

320 Steering and Wheel Alignment

GENERAL	320-1	Power steering pump, removing and installing (N54 engine)	320-18
Steering system	320-2	Power steering pump, removing and installing (V8 engine)	320-22
Steering components	320-2	MECHANICAL STEERING COMPONENTS	320-23
Servotronic	320-2	Steering rack, removing and installing (rear-wheel-drive)	320-23
Active steering	320-3	Steering rack, removing and installing (xDrive)	320-26
Active steering, adjusting	320-4	Tie rod end, replacing	320-29
Power steering fluid	320-4	Tie rod, replacing	320-30
Hydraulic line quick disconnect coupling	320-5	Steering rack boot, replacing	320-31
Warnings and Cautions	320-5	WHEEL ALIGNMENT	320-32
TROUBLESHOOTING	320-6	Preparing for alignment	320-32
Corrosion damage	320-6	Normal loaded position	320-32
Active steering faults	320-7	Ride height	320-32
STEERING WHEEL	320-8	Front toe, setting	320-33
Steering wheel components	320-8	Front camber, adjusting	320-35
Sport steering wheel components	320-8	Rear camber, adjusting	320-36
Steering angle sensor	320-8	Rear toe, setting	320-36
Steering wheel, removing and installing	320-8	Caster	320-36
STEERING COLUMN	320-10	Alignment specifications	320-37
Adjustable steering column	320-10		
Steering column components	320-10	TABLES	
Steering column, removing and installing	320-11	a. Front ride height	320-33
Steering shaft spindle, removing and installing	320-13	b. Rear ride height, Sedan (E60)	320-33
POWER STEERING PUMP	320-14	c. Rear ride height, Sports Wagon (E61)	320-33
Power steering system, bleeding and filling	320-14	d. Alignment specifications, Sedan (E60)	320-37
Power steering pump, removing and installing (M54 engine)	320-15	e. Alignment specifications, Sports Wagon (E61)	320-38
Power steering pump, removing and installing (N52 engine)	320-16		

GENERAL

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

- **310 Front Suspension** for active stabilizer
- **513 Interior Trim** for steering column trim
- **612 Switches** for steering column switch cluster (SZL), ignition switch and START / STOP switch
- **721 Airbag System (SRS)** for driver airbag

320-2 Steering and Wheel Alignment

Steering system

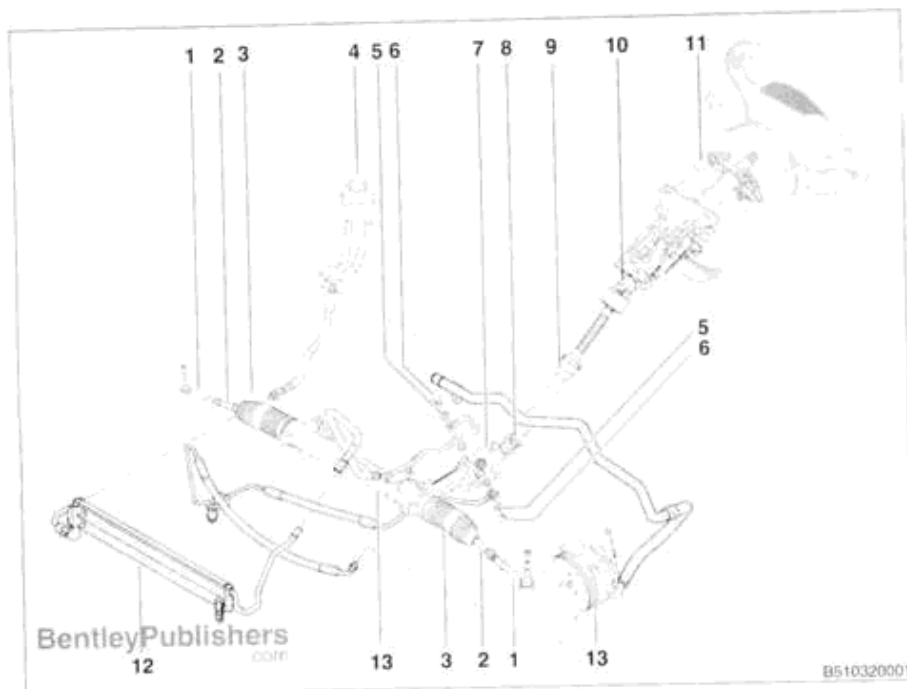
Steering system

5 Series models are equipped with a power-assisted steering rack mounted to an aluminum subframe. Power boost for the steering is provided by an engine-driven hydraulic pump.

The steering wheel connects to the steering rack via an adjustable steering column which incorporates a sliding spindle to dampen vibration and noise.

Power steering fluid is supplied from the fluid reservoir to the pump and to the steering rack via rubber and metal lines. The return line from the steering rack to the reservoir loops forward and connects to the steering fluid cooler.

Steering components



1. Tie rod end
2. Inner tie rod
3. Steering rack boot
4. Steering fluid reservoir
5. Sealing O-ring
 - Replace with new
6. Banjo bolt M14 or M16
 - Tighten to 33 - 35 Nm (24 - 26 ft-lb)
7. Steering rack gear housing with servotronic valve
8. Steering spindle lower universal joint
 - Rethread threads in pinch collar
 - Replace M8 Torx pinch bolt with new
 - Tighten to 22 Nm (16 ft-lb)
9. Lower steering spindle
10. Steering spindle upper universal joint
 - Rethread threads in pinch collar
 - Replace M8 Torx pinch bolt with new
 - Tighten to 22 Nm (16 ft-lb)
11. Steering column
12. Steering fluid cooler
13. Steering rack
14. Power steering pump.

Servotronic

The servotronic system uses an electrohydraulic valve at the steering rack to control the degree of steering assistance provided by the power steering as a function of vehicle speed. The flow of hydraulic fluid is restricted to a greater or lesser extent depending on how the servotronic valve is actuated electronically by the safety and gateway module (SGM).

The servotronic valve is actuated when terminal 15 is ON (ignition ON). The vehicle speed signal from the DSC control module is used by SGM software to modulate the servotronic valve signal.

Current supply to the servotronic valve is interrupted by the faults listed below. Under these circumstances, steering assistance is limited to minimum:

- Vehicle speed signal from DSC control module incorrect; or no vehicle speed signal.
- Terminal status from CAS control module via K-CAN incorrect or missing.
- Electrical fault in servotronic valve circuit (exception: short-circuit to positive).

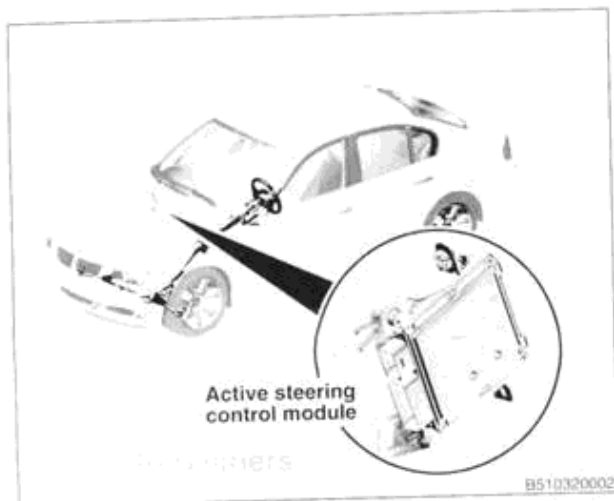
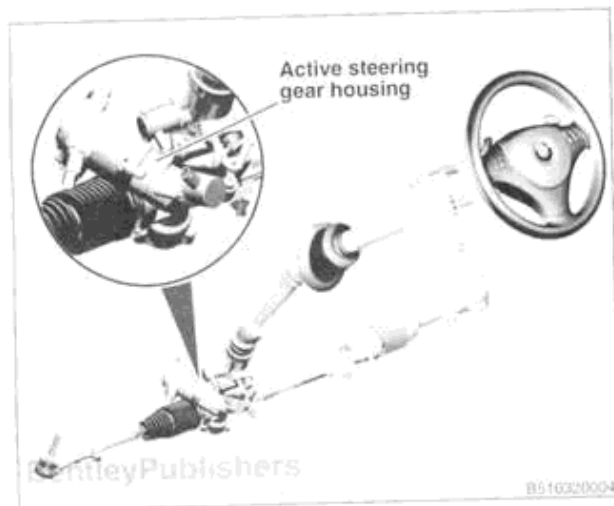
In case of a short-circuit to positive, full voltage is applied to the servotronic valve, activating it fully and increasing steering assistance to maximum.

Active steering

- The optional active front steering system (acronyms AS, AFS or AL) provides steering power assist with variable steering ratio. Steering ratio adapts to road speed and to the steering angle requested by the driver. The steering is designed to be indirect at high speeds and direct at low speeds.

At slow speeds and when parking, vehicle maneuverability is significantly increased so that the driver does not need to grip the steering wheel excessively hard. When the vehicle is stationary, 2 turns are enough to move the steering wheel lock to lock.

At high speeds (above 75 mph / 120 kph), active steering allows a more indirect steering gear ratio than conventional steering. Unintentional steering movements are prevented in conjunction with the increased steering torque level.



- The active steering control module is in the right footwell, attached to the floor pan and protected by a kick plate.

In vehicles equipped with active steering, the Servotronic valve is activated by the active steering control module.

320-4 Steering and Wheel Alignment

Active steering, adjusting

Active steering, adjusting

Use BMW scan tool to adjust (or commission) active steering system under the following circumstances:

- If front suspension or steering components are repaired, modified or aligned.
- If battery is disconnected and reconnected.
- If electrical connections on the steering column switch cluster (SZL) are disconnected and reconnected.
- If active steering or DSC electronic components are replaced, coded or programmed.

Note that steering wheel position and the position of the steered wheels are synchronized as soon as the engine is started. This ensures that the positions of the steering wheel and the road wheels match if, for example, the steering wheel was moved while the vehicle was at a standstill with the ignition switched OFF.

The synchronization procedure can cause the steering wheel or the vehicle's front wheels to move. Movements of the steering wheel or the vehicle's front wheels might be perceptible while synchronization is in progress. Synchronization also occurs while the vehicle is on the move, but the process is extremely slow and virtually imperceptible.

Power steering fluid

The power steering system is permanently filled with either ATF or Pentosin hydraulic fluid. Routinely adding fluid is not required unless the system is leaking.

CAUTION—

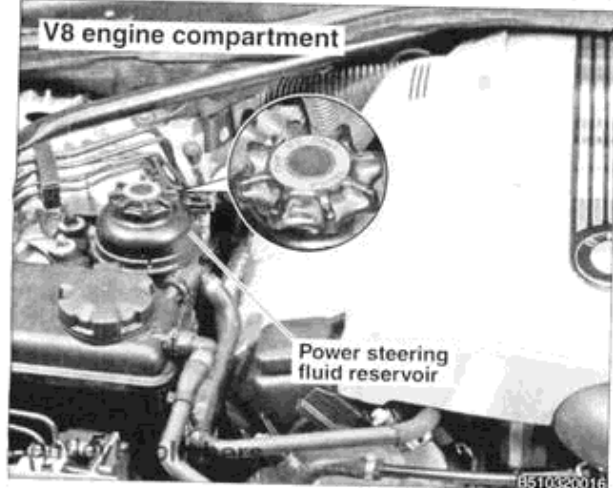
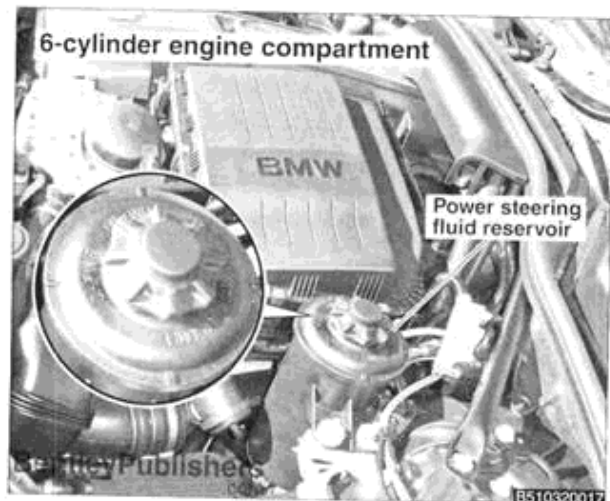
- Power steering reservoir cap is marked with the type of fluid being used—ATF or CHF. Do not mix.

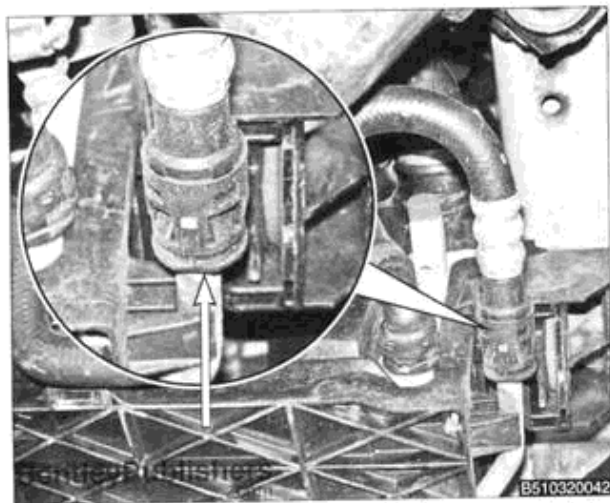
Hydraulic fluid

As recommended on reservoir cap for power steering, active steering, active stabilizer:

- Automatic transmission fluid (ATF)
- Pentosin CHF 11S

For filling and bleeding procedure, see **Power steering system, bleeding and filling** in this repair group.





Hydraulic line quick disconnect coupling

- To disconnect quick disconnect coupling (**inset**), press plastic ring into coupling (**arrow**). Be prepared to catch dripping fluid.
- To reconnect, push coupling together until a distinct click is heard. Attempt to pull coupling apart forcefully to test for correct seating.

Warnings and Cautions

WARNING—

- The airbag mounted in the steering wheel is an explosive device. Treat it with extreme caution. Follow the airbag removal procedure in **721 Airbag System (SRS)**.
- Serious injury may result if airbag system service is attempted by persons unfamiliar with the BMW SRS and its approved service procedures.
- Before performing any work involving airbags, disconnect the negative (-) battery cable.
- Prior to disconnecting the battery, read the battery disconnection cautions given in **001 Warnings and Cautions**.
- BMW airbags are equipped with a back-up power supply inside the airbag control module. Observe a 5 second waiting period after disconnecting the battery cable to 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. Replace with new.
- Do not install bolts and nuts coated with undercoating wax, as correct tightening torque cannot be assured. Clean the threads with solvent before installation, or install new parts.
- Do not attempt to weld or straighten steering components. Replace damaged parts.
- Power steering and hydraulic fluid (ATF or Pentosin) are injurious to skin and eyes. Wear protective gloves and eyewear.
- Follow local, state and federal regulations for safe disposal of power steering fluid.

320-6 Steering and Wheel Alignment

Corrosion damage

CAUTION—

- When filling or bleeding steering and hydraulic system, do not allow contamination of fluid or reservoir.
- Using contaminated equipment to add fluid may introduce dirt particles into the fluid reservoir and significantly reduce the service life of system components.
- To avoid electrochemical corrosion to engine components made of aluminum-magnesium alloy, do not use steel fasteners. Use aluminum fasteners only.
- The end faces of aluminum fasteners are usually painted blue. For reliable identification, test fasteners for aluminum composition with magnet.
- Replace aluminum bolts each time they are loosened.
- Follow torque instructions, including angle of rotation specifications, when installing aluminum fasteners.
- To prevent marring interior trim, work with plastic prying tools or wrap the tips of screwdrivers and pliers with tape before prying out switches or trim.
- Static discharge may permanently damage an electronic component such as control module or sensor. Handle electronic components using accepted static prevention equipment and techniques. See **600 Electrical System—General**.

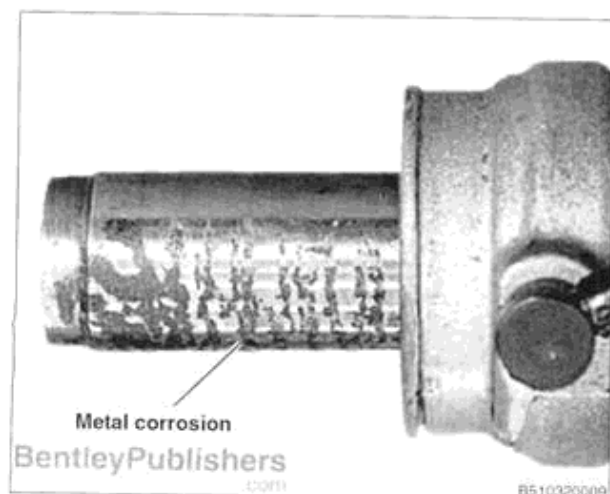
TROUBLESHOOTING

Corrosion damage

Inspect tie rod ends and steering rack boots periodically for damage or tears. Replace as necessary. See **Tie rod end, replacing** and **Steering rack boot, replacing** in this repair group.

Note that rodent bite damage to rack boot is difficult to detect. Bite marks are often small and only on one side. Leakage at one rack boot can result in corrosion of rack shaft metal at both ends.

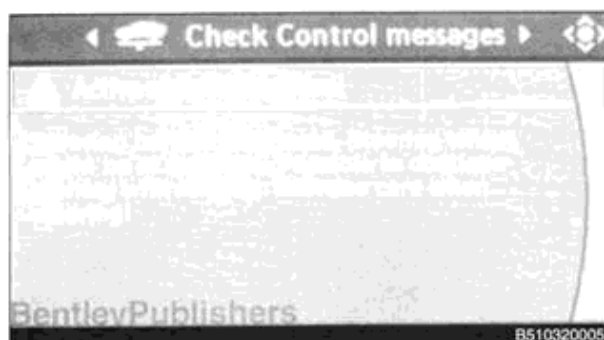
- ◀ If steering rack metal shows sign of corrosion, replace complete rack. See **Steering rack, removing and installing (rear-wheel-drive)** or **Steering rack, removing and installing (xDrive)** in this repair group.



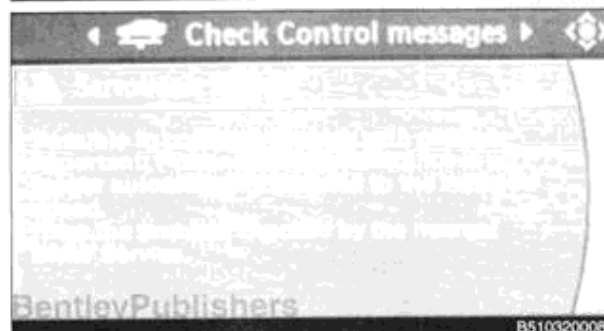
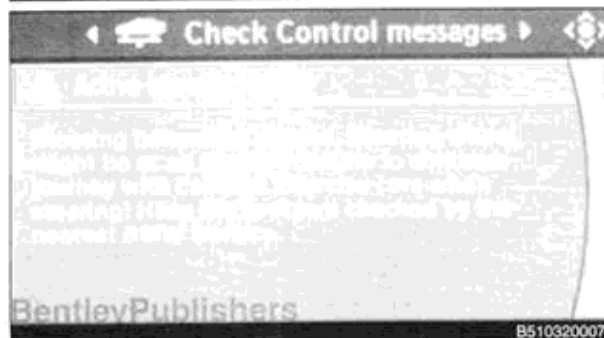


Active steering faults

- The driver is alerted to active steering system faults by a warning icon and a Check Control warning triangle in instrument cluster.

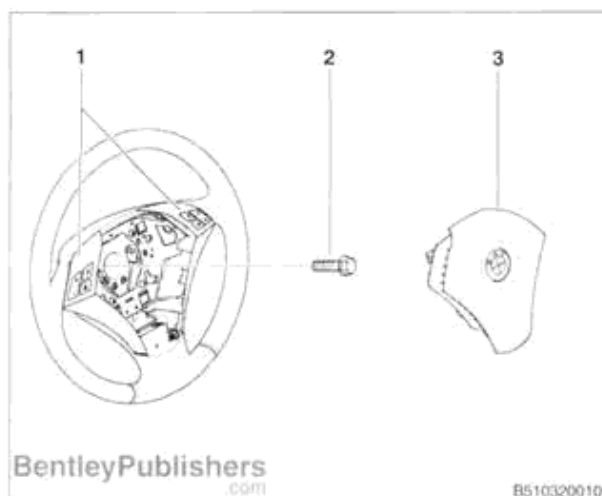


- Check Control messages in center dashboard (iDrive) display details about active steering failure and instruction on how to proceed.



320-8 Steering and Wheel Alignment

Steering wheel components



STEERING WHEEL

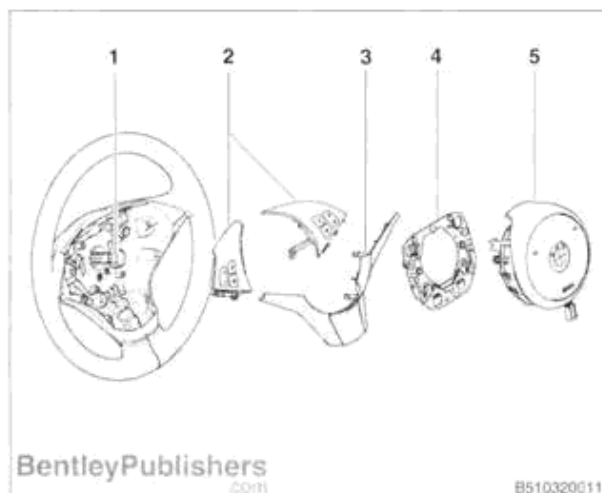
5 Series vehicles are equipped with one of two different styles of steering wheel:

Steering wheel components

1. Multifunction switches
2. M12 mounting bolt
 - Tighten to 63 Nm (46 ft-lb)
3. Airbag unit and horn button

Sport steering wheel components

1. M12 mounting bolt
 - Tighten to 63 Nm (46 ft-lb)
2. Multifunction switches
3. Plastic trim
4. Mounting plate
5. Airbag unit and horn button



Steering angle sensor

The steering angle sensor is integral with the steering column switch cluster (SZL). For more information, including removal and installation of the SZL, see **612 Switches**.

To reset steering angle sensor, connect vehicle to BMW scan tool and carry out steering angle sensor adjustment system function.

Steering wheel, removing and installing

- Center steering wheel. Make sure front wheels are pointed straight ahead.
- Extend steering wheel as far back and as low as possible.
- Disconnect negative (-) cable from battery.

CAUTION—

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

Steering and Wheel Alignment 320-9

Steering wheel, removing and installing

- Remove driver airbag in steering wheel. See **721 Airbag System (SRS)**.

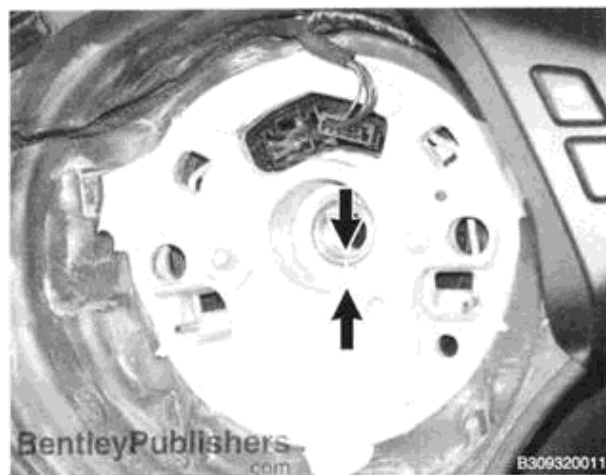
WARNING—

- The steering wheel mounted airbag is an explosive device. Treat with extreme caution. Follow the airbag removal procedure in **721 Airbag System (SRS)**.
- Airbag removal may set SRS fault codes. The SRS indicator light remains ON until problems are corrected and fault memory cleared.

- Remove steering wheel center bolt (arrow).

CAUTION—

- The SRS contact reel (also known as airbag contact ring / slip ring) is integral with the steering column switch block. The contact reel is a wound coil of wire that ensures continuous electrical contact for the airbag and steering wheel electrical components. When the steering wheel is removed the contact reel is locked and its position must not be altered.



- The steering column and steering wheel are match marked at the factory. Check for proper alignment of steering column marks (arrows) before removing steering wheel.

- Remove steering wheel.
- When installing 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.

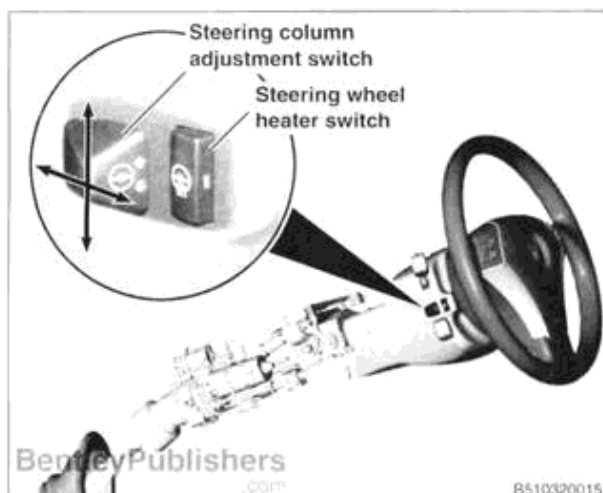
Tightening torques

Steering wheel to steering shaft (M12)	63 Nm (47 ft-lb)
--	------------------

- Carefully install airbag. See **721 Airbag System (SRS)**.

320-10 Steering and Wheel Alignment

Adjustable steering column



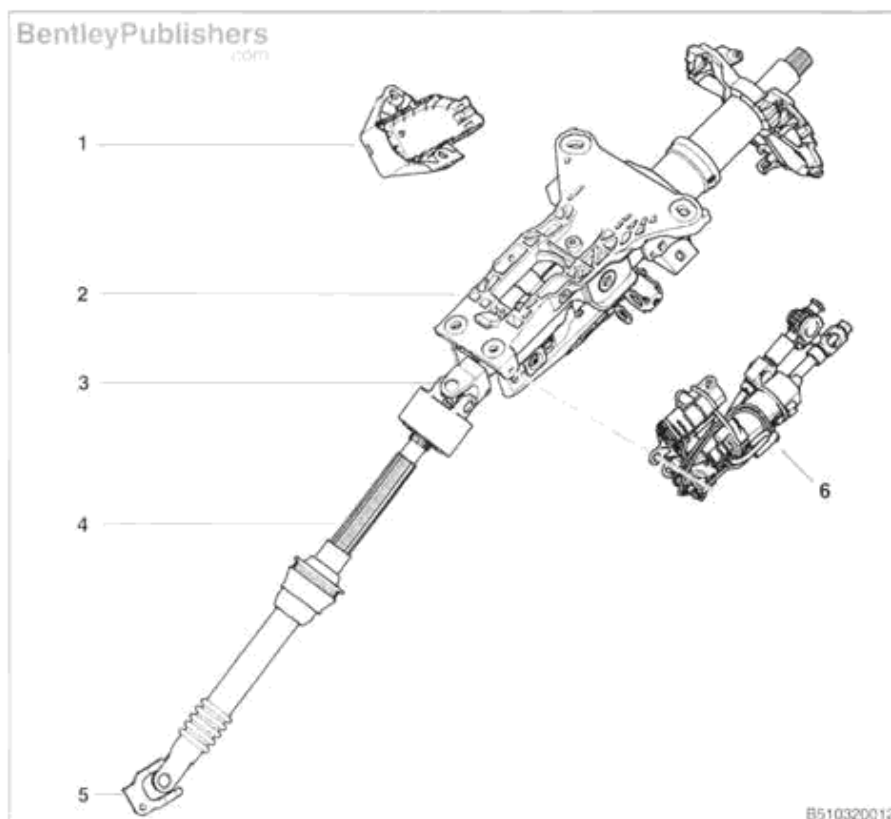
STEERING COLUMN

Adjustable steering column

- ◀ The steering column adjustment switch is used to control two motors in the steering column, one for tilt and the other for extension.

Column position is memorized and stored, along with driver seat and outside rear view mirror positions, in the seat memory module.

Steering column components



1. Electric steering lock or ELV (2006 only)
2. Steering column assembly
3. Upper steering shaft universal joint
4. Steering shaft spindle
5. Lower steering shaft universal joint
6. Steering column adjustment motors

Steering column, removing and installing

- Center steering wheel. Make sure front wheels are pointed straight ahead. Extend steering wheel as far back and as low as possible.
- 2004 - 2005 model: Remove ignition key.
- Disconnect negative (-) battery cable and cover battery terminal to keep cable from accidentally contacting terminal.

CAUTION—

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

- Remove driver airbag. See **721 Airbag System (SRS)**.

WARNING—

- The steering wheel mounted airbag is an explosive device. Treat with extreme caution. Follow the airbag removal procedure in **721 Airbag System (SRS)**.

- Remove steering wheel. See **Steering wheel, removing and installing** in this repair group.

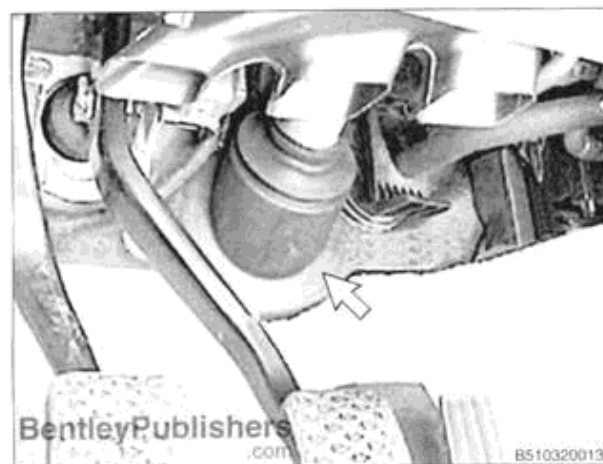
CAUTION—

- Do not move front wheels from straight-ahead position while steering wheel is off.
- Do not turn or twist the airbag and horn contact spring.

- Remove steering column trim, left lower dashboard trim and left dashboard panel. See **513 Interior Trim**.
- Remove airbag and horn contact spring and steering column switch cluster (SZL). See **612 Switches**.
- 2004 - 2005 model with automatic transmission: Detach ignition interlock cable end (**arrow**) from steering lock.
- Detach wiring harnesses and cables from steering column and place to one side.



BentleyPublishers.com BS10320018

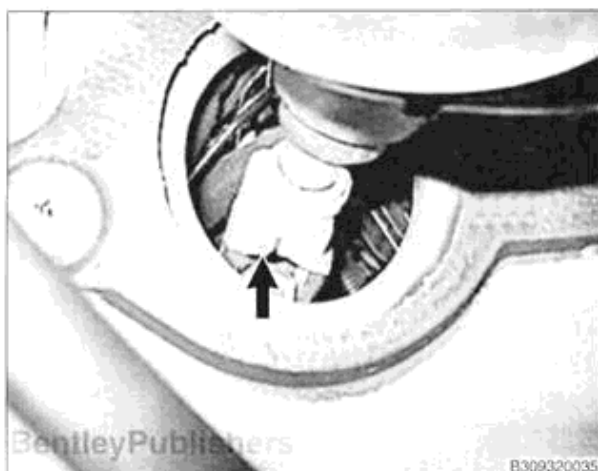


BentleyPublishers.com BS10320013

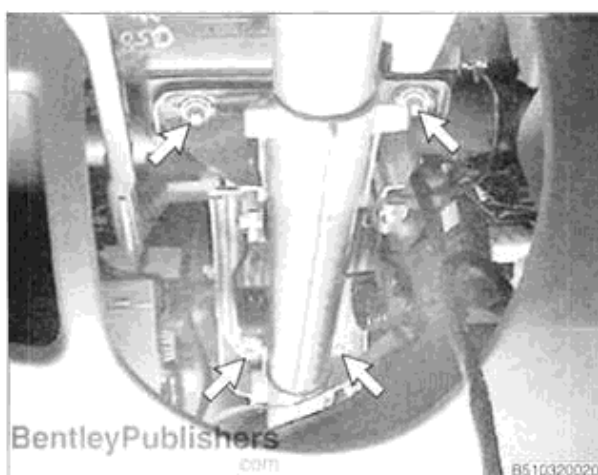
- Working in left footwell, slide sleeve (**arrow**) for steering spindle upwards on steering column.

320-12 Steering and Wheel Alignment

Steering column, removing and installing



- Remove steering shaft upper universal joint pinch bolt (**arrow**).

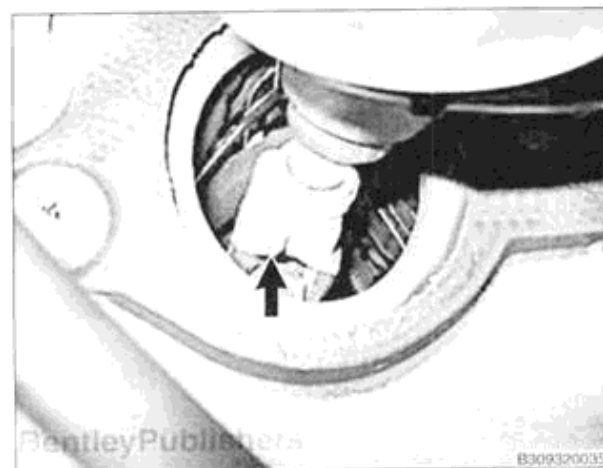
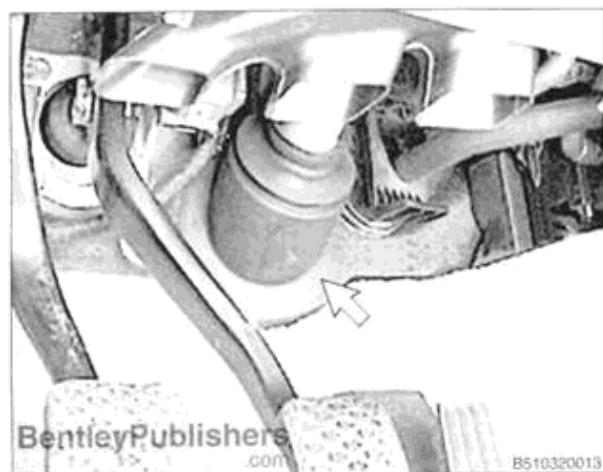


- Working underneath steering column:
- Mark installation position of steering column.
 - Loosen and remove steering column fasteners (**arrows**). Be sure to have an assistant support column as last bolts are removed.
 - Guide column off steering spindle universal joint and remove.
- Installation is reverse of removal. Remember to:
- Recut threads in spindle universal joint pinch collar.
 - Slide universal joint splines over column shaft. Splines fit only one way. Install new Torx pinch bolt. Pinch bolt rests in groove of steering column shaft.
 - Fit spindle sleeve back into opening in floorboard. Align marks on sleeve and floorboard.
 - Use new bolts to mount column to dashboard and dashboard brace. Match position marks made previously.

Tightening torques

Steering column to dashboard or dashboard brace (replace M8 bolt with new)	21 Nm (15 ft-lb)
Steering shaft spindle universal joint pinch bolt (recut pinch collar threads, replace M8 Torx bolt with new)	22 Nm (16 ft-lb)

- Check steering system for freedom of movement through entire steering column adjustment range.
- Carry out steering angle sensor adjustment using BMW scan tool. If replacing steering angle sensor, code using BMW scan tool before performing steering angle offset check.
- If airbag warning light illuminates, use BMW scan tool to check and clear fault codes.
- Test drive vehicle to check directional stability.



Steering shaft spindle, removing and installing

- Raise front of 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, not underneath suspension parts.

- Remove splash shield and front end reinforcement panel from underneath engine. Also remove left side splash shield at front suspension.
- Remove steering spindle lower pinch bolt and slide universal joint off steering rack shaft (**arrow**).

CAUTION—

- While steering spindle is detached from steering rack, make sure steering wheel is not rotated. Rotating the wheel may damage the airbag and horn contact spring.

- Remove left lower dashboard trim (pedal cluster trim). See 513 Interior Trim.
- Working in left footwell, slide sleeve (**arrow**) for steering spindle upwards on steering column.

- Remove steering shaft upper universal joint pinch bolt (**arrow**) and slide universal down and off steering column shaft.

- Installation is reverse of removal. Remember to:
 - Rethread threads in spindle universal joint pinch collars.
 - Slide universal joint splines over steering column and steering rack shafts. Splines fit only one way. Install new Torx pinch bolts. Pinch bolts rest in shaft grooves.
 - Fit spindle sleeve back into opening in floorboard. Align marks on sleeve and floorboard.

Tightening torque

Steering shaft spindle universal joint pinch bolt (recut pinch collar threads, replace M8 Torx bolt with new)	22 Nm (16 ft-lb)
---	------------------

- Check steering system for freedom of movement through entire steering column adjustment range. Check directional stability of vehicle on test drive.
- Carry out steering angle sensor adjustment using BMW scan tool.

320-14 Steering and Wheel Alignment

Power steering system, bleeding and filling

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 in the engine compartment:

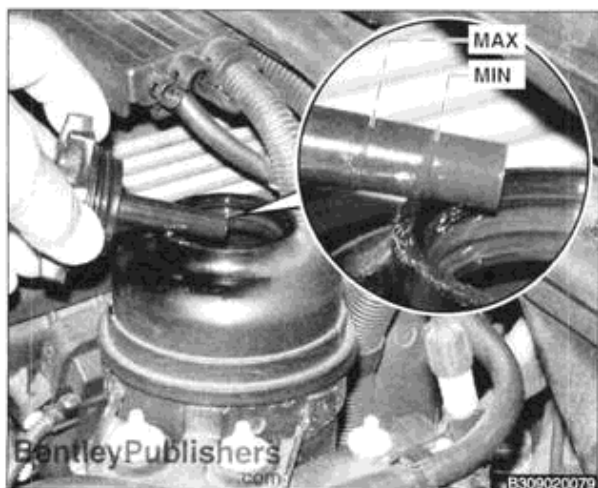
- 6-cylinder model: Left side of engine compartment
- V8 models: Right side of engine compartment

Power steering system, bleeding and filling

- The power steering system is permanently filled with either CHF (Pentosin hydraulic fluid) or ATF. Routinely adding fluid is not required unless the system is leaking.

CAUTION—

- Power steering reservoir cap is marked with the type of fluid being used— CHF or ATF. Do not mix.



- To check power steering fluid level in fluid reservoir:
- Park vehicle on level ground with engine OFF.
 - Level is correct if it is between **MIN** and **MAX** marks on dipstick.
 - If level is below **MIN** mark, add fluid to reservoir to bring level up.

CAUTION—

- Correct power steering fluid level can be as much as 10 mm (0.4 in) higher than **MAX** mark when engine is at normal operating temperature. Do not draw off fluid to **MAX** mark when checking fluid with engine warmed up.

- To bleed power steering system, start engine. Turn steering wheel twice to left lock and right lock.
- Recheck fluid level with engine off. Fill to **MAX**.

Power steering fluid application

Black label (check cap)	ATF Dexron III
Green label (check cap)	Pentosin CHF 11 S

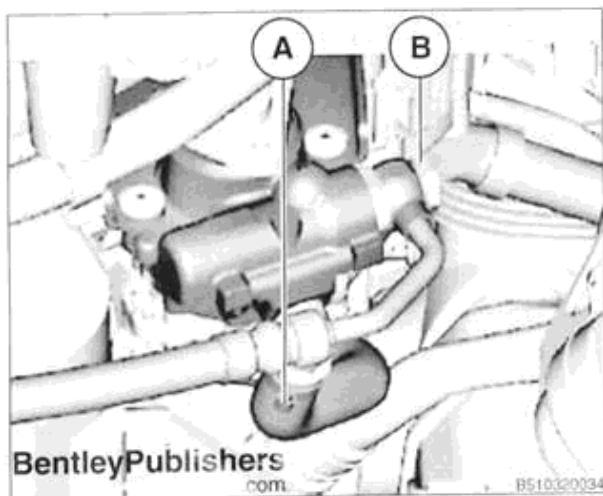
- Hand-tighten reservoir cap.

Power steering pump, removing and installing (M54 engine)

- Drain power steering fluid reservoir using clean syringe. Do not reuse fluid.
- Mark engine accessory belt direction of rotation, then remove belt. See **020 Maintenance**.
- Raise front of 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, not underneath suspension parts.



- Remove splash shield underneath front of engine. See **020 Maintenance**.
- Remove power steering pump pulley.
- Remove alternator idler pulley.

Working at power steering pump, detach fluid lines. Be prepared to catch dripping fluid. Plug open fluid ports.

- Cut supply hose clamp (A) and separate hose from pump inlet.
- Remove banjo bolt (B) and remove pressure line.

Remove pump mounting bolts and lower pump.

- A = M8 x 70 mm ZNS bolt
- B = M8 x 100 mm ZNS bolt
- C = M8 x 22 mm ZNS bolt

Installation is reverse of removal. Keep in mind the following:

- Use new O-ring seals at pressure line banjo bolt. Route pressure line tension-free and with sufficient distance to adjoining components.
- Match markings on supply line and pump connection. Use new hose clamp at connection.
- Lettering on pump pulley faces forward.

Tightening torques

Pressure line to pump (M16 banjo bolt, use new O-ring seals)	35 Nm (26 ft-lb)
Pulley to power steering pump (M8 x 14 mm 10.9 grade bolts)	27 Nm (20 ft-lb)
Power steering pump to engine block (M8 ZNS bolts)	21 Nm (16 ft-lb)

- Fill and bleed steering system with correct fluid. See **Power steering system, bleeding and filling** in this repair group.
- Run engine and check fluid connections for leaks.

320-16 Steering and Wheel Alignment

Power steering pump, removing and installing (N52 engine)

Power steering pump, removing and installing (N52 engine)

- Drain power steering fluid reservoir using clean syringe. Do not reuse fluid.
- Raise front of 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, not underneath suspension parts.*

- Remove splash shield underneath front of engine. See **020 Maintenance**.

- Remove air filter housing. See **130 Fuel Injection**.

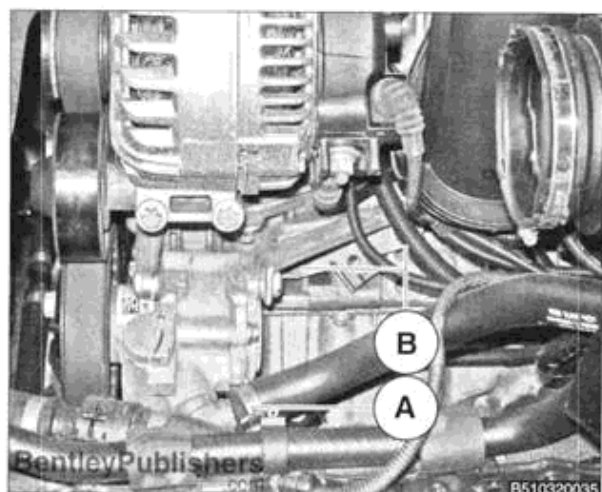


Working from above on left side of engine:

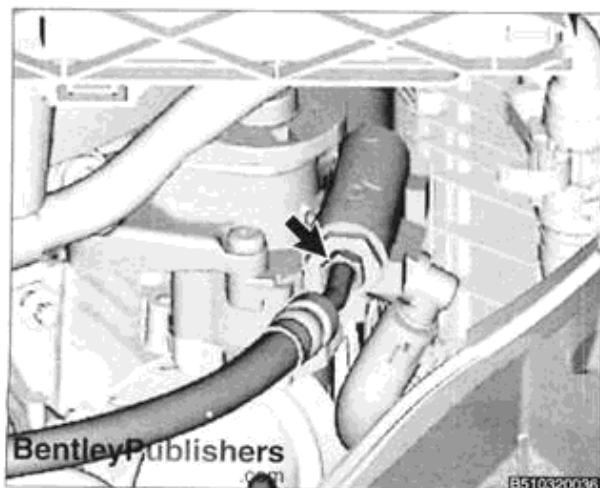
- Cut supply hose clamp (**A**) and separate hose from pump inlet. Be prepared to catch dripping fluid. Plug open fluid ports.
- Remove steering pump rear bracket mounting bolts (**B**). Discard aluminum bolts.

- Mark engine accessory belt direction of rotation, then remove belt. See **020 Maintenance**.

- Working underneath front of vehicle, remove power steering pump pulley.

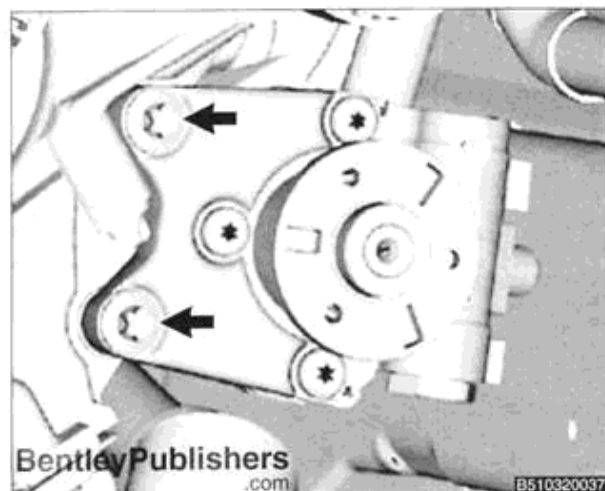


Loosen union nut (**arrow**) and detach pressure line from pump. Be prepared to catch dripping fluid. Plug open fluid ports.



Steering and Wheel Alignment 320-17

Power steering pump, removing and installing (N52 engine)



- Remove pump mounting bolts (**arrows**) and lower pump. Discard aluminum bolts.

- When installing pump, replace aluminium bolts with new, tighten finger tight and observe the following tightening sequence:
 1. Tighten rear bracket fasteners to 2 Nm (18 in-lb).
 2. Tighten front fasteners to 2 Nm (18 in-lb).
 3. Tighten front fasteners to final specification.
 4. Loosen rear bracket fasteners and make sure bracket is flush with engine block.
 5. Tighten rear bracket fasteners to final specification.

Tightening torque

Power steering pump to block (replace M10 x 33 mm aluminum bolts with new)	20 Nm (15 ft-lb) additional 90°
--	---------------------------------

- Remainder of installation is reverse of removal. Keep in mind the following:
 - Route fluid lines tension-free and with sufficient distance to adjoining components.
 - Match markings on supply line and pump connection. Use new hose clamp at connection.
 - Lettering on pump pulley faces forward.

Tightening torques

Pressure line to pump	36 Nm (27 ft-lb)
Pulley to power steering pump (M8 8.8 grade bolts)	21 Nm (20 ft-lb)

- Fill and bleed steering system with correct fluid. See **Power steering system, bleeding and filling** in this repair group.
- Run engine and check fluid connections for leaks.

320-18 Steering and Wheel Alignment

Power steering pump, removing and installing (N54 engine)

Power steering pump, removing and installing (N54 engine)

- Disconnect negative (-) battery cable and cover battery terminal to keep cable from accidentally contacting terminal.

CAUTION—

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

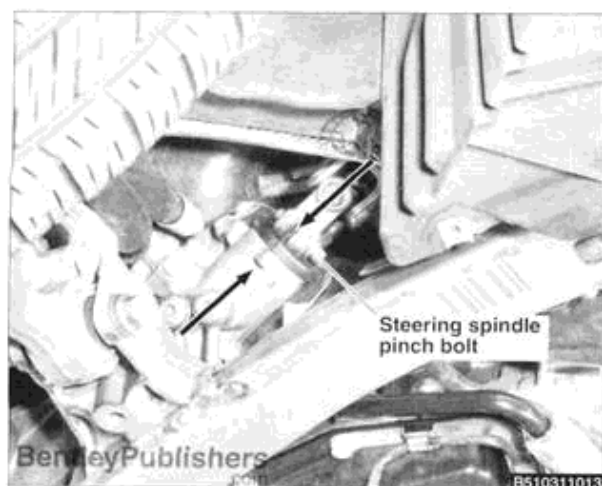
- Mark engine accessory belt direction of rotation, then remove belt. See **020 Maintenance**.
- Drain power steering fluid reservoir using clean syringe. Do not reuse fluid.
- Raise front of car and remove front wheels.

WARNING—

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



- Remove splash shield and front end reinforcement panel from underneath engine. Also remove side splash shields at front suspension.
- Install engine support brace across engine bay and support weight of engine.
- ◀ Working underneath engine, remove right and left engine mount upper nuts (arrow). Raise engine slightly ($\frac{1}{4}$ - $\frac{1}{2}$ in) to release load on engine mounts.
- Detach both tie rod ends from steering knuckles. See **Tie rod end, replacing** in this repair group.
- xDrive: Detach left and right control arms from steering knuckles. Detach left and right front stabilizer bar links from stabilizer bar. See **310 Front Suspension**.



- ◀ Detach steering spindle from steering rack:
 - Move steering wheel so that front wheels point straight ahead. Vehicle with steering lock: Remove ignition key and make sure steering locks in straight ahead position.
 - With front wheels pointing straight ahead, make sure steering spindle pointer and steering rack pointer line up (arrows). Remove lower steering spindle pinch bolt and detach steering universal joint from steering rack shaft.

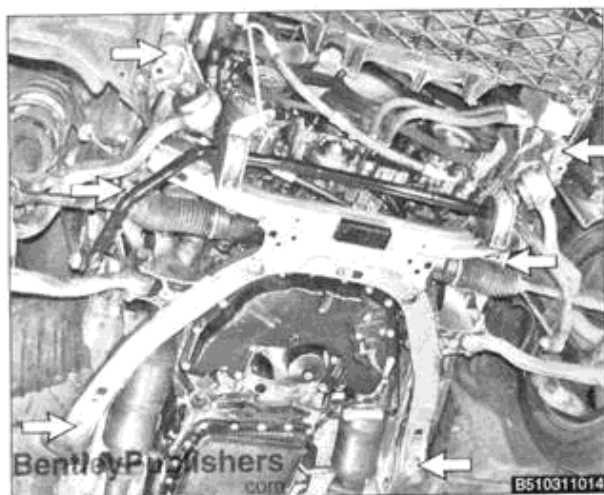
CAUTION—

- While steering spindle is detached from steering rack, make sure steering wheel is not rotated. Rotating the wheel may damage the airbag and horn contact spring.

Steering and Wheel Alignment 320-19

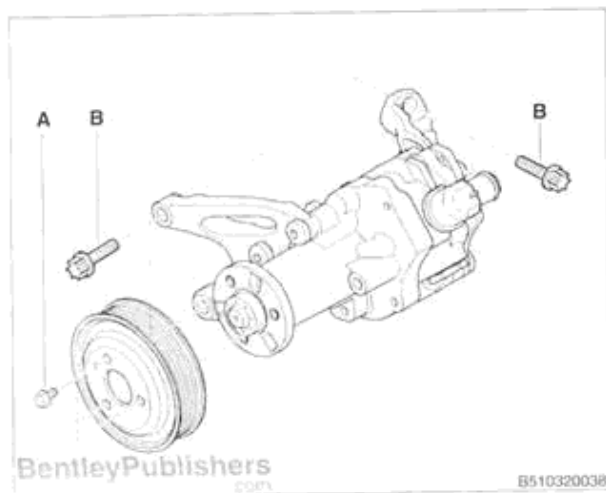
Power steering pump, removing and installing (N54 engine)

- If applicable, detach electrical connectors at front suspension ride height sensor, Servotronic sensor and engine mount vacuum line.
 - Vehicle with active stabilizers (dynamic drive):
 - Remove right front wheel housing liner. See **410 Fenders, Engine Hood**.
 - Separate fluid lines to front stabilizer oscillating motor. Be prepared to catch dripping fluid. Plug open fluid lines immediately.
 - Vehicle with active steering: Detach active steering gearbox electrical connectors. Detach wiring harness from front subframe.
- ⚠ Support front subframe with transmission jack. Remove subframe mounting bolts (**arrows**) and lower subframe about 100 mm (4 in).



CAUTION—

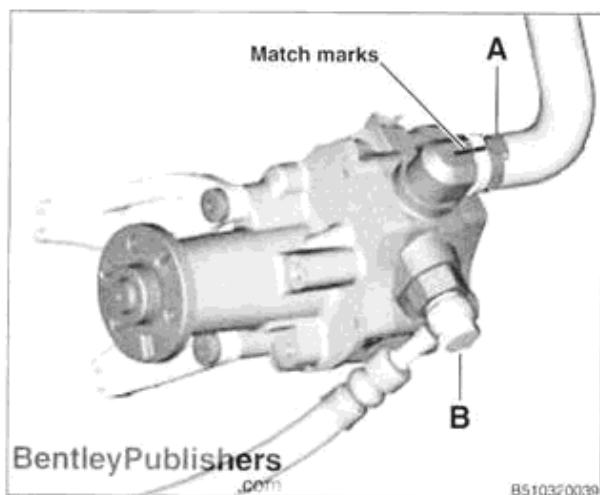
- Do not bend or stretch fluid lines and hoses when lowering or raising subframe.
- N54 with automatic transmission: Disconnect transmission fluid cooler lines from subframe.



- ⚠ Working underneath front of vehicle:
- Remove power steering pump pulley bolts (**A**) and take pulley off pump.
 - Remove pump mounting bolts (**B**) and pull pump forward. Discard aluminum bolts.

320-20 Steering and Wheel Alignment

Power steering pump, removing and installing (N54 engine)



Working at steering pump, detach fluid lines. Be prepared to catch dripping fluid. Plug open fluid ports.

- Cut supply hose clamp (A) and separate hose from pump inlet. Note match marks on supply hose and pump connection.
- Remove banjo bolt (B) and remove pressure line.
- Lower steering pump.

Attach fluid lines to new pump:

- Use new O-ring seals at pressure line banjo bolt. Route pressure line tension-free and with sufficient distance to adjoining components.
- Match markings on supply line and pump connection. Use new hose clamp at connection.

Tightening torques

Pressure line to pump (M14 banjo bolt, use new O-ring seals)	33 Nm (24 ft-lb)
---	------------------

Raise pump into position on engine block. Replace aluminium bolts with new and tighten finger tight. Observe the following tightening sequence:

1. Tighten rear fasteners to 2 Nm (18 in-lb).
2. Tighten front fasteners to 2 Nm (18 in-lb).
3. Tighten front fasteners to final specification.
4. Loosen rear fasteners and make sure bracket is flush with engine block.
5. Tighten rear bracket fasteners to final specification.

Tightening torque

Power steering pump to block (replace M10 x 35 mm aluminum bolts with new)	38 Nm (28 ft-lb)
--	------------------

Reinstall pump pulley. Lettering on pump pulley faces forward.

Tightening torque

Pulley to power steering pump (M8 x 12 mm 8.8 grade bolts)	22 Nm (16 ft-lb)
---	------------------

Steering and Wheel Alignment 320-21

Power steering pump, removing and installing (N54 engine)

- Remainder of installation is reverse of removal. Keep in mind the following:
 - Raise front subframe into place carefully, watching to make sure fluid lines and electrical harnesses are not crushed.
 - Use new fasteners as indicated in torque specifications table.

Tightening torques	
Control arm to steering knuckle (replace M14 x 1.5 self-locking flange nut with new)	165 Nm (122 ft-lb)
Engine mount to engine bracket (replace M10 10.9 grade self-locking nuts with new)	56 Nm (41 ft-lb)
Front end reinforcement panel to subframe (replace M10 x 35 mm 10.9 grade ZNS bolts with new): • Stage 1 • Stage 2	56 Nm (41 ft-lb) + additional 90°
Front subframe to chassis (replace M12 x 1.5 10.9 grade bolts with new): • Stage 1 • Stage 2	100 Nm (74 ft-lb) + additional 90°
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)
Stabilizer link to stabilizer bar (replace M10 ZNS3 nut with new)	65 Nm (48 ft-lb)
Steering shaft spindle universal joint pinch bolt (recut pinch collar threads, replace M8 Torx bolt with new)	22 Nm (16 ft-lb)
Tie rod ball joint to steering knuckle (replace M14 x 1.5 ZNS3 nut with new)	80 Nm (59 ft-lb)

- Fill and bleed steering system with correct fluid. See **Power steering system, bleeding and filling** in this repair group.
- Run engine and check fluid connections for leaks.
- Carry out steering angle sensor adjustment using BMW scan tool.

320-22 Steering and Wheel Alignment

Power steering pump, removing and installing (V8 engine)

Power steering pump, removing and installing (V8 engine)

- Drain power steering fluid reservoir using clean syringe. Do not reuse fluid.
- Mark engine accessory belt direction of rotation, then remove belt. See **020 Maintenance**.
- Raise front of 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, not underneath suspension parts.

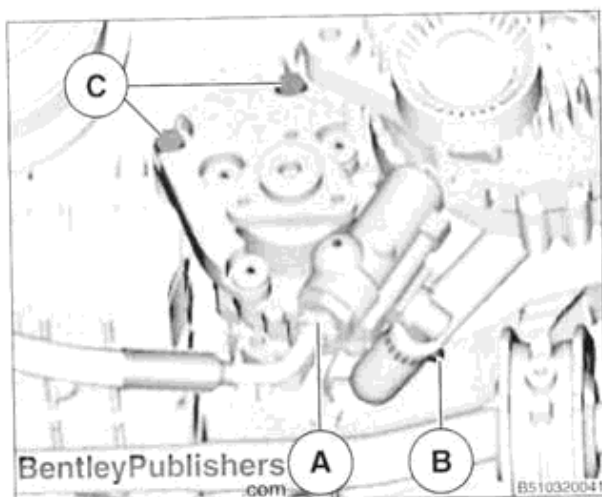
- Remove splash shield underneath front of engine. See **020 Maintenance**.

- Remove power steering pump pulley.

- Working at steering pump, detach fluid lines. Be prepared to catch dripping fluid. Plug open fluid ports.

- Cut supply hose clamp (A) and separate hose from pump inlet.
- Loosen union nut (B) and remove pressure line.
- Remove pump mounting fasteners (C) and lower pump.

- Installation is reverse of removal. Keep in mind the following:
 - Route pressure line tension-free and with sufficient distance to adjoining components.
 - Match markings on supply line and pump connection. Use new hose clamp at connection.
 - Lettering on pump pulley faces forward.



Tightening torques

Pressure line to pump	36 Nm (27 ft-lb)
Pulley to power steering pump (M8 x 14 mm 10.9 grade bolts)	27 Nm (20 ft-lb)
Power steering pump to engine block (M8 8.8 grade fasteners)	21 Nm (16 ft-lb)

- Fill and bleed steering system with correct fluid. See **Power steering system, bleeding and filling** in this repair group.
- Run engine and check fluid connections for leaks.

Steering and Wheel Alignment 320-23

Steering rack, removing and installing (rear-wheel-drive)

MECHANICAL STEERING COMPONENTS

Steering rack, removing and installing (rear-wheel-drive)

- Disconnect negative (-) battery cable and cover battery terminal to keep cable from accidentally contacting terminal.

CAUTION—

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

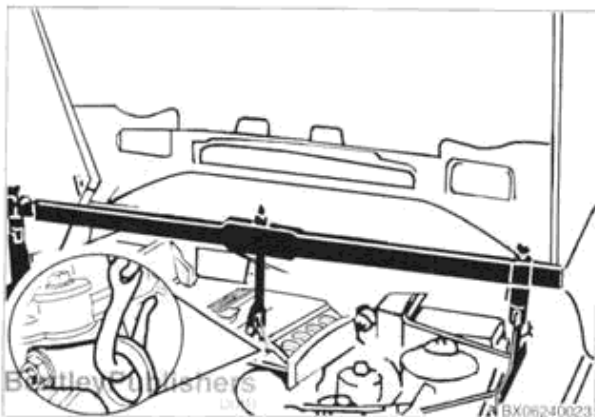
- Drain power steering fluid reservoir using clean syringe. Do not reuse fluid.
- Raise front of car and remove front wheels.

WARNING—

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

- Remove splash shield and front end reinforcement panel from underneath engine. Also remove side splash shields at front suspension.

- ◀ Install engine support brace across engine bay.



- ◀ Working underneath engine, remove right and left engine mount upper nuts (**arrow**). Raise engine slightly ($\frac{1}{4}$ - $\frac{1}{2}$ in) to release load on engine mounts.

- Detach both tie rod ends from steering knuckles. See **Tie rod end, replacing** in this repair group.



320-24 Steering and Wheel Alignment

Steering rack, removing and installing (rear-wheel-drive)



Detach steering spindle from steering rack:

- Move steering wheel so that front wheels point straight ahead. Vehicle with steering lock: Remove ignition key and make sure steering locks in straight ahead position.
- With front wheels pointing straight ahead, make sure steering spindle pointer and steering rack pointer line up (**arrows**). Remove steering spindle pinch bolt and detach steering universal joint from steering rack shaft.

CAUTION—

- While steering spindle is detached from steering rack, make sure steering wheel is not rotated. Rotating the wheel may damage the airbag and horn contact spring.

- If applicable, detach electrical connectors at front suspension ride height sensor, Servotronic sensor and engine mount vacuum line.
- Vehicle with active stabilizers (dynamic drive):
 - Remove right front wheel housing liner. See **410 Fenders, Engine Hood**.
 - Separate fluid lines to front stabilizer oscillating motor. Be prepared to catch dripping fluid. Plug open fluid lines immediately.
- Vehicle with active steering: Detach active steering gearbox electrical connectors. Detach wiring harness from front subframe.
- Support front subframe with transmission jack. Remove subframe mounting bolts (**arrows**) and lower subframe about 100 mm (4 in).

CAUTION—

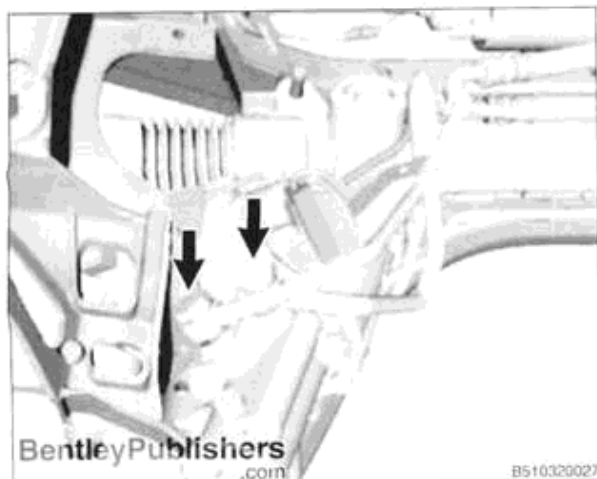
- Do not bend or stretch fluid lines and hoses when lowering or raising subframe.
- N54 with automatic transmission: Disconnect transmission fluid cooler lines from subframe.

- Remove left engine mounting bracket from subframe.
- If necessary, remove heat shield from power steering rack.



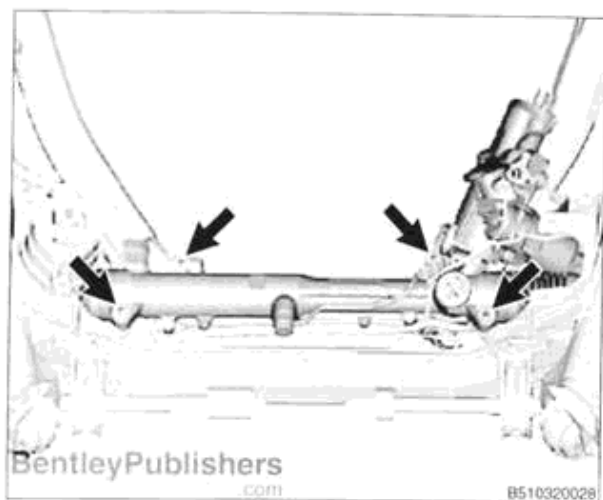
Working at steering rack, remove banjo bolts (**arrows**) and disconnect fluid lines from rack gear box.

- Be prepared to catch dripping fluid. Plug open fluid ports.
- Discard sealing O-rings.



Steering and Wheel Alignment 320-25

Steering rack, removing and installing (rear-wheel-drive)



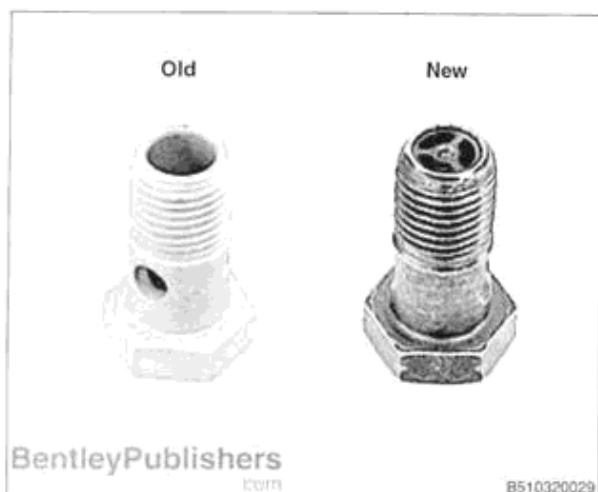
- Remove steering rack mounting fasteners (arrows).

- Vehicle with active steering: Detach electrical connectors at rack gear box.
- Slide rack to right and remove toward rear. Check for wiring, fluid lines or mechanical parts that might become snagged as rack is removed.
- When installing, use new mounting bolts and self-locking nuts. Tighten in two stages.

Tightening torque

Steering rack to front subframe (replace M10 10.9 grade fasteners with new)	
• Stage 1	
• Stage 2	

56 Nm (41 ft-lb)
additional 90°



- When reattaching fluid lines:

- Replace old banjo bolt on pressure line with new one fitted with check valve.
- Use new sealing O-rings.

Tightening torque

Steering fluid line banjo bolt to steering pump (M14 or M16, replace sealing O-rings)	
--	--

33 - 35 Nm
(24 - 25 ft-lb)

- Remainder of installation is reverse of removal. Make sure fluid lines and electrical harnesses are routed as before and connected free of stress. Keep in mind the following:
 - Raise front subframe into place carefully, watching to make sure fluid lines and electrical harnesses are not crushed.
 - Use new fasteners as indicated in torque specifications table.
 - Fill and bleed steering and hydraulic system with correct fluid. See **Power steering system, bleeding and filling** in this repair group.
 - Check fluid connections for leaks.
 - Perform wheel alignment.
 - Carry out steering angle sensor adjustment using BMW scan tool.
 - If necessary, adjust active steering. See **Active steering, adjusting** in this repair group.
 - If necessary, commission active stabilizer system. See **310 Front Suspension**.

Tightening torques

Engine mount to engine bracket (replace M10 10.9 grade self-locking nuts with new)	
Front end reinforcement panel to subframe (replace M10 x 35 mm 10.9 grade ZNS bolts with new):	
• Stage 1	
• Stage 2	

56 Nm (41 ft-lb)

56 Nm (41 ft-lb)
+ additional 90°

320-26 Steering and Wheel Alignment

Steering rack, removing and installing (xDrive)

Tightening torques

Front subframe to chassis (replace M12 x 1.5 10.9 grade bolts with new): • Stage 1 • Stage 2	100 Nm (74 ft-lb) + additional 90°
Road wheel to hub	120 ± 10 Nm (89 ± 7 ft-lb)
Steering shaft spindle universal joint pinch bolt (recut pinch collar threads, replace M8 Torx bolt with new)	22 Nm (16 ft-lb)
Tie rod ball joint to steering knuckle (replace M14 x 1.5 ZNS3 nut with new)	80 Nm (59 ft-lb)

Steering rack, removing and installing (xDrive)

- Disconnect negative (-) battery cable and cover battery terminal to keep cable from accidentally contacting terminal.

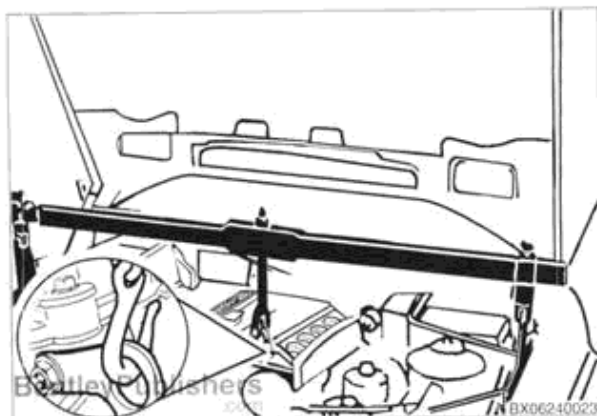
CAUTION—

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

- Drain power steering fluid reservoir using clean syringe. Do not reuse fluid.
- 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 underneath structural chassis points, not underneath suspension parts.



- Remove splash shield and front end reinforcement panel from underneath engine. Also remove side splash shields at front suspension.
- ◀ Install engine support brace across engine bay.
- ◀ Working underneath engine, remove right and left engine mount upper nuts (arrow). Raise engine slightly ($\frac{1}{4}$ - $\frac{1}{2}$ in) to release load on engine mounts.
- Detach left and right tie rod ends from steering knuckles. See **Tie rod end, replacing** in this repair group.
- Detach left and right control arms from steering knuckles. See **310 Front Suspension**.
- Detach left and right front stabilizer bar links from stabilizer bar. See **310 Front Suspension**.

Steering and Wheel Alignment 320-27

Steering rack, removing and installing (xDrive)



Detach steering spindle from steering rack:

- Move steering wheel so that front wheels point straight ahead. Vehicle with steering lock: Remove ignition key and make sure steering locks in straight ahead position.
- With front wheels pointing straight ahead, make sure steering spindle pointer and steering rack pointer line up (**arrows**). Remove steering spindle pinch bolt and detach steering universal joint from steering rack shaft.

CAUTION—

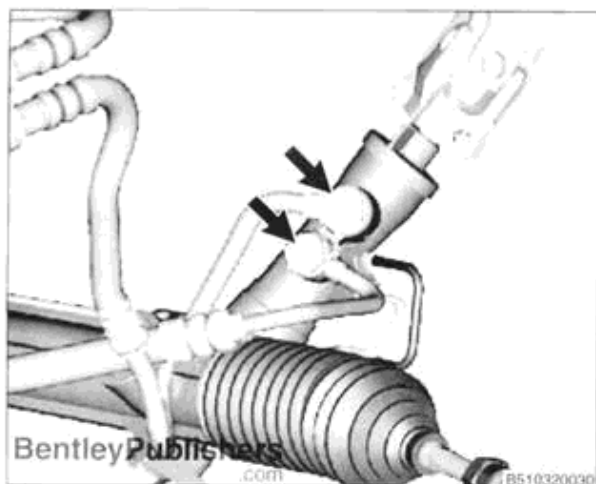
- While steering spindle is detached from steering rack, make sure steering wheel is not rotated. Rotating the wheel may damage the airbag and horn contact spring.

- If applicable, detach electrical connectors at front suspension ride height sensor and Servotronic sensor.

Support front subframe with transmission jack. Remove subframe mounting bolts (**arrows**) and lower subframe until steering rack rests on front drive axle (about 100 mm or 4 in).

CAUTION—

- Do not bend or stretch fluid lines and hoses when lowering or raising subframe.
- Make sure tension strut bushing cover is free to move.
- N54 with automatic transmission: Disconnect transmission fluid cooler lines from subframe.

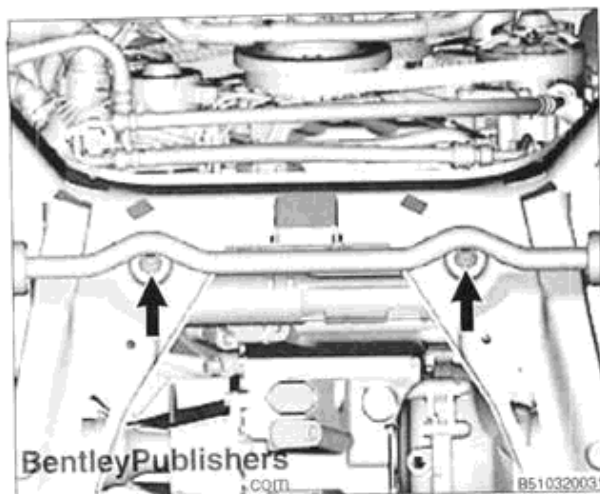


Working at steering rack, remove banjo bolts (**arrows**) and disconnect fluid lines from rack gear box.

- Be prepared to catch dripping fluid. Plug open fluid ports.
- Discard sealing O-rings.

320-28 Steering and Wheel Alignment

Steering rack, removing and installing (xDrive)



➤ Remove steering rack mounting fasteners (arrows).

- Push front subframe forward and guide steering rack past drive axle.
- Lower subframe as much as possible without damaging hose and lines. Slide rack toward rear, rotate and remove from left side. Check for wiring, fluid lines or mechanical parts that might become snagged as rack is removed.
- When installing, use new mounting bolts and self-locking nuts.

Tightening torque

Steering rack to front subframe (replace M12 10.9 grade fasteners with new)	120 Nm (89 ft-lb)
--	-------------------



➤ When reattaching fluid lines:

- Replace old banjo bolt on pressure line with new one fitted with check valve.
- Use new sealing O-rings.

Tightening torque

Steering fluid line banjo bolt to steering pump (M14 or M16, replace sealing O-rings)	33 - 35 Nm (24 - 25 ft-lb)
--	-------------------------------

- Remainder of installation is reverse of removal. Make sure fluid lines and electrical harnesses are routed as before and connected free of stress. Keep in mind the following:
 - Raise front subframe into place carefully, watching to make sure fluid lines and electrical harnesses are not crushed.
 - Use new fasteners as indicated in torque specifications table.
 - Fill and bleed steering and hydraulic system with correct fluid. See **Power steering system, bleeding and filling** in this repair group.
 - Check fluid connections for leaks.
 - Perform wheel alignment.
 - Carry out steering angle sensor adjustment using BMW scan tool.

Tightening torques

Control arm to steering knuckle (replace M14 x 1.5 self-locking flange nut with new)	165 Nm (122 ft-lb)
Engine mount to engine bracket (replace M10 10.9 grade self-locking nuts with new)	56 Nm (41 ft-lb)
Front end reinforcement panel to subframe (replace M10 x 35 mm 10.9 grade ZNS bolts with new): • Stage 1 • Stage 2	56 Nm (41 ft-lb) + additional 90°
Front subframe to chassis (replace M12 x 1.5 10.9 grade bolts with new): • Stage 1 • Stage 2	100 Nm (74 ft-lb) + additional 90°

Tightening torques

Road wheel to hub	120 $\pm$ 10 Nm (89 $\pm$ 7 ft-lb)
Stabilizer link to stabilizer bar (replace M10 ZNS3 nut with new)	65 Nm (48 ft-lb)
Steering shaft spindle universal joint pinch bolt (recut pinch collar threads, replace M8 Torx bolt with new)	22 Nm (16 ft-lb)
Tie rod ball joint to steering knuckle (replace M14 x 1.5 ZNS3 nut with new)	80 Nm (59 ft-lb)

Tie rod end, replacing

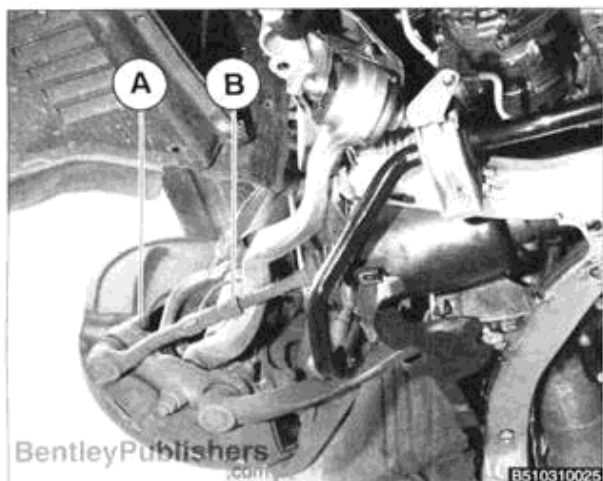
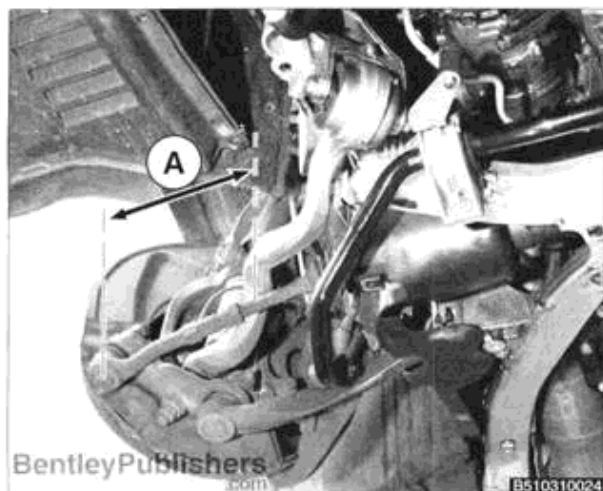
- Raise front of car. Remove road wheel.

WARNING —

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

- Remove splash shield underneath engine.

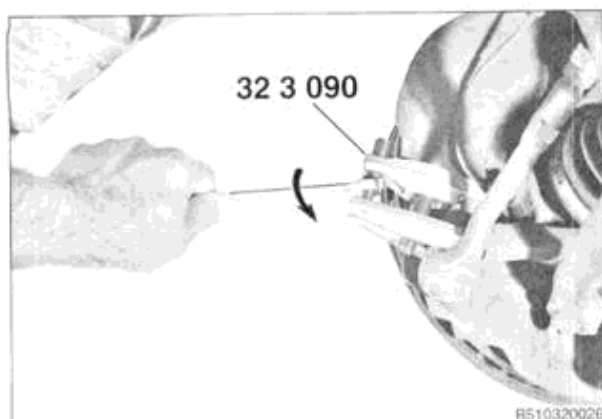
- ◀ Make reference measurement (A) of outer tie rod end to tie rod. Record measurement.
- Accurate measurement of tie rod end with reference to tie rod helps approximate correct wheel alignment when new parts are installed.



- ◀ Working at outer end of tie rod:
 - Remove tie rod end nut (A) at steering knuckle. If necessary, counterhold tie rod ball joint shaft with Torx tool.
 - Loosen tie rod adjustment lock nut (B).

320-30 Steering and Wheel Alignment

Tie rod, replacing



- Use BMW special tool 32 3 090 or equivalent to press tie rod end out of steering knuckle.
- Unscrew tie rod end from tie rod shaft.
- Check steering rack boot carefully for damage. Replace if necessary. See **Steering rack boot, replacing** in this repair group.
- Installation is reverse of removal.
 - Make sure threaded parts are clean.
 - Use anti-seize paste on inner tie rod threads.
 - Use new self-locking nuts where applicable.
 - Use previously made reference marks to set toe temporarily.

Tightening torques

Lock nut to tie rod end (M16 x 1.5)	51 Nm (38 ft-lb)
Tie rod ball joint to steering knuckle (replace M14 x 1.5 ZNS3 nut with new)	80 Nm (59 ft-lb)

- After reassembling steering:
 - Have car aligned.
 - Adjust active steering (if applicable).
 - Carry out steering angle sensor adjustment using BMW scan tool.

Tie rod, replacing

- Raise front of car. Remove road wheel.

WARNING—

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

- Make length reference mark on tie rod, then remove outer tie rod end. See **Tie rod end, replacing**. Remove lock nut.
- Cut rack boot clamps and slide boot off. Check boot carefully for damage. Replace if necessary. See **Steering rack boot, replacing** in this repair group.
- Use BMW special tool 32 3 160 or equivalent 38 mm crowfoot wrench to loosen and 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 inside rack housing.

- Replace rack end sealing O-ring (arrow).
- 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.



Steering and Wheel Alignment 320-31

Steering rack boot, replacing

- Installation is reverse of removal, noting the following:
 - Make sure threaded parts are clean.
 - Use anti-seize paste on inner tie rod threads.
 - Use new self-locking nuts where applicable.
 - Use previously made reference marks to set toe temporarily.

Tightening torques	
Lock nut to tie rod end (M16 x 1.5)	51 Nm (38 ft-lb)
Tie rod ball joint to steering knuckle (replace M14 x 1.5 ZNS3 nut with new)	80 Nm (59 ft-lb)
Tie rod to steering rack	110 Nm (81 ft-lb)

- After reassembling steering:
 - Have car aligned.
 - Adjust active steering (if applicable).
 - Carry out steering angle sensor adjustment using BMW scan tool.

Steering rack boot, replacing

- Raise front of car. Remove road wheel.

WARNING—

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

- Remove splash shield underneath engine and side splash shields.
- Make length reference mark on tie rod, then remove outer tie rod end. See **Tie rod end, replacing**.
- Cut rack boot band clamps and slide off boot. Inspect boot for any sign of damage. Replace if necessary. New rack boot kit comes with new band clamps.
- Inspect exposed ends of steering rack shaft. If polished surface shows signs of corrosion, replace complete steering rack. See **Corrosion damage** in this repair group.
- 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. Reinstall tie rod end using previously made reference marks.

Tightening torques	
Tie rod end to tie rod (pinch bolt)	40 Nm (30 ft-lb)
Tie rod to steering knuckle (use new nut)	80 Nm (59 ft-lb)

- After reassembling steering:
 - Have car professionally aligned.
 - Carry out steering angle sensor adjustment using BMW scan tool.

320-32 Steering and Wheel Alignment

Preparing for alignment

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.

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

For front and rear alignment specifications, see **Alignment specifications** in this repair group.

Preparing for alignment

The following conditions are necessary before wheel alignment:

- Correct wheels and identical tires in good condition and inflated correctly. Tire tread depth for each axle may differ left to right by max. 1 - 2 mm (0.04 - 0.08 in).
- Steering and suspension parts and bushings undamaged and showing no signs of abnormal wear.
- Wheel bearings in good condition.
- Ride height in accordance with specifications. See **Ride height** in this repair group.
- Vehicle with electronic height control (EHC): Remove EHC fuse to prevent automatic height adjustment. See **ECL Electrical Component Locations**.
- Vehicle with active steering: Remove active steering fuse to deactivate active steering. See **ECL Electrical Component Locations**.
- Vehicle in normal loaded position. See **Normal loaded position** in this repair group.

Normal loaded position

BMW defines vehicle normal loaded position as follows.

Normal loaded position	
Each front seat, seats in central position	68 Kg (150 lb)
Center of rear seat	68 Kg (150 lb)
Cargo compartment	21 Kg (46 lb)
Fuel tank	Full

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** in this repair group.
 - Specified tires and wheels, correct tire pressure, even tire wear.
 - Correct wheel bearing play.
- If ride height is outside specifications listed, install new springs. Suspension spring removal and installation is covered in **310 Front Suspension** and **330 Rear Suspension**.

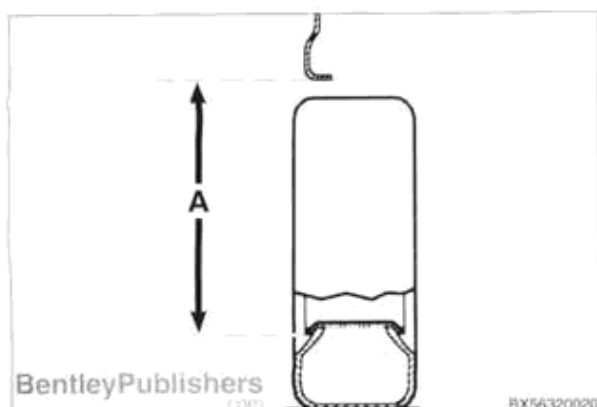


Table a. Front ride height (measurement A)

Wheel size	Ride height in mm (in)					
	Normal suspension	Sport suspension	Rough road package	Long version	Security version	xDrive (E60, E61)
16 inch	589 (23.189)	574 (22.5984)	607 (23.8976)			
17 inch	605 (23.8189)	589 (23.189)	622 (24.4882)	610 (24.0157)	605 (23.8189)	619 (24.3701)
18 inch	617 (24.2913)	602 (23.7008)	635 (25)		617 (24.2913)	632 (24.8819)
19 inch	630 (24.8031)	614 (24.5669)	648 (25.5118)			
Maximum combined deviation from specification: 10 mm (0.4 in)						
Maximum difference between left and right: 10 mm (0.4 in)						

Table b. Rear ride height, Sedan (E60) (measurement A)

Wheel size	Ride height in mm (in)					
	Normal suspension	Sport suspension	Rough road package	Long version	Security version	xDrive
16 inch	573 (22.5591)	558 (21.9685)	589 (23.189)			
17 inch	588 (23.1496)	573 (22.5591)	604 (23.7795)	593 (23.3465)	588 (23.1496)	599 (23.5827)
18 inch	601 (23.6614)	585 (23.0315)	617 (24.2913)		600 (23.622)	611 (24.0551)
19 inch	613 (24.1339)	598 (23.5433)	629 (24.7638)		612 (24.0945)	
Maximum combined deviation from specification: 10 mm (0.4 in)						
Maximum difference between left and right: 10 mm (0.4 in)						

Table c. Rear ride height, Sports Wagon (E61) (measurement A)

Wheel size	Ride height in mm (in)		
	Normal suspension	Sport suspension	xDrive
16 inch	588 (23.1496)	578 (22.7559)	
17 inch	603 (23.7402)	593 (23.3465)	603 (23.7402)
18 inch	615 (24.2126)	605 (23.8189)	616 (24.252)
Maximum combined deviation from specification: 10 mm (0.4 in)			
Maximum difference between left and right: 10 mm (0.4 in)			

Front toe, setting

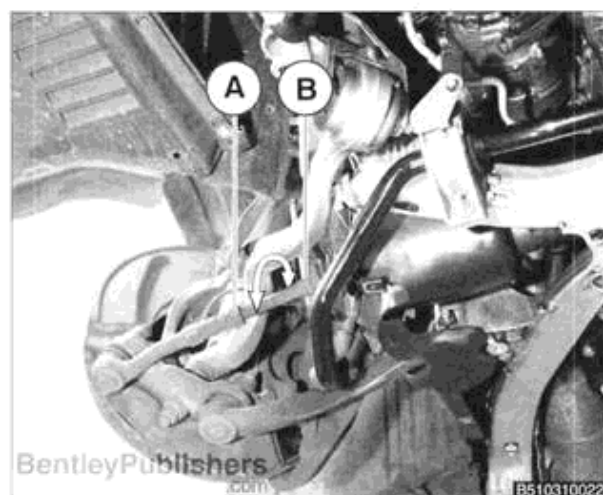
Set front toe before adjusting camber. Camber and toe influence each other. Toe is the difference in the distance between the front of the wheels and the rear of the wheels. It is adjusted by altering the length of the tie rods.

Make toe adjustments with vehicle in normal loaded position. See **Normal loaded position** in this repair group.

- Center steering wheel. Make sure front wheels are pointed straight ahead.

320-34 Steering and Wheel Alignment

Front toe, setting



- 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, not underneath suspension parts.

- Remove splash shield and front end reinforcement panel from under engine.
- Remove side suspension splash shields.
- ◀ Working underneath vehicle, make sure steering spindle pointer and steering rack pointer line up (**arrows**).
- Use steering wheel holding tool to lock steering wheel in centered position.
- Working underneath vehicle, clean threads on tie rod shaft.

- ◀ Counterhold tie rod end and loosen tie rod adjuster lock nut (**A**).
 - To adjust toe, counterhold tie rod end and turn inner tie rod shaft (**curved arrow**) to change length.
 - To keep steering wheel centered, adjust both tie rods equal amounts.
 - Loosen or remove rack boot small end clamp (**B**) so that rack boot moves freely on tie rod shaft and does not become twisted.

Tightening torques

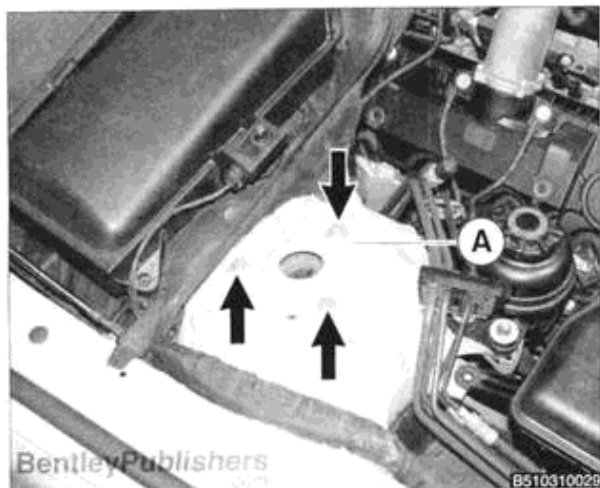
Lock nut to tie rod end (M16 x 1.5)	51 Nm (38 ft-lb)
-------------------------------------	------------------

Front camber, adjusting

Set front toe before adjusting camber. Camber and toe influence each other. Camber is the deviation of each wheel from vertical. If necessary, adjust camber by removing front strut top centering pin.

CAUTION—

- Do not attempt to straighten out accident-caused changes in axle geometry by adjusting the camber.



Working at strut top bearing:

- Remove centering pin (A).
- Loosen strut top bearing mounting nuts (arrows) 1 - 1½ turns.

— Raise vehicle until wheels are off ground. Support vehicle safely.

WARNING—

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

— Working below vehicle, use compressed air to clean off debris in wheel housing near strut top bearing.



Fit BMW special tool 32 3 190 over inboard strut top nut.

- Turn knurled nut on tool (arrow) to adjust camber to specified value.
- Replace outboard strut top mounting nuts with new, then tighten down.

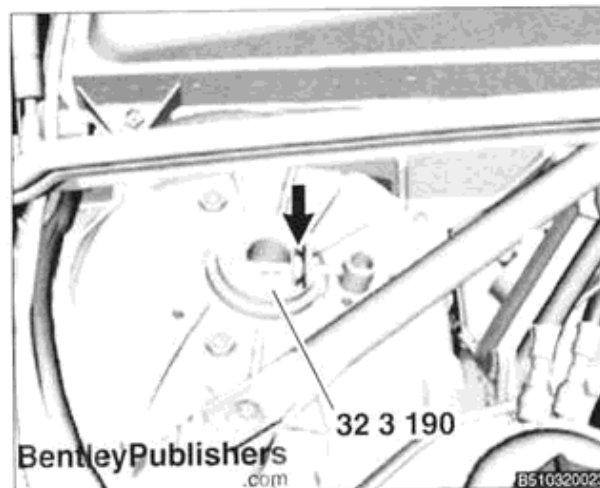
— Remove special tool and replace inboard strut top mounting nut with new, then tighten down.

Tightening torque

Strut top bearing to chassis (replace M8 shoulder nuts with new)	34 Nm (25 ft-lb)
---	------------------

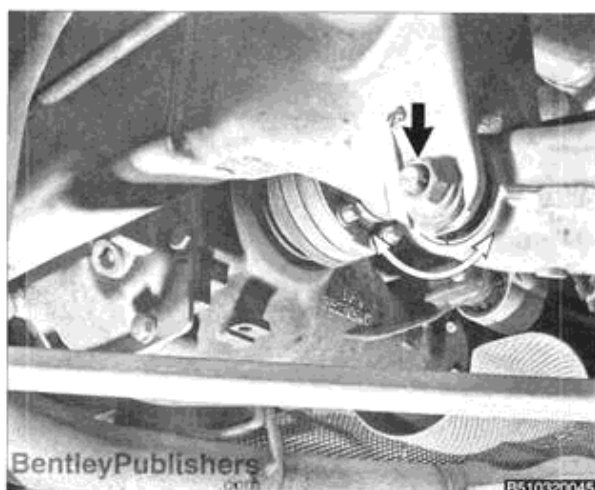
— Check directional stability of vehicle. If necessary, reset toe. See **Front toe, setting**.

— Vehicle with active steering: Use BMW scan tool to zero steering angle sensor and commission active steering.



320-36 Steering and Wheel Alignment

Rear camber, adjusting



Rear camber, adjusting

Adjust rear camber before setting toe. A camber change means a toe change as well. Camber is the deviation of each wheel from vertical.

- Raise vehicle and support safely.

WARNING—

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

- ◀ Working at swing arm underneath rear suspension:

- Replace nut on swing arm eccentric bolt (**arrow**) with new. Tighten to 5 Nm (finger tight).
- Lower vehicle on alignment rack and use eccentric bolt to adjust camber (**curved arrow**).
- Tighten swing arm eccentric bolt to specification with vehicle in normal loaded position.

Tightening torque

Swing arm eccentric fastener to rear subframe (replace nut, tighten with suspension loaded)	165 Nm (122 ft-lb)
---	--------------------

Rear toe, setting

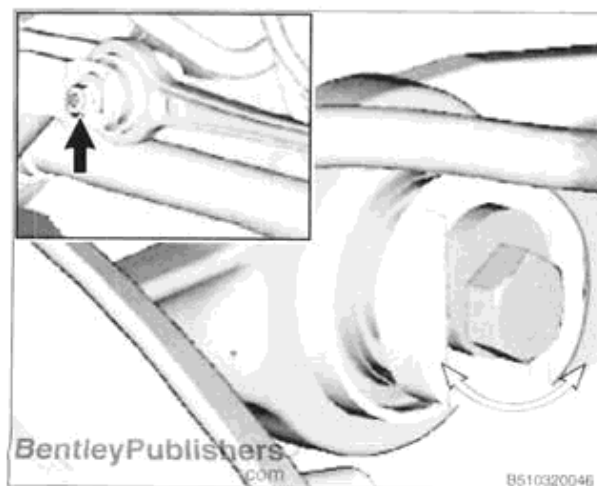
Adjust rear camber before setting toe. A camber change means a toe change as well. Toe is the difference in the distance between the front of the wheels and the rear of the wheels.

- ◀ Working at guide link:

- Replace nut (**arrow**) on eccentric bolt. Tighten to 5 Nm (finger tight).
- Lower vehicle on alignment rack and use eccentric bolt to set toe (**curved arrow**).
- Tighten guide link eccentric bolt to specification with vehicle in normal loaded position.

Tightening torque

Guide link eccentric fastener to rear subframe (replace nut, tighten with suspension loaded)	65 Nm (48 ft-lb)
--	------------------



Caster

Front and rear caster are fixed 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.

Alignment specifications

Table d. Alignment specifications, Sedan (E60)

Parameter	Specifications				
	Standard suspension	Sport suspension	Rough road suspension	Long wheelbase	xDrive
Front axle					
Total toe	0° 8' ± 12'	0° 8' ± 12'	0° 8' ± 12'	0° 12' ± 12'	0° 12' ± 12'
Adjustment total toe*	0° 8' ± 4'	0° 8' ± 4'	0° 8' ± 4'	0° 12' ± 4'	0° 12' ± 4'
Toe difference between right and left**	max 12'	max 12'	max 12'	max 12'	max 12'
Camber (difference between left / right, maximum 30')	-12' ± 30'	-30' ± 30'	-12' ± 30'	-05' ± 30'	-20' ± 30'
Adjustment camber*	-12' ± 25'	-30' ± 25'	-12' ± 25'	-05' ± 25'	-20' ± 25'
Toe angle difference with 20° lock on inside wheel (difference between left / right, maximum 30')	1° 41' ± 30'	1° 47' ± 30'	1° 43' ± 30'	1° 42' ± 30'	1° 53' ± 30'
Front caster (difference between left / right maximum 30')					
Front wheel displacement	0° ± 15'	0° ± 15'	0° ± 15'	0° ± 15'	0° ± 15'
Maximum wheel lock					
Inside wheel (approx.)	43° 22'	43° 01'	43° 58'	43° 22'	39° 42'
Outside wheel (approx.)	34° 00'	33° 38'	34° 22'	34° 06'	31° 38'
Rear axle					
Total toe	0° 18' ± 12'	0° 18' ± 12'	0° 18' ± 12'	0° 18' ± 12'	0° 18' ± 12'
Adjustment total toe*	0° 18' ± 4'	0° 18' ± 4'	0° 18' ± 4'	0° 18' ± 4'	0° 18' ± 4'
Camber (difference between left / right maximum 30')	-2° 00' ± 25'	-2° 00' ± 25'	-2° 00' ± 25'	-2° 00' ± 25'	-2° 00' ± 25'
Adjustment camber*	-2° 00' ± 5'	-2° 00' ± 5'	-2° 00' ± 5'	-2° 00' ± 5'	-2° 00' ± 5'
Geometrical axis deviation	0° ± 12'	0° ± 12'	0° ± 12'	0° ± 12'	0° ± 12'
* To minimize inaccuracy, use a narrower tolerance					
** Front axle toe difference = criterion for steering wheel inclination					

320-38 Steering and Wheel Alignment

Alignment specifications

Table e. Alignment specifications, Sports Wagon (E61)			
Parameter	Specifications		
	Standard suspension	Sport suspension	xDrive
Front axle			
Total toe	0° 12' ± 10'	0° 12' ± 10'	0° 12' ± 12'
Adjustment total toe*	0° 12' ± 4'	0° 12' ± 4'	0° 12' ± 4'
Toe difference between right and left**	max 12'	max 12'	max 12'
Camber (difference between left / right, maximum 30')	-12' ± 30'	-30' ± 30'	-20' ± 30'
Adjustment camber*	-12' ± 25'	-30' ± 25'	-20' ± 25'
Toe angle difference with 20° lock on inside wheel (difference between left / right, maximum 30')	1° 41' ± 30'	1° 47' ± 30'	1° 53' ± 30'
Front caster (difference between left / right maximum 30')			
Front wheel displacement	0° ± 15'	0° ± 15'	0° ± 15'
Maximum wheel lock			
Inside wheel (approx.)	43° 22'	43° 01'	39° 42'
Outside wheel (approx.)	34° 00'	33° 38'	31° 38'
Rear axle			
Total toe	0° 18' ± 12'	0° 18' ± 12'	0° 18' ± 12'
Adjustment total toe*	0° 18' ± 4'	0° 18' ± 4'	0° 18' ± 4'
Camber (difference between left / right maximum 30')	-2° 00' ± 25'	-2° 00' ± 25'	-2° 00' ± 25'
Adjustment camber*	-2° 00' ± 5'	-2° 00' ± 5'	-2° 00' ± 5'
Geometrical axis deviation	0° ± 12'	0° ± 12'	0° ± 12'
* To minimize inaccuracy, use a narrower tolerance			
** Front axle toe difference = criterion for steering wheel inclination			

