

General

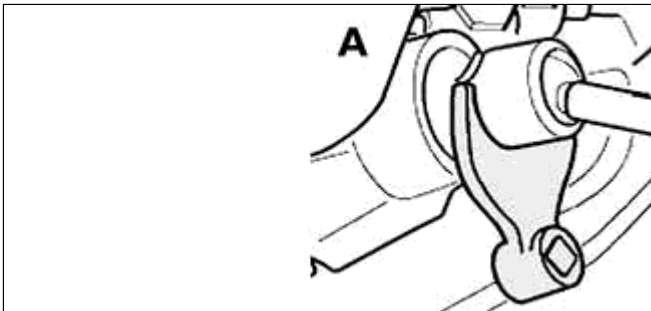
This repair group covers steering wheel and column removal and steering system service, including wheel alignment information.

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

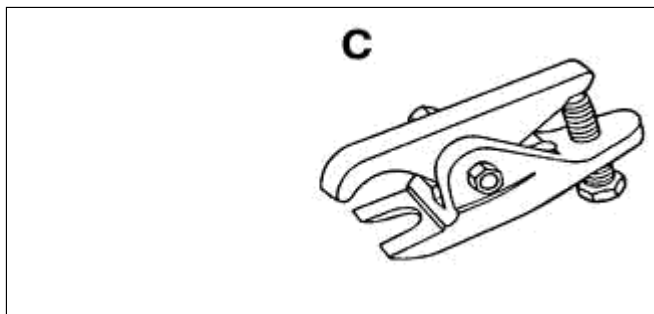
Some special tools are necessary to carry out the repairs and adjustments required for steering service and wheel alignment. Be sure to read the procedures through before starting work on the vehicle.



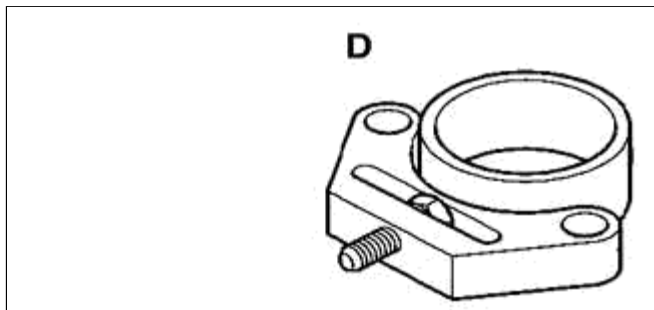
- ◀ Inner tie rod removal tool BMW 32 2 110



- ◀ Rear toe adjusting tool BMW 32 3 030



➤ Tie rod end removal tool BMW 32 3 090



➤ Front camber adjusting tool BMW 32 3 140

Steering system

The variable-assist power steering system consists of an engine-driven hydraulic pump, a rack-and-pinion steering rack assembly with an integral hydraulic control valve, and connecting linkage to the road wheels.

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 assist is provided by a belt-driven pump on the lower left front of the engine, just below the alternator.



➤ The steering rack is bolted to the front subframe underneath the engine. The steering wheel connects to the rack via a telescoping column which incorporates a rubber coupling ("guibo") to dampen vibration and noise.

The power steering fluid is fed from the fluid reservoir to the pump and to the rack via rubber/metal hoses. The return



line from the steering rack to the reservoir loops into the airstream in front of the vehicle and is used as a steering fluid cooler.

The steering rack and linkage require no maintenance other than alignment and periodic inspection for worn components. The rubber rack boots and tie-rod end boots should be inspected periodically for tears or damage and replaced if necessary.

WARNING!

- ♦ ***The BMW airbag system (MRS II) 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 E46 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 MRS II 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.*

Note:

The airbag system is traditionally referred to as Supplemental Restraint System (SRS). The BMW version of SRS used in 1999 to 2001 E46 models is known as the Multiple Restraint System (MRS II).

Steering Wheel

Steering wheel, removing and installing

- 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 at the front of this manual on page viii.

- Carefully remove airbag from front of steering wheel. See ⇒ [721 Airbag System \(SRS\)](#). Store airbag unit in a safe place.

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.

Note:



*The steering column and steering wheel are matchmarked (**arrow**) at the factory. Confirm these marks before removing wheel from column.*

- 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.

Tightening torque	
Steering wheel to steering shaft	63 Nm (46 ft-lb)

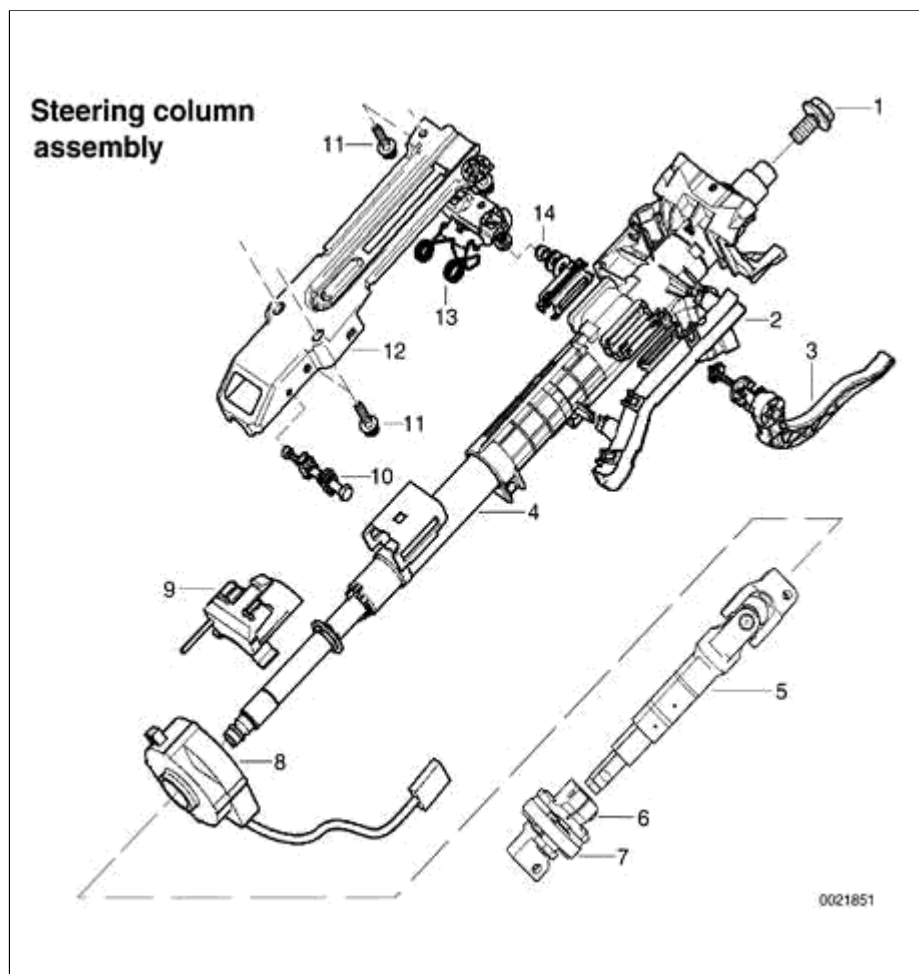
- Carefully install airbag. See ⇒ [721 Airbag System \(SRS\)](#)

Tightening torque	
Airbag to steering wheel	8 Nm (71 in-lb)

Note:

The airbag in some models is attached to the steering wheel using spring clips instead of mounting screws.

Steering Column



Steering column assembly

- 1 - Hex bolt (M14 x 1.5)

◆ tighten to 63 Nm (46 ft-lb)

- 2 - Cable duct

- 3 - Steering column adjustment lever

- 4 - Upper steering column

- 5 - Lower steering column with universal joint

- 6 - Torx bolt (M8 x 33)

◆ tighten to 22 Nm (16 ft-lb)

- 7 - Flexible joint (guibo)

- 8 - Steering angle sensor

- 9 - Steering angle sensor bracket

- 10 - Column pivot bushing

- 11 - Bolt (M8 x 36)

- ◆ tighten to 22 Nm (16 ft-lb)

12 - **Steering column mounting bracket**

13 - **Column return spring**

14 - **Nut (M8)**

- ◆ tighten to 4.8 Nm (3.5 ft-lb)

- ◆ recheck as necessary

Ignition lock cylinder, removing and installing

To remove the ring antenna prior to removing ignition lock cylinder, it is necessary to remove the upper and lower steering column trim. Use BMW special tool 61 3 300 to force off the ring antenna. Alternatively, remove the ignition switch key cylinder first.



◀ With ignition key in ON position (60° from LOCKED):

- ◆ Insert a thin piece of stiff wire into opening (**arrow**) in lock cylinder and pull lock cylinder out.
- ◆ Detach ring antenna harness connector.
- ◆ Gently work ring antenna off key cylinder.

- ◆ Reinstallation is reverse of removal.

Lower steering column, removing and installing

Note:

Once the lower steering column has been removed there will be no end stop for the steering wheel. In order to prevent damage to contact ring in steering column, follow procedural steps as listed.

1. Unlock steering wheel.
2. Move steering wheel to straight ahead position.
3. Lock steering wheel and remove ignition key.

- Lift vehicle and support safely.

WARNING!

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

- Remove splash guard under engine.



- ✦ Remove lower steering column flexible joint pinch bolt (**arrow**). Slide lower column up and pull flexible joint off steering rack shaft.

Note:

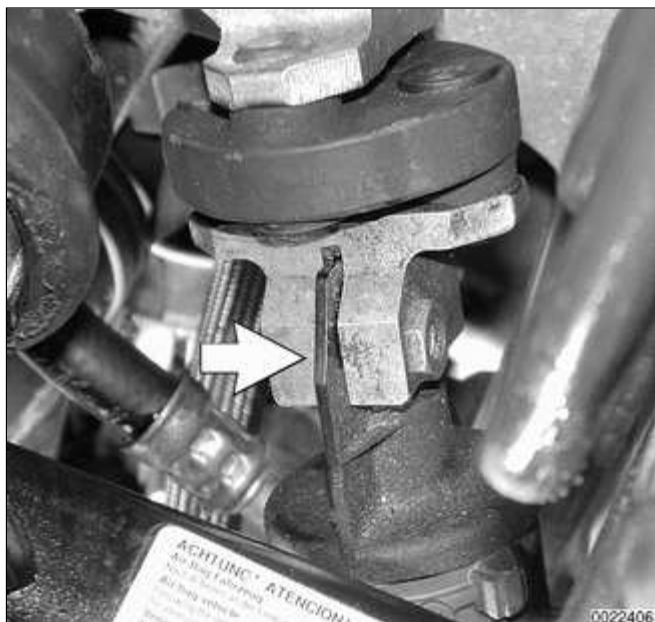
Do not remove alignment flange from steering rack.



- Working near firewall, remove pinch bolt at universal joint and remove lower steering column.

Note:

Upper steering column is keyed to lower steering column universal joint. It can only be installed in one position.



- Installation is reverse of removal, noting the following:
 - Replace flexible and universal joint pinch bolts.
 - Align lower steering column to keyed upper steering column.
 - Align tab (**arrow**) on steering rack flange with lower steering column flexible joint.

Tightening torque

Pinch bolts at steering columns joints

22 Nm (16 ft-lb)

Upper steering column, removing and installing

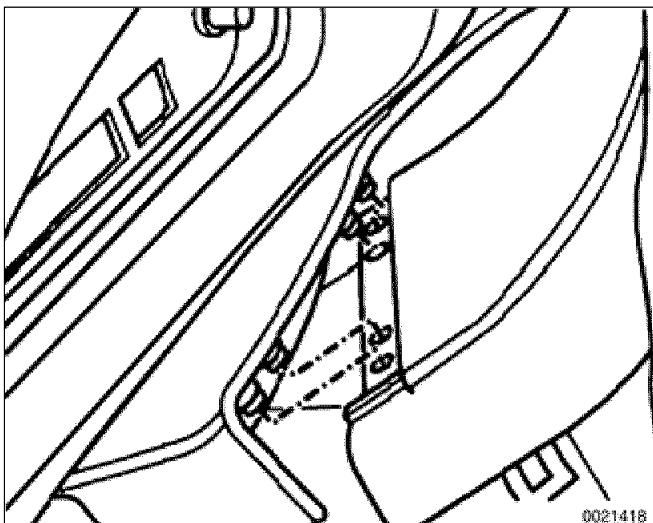
- Remove steering wheel as described earlier.



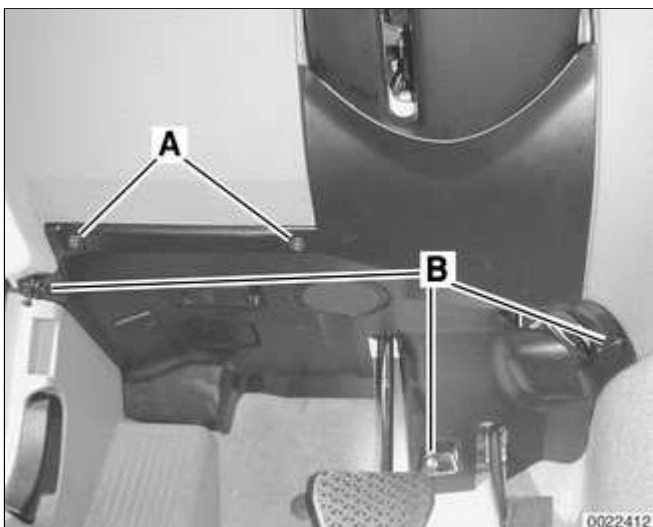
- Fully lower and extend (**arrows**) adjustable steering column.
 - Remove retaining screw from top of steering column upper trim cover.



- Push in sides of upper trim cover (**arrows**) to release from lower trim. Pull back and up on upper trim.



- Pry gently to detach flexible cover from upper trim. Lift off trim.

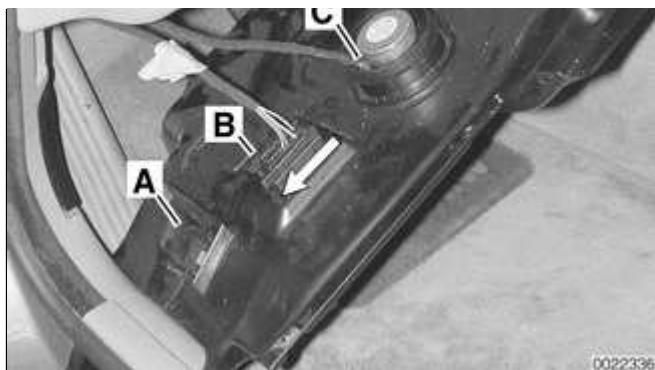


- Remove left footwell (pedal cluster) trim panel.

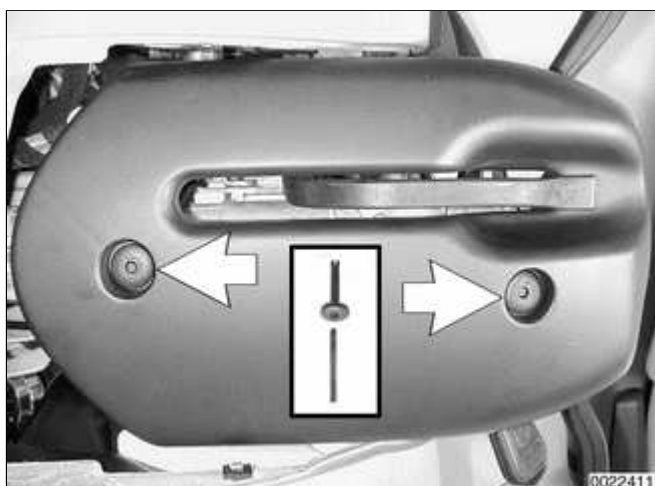
- ◆ Remove screws (**A**).
- ◆ Remove fasteners (**B**).



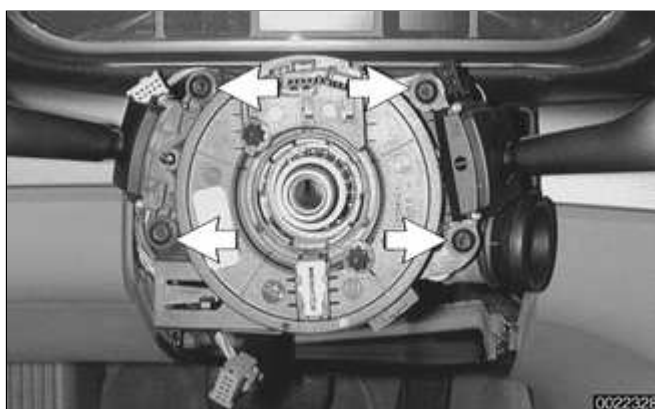
- Disconnect electrical harness connectors at left footwell trim panel and remove panel:



- ◆ Unplug connector at footwell interior light (**A**), if equipped.
- ◆ Slide lock at OBD II connector (**B**) in direction of **arrow**.
- ◆ Unplug connector at cellular phone speaker (**C**) if equipped.
- Remove lower steering column as described earlier.



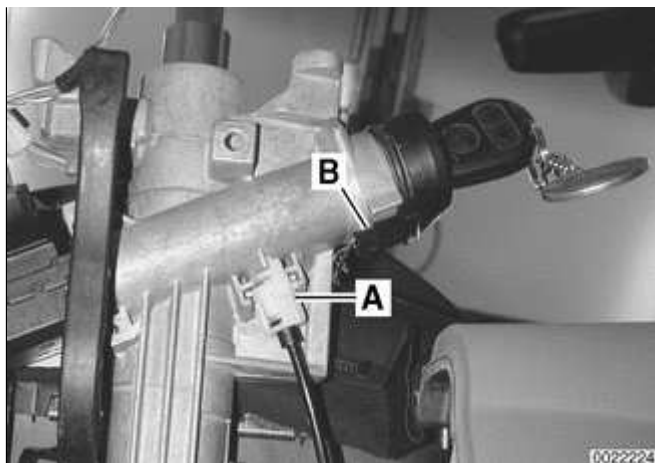
- ⚡ To remove steering column lower trim, drive pins into expansion rivets (**arrows**) to release. Pull down on trim.



- ⚡ Working at steering column:
 - ◆ Remove screws (**arrows**).
 - ◆ Slide switch block out from steering column.
 - ◆ Disconnect electrical harness connectors at ignition switch, wiper switch, turn signal / high beam switch, and steering wheel functions / airbag connector.
 - ◆ Remove switch block.

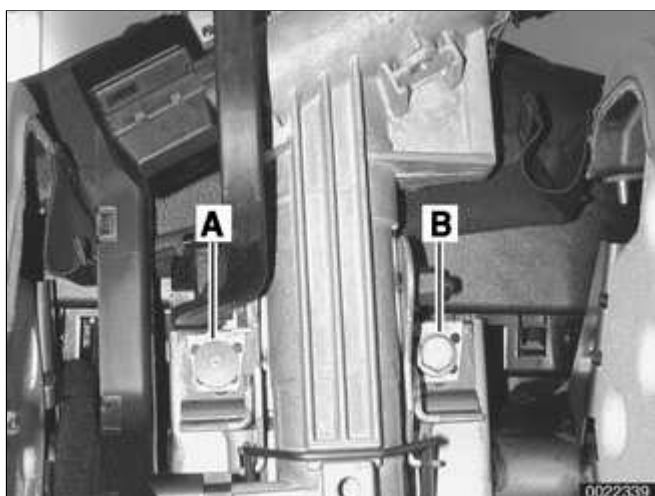


- ⚡ Slide lower section of upper steering column into upper section (**arrow**).

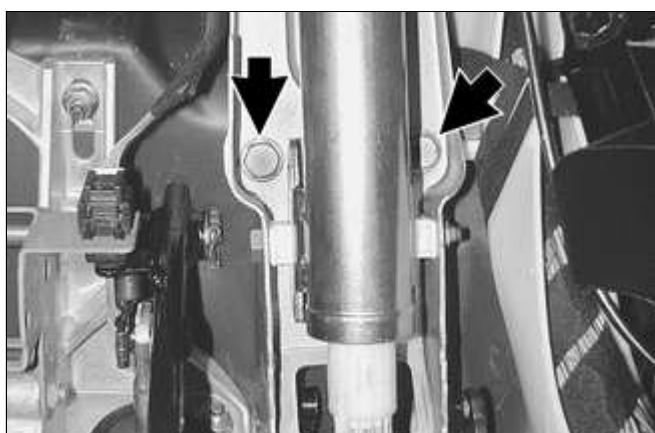


➤ Remove shift interlock cable (A) if necessary.

- Disconnect electrical harness connector at EWS 3.3 ring antenna (B).
- Working at steering column, detach wiring harness from cable duct.



➤ Drill out steering column mounting shear bolt (A), and remove mounting bolt (B).



➤ Remove lower steering column mounting bolts (arrows). Remove upper steering column.

- Installation is reverse of removal, noting the following:
- ◆ Replace shear bolt at steering column mounting bracket. Tighten



until bolt head shears off.

- ◆ Make sure lock of interlock cable snaps into place.
- ◆ When installing column top trim panel, replace expansion nut for trim retaining screw.
- ◆ When installing lower trim panel, push expansion rivet pin into rivet until pin head is flush with rivet head.

Tightening torques	
Universal joint pinch bolt at steering column	22 Nm (16 ft-lb)
Steering column to dashboard carrier	22 Nm (16 ft-lb)

Power Steering System

The power steering fluid reservoir is located on the lower left front of the engine.

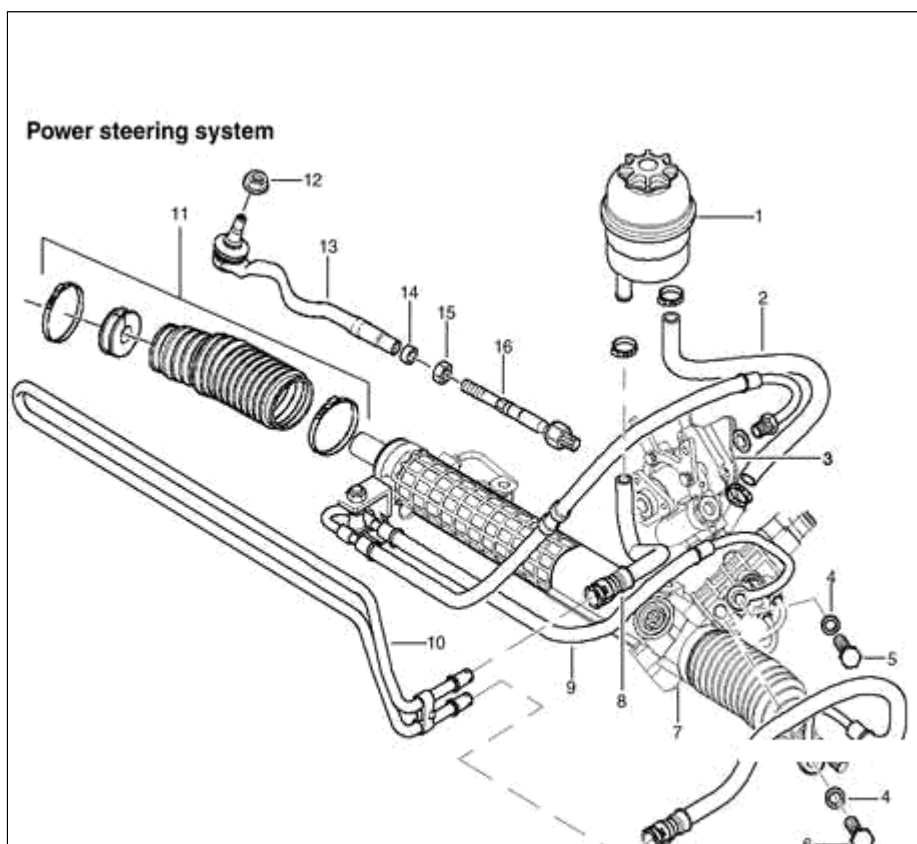
CAUTION!

- ♦ **Maintain clean conditions when working with open power steering fluid lines.**
- ♦ **Plug off power steering lines and connections to keep out contamination.**

Power steering fluid

Recommended fluid

ATF (automatic transmission fluid)



Power steering system

- 1 - Power steering fluid reservoir
 - 2 - Fluid supply line
 - 3 - Power steering pump
 - 4 - Copper sealing ring
 - 5 - Banjo bolt M14
- ♦ tighten to 35 Nm (26 ft-lb)



- 6 - Banjo bolt M16**
 - ◆ tighten to 40 Nm (30 ft-lb)
- 7 - Power steering rack**
- 8 - Pressurized fluid line**
- 9 - Fluid return line**
- 10 - Fluid cooler**
- 11 - Rack boot kit**
- 12 - Tie rod nut**
 - ◆ tighten to 65 Nm (48 ft-lb)
- 13 - Outer tie rod end**
- 14 - Clamp ring**
- 15 - Outer tie rod end lock nut**
 - ◆ tighten to 45 Nm (33 ft-lb)
- 16 - Inner tie rod**
 - ◆ tighten to 100 + 10 Nm (74 + 7 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. Slowly turn steering wheel from lock to lock a minimum of two times.
- Turn engine off and check fluid level, adding more if necessary.

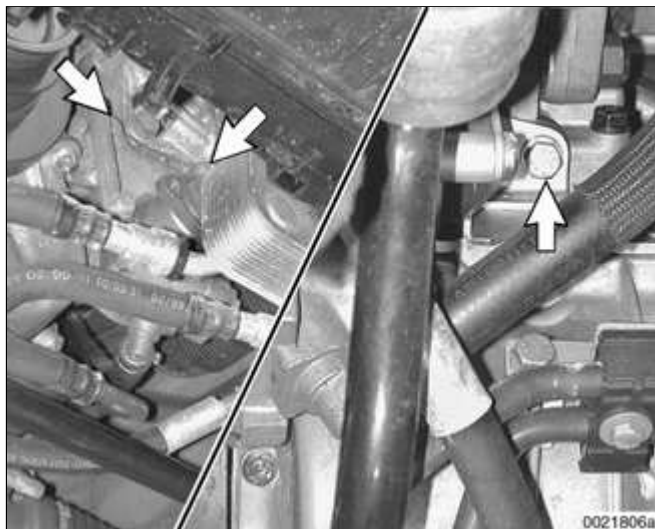
Power steering pump, removing and installing

- Empty power steering fluid reservoir using clean syringe. Do not reuse fluid.
- Raise front of car. Remove splash shield from under engine.
- Remove drive belt from power steering pump. See ⇒ [020 Maintenance](#).

WARNING!

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

- Remove power steering pump drive pulley.
- Remove fluid hoses from pump. Plug openings in pump and hose ends.
- Remove brake cooling ducts on left side.



- Remove front stabilizer bar anchors and swing stabilizer bar down out of the way. See ⇒ [310 Front Suspension](#).

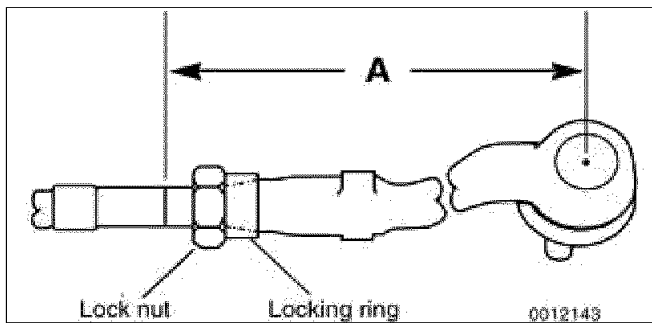
⚠ Remove pump mounting bolts (**arrows**) and remove pump. Rear wheel drive model shown.

- 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. Do not over-torque banjo bolts.
 - ◆ Fill and bleed power steering system as described earlier.

Tightening torques	
Hydraulic hoses to power steering pump	
M14 banjo bolt	35 Nm (26 ft-lb)
M16 banjo bolt	40 Nm (30 ft-lb)
Power steering pump to bracket M8 self-locking nuts	22 Nm (16 ft-lb)
Power steering pump bracket to engine block M8 self-locking nuts	22 Nm (16 ft-lb)

Steering rack, removing and installing

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



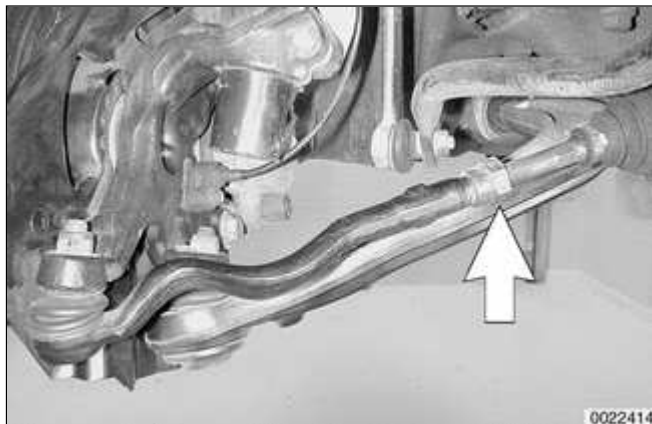
- ◀ Make reference measurement (A) of left outer tie rod end to tie rod. Record measurement.

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*

- Repeat for right side.



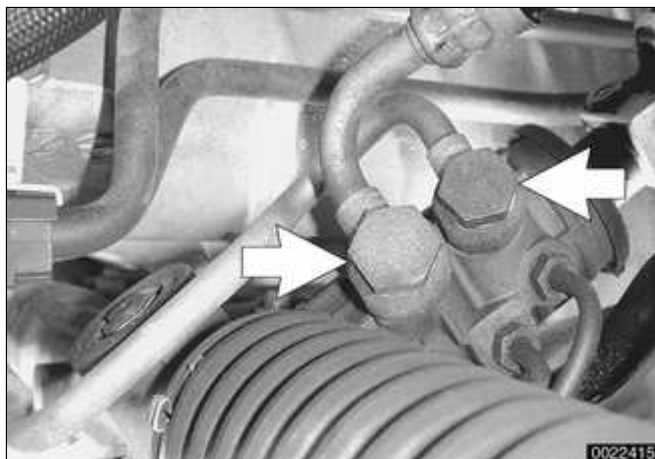
- ◀ Loosen left outer tie rod end lock nut (arrow).

- Unscrew left tie rod end from steering rack by turning inner tie rod shaft.

CAUTION!

Grip end of rack boot to keep it from twisting as the tie rod shaft is unscrewed.

- Repeat for right tie rod.



- Working underneath car, remove fluid line banjo bolts (**arrows**) from steering rack.

CAUTION!

Plug off power steering lines and connections to keep out contamination.

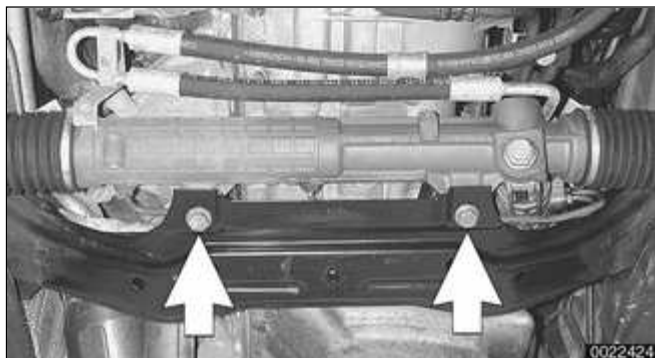
Note:

It may be necessary to remove other components to gain access to steering rack.

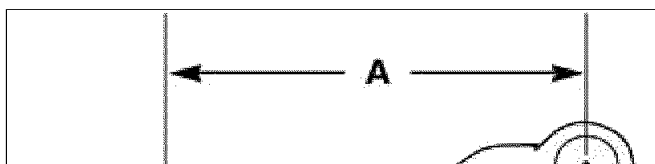


- Remove lower steering column flexible joint pinch bolt (**arrow**). Pull flexible joint off steering rack shaft.

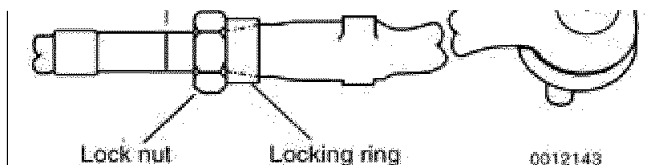
- Move steering wheel to straight ahead position and remove ignition key to lock steering.
- On all wheel drive vehicles:
 - ◆ Support front subframe with a shop hoist or appropriate jack.
 - ◆ Detach subframe from engine and lower approx. 20 mm (in.). See ⇒ [310 Front Suspension](#)



- Remove steering rack mounting bolts (**arrows**). Remove steering rack from subframe by pulling it forward.



- Installation is reverse of removal, noting the following:



- ◆ Make sure all thread bores, bolts, nuts, splines and mating surfaces are clean. 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. Make sure wheels are straight ahead.
- ◆ Use new sealing rings on banjo fittings. Do not over-torque banjo bolts.
- ◆ Use tie rod measurement previously made (measurement **A**) to temporarily set toe.
- ◆ Fill and bleed power steering system as described earlier.
- ◆ Have car professionally aligned.

Tightening torques	
Outer tie rod end to steering arm replace self-locking nut	65 Nm (48 ft-lb)
Outer tie rod end lock nut	45 Nm (33 ft-lb)
Steering column flexible joint to steering rack shaft	22 Nm (16 ft-lb)
Steering rack to subframe	
M10 bolt	42 Nm (32 ft-lb)
Steering fluid lines	

Tightening torques

M14 banjo bolt	35 Nm (26 ft-lb)
M16 banjo bolt	40 Nm (30 ft-lb)

Outer tie rod end, replacing

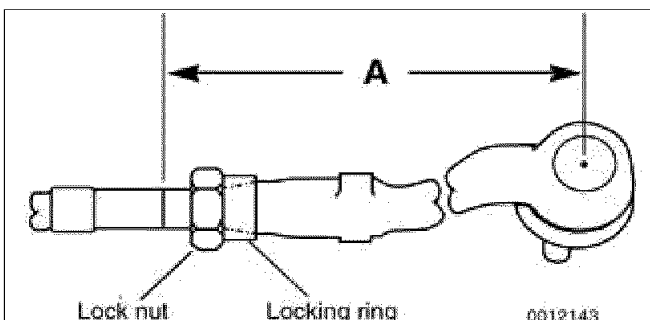
- Raise front of car. Remove road wheel.

WARNING!

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



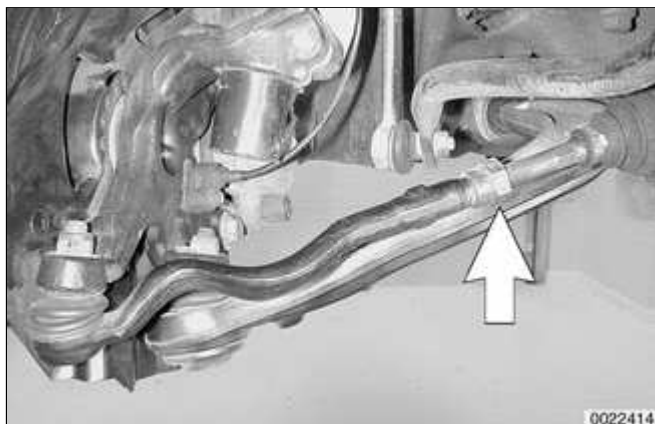
- Remove outer tie rod ball joint nut. Separate outer tie rod end from steering arm using BMW special tool 32 3 090 or equivalent.



- 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**).

- Unscrew tie rod end from tie rod shaft.
- Installation is reverse of removal.

◆ Make sure all threaded parts are clean. Use antiseize paste on inner tie rod threads.

◆ Use new self-locking nuts, where applicable.

◆ Use tie rod measurement (**A**) to set toe.

◆ Have car professionally aligned.

Tightening torques	
Outer tie rod end to steering arm replace self locking nut	65 Nm (48 ft-lb)
Outer tie rod end lock nut	45 Nm (33 ft-lb)

Tie rod or rack boot, replacing

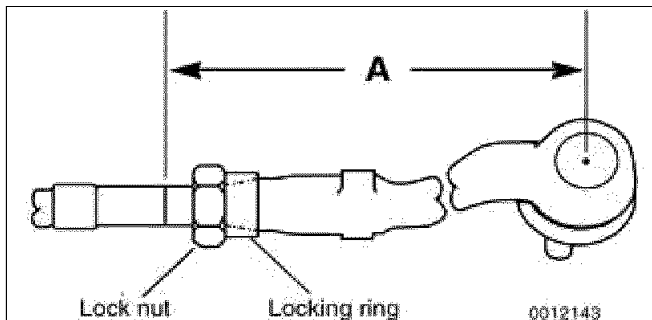
- Raise front of car. Remove splash shield from under engine.

WARNING!

Make sure the car is firmly supported on jack stands designed for the

purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.

- Remove outer tie rod end self-locking nut, and separate outer tie rod end ball joint as described above.



- ◀ Make a reference measurement 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

- Cut rack boot band clamp and slide bellows back. Inspect boot for any sign of damage. Replace if necessary.

Note:

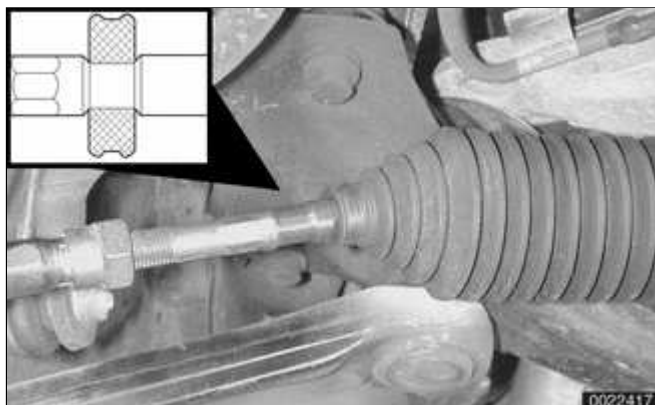
New rack boot kit comes with new band clamp.

- ◀ Using BMW special tool 32 2 110 remove inner tie rod shaft from steering rack.

CAUTION!

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





◀ When reassembling, grease tie rod taper so that rack boot support buffer or small end of rack boot (**inset**) slides on tie rod when tie rod is tightened, preventing rack boot from twisting.

- 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 using reference measurement (**A**) recorded earlier.

- ◆ Have car professionally aligned.

Tightening torques	
Outer tie rod end to steering arm	65 Nm (48 ft-lb)
Outer tie rod end lock nut	45 Nm (33 ft-lb)
Inner tie rod to steering rack	100 + 10 Nm (74 + 7 ft-lb)

Wheel Alignment

Proper handling, stability, tire wear 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.

The BMW E46 uses a sophisticated multi-link suspension at the front and rear of the car. Proper alignment requires computerized alignment equipment.

Alignment specifications only apply under the following conditions:

- ◆ 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 ⇒ [Table a. Front wheel alignment specifications](#) for front wheel alignment specifications, ⇒ [Table b. Rear wheel alignment specifications](#) for rear wheel alignment specifications.

WARNING!

While performing alignment procedures, make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

Normal loaded position	
Each front seat	68 Kg (150 lb)
Rear seat (center)	68 Kg (150 lb)
Trunk	21 Kg (46 lb)
Fuel tank	full

Table a. Front wheel alignment specifications

Parameter	Standard suspension	All wheel drive suspension	Sport suspension	Rough road suspension
Toe angle (total)	$0^{\circ} 14' \pm 8'$			
Camber (difference between left/right max. 30') track differential angle with 20° lock on inside wheel	$-20' \pm 20'$ $-1^{\circ} 34' \pm 30'$	$20' \pm 20'$ $-53' \pm 30'$	$43' \pm 20'$ $-1^{\circ} 34' \pm 30'$	$+8' \pm 20'$ $-1^{\circ} 34' \pm 30'$
Caster (difference between left/right max. 30') with 10 wheel lock with 20 wheel lock	$5^{\circ} 26' \pm 30'$ $5^{\circ} 37' \pm 30'$	$5^{\circ} 27' \pm 30'$ $5^{\circ} 37' \pm 30'$	$5^{\circ} 36' \pm 30'$ $5^{\circ} 47' \pm 30'$	$5^{\circ} 17' \pm 30'$ $5^{\circ} 27' \pm 30'$
Front wheel displacement	$0^{\circ} \pm 15'$			

Table b. Rear wheel alignment specifications

Parameter	Standard suspension	All wheel drive suspension	Sport suspension	Rough road suspension
Toe angle (total)	$0^{\circ} 16' \pm 6'$			

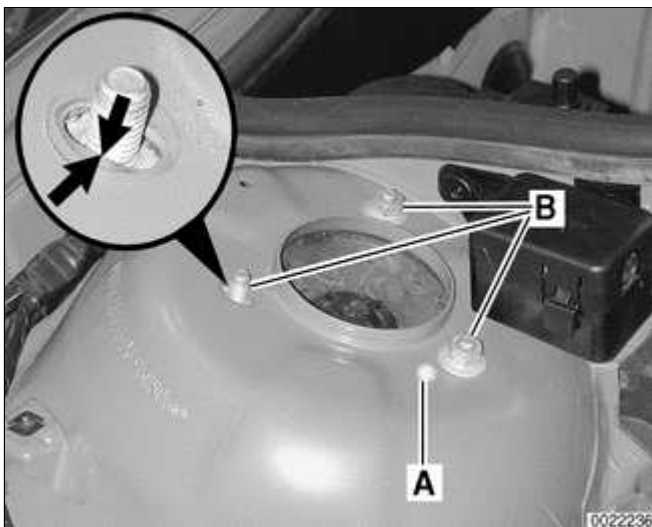
Parameter	Standard suspension	All wheel drive suspension	Sport suspension	Rough road suspension
Camber (difference between left/right max. 15') maximum allowable deviation between sides	-1° 30' ± 15'	-1° 15' ± 15'	-2° 04' ± 15'	-46' ± 15'
Geometrical axis deviation	0° ± 6'			

Front wheel camber

Any change to the camber will also change the toe setting. Always adjust camber prior to adjusting toe.

◀ Front wheel camber adjustment can be made by driving out factory strut alignment pin (A) in upper strut housing.

- Loosen upper strut mount nuts (B).
- Use BMW special tool 32 3 140 to adjust position of upper strut mount studs in slotted holes (arrows).



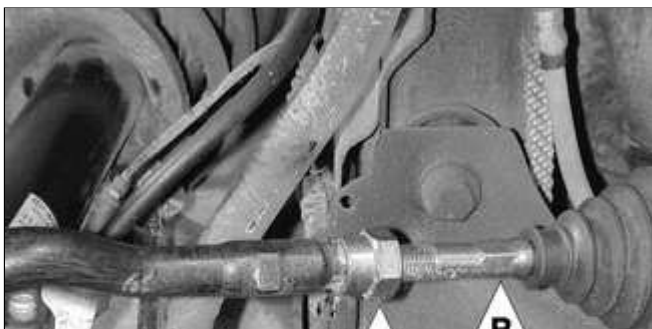
Tightening torque

Upper strut mount to body	24 Nm (17 ft-lb)
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Front wheel toe

◀ Front wheel toe is adjusted at tie rod ends:

- ◆ Loosen tie rod lock nut (A).
- ◆ Adjust tie rod by turning inner tie rod (B) to change length.

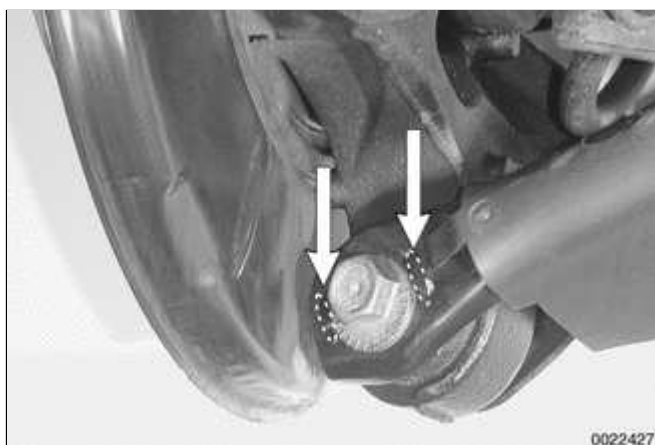


**Note:**

- ◆ *Steering rack 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.*
- ◆ *Make sure the rubber boot on the rack moves freely on the tie rod and does not become twisted.*

Tightening torque

Tie rod lock nut	45 Nm (33 ft-lb)
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Rear wheel camber

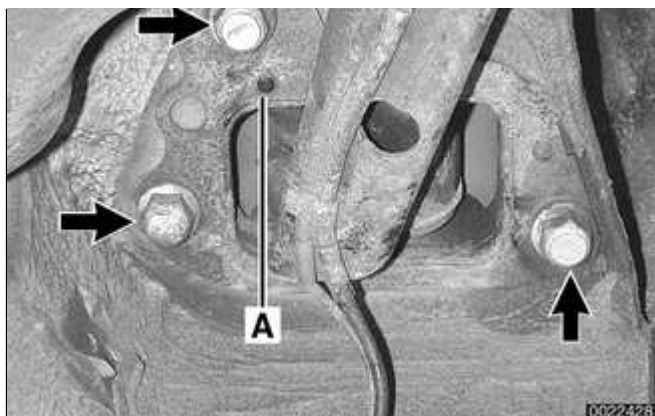
- ◀ Rear wheel camber is adjusted at outer end of rear lower control arm using camber adjusting bolt.
- ◆ Make sure bolt remains between two alignment lugs (**arrows**) on end of control arm.
- ◆ Check toe setting as described below.

Tightening torque

Rear lower control arm to rear trailing arm	77 Nm (57 ft-lb)
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Rear wheel toe

- ◀ Loosen trailing arm bracket mounting bolts (**arrows**).



- Install BMW special tool 32 3 030 over alignment lug (A) and adjacent bolt.
- ◆ Use tool to adjust position of bracket.
- ◆ Remove tool and tighten trailing arm bracket mounting bolts.

Tightening torque	
Rear trailing arm bracket to body	77 Nm (57 ft-lb)