

300 Suspension, Steering and Brakes - General

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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.

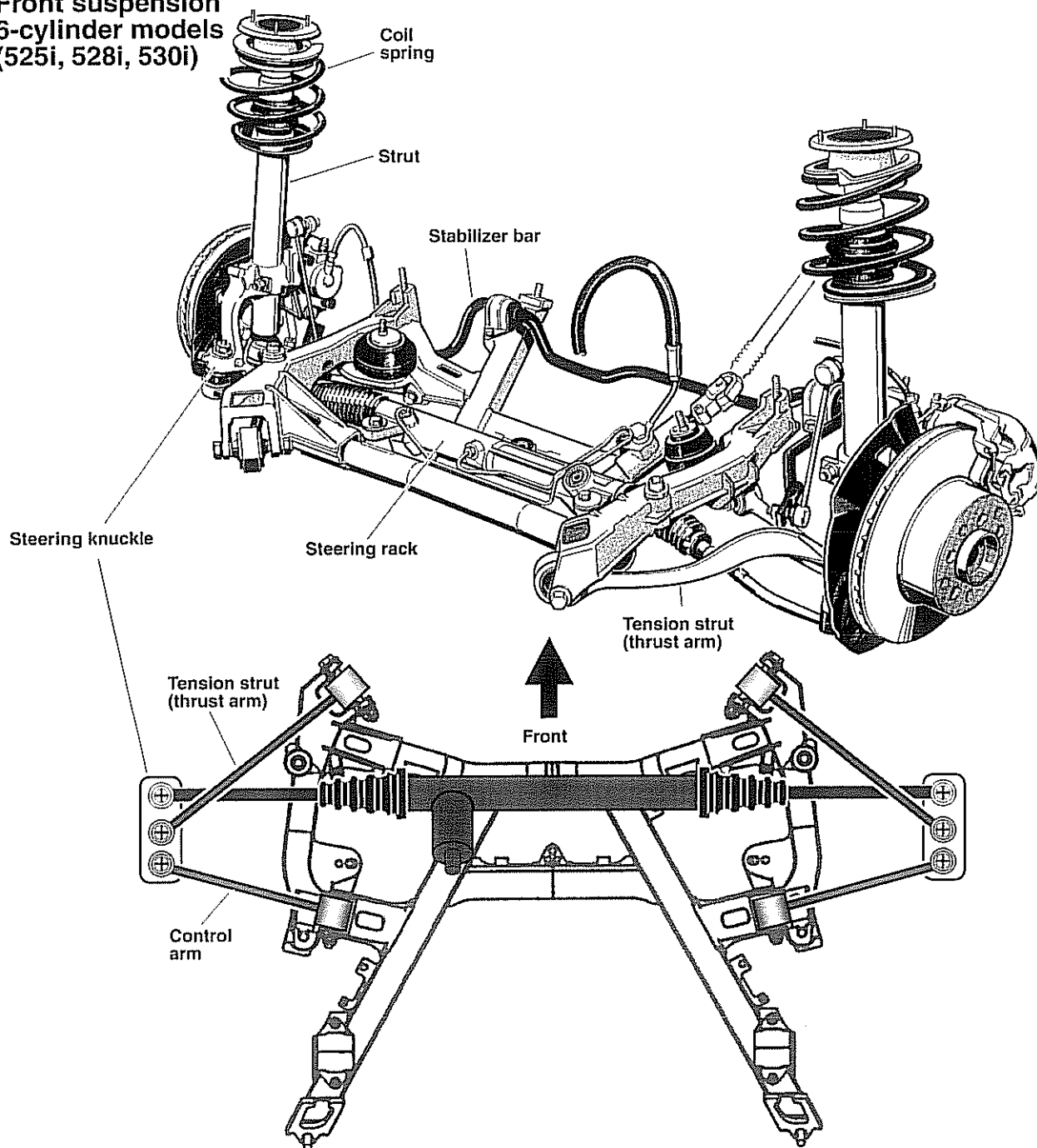
The suspension arms, known as the lower control arms and the tension struts (thrust arms), are connected to the subframe through rubber bushings. The arms are connected to the steering knuckles in a double pivot configuration.

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.

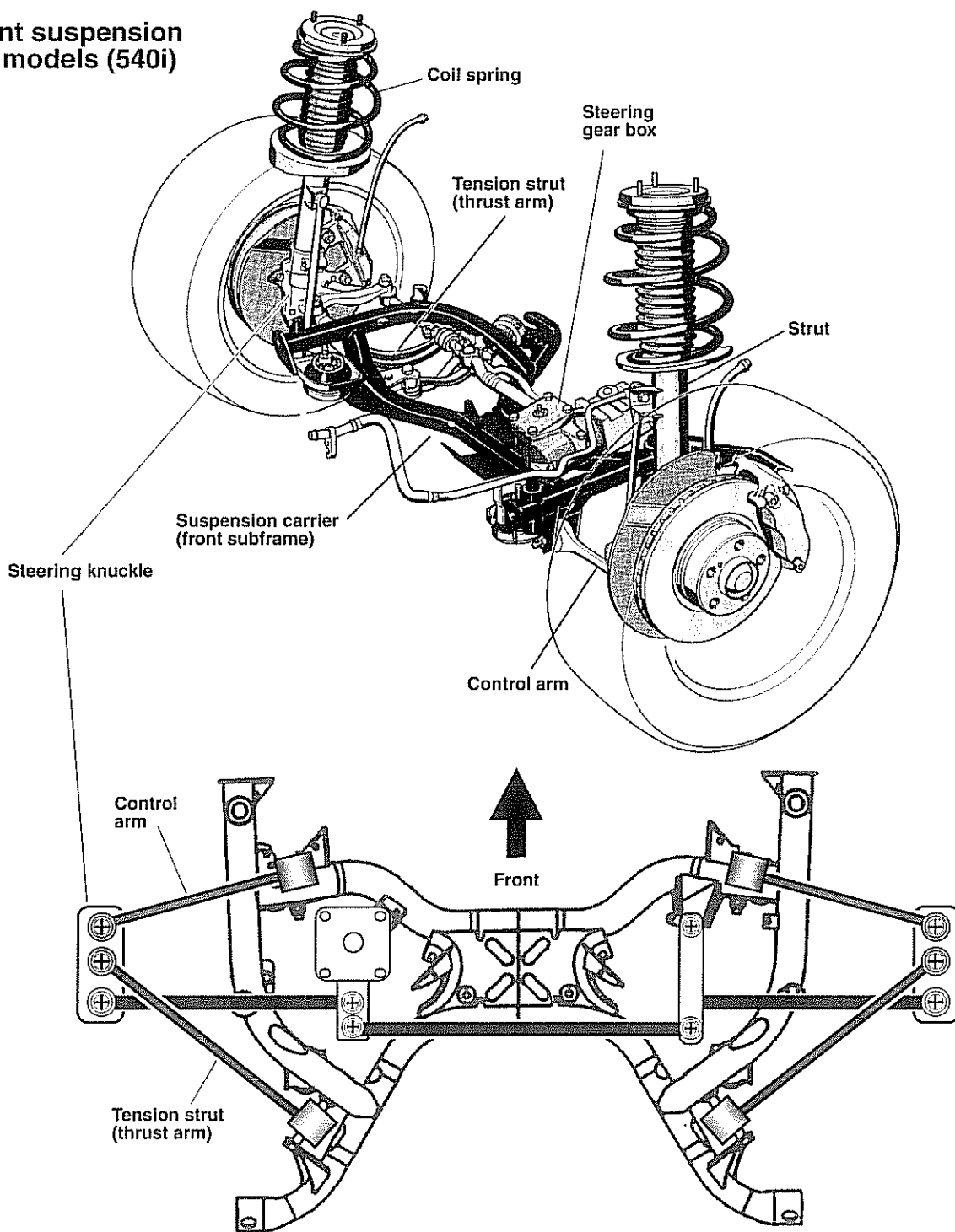
Front suspension 6-cylinder models (525i, 528i, 530i)

Front suspension 6-cylinder models (525i, 528i, 530i)



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Front suspension V-8 models (540i)

Front suspension
V-8 models (540i)

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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.

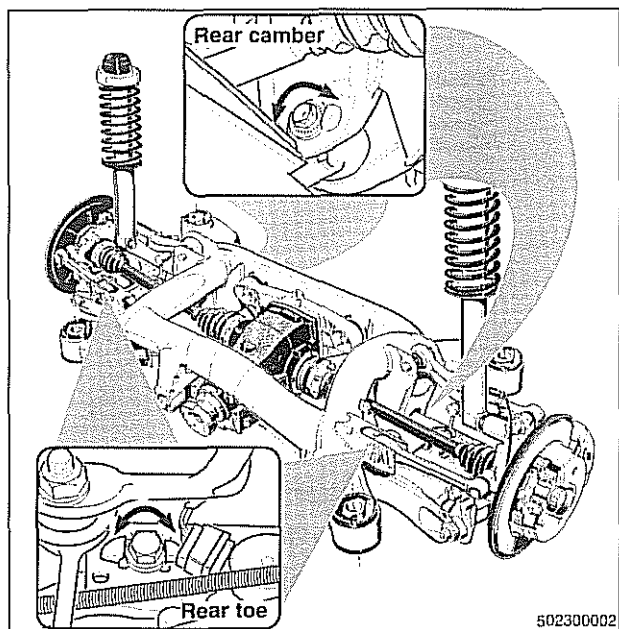
The inner end of the upper front control arm, called the traction strut, is also mounted with an eccentric fastener, used to adjust rear toe.

Drive axles with constant-velocity (CV) joints at both ends transfer power from the differential to the road wheels.

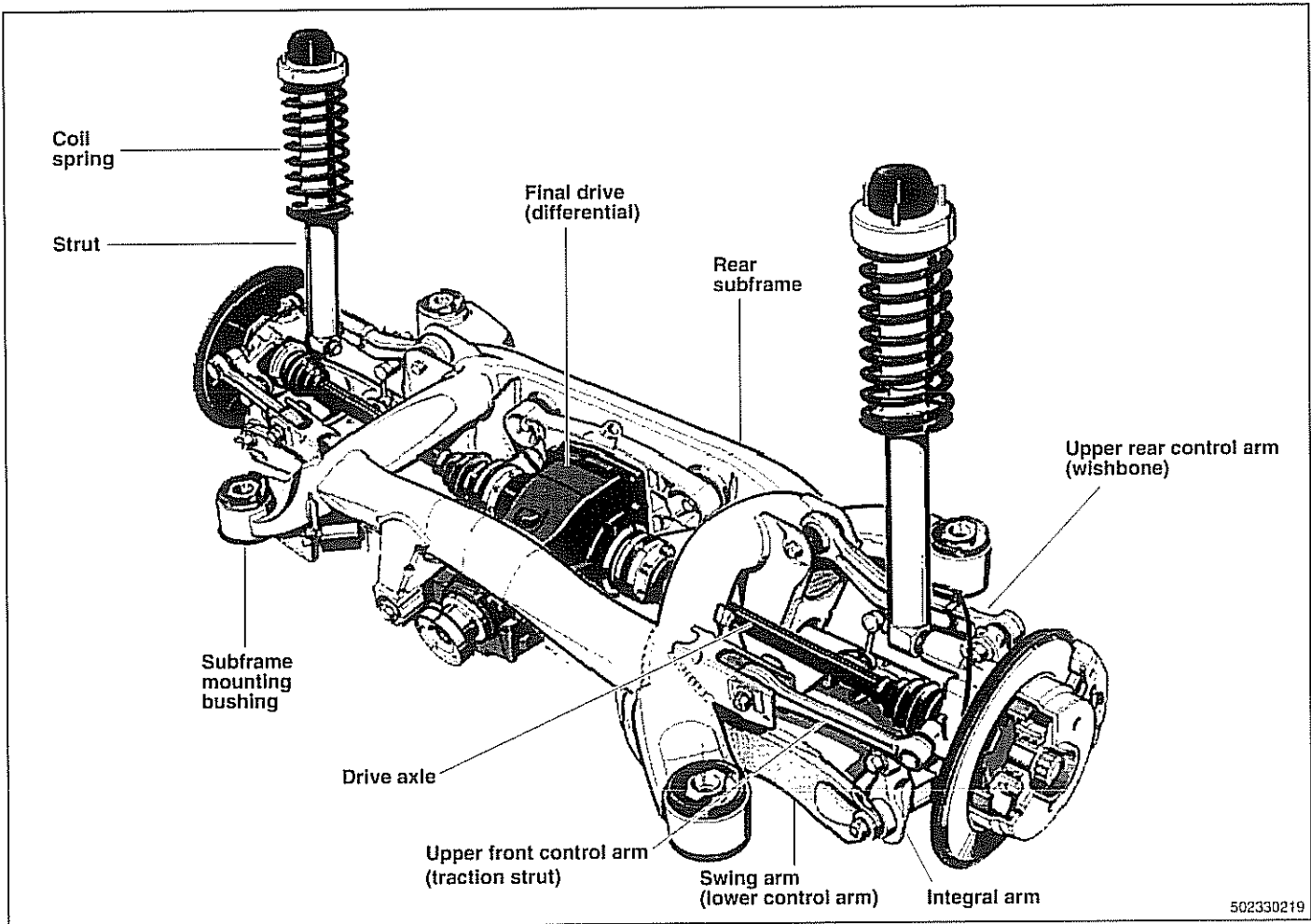
Sedan models

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



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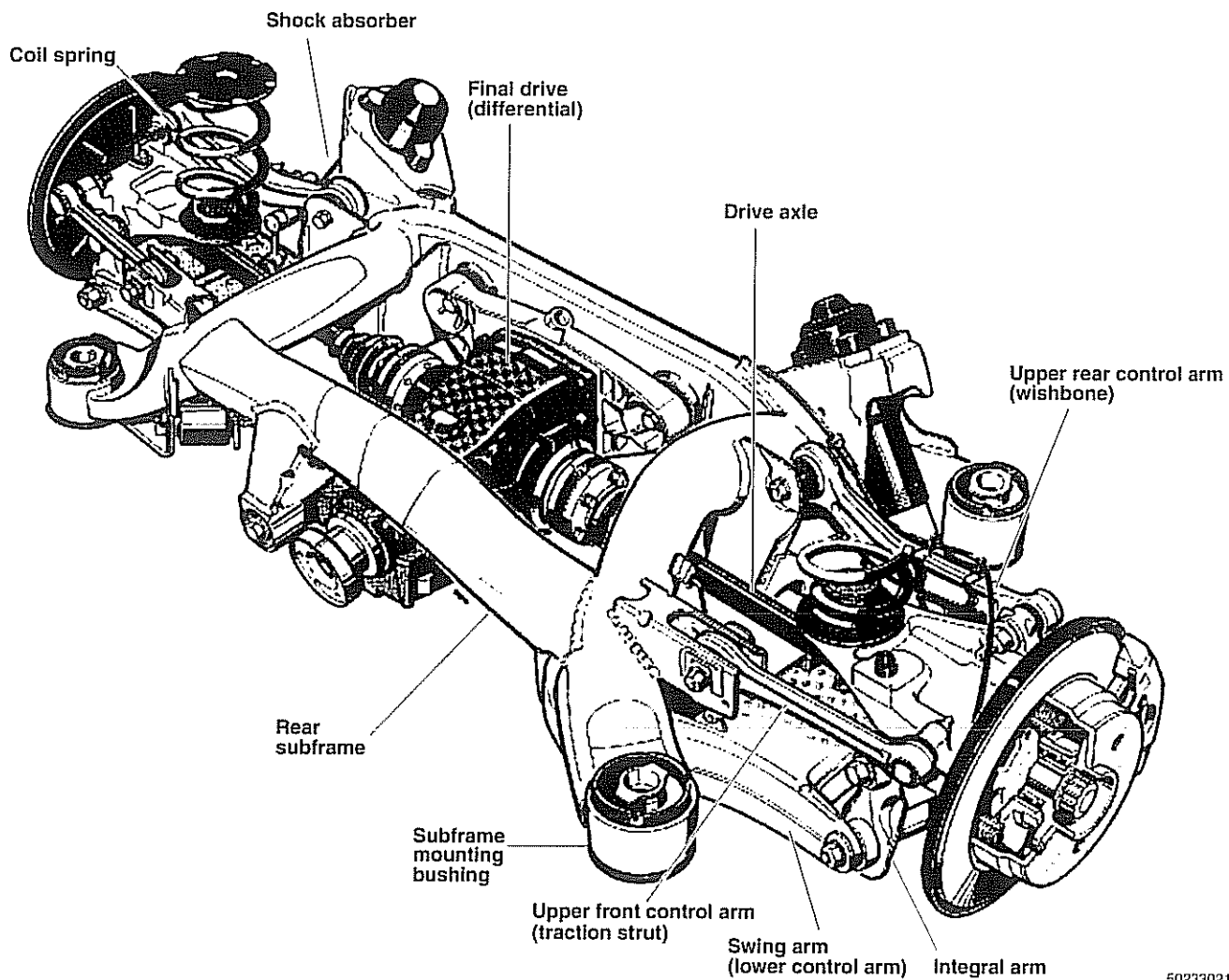
Sport Wagon models

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.

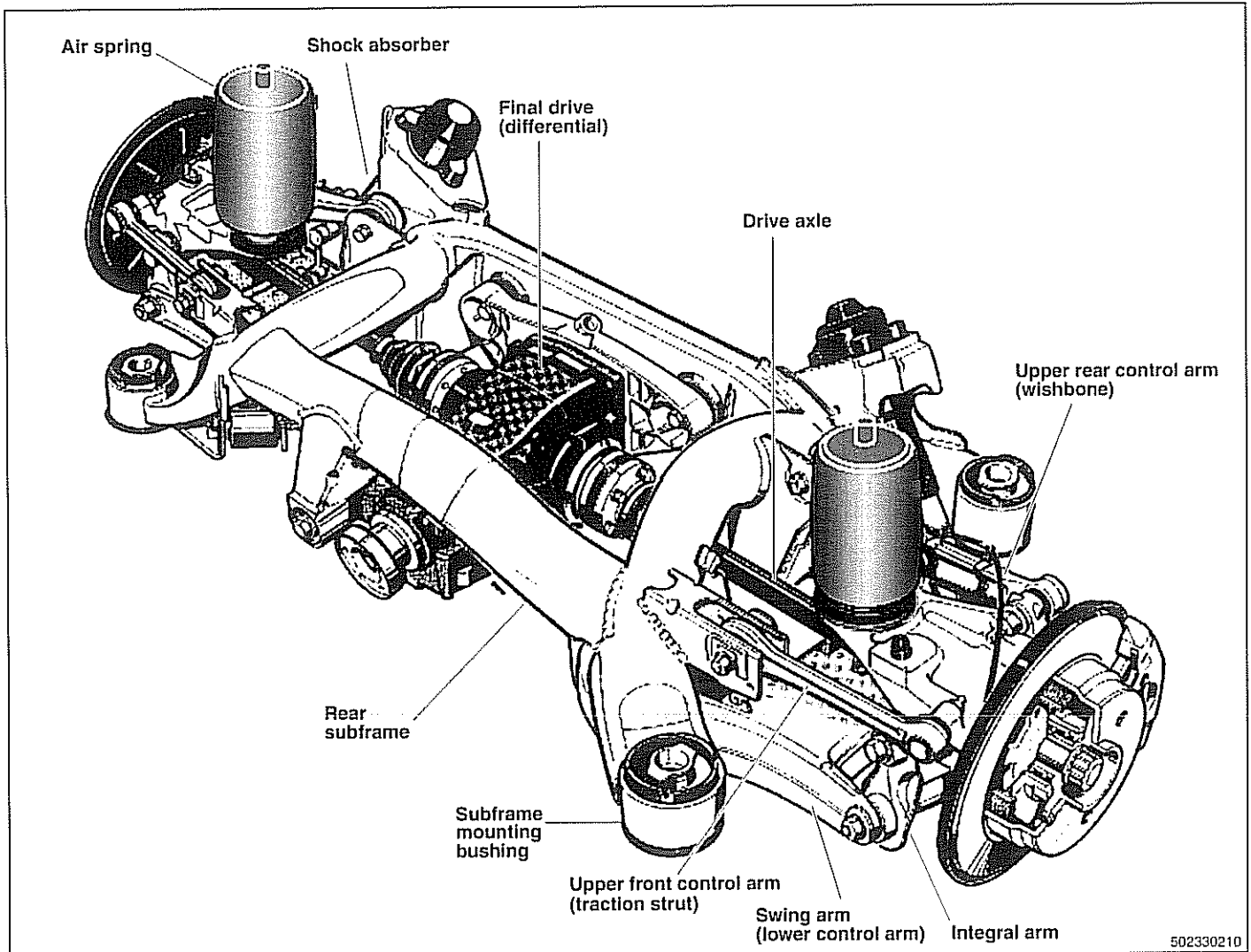
On models fitted with electronic height control (EHC) rear suspension, the standard coil springs are replaced by air springs. Air pressure in the air springs is automatically controlled by the EHC system to compensate for ride height and load variations.

Rear suspension Sport Wagon (with coil springs)



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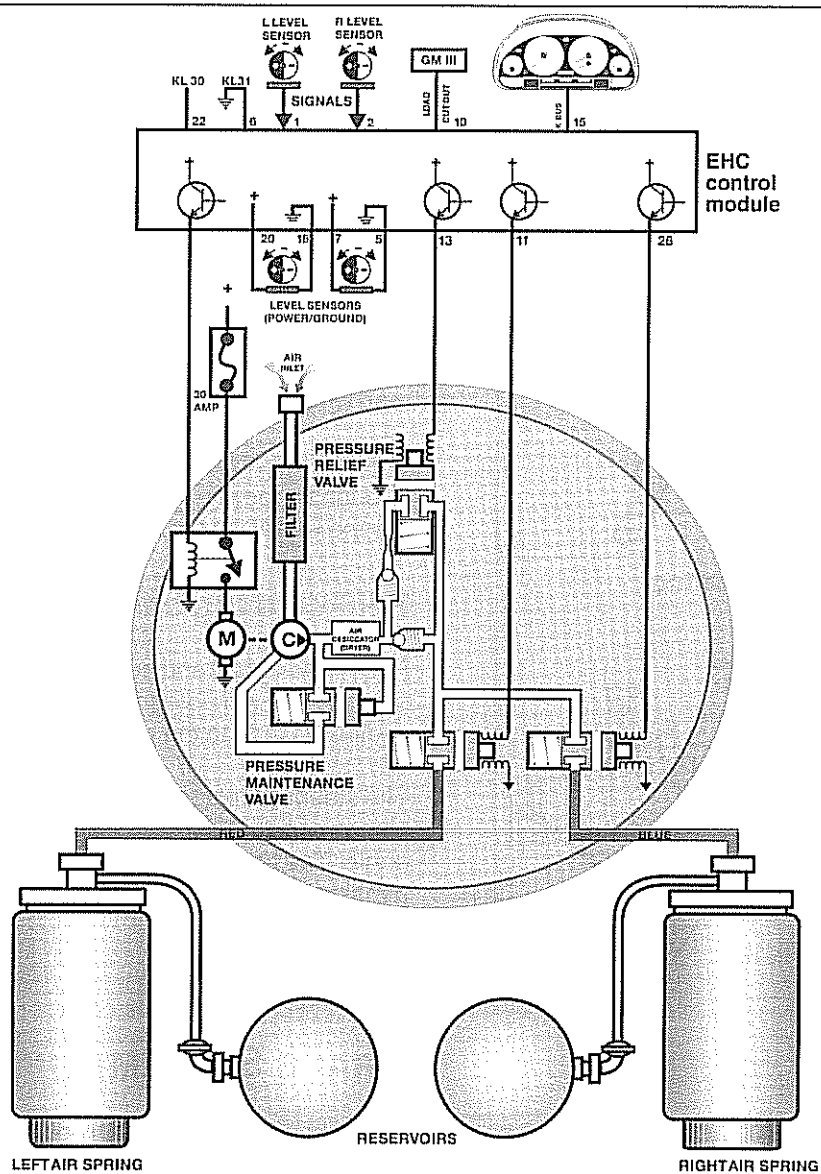
Rear suspension Sport Wagon (EHC with air springs)



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

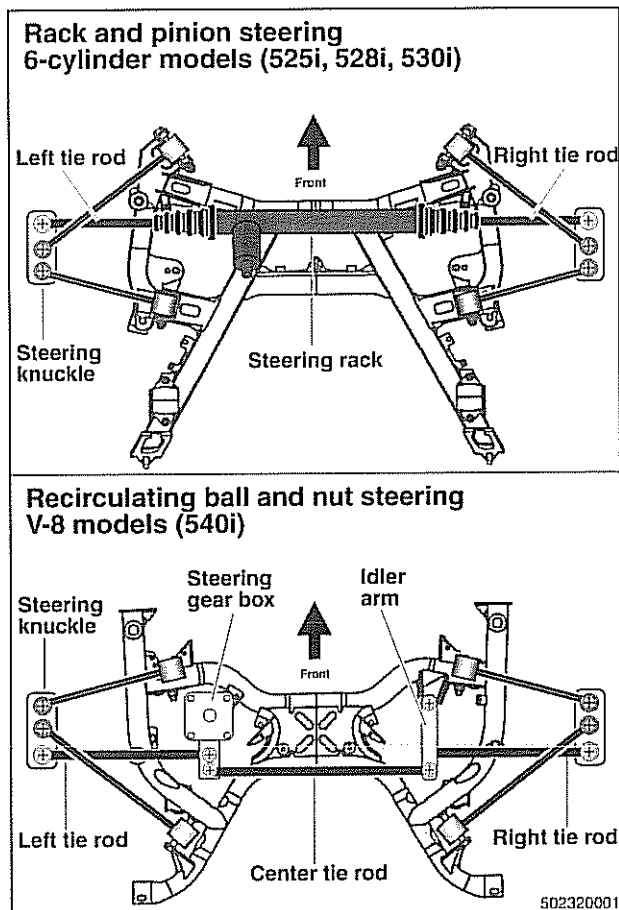


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STEERING

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

	Standard		Optional	
Model	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—

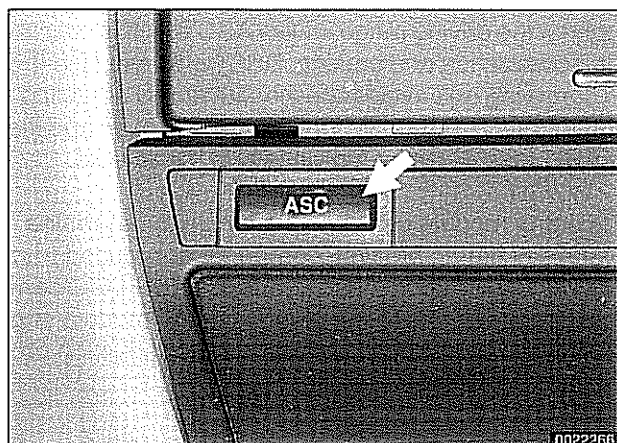
ASC (Automatic Stability Control) may also be referred to as ASC+T (Automatic Stability Control+Traction).

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.

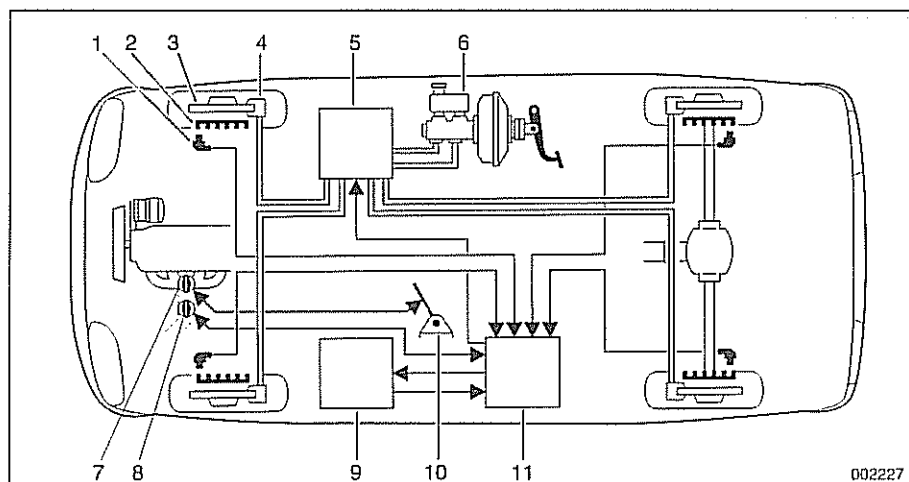
➤ A switch (arrow) on the center console is used to toggle the ASC on or off.

NOTE —

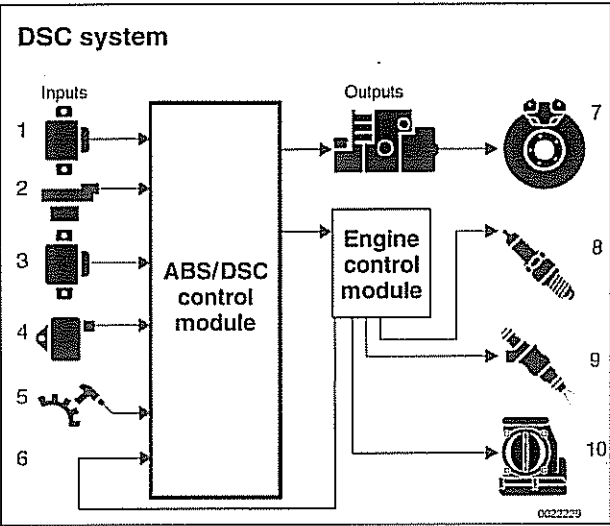
Even with the ASC system turned off, if the ASC control module senses a difference in wheel speed (one wheel spinning) the ASC system applies modulated braking force to the slipping wheel until traction is regained. There is no override of fuel injection function.

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.

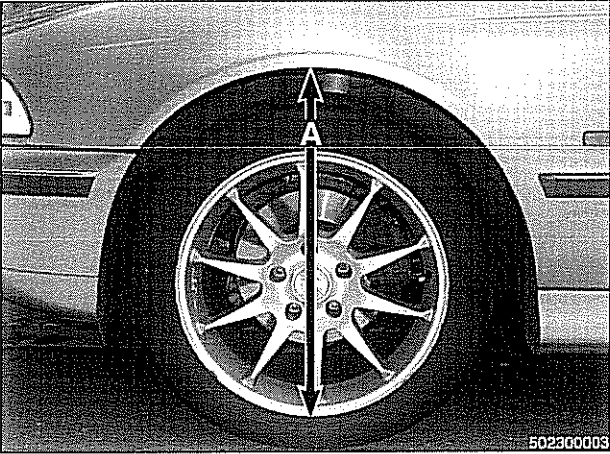
NOTE—

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



Suspension, Steering and Brakes - General

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

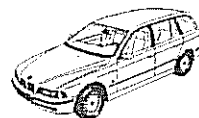
Wheel size	Standard suspension	Sports suspension	Ride level control	Rough road suspension	M sports package
15 inch	547 mm (21.5 in)	532 mm (20.9 in)	562 mm (22.1 in)	567 mm (22.3 in)	532 mm (20.9 in)
16 inch	560 mm (22.0 in)	545 mm (21.5 in)	575 mm (22.6 in)	580 mm (22.8 in)	545 mm (21.5 in)
17 inch	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

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Front Strut Assembly	310-4
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Front Stabilizer Bar	310-22
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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.

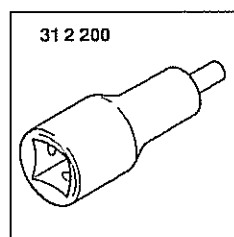
See **300 Suspension, Steering and Brakes-General** for a description of the front suspension and components, as well as specifications for setting ride height.

CAUTION—

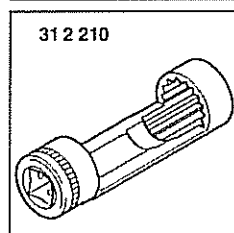
- Some E39 models are equipped with aluminum suspension components. The following cautions apply:
- Due to the chemical and corrosion characteristics of aluminum, do not bring into contact with battery acid.
- Do not clean with wire brushes with brass or iron bristles. Only use brushes with stainless 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

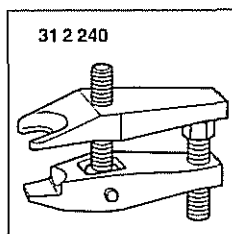
Special service tools are required for most of the work described in this repair group. In addition to the tools depicted in the illustrations, a variety of press tools are necessary for control arm bushing replacement. Read the procedures through before beginning any job.



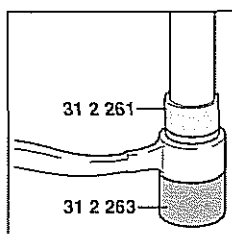
- Wheel carrier expander
(Tool No. BMW 31 2 200)



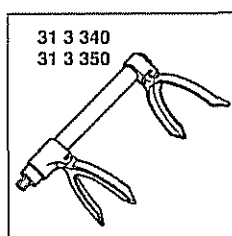
- Strut nut socket
(Tool No. 31 2 210)



➤ Ball joint press
(Tool No. BMW 31 2 240)

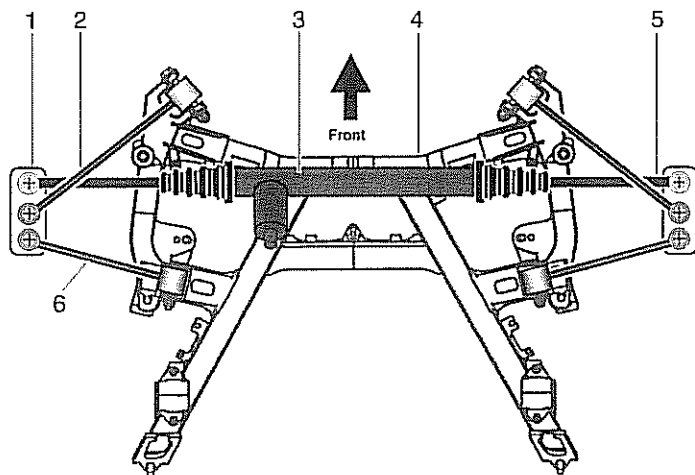


➤ Bushing press tools
(Tool No. BMW 31 2 261/263)



➤ Spring compressor and spring holder arms
(Tool No. BMW 31 3 340 / 31 3 350)

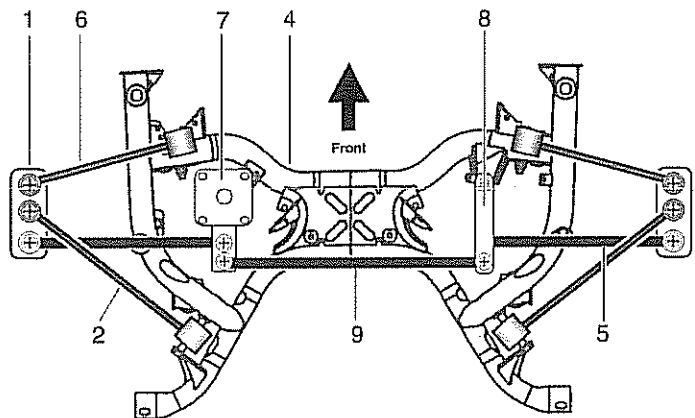
6-cylinder models



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:

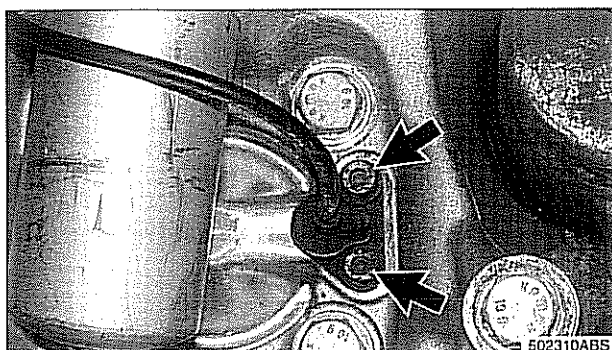
- Removal of strut assembly from vehicle
- Disassembly and replacement of component on work bench

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.

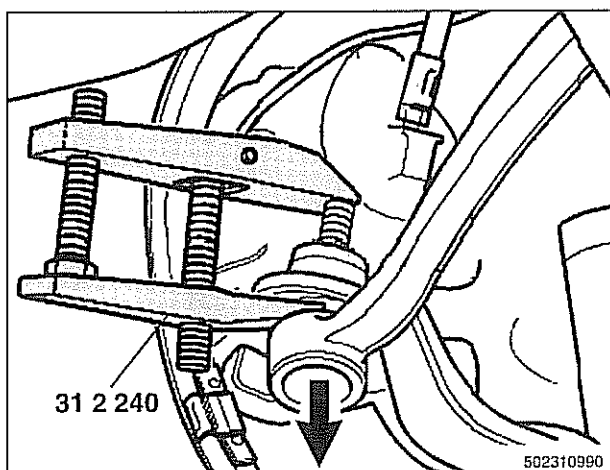


- Unbolt brake caliper assembly, keeping brake hose connected. Secure brake caliper to body with wire. Do not let it hang from brake hose. See **340 Brakes**.
- Remove ABS pulse sensor mounting bolts (**arrows**) and remove sensor from housing.
- Detach ABS sensor wire harness and brake pad wear sensor 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.

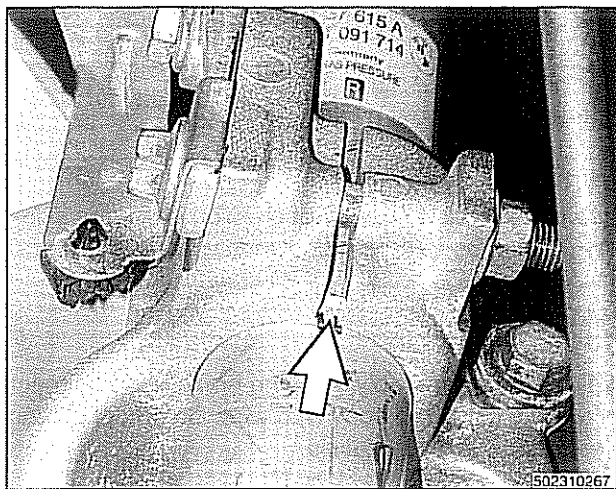
NOTE—

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.



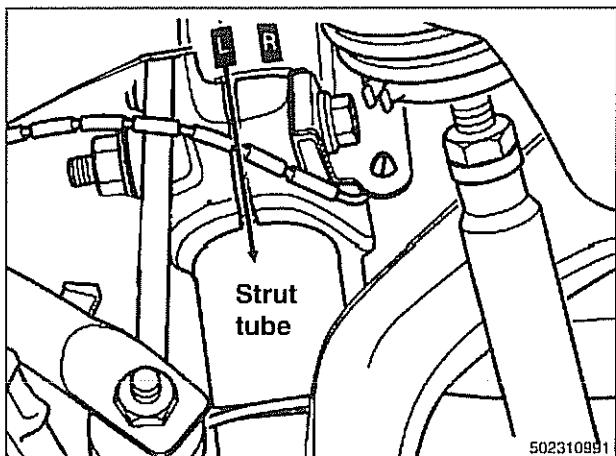
Front Suspension



- 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.

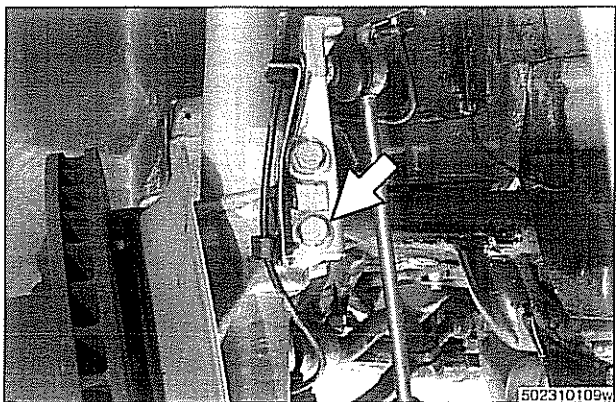


- Letter on strut tube designates mounting location.

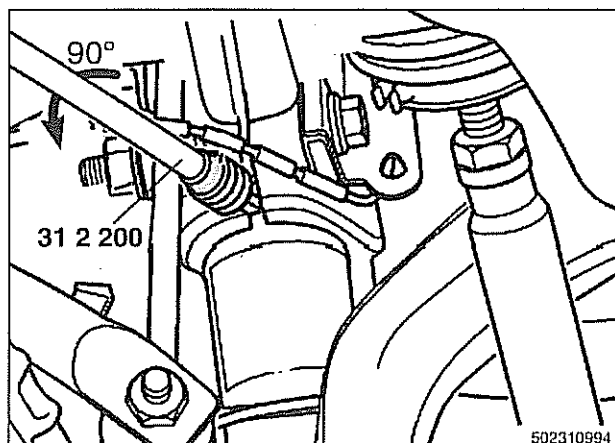
- R — Right side installation position
- L — Left side installation position

NOTE—

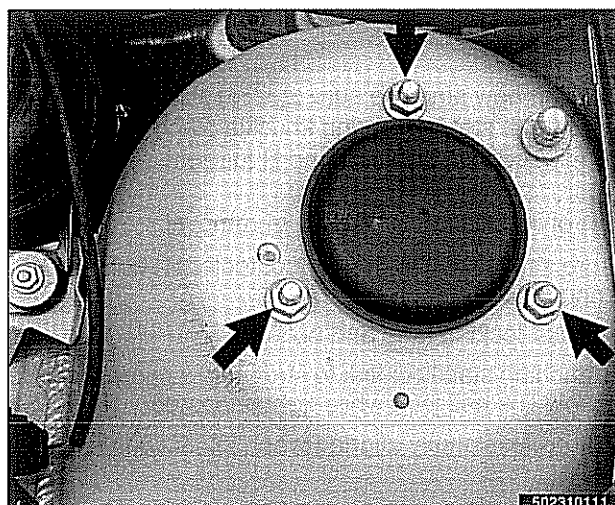
Marking the strut tube is not necessary if factory marks (L or R) are still visible.



- Counterhold strut tube pinch bolt (**arrow**) while loosening nut.



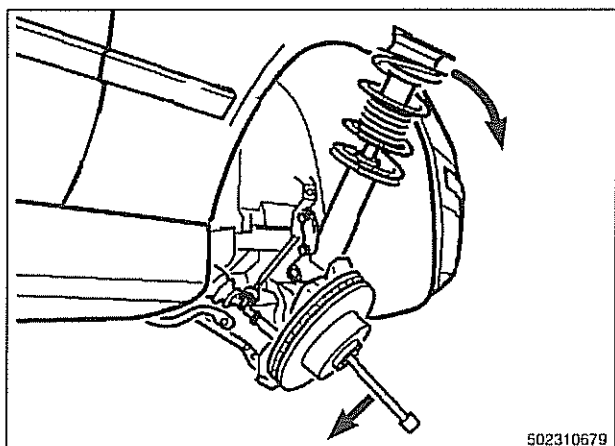
- ◀ Spread steering knuckle slot in pinch collar with BMW special tool 31 2 200.



- ◀ 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 —

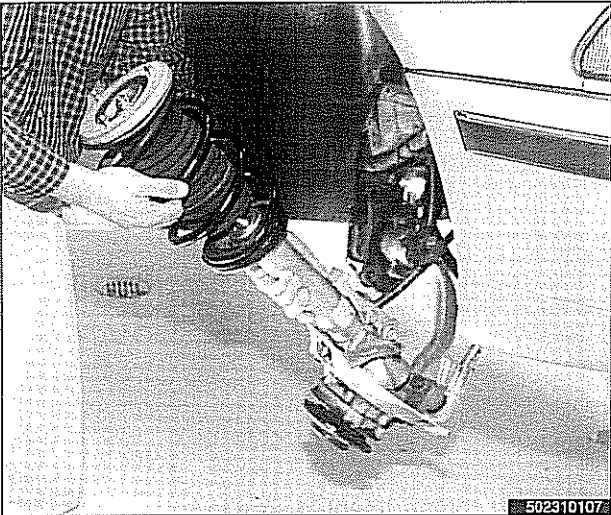
Do not remove center strut retaining nut.



- ◀ Use lever to push down on wheel hub. Tilt strut outward.

NOTE —

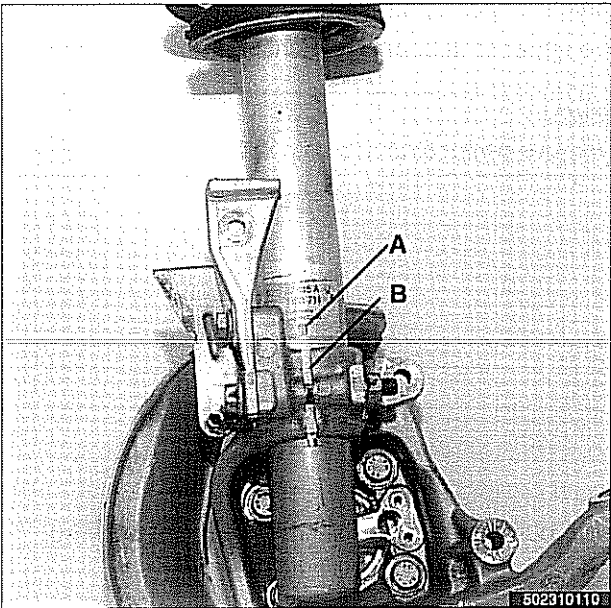
Use masking tape to protect fender arch from possible damage.



- 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.

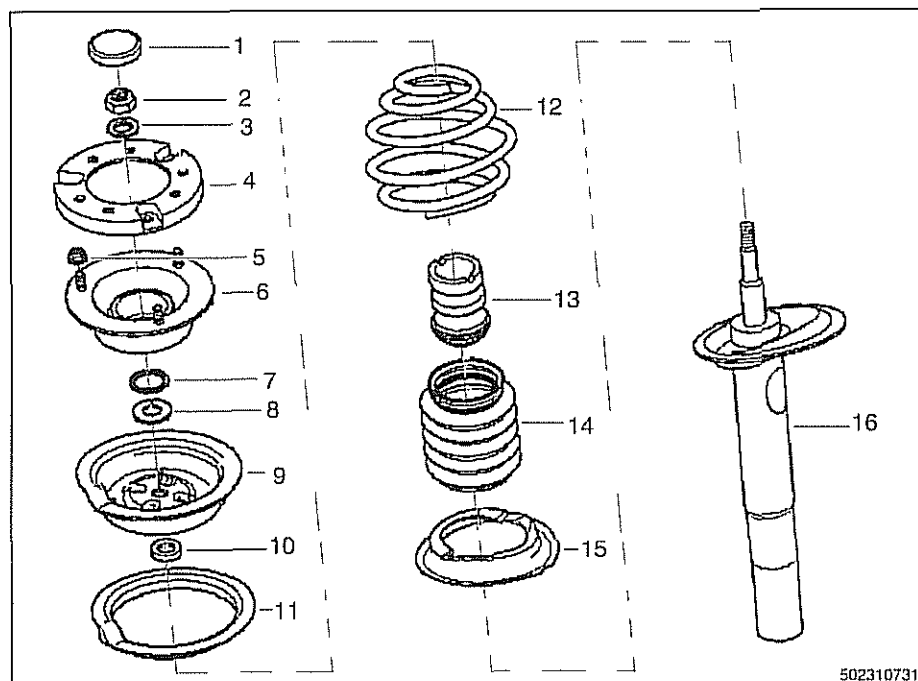
- Disassemble and reassemble strut assembly as described later.



- 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.

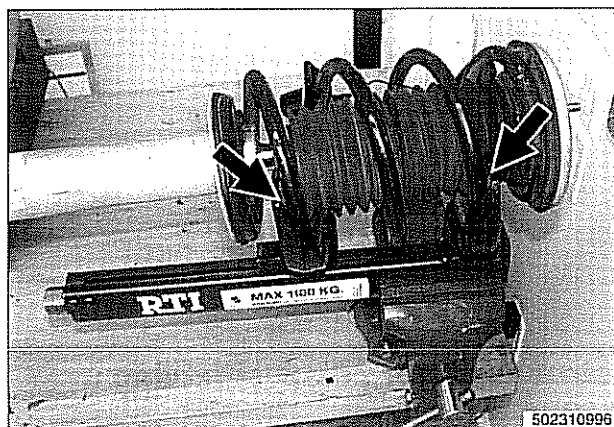
Front Suspension



- Clamp spring compressor (BMW special tool 31 3 340 or equivalent) in shop vise.

WARNING —

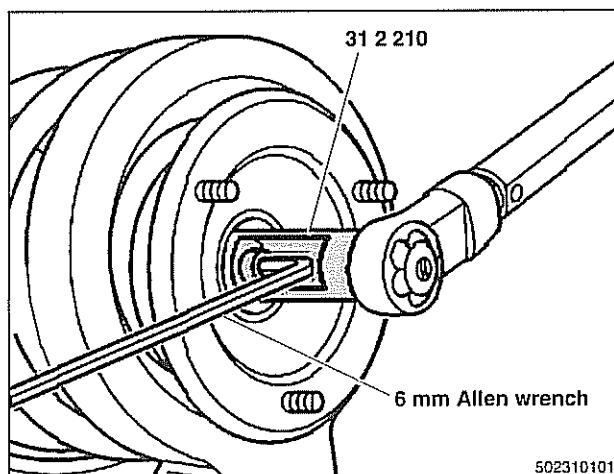
- Do not attempt to disassemble the strut assembly without a spring compressor designed specifically for this job.
- Prior to each use, check special tool for functionality.
- Do not use a damaged tool.
- Do not make any modifications to tool.
- Use correct size spring retainers when compressing coil 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.

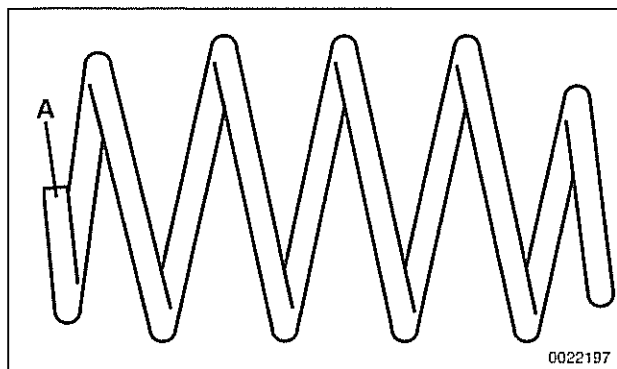


- Use BMW special tool 31 2 210 or equivalent to remove strut nut. Counterhold strut shaft using 6 mm Allen wrench.

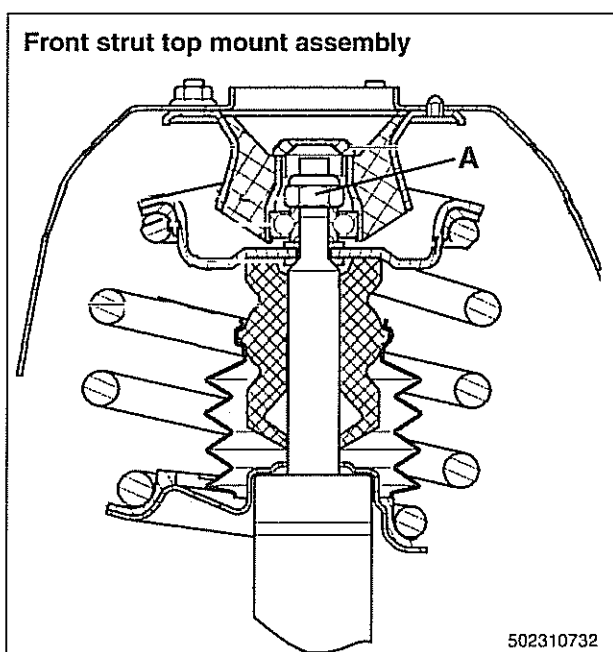
CAUTION —

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:

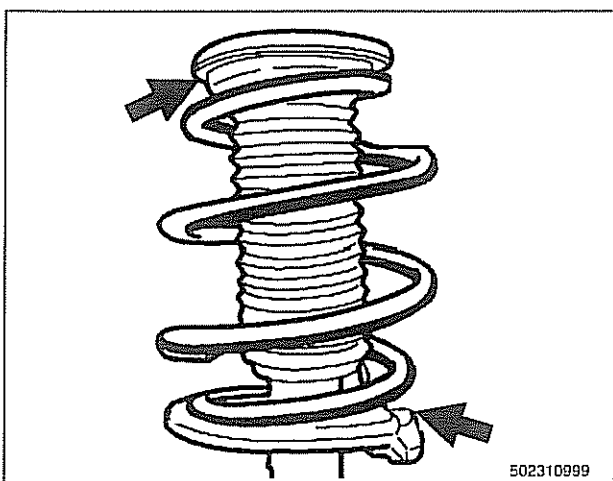
- Use a new upper strut self-locking nut (A). Tighten nut fully before releasing spring compressor.

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.

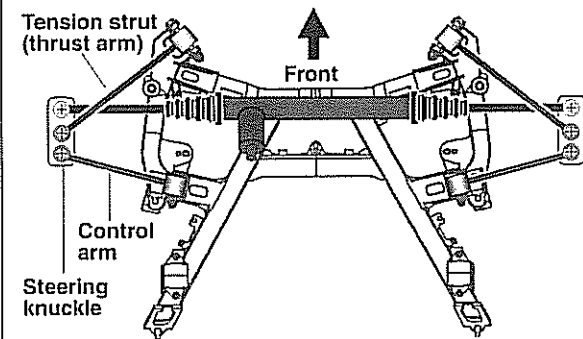
- Release spring compressor carefully and evenly, allowing spring to expand slowly.
- Have car professionally aligned when job is complete.

Tightening torques

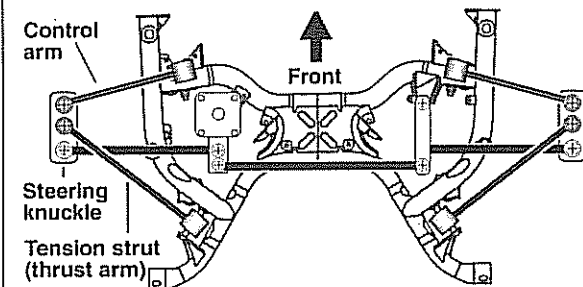
Upper strut mount to strut shaft (M14)	64 Nm (47 ft-lb)
Strut mount to strut tower (M8)	24 Nm (18 ft-lb)

Front Suspension

Front suspension arms 6-cylinder models (525i, 528i, 530i)



Front suspension arms V-8 models (540i)



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FRONT SUSPENSION ARMS

- Control arms and tension struts are attached to the front subframe 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)

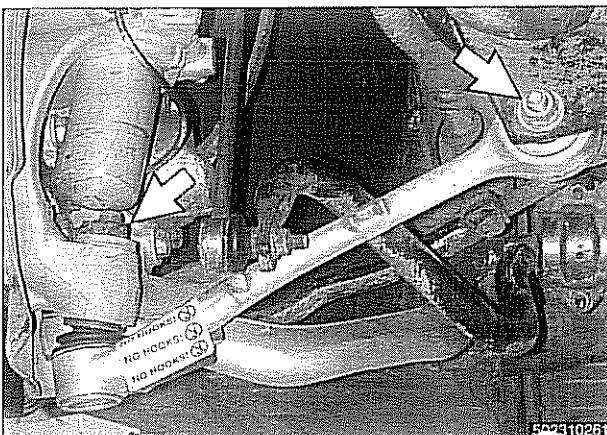
- Raise car and remove wheel.

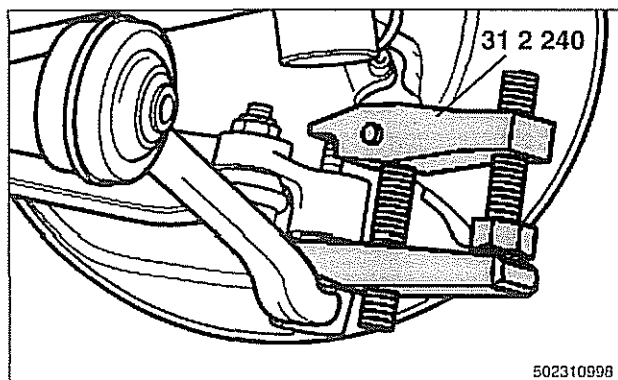
WARNING—

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

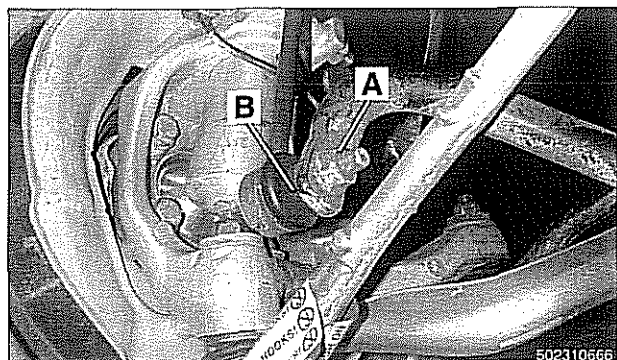
Control arm to steering knuckle	80 Nm (59 ft-lb)
Control arm to subframe	110 Nm (81 ft-lb)
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)

Control arm, removing and installing (V-8 models)

- Raise car and remove wheel.

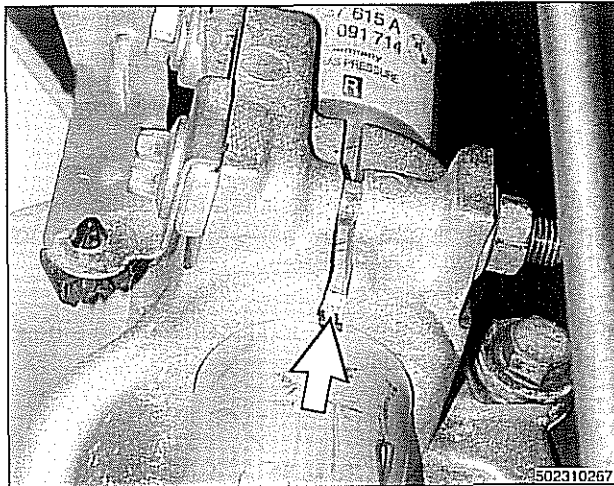
WARNING —

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



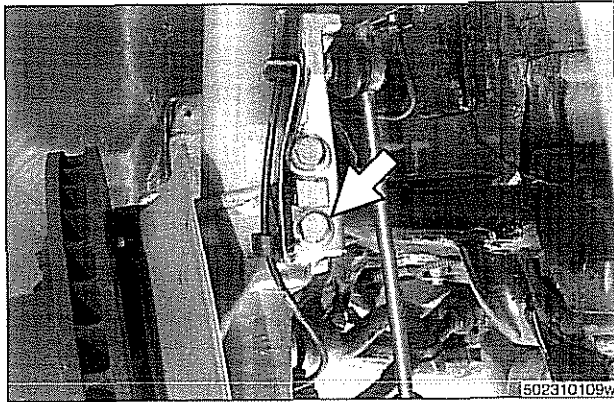
- Mark installation position of strut tube (arrow) at steering knuckle pinch collar.

NOTE—

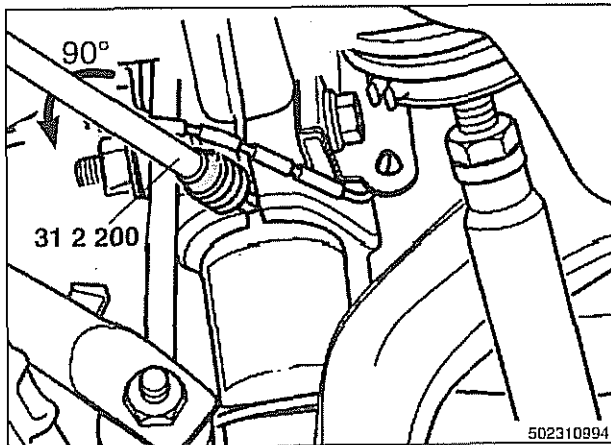
- The strut tube installation position is marked on factory strut tubes: L for left and R for right.
- Marking the strut tube is not necessary if factory marks (L or R) are still visible.

CAUTION—

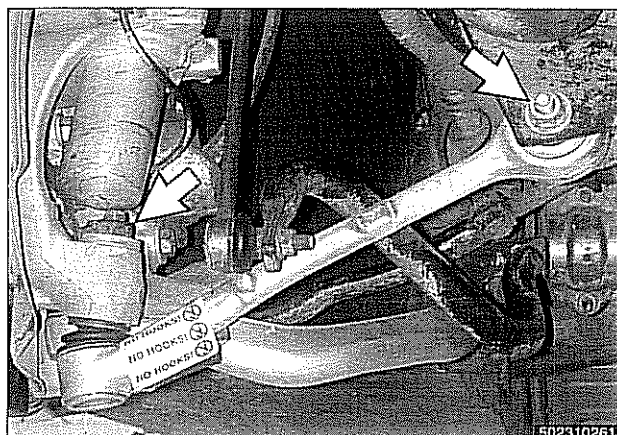
Use paint, not a scribe tool, to mark location of strut tube.



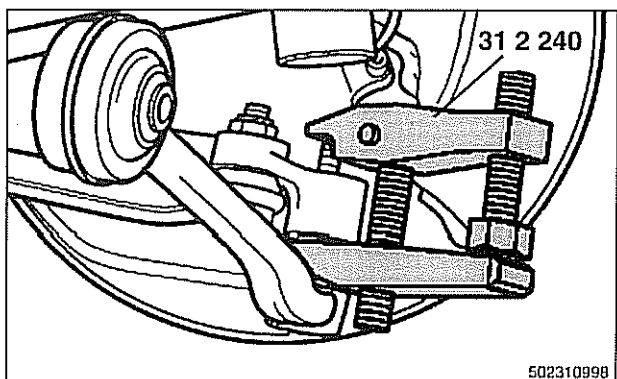
- Counterhold strut tube pinch bolt (arrow) while loosening nut.



- 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.

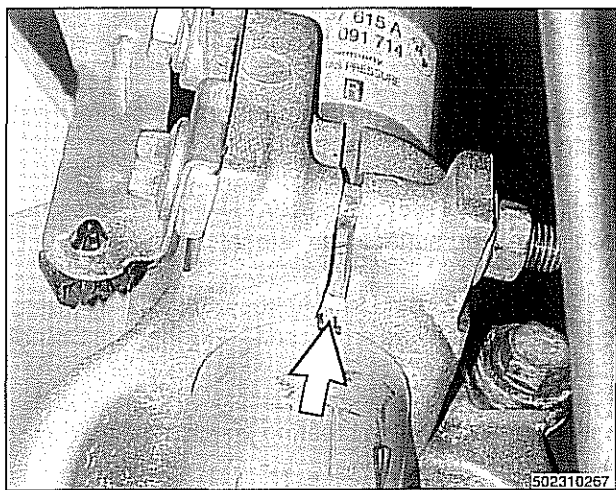
NOTE—

- 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.

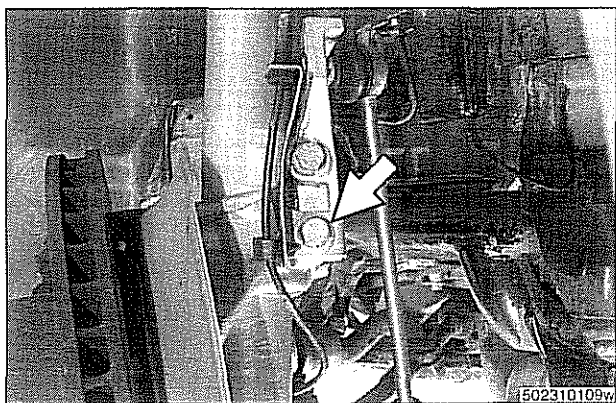
CAUTION—

Use paint, not a scribe tool, to mark location of strut tube.

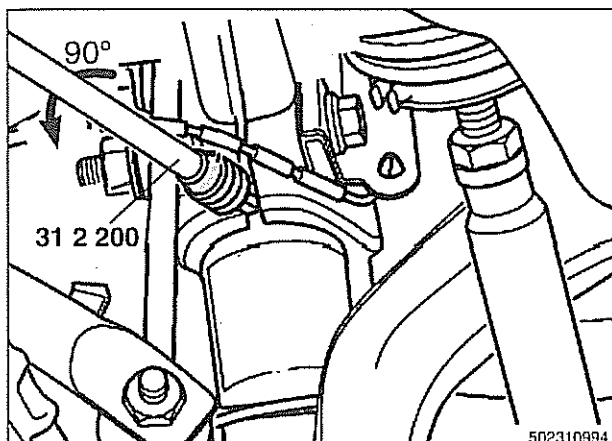
- Counterhold strut tube pinch bolt (**arrow**) while loosening nut.



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- 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)

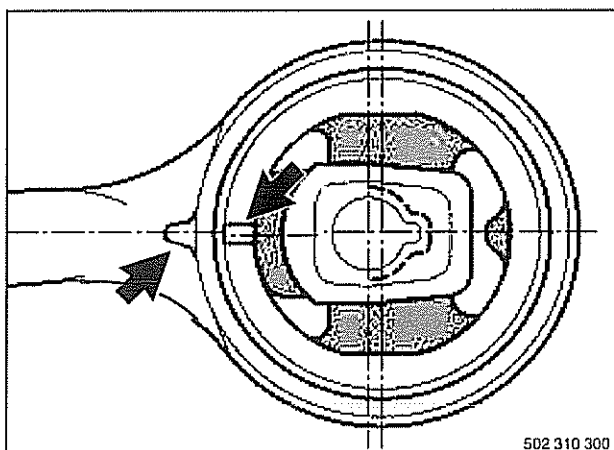
Tension strut bushing, replacing

- 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

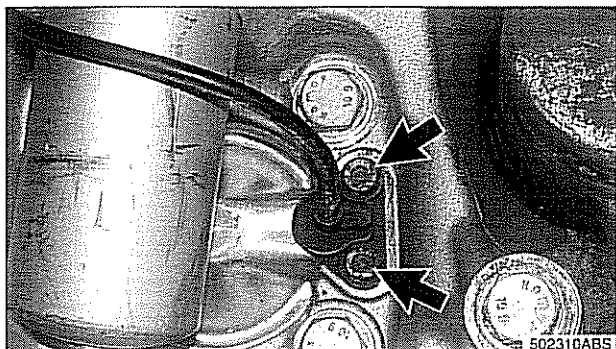
The front wheel bearings are permanently sealed and require no maintenance. The bearing is integral with the wheel hub. The wheel bearing and hub assembly is bolted to the steering knuckle.

- Raise car and remove front wheel.

WARNING—

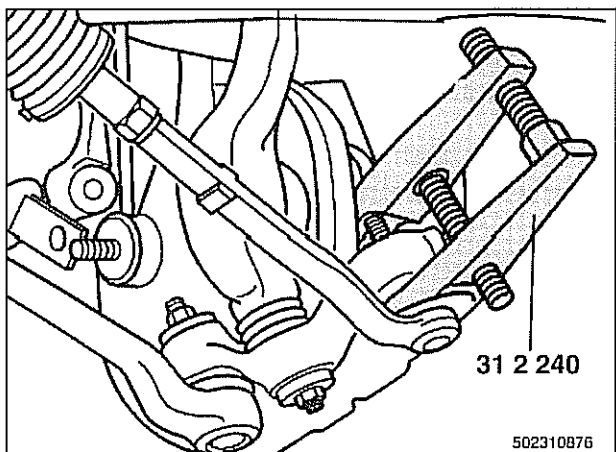
Make sure that the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.

- Unbolt brake caliper and hang to side with stiff wire. Do not disconnect brake hose. Remove brake disc. See **340 Brakes**.

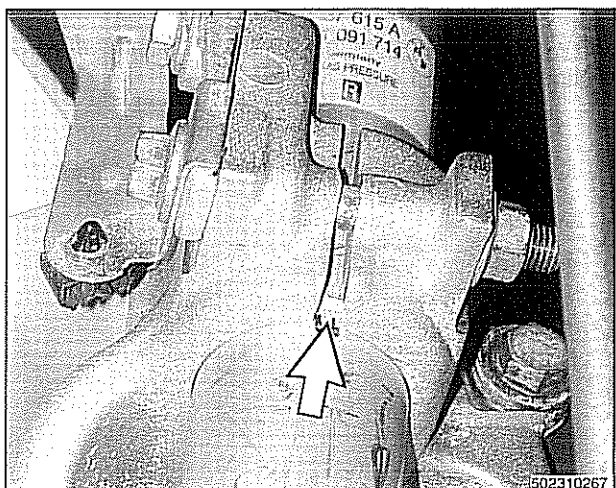


➤ Remove ABS pulse sensor mounting bolts (**arrows**) and pull sensor from housing.

— 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.

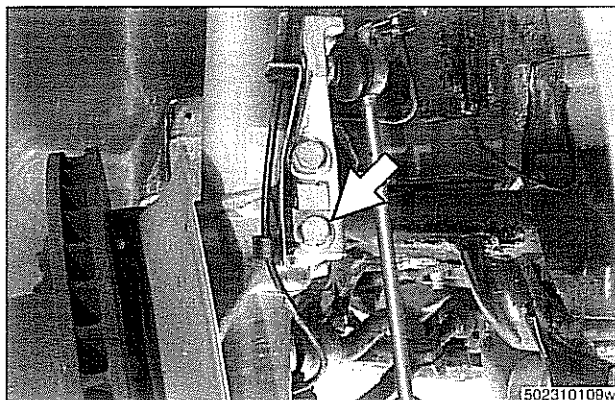
NOTE —

The strut tube installation position is marked on factory strut tubes: L for left and R for right.

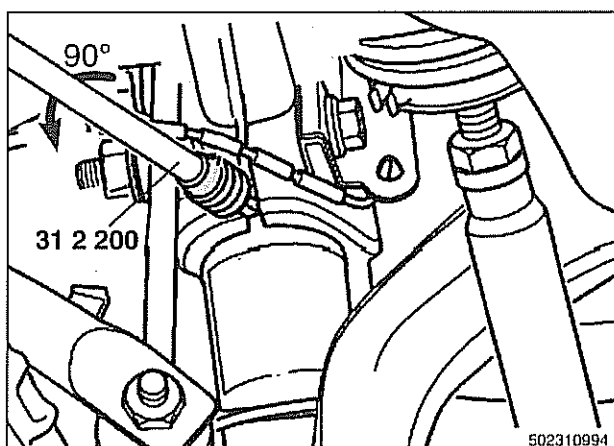
CAUTION—

Use paint, not a scribe tool, to mark location of strut tube.

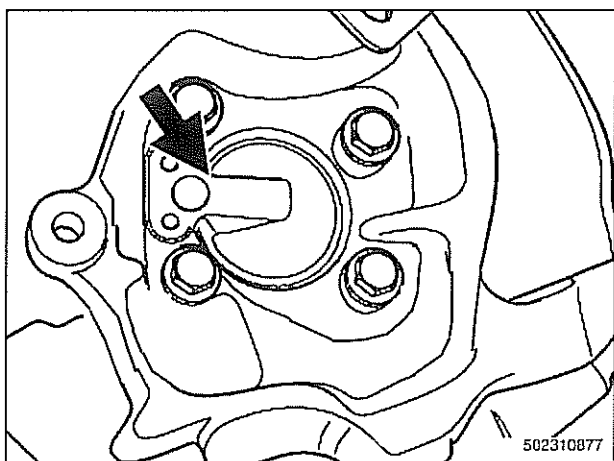
Front Suspension



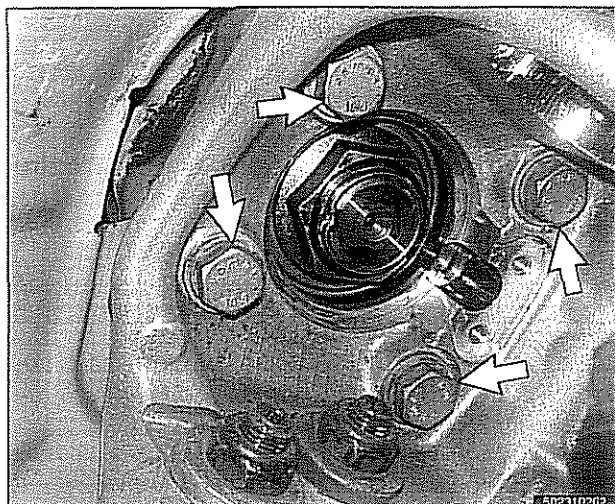
- Counterhold strut tube pinch bolt (**arrow**) while loosening nut.



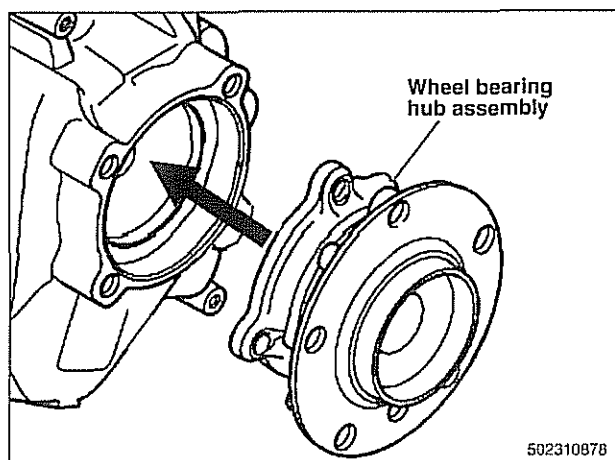
- Spread steering knuckle pinch collar with BMW special tool 31 2 200 to release strut tube.
- Pull steering knuckle down so that strut tube slides up far enough to gain access to wheel bearing hub mounting bolts.



- 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

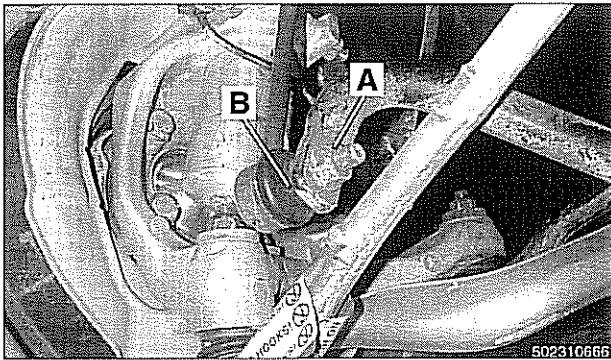
Stabilizer bar, removing and installing

On E39 models the front stabilizer bar links attach to the strut assemblies.

- Raise car and support safely.

WARNING —

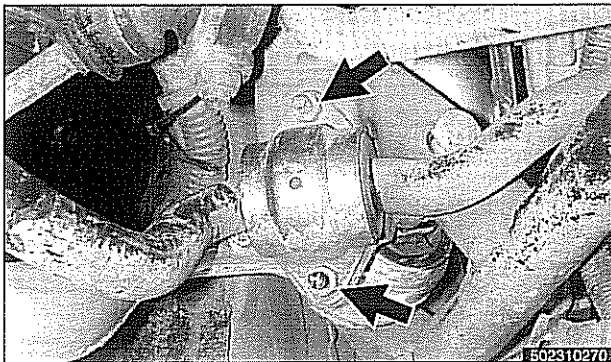
Make sure that the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.



- Remove stabilizer bar connecting link mounting nuts (A) from right and left sides of stabilizer bar. Counterhold ball joint (B) with flat wrench.

NOTE —

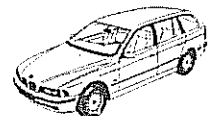
Use a thin wrench to counterhold shaft of stabilizer bar link ball joint while removing mounting nut.



- 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

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GENERAL

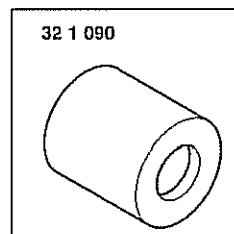
This repair group covers steering wheel and column removal and steering system service, including wheel alignment information.

NOTE—

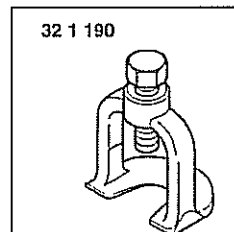
- Ignition lock cylinder replacement is covered in this section.
- For information on steering column mounted switches, including the ignition switch, see **612 Switches**.

Special tools

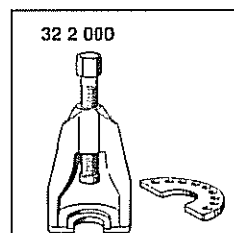
Some special tools are necessary to carry out the repairs and adjustments required for steering service and wheel alignment. Be sure to read the procedures through before starting work on the vehicle.



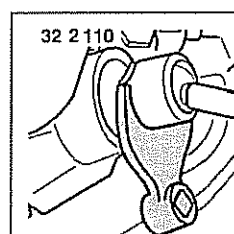
- Steering shaft retaining ring installation tool
(Tool No. BMW 32 1 090)



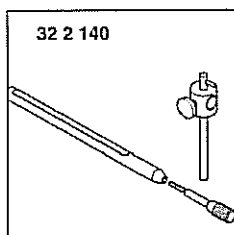
- Ball joint removal tool
(Tool No. BMW 32 1 190)



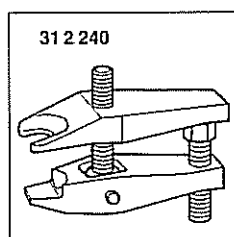
- Pitman arm removal tool
(Tool No. BMW 32 2 000)



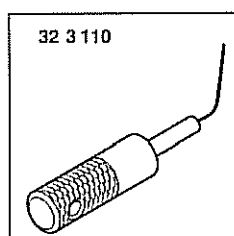
- Inner tie rod removal tool
(Tool No. BMW 32 2 110)



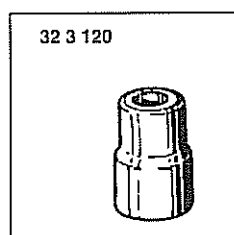
➤ Pitman arm height measurement gauge
(Tool No. BMW 32 2 140)



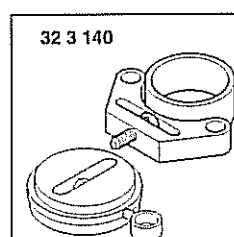
➤ Ball joint removal tool
(Tool No. BMW 31 2 240)



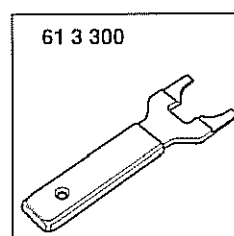
➤ Ignition lock releasing tool
(Tool No. BMW 32 3 110)



➤ 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.

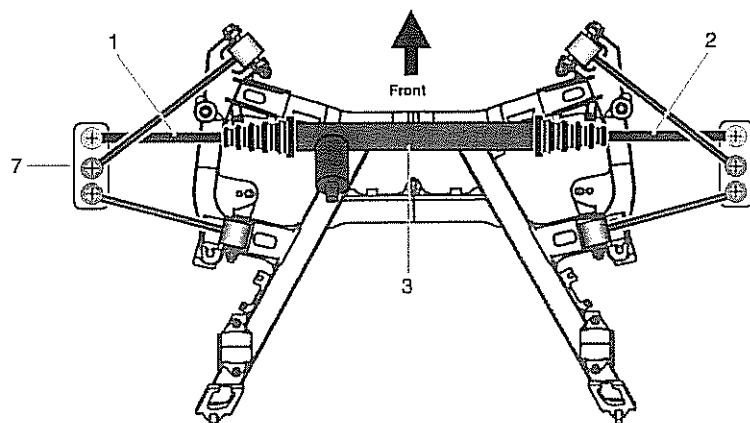
The return line from the steering gear to the reservoir loops into the airstream in front of the radiator and connects to the steering fluid cooler. The fluid cooler is attached to a cassette which also includes cooling coils for engine oil, transmission fluid and A/C condenser.

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).

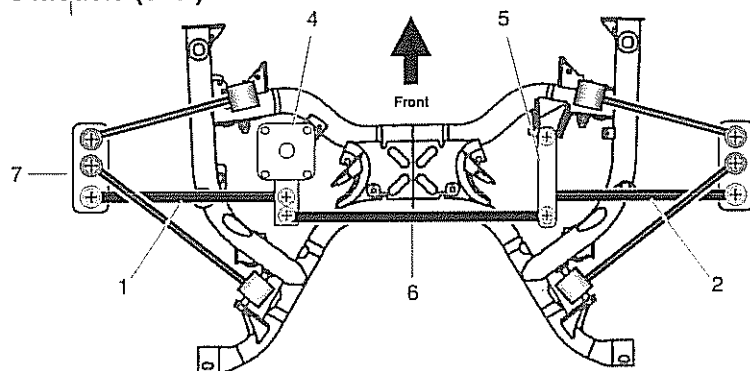
Rack and pinion steering
6-cylinder models (525i, 528i, 530i)



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

Recirculating ball and nut steering
V-8 models (540i)



502320001a

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

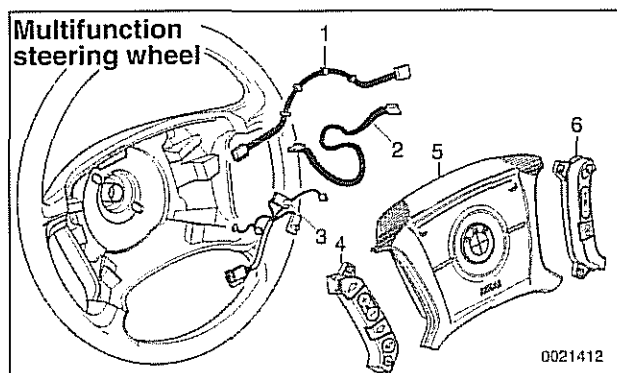
Steering wheel, removal and installation

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.

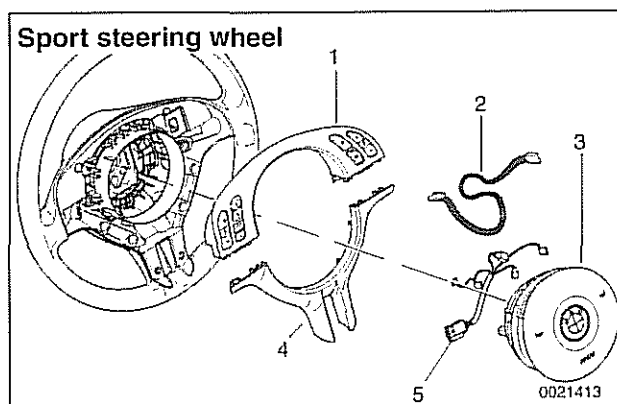
E39 cars may come with either one of two different styles of steering wheel:

- 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:

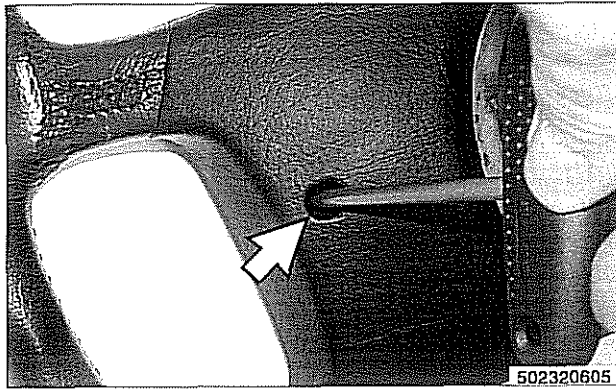
1. Switch carrier
2. Steering wheel switch set electrical harness
3. Airbag
4. Lower cover
5. Horn button and airbag electrical harness

- Center steering wheel. Make sure front wheels are pointed straight ahead.
- Disconnect negative (-) cable from battery.

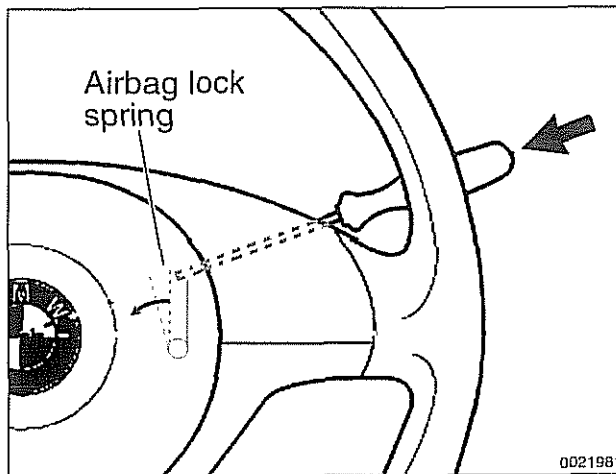
CAUTION—

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).



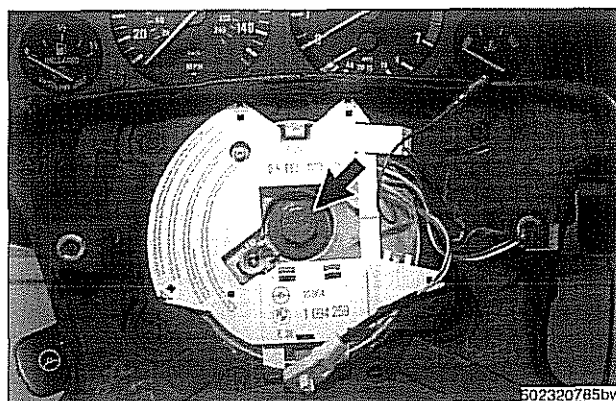
- Sport steering wheel:
- Insert screwdriver through opening in rear of steering wheel and push against spring tension to release airbag.
 - Repeat procedure on other side of steering wheel.
- Carefully lift airbag from steering wheel and disconnect electrical harnesses from back side of unit. Refer to component illustrations above. Also see **721 Airbag System (SRS)**.

WARNING—

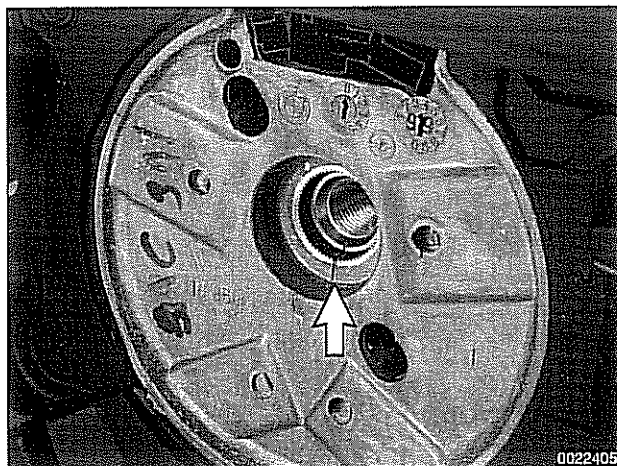
Improper handling of the airbag could cause serious injury. Store the airbag with the horn pad facing up. If stored facing down, accidental deployment could propel it violently into the air, causing injury.

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).

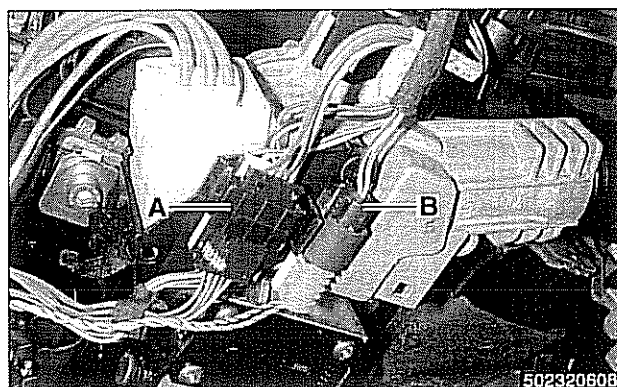


- ◀ Check for proper alignment of steering column marks (arrow) before removing steering wheel.

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**.



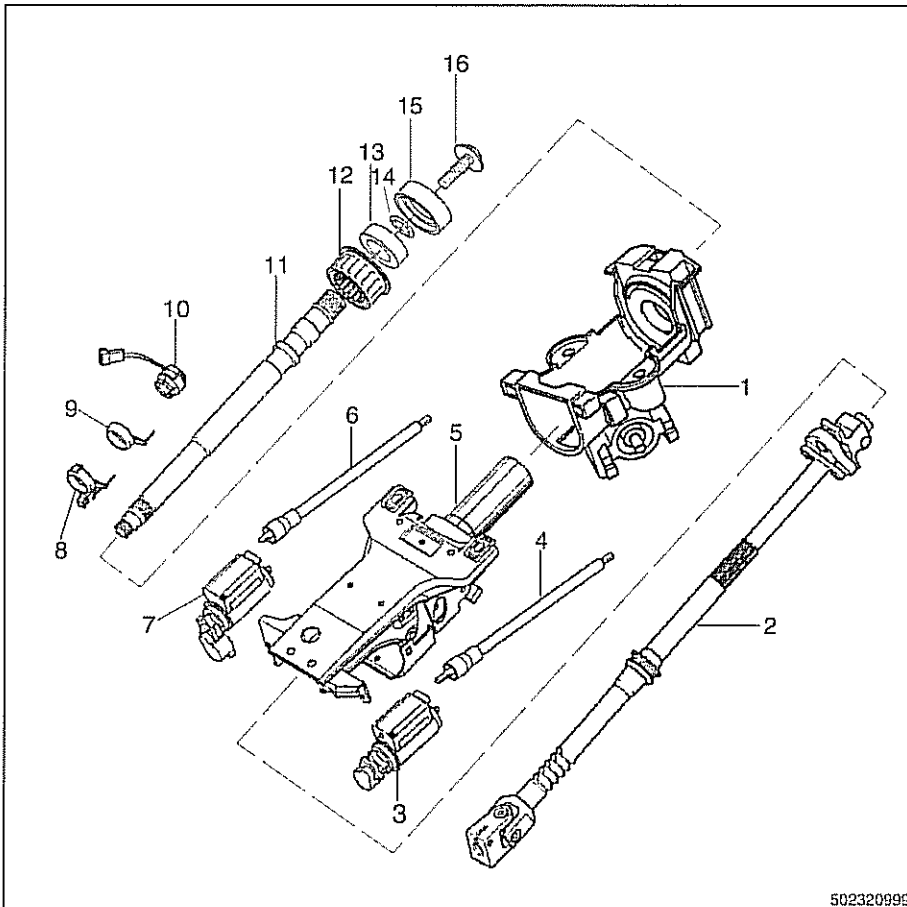
- ◀ Working underneath steering column, disconnect electrical harnesses (A) and (B).

- 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

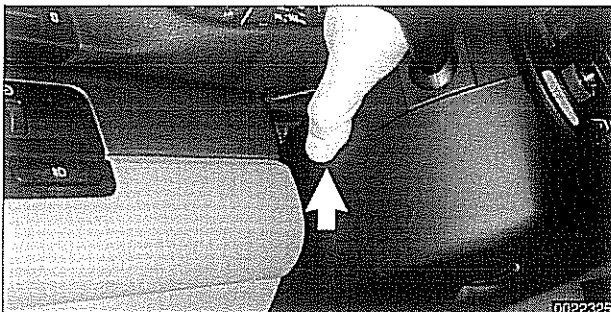


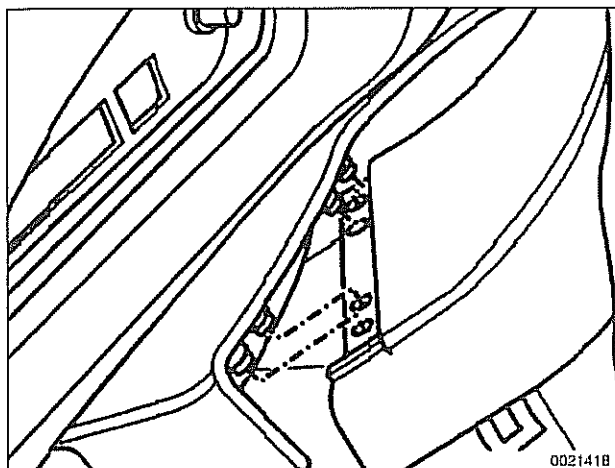
Steering column components

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

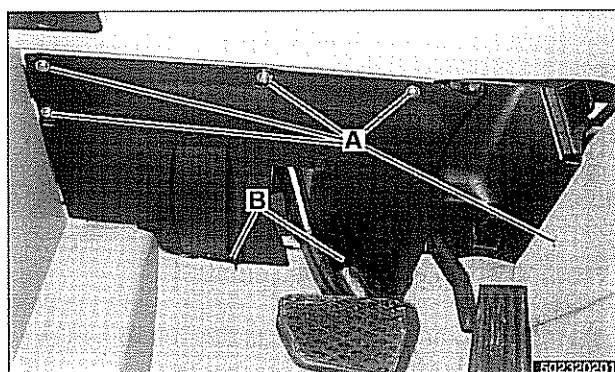
Steering column trim, removing and replacing

- 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.

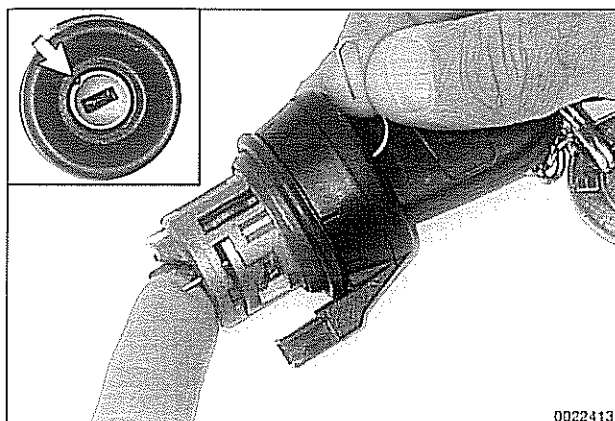
Ignition lock cylinder, removing and installing

- 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.

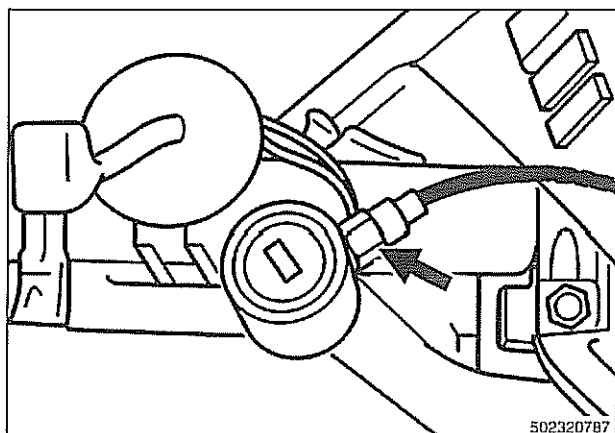
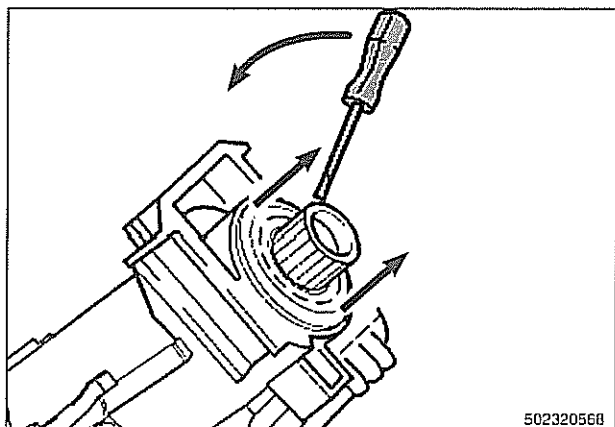
Steering column lock, removing and installing

- Disconnect negative (-) cable from battery.

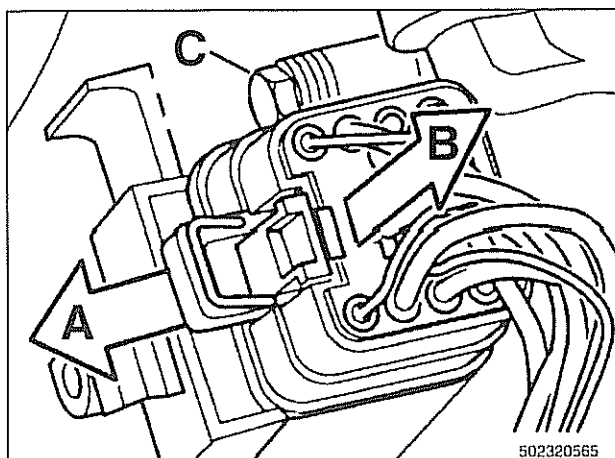
CAUTION—

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

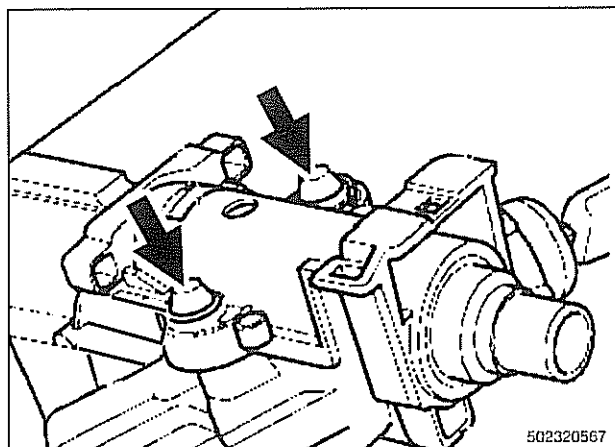
- Remove steering wheel as described earlier.
- Remove steering column trim panels as described earlier.
- Remove collar and circlip from steering shaft. Refer to illustration of steering column components.
- Pry steering shaft bearing with inner sleeve out of lock housing.
- Remove ring antenna as described earlier.
- Remove column switches. See 612 Switches.



- 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.

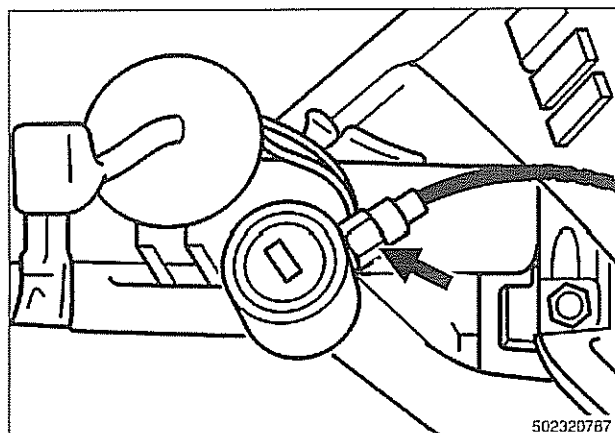
NOTE—

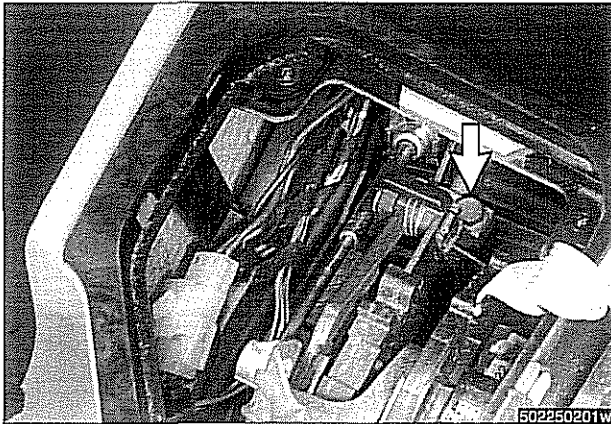
The shear bolts can be drilled and then removed using an easy-out.

- 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)

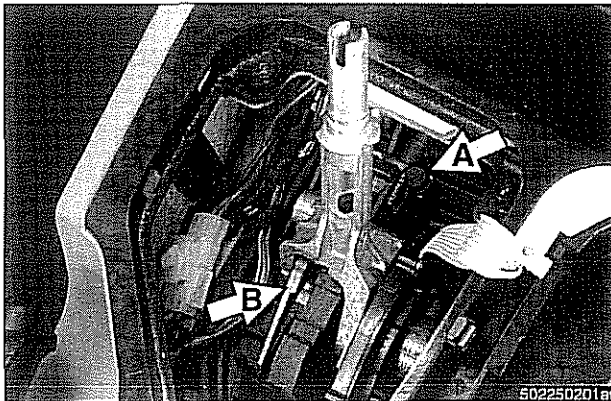
- Remove steering column trim panels as described earlier.
- ◀ Loosen and disconnect interlock cable (arrow) from ignition lock assembly.
- Remove center console trim panel.





- 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)



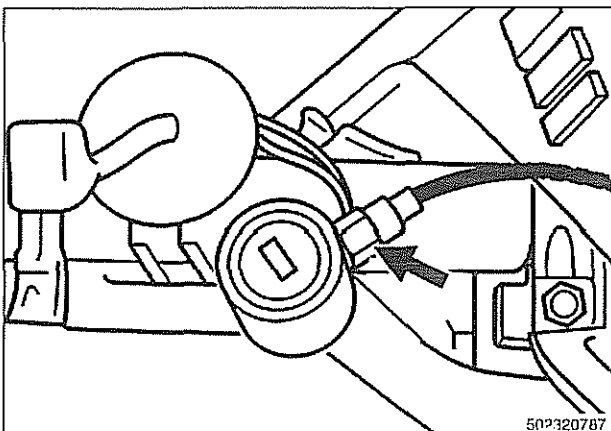
- Remove center console trim panel.
- Place gear shift selector lever in PARK.
- Loosen cable mounting fastener (A).
- Remove ignition key.
- Press down on interlock lever (B) and tighten cable mounting fastener (A).

Steering column, removing and installing

- Disconnect negative cable from battery.

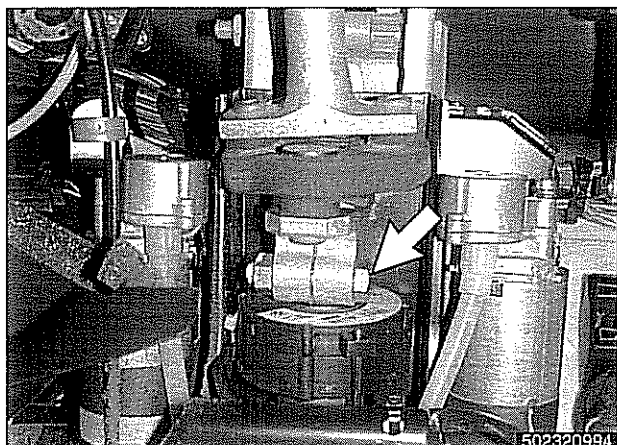
CAUTION—

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



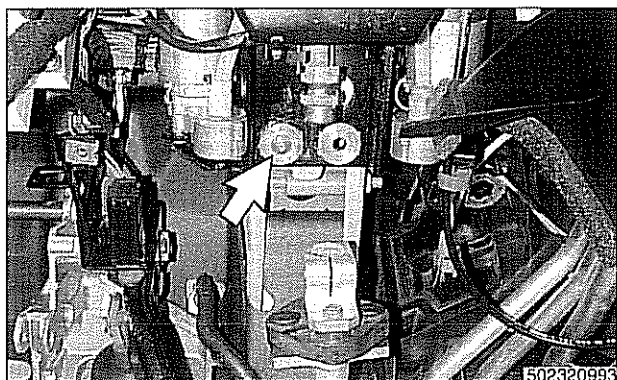
- Remove steering wheel as described earlier.
- Remove steering column trim panels as described earlier.
- Remove steering shaft collar.
- Automatic transmission models: Loosen and disconnect interlock shift cable (arrow) from ignition lock assembly.
- Disconnect steering angle sensor electrical harness.

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.

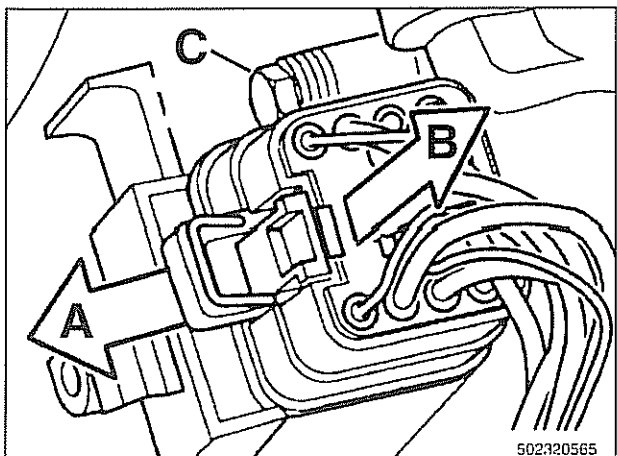


➤ Drill steering column mounting shear bolts (**arrow**) and use easy-out to remove.



➤ 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—

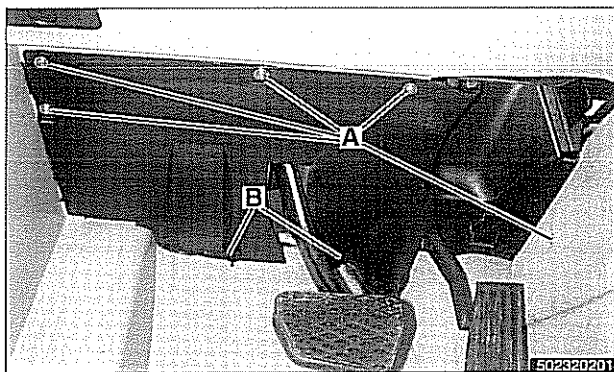
The steering angle sensor must be coded using a BMW scan tool if it has been replaced. A steering angle offset check must then be carried out using the same BMW scan tool.

CAUTION—

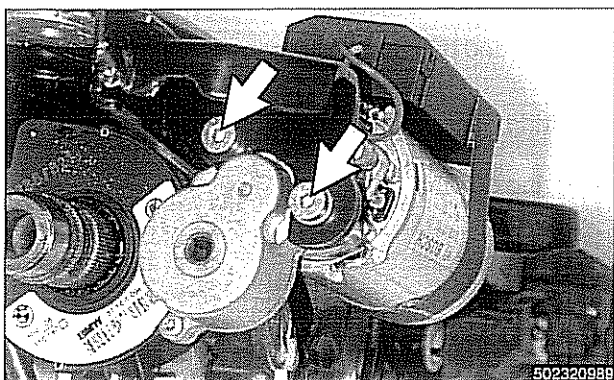
Check steering system for freedom of movement through entire steering column adjustment range.

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

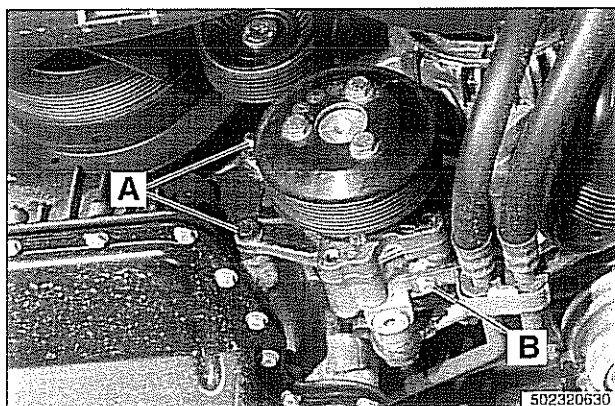
CAUTION—

When working with power steering components, absolute cleanliness is needed to ensure proper operation of the hydraulic system.

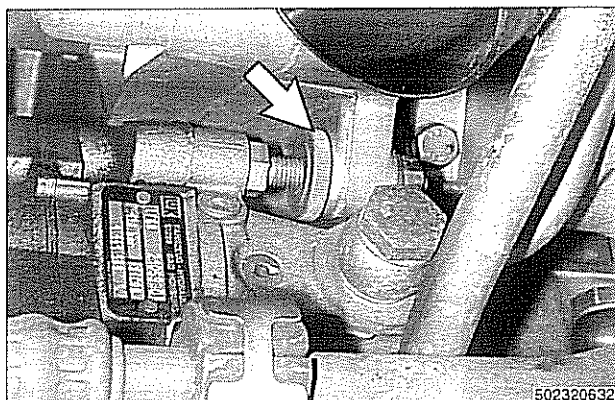
- Empty power steering fluid reservoir using clean syringe. Do not reuse fluid.
- Raise front of car. Remove splash shield from under engine.

WARNING—

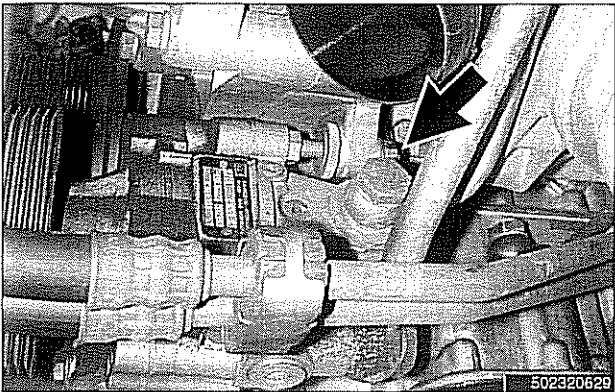
Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands beneath structural chassis points. Do not place jack stands under suspension parts.



- 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

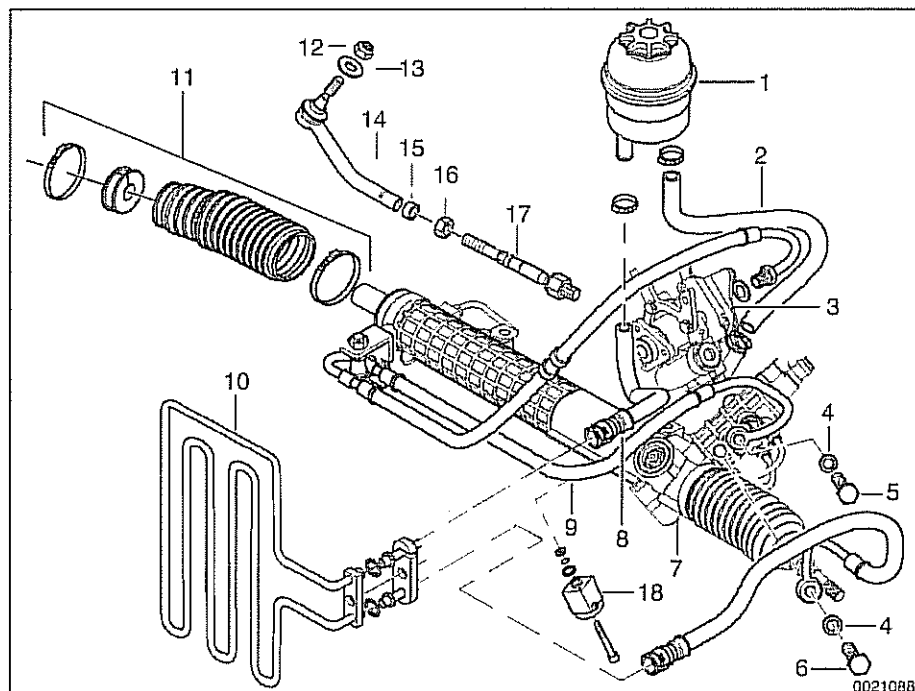
Hydraulic lines to steering pump (banjo bolts)	
• M 10	12 Nm (9 ft-lb)
• M 14	35 Nm (26 ft-lb)
• M 16	40 Nm (30 ft-lb)
• M 18	45 Nm (33 ft-lb)
Pump brackets to engine block	25 Nm (18 ft-lb)
Rear pump support stud to pump housing	22 Nm (16 ft-lb)

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

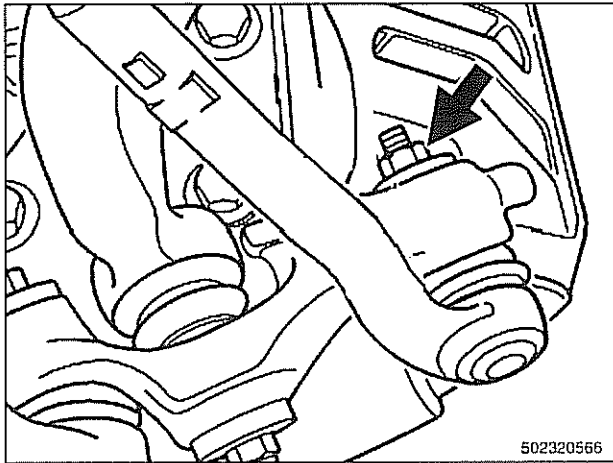
Steering rack, removing and installing

- Remove steering wheel as described earlier.
- Raise front of car, and remove front wheels.

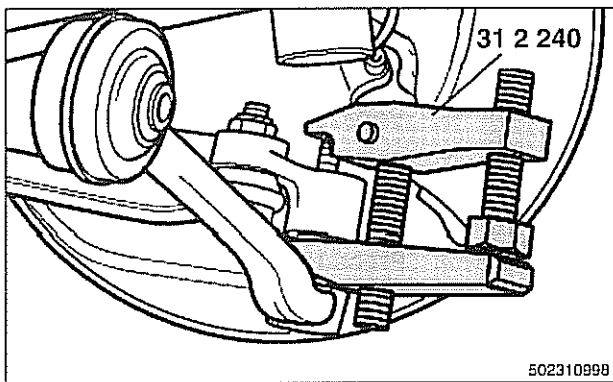
WARNING—

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.

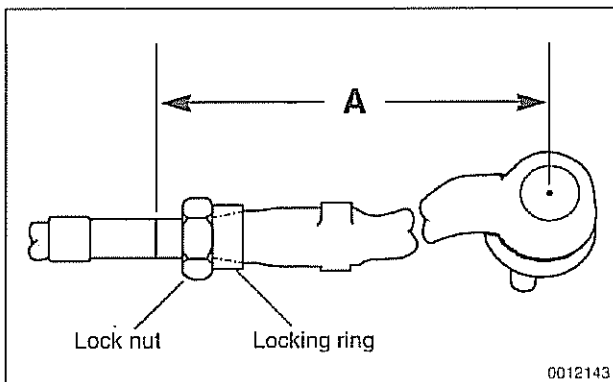
- Remove splash shield from under engine.
- Remove right and left engine mount fasteners.



- 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.



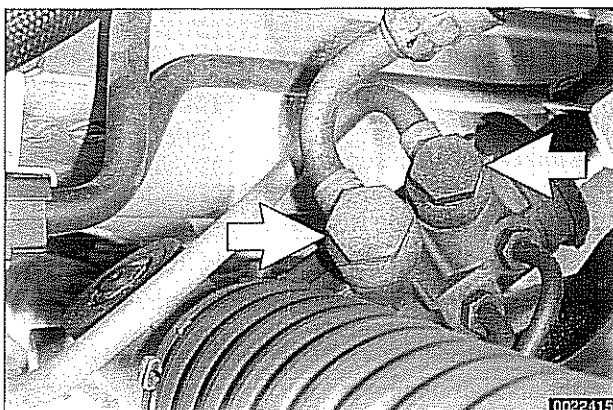
- Press right tie rod out of right steering knuckle using BMW special tool 31 2 240. Repeat for left.



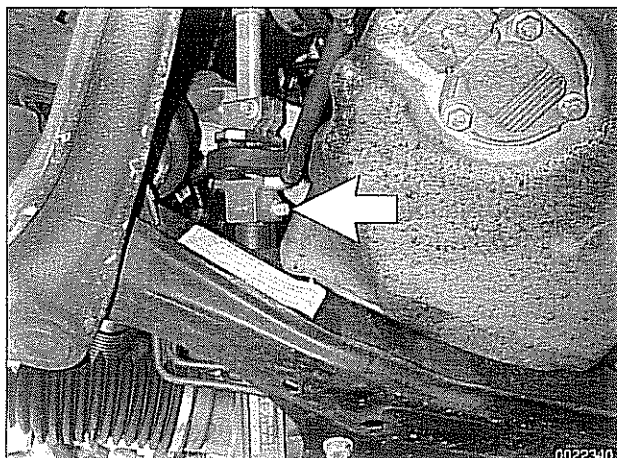
- Make reference measurement (**A**) of right tie rod end to tie rod. Record measurement. Repeat for left.

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.

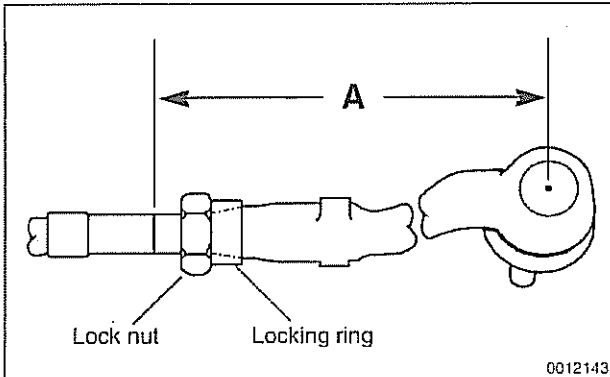
- Grease tie rod taper so that small end of rack boot slides on tie rod when tie rod is tightened, preventing rack boot from twisting.
- Slide new boot into position and replace band clamps.

Tie rod (outer), replacing

- Raise front of car. Remove road wheel.

WARNING —

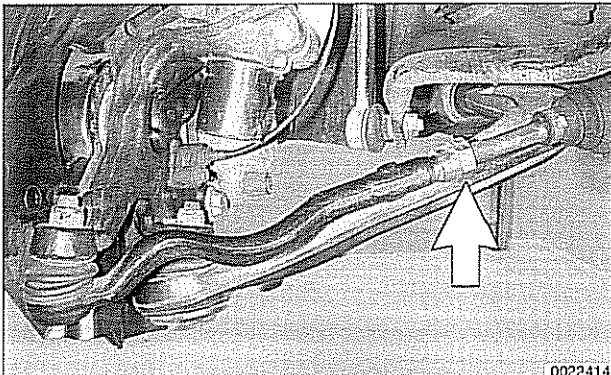
Make sure car is firmly supported on jack stands designed for the purpose. Place jack stands beneath structural chassis points. Do not place jack stands under suspension parts.



- 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 —

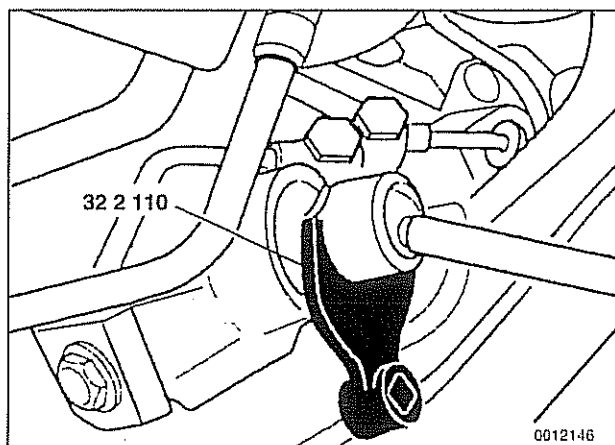
To avoid damage to steering rack while removing tie rod, turn steering until end of rack is as far as possible inside rack housing.

- 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.



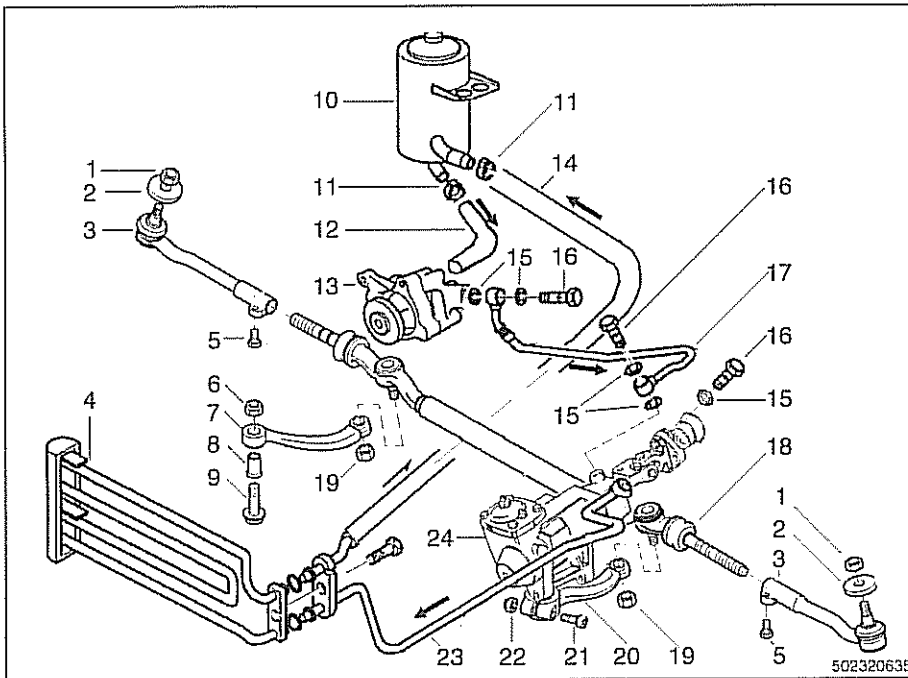
Tightening torques

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 —

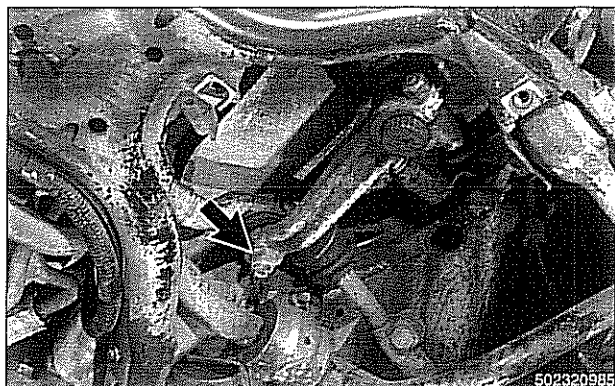
Improper handling of the airbag could cause serious injury. Store the airbag with the horn pad facing up. If stored facing down, accidental deployment could propel it violently into the air, causing injury.

- Remove steering wheel as described earlier.
- Drain power steering system reservoir.
- Raise front of car.

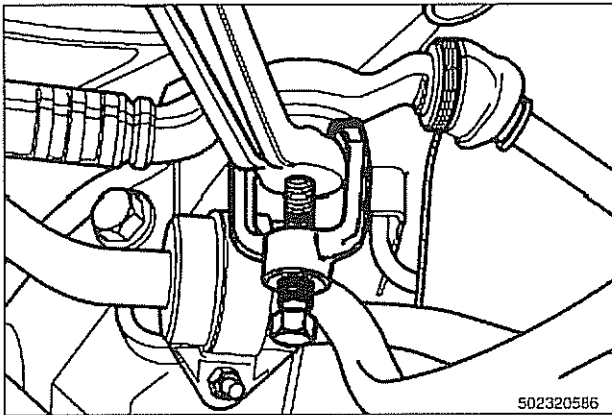
WARNING —

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.

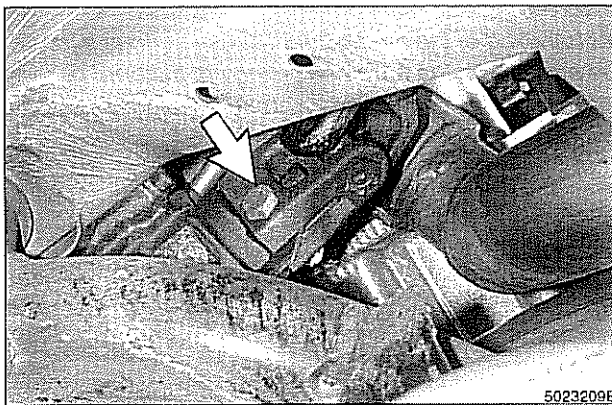
- Remove heat shield from left side of subframe.
- Remove fluid hoses from top of steering gearbox. Immediately plug all fluid openings.
- Remove and discard pitman arm self-locking nut (arrow).



Steering and Wheel Alignment

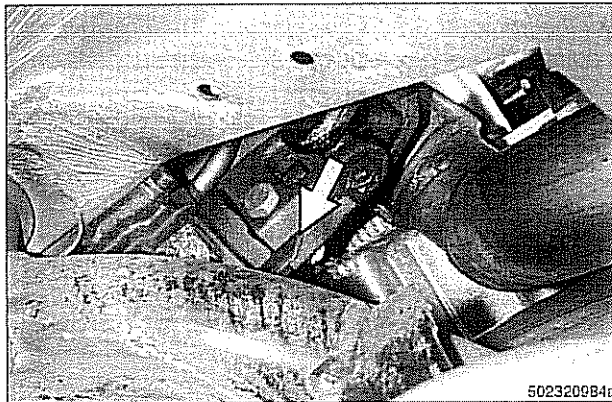


- Press center tie rod off pitman arm.



- Remove lower steering column universal joint clamping bolt (arrow) and slide universal joint up off steering gearbox shaft.

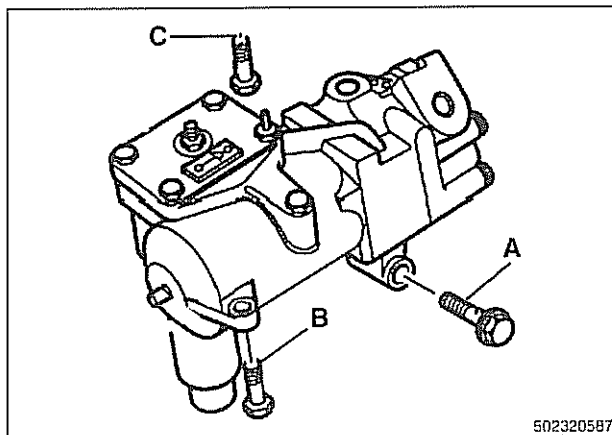
- Disconnect harness connector for electro-hydraulic regulator at bottom of steering gearbox if necessary.
- Remove steering gearbox mounting bolts.
- Remove steering gearbox by sliding it forward and down.
- Make sure all thread bores, bolts, nuts, splines and mating surfaces are clean.



- 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.

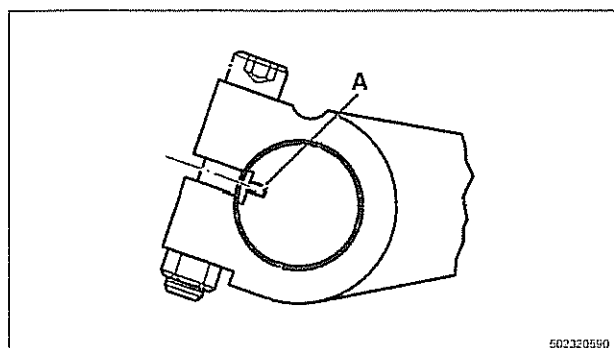
NOTE —

Make sure the clamping bolt fits into the machined groove in the steering gearbox shaft when mating the universal joint to the shaft.



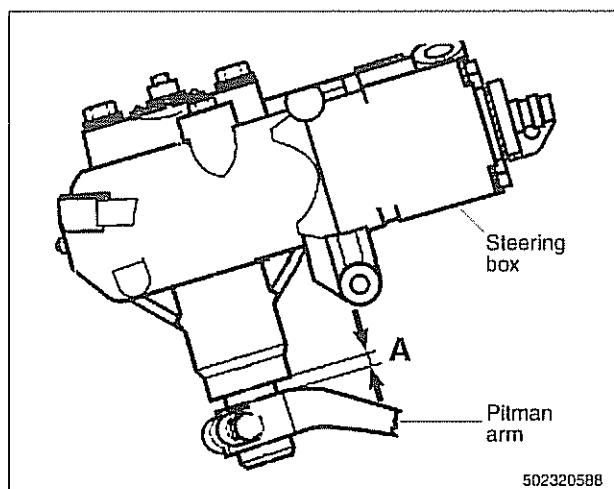
- Draw steering gearbox into place using bolt A. Hand tighten only. Tighten bolts (B and C) to torque specification.
- Install pitman arm on steering gearbox shaft. Do not tighten pinch bolt at this point.

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

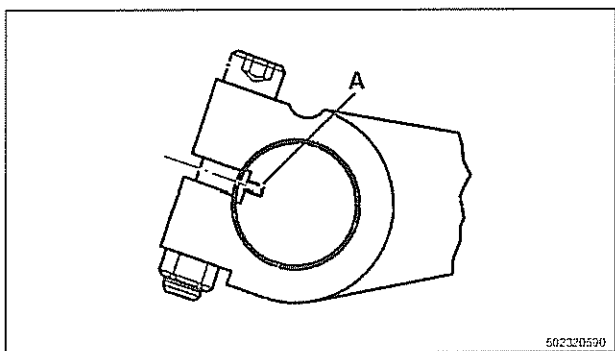
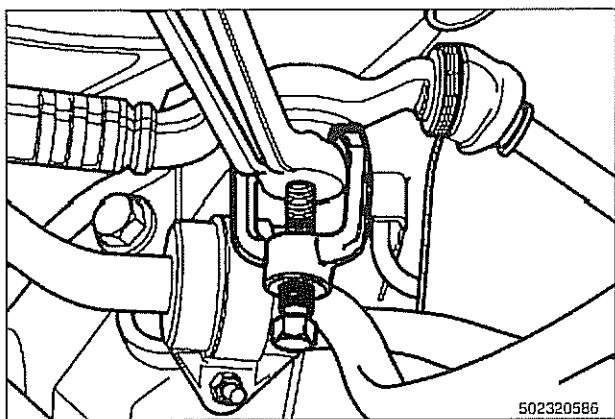
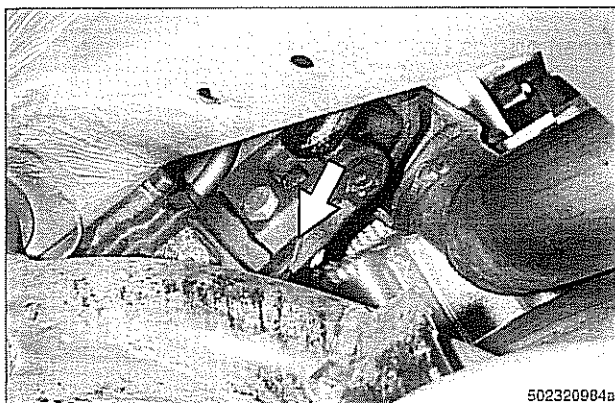
Pitman arm pinch bolt (note direction of threads)	61 Nm (52 ft-lb)
Steering gearbox to subframe	62 Nm (46 ft-lb)
Steering shaft universal joint to steering gearbox (replace bolt)	19 Nm (14 ft-lb)

- 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.



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)

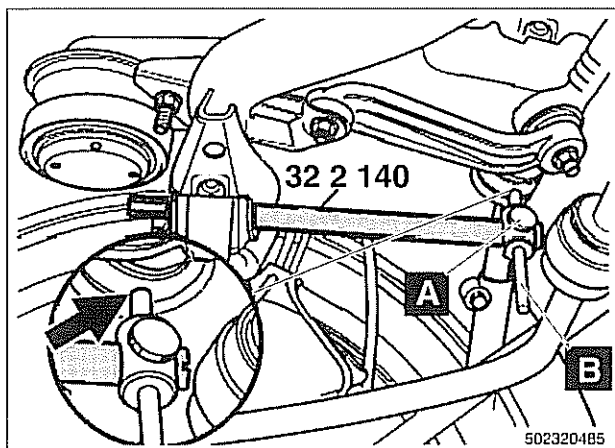
Pitman arm, adjusting

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.

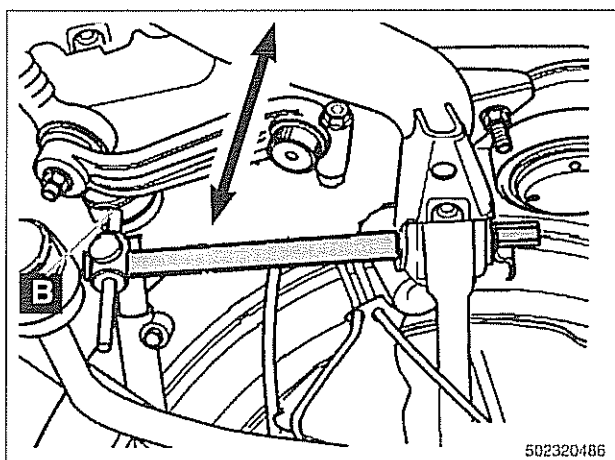
- Raise front of car. Remove splash shield from under engine.

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.



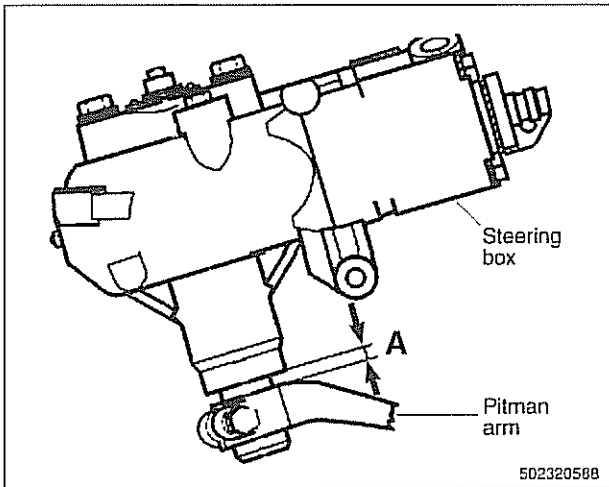
- Remove bolts from left and right inner control arm mounts.
- Place BMW special tool 32 2 140 through right side control arm mounting bolt hole.
 - Loosen fastener **A** and push pin **B** up so that it is firmly against tie rod (arrow). Tighten fastener **A**.
- Remove tool without disturbing position 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 $\pm 1.5 \text{ mm } (\pm 0.06 \text{ in})$



◀ 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)

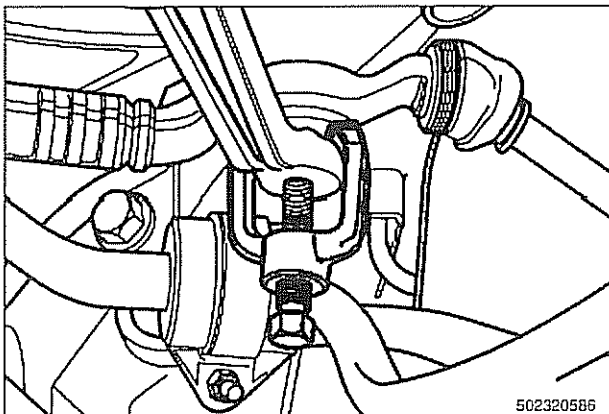
Steering idler arm, removing and installing

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.



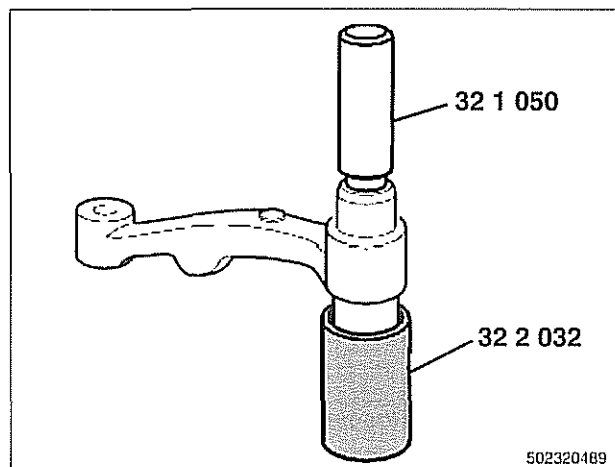
◀ Remove center tie rod fastener and press tie rod out of idler arm with BMW special tool 32 1 190.

- 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

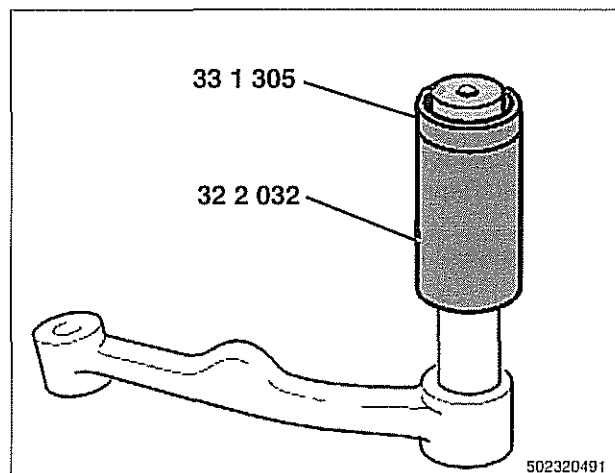
Center tie rod to idler arm (replace self-locking nut)	65 Nm (48 ft-lb)
Idler arm to front subframe (replace self-locking nut)	62 Nm (46 ft-lb)

Idler arm bushing, replacing

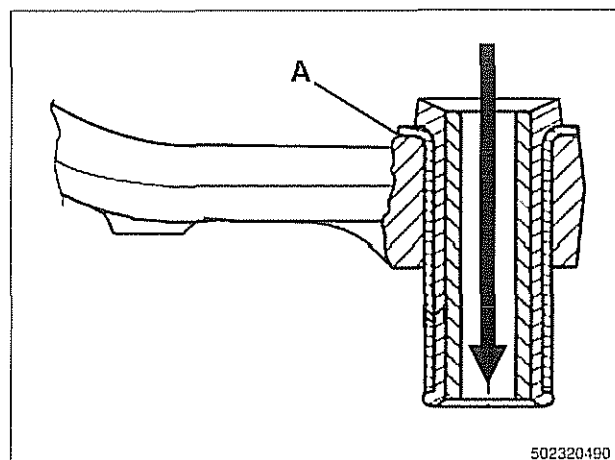


— Remove idler arm as described earlier.

➤ 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**).

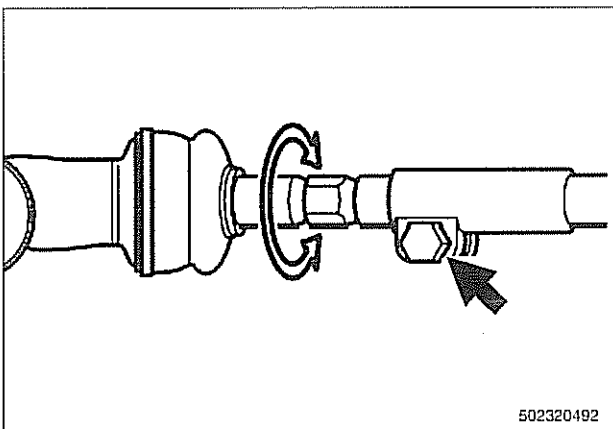
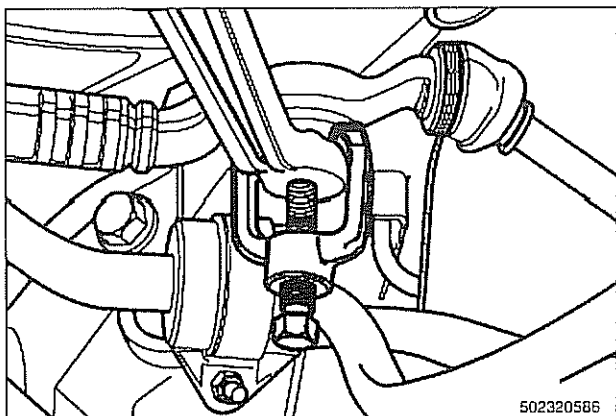
- Press bushing in until lip makes firm contact (**A**) with idler arm.

— 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.

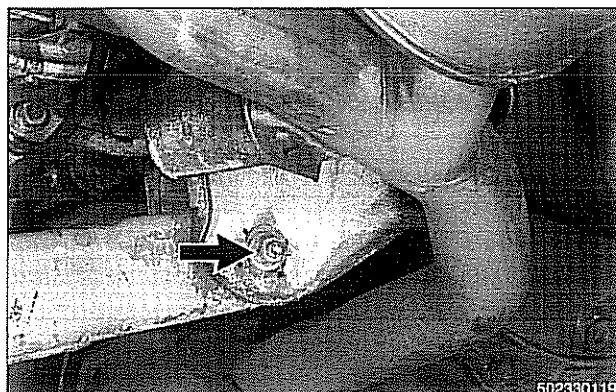
Front and rear alignment specification are given in tables at the end of this repair group.

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.

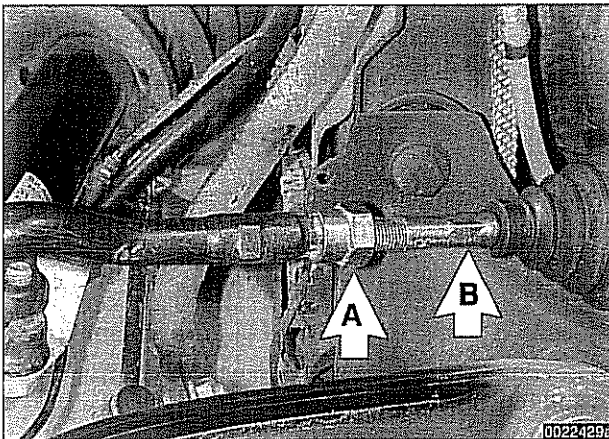
- Check front suspension arms and bushings for wear, damage and deformation if front caster problems are present.
- Check rear axle subframe and traction struts if rear caster problems are present.

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)

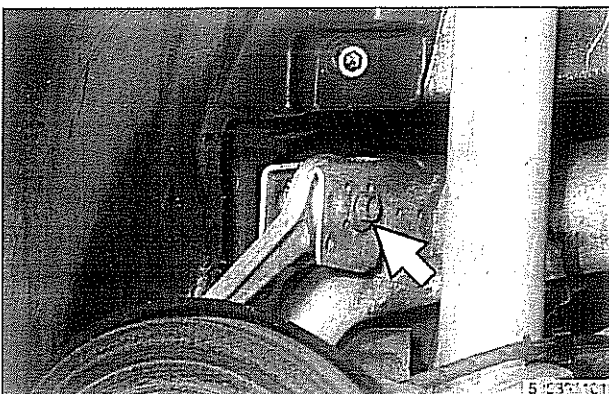
Rear toe

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'

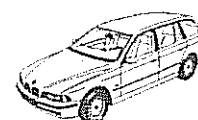
Steering and Wheel Alignment

V-8 Sedan (540i)

Parameter	Standard suspension	M Sport suspension	Sport suspension
Front axle			
Total toe	$0^{\circ} 14' \pm 10'$	$0^{\circ} 10' \pm 10'$	$0^{\circ} 14' \pm 10'$
Camber (difference between left/right maximum $40'$)	$-13' \pm 30'$	$-30' \pm 30'$	$-37' \pm 30'$
Track (differential angle with 20° lock on inside wheel)	$-1^{\circ} 35' \pm 30'$	$-1^{\circ} 43' \pm 30'$	$-1^{\circ} 44' \pm 30'$
Caster (difference between left/right maximum $30'$)	N/A	N/A	N/A
With $\pm 10^{\circ}$ wheel lock	$6^{\circ} 18' \pm 30'$	$6^{\circ} 27' \pm 30'$	$6^{\circ} 34' \pm 30'$
With $\pm 20^{\circ}$ wheel lock	$6^{\circ} 36' \pm 30'$	$6^{\circ} 49' \pm 30'$	$6^{\circ} 50' \pm 30'$
Front wheel displacement	$0^{\circ} \pm 15'$	$0^{\circ} \pm 10'$	$0^{\circ} \pm 15'$
Inside wheel (approx. $^{\circ}$)	42	41.5	42
Outside wheel (approx. $^{\circ}$)	32.6	32	31.8
Rear axle			
Total toe	$0^{\circ} 22' \pm 4'$	$0^{\circ} 10' \pm 8'$	$0^{\circ} 22' \pm 4'$
Camber (difference between left/right maximum $15'$)	$-2^{\circ} 04' \pm 5'$	$-1^{\circ} 49' \pm 5'$	$-2^{\circ} 04' \pm 5'$
Geometrical axis deviation	$0^{\circ} \pm 12'$	$0^{\circ} \pm 12'$	$0^{\circ} \pm 12'$

V-8 Sport Wagon (540i)

Parameter	Standard suspension	Sport suspension
Front axle		
Total toe	$0^{\circ} 14' \pm 10'$	$0^{\circ} 14' \pm 10'$
Camber (difference between left/right maximum $40'$)	$-13' \pm 30'$	$-37' \pm 30'$
Track (differential angle with 20° lock on inside wheel)	$-1^{\circ} 35' \pm 30'$	$-1^{\circ} 44' \pm 30'$
Caster (difference between left/right maximum $30'$)	N/A	N/A
With $\pm 10^{\circ}$ wheel lock	$6^{\circ} 18' \pm 30'$	$6^{\circ} 34' \pm 30'$
With $\pm 20^{\circ}$ wheel lock	$6^{\circ} 36' \pm 30'$	$6^{\circ} 50' \pm 30'$
Front wheel displacement	$0^{\circ} \pm 15'$	$0^{\circ} \pm 15'$
Inside wheel (approx. $^{\circ}$)	42	42
Outside wheel (approx. $^{\circ}$)	32.65	31.8
Rear axle		
Total toe	$0^{\circ} 16' \pm 10'$	$0^{\circ} 16' \pm 10'$
Camber (difference between left/right maximum $15'$)	$-1^{\circ} 50' \pm 20'$	$-1^{\circ} 50' \pm 20'$
Geometrical axis deviation	$0^{\circ} \pm 12'$	$0^{\circ} \pm 12'$



330 Rear Suspension

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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**.

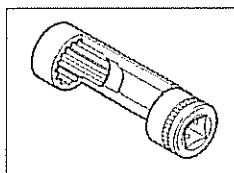
CAUTION—

- 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.

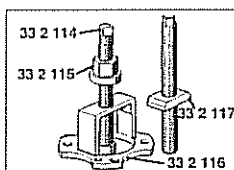
Special tools

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.

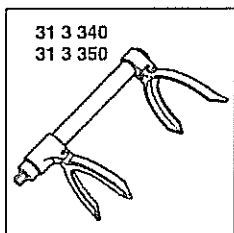
Read the procedures through before beginning any job.



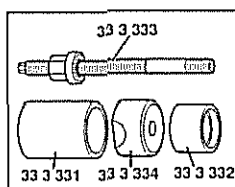
- Strut upper mounting nut socket
(Tool No. BMW 31 2 210)



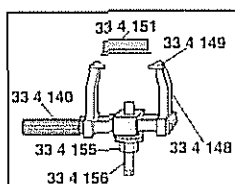
- Axle shaft removal and installation set
(Tool No. BMW 33 2 114, 33 2 114, 33 2 115, 33 2 116 and 33 2 117)



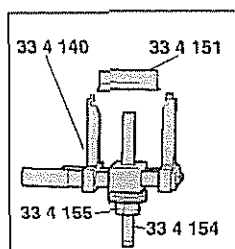
- Spring compressor
(Tool No. BMW 31 3 340, 31 3 350)



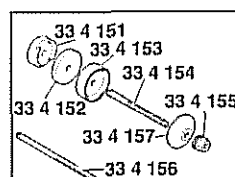
- Rubber bushing removal tool set
(Tool No. BMW 33 3 331, 33 3 332, 33 3 333, 33 3 334)



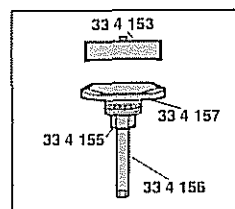
- Subframe mount removal set
(Tool No. BMW 33 4 140, 33 4 148, 33 4 149, 33 4 151, 33 4 155, 33 4 156)



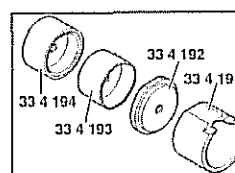
- Subframe mount tool set
(Tool No. BMW 33 4 151, 33 4 140, 33 4 155, 33 4 154)



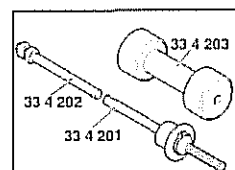
- Rear wheel bearing carrier mount tool set
(Tool No. BMW 33 4 151, 33 4 152, 33 4 153, 33 4 154, 33 4 156, 33 4 157)



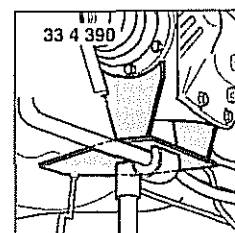
- Subframe mount installation set
(Tool No. BMW 33 4 153, 33 4 155, 33 4 156, 33 4 157)



- Support tube set
(Tool No. BMW 33 4 191, 33 4 192, 33 4 193, 33 4 194)



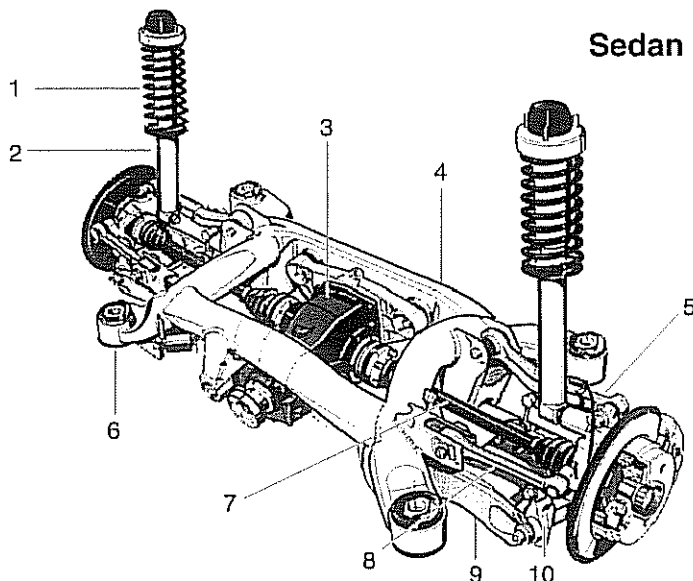
- Slide hammer set
(Tool No. BMW 33 4 201, 33 4 202, 33 4 203)



- Final drive support
(Tool No. BMW 33 4 390)

Rear Suspension

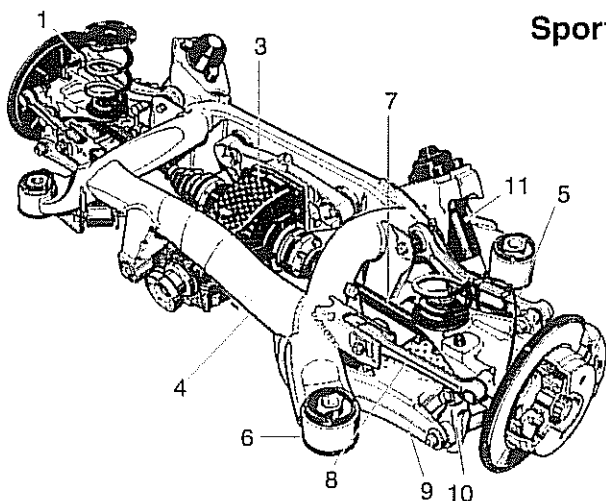
Sedan models



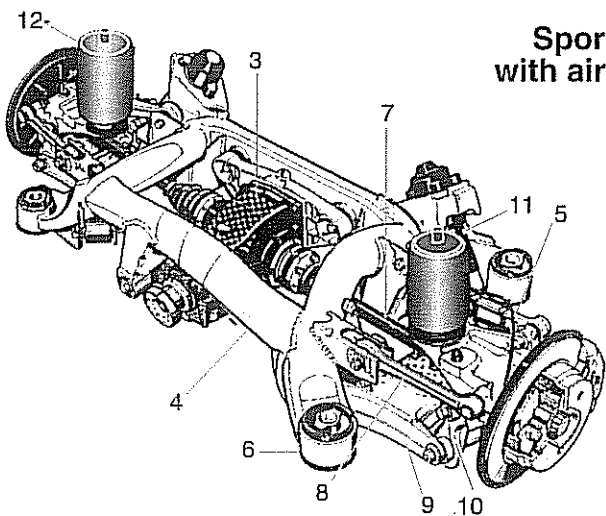
Rear suspension variations

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

Sport Wagon models



Sport Wagon with air springs



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REAR STRUTS AND SPRINGS (SEDAN MODELS)

Rear strut assembly, removing and installing

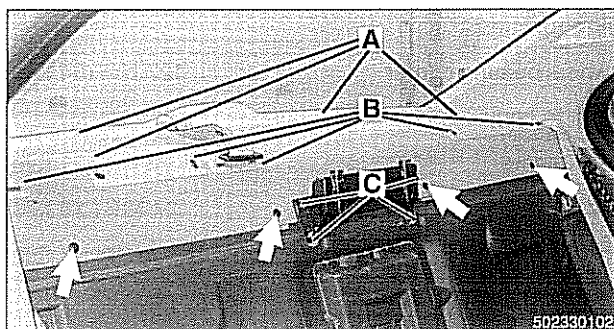
Replace struts and coil springs in pairs only.

- 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.

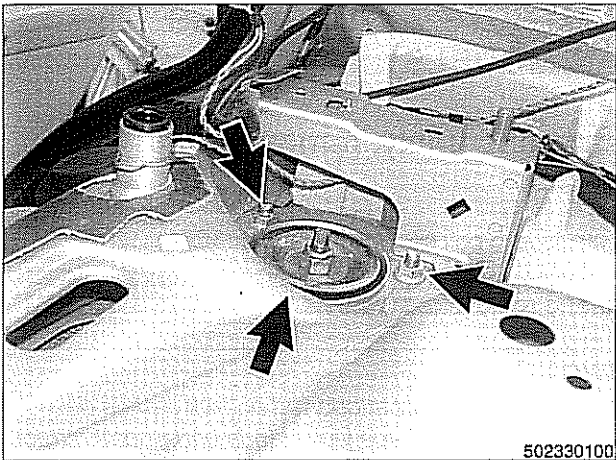


- Gently pry rear speaker cover grilles and rear window defogger grilles (A) out of parcel shelf.
 - Carefully remove seat belt and headrest mount finisher strips (B).
 - Remove middle seat headrest anchor bolts (C). Remove headrest anchor.
 - Remove expansion rivets (arrows) and lift out parcel shelf.
- Remove rear speakers.
- Remove rear wheels. Remove wheel arch trim.
- Support rear wheel bearing carrier.

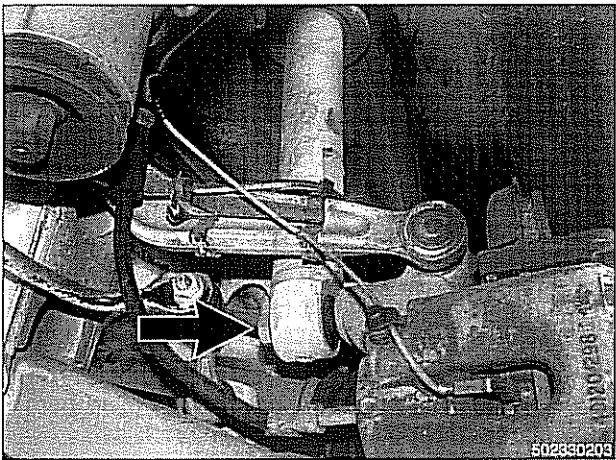
CAUTION—

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	
• Gray fasteners	28 Nm (21 ft-lb)
• Yellow fasteners	24 Nm (18 ft-lb)
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)

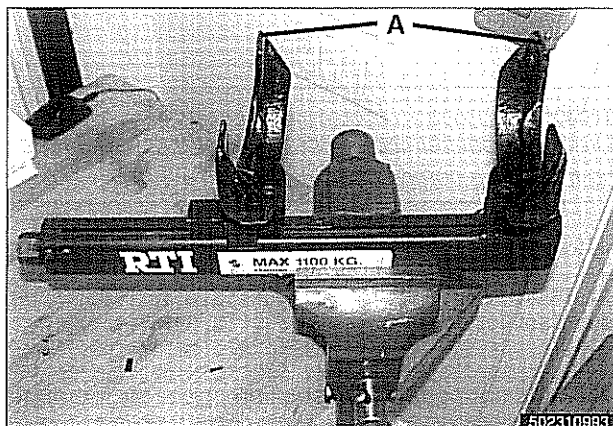
Rear strut assembly, disassembling and assembling

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.

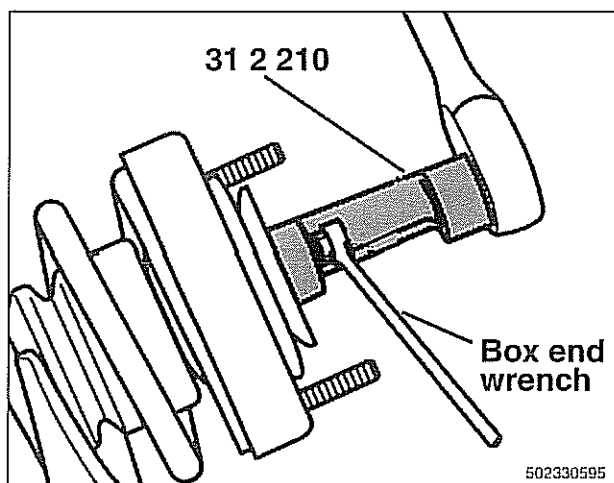
NOTE —

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.

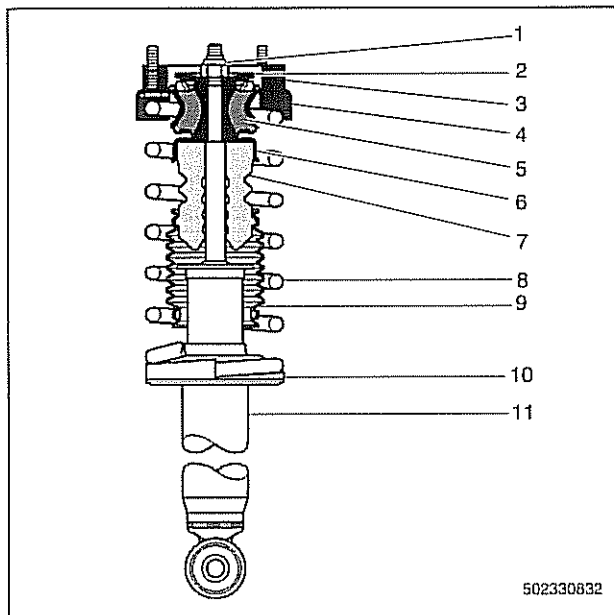
- Replace strut, rubber bumper, upper strut mount or spring, as needed.

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



502330832

◀ 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

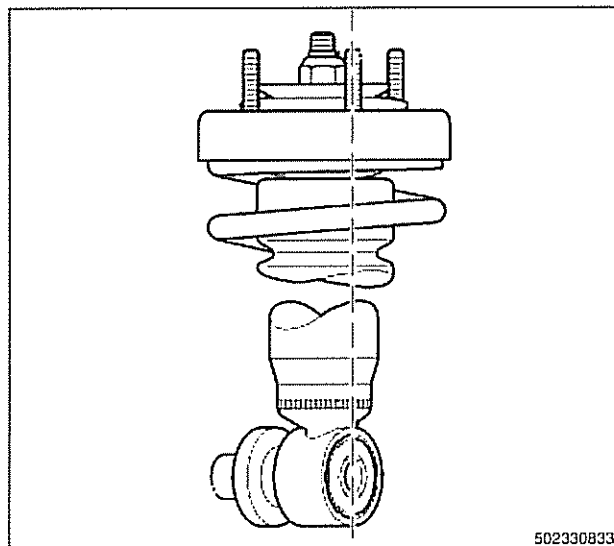
WARNING—

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)



502330833

◀ 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—

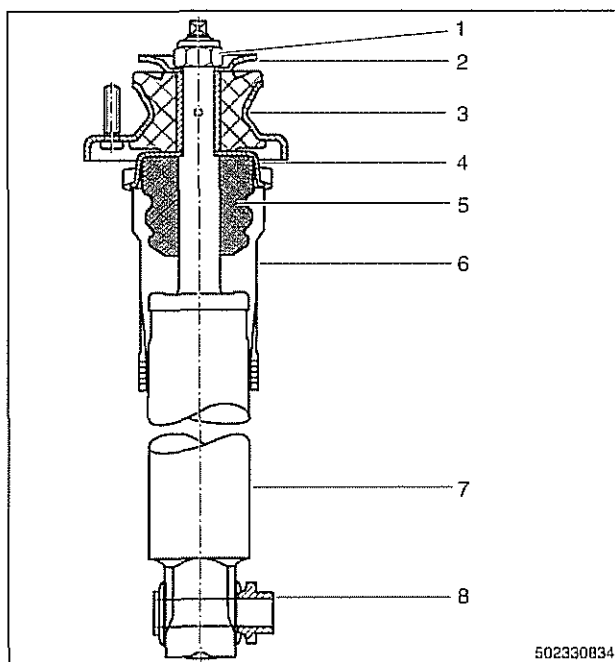
If working on a vehicle with compressed air shock absorbers, disable air supply pump by disconnecting electrical plug before performing any repairs. Pump is located beneath a cover under the spare tire in the floor of the cargo compartment.

- 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

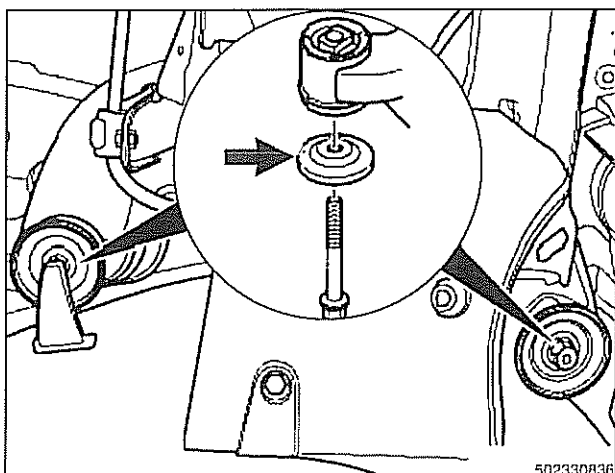
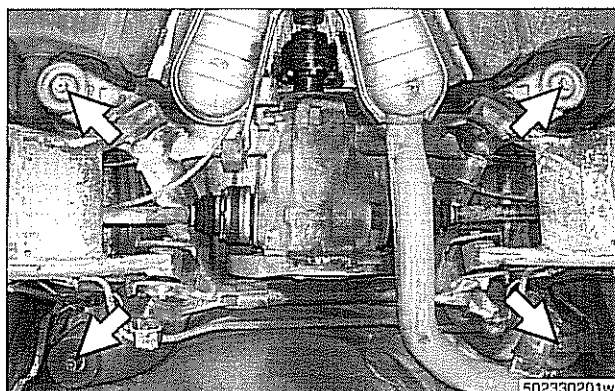
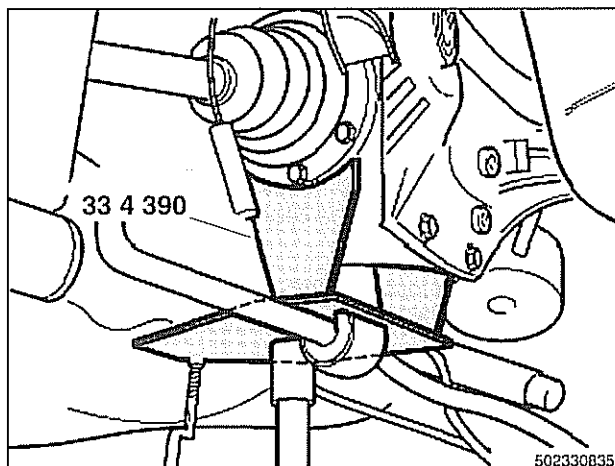
Quick coupling screw to air shock absorber	2 Nm (18 in-lb)
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)
Shock absorber to swing arm	127 Nm (94 ft-lb)
Strut mount to body	
• Gray fasteners	28 Nm (21 ft-lb)
• Yellow fasteners	24 Nm (18 ft-lb)

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.

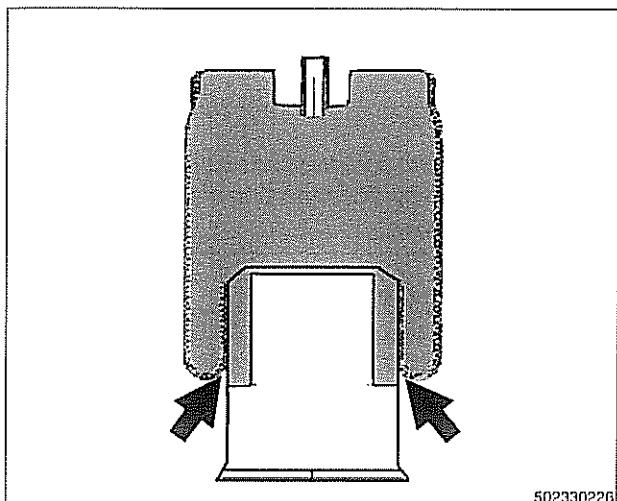
WARNING—

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

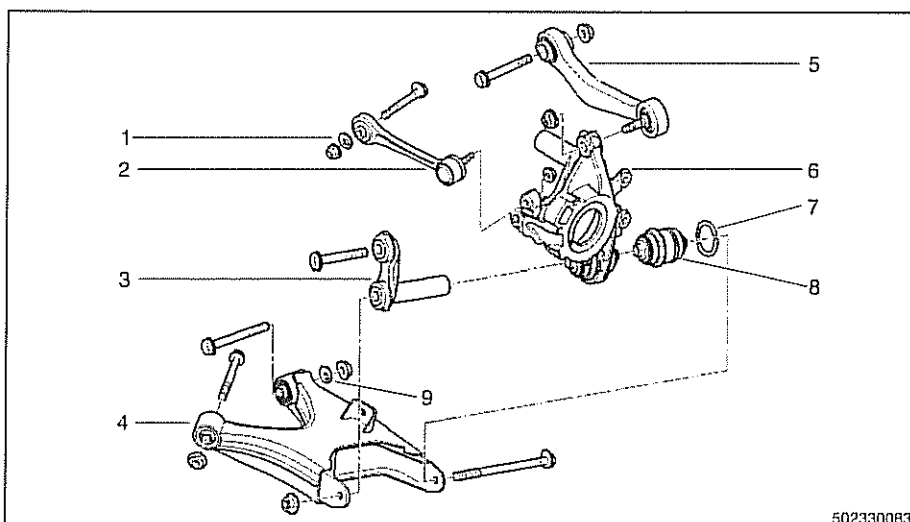
Air line connection	2 Nm (18 in-lb)
Air spring to wheel bearing carrier	20 Nm (15 ft-lb)
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)

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.



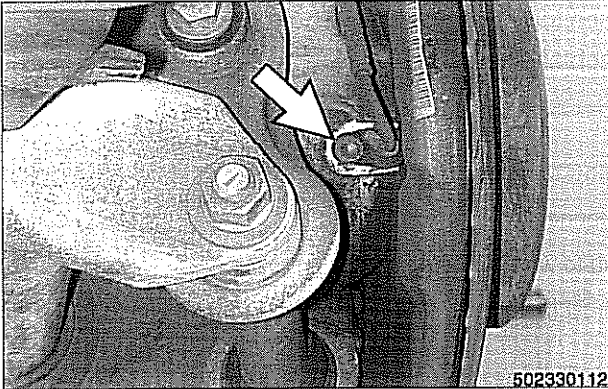
Rear suspension arm components

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—

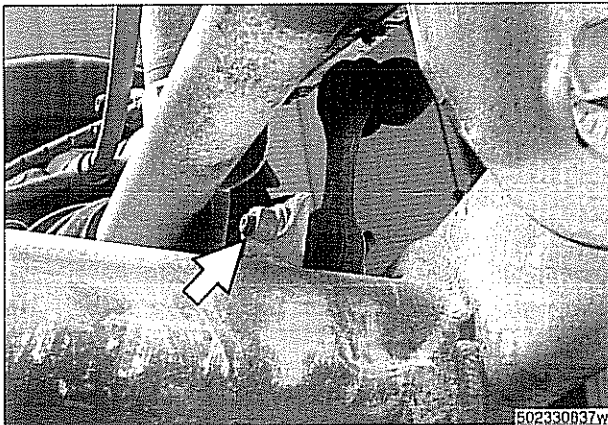
If working on a vehicle with compressed air shock absorbers, disable air supply pump by disconnecting electrical plug before performing any repairs.



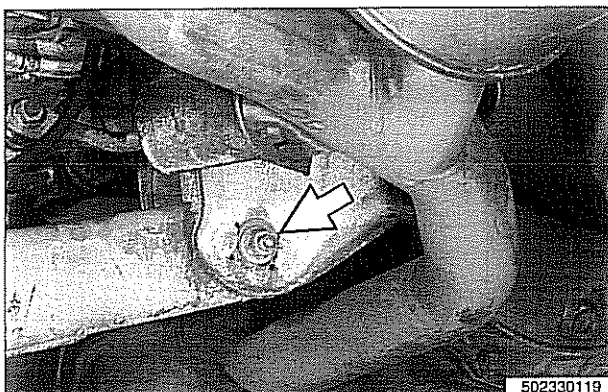
- Raise rear end of car and remove wheel.

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.

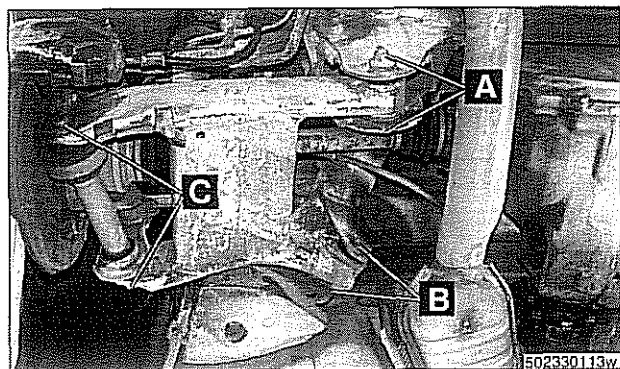


- Mark location (arrow) of rear camber adjustment washer and bolt.

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) (A)	115 Nm (85 ft-lb)
Swing arm to rear subframe (B)	58 Nm (43 ft-lb)
Swing arm to wheel bearing carrier (C)	256 Nm (189 ft-lb)

Swing arm, removing and installing (Sport Wagon models)

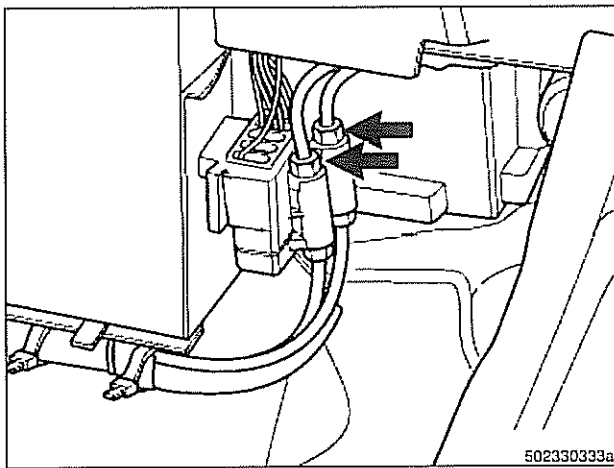
- Raise rear end of car and remove wheel.

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.

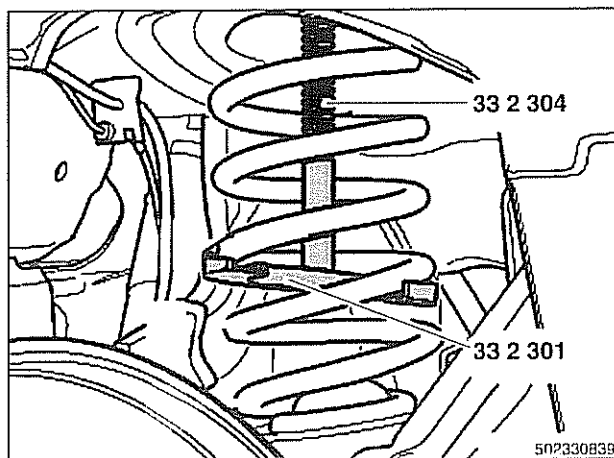
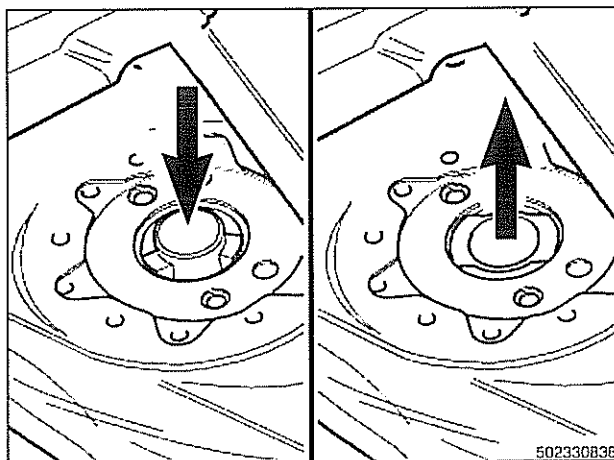


- Model with air springs: Loosen compressed air pipes (arrows) at air distribution assembly to release system pressure.

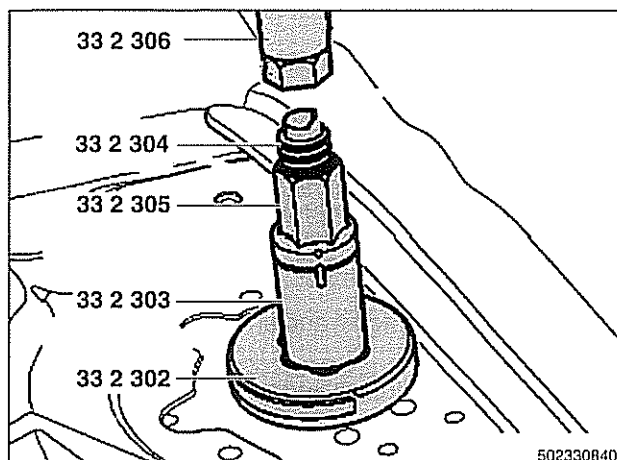
NOTE—

Vehicle will stand quite low.

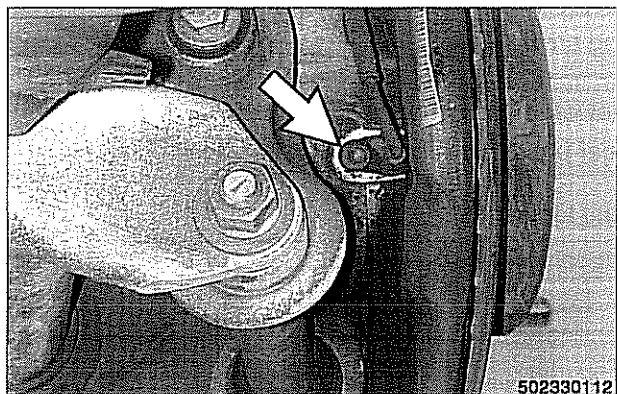
- If applicable: Detach air supply line from shock absorber. Plug ports and lines to keep out dirt.
- Model with rear coil springs: Remove cargo compartment floor carpet.
- Working at top of coil spring, press center cap down or pry upward to remove. If pushed down, remove from inside coil spring from 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.



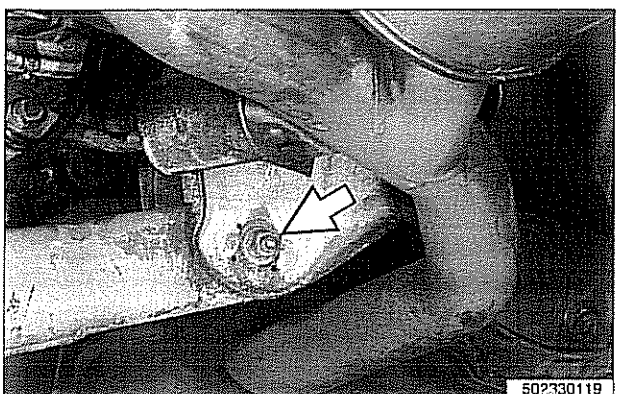
- ◀ Remove ABS pulse sensor (**arrow**) from wheel bearing carrier.
- Support wheel bearing carrier from below.

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.

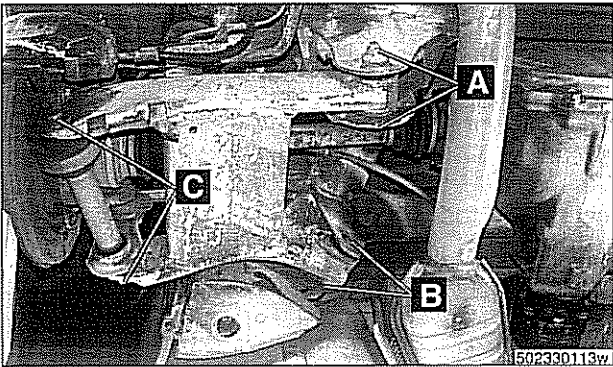


- ◀ Mark location (**arrow**) of rear camber adjustment washer and bolt.

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) (A)	115 Nm (85 ft-lb)
Swing arm to rear subframe (B)	58 Nm (43 ft-lb)
Swing arm to wheel bearing carrier (C)	256 Nm (189 ft-lb)

Swing arm ball joint, replacing

- Raise rear end of car and remove wheel.

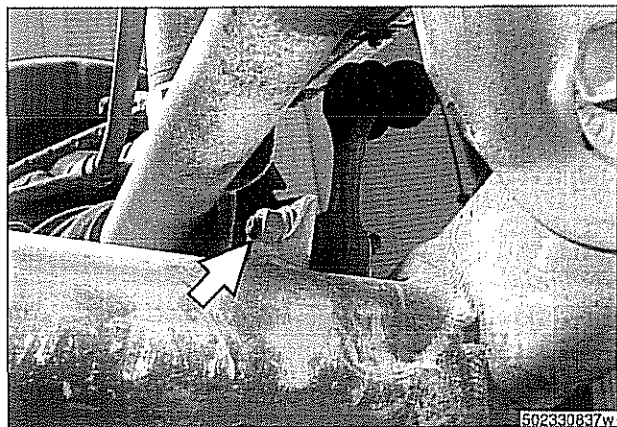
WARNING —

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 —

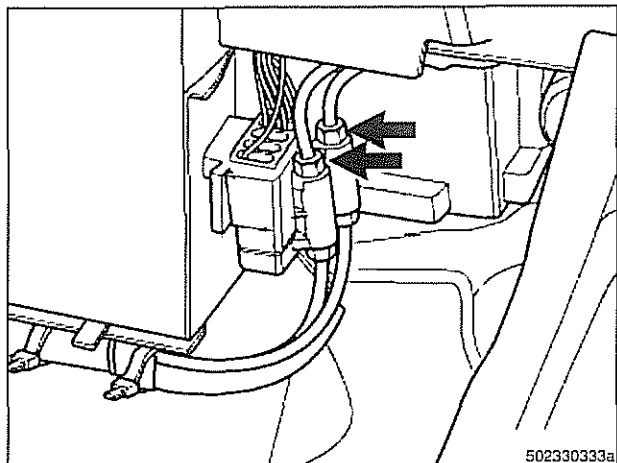
The shock absorber prevents the drive axle and wheel bearing carrier from dropping too far. Supporting the wheel bearing carrier before disconnecting the shock absorber mounting fastener prevents damage to the brake hose, parking brake cable and drive axle CV joints.



- 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.



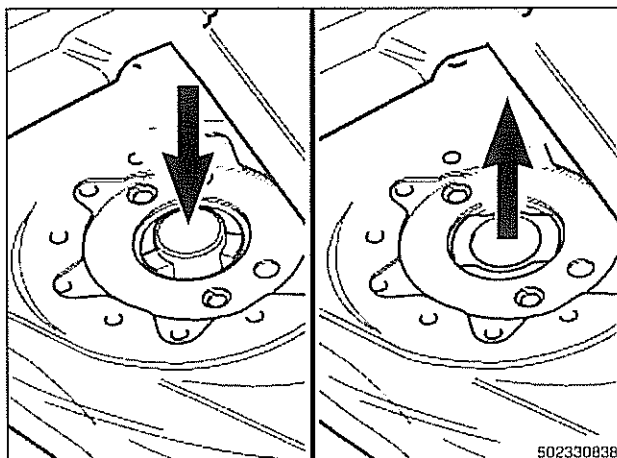
- Model with air springs: Loosen compressed air pipes (arrows) at air distribution assembly to release system pressure.

WARNING —

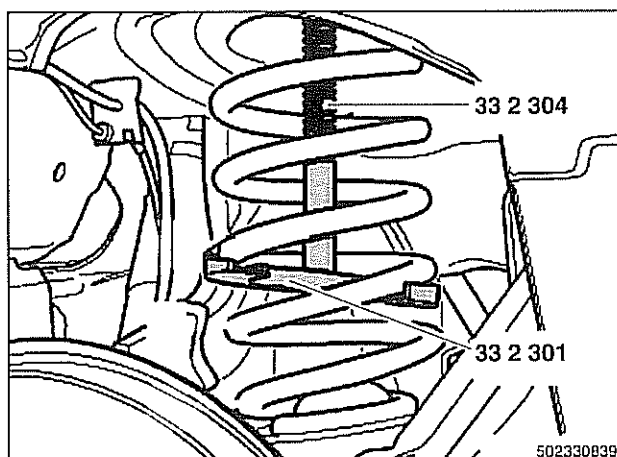
Vehicle will lower when the air pipes are opened.

- Models with rear coil springs: Remove cargo compartment floor carpet.

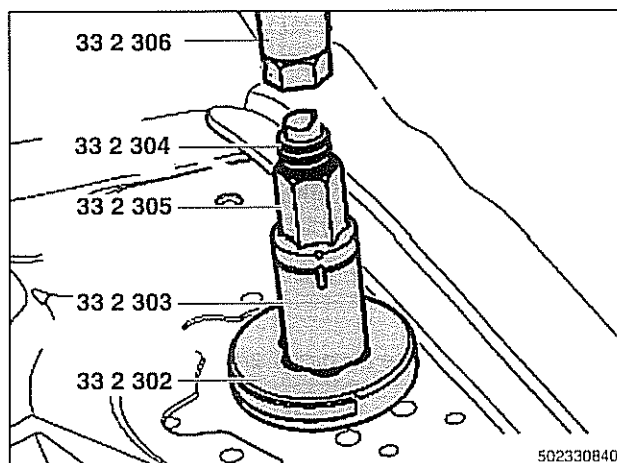
Rear Suspension



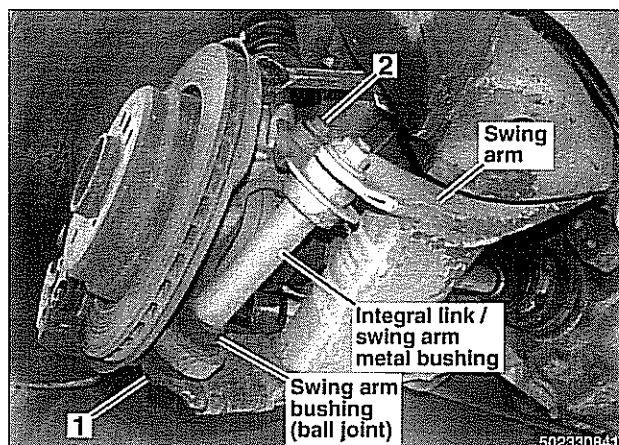
- Models with coil springs: Working at top of spring, press center cap down or pry upward to remove. If pushed down, remove from inside coil spring from under car.



- 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.

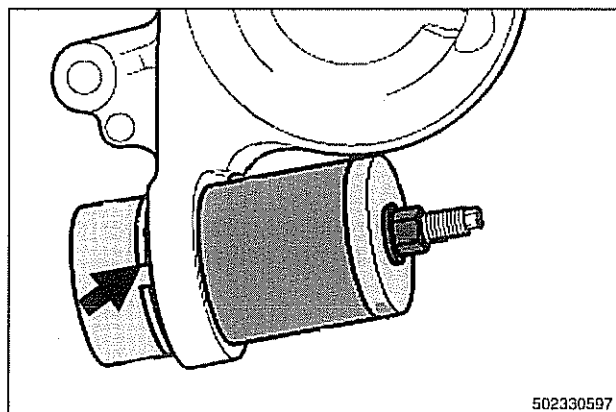


- Working in cargo compartment, attach BMW special tools 33 2 302, 33 2 303 and 33 2 305 to special tool 33 2 304.
- Use special tool 33 2 306 to compress spring.
 - Tighten until lower spring coil lifts off spring seat on wheel bearing carrier.

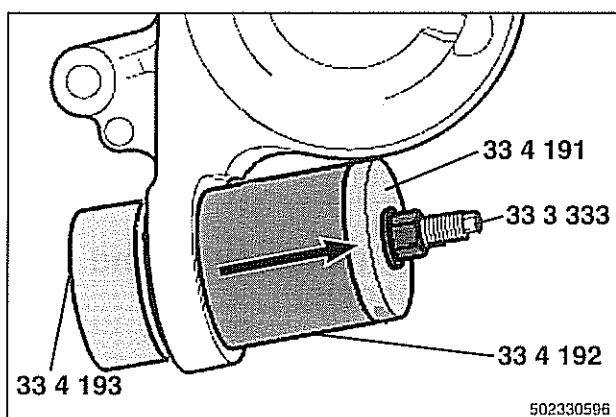


Remove outer mounting bolt (1) from swing arm. Pull swing arm down.

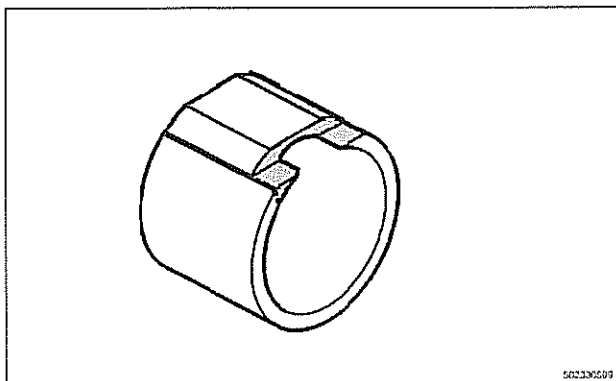
- Remove integral link / swing arm metal bushing locating bolt (2). Remove integral link.



Remove swing arm bushing retaining snap ring (arrow).



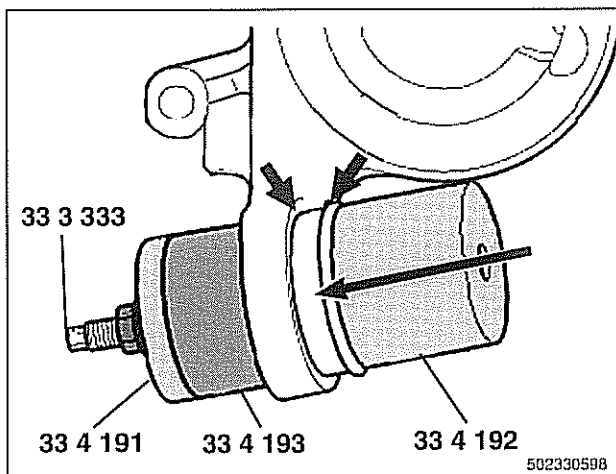
Press bushing out of wheel bearing carrier using BMW special tools 33 4 191, 33 4 192, 33 4 193 and 33 3 333.



◀ 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

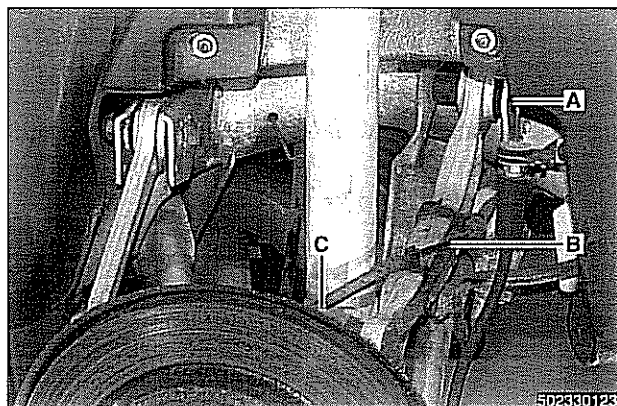
Integral link to wheel bearing carrier	105 Nm (77 ft-lb)
Quick coupling screw to air shock absorber	2 Nm (18 in-lb)
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)
Shock absorber to lower control arm	127 Nm (94 ft-lb)
Stabilizer link to swing arm	65 Nm (48 ft-lb)
Swing arm to wheel bearing carrier (C)	256 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)

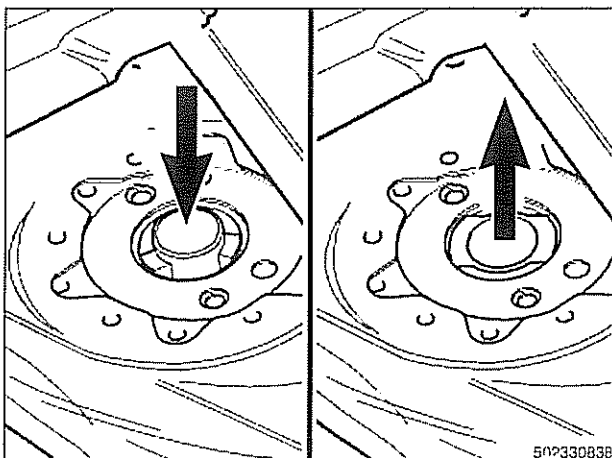
CAUTION—

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.

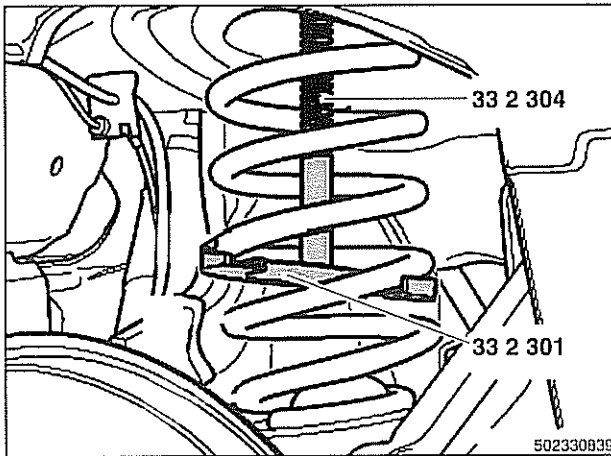
WARNING—

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.

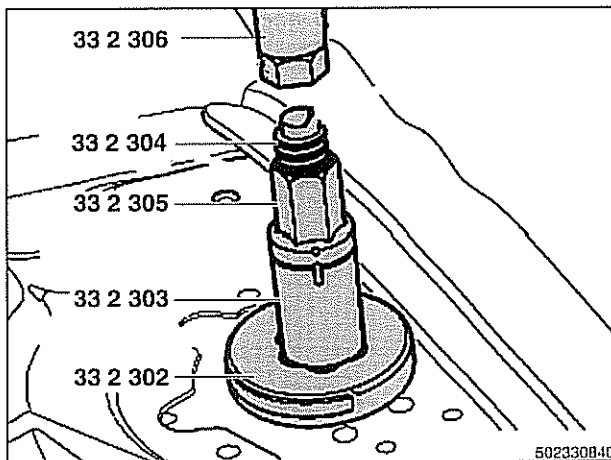


- Models with rear coil springs: Remove cargo compartment floor carpet.
- Working at top of coil spring, press center cap down or pry upward to remove. If pushed down, remove from inside coil spring from under car.

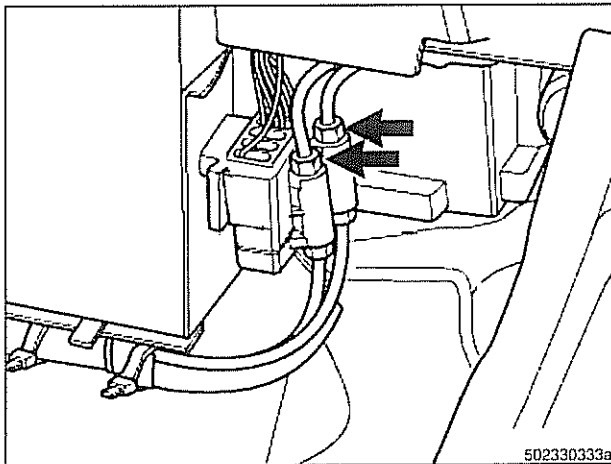
Rear Suspension



- 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 —

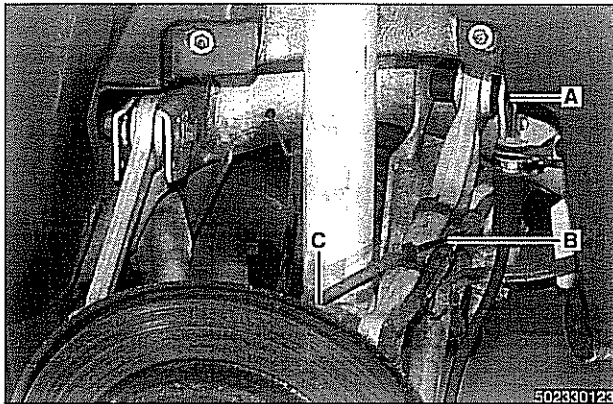
Vehicle will lower when the air pipes are opened.

- 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

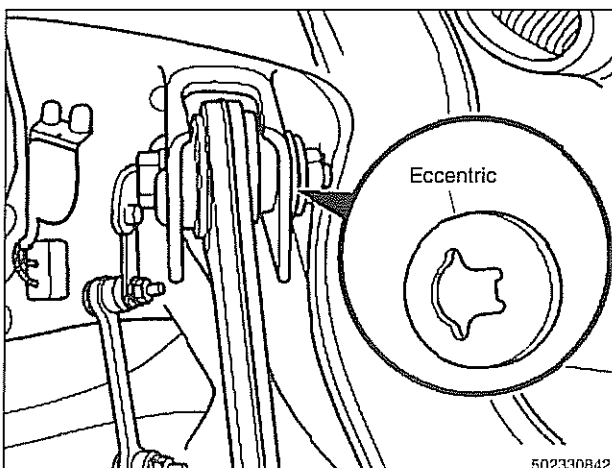
Control arm to subframe (M12)	110 Nm (81 ft-lb)
Control arm ball joint to wheel bearing carrier (M14)	142 Nm (105 ft-lb)
Quick coupling screw to air shock absorber	2 Nm (18 in-lb)
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)
Shock absorber to lower control arm	127 Nm (94 ft-lb)

Upper front control arm (traction strut), removing and installing

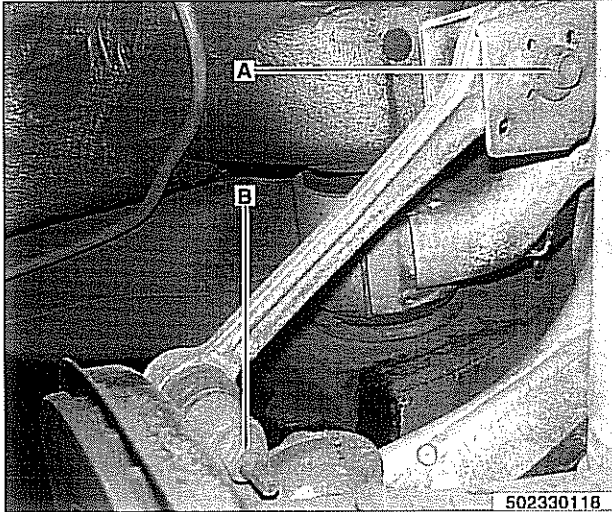
- Raise rear end of car and remove wheel.

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).



- 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)

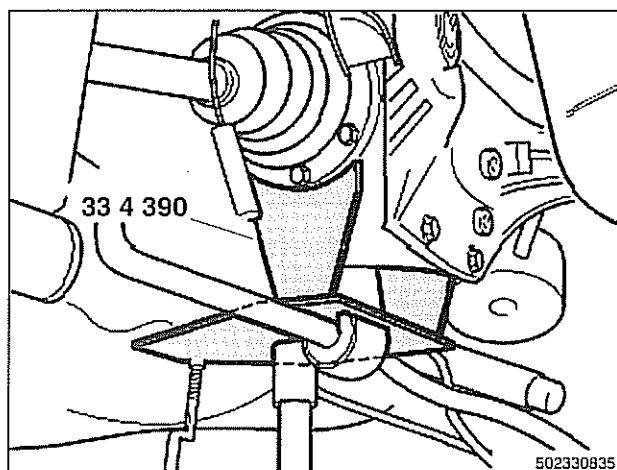
In case of damage to the subframe, or if a pressed-in bushing is worn, remove subframe by removing complete axle assembly.

- 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.

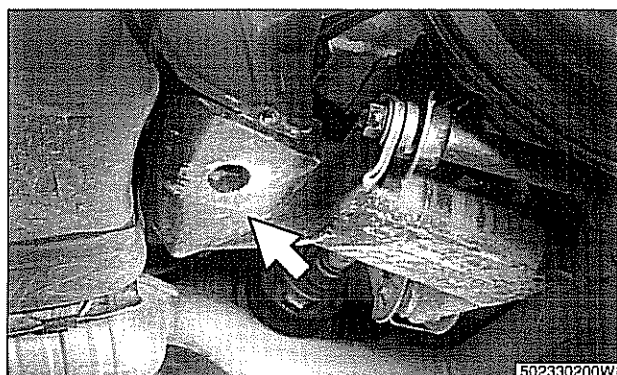
- Remove exhaust system. See **180 Exhaust System**.
- Detach driveshaft from differential. See **260 Driveshaft**.
- Remove brake caliper and brake disc. Hang brake caliper aside with stiff wire. Do not disconnect brake fluid hose. See **340 Brakes**.
- Remove left and right ABS sensors from wheel bearing carriers.
- Disconnect parking brake cable from brake shoe expander. See **340 Brakes**.
- Remove heat shield from above driveshaft.



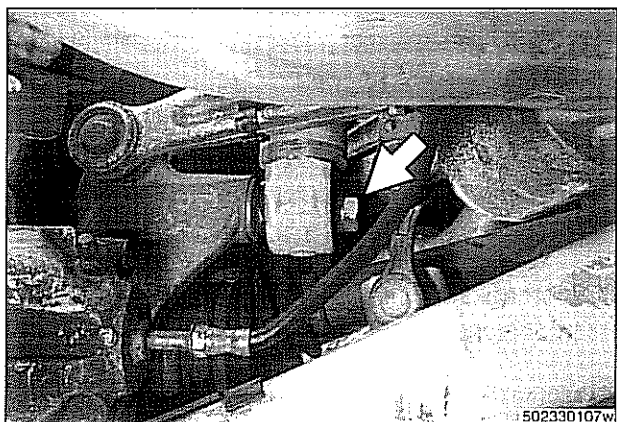
- If equipped, remove ride height sensor connectors.
- Support final drive unit from below using transmission jack (BMW special tools 00 2 030 and 33 4 390 or equivalent).

NOTE —

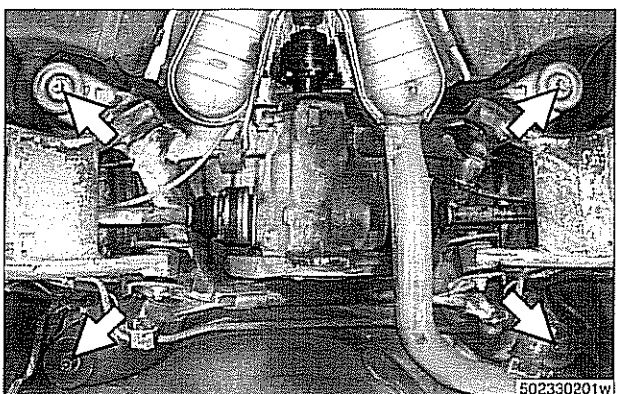
Special tool 33 4 390 will need modifications to cradle the final drive properly.



- Remove right and left suspension trim panels (arrow).

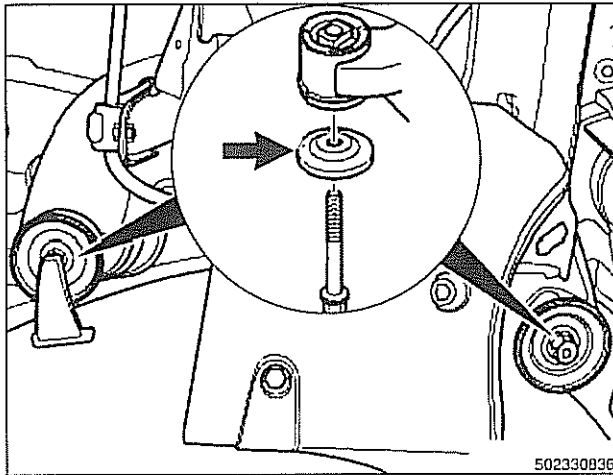


- Remove right and left lower strut mount bolts (arrow).



- 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)

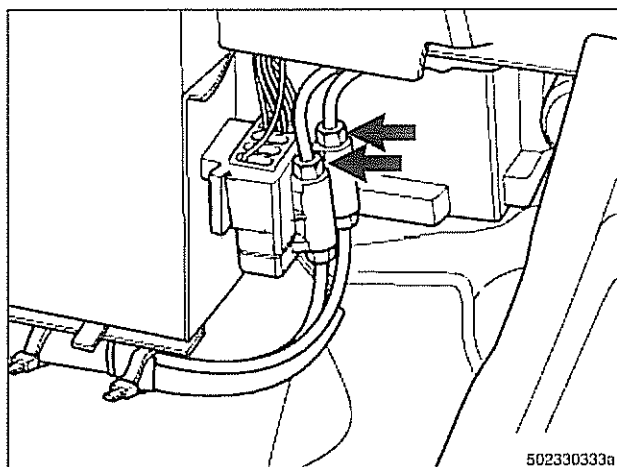
In case of damage to the subframe, or if a pressed-in bushing is worn, remove subframe by removing complete axle assembly.

- 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.

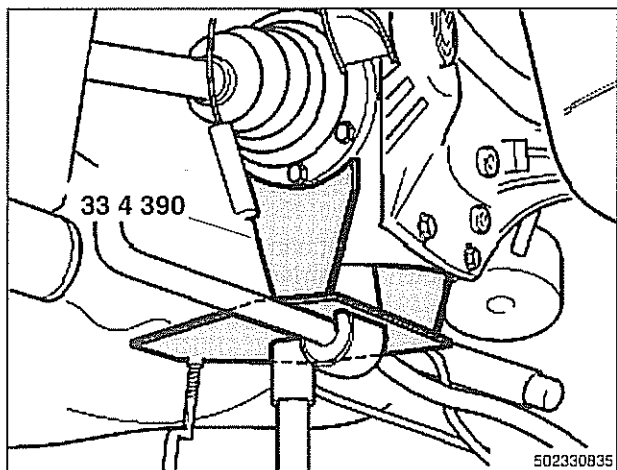
**CAUTION—**

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.

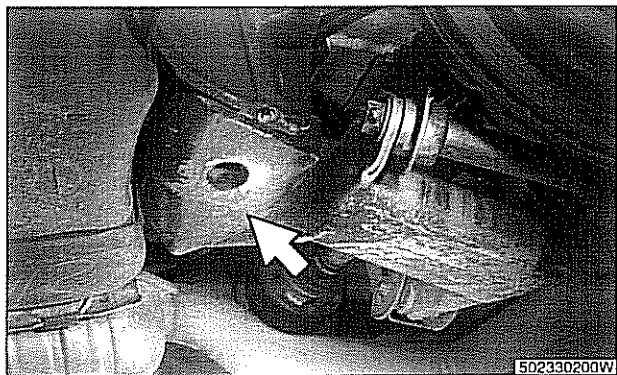


- Working underneath rear suspension, lift wheel bearing carrier to relieve rear spring tension. Then unbolt air spring mounting bolt from seat on wheel bearing carrier.
- Support final drive unit from below using transmission jack (BMW special tools 00 2 030 and 33 4 390 or equivalent).

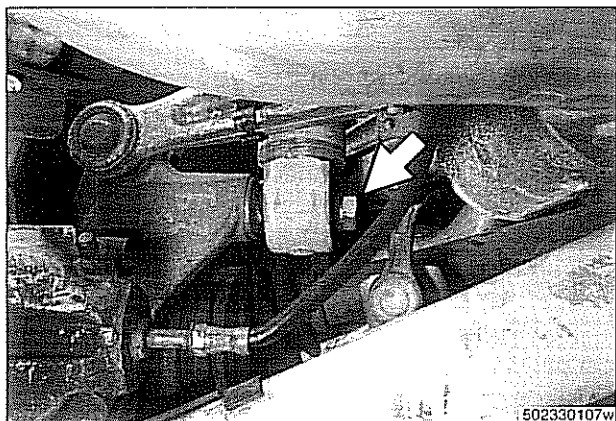
NOTE—

Special tool 33 4 390 will need modifications to cradle the final drive properly.

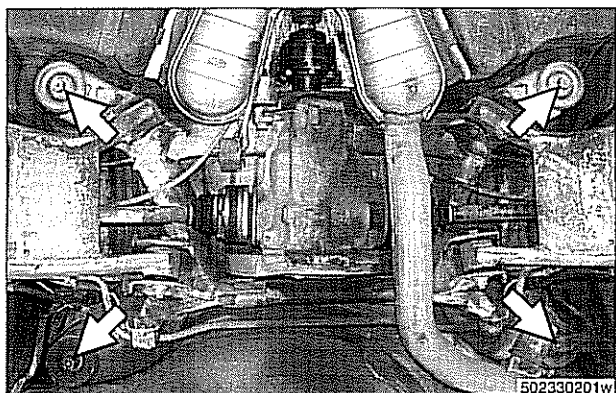
- Remove right and left suspension trim panels (arrow).



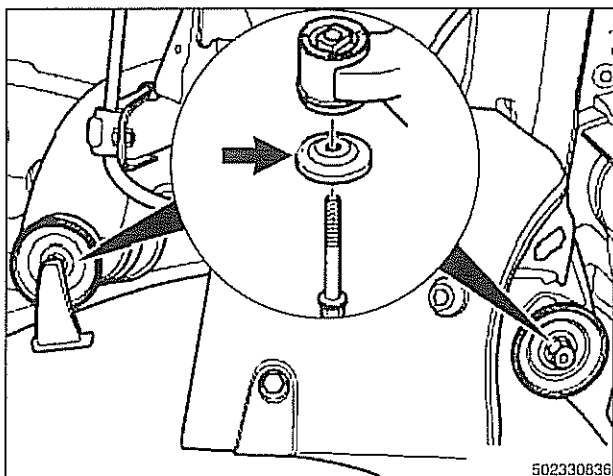
Rear Suspension



- 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)

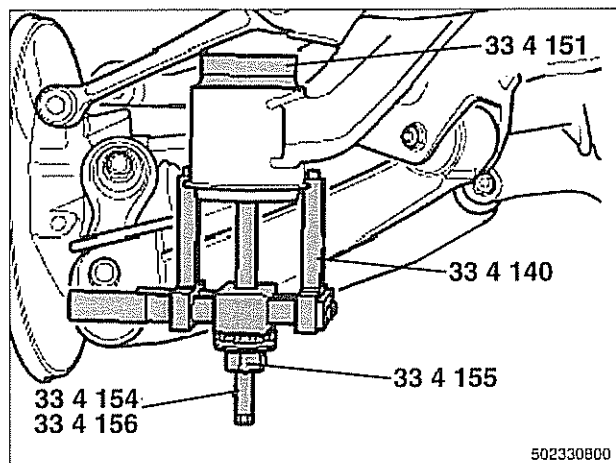
- Remainder of installation is reverse of removal, noting the following.
 - Tighten suspension arm and shock absorber fasteners to final torque only after vehicle has been lowered and suspension has settled.

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

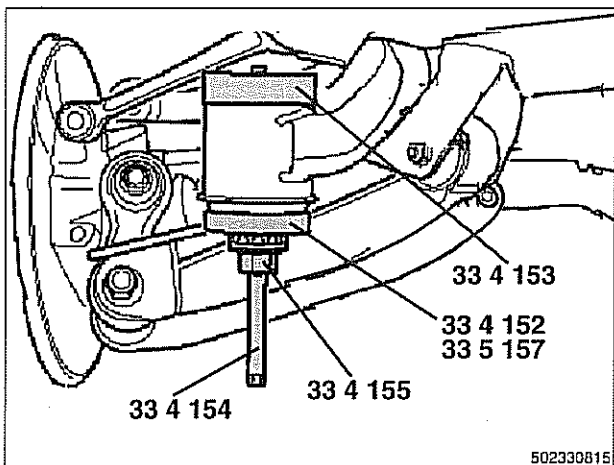
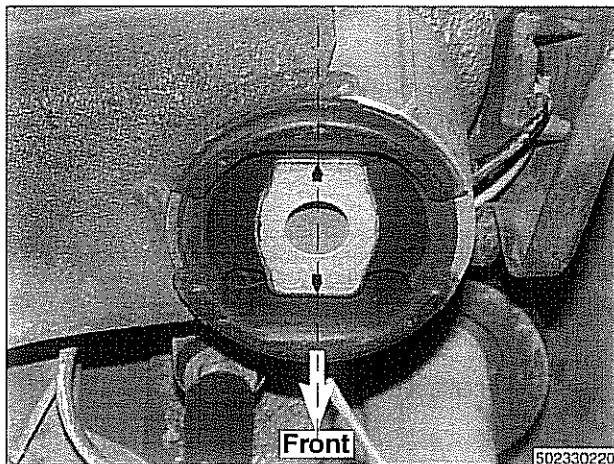
- Remove rear subframe mounting bolts as described earlier. Lower subframe approximately 40 – 45 mm (1 — 2 in).
- Install BMW special tools 33 4 140, 33 4 151, 33 4 154, 33 4 155, 33 4 156 as shown.
 - Use hot air gun with a maximum output temperature of 600° C (1100° F) to heat bushing area of subframe 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.

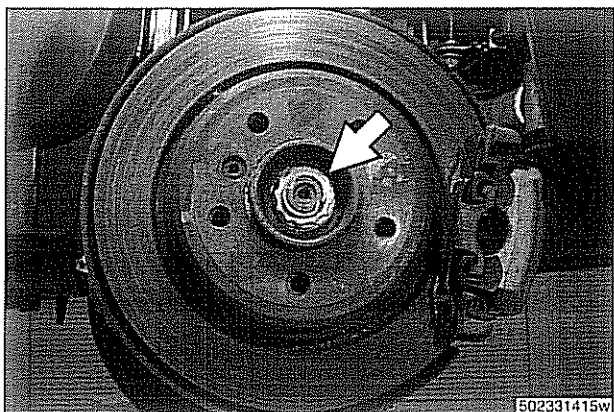
REAR WHEEL BEARINGS

Rear wheel bearing carrier, removing and installing (sedan models)

— Raise rear end of car and remove wheel.

WARNING—

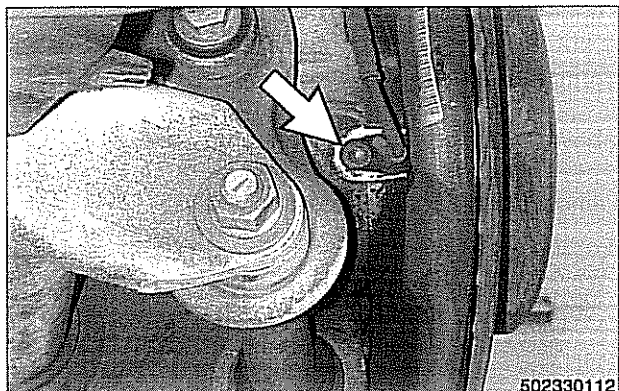
Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.



➤ 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.

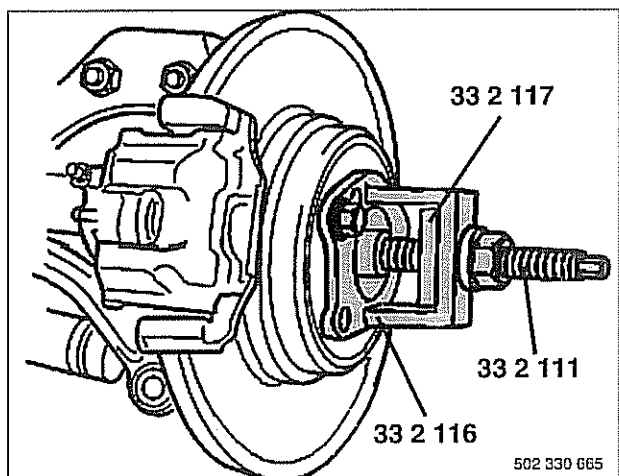
— Disconnect parking brake cable from brake shoe expander. See 340 Brakes.



- Remove ABS sensor mounting fastener (arrow) and sensor.

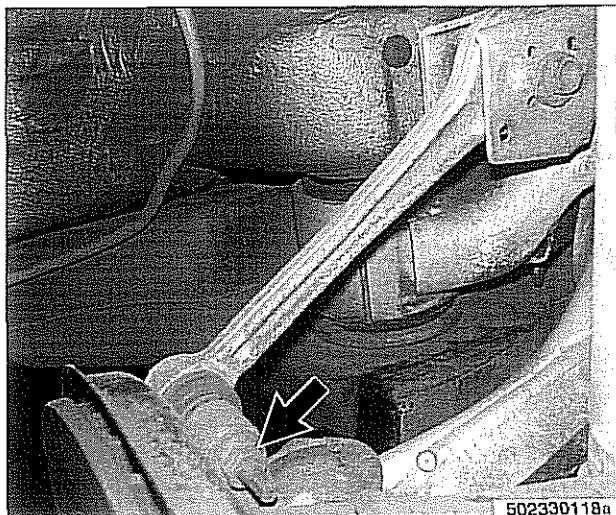


- Remove outer swing arm nut (arrow) and bolt.



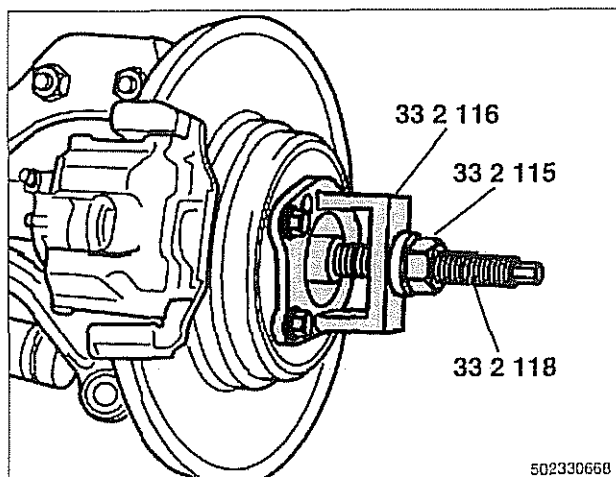
- Press out axle shaft using BMW special tools 33 2 117, 33 2 116 and 33 2 111.
- Support wheel bearing carrier. Remove lower strut mounting fastener.

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 —

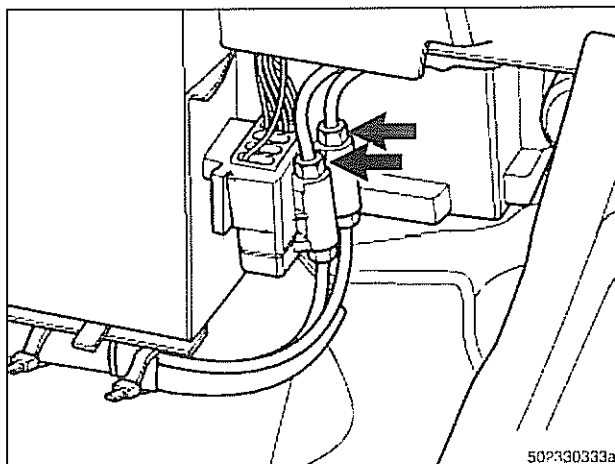
Models with air springs: Disable air supply pump by disconnecting electrical plug before performing any repairs. Pump is located beneath a cover under the spare tire in the floor of the cargo compartment.



Models with air springs: Loosen compressed air pipes (arrows) at air distribution assembly to release system pressure.

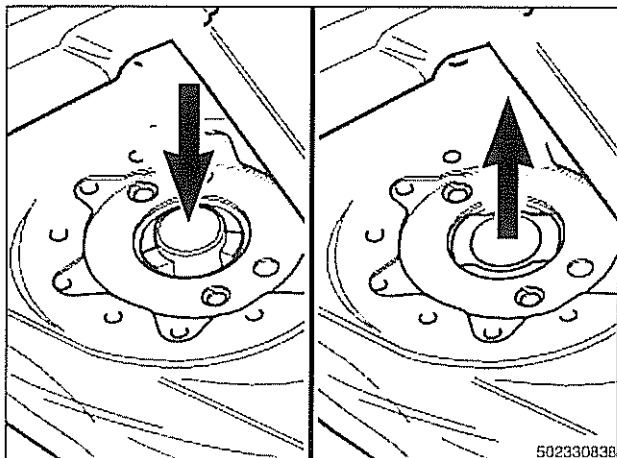
WARNING —

Vehicle will lower when the air pipes are opened.

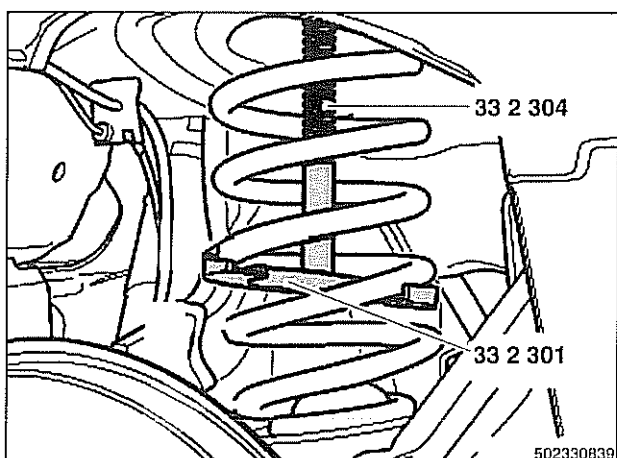


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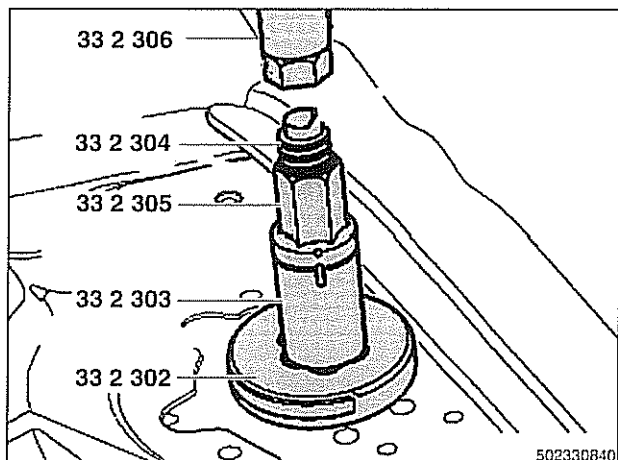
Rear Suspension



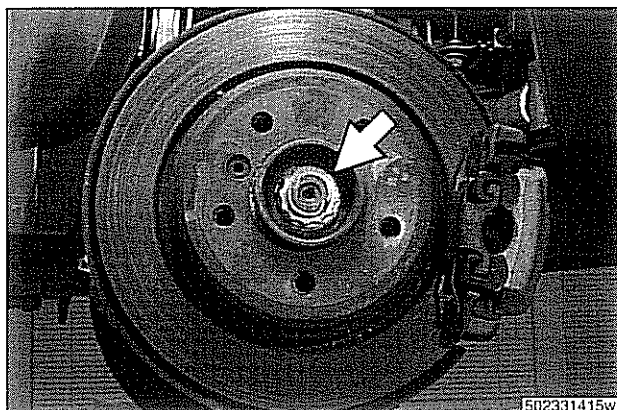
- Working underneath rear suspension, lift wheel bearing carrier to relieve rear spring tension. Then unbolt air spring mounting bolt from seat on wheel bearing carrier.
- Models with rear coil springs: Remove cargo compartment floor carpet.
- Working at top of coil spring, press center cap down or pry 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.

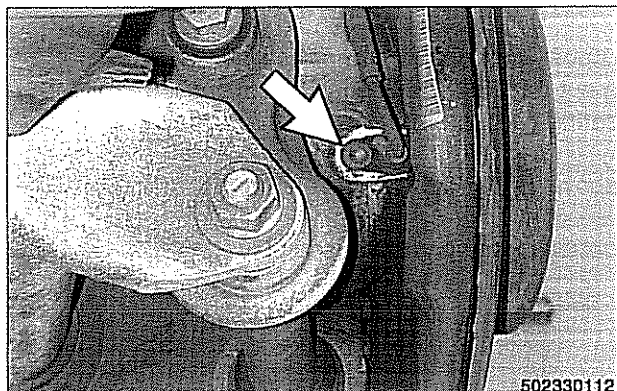


- Working in cargo compartment, attach BMW special tools 33 2 302, 33 2 303 and 33 2 305 to special tool 33 2 304.
 - Use special tool 33 2 306 to compress spring.
 - Tighten until lower spring coil lifts off spring seat on wheel bearing carrier.



◀ With an assistant applying brakes, break free and remove staked collar nut (**arrow**).

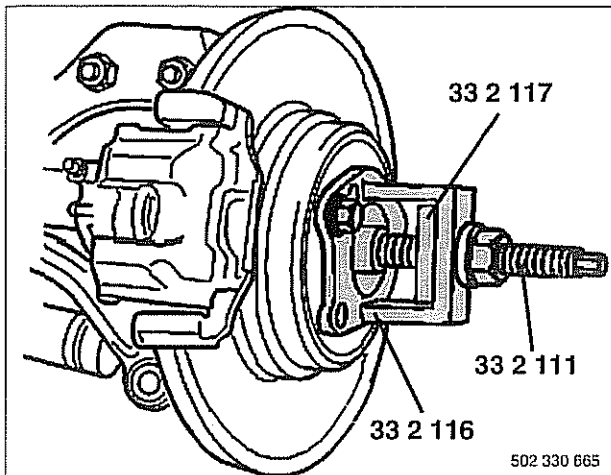
- Remove brake caliper and brake disc. Hang brake caliper aside with stiff wire. Do not disconnect brake fluid hose. See **340 Brakes**.
- Disconnect parking brake cable from brake shoe expander. See **340 Brakes**.



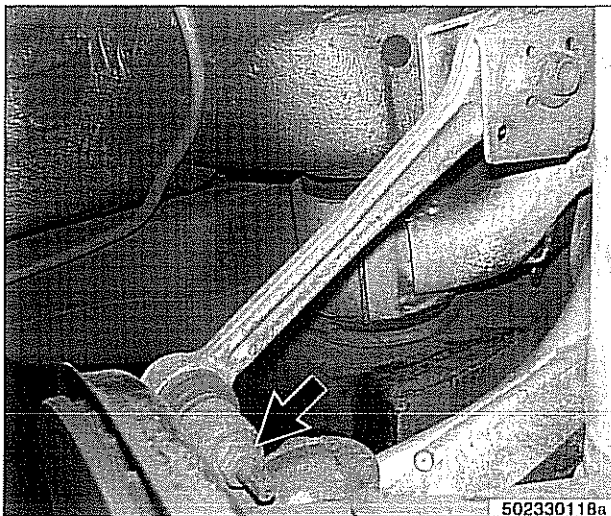
◀ Remove ABS sensor mounting fastener (**arrow**) and sensor.



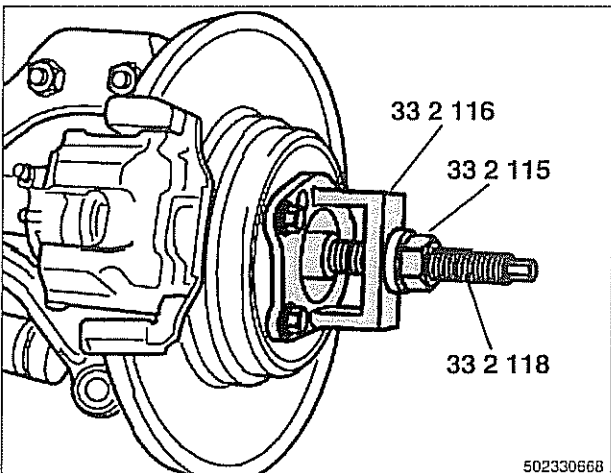
◀ Remove outer swing arm nut (**arrow**) and bolt.



- Press out axle shaft using BMW special tools 33 2 117, 33 2 116 and 33 2 111.



- 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

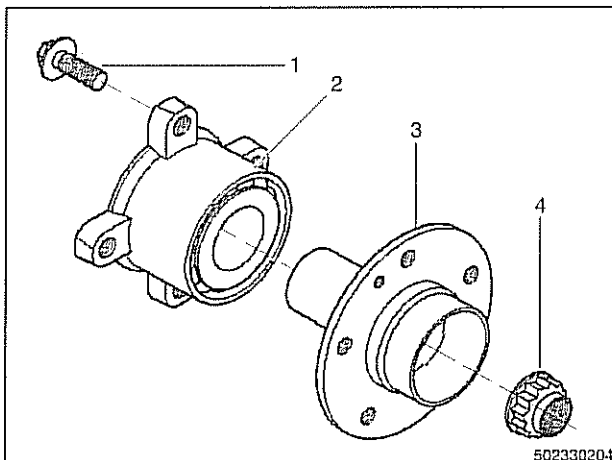
- ◀ The rear wheel bearing is integrated with its mounting flange.

1. Torx bolt
2. Wheel bearing and mounting flange
3. Wheel hub
4. Collar nut

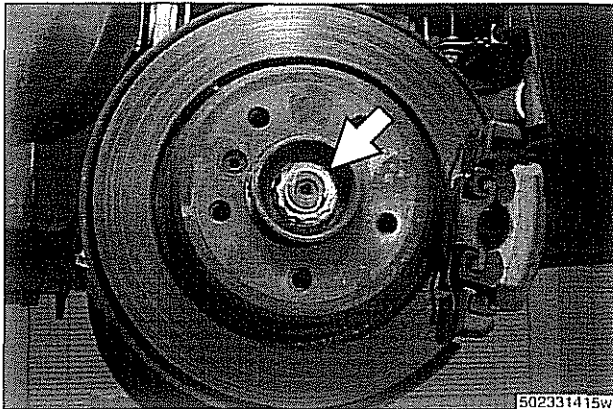
- Raise rear end of car and remove wheel.

WARNING —

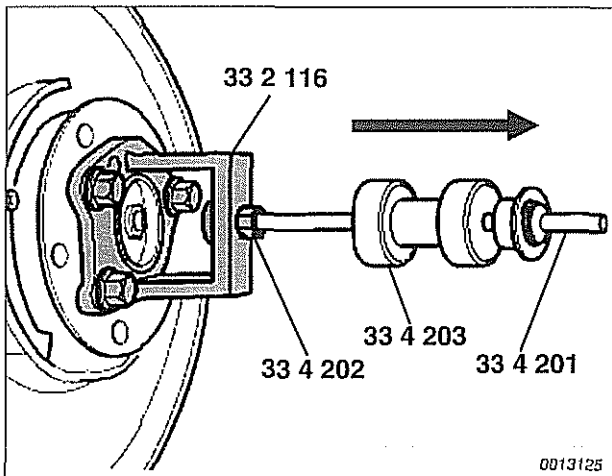
Make sure the car is firmly supported on jack stands designed for the purpose. Place jack stands underneath structural chassis points. Do not place jack stands under suspension parts.



Rear Suspension



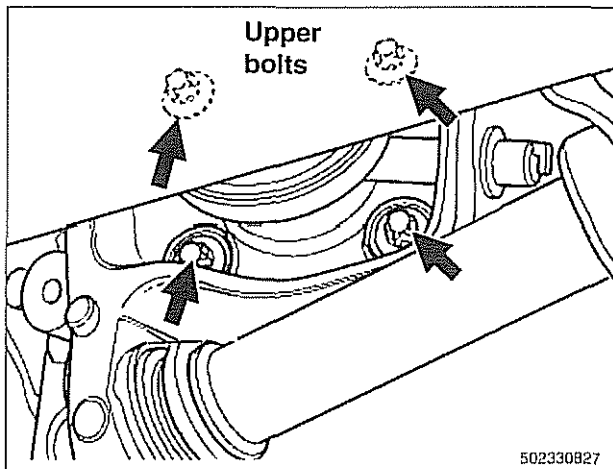
- With an assistant applying brakes, break free and remove staked collar nut (**arrow**).
- If equipped, disconnect brake pad sensor connector at brake caliper.
- Remove brake caliper assembly and rotor. See **340 Brakes**. Leave brake hose connected to caliper. Suspend caliper assembly from chassis using stiff wire.
- Remove ABS pulse sensor at wheel bearing carrier.



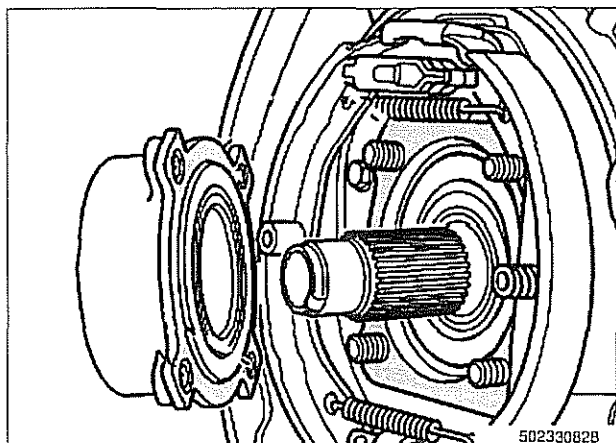
- Remove drive flange from bearing assembly using impact style puller (BMW special tools 33 2 116, 33 4 201/202/203 or equivalent).

CAUTION—

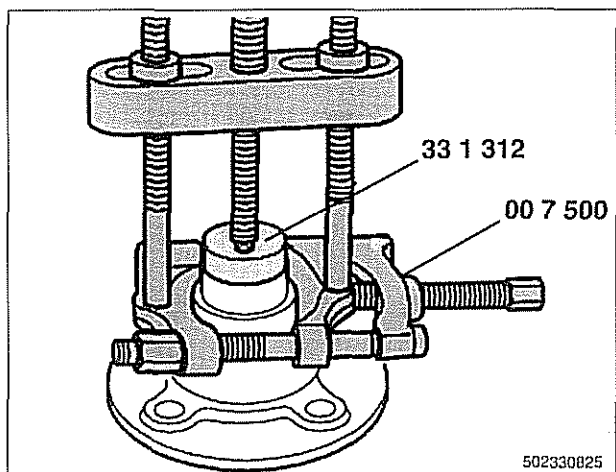
The wheel bearing is destroyed when the drive flange is removed. Do not attempt to reuse bearing.



- Remove four wheel bearing flange (Torx) bolts (**arrows**).



- Remove wheel bearing assembly.



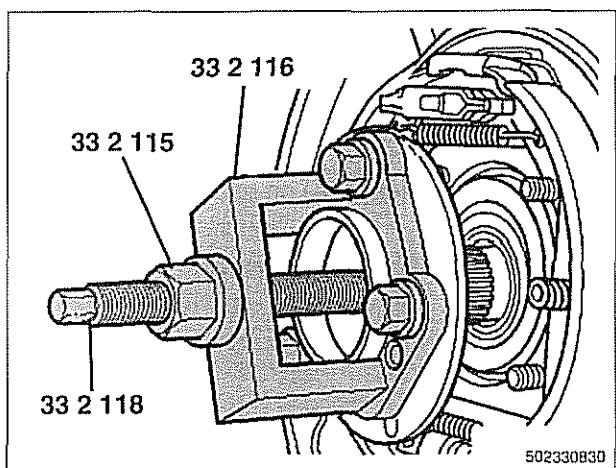
- Remove inner wheel bearing race with BMW special tools 33 1 312 and 00 7 500 or equivalent.

- 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.

- 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.

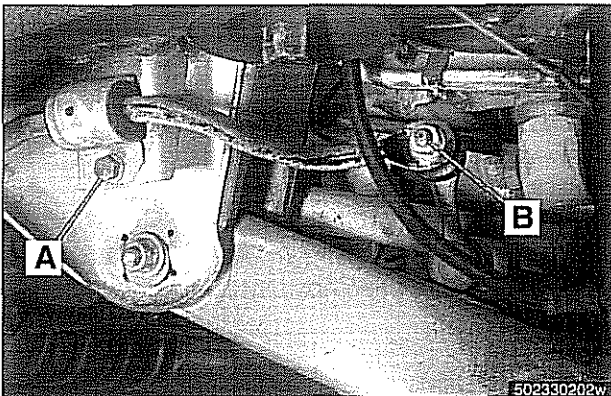
Stabilizer bar, removing and installing

- 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.

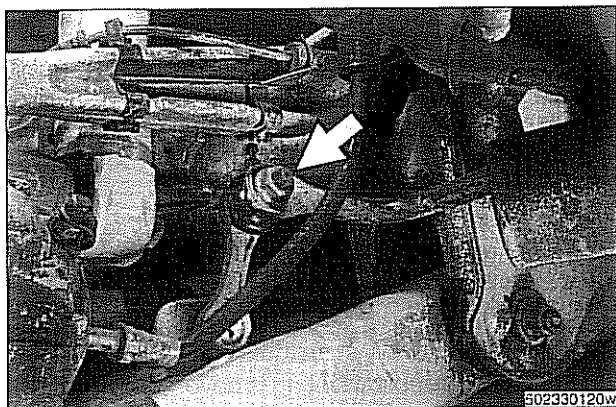


Tightening torques

Stabilizer link to stabilizer bar	42 Nm (32 ft-lb)
Stabilizer bar bracket to subframe (M8)	22 Nm (16 ft-lb)

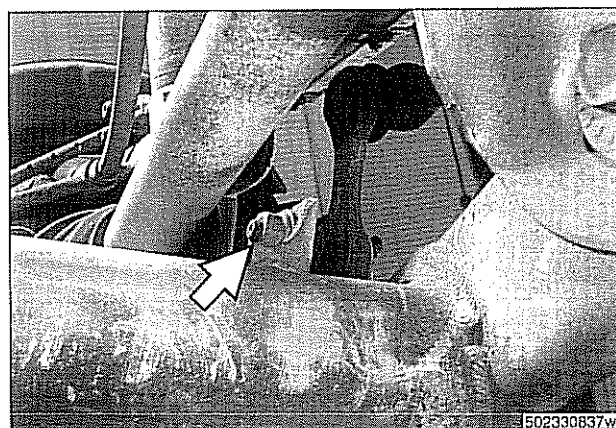
Stabilizer bar link, removing and installing

- 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.

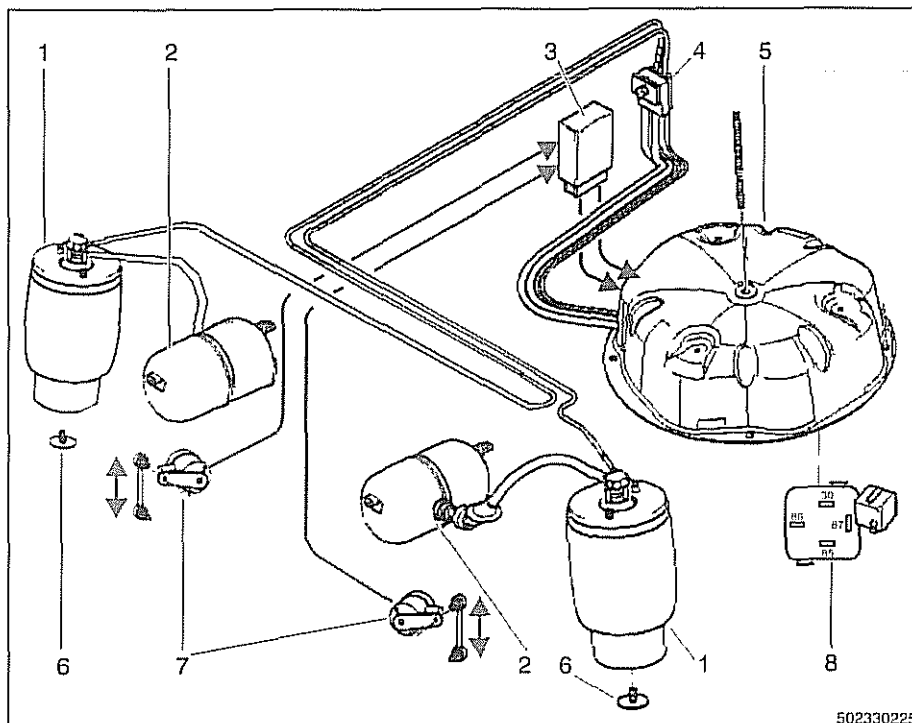
With vehicle lifted off the ground, if the rear air springs can be compressed by hand, either the spring is defective or the system is depressurized.

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—

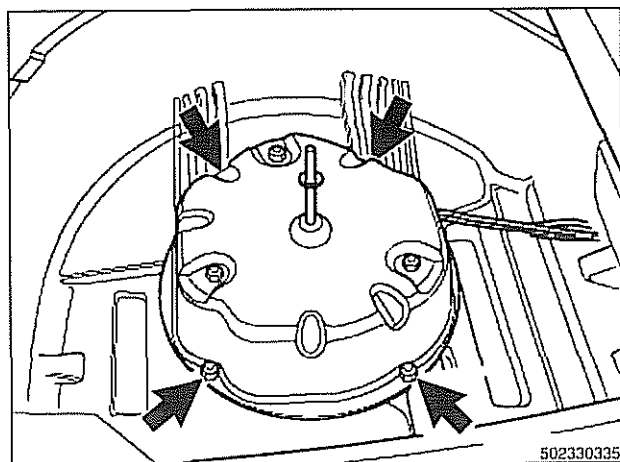
Maintain high levels of cleanliness around air line connections when disassembling and assembling air suspension components. Even small dirt particles can cause leakage in the pressurized system.



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

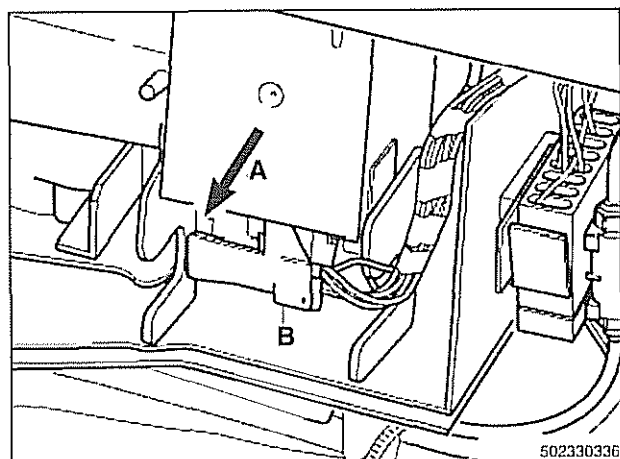
Air compressor pump relay, removing and installing



- 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

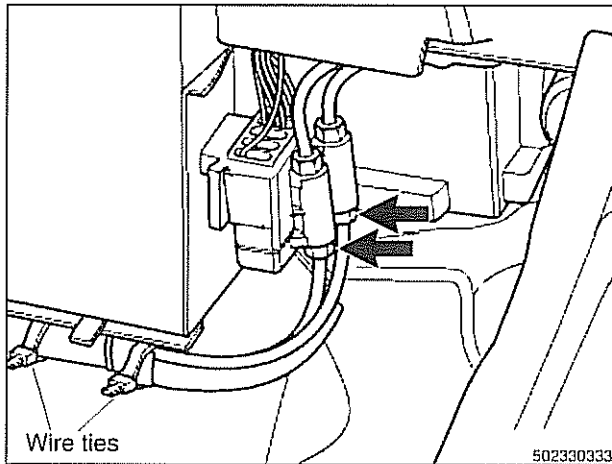
CAUTION—

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

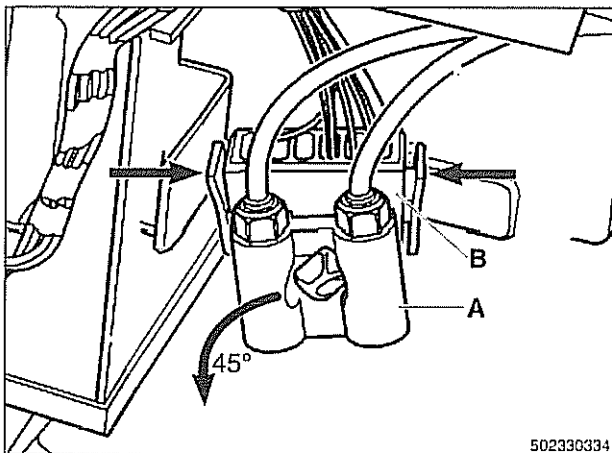


- Remove air line fittings (A) from bottom of air distribution connectors.

- Cut off wire ties.

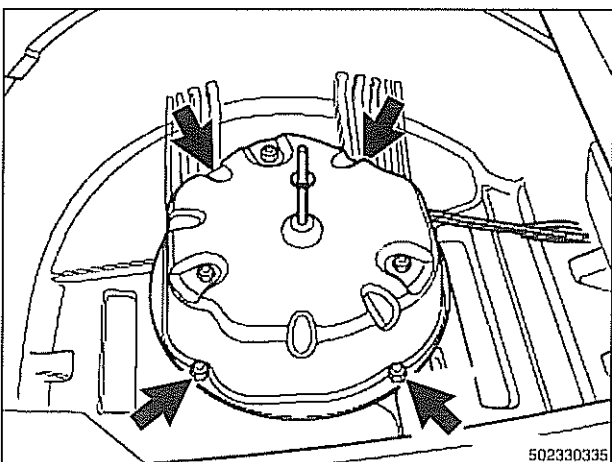
WARNING—

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.



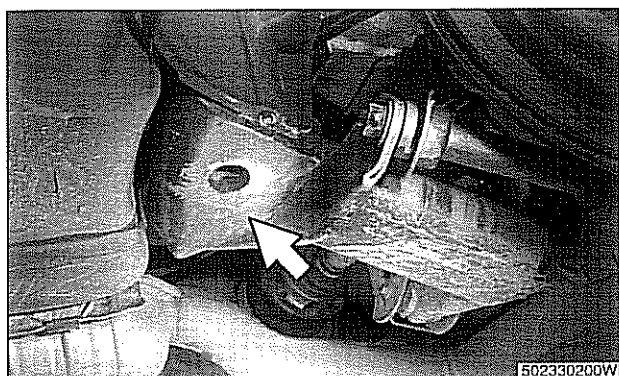
- Remove air supply unit mounting fasteners (arrows) and remove unit.

— 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.

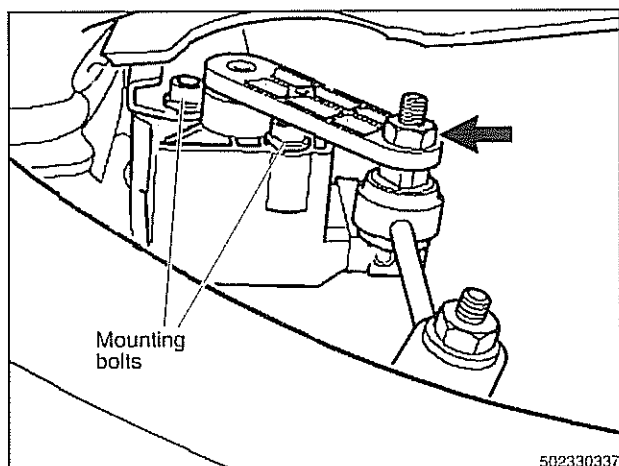
- ◀ Remove control rod mounting nut (arrow). Turn control rod to access sensor mounting fastener.

- 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

General	331-2
Special tools	331-2
Aluminum suspension components	331-4

Final Drive	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

Drive Axles	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

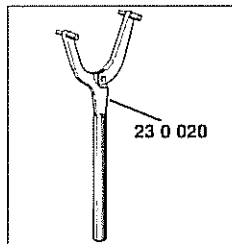
GENERAL

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.

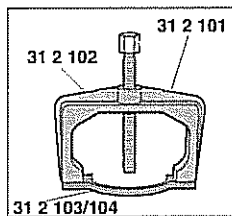
Internal repairs of the differential assembly are not covered in this manual.

Special tools

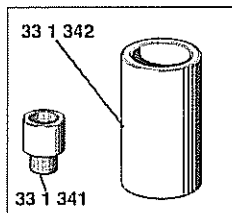
BMW recommends some special tools for the removal of the drive axles as well as the installation of rear differential input and output drive flange seals. Some common pullers and drifts can often be substituted for these tools.



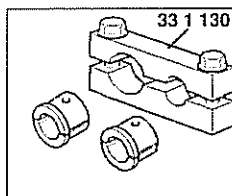
➤ Drive flange holder
(Tool No. BMW 2 30 020)



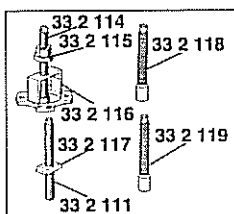
➤ Drive flange puller
(Tool No. BMW 31 2 101 / 31 2 102 / 31 2 103 / 31 2 104)



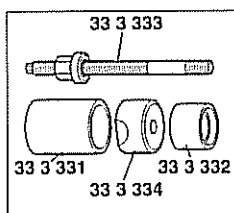
➤ Drive pinion set
(Tool No. BMW 33 1 340)



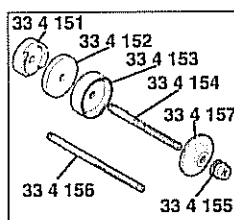
➤ Clamping tool set
(Tool No. BMW 33 2 101 / 33 2 102 / 33 2 103)



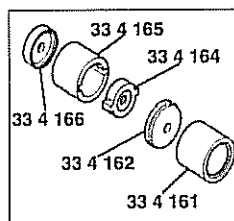
- Output shaft tool set
(Tool No. BMW 33 2 111 / 33 2 114 / 33 2 115 / 33 2 116 / 33 2 117 / 33 2 118 / 33 2 119)



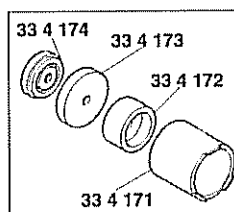
- Trailing arm tool set
(Tool No. BMW 33 3 331 / 33 3 332 / 33 3 333 / 33 3 334)



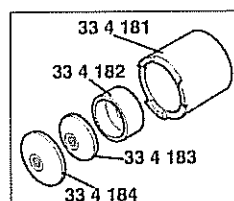
- Final drive mount set
(Tool No. BMW 33 4 151 / 33 4 152 / 33 4 153 / 33 4 154 / 33 4 155 / 33 4 156 / 33 4 157 / 33 4 158 / 33 4 159)



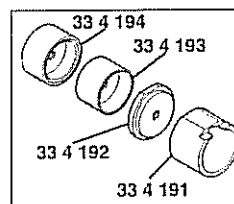
- Differential mount press set
(Tool No. BMW 33 4 161 / 33 4 162 / 33 4 164 / 33 4 165 / 33 4 166)



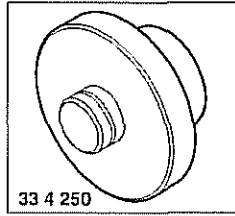
- Differential mount press set
(Tool No. BMW 33 4 171 / 33 4 172 / 33 4 173 / 33 4 174)



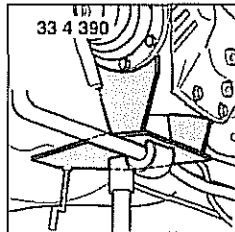
- Differential mount press set
(Tool No. BMW 33 4 181 / 33 4 182 / 33 4 183 / 33 4 184)



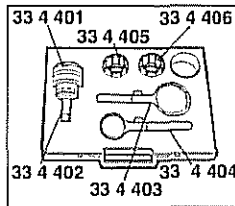
- Support tube set
(Tool No. BMW 33 4 191 / 33 4 192 / 33 4 193 / 33 4 194)



- 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.

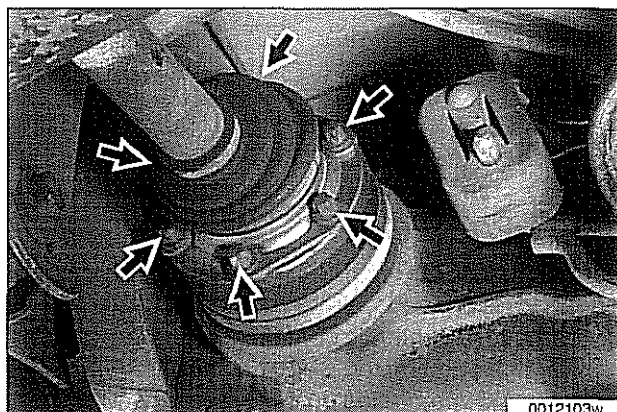
FINAL DRIVE

Final drive, removing and installing

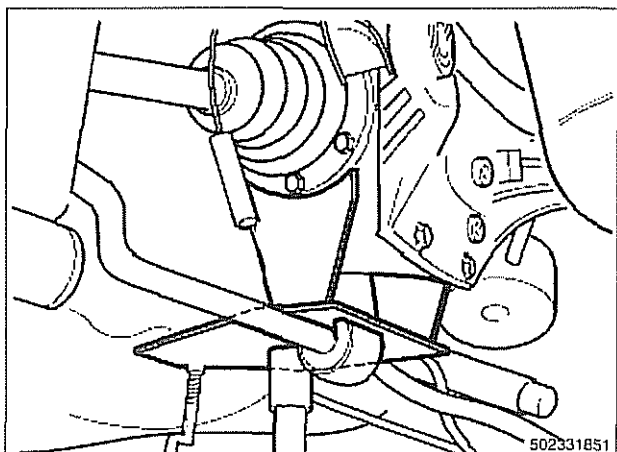
- Raise rear of car.

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.

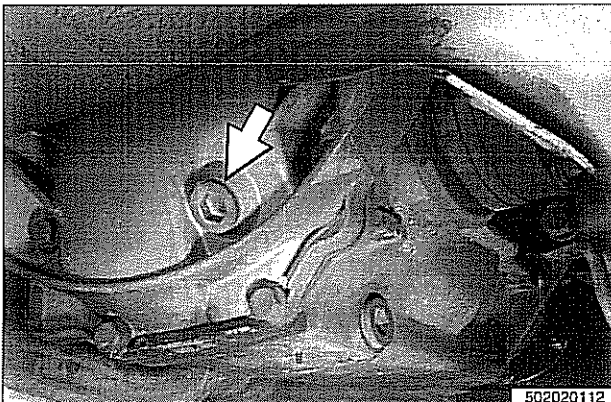
- Check differential oil level. See **Differential oil level, checking**.
- Remainder of installation is reverse of removal.

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 —

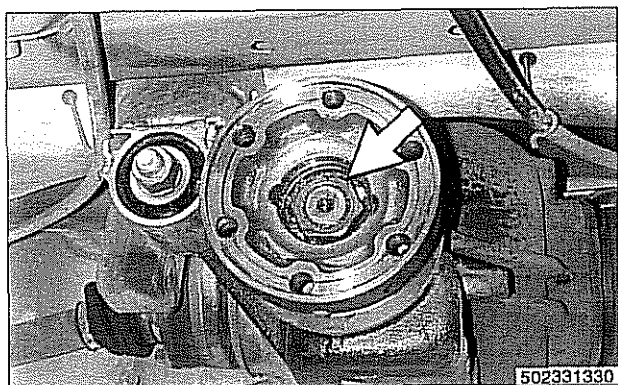
- Use either a 14 mm or 17 mm Allen socket to remove the drain plug.
- If car is raised in the air, it should be level when checking or filling final drive fluid level.

Tightening torque

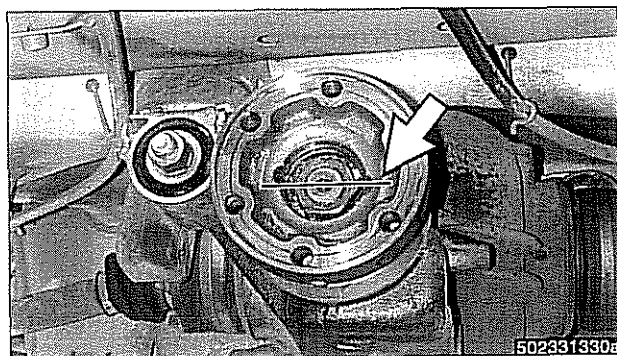
Filler plug to final drive housing	70 Nm (52 ft-lb)
------------------------------------	------------------

Final drive input shaft seal, replacing

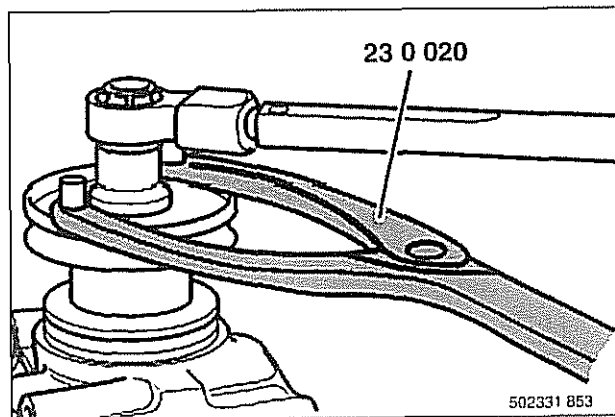
- Remove exhaust system. See 180 Exhaust System.
- Remove drive shaft. See 260 Driveshaft.
- Lift out collar nut locking plate (arrow).



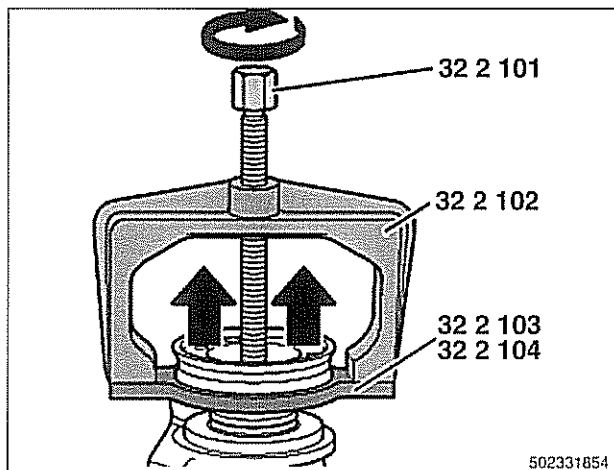
- Mark position of collar nut to pinion shaft (arrow) with a center punch.



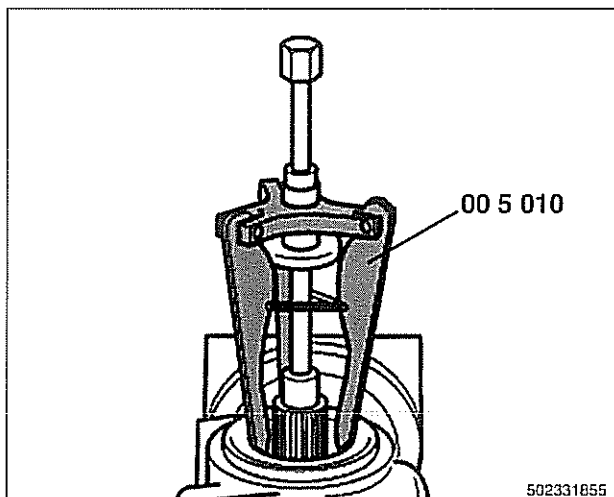
- While counterholding drive flange with special BMW tool 23 0 020 loosen and remove collar nut.



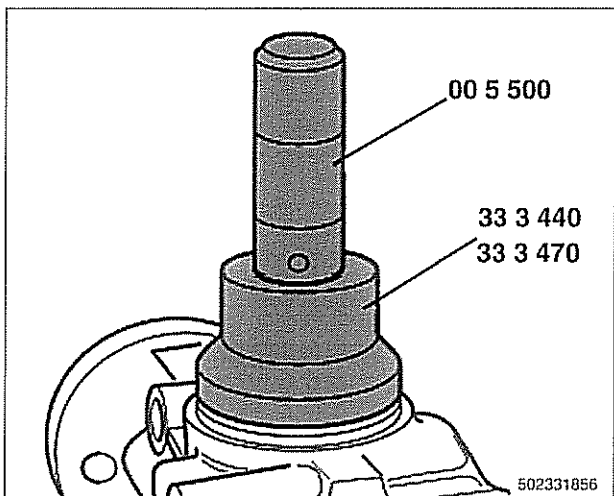
Final Drive



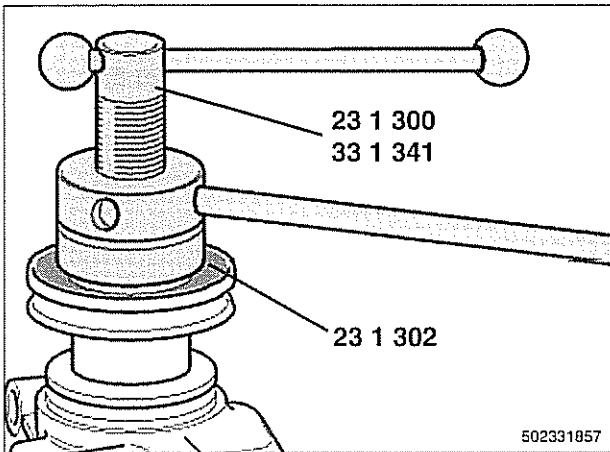
- Remove final drive input flange using BMW special tools 31 2 101, 31 2 102, 31 2 103 and 31 2 104 or equivalent.



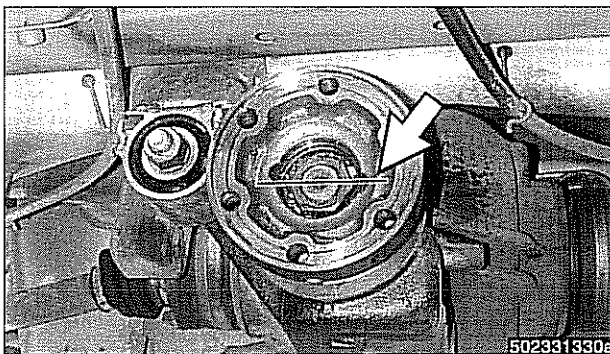
- Using BMW special tool 00 5 010 or equivalent remove seal from final drive housing.



- 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

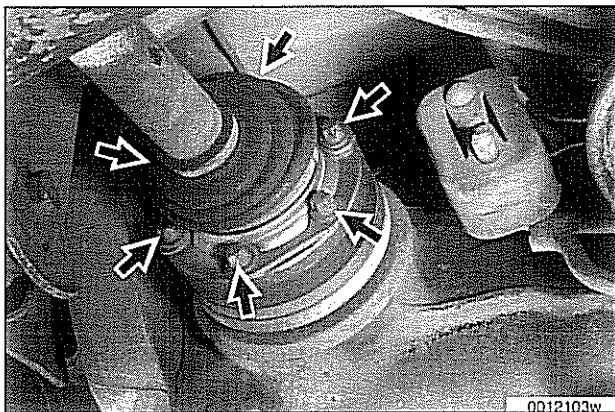
Driveshaft CV joint to final drive flange

- | | |
|------------------------|------------------|
| • M10 (Torx bolt) | 70 Nm (51 ft-lb) |
| • M8 (compression nut) | 32 Nm (24 ft-lb) |

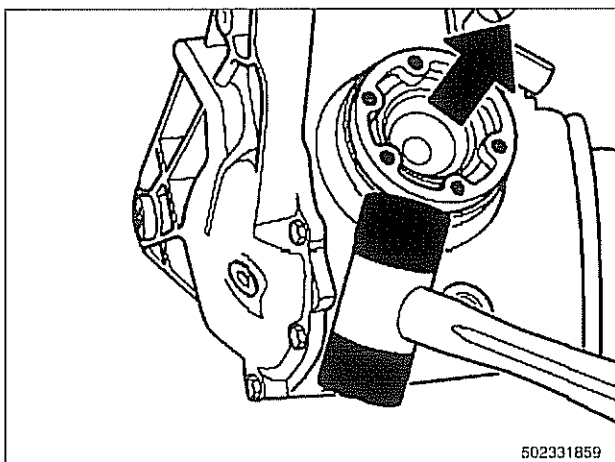
Final drive output shaft seals, replacing

- Remove exhaust system (if necessary). See **180 Exhaust System**.

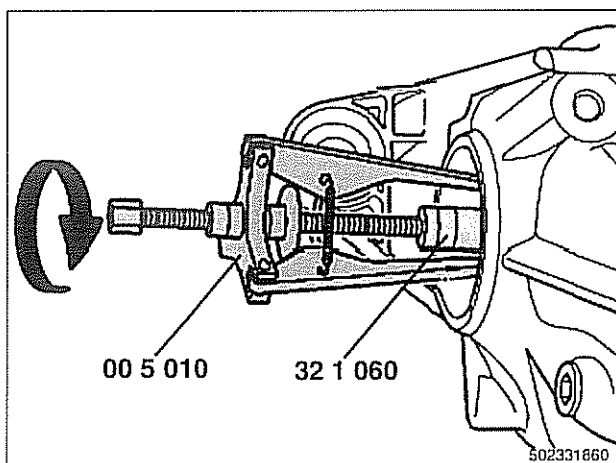
- Remove drive axle CV joint bolts (**arrows**). Suspend drive axle from body using stiff wire.

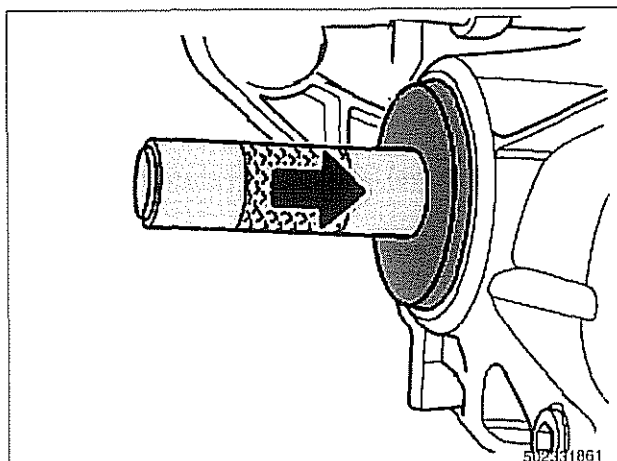


- Drive out final drive output flange using soft faced hammer.

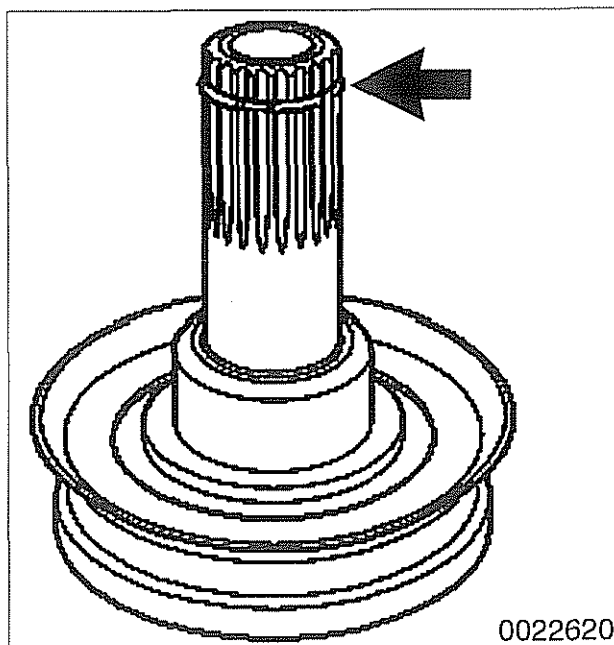


- Remove seal using BMW special tool 00 5 010 and 32 1 060 or equivalent.





- Coat seal with differential oil and drive into place using BMW special tools 00 5 500 and 33 4 250 or equivalent.

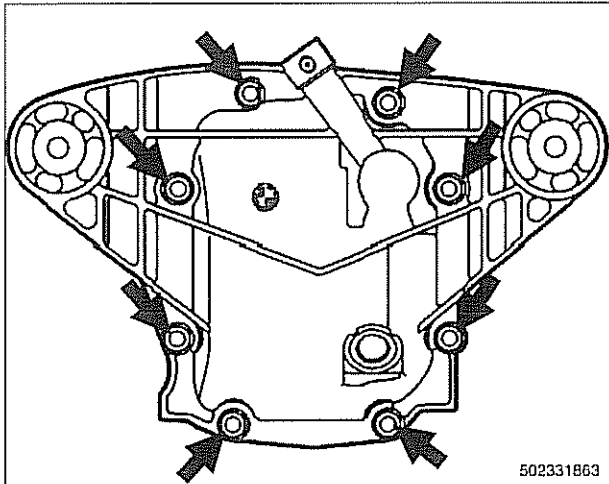


- Replace snap ring (**arrow**) on final drive output flange shaft.
- Coat output flange shaft with differential oil where it contacts shaft seal.
 - Push output flange into final drive until flange splines engage splines of differential gear and snap ring can be heard to snap into place.
- Remainder 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

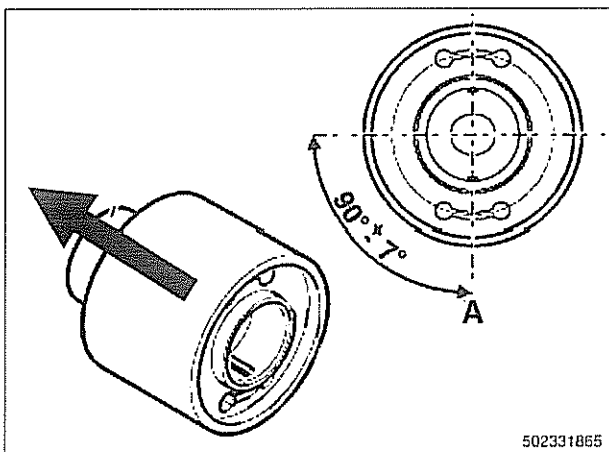
- | | |
|--------------------|------------------|
| • M10 (8.8 grade) | 45 Nm (33 ft-lb) |
| • M10 (10.9 grade) | 90 Nm (66 ft-lb) |

Final drive mounts, replacing

- Remove final drive. See **Final drive, removing and installing**.

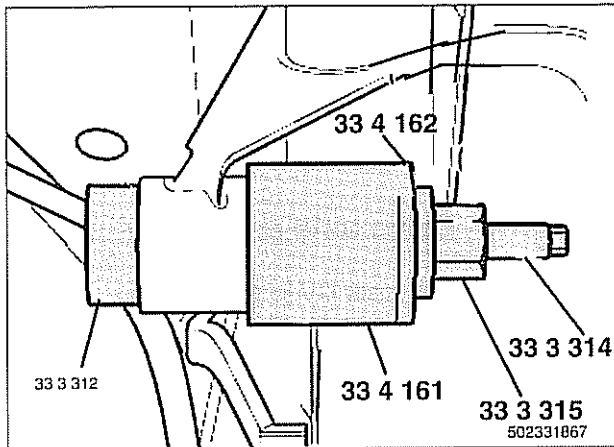
Rear final drive mounts

- 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.

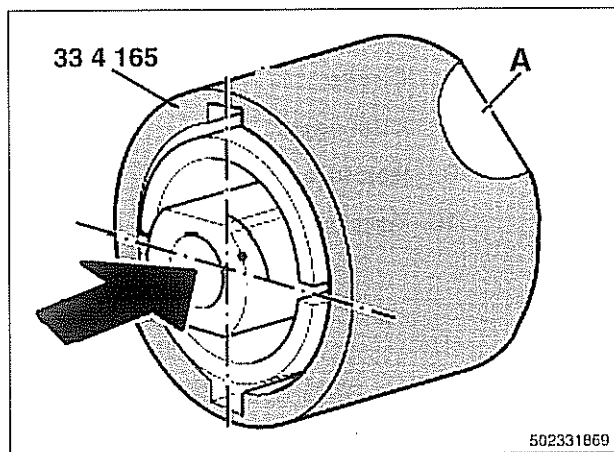


- Coat bearing sleeve in rear axle carrier and rubber mount with Circolight® anti-friction agent.

- 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.

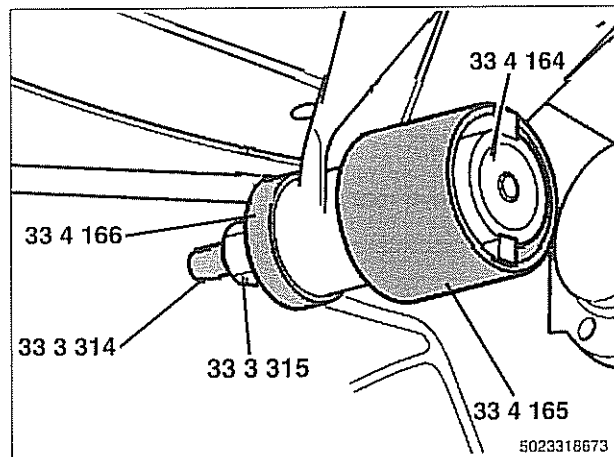


- Draw rubber mount in firmly with BMW special tools 33 3 314, 33 3 315, 33 4 164, 33 4 165 and 33 4 166.

NOTE —

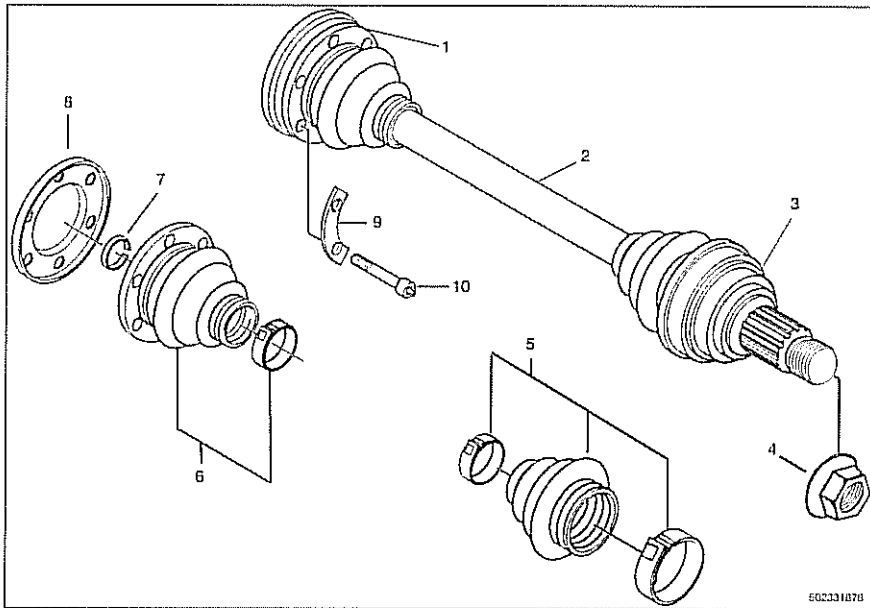
- Make sure special tool 33 4 166 is properly seated.
- Rubber mount must locate flush in rear axle carrier. If necessary, rotate special tool 33 4 164 through 90° and draw in overlap.

- Remainder of installation is reverse of removal.



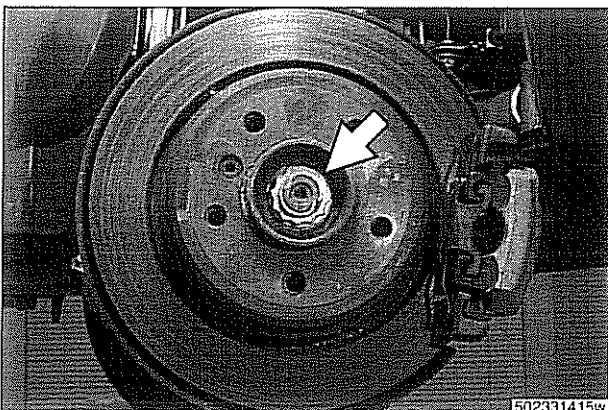
DRIVE AXLES

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 —

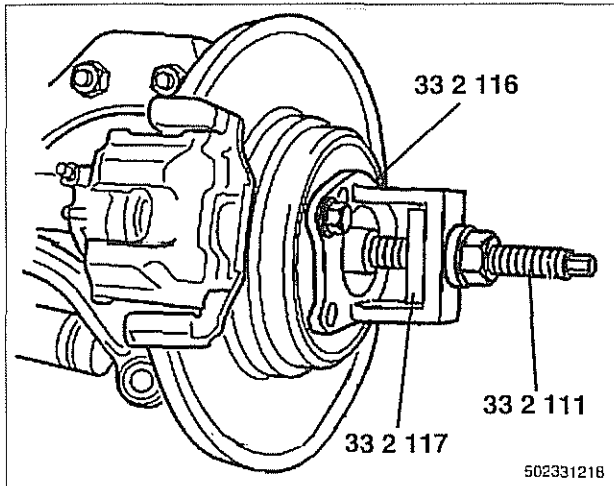
The drive flange collar nut is tightened to a torque of over 300 Nm (221 ft-lb). Make sure the car is firmly on the ground.

- 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**.

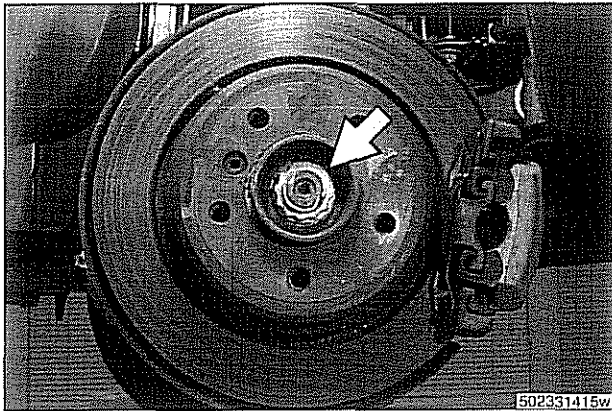


- Remove staked collar nut and press output shaft out of wheel hub with special BMW tool 33 2 111/116/117.
- Remove drive axle.
- Installation is reverse of removal, noting the following:
 - Use a new collar nut.
 - Apply a light coating of oil to contact face of collar nut and install it loosely.
 - 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 —

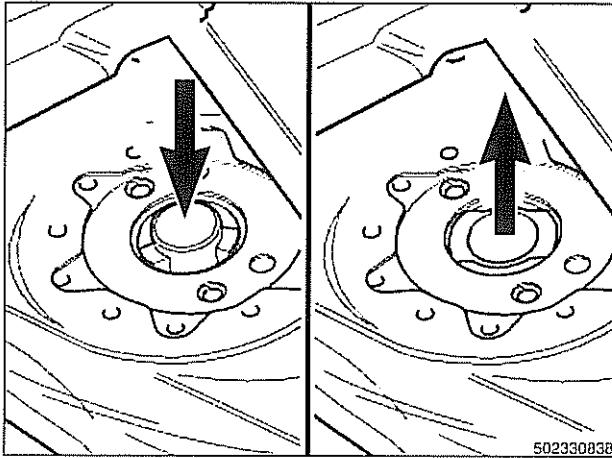
Disable air supply pump (if applicable) by disconnecting electrical plug before performing any repairs. Pump is located beneath a cover under the spare tire in the floor of the cargo compartment.

- Raise rear of car. Remove rear wheel.

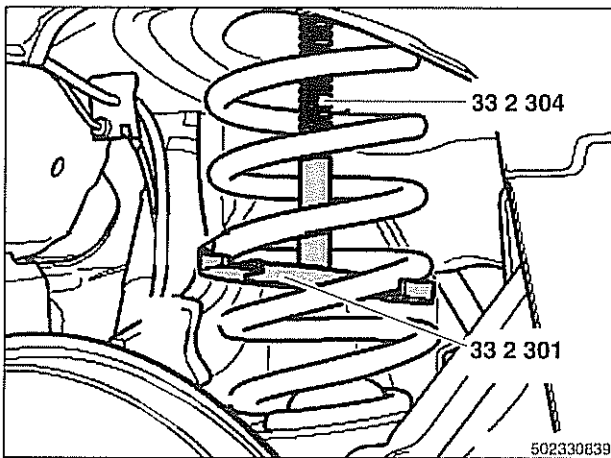
WARNING —

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.

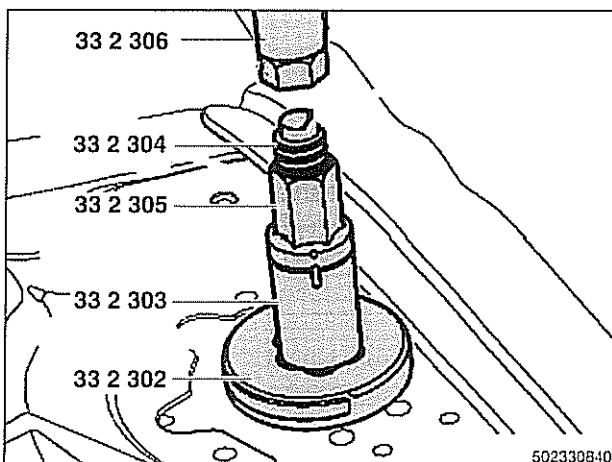
- Models with rear coil springs: Remove cargo compartment floor carpet.



- 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.



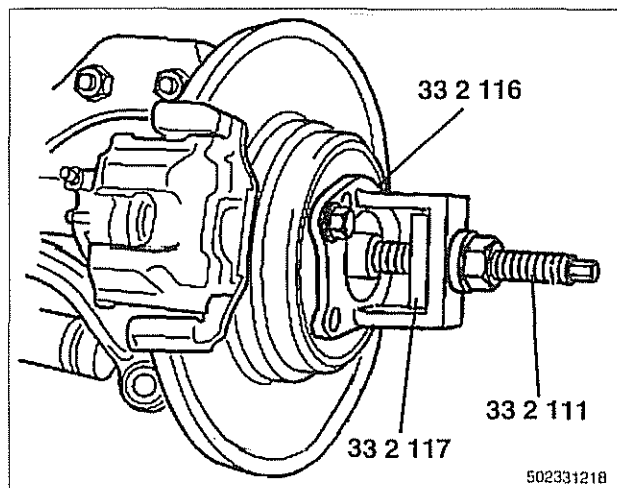
- Working in cargo compartment, attach BMW special tools 33 2 302, 33 2 303 and 33 2 305 to special tool 33 2 304.
- Use special tool 33 2 306 to compress spring.
 - Tighten until lower spring end lifts off spring seat on wheel bearing carrier.

- 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.

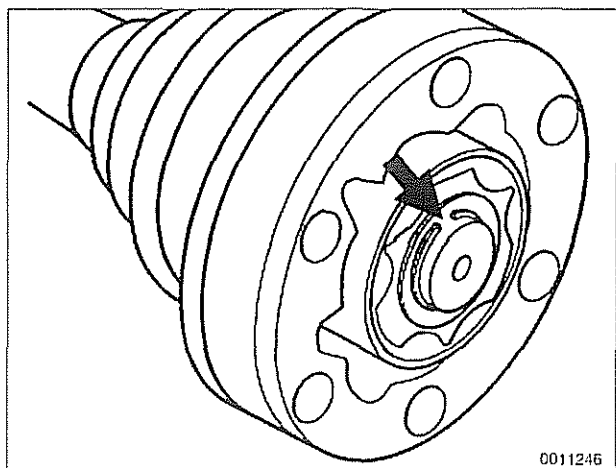
Tightening torques

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)

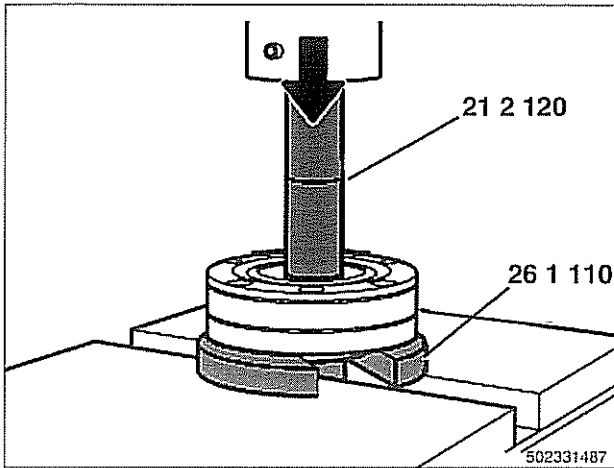
CV joint boots

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.

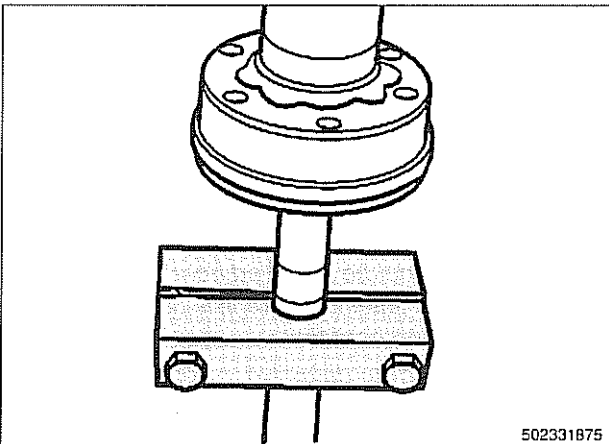
NOTE—

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

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GENERAL

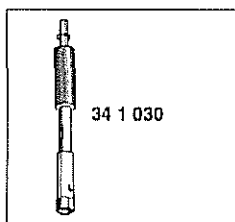
This repair group covers brake service:

- 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**.

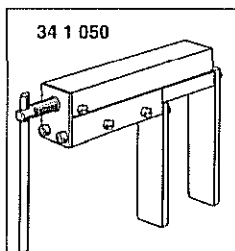
Special Tools

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.



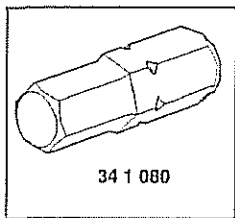
34 1 030

- Parking brake cable adjusting tool
(Tool No. BMW 34 1 030)



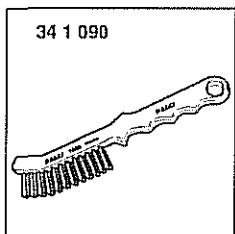
34 1 050

- Brake piston expander
(Tool No. BMW 34 1 050)



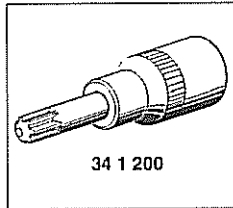
34 1 080

- Brake caliper bolt tool (7 mm Allen)
(Tool No. BMW 34 1 080)

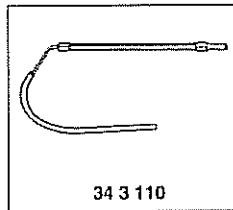


34 1 090

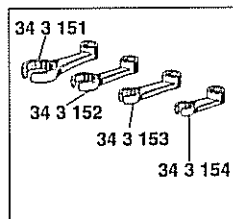
- Steel wire brush
(Tool No. BMW 34 1 090)



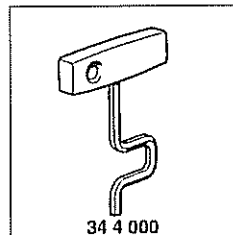
- Brake caliper bolt tool
(Tool No. BMW 34 1 200)



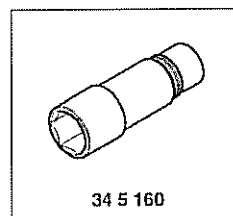
- ASC bleeder wrench
(Tool No. BMW 34 3 110)



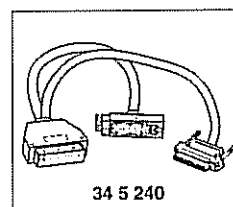
- Brake line flare wrench set (12 mm, 14 mm, 17 mm, 19 mm)
(Tool No. BMW 34 3 150)



- 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 310 Front Suspension or 330 Rear Suspension .
	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 310 Front Suspension or 330 Rear Suspension .
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

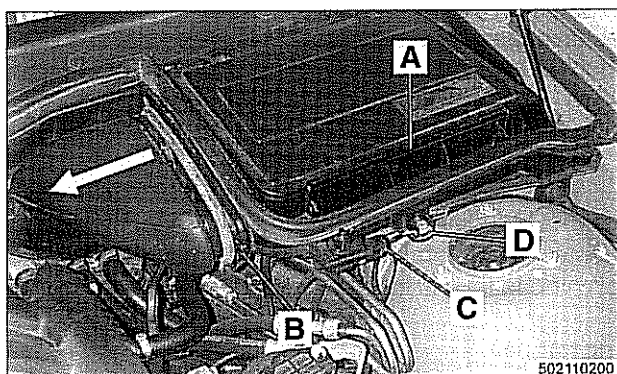
Brakes, bleeding

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

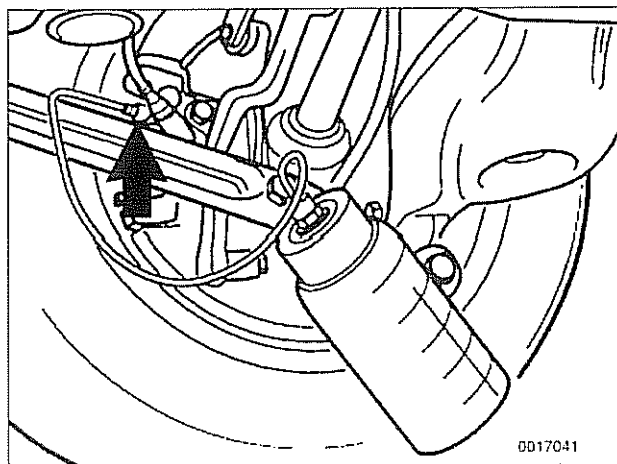
ABS / ASC and ABS / DSC models with precharge pump (to 9/1998)	DOT 4 brake fluid
ABS / DSC models without precharge pump (9/1998 and later)	DOT 4 low viscosity brake fluid



- 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 submersed 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.

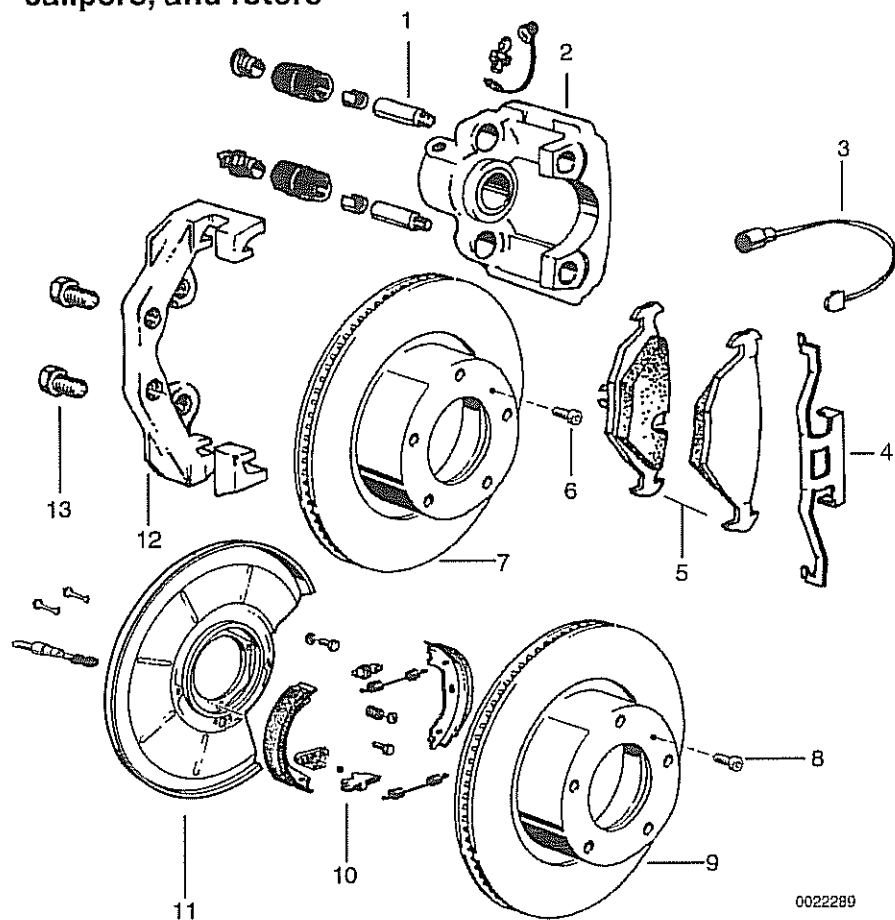
Tightening torques

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.

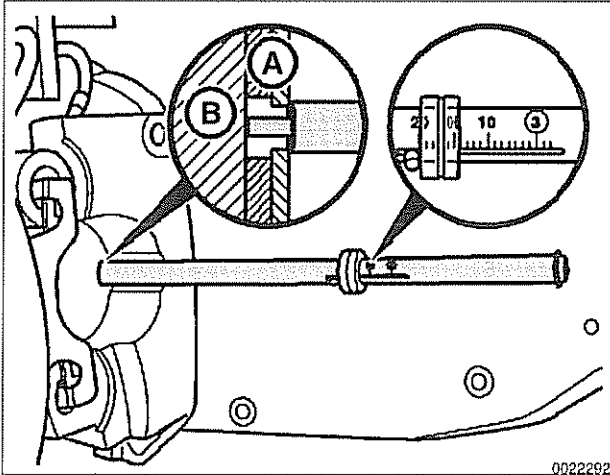
Front and rear brake pad replacement procedures are identical.

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.

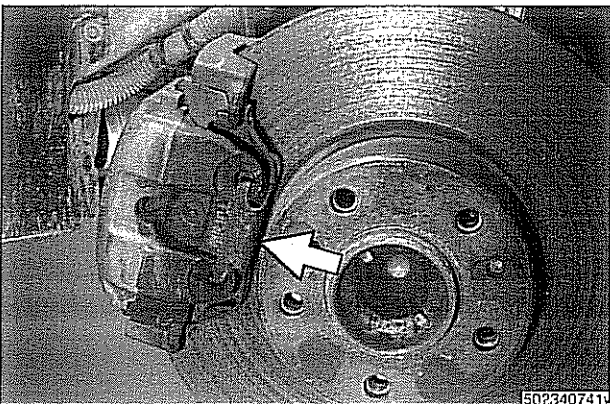


- Raise car and remove wheels.

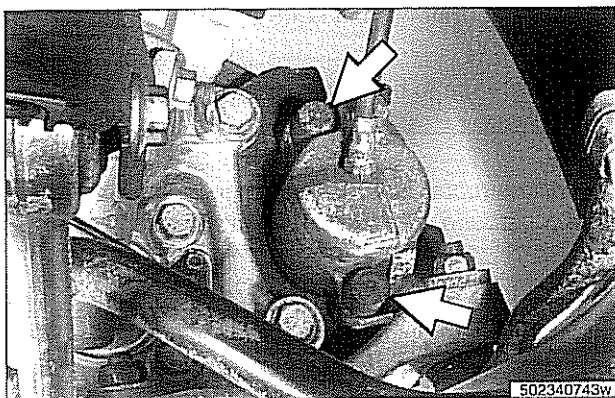
WARNING—

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).

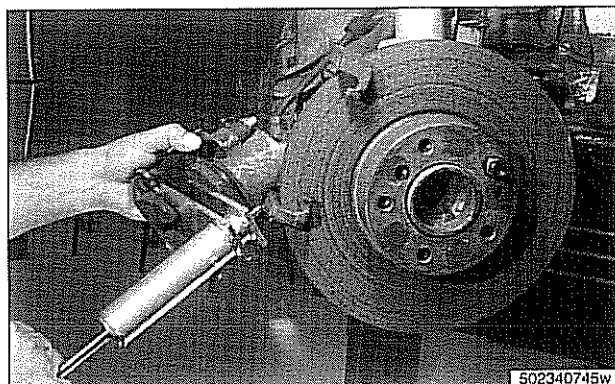


- Remove plastic caps from caliper mounting bolts (**arrows**). Use BMW special tool 34 1 080 (7 mm Allen wrench) to remove caliper mounting bolts. Remove caliper from pad carrier.

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.



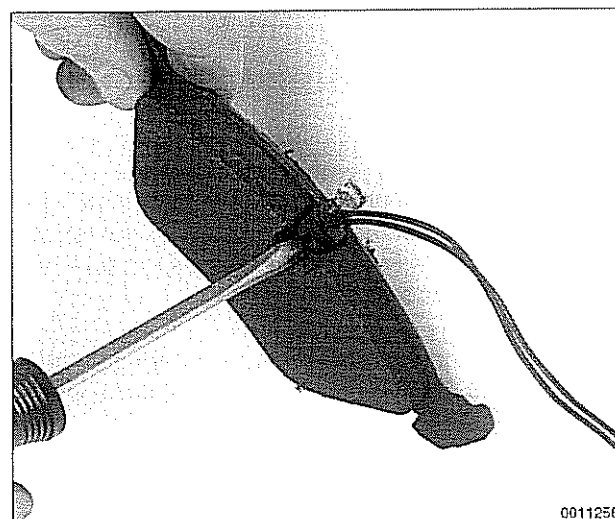
- Spread brake pads using BMW special tool 34 1 050 or equivalent. Remove brake pads.

CAUTION—

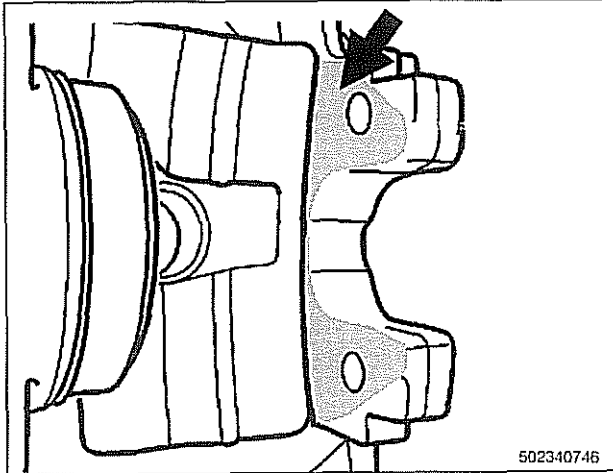
Pressing caliper pistons in may cause brake fluid reservoir to overflow. To prevent this, use a clean syringe to first remove some fluid from reservoir.

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.

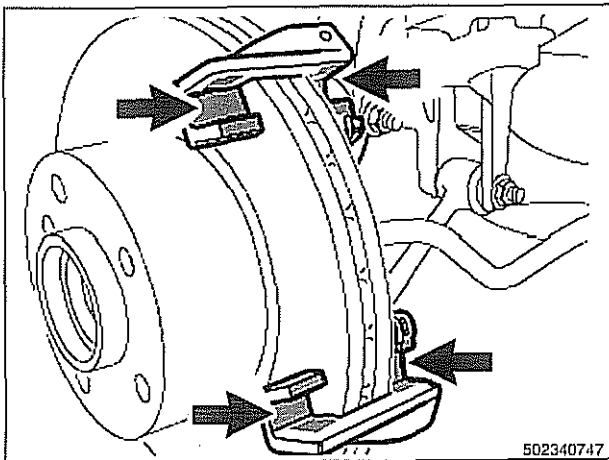


- ◀ Apply a thin coating of BMW anti-squeal compound to caliper contact face (**arrow**).

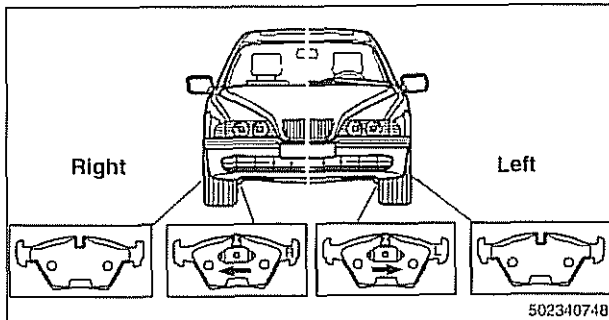
- Do not apply grease to brake pad backing plate.

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—

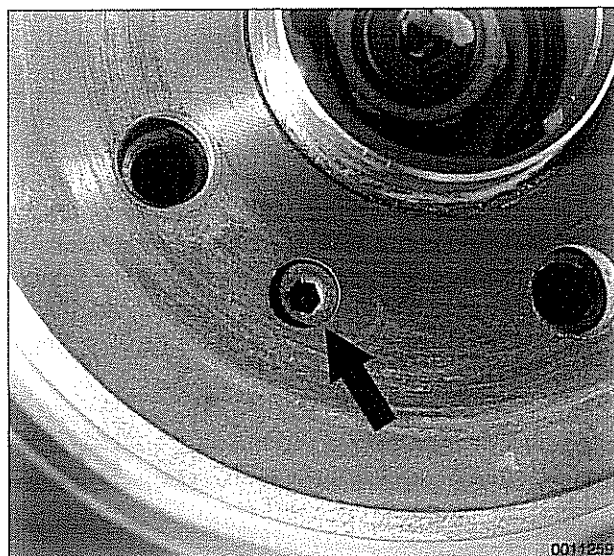
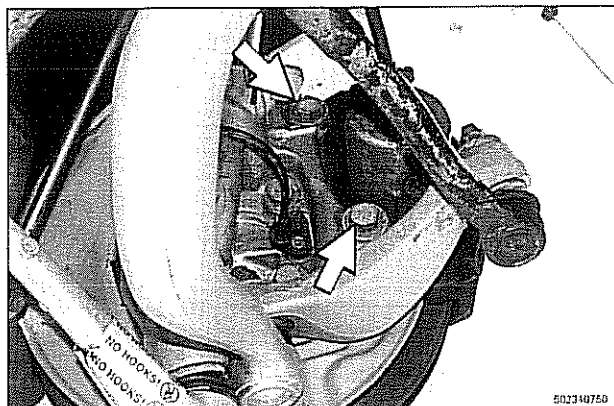
Make sure that the car is firmly supported on jack stands designed for the purpose. Place jack stands beneath structural chassis points. Do not place jack stands under suspension parts.

- 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) • V-8 models (540i)	20.4 mm (0.80 in) 28.4 mm (1.12 in)	18.4 mm (0.72 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.

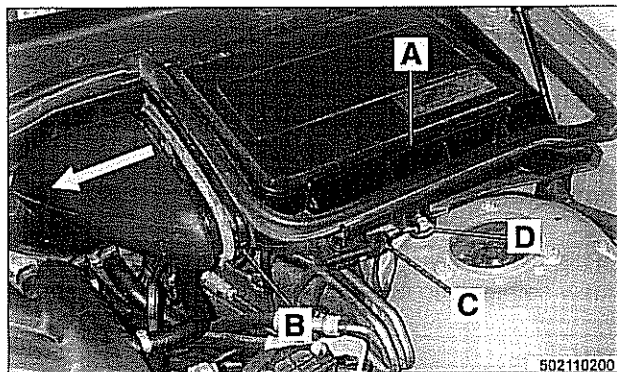
CAUTION—

*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.*

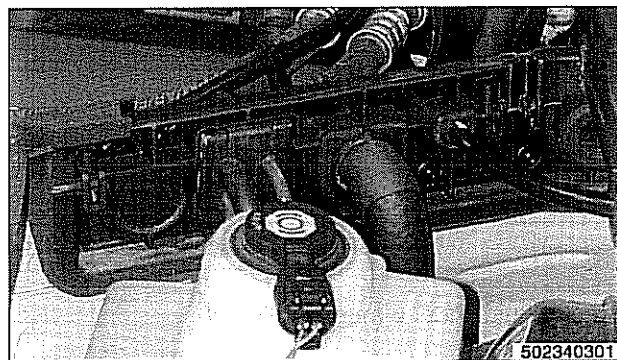
Master cylinder, removing and installing

CAUTION—

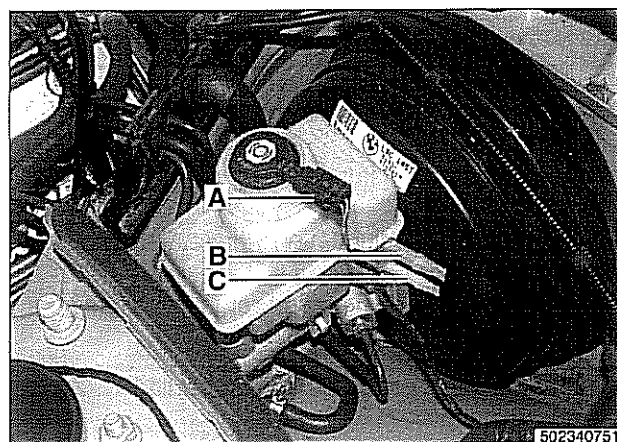
Brake fluid is highly corrosive and dangerous to the environment. Dispose of it properly.



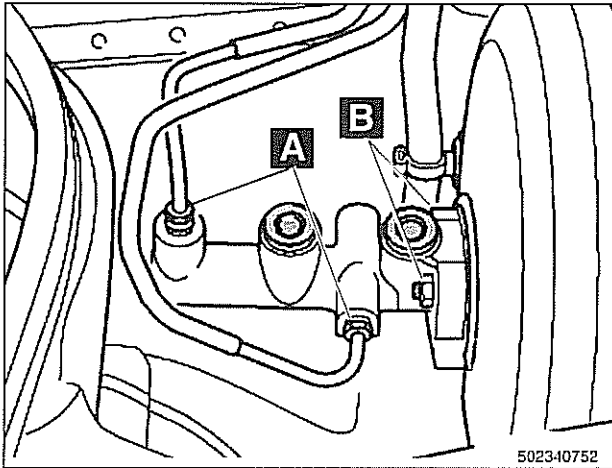
- Remove left side interior ventilation microfilter housing:
 - Remove upper cover and microfilter locking clip (A).
 - Release locking clamp (B), and rotate air tube in direction of arrow to remove.
 - Disconnect wiring harness from hood switch (C).
 - Release filter body mounting clamp (D) and remove 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)
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- Connect brake fluid lines to master cylinder.

Tightening torque

Brake fluid line to master cylinder	18 Nm (13 ft-lb)
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- 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.

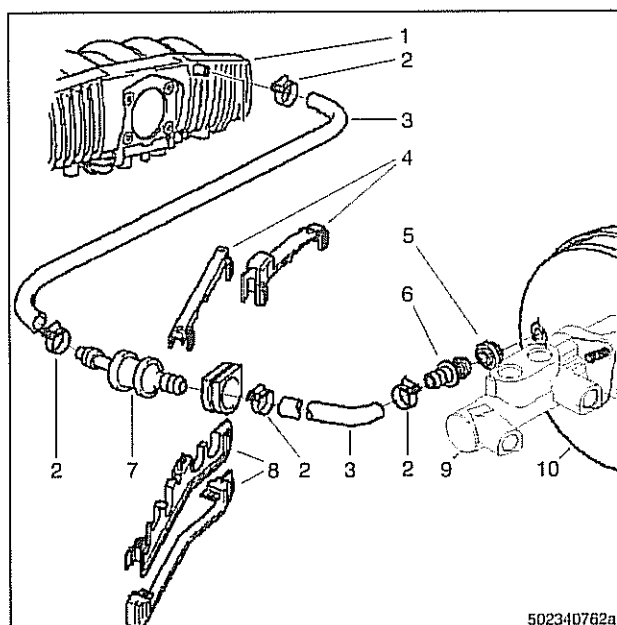
BRAKE BOOSTER

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

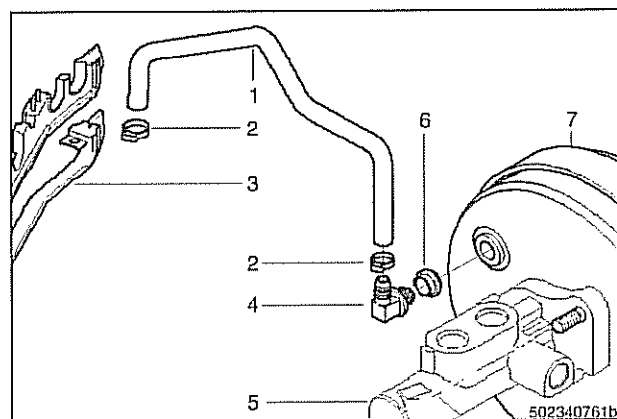
The check valve in the brake booster vacuum line prevents contamination from engine backfires and other sources from entering the brake booster.

Location of check valve varies, depending on year and model.



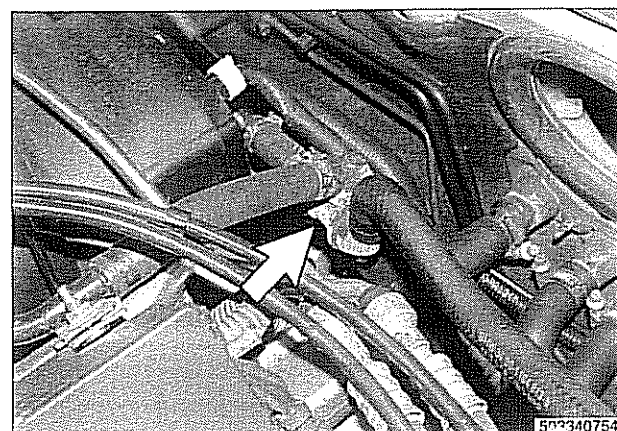
6-cylinder models (528i):

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



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



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.*

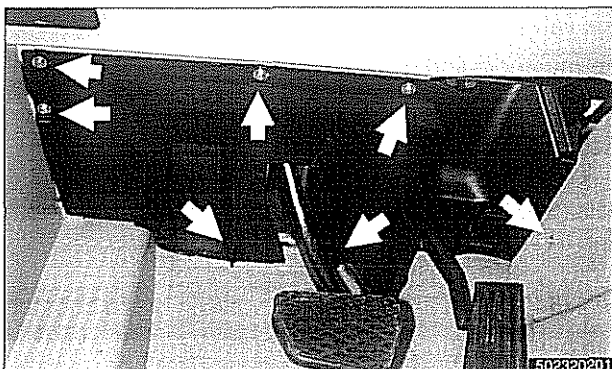
- Disconnect negative (-) cable from battery.

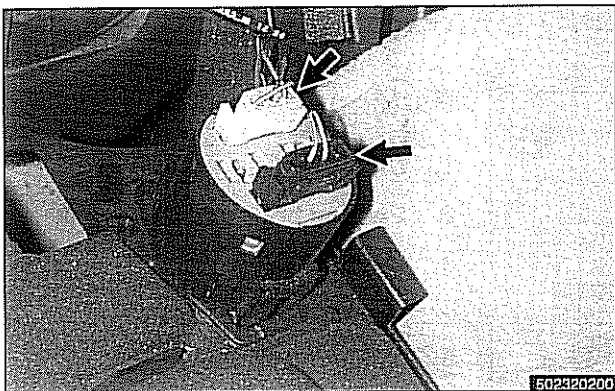
CAUTION—

*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.

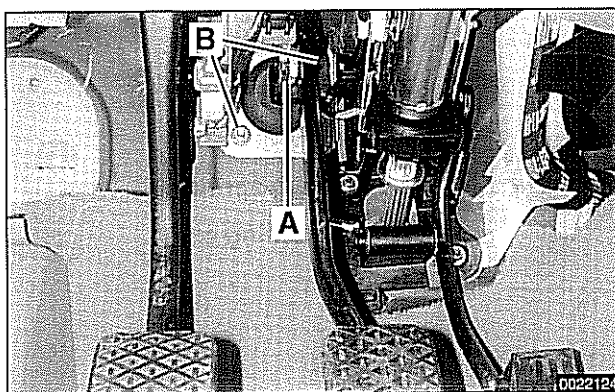
- ◀ Working in interior, remove left footwell (pedal cluster) trim panel (arrows).





➤ 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.*

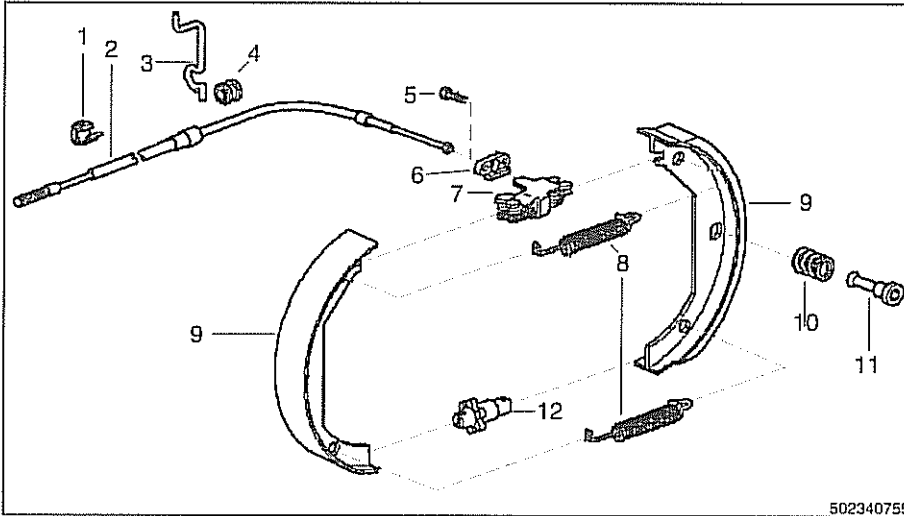
Tightening torques

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



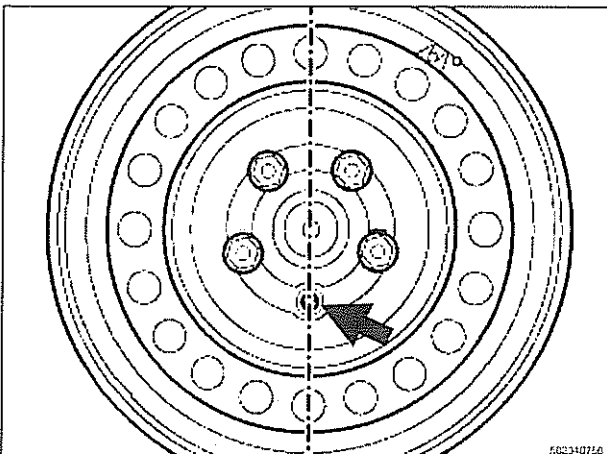
Parking brake components

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
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- 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)
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Parking brake shoes, removing and installing

- Raise rear of car and remove road wheels.

WARNING —

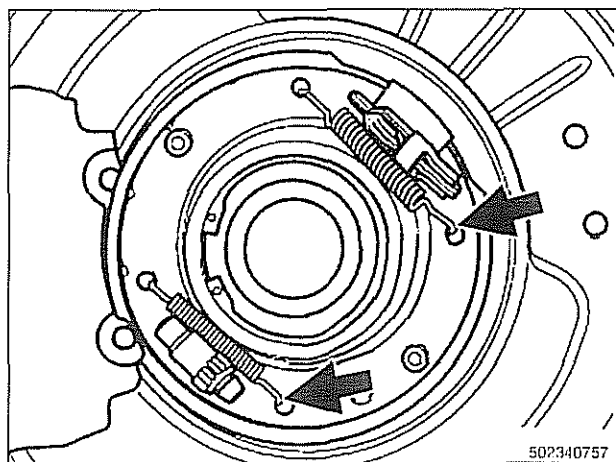
Make sure that the car is firmly supported on jack stands designed for the purpose. Place jack stands beneath structural chassis points. Do not place jack stands under suspension parts.

- Without disconnecting brake fluid hose, remove rear brake calipers from trailing arms. Remove rear brake rotors as described earlier.

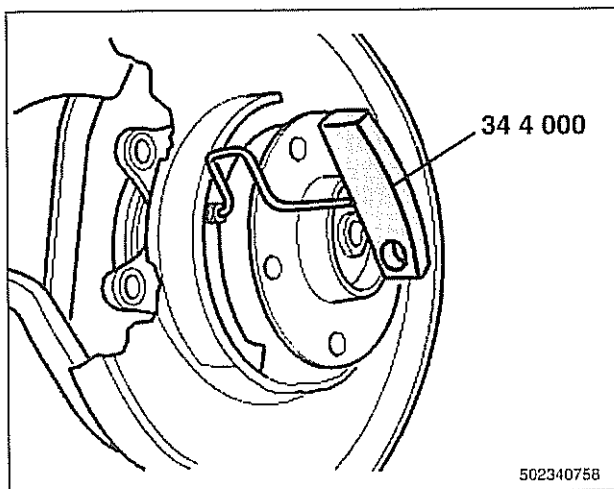
CAUTION —

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.

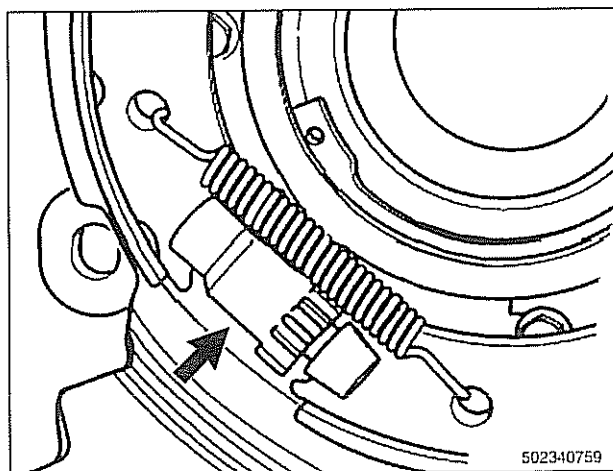


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➤ Remove brake shoe retaining pins using BMW special tool 34 4 000 or equivalent.

- 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.

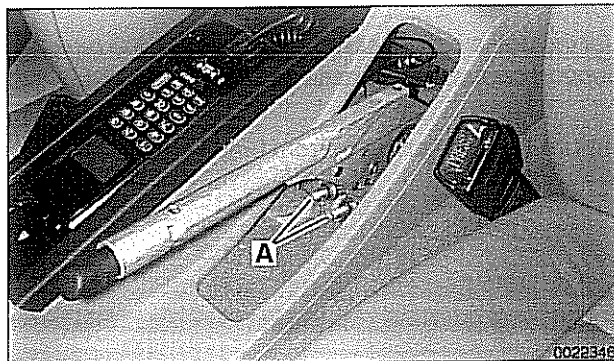
Tightening torque

Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)
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Parking brake cable, replacing

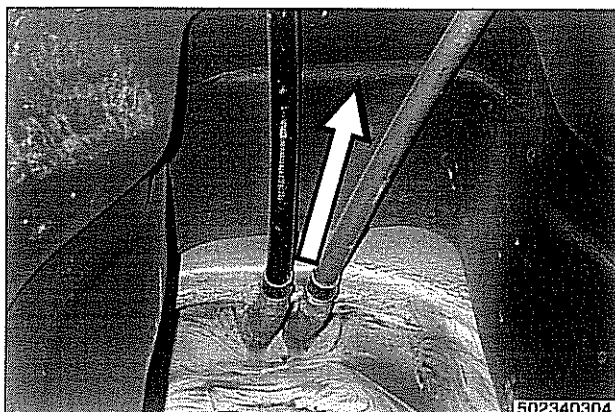
The parking brake is actuated by two separate Bowden cables. Each cable can be replaced separately.

- 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.

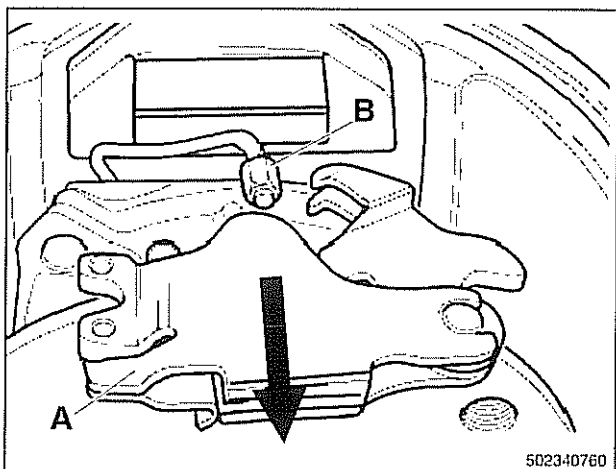


WARNING —

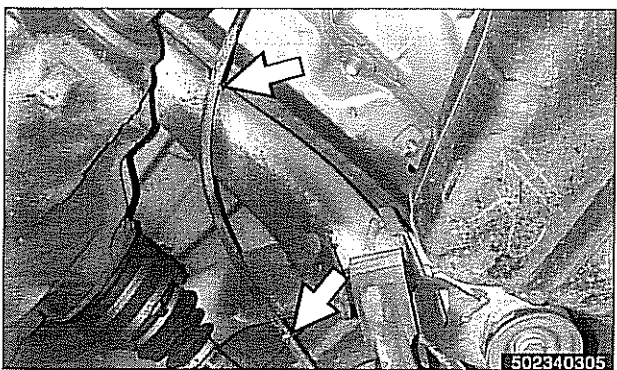
Make sure that the car is firmly supported on jack stands designed for the purpose. Place jack stands beneath structural chassis points. Do not place jack stands under suspension parts.



- 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.

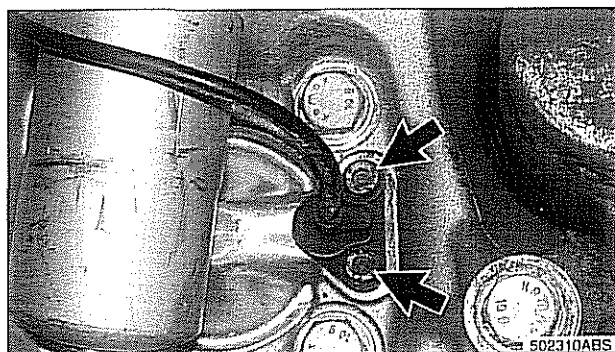
For ABS system and component descriptions, see **300 Suspension, Steering and Brakes-General**.

Wheel speed sensor, replacing

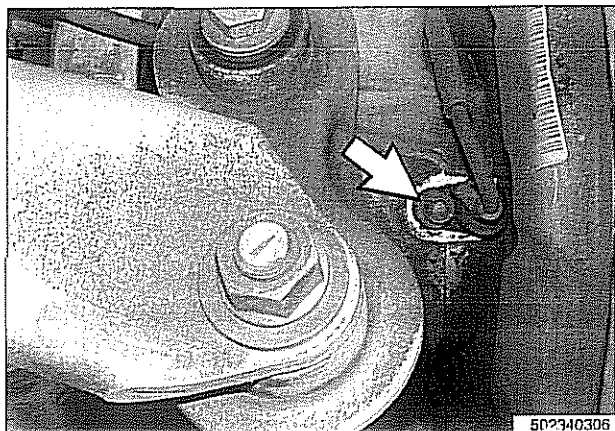
- Raise applicable end of car.

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.



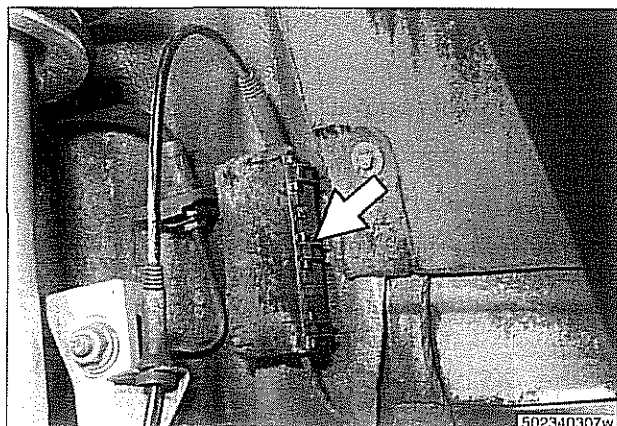
- Front sensor: Unscrew mounting bolts (**arrows**) at steering knuckle.



- 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)
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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.



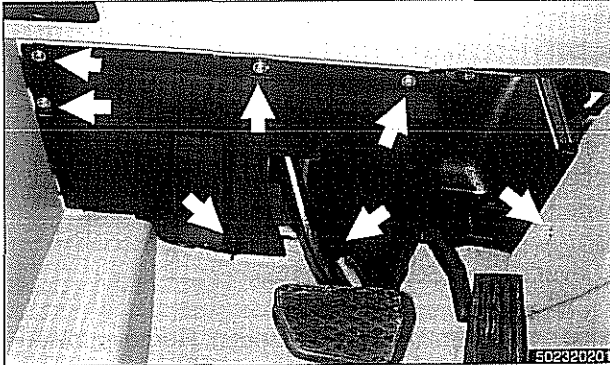
- Remove sensor mounting screws. Lift sensor away from bracket.
- Installation is reverse of removal.

CAUTION—

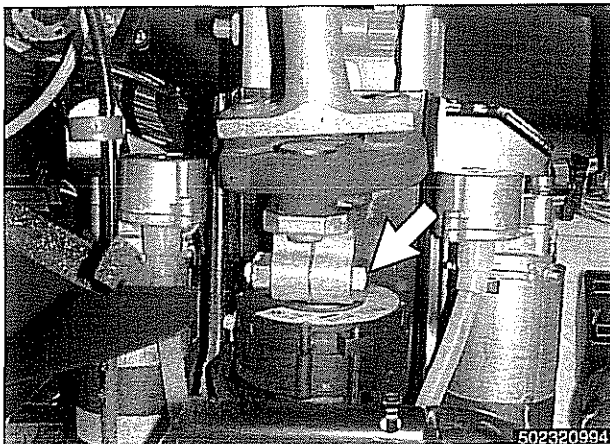
- Be sure to tighten the DSC acceleration sensor(s) and mounting bracket, if applicable, to specified torques. The sensor is vibration sensitive and subject to cause DSC malfunctions if installed improperly.
- After replacing the sensor, perform sensor adjustment using either DIS or MoDiC under Service Functions menu.

Tightening torques

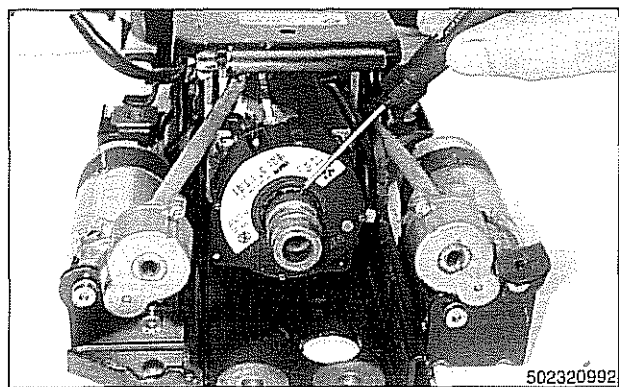
Lateral acceleration / rotational rate sensor to bracket	8 Nm (6 ft-lb)
Sensor bracket to body	8 Nm (6 ft-lb)

DSC steering angle sensor, removing and installing

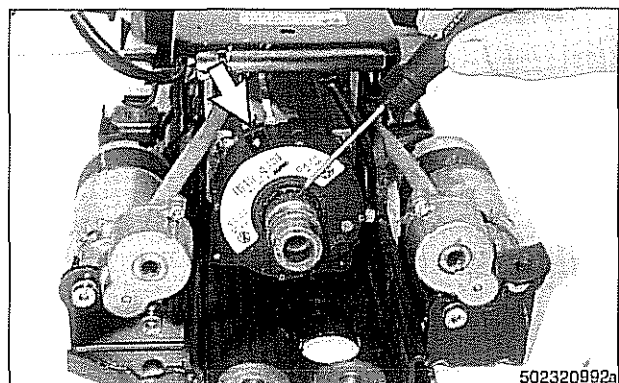
- Remove lower dash panel mounting fasteners (A) and (B).
- Remove steering column lower trim panel. See 320 Steering and Wheel Alignment.



- 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.

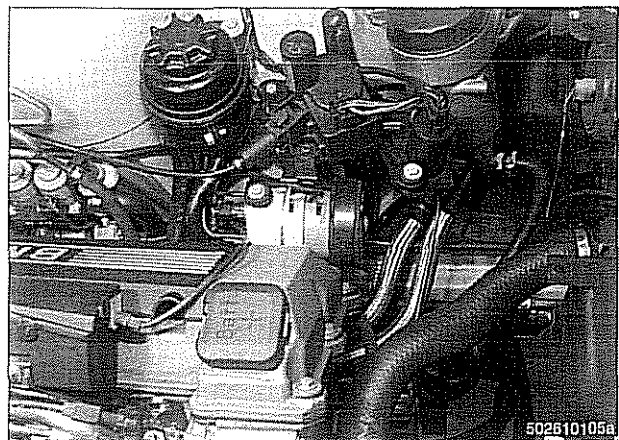
CAUTION—

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)
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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—

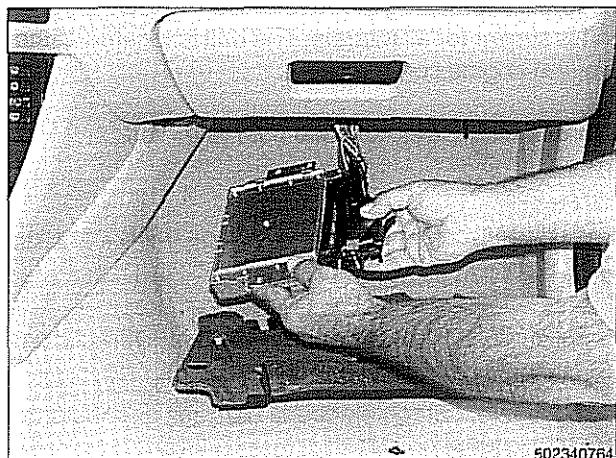
- *E39 cars require special BMW service equipment to properly bleed the brakes. Removal of the DSC pressure sensor is not recommended unless this equipment is available. For safety reasons, the brake system on cars with ABS must be bled using the procedures described in this repair group.*
- *Switch 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)
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- 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)
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- 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 —

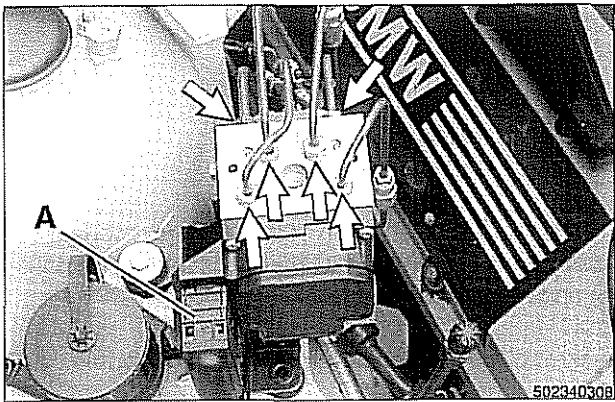
- Before starting this procedure, read control module memory and print out diagnostic record.
- DSC system: Adjust steering angle sensor using either DISplus, GT1, or MoDiC. After completing work, function test control module.

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)

