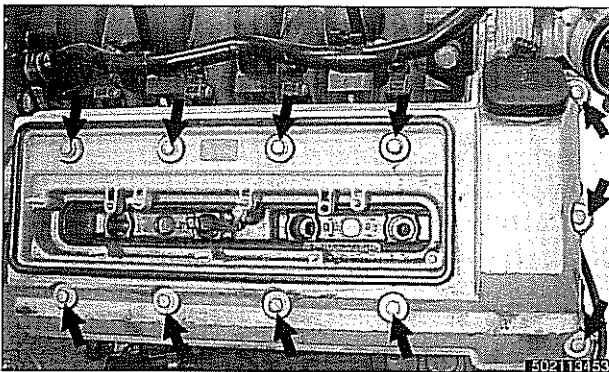


## Cylinder Head Removal and Installation

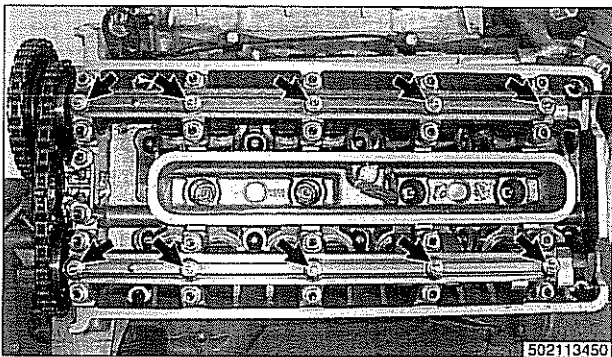


– Remove viscous clutch cooling fan. See 170 Radiator and Cooling System.

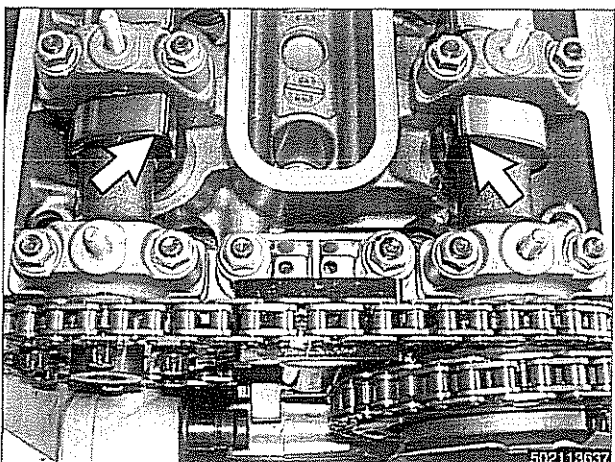
- ⤵ Remove ignition coil fasteners and coils (noting location of ground strap).
  - Remove spark plugs.



- ⤵ Remove cylinder head cover fasteners (arrows) and remove covers from right and left cylinder heads.

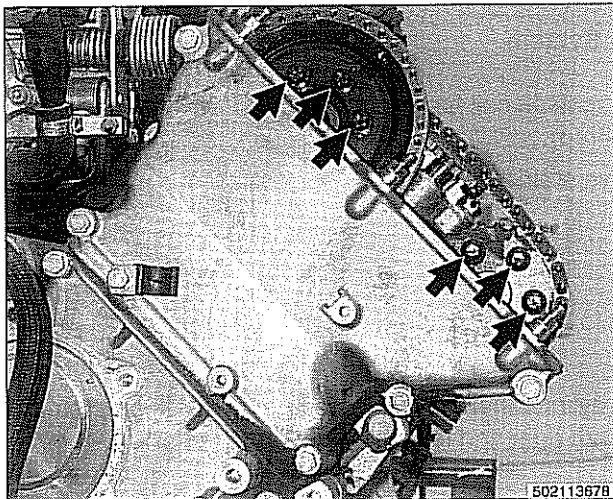


- ⤵ Remove oil distribution tube fasteners and remove tubes from both cylinder heads.



- ⤵ Using crankshaft center bolt, turn crankshaft clockwise until number one cylinder (front cylinder right side) is in TDC (arrows).

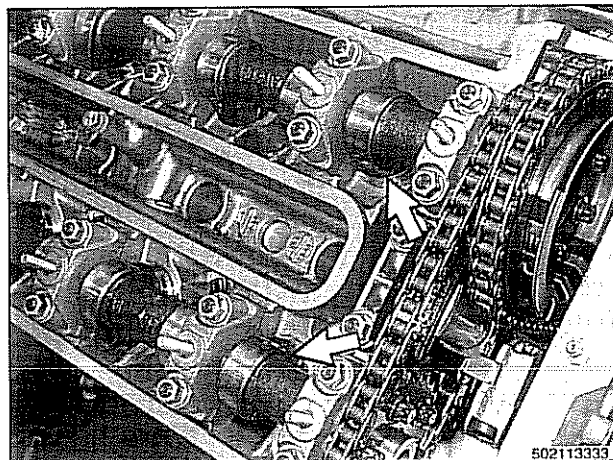
## Cylinder Head Removal and Installation



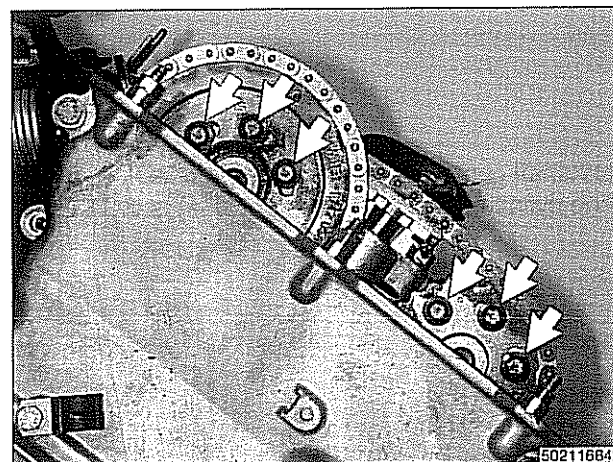
- Work at left side cylinder head loosen three accessible camshaft sprocket fasteners (**arrows**) on both intake and exhaust camshafts approximately  $\frac{1}{2}$  turn.

### CAUTION—

To prevent valve to piston contact, counterhold camshaft with 27 mm open-end wrench whenever loosening or tightening camshaft sprocket fasteners. If necessary, grind outer side of wrench jaws to prevent damaging cylinder head.



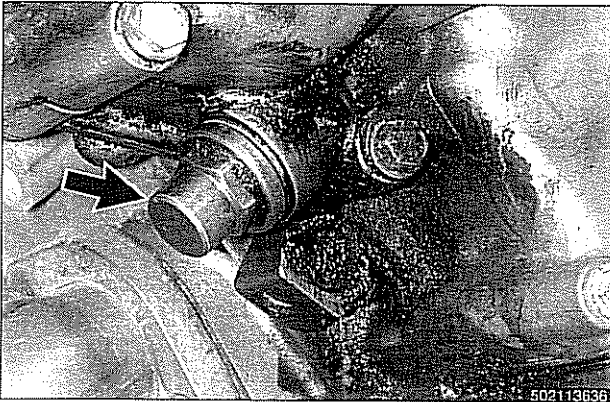
- Rotate crankshaft one complete rotation to TDC overlap. Right (passenger's side of engine) side camshaft lobes for number one cylinder should be in overlap position as shown (**arrows**).



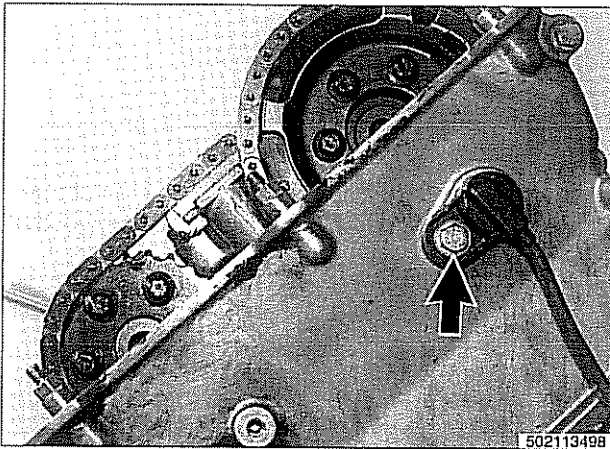
- Working at left cylinder head, loosen remaining sprocket fasteners (**arrows**) on both intake and exhaust camshafts approximately  $\frac{1}{2}$  turn.



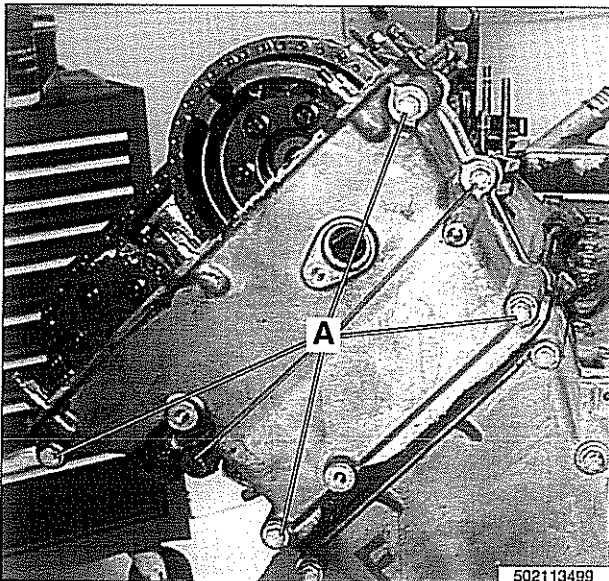
## Cylinder Head Removal and Installation



- Loosen and remove primary timing chain tensioner (arrow) from right cylinder head.

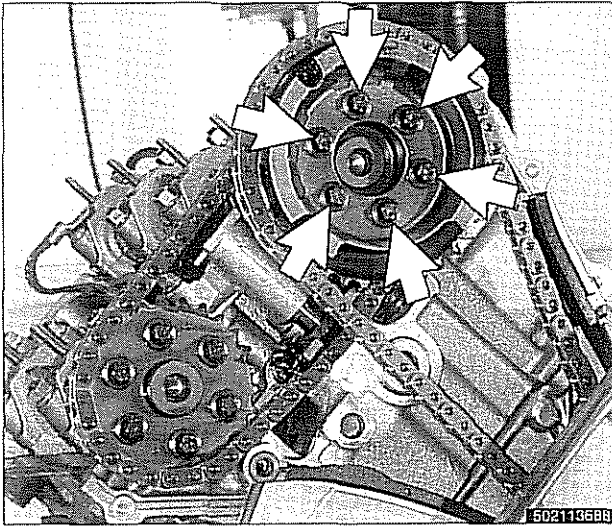


- Remove camshaft position sensor (arrow) from upper timing chain cover on right cylinder head.
- Remove dip stick tube support fastener.

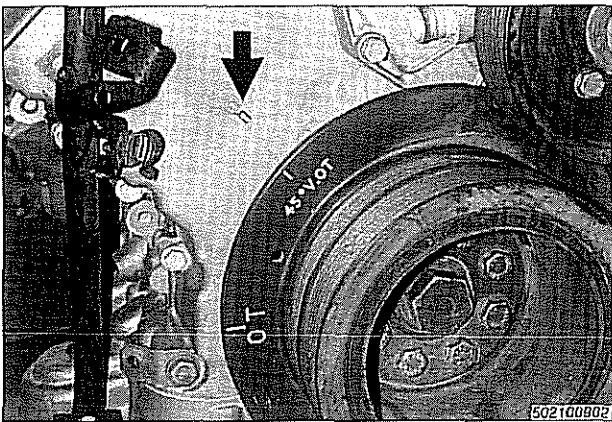


- Remove upper timing chain cover fasteners (A) and remove cover from right cylinder head.

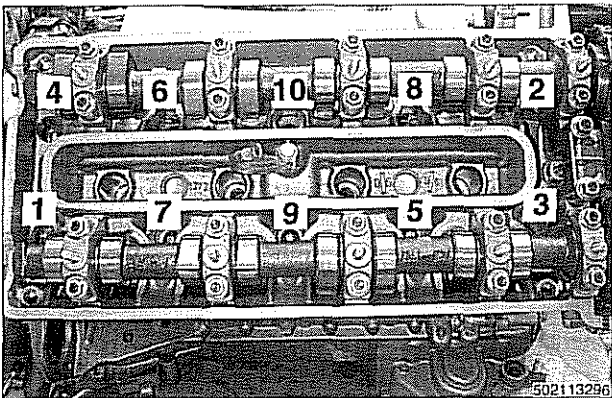
## Cylinder Head Removal and Installation



- Remove fasteners from intake camshaft sprocket (**arrows**) on right cylinder head.
- Remove primary timing chain sprocket and suspend timing chain using mechanics wire to prevent chain from dropping into lower housing.



- Turn crankshaft counterclockwise until 45° mark on crankshaft is aligned with boss on front timing chain cover (**arrow**).



- Loosen cylinder head bolts in sequence 1–10 as shown (**arrows**) and discard used head bolts.
- Evaluate cylinder head. See 116 Cylinder head and valvetrain.



## Cylinder Head Removal and Installation

### Right cylinder head, installing, M62 engine

- Clean cylinder head and block sealing surfaces of gasket debris, making sure no debris drops into coolant or oil passages.

#### CAUTION—

To prevent valve to piston contact when tightening camshaft sprocket fasteners, counterhold camshaft with 27 mm open-end wrench. If necessary, grind outer side of wrench jaws to prevent damaging cylinder head.

- Check cylinder head bolt holes and condition of threads. Remove debris and liquids from holes.

- Check cylinder head locator sleeves (arrows) for damage.

#### CAUTION—

If the cylinder head has been machined, a special 0.3 mm (0.011 in.) thicker gasket should be installed. The thicker gasket is available through an authorized BMW dealer and should be marked accordingly.

- Place new cylinder head gasket over locating sleeve on block.

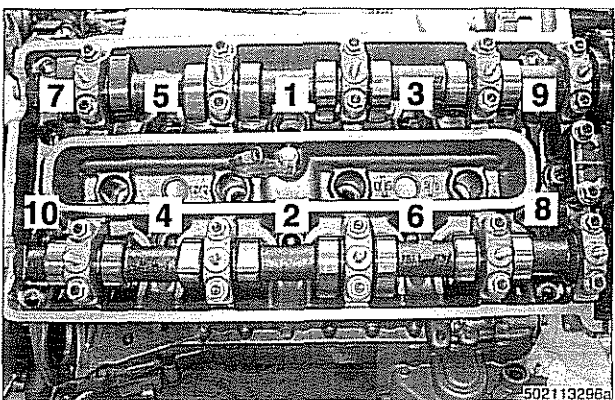
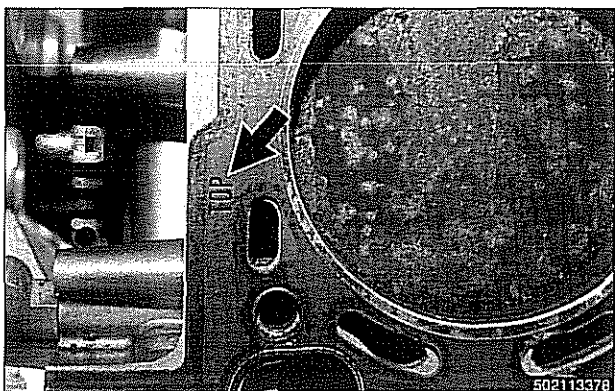
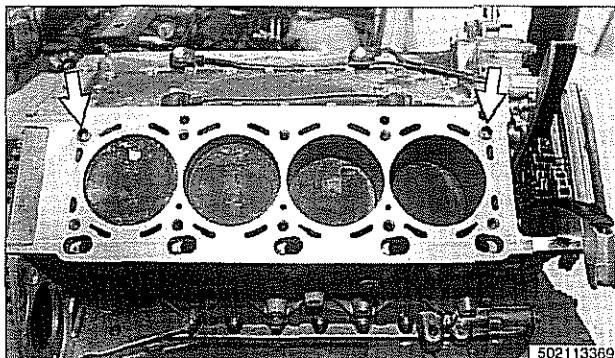
- The word "OBEN" or "TOP" (arrow) printed on the gasket, must face up.

#### CAUTION—

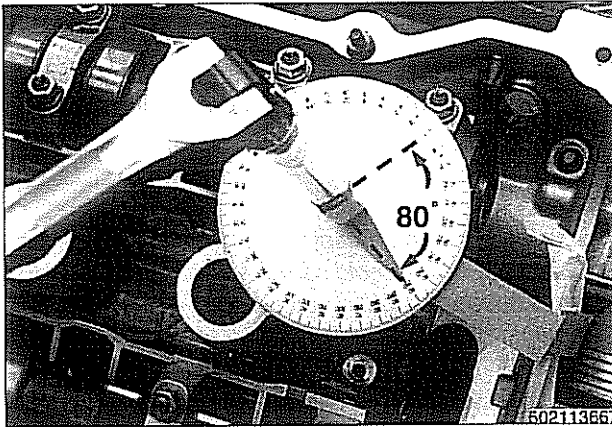
Make sure the crankshaft, which had been rotated approximately 45° opposite the direction of engine rotation from TDC, is still in that position before installing the cylinder head. All pistons must be out of TDC position to prevent valve/piston contact.

- Install new cylinder head bolts and washers finger tight. Be sure not to remove coating from bolts.

- Tighten cylinder head bolts in correct sequence (1-10) to stage 1 torque values.



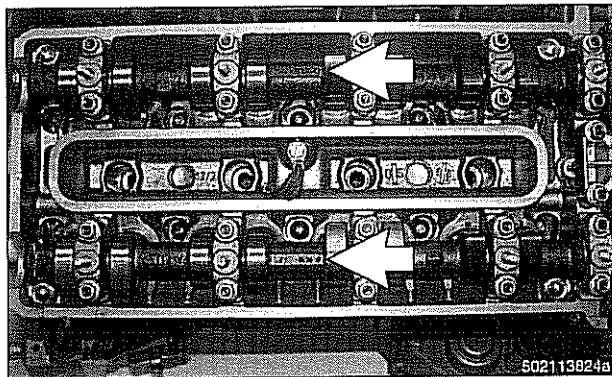
**Cylinder Head Removal and Installation**



Using a torque angle gauge, tighten cylinder head bolts to specified torque angle in stages 2 and 3.

**Tightening torques**

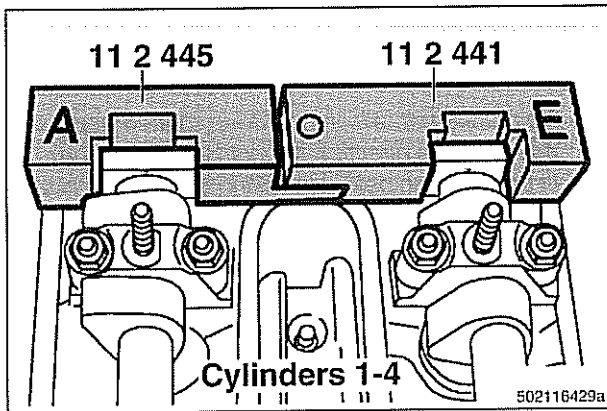
Stage I	30 Nm (22 ft-lb)
Stage II	+80°
Stage III	+80°



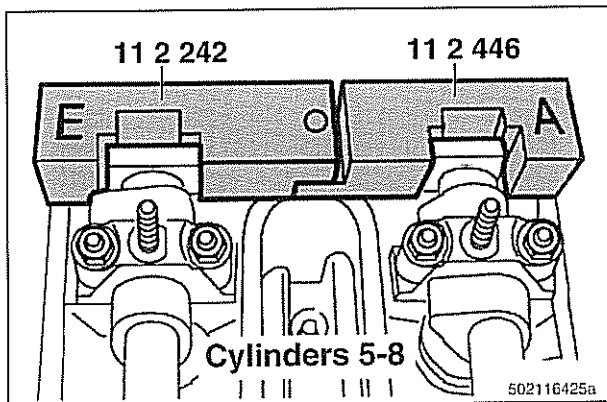
Using BMW special tool 11 3 430, or a 27 mm open-ended wrench, rotate camshafts until marker bores (drilled holes) point upwards (arrows).

**CAUTION—**

*Do not damage cylinder head with wrench. If necessary, grind outer side of wrench jaws to prevent damaging cylinder head.*

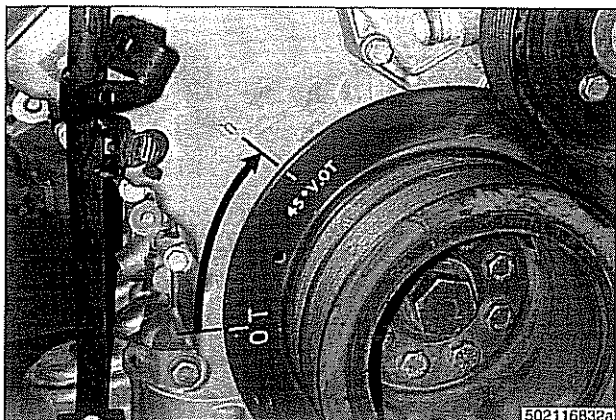


Install camshaft locking tool set (BMW special tool set 11 2 440) on right cylinder head. Fit tools on cylinder heads without gaps.

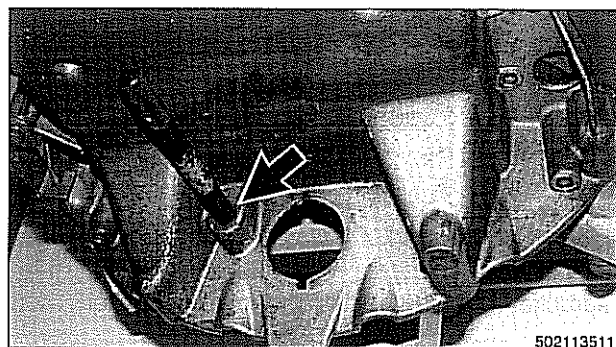


Install camshaft locking tool set (BMW special tool set 11 2 440) on left cylinder head. Fit tools on cylinder head without gaps.

## Cylinder Head Removal and Installation



- ◀ Using crankshaft center bolt, rotate engine clockwise from the 45° before TDC up to TDC position (OIT aligns with casting mark on cylinder block).

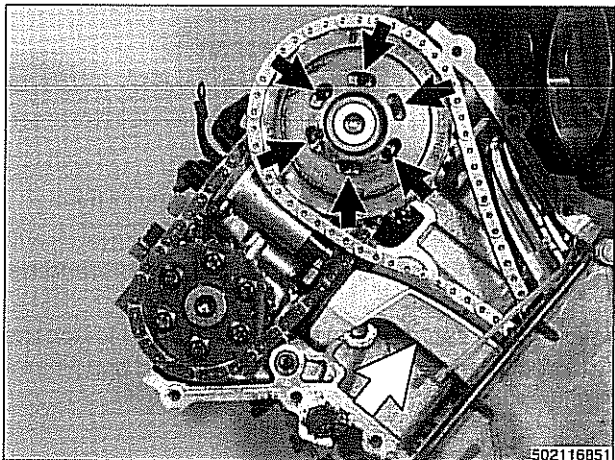


- ◀ Lock crankshaft in TDC position with BMW special tool 11 3 200 (arrow).

**NOTE—**

*Special tool boss located at the rear of upper engine oil pan.*

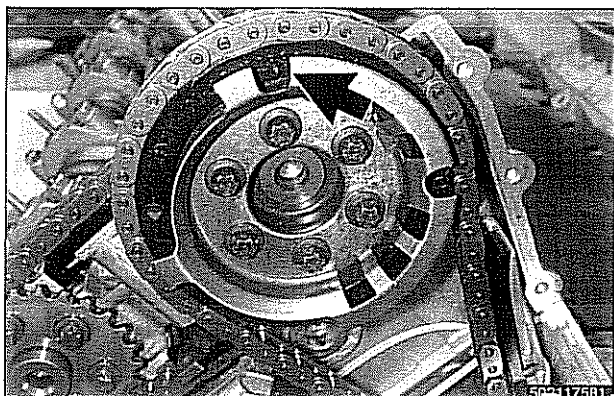
- Working at right cylinder head (cylinder 5–8) fit primary sprocket and chain to camshaft flange.



- ◀ Press timing chain tensioner rail against timing chain (white arrow) to check that fastener holes are centered in sprocket slots (black arrows).

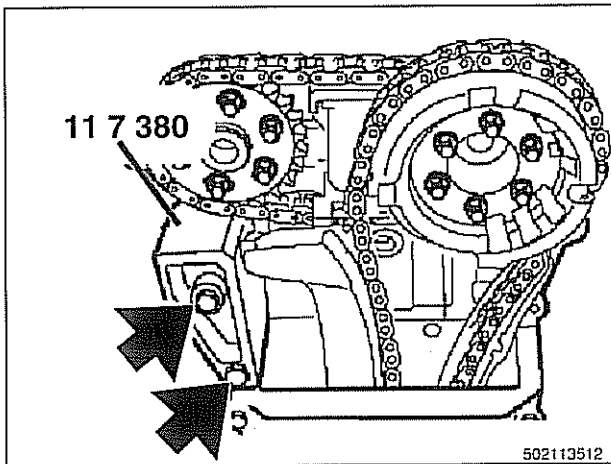
**NOTE—**

*If necessary, remove sprocket and realign position.*

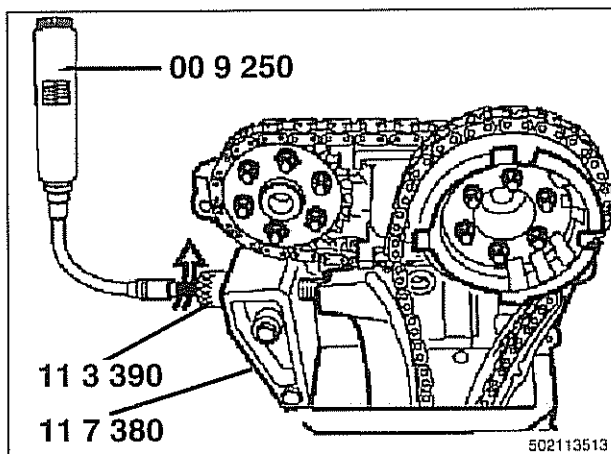


- ◀ Fit sensor gear with mark pointing up (arrow).
- Insert bolts and hand tighten.

## Cylinder Head Removal and Installation



- Install BMW special tool 11 7 380.



- Install special tool 11 3 390 into special tool 11 7 380 and tighten tensioner (11 3 390) to 0.7 Nm (6.3 in-lb) using special tool 00 9 250.

### NOTE—

*BMW special tool 00 9 250 is a flexible shaft torque wrench.*

- Tighten sprocket retaining bolts in the following order:
  - 3 accessible bolts on left exhaust camshaft
  - All bolts on right exhaust camshaft
  - 3 accessible bolts on left intake camshaft
  - All bolts on right intake camshaft

### Tightening torque

Sprocket bolts to camshaft flange	15 Nm (11 ft-lb)
-----------------------------------	------------------

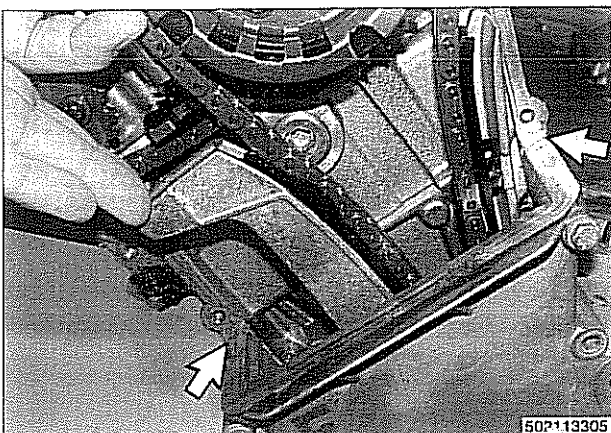
- Remove camshaft and crankshaft locking tools from engine.
- Using crankshaft center bolt, turn engine clockwise to access remaining sprocket retaining bolts of left cylinder head camshafts. Tighten remaining bolts.

### Tightening torque

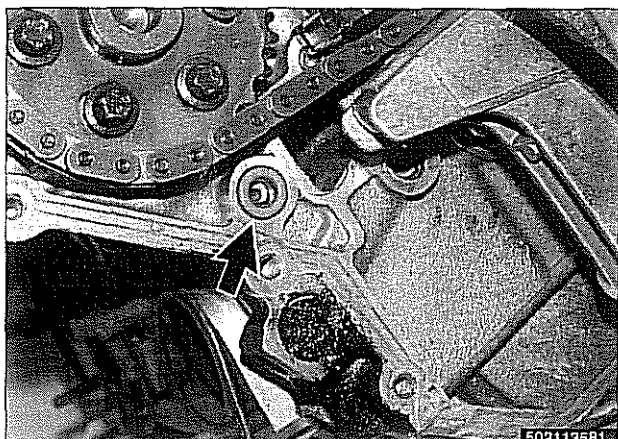
Sprocket bolts to camshaft flange	15 Nm (11 ft-lb)
-----------------------------------	------------------

- Remove BMW special tool 11 3 390 and 11 7 380 from right cylinder head.
- Remove used gasket from right timing chain cover, clean gasket surface.

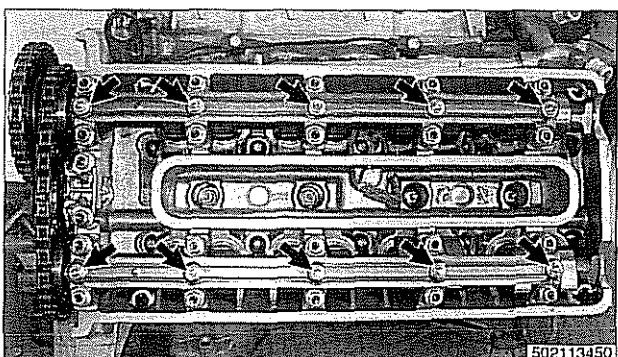
- Install new gasket and apply three Bond 1209® sealant to joint between cylinder head and timing cover (arrows).



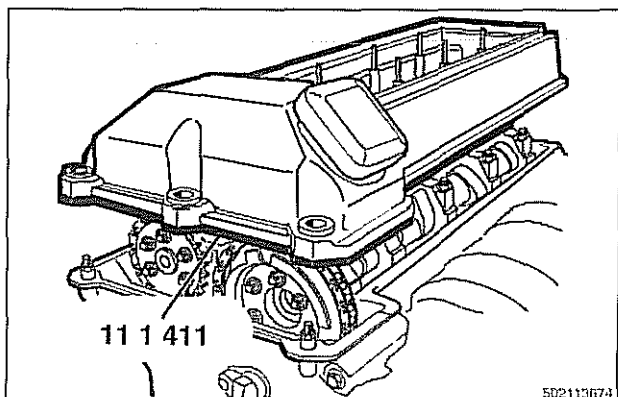
## Cylinder Head Removal and Installation



- Replace sealing O-ring (arrow) in right cylinder head before installing upper timing chain cover.



- Install oil supply lines and mounting nuts on both heads (arrows).
- Using a new gasket, install upper timing chain cover on right head and tighten cover fasteners finger tight.



- Remove right cylinder head cover gasket and install spacing tool (BMW 11 1 411) in place of gasket.
- Install right cylinder head cover fasteners and tighten uniformly in  $\frac{1}{2}$  turn steps.

### Tightening torque

Cylinder head cover fasteners	10 Nm (7.5 ft-lb)
-------------------------------	-------------------

- Tighten right upper timing cover retaining fasteners in two passes.

### Tightening torque

Upper timing chain cover	10 Nm (7.5 ft-lb)
--------------------------	-------------------

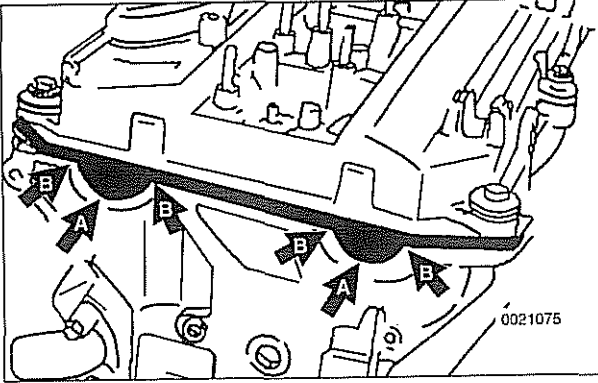
- Reinstall primary timing chain tensioner with new sealing washer.

### Tightening torque

Chain tensioner to timing cover	65 Nm (48 ft-lb)
---------------------------------	------------------

- Remove right cylinder head cover and remove special spacing tool 11 1 411.

## Cylinder Head Removal and Installation



◀ Reinstall cylinder head covers to right and left cylinder heads using new gaskets.

- Check for correct seating of half-moon seals (A) in back of cylinder head cover.
- Use a small amount of Three Bond 1209 ® or equivalent sealer at corners (B) of half-moon cutouts.

— Install cylinder head cover fasteners and tighten uniformly in  $\frac{1}{2}$  turn steps.

### Tightening torque

Cylinder head cover fasteners	10 Nm (7.5 ft-lb)
-------------------------------	-------------------

— Install exhaust manifolds using new gaskets and fasteners. See **180 Exhaust System**.

— Refill and bleed cooling system as described in **170 Radiator and Cooling System**.

— Change engine oil and filter as described in **020 Maintenance**.

### CAUTION—

*To prevent damaging engine electrical systems, be sure to install all ground wires previously removed.*

### Tightening torques

Camshaft sprocket to camshaft	15 Nm (11 ft-lb)
Coolant manifold to cylinder head	10 Nm (7.5 ft-lb)
Cylinder head cover nuts	10 Nm (7.5 ft-lb)
Exhaust manifold to head	22 Nm (17 ft-lb)
Engine mount to subframe	42 Nm (30 ft-lb)
Spark plugs to cylinder head	22 Nm (17 ft-lb)



# 116 Cylinder Head and Valvetrain

<b>General</b> .....	116-2	<b>Valves</b> .....	116-56
Special Tools .....	116-2	Valves, leak test .....	116-56
<b>Cylinder Head</b> .....	116-5	Valves, removing and installing .....	116-56
Valves, leak test .....	116-6	Valve guides .....	116-57
Camshaft wear .....	116-6	Valve stem oil seals .....	116-58
Hydraulic lifters, checking and replacing ...	116-7	Valve seats .....	116-59
		Valve springs .....	116-60
<b>Camshaft and Lifter Removal and Installation</b> .....	116-11		
Camshaft and lifter removal and installation (M52 engine) .....	116-12		
Camshaft and lifter, removal and installation (M52 TU and M54 engine) ....	116-19		
Double VANOS timing chain components .	116-28		
Camshaft removal and installation (M62 engine) .....	116-39		

## GENERAL

This group covers cylinder head and valvetrain service and repair. Some of the repair procedures described here require that the cylinder head first be removed as described in **113 Cylinder Head Removal and Installation**.

### NOTE—

- For timing chain and VANOS repair information, see **117 Camshaft Timing Chain**.
- If it is determined that the cylinder head will require significant reconditioning work, a remanufactured cylinder head may be a good alternative. Remanufactured cylinder heads are available from an authorized BMW dealer.

The information given in this repair group is organized according to engine code. For engine application information, see **100 Engine-General**.

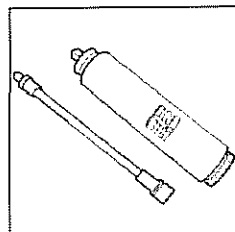
For specific repair procedures, refer to the appropriate repair group:

- **020 Maintenance**
- **100 Engine-General**
- **113 Cylinder Head Removal and Installation**
- **117 Camshaft Timing Chain**
- **170 Radiator and Cooling System**

## Special Tools

Special BMW 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 BMW dealer. If the special tools are not available, have the cylinder head removed and disassembled by an authorized BMW dealer. Be sure to read each procedure thoroughly before starting a job to determine which special tools and equipment will be necessary.

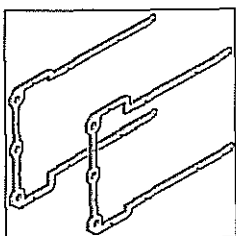
Most of the repairs to a cylinder head require precision machine work to specific tolerances. This type of work should be performed by an authorized BMW repair facility or an ASE certified machinist.



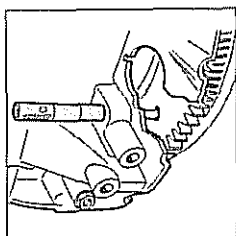
- ◀ Torque wrench with flex shaft  
(Tool No. BMW 00 9 250)



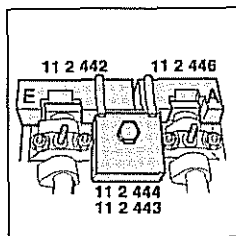
Cylinder Head and Valvetrain



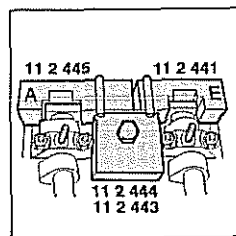
Upper timing cover seal seat tool set  
(Tool No. BMW 11 1 410)



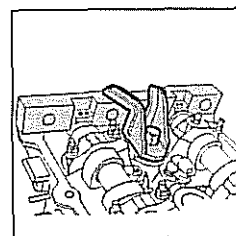
Crankshaft locking tool  
(Tool No. BMW 11 2 300)



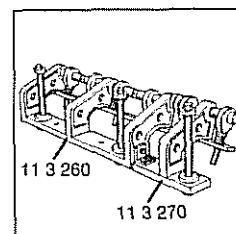
Camshaft locking tools set (V-8, cyl. 1-4)  
(Tool No. BMW 11 2 440)



Camshaft locking tools set (V-8, cyl. 5-8)  
(Tool No. BMW 11 2 440)

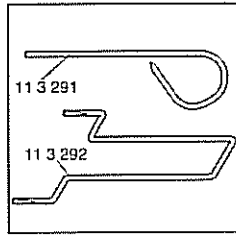


Camshaft locking tools set (6-cylinder)  
(Tool No. BMW 11 3 240)

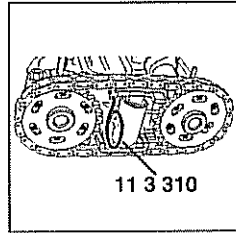


Camshaft bearing cap tensioning jig (6-cylinder)  
(Tool No. BMW 11 3 260/270)

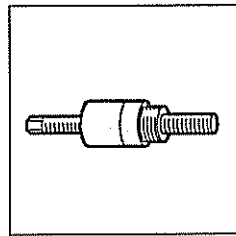
**Cylinder Head and Valvetrain**



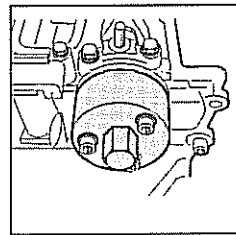
▶ Secondary timing chain tensioner locking pin set (6-cylinder)  
(Tool No. BMW 11 3 290)



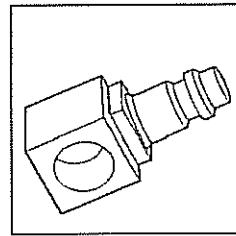
▶ Secondary timing chain tensioner locking pin (V-8)  
(Tool No. BMW 11 3 310)



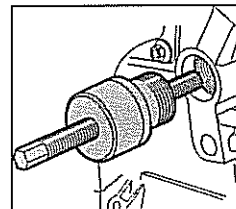
▶ Adjustable primary timing chain tensioner tool (V-8)  
(Tool No. BMW 11 3 390)



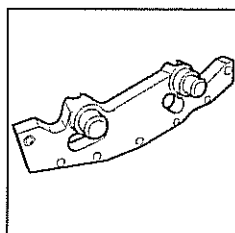
▶ Camshaft installation tool (V-8)  
(Tool No. BMW 11 3 430)



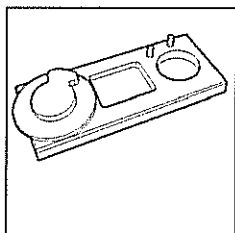
▶ VANOS compressed air fitting  
(Tool No. BMW 11 3 450)



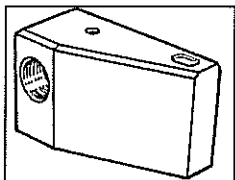
▶ Adjustable primary timing chain tensioner tool (6-cylinder)  
(Tool No. BMW 11 4 220)



- ◀ Double VANOS set-up bracket  
(Tool No. BMW 11 6 150)



- ◀ Double VANOS secondary timing chain/camshaft sprocket setup tool (Tool No. BMW 11 6 180)



- ◀ Timing chain tensioner bracket (V-8)  
(Tool No. BMW 11 7 380)

## CYLINDER HEAD

This section provides the specifications and special reconditioning information necessary to repair the cylinder heads covered by this manual.

The disassembled cylinder head should be inspected for warpage and cracks. Check the valve guides and valve seats for wear before machining a warped head. Always decarbonize and clean the head before inspecting it.

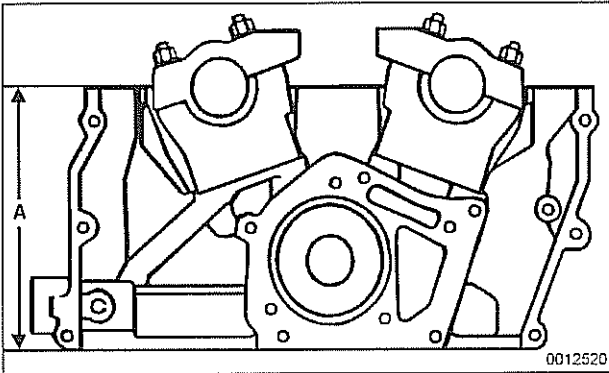
Visually inspect the cylinder head for cracks. If a cracked cylinder head is suspected and no cracks are detected through the visual inspection, have the head further tested for cracks by an authorized BMW dealer or an ASE certified machinist. A cracked cylinder head must be replaced.

### **NOTE**—

*When disassembling and inspecting the cylinder head, be sure to check the camshaft carrier bearing surfaces using a straight edge for warpage, and check the lifter bores for wear.*

A high-quality straight edge can be used to check for warpage. A warpage of 0.05 mm (0.002 in.) is acceptable without machining. A warped cylinder head can be machined provided no more than 0.3 mm (0.012 in.) of material is removed. If further machining is required, the head should be replaced. Removing more than this amount will reduce the size of the combustion chamber and adversely affect engine performance. A 0.3 mm thicker head gasket for machined heads is available from an authorized BMW parts department.

**Cylinder Head and Valvetrain**



⚠ Before machining the head to correct for warpage, measure the total height (A) (thickness of the cylinder head). Minimum height specifications are given in **Table a. Cylinder head height**.

**NOTE—**  
6 cylinder and V-8 engines share cylinder head height specifications.

**Table a. Cylinder head height**

New	Minimum height (A)
140.0 mm (5.512 in.)	139.7 mm (5.500 in.)

**Valves, leak test**

To test the valves for leakage, the cylinder head must be disassembled with camshafts and camshaft carriers removed. With valve assemblies and spark plugs installed, place the cylinder head on a workbench with the combustion chamber facing upward. Fill each combustion chamber with a thin non-flammable liquid. After fifteen minutes, check the level of the fluid. If the fluid level in any cylinder drops, that cylinder is not sealing properly.

**Camshaft wear**

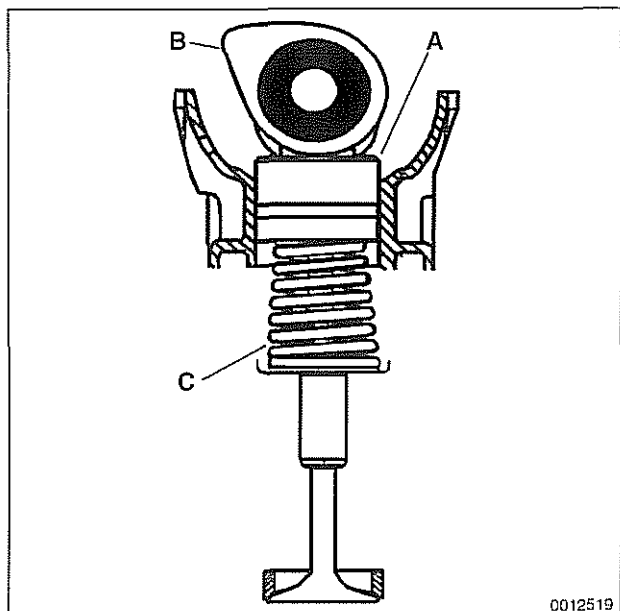
Camshaft wear is usually caused by insufficient lubrication. Visually inspect camshaft lobes and journals for wear. Camshaft wear specifications are given in **Table b. Camshaft wear specifications**.

**CAUTION—**

*If the camshaft is being replaced due to cam lobe wear, it is recommended that the corresponding lifters should also be replaced to avoid damaging the new camshaft.*

**Table b. Camshaft wear specifications**

	6 cylinder engines	V-8 engines
Axial play	0.150-0.330 mm (0.0060-0.013 in.)	0.200-0.360 mm (0.008 - 0.014 in.)
Radial play	0.020-0.054 mm (0.0008-0.0021 in.)	0.040-0.074 mm (0.016 - 0.029 in.)



### Hydraulic lifters, checking and replacing

- Self-adjusting hydraulic lifters (A) keep the valve clearances within a limited working range. Hydraulic lifters are sealed units and require no maintenance. Section view of camshaft (B) and valve with conical valve spring (C) shown.

Under some circumstances, such as a cold start, the cam followers may emit noise. Hydraulic lifter noise is usually a high-pitched tapping or chattering noise. In most instances, this is considered normal as long as the noise goes away in a few minutes (maximum 20 minutes). If the noise does not go away, either the lifter is faulty or the oil pressure to the lifter is low. Hydraulic lifter replacement requires that the camshaft first be removed.

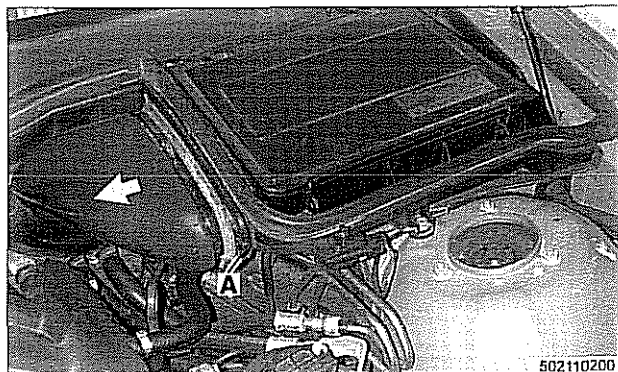
#### NOTE—

*Before checking hydraulic lifters, make sure engine oil is fresh and at the proper level. Sticky lifters can be the result of sludge build up in the cylinder head and lifters.*

- Run engine until it reaches normal operating temperature. Shut off engine.
- Working inside luggage compartment, disconnect negative battery cable.

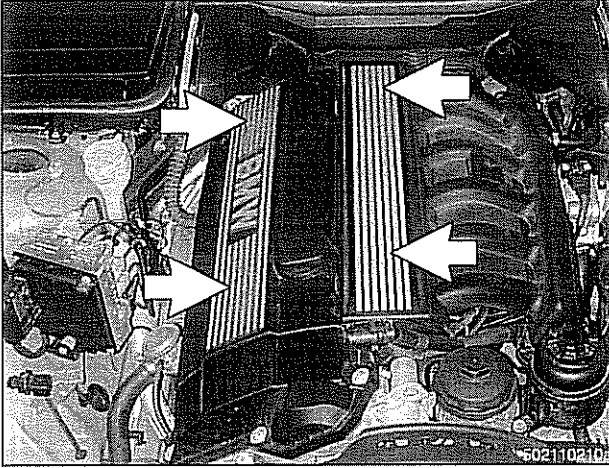
#### CAUTION—

- Prior to disconnecting battery cable, read the battery disconnection cautions given in **001 General Cautions and Warnings**.
- Disconnecting the battery may erase fault code(s) stored in control module memory. Check for fault codes using special BMW diagnostic equipment prior to disconnecting the battery.

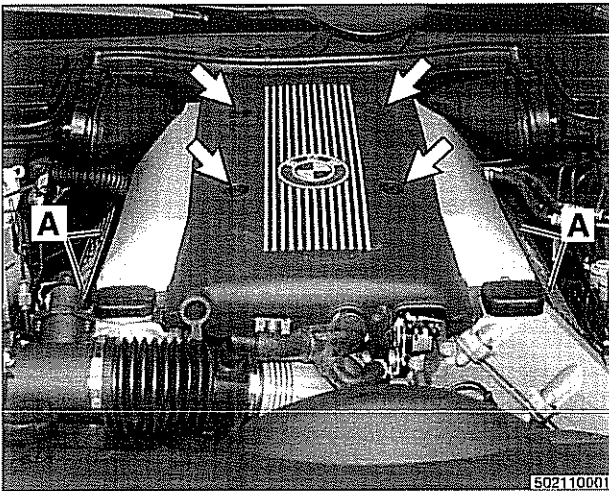


- Remove left and right interior ventilation duct (left side shown):
  - Release plastic locking tab (A) or release locking tabs on top of duct (later models).
  - Rotate duct counterclockwise to unlock from bulkhead and remove (arrow).

## Cylinder Head and Valvetrain



- ◀ 6-cylinder models: remove plastic top covers:
- Pry out caps (**arrows**).
  - Remove fasteners and covers.



- ◀ V-8 models: remove plastic top covers:
- Press down on locking pins (**arrows**) to release locks and remove top cover.
  - Pry out caps (**A**) from covers.
  - Remove fasteners and covers.

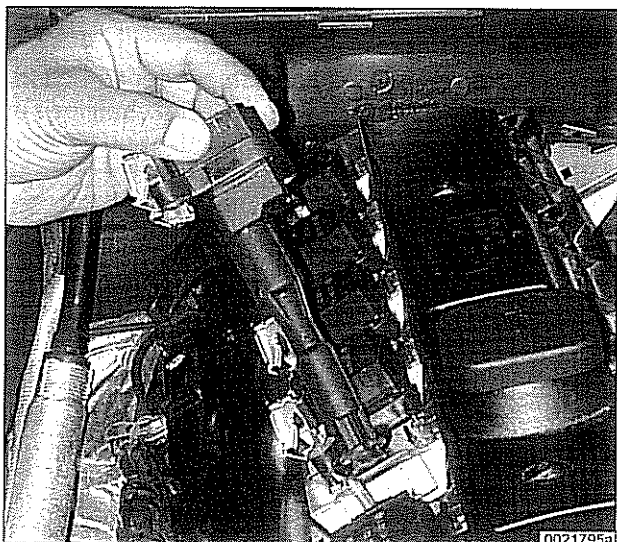


- ◀ Lift metal latch on coil harness connectors and disconnect harness connectors from coils. 6-cylinder shown, V-8 similar.
- Remove coil grounding straps.

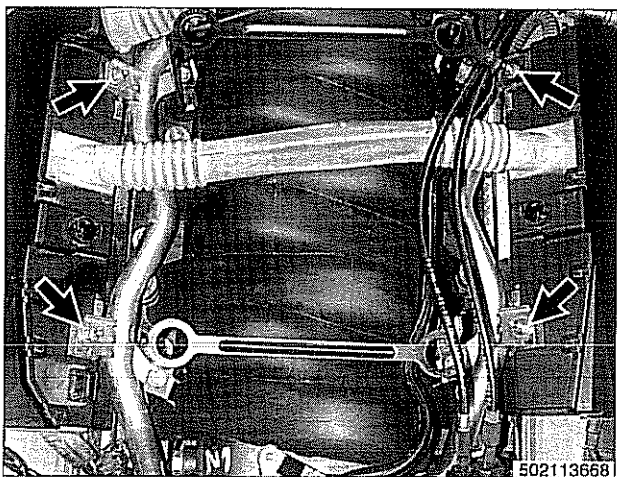
**NOTE** —

*Make note of ground wire at mounting studs arrangement during removal.*

## Cylinder Head and Valvetrain



- Remove ignition coils and spark plugs.



- V-8 models: remove mounting nuts (**arrows**) from wiring harness ducting.

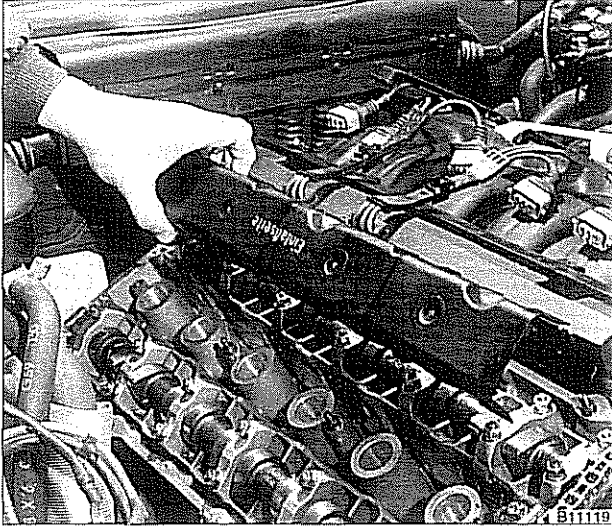


- V-8 models: disconnect fuel injector electrical connectors from injectors:
  - Pry one corner of wire lock clip (**arrow**) on first injector.
  - Repeat for all injectors.
  - Lift wire ducts off and set aside.
- V-8 models: disconnect battery jump start post terminal from left cylinder head cover.
- 6-cylinder models: remove oil filler cap and unclip vent connection from cylinder head cover.
- Remove cylinder head cover mounting fasteners and remove cylinder head cover(s).

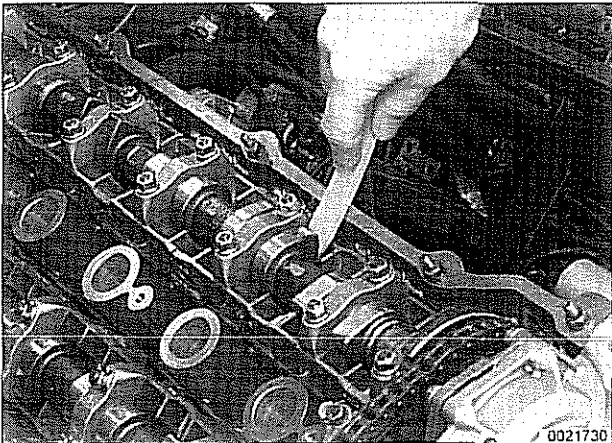
**NOTE** —

*The cylinder head cover mounting bolt insulators and gaskets should be reinstalled in their original locations. Make note of their arrangement during removal.*

## Cylinder Head and Valvetrain



- Remove oil baffle cover from above intake camshaft(s).
- Rotate engine at crankshaft vibration damper center bolt in normal direction of rotation (clockwise) until camshaft lobe of lifter to be tested points away from the lifter, allowing valve to be completely closed.

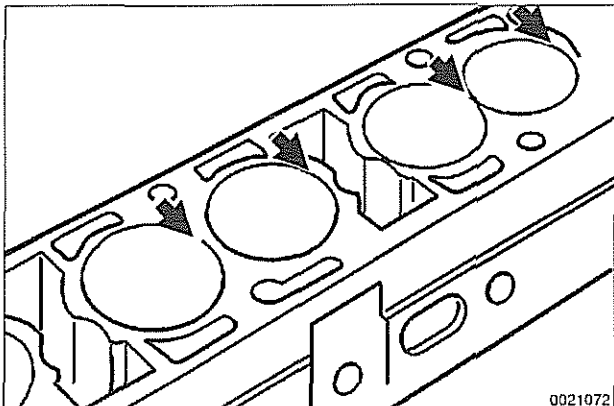


- Use a plastic or wooden stick to press down on top of lifter with approximately 3.5 Nm (2.25 ft-lb) of force.
  - If the lifter collapses slightly as though spring loaded, air may be trapped in the lifter.

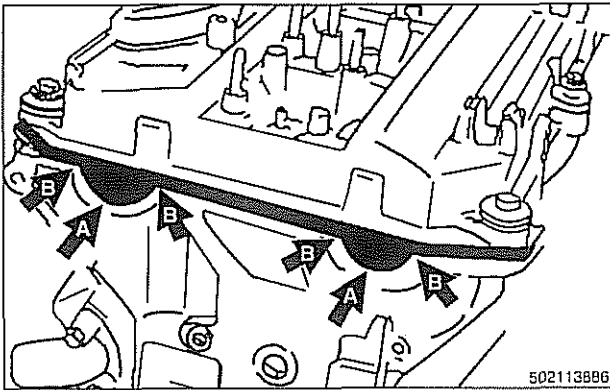
### NOTE—

*Air trapped in hydraulic lifters may result from oil foaming (air being drawn in by the oil pump). This may be caused by a faulty oil pump control valve O-ring; leaking oil pump pickup gasket; or by oil starvation to pump.*

- Press down on top of lifter for 10 to 15 seconds using approximately 6 to 9 Nm (4.5 to 6.75 ft-lb) of force.
  - If any clearance is created between the lifter and the camshaft lobe, the check valve in the lifter is not closing. Replace lifter.
- To replace a hydraulic lifter, remove appropriate camshaft. Refer to camshaft removal procedures given in **Camshaft and lifter removal and installation**.
- Once camshaft is removed, withdraw faulty lifter(s) and replace with new lifter(s). Inspect lifter bores for wear and scoring at arrows.
- Reinstall camshafts. See **Camshaft and lifter removal and installation**.







Install intake camshaft oil baffle cover and cylinder head cover:

- Check for correct seating of half-moon seals (A) in back of cylinder head cover.
- Use a small amount of Three Bond 1209 ® or equivalent sealant at corners (B) of half-moon cutouts and corners in front of cylinder head at joint to timing chain cover.
- Align cover at front and rear, then alternatively tighten fasteners from inside to outside.

#### Tightening torque

Spark plug to cylinder head	25 Nm (18 ft-lb)
Ignition coils to cylinder head	10 Nm (7.5 ft-lb)
Cylinder head cover to cylinder head (M6 screws)	10 Nm (89 in-lb)

## CAMSHAFT AND LIFTER REMOVAL AND INSTALLATION

The camshafts can be removed with the cylinder heads mounted on the engine (in the car).

On 6-cylinder engines there are two different procedures given, depending on whether the engine is equipped with single VANOS (M52 engine) or double VANOS (M52 TU or M54 engine).

For V-8 engines, camshaft removal and installation procedures are only included for the non-VANOS (M62) engine. Camshaft removal and installation for the VANOS equipped V-8 (M62 TU) is not covered in this manual.

Special BMW service tools should always be used to remove and install the camshafts. Removal of the camshafts without the special tools can result in cylinder head damage and camshaft breakage.

## Camshaft and lifter removal and installation (M52 engine)

### Camshafts and lifters, removing (M52 engine)

#### **WARNING** —

- The process of evenly loosening the camshaft bearing cap nuts is **NOT** an acceptable method of removing the camshafts. Special tools should always be used to remove the camshafts. Be sure to read the procedure through before starting a job.
- Allow engine to cool before beginning this procedure.

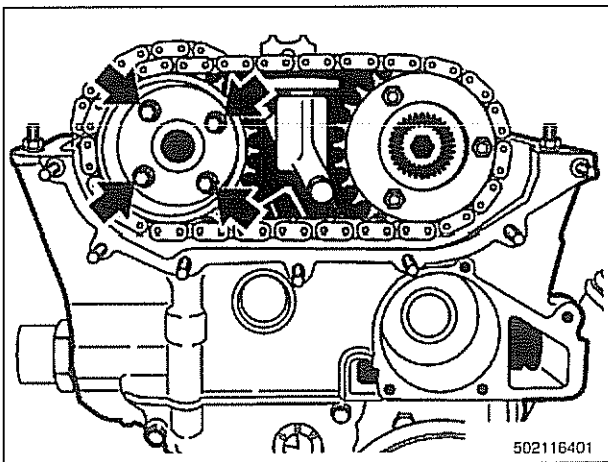
- Disconnect negative (–) cable from battery.

#### **CAUTION**—

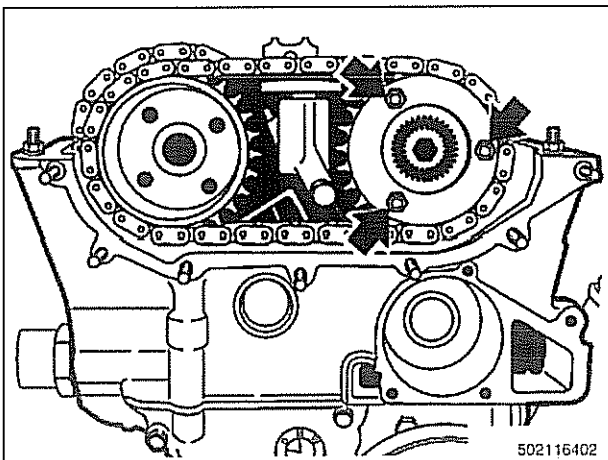
Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.

- Remove VANOS control unit from cylinder head. See **117 Camshaft Timing Chain**.

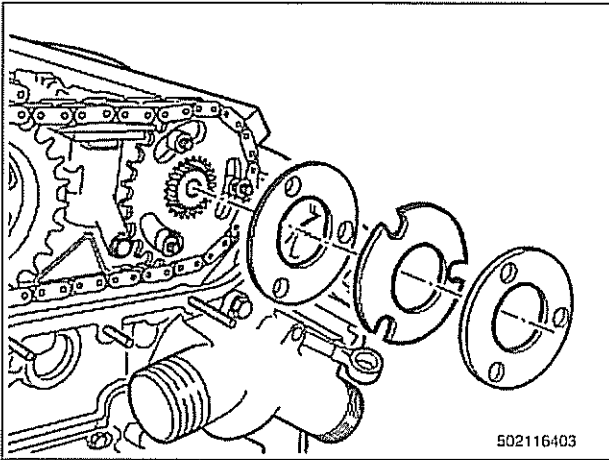
- Remove loosened bolts (arrows) from front of exhaust sprocket.



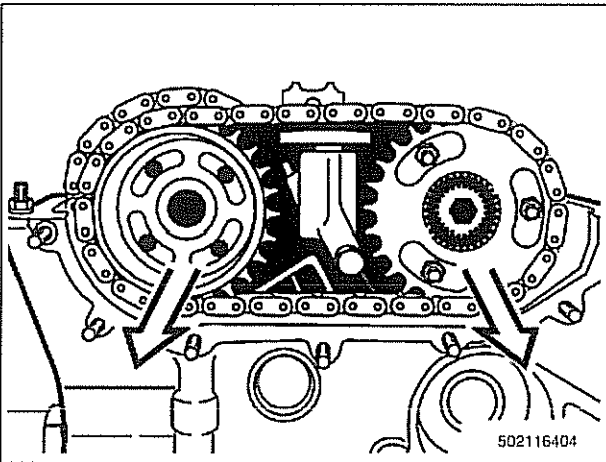
- Remove retaining nuts (arrows) from intake camshaft sprocket.



## Cylinder Head and Valvetrain

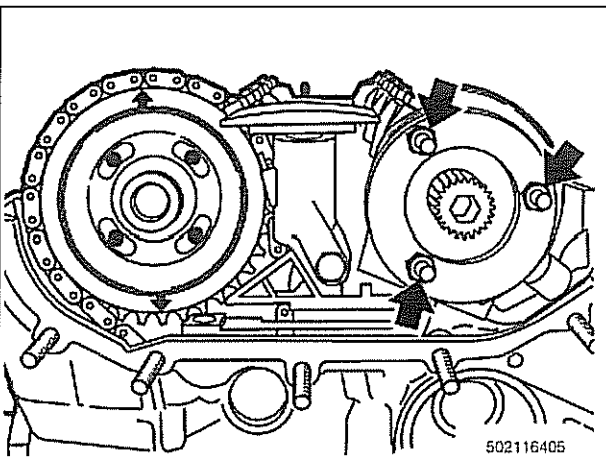


- Remove outer thrust washer, spring plate, and inner thrust washer.



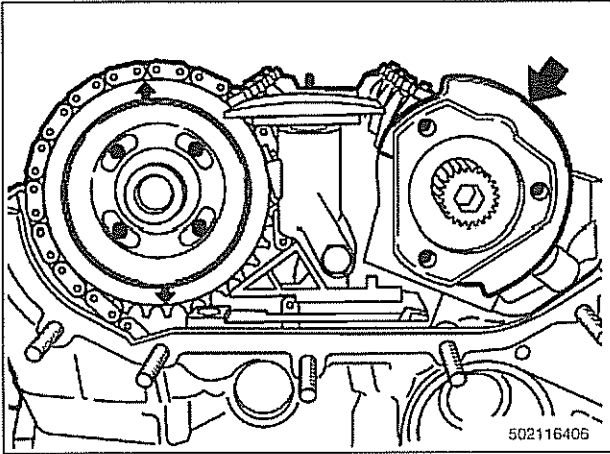
- Remove both camshaft sprockets with secondary timing chain.

**NOTE** —  
Keep chain and sprockets together as an assembly for easier installation.

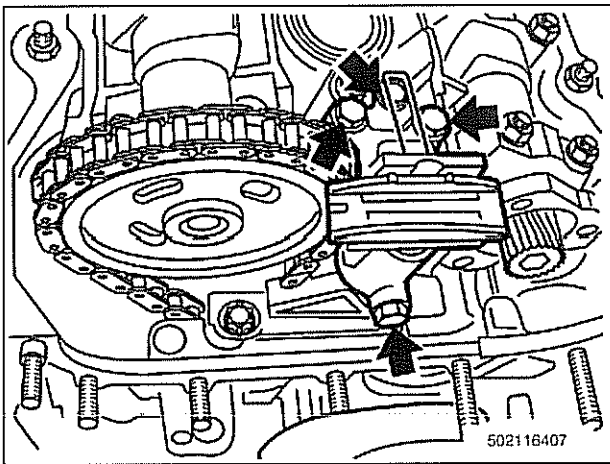


- Remove thrust washer studs (arrows) and remove thrust washer.

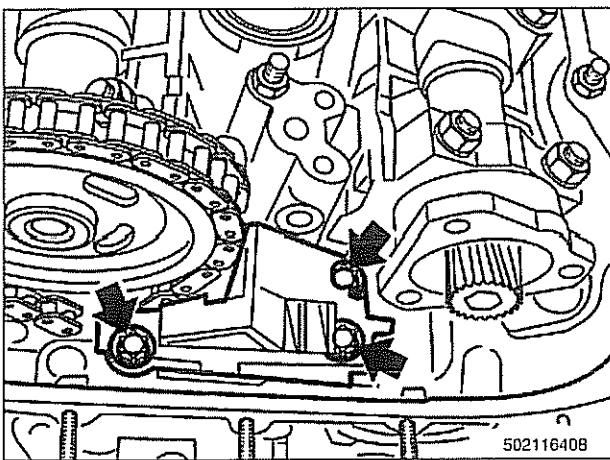
Cylinder Head and Valvetrain



Remove sensor gear (arrow).

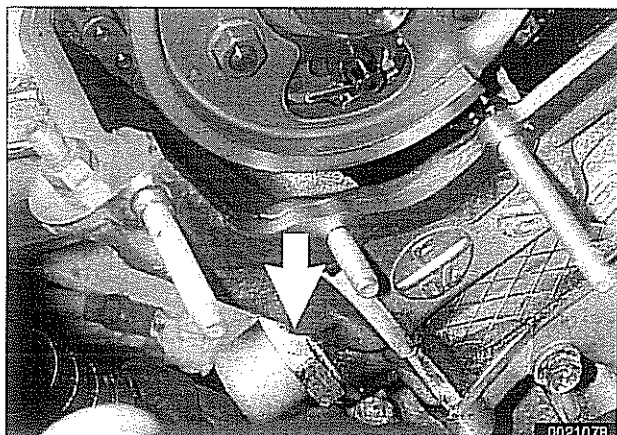


Remove secondary timing chain tensioner retaining bolts (arrows) and remove tensioner.



Remove timing chain guide retaining bolts (arrows) and remove guide.

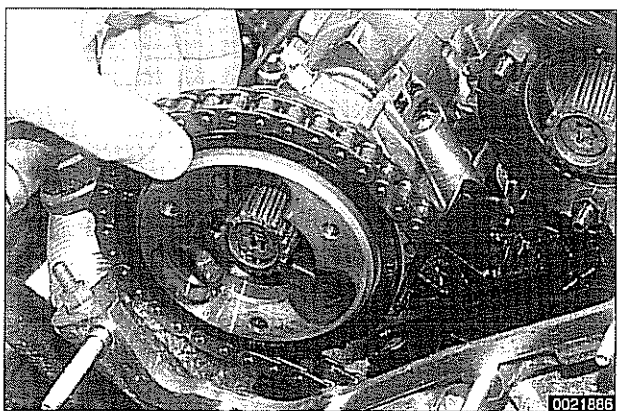
## Cylinder Head and Valvetrain



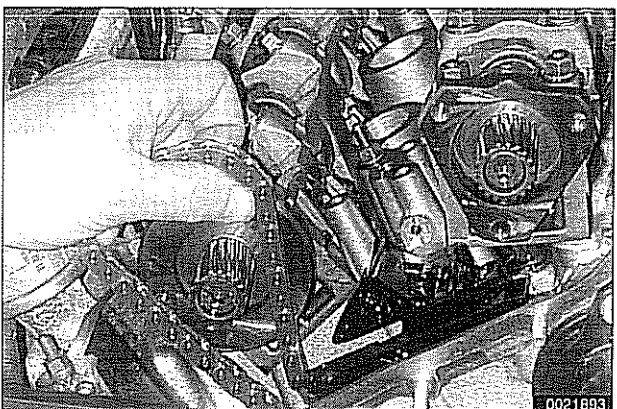
- Remove primary timing chain tensioner plug (arrow) and primary tensioner.

**CAUTION—**

*Primary timing chain tensioner is under spring pressure.*

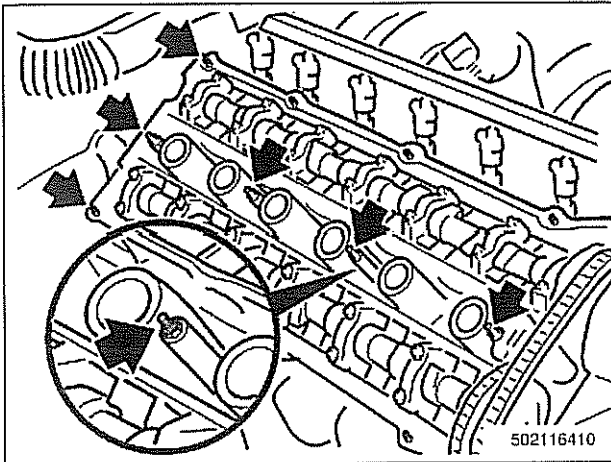


- Remove primary timing chain sprocket and timing chain from exhaust camshaft.
- Remove crankshaft locking tool (BMW 11 2 300) from flywheel (installed during VANOS removal).

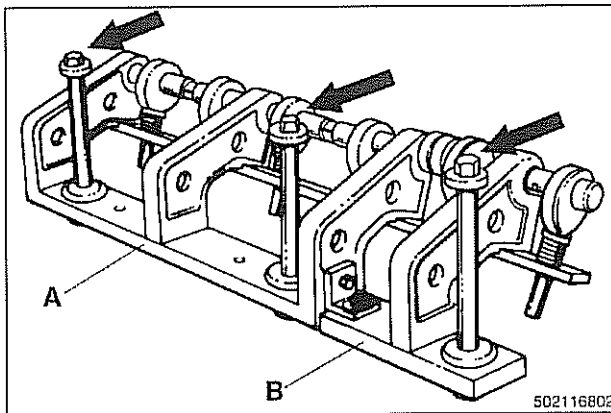


- Lift timing chain (holding under tension) and rotate engine counterclockwise 30° from TDC.
  - Suspend timing chain with mechanic's wire.

## Cylinder Head and Valvetrain



- Remove cylinder head cover retaining studs (**arrows**) from center and rear of cylinder head.



- Remove spark plugs and install BMW special tool 11 3 260 (**A**) and 11 3 270 (**B**) to cylinder head. Tighten tool retaining bolts in spark plug bores. Do not overtighten bolts.

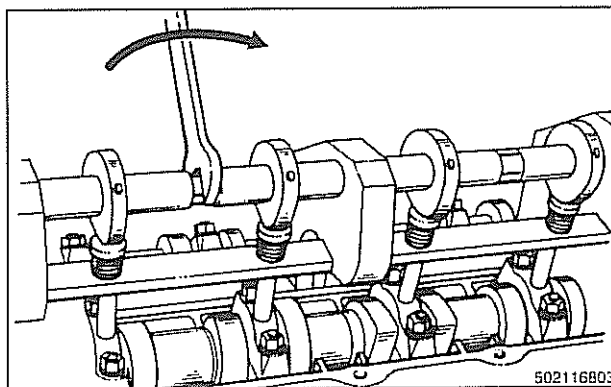
**Tightening torque**

BMW special tool 11 3 260 / 11 3 270 to cylinder head	23 Nm (17 ft-lb)
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- Remove intake camshaft bearing cap for cylinder number 1.

**CAUTION—**

*Intake camshaft bearing cap 1 is centered with adapter sleeves. To avoid camshaft damage, it must be removed before any other caps.*



- Turn eccentric shaft on special tool until pressure is applied to camshaft bearing caps.
- Remove remaining bearing cap mounting nuts.
- Slowly release pressure on camshaft bearing caps by turning eccentric shaft. Remove bearing caps and camshaft. Repeat procedure on remaining camshaft.

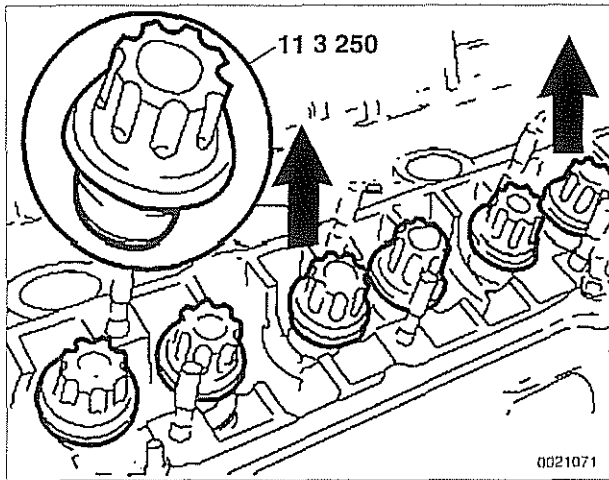
**CAUTION—**

*Camshaft bearing caps must be reinstalled in their original locations.*

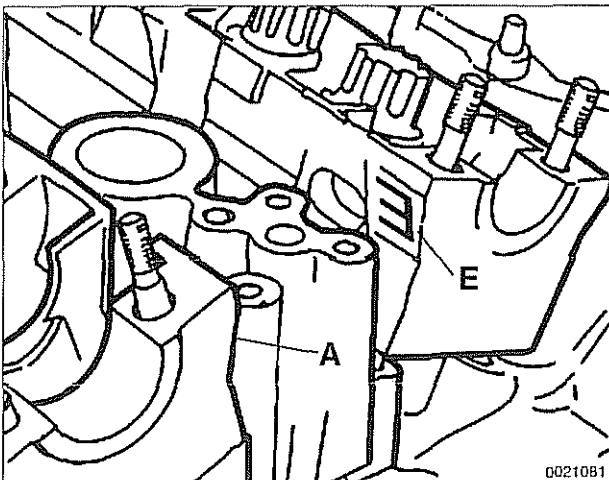
**NOTE—**

- The camshaft bearing caps are coded with a letter and a number. For example, "A1" is the first exhaust camshaft bearing cap at the front of the engine, and "E1" is the intake camshaft bearing cap at the front of the engine.
- The camshafts are stamped with a code letter - "E" for the intake side and "A" for the exhaust side.
- "E" is for Einlaß, (German for intake) and "A" is for Auspuff, (German for exhaust).

## Cylinder Head and Valvetrain



- Secure hydraulic lifters in lifter bores using BMW special tool 11 3 250, or remove lifters using a magnetic pick-up tool.



- Remove camshaft bearing carrier from cylinder head.

**CAUTION—**

Camshaft bearing carriers must be reinstalled in their original locations (E for intake and A for exhaust).

**NOTE—**

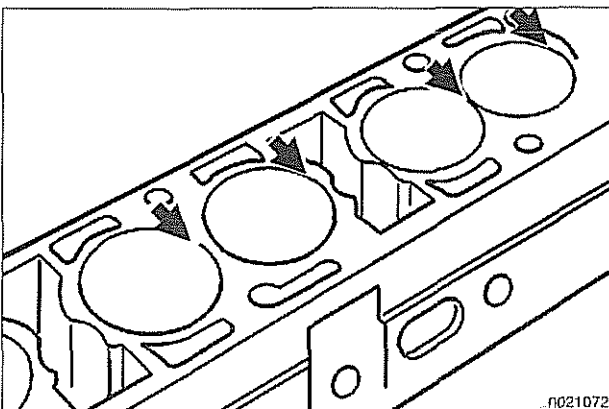
- Do not let hydraulic lifters fall out as the camshaft carrier is removed.
- Hydraulic lifters should be stored in an upright position.
- Used hydraulic lifters must be replaced into original lifter bores.

**Camshafts and lifters, installing (M52 Engine)**

Lubricate camshafts, camshaft carriers, bearing caps, hydraulic lifters, friction washers, splined shafts and spline hubs with assembly lubricant before installation.

**CAUTION—**

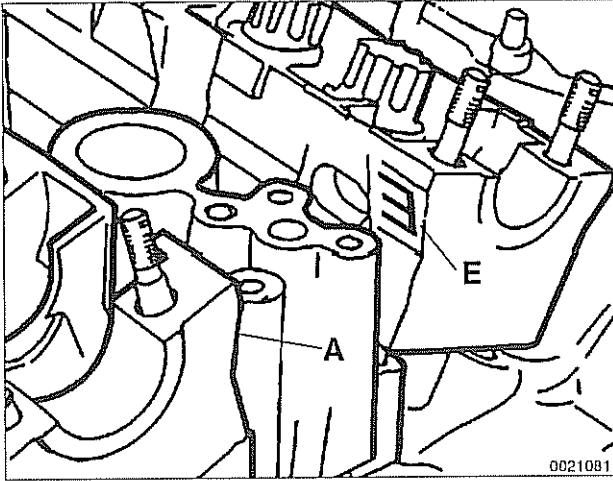
Make sure the crankshaft, which had been rotated approximately 30° opposite the direction of engine rotation from TDC, is still in that position before lowering the camshafts into position. All pistons must be out of TDC position to prevent valve/piston interference when the camshafts are installed.



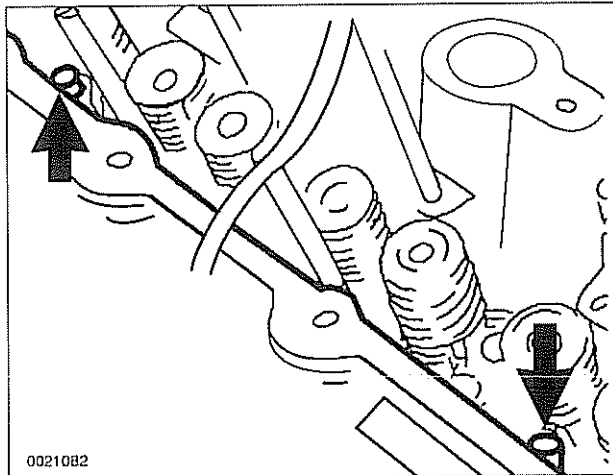
- Before installing camshaft carriers, examine bearing bores (arrows) on hydraulic lifter bores for signs of wear.

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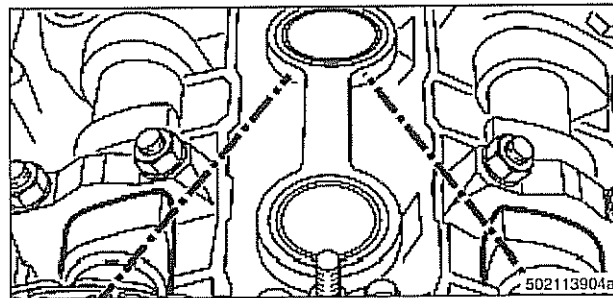
## Cylinder Head and Valvetrain



- ▲ Install camshaft carriers with hydraulic lifters into cylinder head. Note marks on carriers: (E) for intake side and (A) for exhaust side.



- ▲ Center camshaft carrier on pins (arrows) at bearing positions 2 and 7.



- ▲ Install camshafts with number 1 cylinder camshaft lobes facing each other (arrows).

### CAUTION—

A minimum waiting time is required for the hydraulic lifters to "bleed down" after installing the camshafts into the cylinder head, before bringing the pistons to TDC. When the camshafts are removed, the hydraulic lifters can expand. This expansion can cause increased valve lift when the camshafts are bolted down, possibly resulting in piston interference.

### Camshaft installation waiting times

68° F (20° C) or above	4 minutes
50–68° F (10–20° C)	11 minutes
32–50° F (0–10° C)	30 minutes



- Remainder of installation is reverse of removal, noting the following:
  - See **117 Camshaft Timing Chain** for VANOS control unit installation.

#### Tightening torques

Camshaft bearing caps to cylinder head (M7)	15 Nm (11 ft-lb)
Cylinder head cover to cylinder head (M6)	10 Nm (89 in-lb)
Spark plugs (M12)	23 Nm (17 ft-lb)

## Camshaft and lifter, removal and installation (M52 TU and M54 engine)

### Camshafts and lifters, removing (M52 TU and M54 engine)

#### **WARNING—**

*Allow engine to cool before beginning this procedure.*

- Disconnect negative (–) cable from battery.

#### **CAUTION—**

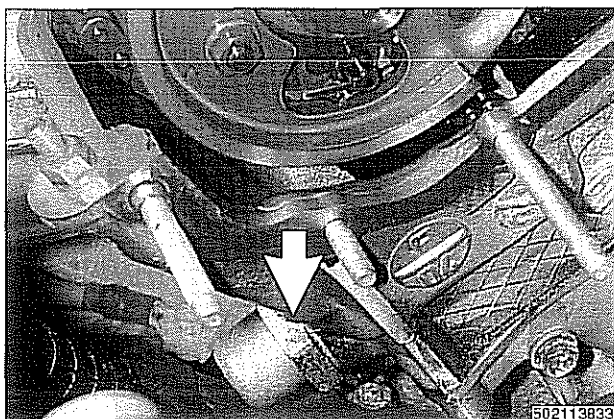
*Prior to disconnecting the battery, read the battery disconnection cautions in **001 General Cautions and Warnings**.*

- Remove VANOS control unit. See **117 Camshaft Timing Chain**.

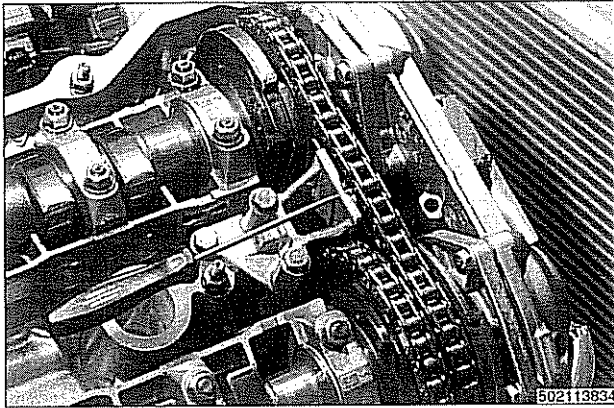
- ◀ Remove primary timing chain tensioner (**arrow**).

#### **CAUTION—**

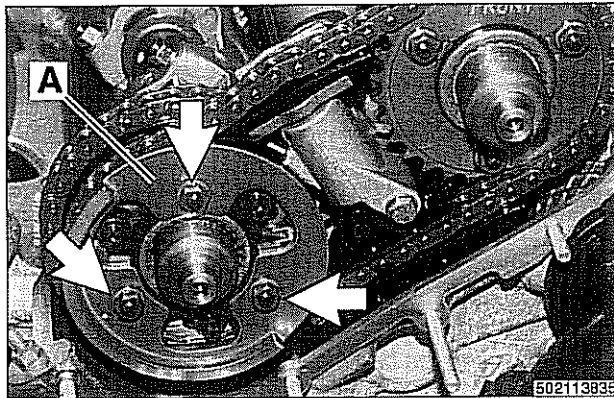
*Primary timing chain tensioner is under spring pressure.*



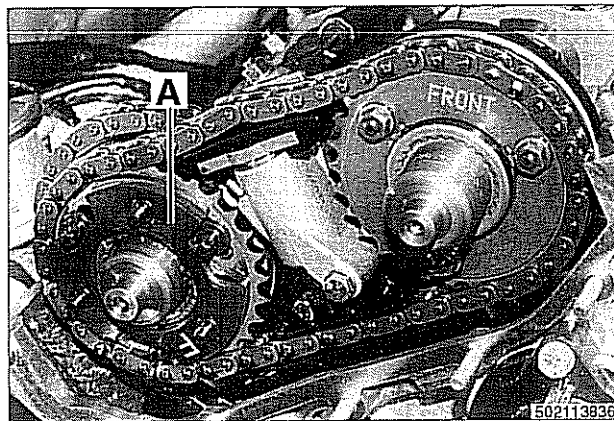
Cylinder Head and Valvetrain



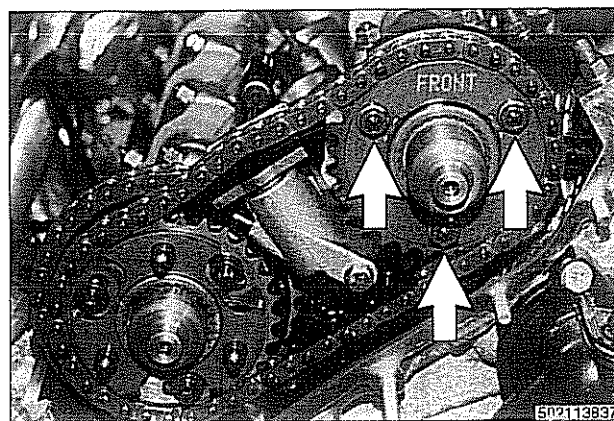
➤ Press down on secondary chain tensioner and lock into place using BMW special tool 11 3 292, or a thin drift or pin.



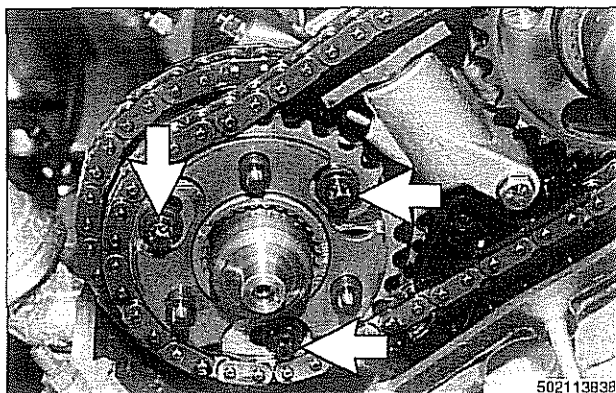
➤ Remove exhaust camshaft impulse wheel mounting nuts (arrows). Remove impulse wheel (A).



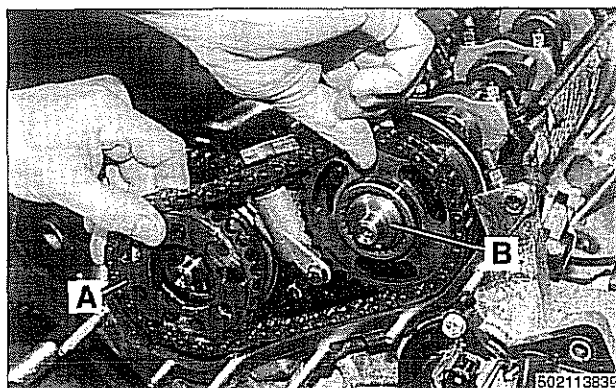
➤ Remove spring plate (A).



➤ Remove intake camshaft sprocket mounting nuts (arrows) and remove spring plate (labelled FRONT).



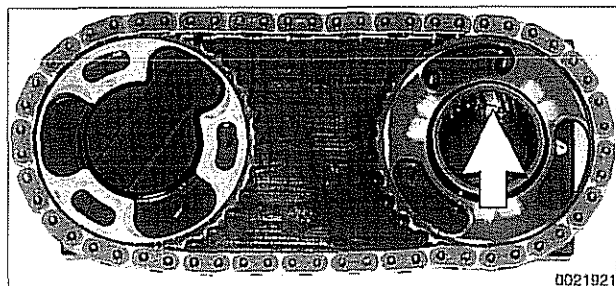
- Remove torx screws from exhaust camshaft sprocket (arrows).



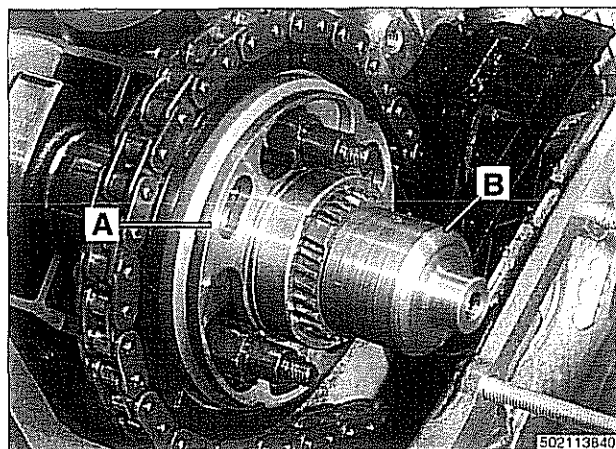
- Lift off exhaust and intake sprockets together with secondary chain, thrust spacer (A) from exhaust camshaft, and splined shaft (B) from intake camshaft.

**CAUTION—**

*Splined shafts share the same part number for both intake and exhaust camshafts. Used splined shafts must be reinstalled in their original locations.*

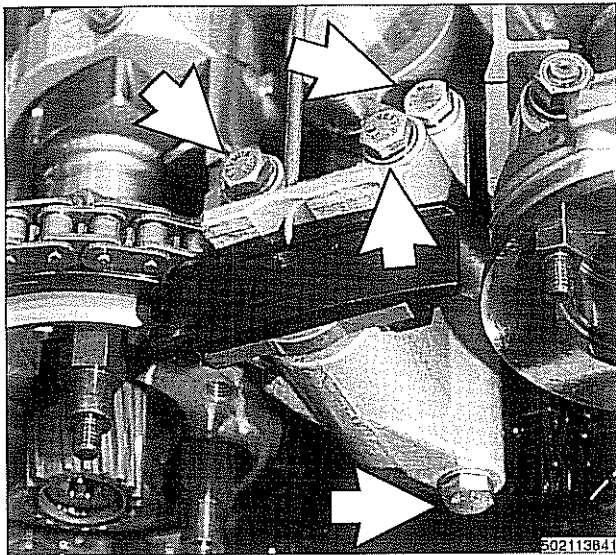


- Place intake and exhaust sprockets in BMW special tool 11 6 180. Position spline gap on intake sprocket (arrow) as shown.

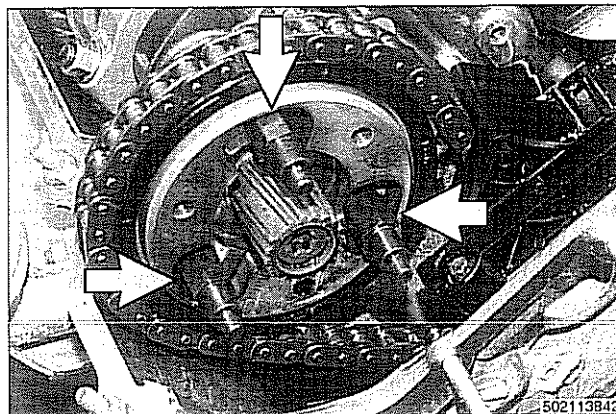


- Remove exhaust camshaft splined sleeve (A) and shaft (B).

## Cylinder Head and Valvetrain



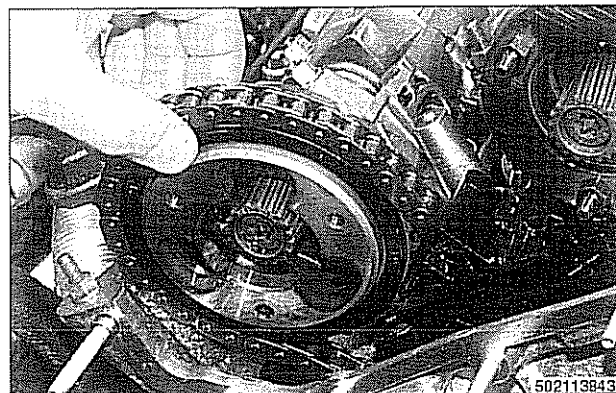
- Remove secondary chain tensioner mounting bolts (**arrows**) and remove tensioner with locking tool in place.



- Remove primary chain sprocket mounting studs (**arrows**) on exhaust camshaft.

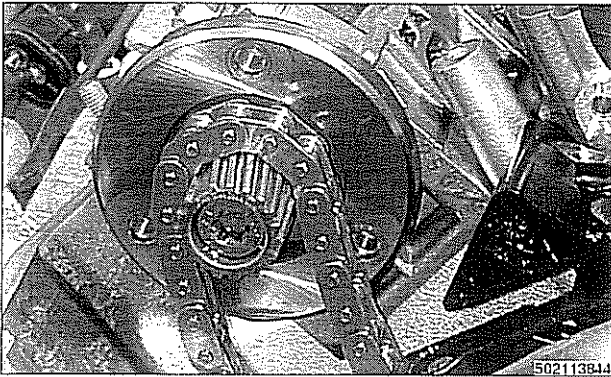
**NOTE**—

*Counterhold camshafts when loosening.*

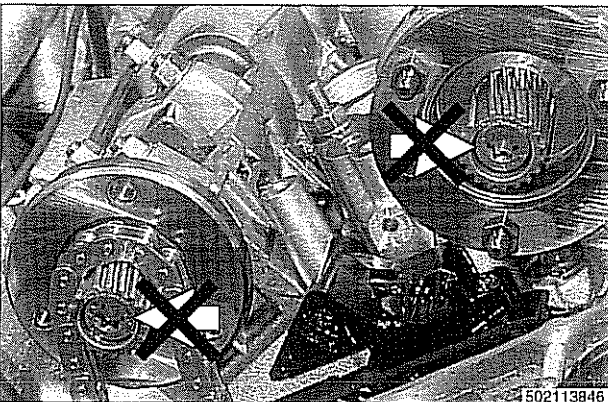


- Lift primary chain sprocket off exhaust camshaft. Remove sprocket from chain.

## Cylinder Head and Valvetrain



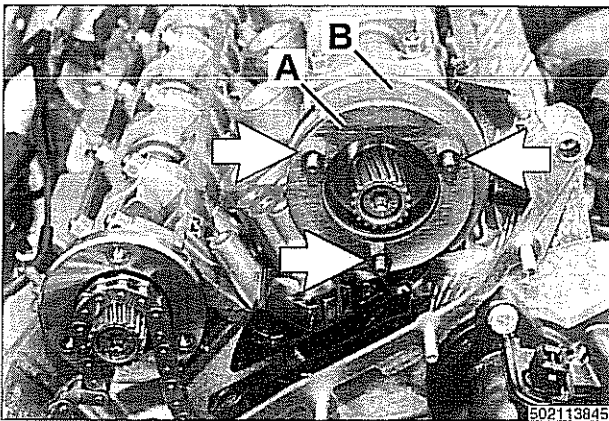
- Place timing chain on end of exhaust camshaft.



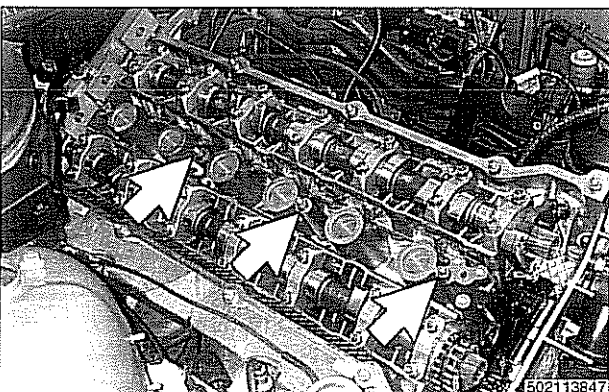
- Do not remove end spline retaining screws from camshafts (arrows).

**CAUTION—**

*The end spline retaining screws precisely locate the end splines to the camshafts. Do not loosen these screws.*

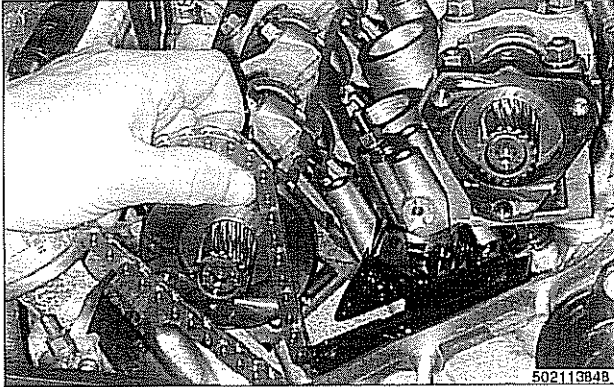


- Remove locating studs (arrows) from intake camshaft. Lift off intake camshaft thrust spacer (A) and impulse wheel (B).



- Remove cylinder head cover mounting studs (arrows) from center of cylinder head.
- Remove crankshaft locking tool (BMW special tool 11 2 300) from crankcase.

## Cylinder Head and Valvetrain

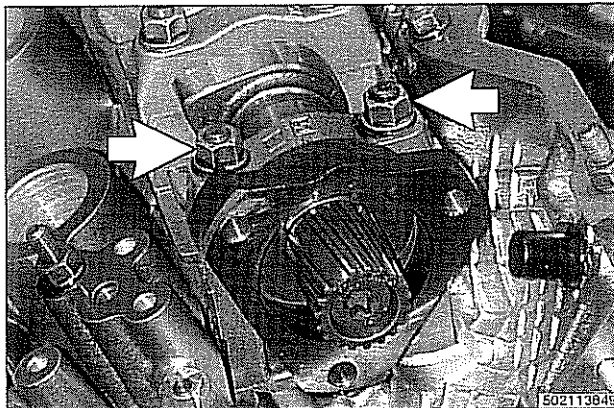


- Lift primary chain and hold under tension, rotate engine against direction of rotation (counterclockwise) approximately 30°.

**CAUTION—**

To prevent damaging valves while working on camshafts, no pistons should be in the TDC position.

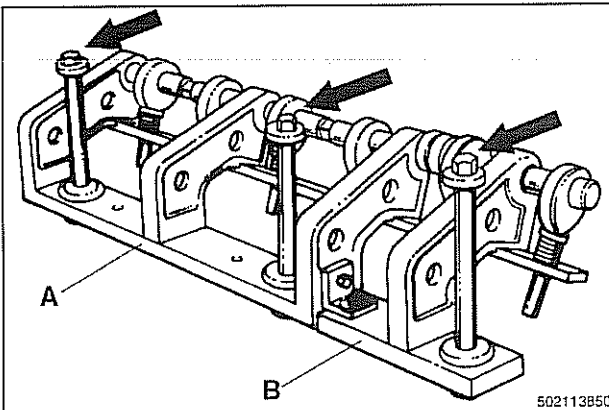
- Remove BMW special tool set 11 3 240 from rear of cylinder head.



- Remove retaining nuts (arrows) and bearing cap 1 of intake camshaft.

**CAUTION—**

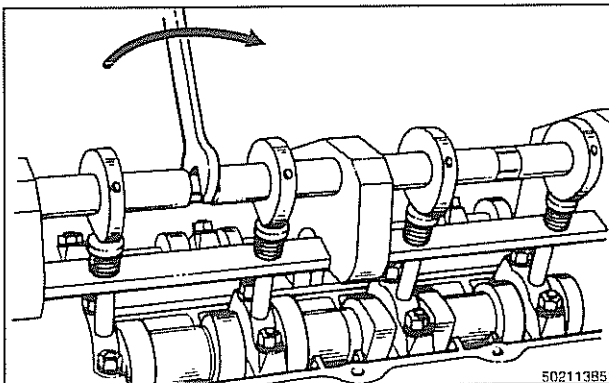
Intake camshaft bearing cap 1 is centered with adapter sleeves. To avoid camshaft damage, it must be removed before any other caps.



- Fit BMW special tools 11 3 260 (A) and 11 3 270 (B) to cylinder head and screw long bolts (arrows) into spark plug threads. Tensioners will align with the bearing caps on the intake camshaft.

**CAUTION—**

Do not over torque bolts into spark plug holes.

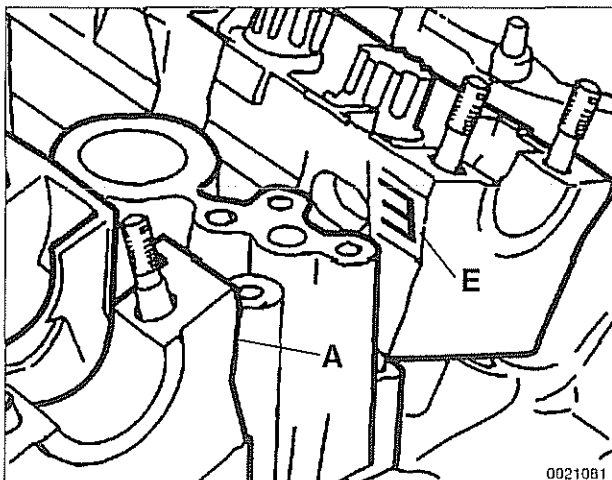
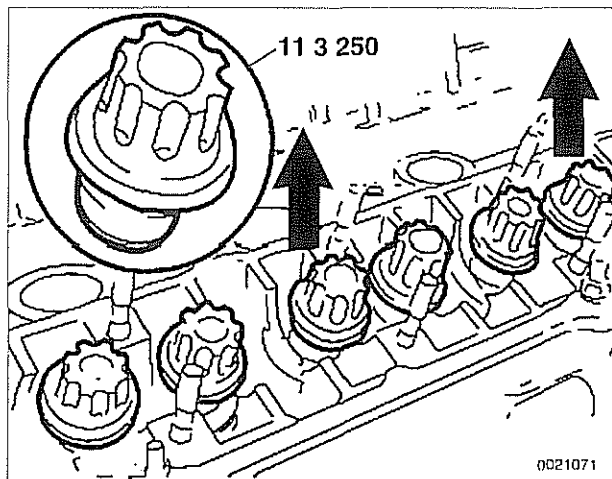


- Turn eccentric shaft of special tool to pretension intake camshaft bearing caps. Remove nuts on remaining bearing caps.
- Slowly release tension on eccentric shaft and remove BMW special tools. Remove bearing caps and set aside in order. Remove camshaft and store safely.

**CAUTION—**

Camshaft bearing caps must be installed in their original locations.



**NOTE—**

- The camshaft bearing caps are coded with a letter and a number. For example, "A1" is the first exhaust camshaft bearing cap at the front of the engine, and "E1" is the intake camshaft bearing cap at the front of the engine.
- The camshafts are stamped with a code letter - "E" for the intake side and "A" for the exhaust side.
- "E" is for Einlaß, (German for intake) and "A" is for Auspuff, (German for exhaust).

— Repeat procedure for exhaust camshaft.

- Secure hydraulic lifters in lifter bores using BMW special tool 11 3 250, or remove lifters using a magnetic pick-up tool.

**CAUTION—**

Used hydraulic lifters must be reinstalled in original lifter bores.

- Remove lower camshaft bearing carriers from cylinder head.

**CAUTION—**

Camshaft bearing carriers must be reinstalled in their original locations (E for intake and A for exhaust).

**NOTE—**

- Do not allow hydraulic lifters to fall out of camshaft carriers.
- Hydraulic lifters should be stored in an upright position.

**Camshafts and lifters, installing (M52TU and M54 engine)**

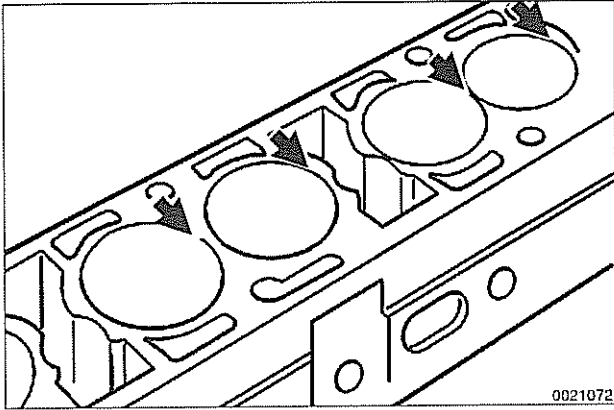
Lubricate camshafts, camshaft carriers, bearing caps, hydraulic lifters, friction washers, splined shafts and spline hubs with assembly lubricant before installation.

**CAUTION—**

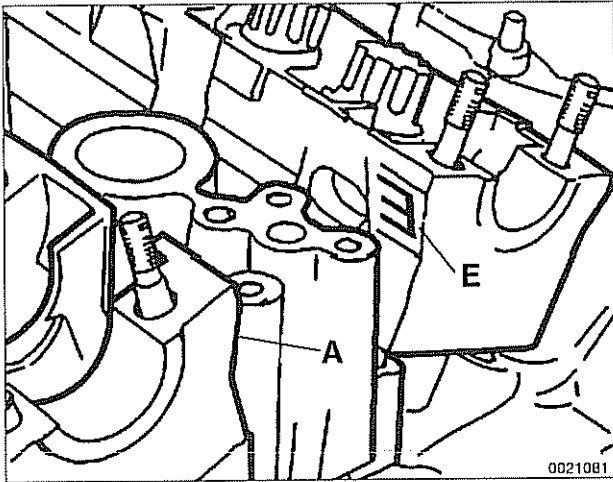
Make sure the crankshaft, which had been rotated approximately 30° opposite the direction of engine rotation from TDC, is still in that position before lowering the camshafts into position. All pistons must be out of TDC position to prevent valve/piston interference when the camshafts are installed.

- Lift timing chain and place exhaust cam onto exhaust camshaft carriers. Place intake camshaft on camshaft carrier.

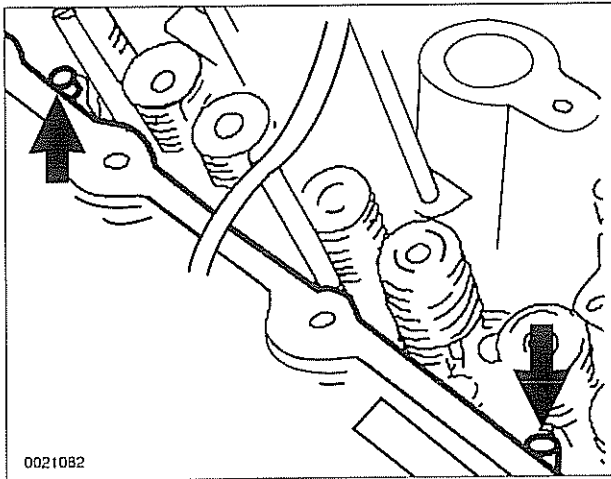
## Cylinder Head and Valvetrain



- Before installing camshaft carriers, examine bearing bores (arrows) on hydraulic lifter bores for signs of wear.



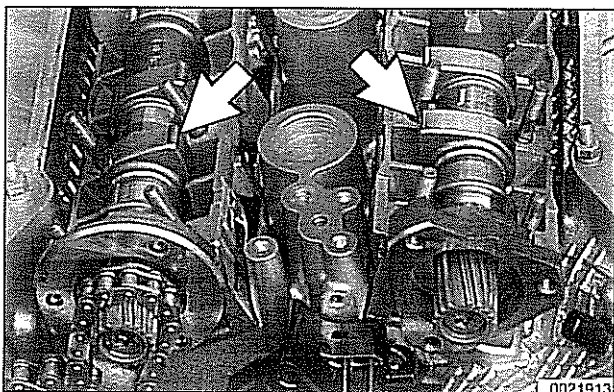
- Install camshaft carriers with hydraulic lifters into cylinder head. Note marks on carriers: (E) for intake side and (A) for exhaust side.



- Center camshaft carrier on pins (arrows) at bearing positions 2 and 7.



## Cylinder Head and Valvetrain

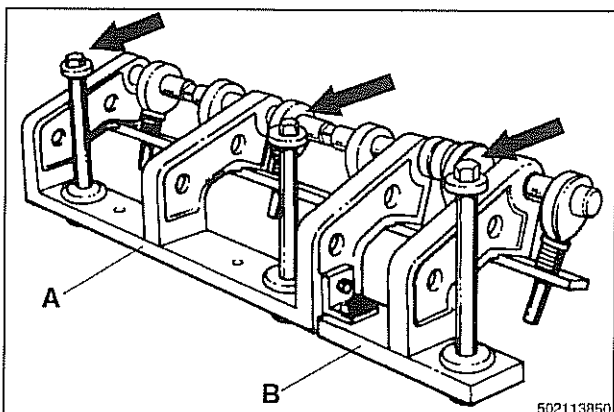


- Rotate camshafts so that intake and exhaust lobes for cylinder 1 face each other (arrows).

**CAUTION—**

A minimum waiting time is required for the hydraulic lifters to "bleed down" after installing the camshafts into the cylinder head, before bringing the piston to TDC. When the camshafts are removed, the hydraulic lifters can expand. This expansion can cause increased valve lift when the camshafts are bolted down, possibly resulting in piston interference.

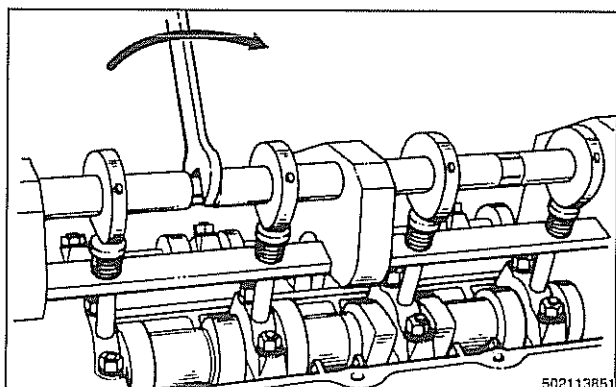
- Place bearing caps on cams, but do not install retaining nuts.



- Fit BMW special tool 11 3 260 (A) and 11 3 270 (B) to cylinder head over intake camshaft and screw long bolts (arrows) into spark plug threads.

**CAUTION—**

Do not overtighten bolts into spark plug holes.



- Turn eccentric shaft of special tool to pretension bearing caps. Install and torque nuts on intake camshaft bearing caps.

**Tightening torque**

Camshaft bearing cap to cylinder head (M7)	14 Nm (10 ft-lb)
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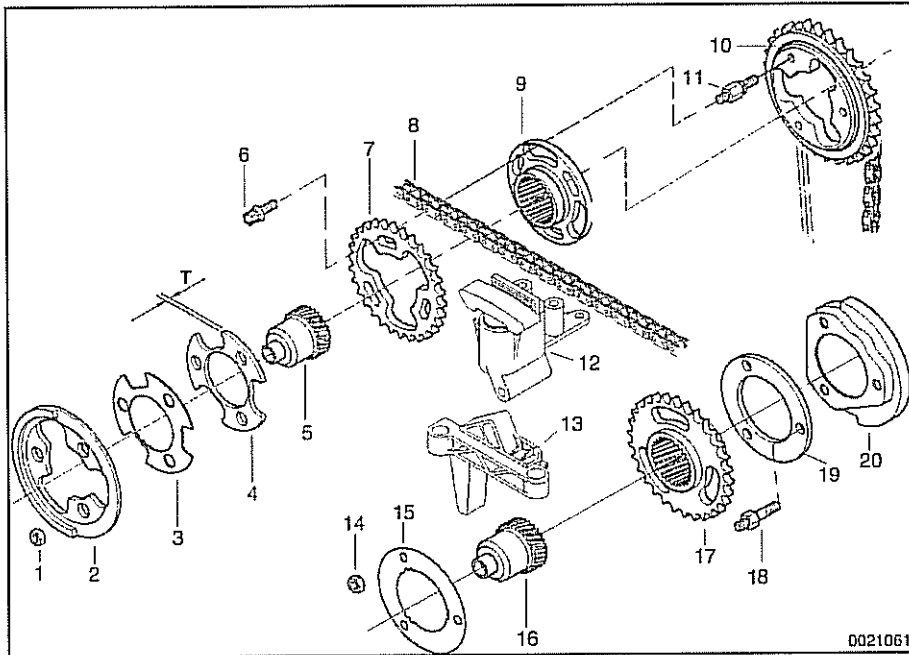
- Release tension on eccentric shaft and remove BMW special tools 11 3 260/270.
- Repeat procedure for exhaust camshaft.

**NOTE—**

Observe waiting time for lifter bleed down before continuing with camshaft installation.

**Crankshaft / valve timing waiting times**

68° F (20° C) and higher	5 minutes
50 – 68° F (10 – 20° C)	15 minutes
32 – 50° F (0 – 10° C)	30 minutes



### Double VANOS timing chain components

1. Impulse wheel mounting nut
2. Exhaust camshaft impulse wheel
3. Spring plate, exhaust
4. Thrust spacer (T = 3.5 mm)
5. Splined shaft
6. Torx screw
7. Exhaust camshaft secondary sprocket
8. Secondary timing chain
9. Splined sleeve
10. Primary sprocket
11. Threaded stud
12. Secondary chain tensioner
13. Secondary chain lower guide
14. Sprocket mounting nut
15. Spring plate, intake
16. Splined shaft
17. Intake camshaft sprocket
18. Locating stud
19. Thrust spacer
20. Intake camshaft impulse wheel

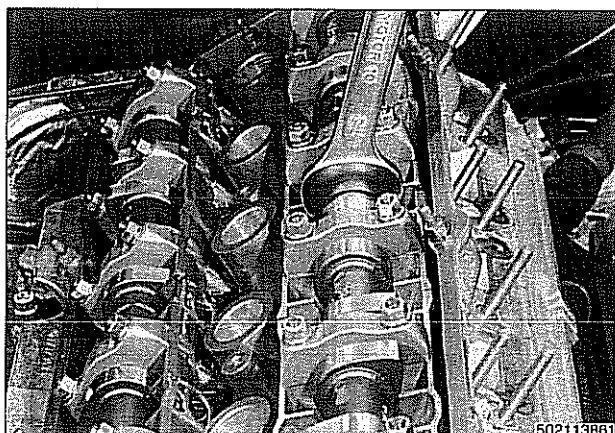
## Cylinder Head and Valvetrain

Double VANOS secondary timing chain components, installing (M52 TU, M54 engine)

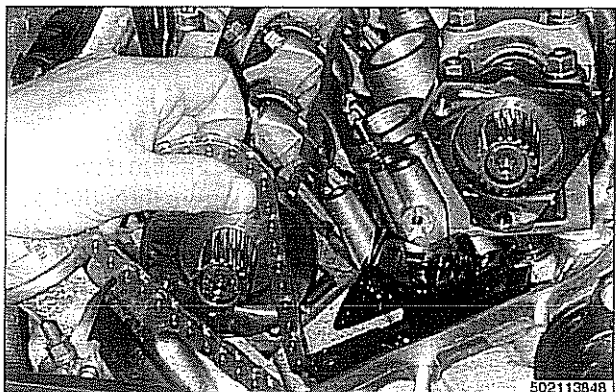
- ◀ Secure camshafts in TDC position using BMW special tool set 11 3 240.



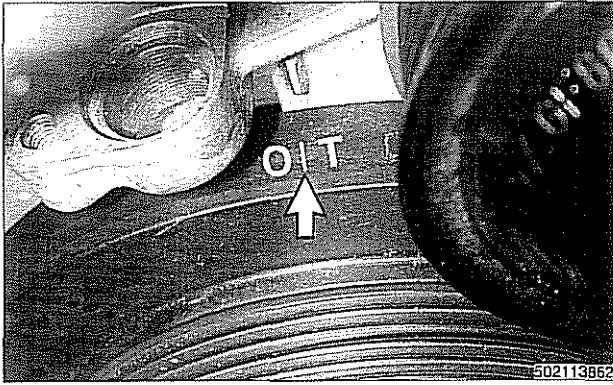
- ◀ If necessary, turn camshaft so that special tools are squarely seated on cylinder head.



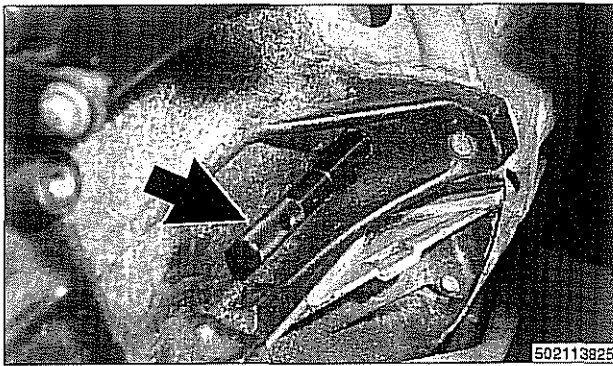
- ◀ Lift timing chain and hold under tension.



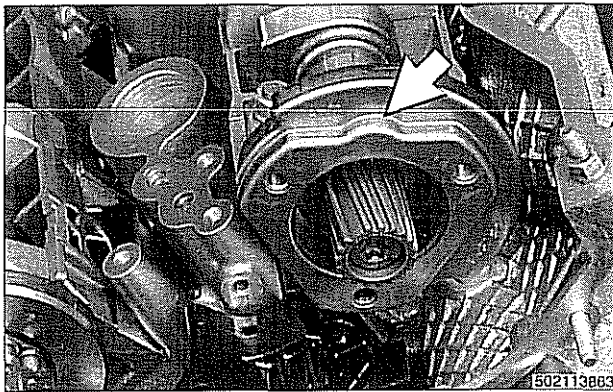
**Cylinder Head and Valvetrain**



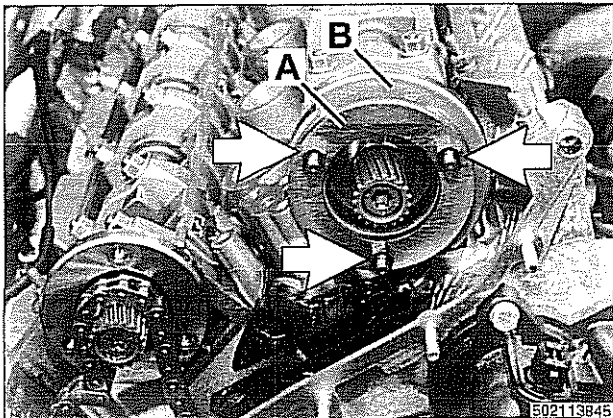
- While maintaining tension on timing chain, rotate crankshaft at vibration dampener from 30° before TDC in direction of rotation (clockwise) until number 1 cylinder is at TDC position with line between the **OIT** mark (arrow) on front pulley aligned with boss on lower timing chain cover.



- Secure crankshaft in TDC position with BMW special tool 11 2 300 (arrow).



- Slide impulse wheel on intake camshaft, aligning boss with raised portion on camshaft (arrow).

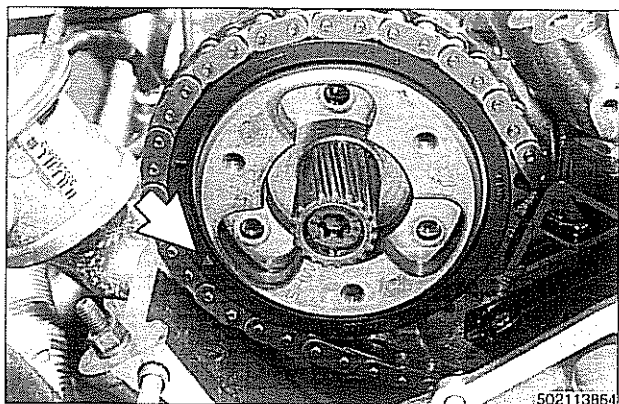


- Fit thrust spacer (**A**) to intake camshaft and tighten down with threaded locating studs (arrows). Place longer threaded portion of studs into camshaft.

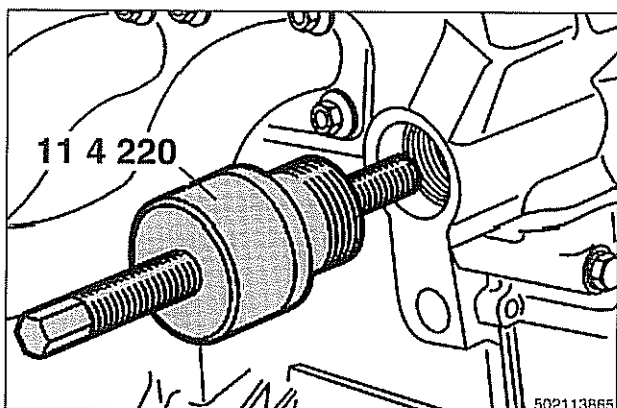
**Tightening torque**

Impulse wheel studs to intake camshaft (M7)	20 Nm (15 ft-lb)
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## Cylinder Head and Valvetrain



- Install primary timing chain on timing chain sprocket and place on exhaust camshaft so that pointer on sprocket (arrow) lines up with cylinder head sealing surface.

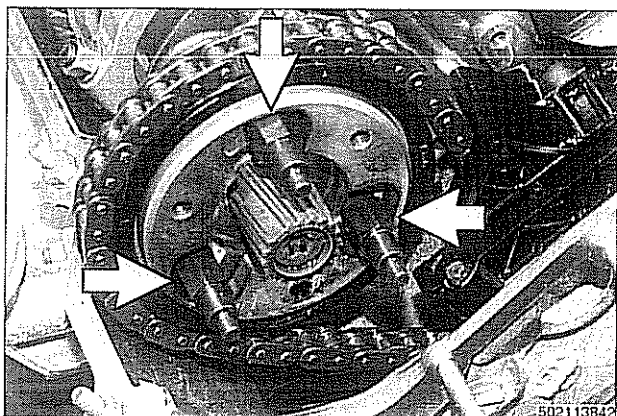


- Insert BMW special tool 11 4 220 into timing chain tensioner bore and bring center spindle into contact with tensioning rail. Tighten until slack is removed, but do not pretension timing chain.

### NOTE—

*BMW special tool 11 4 220 is an adjustable primary chain tensioner and simulates the function of the tensioner.*

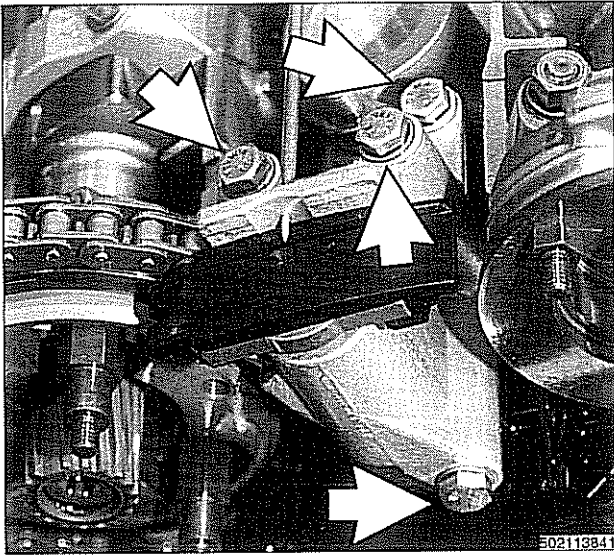
- Recheck arrow on primary sprocket is aligned with upper edge of cylinder head. Reposition sprocket if necessary.



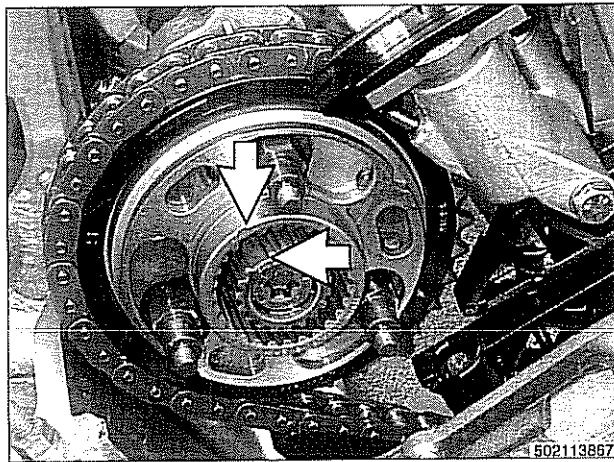
- Insert and tighten threaded locating studs (arrows) in exhaust camshaft.

### Tightening torques

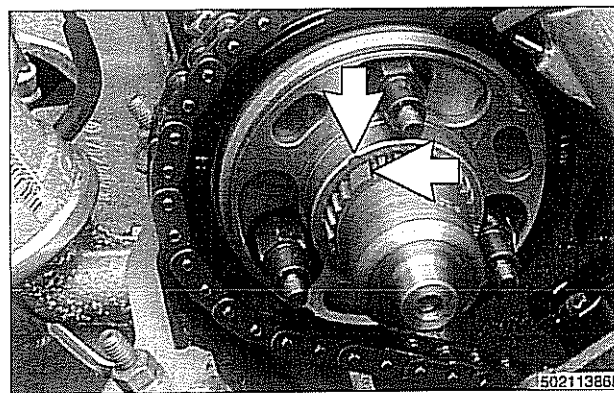
Exhaust camshaft locating stud	20 Nm (15 ft-lb)
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- ◀ Install secondary chain tensioner (**arrows**). Keep tensioner compressed using BMW special tool 11 3 292 or suitable pin.



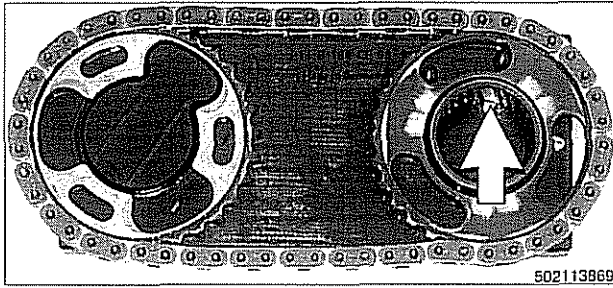
- ◀ Fit exhaust camshaft splined sleeve. Confirm that gap in sleeve splines aligns with corresponding gap in camshaft splines (**arrows**).



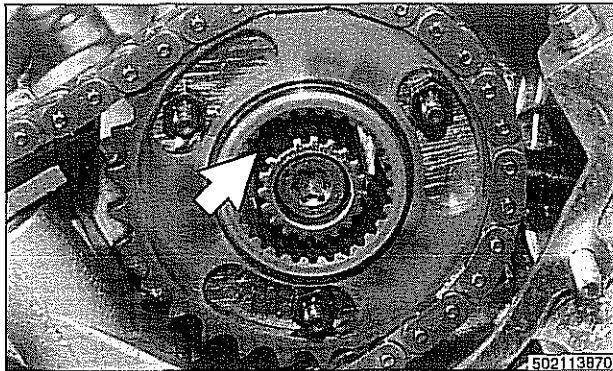
- ◀ Slide splined shaft onto exhaust camshaft so that locating tooth of shaft fits into spline gaps of camshaft and splined sleeve (**arrows**).
- Push splined shaft in further to rotate splined sleeve until the three threaded holes in primary chain sprocket are centered in the small slots of the splined sleeve.



## Cylinder Head and Valvetrain



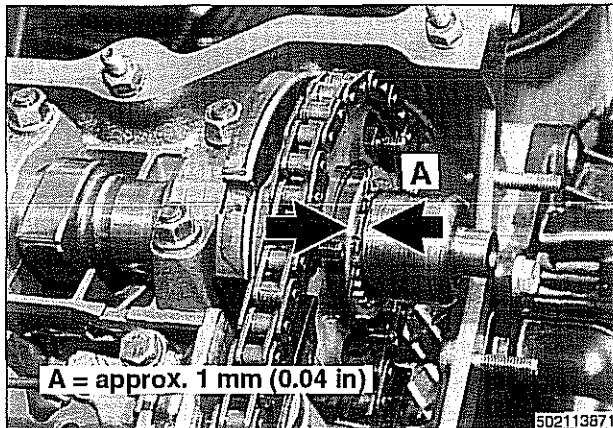
- Place intake and exhaust sprockets in BMW special tool 11 6 180. Position spline gap on intake sprocket (arrow) as shown and place secondary chain on sprockets.



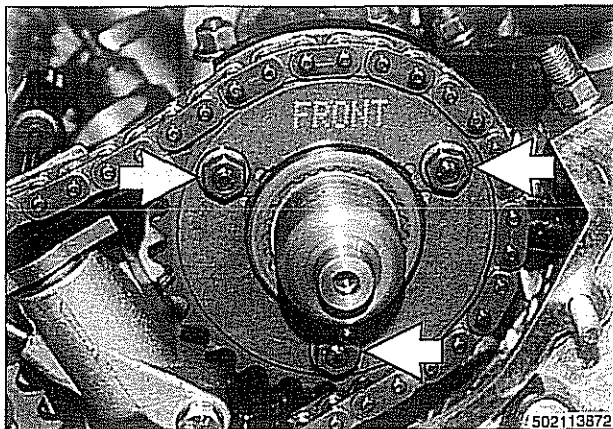
- Remove chain and sprockets from tool and slide sprockets on camshafts. Confirm that gap in intake sprocket splines lines up with corresponding gap in camshaft splines (arrow).

**CAUTION—**

*Do not alter position of sprockets with respect to chain when removing from special tool 11 6 180.*

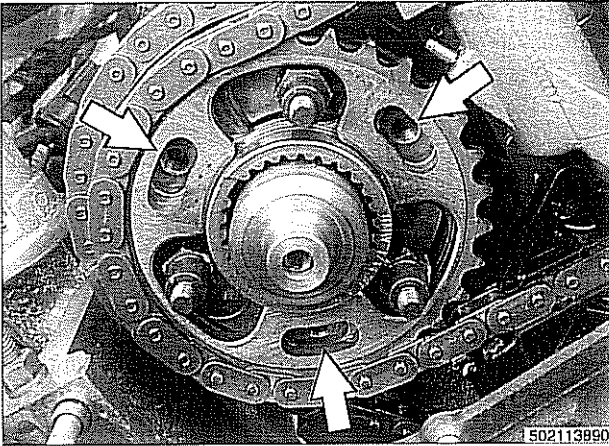


- While aligning locating tooth of shaft with spline gaps on camshaft and sprocket, slide splined shaft onto intake camshaft until approx. 1 mm (0.04 in.) of splines (arrows) are visible.

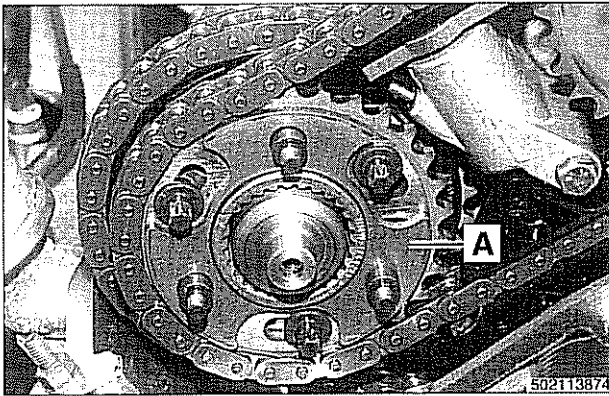


- Install intake camshaft spring plate so that **FRONT** mark is visible. Install mounting nuts (arrows) finger tight.

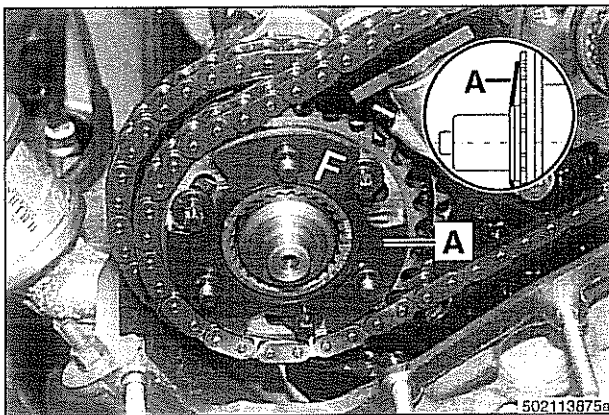
## Cylinder Head and Valvetrain



- Insert sprocket mounting bolts (**arrows**) on exhaust side camshaft assembly.
  - Initially tighten to approx. 5 Nm (44 in-lb) and then back off by half a turn.



- Fit thrust spacer (**A**) on exhaust camshaft.



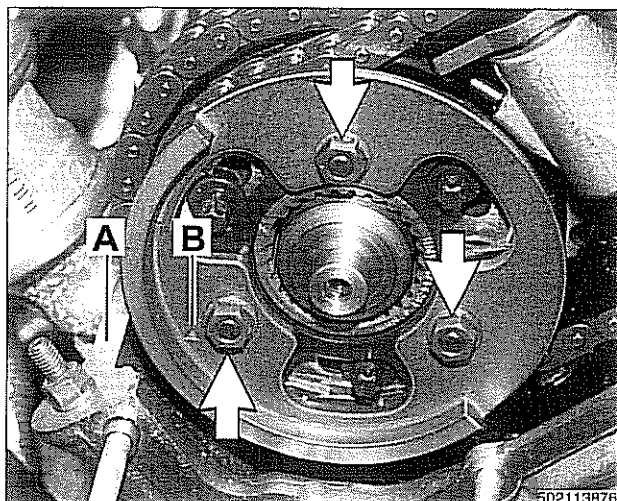
- Install spring plate (**A**) to exhaust camshaft. Make sure that (**F**) mark is visible.

**NOTE —**

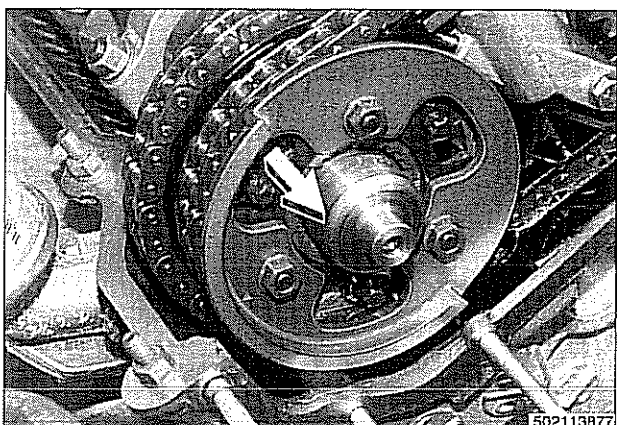
*If F mark is no longer visible, install spring plate as shown in inset.*



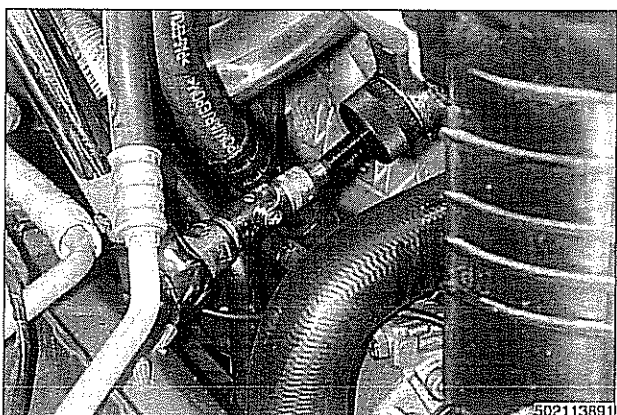
## Cylinder Head and Valvetrain



- Install exhaust camshaft impulse wheel, aligning pointer (B) with top edge of cylinder head (A). Install mounting nuts (arrows) finger tight.



- Pull out exhaust camshaft splined shaft to stop.
- Press down on secondary chain tensioner and remove tensioner lock-down tool.

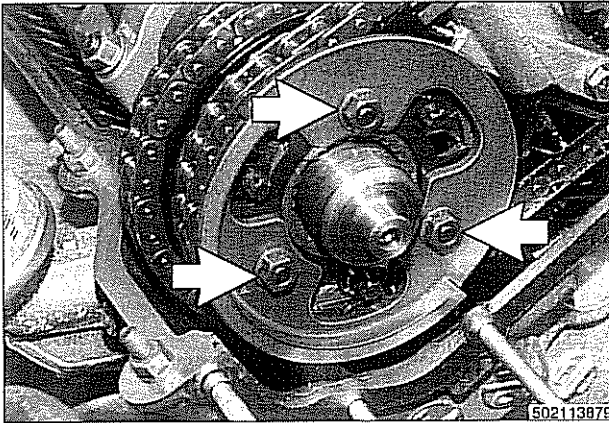


- Preload primary chain:
  - Tighten adjusting screw on BMW special tool 11 4 220 to specified torque.

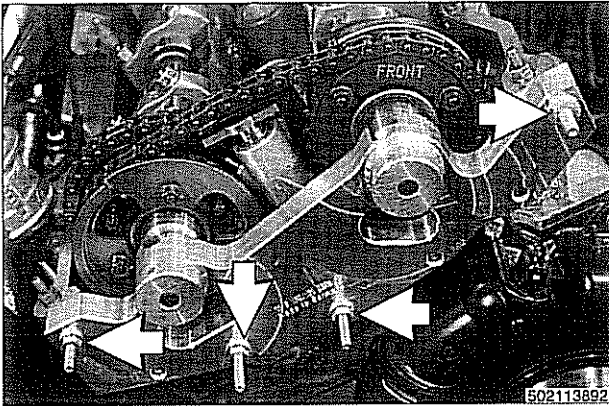
### Tightening torque

Primary chain tensioner preload	0.7 Nm (6 in-lb)
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## Cylinder Head and Valvetrain



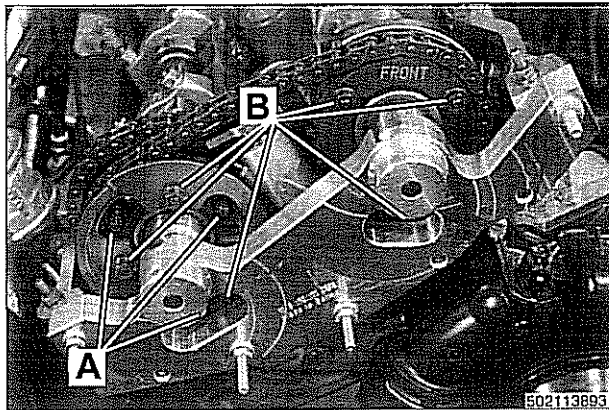
- Preload exhaust camshaft spring plate by pressing on impulse wheel while tightening mounting nuts (**arrows**) finger tight.



- Install BMW special tool 11 6 150 (VANOS setup bracket) to front of cylinder head timing case. Install nuts (**arrows**) finger tight, then tighten down uniformly until special tool is in full contact with cylinder head.

### CAUTION—

*Make sure all gasket material is removed from face of cylinder head. Clean sealing face and keep free of oil.*



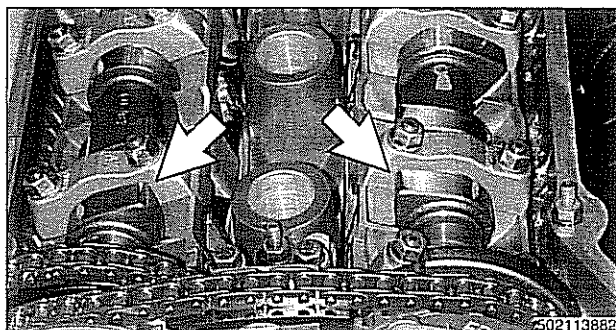
- Secure camshaft sprockets and impulse wheels:
  - Tighten mounting screws (**A**) on exhaust camshaft impulse wheel to approx. 5 Nm (44 in-lb).
  - Tighten mounting nuts (**B**) on exhaust and intake sprocket assemblies to approx. 5 Nm (44 in-lb).
  - Torque down mounting screws (**A**) and nuts (**B**) to final specifications.

### Tightening torques

Sprocket assembly to camshaft initial torque	5 Nm (44 in-lb)
Sprocket assembly wheel to camshaft	
M7 torx screws ( <b>A</b> )	20 Nm (15 ft-lb)
M6 mounting screw ( <b>B</b> )	10 Nm (8 ft-lb)

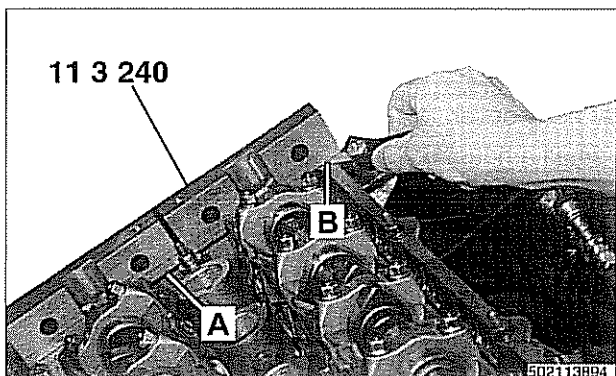
- Remove crankshaft locking tool from crankcase.
- Remove camshaft locking tools from cylinder head.

## Cylinder Head and Valvetrain



- Turn engine over twice in direction of rotation until cylinder 1 intake and exhaust camshaft lobes (arrows) face each other.

- Lock crankshaft in TDC position with BMW special tool 11 2 300.



- Place BMW special tool set 11 3 240 over camshafts and measure clearances.

**NOTE—**

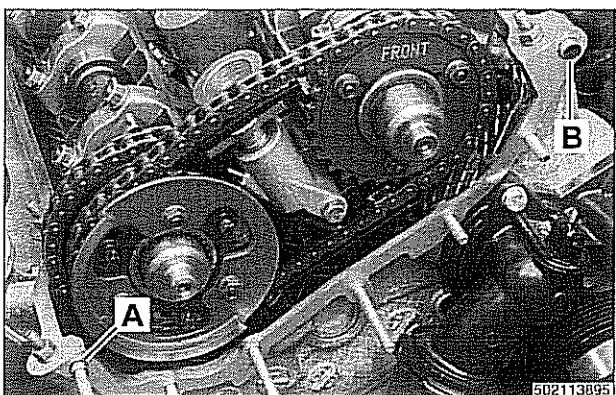
- If the exhaust side of the tool (A) is not flush with the head, camshaft timing is incorrect. Reset camshaft timing as described in 117 **Camshaft Timing Chain**.
- Due to flexible sprocket design, VANOS unit tolerances and play in the VANOS splines, when the camshaft timing is set correctly, the intake side of special tool set 11 3 240 (B) may be up to 1 mm (0.04 in.) above the surface of the cylinder head. This is normal. Reassemble engine. Otherwise, reset camshaft timing as described in 117 **Camshaft Timing Chain**.

- Remove BMW special tool 11 6 150 from front of cylinder head.

- Clean contact edges of cylinder head face and VANOS unit and apply a thin coat of Three Bond 1209® or equivalent sealing compound to surfaces.

**CAUTION—**

- Make sure all gasket material is removed from face of cylinder head. Clean sealing face and keep free of oil.
- Check locating dowel (A) and dowel sleeve (B) at top of cylinder head for damage or incorrect installation.



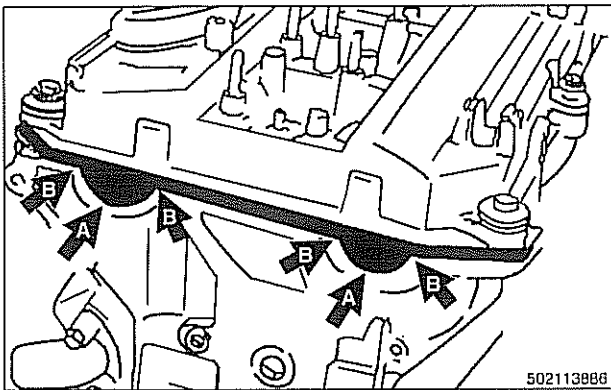
- Using a new steel gasket, install VANOS unit to front of cylinder head. See 117 **Camshaft Timing Chain**.

**NOTE—**

If VANOS control unit is being replaced, be sure to check and adjust camshaft timing as described in 117 **Camshaft Timing Chain**.

- Reinstall engine lifting eye.
- Reconnect electrical harness connectors to camshaft position sensors and VANOS solenoid valves.

## Cylinder Head and Valvetrain



- Remove adjustable primary timing chain tensioner tool and reinstall primary chain tensioner cylinder to cylinder head.

### Tightening torque

Primary chain tensioner cylinder to cylinder head	70 Nm (52 ft-lb)
---	------------------

- Remove flywheel locking tool from crankcase. Replace special tool bore sealing plug.
- Remove camshaft locking tools from cylinder head.

- ▶ Install intake camshaft cover and cylinder head cover.
  - Check for correct seating of half-moon seals (A) in back of cylinder head cover.
  - Use a small amount of Three Bond ® 1209 or equivalent sealing compound at corners (B) of half-moon cutouts.
  - Seat gasket and seal corners at VANOS unit with Three Bond ® 1209.

### Tightening torque

Cylinder head cover to cylinder head (M6)	10 Nm (89 in-lb)
---	------------------

- Installation of the remaining parts is reverse or removal, noting the following:
  - Change engine oil and filter as described in **020 Maintenance**.
  - Reconnect battery.

### CAUTION—

*To prevent damaging the engine electronic systems, install all ground wire previously removed, including the ground wires for the ignition coils.*

### Tightening torque

Radiator cooling fan to coolant pump	40 Nm (30 ft-lb)
Spark plug to cylinder head	25 Nm (18 ft-lb)

## Camshaft removal and installation (M62 engine)

### Camshafts, removing (M62 engine)

Special BMW service tools should always be used to remove and install the camshafts. Removal of the camshafts without the special tools can result in personal injury and /or cylinder head damage.

#### NOTE —

Cylinder bank 1–4 is referred to as the right cylinder bank and is located on the passenger side. Cylinder bank 5–8 is referred to as the left cylinder bank and is located on the driver's side.

#### WARNING —

Allow engine to cool before beginning this procedure.

- Disconnect negative (–) cable from battery.

#### CAUTION —

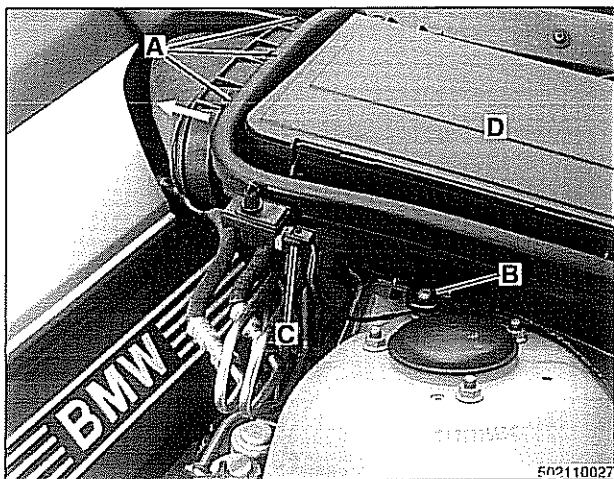
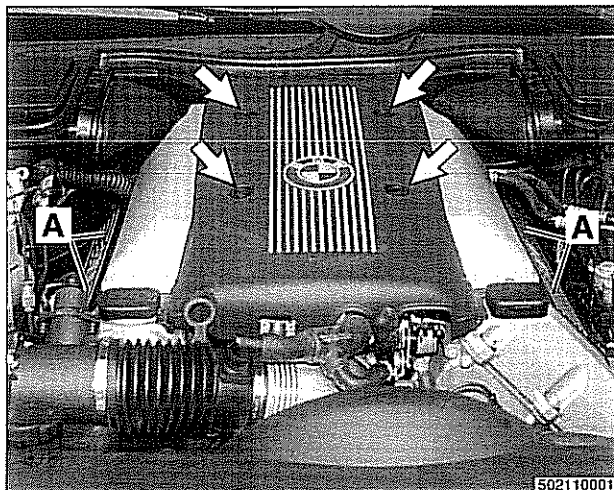
Prior to disconnecting the battery, read the battery disconnection cautions in **001 General Cautions and Warnings**.

- Drain coolant. See **170 Radiator and Cooling System**.



Remove plastic engine covers:

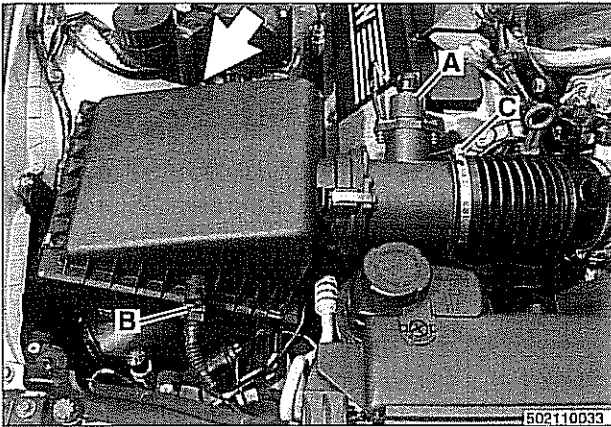
- Press down on locking pins (arrows) and remove top cover.
- Pry out trim caps (A) from covers.
- Remove fasteners from beneath trim caps and remove side covers.



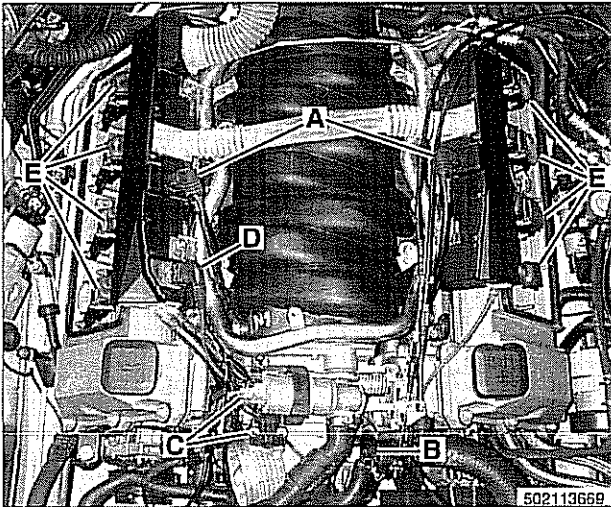
Remove left and right interior ventilation filter housing (left side shown):

- Release locking tabs (A) or locking strap (early models, not shown).
- Rotate duct inward (arrow) to disconnect.
- Release spring lock (B) to unlock ventilation housing.
- Disconnect electrical harness from hood switch (C).
- Release locking clip and remove ventilation filter cover (D).
- Remove filter housing.
- Removal of right side ventilation duct is similar.

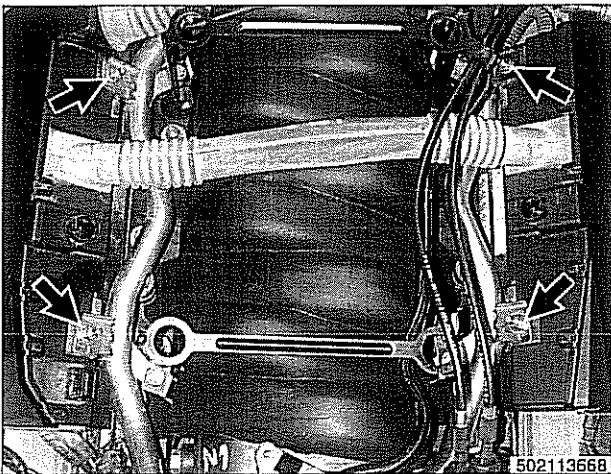
## Cylinder Head and Valvetrain



- Remove air filter housing and ducts:
- Loosen hose clamps as necessary and disconnect electrical harnesses.
  - Remove air filter housing mounting fastener (**arrow**).
  - Loosen hose clamp at throttle body.
  - Remove air filter housing with mass air flow sensor and duct.



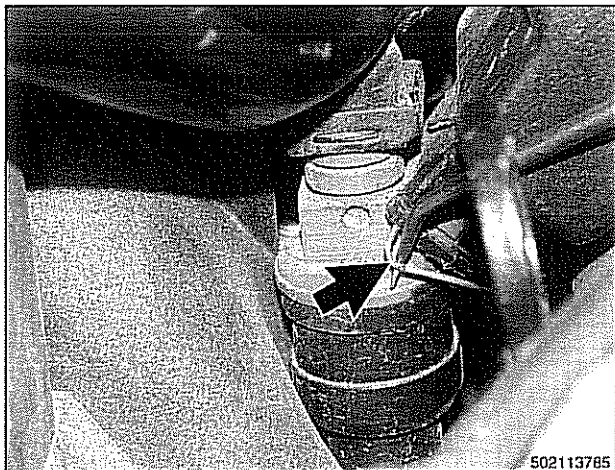
- Disconnect the following electrical harness connectors.
- Knock sensors (**A**).
  - Thermostat housing (**B**).
  - Throttle position sensor/throttle position switch and idle valve (**C**).
  - Camshaft position sensor (**D**).
  - Ignition coils (**E**).



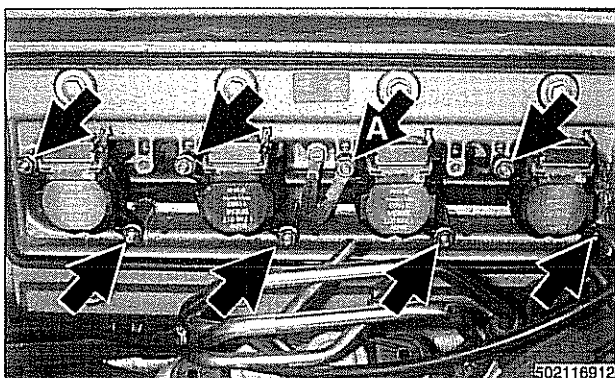
- Remove mounting nuts (**arrows**) from wiring harness ducting.



## Cylinder Head and Valvetrain



- Disconnect fuel injector electrical connectors from injectors.
  - Pry corner of wire lock clip (**arrow**) on first injector.
  - Repeat for all injectors.
  - Lift wiring ducts off and set aside.

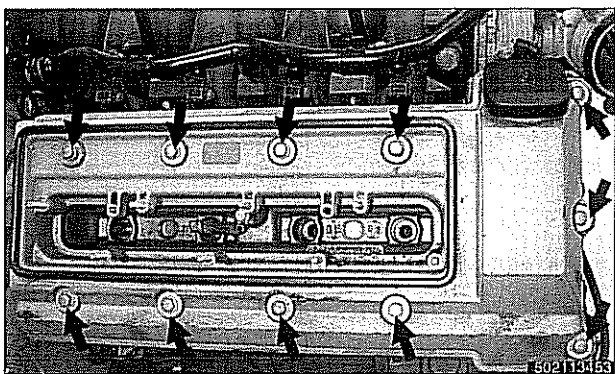


- Remove right and left side ignition coil mounting nuts (**arrows**) and coils.

**NOTE** —

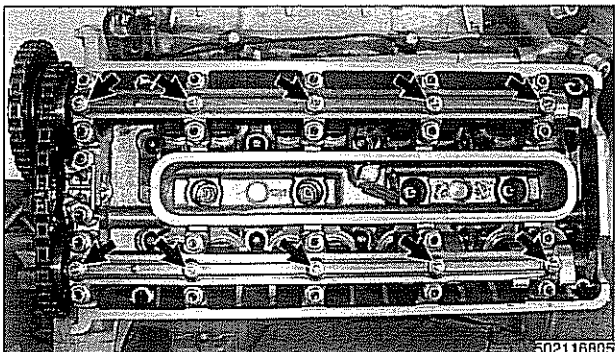
*Make note of location for ground straps (**arrow A**).*

- Remove spark plugs.
- Disconnect positive (+) jumper junction from top of left cylinder head cover.



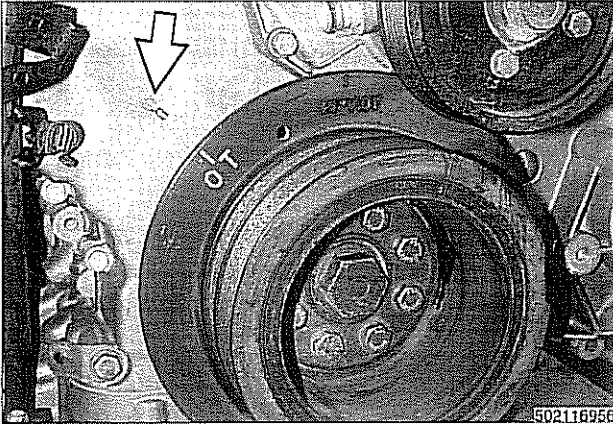
- Remove right and left cylinder head cover cap nuts (**arrows**) and remove covers.

- Remove belt driven cooling fan, see **170 Radiator and Cooling System**.

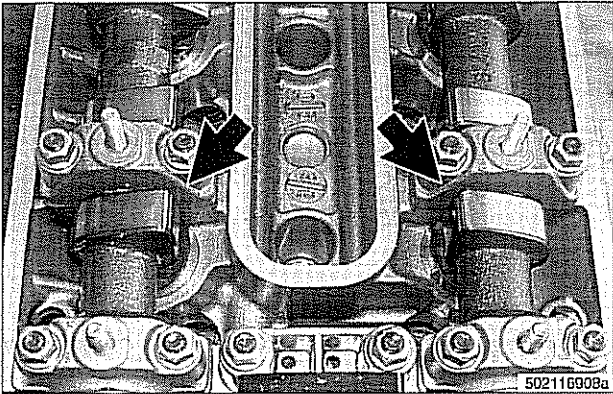


- Remove retaining nuts (**arrows**) and remove oil lines from left and right cylinder heads.

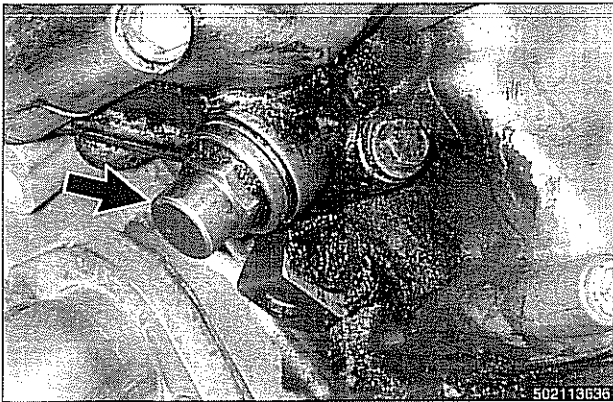
## Cylinder Head and Valvetrain



- Using crankshaft center bolt, rotate engine clockwise one complete rotation until the first cylinder is at TDC.



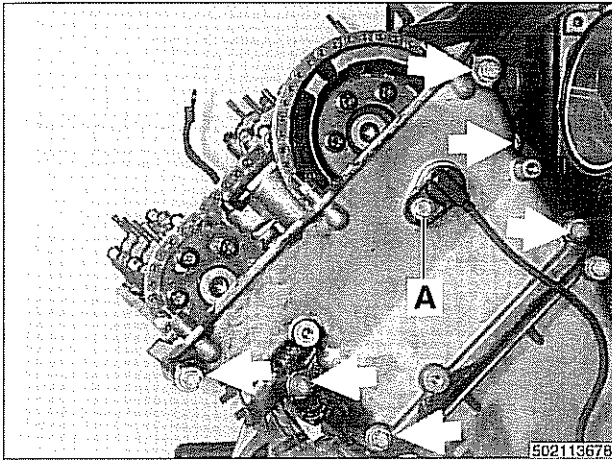
- Confirm TDC position. Lobes of camshafts for cylinder head 1–4 (passengers side) should point up (arrows).



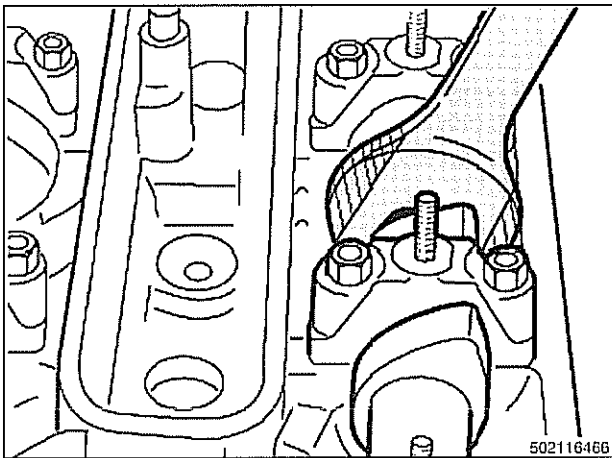
- Remove timing chain tensioner (arrow) from right side upper timing chain cover.
- Remove secondary air injection pipes in front of upper timing chain covers.
- Remove left and right coolant hoses from coolant pump housing.
- Detach dipstick tube from upper right timing cover.



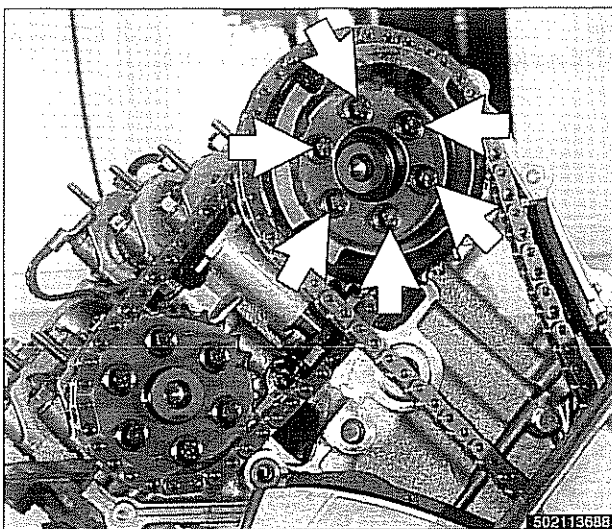
## Cylinder Head and Valvetrain



- Remove camshaft position sensor (A) from timing chain cover. Remove bolts (arrows) from timing chain covers and remove covers from right and left cylinder heads.

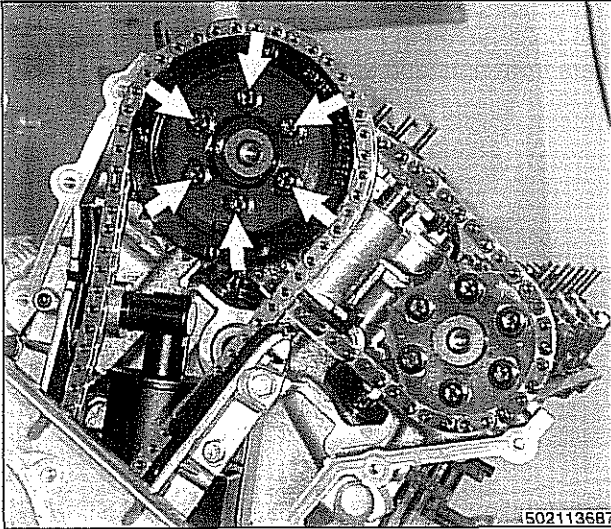


- Counterhold intake camshaft on right cylinder head.

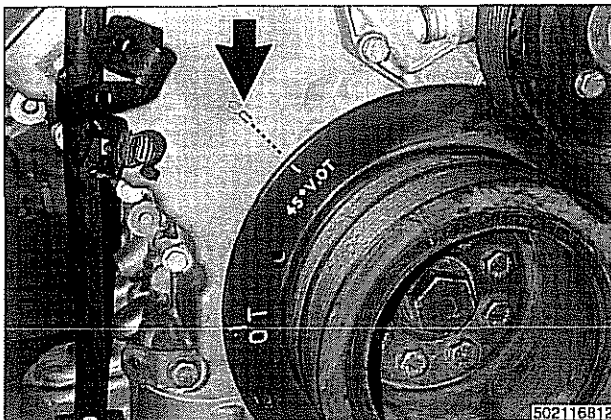


- Counterhold right intake camshaft and remove sprocket mounting bolts (arrows) from right cylinder head.
  - Remove camshaft impulse wheel and primary chain sprocket.
  - Slide primary timing chain off sprocket and suspend chain with stiff wire to prevent it from dropping into lower timing chain cover.

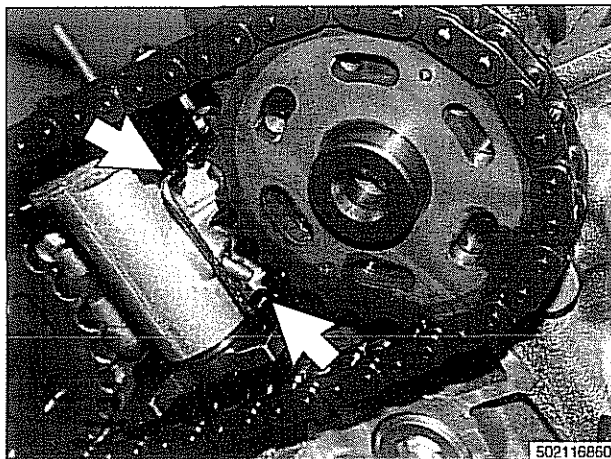
## Cylinder Head and Valvetrain



- ⚠ Counterhold left intake camshaft and remove sprocket mounting bolts (**arrows**) from left cylinder head.
  - Remove primary chain sprocket.
  - Slide primary timing chain off sprocket and suspend timing chain with stiff wire to prevent it from dropping into lower timing chain cover.

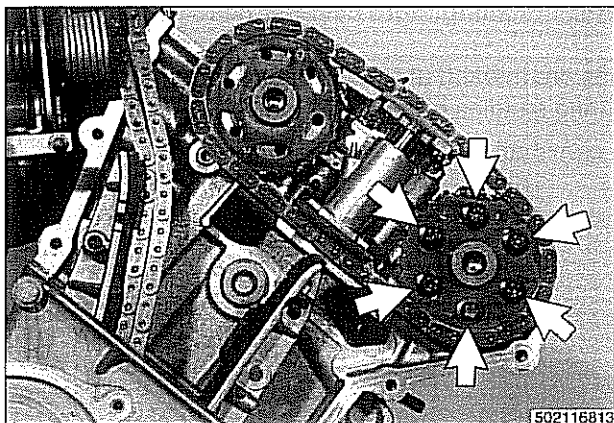


- ⚠ Using crankshaft center bolt, rotate engine counterclockwise to 45° before TDC position. 45° V.O.T mark on pulley will align with boss cast on engine block (**arrow**).

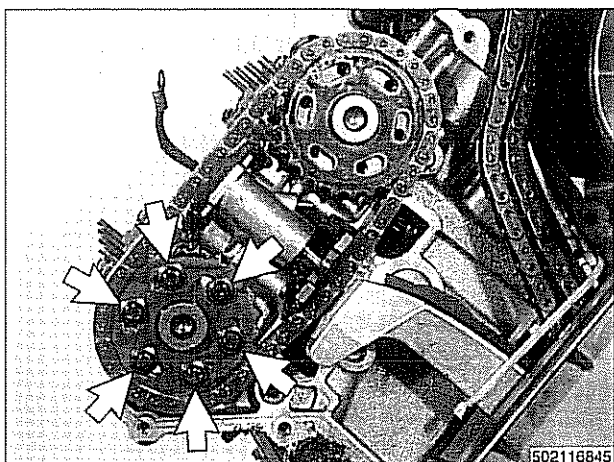


- ⚠ Compress secondary chain tensioners and lock (**arrows**) using BMW special tool 11 3 310 or a stiff wire.

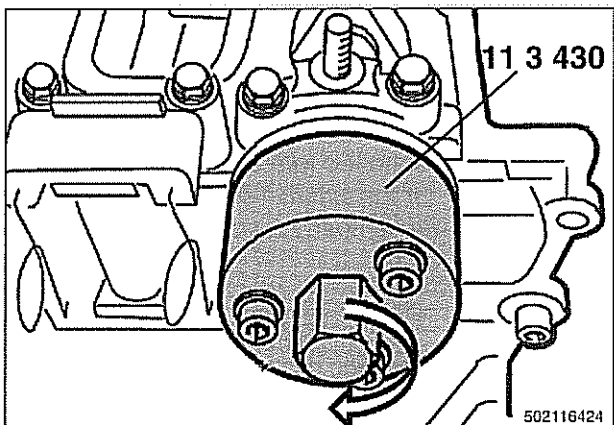
## Cylinder Head and Valvetrain



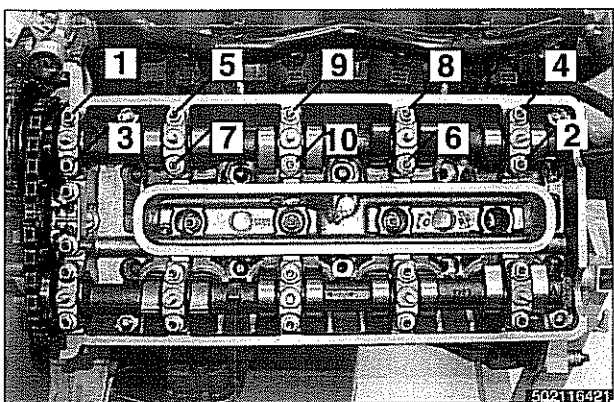
- While counter holding camshaft, remove exhaust camshaft sprocket bolts (**arrows**) from left cylinder head. Remove sprockets with chain.



- While counter holding camshaft, remove exhaust camshaft sprocket bolts (**arrows**) from right cylinder head. Remove sprockets with chain.



- Use BMW special tool 11 3 430 to rotate camshaft into disassembly position.



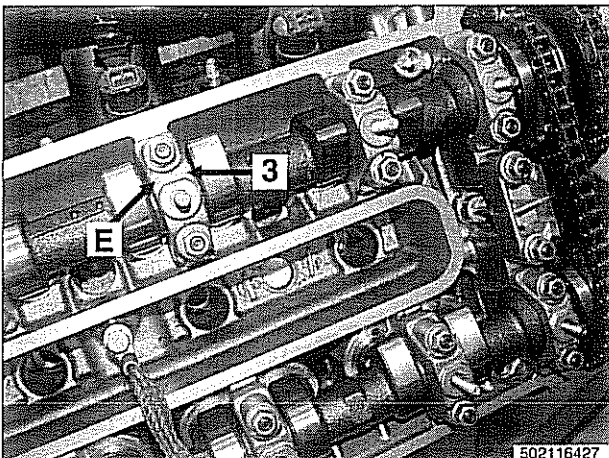
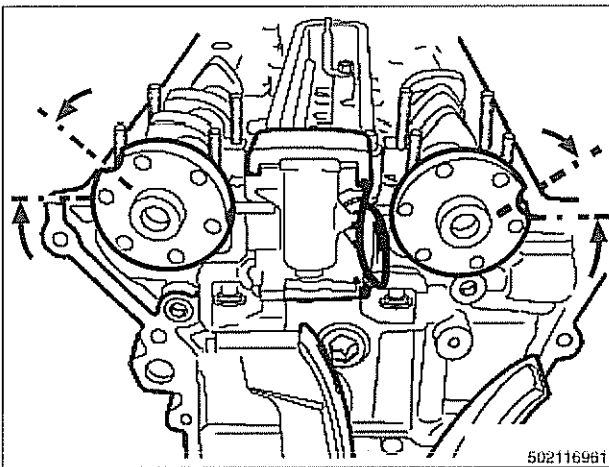
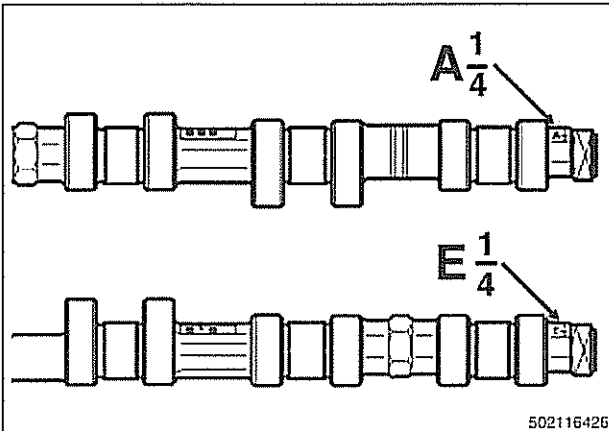
- Loosen camshaft bearing caps nuts in correct sequence (1–10) (left cylinder head shown).

**NOTE —**

*Keep camshaft bearing caps in order. Used caps must not be interchanged.*

- Remove exhaust camshaft by repeating process.
  - Remove camshafts from cylinder head.
- Repeat camshaft removal process for right cylinder head.

## Cylinder Head and Valvetrain



### Camshafts, installing, right cylinder head (M62 engine)

- ◀ Camshafts are marked at rear. Install camshafts into camshaft bearing saddles of cylinder heads.
  - Intake camshaft for right cylinder head (1-4) is labelled E 1-4.
  - Exhaust camshaft for right cylinder head (1-4) is labelled A 1-4.
- ◀ Rotate camshafts so that recesses in intake and exhaust camshafts point upward 30 to 40° above sealing surface for valve cover (arrows).

- ◀ Bearing caps are marked with a code for location.

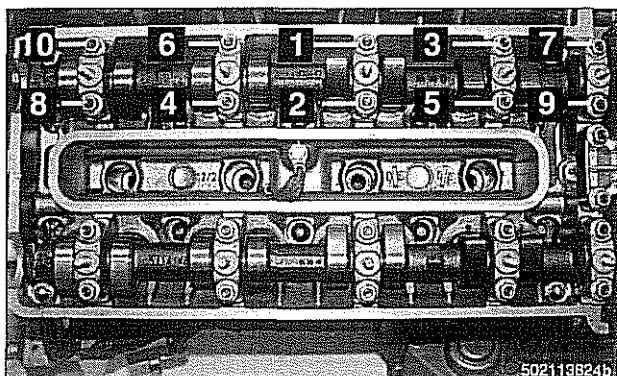
#### NOTE—

The camshaft caps are stamped with a code letter - "E" for the intake side and "A" for the exhaust side. Number code is for position on head, with number 1 being the front bearing cap.

#### CAUTION—

Do not mix up camshaft bearing caps between cylinder banks.

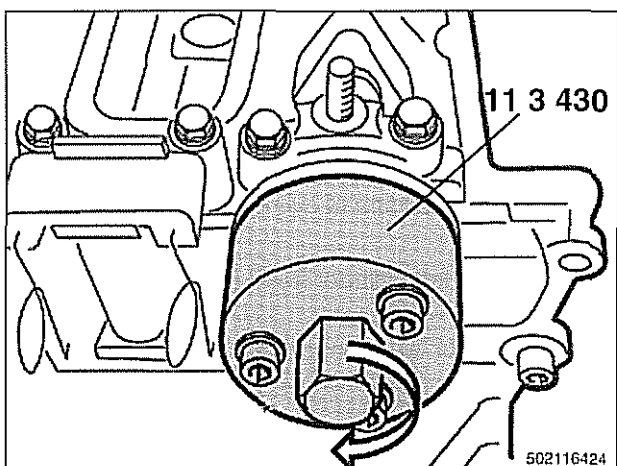
## Cylinder Head and Valvetrain



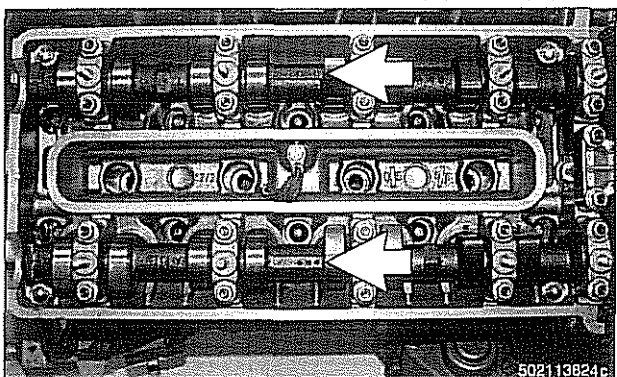
- Evenly tighten down bearing cap nuts in  $\frac{1}{2}$  turn steps starting at number 1.

## Tightening torque

Camshaft bearing cap	14 Nm (10 ft-lb)
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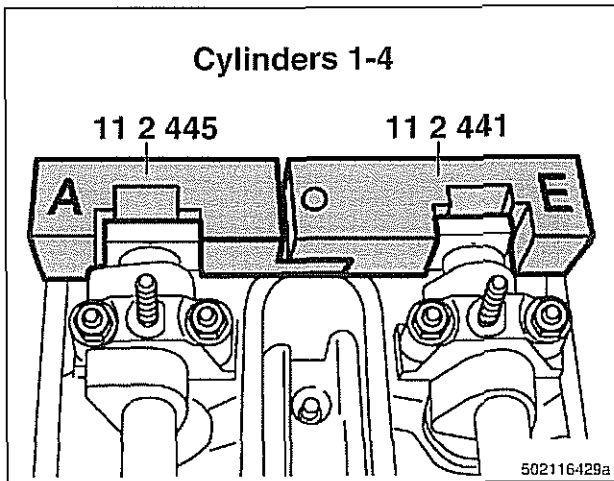


- Install BMW special tool 11 3 430 on camshaft.



- Rotate camshafts until marker bores (**arrows**) point upwards.

## Cylinder Head and Valvetrain

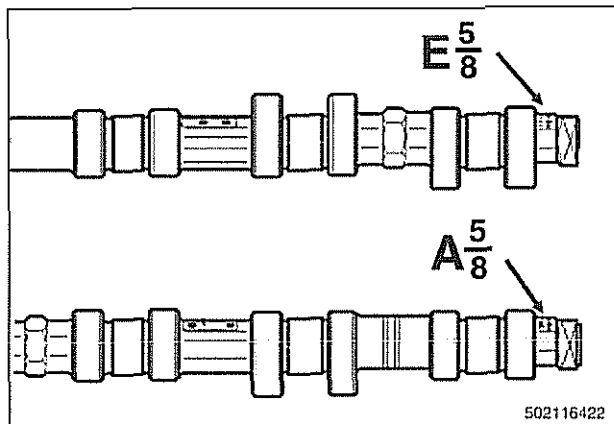


Secure camshafts in TDC position using BMW special tools:

- Align camshafts with open-end 27 mm wrench so BMW special tools fit on cylinder heads without gaps. Secure tool using number 4 cylinder spark plug hole.

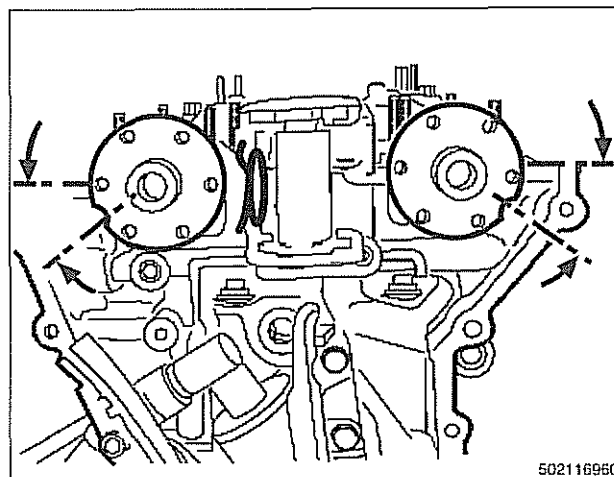
**CAUTION—**

Do not damage the cylinder head. If necessary, machine open-end wrench to fit.

**Left side (cyl. 5-8) camshafts, installing (M62 engine)**

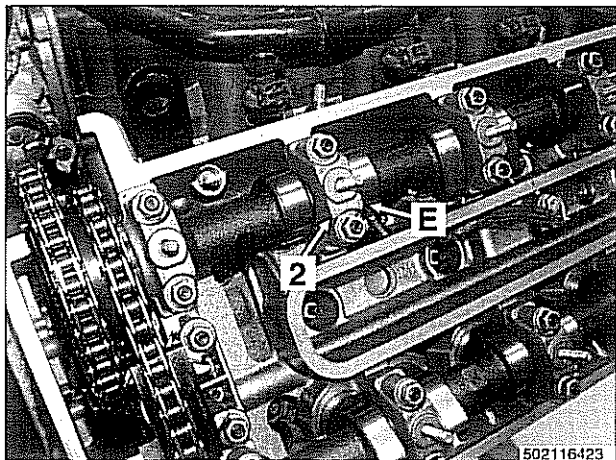
Camshafts are marked for location at rear. Install camshafts into camshaft bearing saddles of cylinder heads, noting the following:

- Intake camshaft for left cylinder head (5-8) is labelled E 5/8.
- Exhaust camshaft for left cylinder head (5-8) is labelled A 5/8.



Rotate camshafts so that recesses in intake and exhaust camshafts point downward 30 to 40° (arrows) from cylinder head cover sealing surface.

## Cylinder Head and Valvetrain



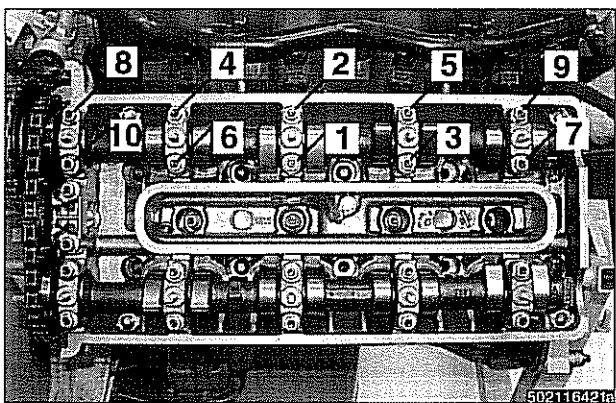
- ◀ Bearing caps are marked with a code for location.

### NOTE—

The camshaft caps are stamped with a code letter - "E" for the intake side and "A" for the exhaust side. Number code is for position on head, with number 1 being the front bearing cap.

### CAUTION—

Do not mix up camshaft bearing caps.

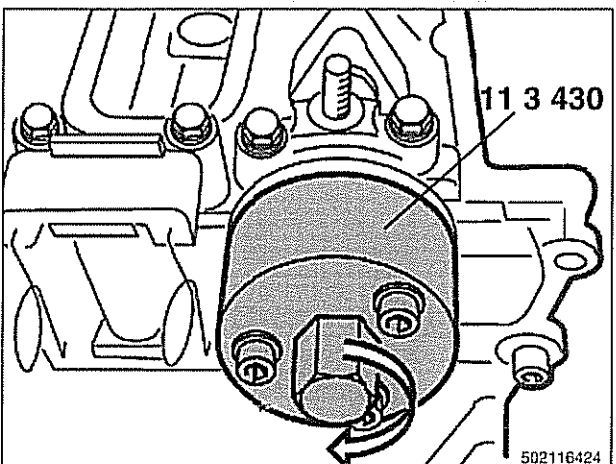


- ◀ Install and evenly tighten down bearing cap nuts in  $\frac{1}{2}$  turn steps starting at number 1.

### Tightening torque

Camshaft bearing cap

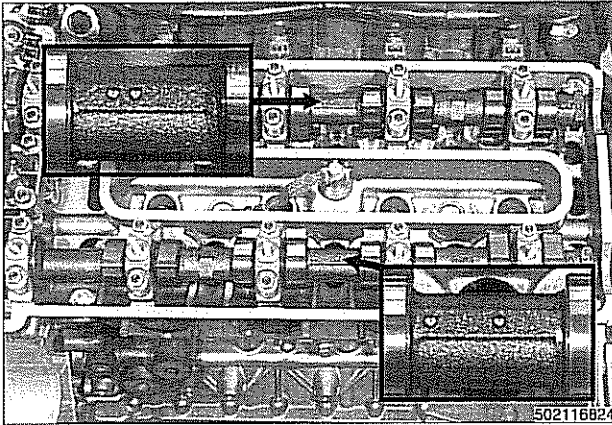
14 Nm (10 ft-lb)



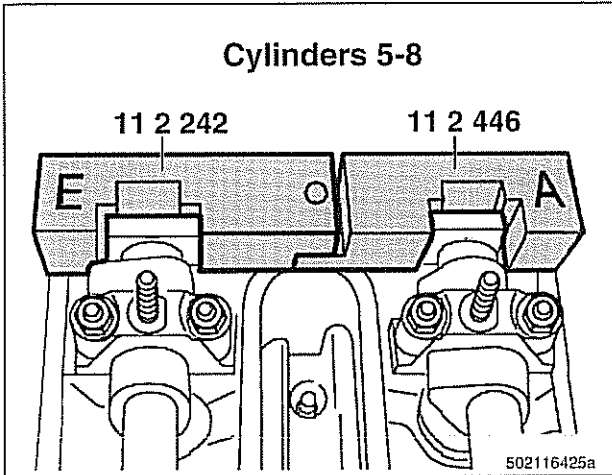
- ◀ Install BMW special tool 11 3 430 on camshaft.



**Cylinder Head and Valvetrain**



➤ Rotate camshafts until marker bores (**insets**) point upwards.



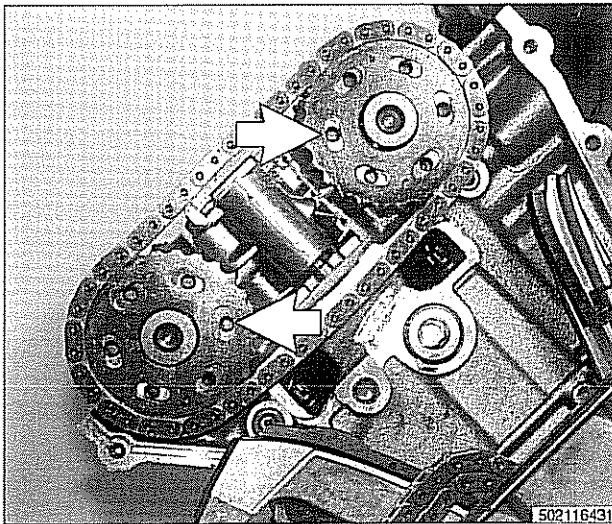
➤ Secure camshafts in TDC position using BMW special tools:

- Align camshafts with open-end 27 mm wrench so BMW special tools fit on cylinder heads without gaps. Secure tool using number 8 cylinder spark plug hole.

**CAUTION—**

*Do not damage the cylinder head. If necessary, machine open-end wrench to fit.*

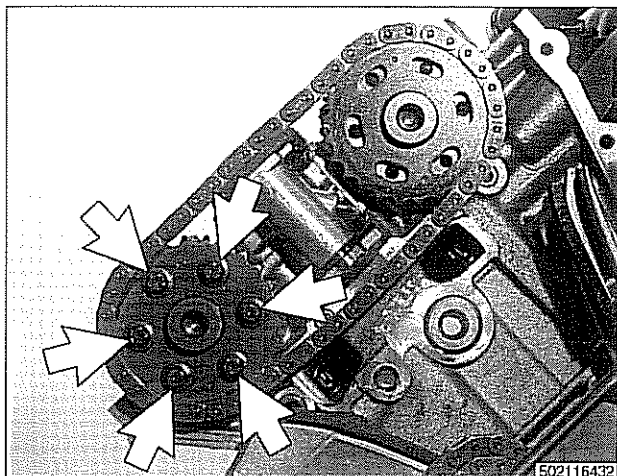
**Timing chains and tensioners, installing (M62 engine)**



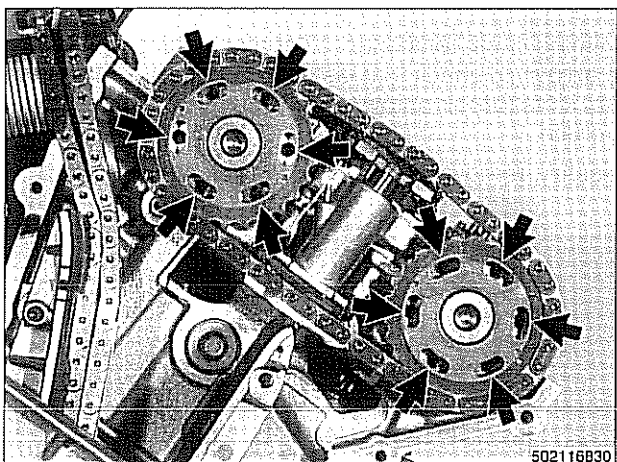
➤ Fit secondary sprockets and chain to camshafts on right cylinder head. Center slots in sprockets to threaded bores in end of camshafts (**arrows**).



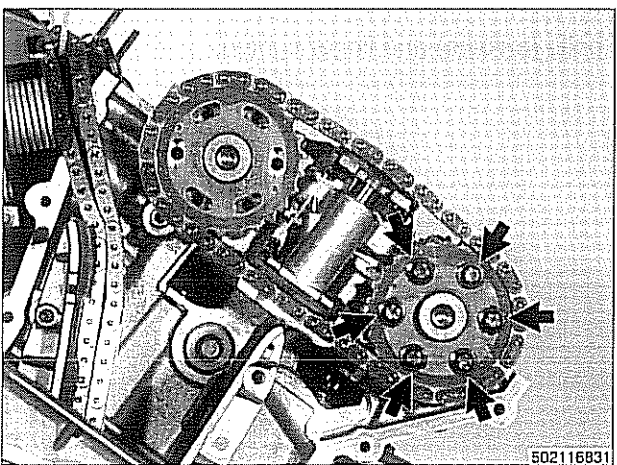
## Cylinder Head and Valvetrain



- Install exhaust camshaft bolts (**arrows**) finger tight.
- Remove secondary timing chain tensioner locking tool.

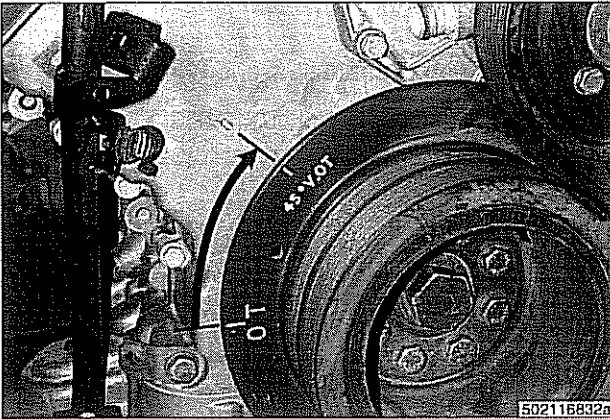


- Fit secondary sprockets and chain to camshafts on left cylinder head. Center slots in sprockets to threaded bores in end of camshafts (**arrows**).

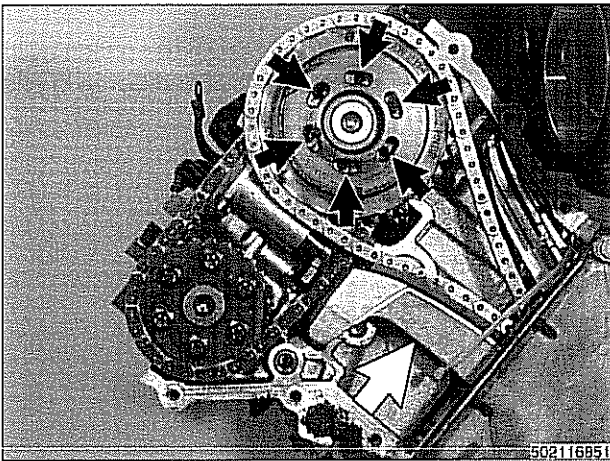


- Insert exhaust camshaft bolts (**arrows**) finger tight in exhaust camshaft on left cylinder head.
- Remove secondary timing chain tensioner locking tools from chain tensioners.

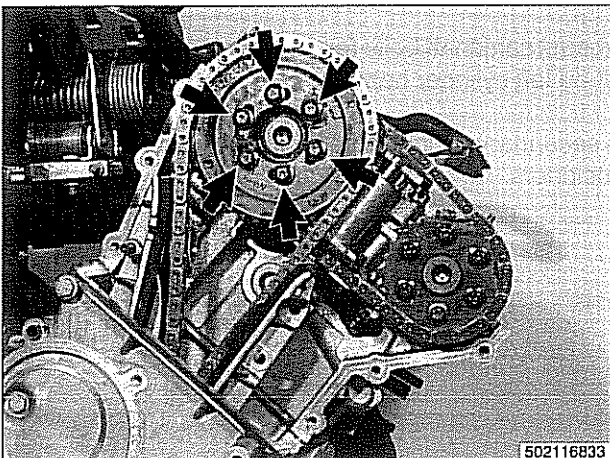
## Cylinder Head and Valvetrain



- Rotate engine clockwise (**arrow**) from 45° before TDC to TDC position.
- Secure crankshaft in TDC position with BMW special tool 11 2 300.

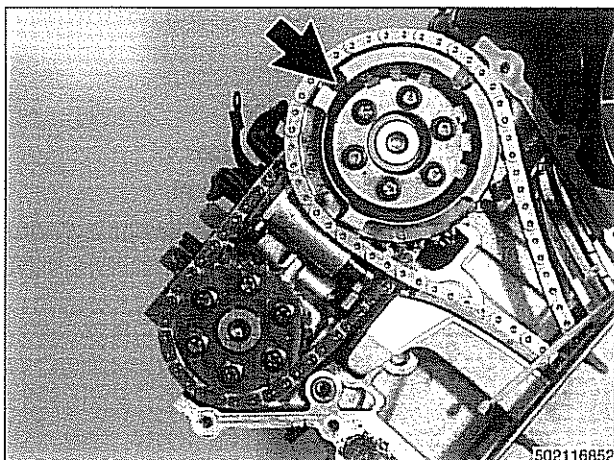


- Fit sprocket with primary chain to intake camshaft on right cylinder head:
  - Press timing chain tensioner rail against timing chain (**white arrow**) to check that fastener holes are centered in sprocket slots (**black arrows**) when slack is removed from timing chain.
  - If necessary, remove sprocket and reposition.

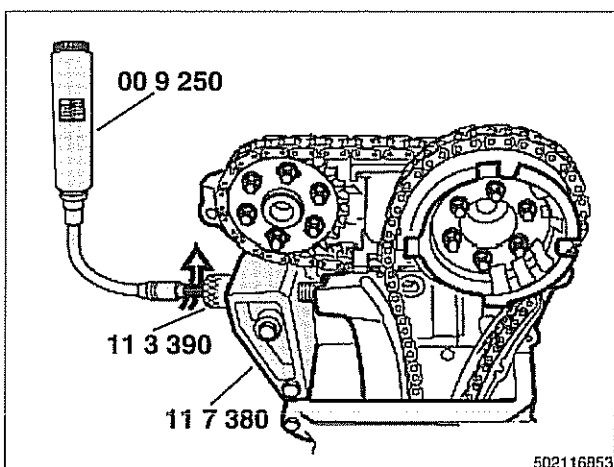


- Fit sprocket with chain to intake camshaft on cylinder head 5–8 with long bores aligned centrally.
  - Install bolts (**arrows**) and finger tighten.

## Cylinder Head and Valvetrain



- Fit sensor gear with mark (arrow) pointing upwards. Install bolts and finger tighten.

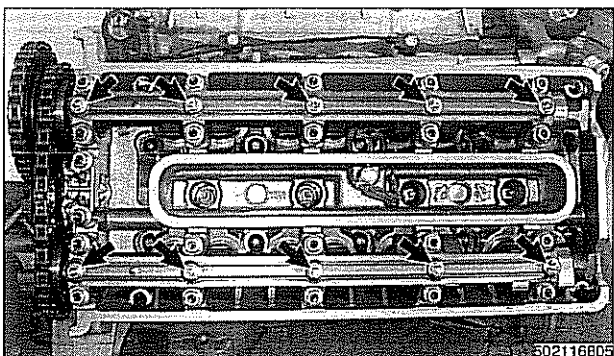


- Attach BMW special tool 11 7 380 to right cylinder head in place of upper timing case cover.
  - Install BMW special tool 11 3 390 into 11 7 380.
  - Using BMW special tool 00 9 250, tighten adjustable tensioner screw on 11 3 390 to 0.7 Nm (6.3 in-lb).
- Tighten camshaft sprocket bolts in the following order:
  1. Exhaust camshaft, left head.
  2. Exhaust camshaft, right head.
  3. Intake camshaft, left head.
  4. Intake camshaft, right head.

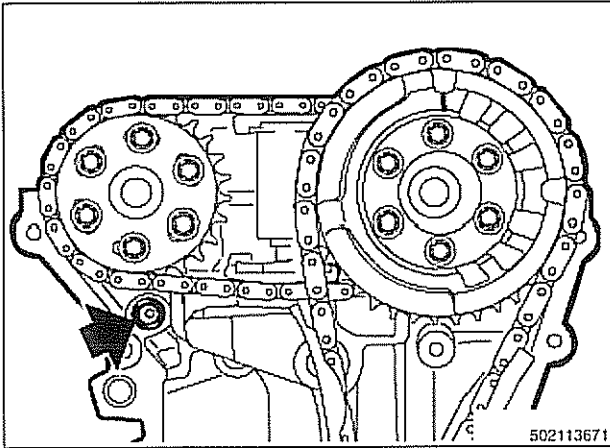
### Tightening torques

Sprocket to camshaft flange	15 Nm (11 ft-lb)
-----------------------------	------------------

- Remove camshaft locking tools from both cylinder heads.
- Remove crankshaft locking tool.
- Install oil lines to left and right cylinder heads.
- Remove adjustable timing chain tensioner tool and setup block from right cylinder head.



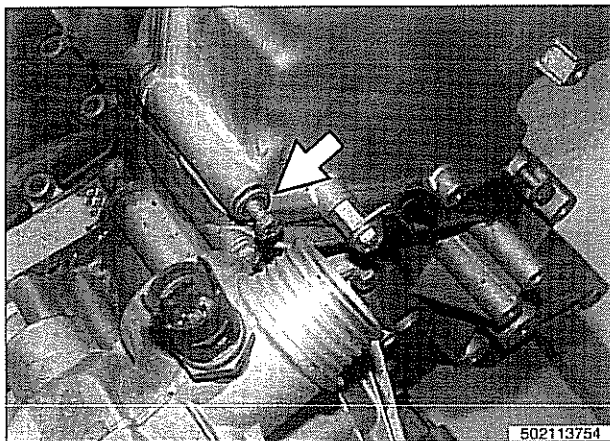
## Cylinder Head and Valvetrain



➤ Replace primary timing chain tensioner O-ring (**arrow**) in right cylinder head.

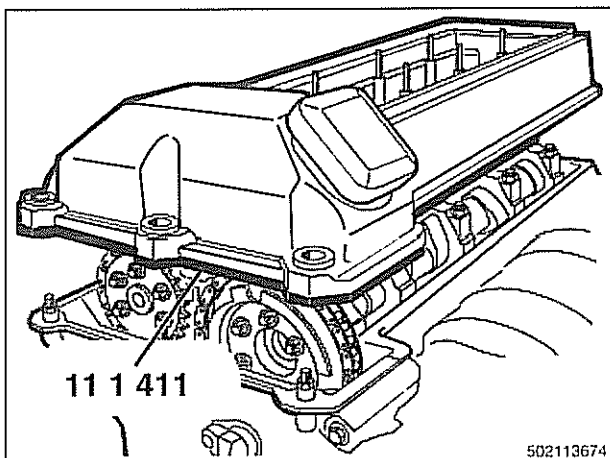
— Install right upper timing cover to engine:

- Remove old gasket from right timing cover.
- Clean gasket groove and install new gasket.
- Apply Three Bond 1209® sealant to joint between cylinder head and timing cover. Install remaining timing cover bolts finger tight.



➤ Install left upper timing chain cover to engine:

- Remove old gasket from right timing chain cover.
- Clean gasket groove and install new gasket.
- Insert lower cover timing chain cover retaining bolt (**arrow**) to cover, then fit cover to cylinder head.
- Apply Three Bond 1209® sealant to joint between cylinder head and timing chain cover. Install upper timing cover bolts finger tight.



➤ Remove cylinder head cover sealing gaskets from right cylinder head cover. Install BMW special tool 11 1 411 into gasket groove of cylinder head cover.

- Install right cylinder head cover with BMW special tool 11 1 411 to right cylinder head. Fit cylinder head cover retaining nuts to cylinder head cover studs at cylinders 1 and 2 (first two cylinders on right cylinder head).
- Tighten nuts uniformly in  $\frac{1}{2}$  turn steps.

### NOTE —

*BMW special tool 11 1 411 presses upper timing chain cover to level of cylinder head.*

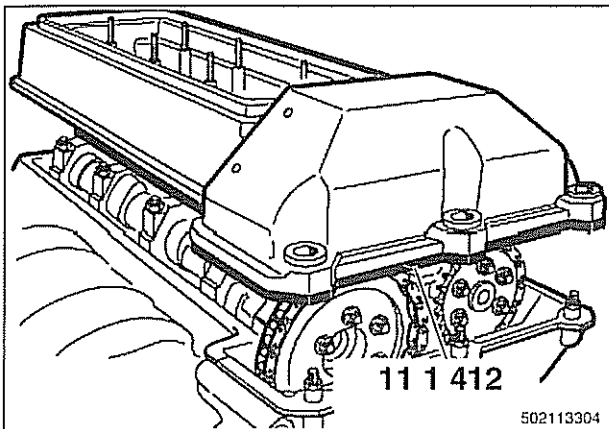
### Tightening torque

Cylinder head cover nuts	10 Nm (7.5 ft-lb)
--------------------------	-------------------

— Tighten right upper timing cover retaining bolts in two passes.

### Tightening torque

Timing chain cover to head	10 Nm (7.5 ft-lb)
----------------------------	-------------------



Remove cylinder head cover sealing gaskets from left cylinder head cover. Install BMW special tool 11 1 412 into gasket groove of cylinder head cover.

- Install left cylinder head cover. Fit cylinder head cover retaining nuts to cylinder head cover studs at cylinders 5 and 6 (first two cylinders on left side cylinder bank).
- Tighten nuts uniformly in  $\frac{1}{2}$  turn steps.

**NOTE —**

BMW special tool 11 1 412 presses upper timing chain cover to level of cylinder head.

**Tightening torque**

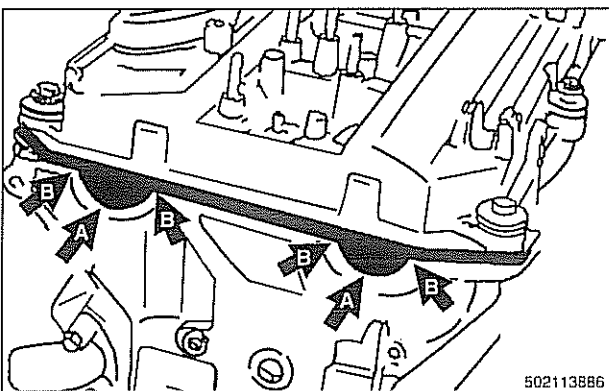
Cylinder head cover nuts	10 Nm (7.5 ft-lb)
--------------------------	-------------------

- Tighten left upper timing chain cover retaining bolts in two passes.

**Tightening torque**

Timing chain cover to head	10 Nm (7.5 ft-lb)
----------------------------	-------------------

- Remove cylinder head covers and remove BMW special tools 11 4 411/412 from cylinder head covers.
- Fit new gasket to cylinder head cover without strain.
- Apply Three Bond® 1209 sealant to joints between cylinder head and timing cover.



Make sure half-moon cutouts (A) at rear of cylinder heads fit correctly to cylinder head sealing surface. Apply Three Bond® 1209 sealant at corners of half-moon cutouts (B).

- Remainder of installation is reverse of removal.

## VALVES

This section covers valve removal and reconditioning, including valve guides, seats, springs, and valve stem oil seals.

### Valves, leak test

To test the valves for leakage, the cylinder head must be disassembled with camshafts and camshaft carriers removed. With valve assemblies and spark plugs installed, place the cylinder head on a workbench with the combustion chamber facing upward. Fill each combustion chamber with a thin non-flammable liquid. After fifteen minutes, check the level of the fluid. If the fluid level in any cylinder drops, that cylinder is not sealing properly.

### Valves, removing and installing

- Remove cylinder head as described in **113 Cylinder Head Removal and Installation**.

**CAUTION—**

- *(M52 TU / M54 engines only) Do not let the hydraulic lifters fall out as the camshaft carrier is removed. Special suction cups are available from BMW to hold the hydraulic lifters in place during carrier removal.*
- *Hydraulic cam lifters should be stored in an upright position. If necessary, use a magnetic tool to aid in removal of the lifters.*

- Remove valves using a valve spring compressor.

**CAUTION—**

*Label each valve assembly as it is removed so it can be installed in its original position.*

- Remove and discard valve stem oil seals from valve guides. See **Valve stem oil seals** later in this section.
- Valve installation is reverse of removal. Remove carbon deposits from the valves using a wire brush or wire wheel.

Valve specifications are listed in **Table c. Valve specifications**.

Table c. Valve specifications

Specification	M52 engine (1997-1998)	M52 TU 2.8 engines (1999 - 2000), M54 2.5/3.0 engines (2001-2002)	M62, M62 TU engines (1997-2002)
Valve head diameter			
Intake	33.0 mm	33.0 mm	35.0 mm
Exhaust	30.5 mm	30.5 mm	30.5 mm
Valve stem diameter - Standard			
Intake	6.0 mm <sup>-0.025</sup> <sub>-0.040</sub>	6.0 mm <sup>-0.025</sup> <sub>-0.040</sub>	6.0 mm <sup>-0.025</sup> <sub>-0.040</sub>
Exhaust	6.0 mm <sup>-0.040</sup> <sub>-0.055</sub>	6.0 mm <sup>-0.040</sup> <sub>-0.055</sub>	6.0 mm <sup>-0.040</sup> <sub>-0.055</sub>
Valve stem diameter - Oversize 1 (identified on stem as R1)			
Intake	6.1 mm <sup>-0.025</sup> <sub>-0.040</sub>	6.1 mm <sup>-0.025</sup> <sub>-0.040</sub>	6.1 mm <sup>-0.025</sup> <sub>-0.040</sub>
Exhaust	6.1 mm <sup>-0.040</sup> <sub>-0.055</sub>	6.1 mm <sup>-0.040</sup> <sub>-0.055</sub>	6.1 mm <sup>-0.040</sup> <sub>-0.055</sub>
Valve stem diameter - Oversize 2 (identified on stem as R2)			
Intake	6.2 mm <sup>-0.025</sup> <sub>-0.040</sub>	6.2 mm <sup>-0.025</sup> <sub>-0.040</sub>	6.2 mm <sup>-0.025</sup> <sub>-0.040</sub>
Exhaust	6.2 mm <sup>-0.040</sup> <sub>-0.055</sub>	6.2 mm <sup>-0.040</sup> <sub>-0.055</sub>	6.2 mm <sup>-0.040</sup> <sub>-0.055</sub>

## Valve guides

BMW does not supply valve guides as replacement parts. If a valve guide is excessively worn, it should be reamed to accept oversized valve stems. Valve guide specifications are listed in **Table d. Valve guide specifications**.

- Valve guides should be checked 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.

### NOTE —

- *International Organization for Standardization (ISO) tolerance classes are listed in Table c. ISO allowances are based on nominal sizes and should be used to determine proper fit. Most machine shops should have this information available.*
- *Replacement valve guides may be available through after-market suppliers. Valve guide replacement requires special tools and a press. It is also necessary to heat the cylinder head and chill the valve guides when replacing the guides.*
- *BMW supplies oversize valves. See Table d. Valve guide specifications for additional information.*

Table d. Valve guide specifications

Specifications	All engines (1997-2002)
Valve guide wear, maximum (valve tilt clearance measured with new valve)	0.5 mm (0.020 in)
Valve guide inside diameter, installed (tolerance per ISO allowance H7)	
Standard	6.0 mm (0.236 in)
Oversize 1	6.1 mm (0.240 in)
Oversize 2	6.2 mm (0.244 in)

### 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—**

*Valve stem oil seals should not be reused. If valves are removed, new valve stem oil seals should be installed.*

Valve stem oil seal replacement requires that the cylinder head be disassembled and the valves removed as described above under **Valves, removing and installing**.

**NOTE—**

*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.*

Lubricate new seal and install using hand pressure only. Be sure to install valve spring seat(s) before installing seal.



## Valve seats

➤ The valve seats should be resurfaced whenever new valves or valve guides are installed. Cutters are required to resurface the seats. Always check the valves for leaks after reconditioning a valve seat as described above. **Table e. Valve seat specifications** lists valve seat dimensions.

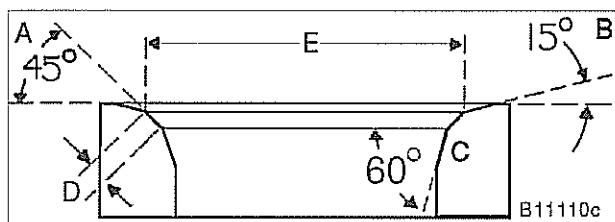


Table e. Valve seat specifications (refer to figure)

Specification	All 6 cylinder engines (1997-2002)	All 8 cylinder engines (1997-2002)
A - Valve seat angle	45°	45°
B - Correction angle, outside	15°	15°
C - Correction angle, inside	60°	60°
D - Valve seat width		
intake	1.65 ± 0.25 mm (0.065 ± 0.010 in)	1.25 ± 0.25 mm (0.049 ± 0.010 in)
exhaust	1.65 ± 0.25 mm (0.065 ± 0.010 in)	1.65 ± 0.35 mm (0.065 ± 0.014 in)
E - Valve seat outside diameter		
intake	32.4 mm (1.276 in)	34.5 mm (1.358 in)
exhaust	<ul style="list-style-type: none"> <li>• M52: 29.4 mm (1.157 in)</li> <li>• M52 TU, M54: 30.0 mm (1.181 in)</li> </ul>	30.0 mm (1.181 in)

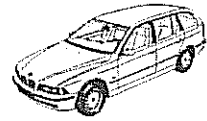
### NOTE —

Standard size replacement valve seats are not available from BMW. Replacement valve seats are only available from BMW in 0.4 mm oversize (oversized in both height and diameter). The manufacturer does not provide specifications for valve seat replacement for the engines covered by this manual.

## Valve springs

The valve springs should be checked for fatigue. To quickly check the springs, line them up in a row. Place a straight edge across the top of the springs. Any spring that is significantly shorter than the others is worn and should be replaced.

Valve spring specifications and wear limits are not available from BMW.



# 117 Camshaft Timing Chain

<b>General</b> .....	117-2	<b>Double VANOS System</b>	
Special tools .....	117-2	<b>(M52 TU and M54 engines)</b> .....	117-34
<b>Crankshaft Oil Seal, Front</b> .....	117-6	Double VANOS system function .....	117-34
Crankshaft oil seal, front, replacing (M52 engine) .....	117-6	Double VANOS control unit .....	117-36
Crankshaft oil seal, replacing (M52 TU and M54 engines) .....	117-9	VANOS control unit, removing (M52 TU and M54 engines) .....	117-37
Crankshaft oil seal, replacing (M62 and M62 TU engines) .....	117-11	VANOS control unit, installing (M52 TU and M54 engines) .....	117-41
<b>VANOS Control Unit and Timing Chain (M52 engine)</b> .....	117-14	VANOS timing, checking and adjusting (M52 TU and M54 engines) .....	117-43
VANOS control unit, removing (M52 engine) .....	117-14	Timing chains assembly (M52 TU and M54 engines) .....	117-50
VANOS control unit, installing (M52 engine) .....	117-19	Timing chains, removing (M52 TU and M54 engines) .....	117-51
VANOS timing, checking and adjusting (M52 engine) .....	117-22	Timing chains, installing (M52 TU and M54 engines) .....	117-57
Timing chains, removing (M52 engine) ...	117-26	<b>Timing Chain (M62 engine to 9/98)</b> ..	117-66
Timing chain, installing (M52 engine) .....	117-30	Timing chains, removing (M62 engine to 9/98) .....	117-66
		Timing chains, installing (M62 engine to 9/98) .....	117-74
		Camshaft timing, checking and adjusting (M62 engine) .....	117-79

## GENERAL

This repair group covers timing chain and VANOS repair information for the following engines:

- M52 (Single VANOS 6-cylinder engine)
- M52 TU and M54 (Double VANOS engines)
- M62 (Non VANOS V-8 engine)

**NOTE** —

*The M62 TU V-8 engine with VANOS Variable Camshaft Timing repair information is not included.*

**NOTE** —

*See 100 Engine General for engine code and application information.*

Worn timing chains and sprockets can lead to noisy operation and erratic valve timing. A faulty tensioner can also cause timing chain noises.

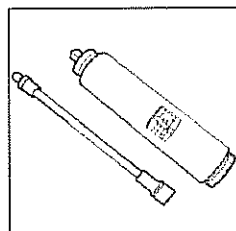
For specific repair procedures, refer to the appropriate repair group:

- 020 Maintenance
- 113 Cylinder Head Removal and Installation
- 119 Lubrication System
- 121 Ignition System
- 170 Radiator and Cooling System

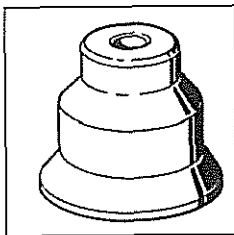
## Special tools

Special BMW service tools are needed to perform the service and repairs procedures covered in this repair group. Many of these tools are expensive and only available through an authorized BMW dealer. Be sure to read each procedure thoroughly before starting a job to determine which special tools will be necessary.

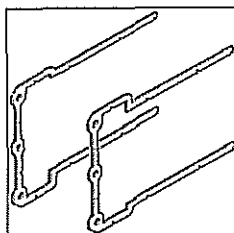
In addition, Double VANOS system diagnosis can only be carried out by using BMW specific electronic scan tools, such as BMW DISplus, MoDiC or equivalent.



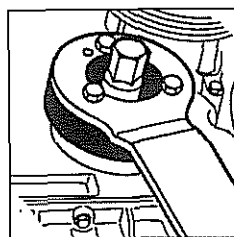
- ▲ Torque wrench w/ flex extension  
(Tool No. BMW 00 9 250)



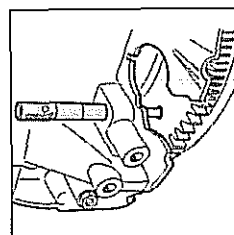
- ◀ Crankshaft seal installation bushing, V-8  
(Tool No. BMW 11 1 220)



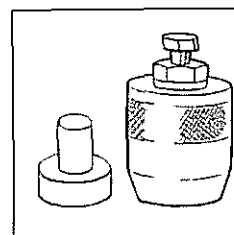
- ◀ Upper timing cover installation tool, V-8  
(Tool No. BMW 11 1 411/412)



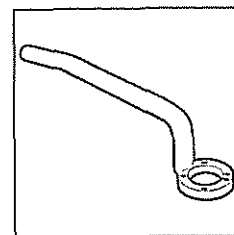
- ◀ Crankshaft hub locking tools (6-cylinder engine with 2 piece vibration dampener) (Tool No. BMW 11 2 150 /11 2 410)



- ◀ Crankshaft locking tool  
(Tool No. BMW 11 2 300)

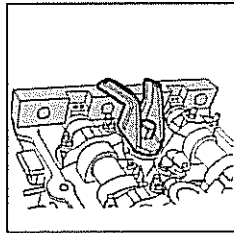


- ◀ Seal extractor tool set  
(Tool No. BMW 11 2 380)

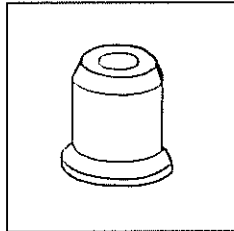


- ◀ Crankshaft holding tool (V-8 engines)  
(Tool No. BMW 11 2 450)

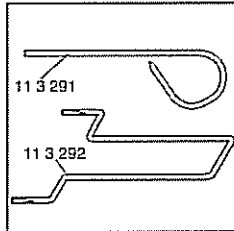
**Camshaft Timing Chain**



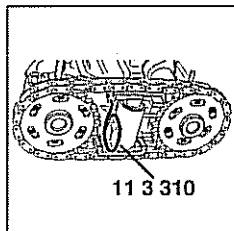
◀ Camshaft locking tool set, 6-cylinder  
(Tool No. BMW 11 3 240)



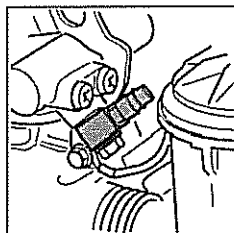
◀ Crankshaft seal installation bushing, 6-cylinder  
(Tool No. BMW 11 3 280)



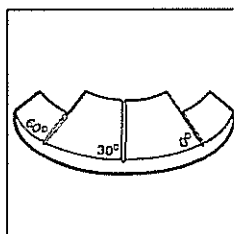
◀ Secondary chain tensioner locking pin set, 6-cylinder  
(Tool No. BMW 11 3 290)



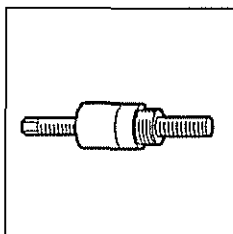
◀ Secondary chain tensioner locking pin, V-8  
(Tool No. BMW 11 3 310)



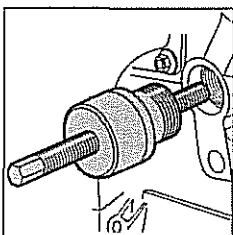
◀ Air line fitting  
(Tool No. BMW 11 3 450)



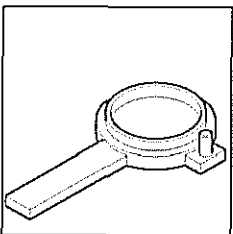
◀ Protractor  
(Tool No. BMW 11 3 460)



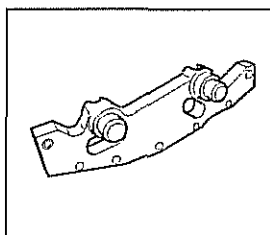
- ▶ Primary chain tensioner tool, V-8  
(Tool No. BMW 11 3 390)



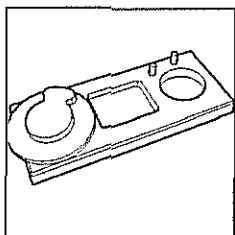
- ▶ Primary chain tensioner tool, 6-cylinder  
(Tool No. BMW 11 4 220)



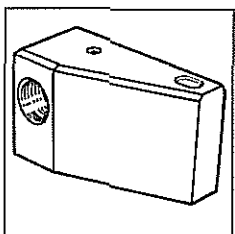
- ▶ VANOS sprocket wrench  
(Tool No. BMW 11 5 490)



- ▶ Double VANOS setup bracket, M52 TU/M54 6-cylinder  
(Tool No. BMW 11 6 150)

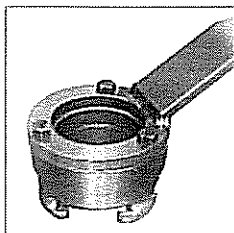


- ▶ Double VANOS sprocket setup tool, M52 TU/M54 6-cylinder  
(Tool No. BMW 11 6 180)

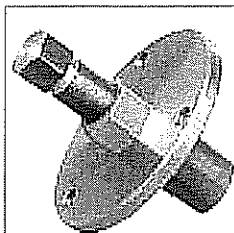


- ▶ Tensioner bracket, V-8  
(Tool No. 11 7 380)

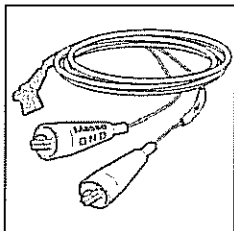
## Camshaft Timing Chain



- ▶ Crankshaft hub locking tool, M54 engine  
(Tool No. BMW 11 8 190 /11 8 200)



- ▶ Puller for crankshaft hub  
(Tool No. BMW 11 8 219)



- ▶ VANOS test lead, M52 6-cylinder  
(Tool No. BMW 12 6 410)

## CRANKSHAFT OIL SEAL, FRONT

### Crankshaft oil seal, front, replacing (M52 engine)

The crankshaft front seal is located in the lower timing cover, behind the vibration damper.

- Disconnect negative (-) cable from battery.

#### **CAUTION—**

- *Disconnecting the battery may erase fault code(s) stored in control module memory. Check for fault codes using special BMW diagnostic equipment.*
- *Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.*

- Remove splash guard from beneath engine.
- Remove engine cooling fan assembly. See **170 Radiator and Cooling System**.

#### **NOTE—**

*Cooling fan nut (32 mm wrench) has left-hand threads.*

- Remove drive belts. See **020 Maintenance**.



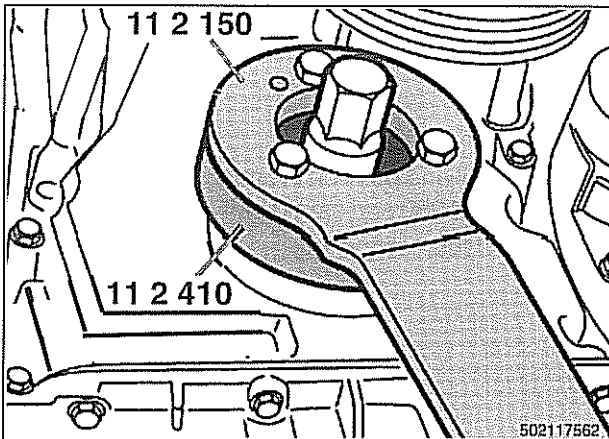
**NOTE—**

Mark direction of belt rotation if reusing belt.

- Remove vibration damper mounting bolts and remove vibration damper and pulley from hub.

**NOTE—**

The M52 6-cylinder engine uses a 2-piece vibration damper and hub assembly.



- Install crankshaft holder (BMW special tools 11 2 150 and 11 2 410).

**NOTE—**

Be careful while aligning locator pin hole in special tool 11 2 410 with vibration damper locator pin.

- While counterholding crankshaft, loosen and remove crankshaft center bolt.

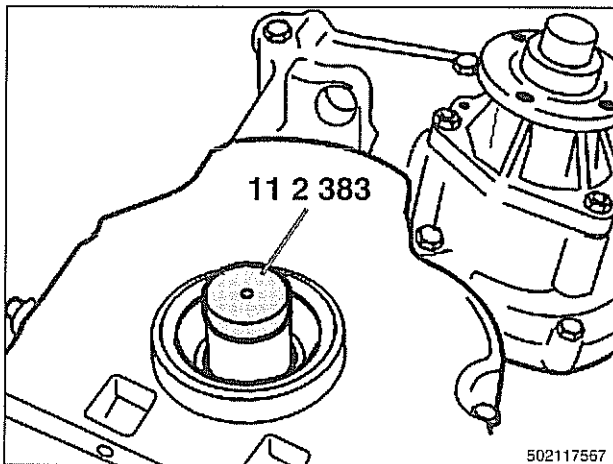
**CAUTION—**

Do not use flywheel locking tool to hold crankshaft stationary to loosen or tighten crankshaft hub center bolt. Use only the special tools specified, or equivalent hub holding tool.

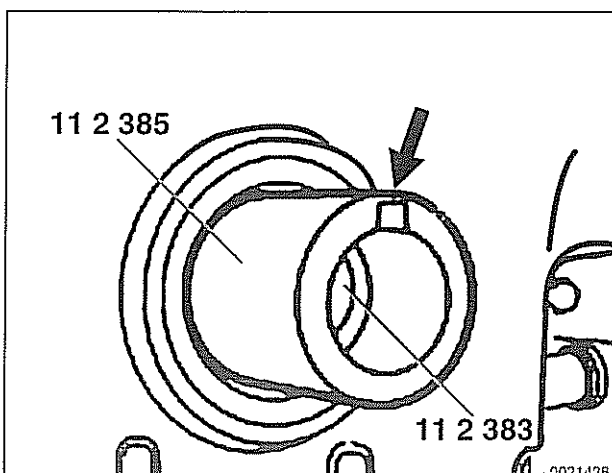
**NOTE—**

The crankshaft hub center bolt is torqued to 410 Nm (300 ft-lb).

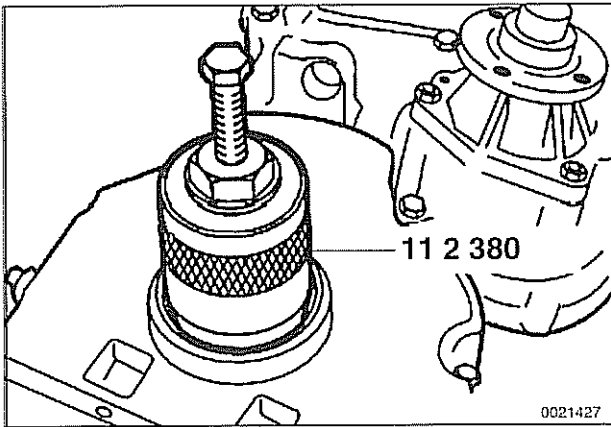
- Remove damper hub and special tools.
- Install cap (BMW special tool 11 2 383) on end of crankshaft.



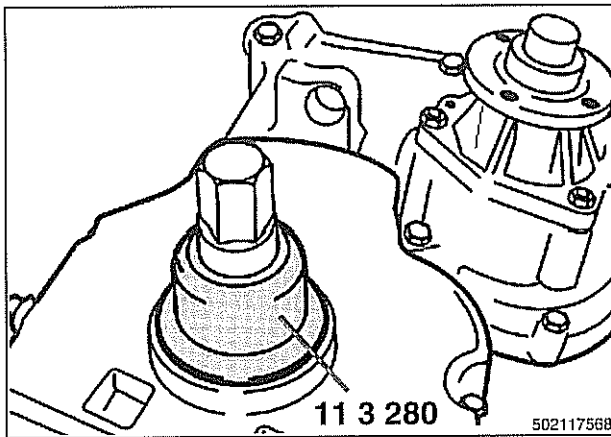
- Install seal guide (BMW special tool 11 2 385) over end of crankshaft. Be sure to align tool with keyway on crankshaft (arrow).



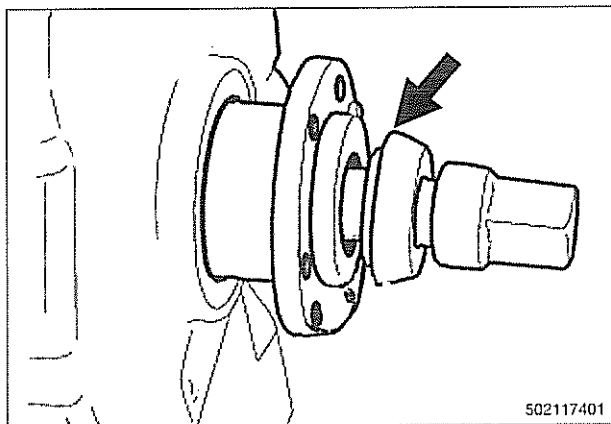
## Camshaft Timing Chain



- Install oil seal puller (BMW special tool 11 2 380) and screw in body of puller until it contacts seal. Tighten center screw to draw seal out of cover.



- Coat new seal with oil and position in timing chain cover. Use BMW special tool 11 3 280 and crankshaft center bolt to draw seal in flush with timing case cover.



- Align hub with keyway and tap into place. Insert **new** center bolt with washer shoulder (**arrow**) facing hub.

**CAUTION—**

*Inspect woodruff key for damage before installing hub.*

- Reinstall crankshaft holder tool.

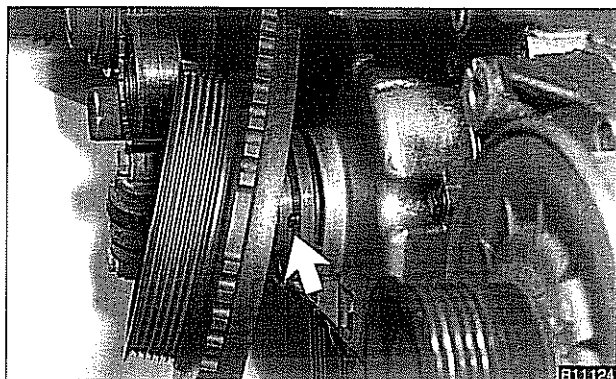
**NOTE—**

*Be careful while aligning locator pin hole in special tool 11 2 410 with vibration damper locator pin.*

- While counterholding crankshaft, tighten crankshaft center bolt.

**Tightening torque**

Vibration damper hub to crankshaft	410 Nm (302 ft-lb)
------------------------------------	--------------------



- ▲ Install vibration damper mounting bolts. Note hub locating dowel (**arrow**).

#### Tightening torque

Vibration damper to crankshaft hub (M8)	22 Nm (16 ft-lb)
---	------------------

- Installation is reverse of removal noting the following:
  - Installing drive belts. See **020 Maintenance**.
  - Install cooling fan. See **170 Radiator and Cooling System**.

### Crankshaft oil seal, replacing (M52 TU and M54 engines)

The crankshaft front seal is located in the lower timing cover, behind the vibration damper.

- Disconnect negative (-) cable from battery.

#### **CAUTION—**

- *Disconnecting the battery may erase fault code(s) stored in control module memory. Check for fault codes using special BMW diagnostic equipment.*
- *Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.*

- Remove splash guard from beneath engine.
- Remove engine cooling fan assembly. See **170 Radiator and Cooling System**.

#### **NOTE—**

*Cooling fan nut (32 mm wrench) has left-hand threads.*

- Remove drive belts. See **020 Maintenance**.

#### **NOTE—**

*Mark direction of belt rotation if reusing belt.*

- Install crankshaft holding tool (BMW special tool 11 8 190/11 8 200). Make sure tool locks into place in openings in damper assembly. While counterholding crankshaft with special tool, remove crankshaft center bolt.

#### **CAUTION—**

- *Do not use flywheel locking tool to hold crankshaft stationary to loosen or tighten crankshaft hub center bolt. Use only the special tools specified, or equivalent hub holding tool.*
- *Use care when removing damper/hub assembly, as it is easy to damage the radiator.*

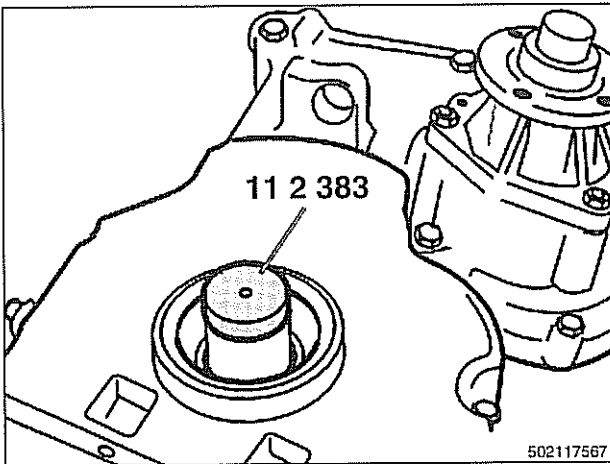
**NOTE—**

The crankshaft hub center bolt is torqued to 410 Nm (300 ft-lb).

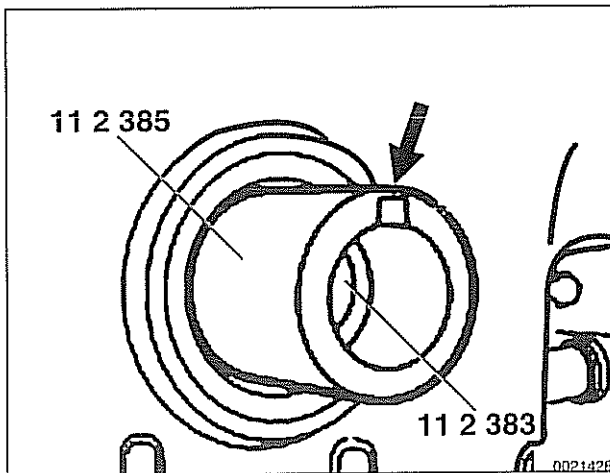
- Install crankshaft damper puller (BMW special tool 11 8 210) to 11 8 200. Use bolt to remove damper from crankshaft.

- **Oil seal replacement:**

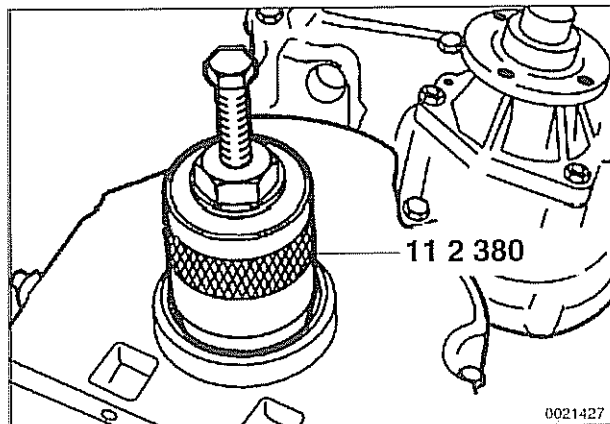
- ◀ Install cap (BMW special tool 11 2 383) on end of crankshaft.

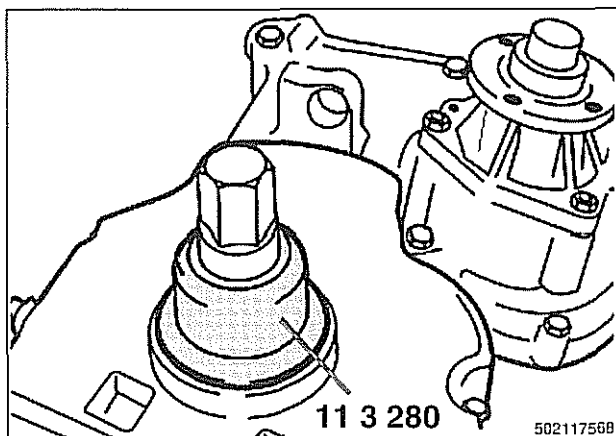


- ◀ Install seal guide (BMW special tool 11 2 385) over end of crankshaft. Be sure to align groove with keyway on crankshaft (arrow).



- ◀ Install oil seal puller (BMW special tool 11 2 380) and screw in body of puller until it contacts seal. Tighten screw in center of tool to draw seal out of cover.





- ▲ Coat new seal with oil and position in timing chain cover. Use BMW special tool 11 3 280 and crankshaft center bolt to draw seal in flush with timing case cover.

- Align vibration damper assembly with keyway and tap into place. Insert new center bolt with washer.

**CAUTION—**

*Inspect woodruff key for damage before installing hub assembly.*

- Install crankshaft holding tool making sure tool locks into place in openings in damper assembly. While counterholding crankshaft, tighten crankshaft center bolt.
- Attach special tools 11 8 200/11 8 190 to damper assembly. Counterhold damper with 11 8 190 while tightening center bolt.

**Tightening torque**

Vibration damper hub to crankshaft	410 Nm (302 ft-lb)
------------------------------------	--------------------

- Installation is reverse of removal noting the following:
  - Install drive belts. See **020 Maintenance**.
  - Install cooling fan. See **170 Radiator and Cooling System**.

### Crankshaft oil seal, replacing (M62 and M62 TU engines)

- Disconnect negative (-) cable from battery.

**CAUTION—**

- *Disconnecting the battery may erase fault code(s) stored in control module memory. Check for fault codes using special BMW diagnostic equipment.*
- *Prior to disconnecting the battery, read the battery disconnection cautions in **001 General cautions and warnings**.*

- Remove splash guard from beneath engine.
- Remove engine cooling fan assembly. See **170 Radiator and Cooling System**.

**NOTE—**

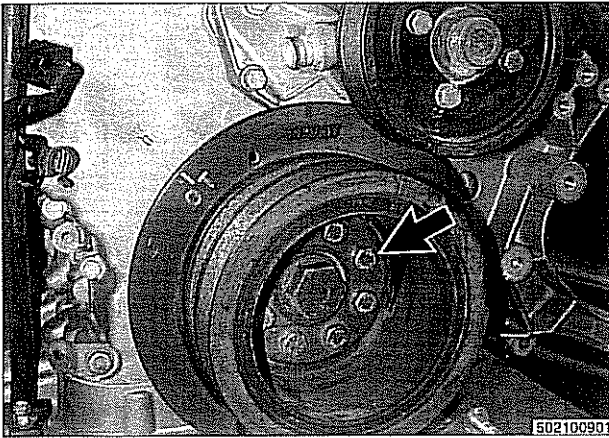
*Cooling fan nut (32 mm wrench) has left-hand threads.*

- Remove drive belts. See **020 Maintenance**.

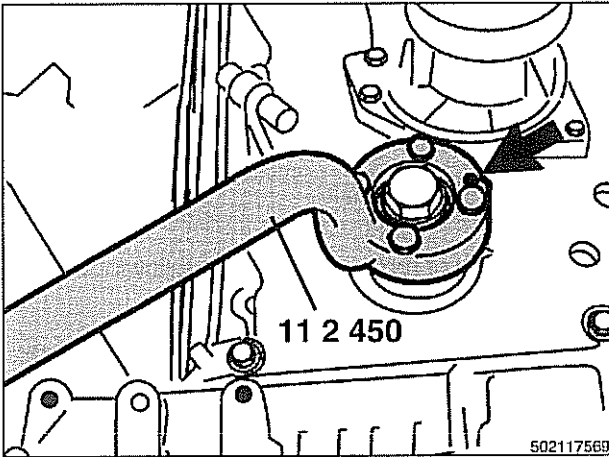
**NOTE—**

*Mark direction of belt rotation if reusing belt.*

## Camshaft Timing Chain



- Remove all vibration damper perimeter mounting bolts (arrow) and remove vibration damper.

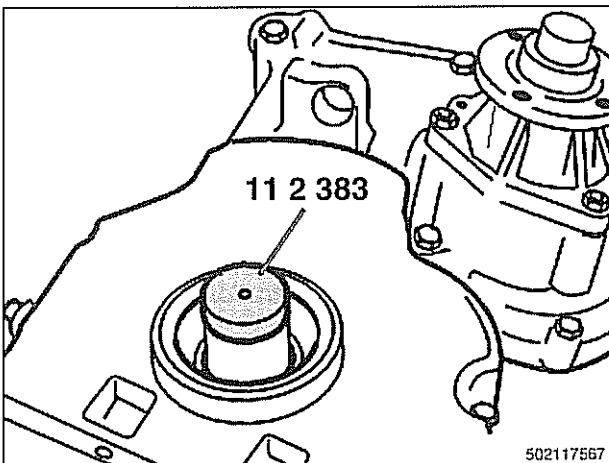


- Install crankshaft holding tool (BMW special tool 11 2 450) and remove and discard crankshaft center bolt.

**NOTE—**

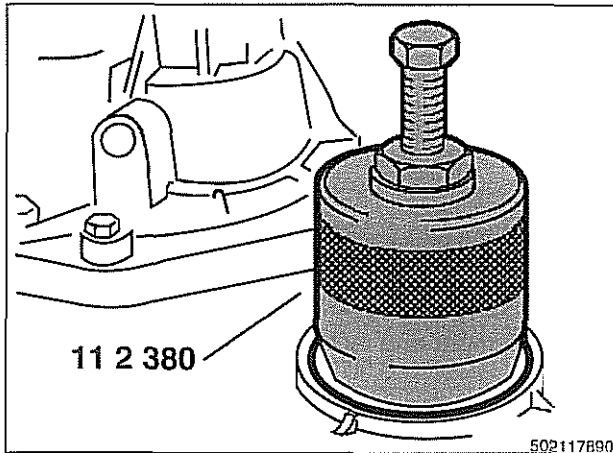
*Be careful to align hub locator pin to hole (arrow) in special tool 11 2 450.*

- If needed, use a puller (BMW 11 8 219) to remove hub from end of crankshaft.

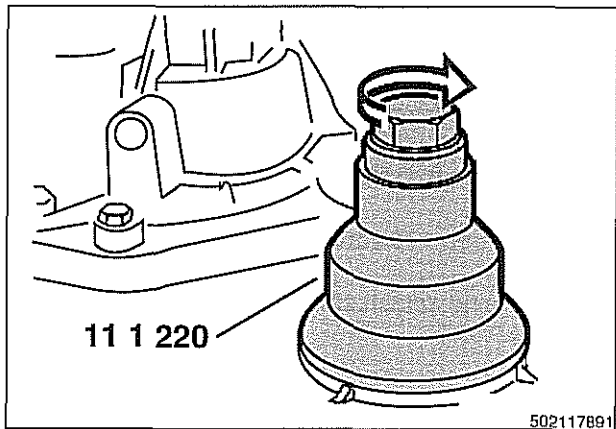


- Install end cap (BMW special tool 11 2 383) on end of crankshaft.

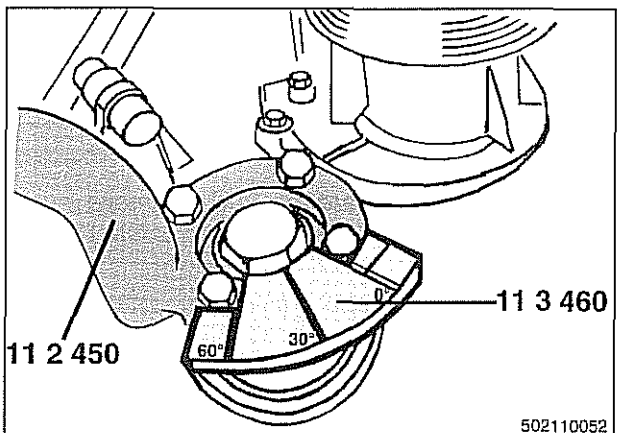
## Camshaft Timing Chain



- ◀ Install seal removing tool (BMW special tool 11 2 380) and screw in body of puller until it makes firm contact with seal. Tighten center screw in end of tool to draw out seal.

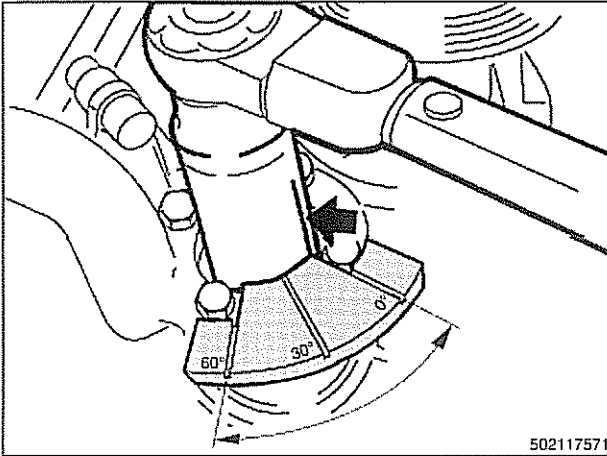


- ◀ Coat new seal with oil, and use BMW special tool 11 1 220 and crankshaft center bolt to draw seal in flush with timing case cover.
- Install damper hub and tighten new center bolt finger tight.



- ◀ Install angle gauge BMW special tool 11 3 460 as shown.

## Camshaft Timing Chain



- Mark 0° location on socket (arrow). Tighten hub bolt in four stages.

### Tightening torque

Vibration damper hub to crankshaft	
Stage 1	100 Nm (74 ft-lb)
Stage 2	60° Torque angle
Stage 3	60° Torque angle
Stage 4	30° Torque angle

- Install vibration damper and mounting bolts.

### NOTE—

*Make sure to align vibration damper with locating dowel pin in hub.*

### Tightening torque

Vibration damper to crankshaft hub (M8)	22 Nm (16 ft-lb)
---	------------------

- Install drive belts. See **020 Maintenance**.
- Install cooling fan. See **170 Radiator and Cooling System**.
- Replace under engine splash shield, then reconnect negative battery cable.

## VANOS CONTROL UNIT AND TIMING CHAIN (M52 ENGINE)

### VANOS control unit, removing (M52 engine)

### NOTE—

- *Special BMW service tools are required to remove and install the VANOS control unit. Read the procedure through before starting the job.*
- *If the camshafts are not properly timed, the pistons can contact the valves.*

- Disconnect negative (-) cable from battery.

### CAUTION—

- *Disconnecting the battery may erase fault code(s) stored in control module memory. Prior to disconnecting the battery, check for fault codes using special BMW diagnostic equipment.*
- *Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.*

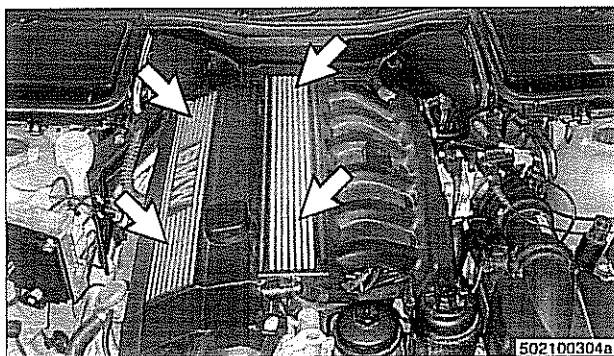


- Remove viscous clutch cooling fan. See 170 Radiator and Cooling System.

**CAUTION—**

*The radiator cooling fan nut (32mm wrench) has left—hand threads.*

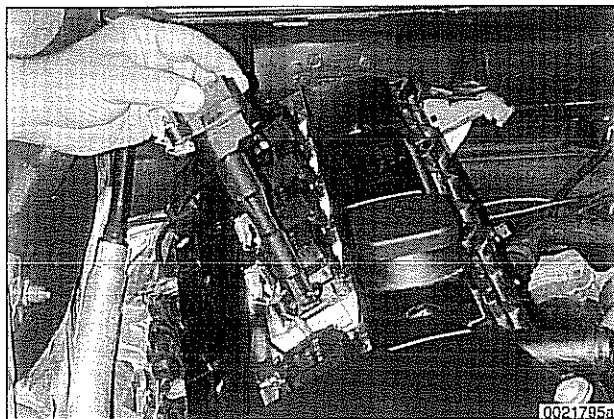
- ◀ Remove engine trim covers:
  - Pry out plastic trim caps (arrows).
  - Remove cover fasteners and covers.



- ◀ Remove ignition coils:
  - Disconnect ignition coil electrical harness connectors.
  - Remove coil mounting fasteners and remove coils.
  - Remove spark plugs.

**NOTE—**

*Make note of ignition coil ground strap locations.*



- ◀ Disconnect VANOS electrical harness connector (A) and oil line fitting (B) from VANOS control unit.

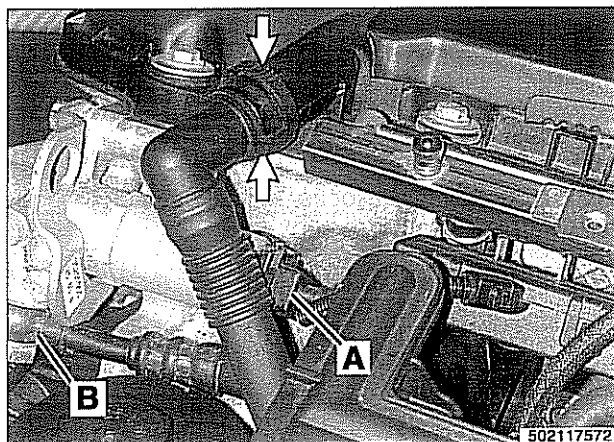
**NOTE—**

*Wrap the VANOS oil line fitting with a shop rag to absorb leaking oil.*

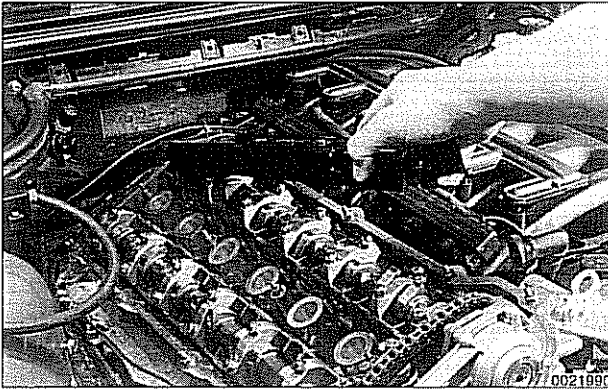
- Disconnect crankcase breather by squeezing at arrows.
- Remove cylinder cover mounting fasteners and remove cylinder head cover.

**NOTE—**

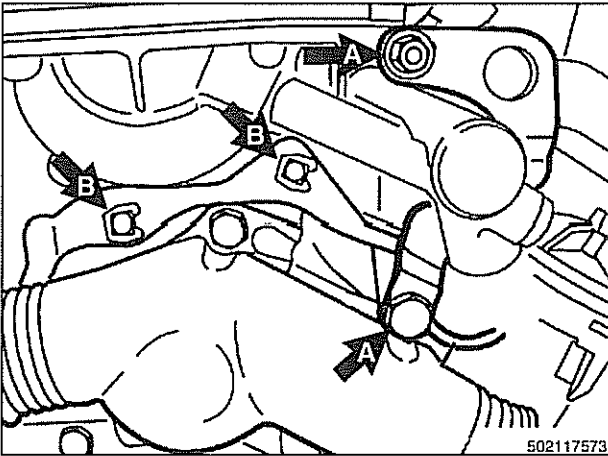
*The cylinder head cover mounting bolt insulators and gaskets should be reinstalled in their original positions. Make note of their arrangement during removal.*



**Camshaft Timing Chain**

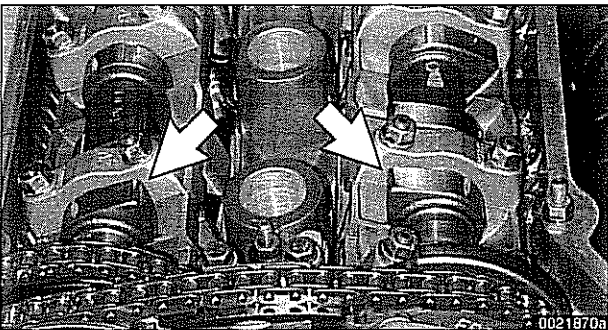


➤ Remove oil baffle cover from intake camshaft.

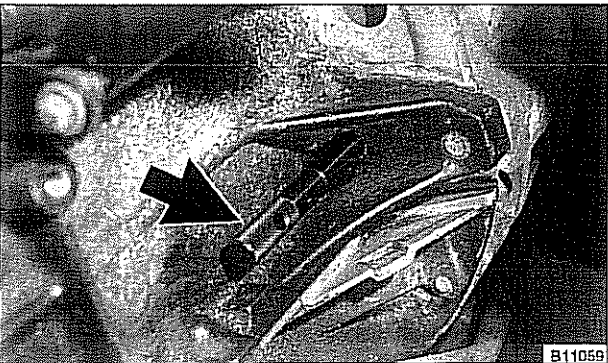


➤ Remove front engine lifting bracket fasteners (arrows A) and remove bracket.

– Remove cable duct clips (arrows B) from front of VANOS control unit.

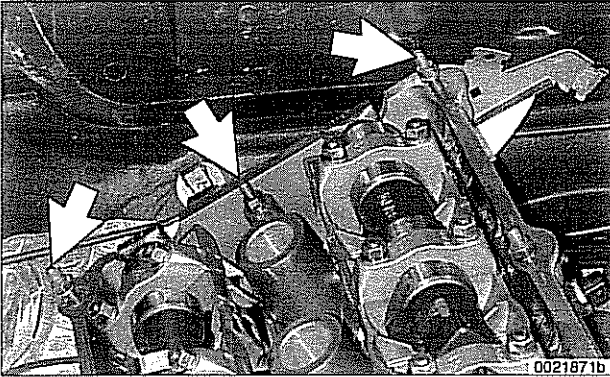


➤ Rotate engine clockwise and set camshafts to Top Dead Center (TDC). Cylinder 1 camshaft lobes will point towards each other (arrows).

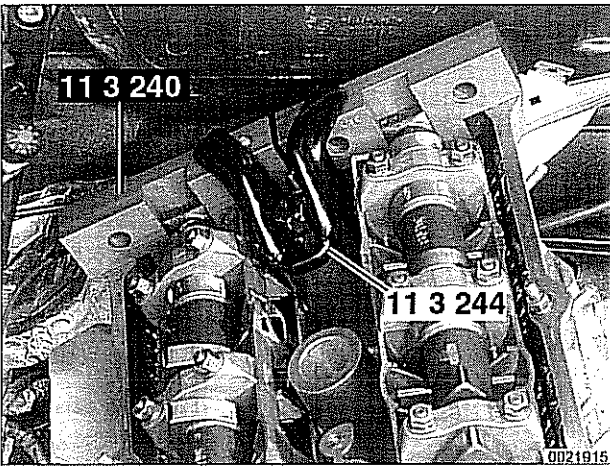


➤ Remove plug from below starter and install crankshaft locking tool (BMW special tool 11 2 300).

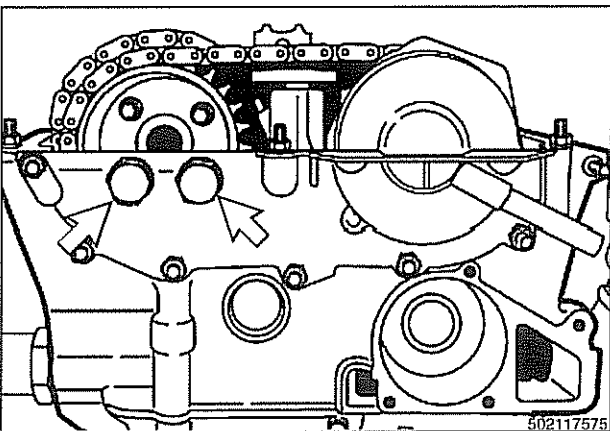
## Camshaft Timing Chain



- Unscrew and remove cylinder head cover studs (arrows) at rear of cylinder head.

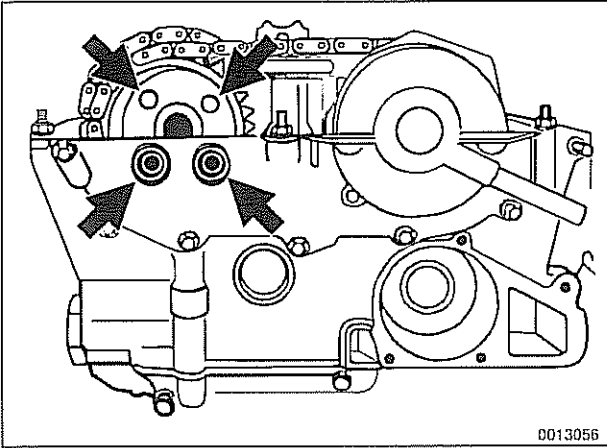


- Secure camshafts in TDC position using BMW special tool set 11 3 240.

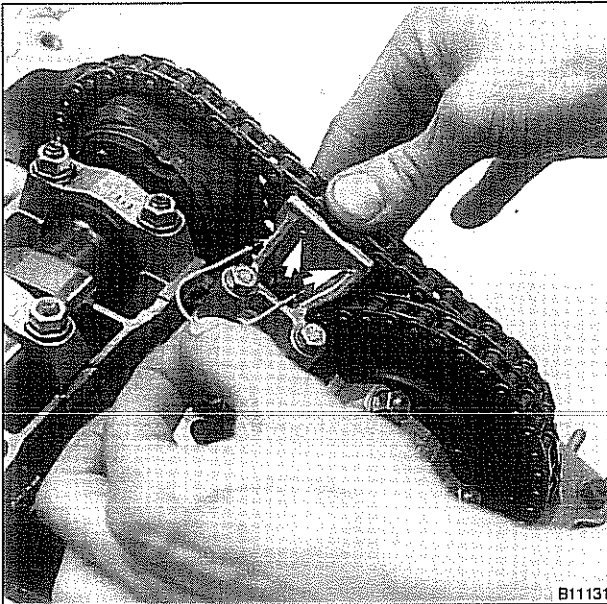


- Remove access plugs (arrows) from VANOS control unit.

## Camshaft Timing Chain



- ◀ Loosen 4 bolts (arrows) from exhaust camshaft sprocket (Torx E10).

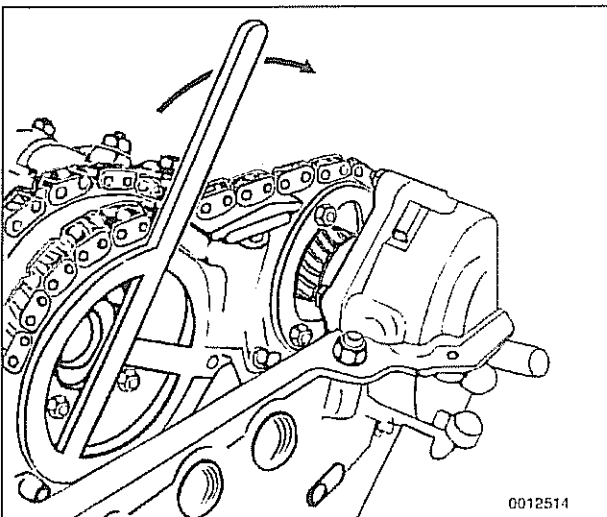


- ◀ Press down on secondary chain tensioner and lock into place using BMW special tool 11 3 292 or a similar size pin.

**NOTE —**

*Two types of secondary timing chain tensioners are used; one with two holes, and one with a single hole for the locking pin tool.*

- Remove VANOS control unit mounting fasteners at front of cylinder head.



- ◀ Install sprocket rotating tool (BMW special tool 11 5 490) on exhaust camshaft.
- Rotate exhaust camshaft sprocket clockwise while sliding VANOS control unit forward to remove from cylinder head.

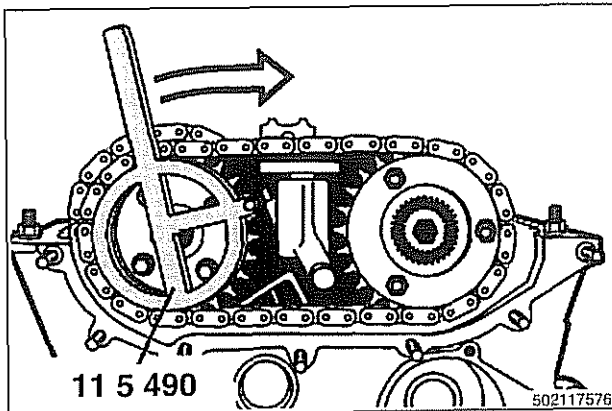
## VANOS control unit, installing (M52 engine)

**CAUTION—**

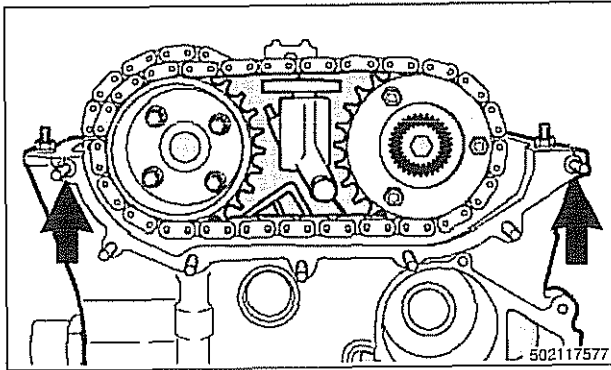
*Incorrect installation of the VANOS control unit may result in damage to the engine.*

- Make sure camshafts and crankshaft are locked in TDC position with BMW special tools as described during VANOS removal.

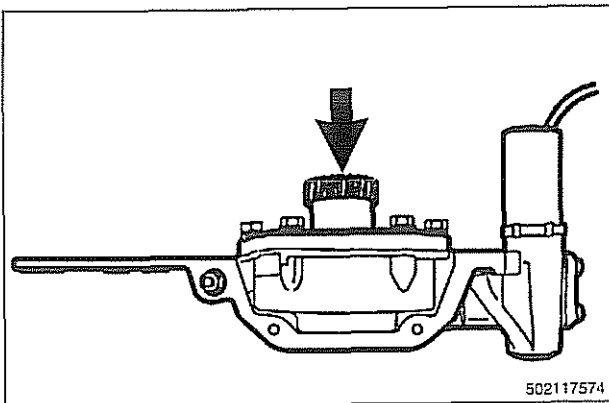
- Rotate exhaust camshaft sprocket clockwise (as viewed from front of engine) using BMW special tool 11 5 490, until detent position stop is reached.



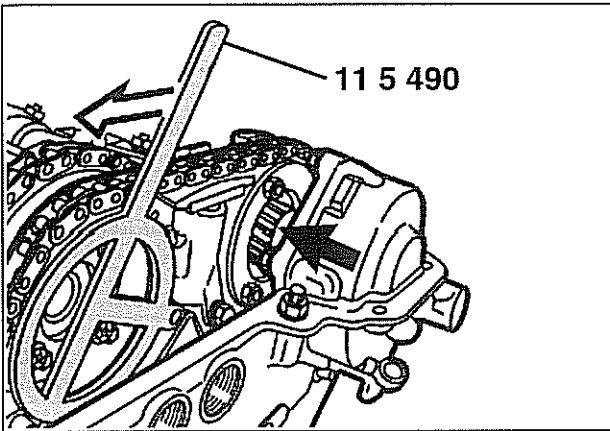
- Apply a small amount of liquid gasket sealer (Three Bond 1209 ® or equivalent) to VANOS housing alignment dowels on front of cylinder head. Install a new gasket.



- Push VANOS piston gear cup (arrow) into VANOS housing until it bottoms out. Position VANOS control unit in front of camshafts, but do not engage splines on gear cup.



**Camshaft Timing Chain**



- ◀ Install BMW special tool 11 5 490 on exhaust camshaft.
- Insert the helical-toothed splined shaft (**arrow**) into the helical-toothed sprocket while rotating gears and chain counter-clockwise with special tool.

**CAUTION—**

*Ensure that the first available tooth engages. It is important that the exhaust camshaft sprocket be turned only the minimum amount necessary to engage the gear cup. If this procedure is done incorrectly, the VANOS system may not fully function.*

- Install and tighten down VANOS control unit fasteners.

**Tightening torques**

VANOS control unit to cylinder head

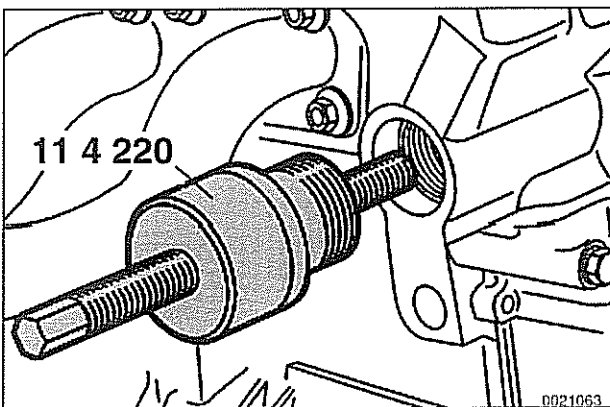
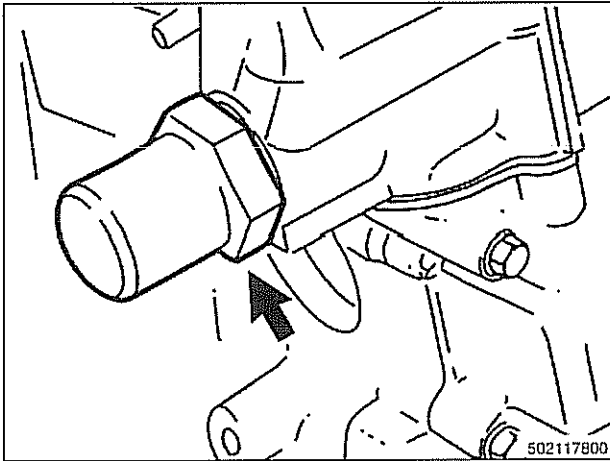
M6 nuts	10 Nm (89 in-lb)
M8 bolts	22 Nm (17 ft-lb)

- Press down on secondary timing chain tensioner and remove lock tool.

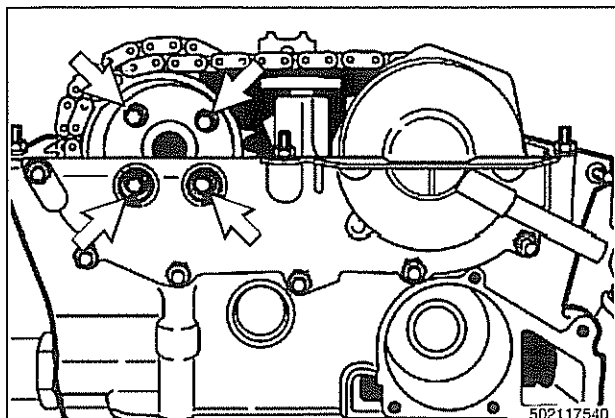
- ◀ Remove primary timing chain tensioner (**arrow**).

**CAUTION—**

*Timing chain tensioner is under spring tension.*



- ◀ Install adjustable primary chain tensioner (BMW special tool 11 4 220) and preload timing chain by tightening to 1.3 Nm (11 in-lb).



- Tighten exhaust camshaft sprocket mounting bolts (arrows) alternately in two stages.

#### Tightening torques

Secondary timing chain sprockets to camshafts

Stage 1	5 Nm (44 in-lb)
Stage 2	22 Nm (17 ft-lb)

- Remove crankshaft locking tool and camshaft locking tool set.
- Install camshaft gear bolt access plugs using new sealing washers and tighten.
- Remove timing chain tensioning tool from side of cylinder head. Install primary chain tensioner with new sealing washer and tighten.

#### Tightening torques

Access plugs to VANOS control unit	50 Nm (37 ft-lb)
Primary timing chain tensioner plug to tensioner sleeve	70 Nm (52 ft-lb)

- Check adjustment VANOS system, see **VANOS timing, checking and adjusting (M52 engine)**.

## VANOS timing, checking and adjusting (M52 engine)

### NOTE—

- Special BMW service tools are required to remove and install the VANOS control unit. Read the procedure through before starting the job.
- If the camshafts are not properly timed, the pistons can contact the valves.

- Disconnect negative (-) cable from battery.

### CAUTION—

- Disconnecting the battery may erase fault code(s) stored in control module memory. Prior to disconnecting the battery, check for fault codes using special BMW diagnostic equipment.
- Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.

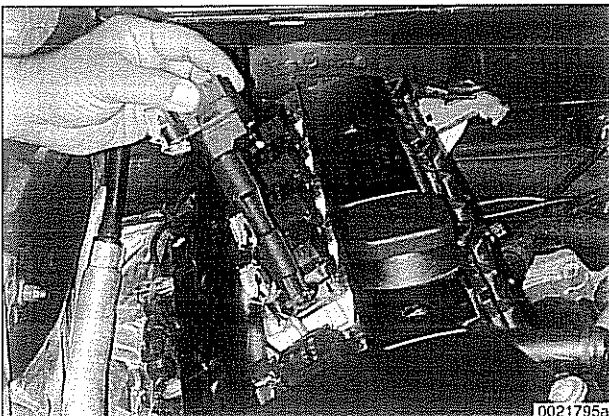
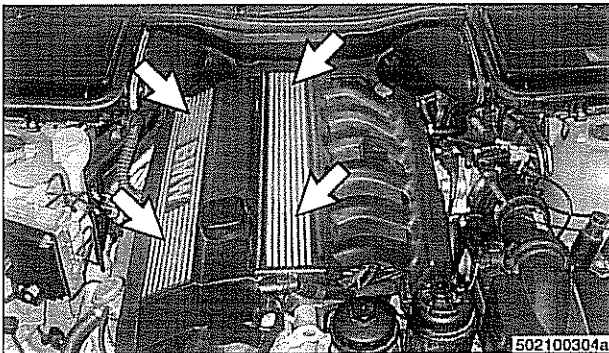
- Remove viscous clutch cooling fan. See **170 Radiator and Cooling System**.

### CAUTION—

The radiator cooling fan nut (32 mm wrench) has left-hand threads.

- Remove engine trim covers:

- Pry out plastic trim caps (arrows).
- Remove cover fasteners and covers.



- Remove ignition coils:

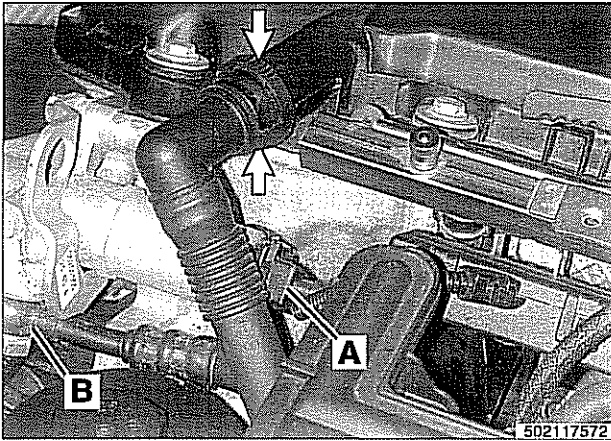
- Disconnect ignition coil electrical harness connectors.
- Remove coil mounting fasteners and remove coils.
- Remove spark plugs.

### NOTE—

Make note of ignition coil ground strap locations.



## Camshaft Timing Chain



- ◀ Disconnect VANOS electrical harness connector (A) and oil line fitting (B) from VANOS control unit.

**NOTE —**

*Wrap the VANOS oil line fitting with a shop rag to absorb leaking oil.*

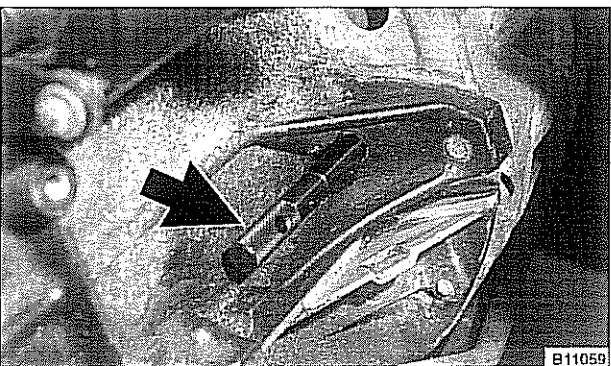
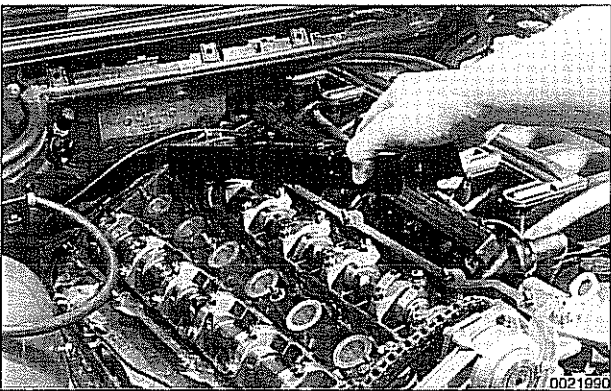
- Disconnect crankcase breather by squeezing at arrows.

- Remove cylinder cover mounting fasteners and remove cylinder head cover.

**NOTE —**

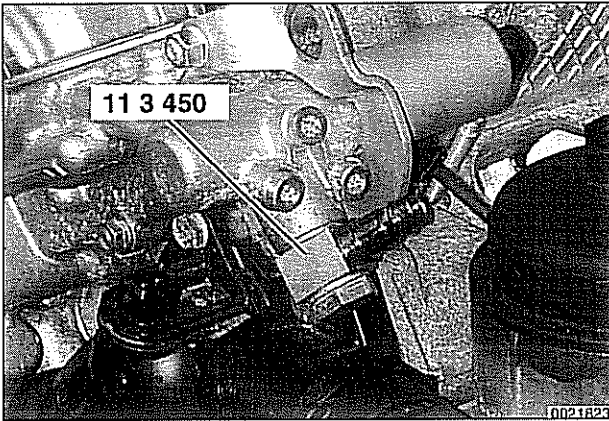
*The cylinder head cover mounting bolt insulators and gaskets should be reinstalled in their original positions. Make note of their arrangement during removal.*

- ◀ Remove oil baffle cover from intake camshaft.



- ◀ Secure crankshaft in TDC position with BMW special tool 11 2 300 (arrow).

## Camshaft Timing Chain

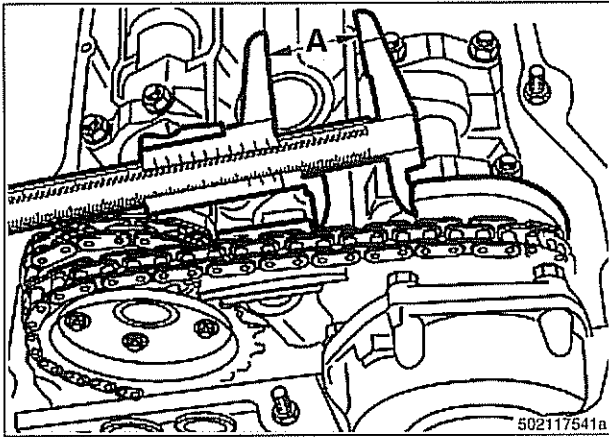


- Remove banjo bolt from VANOS unit oil feed line and install BMW special tool 11 3 450.

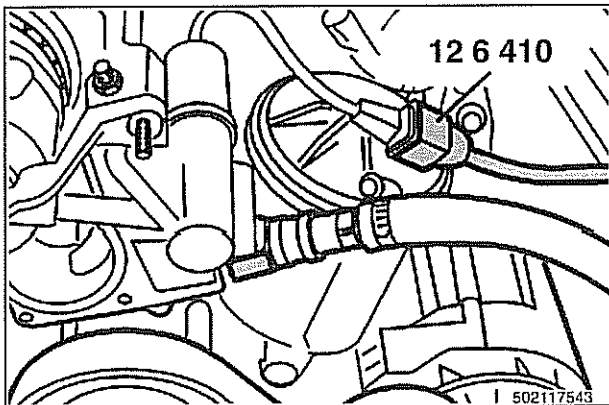
**NOTE—**

*Oil will drain from oil feed line.*

- Connect compressed air line (with pressure set to 2–8 bar or 30–110 psi.) to air fitting.



- Measure gap (A) between secondary timing chain tensioner and intake camshaft sensor wheel. Make note of distance.

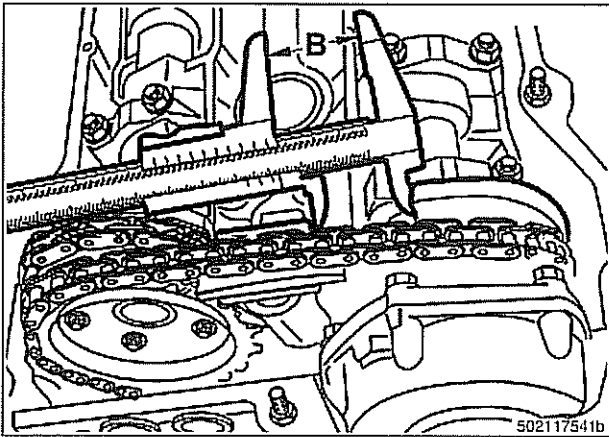


- Connect cable test (BMW special tool 11 6 410) to VANOS connector. Connect positive clip to positive battery terminal.
- Connect negative clip to battery negative terminal.

**CAUTION—**

*Reversing terminals on special tool will damage diode on VANOS solenoid valve.*

## Camshaft Timing Chain



◀ Measure gap (B) between secondary timing chain tensioner and intake camshaft sensor wheel. Make note of distance.

- To determine VANOS control travel:
  - Distance B — distance A = a minimum of 8.5 mm.

### CAUTION—

*If the adjustment travel is less than 8.5 mm, the VANOS adjustment unit must be removed and readjusted. See VANOS control unit, removing (M52 engine) and VANOS control unit, installing (M52 engine).*

- Remove special tools:
  - Crankshaft locking tool.
  - Camshaft locking tool set.
  - Air fitting.
  - VANOS cable adaptor.
- Install VANOS oil line with new seal.
- Install oil baffle cover above intake camshaft.
- Install cylinder head cover mounting studs to rear of head.
- Install cylinder head cover.

### Tightening torques

Cylinder head cover	10 Nm (89 in-lb)
VANOS oil line	32 Nm (24 ft-lb)
VANOS solenoid to control unit	30 Nm (22 ft-lb)

- Installation of remaining parts is reverse of removal.

## Timing chains, removing (M52 engine)

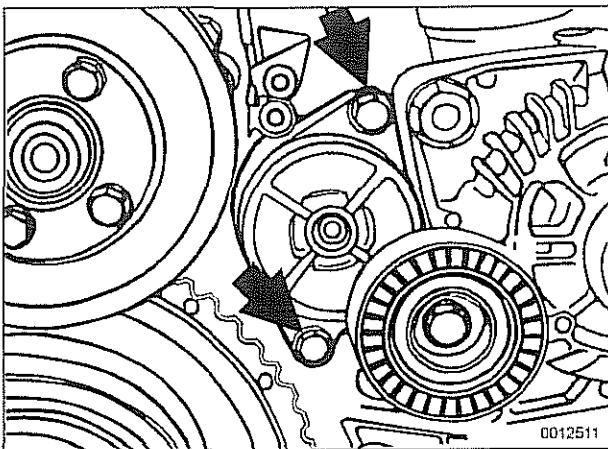
Camshaft timing chain removal on M52 engines requires engine oil pan removal.

Special BMW service tools are needed for timing chain removal and installation procedures. The special tools assure proper timing of the valvetrain. Precise marks to set the timing on the camshafts are not provided for reassembly. Read the procedures through before beginning the job.

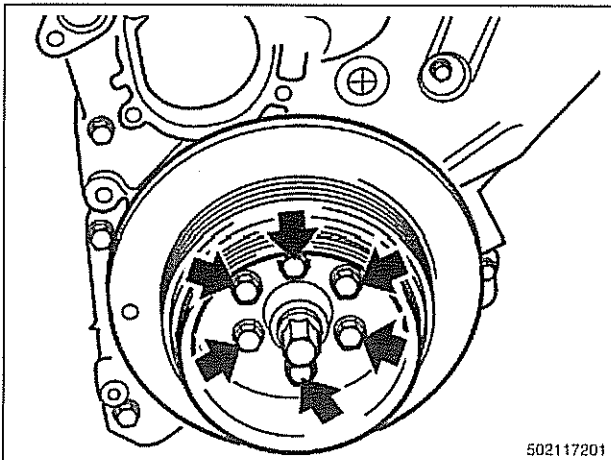
### NOTE—

*If the camshafts are not properly timed, the pistons can contact the valves.*

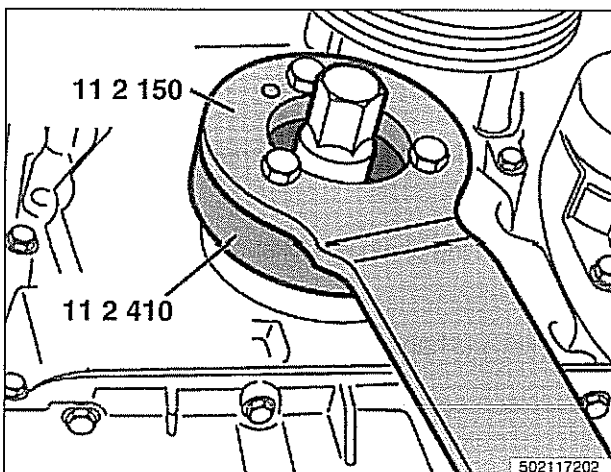
- Remove VANOS control unit. See **VANOS control unit, removing (M52 engine)**.
- Remove radiator cooling fan and shroud. See **170 Radiator and Cooling System**.
- Drain cooling system. See **170 Radiator and Cooling System**.
- Remove coolant hoses from thermostat housing and remove thermostat housing from front of cylinder head.
- Loosen bolts for coolant pump pulley.
- Remove drive belts for alternator and A/C compressor. See **020 Maintenance**.
- Remove coolant pump pulley.
- Remove drive belt tensioner mounting bolts (**arrows**) and remove tensioner from front of engine.
- Remove engine speed sensor from lower timing chain cover.



## Camshaft Timing Chain



- With crankshaft at TDC position, remove vibration damper bolts (arrows) and remove vibration damper.



- Mount crankshaft holding tool (BMW special tool 11 2 150 and 11 2 410) to crankshaft hub. Counter hold crankshaft and loosen crankshaft hub retaining bolt.

**CAUTION—**

*Crankshaft hub retaining bolt is torqued to 410 Nm (300 ft-lb). Do not use flywheel locking tool to hold crankshaft stationary to loosen or tighten crankshaft hub center bolt. Use only the special tools specified, or equivalent hub holding tool.*

- Remove crankshaft hub.
- Remove cylinder cover mounting fasteners and remove cylinder head cover.

**NOTE—**

*The cylinder head cover mounting bolt insulators and gaskets should be reinstalled in their original positions. Make note of their arrangement during removal.*

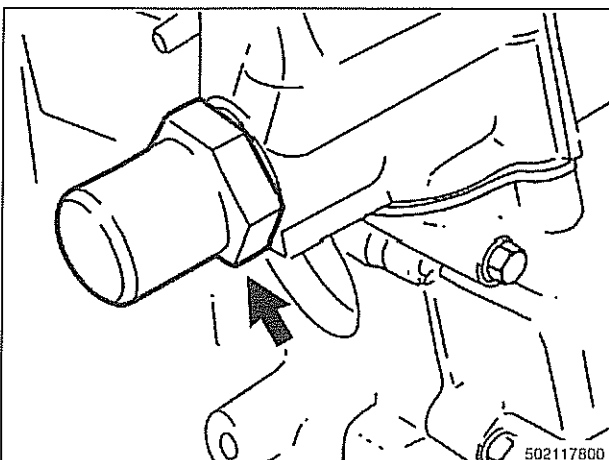
- Drain engine oil, remove oil pan. See 119 Lubrication System.

- Remove primary timing chain tensioner (arrow).

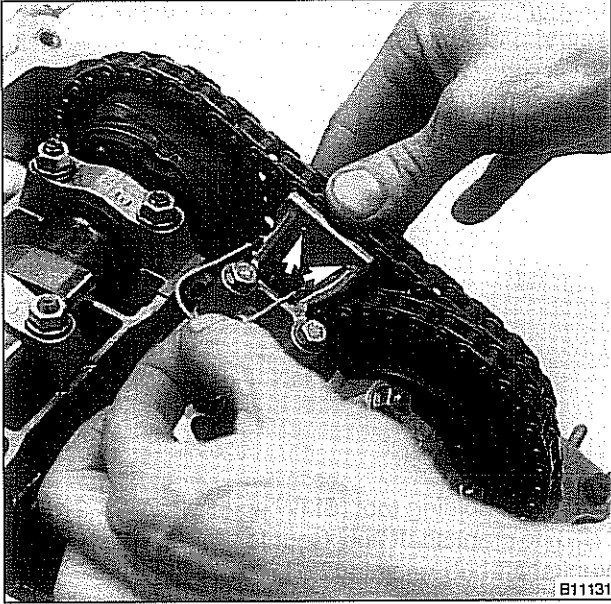
**CAUTION—**

*Timing chain tensioner is under spring tension.*

- Remove VANOS control unit. See **VANOS control unit, removing (M52 engine)**.
- Remove fasteners from intake and exhaust camshaft sprocket.



## Camshaft Timing Chain

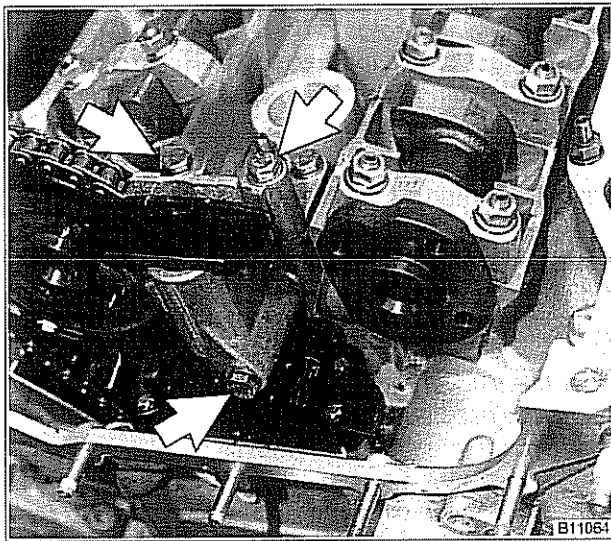


- ▲ While pressing down on secondary timing chain tensioner install locking tool (BMW 11 3 292) or a similar pin.

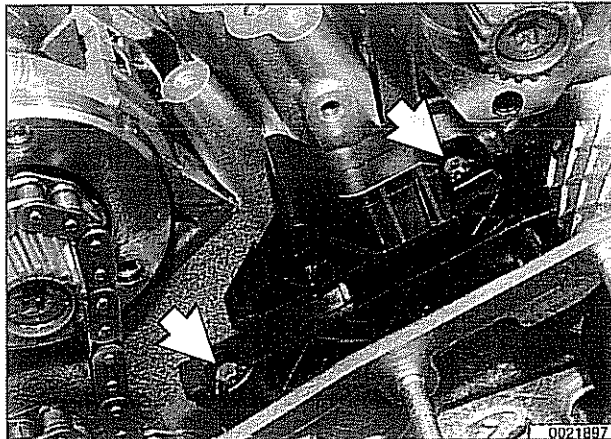
**NOTE —**

*Two types of secondary timing chain tensioners are used, with either two holes (shown) or a single hole for the locking pin tool.*

- Remove intake and exhaust sprockets together with secondary chain.

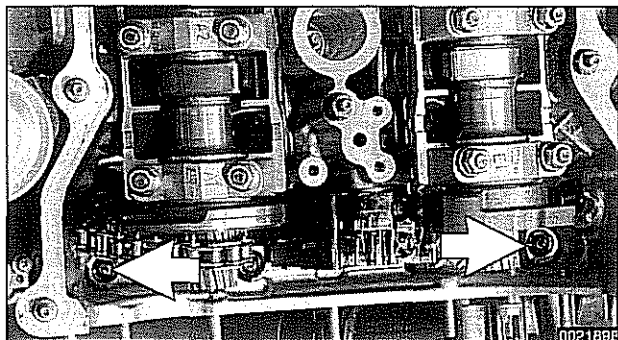


- ▲ Remove secondary timing chain tensioner bolts (**arrows**) and remove tensioner.
- Remove primary timing chain sprocket from exhaust camshaft.
- Remove sprocket and hang timing chain from end of exhaust camshaft.

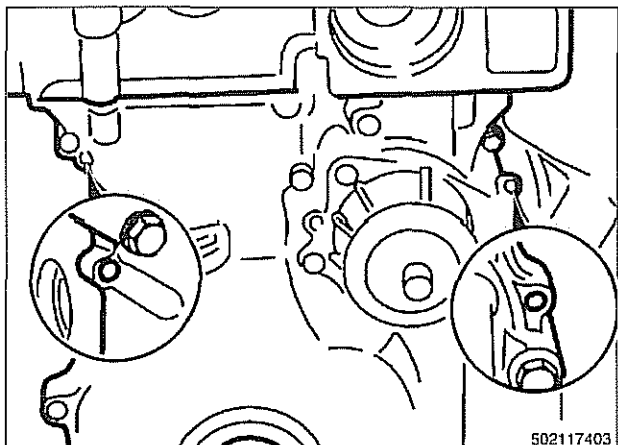


- ▲ Remove secondary chain guide bolts (**arrows**) and remove guide.

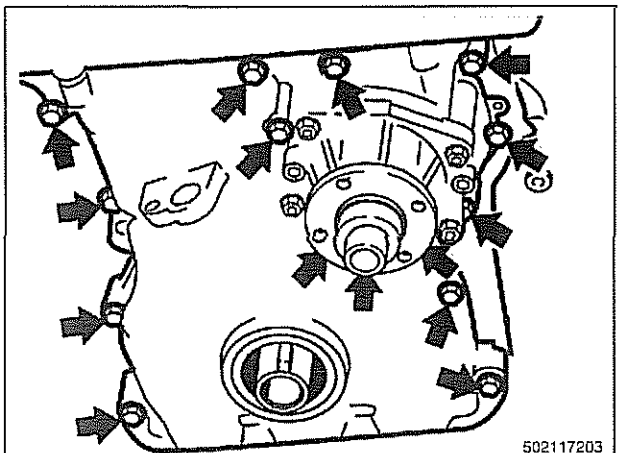
## Camshaft Timing Chain



- ▲ Remove lower timing chain cover to cylinder head bolts (arrows).



- ▲ Using a drift, drive two locating dowels (arrows) in lower timing cover toward rear of car.



- ▲ Remove timing cover mounting bolts (arrows).
  - Carefully slide cover with water pump forward to remove.

**CAUTION—**

- Use care when removing the cover from the cylinder head gasket. If the cover is stuck, use a sharp knife to separate it from the head gasket.
- If cylinder head gasket is damaged, remove cylinder head and replace head gasket. See 113 Cylinder head and valvetrain.

- Remove timing cover locating dowels by driving them forward.
- Lift primary chain sprocket off crankshaft sprocket and remove chain.

## Timing chain, installing (M52 engine)

**CAUTION—**

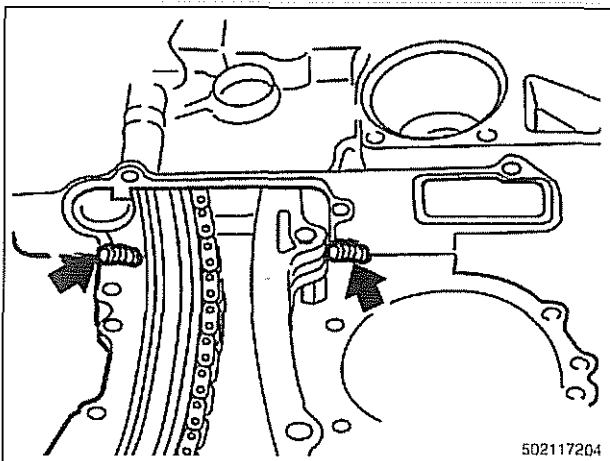
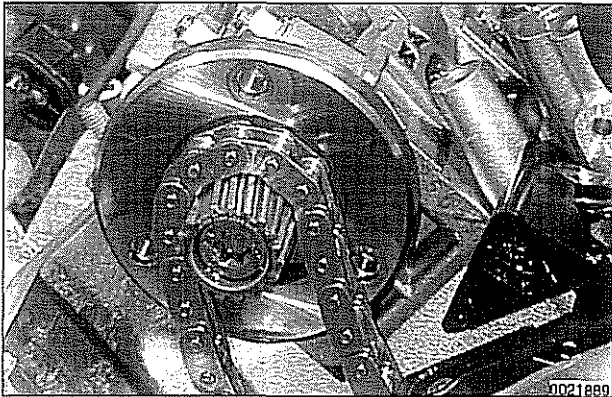
The procedure outlined below assumes that the camshafts and the crankshaft are locked in the TDC position with BMW special tools.

- Inspect timing chain and sprockets and guide rails for wear. Replace worn parts.

**NOTE—**

If any of the sprockets are being replaced due to wear, the chain should also be replaced.

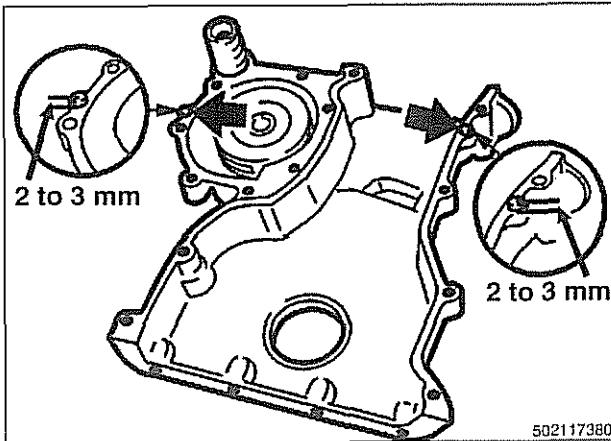
- Install primary timing chain to crankshaft sprocket and hang on exhaust camshaft.



- Apply a small bead of silicon sealer (Three Bond 1209® or equivalent) to corners where timing cover meets cylinder head (arrows).



## Camshaft Timing Chain



- ▶ Tap locating dowels into cover until they protrude 2 to 3 mm from sealing surface.

- Using new gaskets, install lower timing chain cover:
  - Tap cover into position to engage dowels.
  - Install timing chain cover fasteners and tighten to 5 Nm (44 in-lb).
  - Drive dowels in flush to front of cover.
  - Tighten cover mounting bolts alternately and in stages.
  - Install cylinder head to timing chain cover fasteners and tighten.

## Tightening torques

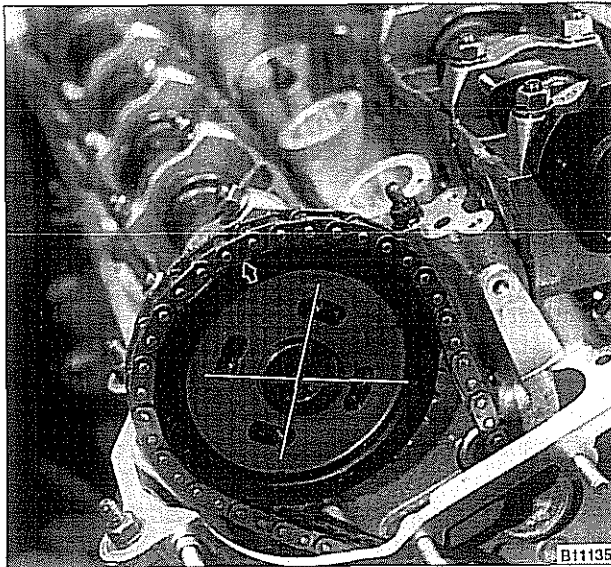
Lower timing chain cover to block

M7

15 Nm (11 ft-lb)

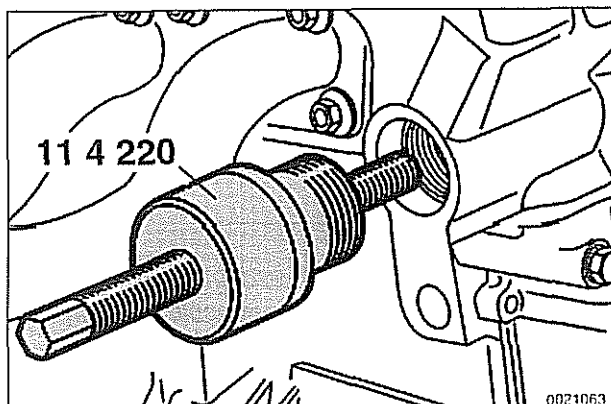
M8

20 Nm (15 ft-lb)



- Replace front crankshaft radial seal. See **Crankshaft oil seal, front, replacing (M52 engine)**.
- Install engine oil pan using a new gasket. See **119 Lubrication System**.

- ▶ Mount primary timing chain sprocket to primary chain so that arrow on sprocket faces up. Mount sprocket to camshaft so that tapped holes in camshaft are on left side of elongated holes in sprocket.



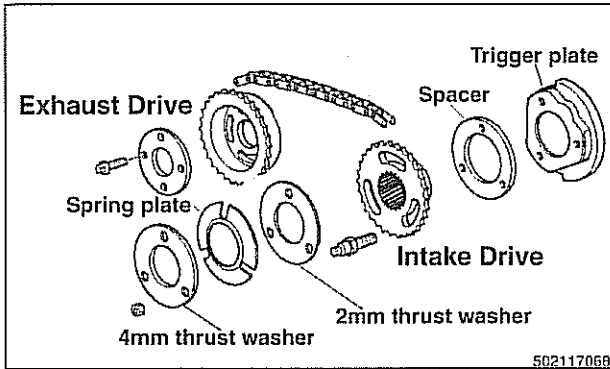
- ▶ Install adjustable timing chain tensioner (BMW special tool 11 4 220). Thread tool in finger tight until slack is removed from chain.

**NOTE**—

*BMW special tool 11 4 220 is an adjustable timing chain tensioner that simulates the function of the hydraulic tensioner.*

- Check that elongated holes in primary sprocket are centered to bolt holes in camshaft and chain is free of slack.
- Install secondary timing chain guide and secondary chain tensioner. Tighten mounting bolts (tensioner remains locked down).

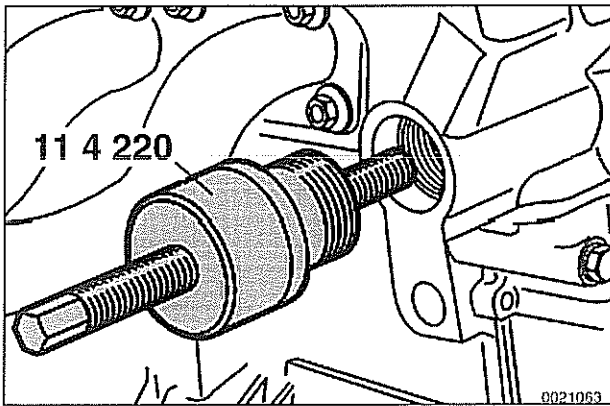
**Camshaft Timing Chain**



- Install cylinder identification trigger plate to front of intake camshaft.
- Install spacer to front of intake camshaft.
- Install secondary chain sprockets and chain as an assembly so that arrows on sprockets are pointing up. Center mounting holes in sprockets to bolt holes in camshafts.
- Install thrust washers and spring plate to intake cam sprocket.
- Tighten intake camshaft sprocket nuts.
- Install VANOS control unit, see **VANOS control unit, installing (M52 engine)**.

**Tightening torque**

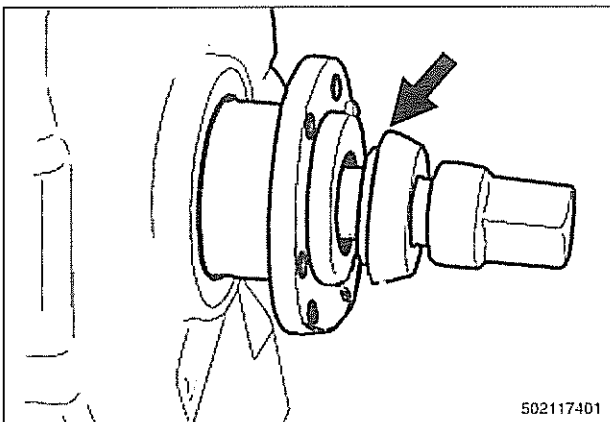
Intake camshaft sprocket nuts to studs (M6)	10 ± 1 Nm (89 ± 9 in-lb)
---	--------------------------



- Unlock and release secondary chain tensioner.
- Preload primary timing chain by torquing adjustable primary chain tensioner (BMW special tool 11 4 220) to 1.3 Nm (11 in-lb).
- Tighten exhaust camshaft sprocket bolts in two stages.

**Tightening torque**

Exhaust camshaft sprocket bolts (M7)	
Stage 1	5 Nm (44 in-lb)
Stage 2	22 Nm (17 ft-lb)



- Remove crankshaft locking tool and camshaft locking tools.
- Align hub with keyway and tap into place. Insert new center bolt with washer shoulder (**arrow**) facing hub.

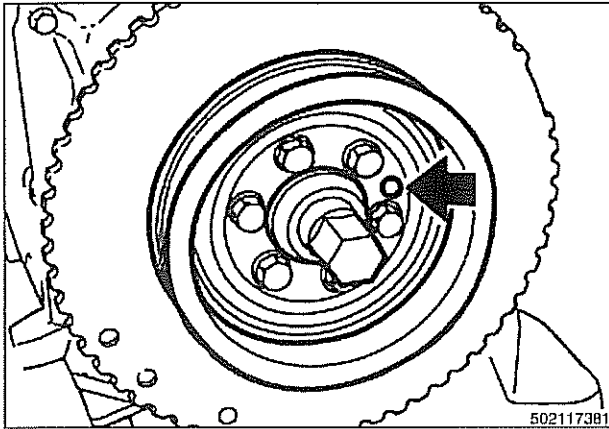
**CAUTION—**

*Inspect woodruff key for damage before installing hub.*

- Attach crankshaft holding tool (BMW special tools 11 2 150/11 2 410) to hub. Counterhold hub with tool while tightening center bolt.

**CAUTION—**

*Do not use flywheel locking tool to hold crankshaft stationary to loosen or tighten crankshaft hub center bolt. Use only the special tools specified, or equivalent hub holding tool.*

**Tightening torque**

Vibration damper hub to crankshaft	410 Nm (300 ft-lb)
------------------------------------	--------------------

- ▶ Install crankshaft hub and vibration damper while aligning locating hole (arrow) in damper with dowel pin in hub.

**Tightening torque**

Vibration damper and pulley to crankshaft hub	22 Nm (17 ft-lb)
---	------------------

- Turn engine over by hand in direction of rotation at least two full rotations. Reinstall camshaft and crankshaft locking tools to recheck engine timing. Remove locking tools if no faults are found.

- Remove BMW special tool 11 3 390 (dummy tensioner) from side of cylinder head.

- Install primary chain tensioner so that cutout in tensioner piston engages chain rail.

**Tightening torque**

Timing chain tensioner to tensioner sleeve	70 Nm (52 ft-lb)
--	------------------

- Install cylinder head cover mounting studs, camshaft cover, and cylinder head cover.

**Tightening torque**

Cylinder head cover to cylinder head	
M6 nut	10 Nm (89 in-lb)
M8 bolt	22 Nm (17 ft-lb)

- Installation of remaining parts is reverse of removal, noting the following:
  - When installing thermostat, make sure arrow or vent hole faces up, if applicable.
  - Refill cooling system as described in **170 Radiator and Cooling System**.
  - Fill engine with oil and install new oil filter as described in **020 Maintenance**.

**Tightening torque**

Upper timing chain cover to cylinder head	
M6 nut	10 Nm (89 in-lb)
M8 bolt	22 Nm (17 ft-lb)

VANOS oil supply pipe to VANOS control unit banjo bolt	32 Nm (24 ft-lb)
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## DOUBLE VANOS SYSTEM (M52 TU AND M54 ENGINES)

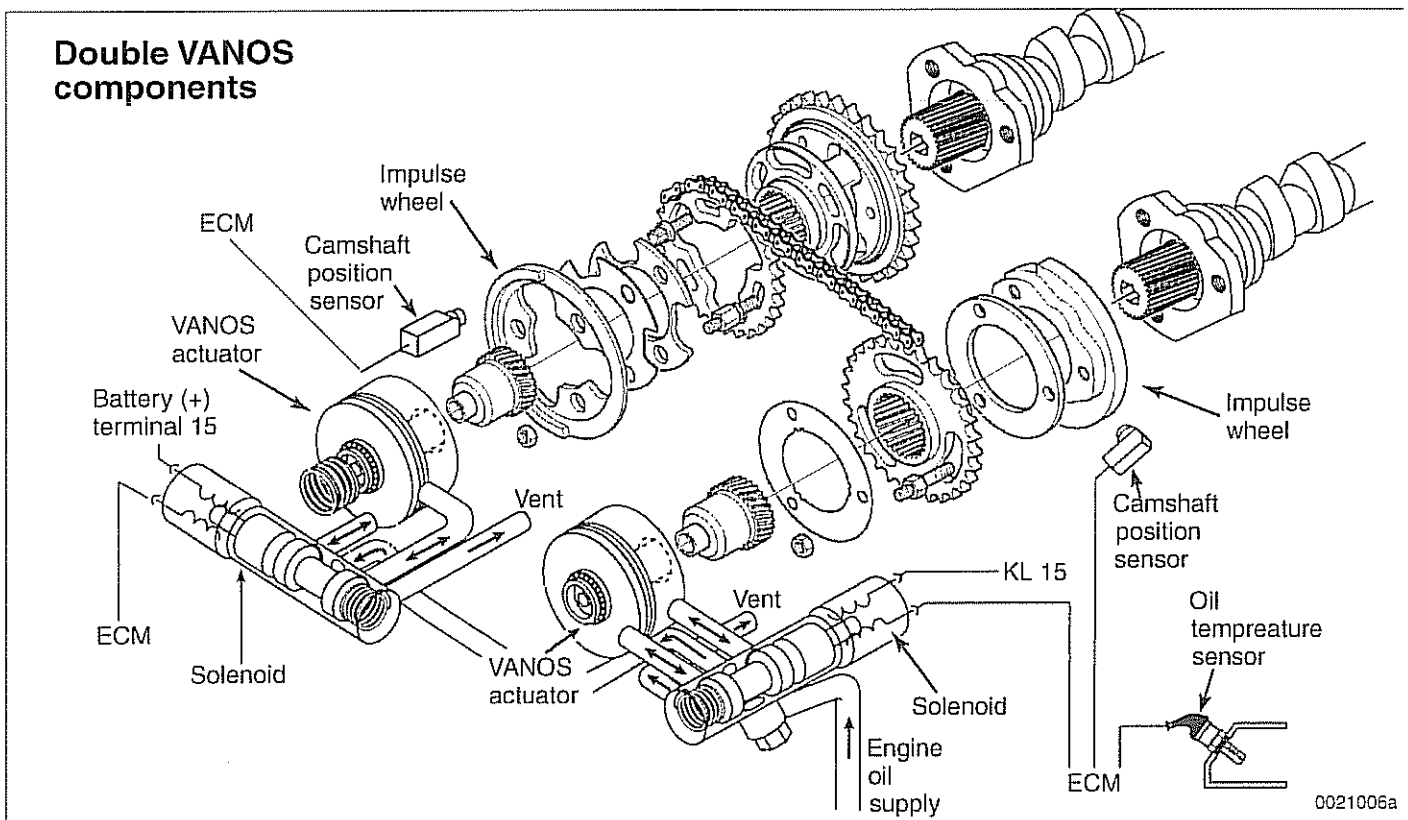
### Double VANOS system function

The M52 TU and M54 6-cylinder engines are equipped with a Double VANOS system that varies intake and exhaust camshaft timing.

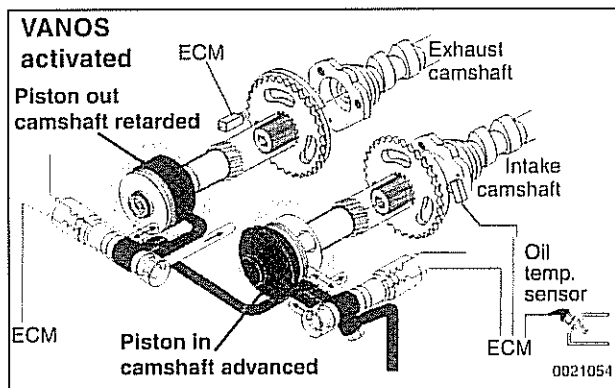
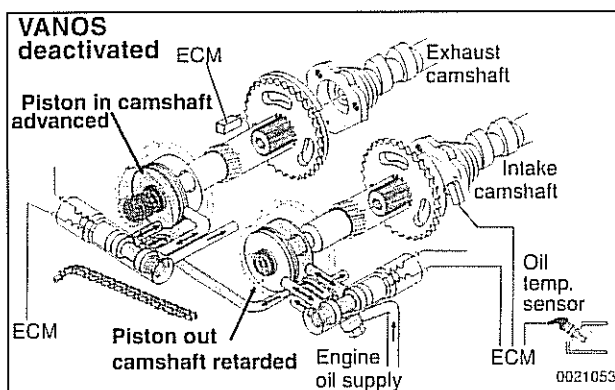
The main components of the Double VANOS system are:

- Intake and exhaust camshafts with helical spline inserts.
- Camshaft sprockets with adjustable gears.
- VANOS actuators (two position piston housing with internal/external helical spline cup).
- Three-way solenoid switching valves.
- Camshaft position impulse wheels.
- Hall effect camshaft position sensors.

Camshaft position is varied based on engine rpm, throttle position signal, intake air and coolant temperature.



## Camshaft Timing Chain



When engine is started, camshafts are in deactivated position:

- Intake camshaft is held in RETARDED position by oil pressure.
- Exhaust camshaft is held in ADVANCED position by preload spring and oil pressure.

Within 2 - 5 seconds (50 engine revolutions), the ECM begins monitoring and controlling camshaft positions.

The Double VANOS system allows full variability of camshaft timing up to the limits of the system. When the ECM detects that the camshafts are in optimum position, the solenoids are modulated at approximately 100 - 220 Hz to maintain oil pressure on both sides of the actuator pistons to maintain timing.

In models with DME MS 43.0 (model year 2001 and newer), the engine control module (ECM) detects camshaft position before the engine starts, thereby adjusting camshaft timing immediately upon start-up.

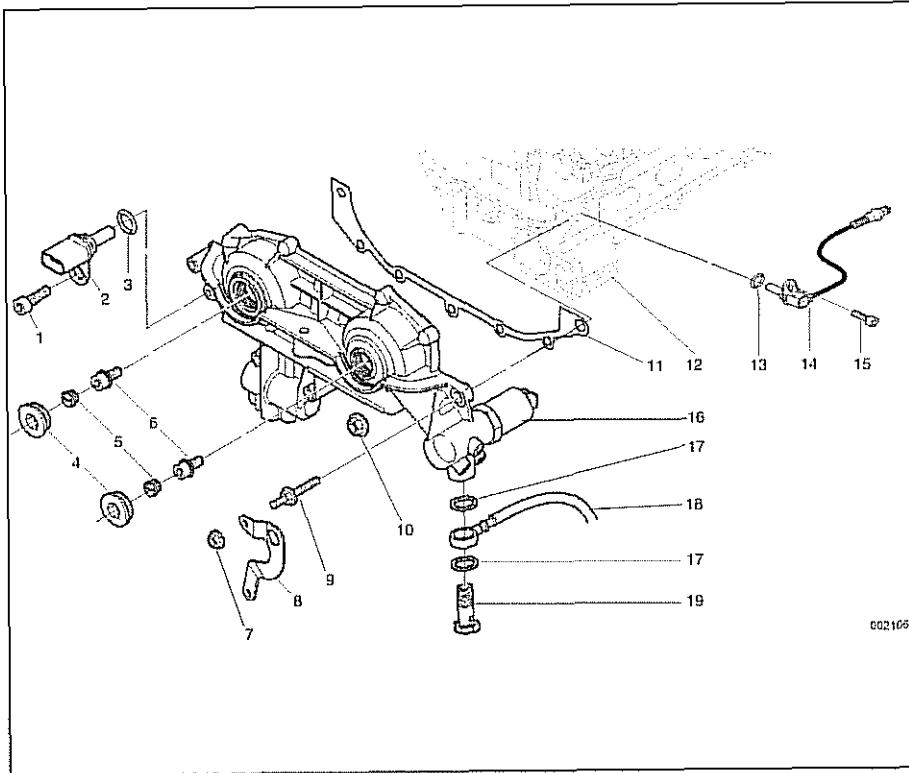
### NOTE —

- *VANOS system troubleshooting and diagnostics is best accomplished using a scan tool.*
- *Diagnostic Trouble Codes (DTCs) pertaining to the VANOS system are listed in the following table. See also **OBD On-Board Diagnostics**.*
- *Elevated oil temperatures can cause VANOS to deactivate. Oil that is too thick (high viscosity) may cause a DTC to be set in the ECM. If VANOS is deactivated (limp-home mode), there will be a noticeable loss of power.*

### VANOS fault codes

BMW code	P-code	Fault description
19	P1529	VANOS solenoid valve activation, exhaust
21	P1525	VANOS solenoid valve activation, intake
103	P1519	VANOS faulty reference value intake
104	P1520	VANOS faulty reference value exhaust
105	P1522	VANOS stuck (Bank 1) intake
106	P1523	VANOS stuck (Bank 2) exhaust

## Camshaft Timing Chain



## Double VANOS control unit

1. Bolt M6
2. Exhaust camshaft position sensor
3. Sealing ring
4. Camshaft end sealing plug -tighten to 50 Nm (37 ft-lb)
5. Camshaft seal cap
6. VANOS hydraulic piston set screw -CAUTION: left hand thread -tighten to 10 Nm (89 in-lb)
7. Nut M7 -tighten to 14 Nm (10 ft-lb)
8. Engine lifting hook
9. Stud M7
10. Nut M6 -tighten to 10 Nm (89 lb-in)
11. Gasket
12. Cylinder head
13. Sealing ring
14. Intake camshaft sensor
15. Bolt M6
16. VANOS control unit
17. Copper sealing ring
18. VANOS oil feed line
19. Banjo bolt -tighten to 32 Nm (24 ft-lb)

## VANOS control unit, removing (M52 TU and M54 engines)

This procedure includes removal of the Double VANOS control unit.

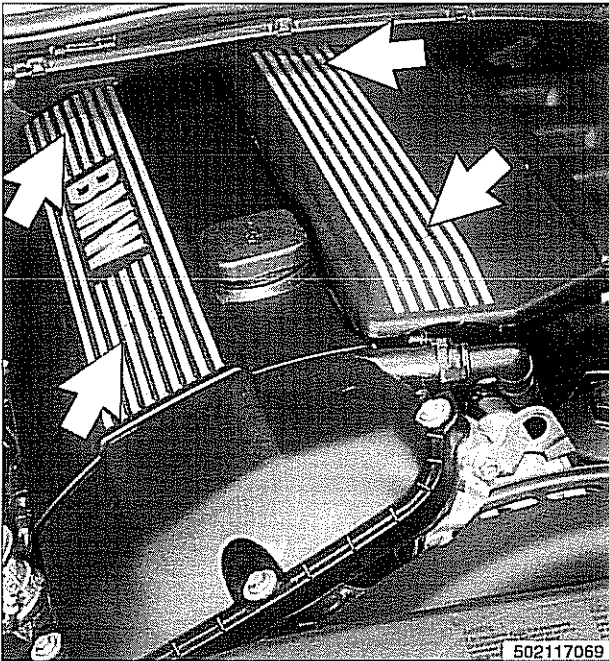
### NOTE—

If the Double VANOS control unit is being replaced, camshaft timing must be checked. This procedure requires multiple special tools. Be sure to read the procedures through before beginning the repair.

- Working inside luggage compartment, disconnect negative (-) battery cable.

### CAUTION—

Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.

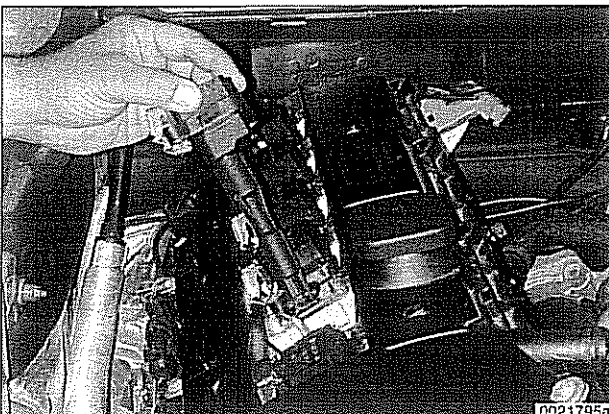


- Remove engine cooling fan assembly. See **170 Radiator and Cooling System**.



Remove engine trim covers.

- Pry out plastic trim caps (arrows).
- Remove cover fasteners, oil filler cap, and covers.



Remove ignition coils:

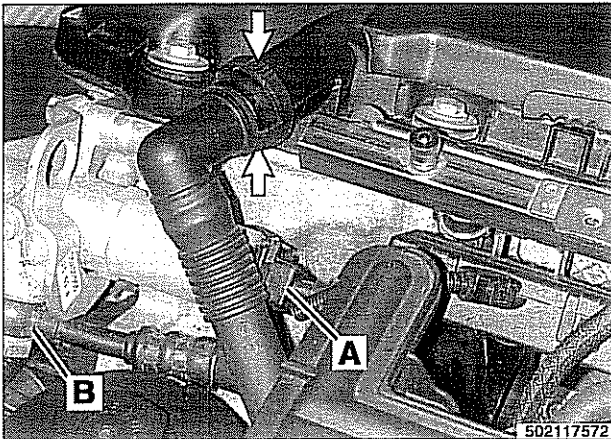
- Disconnect ignition coil electrical harness connectors.
- Remove coil mounting fasteners and coils.

### NOTE—

Make note of ignition coil ground strap locations.

- Remove spark plugs.

## Camshaft Timing Chain

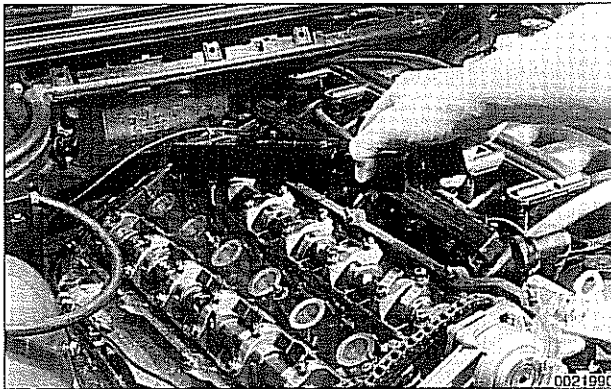


- Disconnect electrical harness connector (A), oil line fitting (B), and crankcase vent tube (squeeze at arrows).

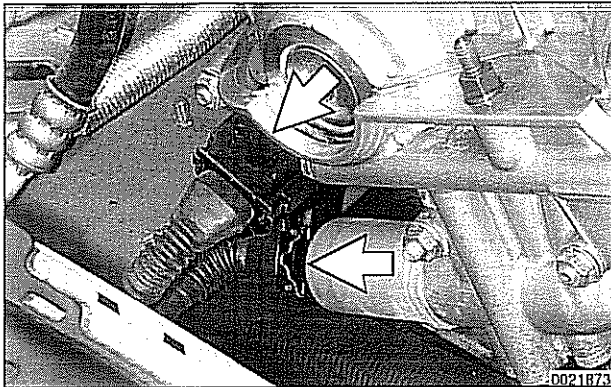
**NOTE —**

*Oil will drain from VANOS unit fitting. Use shop rags to keep oil off drive belts.*

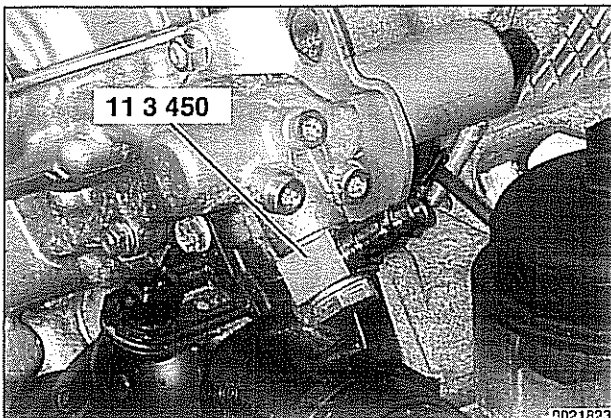
- Remove cylinder head cover fasteners, and cover.



- Remove oil baffle cover from intake camshaft.



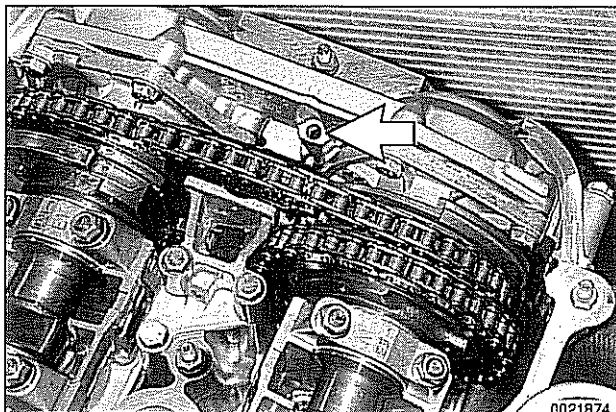
- Disconnect electrical connections from exhaust camshaft position sensor and VANOS control valve (arrows).



- Using banjo bolt from VANOS control unit oil line, install test fitting (BMW special tool 11 3 450) to VANOS control unit.

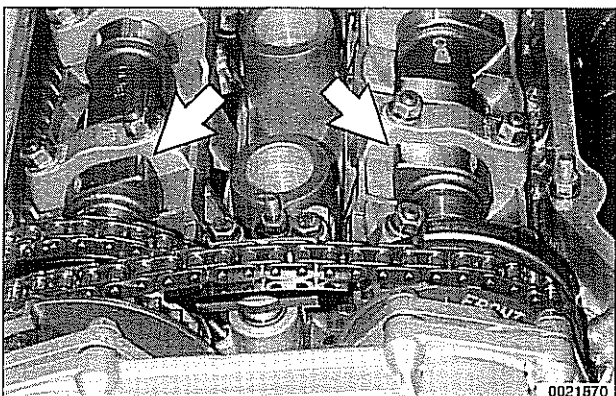


## Camshaft Timing Chain



- Cover oil hole in VANOS control unit (**arrow**) with shop towel to capture oil which will spray when compressed air line is connected.

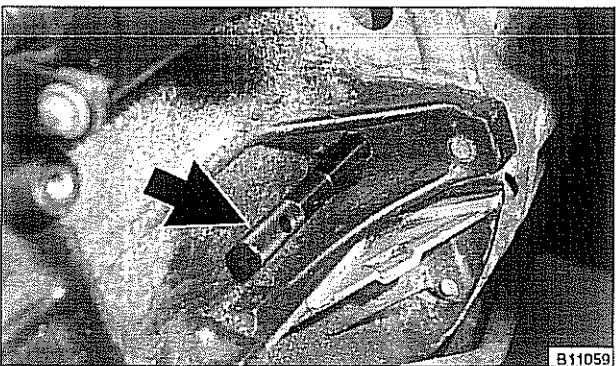
- Connect compressed air line to air fitting. Apply air pressure set to 2 - 8 bar (30 - 110 psi).



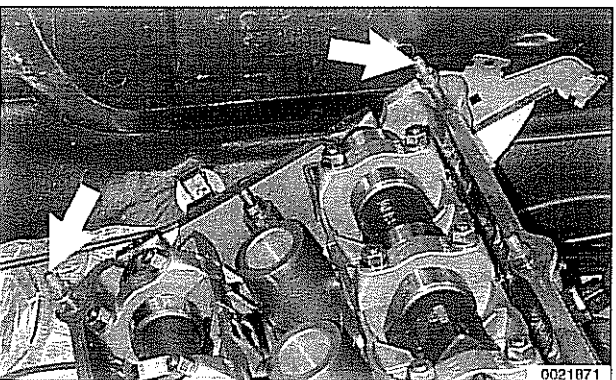
- With compressed air line connected, turn engine clockwise using crankshaft center bolt at least two rotations, until cylinder 1 is at (TDC) position (intake and exhaust camshaft lobes as shown **arrows**).

**CAUTION—**

*Do not rotate engine counterclockwise to reach the top dead center position. Instead, complete another two complete rotations.*

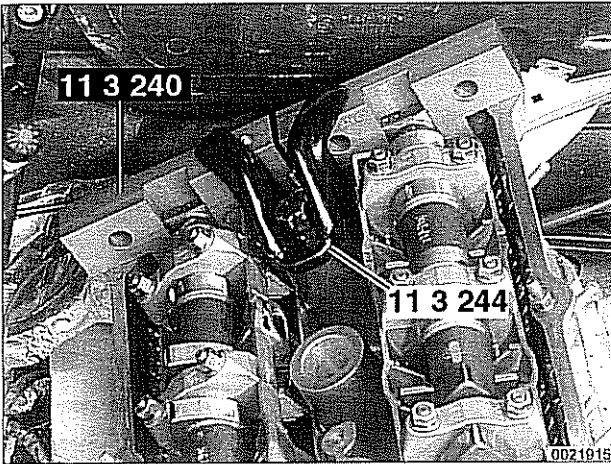


- Remove sealing plug from bore under starter. Lock crankshaft in TDC position with BMW special tool 11 2 300 (**arrow**).



- Unscrew and remove threaded studs (**arrows**) at rear of cylinder head.

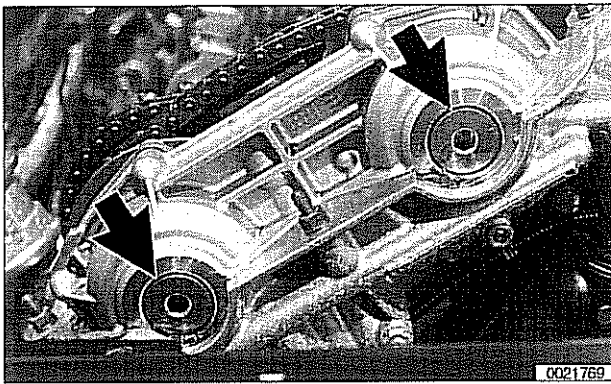
## Camshaft Timing Chain



- Secure camshafts in TDC position using BMW special tool set 11 3 240.
- Disconnect compressed air line, leaving compressed air fitting attached to VANOS control unit.

**NOTE**—

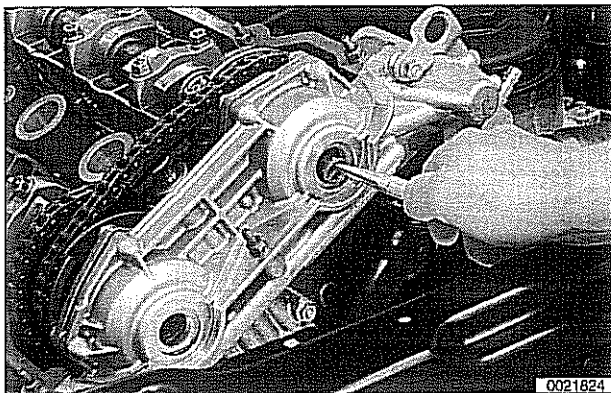
*Oil will drain from pressure line. Have a container and rags ready.*



- Unscrew sealing plugs from VANOS control unit (arrows).

**NOTE**—

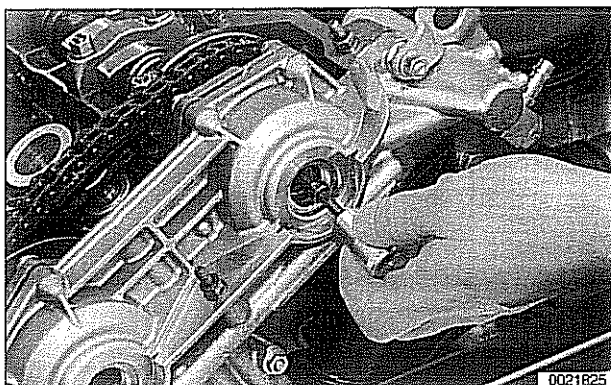
*Oil will drain from sealing plug bores. Have a container and rags ready.*



- Pull sealing caps straight out of VANOS control unit with BMW special tool 11 6 170, or with short nose pliers.

**NOTE**—

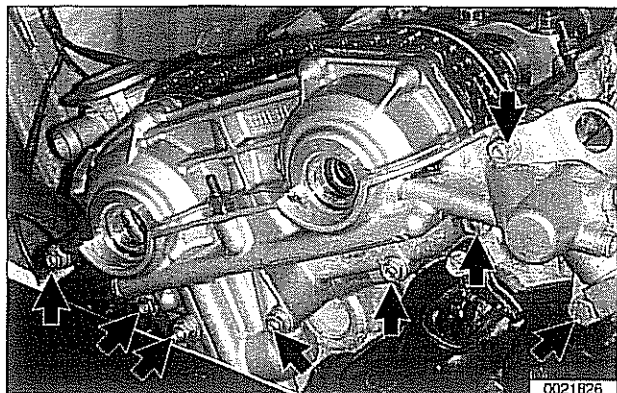
*Additional oil may drain from VANOS control unit.*



- Remove set screws (left-hand thread) on ends of intake and exhaust camshafts.

**NOTE**—

*Set screws have left hand threads. Remove with a clockwise motion.*



➤ Remove VANOS unit:

- Remove fasteners from engine support eye.
- Remove VANOS mounting nuts (arrows) from cylinder head. Slide VANOS control unit and metal gasket off.

**NOTE—**

- The VANOS control unit will contain residual oil. Place shop towels beneath adjustment unit when removing.
- If the VANOS control unit is replaced, or if repair operations are completed that may change camshaft timing, the camshaft timing must be checked as described in **VANOS timing, checking and adjusting (M52 TU and M54 engines)**.

**CAUTION—**

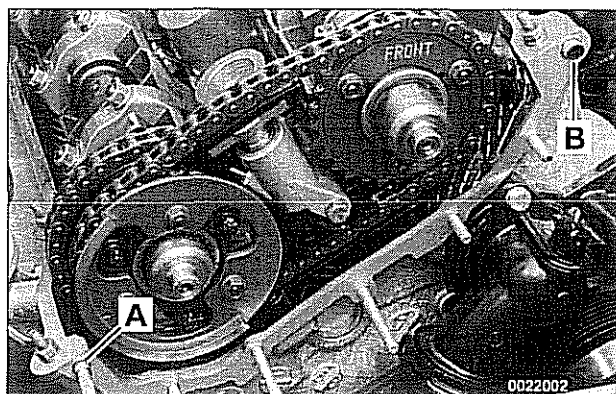
Do not crank the engine with VANOS unit removed. Piston/valve interference may result.

### VANOS control unit, installing (M52 TU and M54 engines)

- Clean contact edges of cylinder head face and double VANOS control unit and apply a thin coat of sealing compound (Three Bond 1209 ® or equivalent) to surfaces.

**CAUTION—**

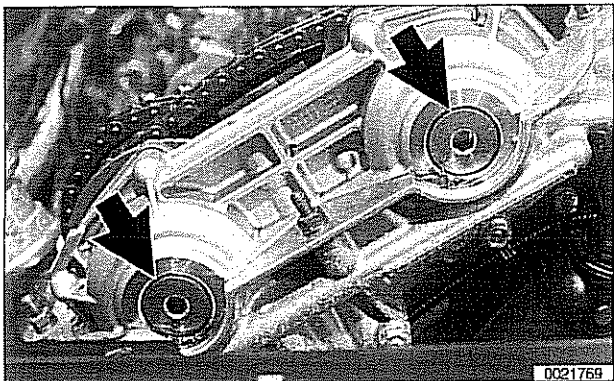
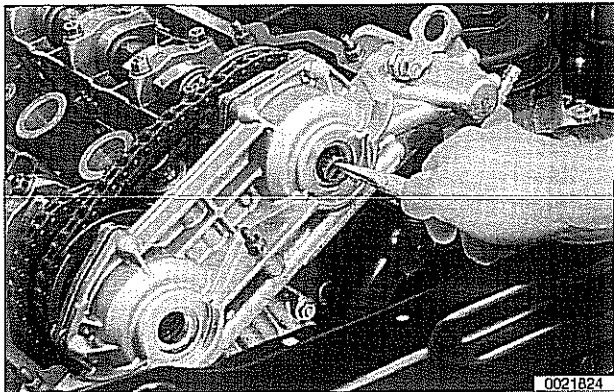
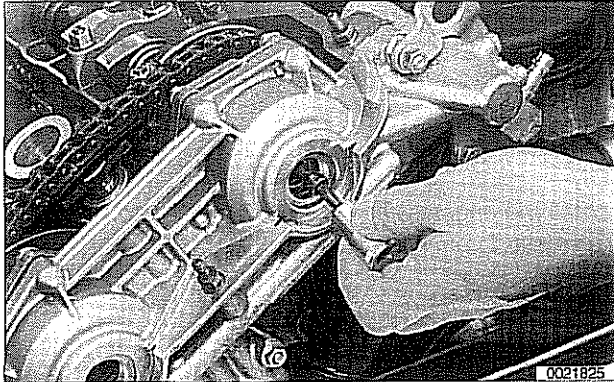
- Make sure all gasket material is removed from face of cylinder head. Clean sealing face and keep free of oil.
- Check locating dowel (A) and dowel sleeve (B) at top of cylinder head for damage or incorrect installation.



**NOTE—**

- If the Double VANOS control unit is being replaced, be sure to check and adjust camshaft timing, see **VANOS timing, checking and adjusting (M52 TU and M54 engines)**.
- If work being carried out has no effect on camshaft timing, it is not necessary to recheck the timing. It is recommended, however, that the VANOS operation be checked using a compatible scan tool once the engine is running.

## Camshaft Timing Chain



- Using new gasket, install VANOS control unit to cylinder head.
- Reinstall engine support eye.

### Tightening torques

VANOS control unit to cylinder head	
M6 nut	10 Nm (89 in-lb)
M7 nut	14 Nm (10 ft-lb)

- Insert and tighten VANOS hydraulic piston set screws on intake and exhaust camshafts.

### CAUTION—

*Set screws have left hand thread. Tighten counterclockwise.*

### Tightening torque

Hydraulic piston to splined shaft (set screw)	10 Nm (89 in-lb)
--	------------------

- Replace sealing caps inside VANOS control unit with BMW special tool 11 6 170, or short flat nosed pliers.

- Insert and secure VANOS sealing plugs (arrows), using new sealing O-rings.

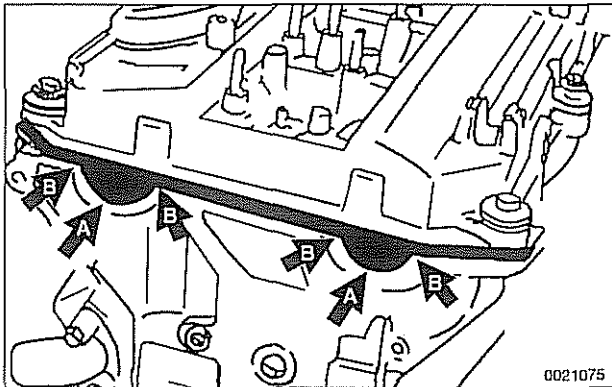
### Tightening torque

Sealing plug to VANOS control unit	50 Nm (37 ft-lb)
------------------------------------	------------------

- Remove compressed air fitting from VANOS control unit.
- Fit VANOS oil line banjo bolt with new seals. Attach oil line to VANOS control unit.

### Tightening torque

Oil line to VANOS control unit (banjo bolt)	32 Nm (24 ft-lb)
---	------------------



- Connect electrical harness connectors to camshaft position sensors and VANOS solenoid valves.
- Remove BMW special locking tools from rear of cylinder head.
- Remove crankshaft locking tool and replace sealing plug.
- Install intake camshaft baffle and cylinder head cover.
  - Check for correct seating of half-moon seals (A) in back of cylinder head cover.
  - Use a small amount of Three Bond 1209 ® or equivalent sealant at corners (B) of half-moon cutouts.
  - Similarly, seat gasket and seal corners in front of cylinder head, at VANOS control unit.

#### Tightening torque

Cylinder head cover to cylinder head (M6)	10 Nm (89 in-lb)
---	------------------

- Remainder of installation is reverse of removal.

#### Tightening torques

Radiator fan (viscous clutch) to coolant pump	40 Nm (30 ft-lb)
Spark plug to cylinder head	25 Nm (18 ft-lb)

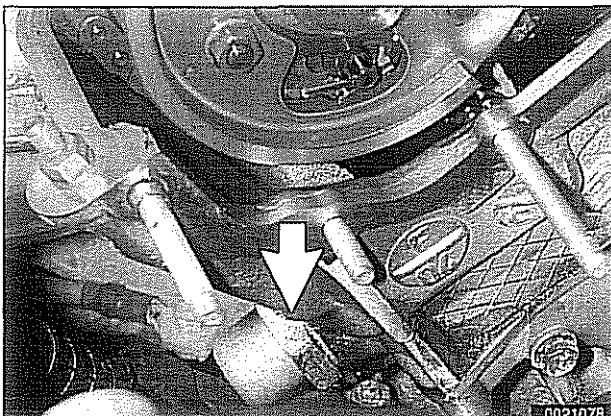
### VANOS timing, checking and adjusting (M52 TU and M54 engines)

Use this procedure to check and, if necessary, adjust camshaft timing. This procedure assumes that the cylinder head cover and intake camshaft plastic baffle have been removed. Also, be sure the cooling fan and the spark plugs have been removed.

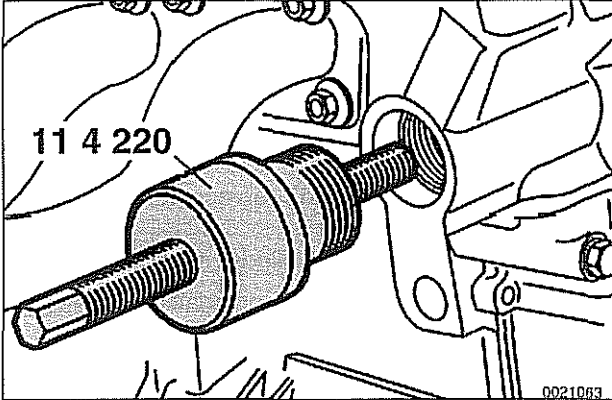
- Remove primary camshaft chain tensioner cylinder (arrow).

#### CAUTION—

Primary camshaft chain tensioning piston is under spring pressure.



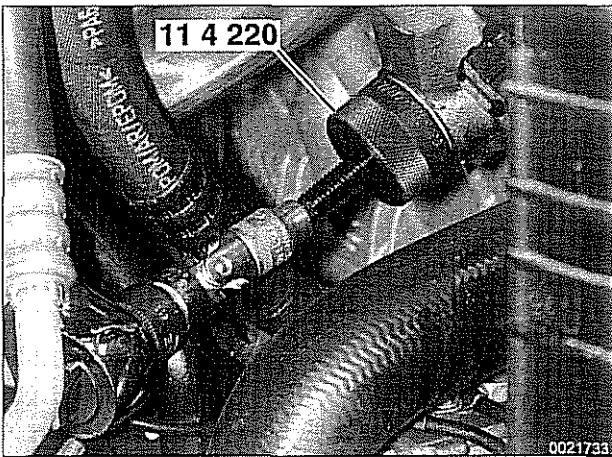
## Camshaft Timing Chain



- ◀ Insert BMW special tool 11 4 220 in cylinder head and bring adjustment screw into contact with tensioning rail.

**NOTE—**

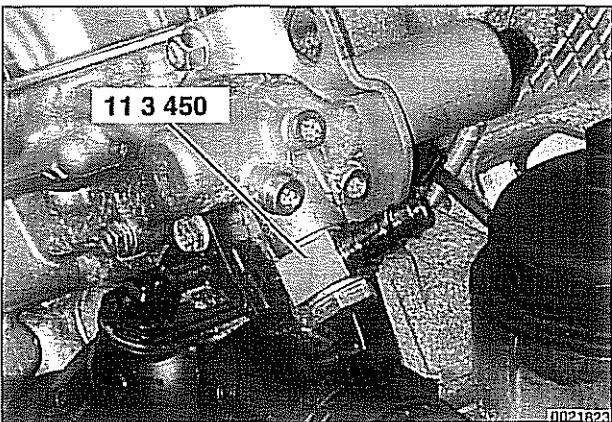
BMW special tool 11 4 220 is an adjustable primary chain tensioner that simulates the function of the tensioner.



- ◀ Preload primary chain tensioner rail:
  - Tighten adjusting screw on BMW special tool 11 4 220.

**Tightening torque**

Primary chain tensioner preload	0.7 Nm (6 in-lb)
---------------------------------	------------------



- ◀ Unscrew oil pressure pipe from VANOS control unit. Remove banjo bolt from oil pressure line and install BMW special tool 11 3 450.

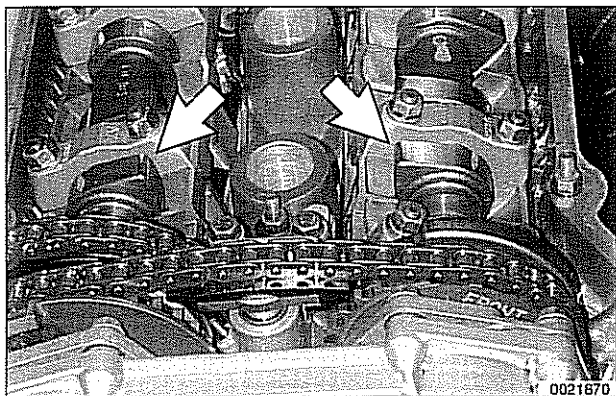
**CAUTION—**

Cover top of VANOS control unit with lint-free shop cloth. Attachment of compressed air line will force oil to spray out of bore.

- Connect compressed air line to air fitting. Apply air pressure set to 2 - 8 bar (30 - 110 psi).



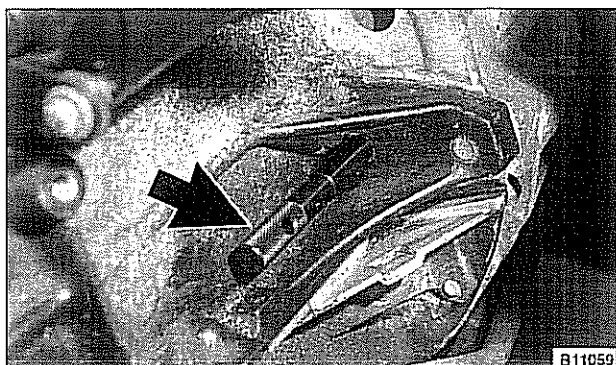
## Camshaft Timing Chain



- With compressed air line connected, turn engine at least twice in direction of rotation until cylinder 1 intake and exhaust camshaft lobes (**arrows**) face each other.

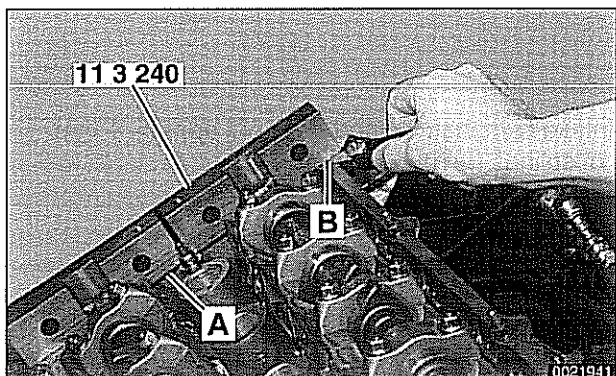
**CAUTION—**

*Do not rotate engine counterclockwise to reach the top dead center position. Instead, complete another two complete rotations.*



- Remove sealing plug from bore at bellhousing. Secure crankshaft in TDC position with BMW special tool 11 2 300 (**arrow**).

- Remove cylinder head cover studs at rear of cylinder head.



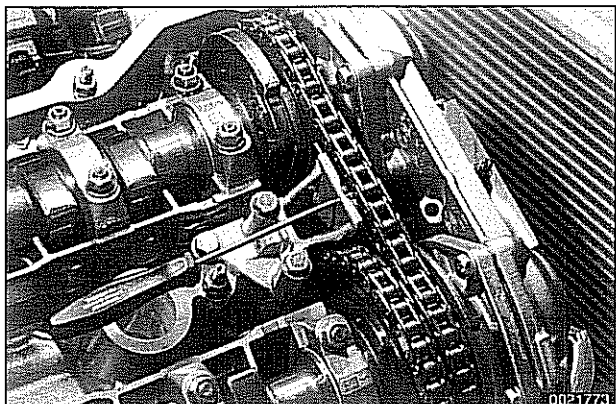
- Place BMW special tool 11 3 240 over camshafts ends and measure clearance of tool to cylinder head surface.

**NOTE —**

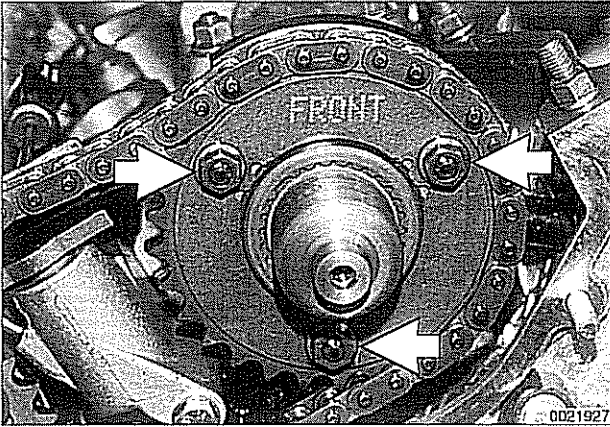
- If the exhaust side of the tool (**A**) is not flush with the head, adjust camshaft timing as described below.
- Due to flexible sprocket design and VANOS control unit tolerances and play, the intake side of special tool 11 3 240 (**B**) may be up to 1 mm (0.04 in) above the surface of the cylinder head. This is normal. Reassemble engine. Otherwise, adjust camshaft timing as described below.

- Remove double VANOS control unit. See **VANOS control unit, removing (M52 TU and M54 engines)**.

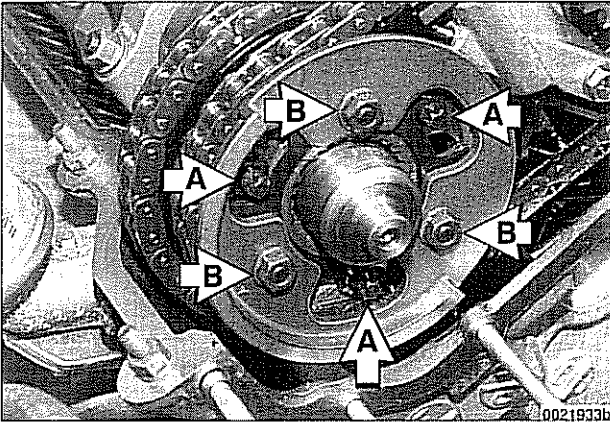
- Press down on secondary chain tensioner and lock into place using BMW special tool 11 3 292 or equivalent pin or drift.



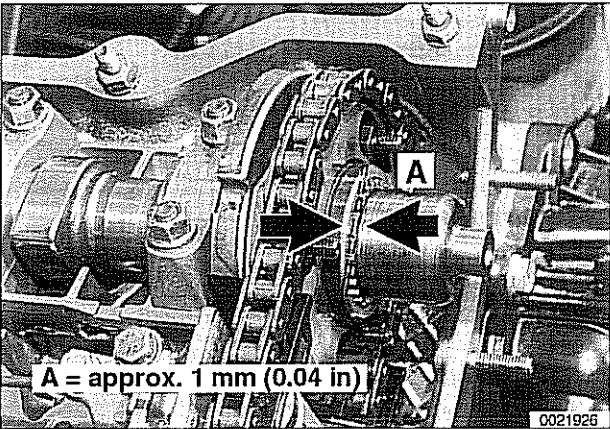
## Camshaft Timing Chain



- ◀ Loosen intake camshaft sprocket mounting nuts (arrows) by 1 turn.



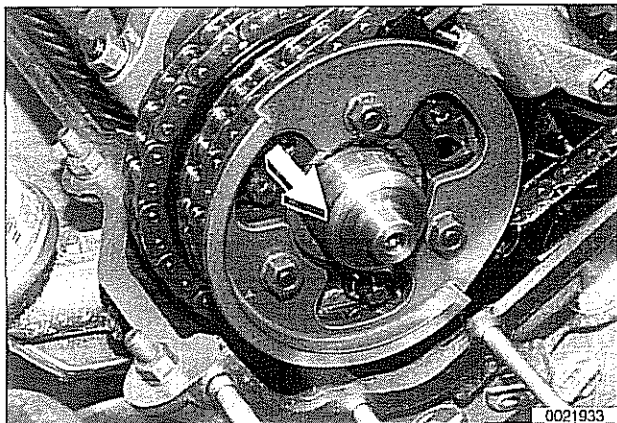
- ◀ Loosen exhaust camshaft sprocket mounting bolts:
  - Release bolts (A) 1/2 turn
  - Release nuts (B) 2 turns



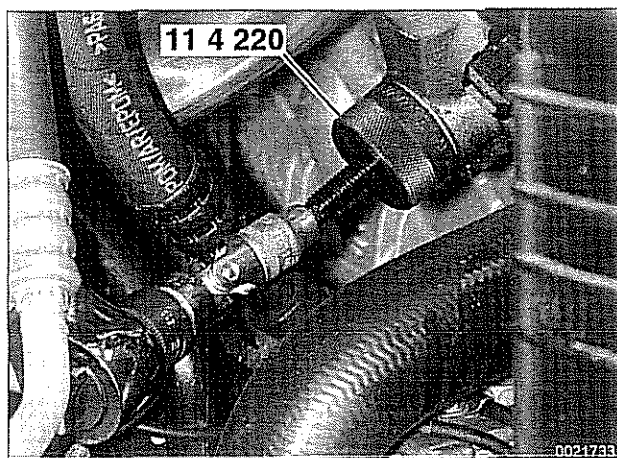
- ◀ Pull out intake camshaft splined shaft out approx. 1 mm (0.04 in) of splines (arrows) can be seen.



## Camshaft Timing Chain



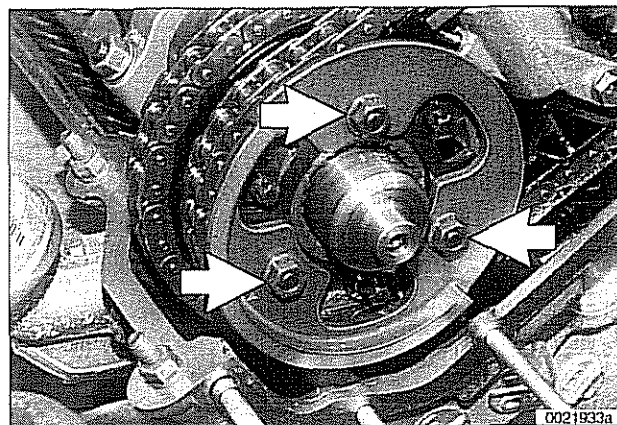
- Pull out exhaust camshaft splined shaft to stop.
- Make sure camshafts are secured in TDC position using BMW special tools 11 3 240 and 11 3 244.



- Preload primary chain tensioning rail:
  - Tighten adjusting screw on BMW special tool 11 4 220.

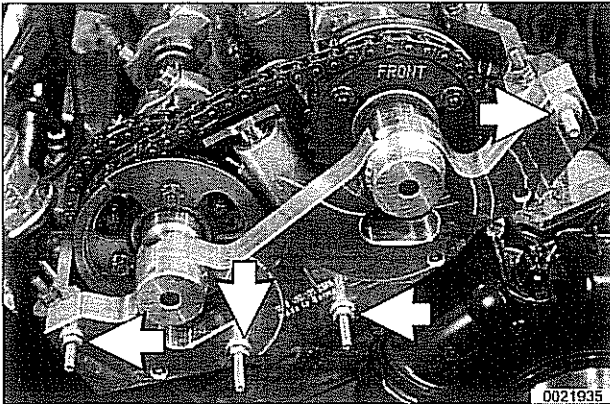
**Tightening torque**

Primary chain tensioner preload	0.7 Nm (6 in-lb)
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- Preload exhaust camshaft spring plate by pressing on impulse wheel. Tighten mounting nuts (arrows) by hand. Do not tighten fully.

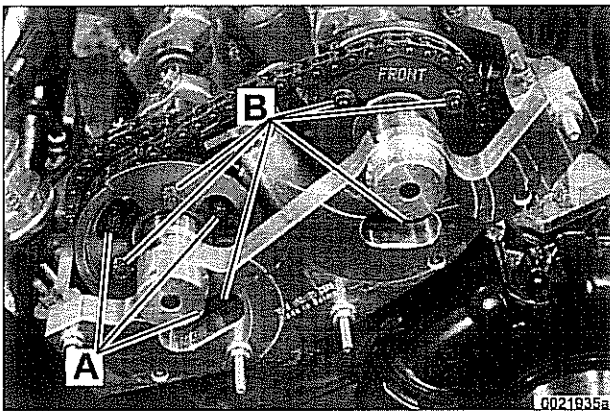
## Camshaft Timing Chain



- Install BMW special tool 11 6 150 (VANOS setup bracket) to front of cylinder head timing case. Tighten nuts (**arrows**) by hand, and then tighten down uniformly until special tool is in full contact with cylinder head.

### CAUTION—

Make sure all gasket material is removed from face of cylinder head. Clean sealing face and keep free of oil.



- Secure camshaft impulse sprockets and wheels:
  - Pretighten Torx screws (**A**) on exhaust camshaft impulse wheel to approx. 5 Nm (44 in-lb).
  - Pretighten mounting nuts (**B**) on exhaust and intake sprocket assemblies to approx. 5 Nm (44 in-lb).
  - Torque down Torx screws (**A**) and nuts (**B**) to final specifications.

### Tightening torques

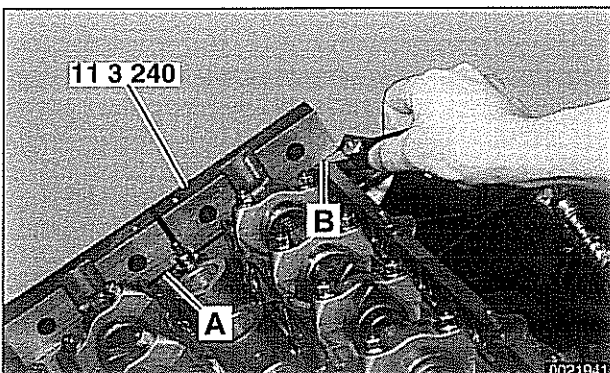
Sprocket assembly to camshaft initial torque	5 Nm (44 in-lb)
Sprocket assembly to camshaft M7 Torx screw ( <b>A</b> )	20 Nm (15 ft-lb)
M6 mounting nut ( <b>B</b> )	10 Nm (89 in-lb)

- Remove flywheel locking tool from transmission bellhousing so that crankshaft is no longer locked.
- Remove camshaft locking tools from rear of cylinder head.
- Crank engine over twice by hand in direction of rotation until cylinder 1 intake and exhaust camshaft lobes face each other again.
- Secure crankshaft with BMW special tool 11 2 300.

- Place BMW special tool 11 3 240 over camshaft ends and measure clearance of tool to cylinder head surface.

### NOTE—

- If the exhaust side of the tool (**A**) is not flush with the head, camshaft timing is incorrect. Repeat camshaft timing procedure.
- Due to flexible sprocket design and VANOS control unit tolerances and play, the intake side of special tool 11 3 240 (**B**) may be up to 1 mm (0.04 in) above the surface of the cylinder head. This is normal. Otherwise, repeat camshaft timing procedure.



- Remove camshaft locking tools from rear of camshafts.
- Remove BMW special tool 11 4 220 (adjustable primary chain tensioner). Reinstall primary chain tensioner.

**Tightening torque**

Primary chain tensioner to cylinder head	70 Nm (52 ft-lb)
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- Remove crankshaft locking tool from transmission bellhousing. Reinstall sealing plug.
- Remove VANOS setup bracket from front of cylinder head.
- Install VANOS control unit as described earlier in this group.
- Remove compressed air fitting (BMW special tool 11 3 450) from VANOS control unit.
- Fit VANOS oil line banjo bolt with new seals. Attach oil line to VANOS control unit.

**Tightening torque**

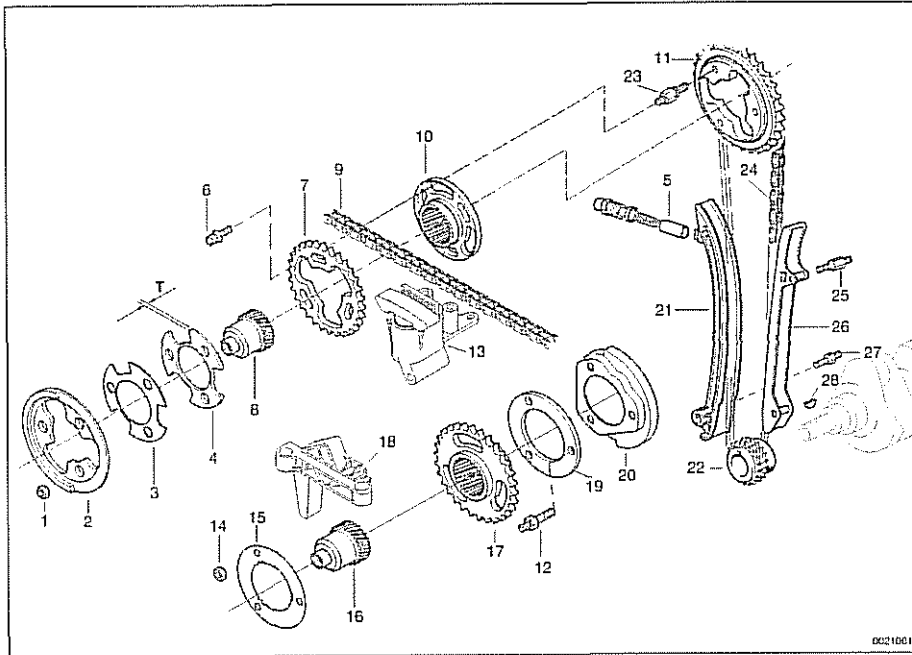
Oil line to VANOS control unit (banjo bolt)	32 Nm (24 ft-lb)
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- Remainder of installation is reverse of removal, noting the following:
  - Install spark plugs.
  - Install intake camshaft plastic baffle prior to installing cylinder head cover. Install ignition coil packs and connect electrical harness connectors.
  - Install radiator cooling fan.
  - Install air filter housing and top engine cover.

**Tightening torque**

Radiator cooling fan (viscous clutch) to coolant pump	40 Nm (30 ft-lb)
Cylinder head cover to cylinder head	10 Nm (89 in-lb)
Spark plug to cylinder head	25 Nm (18 ft-lb)

## Camshaft Timing Chain

Timing chains assembly  
(M52 TU and M54 engines)

1. Impulse wheel mounting nut
2. Camshaft impulse wheel (exh.)
3. Spring plate
4. Thrust spacer (T = 3.5 mm)
5. Primary chain tensioner
6. Torx screw
7. Exhaust secondary sprocket
8. Splined shaft
9. Secondary timing chain
10. Splined sleeve
11. Primary sprocket
12. Threaded stud
13. Secondary chain tensioner
14. Sprocket mounting nut
15. Spring plate
16. Splined shaft
17. Intake camshaft sprocket
18. Secondary chain lower guide
19. Thrust spacer
20. Camshaft impulse wheel (intake)
21. Chain tensioner rail
22. Crankshaft sprocket
23. Threaded stud
24. Primary chain
25. Threaded stud
26. Guide rail
27. Threaded stud
28. Woodruff key

## Timing chains, removing (M52 TU and M54 engines)

Camshaft timing chain removal requires that the oil pan be removed. See **119 Lubrication System**. Also required is removal of the VANOS control unit and disassembly of the intake and exhaust camshaft sprocket assemblies as described earlier in this repair group.

Special BMW service tools are needed for timing chain removal and installation. The special tools assure proper timing of the valvetrain. Precise marks to set the timing on the camshafts are not provided for reassembly. Read the procedures through before beginning the job.

### CAUTION—

*If the camshafts are not properly timed, the pistons can contact the valves.*

- Disconnect negative (-) cable from battery.

### CAUTION—

- *Disconnecting the battery may erase fault code(s) stored in control module memory. Check for fault codes using special BMW diagnostic equipment.*
- *Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.*

- Remove VANOS control unit. See **VANOS control unit, removing (M52 TU and M54 engines)**.

- ◀ Remove sealing plug from crankcase below starter and secure crankshaft with BMW special tool 11 2 300.

- Drain engine cooling system. See **170 Radiator and Cooling System**.

- Remove belt driven cooling fan, fan shroud, and thermostat housing. See **170 Radiator and Cooling System**.

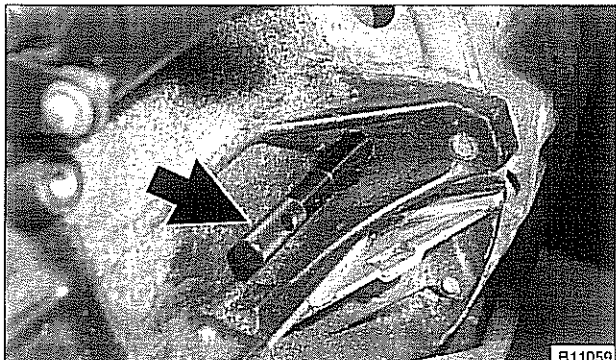
- Remove drive belts. See **020 Maintenance**.

### NOTE—

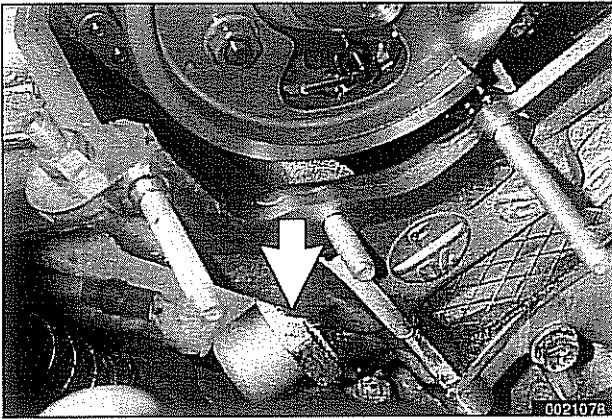
*Mark direction of belt rotation if reusing belt.*

- Remove water pump pulley fasteners and pulley.

- Drain engine oil and remove oil pan as described in **119 Lubrication System**.



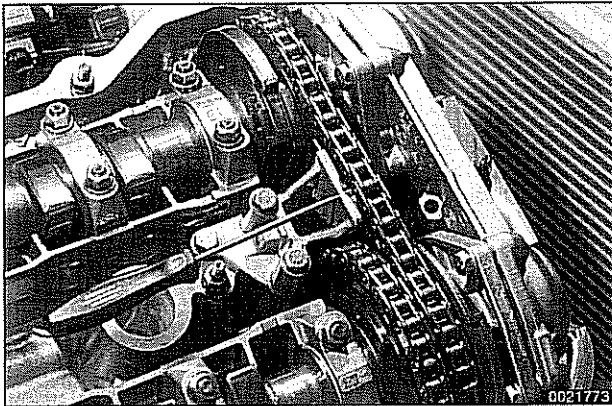
**Camshaft Timing Chain**



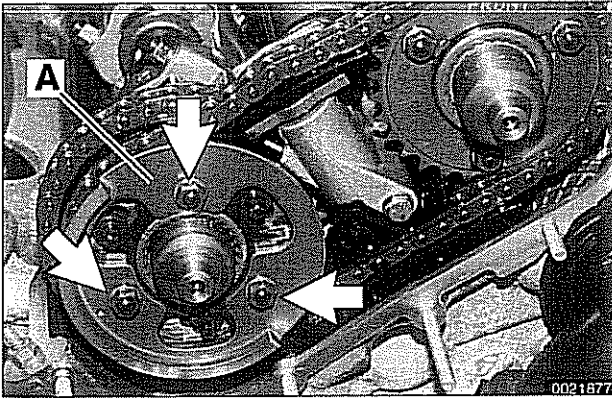
- Remove primary camshaft chain tensioner (arrow) from timing chain cover.

**CAUTION—**

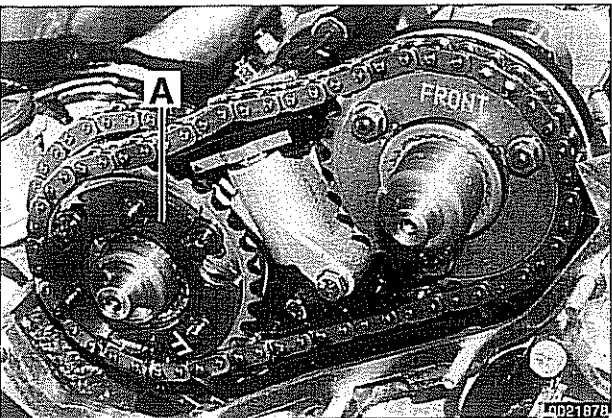
Primary camshaft chain tensioning piston is under spring pressure.



- Press down on secondary chain tensioner and lock into place using BMW special tool 11 3 292 or a similar size wire.

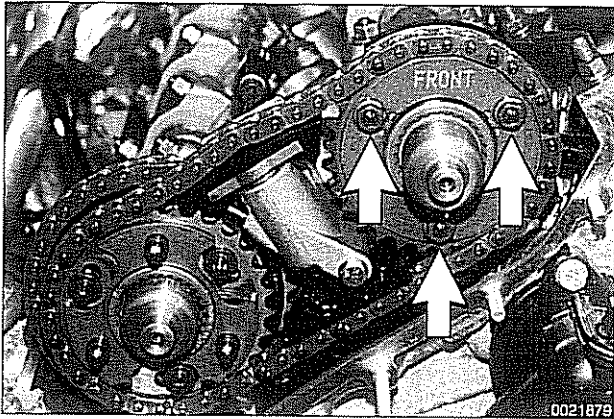


- Remove exhaust camshaft impulse wheel mounting nuts (arrows). Remove impulse wheel (A).

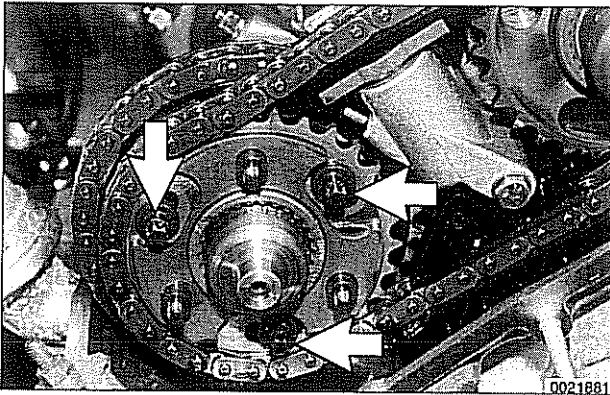


- Remove spring plate (A).

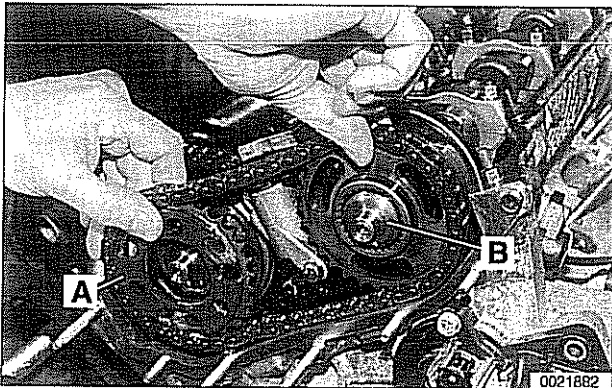
## Camshaft Timing Chain



- Remove intake camshaft sprocket mounting nuts (arrows) and remove spring plate (labelled **FRONT**).



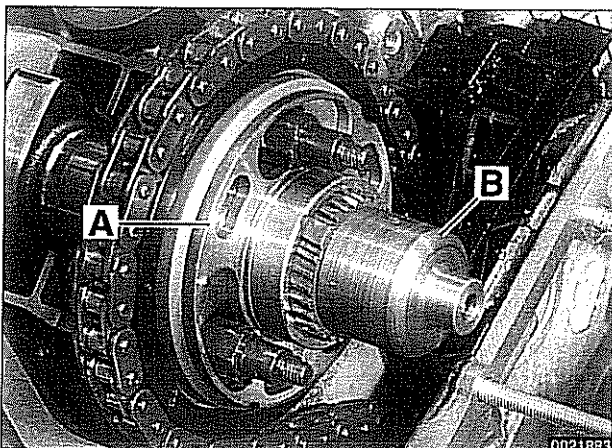
- Remove torx screws from exhaust camshaft sprocket (arrows).



- Lift off exhaust and intake sprockets with secondary chain, thrust spacer (A) and splined shaft (B).

**CAUTION—**

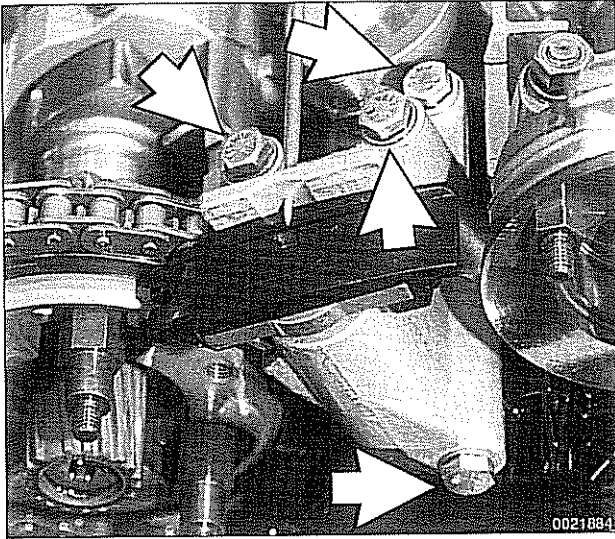
*Splined shafts for both intake and exhaust camshafts share the same part number. Remove and mark used splined shafts in order to reinstall in original locations.*



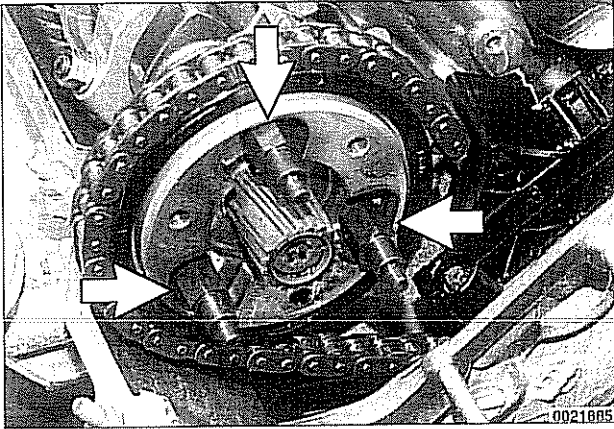
- Remove exhaust camshaft splined sleeve (A) and shaft (B).



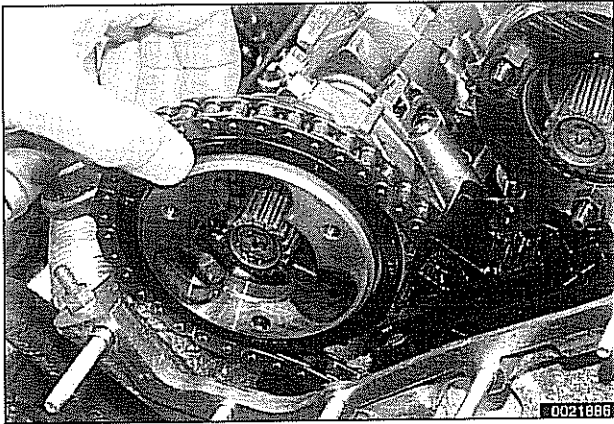
## Camshaft Timing Chain



- Remove secondary chain tensioner mounting bolts (arrows). Remove tensioner while keeping locking pin in place.



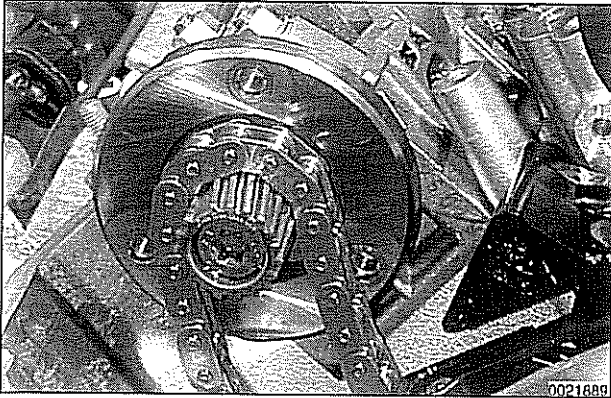
- Remove primary chain sprocket mounting studs (arrows) on exhaust camshaft.



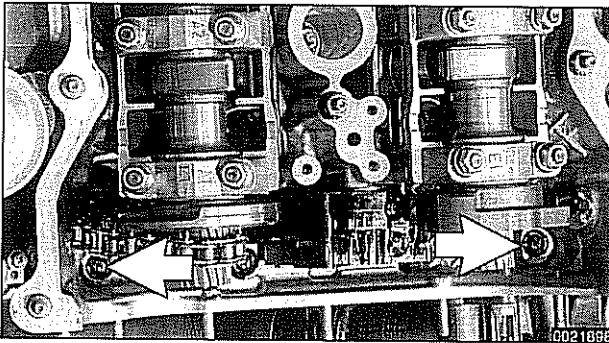
- Lift primary chain sprocket off exhaust camshaft. Remove sprocket from chain.



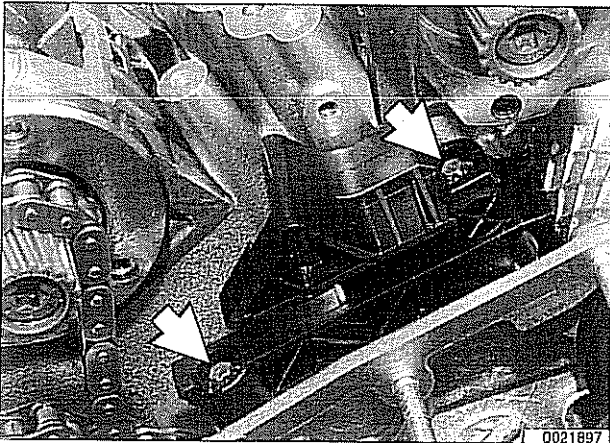
## Camshaft Timing Chain



◀ Set timing chain on exhaust camshaft end.



◀ Working in cylinder head cavity, remove timing chain cover bolts (arrows).



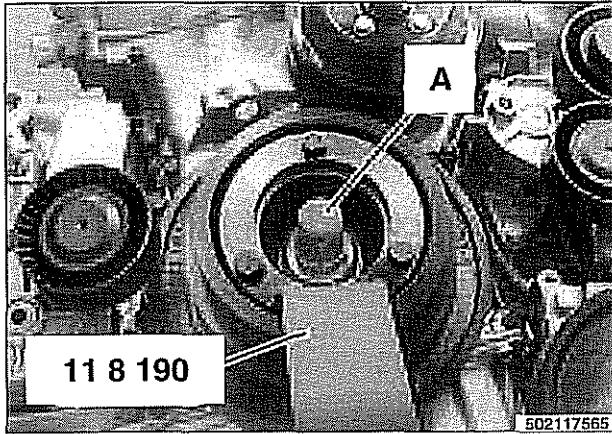
◀ Remove secondary chain lower guide bolts (arrows). Remove chain guide.

**NOTE**—

*Bolt on intake camshaft side is long and extends into timing chain cover.*

— Remove crankshaft locking tool from transmission bellhousing.

## Camshaft Timing Chain



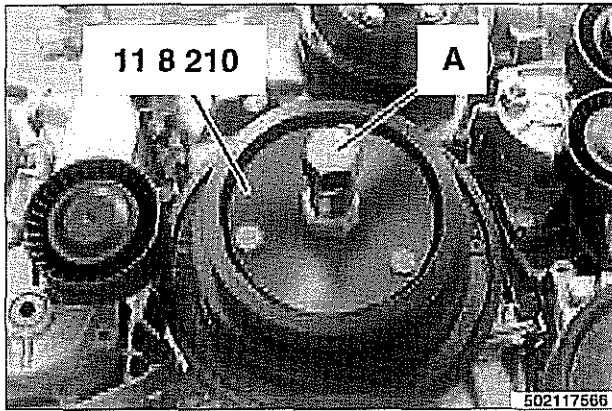
- Install crankshaft holding tool (BMW special tool 11 8 190/11 8 200). Make sure cut outs in tool engages openings in damper assembly. While counterholding crankshaft with special tool, remove crankshaft center bolt (A).

**CAUTION—**

Do not use flywheel locking tool to hold crankshaft stationary to loosen or tighten crankshaft hub center bolt. Use only the special tools specified, or equivalent hub holding tool.

**NOTE—**

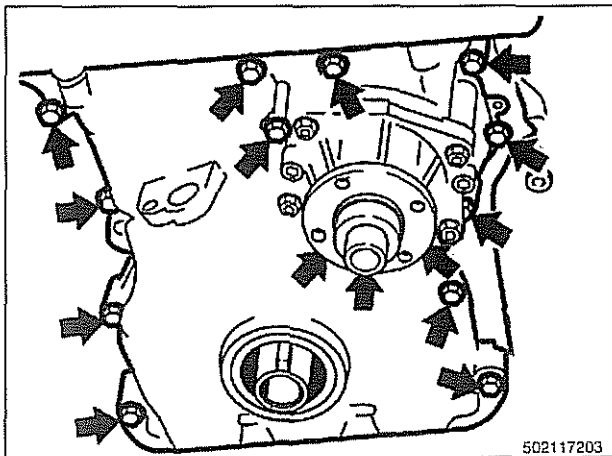
The crankshaft hub center bolt is tightened to a torque of 410 Nm (300 ft-lb).



- Install crankshaft damper puller (BMW special tool 11 8 210) to 11 8 200. and (A) remove damper from crankshaft.

**CAUTION—**

The crankshaft must not be allowed to rotate when the timing chains are loosened or removed. The pistons can contact the valves. Use appropriate crankshaft holding tool when loosening crankshaft hub center bolt.



- Using a drift of less than 5 mm diameter, drive two locating dowels in left and right sides of lower timing chain cover toward engine. Remove cover mounting bolts (arrows) and carefully lift cover off.

**CAUTION—**

- Use care when removing the cover from the cylinder head gasket. If the cover is stuck, use a sharp knife to separate it from the head gasket.
- If cylinder head gasket is damaged, remove cylinder head and replace head gasket. See 113 Cylinder head and valvetrain.

**NOTE—**

- The chain cover can be removed with the coolant pump installed.
- Use care when removing the cover from the coolant pipe at rear.

- Push primary chain tensioner guide rail aside and remove chain.

## Timing chains, installing (M52 TU and M54 engines)

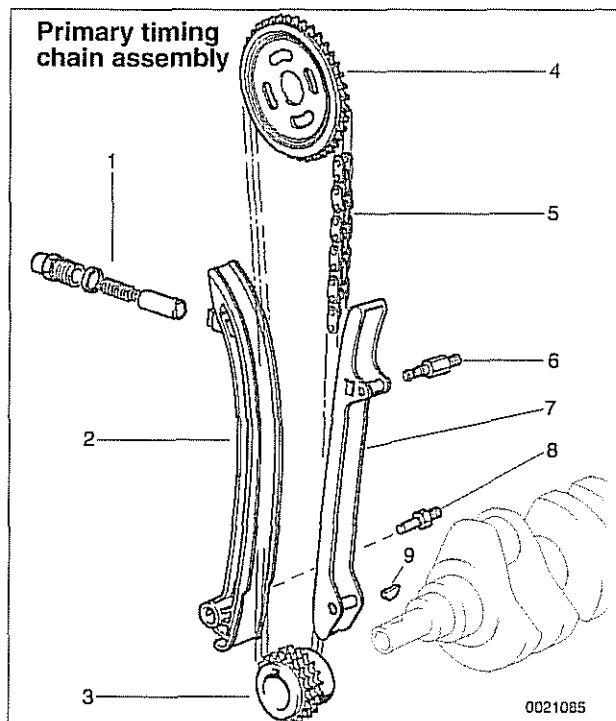
### CAUTION—

The procedure outlined below assumes that the camshafts are locked in the TDC installation position with special locking tools as shown earlier.

- Inspect timing chain sprockets. Inspect guide rail and tensioner rail for damage. Replace any part that is worn or damaged.

### NOTE—

If any sprockets are being replaced due to wear, the chain should also be replaced.



### ◀ Primary timing chain assembly

1. Primary chain tensioner
2. Chain tensioner rail
3. Crankshaft sprocket
4. Exhaust camshaft sprocket
5. Primary chain
6. Anchor bolt
7. Guide rail
8. Anchor bolt
9. Woodruff key

- Install primary timing chain to crankshaft sprocket and hang upper end from exhaust camshaft.
- If necessary, replace crankshaft radial seal in cover. See **Crankshaft oil seal, replacing (M52 TU and M54 engines)**.

## Camshaft Timing Chain

- To install lower timing case cover:
  - Clean cover and cylinder block sealing surfaces.
  - Use new gaskets and coolant pipe O-ring.
  - Remove timing chain cover dowel pins from engine block.
  - Drive timing cover dowels in until they just protrude slightly from sealing surface.
  - Apply a small bead of silicon sealer (Three Bond 1209® or equivalent) to corners of cylinder head where timing cover meets cylinder head and engine block.
  - Tap cover into position until firmly seated.
  - Install all bolts hand tight, including two Torx bolts from above.
  - Install secondary chain lower guide.
  - Tighten cover mounting bolts alternately and in stages.

### Tightening torque

Lower timing cover to cylinder block (M6)	10 Nm (89 in-lb)
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- Install oil pan with new gasket. See **119 Lubrication System**.

### Tightening torque

Oil pan to engine block (M6)	
8.8 grade	10 Nm (89 in-lb)
10.9 grade	12 Nm (9 ft-lb)

- Align damper assembly with keyway and tap into place. Insert new center bolt with washer.

### **CAUTION—**

*Inspect woodruff key for damage before installing hub assembly.*

- Attach special tools 11 8 200/11 8 190 to damper assembly. Counterhold damper with 11 8 190 while tightening center bolt.

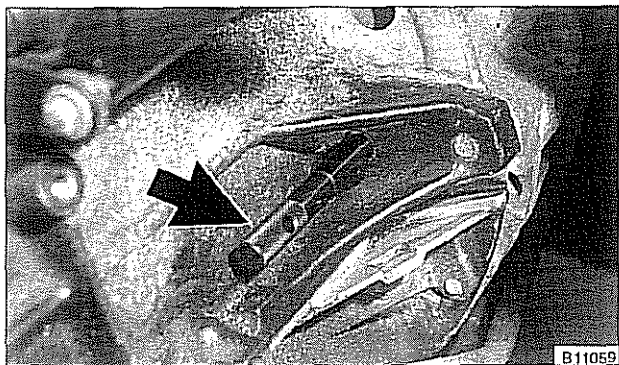
### **CAUTION—**

- *Do not use BMW special tool 11 2 300 to hold crankshaft stationary to tighten crankshaft hub center bolt. Use only the special tools specified, or equivalent hub holding tool.*
- *Have a second person hold special tool 11 8 190 while tightening center crankshaft bolt.*

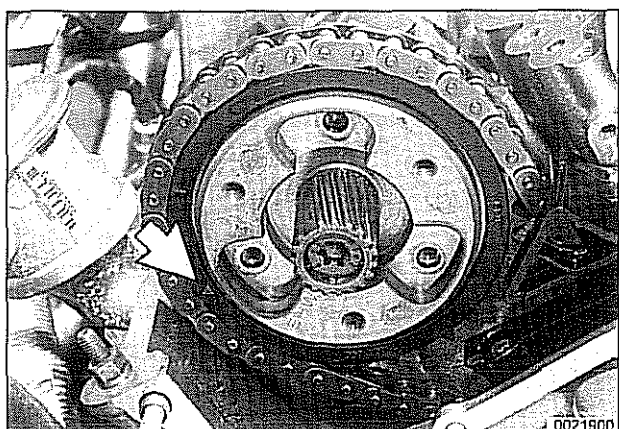
### Tightening torque

Crankshaft hub to crankshaft	410 Nm (300 ft-lb)
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## Camshaft Timing Chain

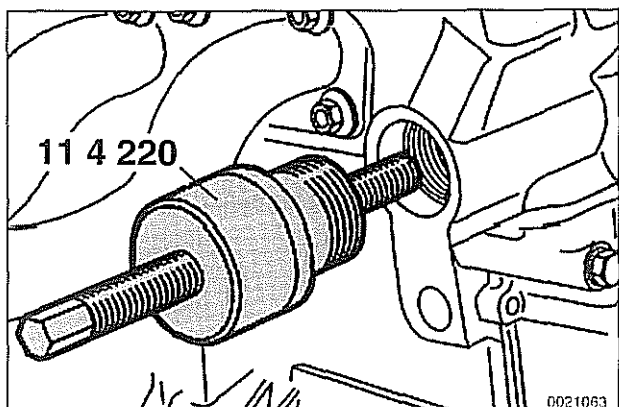


- ◀ Remove BMW special tool 11 2 300.



- ◀ Fit top sprocket to primary timing chain and install on exhaust camshaft so that pointer (**arrow**) on sprocket lines up with cylinder head sealing surface.

- Position sprocket so that chain slack is on tensioner rail side.



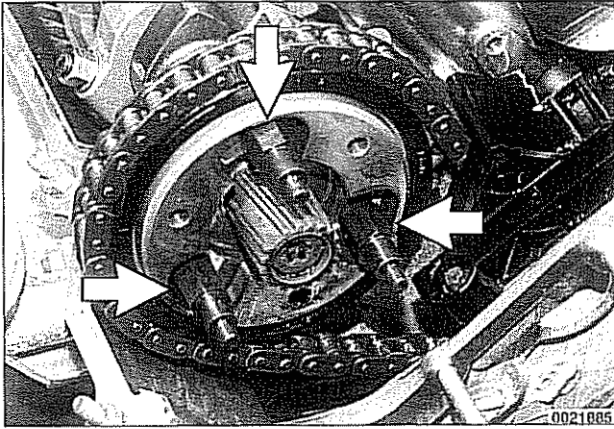
- ◀ Insert BMW special tool 11 4 220 in cylinder head and screw in adjustment screw by hand just until it contacts tensioning rail and chain slack is removed.

**NOTE —**

*BMW special tool 11 4 220 is an adjustable primary chain tensioner that simulates the function of the tensioner.*

- Make sure arrow on top primary sprocket is still lined up with upper edge of cylinder head. Reposition sprocket if necessary.

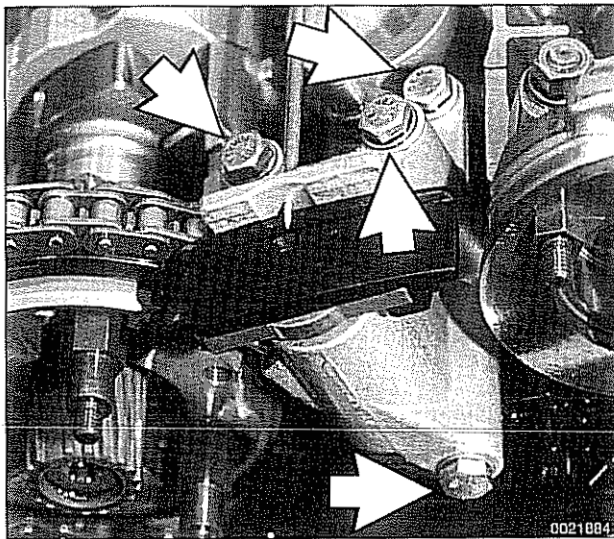
**Camshaft Timing Chain**



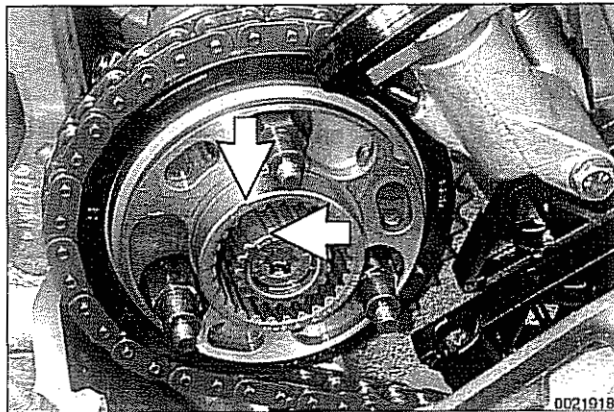
- ◀ Install and tighten down threaded locating studs (**arrows**) in end of exhaust camshaft.

**Tightening torque**

Exhaust camshaft locating stud	20 Nm (15 ft-lb)
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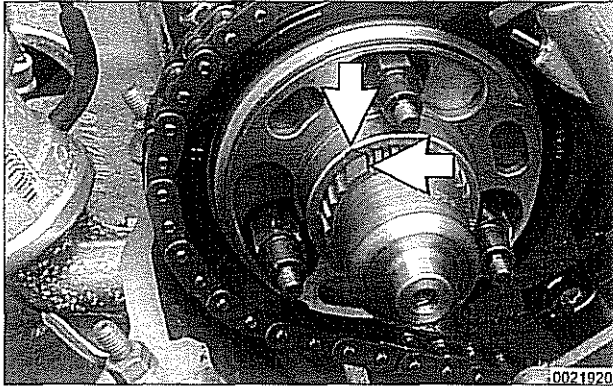


- ◀ Install secondary chain tensioner on cylinder head.
  - Make sure tensioner is locked in compressed position as described earlier.

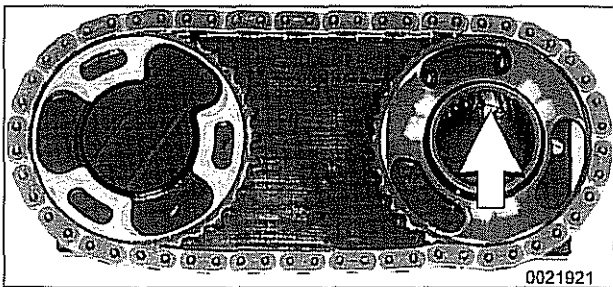


- ◀ Fit exhaust camshaft splined sleeve, aligning gap in sleeve splines with corresponding gap on camshaft splines (**arrows**).

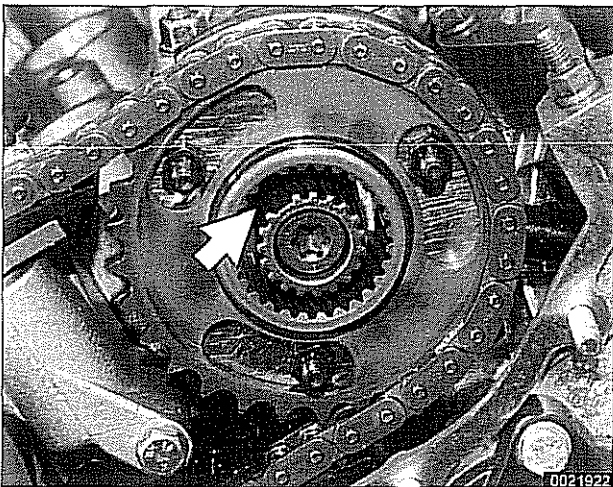
## Camshaft Timing Chain



- Slide splined shaft onto exhaust camshaft, aligning larger tooth with corresponding gap of splined sleeve (**arrows**).
- Slide splined shaft in further until 3 small or elongated slots in splined sleeve are centered to 3 threaded holes in sprocket.



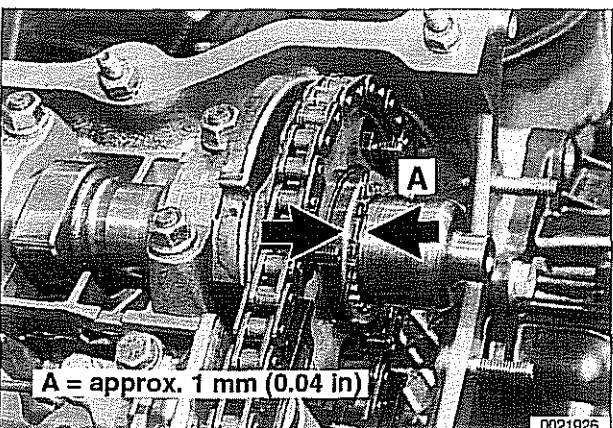
- Place intake and exhaust sprockets in BMW special tool 11 6 180. Position spline gap on intake sprocket (**arrow**) as shown and place secondary chain on sprockets.



- Carefully remove chain and sprockets from tool and slide onto camshafts. Align gap in intake sprocket splines with corresponding gap in camshaft splines (**arrow**).

**CAUTION—**

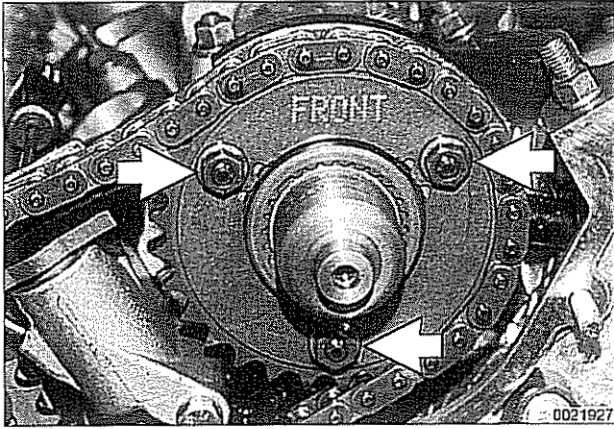
*Do not alter position of sprockets with respect to chain when removing from special tool 11 6 180.*



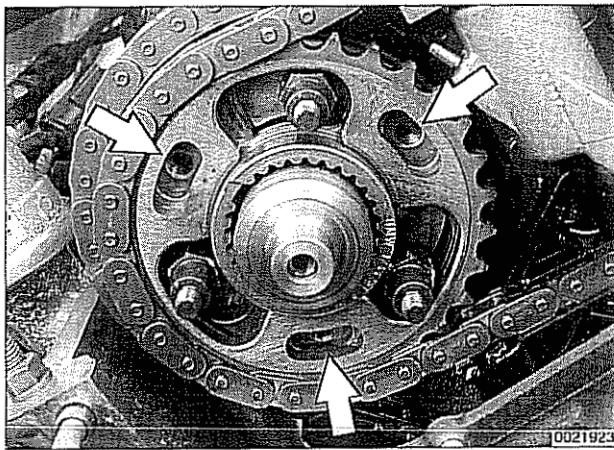
- Slide splined shaft onto intake camshaft until approx. 1 mm (0.04 in.) of splines can still be seen.



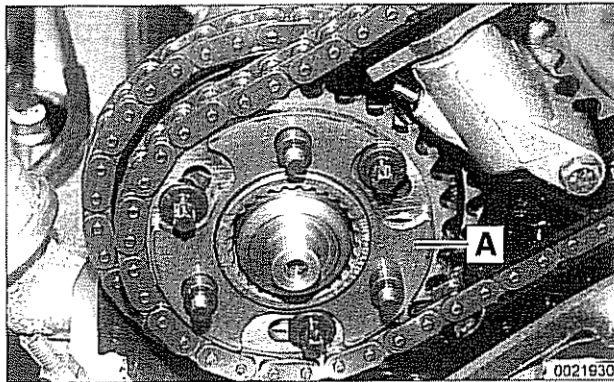
## Camshaft Timing Chain



- ◀ Install intake camshaft spring plate so that FRONT mark is visible. Install mounting nuts (**arrows**) finger tight.



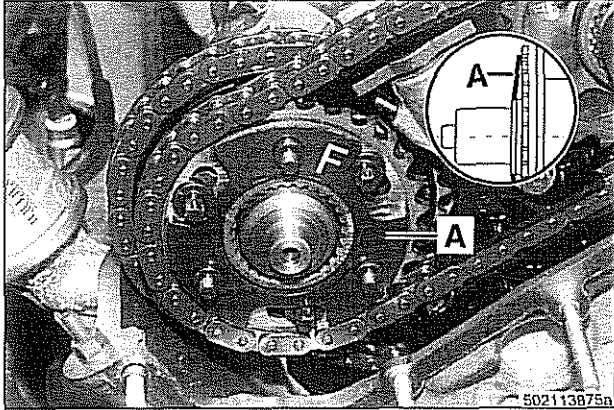
- ◀ Working at exhaust side, insert sprocket mounting Torx screws into threaded holes (**arrows**).
- Initially tighten screws to approx. 5 Nm (44 in-lb), then back off one-half turn.



- ◀ Fit thrust spacer (**A**) on exhaust camshaft.



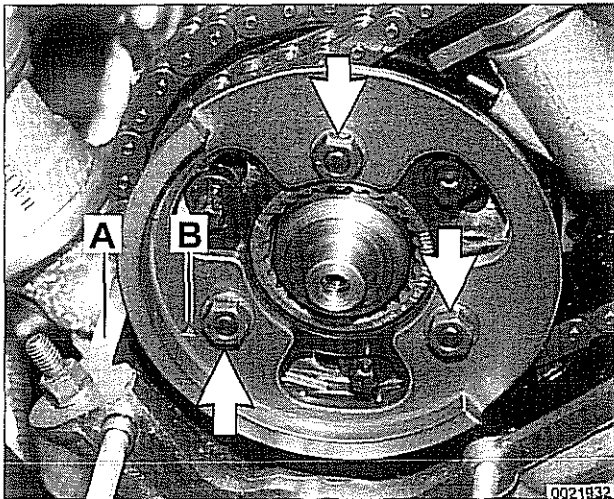
## Camshaft Timing Chain



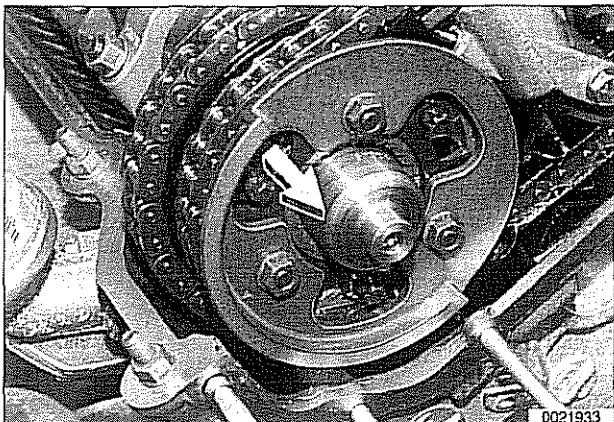
- ◀ Install spring plate (A) to exhaust camshaft. Make sure that F mark is visible.

**NOTE—**

*If F mark is no longer visible, install spring plate as shown.*

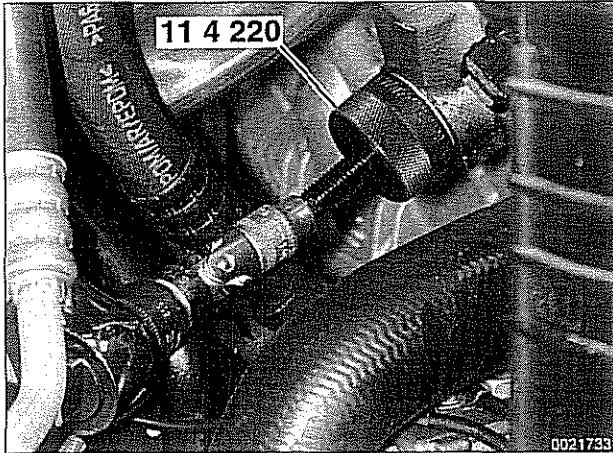


- ◀ Install exhaust camshaft impulse wheel, aligning mark (B) with top edge of cylinder head (A). Install mounting nuts (arrows) finger tight.



- ◀ Pull out exhaust splined shaft until it stops.
- Press down on secondary chain tensioner and remove tensioner lock-down tool.

## Camshaft Timing Chain

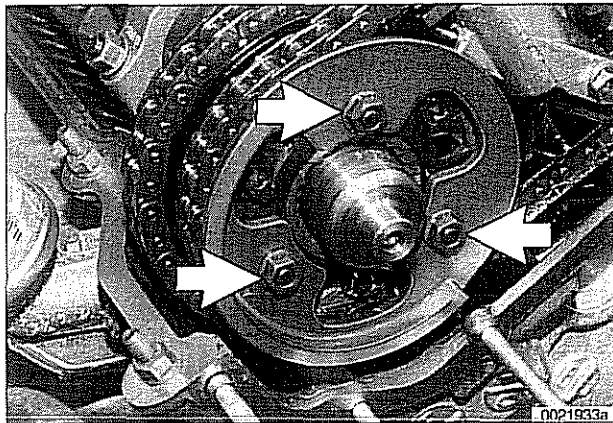


### Preload primary chain:

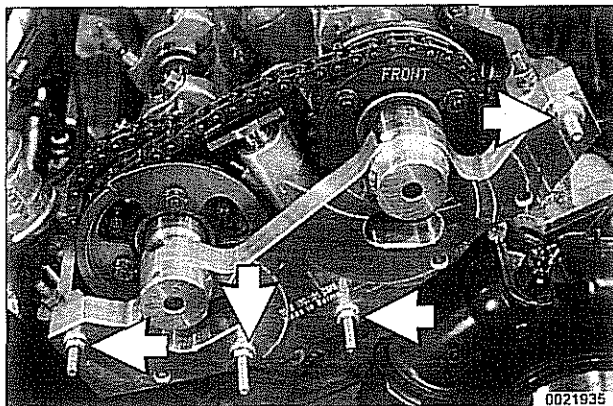
- Tighten adjusting screw on BMW special tool 11 4 220 to specified torque.

### Tightening torque

Primary chain tensioner preload	0.7 Nm (6 in-lb)
---------------------------------	------------------



- Preload exhaust camshaft spring plate by pressing on impulse wheel while tightening mounting nuts (**arrows**) finger tight.



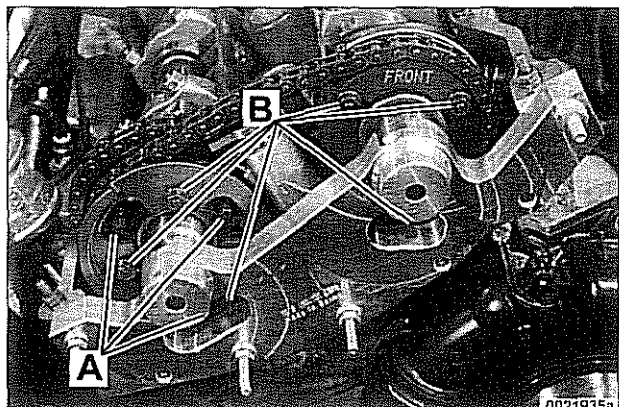
- Install BMW special tool 11 6 150 (VANOS setup bracket) to front of cylinder head timing case.

- Tighten tool mounting nuts (**arrows**) by hand, then tighten down uniformly until special tool is firmly contacting cylinder head.

### CAUTION—

*Make sure all gasket material is removed from face of cylinder head. Clean sealing face and keep free of oil.*

## Camshaft Timing Chain

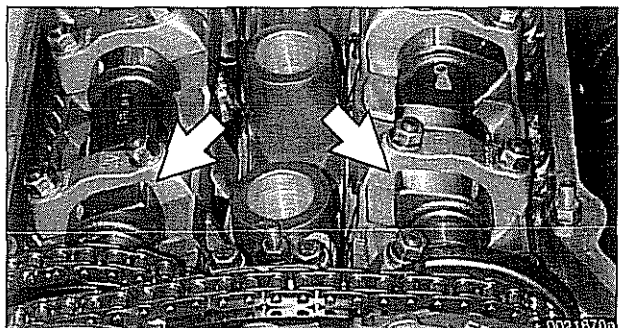


- ◀ Secure camshaft sprockets and impulse wheels:
  - Tighten mounting screws (A) on exhaust camshaft impulse wheel to approx. 5 Nm (44 in-lb).
  - Tighten mounting nuts (B) on exhaust and intake sprocket assemblies to approx. 5 Nm (44 in-lb).
  - Torque down mounting screws (A) and nuts (B) to final specifications.

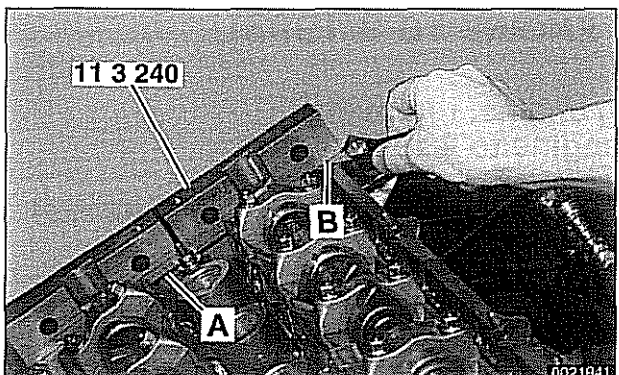
## Tightening torques

Sprocket assembly to camshaft initial torque	5 Nm (44 in-lb)
Sprocket assembly to camshaft M7 Torx screw (A)	20 Nm (15 ft-lb)
M6 mounting nut (B)	10 Nm (89 in-lb)

- Remove flywheel locking tool from transmission bellhousing so that crankshaft is no longer secured.
- Remove camshaft locking tools from rear of camshafts.



- ◀ Crank engine over by hand twice in direction of rotation until cylinder 1 intake and exhaust camshaft lobes (arrows) face each other.
- Secure crankshaft in TDC position with BMW special tool 11 2 300.



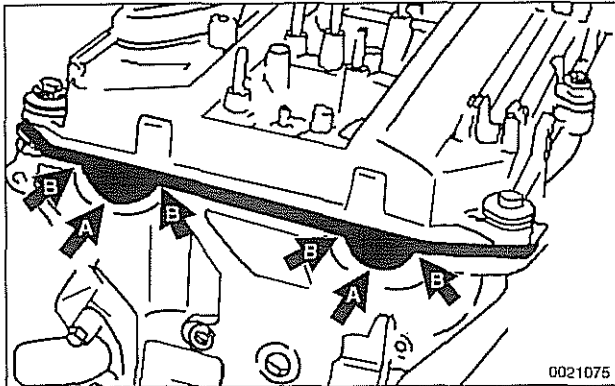
- ◀ Place BMW special tool 11 3 240 over camshaft ends and measure clearance of tool to cylinder head surface.

**NOTE —**

- If the exhaust side of the tool is not flush with the head (gap A), retime the camshafts as described later in this repair group.
- Due to flexible sprocket design and VANOS control unit tolerances and play, the intake side of special tool 11 3 240 may be up to 1 mm (0.04 in) above the surface of the cylinder head (gap B). This is normal. Otherwise, retime the camshafts as described in **VANOS timing, checking and adjusting (M52 TU and M54 engines)**.

- Remove VANOS setup bracket from front of cylinder head.
- Install VANOS control unit. See **VANOS control unit, installing (M52 TU and M54 engines)**.
- Install intake camshaft oil baffle.

## Camshaft Timing Chain



### Install cylinder head cover:

- Check for correct seating of half-moon seals (A) in back of cylinder head cover.
- Use a small amount of Three Bond 1209® or equivalent sealant at corners (B) of half-moon cutouts. Seal corners in front of cylinder head at VANOS control unit.

#### Tightening torque

Cylinder head cover to cylinder head	10 Nm (89 in-lb)
--------------------------------------	------------------

- Remainder of reassembly is reverse of removal, noting the following:
  - Secure all coolant hoses, thermostat housing, engine coolant drains.
  - Install new engine oil filter and oil. See **119 Lubrication System**.
  - Refill and bleed cooling system as described in **170 Radiator and Cooling system**.
  - Use scan tool to check VANOS operation with engine idling.

#### Tightening torques

Coolant drain plug to cylinder block	25 Nm (18 ft-lb)
Radiator cooling fan (viscous clutch) to coolant pump	40 Nm (30 ft-lb)
Radiator drain screw to radiator	2.5 Nm (22 in-lb)
Vibration damper hub to crankshaft	410 Nm (300 ft-lb)

## TIMING CHAIN (M62 ENGINE TO 9/1998)

### Timing chains, removing (M62 engine to 9/1998)

Camshaft timing chain removal requires that the engine oil pan be removed.

Special BMW service tools are needed for timing chain removal and installation procedures. The special tools assure proper timing of the valvetrain. Precise marks to set the timing on the camshafts are not provided for reassembly. Read the procedures through before beginning the job.

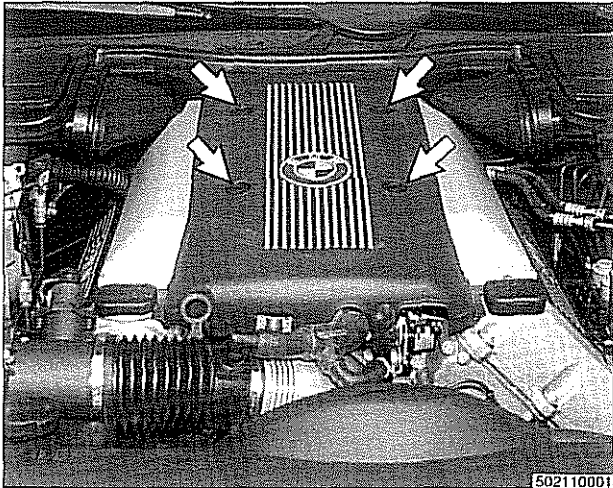
#### **CAUTION—**

*Special BMW service tools are needed for this procedure. Read the procedure through before beginning the job. If the camshafts are not properly timed, the pistons can contact the valves.*

- Disconnect negative cable (-) from battery.

**CAUTION—**

*Prior to disconnecting the battery, read the battery disconnection cautions given in 001 General Cautions and Warnings.*



➤ Removing top and side engine covers:

- Press down on locking pins (**arrows**) to release locks. Lift intake manifold cover straight up to remove.
- Pry out caps from side covers.
- Remove fasteners and covers.

**NOTE—**

*Some early models use pry out trim caps and fasteners to hold the top cover in place.*

- Disconnect electrical harness connectors at ignition coils (**A**).
- Remove left and right side ignition coil mounting fasteners and coils.

**NOTE—**

*Make note of location of ground strap (**arrow**).*

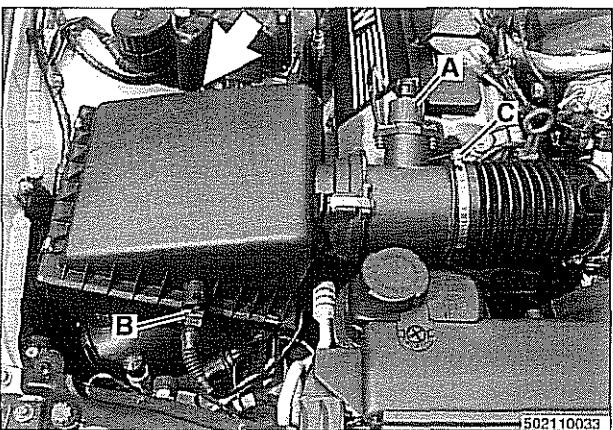
- Remove spark plugs.

- Remove positive (+) terminal cable from left cylinder head cover.

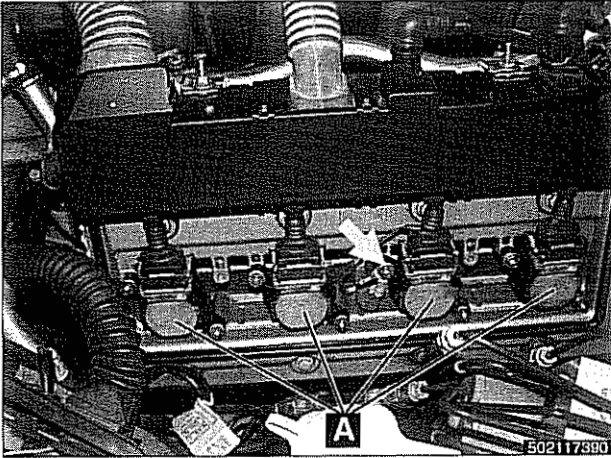
- Unbolt left and right side cable ducts from fuel rail.

➤ Remove air filter housing and mass air flow sensor:

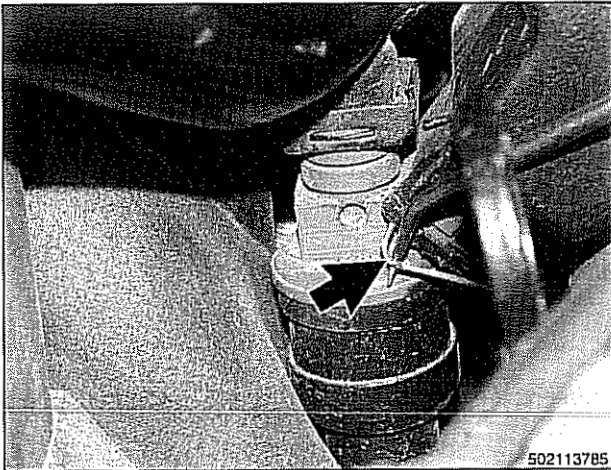
- Disconnect mass air flow sensor and intake air temperature sensor electrical harnesses (**A** and **B**).
- Remove air filter housing mounting fastener (**arrow**).
- Loosen intake hose clamp (**C**).
- Remove air filter housing with mass air sensor and intake duct from throttle body assembly.



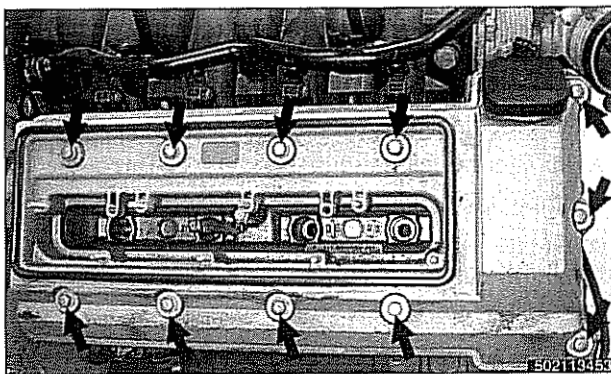
## Camshaft Timing Chain



- ◀ Remove left and right side ignition coils and spark plugs:
  - Remove positive (+) terminal cable from left cylinder head cover.
  - Unbolt left and right side cable ducts from fuel rail.

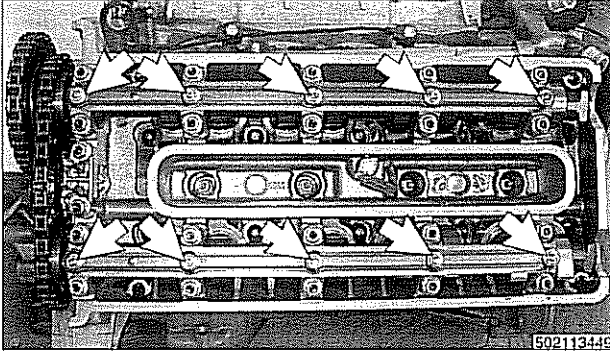


- ◀ Disconnect fuel injector electrical connectors:
  - Pry corner of wire lock clip to release connector from injector (**arrow**).
  - Repeat for all injectors.
  - Lift off wiring ducts.



- ◀ Remove Fasteners (**arrow**) from left and right cylinder head cover fasteners and remove covers.

## Camshaft Timing Chain



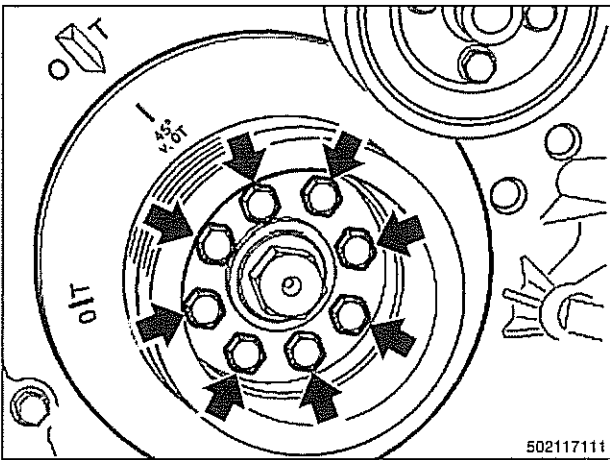
Remove oil lines from camshaft supports (arrows).

- Remove radiator cooling fan and fan shroud. See 170 Radiator and Cooling System.

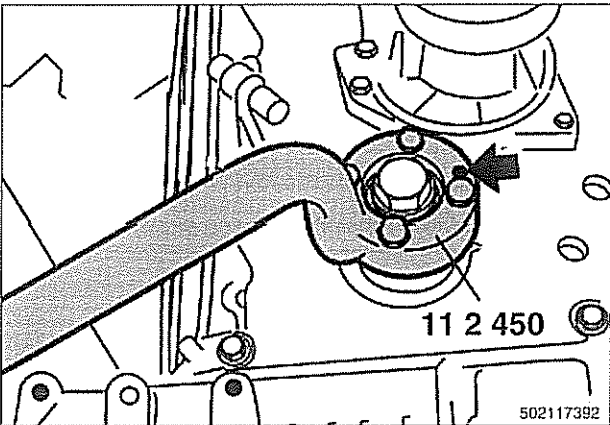
**NOTE—**

The radiator cooling fan nut (32 mm wrench) has left-hand threads.

- Remove engine drive belts alternator and A/C compressor. See 020 Maintenance.



Remove vibration damper bolts (arrows) and remove damper.



Mount BMW special tool 11 2 450 to crankshaft hub while aligning damper locator pin with hole (arrow) in special tool.

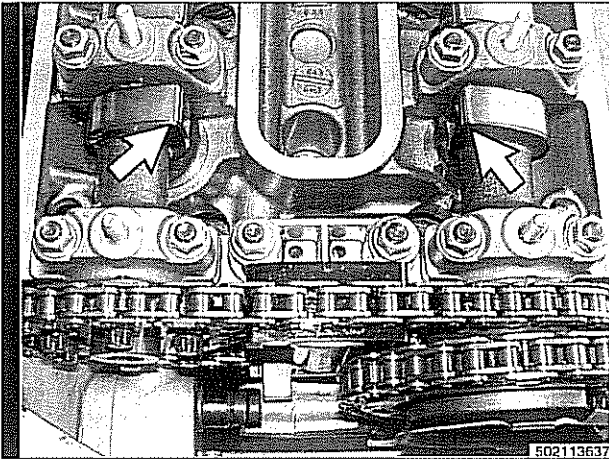
**CAUTION—**

Crankshaft center bolt is torqued to 410 Nm (300 ft-lb) use BMW special tool 11 2 450 to secure crankshaft when removing center bolt.

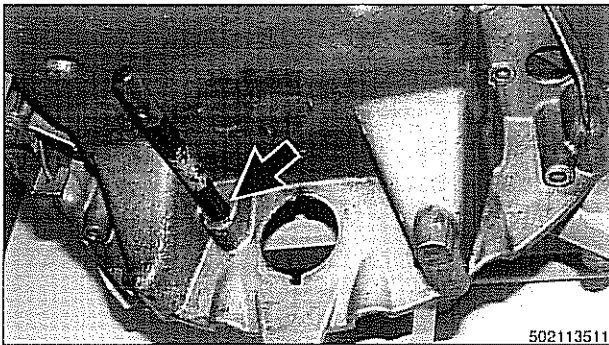
- Loosen and remove crankshaft center bolt.



## Camshaft Timing Chain



- ▲ Using special tool 11 2 450, rotate engine clockwise to TDC with number one cylinder cam lobes facing each other (arrows) as shown.



- ▲ Lock crankshaft in TDC position with BMW special tool 11 3 200 (arrow).

- Remove BMW special tool 11 2 450 and remove hub.
- Remove upper engine oil pan. See **119 Lubrication**.
- Remove alternator. See **121 Battery, Starter, Alternator**.
- Remove retaining bolt for oil dipstick tube from upper timing chain cover on right side.
- Remove camshaft position sensor from right upper timing chain cover.

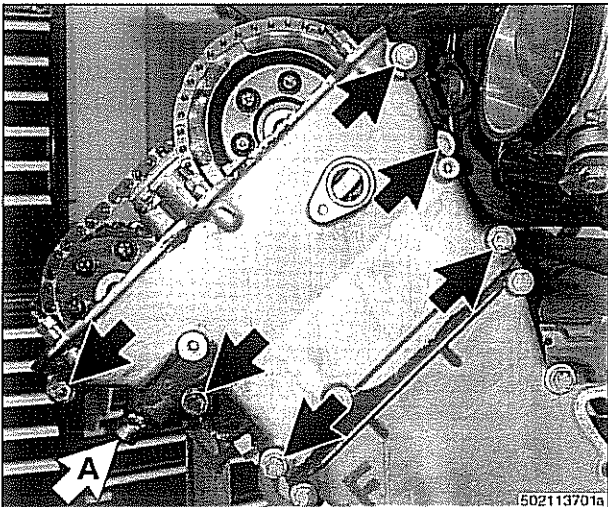
- ▲ Remove right upper timing chain cover:

- Remove chain tensioner (A).

**CAUTION—**

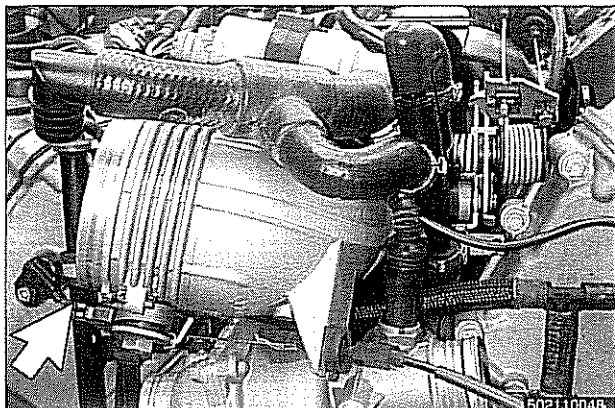
*Tensioner is under spring tension. Release slowly.*

- Release fasteners (arrows) and remove cover.

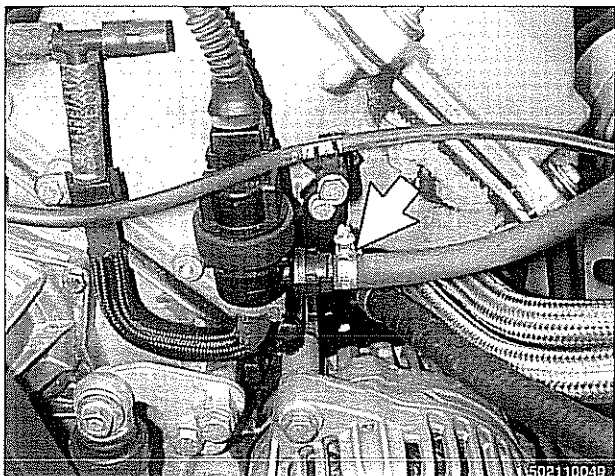




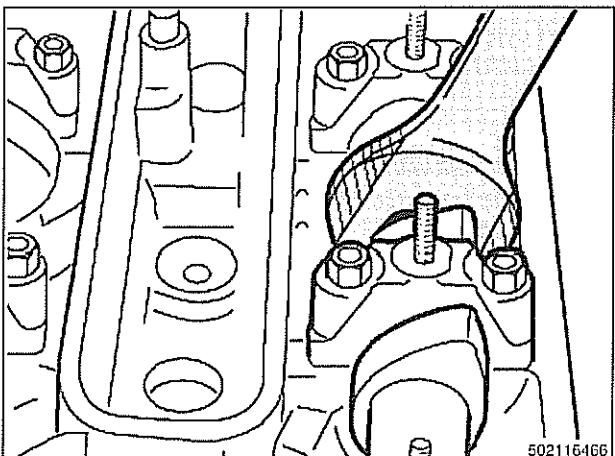
## Camshaft Timing Chain



- Remove Automatic Stability Control (ASC) throttle body:
  - Disconnect electrical harness from throttle position sensor.
  - Disconnect ASC actuator cable (**arrow**).
  - Remove 3 mounting fasteners and remove throttle body.



- Disconnect fuel tank vent valve line and cap off line (**arrow**).
- Drain engine coolant and remove hoses from thermostat housing. See **170 Radiator and Cooling System**.
- Remove water pump and thermostat housing. See **170 Radiator and Cooling System**.
- Remove left side upper timing chain cover retaining bolts and remove cover.

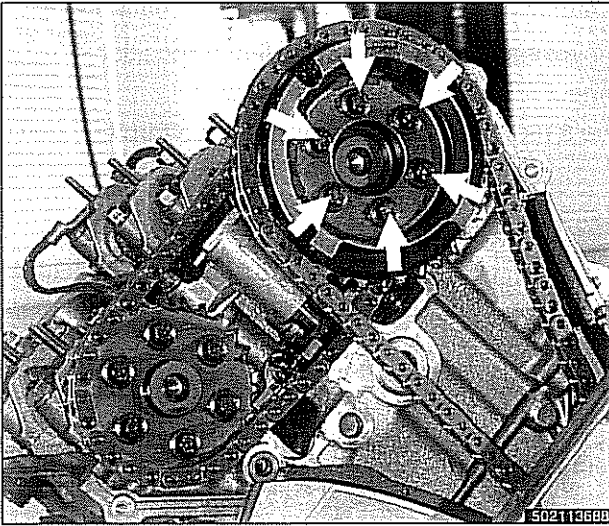


- Counter hold right intake camshaft.

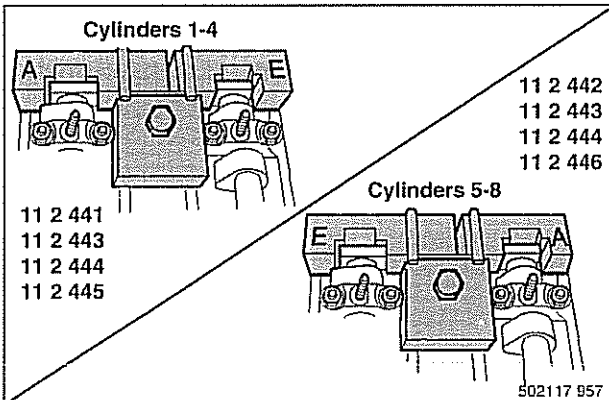
**CAUTION—**

Counter hold camshaft with a 27 mm open-end wrench while loosening sprocket bolts. Grind wrench if necessary to prevent damage to head.

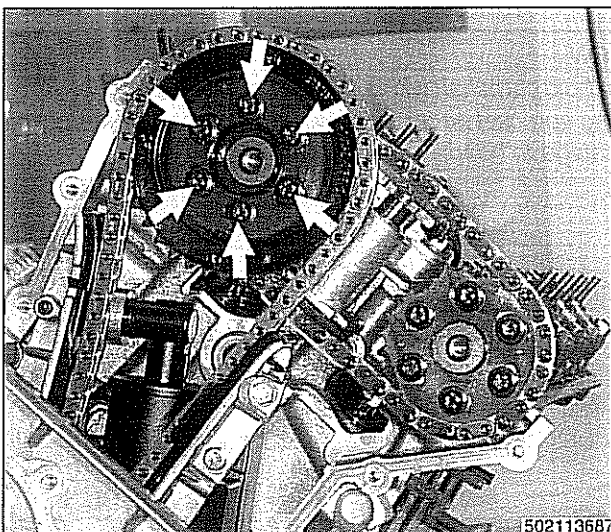
## Camshaft Timing Chain



- ▶ Working at right side cylinder head loosen intake camshaft sprocket bolts (**arrows**).



- ▶ Secure left and right side camshafts in TDC position:
  - Use BMW special tool set 11 2 440.
  - If necessary, turn camshaft so that special tools are squarely seated on cylinder head.



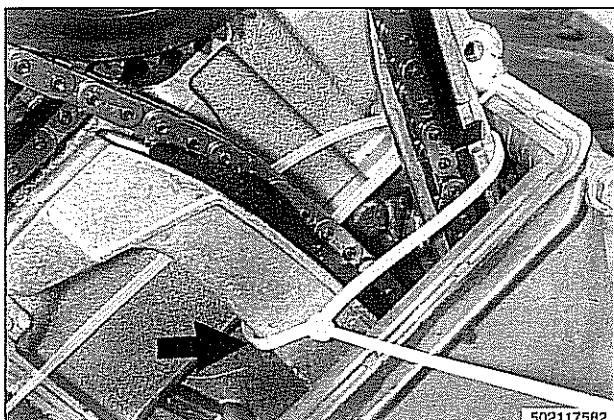
- ▶ Working at left cylinder head loosen intake camshaft sprocket bolts (**arrows**).

**CAUTION—**

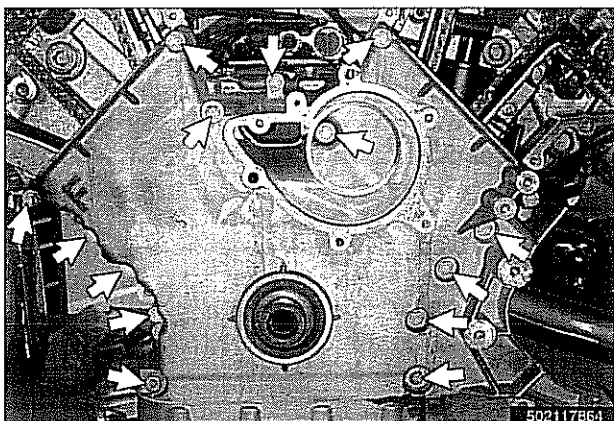
Counter hold camshaft with a 27 mm open-end wrench while loosening sprocket bolts. Grind wrench if necessary to prevent damage to head.

- Remove BMW special tool 11 2 300 from crankshaft locking tool bore.

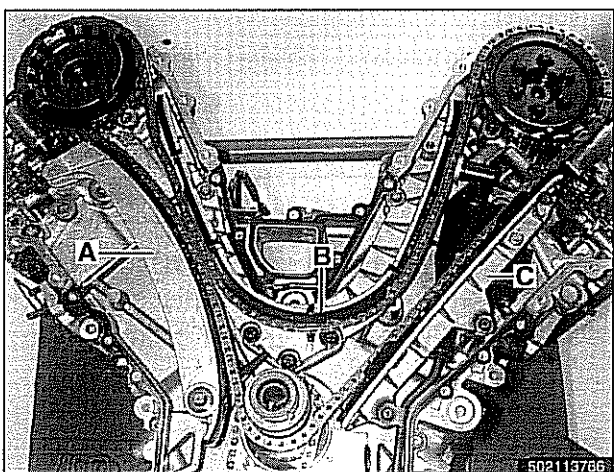
## Camshaft Timing Chain



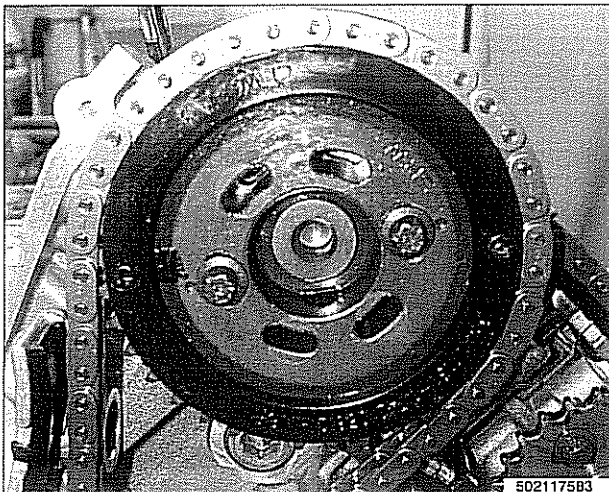
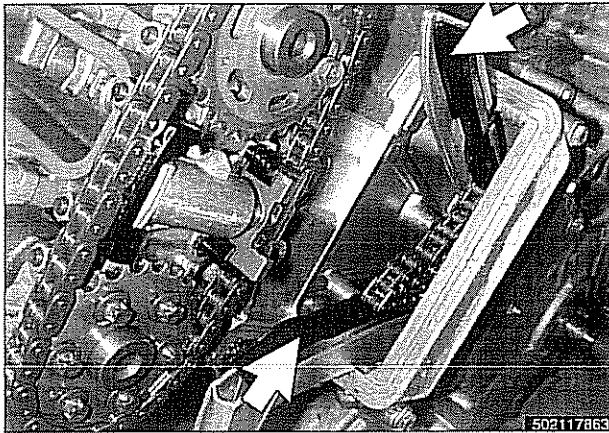
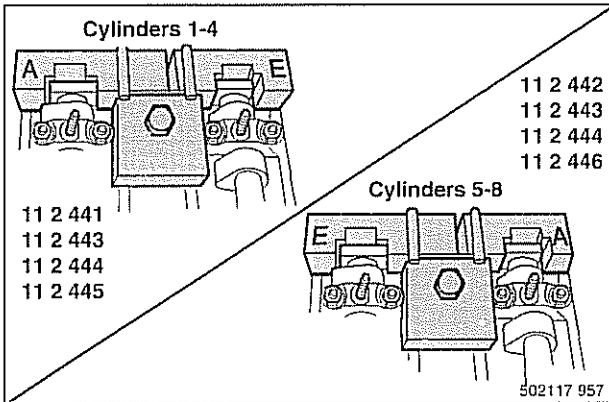
- Secure right side timing chain and guide rails together with a plastic wire ties (arrow).



- Remove lower timing chain cover bolts (arrows) and cover.
- Remove wire ties supporting guide rails.



- Remove sprocket from intake camshafts and remove timing chain.
  - If necessary, remove tensioning rail (A), reversing rail (B), and guide rail (C) to remove timing chain.



## Timing chains, installing (M62 engine to 9/1998)

- ▲ The procedure outlined below assumes that the camshafts are locked in the TDC installation position with special locking tools as shown earlier.

- ▲ Inspect timing chain sprockets and chain. Inspect guide rail and tensioner rail (**arrows**) for grooves caused by chain contact. Replace any part that is worn or damaged.

### NOTE—

*If any sprockets are being replaced due to wear, the chain should also be replaced. If the crankshaft sprocket requires replacement, the oil pump drive sprocket and chain must be removed. See 119 Lubrication System for oil pump removal information.*

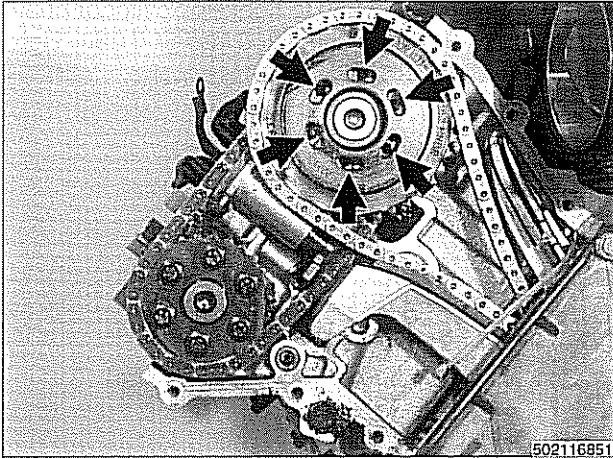
- If removed, reinstall timing chain tensioning rail, reversing rail, and guide rail.
  - If tensioning rail was removed, replace O-ring at tensioning rail oil guide.

### Tightening torque

Reversing rail to engine block	14 Nm (10 ft-lb)
--------------------------------	------------------

- ▲ Install timing chain and intake sprocket to intake camshaft on left cylinder head. Center bores of camshaft flange in sprocket mounting slots. Install two mounting bolts finger tight.

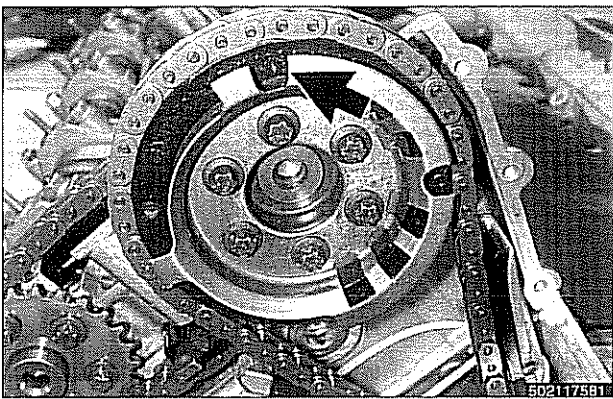
## Camshaft Timing Chain



- Install timing chain and intake sprocket to intake camshaft on right cylinder head. While pressing in on chain tensioner rail, confirm camshaft flange bores (**arrows**) are centered in sprocket mounting slots.

**NOTE** —

*Pressing in on rail will remove slack and reposition sprockets. If necessary, remove sprockets and align bores centrally.*



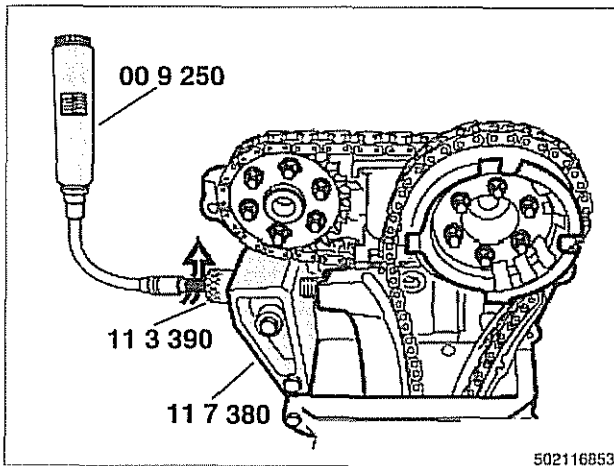
- Install intake camshaft sensor gear with notch upward (**arrow**) at right cylinder head.
- Finger tighten mounting screws.
- Install remaining sprocket bolts to intake camshaft finger tight at left cylinder head.
- Press timing chain tensioning rail against timing chain. Install plastic wire tie, to hold rail against chain.
- Install lower timing chain cover:
  - Clean sealing surfaces and check sleeves are properly seated.
  - Apply a thin coat of Three Bond 1209 ® to front and back of new seal. Also coat joints where block meets cylinder heads and oil pan.
  - Initially hand tighten bolts in alternate sequence to firmly seat cover.
  - Tighten fasteners to final specification in alternate sequence.

### Tightening torques

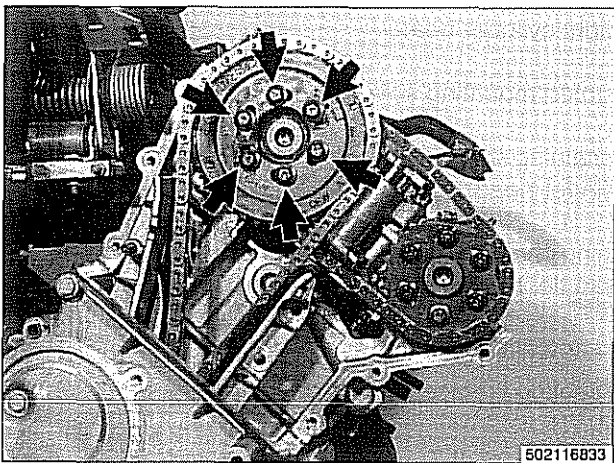
Lower timing cover	
M6 bolts	10 Nm (89 in-lb)
M7 bolts	15 Nm (11 ft-lb)
M8 bolts	22 Nm (16 ft-lb)
M10 bolts	47 Nm (35 ft-lb)

- Replace radial seal in lower timing chain cover, then reinstall crankshaft hub, center bolt, and vibration damper. See **Crankshaft oil seal, replacing (M62 and M62 TU engines)**.
- Install oil pan with new gasket. See **119 Lubrication System**.
- Lock crankshaft in place with BMW special tool 11 2 300.

## Camshaft Timing Chain



- Attach BMW special tool 11 7 380 to right side cylinder head. Install special tool 11 3 390 and 00 9 250 into 11 7 380. Tighten to 0.7 Nm (0.5 ft-lb).

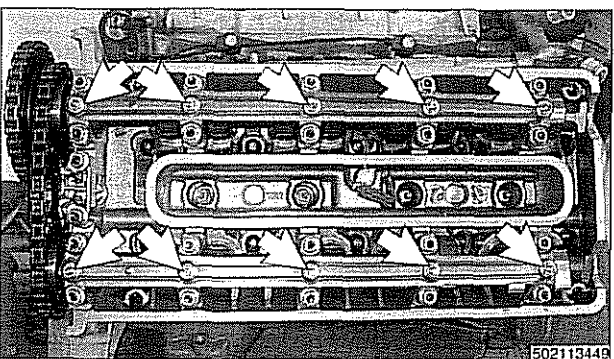


- Secure sprocket to intake camshaft flange on left cylinder head.
  - Repeat for intake sprocket on right cylinder head.

### Tightening torque

Sprocket to camshaft flange	15 Nm (11 ft-lb)
-----------------------------	------------------

- Remove BMW special tools 11 2 444/ 443/ 441/ 445 from right cylinder head.
- Remove BMW special tools 11 2 444/ 443/ 421/ 446 from left cylinder head.



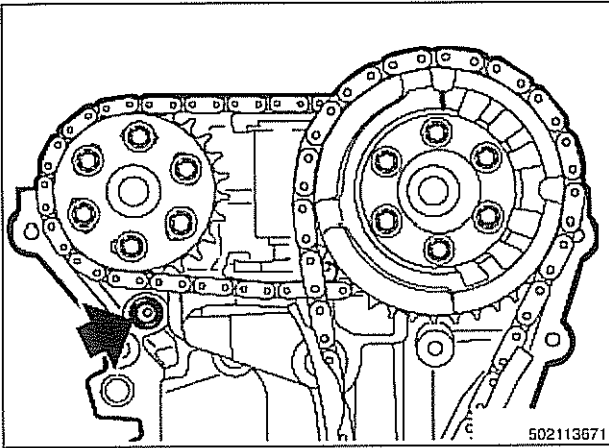
- Install oil lines on left and right cylinder head.

### Tightening torque

Oil lines to camshaft bearing caps	6 Nm (4 ft-lb)
------------------------------------	----------------

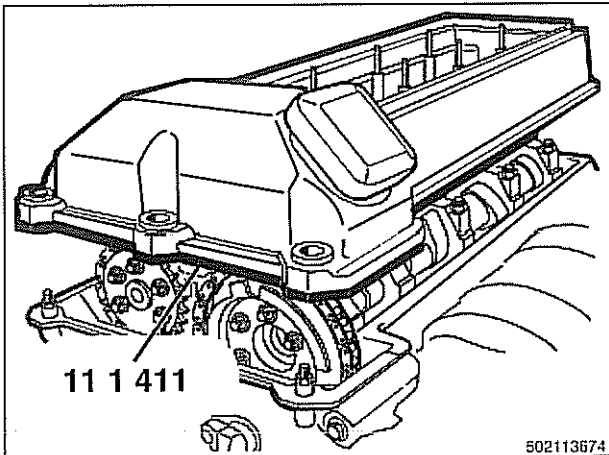
- Relieve load on BMW special tool 11 3 390 and remove along with special tool 11 7 380.
- Remove BMW special tool 11 2 300 from bore at transmission bellhousing and release crankshaft.

## Camshaft Timing Chain



- ◀ Replace primary timing chain tensioner oil supply seal (arrow) in right cylinder head.

- Install right upper timing chain cover to engine:
  - Remove old gasket from left timing cover.
  - Clean gasket groove and install new gasket.
  - Apply Three Bond 1209® sealant to joint between cylinder head and timing cover.
  - Fit timing cover into position on engine and install lower inside cover retaining bolt
  - Timing cover retaining bolts finger tight.



- ◀ Remove cylinder head cover sealing gaskets from right cylinder head cover. Install BMW special tool 11 1 411 into gasket groove of cylinder head cover.

- Install right cylinder head cover with BMW special tool 11 1 411 to right cylinder head. Fit cylinder head cover retaining nuts to cylinder head cover studs at cylinders 1 and 2 (first two cylinders on right side cylinder bank).
- Tighten nuts uniformly in  $\frac{1}{2}$  turn steps.

**NOTE —**

*BMW special tool 11 1 411 presses upper timing cover to cylinder head to aid in proper sealing of timing chain cover to the cylinder head gasket.*

**Tightening torque**

Timing case cover to head	15 Nm (11 ft-lb)
---------------------------	------------------

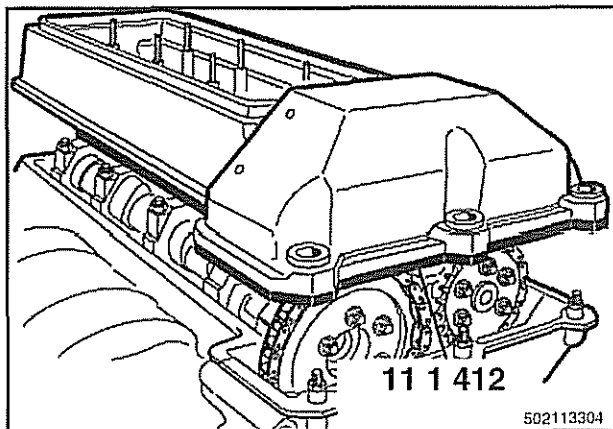
- Remove special tool 11 1 411 and install new gaskets to cylinder head cover:
  - Clean gasket groove and install new gasket.
  - Apply Three Bond 1209® sealant to joint between cylinder head and timing cover and at half-moon shaped cut-outs.
  - Tighten cylinder head cover nuts.

**Tightening torque**

Cylinder head cover to head	15 Nm (11 ft-lb)
-----------------------------	------------------



## Camshaft Timing Chain



Remove cylinder head cover sealing gaskets from left cylinder head cover. Install BMW special tool 11 1 412 into gasket groove of cylinder head cover.

- Install left cylinder head cover. Fit cylinder head cover retaining nuts to cylinder head cover studs at cylinders 5 and 6 (first two cylinders on left side cylinder bank).
- Tighten nuts uniformly in  $\frac{1}{2}$  turn steps.

**Tightening torque**

Timing case cover to head	15 Nm (11 ft-lb)
---------------------------	------------------

Remove special tool 11 1 412 and install new gaskets to cylinder head cover:

- Clean gasket groove and install new gasket.
- Apply Three Bond 1209® sealant to joint between cylinder head and timing cover and at half-moon shaped cut-outs.
- Tighten cylinder head cover nuts.

**Tightening torque**

Cylinder head cover to head	15 Nm (11 ft-lb)
-----------------------------	------------------

Remainder of installation is reverse of removal, noting the following:

- Where applicable remove protective film from gaskets.
- Use new gaskets when mounting intake manifold. Tighten nuts finger tight first, then torque to specification in stages working diagonally from center out.
- Ground straps for ignition coil harnesses are at cylinders no. 3 and no. 7. See **120 Ignition System**.
- Refill and bleed cooling system as described in **170 Radiator and Cooling System**.
- Change engine oil and filter as described in **020 Maintenance**.

**CAUTION—**

*To prevent damaging engine electrical systems, be sure to install all ground wires previously removed.*



## Camshaft timing, checking and adjusting (M62 engine)

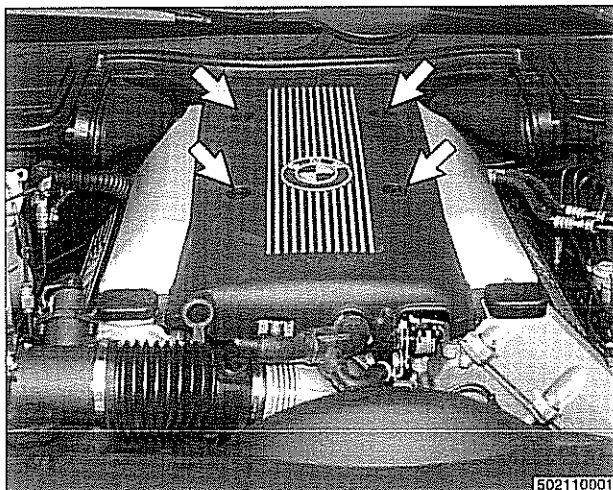
### **WARNING** —

*Allow engine to cool before beginning this procedure.*

- Working inside luggage compartment, disconnect negative battery cable.

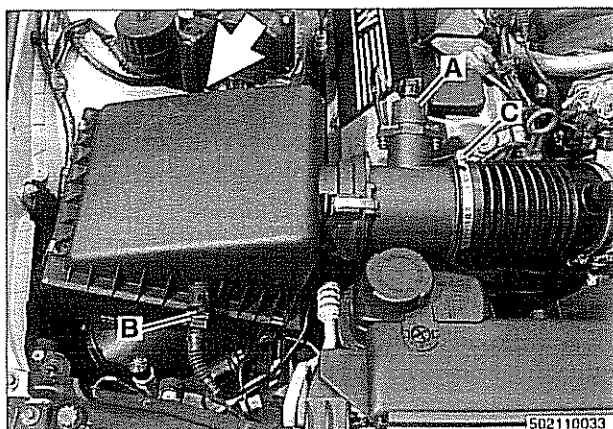
### **CAUTION** —

*Prior to disconnecting battery cable, read the battery disconnection cautions given in 001 General Cautions and Warnings.*



### ◀ Removing plastic top covers:

- Press down on locking pins (**arrows**) to release locks. Lift intake manifold cover straight up to remove.
- Pry out caps from side covers.
- Remove fasteners from beneath caps. Lift off covers.

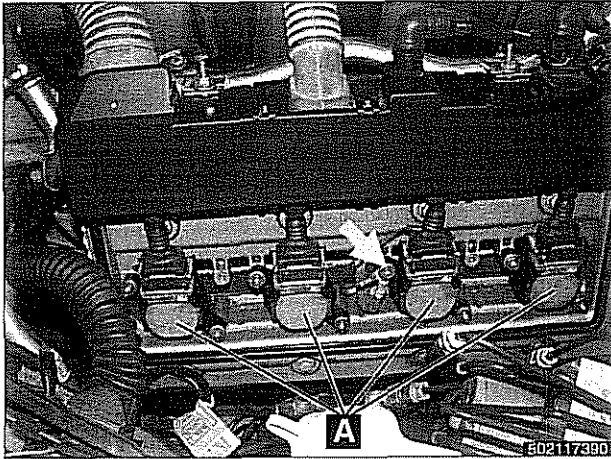


### ◀ Remove air filter housing and ducts:

- Disconnect mass air flow sensor and intake air temperature sensor electrical harnesses (**A** and **B**).
- Remove air filter housing mounting fastener (**arrow**).
- Release hose clamp at intake air duct on base of air filter housing.
- Loosen intake hose clamp (**C**) and release hose from mass air flow sensor.
- Remove hose at idle air stabilizer.
- Release hose clamp at throttle body and remove hose.
- Remove upper air filter housing with mass air flow sensor.

- Unbolt left and right side cable ducts from fuel rail.

## Camshaft Timing Chain

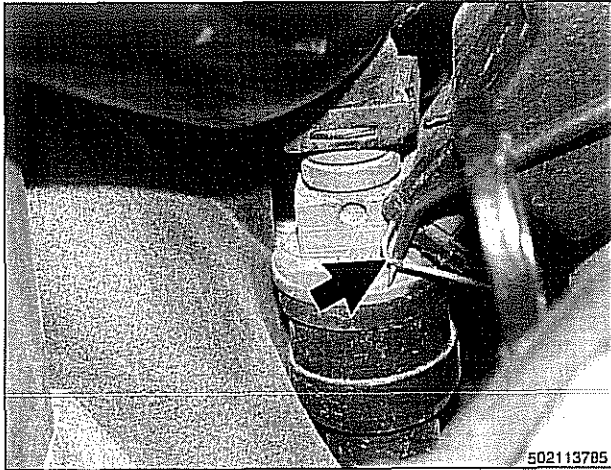


- ◀ Remove left and right side ignition coils and spark plugs:
  - Disconnect electrical harness connectors at ignition coils (A).
  - Remove left and right side ignition coil mounting fasteners and coils.

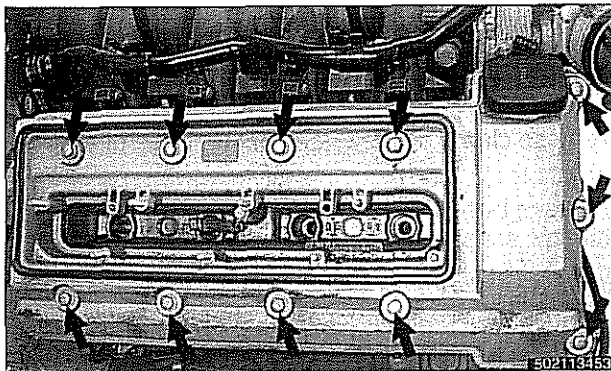
**NOTE—**

*Make note of location of ground strap (arrow).*

- Remove spark plugs.
- Remove positive (+) terminal cable from left cylinder head cover.
- Unbolt cable ducts from fuel rail at left and right sides.

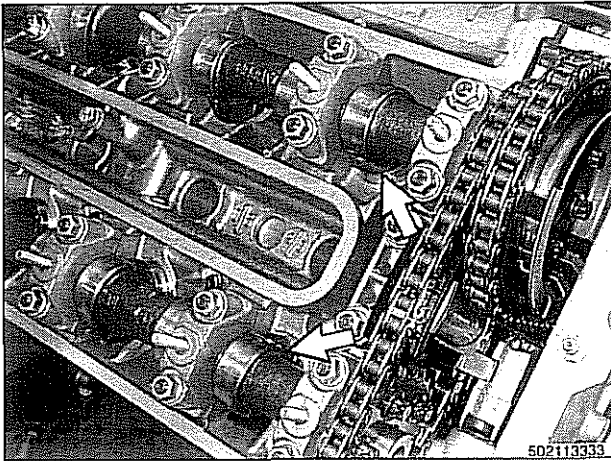


- ◀ Disconnect fuel injector electrical connectors from injectors:
  - Pry corner of wire lock clip (arrow) to release connector.
  - Repeat for remaining injectors.
  - Lift off wiring ducts.



- ◀ Remove right and left cylinder head cover fasteners (arrows) and remove covers.
- Remove viscous clutch cooling fan, see 170 Radiator and Cooling System.

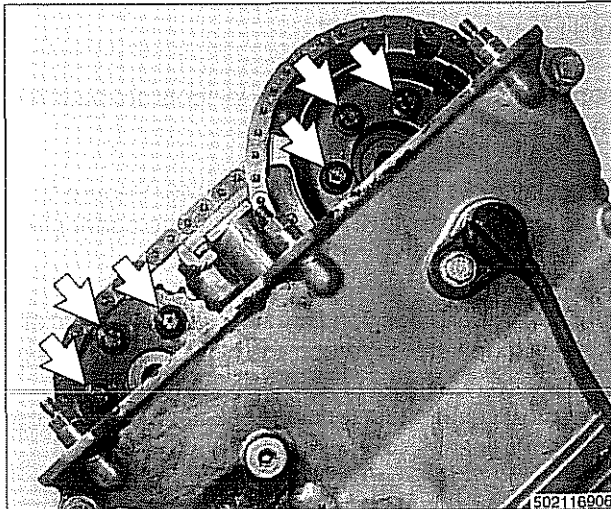
## Camshaft Timing Chain



- Using crankshaft center bolt, turn engine clockwise until number one cylinder (right head) is in TDC overlap position, as shown (arrows).

**NOTE —**

Number one cylinder is at valve overlap when both the intake and exhaust valves are starting to open.

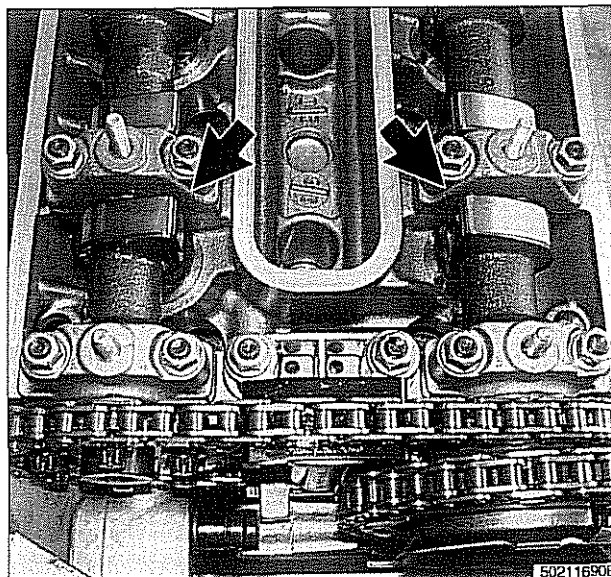


- Loosen accessible bolts (arrows) on right exhaust and intake camshafts (cylinders 1–4) approximately  $\frac{1}{2}$  turn.

**NOTE —**

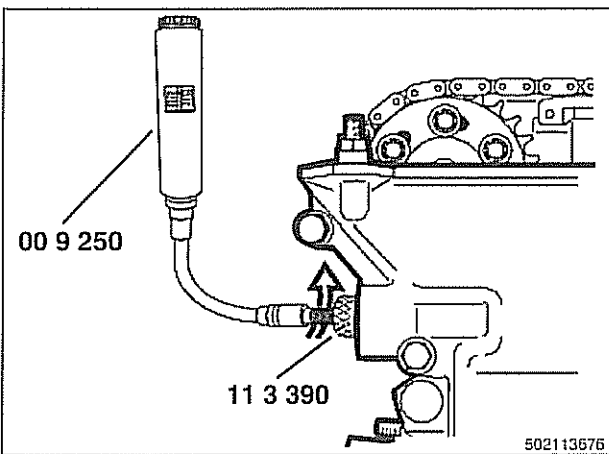
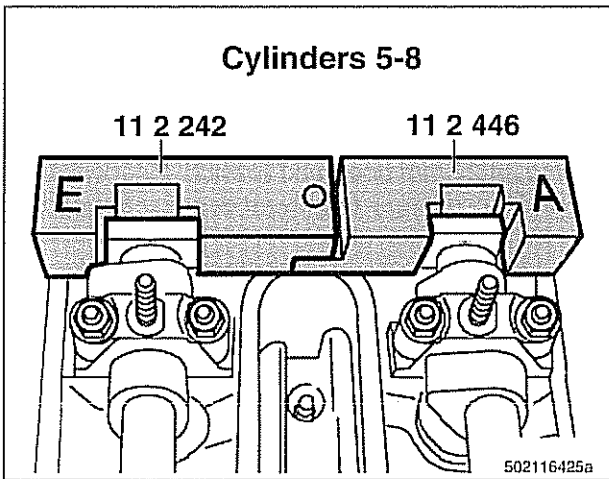
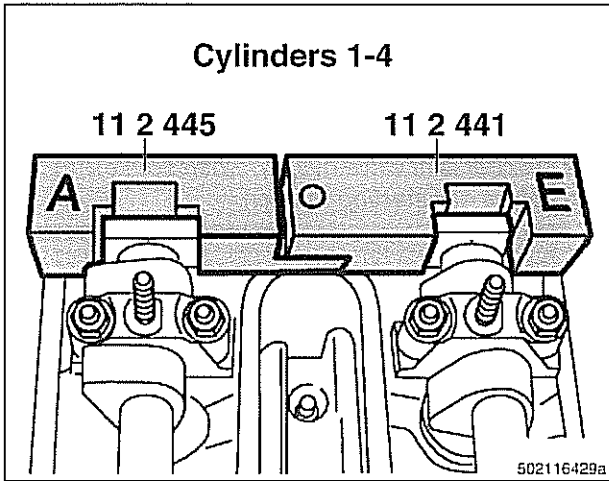
When loosening bolts on camshaft sprocket, counterhold camshaft using an 27 mm open-end wrench. If necessary, machine wrench accordingly to prevent damage to head.

- Repeat for accessible bolts of left exhaust and intake camshafts (cylinders 5–8).



- Using crankshaft center bolt, rotate engine one complete rotation to TDC position. Lobes of camshafts for right cylinder head (cylinders 1–4) should point to each other (arrows).
- Loosen remaining intake and exhaust camshaft sprocket bolts approximately  $\frac{1}{2}$  turn.

## Camshaft Timing Chain



- Secure right side camshafts in TDC position using special BMW tool 11 2 445 and 11 2 441.
- If necessary, turn camshaft with 27 mm wrench so that special tools are squarely seated on cylinder head.
- Fit BMW special tool 11 2 443 to 11 2 441/445. Secure 11 2 443 to cylinder head with 11 2 444 installed into spark plug bore.

- Secure right side camshafts in TDC position using special BMW tool 11 2 442 and 11 2 446.
- If necessary, turn camshaft so that special tools are squarely seated on cylinder head.
- Fit BMW special tool 11 2 443 to 11 2 442/446. Secure 11 2 443 to cylinder head with 11 2 444 installed into spark plug bore.
- Lock crankshaft in TDC position by inserting BMW special tool 11 3 200 through tool bore at transmission bellhousing.
- Remove primary timing chain tensioner piston from right cylinder head upper timing cover.

- Attach BMW special tool 11 3 390 into right cylinder head in place of primary chain tensioner.
  - Using BMW special tool 00 9 250, tighten adjusting screw on 11 3 390 to 0.7 Nm (6.3 in-lb).

**NOTE**—

*BMW special tool 00 9 250 is a flexible shaft torque wrench.*

## Camshaft Timing Chain

- Tighten accessible sprocket retaining bolts in the following order:
  - Left exhaust camshaft
  - Right exhaust camshaft
  - Left intake camshaft
  - Right intake camshaft

### Tightening torque

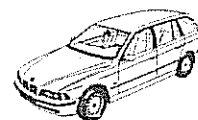
Sprocket bolts to camshaft flange	15 Nm (11 ft-lb)
-----------------------------------	------------------

- Remove BMW special tool 11 2 300 from tool bore at bell-housing and remove camshaft locking tools from cylinder heads.
  - Using crankshaft center bolt, turn engine over clockwise at least one complete rotation so that remaining camshaft sprocket retaining bolts are accessible.
- Tighten remaining camshaft sprocket retaining bolts.

### Tightening torque

Sprocket bolts to camshaft flange	15 Nm (11 ft-lb)
-----------------------------------	------------------

- Remove BMW special tool 11 3 390 from primary timing chain tensioner bore and reinstall primary chain tensioner.
- Remainder of installation is reverse of removal, noting the following:
  - Remove gasket residue from cylinder head sealing surface.
  - Apply a thin bead of Three Bond 1209 ® sealing compound to joints at cylinder head cover and timing case cover and at half-moon sections at rear of cylinder heads.
  - Replace cylinder head cover gaskets if necessary.





# 119 Lubrication System

<b>General</b> .....	119-2	<b>Component Replacement</b> .....	119-20
Special tools .....	119-2	Oil pressure warning switch, replacing (6-cylinder and V-8) .....	119-20
Engine lubrication .....	119-3	Oil level warning switch, replacing (6-cylinder and V-8) .....	119-21
<b>Troubleshooting</b> .....	119-3	Oil pump, removing and installing (6-cylinder) .....	119-22
Oil pressure, checking .....	119-4	Oil pump, removing and installing (V-8) ..	119-24
Oil pressure warning system, testing .....	119-5	Oil pressure relief valve (6-cylinder) .....	119-26
<b>Crankshaft Rear Main Seal</b> .....	119-6	Oil pressure relief valve (V-8) .....	119-27
Crankshaft rear main seal, replacing (6-cylinder) .....	119-6		
Crankshaft rear main seal, replacing (V-8) ..	119-8		
<b>Engine Oil Pan</b> .....	119-10		
Oil pan, removing and installing (6-cylinder) .....	119-10		
Lower oil pan, removing and installing (V-8) .....	119-13		
Upper oil pan, removing and installing (V-8) .....	119-15		

## GENERAL

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

In 6-cylinder models, removal of the oil pan requires the removal of the exhaust system and some front suspension components. Those procedures are fully covered in:

- 180 Exhaust System
- 210 Clutch
- 230 Manual Transmission
- 240 Automatic Transmission
- 310 Front Suspension
- 320 Steering and Wheel Alignment

### NOTE—

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

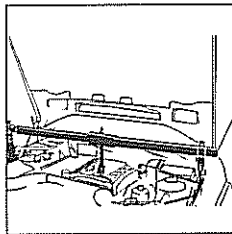
### CAUTION—

*V8 engines: The oil pump fasteners (including the sprocket retaining nut) are known to vibrate loose. This can result in oil starvation and engine failure. Be sure to check oil bolts and nut tightness whenever the oil pump is accessible. If any fasteners are found to be loose, remove them and reinstall with Loctite® and torque to specifications.*

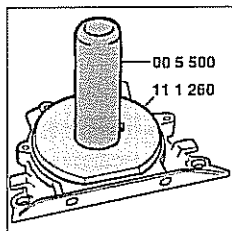
## Special tools

The engine needs to be properly supported while the front suspension subframe is lowered to access the oil pan.

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

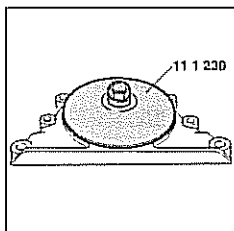


- ◀ Engine support bracket  
(Tool No. BMW 00 0 200/201/202/204/208)

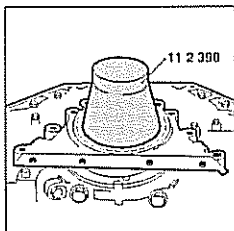


- ◀ 6-cylinder crankshaft rear main seal tools  
(Tool No. BMW 00 5 500/11 1 260)

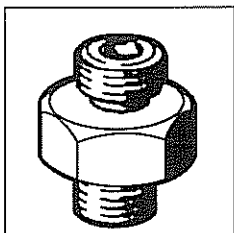




- ◀ V-8 crankshaft rear main seal tool  
(Tool No. BMW 11 1 230)



- ◀ V-8 crankshaft rear main seal guide  
(Tool No. BMW 11 2 390)



- ◀ Adapter for BMW oil pressure gauge  
(Tool No. BMW 11 4 050)

## Engine lubrication

Oil pressure is generated by a gear-type pump bolted to the bottom of the engine block. The oil pump is chain driven off the front of the crankshaft.

**Table a. Engine oil capacity (includes oil filter replacement)**

6-cylinder	6.5 liters (6.9 US qt)
V-8	7.5 liters (7.9 US qt)

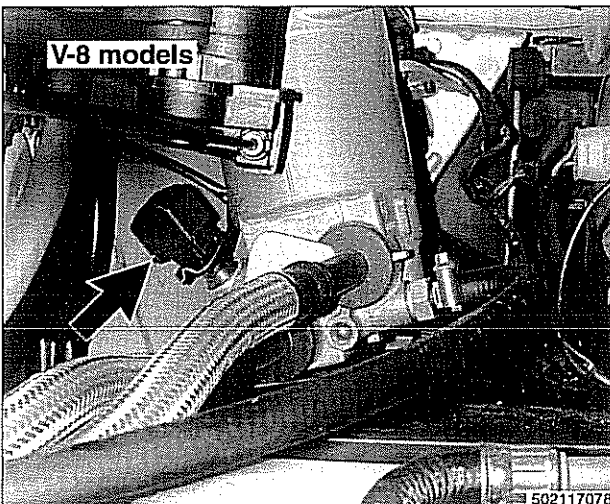
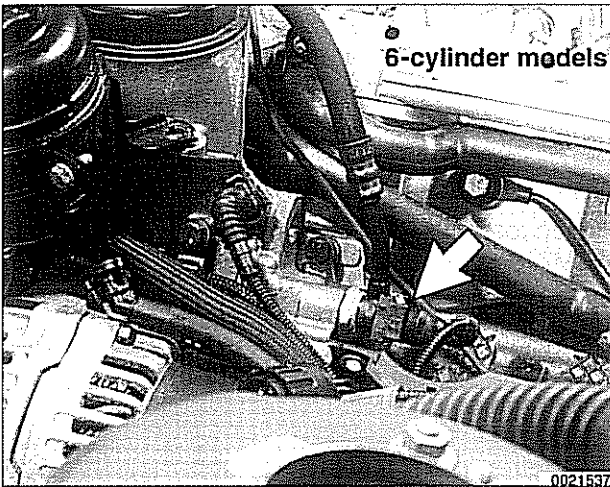
## TROUBLESHOOTING

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

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

### **CAUTION—**

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



## Oil pressure, checking

The oil pressure warning switch is located at the base of the oil filter housing.

- ◀ In 6-cylinder engines access to oil pressure warning switch connector (**arrow**) is extremely restricted (intake manifold removed for the purpose of illustration).

- ◀ V-8 engine oil pressure warning switch (**arrow**) is at base of oil filter housing on left engine compartment inner fender.

Oil pressure is tested by removing oil pressure switch and installing oil pressure gauge in its place.

- Unscrew oil filter cap in order to allow engine oil to drain back down into oil pan.
- Disconnect harness connector from oil pressure switch and remove switch.

### NOTE —

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

- Install pressure gauge in place of oil pressure switch.
- With gauge installed, 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	0.5 bar (7 psi)
At elevated speed	
6-cylinder engine	4.0 bar (59 psi)
V-8 engine	4.5 bar (66 psi)

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

#### Tightening torque

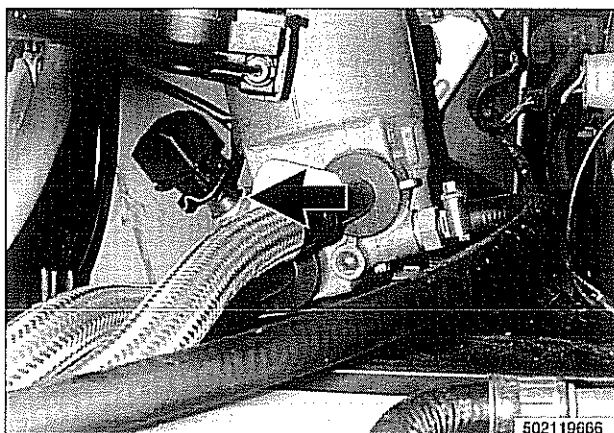
Oil pressure switch to oil filter housing	27 Nm (20 ft-lb)
---	------------------

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 (arrow) 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 up.
- 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.

#### NOTE —

*If there are two wires to the oil pressure switch, ground the brown/green wire that carries the signal to the warning light.*

- 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 switch, connect an ohmmeter between terminal in switch body (**arrow**) and ground. With engine off, there should be continuity. With engine running, oil pressure should open switch and there should be no continuity. Replace a faulty switch.

**CAUTION—**

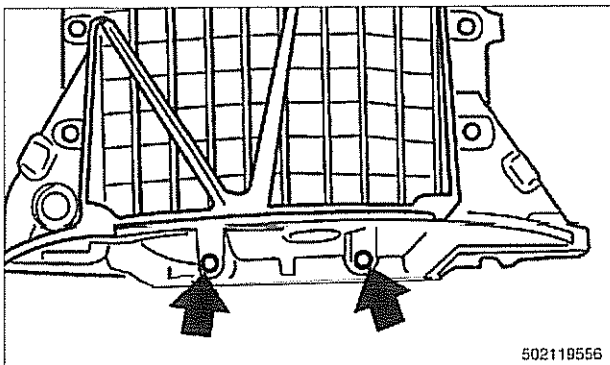
*Keep in mind that low oil pressure may be preventing the switch from turning the light out. If the light remains on while the engine is running, check the oil pressure as described earlier. Do not drive the car until the problem is corrected. The engine may be severely damaged.*

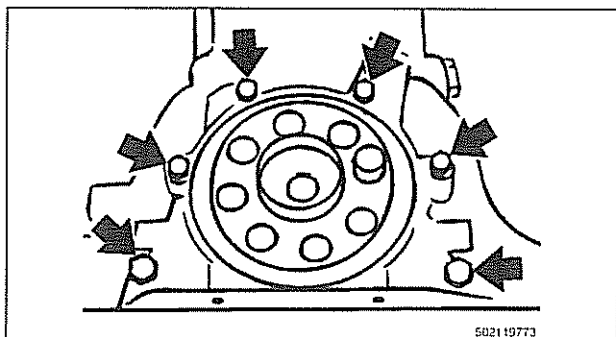
## CRANKSHAFT REAR MAIN SEAL

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

### Crankshaft rear main seal, replacing (6-cylinder)

- Remove transmission. See 230 Manual Transmission or 240 Automatic Transmission.
- Manual transmission vehicles: Remove clutch pressure plate and disc. See 210 Clutch.
- Remove flywheel. See 210 Clutch or 240 Automatic Transmission.
- Drain engine oil.
- ◀ Remove seal carrier bolts from oil pan (**arrows**). Loosen all oil pan bolts.

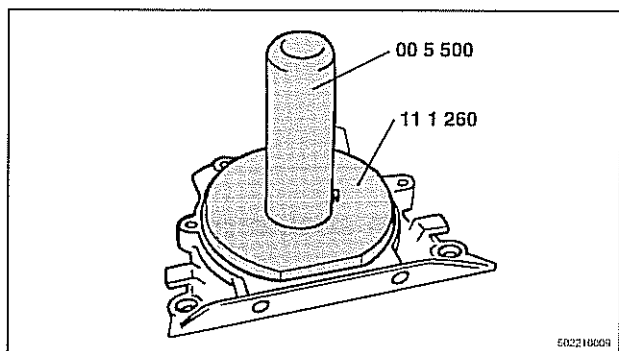




- Remove remaining seal carrier bolts (arrows) and carefully remove seal carrier without damaging the oil pan gasket.

**CAUTION—**

After removing seal carrier, check oil pan gasket for damage. If gasket is damaged during removal, remove oil pan (as described later) and replace gasket.



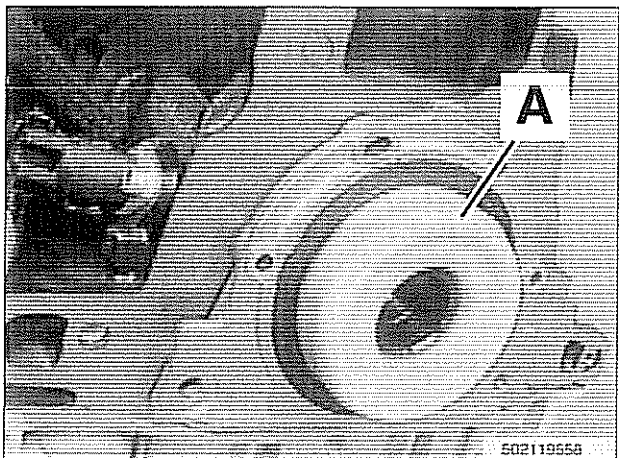
- Remove old seal and install new seal into seal carrier using BMW special tools 11 1 260 and 00 5 500.

**NOTE—**

- A new radial seal is used from 4/98 production, and is the only version available from BMW as a replacement. The new seal no longer uses a spring to support the sealing lip. Do not kink or damage the sealing lip. Do not touch with fingers.
- BMW offers the rear main seal carrier and seal in a kit. A plastic support bushing, required for sliding the seal over the crankshaft, is included with the kit.

**CAUTION—**

Do not use BMW special tool 11 2 213 (installation guide) with the new style seal. Use only the special tool supplied with the seal kit.



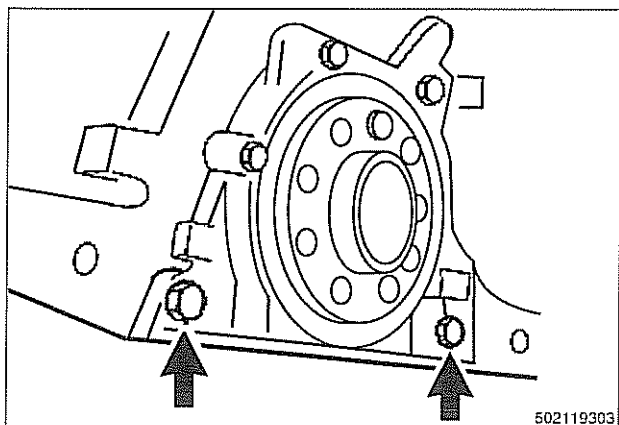
- When reinstalling seal carrier to crankcase:
  - Check locating sleeves for damage.
  - Replace gasket between rear main seal carrier and crankcase.
  - Apply thin coat of 3 Bond ® 1209 or equivalent sealant to oil pan gasket sealing surfaces.
  - Lubricate crankshaft seal contact surface.

- Use plastic support bushing (A) that comes with seal kit as an installation guide, fitting seal over end of crankshaft. Use care to push seal carrier and support bushing on straight, without tilting sideways. Remove support bushing.

- Install seal carrier bolts and torque to specifications.

- Use new bolts (arrows) at base of seal carrier. Coat threads with sealing compound before installing.

- Install and tighten oil pan bolts.



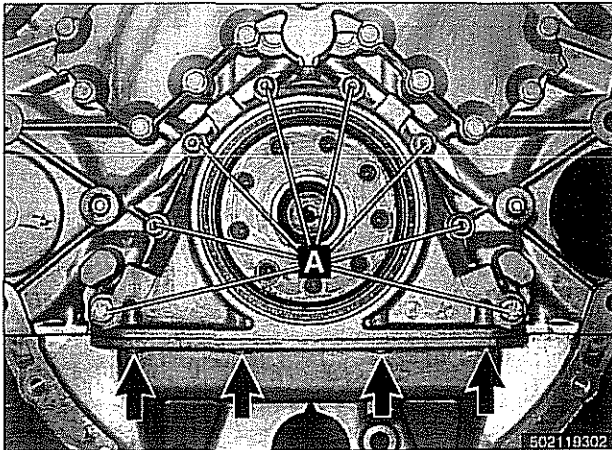
- Remainder of assembly is reverse of disassembly.
  - Install flywheel, clutch or torque converter and transmission.
  - Fill engine with oil.
  - Run engine and check for leaks.

**Tightening torques**

Oil drain plug to oil pan (M12)	25 Nm (18 ft-lb)
Oil pan to engine block	
M6 (8.8 grade)	10 Nm (89 in-lb)
M6 (10.9 grade)	12 Nm (9 ft-lb)
M8 (8.8 grade)	22 Nm (16 ft-lb)
Rear main seal carrier to crankcase	
M6	10 Nm (89 in-lb)
M8	22 Nm (16 ft-lb)

**Crankshaft rear main seal, replacing (V-8)**

- Remove transmission. See **230 Manual Transmission** or **240 Automatic Transmission**.
- Manual transmission vehicles: Remove clutch pressure plate and disc. See **210 Clutch**.
- Remove flywheel. See **210 Clutch**.
- Drain engine oil.
- Remove bolts (A) retaining rear main seal carrier, including bolts at (arrows) oil pan.
  - Carefully separate seal carrier from oil pan gasket and remove carrier.

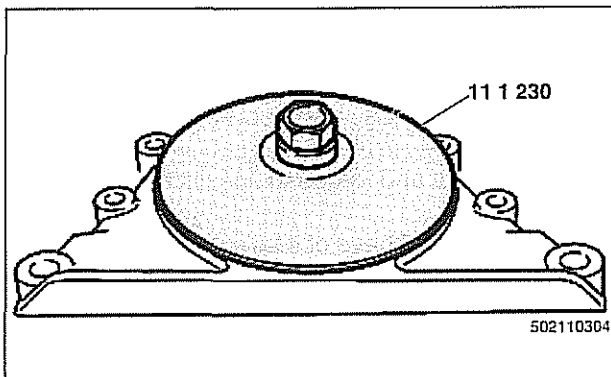
**CAUTION—**

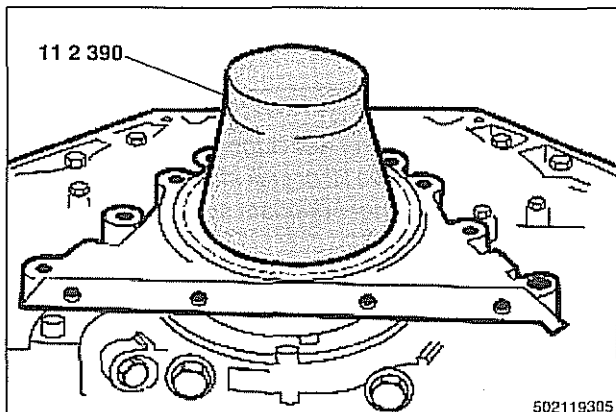
*Do not damage oil pan gasket.*

- Remove old seal and reinstall new seal into seal carrier using BMW special tools 11 1 230 and 00 5 500.

**NOTE—**

*BMW offers the rear main seal carrier and seal in a kit.*





- When reinstalling seal carrier to crankcase:
  - Check locating sleeves for damage.
  - Replace gasket between rear main seal carrier and crankcase.
  - Apply thin coat of 3 Bond ® 1209 or equivalent sealant to oil pan gasket sealing surfaces.
  - Lubricate crankshaft and seal contact surfaces.
- ◀ Use BMW special tool 11 2 390 as an installation guide in fitting seal over end of crankshaft. Use care to push seal carrier and support bushing on straight, without tilting. Remove installation guide carefully.
- Replace sealing washers under seal carrier mounting bolts.
- Install seal carrier mounting bolts and torque to specifications.
- Install oil pan bolts.
- Remainder of assembly is reverse of disassembly.
  - Install flywheel using new bolts,
  - Install clutch or torque converter and transmission.
  - Fill engine with oil.
  - Run engine and check for leaks.

#### Tightening torques

Flywheel to crankshaft (use new bolts)	120 Nm (89 ft-lb)
Oil drain plug to oil pan (M12)	25 Nm (18 ft-lb)
Oil pan to engine block	
M6 (8.8 grade)	10 Nm (89 in-lb)
M6 (10.9 grade)	12 Nm (9 ft-lb)
M8 (8.8 grade)	22 Nm (16 ft-lb)
Rear main seal carrier to crankcase	
M6	10 Nm (89 in-lb)
M8	22 Nm (16 ft-lb)

## ENGINE OIL PAN

### Oil pan, removing and installing (6-cylinder)

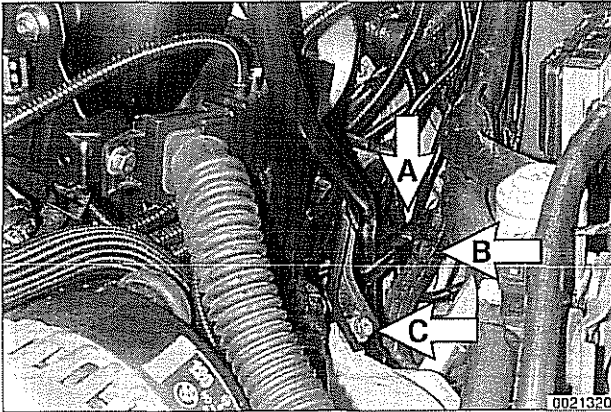
The engine oil pan removal procedure requires that the engine be supported from the top and the front suspension sub-frame be lowered.

- Raise car and place securely on jack stands.

**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.*

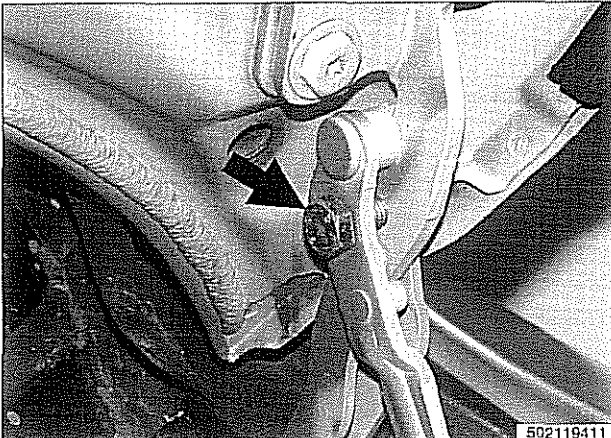
- Remove splash shield from under engine.
- Drain engine oil as described in **020 Maintenance**.



- ◀ Remove oil dipstick guide tube:
  - Disconnect fuel lines and wiring harness from bracket (A).
  - Disconnect oil separator hose (B) from base of guide tube.
  - Remove mounting bolt (C) from left engine mounting bracket and remove tube from oil pan.

**NOTE—**

- If necessary, remove air filter assembly for better access to dipstick tube.
- The dipstick guide tube is sealed in the block using an O-ring. Check that the O-ring comes out with the tube.

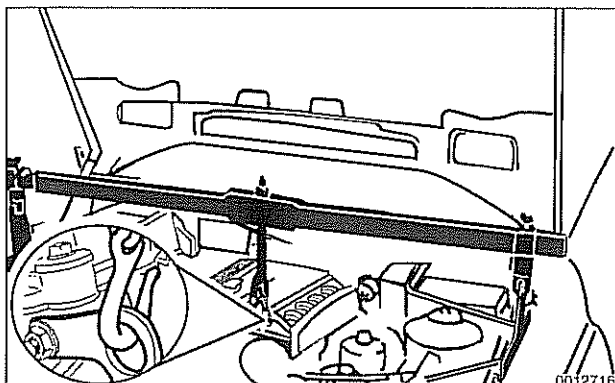


- ◀ Lift hood into assembly position:
  - While supporting the hood, disconnect hood support struts.
  - Raise hood and install locking bolts (arrow) in right and left hinges.

**WARNING—**

*Be sure to support hood while disconnecting support struts.*





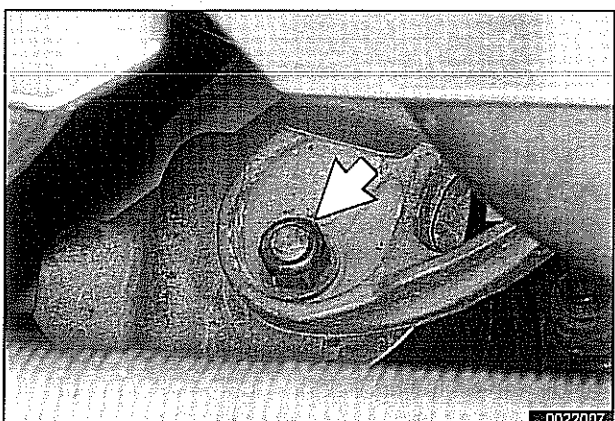
- Install engine lifting tool at front of engine and raise engine approximately 5 mm (1/4 in).



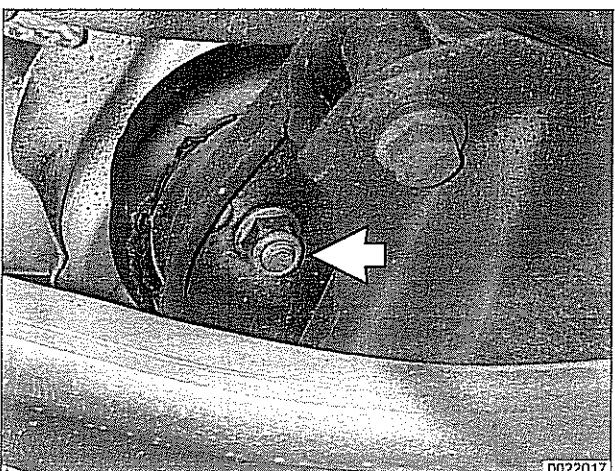
- Remove pinch bolt (arrow) at steering column universal joint near steering rack. See 320 Steering and Alignment.
- Remove power steering pump, leaving hydraulic lines connected to pump. Suspend pump using strong wire. See 320 Steering and Wheel Alignment.

**NOTE—**

For better access to power steering assembly, unbolt fluid reservoir and suspend with wire.

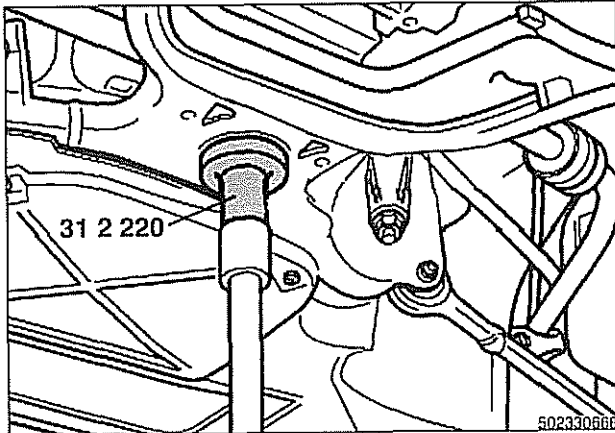


- Loosen upper nuts (arrow) in right and left engine mounts.

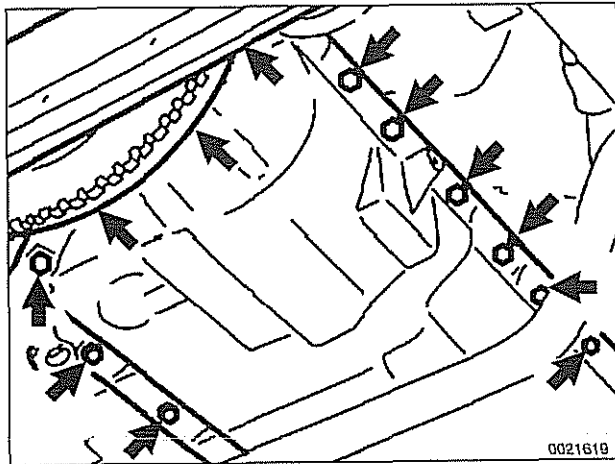


- Remove right and left lower engine mount nuts (arrow).
- On cars with automatic transmission, remove ATF cooler line brackets from engine oil pan.
- Disconnect electrical harness connector at oil level sensor on oil pan.

## Lubrication System



- Support subframe from below using BMW special tool 31 2 220 and appropriate shop lift. Remove subframe mounting bolts and lower subframe as far as possible.



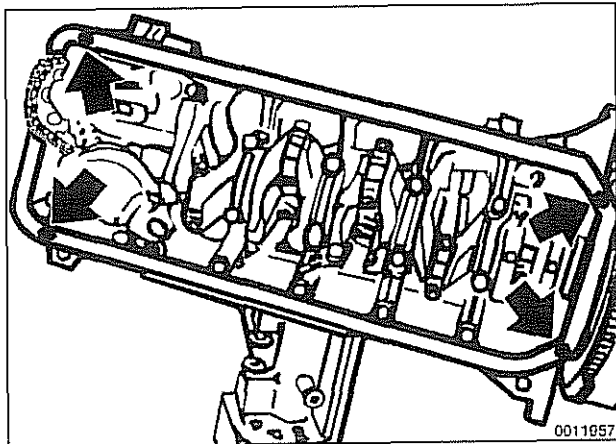
- Remove oil pan screws (arrows) at cylinder block and transmission bellhousing. Lower and remove oil pan.

### NOTE—

If oil pan will not slide backwards, disconnect stabilizer bar links and lower front axle support further.

### CAUTION—

If the oil pan does not separate easily from the engine cylinder block, a few taps with a rubber mallet should break it free. Do not pry the oil pan loose.



- When installing oil pan:

- Thoroughly clean all old gasket material from mating surfaces and use a new gasket.
- Apply a small amount of non-hardening sealer (3 Bond 1209® or equivalent) to oil pan gasket directly below joints (arrows) for end cover and front timing case cover. Apply a bead 3 mm wide by 2 mm high.
- Install all oil pan bolts finger tight. Tighten oil pan bolts toward front of engine first, then pan bolts at transmission end.

### Tightening torques

Oil drain plug to oil pan (M12)	25 Nm (18 ft-lb)
Oil pan to engine block	
M6 (8.8 grade)	10 Nm (89 in-lb)
M6 (10.9 grade)	12 Nm (9 ft-lb)
M8 (8.8 grade)	22 Nm (16 ft-lb)

- Remainder of installation is reverse of removal.
  - Replace self-locking nuts when reinstalling front suspension components.
  - Use new oil dipstick tube sealing O-ring.
  - After adding engine oil, start and run engine. Raise engine speed to 2,500 rpm until oil pressure warning light goes out (about 5 seconds).

**NOTE—**

*BMW does not specify a front end alignment following this procedure.*

**Tightening torques**

Front subframe to body rail (M12, use new bolts)	
8.8 grade	77 Nm (57 ft-lb)
10.9 grade	105 Nm (77 ft-lb)
12.9 grade	110 Nm (81 ft-lb)
Stabilizer bar link to stabilizer bar	65 Nm (48 ft-lb)
Steering shaft universal joint clamping bolt (use new bolt)	19 Nm (14 ft-lb)

**Lower oil pan, removing and installing (V-8)**

- The V-8 engine is equipped with a 2-piece oil pan. The fasteners in V-8 engine oil pump assembly, including the sprocket retaining nut, are known to loosen and fall off into the oil pan. Be sure to install these fasteners with Loctite® or equivalent thread locking product and torque to specifications.

**CAUTION—**

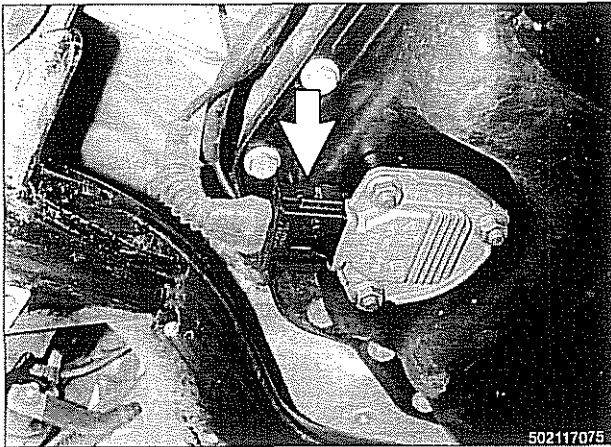
*It is recommended that the oil pump retaining bolts and oil pump drive sprocket retaining nut tightening torque be checked any time the oil pan is removed.*

- Raise car and place securely on jack stands.

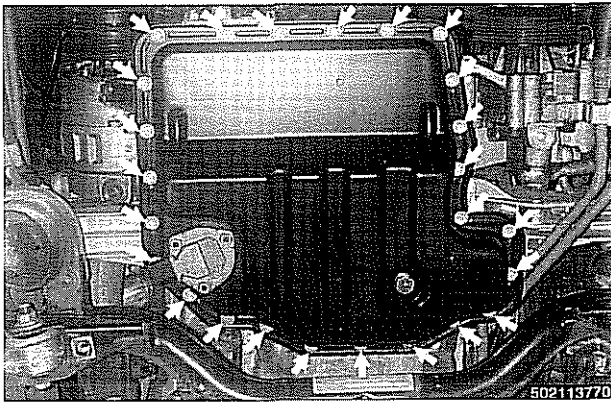
**WARNING—**

*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 splash shield from under engine.
- Drain engine oil.
- On cars with automatic transmission, remove ATF cooler line brackets from oil pan.



- ◀ Disconnect electrical harness connector (arrow) at oil level sensor.

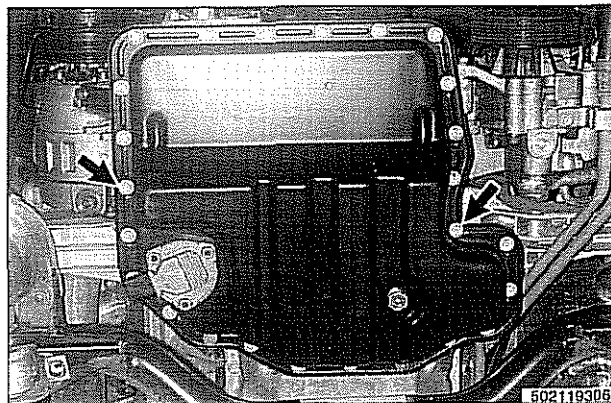


- ◀ Remove lower oil pan mounting bolts (arrows).

**CAUTION—**

*If the lower pan does not separate easily from upper pan, a few taps with a rubber mallet should break it free. Do not pry the oil pan loose.*

- When installing oil pan:
  - Thoroughly clean all old gasket material from mating surfaces and use a new gasket.



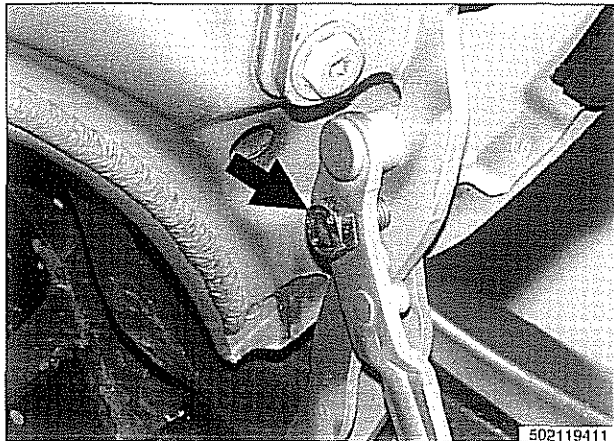
- ◀ Install threaded guide studs at locations marked by arrows to guide new oil pan gasket and oil pan into position and to prevent damage to sealing lip.
  - Install new oil pan mounting bolts (threads coated with sealer).
  - Remove guide studs and install remainder of oil pan bolts.
- Remainder of reassembly is reverse of disassembly.
- After adding engine oil, start and run engine. Raise engine speed to 2,500 rpm until oil pressure warning light goes out (about 5 seconds).

**Tightening torques**

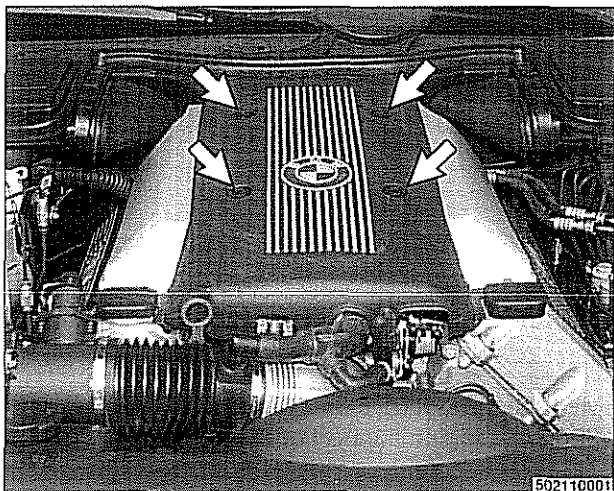
Lower oil pan to upper oil pan	
M6 (8.8 grade)	10 Nm (89 in-lb)
M6 (10.9 grade)	12 Nm (9 ft-lb)
M8 (8.8 grade)	22 Nm (16 ft-lb)
Oil drain plug to oil pan (M12)	25 Nm (18 ft-lb)

## Upper oil pan, removing and installing (V-8)

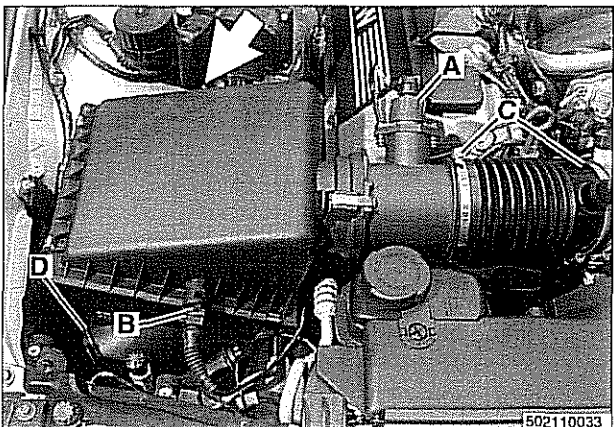
The engine oil pan removal procedure requires that the engine be supported from the top and the front suspension sub-frame be lowered.



- Disconnect negative (-) battery cable.
- Lift hood into assembly position.
  - While supporting hood, disconnect support struts.
  - Open hood fully and lock in place by installing bolts (arrow) in left and right hinges to lock hood in place.

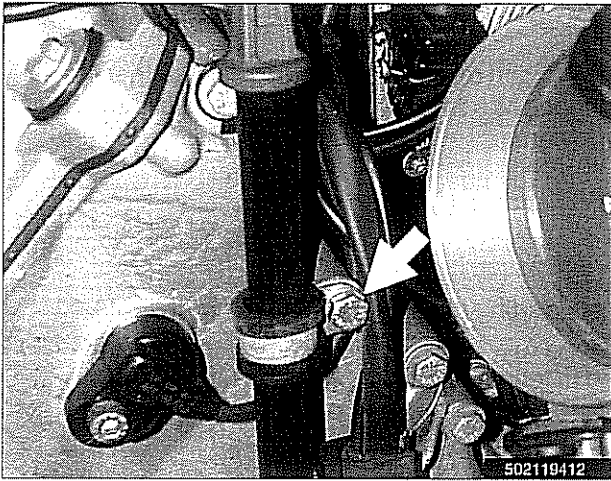


- Remove engine top cover:
  - Early version: Pry off caps (arrows) and remove fasteners.
  - Late version: Depress fasteners (arrows) and lift cover.



- Remove air filter housing and mass air flow sensor:
  - Disconnect mass air flow sensor (A) and intake air temperature sensor (B) electrical harness connectors.
  - Remove air filter housing mounting fastener (arrow).
  - Loosen intake hose clamps (C and D).
  - Remove air filter housing with mass air flow sensor.
  - Remove intake hose from throttle body.

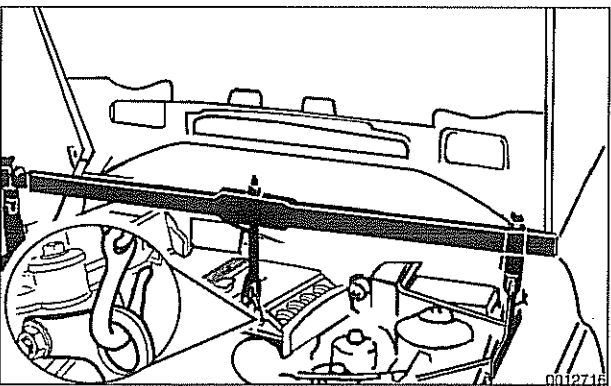
**Lubrication System**



➤ Remove oil dipstick support from right cylinder head.

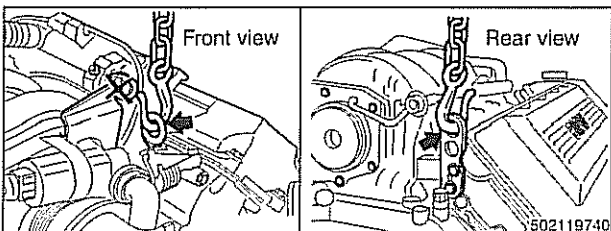


➤ Remove upper nuts (**arrow**) from left and right motor mounts.



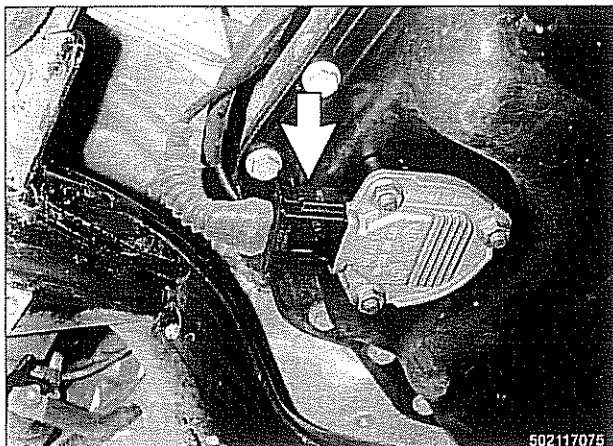
➤ Attach BMW special tool 00 0 200 with tools 201/202/204/208 (engine support bracket).

**NOTE** —  
Side support members (BMW special tool 00 0 208) must make contact with fender mounting bolts.

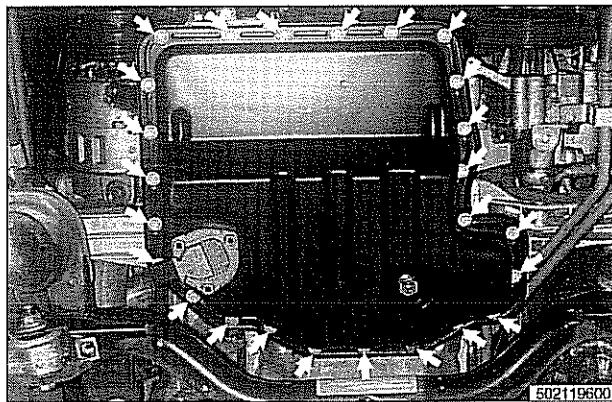


➤ Attach engine lifting chains to front and rear lifting eyes.

- Lift engine approximately 6-8 mm (0.25-0.32 in).
- Loosen oil filter cover, then drain engine oil. See 020 Maintenance.



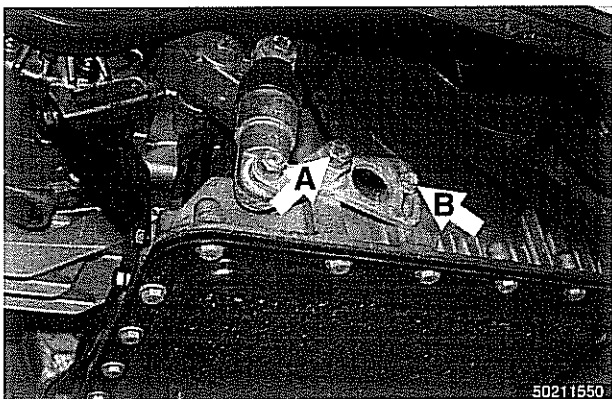
- ◀ Disconnect electrical harness connector (arrow) at oil level sensor.



- ◀ Remove lower oil pan bolts (arrows) and pan.

**CAUTION—**

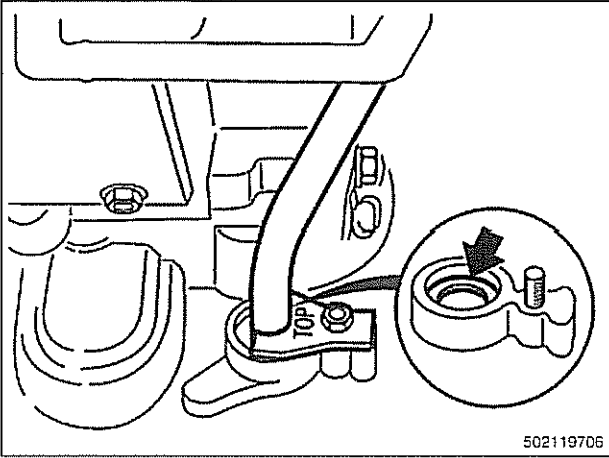
*If the lower pan does not separate easily from upper pan, a few taps with a rubber mallet should break it free. Do not pry the oil pan loose.*



- ◀ Remove A/C drive belt tensioner.
  - Remove adjustment bolt (B).
  - Remove retaining bolt (A) and remove tensioner from oil pan.
- Remove power steering pump from engine block, leaving hydraulic lines connected. Suspend from chassis using stiff wire. See **320 Steering and Wheel Alignment**.

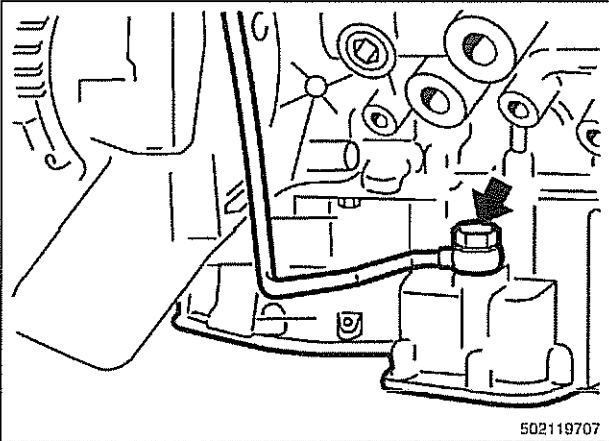


## Lubrication System

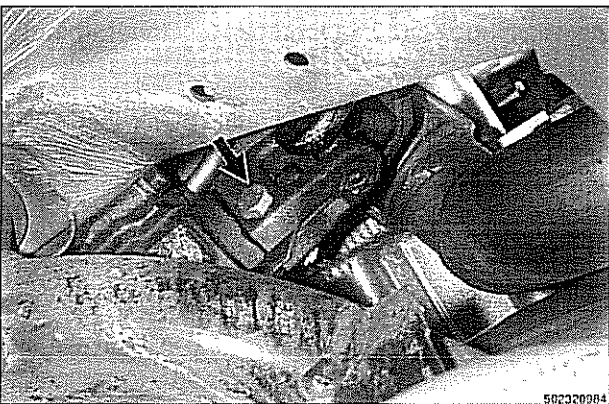


- ▲ Working at left side of engine, remove oil dipstick guide tube mounting bracket and remove dipstick tube.

**NOTE** —  
Replace dipstick O-ring seal.

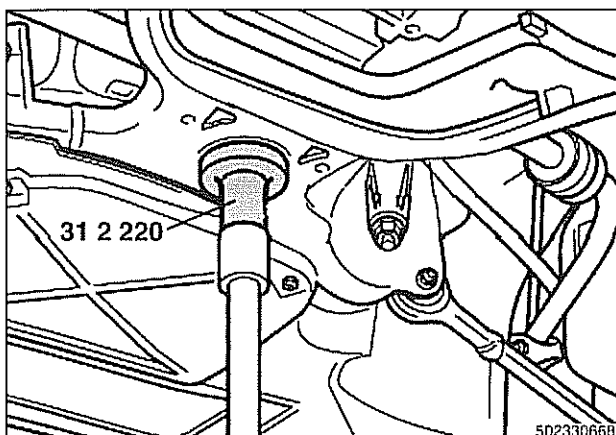


- ▲ Working at right side of engine, remove oil return line from upper section of oil pan.

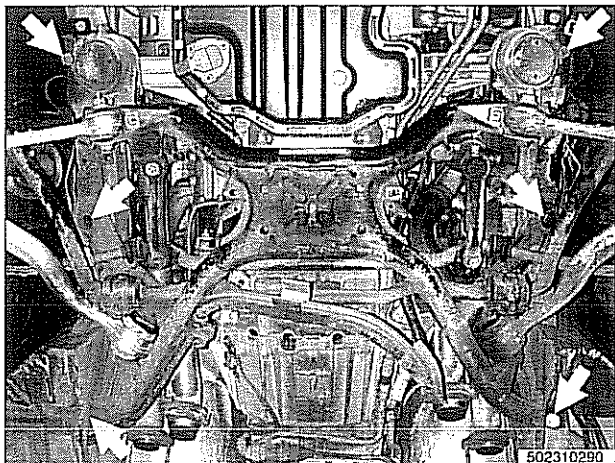


- ▲ Separate lower steering column from steering box:
- Remove retaining bolt (**arrow**) from lower steering column universal joint.
  - Slide lower steering column up and off of connection at steering box.
- Remove support bracket for hydraulic line at subframe.

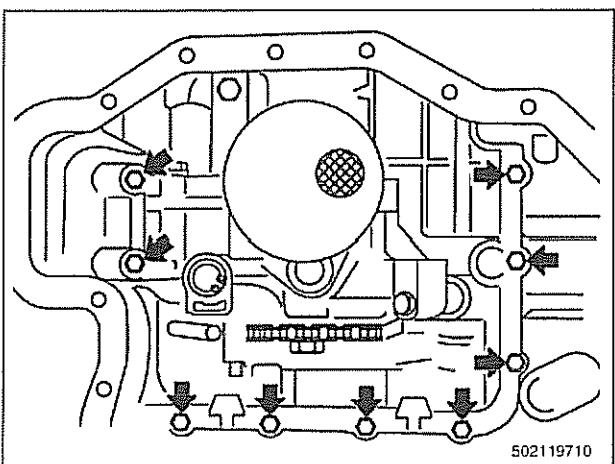




- Support subframe from below using BMW special tool 31 2 220 and appropriate shop lift.

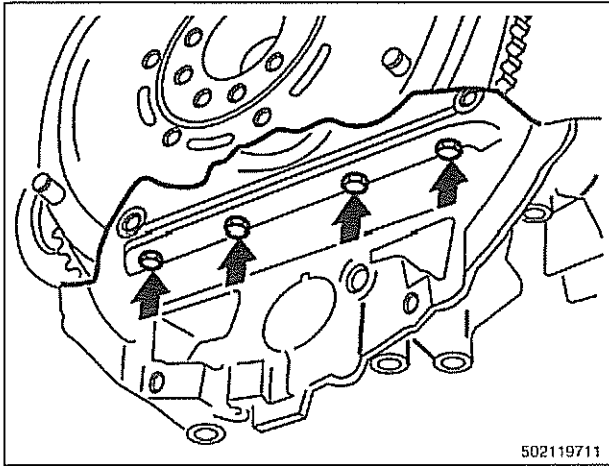


- Remove subframe mounting bolts (**arrows**) and lower subframe as far as possible.



- Working through lower oil pan opening, remove pump mounting bolts (**arrows**).
  - Remove oil pump. See **Oil pump, removing and installing (V-8)**.

## Lubrication System



- ▲ Working at lower rear of engine, remove oil pan retaining bolts (**arrows**).
- If necessary, remove oil cooler bracket from oil pan.
  - Remove remaining oil pan bolts. Slide upper section of oil pan forward to remove.
  - Installation is reverse of removal, noting the following:
    - Clean sealing surfaces of debris.
    - Coat joints with Three Bond 1209 ® sealant.
    - Use new gaskets.
    - Install all oil pan bolts first, installing bolts at transmission end without preload.
    - Tighten oil pan bolts at front end, then tighten bolts at rear of engine.

### CAUTION—

*Be sure to reinstall all oil pump fasteners, including the sprocket retaining nut, using Loctite ® or equivalent thread locking product. Torque to specifications.*

- After adding engine oil, start and run engine. Raise engine speed to 2,500 rpm until oil pressure warning light goes out (about 5 seconds).

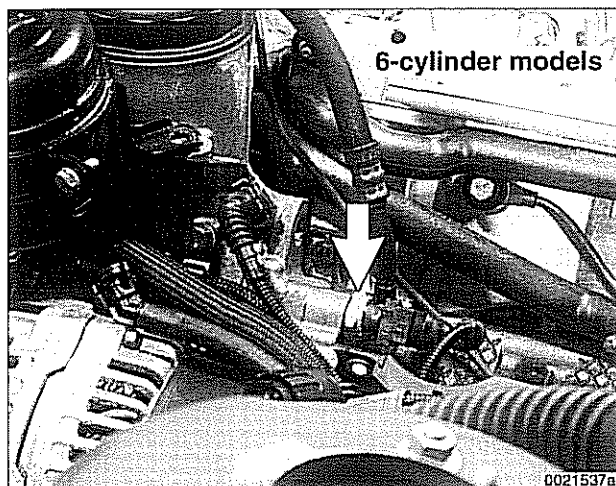
### Tightening torques

A/C drive belt tensioner	
M6	10 Nm (7.5 ft-lb)
M8	24 Nm (18 ft-lb)
Front axle subframe to chassis (Use new fasteners)	77 Nm (57 ft-lb)
Oil drain line to upper oil pan	30 Nm (22 ft-lb)
Oil pump to crankcase	34 Nm (25 ft-lb)
Oil pan fasteners (upper/lower)	
M6 8.8	10 Nm (7.5 ft-lb)
M6 10.9 (replace)	12 Nm (9 ft-lb)
M8 8.8	22 Nm (16 ft-lb)
Steering column universal joint to steering box (replace)	19 Nm (14 ft-lb)

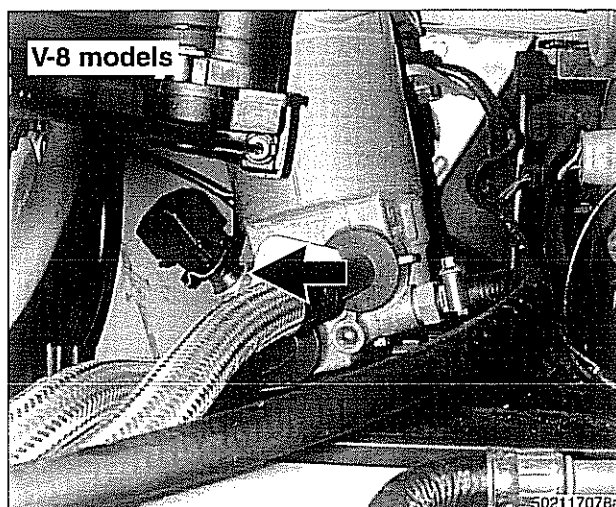
## COMPONENT REPLACEMENT

### Oil pressure warning switch, replacing (6-cylinder and V-8)

- In all models, the oil pressure warning switch is located at the base of the oil filter housing.



- ⚡ 6-cylinder models: Remove intake manifold to access oil pressure switch (arrow).



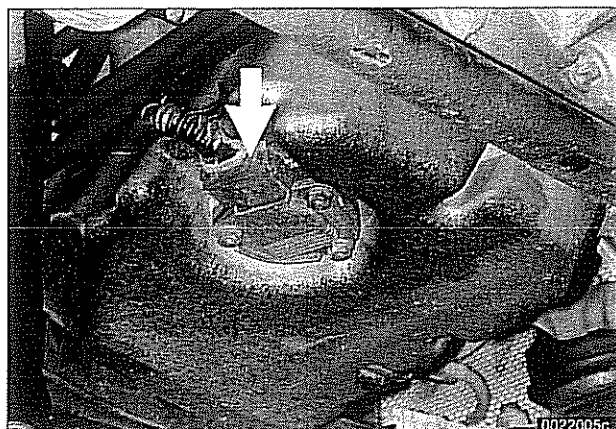
- ⚡ V-8 models: Oil pressure warning switch (arrow) is located under oil filter housing mounted to left inner fender panel.

**NOTE—**

Any time the oil pressure warning switch is removed, be sure to replace the sealing washer.

**Tightening torque**

Oil pressure switch to oil filter housing	27 Nm (20 ft-lb)
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- ⚡ Oil level warning switch is located at bottom of the engine oil pan.

- Drain engine oil before attempting to remove level warning switch.
- Be sure to refill engine and check for leaks after work is completed.

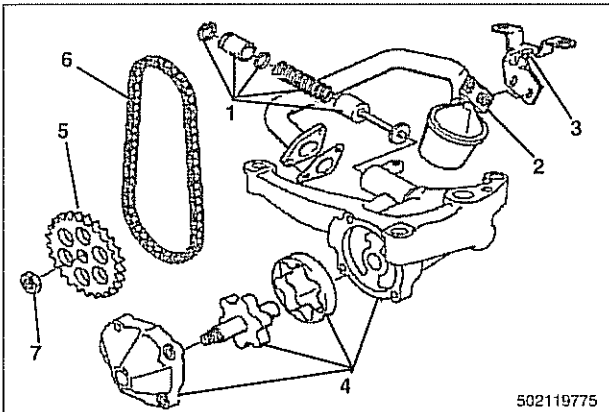
**NOTE—**

Any time the oil level warning switch is removed, be sure to replace the sealing O-ring between switch and oil pan.

## Oil pump, removing and installing (6-cylinder)

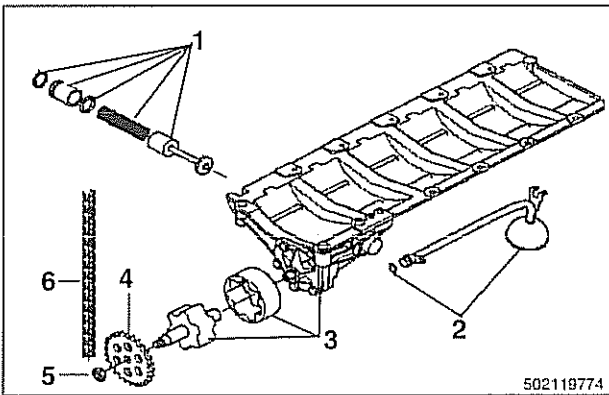
### CAUTION—

Oil pump sprocket nut has left-hand threads. Turn clockwise to loosen.



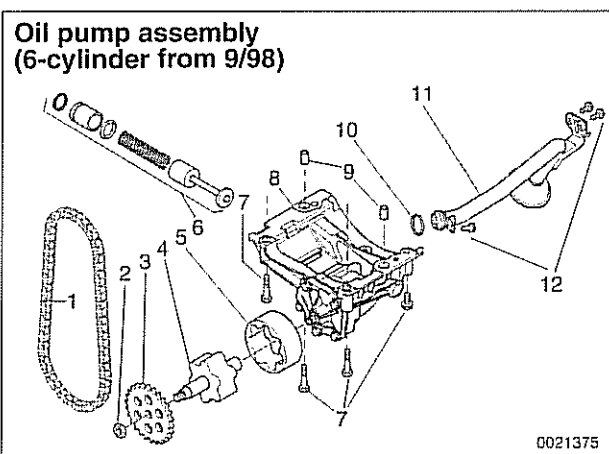
#### Version 1, M52 oil pump assembly.

1. Oil pump pressure relief control valve
2. Oil pump suction tube
3. Suction tube support bracket
4. Oil pump assembly
5. Oil pump drive sprocket
6. Oil pump drive chain
7. Oil pump drive sprocket nut (left hand threads)



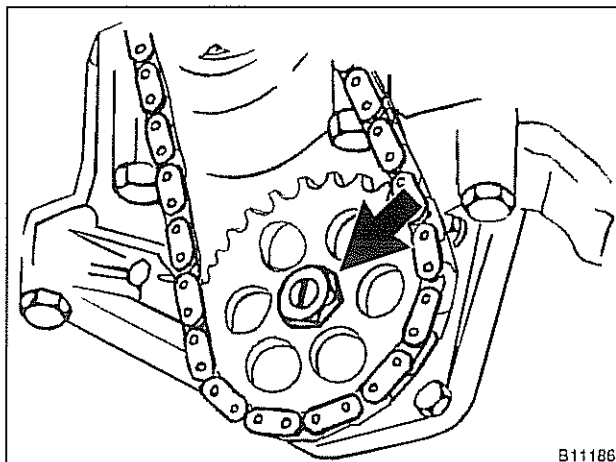
#### Version 2, M52 TU oil pump assembly.

1. Oil pump pressure relief control valve assembly
2. Oil pump suction pick-up and seal
3. Oil pump
4. Oil pump drive sprocket
5. Oil pump shaft locking nut (left-hand thread)
6. Oil pump drive chain



#### Version 3, M54 oil pump assembly.

1. Drive chain
2. M10 x 1 nut  
Tighten to 25 Nm (18 ft-lb)
3. Oil pump sprocket
4. Inner pump rotor
5. Outer pump rotor
6. Oil pressure relief valve assembly
7. M8 bolt.  
Tighten to 23 Nm (17 ft-lb)
8. Oil pump housing
9. Locating dowels
10. Pickup tube sealing O-ring
11. Pickup tube
12. M6 pickup tube mounting bolts  
Tighten to 10 Nm (89 in-lb)



- Lower front suspension and remove oil pan, as described earlier, to gain access to oil pump.
- Remove oil pump sprocket mounting nut (left-hand thread) (arrow). Lift sprocket off together with drive chain.
  - Engines produced to 9/98: Remove oil pump with pick-up tube. Pick-up tube is bolted to side of oil pump.
  - Engines produced from 9/98 to 01/00: Remove pick-up tube, scraper tray and oil pump as a unit.
  - Engines produced from 01/00: Remove oil pump pick-up tube bolts and remove pick-up tube before removing pump.
  - Remove mounting bolts from oil pump. Withdraw pump.

**NOTE—**

- Record location of any spacers between pump and engine block. Note positions of locating dowels.
- Remove cover from oil pump and check for wear or scoring. Spin oil pump shaft and check that gears turn smoothly. Replace pump if gears spin with difficulty or any wear is present.
- Inspect oil pressure relief valve as described later.
- Installation is reverse of removal, noting the following:
  - Replace pick-up tube O-ring (if applicable).
  - Align sprocket splines to oil pump shaft splines before tightening sprocket nut.
- After adding engine oil, start and run engine. Raise engine speed to 2,500 rpm until oil pressure warning light goes out (about 5 seconds).

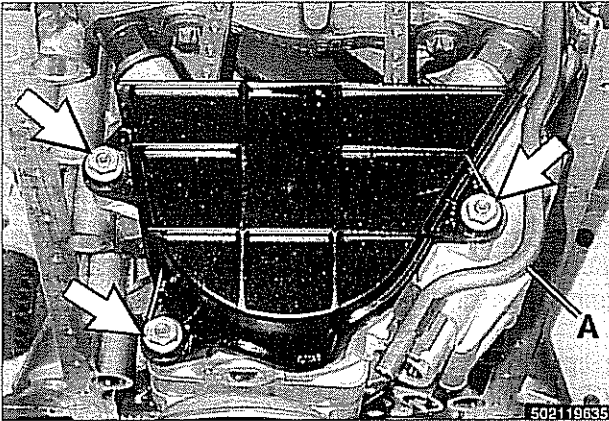
**Tightening torques**

Oil drain plug to oil pan	25 Nm (18 ft-lb)
Oil pan to engine block	
M6 (8.8 grade)	10 Nm (89 in-lb)
M6 (10.9 grade)	12 Nm (9 ft-lb)
M8 (8.8 grade)	22 Nm (16 ft-lb)
Oil pump sprocket to oil pump shaft (M10 x 1) (left hand thread)	25 Nm (18 ft-lb)
Oil pump to crankcase (M8)	22 Nm (16 ft-lb)
Oil pump pickup tube to crankcase (M6)	10 Nm (89 in-lb)

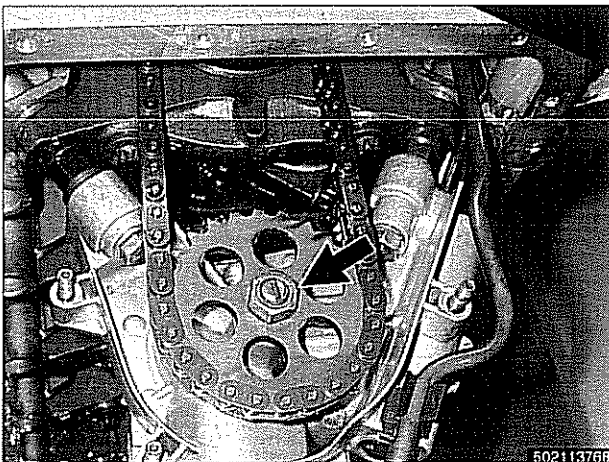
## Oil pump, removing and installing (V-8)

**CAUTION—**

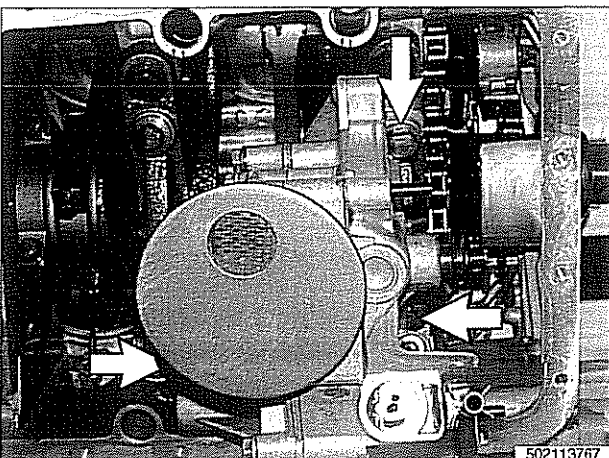
**V8 engines:** The oil pump fasteners (including the sprocket retaining nut) are known to vibrate loose. This can result in oil starvation and engine failure. Be sure to check oil bolts and nut tightness whenever the oil pump is accessible. If any fasteners are found to be loose, remove them and reinstall with Loctite ® and torque to specifications.



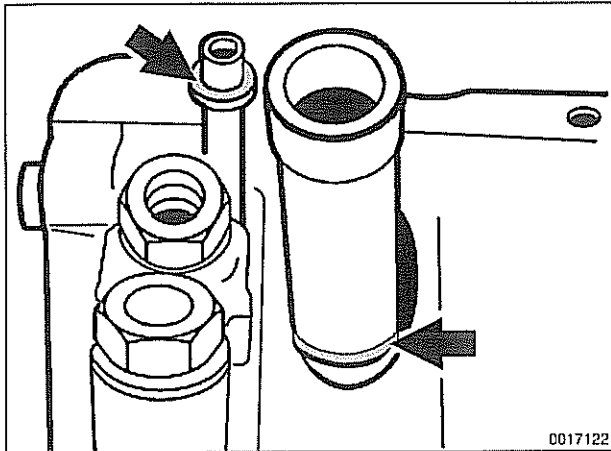
- Remove upper oil pan, as described earlier, to gain access to oil pump.
- If fitted, remove oil pump sprocket cover fasteners (arrows). Remove cover.
  - Unclip oil return line (A).



- Remove oil pump sprocket nut (arrow) and sprocket together with drive chain.



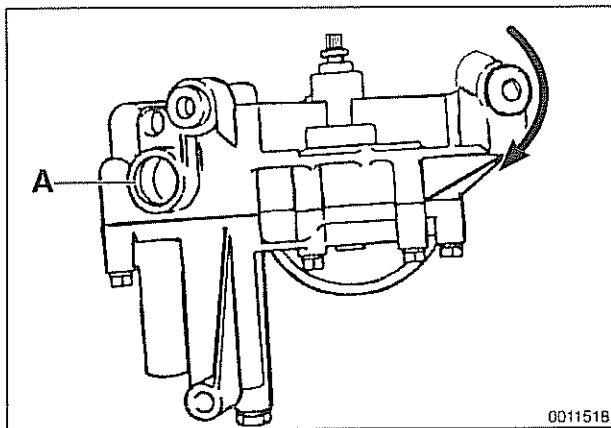
- Unbolt oil pump mounting fasteners (arrows) and remove pump.
- Remove oil pressure relief valve and inspect as described later.



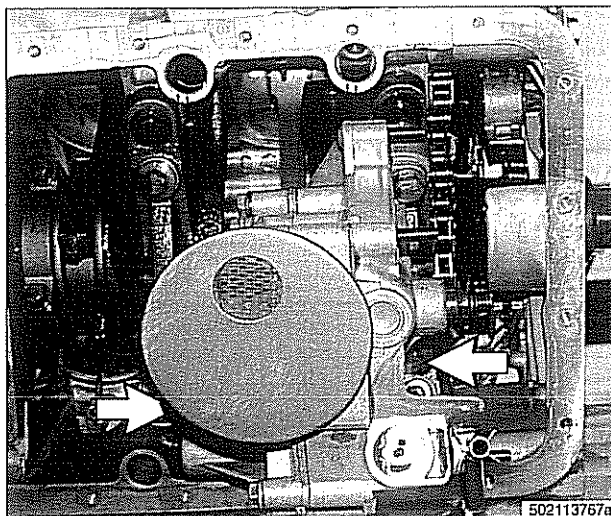
- ▲ Replace O-ring seals (**arrows**) on engine oil pipes. Oil seals lightly.

**CAUTION—**

*During reinstallation, do not damage O-rings on sharp edges of engine block.*



- ▲ Replace sealing O-ring (**A**) in oil pump.
- Turn threaded spacer on pump fully to stop (**arrow**).

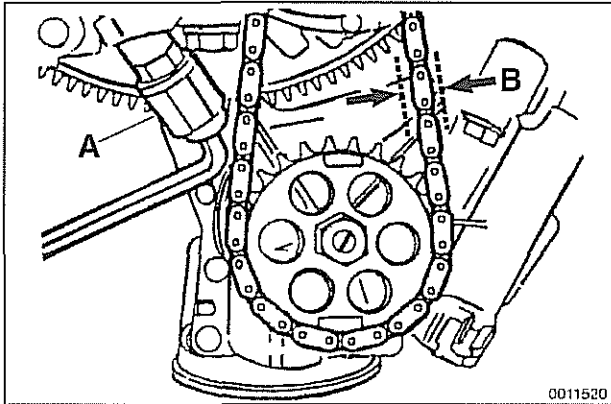


- ▲ Reinstall pump. Coat pump mounting fasteners (**arrows**) with Loctite ® or equivalent thread locking product. Install and tighten.
- Coat pump sprocket shaft threads with Loctite ®. Reinstall pump sprocket with drive chain and tighten mounting nut.

**Tightening torques**

Oil pump cover to oil pump (M6)	10 Nm (89 in-lb)
Oil pump sprocket to shaft (M10)	45 Nm (33 ft-lb)
Oil pump to engine block M8 (8.8 grade)	22 Nm (16 ft-lb)

## Lubrication System



- ▲ Use Allen wrench to adjust chain slack (B) by turning threaded spacer (A).

### Oil pump chain adjustment

Slack B	10 ± 2 mm (0.394 ± 0.079 in)
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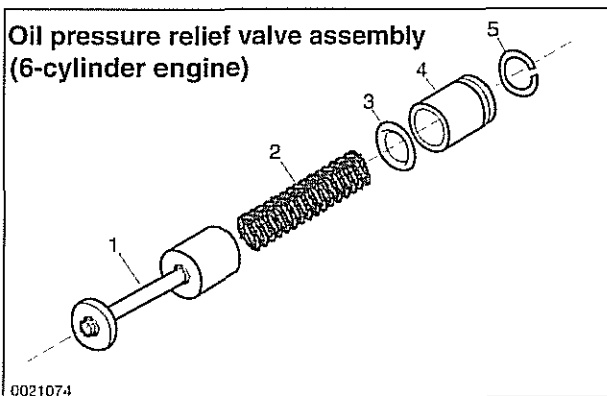
- Coat remaining oil pump mounting fastener with Loctite®. Install and tighten.
- Remainder of assembly is reverse of disassembly.
- After adding engine oil, start and run engine. Raise engine speed to 2,500 rpm until oil pressure warning light goes out (about 5 seconds).

### Tightening torques

Lower oil pan to upper oil pan	
M6 (8.8 grade)	10 Nm (89 in-lb)
M6 (10.9 grade)	12 Nm (9 ft-lb)
M8 (8.8 grade)	22 Nm (16 ft-lb)
Oil drain plug to oil pan (M12)	25 Nm (18 ft-lb)
Oil pump cover to oil pump (M6)	10 Nm (89 in-lb)
Oil pump sprocket to shaft (M10)	45 Nm (33 ft-lb)
Oil pump to engine block	
M8 (8.8 grade)	22 Nm (16 ft-lb)

## Oil pressure relief valve (6-cylinder)

Remove oil pump as described earlier. The oil pump pressure relief valve is held in the side of the oil pump with a circlip.



- ▲ Inspect oil pump relief valve components and bore for scoring or other damage.

1. Control plunger
2. Spring
3. Sealing O-ring
4. Sleeve
5. Circlip

- Install using a new circlip.

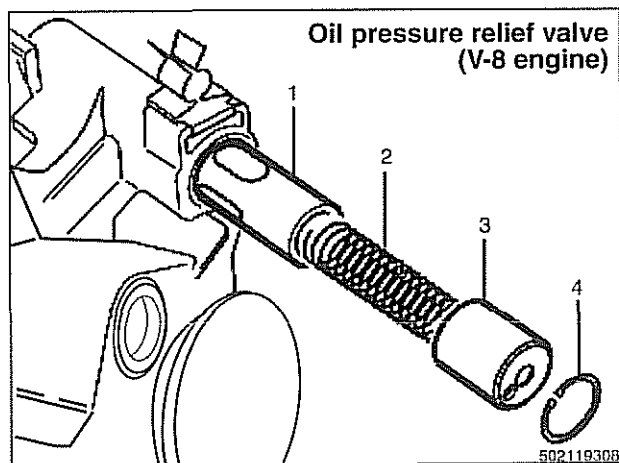
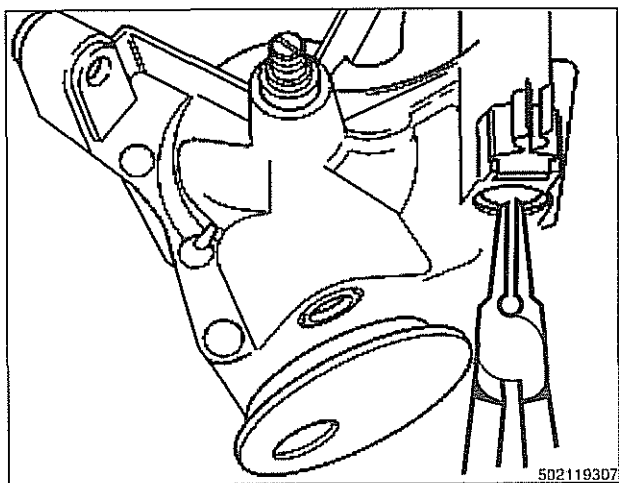


### Oil pressure relief valve (V-8)

- ◀ Remove oil pressure relief valve retaining circlip.
  - Use a suitable drift to remove relief valve assembly from pump.

**CAUTION—**

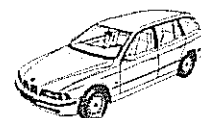
*There is high spring pressure in the relief valve.*



- ◀ Inspect oil pump relief valve components and bore for scoring or other damage.

1. Control plunger
2. Spring
3. Sleeve
4. Circlip

- Install using a new circlip.





# 120 Ignition System

<b>General</b> .....	120-2	<b>Ignition System Service</b> .....	120-9
Special tools .....	120-2	Ignition firing order .....	120-9
Warnings and cautions .....	120-3	Disabling ignition system .....	120-10
Engine management .....	120-3	Checking for spark .....	120-10
Ignition system .....	120-4	Ignition coil assembly, testing and replacing .....	120-10
Ignition system, troubleshooting .....	120-6	Crankshaft speed sensor .....	120-12
Oscilloscope diagnostic diagrams .....	120-6	Camshaft position sensors .....	120-14
Misfire detection .....	120-6	Knock sensors .....	120-16

## GENERAL

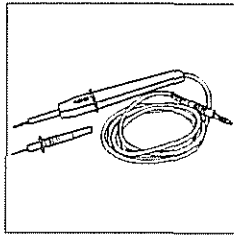
This repair group covers component troubleshooting and replacement information for the ignition system.

When diagnosing engine management problems, including on-board diagnostics (OBD II) fault code analysis, also refer to these repair groups:

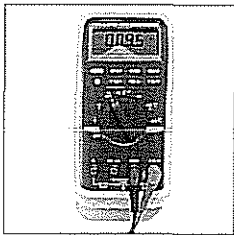
- 130 Fuel Injection
- ELE Electrical Wiring Diagrams
- OBD On-Board Diagnostics

## Special tools

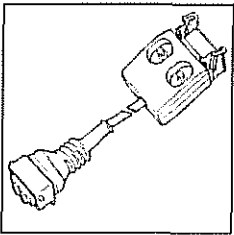
System diagnosis and testing of the ignition system requires special test equipment.



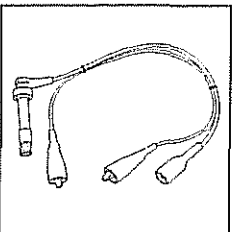
- ◀ LED test light  
(Tool No. Baum 1115)



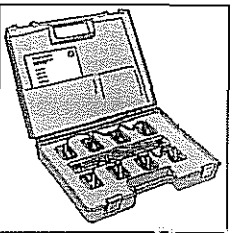
- ◀ Automotive digital multimeter



- ◀ Primary voltage test harness  
(Tool No. BMW 12 7 020)



- ◀ Secondary voltage test harness  
(Tool No. BMW 12 7 030)



- ◀ Ignition coil test adapters  
(Tool No. BMW 12 7 040)

## Warnings and cautions

The ignition system produces dangerous high voltage. In addition the sensitive electronic components can be damaged if proper precautions are not adhered to.

### **WARNING—**

- *Do not touch or disconnect any cables from the coils 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.*

### **CAUTION—**

- *Do not attempt to disable the ignition by removing the coils from the spark plugs.*
- *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.*
- *A high impedance digital multimeter should be used for all voltage and resistance tests. An LED test light should be used in place of an incandescent-type test lamp.*
- *In general, make test connections only as specified by BMW, as described in this manual, or as described by the instrument manufacturer.*

## Engine management

BMW E39 engines use an advanced engine management system known as Digital Motor Electronics (DME). DME incorporates on-board diagnostics, fuel injection, ignition and other engine control functions. DME variants are listed in **Table a. Engine management systems.**

Second generation On-Board Diagnostics (OBD II) is incorporated into the engine management systems used on the cars covered by this manual. Use a BMW-specific electronic scan tool, or a "Generic" OBD II scan tool to access Diagnostic Trouble Codes (DTCs). DTCs can help pinpoint ignition and other engine management problems.

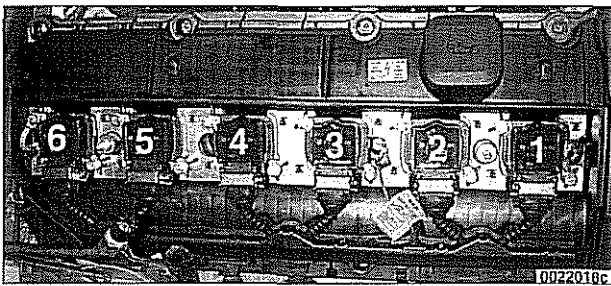
**Ignition System**

Additional information about DTCs and engine management system electronic system diagnosis is provided in **OBD On-Board Diagnostics**.

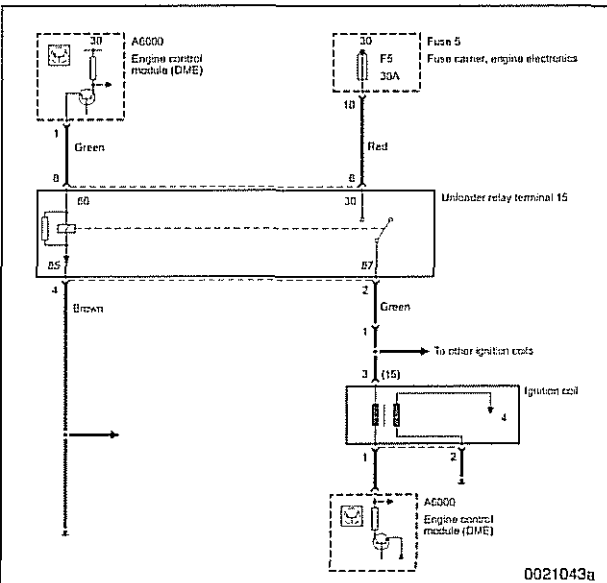
**Table a. Engine management systems**

Year	Engine	Engine type	DME system
1997-1998	M52	6-cylinder	Siemens MS 41.1
1999-2000	M52 TU	6-cylinder	Siemens MS 42.0
2001-2002	M54	6-cylinder	Siemens MS 43.0
1997	M62	V-8	Bosch M 5.2
1998	M62	V-8	Bosch M 5.2.1
1999-2002	M62 TU	V-8	Bosch ME 7.2

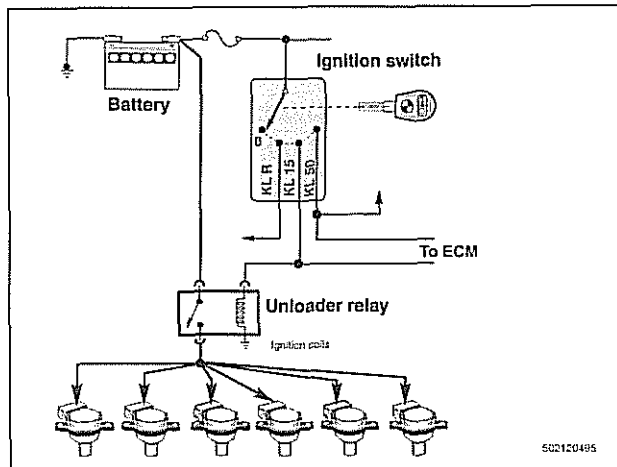
**Ignition system**



➤ All engines use a distributorless ignition system with individual ignition coils for each cylinder. There is no distributor cap or ignition rotor.



➤ Each coil is controlled and monitored by the Engine Control Module (ECM) on a cylinder-by-cylinder basis.



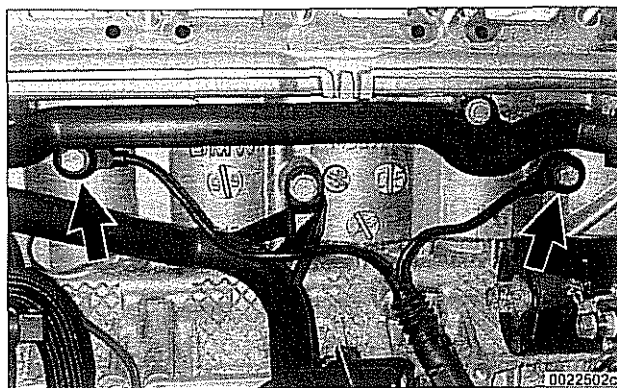
➤ The positive (+) power supply to the ignition coils comes to the ignition switch via an unloader relay. When the ignition switch is turned on, the relay closes, to provide voltage to the ignition coils. The coils are then actuated at the negative side by the engine control module.

**NOTE —**

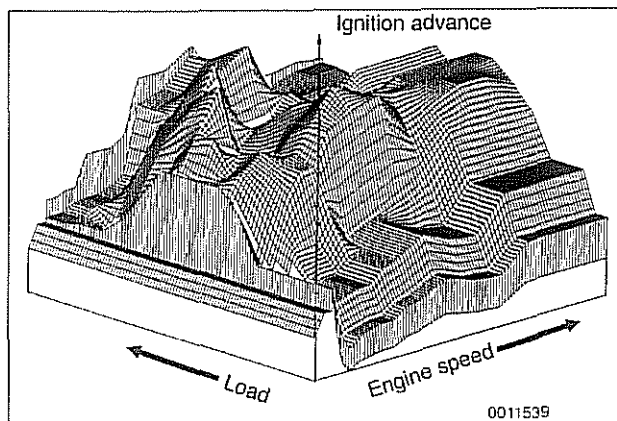
Schematic diagrams shown are for illustrative purposes only. See **ELE Electrical Wiring Diagrams** for engine management specific wiring information.

**WARNING —**

- Do not touch or disconnect any cables from the coils 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.



➤ Knock sensors (**arrows**) monitor the combustion chamber for engine-damaging knock. Six-cylinder models (shown) use two sensors with each sensor monitoring three cylinders. V-8 models use four sensors, each monitoring two cylinders. If engine knock is detected, the ignition point 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.

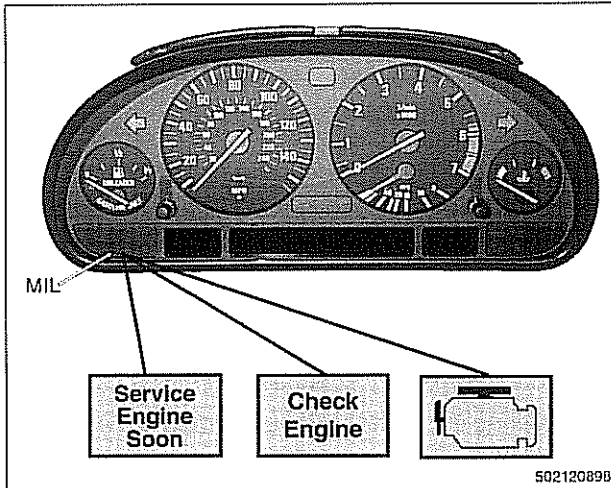
## Ignition system, troubleshooting

Troubleshooting ignition system faults should begin with an interrogation of the On-Board Diagnostics (OBD II) system. The OBD II system detects ignition system misfire and other related faults. When faults are detected, the OBD II system stores a Diagnostic Trouble Code (DTC) in the Engine Control Module (ECM) along with other pertinent fault information.

◀ In addition, the Malfunction Indicator Light (MIL) will come on 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 —

*BMW models covered in this manual were equipped with one of three versions of MIL warning lights (as shown).*



## Misfire detection

Engine misfire in one or more cylinders, may be caused by a variety of malfunctions in various subsystems. The OBD II system incorporated into the engine management systems is designed to detect and warn of misfire faults during engine operation. See **OBD On Board Diagnostics**.

### 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.*

## Oscilloscope diagnostic diagrams

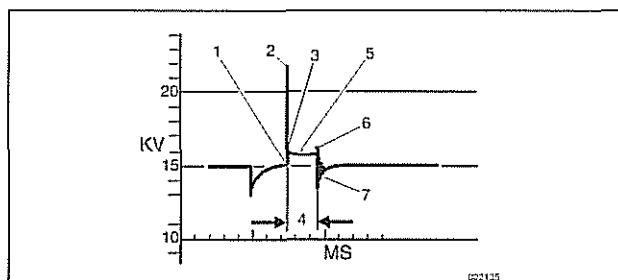
One way to diagnose a faulty coil is to use an oscilloscope to analyze spark quality with the engine running.

See **Table b. Ignition secondary voltage diagnostics** for list of common ignition coil voltage faults and related causes.



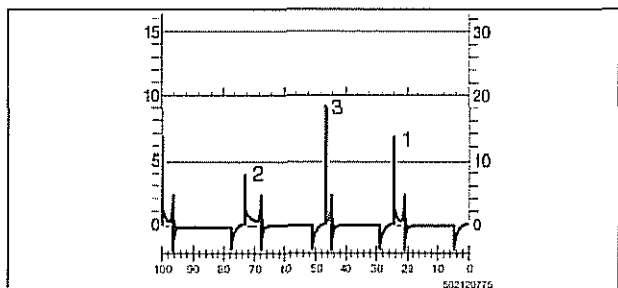
Table b. Ignition secondary voltage diagnostics

	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



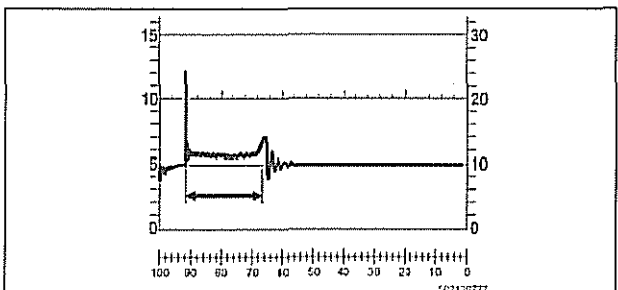
➤ The illustration shows normal scope trace of spark at idle.

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

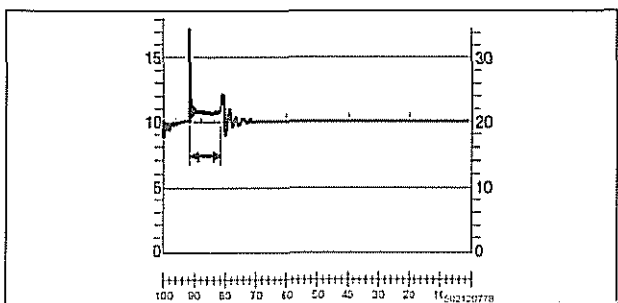


➤ Ignition spark at idle speed.

- A - Normal ignition voltage peak (spark plug is good).
- B - Low voltage peak is an indication of a closed plug gap.
- C - High voltage peak indicates an open plug gap.

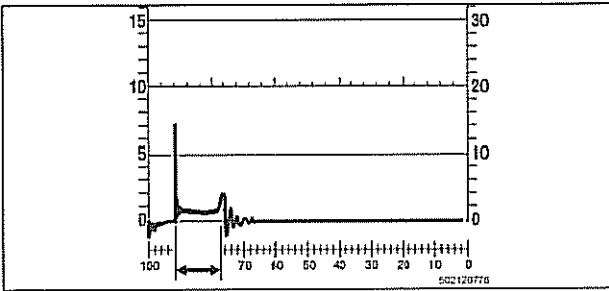


➤ Long combustion period (indicates small spark plug gap).

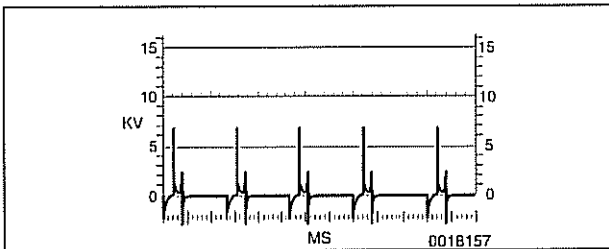


➤ Short combustion period (indicates large spark plug gap).

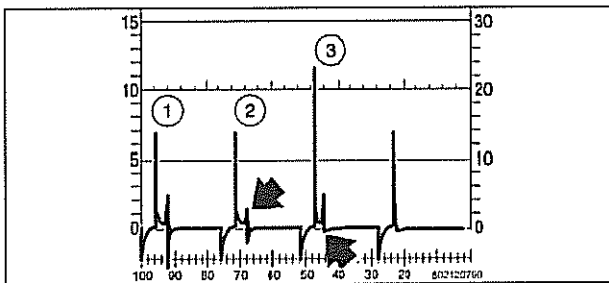
**Ignition System**



◀ Normal combustion period at idle.

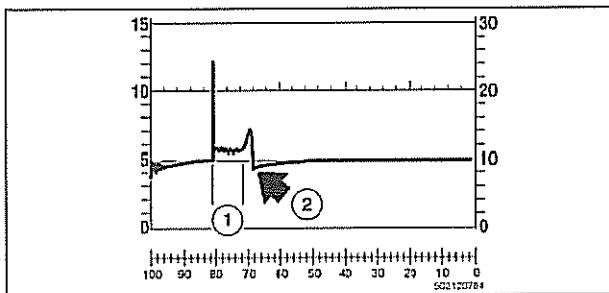


◀ Normal oscilloscope pattern for ignition system at idle.



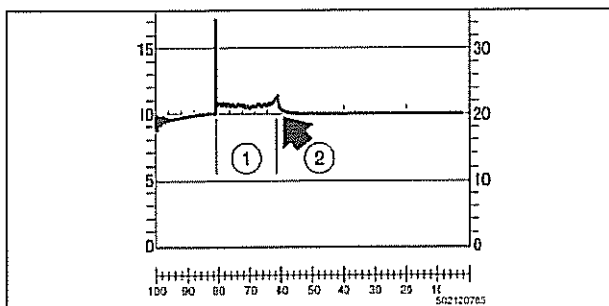
◀ Ignition voltage peaks at idle.

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).



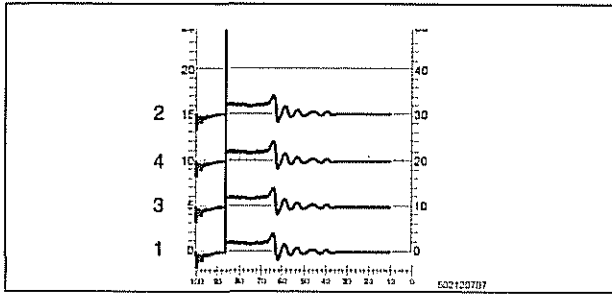
◀ Defective ignition coil.

1. Short spark period.
2. The spark voltage line (**arrow**) is very slight.

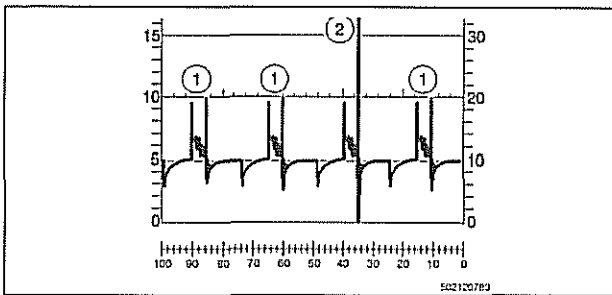


◀ Defective ignition coil.

1. Normal combustion period.
2. Absence of spark voltage line (**arrow**).



◀ Normal secondary voltage patterns (4-cylinder pattern shown).

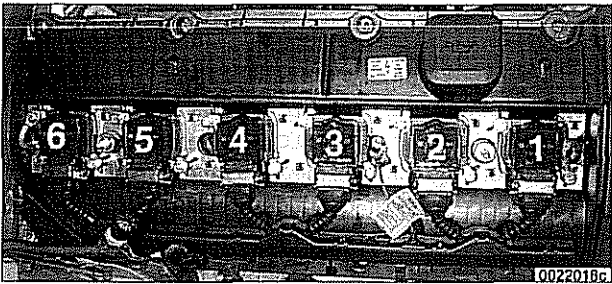


◀ Ignition voltage peaks in response to sudden acceleration load:

1. Normal ignition pattern. Beginning of dying out pattern is not much higher than ignition voltage peak.
2. Beginning of dying out pattern considerably higher than ignition voltage peak. Fault in injection system:
  - Lean fuel mixture
  - Defective fuel injector
  - Low compression in cylinder

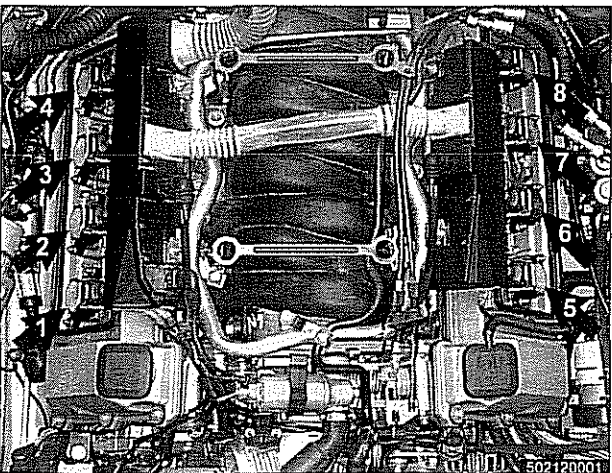
## IGNITION SYSTEM SERVICE

### Ignition firing order



◀ Each ignition coil is mounted above the corresponding spark plug.

— Number one cylinder is located at the front on 6-cylinder models.



◀ Number one cylinder is located at the right (passenger side) front on V-8 models. Cylinder firing order is shown.

#### Firing order

M52 - M52 TU - M54 6-cylinder	1-5-3-6-2-4
M62 - M62 TU V-8	1-5-4-8-6-3-7-2

## Disabling ignition system

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

The engine management system can be disabled by removing the DME main relay. The relay is located in the electronics box (E-box) in the left rear of the engine compartment, beneath the interior microfilter housing.

### CAUTION—

*Relay locations may vary. Use care when identifying relays. See 610 Electrical Component Locations.*

## Checking for spark

### CAUTION—

*If a spark test is done incorrectly, damage to the Engine Control Module (ECM) or the ignition coils may result.*

### NOTE—

*Spark plug replacement is covered in 020 Maintenance.*

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

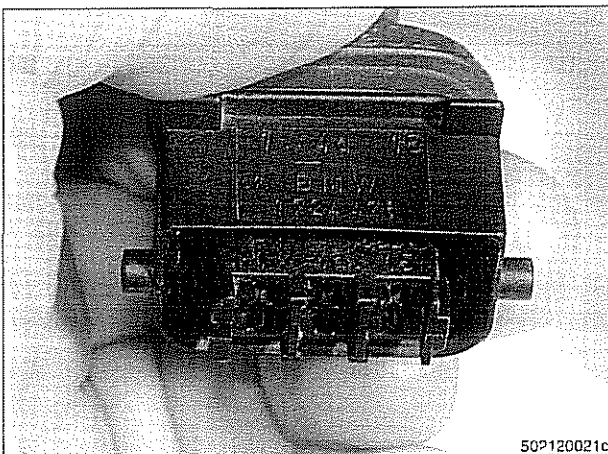
Try removing the spark plugs and inspecting for differences between them. A poor-firing plug may be wet with fuel and/or black and sooty, but not always. If a coil is not operating, the engine management system will electrically disable the fuel injector to that cylinder. The key is to look for differences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

## Ignition coil assembly, testing and replacing

### CAUTION—

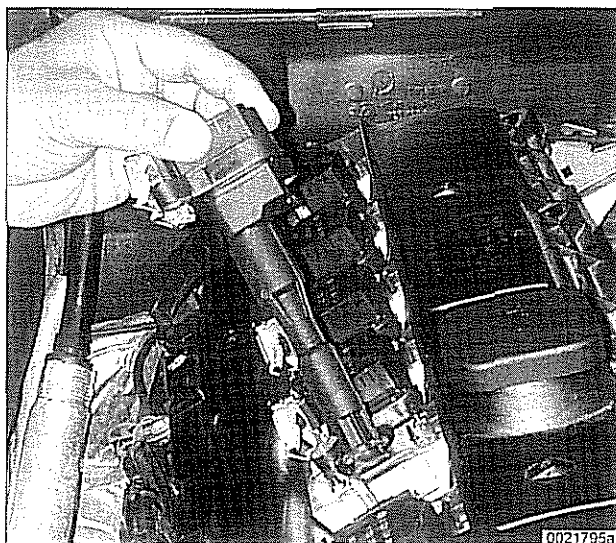
*Use a digital multimeter for the following tests.*

- Remove plastic engine cover from top of valve cover by prying off bolt covers and removing cover mounting bolts.
- Raise car slowly while constantly checking position of jack and car.
- Disconnect harness connector from coil. Connect multimeter between terminal 15 (+) in connector and ground.
- ◀ Terminal identification are typically molded into connector. In photo, terminals are from left to right: 1, 4a, 15.



502120021c

- Turn ignition on and check for battery voltage.
  - If battery voltage is not present, check wire between terminal 15 and the unloader relay. See **ELE Electrical Wiring Diagrams**.
- Turn ignition off.



- Remove coil and inspect coil housing for hairline cracks or leaking casting material. Replace any cracked or leaking coil.

**NOTE—**

A leaky coil may indicate a faulty Engine Control Module (ECM). Check ECM before installing a new coil.

**CAUTION—**

Note location of coil ground straps before coil removal; reinstall in the same location.

- Use a multimeter to test:
  - Coil primary resistance at coil terminals.
  - Spark plug connector resistance.
  - Compare results to specification in **Table c. Ignition coil resistance**.

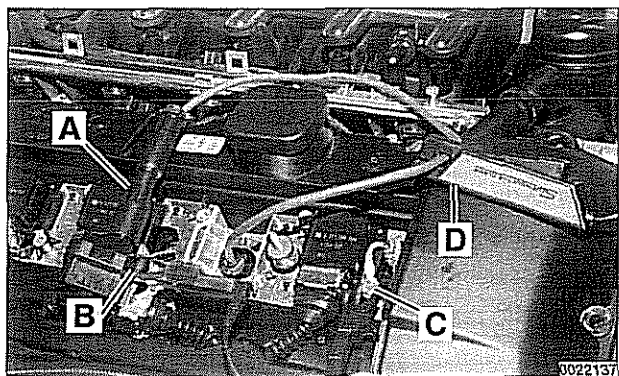
**Table c. Ignition coil resistance**

Component	Terminal	Resistance
Coil primary resistance	1 (-) and 15 (+)	0.8 ohms
Coil secondary resistance	N/A	N/A
Spark plug connector:		
Bosch		1.0 k ohm ± 20%
Beru		1.8 k ohm ± 20%

- Replace ignition coil or spark plug connector if resistance readings do not meet specifications.
- Remove ignition coil to be tested.
  - Install BMW special tool 12 7 030 (A) on coil to be tested.
  - Connect ground jumper between coil mounting point (B) and engine ground point (C).
  - Clip scope high pick-up lead (D) around ignition lead.
  - Start engine.
  - Compare scope pattern with diagrams in **Oscilloscope diagnostic diagrams**.

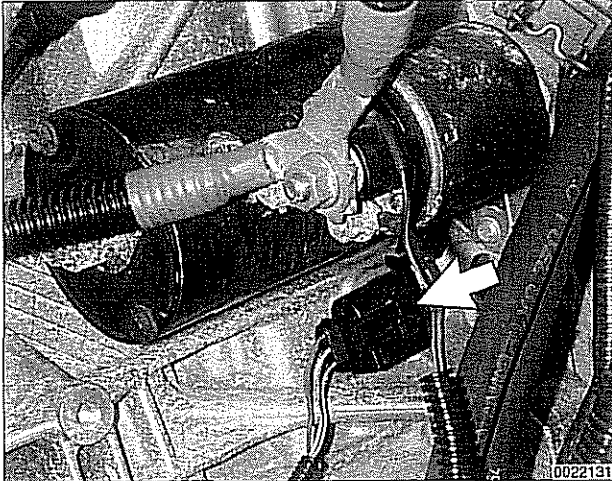
**NOTE—**

When replacing ignition coils, ensure that the replacements are from the same manufacturer with the same part/code numbers. If individual coils with the correct specifications are not available, all coils should be replaced.



## Crankshaft speed sensor

Crankshaft speed sensor, replacing (M52, M52 TU and M54 engines)



◀ Crankshaft speed sensor for 6-cylinder engine is mounted in the left rear side of the cylinder block below the starter (**arrow**). The sensor reads a toothed pulse wheel mounted to the end of the crankshaft.

- If the Engine Control Module (ECM) does not receive a signal from the crankshaft speed sensor during cranking, the engine will not start.
- If the OBD II system misfire detection protocol detects a catalyst damaging fault due to a malfunction in crankshaft speed sensor components, the Check Engine light (Malfunction Indicator Light or MIL) will be illuminated.

### NOTE —

*If the crankshaft speed sensor pulse wheel is damaged, the engine will have to be disassembled down to the crankshaft to replace the wheel.*

- Make certain ignition has been turned off.
- Raise car and support in a safe manner.

### 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 under engine splash guard.

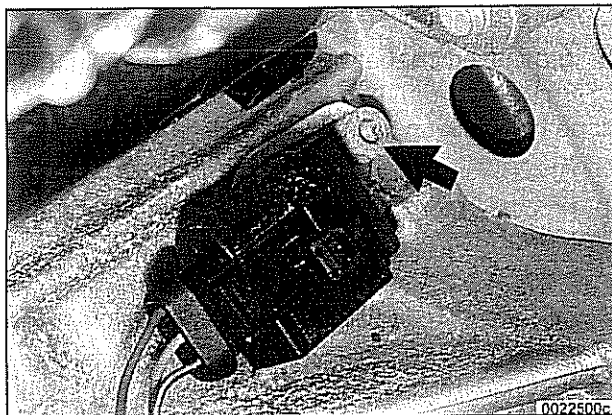
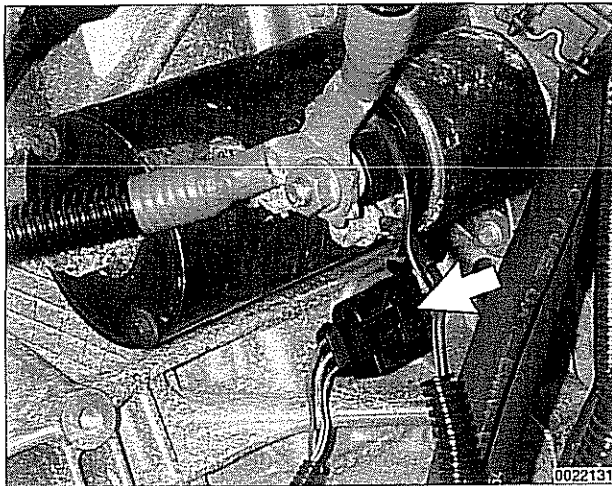
◀ Working underneath starter:

- Cut off wire tie securing crankshaft speed sensor harness connector (**arrow**) to sensor.
- Disconnect harness connector.

◀ Remove sensor mounting fastener (**arrow**) and remove sensor from cylinder block.

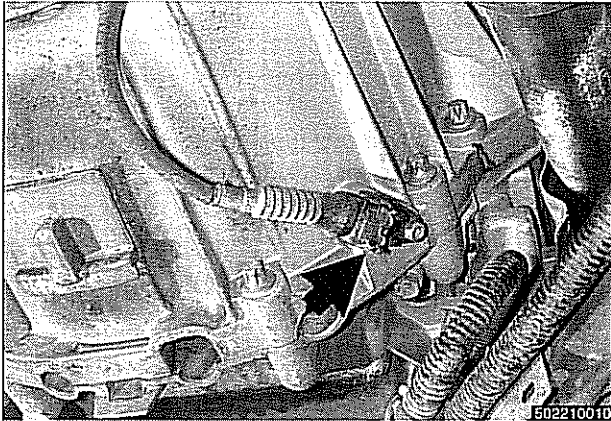
- Installation is reverse of removal, noting the following:

- Use a new O-ring when installing sensor.
- Be sure wiring is routed in same orientation.
- Secure sensor using new wire ties.
- Use scan tool to read out and clear ECM fault memory.



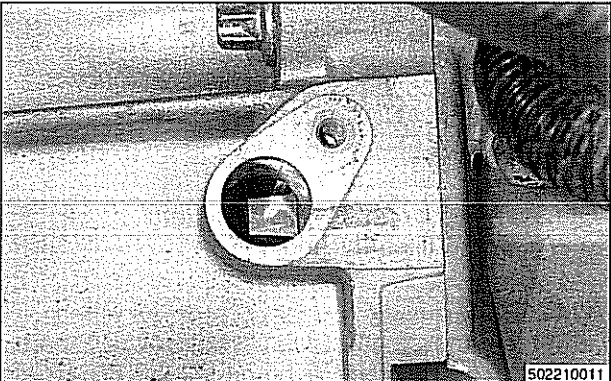
### Crankshaft speed sensor, replacing (M62 and M62 TU engines)

The crankshaft speed sensor reads a toothed pulse wheel mounted on the flywheel. If the Engine Control Module (ECM) does not receive an impulse signal from the crankshaft speed sensor during cranking, the engine will not start. If the OBD II system misfire detection protocol detects a catalyst damaging fault due to a malfunction in the crankshaft speed sensor components, the Check Engine light (Malfunction Indicator Light or MIL) will be illuminated.



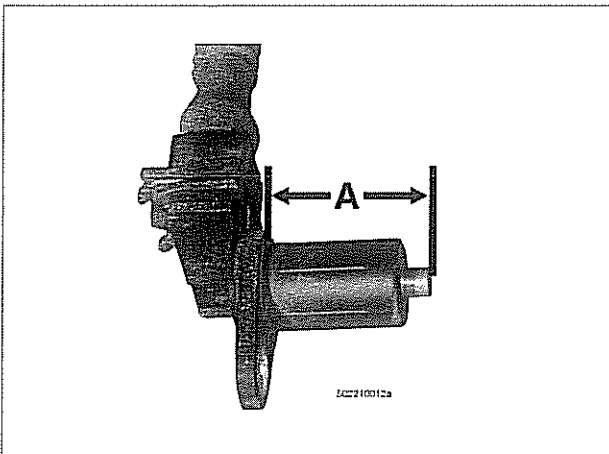
➤ The crankshaft speed sensor (arrow) is mounted in the right lower side of the bell housing.

- Remove speed sensor by disconnecting electrical harness connector and unbolting sensor from bell housing. Do not discard shims, if present.
- Installation is the reverse of removal. Clean mounting surface before installing new sensor, and install shims, if present.



➤ If the flywheel was replaced, the speed sensor must be checked for correct installation depth.

- Crank engine in direction of rotation using crankshaft bolt until a full pulse tooth is centered in the opening for the removed speed sensor.
- Measure depth to top of tooth from speed sensor pulse generator mounting surface on transmission.



➤ Measure length of pulse generator from mounting surface to end (A).

- Subtract length of pulse generator (A) from distance to pulse tooth from mounting area on transmission. This measurement is the gap between the pulse sensor and flywheel. Use shims available from BMW to increase gap as needed to reach specification.

#### Pulse sensor gap

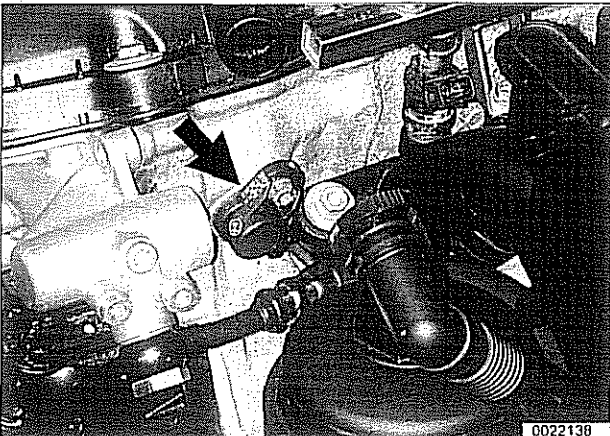
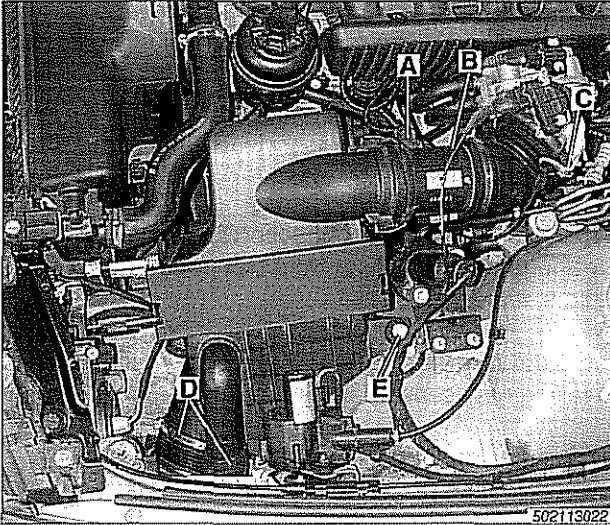
End of sensor to flywheel teeth

$0.55 \pm 0.2$  mm  
 $(0.0217 \pm 0.008$  in)

## Camshaft position sensors

The camshaft position sensors are used by the engine management system for VANOS control, sequential fuel injection and knock control.

### Intake camshaft position sensor, replacing (M52, M52 TU and M54 engines)



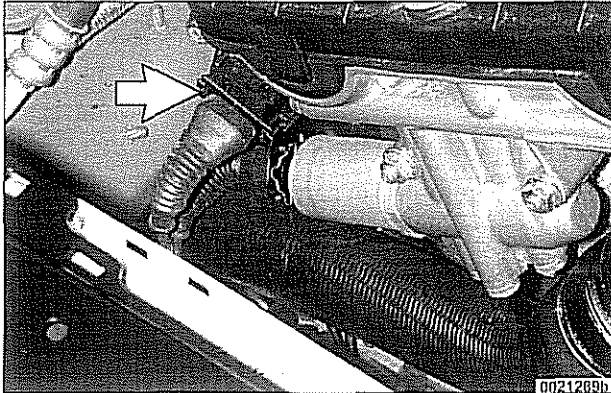
- Make certain ignition has been turned off.
- Remove plastic cover from above fuel injectors by prying off bolt covers and removing cover mounting bolts.
- Remove complete air filter housing:
  - Disconnect electrical harness connector on mass air flow sensor (A).
  - Detach vacuum line at intake boot (B).
  - Loosen hose clamp at intake boot and detach air duct connections (C).
  - Disconnect cold air duct tube (D).
  - Remove filter housing mounting screws (E).
- Disconnect harness connector from VANOS solenoid and unscrew solenoid from VANOS control unit. Be prepared with shop rags to catch oil released from VANOS unit.
- Remove camshaft sensor (arrow) from left front of cylinder head, next to top of oil filter housing.
- Disconnect camshaft sensor harness from under intake manifold. Prior to removal, attach a stiff piece of wire to the harness connector end to preserve proper routing of harness for reinstallation.
- Installation is reverse of removal, noting the following:
  - Use new O-rings when installing sensor and solenoid.
  - Be sure wiring is rerouted in same orientation.
  - Use scan tool to read out and clear ECM fault memory.

### Tightening torques

Intake camshaft sensor to cylinder head	10 Nm (7 ft-lb)
VANOS solenoid to VANOS control unit	30 Nm (22 ft-lb)



### Exhaust camshaft position sensor, replacing (M52 TU and M54 engines)

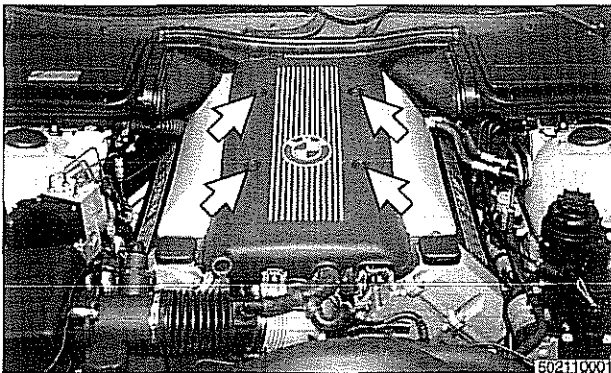


- Make sure ignition has been turned off.
- Working at front of engine on exhaust (right) side, detach exhaust camshaft position sensor electrical harness connector (**arrow**) and remove sensor.
- Installation is reverse of removal, noting the following:
  - Use a new O-ring when installing sensor.
  - Use scan tool to read out and clear ECM fault memory.

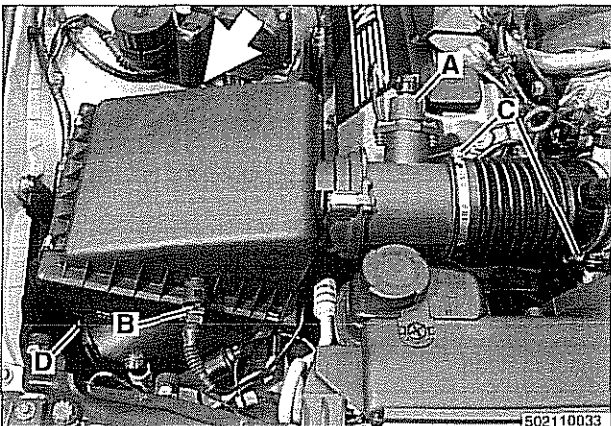
#### Tightening torque

Exhaust camshaft sensor to cylinder head	10 Nm (7 ft-lb)
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### Intake camshaft position sensor, replacing (M62 and M62 TU engines)

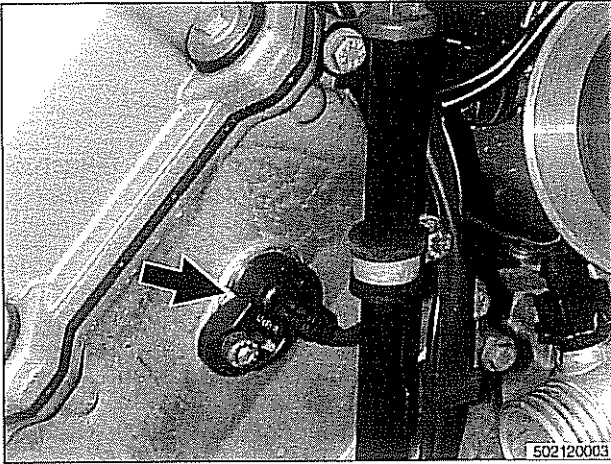


- Make sure ignition has been turned off.
- Remove top engine cover by releasing quick release fasteners (**arrows**) by pressing down.



- Remove air filter housing and mass air flow sensor:
  - Disconnect mass air flow sensor and intake air temperature sensor electrical harnesses (**A** and **B**).
  - Remove air filter housing mounting fastener (**arrow**).
  - Loosen hose clamps (**C** and **D**).
  - Remove hose at idle air stabilizer.
  - Remove air filter housing with mass air flow sensor.
  - Remove intake hose from throttle body.

## Ignition System



- Remove camshaft sensor (arrow) from front of right cylinder head.
- Disconnect camshaft sensor harness from cable duct above right cylinder head.
- Installation is reverse of removal, noting the following:
  - Use new O-ring when installing sensor.
  - Be sure wiring is rerouted in same orientation.
  - Use scan tool to read out and clear ECM fault memory.

### Tightening torque

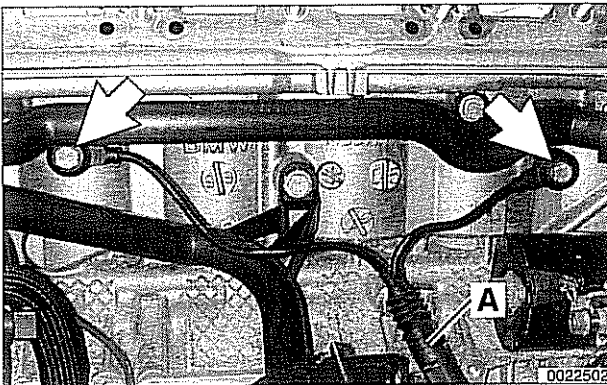
Intake camshaft sensor to timing chain cover	5 Nm (3.5 ft-lb)
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## Knock sensors

### Knock sensors, replacing (M52, M52 TU and M54 engines)

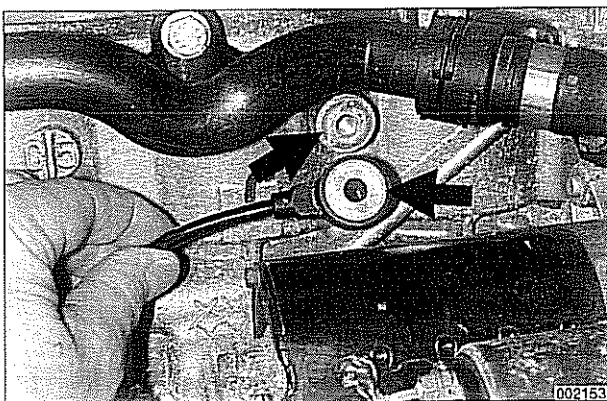
The knock sensors are bolted to the left side of the cylinder block under the intake manifold.

- Remove intake manifold as described in **113 Cylinder Head Removal and Installation**.
- Disconnect knock sensor electrical harness connector (A) on left side of engine cylinder block.
  - Remove knock sensor mounting bolts (arrows) on side of cylinder block. Remove sensors.



### CAUTION—

*Note the installed angle of the knock sensor on the block before removing it. Reinstall the sensor in the same position. Be sure to use a torque wrench when tightening the sensor mounting bolt.*



- Clean knock sensor contact surface on engine block and sensor (arrows) before installing knock sensor.

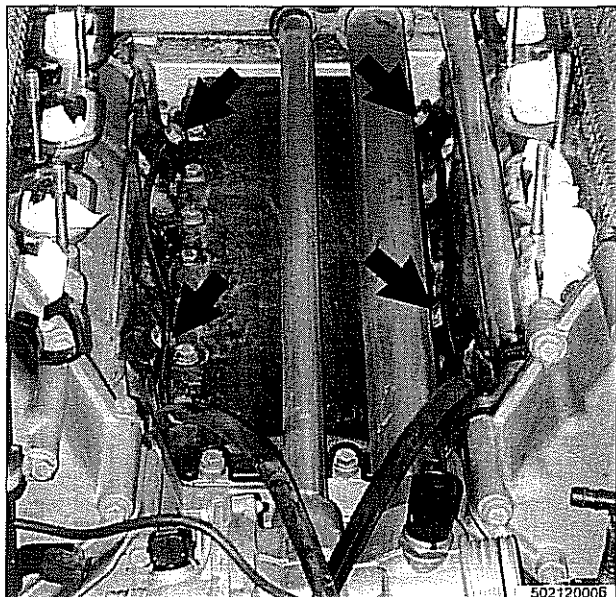
### Tightening torque

Knock sensor to head	20 Nm (15 ft-lb)
----------------------	------------------

- Use scan tool to read out and clear ECM fault memory.

### Knock sensors, replacing (M62 and M62 TU engines)

The knock sensors are bolted to the side of the cylinder block under the intake manifold.



- Remove intake manifold as described in 113 Cylinder Head Removal and Installation.
- Remove knock sensor mounting bolts (arrows) on side of cylinder block. Remove sensors.

**CAUTION—**

*Note the installed angle of the knock sensors on the block before removal it. Reinstall the sensors in the same position. Be sure to use a torque wrench when tightening the sensor mounting bolts.*

- Clean knock sensor contact surfaces on engine block and sensors before installing.

**Tightening torque**

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

- Use scan tool to read out and clear ECM fault memory.
- Installation is reverse of removal.





# 121 Battery, Starter, Alternator

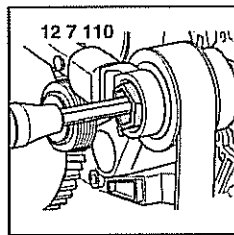
<b>General</b> .....	121-2	<b>Charging System Troubleshooting</b> .	121-12
Special tools .....	121-2	Charging system quick-check .....	121-13
Engine electrical system .....	121-2	Charging system, checking .....	121-13
Battery Safety Terminal .....	121-3	Alternator, removing and installing	
Warnings and cautions .....	121-4	(6-cylinder engine) .....	121-15
<b>Battery</b> .....	121-5	Alternator, removing and installing	
Battery testing .....	121-5	(M62 engine, air cooled) .....	121-16
Hydrometer testing .....	121-5	Alternator, removing and installing	
Battery open-circuit voltage test .....	121-6	(M62 TU engine, water cooled) .....	121-18
Battery load voltage test .....	121-6	<b>Starter</b> .....	121-19
Closed-circuit current measurement .....	121-7	Starter troubleshooting .....	121-19
Battery charging .....	121-9	Starter, removing and installing	
Battery safety terminal, replacing .....	121-9	(6-cylinder engine) .....	121-20
<b>Alternator (generator)</b> .....	121-10	Starter, removing and installing	
Alternator, basic .....	121-11	(V-8 engine) .....	121-21
Alternator with multi-function		Solenoid switch, removing and installing ..	121-23
control (MFR) .....	121-11		
Water-cooled alternator .....	121-12		

## GENERAL

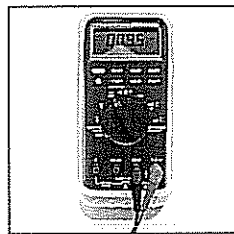
This section covers the battery, alternator, starter and associated components of the electrical system.

Troubleshooting information for these components is found in **Table a. Battery, alternator and starter troubleshooting.** For additional electrical troubleshooting information, see **600 Electrical System—General.**

### Special tools



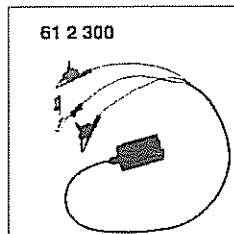
- ◀ Alternator pulley nut removal tool  
(Tool No. BMW 12 7 110)



- ◀ Automotive digital multimeter

#### **CAUTION—**

*Only use a digital multimeter when testing automotive electrical components.*

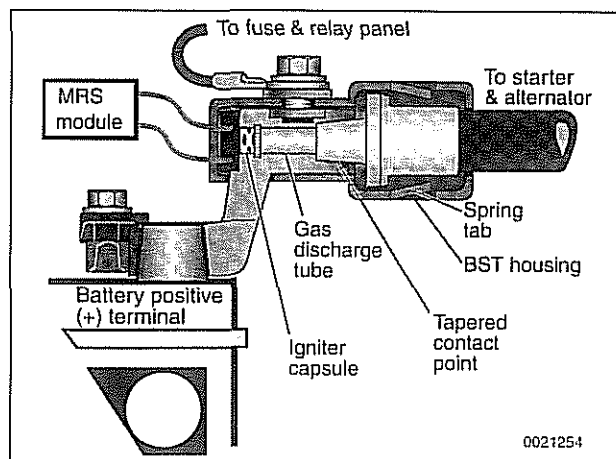


- ◀ Closed-circuit current measurement adaptor  
(Tool No. BMW 61 2 300)

## 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 cable before working on the electrical system.

Various versions of alternators, voltage regulators, starters, and batteries are used in E39 cars. Replace components according to the original equipment specification.



## Battery Safety Terminal

◀ A Battery Safety Terminal (BST) controlled by the Multiple Restraint System (MRS) control unit was introduced for model year 1998 vehicles. The system will disconnect electrical power to the engine compartment in the event of a significant impact. The MRS system fires an encapsulated pyrotechnic device in the positive (+) battery terminal that disconnects power to the engine compartment, but maintains power to the exterior lights and interior of the vehicle.

Table a. Battery, alternator and starter 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 BMW 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 <b>020 Maintenance</b> .
	Battery discharged.	Charge battery and test. Replace if necessary.
	Battery to body ground cable in trunk 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 does not allow battery to recharge.	Evaluate driving style. Where possible, reduce electrical consumption when making short trips.
	Drive belt(s) loose, worn or damaged.	Inspect or replace ribbed belt(s). See <b>020 Maintenance</b> .
	Battery faulty.	Test battery and replace if necessary.
	Battery cables loose, dirty or corroded.	Clean or replace cables. See <b>020 Maintenance</b> .
	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 Cautions and Warnings**.*
- *Models with MS43 engine management: Allow at least 3 minutes to elapse after turning ignition key to OFF position before disconnecting battery. This will allow sufficient time to complete the DMTL (fuel tank pressure) test.*
- *Disconnecting the battery cables may erase fault codes stored in ECM memory.*
- *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 or other electrical components.*
- *Do not depend on the color of insulation to tell battery positive and negative cables apart. Label cables before removing.*
- *The slide-tilt sunroof may fail to function properly after disconnecting and reconnecting the battery. Reinitialize sunroof as described in **540 Sunroof**.*



## BATTERY

The battery is mounted in the right side of the luggage compartment, concealed behind a trim panel. Battery capacity is determined by the amount of current needed to start the vehicle and by the amount of current consumed by the electrical system. This will vary from model to model.



- ▶ BMW batteries are rated by ampere/hours (Ah) and cold cranking amps (CCA) rating, which are listed on the battery. The Ah rating is determined by the average amount of current the battery can deliver over time without dropping below a specified voltage. The CCA is determined by the battery's ability to deliver starting current at 0° F (-18° C) without dropping below a specified voltage. Always replace the battery with one having the same or higher ratings.

### 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 that of checking the specific gravity of the electrolyte using a hydrometer. Before testing the battery, check that the cables are tight and free of corrosion.

### 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 battery charge based on specific gravity values are given in **Table b. Specific gravity of battery electrolyte at 27° C (80° F).**

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 the specific gravity is at or above 1.225, but the battery lacks power for starting, determine the battery's service condition with a load voltage test. If the average specific gravity of the six cells is below 1.225, remove the battery from the luggage compartment and recharge.

### 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. Open-circuit voltage and battery charge**.

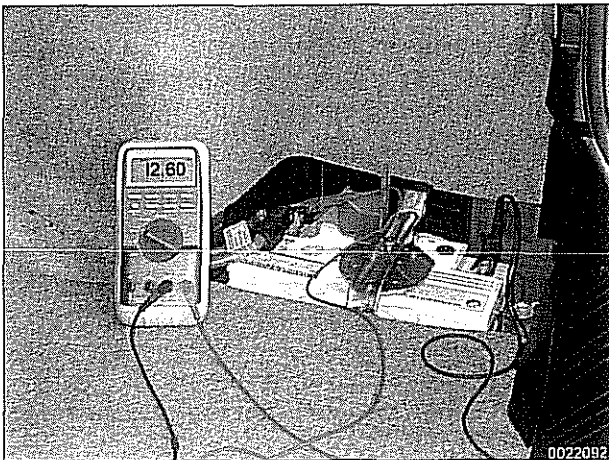
- If open-circuit voltage is OK but battery still lacks power for starting, perform a load voltage test.
- If open-circuit voltage is below 12.4 volts, recharge battery and retest.

Table c. Open-circuit voltage and battery charge

Open-circuit voltage	State of charge
12.6 V or more	Fully charged
12.4 V	75% charged
12.2 V	50% charged
12.0 V	25% charged
11.7 V or less	Fully discharged

### Battery load voltage test

A battery load tester is required for a load voltage test. The test is made by applying a high resistive load to the battery terminals and then measuring battery voltage. The battery should be fully charged for the most accurate results. The battery cables must be disconnected before making the test. Replace the battery if the voltage is below that listed in **Table d. Battery load test - minimum voltage**.



**WARNING—**

*Always wear protective goggles and clothing when performing a load test.*

**Table d. Battery load test - minimum voltage**

Ambient temperature	Voltage*
27° C (80° F)	9.6 V
16° C (60° F)	9.5 V
4° C (40° F)	9.3 V
-7° C (20° F)	8.9 V
-18° C (0° F)	8.5 V

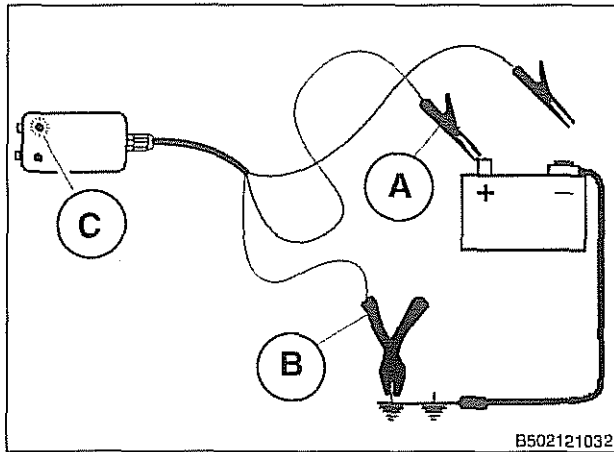
\* Measure after applying a 200 amp load for 15 seconds.

### Closed-circuit current measurement

If the vehicle battery is discharged for an unknown reason, perform a closed-circuit current measurement as the first test. For diagnostic purposes, it is important to not disconnect the battery. Disconnecting the battery may reset a faulty control unit, preventing proper diagnosis.

The following test is generally completed overnight using a multimeter with a closed circuit current measurement adaptor with a recording function.

- Check that battery voltage is 12 volts or higher. If lower, recharge battery.
- Switch off electrical consumers (interior lights, telephone, aftermarket equipment, or others).
- Open luggage compartment and remove battery trim panel. Use screwdriver to lock latch on trunk lid or hatch, simulating closed luggage compartment. Close other doors.
- Open driver's door, then close it, simulating driver entering vehicle.
- Switch ignition to RUN position for at least five seconds, then turn ignition to OFF position. This simulates driving vehicle.
- Open and close driver's door, simulating driver leaving vehicle.
- Lock car and arm alarm.
- Wait at least 16 minutes for consumer cut-off.

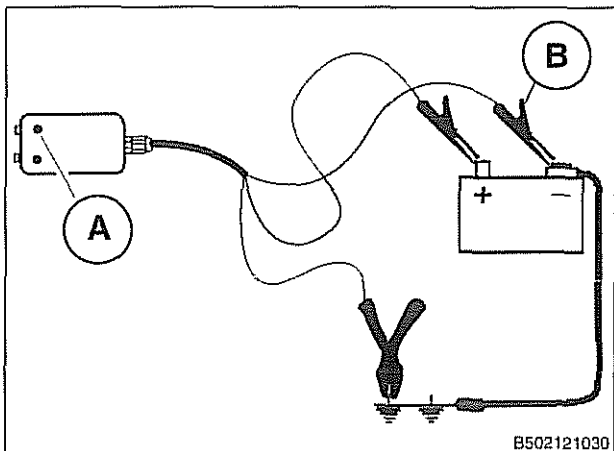


➤ Attach closed-circuit current measurement adaptor (BMW special tool 61 2 300):

- Connect red clamp (marked **A** -BATT (+)) to positive battery terminal.
- Connect black clamp (marked **B** -CHASSIS) to chassis ground point.

**NOTE—**

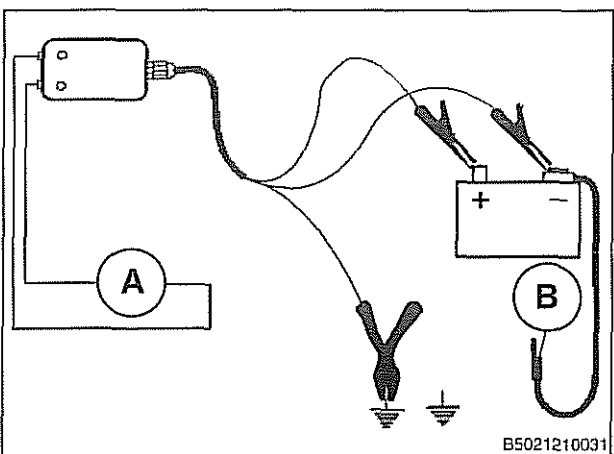
Green LED will light up to indicate correct installation of closed-circuit current measurement adaptor.



➤ Connect black clamp (marked **B** - BATT (-)) to negative battery terminal. Green LED light will go out.

**NOTE—**

Any electrical overloading will be indicated at this point by lighting the red LED. If the red LED lights up, check the adaptor connections.



➤ Set multimeter (**A**) to 10 amp measuring range and connect it to adaptor.

**NOTE—**

- Set multimeter to record average readings.
- If possible, turn off powersaving features of multimeter which prevent a long term (overnight) test by automatically powering down meter.

— Disconnect battery ground strap (**B**) at chassis mounting point.

— Measure closed-circuit current using multimeter.

— Typical average closed-circuit current for E39 vehicles is 40 mA. Readings over 50 mA must be further investigated.

## Battery charging

Discharged batteries can be recharged using a battery charger. Remove the battery from the trunk during charging.

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.

**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.*

**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.*
- *Always disconnect both battery cables and remove battery from vehicle during battery charging. Do not exceed 16.5 charging voltage at the battery.*

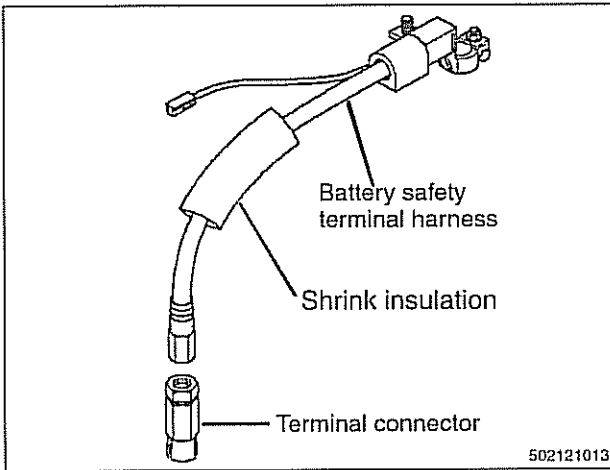
## Battery safety terminal, replacing

If the battery safety terminal has been triggered, investigate and correct the cause prior to replacement.

- Working in right side of luggage compartment, remove battery trim panel.
- Disconnect negative (–) battery terminal and cover with insulator.
- Disconnect positive (+) cable from battery.
- Release positive (+) cable from cable brackets on luggage compartment wall. Lay new repair cable parallel to positive cable.
- Mark off length of new cable on old cable. Allow 10 cm (2.5 in) of slack.
- Saw through old cable.

**CAUTION—**

*Do not use bolt cutters or similar tools to cut through cable. A cable end that has been squashed flat will not fit into the clamping sleeve of the new cable.*



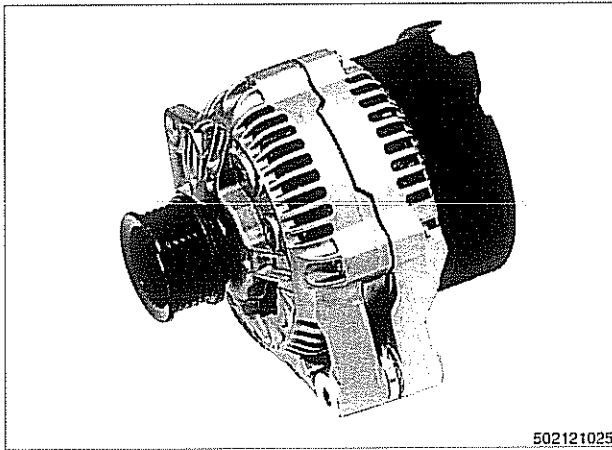
- Strip approximately 15 mm (0.6 in) of insulation from cable end.
- Push terminal connector of new cable over stripped end of old cable. Tighten clamp.
- Slip shrink-fit insulation over positive cable. Attach new safety harness to end of positive cable. Shrink insulation with hot air blower.
- Reinstall cable in cable bracket and attach to battery.
- Reattach negative battery cable. Reinstall luggage compartment trim pieces.
- Use BMW scan tool DISPlus or equivalent to read out airbag control module fault memory. Correct faults, then clear memory.

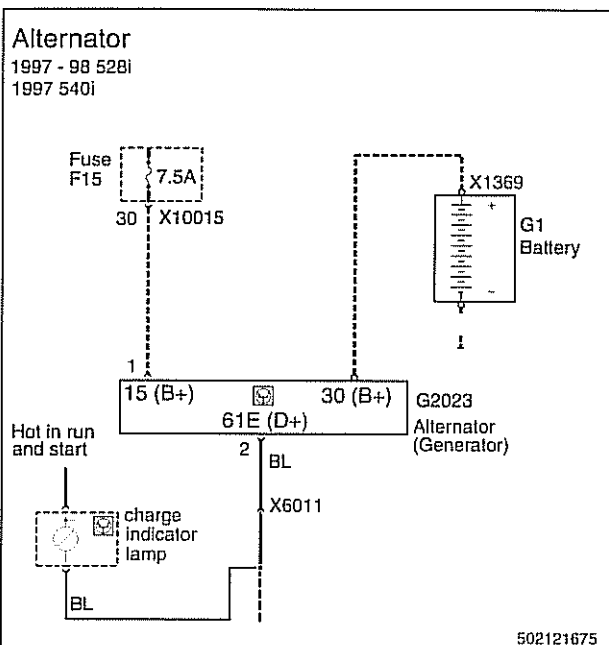
## ALTERNATOR (GENERATOR)

- Various versions of alternators have been used in E39 vehicles. See Table e.

Table e. Alternator application chart

Model	Alternator type
528i	
1997–1998	Air cooled, 90 amp or 120 amp
1999–2000	Air cooled, with multi-function control (MFR), 120 amp or 140 amp
525i, 530i	Air cooled with multi-function control (MFR), 120 amp or 140 amp
540i	
1997	Air cooled, 120 amp or 140amp
1998	Air cooled, with integrated multi-function control (MFR), 120 amp 140 amp
1999–2002	Water cooled, with integrated multi-function control (MFR), 90–150 amp (variable output)





## Alternator, basic

On 1997–1998 6–cylinder and 1997 V-8 models, the charging system indicator light is supplied voltage (+) to one side of the light bulb, and the other side of the bulb is connected to the voltage regulator.

With the engine off and the key in the run position, voltage from the ignition switch flows through the regulator to ground, completing the circuit and illuminating the charge indicator bulb.

When the vehicle is started and the alternator begins to produce voltage, the output of the diode trio increases and the light is turned off.

## Alternator with multi-function control (MFR)

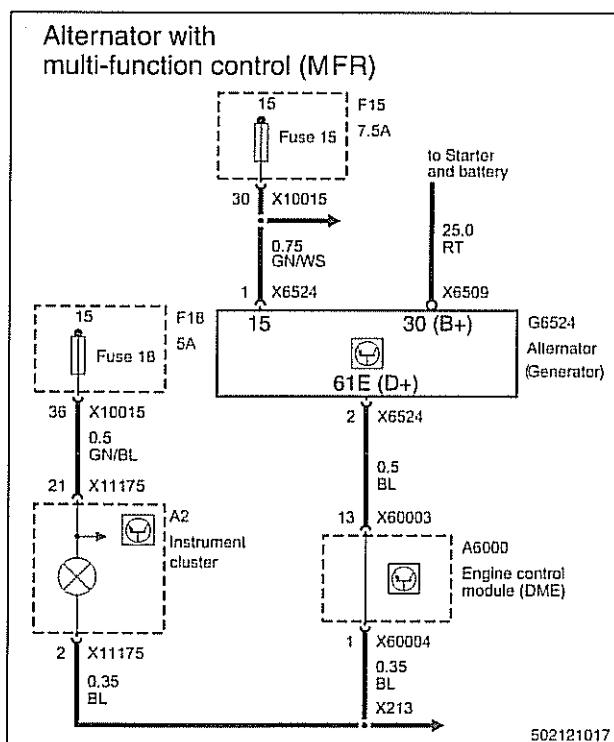
The multi-function controlled alternator is used on:

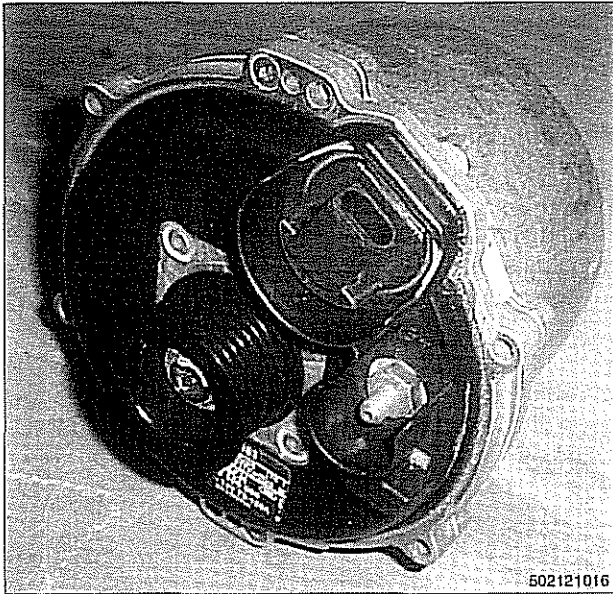
- 1999–2002 6–cylinder models
- 1998–2002 V-8 models

On cars with multi-function control alternator, the charge indicator lamp is activated by means of an electronic switch integrated in the alternator controller. This switch receives its voltage supply from terminal 15 on the 3–pin connector at the rear of the alternator. The controller measures internally the voltage difference between terminal 30 and terminal 15 and signals the DME ECM to turn the charge indicator lamp on.

The controller features integrated fault detection. The battery charge indicator lamp will come on in the event of:

- Failure of belt drive
- No charge due to an electrical/electronic fault
- Interruption in excitation circuit
- Over-voltage due to a defective controller output stage
- Fault or break in charge line
- No charge due to alternator fault





### Water-cooled alternator

◀ The water-cooled alternator, used on 1999 and later M62 TU engines, is a sealed unit housed inside the engine block water jacket. It is cooled via the engine cooling system. It is a "brushless" sealed unit that cannot be serviced. Maintaining consistent alternator temperatures increases the life span of the alternator, and elimination of the alternator cooling fan reduces alternator noise significantly.

The M62 TU water-cooled alternator incorporates load start reduction. This function is intended to shorten the duration of engine starting, particularly at low ambient temperatures. The current load is limited to 20 amps during starting in order to reduce alternator braking torque on the engine. Following the current limiting phase, full power output is then progressively reached.

## CHARGING SYSTEM TROUBLESHOOTING

Charging system diagnostics requires special test equipment. If the test equipment is not available, charging system fault diagnosis can be performed by an authorized BMW dealer or other qualified repair shop. See **Table a. Battery, alternator and starter troubleshooting** for general electrical component troubleshooting.

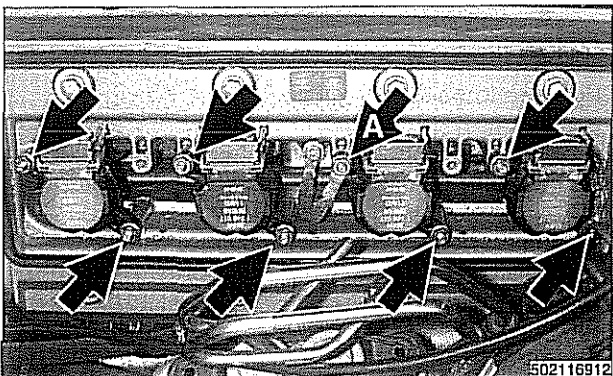
Before checking the alternator, make sure the battery is fully charged and capable of holding a charge. Check that the battery terminals are clean and tight and the alternator drive belt is properly tensioned and not severely worn.

### NOTE—

*Some model require up to 15 second to reach full alternator output.*

### CAUTION—

*If the charge indicator light in the instrument cluster remains on, the charge warning circuit in the instrument cluster may be faulty. Check that the ground lead is securely attached to the grounding stud on the cylinder head (A). Replacing the instrument cluster before repairing the ground lead will both damage the instrument cluster and cause the failure to reoccur.*





## 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—

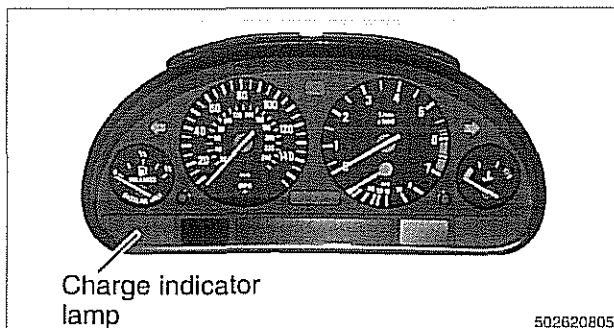
*The regulated voltage (engine running) should be between 13.2 and 14.5, depending on temperature and operating conditions. If the voltage is higher than 14.8, the voltage regulator or multifunction controller is most likely faulty.*

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 alternator drive belt condition and tension.

## Charging system, checking

### CAUTION—

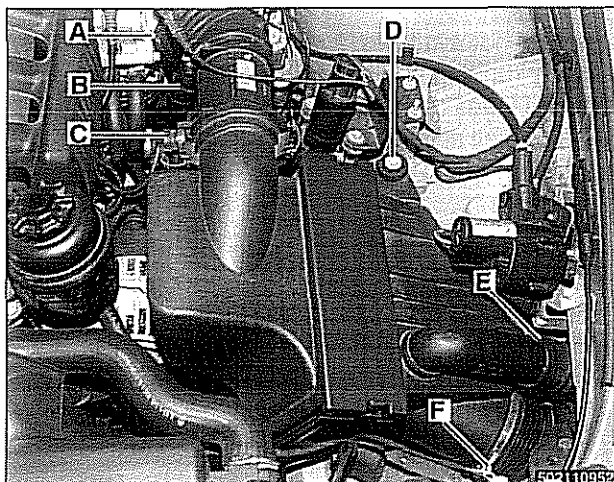
- Do not disconnect the battery while the engine is running. Damage to the alternator and/or engine electronic systems may result.
- Only use a digital multimeter when testing charging system components.



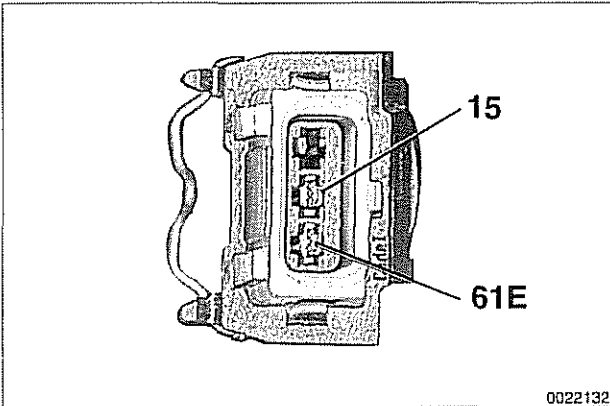
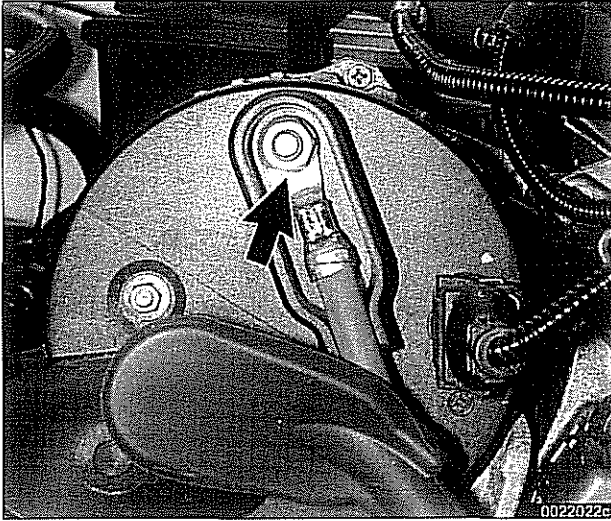
- ▶ Turn ignition key on. Check that battery warning light comes on.

### NOTE—

*If the warning light does not come on, repair bulb or wiring faults before continuing to check the charging system.*



- ▶ 6-cylinder engines only, remove complete air filter housing:
  - Loosen intake duct hose clamp (A) at throttle assembly.
  - Loosen clamp and remove idle control hose from intake duct (B) and disconnect idle speed control valve electrical harness connector.
  - Disconnect electrical harness connector (C) from mass air flow sensor.
  - Remove air filter housing mounting screw (D).
  - Disconnect vent tube (E).
  - Loosen air intake duct clamp (F).
  - Carefully lift air filter housing out of engine bay.



◀ Check for battery voltage at alternator terminal 30 (B+) (arrow):

- Pull back rubber insulating cover at terminal 30 at rear of alternator.
- Connect voltmeter between terminal 30 and ground and check for battery voltage. If voltage is not present, check wiring for faults.

**NOTE —**

*On V-8 engines, access to the rear of the alternator is limited. Check for battery voltage between the jump start post on the left cylinder head and ground.*

◀ Disconnect harness connector from alternator. Turn ignition on and check for battery voltage between terminal 15 and ground. If voltage is not present, check wiring and fuses for faults.

- Reconnect connector to alternator.
- Locate the blue wire coming from terminal 61E of the alternator connector. Carefully connect the positive (+) test lead to the wire using a piercing test lead end.
- Turn ignition key on and check for voltage. Voltage should be less than 1.5 VDC and charge indicator lamp should light.
- Making sure all test equipment and tools are clear, start engine. Voltage should increase to 8.0 VDC or higher. The charge indicator light should go out.
  - If voltage does not increase and system is not charging, the fault is in alternator.
  - If voltage does not increase, but system is charging, interrogate system for faults using an appropriate BMW scan tool and reset fault memory.
- If a load tester is not available, a quick alternator output test can be done by running engine at about 2000 rpm and turning on electrical loads (fans, lights, rear window defroster, and wipers). With all accessories on, battery voltage should be above 12.6 V.

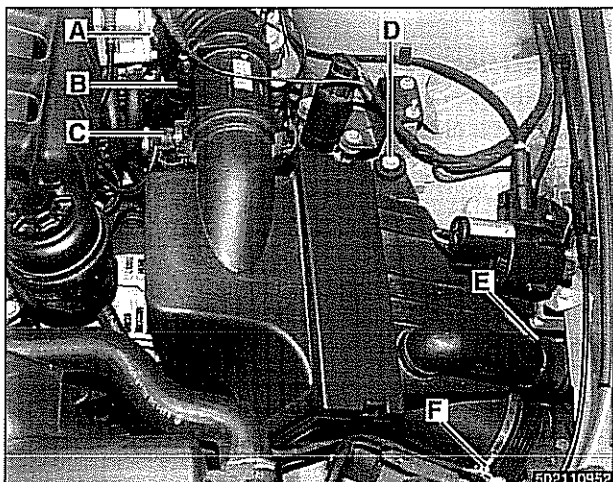
## Alternator, removing and installing (6-cylinder engine)

A replacement alternator should have the same rating as the original. Alternator manufacturer and ampere rating are normally marked on the alternator housing.

- Disconnect negative (–) battery cable.

### CAUTION—

*Prior to disconnecting the battery, read the battery disconnection cautions given in 001 General Warnings and Cautions.*



- Remove complete air filter housing:
  - Loosen intake duct hose clamp (A) at throttle assembly.
  - Loosen clamp and remove idle control hose from intake duct (B) and disconnect idle speed control valve electrical harness connector.
  - Disconnect electrical harness connector (C) from mass air flow sensor.
  - Remove air filter housing mounting screw (D).
  - Disconnect vent tube (E).
  - Loosen air intake duct clamp (F).
  - Carefully lift air filter housing out of engine bay.
- Remove alternator drive belt. See belt removal procedures in 020 Maintenance.

- Remove radiator cooling fan and fan shroud. See 170 Radiator and Cooling System.

### NOTE—

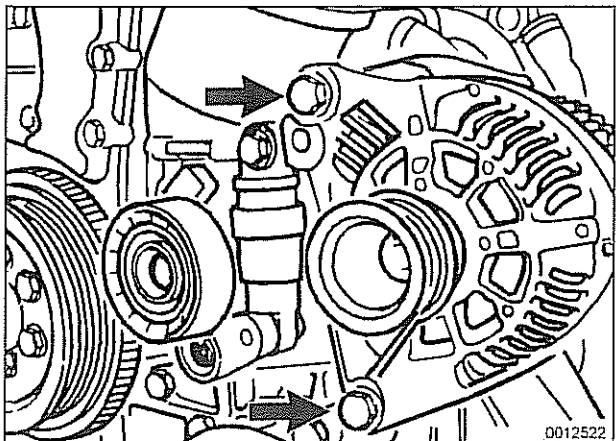
*The radiator cooling fan nut (32 mm wrench) has left-hand threads.*

- Unbolt power steering fluid reservoir and bracket. Suspend to one side without detaching fluid hoses.
- Disconnect alternator air cooling tube.
- Disconnect wiring from rear of alternator.

- Remove upper and lower mounting bolts (arrows) and lift out alternator.

### NOTE—

*If idler pulley for belt interferes, remove pulley cover and retaining bolt to remove pulley.*



0012522

- Installation is reverse of removal.

#### Tightening torques

Belt tensioner to engine block M8 (8.8 grade)	22 Nm (16 ft-lb)
Fan clutch to coolant pump with BMW special tool 11 5 040	30 Nm (22 ft-lb)
without BMW special tool 11 5 040	40 Nm (29 ft-lb)
Pulley to alternator	70 Nm (44 ft-lb)
Terminal 30 (B+) wire to alternator (M8)	13 Nm (10 ft-lb)

### Alternator, removing and installing (M62 engine, air cooled)

A replacement alternator should have the same rating as the original. Alternator manufacturer and ampere rating are normally marked on the alternator housing.

- Disconnect negative (–) battery cable.

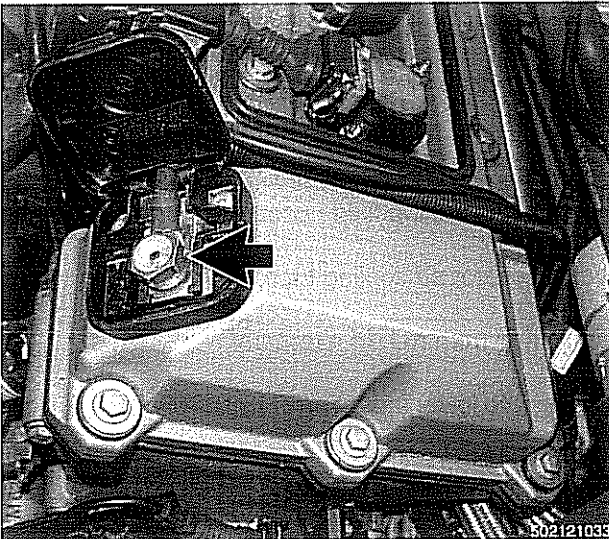
#### **CAUTION—**

*Prior to disconnecting the battery, read the battery disconnection cautions 001 General Warnings and Cautions.*

- Remove cooling fan and alternator drive belt. See **020 Maintenance**.
- Pry out trim caps and remove fasteners from plastic cover on left head. Lift off cover.
- ◀ Disconnect positive (+) lead from jump start post (arrow).
- Raise car and support in a safe manner.

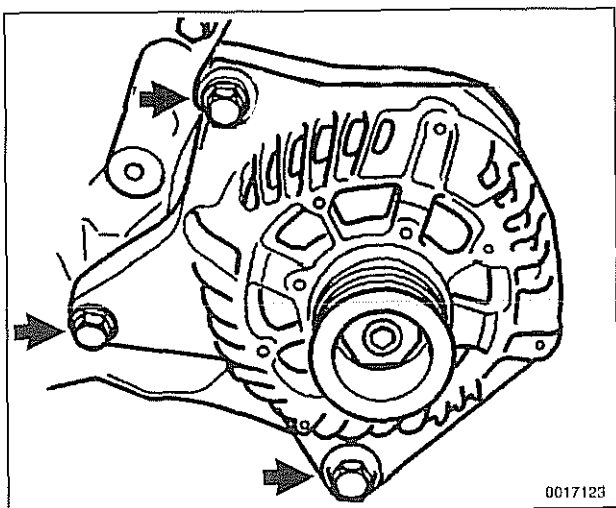
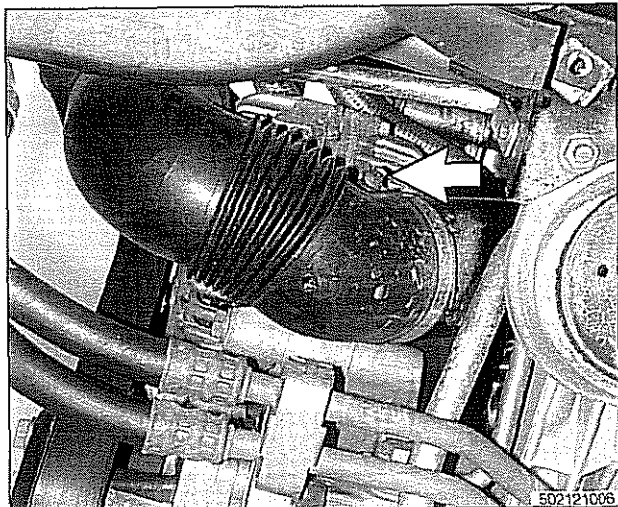
#### **WARNING—**

*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 engine splash shield from underneath car.

- ◀ Working underneath car at rear of alternator, loosen alternator air cooling duct clamp (arrow) and remove duct.



- ◀ Remove three alternator mounting fasteners (arrows).

- Pull alternator forward and disconnect wiring from rear of alternator.
  - Release clip retaining wiring harness to alternator.
- Rotate alternator forward and then up and out of engine compartment, using care to not damage radiator.

**CAUTION—**

*Protect radiator with heavy cardboard or sheet metal.*

- Installation is reverse of removal.

**Tightening torques**

Fan clutch to coolant pump	
with BMW special tool 11 5 040	30 Nm (22 ft-lb)
without BMW special tool 11 5 040	40 Nm (29 ft-lb)
Pulley to alternator	70 Nm (44 ft-lb)
Terminal 30 (B+) wire to alternator (M8)	13 Nm (10 ft-lb)

## Alternator, removing and installing (M62 TU engine, water cooled)

V-8 models produced after 9/98 are equipped with a water cooled alternator.

### CAUTION—

Allow engine to cool before removing alternator as coolant will escape from the alternator water jacket.

- Disconnect negative (–) battery cable.

### CAUTION—

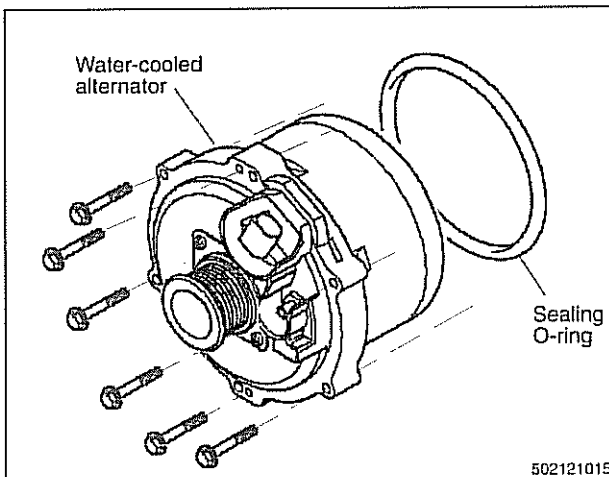
Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Warnings and Cautions**.

- Remove radiator cooling fan and fan shroud. See **170 Radiator and Cooling System**.
- Drain engine cooling system. See **170 Radiator and Cooling System**.
- Remove alternator drive belt. See **020 Maintenance**.
- Disconnect battery lead (terminal 30 or B+) and two-pin harness connector from front of alternator.

- ◀ Remove bolts securing alternator to water jacket and remove alternator.

### NOTE—

- If necessary, raise car and remove engine compartment splash shield to access lower alternator mounting bolts.
- The upper coolant hose can also be removed to assist alternator removal.



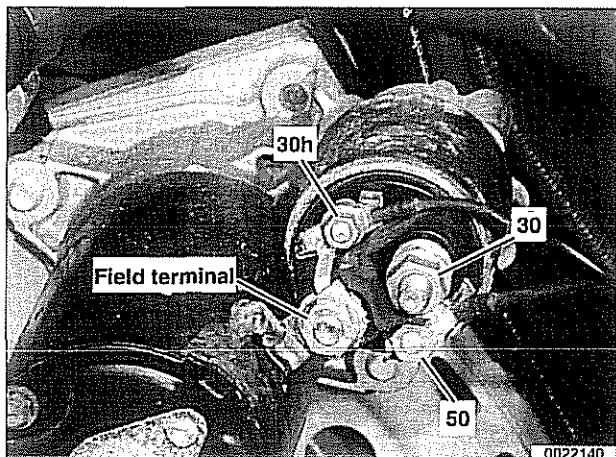
- Installation is reverse of removal, noting the following:
  - Replace alternator rubber sealing O-ring.
  - Fill and bleed cooling system as described in **170 Radiator and Cooling System**.

#### Tightening torques

Fan clutch to coolant pump	
with BMW special tool 11 5 040	30 Nm (22 ft-lb)
without BMW special tool 11 5 040	40 Nm (29 ft-lb)
Terminal 30 (B+) wire to alternator (MB)	13 Nm (10 ft-lb)

## STARTER

### Starter troubleshooting



- ▲ Typical starter wiring terminal identification is shown. Large wire at terminal 30 (not shown in photo) 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 and should be replaced.
- 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, also referred to as EWS, is used on E39 cars. This system prevents operation of the starter if a specially coded ignition key is not used.
- On cars with automatic transmission, the transmission gear position switch signals EWS to prevent the engine from starting in gear positions other than PARK or NEUTRAL.
- On cars with manual transmissions, 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.

- 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 the EWS system and other inputs that disrupt terminal 56 to the 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 (6-cylinder engine)

The starter is removed from below. Access to starter bolts is difficult. Be sure to have the proper tools on hand before proceeding.

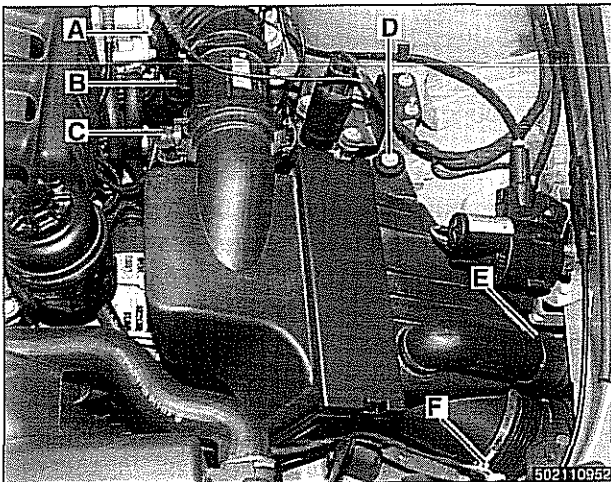
#### **NOTE—**

*Access to the starter wiring is very limited. For better access, it may be necessary to remove the intake manifold.*

- Disconnect negative (–) battery cable.

#### **CAUTION—**

*Prior to disconnecting the battery, read the battery disconnection cautions in **001 General Cautions and Warnings**.*



- ◀ Remove complete air filter housing:
  - Loosen intake duct hose clamp (A) at throttle assembly.
  - Loosen clamp and remove idle control hose from intake duct (B) and disconnect idle speed control valve electrical harness connector.
  - Disconnect electrical harness connector (C) from mass air flow sensor.
  - Remove air filter housing mounting screw (D).
  - Disconnect vent tube (E).
  - Loosen air intake duct clamp (F).
  - Carefully lift air filter housing out of engine bay.

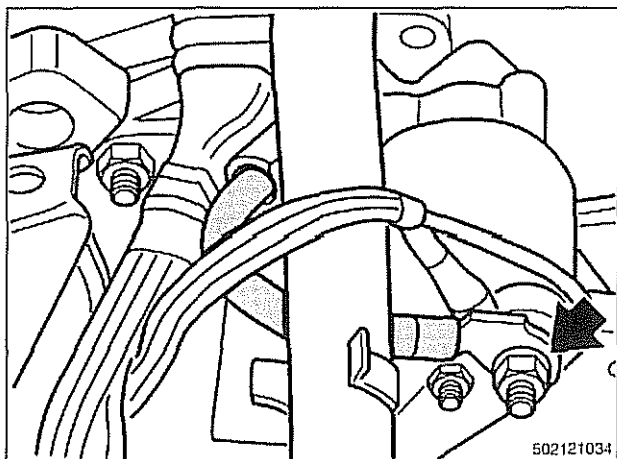
- Disconnect throttle cable.
- Raise vehicle and support safely.

#### **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.*

- Working underneath car, remove engine splash shield.
- Disconnect fuel lines and harness connectors from retaining brackets, as necessary.

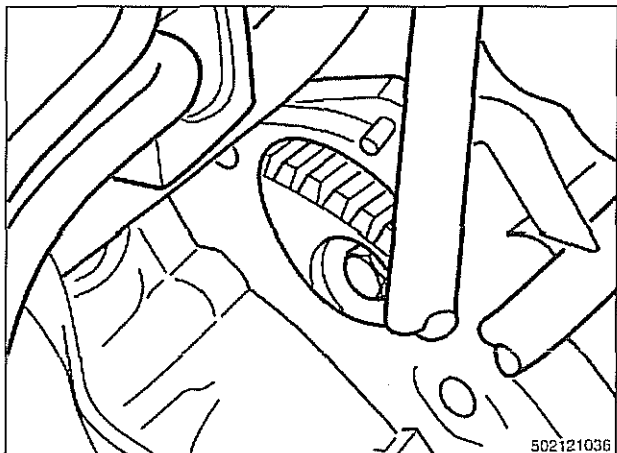




- Disconnect wiring from starter.

⚠ Note routing for cables. Routing varies depending on model and transmission. When reinstalling, make sure cables do not chafe.

- Using a long extension and universal joint from output end of transmission, remove bolts fastening starter to transmission bell housing and engine block.
- Remove starter from below.



⚠ Check starter pinion gear and flywheel teeth for damage.

- Installation is reverse of removal.

#### Tightening torques

Starter to engine	47 Nm (35 ft-lb)
Starter support bracket to starter	5 Nm (44 in-lb)
Starter support bracket to engine	47 Nm (35 ft-lb)
Wire terminals to starter	
M5	5 Nm (44 in-lb)
M6	7 Nm (62 in-lb)
M8	13 Nm (10 ft-lb)

### Starter, removing and installing (V-8 engine)

The starter is on the right (passenger) side of the engine, and is removed from below. Access to starter bolts is difficult. Be sure to have the proper tools on hand before proceeding.

- Disconnect negative (-) battery cable.

#### **CAUTION—**

*Prior to disconnecting the battery, read the battery disconnection cautions in 001 General Cautions and Warnings.*

- Raise vehicle and support safely.

#### **WARNING—**

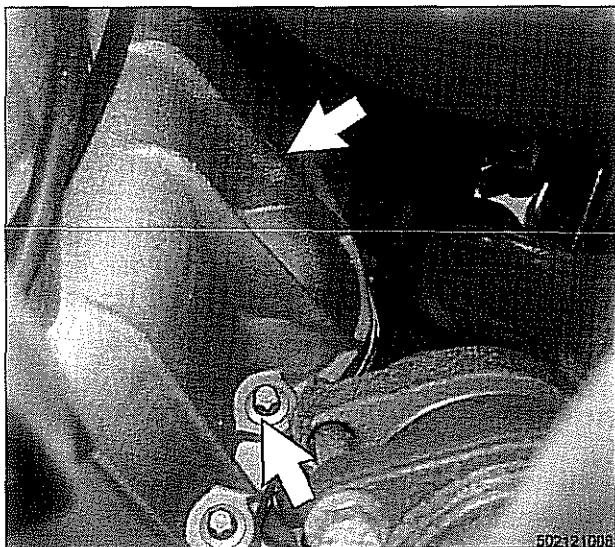
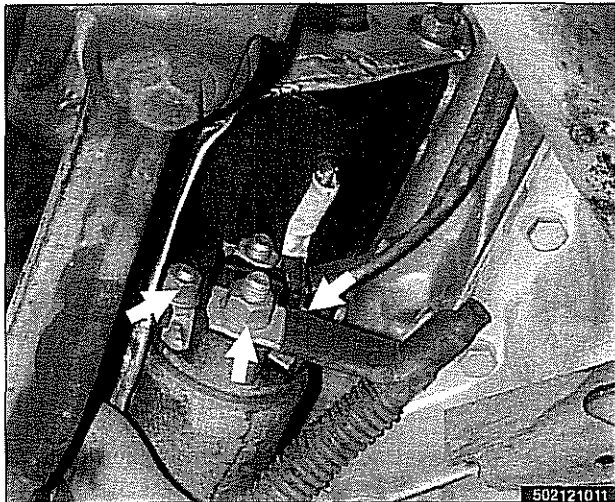
*Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

– Working underneath car, remove engine splash shield.

– Remove heat shield from starter.

◀ Remove starter wire mounting nuts (**arrows**). Disconnect wires from starter terminals and retaining clip.

- Disconnect main positive cable and bracket from suspension.
- If necessary for access, remove right side oxygen sensor harness connector from retaining clip.



◀ Working from end of transmission, use suitable extensions and universal joint to remove starter mounting bolts (**arrows**) at transmission bellhousing.

– Remove starter from below.

– Check starter pinion gear and flywheel teeth for damage.

– Installation is reverse of removal.

#### Tightening torques

Starter to engine	47 Nm (35 ft-lb)
Wire terminals to starter	
M5	5 Nm (44 in-lb)
M6	7 Nm (62 in-lb)
M8	13 Nm (10 ft-lb)

## Solenoid switch, removing and installing

- Remove starter as described previously.
- Disconnect field winding strap between starter motor and solenoid switch.

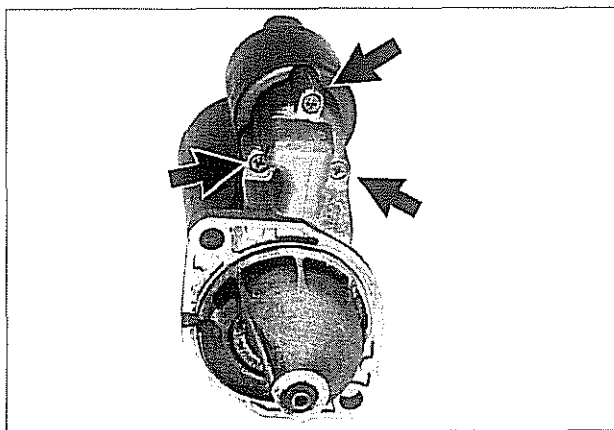
### NOTE—

*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.

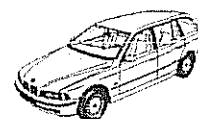


### CAUTION—

*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

<b>General</b> .....	130-2	Siemens MS 42.0 and MS 43.0	
Tools and test equipment .....	130-3	ECM pin assignments .....	130-41
Warnings and cautions .....	130-5	<b>Bosch M5.2 (M62 up to 9/1997)</b>	
<b>Fuel Supply</b> .....	130-6	<b>Bosch M5.2.1 (M62 9/1997 to 9/1998)</b>	130-46
Relieving system fuel pressure .....	130-6	M5.2 system features .....	130-47
<b>Siemens MS 41.1</b> .....	130-7	M5.2.1 system features .....	130-47
ECM relay, testing .....	130-7	ECM relay, testing .....	130-49
Mass air flow (MAF) sensor, checking and replacing .....	130-9	Oxygen sensors, checking .....	130-51
Engine coolant temperature (ECT) sensor, testing and replacing .....	130-10	Fuel injectors, checking and replacing ....	130-52
Intake air temperature (IAT) sensor, testing and replacing .....	130-11	Mass air flow (MAF) sensor, replacing ....	130-53
Throttle position sensor (TPS), testing and replacing .....	130-12	Idle speed control valve, testing and replacing .....	130-54
Idle speed control valve, checking and replacing .....	130-13	Throttle position sensor (TPS), testing and replacing .....	130-55
Fuel injectors, checking and replacing ....	130-15	Engine coolant temperature (ECT) sensor, testing and replacing .....	130-55
Evaporative emissions, overview .....	130-16	Intake air temperature (IAT) sensor, testing and replacing .....	130-57
Secondary air injection, overview .....	130-17	Auxiliary throttle valve (ADS) (M62 and M62 TU engine), replacing ....	130-57
Engine control module (ECM), removing and installing .....	130-18	Evaporative system pressure leak diagnosis, overview (5.2.1 only) ....	130-58
Siemens MS 41.1 ECM pin assignments ..	130-19	Bosch 5.2 ECM pin assignments (M62 up to 9/1997) .....	130-59
<b>Siemens MS 42.0 and MS 43.0</b> .....	130-23	Bosch 5.2.1 ECM pin assignments (M62 9/1997 to 9/1998) .....	130-62
ECM relay, testing .....	130-27	<b>Bosch ME 7.2</b> .....	130-66
Mass air flow (MAF) sensor, checking and replacing .....	130-28	ME 7.2 system overview .....	130-67
Engine coolant temperature (ECT) sensor, testing and replacing .....	130-30	EDK adaptation .....	130-69
Intake air temperature (IAT) sensor, testing and replacing .....	130-31	ECM relay, checking .....	130-69
MS 42.0 throttle valve assembly, replacing.	130-32	Engine coolant temperature (ECT) sensor, testing .....	130-71
MS 43.0 throttle valve assembly, replacing.	130-35	Engine coolant temperature (ECT) sensor, replacing .....	130-71
Throttle cable, adjusting (MS 42.0) .....	130-38	Oxygen sensors, replacing .....	130-72
Idle speed control valve, checking and replacing .....	130-38	Fuel injectors, removing and installing ....	130-72
Evaporative emissions control diagrams ..	130-39	Mass air flow (MAF) sensor, removing and installing .....	130-73
Evaporative emissions control, (MS 42.0 and MS 43.0) .....	130-39	Evaporative system pressure leak diagnosis, overview .....	130-74
Engine control module (ECM), removing and installing .....	130-40	Secondary air injection, overview .....	130-75
		Bosch ME 7.2 ECM pin assignments ....	130-76

## GENERAL

This repair group covers service and repair of the Bosch and Siemens engine management systems used on 1997 through 2002 E39 models. Additional engine management service and repair information may also be found in the following repair groups:

- 020 Maintenance
- 120 Ignition System
- 160 Fuel Tank and Fuel Pump
- 610 Electrical Component Locations
- OBD On Board Diagnostics

### NOTE —

*Camshaft position sensor, crankshaft speed sensor and knock sensors are covered in 120 Ignition System.*

Table a. Engine management system applications

Model/model year	Engine	DME System
528i, 1997-1998	M52, 2.8 liter	Siemens MS 41.1
528i, 1999-2000	M52 TU, 2.8 liter	Siemens MS 42.0
525i, 2001-2002	M54, 2.5 liter	Siemens MS 43.0
530i, 2001-2002	M54, 3.0 liter	Siemens MS 43.0
540i, 1997	M62, 4.4 liter	Bosch M5.2
540i, 1998	M62, 4.4 liter	Bosch M5.2.1
540i, 1999-2001	M62 TU, 4.4 liter	Bosch ME 7.2

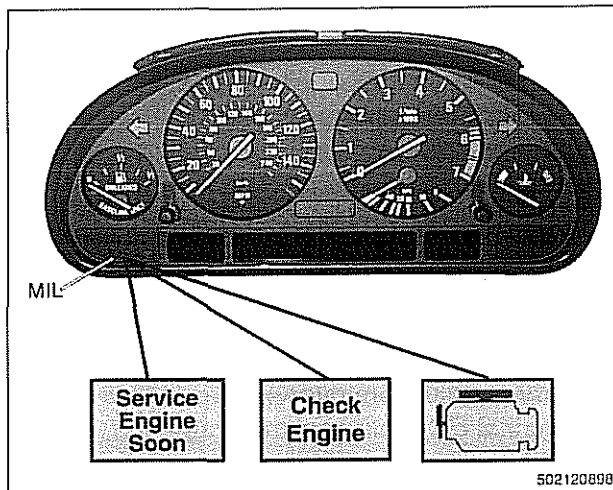
OBD II software and hardware is incorporated in the engine management control systems. The OBD II system monitors components that influence exhaust and evaporative emissions. If a problem is detected, the OBD II system stores the associated fault code and condition.

◀ If vehicle emission levels exceed 1.5 times Federally mandated criteria, the OBD II system illuminates a malfunction indicator light (MIL) in the instrument cluster.

### NOTE —

- For the E39 cars covered by this manual, three different MIL symbols were used, depending on year and model. See illustration.

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



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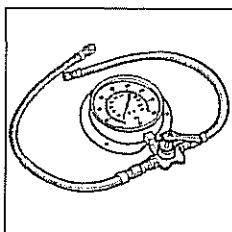
of diagnostic time and to help avoid incorrect component replacement and possible damage to system components.

**NOTE—**

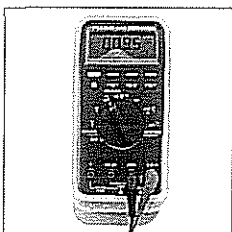
- Professional diagnostic scan tools available at the time of this printing include the BMW factory tools and a small number of aftermarket BMW-specific tools. The CS2000 from Baum Tools Unlimited, the Retriever from Assenmacher Specialty Tools, and the MT2500 from Snap-on are three examples.
- In addition to the BMW-specific professional line of scan tools, there are inexpensive generic OBD II scan tool software programs and handheld units available. Although these tools have limited capabilities as compared to the dedicated tools, they are powerful diagnostic tools.
- For the DIY owner, simple aftermarket DTC reader is available through <http://www.peakeresearch.com>. This tool is capable of checking for DTCs as well as turning off the illuminated MIL and resetting the service indicator lights.

### Tools and test equipment

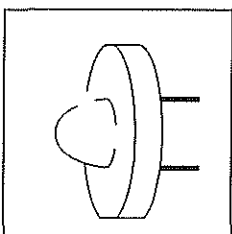
If the equipment required to do the job is unavailable, it is recommended that these repairs be left to an authorized BMW dealer or other qualified BMW repair facility.



◀ Fuel pressure gauge  
(Tool No. Baum 1318)

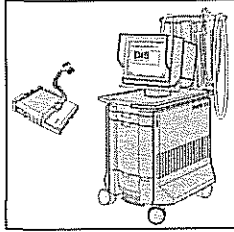


◀ Automotive digital multimeter

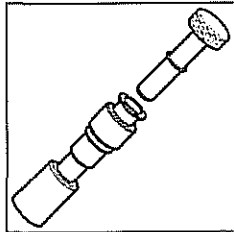


◀ Low current test light ("noid")  
(Tool No. Baum 1115a)

Fuel Injection



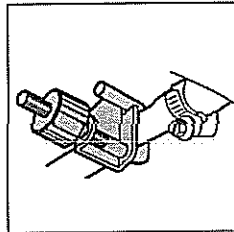
◀ Factory DTC scan tool  
(Tool No. BMW DISplus / GT1 / MoDiC III)



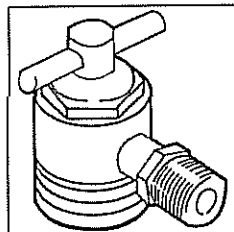
◀ Fuel line plugs  
(Tool No. BMW 13 5 281 / 13 5 282)



◀ Aftermarket DTC scan tool  
(Tool No. Baum CS2000)



◀ Fuel line clamp  
(Tool No. BMW 13 3 010)



◀ Fuel rail to pressure gauge fitting  
(Tool No. BMW 13 5 220)



## Warnings and cautions

For personal safety, as well as the protection of sensitive electronic components, adhere to the warnings and cautions on the following pages.

### **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 DME system wiring and test equipment leads only when the ignition is switched off.*
- *Wait at least 1 minute 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.*
- *Do not connect any test equipment that delivers a 12-volt power supply to terminal 15 (+) of the ignition coil. The current flow may damage the ECM. In general, 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 SUPPLY

Fuel supply to the injection system is provided by a high pressure electric pump mounted inside the fuel tank. The pump is powered via the fuel pump relay. If the relay is faulty, the fuel pump will not run and the engine will not start.

### NOTE—

- *Fuel delivery volume and fuel pressure are critical to proper operation. Fuel pressure directly influences fuel delivery.*
- *Fuel pump relay, fuel pressure and fuel volume tests are given in 160 Fuel Tank and Fuel Pump.*

### Relieving system fuel pressure

The fuel system retains fuel pressure in the system when the engine is off. To prevent fuel from spraying on a hot engine, system fuel pressure should be relieved before disconnecting fuel lines. One method is to tightly wrap a shop towel around a fuel line fitting and loosen or disconnect the fitting. Cleanliness is essential when working with fuel components. Thoroughly clean the unions before disconnecting fuel lines.

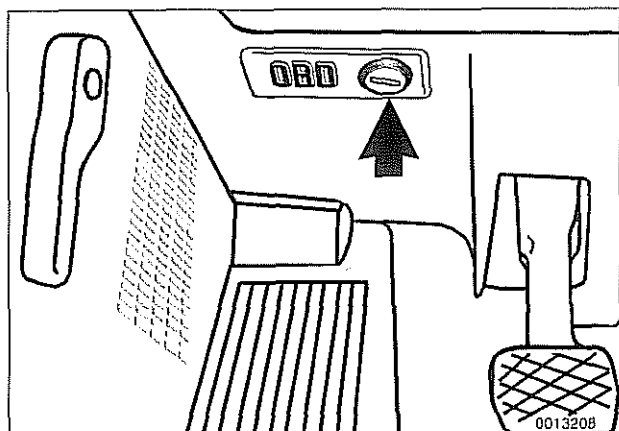
## SIEMENS MS 41.1

When system faults are detected, a diagnostic trouble code (DTC) is stored in the engine control module (ECM). The MIL also illuminates if an emissions-related fault is detected.

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.

### CAUTION—

- *The tests in this section may set fault codes (DTCs) in the ECM and illuminate the MIL. After all testing is completed, access and clear DTC fault memory using an OBD II or BMW compatible scan tool. See **OBD On-Board Diagnostics**.*
- *Only use a digital multimeter for electrical tests.*
- *Relay positions can vary. Be sure to confirm relay position by identifying the wiring in the socket using the wiring diagrams found in **ELE Electrical Wiring Diagrams**.*

**NOTE—**

- OBD II fault memory (including an illuminated MIL) can only be reset using an electronic scan tool. Removing the connector from the ECM or disconnecting the battery will not erase the fault memory.
- The BMW-dedicated 20-pin diagnostic link connector (DLC) is in the right rear of the engine compartment.
- The 16-pin OBD II diagnostic connector (arrow) is located inside the car on the lower left dash panel.

**ECM relay, testing**

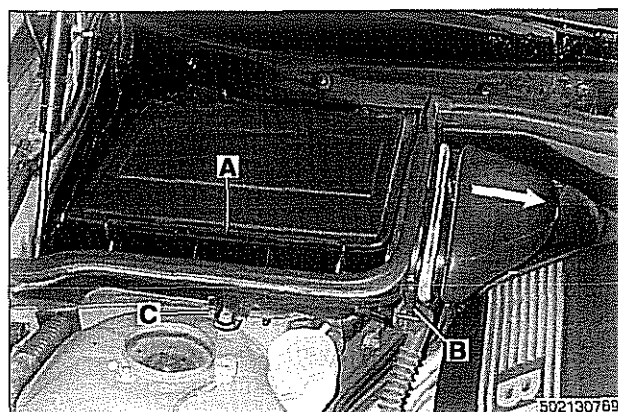
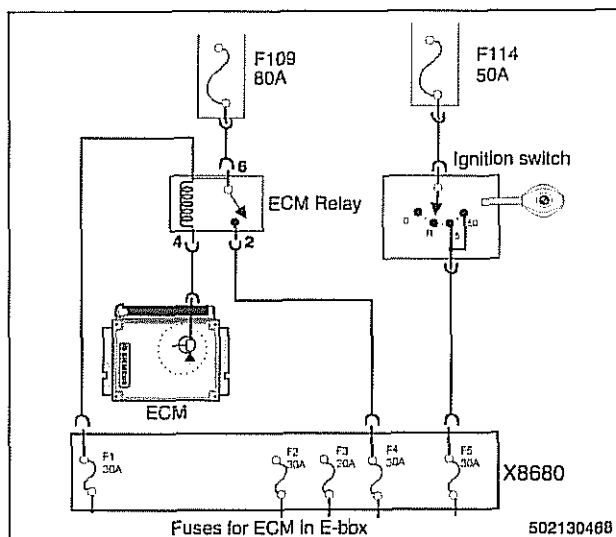
- ⚠ The engine control module (ECM) relay is energized via the ECM and supplies battery positive (B+) power to many of the engine management components and subsystems. If this relay is faulty, the engine will not start.

**CAUTION—**

Relay positions can vary. Be sure to confirm relay position by identifying the wiring in the socket using the wiring diagrams in ELE Electrical Wiring Diagrams.

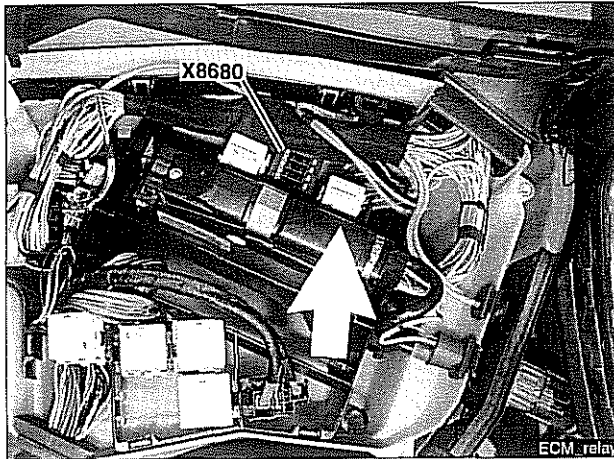
**NOTE—**

The ECM relay is also referred to as the DME main relay.

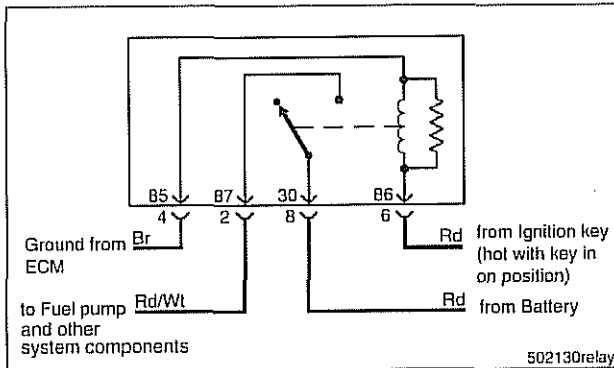


- ⚠ Working in right rear of engine compartment:
- Release interior ventilation filter cover latch (A) and remove cover.
  - Release plastic locking tab (B).
  - Rotate duct inward (arrow) to unlock from bulk head and remove duct.
  - Release spring lock (C) to remove lower filter housing.
  - Slide filter housing away from inner fender to remove.
- Remove electrical box (E-box) cover fasteners and remove cover.

## Fuel Injection



◀ With ignition off, remove main relay (K6300) (arrow) in E-box.



◀ Check for voltage at terminal 8 (30) on relay socket.

- If battery voltage is present continue testing.
- If battery voltage is not present, check fuse 109 (80-amp fusible link) under passenger seat carpet. See **ELE Electrical Wiring Diagrams**.

— Reinstall relay and turn ignition on. Gain access to back side of relay socket and check for ground on terminal 4 (85).

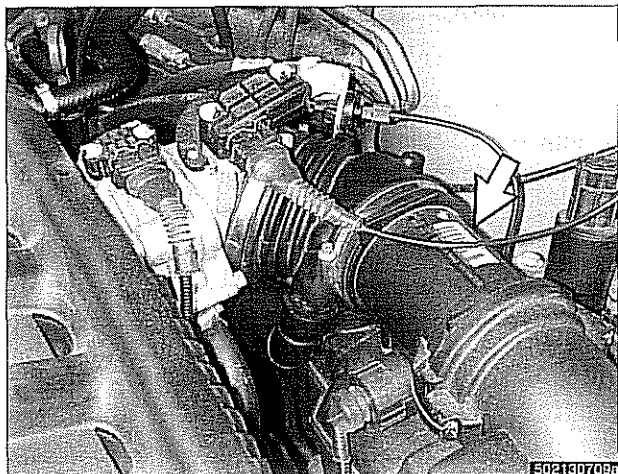
- If ground is present continue testing.
- If ground is not present, signal from ECM is missing. Check wire between ECM and relay.

— With ignition on and relay installed, check for battery voltage on terminal 2 (87).

- If battery voltage is present, relay has energized and is functioning correctly.
- If battery voltage is not present and all earlier tests are OK, relay is faulty and should be replaced.

### NOTE —

*If no faults are found during testing but power is not reaching the ECM or other components, check the fuses in the fuse carrier X8680 in the E-box.*



### Mass air flow (MAF) sensor, checking and replacing

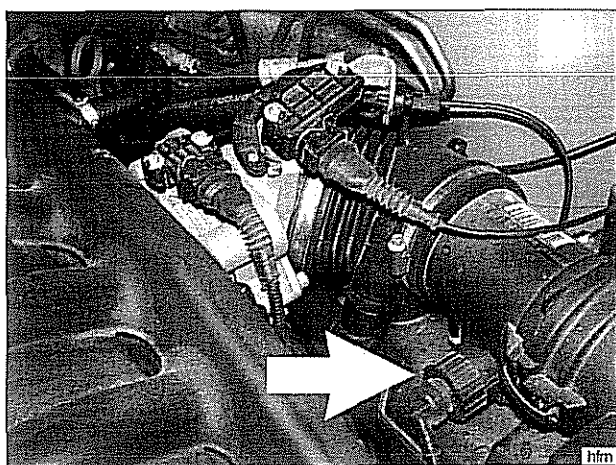
- ◀ The hot film mass air flow (MAF) sensor (**arrow**) sends a varying voltage (approx. 0.5 - 4.5 vdc) to the ECM representing the measured intake air. The air mass input signal is produced electronically by the MAF sensor using a heated metal film in the air flow stream.

The ECM relay provides the operating voltage to the MAF sensor. As air flows through the MAF sensor, the film is cooled. To maintain the film at a constant temperature, additional heating current is necessary. It is this additional current that is the basis for the input signal.

If there is no output signal from the MAF sensor, the ECM operates the engine using throttle position and engine rpm inputs. A faulty MAF sensor illuminates the MIL.

A faulty MAF sensor can produce the following problems:

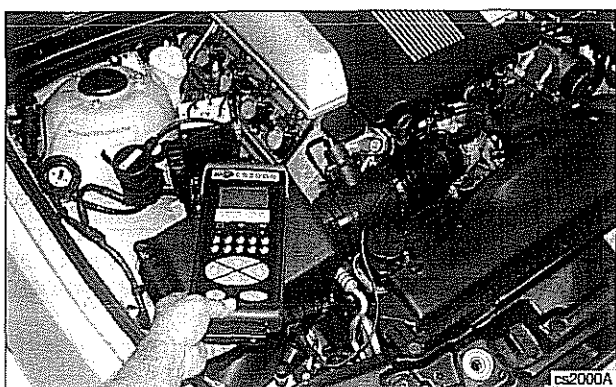
- Difficult to restart when engine is hot.
- Engine starts then stalls.
- Engine starts and runs only with accelerator pedal depressed.



- ◀ Disconnect electrical harness connector from MAF sensor (**arrow**).
- Turn ignition on and check for voltage and ground at connector.
  - There should be ground at pin 1 and battery voltage at pin 3.
  - If any faults are found, check for wiring breaks between MAF sensor and ECM and between MAF sensor and ECM relay.

#### NOTE —

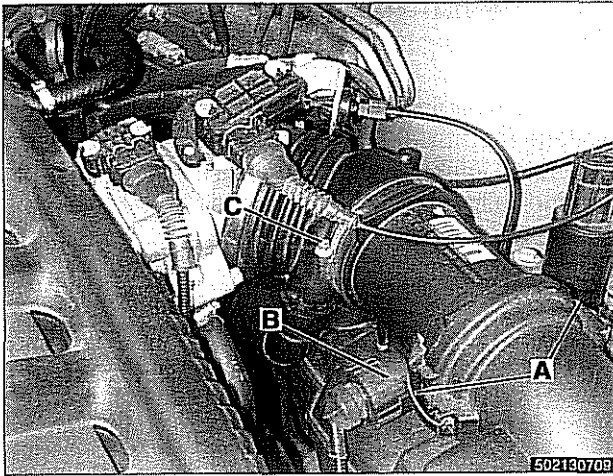
Visually inspect the sensor for damage, missing or blocked screens. The screens affect air flow calibration. Also inspect the sealing O-rings where the sensor inserts into the air filter housing and intake boot. Ensure the pin connections are clean and tight.



- ◀ Connect a BMW-compatible scan tool or an OBD II generic scan tool. Check air mass signal (load signal) with the engine at idle. Raise idle speed and check that load signal changes with rpm.

#### CAUTION—

Be sure ignition is OFF before disconnecting or reconnecting DME system components.



- ◀ Remove MAF sensor:
  - Release clips from air filter housing (A).
  - Disconnect harness connector (B).
  - Loosen intake boot clamp (C) and remove MAF sensor. Note large sealing O-rings.
- Installation is reverse of removal.
  - No adjustment to MAF sensor is possible.
  - Check intake hoses for cracks and vacuum leaks.

### Engine coolant temperature (ECT) sensor, testing and replacing

- ◀ The ECT sensor is located below cylinder 1 intake port.

The ECT sensor is a dual temperature sensor. One circuit provides coolant temperature information to the ECM while the other circuit provides coolant temperature information to the instrument cluster.

The ECM determines the correct ignition timing and air/fuel mixture required for the engine by monitoring an applied voltage (5 vdc) to the sensor. The voltage drop across the sensor varies as the coolant temperature (sensor resistance) changes.

#### NOTE—

The ECT sensor is an NTC (negative temperature coefficient) type sensor. In other words, as the temperature rises, resistance through the sensor decreases.

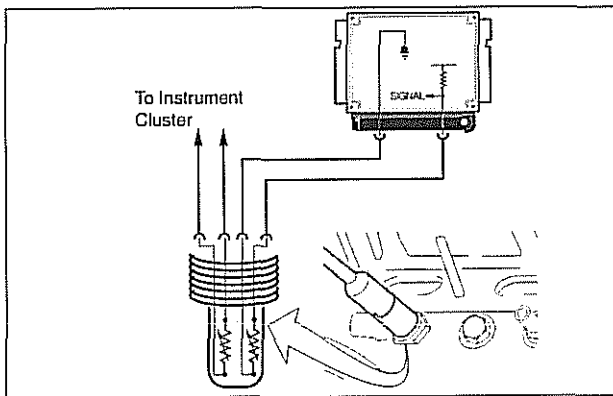
If the ETC sensor input is faulty or non-plausible, the MIL is illuminated when OBD II fault criteria are exceeded. The ECM assumes a substitute value (80° C / 176°F) to maintain engine operation. The ignition timing is set to a conservative/safe basic setting.

- Check ECT sensor resistance using a multimeter at sensor terminals.

ECT sensor resistance @ 20° C (68°F)	2.2 - 2.7 kΩ
Temperature gauge sensor resistance @ 20° C (68°F)	6.7 kΩ

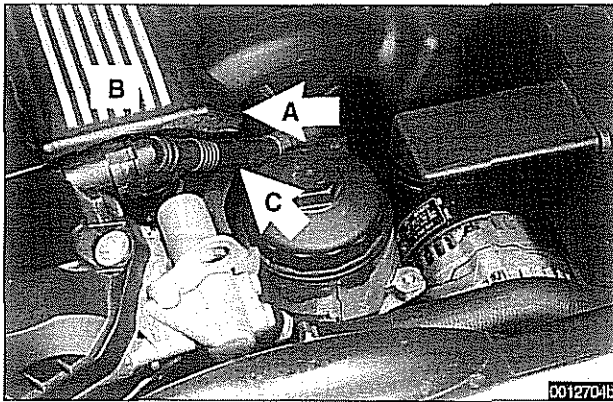
#### WARNING—

Due to risk of personal injury, be sure the engine is cold before disconnecting or reconnecting ECT sensor.



**CAUTION—**

Be sure ignition is OFF before disconnecting or reconnecting DME system components.



- Remove engine coolant temperature sensor:
  - Unclip crankcase vent hose (C) from cylinder head cover.
  - Remove plastic cover (B) from atop intake manifold runners.
  - Working under front of intake manifold, disconnect ECT harness.
  - Unscrew ECT sensor (C) from cylinder head.
- Installation is reverse of removal:
  - Use new copper sealing washers when installing sensor.
  - Replace any engine coolant lost.

**Tightening torque**

Temperature sensor to cylinder head	13 Nm (10 ft-lb)
-------------------------------------	------------------

**Intake air temperature (IAT) sensor, testing and replacing**

- The intake air temperature (IAT) sensor (arrow) signal is used by the ECM to monitor intake air temperature for fuel and ignition adaptation. The sensor is located in the intake manifold behind the throttle housing.

The ECM monitors an applied voltage (5 vdc) to the sensor. The voltage drop across the sensor varies as the intake air temperature (sensor resistance) changes.

**NOTE —**

The IAT sensor is an NTC (negative temperature coefficient) type sensor. In other words, as the temperature rises, resistance through the sensor decreases.

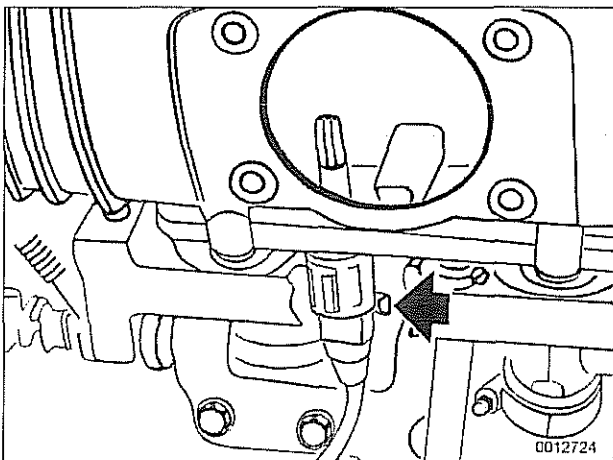
If the IAT sensor input is implausible, a fault code is set. The MIL is illuminated when OBD II fault criteria are exceeded. The ECM then operates the engine using only the engine coolant temperature (ECT) sensor input.

The intake air temperature sensor can be tested using a multimeter across its terminals:

IAT sensor resistance @ 20°C (68°F)	2.2 - 2.7 kΩ
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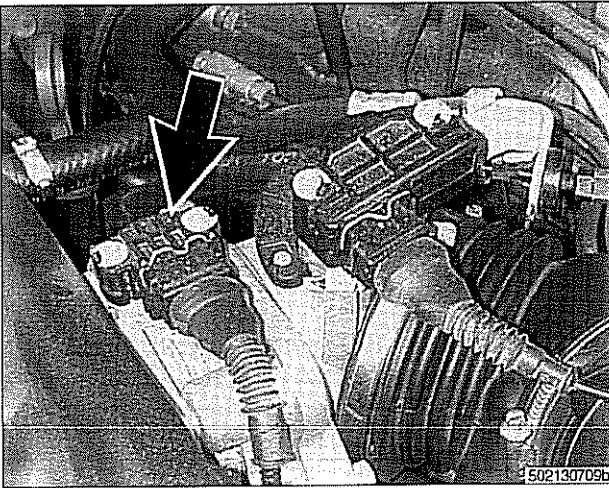
**CAUTION—**

Be sure ignition is OFF before disconnecting or reconnecting DME system components.



- Disconnect intake air boot from throttle housing. Unbolt throttle housing and lay aside. It is not necessary to disconnect throttle cable or electrical harness connectors from throttle housing.
- Remove electrical harness connector from IAT sensor.
- Unclip temperature sensor and remove from intake manifold.
- Installation is reverse of removal. Use a new gasket at throttle housing.

### Throttle position sensor (TPS), testing and replacing



- The throttle position sensor (**arrow**) is located on top of the throttle valve housing and provides the ECM with a voltage value that represents throttle position (angle) and rate of movement.

The TPS is non-adjustable. If the throttle position sensor is replaced, the previous 'learned' TPS settings must be cleared from the ECM using a BMW-compatible scan tool.

If the throttle position sensor signal is defective, a fault code is stored and the MIL is illuminated when OBD II fault criteria are exceeded. The ECM still operates the engine using the mass air flow (MAF) sensor and engine rpm inputs.

- Check throttle position sensor function by disconnecting harness connector and checking continuity across terminals. If test results are incorrect, replace throttle position sensor. The sensor is non-adjustable.

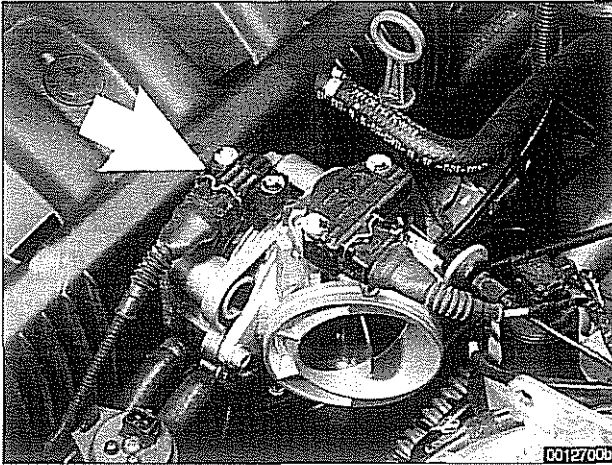
#### Throttle position sensor testing values

Terminals	Test values
1 and ground in harness connector, key on	5 vdc (approx.)
1 and 3 at sensor	4.0 k $\Omega$ (approx.)
1 and 2 at sensor	Throttle plate rotated from idle to full throttle, continuously variable from 1.0 - 4.0 k $\Omega$

#### **CAUTION—**

*Be sure ignition is OFF before disconnecting or reconnecting DME system components.*





- ▲ Unplug harness connector (**arrow**) from sensor.

**CAUTION—**

*Be sure ignition is OFF before disconnecting or reconnecting DME system components.*

**NOTE —**

*Do not confuse the throttle position sensor on the main throttle body with the throttle position switch on the secondary throttle body, where applicable.*

- Remove two mounting screws holding sensor to throttle housing.
- Installation is reverse of removal. Clear adaptation settings from ECM using BMW-compatible scan tool.

**NOTE —**

*Poor idle quality may be noticeable for a period if the adaptation settings are not cleared after installing new TPS.*

### Idle speed control valve, checking and replacing

The idle speed control valve regulates idle speed by redirecting air around the throttle valve. The idle speed control valve is mounted on the underside of the intake manifold adjacent to the dipstick tube bracket. Accessing the valve is best accomplished by first removing the air filter housing and the throttle body assembly.

The valve is supplied with battery voltage from the ECM relay. The idle speed control valve incorporates a two-coil rotary actuator. The ground sides of each coil are pulsed simultaneously by the ECM. The duty cycle of each circuit is varied to achieve the required idle speed.

A faulty Idle speed control valve sets a fault code and the MIL is illuminated when OBD II fault criteria are exceeded.

Before checking the idle speed control valve, confirm that the throttle position sensor is working correctly.

- With engine running, check that idle speed control valve is buzzing.
- Turn on A/C system or shift transmission into drive. Idle should remain steady or increase slightly.

- If idle speed valve is not buzzing, or if idle decreases when A/C is turned on, stop engine and disconnect harness connector from idle speed valve.

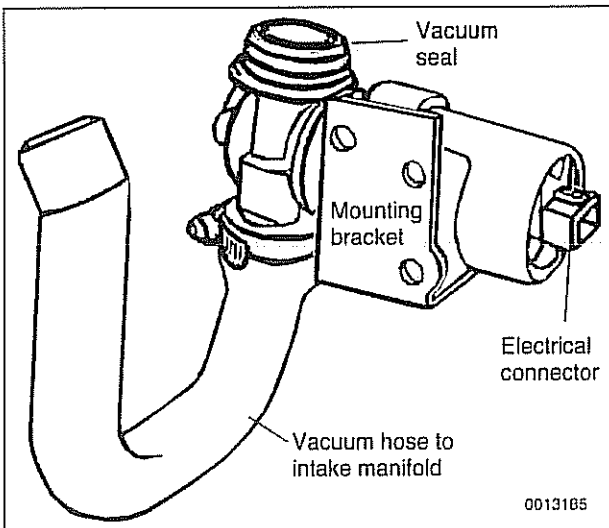
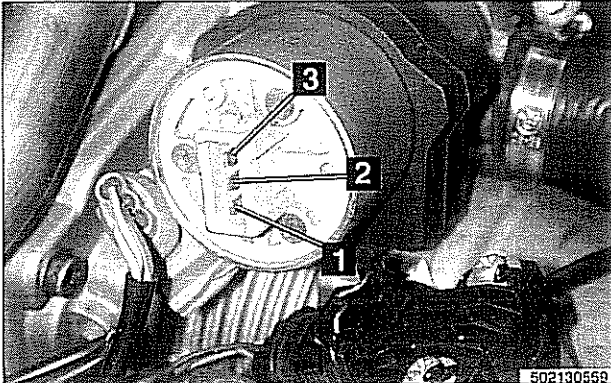
**CAUTION—**

*Be sure ignition is OFF before disconnecting or reconnecting DME system components.*

- ⚡ Check resistance of valve across valve terminals.

**Idle speed control valve resistance**

Terminals 1 and 2	20 ± 2Ω
Terminals 2 and 3	20 ± 2Ω
Terminals 1 and 3	40 ± 4Ω



The idle speed control valve is mounted under the intake manifold. Accessing the valve is best accomplished by first removing the air filter housing and the throttle housing.

- ⚡ Disconnect intake air boot from throttle housing. Unbolt throttle body and lay aside. Do not disconnect throttle cable or electrical harness connectors to throttle body.

**NOTE—**

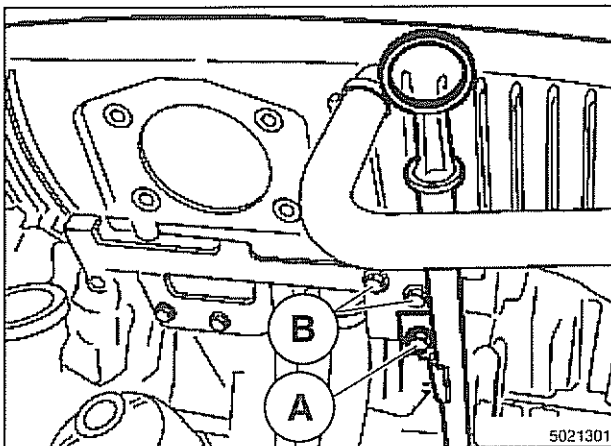
*For additional working room, unfasten and lift out the complete air filter housing.*

- Working under intake manifold, disconnect electrical harness connector from idle speed control valve.

- ⚡ Unbolt dipstick tube bracket (A) from intake manifold.

- Remove two bolts (B) retaining idle speed control valve to underside of intake manifold. Remove valve from intake manifold. Remove hose clamp and disconnect hose.

- Installation is reverse of removal. Use new gaskets when installing.

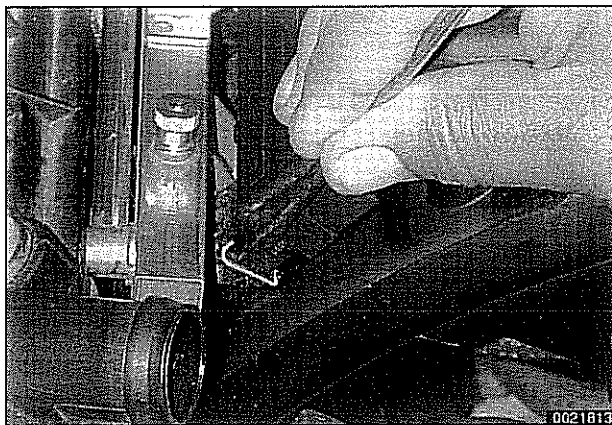


## Fuel injectors, checking and replacing

The fuel injectors are electronically controlled solenoid valves that provide precisely metered and atomized fuel into the engine intake ports.

The injectors receive voltage from the ECM relay. The ECM controls the opening by activating the ground circuit for the injector valve solenoids. The ECM varies the duration (in milliseconds) of "opening" time to regulate the air/fuel ratio.

For a quick check of the injectors, run the engine and touch each injector with a screwdriver or stethoscope. You should feel a vibration or hear a buzzing.



- Remove fuel injection harness from injectors by unclipping locking clip at each injector. Lift harness off injectors.

### CAUTION—

*Be sure ignition is OFF before disconnecting or reconnecting DME system components.*

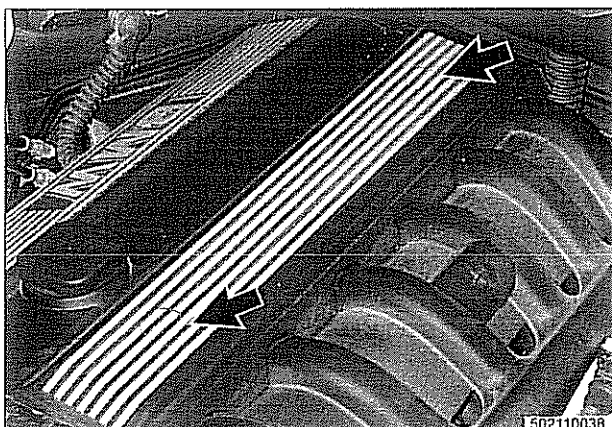
- Use a multimeter to test injector coil resistance between injector terminals.

Fuel injector coil resistance	16Ω at 20° C (68° F)
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- Disconnect negative (-) battery cable.

### CAUTION—

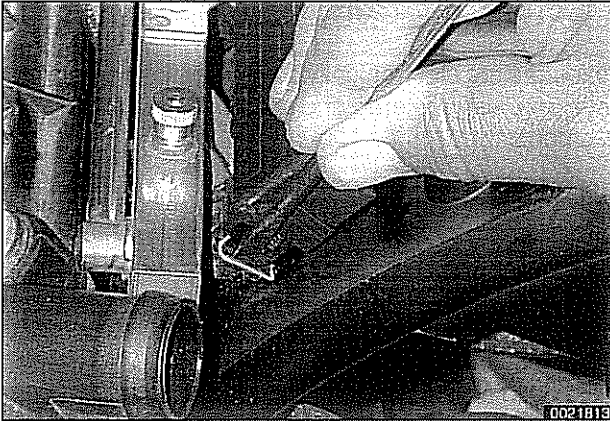
*Prior to disconnecting the battery, read the battery disconnection cautions given in 001 General Warnings and Cautions.*



- Remove plastic trim plugs (arrows) and fasteners, then remove cover from above fuel injectors.

- Disconnect vacuum line from fuel pressure regulator.
- Remove wiring harness duct mounting fasteners.

## Fuel Injection



- ▲ Release injector locking clips at each injector and pry injector wiring duct up off injectors.
- Clamp off fuel supply line and fuel return line at end of fuel rail. Disconnect fuel supply fuel return lines from fuel rail.

### WARNING —

- *Clamp off the fuel lines and then wrap a clean shop towel around the lines before removing them. Residual fuel pressure is present in the lines.*
- *Fuel is discharged. Do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.*

- Remove fuel rail mounting fasteners.
- Pull up on fuel rail and remove individual injectors by removing injector retaining clip and pulling injector from rail.
- Installation is reverse of removal. Fit new O-rings when installing injectors. For ease of installation, lightly lubricate injector O-ring with SAE90 gear lube.

### Tightening torque

Fuel rail to intake manifold	10 Nm (89 in-lb)
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## Evaporative emissions, overview

On E39 MS 41.1 cars, the evaporative emissions system is combined with the tank ventilation system. The evaporative system is monitored by the ECM for correct purge operation and leak detection.

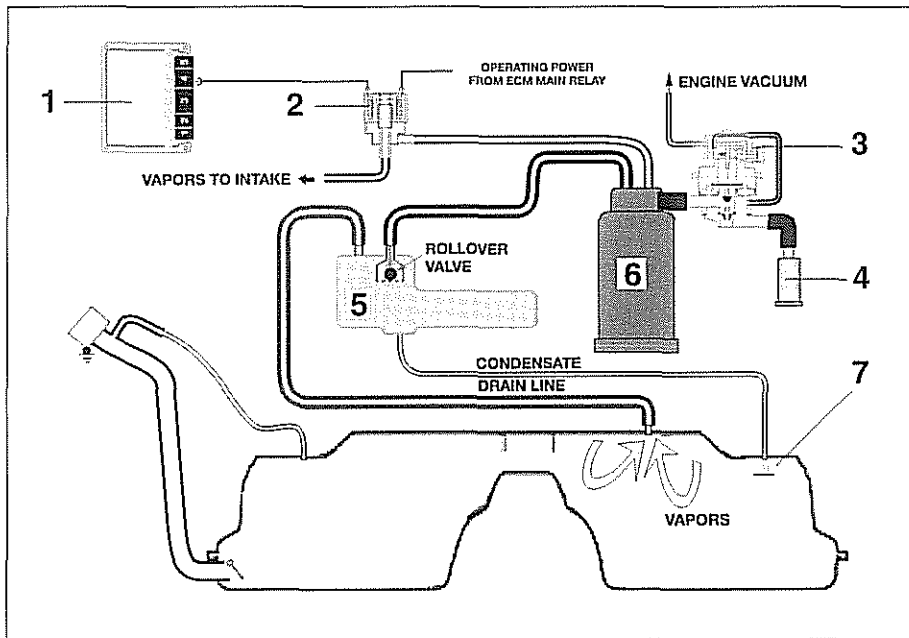
The carbon (purge) canister is purged using engine vacuum via the purge valve. The purge valve (located next to the mass air flow sensor) is ECM controlled and regulates the purge flow into the intake manifold. The valve is powered open and closed by an internal spring.

If the evaporative emission valve circuit is faulty, a fault code is set and the MIL is illuminated when OBD II fault criteria are exceeded. If the valve is mechanically faulty, poor driveability may result and a mixture adaptation fault is stored in the ECM.

The leak diagnosis pump (LDP) is activated by the ECM and pressurizes the fuel tank and evaporative system as apart of the OBD II leak detection monitor. If the LDP or the LDP circuit is defective, a fault code is set and the MIL is illuminated when OBD II fault criteria are exceeded. The LDP is mounted the left rear wheel well behind the fender liner.

**NOTE—**

The 1998 528i with MS 41.1 requires a barometric pressure sensor input signal for activation of the LDP check. This sensor is located on the passenger side strut tower forward of ABS/ASC hydraulic unit.

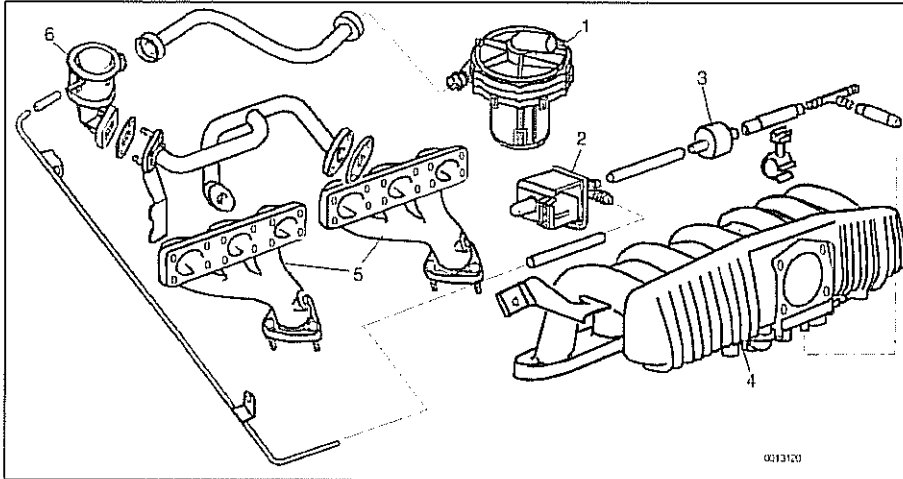
**Evaporative emissions**

1. ECM
2. Purge valve
3. Leak detection pump (LDP) (in left rear wheel housing)
4. Filter
5. Liquid vapor separator
6. Purge canister
7. Fuel tank

**Secondary air injection, overview**

The secondary air system pumps ambient air into the exhaust stream after a cold engine start to reduce the warm up time of the catalytic converters and to reduce HC and CO emissions. The ECM controls and monitors the secondary air injection system. The secondary air pump operates at a start temperature of between 10°C (50°F) and 40°C (104°F) and continues to operate for a maximum of 2 minutes at idle speed.

The electric air pump draws in ambient air and supplies it to the diverter valve. The vacuum vent valve (solenoid) switches vacuum to open the diverter valve when activated by the ECM. Once opened, the diverter valve allows air to be pumped into the exhaust stream.



## Secondary air injection

1. Secondary air pump (in right front wheel housing)
2. Secondary air vacuum vent valve solenoid (on intake manifold)
3. Secondary air check valve
4. Intake manifold
5. Exhaust manifolds
6. Diverter valve (at exhaust manifold)

## Engine control module (ECM), removing and installing

The ECM uses stored functions and processing programs to process the input signals from the sensors. These input signals are used to calculate the control (output) signals to the actuators (e.g., ignition coils, injectors).

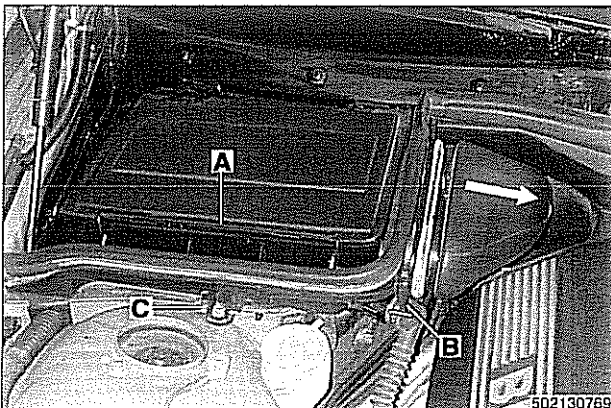
### NOTE—

Consult an authorized BMW dealer before replacing the ECM.

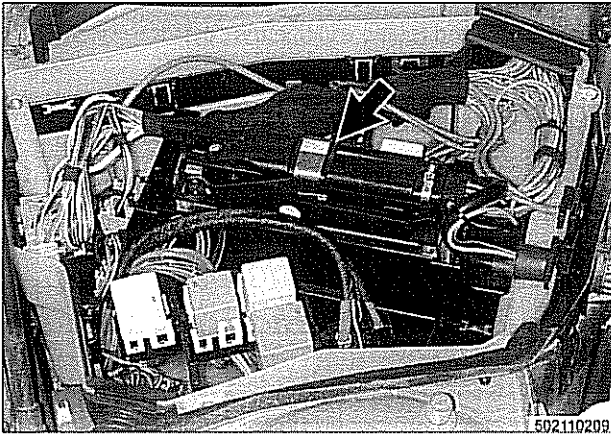
- Disconnect negative (-) battery cable. Wait approximately one minute.

### CAUTION—

Prior to disconnecting the battery, read the battery disconnection cautions in 001 General Warnings and Cautions.



- ◀ Access engine control module (ECM):
  - Release interior ventilation filter cover latch (A) and remove cover.
  - Release plastic locking tab (B).
  - Rotate air duct inward (arrow) to unlock from bulk head and remove duct.
  - Release spring lock (C) to remove lower filter housing.
  - Slide filter housing away from inner fender to remove.
- Remove electrical box (E-box) cover fasteners and remove cover.
- If testing ECM or connected components, use breakout box to allow tests to be made with connector attached to the ECM. This prevents damage to small terminals in connector.



- As an alternative, harness connector housing can be separated so that electrical checks can be made from back of connector.

➤ If replacing ECM, disconnect control module harness connector (**arrow**) by releasing fastener and pivoting connector up and off ECM.

**CAUTION—**

*Be sure ignition is OFF before disconnecting or reconnecting DME system components.*

- Remove ECM from retaining brackets and lift off holder.
- Installation is reverse of removal.
- Before attempting to start engine, use BMW service tester DISplus, MoDiC, GT1 or equivalent:
  - Code replacement ECM with application information (i.e. engine code, transmission type, etc.).
  - Align ECM to EWS (electronic immobilizer).

**Siemens MS 41.1 ECM pin assignments**

ECM pin assignments are given in **Table b**. For engine management system schematics, see **ELE Electrical Wiring Diagrams**.

**CAUTION—**

- *Always wait at least one minute after turning off the ignition before removing the connector from the ECM. If the connector is removed before this time, residual power in the system relay may damage the ECM.*
- *Always connect or disconnect the control module connector and meter probes with the ignition off.*

When making checks at the ECM itself, a breakout box should be used to allow tests to be made with the connector attached to the ECM. This also prevents damage to the small terminals in the connector. As an alternative, the harness connector housing can be separated so that electrical checks can be made from the back of the connector.

**Table b. Siemens MS 41.1 ECM pin assignments**

Pin	Signal	Component/function	Notes
1	output	Ignition coil control, cyl. 2	Primary signal, ignition coil 2
2	output	Ignition coil control, cyl. 4	Primary signal, ignition coil 4
3	output	Ignition coil control, cyl. 6	Primary signal, ignition coil 6
4	ground	Ground	Ground

<b>Fuel Injection</b>
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Table b. Siemens MS 41.1 ECM pin assignments (continued)

Pin	Signal	Component/function	Notes
5	output	Fuel injector control, cyl. 2	Pulsed ground (pulse width in ms), cyl. 2
6	output	Fuel injector control, cyl. 1	Pulsed ground (pulse width in ms), cyl. 1
7	ground	Mass air flow sensor	Mass air flow sensor signal
8	input	Mass air flow sensor	Mass air flow sensor signal
9	output	Instrument cluster	Fuel consumption signal
10	input	Engine coolant temp. (ECT) sensor	ECT signal
11	-	Not used	
12	input	Throttle position sensor (TPS)	Throttle position signal
13	-	Not used	
14	input	Intake air temp. sensor (IAT)	Intake air temperature signal
15	input	Traction control (rear engine speed signal)	ABS/ASC module
16	input	Automatic climate control	
17	-	Not used	
18	input	Electronic immobilizer control (EWS)	
19	input	Auto. climate control (A/C on input)	Automatic climate control
20	output	Instrument cluster	Instrument cluster (CARB signal)
21	output	Camshaft actuator control (VANOS)	Camshaft actuator (VANOS), switched ground
22	output	Fuel injector control, cyl. 3	Pulsed ground (pulse width in ms), cyl. 3
23	output	Fuel injector control, cyl. 6	Pulsed ground (pulse width in ms), cyl. 6
24	output	Fuel injector control, cyl. 4	Pulsed ground (pulse width in ms), cyl. 4
25	ground	Oxygen sensor heater (no. 1 in front of catalytic converter)	Oxygen sensor heater ground
26	input	Power supply (terminal 30)	Battery voltage (B+) at all times
27	output	Idle speed control valve	Pulsed ground-open signal (See pin 53)
28	ground	Ground	Ground
29	output	Ignition coil control, cyl. 1	Primary signal, ignition coil 1
30	output	Ignition coil control, cyl. 3	Primary signal, ignition coil 3
31	output	Ignition coil control, cyl. 5	Primary signal, ignition coil 5
32	ground	Ground	Ground
33	output	Fuel injector control, cyl. 5	Pulsed ground (pulse width in ms), cyl 5
34	ground	Ground	Ground
35	output	Secondary air injection	Secondary air inj. pump relay control
36	output	Engine speed output	Engine speed signal
37	-	Not used	
38	ground	Knock sensor	Shielding for knock sensor
39	output	Intake air temp (IAT) sensor and Engine coolant temp (ECT) sensor	Voltage supply to IAT sensor and ECT sensor



Table b. Siemens MS 41.1 ECM pin assignments (continued)

Pin	Signal	Component/function	Notes
40	ground	Crankshaft position sensor	Crankshaft position sensor control
41	ground	Camshaft position sensor (CMP)	Shielding for CMP sensor
42	ground	Throttle position sensor (TPS)	TPS ground
43	ground	Camshaft position sensor (CMP)	Camshaft position/rpm sensor control
44	output	Throttle position sensor (TPS)	Voltage supply to TPS (5 vdc)
45	output	Throttle position sensor (traction control)	ABS/ASC module
46	output	Instrument cluster	Instrument cluster, fuel reserve signal
47	-	Not used	
48	output	Crankshaft position sensor (Hall effect)	Crankshaft position sensor control
49	input	Power supply (terminal 15)	Battery voltage with key on or engine running
50	-	Not used	
51	-	Not used	
52	-	Not used	
53	output	Idle speed control valve	Pulsed ground-close signal (see pin 26)
54	input	Power supply	Battery voltage from main relay (terminal 87)
55	ground	Oxygen sensor heater (no. 2 in front catalytic converter)	Oxygen sensor heater ground
56	ground	Ignition circuit	Ignition circuit monitoring signal
57	output	Knock sensor (cyl. 1-3)	Knock sensor
58	input	Knock sensor (cyl. 1-3)	Knock sensor signal
59	output	Knock sensor (cyl 4-6)	Knock sensor
60	input/output	Data link connector (TxD)	Diagnostic TxD (transmit) signal to pin 18 in data link connector
61	ground	Oxygen sensor heater (no. 2 behind catalytic converter)	Oxygen sensor heater ground
62	output	Secondary air injection	Secondary air injection control valve
63	input	Knock sensor (cyl. 4-6)	Knock sensor signal
64	input	Camshaft position/rpm sensor	Camshaft position/rpm sensor control
65	input	Camshaft position/rpm sensor	Camshaft position/rpm sensor control
66		Not used	
67	ground	Oxygen sensor (no. 1 in front of catalytic converter)	Oxygen sensor signal ground
68	output	Evaporative purge valve control	Pulse ground with engine at normal temperature with varying engine load
69	output	Fuel pump relay control	Fuel pump relay energizes with engine running
70	ground	Oxygen sensor signal (no. 2 in front of catalytic converter)	Oxygen sensor signal ground
71	ground	Oxygen sensor signal (no. 1 behind catalytic converter)	Oxygen sensor signal ground

<b>Fuel Injection</b>
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Table b. Siemens MS 41.1 ECM pin assignments (continued)

Pin	Signal	Component/function	Notes
72	ground	Oxygen sensor signal (no. 2 behind cat. conv.)	Oxygen sensor signal ground
73	input	ECM relay control	ECM relay activation (terminal 85)
74	output	A/C compressor control	A/C compressor relay control
75	input	Oxygen sensor signal (no. 1 in front of cat. conv.)	Oxygen sensor signal
76	input	Oxygen sensor signal (no. 2 in front of cat. conv.)	Oxygen sensor signal
77	input	Oxygen sensor signal (no. 1 behind cat. conv.)	Oxygen sensor signal
78	input	Oxygen sensor signal (no. 2 behind cat. conv.)	Oxygen sensor signal
79	ground	Oxygen sensor heater (no. 1 behind cat. conv.)	Oxygen sensor heater ground
80	input	Ignition delay (traction control)	ABS/ASC module
81	input	Ignition timing adjustment (traction control)	ABS/ASC module
82	input	Increase idle speed (traction control)	ABS/ASC module
83	input	Crankshaft position sensor (Hall effect)	Crankshaft position sensor control
84		Not used	
85	input/output	CAN-Bus low	Automatic transmission control module (AGS)
86	input/output	CAN-Bus high	Automatic transmission control module (AGS)
87	input	Power supply	Battery voltage from main relay terminal 87
88	input output	Diagnostic connector (TxD)	Diagnostic TxD signal to pin 17 in data link connector

## SIEMENS MS 42.0 AND MS 43.0

When system faults are detected, a diagnostic trouble code (DTC) is stored in the engine control module (ECM). The MIL also illuminates if an emissions-related fault is detected.

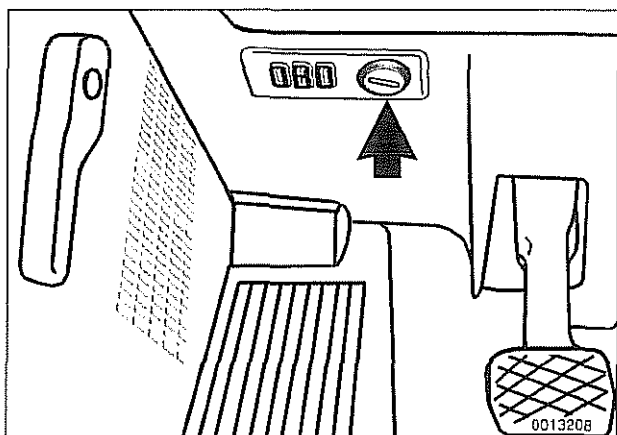
When faults arise, or if the malfunction indicator lamp (MIL) is illuminated, begin troubleshooting by connecting BMW service tester DISplus, MoDiC, GT1 or equivalent scan tool. The capabilities of OBD II software has the potential to save hours of diagnostic time and to help avoid incorrect component replacement and possible damage to system components.

### CAUTION—

- The tests in this section may set fault codes (DTCs) in the ECM and illuminate the MIL. After all testing is completed, access and clear DTC fault memory using an OBD II or BMW compatible scan tool. See **OBD On-Board Diagnostics**.
- Only use a digital multimeter for electrical tests.
- Relay positions can vary. Be sure to confirm relay position by identifying the wiring in the socket using the wiring diagrams found in **ELE Electrical Wiring Diagrams**.

### NOTE—

- OBD II fault memory (including an illuminated MIL) can only be reset using the special scan tool. Removing the connector from the ECM or disconnecting the battery will not erase the fault memory.
- The BMW-dedicated 20-pin diagnostic link connector (DLC) is in the right rear of the engine compartment. The 20-pin DLC is discontinued on models after 6/2000.
- The 16-pin OBD II diagnostic connector (**arrow**) is located inside the car on the lower left dash panel.



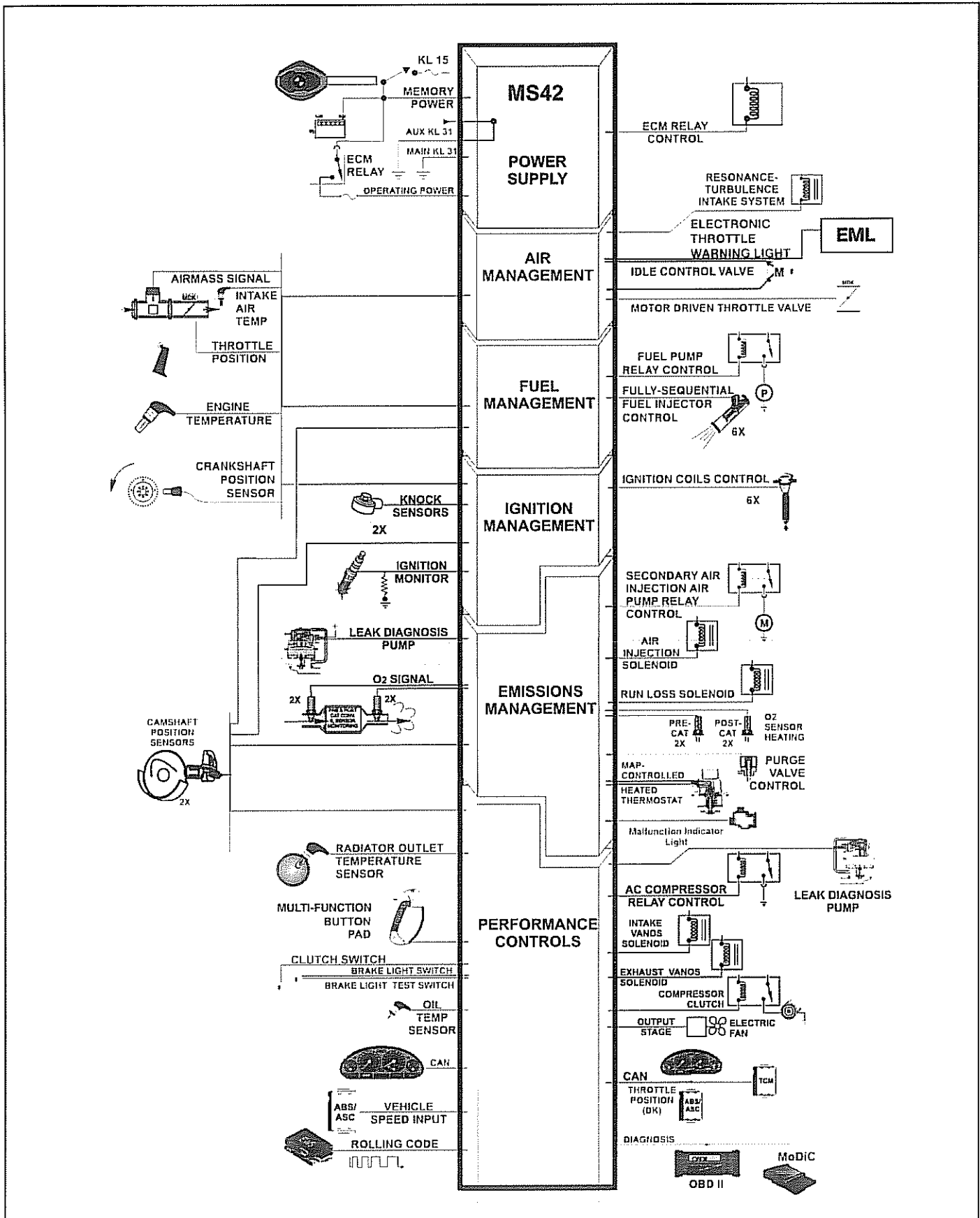
The MS 42.0 and MS 43.0 systems manage the following functions.

- **Air:**
  - Idle speed valve
  - Electronic throttle
  - Hot film mass air flow (MAF) sensor
  - Resonance-turbulence intake control
- **Fuel:**
  - Fuel supply
  - Running losses/non return
  - Fuel injection

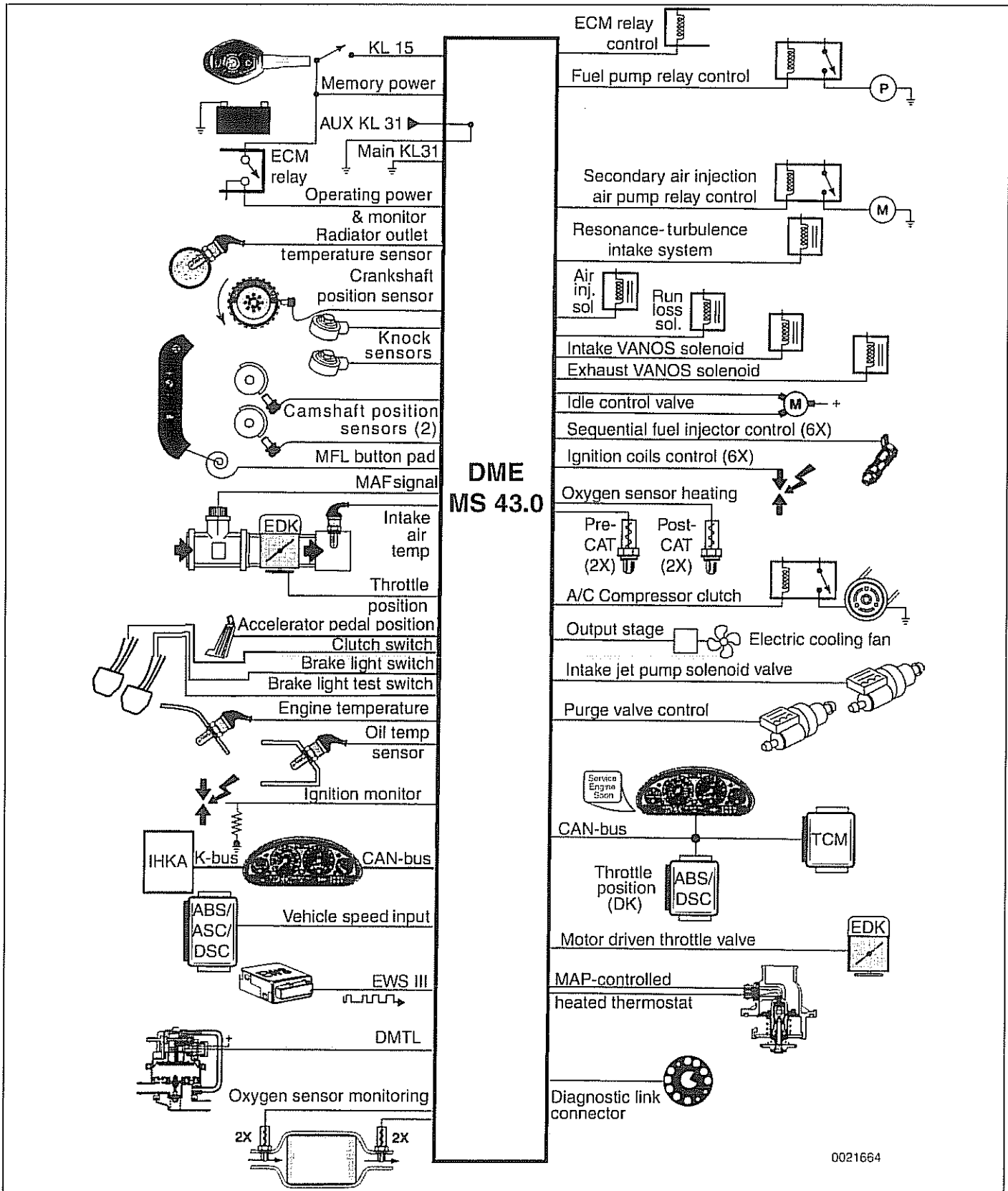
- **Ignition:**
  - Direct ignition
  - Knock control
  - Primary/ secondary ignition monitoring
- **Emissions:**
  - OBD II compliance
  - Secondary air injection
  - Pre- and post-catalyst oxygen sensors
  - Electrically heated DME-mapped thermostat
  - Misfire detection
  - Evaporative emission control and leak detection
  - Malfunction indicator light (MIL)

**Performance controls:**

- Dual VANOS control
- Output of injection signal (TI) for fuel economy gauge
- Output of engine rpm (TD) for tachometer
- A/C compressor control
- Electric radiator cooling fan
- CAN-Bus communication
- Stability and traction system (ABS/ASC/DSC) interface
- Electronic immobilizer (EWS)
- Cruise control
- ECM programming



Fuel Injection



## ECM relay, testing

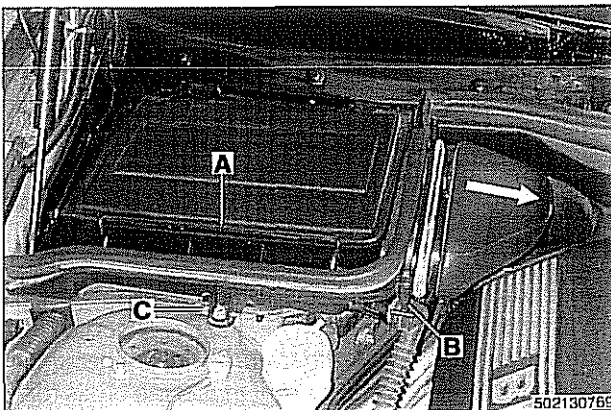
The engine control module (ECM) relay is energized via the ECM and supplies battery positive (B+) power to many of the engine management components and subsystems. If this relay is faulty, the engine will not start.

### NOTE—

The ECM relay is also referred to as the DME main relay.

ECM relay powers:

- ECM
- Ignition coils
- Fuel injection
- Evaporative leak detection pump
- Idle air actuator
- Camshaft sensors
- Evaporative emissions valve
- Hot film mass air flow sensor
- Fuel pump relay
- Oxygen sensor heaters



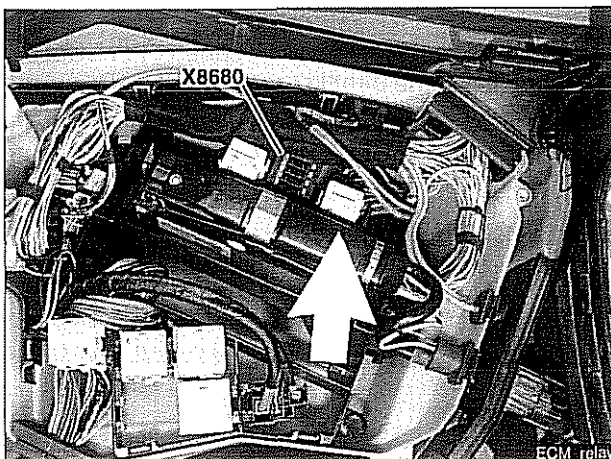
- ◀ Working in right rear of engine compartment:
  - Release interior ventilation filter cover latch (A) and remove cover.
  - Release plastic locking tab (B).
  - Rotate duct inward (arrow) to unlock from bulk head and remove duct.
  - Release spring lock (C) to remove lower filter housing.
  - Slide filter housing away from inner fender to remove.

- Remove electrical box (E-box) cover fasteners and remove cover.

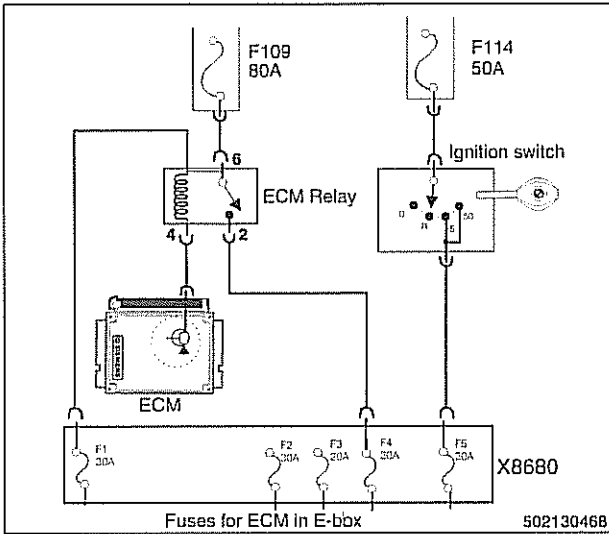
- ◀ With ignition off, remove ECM relay (arrow) in electronics box (E-box) at rear of engine compartment, right side.

### NOTE—

Relay locations can vary. Confirm relay identification by matching wiring colors and terminal numbers.



**Fuel Injection**

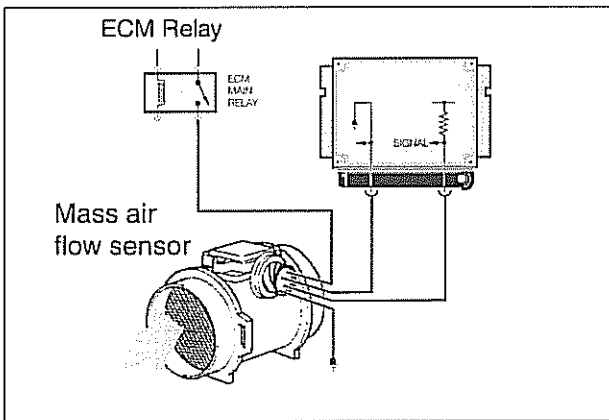


- Check for voltage at terminal 6 (30) at relay socket.
  - If battery voltage is present continue testing.
  - If battery voltage is not present, check fuse **109** (80-amp fusible link) under passenger seat carpet. See **610 Electrical Component Locations**.
- Reinstall relay and turn ignition on. Gain access to back side of relay socket and check for ground at terminal 4.
  - If ground is present continue testing.
  - If ground is not present, signal from ECM is missing. Check wire between ECM and relay.
- With ignition on and relay installed, check for battery voltage at terminal 2.
  - If battery voltage is present, relay has energized and is functioning correctly.
  - If battery voltage is not present and all earlier tests are OK, relay is faulty and should be replaced.

**NOTE—**

*If no faults are found during testing but power is not reaching the ECM or other components, check the fuses in the fuse carrier X8680 in the E-box.*

**Mass air flow (MAF) sensor, checking and replacing**



- The hot film mass air flow (MAF) sensor sends a varying voltage (approx. 0.5 - 4.5 vdc) to the ECM representing the measured intake air. The air mass input signal is produced electronically using an electrically heated metal film in the air flow stream.

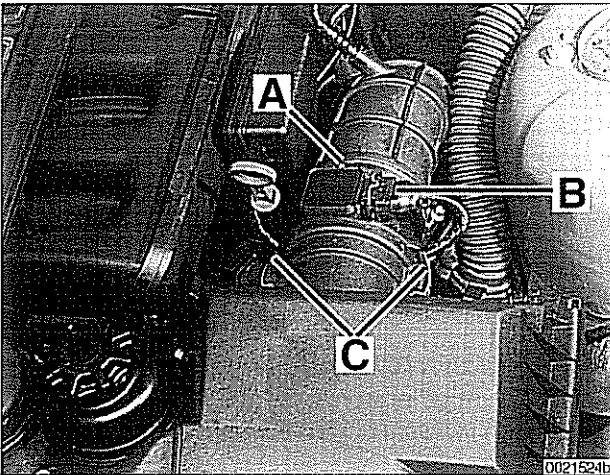
The ECM relay provides the operating voltage to the MAF sensor. As air flows through the sensor, the film is cooled. To maintain the film at a constant temperature, additional current is necessary. It is this additional current that is the basis for the input signal.

If there is no output signal from the MAF sensor, the ECM operates the engine using the throttle position and engine rpm inputs. A faulty MAF sensor illuminates the MIL.



A faulty MAF sensor can produce the following problems:

- Difficult to restart when engine is hot
- Engine starts then stalls
- Engine starts and runs only with accelerator pedal depressed



◀ Disconnect electrical harness connector from MAF sensor (B).

- Turn ignition on and check for voltage and ground at connector.
  - There should be ground at pin 1 and battery voltage at pin 3.
  - If any faults are found, check for wiring breaks between MAF sensor and ECM and between MAF sensor and main DME relay.

**NOTE—**

Visually inspect the sensor for damage, missing or blocked screens. The screens affect air flow calibration. Also inspect the sealing O-rings where the sensor inserts into the air filter housing and intake boot. Ensure the pin connections are clean and tight.

◀ Connect a BMW-compatible scan tool or an OBD II generic scan tool. Check air mass signal (load signal) with the engine at idle. Raise idle speed and check that load signal changes with rpm.

**CAUTION—**

Be sure ignition is OFF before disconnecting or reconnecting DME system components.

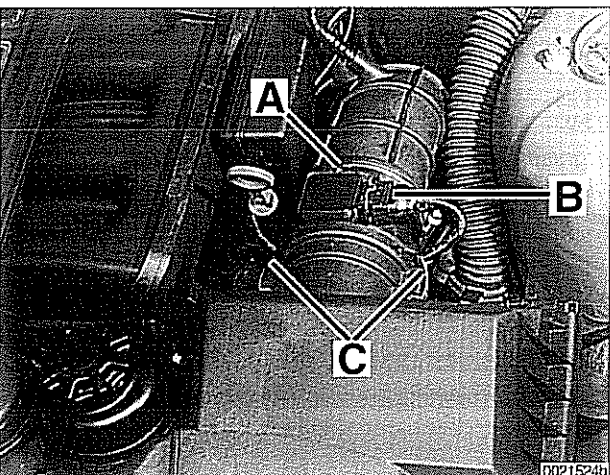


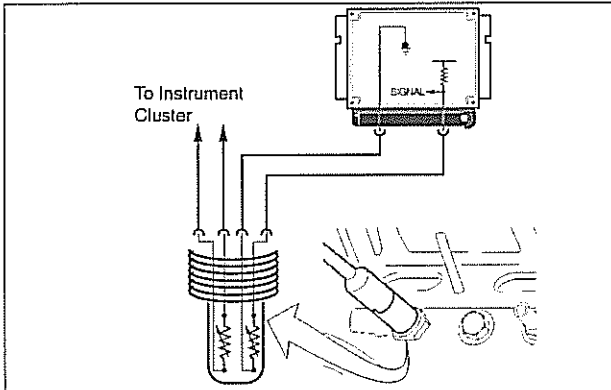
◀ Remove MAF sensor:

- Loosen intake boot clamp (A).
- Disconnect harness connector (B).
- Release clip from air filter housing (C) and remove sensor.

– Installation is reverse of removal.

- No adjustment to MAF sensor is possible.
- Check intake hoses for cracks and vacuum leaks.





## Engine coolant temperature (ECT) sensor, testing and replacing

- The ECT sensor is located below cylinder 6 intake port at the rear of the engine (1).

The ECT sensor is a dual temperature sensor. One circuit provides coolant temperature information to the ECM while the other circuit provides coolant temperature information to the instrument cluster.

The ECM determines the correct ignition timing and air/fuel mixture required for the engine temperature by monitoring an applied voltage (5 vdc) to the sensor. The voltage drop across the sensor varies as the coolant temperature (sensor resistance) changes.

### NOTE —

*The ECT sensor is an NTC (negative temperature coefficient) type sensor. In other words, as the temperature rises, resistance through the sensor decreases.*

If the ETC sensor input is faulty or non-plausible, the MIL is illuminated when the MIL is illuminated when OBD II fault criteria are exceeded. The ECM assumes a substitute value (80° C / 176°F) to maintain engine operation. The ignition timing is set to a conservative/safe basic setting.

- Remove intake manifold to access ECT sensor on the M52 TU and the M54 engines. See **113 Cylinder Head Removal and Installation**.
- Check ECT sensor resistance using a multimeter at sensor terminals.

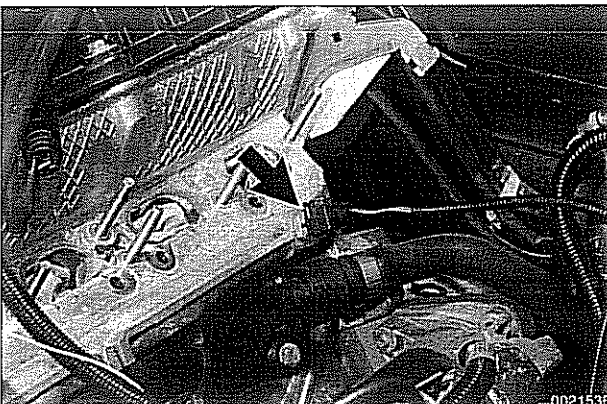
ECT sensor resistance @ 20° C (68°F)	2.2 - 2.7 kΩ
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### WARNING —

*Due to risk of personal injury, be sure the engine is cold before removing ECT sensor connector.*

### CAUTION —

*Be sure ignition is OFF before disconnecting or reconnecting DME system components.*



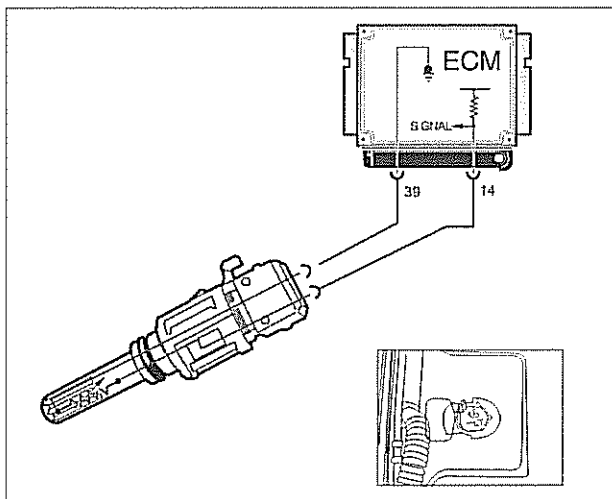
- Disconnect ECT sensor harness connector (arrow). Unscrew ECT sensor from cylinder head.

- Installation is reverse of removal:
  - Use new copper sealing washers when installing sensor.
  - Replace any lost coolant.

#### Tightening torque

Temperature sensor to cylinder head	13 Nm (10 ft-lb)
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### Intake air temperature (IAT) sensor, testing and replacing



- The intake air temperature (IAT) sensor, located at the top of the intake manifold, adapts (fine tunes) the fuel mixture and engine timing based on varying intake air temperatures.

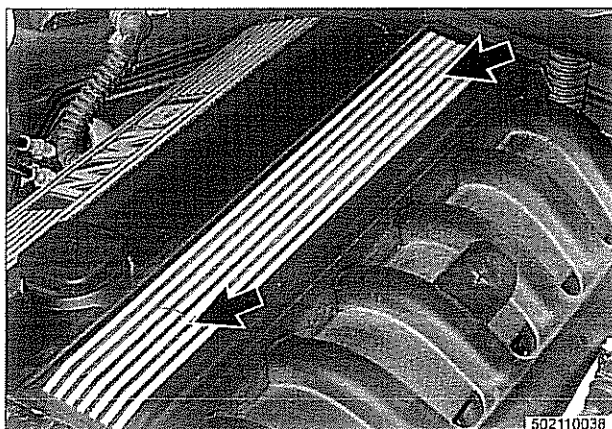
If the intake air temperature signal is implausible, a fault code is set and the MIL is illuminated when OBD II fault criteria are exceeded. The ECM then operates the engine using the ECT sensor signal input as a back up.

#### NOTE —

The IAT sensor is an NTC (negative temperature coefficient) type sensor. In other words, as the temperature rises, resistance through the sensor decreases.

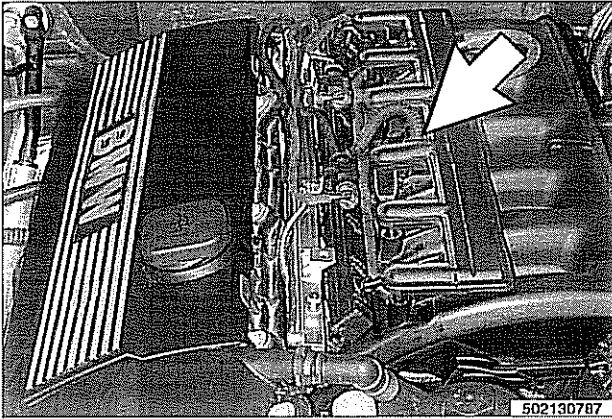
The IAT sensor can be tested using a multimeter:

IAT sensor resistance at 20° C (68°F)	2.2 - 2.7 kΩ
---------------------------------------	--------------



- Remove engine cover by prying off plastic trim caps (arrows) and removing nuts below caps.

## Fuel Injection



- Remove electrical harness connector (arrow) from IAT sensor.

### CAUTION—

*Be sure the ignition switch is in the off position before replacing the intake temperature sensor.*

- Depress locking clip on side of temperature sensor and pull straight out of intake manifold.
- Installation is reverse of removal.
- Use a new sealing O-ring at base of sensor and lubricate with assembly lubricant for ease of installation.

## MS 42.0 throttle valve assembly, replacing

- The motor driven throttle valve for the MS 42.0 system is referred to as MDK (motor driven throttle valve). The MDK unit is electronically operated to regulate intake air flow by the ECM.

The MS 42.0 system uses a throttle cable from the accelerator pedal to the MDK unit. The throttle cable is connected directly to the integral pedal position sensor (PWG) in the MDK unit. This sensor communicates pedal position to the ECM, which in turn electronically regulates throttle plate position. The MDK pulley is linked to the throttle shaft by springs to allow ASC intervention to override the driver's pedal position.

### NOTE—

- *The MDK unit is non-adjustable and must be replaced as a complete unit if found to be faulty.*
- *If replacing the MDK unit, the adaptation values stored in the ECM must be cleared and the new unit initialized using BMW special service tools.*

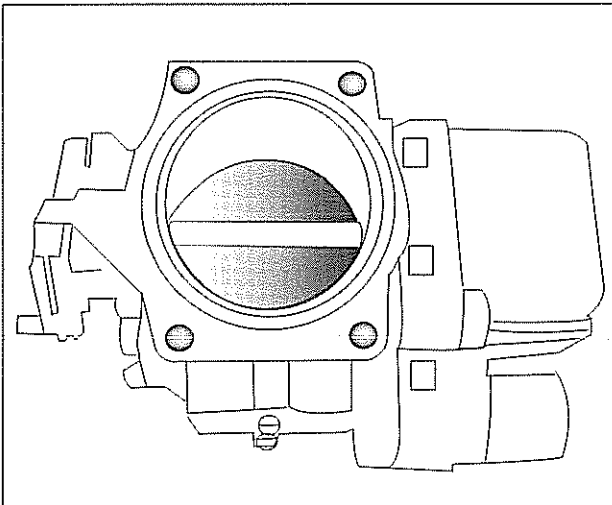
### CAUTION—

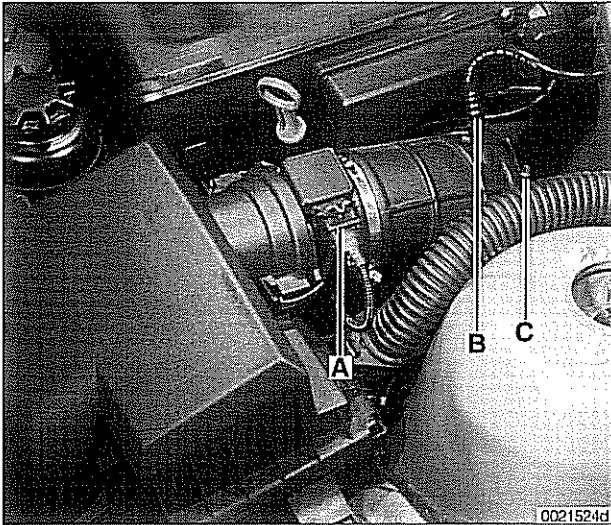
*If the adaptation process is not completed correctly, the engine will not start.*

- Disconnect battery negative (-) cable in luggage compartment.

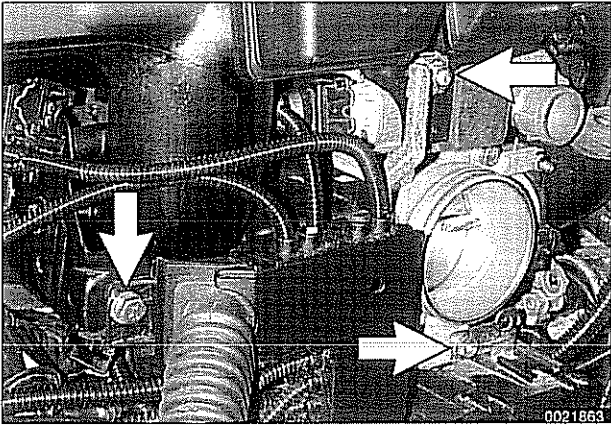
### CAUTION—

*Prior to disconnecting the battery, read the battery disconnection cautions in 001 General Warnings and Cautions.*

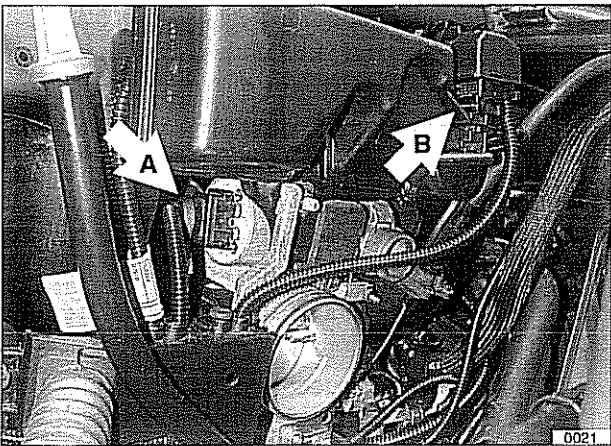




- Remove complete air filter housing:
  - Disconnect electrical harness connector on mass air flow sensor (A).
  - Disconnect vacuum line at intake boot (B).
  - Loosen intake air duct clamp (C).
  - Remove filter housing mounting screws.
  - Disconnect air duct and lift complete air filter housing and MAF sensor out of engine compartment, pulling it forward away from throttle housing.
- Pull throttle cable upwards out of rubber retainer and unhook ball end of cable from throttle actuator.

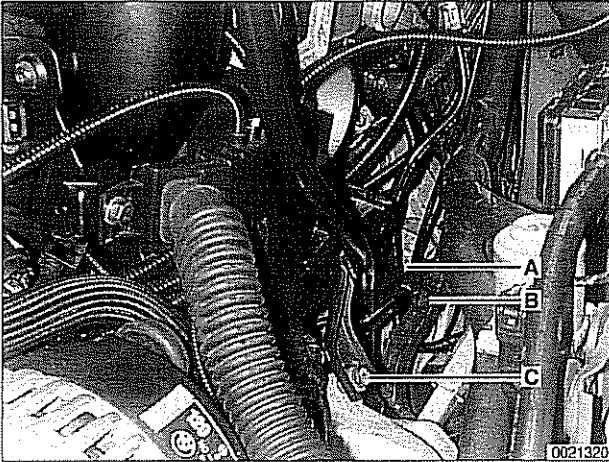


- Remove nuts and bolts (arrows) retaining wiring harness to throttle housing.
- Working at throttle housing, turn harness plug counterclockwise and remove plug.



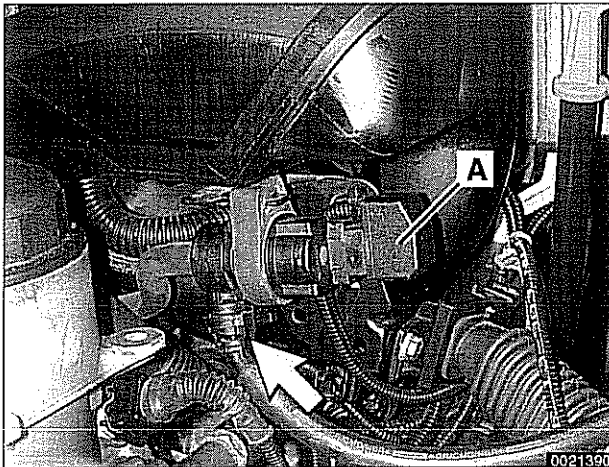
- Working at side of intake manifold, disconnect electrical harness connectors:
  - Idle control valve (A)
  - Intake manifold resonance valve (B)
- Disconnect electrical harness connectors at oil pressure sender and oil temperature sender at base of oil filter housing.

## Fuel Injection

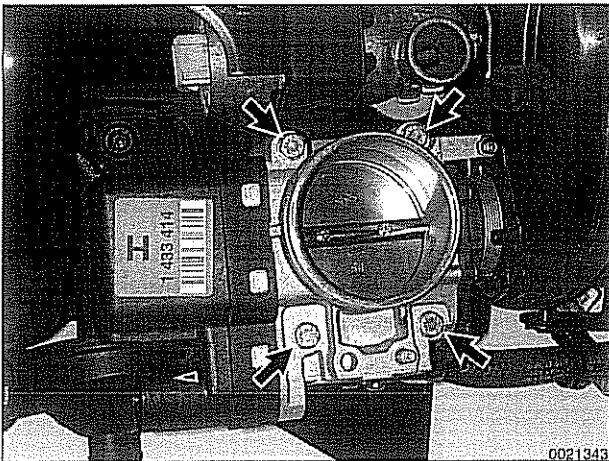


➤ Remove dipstick guide tube:

- Disconnect wiring harness brackets from tube (A).
- Unclip fuel lines from dipstick tube (B).
- Remove lower guide tube mounting bolt (C). Pull out dipstick guide tube.



➤ If necessary, disconnect electrical harness connector at fuel tank venting valve (A). Disconnect hose at quick disconnect fitting (arrow).



➤ Working at throttle housing, turn harness plug counterclockwise and disconnect. Remove throttle assembly mounting fasteners (arrows) and pull assembly off manifold.

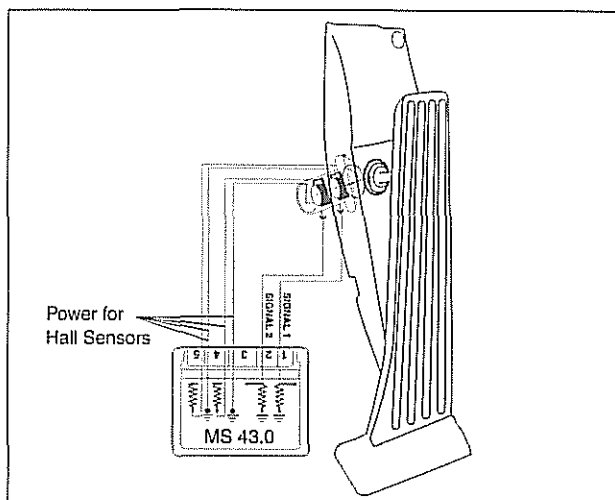
— Installation is reverse of removal.

- Replace sealing ring between throttle assembly and intake manifold.
- Reattach throttle assembly harness connector with care. Arrow on fully tightened connector must line up with corresponding arrow on throttle assembly housing.
- Connect BMW test equipment or equivalent and carry out throttle plate adaptation following the on-screen directions.
- Reattach throttle cable and check cable adjustment as described under **Throttle cable, adjusting (MS 42.0)**.

## MS 43.0 throttle valve assembly, replacing

The electronic throttle valve assembly for the MS43.0 system is referred to as EDK (electronic throttle valve). There is no mechanical (cable) link between the accelerator pedal and the throttle plate.

- ⚡ The accelerator pedal module (PWG) at the pedal assembly communicates the pedal position directly to the ECM. The module provides two variable voltage signals (via two Hall sensors) to the ECM for pedal position and rate of movement.



### NOTE —

- The EDK unit is non-adjustable and must be replaced as a complete unit if found to be faulty.
- If replacing the EDK unit, the adaptation values stored in the ECM must be cleared and the new unit initialized using BMW special service tools.

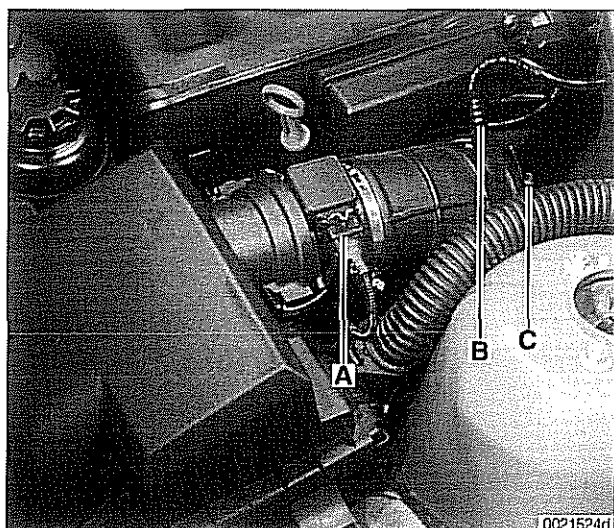
### CAUTION —

If the adaptation process is not completed correctly, the engine will not start.

- Disconnect battery negative (-) cable in luggage compartment.

### CAUTION —

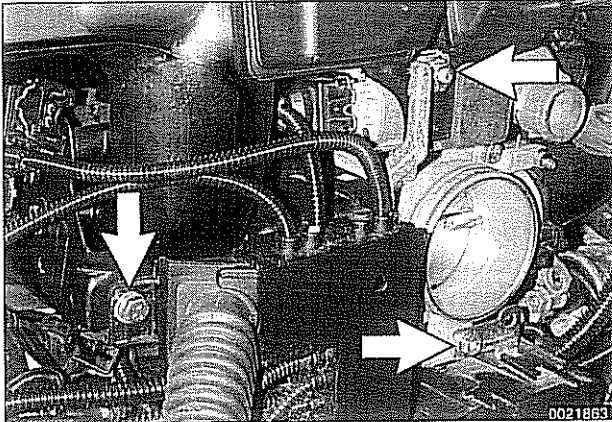
Prior to disconnecting the battery, read the battery disconnection cautions given in 001 General Warnings and Cautions.



- ⚡ Remove complete air filter housing:
- Disconnect electrical harness connector on mass air flow sensor (A).
  - Disconnect vacuum line at intake boot (B).
  - Loosen intake air duct clamp (C).
  - Remove filter housing mounting screws.
  - Disconnect air duct and lift complete air filter housing and MAF sensor out of engine compartment, pulling it forward away from throttle housing.

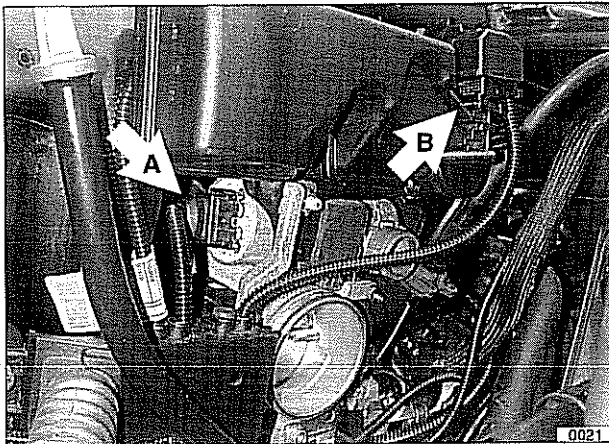


## Fuel Injection



- Remove nuts and bolts (arrows) retaining wiring harness to throttle housing.

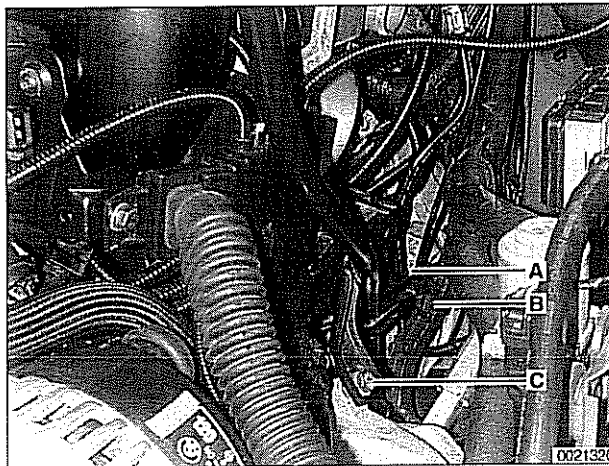
- Working at throttle housing, turn harness plug counterclockwise and remove.



- Working at side of intake manifold, disconnect electrical harness connectors:

- Idle control valve (A)
- Intake manifold resonance valve (B)

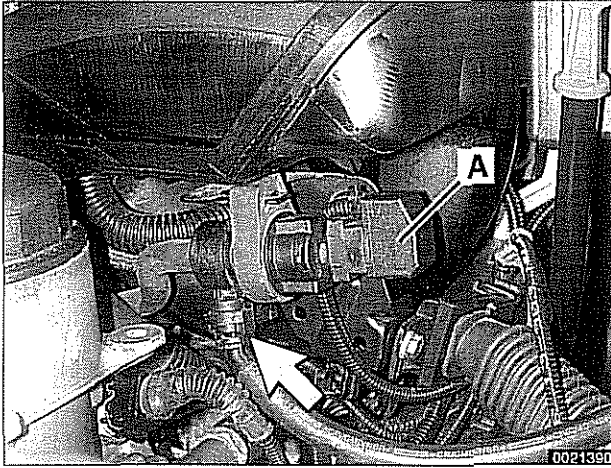
- Disconnect electrical harness connectors at oil pressure sender and oil temperature sender at base of oil filter housing.



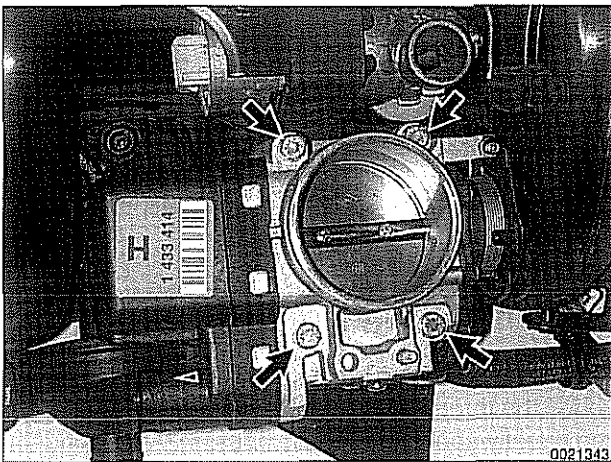
- Remove dipstick guide tube:

- Disconnect wiring harness brackets from tube (A).
- Unclip fuel lines from tube (B).
- Remove lower guide tube mounting bolt (C).
- Pull out dipstick guide tube.





- ⚡ If necessary, disconnect electrical harness connector at fuel tank venting valve (A). Disconnect hose at quick disconnect fitting (arrow).

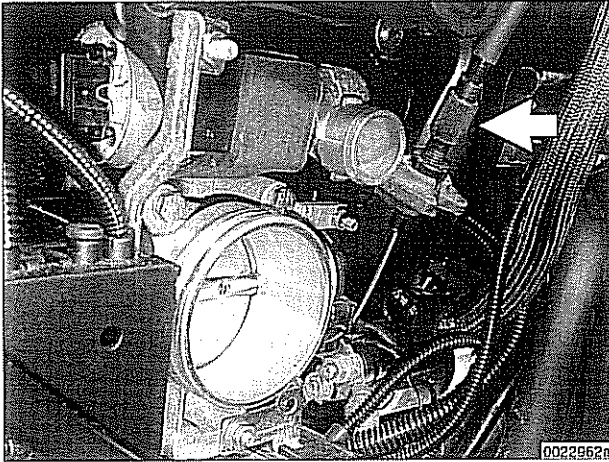


- ⚡ Working at throttle housing, turn harness plug counterclockwise and disconnect. Remove throttle assembly mounting fasteners (arrows) and pull assembly off manifold.

- Installation is reverse of removal.
  - Replace sealing ring between throttle assembly and intake manifold.
  - Reattach throttle assembly harness connector with care.
  - Arrow on fully tightened connector must line up with corresponding arrow on throttle assembly housing.
  - Use BMW scan tool to reset ECM adaptation values.

## Throttle cable, adjusting (MS 42.0)

The throttle assembly on MS 42.0 cars uses a throttle cable. The cable should be adjusted any time it is disconnected or replaced. This procedure requires the factory scan tool or an equivalent to read and adjust throttle angle. It is recommended the procedure be done by an authorized BMW dealer service department.



### Basic adjustment:

- Ensure that at idle (accelerator pedal in rest position) throttle cable has detectable play at throttle lever attaching point. Play must not exceed maximum allowable.
- Adjust by turning knurled adjuster (**arrow**) on end of throttle cable sheath at throttle housing.

Max. play at throttle plate lever	3 mm (0.125 in)
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### NOTE —

Faulty throttle adjustment values must be reset using the BMW service tester DISplus, MoDiC, GT1 or equivalent.

## Idle speed control valve, checking and replacing

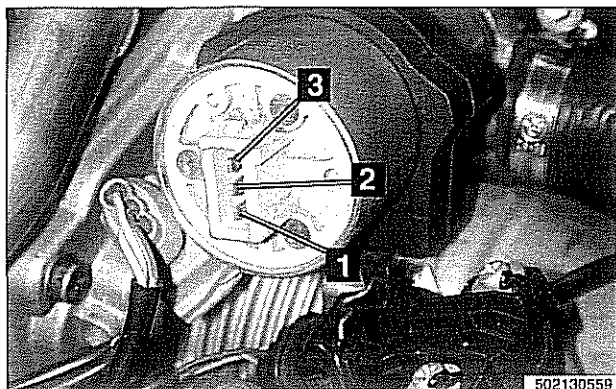
The idle speed control valve regulates idle speed by redirecting air around the throttle valve. The idle speed control valve is mounted directly above the throttle housing. Accessing the valve is best accomplished by first removing the air filter housing and associated ducting.

The valve is supplied with battery voltage from the ECM relay. The idle speed control valve incorporates a two-coil rotary actuator. The ground sides of each coil are pulsed simultaneously by the ECM. The duty cycle of each circuit is varied to achieve the required idle speed.

A faulty idle speed control valve sets a fault code and the MIL is illuminated when OBD II fault criteria are exceeded.

Before checking the idle speed control valve, confirm that the throttle position sensor is working correctly.

- With engine running, check that idle speed control valve is buzzing.
- Turn on A/C system or shift transmission into drive. Idle should remain steady or increase slightly.
- If idle speed valve is not buzzing, or if idle decreases when A/C is turned on, stop engine and disconnect harness connector from idle speed valve.



◀ Check resistance of valve across valve terminals.

#### Idle speed control valve coil resistance

Terminals 1 and 2	$20 \pm 2\Omega$
Terminals 2 and 3	$20 \pm 2\Omega$
Terminals 1 and 3	$40 \pm 4\Omega$

#### CAUTION—

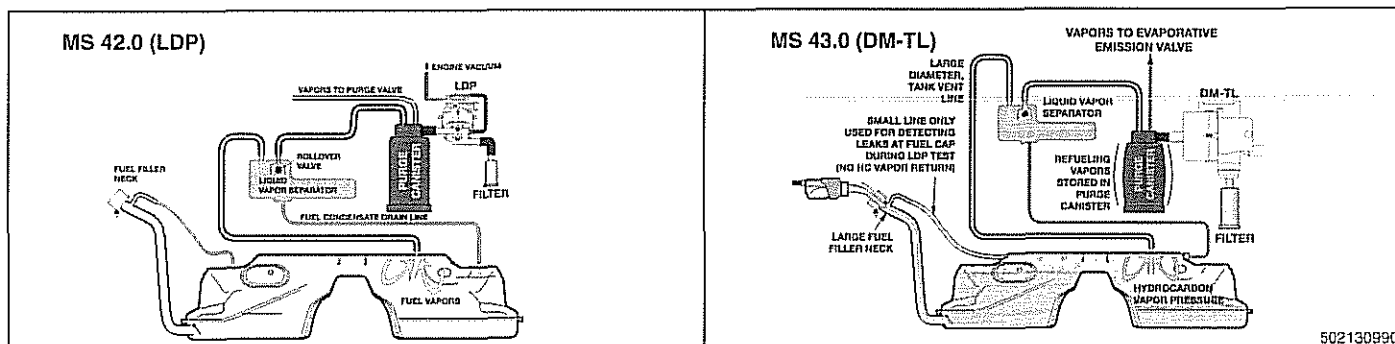
Be sure ignition is OFF before disconnecting or reconnecting DME system components.

- To remove valve, remove cable bracket mounting bolt and idle speed control valve mounting bracket bolts from front of throttle housing and remove idle speed control valve with attached bracket.

#### NOTE—

When installing idle speed control valve, remove intake boot sealing ring from valve and install into intake air boot. Then install valve into sealing ring.

## Evaporative emissions control diagrams



### Evaporative emissions control, (MS 42.0, MS 43.0)

E39 models with MS 42.0 or MS 43.0 engine are equipped with a fuel system evaporative pressure leak diagnosis system. The main component of this system is the leak diagnosis pump (LDP or DM-TL). The function of either system is to pressurize the fuel tank and the evaporative emission system for the purpose of detecting leaks.

## Engine control module (ECM), removing and installing

The ECM uses stored functions and processing programs to process the input signals from the sensors. These input signals are used to calculate the control (output) signals to the actuators (e.g., ignition coils, injectors).

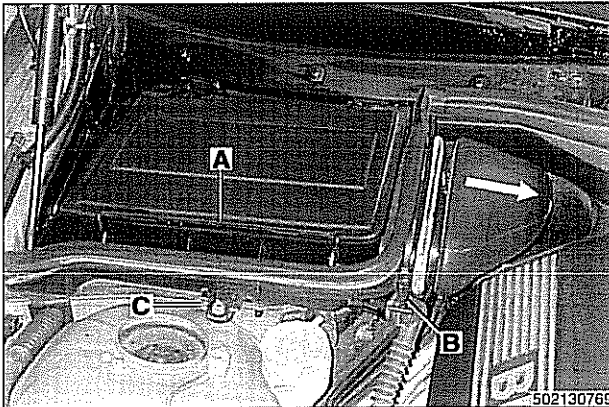
### NOTE—

Consult an authorized BMW dealer before replacing the ECM.

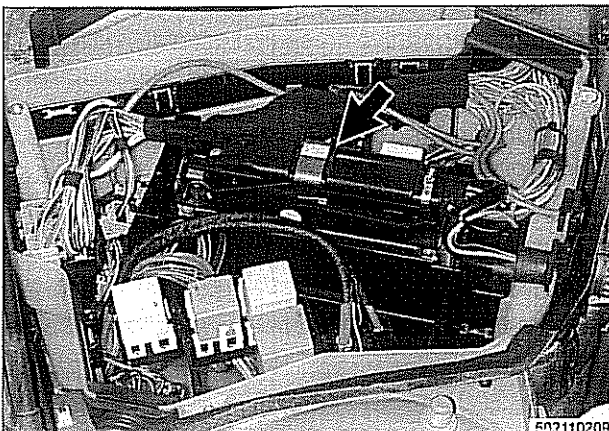
- Disconnect negative (-) battery cable. Wait approximately one minute.

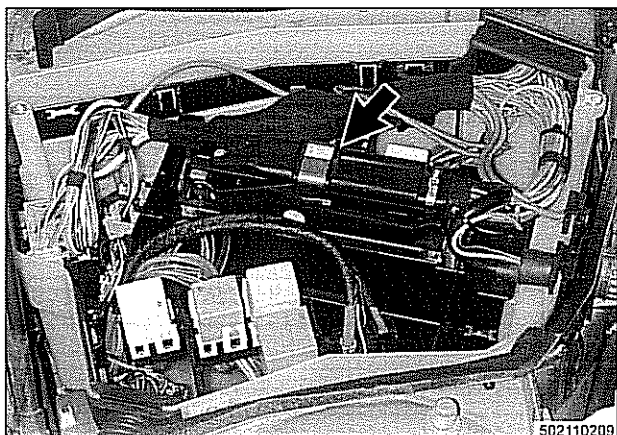
### CAUTION—

Prior to disconnecting the battery, read the battery disconnection cautions in 001 General Warnings and Cautions.



- ▲ Access engine control module (ECM):
  - Release interior ventilation filter cover latch (A) and remove cover.
  - Release plastic locking tab (B).
  - Rotate air duct inward (**arrow**) to unlock from bulk head and remove duct.
  - Release spring lock (C) to remove lower filter housing.
  - Slide filter housing away from inner fender to remove.
- Remove electrical box (E-box) cover fasteners and remove cover.
- If testing ECM or connected components, use breakout box to allow tests to be made with connector attached to ECM. This prevents damage to small terminals in connector.
- As an alternative, harness connector housing can be separated so that electrical checks can be made from back of connector.
- ▲ If replacing ECM, disconnect control module harness connector (**arrow**) by releasing fastener and pivoting connector up and off ECM.





- ◀ Working inside E-box, disconnect ECM harness connector (arrow) by releasing fastener and pivoting connector up and off ECM.

**CAUTION—**

*Be sure ignition is OFF before disconnecting or reconnecting DME system components.*

- Remove ECM from retaining brackets and lift off holder.
- Installation is reverse of removal.
- Before attempting to start engine, use BMW service tester DISplus, MoDiC, GT1 or equivalent:
  - Code replacement ECM with application information (i.e. engine code, transmission type, etc.).
  - Align ECM to EWS (electronic immobilizer).

### Siemens MS 42.0 and MS 43.0 ECM pin assignments

ECM pin assignments are given in **Table c.** For engine management system schematics, see **ELE Electrical Wiring Diagrams.**

**CAUTION—**

- *Always wait at least one minute after turning off the ignition before removing the connector from the ECM. If the connector is removed before this time, residual power in the system relay may damage the ECM.*
- *Always connect or disconnect the control module connector and meter probes with the ignition off.*

When making checks at the ECM itself, a breakout box should be used to allow tests to be made with the connector attached to the ECM. This also prevents damage to the small terminals in the connector. As an alternative, the harness connector housing can be separated so that electrical checks can be made from the back of the connector.

**Table c. Siemens MS 42.0 and MS 43.0 ECM pin assignments**

Pin	Signal	Component/function	Notes
<b>Connector X60001 9-pin black</b>			
1	Output	Terminal 15	Unloader relay terminal 15
2		Not used	
3		Not used	
4	Ground	Ground	Ground point

<b>Fuel Injection</b>
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Table c. Siemens MS 42.0 and MS 43.0 ECM pin assignments (continued)

Pin	Signal	Component/function	Notes
5	Ground	Ground	Ground connector
6	Ground	Ground	Ground connector
7	Input	Terminal 30	B+ terminal
8	Input	Voltage supply	Fuse carrier, engine electronics
9	Input	Voltage supply	Fuse carrier, engine electronics

**Connector X60002 24-pin**

1	Input	Heater, precatlyst oxygen sensor 1	Heated oxygen sensor 1 in front of cat. conv.
2		Not used	
3	Input-output	CAN-Bus signal, low	Transmission control module
4	Input-output	Can-Bus signal, high	Transmission control module
5		Not used	
6	Input-output	Transmit diagnosis line (TXD) data link signal	Transmission control module
7	Input	Heater, post-catalyst oxygen sensor 1, ground	Heated oxygen sensor 1 behind cat. conv.
8		Not used	
9		Not used	
10		Not used	
11		Not used	
12	Input	Signal, 3/2-way valve, running losses (MS 42.0)	3/2 way valve, running losses (MS 42.0)
13	Input	Heater, precatlyst oxygen sensor 2	Heated oxygen sensor 2 in front of cat. conv.
14	Input	Heater, precatlyst oxygen sensor 1	Heated oxygen sensor 1 in front of cat. conv.
15	Input	Heater, precatlyst oxygen sensor 2	Heated oxygen sensor 2 in front of cat. conv.
16	Input	Heater, post-catalyst oxygen sensor 1	Heated oxygen sensor 1 behind cat. conv.
17		Not used	
18	Input	Heater, post-catalyst oxygen sensor 2	Heated oxygen sensor 2 behind cat. conv.
19	Input	Heater, post-catalyst oxygen sensor 2	Heated oxygen sensor 2 behind cat. conv.
20	Ground	Ground, precatlyst oxygen sensor 1	Heated oxygen sensor 1 in front of cat. conv.
21	Ground	Ground, precatlyst oxygen sensor 2	Heated oxygen sensor 2 in front of cat. conv.
22	Ground	Ground, post catalyst oxygen sensor 1	Heated oxygen sensor 1 behind cat. conv.
23	Input	ECM (DME main) relay signal activation	ECM
24	Ground	Ground, post catalyst oxygen sensor 2	Heated oxygen sensor 2 behind cat. conv.

**Connector X60003 52-pin**

1	Input	Signal, mass air flow sensor	Hot film mass air flow sensor
2	Input	Signal, exhaust camshaft sensor	Camshaft position sensor
3		Not used	
4	Output	Throttle valve supply (MS 42.0)	Throttle valve (MS 42)
5	Input	Signal, intake camshaft position sensor	Camshaft position sensor 1

Table c. Siemens MS 42.0 and MS 43.0 ECM pin assignments (continued)

Pin	Signal	Component/function	Notes
6		Not used	
7	Output	Throttle valve supply potentiometer 2	Throttle valve
8	Input	Signal, crankshaft position sensor	Crankshaft position sensor
9	Input	Signal, pedal position sensor 2 (MS 42.0)	Throttle valve (MS 42.0)
10	Input	Signal, throttle position sensor 1	Throttle valve
11		Not used	
12	Input	Feedback signal, engine start	Starter
13	Input	Signal, battery charge indicator lamp	Alternator (generator)
14	Ground	Ground, throttle position sensor (MS 42.0)	Throttle valve (MS 42.0)
15	Ground	Ground, exhaust camshaft sensor 1	Camshaft position sensor I
16	Input	Signal, pedal position sensor 1 (MS 42.0)	Throttle valve (MS 42.0)
17	Ground	Ground, mass air flow sensor	Hot film mass air flow sensor
18	Ground	Ground, intake camshaft sensor 1	Camshaft position sensor I
19	Input	Signal, throttle potentiometer 1	Throttle valve
20	Ground	Ground, throttle position sensor	Throttle valve
21	Ground	Ground, crankshaft position sensor	Crankshaft position sensor
22	Output	Signal, intake air temperature	Intake air temperature sensor
23	Ground	Ground, intake air temperature sensor	Intake air temperature sensor
24	Output	Signal, coolant temperature sensor	Coolant temperature sensor
25	Ground	Ground, coolant temperature sensor	Coolant temperature sensor
26	Input	Signal, oil pressure	Oil pressure switch
27	Output	Signal, engine oil temperature sensor	Oil temperature sensor
28	Ground	Ground, engine oil temperature sensor	Oil temperature sensor
29	Output	Signal, knock sensor	Knock sensor
30	Output	Signal, knock sensor	Knock sensor
31	Output	Signal, knock sensor	Knock sensor
32	Output	Signal, knock sensor	Knock sensor
33	Input	Signal, cylinder 1 fuel injector	Cylinder 1 fuel injector
34	Input	Signal, cylinder 2 fuel injector	Cylinder 2 fuel injector
35	Input	Signal, cylinder 3 fuel injector	Cylinder 3 fuel injector
36	Input	Signal, cylinder 4 fuel injector	Cylinder 4 fuel injector
37	Input	Signal, cylinder 5 fuel injector	Cylinder 5 fuel injector
38	Input	Signal, cylinder 6 fuel injector	Cylinder 6 fuel injector
39	Input	Signal, oil level sensor	Oil level sensor
40	Input	Signal, VANOS inlet valve	VANOS inlet valve
41	Input	Signal, VANOS outlet valve	VANOS outlet valve

<b>Fuel Injection</b>
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Table c. Siemens MS 42.0 and MS 43.0 ECM pin assignments (continued)

Pin	Signal	Component/function	Notes
42	Input	Signal, evaporative emissions valve	Evaporative emissions valve
43	Input	Signal, throttle valve drive	Throttle valve
44	Input	Signal, throttle valve drive	Throttle valve
45	Input	Signal, engine coolant thermostat	Engine coolant thermostat (map controlled)
46	Input	Signal, close idle speed control valve	Idle speed control valve
47	Input	Signal, open idle speed control valve	Idle speed control valve
48	Ground	Signal, shield knock sensor	Shield, knock sensor
49	Input	Signal, resonance valve intake system	Resonance valve intake system
50		Not used	
51		Not used	
52	Input	Signal, secondary air injection pump valve	Secondary air injection valve

**Connector X60004 40-pin**

Pin	Signal	Component/function	Notes
1	Input	Signal, battery charge indicator lamp	Instrument cluster control unit
2	Input	Feedback signal, engine start	Instrument cluster control module
3	Input	Signal, secondary air injection pump	Secondary air injection pump relay
4	Input	Signal, electric cooling fan	Electric (auxiliary) fan motor
5		Not used	
6		Not used	
7		Pedal position sensor (PWG) (MS 43.0)	Pedal position sensor (PWG) (MS 43.0)
8		Signal, pedal position sensor (PWG) (MS 43.0)	Pedal position sensor (PWG) (MS 43.0)
9		Pedal position sensor (PWG) (MS 43.0)	Pedal position sensor (PWG) (MS 43.0)
10	Input	Signal, fuel pump relay 1	Fuel pump relay 1
11	Input	Signal, oil pressure switch	Instrument cluster control module
12		Pedal position sensor (PWG) (MS 43.0)	Pedal position sensor (PWG) (MS 43.0)
13		Signal, pedal position sensor (PWG) (MS 43.0)	Pedal position sensor (PWG) (MS 43.0)
14		Pedal position sensor (PWG) (MS 43.0)	Pedal position sensor (PWG) (MS 43.0)
15		Not used	
16		Not used	
17	Input	Speed signal (MS 42.0 up to 6/2000) (MS 42.0 from 6/2000 and all MS 43.0)	Data link connector OBD II 16 pin connector
18		Not used	
19		Not used	
20	Output	Diagnostic module tank leak (DM-TL) detection (MS 43.0)	Leak detection (DM-TL) (MS 43.0)
21	Input	Signal, oil level sensor	Instrument cluster control module
22	Input	Signal, processed wheel speed, right rear	ABS/ASC module, ABS/DSC module



Table c. Siemens MS 42.0 and MS 43.0 ECM pin assignments (continued)

Pin	Signal	Component/function	Notes
23	Output	Signal, clutch pedal position switch	Clutch pedal position switch
24	Input	Signal, brake light switch	Light switching center control unit
25		Not used	
26	Input	Terminal 15	Fuse F29
27	Output	Voltage supply, multifunction steering wheel	Volute spring
28	Input	Signal, brake light switch	Brake light switch
29	Input	Signal, relay A/C compressor	A/C compressor relay
30		Signal, leakage diagnosis pump (MS 42.0) Signal, diagnostic module (MS 43.0)	Leakage diagnosis pump Leakage detection (MS 43.0)
31		Not used	
32	Input-output	Transmit diagnosis line (TXD) data link signal	Data link connector (MS 42.0) OBD II connector (MS 43.0)
33	Input	Electronic immobilization (EWS)	Electronic immobilizer (EWS) control module
34		Signal, leakage diagnosis pump (LDP) (MS 42.0)	Leakage diagnosis pump (LDP) (MS 42.0)
35		Not used	
36	Input-output	CAN-Bus signal, high	Connector, CAN bus
37	Input-output	CAN-Bus signal, low	Connector, CAN bus
38	Ground	Ground, coolant outlet temperature sensor	Temperature sensor
39	Output	Signal, coolant outlet temperature sensor	Temperature sensor
40		Not used	

**Connector X60005 9-pin**

1	Input	Signal, ignition coil 3	Ignition coil 3
2	Input	Signal, ignition coil 2	Ignition coil 2
3	Input	Signal, ignition coil 1	Ignition coil 1
4		Not used	
5	Ground	Ground	Ground connector
6	Ground	Ground	Ground connector
7	Input	Signal, ignition coil 6	Ignition coil 6
8	Input	Signal, ignition coil 5	Ignition coil 5
9	Input	Signal, ignition coil 4	Ignition coil 4

## BOSCH M5.2 (M62 TO 9/1997) BOSCH M5.2.1 (M62 9/1997 TO 9/1998)

When system faults are detected, a diagnostic trouble code (DTC) is stored in the engine control module (ECM). The MIL also illuminates if an emissions-related fault is detected.

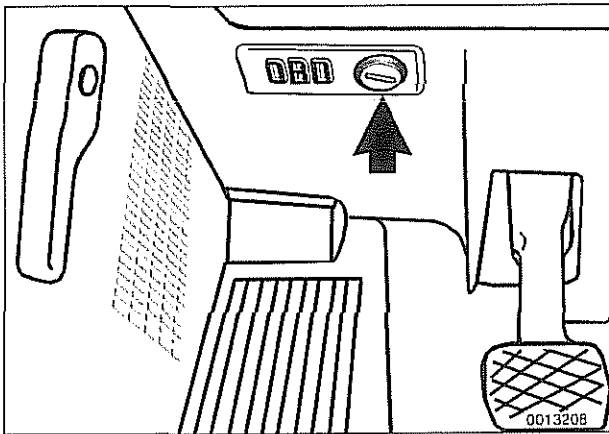
When faults arise, or if the malfunction indicator lamp (MIL) is illuminated, begin troubleshooting by connecting BMW service tester DISplus, MoDiC, GT1 or equivalent scan tool. The capabilities of OBD II software has the potential to save hours of diagnostic time and to help avoid incorrect component replacement and possible damage to system components.

### CAUTION—

- The tests in this section may set fault codes (DTCs) in the ECM and illuminate the MIL. After all testing is completed, access and clear DTC fault memory using an OBD II or BMW compatible scan tool. See **OBD On-Board Diagnostics**.
- Only use a digital multimeter for electrical tests.
- Relay positions can vary. Be sure to confirm relay position by identifying the wiring in the socket using the wiring diagrams found in **ELE Electrical Wiring Diagrams**.

### NOTE—

- OBD II fault memory (including an illuminated MIL) can only be reset using the special scan tool. Removing the connector from the ECM or disconnecting the battery will not erase the fault memory.
- The BMW-dedicated 20-pin diagnostic link connector (DLC) is in the right rear of the engine compartment.
- The 16-pin OBD II diagnostic connector (**arrow**) is located inside the car on the lower left dash panel.



## M5.2 system features

The Bosch M5.2 system used on 1997 540i models uses an 88-pin control unit. The M5.2 system has the following functions and capabilities:

- Fully sequential cylinder-individual fuel injection.
- Integrated adaptive knock control.
- Oxygen sensor fuel mixture control.
- Self-diagnosis and emergency operation characteristics.
- CAN-Bus link.
- OBD II functions (misfire detection, catalytic converter monitoring, oxygen sensor monitor, and fuel tank ventilation system).
- Electronic vehicle immobilization via EWS.
- One-touch starter function.
- Control of characteristic map thermostat.

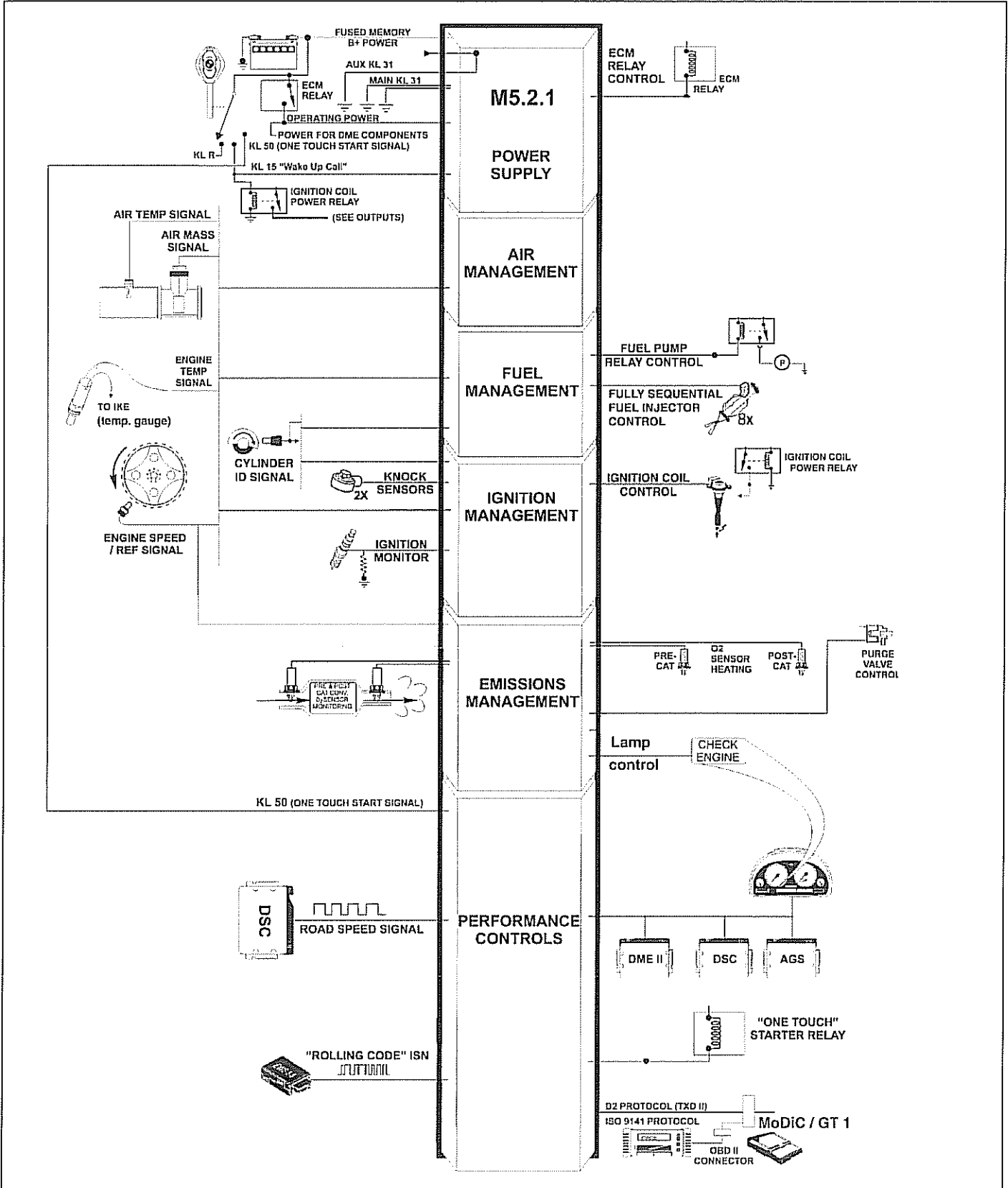
### M5.2.1 system features

The Bosch M5.2.1 system is used on 1998 540i models. The M5.2.1 control module utilizes the SKE (standard shell construction housing) with 5 connectors and a combined total of 134 pins.

The M5.2.1 system has the following functions or capabilities:

- Separate power supply relay for ignition coils.
- Leak diagnosis pump (LDP) control and feedback monitoring for evaporative system leak testing.
- Fuel evaporative system providing ORVR (on-board refueling vapor recovery) compliancy.
- Battery/alternator charge logic (idle speed varied with the battery state of charge).
- CAN-Bus communications with the instrument cluster.
- EWS III "rolling code" ISN interface.
- More sensitive ignition knock sensors.
- Pulse width modulated (P-W-M) Heating and A/C (IHKA) status signal.
- Running loss (3/2-way) solenoid valve.

Fuel Injection



## ECM relay, testing

The engine control module (ECM) relay is energized via the ECM and supplies battery positive (B+) power to many of the engine management components and subsystems. If this relay is faulty, the engine will not start.

### CAUTION—

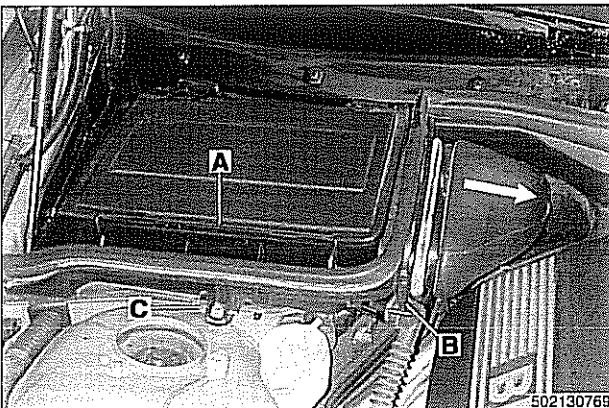
Relay positions can vary. Be sure to confirm relay position by identifying the wiring in the socket using the wiring diagrams in ELE Electrical Wiring Diagrams.

### NOTE—

The ECM relay is also referred to as the DME main relay.

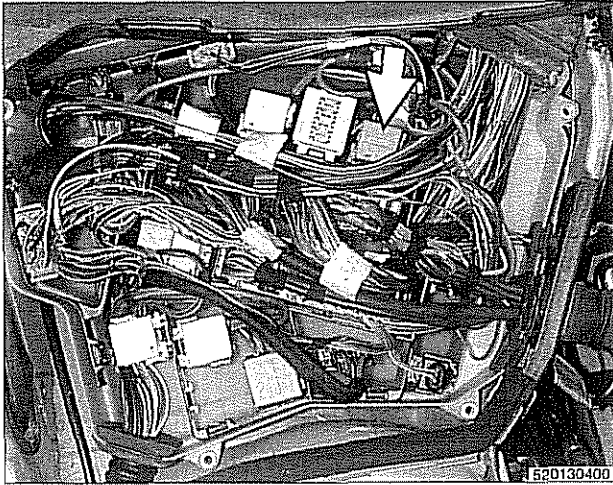
ECM relay powers:

- ECM
- Ignition coils
- Fuel injection
- Evaporative leak detection pump (5.2.1 only)
- Idle air actuator
- Camshaft sensors
- Evaporative emissions valve
- Hot film mass air flow sensor
- Fuel pump relay
- Oxygen sensor heaters



- ◀ Working in right rear of engine compartment:
  - Release interior ventilation filter cover latch (A) and remove cover.
  - Release plastic locking tab (B).
  - Rotate duct inward (arrow) to unlock from bulk head and remove duct.
  - Release spring lock (C) to remove lower filter housing.
  - Slide filter housing away from inner fender to remove.
- Remove electrical box (E-box) cover fasteners and remove cover.

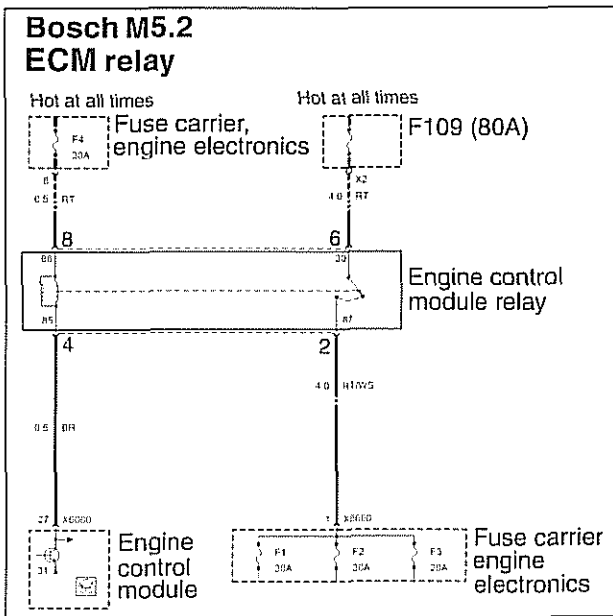
Fuel Injection



➤ With ignition off, remove ECM relay (**arrow**) in electronics box (E-box) at right rear of engine compartment.

**NOTE**—

Relay locations can vary. Confirm relay identification by matching wiring colors and terminal numbers.

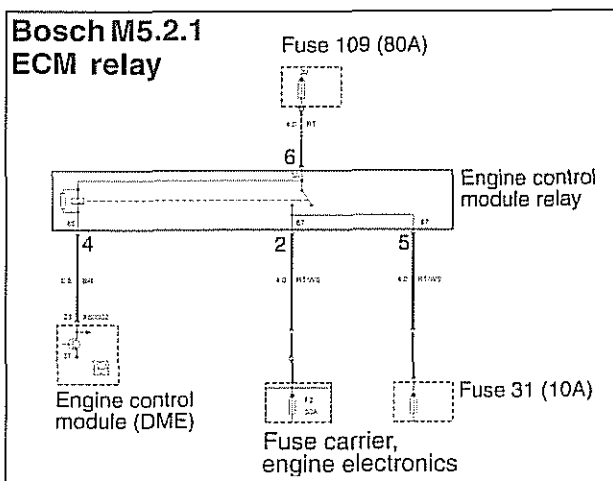


➤ Check for voltage at terminal 6 of main relay socket (30-red wire). On M5.2 cars also check for battery voltage at terminal 8.

- If battery voltage is present, continue testing.
- If battery voltage is not present, check large red wire(s) in relay socket. See **ELE Electrical Wiring Diagrams**.

— Reinstall relay and turn ignition on. Gain access to underside of relay socket and check for ground at terminal 4 (85-brown wire).

- If ground is present, continue testing.
- If ground is not present, signal from ECM is missing. Check wire between ECM and relay.



➤ With ignition on and relay installed, check for battery voltage at terminal 2 (87-red/white wire). On M5.2.1 cars also check for battery voltage at terminal 5.

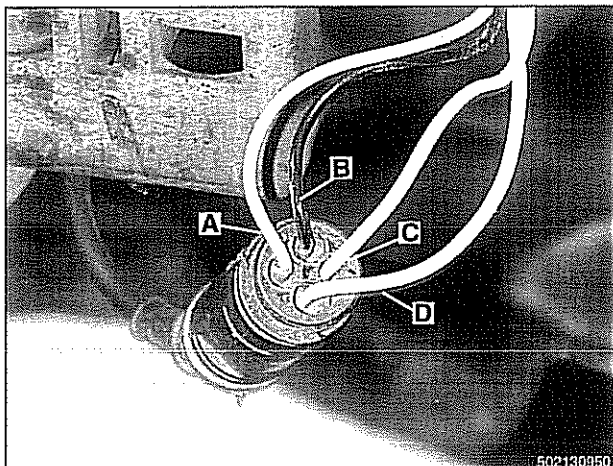
- If battery voltage is present, relay has energized and is functioning correctly.
- If battery voltage is not present and all earlier tests are OK, relay is faulty and should be replaced.

## Oxygen sensors, checking

The oxygen sensor provides an input voltage signal [0.2 vdc (lean) to 0.8 vdc (rich)] to the ECM based on the oxygen content in the exhaust gas. To generate voltage, the sensor temperature must exceed 575° F (300° C). Therefore the sensor is electrically heated.

### NOTE —

- The test given below is not a conclusive test of oxygen sensor efficiency and does not test how the oxygen sensor reacts to changing conditions. Pin numbers and wire colors can vary. Always check the wiring diagrams to confirm wire color and pin assignment.
- The oxygen sensor connector plugs are located next to the catalytic converters.



- ◀ With connector attached to sensor, connect digital voltmeter between **A** and **B** wires in connector.

### WARNING —

Exhaust manifolds and pipes can be hot enough to cause serious burns. Wear suitable heavy gloves and other appropriate protection.

### NOTE —

Connector style may vary depending on system application. Consult wiring diagram for system-specific wiring. See **ELE Electrical Wiring Diagrams**.

- Start engine. A fluctuating voltage signal should show on the meter. If voltage is incorrect, turn engine off and check pre-heater circuit as described below.

Oxygen sensor voltage at idle	0.2 to 0.8 vdc fluctuating
-------------------------------	----------------------------

### NOTE —

To check sensor response to lean and rich mixtures, create an air leak.

- Connect digital voltmeter between sensor heater wires (white wires, **C** and **D**). Start engine and check for battery voltage. If voltage is not present, check oxygen sensor heater fuses.

### NOTE —

The oxygen sensor heater is powered via fused positive (+) battery voltage and a switched ground from the ECM. See **ELE Electrical Wiring Diagrams** for specific circuit information.

- The ground side of the oxygen sensor heater circuit is pulsed on and off by the DME control module.

**NOTE—**

With engine off, disconnect harness connector and check heating element resistance between white wires on the sensor side of harness. If the element is electrically open (no continuity), replace sensor.

- If oxygen sensor does not produce a fluctuating voltage and preheater circuit is OK, replace sensor.

**NOTE—**

If not already applied, coat oxygen sensor threads with anti-seize compound before installation. Do not get the compound on the sensor tip.

**Tightening torque**

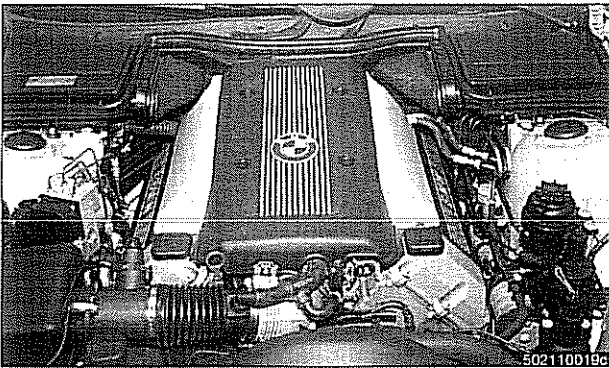
Oxygen sensor to exhaust system	55 Nm (41 ft-lb)
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**Fuel injectors, checking and replacing**

The fuel injectors are switched on and off (opened and closed) by the ECM. The injectors are connected to a common power source. A ground signal from the ECM is used to open and close the injectors.

**CAUTION—**

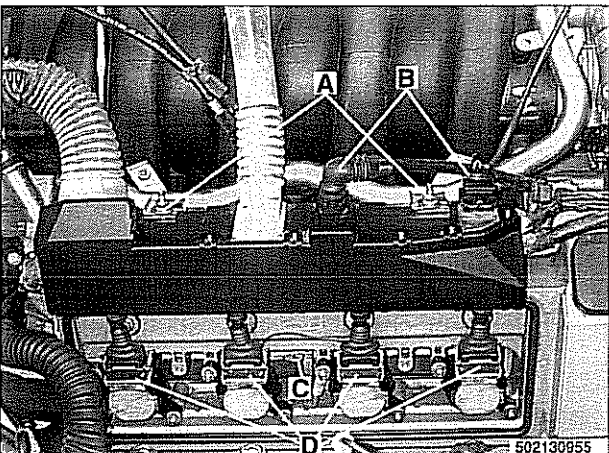
Use only a digital multimeter or an LED injector tester when testing injectors or wiring. Use of an analog VOM or incandescent test light may damage the engine control module.



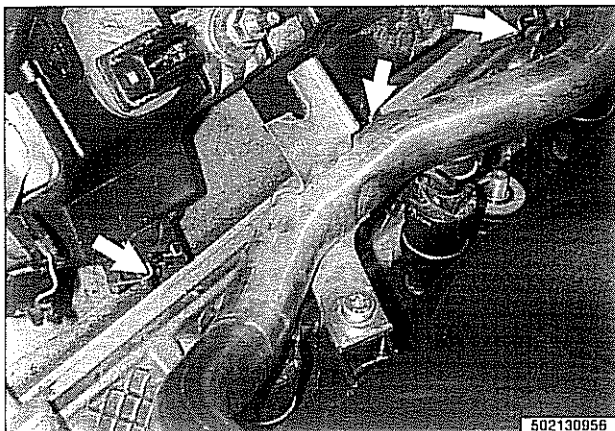
- Remove fuel rail cover. See **110 Engine Removal and installation**.

- With the engine running, place the point of a long screwdriver on each injector and check for a clicking vibration. If no vibration is found do the voltage check shown below.

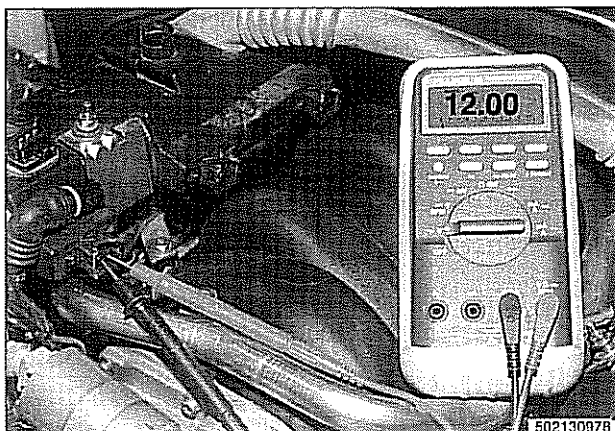
- Injector electrical loom removal:
  - Loosen mounting nuts **A**.
  - Remove ground wire **C**.
  - Disconnect ignition coil harness **D**.







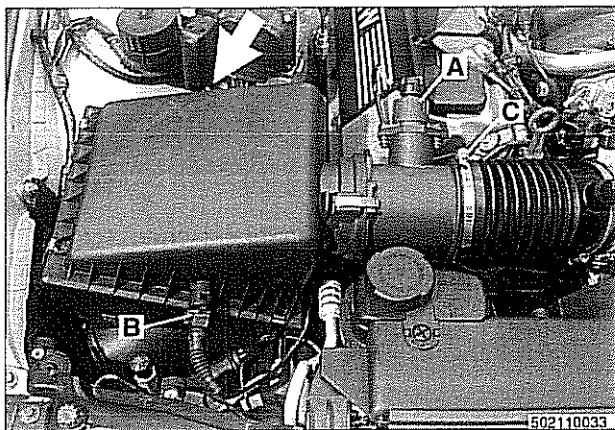
- Release spring clips (**arrows**) from fuel injectors and pull injector electrical loom straight up to remove.



- Check that ECM signal is present at injector connectors.
  - Connect digital voltmeter to fuel injector harness plug.
  - Operate starter and check for voltage pulse.
  - Repeat for each injector.
- Remove fuel injectors by removing retaining clips.
- Installation is reverse of removal:
  - Fit new O-rings when installing injectors. For ease of installation, lightly lubricate all fuel system O-rings with assembly lubricant.
  - Check that injector electrical connections are correctly fitted and that injectors are fully seated prior to installing fuel rail mounting bolts.

### Mass air flow sensor (MAF), replacing

The MAF sensor is provided with operating power from the ECM relay. Based on calculated intake air mass, the MAF generates a varying voltage (approx. 0.5 - 4.5 vdc) as an input signal to the ECM.



- Remove MAF sensor:
  - Remove upper air filter housing locking clips.
  - Unscrew and remove MAF sensor harness (**A**).
  - Disconnect intake air temperature sensor harness (**B**).
  - Loosen hose clamp (**C**).
  - Remove upper filter housing with sensor.
- Installation is reverse of removal.

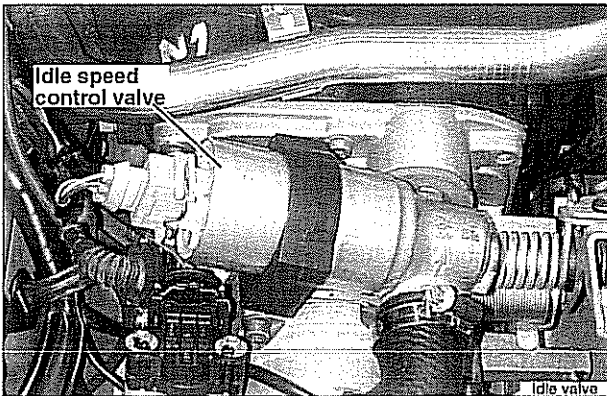
## Idle speed control valve, testing and replacing

Idle speed is maintained by the ECM through the idle speed control valve. The idle control function compensates for engine load and engine operating conditions. Idle speed is adaptive through the ECM and no adjustments can be made.

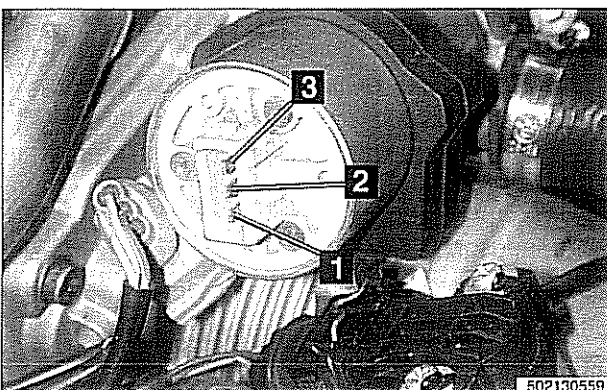
Before checking valve, confirm that throttle position sensor is working correctly.

### NOTE—

*The test given below is an electrical check only. It does not check the mechanical operation of the valve. If the valve is sticking, hanging up or is sluggish in operation, substituting a known good valve is the best way to check it.*



- ◀ With engine running, check that idle speed control valve is buzzing.
  - Turn on A/C or shift car into drive. Idle should remain steady or increase slightly.
  - If valve is not buzzing, or if idle decreases in step above, stop engine and disconnect harness connector from valve.



- ◀ Check resistance of valve across its terminals. Test values are listed below.

### Idle speed control valve coil resistance

Terminals 1 and 2	$20 \pm 2\Omega$
Terminals 2 and 3	$20 \pm 2\Omega$
Terminals 1 and 3	$40 \pm 4\Omega$

### NOTE—

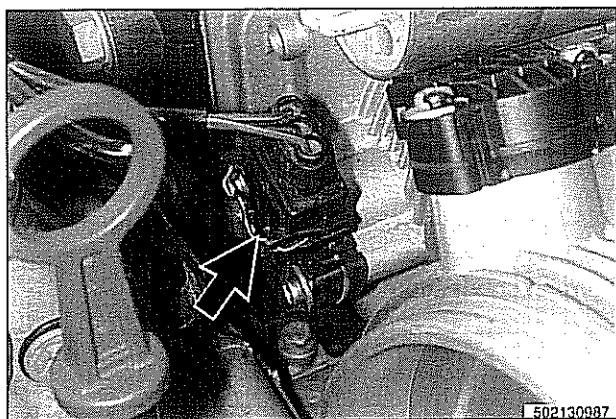
*If you suspect an intermittent fault, lightly tap the valve while testing resistance.*

With valve harness connector disconnected, check for battery voltage at red/white wire in connector with ignition on. If there is no voltage, check wiring between connector and ECM relay. See **ELE Electrical Wiring Diagrams**.

### NOTE—

*The idle speed control valve receives positive (+) battery voltage from the ECM (DME main) relay.*

- If voltage is present as described above, check wiring between ECM and valve. If no wiring faults are found, check ECM signal to valve.
- When replacing idle speed control valve, clean and inspect all sealing areas.
  - Inspect sealing ring in throttle body and replace if necessary.



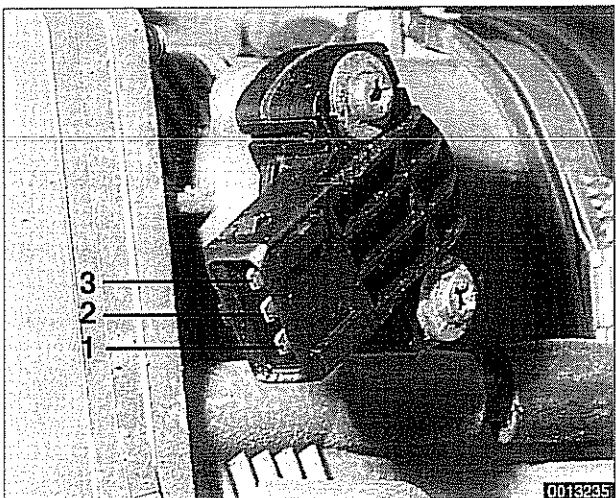
### Throttle position sensor (TPS), testing and replacing

- The throttle position sensor (arrow) is mounted on the side of the primary throttle housing and is directly connected to the throttle valve shaft. The ECM sends a voltage signal to the potentiometer-type sensor and monitors the voltage that comes back. Resistance decreases (voltage increases) as the throttle opens.

#### NOTE—

Do not confuse the TPS on the primary throttle housing with the throttle switch on the ASC secondary throttle housing.

- Check throttle position sensor function by disconnecting harness connector and checking across terminals. If any faults are found, replace throttle position sensor.



#### Throttle position sensor (M62 engine)

Test conditions	Test Terminal	Test value
Harness connector disconnected, ignition on	Term. 1 at harness connector and ground	5 vdc (approx.)
Harness connector disconnected, ignition on	Term. 1 and term. 3 at sensor	4.0 k $\Omega$ (approx.)
Throttle plate rotated from idle to full throttle position	Term. 1 and term. 2 at sensor	Continuously variable from 1.0 to 4.0 k $\Omega$ without interruption

### Engine coolant temperature (ECT) sensor, testing and replacing

The ECT sensor is located on the front of the engine in the coolant/thermostat flange. The ECT sensor is a dual temperature sensor. One circuit provides coolant temperature information to the ECM while the other circuit provides coolant temperature information to the instrument cluster.

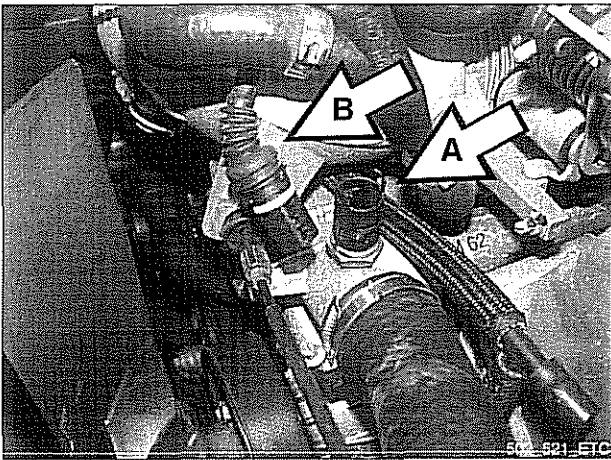
The ECM determines the correct ignition timing and air/fuel mixture required for the engine by monitoring an applied voltage (5 vdc) to the sensor. The voltage drop across the sensor

varies as the coolant temperature (sensor resistance) changes.

**NOTE—**

The ECT sensor is an NTC (negative temperature coefficient) type sensor. In other words, as the temperature rises, resistance through the sensor decreases.

If the ETC sensor input is faulty or non-plausible, the MIL is illuminated when OBD II fault criteria are exceeded. The ECM assumes a substitute value (80° C / 176°F) to maintain engine operation. The ignition timing is set to a conservative/safe basic setting.



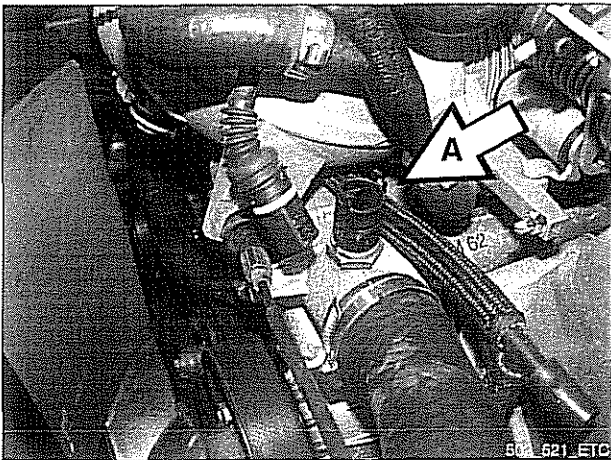
⚡ Disconnect ECT sensor harness (A).

- Check ECT sensor resistance using a multimeter at sensor terminals 3 and 4. Peel back protective boot (B) to ID terminal numbers on connector housing.

ECT sensor resistance @ 20° C (68°F)	2.2 - 2.7 kΩ
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**WARNING—**

Due to risk of personal injury, be sure the engine is cold before disconnecting ECT harness connector.

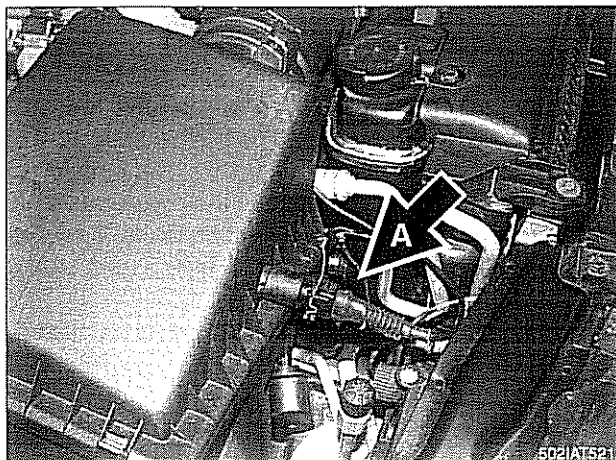


⚡ Sensor replacement: Disconnect ECT sensor harness (A).

- Unscrew ECT sensor from cylinder head and install new sensor.
  - Use new copper sealing washers when installing sensor.
  - Replace any lost coolant.

**Tightening torque**

ECT sensor to coolant flange	13 Nm (10 ft-lb)
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### Intake air temperature (IAT) sensor, testing and replacing

- Disconnect harness connector from intake air temperature sensor (A) at air filter housing.
- Turn ignition on. Using a digital voltmeter, check for 5 volts between supply voltage wire in connector and ground. If voltage is not present, test ECM inputs/outputs as described later.
- With harness connector disconnected, test resistance across sensor terminals. If any faults are found, replace IAT sensor.

#### IAT test resistance

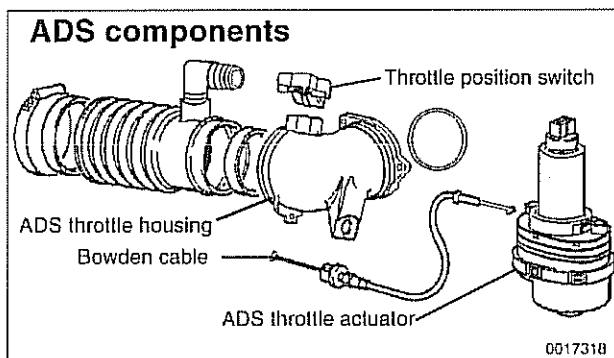
@ 10° ±1°C (50° ±2°F)	7-11.6 kΩ
@ 20° ±1°C (68° ±2°F)	2.1-2.9 kΩ
@ 80° ±1°C (176° ±2°F)	0.27-0.40 kΩ

### Auxiliary throttle valve (ADS) (M62 and M62 TU engine), replacing

- 540i models with ASC and DSC are fitted with a motor-driven auxiliary throttle valve and housing ahead of the standard throttle housing. The ADS throttle valve controls engine throttle intervention based on signals from the DME control module if road conditions, such as slipping driven wheel, warrant reduced engine power.

#### NOTE—

Before replacing the ADS throttle housing, read DME fault codes.



- ADS throttle housing replacement:
  - Switch off ignition and disconnect electrical connector on ADS throttle body.
  - Remove hose from idle control valve.
  - Loosen hose clamps and remove throttle housing air intake boot.
  - Disconnect cable from ADS throttle body.
  - Unscrew 3 bolts and remove ADS throttle body.
  - Installation is reverse of removal.
  - Adjust cable so that no free play is present.

## Evaporative fuel system pressure leak diagnosis, overview (M5.2.1 only)

1998 540i models are equipped with an evaporative fuel system pressure leak diagnosis system. The main component of this system is the leak diagnosis pump (LDP). The function of the LDP is to pressurize the fuel tank and the evaporative emission system for the purpose of detecting leaks. This system is capable of detecting a leak as small as 0.5 mm.

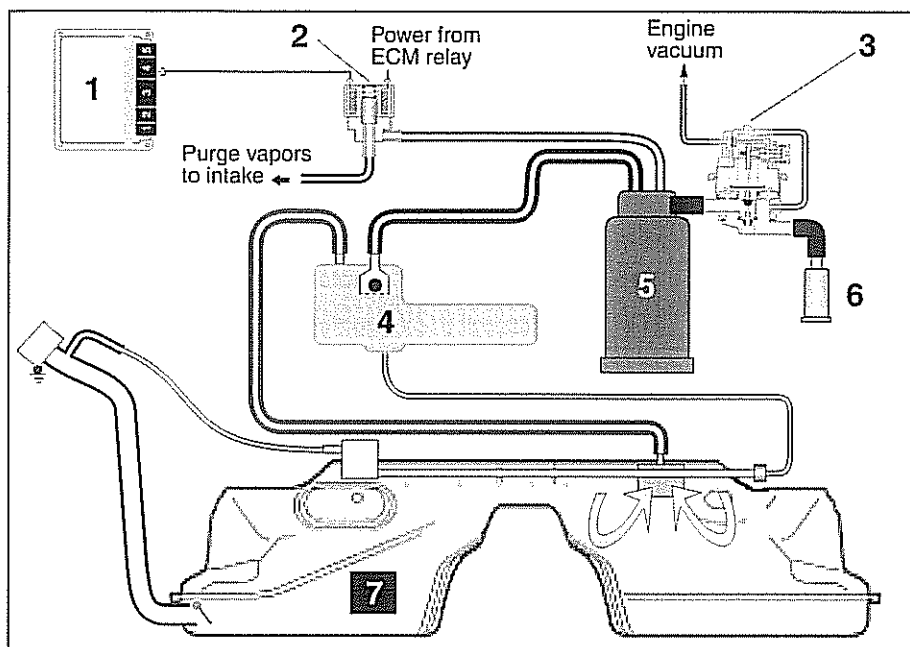
The LDP, located in the left rear wheel housing, is a unitized component that contains the following:

- Vacuum chamber.
- Pneumatic pump chamber.
- DME activated vacuum solenoid.
- Reed switch (provides switched voltage feedback signal to ECM).

The vacuum supply line is in the wiring harness from the engine compartment and runs down the driver's side of the vehicle.

The canister vent valve is integrated into the LDP, which is electrically controlled by the ECM. The canister vent valve is opened to provide fresh air entry into the fuel system only during purge operation.

- Purge operation characteristics:
  - Off idle through full throttle: purge valve opened by pulse width modulated (PWM) control of the ECM. PWM duty cycle varies by engine operating conditions (e.g. warm idle, purge valve opened slightly; cold idle/decel with engine temp < 67° C, purge valve always closed).



### Evaporative emissions control diagram (M5.2.1)

1. ECM
2. Purge valve
3. Leak detection pump (LDP)
4. Liquid vapor separator
5. Purge canister
6. Filter
7. Fuel tank

### Bosch M5.2 ECM pin assignments (M62 up to 9/1997)

Table d. Bosch M5.2 ECM pin assignments

Pin	Type	Component/function	Note
1	output	Oxygen sensor heater signal	DME heated oxygen sensor 1 splice
2	output	Idle speed control - closing winding	Idle speed control valve (cycled ground)
3	output	Cyl. 1 fuel injection valve	Cyl. 1 fuel injection valve (cycled ground)
4	output	Cyl. 4 fuel injection valve	Cyl. 4 fuel injection valve (cycled ground)
5	output	Cyl. 5 fuel injection valve	Cyl. 5 fuel injection valve (cycled ground)
6	ground	Fuel injection valve ground	Ground
7	output	Cyl. 6 fuel injection valve	Cyl. 6 fuel injection valve (cycled ground)
8	output	Malfunction indicator light (MIL) (USA only)	Illuminated for exhaust gas related diagnostic trouble code
9	input	Start signal	Starter relay
10	input	Electronic immobilizer (EWS)	Electronic immobilizer (EWS) control unit
11	output	A/C compressor signal	Heating and A/C control module
12	input	Terminal 50 signal	Ignition switch
13	input	Knock sensor signal	Knock sensor
14		Not used	
15		Not used	
16	output	Intake air temperature	Intake air temperature sensor (voltage value)
17	ground	Hot film mass air flow (MAF) sensor ground	Hot film mass air flow (MAF) sensor ground
18	input	Heated oxygen sensor signal	Heated oxygen sensor II in front of catalytic converter (0.1-1.0 V with engine running at operating temperature)
19	input	Heated oxygen sensor signal	Heated oxygen sensor I in front of catalytic converter (0.1-1.0 V with engine running at operating temperature)

<b>Fuel Injection</b>
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Table d. Bosch M5.2 ECM pin assignments

Pin	Type	Component/function	Note
20	output	Crankshaft position sensor (speed and position)	Crankshaft position/rpm sensor
21	output	Camshaft position sensor (cylinder reference)	Hall effect camshaft position sensor
22	output	Cyl. 6 ignition signal (primary signal)	Cyl. 6 ignition coil (RZV adapter)
23	output	Cyl. 3 ignition signal (primary signal)	Cyl. 3 ignition coil (RZV adapter)
24	output	Cyl. 7 ignition signal (primary signal)	Cyl. 7 ignition coil (RZV adapter)
25	output	Cyl. 2 ignition signal (primary signal)	Cyl. 2 ignition coil (RZV adapter)
26	input	Terminal 30	Fuse carrier, engine electronics
27	output	Engine control module relay	Engine control module relay
28	ground	Ground for electronics and sensor shield	Ground splice
29	output	Idle speed control - opening winding	Idle speed control valve (cycled ground)
30	output	Oxygen sensor heater signal	Heated oxygen sensor I in front of catalytic converter, Heated oxygen sensor II in front of catalytic converter
31	output	Cyl. 5 fuel injection valve	Cyl. 5 fuel injection valve (cycled ground)
32	output	Cyl. 8 fuel injection valve	Cyl. 8 fuel injection valve (cycled ground)
33	output	Cyl. 3 fuel injection valve	Cyl. 3 fuel injection valve (cycled ground)
34	ground	Remaining output stages ground (not ignition and fuel injection valves)	Ground point
35	output	Cyl. 2 fuel injection valve	Cyl. 2 fuel injection valve (cycled ground)
36	output	A/C compressor relay signal	Heating and A/C control module (ground - compressor OFF)
37		Not used	
38		Not used	
39		Not used	
40	input	Knock sensor signal	Knock sensor
41	input	Knock sensor signal	Knock sensor
42	input	Fuel reserve signal	Instrument cluster
43		Not used	
44	input	Throttle position sensor signal (0.4-4.2 V)	Throttle position sensor
45	output	Hot film mass air flow sensor signal (0-5 V)	Hot film mass air flow sensor
46	ground	Heated oxygen sensor signal (voltage 0.1-1.0 V)	Oxygen sensors
47		Not used	
48		Not used	
49	output	Cyl. 1 ignition signal (primary signal)	Cyl. 1 ignition coil (RZV adapter)
50	output	Cyl. 5 ignition signal (primary signal)	Cyl. 5 ignition coil (RZV adapter)
51	output	Cyl. 4 ignition signal (primary signal)	Cyl. 4 ignition coil (RZV adapter)
52	output	Cyl. 8 ignition signal (primary signal)	Cyl. 8 ignition coil (RZV adapter)
53	output	Throttle position sensor (+ 5 V voltage supply)	Throttle position sensor
54	input	Terminal 87 (> 10 V)	Fuse F1
55	ground	Ignition ground	Ground point
56	input	Terminal 15 (> 10 V)	Ignition switch



Table d. Bosch M5.2 ECM pin assignments

Pin	Type	Component/function	Note
57		Not used	
58		Not used	
59	input	Heated thermostat (characteristic map, cooling)	Characteristic map, cooling
60	input	Programming voltage input (voltage value)	Data link connector
61	input	Signal input Evaporative emission valve	Evaporative emission valve
62		Not used	
63	input	Fuel pump relay (ground)	Fuel pump relay
64		Not used	
65		Not used	
66		Not used	
67		Not used	
68		Not used	
69	input	A/C system standby signal (> 10 V)	Heating and A/C control module
70	input	Knock sensor signal	Knock sensor
71	ground	Control module ground	Ground splice
72		Not used	
73		Not used	
74	input	Coolant temperature	Dual temperature switch
75		Not used	
76	input	Heated oxygen sensor signal (voltage 0.1-1.0 V)	Heated oxygen sensor II behind catalytic converter
77	input	Heated oxygen sensor signal (voltage 0.1-1.0 V)	Heated oxygen sensor I behind catalytic converter
78	input	Crankshaft position sensor signal (speed and position, AC voltage)	Crankshaft position/rpm sensor
79	input	Right rear wheel speed signal	ABS/ASC control module
80	output	TD signal (engine speed)	TD signal splice
81		Not used	
82		Not used	
83	output	Injection signal	Integrated instrument cluster control module (IKE)
84		Not used	
85	input-output	CAN-Bus low	Transmission control module (AGS)
86	input-output	CAN-Bus high	Transmission control module (AGS)
87		Not used	
88	input-output	Data link TxD	Data link connector

<b>Fuel Injection</b>
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### Bosch M5.2.1 ECM pin assignments (M62 from 9/1997 to 9/1998)

Table e. Bosch 5.2.1 ECM pin assignments

Pin	Signal	Description	Note
<b>Connector X60001</b>			
1		Not used	
2		Not used	
3		Not used	
4	Ground	Ground	Ground point right-hand drive Ground connector X6460
5		Not used	
6	Ground	Ground	Ground point right-hand drive Ground connector X6460
7	Input	Terminal 30 voltage supply	Fuse F4
8	Input	Terminal 87	Fuse F1
9		Not used	
<b>Connector X60002</b>			
1	Output	Oxygen sensor heater signal	Heater oxygen sensor II behind catalytic converter
2	Input	Not used	Back up light switch
3	Input Output	CAN-Bus low	Transmission control module (AGS)
4	Input Output	CAN-Bus high	Transmission control module (AGS)
5	Ground	Ground	Ground connector X6480
6		Not used	
7	Output	Oxygen sensor heater signal	Heater oxygen sensor I behind catalytic converter
8	Ground	Oxygen sensor heater ground	Heater oxygen sensor II behind catalytic converter
9	Ground	Oxygen sensor heater ground	Heater oxygen sensor I in front of catalytic converter
10	Ground	Oxygen sensor heater ground	Heater oxygen sensor II in front of catalytic converter
11	Ground	Oxygen sensor heater ground	Heater oxygen sensor I behind catalytic converter
12		Not used	
13	Output	Oxygen sensor heater ground	Heater oxygen sensor II in front of catalytic converter
14	Input	Oxygen sensor heater ground	Heater oxygen sensor II behind catalytic converter
15	Input	Oxygen sensor heater ground	Heater oxygen sensor I in front of catalytic converter
16	Input	Oxygen sensor heater ground	Heater oxygen sensor II in front of catalytic converter
17	Input	Oxygen sensor heater ground	Heater oxygen sensor I behind catalytic converter
18	Output	Signal, running losses	Fuel changeover (3/2 way valve) circuit
19	Output	Oxygen sensor heater ground	Heater oxygen sensor I in front of catalytic converter
20		Not used	
21		Not used	
22		Not used	
23	Output	Terminal 85 control	Engine control module relay
24		Not used	

Table e. Bosch 5.2.1 ECM pin assignments

Pin	Signal	Description	Note
<b>Connector X60003</b>			
1	Output	Injection signal	
2	Output	Injection signal	
3	Output	Signal, evaporative emission valve	Evaporative emission valve
4		Not used	
5		Not used	
6	Ground	Ground for electronic components	Ground point right-hand drive Ground connector X6460
7		Not used	
8		Not used	
9	Ground	Hot film mass air flow sensor ground	Hot film mass air flow sensor
10	Output	Throttle position sensor voltage supply	Throttle position sensor
11	Output	Signal, secondary air injection pump valve	Secondary air injection pump valve
12	Input	Terminal 30 voltage supply	Starter
13	Input	Alternator D+ (terminal 61) signal	Alternator (generator)
14		Injection signal	Cylinder 7 fuel injection valve
15		Injection signal	Cylinder 6 fuel injection valve
16		Not used	
17		Not used	
18		Not used	
19		Not used	
20	Input	Camshaft position sensor signal	Camshaft position sensor (Hall effect)
21	Ground	Ground	Dual temperature switch
22	Input	Signal, engine coolant temperature sensor	Dual temperature switch
23	Input	Hot film mass air flow sensor signal	Hot film mass air flow sensor
24	Input	Throttle position sensor slider voltage	Throttle position sensor
25	Ground	Shield, throttle potentiometer (DK)	Throttle position sensor
26		Not used	
27	Output	Injection signal	Cylinder 8 fuel injection valve
28	Output	Injection signal	Cylinder 5 fuel injection valve
29		Not used	
30		Not used	
31	Output	Signal, cooling characteristic map	Characteristic map, cooling
32	Input	Crankshaft position sensor signal	Crankshaft position/rpm sensor
33		Not used	
34	Input	Intake air temperature	Intake air temperature sensor
35	Ground	Shield, knock sensor	Knock sensor
36	Input	Signal, sensor 2	Knock sensor
37	Input	Signal, sensor 4	Knock sensor

<b>Fuel Injection</b>
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Table e. Bosch 5.2.1 ECM pin assignments

Pin	Signal	Description	Note
38	Ground	Shield, knock sensor	Knock sensor
39	Input	Oil level - thermal	Oil level sensor
40	Output	Injection signal	Cylinder 4 fuel injector valve
41	Output	Injection signal	Cylinder 1 fuel injector valve
42	Output	Idle speed control - opening winding	Idle speed control valve
43	Output	Idle speed control - closing winding	Idle speed control valve
44		Not used	
45	Ground	Ground	Shield, crankshaft sensor
46	Input	Crankshaft position sensor	Crankshaft position/rpm sensor
47	Ground	Ground	Intake air temperature sensor
48	Ground	Shield, knock sensor	Knock sensor
49	Input	Shield, sensor 1	Knock sensor
50	Ground	Shield, sensor 3	Knock sensor
51	Ground	Shield, knock sensor	Knock sensor
52		Not used	

**Connector X60004**

1	Output	Alt. charge indicator signal, terminal 61	Instrument cluster
2	Input	Terminal 30 voltage supply	Integrated instrument cluster control module (IKE)
3		Not used	
4		Not used	
5		Not used	
6	Input	Start signal terminal 50	Ignition switch
7		Not used	
8		Not used	
9		Not used	
10	Output	Activation of relay for fuel pump	Fuel pump relay
11		Not used	
12		Not used	
13		Not used	
14		Not used	
15		Not used	
16		Not used	
17	Output	Engine speed signal output (TD)	Cruise control module (Tempomat)
18		Not used	
19		Not used	
20	Output	CARB signal	Data link connector
21	Output	Washer fluid level, brake fluid level	Light module
22	Input	Right rear wheel speed signal	ABS/ASC or ABS/DSC control module
23		Not used	

Table e. Bosch 5.2.1 ECM pin assignments

Pin	Signal	Description	Note
24		Not used	
25		Not used	
26	Input	Voltage supply, terminal 15	Fuse F14
27		Not used	
28		Not used	
29	Input	Compressor ON signal from engine control module (DME)	Heating and A/C control module
30	Ground	Ground	Leakage diagnosis pump
31		Not used	
32	Output	Diagnosis signal TXD	Data link connector
33	Input- output	Communication link (EWS)	Electronic immobilizer (EWS)
34	Output	Signal, leak diagnosis pump	Leakage diagnosis pump (LDP)
35		Not used	
36	Input- output	CAN-Bus high	CAN link
37	Input- output	CAN-Bus low	CAN link
38		Not used	
39		Not used	
40	Output	Start signal	Starter relay
<b>Connector X60005</b>			
1	Output	Terminal 1 signal	Cylinder 7 ignition coil
2	Output	Terminal 1 signal	Cylinder 8 ignition coil
3	Output	Terminal 1 signal	Cylinder 2 ignition coil
4	Output	Terminal 1 signal	Cylinder 3 ignition coil
5	Ground	Ground	Ground point
6	Output	Terminal 1 signal	Cylinder 1 ignition coil
7	Output	Terminal 1 signal	Cylinder 4 ignition coil
8	Output	Terminal 1 signal	Cylinder 5 ignition coil
9	Output	Terminal 1 signal	Cylinder 6 ignition coil

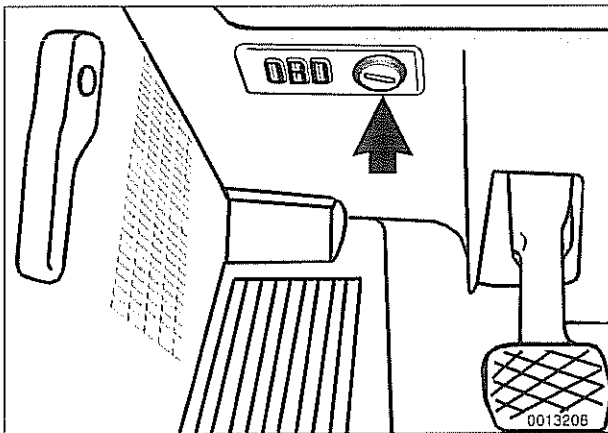
## BOSCH ME 7.2

When system faults are detected, a diagnostic trouble code (DTC) is stored in the engine control module (ECM). The MIL also illuminates if an emissions-related fault is detected.

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.

### CAUTION—

- The tests in this section may set fault codes (DTCs) in the ECM and illuminate the MIL. After all testing is completed, access and clear DTC fault memory using an OBD II or BMW compatible scan tool. See **OBD On-Board Diagnostics**.
- Only use a digital multimeter for electrical tests.
- Relay positions can vary. Be sure to confirm relay position by identifying the wiring in the socket using the wiring diagrams found in **ELE Electrical Wiring Diagrams**.



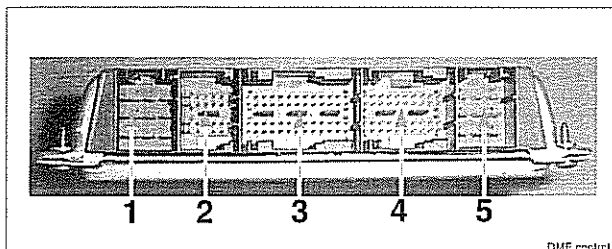
### NOTE—

- OBD II fault memory (including an illuminated MIL) can only be reset using the special scan tool. Removing the connector from the ECM or disconnecting the battery will not erase the fault memory.
- The BMW-dedicated 20-pin diagnostic link connector (DLC) is in the right rear of the engine compartment. The 20-pin DLC was eliminated on models after 6/2000.
- The 16-pin OBD II diagnostic connector (**arrow**) is located inside the car on the lower left dash panel.

## ME 7.2 system overview

The Bosch ME 7.2 system is used on 1999 - 2002 540i models.

➤ The ME 7.2 engine control module (ECM), located on the right side of the engine compartment in the E-box, utilizes the SKE (standard shell housing) construction with 5 connectors and a combined total of 134 pins.



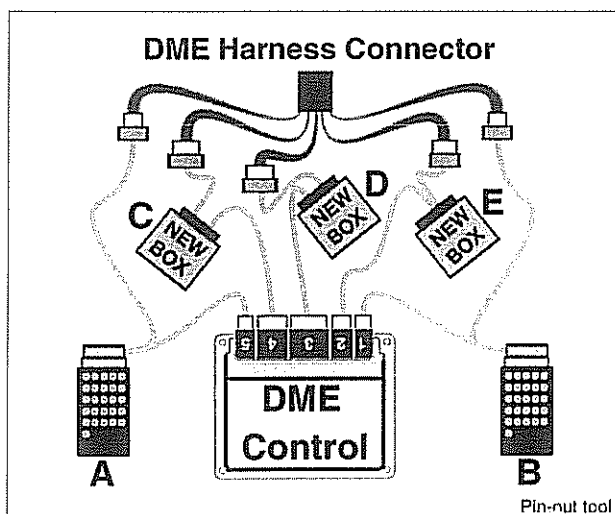
1. 9 pin connector
2. 24 pin connector
3. 52 pin connector
4. 40 pin connector
5. 9 pin connector

The ME 7.2 system has the following functions or capabilities:

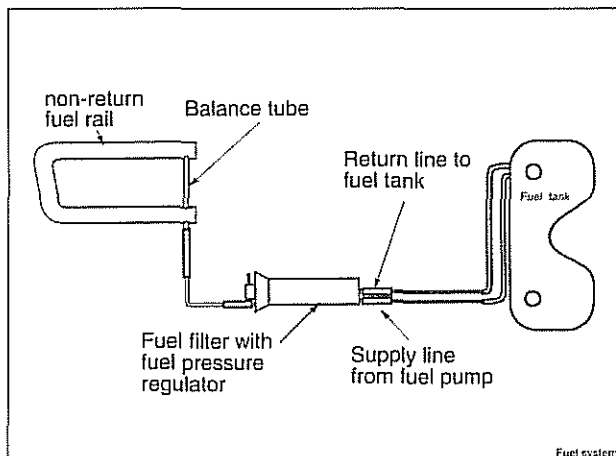
- Electronic throttle control (EDK) integrates idle and cruise control functions. ECM carries out all throttle and idle control functions directly via EDK system.
- Leak diagnosis pump (LDP) control and feedback monitoring for evaporative system leak testing.
- Battery/alternator charge logic (idle speed varies with battery state of charge).
- CAN-Bus communications with instrument cluster.
- EWS III (3.3) "rolling code" ISN interface.
- Ignition knock sensors.
- DSC (dynamic stability control) torque reduction.
- Monitoring and control of VANOS (camshaft timing) with active Hall sensor for camshaft position monitoring.
- Integrated altitude sensor.
- One touch engine start control.
- Single speed secondary air injection system.
- Electrically heated (characteristic map) cooling system thermostat.
- Long life spark plugs.
- IHKA auxiliary (electric) cooling fan control.

All emissions-related ME 7.2 electrical components are monitored for faults. If driveability complaints are encountered or the malfunction indicator light (MIL) is illuminated, interrogate fault memory using a compatible scan tool.

➤ Use a break-out box for ME 7.2 system testing and diagnosis at the control module (break out box set: BMW special tool 90 88 6 121 300).



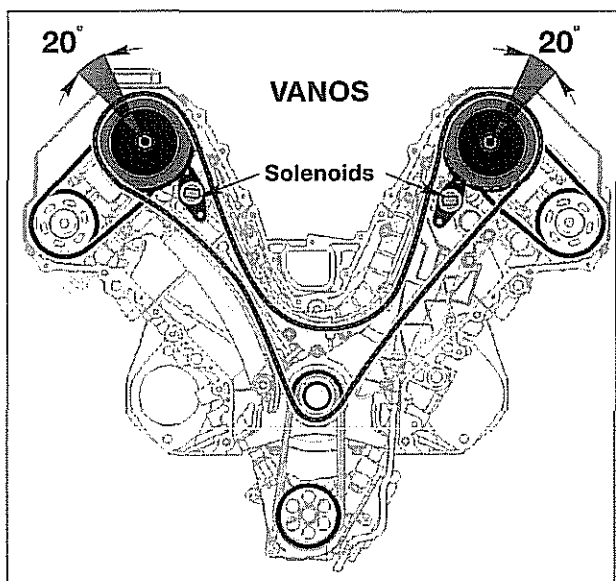
## Fuel Injection



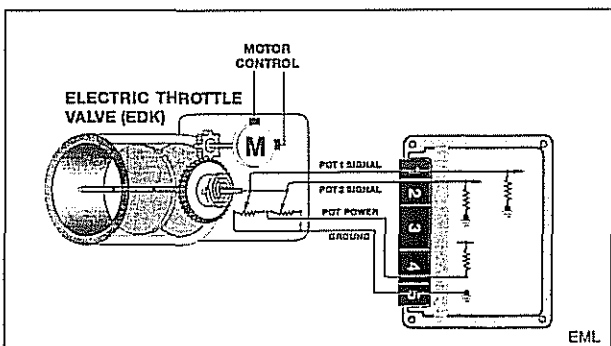
- ▶ The ME 7.2 uses a non-return fuel rail. The fuel pressure regulator is integrated into the fuel filter.

### NOTE—

The fuel filter is available as a replacement part without the fuel pressure regulator. When replacing the fuel filter, transfer the fuel pressure regulator from the old filter to the new filter.



- ▶ The M62 TU engine uses a continuously variable VANOS system at each intake camshaft. This system enhances engine performance and reduces tailpipe emissions. Both camshafts are adjusted simultaneously within 20° (maximum) of the camshafts rotational axis. This equates to a maximum span of 40° crankshaft rotation.

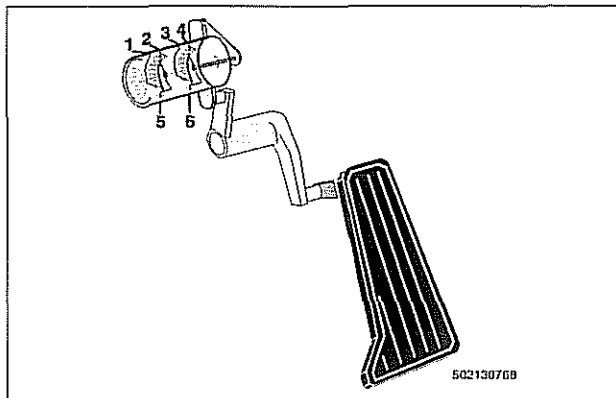


- ▶ The M62 TU engine uses an electrically controlled throttle valve called EDK. The throttle plate is positioned by a DC gear reduction motor based on inputs signals to the ECM from the pedal position sensor (PWG).

When the accelerator pedal is moved, the PWG provides a change in the monitored signals. The ME 7.2 control module compares the input signal to a programmed map and appropriately activates the EDK motor via proportional pulse width modulated control signals. The control module self-checks its activation of the EDK motor via the EDK feedback potentiometers.

Engine idle speed control is a function of the EDK. The M62 TU engine does not use a separate idle control valve.





◀ The PWG potentiometers provide DC voltage signals as input to the ME 7.2 control module for throttle and idle control functions. Potentiometer signal 1 is the primary signal, potentiometer 2 is used for a plausibility cross-check.

1. Potentiometer 1 ground
2. Potentiometer 1 power
3. Potentiometer 2 ground
4. Potentiometer 2 power
5. Potentiometer 1 signal to ECM
6. Potentiometer 2 signal to ECM

If errors are detected between potentiometer 1 and 2, the ECM calculates the engine intake air mass (from MAF sensor signal) and only utilizes the potentiometer signal that closely matches the detected intake air mass. The ECM control module uses the air mass signal for a comparative source to provide fail-safe operation. If the ECM cannot calculate a plausible conclusion from the monitored potentiometer the EDK motor is switched off and fuel injection cut-out is activated (no fail-safe operation possible).

EDK is continuously monitored during all phases of engine operation. If faults are detected, the EDK motor is switched off and fuel injection cut off is activated. The engine continues to run extremely roughly at idle speed.

### EDK adaptation

When the EDK throttle assembly is replaced, the adaptation values of the previous EDK must be cleared from the ME 7.2 ECM using the BMW service tester or an equivalent scan tool. Once the old adaptation values have been cleared, the new EDK assembly should be installed and adapted as follows:

- Switch ignition OFF for 10 seconds.
- Switch ignition ON. After approximately 30 seconds, the EDK is briefly activated indicating that the replacement unit is now adapted to the ME 7.2 system.

#### NOTE—

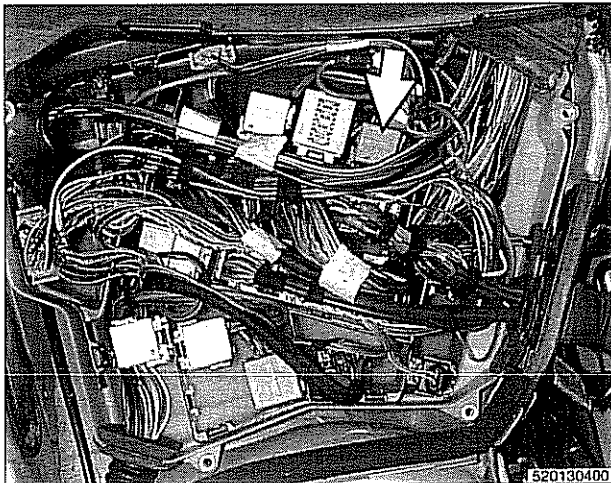
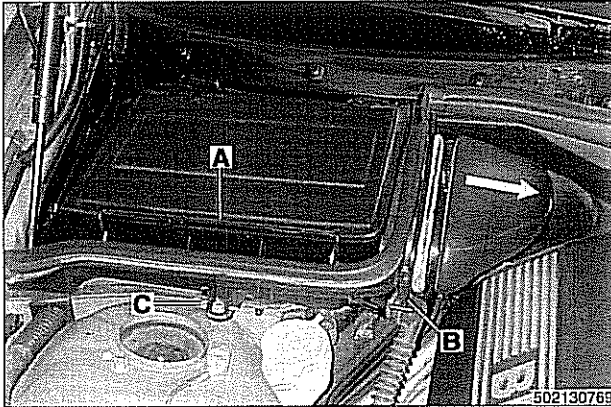
*This EDK adaptation procedure is also necessary after replacing the ME 7.2 engine control module. However, the adaptation values do not require clearing since they have not yet been established.*

### ECM relay, testing

The engine control module (ECM) relay is energized via the ECM and supplies battery positive (B+) power to many of the engine management components and subsystems. If this relay is faulty, the engine will not start.

#### NOTE—

*The ECM relay is also referred to as the DME main relay.*

**CAUTION—**

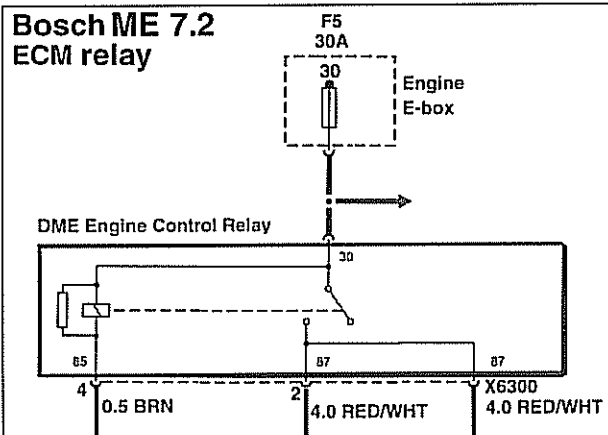
Relay positions can vary. Be sure to confirm relay position by identifying the wiring in the socket using the wiring diagrams in **ELE Electrical Wiring Diagrams**.

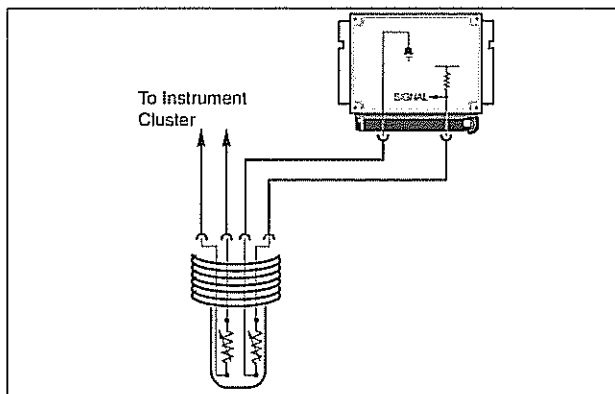
- Working in right rear of engine compartment:
  - Release interior ventilation filter cover latch (A) and remove cover.
  - Release plastic locking tab (B).
  - Rotate duct inward (arrow) to unlock from bulk head and remove duct.
  - Release spring lock (C) to remove lower filter housing.
  - Slide filter housing away from inner fender to remove.
- Remove electrical box (E-box) cover fasteners and remove cover.
- With ignition off, remove main relay (arrow) in electronics box (E-box) at right rear of engine compartment.

**NOTE—**

Relay locations can vary. Confirm relay identification by matching wiring colors and terminal numbers.

- Check for voltage at terminal 6 of main relay socket (30-red wire).
  - If battery voltage is present, continue testing.
  - If battery voltage is not present, check large red wire in relay socket. See **ELE Electrical Wiring Diagrams**.
- Reinstall relay and turn ignition on. Gain access to underside of relay socket and check for ground at terminal 4 (85-brown wire).
  - If ground is present, continue testing.
  - If ground is not present, switched ground signal from ECM is missing. Check wire between ECM and relay.
- With ignition on and relay installed, check for battery voltage at terminal 2 (87-red/white wire).
  - If battery voltage is present, relay has energized and is functioning correctly.
  - If battery voltage is not present and all earlier tests are OK, relay is faulty and should be replaced.





## Engine coolant temperature (ECT) sensor, testing

- The ECT sensor is located on the front of the engine in the coolant/thermostat flange. The ECT sensor is a dual temperature sensor. One circuit provides coolant temperature information to the ECM while the other circuit provides coolant temperature information to the instrument cluster.

The ECM determines the correct ignition timing and air/fuel mixture required for the engine by monitoring an applied voltage (5 vdc) to the sensor. The voltage drop across the sensor varies as the coolant temperature (sensor resistance) changes.

### NOTE —

The ECT sensor is an NTC (negative temperature coefficient) type sensor. In other words, as the temperature rises, resistance through the sensor decreases.

If the ETC sensor input is faulty or non-plausible, the MIL is illuminated when OBD II fault criteria are exceeded. The ECM assumes a substitute value (80° C / 176°F) to maintain engine operation. The ignition timing is set to a conservative/safe basic setting.

- Disconnect harness from ECT sensor (A) at coolant flange at front of engine.
- Check ECT sensor resistance using a multimeter at sensor terminals 3 and 4. Peel back protective boot (B) to ID terminal numbers on connector housing.

ECT sensor resistance @ 20° C (68°F)	2.2 - 2.7 kΩ
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## Engine coolant temperature (ECT) sensor, replacing

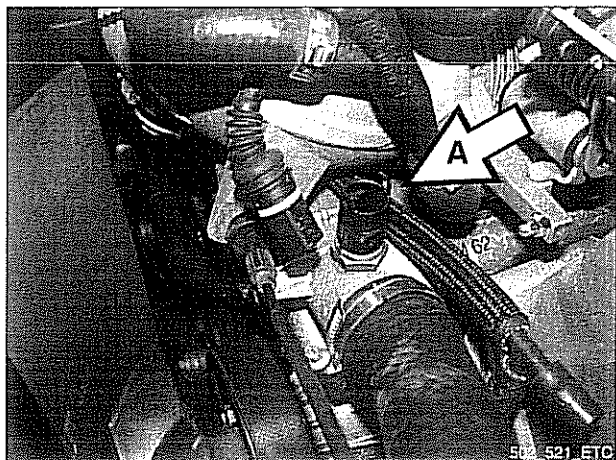
### WARNING —

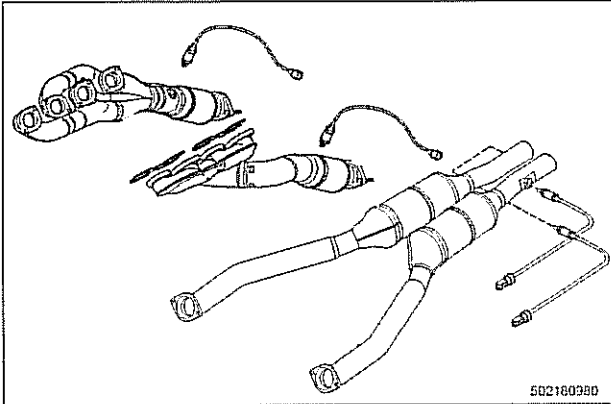
Due to risk of personal injury, be sure the engine is cold before replacing ECT sensor.

- Disconnect ECT sensor harness.
- Unscrew ECT sensor from cylinder head and install new sensor.
  - Use new copper sealing washers when installing sensor.
  - Replace any lost coolant.

### Tightening torque

ECT sensor to coolant flange	13 Nm (10 ft-lb)
------------------------------	------------------





## Oxygen sensors, replacing

- ◀ Four Bosch oxygen sensors (2 pre-catalytic converter sensors and 2 post-catalytic converter sensors) provide a varying voltage signal [0.2 vdc (max. lean) to 0.8 vdc (max. rich)] to the ME 7.2 ECM representing oxygen content in the exhaust gas.

### **WARNING—**

*Exhaust manifolds and pipes can be hot enough to cause serious burns. Wear suitable heavy gloves and other appropriate protection.*

- Using a special oxygen sensor socket, remove the threaded sensors from the exhaust system.
- If not already applied, coat the new oxygen sensor threads with an anti-seize compound before installation. Do not get compound on the sensor tip.

### Tightening torque

Oxygen sensor to exhaust system	50 Nm (37 ft-lb)
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## Fuel injectors, removing and installing

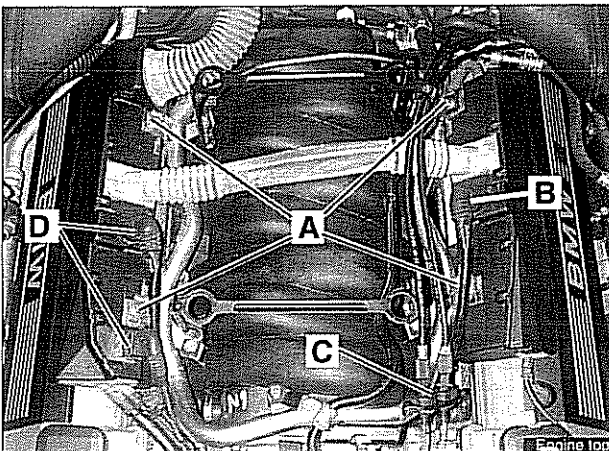
The ME 7.2 system uses ball seat type fuel injectors. This design provides precise sealing when the injector is closed thereby eliminating raw HC (unburned fuel) formation in the intake. The fuel injectors are switched on and off by the ECM at the ground side.

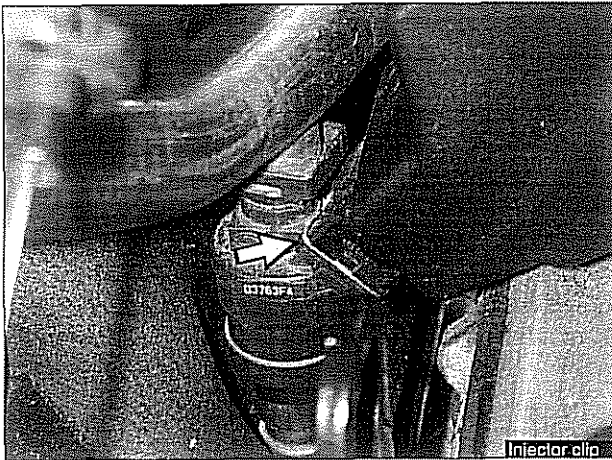
- Remove plastic cover from above fuel rail. See **100 Engine Removal and Installation**.
- Disconnect battery negative (-) cable.

### **CAUTION—**

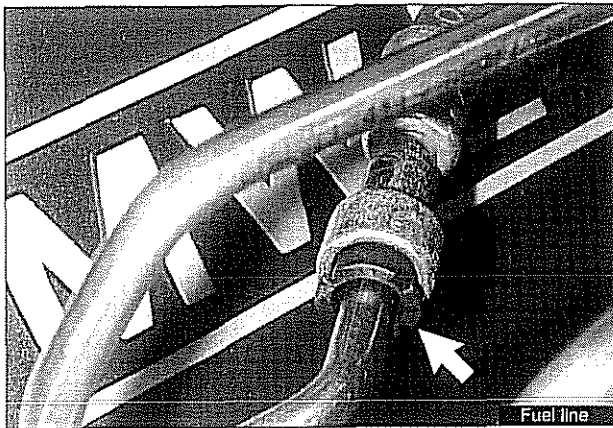
*Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual. See **001 General Warnings and Cautions**.*

- Remove both ignition coil covers.
  - Disconnect ignition coil connectors.
  - Remove left and right ignition coil ground wires.
- ◀ Remove fuel injector loom boxes.
  - Loosen mounting fasteners (A).
  - Disconnect electrical plugs (B and D).





- Release fuel injector locking clips (**arrow**).
- Remove fuel injector loom boxes and lay to one side.
- Remove 4 fuel rail mounting fasteners.



- Disconnect fuel line at quick-disconnect. To disconnect, press in plastic collar (**arrow**) and separate fuel line.

**WARNING—**

*Fuel may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hose to absorb any leaking fuel. Plug all open fuel lines.*

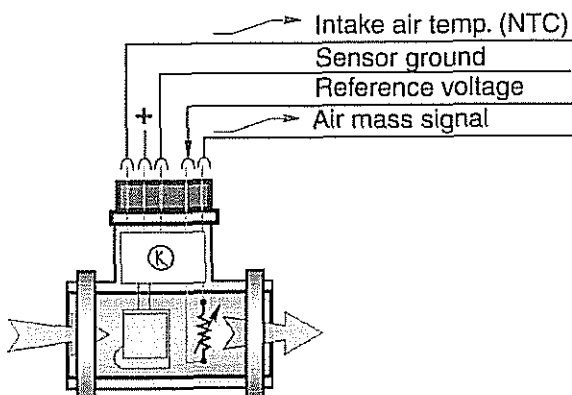
- Lift fuel rail and injectors straight up to remove.
- Installation is reverse of removal. Use new injector seals and clamps during installation.

### Mass air flow (MAF) sensor, removing and installing

- The MAF sensor is provided with operating power from the ECM relay. Based on intake air mass, the MAF sensor generates a varying voltage (approx. 0.5 - 4.5 vdc) as an input signal back to the ECM. A separate intake air temperature sensor is not used.

- Removing MAF sensor:
  - Remove upper air filter housing locking clips.
  - Unscrew and remove sensor harness.
  - Disconnect air temperature sensor harness.
  - Loosen hose clamp.
  - Remove upper filter housing with sensor.
- Installation is reverse of removal.

#### Mass Air Flow Sensor



## Evaporative system pressure leak diagnosis, overview

The M62 TU engine is equipped with an evaporative fuel system pressure leak diagnosis system. The main component of this system is the leak diagnosis pump (LDP). The function of the LDP is to pressurize the fuel tank and the evaporative emission system for the purpose of detecting leaks.

This system is capable of detecting a leak as small as 0.5 mm. The LDP, located in the left rear wheel housing, contains the following:

- Vacuum chamber.
- Pneumatic pump chamber.
- DME activated vacuum solenoid.
- Reed switch (provides switched voltage feedback signal to DME).

The vacuum supply line is in the wiring harness from the engine compartment and runs down the driver's side of the vehicle.

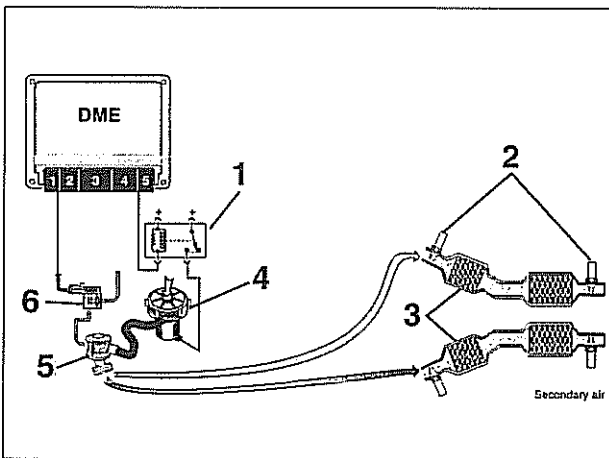
The canister vent valve is integrated into the LDP, which is electrically controlled by the ECM. The canister vent valve is opened to provide fresh air entry into the fuel system only during purge operation.

- Purge operation characteristics:
  - Off idle through full throttle: purge valve opened by pulse width modulated (PWM) control of the ECM. PWM duty cycle varies by engine operating conditions (e.g. warm idle, purge valve opened slightly; cold idle/decel with engine temp < 67° C, purge valve always closed).

## Secondary air injection, overview

The secondary air system pumps ambient air into the exhaust stream after a cold engine start to reduce the warm-up time of the catalytic converters and to reduce HC and CO emissions. The ME 7.2 ECM controls and monitors the secondary air injection system. The secondary air pump operates at a start temperature of between 10°C (50°F) and 40°C (104°F), and continues to operate for a maximum of 2 minutes at idle speed.

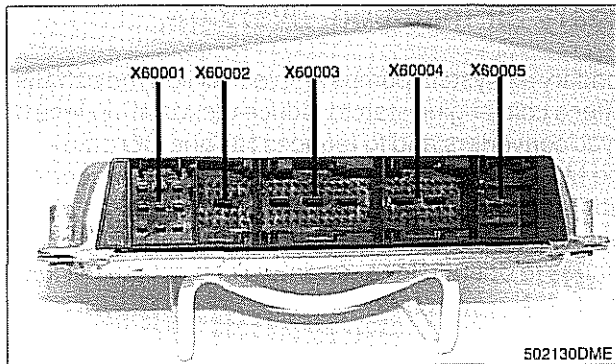
The electric air pump draws in ambient air and supplies it to the check valve. The vacuum vent valve (solenoid) switches vacuum to open the check valve when activated by the ECM. Once opened, the check valve allows air to be pumped into the exhaust stream.



◀ The secondary air injection system consists of the following components:

1. Secondary air pump relay
2. Oxygen sensors
3. Catalytic converters
4. Electric air pump
5. Non-return valve
6. Vacuum vent valve

## Fuel Injection



## Bosch ME 7.2 ECM pin assignments

## Bosch ME 7.2 ECM connectors

X60001	9-pin, Black
X60002	24-pin, Black
X60003	52-pin, Black
X60004	40-pin, Black
X60005	9-pin, Black

Table e. Bosch ME 7.2 ECM pin assignments

## Connector X60001

Pin	Type	Description/function	Notes
1		Not used	
2		Not used	
3		Not used	
4	Ground	Ground	Ground connector X6460
5	Ground	Ground	Ground connector X6460
6	Ground	Ground	Ground connector X6460
7	Input	Terminal 30 voltage supply	Fuse F4
8	Input	Terminal 87 voltage supply	Fuse F1
9		Not used	

## Connector X60002

Pin	Type	Description/function	Notes
1	Ground	Heated oxygen sensor, heater ground	Heated oxygen sensor II behind catalytic converter
2	Input	Back-up light signal	Back-up light switch
3	Input/ Output	CAN-Bus Low	Automatic transmission control module (AGS)
4	Input/ Output	CAN-Bus High	Automatic transmission control module (AGS)
5		Not used	
6		Not used	
7	Ground	Heated oxygen sensor, heater ground	Heated oxygen sensor I behind catalytic converter
8	Ground	Heated oxygen sensor ground	Heated oxygen sensor II behind catalytic converter
9	Ground	Heated oxygen sensor ground	Heated oxygen sensor I in front of catalytic converter
10	Ground	Heated oxygen sensor ground	Heated oxygen sensor II in front of catalytic converter
11	Ground	Heated oxygen sensor ground	Heated oxygen sensor I behind catalytic converter
12		Not used	
13	Ground	Heated oxygen sensor, heater ground	Heated oxygen sensor II in front of catalytic converter



## Connector X60002 (continued)

14	Input	Heated oxygen sensor signal	Heated oxygen sensor II behind catalytic converter
15	Input	Heated oxygen sensor signal	Heated oxygen sensor I in front of catalytic converter
16	Input	Heated oxygen sensor signal	Heated oxygen sensor II in front of catalytic converter
17	Input	Heated oxygen sensor signal	Heated oxygen sensor I behind catalytic converter
18		Not used	
19	Ground	Heated oxygen sensor, heater ground	Heated oxygen sensor I in front of catalytic converter
20		Not used	
21		Not used	
22		Not used	
23	Output	Terminal 85 control	Engine control module relay
24		Not used	

## Connector X60003

Pin	Type	Description/function	Notes
1	Output	Injection signal	Cylinder 2 fuel injector valve
2	Output	Injection signal	Cylinder 3 fuel injector valve
3	Output	Signal evaporative emission valve	Evaporative emission valve
4	Output	Temperature signal, E-box fan	E-box fan
5		Not used	
6	Ground	Ground for electronic components	Ground connector X6460
7	Output	Voltage supply for hot film mass air flow sensor	Hot film mass air flow sensor
8	Input	Signal EDK (electric throttle actuator)	Electric throttle actuator
9	Ground	Hot film mass air flow sensor, ground	Hot film mass air flow sensor
10	Output	Electric throttle actuator	Electric throttle actuator, voltage supply
11		Not used	
12	Input	Voltage signal, terminal 30h	Starter
13	Input	Alternator D+ (terminal 61) signal	Alternator (generator)
14	Output	Injection signal	Cylinder 7 fuel injection valve
15	Output	Injection signal	Cylinder 6 fuel injection valve
16	Input	VANOS valve, signal	VANOS valve, cylinder 5-8
17		Not used	
18		Not used	
19		Not used	
20	Input	Camshaft position sensor signal	Hall effect sensor, camshaft 2
21	Ground	Ground	Dual temperature sensor
22	Input	Signal, coolant temperature	Dual temperature sensor
23	Input	Hot film mass air flow sensor, signal	Hot film mass air flow sensor
24	Input	Electric throttle actuator, signal	Electric throttle actuator

**Fuel Injection****Connector X60003 (continued)**

25	Input	Ground, electric throttle actuator	Electric throttle actuator
26		Not used	
27	Output	Injection signal	Cylinder 8 fuel injection valve
28	Output	Injection signal	Cylinder 5 fuel injection valve
29	Input	VANOS valve, signal	VANOS valve, cylinders 1-4
30		Not used	
31	Output	Thermostat characteristic map, signal	Characteristic map
32	Input	Crankshaft position sensor, signal	Crankshaft position/rpm sensor
33		Not used	
34	Input	Hot film mass air flow sensor, signal	Hot film mass air flow sensor
35	Ground	Knock sensor, shield	Knock sensor
36	Input	Knock sensor 2, signal	Knock sensor
37	Input	Knock sensor 4, signal	Knock sensor
38	Ground	Knock sensor, shield	Knock sensor
39	Input	Oil level (thermal)	Oil level sensor
40	Output	Injection, signal	Cylinder 4 fuel injection valve
41	Output	Injection, signal	Cylinder 1 fuel injection valve
42	Input	Electric throttle actuator, signal	Electric throttle actuator
43	Input	Electric throttle actuator, signal	Electric throttle actuator
44		Not used	
45	Ground	Ground	Crankshaft sensor shield
46	Input	Crankshaft position sensor, signal	Crankshaft position/rpm sensor
47		Not used	
48	Ground	Knock sensor, shield	Knock sensor
49	Input	Knock sensor 1, signal	Knock sensor
50	Input	Knock sensor 3, signal	Knock sensor
51	Ground	Knock sensor, shield	Knock sensor
52	Input	Secondary air injection pump valve, signal	Secondary air injection pump valve

**Connector X60004**

Pin	Type	Description/signal type	Notes
1	Output	Charge indicator signal (terminal 61)	Instrument cluster
2	Output	Voltage signal, terminal 30h	Integrated instrument cluster control
3	Output	Secondary air pump relay, activation	Secondary air injection pump relay
4	Input	Signal, electric (auxiliary) cooling fan, signal	Electric (auxiliary) cooling fan
5		Not used	
6	Input	Start signal (terminal 50, start detection)	Ignition switch
7	Ground	Pedal position sensor (PWG), ground	Pedal position sensor

## Connector X60004 (continued)

8	Input	Pedal position sensor (PWG), signal	Pedal position sensor
9	Output	Pedal position sensor (PWG), power supply	Pedal position sensor
10	Output	Fuel pump relay, activation	Fuel pump relay
11	Output	Oil pressure indicator	Instrument cluster
12	Ground	Pedal position sensor (PWG), ground	Pedal position sensor
13	Input	Pedal position sensor (PWG), signal	Pedal position sensor
14	Output	Pedal position sensor (PWG), power supply	Pedal position sensor
15		Not used	
16		Not used	
17	Output	Engine speed signal output (TD)	OBD II plug
18		Not used	
19		Signal back-up light	Integrated instrument cluster control module (IKE)
20	Input	DM-TL (diagnostic module, tank leakage)	
21	Output	Signal oil level sensor	Light module
22	Input	Right rear wheel speed, signal	ABS/DSC control module
23	Input	Clutch pedal position switch, signal	Clutch pedal position switch
24	Input	Brake light switch, signal	Brake light switch
25		Not used	
26	Input	Voltage supply, terminal 15	Fuse F14
27	Input	Data link, MFL (multi-function steering wheel)	Airbag contact coil spring
28	Input	Brake light test signal	Brake light switch
29	Input	A/C compressor signal	Heating and A/C control module
30	Input	DM-TL (diagnostic module, tank leakage)	
31		Not used	
32	Output	Diagnosis signal TxD	OBD II plug
33	Input/output	Communication link (EWS)	Electronic immobilizer (EWS)
34		Not used	
35		Not used	
36	Input/output	CAN-Bus high	CAN-Bus link
37	Input/output	CAN-Bus low	CAN-Bus link
38	Ground	Ground	Coolant outlet temperature sensor
39	Input	Signal	Coolant outlet temperature sensor
40	Output	Start signal	Starter relay

## Connector X60003

Pin	Type	Description/signal type	Notes
1	Output	Terminal 1 signal	Cylinder 7 ignition coil
2	Output	Terminal 1 signal	Cylinder 8 ignition coil

**Fuel Injection****Connector X60005 (continued)**

3	Output	Terminal 1 signal	Cylinder 2 ignition coil
4	Output	Terminal 1 signal	Cylinder 3 ignition coil
5	Ground	Ground	Ground point
6	Output	Terminal 1 signal	Cylinder 1 ignition coil
7	Output	Terminal 1 signal	Cylinder 4 ignition coil
8	Output	Terminal 1 signal	Cylinder 5 ignition coil
9	Output	Terminal 1 signal	Cylinder 6 ignition coil



# 160 Fuel Tank and Fuel Pump

<b>General</b> .....	160-2	<b>Fuel Pump and Fuel Level Sender</b> ..	160-15
Special tools .....	160-2	Fuel level sender (right side) and fuel pump, removing and installing .....	160-15
Fuel pump .....	160-3	Fuel level sender (left side), removing and installing .....	160-17
Fuel tank evaporative control system .....	160-3	Siphon pump, removing and installing .....	160-19
Evaporative system troubleshooting .....	160-4	<b>Fuel Tank and Fuel Lines</b> .....	160-20
Warnings and cautions .....	160-5	Fuel tank, draining .....	160-20
<b>Fuel System Troubleshooting</b> .....	160-6	Fuel tank, removing and installing .....	160-21
Fuel pump fuse and relay .....	160-6	Fuel expansion tank, removing and installing .....	160-23
Operating fuel pump for tests .....	160-6	Activated carbon canister / fuel tank leak detection unit (LDP or DMTL), removing and installing .....	160-24
Fuel pump electrical circuit, testing .....	160-7	Running losses (3/2-way) valve, removing and installing .....	160-24
Fuel pump power consumption, testing .....	160-9		
Fuel pressure gauge, installing (6-cylinder models) .....	160-10		
Fuel pressure gauge, installing (V-8 models) .....	160-11		
Fuel delivery, testing .....	160-12		

## GENERAL

This repair group covers service information specifically for the fuel supply system. Information on the fuel injection system is covered in **130 Fuel Injection**.

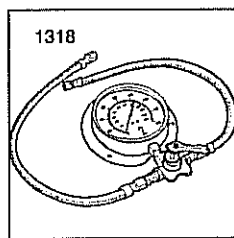
In the descriptions and procedures given below, engine and engine management (DME) systems are referred to by manufacturer code. If necessary, see **100 Engine-General** for model year, engine code, and DME applications.

### NOTE—

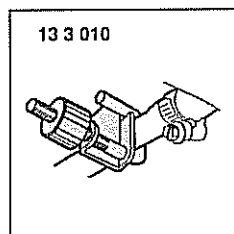
*Fuel filter replacement is covered in 020 Maintenance.*

## Special tools

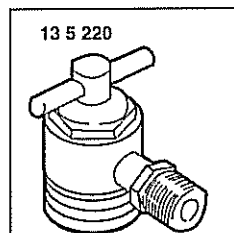
Some of the procedures in this group require the use of special tools.



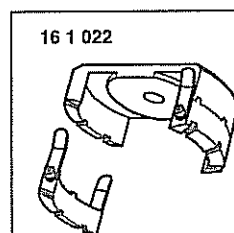
- ◀ Fuel pressure gauge  
(Tool No. 1318 [Source: Baum Tools Unlimited])



- ◀ Fuel line clamp  
(Tool No. BMW 13 3 010)



- ◀ Fuel pressure gauge T-fitting with shut-off valve  
(Tool No. BMW 13 5 220)



- ◀ Fuel tank threaded collar spanner  
(Tool No. BMW 16 1 022)

## Fuel pump

The electric fuel pump is mounted in the fuel tank in tandem with the right side fuel level sender. The fuel pump delivers pressurized fuel to the fuel injection system. A pressure regulator maintains system pressure. The quantity of fuel supplied exceeds demand, so excess fuel returns to the fuel tank via a return line. See **130 Fuel Injection** for more information.

### NOTE—

*Fuel pump removal procedures are given under **Fuel level sender (right side) and fuel pump, removing and installing.***

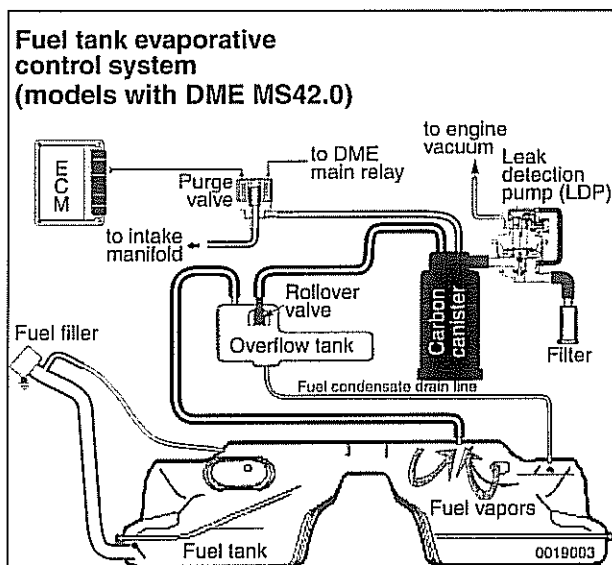
## Fuel tank evaporative control system

Evaporative control, also referred to as running losses 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).

### NOTE—

*1997 V-8 models (540i) with Bosch DME M5.2 are not equipped with an OBD II running losses monitoring system.*



▶ The main components of the evaporative control system and their functions:

- Fuel overflow tank acts as a liquid/vapor separator.
- Carbon canister stores evaporated fuel.
- Plumbing ducts vapors from fuel tank to canister and from canister to intake manifold.
- Carbon canister purge valve is controlled by engine control module (ECM).
- Running losses or 3/2-way valve (not shown) shunts excess fuel volume directly back to fuel tank before it circulates through injector fuel rail (models with Siemens MS42 or Bosch M5.2.1 engine management only).
- Leak detection unit (LDP or DMTL) pressurizes fuel tank and evaporative system to monitor system leaks (models with Siemens MS42 or Bosch M5.2.1 and later).

Leak detection systems vary among models and years, and are further described in **130 Fuel Injection**.

### NOTE—

*"3/2-way valve", "running losses valve" and "fuel changeover valve" are used interchangeably in BMW technical literature.*

### Evaporative system troubleshooting

- Start by accessing diagnostic trouble codes (DTCs) using a BMW or BMW compatible aftermarket scan tool.
  - For purposes of OBD II emissions compliance, the DME system sets a diagnostic trouble code (DTC) when it detects a leak that is equal or larger than minimum leak sensed by system.
  - Malfunction Indicator Light (MIL) is illuminated upon second recurrence of fault. See **OBD On-Board Diagnostics**.
  
- When leak testing, observe following conditions to obtain plausible results:
  - Fuel tank  $\frac{1}{4}$  to  $\frac{3}{4}$  full.
  - Vehicle parked for at least 2 hours to allow fuel to reach room temperature. Ideal fuel temperature is 10° - 20° C (50° - 68° F).
  - Do not refuel immediately before leak test.
  
- If a leak is detected, check the following areas:
  - Fuel filter cap (leaking or off).
  - Fuel tank ventilation lines leaking at fuel tank or activated carbon canister.
  - Tank ventilation valve leaking (in engine compartment).
  - Fuel level sensor/fuel pump cap leaking.

Evaporative system component replacement is covered later in this group in **Fuel Tank and Fuel Lines**.



## 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.*
- *When disconnecting a fuel hose, wrap shop rag around end of hose to prevent spray of fuel under pressure.*
- *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.*

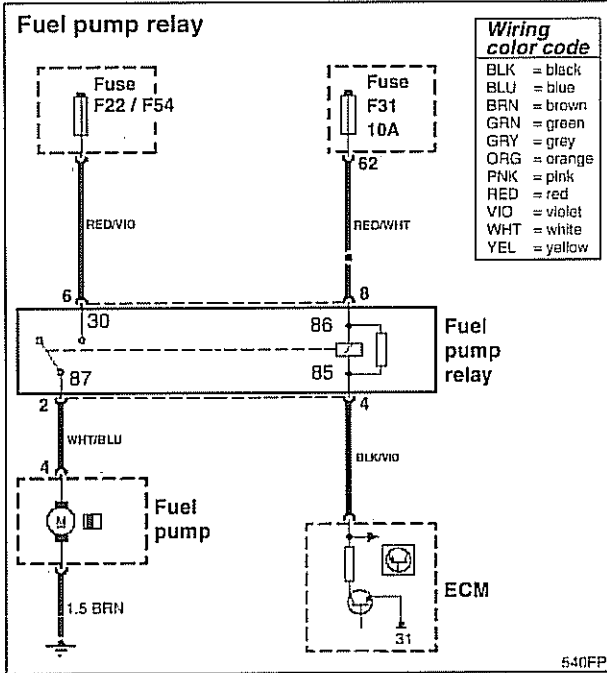
### **CAUTION—**

- *Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.*
- *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 DME components, including the engine control module (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 pump fuse and relay

Troubleshooting of any fuel pump fault should begin with checking the fuel pump fuse and the fuel pump relay. The DME main relay should also be checked. The fuel pump relay is located behind right side luggage compartment interior panel.



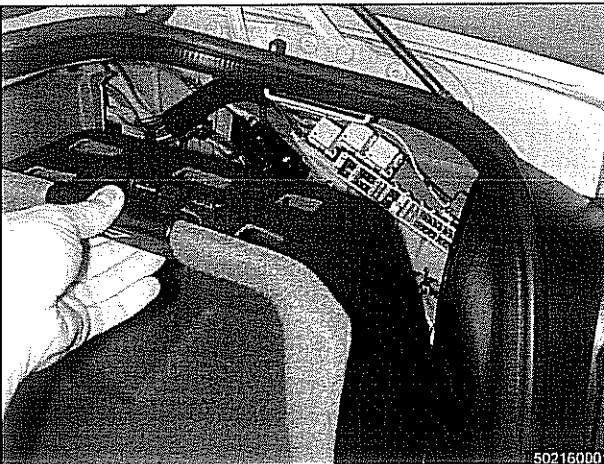
**NOTE—**

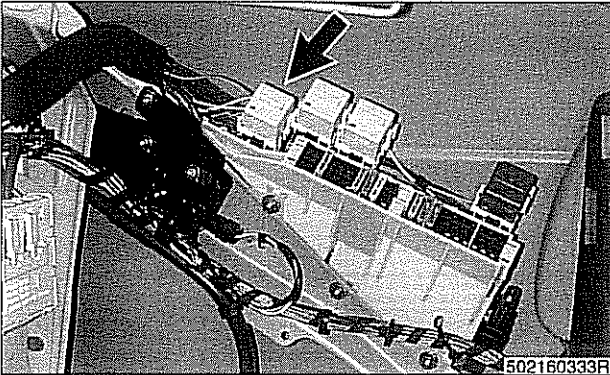
Special tools are required for some of the tests described here.

- Fuel pump circuit is fuse-protected.
  - 6-cylinder models with Siemens DME MS41.1, MS42, V-8 models with Bosch DME M5.2, M5.2.1 engine management: Fuse F54, 15A (luggage compartment fuse panel)
  - 6-cylinder models with Siemens DME MS43 engine management: Fuse F22, 25A (glove compartment fuse panel)
  - V-8 models with Bosch DME M7.2: Fuse F54, 25A (luggage compartment fuse panel)
- Fuse 31 in glove compartment fuse panel supplies power to coil side of fuel pump relay. Engine control module (ECM) supplies switched ground to relay. During starting, fuel pump runs as long as ignition switch is in START position and continues to run once engine starts. If electrical system fault interrupts power to fuel pump, engine will not run.

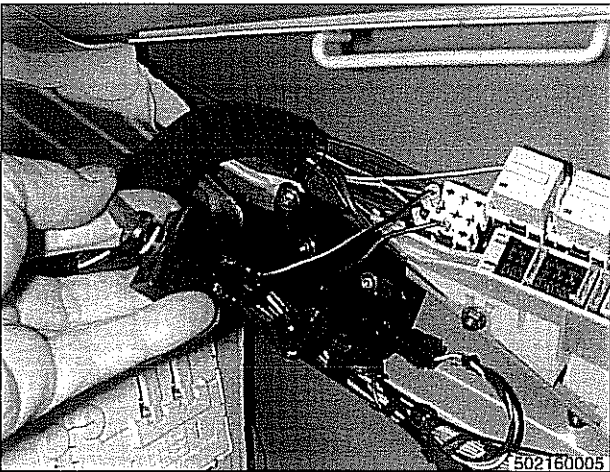
### Operating fuel pump for tests

- To operate fuel pump for testing purposes without having to run engine, bypass fuel pump relay to power pump directly.
- To run fuel pump, open luggage compartment and release right side trim panel.





- Remove fuel pump relay (arrow).



- Connect relay socket terminal 6 (red/violet wire) to relay socket terminal 2 (white/blue wire) with a fused jumper wire. After completing tests, remove jumper harness.

**CAUTION—**

- Relay locations may vary. Use care when identifying relays and making electrical checks at the fuse/relay panel. See **610 Electrical Component Locations** for additional relay information.
- The fuel pump relay has a 1.5 mm<sup>2</sup> red/violet wire at terminal 6 in the relay socket. Terminal 2 has a 2.5 mm<sup>2</sup> white/blue wire. See **ELE Electrical Wiring Diagrams** for additional wiring information.

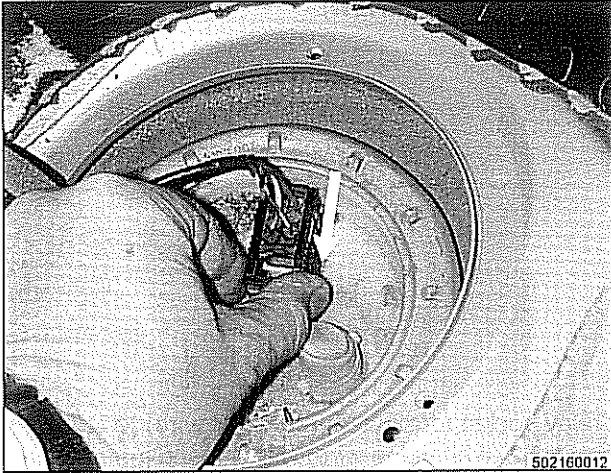
**NOTE —**

- The fuel pump will run as soon as the jumper wire is attached.
  - The jumper wire should be 1.5 mm<sup>2</sup> (14 ga.) and include an in-line fuse holder with a 15A fuse. To avoid fuse/relay panel damage from repeated connecting and disconnecting, also include a toggle switch in the jumper harness.
- If pump does not run with jumper installed, fault could be in fuel pump, fuses F31 or F22 / F54, or wiring to pump. Check pump, fuses and its wiring as described below.

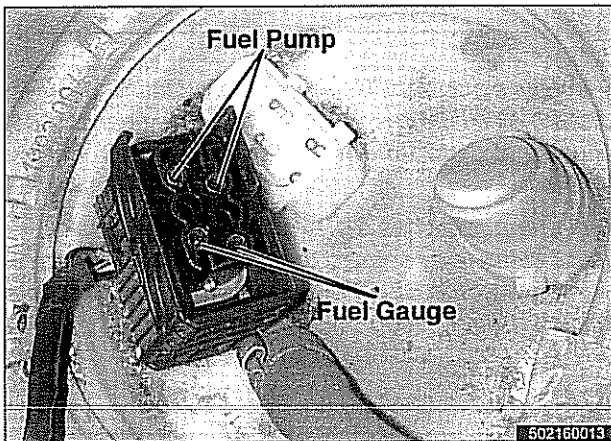
### Fuel pump electrical circuit, testing

- The test given below assumes that the fuel pump relay circuit is functioning correctly as described earlier. Access to the pump is from below the rear seat bottom cushion.
- Remove rear seat lower cushion by lifting front edge off left and right catches.

## Fuel Tank and Fuel Pump



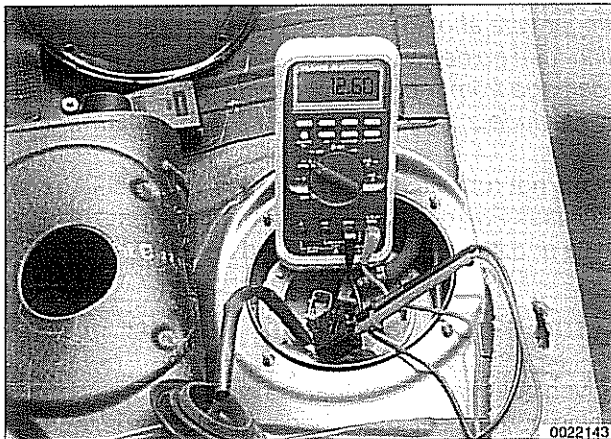
- Disconnect harness connector from tank sending unit by sliding connection lock to release connector.



- Connect voltmeter between fuel pump terminals on connector.

**NOTE —**

*Fuel pump power (+) is supplied through the white/blue wire.  
Ground (-) is supplied by the brown wire.*



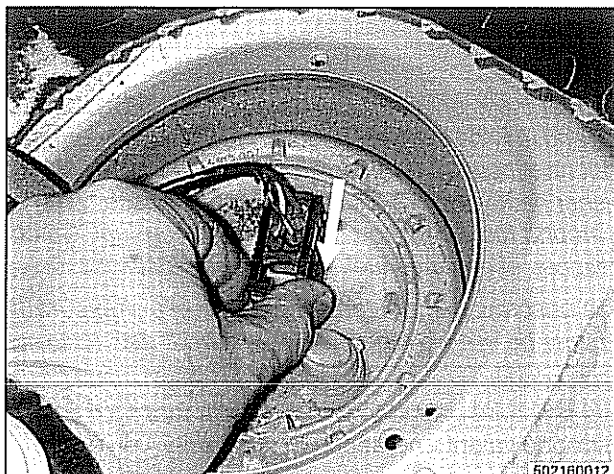
- With jumper wire connected in place of fuel pump relay as described above, check for battery voltage at fuel pump harness connector terminals.
- If voltage and ground are present, fuel pump is probably faulty. If there is no voltage, check wiring between fuel pump and relay.

## Fuel pump power consumption, testing

To achieve accurate test results, the battery voltage at the fuel pump connector should be 12.6 volts. Charge the battery as necessary.

A higher than normal power consumption may indicate a worn fuel pump, which may cause intermittent fuel starvation due to pump overheating and seizure. The only remedy is pump replacement. A lower than normal power consumption may indicate a blockage. Be sure to check that the return line and the pump pickup are not obstructed before replacing the pump.

- Expose right side access cover:
  - Peel forward lip of carpet.
  - Release rubber grommet from center of access cover insulation.
  - Peel back insulation at perforations to expose fuel tank access cover.
  - Remove right side cover to expose electrical harness connector.
- ⚡ Disconnect harness connector from tank sending unit by sliding lock back. Lift off connector.



- ⚡ Test fuel pump for current draw by attaching digital ammeter between pump and harness (terminal 2, white/blue wire) and connect a jumper wire between pump and harness (terminal 1, brown wire) as shown.

### CAUTION—

*Do not allow the test leads to short to ground.*

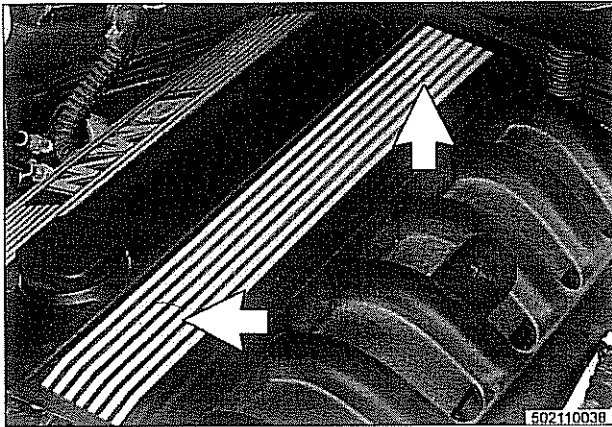
### NOTE—

*See 600 Electrical System-General for information on electrical tests using a digital multimeter.*

- Run pump as described in **Operating fuel pump for tests**.
- Compare ammeter reading with specification listed in accompanying table.

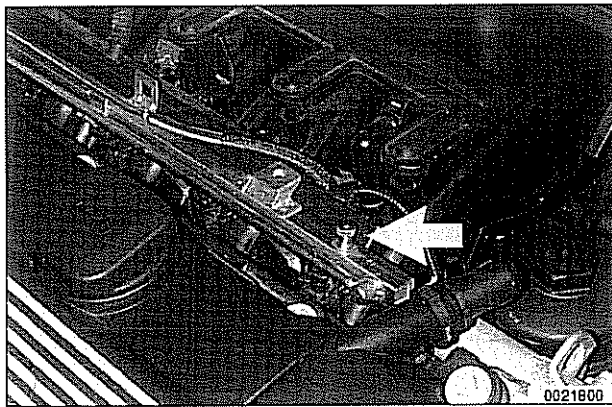
### Fuel pump current

Current consumption (average)	9.5 amps
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### Fuel pressure gauge, installing (6-cylinder models)

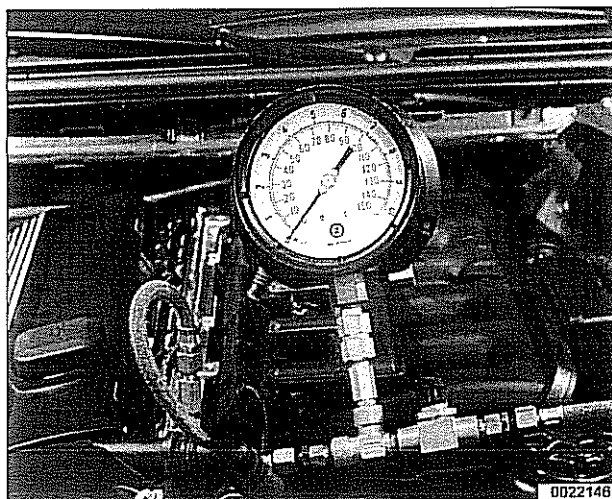
- Remove fuel rail cover by prying off trim covers (arrows) and removing nuts.



- If equipped, remove schraeder valve cap (arrow). Blow fuel back through feed line using a brief burst of compressed air (maximum 3 bar or 43.5 psi).

#### WARNING—

- Fuel in fuel line is under pressure (approx. 3 - 5 bar or 45 - 75 psi) and may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Catch and dispose of escaped fuel. Plug all open fuel lines.
- Always unscrew the fuel tank cap to release pressure in the tank before working on the tank or lines.



- Attach fuel pressure gauge to BMW special tool 13 5 220 (T-fitting) or equivalent and attach to schraeder valve.

#### WARNING—

The fuel pressure gauge must be securely connected to prevent it from coming loose under pressure.

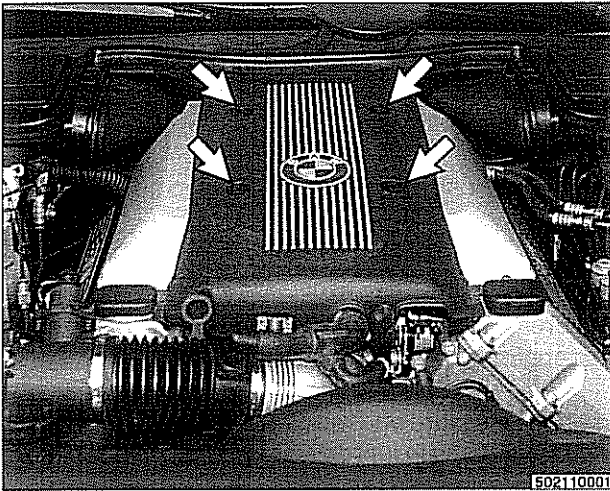
#### CAUTION—

When using the BMW special tool, use care when turning the T-handle in to open the schraeder valve. Screw the handle in just until the schraeder valve opens. Turning the handle in too far will damage the schraeder valve.

#### NOTE—

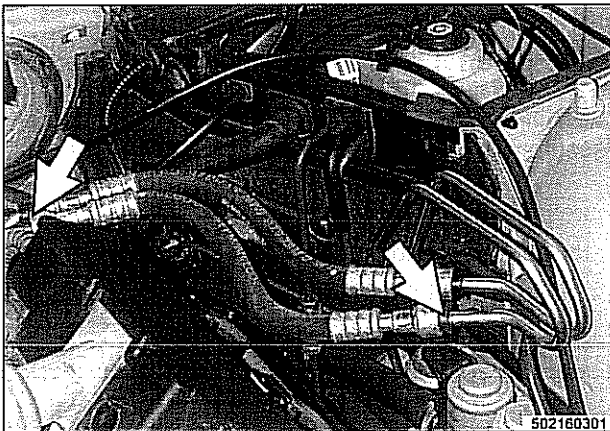
- The schraeder valve must be opened to the fuel pressure gauge connection. Either remove the valve using a standard tire valve removal tool or use the BMW special tool 15 5 220.
- The fuel pressure gauge should have a minimum range of 0 to 5 bar (0 to 75 psi).

- For vehicles without the schraeder valve on the fuel rail, attach the fuel pressure gauge in line with the fuel supply line to the fuel rail.



### Fuel pressure gauge, installing (V-8 models)

- Remove engine cover by pressing down on pins (arrows) to release cover locks.



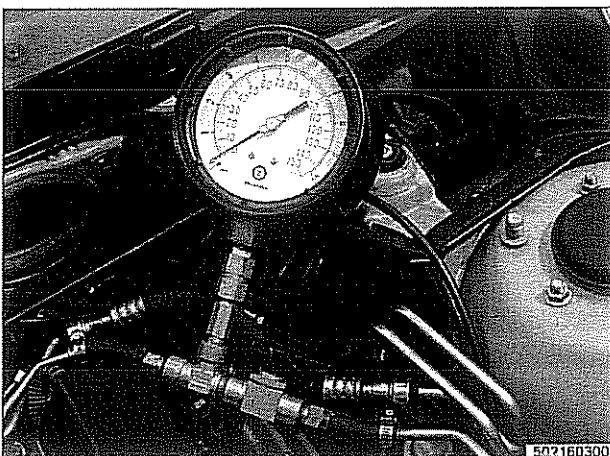
- Disconnect and remove fuel supply line from left side of fuel rail by sliding locking collar in (arrows) and pulling lines apart.

#### NOTE —

- M62 TU and MS43 vehicles (1999 and later models) use a non-return fuel line with only one line to the fuel rail.
- BMW uses three styles of fuel line connections; a one-use clamp, a locking fitting that uses BMW special tool 16 1 050 to release, and a quick release sleeve (above) that disconnects the line when depressed.

#### WARNING —

- Fuel in fuel line is under pressure (approx. 3 - 5 bar or 45 - 75 psi) and may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Catch and dispose of escaped fuel. Plug all open fuel lines.
- Always unscrew the fuel tank cap to release pressure in the tank before working on the tank or lines.



- Install inline fuel pressure gauge.

#### WARNING —

The fuel pressure gauge must be securely connected to prevent it from coming loose under pressure.

#### NOTE —

The fuel pressure gauge should have a minimum range of 0 to 5 bar (0 to 75 psi).



## Fuel delivery, testing

Checking fuel delivery is a fundamental part of troubleshooting and diagnosing the DME system. Fuel pressure directly influences fuel delivery. An accurate fuel pressure gauge will be needed to make the tests.

There are two significant fuel delivery values to be measured:

- System pressure — created by fuel pump and maintained by pressure regulator
- Residual pressure — pressure maintained in closed system after engine and fuel pump are shut off

If proper system pressure and residual pressure are present, also check for problems in fuel delivery volume, which can be affected by restrictions such as clogged fuel filter or fuel pick-up port in the fuel tank.

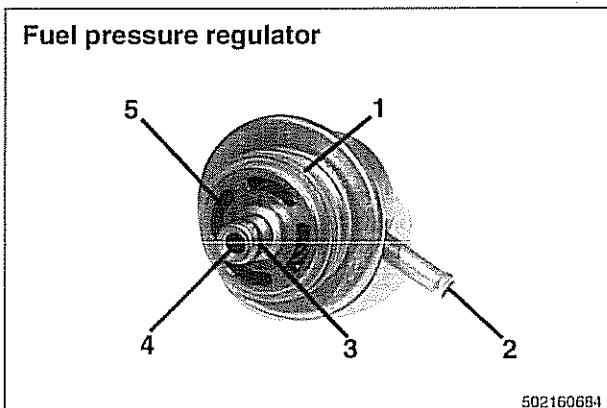
### System pressure, testing

System pressure is created by the fuel pump and maintained by the pressure regulator. System pressure is not adjustable.

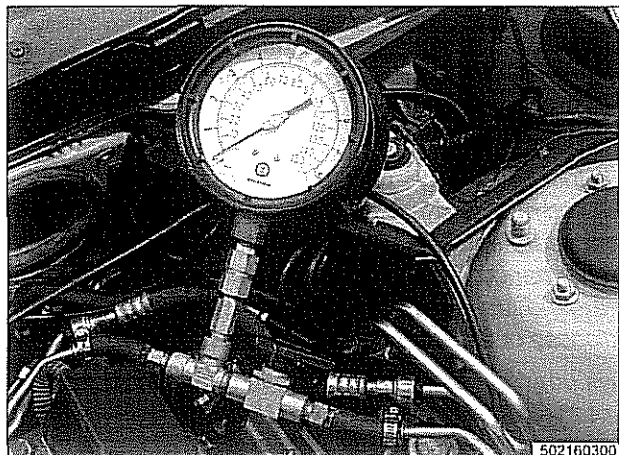
1. Fuel pressure regulator outer seal.
2. Vacuum line connection.
3. Fuel pressure regulator inner seal.
4. Fuel flow back to fuel tank.
5. Fuel flow from fuel pump.

### Fuel pressure regulator locations

M52	In fuel injector rail, in engine compartment
M52 TU	In 3/2 way valve, below vehicle under driver seat
M54	In fuel filter
M62 to 9/97	In fuel injector rail, in engine compartment
M62 from 9/97 to 9/98	In 3/2 way valve, below vehicle under driver seat
M62 TU from 9/98	In fuel filter, below vehicle under driver seat







- Relieve system pressure and attach a fuel pressure gauge as described in **Fuel pressure gauge, installing (6-cylinder models)** or **Fuel pressure gauge, installing (V-8 models)**.

**WARNING—**

- *Fuel in fuel line is under pressure (approx. 3 - 5 bar or 45 - 75 psi) and may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Catch and dispose of escaped fuel. Plug all open fuel lines.*
- *Always unscrew the fuel tank cap to release pressure in the tank before working on the tank or lines.*

- Operate fuel pump as described in **Operating fuel pump for tests**. Compare fuel pressure to specifications in accompanying table.

**Fuel pressure specification**

All E39 vehicles	3.5 ±0.2 bar (50.76 ±2.9 psi)
------------------	-------------------------------

- If pressure is low, repeat test while gradually pinching off return hose to fuel tank. Pressure should rise rapidly. If not, fuel pump is most likely faulty. If pressure rises, the fuel pressure regulator is most likely faulty.
- If pressure is too high, check return line from pressure regulator to tank. Check for kinks in hose. If no faults can be found, pressure regulator is most likely faulty.

**CAUTION—**

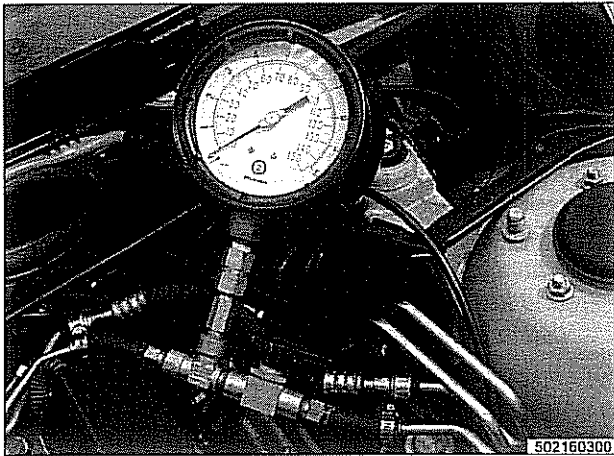
*The fuel pump is capable of developing a higher pressure than that regulated by the pressure regulator. In the event the fuel pump check valve is faulty (stuck closed), make sure the fuel pressure does not rise above 6.0 bar (87 psi). Damage to the fuel lines or fuel system components could result.*

- Reassemble engine, noting the following:
  - Remove fuel pressure gauge and fittings.
  - Replace schraeder valve, if removed.
  - Replace fuel pump relay.
  - Replace fuel filler cap.

**Residual pressure, testing**

For quick restarts and to avoid vapor lock when the engine is hot, the fuel injection system retains fuel pressure after the engine is shut off. This residual pressure is primarily maintained by the fuel pressure regulator and a check valve at the fuel pump outlet.

## Fuel Tank and Fuel Pump



- ◀ Relieve system pressure and attach a fuel pressure gauge as described in **Fuel pressure gauge, installing (6-cylinder models)** or **Fuel pressure gauge, installing (V-8 models)**.

### **WARNING**—

- *Fuel in fuel line is under pressure (approx. 3 - 5 bar or 45 - 75 psi) and may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Catch and dispose of escaped fuel. Plug all open fuel lines.*
- *Always unscrew the fuel tank cap to release pressure in the tank before working on the tank or lines*

- Start engine allow it to run for approximately one minute. Note fuel pressure reading.
- Observe fuel pressure reading after approximately 20 minutes. The pressure should not drop more than 0.5 bar from system pressure listed in fuel pressure specifications in accompanying table.

### **Fuel pressure specification**

All E39 vehicles	3.5 ±0.2 bar (50.76 ±2.9 psi)
------------------	-------------------------------

- When finished, disconnect pressure gauge and fitting, and replace schraeder valve, if removed.
- If fuel system does not maintain pressure:
  - Visually check for leaks in fuel lines and unions.
  - Check for leaking injector(s).
  - Check for faulty fuel pump check valve.
- To test fuel pump check valve:
  - Repeat residual pressure test.
  - Immediately after shutting off engine, pinch off fuel delivery line using a fuel hose pinch clamp (BMW 13 3 010 or equivalent).
  - If pressure is now maintained, fault is most likely at fuel pump check valve.
  - If pressure again drops below specifications, fault is most likely in fuel pressure regulator.

## FUEL PUMP AND FUEL LEVEL SENDER

E39 models use a two-lobed fuel tank. Each lobe of the tank has its own fuel level sending unit. Each sender has a float connected to a variable resistance wiper contact. To equalize fuel level between the two tank lobes, a siphon pump is installed in the left lobe.

When replacing a sender or fuel pump, always replace hose clamps, gaskets and O-rings.

### **WARNING—**

*When removing the fuel level sender or the fuel pump, the fuel tank should be drained to 1/4 capacity or below as described later in this repair group.*

### **NOTE—**

*The compensating siphon pump maintains the fuel level between the right and left tank lobes. If fuel level sender resistances are not approximately the same on left and right, remove the senders and visually inspect the level in each lobe. If the levels are different, check the siphon pump.*

### Fuel level sender resistances

Float position	Test results ( $\Omega$ )
Down (empty)	50 — 70
Up (full)	401 — 415

## Fuel level sender (right side) and fuel pump, removing and installing

- Drain fuel from tank as described later.
- Disconnect negative cable from battery.

### **CAUTION—**

*Prior to disconnecting the battery, read the battery disconnection cautions given in 001 General Cautions and Warnings.*

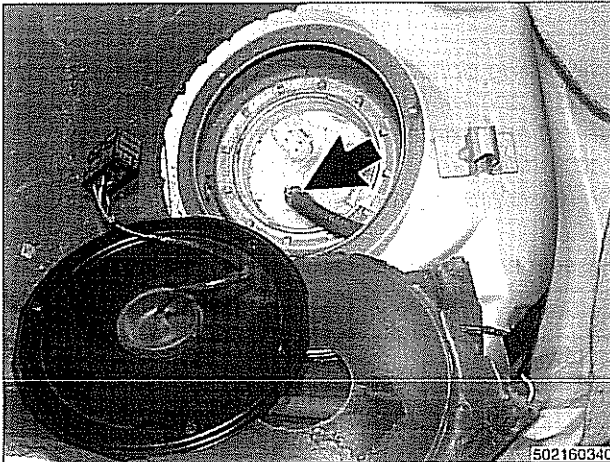
- To access top of fuel tank, remove rear seat lower cushion by lifting front edge off catches.

## Fuel Tank and Fuel Pump

- Expose right side access cover:
  - Peel forward lip of carpet.
  - Release rubber grommet from center of access cover insulation.
  - Peel back insulation at perforations to expose fuel tank access cover.
  - Remove right side cover to expose electrical harness connector.

### WARNING—

- Fuel may be spilled. Do not smoke or work near heaters or other fire hazards.
- When disconnecting fuel hose, wrap shop rag around end of hose to prevent spray of fuel under pressure.



- Remove tank sending unit:
  - Release electrical harness by sliding lock back, then lifting off connector.
  - Disconnect hose (arrow).
  - Unscrew threaded collar from fuel pump/fuel level sender.

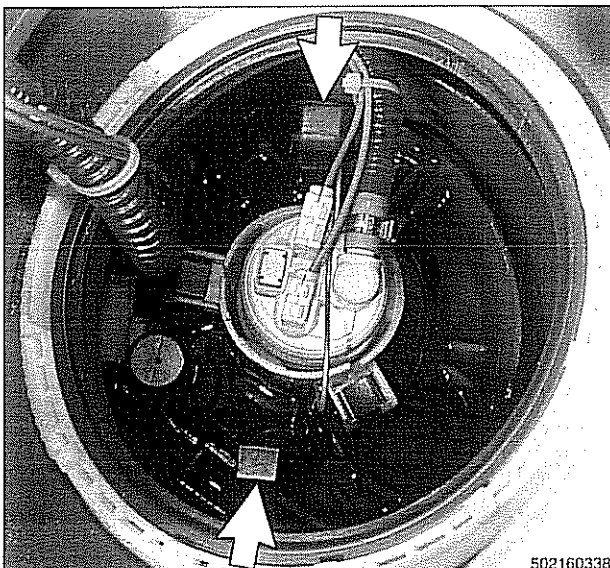
### NOTE—

*BMW special spanner 16 1 020 should be used to remove and install the threaded collar. Damage to the collar may result if the special tool is not used.*

- Slowly withdraw assembly from tank, allowing fuel to drain off. If necessary, push level sender arm toward sending unit to facilitate removal.

### CAUTION—

*Do not bend fuel level sender arm.*



- To remove fuel pump, press locking tabs (arrows) towards pump body. Lift out pump, using care not to damage hoses.

- To reinstall:
  - Use new sealing ring at tank collar.
  - Align tab of sending unit with matching recess in opening of tank.
  - Be sure that fuel line connections point in same direction as they came out.
  - Reconnect harness connector and hose.
  - Fill tank and check for leaks by running engine.
  - Install access cover and its mounting fasteners.

**CAUTION—**

*After finishing repairs but before starting engine, be sure there is at least 5 liters (1.5 gallons) of fuel in the tank. The fuel pump will be damaged if run without fuel.*

**NOTE—**

*It is common practice to replace the fuel filter when the fuel pump unit is replaced. See 020 Maintenance.*

**Tightening torque**

Tank collar locking ring to tank	35 Nm (26 lb-ft)
----------------------------------	------------------

### Fuel level sender (left side), removing and installing

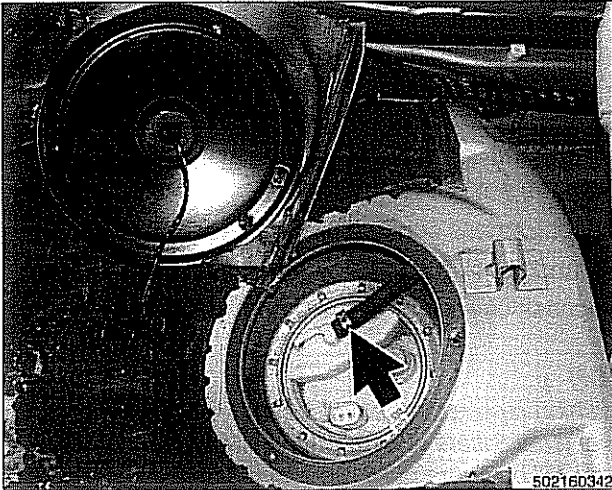
The procedure for removing and replacing the left side fuel level sender is similar to that used for the right side. There is no fuel pump on the left side.

- Remove rear seat lower cushion by lifting off catches at front.
- Expose left side access cover:
  - Peel forward lip of carpet.
  - Release rubber grommet from center of access cover insulation.
  - Peel back insulation at perforations to expose fuel tank access cover.
  - Remove cover to expose electrical harness connector.

**WARNING—**

- *Fuel may be spilled. Do not smoke or work near heaters or other fire hazards.*
- *When disconnecting fuel hose, wrap shop rag around end of hose to prevent spray of fuel under pressure.*

## Fuel Tank and Fuel Pump



- ◀ Remove tank sending unit:
  - Disconnect electrical harness connector.
  - Disconnect hose (arrow).
  - Unscrew threaded collar from fuel level sender.

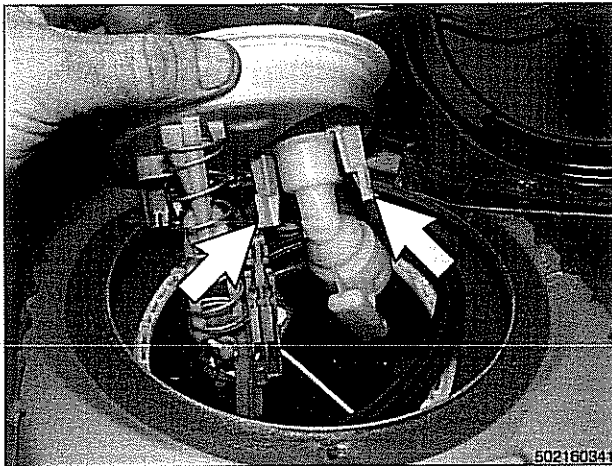
### NOTE—

*BMW special spanner 16 1 020 should be used to remove and install the threaded collar. Damage to the collar may result if the special tool is not used.*

- Slowly withdraw assembly from tank, allowing fuel to drain off. If necessary, push level sender arm toward sending unit to facilitate removal.

### CAUTION—

*Do not bend fuel level sender arm.*



- ◀ Once level sensor unit has been lifted partially out of tank, disconnect tank siphon hose by pressing tabs (arrows).
- Installation is reverse of removal.
  - Attach tank siphon hose to sender unit firmly.
  - Use new sealing ring at tank collar.
  - Be sure that fuel sender float points in same direction as during removal.
  - Reconnect harness connector.
  - Fill tank and check for leaks by running engine.

### CAUTION—

*After finishing repairs but before starting engine, be sure there is at least 5 liters (1.5 gallons) of fuel in tank. The fuel pump will be damaged if run without fuel.*

### Tightening torque

Tank collar locking ring to tank	35 Nm (26 lb-ft)
----------------------------------	------------------

## Siphon pump, removing and installing

The fuel compensating siphon pump equalizes fuel level between the two fuel tank lobes.

- Drain fuel tank as described later.

**WARNING—**

*Fuel may be spilled. Do not smoke or work near heaters or other fire hazards.*

- Remove left and right fuel level sensors and fuel pump as described earlier.

- ◀ Once left side level sensor unit has been lifted partially out of tank, disconnect tank siphon hose by pressing tabs (arrows).

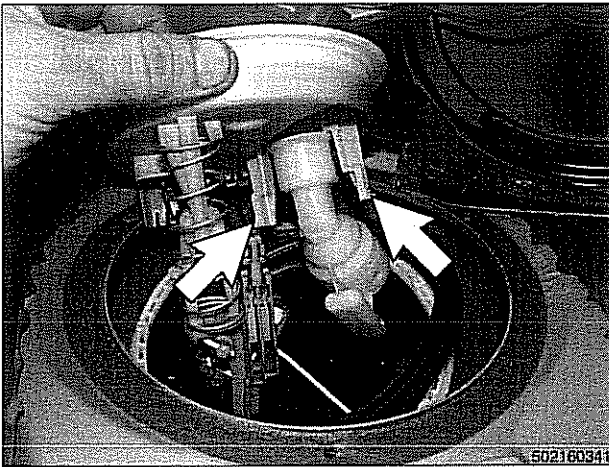
- The tank lobe siphon pump is held to baffle in bottom of right tank lobe. Release retainer and lift out pump.

- Installation is reverse of removal.

- Attach siphon pump to right side baffle.
- Attach tank siphon hose to left sender unit firmly.
- Use new sealing ring at tank collars.
- Be sure that fuel sender floats point in same direction as during removal.
- Reconnect harness connectors.
- Before starting engine, fill fuel tank with at least 5 liters (1.5 gallons) of fuel.
- Check for leaks by running engine.

**CAUTION—**

*After finishing repairs but before starting engine, be sure there is at least 5 liters (1.5 gallons) of fuel in tank. The fuel pump will be damaged if run without fuel.*



## FUEL TANK AND FUEL LINES

The plastic fuel tank is mounted underneath 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 for E39 models

Tank capacity	70 liters (18.5 gal)
Reserve capacity	8 liters (2.1 gal)

### Fuel tank, draining

Drain fuel tank into a safe storage unit using an approved fuel pumping device.

#### **WARNING—**

- Before removing 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 130 cm (51 in.), twisting as necessary. Withdraw fuel into storage unit.
- Monitor fuel level reduction in both lobes:
  - Remove rear seat cushion and access both fuel tank sender harness connectors.
  - Use multimeter to measure resistance at both senders. Resistance should drop as fuel level drops.
- If siphoning mechanism is faulty, drain left tank lobe separately by removing sender cover and pumping fuel directly out of left lobe.



- Remove suction hose from tank filler neck carefully to avoid damaging filler neck baffle plate.

**CAUTION—**

*After finishing repairs but before starting engine, be sure there is at least 5 liters (1.5 gallons) of fuel in tank. The fuel pump will be damaged if run without fuel.*

**Fuel tank, removing and installing**

- Remove fuel tank filler cap and drain tank as described earlier.
- Disconnect negative cable from battery.

**CAUTION—**

*Prior to disconnecting the battery, read the battery disconnection cautions given in 001 General Cautions and Warnings.*

- Remove rear seat bottom cushion. Peel forward lip of carpet from beneath seat cushion and carefully peel back insulation to expose fuel tank access cover on left and right sides. Remove covers.

- Disconnect right side supply hose and electrical harness connector (**arrows**).

- Disconnect left side return hose and electrical harness connector.

- Working inside car, disconnect parking brake cable ends from parking brake lever. See **340 Brakes**.

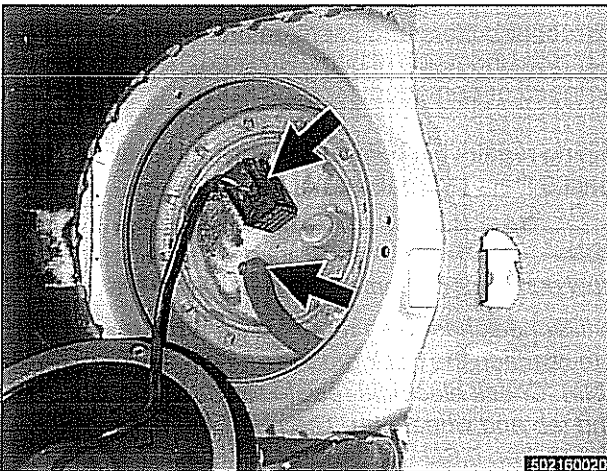
- Lift car and support safely.

**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.*

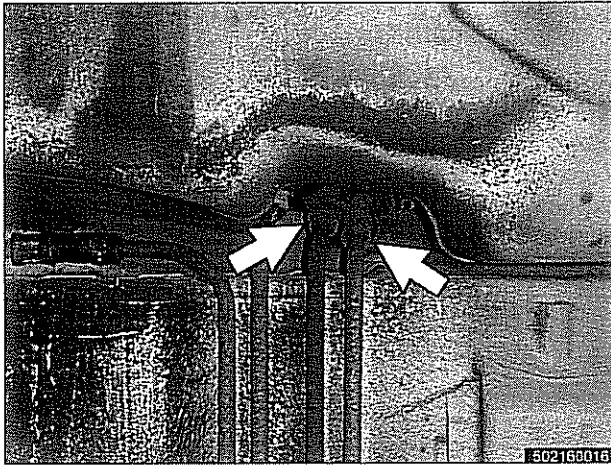
- Remove complete exhaust system and heat shield. See **180 Exhaust System**.

- Remove drive shaft. See **260 Driveshaft**.



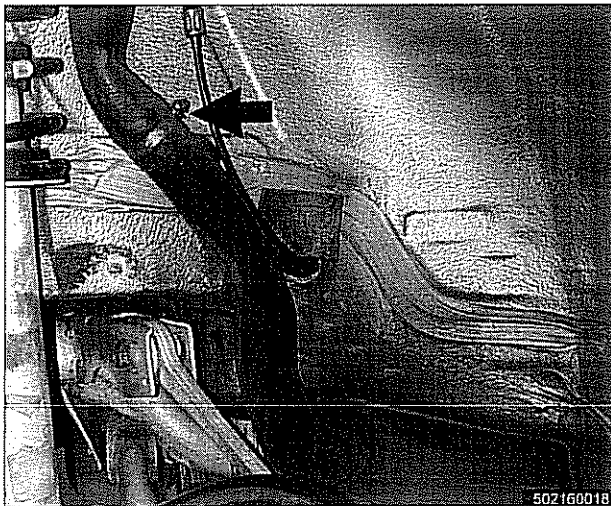
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## Fuel Tank and Fuel Pump



◀ Working underneath car, pinch off supply and return fuel hoses (**arrows**), then disconnect hoses from rigid metal lines.

- Remove right rear wheel and wheel housing splash shield.



◀ Working at right rear wheel housing, loosen hose clamp (**arrow**) and disconnect filler pipe from tank.

- Support tank from below. Remove tank strap mounting bolts. Lower and remove tank, disconnecting right side vent and other hoses/electrical connectors as necessary.
  - 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.
- 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 run without fuel.*
- *If the filler neck has been removed from the body, be sure to reattach the neck grounding screw (where applicable). Check electrical resistance between the ground tab and wheel hub. The resistance should be no higher than 0.6Ω*

### **Tightening torques**

Fuel tank to body	23 Nm (17 ft-lb)
Hose clamp 8 -13 mm dia.	2 Nm (18 in-lb)
Hose clamp 13 - 16 mm dia.	3 Nm (27 in-lb)
Hose clamp 42 - 48 mm dia.	4 Nm (36 in-lb)

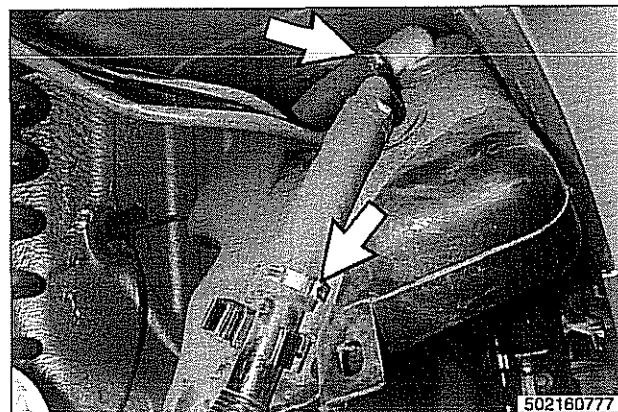
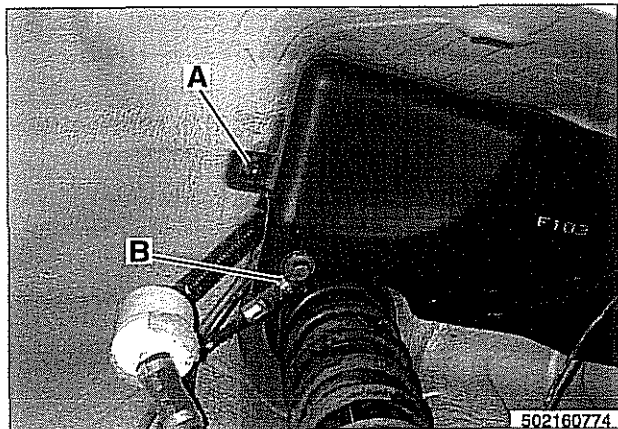
## Fuel expansion tank, removing and installing

- Raise rear end of car and support safely.

### 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 wheel housing inner shield.
- ◀ Remove plastic nut (A) and disconnect hose (B).



- ◀ Tilt vent tank down and loosen or cut off hose clamps (arrows). Pull hoses off fittings.
- Release vacuum line locking clips and remove tank.
- Installation is reverse of removal. Use new hose clamps.

### Tightening torques

Hose clamp 8 - 13 mm dia.	2 Nm (18 in-lb)
Hose clamp 13 - 16 mm dia.	3 Nm (27 in-lb)
Hose clamp 42 - 48 mm dia.	4 Nm (36 in-lb)

## Activated carbon canister / fuel tank leak detection unit (LDP or DMTL), removing and installing

- Raise rear end of car and support safely.

### CAUTION—

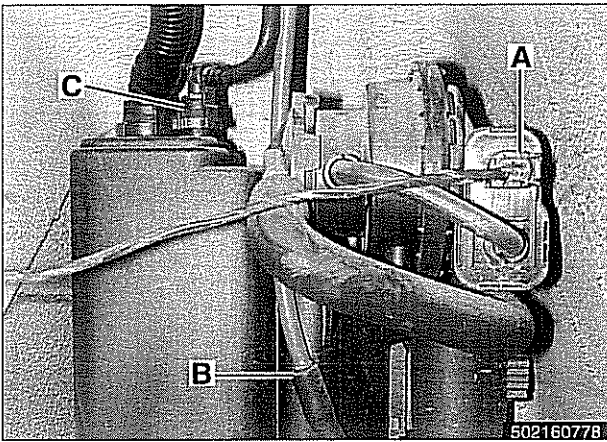
*Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

- Remove left rear wheel and inner fender panel.

- Remove carbon canister/fuel tank leak detection unit (V-8 model shown):

- Disconnect electrical harness connector (A) from fuel tank leak detection unit.
- Pinch and remove quick-disconnect fittings at intake line to air filter housing (B) and hose to expansion tank (C).
- Remove mounting clamp and lower canister with fuel tank leak detection unit.

- Installation is reverse of removal.



### Tightening torques

Hose clamp 8 - 13 mm dia.	2 Nm (18 in-lb)
Hose clamp 13 - 16 mm dia.	3 Nm (27 in-lb)

## Running losses (3/2-way) valve, removing and installing

The running losses (3/2-way) valve is located under the car beneath the driver's seat, just ahead of the fuel filter. A protective cover shields fuel system components from road hazards and dirt.

The engine control module (ECM) controls the operation of the 3/2-way valve (pulse-width modulated). On engine start up, the valve solenoid is energized for 20 seconds in order to supply full fuel volume to the fuel rail. After 20 seconds, the solenoid is deactivated and sprung closed (the bypass is opened). This reduces the amount of fuel circulating through the fuel rail and diverts the excess to return to the fuel tank through the fuel pressure regulator.

The fuel injectors are supplied with pressurized fuel, but excess fuel is diverted to the fuel tank without first passing through the fuel rail. This prevents the excess fuel from absorbing heat in the engine compartment, thus lowering the temperature and amount of vaporization in the fuel tank.

The 3/2-way valve is also activated briefly if an engine misfire is detected. This provides full fuel flow through the fuel rail to determine if the misfire was caused by a lean fuel condition. The valve is monitored by the ECM for faults.

- Using BMW or compatible scan tool, read out fault memory. See **OBD On-Board Diagnostics**.
- Turn off ignition.
- Raise car and support safely.

**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.*

- Working under car beneath driver's seat, remove protective panel from fuel filter and 3/2-way valve.
- Clamp off fuel lines at 3/2-way valve.



To remove 3/2-way valve (V-8 model shown):

- Disconnect electrical harness connector (A) from valve.
- Remove vacuum hose (B) from fuel pressure regulator.
- Remove hose clamps (arrows) and disconnect fuel lines.
- Remove M6 mounting nuts and lower 3/2-way valve.

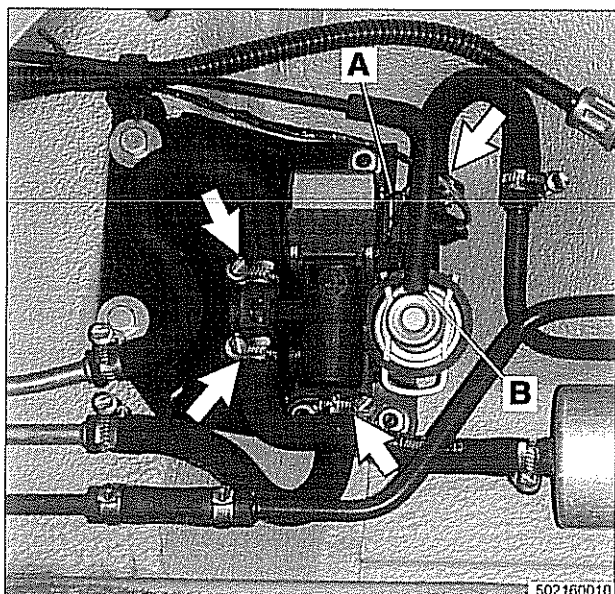
**WARNING—**

*Fuel will be spilled. Use shop rags to capture fuel as fuel lines are disconnected. Do not smoke or work near heaters or other fire hazards.*

- Installation is reverse of removal. Use new hose clamps.

**NOTE—**

*Install protective cover and seals correctly to keep moisture and road dirt out of underbody fuel system components.*



**Tightening torques**

Hose clamps 8 - 13 mm dia.	2 Nm (18 in-lb)
Hose clamps 10 - 16 mm dia.	2 Nm (18 in-lb)
Hose clamps 18 mm dia.	3 Nm (27 in-lb)
Hose clamps 42 - 48 mm dia.	4 Nm (36 in-lb)





# 170 Radiator and Cooling System

<b>General</b> .....	170-2	<b>Cooling System Service</b> .....	170-10
Special tools .....	170-2	Coolant, draining and filling	
Cooling system overview		(6-cylinder models) .....	170-10
(M52 TU shown, others similar) .....	170-3	Coolant, draining and filling (V-8 models) .	170-12
Coolant pump .....	170-3	Cooling system, bleeding .....	170-14
Thermostat .....	170-3	Mechanical (viscous clutch) cooling fan,	
Mechanical thermostat (M52 engine) .....	170-4	removing and installing .....	170-14
Electrically heated thermostat .....	170-4	Electric cooling fan,	
Radiator and expansion tank .....	170-4	removing and installing .....	170-15
Mechanical cooling fan with viscous clutch .	170-4	Thermostat, removing and installing	
Electric (auxiliary) cooling fan .....	170-4	(M52 engine) .....	170-16
Transmission fluid heat exchanger .....	170-5	Thermostat, removing and installing	
Warnings and cautions .....	170-7	(M52 TU or M54 engine) .....	170-17
<b>Troubleshooting</b> .....	170-7	Thermostat, removing and installing	
Cooling system inspection .....	170-8	(V-8 models) .....	170-18
Cooling system pressure test .....	170-9	Coolant pump, replacing	
Combustion chamber leak test .....	170-10	(6-cylinder models) .....	170-19
Thermostat .....	170-10	Coolant pump, replacing (V-8 models) . . .	170-20
		Radiator, removing and installing .....	170-22
		Expansion tank, removing and installing . .	170-24

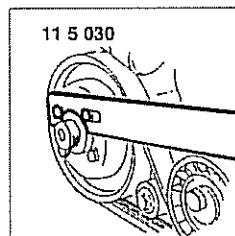
## GENERAL

This section covers component repair information for the engine cooling system.

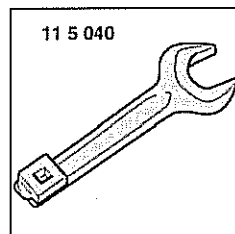
Heater core replacement is covered in **640 Heating and Air Conditioning**.

## Special tools

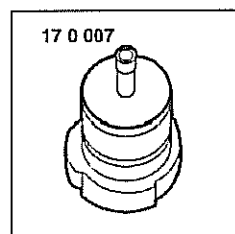
Special tools are necessary for belt-driven fan clutch removal and also for pressure testing the cooling system.



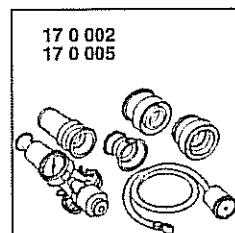
- ◀ Cooling fan counterhold wrench  
(Tool No. BMW 11 5 030)



- ◀ Cooling fan wrench  
(Tool No. BMW 11 5 040)



- ◀ Expansion tank cap test adaptor  
(Tool No. BMW 17 0 007)

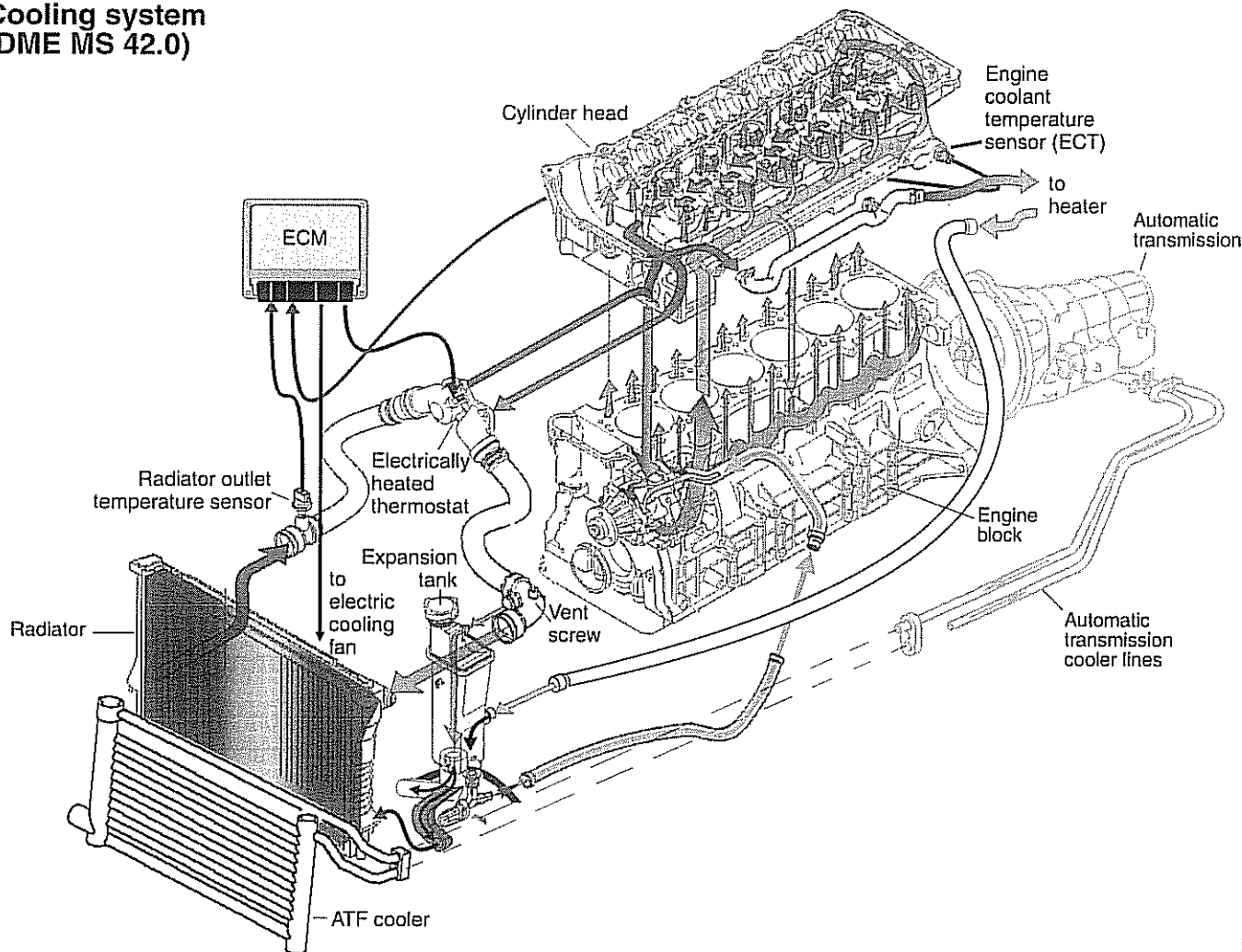


- ◀ Cooling system pressure tester set  
(Tool No. BMW 17 0 002/17 0 005)



## Cooling system overview (M52 TU shown, others similar)

### Cooling system (DME MS 42.0)



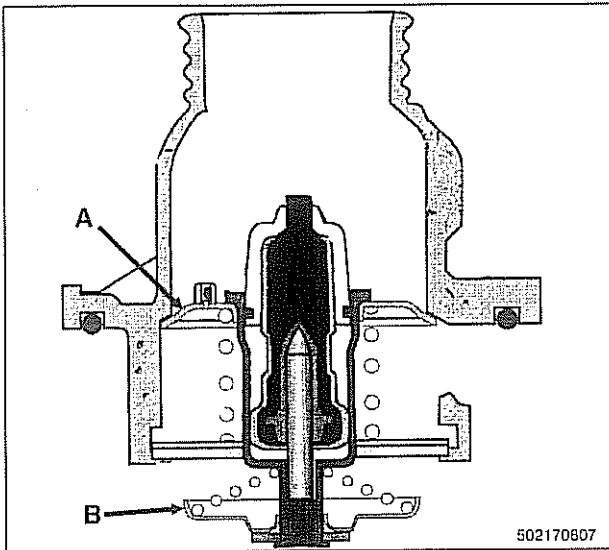
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### Coolant pump

A centrifugal coolant pump is mounted to the front of the engine. The belt-driven pump circulates coolant through the system whenever the engine is running.

### Thermostat

Two types of thermostats are used in the cars covered by this manual. 6-cylinder models built up to 9/1998 (M52 engine) use a conventional mechanical thermostat. All V-8 models and 6-cylinder models from 9/1998 use an electrically heated thermostat.



### Mechanical thermostat (M52 engine)

- ▶ The mechanical thermostat relies on coolant temperature to operate. While coolant is cold, it 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. Port A restricts coolant flow from radiator, and port B restricts coolant flow to radiator.

### Electrically heated thermostat

- ▶ The electrically heated thermostat is DME map-controlled. The engine control module (ECM) activates the thermostat to maintain engine coolant temperature within a narrow range.

In case of failure of the electronics, the mechanical function of the thermostat acts as a fail-safe.

### 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.

On cars with automatic transmission, ATF is circulated through an additional heat exchanger (ATF cooler).

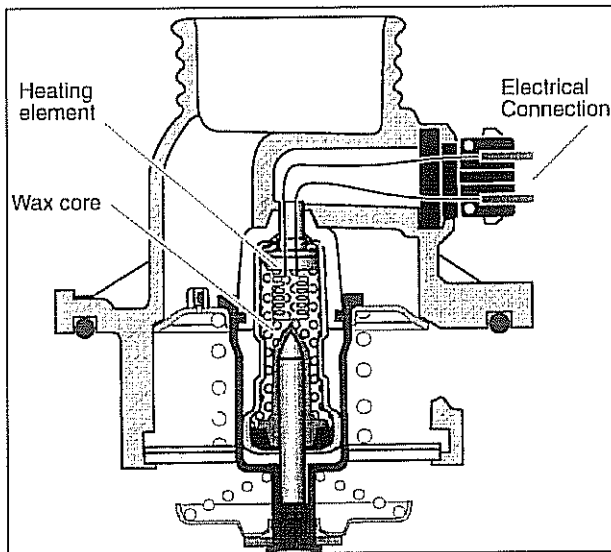
### Mechanical cooling fan with viscous clutch

The mechanical cooling fan is belt-driven via a viscous fluid coupling (clutch) attached to the front of the coolant pump. The fan clutch controls the speed of the fan based on the temperature of the air flowing through the radiator core.

### Electric (auxiliary) cooling fan

The electric cooling fan is mounted on the bumper side of the radiator.

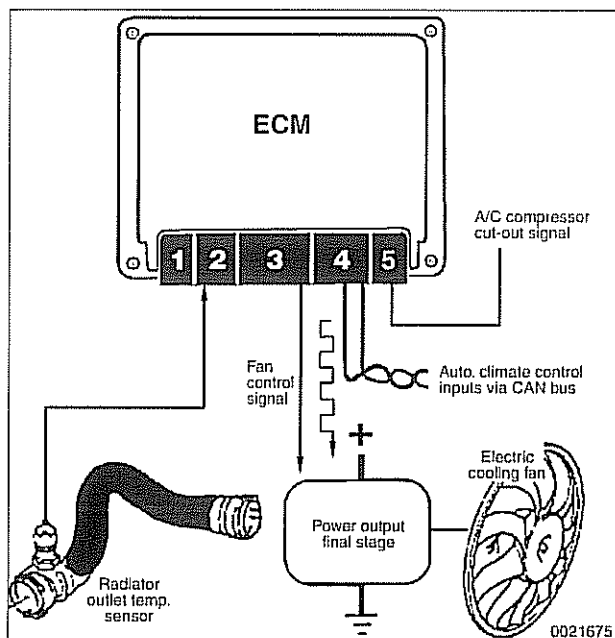
In models manufactured up to 9/1998 (M52 or 1997 M62 engine), the electric cooling fan is controlled by a dual temperature fan switch mounted in the side of the radiator.



### Fan switch calibration (M52, M62 engine)

Electric fan activation:

- |              |                 |
|--------------|-----------------|
| • Low speed  | 91° C (196° F)  |
| • High speed | 104° C (219° F) |



▲ In models manufactured after 9/1998 (M52 TU engine, M54 engine, M62 TU engine), the electric cooling fan is controlled by the engine control module (ECM) via the output final stage.

The output final stage is mounted on the fan housing, next to the fan motor. The fan is operated using a pulse width modulated signal. Fan circuit wiring is protected by a 50-amp fuse. Electric fan activation is based on the following inputs to the ECM:

- Radiator outlet temperature
- Calculated catalytic converter temperature
- Vehicle speed
- Battery voltage
- Calculated A/C pressure

When the vehicle is first started, the ECM activates the electric fan briefly at 20% of its maximum speed, then switches off. This is for diagnostic monitoring. The voltage generated by the fan when it slows down (acting as a generator) must match the stored rpm values in the fan output stage to confirm that the fan is operating correctly.

#### NOTE —

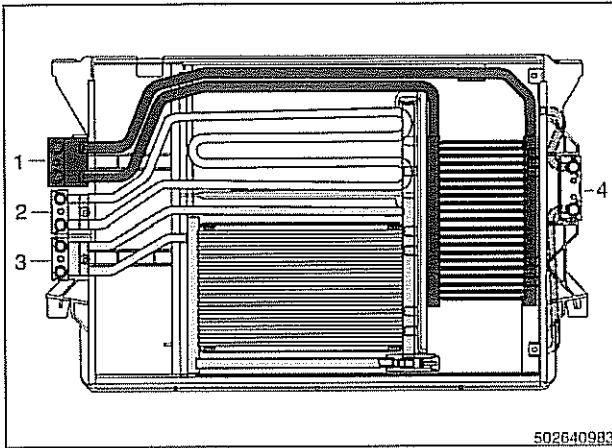
- If the ECM fault memory indicates a cooling fan fault, check that the fan is not seized and that it spins freely.
- When A/C is switched ON, the electric fan is not immediately turned on.
- After the engine is switched OFF, the fan may continue to run at varying speeds for up to 10 minutes, based on calculated catalyst temperature.

### Transmission fluid heat exchanger

Automatic transmission fluid lines circulate transmission fluid (ATF) to and from a heat exchanger at the radiator.

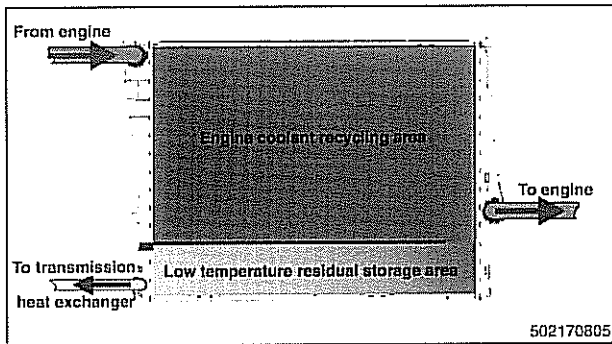
All 6-cylinder models and V-8 models produced to 9/1998 are equipped with a transmission cooler located in a cooling cassette in front of the radiator.

## Radiator and Cooling System



➤ The cooling cassette incorporates cooling coils for various vehicle systems:

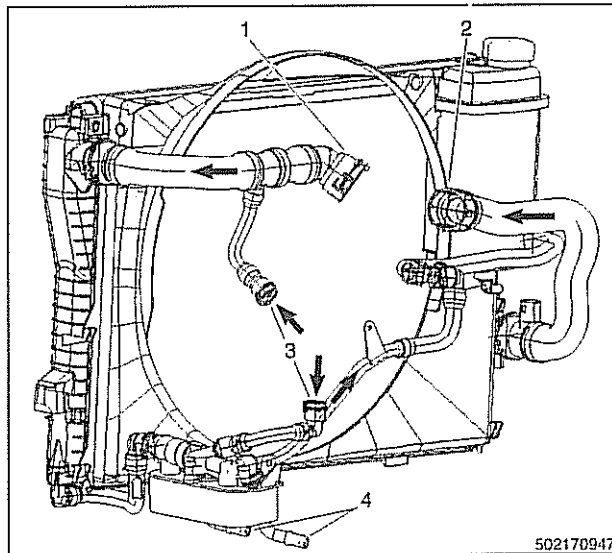
1. Steering fluid cooler
2. Transmission oil cooler
3. A/C condenser



➤ In V-8 cars produced after 9/1998 (M62 TU engine), the engine radiator is divided into an upper chamber (about 80%) and a lower chamber (about 20%). The ATF heat exchanger is coupled to the lower chamber.

On cold engine start-up, the engine coolant is heated more quickly than the transmission fluid. Heat from engine coolant is used to warm up the ATF faster, reducing drag in the transmission and improving fuel mileage.

Once the ATF has reached normal operating temperature, the ATF heat exchanger acts as cooling device. The lower 20% of the radiator stays cooler than the upper chamber, so the ATF is cooled more effectively.



➤ M62 TU cooling system ducting at radiator:

1. Coolant distribution housing connection
2. Thermostat connection
3. Water cooled alternator connections
4. Transmission fluid heat exchanger connections

## 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 the coolant 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. BMW recommends removal of the radiator and expansion tank to flush.*
- *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 the diagnosis of cooling system problems with a thorough visual inspection. If no visual faults are found, it is recommended that the engine control module (ECM) fault memory be checked for stored diagnostic trouble codes (DTCs) using BMW scan tool DISplus or equivalent.

Common cooling system faults can be grouped into one of 4 categories:

- Cooling system leaks
- Poor coolant circulation
- Radiator cooling fan faults
- Electrical/electronic faults

### Cooling system inspection

- Check that coolant pump drive belt tensioner is functioning properly and that belt tension is correct. Belt tensioner systems for the different models are shown in **020 Maintenance**.
- Check condition of coolant pump drive belt.
- Check coolant hoses for cracks or softness. Check clamps for looseness. Check coolant level and check for evidence of coolant leaks from engine.
- Check that radiator fins are not blocked with dirt or debris. Clean radiator using low-pressure water or compressed air. Blow outward, from engine side out.
- To check coolant pump:
  - Remove mechanical cooling fan. See **Mechanical (viscous clutch) cooling fan, removing and installing**.
  - 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** —

*The coolant provides lubrication for the pump shaft, so an occasional drop of coolant leaking 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 boiling point of coolant. Leaks may prevent system from becoming pressurized. If visual evidence is inconclusive, pressure test cooling system as described later to help pinpoint hard-to-find leaks.
- If cooling system is full of coolant and holds pressure:
  - Use an appropriate scan tool to interrogate engine control module (ECM) for radiator fan or DME control circuit faults.
  - Check for loose or worn drive belt.
  - Test for failed thermostat or coolant pump impeller. Some pumps may be fitted with plastic impellers.

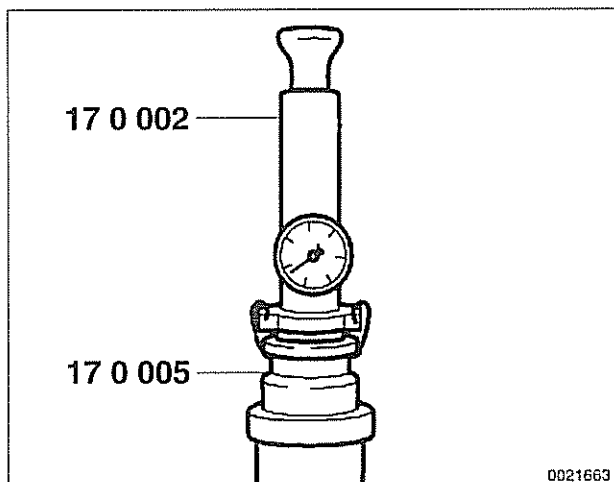
- Check for clogged/plugged radiator or coolant passages.

### 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 engine cold, install pressure tester (BMW special tools 17 0 002/17 0 005 or equivalent) to expansion tank. Pressurize system to specification listed in **Table a. Cooling system test pressures**.

- 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.
- Test expansion tank cap using pressure tester with correct adapter (BMW special tool 17 0 007 or equivalent). Replace faulty cap or cap gasket.

**Table a. Cooling system test pressures**

Component	Test pressure
Radiator	1.5 bar (21.75 psi)
Radiator cap	2 bar (29 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

If the engine overheats or runs too cool and no other cooling system tests indicate trouble, the thermostat may be faulty.

In V-8 models and 6-cylinder models produced after 9/1998 (M52 TU or M54 engine), the electrically heated thermostat is monitored by the OBD II diagnostic software. The fault may lie in the DME software or hardware, or it may lie in the wiring to the thermostat. See **OBD On-Board Diagnostics**.

## COOLING SYSTEM SERVICE

### Coolant, draining and filling (6-cylinder models)

#### WARNING—

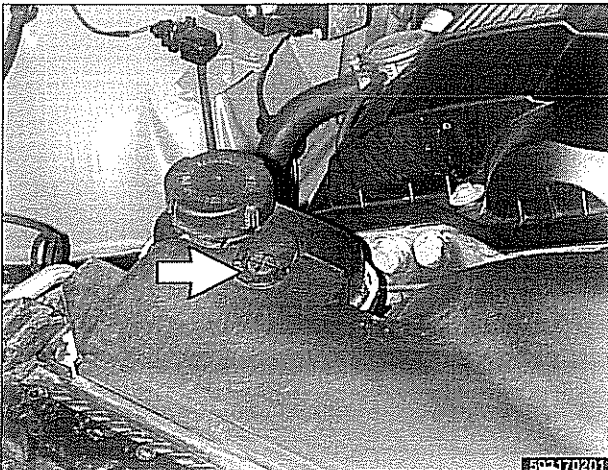
Allow the cooling system to cool before opening or draining the cooling system.

- Raise front of car and support safely.

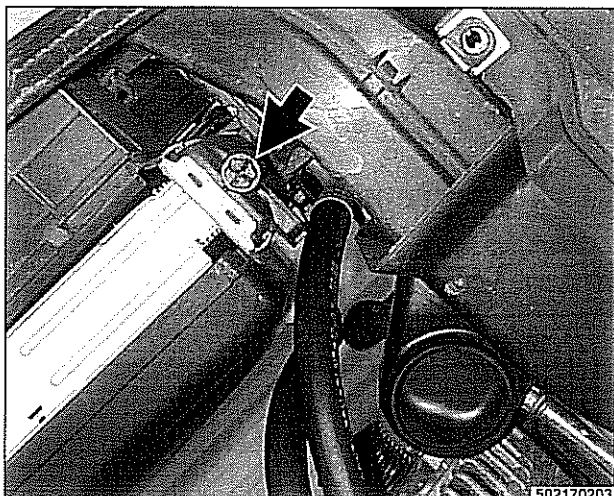
#### WARNING—

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 splash shield from under engine.
- Loosen radiator bleed screw at top radiator fitting (arrow).
- Remove cap from radiator expansion tank. Set temperature controls to full warm.
- Place 3-gallon pail underneath radiator.





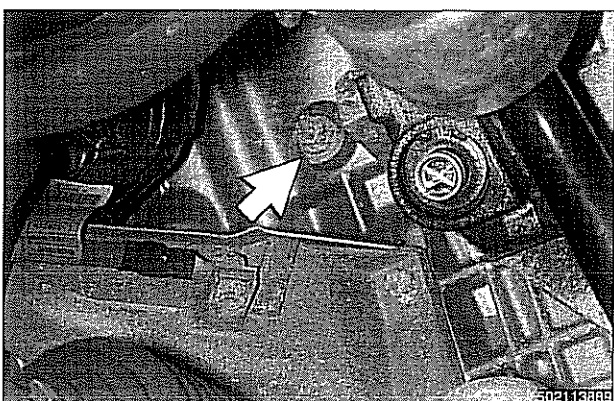


- ◀ Remove drain plug (arrow) at bottom of radiator.

**WARNING—**

*Coolant is poisonous. It is especially lethal to pets. Clean up spills immediately and rinse the area with water. If coolant is ingested, immediately seek medical attention.*

- Place a 3-gallon pail beneath the engine block. Remove engine block coolant drain plug and drain coolant.



- ◀ M52 TU / M54 engine: Block drain plug is located on exhaust side of engine block at cylinder 2 (arrow).

- M52 engine: Block drain plug is located on exhaust side of engine block between cylinders 3 and 4.

- Reinstall radiator and engine block drain plugs using new sealing washers.
- Before refilling radiator:
  - Switch ignition to ON. (Do not start engine).
  - Set temperature controls to full warm.
  - Set blower control to low.
- Using a coolant mixture of 50% antifreeze and 50% distilled water, fill expansion tank slowly. Continue until coolant emerges from bleed screw. Cooling system capacity is listed in **Table c. Cooling system capacity (6-cylinder models)**.

**NOTE—**

- Be sure radiator bleed screw is loose when filling cooling system.
- Tap water may cause corrosion of radiator, engine and coolant hoses.
- Coolant can be reused provided it is clean and less than two years old. Do not reuse coolant when replacing damaged engine parts.
- Bleed cooling system. See **Cooling system, bleeding**.

**Table c. Cooling system capacity (6-cylinder models)**

Engine	Capacity
M52, M52TU, M54	10.5 liters (11.1 US qts)

**Tightening torques**

Block drain plug to block	25 Nm (18 ft-lb)
Radiator drain plug to radiator	2-3 Nm (18-27 in-lb)

**Coolant, draining and filling (V-8 models)****WARNING**—

*Allow the cooling system to cool before opening or draining the cooling system.*

- Raise front of car and support safely.

**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 splash shield from under engine.

- Loosen radiator bleed screw at top radiator fitting (**arrow**).

- Remove cap from radiator expansion tank. With ignition switch in ON position, set temperature controls to full warm.
- Place 5-gallon pail underneath radiator.



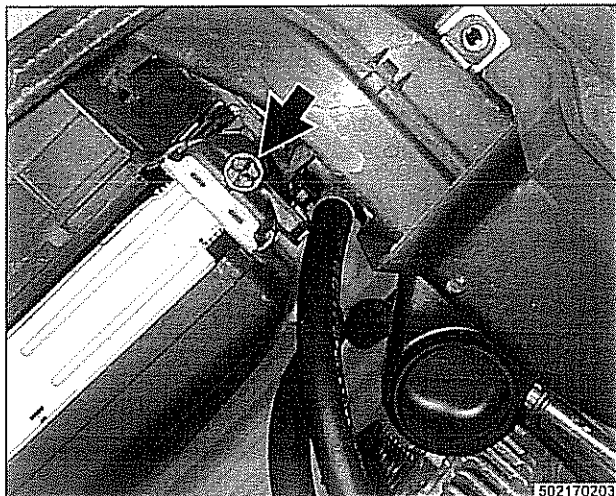
- Remove drain plug (**arrow**) on bottom of radiator and allow coolant to drain.

**NOTE**—

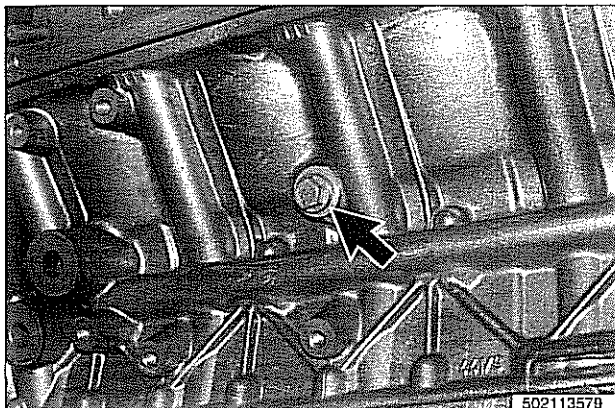
*For radiators without drain plug, remove lower hose to drain radiator.*

**WARNING**—

*Coolant is poisonous. It is especially lethal to pets. Clean up spills immediately and rinse the area with water. If coolant is ingested, immediately seek medical attention.*



## Radiator and Cooling System



◀ V-8 engine block drain plugs (one shown at arrow) are located on each side of engine block (exhaust manifold removed for photo).

- Place 5-gallon pail underneath engine block coolant drain plugs.
- Remove engine block coolant drain plugs and drain coolant.
- Reinstall radiator and engine block drain plugs using new sealing washers.
- Before refilling radiator:
  - Switch ignition to **ON**. (Do not start engine).
  - Set temperature controls to full warm.
  - Set blower control to low.
- Using a coolant mixture of 50% antifreeze and 50% distilled water, fill expansion tank slowly. Continue until coolant emerges from bleed screw. Cooling system capacity is listed in **Table d. Cooling system capacity (V-8 models)**.

### NOTE—

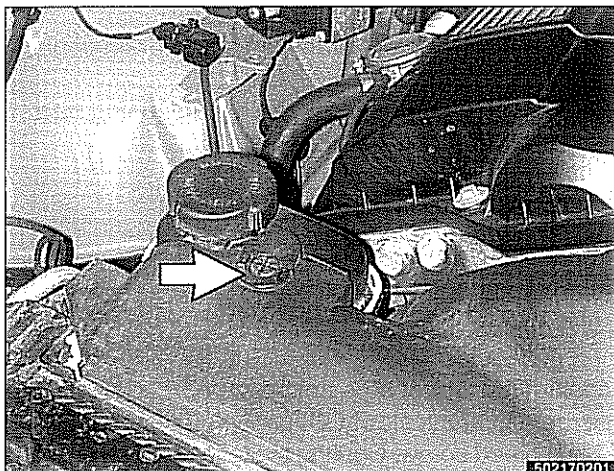
- Be sure radiator bleed screw is loose when filling cooling system.
  - Tap water may cause corrosion of radiator, engine and coolant hoses.
  - Coolant can often be reused provided it is clean and less than two years old. Do not reuse coolant when replacing damaged engine parts.
- Bleed cooling system. See **Cooling system, bleeding**.

**Table d. Cooling system capacity (V-8 models)**

Engine	Capacity
M62, M62 TU	12.0 liters (12.7 US qts)

### Tightening torques

Block drain plug	25 Nm (18 ft-lb)
Radiator drain plug	2 - 3 Nm (18 - 27 in-lb)



## Cooling system, bleeding

Trapped air in the cooling system can prevent proper coolant circulation and overheating. Whenever the coolant is drained and filled, bleed the cooling system to remove trapped air.

- Loosen bleed screw (**arrow**) on radiator expansion tank.
- Set temperature controls in passenger compartment to full warm, set blower to low setting and turn ignition to ON position (do not start engine).

### CAUTION—

*On late model cars with latent heat pump, do not turn ignition to ON position.*

- Slowly add coolant/distilled water mixture to expansion tank until it spills from bleed screw. When coolant spilling from bleed screws is free of air bubbles, tighten screw and replace cap on expansion tank.
  - Run engine until it reaches operating temperature.
  - After engine has cooled, recheck coolant level.
  - Top up so that coolant level indicator is at MAX.
- If trapped air cannot be bled manually, pressure-bleed system using cooling system pressure tester.

### CAUTION—

*Always use genuine BMW coolant or its equivalent to avoid the formation of harmful, clogging deposits in the cooling system.*

### Tightening torque

Radiator bleed screw to radiator	2.5 Nm (22 in-lb)
----------------------------------	-------------------

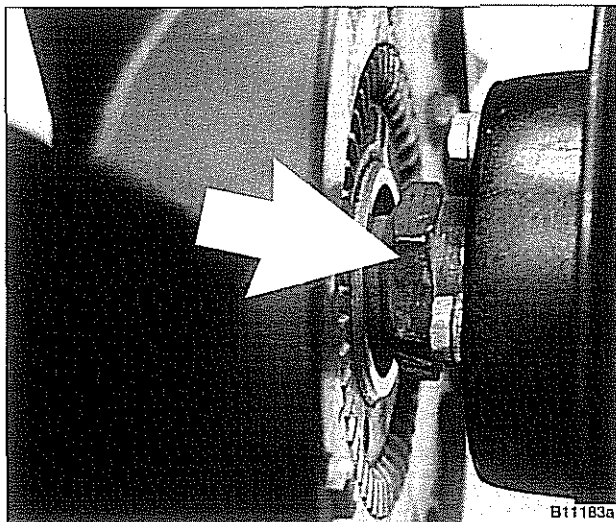
## Mechanical (viscous clutch) cooling fan, removing and installing

The procedure given here describes the removal of the mechanical fan and fan shroud. It is possible to remove the fan without the shroud.



- Working at top of fan shroud:
  - Remove expansion tank bleed screw (**arrow**) and expansion tank locking tabs.
  - Push top of expansion tank toward engine and lift to free from lower mounts.
- Remove two expansion rivets in upper corners of fan shroud. Unclip expansion tank bleed hose located under shroud.

## Radiator and Cooling System



- Remove rubber trim strip between top of shroud and radiator.

- Using 32 mm wrench (BMW special tool 11 5 040) on fan clutch nut (**arrow**), turn wrench in a clockwise direction (working from front of car) while counterholding pulley with BMW special tool 11 5 030. Spin fan off coolant pump.

### NOTE —

The radiator cooling fan nut (32 mm wrench) has left-hand threads.

- Unclip AUC (air quality) sensor from shroud.
- M54 engine: Disconnect auxiliary coolant pump from base of fan shroud.

- Lift fan and shroud together out of engine compartment.

- To replace fan clutch, remove fan mounting bolts and separate viscous clutch from fan.

- Installation is reverse of removal.

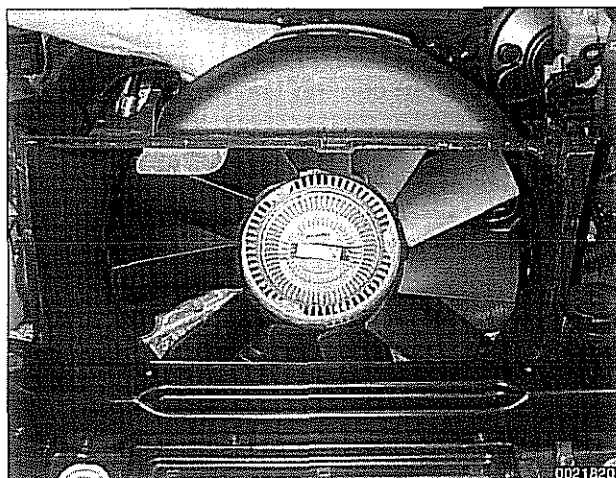
### Tightening torques

#### Clutch nut to pump

- Without BMW tool 11 5 040 40 Nm (29 ft-lb)
- With BMW tool 11 5 040 30 Nm (22 ft-lb)

#### Fan to viscous clutch

10 Nm (89 in-lb)



## Electric cooling fan, removing and installing

The electric cooling fan is mounted behind the front bumper, in front of the A/C condenser.

- Remove front bumper. See **510 Exterior Trim, Bumpers**.
- Remove left and right headlights. See **630 Lights**.
- Where applicable, detach horizontal air ducts behind front bumper and fold to side.
- Disconnect fan electrical connector on right side of radiator shroud and lay aside.
- Detach wire loom from air duct in front of cooling fan.
- Pry out expansion rivets holding air duct. Slide air duct downward to remove.

- Remove fan and fan shroud mounting fasteners. Slide fan and fan shroud downward to remove.
- Reinstallation is reverse of removal.

### Thermostat, removing and installing (M52 engine)

The coolant thermostat is installed in a housing at the front of the engine.

- Drain coolant from radiator and engine block. See **Coolant, draining and filling (6-cylinder models)**.

**WARNING—**

*Allow the cooling system to cool before opening or draining the system.*

- Remove mechanical cooling fan and fan shroud. See **Mechanical (viscous clutch) cooling fan, removing and installing**.
- Disconnect coolant hoses from thermostat housing.
- Remove thermostat housing from front of engine.
- Remove thermostat. Note thermostat direction and orientation before removing.
- Installation is reverse of removal, noting the following:
  - Use new O-ring and gasket(s) when installing thermostat and housing.

**NOTE—**

*Some thermostats have a direction arrow or vent hole near the edge. Install the thermostat so that either the arrow or hole are at the top.*

- Fill system with coolant as described in **Coolant, draining and filling (6-cylinder models)**.

**CAUTION—**

*Be sure to reconnect ground wire(s) at thermostat housing mounting bolt, where applicable.*

**Tightening torques**

Block drain plug to block	25 Nm (18 ft-lb)
Coolant hose clamp (32 — 48 mm hose diameter)	2.5 Nm (22 in-lb)
Radiator drain plug to radiator	2 - 3 Nm (18 - 27 in-lb)
Thermostat housing to cylinder head	10 Nm (89 in-lb)

**Thermostat, removing and installing (M52 TU or M54 engine)**

➤ The electric map-controlled thermostat is part of the thermostat housing at the front of the cylinder head.

1. Bolts (M6)
2. Bolt (M8)
3. Housing with thermostat
4. Gasket

- If a faulty thermostat is suspected, use appropriate scan tool to interrogate ECM for stored fault codes.
- Drain radiator and engine block. See **Coolant, draining and filling (6-cylinder models)**.

**CAUTION—**

*Allow cooling system to cool before opening or draining the system.*

- Remove cooling fan and fan shroud. See **Mechanical (viscous clutch) cooling fan, removing and installing**.

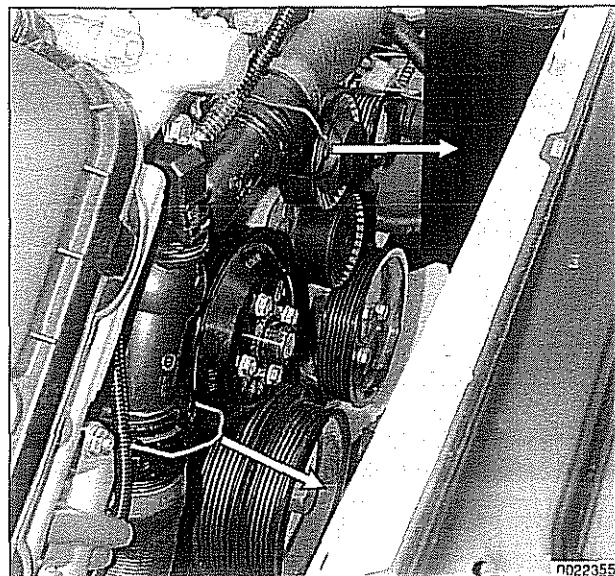
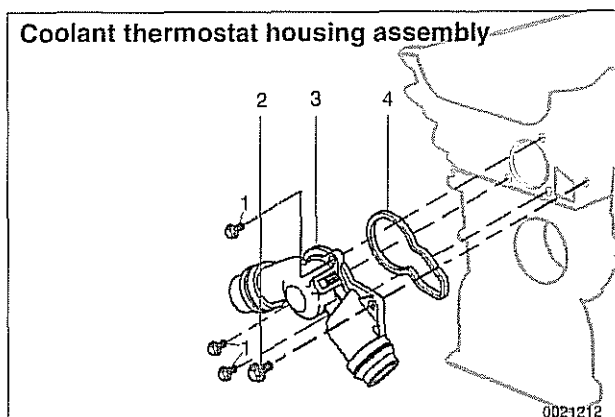
- Disconnect electrical harness connector from thermostat housing.

➤ Lever out retaining clips (**arrows**) and pull hose fittings off thermostat housing.

- Unbolt and remove thermostat housing from front of engine. Loosen nut at top of engine lifting eye to facilitate removal.

- Installation is reverse of removal, noting the following:

- Keep sealing faces free of oil.
- Use new sealing gasket.
- When reinstalling hose to thermostat housing, install clip on hose end fitting, then push hose onto housing until it clicks into place.
- Fill system with coolant. See **Coolant, draining and filling (6-cylinder models)**.

**Coolant thermostat housing assembly**

**Tightening torques**

Block drain plug to block	25 Nm (18 ft-lb)
Radiator drain plug to radiator	2 - 3 Nm (18 - 27 in-lb)
Thermostat housing to cylinder head	10 Nm (89 in-lb)

**Thermostat, removing and installing (V-8 models)**

The electrically-heated thermostat is an integral part of the thermostat housing. The operation of the thermostat is monitored by the engine control module (ECM).

- If a faulty thermostat is suspected, use appropriate scan tool to interrogate ECM for stored fault codes.
- Drain radiator and engine block. See **Coolant, draining and filling (V-8 models)**.

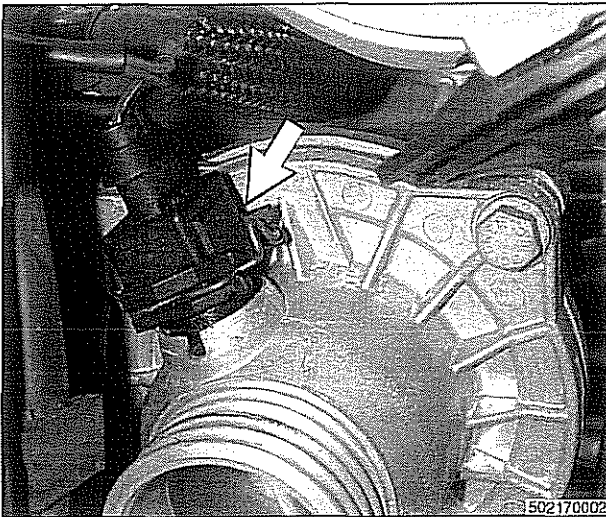
**WARNING —**

*Allow cooling system to cool before opening or draining the system.*

- Disconnect mass air flow (MAF) sensor electrical harness connector. Remove air intake duct together with MAF sensor.
- Remove mechanical cooling fan and fan shroud. See **Mechanical (viscous clutch) cooling fan, removing and installing**.
- Disconnect electrical harness connector (arrow) from thermostat housing.
- Remove coolant hose from thermostat housing.

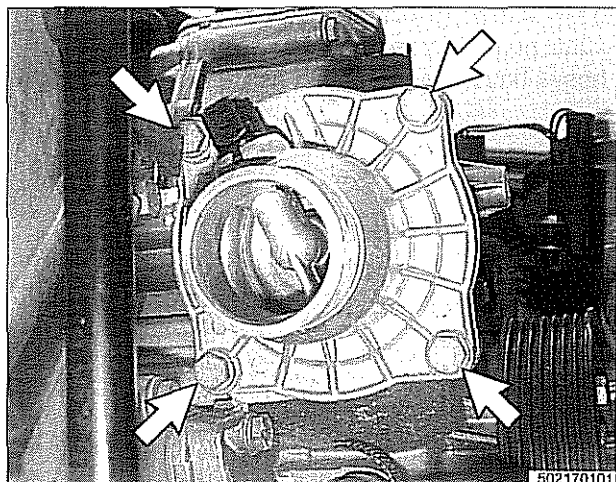
**NOTE —**

- M62 engine: Hose is clamped on.
- M62 TU engine: Hose is attached with quick-disconnect fitting. Remove clip to disconnect hose.





## Radiator and Cooling System



Remove thermostat housing fasteners (**arrows**) and remove thermostat housing.

- Installation is reverse of removal, noting the following:
  - Keep sealing faces clean and free of oil.
  - Use new sealing gasket.
  - Fill system with coolant. See **Coolant, draining and filling (V-8 models)**.

### Tightening torques

Block drain plug to block	25 Nm (18 ft-lb)
Coolant hose clamp (32 — 48 mm hose diameter)	2.5 Nm (22 in-lb)
Radiator drain plug to radiator	2 - 3 Nm (18 - 27 in-lb)
Thermostat cover to coolant pump	10 Nm (89 in-lb)

### Coolant pump, replacing (6-cylinder models)

The engine coolant pump is mounted in the front of the engine in the timing chain cover.

- Drain cooling system as described earlier. See **Coolant, draining and filling (6-cylinder models)**.

#### **WARNING**—

*Allow cooling system to cool before opening or draining system.*

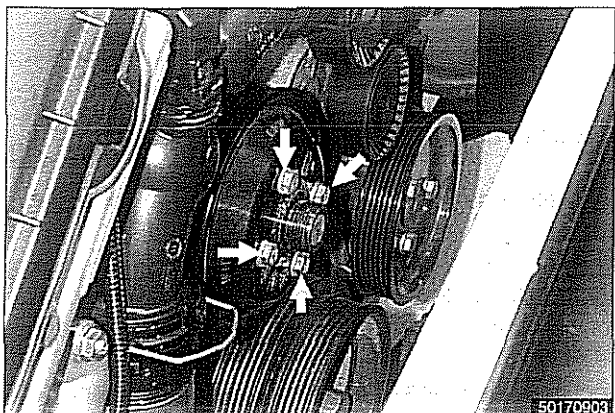
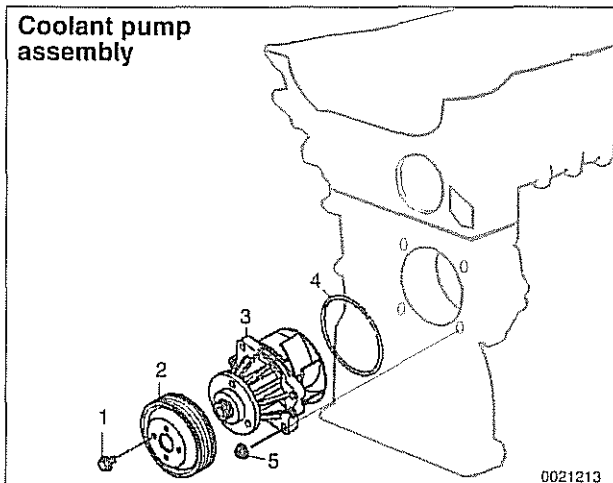
- Remove cooling fan and fan shroud. See **Mechanical (viscous clutch) cooling fan, removing and installing**.
- Remove coolant pump drive belt. See **020 Maintenance**.

Remove coolant pump pulley bolts (**arrows**) and remove pulley from pump.

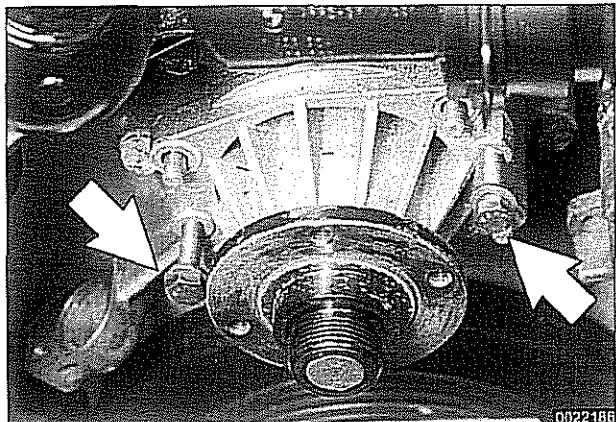
- Remove nuts retaining pump to engine block.

#### **NOTE**—

*The coolant pump is mounted on studs and retained by nuts.*



## Radiator and Cooling System



Insert two M6 screws (**arrows**) in tapped bores and tighten uniformly until pump is free from timing chain cover (thermostat and hoses have been removed for purposes of visual clarity).

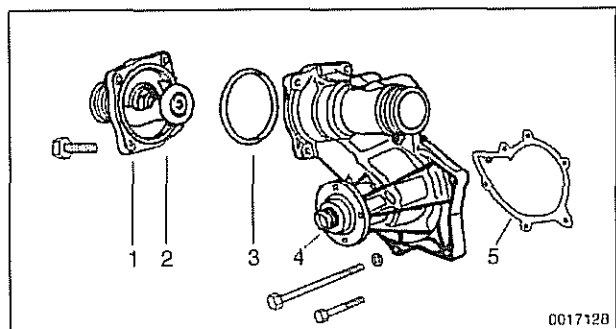
- Installation is reverse of removal, noting the following:
  - Be sure to replace sealing O-ring and gaskets.
  - Coat O-ring with water-based lubricant during installation.
  - Refill with coolant. See **Coolant, draining and filling (6-cylinder models)**.

### Tightening torques

Coolant pump to timing chain cover	10 Nm (89 in-lb)
Coolant pump pulley to coolant pump	10 Nm (89 in-lb)
Engine block drain plug to block	25 Nm (18 ft-lb)
Radiator drain plug to radiator	2 - 3 Nm (18 - 27 in-lb)

### Coolant pump, replacing (V-8 models)

The engine coolant pump is mounted in the front of the engine in the timing chain cover.



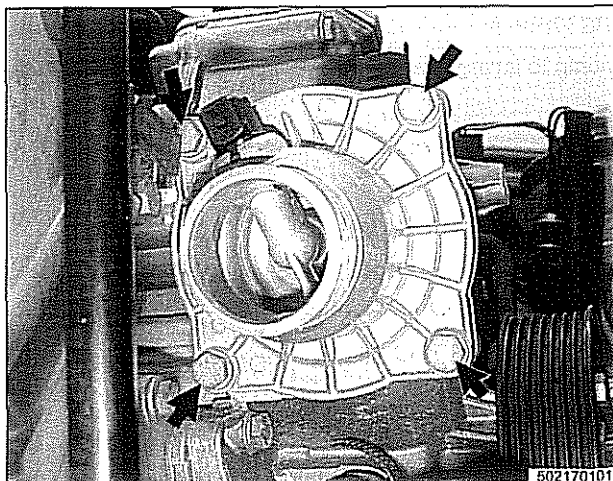
1. Thermostat housing
  2. Thermostat
  3. Thermostat sealing O-ring
  4. Water pump
  5. Water pump gasket
- Drain cooling system. See **Coolant, draining and filling (V-8 models)**.
  - Remove cooling fan and fan shroud. See **Mechanical (viscous clutch) cooling fan, removing and installing**.
  - Remove engine drive belts: See **020 Maintenance**.

#### NOTE —

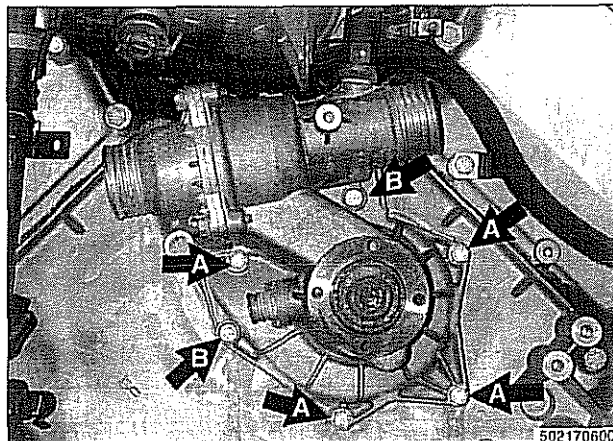
Mark direction of drive belt rotation if reusing belt.

- Remove vibration dampener. See **117 Camshaft and Timing Chain**.
- Disconnect mass air flow (MAF) sensor electrical harness connector. Remove air intake duct together with MAF sensor.
- Disconnect coolant hoses from thermostat housing and coolant pump housing.

## Radiator and Cooling System



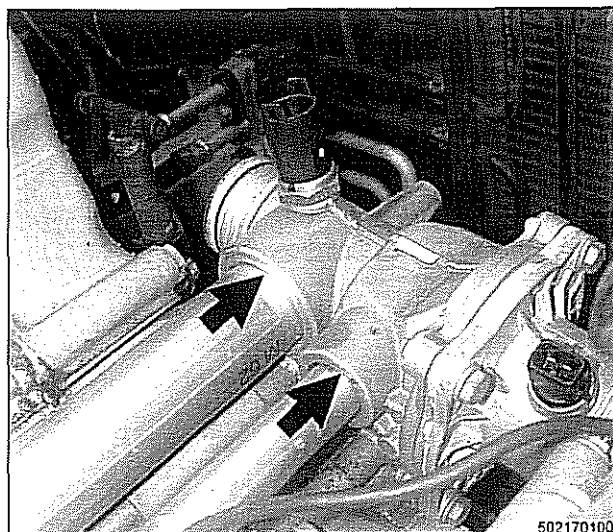
- Disconnect thermostat and cooling system temperature sensor plug connectors.
- ◀ Remove thermostat housing fasteners and remove housing.
- Remove coolant pump pulley bolts and remove pulley from pump.



- ◀ Remove fasteners A and B (arrows).

**NOTE —**

- The coolant pump is retained to the block using different length bolts.
- Bolts A: M6 X 105 mm
- Bolts B: M6 X 35 mm



- ◀ Slide coolant pump away from coolant pipes (arrows) while being careful not to dislodge pipes from fittings at rear of engine.
- Installation is reverse of removal, noting the following:
  - Replace all sealing O-rings and washers.
  - Coat O-rings with water-based lubricant during installation.
  - Fill system with coolant. See **Coolant, draining and filling (6-cylinder models)** or **Coolant, draining and filling (V-8 models)**.

## Radiator and Cooling System

### Tightening torques

Coolant pump to timing chain cover	10 Nm (89 in-lb)
Coolant pump pulley to coolant pump	10 Nm (89 in-lb)
Engine block drain plug to block	25 Nm (18 ft-lb)
Radiator drain plug to radiator	2 - 3 Nm (18 - 27 in-lb)
Thermostat cover to coolant pump assembly	10 Nm (89 in-lb)

### Radiator, removing and installing

Removal of the radiator is similar for V-8 and 6-cylinder models.

- Raise front of car and support safely.

#### **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 splash shield from under engine.
- Drain radiator and engine block. See **Coolant, draining and filling (V-8 models)**.

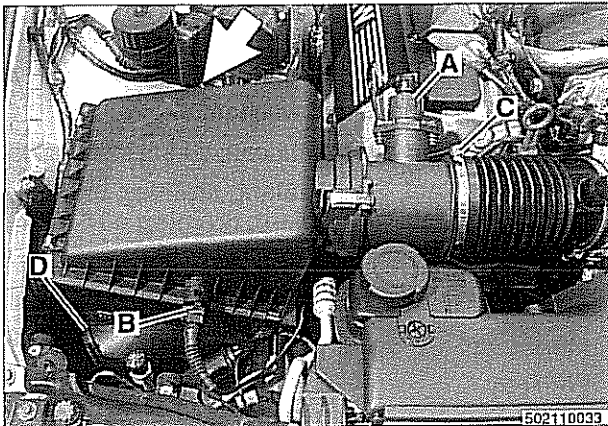
#### **WARNING**—

*Allow cooling system to cool before opening or draining system.*

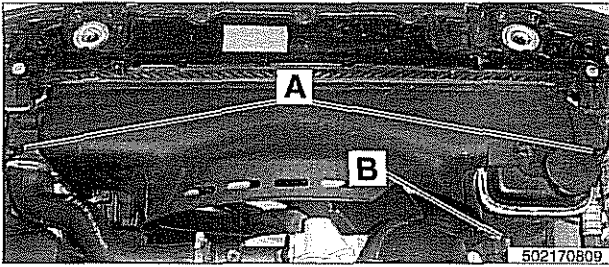


Remove air filter housing:

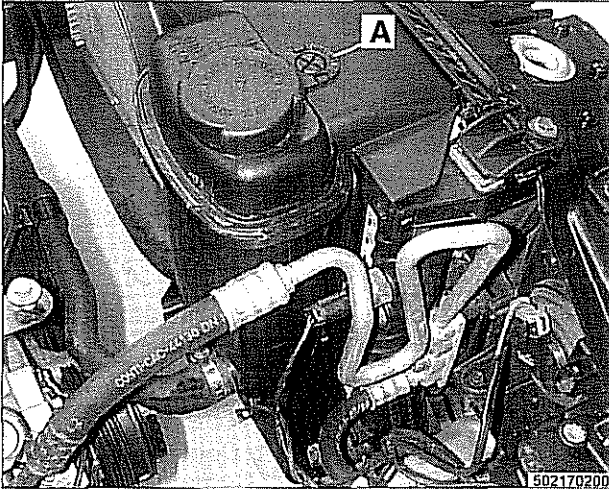
- Disconnect electrical harness connectors (**A** and **B**).
- Loosen clamps (**C** and **D**).
- Remove mounting fastener (**arrow**) and remove air filter housing together with mass air flow (MAF) sensor.



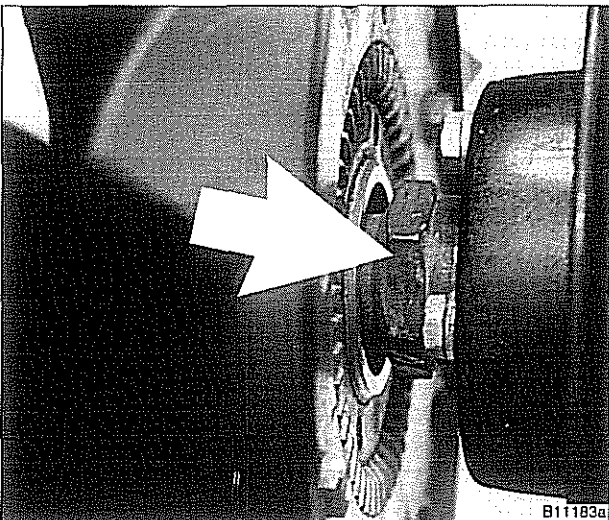
## Radiator and Cooling System



- Pry out expansion rivets (A) on left and right side of fan shroud. Loosen hose clamp (B) and remove hose from expansion tank.



- Remove expansion tank:
  - Remove expansion tank cap, vent plug (A) and tank retaining clips (arrows).
  - Lift expansion tank upward and off lower retaining lugs.
  - Push shroud back to expose expansion tank vent line. Remove line.



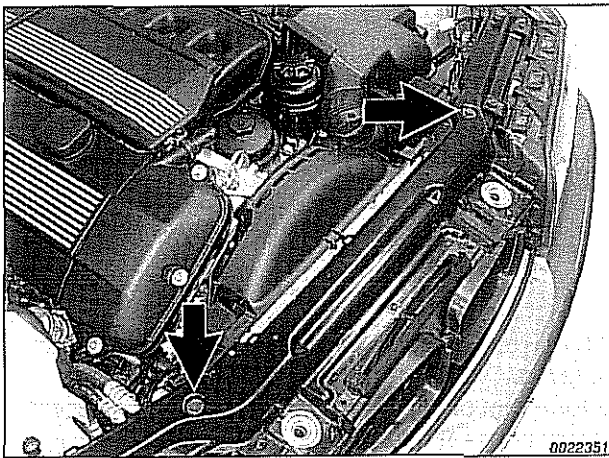
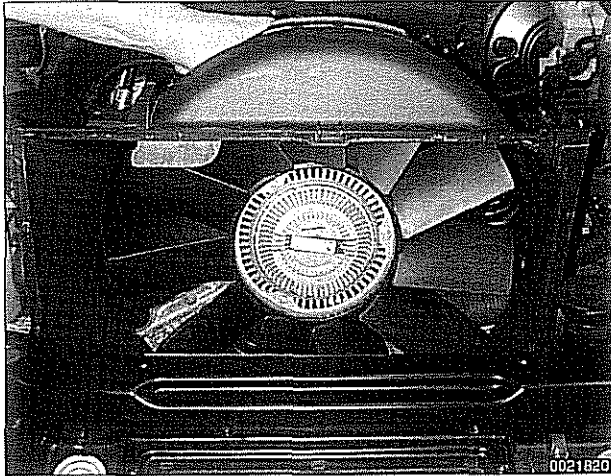
- Using 32 mm wrench (BMW special tool 11 5 040) on fan clutch nut (arrow), turn wrench in a clockwise direction (working from front of car) while counterholding pulley with BMW special tool 11 5 030. Spin fan off coolant pump.

### NOTE —

*The radiator cooling fan nut (32 mm wrench) has left-hand threads.*

- Disconnect electrical harnesses from AUC (air quality) sensor and coolant level sensor.

## Radiator and Cooling System



▲ Lift fan and shroud together out of engine compartment.

– Detach upper and lower radiator hoses.

**NOTE—**

*Later models use retaining clips to fasten coolant hoses to expansion tank and radiator.*

– Disconnect temperature sensor harness connector.

▲ Remove radiator support bolts and supports (arrows), 6-cylinder shown.

– Slide right side of radiator back toward engine and pull radiator up to remove.

– Installation is reverse of removal, noting the following:

- Fill radiator and cooling system. See **Coolant, draining and filling (6-cylinder models)** or **Coolant, draining and filling (V-8 models)**.

**Tightening torques**

Engine block drain plug to block	25 Nm (18 ft-lb)
Radiator drain plug to radiator	2 - 3 Nm (18 - 27 in-lb)

### Expansion tank, removing and installing

– Raise front of car and support safely.

**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.*

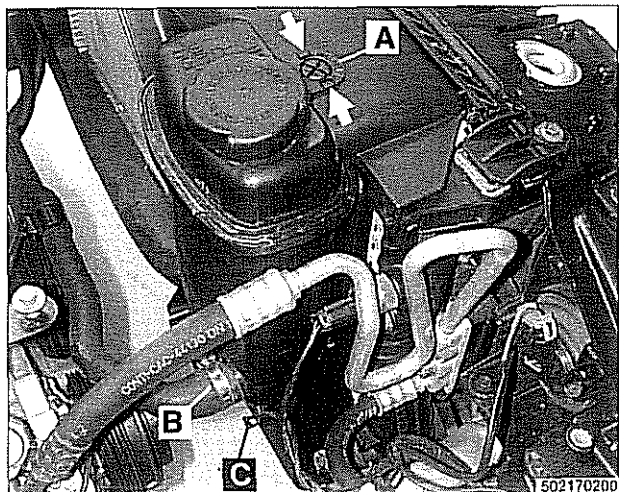
– Remove splash shield from under engine.

– Drain radiator as described earlier. See **Coolant, draining and filling (6-cylinder models)** or **Coolant, draining and filling (V-8 models)**.

**WARNING—**

*Allow cooling system to cool before opening or draining system.*

## Radiator and Cooling System



### ◀ Disconnect expansion tank:

- Remove expansion tank bleed screw and support clip (A).
- Loosen hose clamp (B) and disconnect coolant hose from expansion tank.
- Disconnect harness connector from coolant level sensor (C).
- Push top of expansion tank toward engine and disconnect bleed hose.
- Lift expansion tank to free it from lower mounts, then lift straight up to remove.

### — Installation is reverse of removal, noting the following:

- *Fill radiator and cooling system as described earlier. See **Coolant, draining and filling (6-cylinder models) or Coolant, draining and filling (V-8 models).***







# 180 Exhaust System

<b>General</b> .....	180-2	<b>Oxygen Sensors</b> .....	180-9
<b>Exhaust System</b> .....	180-2	Oxygen sensors (precatalyst), replacing (M52 TU and M54) .....	180-9
Exhaust system, removing and installing ...	180-2	Oxygen sensors (post-catalyst), replacing (M52 TU and M54) .....	180-9
Muffler, replacing .....	180-4	Oxygen sensor, replacing (M52 and M62 engine) .....	180-10
<b>Exhaust Manifolds</b> .....	180-5	<b>Exhaust System Diagrams</b> .....	180-11
Exhaust manifolds, removing and installing (M52 engine) .....	180-5	M52 engine (528i 1997–1998) .....	180-11
Exhaust manifolds, removing and installing (M52 TU and M54 engines) .....	180-6	M52 TU and M54 engines (528i 1999–2000 and 525i 2001–2003) ...	180-12
Exhaust manifolds, removing and installing (M62 engine) .....	180-7	M54 engine (530i 2001–2003) .....	180-13
		M62 engine (540i 1997–1998) .....	180-14
		M62 TU engine (540i 1999–2003) .....	180-15

## 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 clothing 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 old exhaust parts.*

## Exhaust system, removing and installing

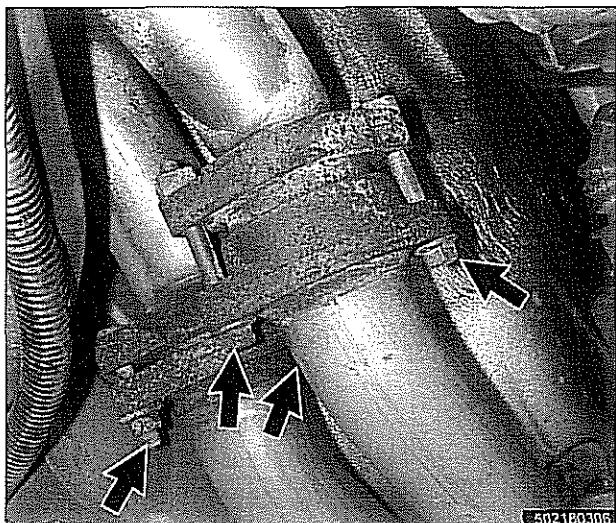
The removal and installation procedures given here are general procedures for all models. The removal of the exhaust system as a complete unit is recommended. Once the complete system is removed from the car, individual pipes and mufflers can be more easily replaced.

### **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 oxygen sensors. Oxygen sensors can be easily ruined.*



- With 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.*

- Disconnect oxygen sensor connector(s).
- ◀ Loosen and remove bolts holding front exhaust pipes to exhaust manifolds (**arrows**). Right side of V8 model shown.
- Support exhaust system.
- Where applicable, disconnect exhaust support bracket assembly from transmission.
- ◀ Remove hangers by prying off bracket (**arrows**).
- Lower exhaust system as a single unit to ground.

**NOTE —**

*If the catalytic converter/front exhaust pipe assembly is to be replaced, transfer the oxygen sensors to the new pipe(s).*

**Tightening torque**

Oxygen sensor	55 Nm (41 ft-lb)
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- Installation is reverse of removal.
  - Make sure there is at least 20 mm (3/4 in.) clearance between exhaust system and car body at every point.
  - Loosely install all exhaust system mounting hardware and hangers before tightening fasteners to their final torque.
  - Coat manifold studs with copper paste before installing nuts.

**NOTE —**

*Where applicable, tighten front pipe with semi-flexible compensator last when installing front pipe to manifolds.*

**Tightening torques**

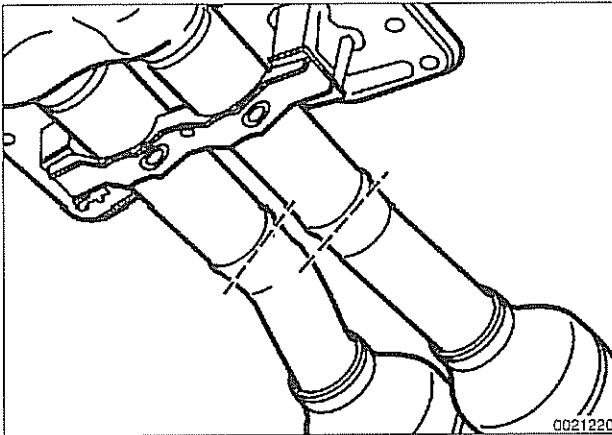
Exhaust manifolds to cylinder head	22 Nm (17 ft-lb)
Front exhaust pipe to manifolds	30 Nm (22 ft-lb)

To prevent exhaust system rattles and vibration, the system should be slightly preloaded by pushing the rear clamping brackets forward about 7 mm (1/4 in).



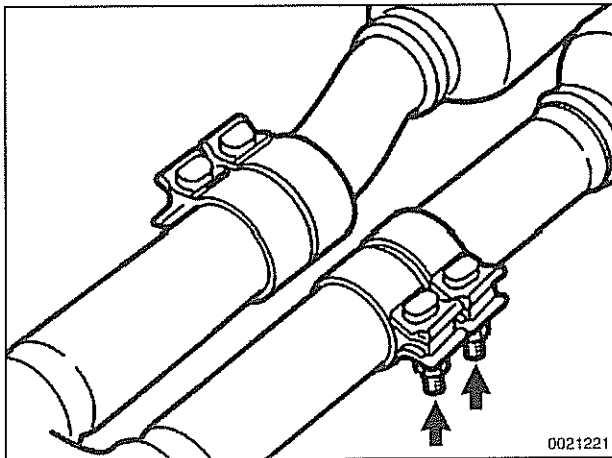
## Muffler, replacing

BMW offers individual mufflers as replacement parts for the original one-piece assembly. Replacement of a rear muffler may be possible with the system installed on the car. Replacement of the front or middle muffler should only be done with the exhaust removed from the car.



◀ Mark length of new muffler pipe(s) on old system.

- Use exhaust pipe cutter to cut pipe(s). Deburr cut pipe end(s).



◀ Use clamping sleeves to join new pipe(s) to old.

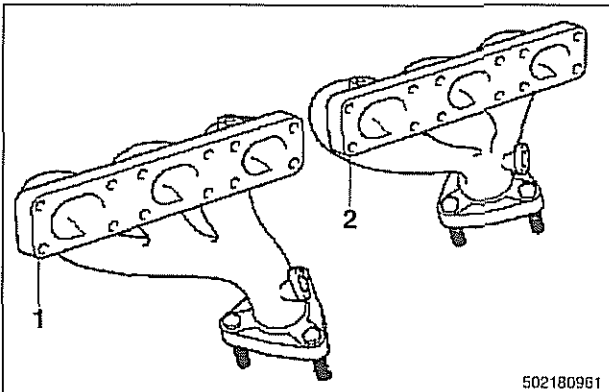
- Make sure pipe ends are centered inside sleeve.
- Point clamping sleeve bolt threads (**arrows**) down.

- Reinstall exhaust system.

## EXHAUST MANIFOLDS

Exhaust manifold removal procedures are organized according to engine code. If necessary, see **100 Engine-General** for engine code and application information.

### Exhaust manifolds, removing and installing (M52 engine)



- ◀ Exhaust manifolds for the M52 engine.

Always use new retaining nuts and gaskets when removing and installing the exhaust manifolds.

- With exhaust system 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.*

- Disconnect secondary air check valve and pipe from exhaust manifold.
- Unbolt front exhaust pipe(s) from exhaust manifold(s).
- Remove exhaust support bracket from transmission.
- Loosen and remove nuts from exhaust manifolds and remove manifolds. Discard nuts and gaskets.

#### **NOTE** —

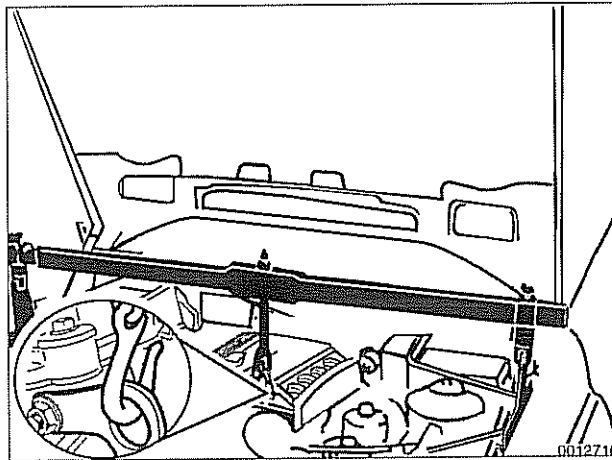
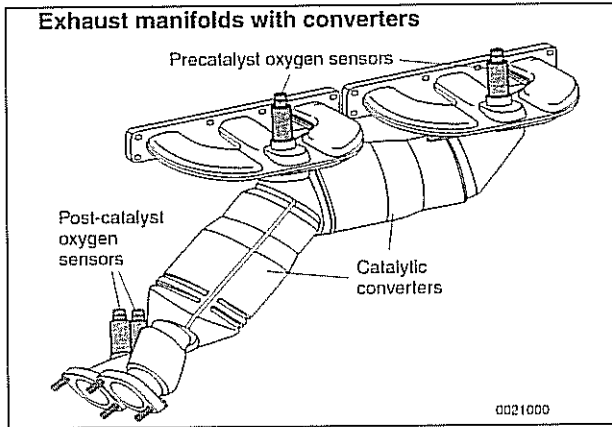
*On cars with oxygen sensors mounted in the exhaust manifolds, use care when removing manifolds. To be safe, remove the sensors from the manifolds before removing manifolds.*

- Installation is reverse of removal.
  - Coat exhaust manifold mounting studs with copper paste before installing new nuts.
  - Install manifold gaskets with arched side facing manifolds.

#### **Tightening torque**

Exhaust manifolds to cylinder head	20 Nm (15 ft-lb)
------------------------------------	------------------

## Exhaust manifolds, removing and installing (M52 TU and M54 engines)



- ▲ The exhaust manifolds incorporate the catalytic converters. Two precatalyst and two post-catalyst oxygen sensors are mounted in the exhaust manifold assembly.

Under normal conditions, the catalytic converters do not require replacement unless damaged. Always use new retaining nuts and gaskets when removing and installing the exhaust manifolds.

- ▲ Using engine support equipment (BMW special tools 00 0 200, 00 0 201, 00 0 202, 00 0 204, 00 0 208 or equivalent), connect to lifting eye on front of engine. Raise engine approx. 5 mm (1/4 in).

- With exhaust system cold, raise and support car for access to exhaust system.

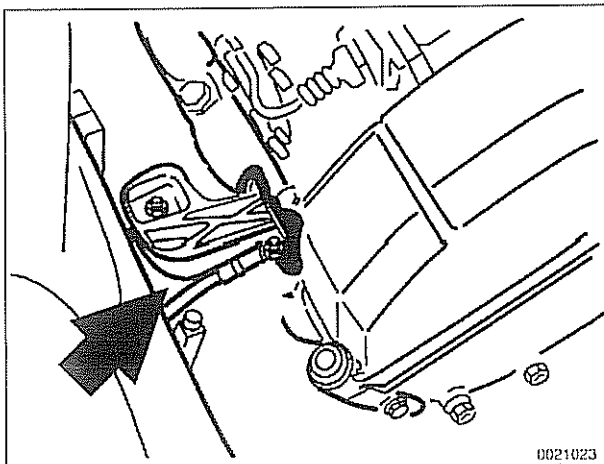
### **WARNING—**

*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.*

- In order to avoid damaging oxygen sensors:
  - Detach oxygen sensor harness connectors.
  - Remove oxygen sensors from exhaust manifolds as described later in this group.

### **CAUTION—**

*Take care that the front and rear oxygen sensor connectors are not mixed up.*



- Unbolt and remove secondary air check valve and pipe from right front of cylinder head/exhaust manifold.
- Working underneath car, unbolt front exhaust pipes from exhaust manifolds.
- ▲ With engine supported from above, remove right engine mount bracket and right engine mount (arrow).
- Loosen and remove nuts from exhaust manifolds and remove manifolds. Discard nuts and gaskets.

**NOTE—**

The front exhaust manifold must be removed before the rear manifold.

- Installation is reverse of removal.
  - Coat exhaust mounting studs with CRC or equivalent copper paste.
  - Use new gaskets and self-locking nuts.

**Tightening torques**

Exhaust manifold to cylinder head	20 Nm (15 ft-lb)
Front exhaust pipe to manifold	30 Nm (22 ft-lb)
Oxygen sensor to manifold	50 Nm (37 ft-lb)

**Exhaust manifolds, removing and installing (M62 engine)**

Always use new retaining nuts and gaskets when removing and installing the exhaust manifolds.

**NOTE—**

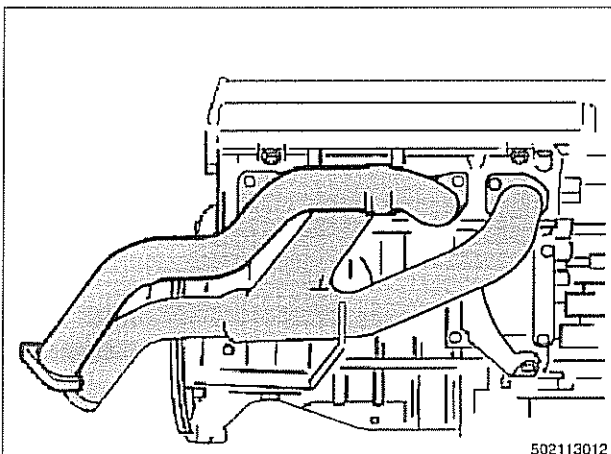
Access to manifolds is extremely limited. If removing exhaust manifolds as part of additional engine work (such as cylinder head removal), it may be easier to first remove engine.

- With exhaust system cold, raise and support car for access to exhaust system.

**WARNING—**

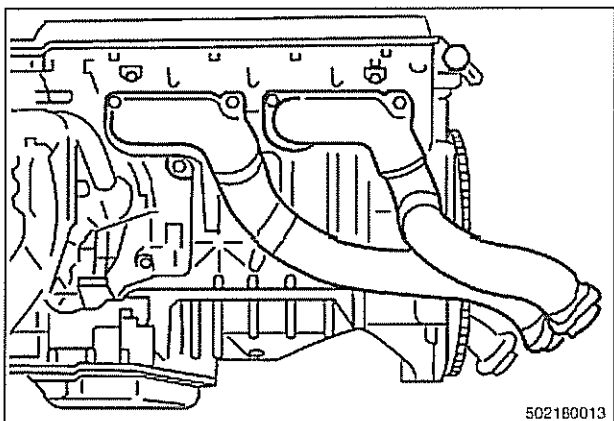
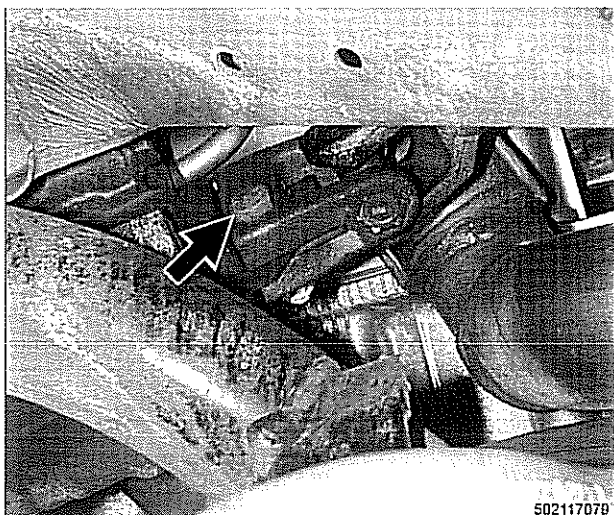
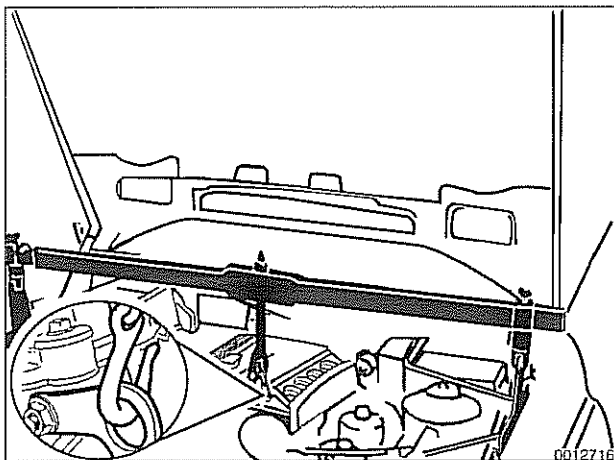
Do not work under a lifted car unless it is solidly supported on jack stands designed for the purpose. Never work under a car that is supported solely by a jack.

- Remove exhaust system. See **Exhaust system, removing and installing**.
- Removing right side exhaust manifolds (cylinder bank 1–4):
  - Remove heat baffle plate.
  - Disconnect plug connection to oxygen sensor.
  - ◀ Remove nuts securing exhaust manifolds to head.
    - Remove manifolds towards bottom.
- Installation is the reverse of removal.
  - Coat exhaust mounting studs with CRC or equivalent copper paste.
  - Use new gaskets and self-locking nuts.



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## Exhaust System



- Removing left side exhaust manifolds (cylinder bank 5-8):
  - Remove heat baffle plate on left side.
  - Remove oxygen sensor using BMW special tool 11 7 030 or similar oxygen sensor socket.

- ▲ Install BMW special tools 00 0 200, 00 0 201, 00 0 202, 00 0 204, and 00 0 208 or other suitable engine lifting support above engine and attach to lifting eye on left head.

### NOTE—

*The supports on special tool 00 0 208 must rest on the screws on the fenders.*

- Remove nut at top of engine support on left side.
- Raise engine at front suspension lug a maximum of 25 mm (1.0 in).
- ▲ Release clamping bolt and nut (**arrow**) and slide universal joint off steering gear.

- ▲ Remove nuts securing left exhaust manifold to head.
  - Raise front of manifold as high as possible past end position of steering gear and feed out towards bottom.
- Installation is reverse of removal.
  - Coat exhaust mounting studs with CRC or equivalent copper paste.
  - Use new exhaust gaskets and self-locking nuts.
  - Install new self-locking nuts on engine mount and steering shaft bolt.



## OXYGEN SENSORS

### Oxygen sensors (precatalyst), replacing (M52 TU and M54)

The precatalyst oxygen sensors are installed at the top of the exhaust manifolds.

**WARNING—**

*Allow components to cool before servicing.*

- Using BMW scan tool DISplus (Diagnostic Information System) or equivalent, read out and clear ECM fault codes.
- ◀ Working at right side of engine above exhaust manifolds, remove front or rear oxygen sensor harness connector (arrows) from bracket, then separate plug.

**NOTE—**

*In photo, secondary air pump has been removed for clarity.*

- Remove oxygen sensor using special oxygen sensor removal socket.
- Installation is reverse of removal.
  - New sensor threads come coated with anti-seize paste.
  - If reusing a sensor, apply thin coat of anti-seize paste to threads only. Do not contaminate tip of sensor with paste or lubricants of any sort.
  - Install harness and connector in original location.

**Tightening torque**

Oxygen sensor to manifold	50 Nm (37 ft-lb)
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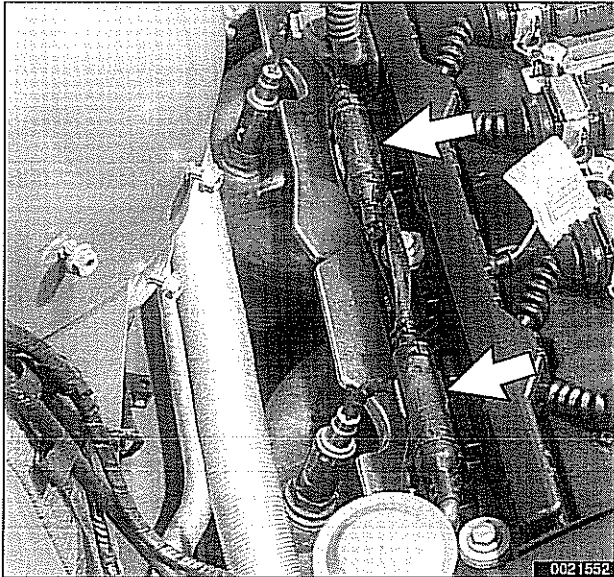
### Oxygen sensors (post-catalyst), replacing (M52 TU and M54)

The post-catalyst oxygen sensors are installed at the rear of the catalytic converters.

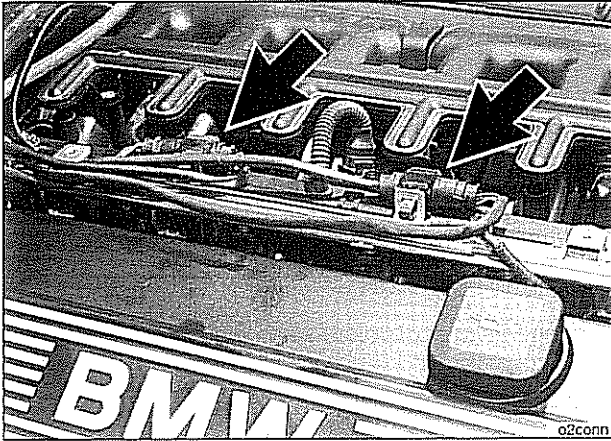
**WARNING—**

*Allow components to cool before servicing.*

- Using BMW scan tool DISplus or equivalent, read out and clear ECM fault codes.
- Remove large cover from above fuel rail/intake manifold.



## Exhaust System



- ⚠ Label and disconnect sensor harness connectors (arrows).

**CAUTION—**

Label connectors so that front and rear connectors are not mixed up.

- Detach harness from guides and brackets.
- Remove oxygen sensor from exhaust manifold using special tool 11 7 030 or equivalent.
- Installation is reverse of removal.
  - New sensor threads come coated with anti-seize paste.
  - If reusing old sensor, apply thin coat of anti-seize paste to threads only. Do not contaminate tip of sensor with paste or lubricants of any sort.
  - Install harness and connector in original location.

**Tightening torque**

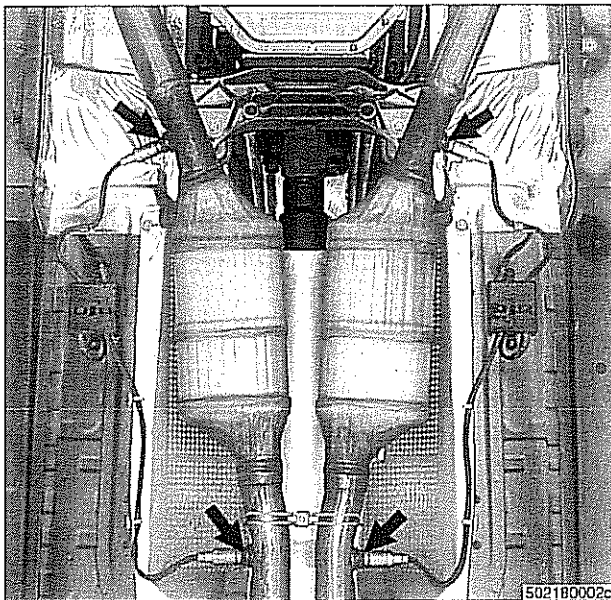
Oxygen sensor to manifold	50 Nm (37 ft-lb)
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### Oxygen sensor, replacing (M52 and M62 engine)

The sensors are installed at the front and rear of the catalytic converters.

**WARNING—**

Allow components to cool before servicing.

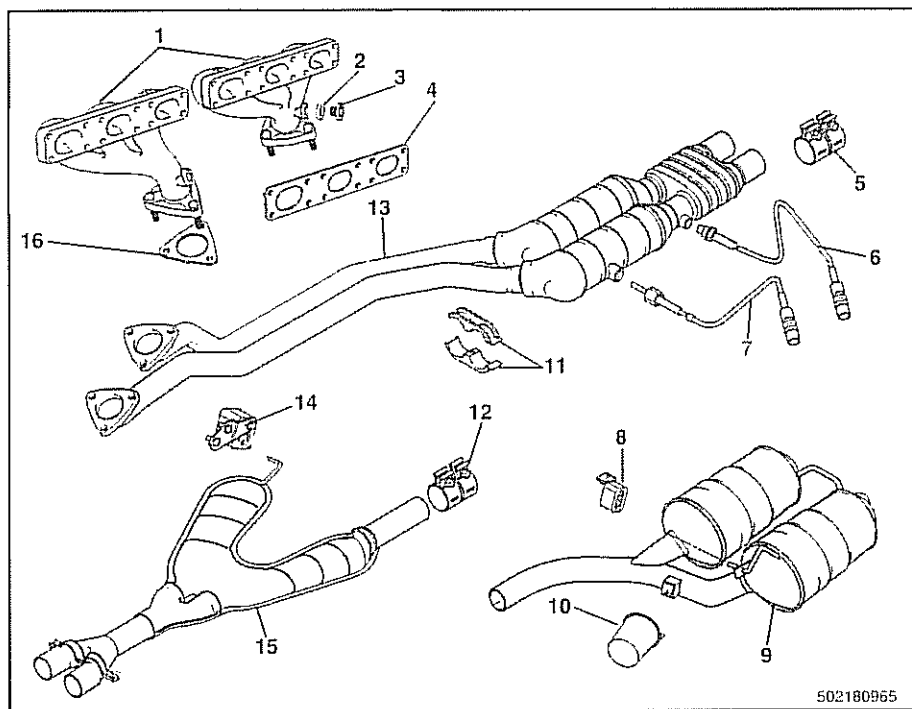


- Using BMW scan tool DISplus or equivalent, read out and clear ECM fault codes.
- Detach harness from guides and brackets.
- ⚠ Remove oxygen sensors (**arrows**) from exhaust using special tool 11 7 030 or equivalent.
- Installation is reverse of removal.
  - New sensor threads come coated with anti-seize paste.
  - If reusing a sensor, apply thin coat of anti-seize paste to threads only. Do not contaminate tip of sensor with paste or lubricants of any sort.
  - Install harness and connector in original location.

**Tightening torque**

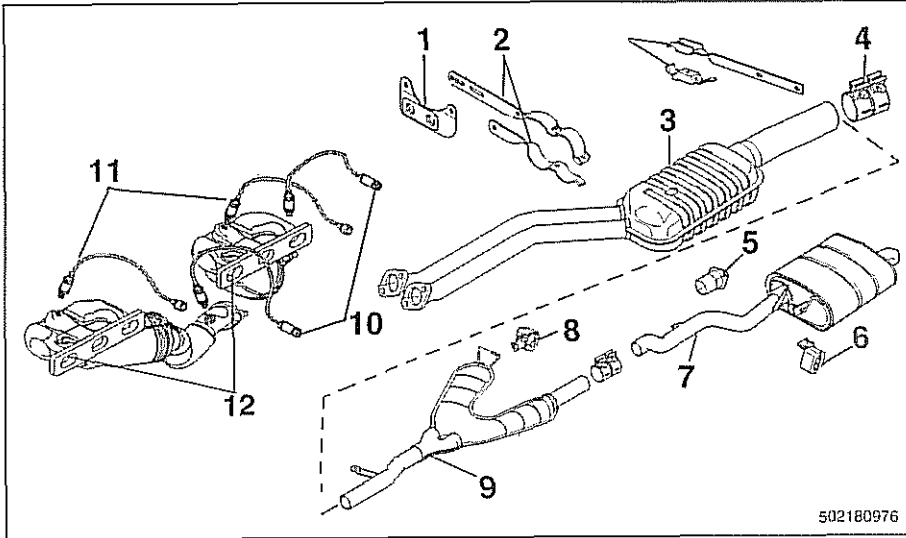
Oxygen sensor to manifold	50 Nm (37 ft-lb)
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## EXHAUST SYSTEM DIAGRAMS


**M52 engine  
(528i 1997-1998)**

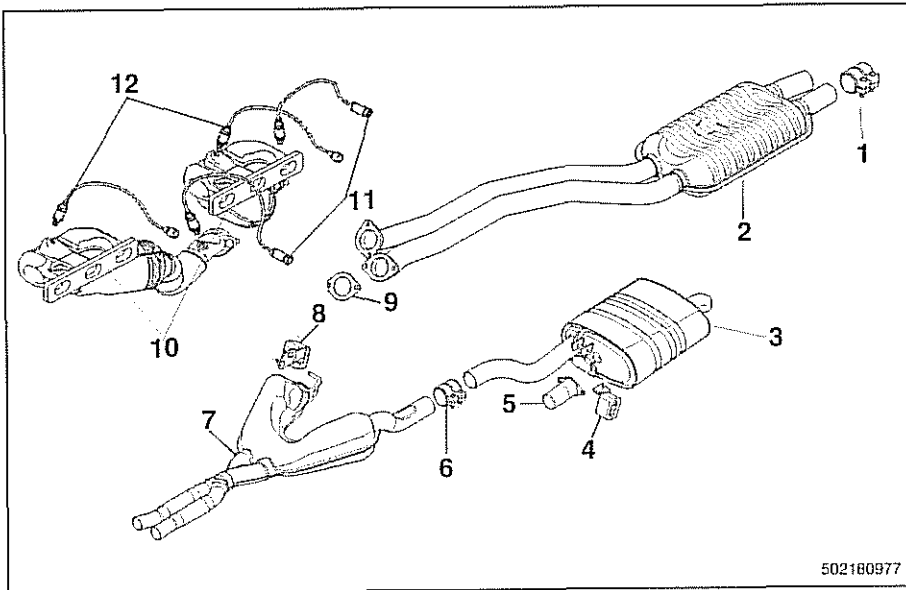
1. Exhaust manifolds
2. Sealing washer
3. Plug
4. Gasket (manifold to cylinder head)
5. Clamping sleeve
6. Post-catalytic converter oxygen sensor
7. Pre-catalytic converter oxygen sensor
8. Hanger
9. Rear muffler
10. Vibration dampener
11. Center support bracket
12. Clamping sleeve
13. Front pipe with catalytic converters
14. Hanger
15. Center muffler
16. Gasket (front pipe to manifold)

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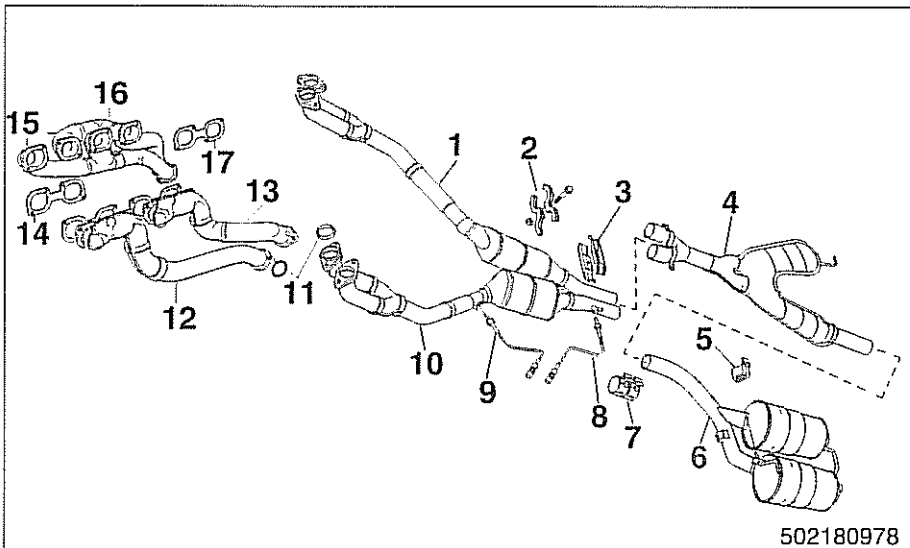
**M52 TU and M54 engines  
(528i 1999–2000  
and 525i 2001–2003)**

1. Transmission bracket
2. Center support bracket
3. Front muffler
4. Clamping sleeve
5. Vibration dampener
6. Hanger
7. Rear muffler
8. Hanger
9. Center muffler
10. Oxygen sensors, post-catalytic converter
11. Oxygen sensors, pre-catalytic converter
12. Exhaust manifold/catalytic converter assemblies



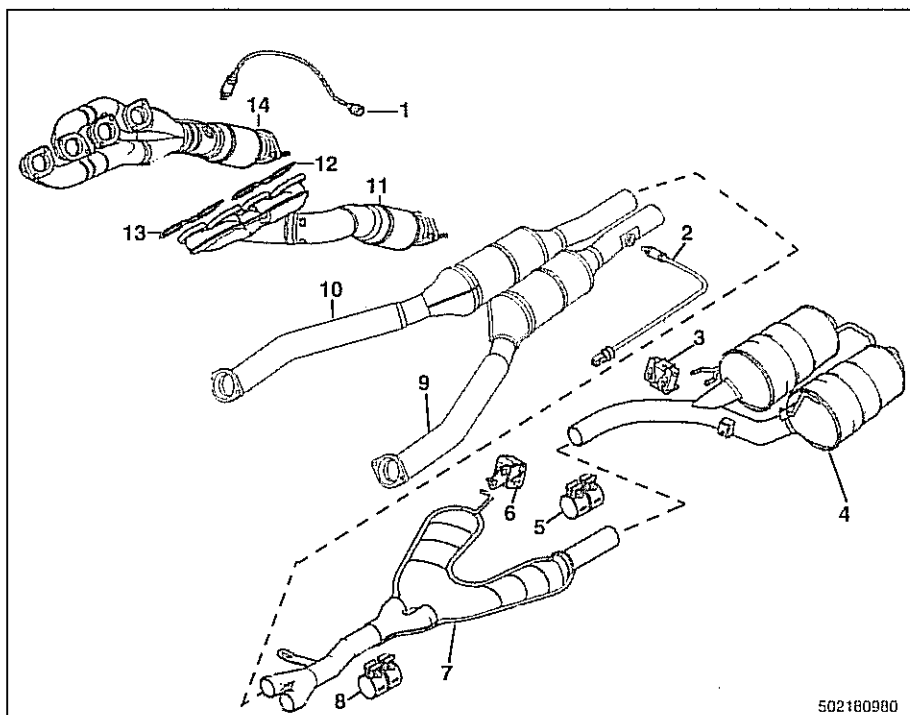
### M54 engine (530i 2001-2003)

1. Clamping sleeve
2. Front muffler
3. Rear muffler
4. Hanger
5. Vibration dampener
6. Clamping sleeve
7. Center muffler
8. Hanger
9. Gasket (front pipe to manifold)
10. Exhaust manifold/catalytic converter assemblies
11. Oxygen sensors, post-catalytic converter
12. Oxygen sensors, pre-catalytic converter



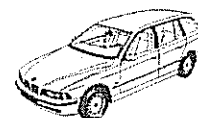
### M62 engine (540i 1997-1998)

1. Right side catalytic converters
2. Support bracket
3. Support bracket
4. Center muffler
5. Hanger
6. Rear muffler
7. Clamping sleeve
8. Oxygen sensors, post-catalytic converter
9. Oxygen sensors, pre-catalytic converter
10. Left side catalytic converter
11. Sealing rings
12. Left front exhaust manifold
13. Left rear exhaust manifold
14. Gasket
15. Exhaust manifold, right front
16. Exhaust manifold, right rear



### M62 TU engine (540i 1999–2003)

1. Oxygen sensors, pre-catalytic converter (2)
2. Oxygen sensors, post-catalytic converter (2)
3. Hanger
4. Rear muffler
5. Clamping sleeve
6. Hanger
7. Center muffler
8. Clamping sleeve
9. Catalytic converter, left side
10. Catalytic converter, right side
11. Exhaust manifold/catalytic converter, left side
12. Gasket (2)
13. Gasket (2)
14. Exhaust manifold/catalytic converter, right side







# 200 Transmission-General

<b>General</b> .....	200-2	<b>Automatic Transmission</b> .....	200-3
<b>Drivetrain</b> .....	200-2	<b>Transmission Lubricants</b> .....	200-4
<b>Manual Transmission</b> .....	200-2		

## GENERAL

This repair group covers general application information for the clutch, manual and automatic transmissions, shift linkages and driveshaft.

## Drivetrain

BMW E39 models are equipped with a longitudinal drivetrain. The transmission is bolted directly to the rear of the engine. A driveshaft connects the output shaft of the transmission to the rear final drive. Individual drive axles with integrated constant velocity joints transfer rotational power from the final drive unit to the rear wheels.

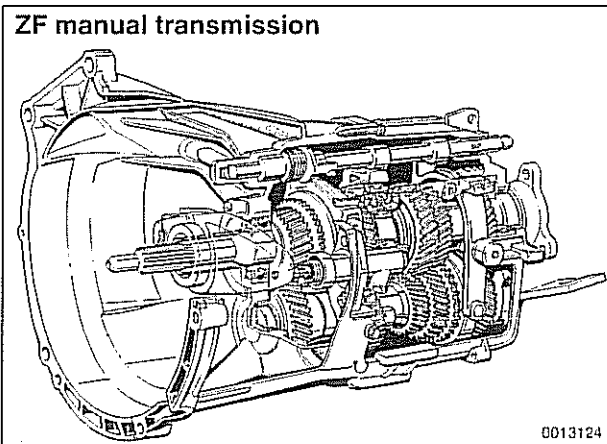
## MANUAL TRANSMISSION

- ◀ Due to different power characteristics and performance requirements, various manual transmissions are used in models covered by this manual. Manual transmission applications are given in the table below.

For manual transmission specifications or repair procedures, refer to **230 Manual Transmission**.

Manual transmission models use a single disc clutch with dual-mass flywheel. For further information, see **210 Clutch**.

The manual transmission metal ID plate is mounted on side of transmission. Do not rely on numbers cast on transmission case for identification.



### Manual transmission applications

Model	Year	Engine	Transmission
525i	2001 — 2002	M52TU, M54	Getrag S5D 250G
528i	1997 — 2002	M52	ZF S5D 320Z
530i	2001 — 2002	M54	ZF S5D 320Z
540i	1997 — 2002	M62	ZF S6S 420G

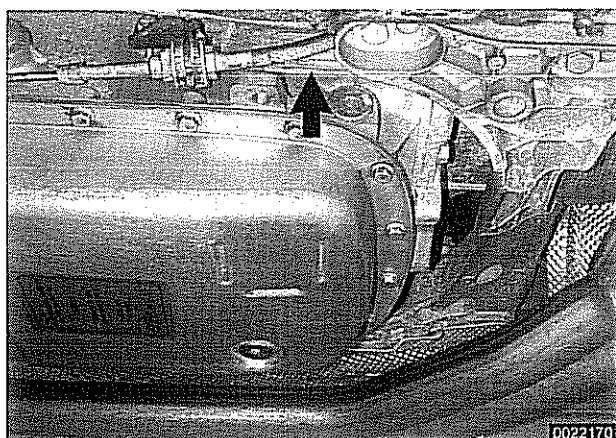
## AUTOMATIC TRANSMISSION

Different automatic transmissions are used, depending on model and model year and/or production date. All of the automatic transmissions are electrohydraulically controlled with five forward speeds. Automatic transmission applications are given in the table below.

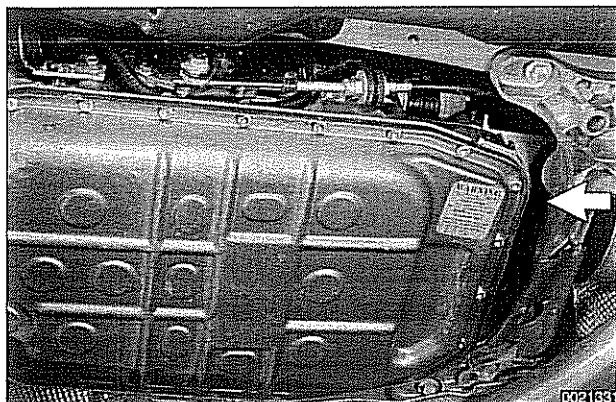
### Automatic transmission applications

Model	Year	Engine	Transmission
528i	to 9/1999	M52	A4S 310R
528	from 9/1999	M52 TU	A5S 360R
525i	to 3/2001	M54	A5S 390R
525i	from 3/2001	M54	A5S 325Z
530i	to 3/2001	M54	A5S 390R
530i	from 3/2001	M54	A5S 325Z
540i	to 1/1997	M62	A5S 560Z
540i	from 1/1997	M62 TU	A5S 440Z

Automatic transmission identification metal ID plate is mounted to body of transmission.



- ◀ GM transmission ID tag (arrow) is on left side of transmission housing, behind transmission selector cable, just above transmission pan.



- ◀ ZF transmission ID tag (arrow) is on left rear of transmission, just above transmission pan.

## TRANSMISSION LUBRICANTS

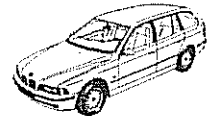
The lubricant used varies, depending on transmission and model year. Fluid application information is clearly marked on a label on transmission.

On manual transmission, either ATF (orange label reads ATF-Oil) or a special BMW lubricant (yellow label reads MTF-LT 1) is used. See **230 Manual Transmission**.

Automatic transmission is filled with either Dexron III ATF (black transmission ID plate reads ATF-Oil), or special life-time oil (green transmission ID plate reads Life-Time Oil). See **240 Automatic Transmission**.

### **CAUTION—**

*If in doubt as to the type of fluid installed in a particular transmission, consult an authorized BMW dealer service department for the latest in operating fluids.*



# 210 Clutch

<b>General</b> .....	210-2	Flywheel, removing and installing (6 cylinder engine) .....	210-12
Special tools .....	210-2	Flywheel, removing and installing (V-8 engine) .....	210-13
<b>Clutch Hydraulics</b> .....	210-4	Transmission pilot bearing, replacing ....	210-15
Clutch hydraulic system, bleeding and flushing .....	210-4	Clutch, installing (non-SAC components) .	210-16
Clutch master cylinder, replacing .....	210-6	Clutch, installing (new SAC components) .	210-17
Clutch slave cylinder, replacing .....	210-8	Clutch, installing (used SAC components)	210-19
<b>Clutch Mechanical</b> .....	210-9	Self-adjusting clutch (SAC), breaking in .	210-21
Clutch variations .....	210-9		
Clutch, removing .....	210-11		
Clutch components, inspecting .....	210-11		

## GENERAL

This repair group covers replacement of clutch mechanical and hydraulic components.

BMW 5 Series models with manual transmission use a single disc hydraulically actuated clutch. Two versions of the clutch are used:

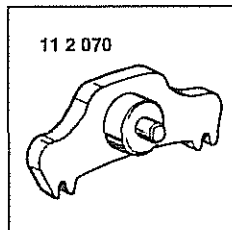
- 1997 528i (6 cylinder) uses traditional clutch components.
- All 540i (V-8) and 1998 and later 6 cylinder models use a self-adjusting clutch (SAC).

### NOTE —

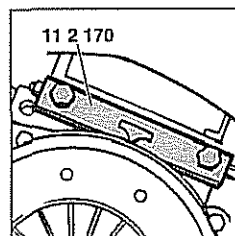
See **200 Transmission-General** for transmission application information.

## Special tools

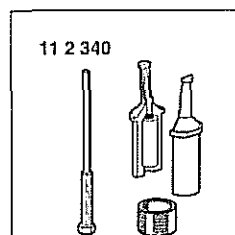
Some special tools and techniques are required for clutch repairs. Be sure to read a procedure through before beginning a job.



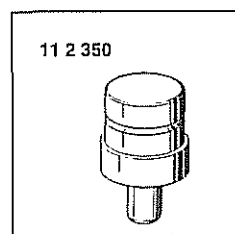
- ◀ Flywheel locking tool (V-8 models)  
(Tool No. 11 2 070)



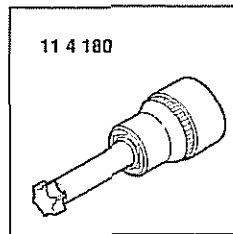
- ◀ Flywheel locking tool (6 cylinder models)  
(Tool No. 11 2 170)



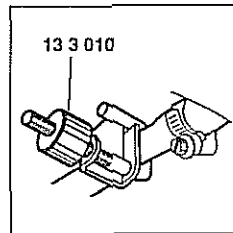
- ◀ Pilot bearing removal tools  
(Tool No. 11 2 340)



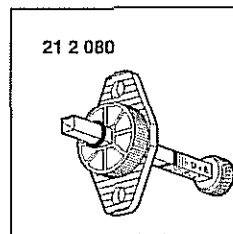
- ◀ Pilot bearing installation tool  
(Tool No. 11 2 350)



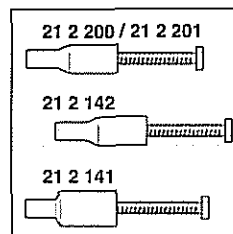
- Torx T60 socket for V-8 flywheel bolt removal (Tool No. 11 4 180)



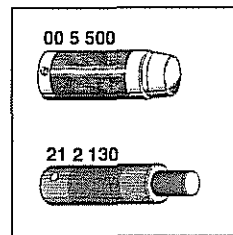
- Hose clamping tool (Tool No. 13 3 010)



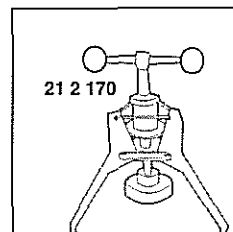
- Clutch disc lining gauge (Tool No. 21 2 080)



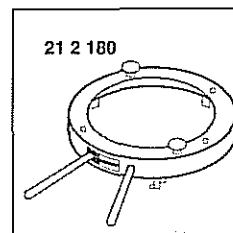
- Clutch disc centering mandrels (non-SAC clutch) (Tool No. 21 2 141, 21 2 142, 21 2 200, 21 2 201)



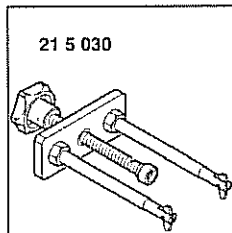
- Clutch disc alignment tools (SAC clutch) (Tool No. 00 5 500 (handle), 21 2 130 (drift))



- SAC tensioning tool (Tool No. 21 2 170)



- SAC locating ring (Tool No. 21 2 180)



◀ Tool for bleeding clutch hydraulics (Tool No. 21 5 030)

## CLUTCH HYDRAULICS

The clutch is hydraulically actuated by the master and slave cylinders. With the self-adjusting clutch (SAC), clutch disc wear is automatically taken up through the self-adjusting pressure plate springs, making pedal feel consistent throughout the life of the clutch.

A soft or spongy feel to the clutch pedal, long pedal free-play, or grinding noises from the gears while shifting can all indicate problems with the clutch hydraulics. In these circumstances it is best to start with a clutch fluid flush, followed, if necessary, by replacement of the hydraulic parts.

### NOTE—

*The clutch hydraulic system shares the fluid reservoir and fluid with the brake hydraulic system.*

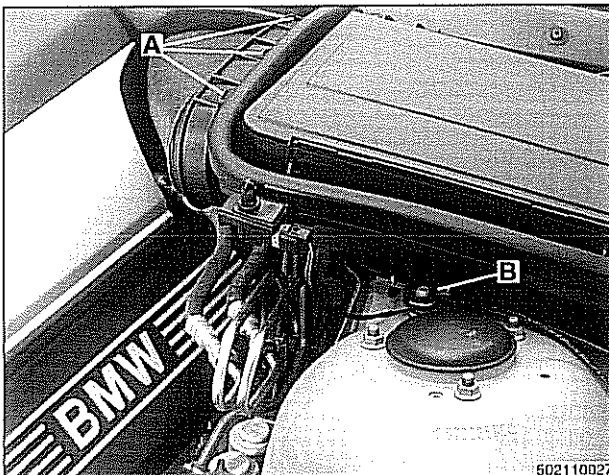
## Clutch hydraulic system, bleeding and flushing

If the clutch/brake fluid is murky or muddy, or has not been changed within the last two years, flush the system and change the fluid. Flushing the old fluid from the clutch lines is done using a brake system pressure bleeder.

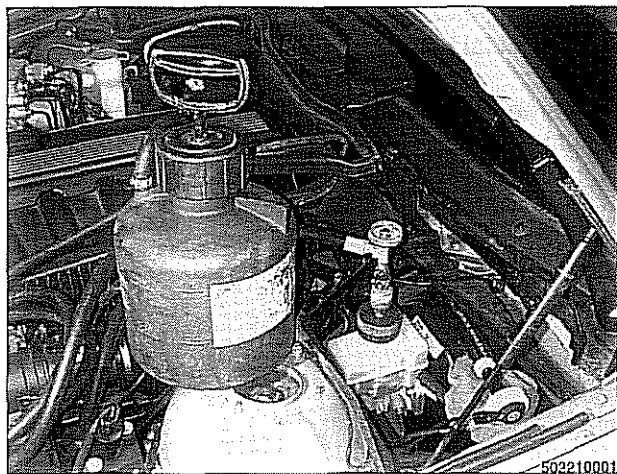
- Remove brake fluid reservoir cap. Using a clean syringe, remove brake fluid from reservoir. Refill reservoir with clean DOT 4 brake fluid.

◀ Working inside engine compartment, remove left interior ventilation filter housing:

- Release 3 plastic taps (A) on duct. Earlier models use a single release latch.
- Rotate duct inward to remove.
- Disconnect electrical harness to hood position switch.
- Remove filter housing cover.
- Release spring lock (B) on interior ventilation housing and remove housing.







- Attach pressure brake bleeder to fluid reservoir and pump bleeder a few times to pressurize hydraulic fluid system.

**CAUTION—**

- Do not exceed 2 bar (29 psi) pressure at the fluid reservoir when bleeding or flushing the hydraulic system.
- Brake fluid is poisonous, highly corrosive and dangerous to the environment. Wear safety glasses and rubber gloves when working with brake fluid. Do not siphon brake fluid with your mouth. Immediately clean away any fluid spilled on painted surfaces and wash with water, as brake fluid will remove paint.
- Always use new brake fluid from a fresh, unopened container. Brake fluid will absorb moisture from the air. This can lead to corrosion problems in the clutch and brake hydraulic systems, and will also lower the brake fluid boiling point. Dispose of brake fluid properly.

- Raise and safely support vehicle.

**WARNING—**

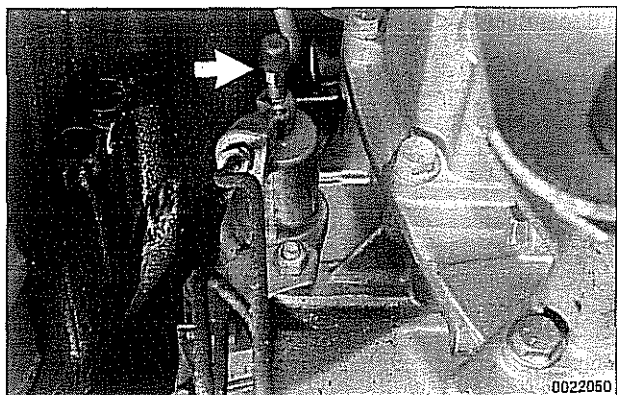
Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

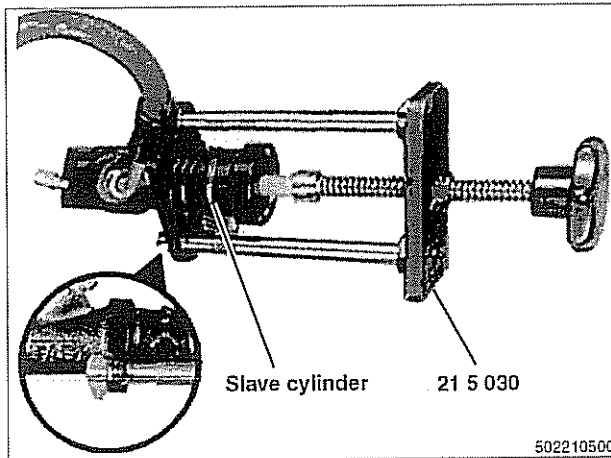
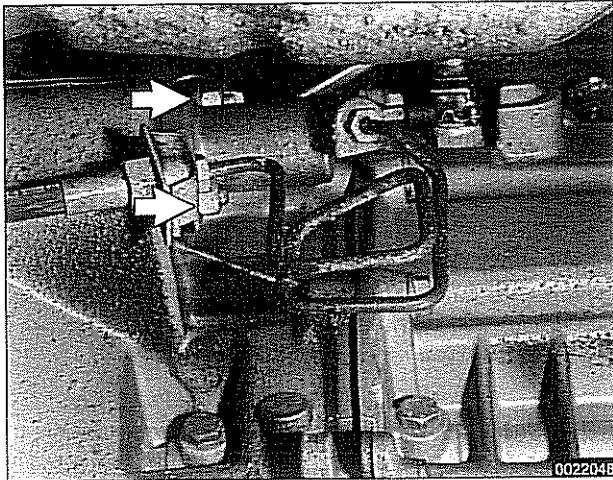
- If necessary, remove transmission splash shield.

**Hydraulic system, bleeding**

- Working underneath transmission, connect a hose from clutch slave cylinder bleeder valve (**arrow**) to a container.

- Open bleeder valve and allow brake fluid to expel until clean fluid comes out, free of air bubbles.
- Close bleeder valve and disconnect pressure bleeding equipment from fluid reservoir.
- Slowly operate clutch pedal about 10 times. Fill reservoir with clean fluid as necessary.





### Hydraulic system, bleeding (using BMW special tool 21 5 030)

- Working underneath transmission, remove slave cylinder mounting nuts (**arrow**) from clutch housing and remove cylinder. Leave fluid line attached.
- Use BMW special tool 21 5 030 to press slave cylinder push-rod completely into slave cylinder.
  - Hold slave cylinder so that bleeder valve is at highest point.
  - Open bleeder valve and allow brake fluid to expel until clean fluid comes out, free of air bubbles.
  - Close bleeder valve and disconnect pressure bleeding equipment from fluid reservoir.
  - Slowly unscrew and detach special tool 21 5 030 from slave cylinder.

#### **CAUTION—**

*Do not remove tool if hydraulic system is pressurized.*

- Reinstall slave cylinder.

#### Tightening torque

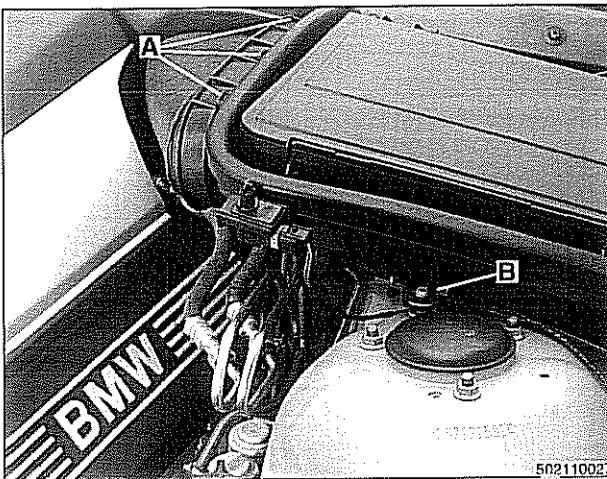
Slave cylinder to transmission case	22 Nm (16 ft-lb)
-------------------------------------	------------------

- Slowly operate clutch pedal about 10 times. Fill reservoir with clean fluid as necessary.

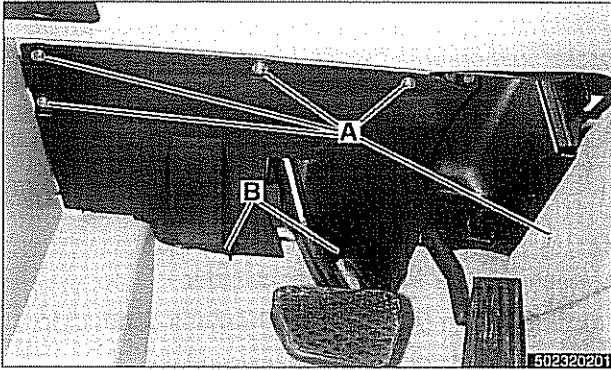
### Clutch master cylinder, replacing

The clutch master cylinder is mounted to the pedal assembly directly above the clutch pedal.

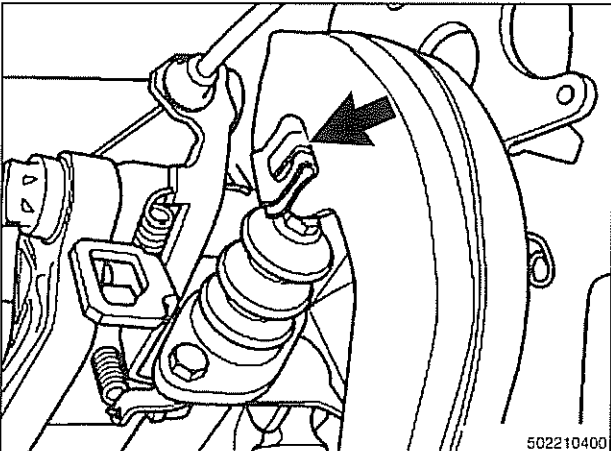
- Working inside engine compartment, remove left interior ventilation filter housing:
  - Release 3 plastic taps (**A**) on duct. Earlier models use a single release latch.
  - Rotate duct inward to remove.
  - Disconnect electrical harness to hood position switch. Remove filter housing cover.
  - Release spring lock (**B**) on interior ventilation housing and remove housing.



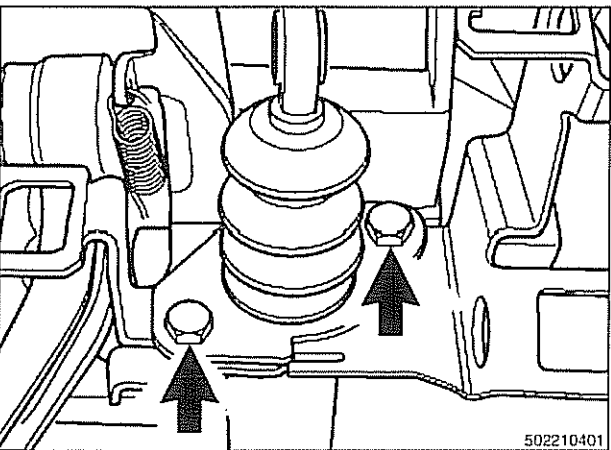
- Remove brake fluid reservoir cap. Using a clean syringe, remove brake fluid from reservoir to below level of clutch hydraulic supply hose.
- Detach clutch hydraulic supply hose from brake fluid reservoir. Plug reservoir outlet and hose.
- Remove lower dash trim panel fasteners (A) and (B).
  - Lower trim panel and disconnect wiring harnesses on back side of panel.
  - Remove trim panel.

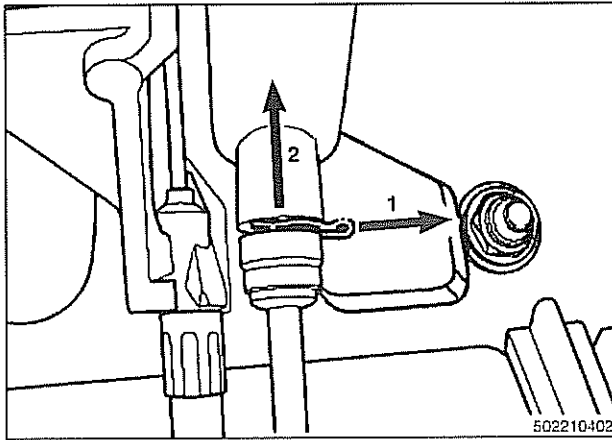


- Working under dash, remove clutch master cylinder pushrod retaining clip (arrow) and pin from clutch pedal.



- Remove master cylinder mounting bolts (arrows).



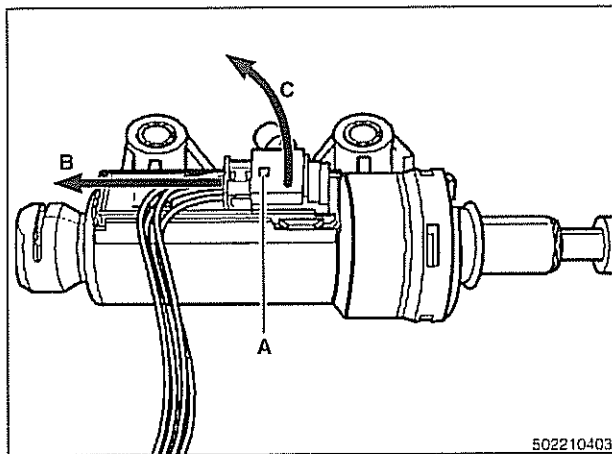


- Remove hydraulic line locking clip (1) and pull line (2) off master cylinder.

**CAUTION—**

- To prevent brake fluid spill, wrap clutch master cylinder with shop rags when removing hydraulic fluid lines from master cylinder.
- Brake fluid damages paint and stains carpets. Clean off any brake fluid on or in the car immediately.

- Remove master cylinder with supply hose.



- Remove switch module from master cylinder.
  - Press locking button (A) to release harness connector.
  - Pull harness connector (B) off switch module.
  - Use screwdriver to lever off switch module (C).
- Installation is reverse of removal.

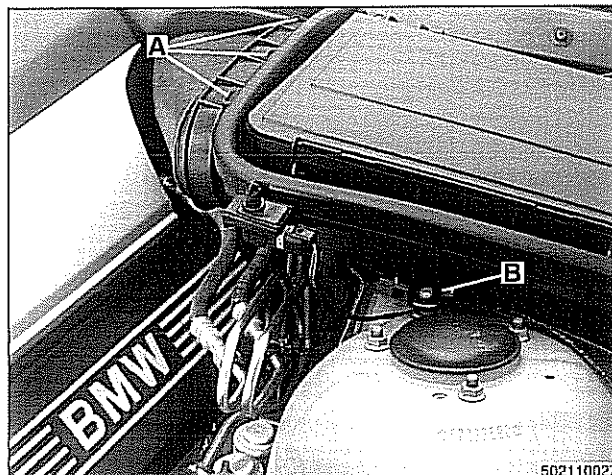
**CAUTION—**

Switch module must snap firmly into place on the master cylinder during installation.

**Tightening torques**

Clutch master cylinder to pedal cluster	10 Nm (89 in-lb)
Fluid line to master cylinder or slave cylinder	17 Nm (13 ft-lb)

- Fill fluid reservoir with clean fluid. Bleed clutch hydraulics as described earlier.

**Clutch slave cylinder, replacing**

- Working inside engine compartment, remove left interior ventilation filter housing:
  - Release 3 plastic taps (A) on duct. Early models: release latch.
  - Rotate duct inward to remove.
  - Disconnect electrical harness to hood position switch.
  - Release spring lock (B) on interior ventilation housing and remove housing.
- Pinch off brake fluid supply hose to clutch master cylinder using BMW special tool 13 3 010 or equivalent hose clamping tool.

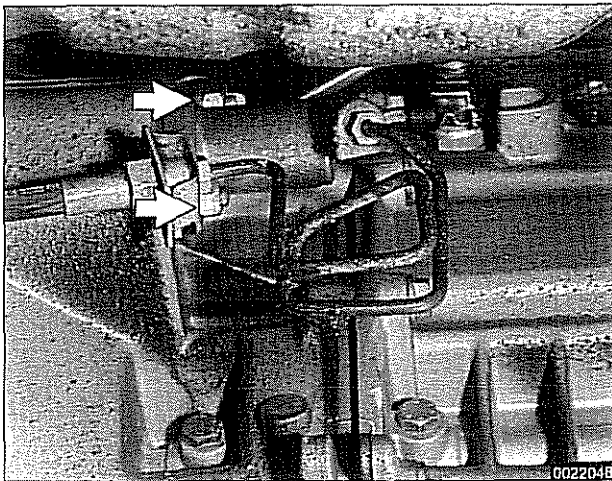
- Raise and safely support vehicle.

**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.*

- If necessary, remove transmission splash shield.
- Disconnect fluid line from slave cylinder on left side of transmission. Place pan under hose to catch dripping fluid.

- Working underneath transmission, remove slave cylinder mounting nuts (arrow) from clutch housing and remove cylinder.



- Installation is reverse of removal, noting the following:
  - Check for wear on slave cylinder. Any wear except on tip is caused by misalignment of clutch components.
  - Lightly coat pushrod tip with molybdenum disulfide grease (Molykote® Longterm or equivalent).
  - During installation be sure pushrod tip engages recess in clutch release lever.
  - Fill fluid reservoir with clean fluid.
  - Bleed clutch hydraulics as described earlier.

**Tightening torques**

Clutch slave cylinder to transmission	22 Nm (16 ft-lb)
Fluid line to slave cylinder	17 Nm (13 ft-lb)

**CLUTCH MECHANICAL**

The transmission must be removed from the engine to access the clutch mechanical components. It is recommended that the clutch disc, pressure plate and release bearing be replaced during a clutch overhaul.

Be sure to check the bottom of the bellhousing for oil. If engine oil is found, check for a faulty rear crankshaft main oil seal. See **119 Lubrication** for rear main seal replacement.

**Clutch variations**

Two versions of the clutch are used:

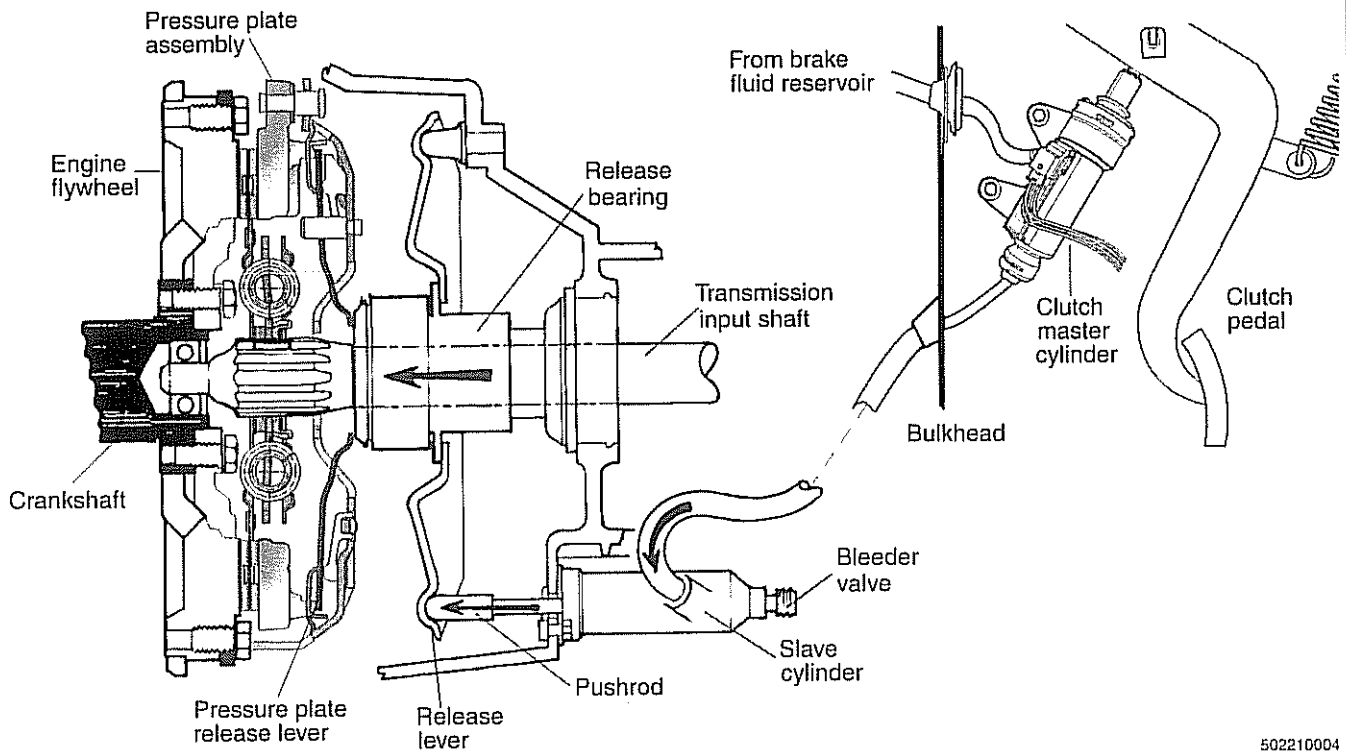
- 1997 528i (6 cylinder) uses traditional clutch components.
- All 540i (V-8) and 1998 and later 6 cylinder models from use a self-adjusting clutch (SAC).

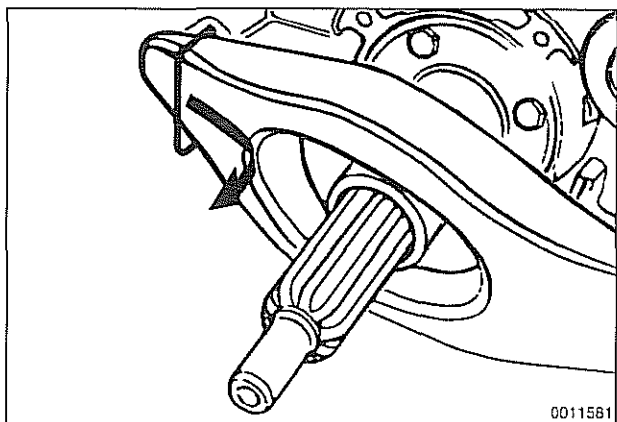
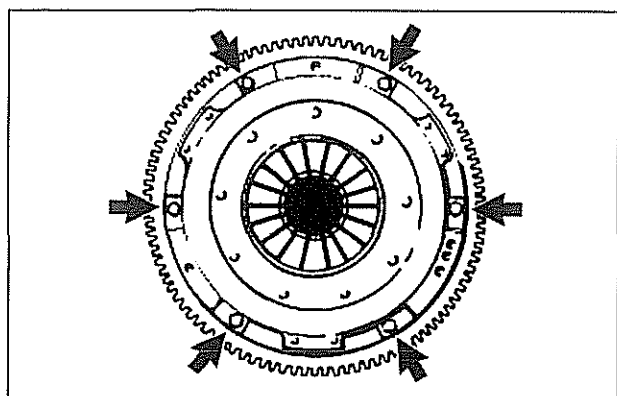
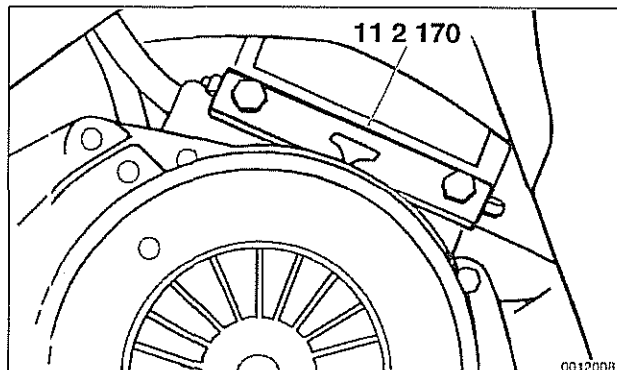
Installing the non-SAC clutch (1997 528i model) requires the use of only a flywheel lock and traditional clutch disc alignment tool.

Installing the self-adjusting clutch (SAC) requires several special tools for aligning and assembling the clutch, as well as locking the flywheel in place. In addition, the procedure for re-installing a previously used SAC differs from the procedure for installing a new SAC. Be sure to read the SAC installation procedure through before starting the job.

The pressure plate of the SAC uses a spring-loaded wedge ring to compensate for clutch disc wear. The wedge ring adjusts by means of spring tension, so special tools must be used to apply and relieve spring tension as the clutch pressure plate is installed.

### Self adjusting clutch (SAC) and clutch hydraulics





## Clutch, removing

The procedure given here applies to both non-SAC and SAC clutch assemblies.

- Remove transmission from engine. See **230 Manual Transmission**.
- Lock engine flywheel in position using BMW special tool 11 2 170 (6 cylinder engine), or 11 2 070 (V-8 engine).
- Loosen 6 clutch mounting bolts (arrows) evenly.
- Remove pressure plate and clutch disc.

### **WARNING** —

*The clutch disc contains asbestos. Inhaling or ingesting asbestos dust can cause severe health problems. Always wear an approved respirator and protective clothing when handling components containing asbestos. Do not use compressed air to clean components. Do not grind, heat, weld, or sand on or near any asbestos materials.*

- Pull release bearing off transmission input shaft. Remove clutch release lever by sliding it out of spring clip in direction of arrow.

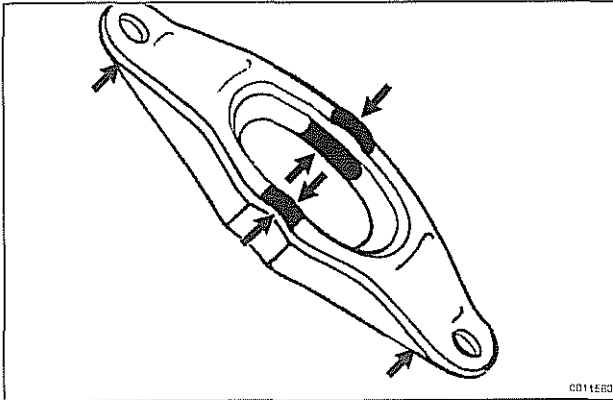
## Clutch components, inspecting

- Inspect clutch disc for wear, cracks, loose rivets, contamination or excessive runout (warping). Replace if necessary.
- Measure clutch disc lining thickness at shallowest rivet head.

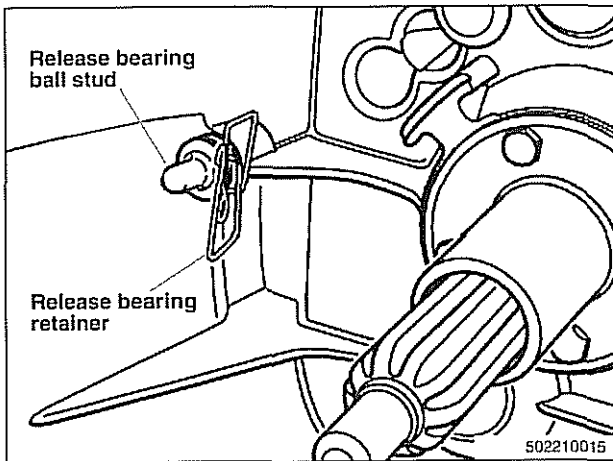
### Clutch and pressure plate wear limits

Minimum clutch disc lining thickness (at rivets)	1.0 mm (0.04 in)
Maximum lateral runout (diaphragm springs to pressure plate)	0.6 mm (0.02 in)

## Clutch



- Inspect flywheel for scoring, hot spots, cracks or loose or worn guide pins. If any faults are found, replace flywheel as described later.
- Inspect transmission pilot bearing in end of crankshaft. The bearing should rotate smoothly without play. If necessary, replace as described later.
- Inspect and clean release bearing lever. Apply a thin coat of grease to release bearing lever lubrication points (**arrows**). Clean and lightly lubricate clutch disc splines and transmission input shaft splines.



- Check release bearing ball stud and spring retainer. Replace if damaged or worn.

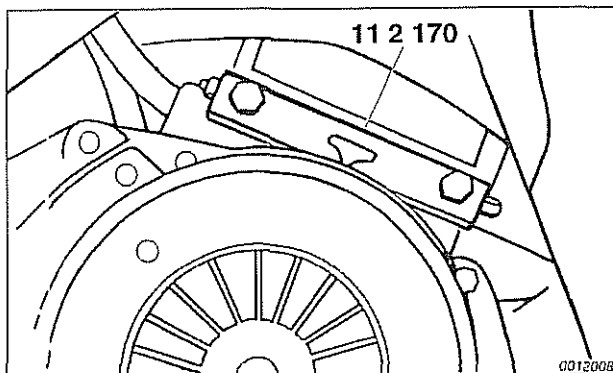
**CAUTION—**

*On S6S 420G transmission, always replace release bearing ball stud and retainer spring.*

- Clean release bearing guide sleeve.

**CAUTION—**

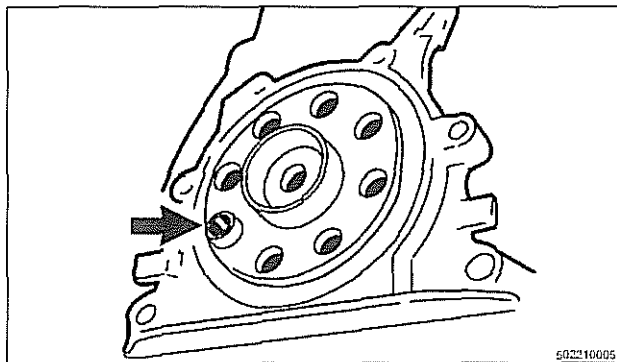
*Do not grease guide sleeve. If guide sleeve is greased, release bearing may stick to it.*



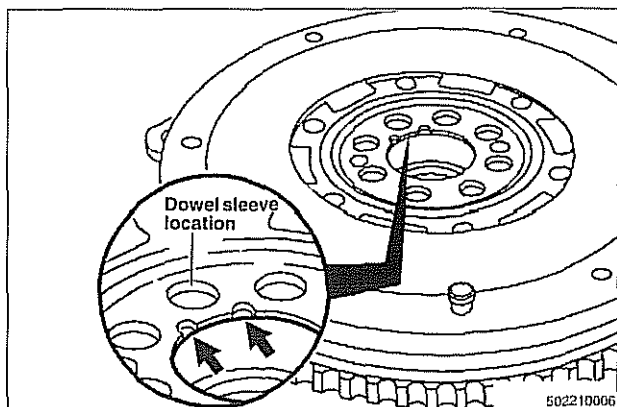
### Flywheel, removing and installing (6 cylinder engine)

- Inspect flywheel for scoring, hot spots, cracks or loose or worn guide pins. Replace flywheel if any faults are found.
- Lock flywheel with BMW special tool 11 2 170. Remove pressure plate and clutch disc as described earlier.
- Loosen and remove flywheel mounting bolts. Remove flywheel.
- Clean flywheel bolt threads in crankshaft.





- Check flywheel location dowel sleeve (arrow) for damage and correct installation.



- When installing dual-mass flywheel, position dowel sleeve next to two locating notches (arrows).

- Install flywheel using new self-locking bolts.

#### Tightening torque

Flywheel to crankshaft  
(use new self-locking bolts)

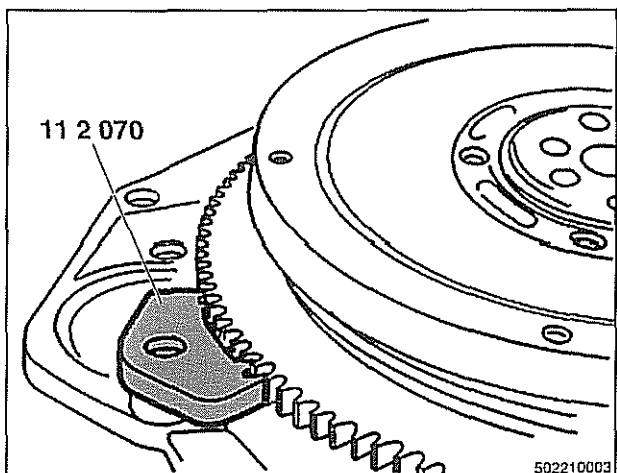
120 Nm (89 ft-lb)

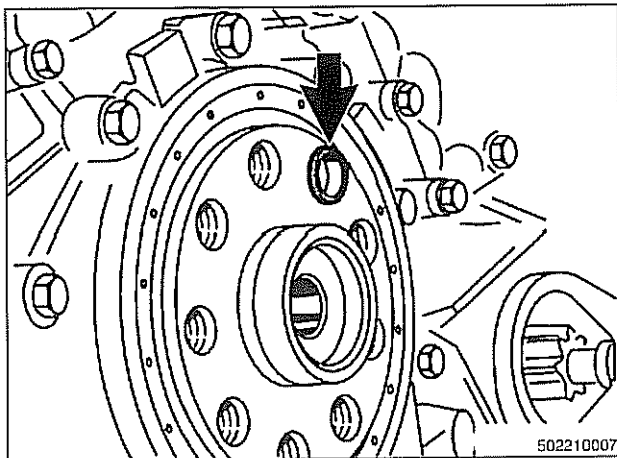
#### CAUTION—

Use new self-locking bolts to install flywheel. Do not reuse the old stretch-type bolts. Do not install bolts with Loctite® or similar thread locking compound.

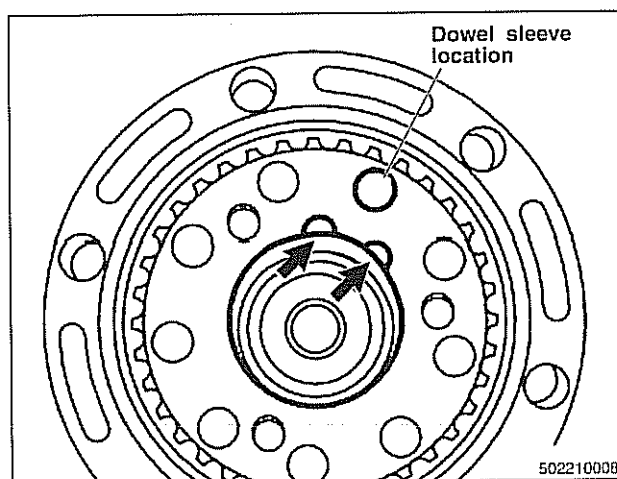
### Flywheel, removing and installing (V-8 engine)

- Inspect flywheel for scoring, hot spots, cracks or loose or worn guide pins. Replace flywheel if any faults are found.
- Lock flywheel with BMW special tool 11 2 070. Remove pressure plate and clutch disc as described earlier.
- Use BMW special tool 11 4 180 (Torx T60) to loosen and remove flywheel mounting bolts. Remove flywheel.
- Clean flywheel bolt threads in crankshaft.





- ⚠ Check flywheel location dowl sleeve (**arrow**) for damage and correct installation.



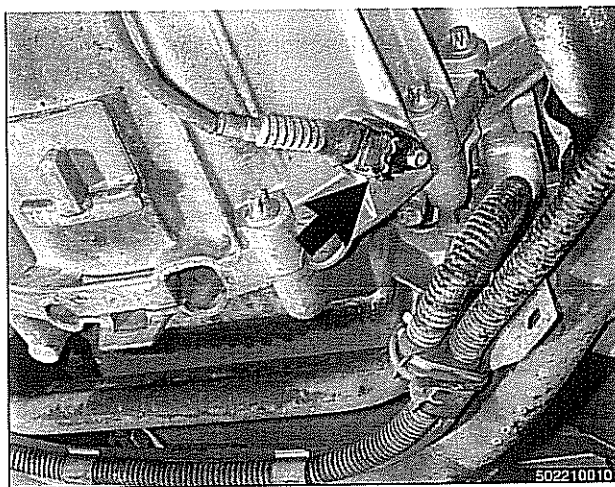
- ⚠ When installing dual-mass flywheel, position dowl sleeve next to two locating notches (**arrows**).
- Lightly oil flywheel mounting bolt threads and torque to specification.

#### Tightening torque

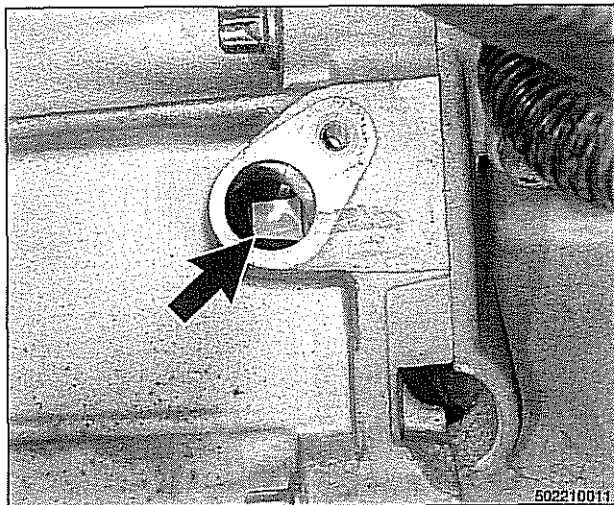
Flywheel to crankshaft	105 Nm (77 ft-lb)
------------------------	-------------------

#### CAUTION—

*Do not reinstall flywheel bolts with Loctite® or similar thread locking compound.*

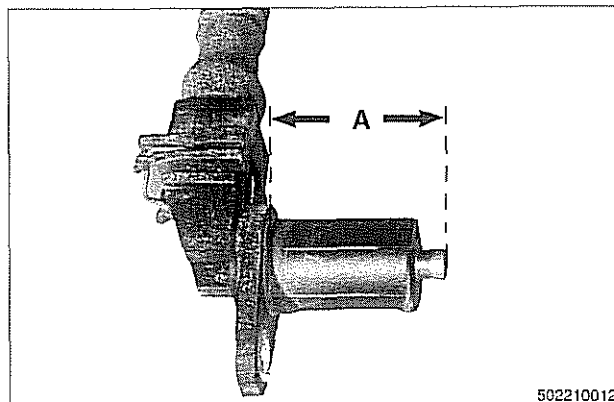


- Install transmission as described in **230 Manual Transmission**.
- ⚠ If flywheel was replaced, check pulse sensor (**arrow**) for correct installation depth.
- Remove pulse sensor.



Use crankshaft pulley bolt to rotate engine in direction of rotation until a full pulse tooth (arrow) is centered in pulse sensor opening.

- Measure depth from pulse sensor mounting surface on transmission to top of tooth.



Measure length (A) of pulse sensor from mounting surface to end.

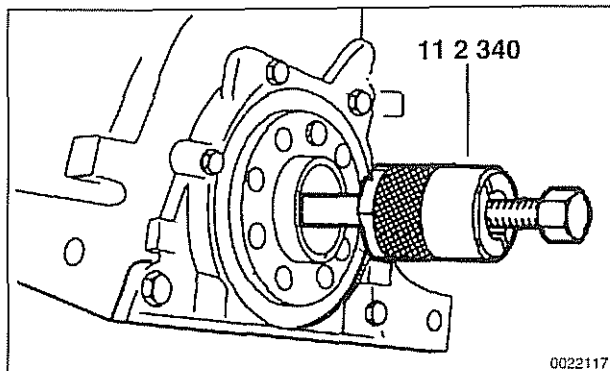
- Subtract length of pulse sensor (A) from distance to pulse tooth from mounting area on transmission. This resulting measurement is the pulse sensor air gap. Use shims available from BMW to adjust air gap to specification.

#### Pulse air sensor gap

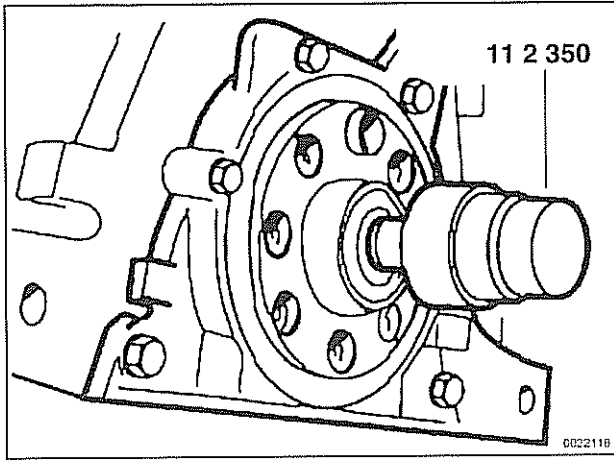
End of sensor to flywheel teeth	$0.55 \pm 0.2$ mm ( $0.0217 \pm 0.0079$ in)
---------------------------------	--

### Transmission input shaft pilot bearing, replacing

- Remove clutch as described earlier.
- Remove pilot bearing from end of crankshaft using BMW special tool 11 2 340 or equivalent puller.



**Clutch**



- Press new bearing into place using BMW special tool 11 2 350 or equivalent driver.

**Clutch, installing (non-SAC)**

**CAUTION—**

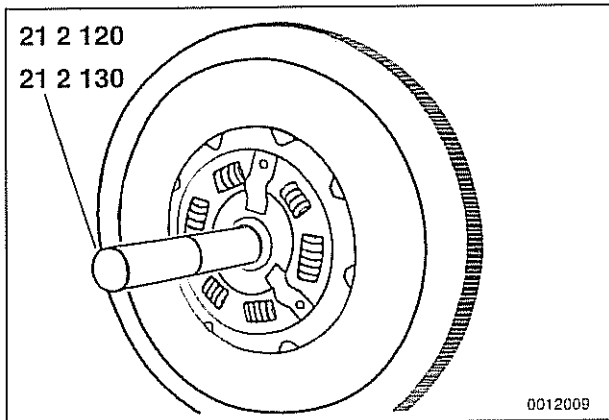
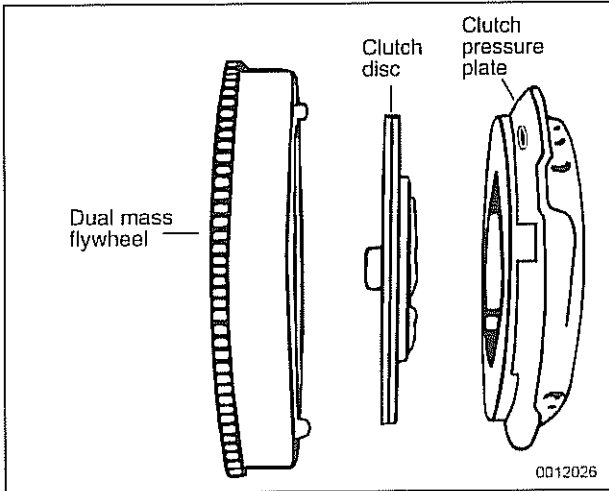
*Avoid contaminating clutch friction surfaces with oil or grease. Do not touch these surfaces.*

- Install flywheel lock, BMW special tool 11 2 170.

- Install pressure plate and clutch disc to flywheel. Install and tighten bolts hand-tight.

**CAUTION—**

*Be sure clutch disc is facing the correct way. The disc should be marked "engine side" or "transmission side".*



- Center clutch disc on flywheel using centering tool.

- 5-speed transmission: Special tool 21 2 130

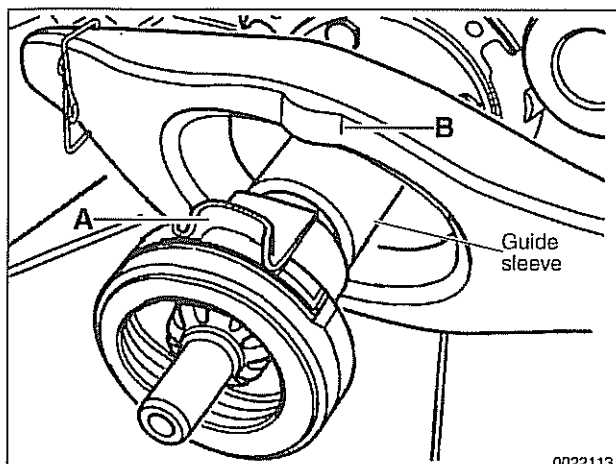
- Tighten each clutch bolt one turn at a time until pressure plate is fully seated. Torque to specification.

**Tightening torques**

Clutch to flywheel

- M8 (8.8 grade) 24 Nm (18 ft-lb)
- M8 (10.9 grade) 34 Nm (25 ft-lb)

- Remove clutch disc centering tool.



0022113

- Remove flywheel locking tool.

▲ Inspect and clean release bearing lever. Apply a thin coat of grease to release bearing lever lubrication points. Install release bearing. Bearing tabs (A) align with contact points (B) on release lever.

**CAUTION—**

*Do not grease release bearing guide sleeve. If guide sleeve is greased, release bearing may stick to it.*

- Clean and lightly lubricate clutch disc splines and transmission input shaft splines.
- Install transmission. See **230 Manual Transmission**.

**Tightening torques**

Transmission to engine

• M8 (Torx)	22 Nm (16 ft-lb)
• M10 (Torx)	43 Nm (32 ft-lb)
• M12 (Torx)	72 Nm (53 ft-lb)

**Clutch, installing (new SAC components)**

V-8 models and 1998 and later 6 cylinder models are equipped with the self-adjusting clutch (SAC) pressure plate. The SAC pressure plate, when new, comes from the factory with a lock plate at the center which maintains spring tension on the self-adjusting springs. This locking ring must not be removed until the pressure plate is securely installed on the flywheel with the clutch disk in place.

**CAUTION—**

*Avoid contaminating clutch friction surfaces with oil or grease. Do not touch these surfaces.*

▲ Center clutch disc on flywheel using centering tool.

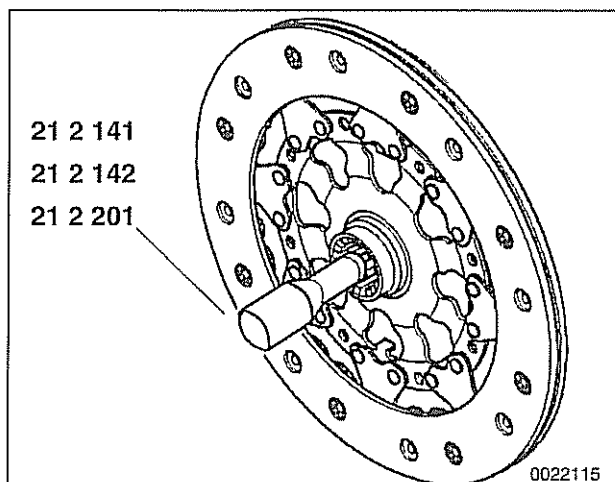
- 5-speed transmission: Special tool 21 2 142
- 6-speed transmission: Special tool 21 2 141
- G6S-37BZ transmission: Special tool 21 2 201

**CAUTION—**

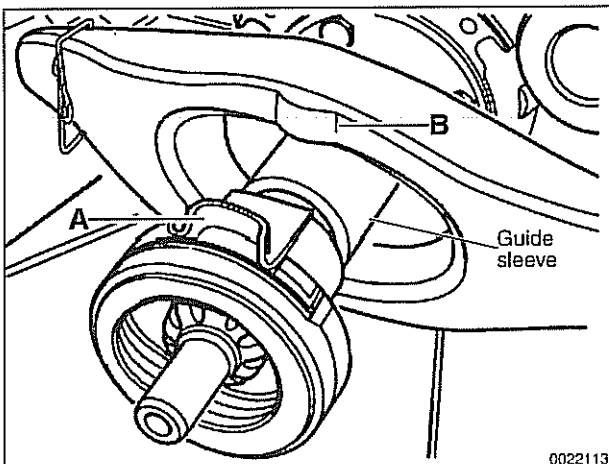
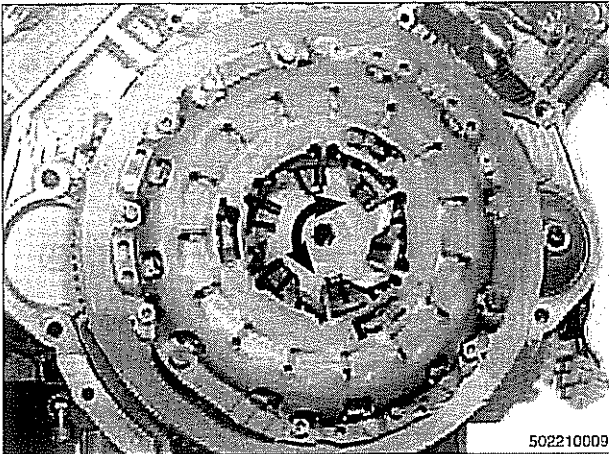
*Be sure clutch disc is facing the correct way. The disc should be marked "engine side" or "transmission side".*

**NOTE—**

*The large bolt in the clutch disc centering tool is used to install and remove the tool only. Once the disc is in place on the flywheel, remove the bolt to make room for the SAC pressure plate.*



0022115



- Install flywheel lock, special tool 11 2 170 (6 cylinder model) or 11 2 070 (V-8 model).
- Install SAC pressure plate on dowel pins at flywheel. Install clutch mounting bolts and tighten each one turn at a time until pressure plate is fully seated. Torque to specification.

#### Tightening torques

##### Clutch to flywheel

- |                   |                  |
|-------------------|------------------|
| • M8 (8.8 grade)  | 24 Nm (18 ft-lb) |
| • M8 (10.9 grade) | 34 Nm (25 ft-lb) |

- Use 14 mm Allen wrench to unscrew (clockwise or counter-clockwise) lock plate in center of pressure plate.

#### NOTE—

*The spring lock plate may make snapping noises while being unscrewed.*

- Using large bolt, pull out clutch centering tool.
- Remove flywheel locking tool.
- Inspect and clean release bearing lever. Apply a thin coat of grease to release bearing lever lubrication points. Install release bearing. Bearing tabs (A) align with contact points (B) on release lever.

- Clean release bearing guide sleeve.

#### CAUTION—

*Do not grease guide sleeve. If guide sleeve is greased, release bearing may stick to it.*

- Clean and lightly lubricate clutch disc splines and transmission input shaft splines.
- Install transmission. See 230 Manual Transmission.

#### Tightening torques

##### Transmission to engine

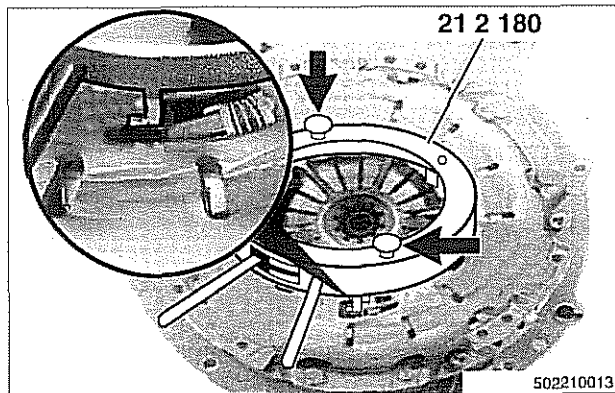
- |              |                  |
|--------------|------------------|
| • M8 (Torx)  | 22 Nm (16 ft-lb) |
| • M10 (Torx) | 43 Nm (32 ft-lb) |
| • M12 (Torx) | 72 Nm (53 ft-lb) |

## Clutch, installing (used SAC components)

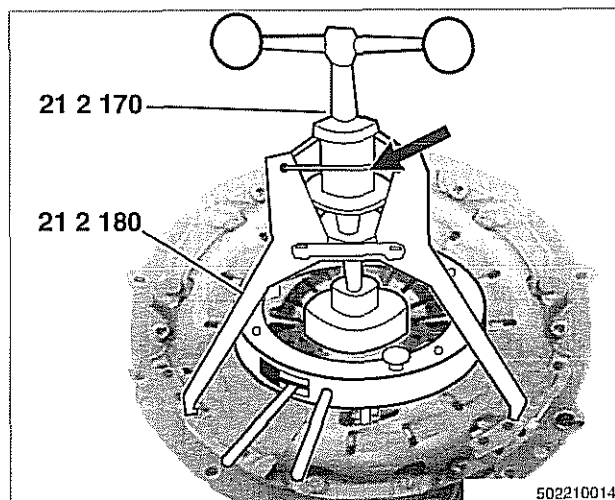
When reinstalling a previously used self-adjusting clutch (SAC), special tools are needed to reset the self-adjusting ring to its original position.

### CAUTION—

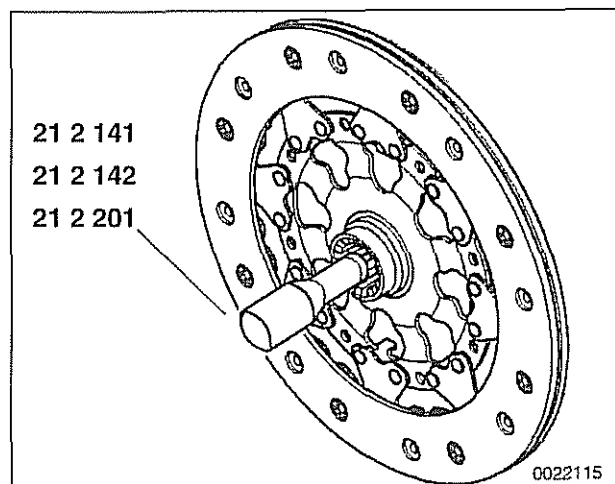
Avoid contaminating clutch friction surfaces with oil or grease. Do not touch these surfaces.



- Place SAC pressure plate on clean work surface.
- Place BMW special tool 21 2 180 on pressure plate.
  - Note that locating hooks of special tool engage pressure plate adjusting ring openings (**inset**).
  - Grip tool firmly and squeeze special tool handles together.
  - Tighten down special tool knurled screws (**arrows**).
  - SAC adjustment ring is now in its original position.



- Install BMW special tool 21 2 170 on SAC pressure plate.
  - Fit fingers of special tool in slots above dowel pin bores.
  - Tighten down knurled nut (**arrow**) finger-tight.
  - Screw in T-handle until pressure plate diaphragm spring is pretensioned to stop.



- Center clutch disc on flywheel using centering tool.
  - 5-speed transmission: Special tool 21 2 142
  - 6-speed transmission: Special tool 21 2 141
  - G6S-37BZ transmission: Special tool 21 2 201

### CAUTION—

Be sure clutch disc is facing the correct way. The disc should be marked "engine side" or "transmission side".

### NOTE—

The large bolt in the clutch disc centering tool is used to install and remove the tool only. Once the disc is in place on the flywheel, remove the bolt to make room for the SAC pressure plate.

- Install flywheel lock, special tool 11 2 170 (6 cylinder model) or 11 2 070 (V-8 model).
- Install SAC pressure plate on dowel pins at flywheel. Install clutch mounting bolts and tighten each one turn at a time until pressure plate is fully seated. Torque to specification.

#### Tightening torques

##### Clutch to flywheel

- |                   |                  |
|-------------------|------------------|
| • M8 (8.8 grade)  | 24 Nm (18 ft-lb) |
| • M8 (10.9 grade) | 34 Nm (25 ft-lb) |

- Slip out clutch centering tool using large bolt.
- Remove flywheel locking tool.

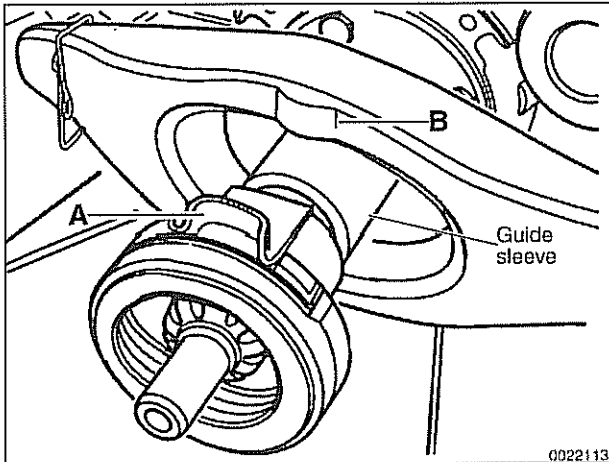
- ◀ Inspect and clean release bearing lever. Apply a thin coat of grease to release bearing lever lubrication points. Install release bearing. Bearing tabs (A) align with contact points (B) on release lever.

- Clean release bearing guide sleeve.

#### CAUTION—

*Do not grease guide sleeve. If guide sleeve is greased, release bearing may stick to it.*

- Clean and lightly lubricate clutch disc splines and transmission input shaft splines.
- Install transmission. See 230 Manual Transmission.



#### Tightening torques

##### Transmission to engine

- |              |                  |
|--------------|------------------|
| • M8 (Torx)  | 22 Nm (16 ft-lb) |
| • M10 (Torx) | 43 Nm (32 ft-lb) |
| • M12 (Torx) | 72 Nm (53 ft-lb) |



## Self-adjusting clutch (SAC), breaking in

With normal driving, 800 to 1000 gearshifts are required to break in the clutch.

Break in the SAC gradually, with light to medium loads, to ensure correct operation and long life. Fast sports driving maneuvers may destroy a new clutch. The following break-in procedure helps to create the correct coefficient of friction.

- Drive normally on level grade. Starting speeds on level grade may be up to 2000 rpm.
- Upshift and downshift through all the gears at 3500 - 4000 rpm.
- On medium grades (approx. 12% and up), start off at approx. 2500 rpm for the first 5 or so times.

### Tightening torques

Clutch slave cylinder to transmission case	22 Nm (16 ft-lb)
Clutch master cylinder to pedal cluster	10 Nm (89 in-lb)
Brake fluid line to clutch master or slave cylinder	17 Nm (13 ft-lb)
Transmission to engine	
• M8 (Torx)	22 Nm (16 ft-lb)
• M10 (Torx)	43 Nm (32 ft-lb)
• M12 (Torx)	72 Nm (53 ft-lb)
Flywheel to crankshaft	
• 6 cylinder engine (use new self-locking bolts)	105 Nm (77 ft-lb)
• V-8 engine	105 Nm (77 ft-lb)
Clutch to flywheel	
• M8 (8.8 grade)	24 Nm (18 ft-lb)
• M8 (10.9 grade)	34 Nm (25 ft-lb)





# 230 Manual Transmission

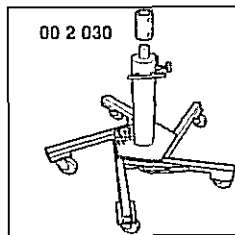
<b>General</b> .....	230-2	Output shaft seal, replacing (5-speed transmission) (transmission installed) . . . .	230-10
Special tools .....	230-2	Output shaft seal, replacing (6-speed transmission) (transmission installed) . . . .	230-12
Manual transmission applications .....	230-5	Input shaft seal, replacing (transmission removed) .....	230-15
<b>Transmission Fluid Service</b> .....	230-6	<b>Transmission Removal and Installation</b> .....	230-16
Transmission fluid level, checking .....	230-6	Transmission, removing and installing . . .	230-16
Transmission fluid, replacing .....	230-6		
<b>Transmission External Service</b> .....	230-7		
Back-up light switch, replacing .....	230-7		
Selector shaft seal, replacing (transmission installed) .....	230-8		

## GENERAL

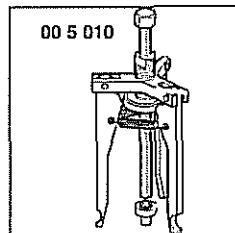
This repair group covers external transmission service, including removal and installation of the transmission unit. Internal transmission repair is not covered. Special tools and procedures are required to disassemble and service the internal geartrain.

## Special tools

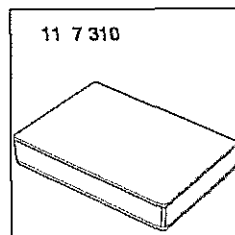
BMW specified tools are required for removal and installation of the manual transmission, as well as the removal and installation of seals at the transmission input, output, and selector shafts. If these tools are unavailable, equivalent tools may be substituted.



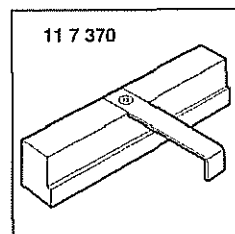
Transmission jack  
(Tool No. BMW 00 2 030)



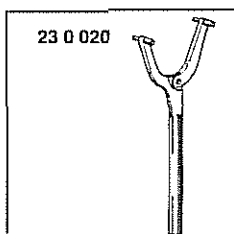
Seal puller  
(Tool No. BMW 00 5 010)



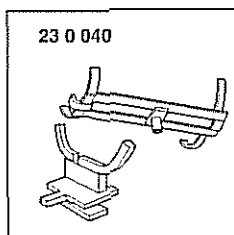
Engine support block (V-8 models)  
(Tool No. BMW 11 7 310)



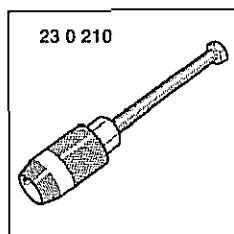
Engine support block (6 cylinder models)  
(Tool No. BMW 11 7 370)



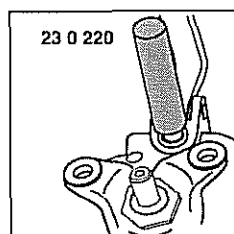
◀ Transmission flange counterhold tool  
(Tool No. BMW 23 0 020)



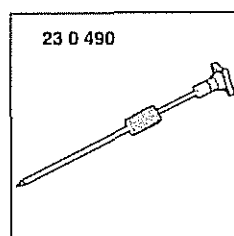
◀ Transmission support (for use with transmission jack)  
(Tool No. BMW 23 0 040)



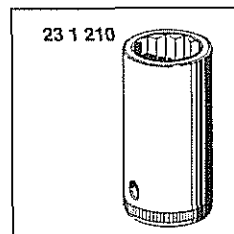
◀ Selector seal extractor  
(Tool No. BMW 23 0 210)



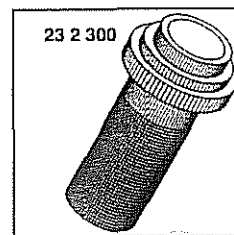
◀ Selector seal installation drift  
(Tool No. BMW 23 0 220)



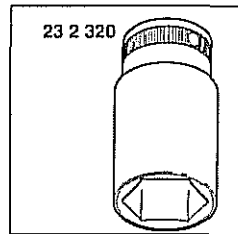
◀ Input shaft seal puller (slide hammer)  
(Tool No. BMW 23 0 490)



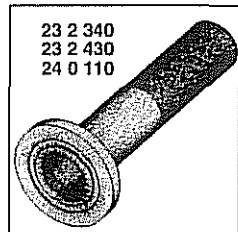
◀ Output shaft flange nut socket (27 mm)  
(Tool No. 23 1 210)



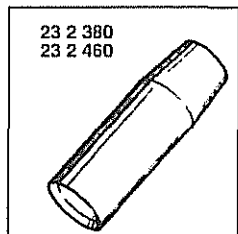
◀ Output seal installation drift  
(Tool No. BMW 23 2 300)



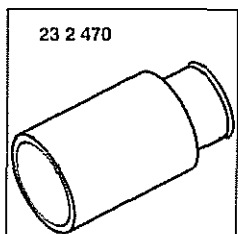
- Output shaft flange nut socket (36 mm)  
(Tool No. BMW 23 2 320)



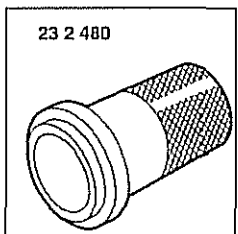
- Seal installation drift  
(Tool No. BMW 23 2 340, 23 2 430, 24 0 110)



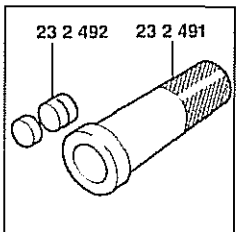
- Input shaft seal installation sleeve  
(Tool No. BMW 23 2 380, 23 2 460)



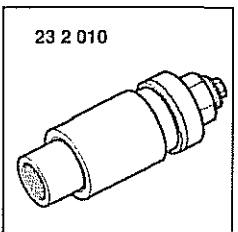
- Output flange nut retaining plate installer  
(6-speed transmission) (Tool No. BMW 23 2 470)



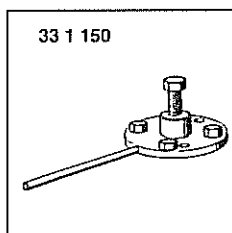
- Output shaft seal installation drift  
(6-speed transmission) (Tool No. BMW 23 2 480)



- Input shaft seal installation tools (6-speed transmission)  
(Tool No. BMW 23 2 490 (23 2 491 and 23 2 492))



- Output flange installation tool  
(6-speed transmission) (Tool No. BMW 23 3 010)



▲ Output flange puller (Tool No. BMW 33 1 150)

## Manual transmission applications

Manual transmissions used are based on engine application. See **Table a. Manual transmission applications**. For gear ratio specifications, see **Table b. Manual transmission gear ratios**.

**Table a. Manual transmission applications**

Model	Year	Engine	Transmission
525i			
Sedan	2001-2002	M54	Getrag S5D 250G
Sport Wagon	2001-2002	M54	ZF S5D 320Z
528i all	1997-2000	M52, M52 TU	ZF S5D 320Z
530i Sedan	2001-2002	M54	ZF S5D 320Z
540i Sedan	1997-2002	M62, M62 TU	ZF S6S 420G

**NOTE —**

*Do not rely on casting numbers for transmission code identification.*

**Table b. Manual transmission gear ratios**

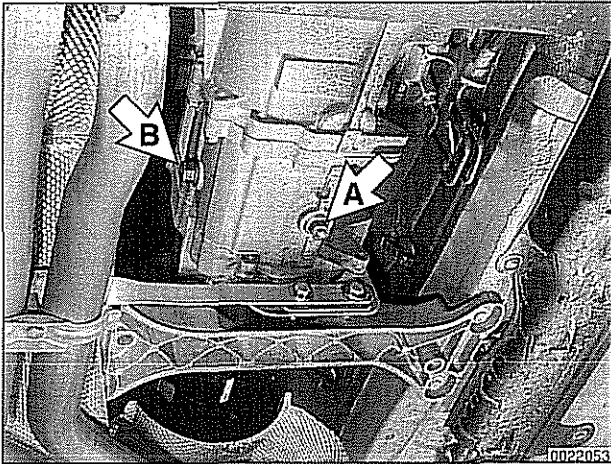
Gear	Getrag S5D 250G 5-speed	ZF S5D 320Z 5-speed	Getrag S6S 420G 6-speed
1 st	4.23	4.21	4.23
2 nd	2.52	2.49	2.53
3 rd	1.66	1.66	1.67
4 th	1.22	1.24	1.23
5 th	1.00	1.00	1.00
6 th			0.83
Reverse	4.04	3.89	3.75
Final drive	3.15	525i: 3.23 528i, 530i: 2.93	2.81

## TRANSMISSION FLUID SERVICE

Manual transmissions installed in the 5 Series are normally filled with a "Lifetime" manual transmission fluid (BMW MTF LT-1) and do not require periodic fluid changes. Transmissions filled with MTF LT-1 lifetime oil are identified with a yellow label near the transmission fill plug labeled "Lifetime Oil MTF-LT-1".

### Transmission fluid level, checking

- Drive vehicle for a few miles to warm transmission.
- Raise and safely support vehicle to access transmission filler plug.



#### 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 side filler plug (B). Insert finger into hole to check fluid level. If fluid level is up to bottom of filler hole (finger is wetted by transmission fluid), level is correct.

#### NOTE—

- Check and fill transmission with car on level surface.
- 5-speed transmission shown in illustration. 6-speed transmission is similar.

- Install and torque filler plug.

#### Tightening torque

Transmission drain or fill plug  
to transmission case

50 Nm (37 ft-lb)

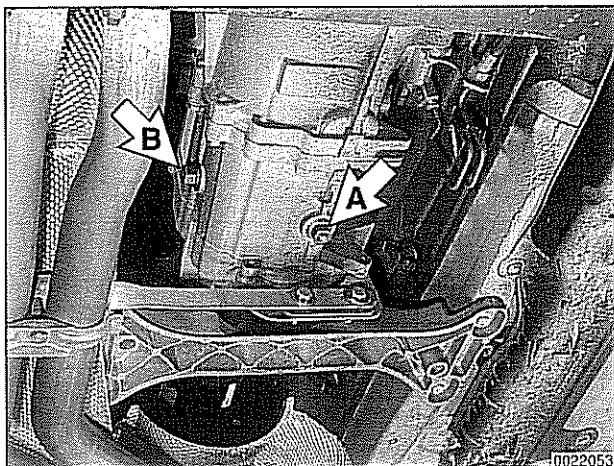
### Transmission fluid, replacing

- Drive vehicle for a few miles to warm transmission.
- Raise and safely support vehicle to access drain plug.

#### 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.
- Check that the fill plug is not seized prior to draining transmission fluid.





Place drain pan under transmission and remove drain plug (A) at bottom of transmission.

- Drain fluid.
- Install and torque drain plug.
- Remove fill plug (B) from side of transmission.
- Slowly fill transmission with fluid until fluid overflows fill hole.
- Install and torque fluid fill plug.

**NOTE** —

5-speed transmission shown in illustration. 6-speed transmission is similar.

**Fluid capacity**

Transmission	Initial fill new/rebuilt unit	Fluid change
Getrag S5D 250G	1.1 liter (1.2 US qt)	1.0 liter (1.1 US qt)
Getrag S6S 420G	1.9 liter (2.0 US qt)	1.7 liter (1.8 US qt)
ZF S5D 320Z	1.3 liter (1.4 US qt)	1.2 liter (1.3 US qt)

**Tightening torque**

Transmission drain or fill plug to transmission case	50 Nm (37 ft-lb)
--	------------------

## TRANSMISSION EXTERNAL SERVICE

### Back-up light switch, replacing

- Raise and safely support vehicle to access back-up light switch.

**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.

- Unscrew switch from transmission.

**NOTE** —

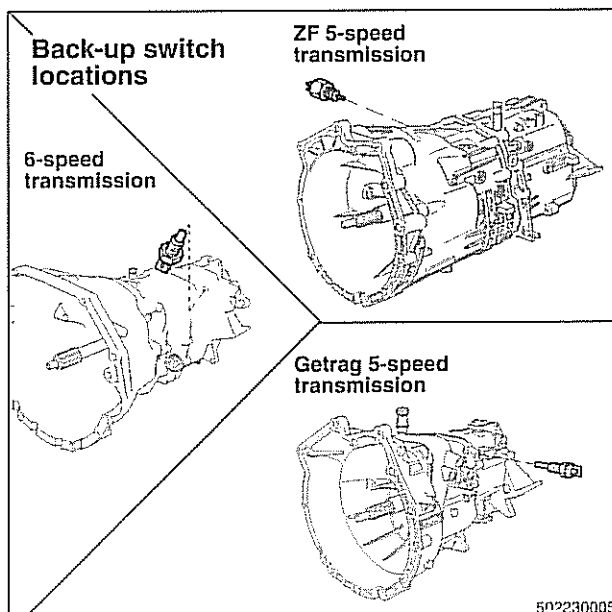
Back-up light switch location on transmission varies. Refer to illustration.

- Install new switch.

**Tightening torque**

Back-up light switch to transmission	18 Nm (13 ft-lb)
--------------------------------------	------------------

- Check transmission fluid level before lowering vehicle.



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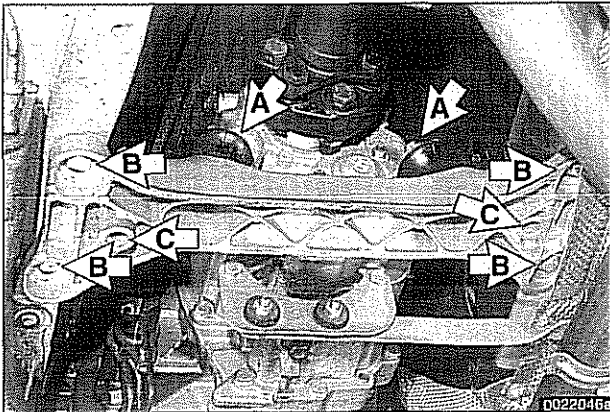
## Selector shaft seal, replacing (transmission installed)

- Put transmission into second gear.
- Raise and safely support vehicle.

### **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.*

- 6-speed transmission: Remove rear engine splash shield.
- Remove exhaust system and heat shields. See **180 Exhaust System**.
- Support transmission with transmission jack.
- Disconnect driveshaft at transmission and tie to side. See **260 Driveshaft**.



- ◀ Remove transmission crossmember:
  - Where applicable, release electrical harnesses from transmission crossmember.
  - Remove transmission mounting bolts (A).
  - Remove transmission crossmember bolts (B).
  - Where applicable, remove bolts (C).

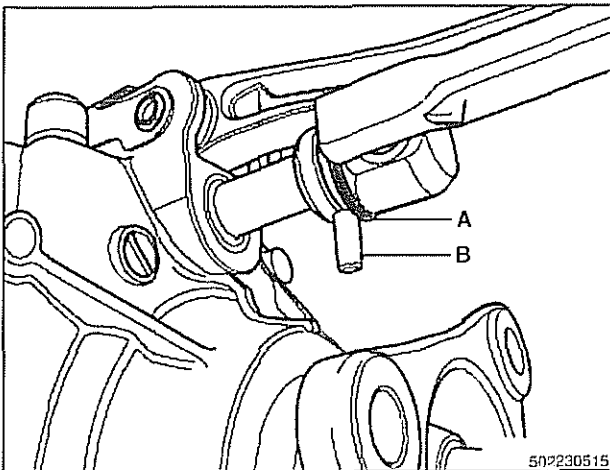
### **NOTE—**

*5-speed transmission shown in illustration. 6-speed transmission is similar.*

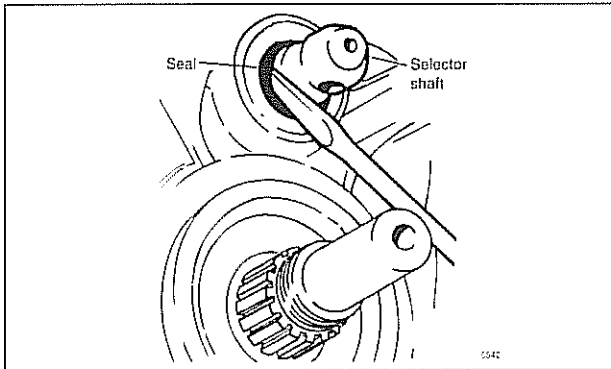
- Tilt down rear of transmission.

### **CAUTION—**

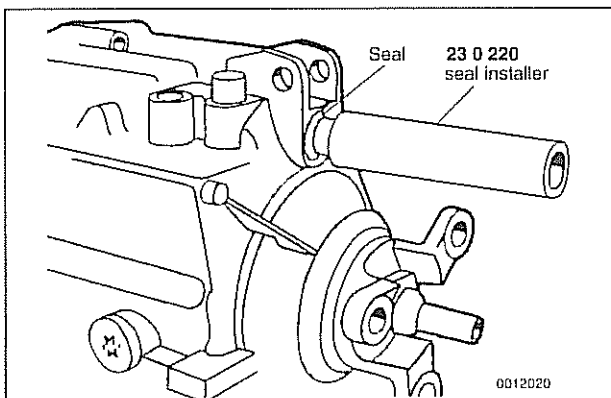
*Tilting the engine to lower the transmission can lead to damage to various components due to lack of clearance.*



- ◀ Pry spring locking ring (A) out of groove and press pin (B) out of shift rod.
  - Detach shift rod from selector shaft and tie aside.



- ⚠ Carefully pry out selector shaft oil seal with BMW special tool 23 0 210, or with a narrow seal remover or small screwdriver.



- ⚠ Coat new selector shaft seal with transmission fluid. Drive new seal in flush with housing. Use BMW special seal installation tool 23 0 220 or equivalent and a soft-faced (plastic) hammer.

- Remainder of installation is reverse of removal, noting the following:
  - Install driveshaft using new lock nuts.
  - Check transmission oil level, topping up as necessary.

#### Tightening torques

##### Aluminum driveshaft to flex-disc

- M12 (use Dacromet-coated washers) 90 Nm (66 ft-lb)

##### Driveshaft CV joint to final drive flange

- M10 (Torx bolt) 70 Nm (51 ft-lb)
- M8 (compression nut) 32 Nm (24 ft-lb)

##### Flex-disc to transmission flange or driveshaft

- M10 (8.8 grade) 48 Nm (35 ft-lb)
- M10 (10.9 grade) 60 Nm (44 ft-lb)
- M12 (8.8 grade) 81 Nm (60 ft-lb)
- M12 (10.9 grade) 100 Nm (74 ft-lb)
- M14 140 Nm (103 ft-lb)

##### Transmission crossmember

- to transmission (M8) 21 Nm (15 ft-lb)
- to chassis (M10) 42 Nm (30 ft-lb)

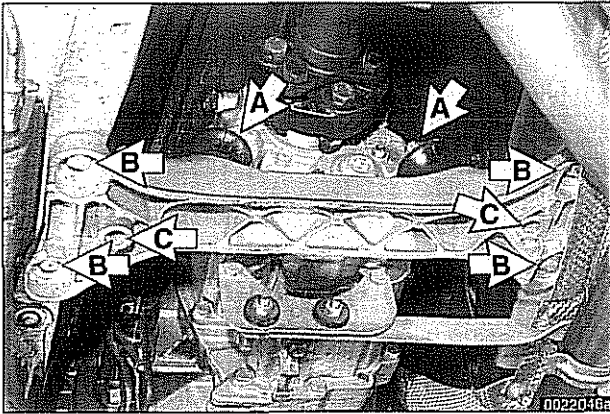
### Output shaft seal, replacing (5-speed transmission) (transmission installed)

- Raise and safely support vehicle.

**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 system and heat shields. See **180 Exhaust System**.
- Support transmission with transmission jack.
- Disconnect driveshaft at transmission output flange, and hang driveshaft to side. See **260 Driveshaft**.



- Remove transmission crossmember:
  - If applicable, release electrical harnesses from transmission crossmember.
  - Remove transmission mounting bolts (A).
  - Remove transmission crossmember bolts (B).
  - Where applicable, remove bolts (C).

- Tilt down rear of transmission.

**CAUTION—**

*Tilting the engine to lower the transmission can lead to damage to various components due to lack of clearance.*

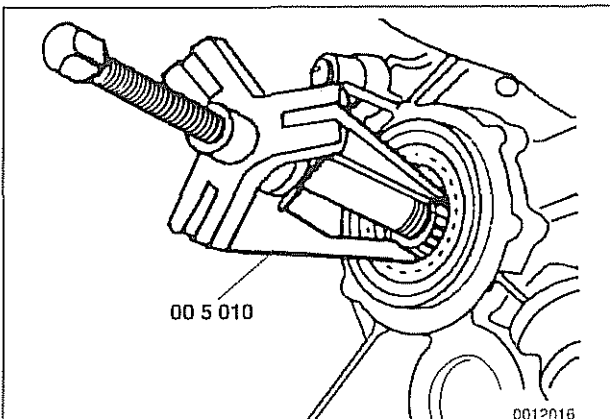
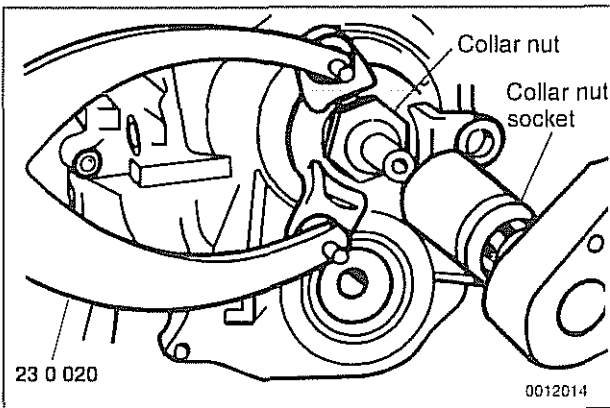
- Remove collar nut with BMW special tool (see table below) or suitable thin-walled deep socket. Use BMW special tool 23 0 020 or equivalent to counterhold output flange.

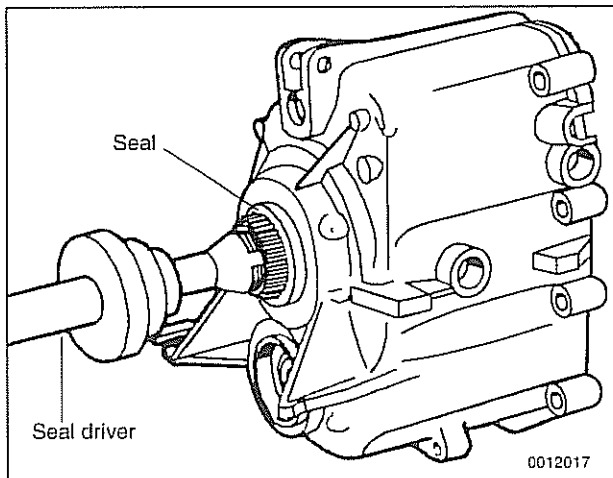
**Collar nut sockets**

Transmission	BMW special tool
Getrag S5D 250G	23 1 210 (27 mm)
ZF S5D 320Z	23 2 320 (36 mm)

- Use puller (BMW special tool 33 1 150 or equivalent) to remove output flange.

- Use BMW special tool 00 5 010 or other suitable seal puller to remove seal from transmission housing.





- ◀ Coat new seal with transmission fluid. Use seal installation drift (see table below) to drive seal into position until it is flush with housing.

#### Output seal drives

Transmission	BMW special tool
Getrag S5D 250G	24 0 110
ZF S5D 320Z	23 2 300

- Inspect sealing surface on output flange. Replace if flange surface is worn or damaged.
- Heat output flange to about 176° F (80° C) to aid in installation. This can be done by placing flange in hot water. Reinstall output flange to output shaft.
- Coat flange nut with Loctite® 243 and reinstall. Torque in two stages.

#### Tightening torques

##### Output flange to output shaft

- Stage I 190 Nm (140 ft-lb)
- Stage II (after loosening) 120 Nm (89 ft-lb)

- Remainder of installation is reverse of removal, noting the following:
  - Install driveshaft using new nuts. See **260 Driveshaft**.
  - Check transmission fluid level, topping up as necessary.

#### Tightening torques

##### Aluminum driveshaft to flex-disc

- M12 (use Dacromet-coated washers) 90 Nm (66 ft-lb)

##### Driveshaft CV joint to final drive flange

- M10 (Torx bolt) 70 Nm (51 ft-lb)
- M8 (compression nut) 32 Nm (24 ft-lb)

##### Flex-disc to transmission flange or driveshaft

- M10 (8.8 grade) 48 Nm (35 ft-lb)
- M10 (10.9 grade) 60 Nm (44 ft-lb)
- M12 (8.8 grade) 81 Nm (60 ft-lb)
- M12 (10.9 grade) 100 Nm (74 ft-lb)
- M14 140 Nm (103 ft-lb)

##### Transmission crossmember

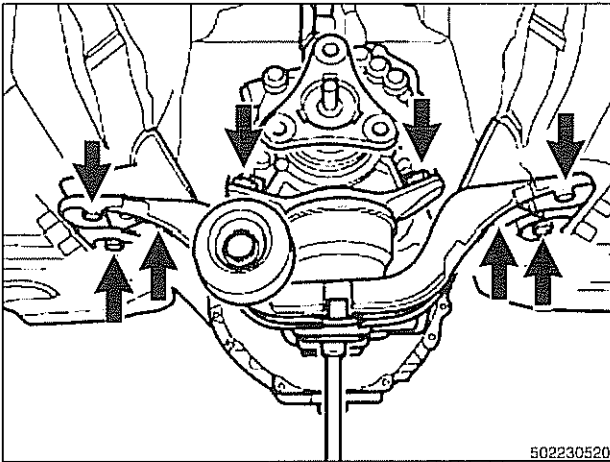
- to transmission (M8) 21 Nm (15 ft-lb)
- to chassis (M10) 42 Nm (30 ft-lb)

## Output shaft seal, replacing (6-speed transmission) (transmission installed)

- Raise and safely support vehicle.

### **WARNING** —

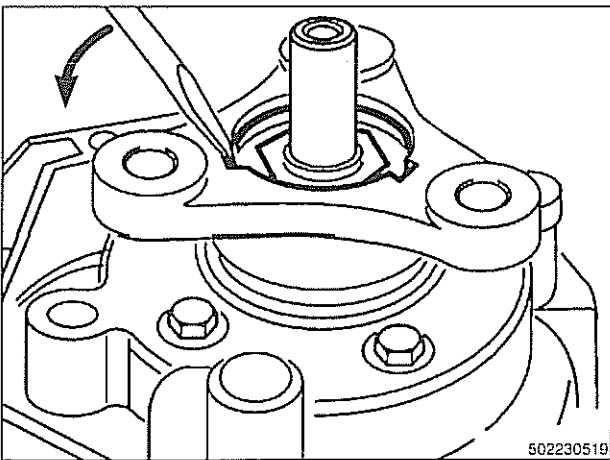
*Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*



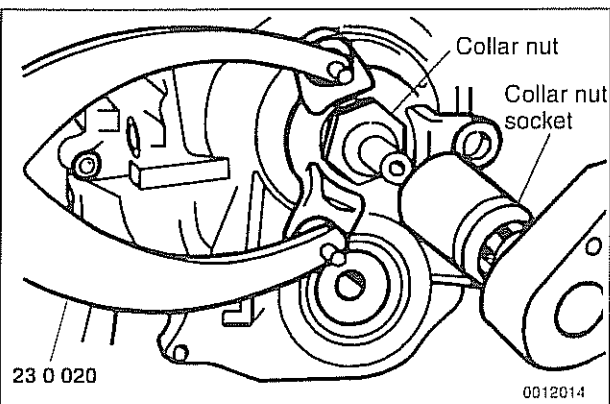
- Remove exhaust system and heat shields. See **180 Exhaust System**.
- Support transmission with transmission jack.
- Disconnect driveshaft at transmission output flange, and hang driveshaft to side. See **260 Driveshaft**.
- ◀ Remove transmission crossmember:
  - If applicable, release electrical harnesses from transmission crossmember.
  - Remove transmission and crossmember mounting bolts (arrows).
- Tilt down rear of transmission.

### **CAUTION** —

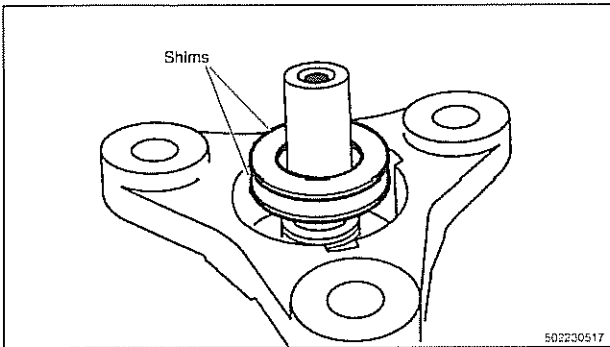
*Tilting the engine to lower the transmission can lead to damage to various components due to lack of clearance.*



- ◀ Use screwdriver to pry out output flange collar nut retaining plate.

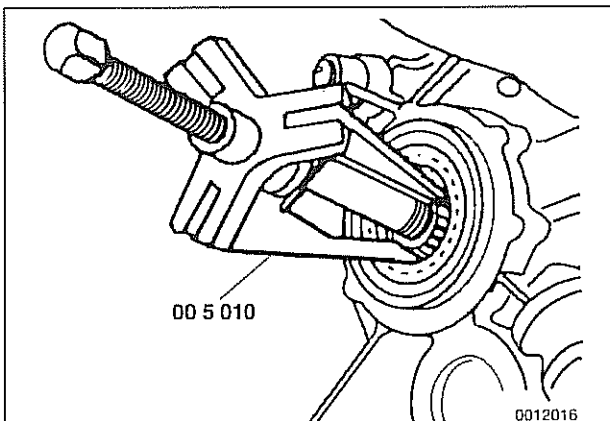


- ◀ Remove collar nut with BMW special tool 23 2 320 or equivalent thin-walled deep socket (36 mm). Use BMW special tool 23 0 020 or equivalent to counterhold output flange.

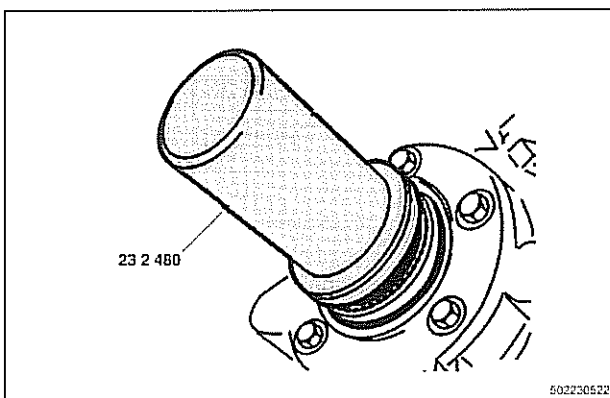


◀ Remove shims under collar nut and set aside.

– Use puller to remove output flange.



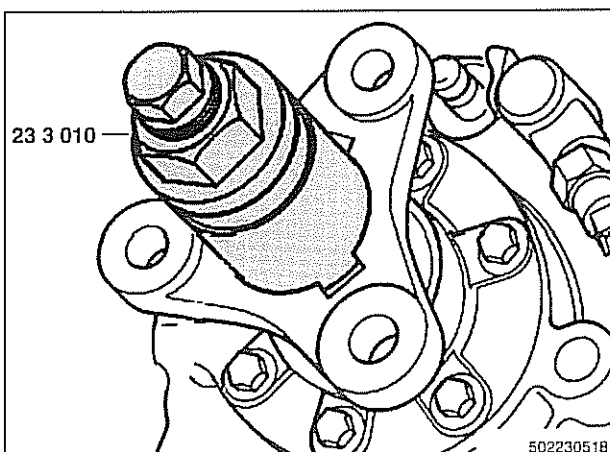
◀ Use BMW special tool 00 5 010 or other suitable seal puller to remove seal from transmission housing.



◀ Coat new seal with transmission fluid. Use seal installation drift, BMW special tool 23 2 480 or equivalent, to drive seal into housing as far as it will go.

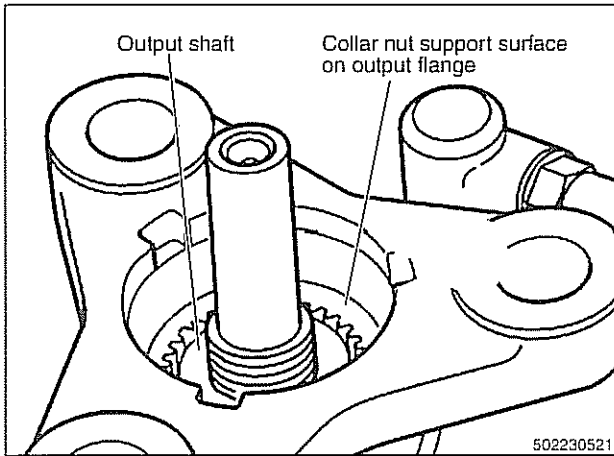
– Inspect sealing surface on output flange. Replace if worn or damaged.

– Coat sealing lip of seal, sealing surface of output flange and transmission splined shaft with transmission oil.



◀ Press output flange on output shaft using BMW special tool 23 3 010.

- Counterhold flange with BMW special tool 23 0 020.
- Tighten special tool 23 2 010 to 200 Nm (148 ft-lb).
- Remove special tools.



- ⚠ If installing new output flange: Recalculate thickness of shims based on difference in height between output shaft surface and collar nut support surface. Shims must be within the output flange preload specification below the collar nut support surface.

#### Output flange preload

Difference between heights of shaft and output flange sealing surface MINUS thickness of shims	0.05 - 0.22 mm (0.002 - 0.009 in)
--	--------------------------------------

#### NOTE—

Shims are available in increasing sizes of 0.1 mm from 1.4 mm to 2.1 mm (0.055 in to 0.083 in) from BMW parts.

- Install shims. Install and torque flange collar nut.

#### Tightening torques

##### Output flange to out put shaft

- Stage I 190 Nm (140 ft-lb)
- Stage II (after loosening) 120 Nm (89 ft-lb)

- Use BMW special tool 23 2 470 to install flange nut retaining plate.
- Remainder of installation is reverse of removal, noting the following:
  - Install driveshaft using new nuts. See **260 Driveshaft**.
  - Check transmission fluid level, topping up as necessary.

#### Tightening torques

##### Aluminum driveshaft to flex-disc

- M12 (use Dacromet-coated washers) 90 Nm (66 ft-lb)

##### Driveshaft CV joint to final drive flange

- M10 (Torx bolt) 70 Nm (51 ft-lb)
- M8 (compression nut) 32 Nm (24 ft-lb)

##### Flex-disc to transmission flange or driveshaft

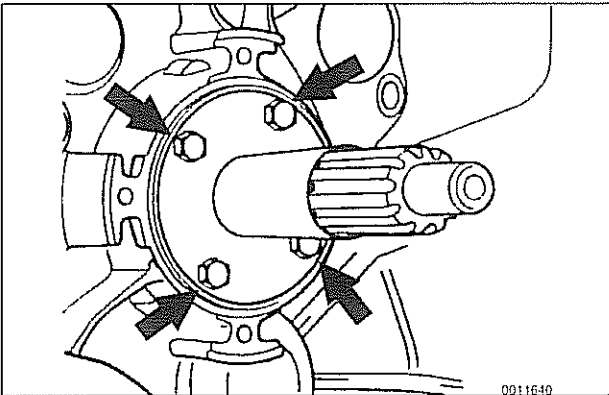
- M10 (8.8 grade) 48 Nm (35 ft-lb)
- M10 (10.9 grade) 60 Nm (44 ft-lb)
- M12 (8.8 grade) 81 Nm (60 ft-lb)
- M12 (10.9 grade) 100 Nm (74 ft-lb)
- M14 140 Nm (103 ft-lb)

##### Transmission crossmember

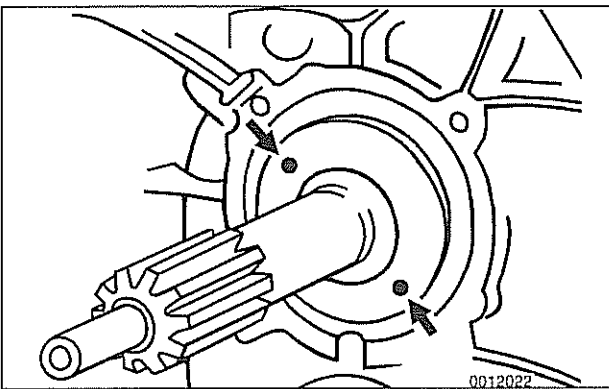
- to transmission (M8) 21 Nm (15 ft-lb)
- to chassis (M10) 42 Nm (30 ft-lb)



## Input shaft seal, replacing (transmission removed)



- Remove transmission from vehicle as described later in this group.
- Remove clutch release bearing and release bearing lever from inside bellhousing.
- Remove bolts (**arrows**) for clutch release-bearing guide sleeve, noting bolt lengths (Getrag transmission shown). Remove sleeve and any spacers (shims) under it.



- Two covered removal holes (**arrows**) are present in seal. Thread BMW special tool 23 0 490 or equivalent slide hammer seal puller into one hole and remove seal.
- Getrag S5D 250G transmission:
  - Place BMW special tool 23 2 460 or similar protective sleeve over input shaft.
  - Coat sealing lip of new seal with transmission oil and push over protective sleeve up to transmission housing.
  - Remove protective sleeve from input shaft.
  - Use BMW special tool 23 2 430 or similar drift to drive seal until fully seated.
- ZF S5D 320Z transmission:
  - Place BMW special tool 23 2 380 or similar protective sleeve over input shaft.
  - Coat sealing lip of new seal with transmission oil and push over protective sleeve up to transmission housing.
  - Remove protective sleeve from input shaft.
  - Use BMW special tool 23 2 340 or similar drift to drive seal until fully seated.
- 6-speed transmission:
  - Fit cap of BMW special tool 23 2 492 over tool sleeve.
  - Coat sealing lip of new seal with transmission oil and push on tool sleeve. Remove tool cap from tool sleeve.
  - Push sleeve with seal on input shaft.
  - Use BMW special tool 23 2 491 or similar drift to drive seal until fully seated.
  - Remove protective sleeve from input shaft.

- Thoroughly clean guide sleeve mounting bolts, sealing surfaces, and threads. Apply Loctite®243 or equivalent thread locking compound to guide sleeve bolts. Reinstall guide sleeve and spacer(s).

#### Tightening torques

##### Guide sleeve to transmission case

• M6	10 Nm (89 in-lb)
• M8 x 22	18 Nm (13 ft-lb)
• M8 x 30	25 Nm (18 ft-lb)

- Reinstall transmission.

## TRANSMISSION REMOVAL AND INSTALLATION

Removal and installation of the transmission is best accomplished on a lift using a transmission jack. The engine must be supported using appropriate support equipment. This allows the engine to pivot on its mounts to access the upper Torx-head bolts at the bellhousing.

#### **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.*
- *The removal of the transmission may upset the balance of the vehicle on a lift.*

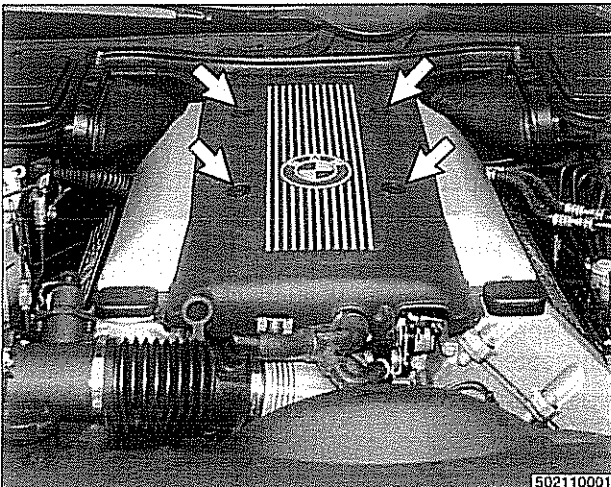
### Transmission, removing and installing

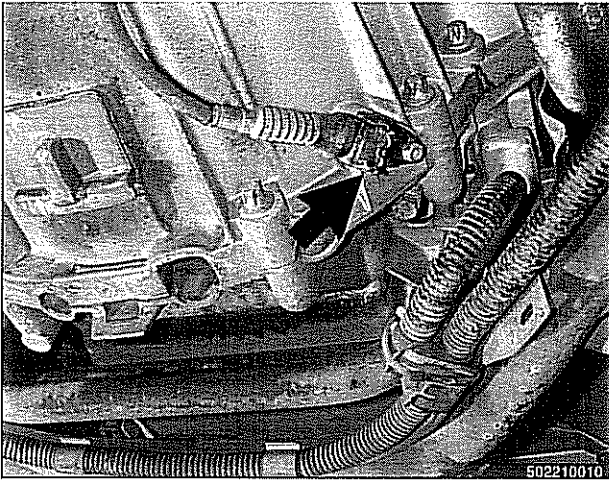
- Disconnect negative (-) cable from battery.

#### **CAUTION—**

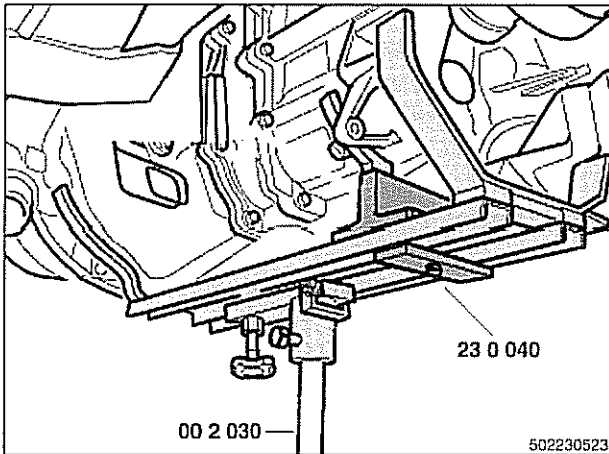
*Prior to disconnecting the battery, read the battery disconnection cautions given in 001 Warnings and Cautions.*

- ◀ V-8 engine: Remove plastic engine cover.
  - Early models: pry out protective caps (**arrows**), then remove nuts securing cover. Lift off cover.
  - Later models: depress four studs to release, then lift off cover.
- Raise and safely support vehicle.
- Remove engine splash shield from underside of vehicle.
- Remove exhaust system and heat shields. See **180 Exhaust System**.

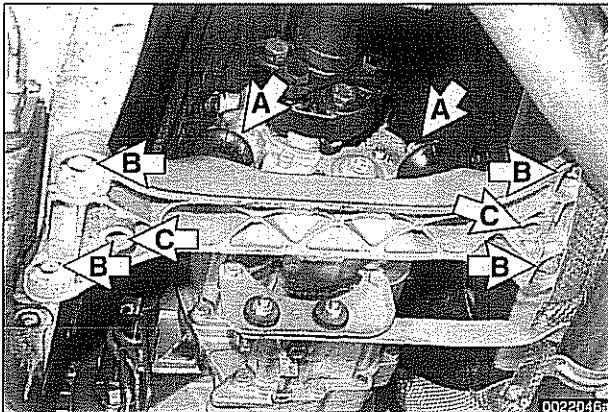




- V-8 engine: Remove heat shield from left front axle support.
- ◀ V-8 engine: Remove engine speed reference sensor from transmission.
- Where applicable, remove brackets for transmission underbody protection (adjacent to transmission).



- ◀ Support transmission with transmission jack.
- Where applicable, remove reinforcing cross brace from below driveshaft at transmission.
- Disconnect harness connector from back-up light switch on transmission.
- Free harnesses for oxygen sensors and back-up lights from crossmember and transmission.



- ◀ Remove transmission crossmember:
  - Remove transmission mount bolts (A).
  - Remove transmission crossmember bolts (B).
  - Where applicable, remove bolts (C).

**NOTE—**

5-speed transmission shown in illustration. Crossmember assembly for 6-speed transmission is similar.

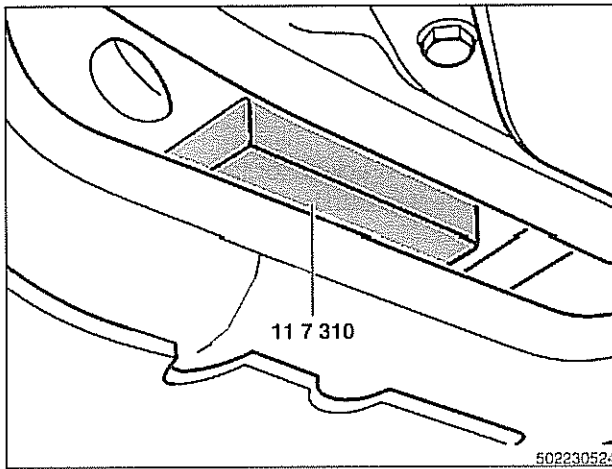
- Disconnect driveshaft from transmission and hang to one side. See 260 Driveshaft.

**CAUTION—**

Do not damage constant velocity joint or protective boot at rear differential.

- 6-cylinder engine: Remove stabilizer bar links and swivel stabilizer bar upwards.

## Manual Transmission



- Unbolt clutch slave cylinder from side of transmission. Do not disconnect fluid hose. Suspend slave cylinder from chassis using stiff wire.

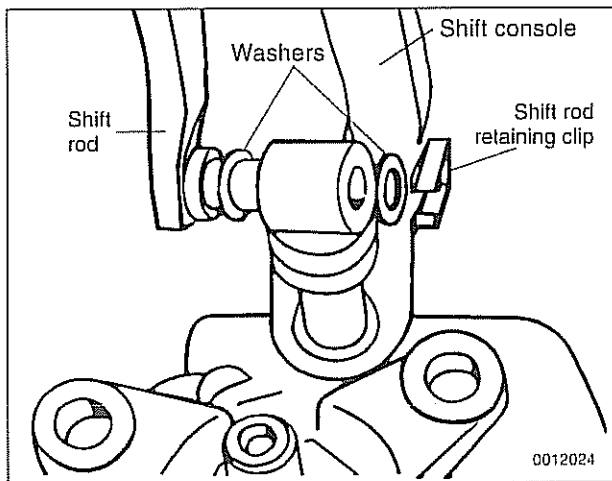
**CAUTION—**

- *Unbolt clutch slave cylinder slowly to prevent air being drawn into hydraulic system.*
- *Do not operate clutch pedal with slave cylinder removed from transmission.*

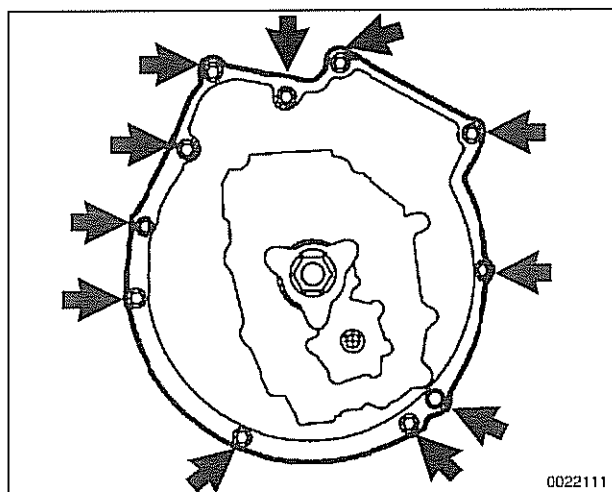
- Put BMW special tool 11 7 370 or appropriate sized spacer between engine oil sump and front axle support. Lower transmission until engine is supported on spacer.

**CAUTION—**

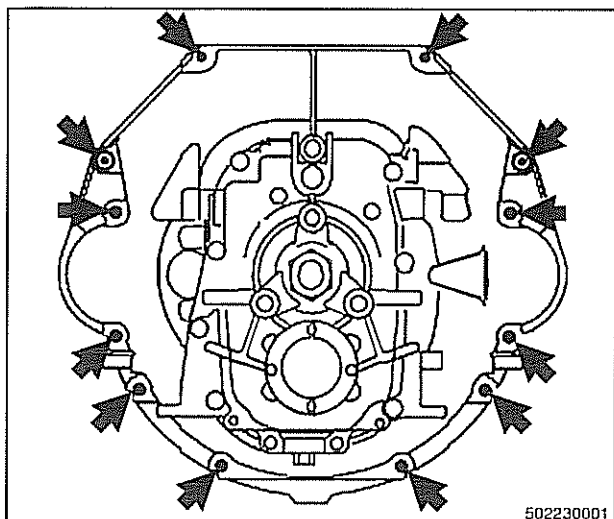
- *V-8 vehicle: Turn front wheels to prevent strain from being placed on center tie rod.*
- *All vehicles: Tilting the engine to lower the transmission can lead to damage to various components due to lack of clearance at rear of engine. Lower transmission slowly.*



- Support front of engine with floor jack.
- Disconnect shift rod from selector shaft coupling.
- Disconnect shift console from top of transmission. See **250 Gearshift Linkage**.



- 6-cylinder: Remove transmission mounting Torx-head bolts (arrows). Note length and location of bolts.
- Remove transmission by pulling backward until transmission input shaft clears clutch disc splines, then pull downwards. Lower transmission jack to remove transmission.



◀ V-8 engine: Remove transmission mounting Torx-head bolts (**arrows**). Note length and location of bolts.

- Remove transmission by pulling backward until transmission input shaft clears clutch disc splines, then pull downwards. Lower transmission jack to remove transmission.

— Installation is reverse of removal, keeping in mind the following:

- When installing a new transmission, be sure to transfer parts from old transmission if applicable.
- Thoroughly clean input shaft and clutch disc splines. Lightly lubricate transmission input shaft before installing.
- Be sure bellhousing alignment dowel sleeves are located correctly. Replace damaged sleeves.
- Center rear of transmission in driveshaft tunnel before tightening transmission support bracket.

**NOTE** —

*In order to avoid difficulties in transmission removal at a future time, use washers with Torx-head mounting bolts.*

- Reinstall driveshaft. Use new nuts when mounting driveshaft to transmission/flex disc. See **260 Driveshaft**.
- Refill transmission with appropriate lubricant before starting or towing car. See **Transmission fluid service** earlier in this repair group.

### Tightening torques

#### Flex-disc to transmission output flange

• M10 (8.8 grade)	48 Nm (35 ft-lb)
• M10 (10.9 grade)	60 Nm (44 ft-lb)
• M12 (8.8 grade)	81 Nm (60 ft-lb)
• M12 (10.9 grade)	100 Nm (74 ft-lb)
• M14	140 Nm (103 ft-lb)

Rubber mount to transmission or crossmember (M8)	21 Nm (15 ft-lb)
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Slave cylinder to transmission	22 Nm (16 ft-lb)
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#### Transmission crossmember to chassis or transmission

• M8	21 Nm (15 ft-lb)
• M10	42 Nm (32 ft-lb)

#### Transmission to engine (Torx-head)

• M8	22 Nm (16 ft-lb)
• M10	43 Nm (32 ft-lb)
• M12	72 Nm (53 ft-lb)

Transmission drain/fill plug to transmission case	50 Nm (37 ft-lb)
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# 240 Automatic Transmission

<b>General</b> .....	240-2	ATF, draining and filling .....	240-7
Special tools .....	240-2	Automatic transmission fluid pan and strainer .....	240-9
Automatic transmission applications .....	240-4	<b>Transmission Removal and Installation</b> .....	240-10
<b>Troubleshooting</b> .....	240-4	Transmission, removing and installing ...	240-10
<b>Automatic Transmission Fluid (ATF) Service</b> .....	240-6		
Automatic transmission fluid (ATF) .....	240-6		
ATF level, checking .....	240-6		

## GENERAL

This section covers maintenance and replacement of the automatic transmission for E39 models.

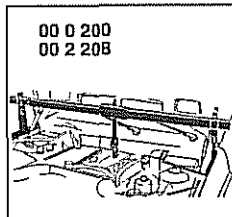
Automatic transmission internal repairs are not covered. Such repairs require special service equipment and knowledge. If it is determined that transmission internal service is required, consult an authorized BMW dealer about a factory reconditioned unit or a transmission rebuild.

### CAUTION—

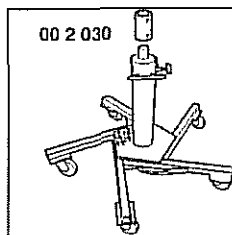
*ATF does not circulate unless the engine is running. When towing an automatic transmission vehicle, use a flat bed truck or raise the rear wheels off the ground.*

## Special tools

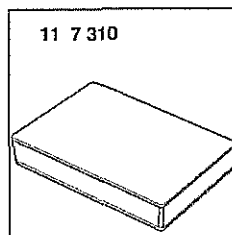
Some special tools are required for the removal and installation of an automatic transmission on the E39 BMW models. While these tools are not absolutely necessary, they are especially helpful when dealing with the removal and replacement of the torque converter.



- ◀ Engine support bracket  
(Tool No. BMW 00 0 200, 00 0 208)

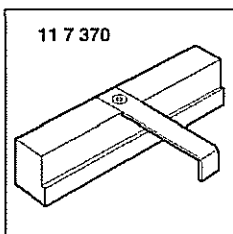


- ◀ Transmission jack  
(Tool No. BMW 00 2 030)

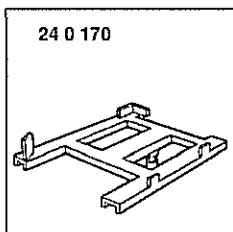


- ◀ Engine support block (V-8 models)  
(Tool No. BMW 11 7 310)

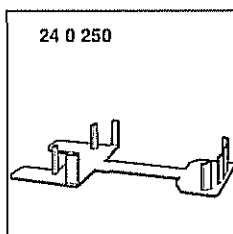




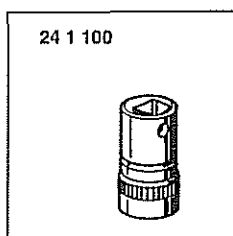
- ◀ Engine support block (6-cylinder models)  
(Tool No. BMW 11 7 370)



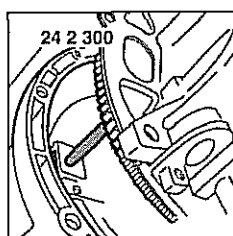
- ◀ Transmission support (for use with transmission jack, A5S 560Z transmission) (Tool No. BMW 24 0 170)



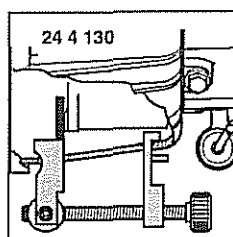
- ◀ Transmission support (for use with transmission jack, A5S 440Z transmission) (Tool No. BMW 24 0 250)



- ◀ Torque converter socket  
(Tool No. BMW 24 1 100)



- ◀ Spline bore alignment tool  
(Tool No. BMW 24 2 300)



- ◀ Torque converter clamp set  
(Tool No. BMW 24 4 130)

## Automatic transmission applications

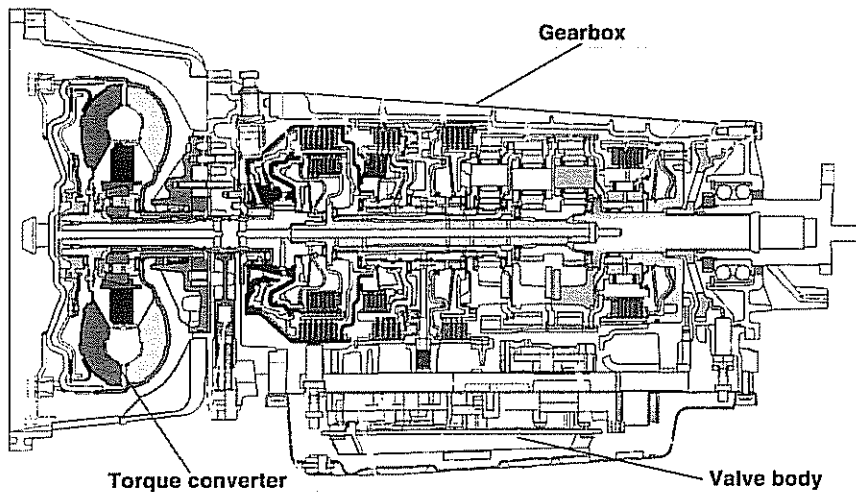
Automatic transmissions are identified by code letters found on a data plate located on the side or rear of the transmission case. See table below for application information.

### Automatic transmission applications

Model	Year	Engine	Transmission
528i	to 9/1999	M52	A4S 310R
528i	from 9/1999	M52 TU	A5S 360R
525i	to 3/2001	M54	A5S 390R
525i	from 3/2001	M54	A5S 325Z
530i	to 3/2001	M54	A5S 390R
530i	from 3/2001	M54	A5S 325Z
540i	to 1/1997	M62	A5S 560Z
540i	from 1/1997	M62 TU	A5S 440Z

## TROUBLESHOOTING

### Automatic transmission basic components



502240700

The automatic transmission fitted to BMW 5 Series models is comprised of 3 main elements:

- Torque converter capable of torque multiplication at an infinitely variable ratio
- Electrohydraulically controlled valve body
- Gearbox containing 5 forward speeds and reverse

Electronics are used to control the operation of these automatic transmissions. Steptronic transmission functions are also programmed into the transmission control module (TCM). The TCM monitors transmission operation for faults and alerts the driver by illuminating the transmission fault indicator on the instrument panel. Diagnostic trouble codes (DTCs) stored in the TCM may be downloaded and interpreted by trained technicians using special BMW diagnostic equipment.

Some minor automatic transmission problems can be corrected by changing the automatic transmission fluid (ATF) and filter. Begin by checking ATF level and condition. Check to see if the fluid is dirty or has a burned odor indicating overheated fluid. The burned odor may be the results of burned discs in the clutch packs. The friction material from the burned disc can clog valve body passages.

**NOTE**—

*The E39 automatic transmission is not equipped with a dipstick. Checking the ATF level must be done while monitoring the ATF temperature with the engine idling. The BMW dealer is equipped with the special equipment to make this check.*

## AUTOMATIC TRANSMISSION FLUID (ATF) SERVICE

### Automatic transmission fluid (ATF)

The E39 automatic transmission is filled with either Dexron III ATF or Texaco 8072B, a life time oil.

#### **CAUTION—**

- Use only the transmission fluid that is approved for use by BMW. All other fluids will cause non warrantable transmission damage.
- Mixing different types of transmission fluids will lead to transmission failure.

#### **NOTE—**

The type of transmission lubricant used can be found on a sticker on the transmission pan. Dexron III ATF (black sticker) reads "ATF-Oil". Special life time oil (green sticker) reads "Life-Time Oil". If in doubt, consult an authorized BMW dealer for alternate fluid use and current information regarding transmission operating fluids.

### ATF level, checking

Check ATF level if there is evidence of a leak, a complaint related to fluid level or after transmission repairs.

The automatic transmission is not equipped with a dipstick. Checking the ATF level requires that the transmission be at operating temperature during the checking procedure.

#### **NOTE—**

Vehicle must be level throughout tests.

- Drive vehicle to warm up ATF to operating temperature.
- Connect BMW diagnostic scan tool DISplus, MoDiC, GT1 or equivalent to determine transmission oil temperature.

#### **ATF level checking**

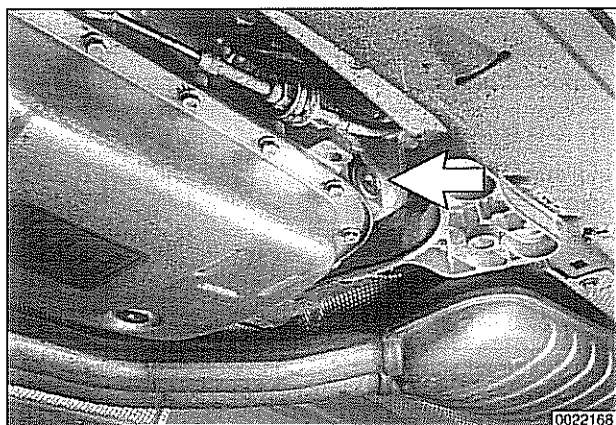
Fluid temperature	30° - 50° C (85° - 120° F)
-------------------	----------------------------

- With engine running, switch on air conditioning to increase engine idle speed.
- Apply parking brake.
- While applying foot brake firmly move gear shift selector lever through all gear positions, pausing in each gear briefly.

- Raise and safely support vehicle.

**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.

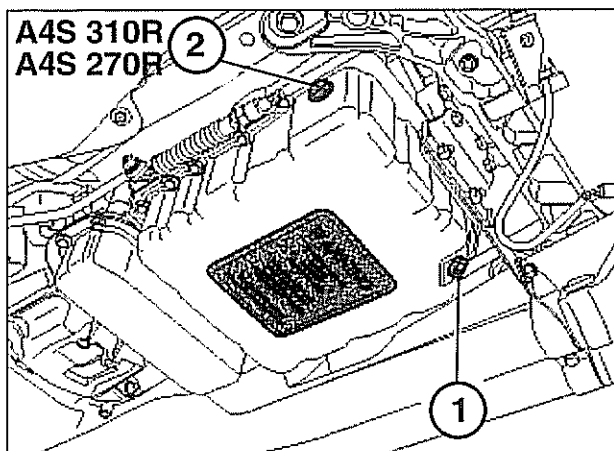


- With engine running and selector lever in PARK, remove filler plug (arrow) (A5S 360R transmission shown, refer to other illustrations for location of filler and drain plugs on other transmissions).

- If a small stream of fluid runs out of the filler hole the level is correct.
- If no fluid leaks out when plug is removed, fluid level is too low. Add ATF fluid until it starts to overflow.
- Install filler plug using a new sealing ring.

**WARNING—**

Hot ATF can scald. Wear eye protection and protective clothing and gloves during the check. If the transmission was overfilled, hot ATF will spill from the filler hole when the fill plug is removed.

**ATF, draining and filling**

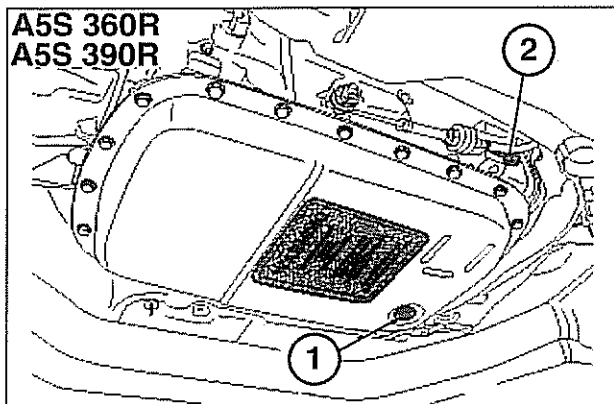
The procedure given here includes removal and installation of the fluid strainer (filter). Refer to illustrations in **Automatic transmission fluid pan and strainer**.

- Remove ATF drain plug (1) and drain fluid into container.

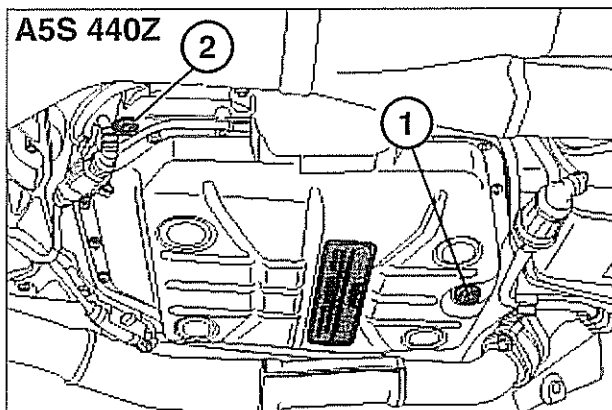
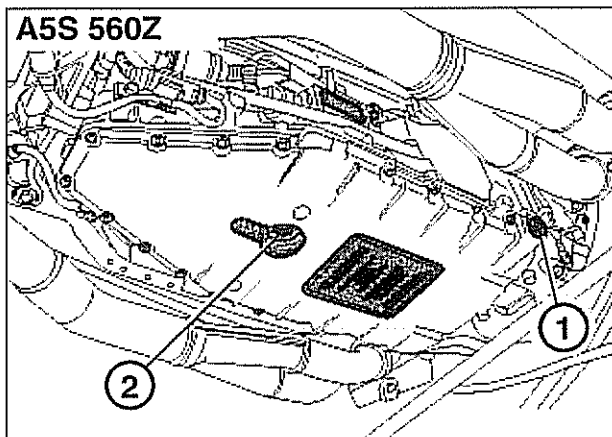
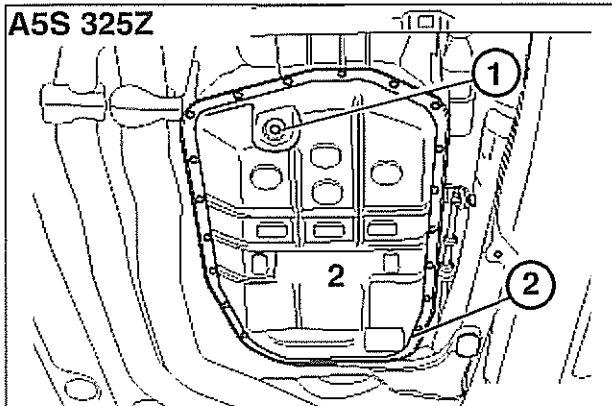
**WARNING—**

ATF should be warm when draining. Hot ATF can scald. Wear eye protection, protective clothing and gloves.

- Remove transmission pan mounting bolts and remove pan.
- Remove pan gasket and clean gasket sealing surface.
- Pull ATF strainer from transmission pump housing. If strainer sealing ring remains in pump housing remove using a seal puller.
- Installation is reverse of removal.
  - Always replace seal for drain plug and all gasket(s) and O-rings.
  - Clean sump and sump magnet(s) using a lint-free cloth.
  - Tighten transmission pan bolts in sequential order.
  - Using filler plug (2), fill transmission with approved ATF.
  - Check fluid level as described earlier.



## Automatic Transmission



### NOTE —

Use new ATF pan bolts purchased from BMW. Alternatively, clean old bolts and coat with Loctite® thread locking compound or equivalent.

### Automatic transmission fluid capacity

#### A4S 310R

with torque converter	7.8 liters (8.3 US qt)
without torque converter	3.3 liters (3.5 US qt)

#### A5S 360R / A5S 390R

with torque converter	9 liters (9.5 US qt)
without torque converter	4 liters (4.2 US qt)

#### A5S 325Z (2.5 liter engine)

with torque converter	8.9 liters (9.4 US qt)
without torque converter	6.2 liters (6.5 US qt)

#### A5S 325Z (3.0 liter engine)

with torque converter	8.7 liters (9.3 US qt)
without torque converter	6.1 liters (6.4 US qt)

#### A5S 560Z

with torque converter	13.1 liters (13.8 US qt)
without torque converter	5.5 liters (5.8 US qt)

#### A5S 440Z

with torque converter	9.7 liters (10.2 US qt)
without torque converter	4.0 liters (4.2 US qt)

### Tightening torques

#### ATF drain plug to ATF pan

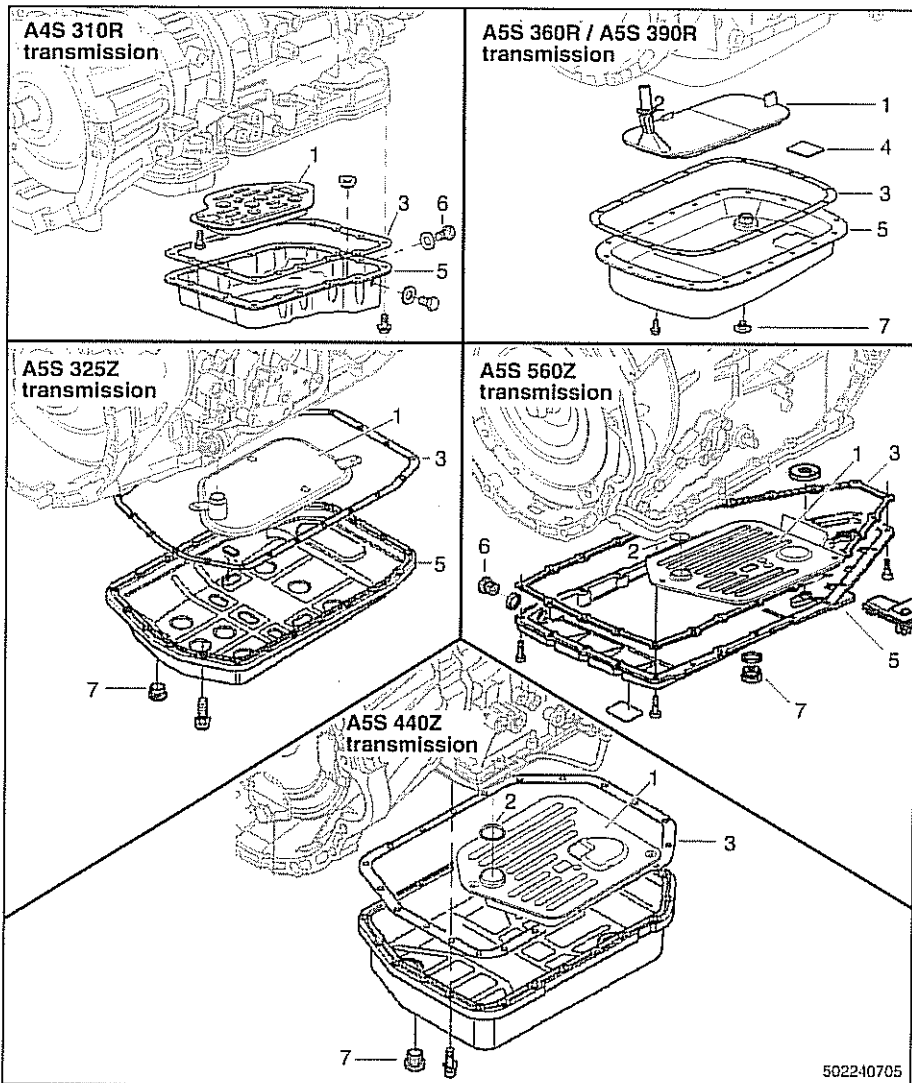
A4S 310R	33 Nm (24 ft-lb)
A5S 360R / A5S 390R (M14)	20 Nm (15 ft-lb)
A5S 325Z	35 Nm (26 ft-lb)
A5S 560Z	50 Nm (37 ft-lb)
A5S 440Z (M16)	30 Nm (23 ft-lb)

#### ATF fill plug to transmission housing

A4S 310R	25 Nm (18 ft-lb)
A5S 360R / A5S 390R (M14)	20 Nm (15 ft-lb)
A5S 325Z	30 Nm (23 ft-lb)
A5S 560Z	100 Nm (74 ft-lb)
A5S 440Z (M18)	35 Nm (26 ft-lb)

#### ATF pan to transmission (M6)

A4S 310R	12 Nm (9 ft-lb)
A5S 360R / A5S 390R	10 Nm (7 ft-lb)
A5S 325Z	6 Nm (4 ft-lb)
A5S 560Z	10 Nm (7 ft-lb)
A5S 440Z	10 Nm (7 ft-lb)



**Automatic transmission fluid pan and strainer**

1. ATF strainer
2. ATF strainer seal
3. Pan gasket
4. Sump magnet
5. ATF pan
6. Filler plug
7. Drain plug

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## TRANSMISSION REMOVAL AND INSTALLATION

Removal and installation of the transmission is best accomplished on an automotive lift using a transmission jack. Use caution and safe workshop practices when working beneath car and lowering transmission.

Torx-head bolts are used to mount the transmission to the bellhousing. Be sure to have appropriate tools on hand before starting the job.

### **WARNING—**

*Be sure the vehicle is properly supported. The removal of the transmission may upset the balance of the vehicle on a lift.*

### **CAUTION—**

*Tilting the engine to remove the transmission can lead to damage to various components due to lack of clearance.*

## Transmission, removing and installing

### **WARNING—**

*Allow engine and transmission to cool down before starting work on the transmission.*

- Disconnect negative (-) cable from battery.

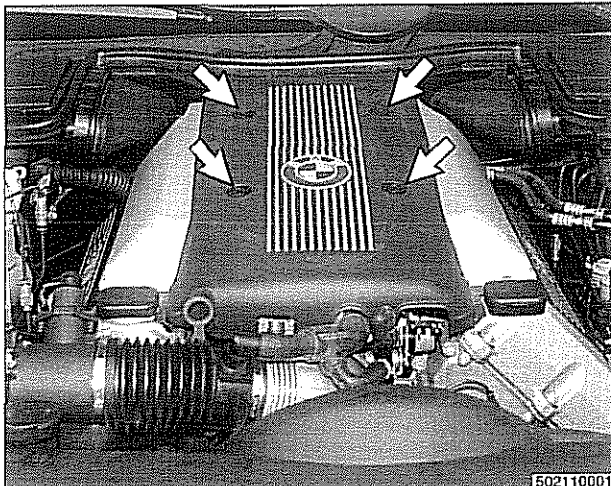
### **CAUTION—**

*Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.*



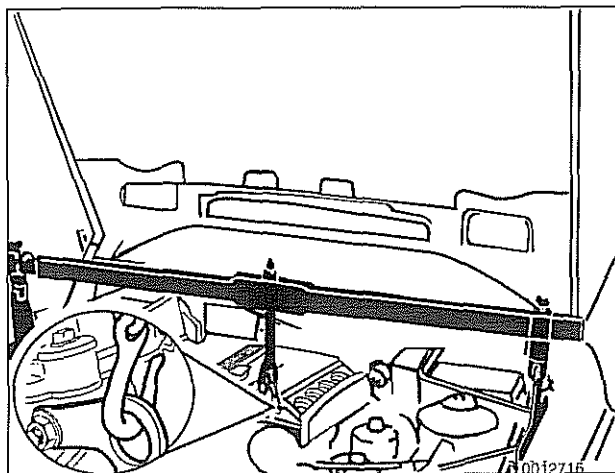
V-8 engine: Remove plastic engine cover.

- Early models: pry out protective caps (**arrows**), then remove nuts securing cover. Lift off cover.
- Later models: depress four studs to release, then lift off cover.





## Automatic Transmission



- ◀ Install engine support across engine bay. Raise and safely support vehicle.

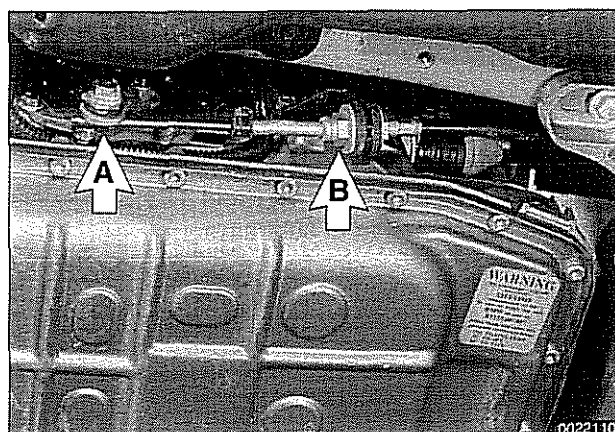
**WARNING—**

*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.*

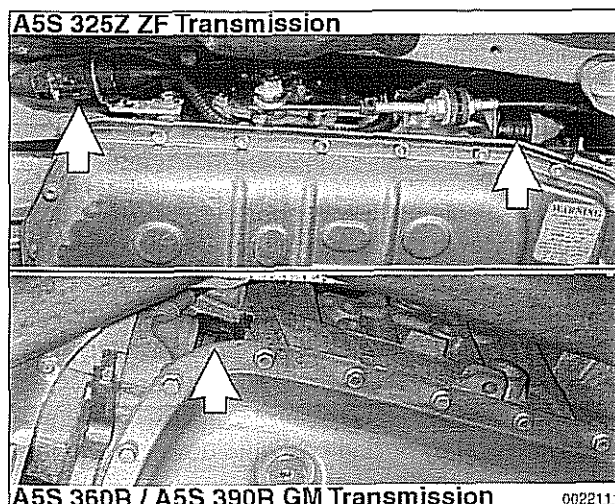
**CAUTION—**

*Removal of transmission will cause engine to tip unless engine support is used.*

- Remove splash shields from underside of vehicle.
- 6-cylinder models: Detach front stabilizer bar from stabilizer bar links. Swivel stabilizer bar upward.
- Drain ATF from transmission as described earlier.
- Remove exhaust system and exhaust heat shield. See **180 Exhaust System**.
- Disconnect driveshaft from transmission and hang to one side. See **260 Driveshaft**.

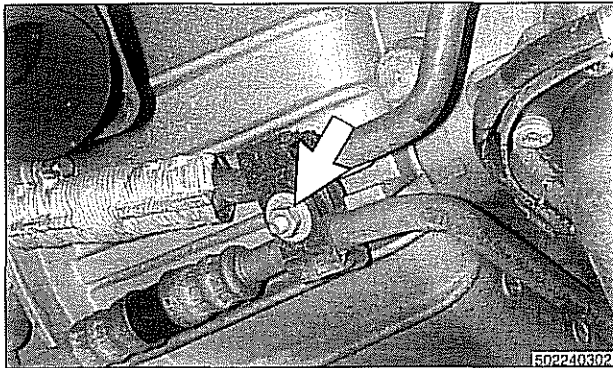


- ◀ With selector lever in park:
  - Hold linkage clamping bolt (A) stationary when loosening selector lever cable clamping nut (B).
  - Loosen cable clamping nut and remove cable from bracket (A5S 325Z transmission shown).
- Where applicable, disconnect vehicle speed sensor harness connector.



- ◀ Disconnect main electrical harness connector(s) from transmission by turning bayonet lock ring(s) (arrows) counter-clockwise.
  - A4S 310R transmission: Harness connector at right rear of transmission.
  - A5S 360R / A5S 390R transmission: Harness connector (arrow) at right rear of transmission.
  - A5S 325Z transmission: Two connectors (arrows) on left side of transmission.
  - A5S 560Z transmission: Harness connector at right rear of transmission.
  - A5S 440Z transmission: Harness connector at top left rear of transmission.
- Remove wiring harness from transmission housing.

## Automatic Transmission

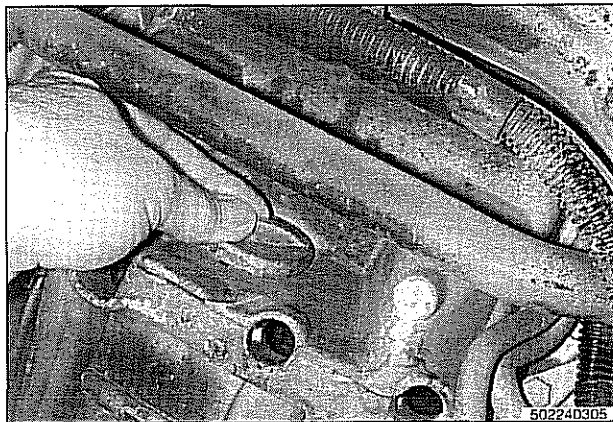


➤ Remove transmission cooler line clamp mounting nut (arrow) from transmission bell housing. Disconnect cooler lines from transmission.

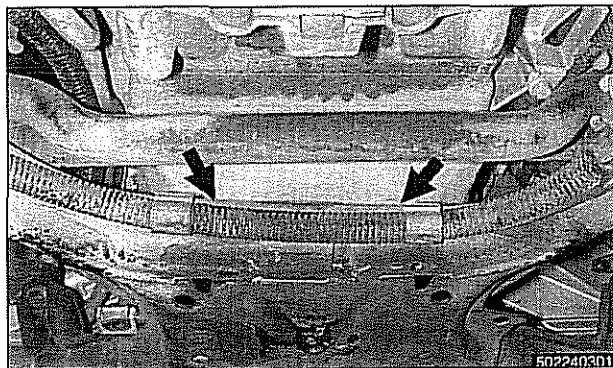
- Disconnect both transmission cooler fluid lines from transmission.

**CAUTION—**

*Place a pan under transmission fluid lines to catch dripping fluid.*

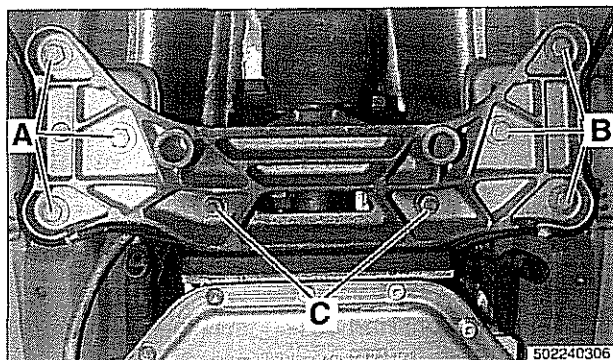


➤ Remove access plug in cover plate below engine oil pan (V-8 models) or left side of bellhousing (6-cylinder models). Remove torque converter bolts. Turn crankshaft to access bolts.



➤ V-8 models: Place BMW special tool 23 3 030 between engine oil pan and front subframe (arrows).

- 6-cylinder models: Place BMW special tool 11 7 370 between engine oil pan and front subframe.
- Support transmission with transmission jack.



➤ Remove transmission crossmember bolts A, B and C and remove transmission support crossmember (V-8 model shown, 6-cylinder models are similar).

- Remove bellhousing-to-engine mounting bolts.
- Use appropriate selection of BMW special tools 24 4 130 to hold torque converter in place during transmission removal.

**CAUTION—**

*Do not allow the torque converter to fall off the transmission input shaft.*

- Remove transmission by pulling back and down. Lower jack to allow transmission to clear vehicle.

- Blow out oil cooler lines with low-pressure compressed air and flush cooler with clean ATF twice before reattaching lines to transmission.

**CAUTION—**

- *Wear safety glasses when working with compressed air.*
- *Do not reuse ATF used for flushing.*

- Remainder of installation is reverse of removal, noting the following:
  - Reinstall driveshaft using new nuts.
  - Install new sealing washers on transmission cooling line banjo bolts.
  - Install new O-rings on transmission cooler lines, where applicable.
  - Inspect engine drive plate (flywheel) for cracks or elongated holes. Replace if necessary.
  - Be sure bellhousing alignment dowel sleeves are located correctly. Replace damaged sleeves.
  - Check to be sure torque converter is seated correctly in transmission during final installation.
  - Use BMW special tool 24 2 300 to align three mounting tabs on torque converter with indentations on drive plate (flywheel).
  - Fill transmission with clean ATF until oil level is even with fill hole. Then check fluid level as described earlier.
  - Adjust gearshift mechanism. See **250 Gearshift Linkage**.

**NOTE—**

*In order to avoid difficulties in transmission removal at a future time, use washers with Torx-head mounting bolts.*

**Tightening torques**

## ATF drain plug to ATF pan

A4S 310R	25 Nm (18 ft-lb)
A5S 360R / A5S 390R (M14)	18 Nm (14 ft-lb)
A5S 325Z	35 Nm (26 ft-lb)
A5S 560Z	50 Nm (37 ft-lb)
A5S 440Z (M16)	30 Nm (23 ft-lb)

## ATF fill plug to transmission housing

A4S 310R	33 Nm (24 ft-lb)
A5S 360R / A5S 390R (M14)	18 Nm (14 ft-lb)
A5S 325Z	30 Nm (23 ft-lb)
A5S 560Z	100 Nm (74 ft-lb)
A5S 440Z (M18)	35 Nm (26 ft-lb)

## Flex-disc to transmission output flange

M10 (8.8 grade)	48 Nm (35 ft-lb)
M10 (10.9 grade)	60 Nm (44 ft-lb)
M12 (8.8 grade)	81 Nm (60 ft-lb)
M12 (10.9 grade)	100 Nm (74 ft-lb)
M14	140 Nm (103 ft-lb)

Torque converter to drive plate  
(flywheel) (M10)

45 Nm (33 ft-lb)

## Transmission crossmember to chassis or transmission

M8	21 Nm (15 ft-lb)
M10	42 Nm (32 ft-lb)

## Transmission cooler lines to transmission

Banjo bolt (M18, A5S 440Z transmission)	25 Nm (18 ft-lb)
Banjo bolt (M16)	37 Nm (27 ft-lb)
Banjo bolt cap screw (M18, A5S 440Z transmission)	20 Nm (15 ft-lb)
Compression fitting (M14 or M16)	37 Nm (27 ft-lb)
Oil cooler bracket to transmission (M8)	21 Nm (15 ft-lb)

## Transmission to engine

M8	21 Nm (15 ft-lb)
M10	42 Nm (31 ft-lb)
M12	72 Nm (53 ft-lb)



# 250 Gearshift Linkage

<b>General</b> .....	250-2	<b>Automatic Transmission Gearshift</b> . . .	250-6
Special tools .....	250-2	Gearshift mechanism, adjusting	
<b>Manual Transmission Gearshift</b> .....	250-3	(automatic transmission) .....	250-6
Gearshift lever, removing		Automatic shiftlock, checking function	
(manual transmission) .....	250-3	(automatic transmission) .....	250-7
Gearshift lever, installing		Shift interlock, checking function	
(manual transmission) .....	250-4	(automatic transmission) .....	250-8

## GENERAL

This repair group covers transmission gearshift and linkage service for both manual and automatic transmission equipped vehicles.

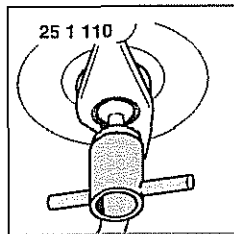
To gain access to the complete gearshift mechanism it is necessary to remove the exhaust system and the driveshaft as described in **180 Exhaust System** and **260 Driveshaft**.

### NOTE—

*In models with automatic transmission, the electronic immobilizer (EWS) prevents starter operation unless the gear position is Park or Neutral.*

## Special tools

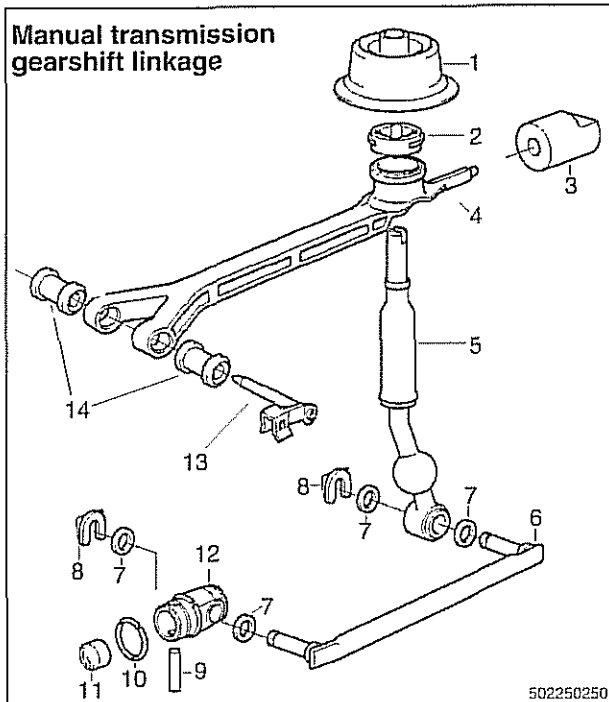
BMW suggests the use of one special tool in the removal of the gear shift lever for manual transmission equipped vehicles.



- ◀ Shifter spanner  
(Tool No. BMW 25 1 110)

## MANUAL TRANSMISSION GEARSHIFT

- ◀ Gearshift linkage



1. Inner rubber boot
2. Shift lever mounting ring
3. Bushing
4. Shift console
5. Shift lever
6. Selector rod
7. Spacer ring
8. Circlip
9. Dowel pin
10. Locking ring
11. Washer
12. Gear selector rod coupling
13. Locking pin
14. Bushing

## Gearshift lever, removing (manual transmission)

Use the accompanying illustration as a guide when removing and installing the gearshift linkage.

- Remove shift knob by pulling knob straight off shift lever.

### **NOTE—**

*Pull up on the shift knob with about 90 lbs. of force. Do not twist knob or locating key can be damaged.*

- Squeeze sides of shift boot to unclip from center console. Pull boot up and off shift lever.
- Remove sound insulation at base of shift lever.
- Raise vehicle to gain access to underside of vehicle.

### **WARNING—**

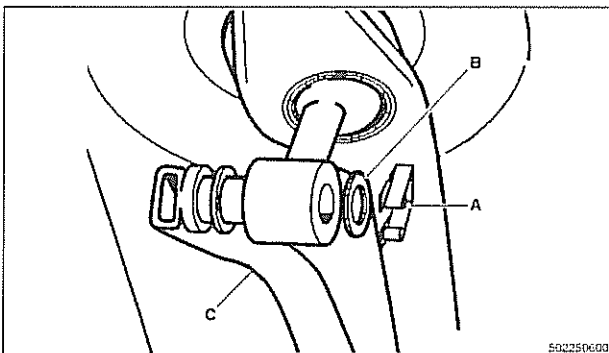
*Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

- Remove complete exhaust system. See **180 Exhaust System**.
- Remove driveshaft. See **260 Driveshaft**.
- Support transmission with transmission jack. Remove crossmember from rear of transmission.
- Lower rear of transmission to access gearshift linkage.

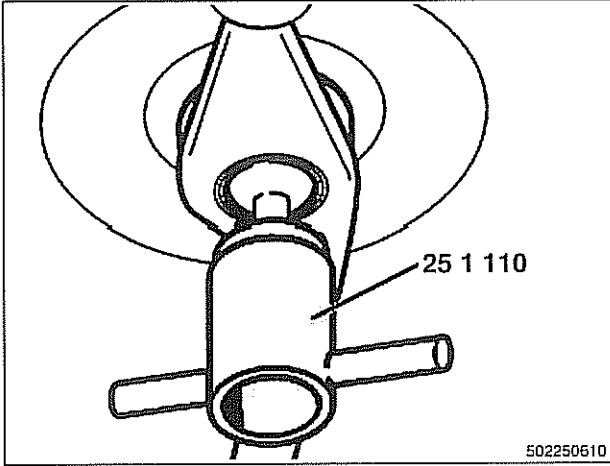
### **CAUTION—**

*Tilting the engine to lower the transmission can lead to damage to various components due to lack of clearance.*

- ◀ Working above transmission, disconnect selector rod:
  - Pull off shift rod retaining circlip (A).
  - Remove washer (B).
  - Disengage selector rod (C) from gearshift lever.



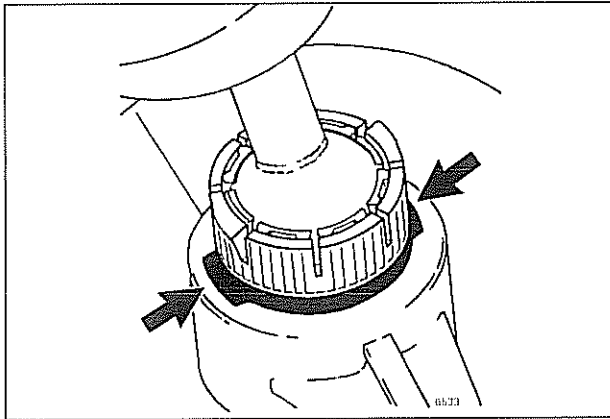
## Gearshift Linkage



◀ Release gearshift lever mounting ring from below using BMW special spanner 25 1 110. Turn tool 90° ( $\frac{1}{4}$  turn) counterclockwise.

- Push shift lever up to remove from shift console.
- Raise transmission and temporarily install transmission crossmember.
- Lower vehicle. Working from inside passenger compartment, pull up on shift lever to remove it together with inner rubber boot and shift lever mounting ring.

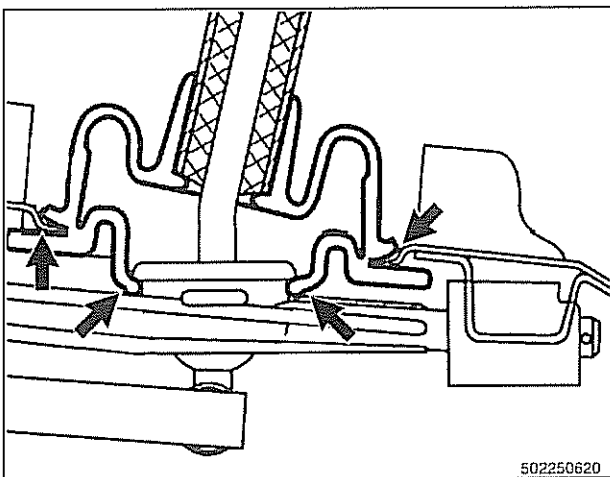
### Gearshift lever, installing (manual transmission)



- Clean old grease from shift lever ball and mounting ring. Also clean shift console bowl. Lubricate with molybdenum disulfide grease.
- Insert shift lever together with inner boot and mounting ring into center console.
- ◀ Align shift lever mounting ring locking tabs with slots (arrows) in shift console bowl. Press down until ring snaps into place.

**NOTE—**

*Install mounting ring with arrow pointing toward front of car.*



- ◀ Pull inner rubber boot over shift console bowl (arrows) to seal base of shift lever.

**NOTE—**

*Install rubber boot with arrow pointing toward front of car.*

- Raise car and support transmission. Remove transmission crossmember and lower transmission to access base of shift lever.

**CAUTION—**

*Tilting the engine to lower the transmission can lead to damage to various components due to lack of clearance.*



- Connect selector rod to shift lever. Lift transmission, install crossmember and tighten crossmember bolts.
  - Install driveshaft and heat shield. See **260 Driveshaft**.
  - Reinstall exhaust system. See **180 Exhaust System**.
  - Lower vehicle. Install shift boot. Push shift knob on lever.

#### Tightening torque

---

##### Driveshaft CV joint to final drive flange

- |                        |                  |
|------------------------|------------------|
| • M10 (Torx bolt)      | 70 Nm (51 ft-lb) |
| • M8 (compression nut) | 32 Nm (24 ft-lb) |

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##### Driveshaft clamping sleeve

- |                       |                  |
|-----------------------|------------------|
| • M10 ribbed nuts     | 80 Nm (59 ft-lb) |
| • M10 compressed nuts | 64 Nm (47 ft-lb) |

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##### Flex-disc to driveshaft or transmission flange

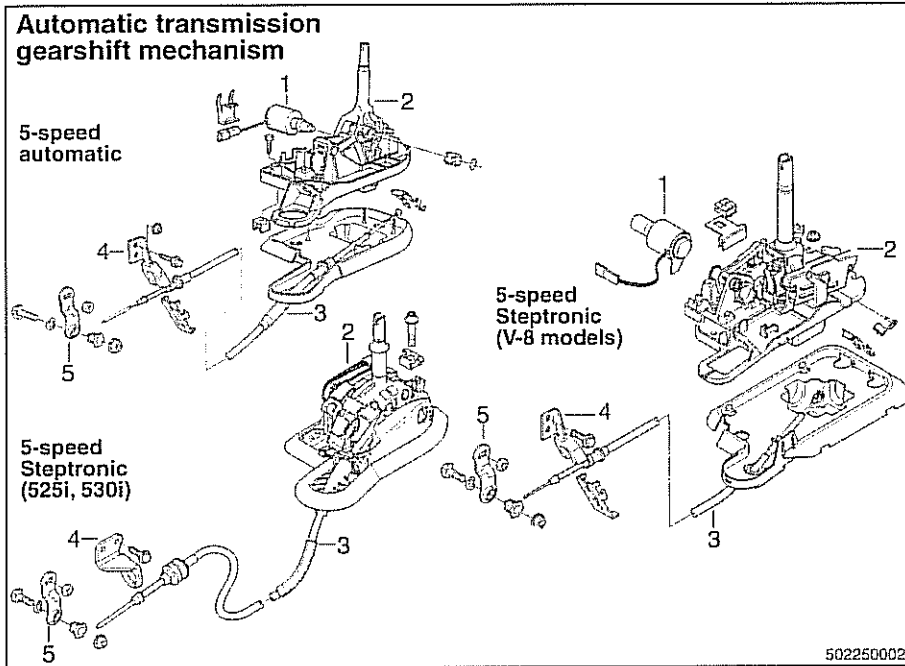
- |                    |                    |
|--------------------|--------------------|
| • M10 (8.8 grade)  | 48 Nm (35 ft-lb)   |
| • M10 (10.9 grade) | 60 Nm (44 ft-lb)   |
| • M12 (10.9 grade) | 100 Nm (74 ft-lb)  |
| • M14              | 140 Nm (103 ft-lb) |

---

##### Transmission crossmember

- |                   |                  |
|-------------------|------------------|
| • to transmission | 21 Nm (15 ft-lb) |
| • to chassis      | 42 Nm (30 ft-lb) |
-

## AUTOMATIC TRANSMISSION GEARSHIFT



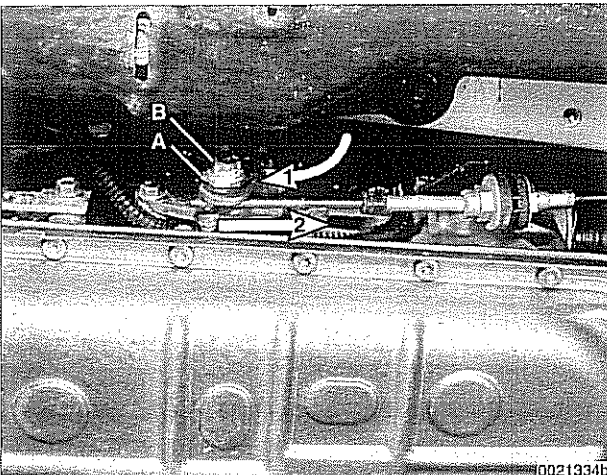
1. Shift lock solenoid
2. Shifter assembly
3. Shift cable
4. Support bracket
5. Selector lever

### Gearshift mechanism, adjusting (automatic transmission)

- Position gearshift lever in Park.
- Raise vehicle to gain access to shift linkage.

#### **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.*



- ◀ Counterhold bushing A and loosen cable clamping nut B.
  - Push transmission shift arm forward toward engine (arrow 1) (Park position).
  - Push cable end backward away from engine (arrow 2). Release pressure on cable.
  - Tighten clamping nut.

#### **CAUTION—**

*Do not overtighten the nut so that it twists the cable.*

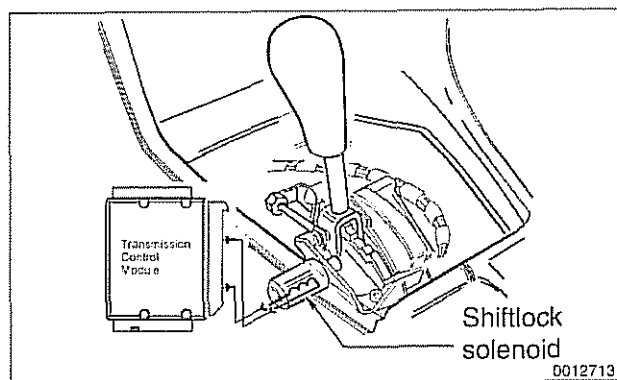
#### Tightening torque

Shift cable clamping nut

10 Nm (7.5 ft-lb)

## Automatic shiftlock, checking function (automatic transmission)

The automatic shiftlock uses an electric solenoid to lock the selector lever in Park or Neutral. Depressing the foot brake with the ignition on energizes the solenoid, allowing the lever to be moved into a drive gear. The solenoid is energized only when the engine speed is below 2,500 rpm and the vehicle speed is below 3 mph (5 kph). The solenoid is mounted in the right side of the selector lever housing.



⚡ Automatic shiftlock prevents drive gear selection until brake pedal is depressed.

- With engine running and car stopped, place selector lever in Park or Neutral.
- Without depressing brake pedal, check that selector lever is locked in position (Park or Neutral).
- Depress brake pedal firmly. Solenoid should click audibly.
- Check that selector lever can now be moved out of Park or Neutral.

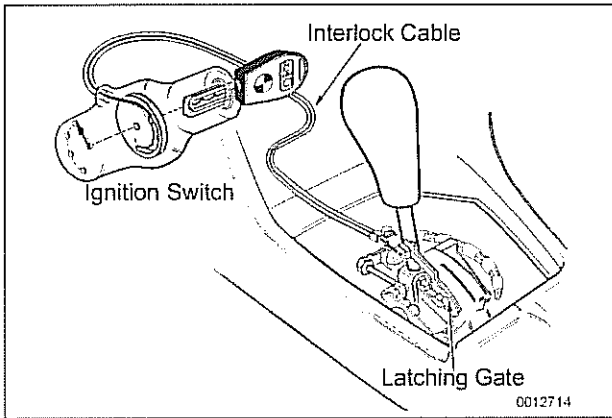
### NOTE —

*The next test should be performed in an open area with the parking brake on and with extreme caution.*

- With selector lever in Park or Neutral and brake pedal depressed, raise engine above 2,500 rpm. Check that selector lever cannot be moved out of Park or Neutral.
- If any faults are found check the electrical operation of the shiftlock solenoid and check for wiring faults to or from the transmission control module (TCM). See **610 Electrical Component Locations** and **ELE Electrical Wiring Diagrams**.

### NOTE —

*The solenoid is controlled via the TCM, using brake pedal position, engine speed, and road speed as controlling inputs.*

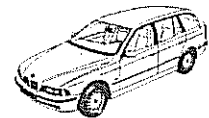


### Shift interlock, checking function (automatic transmission)

- ◀ The shift interlock uses a cable between the ignition switch and the shift lever to lock the shift lever in the park position when the key is in the off position or removed. This feature also prevents the key from being removed from the ignition lock until the selector lever is in Park.
- Shift selector lever to Park position and turn ignition key to the off position.
  - Remove ignition key. Check that selector lever cannot be shifted out of Park position.
  - Turn ignition key on and depress brake pedal. Check that selector lever moves freely from gear to gear.
  - With selector lever in a gear position other than Park, attempt to turn key to off position and remove. Key should not go into off position.
  - If any faults are found check cable for kinks and check cable attachment points for damage or faults.

#### NOTE—

- *It must only be possible to remove ignition key with selector lever in Park position.*
- *Do not kink shift interlock cable.*
- *Shift interlock repair is covered in 320 Steering and Wheel Alignment.*



# 260 Driveshaft

<b>General</b> .....	260-2	Driveshaft, installing .....	260-10
Special tools .....	260-2	Flex-disc, replacing .....	260-11
Driveshaft description .....	260-3	Center bearing assembly, replacing .....	260-12
Troubleshooting .....	260-3	Front centering guide, replacing .....	260-13
<b>Driveshaft Service</b> .....	260-6	Constant velocity (CV) joint, replacing .....	260-14
Driveshaft, aligning .....	260-7		
Driveshaft, removing .....	260-8		

## GENERAL

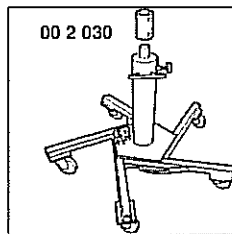
This repair group covers repair and replacement of the driveshaft and driveshaft components.

Driveshaft repairs consist of replacement of front flex-disc, center mount or rear CV joint. If the driveshaft joint is defective, replace the complete driveshaft.

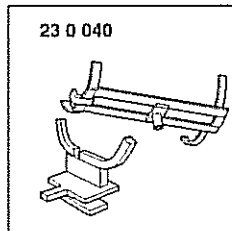
Drive axle repairs are covered in **331 Final Drive**.

## Special tools

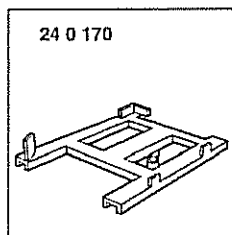
BMW suggests the use of certain special tools in removing, installing or servicing the driveshaft or its components.



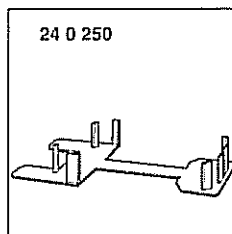
- ◀ Transmission jack  
(Tool No. BMW 00 2 030)



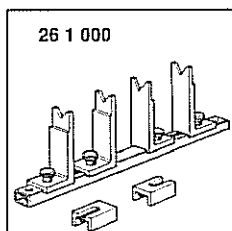
- ◀ Transmission support (for use with transmission jack)  
(Tool No. BMW 23 0 040)



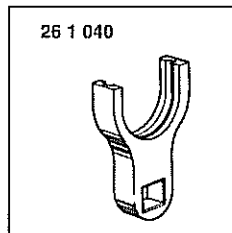
- ◀ Transmission support (for use with transmission jack,  
A5S 560Z transmission)  
(Tool No. BMW 24 0 170)



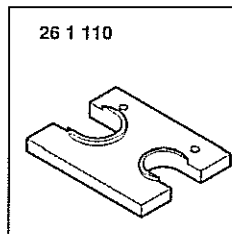
- ◀ Transmission support (for use with transmission jack,  
A5S 440Z transmission)  
(Tool No. BMW 24 0 250)



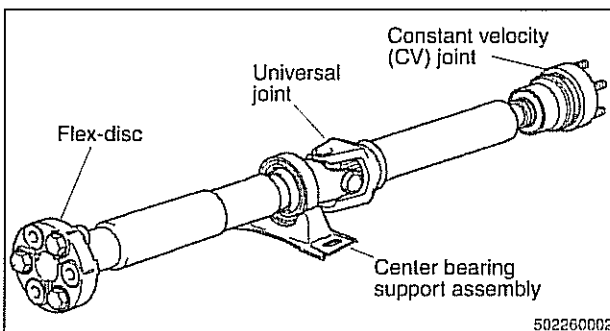
- ◀ Driveshaft center mount aligning jig  
Tool No. BMW 26 1 000)



- ◀ Driveshaft center slide nut spanner  
(Tool No. BMW 26 1 040)



- ◀ CV joint removal tool  
(Tool No. BMW 26 1 110)



## Driveshaft description

- ◀ The two-piece driveshaft is connected to the transmission by a rubber flex-disc and to the rear final drive by a constant velocity (CV) joint.

- A universal joint is used at the center of the driveshaft and the shaft is supported in the middle by a center support bearing. The bearing is mounted in rubber to isolate vibration.
- The rear constant velocity joint compensates for fore and aft movement of the drive line.

## Troubleshooting

The source of driveline vibrations and noise can be difficult to pinpoint. Engine, transmission, rear axle, or wheel vibrations can be transmitted through the driveshaft to the car body. Noises from the car may be caused by final drive problems, or by faulty wheel bearings, drive axles, or even worn or improperly inflated tires.

### NOTE —

*For drive axle repair information, see 331 Final Drive.*

Driveshaft noise or vibration may be caused by worn or damaged components. Check the universal joint for play. With the driveshaft installed, pull and twist the driveshaft while watching the joint. The BMW specification for play is very small, so almost any noticeable play could indicate a problem.

Check the torque of the fasteners at the flange connections. Check the rubber of the flex-disc and center bearing for deterioration or tearing. Check the driveshaft for broken or missing balance weights. The weights are welded tabs on the driveshaft tubes. In addition to inspecting for faulty driveshaft parts, the installed angles of the driveshaft should also be considered.

Further inspection requires removal of the driveshaft. Check the front centering guide on the transmission output flange for damage or misalignment. Also check runout at the transmission output flange and output shaft, and at the final drive input flange. Check the bolt hole bores in the flange for wear and elongation.

#### Driveshaft flange runout (max. allowable)

Transmission flange	
• Axial play	0.10 mm (0.004 in.)
• Radial play	0.07 mm (0.003 in.)

Spin the driveshaft center bearing and check for smooth operation without play. Check the constant velocity joint for wear or play. Check the universal joint for wear or binding. If it is difficult to move or binds, the driveshaft section should be replaced.

#### Universal joint play

Maximum allowable	0.15 mm (0.006 in.)
-------------------	---------------------

#### NOTE —

*With the driveshaft installed, the actual amount that the driveshaft joint pivots is limited. For the most accurate test, check joint in its normal range of movement.*

If inspection reveals nothing wrong with the driveshaft, it may need to be rebalanced. This can be done by a speciality driveshaft repair shop. Also, check driveshaft alignment as described below.

#### NOTE —

*Minor driveshaft vibrations can often be corrected simply by disconnecting the driveshaft at the final drive and repositioning it 90°, 180° or 270° in relation to the final drive input flange.*

The troubleshooting table below lists symptoms of driveshaft problems and their probable causes. Most of the repair information is contained within this repair group. There are references to other repair groups, where applicable.



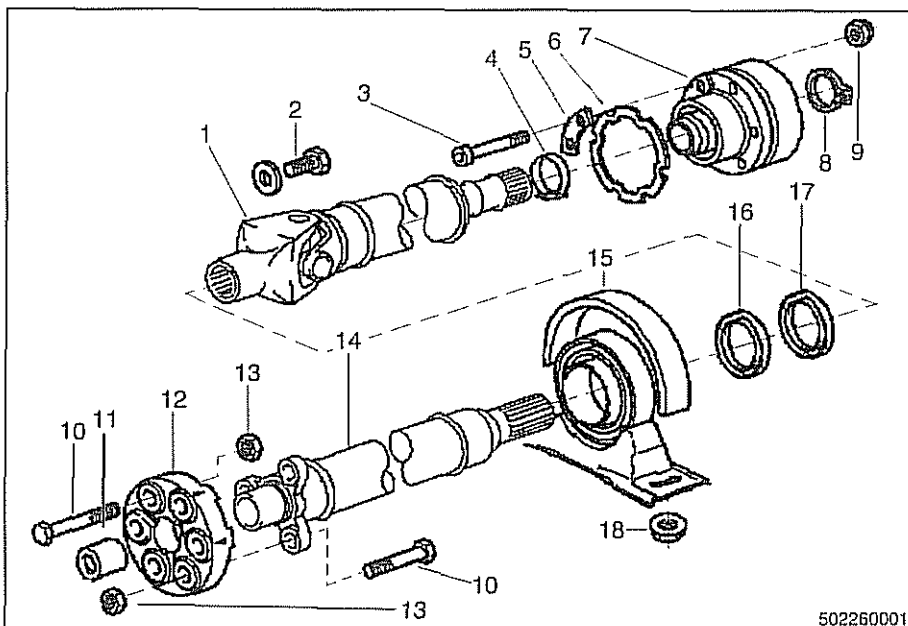
## Driveshaft problems and causes

Symptom	Probable cause	Corrective action
Vibration when starting off (forward or reverse)	Center bearing rubber deteriorated.	Inspect center bearing and rubber. Replace if necessary.
	Flex-disc damaged or worn.	Inspect flex-disc. Replace if necessary.
	Engine or transmission mounts faulty.	Inspect engine and transmission mounts. Align or replace, if necessary.
	Front centering guide worn, or driveshaft mounting flanges out of round.	Check front centering guide and replace if necessary. Check runout of driveshaft flanges.
	Universal joint worn or seized.	Check universal joint play and movement. Replace driveshaft if necessary.
	Driveshaft misaligned.	Check driveshaft alignment.
Noise during on/off throttle or when engaging clutch.	Final drive components worn or damaged (excessive pinion-to-ring-gear clearance).	Remove final drive and repair. <b>331 Final Drive</b>
	Drive axle or CV joint faulty.	Inspect drive axles and CV joints. Repair or replace as necessary. <b>331 Final Drive</b>
Vibration at 25 to 30 mph (40 to 50 km/h).	Front centering guide worn, or driveshaft mounting flanges out of round or damaged.	Check front centering guide and replace if necessary. Check runout of driveshaft mounting flanges.
	Universal joint worn or seized.	Check universal joint play and movement. Replace driveshaft if necessary.
	Flex-disc damaged or worn.	Inspect flex-disc. Replace if necessary.
	Center bearing rubber deteriorated.	Inspect center bearing. Replace if necessary.
	Misaligned installed position.	Check driveshaft alignment.
Vibration, audible rumble over 35 mph (60 km/h).	Front centering guide worn, or driveshaft mounting flanges out of round or damaged.	Check front centering guide and replace if necessary. Check runout of driveshaft mounting flanges.
	Mounting flange bolts loose or holes worn.	Remove driveshaft and check transmission output flange and final drive input flange. Replace if necessary.
	Driveshaft unbalanced.	Check driveshaft for loose or missing balance weights. Have driveshaft rebalanced or replace if necessary.
	Universal joint worn or seized.	Check universal joint play and movement. Replace driveshaft if necessary.
	Center bearing faulty.	Replace center bearing.
	Final drive rubber mount faulty.	Inspect final drive rubber mount and replace if necessary.
	Driveshaft misaligned.	Check driveshaft alignment.

## DRIVESHAFT SERVICE

Repair kits for the universal joint are not available for BMW driveshafts. A worn or damaged universal joint usually require replacement of the driveshaft.

The driveshaft is balanced to close tolerances. Whenever it is to be removed or disassembled, the mounting flanges and driveshaft sections should be marked with paint or a punch before proceeding with work. This will ensure that the drive shaft can be reassembled and installed in exactly the original orientation.



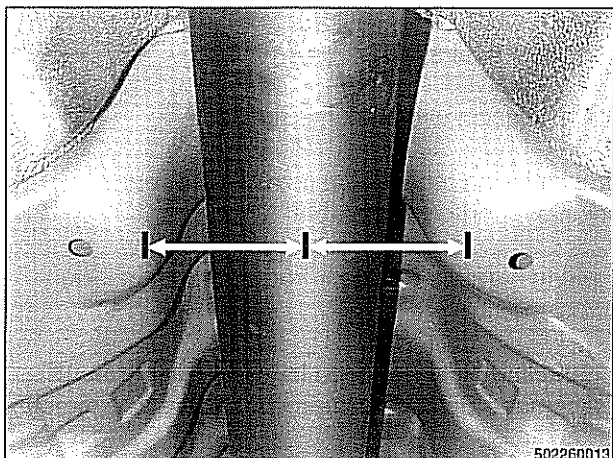
1. Rear section of drive shaft
2. Hex bolt, M12 x 1.5 x 25
3. Knurled bolt
4. Clamp
5. Reinforcement
6. Seal
7. Constant velocity joint
8. Circlip
9. Hex nut
10. Hex bolt, M12 x 1.5 x 58
11. Centering sleeve
12. Flexible disk
13. Self-locking hex nut
14. Front section of driveshaft
15. Center bearing
16. Dust cover (some models)
17. Spacer (some models)

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## Driveshaft, aligning

The alignment of the driveshaft does not normally need to be checked unless the engine/transmission or the final drive have been removed and installed. If all other parts of the driveshaft have been inspected and found to be okay, but there is still noise or vibration, driveshaft alignment should be checked.

There are two important driveshaft alignment checks. The first is to make sure that the driveshaft runs straight from the transmission to the final drive, without any variation from side-to-side caused by misalignment of the engine/transmission in its mounts. Make a basic check by sighting along the driveshaft from back to front. Any misalignment should be apparent from the center bearing forward.

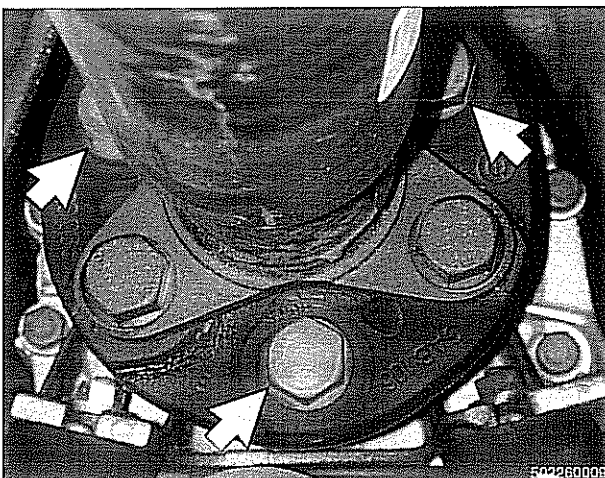
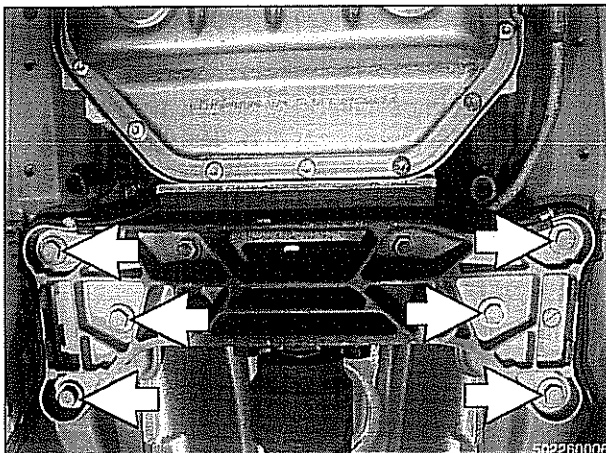
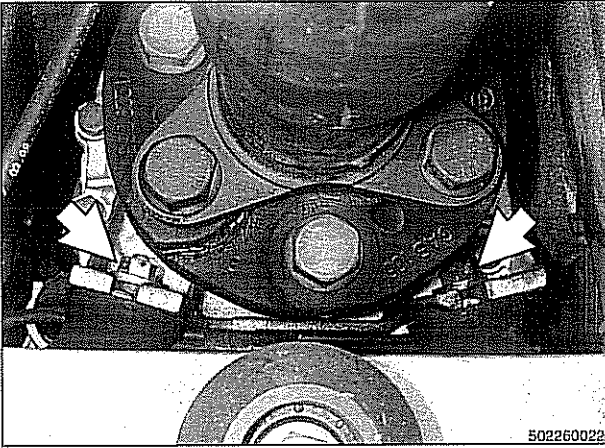


- ▶ To adjust the side-to-side alignment, loosen transmission or engine mounts to reposition them, then retighten mounts. The driveshaft should be exactly centered in driveshaft tunnel.
- The second important driveshaft alignment check is more complicated. It checks the amount the driveshaft is angled vertically at the joints. This angle is known as driveshaft deflection.
- In general, there should be little deflection in the driveshaft between the engine, the center bearing, and the final drive. Precise checks require the use of a large protractor or some other means of measuring the angle of the engine and the final drive and comparing these angles to the angle of the driveshaft sections.
- To change the deflection angle, shims can be placed between the center bearing and the body or between the transmission and its rear support. When using shims to change a deflection angle, keep in mind that the angle of adjacent joints will also change. Deflection angles should be as small as possible.

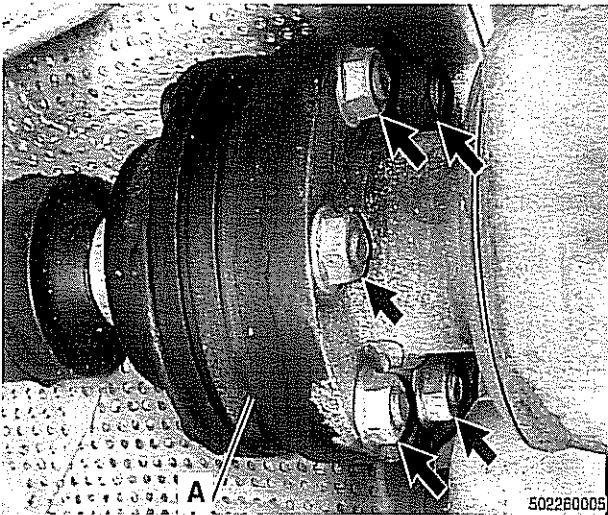
## Driveshaft, removing

### CAUTION—

- Be sure the wheels are off the ground before removing the driveshaft. Set the parking brake before removing the driveshaft.
- Once the driveshaft has been removed, the vehicle can roll regardless of whether the transmission is in gear or not.
- The driveshaft is mounted to the transmission and final drive with self-locking nuts. These nuts are designed to be used only once and should be replaced during reassembly.

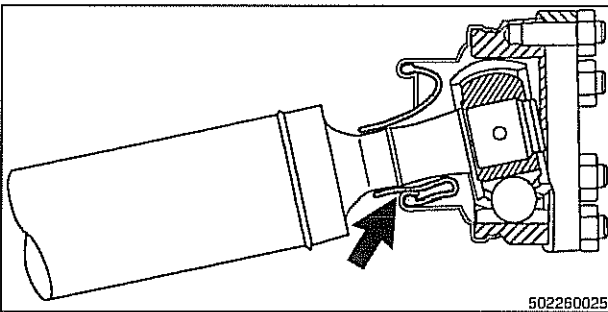


- Remove complete exhaust system. See **180 Exhaust System**.
- Remove exhaust heat shields.
- Support transmission with transmission jack.
- Loosen transmission mount nuts (**arrows**) on rear transmission support crossmember.
- Release wiring harness retainers from rear transmission support crossmember.
- Remove mounting bolts (**arrows**) for rear transmission support crossmember. Slide crossmember rearward to remove.
- Matchmark front and rear driveshaft halves to corresponding transmission output and final drive input flanges.
- Remove nuts securing driveshaft mounting bolts at transmission output flange. Counterhold bolts (**arrows**) at transmission flex-disc. Discard old nuts.
- Hang driveshaft front section from body using stiff wire.

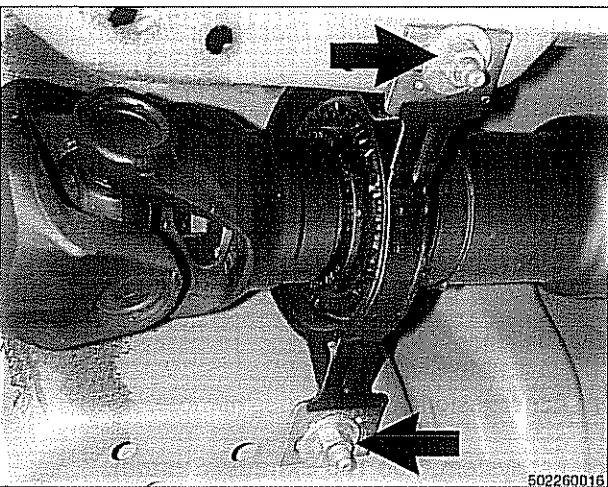


Remove nuts (arrows) from constant velocity joint mounting bolts at final drive. Pry constant velocity joint free from final drive input flange at groove (A).

- Hang driveshaft rear section from body using stiff wire.



Do not let driveshaft hang unsupported, as rear CV joint rubber boot (arrow) may be damaged.



Remove center support bearing mounting nuts (arrows).

- Remove driveshaft. Pull down on center of driveshaft to facilitate removal.

**CAUTION—**  
Protect CV joint with plastic cover.

## Driveshaft, installing

- Prepare CV joint for reinstallation:
  - Extend joint to limit.
  - Clean off old grease and fill with fresh grease.
  - Install new seal.
- Bend driveshaft slightly at center universal joint to install.

**CAUTION—**

*Do not allow CV joint seal to become displaced.*

- Align matchmarks on driveshaft to matchmarks on final drive and transmission flanges.
- Fit constant velocity joint to final drive input flange. Alternately tighten two opposite nuts to draw constant velocity joint evenly into the final drive input flange. Once seated, tighten down remaining nuts.

**CAUTION—**

*Do not reuse self-locking nuts. These nuts are designed to be used only once.*

- Insert bolts in front of driveshaft to transmission output flange. Counterhold each bolt while tightening nut.

**CAUTION—**

- *Do not reuse self-locking nuts. These nuts are designed to be used only once.*
- *Avoid stressing the flex-disc when torquing the bolts. Do this by counterholding the bolts and turning the nuts on the flange side.*

- Position center support bearing and install mounting nuts. Use new self-locking nuts.
- Install heat shields.
- Install rear transmission support crossmember.
- Install exhaust system. See **180 Exhaust System**. Reconnect oxygen sensor wiring harnesses and reattach wiring harness retainers to rear transmission support crossmember.

- Road test vehicle to check for noise or vibration.

**CAUTION—**

- Do not reuse self-locking nuts. These nuts are designed to be used only once.
- Avoid stressing the flex-disc when torquing the bolts. Do this by counterholding the bolts and turning the nuts on the flange side.

**Tightening torques**

## Aluminum driveshaft to flex-disc

- M12 (use coated washers) 90 Nm (66 ft-lb)

## Driveshaft CV joint to final drive flange

- M10 (Torx bolt) 70 Nm (51 ft-lb)
- M8 (compression nut) 32 Nm (24 ft-lb)

## Flex-disc to transmission flange or driveshaft

- M10 (8.8 grade) 48 Nm (35 ft-lb)
- M10 (10.9 grade) 60 Nm (44 ft-lb)
- M12 (8.8 grade) 81 Nm (60 ft-lb)
- M12 (10.9 grade) 100 Nm (74 ft-lb)
- M14 140 Nm (103 ft-lb)

## Transmission crossmember

- to transmission (M8) 21 Nm (15 ft-lb)
- to chassis (M10) 42 Nm (30 ft-lb)

**NOTE—**

*Bolt grade is marked on the bolt head. When replacing bolts, only use bolts of the same strength and hardness as the originals installed.*

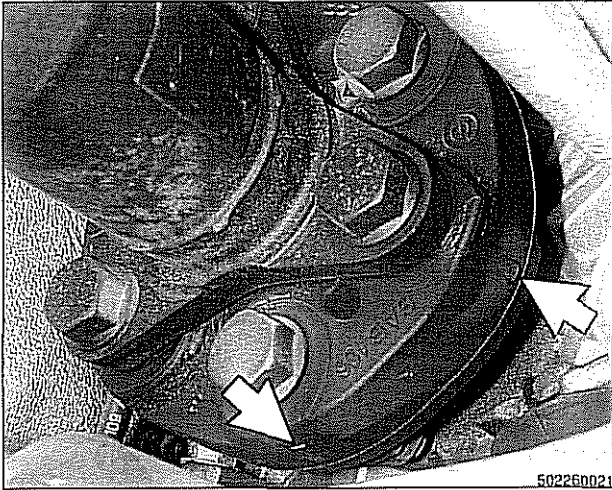
**Flex-disc, replacing**

- Check flex-disc between front section of driveshaft and transmission output flange for cracks, tears, missing pieces, or distortion. Check for worn bolt hole bores in flange.
- If flex-disc needs replacement, remove driveshaft as described earlier.
- Unbolt flex-disc from driveshaft.

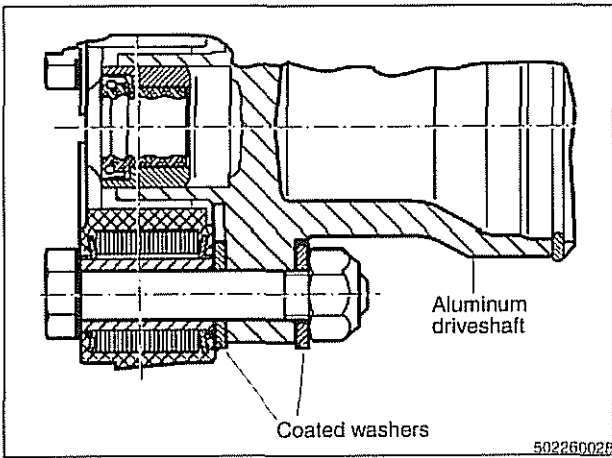
**NOTE—**

*Removal and installation of the bolts may be made easier by placing a large hose clamp around the flex-disc, and tightening the clamp slightly to compress the rubber.*

## Driveshaft



- Install new flex-disc using new self-locking nuts. Molded arrows (**arrows**) on coupling should point towards flange arms.



- On vehicles with aluminum driveshaft, use coated washers to prevent contact corrosion.
  - Counterhold bolts while tightening nuts.

### Tightening torque

#### Aluminum driveshaft to flex-disc

- M12 (use coated washers) 90 Nm (66 ft-lb)

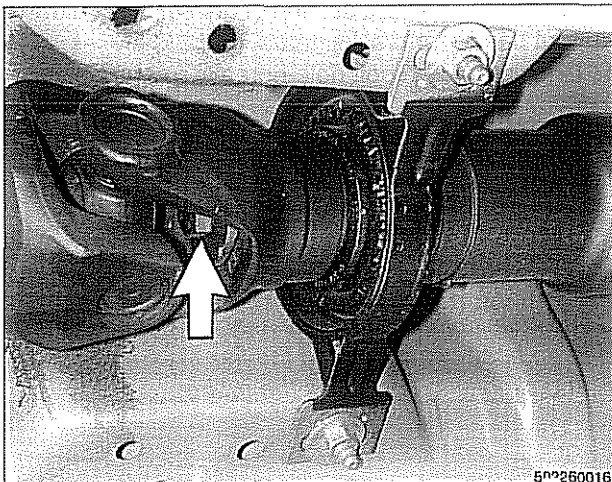
#### Steel driveshaft to flex-disc

- M10 (8.8 grade) 48 Nm (35 ft-lb)
- M10 (10.9 grade) 60 Nm (44 ft-lb)
- M12 (8.8 grade) 81 Nm (60 ft-lb)
- M12 (10.9 grade) 100 Nm (74 ft-lb)
- M14 140 Nm (103 ft-lb)

- Install driveshaft as described earlier.

## Center bearing assembly, replacing

The center bearing assembly consists of a grooved ball bearing in a rubber mount. The bearing assembly is pressed onto the driveshaft.



- Remove driveshaft. See **Driveshaft, removing**.
- Matchmark front and rear driveshaft sections before separating.
- Remove bolt (**arrow**) securing front and rear halves of driveshaft and pull driveshaft apart.
- Remove shim and dust shield, where fitted.
- Use puller to remove center bearing assembly from driveshaft.



- On installation, drive new center bearing firmly to stop. Reassemble driveshaft using matchmarks made prior to disassembly.
- Clean threads and install bolt securing driveshaft halves. Use thread locking compound Loctite® or equivalent.

#### Tightening torque

Driveshaft front half to rear half (use thread locking compound)	97 Nm (72 ft-lb)
---	------------------

- Install driveshaft as described earlier.

### Front centering guide, replacing

The front centering guide centers the driveshaft in relation to the transmission. The guide is press-fit into a cavity in the front of the driveshaft and slides onto the transmission output shaft.

No specifications are given for wear of the guide, but generally the guide should fit snugly on the transmission output shaft.

#### NOTE —

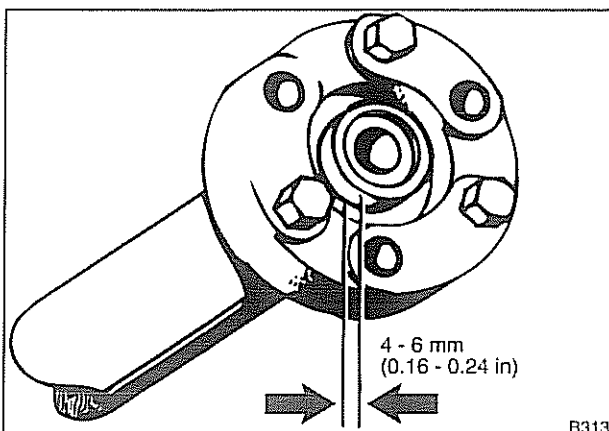
*Some driveshafts have a dust cap installed on the end of the driveshaft, over the centering guide. The dust cap may become bent or distorted when the driveshaft is removed or installed. Damage to the dust cap should not affect the centering guide and should not be mistaken for guide wear.*

- Remove driveshaft as described earlier.
- Pack cavity behind centering guide with heavy grease until grease is flush with bottom edge of guide.
- Insert 14 mm (approximately 9/16 in.) diameter mandrel or metal rod into guide. Strike guide with hammer to force centering guide out.

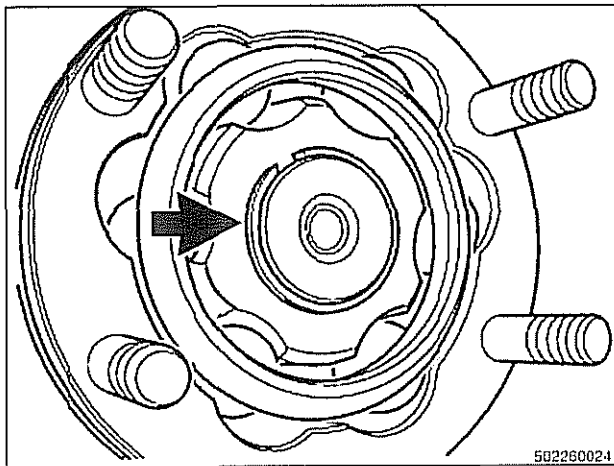
#### NOTE —

*The mandrel should fit snugly in the centering guide so that the grease cannot escape around the sides of the mandrel.*

- Remove old grease from driveshaft, lubricate new centering guide with molybdenum disulfide grease (Molykote®, Long-term® 2 or equivalent) and drive it into driveshaft.
- ◀ When installing new driveshaft centering guide, be sure sealing lip of guide faces outward. Drive guide into driveshaft to a protrusion depth of 4 — 6mm (0.16 — 0.24 in.).
- Install driveshaft as described earlier.



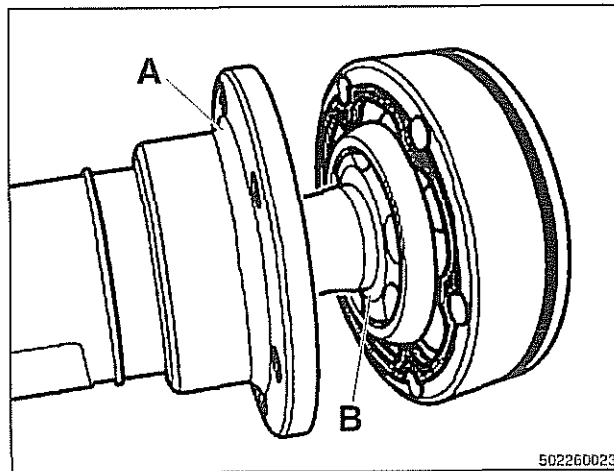
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## Constant velocity (CV) joint, replacing

The CV joint at the rear of the driveshaft is available from BMW as a separate part.

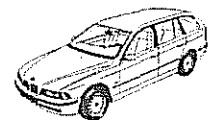
- Remove complete driveshaft as described earlier in this section.
- Clean grease off CV joint. Remove retaining circlip (arrow) from CV joint end of driveshaft.
- Drive out bolts from CV joint.



- Remove CV joint from driveshaft:
  - Pry back protective boot (A).
  - Using BMW special tool 26 1 110 on inner race (B), press or pull joint off shaft.
- Check protective boot for damage. Replace if necessary.
- Install new CV joint:
  - Working from both sides of joint, inject approximately 80 grams of Optimol® grease (or equivalent) into joint.
  - Install new sealing gasket on joint face that mates with protective boot. Seal fits in groove on outer race of joint.
  - Clean grease off driveshaft and mating splines on joint.
  - Apply Loctite® 648 to driveshaft splines.
  - Press new CV joint onto shaft as far as it will go.

**CAUTION—**  
Only press on inner CV joint race.

- Install new retaining circlip to end of driveshaft.
- Insert CV joint mounting bolts. Be sure to reuse washers.
- Install driveshaft as described earlier in this section.



# 300 Suspension, Steering and Brakes - General

<b>General</b> .....	300-2	<b>Brake System</b> .....	300-10
Aluminum suspension components .....	300-2	<b>Wheels and Tires</b> .....	300-11
<b>Front Suspension</b> .....	300-2	Rim and tire sizes table .....	300-11
Front suspension 6-cylinder models (525i, 528i, 530i) .....	300-3	<b>Electronic Brake and Stability Control Systems</b> .....	300-11
Front suspension V-8 models (540i) .....	300-4	E39 electronic brake and stability control systems application table .....	300-12
<b>Rear Suspension</b> .....	300-5	ABS system .....	300-12
Sedan models .....	300-5	Automatic Stability Control (ASC) .....	300-12
Rear suspension sedan models .....	300-6	ABS/ASC traction control system .....	300-13
Sport Wagon models .....	300-6	Dynamic Stability Control (DSC) .....	300-14
Rear suspension Sport Wagon (with coil springs) .....	300-7	<b>Ride Height</b> .....	300-14
Rear suspension Sport Wagon (EHC with air springs) .....	300-8	Front ride height specifications .....	300-15
EHC operational diagram .....	300-9	Rear ride height specifications .....	300-16
<b>Steering</b> .....	300-10		
Rack-and-pinion steering .....	300-10		
Recirculating ball and nut steering .....	300-10		

## GENERAL

This section of the manual covers front and rear suspension, braking and steering systems, and contains wheel, tire and wheel alignment information and specifications. Also covered here are the integrated braking and suspension systems including antilock braking (ABS), traction control (ASC/DSC), and electronic height control (EHC).

Vehicle ride height information is at the end of this repair group. Alignment information is in **320 Steering and Wheel Alignment**.

### Aluminum suspension components

In order to reduce vehicle weight, aluminum suspension components are used in some models. A test with a magnet will easily reveal the metal used. If working with aluminum components, be sure to read and follow the cautions below.

#### **CAUTION—**

- *Due to the chemical and corrosion characteristics of aluminum, do not bring into contact with battery acid.*
- *Do not use wire brushes with brass or iron bristles. Only use brushes with stainless steel bristles.*
- *Do not expose to flying sparks from grinding/cutting operations.*
- *Do not subject to steel welding splashes.*
- *Do not expose to temperatures over 80°C (176°F), even for short periods. Temperatures in painting facilities are not a problem.*

## FRONT SUSPENSION

The E39 front suspension subframe is used as a rigid mounting platform for the front suspension arms, stabilizer bar and steering gear.

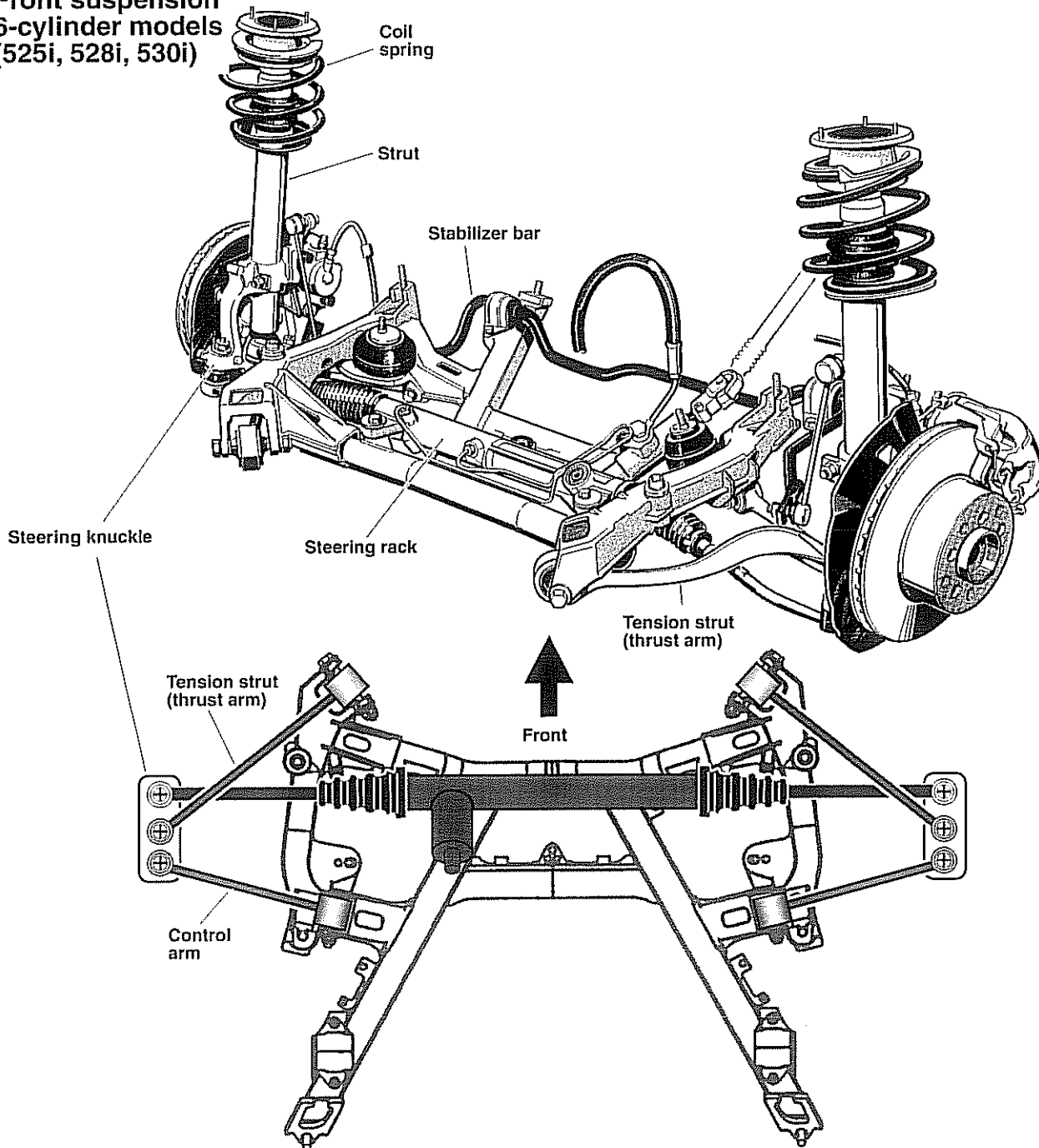
The suspension arms, known as the lower control arms and the tension struts (thrust arms), are connected to the subframe through rubber bushings. The arms are connected to the steering knuckles in a double pivot configuration.

Each front strut assembly includes a tubular strut and a coil spring. The upper strut mount includes a bearing. The lower end of each strut housing is fitted to the steering knuckle. The integral wheel bearing and hub are bolted to the steering knuckle.

6-cylinder and V-8 models use different steering systems and other front suspension components.

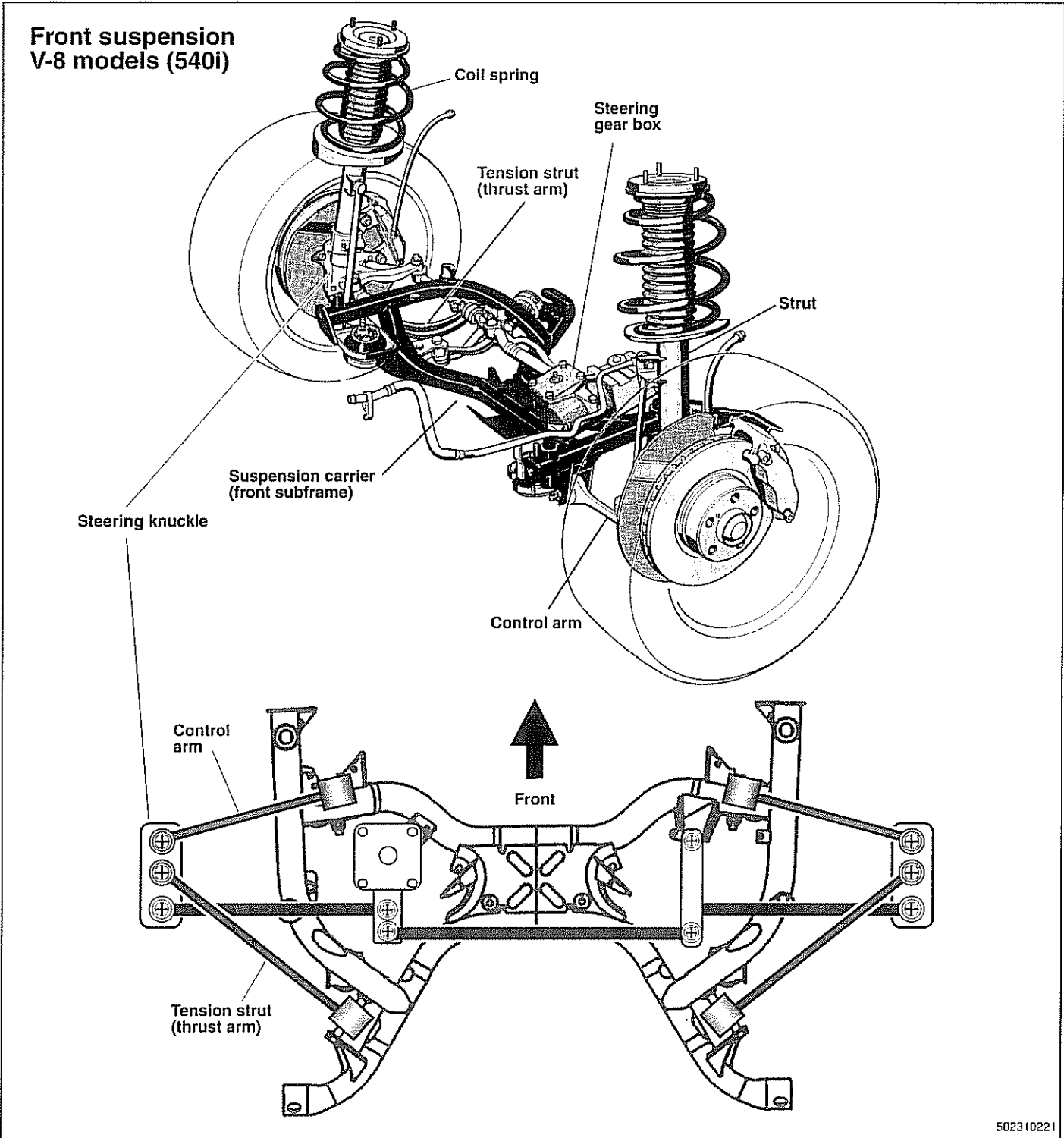
### Front suspension 6-cylinder models (525i, 528i, 530i)

#### Front suspension 6-cylinder models (525i, 528i, 530i)



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Front suspension V-8 models (540i)



## REAR SUSPENSION

The E39 rear suspension subframe is used as a rigid mounting platform for the differential (also called final drive) and rear suspension components. The differential is mounted to the subframe and the subframe is bolted to the body through rubber bushings which help isolate drivetrain noise and vibration.

The E39 rear suspension is known as a modified multi-link system. Three control arms on each side locate the rear wheels.

The lower control arm, called the swing arm, is attached to the wheel bearing carrier through a pivoting integral link.

- ▲ An eccentric mounting bolt at the rear inner mounting of the swing arm is used for rear camber adjustment.

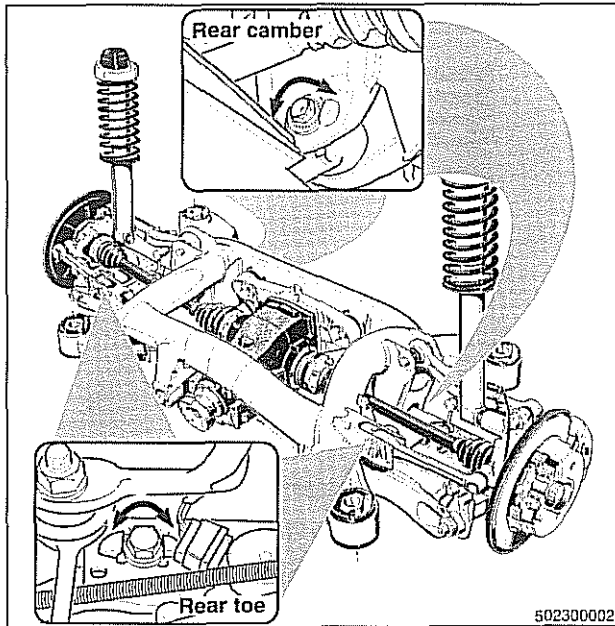
The inner end of the upper front control arm, called the traction strut, is also mounted with an eccentric fastener, used to adjust rear toe.

Drive axles with constant-velocity (CV) joints at both ends transfer power from the differential to the road wheels.

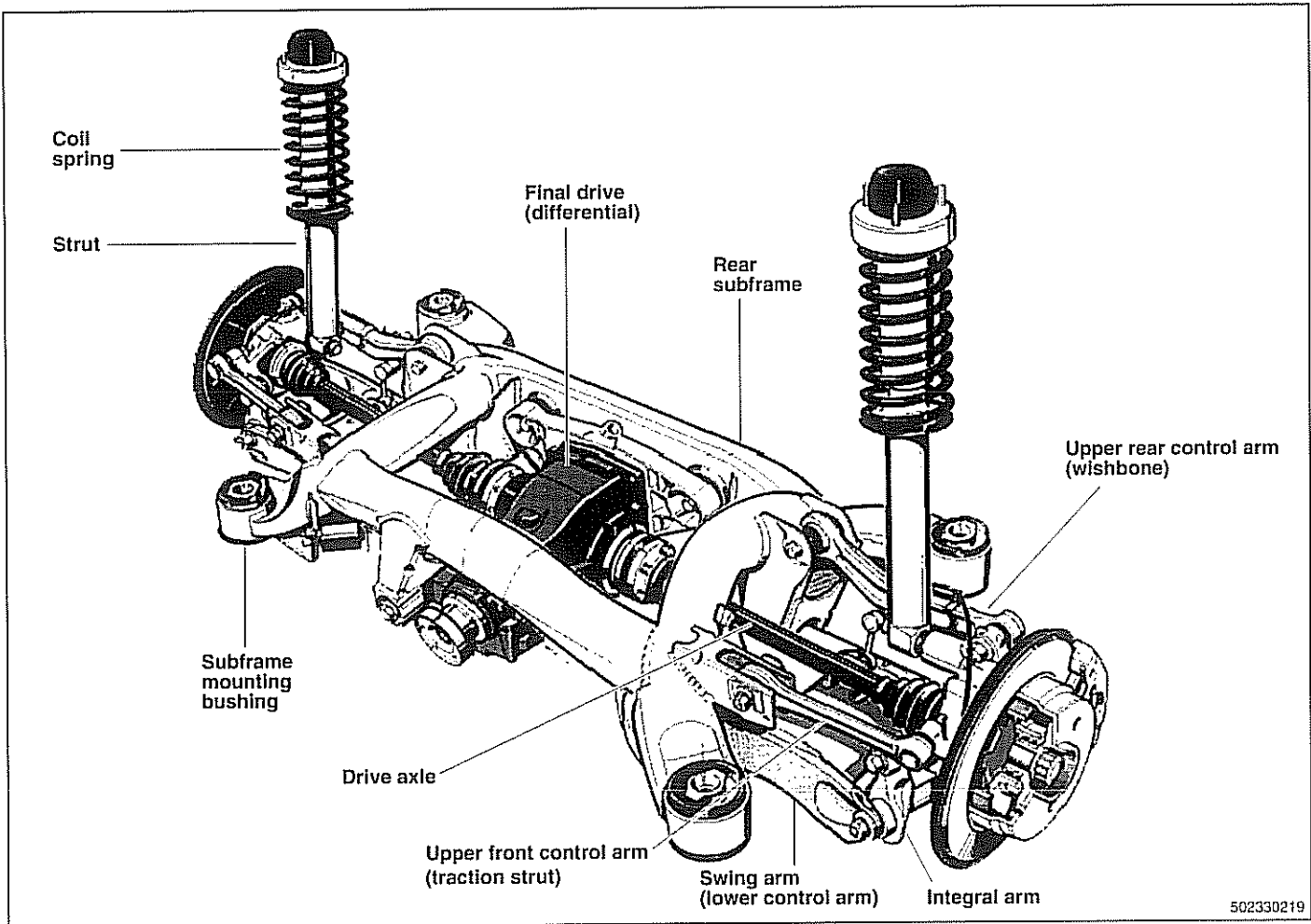
### Sedan models

The rear suspension in sedan models uses coil springs over strut shock absorbers. The bottom of each strut bolts to the wheel carrier. The top strut mount attaches just below the rear parcel shelf of the car.

Sedan models fitted with EDC (Electronic Dampening Control) use air struts.



## Rear suspension sedan models



## Sport Wagon models

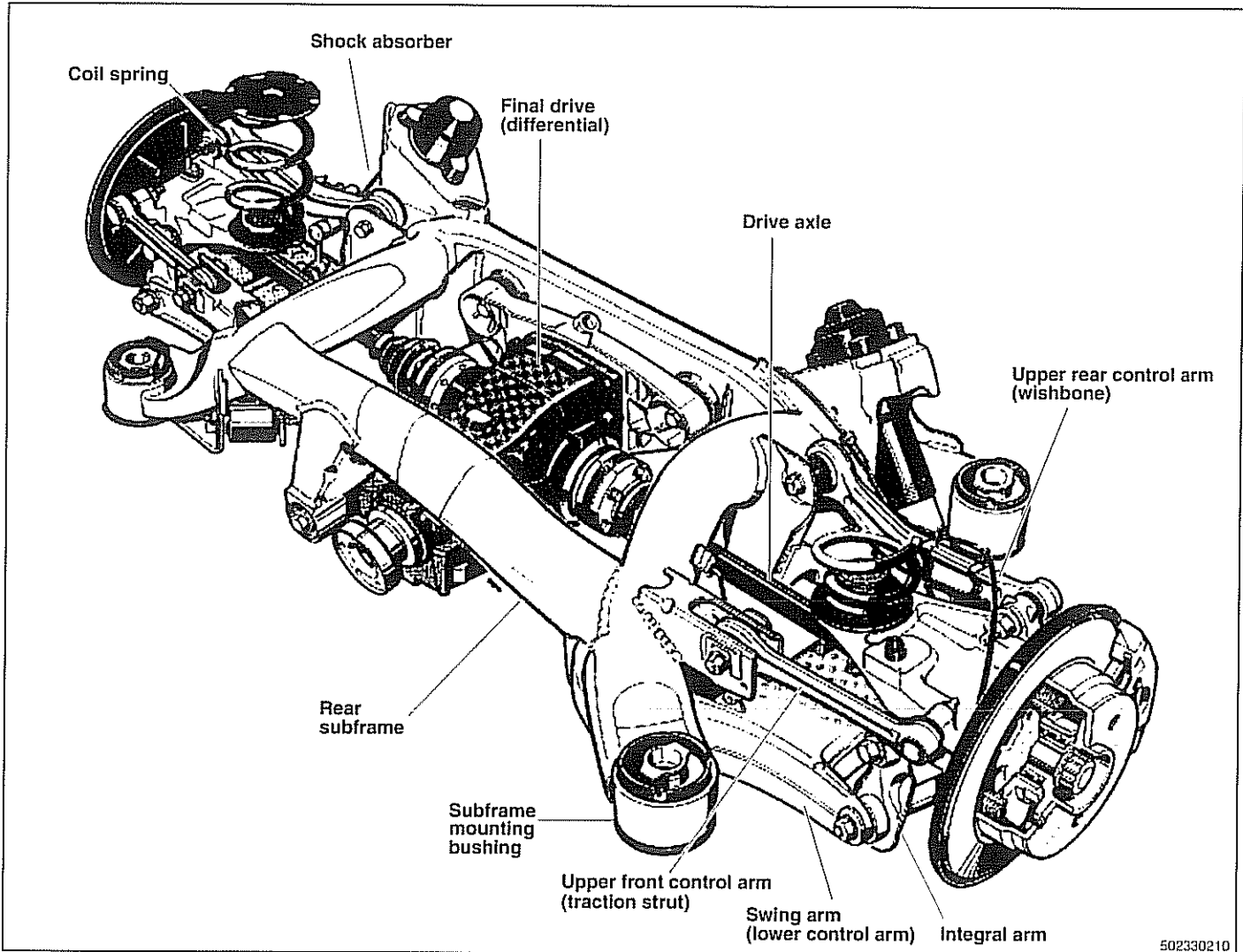
In order to provide a wide, flat floor in the cargo compartment, the rear suspension on the Sport Wagon is unique to itself. The shock absorber is attached diagonally between the lower swing arm and a mounting bracket on the subframe. The spring on each side is mounted between a perch at the top of the wheel bearing carrier and the bottom of the cargo compartment floor.

Starting with 1999 Sport Wagon models, a self-leveling air suspension system with electronic height control (EHC) was introduced. The system is standard on V-8 models and optional on 6-cylinder models.

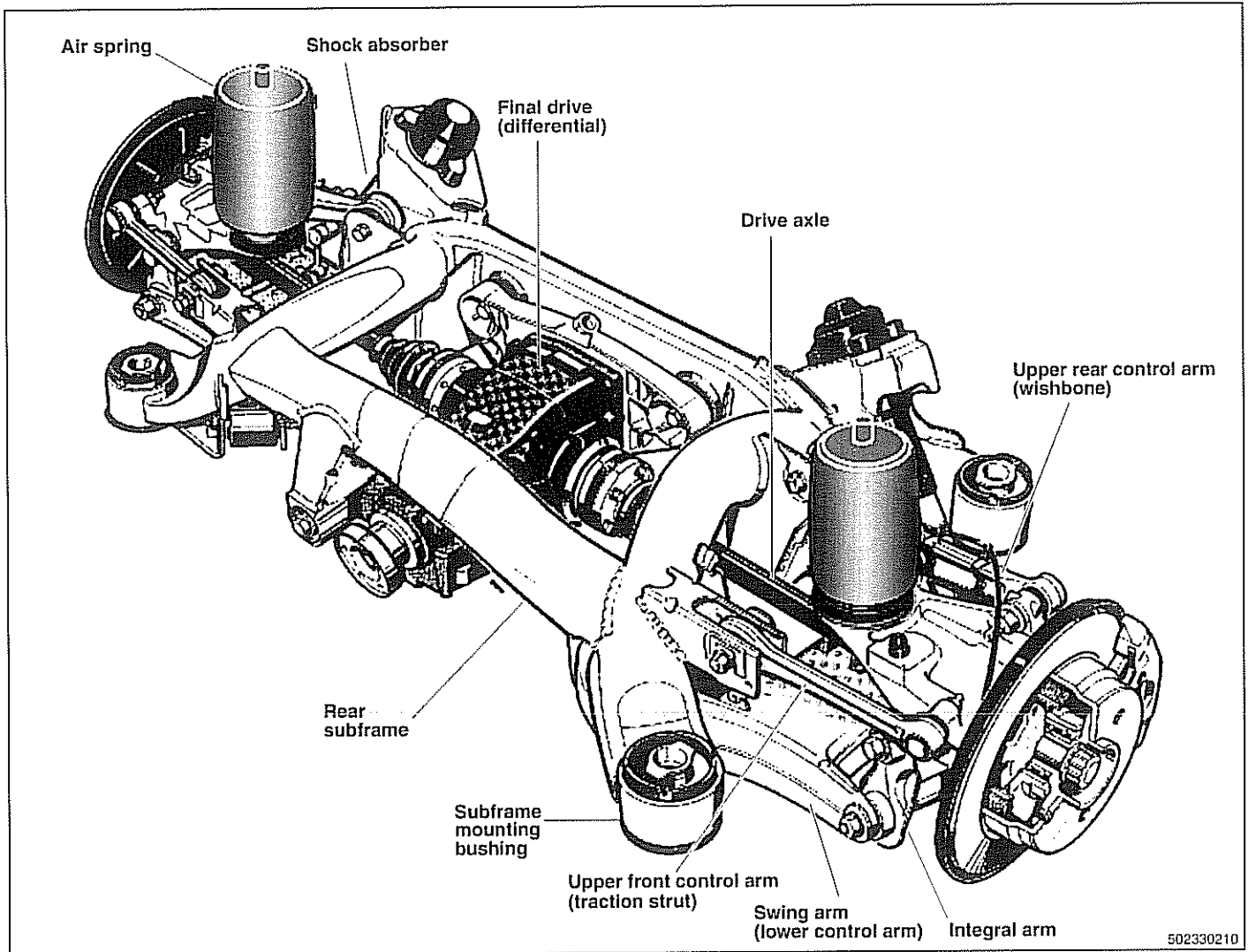
On models fitted with electronic height control (EHC) rear suspension, the standard coil springs are replaced by air springs. Air pressure in the air springs is automatically controlled by the EHC system to compensate for ride height and load variations.



### Rear suspension Sport Wagon (with coil springs)



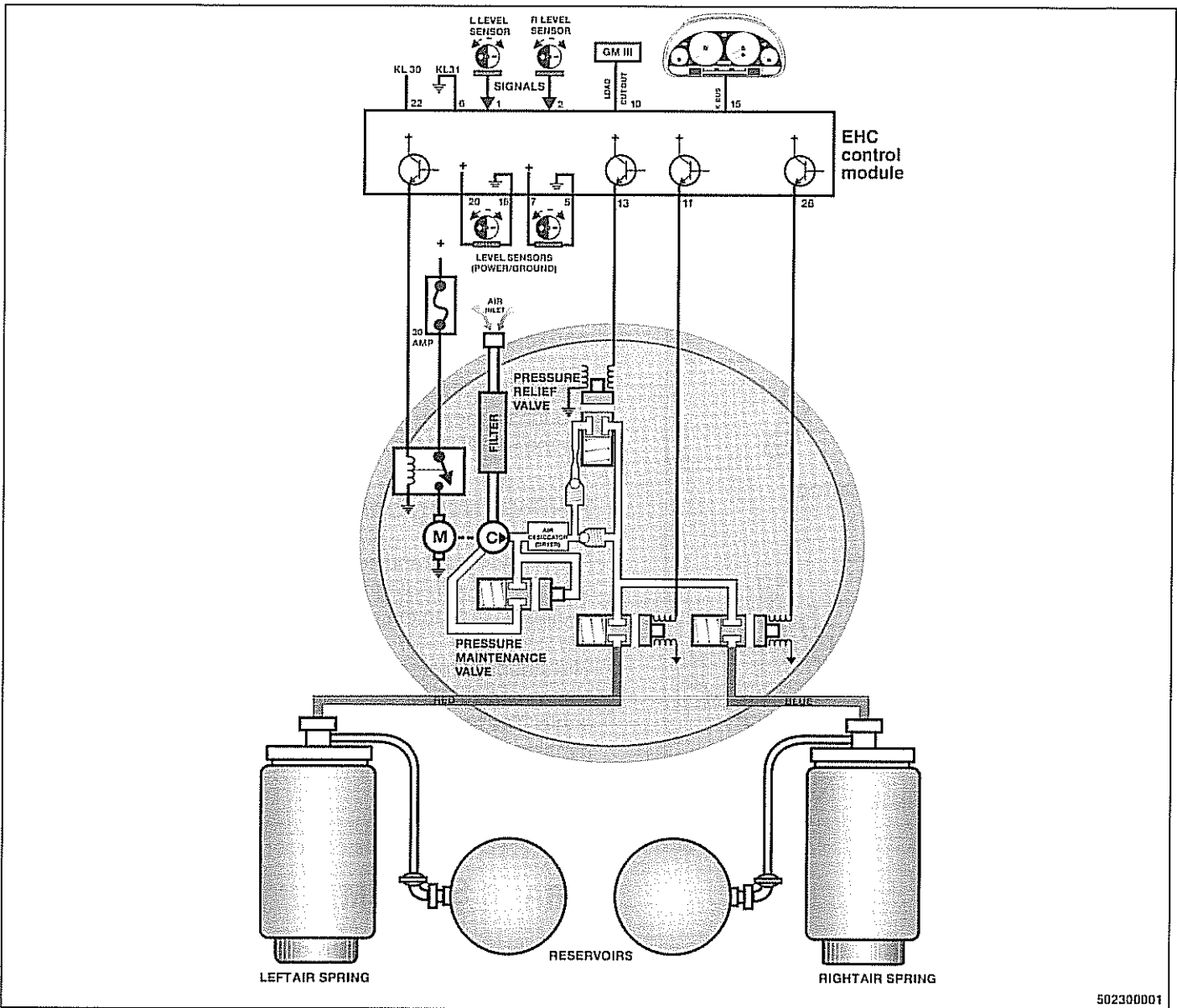
### Rear suspension Sport Wagon (EHC with air springs)



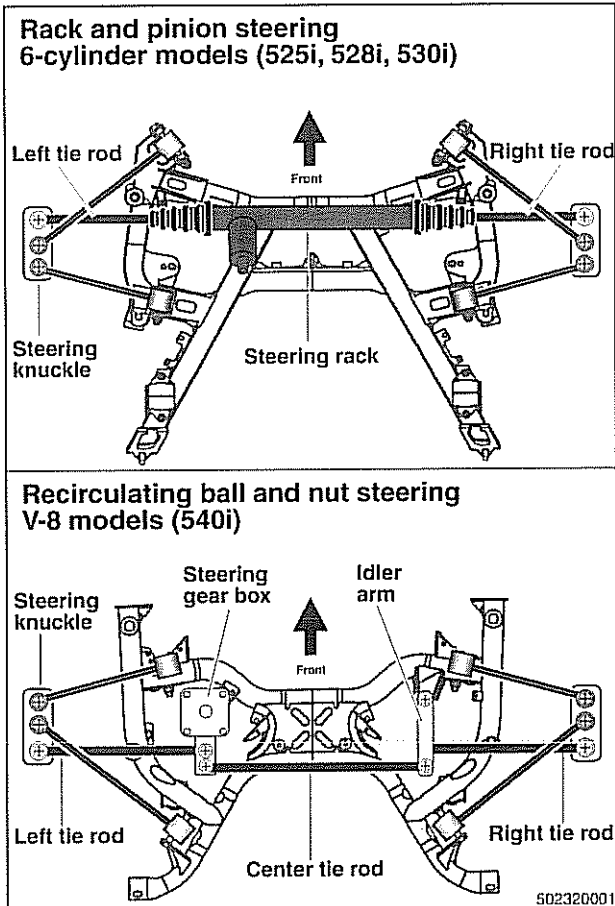
EHC initiates a control sequence as necessary. The system offers the following features:

- Control system independent from vehicle engine (no engine driven hydraulic pump system)
- Individual control of rear wheels
- Uneven load identified and compensated for
- Uneven road surfaces identified and not compensated for
- Automatic control interrupted when cornering
- System diagnosable using the BMW Service Tester (DIS-plus, GT1, or MoDiC)

EHC operational diagram



502300001



## STEERING

The steering system features variable power assist provided by an engine-driven hydraulic pump.

- Two types of steering systems are used in E39 models. 6-cylinder (525i, 528i, 530i) models are equipped with a steering rack system. V-8 (540i) models are equipped with a recirculating ball and nut steering gearbox.

### Rack-and-pinion steering

Steering components in 6-cylinder models consist of a rack-and-pinion type steering gear and connecting linkage to the road wheels.

The steering linkage connects the rack-and-pinion unit through tie rods to the steering knuckles. The tie rod ends allow the wheels to pivot and react to suspension travel.

### Recirculating ball and nut steering

Recirculating ball and nut steering in V-8 models consists of a steering box with integrated hydraulic control valve and connecting linkage to the road wheels.

The steering linkage connects the steering gearbox through a pitman arm to the wheels. An idler arm maintains correct toe angle. The tie rod allow the wheels to pivot and react to suspension travel.

## BRAKE SYSTEM

E39 cars are equipped with power disc brakes with integral antilock brakes (ABS). The parking brake is a dual-drum system integrated with the rear brake rotors.

Power assist is provided by a vacuum booster when the engine is running. The brake pedal pushrod is connected directly to the master cylinder, so failure of the vacuum booster does not normally result in total brake failure.

Each disc brake uses a caliper with a single hydraulic cylinder. Brake pads in the left front and right rear contain wear sensors. When brake pads need replacement, the sensors illuminate a light on the dashboard.

## WHEELS AND TIRES

Tire size is critical to the proper operation of the antilock brake system and traction control system. Several different styles of wheels in 15, 16, and 17 inch diameters are available from an authorized BMW dealer.

Rim and tire size applications are listed in the table below.

### Rim and tire sizes table

Model	Standard		Optional	
	Rim size	Tire size	Rim size	Tire size
525i	16 x 7		17 x 8	245/45R-17
528i	15 x 7	225/60R-15	Front 17 x 8 Rear 17 x 9	Front 235/45-17 255/40R-17
530i	16 x 7		17 x 8	235/45R-17
540i (manual transmission)	17 x 8	235/45-17	Front 17 x 8 Rear 17 x 9	Front 235/45-17 Rear 255/40R-17
540i (automatic transmission)	16 x 7	225/55-16	Front 17 x 8 Rear 17 x 9	Front 235/45-17 Rear 255/40R-17

## ELECTRONIC BRAKE AND STABILITY CONTROL SYSTEMS

All E39 vehicles are equipped with the Antilock Braking System (ABS). Early production models featured ABS with Automatic Stability Control (ABS/ASC). Later models came equipped with ABS and Dynamic Stability Control (ABS/DSC). DSC builds upon the existing ABS/ASC system to provide electronic control of drive and braking systems to insure vehicle stability.

This manual will refer to these systems as ABS, ASC or DSC will be specified when necessary. ABS component replacement is covered in **340 Brakes**.

ABS applications are shown in the accompanying table.

## E39 electronic brake and stability control systems application table

Year (model)	System	Identifiers
Manuf. up to 9/1998 (528i, 540i)	Automatic Stability Control plus Traction (ASC)	Electronic control module next to glove compartment
		Hydraulic unit in right rear of engine compartment
		No precharge pump
Manuf. up to 9/1999 (540i optional)	Dynamic Stability Control (Bosch DSC III v. 5.3)	Electronic control module next to glove compartment
		Hydraulic unit in right rear of engine compartment
		Precharge pump in left front of engine compartment, below steering fluid reservoir
		Separate rotational rate (yaw) and lateral acceleration sensors
Manuf. from 9/1999 (all models)	Dynamic Stability Control (Bosch DSC III v. 5.7)	Control module/hydraulic unit in right rear of engine compartment
		No precharge pump
		Combined rotational rate (yaw) and lateral acceleration sensors

### ABS system

The electronically controlled ABS maintains vehicle stability and control during emergency braking by preventing wheel lock-up. ABS provides optimum deceleration and stability during adverse conditions. It automatically adjusts brake system hydraulic pressure at each wheel to prevent wheel lock-up.

### Automatic Stability Control (ASC)

#### NOTE—

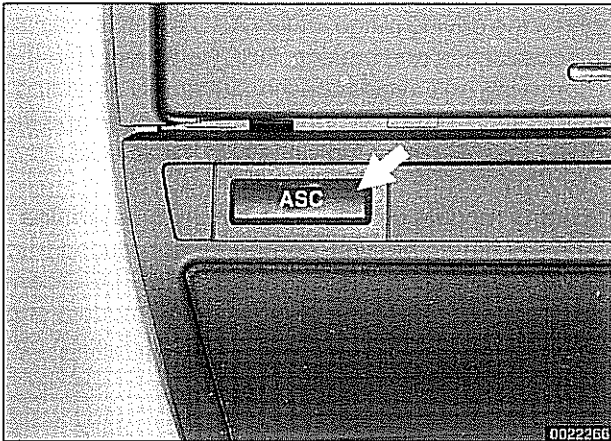
*ASC (Automatic Stability Control) may also be referred to as ASC+T (Automatic Stability Control+Traction).*

ASC works in conjunction with ABS and the engine management system to enhance vehicle control. The main function of the ASC system is to maintain the contact between the tires and the road surface under all driving conditions. This is achieved through exact application and management of braking and drivetrain forces.

The ASC system improves traction by electronically applying the rear brakes when the rear drive wheels are spinning at a faster rate than the front wheels. The combined ABS/ASC control module, operating through the ABS hydraulic control unit, modulates braking force at the rear wheels.

In addition, ASC overrides the throttle opening to reduce engine torque and maintain vehicle traction. Because the throttle is controlled electronically, the driver cannot increase engine power output during ASC intervention regardless of how far the accelerator pedal is pushed.

The main components of the system are the wheel speed (pulse) sensors, the ABS/ASC or ABS/DSC control module, and the hydraulic control unit.



Traction control also comes into operation during deceleration. Decelerating on snowy or icy road surfaces can lead to rear wheel slip. If a rear wheel starts to drag or lock up, the ASC system can limit the problem by adjusting throttle, fuel injection and ignition timing.

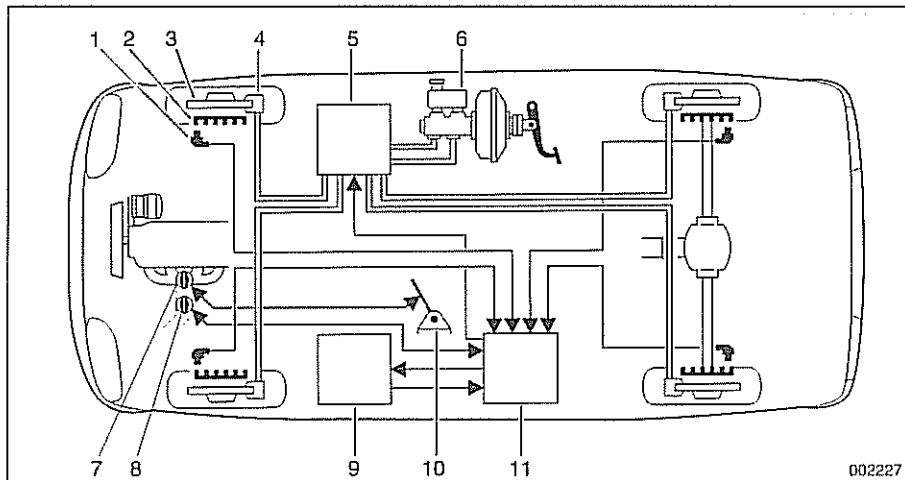
⚡ A switch (arrow) on the center console is used to toggle the ASC on or off.

**NOTE —**

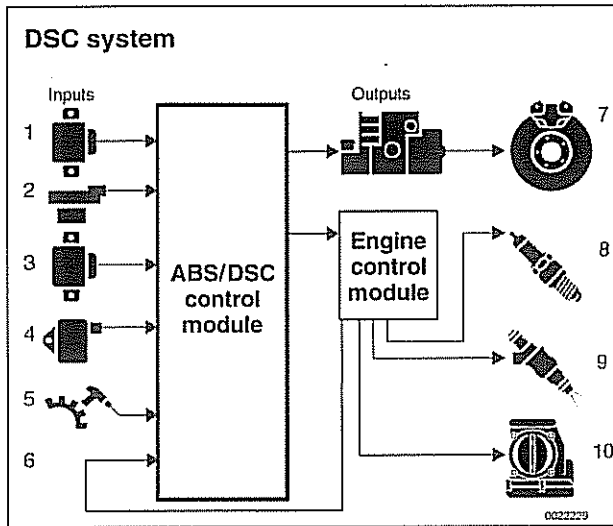
Even with the ASC system turned off, if the ASC control module senses a difference in wheel speed (one wheel spinning) the ASC system applies modulated braking force to the slipping wheel until traction is regained. There is no override of fuel injection function.

The ASC system is designed to be maintenance free. There are no adjustments that can be made. Repair and troubleshooting of the ASC system requires special test equipment and knowledge and should be performed only by an authorized BMW dealer.

### ABS/ASC traction control system



1. Wheel speed sensor
2. Wheel speed pulse wheel
3. Brake disk
4. Brake caliper
5. ABS/ASC hydraulic unit
6. Brake master cylinder
7. Pedal operated throttle valve
8. ASC controlled throttle valve
9. Engine control module (ECM)
10. Accelerator pedal
11. ABS/ASC control module



## Dynamic Stability Control (DSC)

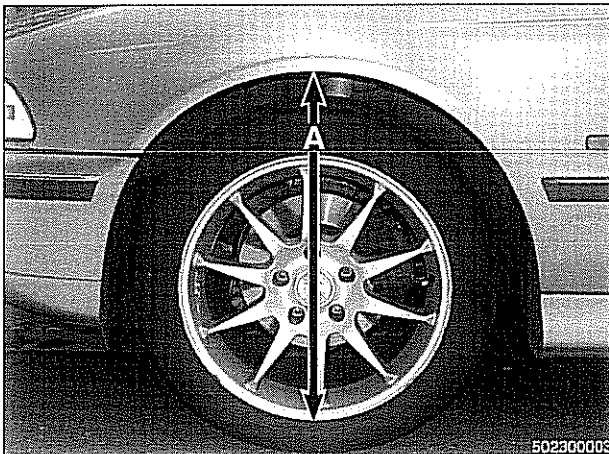
Dynamic Stability Control (DSC) utilizes many principles and components of the ASC traction control system. DSC is active throughout the driving range, unlike ASC which is only active during acceleration and braking. DSC helps stabilize the vehicle in cornering and avoidance maneuvers by adjusting engine controls such as throttle, ignition, fuel injection and the application of brake pressure individually to the wheels.

- The DSC control module uses various inputs to determine vehicle instability during braking, cornering, or reduced traction situations. Based upon these inputs the ABS/DSC control module sends outputs to the engine control module and the ABS/DSC hydraulic unit to activate torque reduction protocols and braking intervention.

The DSC system can be toggled on and off by a switch mounted on the center console. Turning off the DSC system does not disable ABS or ASC functions.

## RIDE HEIGHT

- Measure ride height (A) from center of fender arch to bottom of wheel rim.



- Car in normal loaded position on the ground. See **Normal loaded position**.
- Specified tires and wheels, correct tire pressure, even tire wear
- Correct wheel bearing play

- Model with air suspension (EHC): Disconnect electrical harness connector to air supply pump to prevent automatic height regulation.

- When finished, reset ride height using BMW diagnostic scan tools DIS or MoDiC.

### NOTE—

*Air supply pump is located beneath a cover under the spare tire in the floor of the cargo compartment.*

- If ride height is outside specification listed, install new springs. Suspension spring removal and installation is covered in **310 Front Suspension** and **330 Rear Suspension**.

### Normal loaded position

Each front seat	68 kg (150 lb)
Center of rear seat	68 kg (150 lb)
Trunk	21 kg (46 lb)
Fuel tank	full



### Front ride height specifications (measurement A)

#### E39 6-cylinder (525i, 528i, 530i) models

Wheel size	Standard suspension	Sports suspension	Rough road suspension	M sports package
15 inch	579 mm (22.8 in)	559 mm (22.0 in)	599 mm (23.6 in)	559 mm (22.0 in)
16 inch	592 mm (23.3 in)	572 mm (22.5 in)	612 mm (24.1 in)	572 mm (22.5 in)
17 inch	607 mm (23.9 in)	587 mm (23.1 in)	627 mm (24.7 in)	587 mm (23.1 in)
18 inch	620 mm (24.4 in)	600 mm (23.6 in)	640 mm (25.2 in)	600 mm (23.6 in)
Maximum variation between sides: 10 mm (0.4 in)				
Maximum deviation from specifications: 10 mm (0.4 in)				

#### E39 V8 (540i) models

Wheel size	Standard suspension	Sports suspension	Rough road suspension	M sports package
15 inch	579 mm (22.8 in)	559 mm (22.0 in)	599 mm (23.6 in)	562 mm (22.1 in)
16 inch	592 mm (23.3 in)	572 mm (22.5 in)	612 mm (24.1 in)	575 mm (22.6 in)
17 inch	607 mm (23.9 in)	587 mm (23.1 in)	627 mm (24.7 in)	590 mm (23.2 in)
18 inch	620 mm (24.4 in)	600 mm (23.6 in)	640 mm (25.2 in)	603 mm (23.7 in)
Maximum variation between sides: 10 mm (0.4 in)				
Maximum deviation from specifications: 10 mm (0.4 in)				

## Suspension, Steering and Brakes - General

### Rear ride height specifications (measurement A)

#### E39 6-cylinder (525i, 528i, 530i) models

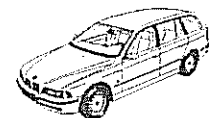
Wheel size	Standard suspension	Sports suspension	Ride level control	Rough road suspension	M sports package
15 inch	547 mm (21.5 in)	532 mm (20.9 in)	562 mm (22.1 in)	567 mm (22.3 in)	532 mm (20.9 in)
16 inch	560 mm (22.0 in)	545 mm (21.5 in)	575 mm (22.6 in)	580 mm (22.8 in)	545 mm (21.5 in)
17 inch	575 mm (22.6 in)	560 mm (22.0 in)	590 mm (23.2 in)	595 mm (23.4 in)	560 mm (22.0 in)
18 inch	588 mm (23.1 in)	573 mm (22.6 in)	603 mm (23.7 in)	608 mm (23.9 in)	573 mm (22.6 in)
Maximum variation between sides: 10 mm (.04 in)					
Maximum deviation from specifications: 10 mm (.04 in)					

#### E39 V8 (540i) models

Wheel size	Standard suspension	Sports suspension	Ride level control	Rough road suspension	M sports package
15 inch	547 mm (21.5 in)	532 mm (20.9 in)	562 mm (22.1 in)	567 mm (22.3 in)	536 mm (21.1 in)
16 inch	560 mm (22.0 in)	545 mm (21.5 in)	575 mm (22.6 in)	580 mm ( in)	549 mm (21.6 in)
17 inch	575 mm (22.6 in)	560 mm (22.0 in)	590 mm (23.2 in)	595 mm (23.4 in)	564 mm (22.2 in)
18 inch	588 mm (23.1 in)	573 mm (22.6 in)	603 mm (23.7 in)	608 mm (23.9 in)	577 mm (22.7 in)
Maximum variation between sides: 10 mm (.04 in)					
Maximum deviation from specifications: 10 mm (.04 in)					

#### E39 Sport Wagon models

Wheel size	Standard suspension	Sports suspension with air spring	Ride level control	Rough road suspension
15 inch	548 mm (21.5 in)	548 mm (21.5 in)	563 mm (22.1 in)	568 mm (22.4 in)
16 inch	561 mm (22.0 in)	561 mm (22.0 in)	576 mm (21.6 in)	581 mm (22.9 in)
17 inch	576 mm (22.6 in)	576 mm (22.6 in)	591 mm (23.2 in)	596 mm (23.5 in)
18 inch	589 mm (23.1 in)	589 mm (23.1 in)	604 mm (23.7 in)	609 mm (24.0 in)
Maximum variation between sides: 10 mm (.04 in)				
Maximum deviation from specifications: 10 mm (.04 in)				



# 310 Front Suspension

<b>General</b> .....	310-2	<b>Front Suspension Arms</b> .....	310-12
Special tools .....	310-2	Control arm, removing and installing (6-cylinder models) .....	310-12
Front suspension variations .....	310-4	Control arm, removing and installing (V-8 models) .....	310-13
<b>Front Strut Assembly</b> .....	310-4	Tension strut, removing and installing ....	310-16
Front strut assembly, removing and installing .....	310-5	Tension strut bushing, replacing .....	310-18
Front strut assembly components (6-cylinder models) .....	310-9	<b>Wheel Bearings, Front</b> .....	310-18
Front strut assembly, disassembling and assembling .....	310-9	<b>Front Stabilizer Bar</b> .....	310-22
		Stabilizer bar, removing and installing ....	310-22

## GENERAL

This repair group covers the repair and replacement of components that make up the front suspension of E39 cars.

Two different types of steering systems are used in the E39 series. 6-cylinder (525i, 528i and 530i) models are equipped with a rack and pinion type steering system mounted to an aluminum subframe. V-8 (540i) models use a steering gear-box type system mounted to a steel subframe.

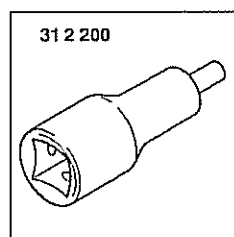
See **300 Suspension, Steering and Brakes-General** for a description of the front suspension and components, as well as specifications for setting ride height.

### CAUTION—

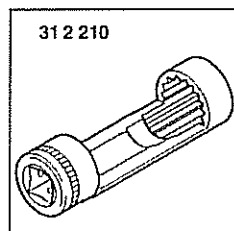
- Some E39 models are equipped with aluminum suspension components. The following cautions apply:
- Due to the chemical and corrosion characteristics of aluminum, do not bring into contact with battery acid.
- Do not clean with wire brushes with brass or iron bristles. Only use brushes with stainless steel bristles.
- Do not expose to flying sparks from grinding/cutting operations.
- Do not subject to steel welding splashes.
- Do not expose to temperatures over 80°C (176°F), even for short periods. Temperatures in painting facilities are not a problem.

## Special tools

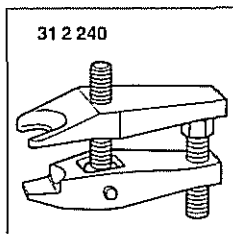
Special service tools are required for most of the work described in this repair group. In addition to the tools depicted in the illustrations, a variety of press tools are necessary for control arm bushing replacement. Read the procedures through before beginning any job.



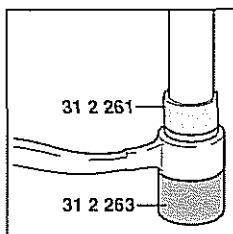
- ▲ Wheel carrier expander  
(Tool No. BMW 31 2 200)



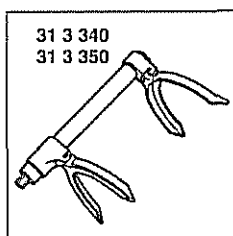
- ▲ Strut nut socket  
(Tool No. 31 2 210)



Ball joint press  
(Tool No. BMW 31 2 240)

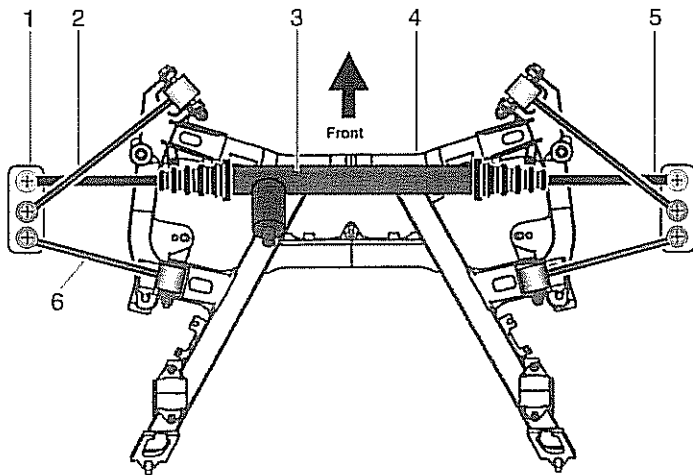


Bushing press tools  
(Tool No. BMW 31 2 261/263)



Spring compressor and spring holder arms  
(Tool No. BMW 31 3 340 / 31 3 350)

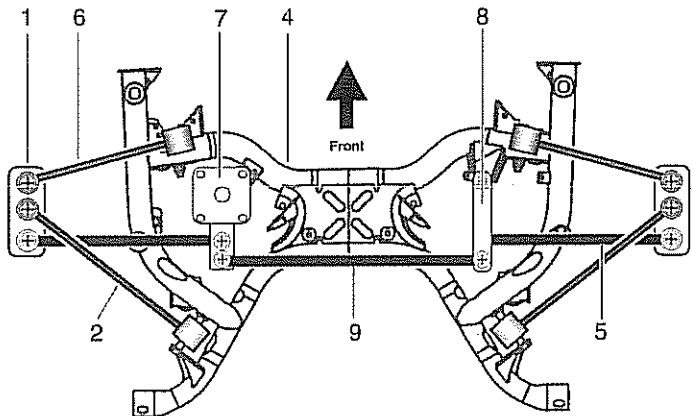
## 6-cylinder models



## Front suspension variations

1. Steering knuckle
2. Tension strut (thrust arm)
3. Steering rack
4. Front suspension subframe
5. Outer tie rod
6. Control arm
7. Steering box
8. Idler arm
9. Center tie rod

## V-8 models



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## FRONT STRUT ASSEMBLY

The front suspension shock absorbers on E39 cars are MacPherson struts. The strut is a major component of the front suspension and supports the spring. Most strut assembly components are available as replacement parts. Always replace struts and springs in pairs.

Front strut, upper strut mount or spring replacement is a two-step procedure:

- Removal of strut assembly from vehicle
- Disassembly and replacement of component on work bench

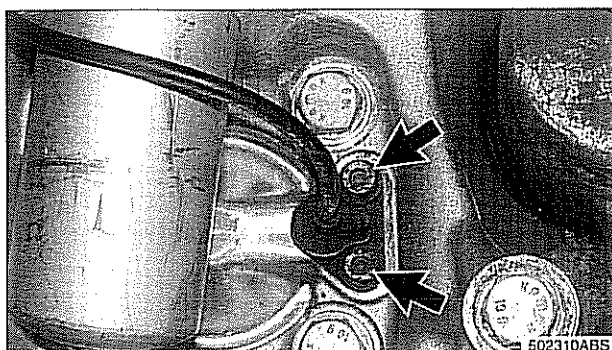
## Front strut assembly, removing and installing

- Raise car and remove front wheel.

### **WARNING**—

*Make sure that the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.*

- Unbolt brake caliper assembly, keeping brake hose connected. Secure brake caliper to body with wire. Do not let it hang from brake hose. See **340 Brakes**.



- Remove ABS pulse sensor mounting bolts (**arrows**) and remove sensor from housing.
- Detach ABS sensor wire harness and brake pad wear sensor wire harness (if equipped) from strut housing.

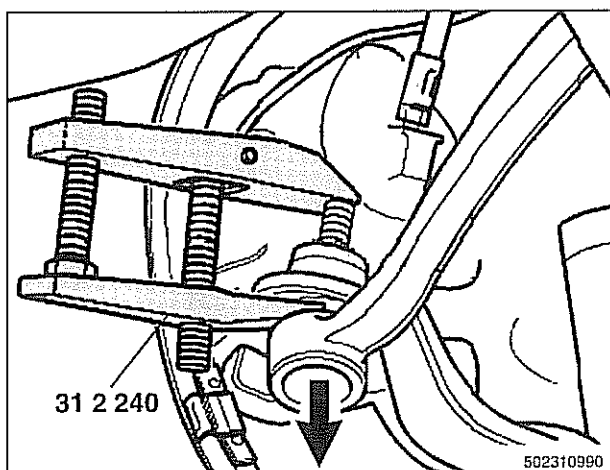
- Loosen and remove stabilizer bar link mounting nut while counterholding link ball joint. Disconnect stabilizer link from strut.

### **NOTE**—

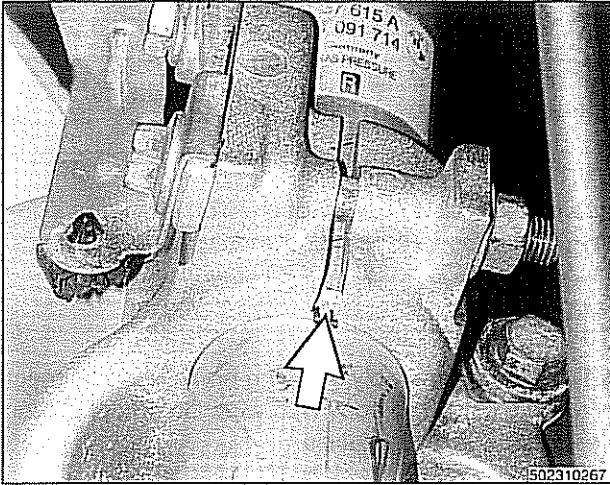
*Use a thin wrench to counterhold shaft of stabilizer bar link ball joint.*

- Cars equipped with vertical headlight adjustment system: Disconnect control arm from level sensor.

- Remove outer tie rod end nut. Use BMW special tool 31 2 240 or equivalent to press tie rod end out of steering arm.



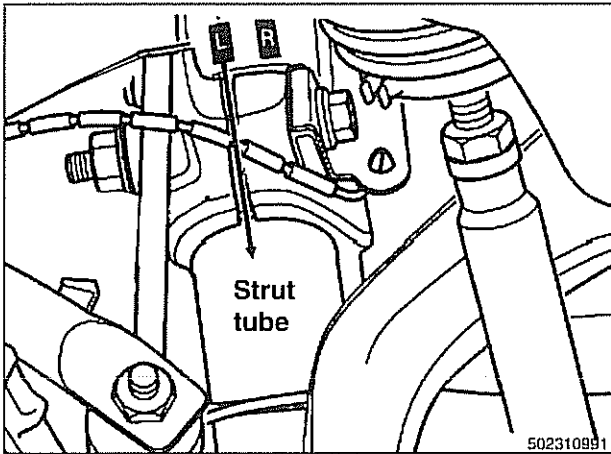
## Front Suspension



- Mark installation position of strut tube (arrow) in steering knuckle pinch collar.

**CAUTION—**

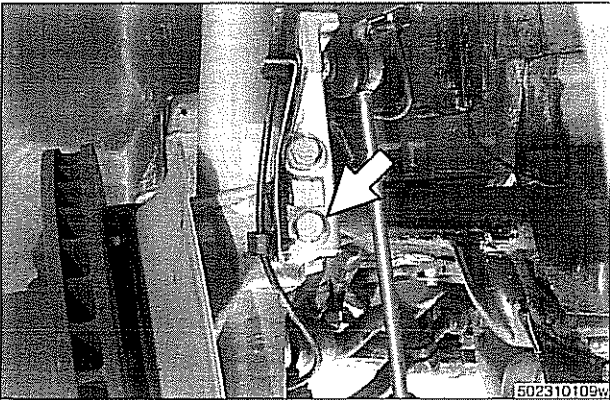
*Use paint, not a scribe tool, to mark location of strut tube.*



- Letter on strut tube designates mounting location.
  - R — Right side installation position
  - L — Left side installation position

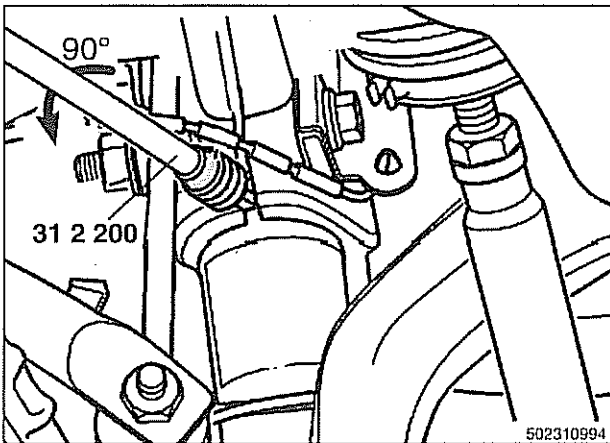
**NOTE—**

*Marking the strut tube is not necessary if factory marks (L or R) are still visible.*

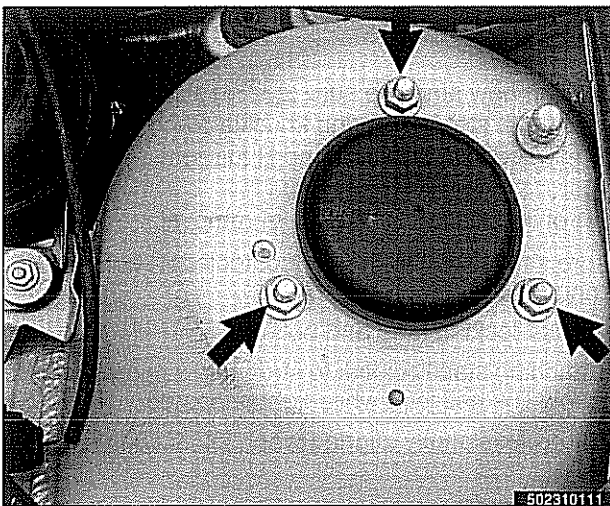


- Counterhold strut tube pinch bolt (arrow) while loosening nut.





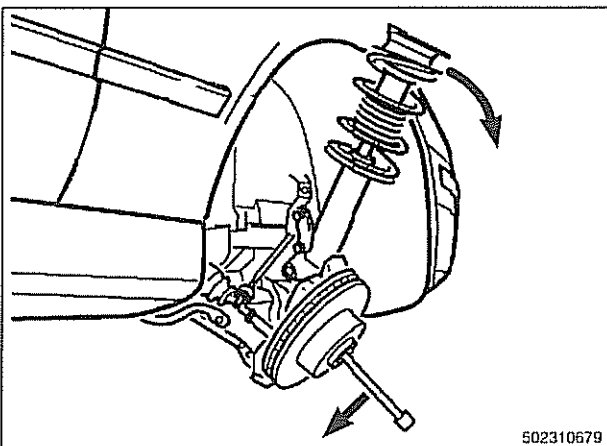
- ◀ Spread steering knuckle slot in pinch collar with BMW special tool 31 2 200.



- ◀ Working in engine compartment at strut tower:
  - If applicable, disconnect plug connector at top of strut for Electronic Damper Control and remove cap from cable.
  - Remove upper strut bearing mounting fasteners (arrows).

**WARNING**—

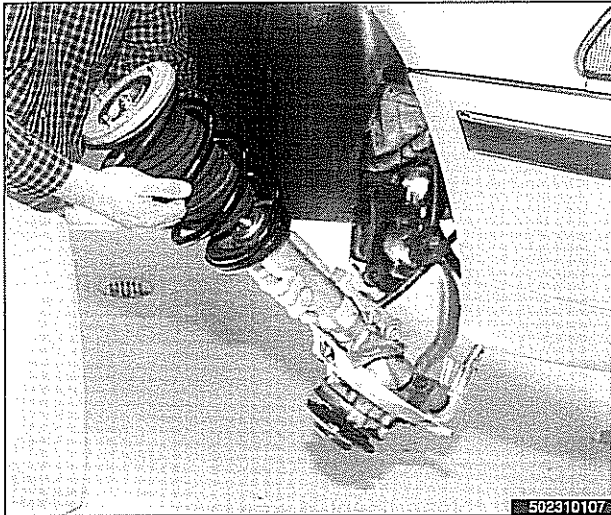
Do not remove center strut retaining nut.



- ◀ Use lever to push down on wheel hub. Tilt strut outward.

**NOTE**—

Use masking tape to protect fender arch from possible damage.

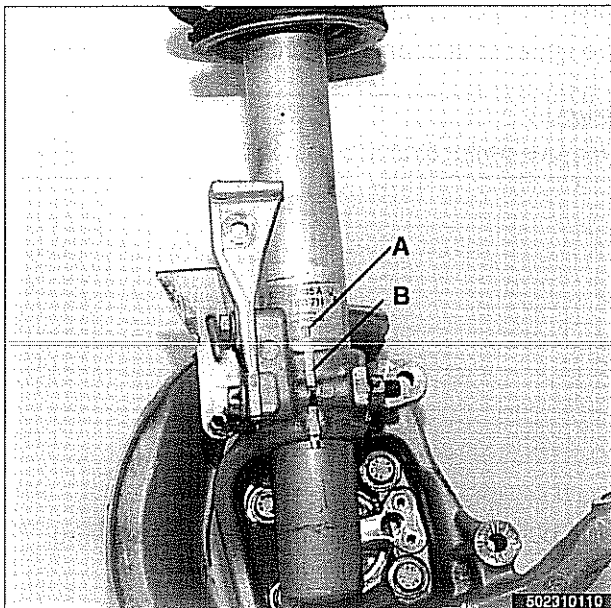


- Slide strut assembly out of steering knuckle pinch collar. If necessary use pry bar.

**CAUTION—**

*Do not pull strut out of steering knuckle with twisting motion. This can scratch and damage the strut.*

- Disassemble and reassemble strut assembly as described later.

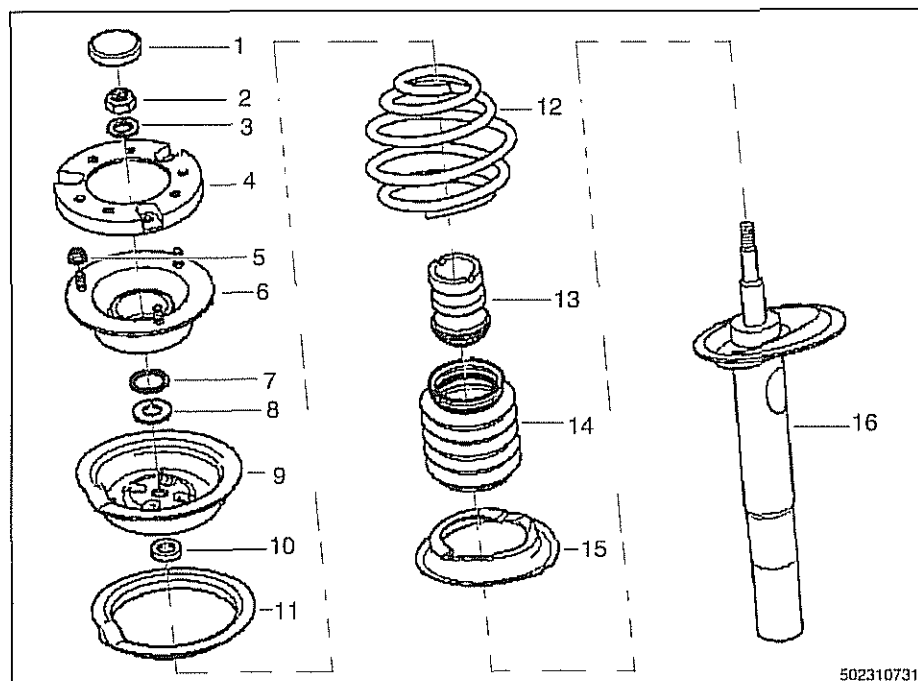


- When installing new strut, be sure to align locator letter (A) on strut body with slot in steering knuckle pinch collar (B). Struts are marked with L for left and R for right.

- Remainder of installation is reverse of removal.
  - Make sure strut shoulder (below locator letter) bottoms out in steering knuckle pinch collar.
  - Use new self-locking nuts and bolts.
  - When attaching stabilizer link to strut, use a thin wrench to counterhold link ball joint while tightening nut.
  - Have car professionally aligned when job is complete.

**Tightening torques**

Brake caliper to steering knuckle	110 Nm (81 ft-lb)
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)
Stabilizer bar link to strut	65 Nm (48 ft-lb)
Steering knuckle pinch bolt at strut mounting collar	81 Nm (60 ft-lb)
Steering tie rod to steering knuckle	65 Nm (48 ft-lb)
Strut assembly top to strut tower	24 Nm (18 ft-lb)



### Front strut assembly components (6-cylinder models)

1. Cap
2. Upper strut self-locking nut
3. Washer
4. Strut bearing reinforcement
5. Strut mount self-locking nut
6. Upper strut mount
7. Dust protector collar
8. Spacer
9. Upper spring seat
10. Spacer
11. Upper spring pad
12. Coil spring
13. Rubber stop
14. Dust boot
15. Lower strut pad
16. Strut with lower spring seat

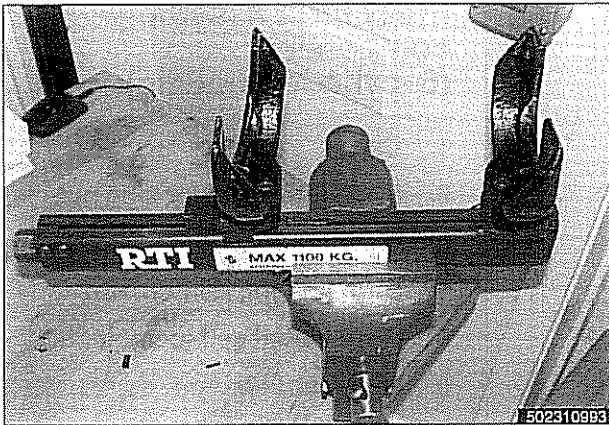
### Front strut assembly, disassembling and assembling

Replacing the strut, upper strut mount or spring requires that the strut assembly first be removed from the car and disassembled. For a guide to parts used during component replacement, see the accompanying diagram.

#### **NOTE**—

*Illustration shows components for 6-cylinder models (525i, 528i, 530i). V-8 models (540i) are similar but not identical.*

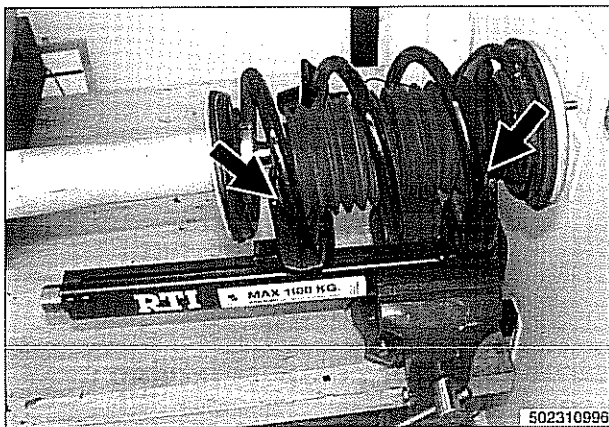
## Front Suspension



- Clamp spring compressor (BMW special tool 31 3 340 or equivalent) in shop vise.

**WARNING—**

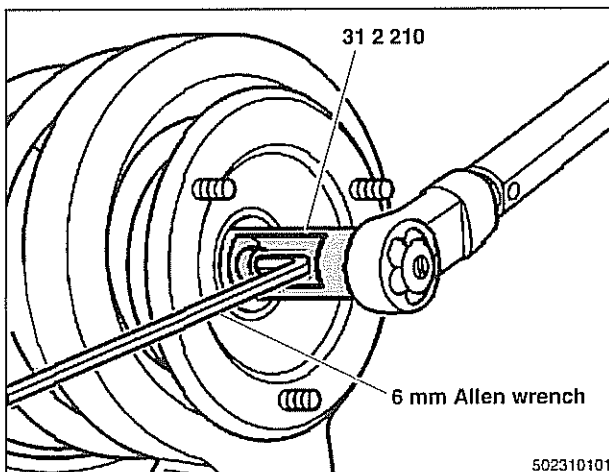
- Do not attempt to disassemble the strut assembly without a spring compressor designed specifically for this job.
- Prior to each use, check special tool for functionality.
- Do not use a damaged tool.
- Do not make any modifications to tool.
- Use correct size spring retainers when compressing coil spring.
- When assembling BMW spring compressor (special tool 31 3 340), make sure spring retainer plates are felt and heard snapping into place. Check seating of spring retainers carefully.



- Position coil spring between spring holders so that 3 coils lie between spring holders (arrows). Compress spring.

**WARNING—**

- When tensioned, the spring coils must rest completely in the spring holder recess.
- Never tighten or loosen spring compressor with an impact tool.
- Only tighten down the coil springs until stress on the thrust bearing is relieved.
- Only loosen strut nut if spring coils are completely inserted in the spring holder grooves. If necessary, loosen compressor, reposition and recompress.

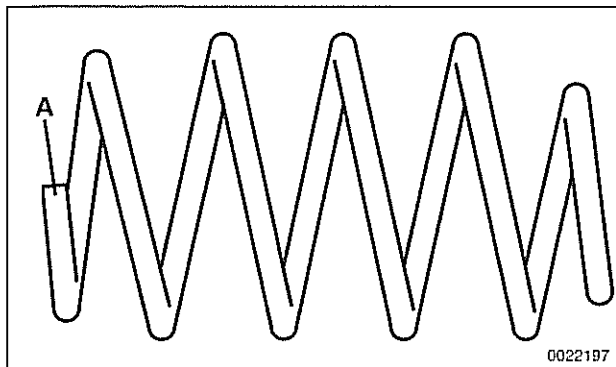


- Use BMW special tool 31 2 210 or equivalent to remove strut nut. Counterhold strut shaft using 6 mm Allen wrench.

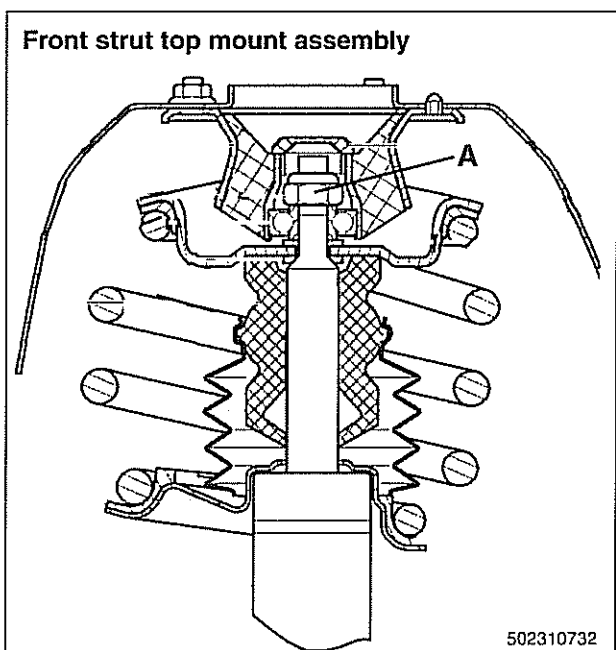
**CAUTION—**

Do not remove strut nut with impact tool.

- Remove upper strut bearing and related components.
- If a new coil spring is being installed, relieve tension on spring compressor and remove coil spring.
- Check strut dust boot, rubber stop and spring pads. Replace as necessary.
- Replace strut, upper strut mount or spring, as needed.



- Replace springs in matched pairs only. BMW ID number is stamped near end (A).



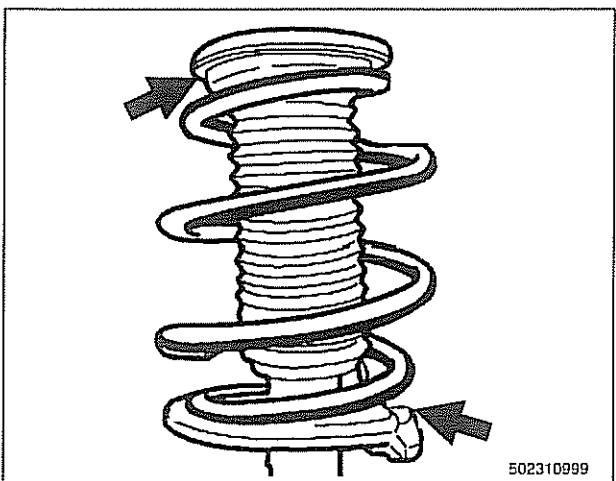
- Assembly is reverse of disassembly, noting the following:
  - Use a new upper strut self-locking nut (A). Tighten nut fully before releasing spring compressor.

**CAUTION—**

Do not tighten strut nut with impact tool.

**NOTE—**

Illustration shows components for 6-cylinder models (525i, 528i, 530i). V-8 models (540i) are similar but not identical.

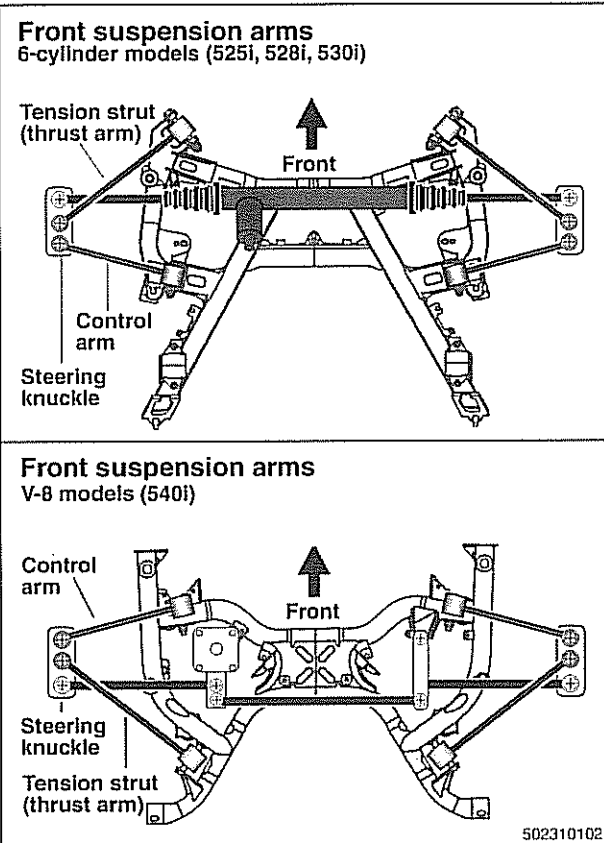


- Be sure upper and lower spring pads (arrows) are correctly installed to spring seats before releasing spring compressor.
  - Release spring compressor carefully and evenly, allowing spring to expand slowly.
  - Have car professionally aligned when job is complete.

**Tightening torques**

Upper strut mount to strut shaft (M14)	64 Nm (47 ft-lb)
Strut mount to strut tower (M8)	24 Nm (18 ft-lb)

**Front Suspension**



**FRONT SUSPENSION ARMS**

Control arms and tension struts are attached to the front sub-frame through rubber bushings and to the steering knuckles by ball joints.

**NOTE —**

- Tension struts are sometimes called thrust arms or thrust rods.
- Control arms or tension struts are sometimes called lower front arms or lower rear arms.

Inspect ball joints for wear and looseness. Inspect bushings for wear or fluid leaks. The ball joint can only be replaced as part of an entire suspension arm assembly. Some suspension arm bushings are available as replacement parts. Always replace in pairs.

**NOTE —**

Steering wheel vibration during braking (usually at road speeds of 50 to 60 m.p.h.) are often caused by faulty suspension arm bushings, not out-of-true brake rotors.

Some special tools may be required to remove suspension arms and to replace bushings. Read procedures through before beginning the job.

**Control arm, removing and installing (6-cylinder models)**

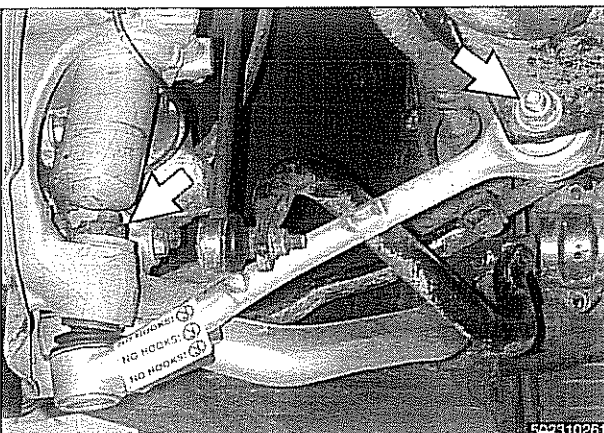
- Raise car and remove wheel.

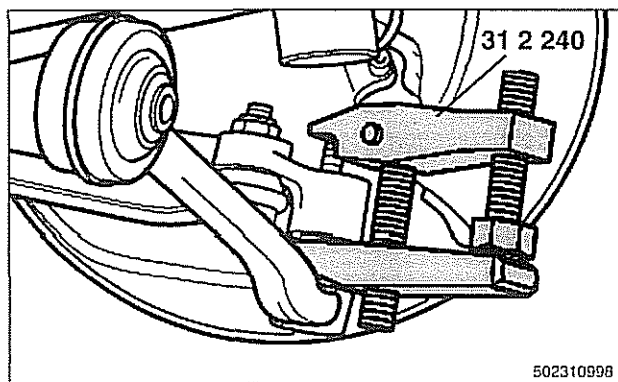
**WARNING —**

Make sure that the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.

- Cars equipped with vertical headlight adjustment system: Disconnect control arm from level sensor.

Remove control arm fasteners (arrows). Lightly tap inner control arm mounting bolt out of subframe.





- ◀ Use BMW special tool 31 2 240 or equivalent to separate control arm ball joint from steering knuckle.
- When installing control arm, make sure all thread bores, bolts, nuts and mating surfaces are clean.
- Install bushing end of control arm to subframe, using washers on both sides of bolt and a new self—locking nut. Do not tighten nut at this time.
- Install control arm ball joint to steering knuckle using a new self—locking nut. Tighten fully.
- Install wheel and lower car.
- Load car to normal loaded position as described under **Ride height**. See **300 Suspension, Steering and Brakes-General**. Bounce suspension a few times.
- With car on ground and loaded, tighten control arm bushing through-bolt.

#### Tightening torques

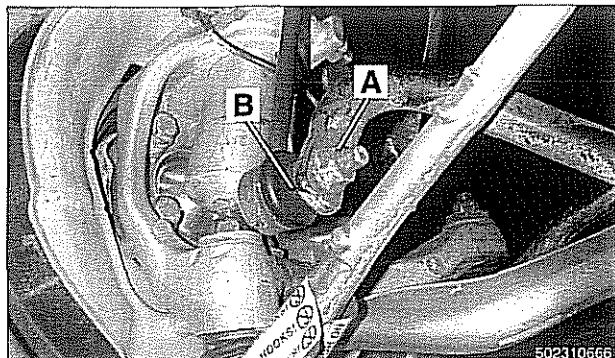
Control arm to steering knuckle	80 Nm (59 ft-lb)
Control arm to subframe	110 Nm (81 ft-lb)
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)

### Control arm, removing and installing (V-8 models)

- Raise car and remove wheel.

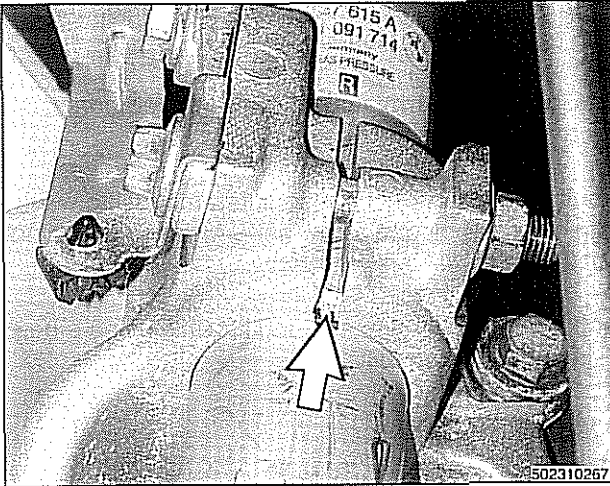
#### **WARNING** —

*Make sure that the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.*



- ◀ Loosen and remove stabilizer bar link mounting nut (A) while counterholding ball joint (B). Disconnect stabilizer link from stabilizer bar.
- Cars equipped with vertical headlight adjustment system: Disconnect control arm from level sensor.

## Front Suspension



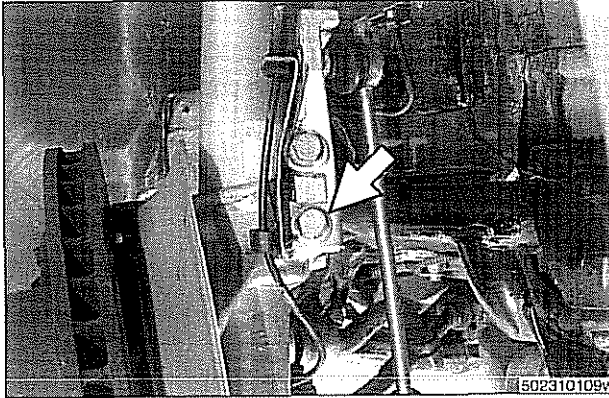
- Mark installation position of strut tube (arrow) at steering knuckle pinch collar.

**NOTE—**

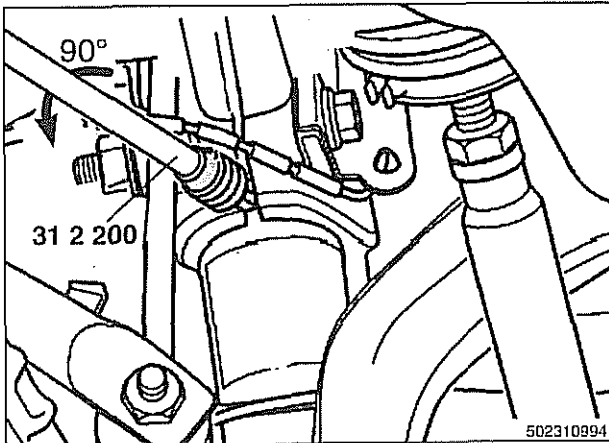
- The strut tube installation position is marked on factory strut tubes: L for left and R for right.
- Marking the strut tube is not necessary if factory marks (L or R) are still visible.

**CAUTION—**

Use paint, not a scribe tool, to mark location of strut tube.

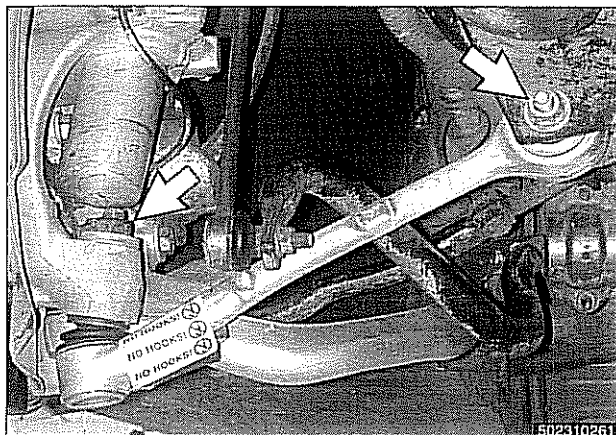


- Counterhold strut tube pinch bolt (arrow) while loosening nut.

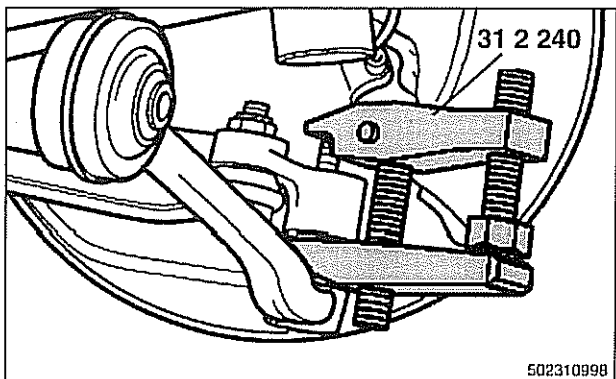


- Spread steering knuckle pinch collar with BMW special tool 31 2 200 to release strut tube.
- Pull steering knuckle down so that strut tube slides up far enough to gain better access to control arm nut.





- Remove control arm fasteners (**arrows**). Lightly tap inner control arm mounting bolt out of subframe.



- Use BMW special tool 31 2 240 or equivalent to separate ball joint from steering knuckle.

- When installing control arm, make sure all thread bores, bolts, nuts and mating surfaces are clean.
- Install bushing end of control arm to subframe, using washers on both sides of bolt and a new self-locking nut. Do not tighten nut at this time.
- Install control arm ball joint to steering knuckle, using new self-locking nut. Tighten fully.
- Slide strut back into position and tighten strut pinch bolt fully.
- Install wheel and lower car.
- Load car to normal loaded position as described under **Ride height**. See **300 Suspension, Steering and Brakes-General**. Bounce suspension a few times.
- With car on ground and loaded, tighten control arm bushing through-bolt.

#### Tightening torques

Control arm to steering knuckle	80 Nm (59 ft-lb)
Control arm to subframe	78 Nm (58 ft-lb)
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)
Stabilizer bar link to stabilizer bar	59 Nm (44 ft-lb)
Strut pinch bolt	81 Nm (60 ft-lb)

## Tension strut, removing and installing

- Raise car and remove wheel.

### **WARNING—**

*Make sure that the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.*

- Remove engine splash shield.
- 6-cylinder models: Remove brake cooling duct.
- V-8 models: Detach stabilizer bar from front subframe.

- Mark installation position of strut tube (**arrow**) at steering knuckle pinch collar.

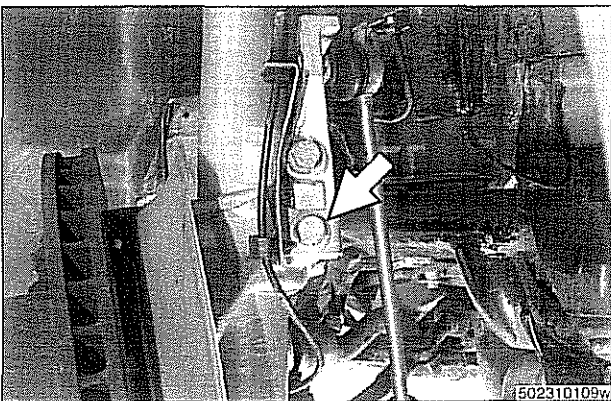
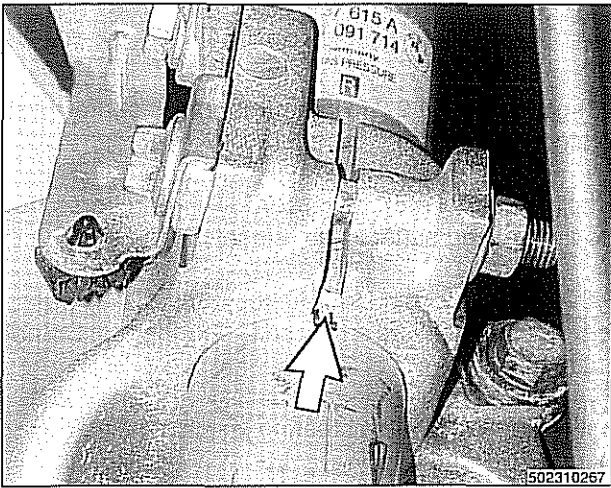
### **NOTE—**

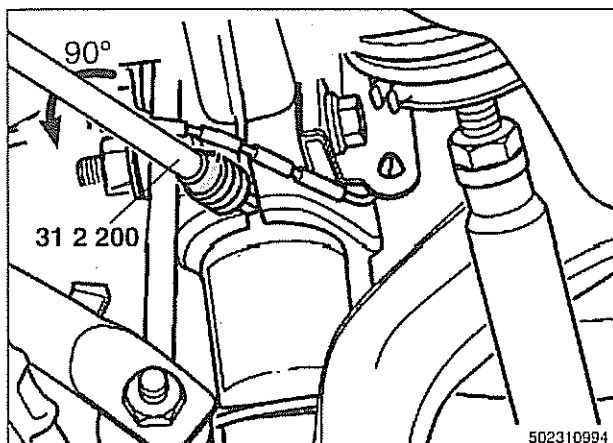
- The strut tube installation position is marked on factory strut tubes: L for left and R for right.
- Marking the strut tube is not necessary if factory marks (L or R) are still visible.

### **CAUTION—**

*Use paint, not a scribe tool, to mark location of strut tube.*

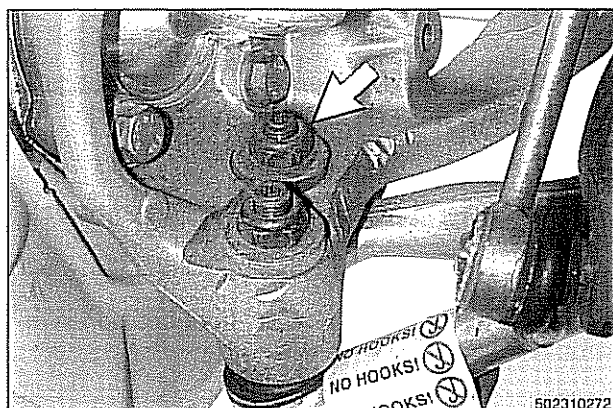
- Counterhold strut tube pinch bolt (**arrow**) while loosening nut.





➤ Spread steering knuckle pinch collar with BMW special tool 31 2 200 to release strut tube.

- Pull steering knuckle down so strut tube slides up far enough to gain better access to tension strut or tension strut nut.



➤ Unscrew ball joint nut (arrow) from steering knuckle. Use BMW special tool 31 2 240 to remove ball joint from steering knuckle.

**CAUTION—**

*Take care not to damage the ball joint threads if the tension strut is to be reused.*

- Remove through-bolt attaching tension strut to subframe.
- When installing tension strut, make sure all thread bores, bolts, nuts and mating surfaces are clean.
- Install bushing end of tension strut to subframe using washers on both sides of bolt and a new self-locking nut. Do not tighten nut at this time.
- Install tension strut ball joint to steering knuckle using new self-locking nut. Tighten fully.
- Slide strut back into position and tighten strut pinch bolt fully.
- Install wheel and lower car.
- Load car to normal loaded position as described under **Ride height**. See **300 Suspension, Steering and Brakes-General**. Bounce suspension a few times.
- With car on ground and loaded, tighten tension strut bushing through-bolt.

**Tightening torques**

Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)
Stabilizer bar to subframe	24 Nm (18 ft-lb)
Tension strut to steering knuckle	80 Nm (59 ft-lb)
Tension strut to subframe	110 Nm (81 ft-lb)
Strut pinch bolt	81 Nm (60 ft-lb)

## Tension strut bushing, replacing

- Raise car and remove wheel.

### **WARNING—**

*Make sure that the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.*

- Remove tension strut from car as described earlier.
- Using a service press and appropriate press tools (BMW special tools 31 2 261/262/263 or equivalent), press bushing out of tension strut.



- Clean bushing bore and press in new bushing while aligning mark on bushing with mark on tension strut (**arrows**).

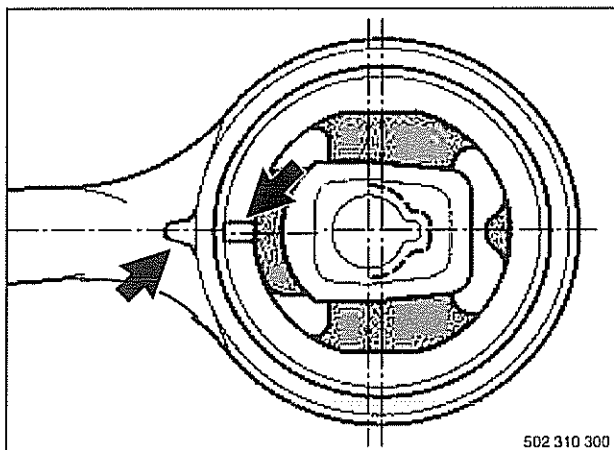
### **CAUTION—**

*To avoid damaging the new bushing, press only on the outer steel sleeve during installation.*

- Press bushing in so it protrudes equally from both sides of tension strut.
- Install tension strut as described earlier.

### **CAUTION—**

*Tighten the tension strut bushing through-bolt to its final torque only with car on the ground and the suspension normally loaded as described earlier.*



## WHEEL BEARINGS, FRONT

The front wheel bearings are permanently sealed and require no maintenance. The bearing is integral with the wheel hub. The wheel bearing and hub assembly is bolted to the steering knuckle.

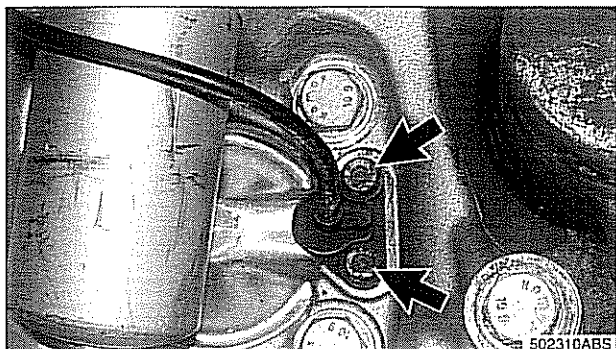
- Raise car and remove front wheel.

### **WARNING—**

*Make sure that the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.*

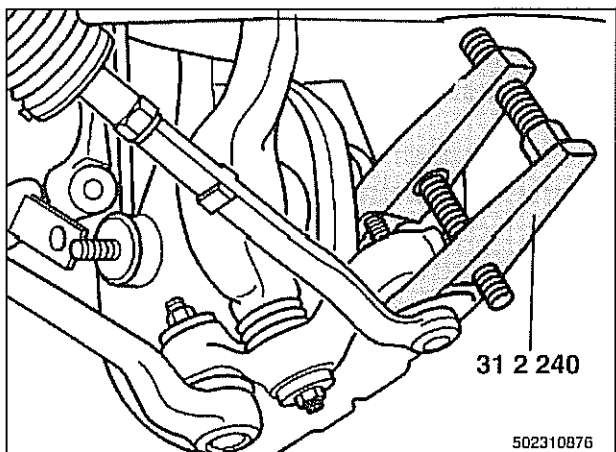
- Unbolt brake caliper and hang to side with stiff wire. Do not disconnect brake hose. Remove brake disc. See **340 Brakes**.

## Front Suspension

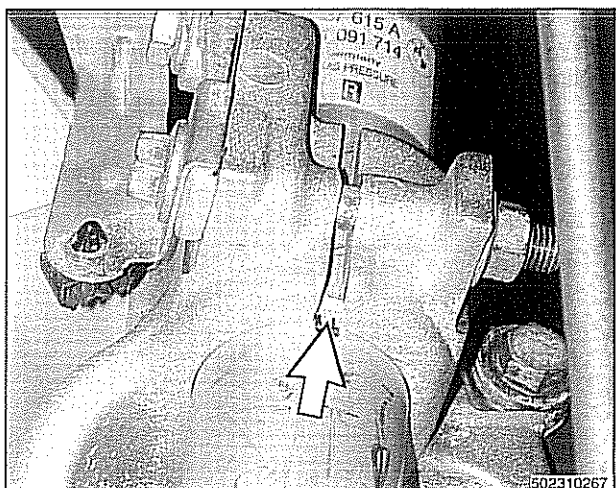


➤ Remove ABS pulse sensor mounting bolts (arrows) and pull sensor from housing.

— Detach stabilizer bar link from stabilizer bar.



➤ 6-cylinder models: Remove tie rod outer end nut. Use BMW special tool 31 2 240 or equivalent to press tie rod end off steering arm.



➤ Mark installation position of strut tube (arrow) at steering knuckle pinch collar.

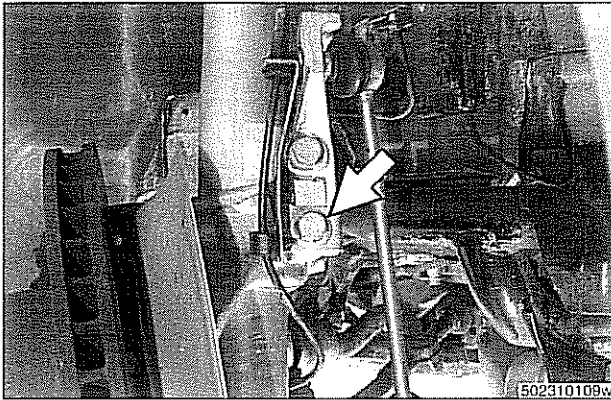
**NOTE—**

*The strut tube installation position is marked on factory strut tubes: L for left and R for right.*

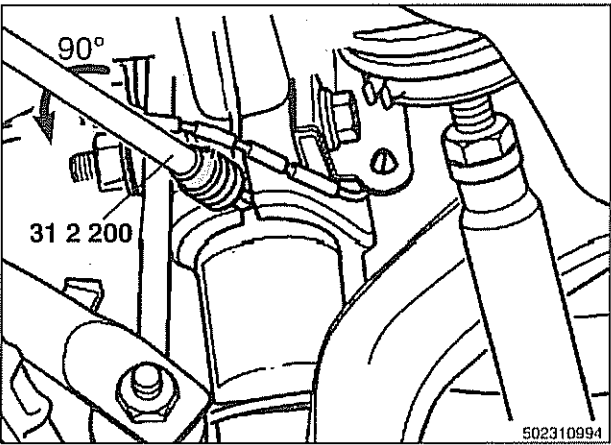
**CAUTION—**

*Use paint, not a scribe tool, to mark location of strut tube.*

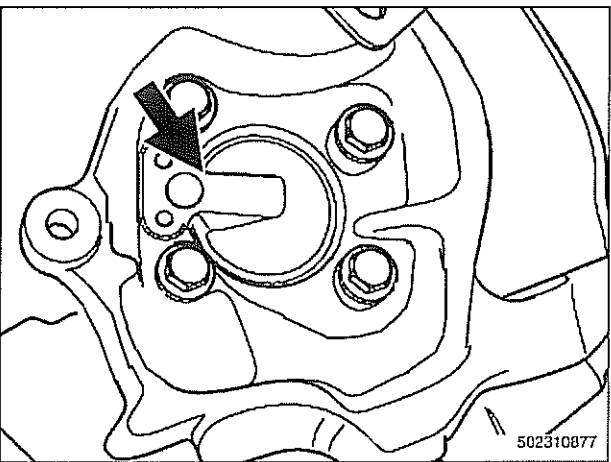
Front Suspension



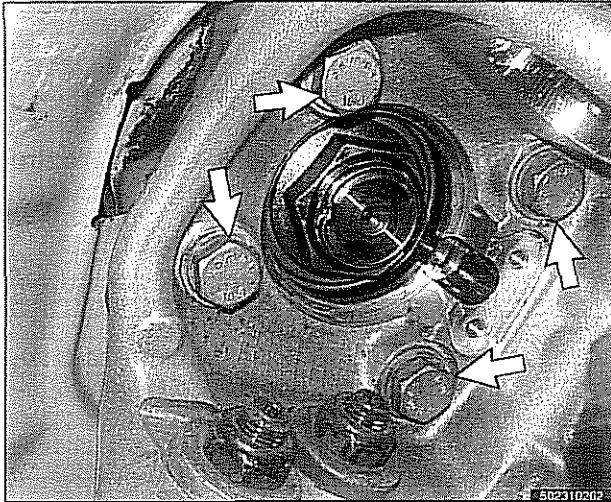
⚡ Counterhold strut tube pinch bolt (**arrow**) while loosening nut.



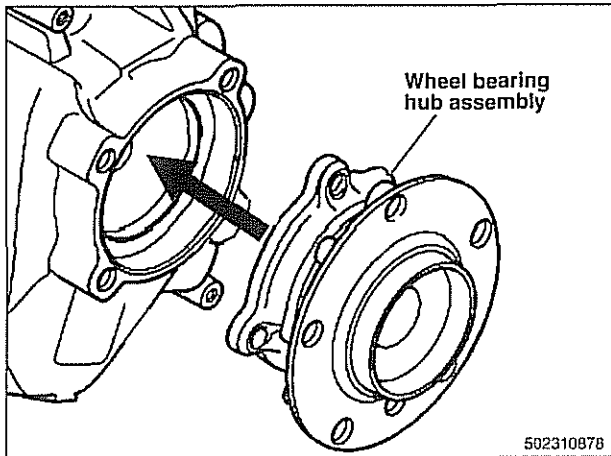
⚡ Spread steering knuckle pinch collar with BMW special tool 31 2 200 to release strut tube.  
- Pull steering knuckle down so that strut tube slides up far enough to gain access to wheel bearing hub mounting bolts.



⚡ Carefully pry out dust cover on back side of bearing while noting location (**arrow**) of cover.



- Remove four bearing hub mounting bolts (arrows) and tap hub assembly out of steering knuckle.



- Before installing new wheel bearing and hub assembly, be sure hub and steering knuckle sealing surfaces are free of dirt and grease.
- Installation is reverse of removal.
  - Replace hub mounting bolts.
  - Use new self-locking nuts at steering tie rod and stabilizer link.

#### Tightening torques

Road wheel lugs to hub	120 ± 10 Nm (89 ± 7 ft-lb)
Stabilizer link to stabilizer bar	65 Nm (48 ft-lb)
Steering tie rod to steering knuckle	65 Nm (48 ft-lb)
Tension strut to steering knuckle	80 Nm (59 ft-lb)
Wheel bearing hub to steering knuckle (replace bolts)	110 Nm (81 ft-lb)

## FRONT STABILIZER BAR

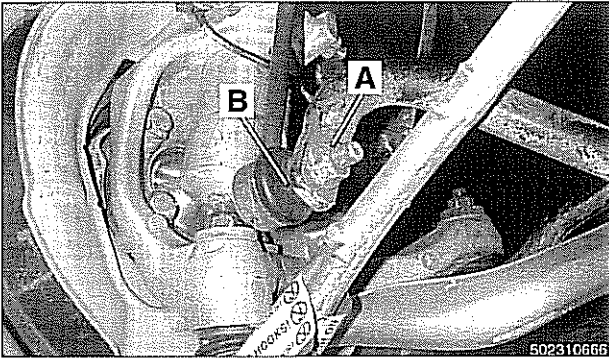
### Stabilizer bar, removing and installing

On E39 models the front stabilizer bar links attach to the strut assemblies.

- Raise car and support safely.

**WARNING—**

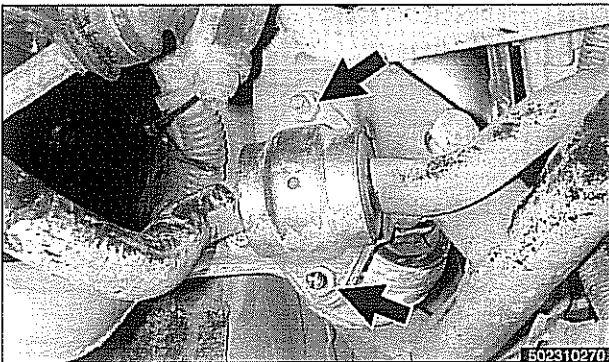
*Make sure that the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.*



- Remove stabilizer bar connecting link mounting nuts (A) from right and left sides of stabilizer bar. Counterhold ball joint (B) with flat wrench.

**NOTE—**

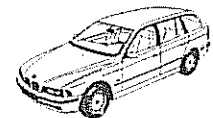
*Use a thin wrench to counterhold shaft of stabilizer bar link ball joint while removing mounting nut.*



- Remove stabilizer bar anchor bushing nuts (arrows) on right and left sides and remove bar.
- Installation is the reverse of removal, noting the following.
  - Use new self-locking nuts on stabilizer bar links.
  - Installation of stabilizer bar is easiest with car level (front wheels at the same height).

**Tightening torques**

Stabilizer bar to stabilizer link	59 Nm (44 ft-lb)
Stabilizer anchor to subframe	22 Nm (16 ft-lb)





# 320 Steering and Wheel Alignment

<b>General</b> .....	320-2	<b>Rack and Pinion Steering</b>	
Special tools .....	320-2	<b>(6-cylinder models)</b> .....	320-19
Steering system .....	320-4	Rack and pinion steering components	
Steering system variations .....	320-5	(6-cylinder models) .....	320-19
Steering system warnings and cautions . . . .	320-6	Steering rack, removing and installing . . . .	320-19
<b>Steering Wheel</b> .....	320-7	Steering rack boot, replacing .....	320-22
Steering wheel, removal and installation . . .	320-7	Tie rod (outer), replacing .....	320-22
<b>Steering Column</b> .....	320-10	Tie rod (inner), replacing .....	320-23
Steering column components .....	320-10	<b>Steering Gearbox (V-8 models)</b> . . . .	320-24
Steering column trim, removing		Steering gearbox system components	
and replacing .....	320-10	(V-8 models) .....	320-24
Ignition switch ring antenna (EWS),		Steering gearbox, removing and installing	320-25
removing and installing .....	320-11	Pitman arm, removing and installing . . . . .	320-28
Ignition lock cylinder,		Pitman arm, adjusting .....	320-29
removing and installing .....	320-11	Steering idler arm, removing	
Steering column lock, removing		and installing .....	320-30
and installing .....	320-12	Idler arm bushing, replacing .....	320-31
Ignition interlock cable, removing and installing		Center tie rod, replacing .....	320-32
(models with automatic transmission) . . . .	320-13	<b>Wheel Alignment</b> .....	320-33
Interlock cable, adjusting		Camber .....	320-33
(models with automatic transmission) . . . .	320-14	Caster .....	320-33
Steering column, removing and installing . .	320-14	Front toe and toe difference angle .....	320-34
Steering column adjustment motors,		Rear toe .....	320-34
removing and installing .....	320-16	Preparing for alignment .....	320-35
<b>Power Steering Pump</b> .....	320-17	Alignment specifications tables .....	320-35
Power steering pump, removing			
and installing .....	320-17		
Power steering system,			
bleeding and filling .....	320-18		

## GENERAL

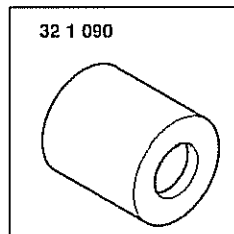
This repair group covers steering wheel and column removal and steering system service, including wheel alignment information.

### NOTE—

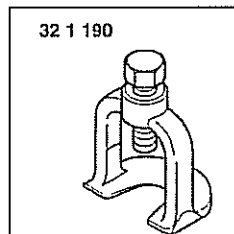
- Ignition lock cylinder replacement is covered in this section.
- For information on steering column mounted switches, including the ignition switch, see **612 Switches**.

## Special tools

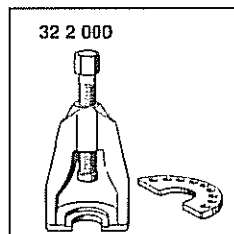
Some special tools are necessary to carry out the repairs and adjustments required for steering service and wheel alignment. Be sure to read the procedures through before starting work on the vehicle.



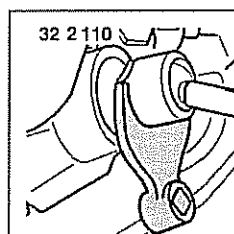
- ▲ Steering shaft retaining ring installation tool  
(Tool No. BMW 32 1 090)



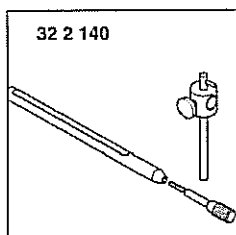
- ▲ Ball joint removal tool  
(Tool No. BMW 32 1 190)



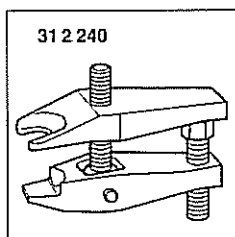
- ▲ Pitman arm removal tool  
(Tool No. BMW 32 2 000)



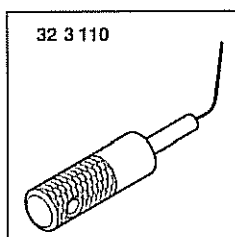
- ▲ Inner tie rod removal tool  
(Tool No. BMW 32 2 110)



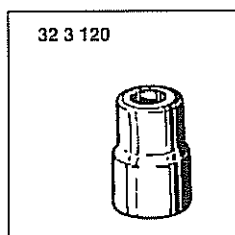
- Pitman arm height measurement gauge  
(Tool No. BMW 32 2 140)



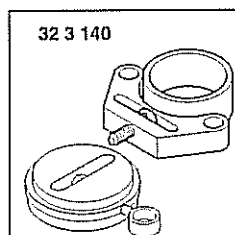
- Ball joint removal tool  
(Tool No. BMW 31 2 240)



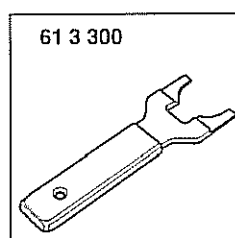
- Ignition lock releasing tool  
(Tool No. BMW 32 3 110)



- Steering column shear bolt Torx socket (E8)  
(Tool No. BMW 32 3 120)



- Camber setting tool set  
(Tool No. BMW 32 3 140)



- Ring antenna removal tool  
(Tool No. BMW 61 3 300)

## Steering system

Two types of steering gear are used in the E39 series models.

- 6-cylinder (525i, 528i and 530i) models are equipped with rack and pinion steering. The steering rack is mounted to an aluminum subframe.
- V-8 (540i) models are equipped with a recirculating ball and nut steering gearbox mounted to a steel subframe.

At low speeds, maximum power assist is provided to ease parking and city driving. At high speeds, assist is reduced to ensure stability. The power steering system varies assist based on engine speed.

Power boost for the steering is provided by an engine-driven hydraulic pump. A hydraulic control valve is used to control boost pressure.

The steering wheel connects to the steering gear via an adjustable steering column which incorporates a rubber coupling ("guibo") to dampen vibration and noise.

Power steering fluid is supplied from the fluid reservoir to the pump and to the steering gear via rubber/metal hoses.

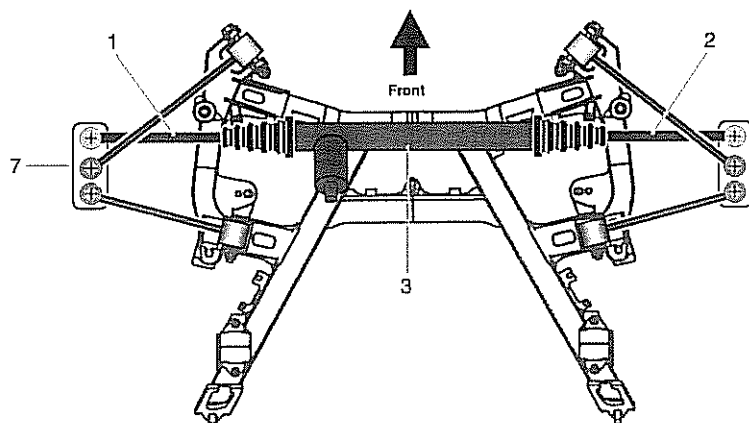
The return line from the steering gear to the reservoir loops into the airstream in front of the radiator and connects to the steering fluid cooler. The fluid cooler is attached to a cassette which also includes cooling coils for engine oil, transmission fluid and A/C condenser.

The steering gear requires no maintenance other than alignment and periodic inspection for worn components. Inspect rubber rack boots (rack and pinion system) and tie-rod end boots periodically for tears or damage. Replace if necessary.

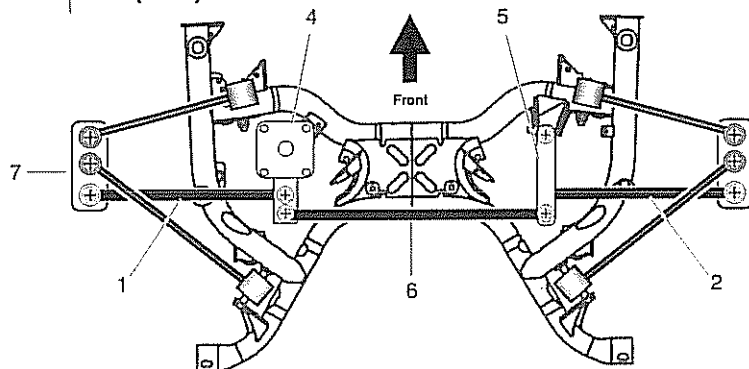
### **NOTE** —

*The airbag system is traditionally referred to as Supplemental Restraint System (SRS). The BMW version of SRS used in the E39 models is known as the Multiple Restraint System (MRS).*

**Rack and pinion steering**  
6-cylinder models (525i, 528i, 530i)



**Recirculating ball and nut steering**  
V-8 models (540i)



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### Steering system variations

1. Left tie rod
2. Right tie rod
3. Steering rack
4. Steering gearbox
5. Idler arm
6. Center tie rod
7. Steering knuckle

## Steering system warnings and cautions

### **WARNING—**

- *The BMW airbag system is complex. Special precautions must be observed when servicing the system. Serious injury may result if system service is attempted by persons unfamiliar with the BMW airbag system and its approved service procedures. BMW specifies that all inspection and service should be performed by an authorized BMW dealer.*
- *The BMW E39 is equipped with an airbag mounted in the steering wheel. The airbag is an explosive device and should be treated with extreme caution. Always follow the airbag removal procedure as outlined in 721 Airbag System (SRS).*
- *BMW airbags are equipped with a back-up power supply inside the airbag control module. A 5 second waiting period should be observed after the battery cable has been disconnected. This will allow the reserve power supply to discharge.*
- *Do not reuse self-locking nuts. They are designed to be used only once and may fail if reused. Always replace them with new locking nuts.*
- *Do not install bolts and nuts coated with undercoating wax, as correct tightening torque cannot be assured. Always clean the threads with solvent before installation, or install new parts.*
- *Do not attempt to weld or straighten any steering components. Always replace damaged parts.*

### **CAUTION—**

- *Some E39 models are equipped with aluminum suspension components. The following cautions apply:*
- *Due to the chemical and corrosion characteristics of aluminum, do not bring into contact with battery acid.*
- *Do not clean with wire brushes with brass or iron bristles. Only use brushes with stainless steel bristles.*
- *Do not expose to flying sparks from grinding/cutting operations.*
- *Do not subject to steel welding splashes.*
- *Do not expose to temperatures over 80°C (176°F), even for short periods. Temperatures in painting facilities are not a problem.*

## STEERING WHEEL

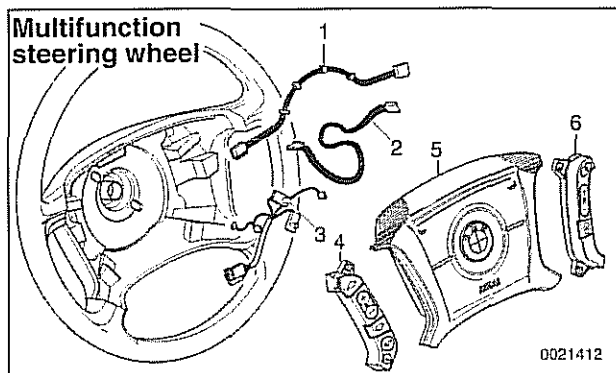
### Steering wheel, removal and installation

#### WARNING—

The BMW airbag system (Supplemental Restraint System or SRS) is complex. Special precautions must be observed when servicing. Serious injury may result if SRS system service is attempted by persons unfamiliar with the BMW SRS and its approved service procedures. BMW specifies that all inspection and service should be performed by an authorized BMW dealer.

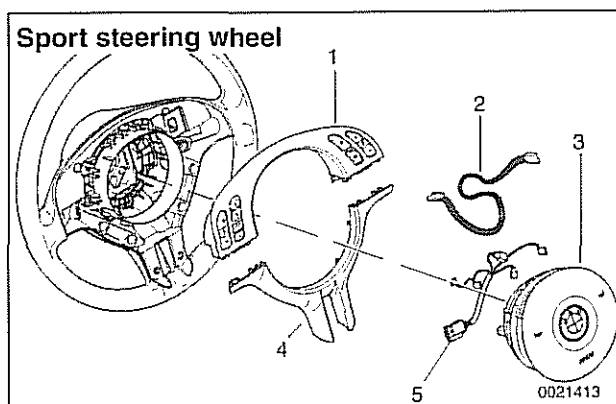
E39 cars may come with either one of two different styles of steering wheel:

- Multifunction (MFL) steering wheel
- Sport steering wheel



#### ◀ Multifunction (MFL) steering wheel components:

1. Cruise control / radio / telephone electrical harness
2. Horn button electrical harness
3. Airbag electrical harness
4. Radio / telephone control switch set
5. Air bag
6. Cruise control switch set



#### ◀ Sport steering wheel components:

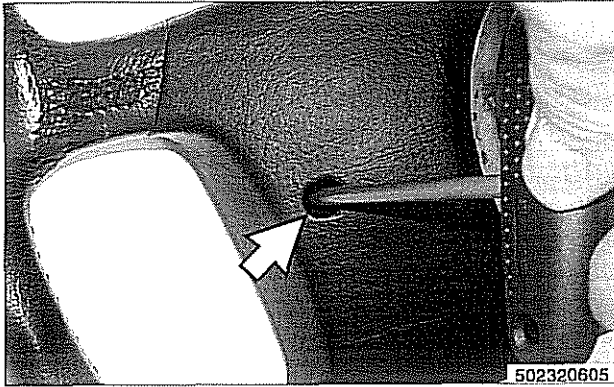
1. Switch carrier
2. Steering wheel switch set electrical harness
3. Airbag
4. Lower cover
5. Horn button and airbag electrical harness

- Center steering wheel. Make sure front wheels are pointed straight ahead.
- Disconnect negative (-) cable from battery.

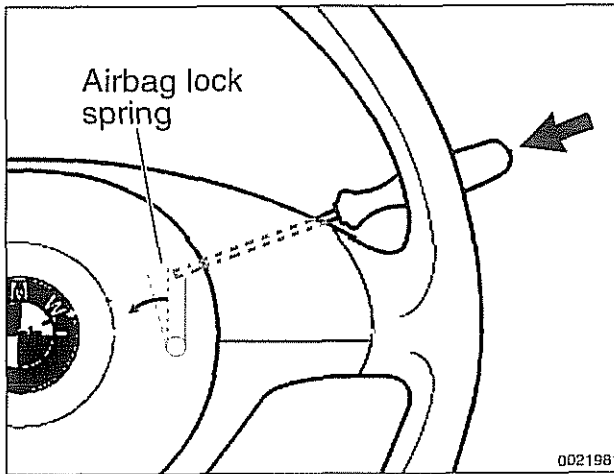
#### CAUTION—

Prior to disconnecting the battery, read the battery disconnection cautions given in 001 General Cautions and Warnings.

## Steering and Wheel Alignment



- MFL steering wheel: Loosen 2 airbag mounting fasteners (Torx T27 or T30) located at rear of steering wheel (arrow).



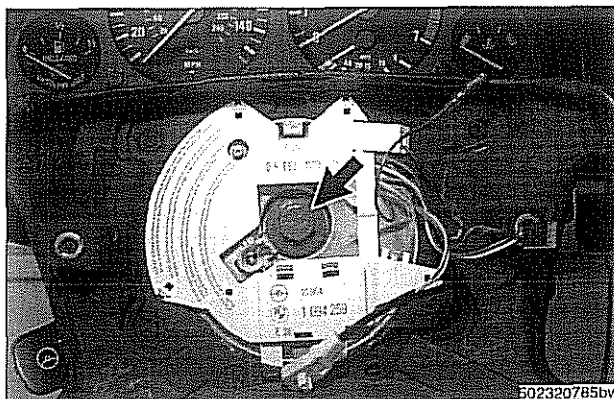
- Sport steering wheel:
  - Insert screwdriver through opening in rear of steering wheel and push against spring tension to release airbag.
  - Repeat procedure on other side of steering wheel.
- Carefully lift airbag from steering wheel and disconnect electrical harnesses from back side of unit. Refer to component illustrations above. Also see **721 Airbag System (SRS)**.

**WARNING—**

*Improper handling of the airbag could cause serious injury. Store the airbag with the horn pad facing up. If stored facing down, accidental deployment could propel it violently into the air, causing injury.*

**CAUTION—**

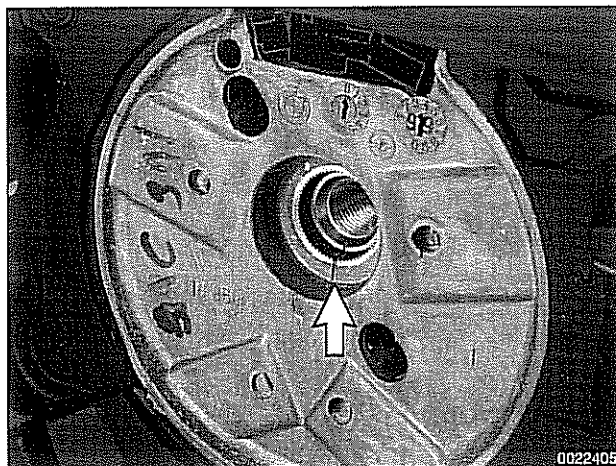
*Avoid damaging the variety of convenience switches, such as radio and cruise controls, installed in the steering wheel of some models.*



- Remove steering wheel center bolt (arrow).



## Steering and Wheel Alignment

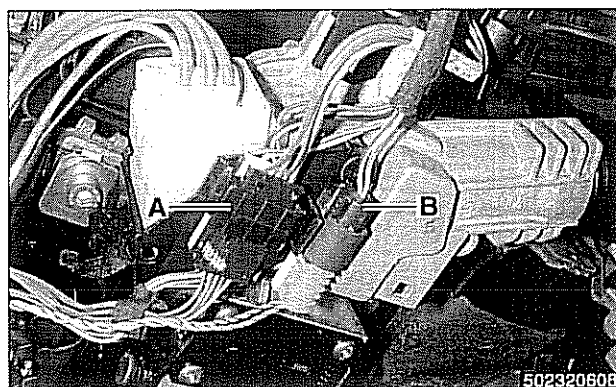


- ◀ Check for proper alignment of steering column marks (arrow) before removing steering wheel.

**NOTE** —

The steering column and steering wheel are match marked at the factory.

- Remove lower steering column trim panel. See **Steering column trim, removing and replacing**.



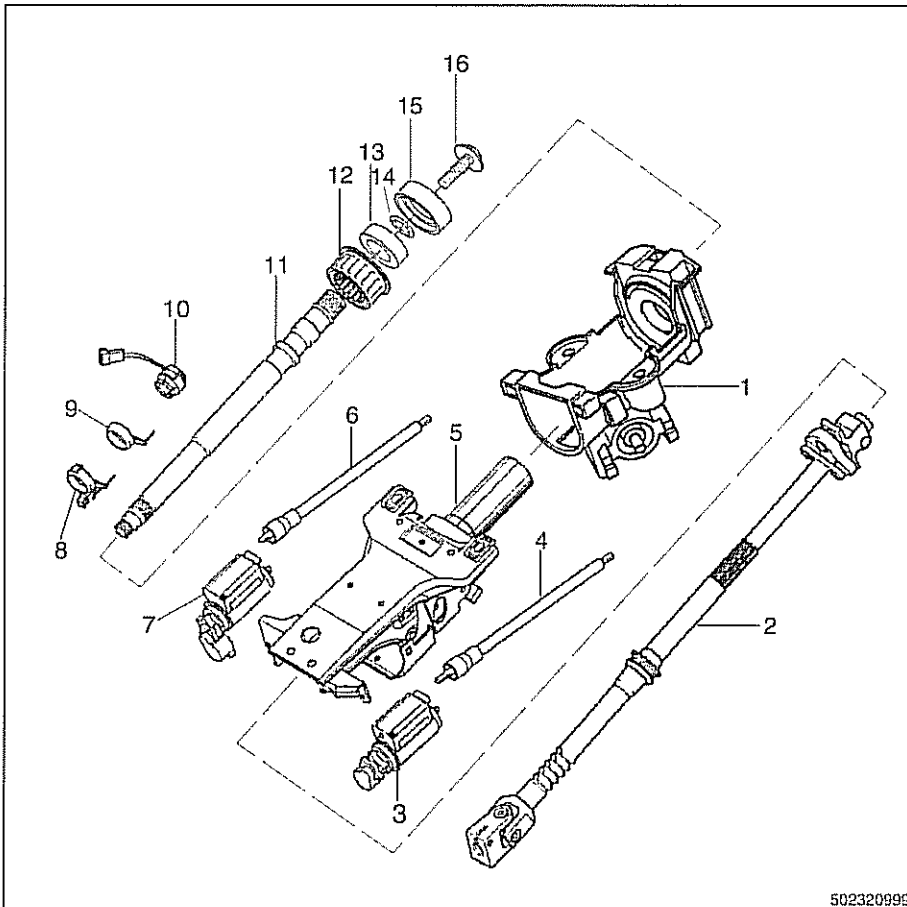
- ◀ Working underneath steering column, disconnect electrical harnesses (A) and (B).

- Remove steering wheel.
- When reinstalling steering wheel:
  - Align steering wheel and column match marks.
  - Align steering wheel to alignment pins located on steering column switch block.
  - Install steering column center bolt. Do not over-torque.
- Carefully install airbag. See **721 Airbag System (SRS)**.

**Tightening torques**

Steering wheel to steering shaft (M14)	63 Nm (47 ft-lb)
Airbag to steering wheel (MFL only)	8 Nm (6 ft-lb)

## STEERING COLUMN

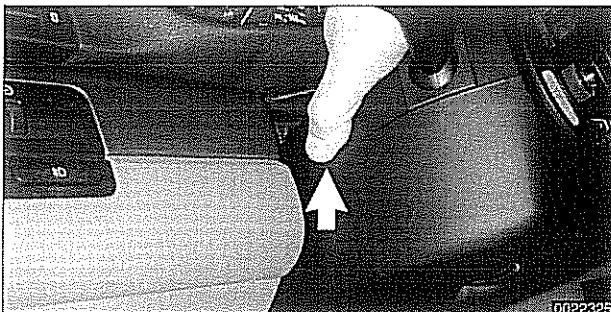


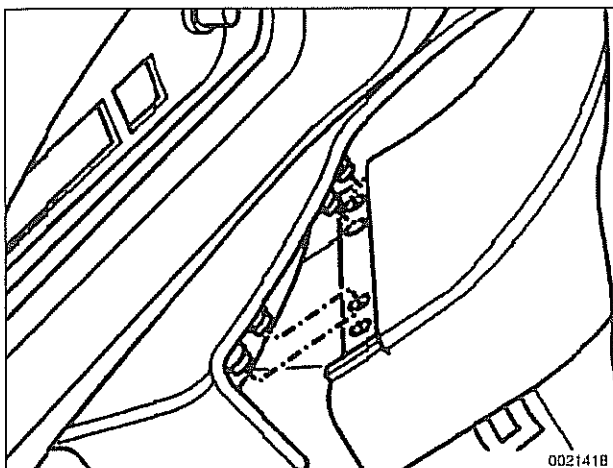
### Steering column components

1. Steering lock
2. Lower steering shaft
3. Horizontal drive motor
4. Longitudinal adjusting drive shaft
5. Steering column support
6. Vertical adjusting drive shaft
7. Vertical drive motor
8. Lower support ring for steering angle sensor
9. Upper support ring for steering angle sensor
10. Steering angle sensor
11. Upper steering shaft
12. Steering shaft bearing
13. Bearing inner sleeve
14. Circlip
15. Collar
16. Steering wheel mounting bolt

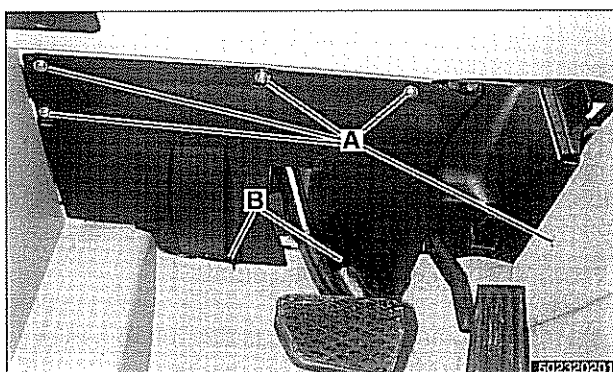
### Steering column trim, removing and replacing

- Tilt steering column down and extend fully.
- Remove plastic retaining screw from upper trim cover.
- Push in sides of upper trim cover (**arrow**) to release from lower trim. Pull back and up on upper trim.





- ◀ Pry gently to detach flexible cover from upper trim. Lift off trim.



- ◀ Remove lower dash trim panel fasteners (A) and (B).
  - Lower trim panel and disconnect wiring harnesses on back side of panel.
  - Remove trim panel.
- Installation is reverse of removal.

### Ignition switch ring antenna (EWS), removing and installing

- Remove upper and lower steering column trim as described earlier.
- Disconnect electrical harness plug from ring antenna.
- Use flat side of BMW special tool 61 3 300 to pry ring antenna off ignition lock cylinder.
- Installation is reverse of removal.

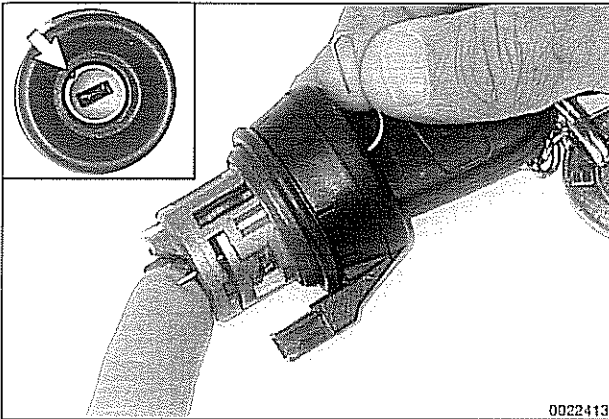
### Ignition lock cylinder, removing and installing

- Disconnect negative (-) cable from battery.

#### **CAUTION—**

*Prior to disconnecting the battery, read the battery disconnection cautions given in 001 General Cautions and Warnings.*

- Remove upper and lower steering column trim as described earlier.



- With ignition key in ON position (60° from LOCKED):
  - Disconnect ring antenna harness connector.
  - Insert BMW special tool 32 3 110 or a thin piece of stiff wire into opening (arrow) in lock cylinder.
  - Turn tool forward (clockwise) approximately 90° and remove lock cylinder.
  - Reinstallation is reverse of removal.

**NOTE—**

*Using the valet key during this procedure will provide better access to lock opening.*

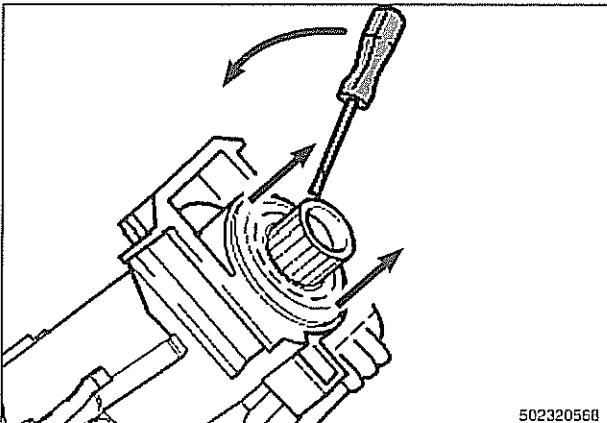
### Steering column lock, removing and installing

- Disconnect negative (-) cable from battery.

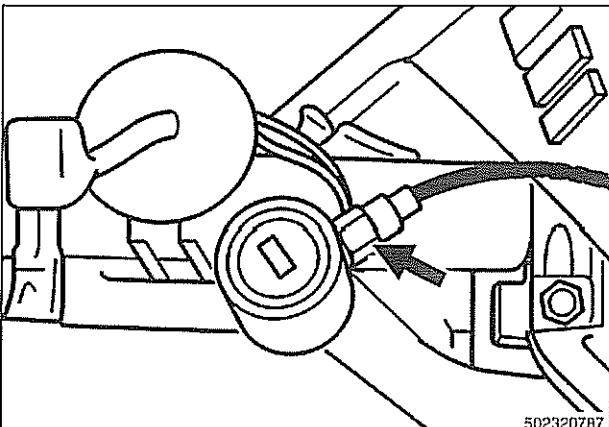
**CAUTION—**

*Prior to disconnecting the battery, read the battery disconnection cautions given in 001 General Cautions and Warnings.*

- Remove steering wheel as described earlier.
- Remove steering column trim panels as described earlier.
- Remove collar and circlip from steering shaft. Refer to illustration of steering column components.
- Pry steering shaft bearing with inner sleeve out of lock housing.
- Remove ring antenna as described earlier.
- Remove column switches. See 612 Switches.

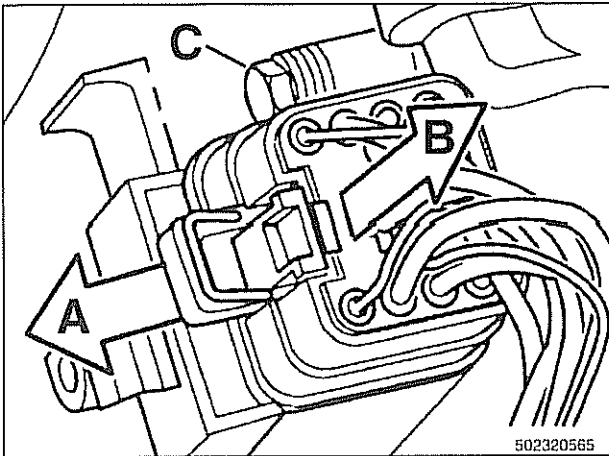


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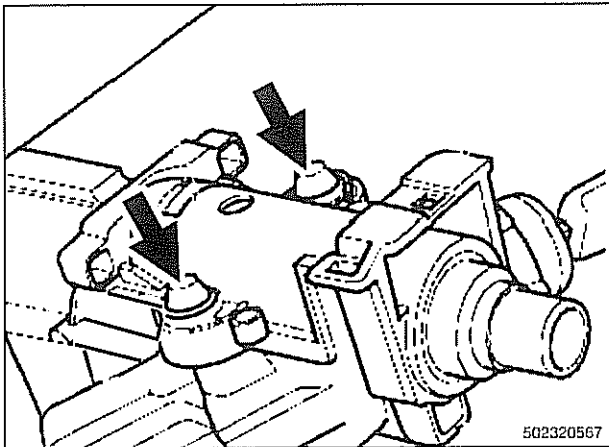


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- Automatic transmission models: Loosen and disconnect interlock shift cable (arrow) from ignition lock assembly.



- ◀ Release lock (A) and pull up on harness connector (B) to disconnect ignition switch harness.
  - Remove wire harness bracket fastener (C).



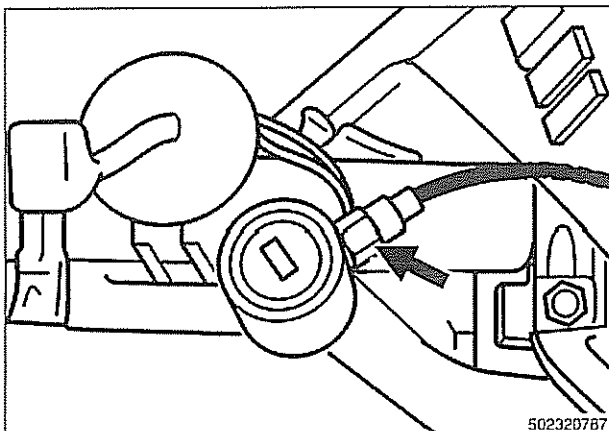
- ◀ Remove shear bolts (arrows) using a chisel or punch.

**NOTE—**

*The shear bolts can be drilled and then removed using an easy-out.*

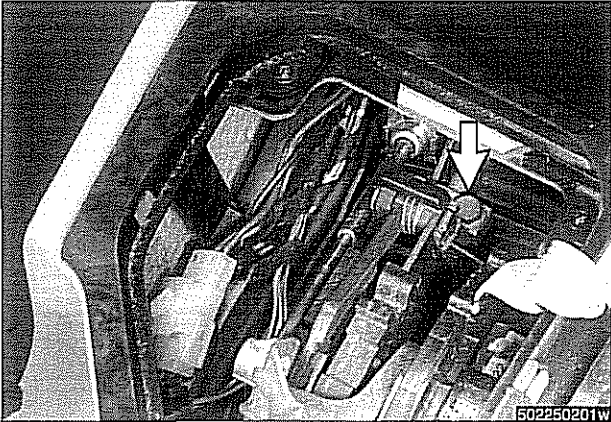
- Remove steering column lock housing.
- Installation is reverse of removal.
  - Tighten new shear bolts until bolt heads shear off.

### Ignition interlock cable, removing and installing (models with automatic transmission)

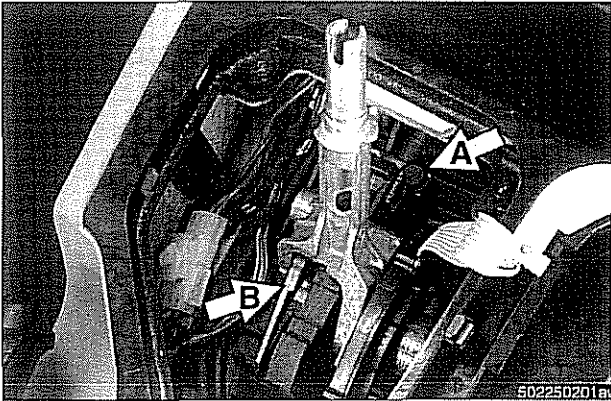


- Remove steering column trim panels as described earlier.
- ◀ Loosen and disconnect interlock cable (arrow) from ignition lock assembly.
- Remove center console trim panel.

## Steering and Wheel Alignment



- ◀ Remove cable mounting fastener (arrow). Disconnect cable from shift linkage.
- Remove old cable and replace with new cable.
- Reinstall trim.



### Interlock cable, adjusting (models with automatic transmission)

- Remove center console trim panel.
- Place gear shift selector lever in PARK.
- ◀ Loosen cable mounting fastener (A).
- Remove ignition key.
- Press down on interlock lever (B) and tighten cable mounting fastener (A).

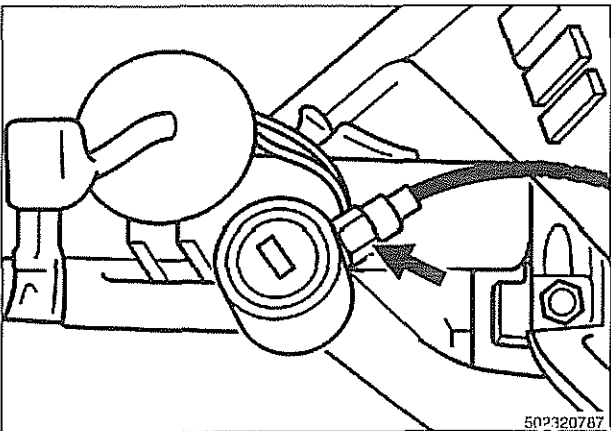
### Steering column, removing and installing

- Disconnect negative cable from battery.

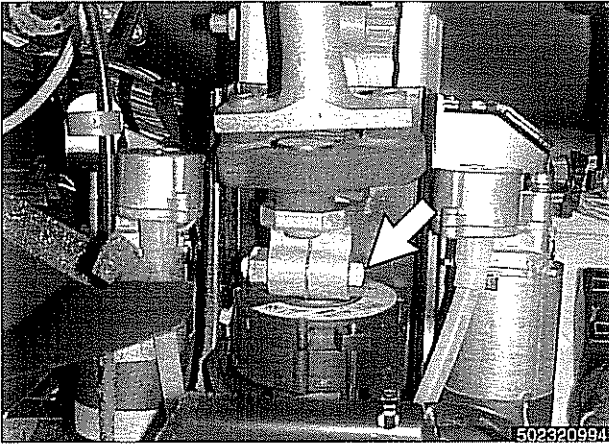
#### **CAUTION—**

*Prior to disconnecting the battery, read the battery disconnection cautions given in 001 General Cautions and Warnings.*

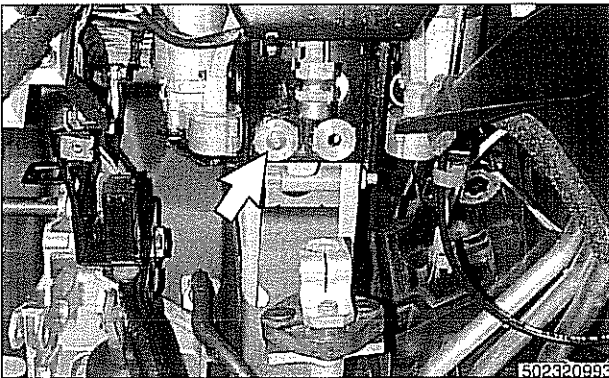
- Remove steering wheel as described earlier.
- Remove steering column trim panels as described earlier.
- Remove steering shaft collar.
- ◀ Automatic transmission models: Loosen and disconnect interlock shift cable (arrow) from ignition lock assembly.
- Disconnect steering angle sensor electrical harness.



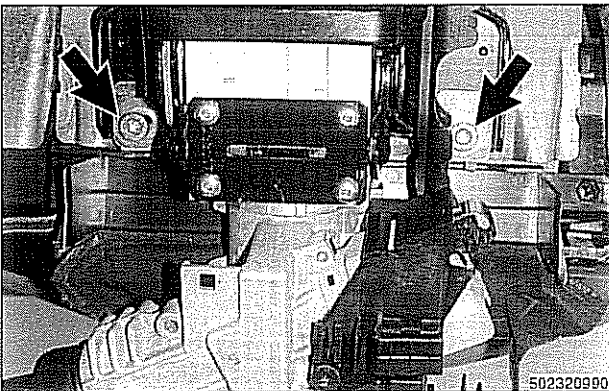
## Steering and Wheel Alignment



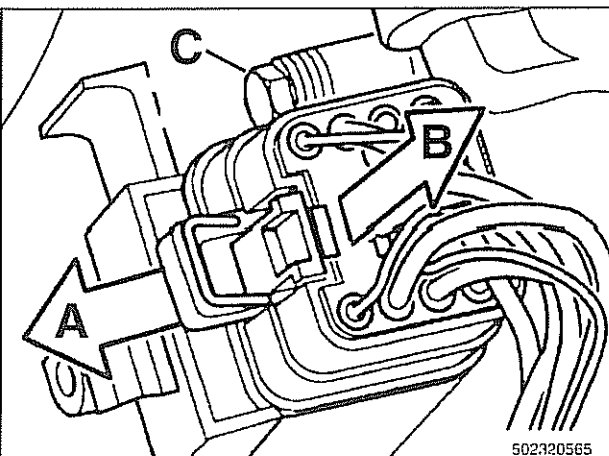
- Remove steering shaft coupler clamping bolt (**arrow**) at base of column.
- Slide lower steering shaft forward to gain access to column mounting shear bolts.



- Drill steering column mounting shear bolts (**arrow**) and use easy-out to remove.



- Remove upper steering column mounting bolts (**arrows**). Remove upper steering column.
- Disconnect electrical harnesses from steering column switches.



- Release lock (**A**) and pull up on harness connector (**B**) to disconnect harness.
  - Remove wiring harness mounting bolt (**C**).
- Remove steering column assembly.

- Installation is reverse of removal, noting the following:
  - Replace shear bolts at steering column mounting bracket.
  - Tighten until bolt heads shear off.
  - Make sure interlock cable snaps into place.
  - When installing column top trim panel, replace expansion nut for trim retaining screw.

**NOTE—**

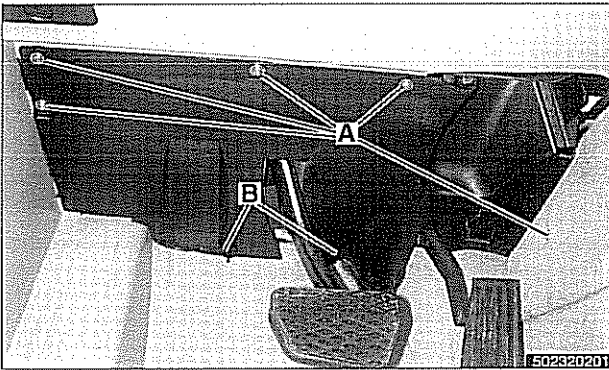
*The steering angle sensor must be coded using a BMW scan tool if it has been replaced. A steering angle offset check must then be carried out using the same BMW scan tool.*

**CAUTION—**

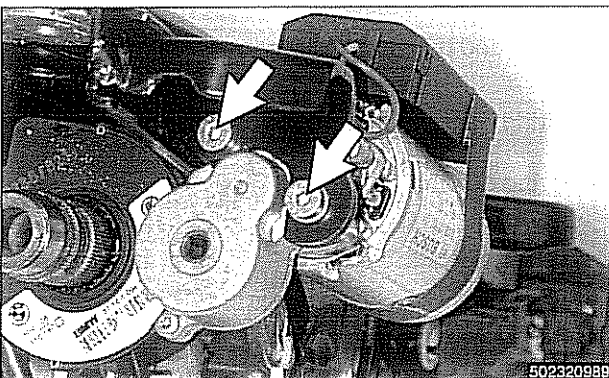
*Check steering system for freedom of movement through entire steering column adjustment range.*

**Tightening torques**

Steering shaft coupler to steering shaft (replace bolt)	25 Nm (18 ft-lb)
Steering column to body	22 Nm (16 ft-lb)

**Steering column adjustment motors, removing and installing**

- ◀ Remove lower dash panel mounting fasteners (A) and (B).
- Lower panel and disconnect wiring harness from back side.
- Remove steering column lower trim panel. See **Steering column trim, removing and replacing.**
- Disconnect electrical harness from motor.



- ◀ Remove motor mounting fasteners (arrows).
- Slide motor to side and forward to remove.
- Installation is reverse of removal.



## POWER STEERING PUMP

Power assist is provided by a belt-driven pump at the lower left front of the engine. The power steering fluid reservoir is located at the left side of the engine compartment.

### Power steering pump, removing and installing

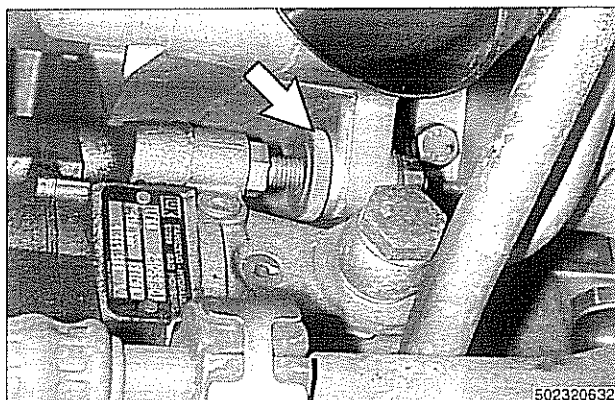
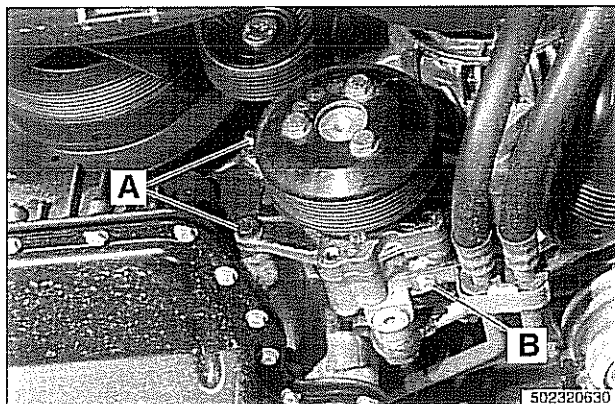
#### **CAUTION—**

*When working with power steering components, absolute cleanliness is needed to ensure proper operation of the hydraulic system.*

- Empty power steering fluid reservoir using clean syringe. Do not reuse fluid.
- Raise front of car. Remove splash shield from under engine.

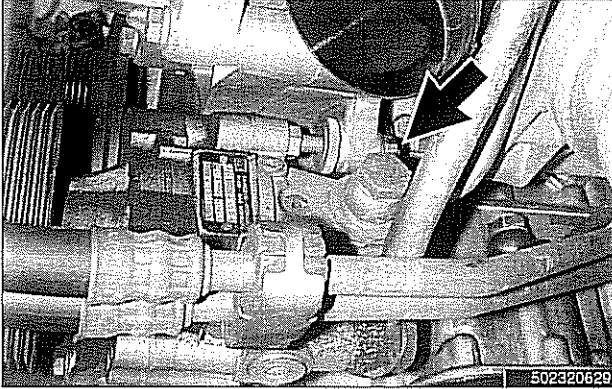
#### **WARNING—**

*Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands beneath structural chassis points. Do not place jack stands under suspension parts.*



- Remove drive belt from power steering pump. See **020 Maintenance**.
- Remove alternator cooling duct.
- Remove fluid hoses from pump. Plug openings in pump and hose ends.
- Remove pump front mounting bolts (A).
  - Remove fluid line support bracket (B).
- Remove pump rear mounting bolt (arrow).
- Installation is reverse of removal, noting the following:
  - Make sure all thread bores, bolts, nuts, fluid couplings and mating surfaces are clean, and inside surface of multi-ribbed-belt is free of grease and dirt.
  - Use new sealing washers when reattaching power steering pressure lines.
  - Make sure hoses have adequate clearance from chassis.
  - Install front pump fasteners.

## Steering and Wheel Alignment



◀ Hand tighten rear support nut (**arrow**) against mounting bracket.

- Install rear mounting nut and tighten.
- Do not over-torque banjo bolts.
- Fill and bleed power steering system as described later.

### Tightening torques

#### Hydraulic lines to steering pump (banjo bolts)

• M 10	12 Nm (9 ft-lb)
• M 14	35 Nm (26 ft-lb)
• M 16	40 Nm (30 ft-lb)
• M 18	45 Nm (33 ft-lb)

Pump brackets to engine block 25 Nm (18 ft-lb)

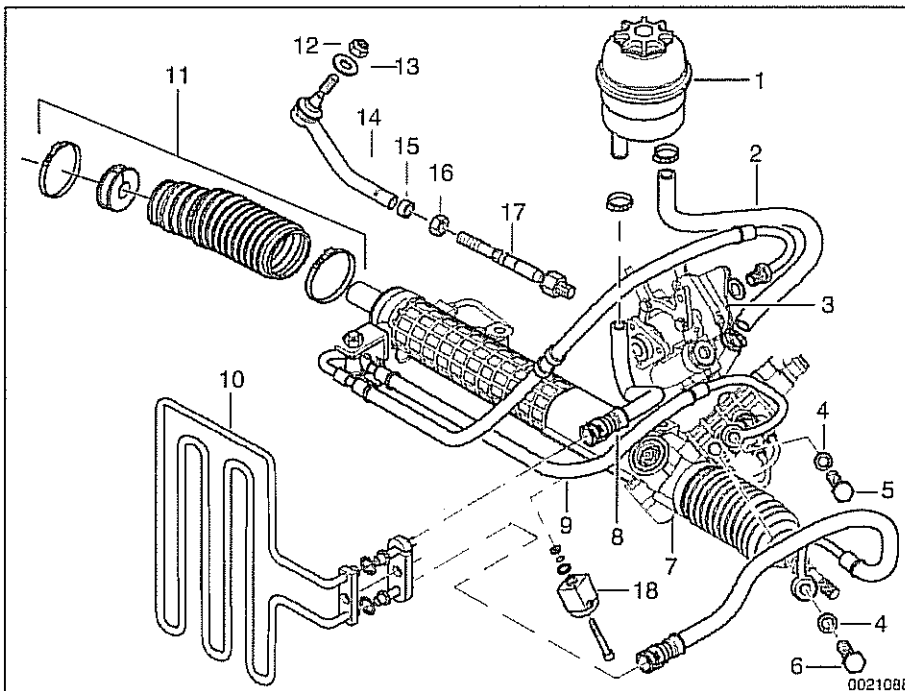
Rear pump support stud to pump housing 22 Nm (16 ft-lb)

### Power steering system, bleeding and filling

- With engine off, fill power steering fluid reservoir with clean fluid. Fill level to MAX mark on dip stick.
- Start engine. Turn steering wheel twice to left lock and right lock.
- Recheck fluid level with engine off. Fill to MAX.

## RACK AND PINION STEERING (6-CYLINDER MODELS)

Refer to the steering components illustration when performing the procedures below.



### Rack and pinion steering components (6-cylinder models)

1. Power steering fluid reservoir
2. Fluid supply line
3. Power steering pump
4. Copper sealing ring
5. Banjo bolt M14
6. Banjo bolt M16
7. Power steering rack
8. Fluid return line
9. Pressurized fluid line
10. Steering fluid cooler
11. Rack boot components
12. Tie rod nut
13. Washer
14. Outer tie rod end
15. Tie rod locking ring
16. Outer tie rod end lock nut
17. Inner tie rod
18. Hydraulic control valve

### Steering rack, removing and installing

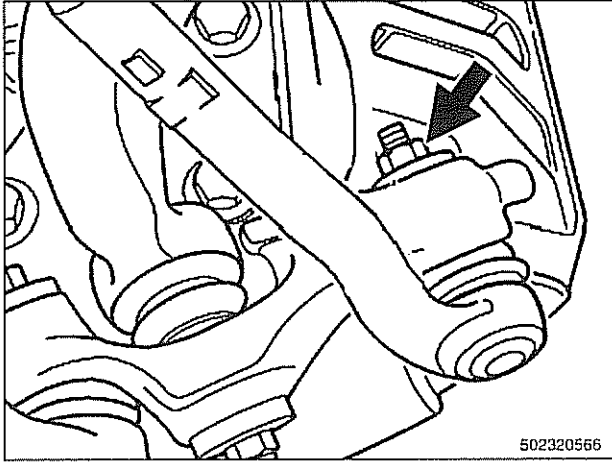
- Remove steering wheel as described earlier.
- Raise front of car, and remove front wheels.

#### **WARNING** —

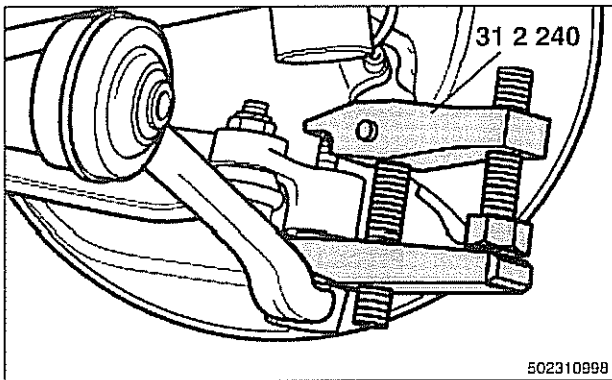
*Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands beneath structural chassis points. Do not place jack stands under suspension parts.*

- Remove splash shield from under engine.
- Remove right and left engine mount fasteners.

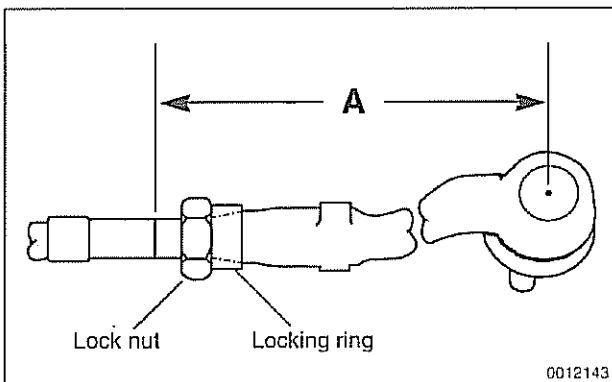
## Steering and Wheel Alignment



- Raise engine approximately 40 mm (1.6 in). See 110 Engine Removal and Installation.
- Remove right and left engine mounts and remove mount brackets from subframe.
- Empty power steering fluid reservoir using a clean syringe. Do not reuse power steering fluid.
- Remove right tie rod fastener (**arrow**) from right steering knuckle. Repeat for left.



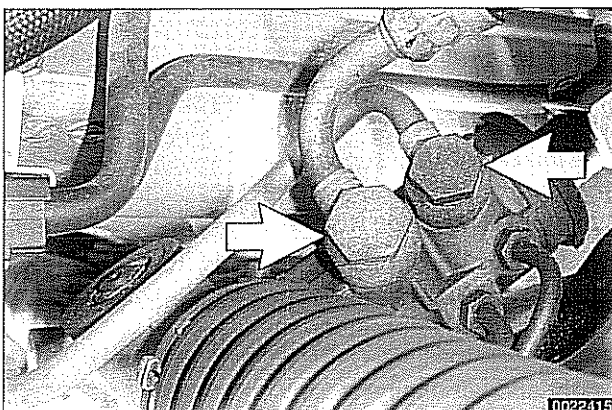
- Press right tie rod out of right steering knuckle using BMW special tool 31 2 240. Repeat for left.



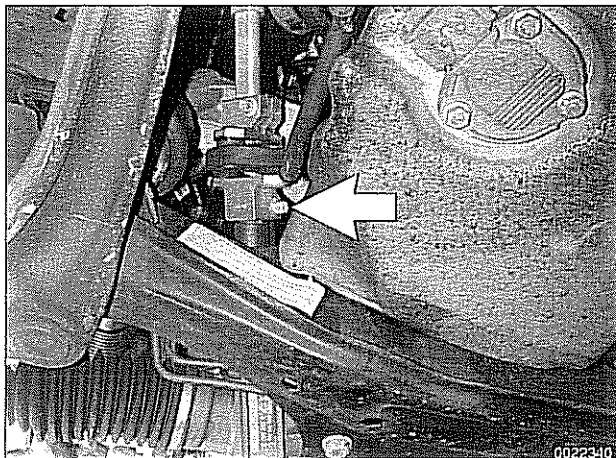
- Make reference measurement (A) of right tie rod end to tie rod. Record measurement. Repeat for left.

**NOTE**—

- Accurate measurement of tie rod end with reference to tie rod will help approximate correct wheel alignment during reassembly.
- Note correct placement of inner taper on locking ring.



- Remove fluid line banjo bolts (**arrows**) from steering rack.



- ▲ Remove lower steering column flexible joint pinch bolt (arrow). Pull flexible joint off steering rack shaft.
- Remove steering rack mounting bolts. Remove steering rack from subframe by pulling it to left.
- Installation is reverse of removal, noting the following:
  - Make sure all thread bores, bolts, nuts, splines and mating surfaces are clean.
  - Use new steering rack mounting bolts. Tighten in two stages. Note tightening instructions in torque table below.
  - Use anti-seize paste on inner tie rod threads.
  - Use new self-locking nuts wherever applicable.
  - Use keyed components to reassemble steering column flexible joint to steering rack shaft.
  - Use new bolt at steering shaft coupling.
  - Use new sealing O-rings on banjo fittings.
  - Do not over-torque banjo bolts.
  - Fill and bleed power steering system as described earlier.
  - Use tie rod measurement previously made (measurement A) to temporarily set toe.
  - Have car professionally aligned.

#### Tightening torques

##### Hydraulic lines to steering rack (use new O-ring seals)

- M14 banjo bolt 35 Nm (26 ft-lb)
- M16 banjo bolt 40 Nm (30 ft-lb)

##### Steering shaft coupling to rack (use new bolt) 19 Nm (14 ft-lb)

##### Steering rack to subframe (use new bolts)

- Initial torque 50 Nm (37 ft-lb)
- Torque angle 90°

##### Tie rod

- to Steering knuckle (replace self-locking nut) 65 Nm (48 ft-lb)
- to Steering rack 71 Nm (52 ft-lb)
- Outer tie rod end lock nut 51 Nm (38 ft-lb)

### Steering rack boot, replacing

- Remove outer tie rod end. See **Tie rod (outer), replacing**.
- Cut rack boot band clamps and remove boot.
- Cut rack boot band clamp and slide bellows back. Inspect boot for any sign of damage. Replace if necessary.

#### NOTE —

*New rack boot kit comes with new band clamp.*

- Grease tie rod taper so that small end of rack boot slides on tie rod when tie rod is tightened, preventing rack boot from twisting.
- Slide new boot into position and replace band clamps.

### Tie rod (outer), replacing

- Raise front of car. Remove road wheel.

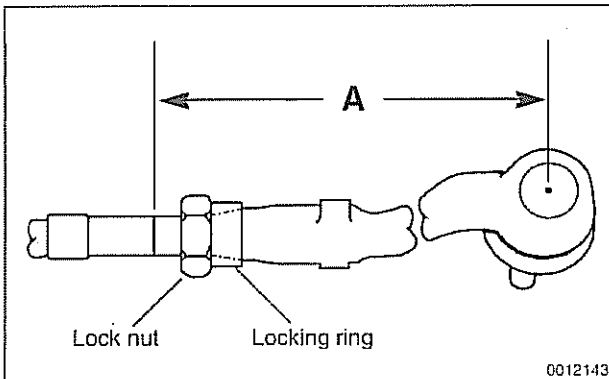
#### WARNING —

*Make sure car is firmly supported on jack stands designed for the purpose. Place jack stands beneath structural chassis points. Do not place jack stands under suspension parts.*

- Make reference measurement (A) of outer tie rod end to tie rod. Record measurement.

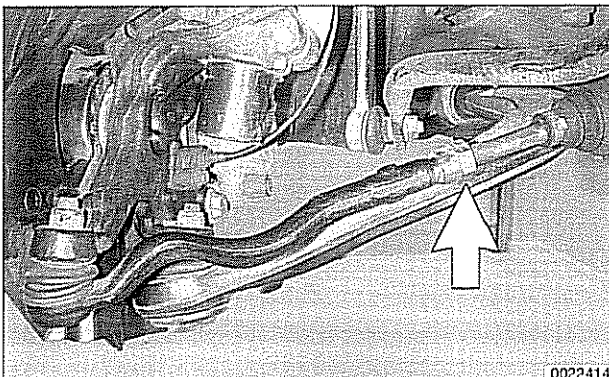
#### NOTE —

- *Accurate measurement of the tie rod end with reference to the tie rod will help approximate correct wheel alignment when new parts are installed.*
- *Note correct placement of inner taper on locking ring.*



- Loosen outer tie rod end lock nut (arrow).

- Remove tie rod lock nut from steering knuckle.
- Press tie rod out of steering knuckle using BMW special tool 31 2 240 or equivalent.
- Unscrew tie rod end from tie rod shaft.



- Installation is reverse of removal.
  - Make sure all threaded parts are clean.
  - Use anti-seize paste on inner tie rod threads.
  - Use new self-locking nuts, where applicable.
  - Use tie rod measurement (A) to set toe temporarily.
  - Have car professionally aligned.

#### Tightening torque

##### Tie rod

- to steering knuckle (replace self-locking nut) 65 Nm ( 48 ft-lb)
- Outer tie rod end lock nut 51 Nm (38 ft-lb)

### Tie rod (inner), replacing

- To replace inner tie rod, first remove outer tie rod end. See **Tie rod (outer), replacing**.
- Cut rack boot clamps and slide bellows back.
- ◀ Loosen and remove inner tie rod shaft from steering rack with special tool 32 2 110.

#### NOTE—

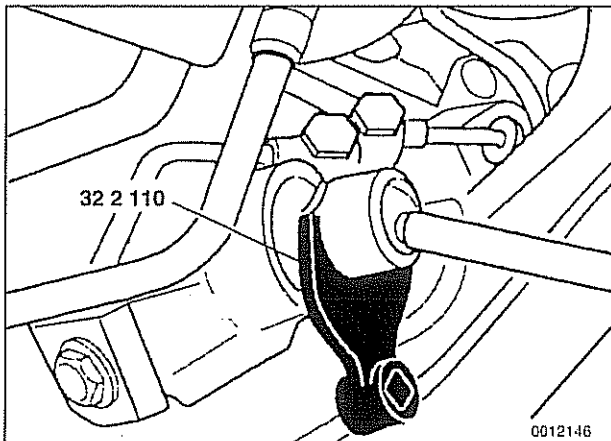
To avoid damage to steering rack while removing tie rod, turn steering until end of rack is as far as possible inside rack housing.

- When reassembling, grease tie rod taper so that rack boot support buffer or small end of rack boot slides on tie rod when tie rod is tightened, preventing rack boot from twisting.
- Inspect boot for any signs of damage. Replace boot if necessary, using new clamps.

#### NOTE—

New rack boot comes with new band clamps.

- Installation is reverse of removal, noting the following:
  - Make sure all threaded parts are clean.
  - Replace self-locking nuts.
  - Install outer tie rod end to new tie rod. Use tie rod measurement (A) to set toe temporarily.
  - Have car professionally aligned.



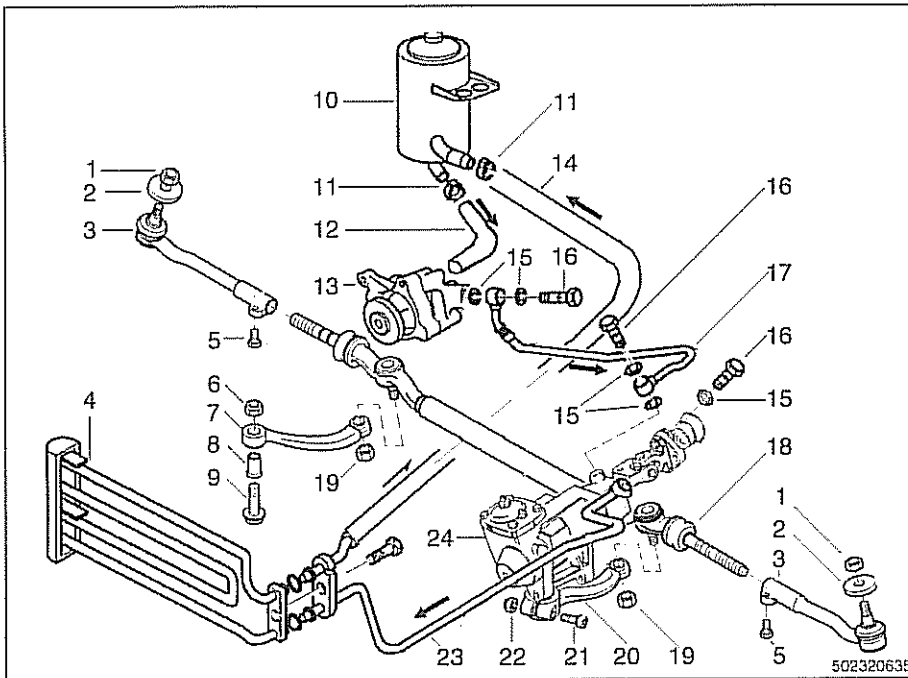
**Tightening torques**

## Tie rod

- to Steering knuckle (replace self-locking nut) 65 Nm (48 ft-lb)
- to Steering rack 71 Nm (52 ft-lb)
- Outer tie rod end lock nut 51 Nm (38 ft-lb)

**STEERING GEARBOX (V-8 MODELS)**

Refer to the steering components illustration when performing the procedures below.

**Steering gearbox system components (V-8 models up to 9/1999)**

1. Tie rod end nut
2. Washer
3. Tie rod end
4. Steering fluid cooler
5. Tie rod end clamp bolt
6. Nut
7. Idler arm
8. Idler arm bushing
9. Idler arm bolt
10. Steering fluid reservoir
11. Hose clamp
12. Fluid supply line
13. Power steering pump
14. Fluid return line
15. O-ring seal
16. Banjo bolt
17. High pressure line
18. Center tie rod
19. Nut
20. Pitman arm
21. Pitman arm pinch bolt
22. Nut
23. Fluid cooler supply line
24. Steering gearbox



## Steering gearbox, removing and installing

- Disconnect negative (-) battery cable. See **020 Maintenance**.

**CAUTION—**

*Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.*

- Remove airbag unit from steering wheel. See **721 Airbag System (SRS)**.

**WARNING—**

*Improper handling of the airbag could cause serious injury. Store the airbag with the horn pad facing up. If stored facing down, accidental deployment could propel it violently into the air, causing injury.*

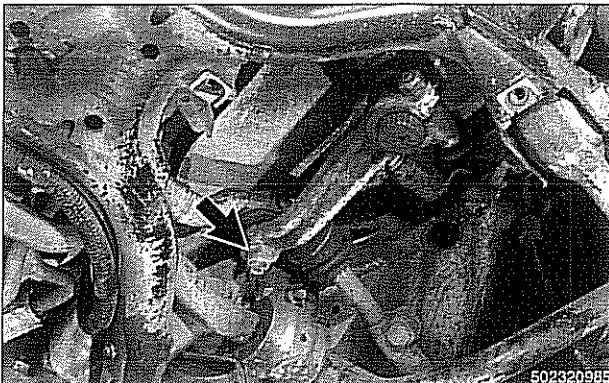
- Remove steering wheel as described earlier.
- Drain power steering system reservoir.
- Raise front of car.

**WARNING—**

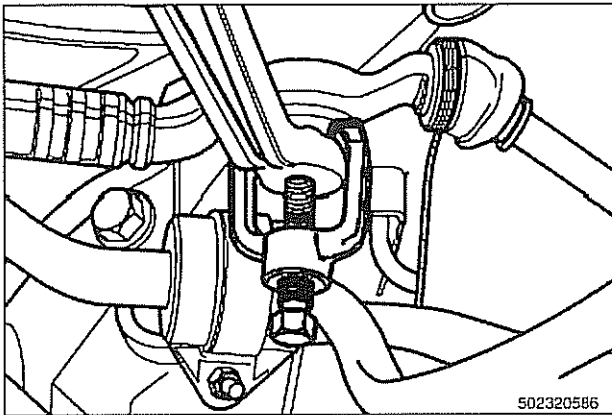
*Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands beneath structural chassis points. Do not place jack stands under suspension parts.*

- Remove heat shield from left side of subframe.
- Remove fluid hoses from top of steering gearbox. Immediately plug all fluid openings.

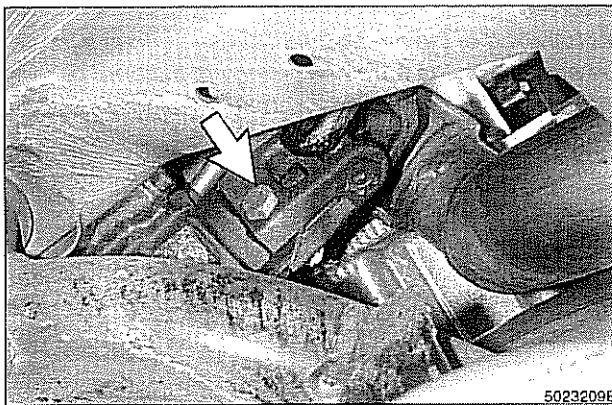
- ◀ Remove and discard pitman arm self-locking nut (arrow).



## Steering and Wheel Alignment



- Press center tie rod off pitman arm.



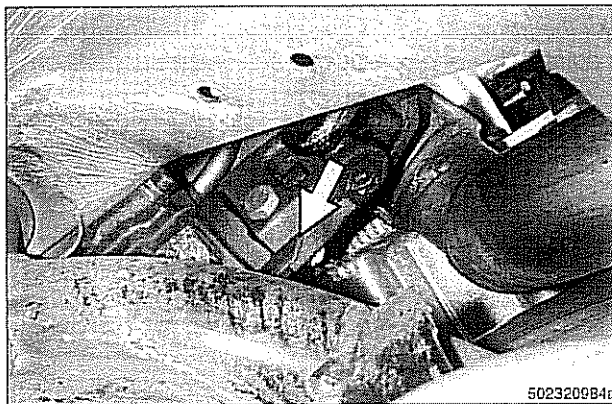
- Remove lower steering column universal joint clamping bolt (**arrow**) and slide universal joint up off steering gearbox shaft.

- Disconnect harness connector for electro-hydraulic regulator at bottom of steering gearbox if necessary.

- Remove steering gearbox mounting bolts.

- Remove steering gearbox by sliding it forward and down.

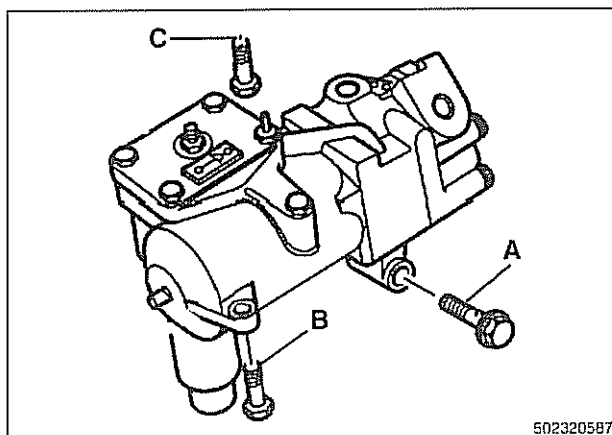
- Make sure all thread bores, bolts, nuts, splines and mating surfaces are clean.



- To install steering gearbox, center steering column to gearbox by aligning universal joint split with tab on steering gearbox (**arrow**). Install new clamping bolt and self-locking nut.

**NOTE** —

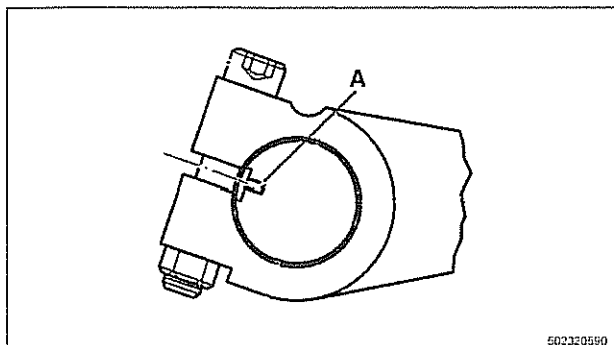
*Make sure the clamping bolt fits into the machined groove in the steering gearbox shaft when mating the universal joint to the shaft.*



- Draw steering gearbox into place using bolt **A**. Hand tighten only. Tighten bolts (**B** and **C**) to torque specification.

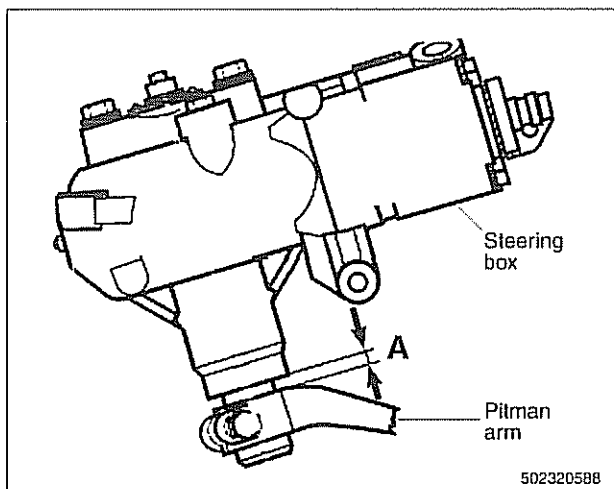
- Install pitman arm on steering gearbox shaft. Do not tighten pinch bolt at this point.

## Steering and Wheel Alignment



➤ Mark **A** on steering gearbox shaft must be located in center of pitman arm slot.

- Adjust pitman arm as described later.



➤ Gap **A** = 0.5 — 8.5 mm (0.02 — 0.33 in)

- Tighten pitman arm pinch bolt to specification.

### Tightening torques

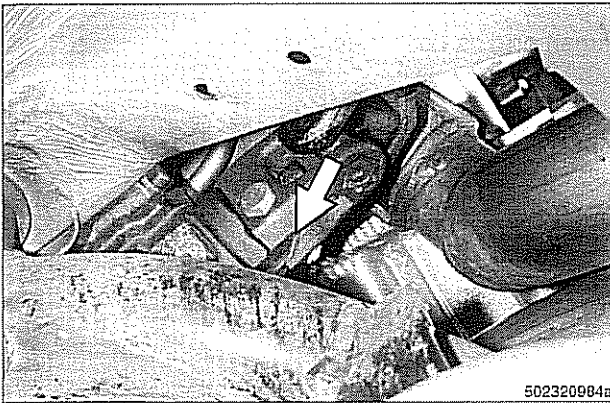
Pitman arm pinch bolt (note direction of threads)	61 Nm (52 ft-lb)
Steering gearbox to subframe	62 Nm (46 ft-lb)
Steering shaft universal joint to steering gearbox (replace bolt)	19 Nm (14 ft-lb)

- Install center tie rod to pitman arm using a new self locking nut.
- Connect harness connector for Servotronic electro-hydraulic regulator if necessary.
- Connect fluid hoses to steering gearbox. Use new sealing washers at couplings and make sure not to overtorque banjo bolts.

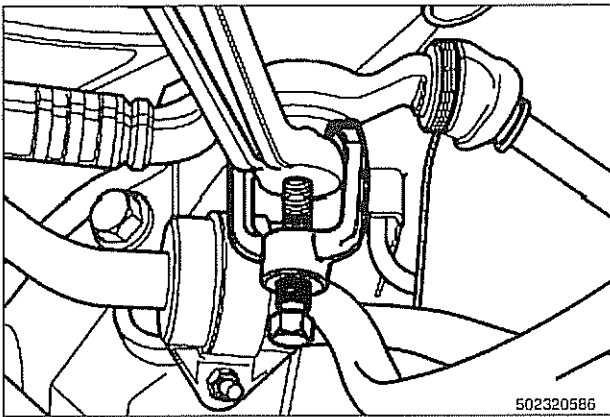
### Tightening torques

Hydraulic lines to steering gearbox (banjo bolts)	
• M 10	12 Nm (9 ft-lb)
• M 14	35 Nm (26 ft-lb)
• M 16	40 Nm (30 ft-lb)
• M 18	45 Nm (33 ft-lb)
Center tie rod to pitman arm (use new self-locking nut)	65 Nm (48 ft-lb)

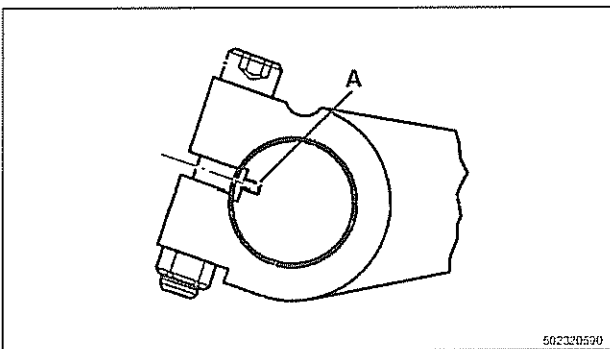
- Reconnect negative (-) battery cable.
- Install airbag unit. See **721 Airbag System (SRS)**.
- Fill and bleed power steering system as described earlier.



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## Pitman arm, removing and installing

- Raise front of car. Remove splash shield from under engine.

### **WARNING** —

*Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands beneath structural chassis points. Do not place jack stands under suspension parts.*

- Set steering wheel in straight ahead position with tab (**arrow**) aligned with mark on steering gearbox.
- Remove center tie rod fastener and press tie rod out of pitman arm with BMW special tool 32 1 190.
- Loosen and remove pitman arm pinch bolt.

- Mark **A** on steering gearbox shaft must be located in center of pitman arm slot.
- Reinstall center tie rod and tighten nut.
- Adjust pitman arm height as described later.
- Have vehicle professionally aligned.

### **Tightening torques**

Center tie rod to pitman arm (use new self-locking nut)	65 Nm (48 ft-lb)
Pitman arm pinch bolt (note direction of threads)	61 Nm (45 ft-lb)

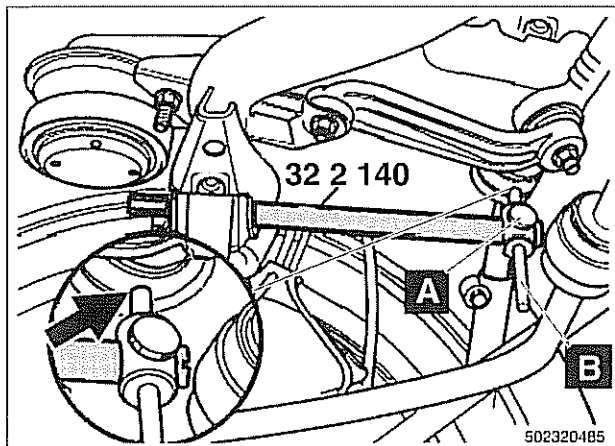
## Pitman arm, adjusting

As the vehicle suspension settles down, the toe on the left and right wheels must remain identical for proper handling. By adjusting the height of the pitman arm, the left and right tie rods are moved to the same ride level setting. This will optimize straight-ahead travel on uneven road surfaces.

- Raise front of car. Remove splash shield from under engine.

### **WARNING**—

*Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands beneath structural chassis points. Do not place jack stands under suspension parts.*



- Remove bolts from left and right inner control arm mounts.
- ▲ Place BMW special tool 32 2 140 through right side control arm mounting bolt hole.

- Loosen fastener **A** and push pin **B** up so that it is firmly against tie rod (arrow). Tighten fastener **A**.

- Remove tool without disturbing position of pin **B**.

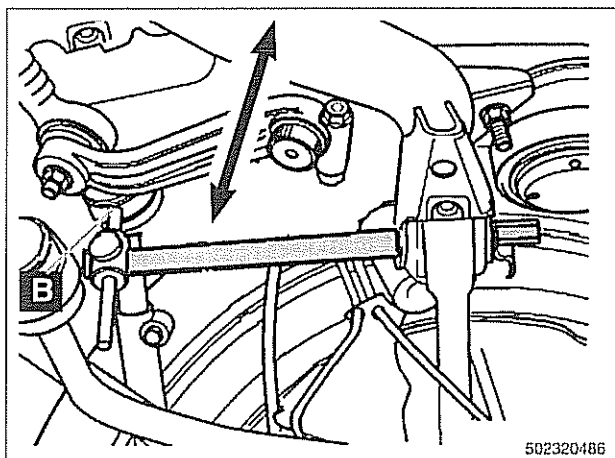
- Loosen pitman arm clamping bolt and slide arm up.

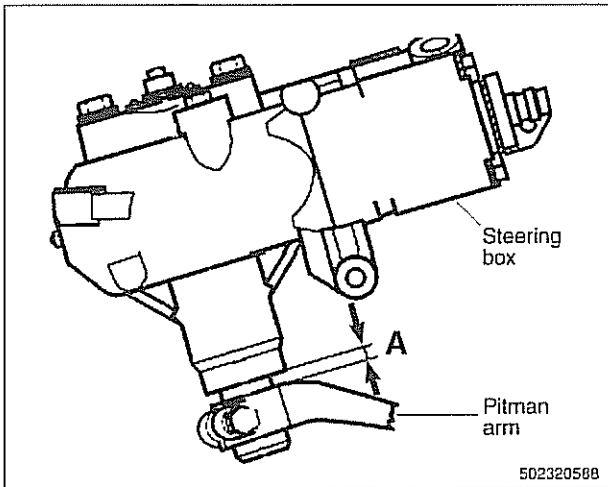
- ▲ Place special tool 32 2 140 through left side control arm mounting bolt hole.

- Slide pitman arm up or down until tie rod makes contact with pin (**B**).
- Tighten pitman arm clamping bolt.

### Tie rod height differences

Deviation between left and right tie rod height  $\pm 1.5$  mm ( $\pm 0.06$  in)





◀ Gap A = 0.5 — 8.5 mm (0.02 — 0.33 in)

- Reinstall inner control arm bolts.

#### Tightening torques

Control arm to subframe (tighten with wheel on ground)	78 Nm (58 ft-lb)
Pitman arm pinch bolt (note direction of threads)	61 Nm (45 ft-lb)

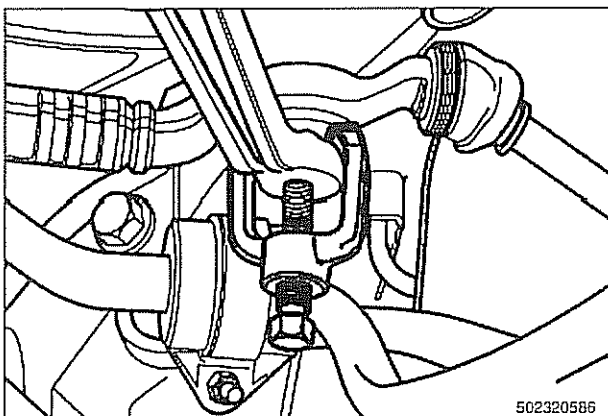
## Steering idler arm, removing and installing

The idler arm is bolted to the subframe through a bushing. The bushing is subject to wear and is available as a replacement part.

- Raise front of car. Remove splash shield from under engine.

#### **WARNING —**

*Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands beneath structural chassis points. Do not place jack stands under suspension parts.*



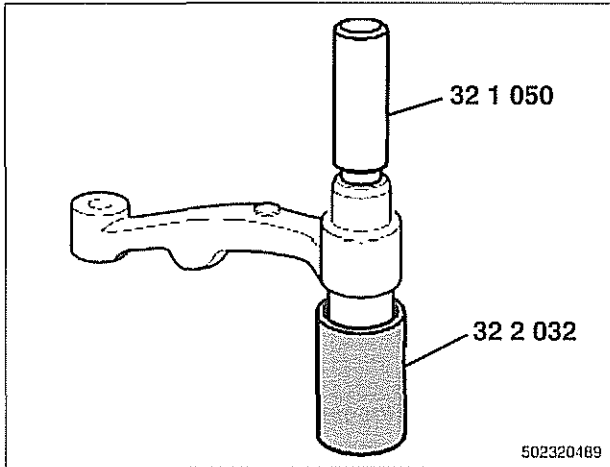
◀ Remove center tie rod fastener and press tie rod out of idler arm with BMW special tool 32 1 190.

- Remove idler arm mounting bolt through opening in subframe and remove idler arm from car.
- Installation is reverse of removal.
  - Make sure all thread bores, bolts, nuts and mating surfaces are clean.
  - Use new self locking nuts to mount idler arm to subframe and center tie rod to idler arm.
  - If idler arm or idler arm bushing is replaced, adjust pitman arm as described earlier.
  - Have car professionally aligned.

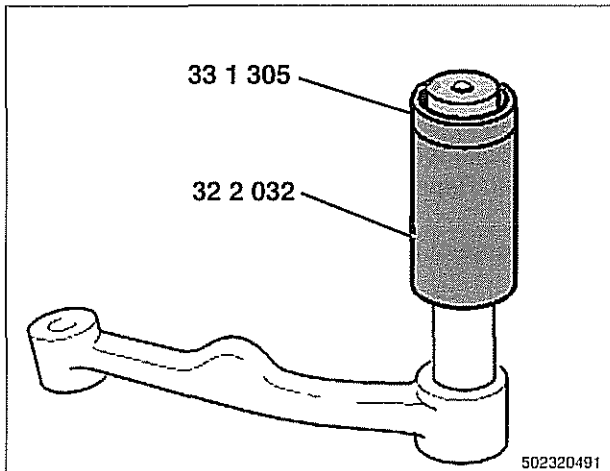
#### Tightening torques

Center tie rod to idler arm (replace self-locking nut)	65 Nm (48 ft-lb)
Idler arm to front subframe (replace self-locking nut)	62 Nm (46 ft-lb)

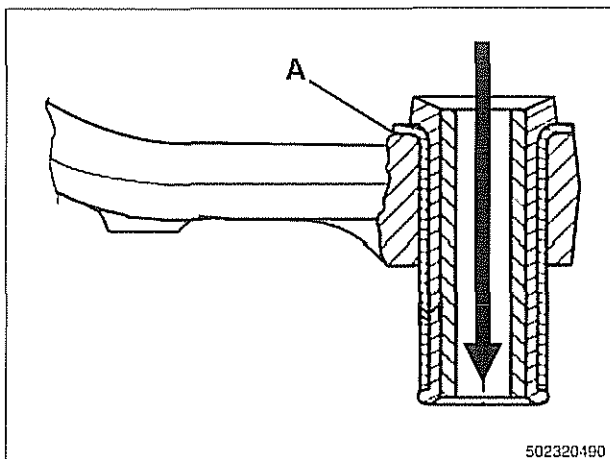
### Idler arm bushing, replacing



- Remove idler arm as described earlier.
- Press out bushing. Use BMW special tools 32 1 050 and 32 2 032 or equivalent press fittings.



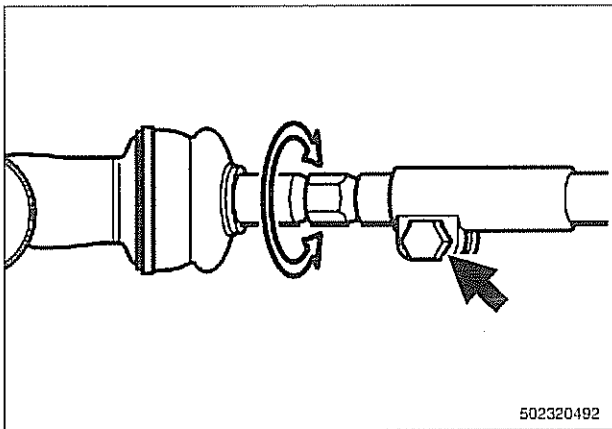
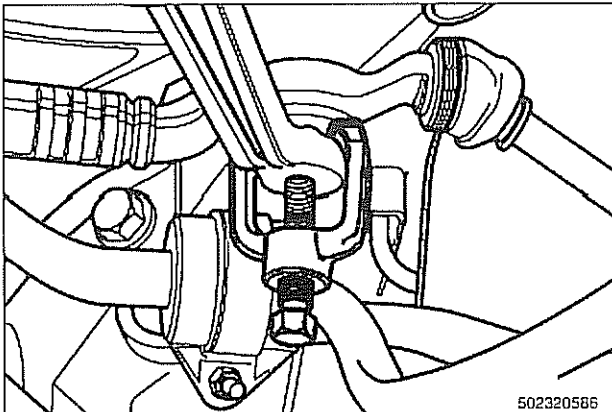
- Press in new bushing with BMW special tools 33 1 305 and 32 2 032 or equivalent press fittings.



- Press new bushing in correct direction (**arrow**).
  - Press bushing in until lip makes firm contact (**A**) with idler arm.
- Installation is the reverse of removal.
  - Use new self locking nuts to mount idler arm to subframe and track arm.
  - Adjust pitman arm height as described earlier.
  - Have vehicle professionally aligned.

#### Tightening torques

Center tie rod to idler arm (replace self-locking nut)	65 Nm (48 ft-lb)
Idler arm to front subframe (replace self-locking nut)	62 Nm (46 ft-lb)



## Center tie rod, replacing

- Raise front of car. Remove splash shield from under engine.

### **WARNING**—

*Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands beneath structural chassis points. Do not place jack stands under suspension parts.*

- Measure length of left and right (outer) tie rods. Write down measurements.

### **NOTE**—

*Accurate measurement of the tie rod end with reference to the center tie rod will help approximate correct wheel alignment when new parts are installed.*

- Remove self-locking nuts connecting center tie rod to pitman and idler arms. Press tie rod off pitman and idler arms using BMW special tool 32 1 190 or equivalent.
- Loosen left tie rod clamping bolt (**arrow**). Unscrew left tie rod from center tie rod. Repeat for right.
- Installation is reverse of removal.
  - Make sure all threaded parts are clean.
  - Coat threads with antiseize compound.
  - Replace self-locking nuts.
  - Check tie rod end ball joints and idler arm bushing for wear.
  - Use tie rod measurements previously made to temporarily set toe.
  - Have car professionally aligned.

### Tightening torques

Center tie rod to pitman and idler arms (replace self-locking nuts)	65 Nm (48 ft-lb)
Left or right outer tie rod clamping bolt	27 Nm (20 ft-lb)



## WHEEL ALIGNMENT

Proper handling, stability and driving ease depend upon the correct alignment of all four wheels. The front axle is aligned in relation to the rear axle, then the front wheels are aligned in relation to one another. This is known as a four-wheel or thrust-axis alignment.

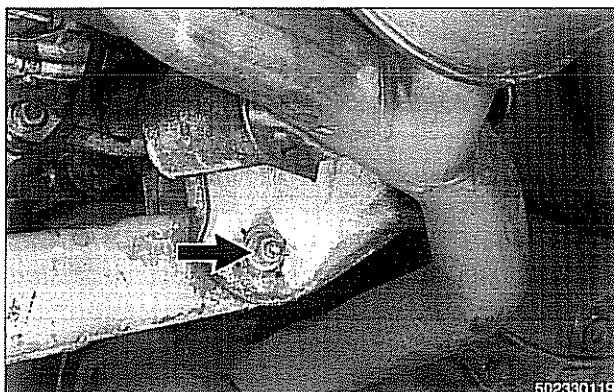
Front and rear alignment specification are given in tables at the end of this repair group.

BMW E39 cars use a sophisticated multi-link suspension at the front and rear of the car. Proper alignment requires computerized alignment equipment.

### Camber

Front wheel camber is set at the factory and cannot be adjusted. Rear wheel camber is fully adjustable.

Always set rear camber before adjusting toe.



- ◀ Before making rear camber adjustment, install a new rear control arm mounting nut (**arrow**) and tighten.
- Loosen mounting nut one-half to one full turn.
  - Using eccentric bolt, adjust camber to factory settings.
  - Tighten nut only after car has been lowered to ground and suspension has settled.
  - Tighten nut while counterholding adjustment bolt.

#### Tightening torque

##### Camber adjusting nut (rear)

• M12 (sedan)	115 Nm (85 ft-lb)
• M14 (Sport Wagon)	174 Nm (128 ft-lb)

### Caster

Front and rear caster are fixed by the design of the car and deviations are usually the result of worn or damaged suspension or body parts.

- Check front suspension arms and bushings for wear, damage and deformation if front caster problems are present.
- Check rear axle subframe and traction struts if rear caster problems are present.

## Front toe and toe difference angle

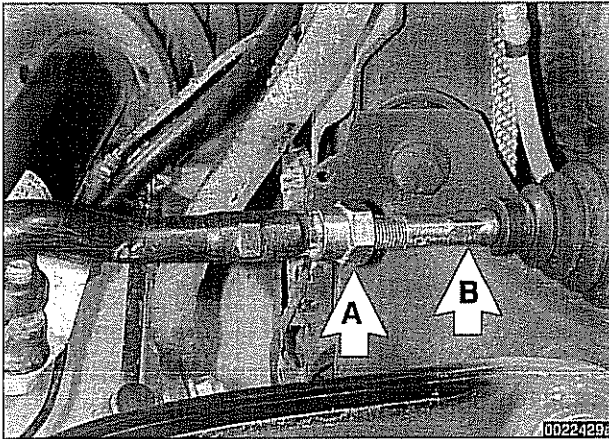
Toe is the difference in the distance between the front of the front wheels and the rear of the front wheels. It is adjusted by altering the length of the tie rods.

Toe difference angle determines the progressively different paths taken by the front wheels as the car is turning. In V-8 models, it is set by the pitman arm adjustment, but depends on accurate setting of the toe.

Toe adjustments should only be made on specialized alignment equipment and only with the car in normal loaded position, described below.

- Set front wheel toe at tie rod ends:

- ◀ 6-cylinder models: Loosen tie rod lock nut (A).
  - Adjust toe by turning inner tie rod (B) to change length.
- V-8 models: Loosen left and right tie rod clamp bolts.
  - Adjust toe by turning inner tie rod to change length.



### NOTE —

- *Steering rack or steering gearbox can be centered by aligning centering mark on steering shaft with lug on steering rack.*
- *To keep steering wheel centered, adjust both tie rods equal amounts.*
- *6-cylinder models: Make sure the rubber boot on the rack moves freely on the tie rod and does not become twisted.*

### Tightening torques

Tie rod clamp bolt	27 Nm (20 ft-lb)
Tie rod collar nut	45 Nm (33 ft-lb)

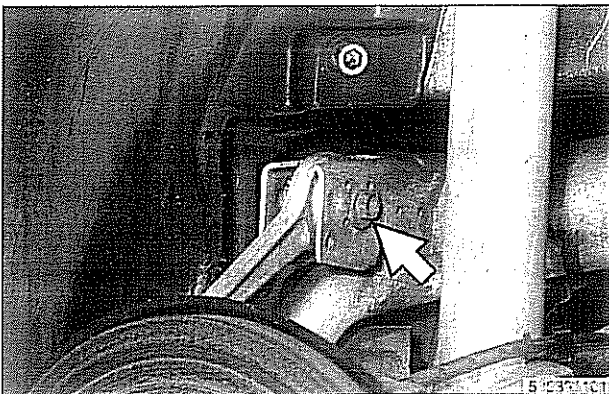
## Rear toe

To adjust rear wheel toe, turn eccentric inner mounting bolt in upper front control arm (traction strut).

### NOTE —

*Always adjust rear camber first.*

- Before making toe adjustment, install new rear control arm mounting nut and tighten.
- Loosen nut one-half to one full turn.
- ◀ Turn eccentric bolt (arrow) to adjust toe.



- Tighten nut while counterholding adjusting bolt.
  - Tighten nut only after car has been lowered to ground and suspension has settled.

### Preparing for alignment

- The following conditions are necessary prior to wheel alignment:
  - Correct wheels and tires are installed, in good condition, and are at the correct inflation pressures.
  - All steering and suspension parts and bushings are undamaged and show no signs of abnormal wear. Wheel bearings are in good condition.
  - Ride height is in accordance with specifications. See **300 Suspension, Steering and Brakes-General**.
  - Car is in normal loaded position. See below.
  - Cars with air suspension: Remove air suspension power fuse.

#### Normal loaded position

Each front seat	68 Kg (150 lb)
Center of rear seat	68 Kg (150 lb)
Trunk	21 Kg (46 lb)
Fuel tank	Full

### Alignment specifications tables

In the alignment specification tables that follow, reference is made to the various types of suspension used in E39 cars. The type of suspension can be identified by looking at the label on the front strut tube.

Identifying symbol	Version	Model
None	Standard suspension	Sedan
Solid circle	Sports suspension	6-cylinder sedan
Solid triangle	Sports suspension	V-8 sedan
M5	M sport package	V-8 sedan
Circle	Standard suspension	Touring (Sport Wagon)
Triangle	Sports suspension	Touring (Sport Wagon)

## Steering and Wheel Alignment

## 6-cylinder sedan (525i, 528i, 530i)

Parameter	Standard suspension	M Sport suspension	Sport suspension
Front axle			
Total toe	0° 5' ± 10'	0° 5' ± 10'	0° 5' ± 10'
Camber (difference between left/right maximum 40')	- 13' ± 30'	- 36' ± 30'	- 36' ± 30'
Track (differential angle with 20° lock on inside wheel)	-1° 56' ± 30'	-1° 56' ± 30'	-1° 56' ± 30'
Caster (difference between left/right maximum 30')	N/A	N/A	N/A
With ± 10° wheel lock	6° 28' ± 30'	6° 41' ± 30'	6° 41' ± 30'
With ± 20° wheel lock	6° 42' ± 30'	6° 55' ± 30'	6° 55' ± 30'
Front wheel displacement	0° ± 15'	0° ± 15'	0° ± 15'
Inside wheel (approx. °)	42	41.5	41.5
Outside wheel (approx. °)	33.5	33	33
Rear axle			
Total toe	0° 22' ± 4'	0° 22' ± 4'	0° 22' ± 4'
Camber (difference between left/right maximum 15')	-2° 04' ± 5'	-2° 04' ± 5'	-2° 04' ± 5'
Geometrical axis deviation	0° ± 12'	0° ± 12'	0° ± 12'

## 6-cylinder Sport Wagon (525i, 528i)

Parameter	Standard suspension	Sport suspension
Front axle		
Total toe	0° 5' ± 10'	0° 5' ± 10'
Camber (difference between left/right maximum 40')	- 13' ± 30'	- 36' ± 30'
Track (differential angle with 20° lock on inside wheel)	-1° 56' ± 30'	-1° 56' ± 30'
Caster (difference between left/right maximum 30')	N/A	N/A
With ± 10° wheel lock	6° 28' ± 30'	6° 41' ± 30'
With ± 20° wheel lock	6° 42' ± 30'	6° 55' ± 30'
Front wheel displacement	0° ± 15'	0° ± 15'
Inside wheel (approx. °)	42	41.5
Outside wheel (approx. °)	33.5	33
Rear axle		
Total toe	0° 16' ± 10'	0° 16' ± 10'
Camber (difference between left/right maximum 15')	-1° 50' ± 20'	-1° 50' ± 20'
Geometrical axis deviation	0° ± 12'	0° ± 12'

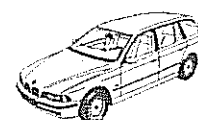
## Steering and Wheel Alignment

## V-8 Sedan (540i)

Parameter	Standard suspension	M Sport suspension	Sport suspension
Front axle			
Total toe	0° 14' ± 10'	0° 10' ± 10'	0° 14' ± 10'
Camber (difference between left/right maximum 40')	- 13' ± 30'	- 30' ± 30'	- 37' ± 30'
Track (differential angle with 20° lock on inside wheel)	-1° 35' ± 30'	-1° 43' ± 30'	-1° 44' ± 30'
Caster (difference between left/right maximum 30')	N/A	N/A	N/A
With ± 10° wheel lock	6° 18' ± 30'	6° 27' ± 30'	6° 34' ± 30'
With ± 20° wheel lock	6° 36' ± 30'	6° 49' ± 30'	6° 50' ± 30'
Front wheel displacement	0° ± 15'	0° ± 10'	0° ± 15'
Inside wheel (approx. °)	42	41.5	42
Outside wheel (approx. °)	32.6	32	31.8
Rear axle			
Total toe	0° 22' ± 4'	0° 10' ± 8'	0° 22' ± 4'
Camber (difference between left/right maximum 15')	-2° 04' ± 5'	-1° 49' ± 5'	-2° 04' ± 5'
Geometrical axis deviation	0° ± 12'	0° ± 12'	0° ± 12'

## V-8 Sport Wagon (540i)

Parameter	Standard suspension	Sport suspension
Front axle		
Total toe	0° 14' ± 10'	0° 14' ± 10'
Camber (difference between left/right maximum 40')	- 13' ± 30'	- 37' ± 30'
Track (differential angle with 20° lock on inside wheel)	-1° 35' ± 30'	-1° 44' ± 30'
Caster (difference between left/right maximum 30')	N/A	N/A
With ± 10° wheel lock	6° 18' ± 30'	6° 34' ± 30'
With ± 20° wheel lock	6° 36' ± 30'	6° 50' ± 30'
Front wheel displacement	0° ± 15'	0° ± 15'
Inside wheel (approx. °)	42	42
Outside wheel (approx. °)	32.65	31.8
Rear axle		
Total toe	0° 16' ± 10'	0° 16' ± 10'
Camber (difference between left/right maximum 15')	-1° 50' ± 20'	-1° 50' ± 20'
Geometrical axis deviation	0° ± 12'	0° ± 12'





# 330 Rear Suspension

<b>General</b> .....	330-2	<b>Rear Wheel Bearings</b> .....	330-32
Special tools .....	330-2	Rear wheel bearing carrier, removing and installing (sedan models) .....	330-32
Rear suspension variations .....	330-4	Rear wheel bearing carrier, removing and installing (Sport Wagon models) .....	330-35
<b>Rear Struts and Springs (sedan models)</b> .....	330-5	Rear wheel bearing, replacing .....	330-39
Rear strut assembly, removing and installing .....	330-5	<b>Rear Stabilizer Bar</b> .....	330-42
Rear strut assembly, disassembling and assembling .....	330-7	Stabilizer bar, removing and installing ....	330-42
<b>Rear Shock Absorbers and Springs (Sport Wagon models)</b> .....	330-9	Stabilizer bar link, removing and installing .....	330-43
Rear shock absorber, removing and installing .....	330-9	<b>Electronic Height Control (EHC) Component Replacement</b> .....	330-44
Coil spring, removing and installing .....	330-11	Electronic height control (EHC) components .....	330-44
Air spring, removing and installing .....	330-12	Air compressor pump relay, removing and installing .....	330-45
<b>Rear Suspension Arms, Subframe and Bushings</b> .....	330-13	EHC control module, removing and installing .....	330-45
Rear suspension arm components .....	330-13	Air supply unit, removing and installing ...	330-45
Swing arm, removing and installing (sedan models) .....	330-14	Ride height sensor, removing and installing .....	330-47
Swing arm, removing and installing (Sport Wagon models) .....	330-16		
Swing arm ball joint, replacing .....	330-19		
Upper rear control arm, removing and installing (sedan models) .....	330-22		
Upper rear control arm, removing and installing (Sport Wagon models) .....	330-23		
Upper front control arm (traction strut), removing and installing .....	330-25		
Rear axle assembly, removing and installing (sedan models) .....	330-26		
Rear axle assembly, removing and installing (Sport Wagon models) .....	330-28		
Rear subframe mounting bushings, removing and installing .....	330-31		

## GENERAL

This repair group covers removal and replacement of E39 rear suspension components. A general description of suspension systems and ride height specifications can be found in **300 Suspension, Steering and Brakes - General**.

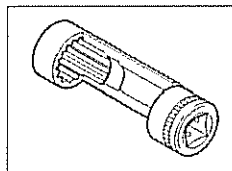
### CAUTION—

- Some E39 models are equipped with aluminum suspension components. The following cautions apply:
- Due to the chemical and corrosion characteristics of aluminum, do not bring into contact with battery acid.
- Do not clean with wire brushes with brass or iron bristles. Only use brushes with stainless steel bristles.
- Do not expose to flying sparks from grinding/cutting operations.
- Do not subject to steel welding splashes.
- Do not expose to temperatures over 80°C (176°F), even for short periods. Temperatures in painting facilities are not a problem.

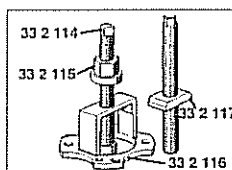
## Special tools

Special service tools are required for some of the work described in this repair group. Most of these tools are specialized press jigs and pullers that might be replaced by standard pullers of various sizes.

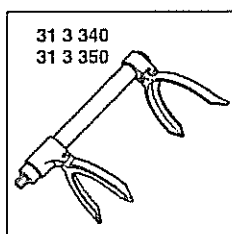
Read the procedures through before beginning any job.



- ◀ Strut upper mounting nut socket  
(Tool No. BMW 31 2 210)

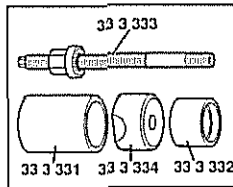


- ◀ Axle shaft removal and installation set  
(Tool No. BMW 33 2 114, 33 2 114, 33 2 115, 33 2 116 and 33 2 117)

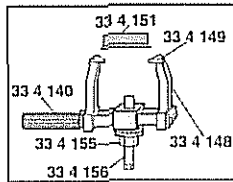


- ◀ Spring compressor  
(Tool No. BMW 31 3 340, 31 3 350)

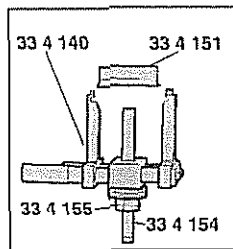




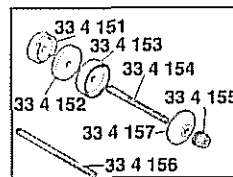
- Rubber bushing removal tool set  
(Tool No. BMW 33 3 331, 33 3 332, 33 3 333, 33 3 334)



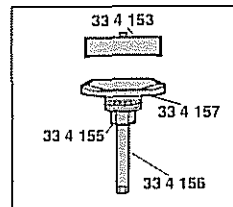
- Subframe mount removal set  
(Tool No. BMW 33 4 140, 33 4 148, 33 4 149, 33 4 151, 33 4 155, 33 4 156)



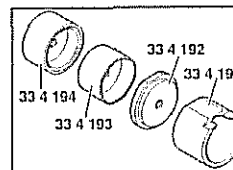
- Subframe mount tool set  
(Tool No. BMW 33 4 151, 3 4 140, 33 4 155, 33 4 154)



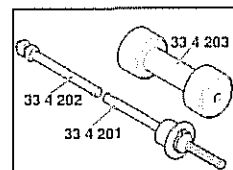
- Rear wheel bearing carrier mount tool set  
(Tool No. BMW 33 4 151, 33 4 152, 33 4 153, 33 4 154, 33 4 156, 33 4 157)



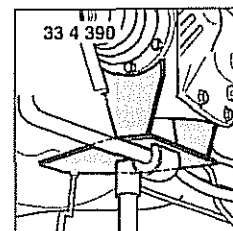
- Subframe mount installation set  
(Tool No. BMW 33 4 153, 33 4 155, 33 4 156, 33 4 157)



- Support tube set  
(Tool No. BMW 33 4 191, 33 4 192, 33 4 193, 33 4 194)

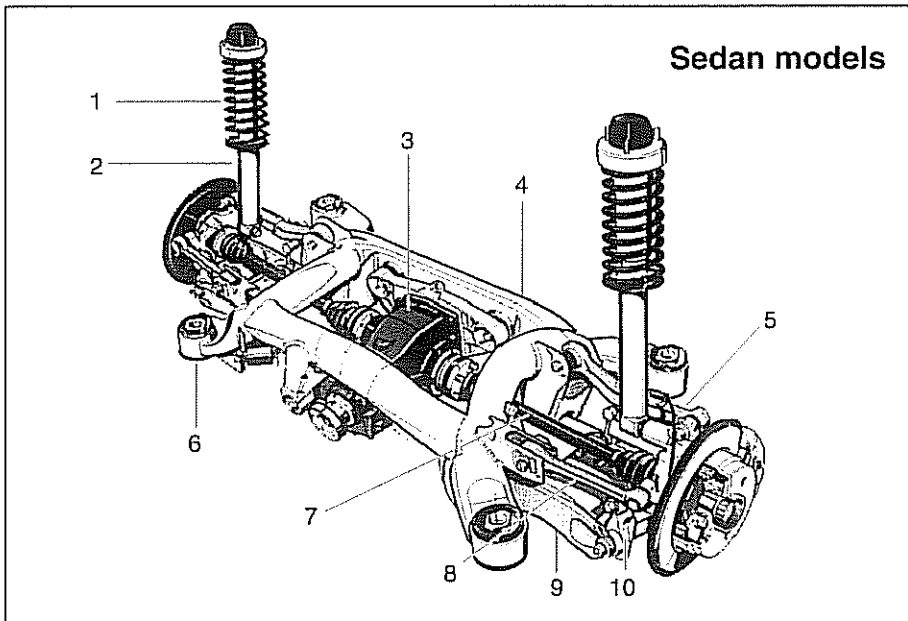


- Slide hammer set  
(Tool No. BMW 33 4 201, 33 4 202, 33 4 203)



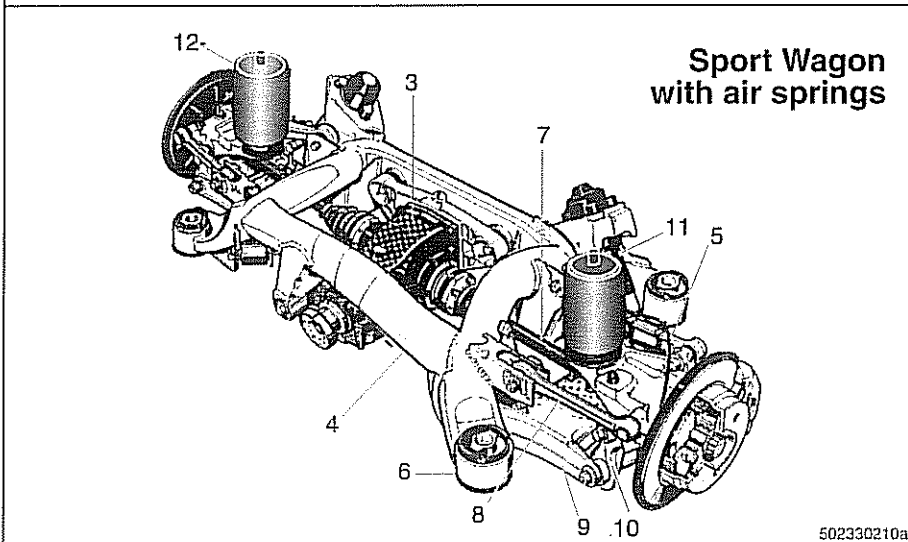
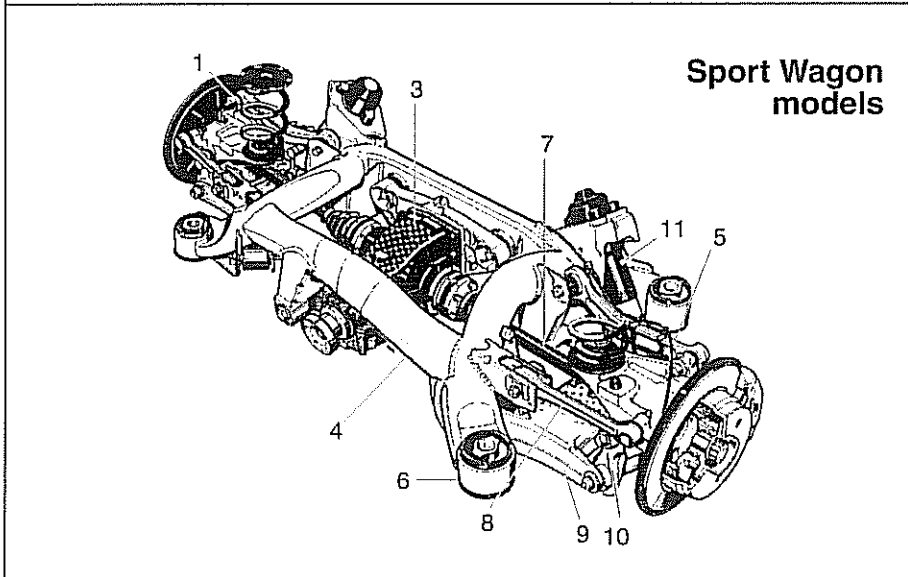
- Final drive support  
(Tool No. BMW 33 4 390)

Rear Suspension



Rear suspension variations

1. Coil spring
2. Strut
3. Final drive (differential)
4. Rear subframe
5. Upper rear control arm (wishbone)
6. Subframe mounting bushing
7. Drive axle
8. Upper front control arm (traction strut)
9. Swing arm (lower control arm)
10. Integral link
11. Shock absorber
12. Air spring



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## REAR STRUTS AND SPRINGS (SEDAN MODELS)

### Rear strut assembly, removing and installing

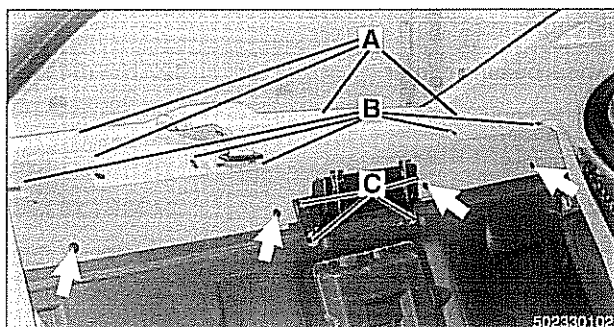
Replace struts and coil springs in pairs only.

- Raise car and remove rear wheels.

#### **WARNING—**

*Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.*

- Remove rear parcel shelf:
  - Remove rear seat headrests by pulling straight up.
  - Remove both rear roof pillar (C-pillar) trim panels.
  - Unbolt rear seat belt anchors. See **720 Seat Belts**.
  - Models with fixed rear seat: Remove rear seat backrest. See **520 Seats**.
  - Models with fold-down rear seat: Remove rear seat backrest side sections. See **520 Seats**. Fold down backrest.
  - Working inside trunk, remove roller blind mounting nuts and bolts, if applicable. Also disconnect roller blind harness connector at right edge of rear seat backrest.

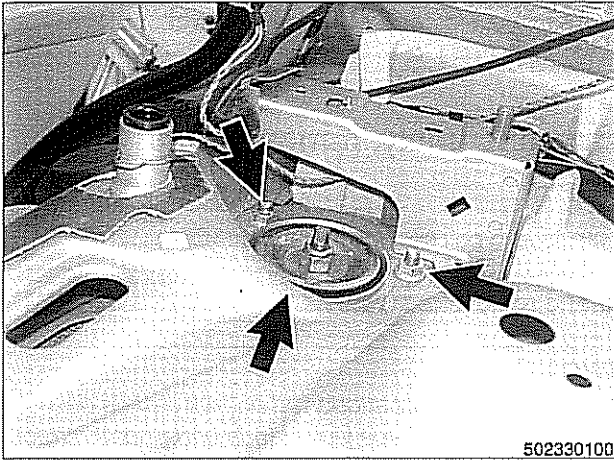


- Gently pry rear speaker cover grilles and rear window defogger grilles (A) out of parcel shelf.
  - Carefully remove seat belt and headrest mount finisher strips (B).
  - Remove middle seat headrest anchor bolts (C). Remove headrest anchor.
  - Remove expansion rivets (arrows) and lift out parcel shelf.
- Remove rear speakers.
- Remove rear wheels. Remove wheel arch trim.
- Support rear wheel bearing carrier.

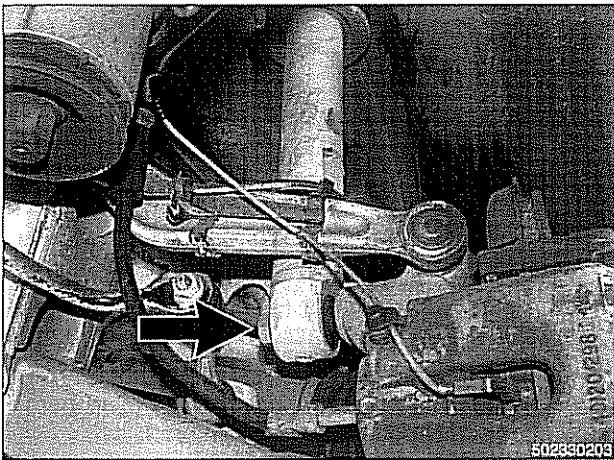
#### **CAUTION—**

*The strut assembly prevents the drive axle and wheel bearing carrier from dropping too far. Supporting the wheel bearing carrier before disconnecting the strut mounting fasteners prevents damage to the brake hose, parking brake cable and drive axle CV joints.*

## Rear Suspension



- ◀ Remove rear strut top cover. Remove upper strut mounting nuts (arrows).



- ◀ Remove strut assembly lower mounting bolt (arrow).

- Disassemble strut and spring assembly as described below in **Rear strut assembly, disassembling and reassembling**.
- Installation of assembly to car is reverse of removal, noting the following:
  - Make sure all threaded bolts, nuts and mating surfaces are clean.
  - Install strut assembly top mount using new self-locking nuts.
  - Make sure long lower strut bushing fits in hole in wheel bearing carrier.

## Tightening torques

Strut to wheel bearing carrier	127 Nm (94 ft-lb)
Strut mount to body	
<ul style="list-style-type: none"> <li>• Gray fasteners</li> <li>• Yellow fasteners</li> </ul>	28 Nm (21 ft-lb) 24 Nm (18 ft-lb)
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)

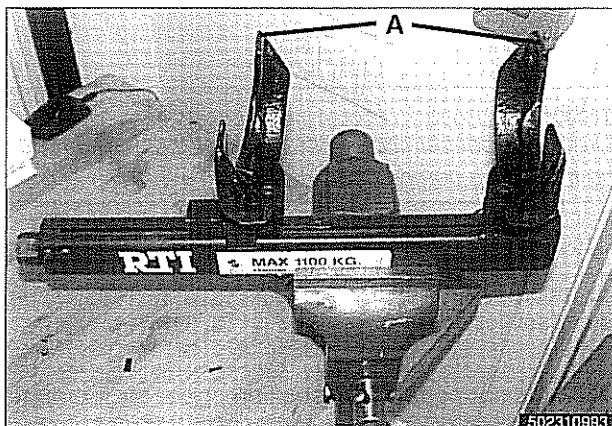
## Rear strut assembly, disassembling and assembling

Replace struts and coil springs in pairs only.

Replacing the upper strut mount, spring or strut requires that the strut assembly first be removed from the car, as described earlier. Strut disassembly requires a spring compressor.

### WARNING —

*Do not attempt to disassemble the strut without a spring compressor designed specifically for the job.*



- Remove strut assembly from car as described in **Rear strut assembly, removing and installing**.

- Mount spring compressor (BMW special tools 31 3 340 and 31 3 350 or equivalent) in shop vice. Install correct—sized spring retainers (A).

### WARNING —

- *Do not attempt to disassemble the struts without a spring compressor designed specifically for this job.*
- *Prior to using the spring compressor check its operation. Do not use a spring compressor that is damaged. Do not make any modifications to the spring compressor.*
- *Never use an impact wrench to compress or relieve tension when using a spring compressor.*

- Place strut assembly coil spring in spring retainers. Compress spring until force on upper strut mount is relieved.

- Remove strut top mount self-locking nut with BMW special tool 31 2 210 while counterholding strut shaft with a box end wrench.

- Remove upper strut mount and related components. Separate strut from spring.

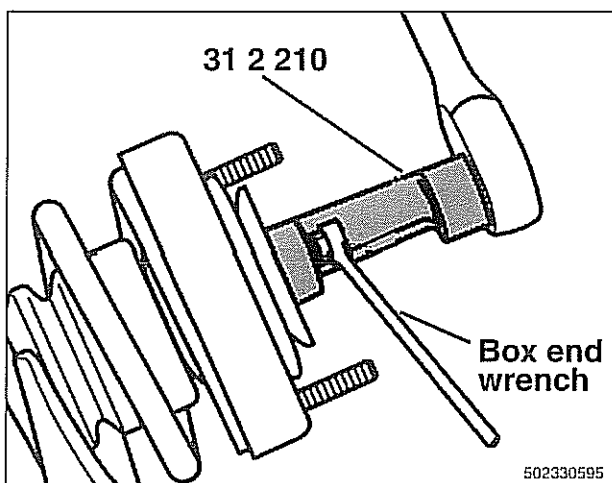
### NOTE —

*Store the removed shock absorber upright. Do not allow it to lie horizontally or upside down for any length of time. If incorrect storage has occurred, place the shock absorber upright with the rod fully extended for at least 24 hours.*

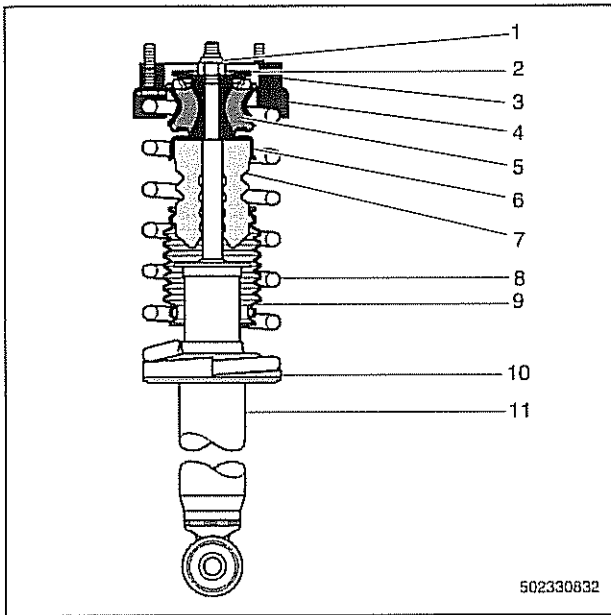
- Replace strut, rubber bumper, upper strut mount or spring, as needed.

### NOTE —

- *Relieve tension on spring compressor slowly and carefully.*
- *Fit new spring in spring compressor so that one coil at each end is outside spring retainer.*



## Rear Suspension



⚠ Compress spring and install it and related components to shock absorber. Use new self-locking upper strut mounting nut.

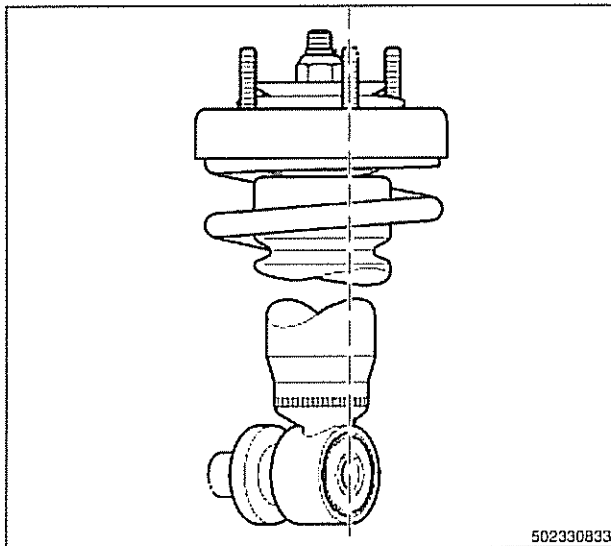
1. Upper strut mount self-locking nut
2. Washer
3. Poor road surface adapter
4. Upper spring seat
5. Upper strut mount
6. Upper rubber bumper seat
7. Rubber bumper
8. Coil spring
9. Dust boot
10. Lower spring seat
11. Strut

**WARNING—**

*Make sure the upper self-locking nut is fully tightened before releasing the spring compressor.*

## Tightening torque

Upper strut mount to strut shaft (M14, replace self-locking nut)	27 Nm (20 ft-lb)
---	------------------



⚠ Before releasing spring tension, position upper strut mount so that one threaded stud is on a plane with flat end of strut bushing at other end of strut.

- Release spring compressor slowly, positioning spring ends in shoulders of spring seats.
- Reinstall strut assembly in vehicle, as described above in **Rear strut assembly, removing and installing.**

## REAR SHOCK ABSORBERS AND SPRINGS (SPORT WAGON MODELS)

Depending on year and model applications, the Sport Wagon rear suspension may be equipped with:

- Conventional shock absorbers and coil springs
- Electronic height control (EHC) system which incorporates air springs

### NOTE—

- *Suspension and EHC troubleshooting is covered in 300 Suspension, Steering and Brakes—General.*
- *EHC system repairs, other than air spring replacement, are covered in Electronic height control (EHC) component replacement.*

Replace shock absorbers and springs in pairs only.

### Rear shock absorber, removing and installing

- Raise car and remove rear wheels.

#### WARNING—

*Make sure that the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.*

#### CAUTION—

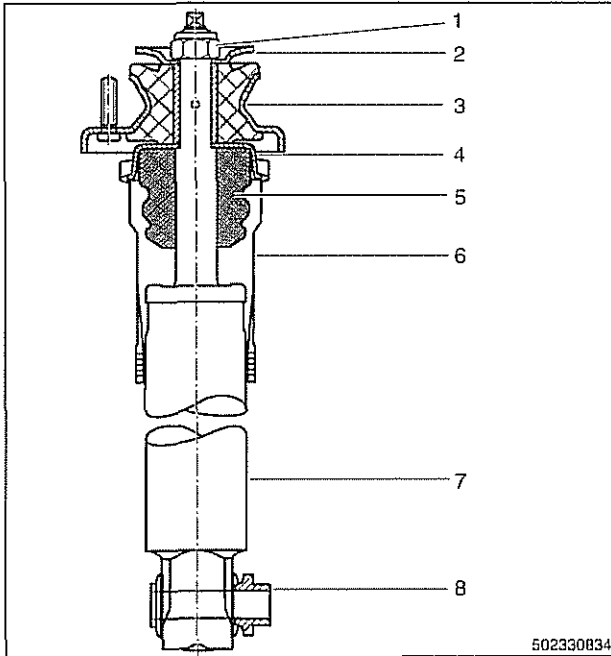
*If working on a vehicle with compressed air shock absorbers, disable air supply pump by disconnecting electrical plug before performing any repairs. Pump is located beneath a cover under the spare tire in the floor of the cargo compartment.*

- Support swing arm from below.

#### CAUTION—

*The shock absorber prevents the drive axle and wheel bearing carrier from dropping too far. Supporting the wheel bearing carrier before disconnecting the shock absorber mounting fasteners prevents damage to the brake hose, parking brake cable and drive axle CV joints.*

- Working in cargo compartment, remove carpet. Remove triangular upper shock mount covers located beside spare tire well.
- If applicable: Detach air supply line from shock absorber. Plug ports and lines to keep out dirt.



- Remove rubber protective cap from shock absorber upper mount.
- Remove shock absorber upper mounting nuts.
- Remove shock absorber lower mounting bolt. Lower shock absorber out of wheel housing.

◀ Transfer shock top mounting plate, dust cover (if applicable) and related components to new shock absorber.

1. Self-locking nut
2. Washer
3. Upper shock absorber mount
4. Rubber bumper seat
5. Rubber bumper
6. Dust boot
7. Shock absorber
8. Long lower bushing

#### Tightening torques

Shock absorber to upper mount (M14, replace self-locking nut)	27 Nm (20 ft-lb)
--	------------------

- Installation on car is reverse of removal, noting the following:
  - Make sure all threaded bolts, nuts and mating surfaces are clean.
  - Install shock absorber upper mount to subframe using new self-locking nuts.
  - Make sure long lower shock absorber bushing fits in hole in suspension swing arm.
  - Tighten lower shock absorber bolt to its final torque once car is on ground.

#### Tightening torques

Quick coupling screw to air shock absorber	2 Nm (18 in-lb)
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)
Shock absorber to swing arm	127 Nm (94 ft-lb)
Strut mount to body	
• Gray fasteners	28 Nm (21 ft-lb)
• Yellow fasteners	24 Nm (18 ft-lb)

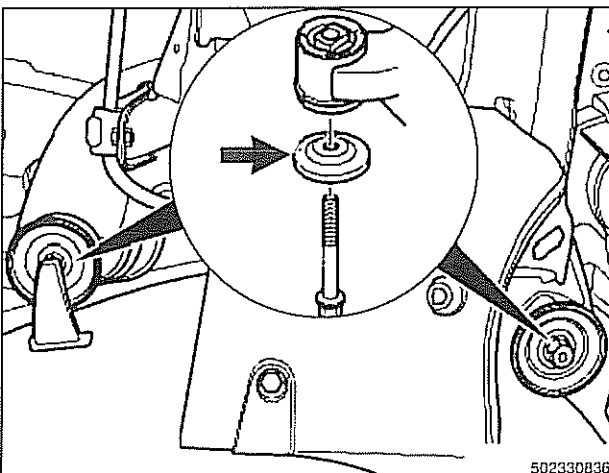
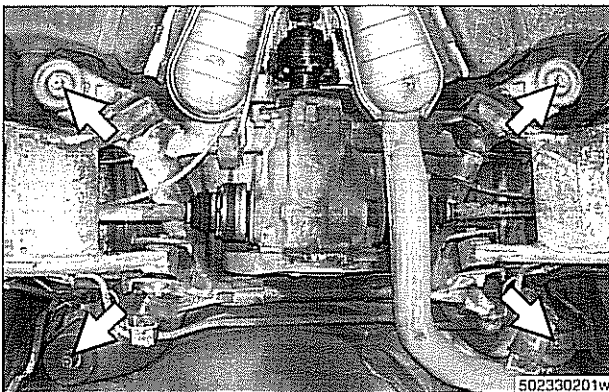
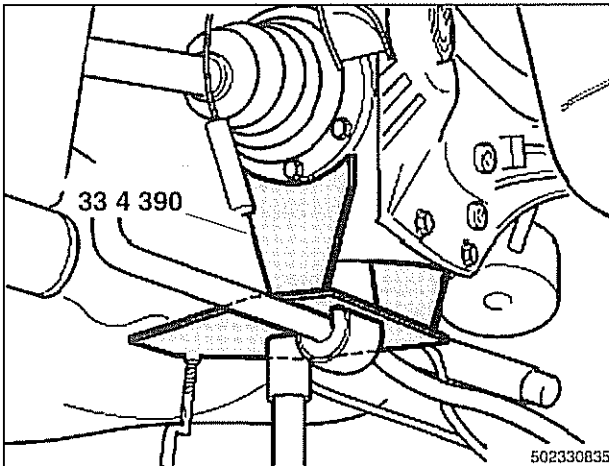


## Coil spring, removing and installing

Raise car and remove rear wheels.

### WARNING—

Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.



- Remove brake caliper and brake disc. Hang brake caliper aside with stiff wire. Do not disconnect brake fluid hose. See **340 Brakes**.
- Remove exhaust system. See **180 Exhaust System**.
- Disconnect driveshaft from final drive. See **260 Driveshaft**.
- Detach parking brake cables from mounting brackets on subframe.
- Support final drive unit from below using transmission jack and BMW special tool 33 4 390 or equivalent.
- Remove rear suspension subframe mounting bolts (arrows).
- Lower rear subframe until coil springs can be removed.
- When reinstalling springs, replace upper and lower spring pads if necessary.
- Slowly lift suspension back into position, making sure coil springs are correctly seated in upper and lower spring seats.
- Install and tighten subframe mounting bolts. Note that on each bolt, rubber-coated detent plate (arrow) must be installed at rear in driving direction.
- Remainder of installation is reverse of removal.

### Tightening torques

Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)
Subframe to body	163 Nm (120 ft-lb)

## Air spring, removing and installing

### CAUTION—

*If vehicle is driven with air spring depressurized, the air spring will be permanently damaged and must be replaced.*

An air spring is made from a flexible rubber material which forms an airtight cavity. It is pressurized by an air supply pump activated by an electronic control unit to provide a variable spring rate depending on vehicle load.

### CAUTION—

- *Disable air supply pump by disconnecting electrical plug before performing any repairs. Pump is located beneath a cover under the spare tire in the floor of the cargo compartment.*
- *When removing and installing air connections, extreme cleanliness must be followed. Small dirt particles can cause leakage in the system.*

Remove luggage compartment floor mat.

- Working above air spring, loosen quick coupling screw connection to allow air pressure to escape.
- Once pressure has been reduced, retighten screw.

### Tightening torque

Quick coupling screw to air pump	2 Nm (18 in-lb)
----------------------------------	-----------------

- Remove quick coupler. Plug openings to keep dirt out.
- Remove air spring mounting clips.
- Raise car and remove rear wheels.

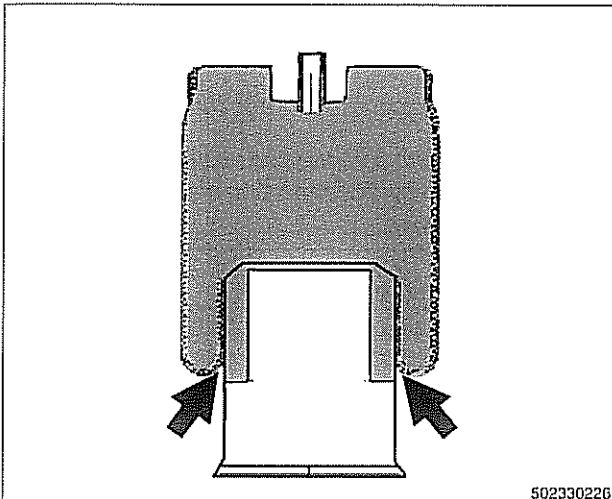
### WARNING—

*Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.*

- Working underneath rear suspension, lift wheel bearing carrier to relieve rear spring tension. Then unbolt air spring mounting bolt from seat on wheel bearing carrier. Remove air spring.

### NOTE—

*Left and right air springs are different. The left air spring is marked with a red identification mark. The right air spring is marked with a blue identification mark.*



- ◀ Check roll fold of air spring (arrows). Reinstall only if roll fold is undamaged and formed correctly.
- To install air spring:
  - Check sealing O-rings at air spring inlet. Replace if damaged. Do not grease O-rings. Reinstall protective plug.
  - Install spring above suspension subframe. Make sure eccentric lug at bottom of air spring fits in recess of subframe spring seat.
  - Reattach top spring mounting clips.
  - Reattach air line connections.
- Remainder of installation is reverse of removal.

#### Tightening torques

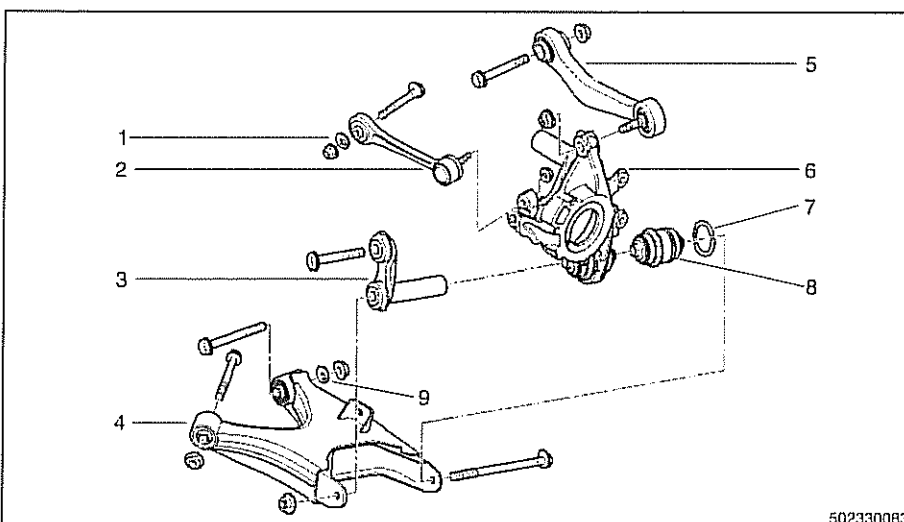
Air line connection	2 Nm (18 in-lb)
Air spring to wheel bearing carrier	20 Nm (15 ft-lb)
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)

## REAR SUSPENSION ARMS, SUBFRAME AND BUSHINGS

A damaged suspension arm or worn bushings will change the rear wheel alignment and may adversely affect handling and stability.

#### **WARNING**—

*Do not attempt to straighten a damaged suspension arm. Bending or heating may weaken the original part. Always replace a damaged suspension arm.*



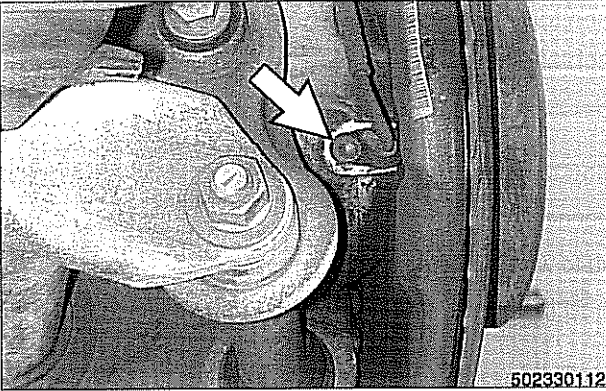
### Rear suspension arm components

1. Eccentric washer (for rear toe adjustment)
2. Upper front control arm (guide link or traction strut)
3. Outer swing arm bushing and integral link
4. Swing arm (lower control arm)
5. Upper rear control arm (wishbone)
6. Wheel bearing carrier
7. Circlip
8. Swing arm ball joint
9. Eccentric washer (rear camber adjustment)

## Swing arm, removing and installing (sedan models)

### CAUTION—

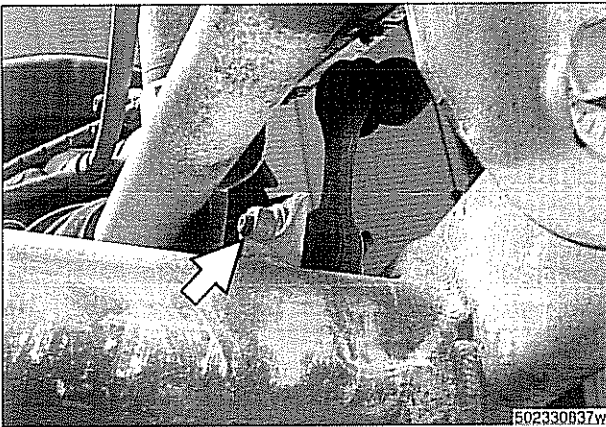
If working on a vehicle with compressed air shock absorbers, disable air supply pump by disconnecting electrical plug before performing any repairs.



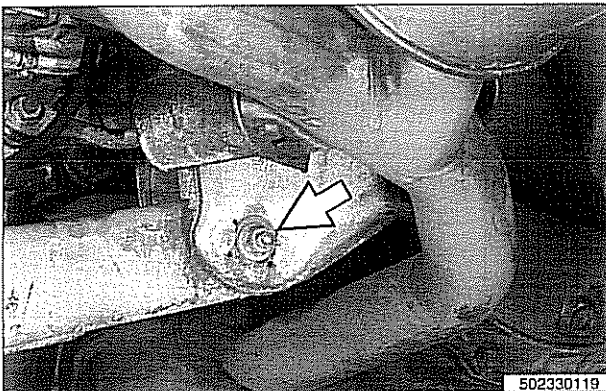
- Raise rear end of car and remove wheel.

### WARNING—

Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.



- Disconnect control rod for ride height sensor if applicable.
- Remove ABS pulse sensor (arrow) from wheel bearing carrier.
- Remove stabilizer bar link mounting nut (arrow). Press link out of swing arm.

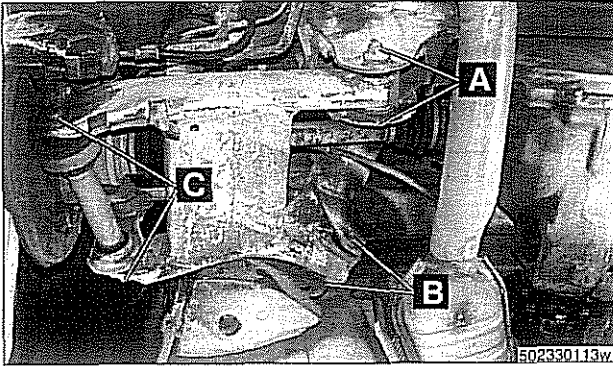


- Mark location (arrow) of rear camber adjustment washer and bolt.

### NOTE—

Rear camber is adjusted at the inner swing arm eccentric rear mounting bolt.

- Support wheel bearing carrier from below.



- ◀ Remove fasteners **A**, **B** and **C** while supporting swing arm from below.
- Carefully pry swing arm away from mounting points, while continuing to support from below.
  - Remainder of installation is reverse of removal, noting the following:
    - Use new self-locking nuts.
    - Install bolt (**C**) through bracket and arm. Install and tighten nut finger tight.
    - Install bolts (**A**) and (**B**). Install and tighten nuts finger tight.
    - Line up eccentric camber adjusting bolt with marks made previously.
    - Tighten fasteners to final torque only after vehicle has been lowered and suspension has settled.
    - Have car professionally aligned when job is complete.

#### Tightening torques

ABS pulse sensor to wheel bearing carrier	8 Nm (6 ft-lb)
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)
Stabilizer link to swing arm	65 Nm (48 ft-lb)
Swing arm to rear subframe (camber bolt M12) ( <b>A</b> )	115 Nm (85 ft-lb)
Swing arm to rear subframe ( <b>B</b> )	58 Nm (43 ft-lb)
Swing arm to wheel bearing carrier ( <b>C</b> )	256 Nm (189 ft-lb)

## Swing arm, removing and installing (Sport Wagon models)

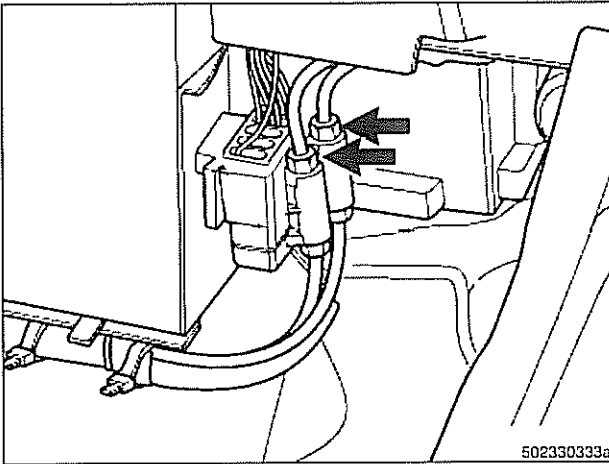
- Raise rear end of car and remove wheel.

### WARNING—

Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.

### CAUTION—

Model with air springs: Disable air supply pump by disconnecting electrical plug before performing any repairs. Pump is located beneath a cover under the spare tire in the floor of the cargo compartment.



- Model with air springs: Loosen compressed air pipes (arrows) at air distribution assembly to release system pressure.

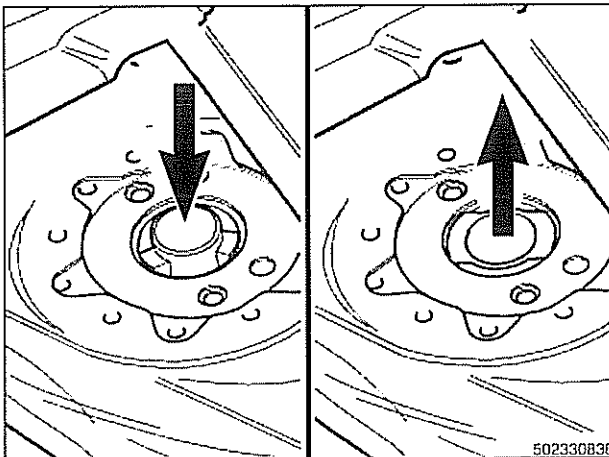
### NOTE—

Vehicle will stand quite low.

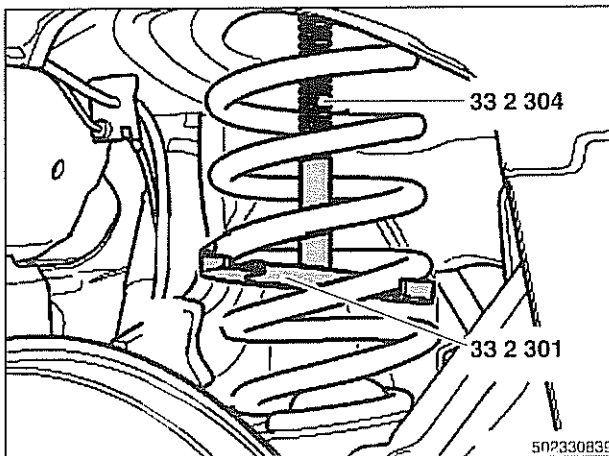
- If applicable: Detach air supply line from shock absorber. Plug ports and lines to keep out dirt.

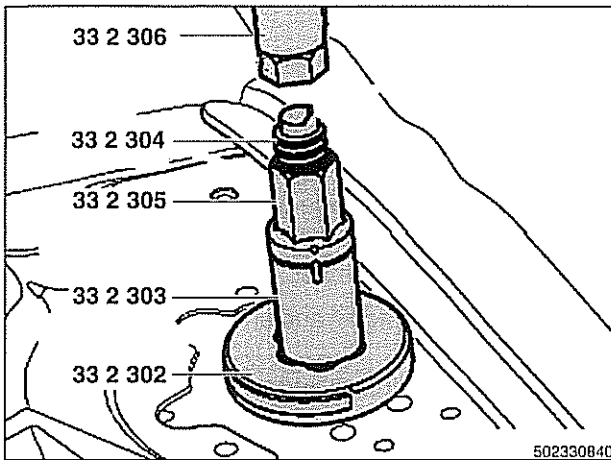
- Model with rear coil springs: Remove cargo compartment floor carpet.

- Working at top of coil spring, press center cap down or pry upward to remove. If pushed down, remove from inside coil spring from under car.

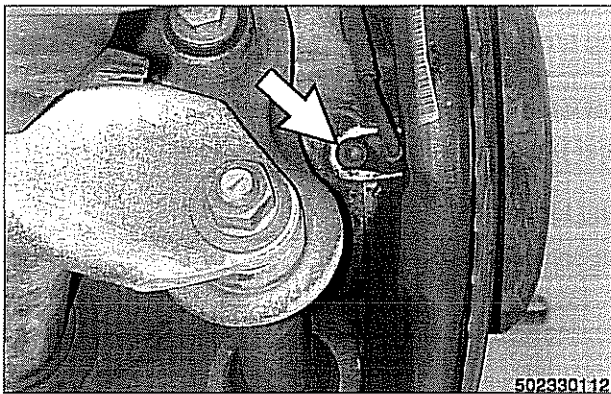


- Working from underneath, position BMW special tool 33 2 301 between 2nd and 3rd spring coil from bottom.
  - Make sure tool recess faces upward.
  - Working in cargo compartment, guide BMW special tool 33 2 304 from above and thread into special tool 33 2 301.





- Working in cargo compartment, attach BMW special tools 33 2 302, 33 2 303 and 33 2 305 to special tool 33 2 304.
  - Use special tool 33 2 306 to compress spring.
  - Tighten until lower spring coil lifts off spring seat on wheel bearing carrier.
- Disconnect control rod for ride height sensor if applicable.



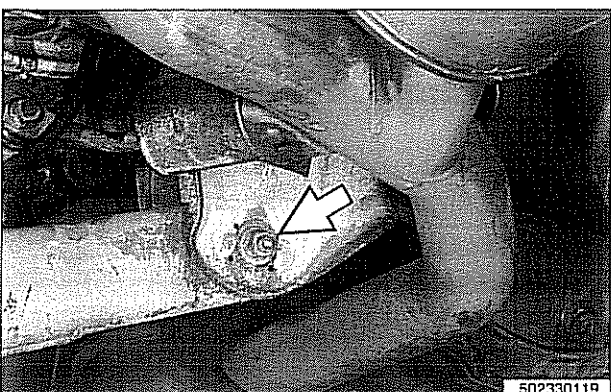
- Remove ABS pulse sensor (**arrow**) from wheel bearing carrier.
- Support wheel bearing carrier from below.

**CAUTION—**

*The shock absorber prevents the drive axle and wheel bearing carrier from dropping too far. Supporting the wheel bearing carrier before disconnecting the shock absorber mounting fastener prevents damage to the brake hose, parking brake cable and drive axle CV joints.*



- Remove shock absorber lower mounting bolt.
- Remove stabilizer bar link mounting nut (**arrow**). Press link out of swing arm.

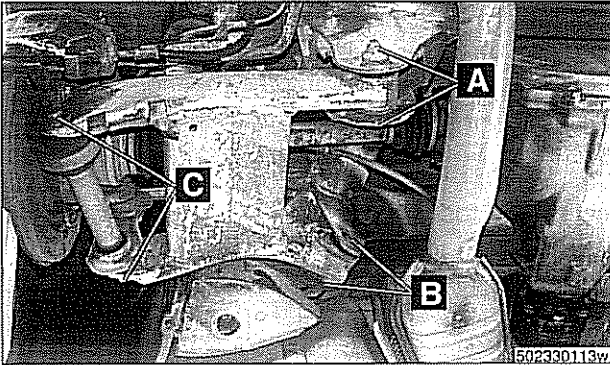


- Mark location (**arrow**) of rear camber adjustment washer and bolt.

**NOTE—**

*Rear camber is adjusted at the inner swing arm eccentric rear mounting bolt.*

## Rear Suspension



- ⚠ Remove fasteners **A**, **B** and **C** while supporting swing arm from below.
- Carefully pry swing arm away from mounting points, while continuing to support from below.
  - Remainder of installation is reverse of removal, noting the following:
    - Use new self-locking nuts.
    - Install bolt (**C**) through bracket and arm. Install and tighten nut finger tight.
    - Install bolts (**A**) and (**B**). Install and tighten nuts finger tight.
    - Line up eccentric camber adjusting bolt with marks made previously.
    - Make sure long lower shock absorber bushing fits in hole in swing arm.
    - Tighten fasteners to final torque only after vehicle has been lowered and suspension has settled.
    - Have car professionally aligned when job is complete.

### Tightening torques

ABS pulse sensor to wheel bearing carrier	8 Nm (6 ft-lb)
Quick coupling screw to air shock absorber	2 Nm (18 in-lb)
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)
Shock absorber to lower control arm	127 Nm (94 ft-lb)
Stabilizer link to swing arm	65 Nm (48 ft-lb)
Swing arm to rear subframe (camber bolt M12) ( <b>A</b> )	115 Nm (85 ft-lb)
Swing arm to rear subframe ( <b>B</b> )	58 Nm (43 ft-lb)
Swing arm to wheel bearing carrier ( <b>C</b> )	256 Nm (189 ft-lb)



## Swing arm ball joint, replacing

- Raise rear end of car and remove wheel.

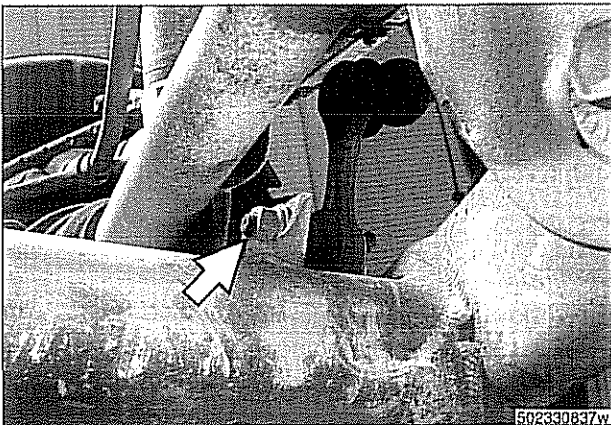
### **WARNING**—

*Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.*

- Sport Wagon model: Support wheel bearing carrier from below.

### **CAUTION**—

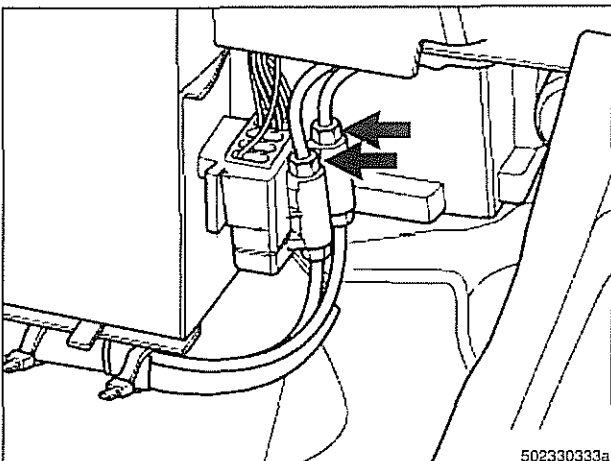
*The shock absorber prevents the drive axle and wheel bearing carrier from dropping too far. Supporting the wheel bearing carrier before disconnecting the shock absorber mounting fastener prevents damage to the brake hose, parking brake cable and drive axle CV joints.*



- Model with air shock absorbers: Detach air supply line from shock absorber. Plug ports and lines to keep out dirt.
- Sport Wagon model: Remove shock absorber lower mounting bolt.
- ◀ Remove stabilizer bar link mounting nut (**arrow**). Press link out of swing arm.

### **CAUTION**—

*Model with air springs: Disable air supply pump by disconnecting electrical plug before performing any repairs. Pump is located beneath a cover under the spare tire in the floor of the cargo compartment.*



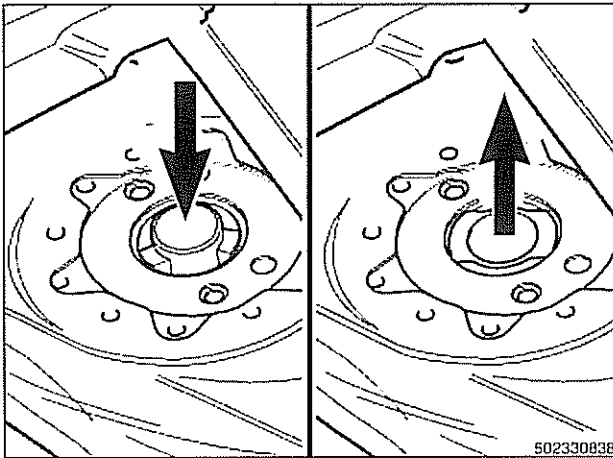
- ◀ Model with air springs: Loosen compressed air pipes (**arrows**) at air distribution assembly to release system pressure.

### **WARNING**—

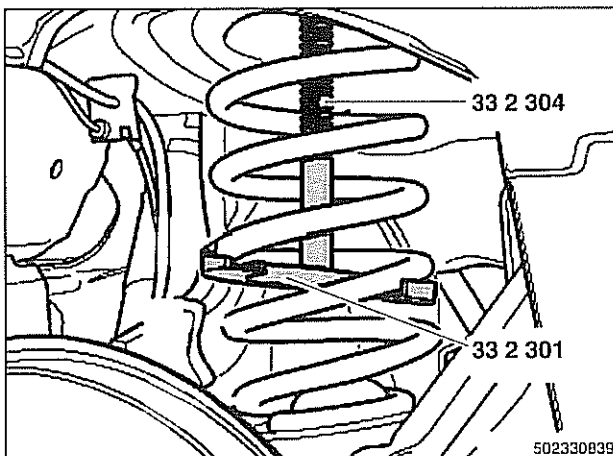
*Vehicle will lower when the air pipes are opened.*

- Models with rear coil springs: Remove cargo compartment floor carpet.

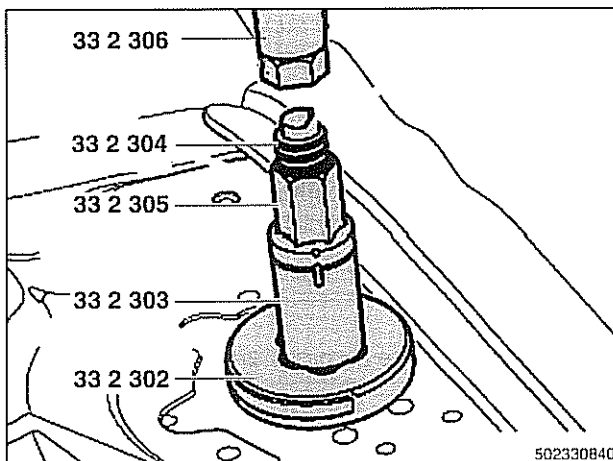
## Rear Suspension



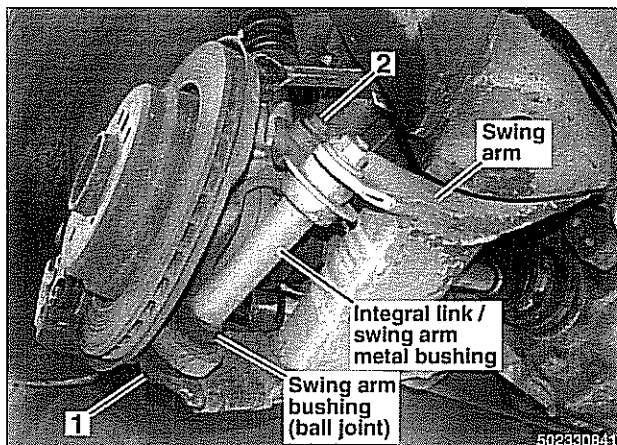
- Models with coil springs: Working at top of spring, press center cap down or pry upward to remove. If pushed down, remove from inside coil spring from under car.



- Working from underneath, position BMW special tool 33 2 301 between 2nd and 3rd spring coil from bottom.
  - Make sure tool recess faces upward.
  - Working in cargo compartment, guide BMW special tool 33 2 304 from above and thread into special tool 33 2 301.

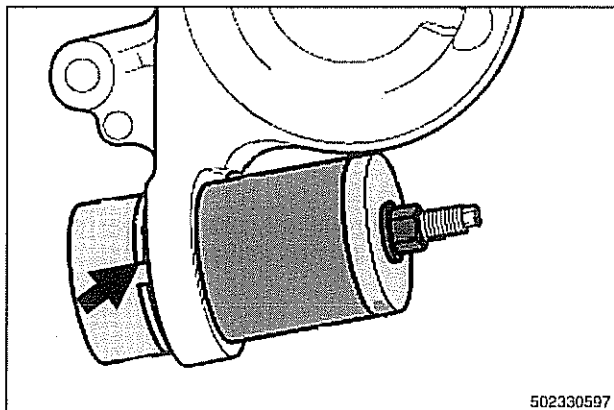


- Working in cargo compartment, attach BMW special tools 33 2 302, 33 2 303 and 33 2 305 to special tool 33 2 304.
  - Use special tool 33 2 306 to compress spring.
  - Tighten until lower spring coil lifts off spring seat on wheel bearing carrier.

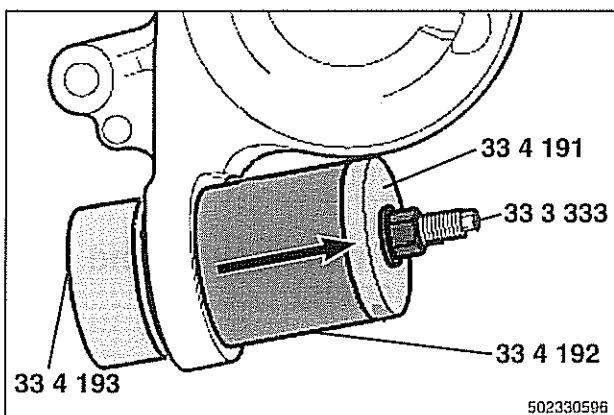


Remove outer mounting bolt (1) from swing arm. Pull swing arm down.

- Remove integral link / swing arm metal bushing locating bolt (2). Remove integral link.

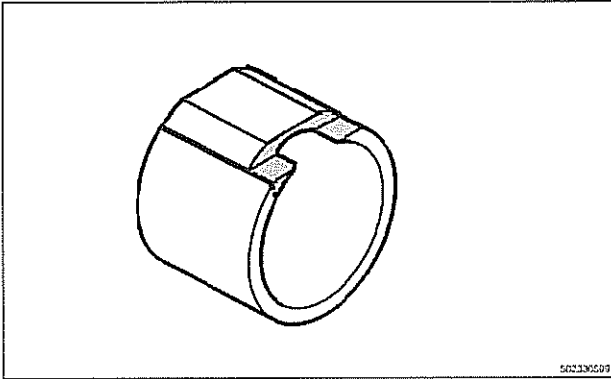


Remove swing arm bushing retaining snap ring (arrow).



Press bushing out of wheel bearing carrier using BMW special tools 33 4 191, 33 4 192, 33 4 193 and 33 3 333.

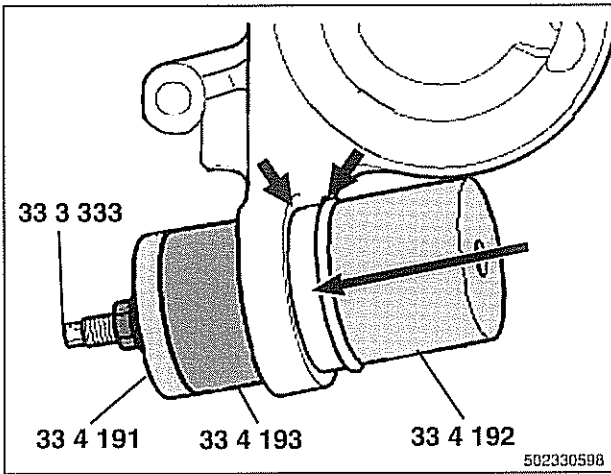
## Rear Suspension



◀ If necessary, machine special tool 33 4 191 as shown.

**NOTE—**

*Slotted end of special tool 33 4 191 points toward wheel bearing carrier.*



◀ Press new bushing into wheel bearing carrier using BMW special tools 33 4 191, 33 4 192, 33 4 194 and 33 3 333 until bushing collar is flush with carrier (**arrows**).

- Install new snap ring.
- Reassembly is reverse of disassembly.
  - Use new self-locking nuts.
  - Tighten fasteners to final torque only after vehicle has been lowered and suspension has settled.

**Tightening torques**

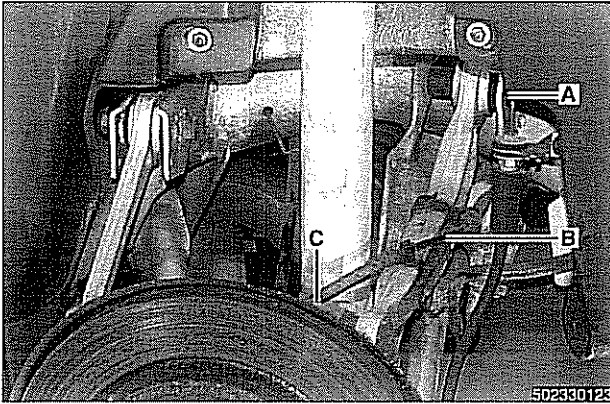
Integral link to wheel bearing carrier	105 Nm (77 ft-lb)
Quick coupling screw to air shock absorber	2 Nm (18 in-lb)
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)
Shock absorber to lower control arm	127 Nm (94 ft-lb)
Stabilizer link to swing arm	65 Nm (48 ft-lb)
Swing arm to wheel bearing carrier (C)	256 Nm (189 ft-lb)

**Upper rear control arm, removing and installing (sedan models)**

- Raise rear end of car and remove wheel.

**WARNING—**

*Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.*



- Remove rear control arm:
  - Remove inner control arm bolt (A).
  - Detach plastic wiring harness support (B).
  - Remove outer control arm ball joint nut (C). Press ball joint out of rear wheel bearing carrier.
- Installation is reverse of removal, noting the following:
  - Always use new self-locking nuts.
  - Make sure all threaded bolts, nuts and mating surfaces are clean.
  - Inner control arm mounting bolt must thread to rear (bolt head at front).
  - Tighten fasteners to final torque only after vehicle has been lowered and suspension has settled.
  - Have car professionally aligned when job is complete.

#### Tightening torques

Control arm to subframe (M12)	110 Nm (81 ft-lb)
Control arm ball joint to wheel bearing carrier (M14)	142 Nm (105 ft-lb)
Quick coupling screw to air shock absorber	2 Nm (18 in-lb)
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)

### Upper rear control arm, removing and installing (Sport Wagon models)

#### CAUTION—

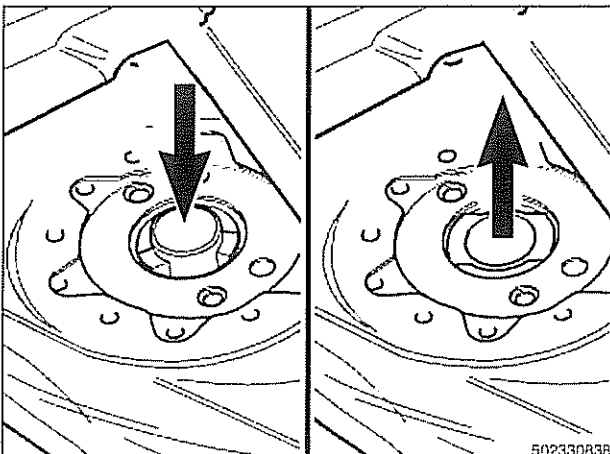
Disable air supply pump by disconnecting electrical plug before performing any repairs. Pump is located beneath a cover under the spare tire in the floor of the cargo compartment.

- Raise rear end of car and remove wheel.

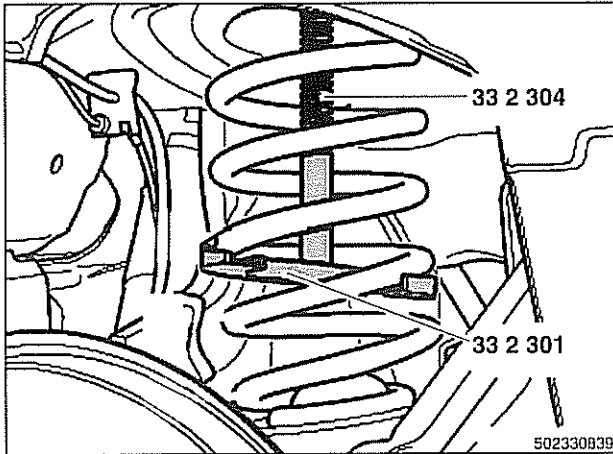
#### WARNING—

Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.

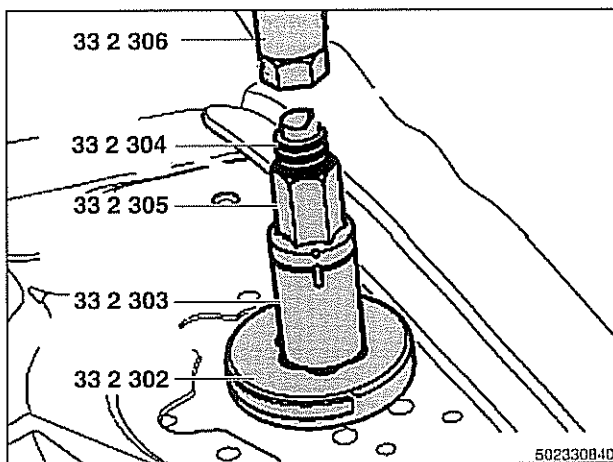
- Models with rear coil springs: Remove cargo compartment floor carpet.
- Working at top of coil spring, press center cap down or pry upward to remove. If pushed down, remove from inside coil spring from under car.



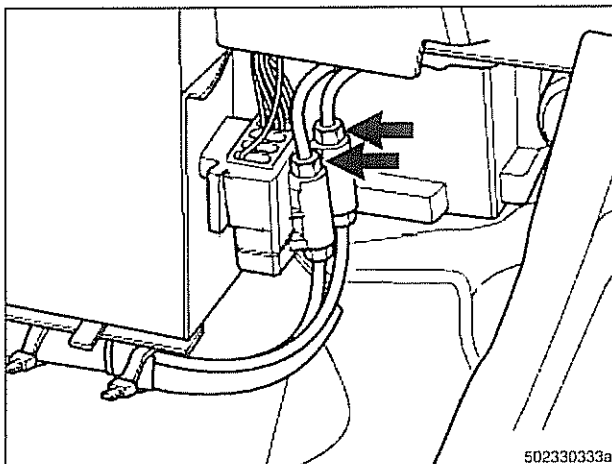
## Rear Suspension



- ▲ Working from underneath, position BMW special tool 33 2 301 between 2nd and 3rd spring coil from bottom.
  - Make sure tool recess faces upward.
  - Working in cargo compartment, guide BMW special tool 33 2 304 from above and thread into special tool 33 2 301.



- ▲ Working in cargo compartment, attach BMW special tools 33 2 302, 33 2 303 and 33 2 305 to special tool 33 2 304.
  - Use special tool 33 2 306 to compress spring.
  - Tighten until lower spring coil lifts off spring seat on wheel bearing carrier.



- ▲ Models with air springs: Loosen compressed air pipes (arrows) at air distribution assembly to release system pressure.

**WARNING—**

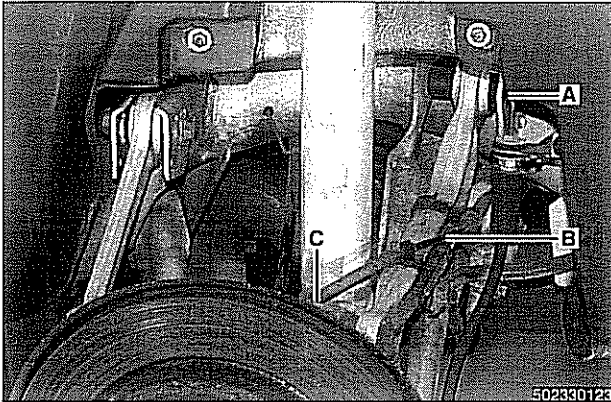
*Vehicle will lower when the air pipes are opened.*

- Support wheel bearing carrier from below.

**CAUTION—**

*The shock absorber prevents the drive axle and wheel bearing carrier from dropping too far. Supporting the wheel bearing carrier before disconnecting the shock absorber mounting fastener prevents damage to the brake hose, parking brake cable and drive axle CV joints.*

- Models with air shock absorbers: Detach air supply line from shock absorber. Plug ports and lines to keep out dirt.
- Remove shock absorber lower mounting bolt.



- Remove rear control arm:
  - Remove inner control arm bolt (A). Push shock absorber out of the way to slide bolt out.
  - Detach plastic wiring harness support (B).
  - Remove outer control arm ball joint nut (C). Press ball joint out of rear wheel bearing carrier.
- Installation is reverse of removal, noting the following:
  - Always use new self-locking nuts.
  - Make sure all threaded bolts, nuts and mating surfaces are clean.
  - Inner control arm mounting bolt must thread to front (bolt head at rear).
  - Make sure long lower shock absorber bushing fits in hole in suspension swing arm.
  - Tighten fasteners to final torque only after vehicle has been lowered and suspension has settled.
  - Have car professionally aligned when job is complete.

#### Tightening torques

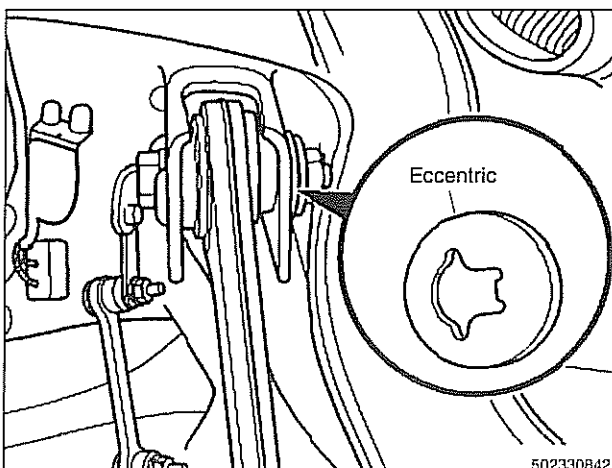
Control arm to subframe (M12)	110 Nm (81 ft-lb)
Control arm ball joint to wheel bearing carrier (M14)	142 Nm (105 ft-lb)
Quick coupling screw to air shock absorber	2 Nm (18 in-lb)
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)
Shock absorber to lower control arm	127 Nm (94 ft-lb)

### Upper front control arm (traction strut), removing and installing

- Raise rear end of car and remove wheel.

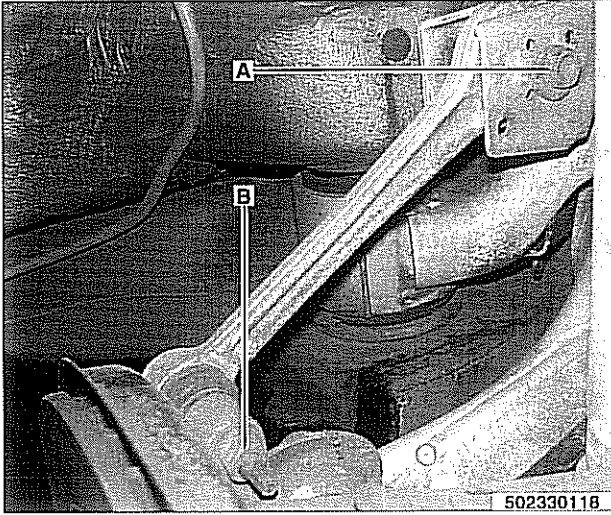
#### **WARNING**—

*Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.*



- Mark location of inner control arm eccentric washer (rear toe adjuster).

## Rear Suspension



- ▲ Remove inner control arm eccentric nut and bolt (A).
  - Remove control arm ball joint nut (B). Press ball joint out of wheel bearing carrier.
  - Lift out control arm.
- Installation is reverse of removal, noting the following:
  - Use previously made marks to install eccentric bolt and nut.
  - Always use new self-locking nuts.
  - Tighten fasteners to final torque only after vehicle has been lowered and suspension has settled.
  - Have car professionally aligned when job is complete.

### Tightening torques

Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)
Upper front control arm (traction strut) to subframe (rear toe adjusting bolt)	60 Nm (44 ft-lb)
Upper front control arm (traction strut) to wheel carrier	65 Nm (48 ft-lb)

## Rear axle assembly, removing and installing (sedan models)

In case of damage to the subframe, or if a pressed-in bushing is worn, remove subframe by removing complete axle assembly.

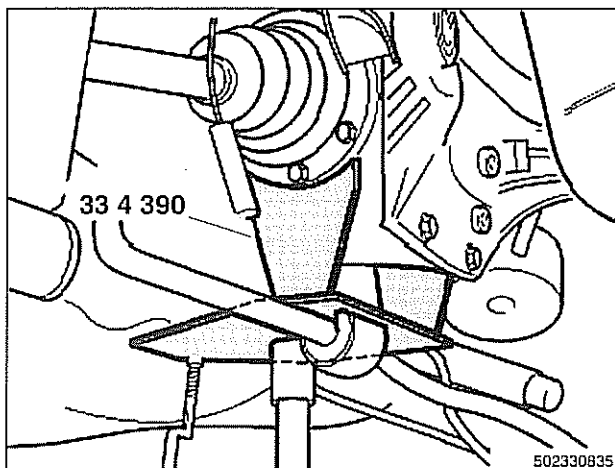
- Raise car and remove rear wheels.

### **WARNING** —

*Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.*

- Remove exhaust system. See **180 Exhaust System**.
- Detach driveshaft from differential. See **260 Driveshaft**.
- Remove brake caliper and brake disc. Hang brake caliper aside with stiff wire. Do not disconnect brake fluid hose. See **340 Brakes**.
- Remove left and right ABS sensors from wheel bearing carriers.
- Disconnect parking brake cable from brake shoe expander. See **340 Brakes**.
- Remove heat shield from above driveshaft.

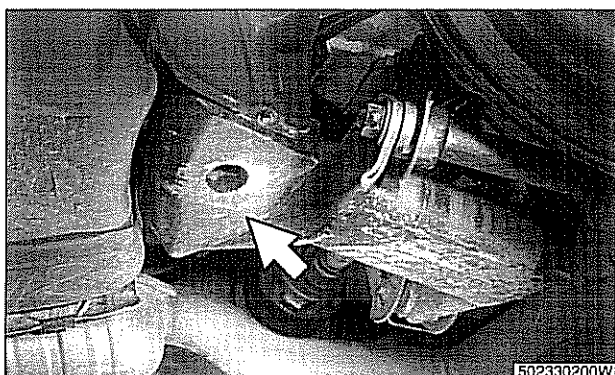




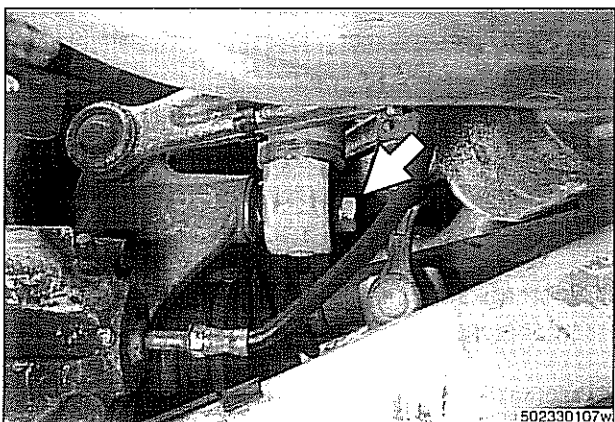
- If equipped, remove ride height sensor connectors.
- ▲ Support final drive unit from below using transmission jack (BMW special tools 00 2 030 and 33 4 390 or equivalent).

**NOTE**—

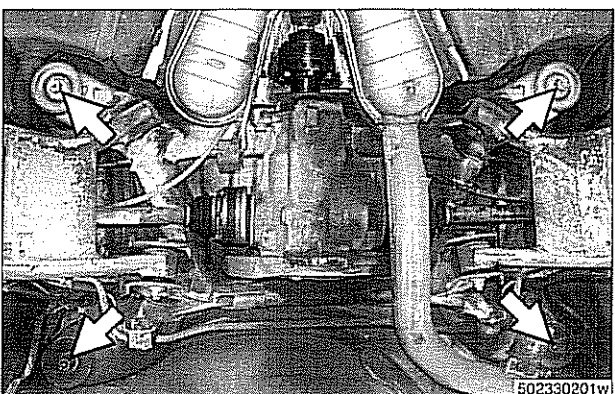
*Special tool 33 4 390 will need modifications to cradle the final drive properly.*



- ▲ Remove right and left suspension trim panels (arrow).

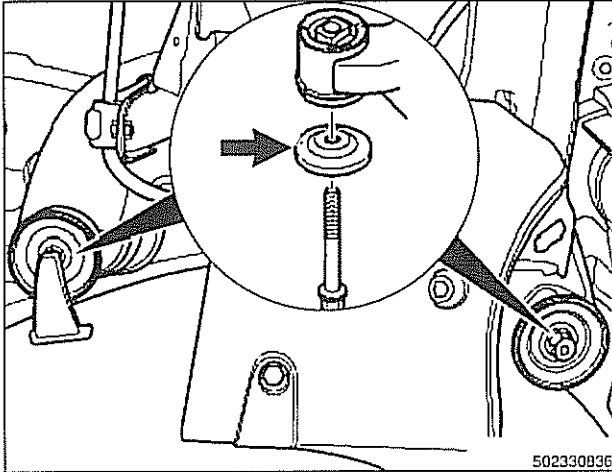


- ▲ Remove right and left lower strut mount bolts (arrow).



- ▲ Remove rear suspension subframe by removing 4 mounting bolts (arrows).
- Carefully lower rear suspension subframe away from body to remove.

## Rear Suspension



- ▲ To install, jack subframe into position. Install and tighten subframe mounting bolts. Note that on each bolt, rubber-coated detent plate (arrow) must be installed at rear in driving direction.

### Tightening torques

Rear subframe to body (M12)	163 Nm (120 ft-lb)
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- Remainder of installation is reverse of removal, noting the following.
  - Make sure long lower strut bushing fits in hole in wheel bearing carrier.
  - Tighten suspension arm and shock absorber fasteners to final torque only after vehicle has been lowered and suspension has settled.
  - Have car professionally aligned when job is complete.

### Tightening torques

ABS pulse sensor to wheel bearing carrier	8 Nm (6 ft-lb)
Brake rotor to hub	16 Nm (12 ft-lb)
Driveshaft CV joint to final drive flange	
• M10 (Torx bolts)	70 Nm (51 ft-lb)
• M8 (compression nut)	32 Nm (24 ft-lb)
Rear brake pad carrier (caliper) to wheel bearing carrier	65 Nm (48 ft-lb)
Rear strut to wheel bearing carrier	127 Nm (94 ft-lb)
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)

## Rear axle assembly, removing and installing (Sport Wagon models)

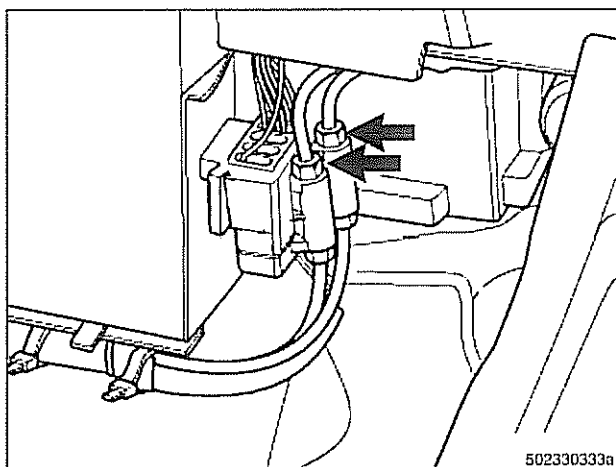
In case of damage to the subframe, or if a pressed-in bushing is worn, remove subframe by removing complete axle assembly.

- In Sport Wagon models with conventional coil spring, lower subframe slowly, making sure rear springs stay on spring seats.
  - In models with air suspension (EHC), disable the air supply pump, deflate the air springs and disconnect them from the wheel carriers before lowering the subframe.
- Raise car and remove rear wheels.

### **WARNING**—

*Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.*

- Remove exhaust system. See **180 Exhaust System**.
- Detach driveshaft from differential. See **260 Driveshaft**.
- Remove brake caliper and brake disc. Hang brake caliper aside with stiff wire. Do not disconnect brake fluid hose. See **340 Brakes**.
- Remove left and right ABS sensors from wheel bearing carriers.
- Disconnect parking brake cable from brake shoe expander. See **340 Brakes**.
- Remove heat shield from above driveshaft.
- If equipped, remove ride height sensor connectors.

**CAUTION—**

*Models with air springs: Disable air supply pump by disconnecting electrical plug before performing any repairs. Pump is located beneath a cover under the spare tire in the floor of the cargo compartment.*

- Models with air springs: Loosen compressed air pipes (arrows) at air distribution assembly to release system pressure.

**WARNING—**

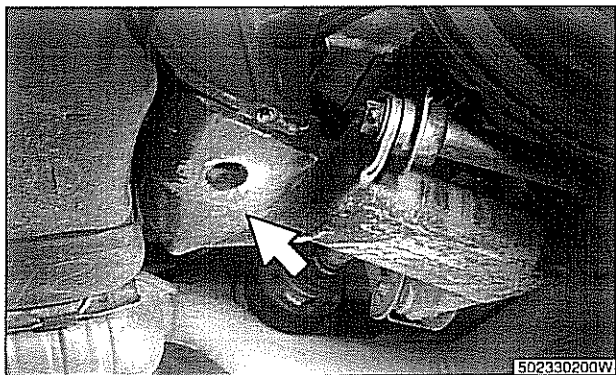
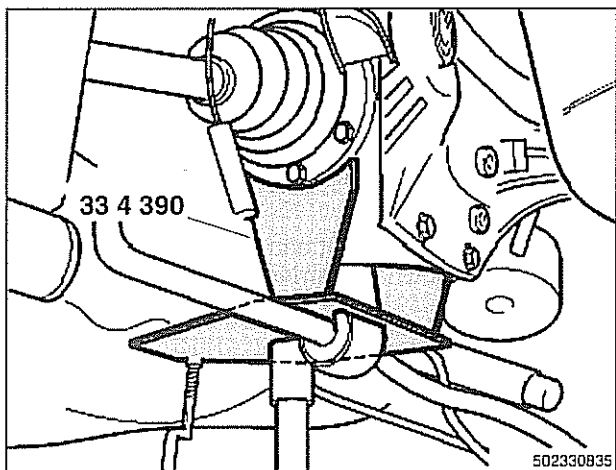
*Vehicle will lower when the air pipes are opened.*

- Working underneath rear suspension, lift wheel bearing carrier to relieve rear spring tension. Then unbolt air spring mounting bolt from seat on wheel bearing carrier.
- Support final drive unit from below using transmission jack (BMW special tools 00 2 030 and 33 4 390 or equivalent).

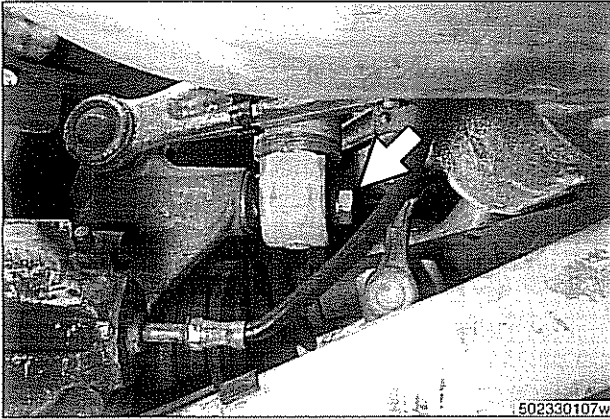
**NOTE—**

*Special tool 33 4 390 will need modifications to cradle the final drive properly.*

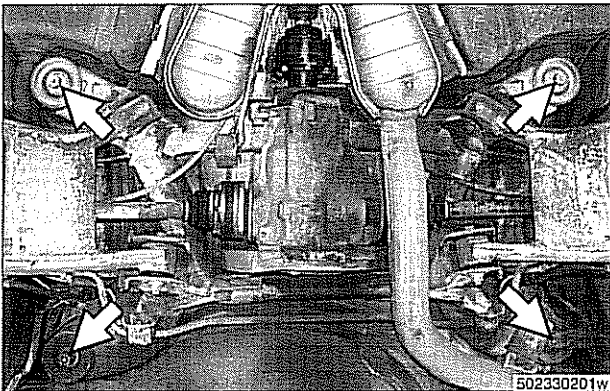
- Remove right and left suspension trim panels (arrow).



## Rear Suspension

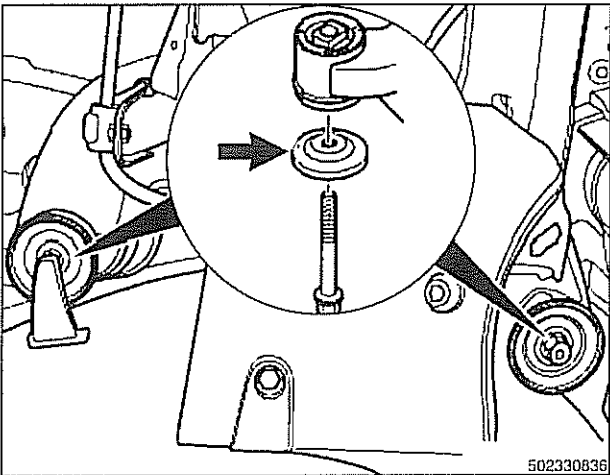


➤ Remove right and left lower strut mount bolts (arrow).



➤ Remove rear suspension subframe by removing 4 mounting bolts (arrows).

– Carefully lower rear suspension subframe away from body to remove.



➤ To install, jack subframe into position. Install and tighten subframe mounting bolts. Note that on each bolt, rubber—coated detent plate (arrow) must be installed at rear in driving direction.

- Models with coil springs: Fit springs correctly in lower spring seats.
- Models with air suspension: Fit eccentric lug at bottom of air spring in recess of wheel carrier spring seat.

### Tightening torques

Air spring to wheel bearing carrier	20 Nm (15 ft-lb)
Rear subframe to body (M12)	163 Nm (120 ft-lb)

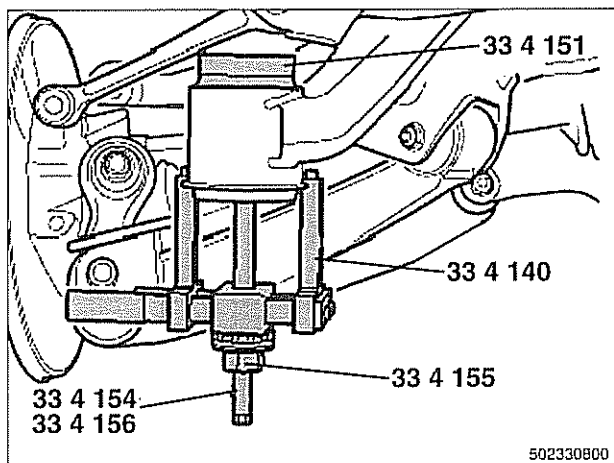
- Remainder of installation is reverse of removal, noting the following.
  - Tighten suspension arm and shock absorber fasteners to final torque only after vehicle has been lowered and suspension has settled.

#### Tightening torques

ABS pulse sensor to wheel bearing carrier	8 Nm (6 ft-lb)
Air line connection	2 Nm (18 in-lb)
Brake rotor to hub	16 Nm (12 ft-lb)
Driveshaft CV joint to final drive flange	
• M10 (Torx bolts)	70 Nm (51 ft-lb)
• M8 (compression nut)	32 Nm (24 ft-lb)
Rear brake pad carrier (caliper) to wheel bearing carrier	65 Nm (48 ft-lb)
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)

#### Rear subframe mounting bushings, removing and installing

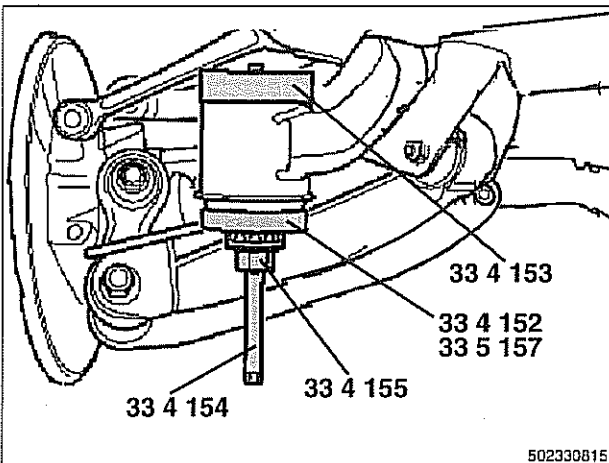
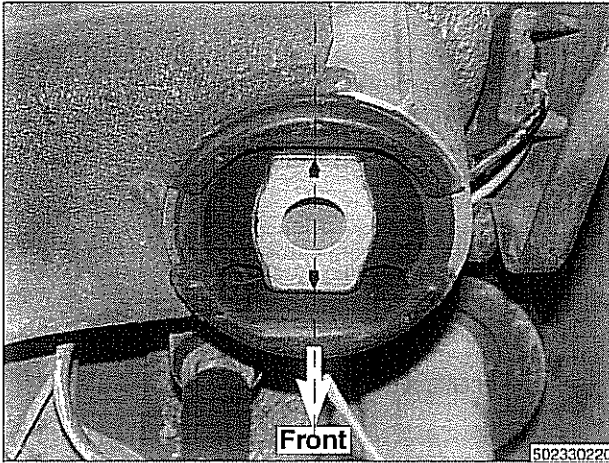
- Remove rear subframe mounting bolts as described earlier. Lower subframe approximately 40 – 45 mm (1 — 2 in).
- ▲ Install BMW special tools 33 4 140, 33 4 151, 33 4 154, 33 4 155, 33 4 156 as shown.
  - Use hot air gun with a maximum output temperature of 600° C (1100° F) to heat bushing area of subframe for no more than 2 minutes. Remove rubber mount from subframe.



#### CAUTION—

- Aluminum suspension parts may be severely damaged with intense heat.
- Heating for 2 minutes with the recommended heat source is intended to keep the temperature of the aluminum parts below the safety threshold of 80°C (176°F).

## Rear Suspension



⚠ When installing subframe bushing, be sure alignment arrows point front and rear.

- Coat new mount with Circolight® anti-friction agent.

⚠ Draw new bushing into subframe using BMW special tools 33 4 152, 33 4 153, 33 4 154, 33 4 155, 33 4 157.

— Remainder of installation is reverse of removal, noting the following.

- Tighten suspension arm and shock absorber fasteners to final torque only after vehicle has been lowered and suspension has settled.

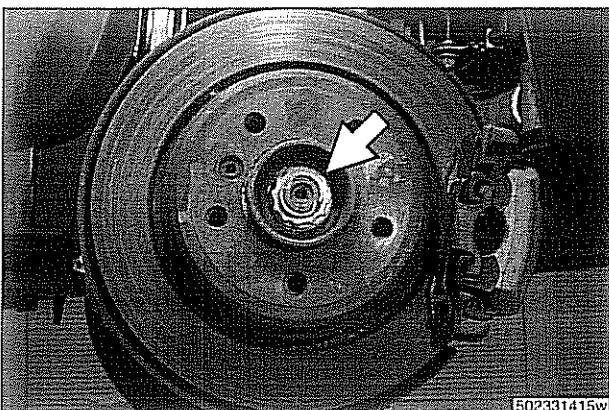
## REAR WHEEL BEARINGS

### Rear wheel bearing carrier, removing and installing (sedan models)

— Raise rear end of car and remove wheel.

#### **WARNING—**

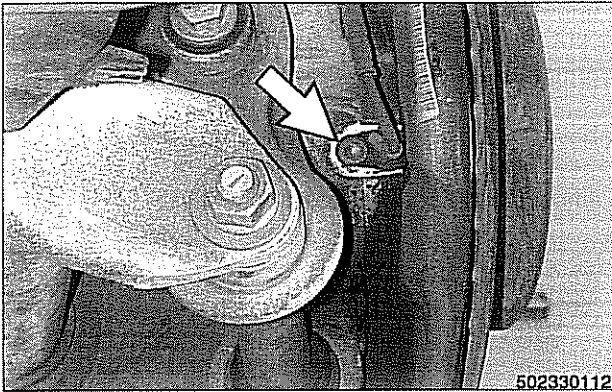
*Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.*



⚠ With an assistant applying brakes, break free and remove staked collar nut (arrow).

— Remove brake caliper and brake disc. Hang brake caliper aside with stiff wire. Do not disconnect brake fluid hose. See 340 Brakes.

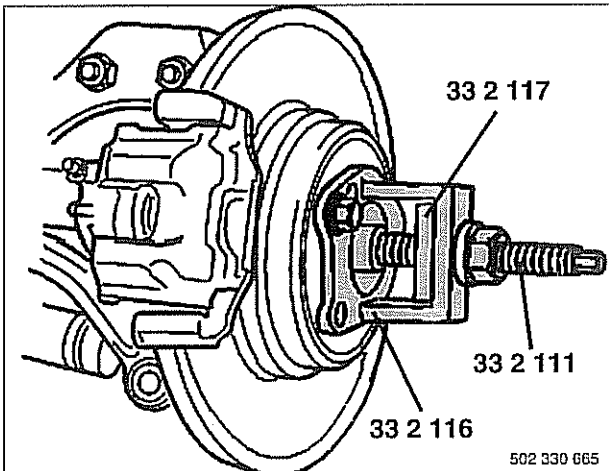
— Disconnect parking brake cable from brake shoe expander. See 340 Brakes.



- Remove ABS sensor mounting fastener (arrow) and sensor.

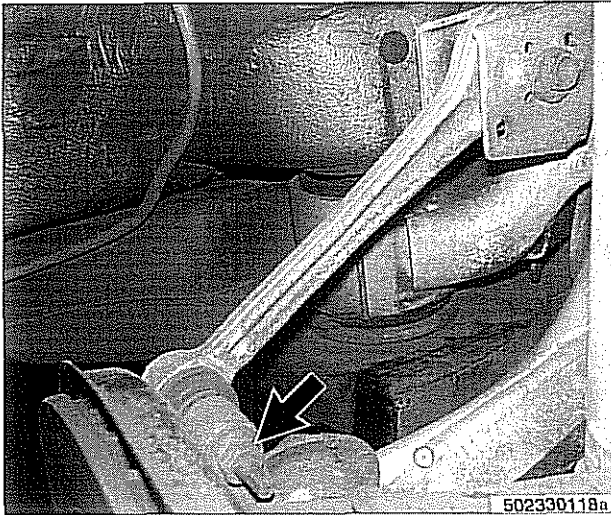


- Remove outer swing arm nut (arrow) and bolt.



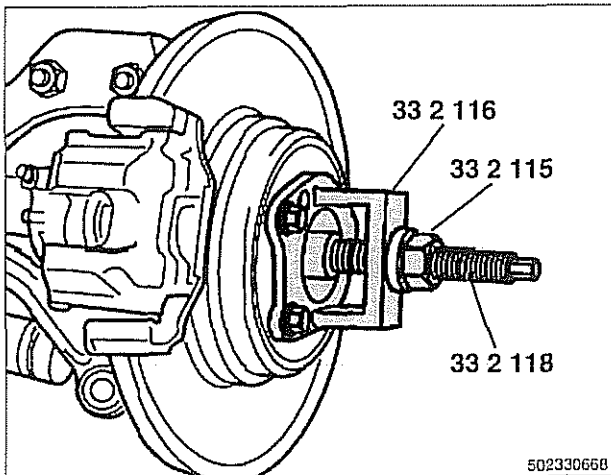
- Press out axle shaft using BMW special tools 33 2 117, 33 2 116 and 33 2 111.
- Support wheel bearing carrier. Remove lower strut mounting fastener.

## Rear Suspension



◀ Remove upper front control arm (traction strut) ball joint mounting nut (**arrow**). Press control arm ball joint out of wheel bearing carrier.

- Repeat above process on upper rear control arm.
- Remove wheel bearing carrier assembly.



◀ When reinstalling, pull axle shaft through wheel bearing carrier using BMW special tools 33 2 115, 33 2 116 and 33 2 118.

- Lightly oil bearing surface of axle collar nut and install. Tighten collar nut firmly, but do not fully tighten it at this time.

**WARNING —**

*For safety reasons, the axle collar nut should only be tightened to its final torque with the wheel installed and the car lowered to the ground. However, loading the bearing without the nut tightened sufficiently may damage the bearing.*



- Remainder of installation is reverse of removal, noting the following.
  - Always use new self-locking nuts.
  - Make sure all threaded bolts, nuts and mating surfaces are clean.
  - Make sure long lower strut bushing fits in hole in wheel bearing carrier.
  - Tighten fasteners to final torque only after vehicle has been lowered and suspension has settled.
  - Stake axle collar nut after tightening.

#### Tightening torques

ABS pulse sensor to wheel bearing carrier	8 Nm (6 ft-lb)
Brake rotor to hub	16 Nm (12 ft-lb)
Rear brake pad carrier (caliper) to wheel bearing carrier	65 Nm (48 ft-lb)
Rear axle shaft to hub (M27)	300 Nm (221 ft-lb)
Rear strut to wheel bearing carrier	127 Nm (94 ft-lb)
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)
Swing arm to wheel bearing carrier	256 Nm (189 ft-lb)
Upper front control arm (traction strut) to wheel carrier	65 Nm (48 ft-lb)
Upper rear control arm to wheel carrier	142 Nm (105 ft-lb)

### Rear wheel bearing carrier, removing and installing (Sport Wagon models)

- Raise rear end of car and remove wheel.

#### **WARNING** —

Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.

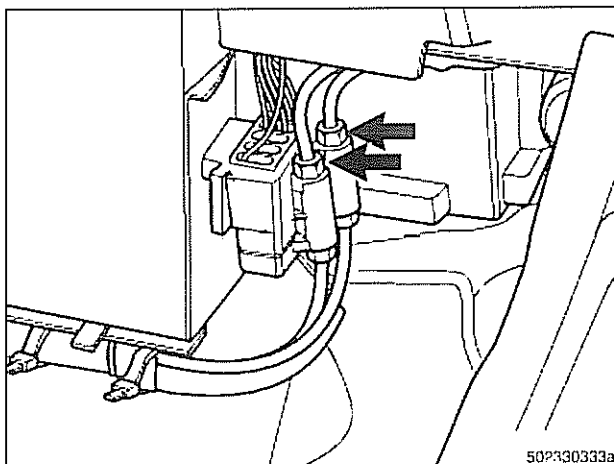
#### **CAUTION** —

Models with air springs: Disable air supply pump by disconnecting electrical plug before performing any repairs. Pump is located beneath a cover under the spare tire in the floor of the cargo compartment.

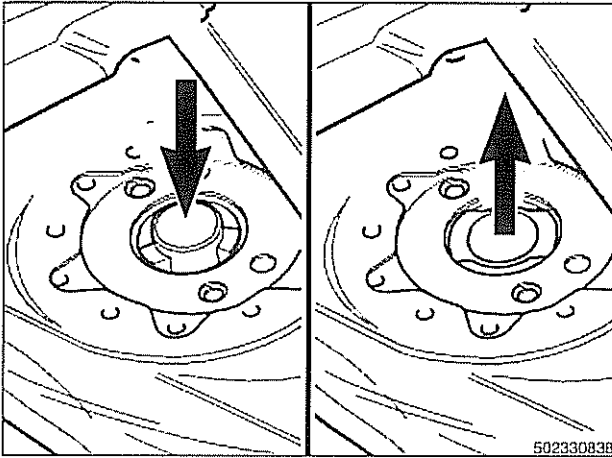
- ◀ Models with air springs: Loosen compressed air pipes (**arrows**) at air distribution assembly to release system pressure.

#### **WARNING** —

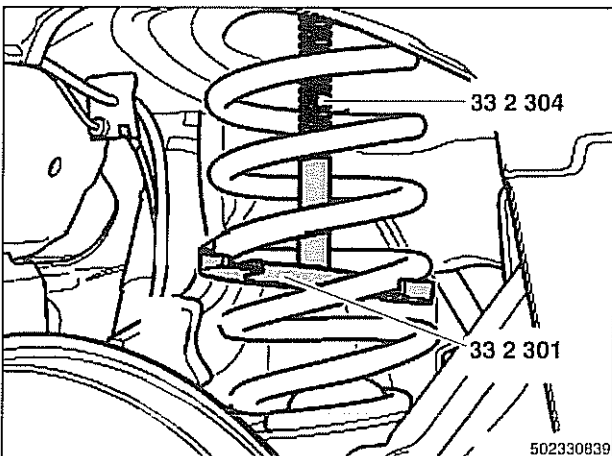
Vehicle will lower when the air pipes are opened.



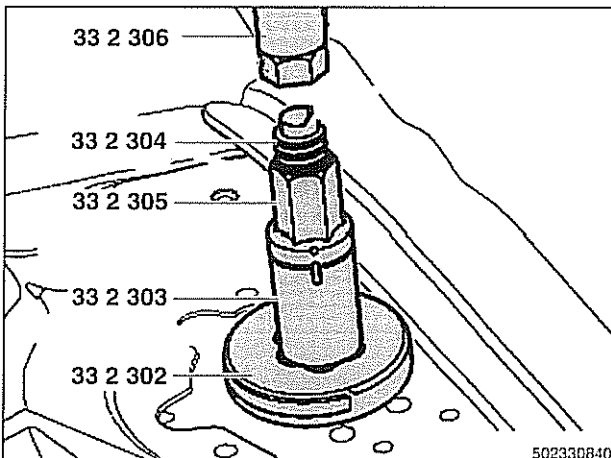
## Rear Suspension



- Working underneath rear suspension, lift wheel bearing carrier to relieve rear spring tension. Then unbolt air spring mounting bolt from seat on wheel bearing carrier.
- Models with rear coil springs: Remove cargo compartment floor carpet.
- Working at top of coil spring, press center cap down or pry upward to remove. If pushed down, remove from inside coil spring from under car.

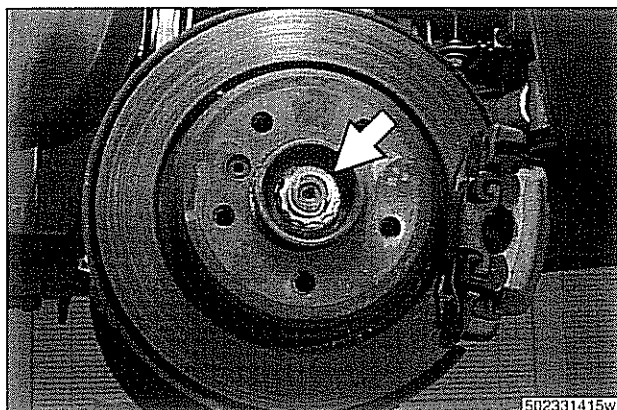


- Working from underneath, position BMW special tool 33 2 301 between 2nd and 3rd spring coil from bottom.
  - Make sure tool recess faces upward.
  - Working in cargo compartment, guide BMW special tool 33 2 304 from above and thread into special tool 33 2 301.



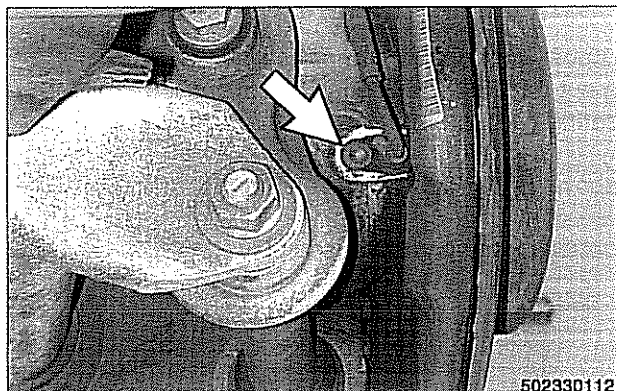
- Working in cargo compartment, attach BMW special tools 33 2 302, 33 2 303 and 33 2 305 to special tool 33 2 304.
  - Use special tool 33 2 306 to compress spring.
  - Tighten until lower spring coil lifts off spring seat on wheel bearing carrier.

## Rear Suspension



◀ With an assistant applying brakes, break free and remove staked collar nut (**arrow**).

- Remove brake caliper and brake disc. Hang brake caliper aside with stiff wire. Do not disconnect brake fluid hose. See **340 Brakes**.
- Disconnect parking brake cable from brake shoe expander. See **340 Brakes**.

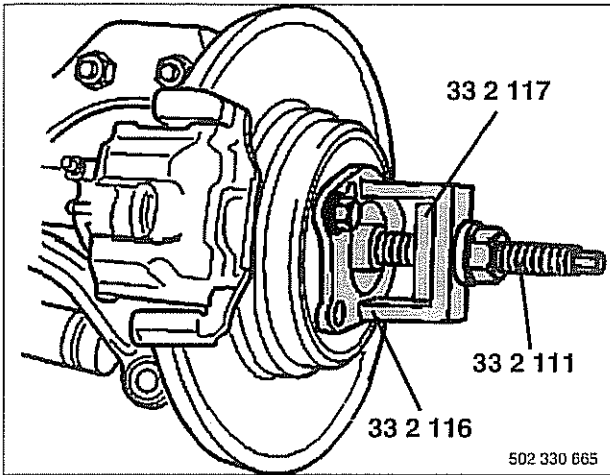


◀ Remove ABS sensor mounting fastener (**arrow**) and sensor.

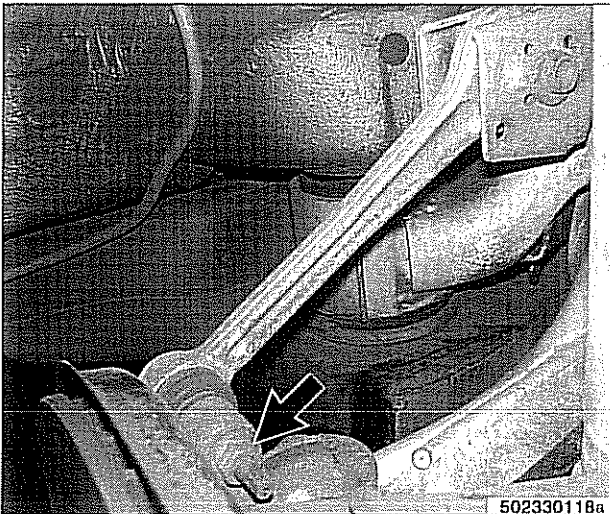


◀ Remove outer swing arm nut (**arrow**) and bolt.

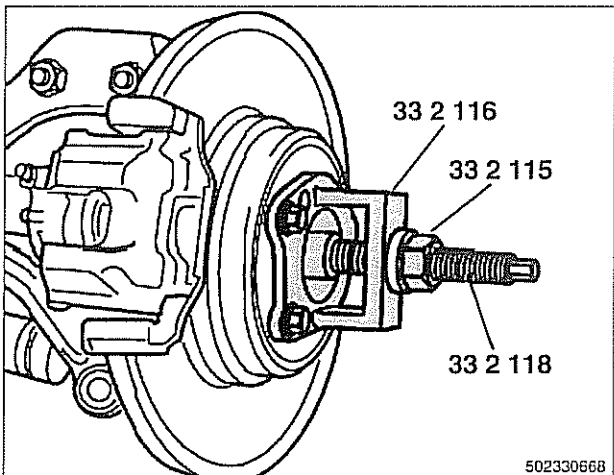
## Rear Suspension



- Press out axle shaft using BMW special tools 33 2 117, 33 2 116 and 33 2 111.



- Remove upper front control arm (traction strut) ball joint mounting nut (arrow). Press control arm ball joint out of wheel bearing carrier.
- Repeat above process on upper rear control arm.
- Remove wheel bearing carrier assembly.



- When reinstalling, pull axle shaft through wheel bearing carrier using BMW special tools 33 2 115, 33 2 116 and 33 2 118.
- Lightly oil bearing surface of axle collar nut and install. Tighten collar nut firmly, but do not fully tighten it at this time.

**WARNING—**

*For safety reasons, the axle collar nut should only be tightened to its final torque with the wheel installed and the car lowered to the ground. However, loading the bearing without the nut tightened sufficiently may damage the bearing.*

- Remainder of installation is reverse of removal, noting the following.
  - Models with coil springs: Fit spring correctly in lower spring seat.
  - Models with air suspension: Fit eccentric lug at bottom of air spring in recess of wheel carrier spring seat.
  - Always use new self-locking nuts.
  - Make sure all threaded bolts, nuts and mating surfaces are clean.
  - Tighten fasteners to final torque only after vehicle has been lowered and suspension has settled.
  - Stake axle collar nut after tightening.

#### Tightening torques

ABS pulse sensor to wheel bearing carrier	8 Nm (6 ft-lb)
Air spring to wheel bearing carrier	20 Nm (15 ft-lb)
Brake rotor to hub	16 Nm (12 ft-lb)
Rear axle shaft to hub (M27)	300 Nm (221 ft-lb)
Rear brake pad carrier (caliper) to wheel bearing carrier	65 Nm (48 ft-lb)
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)
Swing arm to wheel bearing carrier	256 Nm (189 ft-lb)
Upper front control arm (traction strut) to wheel carrier	65 Nm (48 ft-lb)
Upper rear control arm to wheel carrier	142 Nm (105 ft-lb)

### Rear wheel bearing, replacing

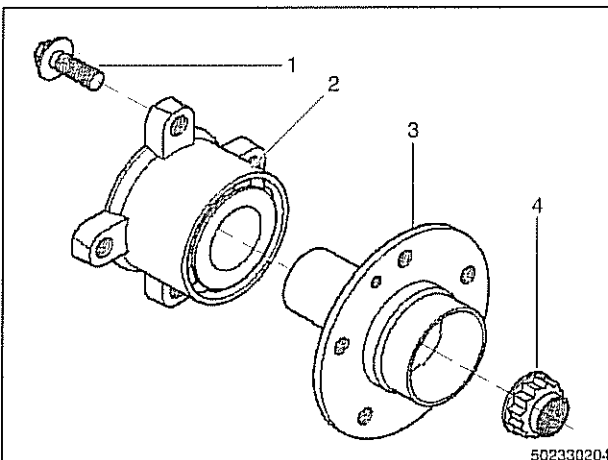
- ◀ The rear wheel bearing is integrated with its mounting flange.

1. Torx bolt
2. Wheel bearing and mounting flange
3. Wheel hub
4. Collar nut

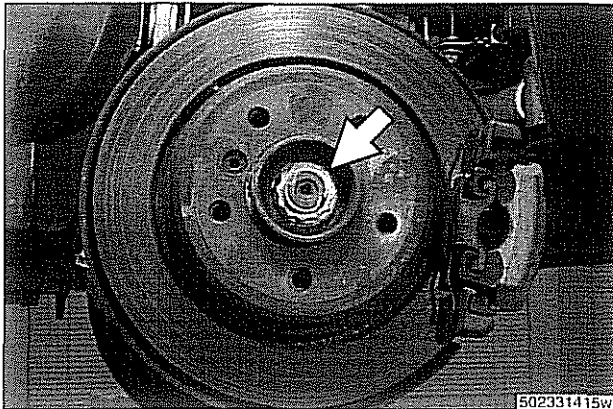
- Raise rear end of car and remove wheel.

#### **WARNING** —

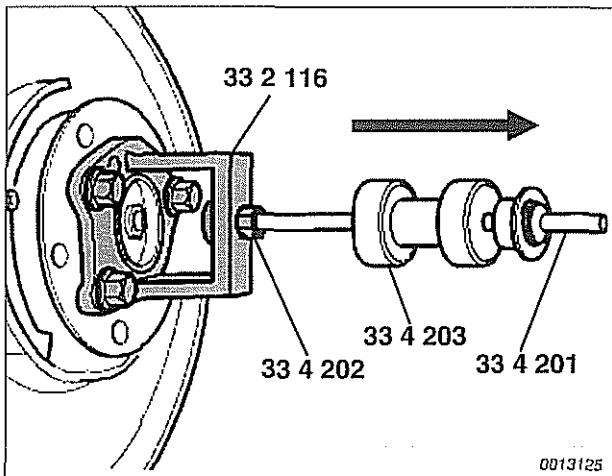
*Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.*



## Rear Suspension



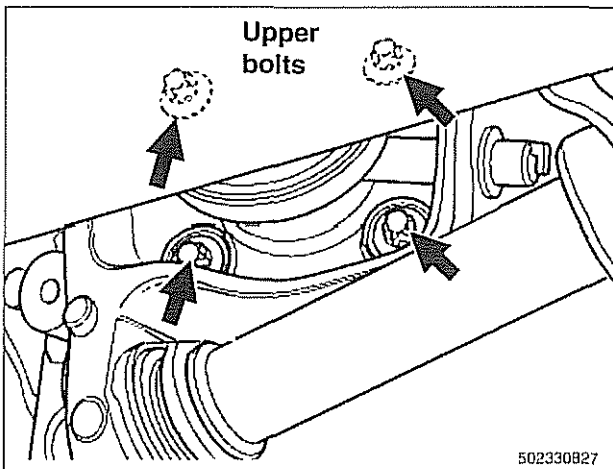
- ◀ With an assistant applying brakes, break free and remove staked collar nut (**arrow**).
- If equipped, disconnect brake pad sensor connector at brake caliper.
- Remove brake caliper assembly and rotor. See **340 Brakes**. Leave brake hose connected to caliper. Suspend caliper assembly from chassis using stiff wire.
- Remove ABS pulse sensor at wheel bearing carrier.



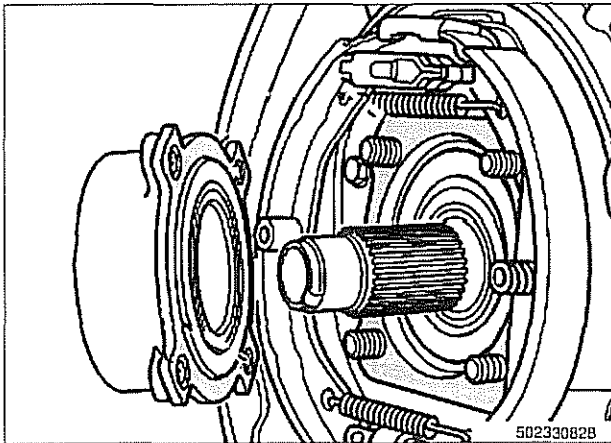
- ◀ Remove drive flange from bearing assembly using impact style puller (BMW special tools 33 2 116, 33 4 201/202/203 or equivalent).

**CAUTION—**

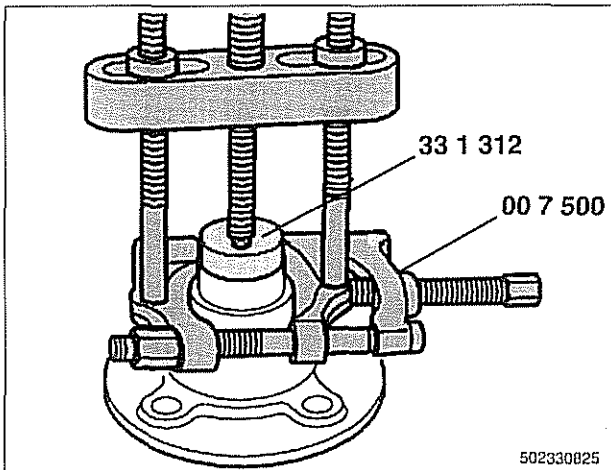
*The wheel bearing is destroyed when the drive flange is removed. Do not attempt to reuse bearing.*



- ◀ Remove four wheel bearing flange (Torx) bolts (**arrows**).



- ◀ Remove wheel bearing assembly.

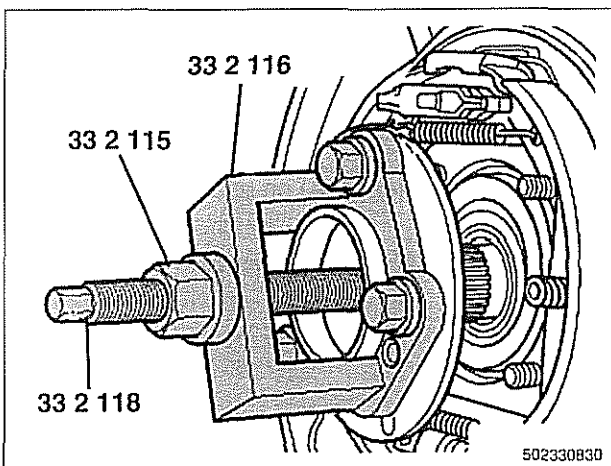


- ◀ Remove inner wheel bearing race with BMW special tools 33 1 312 and 00 7 500 or equivalent.
- Install new wheel bearing assembly. Make sure mounting surfaces are free of dirt and grease.

#### Tightening torques

Wheel bearing to wheel bearing carrier (use new Torx bolts)

- Stage 1 30 Nm (22 ft-lb)
- Stage 2 90° torque angle



- ◀ Reinstall wheel hub.
  - Lightly oil wheel bearing and axle shaft contact surfaces on wheel hub.
  - Use BMW special tools 33 2 115, 33 2 116 and 33 2 118 or equivalent press tools to press wheel hub to bearing.

#### CAUTION—

BMW specifies special tools to pull the wheel hub through the wheel bearing into position. If using alternative tools, be sure to support the bearing inner race when pressing or pulling the hub into place.

- Lightly oil the bearing surface of the axle collar nut and install. Tighten collar nut firmly, but do not fully tighten it at this time.

#### WARNING—

For safety reasons, the axle collar nut should only be tightened to its final torque with the wheel installed and the car lowered to the ground. However, loading the bearing without the nut tightened sufficiently may damage the bearing.

## Rear Suspension

- Install ABS sensor and road wheel.
- Lower car to ground. With an assistant applying brakes, use new axle collar nut to tighten to final torque. Stake nut.
- Remainder of installation is reverse of removal.

### Tightening torques

ABS pulse sensor to wheel bearing carrier	8 Nm (6 ft-lb)
Brake disc to hub	16 Nm
Rear brake pad carrier (caliper) to wheel bearing carrier	65 Nm (48 ft-lb)
Rear axle shaft to hub (M27)	300 Nm (221 ft-lb)
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)

## REAR STABILIZER BAR

The rear stabilizer bar is mounted to the rear subframe and attached via stabilizer bar links to the lower swing arms.

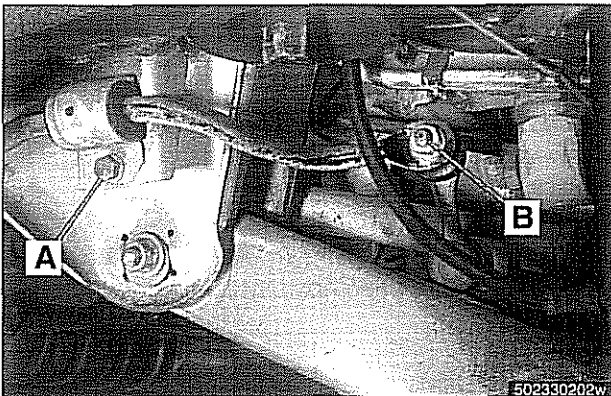
### Stabilizer bar, removing and installing

- Raise rear end of car.

#### **WARNING—**

*Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.*

- Paint mark stabilizer bar on left side for ease of assembly.
- ◀ Remove stabilizer link fastener (A) on each side. Press out stabilizer link ball joints.
  - Remove stabilizer support bracket fastener (B) on each side.
- Remove stabilizer bar.
- Installation is reverse of removal. Use previously made paint mark for reassembly.

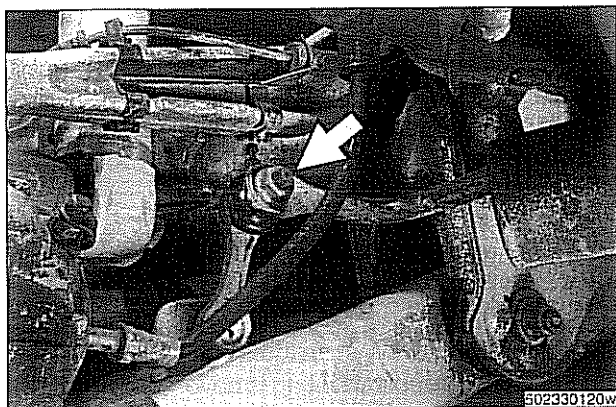


### Tightening torques

Stabilizer link to stabilizer bar	42 Nm (32 ft-lb)
Stabilizer bar bracket to subframe (M8)	22 Nm (16 ft-lb)



### Stabilizer bar link, removing and installing



- Remove stabilizer link mounting nut (**arrow**) at stabilizer bar.



- Remove stabilizer link mounting nut (**arrow**) at swing arm.
- Press out stabilizer link ball joints.
- Installation is reverse of removal.

#### Tightening torques

Stabilizer link to swing arm	65 Nm (48 ft-lb)
Stabilizer link to stabilizer bar	42 Nm (32 ft-lb)

## ELECTRONIC HEIGHT CONTROL (EHC) COMPONENT REPLACEMENT

Sport Premium rear suspension is an option on Sport Wagon models and standard on 1999 and later V-8 Sport Wagons. This suspension incorporates electronic height control (EHC) using air springs.

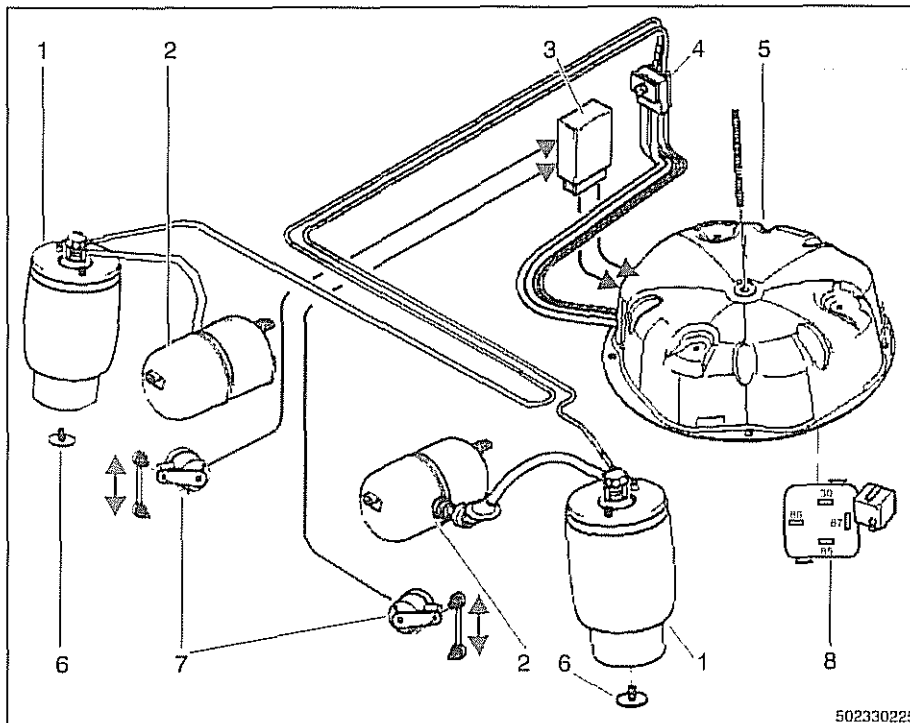
With vehicle lifted off the ground, if the rear air springs can be compressed by hand, either the spring is defective or the system is depressurized.

Locate EHC faults using BMW scan tools DIS or MoDiC. EHC description and some troubleshooting is covered in **300 Suspension, Steering and Brakes—General**.

Air spring replacement is covered earlier in this chapter. See **Air spring, removing and installing**.

### CAUTION—

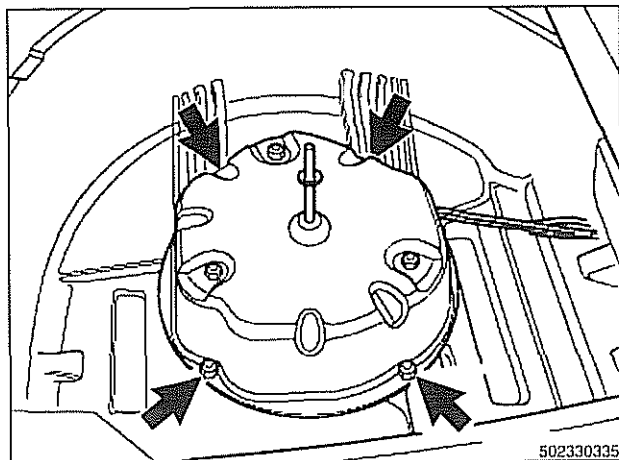
Maintain high levels of cleanliness around air line connections when disassembling and assembling air suspension components. Even small dirt particles can cause leakage in the pressurized system.



### Electronic height control (EHC) components

1. Air spring
2. 1 liter air reservoir
3. EHC control module
4. Air supply distributor
5. Air supply pump (under spare tire)
6. Air spring mounting bolt (at wheel bearing carrier)
7. Rear ride height sensors (Hall effect)
8. Air supply pump relay

### Air compressor pump relay, removing and installing

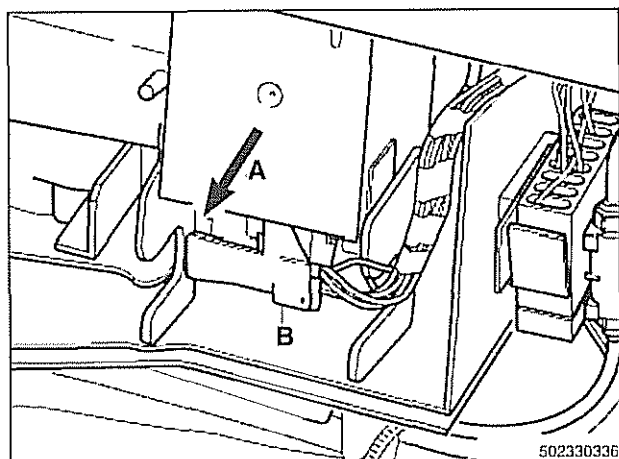


- Working in cargo compartment, remove spare wheel.
- Remove air supply pump fasteners (arrows). Turn pump over.
- Turn relay plug 45° and remove relay.

### EHC control module, removing and installing

The EHC control module is mounted on the right side of the spare tire well in the cargo compartment.

- Remove spare tire.
- Remove electrical components cover (A).
- Release control module wiring harness plug locking clip (B) and remove module.
- Installation is reverse of removal.
- After assembly, reset ride height using BMW diagnostic scan tool DIS.



### Air supply unit, removing and installing

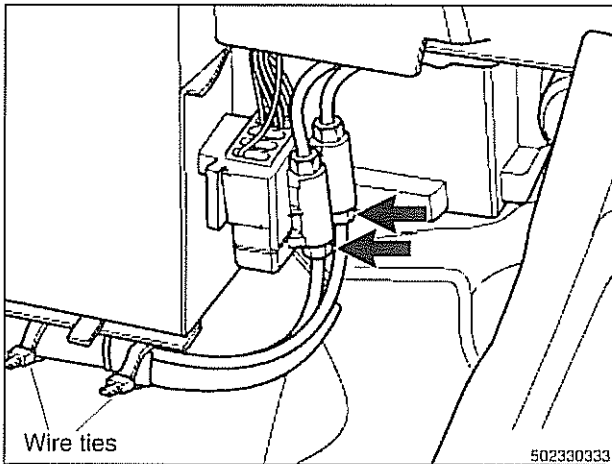
#### CAUTION—

Maintain high levels of cleanliness around air line connections when disassembling and assembling air suspension components. Even small dirt particles can cause leakage in the pressurized system.

When the air supply unit is removed for any reason, reset ride height using BMW scan tools DIS or MoDiC.

- Remove spare tire.

## Rear Suspension

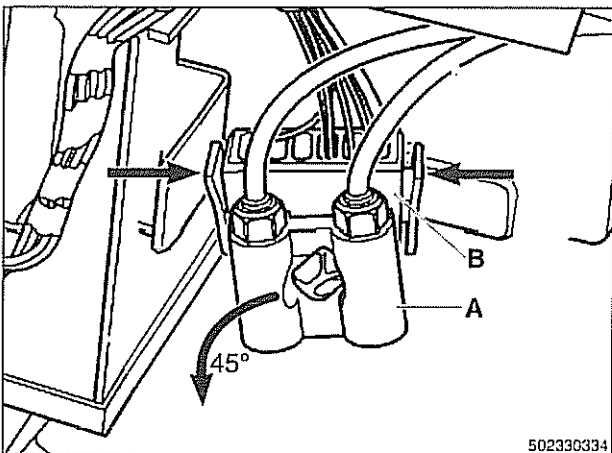


- Remove air line fittings (A) from bottom of air distribution connectors.

- Cut off wire ties.

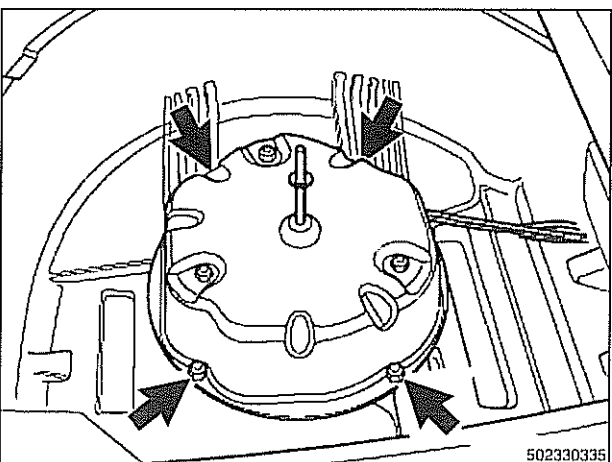
**WARNING—**

*Vehicle will lower when the air pipes are opened.*



- Rotate air line distribution connector (A) 45° in direction of arrow to remove.

- Rotate electrical connector (B) 45° in direction of arrow to remove.
- Compress wiring connector locking clips (arrows) and disconnect wiring harness.



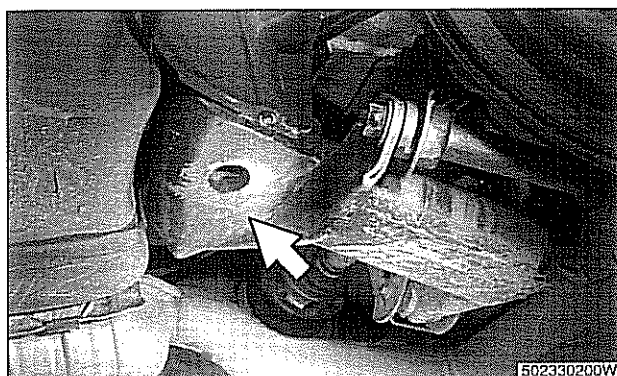
- Remove air supply unit mounting fasteners (arrows) and remove unit.

— Installation is reverse of removal.

- When installing air lines always match line colors.
- After assembly, reset ride height using BMW diagnostic scan tool DIS.

## Ride height sensor, removing and installing

Hall effect sensors for vehicle height detection are mounted on the left and right sides of the rear suspension. A coupling rod mounted between the rear suspension arm and the sensor arm is used to send a varying voltage signal to the EHC control module.



- Raise car and support safely.

### **WARNING** —

*Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.*

- ◀ Working underneath rear of car, remove trim panel (**arrow**) just ahead of suspension subframe.

- Disconnect electrical harness connector from sensor.

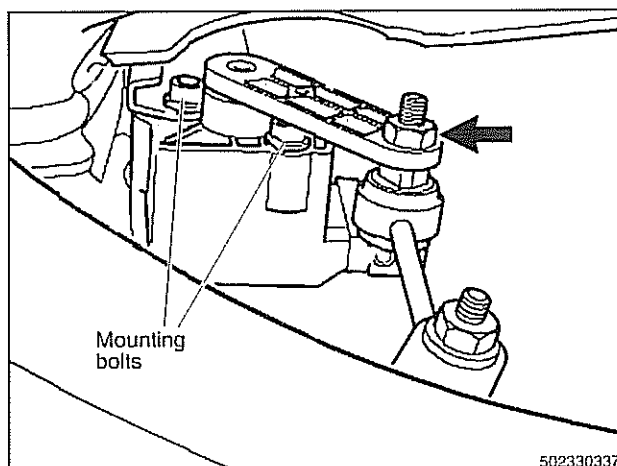
- ◀ Remove control rod mounting nut (**arrow**). Turn control rod to access sensor mounting fastener.

- Remove sensor mounting fasteners.

- Remove ride height sensor.

- Installation is reverse of removal.

- Make sure sensor lever points outward. After assembly, re-set ride height using BMW diagnostic scan tool DIS.



### Tightening torques

Ride height sensor to bracket	5 Nm (44 lb-in)
Lever to height sensor	9 Nm (80 lb-in)





# 331 Final Drive

<b>General</b> .....	331-2
Special tools .....	331-2
Aluminum suspension components .....	331-4
<b>Final Drive</b> .....	331-5
Final drive, removing and installing .....	331-5
Differential oil level, checking .....	331-6
Final drive input shaft seal, replacing .....	331-7
Final drive output shaft seals, replacing ...	331-10
Final drive cover, removing and installing .	331-12
Final drive mounts, replacing .....	331-12

<b>Drive Axles</b> .....	331-14
Drive axle assembly .....	331-14
Drive axle, removing and installing (sedan) .....	331-14
Drive axle, removing and installing (Sport Wagon) .....	331-15
CV joint boots .....	331-17

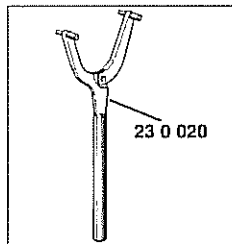
## GENERAL

This repair group covers removal and repair information for the final drive (differential), axle shafts, CV joints, CV joint boots, and final drive seal replacement.

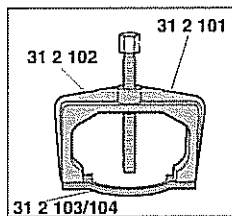
Internal repairs of the differential assembly are not covered in this manual.

## Special tools

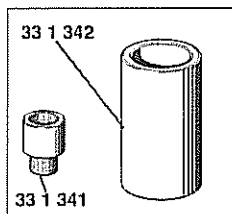
BMW recommends some special tools for the removal of the drive axles as well as the installation of rear differential input and output drive flange seals. Some common pullers and drifts can often be substituted for these tools.



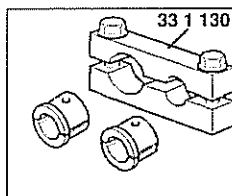
- ◀ Drive flange holder  
(Tool No. BMW 2 30 020)



- ◀ Drive flange puller  
(Tool No. BMW 31 2 101 / 31 2 102 / 31 2 103 / 31 2 104)

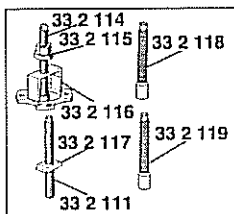


- ◀ Drive pinion set  
(Tool No. BMW 33 1 340)

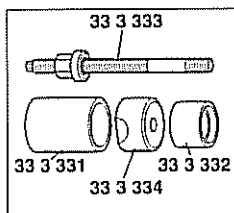


- ◀ Clamping tool set  
(Tool No. BMW 33 2 101 / 33 2 102 / 33 2 103)

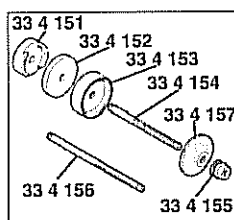




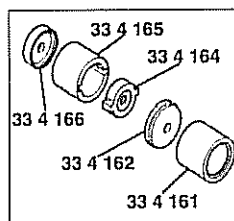
Output shaft tool set  
 (Tool No. BMW 33 2 111 / 33 2 114 / 33 2 115 / 33 2 116 /  
 33 2 117 / 33 2 118 / 33 2 119)



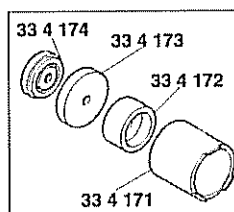
Trailing arm tool set  
 (Tool No. BMW 33 3 331 / 33 3 332 / 33 3 333 / 33 3 334)



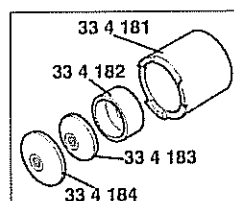
Final drive mount set  
 (Tool No. BMW 33 4 151 / 33 4 152 / 33 4 153 / 33 4 154 /  
 33 4 155 / 33 4 156 / 33 4 157 / 33 4 158 / 33 4 159)



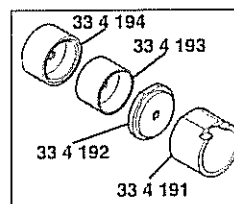
Differential mount press set  
 (Tool No. BMW 33 4 161 / 33 4 162 / 33 4 164 / 33 4 165 /  
 33 4 166)



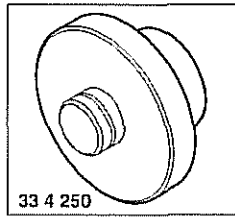
Differential mount press set  
 (Tool No. BMW 33 4 171 / 33 4 172 / 33 4 173 / 33 4 174)



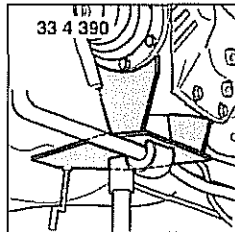
Differential mount press set  
 (Tool No. BMW 33 4 181 / 33 4 182 / 33 4 183 / 33 4 184)



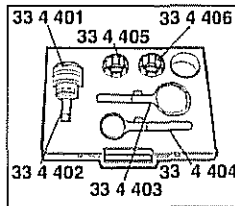
Support tube set  
 (Tool No. BMW 33 4 191 / 33 4 192 / 33 4 193 / 33 4 194)



- Final drive output shaft seal tool  
(Tool No. BMW 33 4 250)



- Final drive support  
(Tool No. BMW 33 4 390)



- Pulling set  
(Tool No. BMW 33 4 401 / 33 4 402 / 33 4 403 / 33 4 404 /  
33 4 405 / 33 4 406)

## Aluminum suspension components

In order to reduce vehicle weight, aluminum suspension components are used in some models. A test with a magnet will easily reveal the metal used. If working with aluminum components, be sure to read and follow the cautions below.

### CAUTION—

- Due to the chemical and corrosion characteristics of aluminum, do not bring into contact with battery acid.
- Do not use wire brushes with brass or iron bristles. Only use brushes with stainless steel bristles.
- Do not expose to flying sparks from grinding/cutting operations.
- Do not subject to steel welding splashes.
- Do not expose to temperatures over 80°C (176°F), even for short periods. Temperatures in painting facilities are not a problem.

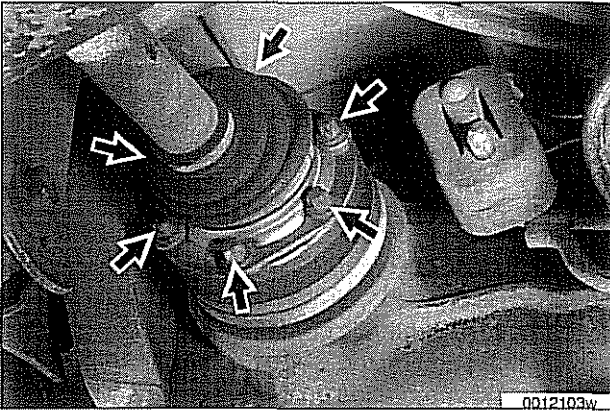
## FINAL DRIVE

### Final drive, removing and installing

- Raise rear of car.

**WARNING—**

*Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath structural chassis points. Do not place jack stands under suspension parts.*



- Remove exhaust system. See **180 Exhaust System**.
- Disconnect drive shaft from final drive. See **260 Driveshaft**.
- Remove drive axle CV joint bolts (arrows) at left and right sides. Suspend drive axles from body using stiff wire.

- Support final drive with BMW special tool 33 4 390.
  - Remove front final drive mounting bolt.
  - Remove rear final drive mounting bolts (2).
  - Carefully lower final drive unit.
- To install, use BMW special tool 33 4 390 to lift final drive into place.

**CAUTION—**

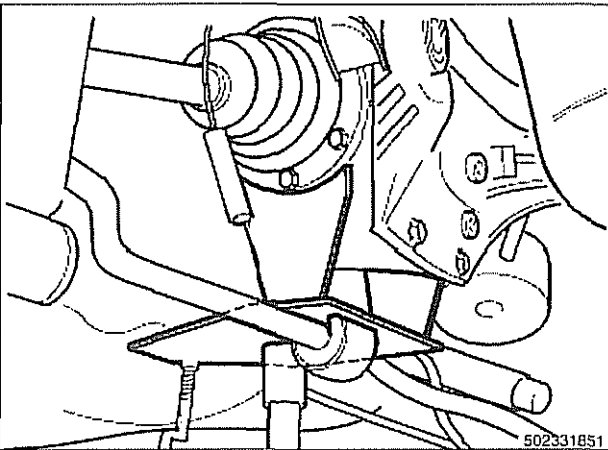
*The following sequence must be used when installing the final drive to prevent torsion stress on the final drive during installation.*

- Install mounting bolts and finger tighten only.
- Remove final drive support.
- Tighten both rear mounting bolts.
- Tighten front mounting bolt.

**NOTE—**

*Use new self-locking nuts.*

- Check differential oil level. See **Differential oil level, checking**.
- Remainder of installation is reverse of removal.

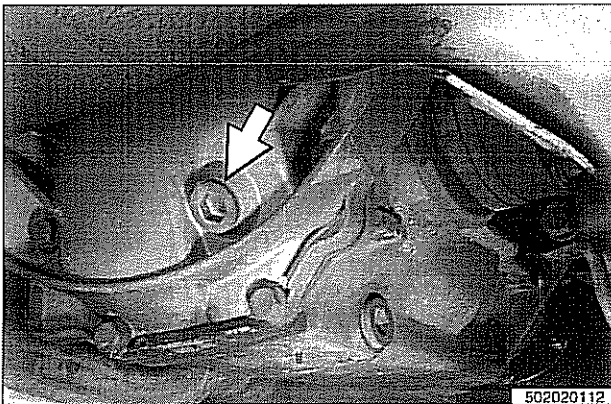


### Tightening torques

Final drive to rear axle carrier	105 Nm (77 ft-lb)
Driveshaft CV joint to final drive flange	
• M10 (Torx bolt)	70 Nm (51 ft-lb)
• M8 (compression nut)	32 Nm (24 ft-lb)
Drive axle to final drive flange	
• Torx bolts (M10)	83 Nm (61 ft-lb)
• Torx bolt with ribbed teeth (M10)	64 Nm (47 ft-lb)
• Torx bolt with ribbed teeth (M10 silver)	80 Nm (59 ft-lb)
• Torx bolt with ribbed teeth (M10 black)	100 Nm (74 ft-lb)
• Torx bolt with ribbed teeth (M12)	135 Nm (100 ft-lb)

### Differential oil level, checking

The E39 differential is filled with lifetime oil that ordinarily does not need to be changed. BMW recommends using only a specially formulated synthetic gear oil (SAF-XO) that is available through an authorized BMW dealer parts department. For additional information on this lubricant and any other lubricants that may be compatible, contact an authorized BMW dealer service department.



◀ Check rear differential oil level at filler plug (arrow).

- Check lubricant level with car on a level surface:
  - Level is correct when fluid just reaches edge of filler hole.
  - If necessary, top up fluid.
  - Replace filler plug sealing ring.
  - Install and tighten oil filler plug when oil level is correct.

#### NOTE—

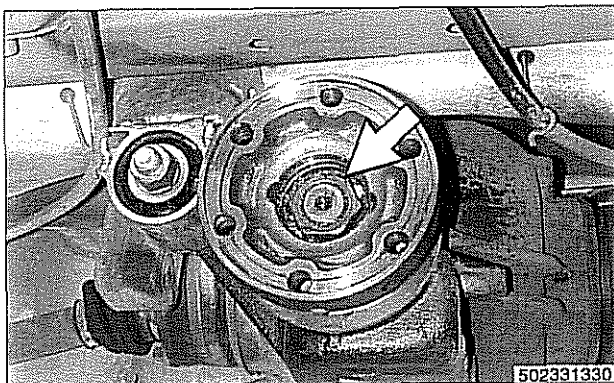
- Use either a 14 mm or 17 mm Allen socket to remove the drain plug.
- If car is raised in the air, it should be level when checking or filling final drive fluid level.

### Tightening torque

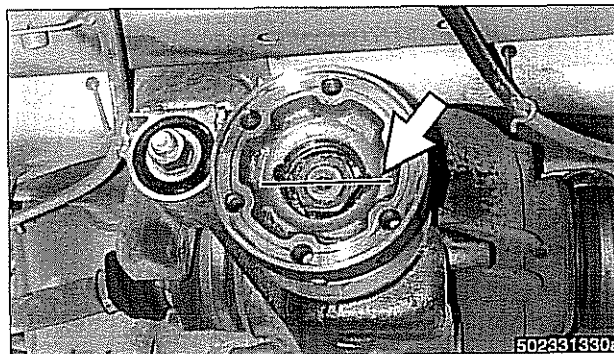
Filler plug to final drive housing	70 Nm (52 ft-lb)
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## Final drive input shaft seal, replacing

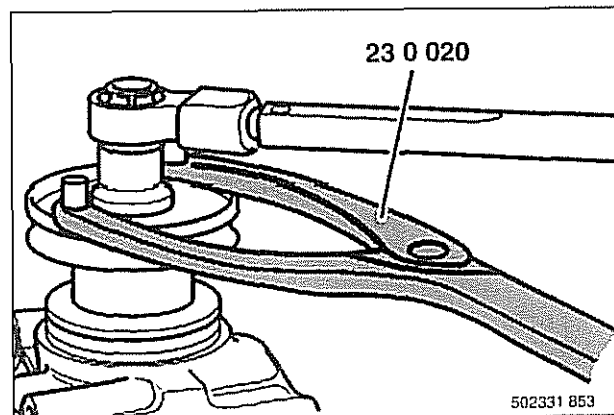
- Remove exhaust system. See 180 Exhaust System.
- Remove drive shaft. See 260 Driveshaft.
- ⚡ Lift out collar nut locking plate (arrow).



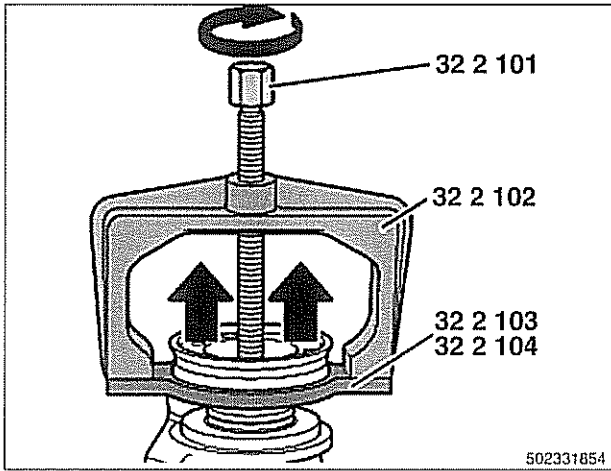
- ⚡ Mark position of collar nut to pinion shaft (arrow) with a center punch.



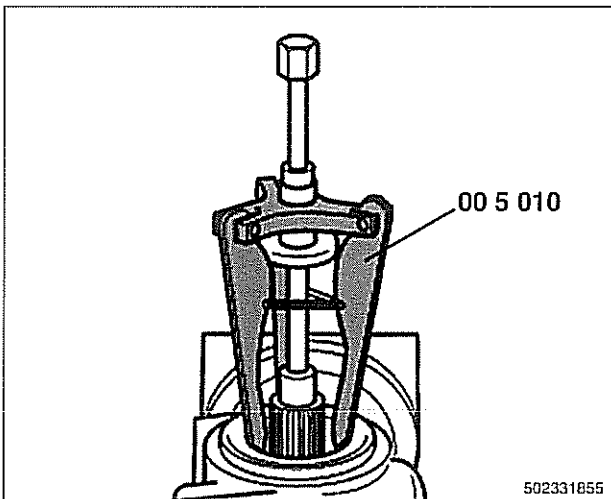
- ⚡ While counterholding drive flange with special BMW tool 23 0 020 loosen and remove collar nut.



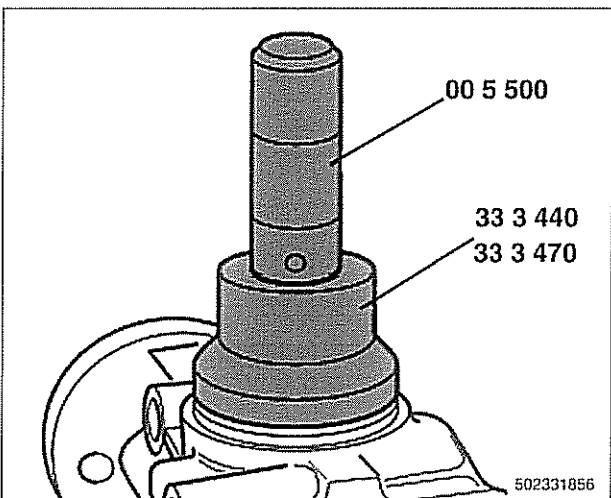
Final Drive



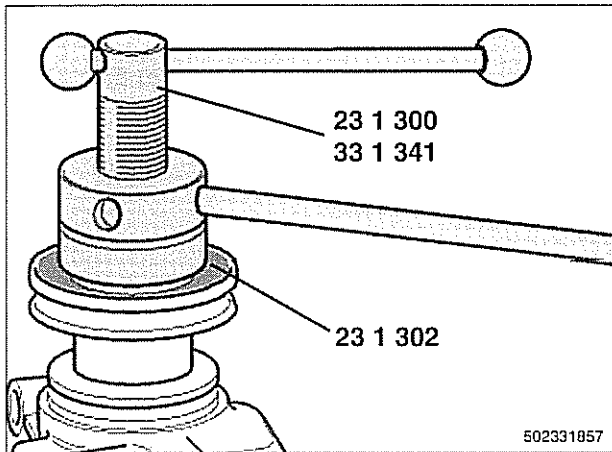
Remove final drive input flange using BMW special tools 31 2 101, 31 2 102, 31 2 103 and 31 2 104 or equivalent.



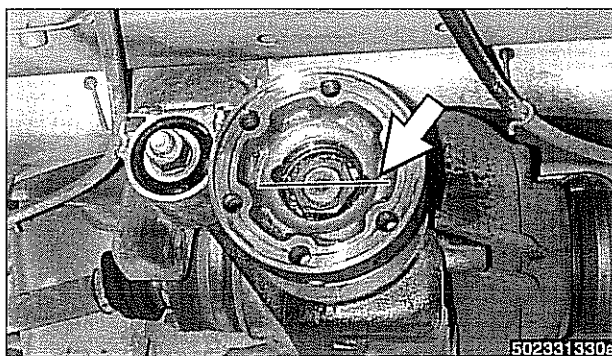
Using BMW special tool 00 5 010 or equivalent remove seal from final drive housing.



Drive new seal into place until its fully seated using BMW special tools 00 5 500, 33 3 440 and 33 3 470 or equivalent.



- ◀ Coat drive flange sealing area and seal lip with differential oil.
  - Install drive flange on pinion shaft.
  - Using BMW special tools 23 1 300, 33 1 341 and 23 1 302 press drive flange on to pinion shaft only to extent as to allow collar nut to be installed.



- ◀ Tighten collar nut only until previously marked points are aligned (**arrow**).

**CAUTION—**

*Do not under any circumstances tighten collar nut beyond the marked points, otherwise clamping sleeve will have to be replaced.*

- Using a suitable drift, install new collar nut locking plate. Stake plate in place.
- Remainder of installation is reverse of removal.
- Check and, if necessary, set differential oil level. See **Differential oil level, checking**.

**Tightening torque**

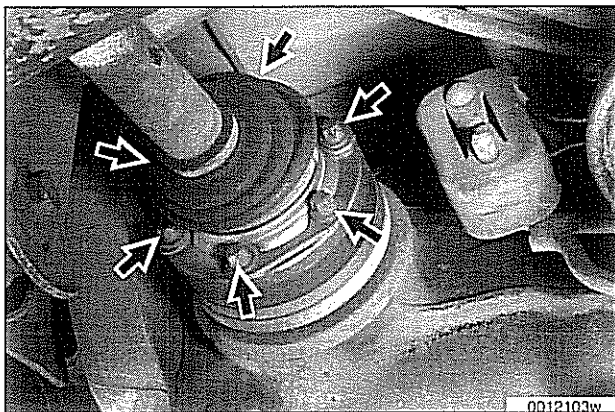
Driveshaft CV joint to final drive flange

- |                        |                  |
|------------------------|------------------|
| • M10 (Torx bolt)      | 70 Nm (51 ft-lb) |
| • M8 (compression nut) | 32 Nm (24 ft-lb) |

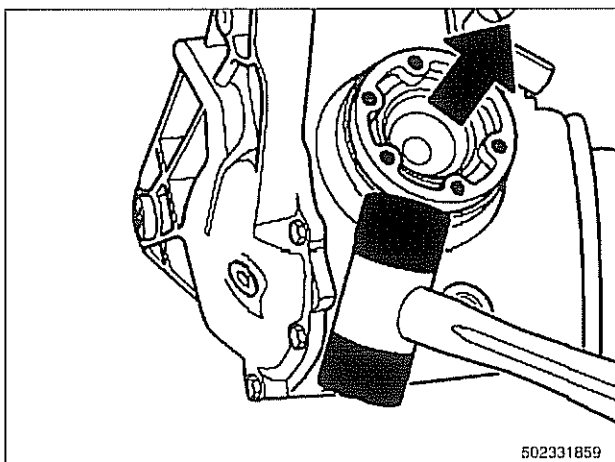
## Final drive output shaft seals, replacing

- Remove exhaust system (if necessary). See 180 Exhaust System.

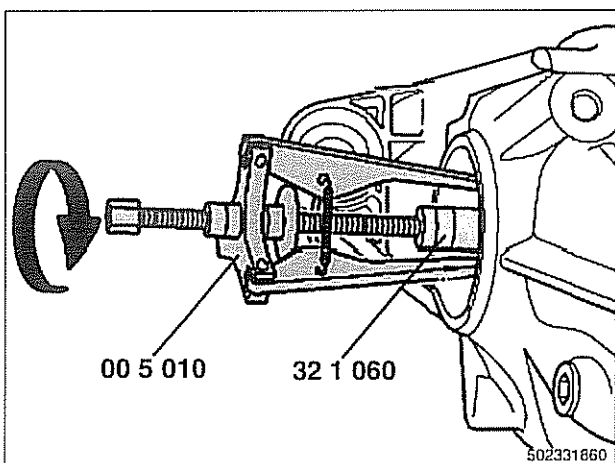
- ⚠ Remove drive axle CV joint bolts (arrows). Suspend drive axle from body using stiff wire.



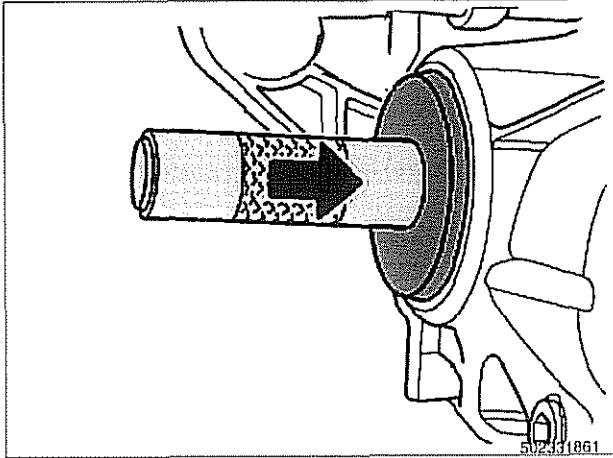
- ⚠ Drive out final drive output flange using soft faced hammer.



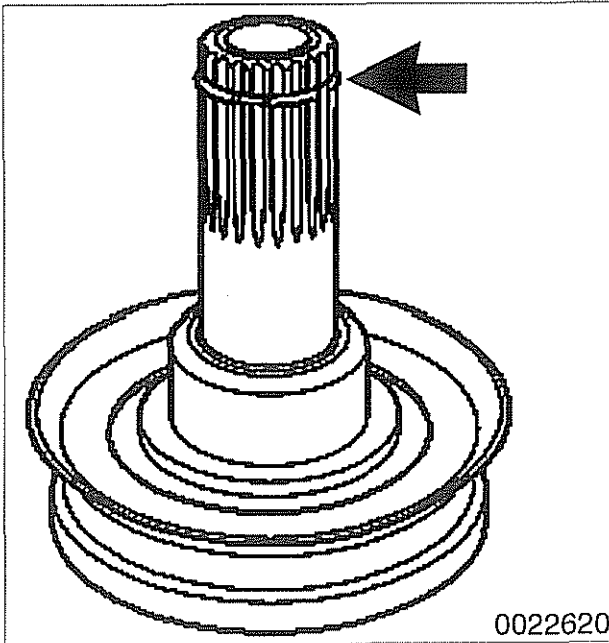
- ⚠ Remove seal using BMW special tool 00 5 010 and 32 1 060 or equivalent.







- Coat seal with differential oil and drive into place using BMW special tools 00 5 500 and 33 4 250 or equivalent.

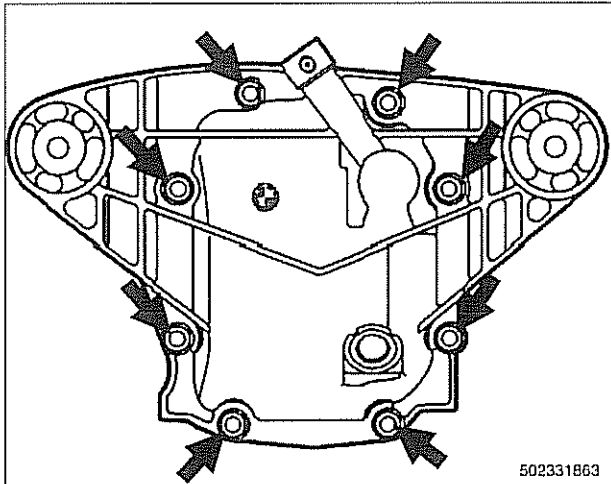


- Replace snap ring (arrow) on final drive output flange shaft.
  - Coat output flange shaft with differential oil where it contacts shaft seal.
  - Push output flange into final drive until flange splines engage splines of differential gear and snap ring can be heard to snap into place.
- Remainder of installation is reverse of removal.
  - Check and, if necessary, set differential oil level. See **Differential oil level, checking**.

#### Tightening torques

##### Drive axle to final drive flange

• Torx bolts (M10)	83 Nm (61 ft-lb)
• Torx bolt with ribbed teeth (M10)	64 Nm (47 ft-lb)
• Torx bolt with ribbed teeth (M10 silver)	80 Nm (59 ft-lb)
• Torx bolt with ribbed teeth (M10 black)	100 Nm (74 ft-lb)
• Torx bolt with ribbed teeth (M12)	135 Nm (100 ft-lb)



## Final drive cover, removing and installing

- Remove final drive. See **Final drive, removing and installing**.
- ▲ Remove fasteners (**arrows**) from rear cover and remove cover.
  - Clean cover and final drive housing sealing surfaces.
  - Install new gasket with cover.
  - Installation is reverse of removal.
- Check differential oil level. See **Differential oil level, checking**.

### Tightening torque

#### Final drive cover to final drive housing

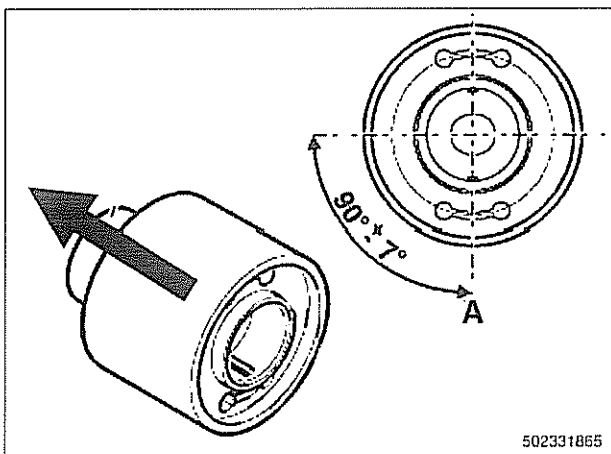
- |                    |                  |
|--------------------|------------------|
| • M10 (8.8 grade)  | 45 Nm (33 ft-lb) |
| • M10 (10.9 grade) | 90 Nm (66 ft-lb) |

## Final drive mounts, replacing

- Remove final drive. See **Final drive, removing and installing**.

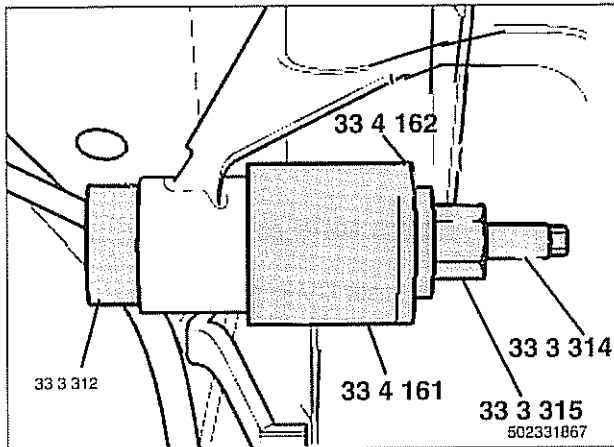
### Rear final drive mounts

- Remove rear final drive rubber mounts using BMW special tools 33 3 314, 33 3 315, 33 4 181, and 33 4 183.
- ▲ Coat new mount with Circolight® anti-friction agent and install, noting the following:
  - Long bushing on mount must face forward (**arrow**).
  - **A** shows installation position of mounts.



## Front final drive mount

- Remove front final drive mount using BMW special tools 33 3 312, 33 3 314, 33 3 315, 33 4 161 and 33 4 162.

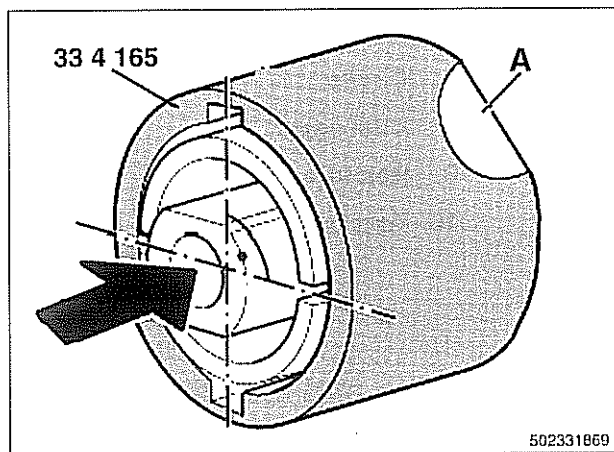


- Coat bearing sleeve in rear axle carrier and rubber mount with Circolight® anti-friction agent.

- Slide rubber mount from side with large diameter into BMW special tool 33 4 165.
- Milled recess (A) makes firm contact with rear axle carrier when top rubber mount is tightened down.

**CAUTION—**

The slotted side of the rubber mount must be at right angles to the groove in special tool 33 4 165 and should be tightened down transversely across the vehicle axis.

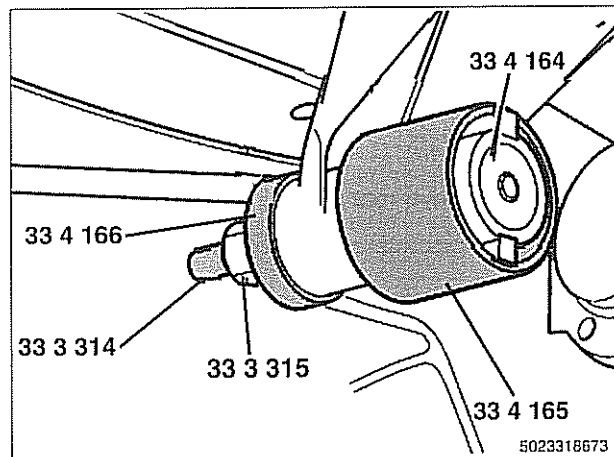


- Draw rubber mount in firmly with BMW special tools 33 3 314, 33 3 315, 33 4 164, 33 4 165 and 33 4 166.

**NOTE—**

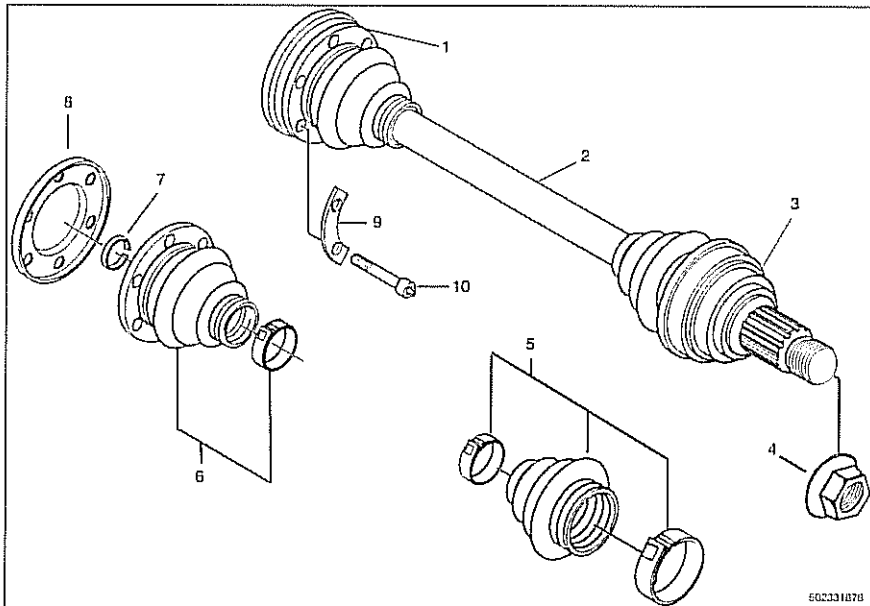
- Make sure special tool 33 4 166 is properly seated.
- Rubber mount must locate flush in rear axle carrier. If necessary, rotate special tool 33 4 164 through 90° and draw in overlap.

- Remainder of installation is reverse of removal.



## DRIVE AXLES

Drive axles use constant-velocity (CV) joints on both ends. For replacement parts, only CV joint boots or complete axles are offered by BMW. The procedure for drive axle removal varies for sedan and sport wagon. Follow the appropriate procedure below.



### Drive axle assembly

1. Inner CV joint
2. Drive axle
3. Outer CV joint
4. Collar nut
5. Outer CV boot kit
6. Inner CV boot kit
7. Circlip
8. Dust cover
9. Reinforcement
10. Torx bolt

### Drive axle, removing and installing (sedan)

- With an assistant applying brakes, break free staked collar nut (arrow) at center of rear wheel hub. Do not remove completely.

#### NOTE—

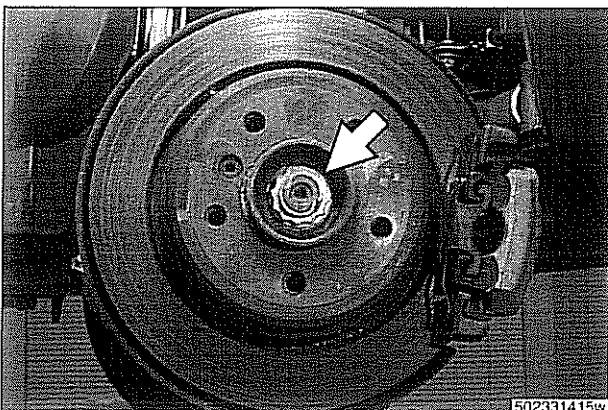
The drive flange collar nut is tightened to a torque of over 300 Nm (221 ft-lb). Make sure the car is firmly on the ground.

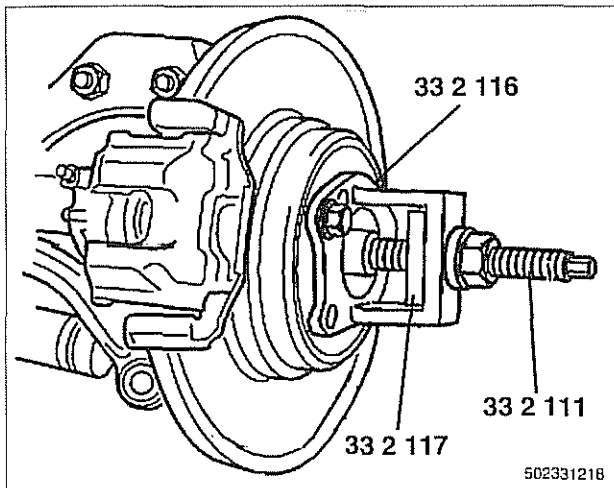
- Raise rear of car. Remove rear wheel.

#### WARNING—

Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath structural chassis points. Do not place jack stands under suspension parts.

- Remove final drive. See Final drive, removing and installing.





- Remove staked collar nut and press output shaft out of wheel hub with special BMW tool 33 2 111/116/117.
- Remove drive axle.
- Installation is reverse of removal, noting the following:
  - Use a new collar nut.
  - Apply a light coating of oil to contact face of collar nut and install it loosely.
  - Install road wheel and lower car to ground.
  - With an assistant applying brakes, tighten drive axle collar nut to its final torque.
  - Stake collar nut.

#### Tightening torques

Drive axle collar nut to drive flange M27	300 Nm (221 ft-lb)
Drive axle to differential flange	
• M10x20 mm black Torx bolt	83 Nm (61 ft-lb)
• M10x20 mm silver Torx bolt	100 Nm (74 ft-lb)
Road wheel to hub	120 Nm $\pm$ 10 (89 ft-lb $\pm$ 7)

### Drive axle, removing and installing (Sport Wagon)

- With an assistant applying brakes, break free staked collar nut (arrow) at center of rear wheel hub. Do not remove completely.

#### NOTE —

The drive flange collar nut is tightened to a torque of over 300 Nm (221 ft-lb). Make sure the car is firmly on the ground.

#### WARNING —

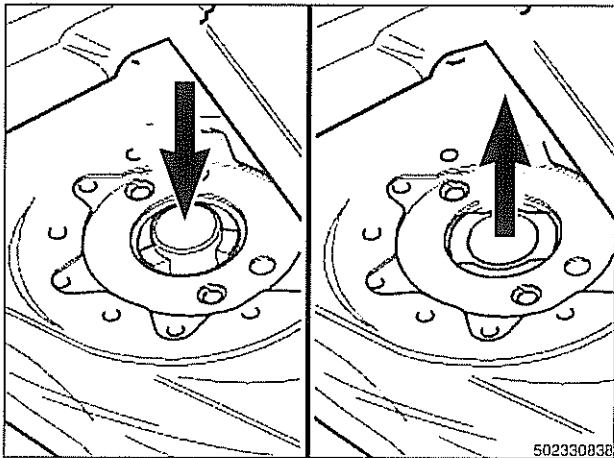
Disable air supply pump (if applicable) by disconnecting electrical plug before performing any repairs. Pump is located beneath a cover under the spare tire in the floor of the cargo compartment.

- Raise rear of car. Remove rear wheel.

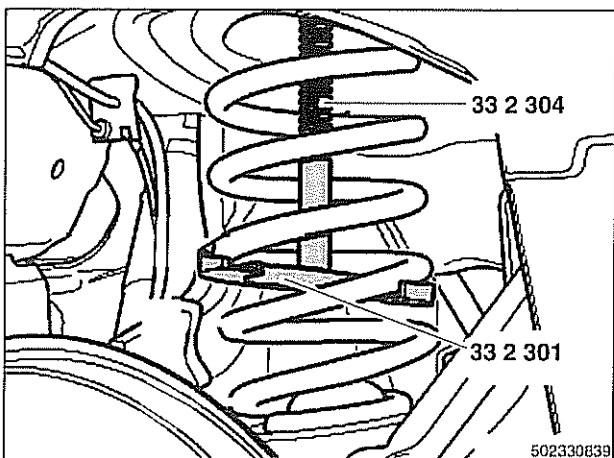
#### WARNING —

Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath structural chassis points. Do not place jack stands under suspension parts.

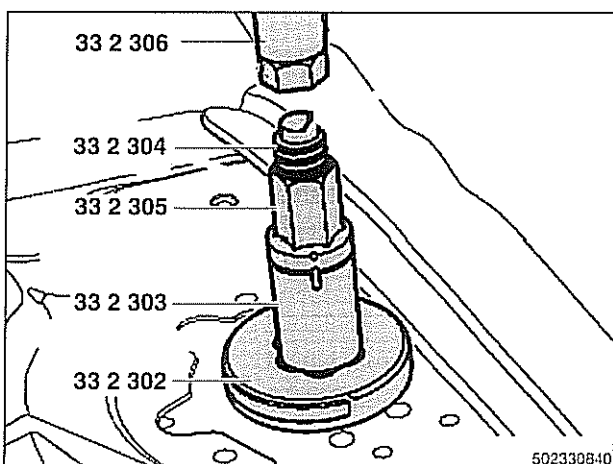
- Models with rear coil springs: Remove cargo compartment floor carpet.



- ◀ Working at top of coil spring, press center cap down or pry upward to remove. If pushed down, remove from inside coil spring.



- ◀ Working from underneath, position BMW special tool 33 2 301 between 2nd and 3rd spring coil from the bottom.
  - Make sure tool recess faces upward.
  - Working in cargo compartment, guide BMW special tool 33 2 304 from above and thread into special tool 33 2 301.

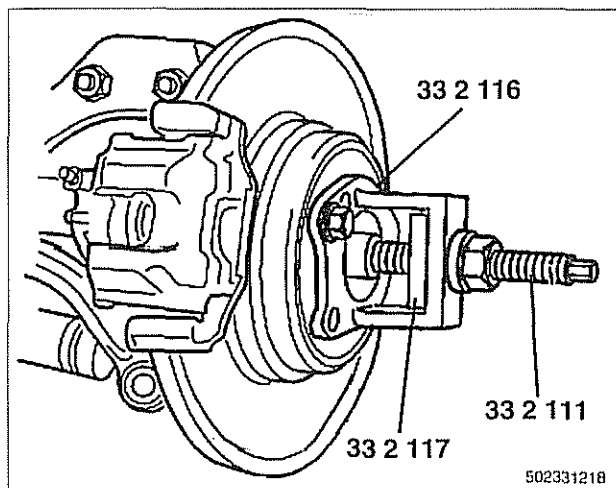


- ◀ Working in cargo compartment, attach BMW special tools 33 2 302, 33 2 303 and 33 2 305 to special tool 33 2 304.
  - Use special tool 33 2 306 to compress spring.
  - Tighten until lower spring end lifts off spring seat on wheel bearing carrier.
- Model with air springs: Loosen compressed air pipes at air distribution assembly to release system pressure.

**WARNING—**

*The vehicle will lower when the air pipes are loosened.*

- Remove final drive. See **Final drive, removing and installing.**



➤ Remove staked collar nut and press output shaft out of wheel hub with special BMW tool 33 2 111/116/117.

- Remove drive axle.
- Installation is reverse of removal, noting the following:
  - Use a new collar nut.
  - Apply a light coating of oil to contact face of collar nut and install it loosely.
  - Install road wheel and lower car to ground.
  - With an assistant applying brakes, tighten drive axle collar nut to its final torque.
  - Stake collar nut.

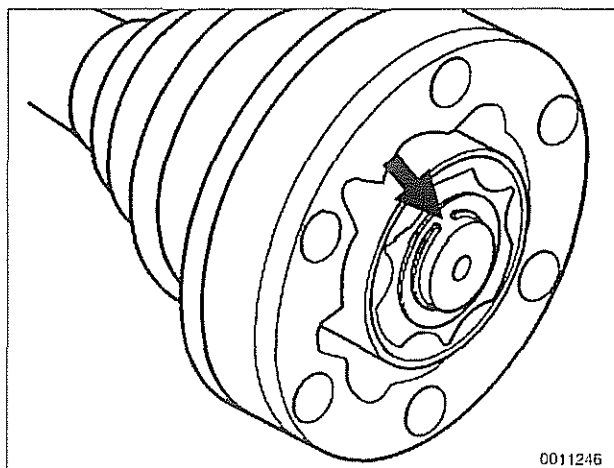
#### Tightening torques

Drive axle collar nut to drive flange M24	300 Nm (221 ft-lb)
Drive axle collar nut to drive flange M27	300 Nm (221 ft-lb)
Drive axle to differential flange	
• M10x20 mm black Torx bolt	83 Nm (61 ft-lb)
• M10x20 mm silver Torx bolt	100 Nm (74 ft-lb)
Road wheel to hub	120 Nm ±10 (89 ft-lb ±7)

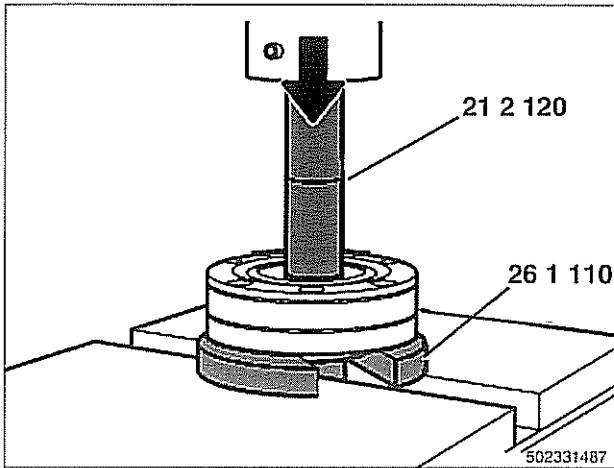
## CV joint boots

### NOTE—

- When replacing a CV joint boot, use a complete CV joint boot repair kit. The kit will include a new boot, clamping bands, special lubricant, and a new inner CV joint circlip. The kit is available from an authorized BMW dealer parts department.
- The outer CV joint cannot be removed from the axle shaft. In order to replace the outer CV boot, it is necessary to remove the inner joint and boot first.
- If the CV joints are worn or defective, a complete rebuilt axle shaft is available from an authorized BMW dealer parts department.



- Remove appropriate axle shaft. See **Drive axle, removing and installing (sedan)**, or **Drive axle, removing and installing (Sport Wagon)**.
- Working with axle shaft at bench, cut off old boot clamps and remove boot. Clean old grease off joint and shaft. Use new grease from CV joint boot kit.
- Remove dust cover from CV joint and remove circlip (arrow) retaining joint inner hub to axle shaft.



- ◀ Support inner hub with BMW special tools 26 1 110 and press axle shaft out of joint using BMW special tool 21 2 120.
- Clean all old lubricant off shaft splines and inner joint splines.

**CAUTION—**

*If the CV joint must be disassembled for cleaning and inspection, be sure to matchmark inner and outer race and intermediate ball cage. This allows reassembly of parts in their original positions.*

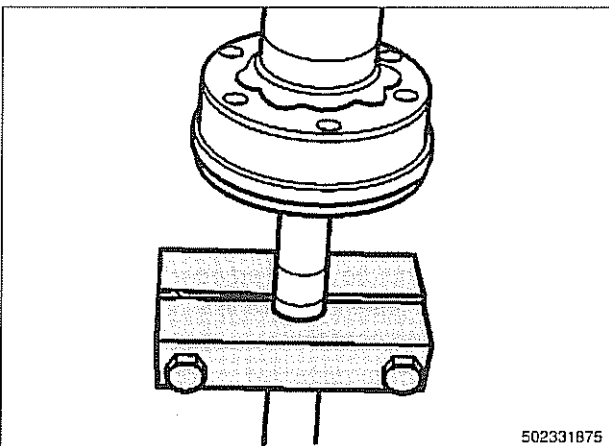
**NOTE—**

*To inspect a CV joint, clean away the grease and look for galling, pitting, and other signs of wear or physical damage. Polished surfaces or visible ball tracks alone are not necessarily cause for replacement. Discoloration due to overheating indicates lack of lubrication.*

- Slide CV joint boot onto axle shaft.
- Apply Loctite® 270 or an equivalent heavy-duty locking compound to drive axle splines. Position new CV joint on shaft so that raised or taller side of hub is facing shaft.

**WARNING—**

*Do not let the locking compound contact the balls in the joint. Apply only a thin coat to cover the splines.*



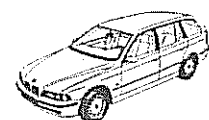
- ◀ While supporting axle shaft with BMW special tool 33 2 130 press inner hub of CV joint onto shaft. Install a new circlip.
- Install new boot clamps.
- Use sealing gel to seal dust cover to CV joint prior to reinstallation.

**NOTE—**

- Do not let the ball hub pivot too far in the outer ring of the joint. The balls will fall out.
- Before installing each small boot clamp be sure to "burp" the boot by flexing the CV joint. A small screwdriver inserted between the boot and the axle shaft will help the process.

**CV joint lubricant capacity**

Wheel hub end	80 gram (2.8 oz)
Differential end	85 gram (3.0 oz)





# 340 Brakes

<b>General</b> .....	340-2	<b>ABS Component Replacement</b> .....	340-26
Special Tools .....	340-2	Wheel speed sensor, replacing .....	340-26
E39 brake system .....	340-4	ABS impulse wheel .....	340-27
Electronic braking and stability control .....	340-4	DSC lateral acceleration or	
Troubleshooting .....	340-5	rotational rate (yaw) sensor, replacing ...	340-27
Warnings and cautions .....	340-7	DSC steering angle sensor,	
<b>Bleeding Brakes</b> .....	340-8	removing and installing .....	340-28
Brakes, bleeding .....	340-9	DSC precharge pump,	
<b>Brake Pads, Calipers and Rotors</b> ....	340-11	removing and installing (1998 models) ...	340-29
Braking system components .....	340-11	DSC pressure sensor	
Brake pads, checking and replacing .....	340-12	(1999 – 2002 models) .....	340-30
Brake rotors, removing and installing .....	340-15	ABS / traction electronic control	
<b>Master Cylinder</b> .....	340-16	module (1997 –1998 models) .....	340-31
Master cylinder, removing and installing ..	340-17	ABS / DSC control module	
<b>Brake Booster</b> .....	340-19	(1999 – 2002 models) .....	340-31
Brake booster check valve .....	340-19	ABS / traction control hydraulic unit,	
Brake booster, removing and installing ...	340-20	removing and installing .....	340-31
<b>Parking Brake</b> .....	340-22		
Parking brake components .....	340-22		
Parking brake, adjusting .....	340-22		
Parking brake shoes, removing			
and installing .....	340-23		
Parking brake cable, replacing .....	340-24		

## GENERAL

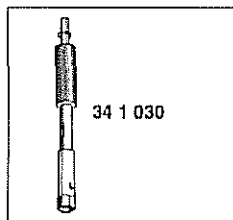
This repair group covers brake service:

- Brake pads, calipers, and disks
- Master cylinder, brake booster, and parking brake
- ABS / ASC and ABS / DSC component replacement

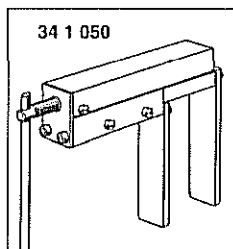
ABS / ASC and ABS / DSC system descriptions are covered in **300 Suspension, Steering and Brakes — General**.

## Special Tools

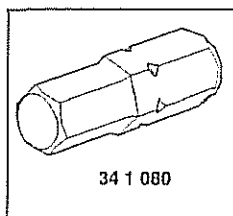
BMW requires the use of either the DIS or the MoDiC diagnostic tool to safely and completely bleed the braking and traction control systems. Read all procedures through before beginning a job.



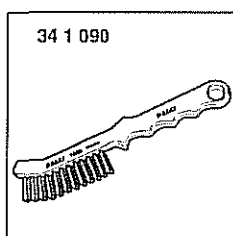
- ▶ Parking brake cable adjusting tool  
(Tool No. BMW 34 1 030)



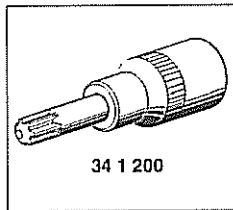
- ▶ Brake piston expander  
(Tool No. BMW 34 1 050)



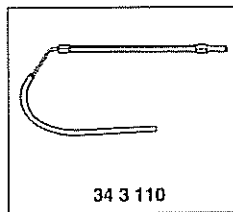
- ▶ Brake caliper bolt tool (7 mm Allen)  
(Tool No. BMW 34 1 080)



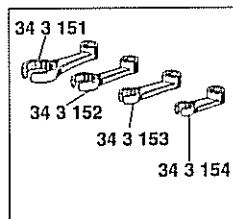
- ▶ Steel wire brush  
(Tool No. BMW 34 1 090)



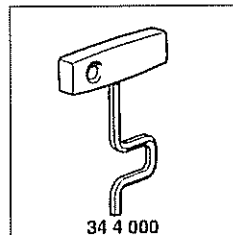
- ▲ Brake caliper bolt tool  
(Tool No. BMW 34 1 200)



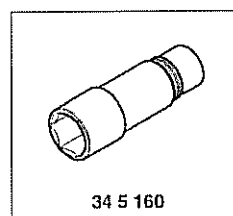
- ▲ ASC bleeder wrench  
(Tool No. BMW 34 3 110)



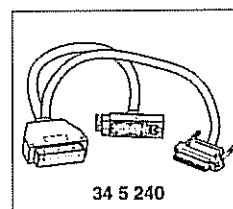
- ▲ Brake line flare wrench set (12 mm, 14 mm, 17 mm, 19 mm)  
(Tool No. BMW 34 3 150)



- ▲ Brake shoe spring tool  
(Tool No. BMW 34 4 000)



- ▲ DSC pressure sensor installation socket  
(Tool No. BMW 34 5 160)



- ▲ ABS / ASC or ABS / DSC control unit 42-pin harness adapter  
(break-out adapter)  
(Tool No. BMW 34 5 240)

## E39 brake system

BMW E39 models are equipped with vacuum power-assisted four-wheel disc brakes with an integral Antilock Brake System (ABS). Single-piston calipers act on vented front and rear rotors. A brake pad wear sensor for each axle indicates when brake pads need replacement. The dual drum-type parking brake system is integrated with the rear brake rotors.

## Electronic braking and stability control

E39 models were introduced with Automatic Stability Control, a computer controlled traction control system that uses the ABS system in conjunction with engine management controls to control wheel spin during take-off and maintain vehicle stability while braking.

Added in the 1998 model year was Dynamic Stability Control (DSC). This system implements wheel speed modulation throughout all stages of driving. For example, DSC is able to reduce understeer by applying differing amounts of braking force to each wheel, or it can override the engine management system during hard cornering.

A summary of distinguishing characteristics of the various systems is shown in the table **E39 electronic braking and stability control systems**.

For ABS, ASC and DSC system and component descriptions, see **300 Suspension, Steering and Brakes-General**.

### **WARNING—**

*A car with electronic stability control is still subject to normal physical laws. Avoid excessive speeds for the road conditions encountered.*

## E39 electronic braking and stability control systems

Year (model)	System	Identifiers
manuf. up to 9/1998 (528i, 540i)	Automatic Stability Control (ASC)	Electronic control module next to glove compartment Hydraulic unit in right rear of engine compartment No precharge pump
manuf. from 9/1999 (540i optional)*	Dynamic Stability Control (Bosch DSC III v. 5.3)	Electronic control module next to glove compartment Hydraulic unit in right rear of engine compartment Precharge pump in left front of engine compartment, below steering fluid reservoir Separate rotational rate (yaw) and lateral acceleration sensors
From 9/1999 (all models)	Dynamic Stability Control (Bosch DSC III v. 5.7)	Control module/hydraulic unit in right rear of engine compartment No precharge pump Combined rotational rate (yaw) and lateral acceleration sensors

## Troubleshooting

Brake performance is mainly affected by three things:

- Level and condition of brake fluid
- Ability of brake system to create and maintain pressure
- Condition of friction components

Air in brake fluid will make the brake pedal feel spongy during braking or will increase the brake pedal force required to stop. Fluid contaminated by moisture or dirt can corrode the system. Inspect the brake fluid inside the reservoir. If it is dirty or murky, or is more than two years old, replace fluid.

To check the function of the master cylinder hold the brake pedal down hard with the engine running. If the pedal slowly falls to the floor, either the master cylinder is leaking internally, or fluid is leaking externally.

Inspect the rotors for glazing, discoloration and scoring. Steering wheel vibration while braking at speed is often caused by warped rotors, but can also be caused by worn suspension components.

When troubleshooting, keep in mind that tire inflation, wear and temperature can all have an affect on braking. See **300 Suspension, Steering and Brakes-General** for additional suspension and brake system troubleshooting.

The table **Brake system troubleshooting** lists symptoms of brake problems, probable causes, and suggested corrective actions. Unless noted otherwise, relevant repairs are described later in this repair group.

## Brake system troubleshooting

Symptom	Probable cause	Repairs
Brake squeal	Brake pad carriers dirty or corroded or pads loose (poor fit) in pad carrier	Remove brake pads and clean calipers. Use original equipment pads for proper fit and use BMW anti-squeal compound during installation.
	Brake pads heat-glazed or oil-soaked	Replace brake pads. Clean rotors. Replace leaking calipers as required.
	Wheel bearings worn (noise most pronounced when turning)	Replace worn bearings. See <b>310 Front Suspension</b> or <b>330 Rear Suspension</b> .
	Incorrectly installed brake pads, parking brake shoes, or brake parts	Check component installation. Check/replace anti-rattle springs.
Pedal goes to floor when braking	Brake fluid loss due to system leaks	Check fluid level and inspect for signs of leakage.
	Master cylinder or traction control system faulty	Replace master cylinder. Diagnose traction control system using factory or compatible diagnostic tool.
Low pedal after system bleeding	Master cylinder faulty	Replace master cylinder.
Pedal spongy or brakes work only when pedal is pumped	Air in brake fluid	Bleed system using factory or compatible diagnostic tool.
	Master cylinder or traction control system faulty	Replace master cylinder. Diagnose traction control system using factory or compatible diagnostic tool.
Excessive braking effort	Brake pads wet	Use light pedal pressure to dry pads while driving.
	Brake pads heat-glazed or fluid-soaked	Replace brake pads and rotors. Replace leaking calipers.
	Vacuum booster or vacuum hose connections to booster faulty	Inspect vacuum lines. Test vacuum booster and replace as required. Test vacuum non-return valve for one-way flow.
Brakes pulsate, chatter or grab	Warped brake rotors	Resurface or replace rotors.
	Brake pads worn	Replace brake pads.
	Brake pads heat-glazed or oil-soaked	Clean rotors. Replace leaking calipers.
Uneven braking, car pulls to one side, rear brakes lock	Incorrect tire pressures or worn tires	Inspect tire condition. Check and correct tire pressures.
	Brake pads on one side of car heat-glazed or fluid-soaked	Replace brake pads. Clean rotors. Replace leaking calipers.
	Caliper or brake pads binding	Clean and recondition brakes.
	Worn suspension components	Inspect for worn or damaged suspension components. See <b>310 Front Suspension</b> or <b>330 Rear Suspension</b> .
Brakes drag, bind or overheat	Brake caliper or brake pads binding	Clean or replace caliper.
	Master cylinder or traction control system faulty	Replace master cylinder. Diagnose traction control system using factory or compatible diagnostic tool.

## Warnings and cautions

### **WARNING—**

- *E39 cars require special BMW service equipment to properly bleed the brake hydraulic system. See **Bleeding Brakes** for additional information.*
- *Semi-metallic and metallic brake friction materials in brake pads or shoes may produce dangerous dust.*
- *Brake fluid is poisonous, corrosive and dangerous to the environment. Wear safety glasses and rubber gloves when working with brake fluid. Do not siphon brake fluid with your mouth. Dispose of brake fluid properly.*
- *Do not reuse self-locking nuts, bolts or fasteners. They are designed to be used only once and may fail if re-used. Always replace them with new self-locking fasteners.*

### **CAUTION—**

- *Immediately clean brake fluid spilled on painted surfaces and wash with water, as brake fluid will remove paint.*
- *Always use new brake fluid from a fresh, unopened container. Brake fluid will absorb moisture from the air. This can lead to corrosion problems in the braking system, and will also lower the fluid boiling point.*
- *Plug open lines and brake fluid ports to prevent contamination.*
- *Only tighten brake hoses on front wheels with wheels in straight ahead position.*
- *If carrying out electric welding work, be sure to disconnect electrical harness connector from electronic control module.*
- *Do not expose electronic control modules to high sustained heat, such as in a paint drying booth. Maximum heat exposure: -95°C (203°F) for short periods of time- 85°C (185°F) for long periods of time (approx. 2 hours)*

## BLEEDING BRAKES

Brake bleeding is usually done for one of two reasons: either to replace old brake fluid as part of routine maintenance or to expel trapped air in the system that resulted from opening the brake hydraulic system during repairs.

Read the **Warnings** listed below before beginning the bleeding procedure on any E39 car. If air enters the ACS or DSC hydraulic unit, the factory BMW Service Tester MUST be used in conjunction with a brake pressure bleeder before the vehicle is driven.

The BMW Service Tester (DISplus/GT1/MoDiC) must be used to bleed the brakes if:

- Any hydraulic brake system components are replaced, including brake lines.
- Air has entered the ABS/ASC or ABS/DSC hydraulic unit.

### **WARNING —**

- *The ASC and DSC systems use electronic controls and a sophisticated hydraulic unit. Once air enters the hydraulic unit, it is very difficult to remove using traditional methods. For this reason, pressure brake bleeding should be done in conjunction with the BMW Service Tester (DISplus/GT1/MoDiC). The tester electrically cycles the hydraulic unit solenoids in the hydraulic unit while pressurized brake fluid is forced through the system.*
- *When flushing the brake fluid from the system, use extreme care to not let the brake fluid reservoir run dry. If air enters the hydraulic unit, the BMW Service Tester MUST be used to bleed the brake system before the vehicle is driven.*

Always use new brake fluid from an unopened container. It is important to bleed the entire system when any part of the hydraulic system has been opened. Be sure to have the special equipment needed before beginning the job.

When bleeding the brakes, start at the wheel farthest from the master cylinder and progress in the following order:

- right rear brake
- left rear brake
- right front brake
- left front brake



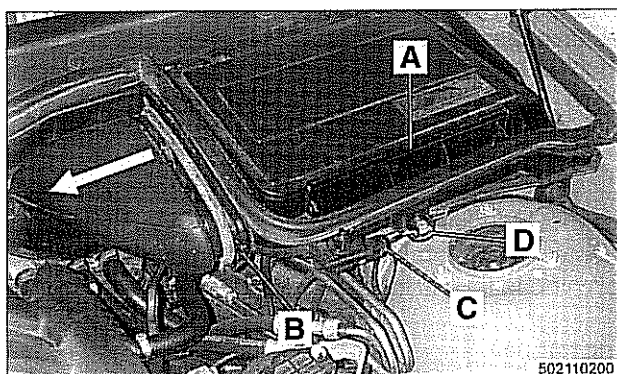
## Brakes, bleeding

The procedure below requires a BMW Service Tester (DIS-plus/GT1/MoDiC).

- Determine type of traction control (ASC, DSC with precharge pump, DSC without precharge pump). Be sure to use correct specification brake fluid, according to application table below.

### Brake fluid applications

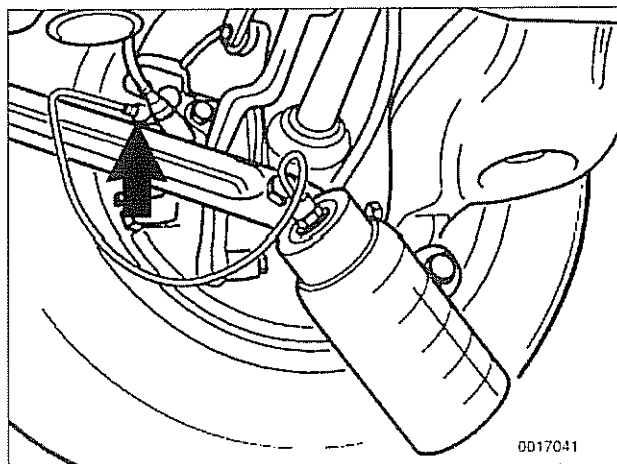
ABS / ASC and ABS / DSC models with precharge pump (to 9/1998)	DOT 4 brake fluid
ABS / DSC models without precharge pump (9/1998 and later)	DOT 4 low viscosity brake fluid



- Remove left side interior ventilation microfilter housing:
  - Remove upper cover and microfilter locking clip (A).
  - Release locking clamp (B), and rotate air tube in direction of arrow to remove.
  - Disconnect wiring harness from hood switch (C).
  - Release filter body mounting clamp (D) and remove lower microfilter housing.
- Top off brake fluid in reservoir and connect BMW Service Tester to 20 pin Data Link Connector (DLC) under hood or 16 pin DLC/OBD II connector under dash.
- Call up service function Bleeding ABS / ASC or service function Bleeding ABS / DSC, depending on installed system.
- Fill pressure bleeding device with the correct brake fluid and connect to brake fluid reservoir and apply pressurize.

#### CAUTION—

*Do not exceed a pressure of 2 bar (29 psi) when pressure bleeding the brake system. Excessive pressure will damage the brake fluid reservoir.*



- Starting at **right rear** wheel, connect bleed hose and fluid receptacle to bleeder screw (arrow).

#### CAUTION—

*Bleeder hose must always remain submerged in clean brake fluid whenever the bleeder valve is open.*

- Open bleeder screw. Carry out bleeding procedure with BMW Service Tester until clear, bubble-free fluid flows.
  - Models with DSC: After BMW Service Tester bleeding routine has finished, press brake pedal to floor 5 times until clear, bubble-free fluid runs out. Close **right rear** bleeder valve.
  - Models with ASC: Close **right rear** bleeder valve.
- Repeat procedure at **left rear** brakes.
- Repeat BMW Service Tester bleeding at **right front** brakes.
  - Models with DSC: After BMW Service Tester bleeding routine has finished, press brake pedal to floor 5 times until clear, bubble-free fluid runs out. Close **right front** bleeder valve.
  - Models with ASC: After BMW Service Tester bleeding routine has finished, press brake pedal to floor 12 times until clear, bubble-free fluid runs out. Close **right front** bleeder valve.
- Repeat procedure at **left front** brakes.
- Remove brake bleeding apparatus and disconnect BMW Service Tester. Top up brake fluid. Check to make sure brake fluid reservoir cap seal is intact.

#### Tightening torques

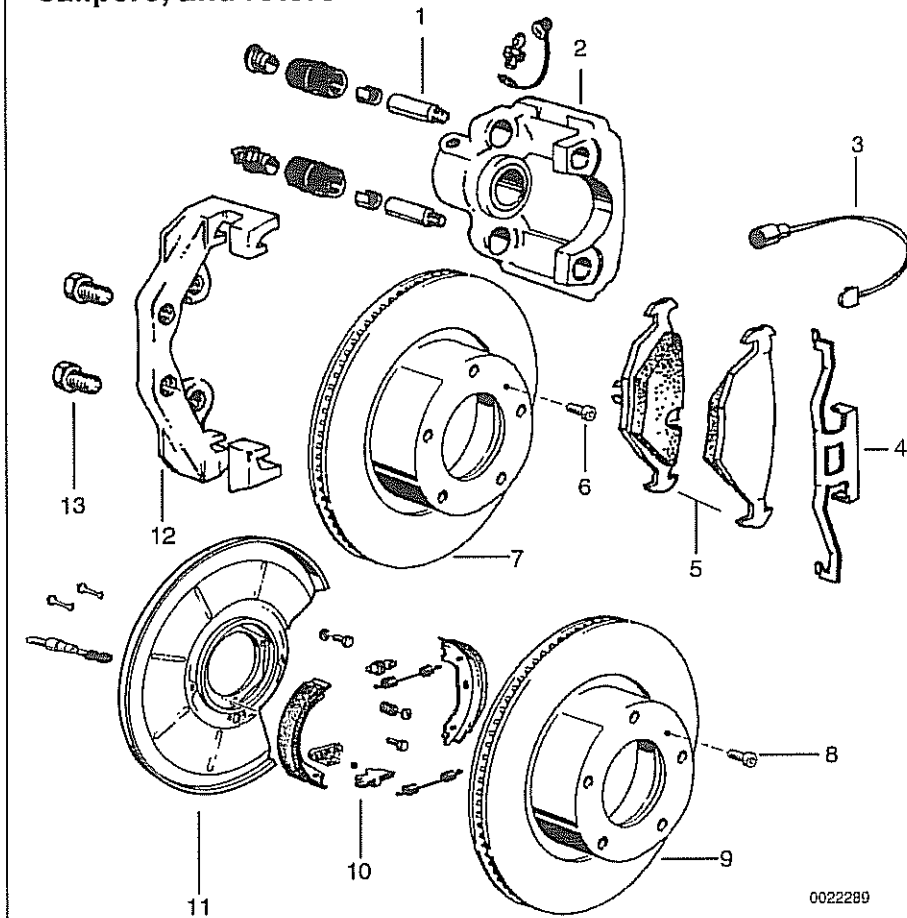
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##### Bleeder screws (wrench size)

- |               |                              |
|---------------|------------------------------|
| • 7 mm screw  | 3.5 - 5 Nm (2.5 - 3.7 ft-lb) |
| • 11 mm screw | 12 - 16 Nm (9 - 12 ft-lb)    |
-

## BRAKE PADS, CALIPERS AND ROTORS

### Brake pads, calipers, and rotors



### Braking system components

1. Brake caliper guide bolts
2. Brake caliper
3. Brake pad wear sensor
4. Brake pad anti-rattle clip
5. Brake pads
6. Front brake rotor retaining bolts
7. Front brake rotor
8. Rear brake rotor retaining bolt
9. Rear brake rotor
10. Parking brake shoes with hardware
11. Rear brake backing plate
12. Brake pad carrier
13. Brake pad carrier retaining bolts

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## Brake pads, checking and replacing

Brake pads can be replaced without disconnecting the brake fluid hose from the caliper or having to bleed the brakes. The rotors can be replaced without disassembling wheel hub and bearing. Always machine or replace rotors in pairs. Replace pads in sets.

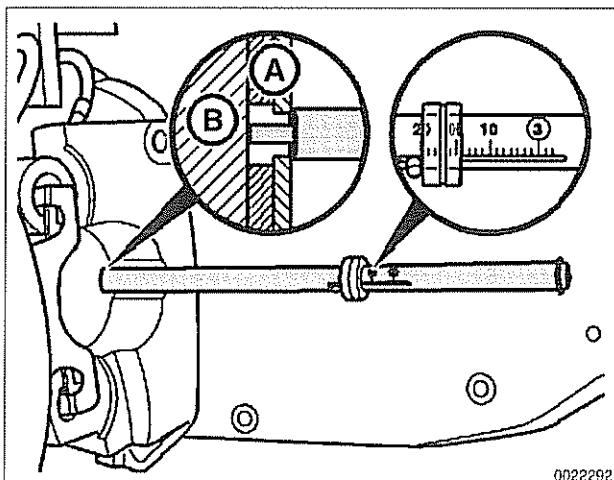
Front and rear brake pad replacement procedures are identical.

### WARNING—

- Although semi-metallic and metallic brake friction materials in brake pads or shoes no longer contain asbestos, they produce dangerous dust.
- Treat all brake dust as a hazardous material.
- Do not create dust by grinding, sanding, or cleaning brake friction surfaces with compressed air.

### CAUTION—

Pressing caliper piston in may cause brake fluid reservoir to overflow. To prevent this, use a clean syringe to first remove some fluid from reservoir.

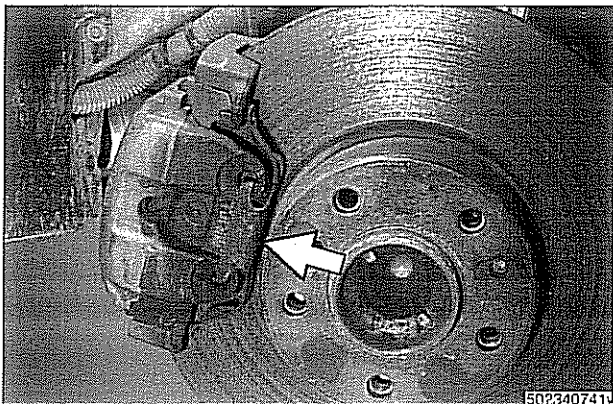


- Raise car and remove wheels.

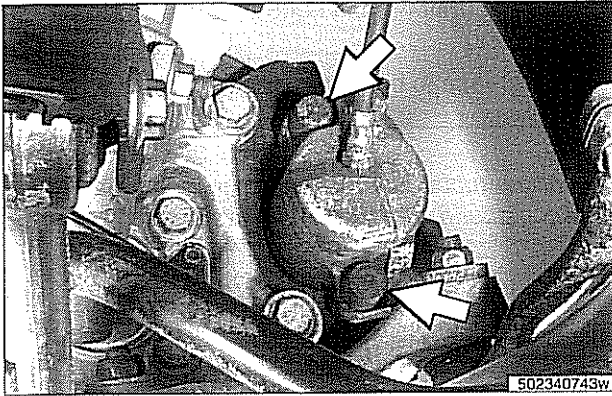
### WARNING—

Make sure that the car is firmly supported on jack stands designed for the purpose. Place jack stands beneath structural chassis points. Do not place jack stands under suspension parts.

- ◀ To measure brake pad lining thickness, insert BMW special tool 34 1 260 at either front right wheel or left rear wheel.
  - Move wheel until notch for brake wear indicator can be seen through wheel opening.
  - Insert tip of tool into notch so that the body of tool rests on brake pad backing plate (A), and tip touches brake disc (B).
  - Replace pads if thickness is 3.0 mm (0.12 in) or less.



- ◀ Pry off brake caliper anti-rattle spring (arrow).

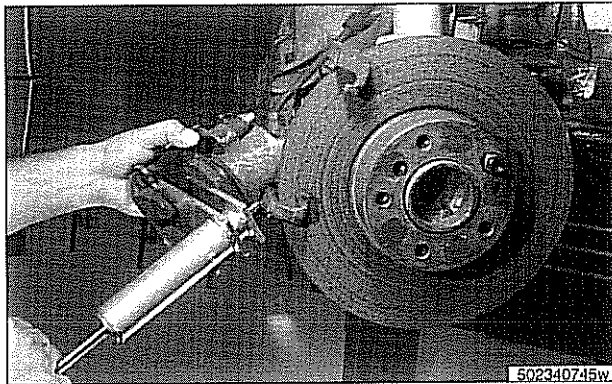


- Remove plastic caps from caliper mounting bolts (arrows). Use BMW special tool 34 1 080 (7 mm Allen wrench) to remove caliper mounting bolts. Remove caliper from pad carrier.

**NOTE—**

*If there is a ridge on brake rotor edge, press caliper pistons back into caliper before removing caliper.*

- Check brake rotor thickness. Inspect for rust or damage. If necessary replace or machine brake rotors as described later. Brake rotor specifications are given in table below.



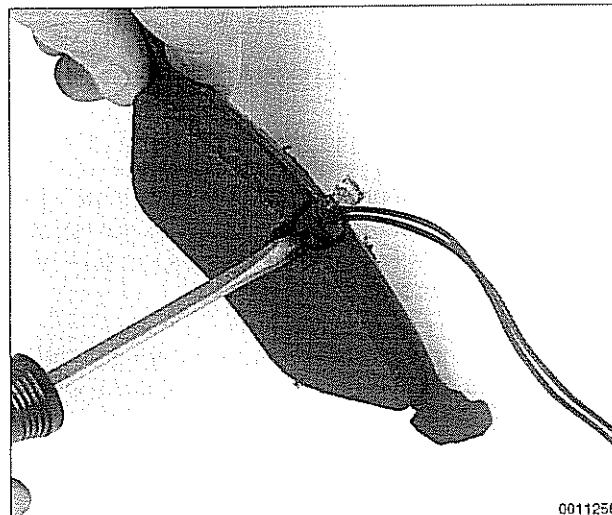
- Spread brake pads using BMW special tool 34 1 050 or equivalent. Remove brake pads.

**CAUTION—**

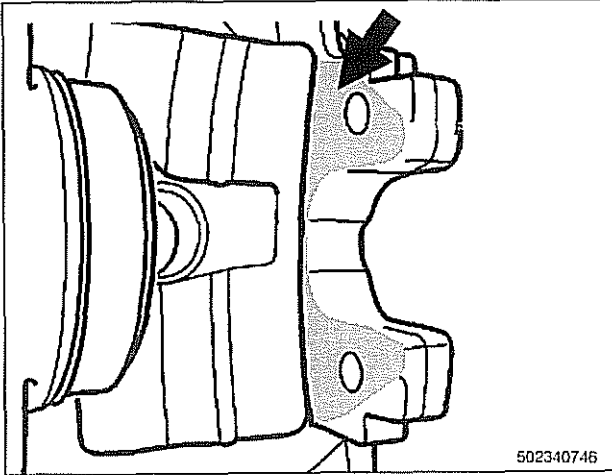
*Pressing caliper pistons in may cause brake fluid reservoir to overflow. To prevent this, use a clean syringe to first remove some fluid from reservoir.*

**NOTE—**

*Inner brake pad has a spring to locate it in the caliper piston.*



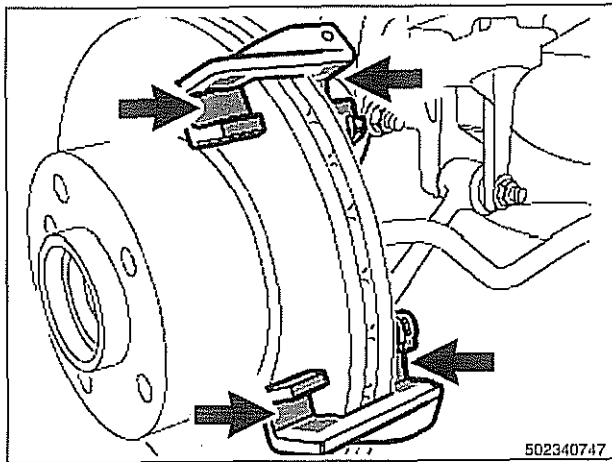
- Carefully pry pad wear sensor from brake pad.
- Check caliper dust boots for damage and replace if necessary.
- Clean contact surfaces between caliper and caliper carrier.



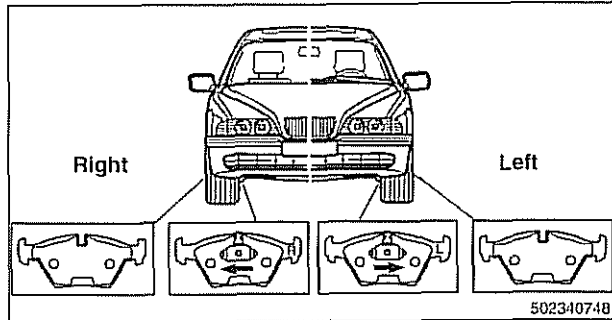
- ◀ Apply a thin coating of BMW anti-squeal compound to caliper contact face (**arrow**).
- Do not apply grease to brake pad backing plate.

**CAUTION—**

*Do not let calliper rubber dust sleeve come in contact with anti-squeal compound. The rubber will swell and deteriorate.*



- ◀ Apply a thin coating of BMW anti-squeal compound to brake pad rests (**arrows**) on pad carrier.



- ◀ When installing directional brake pads, install the marked pads as shown.

**NOTE—**

*BMW-supplied (OEM) front brake pads may be marked as directional pads. Aftermarket brands are generally not labeled as directional. When installing directional pads, be sure to install them as indicated in the illustration.*

- Where applicable, insert brake pad wear sensor into cutout in new pad. Push sensor into pad cutout until it locks into place.

**NOTE—**

*If brake lining indicator light illuminated prior to brake pad replacement, replace wear sensor.*

- Route pad wear sensor wiring through caliper opening and under bleeder dust cap.

- Remainder of installation is reverse of removal.
  - Clean brake caliper mounting bolts (7 mm Allen). Replace ones which are not in perfect condition. Do not grease.
  - Top up brake fluid to MAX marking.
  - Before driving car, pump brake pedal several times so that brake pads contact brake rotors.
  - Check that brake fluid level is correct. Top up if necessary.
  - Hold ignition key for at least 30 seconds in accessory position without starting engine. This clears any fault codes in memory and turns off brake pad warning light.

#### Tightening torques

##### Brake caliper to pad carrier (7 mm Allen)

- Front caliper 30 Nm (22 ft-lb)
- Rear caliper 28 Nm (21 ft-lb)

Road wheel to hub 120 ± 10 Nm (89 ± 7 ft-lb)

#### Brake rotors, removing and installing

- Raise car and remove wheels.

##### **WARNING—**

*Make sure that the car is firmly supported on jack stands designed for the purpose. Place jack stands beneath structural chassis points. Do not place jack stands under suspension parts.*

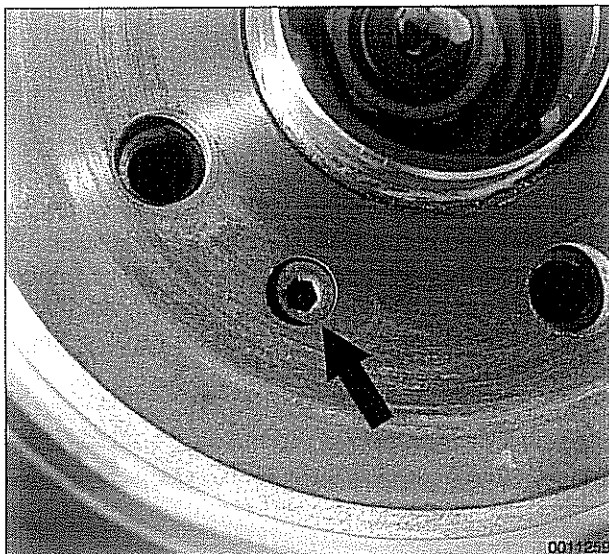
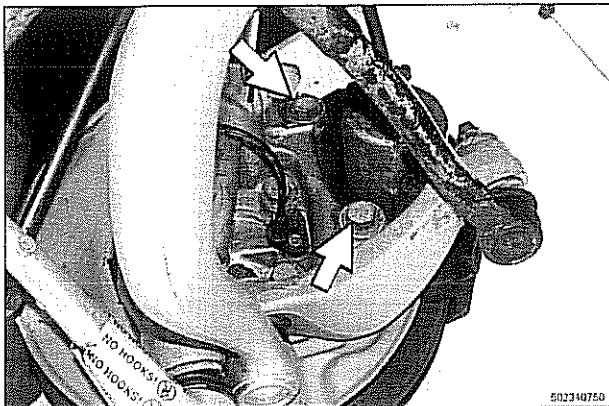
- Remove brake caliper carrier bolts (**arrows**). Suspend brake caliper from chassis using stiff wire.

##### **NOTE—**

*Hydraulic brake line remains connected.*

- Remove brake rotor mounting screw (**arrow**) and remove rotor.

- Inspect rotor for cracks, signs of overheating and scoring.
- Minimum allowable thickness (MIN TH) is stamped on rotor hub. Measure rotor braking surface with a micrometer at eight to ten different points and use the smallest measurement. Compare to specifications in table below.
- If rotor does not pass minimum thickness requirements or is damaged, replace rotor.



Brake rotor reconditioning specifications		
Model	Front	Rear
Vented rotor wear limit (min. thickness)		
• 6-cylinder models (525i, 528i, 530i)	20.4 mm (0.80 in)	18.4 mm (0.72 in)
• V-8 models (540i)	28.4 mm (1.12 in)	
Max. machine limit per friction ring side	0.8 mm (0.03 in)	

Brake rotor sizes		
Model	Front	Rear
6-cylinder models (525i, 528i, 530i)	296 mm (11.65 in)	298 mm (11.73 in)
V-8 models (540i)	324 mm (12.76 in)	

- Replace brake rotors in pairs.
- Clean rotor with brake cleaner before installing.
- When installing new rear brake rotors, adjust parking brake as described later, in **Parking brake, adjusting**.

#### Tightening torques

Brake rotor to hub	16 Nm (12 ft-lb)
Front brake pad carrier to steering knuckle	110 Nm (81 ft-lb)
Rear brake pad carrier to wheel bearing carrier	65 Nm (48 ft-lb)
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)

## MASTER CYLINDER

The brake master cylinder is mounted to the front of the vacuum booster on the driver side bulkhead.

#### **CAUTION—**

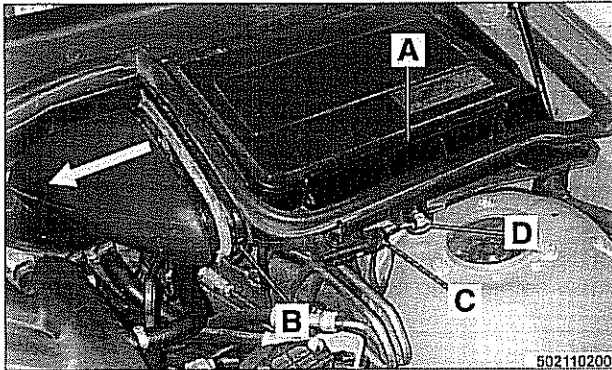
*All E39 vehicles sold in the USA are equipped with Antilock Braking System (ABS) and either Automatic Stability Control (ASC) or Dynamic Stability Control (DSC). In order for the braking and stability controls to work properly, if the brake master cylinder is replaced, make sure that the brake system is bled by an authorized BMW dealer or other qualified repair facility using the BMW Service Tester. See **Brake Bleeding** earlier in this group.*



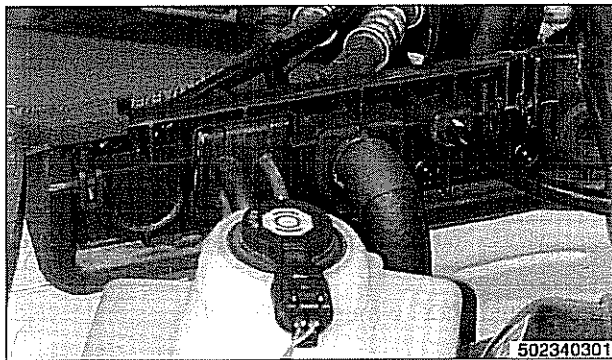
## Master cylinder, removing and installing

### CAUTION—

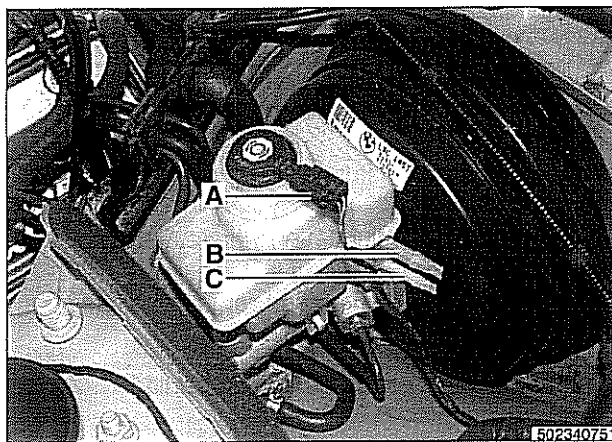
Brake fluid is highly corrosive and dangerous to the environment. Dispose of it properly.



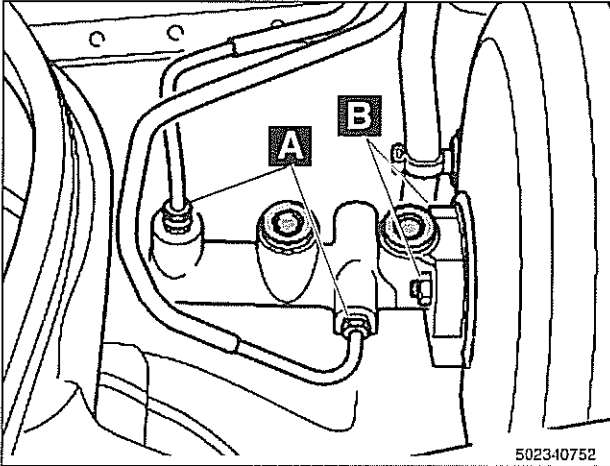
- Remove left side interior ventilation microfilter housing:
  - Remove upper cover and microfilter locking clip (A).
  - Release locking clamp (B), and rotate air tube in direction of arrow to remove.
  - Disconnect wiring harness from hood switch (C).
  - Release filter body mounting clamp (D) and remove lower microfilter housing.



- Remove side trim panel from left rear of engine compartment by releasing clips (arrows).



- Disconnect brake fluid level sensor connector (A) from fluid reservoir. Remove reservoir cap.
  - Using a clean syringe, empty brake fluid reservoir.
  - Where applicable, disconnect hydraulic clutch system supply line from fluid reservoir duct (B). Keep supply line supported and above clutch master cylinder to prevent air bubbles from reaching clutch hydraulic system.
  - Where applicable, disconnect DSC system precharge pump supply line from fluid reservoir duct (C). Secure supply line in vertical position to prevent fluid loss.
  - Plug open brake fluid lines and ducts to prevent fluid leakage or contamination.
- Remove brake fluid reservoir by tilting sideways.



- ◀ Disconnect master cylinder brake lines (A).
  - Plug open brake lines to prevent contamination.
  - Remove master cylinder mounting nuts (B) and remove cylinder.

**NOTE—**

*It may be necessary to remove the brake booster with master cylinder attached due to limited access. Brake master cylinder can then be removed from booster. See **Brake booster, removing and installing** later in this repair group.*

- During reinstallation, make sure all nuts, fluid couplings, thread bores, and mating surfaces are clean.
- Mount master cylinder to brake booster using new sealing O-ring and new self-locking nuts.

**CAUTION—**

- *Be sure to align master cylinder pushrod and booster pushrod.*
- *Do not over-torque master cylinder mounting nuts. This could damage the brake booster and prevent proper vacuum build-up.*

**Tightening torque**

Brake master cylinder to brake booster	26 Nm (19 ft-lb)
--	------------------

- Connect brake fluid lines to master cylinder.

**Tightening torque**

Brake fluid line to master cylinder	18 Nm (13 ft-lb)
-------------------------------------	------------------

- Carefully reinstall fluid reservoir using new sealing grommets.
- Reconnect precharge pump fluid supply hose, if applicable.
- Reconnect hydraulic clutch fluid supply hose, if applicable.
- Remainder of installation is reverse of removal.
  - Top up with fresh brake fluid.
  - Bleed entire brake system as described earlier.

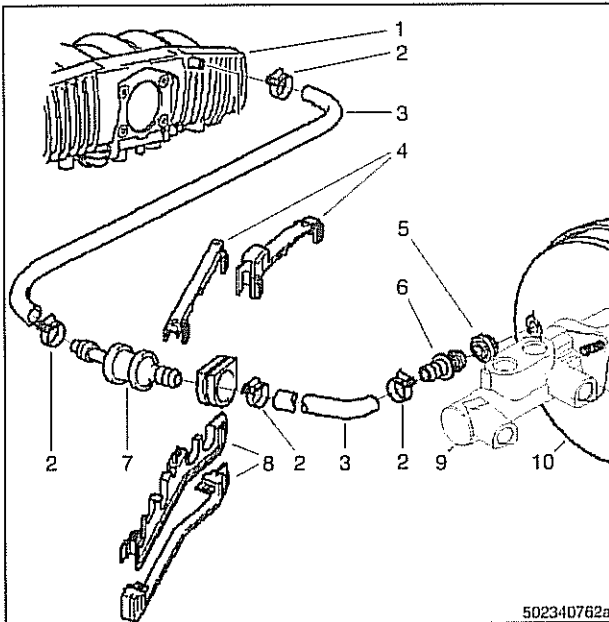
## BRAKE BOOSTER

The brake booster is mounted to the bulkhead on driver's side of the engine compartment, directly behind the brake master cylinder. Intake manifold vacuum acts on a large diaphragm in the brake booster to reduce brake pedal effort.

### Brake booster check valve

The check valve in the brake booster vacuum line prevents contamination from engine backfires and other sources from entering the brake booster.

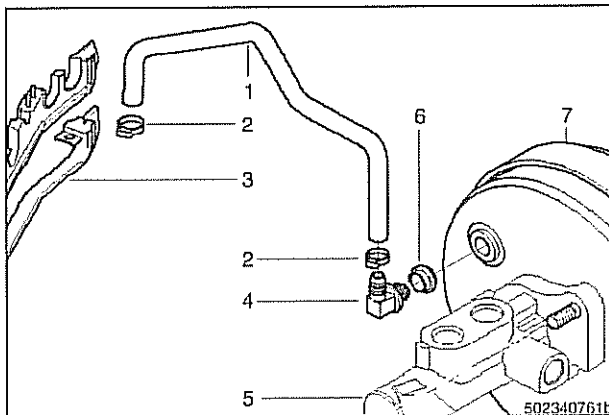
Location of check valve varies, depending on year and model.



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#### 6-cylinder models (528i):

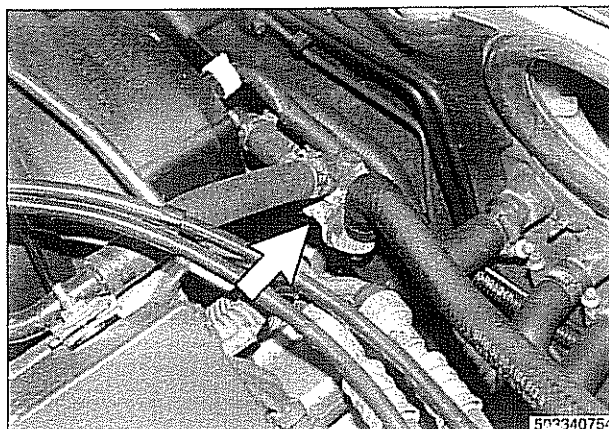
1. Intake manifold
2. Hose clamp
3. Vacuum line
4. Upper hose bracket
5. Grommet
6. From 9/1998: Check valve in grommet in booster. Remove left ventilation filter housing for access.
7. To 9/1998: Check valve in vacuum hose. Remove left ventilation filter housing, peel back trim rubber below housing and unclip upper hose brackets to access hose clamps and valve.
8. Lower hose bracket
9. Brake master cylinder
10. Brake booster



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#### 6-cylinder models (525i, 530i): Remove left ventilation filter housing to access check valve.

1. Vacuum hose
2. Hose clamp
3. Hose bracket
4. Check valve in grommet in booster
5. Brake master cylinder
6. Grommet
7. Brake booster



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#### V-8 models (540i) to 9/1998: Check valve (arrow) in vacuum line behind left cylinder head.

- V-8 models (540i) from 9/1998: Check valve in brake booster.
  - Remove left ventilation filter housing to access valve.

- Pump brake pedal a few times to reduce vacuum in brake booster. This makes removal of check valve easier.
- Remove or loosen hose clamp(s) at check valve.
- Disconnect hoses. Remove valve to test or replace.

**NOTE—**

*If valve is pressed into grommet in vacuum booster, pry it out carefully.*

- Reinstall valve using new hose clamps.

**NOTE—**

*Install the valve so that the molded arrow is pointing toward the intake manifold.*

## Brake booster, removing and installing

**CAUTION—**

*All E39 vehicles sold in the USA are equipped with Antilock Braking System (ABS) and either Automatic Stability Control (ASC) or Dynamic Stability Control (DSC). In order for the braking and stability controls to work properly, if brake fluid lines are disconnected and reconnected, make sure that the brake system is bled by an authorized BMW dealer or other qualified repair facility using the BMW Service Tester. See **Brake Bleeding** earlier in this group.*

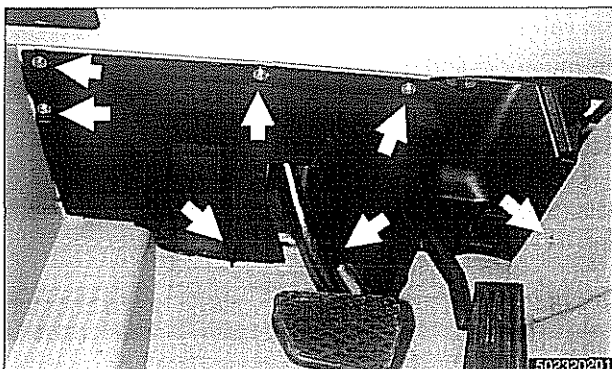
- Disconnect negative (-) cable from battery.

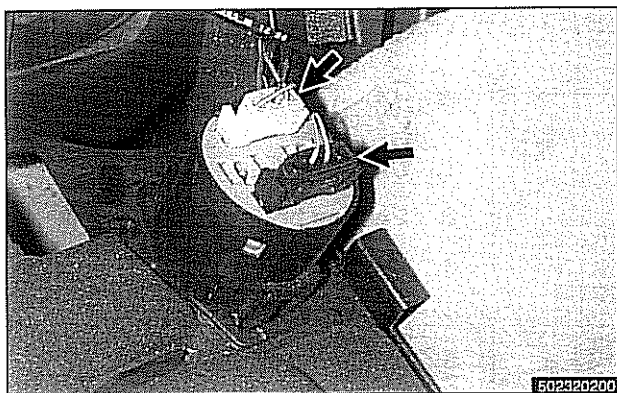
**CAUTION—**

*Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.*

- Remove brake master cylinder as described earlier.
- Disconnect engine vacuum hose from brake booster.

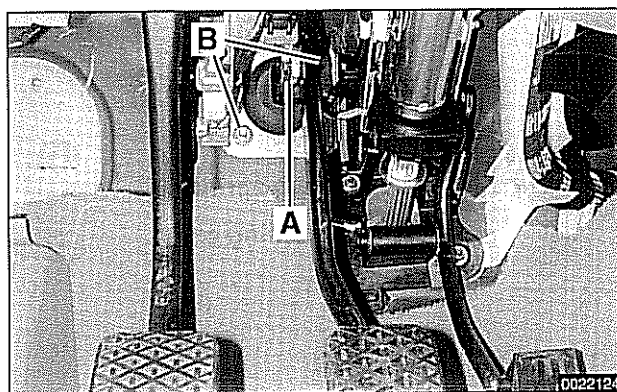
- ◀ Working in interior, remove left footwell (pedal cluster) trim panel (arrows).





➤ Pull down panel.

- If applicable, disconnect electrical harness connectors (arrows) from 16-pin OBD-II plug.
- Remove panel from interior.



➤ Working above and in front of pedals, remove locking clip (A) and slide brake booster pushrod off brake pedal pin. Remove brake booster mounting nuts (B).

- Working in engine compartment, carefully separate brake booster from engine compartment bulkhead.

**CAUTION—**

*Do not use force on booster when separating from bulkhead. This can damage booster and pushrod.*

- Remove booster by tilting out in direction of engine. Lift booster up and out of engine compartment.
- Installation is reverse of removal, noting the following:
  - Make sure all nuts, fluid couplings, thread bores and mating surfaces are clean.
  - Replace brake booster self-locking mounting nuts.
  - Replace sealing O-ring between master cylinder and brake booster.
  - Bleed brake system as described earlier.

**CAUTION—**

- *Do not over-torque the master cylinder mounting bolts. This could damage the brake booster and prevent proper vacuum build-up.*
- *After 30 minutes of use recheck the torque on brake booster mounting nuts.*

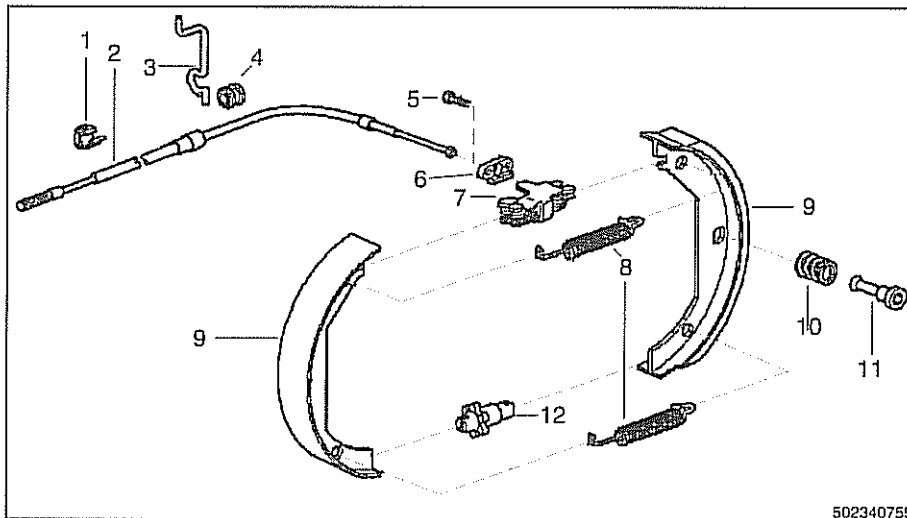
**Tightening torques**

Brake master cylinder to brake booster	26 Nm (19 ft-lb)
Brake booster to bulkhead (Recheck torque after 30 minutes of use.)	22 Nm (16 ft-lb)
Brake fluid line to master cylinder	18 Nm (13 ft-lb)

**NOTE—**

*When replacing the brake booster check valve or vacuum hose, install the valve so that the molded arrow is pointing toward the intake manifold. Use new hose clamps.*

## PARKING BRAKE



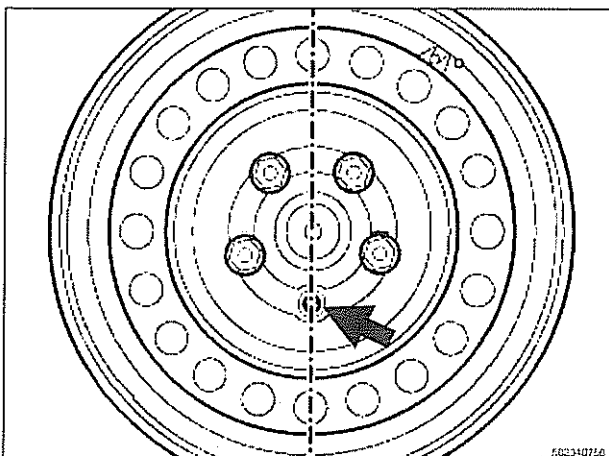
### Parking brake components

1. Clamp
2. Parking brake cable
3. Cable bracket
4. Grommet
5. Adjusting screw
6. Support
7. Shoe expander
8. Return springs
9. Parking brake shoe
10. Lock down spring
11. Shoe retaining pin
12. Adjuster

### Parking brake, adjusting

The parking brake is a brake drum system integrated into the rear brake rotors. It can be adjusted with the wheels installed, although the rear wheels will have to be raised off the ground.

- Adjusting the parking brake becomes necessary under the following circumstances:
  - After replacing parking brake shoes
  - After replacing rear brake rotors
  - Excessive stroke of parking brake handle required for actuation (more than 10 clicks)
  - After replacement of brake shoe adjuster or parking brake cable(s)
- Lift parking brake lever boot out of console. While holding cables stationary, loosen parking brake cable nuts until cables are completely slack.
- Raise rear of car.



#### **WARNING—**

Make sure that the car is firmly supported on jack stands designed for the purpose. Place jack stands beneath structural chassis points. Do not place jack stands under suspension parts.

- Remove one lug bolt from each rear wheel. Turn road wheel until lug bolt hole lines up with parking brake adjuster (arrow).

- Using flat-bladed screwdriver, reach into brake drum through lug bolt hole. Turn brake adjuster until wheel no longer turns. Back adjuster off 12 notches.

#### Parking brake adjusting (initial)

Back off adjuster through wheel lug bolt hole	12 notches
---	------------

- Working inside car, set parking brake several times to seat cable. Then pull parking brake lever up two notches. Tighten cable adjusting nuts until it is just possible to turn rear wheels with slight resistance.
- Release lever and make sure rear wheels turn freely.
- Turn on ignition. Pull up parking brake lever 1 notch and make sure that parking brake warning light comes on. If not, adjust parking brake warning light contact switch.
- Install parking brake lever boot. Install road wheel lug bolts.

#### Tightening torque

Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)
-------------------	----------------------------

### Parking brake shoes, removing and installing

- Raise rear of car and remove road wheels.

#### **WARNING**—

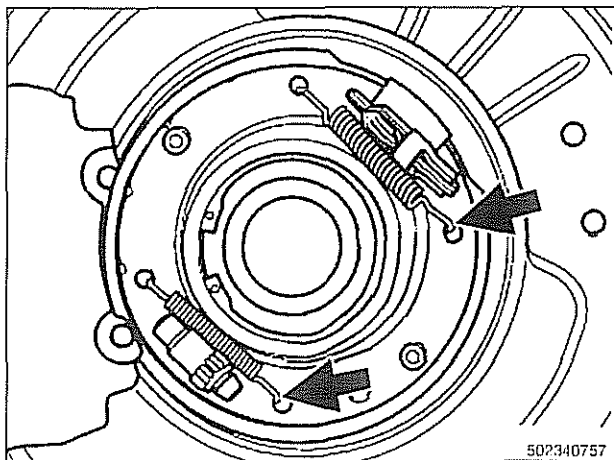
*Make sure that the car is firmly supported on jack stands designed for the purpose. Place jack stands beneath structural chassis points. Do not place jack stands under suspension parts.*

- Without disconnecting brake fluid hose, remove rear brake calipers from trailing arms. Remove rear brake rotors as described earlier.

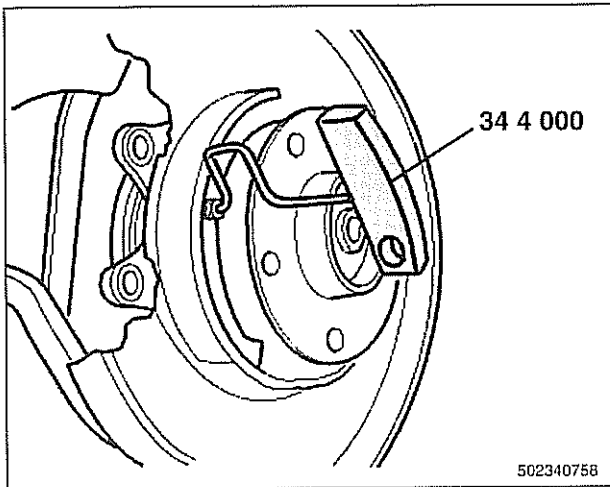
#### **CAUTION**—

*Do not let the brake caliper assembly hang from the brake hose. Support caliper from chassis with strong wire.*

- Unhook return springs (arrows) from brake shoes.

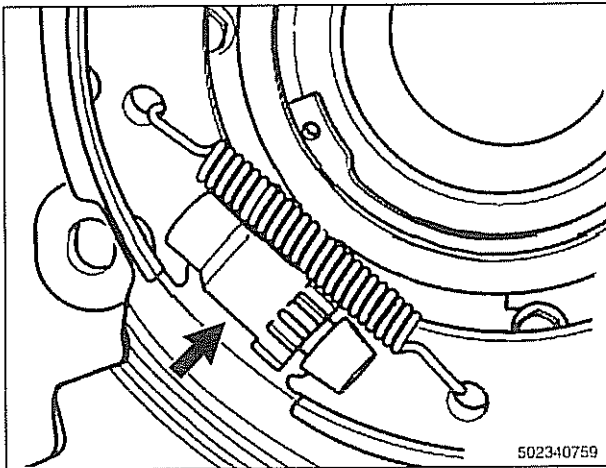


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➤ Remove brake shoe retaining pins using BMW special tool 34 4 000 or equivalent.

- Rotate retainer 1/4 turn to release.
- Spread shoes apart and lift out.



➤ Note position of brake shoe adjuster (**arrow**).

- Right side is illustrated. Left is mirror image of this.

- Apply thin coat of grease to sliding parts and pins before re-assembly.
- Installation is reverse of removal. Be sure to adjust parking brake cables as described earlier.

#### Tightening torque

Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)
-------------------	----------------------------

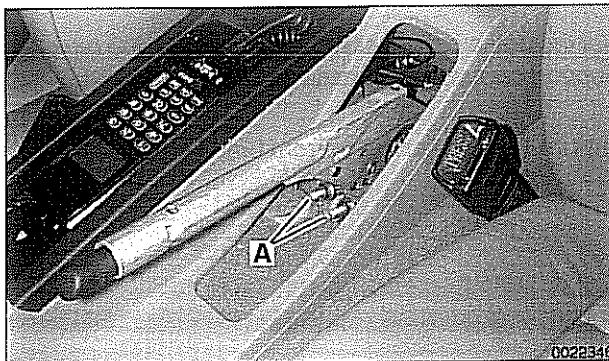
## Parking brake cable, replacing

The parking brake is actuated by two separate Bowden cables. Each cable can be replaced separately.

- Working inside car, gain access to base of parking brake handle by removing center console storage tray and center armrest, as necessary.

➤ Use BMW special tool 34 1 030 or equivalent deep 10 mm socket to remove parking brake cable lock nuts (**A**) at base of parking brake handle.

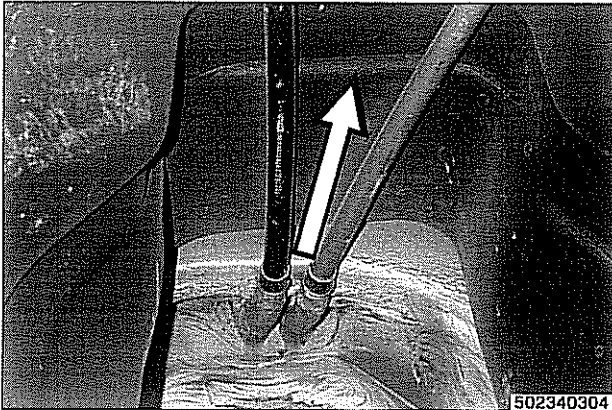
- Raise rear of car.



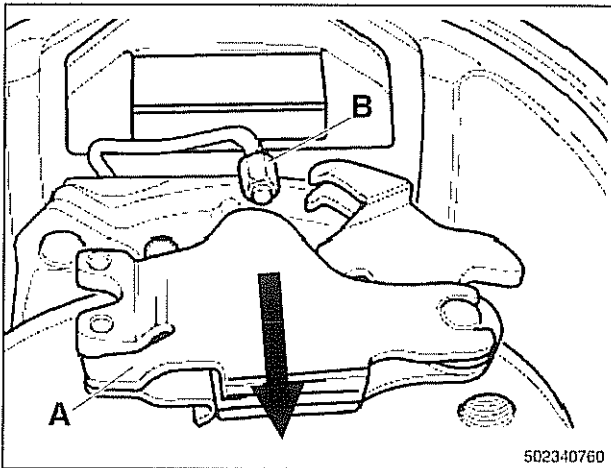
#### **WARNING** —

*Make sure that the car is firmly supported on jack stands designed for the purpose. Place jack stands beneath structural chassis points. Do not place jack stands under suspension parts.*

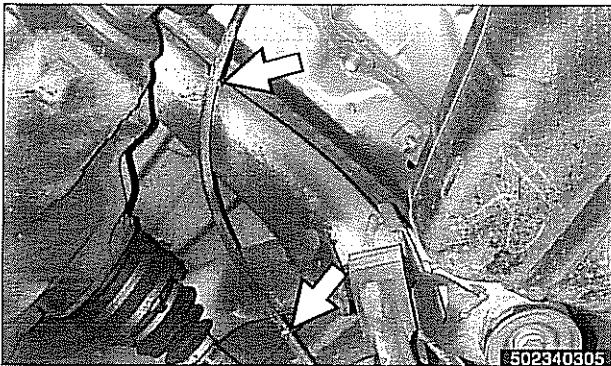




- Remove complete exhaust system as described in 180 Exhaust System.
- Remove center tunnel heat shield.
- Pull parking brake cable out of body guide tube (arrow) and detach from routing brackets, noting correct routing for reinstallation.
- Remove parking brake shoes as described earlier.



- Pull shoe expander (A) forward, disconnect parking brake cable (B) and remove expander.



- Reroute new cable under car, attaching to brackets (arrows).
- Remainder of installation is reverse of removal.
  - Adjust parking brake as described earlier.

## ABS COMPONENT REPLACEMENT

### CAUTION—

- If the tires on the car are of different makes, the ABS/traction control system may overreact. Only fit tires of the same make and tread pattern.
- In adverse conditions, such as trying to rock the car out of deep snow or other soft surface, or when snow chains are fitted, it is advisable to switch off traction control and allow the car driveline to operate conventionally.

All E39 vehicles are equipped with Antilock Braking System (ABS). Early production models featured ABS with Automatic Stability Control (ABS / ASC). Later models came equipped with ABS and Dynamic Stability Control (ABS / DSC). This manual will refer to these systems as ABS. ASC or DSC will be specified when necessary.

For ABS system and component descriptions, see **300 Suspension, Steering and Brakes-General**.

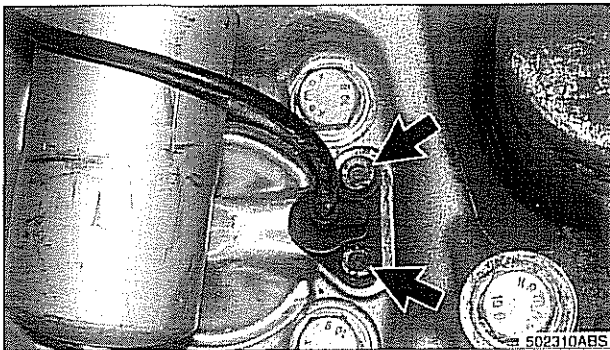
### Wheel speed sensor, replacing

- Raise applicable end of car.

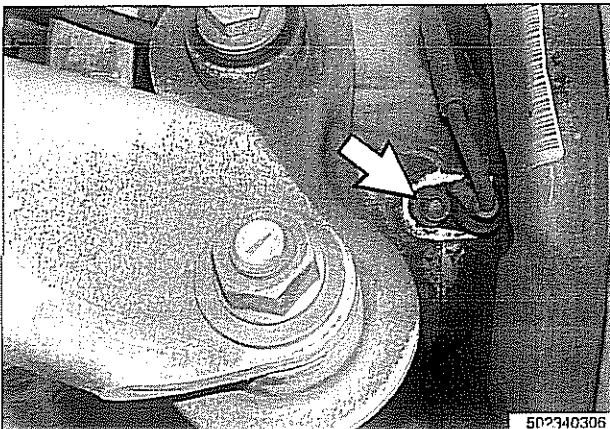
### WARNING—

Make sure that the car is firmly supported on jack stands designed for the purpose. Place jack stands beneath structural chassis points. Do not place jack stands under suspension parts.

- Front sensor: Unscrew mounting bolts (arrows) at steering knuckle.

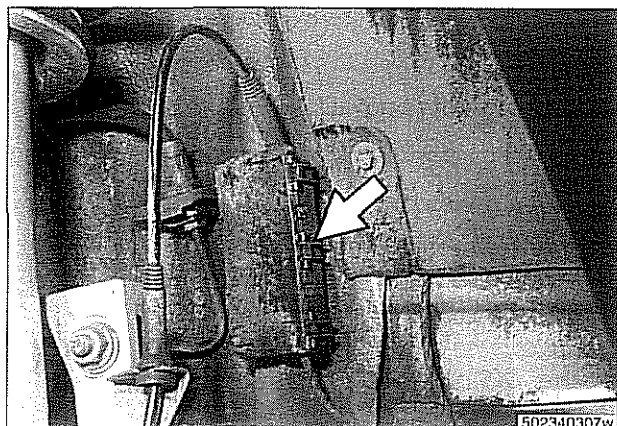


- Rear sensor: Unscrew mounting bolt (arrows) in rear wheel bearing carrier.



### NOTE—

ABS wheel speed sensor application may vary depending on traction control system installed.



- Disconnect and remove speed sensor electrical harness (arrow) from retaining mounts. (Left front wheel shown).
- During installation, apply thin coat of Staburags@NBU 12/K or equivalent grease to speed sensor and housing.
- Installation is reverse of removal.

#### Tightening torque

ABS wheel speed sensor to steering knuckle or rear wheel bearing carrier	8 Nm (6 ft-lb)
--	----------------

### ABS impulse wheel

The front and rear impulse wheels are integral with the inner wheel bearing seal and not available as separate part. See **310 Front Suspension** or **330 Rear Suspension** for wheel bearing replacement procedures.

### DSC lateral acceleration or rotational rate (yaw) sensor, replacing

DSC system on 1998 cars (Bosch DSC III v. 5.3): Lateral acceleration sensor and rotational rate (yaw) sensor are separate units, both mounted underneath or in front of driver's seat.

DSC system on 1999 and later cars (Bosch DSC III v. 5.7): Lateral acceleration sensor and rotational rate (yaw) sensor are combined into one unit, located under driver's seat.

- Remove driver's seat. See **520 Seats**.
- Lateral acceleration sensor (1998 models): Remove lower left door pillar trim (driver's kick panel) to access sensor. Pull up carpet as necessary to reach sensor harness connector or fasteners.
- Rotational rate (yaw) sensor (1998 models): Remove plastic trim at door sill to access sensor (arrow). Pull up carpet and move insulation forward as necessary to reach sensor harness connector or fasteners.
- Combined lateral acceleration / rotational rate (yaw) sensor (1999 and later models): Remove plastic trim at door sill to access sensor. Pull up carpet and move insulation forward as necessary to reach sensor harness connector or fasteners.
- Disconnect electrical harness connector at sensor.
- Combined sensor (1999 and later models): Remove sensor bracket mounting screws.



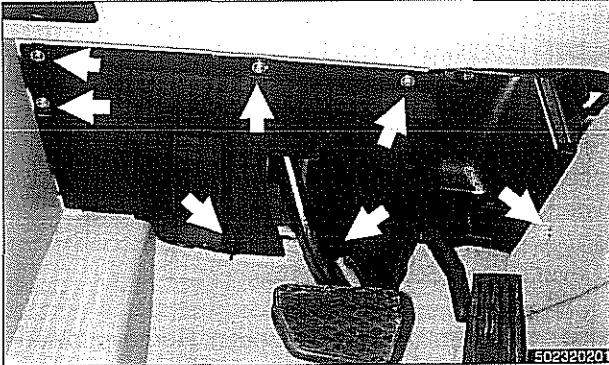
- Remove sensor mounting screws. Lift sensor away from bracket.
- Installation is reverse of removal.

**CAUTION—**

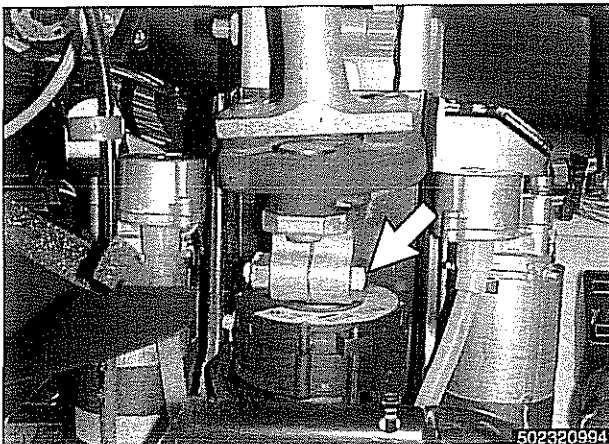
- Be sure to tighten the DSC acceleration sensor(s) and mounting bracket, if applicable, to specified torques. The sensor is vibration sensitive and subject to cause DSC malfunctions if installed improperly.
- After replacing the sensor, perform sensor adjustment using either DIS or MoDiC under Service Functions menu.

**Tightening torques**

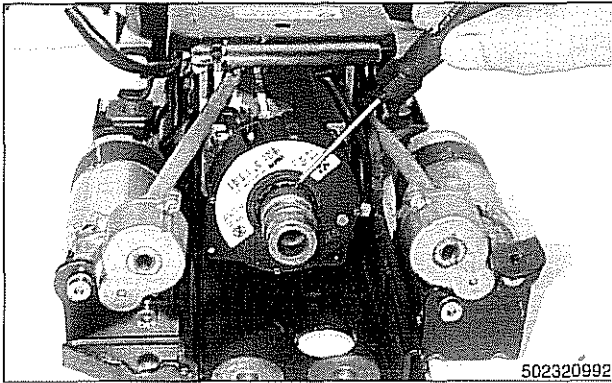
Lateral acceleration / rotational rate sensor to bracket	8 Nm (6 ft-lb)
Sensor bracket to body	8 Nm (6 ft-lb)

**DSC steering angle sensor, removing and installing**

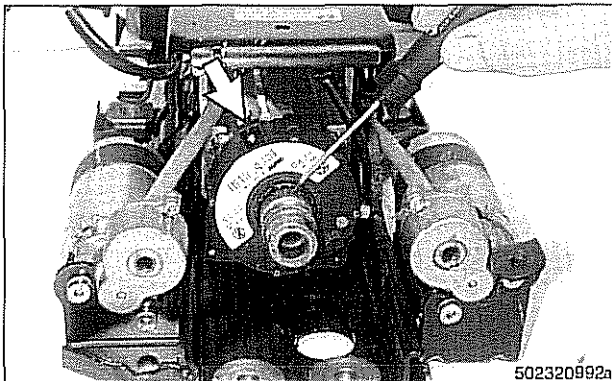
- Remove lower dash panel mounting fasteners (A) and (B).
- Remove steering column lower trim panel. See 320 Steering and Wheel Alignment.



- Remove steering shaft clamping bolt (arrow).
- Disconnect sensor wiring harness connector.



- Remove snap ring from steering shaft.
- Slide steering angle sensor off steering shaft.



- Installation is reverse of removal, noting the following.
  - Take care to line up locking pin (**arrow**) with mount hole in sensor.
  - Perform steering angle offset test using BMW scan tools DISplus, GT1, or MoDiC. Once calibrated, the sensor sends a confirmation ID code to the DSC control module to indicate proper calibration.

### DSC precharge pump, removing and installing (1998 models)

1998 V-8 cars with Bosch DSC III v. 5.3 are equipped with a DSC precharge pump mounted in the engine compartment. There is no separate precharge pump in the Bosch DSC III v. 5.7 system (1999 models and later).

#### **WARNING—**

*E39 cars require special BMW service equipment to properly bleed the brakes. Removal of hydraulic components is not recommended unless this equipment is available. For safety reasons, the brake system on cars with ABS must be bled using the procedures described in this repair group.*

- Using a clean syringe, empty brake fluid reservoir.

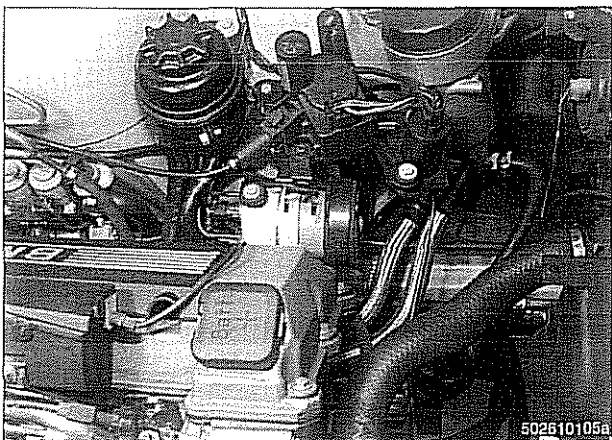
#### **CAUTION—**

*Brake fluid is highly corrosive and dangerous to the environment. Dispose of it properly.*

- Working at precharge pump, disconnect hydraulic lines (**A**) and electrical harness connector (**B**). Clean up dripping fluid.

#### **CAUTION—**

*Do not mix up fluid lines at the hydraulic unit. Label all connections before disconnecting.*



- Remove precharge pump mounting bracket fasteners and remove pump.
- Installation is reverse of removal, noting the following:
  - Be sure to replace rubber pump mounts if damaged or worn.
  - Bleed brakes as described earlier.

#### Tightening torque

Brake line to precharge pump	18 Nm (13 ft-lb)
------------------------------	------------------

### DSC pressure sensor (1999 – 2002 models)

On 1999 and later DSC systems, the DSC pressure sensor is screwed into the DSC hydraulic unit (right rear of engine compartment).

#### **WARNING—**

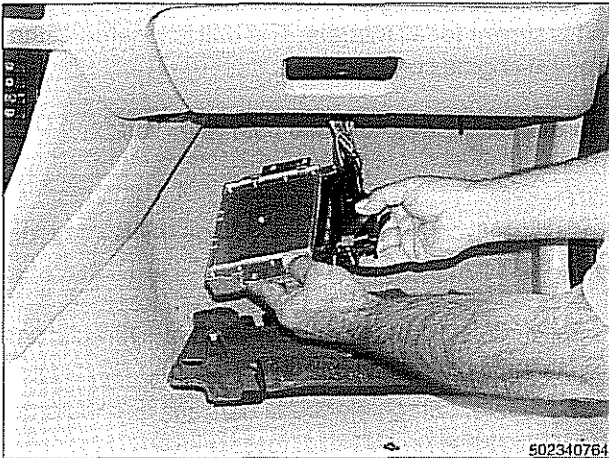
- *E39 cars require special BMW service equipment to properly bleed the brakes. Removal of the DSC pressure sensor is not recommended unless this equipment is available. For safety reasons, the brake system on cars with ABS must be bled using the procedures described in this repair group.*
- *Switch off ignition and remove key to make sure brake system cannot be activated.*

- Disconnect electrical harness connector at switch.
- Use BMW special tool 34 5 160 to remove and install sensor.
  - Inspect threads and sealing surfaces for damage.
  - Work quickly to avoid excessive brake fluid leakage.

#### Tightening torque

Pressure sensor to hydraulic unit	19 Nm (14 ft-lb)
-----------------------------------	------------------

- Reconnect harness connector.
- Bleed front brakes as described earlier.
- Press on brakes and check for leaks at sensor.
- Turn on ignition and firmly depress brake pedal. Check that DSC warning light does not come on.



### ABS / traction electronic control module (1997 – 1998 models)

- ◀ The traction control electronic control module in 1997 – 1998 models is located to the left of the glove compartment.

#### NOTE —

*In both ASC and early DSC systems this location is used for the electronic control unit.*

- Before removing the traction control electronic module, read any fault codes in memory.

### ABS / DSC control module (1999 – 2002 models)

The DSC electronic control unit in 1999 and later models (from 9/1998) is bolted to the DSC hydraulic unit in the right rear of the engine compartment.

- Before removing the traction control electronic module, read any fault codes in memory.
- Install electronic control unit using new screws.

#### Tightening torque

DSC electronic control unit to hydraulic unit (use new screws)	2.9 Nm (26 in-lb)
--	-------------------

- Code newly installed module using either DIS or MoDiC.
- Adjust steering angle sensor using menu item Service function in DIS or MoDiC.

### ABS / traction control hydraulic unit, removing and installing

#### WARNING —

*E39 cars require special BMW service equipment to properly bleed the brakes. Removal of the hydraulic unit is not recommended unless this equipment is available. For safety reasons, the brake system on cars with ABS must be bled using the procedures described in this repair group.*

#### NOTE —

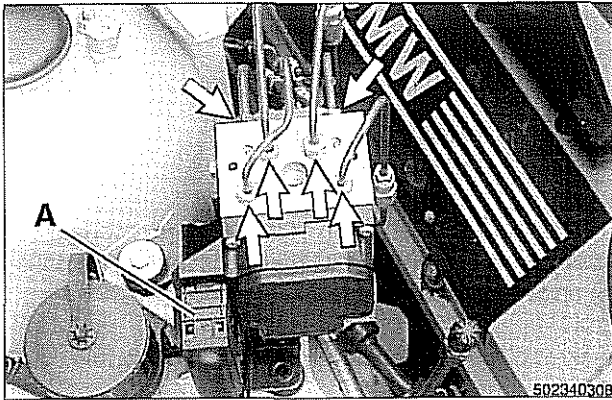
- Before starting this procedure, read control module memory and print out diagnostic record.
- DSC system: Adjust steering angle sensor using either DISplus, GT1, or MoDiC. After completing work, function test control module.

The procedure for removing the ABS / ASC or ABS / DSC hydraulic unit is similar for all models. The unit is located at the right rear of the engine compartment.

- Using a clean syringe, empty brake fluid reservoir.

**CAUTION—**

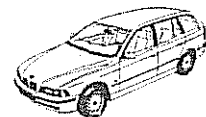
*Brake fluid is highly corrosive and dangerous to the environment. Dispose of it properly.*



- ◀ Disconnect electrical harness connector (A) at hydraulic unit (1998 DSC hydraulic unit in V-8 model shown).
  - Where applicable, detach electrical harness connector to DSC pressure sensor.
  - Mark brake lines (arrows) in relation to their placement on hydraulic unit. Detach lines from unit using appropriate sized flare wrench.
  - Seal open brake fluid lines and bores with suitable plugs to prevent contamination.
- Carefully push aside brake lines from retainers/grommets that may be in the way of hydraulic unit removal. Use care not to kink brake lines.
- Remove hydraulic unit mounting screws. Remove hydraulic unit.
- If necessary, separate hydraulic unit from control module.
- Installation is reverse of removal, noting the following:
  - Check rubber mount for hydraulic unit / control module. Replace if damaged.
  - Make sure all nuts, fluid couplings, thread bores and mating surfaces are clean.
  - Avoid bending pins on control module harness connector when reattaching.
  - Make sure brake lines are securely seated in grommets before installing brake lines in hydraulic unit bores.
  - Bleed brakes using BMW Service Tester as described earlier.

**Tightening torques**

Brake lines to hydraulic unit	18 Nm (13 ft-lb)
DSC electronic control unit to hydraulic unit (use new screws)	2.9 Nm (26 in-lb)
Hydraulic unit to body	8 Nm (6 ft-lb)
Mounting bracket to hydraulic unit	8 Nm (6 ft-lb)





# 400 Body-General

<b>General</b> .....	400-2	Roof padding .....	400-7
<b>Body Assembly</b> .....	400-2	Seat belts .....	400-7
Body dimensions (in inches) .....	400-2	Airbags .....	400-8
Body shell .....	400-3	Battery safety terminal (BST) .....	400-9
Exterior and aerodynamics .....	400-3	Security .....	400-9
<b>Sport Wagon</b> .....	400-4	<b>Interior Features</b> .....	400-9
Tailgate .....	400-5	Seats .....	400-10
Tailgate lock system .....	400-5	Instruments and controls .....	400-10
Rear wiper system .....	400-6	Central body electronics .....	400-11
Antenna and sound system .....	400-6	<b>Heating and Air</b>	
<b>Safety and Security Features</b> .....	400-7	<b>Conditioning (IHKA)</b> .....	400-12
Safety cage .....	400-7		
Door locks and door handles .....	400-7		

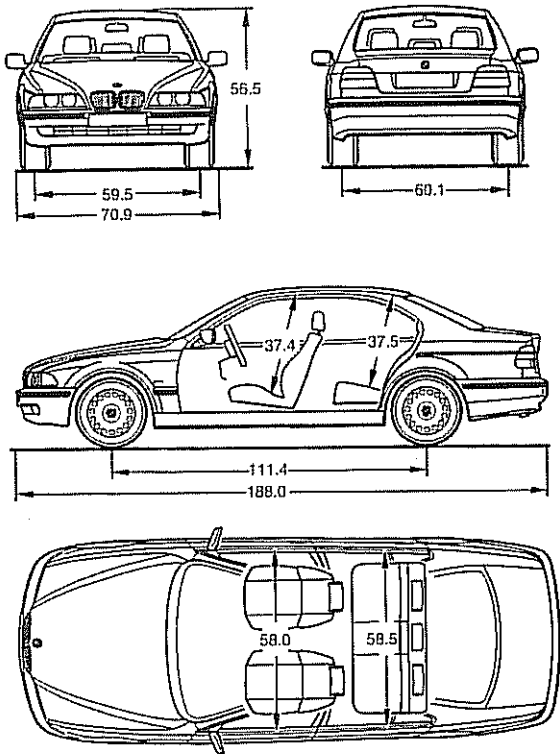
## GENERAL

This chapter covers system descriptions and general information for the repair groups found in sections 4 **Body** and 5 **Body Equipment**.

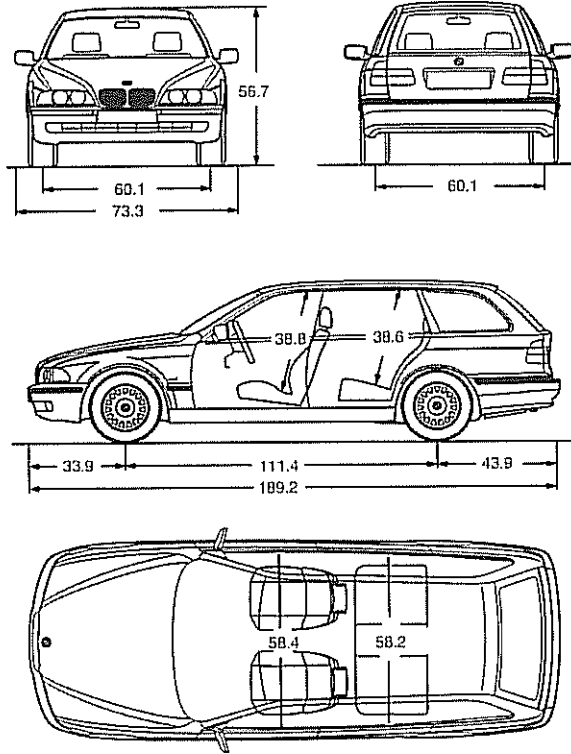
## BODY ASSEMBLY

Body dimensions (in inches)

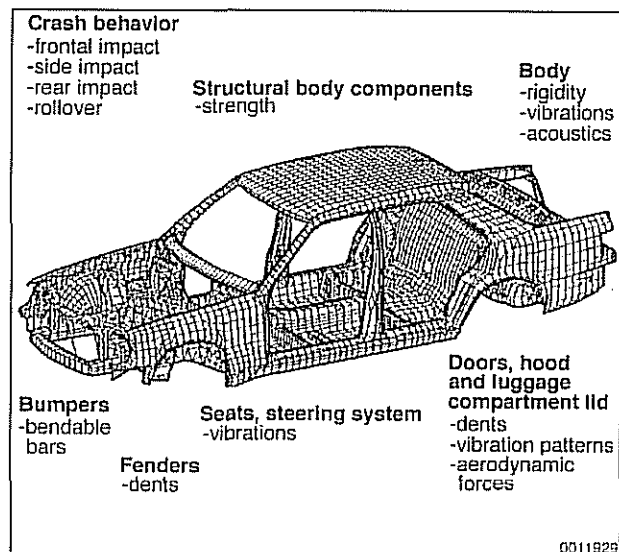
E39 sedan



E39 Sport Wagon



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## Body shell

The BMW 5 Series chassis is a unibody design constructed of high strength steel. Attaching parts, such as the front fenders, rear quarter panels, doors, trunk lid and hood are also constructed of steel.

- ◀ Computer aided design (CAD) techniques have been used in refining the E39 body to reduce vehicle weight while retaining strength and increasing torsional rigidity. For good handling purposes, the more rigid the structure the more precisely the suspension can operate.

## Exterior and aerodynamics

With its traditional styling features, such as the kidney grille, circular headlights behind a glass cover (for reasons of streamlining), and the "kick" in the rear most roof pillar (C-pillar), the E39 can be immediately recognized as a BMW.

### Wind resistance

Windows bonded flush to the body and the guided flow of cooling air into the engine compartment provide the car with a good coefficient of drag (Cd). E39 cars have been designed for balanced aerodynamics but not necessarily an extremely low Cd. See table below.

Windshield wipers are designed for effectiveness at speeds up to and beyond 200 kph (124 mph).

#### Coefficient of aerodynamic drag (Cd)

6-cylinder sedan	0.30
V-8 sedan	0.31
6-cylinder Sport Wagon	0.31
V-8 Sport Wagon	0.33

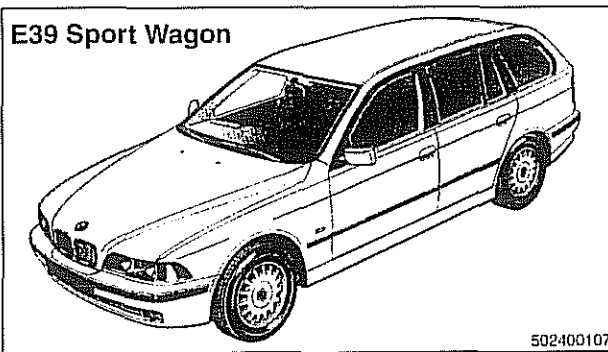
### Fenders

The exterior panels are corrosion-resistant zinc coated (galvanized) steel. The front fenders are bolted on. For front fender replacement information, see **410 Fenders, Engine Hood**.

## Bumpers

The front and rear bumpers are clad in high quality deformable plastic and, at solid barrier impact speeds of 4 kph (2.5 mph), provide protection with virtually no damage to the bumper or the vehicle. In addition to hydraulic dampeners, which absorb the initial impact energy, these bumpers are backed by compressible tubes. These deform in a controlled manner at impact speeds greater than that for which bumpers and hydraulic dampeners are designed. This helps avoid expensive damage to the body at impact speeds up to 14 kph (9 mph).

## SPORT WAGON



◀ The E39 Sport Wagon was introduced to the US market in 9/1998 (model year 1999). It shares many components with the E39 sedan and is identical to it from the B-pillar forward.

US market 5 Series Sport Wagons are available in two variants:

- 6-cylinder (525i, 528i) powered by the 2.8 liter M52 TU engine (1999) or the 2.5 liter M54 engine (2000 and later)
- V-8 (540i) powered by the 4.4 liter M62 TU engine

The wheelbase of the Sport Wagon is the same as the sedan. However the body is 30 mm (1.2 in) longer and 10 mm (0.4 in) higher.

The Sport Wagon rear suspension was redesigned to eliminate the upper rear spring strut mounting on the E39 sedan. The use of separate coil springs and shock absorbers results in a flat, wide floor in the cargo area. See **300 Suspension, Steering and Brakes-General**.

The self-leveling air spring suspension system (electronic height control or EHC) is standard on Sport Wagon V-8 models and optional on 6-cylinder models.

Sport Wagon cargo capacities are shown below.

### Sport Wagon load capacities

#### Cargo capacity

- |                         |                          |
|-------------------------|--------------------------|
| • Rear seat up          | 909 liters (32.1 cu ft)  |
| • Rear seat folded down | 1809 liters (63.9 cu ft) |

#### Load limit

- |                     |                  |
|---------------------|------------------|
| • Cargo compartment | 460 Kg (1014 lb) |
| • Roof              | 100 Kg (220 lb)  |

## Tailgate

The E39 Sport Wagon tailgate is large with a low sill for easy cargo loading. The tailgate opens to an angle of 88° measured from the rear roof pillar (D-pillar) and to a height of 2029 mm (79.8 in) measured from the ground to the upper edge of the raised tailgate.

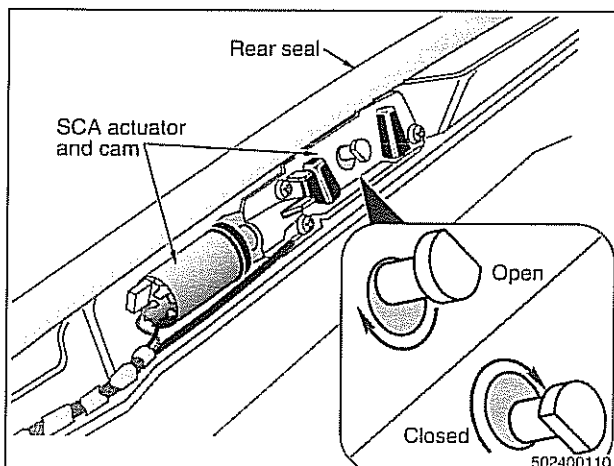
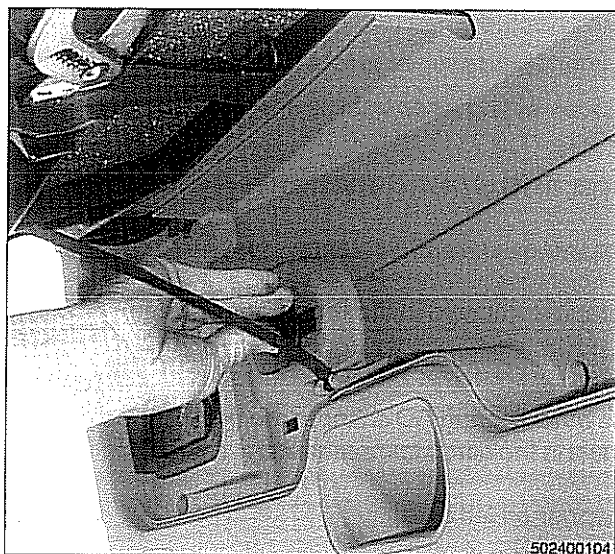
The rear window is bonded to a load bearing frame and can be opened separately from the main tailgate. Tailgate support gas springs are recessed into cavities in the roof.

## Tailgate lock system

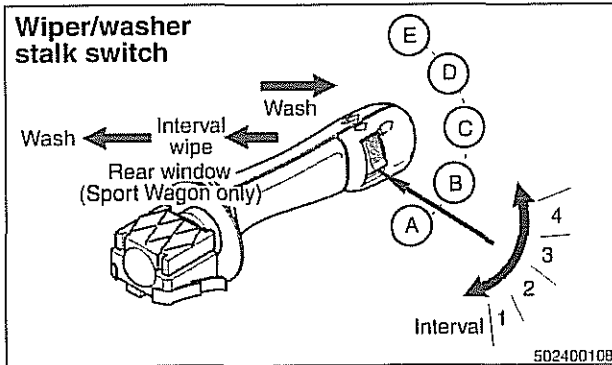
A mechanical tailgate lock cylinder is not used; the tailgate is opened by the unlock pad above the license plate, the remote tailgate switch located in the drivers kick panel, or via FZV (keyless entry) control.

- ◀ An emergency release mechanism is incorporated into the latch assembly to open the hatch from the vehicle interior if a malfunction occurs.

The tailgate lock assembly includes an automatic soft close (SCA) feature. The electrical operation of SCA is a function of central body electronics (ZKE III). The SCA actuator is located in the rear cowl panel below the tailgate. The actuator is controlled by a load relay in the General Module. A locking cam is mounted on an eccentric that is driven by the actuator.



- ◀ The SCA cam always turns in the same direction to open or close the tailgate. The cam turns 180° to open or to close. When the cam turns in the up direction the notch in the cam pushes on a lever on the back of the latch in the tailgate. This mechanically unlocks the latch. The tailgate is raised up and can be opened.



## Rear wiper system

The rear wiper assembly on the E39 Sport Wagon is a self-contained unit. The control electronics are integrated into the gear drive that is part of the motor assembly. The control electronics contain two hall sensors, one for the park position and one for the end stop or to signal reverse direction of the wiper motor.

◀ The rear wiper is controlled through the stalk switch on the steering column. The switch includes the following functions:

- Intermittent rear window wiping
- Programmed rear window wiping interval
- Operation of rear window washer

The wiper system automatically controls the following safety and convenience features:

- Wiper interrupted when rear glass is opened
- Wiper interrupted if wiper arm is blocked
- Continuous wiping when vehicle is shifted into reverse

## Antenna and sound system

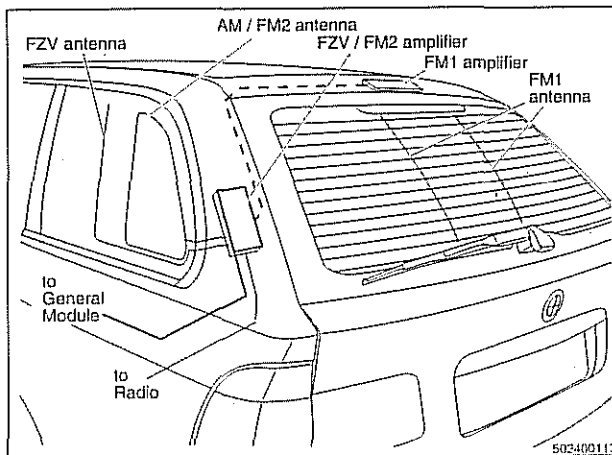
◀ There are two diversity FM antenna amplifiers:

- FM1 amplifier located in the rear window frame
- FM2 / FZV amplifier located in the left D-pillar

The radio amplifier and CD changer are behind the side access panels in the cargo compartment:

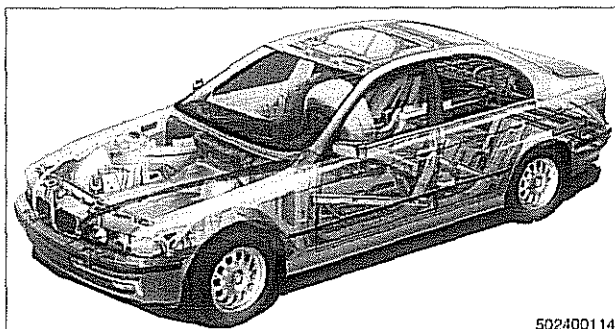
- CD changer on left side
- Sound system subwoofer on right side

The subwoofer has a hold down knob and is mounted on a hinge. It can be swung out to access the battery and fuse panel by unscrewing the knob.



## SAFETY AND SECURITY FEATURES

A number of new or improved safety and security features are incorporated in E39 cars.



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### Safety cage

- The body safety cage is a continuation of an established BMW concept for passenger protection. Tubular impact structures built into the body provide protection against passenger injury during front or rear impacts.

### Door locks and door handles

- The door handles allow easy door opening, but are secure in accidents.

Electrical components in the locks are fully encapsulated and cannot be picked easily. The door handles, latches and lock assemblies offer reliability and security against theft.

Door position and lock condition are detected by hall sensors.



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### Roof padding

In addition to the side and head protection airbags, there is supplementary padding at the roof pillars and along the roof above the doors. This is positioned to present energy absorbing surfaces to passengers thrown around by side impact forces.

### Seat belts

Each front seat belt assembly has a height-adjustable anchor at the B-pillar.

An automatic pyrotechnic (explosive charge) tensioner tightens the front belt at the buckle upon impact, snugging up lap and shoulder segments of the belt. The tensioners are designed to automatically tension the belts by about 2 inches (55 mm) in the event of a collision.

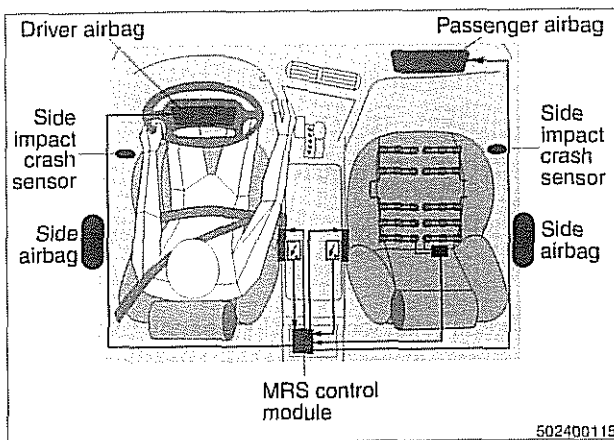
A force limiter puts an upper limit on the amount of force each belt can exert on the passenger.

## Airbags

Front airbags, side airbags, pyrotechnic seat belt tensioners and the Battery Safety Terminal (BST) are integrated into the Supplemental Restraint System (SRS) and its variants.

### NOTE —

The BMW SRS system is called Multiple Restraint System (MRS). Over the years, E39 cars were equipped with MRS, MRS II, MRS III. Each version offers varied features and improvements over the previous system.



As many as 8 airbags may be installed in E39 cars, depending on model and MRS version.

The front airbags operate without sodium azide propellant, widely considered an irritant when an airbag is deployed.

Starting with 1999 models, "smart" front passenger and driver airbags were installed. These are of the dual-threshold, dual stage design, including a sensor to help prevent the unnecessary deployment of the passenger side airbag if the seat is unoccupied.

Depending on options chosen, one airbag may be installed in each door of the sedan and Sport Wagon models, protecting passengers against side impacts.

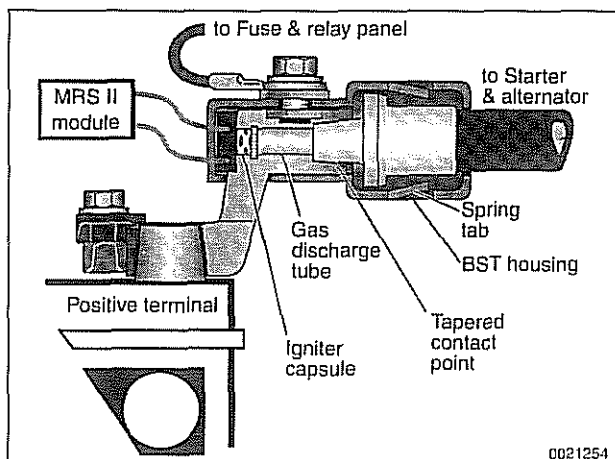
Head Protection System (ITS) airbags stretch diagonally across the tops of the front doors.

Airbag deployment automatically triggers fuel shutoff, turns on the hazard and interior lights, and unlocks the doors.

### WARNING —

- Airbags are inflated by an explosive device. Handled improperly or without adequate safeguards, airbag units can be very dangerous. Special precautions must be observed prior to any work at or near any of the airbags. See 721 Airbag System (SRS).
- Always disconnect the battery and cover the negative (-) battery terminal with an insulator before starting diagnostic, troubleshooting or service work on cars fitted with SRS, and before doing any welding on the car.





## Battery safety terminal (BST)

- Starting with 1999 models (9/98 production and later), a pyrotechnic (explosive charge) device automatically disconnects the battery positive terminal during impacts. Key features, like power windows and door locks, remain operational.

## Security

### Electronic immobilization (EWS)

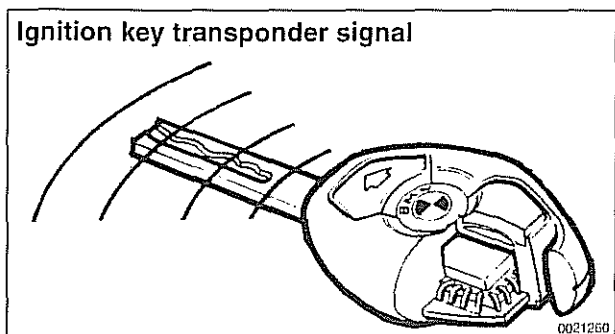
- All E39 vehicles incorporate an electronic immobilization system known as EWS. This system uses a wireless communication link between a transponder chip in the ignition key and the ring antenna surrounding the ignition switch. The EWS control module blocks the starting of the vehicle unless the correct coded ignition key is used.

#### NOTE—

Electronic immobilization is sometimes referred to as the driveaway protection system.

### Antitheft alarm (DWA)

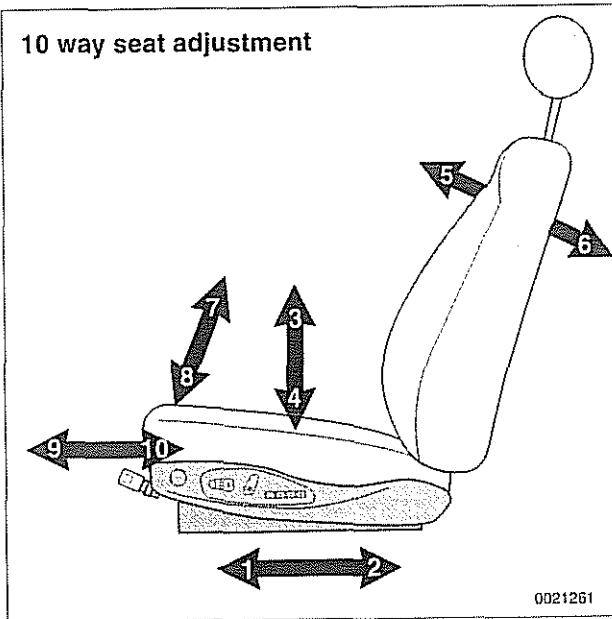
This is a dealer-installed option for which the E39 vehicles are factory-wired. When armed, the system monitors door lock contacts and trunk and engine hood locks and sounds a siren if it detects tampering.



## INTERIOR FEATURES

E39 interiors have a unique character, with a combination of sporty features and innovative design. All body versions were made in a wide choice of interior and exterior colors. New colors with matching leather or leatherette upholstery were introduced for each model year.

Driving comfort is enhanced by power steering, tilt steering wheel, height-adjustable front seats, and electrically adjustable and heated rear-view mirrors. Inside the car there are reading lights at four seating positions.



## Seats

◀ Anatomically correct seats are constructed from polyurethane foam containing areas or "zones" of different firmness. They offer good lateral support without constricting the occupant.

The seats have a passive internal ventilation system: Cylindrical cavities within the cushions and backrests generate a *pumping effect* as the ride motions cause occupant motion. This helps remove moisture and feeds fresh air into the seats.

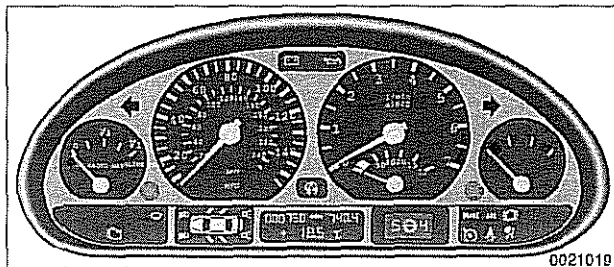
Other features of the seating system:

- The seat bases have steel springs for added support and strength.
- The seat control switches are along the outside edge of the seat.
- Heated seats are an option in all models.
- In cars equipped with seat position memory, three different seat configurations can be memorized by the seat control module(s). *Seat memory coordinates with outside mirror memory.* These functions are controlled by the seat memory module(s).
- For security reasons, the release lever to fold the rear seat backrest forward is installed in the trunk.
- Sport Wagon models: Rear seat backs are split 60/40, with the center armrest on the left seat back.
- The center armrest incorporates a non adjustable headrest. When folded down, the armrest opens out with cupholders and a storage compartment. See **520 Seats** for more details.

## Instruments and controls

Everything in the interior passenger compartment essential to the driver is logically grouped and easy to reach. All instruments and controls have been arranged ergonomically and are fully integrated into the overall design of the vehicle.

- Tilt-telescopic steering wheel has 30 mm (1.2 in) of vertical and longitudinal adjustment.
- Multifunction steering wheel contains two key pads containing controls for the sound system, telephone and cruise control.
- Padded dashboard houses the instrument cluster and the ventilation and heating system.



### Instrument cluster

- Instrument cluster uses large easy-to-read analog instruments and is removable as a unit without removing the dashboard. On-board computer and Check Control functions are integrated into the instrument cluster displays.

### Service Interval Display

Service Interval Display calculates vehicle service needs based on current driving patterns, and indicates to the driver when the car requires service.

### On-board navigation

An integrated on-board navigation system, based on Global Positioning System (GPS) technology, is optionally available on E39 cars. When installed, a multifunction monitor is included in the center of the dash above the radio. In addition to displaying navigation system information, this monitor accesses On-Board Computer functions, audio system controls, mobile phone dialing and memory, and automatic ventilation.

### Park Distance Control (PDC)

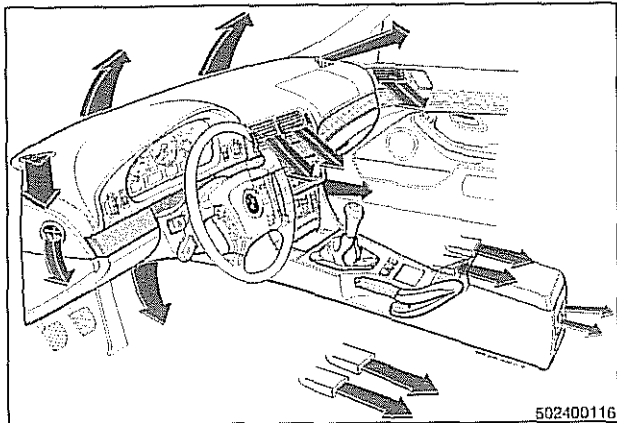
Park Distance Control (PDC) is an optional system which uses ultrasonic sensors in the rear bumper trim to warn the driver of approaching too close to obstacles when parking.

### Central body electronics

E39 vehicles are equipped with an integrated complex of electronic modules connected mostly via K-Bus. This system, called central body electronics (ZKE III), is primarily controlled by the general module (GM III). An overview of ZKE III functions is found in **600 Electrical System-General**. Details of ZKE III functioning is in the following repair groups:

- 512 Door Windows
- 515 Central Locking and Anti-Theft
- 520 Seats
- 540 Sunroof
- 611 Wipers and Washers
- 620 Instruments

## HEATING AND AIR CONDITIONING (IHKA)



← The integrated heating and air conditioning (IHKA) system uses an extra large, infinitely variable radial blower motor for *good distribution of air*. Fresh air enters through the grille below the engine hood and into the passenger compartment via the dashboard and footwell vents.

- Repair information for the heating and air conditioning system is covered in **640 Heating and Air Conditioning**.



# 410 Fenders, Engine Hood

<b>General</b> .....	410-2	<b>Engine Hood</b> .....	410-6
Special tools .....	410-2	Hood, raising to service position .....	410-6
<b>Front Fenders</b> .....	410-2	Hood, removing and installing .....	410-7
Front fender, removing and installing .....	410-2	Hood, aligning .....	410-8
		Hood latch components .....	410-10
		Hood release cable and spring pins, adjusting .....	410-11

## GENERAL

This repair group covers replacement of the front fenders and removal and installation of the engine hood.

### NOTE—

*The body is painted at the factory after assembly. Realignment of body panels may expose unpainted metal. Paint all exposed metal once the work is complete.*

## Special tools

Most body repairs can be performed using regular automotive service tools. Some BMW special tools are required to set body pieces into the service positions.

## FRONT FENDERS

### Front fender, removing and installing

- Raise front of vehicle and remove wheel.

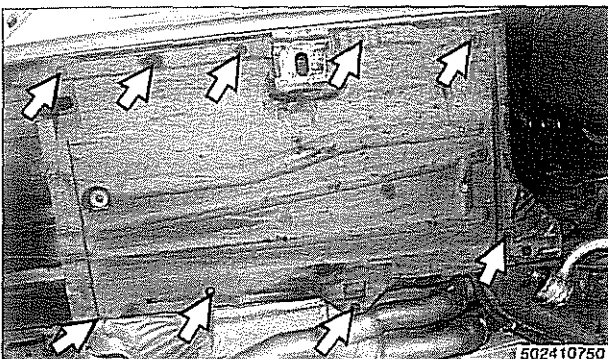
#### WARNING—

*Make sure that the car is firmly supported on jack stands designed for the purpose. Place jack stands beneath structural chassis points. Do not place jack stands under suspension parts.*

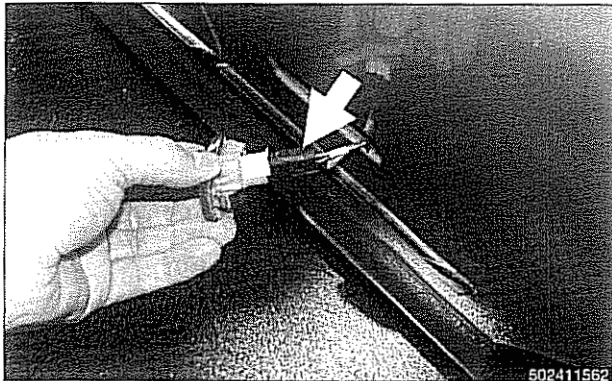
- Raise hood to service position. See **Hood, raising to service position.**

- ◀ Working beneath vehicle, remove fasteners (arrows) from left side floor panel and remove panel.

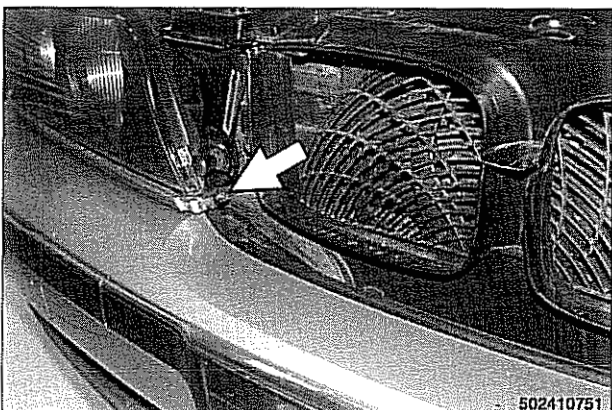
- Remove inner plastic liner from wheel housing.



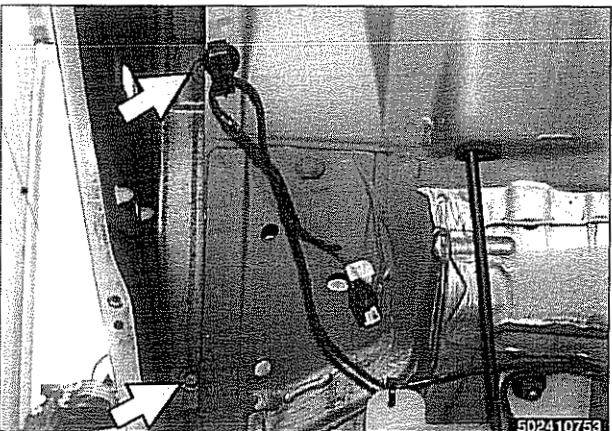
## Fenders, Engine Hood



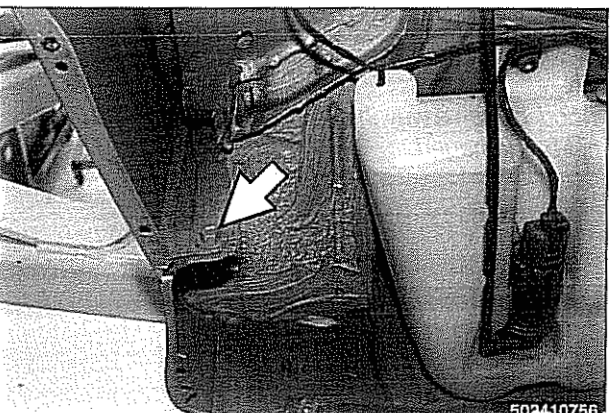
- ◀ Carefully pry front turn signal assembly from fender and disconnect electrical harness (arrow).



- ◀ Release headlight trim panel locking clip with a screwdriver (arrow).
  - Working at corner of side trim panel, pull trim panel out from side of fender to remove.
- Remove front bumper. See 510 Exterior Trim, Bumpers.

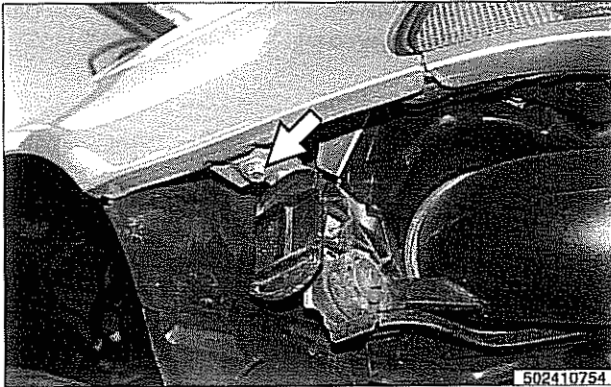


- ◀ Working at rear of fender well, remove fender mounting fasteners (arrows).

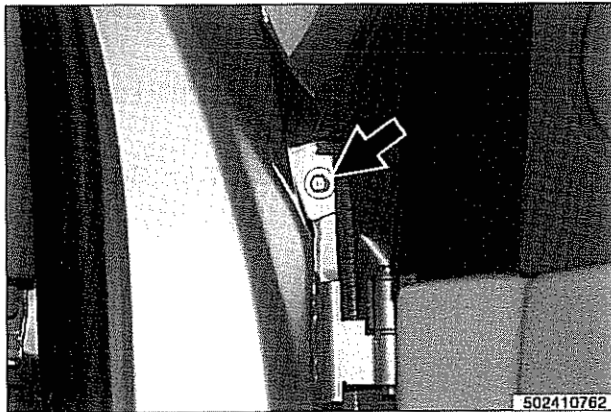


- ◀ Remove lower fender attaching bolts (arrow) at rear of wheel housing.

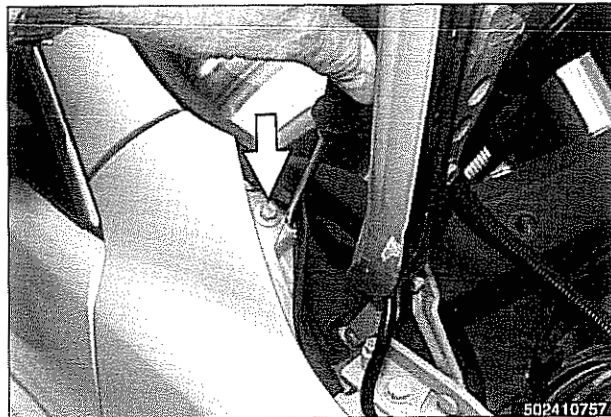
## Fenders, Engine Hood



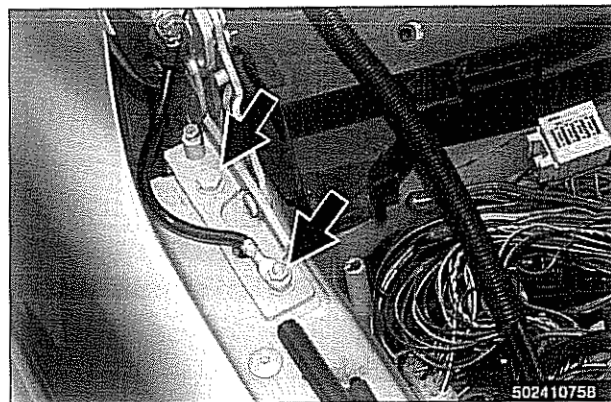
- Working from below, remove front wheel arch fastener (arrow).



- With door open remove fastener (arrow) attaching upper fender to door post.



- Remove screw (arrow) at front of fender.



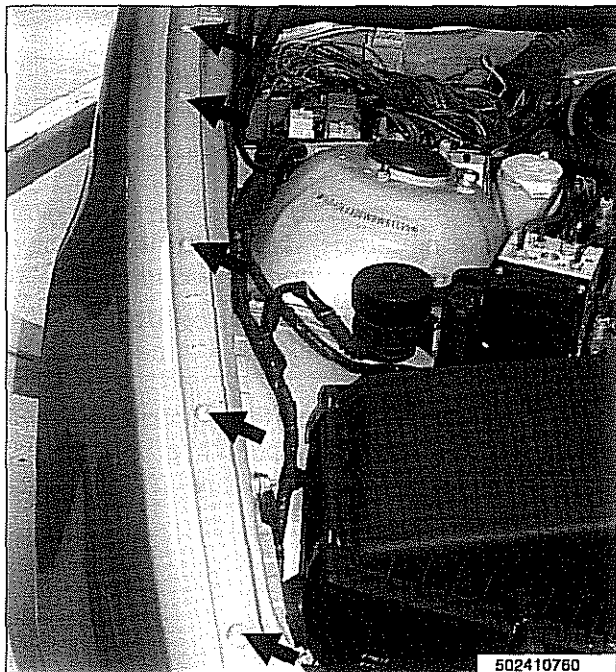
- Remove ground strap nut and hood hinge bolts (arrows).

**CAUTION—**

Secure hood in such a way that the windshield and body panels will not be damaged.

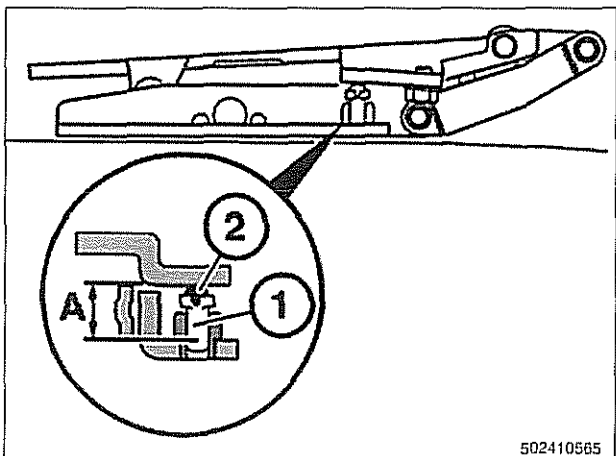


## Fenders, Engine Hood



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- ◀ Remove bolts (**arrows**) along top edge of fender.
- Carefully remove fender from body.



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- ◀ Detent screw on left and right hood hinge (1) must be set at  $25 \pm 1$  mm ( $1 \pm .04$  in).
- Installation is reverse of removal, noting the following:
  - Before installing new fender, clean old sealant and protective coating from mounting surfaces.
  - Position new fender and loosely install all mounting bolts.
  - Align fender with door pillar and inner fender, then tighten bolts.
  - Repair any paint damage and paint any exposed metal.
  - Reseal and apply protective coating to mounting surfaces.

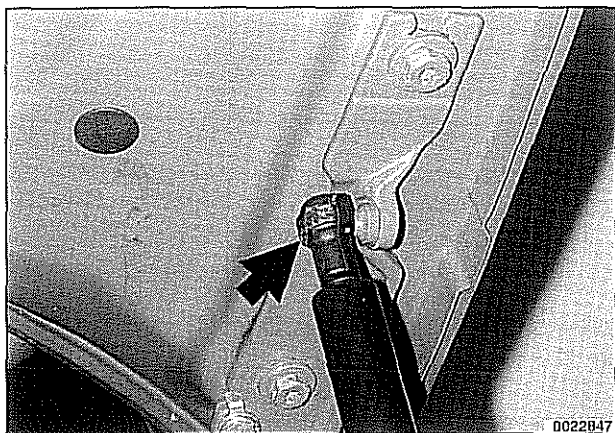
## ENGINE HOOD

### Hood, raising to service position

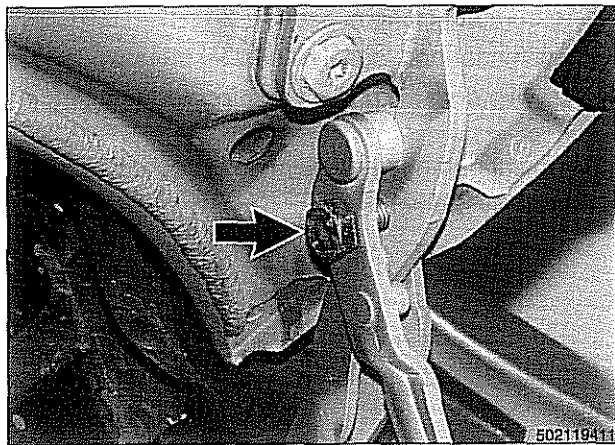
#### CAUTION—

- Do not switch on the windshield wipers with the engine hood raised. As a precaution, remove the wiper motor fuse. See **610 Electrical Component Locations**.
- The hood is heavy. Before removing the hood supports, be sure to have an assistant help support the hood.

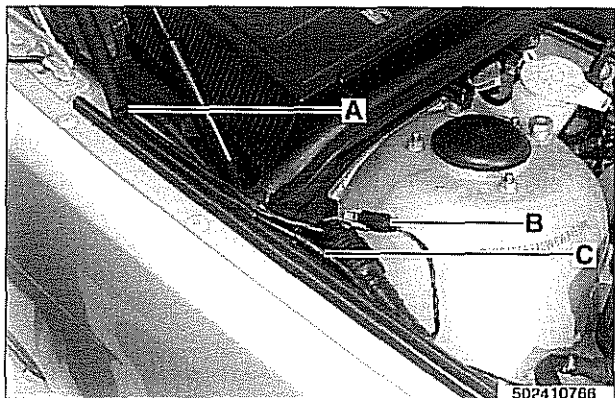
➤ Open hood fully. With the help of a partner, support hood and remove retaining clips (**arrow**) on upper end of pressurized lifting struts. Pull struts off hood.



➤ Raise hood to service position and lock in position by placing bolts (**arrow**) in right and left hinges.



## Hood, removing and installing



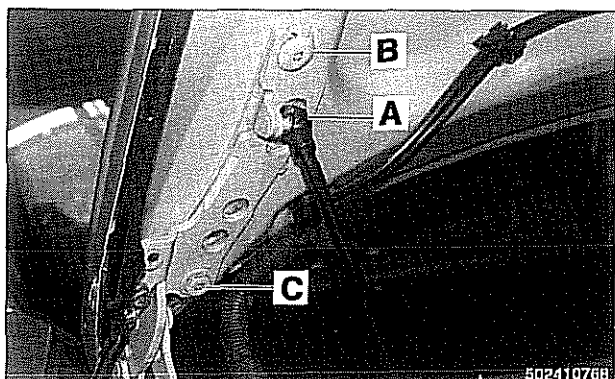
◀ With hood open:

- Remove hood wiring harness mounting clip (A).
- Disconnect electrical harness connector (B).
- Unplug windshield washer hose (C).

### WARNING—

*The hood is heavy. Before removing the hood supports, be sure to have an assistant help support the hood.*

- Mark position of hinge plates.



◀ With the help of a assistant, support hood and remove retaining clips (A) on upper end of pressurized lifting struts. Pull struts off hood.

- Loosen upper hinge bolts (B).
- Remove lower hinge bolts (C). Lift hood off carefully.
- Installation is reverse of removal.
  - Repair any paint damage and paint any exposed metal.
  - Check hood alignment. See **Hood, aligning**.

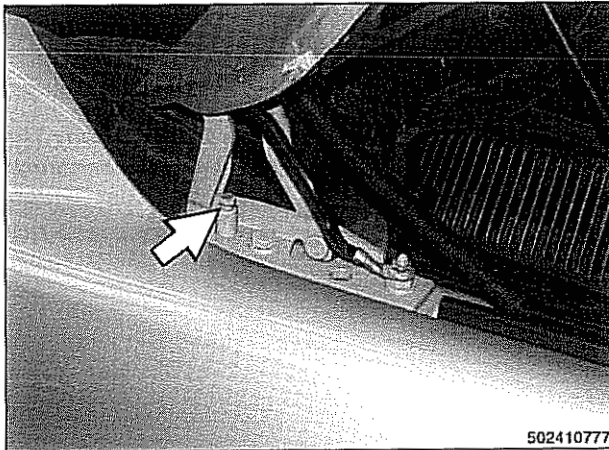
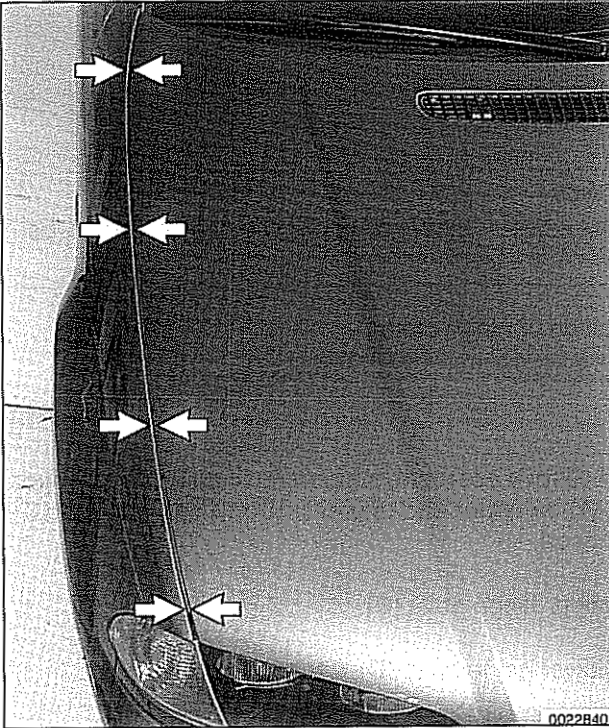
### NOTE—

*The hood was fitted and attached to an unfinished body at the factory. Unfinished surfaces exposed by this procedure must be touched up with paint.*

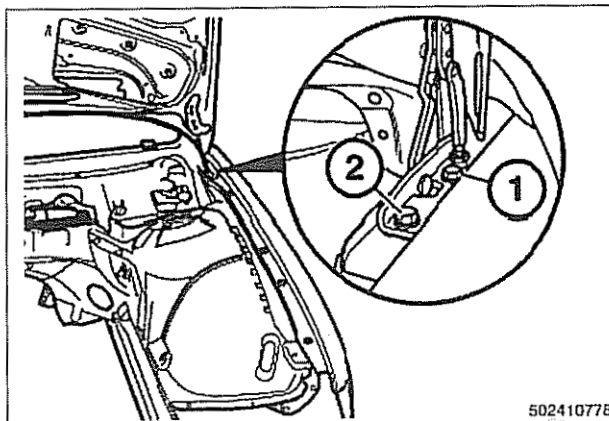
### Hood, aligning

When installing the hood, align the hinges as close to the original painted surface as possible. Movement of the hood on its attaching hardware may require touch-up paint.

- The hood should be aligned so that gap (**arrows**) to fender is as even as possible.

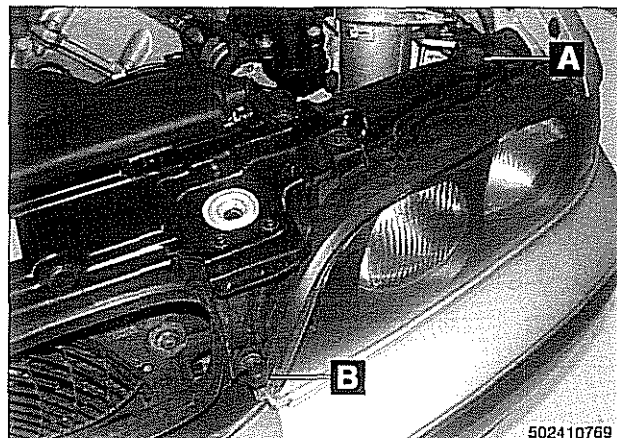


- If height adjustment at rear of hood is off, adjust height using adjusting screw in lower hinge (**arrow**). Loosen and reposition as necessary.



- If height adjustment at rear of hood cannot be completed using adjusting screw:

- Loosen lower hinge screws (1) and (2).
- Add or remove washers as needed to correct height setting.

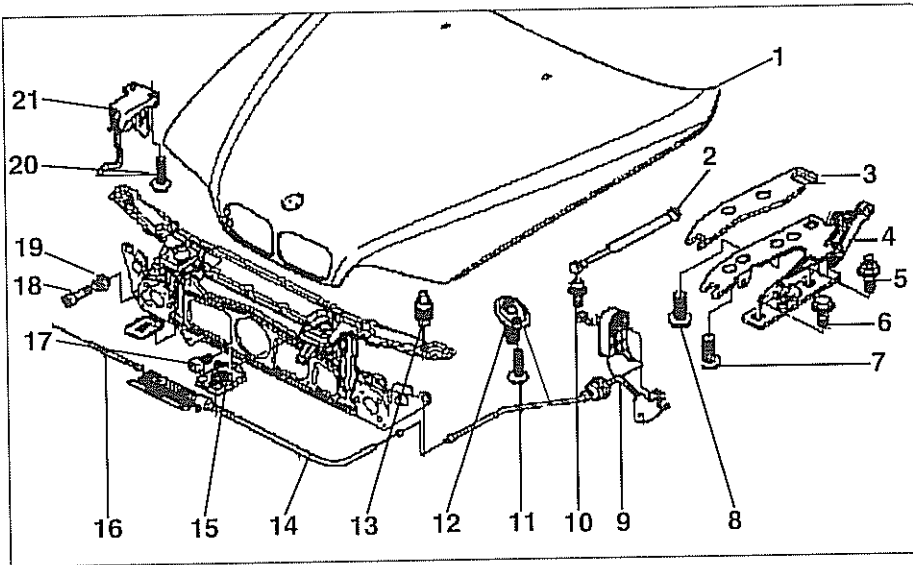


◀ Adjusting detent buffers for hood:

- Raise hood.
  - Shape pieces of rubber (butyl) tape into two 10mm columns and place on buffers (A).
  - Close hood.
  - Measure dimension of the compressed rubber tape.
  - Using measurement dimension, adjust detent buffer (A). Hood should be under a slight preload. (+0.5 mm).
  - Follow the same procedure on the front buffers (B).
- After adjustment have been made, check that hood lid is flush against detent buffers and if necessary repeat the adjustment.

**CAUTION—**

*To avoid excessive wind noise, the hood must not protrude beyond the front side panels.*

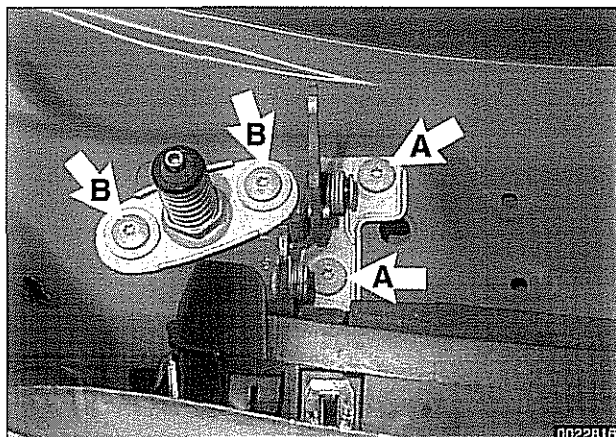


### Hood latch components

1. Hood
2. Gas pressurized strut
3. Spacer
4. Hinge
5. Ground stud
6. Torx bolt
7. Torx bolt
8. Hex bolt
9. Bowden cable bracket
10. Ball pin
11. Torx bolt
12. Spring pin
13. Stop buffer
14. Bowden cable
15. Lower hood lock
16. Bowden cable
17. Torx bolt
18. Stop buffer
19. Hex nut
20. Torx bolt
21. Hood latch

## Hood release cable and spring pins, adjusting

Before adjusting hood pins, be sure the hood is aligned evenly to fenders and front panel.



- Make sure bowden cable, which connects both hood locks together, is seated in lock guide on both left and right locks.

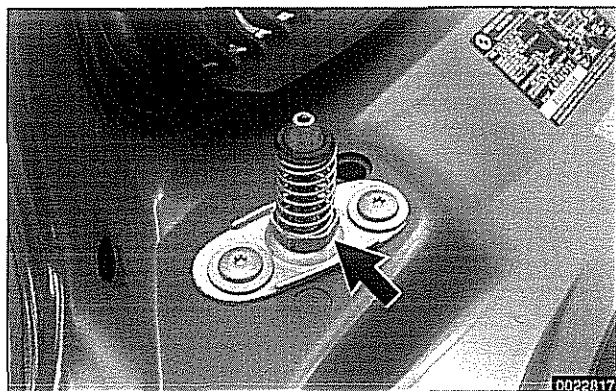
⚠ Loosen hood spring pin bolts (A) and retaining hook bolts (B) at hood on left and right sides only enough to allow movement.

- Lower (but do not fully latch) hood several times so pins on hood center themselves in lower locks.

### NOTE—

*Do not let hood lock with latch bolts loose.*

- Tighten hood spring pin bolts and latch bolts when alignment is correct.
- Remove one bolt at a time from each side, clean and coat with Loctite® 270 or equivalent, and reinstall. Repeat process on all other bolts.
- Adjust rubber stop buffers above headlight assemblies. See **Hood, aligning**.
- Test hood for correct closure and opening. If hood does not spring open, lengthen spring pins.
- To lengthen spring pin, loosen locknut (arrow) with wrench inserted through spring, then turn pin counterclockwise.







# 411 Doors

<b>General</b> .....	411-2	Door hinge adjustment .....	411-5
<b>Doors</b> .....	411-2	Door hinge assembly .....	411-6
Front or rear door, removing and installing .....	411-2	<b>Door Panels</b> .....	411-7
Door check, replacing .....	411-4	Door trim panel, removing and installing ...	411-7
		Sill trim panels .....	411-10

## GENERAL

This repair group covers front and rear door repair information. It includes removal and installation of front and rear doors and trim panels.

For information on airbag removal and installation, see **721 airbag**.

For information on the power door windows and door glass replacement, see **512 Door Windows**.

For information on the power door locking system, see **515 Central Locking and Anti-Theft**.

## DOORS

### **WARNING—**

*E39 cars are fitted with side-impact airbags in the front doors and optional side impact airbags in the rear doors. When servicing doors, always disconnect the negative (-) battery terminal. See **721 Airbag System (SRS)** for cautions and procedures relating to the airbag system.*

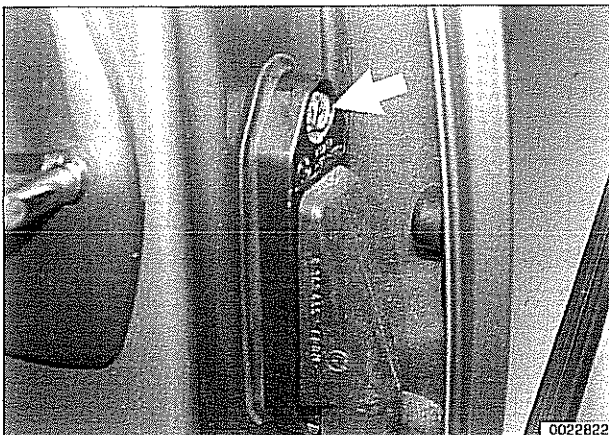
### Front or rear door, removing and installing

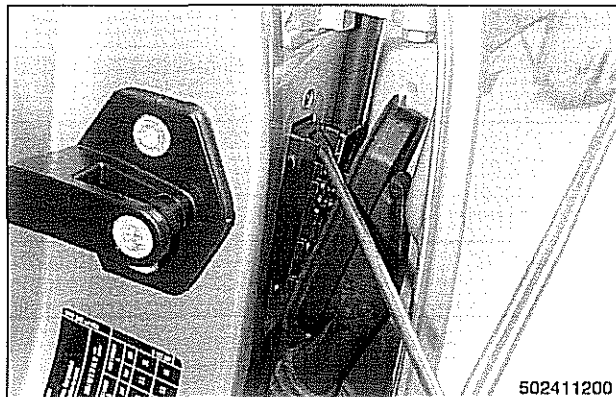
- Disconnect negative (-) battery cable.

### **CAUTION—**

*Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and warnings**.*

- ◀ Remove harness connector mounting bolt (arrow) at door pillar.

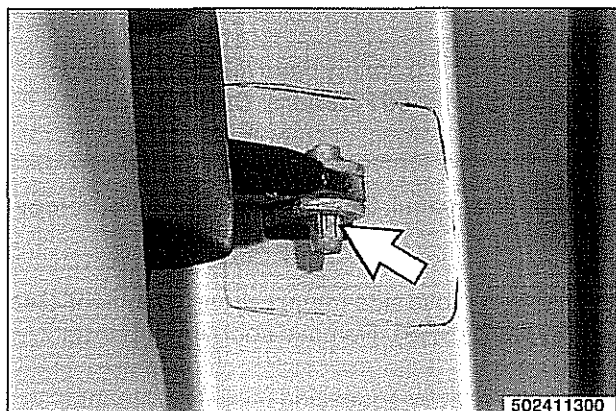




- Pull up on locking clip and remove connector.



- With door fully open, unscrew pin bolts (**arrow**) from top and bottom hinges.



- Disconnect door check by squeezing mounting pin tabs (**arrow**) and driving pin up.

- Remove door by lifting up off lower hinge halves.

**CAUTION—**

*Be careful not to damage door or other painted body surfaces. Make sure no load is placed on wiring harness.*

- Installation is reverse of removal. Keep in mind the following:
  - Mount and align rear doors first, followed by the front doors.
  - Align door so that panel gaps are equal on either side, see specifications at the end of this procedure. If necessary, adjust door hinges. See **Door hinge adjustment**.
  - Adjust door striker so that trailing edge of front door is slightly higher (1 mm / 0.04 in.) than leading edge of rear door. See **515 Central Locking and Anti-Theft**.
  - Repair any paint damage and paint any exposed metal.

**Door adjustment**

Front fender to front door gap	4.25 mm $\pm$ 0.25 mm (0.17 $\pm$ 0.01 in)
Front door to rear door gap	4.5 mm $\pm$ 0.25 mm (0.18 $\pm$ 0.01 in)
Rear door to rear fender	4.0 mm $\pm$ 0.25 mm (0.16 $\pm$ 0.01 in)
Permissible deviation from parallel	1.0 mm (0.04 in)

**Tightening torque**

Door hinge to door frame	20 Nm (15 ft-lb)
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**Door check, replacing****WARNING—**

*E39 cars are fitted with side-impact airbags in the front doors and optional side impact airbags in the rear doors. When servicing doors, always disconnect the negative (-) battery terminal. See **721 Airbag System (SRS)** for cautions and procedures relating to the airbag system.*

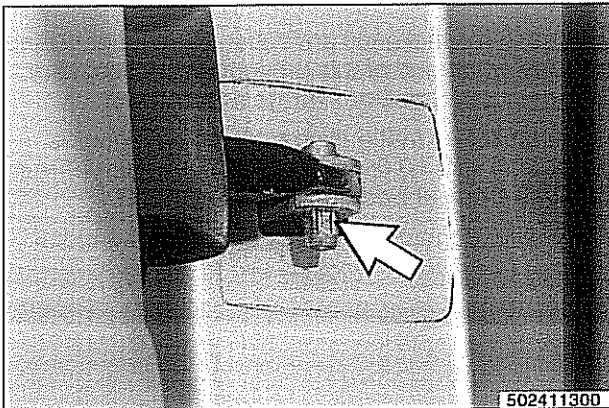
- Close door window completely.
- Disconnect negative (-) battery cable.

**CAUTION—**

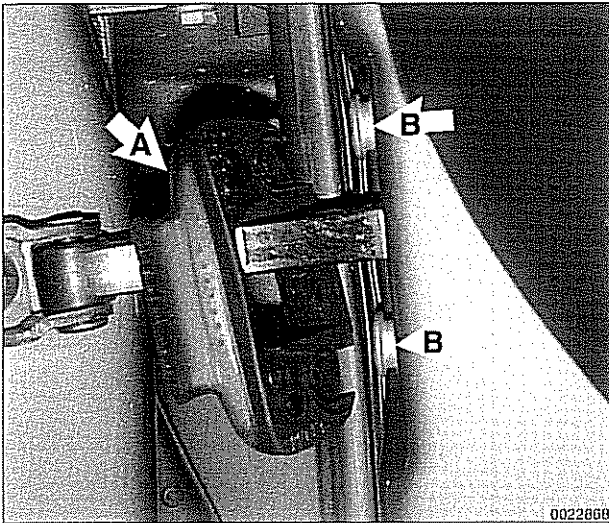
*Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.*

- Remove interior door panel. See **Door trim panels, removing and installing**.
- Where applicable, remove side-impact airbag from door. See **721 Airbag System (SRS)**. Remove door vapor barrier.

- Disconnect door check by squeezing mounting pin tabs (**arrow**) and removing pin.



502411300



◀ Remove rubber cover (A) and bolts (B) from door check lock-plate on door.

- Working inside door, remove door check assembly.
- Installation is reverse of removal.
  - Lubricate door check before installing.
  - If removed, use new mounting bolts when reinstalling side-impact airbag to door.

#### Tightening torque

Door check to door frame	24 Nm (16 ft-lb)
--------------------------	------------------

## Door hinge adjustment

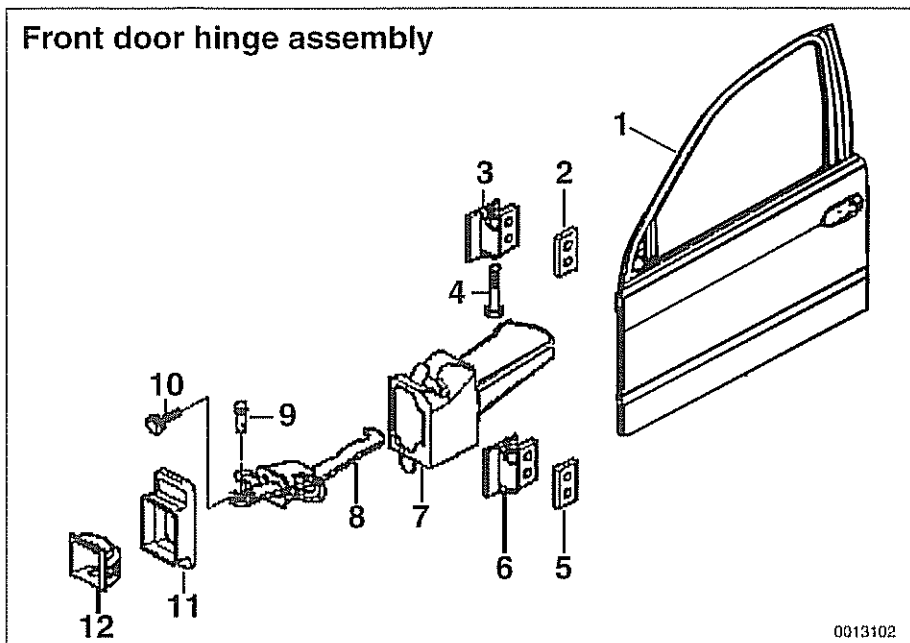
If the installed door is uneven or out of parallel, spacers can be used to correct its position. Spacers are placed behind the hinge and are available in two different thicknesses (0.5 mm and 1.0 mm).

- Front and rear door adjustment procedure is similar.

#### Tightening torque

Door hinge to door frame	20 Nm (15 ft-lb)
--------------------------	------------------

## Front door hinge assembly



## Door hinge assembly

1. Door
2. Spacer ring
3. Upper hinge
4. Hex bolt
5. Spacer ring
6. Lower hinge
7. Door check gasket
8. Door check
9. Pin
10. Torx bolt
11. Gasket
12. Cover

## DOOR PANELS

### WARNING—

*E39 cars are fitted with side-impact airbags in the front doors and optional side impact airbags in the rear doors. When servicing doors, always disconnect the negative (-) battery terminal. See 721 Airbag System (SRS) for cautions and procedures relating to the airbag system.*

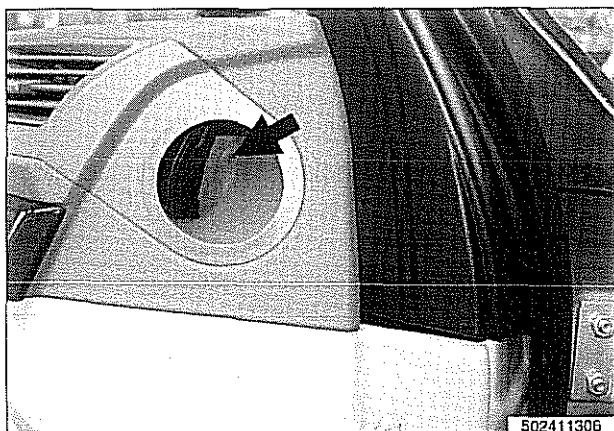
### Door trim panel, removing and installing

- Disconnect negative (-) battery cable.

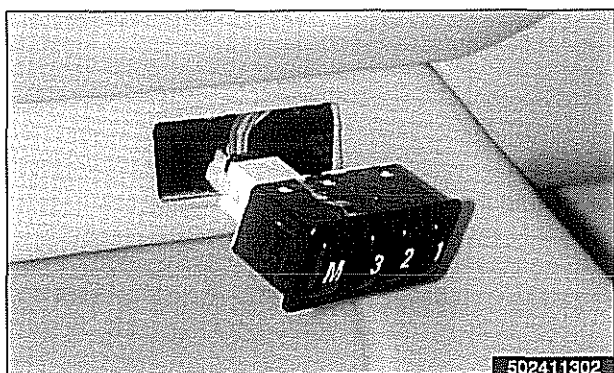
### CAUTION—

*Prior to disconnecting the battery, read the battery disconnection cautions given in 001 General Cautions and warnings.*

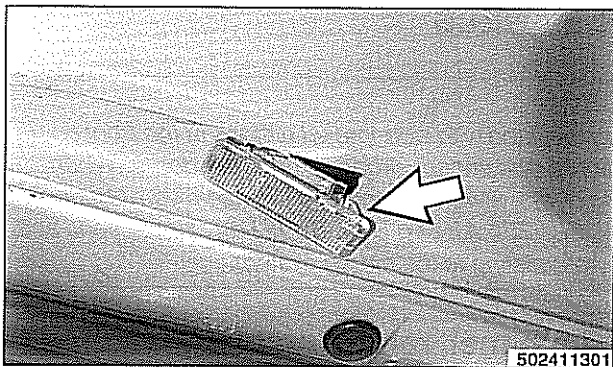
- ◀ Open door, and remove screw (arrow) located in air duct.



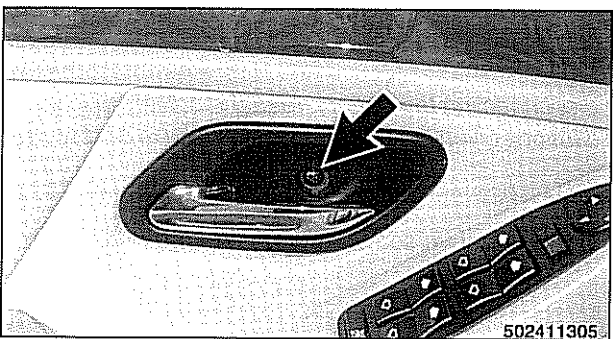
- ◀ Pry out seat memory switch and disconnect wiring harness.



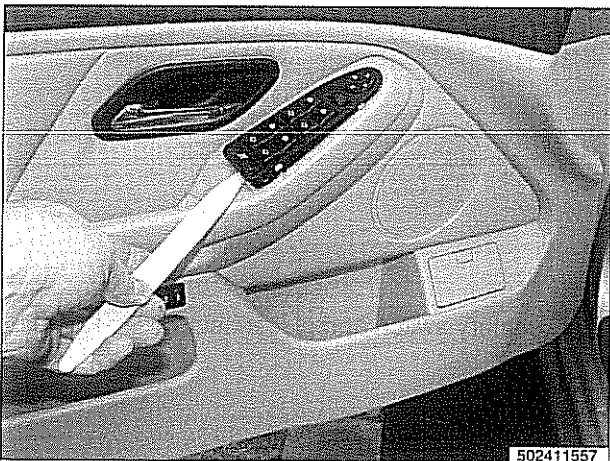
**Doors**



Working at bottom of door, pry out door panel light (arrow) and disconnect wiring harness.



Pry off plastic plug (arrow) from door handle trim and remove screw.

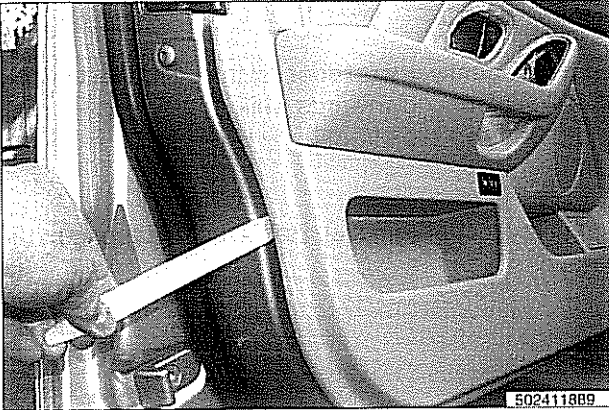


Carefully pry out window switch panel and disconnect electrical harness plugs.

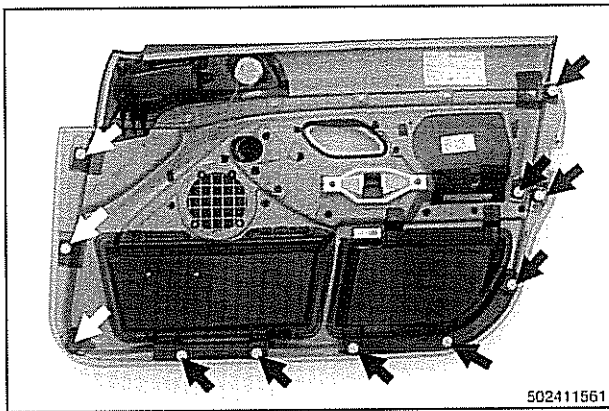


Slide door handle through trim panel.





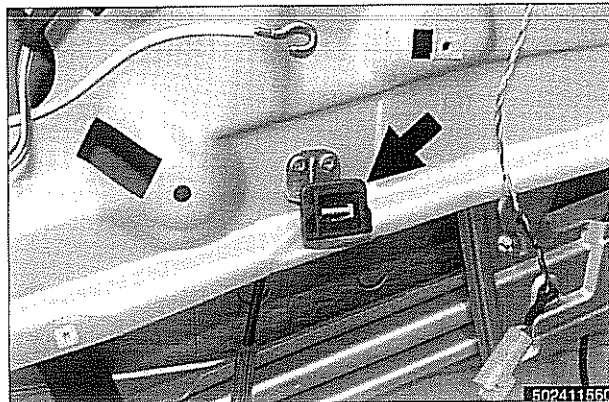
- Unclip door panel from door perimeter using a plastic trim panel tool. Pry panel retaining clips off one at a time.
- Lift bottom of door trim panel up and away from window trim to release clips.
- Pull door panel upwards to release center mount clip.
- Disconnect radio speaker wiring harness.
- Remove door trim panel.



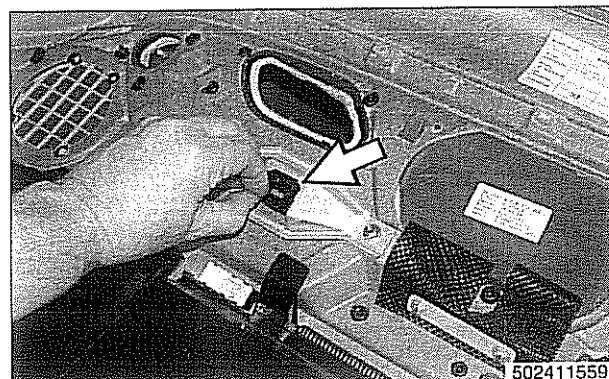
- Before installing door trim panel, replace any damaged plastic clips (**arrows**).

**NOTE** —

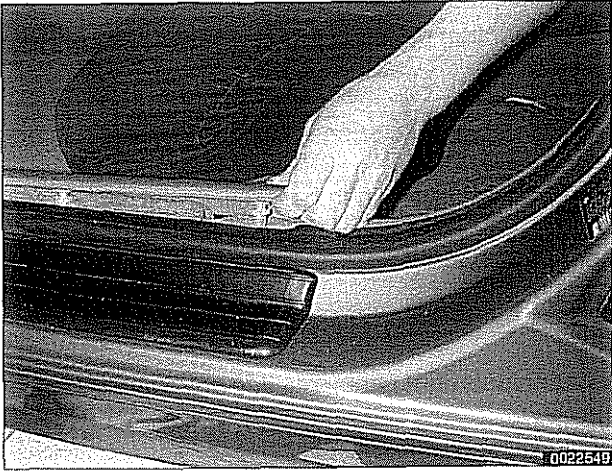
Yellow door trim clips (**white arrows**) at front are longer than white door trim clips (**black arrows**).



- Check if support clip for door bracket remains on door (**arrow**).



- If so, remove support clip from door and replace in bracket on door trim panel (**arrow**).
- Remainder of installation is reverse of removal. Note the following:
  - Align metal retainers on window sill with openings on top of door panel.
  - Check door-lock mechanism and window for ease of movement.



### Sill trim panels

- ◀ Using a trim tool, gently pry up door sill trim. Starting at A-pillar, press radius of trim downwards while sliding trim forward off trim clips. Remove clips from body using pliers. Save for installation.
- Installation is reverse of removal. Replace any damaged plastic parts or clips.



# 412 Trunk Lid, Tailgate

<b>General</b> .....	412-2	Window strut removal diagram .....	412-8
<b>Trunk Lid</b> .....	412-2	Rear window gas strut, removing and installing .....	412-9
Trunk lid, removing and installing .....	412-2	Tailgate gas strut, removing and installing .....	412-10
Trunk lid, adjusting .....	412-4	Tailgate, removing and installing .....	412-11
Trunk lid support strut, removing and installing .....	412-6	Rear window, removing and installing ....	412-12
<b>Tailgate (Sport Wagon Models)</b> .....	412-6	Rear window and tailgate, alignment .....	412-13
Tailgate, emergency release .....	412-6		
Tailgate and window strut diagram .....	412-7		

## GENERAL

This repair group covers trunk lid and tailgate removal and installation. Also included here are replacement procedures for the gas-charged support struts that hold the trunk lid or tailgate in the open position.

### NOTE—

*The body is painted at the factory after assembly. Realignment of body panels may expose unpainted metal. Paint all exposed metal once the work is complete.*

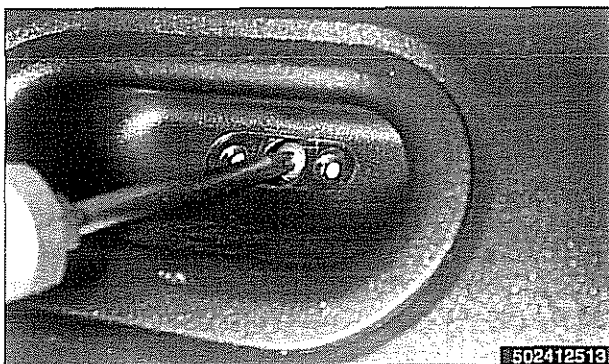
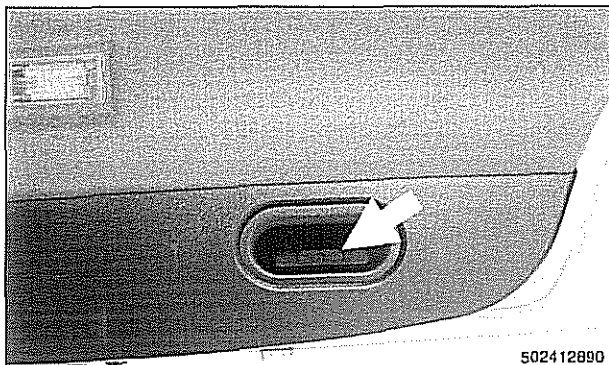
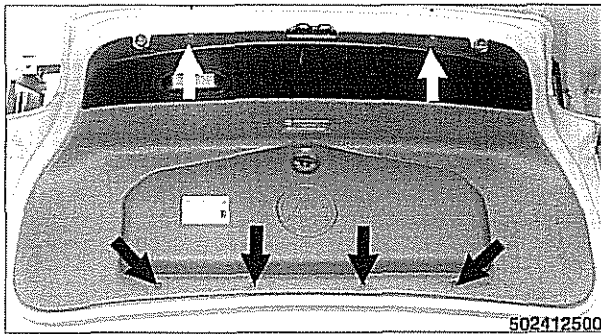
## TRUNK LID

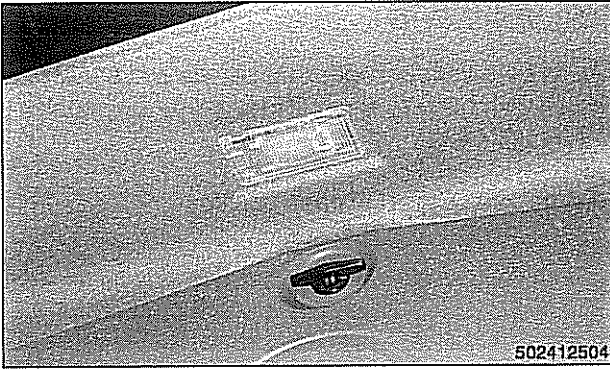
### Trunk lid, removing and installing

- Raise trunk lid.
  - Open tool kit cover and remove screws attaching tool kit to trunk lid (**black arrows**).
  - Disconnect tool kit cover retaining strap from trunk lid and remove tool kit.
  - Remove insulating liner expansion rivets (**white arrows**).

- Pry out moulded trim cover (**arrow**).

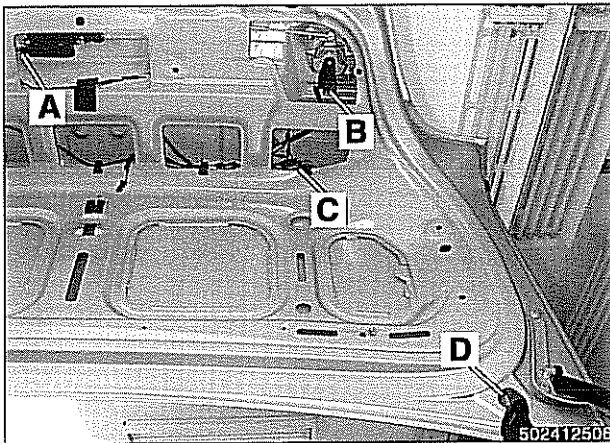
- Remove trim handle mounting screw.



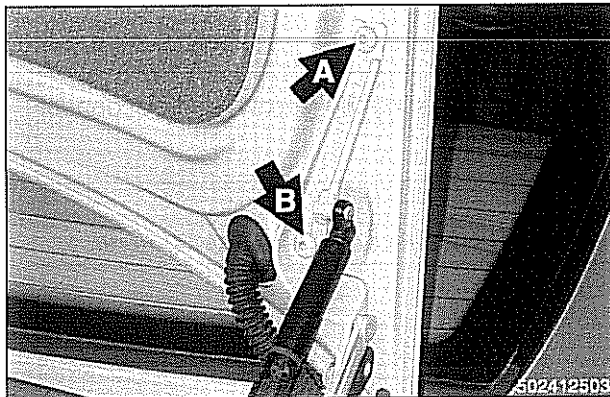


⚡ Pry out trunk light and disconnect electrical harness plug connector.

- Gently pry trunk liner away from lid and remove.



⚡ Disconnect Wiring connectors A, B and C. Remove wiring harness by pulling through opening in lid frame D.

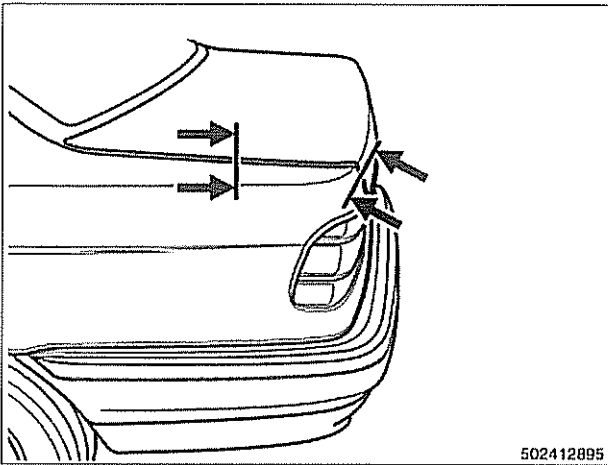


⚡ While supporting trunk lid, loosen left and right top hinge fasteners (arrow A) and remove lower fasteners (arrow B).

**NOTE** —

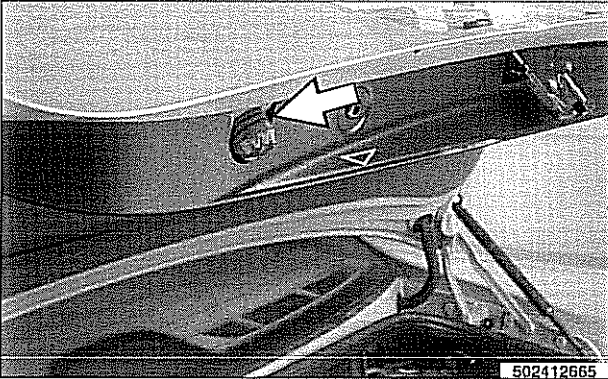
*Before loosening hinge bolts, mark hinge and hinge bolt locations for reinstallation.*

- Lift trunk lid straight up to remove.
- Installation is reverse of removal. If necessary, align trunk lid to body as described in **Trunk lid, adjusting**.

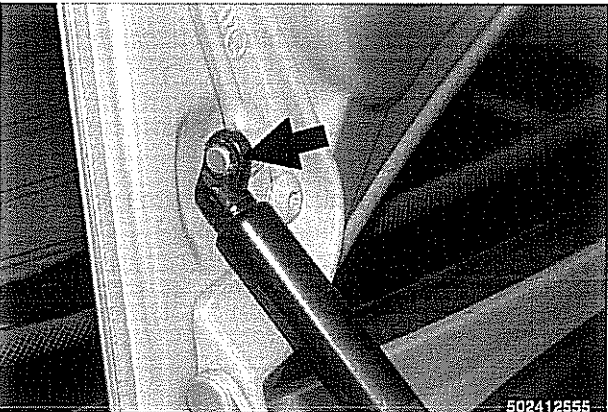


### Trunk lid, adjusting

- Trunk lid must be parallel to both side panels and should be mounted flush with body side panels (**arrows**). Lid fit tolerance is  $\pm 1$  mm (0.04 in).
- Raise trunk lid and support in open position.



- Turn trunk lid detent buffers in.

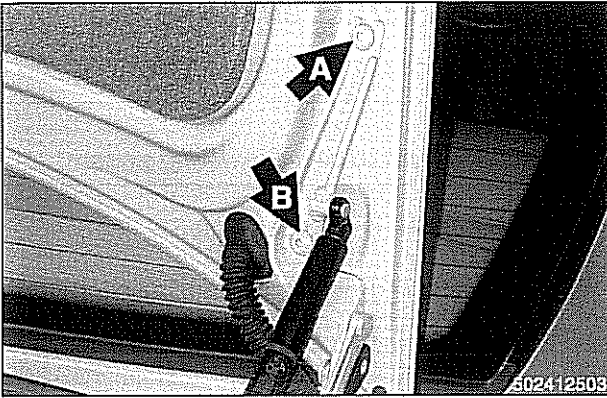


- Remove trunk strut retaining clip (**arrow**) and disconnect struts.

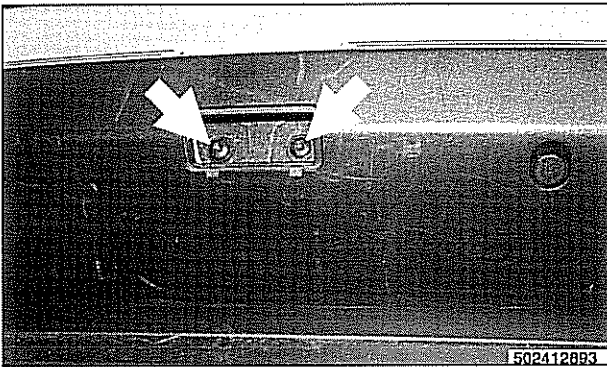
**WARNING—**

*Make sure to support trunk lid before removing struts.*

## Trunk Lid, Tailgate



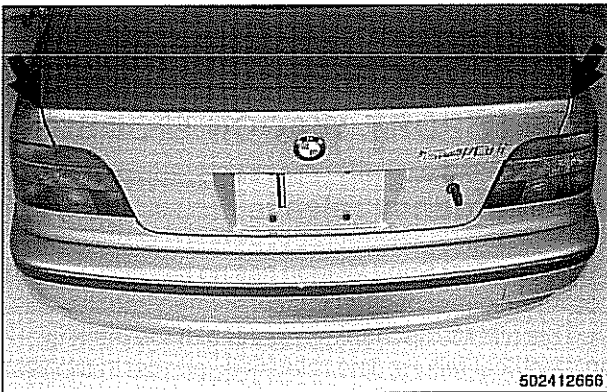
- Loosen bolts at left and right trunk hinges fasteners (arrows) to point where lid can be moved.



- Remove plastic cover from lower trunk lock. Loosen lock bolts (arrows) until lock assembly can be moved.

**CAUTION—**

Before locking trunk lid, check that trunk lid is not able to damage the body or rear window.



- Carefully close trunk lid and check side gaps (arrows). Minimum gap is 0.5 mm (0.02 in).
  - Adjust to fit side body panels.
  - Open trunk lid. Be careful not to alter adjustments.
  - Tighten lower trunk lock fasteners.
  - Close trunk lid and check adjustments.
  - Repeat process if necessary.

- Close trunk lid. Measure gap between trunk lid and lower body panel.
  - Position lower section of rear trunk lid lock higher or lower so that a gap of 5.0 mm (0.04 in) exists between trunk lid and lower body panel.
  - Check adjustment and repeat if necessary.



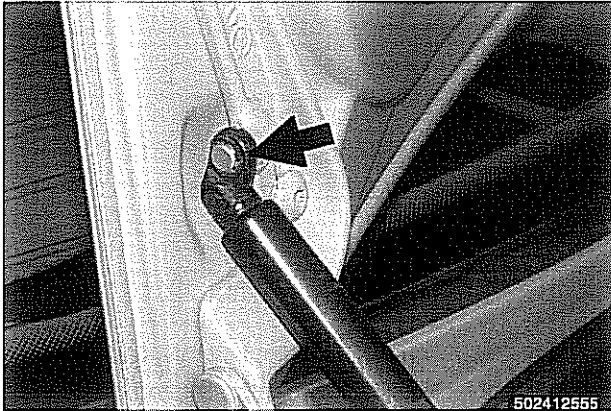
- Screw out detent buffers (arrow) until left and right sides of trunk lid rest against detent buffers with lid closed.



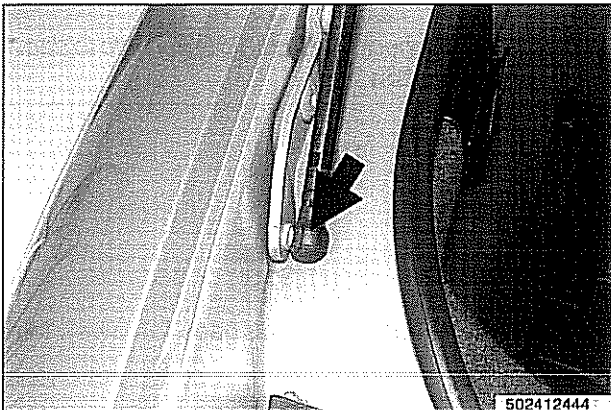
## Trunk lid support strut, removing and installing

### CAUTION—

*Make sure to support trunk lid before removing struts.*



- Open trunk lid and support in open position.
- Remove trunk strut retaining clip (**arrow**) and disconnect struts.



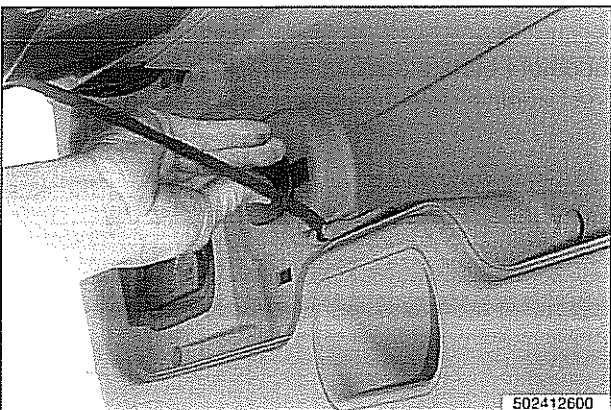
- Remove spring clip (**arrow**) from lower end of strut and remove strut.
- Installation is reverse of removal. Replace retaining clips damaged during removal.

## TAILGATE (SPORT WAGON MODELS)

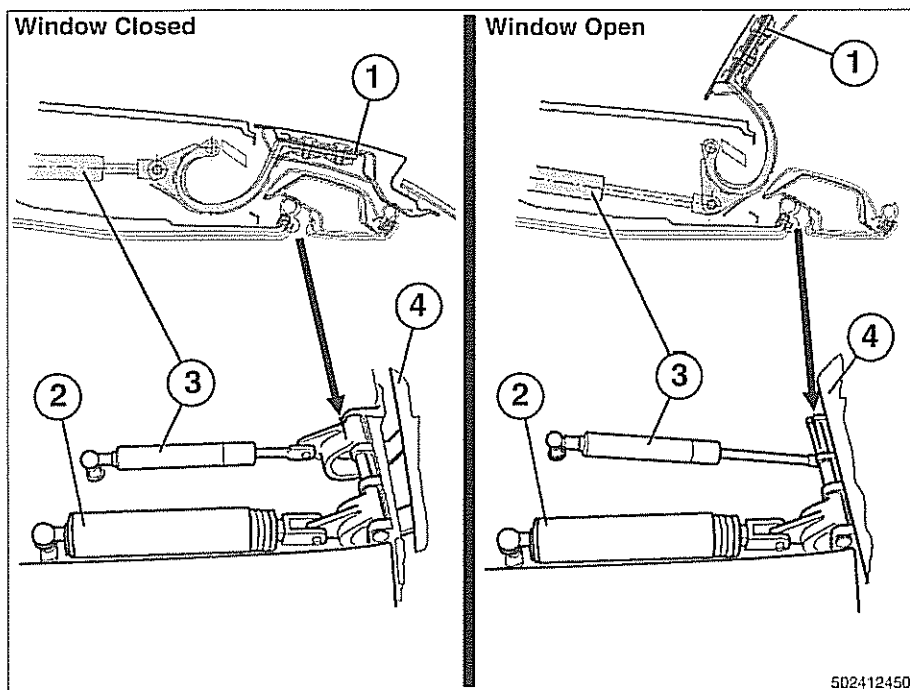
### Tailgate, emergency release

The tailgate of the E39 Sport Wagon has no key cylinder. An emergency release mechanism is incorporated into the tailgate latch. This allows mechanical opening of the latch in case of an electrical failure. The release is located in the rear cargo area, along the lower edge of the rear apron behind a small access cover.

- Working inside car, at base of tailgate:
  - Open tool compartment cover.
  - Pry out emergency release cable cover.
  - Pull plastic cable to release rear tailgate latch.

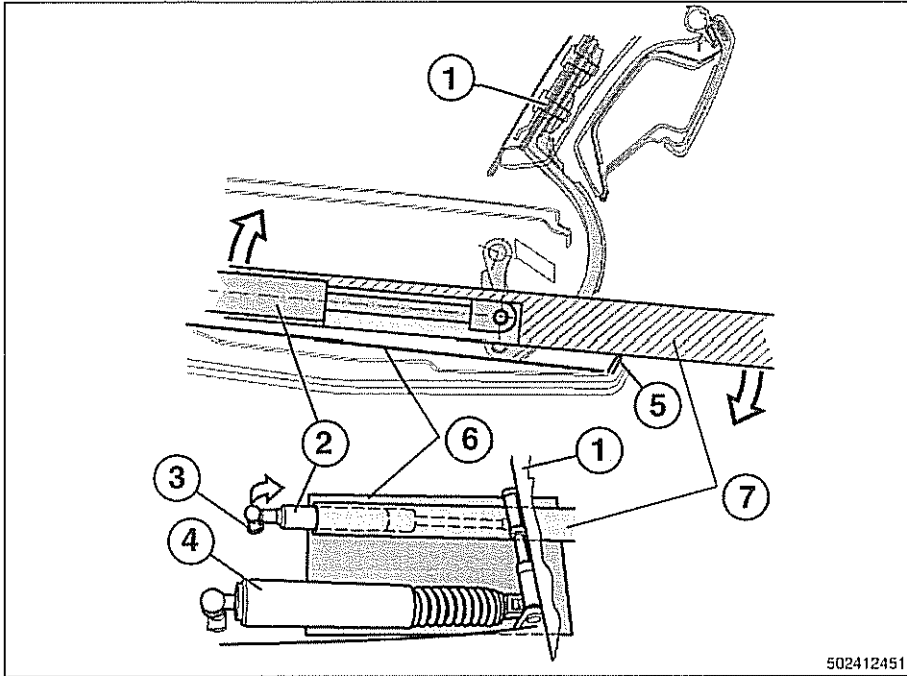






### Tailgate and window strut diagram

1. Rear window frame
2. Gas struts for tailgate
3. Gas struts for rear window
4. Rear window frame



### Window strut removal diagram

1. Rear window
2. Rear window gas strut
3. Inner strut support
4. Tailgate gas strut
5. Area to install protective tape
6. BMW special tool 51 2 153
7. BMW special tool 51 2 152

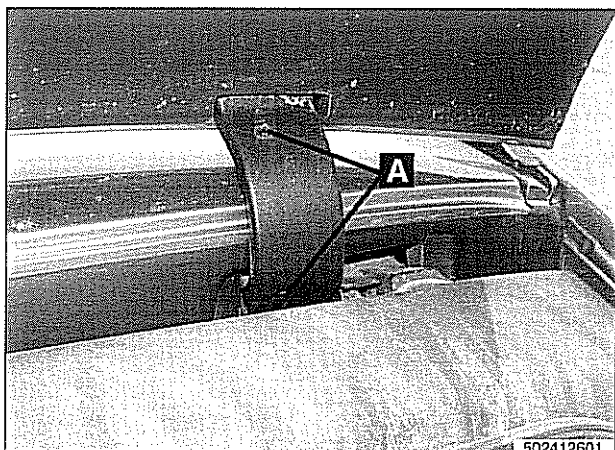
## Rear window gas strut, removing and installing

- Tailgate and window struts are located in left and right sides of roof.
- Open rear window.

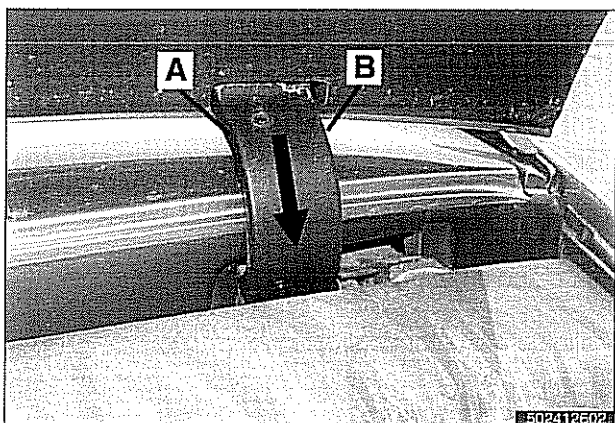
### **WARNING** —

*The tailgate is very heavy and will close without both pressurized lifting struts installed. Properly support tailgate prior to removal of the lifting struts.*

- Remove fasteners (A) from rear window hinge trim cover.

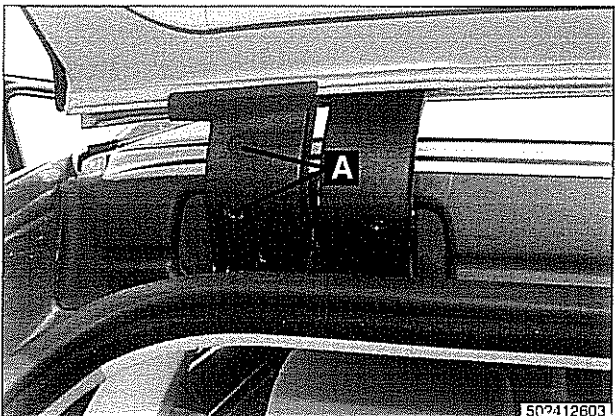


- While pressing detents (A) and (B) pull down (arrow) on trim panel to remove.

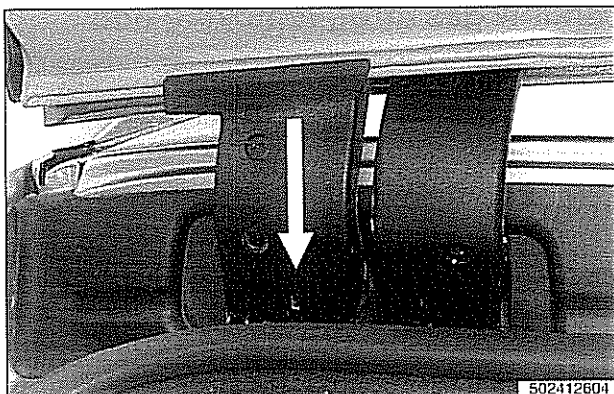


- Close rear window and open tailgate and support.
- Remove weather stripping along rear of roof panel.

- Remove tailgate hinge trim panel fasteners (A).



## Trunk Lid, Tailgate



- ◀ Starting at top, pull down (**arrow**) on trim cover. Carefully remove wiring harness support clip from trim cover.

**NOTE**—

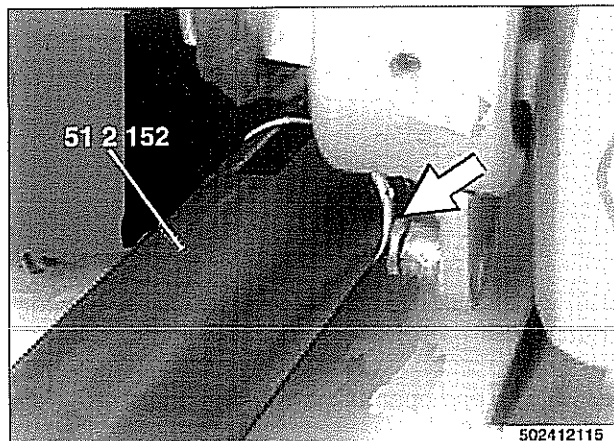
*Tailgate window trim cover and weather stripping shown in place.*

- Insert BMW special tool 51 2 153 into body cavity below hinge.

**WARNING**—

*The tailgate is very heavy and will close without both pressurized lifting struts installed. Properly support tailgate prior to removal of the lifting struts.*

- Working at hinge end of strut, remove strut retaining clip and remove strut from mounting pin.



- ◀ Slide BMW special tool 51 2 152 over strut until end of tool is aligned with strut pin (**arrow**).

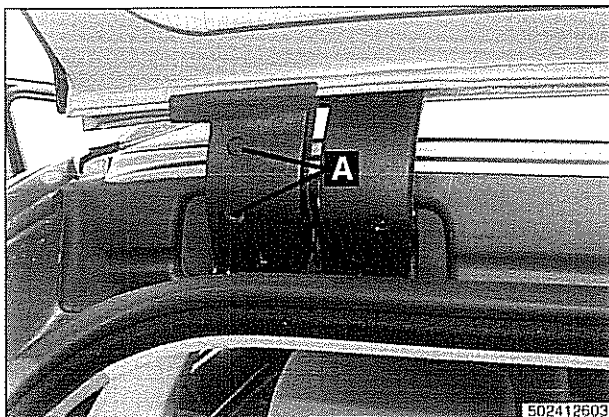
- Press down on outer end of special tool to release inner strut mount.
- Remove special tool with strut.

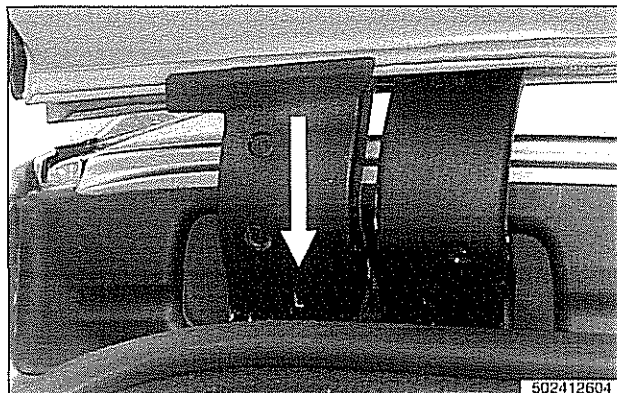
- When installing strut make sure ball cup is pointing straight down.
- Remainder of installation is reverse of removal.

**Tailgate gas strut, removing and installing**

- Open tailgate and support.

- ◀ Remove tailgate hinge trim panel fasteners (**A**).





- ◀ Starting at top, pull down (arrow) on trim cover. Carefully remove wiring harness support clip from trim cover.
- Install protective plate (BMW special tool 51 2 153) between roof panel and hinges.

**WARNING —**

*The tailgate is very heavy and will close without both pressurized lifting struts installed. Properly support tailgate prior to removal of the lifting struts.*

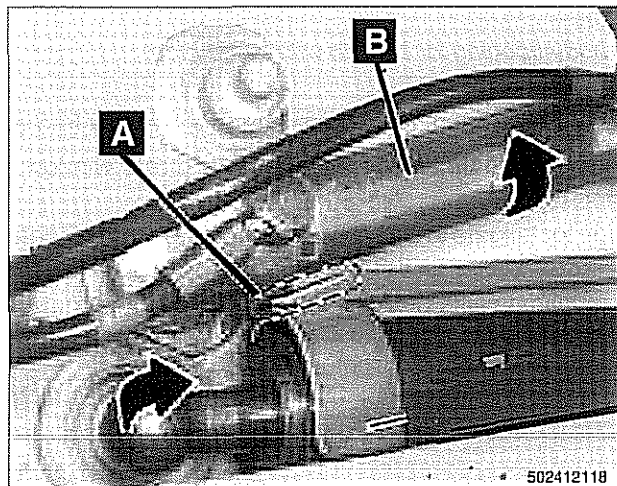
- Working at left side:
  - Remove gas strut retaining clip and pin (arrow).

- ◀ Insert BMW special tool 51 2 151 over strut.

**NOTE —**

*BMW special tool 51 2 151 must be chamfered in area (A).*

- Press tool down to release inner end of gas strut.
- Push strut forward and toward center of vehicle to remove.
- When installing strut make sure ball cup is pointing straight down.
- Remainder of installation is reverse of removal.

**Tailgate, removing and installing**

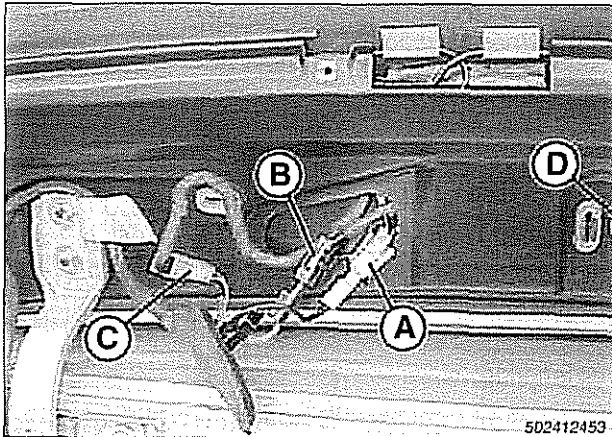
- Remove radio antenna amplifier. See **650 Radio**.
- Disconnect outer end of window and tailgate gas struts. See **Rear window gas strut, removing and installing** and **Tailgate gas strut, removing and installing**.

**WARNING —**

*The tailgate is very heavy, and will close without both pressurized lifting struts installed. Properly support tailgate prior to removal of the lifting struts.*

- Remove trim panel from tailgate.

## Trunk Lid, Tailgate



- Remove rubber grommet and applicable connectors. Disconnect rear window washer hose.

### NOTE —

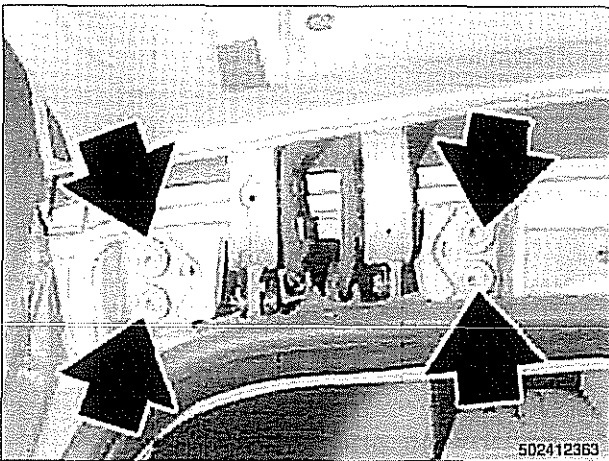
To facilitate installation, mark position of hinges for tailgate and rear window frame on body.

### WARNING —

- The tailgate is very heavy and will close without both pressurized lifting struts installed. Properly support tailgate prior to removal of the lifting struts.
- There is risk of fingers being trapped once tailgate fasteners are removed.

### CAUTION —

Protect body opening for tailgate with fabric tape.



- Remove hinge fasteners for tailgate and rear window frame.
  - Lower tailgate so that hinge for tailgate and rear window can be tilted.
  - Tilt hinge for tailgate and rear window frame so that tailgate can be moved towards the rear with rear window frame.
  - Remove tailgate with rear window frame towards rear.
- Installation is the reverse of removal.

## Rear window, removing and installing

- Disconnect electrical harnesses.
- Support window in open position.
  - Loosen fasteners on each window hinge.

### NOTE —

Note positions of any spacers for reinstallation.

### CAUTION —

Rear window is heavy. Use a second person to support window prior to releasing from hinges.

- Remove window hinge fasteners and lift off window.
- Installation is reverse of removal. Replace waterproofing sheeting where disturbed.
- Align window. See Rear window and tailgate, alignment.

## Rear window and tailgate, alignment

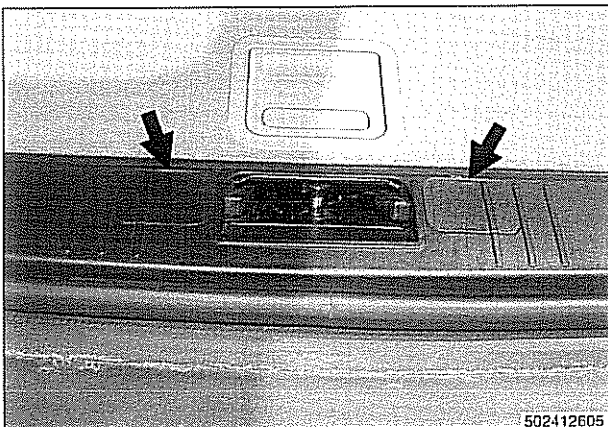
- Alignment procedures involve adjusting tailgate, window, and spoiler to have equal space between left and right sides and to be flush with body. Measurement locations and specific dimensions are shown.
- If alignment has been disturbed during repair, adjust fit of tailgate to body. Then adjust fit of rear window to tailgate.
  - Clearance of the rear window is adjusted by adding or removing shims between hinge bracket and rear window (maximum of three shims).
  - Adjust spoiler gap to body last.
  - Height of spoiler is set by alignment of the rear tailgate.
  - Gap of spoiler to body is set by adjusting spoiler attachment fasteners.
- Lateral and vertical alignment of the window and tailgate is done using hinge bolts. Fine adjustment of the tailgate to the body is made using rubber stop buffers and latch assembly.

### Spoiler gap specification

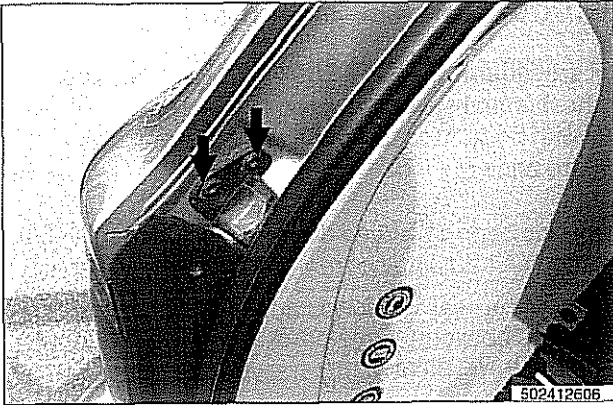
Rear spoiler to roof	4.25 - 5 mm (0.167 - 0.197 in)
Max. deviation from parallel	0.5 mm (0.019 in)

### Tailgate alignment, preliminary work

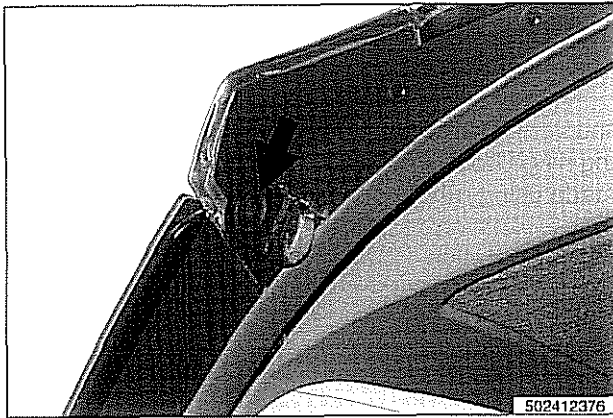
- Open rear window and tailgate.
- ◀ Remove lower sill trim panel fasteners covers (**arrows**) and fasteners.
- Remove rear window and tailgate trim panel.
- Check left and right side lateral guides and tailgate latch fulcrums for wear or damage. Replace if necessary.



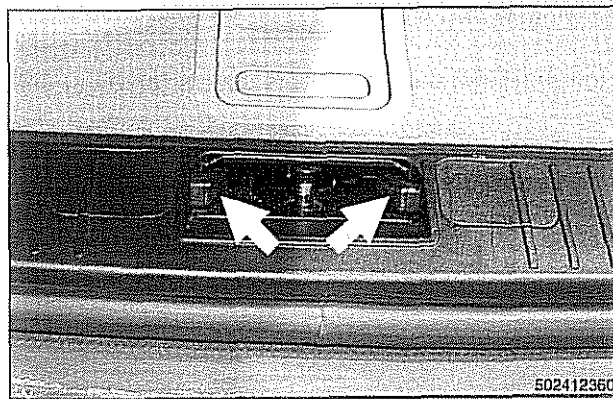
Trunk Lid, Tailgate



Loosen left and right lateral guide to body fasteners (**arrows**) until guide can be moved.

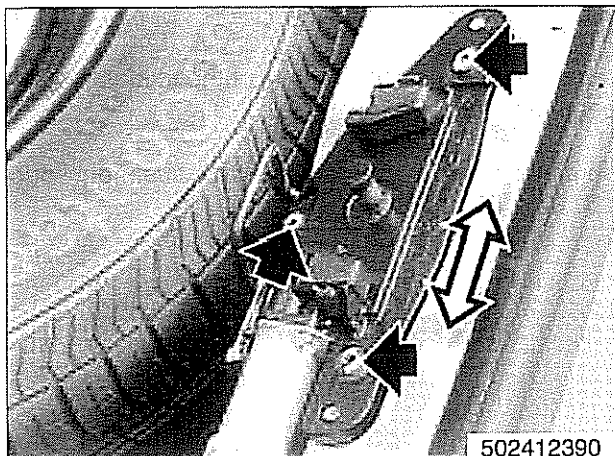


Loosen left and right tailgate lateral guide fasteners (**arrow**) and fully retract guides.



Check fulcrum pads (**arrows**) on lower section of tailgate lock for damage. Replace if necessary.





- ◀ Loosen lower tailgate lock fasteners (**arrows**) so that tailgate lock can center itself.

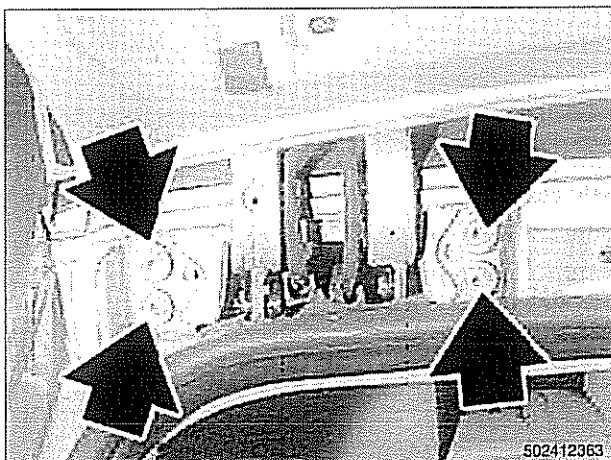
**CAUTION—**

- The lower section of tailgate lock must not scrape against the upper section.
- The eccentric pin on the lower section of the tailgate lock rotates when being locked from upper section of tailgate lock.

- Disconnect tailgate latch actuator motor by squeeze locking tabs on electrical harness connector and disconnecting.

**CAUTION—**

- Eccentric pin in lower section of trunk lid lock must be at lower dead center.
- After disconnecting plug connector from actuator motor, tailgate is opened by electric unlocking fixture of upper section of tailgate lock.
- For this reason, the cable connections to the upper section of the tailgate lock must remain connected. Otherwise the tailgate can only be opened by the emergency handle. Eccentric pin of lower section of tailgate lock remains at bottom dead center point after unlocking.

**Tailgate alignment, height adjustment**

- ◀ Loosen left and right tailgate hinge fasteners (**arrows**) to allow tailgate to be adjusted.

**CAUTION—**

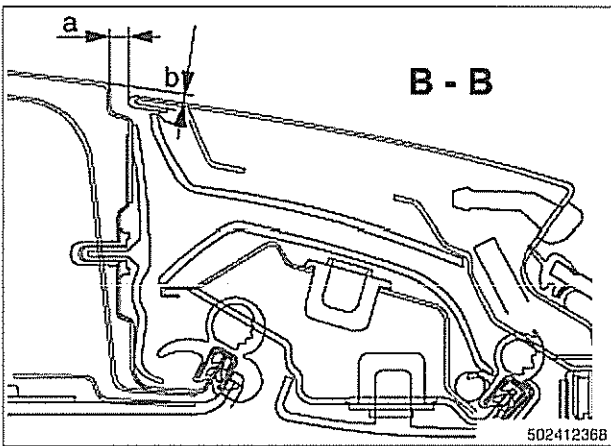
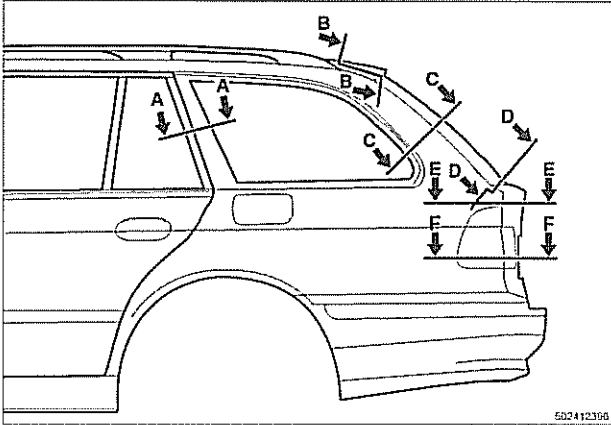
- When the hinge screws for the tailgate are released, the position of the overall assembly changes with respect to the body.
- The position of the rear window frame to the tailgate remains unchanged.

- Close tailgate carefully and check gap dimensions. See Tailgate alignment specifications below.
- Tighten hinge screws when gap dimensions are correct.

## Tailgate alignment specifications

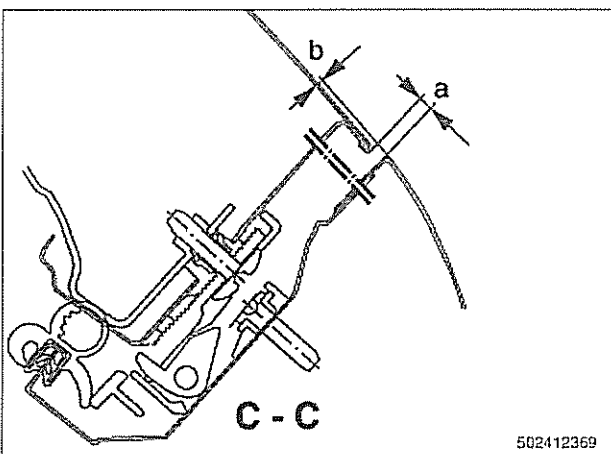
- The following illustrations show details of the tailgate adjustment at each marked point.

◀ Adjust gap dimensions in accordance with adjustment specifications B, C, D, E, and F.



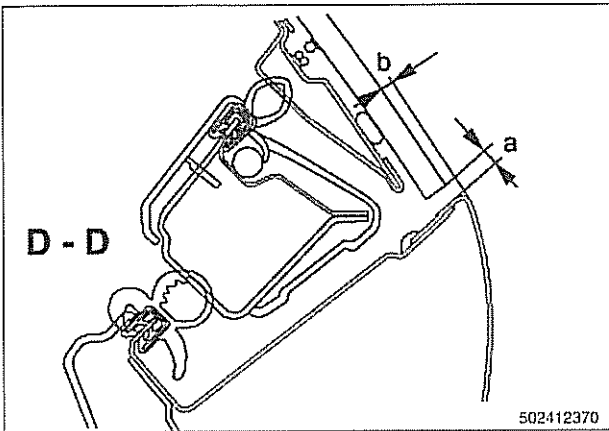
◀ Adjustment B:

- $a = +1 / -0.5 \text{ mm} (+0.04 \text{ in} / -0.02 \text{ in})$
- $b = 1 \text{ mm} +1 / -0.5 \text{ mm} (+0.04 \text{ in} / -0.02 \text{ in})$



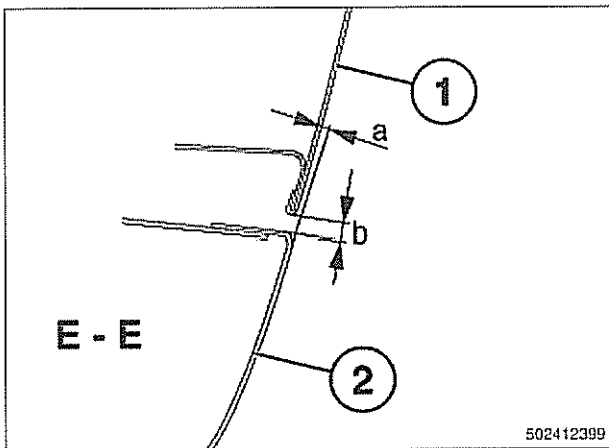
◀ Adjustment C:

- $a = 4.5 \text{ mm} +1 / -0.5 \text{ mm} (0.18 \text{ in} + 0.04 / -0.02 \text{ in})$
- $b = 0.8 \text{ mm} \pm 0.6 \text{ mm} (0.03 \text{ in} \pm 0.02 \text{ in})$



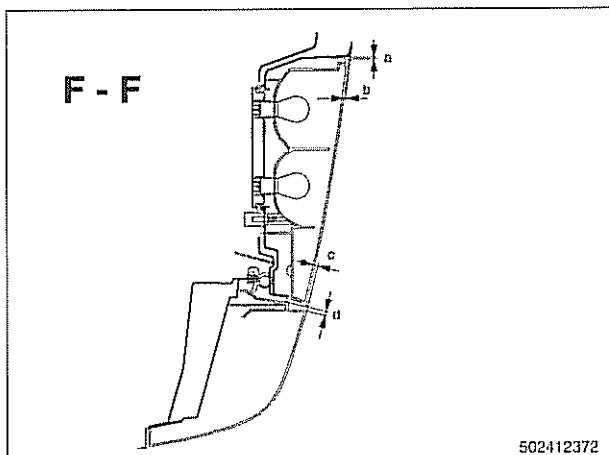
◀ Adjustment D:

- $a = 4.5 \text{ mm} + 1 / - 0.5 \text{ mm}$  (0.18 in + 0.04 / - 0.02 in)
- $b = 3.7 \text{ mm} + 2 / - 1 \text{ mm}$  (0.15 in + 0.08 / - 0.04 in)



◀ Adjustment E:

- 1 tailgate lid
- $a = 1.3 \text{ mm} \pm 1 \text{ mm}$  (0.05 in  $\pm$  0.04 in)
- 2 rear side panel
- $b = 4.5 \text{ mm} + 1 / - 0.5 \text{ mm}$  (0.18 in + 0.04 / - 0.02 in)



◀ Adjustment F:

- $a = 1.3 \text{ mm} \pm 1 \text{ mm}$  (0.05 in  $\pm$  0.04 in)
- $b = 1 \text{ mm} \pm 0.5 \text{ mm}$  (0.04  $\pm$  0.02 in)
- $c = 1.3 \text{ mm} + 1 \text{ mm} / - 1.3 \text{ mm}$  (0.05 in + 0.04 in - 0.05 in)
- $d = 4.5 \text{ mm} + 1 \text{ mm} / - 0.5 \text{ mm}$  (0.18 in + 0.04 / - 0.02 in)

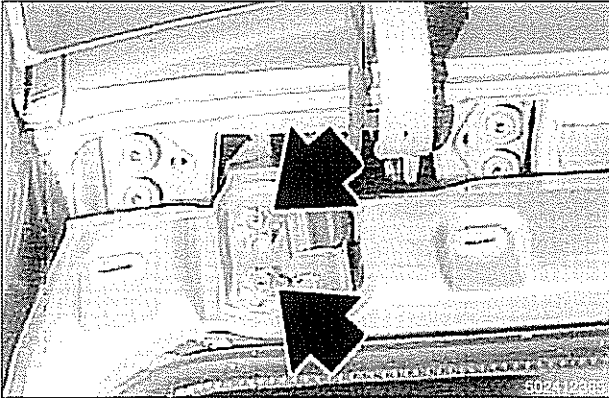
**CAUTION—**

Rear window frame must not extend above height of roof.  
Otherwise, wind noise will be created.

### Tailgate gap and length adjustment

- Close tailgate and open rear window.

- ◀ Loosen left and right tailgate hinge bracket fasteners (arrows) to allow movement of tailgate.



#### CAUTION—

- When the hinge bracket fasteners are loosened, the position of the rear window frame changes with respect to the tailgate.
- Always check the settings of the rear window frame to the tailgate and make adjustment if necessary.

- ◀ Adjust gap dimensions and position of tailgate. See **Tailgate alignment specifications**.

#### NOTE—

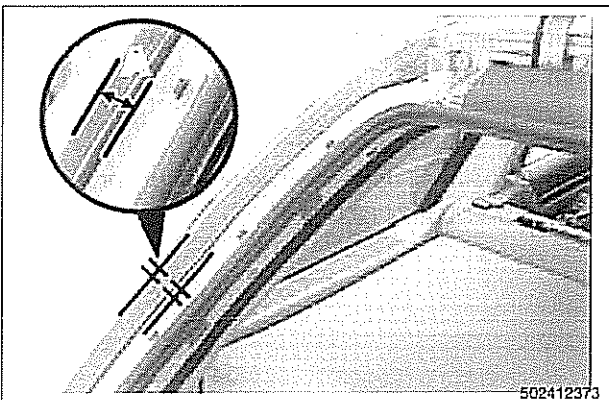
The tailgate should be approximately 1 mm lower than side walls.



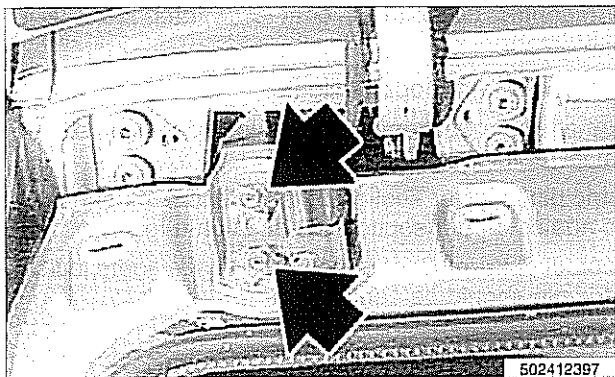
- ◀ To obtain tailgate to body parallel alignment, top edge of tailgate must first be adjusted parallel to the edge of D-pillar (A).

D-pillar gap	27 mm (1.6 in)
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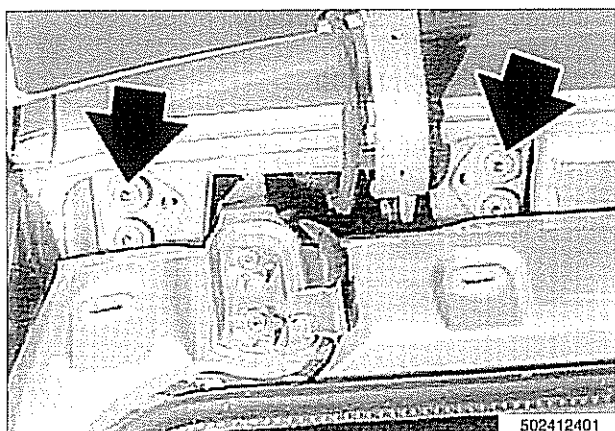
- Adjust gap with window open and tailgate closed.



## Trunk Lid, Tailgate

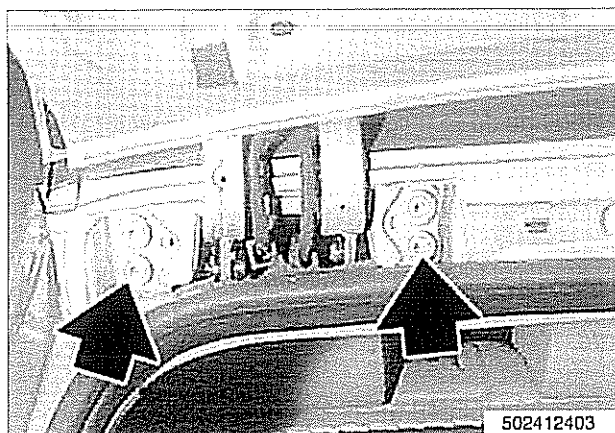


⤵ Tighten left and right tailgate bracket fasteners (arrows).



⤵ Tighten upper left and right tailgate fasteners (arrows).

- Open tailgate while taking care not to change hinge positions.



⤵ Tighten lower tailgate hinge fasteners (arrows).

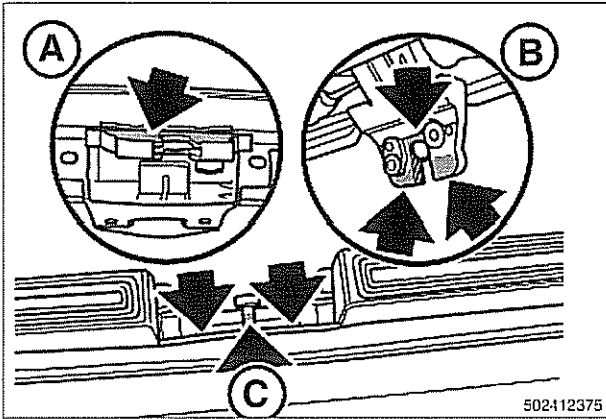
- Reconnect eccentric pin actuator motor electrical harness plug.

**CAUTION—**

*The eccentric pin in the lower section of the tailgate lock turns in the tailgate when the button is pressed.*

- Operate button in tailgate to actuate locking motor. Eccentric pin should move to top dead center position.

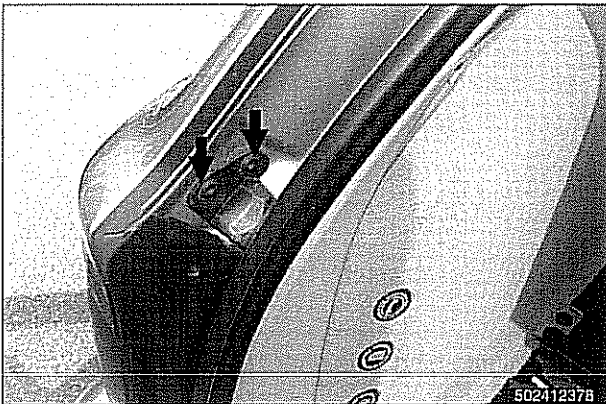
## Trunk Lid, Tailgate



➤ To perform contact pattern test, coat lower latch areas **A**, **B** and **C** with grease.

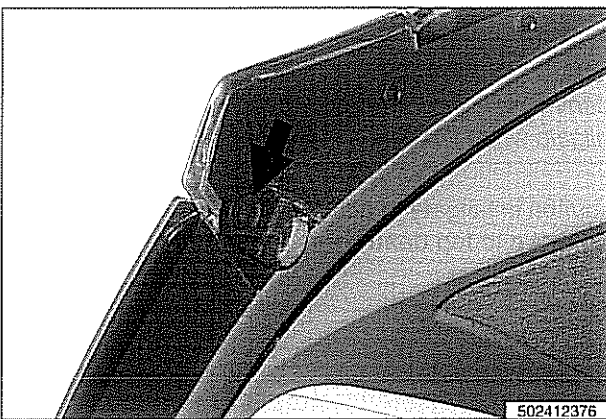
- Carefully close and reopen tailgate.
- Check that upper section of tailgate lock does not scrape against lower latch.
- Eccentric pin in lower section of tailgate lock must not scrape against upper section (**B**) of tailgate lock.
- The contact pattern (**C**) of upper section of tailgate lock on eccentric pin should be centered.

- To adjust height of upper section of tailgate lock, loosen fasteners, move upper section of lock and retighten fasteners.
  - Repeat contact pattern test after height adjustment.

**Tailgate lateral guide, adjusting**

➤ If necessary, loosen lateral guide to body fasteners (**arrows**) to allow it to move.

- Move lateral guides to center position.



➤ Loosen lateral guide to tailgate fasteners to allow it to move.

- Close tailgate to center guides with respect to each other.

**NOTE —**

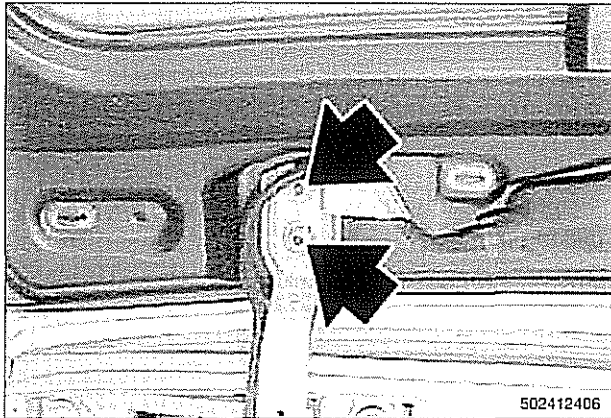
*The bracket of the lateral guide continues to touch against the body without clearance as does the lateral guide against the tailgate.*

- Open tailgate and tighten guide fasteners.

## Rear window, adjusting

**NOTE—**

- Three versions of rear window are used on Sport Wagon models.
- Tailgate must be correctly adjusted before rear window adjustments are made.



◀ With tailgate closed and rear window open, loosen hinge fasteners (arrows) to allow hinge to move.

- Loosen fasteners in lower section of lock to allow movement.
- Carefully close rear window:
  - Adjust gap dimensions and position of rear window relative to body panel. See **Tailgate alignment specifications**.

**CAUTION—**

On transition area between roof/tailgate, tailgate must not extend above height of roof otherwise wind noise will be created.

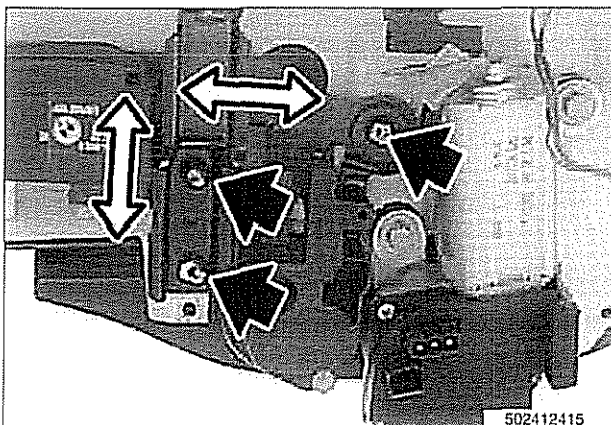
- If necessary, adjust height of rear window frame by inserting spacers between the hinge and the frame.
- Carefully open rear window, taking care not to alter adjustment.
  - Tighten left and right rear window fasteners.
  - Close rear window and check adjustment, repeat step if necessary. See **Tailgate alignment specifications**.

## Rear window locking pin, adjusting

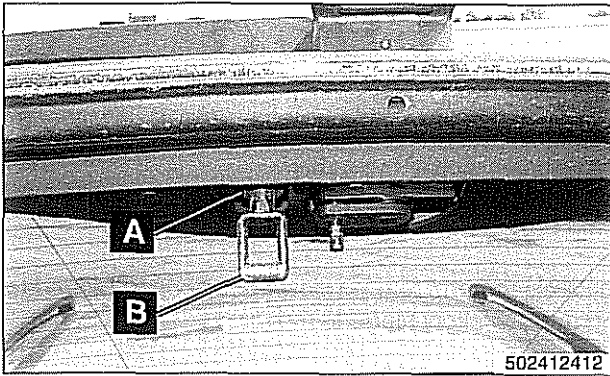
**NOTE—**

- Several versions of rear window locking pin are used on Sport Wagon models. 1999 528i model is shown. Other models are similar.
- For rear window adjustment specifications, see **Tailgate alignment specifications**.

◀ Loosen lower lock assembly fasteners (arrows).



## Trunk Lid, Tailgate



◀ With rear window open, loosen lock nut (A) so that inclination of locking pin (B) can be adjusted.

- Carefully close rear window, while ensuring that locking pin is centered in rotary latch in lower section.

**NOTE—**

*When closing rear window, be sure that there is a gap of approximately 1 mm (0.04 in) between the locking pin and the rotary latch in the lower section of lock.*

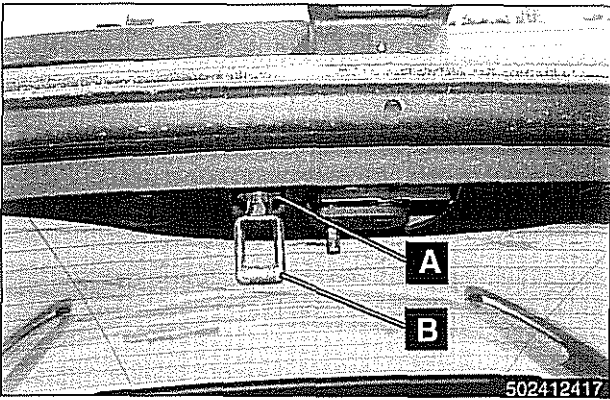
- Open tailgate and tighten lower lock assembly fasteners. Be careful not to alter inclination of locking pin (B) when tightening lock nut (A).

◀ To adjust height of rear window at lock, loosen lock nut (A) and turn locking pin (B).

- Be careful not alter position of locking pin when tightening lock nut (A).

**CAUTION—**

*After adjusting rear window, always check position of wiper axis relative to drive disc and limit stop on rear window wiper motor. Adjust if necessary. See 611 Wipers and Washers.*





# 510 Exterior Trim, Bumpers

<b>General</b> .....	510-2	<b>Exterior Trim</b> .....	510-13
<b>Outside Rear View Mirrors</b> .....	510-2	BMW emblem, removing and installing . . .	510-13
Outside mirror glass, replacing .....	510-2	Body side molding, replacing .....	510-13
Outside mirror housing, removing and installing .....	510-3	Radiator grill, removing and installing . . . .	510-14
Outside mirror assembly, removing and installing .....	510-4	Headlight housing trim panel, removing and installing .....	510-14
<b>Bumpers</b> .....	510-5		
Front bumper assembly .....	510-6		
Front bumper, removing and installing . . . .	510-7		
Front bumper impact absorber, replacing . .	510-8		
Rear bumper assembly .....	510-9		
Rear bumper, removing and installing . . . .	510-10		
Rear bumper impact absorber, replacing . .	510-11		
Front bumper height, adjusting .....	510-12		

## GENERAL

This repair group includes repair information for the outside rear view mirrors, front and rear bumpers, and the easily removable exterior trim parts.

## OUTSIDE REAR VIEW MIRROR

Many of the mirror components are separately available from an authorized BMW dealer, including the glass and outside plastic housing.

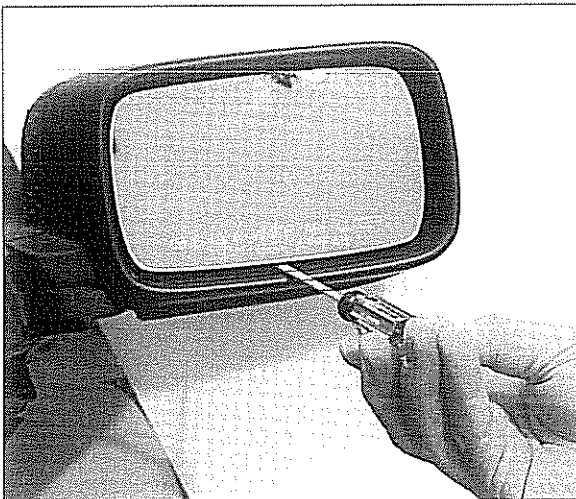
The E39 models offered two types of outside mirrors, standard mirrors or automatic dip mirrors.

### Outside mirror glass, replacing

**CAUTION—**

*Mirror should be at or above room temperature before removal. Otherwise, small plastic parts or glass may break.*

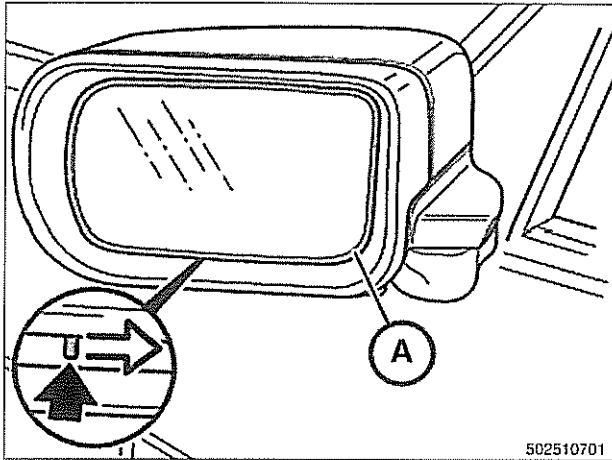
#### Outside mirror glass without automatic dip control, replacing



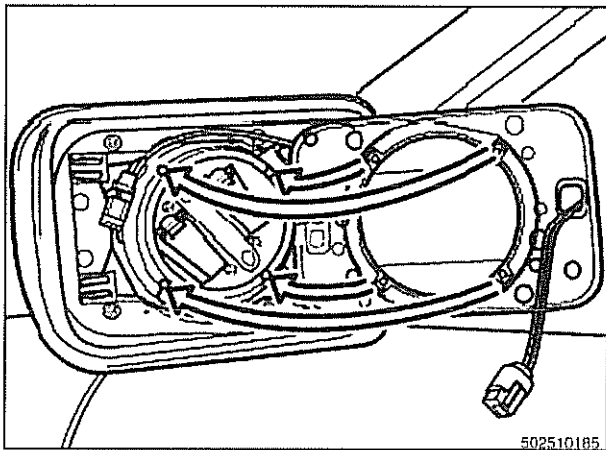
- ▲ Insert thin pry tool (plastic or tape-wrapped screwdriver) between bottom mirror edge and mirror housing and carefully pry out mirror glass from housing.
- If equipped with heated mirrors: remove heating element harness connectors from back of mirror glass.
- Installation:
  - Connect mirror heating harness if equipped.
  - Ensure correct alignment of locking pins.
  - Press mirror glass firmly until it locks in place.

### Outside mirror glass with automatic dip control, replacing

- Slide locking pin (arrow) right to release glass (A).
- If equipped with heated mirrors: remove heating element harness connectors from back of mirror glass.



- Install mirror glass by placing glass on lugs (arrows) and turn locking pin until glass is locked in place.

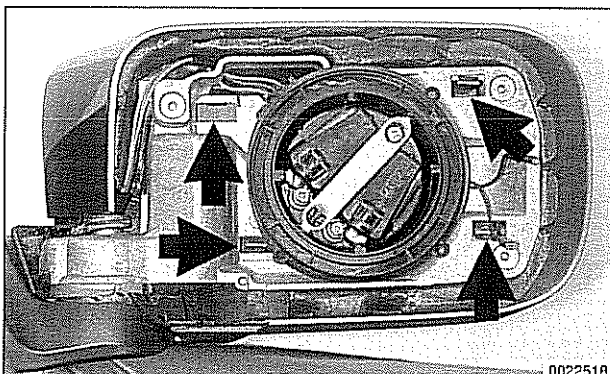


### Outside mirror housing, removing and installing

- Remove mirror glass as described above.
- Compress plastic retainers (arrows).

#### **NOTE—**

*The front mirror housing is retained by either three or four clips, depending on model.*





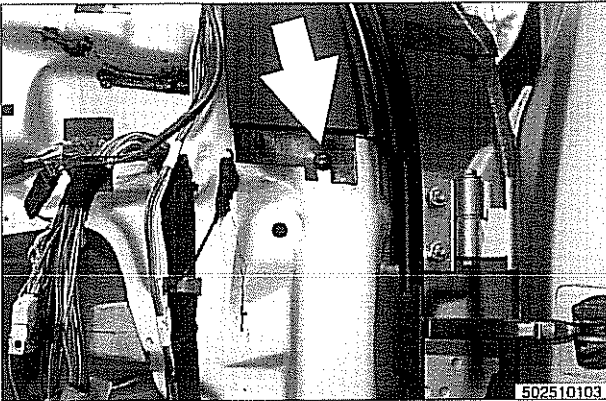
- ⚠ Carefully remove mirror housing from frame.
- Installation is reverse of removal.

**NOTE—**

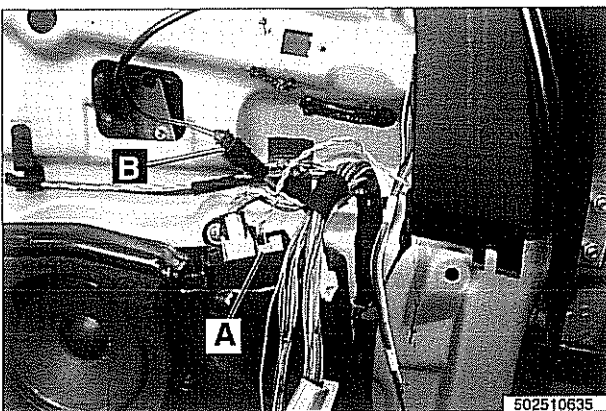
*Check mirror function before installing covering parts.*

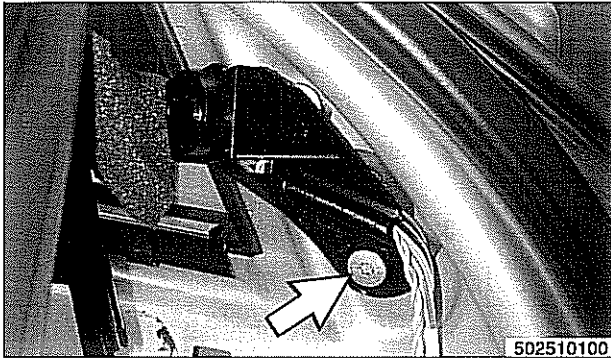
### Outside mirror assembly, removing and installing

- Remove front door panel trim. See 411 Doors.
- ⚠ Carefully lift inner trim panel up to remove from retaining clip (arrow).

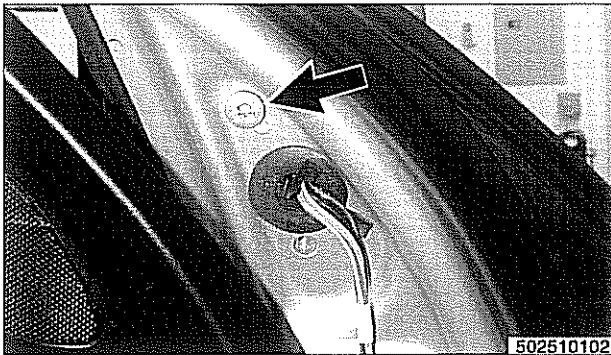


- ⚠ Disconnect electrical harness connectors for window anti-trapping protection (B) and speaker (A), if equipped.





- Lift trim panel to expose speaker fastener (**arrow**) and remove fastener.



- While supporting mirror, remove top mounting fastener (**arrow**).
  - Lift mirror up to remove from door, feed mirror electrical harness through opening to remove.
- Installation is reverse of removal.

**NOTE—**

*Check mirror function before installing covering parts.*

**Tightening torque**

Outside mirror to door (M6)

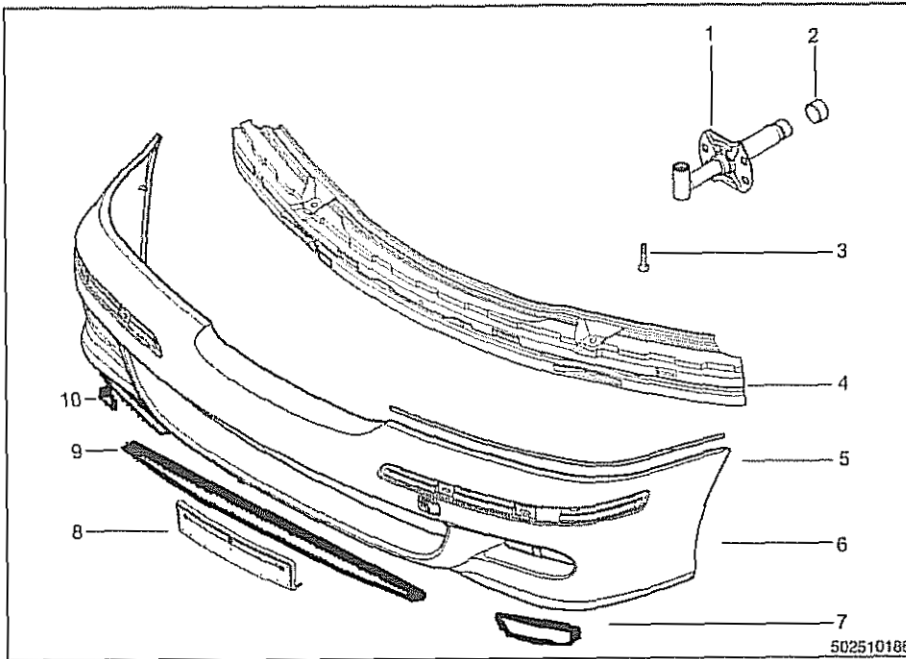
6 Nm (4.5 ft-lb)

## BUMPERS

- Raise and properly support vehicle.

**WARNING—**

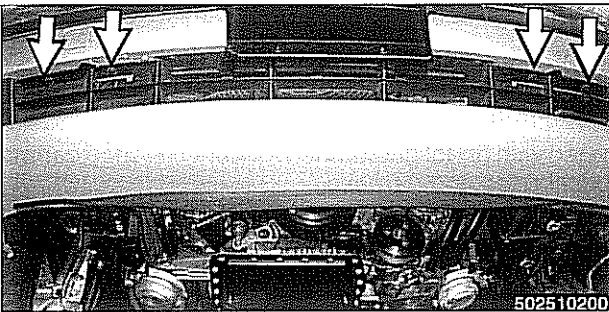
*Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands under structural chassis points. Do not place jack stands under suspension parts.*



### Front bumper assembly

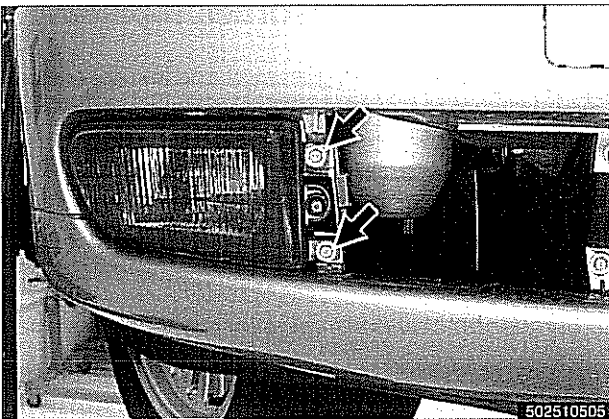
1. Bumper support shock absorber
2. Bumper support shock absorber seal
3. Bumper mounting bolt
4. Bumper support
5. Bumper to body gasket
6. Bumper cover
7. Grill panel
8. Lower bumper grill
9. Spoiler
10. Towing hinge flap

## Front bumper, removing and installing

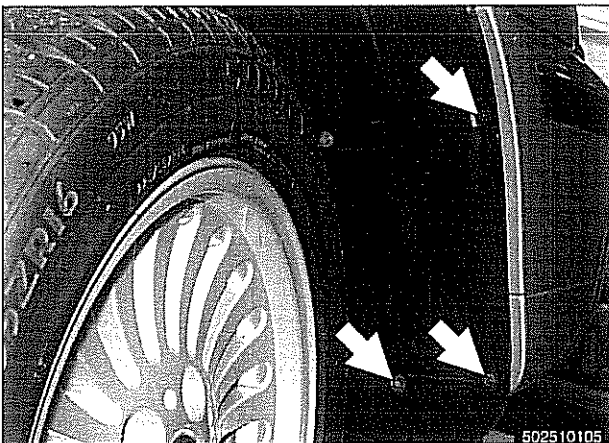


### Working underneath car:

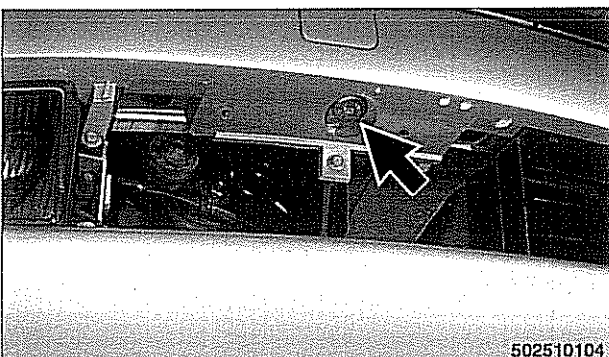
- Remove expansion rivets (**arrows**) from left and right side trim panels.
- Remove bumper trim panels.



- ### Remove driving light mounting fasteners (**arrows**) and disconnect wiring connectors.



- ### Working at front of wheel wells remove left and right inner panel fasteners (**arrows**).



- ### Remove left and right bumper mounting bolts (**arrow**).

- Slide bumper straight forward to remove.

### **NOTE**—

*If equipped with headlight washers or PDC (park distance control), slide bumper forward and disconnect head light washer hoses and electrical harnesses from PDC sensors.*

- Installation is reverse of removal, noting the following:
  - Carefully slide bumper side panels over mounting brackets on fenders.
  - Make sure gap between body and bumper is set to specifications. Adjust height as necessary. See **Front bumper height, adjusting**.
  - If equipped with headlight washers or park distance control reconnect hoses and harness.

#### Tightening torque

Bumper to impact absorber (M10)	41 Nm (30 ft-lb)
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### Front bumper impact absorber, replacing

To access front bumper mounting bracket and impact absorber mounting hardware remove front bumper cover. See **Front bumper, removing and installing**.

- Remove front bumper impact absorber mounting nuts (A) and drill out rivets (B).

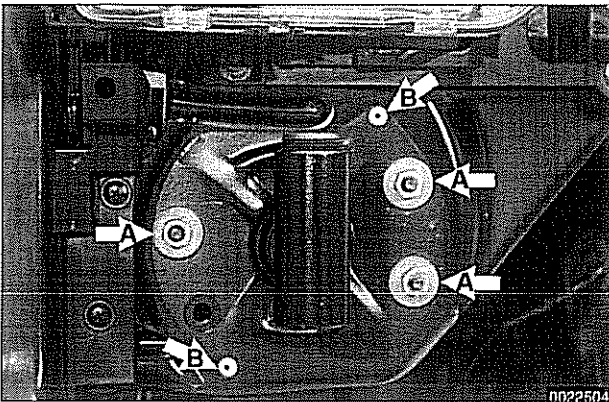
#### NOTE—

*Install the bumper bracket bolts using thread locking compound.*

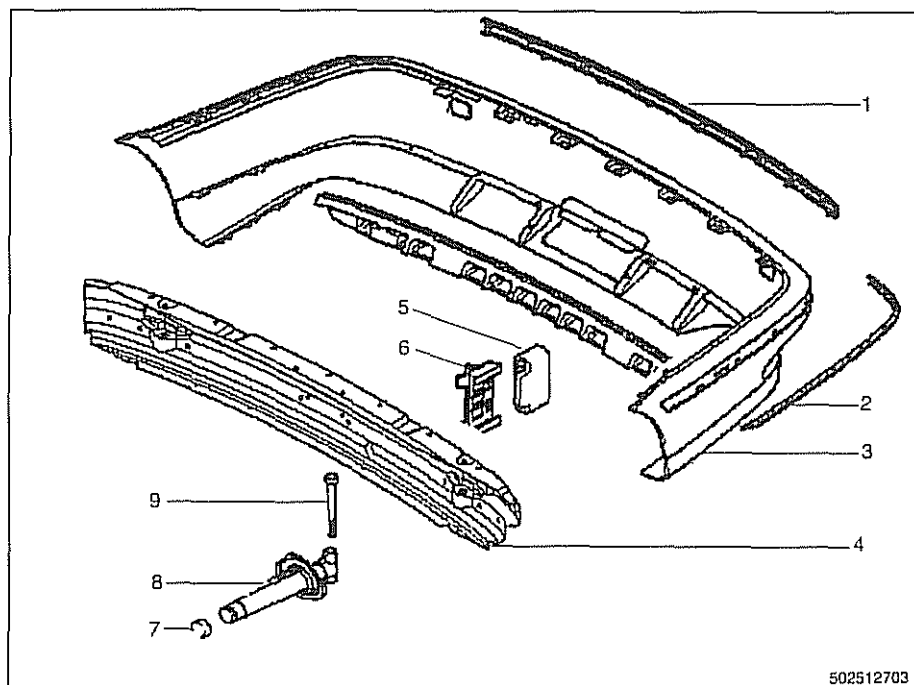
- Installation is the reverse of removal.

#### Tightening torques

Bumper to impact absorber	41 Nm (30 ft-lb)
Impact absorber to body (6M)	9 Nm (7 ft-lb)
Impact absorber to body (8M)	22 Nm (16 ft-lb)



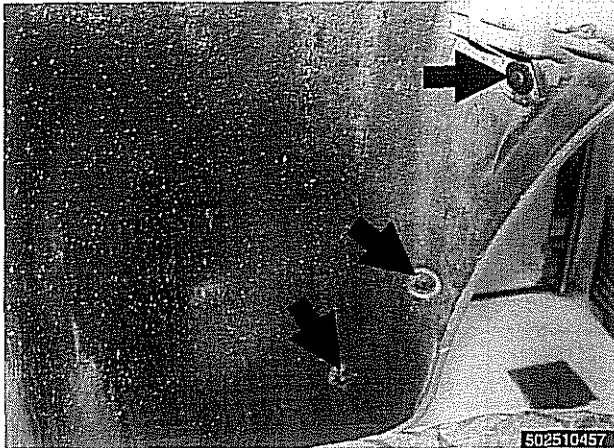




### Rear bumper assembly

1. Center trim cover
2. Side trim cover
3. Bumper cover
4. Bumper support
5. Outer support guide
6. Inner support guide
7. Bumper shock absorber seal
8. Bumper shock absorber
9. Bumper support mount bolt

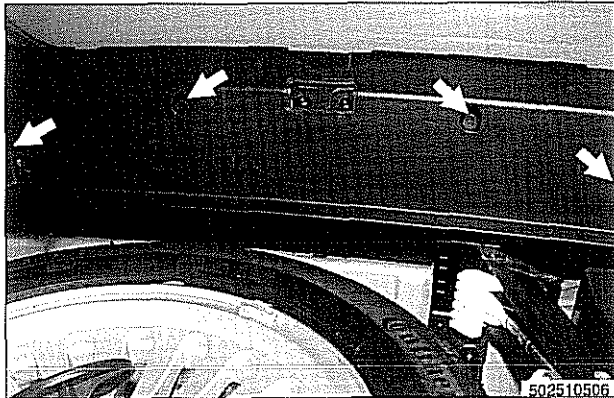
502512703



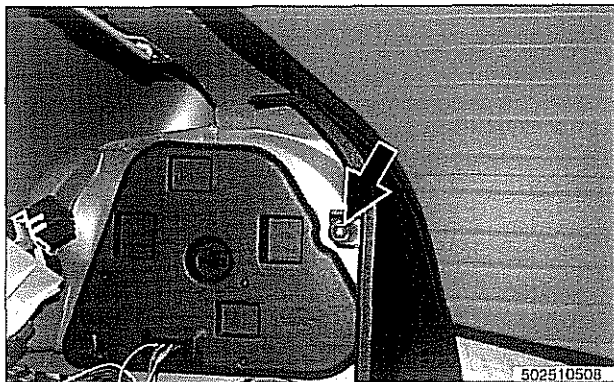
- Rear bumper, removing and installing**
- ◀ Remove expansion rivets from rear inner fender well panels (arrows).

– Working in luggage compartment:

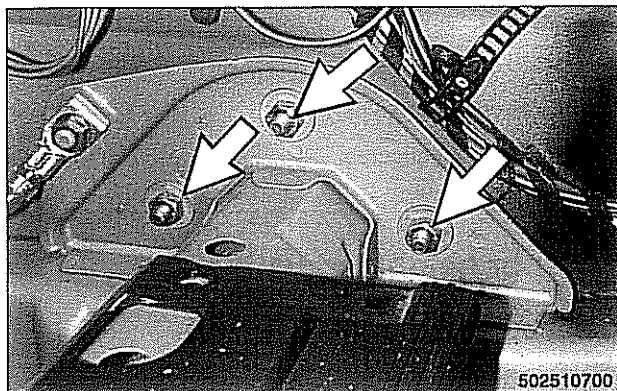
- Raise spare tire cover.
- Remove trim panel covering luggage compartment latch.
- Open battery cover trim panel on right side and luggage compartment.
- Open left side trim panel.



- ◀ Remove expansion rivets (arrows) from rear panel.



- ◀ Remove left and right side panel mounting nuts (arrow) and remove panel.



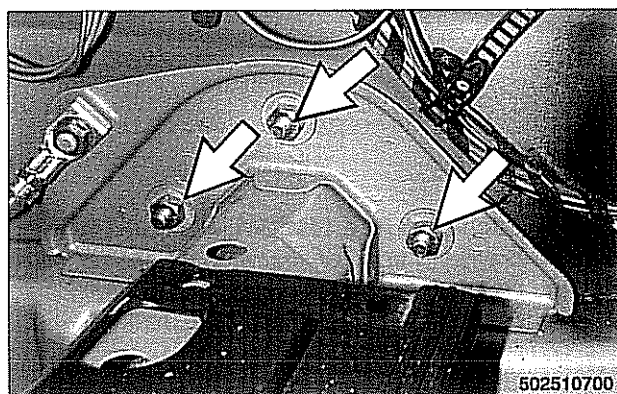
➤ Remove bumper mounting nuts (arrows).

- Slide bumper straight off bumper side mounting brackets.

**NOTE—**

*If equipped with PDC (Park Distance Control) remove electrical harness grommet and remove harness.*

- Installation is reverse of removal, noting the following:
  - Make sure gap between body and bumper is set to specifications. Adjust height as necessary.



➤ To adjust bumper height, loosen bumper mounting nuts (arrows) and adjust height.

**Tightening torques**

Impact absorber to chassis (M8 nut)	20 Nm (15 ft-lb)
Side bracket to body	6 Nm (53 in-ft)

### Rear bumper impact absorber, replacing

- Raise and properly support vehicle.

**WARNING—**

*Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath structural points chassis. Do not place jack stands under suspension parts.*

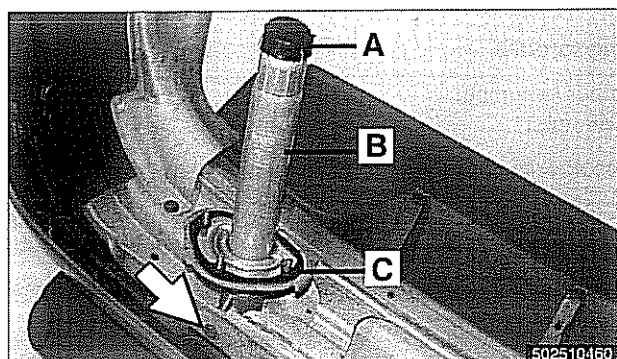
- Remove bumper. See **Rear bumper, removing and installing**.

- Remove bumper cover expanding rivets and remove cover.

➤ Remove bumper impact absorber (B) bolt (arrow).

- If necessary, replace mounting seals (C).
- On right side only, replace Impact absorber end cover (A) if necessary.

- Installation is reverse of removal.



**Tightening torques**

Impact absorber to chassis (M8 nut)	20 Nm (15 ft-lb)
Impact absorber to chassis (M6 nut)	9 Nm (80 in-lb)
Bumper bracket to impact absorber (M10 bolt)	45 Nm (32 ft-lb)

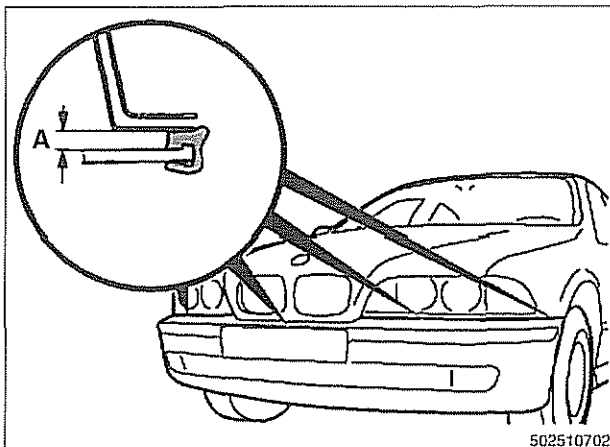
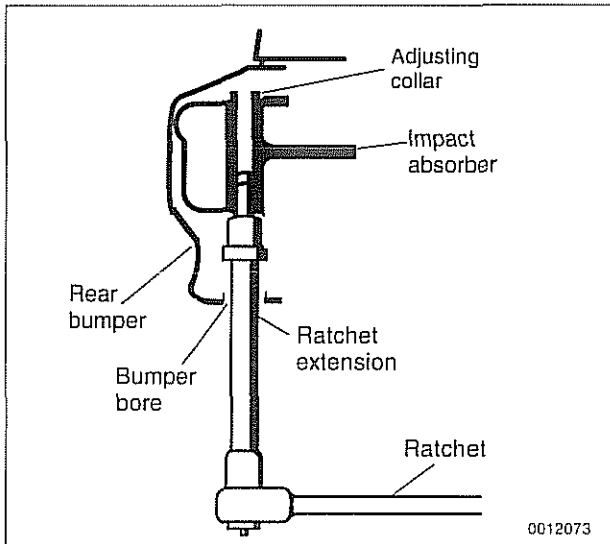
**Front bumper height, adjusting**

- A 14 mm allen socket is needed to make adjustments.
- Raise and properly support vehicle.

**WARNING—**

*Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.*

- Using a 12-inch extension and a 14 mm Allen socket, turn adjusting collar clockwise or counterclockwise as needed to change height of adjusting collar.



- Distance (A) must be the same at all points ( $A = 5 \pm 1$  mm (0.2 to 0.04 in)).
- Reinstall mounting fasteners and check bumper height.

**Tightening torques**

Front bumper to bumper bracket (M8 nuts)	20 Nm (15 ft-lb)
Impact absorber to chassis (M6 nuts)	9 Nm (80 in-lb)
Front bumper bracket to impact absorber (M10 bolts)	41 Nm (31 ft-lb)

## EXTERIOR TRIM

Exterior trim is attached to the body with plastic clips and fasteners that may be damaged during removal. Be sure to have necessary fasteners on hand when reinstalling exterior trim pieces.

### BMW emblem, removing and installing

The procedure given below applies to both front and rear emblems.

- Wrap end of a screwdriver with tape.

#### **CAUTION—**

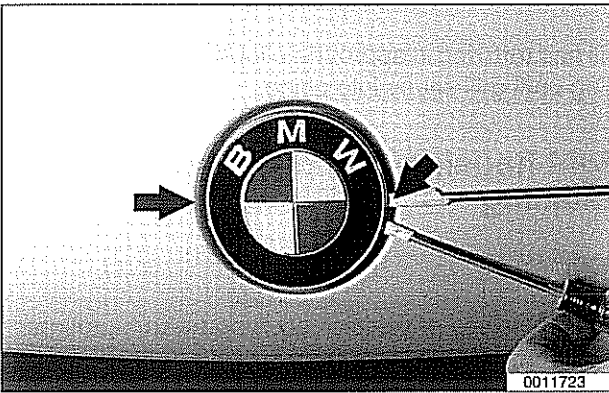
*Protect hood paint by covering area around emblem with tape.*

- ◀ Pry up emblem carefully on either side (arrows).

#### **NOTE—**

*Notice tape on screwdriver tips.*

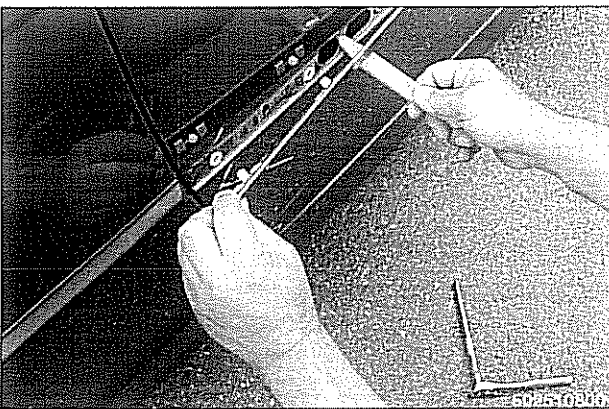
- Installation is reverse of removal.
  - Replace plastic inserts in body if damaged.
  - If emblem fits loosely, use a small amount of body molding tape or adhesive on rear of emblem before installing.

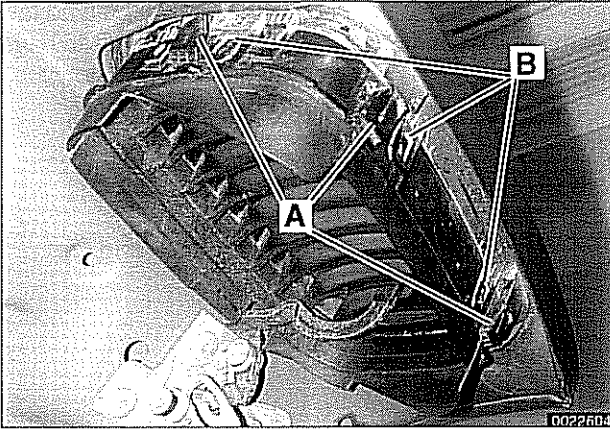


### Body side molding, replacing

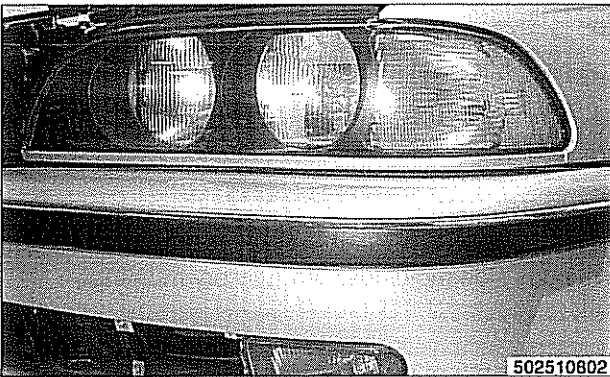
To remove body side moldings, carefully pry moldings straight off.

- ◀ Installation is reverse of removal. Replace any clips or clip covering boots damaged during removal.



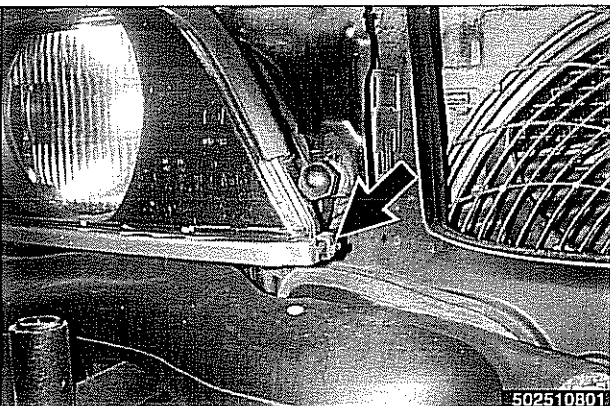


- ### Radiator grill, removing and installing
- Open hood.
  - ⚡ Carefully pry out tab on left or right side of grill trim ring (A), as well as tabs on bottom.
  - Push grill out through opening. Be careful of hood lever on passengers side of grill.
  - Once grill is removed, pry remaining tabs (B) to separate inner grill from chrome trim ring.
  - Before installation, assemble chrome trim ring and grill insert securely. Replace components if tabs or catches are broken or missing.
  - Install grill and trim ring in appropriate location in hood. Press on trim ring until grill snaps into place.



### Headlight housing trim panel, removing and installing

- ⚡ Open hood.
- Remove spray nozzle of vehicles equipped with headlight cleaning systems. See 611 Wipers and Washers.



- ⚡ Release inner tab (arrow) support.
- Swing trim out to release outer hook from fender mounting point.
- Installation is reverse of removal.



# 512 Door Windows

<b>General</b> .....	512-2	<b>Window Service</b> .....	512-5
Special tools .....	512-2	Window anti-trap strip, testing .....	512-6
Power windows .....	512-2	Front window anti-trap strip, removing .....	512-6
Window switches .....	512-3	Rear window anti-trap strip, removing .....	512-7
Rear window child lockout switch .....	512-3	Door window, adjusting .....	512-8
Power window motors .....	512-4	Door window, removing and installing .....	512-9
Convenience opening/closing .....	512-4	<b>Window Regulator Service</b> .....	512-11
Window anti-trap protection .....	512-4	Front window regulator removing and installing .....	512-11
Window motor limit stop function .....	512-5	Rear window regulator, removing and installing .....	512-13

## GENERAL

This repair group covers door glass, window regulator and power window motor repair information.

### **CAUTION—**

*All E39 models are equipped with side-impact airbags in the front doors. Some models are also equipped with airbags in the rear doors. Be sure to read the airbag warnings and cautions in 721 Airbag System (SRS).*

Electric window switch replacement is covered in **612 Switches**.

The windshield, rear window, fixed rear door glass, and cargo compartment glass (Sport Wagon only) are bonded using special adhesives and tools. It is recommended that bonded glass replacement be done by an authorized BMW service facility or an automotive glass installer.

## Special tools

Some window repair operations require special tools.

## Power windows

- Power window features in E39 models include:
  - Control of the front and rear door window motors is carried out directly by the General Module (GM III).
  - One-touch operation in both directions on all four windows.
  - Cable type window regulator used for all door windows.
  - Anti-trap protection provided by pressure sensitive finger guard.
  - Right front and each rear door has a single window switch located in door handle trim.
  - Rear door window switches can be deactivated by pressing child lock-out switch in the driver's window switch block.
  - Convenience closing/opening of the windows from driver's lock cylinder or convenience opening only from remote unlocking feature (FZV) remote key.
  - Window (FZV) operation can be owner customized with Car Memory function. See **515 Central Locking and Anti-Theft**.
  - After ignition is switched off, electric windows can be operated until a door is opened or until 16 minutes has elapsed.
  - The GM III bases window motor end position on current draw (load). There is a maximum window motor run time of 6 seconds. The motor is then switched off even if the end position load sensor fails.



## Window switches



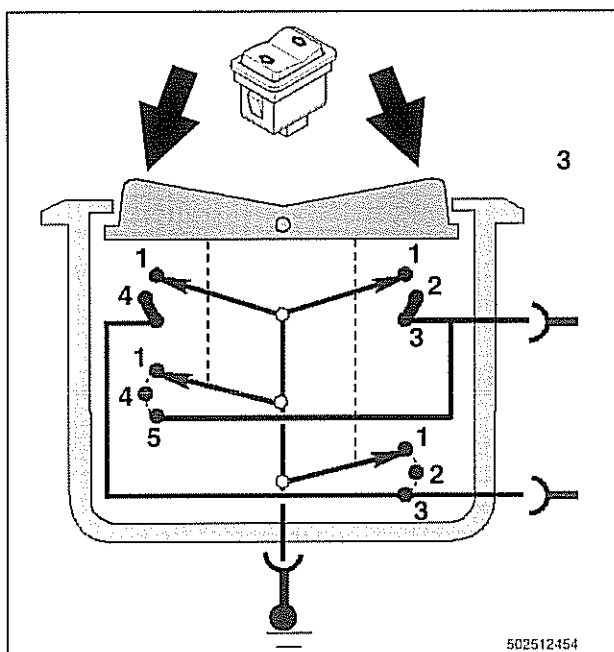
➤ The push type window switch provides the GM III with a coded ground signal. Holding a switch at the first detent provides a single ground signal on one wire requesting the GM III to open the window. When released, the ground signal is removed and the window motor stops.

— Momentarily pushing the switch to the second detent and releasing provides an additional ground signal on the second wire requesting "one touch mode". The GM III lowers the window automatically until it reaches the end position. Each window has four positions, two each for the standard mode of operation and two for the one-touch mode. All window operation signals are digital inputs to the door modules and GM III.

— The switch functions in the same manner for window closing but the ground signal sequence is reversed.

➤ Window switch positions.

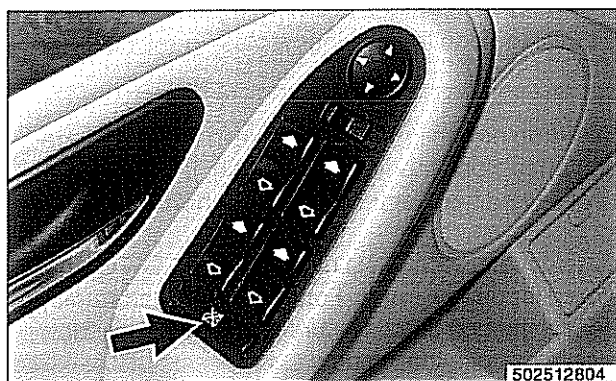
1. Off
2. Open
3. One touch open
4. Close
5. One touch close



## Rear window child lockout switch

➤ The rear window child lockout switch (arrow) is incorporated in the driver's window switch block in left front door arm rest. When activated, it provides a constant ground signal to the GM III, preventing the windows from being operated from the rear door switches.

— The lockout switch ground signal is overridden by the GM III if a passive safety system (MRS) crash signal is received.



## Power window motors

The window motors are mounted on cable regulators. The window motor control circuit consists of two wires for operating the motor in both directions.

The motors are activated by relays in the GM III. The relays provide either power or ground depending on the direction of window travel. The GM III controls the polarity based on a request to run the window from a window switch or a convenience opening/closing signal.

## Convenience opening/closing

The GM III provides the convenience open/close feature, providing control of the power windows (and sunroof) from outside the vehicle with the key in the driver's door lock. The FZV (remote key) provides the same function for window opening only.

Anti-trap protection is active during convenience closing from the driver's door lock.

If the GM receives a request to operate convenience closing or opening for more than 110 seconds, the function is deactivated and a fault code is stored.

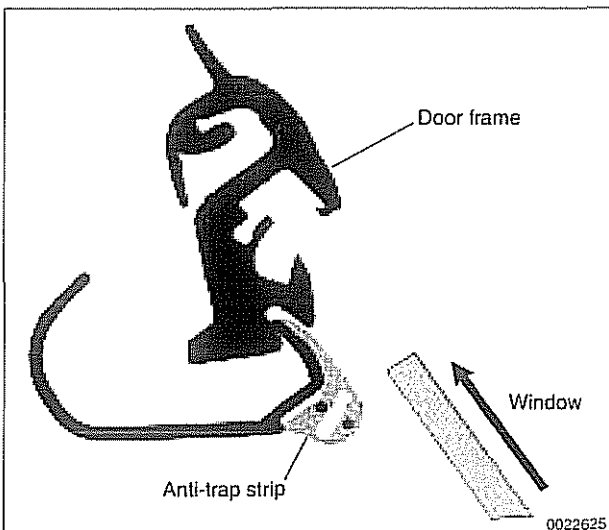
## Window anti-trap protection

➤ A rubber pressure guard is located at the top edge of each door frame. It consists of two contact strips that close when subjected to pressure. When the contact strip closes (for example, a hand is trapped between the top of the window and the door frame), an anti-trap signal is sent to the GM III. The window immediately (within 10 milliseconds) reverses direction. This feature does not require initialization.

The E39 pressure sensor finger guard has a resistance of 3 Kw and it is monitored for open circuits. When pressed, the monitored resistance changes to < 1Kw. If anti-trap protection becomes faulty the one touch window closing will not function.

Window anti-trap protection is only active in the one touch and convenience close modes of operation. If the window switch is pulled and held, anti-trap protection will not function.

The anti-trap contact strip has a resistance of 1.2 K Ohm and it is monitored for open circuits. Faults with the anti-trap system will cancel the one touch feature requiring the window switch be held to close the window.



## Window motor limit stop function

If repeated window activation (up/down cycles) exceeds one minute, the GM III deactivates the internal relays and disregards any further up/down requests. The GM III provides motor activation after a short duration but not for the full one minute monitoring cycle.

The GM III monitors the number of times a window motor is activated. It counts each cycle and stores the number in memory. After the stop function limit is reached and the window motor is deactivated, the GM III slowly reverses the stored count of activation until the stored number equals 0, thus allowing the window motor to cool down.

### **WARNING—**

- *Always wear hand and eye protection when working with broken glass.*
- *If a window is broken, all of the glass bits should be vacuumed out of the door cavity. Use a blunt screwdriver to clean out any remaining glass pieces from the window guide rails.*
- *When servicing the door windows, the harness connector to the window regulator should always be disconnected to prevent pinching fingers in the moving window mechanism.*

## WINDOW SERVICE

Sedan and Sport Wagon doors are similar. Use the following procedures for window service on these models.

### **WARNING—**

- *E39 cars are fitted with side-impact airbags in the front doors. Some are equipped with airbags in the rear doors as well. When servicing the door windows on cars with side-impact airbags, always disconnect the negative (-) battery cable. See **721 Airbag System (SRS)** for cautions and procedures relating to the airbag system.*
- *Prior to disconnecting the battery, read the battery disconnection cautions given **001 General Warnings and Cautions**.*

## Window anti-trap strip, testing

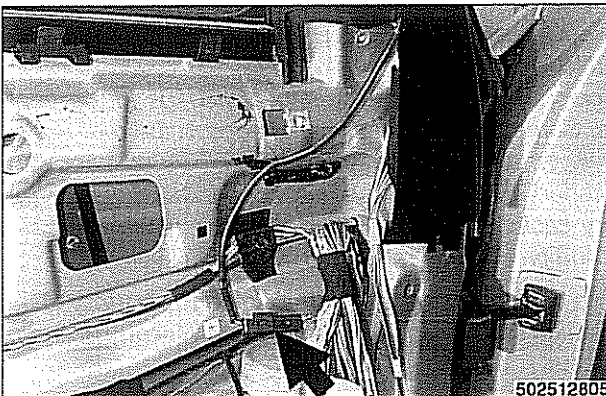
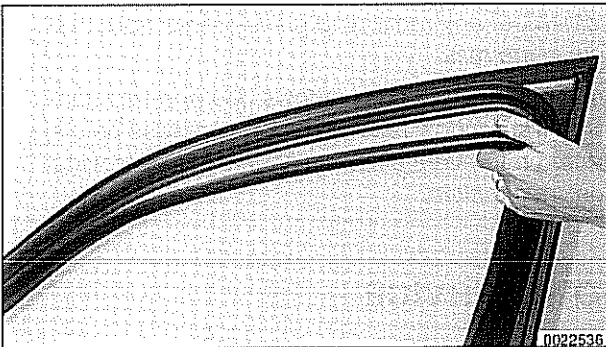
- To test function of anti-trap strip on any window:
  - With key ON and window down, pull up window switch to second detent, thus activating one-touch close operation.
  - Insert wooden block or other soft object between glass and upper door frame.
  - Window should contact block, then immediately reverse direction and lower by approximately 25 mm (1 in).

### NOTE —

*Anti-trap strip is integrated into the molding strip of the door window frame.*

## Front window anti-trap strip, removing

- Remove front door panel and vapor barrier as described in 411 Doors.
- Remove window frame molding strip and peel toward inside of vehicle.

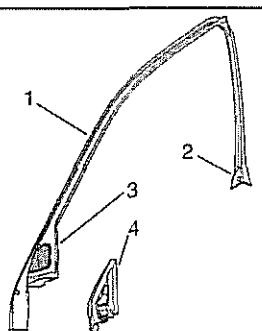


- Separate anti-trap electrical harness connector (arrow) at top front of door.

### NOTE —

*Wire color for anti-trap strip is dark gray.*

### Front window frame molding and anti-trap strip



➤ If replacing molding with new one, transfer mounting clips and foam insulation as necessary.

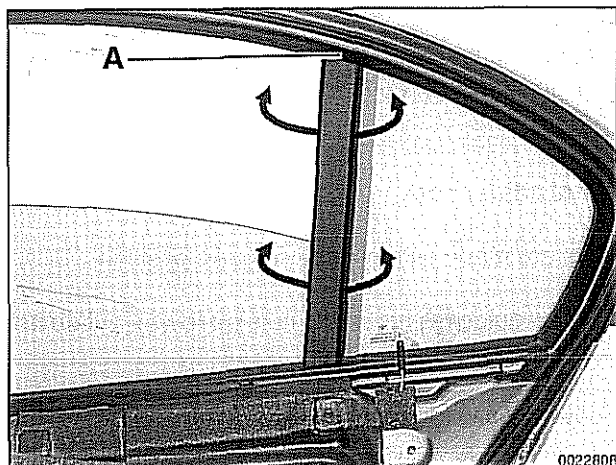
1. Window frame molding
2. Clip
3. Door corner speaker cover
4. Foam insulation

– After installation, recheck anti-trap protection.

### Rear window anti-trap strip, removing

– Remove rear door panel and vapor barrier as described in **411 Doors**.

➤ Remove window frame molding strip, peeling it off fixed window partition (**arrows**). Do not tear strip in area (**A**).



➤ Disconnect electrical harness connector (**arrow**).

– After installation, recheck anti-trap protection.



## Door window, adjusting

Whenever the door window or window regulator is removed, window adjustment should be checked. The glass should contact the top of the window squarely and should seat against the window seal uniformly.

### NOTE—

*If the window does not contact the window seal uniformly, wind noise or water infiltration may result.*

- Remove door panel as described in **411 Doors**.
- Disconnect negative (–) cable from battery. Remove airbag unit and vapor barrier from door. See **721 Airbag System (SRS)**.

### WARNING—

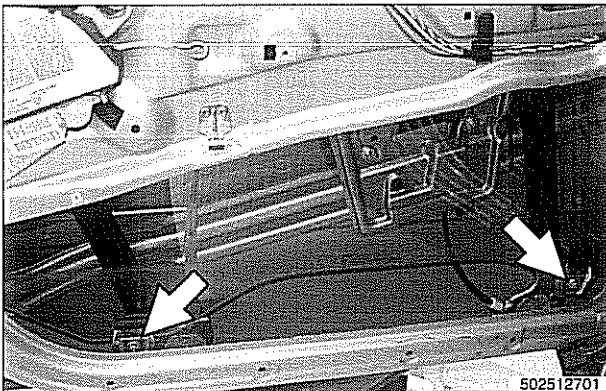
*Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Warnings and Cautions**.*

### Longitudinal adjustment

- Adjustments are made with window in open position.
- Loosen window guide rail mounting nuts (**arrows**), but do not remove.
- Slide window glass in longitudinal direction to adjust.
- Tighten guide rail nuts.

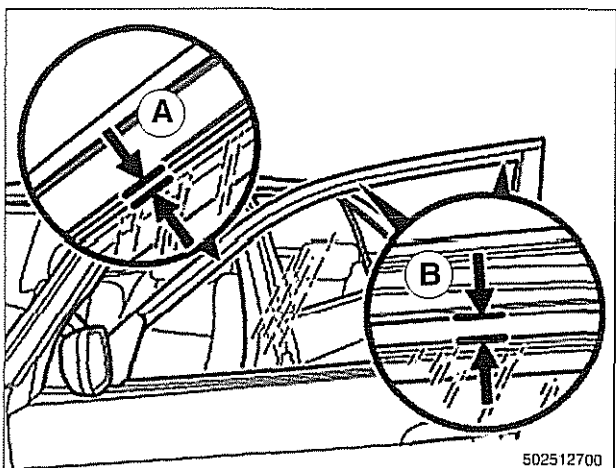
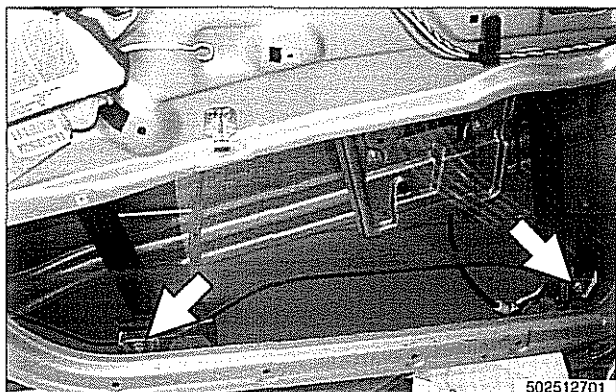
### Tightening torque

Window regulator guide rail to door	10 Nm (89 in-lb)
-------------------------------------	------------------



### Vertical adjustment

- Adjustments are made with window in open position.
- Loosen window clamping fasteners (arrows), but do not remove.
  - Adjust rear clamp and tighten fastener.
  - Tighten front clamp fastener.



- Raise door window up to stop:
  - Check gap (A) at window front edge.
  - Check gap (B) at window top edge.

#### NOTE —

Measure window frame between door window edge and panel.

#### Front window gap settings

Front of window (A)	5.4 mm (0.21 in)
Top of window (B)	10 mm (0.39 in)

#### Tightening torque

Window regulator guide rail to door	10 Nm (89 in-lb)
-------------------------------------	------------------

### Door window, removing and installing

- Remove door panel as described in 411 Doors.
- Reconnect window switch and lower window down to convenient height and disconnect window switch.
- Disconnect negative (–) cable from battery, then remove airbag unit and vapor barrier from door. See 721 Airbag System (SRS).

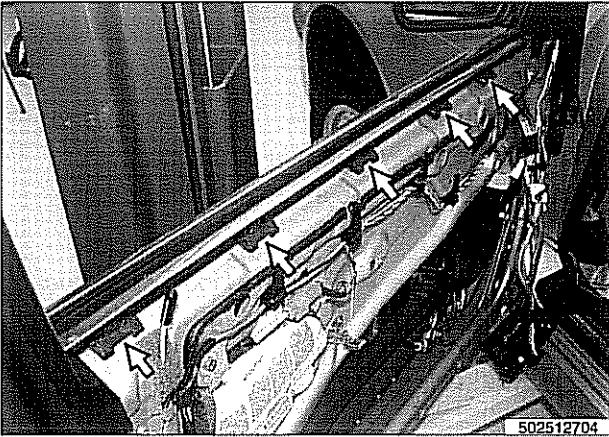
#### WARNING —

Prior to disconnecting the battery, read the battery disconnection cautions given in 001 General Warnings and Cautions.

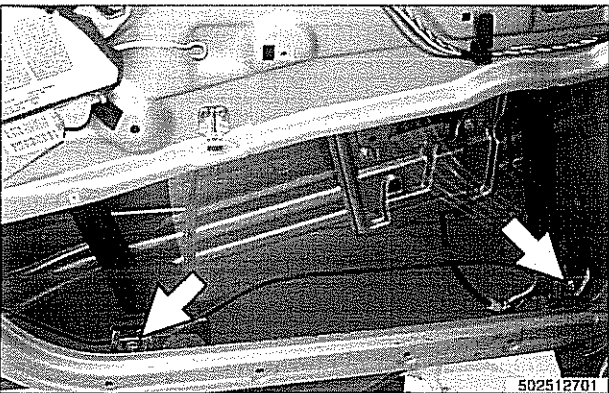
Door Windows



Working carefully with a plastic prying tool, remove window trim strip from door.

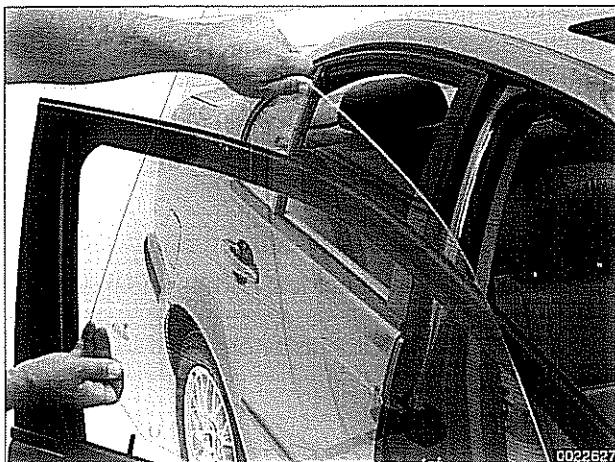


Starting from rear of inner window trim strip, carefully pry up on trim strip clips (arrows) to remove window trim.



Loosen window clamping jaw fasteners (arrows).





- ◀ Tilt window glass carefully inside door cavity and lift out of door.
- Installation is reverse of removal.
  - Replace plastic window retainers once glass is inside door.
  - Use new mounting bolts when reinstalling side-impact airbag to door.
  - Adjust window as described earlier.

## WINDOW REGULATOR SERVICE

Sedan and Sport Wagon doors are similar. There are two window rails in each front window regulator, only one in the rear. Otherwise the front and rear regulators are similar.

### **WARNING —**

- E39 cars are fitted with side-impact airbags in the front doors. Some are equipped with airbags in the rear doors as well. When servicing the door windows on cars with side-impact airbags, always disconnect the negative (–) battery cable. See **721 Airbag System (SRS)** for cautions and procedures relating to the airbag system.
- Prior to disconnecting the battery, read the battery disconnection cautions given at the front **001 General Warnings and Cautions**.

### **NOTE —**

Because window operation is electronically controlled, a window motor does not have mechanical end positions. For this reason it can be removed and installed with the window in any position and does not need reinitialization.

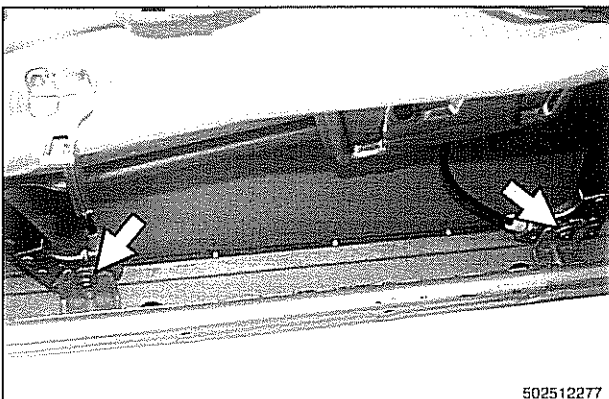
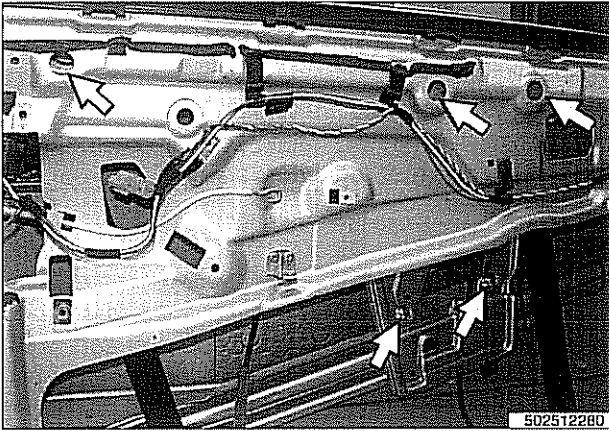
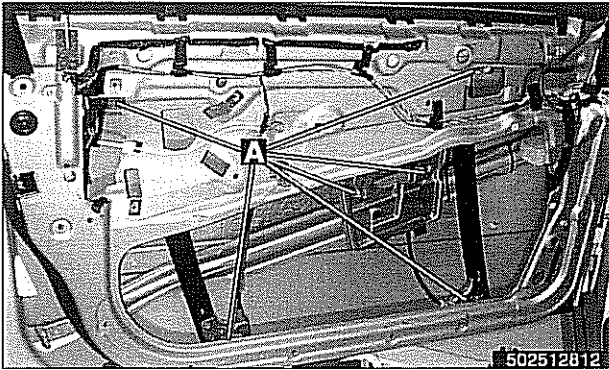
## Front window regulator removing and installing

### **NOTE —**

BMW recommends removing the window regulator and motor as one unit, then separating the two on the bench.

- Remove front door panel as described in **411 Doors**.
- Disconnect negative (–) cable from battery, then remove airbag unit and vapor barrier from door. See **721 Airbag System (SRS)**.

## Door Windows



- Disconnect window from window guide rail as described in **Door window, removing and installing**. Do not remove window from door.
  - Push window up and use wedge to hold in position.
- If necessary, remove speaker unit from door.
- Removing window regulator from door:
  - Disconnect window motor electrical harness connector.
- ◀ Remove lower window regulator fasteners (**arrows**).
- ◀ Remove upper window regulator fasteners (**arrows**).
- ◀ Loosen fasteners (**arrows**) and slide regulator up to remove from mounts.
- Remove window regulator through opening in bottom of door, checking for any wiring that might become snagged during removal.
- Installation is reverse of removal.
  - Be sure to route wiring harnesses to keep them away from moving window mechanism. Use new wire ties as necessary.
  - Adjust window as described earlier.

### Tightening torques

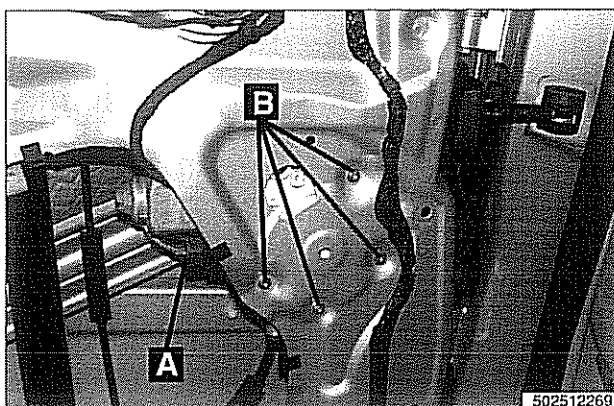
Window motor to regulator	5 Nm (44 in-lb)
Window regulator to door	8 Nm (71 in-lb)
Window to guide	8 Nm (71 in-lb)

## Rear window regulator, removing and installing

### NOTE—

*BMW recommends removing the window regulator and motor as one unit, then separating the two on the bench.*

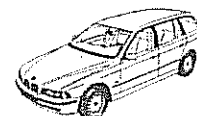
- Disconnect negative (–) cable from battery.
  - Remove door panel as described in **411 Doors**.
  - Remove airbag unit and vapor barrier from door. See **721 Airbag System (SRS)**.
  - Disconnect window from window guide rail as described in **Door window, removing and installing**. Do not remove window from door.
    - Push window up and use wedge to hold in position.
- ◀ Loosen fastener (**arrow**) and slide window regulator up and out of mount.



- ◀ Disconnect wiring harness connector (**A**) and remove fasteners (**B**).
- Remove window regulator and motor through opening in door.
- Installation is the reverse of removal.
    - Be sure to route wiring harnesses to keep them away from moving window mechanism. Use new wire ties as necessary.

### Tightening torques

Window motor to regulator	5 Nm (44 in-lb)
Window regulator to door	8 Nm (71 in-lb)
Window to guide	8 Nm (71 in-lb)





# 513 Interior Trim

<b>General</b> .....	513-2	Window and door post trim panels, removing and installing .....	513-12
Interior trim repairs .....	513-2	Dash panel support, removing and installing .....	513-15
<b>Center Console</b> .....	513-3	Rear parcel shelf panel, removing and installing .....	513-15
Center console, removing and installing . . .	513-3	Glove compartment, removing and installing .....	513-16
<b>Dash Panel</b> .....	513-7		
Lower dash panel assembly, removing and installing .....	513-7		
Upper dash assembly, removing and installing .....	513-11		

## GENERAL

This repair group covers interior trim removal and installation procedures.

- Refer to the following repair groups for additional information:
  - 250 Gearshift Linkage
  - 411 Doors (interior door panels)
  - 612 Switches
  - 620 Instruments
  - 640 Heating and Air Conditioning (IHKA control panel)
  - 650 Radio
  - 721 Airbag System (SRS)

## Interior trim repairs

Interior trim and finish panels are clipped or screwed into place. Many of the trim retaining clips are designed to be used only once. When removing trim that is held in place with clips, it is a good idea to have spare clips on hand before beginning the job.

### **WARNING—**

- *Special precautions must be observed when servicing the BMW Supplemental Restraint System (SRS). Serious injury may result if system service is attempted by persons unfamiliar with the BMW SRS and its approved service procedures. BMW specifies that all inspection and service should be performed by an authorized BMW dealer.*
- *Before performing any work involving airbags, disconnect the negative (-) battery cable. See 721 Airbag System (SRS).*
- *Airbags contain a back-up power supply within the SRS control module. A 5 second discharge period should be allowed after the battery cable has been disconnected.*

### **CAUTION—**

- *When working on electrical switches or lights, always disconnect the negative (-) cable from the battery and insulate the cable end to prevent accidental reconnection.*
- *Prior to disconnecting the battery, read the battery disconnection cautions given in 001 General Warnings and Cautions.*
- *To prevent marring the trim when working on interior components, work with plastic prying tools or wrap the tips of screwdrivers and pliers with tape before prying out switches or electrical accessories.*

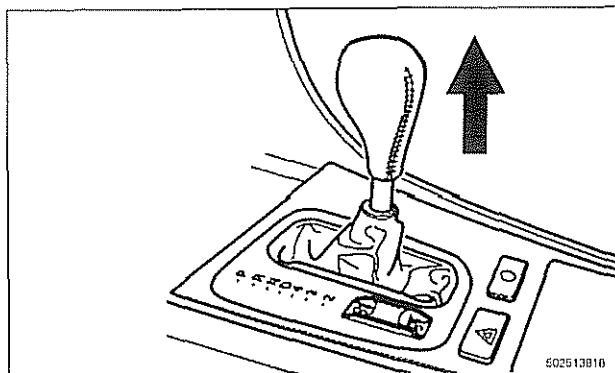
## CENTER CONSOLE

The console between the two front seats starts behind the shifter housing. It houses the parking brake handle, optional telephone and oddments storage tray. The rear portion of the console houses the ashtray and covers the emergency brake cable ends.

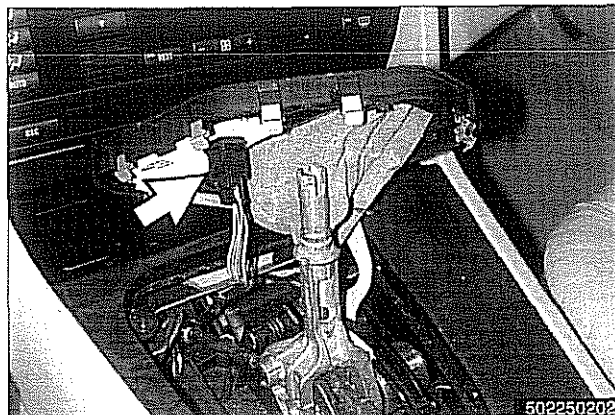
### NOTE—

*The accompanying photos illustrate a model with automatic transmission. Manual transmission models are similar.*

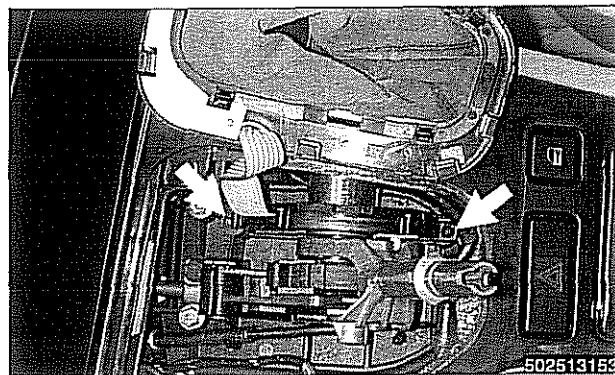
### Center console, removing and installing



- Remove shift knob by pulling straight up (arrow).

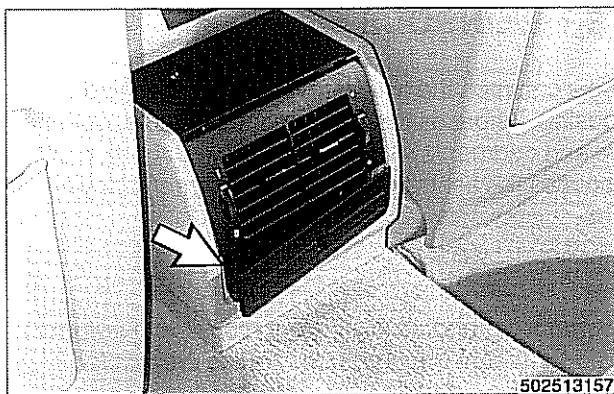


- Gently pry shift bezel up out of console and disconnect wiring harness (arrow).

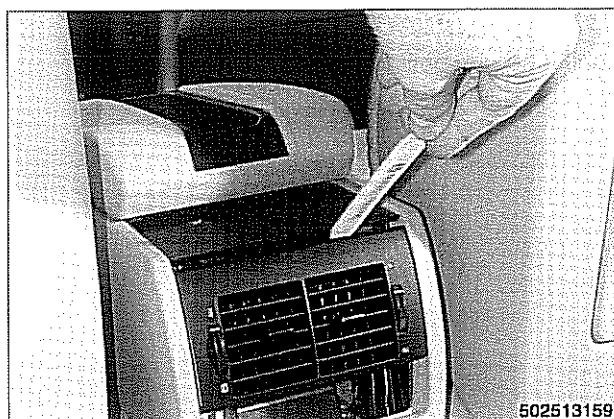


- Models equipped with automatic transmission remove neutral safety switch fasteners (arrows) and remove bezel with switch.

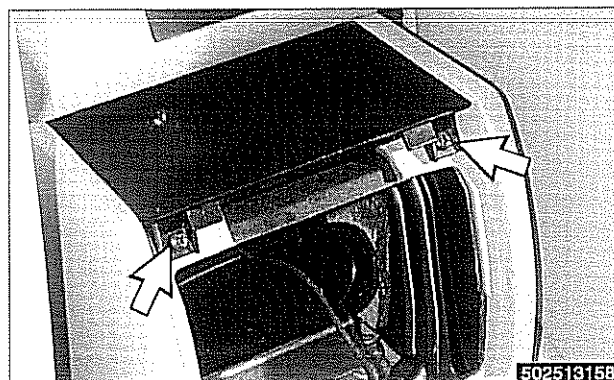
## Interior Trim



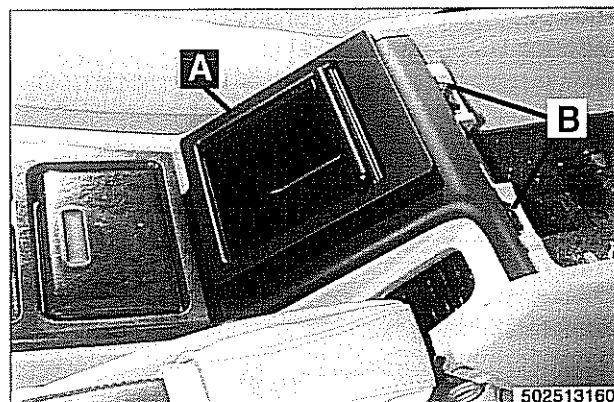
⚠ Carefully pry cup holder (arrow) out of console.



⚠ Pry air vent down to release locking clips and remove.



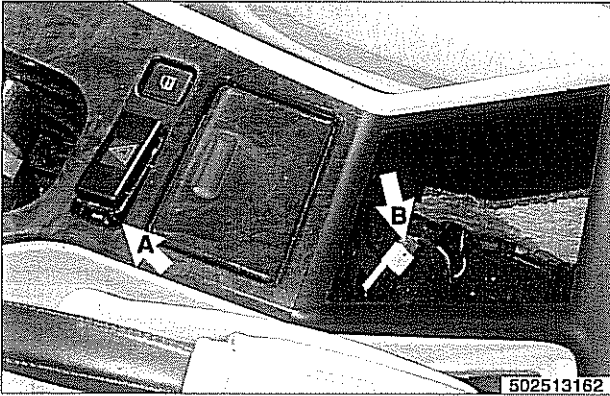
⚠ Remove screws (arrows) at base of front seat armrest and slide armrest forward to remove.



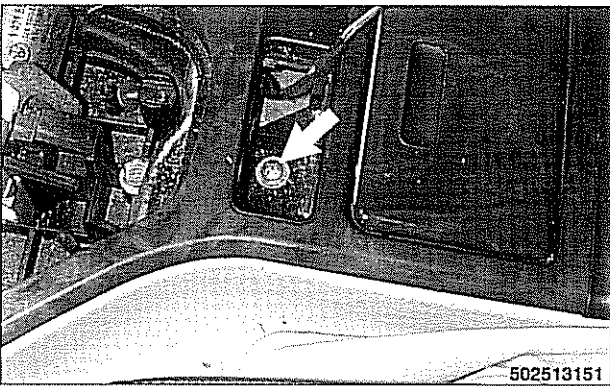
⚠ Remove console glove box (A).

- Remove rear trim panel fasteners (B).

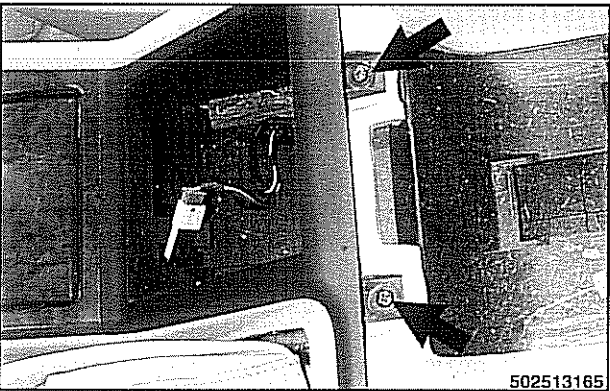




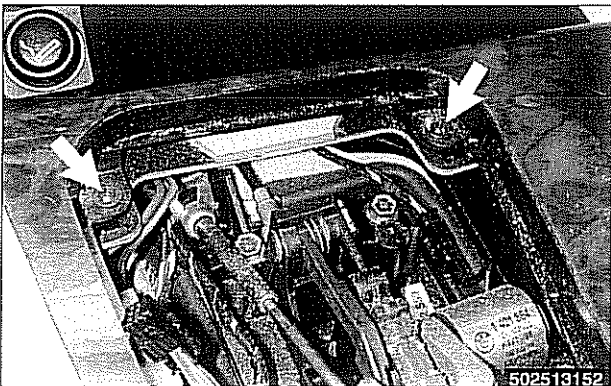
- ◀ Carefully pry out 4-way hazard flasher switch (A).
- Disconnect wiring harness (B).



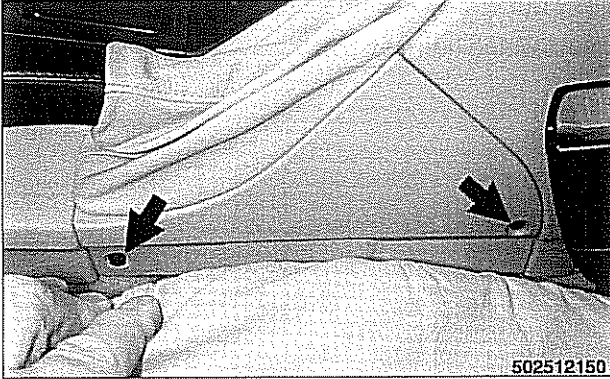
- ◀ Remove trim panel fastener (arrow) under 4 way flasher switch.



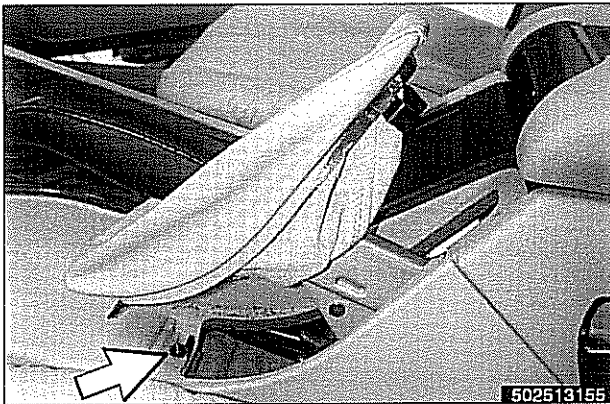
- ◀ Remove console trim panel retaining fasteners (arrow) at rear of trim panel.



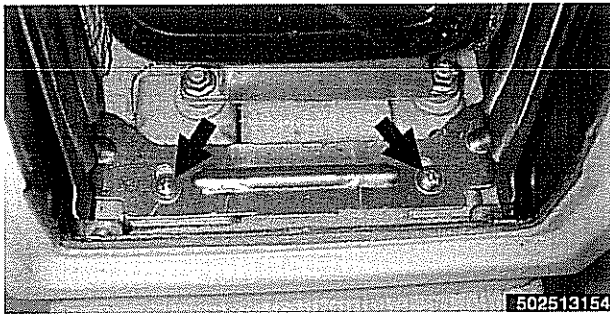
- ◀ Remove front console trim fasteners (arrows) and carefully remove trim panel.



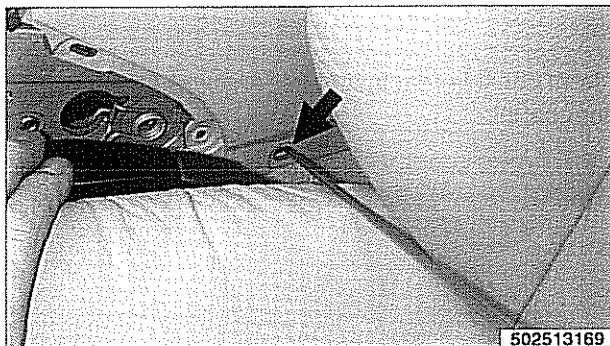
- Remove parking brake lever side cover fasteners (arrows).



- Unclip trim boot for parking brake lever and pull boot and handle forward off brake lever. Remove parking brake cover fastener (arrow) and remove cover.



- Remove fasteners at rear of console (arrows).



- With left and right seats in lowest position, remove side console fasteners (arrow).
- Remove left and right side console trim covers. See **Lower dash panel assembly, removing and installing**.
  - Remove center console.
  - Installation is reverse of removal.

## DASH PANEL

The E39 dashboard assembly includes the instrument cluster, passenger side airbag, glove compartment, fuse and relay panel, radio, IHKA control panel or on-board monitor (if equipped with GPS). The dash is made up of an upper and lower sections. The lower section must be removed before the upper section can be removed.

Dashboard removal is a complex operation. Read the procedures through before starting work.

### Lower dash panel assembly, removing and installing

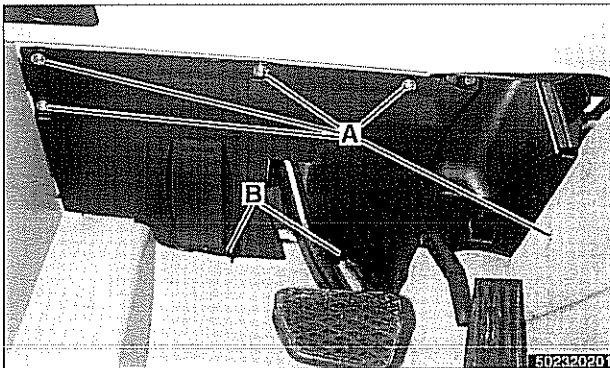
- Disconnect negative (–) cable from battery and cover terminal with insulating material.

#### **CAUTION—**

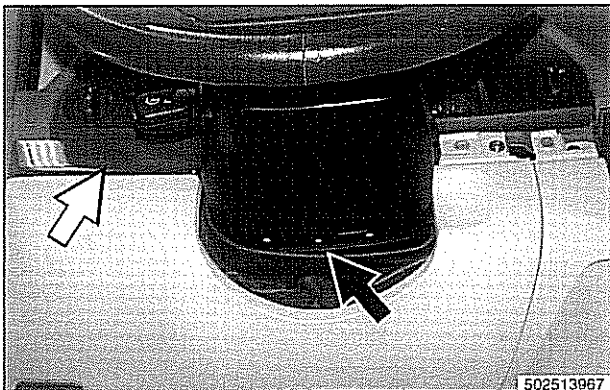
*Prior to disconnecting the battery, read the battery disconnection cautions given at the front in 001 General Warnings and Cautions.*

- Place steering column in down and extended position.

- Remove left side foot well panel fasteners (A and B).



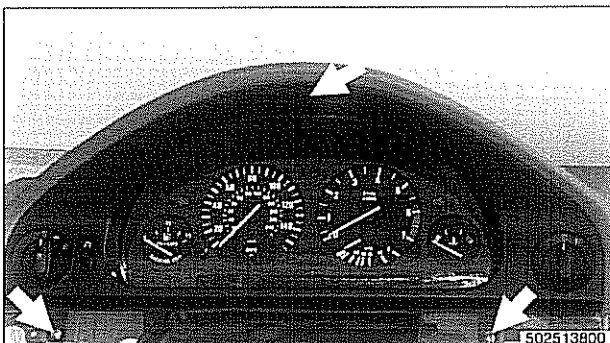
- Using a plastic trim tool, gently pry left and right steering column trim panels (white arrow) to remove and release snap clip on column boot (black arrow).



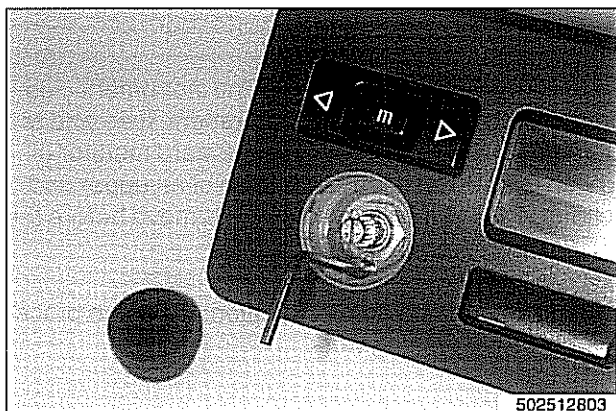
- Remove instrument cluster trim panel fasteners (arrows).

- Pull trim panel out and disconnect harnesses for light switches.

- Remove radio volume control knob.

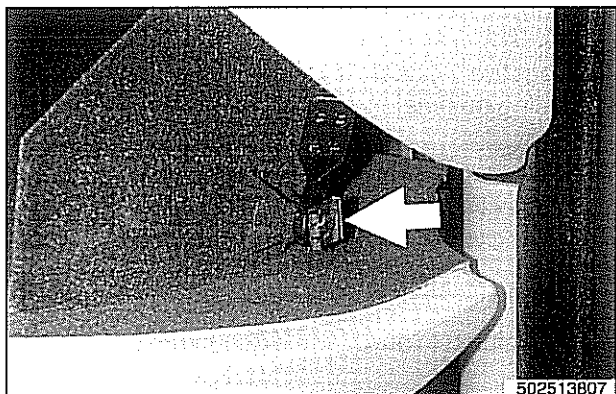


## Interior Trim



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- ◀ Insert allen wrench into slot approximately 1 mm and turn through 90°.
- Disconnect wiring harnesses from radio.
- Remove radio.



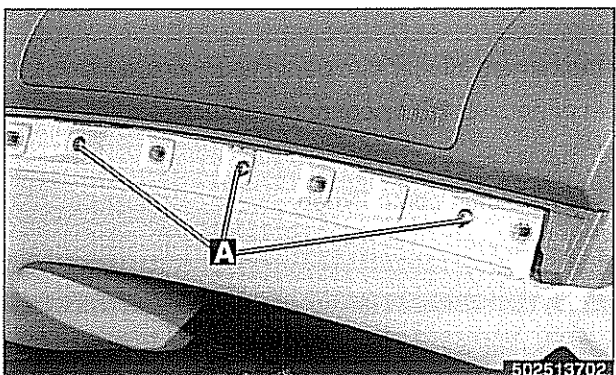
502513807

- ◀ Remove left and right locking clips (**arrow**) from glove compartment straps.



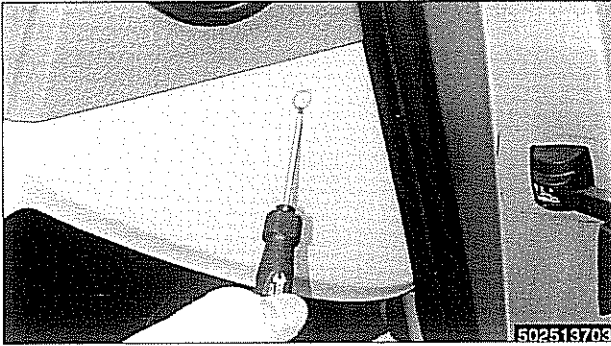
502513701

- ◀ Carefully pry left and right dashboard trim out to remove.



502513702

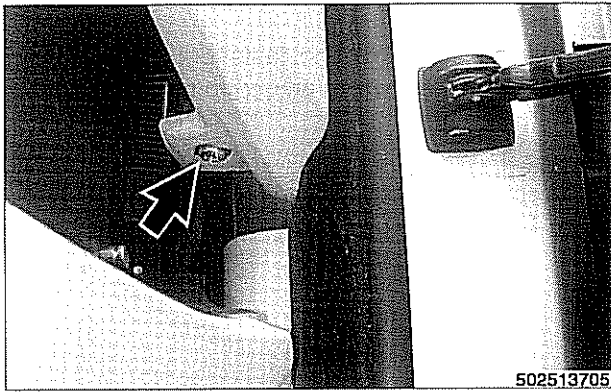
- ◀ Remove right side lower dash support screws (**A**).



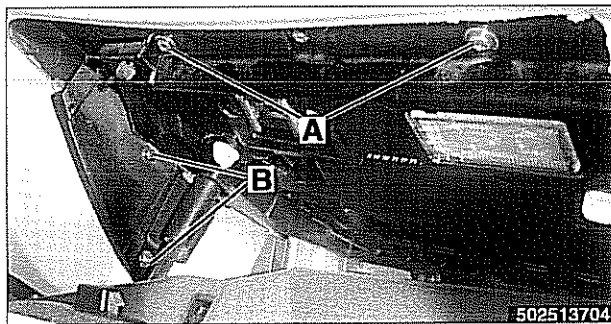
➤ Remove trim plug from right side of lower dash and remove screw.

— Open glove compartment door.

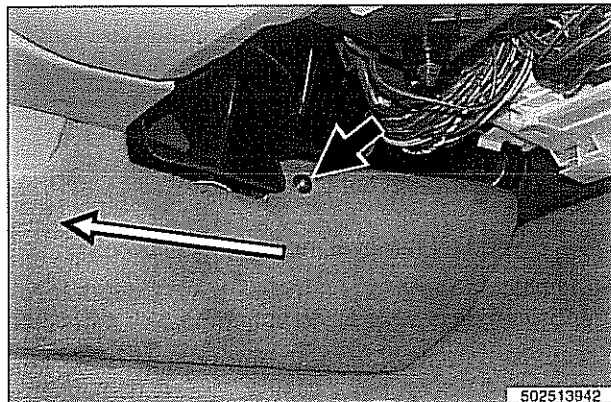
— Remove right side foot well trim panel screw and slide rim panel back to remove.



➤ Remove glove compartment mounting screw from right side of dash (arrow).

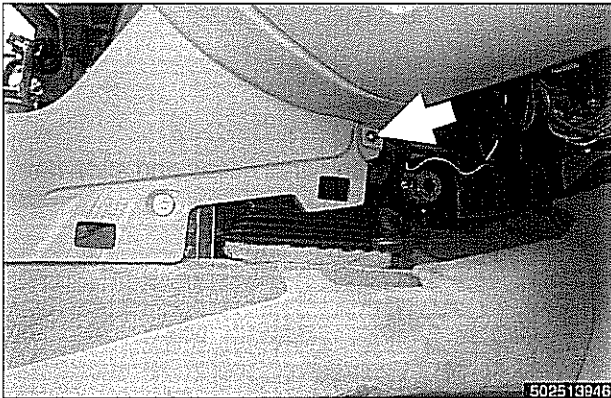


➤ Remove screws **A** and **B** inside glove compartment.

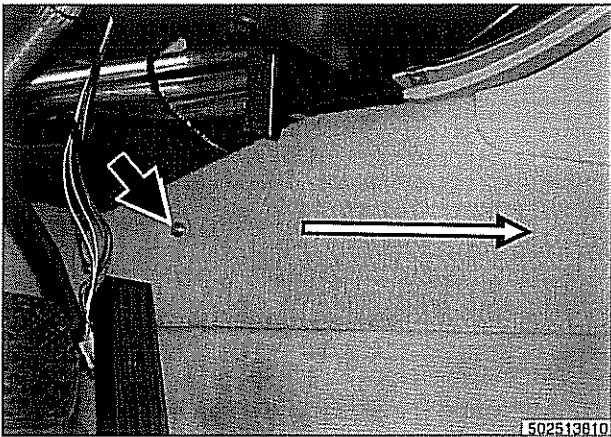


➤ Remove right side console trim panel fasteners (black arrow) and pull panel back (white arrow) to remove.





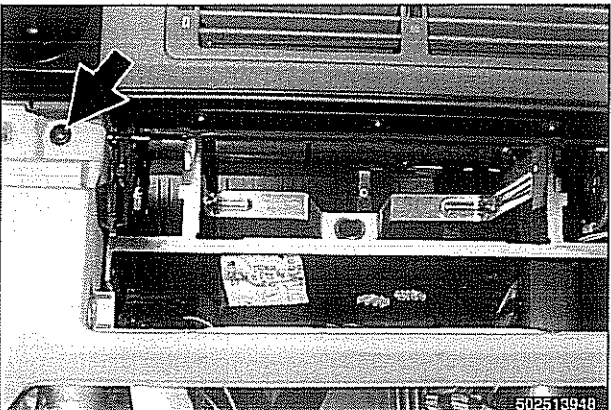
- Remove right side lower dash fastener (**arrow**).



- Remove left side console trim panel fasteners (**black arrow**) and slide panel backward (**white arrow**) to remove.

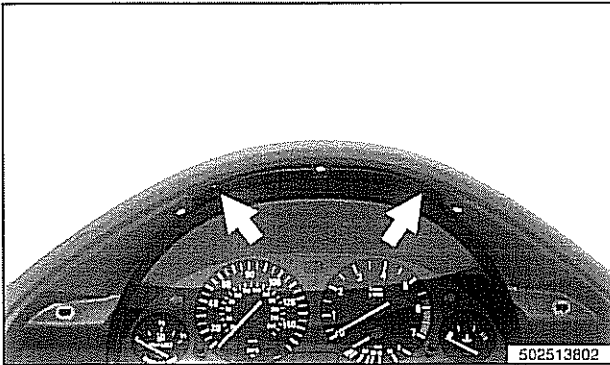


- Remove left side lower dash fastener (**arrow**).

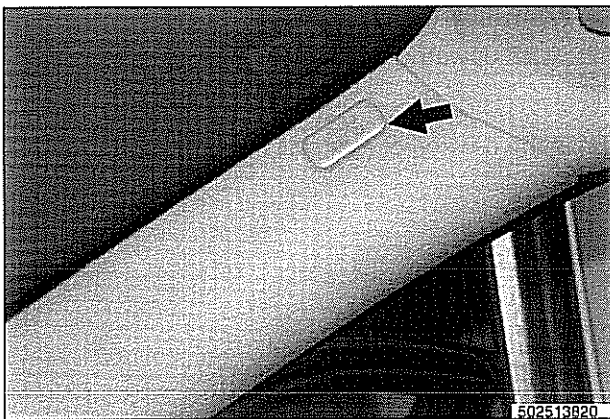


- Remove upper dash fastener (**arrow**).
  - Pull bottom of lower dash out to remove.
- Installation is reverse of removal, noting the following:
  - Instrument cluster harness connector locking levers must be in up position before installing connectors.
  - If replacing instrument cluster with new unit, recode new cluster using BMW scan tool DISplus, MoDiC or equivalent.

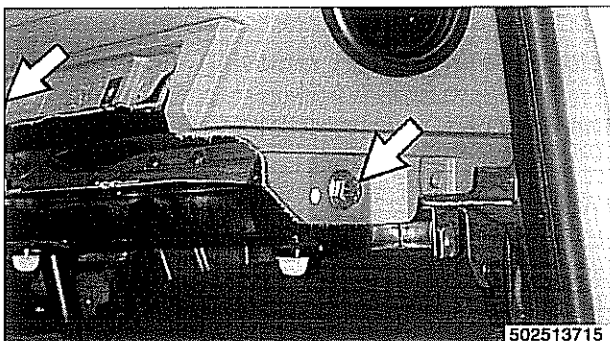
## Upper dash assembly, removing and installing



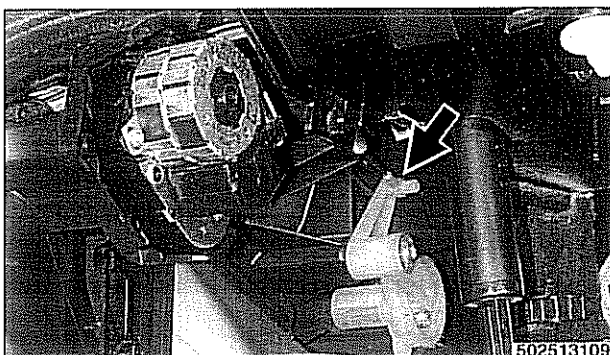
- Remove lower dash assembly. See **Lower dash panel assembly, removing and installing**.
- Remove instrument cluster fasteners (**arrows**) and swing cluster out to remove.
  - Disconnect wiring harnesses from instrument cluster.



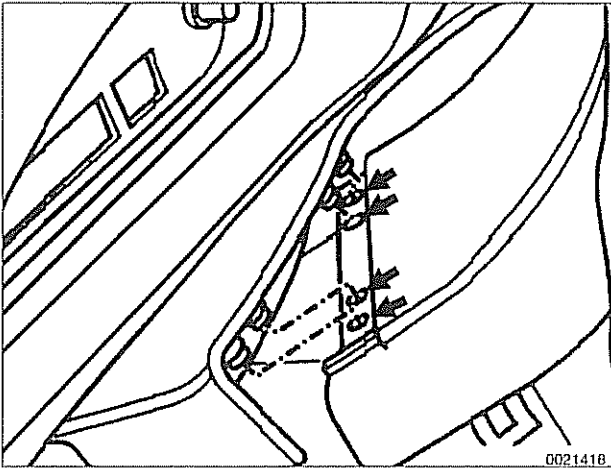
- Remove A-pillar (windshield pillar) trim on left and right sides by prying out HPS cover (**arrow**).
  - Remove screws beneath covers.
- Remove passenger side airbag. See **721 Airbag System (SRS)**.



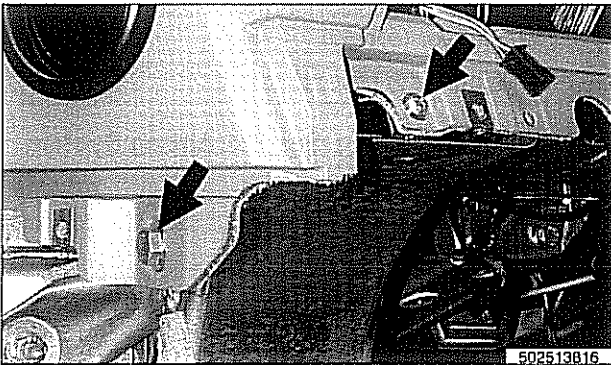
- Remove right side upper dash fasteners (**arrows**).



- Disconnect Bowden cable (**arrow**) from temperature control ventilation arm.



- Remove steering column trim panel by releasing clips (arrows).



- Remove left side mounting fasteners (arrows).
  - Lift dash panel upwards and remove through passenger door.
- Installation is the reverse of removal.

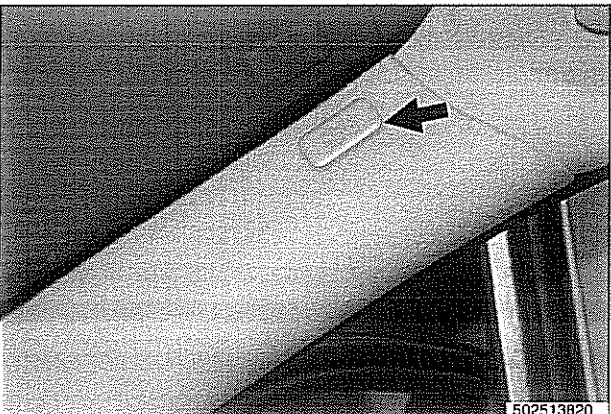
## Window and door post trim panels, removing and installing

### Windshield post trim (A pillar), removing and installing

- On 1998 and later cars, disconnect battery negative (-) cable.

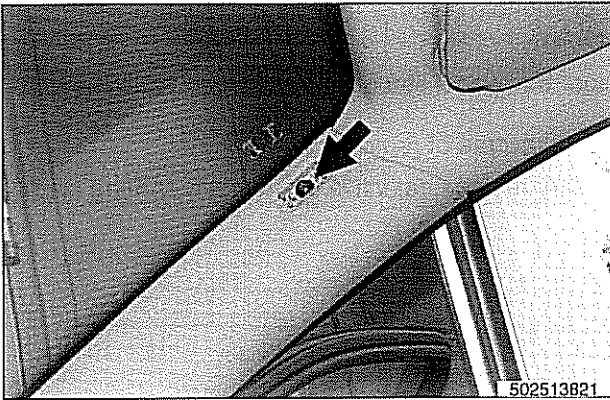
#### **WARNING—**

On 1998 and later models, front Head Protection System (HPS) airbags are installed in the driver and passenger side windshield post trim (A-pillar). See 721 Airbag System (SRS) for warnings and cautions regarding airbags.



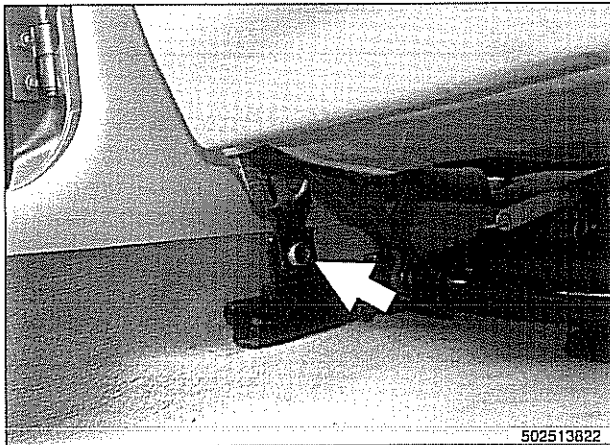
- Remove A-pillar trim panel fastener cap (arrow).



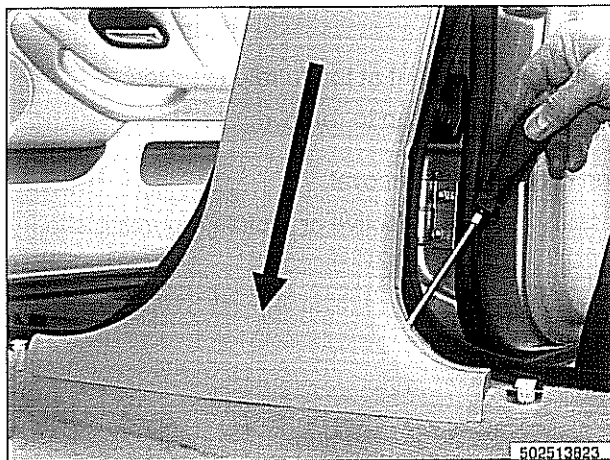


- Remove fastener (**arrow**) beneath trim cap.
  - Working from top carefully pull trim panel away from A-pillar and pull up to remove.
- Installation is reverse of removal.
  - If necessary replace defective or broken mounting clips.

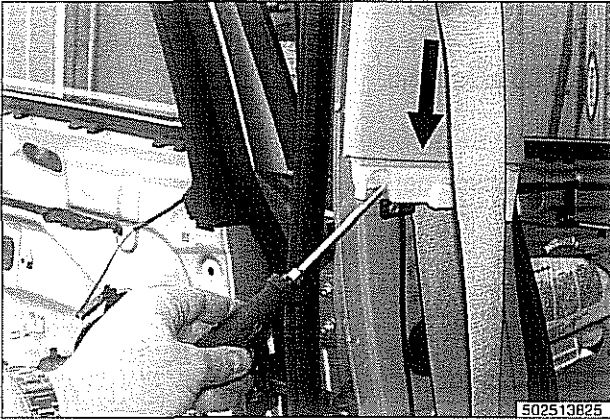
#### Door post trim panel (B-pillar), removing and installing



- Remove seat belt fastener (**arrow**) from seat frame.
- Remove front and rear door sill trim panels.
- Pull front and rear rubber door seal away from trim panel.



- Carefully pull bottom of lower trim panel away from door post to release clips.
  - Pull trim lower panel straight down (**arrow**) to remove.

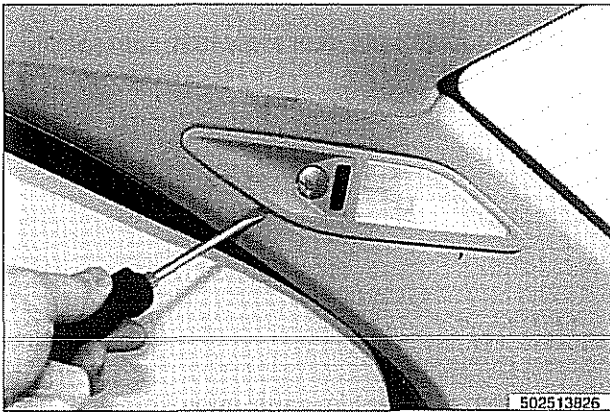


- ⚠ Carefully pry bottom of upper trim panel away from door post to release clips.
  - Pull upper trim panel straight down (**arrow**) to remove.
- Installation is reverse of removal.
  - If necessary replace defective or broken mounting clips.

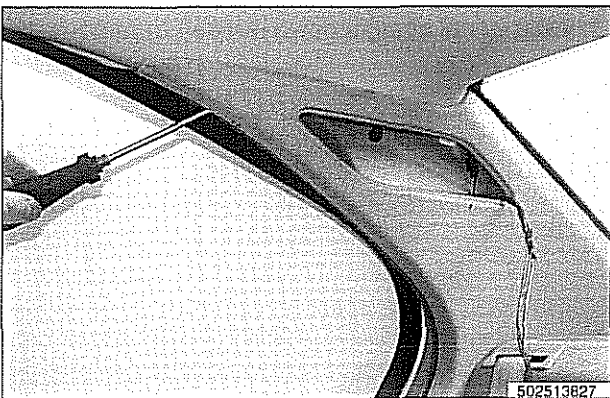
#### Rear window pillar trim (C-pillar), removing and installing (models without rear HPS airbags)

##### **WARNING —**

*On 1998 and later models, rear Head Protection System (HPS) airbags may be installed (optional equipment) in the driver and passenger side C-pillar area. The procedure given below does not cover models with rear HPS airbags. See 721 Airbag System (SRS).*

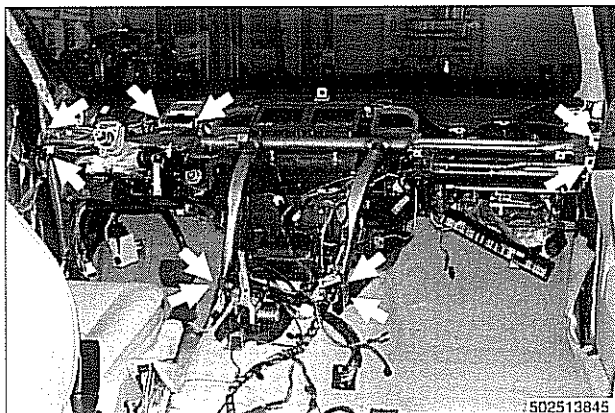


- ⚠ Carefully pry interior light out of C-pillar trim panel and disconnect wiring harness.



- ⚠ Carefully pry trim panel out at top to release clips.
  - Pull trim panel straight up to remove.
- Installation is reverse of removal.
  - If necessary replace defective or broken mounting clips.

## Dash panel support, removing and installing



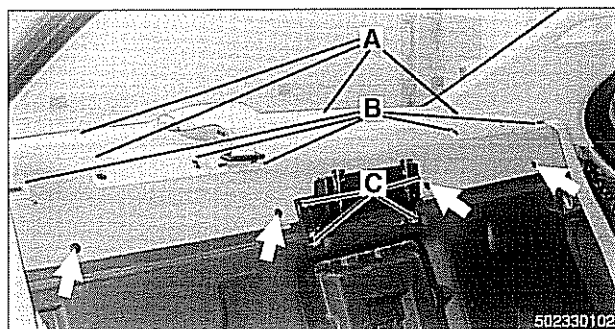
- Remove lower dash panel. See **Lower dash panel assembly, removing and installing**.
- Remove upper dash panel. See **Upper dash assembly, removing and installing**.
- Remove upper steering column fasteners. See **320 Steering and Wheel Alignment**.
- Remove dash support fasteners (**arrows**).
  - Remove wire ties as necessary and remove support.
- Installation is reverse of removal.

## Rear parcel shelf, removing and installing (models without rear HPS airbags)

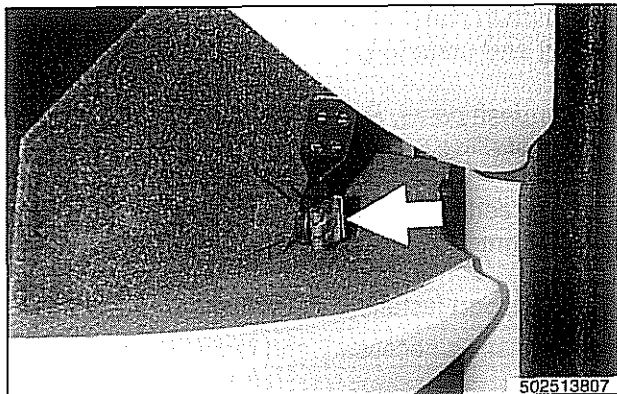
### **WARNING —**

*On 1998 and later models, rear Head Protection System (HPS) airbags may be installed (optional equipment). The procedure given below does not cover models with rear HPS airbags. See 721 Airbag System (SRS).*

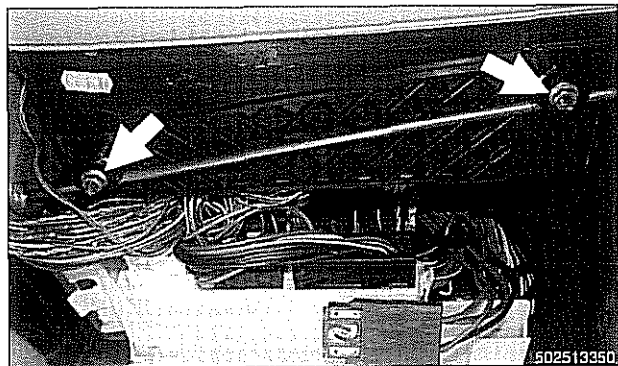
- Remove C-pillar trim panels. See **Rear window pillar trim panel (C-pillar), removing and installing**.
- Remove rear seat backrest. See **520 Seats**.
- Rear parcel shelf removing:
  - Remove center headrest fasteners.
  - Remove seatbelt floor mounting fasteners.
  - Carefully pry out safety belt trim panels and feed seatbelt through slots.
  - Remove expansion rivets and slide panel forward to remove.
- Remove expansion rivets (**arrows**).
  - Remove vent panels (**A**).
  - Remove speaker panels (**B**).
  - Remove center head rest support fasteners (**C**).
  - Slide parcel shelf forward to remove.
- Installation is reverse of removal.



## Glove compartment, removing and installing



- Open glove compartment and remove left and right side mounting clips (**arrow**) and support straps.
  - Close glove compartment.
  - Remove right side lower dash panel.



- Working under right side of dash, remove glove compartment hinge fasteners (**arrows**).
  - While supporting glove compartment, release latch to remove.
  - Installation is reverse of removal.



# 515 Central Locking and Anti-Theft

<b>General</b> .....	515-2	<b>Trunk Lock Assembly</b> .....	515-19
<b>Central Locking</b> .....	515-2	Trunk lock, removing and installing .....	515-19
General Module .....	515-2	Trunk lock striker plate, removing and installing .....	515-20
Central locking inputs and outputs .....	515-3	Tailgate lock, emergency release .....	515-21
Door locks .....	515-5	<b>Electronic Immobilization (EWS)</b> ...	515-21
Trunk lock .....	515-7	EWS variations .....	515-22
Remote entry (FZV) .....	515-7	EWS control module, replacing .....	515-23
Remote entry (FZV) inputs and outputs ...	515-8	Transmitter / receiver module .....	515-23
Car Memory / Key Memory .....	515-12	Ring antenna .....	515-23
Trunk lid soft close (SCA) .....	515-13	<b>Anti-theft System (DWA)</b> .....	515-24
SCA subsystem .....	515-14	DWA LED Status .....	515-24
Tailgate and rear window locks .....	515-14	Tilt sensor .....	515-24
Sport Wagon tailgate and rear window lock schematic .....	515-15	Interior protection .....	515-25
<b>Door Handles and Locks</b> .....	515-16	Glass breakage sensors .....	515-26
Door handle (outer), removing and installing .....	515-16	Emergency disarming .....	515-26
Door latch, removing and installing .....	515-17		
Outer door lock cylinder, removing and installing .....	515-18		

## GENERAL

This section covers repair information for door, trunk and cargo compartment locks, central locking, electronic immobilization (EWS) and anti-theft alarm (DWA).

E39 cars are equipped with sophisticated self-diagnostic electrical systems. When experiencing malfunctions relating to central locking, EWS or anti-theft systems, start the diagnosis process using the BMW service tester DIS, GT 1, MoDiC or equivalent scan tool. An advanced diagnostic scan tool can usually pinpoint electrical faults quickly and safely.

Additional electrical information can be found in:

- **610 Electrical Component Locations**
- **ELE Electrical Wiring Diagrams**

## CENTRAL LOCKING

Central locking in E39 vehicles controls the door locks, trunk or tailgate lock and fuel filler flap lock. The control module for the Central Body Electronics system (ZKE III), known as the General Module (GM III), controls central locking.

ZKE III manages the following central locking related functions:

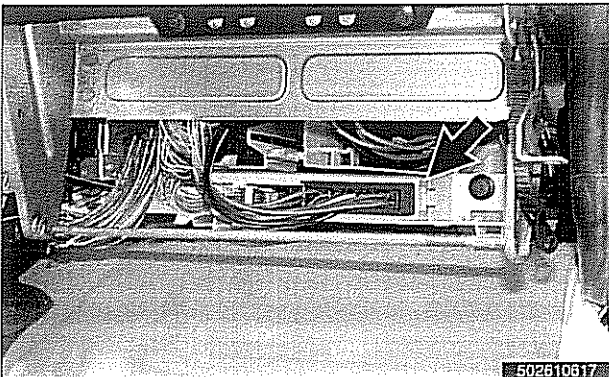
- Central locking
- Keyless entry
- Key memory
- Power trunk release
- Electric opening of tailgate
- DWA alarm system
- Diagnosis

### General Module

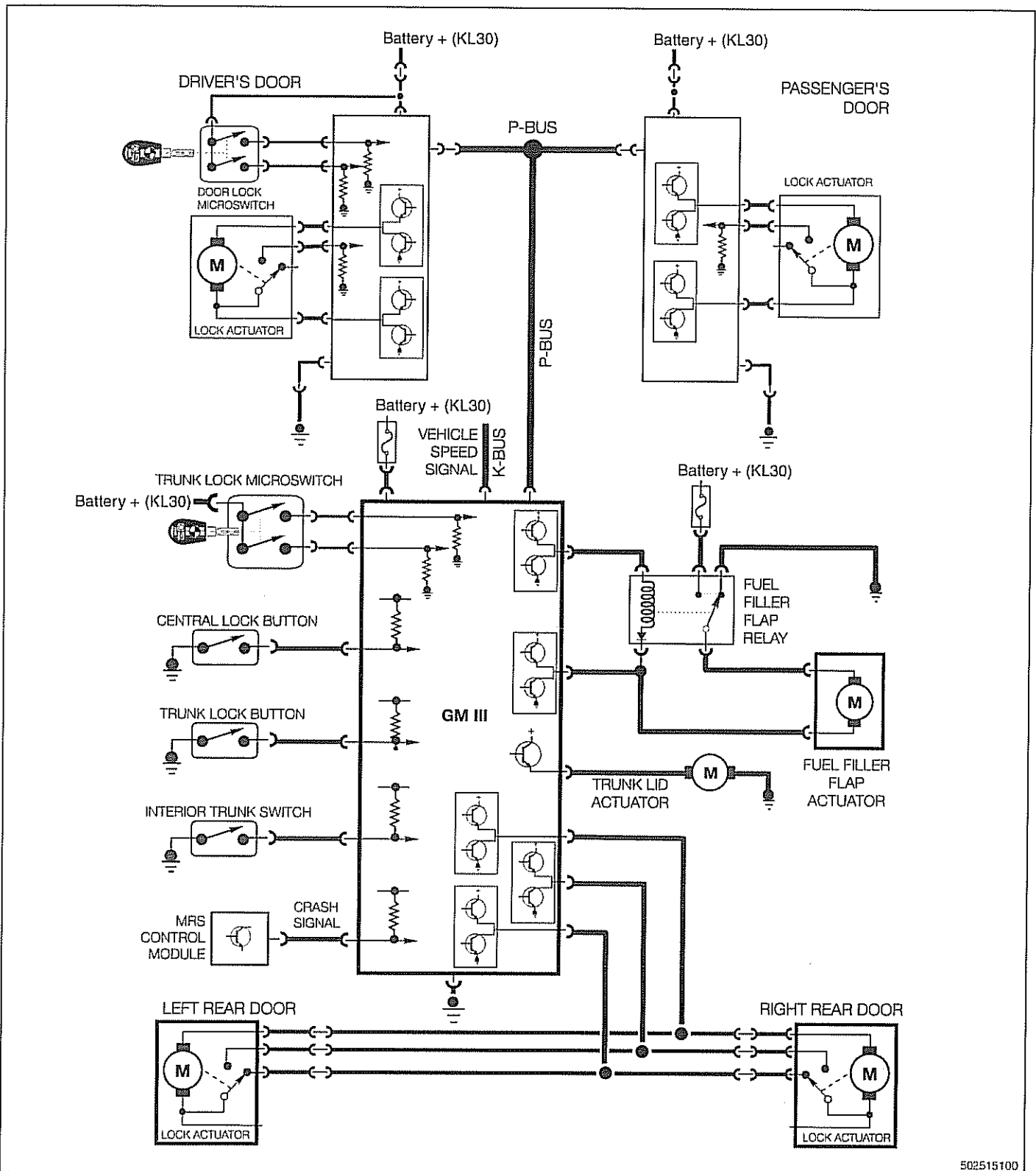
➤ The General Module (GM) (arrow) is responsible for the operation of central body electronics. The GM is located behind the glove compartment.

Based on input information, the GM uses internal transistors to switch current flow (providing voltage or ground) through circuits and actuators. Actuators are the final controlling devices used by GM to operate or control various output functions such as relays and motors.

The accompanying schematic, **Central locking inputs and outputs**, illustrates the GM central locking system.



### Central locking inputs and outputs



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### Driver's door lock

The lock/unlock signals are sent as input to the door module from two microswitches on the lock cylinder. The driver's door module carries out the locking / unlocking functions of the driver's door through its final stage control.

The signal to lock the remaining doors, trunk or tailgate and fuel flap is sent over the P-Bus to the GM and the passenger door module. Activation of the passenger's door lock is carried out by the passenger door module. The rear doors, trunk or tailgate and fuel flap are locked by the final stage in the GM.

When locked from the outside, all doors are set to the double lock position and the GM will not carry out any unlock commands from the central lock button or remote trunk release button.

### Selective unlocking

When unlocking with the key or the remote transmitter, the first unlock request will only unlock the driver's door. A second unlock request will unlock the remaining doors, trunk or tailgate and fuel flap.

### Trunk locking

The vehicle can be locked/unlocked from the trunk lock cylinder. The GM locks the trunk or tailgate, rear doors and fuel filler. The locking command is passed over the P-Bus to the respective door modules to lock the driver's and passenger's doors.

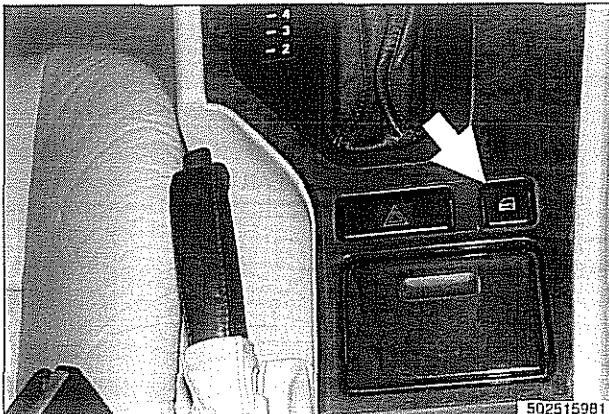
Locking the trunk and removing the key in the horizontal position will set the valet lock and prevent opening of the trunk with the central locking system.

### Central locking switch



The central locking master control switch (arrow) is located in the center console behind the shifter.

- The central locking button will only single lock the doors and trunk. The filler flap remains unlocked for refueling purposes.
- If a door is opened from inside while centrally locked, the remaining doors remain locked.
- The open door can be relocked, when closed, by manually locking or pressing the central locking button twice. This synchronizes the door locks.





### DWA alarm

The DWA alarm system is armed / disarmed when the vehicle is locked / unlocked from either the door or trunk.

### Convenience closing / opening

The windows and sun roof can be closed or opened by holding the key in the lock / unlock position.

### Crash sensor

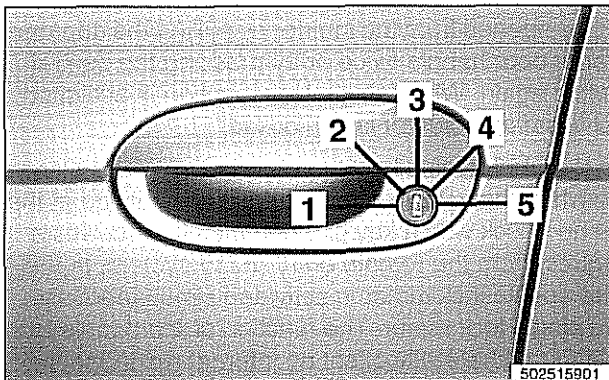
The crash sensor is located in the left front kick panel. It functions by unlocking all doors in the event of an accident.

### NOTE—

*Continuous and repeated locking / unlocking may cause timed arrest of the locking system. When activated, the timed arrest lasts for two minutes. The timed arrest does not affect the crash sensor unlocking the doors in case of an accident.*

### Door locks

The driver's door lock location is the only point outside of the vehicle where the key can mechanically control all of the central locking system functions.



Door key positions for electrical / manual locking and unlocking are:

1. Manual unlock
2. Unlock, DWA disarmed, convenience open (hold until activated)
3. Neutral position
4. Lock, DWA armed, convenience closing (hold until activated)
5. Manual lock

The door lock actuators are sealed, self contained units with no replaceable parts. The actuators use Hall effect sensors in place of pin contacts and microswitches to provide DOOR OPEN / DOOR CLOSED status signal. Each door lock button only affects the actuator it controls. There is no effect on the other doors.

An automatic locking feature activates door locks when a road speed signal of 4 mph is detected via the K-Bus. The factory default coding for this feature is OFF, but can be coded ON for individual users with the Key Memory function. See **Car Memory / Key Memory** later in this section.

Each rear door is equipped with the child lock-out lever, preventing the door from being opened from the inside regardless of lock button position.

Starting with models produced after 9/1997, the General Module and electronic immobilizer (EWS) interface via the K-Bus to monitor double lock status and to initiate double lock override. This feature allows the doors to be opened from the inside if a key accepted by EWS is switched on in the ignition. See **Single lock and double lock function**.

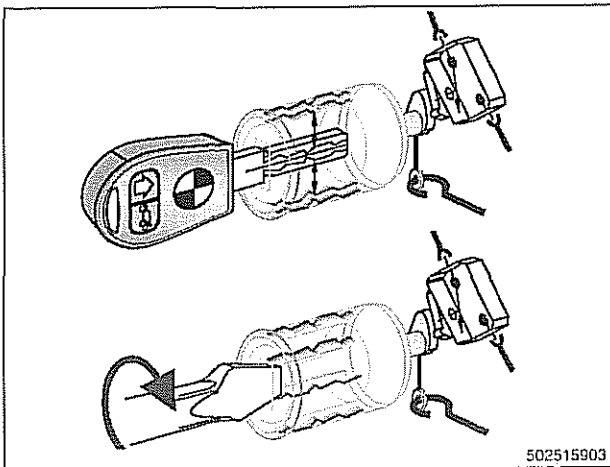
The door lock buttons are mechanically uncoupled from the actuators when locked. The remote keyless entry system (FZV) is standard equipment. This allows for elimination of the passengers side door lock cylinder.

Another function of the locking system is the soft close trunk (SCA) system, where applicable.

### Single lock and double lock function (2000 and later models)

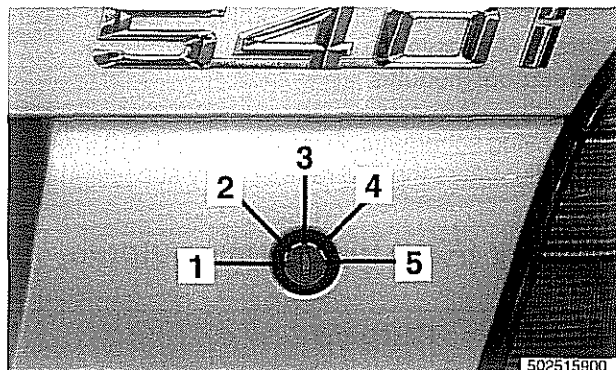
On models produced after 9/1999, each door lock actuator incorporates two motors:

- Single lock motor controls the mechanical lock mechanism when the central lock switch is pressed to single lock the vehicle. The lock mechanism is fully locked at this point but can still be opened from the interior by pulling the appropriate interior door handle twice or by pressing the central lock switch again. When single lock function is activated, the fuel filler flap actuator is not locked.
- *Double lock motor, also known as central arrest, is activated only when the vehicle is locked from the outside at the driver's door lock with a key or when the GM receives a lock request from the remote entry (FZV) system. In this case the double lock motor is activated simultaneously with the single lock motor. The function of the double lock motor is to mechanically offset an internal rod in the lock actuator, disabling it from unlocking the vehicle from the interior. This prevents the doors from being unlocked by any means except from an unlock request at the driver's door or via the FZV remote key.*



### Lock cylinder safety

- ◀ The driver's door lock and the trunk lock incorporate an over-running lock cylinder similar to the ignition lock. If any key other than the vehicle key, or a tool such as a screwdriver or dent-puller, is inserted into the cylinder, it will cause the cylinder to freewheel or spin.



## Trunk lock

Trunk key positions for electrical /manual locking and unlocking are:

1. Manual unlock
2. Unlock, DWA disarmed, convenience open (hold until activated)
3. Neutral position
4. Lock, DWA armed, Convenience closing (hold until activated)
5. Valet lock position

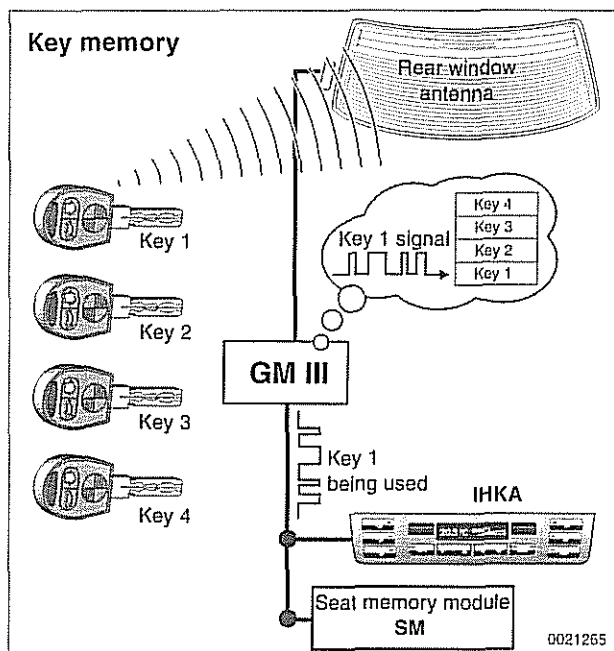
The remote trunk button (arrow) is located in the left kick panel.

- The trunk can be opened from this remote release when the doors are locked from the central locking button. The trunk remote button is disabled when the trunk is locked in the valet position or when a speed signal of 4 mph is present at the GM.

## Remote entry (FZV)

The E39 remote (keyless) entry system (FZV) uses a tiny radio transmitter in the vehicle key to lock and unlock the doors and the trunk by remote control. There are a number of other features incorporated in FZV:

- Locking/unlocking of fuel filler lid
- Selective unlocking of driver's door (as with key in lock)
- Arming/disarming of DWA alarm system
- Remote unlocking of trunk lid or tailgate
- Comfort opening of windows and sunroof
- Interior lighting activation
- Panic mode alarm activation
- Models to 1999: Key incorporates LED. LED informs operator that an FZV signal is being transmitted. LED is also useful indicator of key initialization status and key self-test.
- Keys delivered with four different colored labels. This is helpful to differentiate FZV keys during initialization, preventing possibility of misassigning key ID which would change coded Key Memory functions.

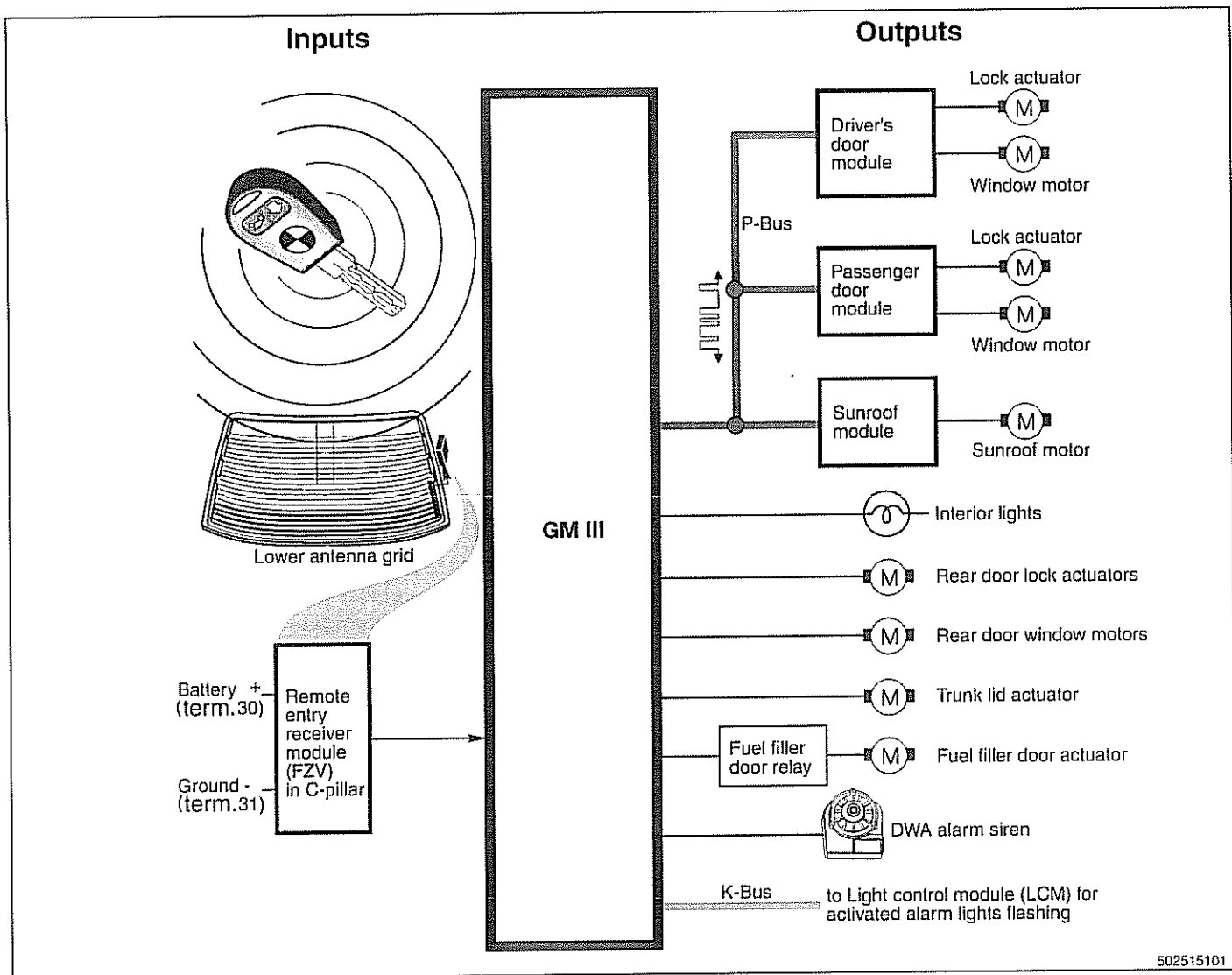


Central Locking and Anti-Theft

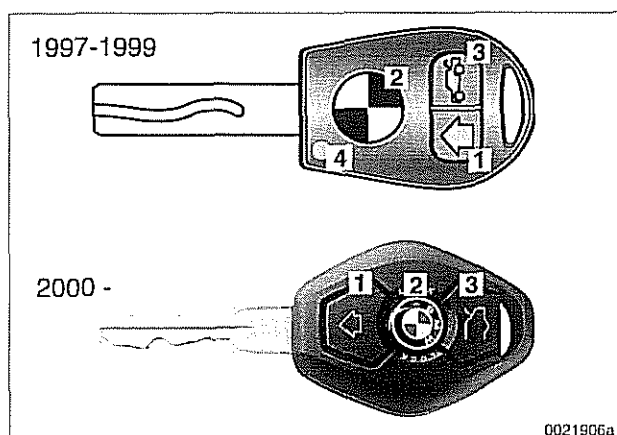
The General Module (GM) is connected to the FZV receiver module (in left rear roof pillar) via K-Bus. Locking and unlocking of doors, trunk or tailgate and convenience closing is carried out by the GM subsystem controlling the door lock, window and sunroof modules.

The accompanying schematic, **Remote entry (FZV) inputs and outputs**, illustrates the GM remote entry subsystem.

Remote entry (FZV) inputs and outputs



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### FZV keys

#### ◀ FZV key button functions:

##### Button 1 press once:

- Unlock driver's door
- DWA disarmed
- Interior lights on

##### Button 1 press twice:

- Total unlocking

##### Button 1 hold:

- Convenience opening

##### Button 2 press once:

- Lock
- DWA armed
- Interior lights ON when vehicle is locked

##### Button 2 press twice within 10 seconds:

- Deactivate interior and tilt monitoring

##### Button 3 press momentarily:

- Trunk lid opens

##### Button 3 press and hold:

- Panic mode (alarm)

LED (4) provides feedback of system operation and battery condition. LED is eliminated from 2000 and later keys.

##### LED flashes indicate the following:

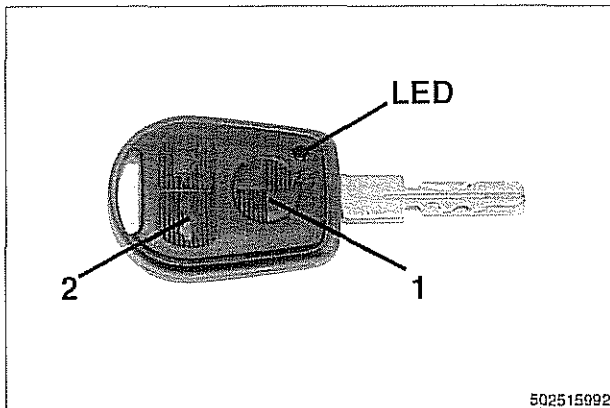
- One flash indicates that FZV lock / unlock signal was sent and batteries are OK.
- Quick flashing LED indicates that convenience opening signal is being sent.
- Slow flashing LED indicates that initialization procedure was successful.
- A steady-on LED [after a self test as described in **Transmitter self-test (models to 1999)**] indicates that hardware/software of transmitter are OK.
- No LED activity could indicate discharged batteries or defective transmitter.

**NOTE—**

- A single unlock request from the driver's door with the FZV key unlocks the driver's door only. A second unlock request unlocks the remaining doors and trunk. This feature can be modified for individual users with the Key Memory capabilities to activate all lock actuators simultaneously. See **Car Memory / Key Memory** later in this section.
- Starting with 2000 models, the battery in the FZV ignition key is recharged by the ignition switch ring antenna while the key is in the ignition switch.

**Transmitter self-test (models to 1999)**

- Press buttons **1** and **2** at the same time. This starts key transmitter self-test. Transmitter is OK when **LED** glows steadily for one second. If LED fails to illuminate, try replacing key batteries.



The state of charge of key transmitter batteries is monitored by the GM. Once the voltage level of the transmitter drops below 4.5 volts, the LED no longer signals transmitter operation. Convenience opening, initialization and self-testing are no longer possible. The GM will store a fault indicating low battery level for that particular key and illuminate an instrument cluster message.

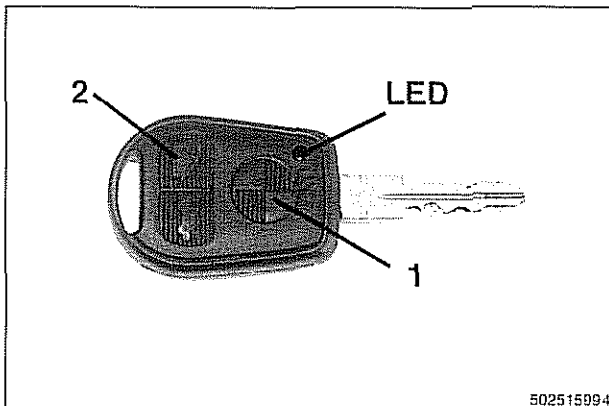
**NOTE—**

- If batteries are replaced within one minute of removal, it is not necessary to perform initialization.
- The state of charge of key batteries has no effect on electronic immobilizer (EWS) function.

**Remote key initialization****NOTE—**

In the accompanying illustration, the key is from a 1998 model. 2000 and later models are equipped with a different looking key, but the button functions are the same.

- Up to four keys can be coded to operate the same system. Initialize all key transmitters at the same time.



- ◀ The initialization procedure is as follows:
- Close all doors and have all keys available.
  - Using key number 1, turn ignition switch to KL R (ACCESSORY), then switch off within 5 seconds and remove first key.
  - Within 30 seconds of turning ignition switch to OFF, press and hold button 2.
  - While holding button 2, press and release (tap) button 1 three times within 10 seconds. Models to 1999: LED flashes momentarily.
  - Release both buttons. GM immediately locks and unlocks doors to signal successful initialization.
  - Initialize remaining keys, repeating steps above.
- If acknowledgement signal (doors lock / unlocking) does not follow initialization procedure, repeat process. If ignition is switched on during process, procedure is cancelled.

#### NOTE —

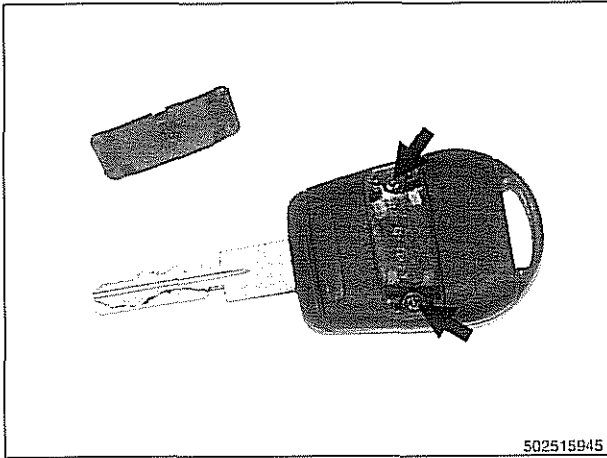
*The Key Memory function of the GM responds to the key identification number of each key. If the keys are not initialized in the same order prior to initialization, the key memory functions activated by the keys will not be assigned correctly. Always initialize the keys in the same order.*

#### Remote system coding

The E39 remote entry system uses coded signals for security purposes. The code signal sent by the transmitter is changed every time the vehicle is locked/unlocked with the transmitter. A separate code signal is used for each transmitter that is initialized to the system. This allows for each transmitter to operate independently of the others.

Due to the changing of the code each time the buttons are depressed, the system allows for a lack of synchronization between the transmitter and receiver. This would occur if the buttons on the transmitter are pressed inadvertently.

Up to 100 erroneous actuations of the transmitter are automatically corrected for by the control module. If more than 100 actuations are present, the operator need only to press the button a second time to restore system operation.



### Key battery

- ◀ 1997 — 1999 models: Two lithium batteries are used to supply power to key transmitter. When replacement is necessary, remove cover and two fasteners (**arrows**) from rear of key to access batteries.

#### NOTE —

*If you replace the batteries within one minute, the FZV key will not require a new initialization procedure.*

2000 and later models: FZV key battery is recharged by ring antenna while key is in ignition switch. There is no need to replace key battery.

## Car Memory / Key Memory

A number of features and functions can be customized to the driver(s) preference. The identity of the vehicle user is provided by a signal from the keyless entry system (FZV).

Car Memory and Key Memory are actually two separate functions, although they are marketed as a combined feature.

### Car Memory

Prior to new vehicle delivery, the BMW scan tool (DISplus, GT1 or MoDIC) is used to code the driver preferences into the appropriate control modules. Thereafter these choices cannot be changed without recoding with a BMW scan tool.

The functions that can be set using Car Memory include:

- Alarm system (DWA) features such as arming/disarming with keyless entry (FZV), activation of tilt sensor or interior sensor
- Interior light activation when central locking is used
- Convenience opening of windows/sunroof
- Interior and external lighting preferences
- Heating / A/C preferences (IHKA)
- Seat and mirror preferences (triggered by Key Memory)
- Instrument cluster display units (for example: km vs. miles)



### Key Memory

Whenever one of the FZV keys is used to lock or unlock the car, the user is identified by the GM. A maximum of four keys can be programmed with the Key Memory feature. The use of the personalized key then triggers Car Memory functions such as heating / A/C (IHKA) settings or memory seat position adjustment.

Most programming of Key Memory requires the use of BMW scan tools (DISplus, GT1 or MoDiC). However, features such as IHKA blower speed and temperature store automatically without the use of scan tools.

Available Key Memory functions vary based on vehicle equipment. The functions that can be set include:

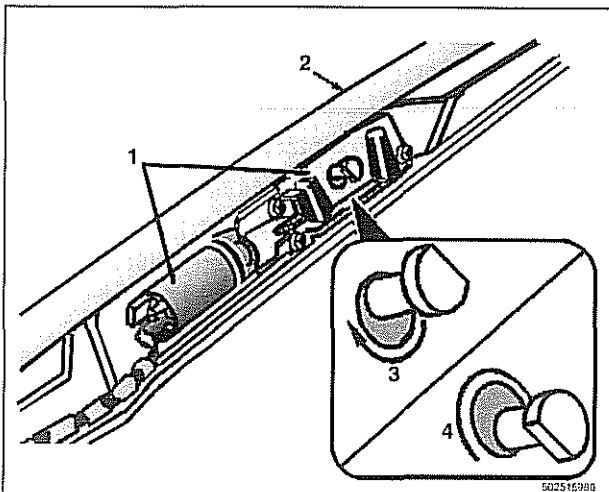
- Automatic locking after start off (vehicle speed)
- Selective locking
- Heating / A/C blower speed, heated or cooled air distribution, automatic blower setting

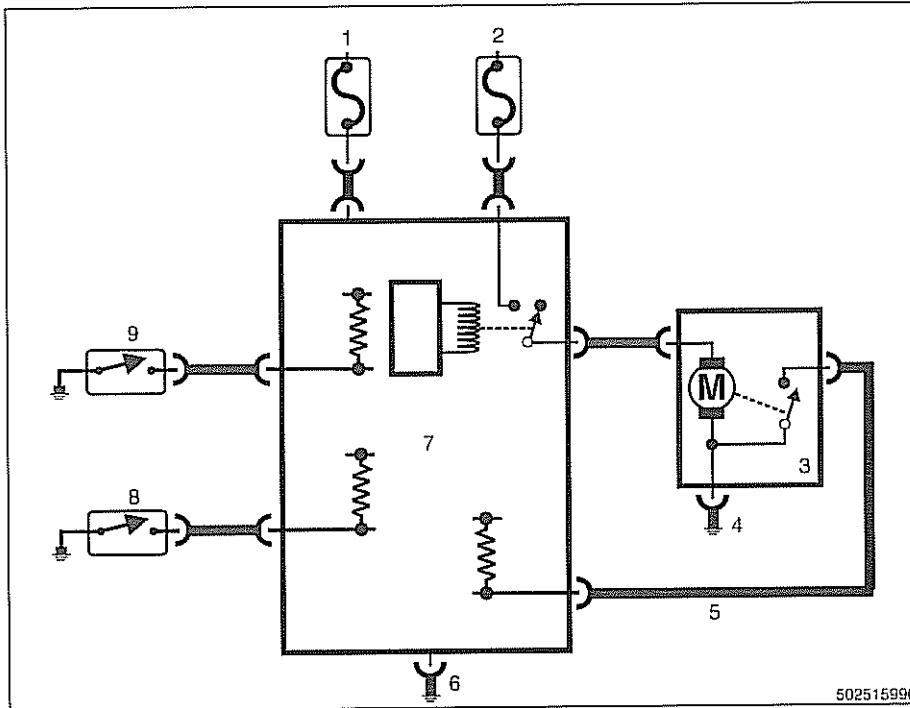
### Trunk lid soft close (SCA)

◀ The optional soft close trunk feature is called SCA. The SCA actuator is located in the panel below the trunk lid.

1. SCA motor and actuator located behind trunk trim in rear wall of trunk
2. Lower edge of trunk seal
3. Cam in open position
4. Cam in closed position

The actuator is controlled by a load relay in the General Module (GM). The closing cam is mounted on an eccentric that is driven by the actuator. The cam always turns 180° in the same direction to open or close the trunk.





### SCA subsystem

1. Battery power (term. 30)
2. Battery power (term. 30)
3. SCA actuator
4. Ground (term. 31)
5. Feedback OPEN
6. Ground (term. 31)
7. General Module (GM)
8. Trunk contact switch
9. Trunk opening switch

### SCA operation

Three microswitches are used to operate trunk latching system.

- Microswitch mounted on lock cylinder. Pushing lock cylinder in will signal GM to activate actuator and open trunk.
- Microswitch in actuator signals GM when trunk has released. Actuator shuts off.
- When closing trunk, third microswitch (on trunk latch) signals GM to activate actuator. Cam turns to pull lid closed.

For overload protection, ON duration of actuator is limited to a max. 5 seconds.

Emergency opening of trunk is provided by a mechanical link from the lock cylinder. If the trunk has been opened by the emergency release, it can be reclosed as a conventional lid with normal pressure.

### Tailgate and rear window locks

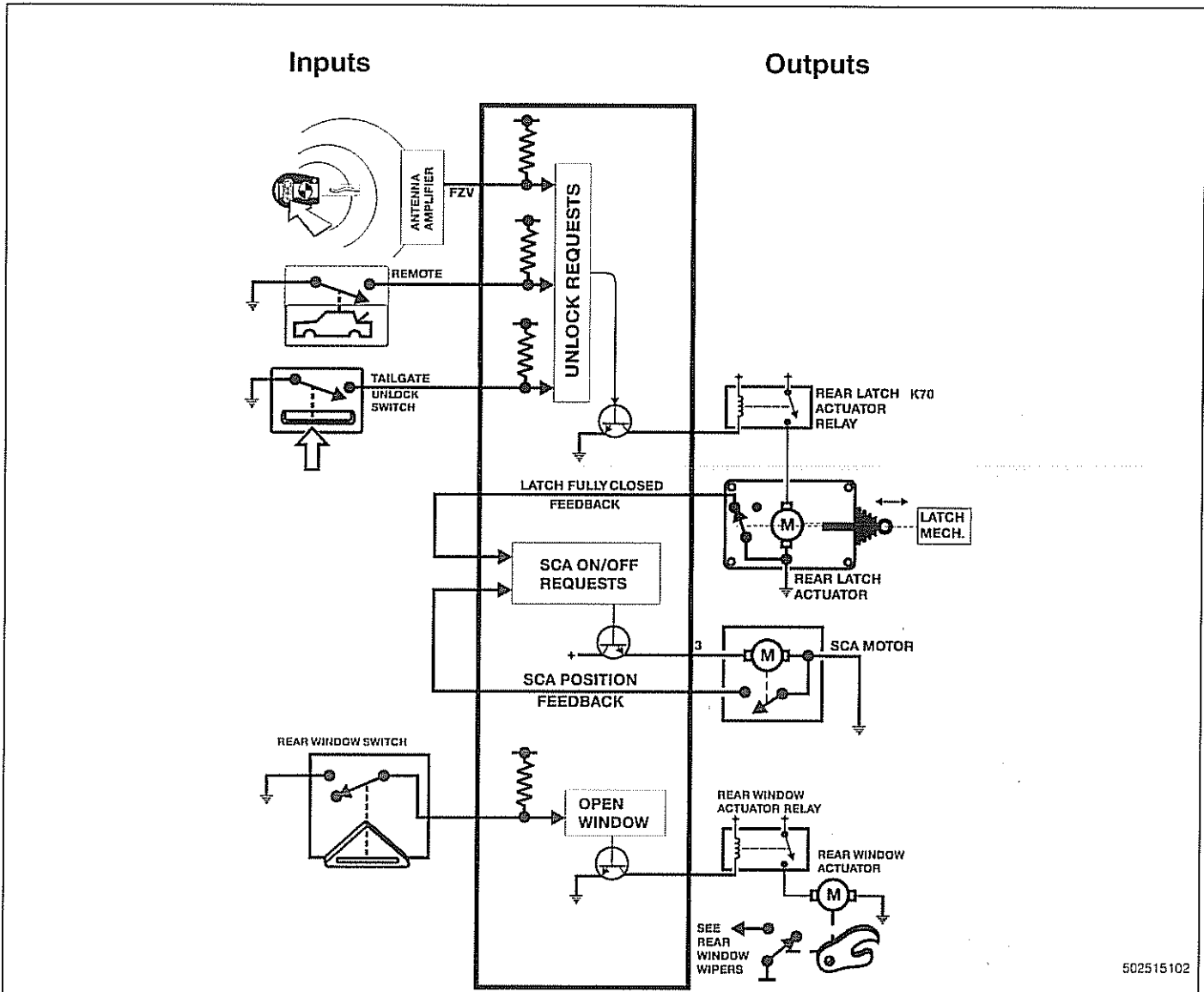
The Sport Wagon tailgate can be opened from:

- Remote key (FZV)
- Interior tailgate release button at driver's kick panel
- Unlock microswitch above rear license plate

Any of these input requests to the GM activates the tailgate latch motor. The GM will also switch on the interior lights with a tailgate unlock request.

The rear window is opened with the release switch on the rear wiper arm cover. Pressing the switch signals the GM to activate the rear window release relay.

### Sport Wagon tailgate and rear window lock schematic



## DOOR HANDLES AND LOCKS

In the procedures that follow, door handle removal, door lock cylinder removal and door latch removal are covered for the left front door. Other doors are similar although simpler, due to the lack of lock cylinder.

Inside door release removal is covered in the procedure for inner door panel removal. See **411 Doors**.

### Door handle (outer), removing and installing

#### NOTE—

If BMW special tools 51 3 201 and 51 3 203 are available, the door handle can be removed without removing the door trim panel or door airbag. Use the access hole behind the rubber sealing plug on the door edge.

- Close window on front door.
- Disconnect battery negative (–) cable.

#### CAUTION—

Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Warnings and Cautions**.

- Remove front door trim panel. See **411 Doors**.
- Remove door-mounted air bag. See **721 Airbag System (SRS)**.
- Remove rubber sealing plug (arrow) from door edge.

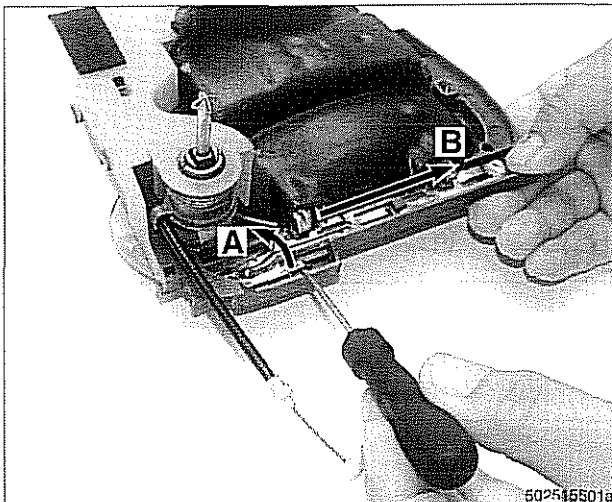
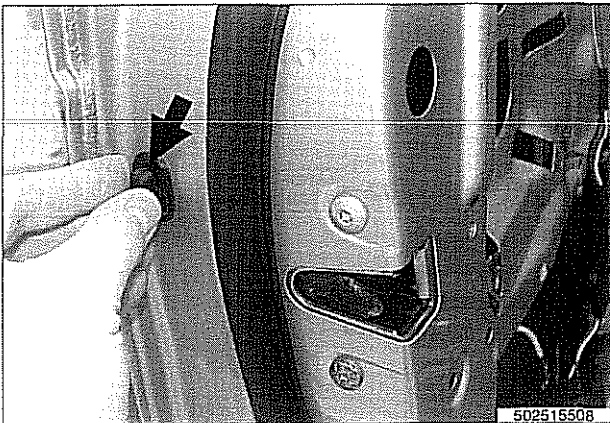
#### NOTE—

In the photo below, door handle and lock cylinder carrier are shown on the work bench for clarity.

- Working inside door cavity:
  - Use long thin screwdriver to release locking tab **A**. Push screwdriver through hole for rubber sealing plug.
  - Slide locking plate **B** toward front of door.
- Working on outside of door, lift out lower edge of handle and pull down to remove.
- Installation is reverse of removal.

#### Tightening torques

Airbag to door (replace screws)	8.5 Nm (75 in-lb)
---------------------------------	-------------------



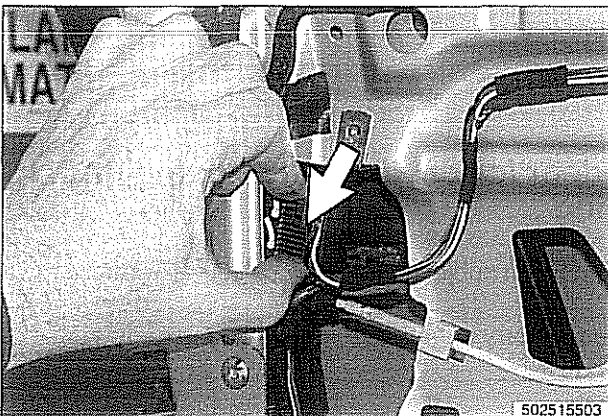
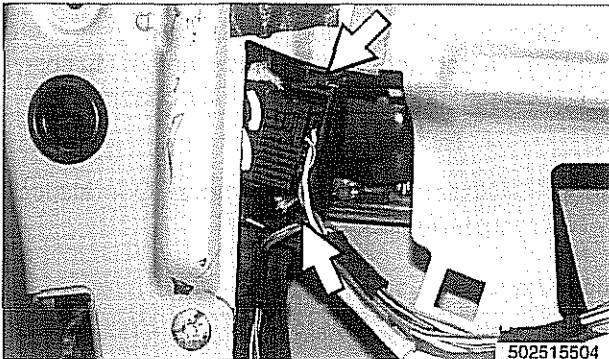
## Door latch, removing and installing

- Close window on subject door and open all other windows.
- Disconnect battery negative (-) cable.

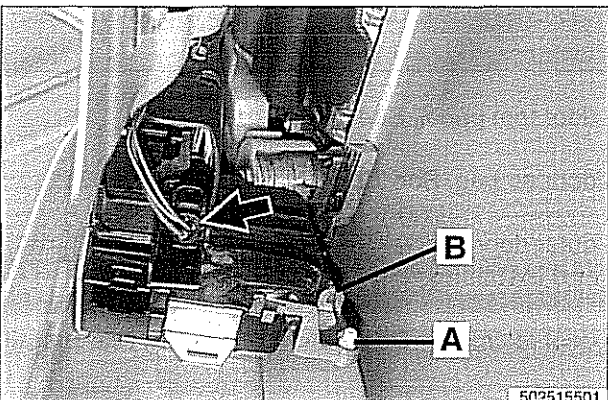
### CAUTION—

Prior to disconnecting the battery, read the battery disconnection cautions given in 001 General Warnings and Cautions.

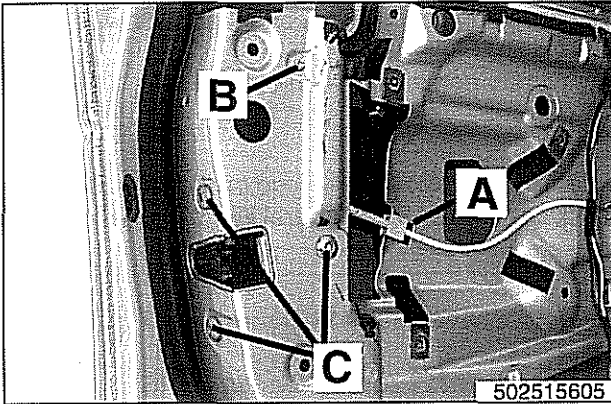
- Remove door trim panel. See 411 Doors.
- Remove air bag. See 721 Airbag System (SRS).
- Remove outer door handle. See **Door handle (outer), removing and installing**.
- Working inside door cavity, release locking tabs (arrows) and open protective cover.



- Pull down on electrical harness connector (arrow) to release.



- Working inside door cavity, next to outside door skin:
  - Disconnect door lock cylinder Bowden cable from latch assembly arm (A) and support (B).
  - Disconnect microswitch connector (arrow).

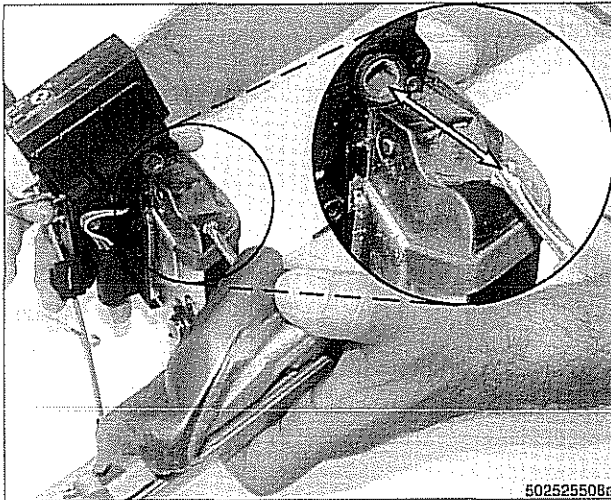


Working at outer door edge:

- Disconnect inside door release Bowden cable guide by sliding mounting clip (A) forward.
- Remove latch mounting fasteners (B) and (C) and remove latch.

**NOTE—**

*In the photo below, door handle assembly and latch assembly are shown removed from the car for clarity.*



Installation: Slide latch into position in door making sure that cross-shaped tip of door lock cylinder mechanism fits correctly into corresponding opening in latch mechanism (inset).

- Remainder of installation is reverse of removal. Operate lock using key before installing door trim panel.

**Tightening torques**

Airbag to door (replace screws)	8.5 Nm (75 in-lb)
---------------------------------	-------------------

## Outer door lock cylinder, removing and installing

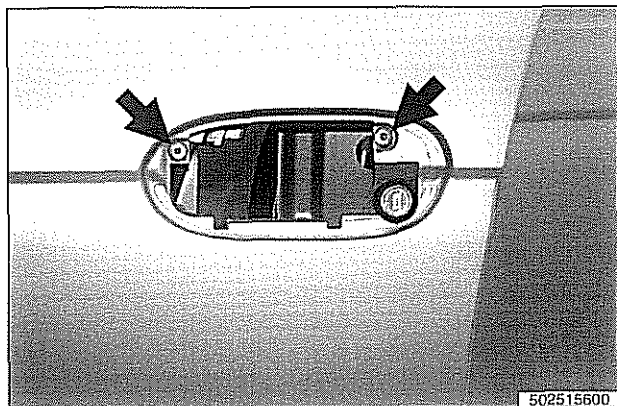
- Close window on subject door. Open all other windows.
- Disconnect battery negative (–) cable.

**CAUTION—**

*Prior to disconnecting the battery, read the battery disconnection cautions given in 001 General Warnings and Cautions.*

- Remove door trim panel. See 411 Doors.
- Remove door air bag. See 721 Airbag System (SRS).
- Remove outer door handle. See Door handle (outer), removing and installing.
- Remove door latch. See Door latch, removing and installing.

## Central Locking and Anti-Theft



➤ Remove lock cylinder carrier mounting screws (arrows).

- Working inside door cavity, turn cylinder carrier assembly counterclockwise and carefully pull down to remove.
- Installation: Place lock cylinder carrier in position in door. Install and tighten mounting screws.
- Remainder of installation is reverse of removal.

### Tightening torques

Airbag to door (replace screws)

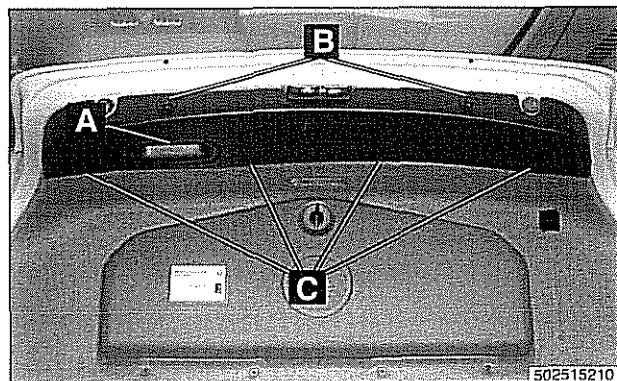
8.5 Nm (75 in-lb)

## TRUNK LOCK ASSEMBLY

### Trunk lock, removing and installing

➤ Remove plastic trim panel:

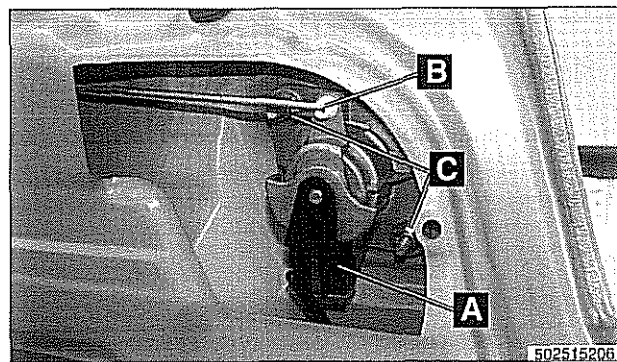
- Remove screw cap and screw (A).
- Remove expansion rivets (B).
- Gently pry out mount clips (C).



➤ To remove trunk lock:

- Disconnect electrical harness (A).
- Snap actuator rod out of mounting clip (B).
- Remove fasteners (C) and remove lock assembly.

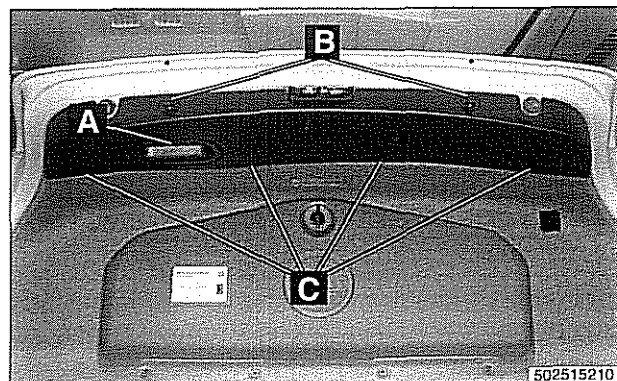
- Installation is reverse of removal.



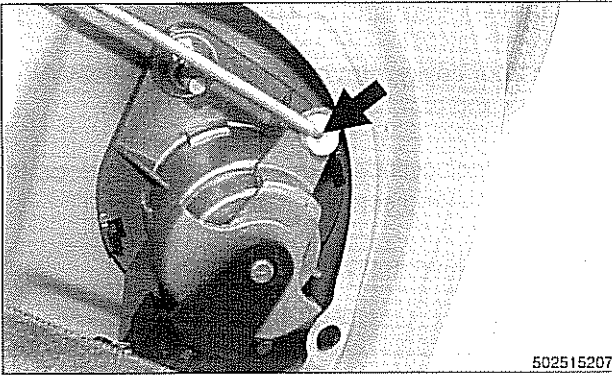
### Trunk latch, removing and installing

➤ Remove plastic trim panel:

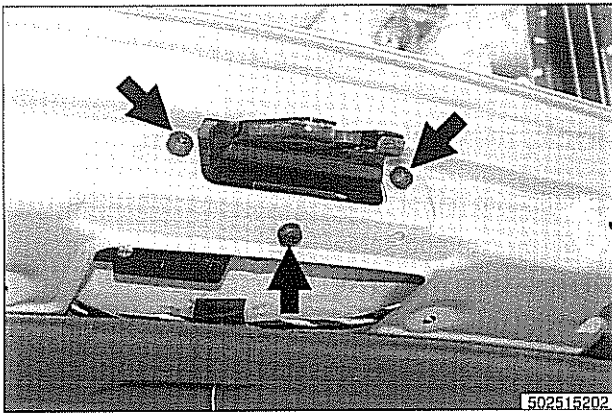
- Remove screw cap and screw (A).
- Remove expansion rivets (B).
- Gently pry out mount clips (C).



Central Locking and Anti-Theft



↖ Disconnect actuator rod (**arrow**) from trunk lock assembly.

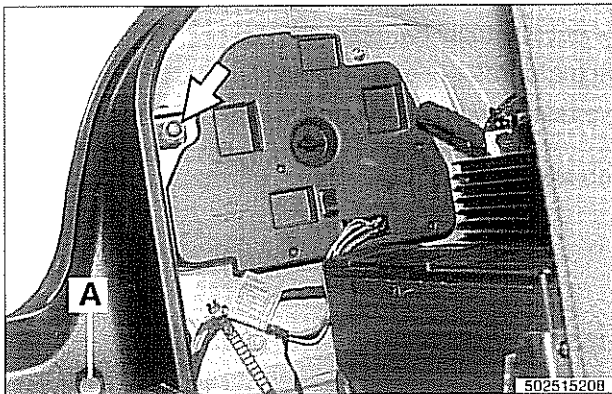


↖ Remove trunk latch fasteners (**arrows**).

— Remove latch and disconnect wiring harness.

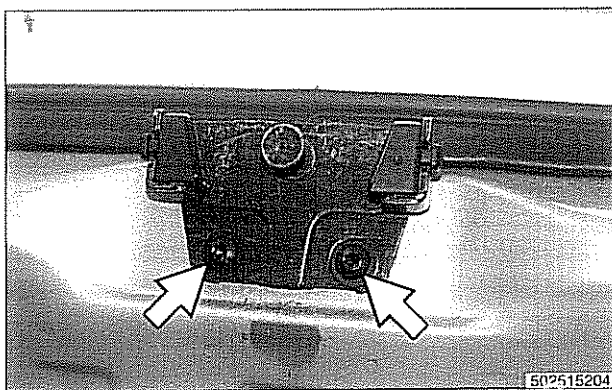
— Installation is reverse of removal.

**Trunk lock striker plate, removing and installing**



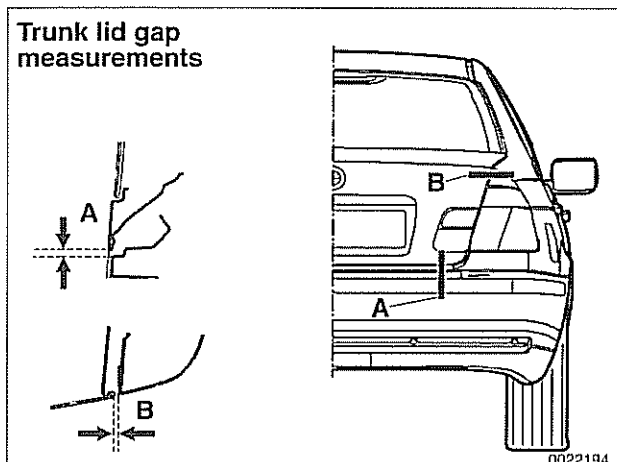
↖ Remove left and right trim panel fasteners (**arrow**).

— Remove (4) trim panel expansion rivets (**A**) and remove trim panel.



↖ Remove striker plate mounting fasteners (**arrows**).

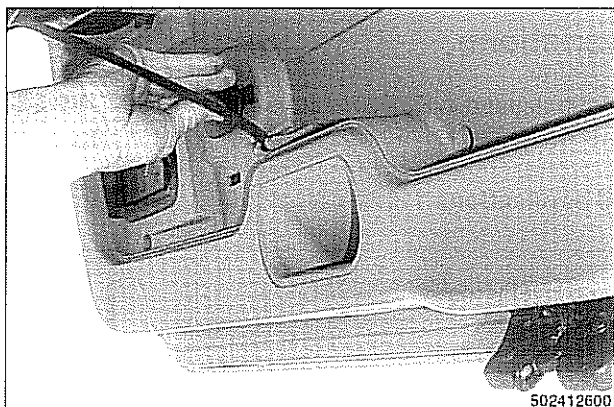




- ◀ When installing, or adjusting trunk lid alignment, adjust position of trunk lock striker with mounting bolts finger tight.
- Check trunk lid lock operation with lid open.
  - Adjust trunk lid alignment. See 412 Trunk Lid, Tailgate for lid adjustment specifications.

**NOTE—**

*Do not lubricate lock or lock striker with grease.*

**Tailgate lock, emergency release**

- ◀ In case of electrical failure, there is an emergency tailgate lock release. The release is located in the tailgate behind the tool door.
- With tool door open, remove access cover and pull to the right to release tailgate.

**ELECTRONIC IMMOBILIZATION (EWS)**

E39 cars are equipped with a passive theft-prevention system. The Electronic Immobilization System (EWS) makes it impossible to start the engine using any means other than the special keys furnished with the vehicle.

**NOTE—**

*Replacement EWS control modules or DME control modules must be electronically aligned to each before the vehicle will start. This requires the use of the BMW Service Tester (DIS-plus, GT1, or MoDiC). Without alignment, the engine will not crank (for example: swapping a known good DME control module into another vehicle for test purposes will result in a no crank situation).*

In the EWS system, the ignition key is embedded with a computer chip (EEPROM) and coded. The key communicates with the vehicle using a transponder in the key and a ring antenna surrounding the steering lock cylinder. Up to 6 replacement keys are permissible. Only an authorized BMW dealer can provide replacement keys.

## Central Locking and Anti-Theft

- If the starter engages, the following EWS inputs are functioning normally:
  - Ignition key
  - Code function
  - Transmission range switch or clutch position switch
  - Engine speed sensor

### NOTE —

- If a vehicle key is lost or stolen, the electronic authorization for that key can be cancelled using the BMW scan and diagnostic tools DISplus, GT1 or MoDiC.
- Force applied to a key can damage the electronic circuitry in the key. A damaged key will not start the engine. In that case, a new key should be purchased and initialized by an authorized BMW dealer.

## EWS variations

EWS variations used in E39 cars are shown in **E39 EWS applications** table below.

### E39 EWS applications

System designation	E39 production dates	Main components, changes, improvements
EWS II	SOP - 3/1997	Key with EEPROM transponder Ring antenna (surrounds ignition switch) Transmitter / receiver module located in right side steering column cover Control module located behind glove compartment, in electrical component panel
EWS III (3.2)	3 /1997 - 9/1997	Transmitter / receiver module eliminated EWS III (3.2) control module incorporates transmitter / receiver module functions Control module located to left of steering column, under dashboard K-Bus input Clutch Hall-effect switch (replaces transmission range switch input)
EWS III (3.3)	9/1997 - 2002	EWS III (3.3) control module with ISN code burned in (cannot be overwritten during alignment) Control module located to left of steering column, under dashboard Transmission range selection input from automatic transmission control module

## EWS control module, replacing

### NOTE—

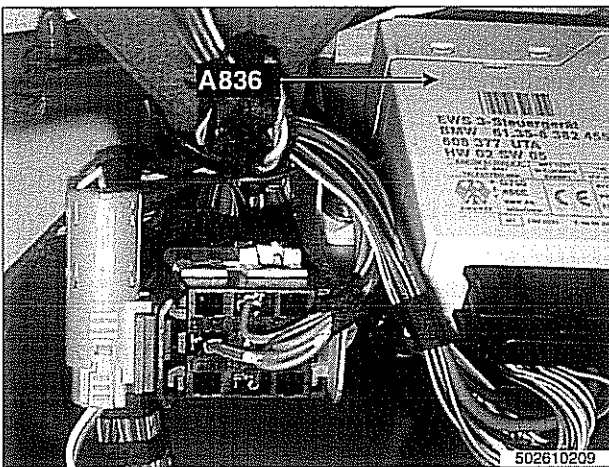
EWS control module location varies depending on version of EWS installed. Check the table **E39 EWS applications**.

- Disconnect battery negative (–) cable.

### CAUTION—

Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Warnings and Cautions**.

- EWS II: Control module is accessible from behind glove compartment.
  - Remove trim below glove compartment.
  - Lower relay and module holder to access EWS control module.
- ◀ EWS III: Control module (A836) is located to left of steering column, below dash.
  - Remove trim below steering column.
  - Unplug module and remove from holder.
- Installation is reverse of removal.

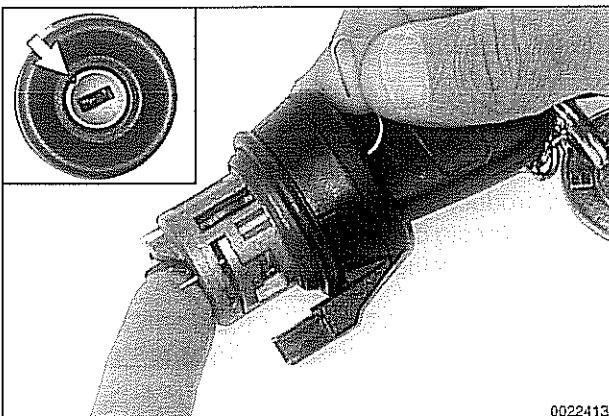


## Transmitter / receiver module

Only EWS II vehicles are equipped with a separate transmitter / receiver module attached to the steering column trim on the right side of the column.

## Ring antenna

- Remove ring antenna using BMW special tool 61 3 300.
  - Remove upper and lower steering column trim.
  - Disconnect harness connector to ring antenna.
  - Pry off ring antenna using BMW special tool 61 3 300 or equivalent flattened prying tool.
- ◀ Alternatively, remove ignition switch key cylinder:
  - With ignition key in ON position (60° from LOCKED), insert thin piece of stiff wire into opening (arrow) in lock cylinder and pull lock cylinder out.
  - Detach ring antenna harness connector.
  - Gently work ring antenna off key cylinder.



## ANTI-THEFT SYSTEM (DWA)

When the anti-theft system (DWA) is armed, the doors, hood, windows, trunk lid or tailgate are monitored against forcible entry by switches and sensors. The vehicle is protected against being jacked up or towed away by a tilt sensor.

The control electronics for DWA are integrated in the General Module (GM). In addition to the control electronics, the system includes the following components.

- DWA horn
- DWA LED indicator
- Tilt sensor
- Monitoring switches and sensors

The system can be armed or disarmed from the driver's door lock, trunk lid lock, tailgate lock or the remote transmitter (FZV key). When armed, the alarm horn sounds for 30 seconds and the low beam headlights and turn signals flash for 5 minutes. The electronic immobilizer (EWS) is also activated when DWA is activated.

The alarm is switched off immediately if key is inserted in door lock or FZV key button is used.

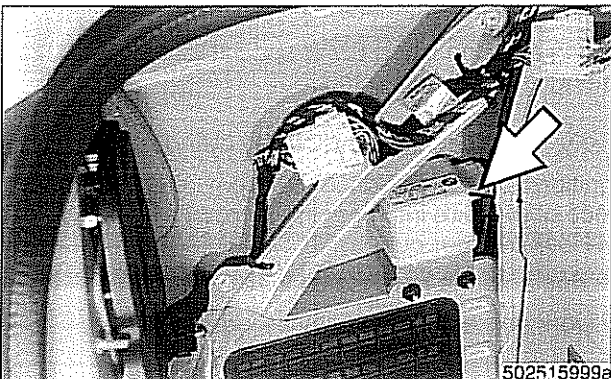
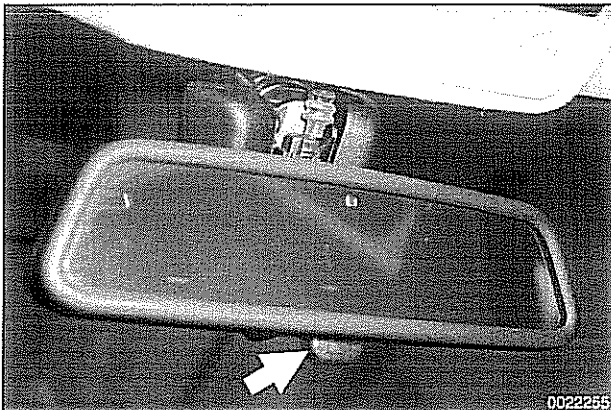
### DWA LED Status

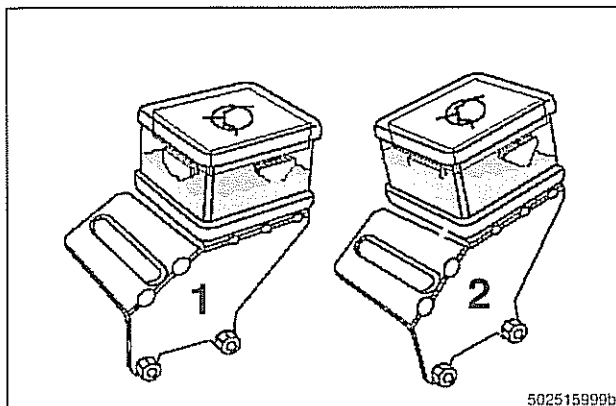
- ◀ The DWA status LED is located in the rear view mirror (**arrow**). When DWA is armed, the LED flashes slowly to indicate armed status.

The LED and exterior lights flash once and the alarm horn sounds when the system is successfully armed or disarmed. The LED will continue to flash slowly denoting the armed status. If any monitored input is not closed when the system is armed, the LED will flash rapidly for 10 seconds to indicate the fault.

### Tilt sensor

- ◀ The tilt sensor, located on the left side of trunk or cargo compartment, consists of a conductive liquid chamber, a processor board and metal probes. The probes are submerged in the liquid and produce a resistance value dependent on the tilt of the sensor (angle of the vehicle). This resistance becomes the reference value when the DWA system is armed.





#### ▲ Tilt sensor operation:

1. DWA armed, vehicle level. Tilt sensor sends HIGH signal to General Module (GM).
2. DWA armed, vehicle tilted. The fluid moves in sensor, changing resistance value. HIGH signal changes to LOW signal. GM activates alarm.

If the vehicle is jacked up or lifted in any way, the angle of the liquid changes, producing a change in the resistance value. The sensor signals the GM to activate the DWA alarm. The sensor resets at the new angle. This allows the DWA system to remain armed and to reactivate the alarm if the vehicle is moved again.

Locking the vehicle twice within a few seconds will deactivate the tilt alarm sensor while arming the remainder of the system. This allows the vehicle to be transported in an armed state without activating the alarm.

### Interior protection

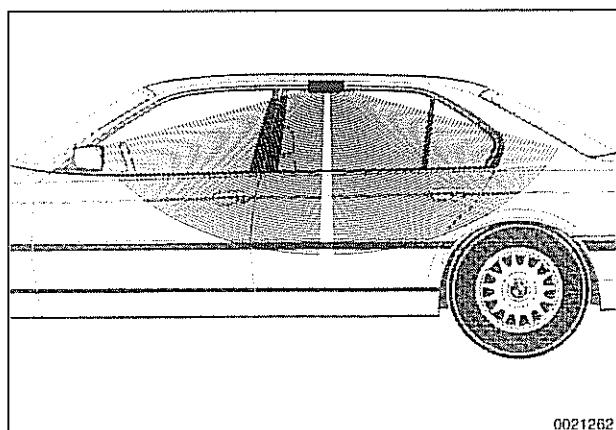
The interior motion sensor is mounted in the center of the headliner panel. Due to the design of the vehicle interior, the sensor must be installed in the correct direction to ensure proper operation of the system.

#### Interior sensor FIS (1997 – 1999 models)

- ▲ When the alarm system is armed, the FIS sensor emits electromagnetic waves at a frequency of 2.45 GHz. As long as nothing is moving in the vehicle, the waves are reflected back to the sensor at the same frequency. If a foreign object enters the vehicle, the frequency of the reflected signal changes. The sensor detects the changed frequency and triggers the alarm.

Every time the DWA system is armed, the sensor adapts to whatever objects might be stationary in the interior. This allows packages or objects to be left inside the car without affecting the operation of the system. The sensitivity of the sensor is set so that the moving object must be at least as large as a bumble bee. This prevents a false alarm from occurring if a small insect is caught in the vehicle.

FIS is switched off when the vehicle is locked two times within ten seconds. The DWA LED will flash one time for confirmation. This allows the sensor to be switched off to avoid false alarms when the windows are left open for venting.



### Interior sensor UIS (2000 and later models)

The UIS system uses ultrasonic sound waves instead of electromagnetic waves. Ultrasonic sound waves are less susceptible to magnetic interference.

Every time the DWA system is armed, the sensor adapts to whatever objects might be stationary in the interior. The sensor emits ultrasonic waves in a programmed timed cycle. It receives echoes of the emitted waves. The UIS amplifies the received sound wave signals and compares them to the echoes of the transmitted waves. The UIS also checks the incoming echoes for background hiss (wind noise through a partially open window) and adapts for this.

- If the echoes are consistently similar, no movement is detected.
- If the echoes are altered, (inconsistent), the UIS determines motion in the interior compartment.
- If motion is detected, the UIS changes to a constant cycle and the echo is compared again.
- If the inconsistency is still present the UIS sends the activate siren signal to the GM.

### Glass breakage sensors

The door windows are monitored by inductive sensors mounted on the inside of the door behind the trim panel. A closed window is recognized by a magnetic plate on the glass lining up with the sensor. If the glass is broken, the plate falls away and the signal from the sensor changes. This causes the GM to activate the alarm.

### Emergency disarming

- An emergency procedure is provided to cancel the DWA in the event that a fault occurs within the system. The procedure is as follows:
  - Driver's door mechanically unlocked and open within 30 seconds. This will cause triggering of alarm.
  - All doors closed.
  - Ignition switch turned to KL R (ACCESSORY). LED indicator will come on.
- After 10 minutes, alarm is disarmed.



# 520 Seats

**General** .....520-2

Seat/Mirror/Steering Column Memory .....520-2

Seat memory position, setting .....520-2

**Front Seats** .....520-4Seat switch and memory module,  
removing and installing .....520-3

Front seat, removing and installing .....520-5

**Rear Seats** ..... 520-7Rear seat cushion and backrest,  
removing and installing (sedan only) ..... 520-7

Headrest, removing and installing. .... 520-8

## GENERAL

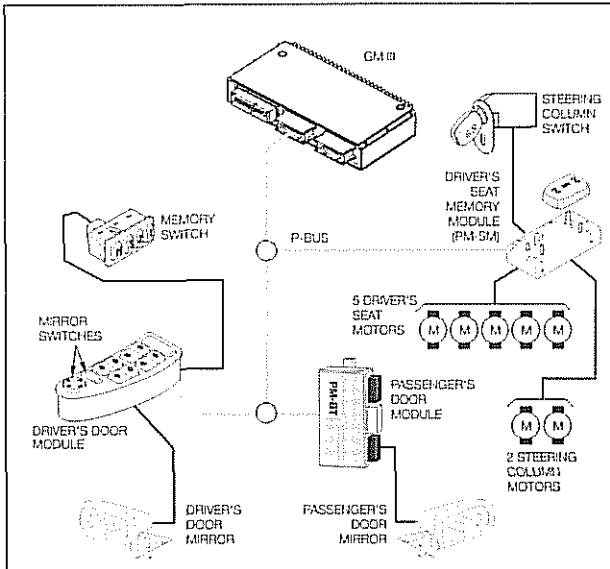
This repair group covers removal and installation of the front and rear seat.

### Seat/Mirror/Steering Column Memory

- ▶ The basic features of seat/mirror/steering column operation, including memory positions are integrated into the ZKE III system. Driver adjustment positions can be memorized and stored for three different users. The seat control module is integral with the seat and mirror switches. The seat control module stores seat memory position via the "ripple" counter module.

#### NOTE —

Passenger seat on sedan models uses a simple control circuit and do not include a memory module or on-board diagnostics.



### Seat memory position, setting

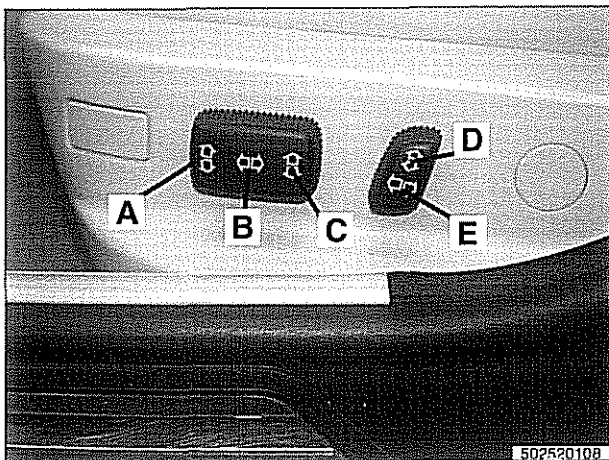
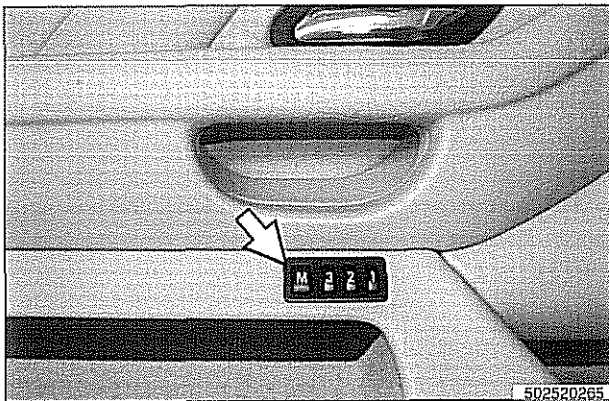
- ▶ With the transmission range selector in "P" and the mirror change over switched in the left position, switch the ignition on and press the "M" on the memory switch.
- Press one of the three position switches (1, 2 or 3) within the 7 second memory period (memory indicator lamp will illuminate for 7 seconds)
  - The current positions of the mirrors, seat and steering column will now be stored in memory.

#### NOTE —

Seat memory is held in an EEPROM in the seat module and is stored in memory before the ZKE goes into its sleep mode. If the battery is disconnected before the 16 minute sleep mode activation, seat memory positions are lost and reprogramming is required.

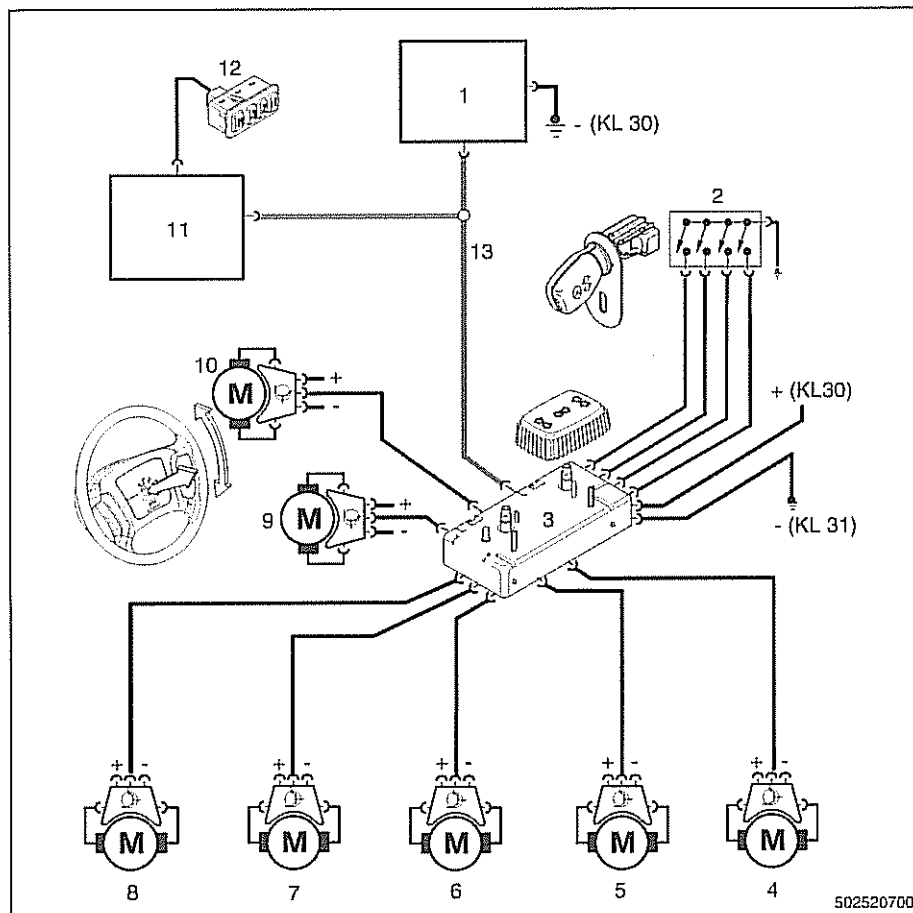
- ▶ Power seat controls.

- A — Seat tilt
- B — Longitudinal adjustment
- C — Cushion height
- D — Head restraint height
- E — Back rest angle





## ZKE seat/mirror/steering column memory operational diagram



1. General module III
2. Steering column adjustment switch
3. Seat memory module with adjustment switches
4. Headrest motor
5. Backrest motor
6. Seat base tilt angle motor
7. Seat base up — down motor
8. Seat forward — back motor
9. Steering column length motor
10. Steering column tilt motor
11. Driver's (left) door module
12. Memory switch
13. P-Bus

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## FRONT SEATS

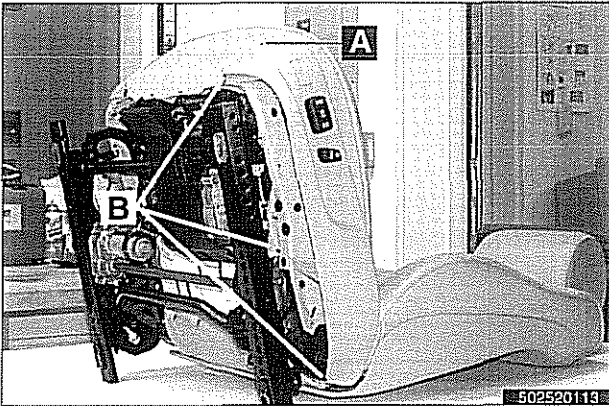
Seat repair and component replacement is possible once the seat has been removed from the vehicle.

Before servicing front seats read safety regulations on handling airbag modules and pyrotechnic seatbelt tensioners. See **720 Seat belts** and **721 Airbag system (SRS)**.

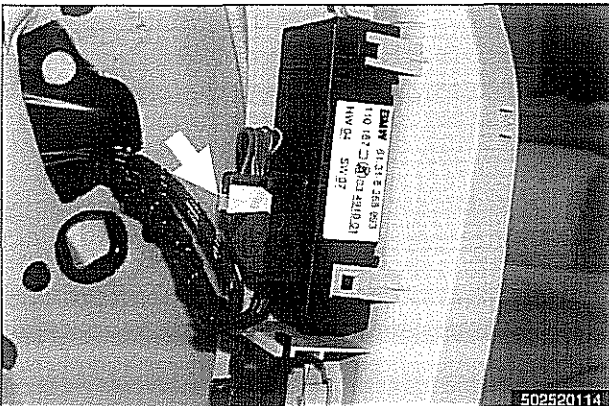
### WARNING—

- The front seats are equipped with pyrotechnic seat belt tensioners. These tensioners are powerful devices and should be handled with extreme care. Incorrect handling can trigger off the tensioner and cause injury.
- BMW recommends that all repair or replacement work on pyrotechnic devices must be carried out by a qualified BMW technician.
- Be sure to disconnect the battery and wait 5 seconds before attempting to work on pyrotechnic devices.
- During body straightening and welding with an electric arc welder, always disconnect the battery and the connection to the pyrotechnic gas generators.

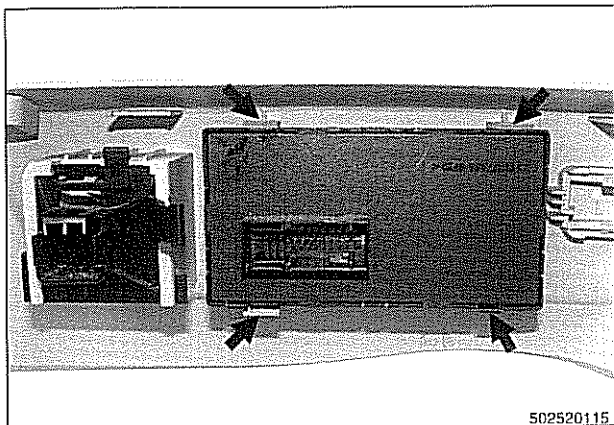
### Seat switch and memory module, removing and installing



- Remove front seat. See **Front seats, removing and installing**.
- Carefully pull seat adjusting knobs straight out to remove.
- Remove screw fastener (A) and trim clips (B), turn side panel downward to remove.



- Disconnect electrical harness connector (arrow).



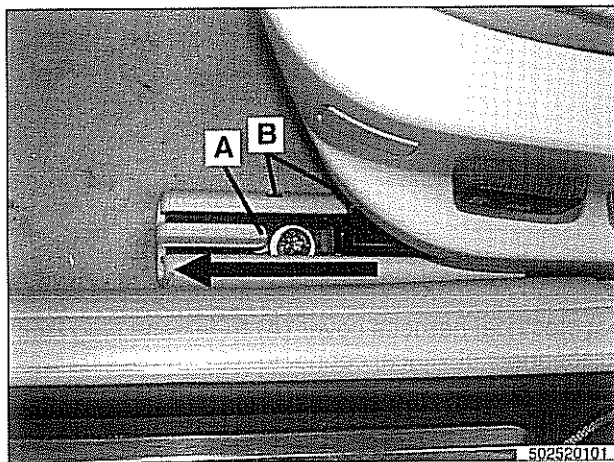
Release mounting tabs (**arrows**) and remove switch module.

### Front seat, removing and installing

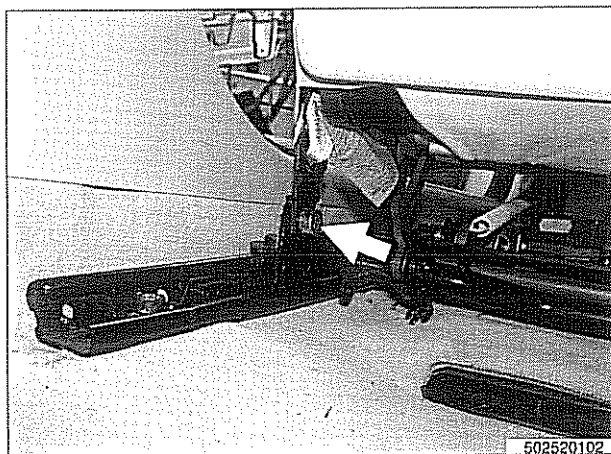
Turn ignition switch to OFF position.

Remove front and rear rail trim panels:

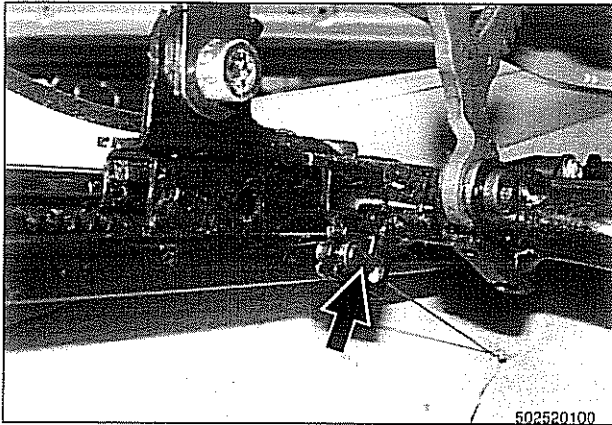
- Raise center of trim panel (**A**) to release locking pin.
- Unlock and lift out inner mounting clips tabs (**B**).
- Slide trim panel off rail (**arrow**) to remove.



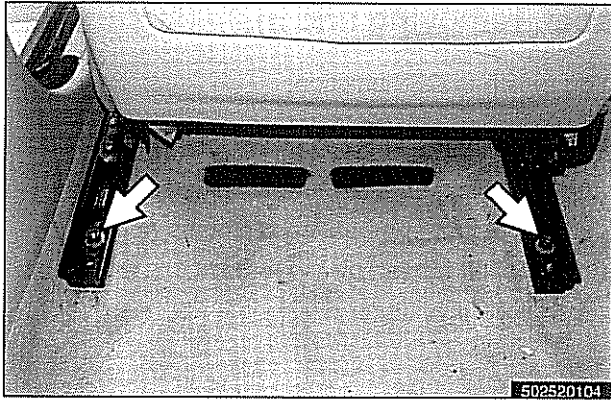
Remove seat belt mounting fastener (**arrow**) from seat frame.



Seats

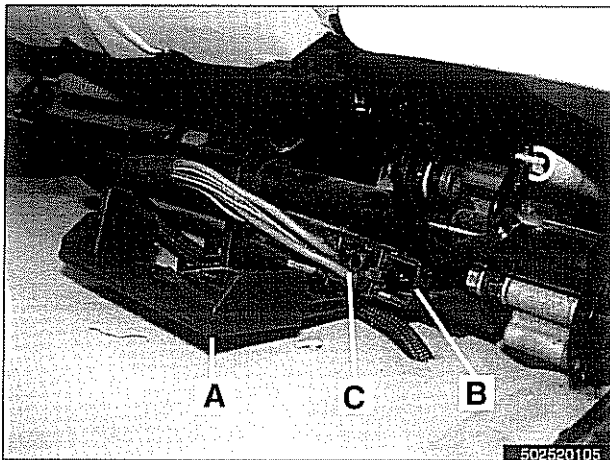


➤ Unlock seat belt cable pin (**arrow**) by turning locking tab upward and removing pin.

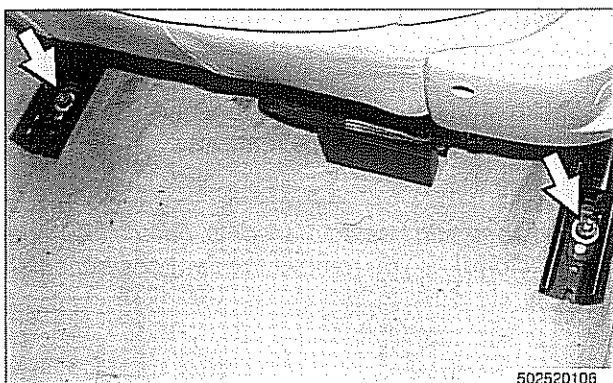


➤ Remove fasteners (**arrows**) from rear of seat rails.

— Move seat as far back as possible.



➤ Open seat electrical harness cover (**A**) to release plug lock (**B**) and disconnect electrical connector (**C**).



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➤ Remove front seat rail fasteners (arrows).

- Remove front seat from car. Headrest may be removed to provide additional clearance.

**NOTE—**

*Use a blanket to protect the door sill from scuffing by seat rails during seat removal.*

- Installation is reverse of removal. Use wire ties or equivalent means to keep seat harness wiring from fraying.

**Tightening torques**

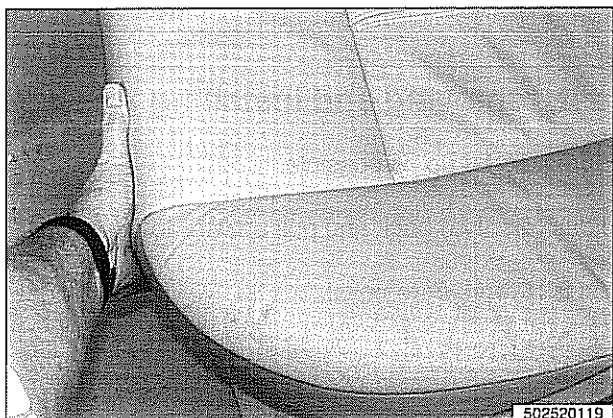
Front seat to floor	42 Nm (31 ft-lb)
Seat belt end to seat frame	48 Nm (35 ft-lb)

## REAR SEATS

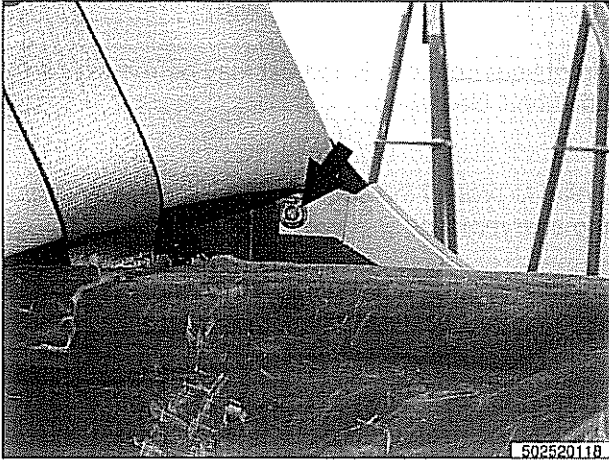
E39 models are equipped with at least three different versions of rear seats. This manual only covers the standard seat used in sedan models.

### Rear seat cushion and backrest, removing and installing (sedan only)

- Pull front of rear seat cushion up to release clips. While holding front of cushion up, pull cushion forward to remove.



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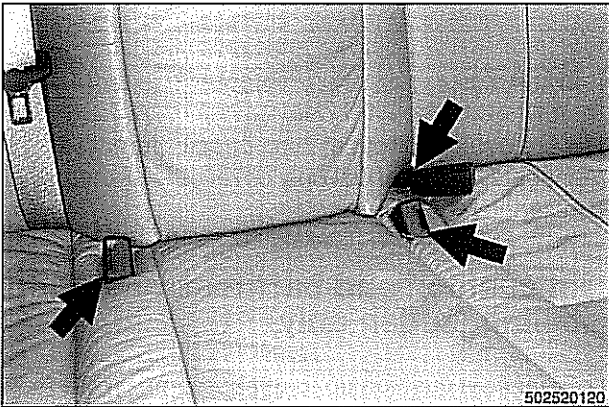


➤ Remove left and right side backrest mounting fasteners (arrow).

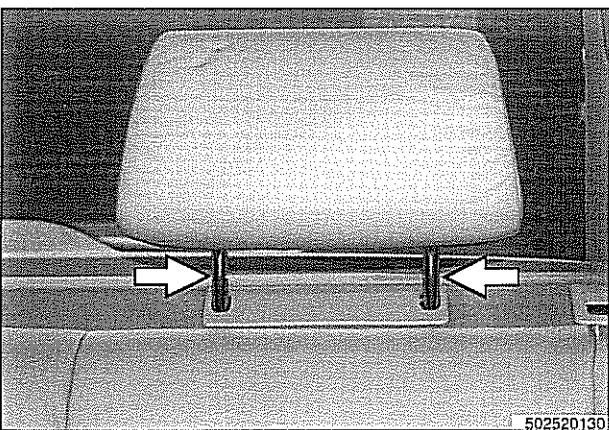
— Pull up on backrest to detach from top retainers. Slide backrest to side to clear seat belts while removing.

**NOTE—**

*If the car is equipped with heated rear seats, detach electrical harness connector(s) as you remove the seat components.*



➤ When reinstalling, be sure to pull seat belts and buckles (arrows) up through appropriate slots in seat cushion.

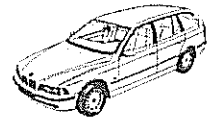


**Headrest, removing and installing**

— Slide headrest as far up as possible.

➤ Press guides (arrows) back and pull upward to remove.

— Installation is reverse of removal.



# 540 Sunroof

<b>General</b> .....	540-2	<b>Sunroof Components</b> .....	540-8
<b>Sunroof Adjustments</b> .....	540-2	Sunroof components (glass) .....	540-8
Sunroof electronic controls, initializing .....	540-2	Sunroof panel, removing and installing (steel or glass) .....	540-8
Sunroof, normalization .....	540-3	Sunroof panel gasket, replacing (steel or glass) .....	540-9
Sunroof, characteristic curve .....	540-3	Sunroof motor, replacing .....	540-10
Sunroof panel, emergency closing .....	540-4		
Sunroof, adjusting .....	540-5		
Sunroof with steel roof panel, adjusting .....	540-5		
Sunroof with glass roof panel, adjusting .....	540-7		

## GENERAL

This repair group covers the slide-tilt sunroof assembly. There are two types of sunroof panels available: steel or glass. Service procedures are different for each type.

Component locations, initialization, sunroof panel replacement, and sunroof height adjustment are covered. Replacement of the cable assembly or frame require that the headliner be removed. Removal and repair of the sunroof assembly and other components inside the roof cavity is beyond the scope of this manual.

When the sunroof is set to the vent position (rear of panel up), the inside headliner moves rearward approximately 120 mm (4.7 in) This provides cabin ventilation with less wind noise. A water channel is incorporated into the sunroof assembly. It automatically rises when the sunroof panel is in the vent position and prevents water from entering the interior during braking.

## SUNROOF ADJUSTMENTS

### Sunroof electronic controls, initializing

- Initialize the sunroof in the following situations:
  - Malfunctions such as lack of one-touch function, lack of comfort opening/closing or lack of safety (anti-trapping) features.
  - If sunroof motor has been removed and reinstalled.
  - If power supply to the sunroof has been interrupted.
  - If repairs have been performed on the slide/tilt mechanism.

**NOTE** —

*The initialization sequence is dependent on the software version of the sunroof module (in the sunroof drive unit).*

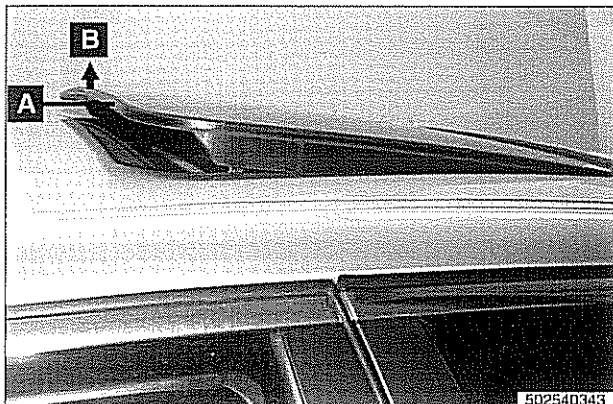
**WARNING** —

*There is no anti-trapping protection during initialization.*



## Sunroof, normalization

During normalization the mechanical end positions of sunroof movement are detected and stored by the General Module (GM III).



- Press and hold sunroof switch in "lift" direction.
  - After reaching end position (A), keep switch pressed for approximately 20 seconds longer.
- Normalization is complete when sunroof in lift position (A) moves briefly in direction of (B).
- Release sunroof switch.

## Sunroof, characteristic curve

### E39 models up to 3/1998

- The characteristic curve for E39 models built up to 3/1998 is learned automatically during operation. After normalization, open and close sunroof once by pressing switch.

#### **NOTE** —

*In the event of a faulty triggering of the anti-trap protection in a specific position, the fault can be rectified by moving over the relevant position several times.*

### E39 models from 3/1998

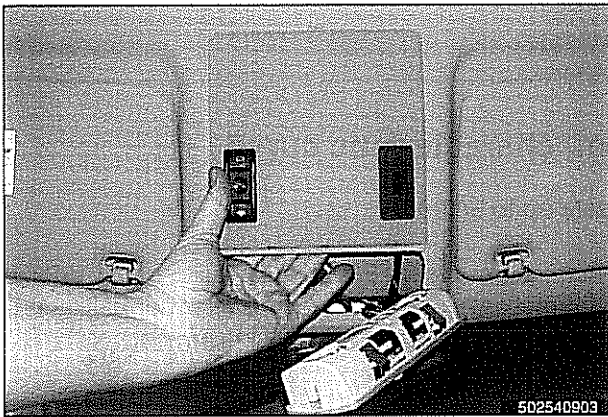
- Characteristic curve is learned manually in the following steps:
  - Release switch after normalization for maximum of 5 seconds.
  - Then hold down switch in sunroof raising position until sunroof has returned to closed position after a complete opening operation.
  - Characteristic curve learning is complete, release sunroof switch.

#### **NOTE** —

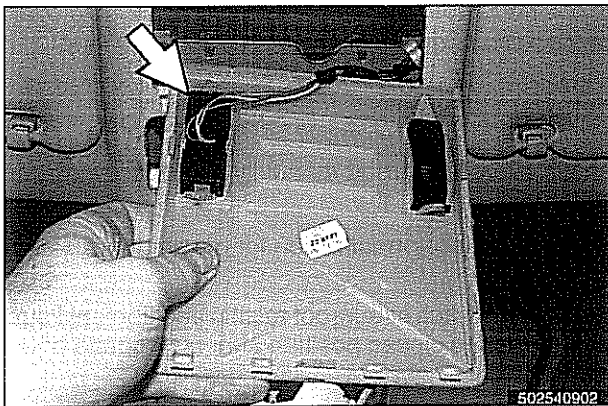
*Carry out function check (tip function, anti-trap protection and, if necessary, comfort function).*



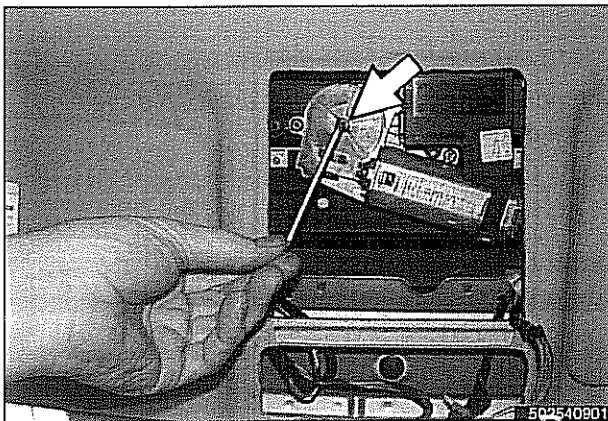
- Sunroof panel, emergency closing**
- Using a plastic tool carefully pry interior light out of headliner.



- Remove access panel from below sunroof motor by inserting fingers through light opening and pressing down.



- Disconnect electrical connections (**arrow**) and lay switch panel aside.



- Insert hex key into drive in sunroof motor (**arrow**), and turn hex key to manually close sunroof.

**NOTE —**

*The hex key for manually (emergency) closing the sunroof can be found in the tool kit located in the trunk lid (sedan models) or under the cargo area floor panel (Sport Wagon).*

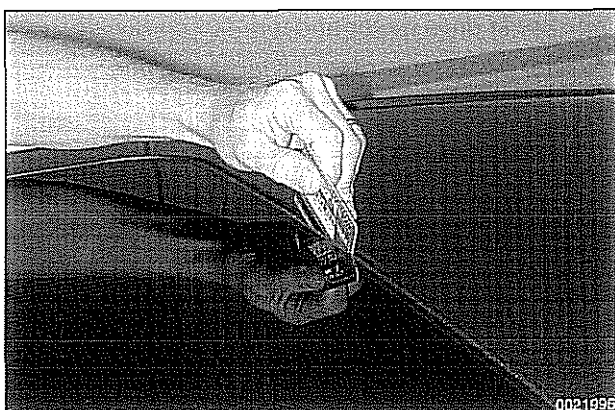
## Sunroof, adjusting

The sunroof is controlled by a set of cables that move the sunroof panel along guide rails when the motor is operated. The sunroof can be adjusted without removing it from the car.

### NOTE—

*Be sure to check drains in front corners of sunroof carrier if water is entering car through headliner.*

- The sunroof panel should be adjusted under the following circumstances:
  - Sunroof misaligned with roof.
  - Sunroof does not close squarely.
  - Wind noise at high speeds (sunroof closed).
  - Sunroof has been removed.



For correct sunroof alignment:

- Sunroof must be fully closed.
- Gap must be even all around edge of sunroof.
- Front of sunroof must be flush to 1 mm (0.04 in.) below surface of roof.
- Rear of sunroof must be flush to 1 mm (0.04) above surface of roof.

### NOTE—

*Use a credit card to measure the gap. The card should insert through the gap with equal resistance all around the perimeter.*

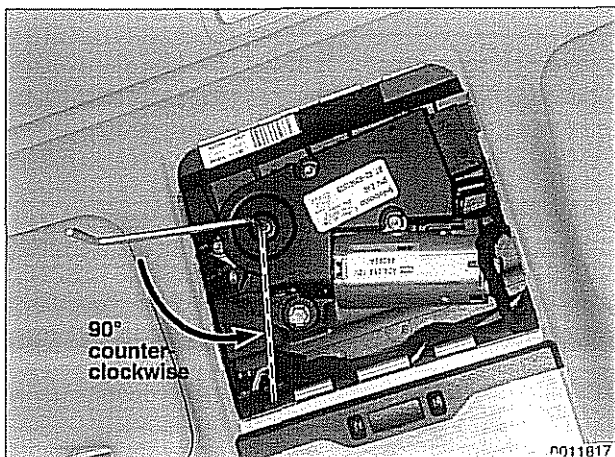
## Sunroof with steel roof panel, adjusting

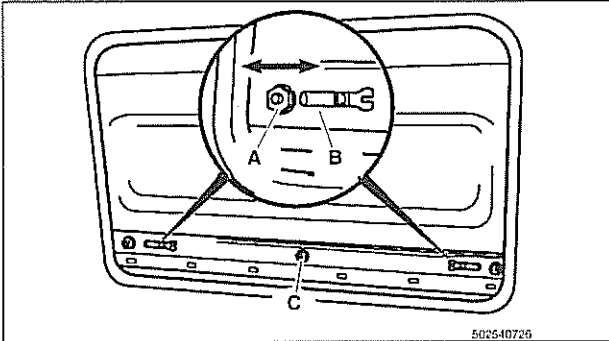
- The headliner panel must be disengaged from the drive assembly and moved rearward in order to access the roof panel attaching screws.

### CAUTION—

*Sunroof panel must never be moved to open position when the headliner is disengaged.*

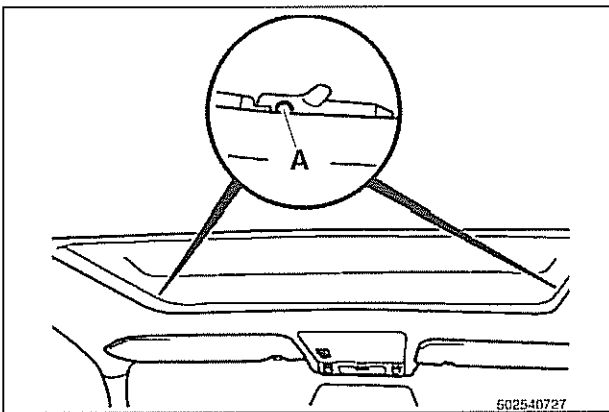
- Start with a fully closed roof panel.
- Remove drive motor access cover. See **Sunroof motor, replacing**.
- ◀ Using hex key from tool kit, turn motor drive 90° counter-clockwise.
  - Rear of sunroof panel will drop 2 to 3 mm (0.08 to 0.12 in). This disengages headliner from sunroof panel.
- Push headliner panel rearward, exposing roof panel attaching screws.





#### Adjusting rear roof height:

- Remove fasteners (A) and (B).
- Slide in left and right side adjusting wedges (C) until ideal setting is reached.
- Press sunroof panel forward and tighten wedge nuts (B).
- Tighten center nut (A).



#### Adjusting front roof height.

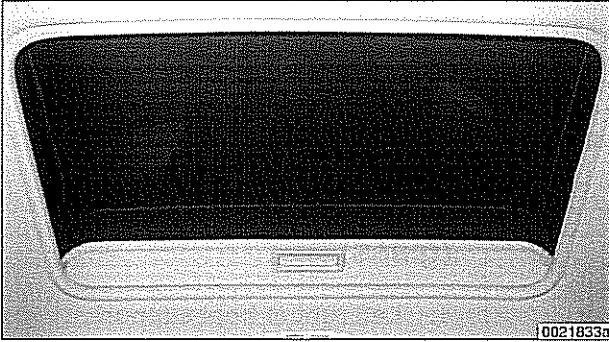
- Loosen left and right fasteners (A).
- Set front of sunroof to ideal height by moving panel up or down.
- Tighten fasteners (A).
- Insert hex key in drive motor and turn 90° clockwise.
- Pull headliner panel forward until it locks in place.

#### Tightening torque

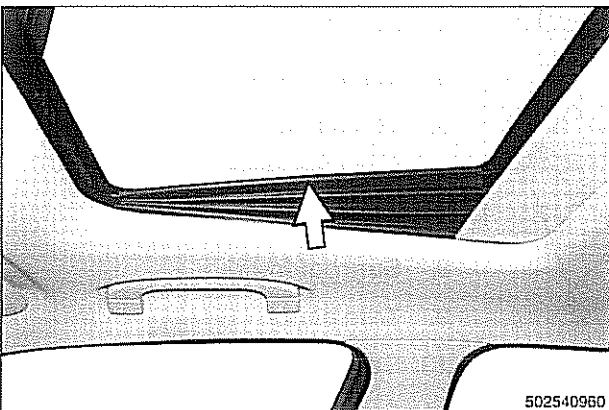
Wedge locking nuts

1.5 Nm (13 in-lb)

### Sunroof with glass roof panel, adjusting



- Slide sunroof liner back into roof cavity until approx. 70 mm (2.75 in) is exposed.

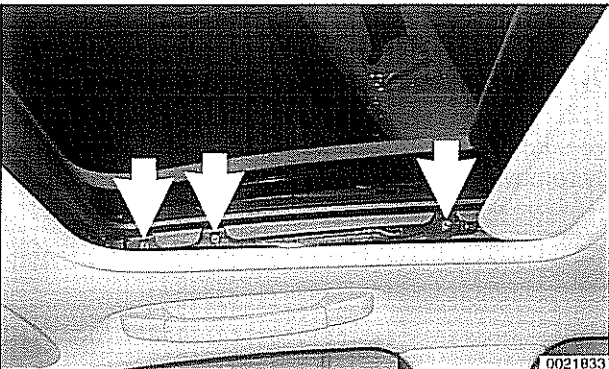


- Raise glass sunroof panel to vent position to expose rubber gaiter (**arrow**).
- Working from center section of gaiter (**arrow**), carefully pull gaiter off slotted mounting on sunroof glass panel.

#### CAUTION—

- The gaiters tear easily.
- Do not attempt to remove gaiters from lower edge of sliding mechanism.

- With gaiters removed, three adjusting screws are visible at front and rear of panel.



- Sunroof panel is retained by three Torx screws (**arrows**) on each side. To adjust sunroof height:
  - Loosen Torx screws until sunroof can just be moved.
  - Push sunroof panel forward.
  - Push sunroof panel up or down until correct height is achieved.
  - Reinstall sunroof gaiter.

#### Sunroof height adjustment specifications

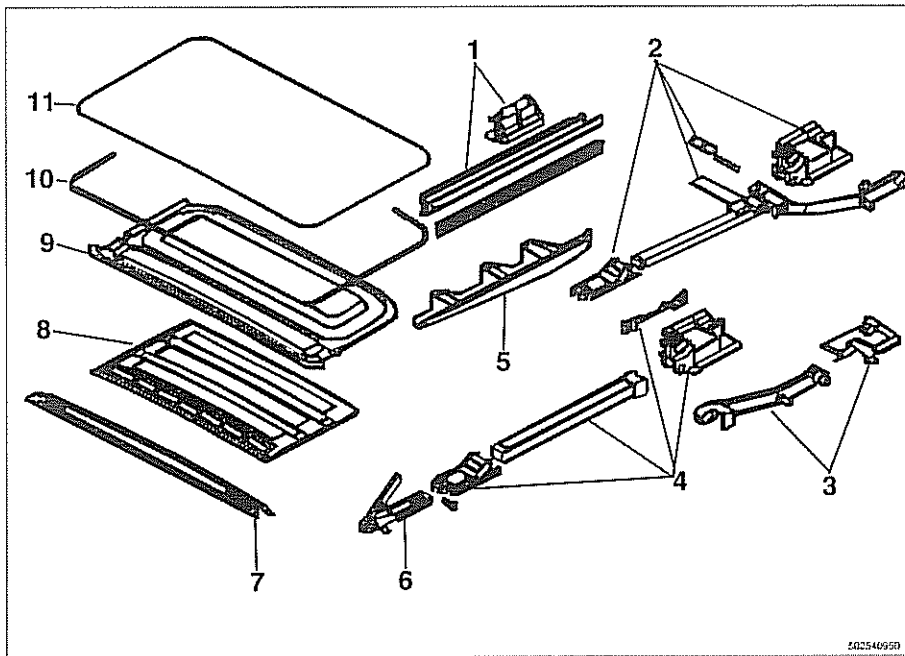
Rear	Flush/ 1 mm (0.04 in) higher than roof top
Front	Flush / 1 mm (0.04 in) lower than roof top

#### Tightening torque

Sunroof panel to roof (Torx)	6 Nm (4.4 in-lb)
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## SUNROOF COMPONENTS

Sunroof assembly removal and installation involves headliner removal, and is not covered in this manual. After sunroof repairs, be sure to follow initialization and adjustment procedures given earlier.

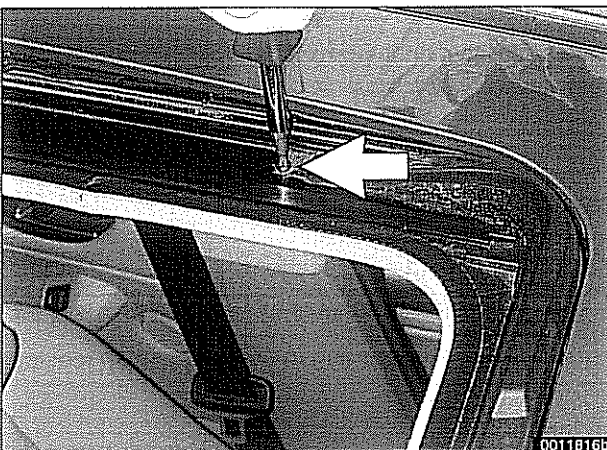


### Sunroof components (glass)

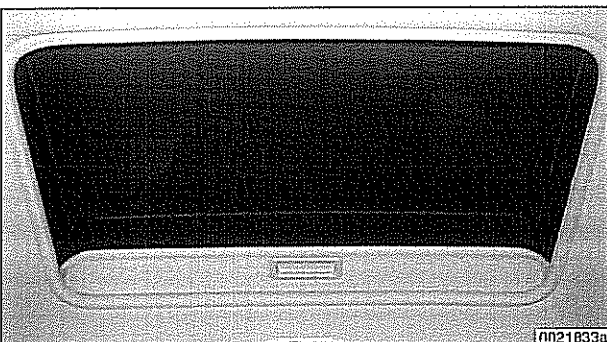
1. Left rubber boot support
2. Left upper control rail
3. Left side water channel repair kit
4. Left lower control rail
5. Left cover
6. Left side slider
7. Cross member
8. Sunroof frame
9. Trim panel
10. Gasket
11. Glass roof cover

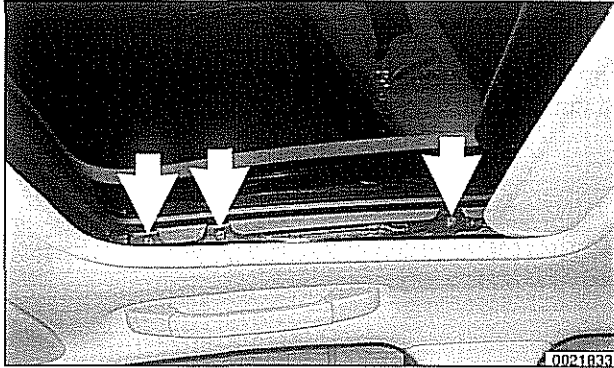
### Sunroof panel, removing and installing (steel or glass)

- To remove sunroof panel, open sunroof and remove wind blocker by removing Torx screw (arrow) on each side.



- Close sunroof and slide sunroof liner back into roof cavity until approximately 70 mm (2.75 in.) is exposed.





- Remove three Torx screws (**arrows**) on each side, and lift panel out.
- Installation is reverse of removal. Adjust sunroof height and gap as described earlier. See **Sunroof, adjusting**.

#### Tightening torques

Wind blocker to roof (Torx)	1 Nm (9 in-lb)
Sunroof panel to roof (Torx)	6 Nm (4.4 ft-lb)

### Sunroof panel gasket, replacing (steel or glass)

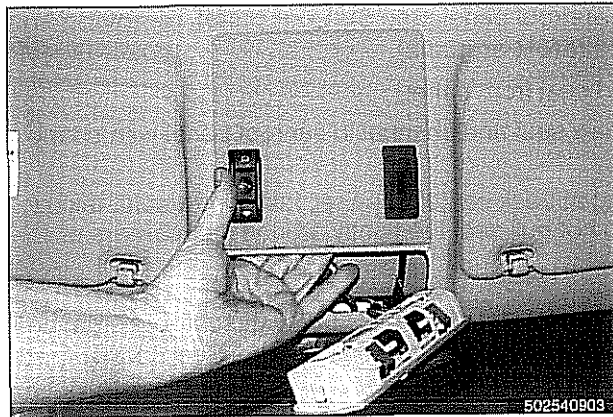
- Remove sunroof panel. See **Sunroof panel, removing and installing (steel or glass)**.
  - Pull old seal from panel.
  - Coat new seal and channel in sunroof panel with soapy water.
  - Starting at back center of panel, install new seal, taking care to not pull seal too tightly around four corners of panel.
- Installation is reverse of removal. Adjust sunroof height and gap as shown earlier in this repair group. See **Sunroof, adjusting**.

#### Tightening torques

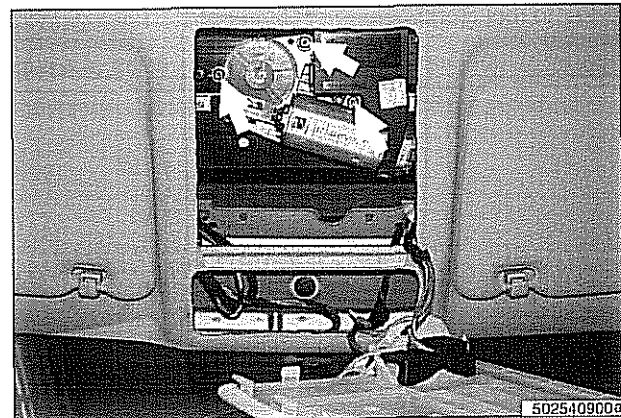
Wind blocker to roof (Torx)	1 Nm (9 in-lb)
Sunroof panel to roof (Torx)	6 Nm (4.4 ft-lb)



- Remove interior light from below sunroof motor by gently prying with a plastic tool.



- Remove access panel from below sunroof motor by inserting fingers through light opening and pressing down.

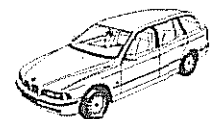


- Remove sunroof motor mounting screws (arrows).

- Installation is the reverse of removal. Perform initialization procedure as described earlier. See **Sunroof electronic controls, initializing**.

#### Tightening torque

Sunroof motor to sunroof carrier	2.8 Nm (25 in-lb)
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# 720 Seat Belts

<b>General</b> .....	720-2
Troubleshooting .....	720-2
<b>Front Seat Belt Assembly</b> .....	720-4
Front seat belt tensioner, removing and installing .....	720-4
Front seat belt assembly .....	720-6
Front seat belt reel, removing and installing (sedan and Sport Wagon models) .	720-6

<b>Rear Seat Belt Assembly</b> .....	720-8
Rear seat belt assembly (sedan) .....	720-8
Rear seat belts (sedan) .....	720-9
Rear seat belt assembly (Sport Wagon) ...	720-9
Rear seat belts (Sport Wagon) .....	720-10

## GENERAL

This section covers repairs to the following seat belts systems. See the table below.

Multiple Restraint Systems	
Years	Restraint system
3/1996 - 8/1997	MRS
9/1997 - 3/1999	MRS II
3/1999 - on	MRS III

Multiple Restraint System electronics integrate seat belt operations and airbag deployment. Airbag repair information is covered in **721 Airbag System (SRS)**.

## Troubleshooting

The seat belt reel should lock when driving quickly through curves, during severe braking or in case of a collision. The automatic reel does not require any servicing and should never be opened.

- In case of an accident, follow the seat belt troubleshooting procedures presented in the table below.

Troubleshooting procedures		
Problem	Probable cause	Repairs
Damage to seat belt.	Accident in which bumper impact absorbers were permanently deformed.	Replace complete automatic seat belt. Also check and replace, if necessary, seat belt mounting on car body and seat belt mounting on seat runner.
Belt creased, unraveled, pinched, cut or melted. Belt buckle or belt lock plastic casing worn, damaged or missing.	Seat belts aged or worn.	Replace complete automatic seat belt.
Seat belt buckle is not ejected with spring pressure when red button on seat belt lock is pressed.	Seat belt lock mechanism worn or damaged.	Replace seat belt lock.
Seat belt automatic reel does not lock when pulled out suddenly.	Automatic reel defective.	Replace reel assembly.
Seat belt automatic reel jams when pulled out.	Automatic reel loose. Return spring broken inside reel.	Tighten reel mounting bolt. Replace reel assembly.
Seat belt does not retract automatically (see note below).	Automatic reel loose. Return spring broken inside reel.	Tighten reel mounting bolt. Replace reel assembly.
Automatic belt squeaks when fastened or unfastened.	Excessive friction in belt guides. Automatic reel loose. Return spring broken inside reel.	Replace reel assembly. Tighten reel mounting bolt. Replace reel assembly.
Seat belt pyrotechnic tensioner triggered.	Accident triggered pyrotechnic deployment.	Replace complete automatic seat belt. Also check retaining bracket of belt tensioner for twist.

**NOTE —**

*The rear bench seat belt strap may not retract fully due to increased friction between strap and seat cover. A small remaining loop in belt strap when fully retracted is acceptable.*

**WARNING —**

- *For maximum protection from injury, seat belts should be replaced as a set (including all hardware), if they are subject to occupant loading in a collision.*
- *Seat belts should not be modified or repaired. The seat belt mounting points should not be changed or modified.*
- *Do not bleach or dye seat belt webbing. Webbing that is severely faded or redyed will not meet the strength requirements of a collision and must be replaced.*
- *Clean belts with a luke-warm soap solution only.*
- *Seat belts should be periodically inspected for webbing defects such as cuts or pulled threads.*
- *Immediately after replacing a damaged or worn seat belt, destroy the old belt to prevent it from being used again.*

## FRONT SEAT BELT ASSEMBLY

### Front seat belt tensioner, removing and installing

The front seat belt locks are equipped with pyrotechnic (explosive charge) automatic tensioners. These tensioners are designed to automatically retract and tension the seat belt by 55 mm (approximately 2 inches) in the event of an accident.

#### **WARNING—**

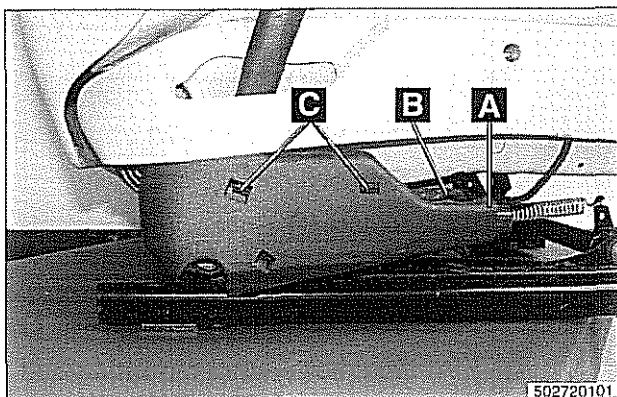
- *Pyrotechnic seat belt tensioners are powerful devices and should be handled with extreme care. Incorrect handling can trigger the tensioner and cause injury.*
- *BMW recommends that all repair or replacement work on pyrotechnic devices must be carried out by a qualified BMW technician.*
- *Be sure to disconnect the battery and wait 5 seconds before attempting to work on pyrotechnic devices.*
- *Pyrotechnic devices cannot be repaired. Always replace them.*
- *Never treat pyrotechnic components with cleaning agents or grease.*
- *Do not expose pyrotechnic components to temperatures above 75°C (167°F).*
- *Pyrotechnic components can only be tested electrically when installed using the BMW Service Tester (DISplus, GT1, or MoDiC).*
- *Do not fire a pyrotechnic gas generator prior to disposal. It must be fired by a special disposal company or shipped back to BMW in the packaging of the new component.*
- *During body straightening and welding with an electric arc welder, always disconnect the battery and the connection to the pyrotechnic gas generators.*

- Disconnect battery negative (–) cable in trunk.

#### **CAUTION—**

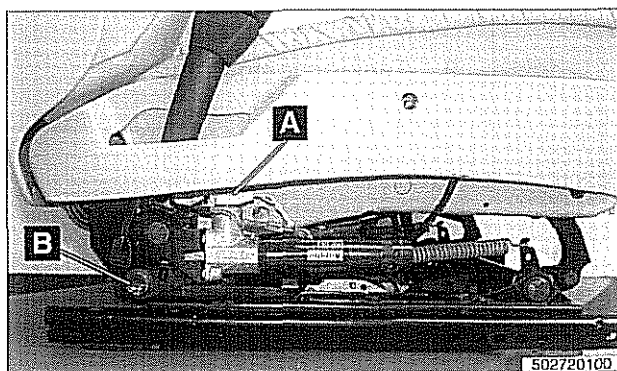
*Prior to disconnecting the battery, read the battery disconnection cautions given in 001 General Warnings and Cautions.*

- Remove front seat as described in 520 Seats.



Remove tensioner cover:

- Cut wire ties (A).
- Release wiring harness from tensioner cover clip (B).
- Release tensioner cover locks (C) and slide cover down to remove.



Remove pyrotechnic tensioner:

- Detach tensioner harness connector from seat rail by cutting wire tie (A).
- Remove tensioner mounting bolt (B).

- Check tensioner mounting bracket for damage or bending. Replace if necessary.

**CAUTION—**

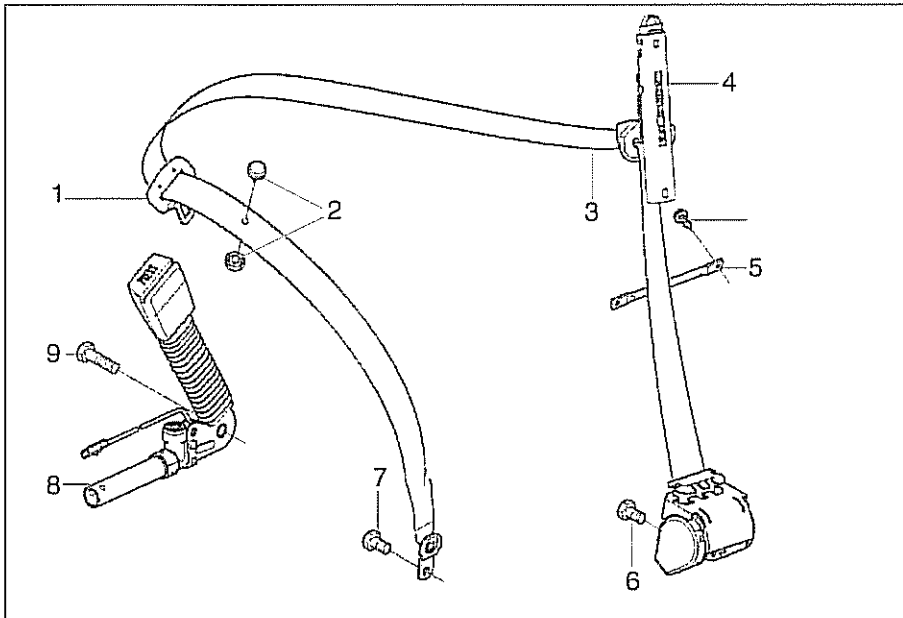
*A bent tensioner mounting bracket may make it impossible to adjust seat height.*

- When reinstalling:

- Replace wire ties to relieve tension on pyrotechnic belt tensioner harness connector.

**Tightening torques**

Front seat to floor (M10)	42 Nm (31 ft-lb)
Seat belt to seat	48 Nm (35 ft-lb)
Tensioner mounting bracket to seat rail	24 Nm (18 ft-lb)
Tensioner to mounting bracket	48 Nm (35 ft-lb)



### Front seat belt assembly

1. Seat belt buckle
2. Seat belt stop button
3. Seat belt
4. Seat belt height adjuster
5. B-pillar cross brace
6. Seat belt reel mounting bolt
7. Seat belt anchor mounting bolt
8. Seat belt lock with pyrotechnic tensioner
9. Tensioner mounting bolt

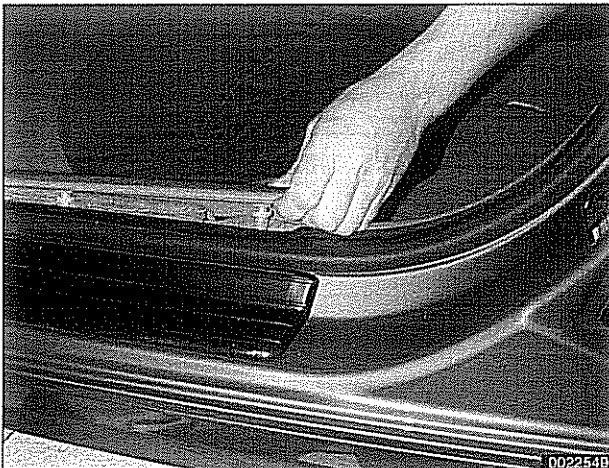
### Front seat belt reel, removing and installing (sedan and Sport Wagon models)

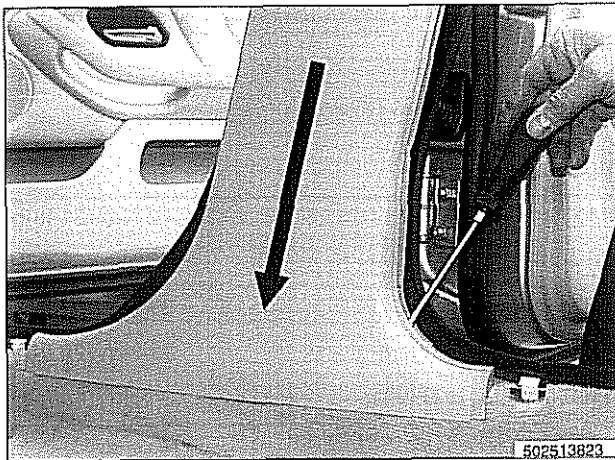
- Detach battery negative (-) cable in trunk.

**CAUTION—**

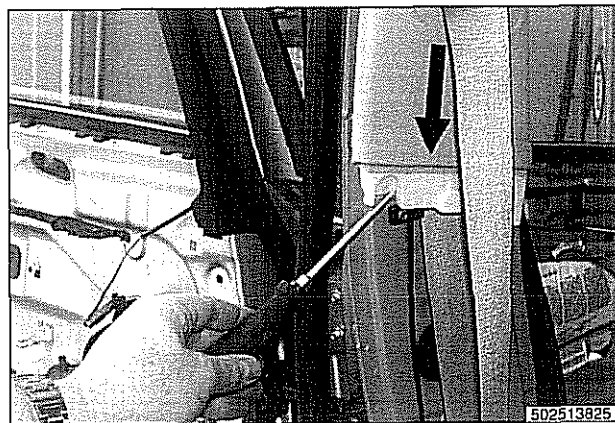
*Prior to disconnecting the battery, read the battery disconnection cautions given in 001 General Warnings and Cautions.*

- Remove front seat as described in 520 Seats.
- ◀ Gently pry up front and rear plastic door sill protector strips to remove.





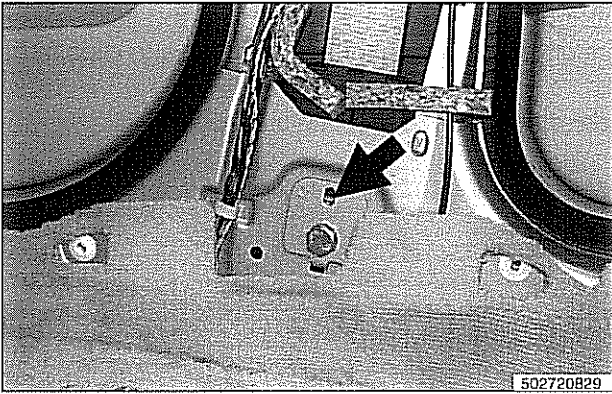
- Remove lower B-pillar (door pillar) plastic trim.
  - Pry carefully along bottom of trim to disengage clips from pillar.
  - Slide trim down (**arrow**) and out to remove.



- Carefully pry bottom of upper door post trim away from post to release clips.
  - Slide upper trim panel down (**arrow**) to remove.



- Remove automatic reel from B-pillar:
  - Remove upper seat belt anchor bolt (**A**).
  - Remove cross-brace mounting bolts (**B**).
  - Remove sound insulation at base of B-pillar.
  - Then remove automatic seat belt reel mounting bolt (**C**). Lift out reel.
- If it is necessary to remove sliding seat belt height adjuster, unscrew mounting bolts from B-pillar.



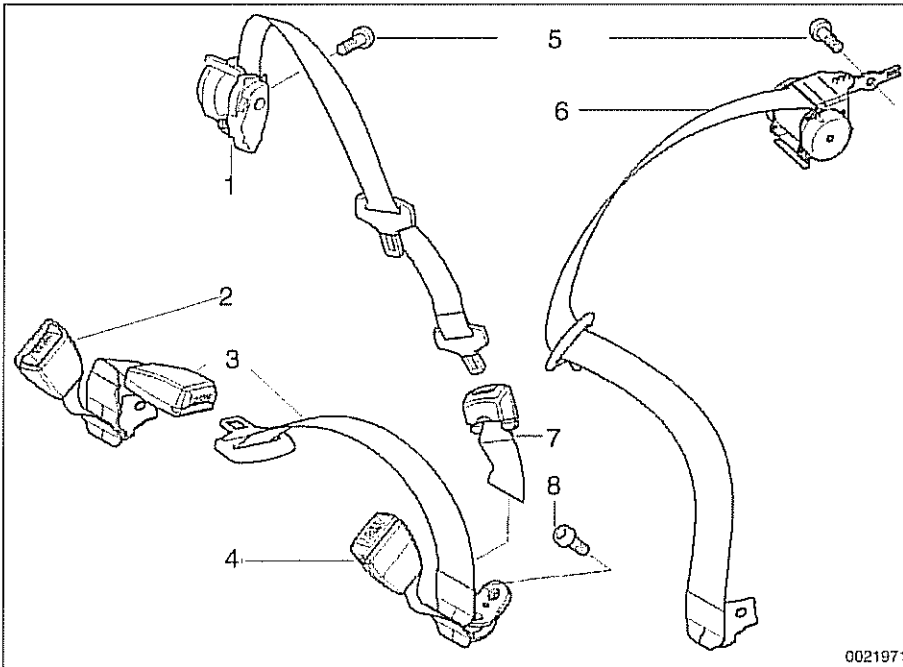
▲ When Installing automatic reel housing to B-pillar, slide tab into locating slot (**arrow**).

— Remainder of installation is reverse of removal.

#### Tightening torques

Front seat to floor (M10)	42 Nm (31 ft-lb)
Seat belt to seat	48 Nm (35 ft-lb)
Seat belt to height adjuster	31 Nm (23 ft-lb)
Seat belt reel to B-pillar bottom	31 Nm (23 ft-lb)
Sliding height adjuster to B-pillar	24 Nm (18 ft-lb)

## REAR SEAT BELT ASSEMBLY



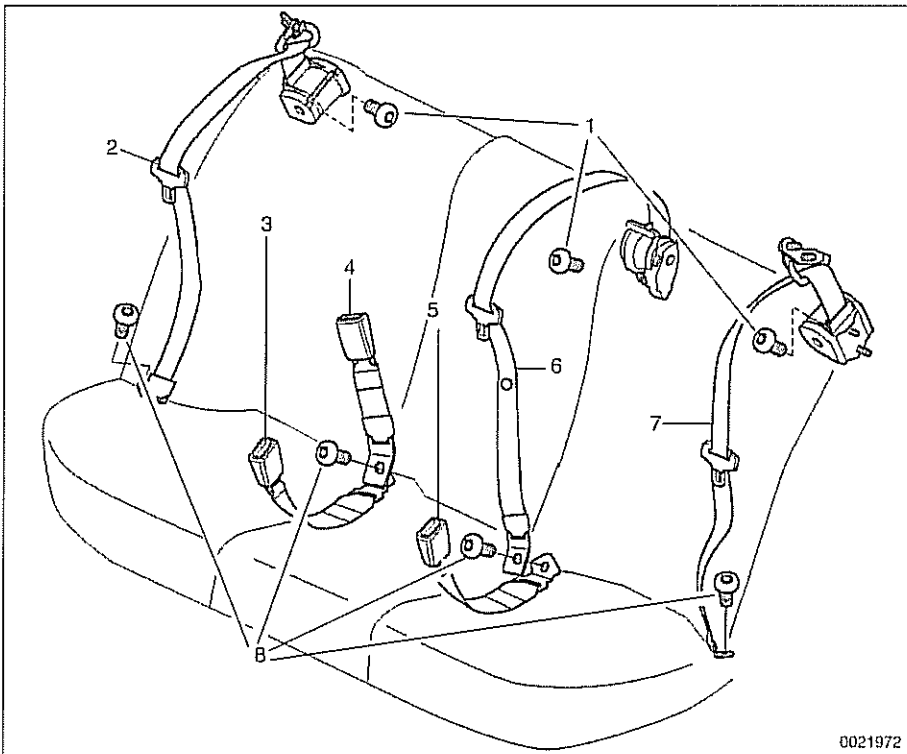
### Rear seat belt assembly (sedan)

1. Center shoulder belt reel assembly (if equipped)
2. Right shoulder belt lock
3. Lap-belt assembly
4. Left shoulder belt lock
5. Bolt M10  
(tighten to 31 Nm, 23 ft-lb)
6. Left shoulder belt reel assembly
7. Center shoulder belt lock (if equipped)
8. Bolt M12  
(tighten to 48 Nm, 35 ft-lb)



### Rear seat belts (sedan)

- Remove rear parcel shelf to access shoulder belt assembly mounting bolts. See 513 Interior Trim.
- Remove rear seat cushion to access rear seat belt lock mounting bolts. See 520 Seats.
- When installing seat belt lock straps:
  - Install right lock strap (which is shorter) underneath middle lock strap.
  - Install left lock strap underneath middle lap belt strap.
  - Metal strap ends must rest against stop on floor underneath seat.



### Rear seat belt assembly (Sport Wagon)

1. Bolt M10  
(tighten to 31 Nm, 23 ft-lb)
2. Right shoulder belt reel assembly
3. Center belt lock
4. Right belt lock
5. Left belt lock
6. Center shoulder belt reel assembly
7. Left shoulder belt reel assembly
8. Bolt M12  
(tighten to 48 Nm, 35 ft-lb)

## Rear seat belts (Sport Wagon)

- Center shoulder belt:
  - Remove shoulder belt guide trim at top of seat backrest.
  - Feed belt out through slot in trim. Working in cargo compartment, partially remove backrest cover to access shoulder belt reel.
  - Remove shoulder belt reel mounting bolt inside backrest.
- Outboard shoulder belt:
  - Remove roof-pillar (C-pillar) trim.
  - Remove center shoulder belt.
- Lift up rear seat cushion(s) to access rear seat belt lock mounting bolt(s).
- When installing seat belt lock straps:
  - Install right belt lock strap (which is shorter) underneath center belt lock strap.
  - Install left belt lock strap underneath center lap belt strap.
- Metal strap ends must rest against stop on floor underneath seat.



# 721 Airbag System (SRS)

<b>General</b> .....	721-2	<b>Airbags</b> .....	721-8
E39 Airbags .....	721-3	Driver airbag, removing and installing .....	721-8
Two-stage airbag (MRS III) .....	721-4	Passenger airbag, removing and installing ..	721-9
Airbag indicator light .....	721-4	Door mounted side-impact airbag, removing and installing .....	721-10
Warnings .....	721-5	Head protection airbag components .....	721-11
<b>Airbag Electronics</b> .....	721-6	Head protection airbag (HPS) .....	721-12
MRS .....	721-6		
MRS airbag system diagram .....	721-6		
MRS control module, replacing .....	721-7		
Side-impact crash sensor, removing and installing .....	721-7		

## GENERAL

This repair group covers airbag components and replacement. Airbag system repair and fault diagnosis is not covered. Diagnostics, component testing, and airbag system repair should be carried out by trained BMW service technicians.

Individual airbag system components can only be tested electronically when installed in the car. BMW service testers DIS or MoDiC or equivalent must be used for diagnostic work.

### **WARNING—**

*Special test equipment is required to retrieve airbag fault codes, diagnose system faults, and reset/turn off the airbag indicator light. The indicator light will remain on until any problem has been corrected and the fault memory has been cleared.*

Airbags are part of the BMW Multiple Restraint System (MRS). Three versions of MRS are available in E39 models.

### Multiple Restraint Systems

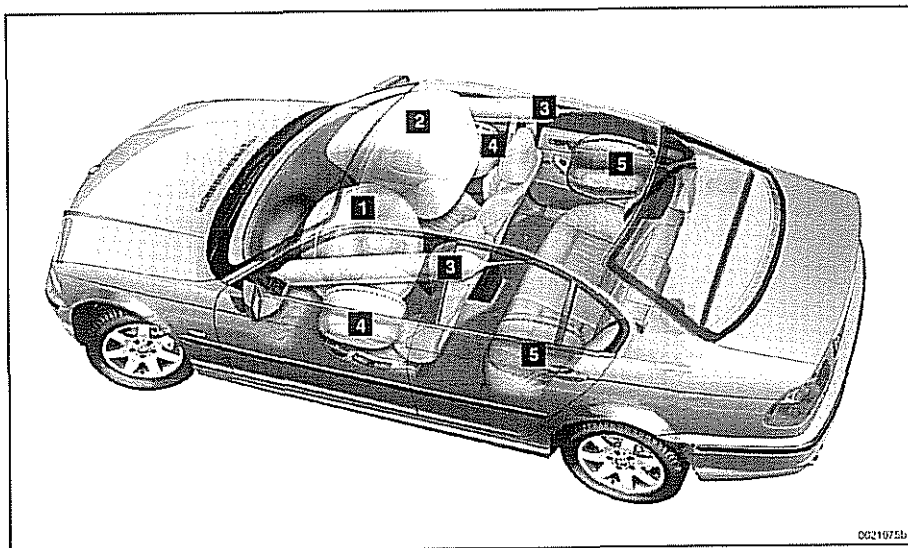
Date of manufacture	Restraint system
3/1996–8/1997	MRS
9/1997–3/1999	MRS II
3/1999–2002	MRS III

**MRS and MRS II** include the following restraint components:

- Driver and passenger front airbags (MRS/MRS II)
- Passenger front two-stage airbag (cars manufactured from 9/1998).
- The seat occupancy sensor (SBE) is used for detection of a passenger in the right front seat. MRS uses the SBE input to determine seat belt tensioner and/or front airbag deployment thresholds.
- Side impact airbag for driver and front passenger (MRS/MRS II)
- Left/right side impact crash sensors (MRS/MRS II)
- Side impact airbag for rear passenger (MRS II) (optional)
- Head Protection System (HPS) for driver and front passenger (MRS II)
- Battery Safety Terminal — BST (MRS II)
- Hall Sensor seat belt switches (MRS II)
- Front pyrotechnic seat belt tensioners
- Fuel pump cut off message

MRS III adds the following features:

- MRS III employs "smart" technology. Smart technology refers to the control module's programming for the deployment of the airbags, in stages depending on the severity of the impact.
- Two-stage airbag for both driver and passenger. Allows for a softer cushioning effect when the airbags are triggered at lighter impact.
- MRS III satellite sensors use 2 wire connectors.
- Rear side airbags arrive de-activated from the factory and can only be activated upon written request from the customer.
- Rear seat head protection is available when ordered with optional rear seat side airbags.



### E39 Airbags

1. Driver airbag
2. Passenger airbag
3. Head Protection System (HPS) Inflatable Tubular Structure (ITS) (MRS II and MRS III)
4. Front side impact airbag
5. Rear door side impact airbag (optional) (MRS II and MRS III)

## Two-stage airbag (MRS III)

Beginning with 2000 model year (9/1999 production) the front airbags were changed to a two-stage style airbag. This ensures that the force of airbag inflation is not greater than necessary to provide protection. The airbags are designed to provide "soft" deployment if the acceleration sensor detects a low-speed impact, and "hard" deployment in higher speed impacts.

### **NOTE**—

*A two-stage passenger airbag was used on cars built between 9/1998 and 3/1999. This pre-smart technology airbag used two ignition stages. Stage one is designed to ignite first during an impact. Stage two ignites after a timed period, as programmed in the MRS II control module.*

## Airbag indicator light

The MRS control module detects and stores system status.

The airbag indicator light in the instrument cluster displays the status of the airbag system when the ignition key is in "accessory" or ON positions.

- System normal: Indicator light comes on briefly, then goes out.
- System malfunction: Indicator light fails to come on.
- System malfunction: Indicator light comes on briefly, goes out and lights up again.

The airbag indicator light also comes on if the seat belt pyrotechnic tensioners have been triggered.

## Warnings

When servicing airbag equipped cars, the following precautions must be observed to prevent personal injury.

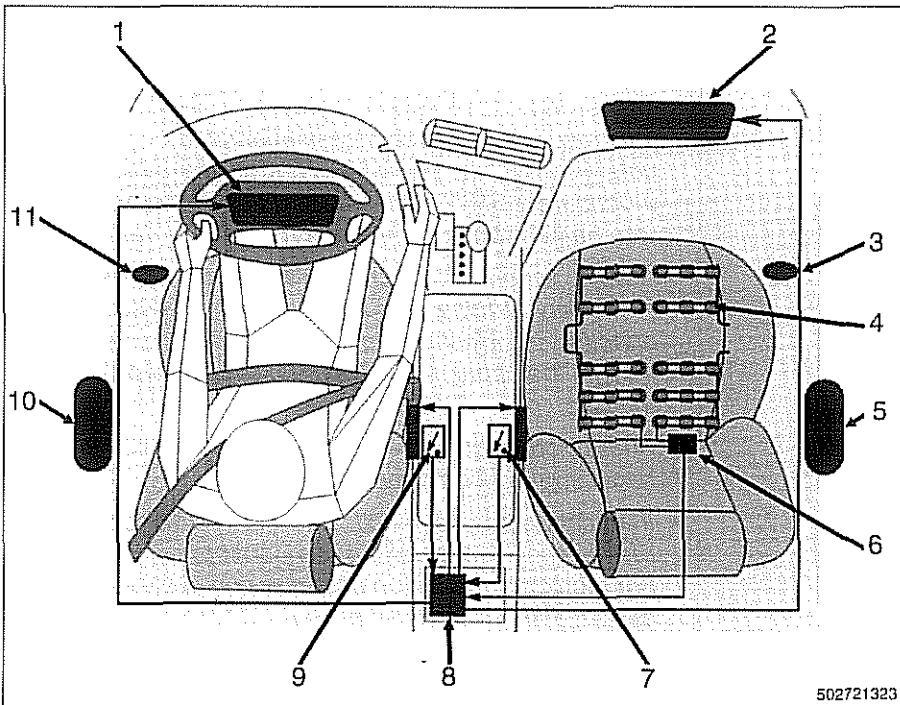
### **WARNING—**

- *If the airbag indicator light is on, there is a risk that the airbags will not be triggered in case of an accident. Be sure to have the system inspected and repaired immediately.*
- *Airbag(s) are inflated by an explosive device. Handled improperly or without adequate safeguards, the system can be very dangerous. Special precautions must be observed prior to any work at or near the airbags.*
- *The airbag is a vehicle safety system. Serious injury may result if system service is attempted by persons unfamiliar with the BMW MRS and its approved service procedures. BMW advises that all inspection and service be performed by an authorized BMW dealer.*
- *Always disconnect the battery and cover the negative (-) battery terminal with an insulator before starting diagnostic, troubleshooting or service work not associated with the airbags, and before doing any welding on the car.*
- *After disconnecting the battery, wait 5 seconds before beginning work on airbag components.*
- *If an airbag has been activated due to an accident, BMW specifies that airbag components be replaced. For more information on post-collision airbag service, see an authorized BMW dealer.*
- *Do not fire an airbag unit prior to disposal. It must be fired by a special disposal company or shipped back to BMW in the packaging of the new components.*
- *When removing a fired airbag unit, avoid contact with the skin; wear gloves. In case of skin contact, wash with water.*
- *Do not allow airbag system components to come in contact with cleaning solutions or grease. Never subject airbag components to temperatures above 167°F (75°C). When reconnecting the battery, no person should be inside the vehicle.*
- *Always place an airbag unit that has been removed from its packaging with the padded side facing upward. Do not leave an airbag unit unattended.*
- *If the airbag unit or airbag control module has been dropped from a height of 1/2 meter (1 1/2 ft.) or more, the airbag unit should not be installed.*

## AIRBAG ELECTRONICS

### MRS

The MRS control module contains the electronic crash sensor for frontal impact. Sensors mounted on the driver and passenger floor are used for side impacts. The MRS control module is located between the front seat under the center console.



**MRS airbag system diagram**

1. Driver's side airbag
2. Passenger's side airbag
3. Right side impact sensor
4. Seat occupancy sensor pad
5. Right side impact airbag
6. SBE control module (analog to digital converter)
7. Passenger pyrotechnic seat belt tensioner and seat belt microswitch (Hall sensor MRS III)
8. MRS control module
9. Driver pyrotechnic seat belt tensioner and seat belt microswitch (Hall sensor MRS III)
10. Left side impact airbag
11. Left side impact sensor



## MRS control module, replacing

- Disconnect negative (–) cable from battery and cover negative terminal with insulating material.

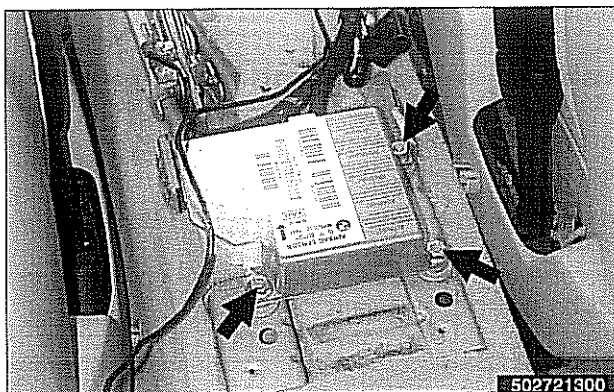
### CAUTION—

*Prior to disconnecting the battery, read the battery disconnection cautions given in 001 General Warnings and Cautions.*

- Remove center console between front seats. See 513 Interior Trim.

◀ Remove module mounting nuts (**arrows**) and lift up control module. Disconnect electrical harness connector.

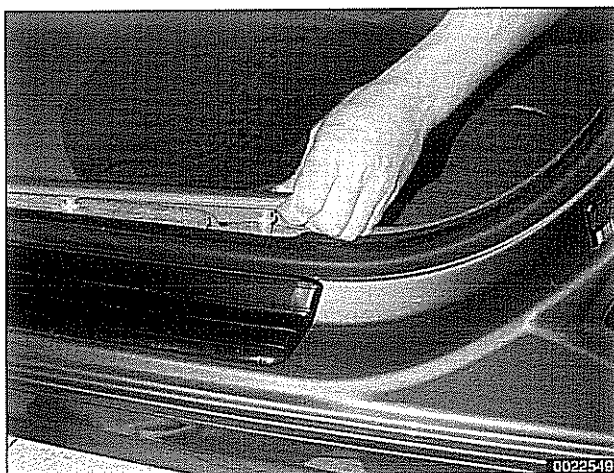
- Installation is reverse of removal.
  - Be sure that MRS control module ground cable is attached to the module mounting stud.



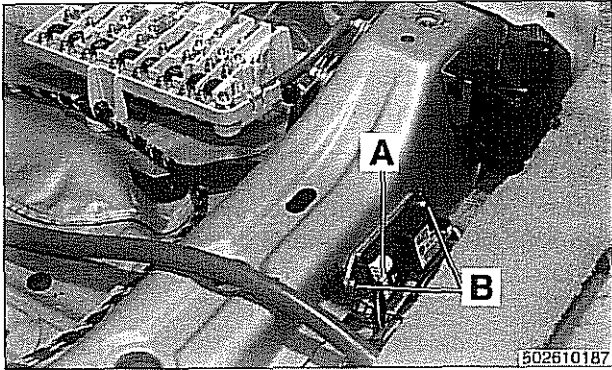
## Side-impact crash sensor, removing and installing

- Make sure ignition key is OFF.
- Remove front seat. See 520 Seats.

◀ Remove plastic door sill trim by lifting to release clips at one end, then sliding off. Fold up carpet towards rear seat floor. If necessary, remove floor level heater duct.



## Airbag System (SRS)



- Remove electrical harness connector from crash sensor (A). Remove sensor retaining screws (B) and remove sensor. Note direction of sensor before removing.

- Installation is reverse of removal.

**NOTE—**

Arrow on sensor must point to door sill.

## AIRBAGS

### Driver airbag, removing and installing

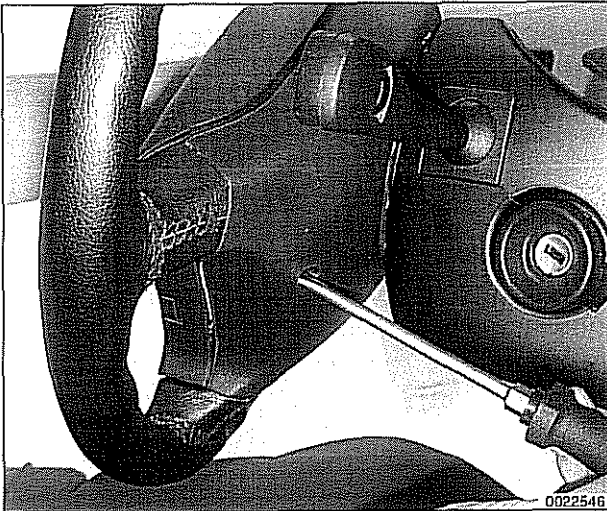
- Disconnect negative (–) cable from battery and cover negative terminal with insulating material.

**WARNING—**

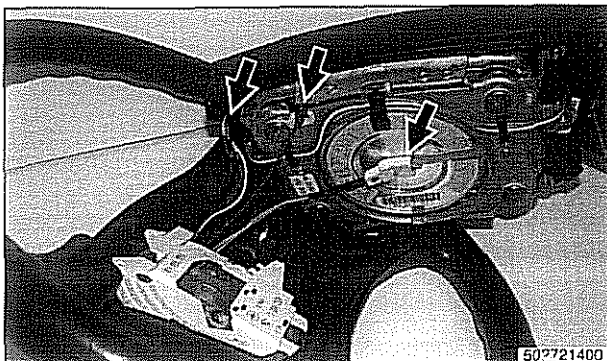
After disconnecting the battery, wait 5 seconds before beginning work on airbag components.

**CAUTION—**

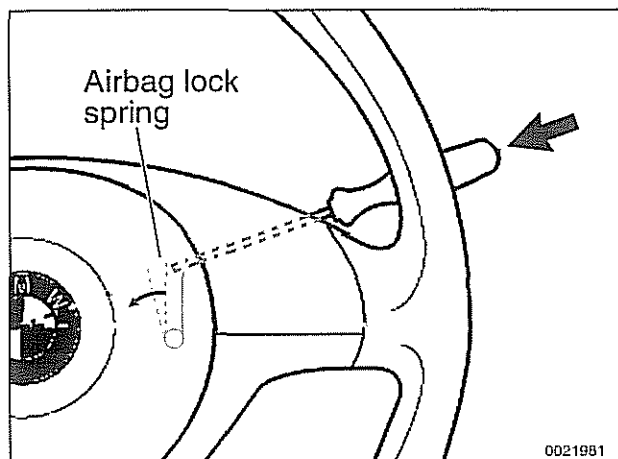
Prior to disconnecting the battery, read the battery disconnection cautions given in 001 General Warnings and Cautions.



- Multifunction (MFL) steering wheel:
  - Working behind steering wheel, completely loosen Torx screws (T30) while holding airbag in place.
  - Support airbag unit to prevent it from falling out.



- Carefully lift airbag unit off steering wheel and disconnect harness connectors (arrows) from rear of airbag unit.



#### ◀ Sport steering wheel:

- Insert screwdriver through opening in rear of steering wheel and push against spring tension to release airbag unit lock.
- Repeat procedure on other side of steering wheel.
- Lift off airbag unit and detach electrical harness connectors.

#### **WARNING—**

- Store the removed airbag unit with the horn pad facing up. If stored facing down, accidental deployment could propel it violently into the air, causing injury.
- Once an airbag is removed, the car must not be driven.
- Do not connect the battery with the airbag disconnected. A fault code will be stored, setting off the airbag indicator light. Special tools are needed to reset the fault memory.
- Once the airbag unit is installed and all other service procedures have been completed, start the engine and check that the airbag indicator light goes out. If the indicator light stays on, the airbag system will not function as designed. Have the system diagnosed and repaired by an authorized BMW dealer.

— Installation is reverse of removal.

- MFL steering wheel: Torque airbag using specification listed below.
- Sport steering wheel: Press airbag unit mounting pins into spring locks in steering wheel until they snap in firmly.

#### **CAUTION—**

*Do not pinch airbag harness in center of steering wheel when installing airbag.*

#### **Tightening torque**

Airbag to steering wheel (MFL)	8 Nm (71 in-lb)
--------------------------------	-----------------

### **Passenger airbag, removing and installing**

- Disconnect negative (–) cable from battery and cover negative terminal with insulating material.

#### **WARNING—**

*After disconnecting the battery, wait 5 seconds before beginning work on airbag components.*

#### **CAUTION—**

*Prior to disconnecting the battery, read the battery disconnection cautions given in 001 General Warnings and Cautions.*

## Airbag System (SRS)



- Pry up cover from top of passenger side airbag on dashboard.



- Remove airbag mounting bolts (arrows).
- Lift airbag and disconnect electrical harness connector. Remove airbag.

### **WARNING—**

*Store the removed airbag unit with the soft pad facing up. If stored facing down, accidental deployment could propel it violently into the air, causing injury.*

- Installation is reverse of removal. Make sure wiring harness is not pinched when installing airbag unit in dashboard.

### **Tightening torques**

Passenger air bag to dashboard (M6)	10 NM (88 in-lb)
-------------------------------------	------------------

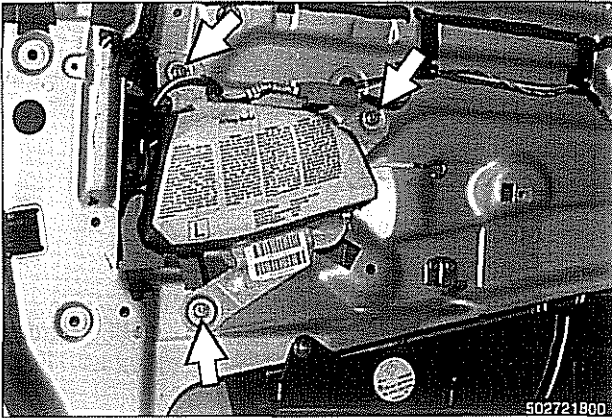
## **Door mounted side-impact airbag, removing and installing**

- Disconnect negative (-) cable from battery and cover negative terminal with insulating material.

### **CAUTION—**

*Prior to disconnecting the battery, read the battery disconnection cautions given in 001 General Warnings and Cautions.*

- Remove inside door panel as described in 411 Doors.



#### Front door airbag:

- Remove airbag mounting bolts (arrows).
- Disconnect electrical harness connector.

#### CAUTION—

When removing and installing the airbag unit, pay attention to the routing of the electrical harness to avoid kinks or breaks in the wire.

— Installation is reverse of removal.

#### Rear door airbag:

- Detach electrical harness connector.
- Remove mounting bolts and remove airbag from door.

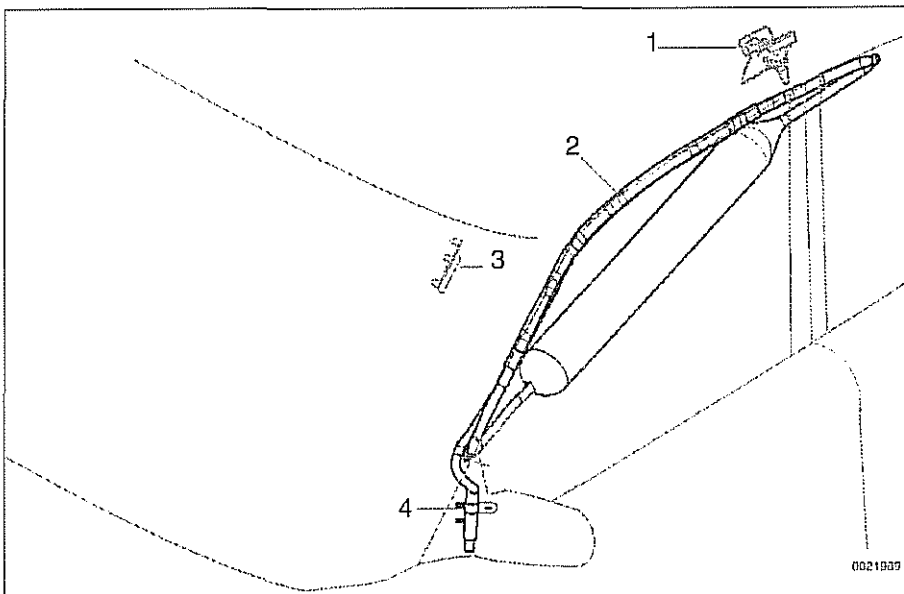
— Installation is reverse of removal.

- Route electrical harnesses as they were before.
- Use new wire ties as necessary.
- Use new self-locking mounting bolts.

#### Tightening torque

Side-impact airbag to door

8.5 Nm (75 in-lb)



#### Head protection airbag components

1. B-pillar deflection plate
2. Head protection airbag
3. Cable holder
4. Gas generator



## Head protection airbag (HPS)

- ◀ Replacement of a head protection airbag (HPS) is an extensive operation, including removal of the following:
  - Complete dashboard
  - Complete headliner
  - Windshield pillar (A-pillar) trim
  - Door pillar (B-pillar) trim
- Before starting work on the HPS airbag, disconnect negative (-) cable from battery and cover negative terminal with insulating material.

### **CAUTION—**

*Prior to disconnecting the battery, read the battery disconnection cautions given in 001 General Warnings and Cautions.*

### Tightening torque

HPS airbag to body	11 Nm (8 ft-lb)
HPS airbag mounting bracket to A or B-pillar	2.5 Nm (22 in-lb)
HPS gas generator to dashboard reinforcement (M6 self-tapping screw)	4 Nm (35 in-lb)



# OBD On-Board Diagnostics

<b>General</b> .....	OBD-1	<b>Diagnostic Trouble Codes (DTCs)</b> ..	OBD-9
<b>On-Board Diagnostics (OBD II)</b> .....	OBD-1	Automatic transmission diagnostic	
Malfunction Indicator Light (MIL) .....	OBD-2	trouble codes .....	OBD-9
Scan tools and scan tool display .....	OBD-3	Engine diagnostic trouble	
Diagnostic monitors .....	OBD-4	codes: M52 engine .....	OBD-13
Drive cycle .....	OBD-6	Engine diagnostic trouble	
Readiness codes .....	OBD-6	codes: M54 engine .....	OBD-17
Diagnostic trouble codes (DTCs) .....	OBD-7	Engine diagnostic trouble	
		codes: M62 engine .....	OBD-24

## GENERAL

This chapter outlines the fundamentals and equipment requirements of On-Board Diagnostics II (OBD II) standards as they apply to BMW vehicles. Also covered here is a listing of BMW and OBD II diagnostic trouble codes (DTCs).

## ON-BOARD DIAGNOSTICS (OBD II)

OBD II standards were developed by the SAE (Society of Automotive Engineers) and CARB (California Air Resources Board). OBD II is the second generation of on-board self-diagnostic equipment requirements. These standards were originally mandated for California vehicles. Since 1996 they have been applied to all passenger vehicles sold in the United States.

On-board diagnostic capabilities are incorporated into the hardware and software of the engine control module (ECM) to monitor virtually every component that can affect vehicle emissions. The OBD II system works to ensure that emissions remain as clean as possible over the life of the vehicle.

Each emission-influencing component is checked by a diagnostic routine (called a monitor) to verify that it is functioning properly. If a problem or malfunction is detected, the **diagnostic executive** built into the OBD II system illuminates a malfunction indicator light (MIL) on the instrument panel.

The OBD II system also stores diagnostic trouble codes (DTCs) about the detected malfunction in the ECM so that a repair technician can accurately find and fix the problem.

Specialized OBD II scan tool equipment is needed to access the fault memory and OBD II data.

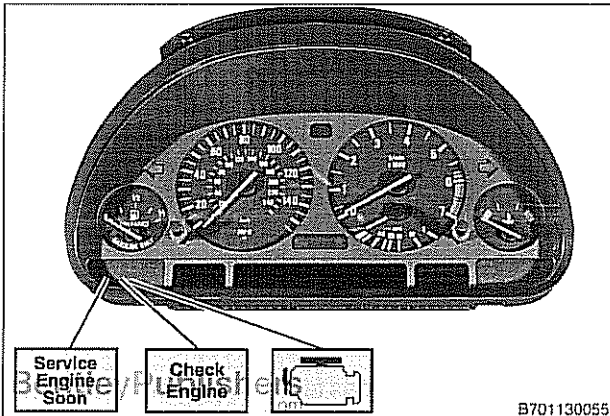
The extra hardware needed to operate the OBD II system consists mainly of the following:

- Additional oxygen sensors downstream of the catalytic converters.
- Fuel tank pressure sensor and device to pressurize fuel storage system.
- Several engine and performance monitoring devices
- Standardized 16-pin OBD II connector under the dashboard.
- Upgraded components for the federally required reliability mandate.

### Malfunction indicator light (MIL)

OBD II software illuminates the malfunction indicator light (MIL) when emission levels exceed 1.5 times Federal standards.

➤ For E34 cars covered by this manual, three different MIL symbols were used, depending on year and model.



MIL illuminates under the following conditions:

- Engine management system fault detected for **two** consecutive OBD II drive cycles. See **Drive cycle** in this repair group.
- Catalyst damaging fault detected.
- Component malfunction causes emissions to exceed 1.5 times OBD II standards.
- Manufacturer-defined specifications exceeded.
- Implausible input signal.
- Misfire faults.
- Leak in evaporative system.
- Oxygen sensors observe no purge flow from purge valve / evaporative system.
- ECM fails to enter closed-loop operation within specified time.
- ECM or automatic transmission control module (TCM) in "limp home" mode.
- Ignition key ON before cranking (bulb check function).

OBD II fault memory (including the MIL) can only be reset using a special scan tool. Removing the connector from the ECM or disconnecting the battery does not erase the fault memory.



**Additional MIL information:**

- A fault code is stored within the ECM upon the first occurrence of a fault in the system being checked.
- Two **complete** consecutive drive cycles with the fault present illuminate the MIL. The exception to the two-fault requirement is a catalyst-damaging fault, which illuminates the MIL immediately.
- If the second drive cycle was not complete and the fault was not checked, the ECM counts the third drive cycle as the next consecutive drive cycle. The MIL illuminates if the system is checked and the fault is still present.
- Once the MIL is illuminated, it remains illuminated until the vehicle completes three consecutive drive cycles without detecting a fault.
- An existing fault code is cleared from memory automatically when the vehicle completes **40** consecutive drive cycles without the fault being detected.

In order to automatically clear a catalyst-damaging fault from memory, the condition under which the fault occurred must be evaluated for 80 consecutive drive cycles without the fault reoccurring.

A generic scan tool connected to the BMW data link connector (DLC) or OBD II plug can display diagnostic trouble codes (DTCs), along with the conditions associated with the illumination of the MIL. Using a more advanced or BMW-dedicated scan tool, additional proprietary information is normally available.

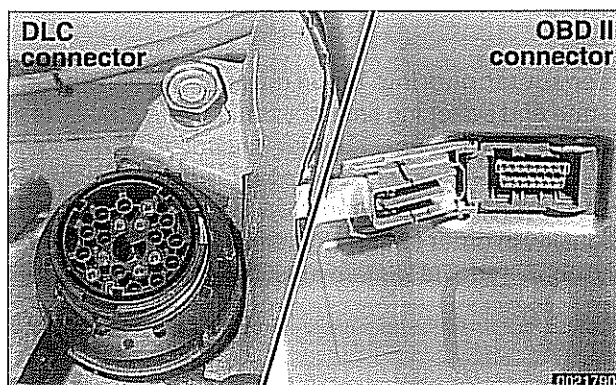
**Scan tool and scan tool display**

The complexity of the OBD II system requires that all diagnostics begin by connecting a scan tool to the vehicle. Aftermarket scan tools can be connected to either the 16-pin OBD II plug or the 20-pin BMW DLC in the engine compartment (if installed). Data from the OBD II plug may be limited, depending on scan tool and vehicle.

OBD II standards require that the 16-pin OBD II plug be located within three (3) feet of the driver and not require any tools to access.

- Starting with June 2000 production, the 20-pin BMW DLC, previously located in the engine compartment, was discontinued. Diagnostic, coding and programming functions are incorporated into the OBD II plug, located under left side of dashboard.

On cars built up to 06 / 2000: when accessing emissions related DTCs through the 16-pin OBD II plug, make sure the BMW 20-pin DLC cap is installed.



Professional diagnostic scan tools available at the time of this printing include the BMW factory tools (DISplus, GT1, MoDiC) and a small number of aftermarket BMW-specific tools. See **020 Maintenance**.

In addition to the professional line of scan tools, inexpensive generic OBD II scan tool software programs and handheld units are readily available. Though limited, they are nonetheless powerful diagnostic tools. These tools read live data streams and freeze frame data as well as a host of other valuable diagnostic data.

### Diagnostic monitors

Diagnostic monitors run tests and checks on specific emission control systems, components, and functions.

A complete drive cycle is required for the tests to be valid. See **Drive cycle** in this repair group. The diagnostic monitor signals the ECM of the loss or impairment of the signal or component and determines if a signal or sensor is faulty based on 3 conditions:

- Signal or component shorted to ground
- Signal or component shorted to B+
- Signal or component missing (open circuit)

The OBD II system monitors all emission control systems that are installed. Emission control systems vary by vehicle model and year. For example, a vehicle may not be equipped with secondary air injection, so no secondary air readiness code would be present.

OBD II software monitors the following:

- Oxygen sensors
- Catalysts
- Engine misfire
- Fuel tank evaporative control system
- Secondary air injection
- Fuel system

**Oxygen sensor monitoring.** When driving conditions allow, response rate and switching time of each oxygen sensor is monitored. The oxygen sensor heater function is also monitored. The OBD II system differentiates between pre-catalyst and post-catalyst oxygen sensors and reads each one individually. In order for the oxygen sensor to be effectively monitored, the system must be in closed loop operation.

**Catalyst monitoring.** This strategy monitors the output of the precatalyst and post-catalyst oxygen sensors, comparing the oxygen content going into the catalytic converter to the oxygen leaving the converter.

The diagnostic executive knows that most of the oxygen should be used up during the oxidation phase. If it detects higher than programmed values, a fault is set and the MIL illuminates.

**Misfire detection.** This strategy monitors crankshaft speed fluctuations and determines if an engine misfire occurs by monitoring variations in speed between each crankshaft sensor trigger point. This strategy is so finely tuned that it can determine the severity of the misfire.

The system determines if a misfire is occurring, as well as other pertinent misfire information such as:

- Specific cylinder(s)
- Severity of the misfire event
- Emissions relevant or catalyst damaging

Misfire detection is an on-going monitoring process that is only disabled under certain limited conditions.

**Secondary air injection monitoring.** Secondary air injection is used to reduce HC and CO emissions during engine warm up. Immediately following a cold engine start (-10° to 40°C), fresh air (and therefore oxygen) is pumped directly into the exhaust manifold. By injecting additional oxygen into the exhaust manifold, catalyst warm-up time is reduced.

Secondary air system components are:

- Electric air injection pump
- Electric pump relay
- Non-return valve
- Vacuum / vent valve
- Stainless steel air injection pipes
- Vacuum reservoir

The secondary air system is monitored via the use of the pre-catalyst oxygen sensors. Once the air pump is active and air is injected into the system, the signal at the oxygen sensor reflects a lean condition. If the oxygen sensor signal does not change, a fault is set and the faulty bank(s) identified. If after completing the next cold start a fault is again present, the MIL illuminates.

**Fuel system monitoring.** This monitor looks at the fuel delivery needed (long / short term fuel trim) for proper engine operation based on programmed data. If too much or not enough fuel is delivered over a predetermined time, a DTC is set and the MIL illuminates.

Fuel trim refers to adjustments to base fuel schedule. Long-term fuel trim refers to gradual adjustments to the fuel calibration adjustment as compared to short term fuel trim. Long term fuel trim adjustments compensate for gradual changes that occur over time.

Fuel system monitoring monitors the calculated injection time (ti) in relation to engine speed, load and precatalytic converter oxygen sensor(s) signals.

Using this data, the system optimizes fuel delivery for all engine operating conditions.

**Evaporative system monitoring.** This monitor checks the the fuel storage system and related fuel lines for leaks. It can detect very small leaks anywhere in the system.

A leak detection unit (LDP or DMTL) is used to pressurize the evaporative control system on a continuous basis (as the drive cycle allows) and to check system integrity.

## Drive cycle

The OBD II drive cycle is an important concept in understanding OBD II requirements. The purpose of the drive cycle is to run all of the emission-related on-board diagnostics over a broad range of driving conditions.

A drive cycle is considered complete when all of the diagnostic monitors have run their tests without interruption. For a drive cycle to be initiated, the vehicle must be started cold and brought up to 160°F and at least 40°F above its original starting temperature.

## Readiness codes

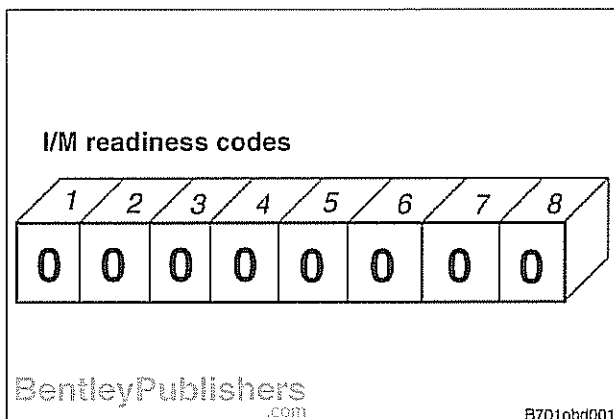
Inspection/maintenance (I/M) readiness codes are mandated as part of OBD II. The readiness code is stored after complete diagnostic monitoring of specified components and systems is carried out. The readiness code function was designed to prevent manipulating an I/M emission test procedure by clearing faults codes or disconnecting the ECM or battery.

Readiness codes indicate whether the OBD II system is actually ready to monitor the various emission control systems on the vehicle. The vehicle must complete a drive cycle to set readiness codes. The code is binary:

- 0 for ready
- 1 for not ready

➤ The parameters which are monitored for readiness are:

1. Catalyst efficiency
2. Catalyst heating
3. Fuel tank evaporative control
4. Secondary air injection
5. A/C refrigerant
6. Oxygen sensors
7. Oxygen sensor heaters
8. Exhaust gas recirculation



When all zeros are displayed, the system has established readiness. Readiness codes can be displayed using BMW and aftermarket scan tools.

Readiness codes are set to 1 (not ready) in the following cases:

- The battery or ECM is disconnected.
- DTCs are erased after completion of repairs and a drive cycle is not completed.

An OBD II scan tool can be used to determine I/M readiness.

## Diagnostic trouble codes (DTCs)

SAE standard J2012 mandates a 5-digit diagnostic trouble code (DTC) standard. Each digit represents a specific value. Emission related DTCs start with the letter P for power train. When the engine service light (MIL) is illuminated it indicates that a DTC has been stored.

- DTCs are stored as soon as they occur, whether or not the engine service light illuminates.
- DTCs store and display a time stamp.
- DTCs record the current fault status: Present, not currently present, or intermittent.

## DTC digit interpretation

1st digit	
P	powertrain
B	body
C	chassis
2nd digit	
0	SAE
1	BMW
3rd digit	
0	total system
1	air/fuel induction
2	fuel injection
3	ignition system or misfire
4	auxiliary emission control
5	vehicle speed & idle control
6	ECM inputs/outputs
7	transmission
4th - 5th digits	
individual circuits or components	

## DTC example: P 0 3 0 6

- **P:** A powertrain problem
- **0:** SAE sanctioned or 'generic'
- **3:** Related to an ignition system / misfire
- **06** Misfire detected at cylinder #6

DTCs provide a **freeze frame** or snap-shot of a vehicle performance or emissions fault at the moment that the fault first occurs. This information is accessible through generic OBD II scan tools.

Freeze frame data contains, but is not limited to, the following information:

- Engine load (calculated)
- Engine rpm
- Short and long term fuel trim
- Vehicle speed
- Coolant temperature
- Intake manifold pressure
- Open/closed loop operation
- Fuel pressure (if available)
- DTC

## DIAGNOSTIC TROUBLE CODES (DTCs)

Below is a listing of E39 powertrain (automatic transmission and engine) SAE P-codes, the corresponding BMW fault codes, and the fault code definitions.

BMW fault codes expand on the SAE sanctioned DTCs and are accessible primarily through the BMW diagnostic scan tool or a BMW-specific scan tool.

Automatic transmission diagnostic trouble codes		
P-code	BMW-FC	DTC Definition
P0560	96	System Voltage
P0600	129	Serial Communication Link
P0600	144	Serial Communication Link
P0601	80	Internal Control Module Memory Check Sum Error
P0603	81	Internal Control Module Keep Alive Memory (KAM) Error
P0606	82	ECM/PCM Processor
P0705	8	Transmission Range Sensor 'A' Circuit Malfunction (PRNDL Input)
P0705	60	Transmission Range Sensor 'A' Circuit Malfunction (PRNDL Input)
P0709	60	Transmission Range Sensor 'A' Circuit Intermittent
P0715	16	Input/Turbine Speed Sensor 'A' Circuit
P0715	33	Input/Turbine Speed Sensor 'A' Circuit
P0716	33	Input/Turbine Speed Sensor 'A' Circuit Range/Performance
P0717	33	Input/Turbine Speed Sensor 'A' Circuit No Signal
P0720	32	Output Speed Sensor Circuit
P0720	42	Output Speed Sensor Circuit
P0720	59	Output Speed Sensor Circuit
P0720	62	Output Speed Sensor Circuit
P0720	106	Output Speed Sensor Circuit
P0721	59	Output Speed Sensor Circuit Range/Performance
P0722	32	Output Speed Sensor Circuit No Signal
P0727	150	Engine Speed Input Circuit No Signal
P0730	100	Incorrect Gear Ratio
P0730	102	Incorrect Gear Ratio
P0731	50	Gear 1 Incorrect Ratio
P0731	51	Gear 1 Incorrect Ratio
P0731	100	Gear 1 Incorrect Ratio
P0731	131	Gear 1 Incorrect Ratio
P0732	52	Gear 2 Incorrect Ratio

**OBD-10****On-Board Diagnostics**

Automatic transmission diagnostic trouble codes (continued)		
P-code	BMW-FC	DTC Definition
P0732	100	Gear 2 Incorrect Ratio
P0732	132	Gear 2 Incorrect Ratio
P0733	53	Gear 3 Incorrect Ratio
P0733	57	Gear 3 Incorrect Ratio
P0733	122	Gear 3 Incorrect Ratio
P0733	133	Gear 3 Incorrect Ratio
P0734	54	Gear 4 Incorrect Ratio
P0734	58	Gear 4 Incorrect Ratio
P0734	123	Gear 4 Incorrect Ratio
P0734	134	Gear 4 Incorrect Ratio
P0735	55	Gear 5 Incorrect Ratio
P0735	101	Gear 5 Incorrect Ratio
P0735	135	Gear 5 Incorrect Ratio
P0740	4	Torque Converter Clutch Circuit/Open
P0740	48	Torque Converter Clutch Circuit/Open
P0740	111	Torque Converter Clutch Circuit/Open
P0741	48	Torque Converter Clutch Circuit Performance or Stuck Off
P0742	48	Torque Converter Clutch Circuit Stuck On
P0743	4	Torque Converter Clutch Circuit Electrical
P0743	32	Torque Converter Clutch Circuit Electrical
P0745	1	Pressure Control Solenoid 'A'
P0748	1	Pressure Control Solenoid 'A' Electrical
P0748	5	Pressure Control Solenoid 'A' Electrical
P0750	16	Shift Solenoid 'A'
P0751	6	Shift Solenoid 'A' Performance or Stuck Off
P0751	16	Shift Solenoid 'A' Performance or Stuck Off
P0752	16	Shift Solenoid 'A' Stuck On
P0753	16	Shift Solenoid 'A' Electrical
P0753	30	Shift Solenoid 'A' Electrical
P0755	17	Shift Solenoid 'B'
P0756	17	Shift Solenoid 'B' Performance or Stuck Off
P0757	17	Shift Solenoid 'B' Stuck On
P0758	17	Shift Solenoid 'B' Electrical
P0758	33	Shift Solenoid 'B' Electrical
P0760	18	Shift Solenoid 'C'
P0761	18	Shift Solenoid 'C' Performance or Stuck Off



Automatic transmission diagnostic trouble codes (continued)		
P-code	BMW-FC	DTC Definition
P0762	18	Shift Solenoid 'C' Stuck On
P0763	2	Shift Solenoid 'C' Electrical
P0763	18	Shift Solenoid 'C' Electrical
P0763	32	Shift Solenoid 'C' Electrical
P0775	2	Pressure Control Solenoid 'B'
P0782	57	2-3 Shift
P0783	58	3-4 Shift
P0795	3	Pressure Control Solenoid 'C'
P0778	2	Pressure Control Solenoid 'B' Electrical
P0798	3	Pressure Control Solenoid 'C' Electrical
P0962	1	Pressure Control Solenoid 'A' Control Circuit Low
P0963	1	Pressure Control Solenoid 'A' Control Circuit High
P0966	2	Pressure Control Solenoid 'B' Control Circuit Low
P0967	2	Pressure Control Solenoid 'B' Control Circuit High
P0970	3	Pressure Control Solenoid 'C' Control Circuit Low
P0971	3	Pressure Control Solenoid 'C' Control Circuit High
P0973	16	Shift Solenoid 'A' Control Circuit Low
P0976	17	Shift Solenoid 'B' Control Circuit Low
P0979	18	Shift Solenoid 'C' Control Circuit Low
P1700	62	Double Error Output Speed and Input/Turbine Speed
P1719	144	CAN Version Error
P1720	129	CAN Timeout Control Module
P1731	51	Gear 1 manual Incorrect Ratio
P1732	65	Gear Monitoring 4 at Electrical Substitute Program
P1734	1	Pressure Control Solenoid 'B' Electrical
P1734	2	Pressure Control Solenoid 'B' Electrical
P1738	3	Pressure Control Solenoid 'C' Electrical
P1738	29	Pressure Control Solenoid 'C' Electrical
P1743	4	Pressure Control Solenoid 'E' Electrical (M44/M52: Brake Band Electrical)
P1743	5	Pressure Control Solenoid 'E' Electrical (M44/M52: Brake Band Electrical)
P1743	51	Pressure Control Solenoid 'E' Electrical (M44/M52: Brake Band Electrical)
P1746	83	Transmission Control Module Output Stage
P1746	104	Transmission Control Module Output Stage
P1747	128	CAN-Bus Monitoring
P1747	129	CAN-Bus Monitoring
P1747	144	CAN-Bus Monitoring

## OBD-12

### On-Board Diagnostics

Automatic transmission diagnostic trouble codes (continued)		
P-code	BMW-FC	DTC Definition
P1747	150	CAN-Bus Monitoring
P1747	151	CAN-Bus Monitoring
P1747	156	CAN-Bus Monitoring
P1748	15	Transmission Control Module Self-Test
P1748	80	Transmission Control Module Self-Test
P1748	81	Transmission Control Module Self-Test
P1748	82	Transmission Control Module Self-Test
P1748	103	Transmission Control Module Self-Test
P1748	105	Transmission Control Module Self-Test
P1748	110	Transmission Control Module Self-Test
P1749	108	Secondary Pressure Solenoid Communication Error (M52: Internal Transmission Control Module Memory Error)
P1750	54	Secondary Pressure Solenoid Circuit Range/Performance (System Voltage Input Low)
P1750	96	Secondary Pressure Solenoid Circuit Range/Performance (System Voltage Input Low)
P1761	2	Shiftlock Solenoid
P1761	19	Shiftlock Solenoid
P1762	19	Shiftlock Solenoid High Input
P1763	19	Shiftlock Solenoid Low Input
P1764	19	Shiftlock Solenoid Open Circuit
P1765	147	CAN Throttle Valve
P1765	154	CAN Throttle Valve
P1765	158	CAN Throttle Valve
P1770	146	CAN Torque Interface
P1780	152	CAN Torque Reduction
P1780	163	CAN Torque Reduction
P1790	80	Internal Transmission Control Module Memory Checksum/EPROM Error
P1791	81	Internal Transmission Control Module Memory Checksum/EEPROM Error
P1792	82	Internal Transmission Control Module Watchdog Error
P1794	80	Internal Transmission Control Module Memory Checksum Error
P1801	16	Shift Solenoid 'A' Low Input
P1802	17	Shift Solenoid 'B' Low Input
P1803	18	Shift Solenoid 'C' Low Input
P1831	1	Pressure Control Solenoid 'A' Circuit High
P1832	2	Pressure Control Solenoid 'B' Circuit High
P1833	3	Pressure Control Solenoid 'C' Circuit High
P1834	4	Pressure Control Solenoid 'D' Circuit High
P1835	5	Pressure Control Solenoid 'E' Circuit High

Automatic transmission diagnostic trouble codes (continued)		
P-code	BMW-FC	DTC Definition
P1841	1	Pressure Control Solenoid 'A' Circuit Low
P1842	2	Pressure Control Solenoid 'B' Circuit Low
P1843	3	Pressure Control Solenoid 'C' Circuit Low
P1844	4	Pressure Control Solenoid 'D' Circuit Low
P1845	5	Pressure Control Solenoid 'E' Circuit Low
P1882	57	2-3 Shift Circuit High
P1883	58	3-4 Shift Circuit High
P1889	96	System Voltage - Electrical
P1891	96	System Voltage High Input
P1892	96	System Voltage Low Input
P1893	83	Supply Voltage Pressure Control Solenoid/Shift Solenoid Circuit High
P1894	83	Supply Voltage Pressure Control Solenoid/Shift Solenoid Circuit Low
P1895	83	Supply Voltage Pressure Control Solenoid/Shift Solenoid No Signal
P2722	5	Pressure Control Solenoid 'E'
P2729	5	Pressure Control Solenoid 'E' Control Circuit Low
P2730	5	Pressure Control Solenoid 'E' Control Circuit High
P2759	4	Torque Converter Clutch Pressure Control Solenoid Control Circuit Electrical
P2761	4	Torque Converter Clutch Pressure Control Solenoid Control Circuit/Open
P2763	4	Torque Converter Clutch Pressure Control Solenoid Control Circuit High
P2764	4	Torque Converter Clutch Pressure Control Solenoid Control Circuit Low

Engine diagnostic trouble codes: M52 engine		
P-code	BMW-FC	DTC Definition
P0101	8	Mass or Volume Air Flow Circuit Range/Performance
P0111	14	Intake Air Temperature Sensor 1 Circuit Range/Performance
P0116	10	Engine Coolant Temperature Circuit Range/Performance
P0120	112	Throttle/Pedal Position Sensor/Switch 'A' Circuit
P0120	113	Throttle/Pedal Position Sensor/Switch 'A' Circuit
P0120	118	Throttle/Pedal Position Sensor/Switch 'A' Circuit
P0120	173	Throttle/Pedal Position Sensor/Switch 'A' Circuit
P0120	174	Throttle/Pedal Position Sensor/Switch 'A' Circuit
P0125	222	Insufficient Coolant Temperature for Closed Loop Fuel Control
P0128	168	Coolant Thermostat (Coolant Temperature Below Thermostat Regulating Temperature)
P0130	150	O2 Sensor Circuit (Bank 1 Sensor 1)
P0130	151	O2 Sensor Circuit (Bank 1 Sensor 1)
P0130	152	O2 Sensor Circuit (Bank 1 Sensor 1)

# OBD-14

## On-Board Diagnostics

Engine diagnostic trouble codes: M52 engine (continued)		
P-code	BMW-FC	DTC Definition
P0133	229	O2 Sensor Circuit Slow Response (Bank 1 Sensor 1)
P0134	186	O2 Sensor Circuit No Activity Detected (Bank 1 Sensor 1)
P0135	25	O2 Sensor Heater Circuit (Bank 1 Sensor 1)
P0136	156	O2 Sensor Circuit (Bank 1 Sensor 2)
P0136	157	O2 Sensor Circuit (Bank 1 Sensor 2)
P0136	215	O2 Sensor Circuit (Bank 1 Sensor 2)
P0139	220	O2 Sensor Circuit Slow Response (Bank 1 Sensor 2)
P0141	61	O2 Sensor Heater Circuit (Bank 1 Sensor 2)
P0150	153	O2 Sensor Circuit (Bank 2 Sensor 1)
P0150	154	O2 Sensor Circuit (Bank 2 Sensor 1)
P0150	155	O2 Sensor Circuit (Bank 2 Sensor 1)
P0153	230	O2 Sensor Circuit Slow Response (Bank 2 Sensor 1)
P0154	187	O2 Sensor Circuit No Activity Detected (Bank 2 Sensor 1)
P0155	55	O2 Sensor Heater Circuit (Bank 2 Sensor 1)
P0156	159	O2 Sensor Circuit (Bank 2 Sensor 2)
P0156	160	O2 Sensor Circuit (Bank 2 Sensor 2)
P0156	216	O2 Sensor Circuit (Bank 2 Sensor 2)
P0159	221	O2 Sensor Circuit Slow Response (Bank 2 Sensor 2)
P0161	79	O2 Sensor Heater Circuit (Bank 2 Sensor 2)
P0170	202	Fuel Trim (Bank 1)
P0173	203	Fuel Trim (Bank 2)
P0201	6	Injector Circuit/Open - Cylinder 1
P0202	5	Injector Circuit/Open - Cylinder 2
P0203	22	Injector Circuit/Open - Cylinder 3
P0204	24	Injector Circuit/Open - Cylinder 4
P0205	33	Injector Circuit/Open - Cylinder 5
P0206	23	Injector Circuit/Open - Cylinder 6
P0301	238	Cylinder 1 Misfire Detected
P0302	239	Cylinder 2 Misfire Detected
P0303	240	Cylinder 3 Misfire Detected
P0304	241	Cylinder 4 Misfire Detected
P0305	242	Cylinder 5 Misfire Detected
P0306	243	Cylinder 6 Misfire Detected
P0325	57	Knock Sensor 1 Circuit (Bank 1 or Single Sensor)
P0330	59	Knock Sensor 2 Circuit (Bank 2)
P0335	83	Crankshaft Position Sensor 'A' Circuit

## Engine diagnostic trouble codes: M52 engine (continued)

P-code	BMW-FC	DTC Definition
P0340	65	Camshaft Position Sensor 'A' Circuit (Bank 1 or Single Sensor)
P0412	62	Secondary Air Injection System Switching Valve A Circuit
P0420	233	Catalyst System Efficiency Below Threshold (Bank 1)
P0430	234	Catalyst System Efficiency Below Threshold (Bank 2)
P0440	250	Evaporative Emission System
P0441	144	Evaporative Emission System Incorrect Purge Flow
P0442	145	Evaporative Emission System Leak Detected (small leak)
P0443	68	Evaporative Emission System Purge Control Valve Circuit
P0500	214	Vehicle Speed Sensor 'A'
P0505	204	Idle Air Control System
P0600	217	Serial Communication Link
P0601	100	Internal Control Module Memory Check Sum Error
P0601	170	Internal Control Module Memory Check Sum Error
P0601	171	Internal Control Module Memory Check Sum Error
P1132	188	O2 Sensor Heater Control Circuit (Bank 1 Sensor 1)
P1133	189	O2 Sensor Heater Control Circuit (Bank 2 Sensor 1)
P1140	149	Mass or Volume Air Flow Circuit Range/Performance Problem
P1145	50	Solenoid Valve Running Losses Control Circuit Electrical
P1161	122	Fuel Trim Adaptation Additive High (Bank 2) (M52: Engine Oil Temperature Sensor Circuit)
P1180	223	O2 Sensor Signal Circuit Slow Switching from Rich to Lean (Bank 1 Sensor 2)
P1181	224	O2 Sensor Signal Circuit Slow Switching from Rich to Lean (Bank 2 Sensor 2)
P1184	220	HO2S Sensor Voltage Excursion Electrical (Bank 1 Sensor 1)
P1185	221	HO2S Sensor Voltage Excursion Electrical (Bank 2 Sensor 1)
P1178	231	O2 Sensor Signal Circuit Slow Switching from Rich to Lean (Bank 1 Sensor 1)
P1179	232	O2 Sensor Signal Circuit Slow Switching from Rich to Lean (Bank 2 Sensor 1)
P1186	190	O2 Sensor Heater Control Circuit (Bank 1 Sensor 2)
P1187	191	O2 Sensor Heater Control Circuit (Bank 2 Sensor 2)
P1188	227	Fuel Control (Bank 1 Sensor 1)
P1189	228	Fuel Control (Bank 2 Sensor 1)
P1190	235	Pre Catalyst Fuel Trim System (Bank 1)
P1191	236	Pre Catalyst Fuel Trim System (Bank 2)
P1192	225	Post Catalyst Fuel Trim System (Bank 1)
P1193	226	Post Catalyst Fuel Trim System (Bank 2)
P1397	18	Camshaft Position Sensor 'B' Circuit (Bank 1)
P1421	246	Secondary Air System (Bank 2)
P1423	245	Secondary Air System (Bank 1)

# OBD-16

## On-Board Diagnostics

Engine diagnostic trouble codes: M52 engine (continued)		
P-code	BMW-FC	DTC Definition
P1432	247	Secondary Air Injection System Incorrect Flow Detected
P1453	35	Secondary Air Injection Pump Relay Control Circuit Electrical
P1470	126	Leakage Diagnostic Pump Control Circuit Electrical
P1475	140	Leakage Diagnostic Pump Reed Switch Did not Close
P1476	143	Leakage Diagnostic Pump Clamped Tube (M52 MY99/00: Leakage Diagnostic Pump Reed Switch Circuit)
P1478	146	Evaporative Emission System Leak Detected (very small leak)
P1509	53	Idle-Speed Control Valve Opening Solenoid Control Circuit Signal Electrical
P1519	03	Oil-Condition Sensor Temperature Measurement (M62/M52/S52: 'A' Camshaft Position Actuator Bank 1)
P1520	104	Oil-Condition Sensor Level Measurement (M52: 'B' Camshaft Position Actuator Bank 1)
P1522	105	Oil-Condition Sensor Permeability Measurement (M62: 'A' Camshaft Position Actuator Bank 2; M52: 'A' Camshaft Position Actuator Tight or Jammed)
P1523	106	'A' Camshaft Position Actuator Signal Low (Bank 1) (M52: 'B' Camshaft Position Actuator Tight or Jammed)
P1525	21	'A' Camshaft Position Actuator Control Open Circuit (Bank 1)
P1529	19	'B' Camshaft Position Actuator Control Circuit Signal Low (Bank 1)
P1542	110	Pedal Position Sensor Electrical
P1542	111	Pedal Position Sensor Electrical
P1542	117	Pedal Position Sensor Electrical
P1542	120	Pedal Position Sensor Electrical
P1542	172	Pedal Position Sensor Electrical
P1542	175	Pedal Position Sensor Electrical
P1542	176	Pedal Position Sensor Electrical
P1550	27	Idle-Speed Control Valve Closing Coil Electrical
P1580	109	Throttle Valve Mechanically Stuck (M73: Throttle Valve 1 Spring Test)
P1580	114	Throttle Valve Mechanically Stuck (M73: Throttle Valve 1 Spring Test)
P1580	119	Throttle Valve Mechanically Stuck (M73: Throttle Valve 1 Spring Test)
P1593	124	DISA (Differentiated Intake Manifold) Control Circuit Electrical
P1622	123	Map Cooling Thermostat Control Circuit Electrical
P1623	115	Pedal Position Sensor Potentiometer Supply
P1623	116	Pedal Position Sensor Potentiometer Supply
P1624	168	Pedal Position Sensor Potentiometer Supply Channel 1 Electrical (M52: Coolant Thermostat (Coolant Temperature Below Thermostat Regulating Temperature))

Engine diagnostic trouble codes: M54 engine		
P-code	BMW-FC	Explanation
P0011	103	'A' Camshaft Position Timing Over-Advanced or System Performance (Bank 1)
P0012	105	'A' Camshaft Position Timing Over-Retarded (Bank 1)
P0014	104	'B' Camshaft Position Timing Over-Advanced or System Performance (Bank 1)
P0015	106	'B' Camshaft Position Timing Over-Retarded (Bank 1)
P0030	25	HO2S Heater Control Circuit (Bank 1 Sensor 1)
P0031	25	HO2S Heater Control Circuit Low (Bank 1 Sensor 1)
P0032	25	HO2S Heater Control Circuit High (Bank 1 Sensor 1)
P0036	79	HO2S Heater Control Circuit (Bank 1 Sensor 2)
P0037	79	HO2S Heater Control Circuit Low (Bank 1 Sensor 2)
P0038	79	HO2S Heater Control Circuit High (Bank 1 Sensor 2)
P0050	55	HO2S Heater Control Circuit (Bank 2 Sensor 1)
P0051	55	HO2S Heater Control Circuit Low (Bank 2 Sensor 1)
P0052	55	HO2S Heater Control Circuit High (Bank 2 Sensor 1)
P0056	61	HO2S Heater Control Circuit (Bank 2 Sensor 2)
P0057	61	HO2S Heater Control Circuit Low (Bank 2 Sensor 2)
P0058	61	HO2S Heater Control Circuit High (Bank 2 Sensor 2)
P0101	149	Mass or Volume Air Flow Circuit Range/Performance
P0102	8	Mass or Volume Air Flow Circuit Low Input
P0103	8	Mass or Volume Air Flow Circuit High Input
P0107	197	Manifold Absolute Pressure/Barometric Pressure Circuit Low Input
P0108	197	Manifold Absolute Pressure/Barometric Pressure Circuit High Input
P0112	14	Intake Air Temperature Sensor 1 Circuit Low
P0113	14	Intake Air Temperature Sensor 1 Circuit High
P0117	10	Engine Coolant Temperature Circuit Low
P0118	10	Engine Coolant Temperature Circuit High
P0121	118	Throttle/Pedal Position Sensor/Switch 'A' Circuit Range/Performance
P0122	112	Throttle/Pedal Position Sensor/Switch 'A' Circuit Low
P0123	112	Throttle/Pedal Position Sensor/Switch 'A' Circuit High
P0125	222	Insufficient Coolant Temperature for Closed Loop Fuel Control
P0128	168	Coolant Thermostat (Coolant Temperature Below Thermostat Regulating Temperature)
P0131	150	O2 Sensor Circuit Low Voltage (Bank 1 Sensor 1)
P0132	150	O2 Sensor Circuit High Voltage (Bank 1 Sensor 1)
P0133	229	O2 Sensor Circuit Slow Response (Bank 1 Sensor 1)
P0133	231	O2 Sensor Circuit Slow Response (Bank 1 Sensor 1)
P0134	150	O2 Sensor Circuit No Activity Detected (Bank 1 Sensor 1)
P0135	188	O2 Sensor Heater Circuit (Bank 1 Sensor 1)

**OBD-18****On-Board Diagnostics**

Engine diagnostic trouble codes: M54 engine (continued)		
P-code	BMW-FC	Explanation
P0137	152	O2 Sensor Circuit Low Voltage (Bank 1 Sensor 2)
P0138	152	O2 Sensor Circuit High Voltage (Bank 1 Sensor 2)
P0139	215	O2 Sensor Circuit Slow Response (Bank 1 Sensor 2)
P0139	248	O2 Sensor Circuit Slow Response (Bank 1 Sensor 2)
P0140	152	O2 Sensor Circuit No Activity Detected (Bank 1 Sensor 2)
P0141	190	O2 Sensor Heater Circuit (Bank 1 Sensor 2)
P0151	151	O2 Sensor Circuit Low Voltage (Bank 2 Sensor 1)
P0152	151	O2 Sensor Circuit High Voltage (Bank 2 Sensor 1)
P0153	230	O2 Sensor Circuit Slow Response (Bank 2 Sensor 1)
P0153	232	O2 Sensor Circuit Slow Response (Bank 2 Sensor 1)
P0154	151	O2 Sensor Circuit No Activity Detected (Bank 2 Sensor 1)
P0155	189	O2 Sensor Heater Circuit (Bank 2 Sensor 1)
P0157	153	O2 Sensor Circuit Low Voltage (Bank 2 Sensor 2)
P0158	153	O2 Sensor Circuit High Voltage (Bank 2 Sensor 2)
P0159	216	O2 Sensor Circuit Slow Response (Bank 2 Sensor 2)
P0159	249	O2 Sensor Circuit Slow Response (Bank 2 Sensor 2)
P0160	153	O2 Sensor Circuit No Activity Detected (Bank 2 Sensor 2)
P0161	191	O2 Sensor Heater Circuit (Bank 2 Sensor 2)
P0171	202	System Too Lean (Bank 1)
P0171	227	System Too Lean (Bank 1)
P0172	202	System Too Rich (Bank 1)
P0172	227	System Too Rich (Bank 1)
P0174	203	System Too Lean (Bank 2)
P0174	228	System Too Lean (Bank 2)
P0175	203	System Too Rich (Bank 2)
P0175	228	System Too Rich (Bank 2)
P0197	122	Engine Oil Temperature Sensor Low
P0198	122	Engine Oil Temperature Sensor High
P0201	6	Injector Circuit/Open - Cylinder 1
P0202	5	Injector Circuit/Open - Cylinder 2
P0203	22	Injector Circuit/Open - Cylinder 3
P0204	24	Injector Circuit/Open - Cylinder 4
P0205	33	Injector Circuit/Open - Cylinder 5
P0206	23	Injector Circuit/Open - Cylinder 6
P0221	119	Throttle/Pedal Position Sensor/Switch 'B' Circuit Range/Performance
P0222	113	Throttle/Pedal Position Sensor/Switch 'B' Circuit Low



Engine diagnostic trouble codes: M54 engine (continued)		
P-code	BMW-FC	Explanation
P0223	113	Throttle/Pedal Position Sensor/Switch 'B' Circuit High
P0261	6	Cylinder 1 Injector Circuit Low
P0262	6	Cylinder 1 Injector Circuit High
P0264	5	Cylinder 2 Injector Circuit Low
P0265	5	Cylinder 2 Injector Circuit High
P0267	22	Cylinder 3 Injector Circuit Low
P0268	22	Cylinder 3 Injector Circuit High
P0270	24	Cylinder 4 Injector Circuit Low
P0271	24	Cylinder 4 Injector Circuit High
P0273	33	Cylinder 5 Injector Circuit Low
P0274	33	Cylinder 5 Injector Circuit High
P0276	23	Cylinder 6 Injector Circuit Low
P0277	23	Cylinder 6 Injector Circuit High
P0301	238	Cylinder 1 Misfire Detected
P0302	239	Cylinder 2 Misfire Detected
P0303	240	Cylinder 3 Misfire Detected
P0304	241	Cylinder 4 Misfire Detected
P0305	242	Cylinder 5 Misfire Detected
P0306	243	Cylinder 6 Misfire Detected
P0313	238	Misfire Detected with Low Fuel
P0313	239	Misfire Detected with Low Fuel
P0313	240	Misfire Detected with Low Fuel
P0313	241	Misfire Detected with Low Fuel
P0313	242	Misfire Detected with Low Fuel
P0313	243	Misfire Detected with Low Fuel
P0327	57	Knock Sensor 1 Circuit Low (Bank 1 or Single Sensor)
P0332	59	Knock Sensor 2 Circuit Low (Bank 2)
P0335	83	Crankshaft Position Sensor 'A' Circuit
P0339	83	Crankshaft Position Sensor 'A' Circuit Intermittent
P0340	65	Camshaft Position Sensor 'A' Circuit (Bank 1 or Single Sensor)
P0344	65	Camshaft Position Sensor 'A' Circuit Intermittent (Bank 1 or Single Sensor)
P0365	18	Camshaft Position Sensor 'B' Circuit (Bank 1)
P0369	18	Camshaft Position Sensor 'B' Circuit Intermittent (Bank 1)
P0413	62	Secondary Air Injection System Switching Valve A Circuit Open
P0414	62	Secondary Air Injection System Switching Valve A Circuit Shorted
P0420	233	Catalyst System Efficiency Below Threshold (Bank 1)

**OBD-20****On-Board Diagnostics**

Engine diagnostic trouble codes: M54 engine (continued)		
P-code	BMW-FC	Explanation
P0430	234	Catalyst System Efficiency Below Threshold (Bank 2)
P0441	250	Evaporative Emission System Incorrect Purge Flow
P0443	68	Evaporative Emission System Purge Control Valve Circuit
P0444	68	Evaporative Emission System Purge Control Valve Circuit Open
P0445	68	Evaporative Emission System Purge Control Valve Circuit Shorted
P0455	143	Evaporative Emission System Leak Detected (large leak)
P0456	143	Evaporative Emission System Leak Detected (very small leak)
P0491	245	Secondary Air Injection System Insufficient Flow (Bank 1)
P0492	246	Secondary Air Injection System Insufficient Flow (Bank 2)
P0500	214	Vehicle Speed Sensor 'A'
P0505	204	Idle Air Control System
P0600	217	Serial Communication Link
P0604	100	Internal Control Module Random Access Memory (RAM) Error
P1083	202	Fuel Control Limit Mixture Too Lean (Bank 1 Sensor 1)
P1084	202	Fuel Control Limit Mixture Too Rich (Bank 1 Sensor 1)
P1085	203	Fuel Control Limit Mixture Too Lean (Bank 2 Sensor 1)
P1086	203	Fuel Control Limit Mixture Too Rich (Bank 2 Sensor 1)
P1087	229	O2 Sensor Circuit Slow Response in Lean Control Range (Bank 1 Sensor 1)
P1088	229	O2 Sensor Circuit Slow Response in Rich Control Range (Bank 1 Sensor 1)
P1089	230	O2 Sensor Circuit Slow Response in Lean Control Range (Bank 1 Sensor 2)
P1090	235	Pre Catalyst Fuel Trim System Too Lean (Bank 1)
P1091	236	Pre Catalyst Fuel Trim System Too Lean (Bank 2)
P1092	235	Pre Catalyst Fuel Trim System Too Rich (Bank 1)
P1093	236	Pre Catalyst Fuel Trim System Too Rich (Bank 2)
P1094	230	O2 Sensor Circuit Slow Response in Rich Control Range (Bank 2 Sensor 1)
P1111	11	Engine Coolant Temperature Sensor Radiator Outlet Low Input
P1112	11	Engine Coolant Temperature Sensor Radiator Outlet High Input
P1120	114	Pedal Position Sensor Circuit
P1121	117	Pedal Position Sensor 1 Range/Performance Problem
P1122	110	Pedal Position Sensor 1 Low Input
P1123	110	Pedal Position Sensor 1 High Input
P1134	25	O2 Sensor Heater Circuit Signal Intermittent (Bank 1 Sensor 1)
P1135	25	O2 Sensor Heater Circuit Low Voltage (Bank 1 Sensor 1)
P1136	25	O2 Sensor Heater Circuit High Voltage (Bank 1 Sensor 1)
P1137	79	O2 Sensor Heater Circuit Signal Intermittent (Bank 1 Sensor 2)
P1138	79	O2 Sensor Heater Circuit Low Voltage (Bank 1 Sensor 2)

## Engine diagnostic trouble codes: M54 engine (continued)

P-code	BMW-FC	Explanation
P1139	79	O2 Sensor Heater Circuit High Voltage (Bank 1 Sensor 2)
P1143	215	O2 Sensor Activity Check Signal Too High (Bank 1 Sensor 2)
P1144	215	O2 Sensor Activity Check Signal Too Low (Bank 1 Sensor 2)
P1149	216	O2 Sensor Activity Check Signal Too High (Bank 2 Sensor 2)
P1150	216	O2 Sensor Activity Check Signal Too Low (Bank 2 Sensor 2)
P1151	55	O2 Sensor Heater Circuit Signal Intermittent (Bank 2 Sensor 1)
P1152	55	O2 Sensor Heater Circuit Low Voltage (Bank 2 Sensor 1)
P1153	55	O2 Sensor Heater Circuit High Voltage (Bank 2 Sensor 1)
P1155	61	O2 Sensor Heater Circuit Signal Intermittent (Bank 2 Sensor 2)
P1156	61	O2 Sensor Heater Circuit Low Voltage (Bank 2 Sensor 2)
P1157	61	O2 Sensor Heater Circuit High Voltage (Bank 2 Sensor 2)
P1171	196	Ambient Pressure Sensor Variant Recognition Value in Boot Range Implausible
P1172	196	Ambient Pressure Sensor Variant Recognition Error Value Stored in Boot Range
P1173	196	Ambient Pressure Sensor Variant Recognition Learning Failed
P1190	235	Pre Catalyst Fuel Trim System (Bank 1)
P1191	236	Pre Catalyst Fuel Trim System (Bank 2)
P1192	225	Post Catalyst Fuel Trim System (Bank 1)
P1193	226	Post Catalyst Fuel Trim System (Bank 2)
P1222	111	Pedal Position Sensor 2 Low Input
P1223	111	Pedal Position Sensor 2 High Input
P1314	202	Fuel Mixture Deviation Detected with Low Fuel
P1314	203	Fuel Mixture Deviation Detected with Low Fuel
P1314	227	Fuel Mixture Deviation Detected with Low Fuel
P1314	228	Fuel Mixture Deviation Detected with Low Fuel
P1342	238	Misfire During Start Cylinder 1
P1343	238	Misfire Cylinder 1 with Fuel Cut-Off
P1344	239	Misfire During Start Cylinder 2
P1345	239	Misfire Cylinder 2 with Fuel Cut-Off
P1346	240	Misfire During Start Cylinder 3
P1347	240	Misfire Cylinder 3 with Fuel Cut-Off
P1348	241	Misfire During Start Cylinder 4
P1349	241	Misfire Cylinder 4 with Fuel Cut-Off
P1350	242	Misfire during Start Cylinder 5
P1351	242	Misfire Cylinder 5 with Fuel Cut-Off
P1352	243	Misfire during Start Cylinder 6
P1353	243	Misfire Cylinder 6 with Fuel Cut-Off

## OBD-22

### On-Board Diagnostics

Engine diagnostic trouble codes: M54 engine (continued)		
P-code	BMW-FC	Explanation
P1413	35	Secondary Air Injection Pump Relay Control Circuit Signal Low
P1414	35	Secondary Air Injection Pump Relay Control Circuit Signal High
P1444	142	Diagnostic Module Tank Leakage (DM-TL) Pump Control Open Circuit
P1445	140	Diagnostic Module Tank Leakage (DM-TL) Pump Control Circuit Signal Low
P1446	140	Diagnostic Module Tank Leakage (DM-TL) Pump Control Circuit Signal High
P1447	142	Diagnostic Module Tank Leakage (DM-TL) Pump Current Too High during Switching Solenoid Test
P1448	142	Diagnostic Module Tank Leakage (DM-TL) Pump Current Too Low
P1449	142	Diagnostic Module Tank Leakage (DM-TL) Pump Current Too High
P1451	126	Diagnostic Module Tank Leakage (DM-TL) Switching Solenoid Control Circuit Signal Low
P1452	126	Diagnostic Module Tank Leakage (DM-TL) Switching Solenoid Control Circuit Signal High
P1500	211	Idle-Speed Control Valve Stuck Open
P1501	211	Idle-Speed Control Valve Stuck Closed
P1502	27	Idle-Speed Control Valve Closing Solenoid Control Circuit Signal High
P1503	27	Idle-Speed Control Valve Closing Solenoid Control Circuit Signal Low
P1504	27	Idle-Speed Control Valve Closing Solenoid Control Open Circuit
P1506	53	Idle-Speed Control Valve Opening Solenoid Control Circuit Signal High
P1507	53	Idle-Speed Control Valve Opening Solenoid Control Circuit Signal Low
P1508	53	Idle-Speed Control Valve Opening Solenoid Control Open Circuit
P1512	124	DISA (Differentiated Intake Manifold) Control Circuit Signal Low
P1513	124	DISA (Differentiated Intake Manifold) Control Circuit Signal High
P1523	21	'A' Camshaft Position Actuator Signal Low (Bank 1) (M52: 'B' Camshaft Position Actuator Tight or Jammed)
P1524	21	'A' Camshaft Position Actuator Control Circuit Signal High (Bank 1)
P1525	21	'A' Camshaft Position Actuator Control Open Circuit (Bank 1)
P1529	19	'B' Camshaft Position Actuator Control Circuit Signal Low (Bank 1)
P1530	19	'B' Camshaft Position Actuator Control Circuit Signal High (Bank 1) (S54 to 09/00: Throttle Valve Position Control, Control Deviation)
P1531	19	'B' Camshaft Position Actuator Control Open Circuit (Bank 1)
P1602	48	Control Module Self-Test, Control Module Defective
P1602	58	Control Module Self-Test, Control Module Defective
P1602	63	Control Module Self-Test, Control Module Defective
P1602	66	Control Module Self-Test, Control Module Defective
P1602	67	Control Module Self-Test, Control Module Defective
P1602	70	Control Module Self-Test, Control Module Defective
P1602	71	Control Module Self-Test, Control Module Defective
P1602	72	Control Module Self-Test, Control Module Defective
P1603	49	Control Module Self-Test, Torque Monitoring

Engine diagnostic trouble codes: M54 engine (continued)		
P-code	BMW-FC	Explanation
P1604	50	Control Module Self-Test, Speed Monitoring
P1604	51	Control Module Self-Test, Speed Monitoring
P1619	123	Map Cooling Thermostat Control Circuit Signal Low
P1620	123	Map Cooling Thermostat Control Circuit Signal High
P1624	146	Pedal Position Sensor Potentiometer Supply Channel 1 Electrical (M52: Coolant Thermostat (Coolant Temperature Below Thermostat Regulating Temperature))
P1625	147	Pedal Position Sensor Potentiometer Supply Channel 2 Electrical
P1632	115	Throttle Valve Adaptation Conditions Not Met
P1633	115	Throttle Valve Adaptation Limp-Home Position Unknown
P1634	115	Throttle Valve Adaptation Spring Test Failed
P1634	135	Throttle Valve Adaptation Spring Test Failed
P1634	136	Throttle Valve Adaptation Spring Test Failed
P1635	115	Throttle Valve Adaptation Lower Mechanical Stop not Adapted
P1636	109	Throttle Valve Control Circuit
P1637	162	Throttle Valve Position Control, Control Deviation
P1638	160	Throttle Valve Position Control Throttle Stuck Temporarily
P1639	161	Throttle Valve Position Control Throttle Stuck Permanently
P1675	135	Throttle Valve Actuator Start Test Re-Adaptation Required
P1694	136	Throttle Valve Actuator Start Test Spring Test and Limp-Home Position Failed
P2088	21	'A' Camshaft Position Actuator Control Circuit Low (Bank 1)
P2089	21	'A' Camshaft Position Actuator Control Circuit High (Bank 1)
P2090	19	'B' Camshaft Position Actuator Control Circuit Low (Bank 1)
P2091	19	'B' Camshaft Position Actuator Control Circuit High (Bank 1)
P2096	225	Post Catalyst Fuel Trim System Too Lean (Bank 1)
P2098	226	Post Catalyst Fuel Trim System Too Lean (Bank 2)
P2228	197	Barometric Pressure Circuit Low
P2229	197	Barometric Pressure Circuit High
P2270	215	O2 Sensor Signal Stuck Lean (Bank 1 Sensor 2)
P2271	215	O2 Sensor Signal Stuck Lean (Bank 1 Sensor 2)
P2272	216	O2 Sensor Signal Stuck Lean (Bank 2 Sensor 2)
P2273	216	O2 Sensor Signal Stuck Lean (Bank 2 Sensor 2)
P3041	10481	O2 Sensor Lean and Rich Voltage Thresholds not Reached (Bank 2 Sensor 2)
P3198	10205	Engine Coolant Temperature Gradient Too High
P3199	10207	Engine Coolant Temperature Signal Stuck
P3238	10289	Control Module Monitoring TPU Chip Defective

## OBD-24

### On-Board Diagnostics

Engine diagnostic trouble codes: M62 engine		
P-code	BMW-FC	Explanation
P0010	33	'A' Camshaft Position Actuator Circuit (Bank 1)
P0011	33	'A' Camshaft Position Timing Over-Advanced or System Performance (Bank 1)
P0012	33	'A' Camshaft Position Timing Over-Retarded (Bank 1)
P0020	34	'A' Camshaft Position Actuator Circuit (Bank 2)
P0021	34	'A' Camshaft Position Timing Over-Advanced or System Performance (Bank 2)
P0022	34	'A' Camshaft Position Timing Over-Retarded (Bank 2)
P0030	13	HO2S Heater Control Circuit (Bank 1 Sensor 1)
P0031	13	HO2S Heater Control Circuit Low (Bank 1 Sensor 1)
P0032	13	HO2S Heater Control Circuit High (Bank 1 Sensor 1)
P036	14	HO2S Heater Control Circuit (Bank 1 Sensor 2)
P0037	14	HO2S Heater Control Circuit Low (Bank 1 Sensor 2)
P0038	14	HO2S Heater Control Circuit High (Bank 1 Sensor 2)
P0050	5	HO2S Heater Control Circuit (Bank 2 Sensor 1)
P0051	5	HO2S Heater Control Circuit Low (Bank 2 Sensor 1)
P0052	5	HO2S Heater Control Circuit High (Bank 2 Sensor 1)
P0056	4	HO2S Heater Control Circuit (Bank 2 Sensor 2)
P0057	4	HO2S Heater Control Circuit Low (Bank 2 Sensor 2)
P0058	4	HO2S Heater Control Circuit High (Bank 2 Sensor 2)
P0102	115	Mass or Volume Air Flow Circuit Low Input
P0103	115	Mass or Volume Air Flow Circuit High Input
P0112	124	Intake Air Temperature Sensor 1 Circuit Low
P0113	124	Intake Air Temperature Sensor 1 Circuit High
P0116	123	Engine Coolant Temperature Circuit Range/Performance
P0117	123	Engine Coolant Temperature Circuit Low
P0118	123	Engine Coolant Temperature Circuit High
P0119	123	Engine Coolant Temperature Circuit Intermittent
P0120	117	Throttle/Pedal Position Sensor/Switch 'A' Circuit
P0121	118	Throttle/Pedal Position Sensor/Switch 'A' Circuit Range/Performance
P0122	118	Throttle/Pedal Position Sensor/Switch 'A' Circuit Low
P0123	118	Throttle/Pedal Position Sensor/Switch 'A' Circuit High
P0125	123	Insufficient Coolant Temperature for Closed Loop Fuel Control
P0128	139	Coolant Thermostat (Coolant Temperature Below Thermostat Regulating Temperature)
P0130	10	O2 Sensor Circuit (Bank 1 Sensor 1)
P0131	10	O2 Sensor Circuit Low Voltage (Bank 1 Sensor 1)
P0132	10	O2 Sensor Circuit High Voltage (Bank 1 Sensor 1)
P0133	15	O2 Sensor Circuit Slow Response (Bank 1 Sensor 1)

## Engine diagnostic trouble codes: M62 engine (continued)

P-code	BMW-FC	Explanation
P0134	10	O2 Sensor Circuit No Activity Detected (Bank 1 Sensor 1)
P0135	13	O2 Sensor Heater Circuit (Bank 1 Sensor 1)
P0136	12	O2 Sensor Circuit (Bank 1 Sensor 2)
P0137	12	O2 Sensor Circuit Low Voltage (Bank 1 Sensor 2)
P0138	12	O2 Sensor Circuit High Voltage (Bank 1 Sensor 2)
P0139	17	O2 Sensor Circuit Slow Response (Bank 1 Sensor 2)
P0140	12	O2 Sensor Circuit No Activity Detected (Bank 1 Sensor 2)
P0141	14	O2 Sensor Heater Circuit (Bank 1 Sensor 2)
P0150	18	O2 Sensor Circuit (Bank 2 Sensor 1)
P0151	18	O2 Sensor Circuit Low Voltage (Bank 2 Sensor 1)
P0152	18	O2 Sensor Circuit High Voltage (Bank 2 Sensor 1)
P0153	21	O2 Sensor Circuit Slow Response (Bank 2 Sensor 1)
P0154	18	O2 Sensor Circuit No Activity Detected (Bank 2 Sensor 1)
P0155	5	O2 Sensor Heater Circuit (Bank 2 Sensor 1)
P0156	20	O2 Sensor Circuit (Bank 2 Sensor 2)
P0157	20	O2 Sensor Circuit Low Voltage (Bank 2 Sensor 2)
P0158	20	O2 Sensor Circuit High Voltage (Bank 2 Sensor 2)
P0159	23	O2 Sensor Circuit Slow Response (Bank 2 Sensor 2)
P0160	20	O2 Sensor Circuit No Activity Detected (Bank 2 Sensor 2)
P0161	4	O2 Sensor Heater Circuit (Bank 2 Sensor 2)
P0171	24	System Too Lean (Bank 1)
P0171	26	System Too Lean (Bank 1)
P0172	24	System Too Rich (Bank 1)
P0172	26	System Too Rich (Bank 1)
P0174	25	System Too Lean (Bank 2)
P0174	27	System Too Lean (Bank 2)
P0175	25	System Too Rich (Bank 2)
P0175	27	System Too Rich (Bank 2)
P0201	150	Injector Circuit/Open - Cylinder 1
P0202	157	Injector Circuit/Open - Cylinder 2
P0203	155	Injector Circuit/Open - Cylinder 3
P0204	152	Injector Circuit/Open - Cylinder 4
P0205	151	Injector Circuit/Open - Cylinder 5
P0206	154	Injector Circuit/Open - Cylinder 6
P0207	156	Injector Circuit/Open - Cylinder 7
P0208	153	Injector Circuit/Open - Cylinder 8

**OBD-26****On-Board Diagnostics****Engine diagnostic trouble codes: M62 engine (continued)**

P-code	BMW-FC	Explanation
P0221	119	Throttle/Pedal Position Sensor/Switch 'B' Circuit Range/Performance
P0222	119	Throttle/Pedal Position Sensor/Switch 'B' Circuit Low
P0223	119	Throttle/Pedal Position Sensor/Switch 'B' Circuit High
P0261	150	Cylinder 1 Injector Circuit Low
P0262	150	Cylinder 1 Injector Circuit High
P0264	157	Cylinder 2 Injector Circuit Low
P0265	157	Cylinder 2 Injector Circuit High
P0267	155	Cylinder 3 Injector Circuit Low
P0268	155	Cylinder 3 Injector Circuit High
P0270	152	Cylinder 4 Injector Circuit Low
P0271	152	Cylinder 4 Injector Circuit High
P0273	151	Cylinder 5 Injector Circuit Low
P0274	151	Cylinder 5 Injector Circuit High
P0276	154	Cylinder 6 Injector Circuit Low
P0277	154	Cylinder 6 Injector Circuit High
P0279	156	Cylinder 7 Injector Circuit Low
P0280	156	Cylinder 7 Injector Circuit High
P0282	153	Cylinder 8 Injector Circuit Low
P0283	153	Cylinder 8 Injector Circuit High
P0300	62	Random/Multiple Cylinder Misfire Detected
P0301	50	Cylinder 1 Misfire Detected
P0302	57	Cylinder 2 Misfire Detected
P0303	55	Cylinder 3 Misfire Detected
P0304	52	Cylinder 4 Misfire Detected
P0305	51	Cylinder 5 Misfire Detected
P0306	54	Cylinder 6 Misfire Detected
P0307	56	Cylinder 7 Misfire Detected
P0308	53	Cylinder 8 Misfire Detected
P0316	62	Engine Misfire Detected on Startup (First 1000 Revolutions)
P0324	214	Knock Control System Error
P0324	215	Knock Control System Error
P0324	216	Knock Control System Error
P0327	210	Knock Sensor 1 Circuit Low (Bank 1 or Single Sensor)
P0328	210	Knock Sensor 1 Circuit High (Bank 1 or Single Sensor)
P0332	212	Knock Sensor 2 Circuit Low (Bank 2)
P0333	212	Knock Sensor 2 Circuit High Input (Bank 2)



Engine diagnostic trouble codes: M62 engine (continued)		
P-code	BMW-FC	Explanation
P0335	111	Crankshaft Position Sensor 'A' Circuit
P0340	113	Camshaft Position Sensor 'A' Circuit (Bank 1 or Single Sensor)
P0342	113	Camshaft Position Sensor 'A' Circuit Low (Bank 1 or Single Sensor)
P0343	113	Camshaft Position Sensor 'A' Circuit High (Bank 1 or Single Sensor)
P0345	114	Camshaft Position Sensor 'A' Circuit (Bank 2)
P0347	114	Camshaft Position Sensor 'A' Circuit Low (Bank 2)
P0348	114	Camshaft Position Sensor 'A' Circuit High (Bank 2)
P0363	62	Misfire Detected - Fueling Disabled
P0370	112	Timing Reference High Resolution Signal 'A'
P0412	85	Secondary Air Injection System Switching Valve A Circuit
P0413	85	Secondary Air Injection System Switching Valve A Circuit Open
P0414	85	Secondary Air Injection System Switching Valve A Circuit Shorted
P0418	84	Secondary Air Injection System Control 'A' Circuit
P0420	40	Catalyst System Efficiency Below Threshold (Bank 1)
P0430	45	Catalyst System Efficiency Below Threshold (Bank 2)
P0440	93	Evaporative Emission System
P0442	183	Evaporative Emission System Leak Detected (small leak)
P0442	188	Evaporative Emission System Leak Detected (small leak)
P0443	98	Evaporative Emission System Purge Control Valve Circuit
P0444	98	Evaporative Emission System Purge Control Valve Circuit Open
P0445	98	Evaporative Emission System Purge Control Valve Circuit Shorted
P0450	185	Evaporative Emission System Pressure Sensor/Switch
P0452	185	Evaporative Emission System Pressure Sensor/Switch Low
P0453	185	Evaporative Emission System Pressure Sensor/Switch High
P0455	183	Evaporative Emission System Leak Detected (large leak)
P0456	187	Evaporative Emission System Leak Detected (very small leak)
P0491	80	Secondary Air Injection System Insufficient Flow (Bank 1)
P0492	81	Secondary Air Injection System Insufficient Flow (Bank 2)
P0500	120	Vehicle Speed Sensor 'A'
P0506	32	Idle Air Control System RPM Lower Than Expected
P0507	32	Idle Air Control System RPM Higher Than Expected
P0600	220	Serial Communication Link
P1102	163	Idle Control System, Adaptation of Unmetered Air Mass Too Low
P1103	163	Idle Control System, Adaptation of Unmetered Air Mass Too Large
P1130	17	O2 Sensor Circuit Dynamic Test (Bank 1 Sensor 2)
P1131	23	O2 Sensor Circuit Dynamic Test (Bank 2 Sensor 2)

## On-Board Diagnostics

Engine diagnostic trouble codes: M62 engine (continued)		
P-code	BMW-FC	Explanation
P1134	13	O2 Sensor Heater Circuit Signal Intermittent (Bank 1 Sensor 1)
P1135	13	O2 Sensor Heater Circuit Low Voltage (Bank 1 Sensor 1)
P1136	13	O2 Sensor Heater Circuit High Voltage (Bank 1 Sensor 1)
P1137	14	O2 Sensor Heater Circuit Signal Intermittent (Bank 1 Sensor 2)
P1138	14	O2 Sensor Heater Circuit Low Voltage (Bank 1 Sensor 2)
P1139	14	O2 Sensor Heater Circuit High Voltage (Bank 1 Sensor 2)
P1151	5	O2 Sensor Heater Circuit Signal Intermittent (Bank 2 Sensor 1)
P1152	5	O2 Sensor Heater Circuit Low Voltage (Bank 2 Sensor 1)
P1153	5	O2 Sensor Heater Circuit High Voltage (Bank 2 Sensor 1)
P1155	4	O2 Sensor Heater Circuit Signal Intermittent (Bank 2 Sensor 2)
P1156	4	O2 Sensor Heater Circuit Low Voltage (Bank 2 Sensor 2)
P1157	4	O2 Sensor Heater Circuit High Voltage (Bank 2 Sensor 2)
P1158	28	Fuel Trim Adaptation Additive Low (Bank 1)
P1159	28	Fuel Trim Adaptation Additive High (Bank 1)
P1160	29	Fuel Trim Adaptation Additive Low (Bank 2)
P1161	29	Fuel Trim Adaptation Additive High (Bank 2)
P1327	211	Knock Sensor 2 Circuit Low Input (Bank 1)
P1328	211	Knock Sensor 2 Circuit High Input (Bank 1)
P1332	213	Knock Sensor 4 Circuit Low Input
P1333	213	Knock Sensor 4 Circuit High Input
P1340	62	Multiple Cylinder Misfire During Start
P1341	62	Multiple Cylinder Misfire with Fuel Cut-Off
P1342	50	Misfire During Start Cylinder 1
P1343	50	Misfire Cylinder 1 with Fuel Cut-Off
P1344	57	Misfire During Start Cylinder 2
P1345	57	Misfire Cylinder 2 with Fuel Cut-Off
P1346	55	Misfire During Start Cylinder 3
P1347	55	Misfire Cylinder 3 with Fuel Cut-Off
P1348	52	Misfire During Start Cylinder 4
P1349	52	Misfire Cylinder 4 with Fuel Cut-Off
P1350	51	Misfire during Start Cylinder 5
P1351	51	Misfire Cylinder 5 with Fuel Cut-Off
P1352	54	Misfire during Start Cylinder 6
P1353	54	Misfire Cylinder 6 with Fuel Cut-Off
P1354	56	Misfire during Start Cylinder 7
P1355	56	Misfire Cylinder 7 with Fuel Cut-Off

Engine diagnostic trouble codes: M62 engine (continued)		
P-code	BMW-FC	Explanation
P1356	53	Misfire during Start Cylinder 8
P1357	53	Misfire Cylinder 8 with Fuel Cut-Off
P1381	215	Control Module Self-Test, Knock Control Offset (Bank 1)
P1382	216	Control Module Self-Test, Knock Control Test Pulse (Bank 1)
P1386	214	Control Module Self-Test, Knock Control Circuit Baseline Test (Bank 1)
P1413	84	Secondary Air Injection Pump Relay Control Circuit Signal Low
P1414	84	Secondary Air Injection Pump Relay Control Circuit Signal High
P1441	1	Leakage Diagnostic Pump Control Open Circuit
P1442	1	Leakage Diagnostic Pump Control Circuit Signal Low
P1443	1	Leakage Diagnostic Pump Control Circuit Signal High
P1444	186	Diagnostic Module Tank Leakage (DM-TL) Pump Control Open Circuit
P1445	186	Diagnostic Module Tank Leakage (DM-TL) Pump Control Circuit Signal Low
P1446	186	Diagnostic Module Tank Leakage (DM-TL) Pump Control Circuit Signal High
P1447	189	Diagnostic Module Tank Leakage (DM-TL) Pump Current Too High during Switching Solenoid Test
P1448	189	Diagnostic Module Tank Leakage (DM-TL) Pump Current Too Low
P1449	189	Diagnostic Module Tank Leakage (DM-TL) Pump Current Too High
P1450	2	Diagnostic Module Tank Leakage (DM-TL) Switching Solenoid Control Open Circuit
P1451	2	Diagnostic Module Tank Leakage (DM-TL) Switching Solenoid Control Circuit Signal Low
P1452	2	Diagnostic Module Tank Leakage (DM-TL) Switching Solenoid Control Circuit Signal High
P1476	184	Leakage Diagnostic Pump Clamped Tube
P1523	165	'A' Camshaft Position Actuator Signal Low (Bank 1)
P1524	165	'A' Camshaft Position Actuator Control Circuit Signal High (Bank 1)
P1525	165	'A' Camshaft Position Actuator Control Open Circuit (Bank 1)
P1526	166	'A' Camshaft Position Actuator Control Open Circuit (Bank 2)
P1527	166	'A' Camshaft Position Actuator Control Circuit Signal Low (Bank 2)
P1528	166	'A' Camshaft Position Actuator Control Circuit Signal High (Bank 2)
P1633	136	Throttle Valve Adaptation Limp-Home Position Unknown
P1634	133	Throttle Valve Adaptation Spring Test Failed
P1635	134	Throttle Valve Adaptation Lower Mechanical Stop not Adapted
P1636	132	Throttle Valve Control Circuit
P1637	130	Throttle Valve Position Control, Control Deviation
P1638	131	Throttle Valve Position Control Throttle Stuck Temporarily
P1639	131	Throttle Valve Position Control Throttle Stuck Permanently
P1643	135	Throttle Valve Actuator Start Test Amplifier Balancing Plausibility
P2088	165	'A' Camshaft Position Actuator Control Circuit Low (Bank 1)
P2089	165	'A' Camshaft Position Actuator Control Circuit High (Bank 1)

## OBD-30

### On-Board Diagnostics

Engine diagnostic trouble codes: M62 engine (continued)		
P-code	BMW-FC	Explanation
P2092	166	'A' Camshaft Position Actuator Control Circuit Low (Bank 2)
P2093	166	'A' Camshaft Position Actuator Control Circuit High (Bank 2)
P2096	225	Post Catalyst Fuel Trim System Too Lean (Bank 1)
P2098	226	Post Catalyst Fuel Trim System Too Lean (Bank 2)
P2177	26	System Too Lean Off Idle (Bank 1)
P2178	26	System Too Rich Off Idle (Bank 1)
P2179	27	System Too Lean Off Idle (Bank 2)
P2180	27	System Too Rich Off Idle (Bank 2)
P2187	28	System Too Lean at Idle (Bank 1)
P2188	28	System Too Rich at Idle (Bank 1)
P2189	29	System Too Lean at Idle (Bank 2)
P2190	29	System Too Rich at Idle (Bank 2)
P2191	24	System Too Lean at Higher Load (Bank 1)
P2192	24	System Too Rich at Higher Load (Bank 1)
P2193	25	System Too Lean at Higher Load (Bank 2)
P2194	25	System Too Rich at Higher Load (Bank 2)
P2270	17	O2 Sensor Signal Stuck Lean (Bank 1 Sensor 2)
P2271	17	O2 Sensor Signal Stuck Rich (Bank 1 Sensor 2)
P2272	23	O2 Sensor Signal Stuck Lean (Bank 2 Sensor 2)
P2273	23	O2 Sensor Signal Stuck Rich (Bank 2 Sensor 2)



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**3/2-way valve (running losses)**  
see Fuel tank

**A**

**Abbreviations, commonly used**  
600-14

**ABS (antilock brake system)**  
see Brakes

**A/C**

air distribution motors  
see stepper motors (below)  
blower final stage (resistor pack),  
replacing 640-16  
blower, removing/installing  
640-15  
compressor, replacing 640-24  
condenser, replacing 640-25  
control panel/module, removing/  
installing 640-11  
evaporator, removing/installing  
640-29  
evaporator temperature sensor  
640-12  
expansion valve, removing/installing  
640-27  
IHKA / IHKR system description 640-5  
receiver/drier, replacing 640-26  
stepper motors 640-13  
ventilation microfilter, replacing  
020-22, 640-17  
see also Heating

**Accelerator linkage**  
see Maintenance

**Activated carbon canister**  
see Fuel tank

**ADS (auxiliary throttle valve)**  
130-57

**Air compressor**  
330-44

**Air conditioning**  
see A/C

**Air distribution (flap) motors**  
see A/C, stepper motors

**Air filter**  
see Maintenance

**Air spring**  
300-8, 330-12

**Airbag system (SRS)**  
2-stage airbag 721-4  
control module, replacing 721-7  
driver airbag, removing/installing  
721-8  
head protection airbag 721-12  
components 721-11  
indicator light 721-4  
passenger airbag, removing/installing  
721-9  
side-impact airbags crash sensor,  
replacing 721-7

**Airflow sensor**  
see 130 under appropriate fuel  
injection system

**Air pump**  
see 130 under appropriate fuel  
injection system, secondary air  
injection system

**Air suspension**  
see Electronic height control  
(EHC)

**Alarm**  
see Anti-theft alarm

**Alignment**  
see Wheel alignment

**Aluminum suspension components**  
300-2

**Antenna**  
650-6

**Alternator**  
see Battery, starter, alternator

**Amplifier**  
650-4

**Anti-theft alarm (DWA)**  
515-24  
emergency disarming 515-31

**Antifreeze (engine coolant)**  
see Maintenance  
see also Cooling system

**Antilock brake system (ABS)**  
see Brakes

**ASC**  
see Brakes

**ATF (automatic transmission fluid)**  
see Automatic transmission  
see also Cooling system

**Automatic headlight adjustment  
(LWR)**  
see Lights

**Automatic seat belt tensioner**  
720-4

**Automatic shiftlock**  
see Gearshift

**Automatic transmission**  
applications 200-3, 240-4  
ATF 020-10, 200-4  
capacity 240-8  
checking 240-6  
draining/filling 240-7  
heat exchanger 170-5  
fluid pan and strainer 240-9  
gearshift  
see Gearshift  
ID tag 200-3  
range switch 610-6  
removal/installation 240-10  
steplonic  
see Gearshift

**Auxiliary cooling fan**  
see Cooling system, electric fan

**Auxiliary throttle valve (ADS)**  
130-57

**Axle joint**  
see Drive axle

**B**

**Back-up light switch**  
automatic transmission  
see Automatic transmission,  
range switch  
manual transmission 230-8

## 2 INDEX

### Battery, starter, alternator

- alternator (generator) 121-10
- 6-cylinder engine, removing/  
installing 121-15
- M62 engine 121-16
- M62 TU engine (water cooled)  
121-18
- battery 121-5
- charging 121-9
- safety terminal 121-3
- testing 121-5
- charging system, troubleshooting  
121-12
- starter 121-19
- 6-cylinder engine, removing/  
installing 121-20
- V-8 engine, removing/installing  
121-21
- solenoid, removing/installing 121-23
- troubleshooting 121-19
- see also* Maintenance

### Bearing, wheel

- see* Front suspension
- see also* Rear suspension

### Belts

- see* Maintenance, drive belts

### Blade, wiper

- see* Wipers and Washers

### Blower motor

- see* A/C

### BMW emblem

- see* Exterior trim

### BMW special tools

- 010-18
- see also* special tools section at  
beginning of each repair group

### Body

- dimensions 400-2
- interior features 400-9
- safety and security 400-7

### Body side molding

- see* Exterior trim

### Bonnet

- see* Engine hood

### Boot

- see* Trunk

### Brake fluid

- 020-24, 340-8

### Brake fluid pressure sensor

- 340-30

### Brakes

- ABS, ASC or DSC system 300-12
- component replacement 340-26
- ASC/DSC switch
- see* Switches
- bleeding brakes 340-8
- brake booster 340-19
- brake pads, calipers and rotors  
340-11
- description 300-10
- electronic brake & stability 300-11
- light switch
- see* Switches
- master cylinder 340-16
- parking brake 340-22
- troubleshooting 340-5

### Bulbs

- see* Lights

### Bumper

- front 510-6
- height, adjusting 510-12
- rear 510-9

### Bus system

- 600-4

## C

### Camber

- 320-33

### Camshaft

- removing/installing
- M52 engine 116-12
- M52 TU / M54 engine 116-19
- M62 engine 116-39
- wear 116-6

### Camshaft position sensors

- see* Ignition system

### Camshaft timing chain

- adjusting
- M52 engine 117-22
- M52 TU / M54 engine 117-43
- M62 engine 117-79
- removing/installing
- M52 engine 117-26
- M52 TU / M54 engine 113-46, 116-  
28
- M62 engine 117-66

### Capacities, fluid

- 020-10

### Car memory/key memory

- 600-10
- see also* Central locking

### Carbon canister, activated

- see* Fuel tank

### Caster

- 320-33

### Catalytic converter

- and oxygen sensor 020-19
- see also* Exhaust system: exhaust  
manifolds

### Cautions

- 001-3

### CD changer

- 650-4

### Center bearing, driveshaft

- see* Driveshaft

### Center brake light

- sedan 630-13

### Center console

- 513-3

### Central body electronics (ZKE III)

- 600-8

### Central locking

- car memory/key memory 515-12
- general module functions 515-2
- remote entry (FZV) 515-8
- remote key initialization 515-10
- single lock/double lock 515-6
- switch 515-4

### Chain

- see* Camshaft timing chain

### Characteristic map (electrically heated) thermostat

- see* Electrically heated thermostat

### Charging system

- see* Battery, starter, alternator

### Cluster

- see* Instruments

### Clutch

- fluid
- see* Maintenance
- hydraulics 210-4
- mechanical 210-9
- switch
- see* Switches, pedal cluster
- variations 210-10

### Codes, fault

- OBD-1

### Coil

- see* Ignition system

### Coil spring

- see* Front suspension
- see also* Rear suspension

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**Component locations**  
see Electrical system

**Compression test**  
113-5

**Compressor**  
see A/C

**Condenser**  
see A/C

**Constant velocity (CV) joint**  
see Maintenance  
see also Driveshaft  
see also Drive axles

**Consumer cutoff**  
600-10

**Control arm**  
see Front suspension  
see also Rear suspension,  
suspension arms

**Coolant (antifreeze)**  
see Maintenance  
see also Cooling system

**Coolant pump**  
see Cooling system

**Cooling system**  
coolant  
bleeding 170-14  
6-cylinder engine, draining/filling 170-10  
V-8 engine, draining/filling 170-12  
coolant pump 170-3  
6-cylinder engine, replacing 170-19  
V-8 engine, replacing 170-20  
cooling fan 170-4  
viscous clutch fan, removing/  
installing 170-14  
electric fan, removing/installing 170-15  
expansion tank, removing/installing 170-22  
electrically heated (characteristic map) thermostat 170-4  
radiator, removing/installing 170-22  
service  
see Maintenance  
thermostat 170-16  
transmission fluid heat exchanger 170-5  
troubleshooting 170-7  
combustion leak test 170-10  
pressure test 170-9

**Crankshaft oil seals**  
front 117-6  
rear 119-6

**Crankshaft speed sensor**  
see Ignition system

**Crash sensor**  
see Airbag system (SRS), side-impact  
airbag crash sensor

**Cruise control**  
clutch switch 612-9

**CV joint**  
see Maintenance  
see also Driveshaft  
see also Drive axles

**CV joint boot**  
see Maintenance  
see also Drive axles

**Cylinder head**  
removing/installing  
M52 engine 113-8  
M52 TU / M54 engine 113-22  
M62 engine 113-56

**Cylinder head and valvetrain**  
hydraulic lifters, checking and replacing 116-7  
leak test 116-5  
valves 116-56  
see also Cylinder head

**D**

**Dashboard**  
513-7

**Deck lid**  
see Trunk lid

**Diagnostic monitors**  
OBD-4

**Diagnostic trouble codes (DTCs)**  
OBD-7

**Digital multimeter**  
010-17

**Differential**  
see Final drive

**DLC (data link connector)**  
020-4, OBD-4

**DME (digital motor electronics)**  
see 130 under appropriate fuel injection system  
see also Ignition system

**DM-TL (detection module-tank leak)**  
see Fuel tank, leak detection unit

**Drive belts**  
see Maintenance

**Dome light**  
see Lights, interior lights

**Door**  
door check, replacing 411-4  
hinge adjustment 411-5  
lock  
see Door lock  
see also Central locking  
removing/installing 411-2  
panel, removing/installing 411-7  
window  
see Door window

**Door check**  
see Door

**Door handle**  
see Door lock

**Door glass**  
see Door window

**Door lock**  
handles and locks 515-16  
see also Central locking

**Door molding**  
510-13

**Door panel**  
see Door

# 4 INDEX

## Door window

- anti-trap 512-4
- convenience opening/closing 512-4
- regulator and motor 512-11
- service 512-5
- switches 512-3
- see also* Switches

## Double VANOS

- see* VANOS

## Drive axle

- CV joint 331-15
- CV joint boot 331-15
- removing/installing 331-14

## Drive belt

- see* Maintenance

## Driveability troubleshooting

- 100-4

## Driveway protection

- see* EWS (electronic immobilization)

## Driveshaft

- aligning 260-7
- center bearing, replacing 260-12
- CV joint, replacing 260-14
- flex-disc, replacing 260-11
- front centering guide, replacing 260-13
- removing/installing 260-8
- troubleshooting 260-3
- U-joint 260-3

## DSC

- see* Brakes

## DTC (diagnostic trouble code)

- OBD-8

## DWA

- see* Anti-theft alarm

## E

### E-box

- 610-37

### ECM (engine control module)

- see* 130 under appropriate fuel injection system

### ECT (engine coolant temperature)

- sensor
- see* 130 under appropriate fuel injection system

### EDK

- adaptation 130-69
- MS 43.0 130-35

### EHC

- see* Electronic height control (EHC)

## Electric cooling fan

- see* Cooling system, cooling fan
- see also* Cooling system, electric fan

## Electrical switches

- see* Switches

## Electrical system

- abbreviations 600-14
- bus system 600-4
- component location table 610-3
- components
- photos 610-36
- Sport Wagon 610-81
- engine 121-2
- troubleshooting 600-15
- voltage and polarity 600-5
- wire color codes 600-12
- wiring diagrams 600-12

## Electrical wiring diagrams

- ELE-1

## Electrically heated thermostat (characteristic map)

- 170-4

## Electronic height control (EHC)

- 300-8, 330-44

## Electronic immobilization

- see* EWS (electronic immobilization)

## Electronics box (E-box)

- 610-37

## Emergencies

- 010-18

## Emergency brake

- see* Brakes, parking brake

## Engine

- see also* Cylinder head and valvetrain applications 100-2
- compression, testing 113-5
- cooling
- see* Cooling system
- crankshaft front oil seal
- see* Crankshaft oil seals
- cylinder leak-down test 113-8
- diagnostic testing 113-1
- drive belts
- see* Maintenance
- driveability troubleshooting 100-4
- engine management systems 100-2
- see also* Ignition
- see also* Fuel injection
- fuel supply 130-6
- ground connections 100-5
- see also* 610
- identifying features 100-3
- lubrication system
- see* Lubrication system
- mount
- 6-cylinder 119-11
- V-8 119-16
- on-board diagnostics OBD-1
- oxygen sensor
- see* Fuel injection
- see also* Exhaust system
- preventive maintenance
- see* Maintenance
- removal/installation
- 6-cylinder 110-3
- V-8 110-16

## Engine control module (ECM)

- see* 130 under appropriate fuel injection system

## Engine coolant temperature (ECT)

- sensor
- see* 130 under appropriate fuel injection system

## Engine cooling fan

- see* Cooling system, electric fan

## Engine hood

- 410-6
- raising to service position 410-6

## Engine troubleshooting

- see* Engine, driveability troubleshooting

## Evaporative control system

- 160-3
- see also* 130 under appropriate fuel injection system

## Evaporator

- see* A/C

## Evaporator temperature sensor

- see* A/C



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**Exhaust manifold**

see Exhaust system

**Exhaust system**

diagrams 180-11  
 exhaust manifolds, removing/installing 180-4  
 muffler, replacing 180-8  
 oxygen sensors 180-8  
 and catalytic converter 020-19  
 see also Fuel injection  
 removing/installing 180-2  
 see also Maintenance

**Expansion tank**

see Cooling system

**Expansion valve**

see A/C

**Exterior lighting**

see Lights

**Exterior trim**

BMW emblem (Roundel), removing/installing 510-13  
 body side molding, replacing 510-13  
 grill, removing/installing 510-14  
 headlight housing trim, removing/installing 510-14  
 outside mirror 510-2

**EWS (electronic immobilization)**

515-21  
 ring antenna, removing/installing 320-11

**F**

**Fan**

see Cooling system

**Fan clutch**

see Cooling system, cooling fan

**Fault codes**

OBD-2  
 storage 100-4, 600-10

**Fender**

front, removing/installing 410-2

**Filters**

see Maintenance

**Final drive**

lubricant specifications 020-9  
 mounts, replacing 331-12  
 oil level 020-26, 331-6  
 removing/installing 331-5  
 seals 331-7

**Firing order**

see Ignition system

**FIS**

see Interior protection

**Flex disc**

see Driveshaft

**Fluids and lubricants**

see Maintenance

**Flywheel**

removing/installing 210-13

**Foglight**

see Lights

**Front centering guide**

see Driveshaft

**Front oil seal**

see Crankshaft oil seals

**Front suspension**

control arm 310-12  
 description 300-2  
 ride height 300-14  
 stabilizer bar, removing/installing 310-21  
 struts/springs 310-4  
 tension strut 310-16  
 thrust arm 310-12  
 variations 310-4  
 wheel bearing 310-18  
 see also Maintenance

**Fuel filter**

see Maintenance

**Fuel injection**

applications 130-2  
 Bosch M5.2, M5.2.1 130-46  
 Bosch ME 7.2 130-66  
 fuel delivery  
 see 130 under appropriate fuel injection system  
 see also Fuel pump  
 see also Fuel tank  
 oxygen sensors 130-72, 180-8  
 Siemens MS 41.1 130-7  
 Siemens MS 42.0, MS 43.0 130-23

**Fuel injector**

see 130 under appropriate fuel injection system

**Fuel level sender**

160-15  
 see also Fuel pump

**Fuel pressure**

160-10  
 see also Fuel pump

**Fuel pump 160-3**

electrical circuit, testing 160-7  
 removing/installing (includes right side fuel level sender) 160-15  
 siphon pump, removing/installing 160-19  
 troubleshooting 160-6  
 see also Fuel tank

**Fuel rail**

see 130 under appropriate fuel injection system

**Fuel supply**

130-6  
 see also Fuel pump  
 see also Fuel tank

**Fuel tank**

3/2-way valve (running losses, removing/installing 160-24  
 carbon canister 160-24  
 draining 160-20  
 evaporative control system 160-3  
 expansion tank, removing/installing 160-23  
 leak detection unit (LDP or DM-TL), removing/installing 160-24  
 level sender 160-15  
 removing/installing 160-21

**Fuse locations**

610-29

**FZV (remote entry)**

see Central locking

## 6 INDEX

### G

- Gaskets**
  - and seals 010-9
- Gearshift**
  - automatic transmission
    - adjusting 250-7
    - shift interlock, checking function 250-9
  - manual transmission
    - gearshift lever, removing/installing 250-5
    - stepronic 250-7
- General module (GM III)**
  - 600-8
  - see also Central locking
- Generator**
  - see Battery, starter, alternator
- Glass**
  - see Door window
- Glove compartment**
  - 513-16
  - see also
- Global positioning system (GPS)**
  - 620-9
- Grill**
  - see Exterior trim
- Grounds**
  - 100-5
- Guide link**
  - see Rear suspension, suspension arms

### H

- Halogen headlight**
  - 630-5
- Hand brake**
  - see Brakes, parking brake
- Handle, door**
  - see Door locks
- Hatch**
  - see Tailgate
- Hazard warning switch**
  - see Switches

- Headlight**
  - housing trim
    - see Exterior trim
  - washer 611-17
  - see also Lights

- Headlight spray nozzle**
  - 611-17

- Headlight switch**
  - see Switches

- Heater core**
  - see Heating

- Heater valve**
  - see Heating

- Heating**
  - heater core, replacing 640-18
  - heater core temperature sensor, removing/installing 640-12
  - heater valve, replacing 640-17
  - IHKA housing, removing/installing 640-21
  - see also A/C

- Hood**
  - 410-6

- Hood latch and release**
  - 410-10

- Hydraulic valve lifters**
  - see Cylinder head and valvetrain

### I

- IAT (intake air temperature) sensor**
  - see 130 under appropriate fuel injection system

- Idle speed control valve**
  - see 130 under appropriate fuel injection system

- Idle stabilizer**
  - see 130 under appropriate fuel injection system, idle speed control valve

- Idler arm**
  - 320-30

- Ignition coil**
  - see Ignition system

- Ignition interlock**
  - 320-13

- Ignition lock cylinder**
  - removing/installing 320-11, 612-4

- Ignition switch**
  - see Switches

- Ignition system**
  - diagnosis
    - checking for spark 120-10
    - disabling ignition system 120-10
    - misfire detection 120-6
    - oscilloscope diagrams 120-6
    - troubleshooting 120-6
  - camshaft position sensors 120-14
  - coils 120-10
  - crankshaft speed sensor 120-12
  - firing order 120-9
  - knock sensors 120-16

- IHKA**
  - see A/C

- IHKR**
  - see A/C

- Injector**
  - see 130 under appropriate fuel injection system, fuel injector

- Input shaft oil seal**
  - see Manual transmission, oil seals

- Inspection**
  - see Maintenance

- Instruments**
  - GPS
    - see Global positioning system (GPS)
    - layout 620-2
    - removing/installing 620-8
    - self-testing 620-6

- Intake air temperature sensor (IAT)**
  - see 130 under appropriate fuel injection system

- Intake manifold**
  - removing/installing
    - 6-cylinder engine 110-10, 113-8, 113-22
    - V-8 engine (M62) 113-56

- Integral link**
  - see Rear suspension, suspension arms

- Interior lights**
  - see Lights

- Interior protection (FIS/UIS)**
  - 515-25

- Interior trim**
  - 513-13

- Interior ventilation microfilter**
  - see A/C, ventilation microfilter

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**J**

**Jack stands**  
010-16

**Jump starting**  
010-19

**K**

**Keys**  
515-11

**Knock sensor**  
*see* Ignition system

**L**

**Leak detection, fuel tank**  
*see* Fuel tank, leak detection unit

**Leather upholstery**  
*see* Maintenance, leather upholstery and trim

**LDP (leak detection pump)**  
*see* Fuel tank, leak detection unit

**Level sender**  
*see* Fuel tank  
*see also* Fuel pump

**License plate light**  
630-11

**Lifters**  
*see* Cylinder head and valvetrain

**Lifting the car**  
010-5

**Lights**

bulb applications 630-2  
control module (LCM) 630-3  
foglights 630-8  
headlights 630-4  
    automatic headlight adjustment (LWR) 630-7  
    vertical aim system 630-8  
interior lights 630-12  
    bulb applications 630-13  
side turn signal 630-9  
taillight 630-10  
trunk light bulb 630-14  
turn signals, taillights 630-12

**Locks**

*see* Central locking  
*see also* Door locks

**Lubrication system**

oil level warning switch, replacing 119-20  
oil pan, removing/installing  
    6-cylinder 119-10  
    V-8 lower 119-13  
    V-8 upper 119-15  
oil pressure  
    checking 119-4  
    warning system, testing 119-5  
    warning switch, replacing 119-20  
oil pressure relief valve  
    6-cylinder 119-26  
    V-8 119-27  
oil pump, removing/installing  
    6-cylinder 119-22  
    V-8 119-4  
troubleshooting 119-3

**Luggage compartment**

*see* Trunk

**M**

**MAF (mass air flow) sensor**  
*see* 130 under appropriate fuel injection system

**Maintenance**

accelerator linkage 020-14  
air filter 020-14  
automatic transmission 020-29  
battery 020-22  
body lubrication 020-31  
body and interior 020-31  
brake fluid 020-24  
brake pad/rotor wear 020-24  
brake system 020-25  
clutch fluid 020-26  
cooling system 020-15  
CV joint boots 020-27  
differential oil level 020-26  
drive belts 020-16  
engine compartment 020-14  
engine cooling system 020-16  
engine oil 020-11  
exhaust system 020-27  
exterior washing 020-31  
fluid and lubricant specifications 020-9  
fuel filter 020-27  
fuel tank and fuel lines 20-28  
idle speed 020-19  
inspection 020-5  
interior care 020-31  
leather upholstery and trim 020-31  
maintenance tables 020-6  
manual transmission oil 020-30  
microfilter 020-22  
oxygen sensors 130-72, 180-8  
parking brake 020-25  
power steering fluid level 020-20  
seat belts 020-32  
service indicator 020-3  
spark plugs 020-20  
special cleaning 020-32  
suspension, front 020-29  
suspension, rear 020-29  
tires 020-29  
washing 020-32  
waxing 020-32  
windshield wiper blade 020-33  
wheels, aligning 020-30

**Malfunction indicator light (MIL)**  
OBD-2

**Manifold, exhaust**  
*see* Exhaust system

**Manifold, intake**  
*see* Intake manifold

## 8 INDEX

### Manual transmission

- applications 200-2, 230-5
- back-up light switch, replacing 230-8
- gear ratios 230-6
- gearshift
  - see Gearshift
- ID tag 200-2
- fluid 020-10, 200-4
- fluid service 230-6
- oil seals
  - input shaft seal, replacing 230-17
  - output shaft seal, replacing 230-11
  - selector shaft seal, replacing 230-8
- pilot bearing 210-16
- removal/installation 230-19
- see also Maintenance

### Map light

- see Lights, interior

### Mass air flow (MAF) sensor

- see 130 under appropriate fuel injection system

### Master cylinder

- see Brakes
- see also Clutch, hydraulics

### MDK

- 130-42

### Microfilter

- see A/C, ventilation microfilter
- see also Maintenance

### Mirror

- see Exterior trim

### Misfire

- see Ignition system, diagnosis

### Motor mount

- see Engine, mount

### MRS (multiple restraint system)

- see Airbag system (SRS)

### Muffler

- see Exhaust system

## N

### Neutral safety switch

- see Automatic transmission, range switch

## O

### OBD II (on-board diagnostics)

- OBD-1

### Oil change equipment

- 010-16

### Oil level sensor

- see Lubrication system

### Oil pan

- see Lubrication system

### Oil pressure

- see Lubrication system

### Oil pump

- see Lubrication system

### Oil service

- 020-11

### On-Board Monitor

- 640-12

### On-board diagnostics

- OBD-1

### Outside air temperature sensor

- 610-14

### Outside door handle

- see Door lock

### Outside mirror switch

- see Switches

### Output shaft oil seal

- see Manual transmission, oil seals

### Overheating

- see Cooling system, troubleshooting

### Overload protection

- 600-11

### Oxygen sensors

- 130-72, 180-8

## P

### P codes

- OBD-10

### Panic mode operation

- 515-11

### Parking brake

- see Brakes
- see also Maintenance

### Parts, buying

- 010-11

### Pedal cluster switches

- see Switches

### Pedal position sensor (PWG)

- 6-cylinder engine
  - MS 42.0 130-32
  - MS 43.0 130-35
- V-8 engine (M62 TU) 130-68

### Pitman arm

- see Steering

### Power steering

- see Steering

### Power steering fluid

- see Maintenance

### Power window switch

- 512-3
- see also Switches

### PWG

- see Pedal position sensor (PWG)

## R

### Rack and pinion steering

- see Steering

### Radiator

- see Cooling system

### Radiator cooling fan

- see Cooling system, cooling fan
- see also Cooling system, electric fan

### Radiator grill

- see Exterior trim

### Radio

- 650-2
- see also Antenna
- see also Speakers

### Rain sensor

- 611-6

### Raising car safely

- 010-5

### Readiness codes

- OBD-6

### Rear door window

- see Door window

### Rear main seal

- see Crankshaft oil seals

### Rear parcel shelf

- 513-16

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**Rear suspension**

- ball joints 330-19
- bushings 330-13
- control arms
  - see suspension arms, below
- description 300-5
- electronic height control (EHC) 330-44
- ride height 300-14
- ride height sensor 330-46
- shock absorbers and springs 330-9
- stabilizer bar 330-42
- struts and springs 330-5
- subframe 330-13
- suspension arms 330-13
- variations 330-4
- wheel bearing, replacing 330-32
  - see also Maintenance
  - see also Drive axles
  - see also Final drive

**Rear window (Sport Wagon)**

see Tailgate

**Rear window defroster**

610-17

**Receiver/drier**

see A/C

**Relay positions**

see Electrical component locations table 610-3

**Remote entry (FZV)**

see Central locking

**Reversing light switch**

see Back-up light switch

**Ride height**

300-14

**Ride height sensor**

see Rear suspension

**Ring antenna**

see EWS (electronic immobilization)

**Rotor**

see Brakes

**Roundel**

see Exterior trim

**Running losses (3/2-way) valve**

see Fuel tank

**S**

**SCA (soft close)**

see Tailgate, soft close  
see also Trunk lid, soft close

**Scan tools**

OBD-3

**Seals**

gaskets and 010-9  
see also Crankshaft seals

**Seat**

front, removing/installing 520-10  
memory system 520-4  
rear 520-13  
see also Seat belt

**Seat belt**

front 720-4  
rear 720-8  
troubleshooting 720-2  
see also Maintenance

**Secondary air injection**

see 130 under appropriate fuel injection system

**Selector shaft seal**

see Manual transmission, oil seals

**Self-adjusting clutch (SAC)**

see Clutch, variations

**Service indicator**

see Maintenance

**Shift interlock**

see Gearshift

**Shift lever**

see Gearshift

**Shift linkage**

see Gearshift

**Shiftlock**

see Gearshift

**Shock absorber**

see Rear suspension

**Side turn signal assembly**

see Lights

**Sill trim panel**

411-10

**Slave cylinder**

see Clutch, hydraulic

**Sleep mode**

600-11

**Soft close (SCA)**

see Tailgate  
see also Trunk lid

**Solenoid**

121-23

**Sound system**

650-2

**Spare parts kit**

010-21

**Spark plugs**

see Maintenance

**Speakers**

650-4

**Specifications, fluid**

020-9

**Sport wagon**

400-4

**Springs**

see Front suspension  
see also Rear suspension

**SRS (supplemental restraint system)**

see Airbag system (SRS)

**Stabilizer bar**

see Front suspension  
see also Rear suspension

**Starter**

see Battery, starter, alternator

# 10 INDEX

## Steering

- description 300-10
- fluid
  - see Maintenance
- gearbox 320-25
- idler arm 320-30
- lock 320-12
- pitman arm 320-28
- power steering pump 320-17
- rack & pinion 320-19
- steering column 320-10
  - motors 320-16
  - removing/installing 320-14
  - trim 320-10
- steering wheel 320-7
- tie rods
  - 6-cylinder, replacing 320-22
  - V-8 center tie rod, replacing 320-32
- variations 310-5

## Steering box

- see Steering, gearbox

## Steering column switches

- see Switches

## Steering column

- see Steering

## Steering lock

- see Steering

## Steering wheel switches

- see Switches

## Stepper motor

- see A/C

## Steptronic transmission

- see Gearshift

## Strut

- see Front suspension
- see also Rear suspension

## Subframe

- see Rear suspension

## Sunroof

- initializing 540-2
- adjusting 540-5
- components, removing/installing 540-9
- emergency closing 540-4

## Suspension, front

- see Front suspension
- see also Aluminum suspension components

## Suspension, rear

- see Rear suspension
- see also Aluminum suspension components

## Swing arm

- see Rear suspension, suspension arms

## Switches

- ASC/DSC 612-12
- back-up
  - manual transmission 230-8
  - automatic transmission, see Automatic transmission, range switch
- center console switches 612-11
- central locking 612-11
- hazard 612-11
- headlight 612-9
- ignition cylinder 320-11, 612-6
- outside mirror 612-11
- pedal cluster switches 612-8
- seat heater 612-12
- steering column positioning 612-7
- steering column switches 612-6
- steering wheel switches 612-2
- turn signal/headlight dimmer 612-6
- window 612-11
- wipers 612-6

## T

### Tailgate

- 412-6
- emergency release 400-4, 412-6, 515-21
- tailgate/rear window locking 515-14
- see also Trunk/tailgate lock
- see also Central locking

### Taillights

- see Lights

### Tape player

- 650-3

## TCM (transmission control module)

- see Automatic transmission

## Tension strut

- see Front suspension

## Thermostat

- see Cooling system
- see also Electrically heated thermostat

## Throttle body

- see 130 under appropriate fuel injection system

## Throttle cable

- 130-38

## Throttle position sensor

- see 130 under appropriate fuel injection system

## Throw-out bearing

- see Clutch, mechanical

## Thrust arm

- see Front suspension

## Tie rod

- see Steering

## Tightening fasteners

- 010-8

## Tilt sensor

- 515-24

## Timing chain

- see Camshaft timing chain

## Tire, changing

- 010-18

## Tires

- 300-11
- see also Maintenance

## Toe

- 320-34

## Tools

- 010-13

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**Towing**

010-20

**Traction control**

see Brakes, ABS, ASC or DSC system

**Traction strut**

see Rear suspension, suspension arms

**Transmission fluid**

200-4  
see Maintenance  
see also Automatic transmission  
see also Manual transmission

**Transmission fluid heat exchanger**

see Cooling system

**Transmission input shaft oil seal**

see Manual transmission

**Transmission lubricant**

200-4  
see also Automatic transmission  
see also Manual transmission

**Transmission output shaft oil seal**  
see Manual transmission

**Transmission pilot bearing**  
replacing 210-16

**Transmission service**  
see Manual transmission, oil seals

**Trim, interior**  
see Interior trim  
see also Steering, steering column trim

**Trunk lid**  
412-2  
soft close (SCA) 515-13  
see also Trunk/tailgate lock  
see also Central locking

**Trunk/tailgate lock**  
tailgate lock emergency release 400-5, 515-21  
tailgate/rear window locking 515-14  
trunk lock 515-19  
key positions 515-7

**Turn signal assembly**  
see Switches  
see also Lights

**U**

**UIS**  
see Interior protection

**U-joint**  
see Driveshaft

**Upholstery**  
see Maintenance, leather upholstery and trim

**V**

**Vacuum booster**  
see Brakes

**Valve guides**  
see Cylinder head and valvetrain

**Valve seals**  
see Cylinder head and valvetrain

**Valve seats**  
see Cylinder head and valvetrain

**Valves**  
see Cylinder head and valvetrain

**Valvetrain**  
see Cylinder head and valvetrain

**VANOS**  
control unit, removing/installing  
M52 engine 117-14  
M52 TU / M54 engine 117-36  
double VANOS  
function 117-34  
timing chain service 113-46, 116-28  
timing, adjusting  
M52 engine 117-22  
M52 TU / M54 engine 117-43

**Vehicle identification number (VIN)**  
010-12

**Ventilation microfilter**  
see A/C  
see also Maintenance

**Viscous clutch**  
see Cooling system, cooling fan

**Voltage and polarity**  
600-5

**Voltage tests**  
see Electrical system, troubleshooting

## 12 INDEX

### W

#### Warnings

001-1

#### Warnings, cautions and notes

010-3

#### Washer fluid pump

*see* Wipers and washers

#### Washers

*see* Wipers and washers

#### Washing

*see* Maintenance

#### Water pump

*see* Cooling system, coolant pump

#### Waxing

*see* Maintenance

#### Wheel, steering

*see* Steering

#### Wheel alignment

320-33

ride height 300-14

*see also* Maintenance

#### Wheel bearing

*see* Front suspension

*see also* Rear suspension

#### Wheels

300-11

#### Window motor

*see* Door window

#### Window regulator

*see* Door window

#### Window switch

512-3

*see* Switches

#### Windows, door

*see* Door window

#### Windshield wipers and washers

*see* Wipers and washers

*see also* Maintenance

#### Wiper motor

*see* Wipers and washers

#### Wipers and washers

rain sensor 611-6

rear window (Sport Wagon)

wiper motor, removing/installing  
611-15

wiper shaft, removing/installing  
611-15

wiper/washer system 611-8

washer system 611-16

wiper assembly 611-12

wiper blades and arms 611-9

#### Wiring codes and abbreviations

600-12

#### Wiring diagrams

ELE-1

*see also* Electrical system

#### Working under car safely

010-6

### X

#### Xenon headlight

630-6

### Z

#### ZKE (central body electronics)

600-8