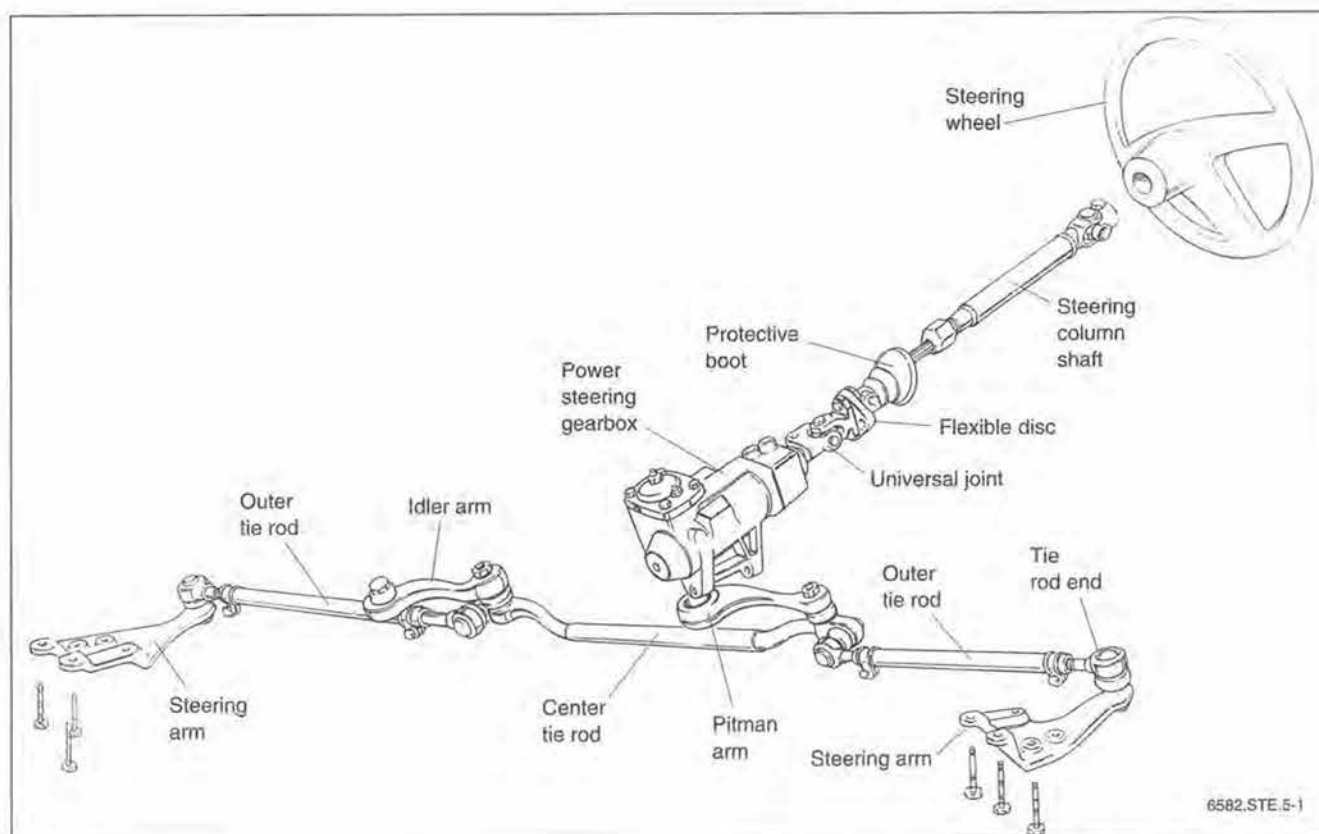


GENERAL	320-1	Steering idler arm, removing and installing ..	320-11
Servotronic Steering System	320-2	Outer tie rod, removing and installing	320-11
STEERING WHEEL	320-2	Tie rod end, replacing	320-12
Steering wheel, removing and installing	320-3	Center tie rod, replacing	320-13
POWER STEERING	320-4	WHEEL ALIGNMENT	320-13
Power steering pump, pressure testing	320-4	Camber	320-13
Power steering pump, removing and installing	320-5	Caster	320-14
Power steering system, filling and bleeding ..	320-7	Front Toe-in and Toe Difference Angle	320-14
STEERING GEAR AND LINKAGE	320-8	Rear Toe-in	320-14
Steering gearbox, removing and installing ...	320-8	Wheel Alignment Specifications	320-14
		TABLES	
		a. Front Wheel Alignment Specifications	320-15

This repair group covers servicing of the mechanical and hydraulic components of the steering system, including wheel alignment information.



GENERAL

320-2 STEERING AND WHEEL ALIGNMENT

NOTE—

For information on steering column switches and the ignition lock see 612 Switches and Electrical Accessories.

WARNING—

- 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.

Servotronic Steering System

The BMW 7 Series cars are equipped with Servotronic steering system which provides variable boost to the steering effort based on road speed.

At low speeds, maximum power assist is provided to ease parking and city driving. At high speeds, assist is reduced to ensure stability. The speedometer sends a speed signal to the Servotronic control module (located in the left kick-panel). The control module converts this signal to a regulating current which is sent to the electro-hydraulic valve at the steering gearbox.

If the electronics in the system fail, the electro-hydraulic valve opens and the steering reverts to conventional power assist.

STEERING WHEEL

All E32 cars are fitted with a driver side SRS airbag mounted to the front of the steering wheel. Special precautions must be observed when removing the steering wheel or servicing components in and around the steering column.

WARNING—

The BMW Supplemental Restraint System (SRS) is complex and 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.

Steering wheel, removing and installing

Use caution when removing the airbag unit from the steering wheel and be sure to follow the airbag removal and installation procedure outlined in **721 Airbag System (SRS)**.

- Make sure front wheels are pointed straight ahead. Center steering wheel.
- Disconnect negative (–) battery cable. See **020 Maintenance**.

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—

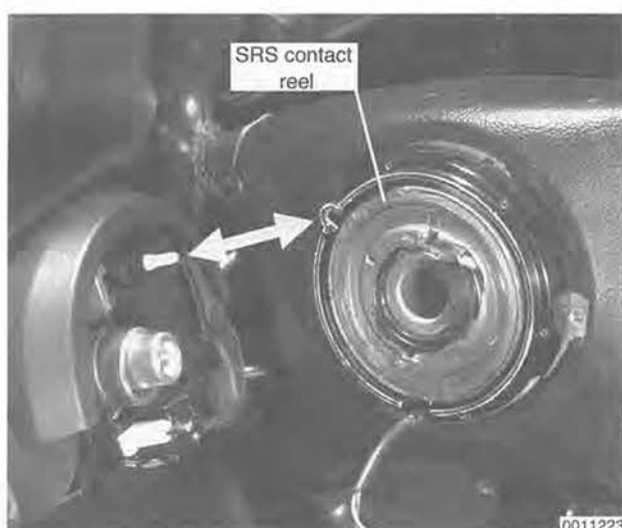
Improper handling of the airbag could cause serious injury. Store the airbag with the horn pad facing up. If stored facing down, accidental deployment could propel it violently into the air, causing injury.



- Remove lower left dash panel as described in **513 Interior Trim**.
- Remove lower steering column trim.
- Remove orange SRS connector (arrow) below steering wheel from its holder and carefully separate connector.
- Remove steering wheel center nut (or bolt) and washer. Lightly punch mark or scribe position of steering wheel to steering column shaft.
- Unlock steering wheel by turning ignition key on. Remove steering wheel.

WARNING—

The SRS contact reel is mounted to the rear of the steering wheel hub. The contact reel is a wound coil of wire that ensures continuous electrical contact for the airbag unit. Once the steering wheel mounting nut or bolt is removed the contact reel is locked in the center position and its position must not be altered.



- Locking pin in column aligns with cutout in contact reel (arrow).
- Install steering wheel while aligning matching marks. Make sure locking pin engages cutout in contact reel.

CAUTION—

Use a new self locking nut on steering wheel. The nut is designed to be used only once.

320-4 STEERING AND WHEEL ALIGNMENT

Tightening Torques

- Steering wheel to steering column spindle
Self locking nut..... 80 Nm (59 ft-lb)
Bolt..... 63 Nm (46 ft-lb)

- Install airbag unit. See **721 Airbag System (SRS)**.
- Reconnect negative (–) battery cable.

WARNING —

Once the airbag unit is installed and all other service procedures have been completed, start the engine and check that the SRS warning light goes out. If the warning light stays on, the SRS system will not function as designed. Have the system diagnosed and repaired by an authorized BMW dealer.

POWER STEERING

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.

NOTE —

Cars equipped with the self levelling rear suspension system (called LAD) use a tandem pump to provide hydraulic pressure to the steering system and the rear shock absorbers. See **370 Integrated Suspension Systems** for additional information.

Power steering pump, pressure testing

Testing power steering system pressure requires a 0–175 bar (0–2500 psi) pressure gauge with a shut-off valve and the correct fittings. Make sure the steering pump drive belt is in good condition and properly adjusted before making the test.

- Connect pressure gauge in high pressure line between pump and gearbox.

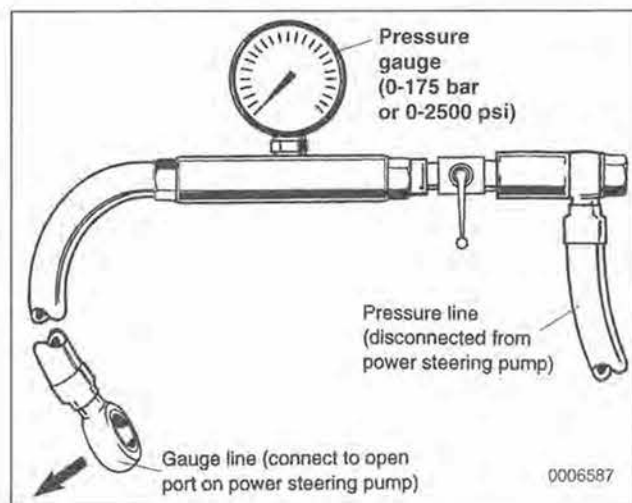
NOTE —

On cars equipped with the LAD, be sure to connect the gauge to the power steering part of the pump. The power steering output line should lead directly to the steering gearbox.

- Center steering wheel with front wheels pointing straight ahead.
- Start engine and let it idle.

WARNING —

Only run the car in a well-ventilated area. Exhaust fumes can be fatal.



POWER STEERING

STEERING AND WHEEL ALIGNMENT 320-5

- Close gauge valve for no more than ten seconds, note pump output pressure, then reopen valve. If pressure gauge reading is not within range listed below, pump should be replaced.

CAUTION—

Do not close the pressure valve for more than 10 seconds. High pressure could damage the seals in the pump or steering gearbox.

Steering System Pressure

- Pressure gauge
valve closed 150 ± 15 bar (2130 ± 213 psi)
- Pressure gauge
valve open 15 bar (210 psi)

- Working beneath car, insert a piece of wood at idler arm to block steering from reaching full lock (about ½ turn before full lock).
- Start car and have a helper turn steering wheel to right until idler arm contacts block. Hold wheel against stop for about 5 seconds. Record pressure.
- Repeat two previous steps for left side.

At each wheel lock position, the system pressure should be within the range specified above. Low pressure indicates internal leaks in the steering gearbox. High pressure indicates a faulty power steering pump.

When finished testing, remove the pressure gauge and install the fluid hose to the pump using a new sealing washer. Take care not to overtorque the banjo bolt. Fill and bleed power steering system as described below.

Tightening Torques

- Hydraulic hose to power steering pump
M14 banjo bolt 35 Nm (26 ft-lb)
M16 banjo bolt 40 Nm (30 ft-lb)

Power steering pump, removing and installing

- Empty power steering fluid reservoir using a clean syringe. Do not reuse fluid.
- Raise front of car.

WARNING—

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

320-6 STEERING AND WHEEL ALIGNMENT



- Remove fluid hoses from pump. Plug openings in pump and in hose ends.

NOTE—

On cars equipped with the self levelling suspension system (called LAD), the power steering/LAD tandem pump is mounted with some additional brackets, spacers, and fluid lines. Note the installed position of these components during removal.

- Remove power steering pump drive belt. See **020 Maintenance**.

- Remove pump mounting bolts (**arrows**) and remove pump. (M30 engine shown, other pump mountings similar.)

- When installing pump make sure all thread bores, bolts, nuts, fluid couplings and mating surfaces are clean.

- Mount pump using new self locking nuts.

Tightening Torque

- Power steering pump to bracket
(self locking nuts) 22 Nm (16 ft-lb)

- On engine with standard V-belt, tension belt as follows:

- Loosen pump mounting bolts.
- Use torque wrench on toothed adjuster and adjust belt so wrench reads 8 Nm (71 in-lb).
- Tighten pump mounting bolts.

- On engines with multi-ribbed belt, install belt to pulleys and release tensioner. See **020 Maintenance**.

Tightening Torque

- Power steering pump bracket to engine
block or oil pan (self locking nuts) 22 Nm (16 ft-lb)

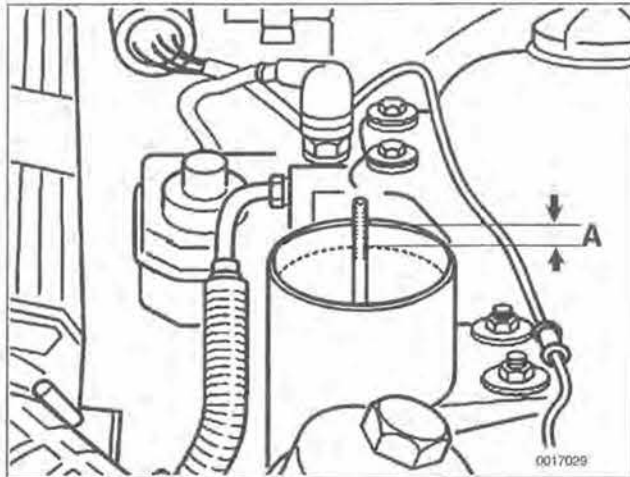
- Install power steering fluid hoses to pump.

- Make sure hoses have adequate clearance from chassis.
- Do not overtorque banjo bolts. Use new sealing washers.

Tightening Torques

- Hydraulic hoses to power steering pump
M14 banjo bolts 35 Nm (26 ft-lb)
M16 banjo bolts 40 Nm (30 ft-lb)

- The remainder of installation is reverse of removal. Fill and bleed power steering system as described below.



Power steering system, filling and bleeding

- With engine off, fill power steering fluid reservoir with clean fluid.

- **Reservoir with dipstick:** fill level to "MAX" mark on dipstick.

Reservoir without dipstick (cars with LAD):

- Fill level A: 25 mm (1 in.) below reservoir rim.

CAUTION—

The power steering systems uses one of three types of fluid; Dexron III[®] automatic transmission fluid (ATF), Pentosin[®] CHF 7.1 hydraulic fluid, or Pentosin[®] CHF 11. Check the power steering system reservoir for a label identifying the type of fluid used. Do not mix the various kinds of fluid.

Power Steering System Capacity

- Without self levelling rear suspension (LAD) 1.2 ltr (1.3 qt)
- With self levelling rear suspension (LAD) 1.8 ltr (1.9 qt)

- Start engine. Slowly turn steering wheel from lock to lock two times.
- Turn engine off and check fluid level, adding fluid if necessary.
- On cars with self levelling rear suspension (LAD), raise rear of car until drive wheels are off ground. Wait two minutes and check fluid level. The level should be no more than 25 mm (1.0 in.) below reservoir rim. Correct level as necessary.

NOTE—

To identify cars with LAD, see 370 Integrated Suspension Systems.

320-8 STEERING AND WHEEL ALIGNMENT

STEERING GEAR AND LINKAGE

The steering gear and linkage require no maintenance other than alignment and a periodic inspection for worn components.

Steering gearbox, removing/installing

Engine lifting equipment is required to raise the engine to gain sufficient clearance to remove the steering gear from below.

- On cars with self levelling rear suspension (LAD), pump brake pedal 20 times to discharge system pressure on cars with LAD.
- Disconnect negative (–) battery cable. See **020 Maintenance**.

CAUTION—

Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

- 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.

- Drain and remove power steering system reservoir.
- Raise front of car.

WARNING—

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

- Remove heat shield from left engine mount. Tilt shield toward engine to remove.
- Remove heat shield protecting left control arm.
- Remove center tie rod to Pitman arm nut (**arrow**). Discard self locking nut. Disconnect tie rod from Pitman arm.



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STEERING GEAR AND LINKAGE

STEERING AND WHEEL ALIGNMENT 320-9

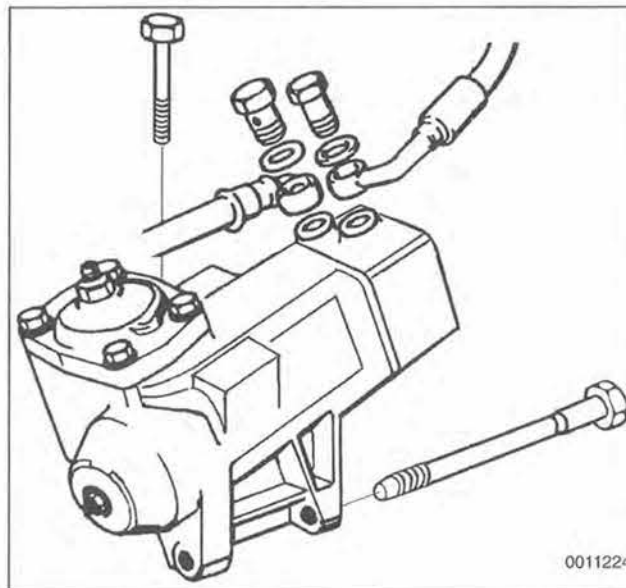


- Remove lower steering column universal joint clamping bolt (**arrow**) and slide universal joint up off steering gearbox shaft.

NOTE—

It may be necessary to remove the air filter housing or other components to gain access to the steering gearbox.

- Disconnect harness connector for electro-hydraulic regulator at bottom of steering gearbox.



- Working in engine compartment, remove fluid hoses from top of steering gearbox. Immediately plug all fluid openings.

- Using engine lifting equipment, raise engine slightly.
- Remove left side engine mount.
- Turn wheels fully to left.
- Remove steering gearbox bolts. Then remove steering gearbox by sliding it forward and down.
- Make sure all thread bores, bolts, nuts, splines and mating surfaces are clean.

Tightening Torques

- Steering gearbox to subframe crossmember
 - M10 bolt (class 10.9 bolt only) 42 Nm (32 ft-lb)
 - M12 bolt 85 Nm (63 ft-lb)

- Install steering column universal joint to steering gearbox shaft.
- Install steering gearbox to subframe crossmember using new self locking nuts.

320-10 STEERING AND WHEEL ALIGNMENT



- ◀ Center steering column to gearbox by aligning universal joint split with mark on steering gearbox (A). Install clamping bolt and new 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.

Tightening Torque

- Steering column universal joint to steering gearbox shaft (self locking nut) 22 Nm (16 ft-lb)

- Install center tie rod to Pitman arm using a new self locking nut.

Tightening Torque

- Center tie rod to Pitman arm. 59 Nm (44 ft-lb)

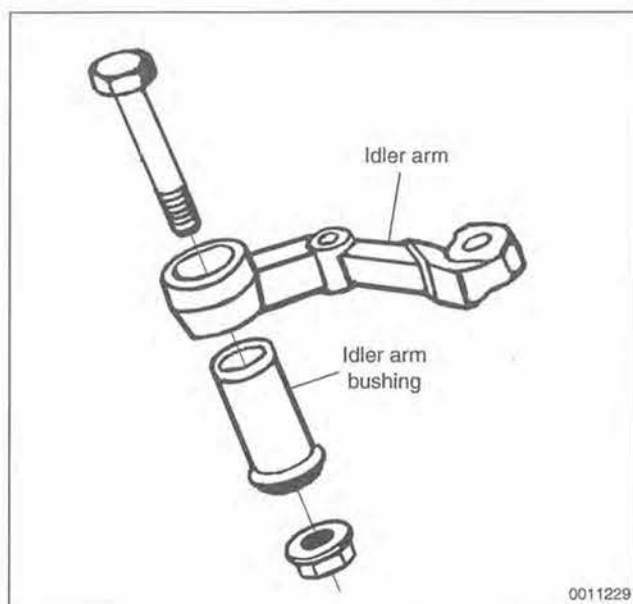
- Connect harness connector for Servotronic electro-hydraulic regulator.

- Connect fluid hoses to steering gearbox. Use new sealing washers at couplings and make sure not to overtorque banjo bolts.

Tightening Torques

- Hydraulic fluid hoses to steering gearbox
 - M14 banjo bolt 35 Nm (26 ft-lb)
 - M16 banjo bolt 40 Nm (30 ft-lb)

- Reconnect negative (–) battery cable.
- Install airbag unit. See **721 Airbag System (SRS)**.
- Fill and bleed power steering system as described above.



Steering idler arm, removing and installing

The idler arm is bolted to the subframe crossmember through a bushing. The bushing is subject to wear and is available as a replacement part.

- Raise front of car.

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 center tie rod self locking nut (1) at idler arm. Remove center tie rod end from idler arm using an appropriate press.
- Remove idler arm mounting bolt through opening in subframe and remove idler arm from car.
- If replacing idler arm bushing, press bushing out using a press (use BMW special tool nos. 32 1 050 and 32 2 032 or equivalent press fittings). Press bushing in correct direction.
- 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 crossmember and center tie rod to idler arm.
 - Have car professionally aligned.

Tightening Torques

- Center tie rod to idler arm 37 Nm (28 ft-lb)
- Idler arm to subframe crossmember
 - M10 bolt 42 Nm (32 ft-lb)
 - M12 bolt 85 Nm (63 ft-lb)

Outer tie rod, removing and installing

- Raise front of car.

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.

320-12 STEERING AND WHEEL ALIGNMENT

- Measure and record overall length of complete installed tie rod assembly.

NOTE—

Accurate measurement of tie rod assembly will help to approximate correct wheel alignment when new parts are installed.

- Remove tie rod end ball joint nuts and press tie rod ends off using a press (BMW special tool no. 32 2 050 or equivalent).
- Installation is reverse of removal.
 - Make sure all thread bores, bolts, nuts and mating surfaces are clean.
 - Use new self locking nuts on both tie rod end ball joints.
 - Have car professionally aligned.

Tightening Torque

- Tie rod end to steering arm
- or center tie rod 37 Nm (28 ft-lb)

Tie rod end, replacing

- Raise car and press off tie rod end ball joint as described above.
- Make a reference measurement of tie rod end to tie rod. Record measurement.

NOTE—

Accurate measurement of tie rod assembly will help to approximate correct wheel alignment when new parts are installed.

- Loosen tie rod end clamping bolt and thread tie rod end out of the rod. Count number of turns as end is removed.
- Installation is reverse of removal.
 - Install tie rod end to tie rod in as close to original position as is possible.
 - Make sure all threaded parts are clean.
 - Use new self locking nuts on tie rod end and tie rod clamping bolt.
 - Have car professionally aligned.

CAUTION—

Always use new self locking nuts. They are designed to be used only once and may fail if reused.

Tightening Torques

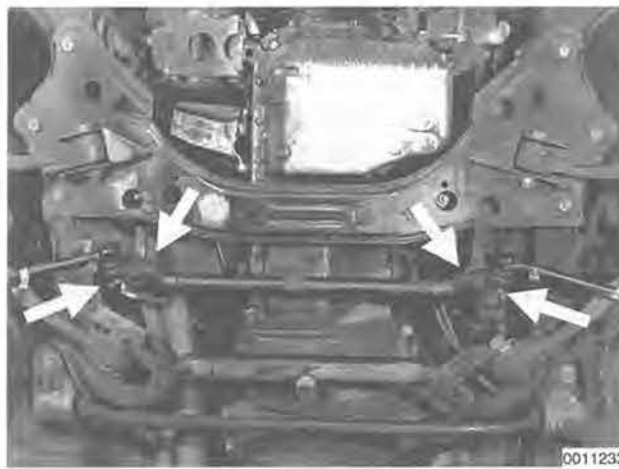
- Tie rod end clamping bolt 14 Nm (10 ft-lb)
- Tie rod end to steering arm
- or center tie rod. 37 Nm (28 ft-lb)

Center tie rod, replacing

- Raise front of car.

WARNING—

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



- Remove self locking nuts connecting center tie rod to outer tie rods, Pitman arm, and idler arm (**arrows**).
- Press outer tie rod ends off center tie rod using a press (BMW special tool no. 32 2 050 or equivalent).
- Press center tie rod off Pitman arm and idler arm using a press (BMW special tool no. 32 2 040 or equivalent).
- Installation is reverse of removal.
 - Make sure all threaded parts are clean.
 - Replace all self locking nuts.
 - Check tie rod end ball joints and idler arm bushing for wear.
 - Have car professionally aligned.

Tightening Torques

- Center tie rod to outer tie rod ends . . . 37 Nm (28 ft-lb)
- Center tie rod to Pitman arm. 59 Nm (44 ft-lb)
- Center tie rod to idler arm 37 Nm (28 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.

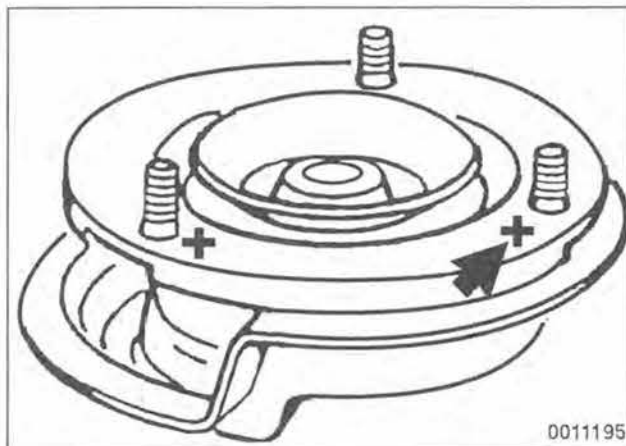
BMW E32 cars use a sophisticated multi-link suspension at the front and rear of the car. Proper alignment requires computerized alignment equipment.

Camber

- Special camber correcting strut mounts are identified by a "+" or "-" mark (**arrow**).
- Front and rear camber are fixed by the design of the car, but some front camber adjustments can be made by replacing the upper strut mounts with special offset mounts available from BMW. Offset strut mounts can correct camber up to $\pm 30'$.

NOTE—

Front upper strut mount replacement is covered in 310 Front Suspension.



WHEEL ALIGNMENT

Caster

Front and rear caster is fixed by the design of the car and deviations are usually the result of worn or damaged suspension or body parts.

Check the control arms and thrust arms (including bushings) for wear, damage and deformation if front caster problems are present. Check the trailing arms, rear axle subframe and thrust arms if rear caster problems are present.

Front Toe-in and Toe Difference Angle

Toe-in 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 outer tie rods.

Toe-in adjustments should only be made on specialized alignment equipment and only with the car in normal loaded position as described below under **Wheel Alignment Specifications**.

Toe difference angle determines the progressively different paths taken by the front wheels as the car is turning. It is fixed by the idler arm, but depends on accurate setting of the toe-in.

Rear Toe-in

There is no provision for routine rear wheel toe-in adjustment. Some correction is possible where rear wheel toe-in falls outside of the allowable limits by removing the trailing arm and replacing the outer trailing arm pivot bushing with an eccentric version. The eccentric bushing repositions the trailing arm slightly, resulting in a toe-in change.

The eccentric bushings are marked indicating increments of change and can be installed in any position to produce a specific amount of toe correction.

NOTE—

Trailing arm bushing replacement is covered in 330 Rear Suspension.

Before replacing trailing arm with corrective bushings, inspect the rear springs and other bushings and flexible mounts in the rear suspension and replace as necessary. This may correct the problem.

Wheel Alignment Specifications

Alignment specifications for all models covered by this manual are listed in **Table a** and **Table b**. The specifications only apply under the following conditions:

- Correct wheels and tires in good condition, at the correct inflation pressures.

STEERING AND WHEEL ALIGNMENT 320-15

- Wheel bearings in good condition.
- Ride height in accordance with specifications. See **310 Front Suspension** and **330 Rear Suspension**.
- Car in normal loaded position.

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

Table a. Front Wheel Alignment Specifications

Toe angle (total)	$0^{\circ} 18' \pm 5'$
Toe difference angle (inside wheel @ 20° lock)	$-1^{\circ} 50' \pm 30'$
Camber	$-11' \pm 30'$
Caster	
@ 10° wheel lock	$7^{\circ} 59' \pm 30'$
@ 20° wheel lock	$8^{\circ} 14' \pm 30'$
Maximum permissible difference between sides	30'
Front Wheel Displacement	$0^{\circ} \pm 15'$
Full lock	
Inside wheel (approximate)	43°
Outside wheel (approximate)	33°
Turning circle diameter	11.6 m (38.1 ft.)

Table b. Rear Wheel Alignment Specifications

Toe angle (total)	$0^{\circ} 18' \pm 7'$
Axis deviation (allowable range)	$0 \pm 15'$
Camber	$-2^{\circ} 20' \pm 30'$
Maximum allowable deviation between sides	30'



WHEEL ALIGNMENT