

STEERING

Electric Power Steering (EPS) - Z4

ELECTRIC POWER STEERING (EPS)

The main difference between hydraulic and electric power steering systems is in the method of generating the power assistance force that reduces the amount of force that the driver has to apply to the steering wheel.

Hydraulic power steering systems feature a pump that is driven either by a belt running off the engine or by an electric motor. The pump is part of a hydraulic system which generates the fluid pressure/flow that is used to produce the power assistance for steering.

Electric power steering systems produce the power assistance force directly by means of an electric motor that transmits its torque either to the steering column or the steering gear. Therefore, such systems generally require extra gearing to connect the electric motor to the existing steering system components.

Otherwise, the basic design of the steering system is the same (e.g. rack-and-pinion steering gear for both hydraulic and electric power steering systems).

The steering characteristics, e.g. amount of steering force required, progression of steering force, feedback from the roadwheels, are subject to strict development specifications that have resulted in continual optimization of the hydraulic power steering systems so far used. The new electric power steering systems have to match up to the outstanding steering characteristics of BMW vehicles BMW owners have come to experience.

VERSIONS OF ELECTRIC POWER STEERING

The table below categorizes EPS systems on the basis of the mounting position of the servo unit consisting of electric motor and reduction gearing. With the advent of EPS, the method of generating the power assistance for steering changes from hydraulic to electrical means.

INDEX EXPLANATION REFERENCE CHART

Index	EPS with APA	C-EPS
Vehicles	Z4 (E89)	Z4 (E85, E86)
Manufacturer	ZF	ZF
Type of Motor	Brushless Motor	Brushless Asynchronous Motor
Location of Motor and Reduction Mechanism	Parallel to Steering Rack	Upper Part of Steering Column Inside Passenger Compartment
Design of Reduction Mechanism	Belt and Ball Screw Drive	Worm Shaft and Gear

DISTINCTION FROM ACTIVE STEERING

The electric motor of an EPS system is capable of superimposing additional force in addition to the force applied by the driver. The EPS is able to determine the level and timing of that force independently of such factors as the engine speed.

The rigid link between the steering wheel and the front wheels remains unchanged with electric power steering. The gear ratio of the rack is fixed, so the position of the steering wheel is always directly related to the position of the front wheels.

The electric motor in an active steering system, by contrast, is capable of superimposing a steering angle (which changes the ratio between steering wheel and front wheels) but not a steering force.

The steering train of an active steering system is split by a double planetary gear. This enables the active steering to alter the steering angle of the roadwheels without it being felt by the driver through the steering wheel.

In order for the wheels to adopt the total steering angle produced by the steering wheel position plus the superimposed adjustment, a bracing force is required: the driver has to hold the steering wheel firmly. A pump unit is also required. This can only be of the hydraulic type on active steering systems. Only hydraulic pump units are currently capable of providing the combination of high positioning force and positioning speed.

FEATURES

The use of electric power steering provides many advantages for the BMW customer, the environment and the BMW Group.

Interacting with the well-proven suspension concepts, a unique combination of driving comfort and dynamics is achieved. The steering properties (e.g. the level of steering torque assistance and damping) can be finely tuned by correspondingly programming the electrical system while ensuring optimum adaptation to the different vehicle philosophies.

Thus, despite the use of identical mechanical components, the system will be capable of perfect adaptation to future BMW models.

Where more precise steering and better handling characteristics are desired for a more sports-style model, it can be achieved by reducing the amount of power assistance.

Although the driver then has to apply slightly more force to the steering wheel, the feedback from the roadwheels gives the more "direct" feel desired.

By contrast, a greater degree of power assistance can be programmed for models whose steering characteristics are to be more comfort-orientated.

With the disappearance of the hydraulic system (consisting of pump, hoses, cooler, fluid, etc.), assembly of the steering on the production line is more efficient for the manufacturer. The EPS steering system is supplied as a pre-assembled unit and fitted to the vehicle as such. In addition, the EPS also eliminates the environmental hazard of hydraulic fluid leakage.

Because the electric motor is activated only when required (when steering but not when driving straight ahead) fuel consumption is reduced and the effective power output of the combustion engine increased when compared to a conventional hydraulic power steering system.

The example figures below illustrate the difference in power consumption between the two steering systems.

POWER CONSUMPTION REFERENCE CHART

Power Consumption	Electric Power Steering	Hydraulic Power Steering
Minimum Demand	10 Watts	300 - 400
Maximum Demand	1,000 Watts	2,000

FEATURES OF ELECTRIC POWER STEERING

Improved Handling Dynamics

- Steering characteristics perfectly adapted to vehicle model
- Active return to center
- Linear dynamics benefits of up to 2 kW

Greater Driving Comfort

- Steering train isolated from suspension vibration while still transmitting the important road feedback (different road surface conditions) to the driver
- Improved isolation of interference from the road surface (less steering judder)
- Electronically controlled, speed-dependent power-assistance (e.g. greater when parking)

Greater Driving Safety

- Servotronic function: EPS assists the driver to hold the correct line, particularly at high speeds, by providing a lower level of power assistance than at low speeds.
- Steering wheel backlash is reduced by active speed-dependent damping. This function also reduces the vehicle's tendency to slew in response to abrupt steering wheel movements made by the driver.

Better Environmental Credentials

- Fuel saving of approx. 0.2 l per 100 km
- No possibility of leakage from the hydraulic system

STEERING

Principles of Operation - Z4

PRINCIPLES OF OPERATION

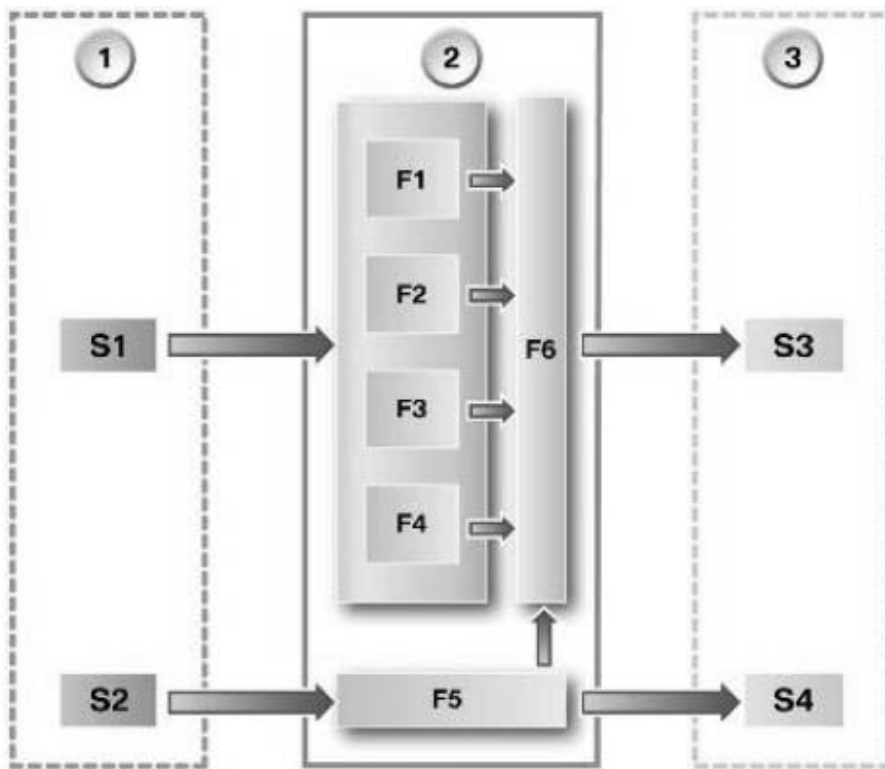


Fig. 1: Overview Of EPS Functions

Courtesy of BMW OF NORTH AMERICA, INC.

INDEX EXPLANATION REFERENCE CHART

Index	Explanation
1	Input
2	EPS control unit
3	Output
S1	Input signals for EPS control and modulation functions ○ Steering force applied by driver ○ Road speed and other variables that describe the driving situation ○ Steering angle, steering angle rate of change
S2	Input signals for EPS status control ○ Terminal 15 on/off

	○ Engine running/not running
F1	"Speed-dependent power steering assistance" function
F2	"Active steering wheel return" function
F3	"Active damping" function
F4	"Active roadwheel feedback" function
F5	"Status control" function
F6	"Co-ordination of specified settings" function
S3	Output signal of EPS control and modulation functions: control of electric motor
S4	Output signal of EPS status control: ○ Demand for higher cooling capacity ○ Control of warning and indicator lamps

EPS INPUT VARIABLES

EPS INPUT VARIABLES REFERENCE CHART

Steering Column Switch Cluster (SZL)	
Transmitter	Steering column switch cluster with steering-angle sensor
Signal	Steering angle set by driver
Transmitted via	PT-CAN
Receiver	EPS control unit
Function	Active steering-wheel return

DYNAMIC STABILITY CONTROL REFERENCE CHART

Dynamic Stability Control (DSC)	
Transmitter	Dynamic stability control with DSC sensor
Signal	Road speed and other variables that describe the driving situation
Transmitted via	PT-CAN
Receiver	EPS control unit
Function	Steering power assistance, active roadwheel feedback

DIGITAL MOTOR ELECTRONICS REFERENCE CHART

Digital Motor Electronics (DME)	
Transmitter	Digital motor electronics
Signal	Engine running
Transmitted via	PT-CAN
Receiver	EPS control unit
Function	Status control

CAR ACCESS SYSTEM REFERENCE CHART

Car Access System (CAS)	
Transmitter	Car Access System

Signal	Terminal 15 status
Transmitted via	PT-CAN
Receiver	EPS control unit
Function	Status control

EPS OUTPUT VARIABLES

DIGITAL MOTOR ELECTRONICS REFERENCE CHART

Digital Motor Electronics (DME)	
Transmitter	EPS control unit
Signal	Demand for greater cooling capacity
Transmitted via	PT-CAN
Receiver	Digital motor electronics
Function	Control of electric fan

INSTRUMENT CLUSTER REFERENCE CHART

Instrument Cluster (Kombi)	
Transmitter	EPS control unit
Signal	Request for failure message
Transmitted via	PT-CAN
Receiver	Instrument cluster
Function	Control of warning and indicator lamps

DME FUNCTIONS USED BY EPS

Intelligent Alternator Control

With the advent of "intelligent alternator control" (IGR) on the DME as an additional means of CO₂ reduction, the alternator voltage is adjusted according to the driving situation and battery charge level. Therefore, there will be periods in which the electrical system voltage is at the level that has been normal up to now (approximately 13.8 V). However, there will also be situations in which the voltage drops to around or just below 12 V.

The EPS components, and in particular the electric motor, are rated for a power supply of 12 V. At that level, the requirements in terms of maximum steering power assistance and speed are satisfied.

If the maximum EPS output were demanded at an alternator voltage of 12 V, the high current draw by the electric motor would produce a voltage drop on the EPS power supply line. The consequence would be an EPS input voltage of substantially below 12 V and, therefore, a reduced level of steering power assistance.

In order to prevent such an undesirable situation occurring, there is an additional IGR function for the EPS that is implemented without additional exchange of signals with the EPS and comprises the following features:

- Observation of whether an operating status exists in which high EPS output is required.

- The bus signals indicating steering angle rate of change and road speed are monitored for that purpose. A high level of EPS output is identified when the steering angle rate of change is high at the same time as the road speed is low.
- Action: Increase of alternator output and temporary increase of electrical system voltage when high EPS output is detected.

This function ensures that the power supply at the EPS input terminals always provides at least the rated voltage of 12 V regardless, to a great extent, of other variables.

NOTE: **Detecting statuses involving high EPS output and raising the electrical system voltage constitute a control cycle that is completed within 2 seconds at most. As it is also an infrequent situation, it is unlikely that it will be the subject of customer complaints. If a particularly observant customer complains of momentarily reduced power steering assistance, this control cycle may possibly be the cause. If there are repeated complaints, performing a diagnosis on the power supply is advisable.**

Speed-dependent Power Steering Assistance

The Servotronic function that is only achievable by means of additional system complexity on hydraulic steering systems is implemented in the form of software on the electric power steering system and is therefore available with EPS.

The customer expects the lightest and smoothest steering movement possible when maneuvering or parking into spaces. Less sensitive steering setup is required when driving at high speed so that the vehicle can be kept on course more effectively.

Based on the sensor signals indicating the vehicle's road speed and the steering torque applied by the driver, the EPS provides a high level of power steering assistance at low speeds and when stationary (maximum convenience).

At high speeds on the other hand, the EPS demands greater steering force from the driver by reducing the level of power steering assistance. This helps the driver to hold a constant line.

As can be seen from the graph, the level of power assistance is computed on the basis not only of vehicle speed but also of the steering torque applied by the driver. If the driver applies a small amount of turning force to the steering wheel, the assistance from the EPS also initially remains at a relatively low level. This produces excellent self-centering characteristics, i.e. the steering does not react over-sensitively from the straight-ahead position.

If the driver applies greater force to the steering wheel, there is a smooth transition to a steeper curve gradient. As a result, the driver obtains the expected high degree of assistance when making abrupt steering movements or tight maneuvers.

The characteristics described here have been adopted by the EPS from the familiar hydraulic steering systems.

The transition between the curves is not abrupt but progressive. The EPS calculates appropriate transitional

levels where necessary.

The steering characteristics of the EPS is influenced by the driver as in other vehicles by pressing the driving dynamics button.

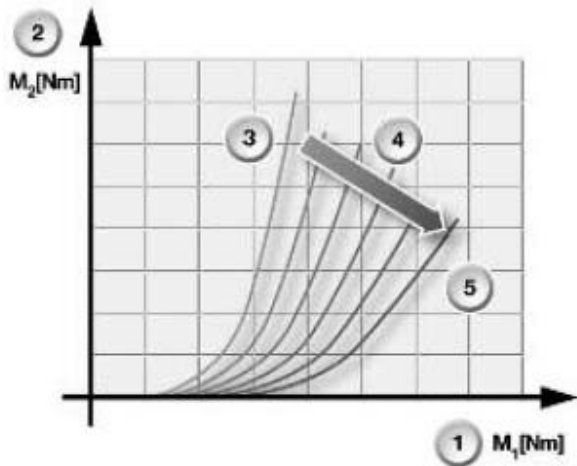


Fig. 2: EPS Speed-Dependent Power Steering Assistance Graph
Courtesy of BMW OF NORTH AMERICA, INC.

INDEX EXPLANATION REFERENCE CHART

Index	Explanation
1	Steering torque applied by driver
2	Power assistance torque provided by EPS
3	Vehicle road speed equal to zero
4	Vehicle road speed increases
5	Vehicle road speed at maximum

Active Steering-wheel Return

In addition to the natural self-centering characteristics inherent in the steering and suspension systems, this function assists steering-wheel return by appropriate operation of the electric motor.

The following signals are required for this purpose:

- Road speed
- Steering torque applied by driver
- Steering angle and
- Steering angle rate of change

However, the steering angle signal is only required for calibration with the electric-motor position sensor in order to determine the target position for steering-wheel return (steering angle equal to zero). Thereafter, the active steering-wheel return function uses the electric-motor position sensor signal as it has a higher resolution

than the steering angle sensor signal and thus enables more precise control.

If the steering-angle sensor signal is not available, e.g. due to a fault on the SZL, the active steering-wheel return function cannot operate. The other EPS functions remain active. Customers may possibly describe the resulting vehicle behavior as "pulling to one side" because the steering wheel does not return to the straight-ahead position as precisely as usual.

The necessity for activation of the active steering-wheel return function arises when, for example, the driver allows the steering wheel to slip when exiting a corner. The signal values reflecting that situation which the EPS uses to detect the situation are:

- Steering angle clearly not equal to zero and
- Steering torque applied by driver approximately equal to zero

The electric motor is then operated by the EPS so as to generate a return force that produces smooth return of the steering wheel to a position close to the straight-ahead position.

NOTE: If a customer complains of the car "pulling to one side" the possible causes to be considered include not only a mechanical problem with the suspension/steering but also a signal or communication fault between the EPS and the steering column switch cluster/steering-angle sensor. In such a situation, the EPS is unable to provide the active steering wheel return function and this may be perceived by the customer as the vehicle "pulling to one side". Therefore, before checking the wheel alignment, the EPS fault memory should be checked and, if necessary, the stored testing sequence followed in order to make certain the signal from the steering-angle sensor is present.

The clearly perceptible improvement compared with the self-centering characteristics of hydraulic power steering systems is evident from the graph below.

The electric power steering returns to the center position more dynamically and precisely. This applies to all electric power steering systems used by BMW because they all incorporate the active steering-wheel return function.

The self-centering characteristics of an EPS system without active steering wheel return shown on the graph are for comparison purposes only. They reveal themselves to be inferior to those of a hydraulic power steering system. This is due to the greater inertia of the electric motor and reduction gearing.

However, all EPS systems used by BMW incorporate active steering-wheel return and therefore offer the benefits described above.

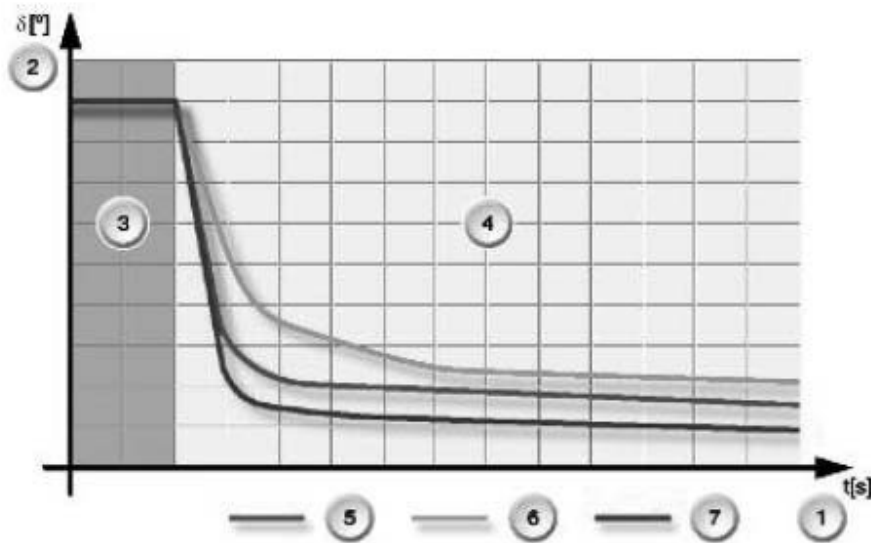


Fig. 3: Self-Centering Characteristics Of Steering Systems
 Courtesy of BMW OF NORTH AMERICA, INC.

INDEX EXPLANATION REFERENCE CHART

Index	Explanation
1	Time
2	Steering wheel angle
3	Driver holds steering at a constant lock (cornering)
4	Driver lets steering wheel slip (exiting corner)
5	Self-centering characteristics of a hydraulic power steering system
6	Theoretical self-centering characteristics of EPS without active steering-wheel return
7	Self-centering characteristics of EPS with active steering-wheel return

Active Damping

The undesirable steering-wheel movements to be damped can be produced either by inadvertent steering input by the driver or feedback from the road/roadwheels.

Damping Roadwheel Feedback

The design of the front suspension (double link Macpherson strut suspension) on its own ensures that vertical wheel movements produce very little lateral force on the track rods.

Due to the low ratio of the reduction gear by which the electric motor is connected to the steering rack, the inertia of the electric motor also has a damping effect on the forces and movements transmitted from the roadwheels to the steering wheel. Those mechanical damping effects are supplemented by an electronic damping function on the part of the EPS. It analyses the movements of the steering rack (using the signals from the electric-motor position sensor) and operates the electric motor accordingly in response.

This means that feedback from external forces is transmitted in controlled amounts to the steering wheel so that,

on the one hand, the driver obtains sufficient information about the nature of the road surface, but on the other, undesirably extreme steering wheel backlash is prevented.

Damping Steering Input from Driver

Particularly at high speeds, unintentional jerky movements of the steering wheel by the driver have a negative effect on vehicle handling stability. So-called "snatching" of the steering wheel can, under certain circumstances, cause the vehicle to start rocking, which can lead to snaking and the driver ultimately losing control of the vehicle if corrective action is not taken quickly enough.

The EPS detects such steering input and operates the electric motor so as to substantially damp the movements, particularly at high speeds. As a result, vehicle rocking is prevented.

Damping of Steering Input by EPS

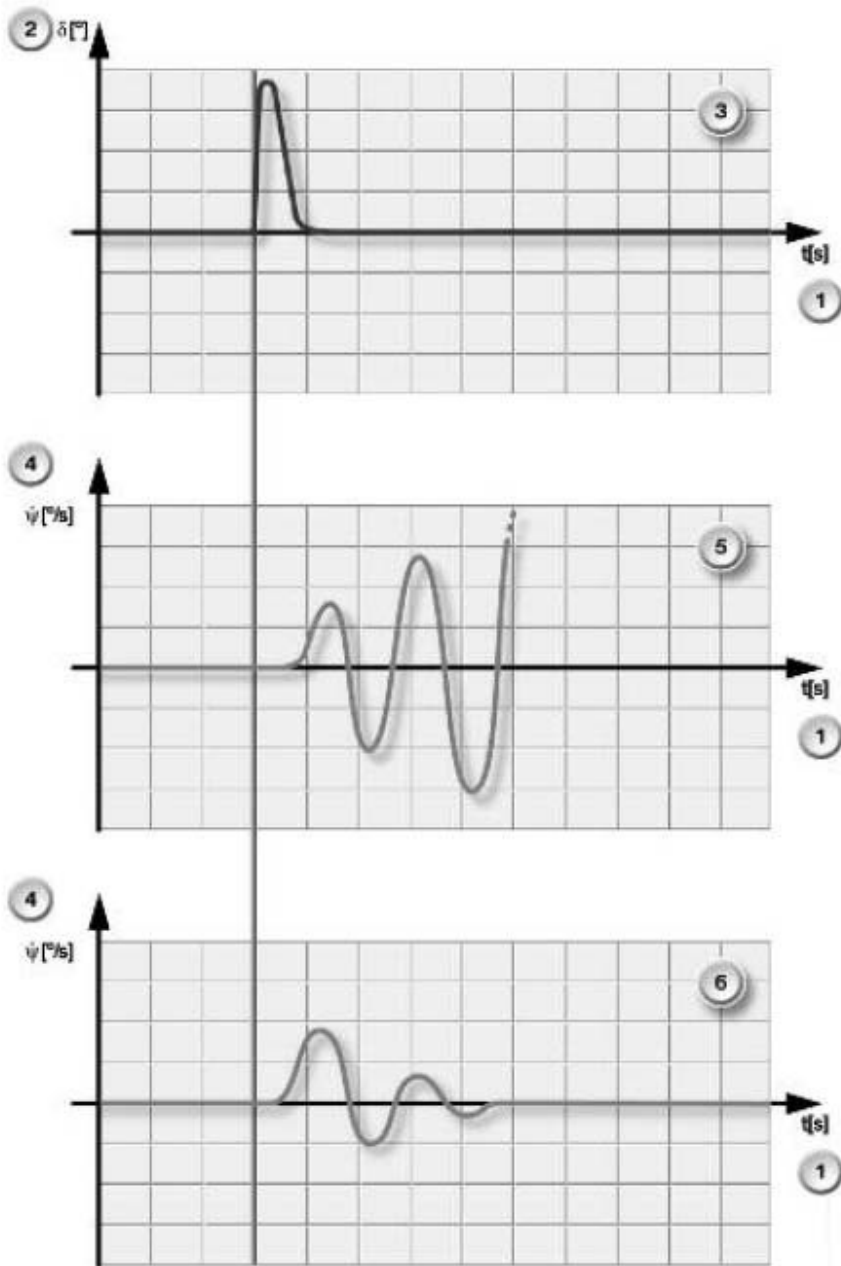


Fig. 4: Damping Of Steering Input By EPS
 Courtesy of BMW OF NORTH AMERICA, INC.

INDEX EXPLANATION REFERENCE CHART

Index	Explanation
1	Time
2	Steering wheel angle
3	Steering angle progression (steering input by driver, "snatching" the steering wheel)
4	Yaw rate

5	Theoretical vehicle response without active damping: the turning action following the steering input is progressively amplified at high vehicle speed.
6	Desirable vehicle response with active damping: the turning action is heavily damped even at high vehicle speeds.

Active Roadwheel Feedback

Partly due to the damping effect of the inertia of the electric motor, an EPS system can inherently not provide as direct feedback about the nature of the road surface as a hydraulic power steering system.

In order to obtain virtually identical roadwheel feedback characteristics on vehicles with EPS, the EPS analyses information that describes the vehicle's dynamic handling situation. From that information, the EPS computes additional "EPS road surface data". As a result, the driver obtains better roadwheel feedback characteristics which are very similar to those of a hydraulic power steering system.

Control

The EPS status control function makes the overriding decision as to whether operation of the electric motor is permissible or not. It produces a clearance signal that is sent to the EPS function that is co-ordinating the subordinate specified settings of the control and modulation functions.

The conditions for allowing operation are the following:

- Ignition must be switched on
- Engine must be running
- There must be no EPS input signal faults or EPS internal faults present

The response to detected faults described below represents an exception.

Status Shutdown in the Event of Faults

A primary aim in the development of the EPS was to ensure that vehicle response in the event of faults would remain manageable by the driver. Therefore, under no circumstances must a sudden high steering force in either direction be allowed to occur. For that reason, the EPS has numerous monitoring functions for detecting faults on the sensors, actuators and associated systems that are involved in EPS operation.

All fault statuses in which reliable and correct control of the electric motor is not possible result in the disabling of motor operation and, therefore, shutdown of the EPS functions.

The consequence of that is that the driver no longer benefits from the convenience of power-assisted steering. More importantly, however, incorrect control of the electric motor is prevented.

NOTE: **The loss of power steering assistance in the event of faults constitutes an intended system response on the part of the EPS. Although such a response may be slightly unnerving for the driver, the vehicle remains fully steerable with greater physical effort.**

Loss of power steering assistance in the event of faults occurs both with electric and hydraulic power steering. The two systems thus also behave in a similar manner in response to faults.

In such a fault situation, a yellow warning lamp lights up on the instrument cluster. The driver is also notified of the fact that power steering assistance from the EPS is no longer available by display of the appropriate Check Control symbol together with the explanatory message on the Central Information Display.



Fig. 5: Identifying Warning Lamp Of Power Steering Fault
Courtesy of BMW OF NORTH AMERICA, INC.

Co-ordination of Specified Settings

The specified settings for the control and modulation functions for operating the electric motor are co-ordinated at a central point by the EPS software. If a clearance signal from the status control function is present, the individual specified settings are normally added together and signalled as a total value.

In certain transitional situations the specified settings are filtered before they are signalled.

The following are examples of such cases:

- The EPS goes into operation after the engine is started. The power assistance torque is increased progressively until the desired level is reached.
- The EPS reduces the power steering assistance for function-related reasons (see also the section "**SUPPLEMENTARY FUNCTIONS**").

In the event of a fault the control signal for the electric motor is abruptly cancelled instead of being filtered in order to prevent incorrect operation as quickly as possible.

Supplementary Functions

The functions described below are encountered only rarely in special operating situations. The information given here can help to distinguish those special operating statuses, which do not require repairs, from genuine faults when handling complaints from customers.

Protection Against Overload

The EPS reduces the degree of power steering assistance if the temperature of EPS components becomes too high. By limiting motor operation, the amount of heat generated by the EPS itself is also limited, thereby protecting the components against excessive thermal stress.

This action starts to come into effect from a temperature of approximately 100°C and escalates to the point where power steering assistance is reduced to zero at a temperature of 115°C.

Upwards of a certain degree of function restriction, the warning light on the instrument cluster is switched on (see the section "**SHUTDOWN IN THE EVENT OF FAULTS**") and a fault registered in the fault memory.

In addition to reducing power steering assistance, the EPS also requests higher electric fan output from the DME in order to produce a greater cooling effect.

This type of overload can occur at high ambient temperatures combined with simultaneous high degrees of steering activity, especially when stationary.

Another overload situation can occur if an attempt is made to turn the front wheels against a solid obstacle (e.g. a kerbstone). If this situation occurs repeatedly at short intervals, the degree of power steering assistance is similarly reduced. This firstly protects the EPS components against excessive mechanical stresses, and secondly signals to the driver that there is a solid object preventing the wheels turning.

The EPS detects such situations by comparing the control signals to the electric motor with the motion of the motor.

NOTE: **The EPS reduces the power steering assistance in overload situations. If customer complaints are received, the customer should be questioned as to the situation in which the symptoms occurred before commencing any repair work. If necessary enlighten the customer as to the way in which these protective functions operate.**

End Stop as Software Function

Although the EPS steering gear also incorporates mechanical end stops, there is a function that steeply reduces the level of power assistance shortly before the mechanical end stops are reached. Although the driver will perceive this as increased steering resistance, it makes turning the wheels to full lock much smoother overall.

In addition, this function reduces the stresses on mechanical and electrical components of the steering system and thus contributes to the achievement of long service life combined with reliable operation.

STEERING

Service Information - Z4

SERVICE INFORMATION

BRAKES

For safety reasons, the parking brake cannot be activated for as long as the EMF control unit is in installation mode. If the EMF button is pulled, the EMF indicator lamp in the instrument cluster will flash yellow.

The exact procedure for bedding-in the service brakes is described in the Repair Instructions. The instructions must be followed exactly.

ADAPTIVE M CHASSIS AND SUSPENSION

For standardization reasons, the continuous electronic damper control on the E89 is simply referred to as EDC.

A detailed functional description of the EDC can be found in Background Material E65 Dynamic Driving Systems from April 2001.

DYNAMIC DRIVING SYSTEMS

Cruise control with brake function is described in detail in the Participant's Manual E90 Dynamic Driving Systems.

Dynamic driving switch

The yellow DSC indicator and warning lamp and the DTC button have new symbols. Beginning with the F01/F02, these new DSC symbols will replace those previously used.

REPLACING AN EPS SYSTEM

The EPS components consisting of steering torque sensor, EPS control module unit, electric motor with position sensor, reduction gear and steering rack form a single unit (often referred to as "EPS steering rack assembly") that can only be replaced as a complete unit. To do so, the unit has to be disconnected from the track rods and the lower end of the steering column.

After a new EPS steering rack is fitted, a front wheel and tracking alignment check is required. The commissioning sequence involves coding the EPS to match the vehicle model and the diagnosis function for learning the end-stop positions.

INTELLIGENT ALTERNATOR CONTROL AND EPS

Detecting statuses involving high EPS output and raising the electrical system voltage constitute a control cycle that is completed within 2 seconds at most. As it is also an infrequent situation, it is unlikely that it will be the subject of customer complaints.

If a particularly observant customer complains of momentarily reduced power steering assistance, this control cycle may possibly be the cause. If there are repeated complaints, performing a diagnosis on the power supply is advisable.

ACTIVE STEERING WHEEL RESET

If a customer complains of the car "pulling to one side" the possible causes to be considered include not only a mechanical problem with the suspension/steering but also a signal or communication fault between the EPS and the steering column switch cluster/steering-angle sensor. In such a situation, the EPS is unable to provide the active steering wheel return function and this may be perceived by the customer as the vehicle "pulling to one side".

Therefore, before checking the wheel alignment, the EPS fault memory should be checked and, if necessary, the stored testing sequence followed in order to make certain the signal from the steering-angle sensor is present.

PROTECTION AGAINST OVERLOAD

The EPS reduces the power steering assistance in overload situations. If customer complaints are received, the customer should be questioned as to the situation in which the symptoms occurred before commencing any repair work.

If necessary enlighten the customer as to the way in which these protective functions operate.

SHUTDOWN IN THE EVENT OF FAULTS

The loss of power steering assistance in the event of faults constitutes an intended system response on the part of the EPS.

Although such a response may be slightly unnerving for the driver, the vehicle remains fully steerable with greater physical effort.

ELECTRICAL CONNECTIONS

If the EPS steering rack assembly has to be replaced, only the power supply and bus connection have to be disconnected and not the connection for the steering torque sensor.

If a customer complains of inadequate power steering assistance, it can be due to a voltage drop across the power supply connection.

Therefore, in such cases the power supply connection should be checked for corrosion.

STEP-DOWN GEAR

If a defective gaiter is discovered, it should be replaced so as to prevent water entering the steering gear. At the same time as replacing the gaiter, the water drain valve at the lowest point of the reduction gear should also be replaced and is included in the repair kit.

Corrosion on the moving parts of the steering gear does not normally result in heavy steering. Instead, corrosion is frequently a cause of noises from the steering mechanism.

If customers complain of loud steering noises and if they are definitely attributable to the EPS steering rack, the complete EPS steering rack assembly must be replaced.

STEERING

Steering - Operating Fluids

1.0 ZF GEMMER STEERING

The ZF Gemmer steering is permanently filled with oil. There is no drain plug.

2.0 ZF RACK AND PINION STEERING WITHOUT POWER ASSIST

The ZF rack and pinion steering is lubricated for its service life and therefore does not require servicing.

In case of repair, steering components on E21 vehicles are to be lubricated with a sodium-based grease, with a temperature range of -30°C to +75°C.

BMW PART NUMBER SPECIFICATION

Calypsol D 4024	BMW Part No. 32 11 1 116 929
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3.0 BALL AND NUT OR RACK AND PINION POWER STEERING

Only reputable brand Automatic Transmission Fluid (ATF) of Dexron® III formulation may be used for the power steering and power steering pump.

In case of brief hydraulic noise after starting at low outside temperatures, we recommend replacing the red ATF with green CHF or LHM oil (see below).

4.0 ZF Ball and Nut Power Steering with H31 System

The approved oils for BMW models with power steering and the H31 brake booster system are identical with those oils approved for power steering without the H31 system except for the following:

E32 models with self-leveling rear suspension and mutual oil supply tank in the engine compartment.

Countries with very low outside temperatures (e.g. Canada) had their power steering systems filled at the factory with Pentosin CHF 7.1 since 9/87 through 9/91. This is also to be used on vehicles built before 9/87.

Since 9/91, vehicles now use Pentosin CHF 11S instead of CHF 7.1.

BMW PART NUMBER SPECIFICATION

Pentosin CHF 7.1	BMW Part No. 81 22 1 468 879
Pentosin CHF 11S	BMW Part No. 82 11 1 468 041

These cars are marked with a pertinent label located close to the oil tank.

LHM oils (green color) of the following manufacturers may also be used instead of Pentosin (CHF 7.1):

Shell LHM

Castrol LHM

Exxon LHM

The mixing of CHF, LHM oils and ATF is not permitted.

Pentosin CHF 4548 was used on vehicles built before 9/87 but is no longer available. However, mixing of Pentosin CHF 7.1 with residual quantities of Pentosin CHF 4548 are permitted in these earlier vehicles. Mixing of these two oils is not permitted for E32 / E38 vehicles.

The hydraulic system for power steering and power-assisted brakes must be drained as completely as possible when changing from one type of oil to the other.

All oil supply reservoirs are marked with the type of oil being used - ATF or CHF.

5.0 OIL CHANGE FOR POWER STEERING

Regular oil changing is not necessary. However, it is recommended to replace the oil after completion of repairs (unit or line replacement). Use ATF of Dexron® III formulation.

6.0 HORN SLIP RINGS

Approved grease is a copper paste (former BMW Part No. 81 22 9 400 794).

BMW PART NUMBER SPECIFICATION

3M	Part No. 8945
CRC	Part No. 3046 010

SUSPENSION

Steering and Wheel Alignment - Repair - Z4

3200 ELECTRONIC CHASSIS ALIGNMENT

32 00 620 ADJUSTING REAR AXLE

NOTE: A camber change always means a toe change as well. The camber must therefore be adjusted first.

Adjusting camber

Replace nut (2) and tighten to 5 Nm.

Turn eccentric bolt (1) to adjust camber to setpoint value.

Tighten nut (2).

Tightening torque **33 32 3AZ** .

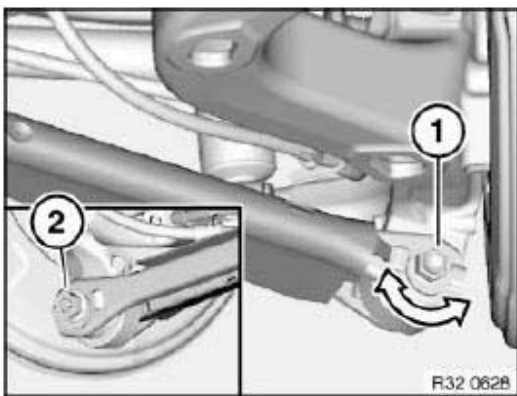


Fig. 1: Turning Eccentric Bolt

Courtesy of BMW OF NORTH AMERICA, INC.

Adjusting toe

Slacken bolts of bearing block by approx. 1 to 1.5 turns.

Attach special tool 32 3 030 to bolt head and pin (1).

Turn special tool 32 3 030 to adjust toe to specified value.

Tighten down screws.

Tightening torque 33 32 2AZ .

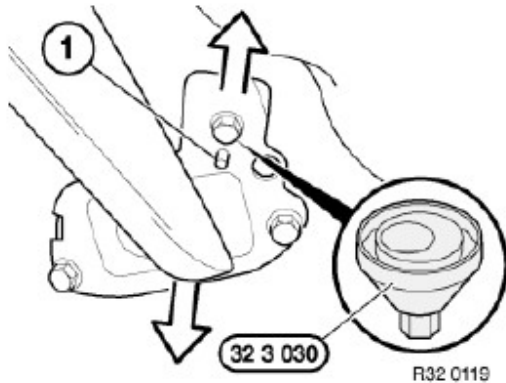


Fig. 2: Attaching Special Tool (32 3 030) To Bolt Head And Pin
Courtesy of BMW OF NORTH AMERICA, INC.

32 00 610 ADJUSTING TOE-IN AND CAMBER ON FRONT AXLE

IMPORTANT: Changes in axle geometry caused by accidents must under no circumstances be rectified by camber adjustment!

NOTE: Camber and toe-in influence each other. Adjust the toe-in first in order to simplify the adjustment procedure.
The centering pin may only be driven or twisted out if the camber is outside the specified tolerance after toe adjustment.

Adjust toe-in

Move steering into straight-ahead position by means of markings on cap (1) and steering gear (2).

Align steering wheel centrally and secure with steering wheel arrester.

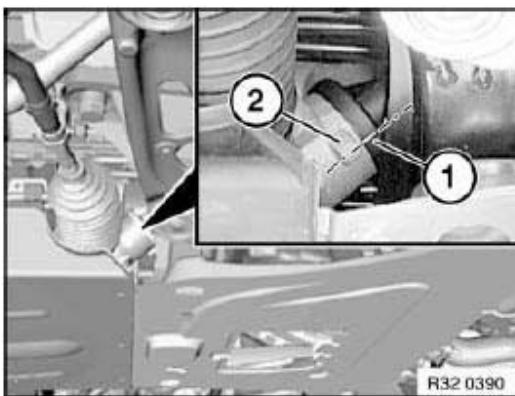


Fig. 3: Identifying Markings On Cap And Steering Gear

Courtesy of BMW OF NORTH AMERICA, INC.

Clean thread on tie rod.

Loosen screw (2).

Turn tie rod (3) and if necessary grip tie rod end (1) to adjust toe-in to setpoint value.

Tighten down clamping nut (2).

Tightening torque **32 21 3AZ** .

If necessary, correct installation position of gaiter.

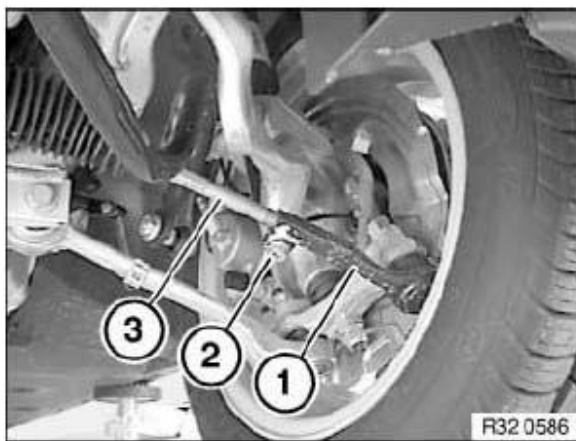


Fig. 4: Identifying Tie Rod With Tie Rod End And Screw
Courtesy of BMW OF NORTH AMERICA, INC.

Adjusting camber

Disassemble adjustment tool 32 3 140, recondition and fit with spindle 32 3 146.

- A. Previous version (consisting of 32 3 144 and 32 3 145)
- B. New version (consisting of 32 3 145, 32 3 146 and 32 3 147)

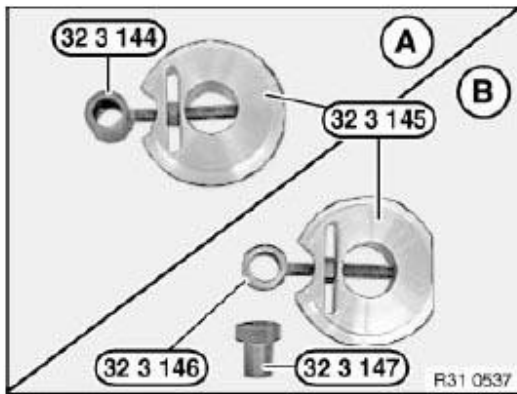


Fig. 5: Identifying Adjustment Tools With Spindles
 Courtesy of BMW OF NORTH AMERICA, INC.

Remove protective cap.

Twist/drive out centering pin (1).

Clean wheel arch from below in area of support bearing with compressed air.

Slacken nut (2).

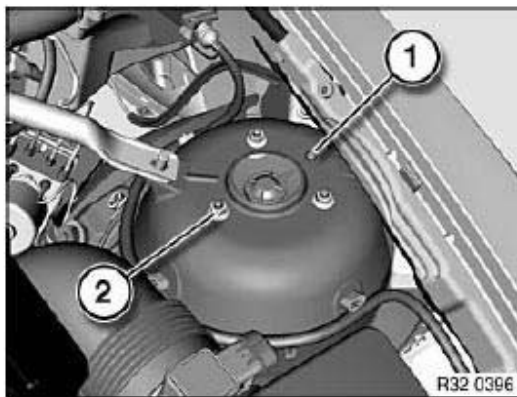


Fig. 6: Identifying Centering Pin And Nut
 Courtesy of BMW OF NORTH AMERICA, INC.

Insert special tool 32 3 140 into opening in wheel arch.

NOTE: The spindle 32 3 146 must be aligned in such a way that the short end of the guide sleeve (3) points upwards.

Screw knurled nut 32 3 147 onto stud.

Replace nuts (1) and screw on but do not tighten down fully.

Turn nut (2) of special tool 32 3 140 to adjust camber to setpoint value.

Tighten down nuts (1).

Tightening torque **31 31 1AZ** .

Remove special tool 32 3 140.

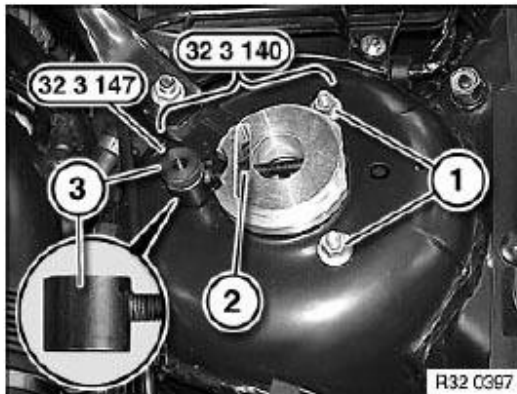


Fig. 7: Identifying Guide Sleeve With Nuts And Special Tools
Courtesy of BMW OF NORTH AMERICA, INC.

Replace nut (1) and tighten down.

Tightening torque **31 31 1AZ** .

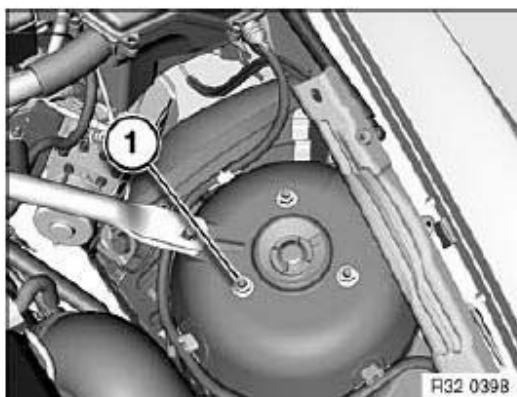


Fig. 8: Identifying Protective Cap Nut
Courtesy of BMW OF NORTH AMERICA, INC.

After installation

- Check directional stability of vehicle, check steering wheel position; if necessary repeat toe-in adjustment

61 31 996 CARRYING OUT STEERING ANGLE SENSOR ADJUSTMENT

NOTE: **Steering angle sensor adjustment must be carried out:**

- **after adjustment work on the front axle/steering**
- **after all mechanical work on the steering system**
- **after disconnection of battery**
- **after replacement/coding/programming of the following components:**
 - **Fixture for switches of steering column/switch cluster/steering angle sensor**
 - **Dynamic Stability Control (DSC) control unit**

Connect vehicle to BMW diagnosis system.

Select and carry out steering angle sensor adjustment under Service functions.

00 DANGER OF POISONING IF OIL IS INGESTED/ABSORBED THROUGH THE SKIN

Danger of poisoning!

Ingesting oil or absorbing through the skin may cause poisoning!

Possible symptoms are:

- Headaches
- Dizziness
- Stomach aches
- Vomiting
- Diarrhoea
- Cramps/fits
- Unconsciousness

Protective measures/rules of conduct

- Pour oil only into appropriately marked containers
- Do **not** pour oil into drinking vessels (drinks bottles, glasses, cups or mugs)
- Observe country-specific safety regulations

First aid measures

- Do not induce vomiting.

If the person affected is still conscious, he/she must rinse out their mouth with water, drink plenty of water and consult a doctor immediately.

If the person affected is unconscious, do not administer anything by mouth, place the person in the

recovery position and seek immediate medical attention.

00 DANGER OF POISONING IF OIL IS INGESTED/ABSORBED THROUGH THE SKIN

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31 00 ... FRONT AXLE + STEERING: WHEEL/CHASSIS ALIGNMENT CHECK MUST BE CARRIED OUT AFTER THE FOLLOWING WORK

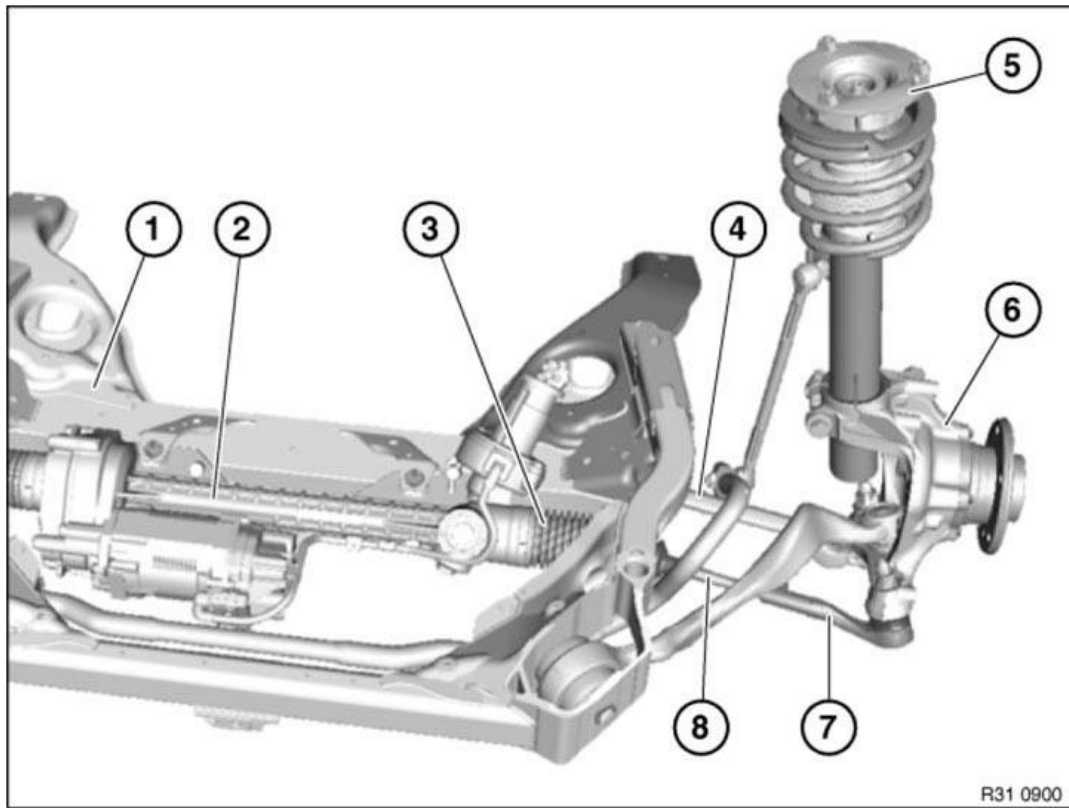
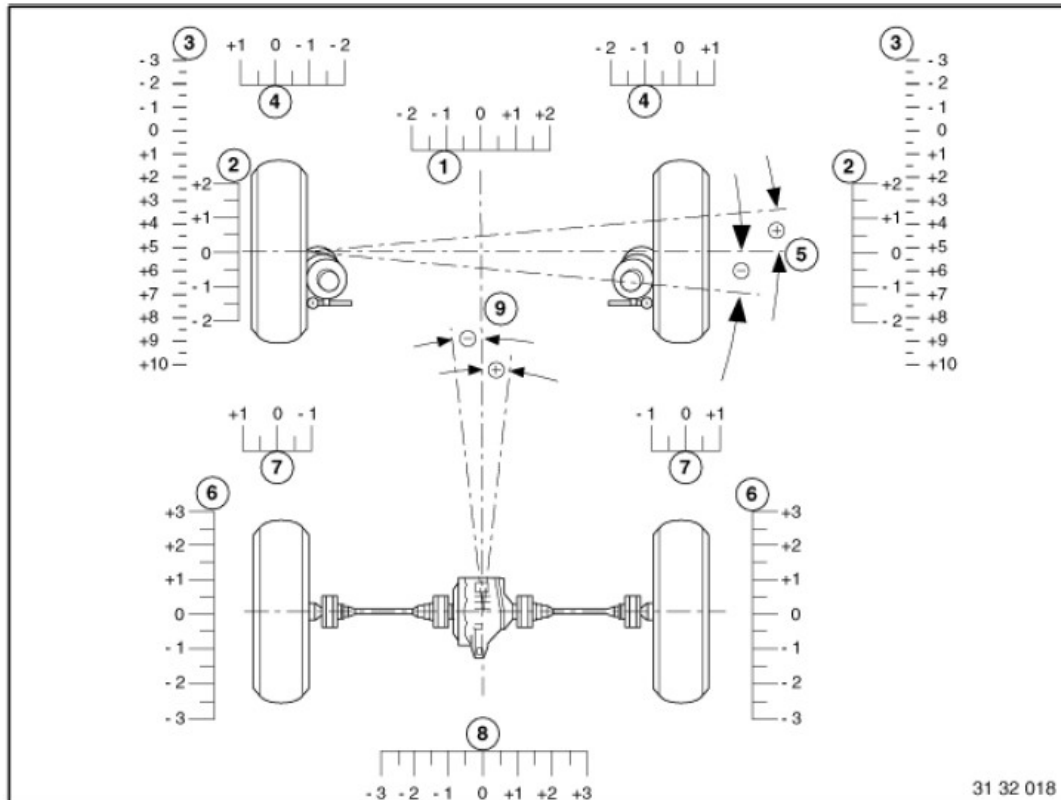


Fig. 9: Identifying Front Axle + Steering Components
 Courtesy of BMW OF NORTH AMERICA, INC.

A **WHEEL/CHASSIS ALIGNMENT CHECK** must be carried out after the following work:

- **Release of following screw/bolt connections:**
 - Steering gear to front axle carrier
 - Control arm to front axle carrier
 - Support bearing to body (if centering pin is missing)
 - Tie rod end to tie rod
- **Replacement of following parts:**
 1. Front axle carrier
 2. Steering gear
 3. Gaiter (if the tie rod end has to be screwed off)
 4. Control arm
 5. Support bearing (only if centering pin is missing)
 6. Swivel bearing
 7. Tie rod end
 8. Tie rod

32 00 ... GENERAL CHASSIS AND SUSPENSION DEFINITIONS



- | | |
|---|------------------------|
| 1. Toe | 5. Wheel misalignment |
| 2. Camber | 6. Camber |
| 3. Caster (with 10° or 20° wheel lock) | 7. Rear-wheel position |
| 4. Toe angle difference (with 20° wheel lock) | 8. Toe |
| 9. Geometrical driving axis | |

Fig. 10: Chassis And Suspension Angles Diagram
Courtesy of BMW OF NORTH AMERICA, INC.

1. Toe
2. Camber
3. Caster (with 10° or 20° wheel lock)
4. Toe angle difference (with 20° wheel lock)
5. Wheel misalignment
6. Camber

7. Rear-wheel position
8. Toe
9. Geometrical driving axis

32 00 ... GENERAL INFORMATION AND DEFINITIONS

Toe angle difference

a Toe difference angle

D Centre point of operating circle

The toe angle difference is the angle adjustment of the inner cornering wheel relative to the outer cornering wheel when negotiating a curve. Steering is designed in such a way that angular position of wheels changes as steering lock progresses.

A correctly adjusted toe angle difference produces equal values for left and right lock with consideration of factory tolerances.

Toe angle difference provides information on corresponding operation of steering trapezoid for left or right steering lock from center position.

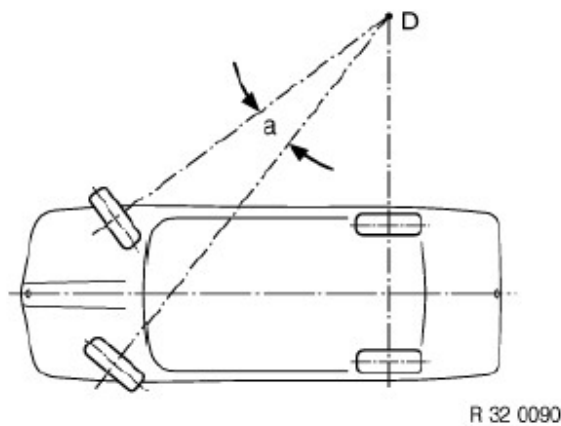


Fig. 11: Identifying Toe Difference Angle From Centre Point Of Operating Circle
Courtesy of BMW OF NORTH AMERICA, INC.

Camber

Inclination of the wheel from the perpendicular.

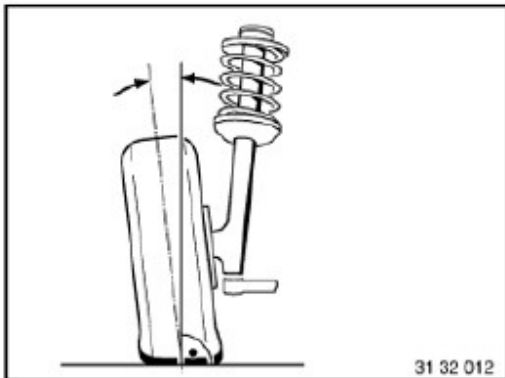


Fig. 12: Identifying Camber (Inclination Of Wheel From Perpendicular)
 Courtesy of BMW OF NORTH AMERICA, INC.

Toe

Reduction in distance of front of front wheels to rear of front wheels. The toe-in prevents the wheels from moving apart during driving and thus:

- the wheels from vibrating and grinding
- excessive tire wear
- excessive strain on the steering linkage and its links/joints
- heavy vehicle steering

Measurement is performed in "straight-ahead mode".

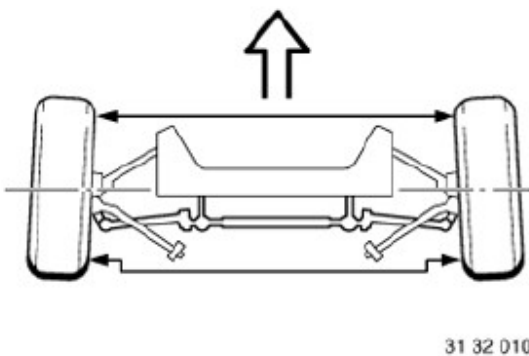


Fig. 13: Identifying Toe-In
 Courtesy of BMW OF NORTH AMERICA, INC.

Castor

Is the inclination of the kingpin in the direction of travel viewed from the side. The line through the center point of the spring strut support bearing and the control arm ball joint corresponds to the "kingpin".

Thanks to caster, wheels are pulled and not pushed. In a similar manner to king pin inclination, when driving in curves or around corners, returning forces are reproduced to help return wheels to straight-ahead position.

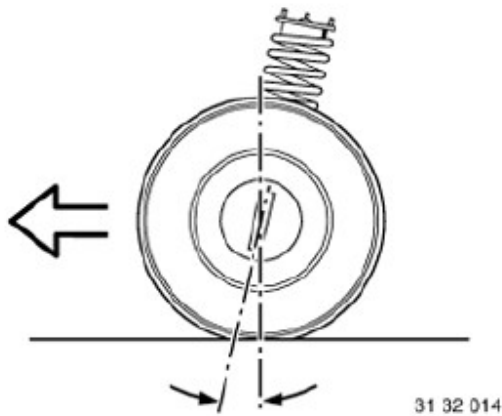


Fig. 14: Identifying Caster
Courtesy of BMW OF NORTH AMERICA, INC.

Geometrical driving axis 1

Is the angle bisector from the total rear-wheel toe.

Front-wheel measurements are taken in reference to this axis.

Symmetrical axis 2

Centre line running through front and rear axles.

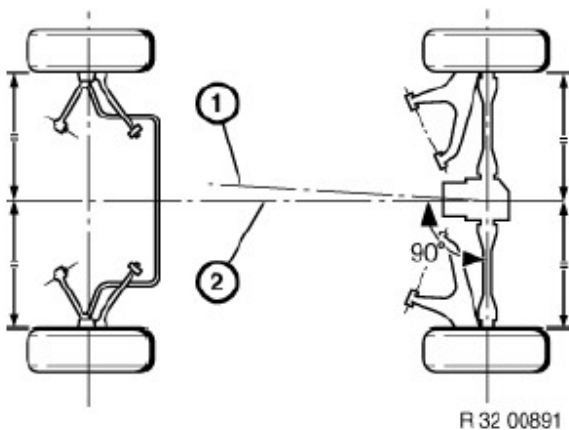
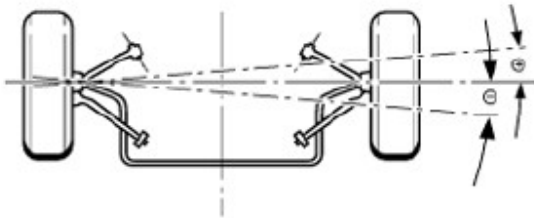


Fig. 15: Identifying Geometrical Driving Axis And Symmetrical Axis
Courtesy of BMW OF NORTH AMERICA, INC.

Wheel misalignment

Angle by which one front wheel is displaced more towards front or rear than the other front wheel. The wheel offset angle is positive when the right wheel is displaced towards the front and negative when it is displaced towards the rear.



31 32 016

Fig. 16: Identifying Positive And Negative Wheel Alignments
Courtesy of BMW OF NORTH AMERICA, INC.

Kingpin offset/scrub radius

Is the distance from the center of the wheel contact face to the intersection point of the kingpin extension. The line through the center point of the spring strut support bearing and the control arm ball joint corresponds to the "kingpin".

The scrub radius is influenced by camber, kingpin angle and wheel offset of the wheel rim.

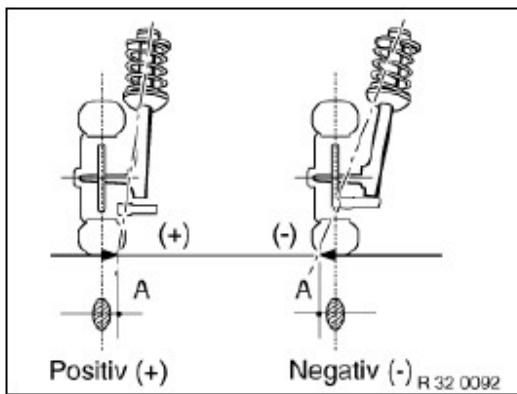


Fig. 17: Identifying Positive And Negative Kingpin Offset
Courtesy of BMW OF NORTH AMERICA, INC.

32 00 ... INFORMATION ON REPLACING STEERING GEAR AFTER ACCIDENT DAMAGE

Situation

In the event of accidents or driving conditions similar to accidents, shocklike loads can cause different types of damage to steering gears. When a steering gear is externally undamaged, it is sometimes only possible to identify damage with great difficulty and with great effort. However, damage of this nature poses an unacceptable risk to the vehicle because it can result in failure of the steering system.

Because of the disproportionate amount of effort involved, it is generally not sensible to check thoroughly all the individual components of the steering gear and as an alternative it is necessary to take into account other components which can be checked more easily.

Procedure

The steering gear must be replaced if one or more of the following points apply:

- A. Visible or noticeable damage to the steering gear
 - Version with electric steering gear (EPS): Examine in particular the control unit with all plug connections for damage and hairline cracks.
- B. Unacceptable torque increase and jamming when the steering gear is turned from lock to lock (without hydraulic/electrical assistance)
- C. Permissible tolerances exceeded during axle/wheel alignment (include alignment record with invoice/report if necessary)
- D. Fire damage
- E. Damage, permanent deformation or fractures to:
 - Wheel rims in the event of a negative result from the wheel/axle alignment check
 - Spring struts, steering knuckles, wheel carriers
 - Control arms
 - struts or diagonal members or stabilizers with this function
 - Body-side screwing/bolting points for wheel guide/control components
 - Front axle support
 - Pitman arms
 - Tie rods
 - Steering gear fixtures
 - Steering Column

This guideline is binding for all accident repairs to BMW and MINI vehicles.

NOTE: If the steering gear replacement work which is required for safety reasons is refused by the customer or an insurance company for cost reasons, a memorandum to that effect must be drawn up and countersigned by the party bearing the costs of the accident repair.

IMPORTANT: The vehicle's type approval will be invalidated whenever the function of any of its safety components is compromised!

32 00 155 KDS CHASSIS/WHEEL ALIGNMENT CHECK WITH RIDE HEIGHT MEASUREMENT WITHOUT VEHICLE LOAD

NOTE: • Read and comply with GENERAL INFORMATION AND DEFINITIONS .

- Read and comply with GENERAL CHASSIS DEFINITION .
- Check compliance with TEST CONDITIONS , repair vehicle if necessary.

- If necessary, prepare vehicle hoist.
- Drive vehicle onto vehicle hoist.

NOTE: **The front and rear wheels must be positioned centrally on the rotary and sliding plates.**

- Remove locking pins from both rotary and sliding plates.

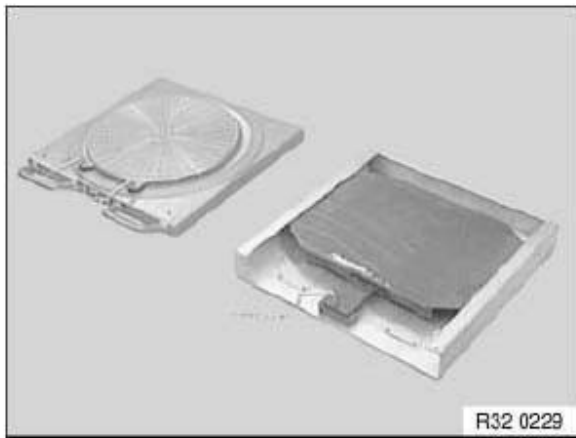


Fig. 18: Identifying Rotary And Sliding Plates
Courtesy of BMW OF NORTH AMERICA, INC.

IMPORTANT: Only use quick-clamping holders with polycontrol pins (1).
Other quick-clamping holders are not permitted because of the inaccuracy of measurement!

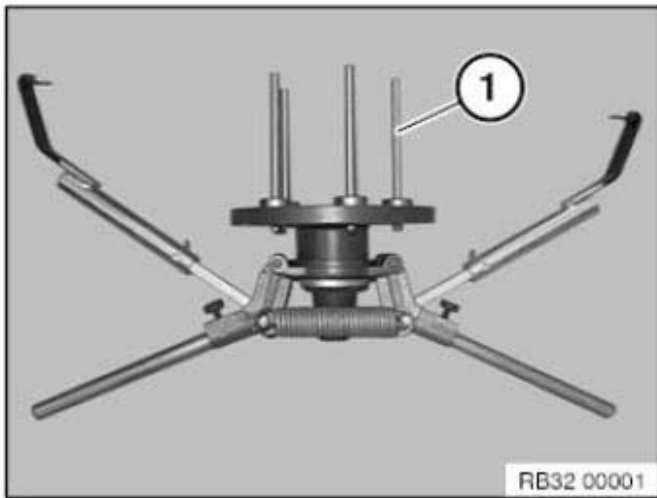


Fig. 19: Identifying Quick-Clamping Holders With Poly Control Arm Pins
 Courtesy of BMW OF NORTH AMERICA, INC.

- Attach quick-clamping holder to vehicle and remove clamping levers in area of front wheels
- Attach pickup to quick-clamping holder, align using bubble level and connect to turntables



Fig. 20: Attaching Quick-Clamping Holder To Vehicle
 Courtesy of BMW OF NORTH AMERICA, INC.

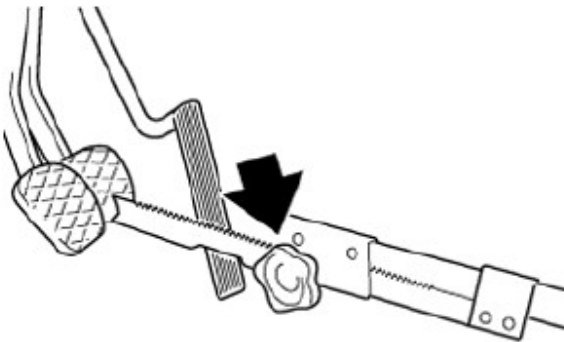
- If necessary, attach spoiler adapter.



R32 0241

Fig. 21: Identifying Spoiler Adapter
Courtesy of BMW OF NORTH AMERICA, INC.

- If necessary, switch on chassis alignment system.
- Enter customer and vehicle data
- Identify chassis and suspension version (standard/VDC suspension) and select vehicle
- Enter tire inflation pressure and tread depth
- Measure and enter **VEHICLE RIDE HEIGHT**
- Install brake tensioner.



31 34 021

Fig. 22: Locating Brake Tensioner
Courtesy of BMW OF NORTH AMERICA, INC.

IMPORTANT: Risk of damage!

In order to avoid damaging the front side panel during the "Max. steering angle" drive-in routine, make sure the pickups are removed from the quick-clamping holders/quick-clamping units during output and input alignment. In the process do not detach the connecting cable from the pickups or the rotary plates.

NOTE: After the drive-in routine, reconnect the pickups to the quick-clamping holders/quick-clamping units, align using the bubble levels and secure in place.

- Perform input measurement in accordance with equipment manufacturer's instructions.
- Compare nominal values See WHEEL ALIGNMENT or WHEEL ALIGNMENT with actual values.

Only in event of customer complaint (e.g. poor driving performance):

IMPORTANT: Do not remove screws/bolts (front axle support to engine support or body)!

Slacken all screws/bolts (front axle support to engine support or body) and then retighten to specified torque.

Refer to LOWERING FRONT AXLE SUPPORT .

If necessary, adjust front axle and rear axle See 3200620 ADJUSTING REAR AXLE or 3200610 ADJUSTING TOE-IN AND CAMBER ON FRONT AXLE

- Perform output measurement in accordance with equipment manufacturer's instructions.
- Save and print out test record.
- Carry out STEERING ANGLE SENSOR ADJUSTMENT
- Insert locking pins into both rotary and sliding plates
- Remove chassis/wheel alignment system
- Drive vehicle off vehicle hoist

32 00 150 KDS CHASSIS/WHEEL ALIGNMENT CHECK WITH VEHICLE LOAD UP TO DESIGN POSITION

NOTE:

- Read and comply with GENERAL INFORMATION AND DEFINITIONS .
- Read and comply with GENERAL CHASSIS DEFINITION .

- If necessary, prepare vehicle hoist.
- Drive vehicle onto vehicle hoist.

NOTE: The front and rear wheels must be positioned centrally on the rotary and sliding plates.

- Remove locking pins from both rotary and sliding plates.

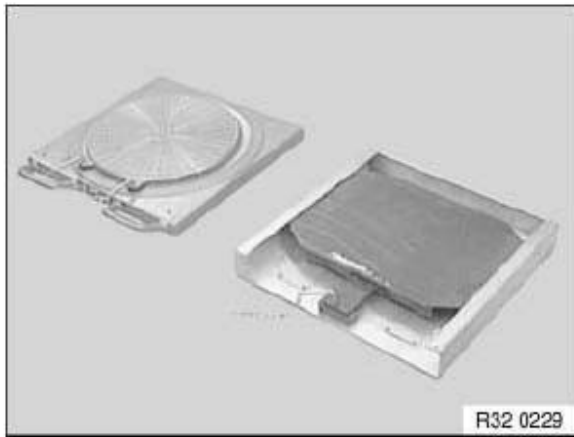


Fig. 23: Identifying Rotary And Sliding Plates
 Courtesy of BMW OF NORTH AMERICA, INC.

IMPORTANT: Use quick-clamping holders with poly control arm bushings (1) only.
 Due to excessive measuring inaccuracy, other quick-clamping units without
 poly control arm bushings are not permitted!

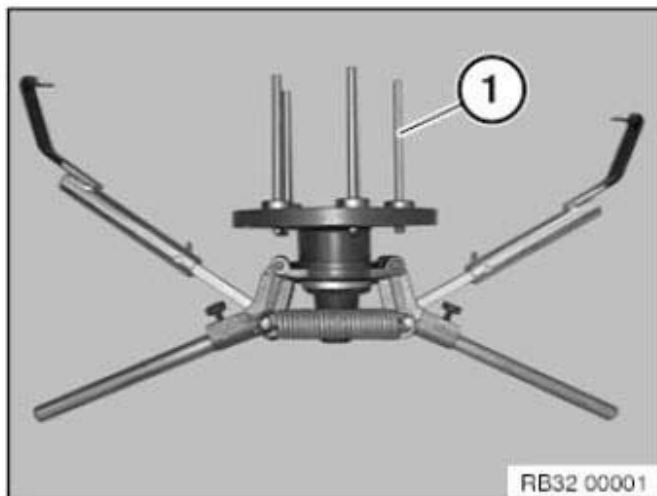


Fig. 24: Identifying Quick-Clamping Holders With Poly Control Arm Pins
 Courtesy of BMW OF NORTH AMERICA, INC.

- Attach quick-clamping holder to vehicle and remove clamping levers in area of front wheels
- Attach pickup to quick-clamping holder, align using bubble level and connect to turntables



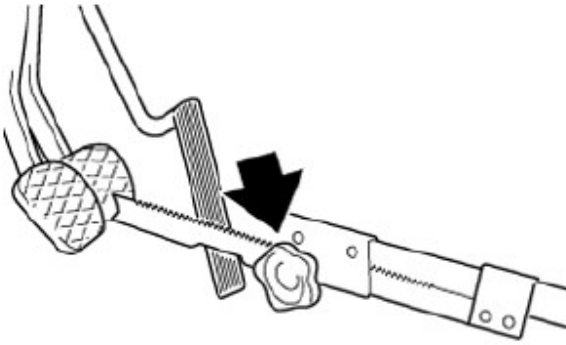
Fig. 25: Attaching Quick-Clamping Holder To Vehicle
 Courtesy of BMW OF NORTH AMERICA, INC.

- If necessary, attach spoiler adapter.



Fig. 26: Identifying Spoiler Adapter
 Courtesy of BMW OF NORTH AMERICA, INC.

- If necessary, switch on chassis alignment system.
- Enter customer and vehicle data
- Identify chassis/suspension version (standard suspension/VDC suspension) and select vehicle
- Enter tire inflation pressure and tread depth
- Move **VEHICLE INTO DESIGN POSITION**
- Install brake tensioner.



31 34 021

Fig. 27: Locating Brake Tensioner

Courtesy of BMW OF NORTH AMERICA, INC.

IMPORTANT: Risk of damage!

In order to avoid damaging the front side panel during the "Max. steering angle" drive-in routine, make sure the pickups are removed from the quick-clamping holders/quick-clamping units during output and input alignment. In the process do not detach the connecting cable from the pickups or the rotary plates.

NOTE: After the drive-in routine, reconnect the pickups to the quick-clamping holders/quick-clamping units, align using the bubble levels and secure in place.

- Perform input measurement in accordance with equipment manufacturer's instructions.
- Compare nominal values See WHEEL ALIGNMENT or WHEEL ALIGNMENT with actual values.

Only in event of customer complaint (e.g. poor driveability):

IMPORTANT: Do not remove screws/bolts (front axle support to engine support or body)!

Slacken all screws/bolts (front axle support to engine support or body) and then retighten to specified torque.

Refer to LOWERING FRONT AXLE SUPPORT .

If necessary, adjust front axle and rear axle See 3200620 ADJUSTING REAR AXLE or 3200610 ADJUSTING TOE-IN AND CAMBER ON FRONT AXLE

- Perform output measurement in accordance with equipment manufacturer's instructions.
- Save and print out test record.
- Insert locking pins into both rotary and sliding plates
- Remove chassis/wheel alignment system
- Drive vehicle off vehicle hoist

32 00 ... MOVING VEHICLE INTO DESIGN POSITION

Necessary preliminary tasks

- Move VEHICLE INTO NORMAL POSITION
- Add/distribute weights in area of spring struts until the vehicle ride height is within the tolerance (refer to Technical Data See REAR AXLE - RIDE HEIGHT E89 or FRONT AXLE - RIDE HEIGHT E89).

Measure ride-level height of vehicle See 3353... MEASURING RIDE HEIGHT OF VEHICLE (REAR AXLE) or 3133095 MEASURE VEHICLE RIDE HEIGHT, FRONT AXLE

32 00 ... MOVING VEHICLE INTO NORMAL POSITION

Necessary preliminary tasks

- Check compliance with TEST CONDITIONS , bring vehicle to a stop if necessary.
- Check vehicle interior and luggage compartment (incl. luggage compartment recess) for load, unload vehicle if necessary
- Introduce DIN load (refer to TECHNICAL DATA) into vehicle

32 00 ... PERFORMING RIM RUNOUT COMPENSATION

NOTE: Rim runout compensation involves electronically recording the lateral runout of the rim and the possible clamping error of the quick-clamping unit for one wheel rotation and compensating the toe and camber for measurement/alignment.

Raise body.

Perform rim runout compensation in accordance with equipment manufacturer's instructions.

Compress/deflect car.

00 RAISING VEHICLE WITH TROLLEY JACK

IMPORTANT: Observe the following trolley-jack-related instructions:

1. Use only BMW-distributed/approved trolley jacks which have rubber plate contact points.
2. Trolley jacks must be regularly serviced and always checked for functional reliability before they are used!
3. Check the rubber plate on the trolley jack prior to each use, replacing if necessary.

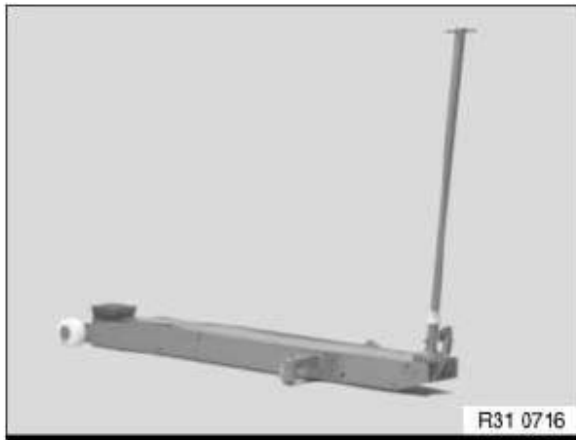


Fig. 28: Identifying Trolley Jack
 Courtesy of BMW OF NORTH AMERICA, INC.

WARNING: The vehicle may be raised with a trolley jack only at the following jacking points!

1. Car jacking point
2. Side car jacking points
3. Rear differential (**REMOVE HEAT SHIELD**)

Risk of damage: It is not permitted to raise the vehicle at the rear differential cover!

4. Bolting point for rear axle tension struts

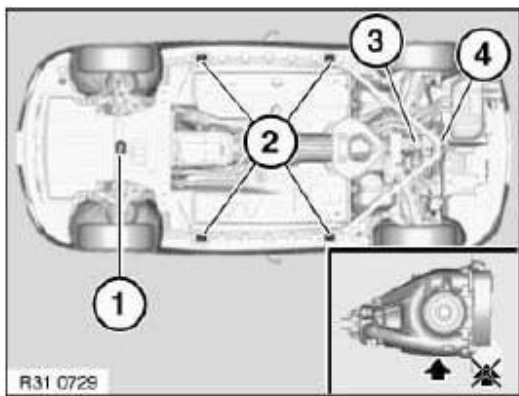


Fig. 29: Identifying Rear Differential With Car Jacking Points
 Courtesy of BMW OF NORTH AMERICA, INC.

33 00 ... REAR AXLE: WHEEL/CHASSIS ALIGNMENT CHECK MUST BE CARRIED OUT AFTER THE FOLLOWING WORK

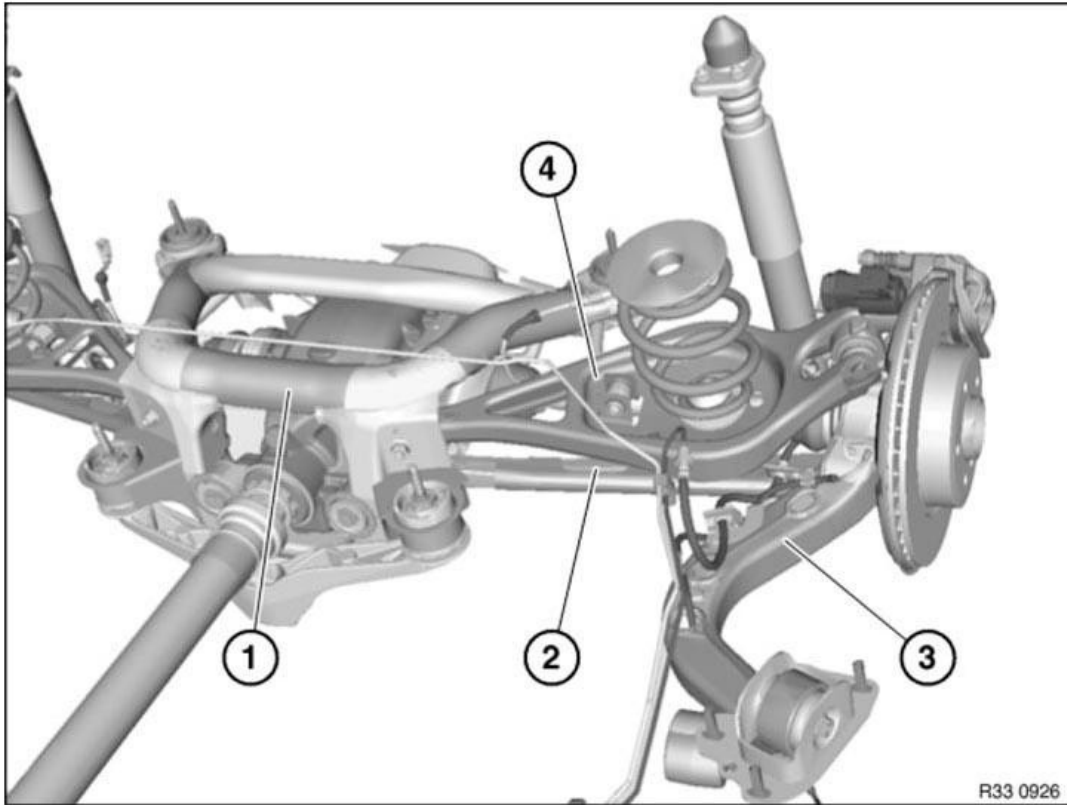


Fig. 30: Identifying Rear Axle + Steering Components
Courtesy of BMW OF NORTH AMERICA, INC.

A **WHEEL/CHASSIS ALIGNMENT CHECK** must be carried out after the following work:

- **Release of following screw/bolt connections:**
 - Bearing block to trailing arm/body
 - Upper control arm to trailing arm
 - Lower control arm to trailing arm
- **Replacement of following parts:**
 1. Rear axle carrier
 2. Lower control arm
 3. Trailing arm/rubber mount/bearing block
 4. Upper control arm

00 RISK OF INJURY IF OIL COMES INTO CONTACT WITH EYES AND SKIN

Danger of injury!

Contact with eyes or skin may result in injury!

Possible symptoms are:

- Impaired sight
- Irritation of the eyes
- Reddening of the skin
- Rough and cracked skin

Protective measures/rules of conduct

- Wear protective goggles
- Wear oil-resistant protective gloves
- Observe country-specific safety regulations

First aid measures

- **Eye contact:** Rinse eyes immediately with plenty of water for at least 15 minutes; if available, use an eye-rinsing bottle. If irritation of the eyes persists, consult a doctor.
- **Skin contact:** Wash off with soap and water immediately. If irritation persists, consult a doctor.

NOTE: Do not use solvents/thinners.

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NOTE: Do not use solvents/thinners.

00 SAFETY INFORMATION FOR WORKING ON VEHICLES WITH AUTOMATIC ENGINE START-STOP FUNCTION (MSA)

WARNING: If the engine hood/bonnet contact is pulled upwards (workshop mode), the information "switch closed" is output. The automatic engine start-stop function is active.
An automatic engine start is possible.

Observe safety precautions when working on MSA vehicles

Before carrying out practical work on the engine, always ensure that the MSA functionality is deactivated so as to prevent automatic engine starting while work is being carried out in the engine compartment.

MSA function is deactivated by

- Deactivate MSA by means of button (1) in passenger compartment
- Open seat belt buckle and driver's door

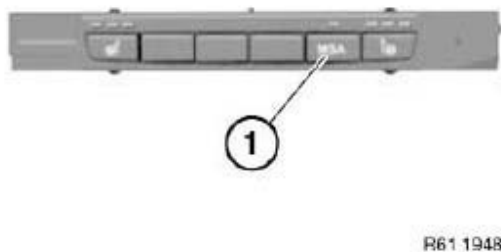


Fig. 31: Identifying MSA Button

Courtesy of BMW OF NORTH AMERICA, INC.

- Open engine bonnet/hood and ensure that engine hood/bonnet contact is not in workshop mode
- Workshop mode

A = 10 mm

- Basic setting (engine hood/bonnet open)

B = 7 mm

To make sure that the engine hood/bonnet contact is at the basic setting, if necessary press the hood/bonnet contact up to the limit position before starting work and slowly release.

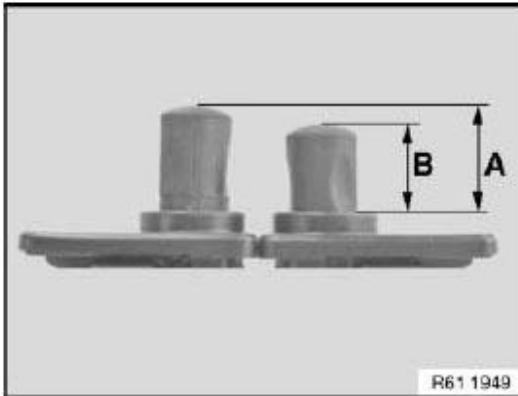


Fig. 32: Identifying Basic Setting For Engine Hood/Bonnet Open
 Courtesy of BMW OF NORTH AMERICA, INC.

When working with diagnosis tools

- Observe instructions in diagnosis tool

00 SAFETY INSTRUCTIONS FOR HANDLING OIL

WARNING: DANGER OF POISONING if oil is ingested/absorbed through the skin!
RISK OF INJURY if oil comes into contact with eyes and skin!

Recycling

Observe country-specific waste-disposal regulations.

Measures if oil is unintentionally released

- **Personal precautionary measures:** Danger of slipping! Keep non-involved persons away from the work area. Wear personal protective clothing/equipment.
- **Environmental protection measures:** Prevent oil from draining into drain channels, sewerage systems, pits, cellars, water and the ground.
- **Limiting spread:** Use oil blocks to prevent the surface spread of oil.
- **Cleaning procedure:** Bind and dispose of escaped oil with nonflammable absorbents.

NOTE: Do not flush oil away with water or aqueous cleaning agents.

32 00 ... TEST CONDITIONS FOR CHASSIS/WHEEL ALIGNMENT CHECK

Observe the following test conditions prior to the chassis/wheel alignment check:

1. Correct and identical rim and tire sizes.
2. Correct tread depth. The tread depth for each axle may differ from left to right by max. 1-2 mm.

3. Correct tire inflation pressure (see instruction plate on car).
4. Wheel bearing clearance OK
5. Steering backlash OK
6. Condition of suspension and shock absorbers OK: Visually inspect for breakage, etc.
7. Cars with ride level control: Pull fuse of air supply unit so that there is no controlling down or up.

3211 MECHANICAL STEERING GEAR

32 00 ... INFORMATION ON REPLACING STEERING GEAR AFTER ACCIDENT DAMAGE

Situation

In the event of accidents or driving conditions similar to accidents, shocklike loads can cause different types of damage to steering gears. When a steering gear is externally undamaged, it is sometimes only possible to identify damage with great difficulty and with great effort. However, damage of this nature poses an unacceptable risk to the vehicle because it can result in failure of the steering system.

Because of the disproportionate amount of effort involved, it is generally not sensible to check thoroughly all the individual components of the steering gear and as an alternative it is necessary to take into account other components which can be checked more easily.

Procedure

The steering gear must be replaced if one or more of the following points apply:

- A. Visible or noticeable damage to the steering gear
 - Version with electric steering gear (EPS): Examine in particular the control unit with all plug connections for damage and hairline cracks.
- B. Unacceptable torque increase and jamming when the steering gear is turned from lock to lock (without hydraulic/electrical assistance)
- C. Permissible tolerances exceeded during axle/wheel alignment (include alignment record with invoice/report if necessary)
- D. Fire damage
- E. Damage, permanent deformation or fractures to:
 - Wheel rims in the event of a negative result from the wheel/axle alignment check
 - Spring struts, steering knuckles, wheel carriers
 - Control arms
 - struts or diagonal members or stabilizers with this function
 - Body-side screwing/bolting points for wheel guide/control components
 - Front axle support
 - Pitman arms
 - Tie rods

- Steering gear fixtures
- Steering Column

This guideline is binding for all accident repairs to BMW and MINI vehicles.

NOTE: If the steering gear replacement work which is required for safety reasons is refused by the customer or an insurance company for cost reasons, a memorandum to that effect must be drawn up and countersigned by the party bearing the costs of the accident repair.

IMPORTANT: The vehicle's type approval will be invalidated whenever the function of any of its safety components is compromised!

32 11 100 REPLACING GAITER FOR STEERING GEAR ON LEFT OR RIGHT

IMPORTANT: The power steering gear must be replaced if the polished surface of the rack is damaged (e.g. by corrosion)!

Necessary preliminary tasks

- Remove front **UNDERBODY PROTECTION**

Release band clamp (1).

Mark screw-in depth of tie rod (2) or count thread turns.

Release screw (3).

Tightening torque **32 21 3AZ** .

Twist tie rod (2) out of tie rod end (4).

Installation:

Replace microencapsulated screw.

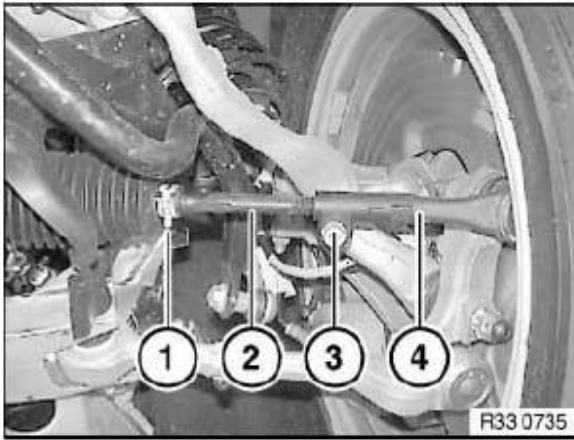


Fig. 33: Identifying Tie Rod With Band Clamp And Tie Rod End
 Courtesy of BMW OF NORTH AMERICA, INC.

Release **EAR CLAMP** (1).

Detach gaiter (2) from tie rod (3).

Installation:

Clean rack and check surface for damage (e.g. by corrosion).

Grease rack (refer to **STEERING AND WHEEL ALIGNMENT - OPERATING FLUIDS**).

Clean tie rod and apply grease to taper. This ensures that the gaiter is not rotated when the tie rod is rotated.

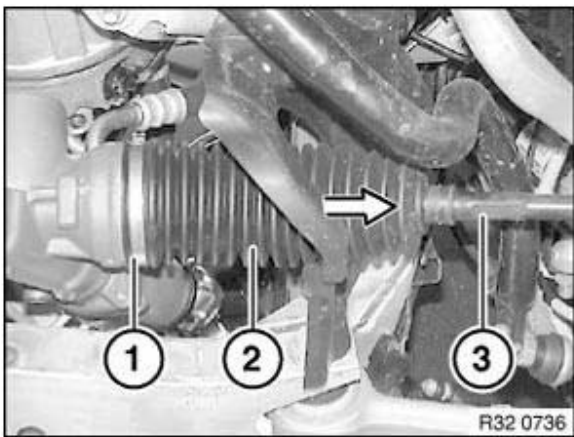


Fig. 34: Removing Gaiter From Tie Rod
 Courtesy of BMW OF NORTH AMERICA, INC.

After installation

- Perform chassis alignment check See **3200150 KDS CHASSIS/WHEEL ALIGNMENT CHECK WITH VEHICLE LOAD UP TO DESIGN POSITION** or **3200155 KDS CHASSIS/WHEEL ALIGNMENT CHECK WITH RIDE HEIGHT MEASUREMENT WITHOUT VEHICLE LOAD**
- Carry out **STEERING ANGLE SENSOR ADJUSTMENT**

3213 STEERING GEAR WITH SERVO UNIT

32 00 ... INFORMATION ON REPLACING STEERING GEAR AFTER ACCIDENT DAMAGE

Situation

In the event of accidents or driving conditions similar to accidents, shocklike loads can cause different types of damage to steering gears. When a steering gear is externally undamaged, it is sometimes only possible to identify damage with great difficulty and with great effort. However, damage of this nature poses an unacceptable risk to the vehicle because it can result in failure of the steering system.

Because of the disproportionate amount of effort involved, it is generally not sensible to check thoroughly all the individual components of the steering gear and as an alternative it is necessary to take into account other components which can be checked more easily.

Procedure

The steering gear must be replaced if one or more of the following points apply:

- A. Visible or noticeable damage to the steering gear
 - Version with electric steering gear (EPS): Examine in particular the control unit with all plug connections for damage and hairline cracks.
- B. Unacceptable torque increase and jamming when the steering gear is turned from lock to lock (without hydraulic/electrical assistance)
- C. Permissible tolerances exceeded during axle/wheel alignment (include alignment record with invoice/report if necessary)
- D. Fire damage
- E. Damage, permanent deformation or fractures to:
 - Wheel rims in the event of a negative result from the wheel/axle alignment check
 - Spring struts, steering knuckles, wheel carriers
 - Control arms
 - struts or diagonal members or stabilizers with this function
 - Body-side screwing/bolting points for wheel guide/control components
 - Front axle support
 - Pitman arms
 - Tie rods
 - Steering gear fixtures
 - Steering Column

This guideline is binding for all accident repairs to BMW and MINI vehicles.

NOTE: If the steering gear replacement work which is required for safety reasons is refused by the customer or an insurance company for cost reasons, a memorandum to that effect must be drawn up and countersigned by the party bearing the costs of the accident repair.

IMPORTANT: The vehicle's type approval will be invalidated whenever the function of any of its safety components is compromised!

32 13 070 REMOVING AND INSTALLING (REPLACING) ELECTRIC STEERING GEAR (EPS)

IMPORTANT: Steering gear:

Check connection of steering gear for corrosion, clean contacts if necessary. The steering gear must be replaced if the corrosion is too far advanced.

Connecting cable:

In the event of moisture/corrosion inside the two plug connections, check the insulation of the connecting cable. If the insulation reveals any noticeable/striking features, it will be necessary to replace the part. Otherwise it will be sufficient to replace the contacts or plug housing.

NOTE: In a warranty case, a fault memory printout must be included with the defective part.

Necessary preliminary tasks

- Disconnect **BATTERY NEGATIVE LEAD**

NOTE: High-current-carrying lead laid with permanent positive connection (80 A fuse protection).

- Remove **FRONT UNDERBODY PROTECTION**
- Remove **V-STRUT ON LEFT AND RIGHT**
- Remove **LOWER SECTION OF STEERING SPINDLE FROM STEERING GEAR**
- Remove both **TIE ROD ENDS FROM SWIVEL BEARING**
- Replacement: Remove **BOTH TIE ROD ENDS FROM STEERING GEAR**

Release cable holder (1) on steering gear.

Unlock plug connections (2) and disconnect.

Installation:

Check plug connections for moisture and corrosion. To do so, read and follow notes/information at the start of the document.

Make sure wiring harnesses are laid correctly.

Plug connections must audibly snap into place.

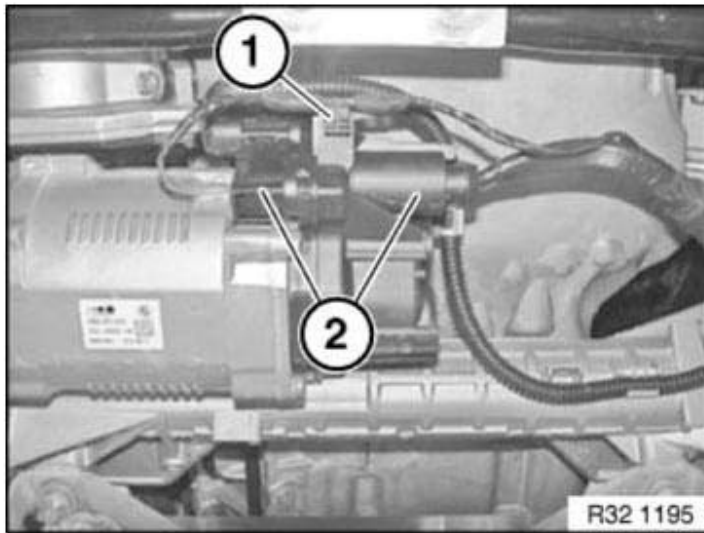


Fig. 35: Identifying Steering Gear Cable Holder And Plug Connections
Courtesy of BMW OF NORTH AMERICA, INC.

Release nuts and remove screws (1) towards bottom.

Remove steering gear (2) towards front.

Installation:

Replace screws and nuts.

Tightening torque **32 00 1AZ** .

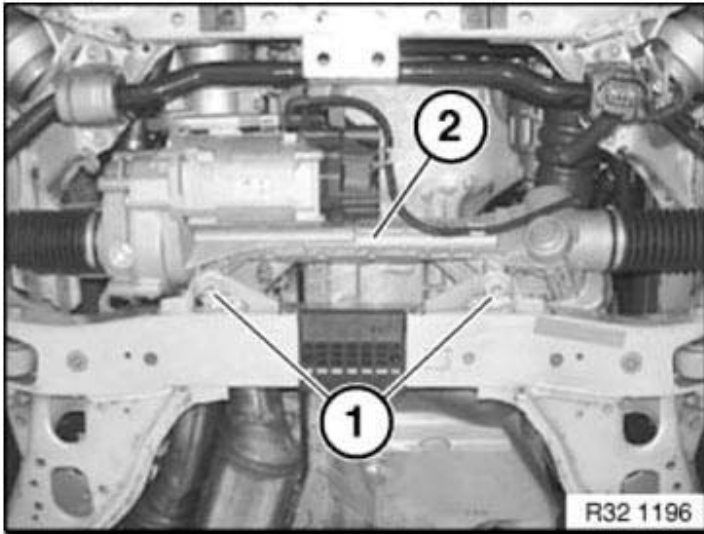


Fig. 36: Identifying Steering Gear With Screws
 Courtesy of BMW OF NORTH AMERICA, INC.

After installation

- Teach in **END STOP SOFTWARE**
- Perform chassis alignment check See **3200150 KDS CHASSIS/WHEEL ALIGNMENT CHECK WITH VEHICLE LOAD UP TO DESIGN POSITION** or **3200155 KDS CHASSIS/WHEEL ALIGNMENT CHECK WITH RIDE HEIGHT MEASUREMENT WITHOUT VEHICLE LOAD**
- Carry out **STEERING ANGLE SENSOR ADJUSTMENT**

32 10 ... TEACHING IN END STOP SOFTWARE FOR ELECTRIC STEERING GEAR (EPS)

NOTE: The end stop software must be taught in:

- after the steering gear is replaced
- after programming/coding

Connect vehicle to BMW diagnosis system.

Select and perform end stop under Service functions.

3221 STEERING ARMS, TIE RODS, STEERING DAMPER

32 41 ... INSTRUCTIONS FOR REMOVING AND INSTALLING EAR CLIPS

NOTE: The work steps are show on assorted components.
 Ear clip must always be replaced.

To remove an ear clip, place special tool 32 1 260 at right angles to ear and cut ear open.

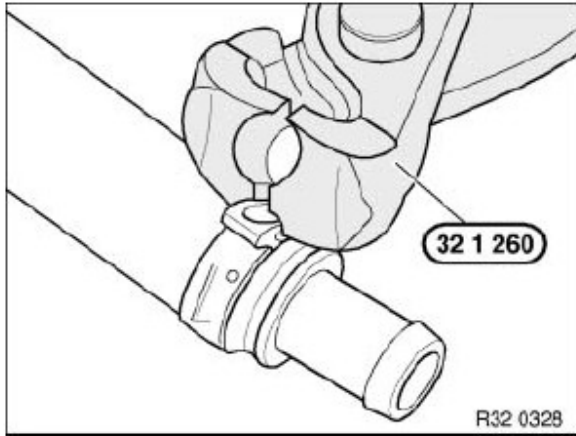


Fig. 37: Removing Ear Clip Using Special Tool (32 1 260)
Courtesy of BMW OF NORTH AMERICA, INC.

The ear clip can be fitted not only axially but also radially after the hook fastener has been opened.

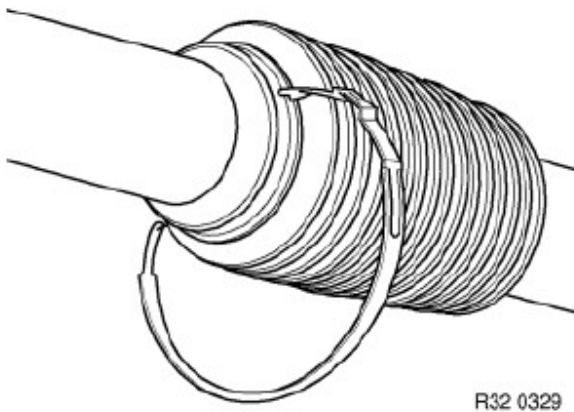


Fig. 38: Identifying Hook Fastener On Ear Clip
Courtesy of BMW OF NORTH AMERICA, INC.

Attach hook fastener and press ear together with special tool 32 1 260.

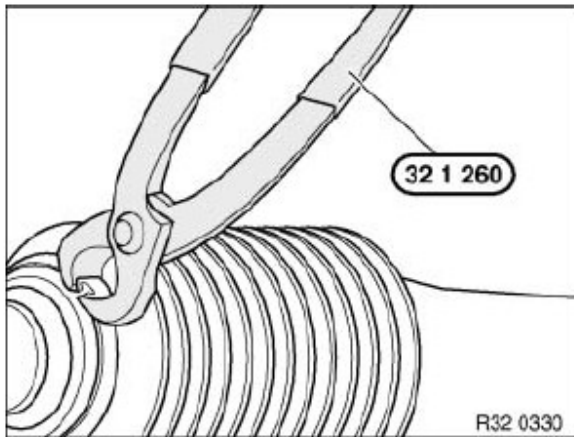


Fig. 39: Pressing Ear Clip Using Special Tool (32 1 260)
 Courtesy of BMW OF NORTH AMERICA, INC.

Side cutter of special tool 32 1 260 can be used in areas which are difficult to access.

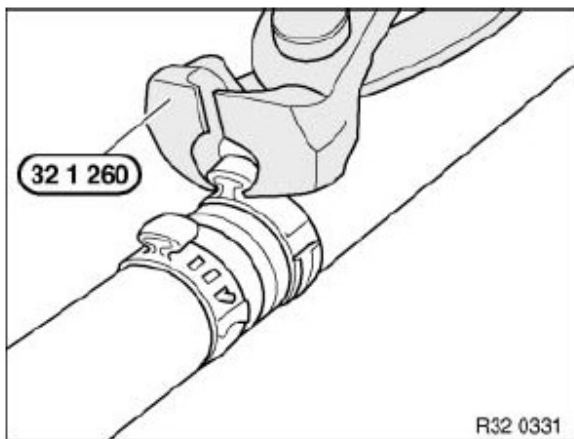


Fig. 40: Identifying Special Tool (32 1 260)
 Courtesy of BMW OF NORTH AMERICA, INC.

IMPORTANT: Gap (A) max. 1 mm!

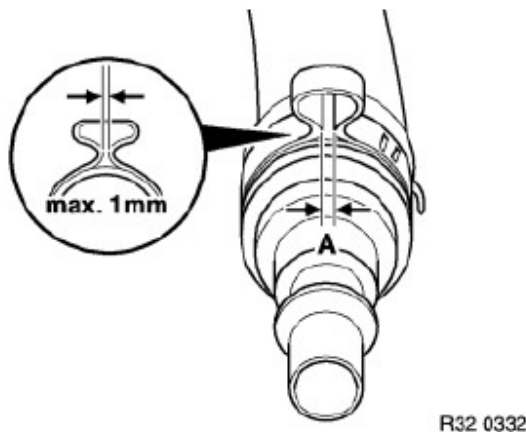


Fig. 41: Identifying Ear Clip Gap
 Courtesy of BMW OF NORTH AMERICA, INC.

32 21 231 REPLACING (REMOVING AND INSTALLING) LEFT OR RIGHT TIE ROD

IMPORTANT: The steering gear must be replaced if the polished surface of the rack is damaged (e.g. by corrosion)!

Necessary preliminary tasks

- Remove **TIE ROD END FROM SWIVEL BEARING**
- Remove **GAITER FROM STEERING GEAR** and slide back

IMPORTANT: To avoid damage to rack and to suspension mounting, move rack in as far as possible.

Release joint (1) with special tool 32 3 160 on steering gear rack.

Tightening torque **32 21 1AZ** .

Installation:

Clean rack.

Check surface of rack for damage (e.g. corrosion).

Lightly grease rack (refer to **STEERING AND WHEEL ALIGNMENT - OPERATING FLUIDS**).

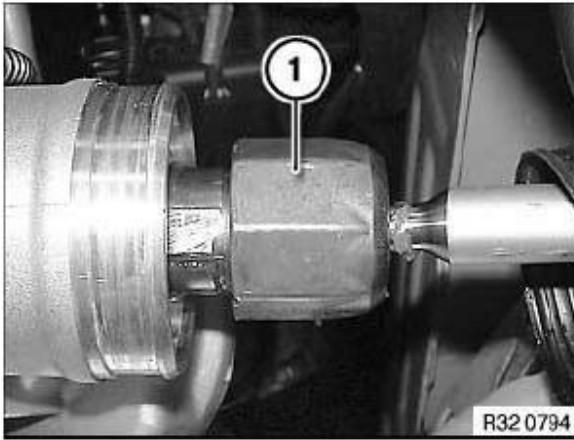


Fig. 42: Identifying Steering Gear Rack Joint
 Courtesy of BMW OF NORTH AMERICA, INC.

On replacement, assemble new part with gaiter

- Determine measurement (A) to simplify following adjustment of front axle

Installation:

Slacken clamping screw (1) and screw off tie rod end.

Tightening torque **32 21 3AZ** .

Slide gaiter with ear clip and band clamp on tie rod.

Screw in tie rod end to measurement (A).

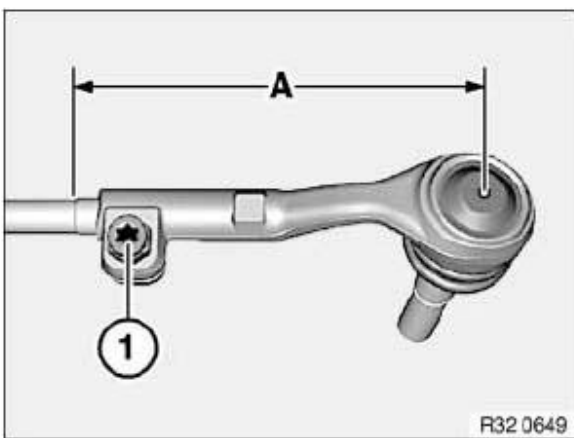


Fig. 43: Identifying Tie Rod With Mounting Screw
 Courtesy of BMW OF NORTH AMERICA, INC.

After installation

- Only if replacing/removing tie rod end: Perform chassis alignment check See **3200150 KDS CHASSIS/WHEEL ALIGNMENT CHECK WITH VEHICLE LOAD UP TO DESIGN POSITION** or **3200155 KDS CHASSIS/WHEEL ALIGNMENT CHECK WITH RIDE HEIGHT MEASUREMENT WITHOUT VEHICLE LOAD**
- Carry out **STEERING ANGLE SENSOR ADJUSTMENT**

32 21 151 REPLACING LEFT OR RIGHT TIE ROD

NOTE: If the tie rod end to tie rod screw/bolt connection is released, it is necessary after reinstallation to carry out a wheel/chassis alignment check.

Release nut (1); if necessary, grip at Torx socket.

Tightening torque **32 21 2AZ** .

Remove tie rod end (2) from swivel bearing.

Installation:

Keep tie rod end to swivel bearing connection clean and free from oil and grease.

Replace self-locking nut.

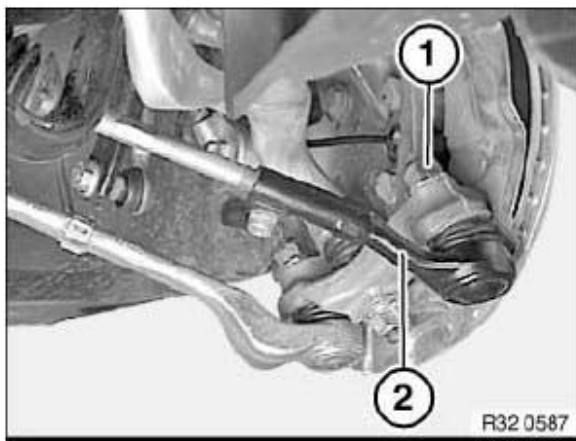


Fig. 44: Identifying Tie Rod End With Nut
Courtesy of BMW OF NORTH AMERICA, INC.

Determine measurement (A) to simplify following adjustment of front axle.

Release bolt (1).

Tightening torque **32 21 3AZ** .

Screw off tie rod end; if necessary, grip tie rod with open-end wrench.

Installation:

Check **GAITER** for damage, replace if necessary.

Screw tie rod end onto tie rod to measurement (A).

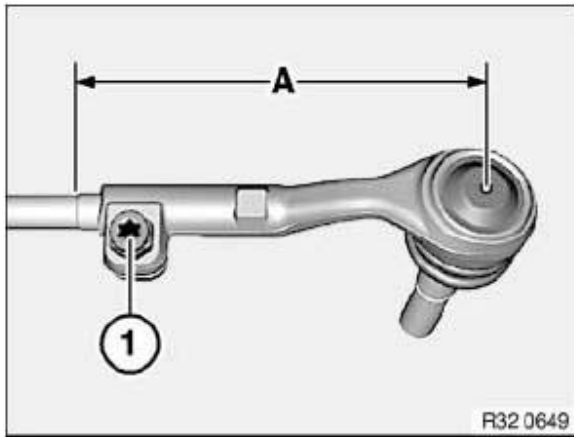


Fig. 45: Identifying Tie Rod With Mounting Screw
Courtesy of BMW OF NORTH AMERICA, INC.

After installation

- Perform chassis alignment check See **3200150 KDS CHASSIS/WHEEL ALIGNMENT CHECK WITH VEHICLE LOAD UP TO DESIGN POSITION** or **3200155 KDS CHASSIS/WHEEL ALIGNMENT CHECK WITH RIDE HEIGHT MEASUREMENT WITHOUT VEHICLE LOAD**
- Carry out **STEERING ANGLE SENSOR ADJUSTMENT**

3231 STEERING COLUMN

32 31 020 REMOVING AND INSTALLING/REPLACING LOWER SECTION OF STEERING COLUMN TRIM

Necessary preliminary tasks

- Remove upper section of **STEERING COLUMN TRIM**

Press detent lugs outwards a little and unclip steering column trim downwards.

Installation:

Align steering column trim by means of detent lugs to steering column and press up as far as it will go.

Press steering column trim on both sides together a little and then press upwards completely until detent lugs snap into place.

Check installation position, correct if necessary.

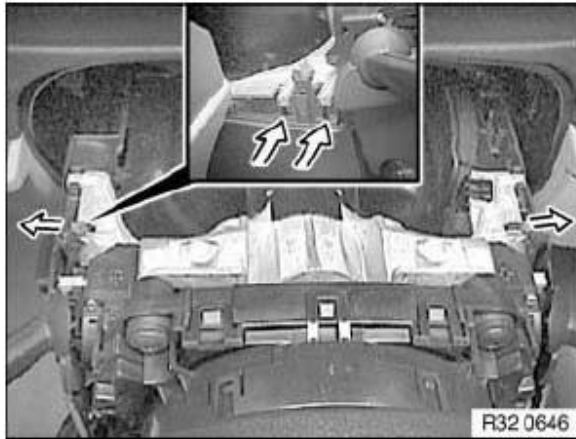


Fig. 46: Pressing Detent Lugs

Courtesy of BMW OF NORTH AMERICA, INC.

32 31 070 REMOVING AND INSTALLING/REPLACING LOWER SECTION OF STEERING SPINDLE

Necessary preliminary tasks

N52K engine:

- Remove **INTAKE FILTER HOUSING**

IMPORTANT: If the lower section of the steering spindle is separated from the steering gear/steering column, the steering-column switch cluster may be damaged when the steering wheel is turned.

Release clamping screw (1).

Return steering to straight-ahead drive setting and remove ignition key.

Detach lower section of steering spindle from steering gear.

Installation:

Clean thread to remove all remnants of screw securing adhesive.

Replace clamping screw.

Lower section of steering spindle can only be attached in one position to the steering gear.

Tightening torque **32 31 1AZ** .

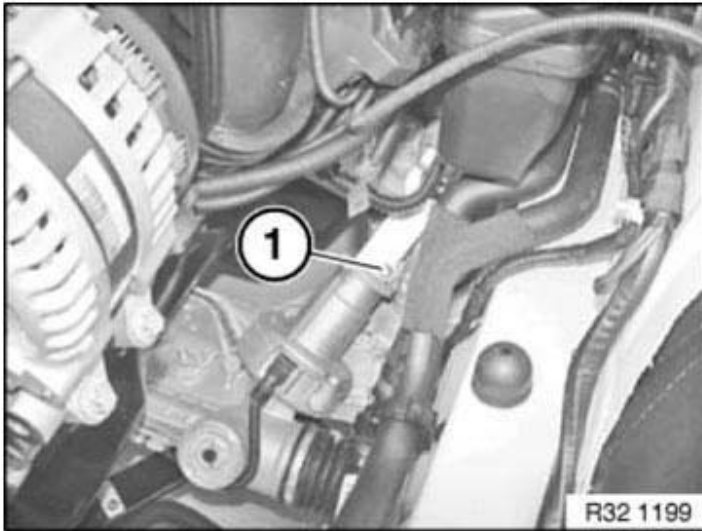


Fig. 47: Identifying Clamping Screw
Courtesy of BMW OF NORTH AMERICA, INC.

Release clamping screw (1).

Detach steering spindle upper section from steering column.

Installation:

Clean thread to remove all remnants of screw securing adhesive.

Replace clamping screw.

Clamping screw must rest in groove of steering column.

Tightening torque **32 31 2AZ** .

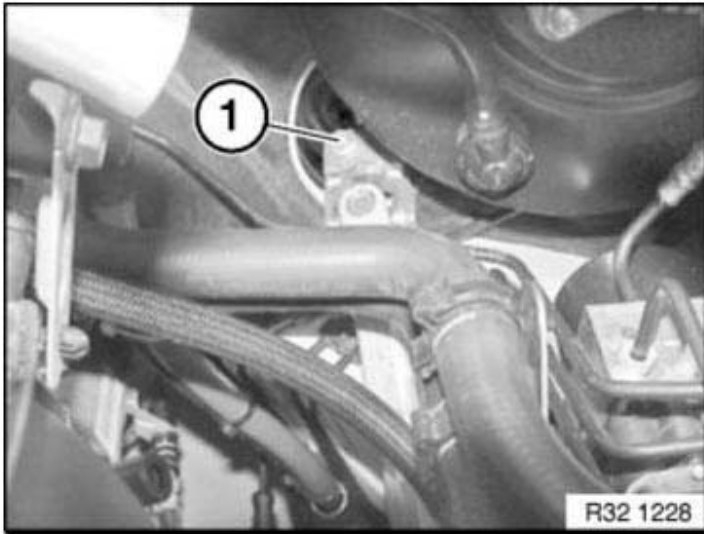


Fig. 48: Identifying Clamping Screw
 Courtesy of BMW OF NORTH AMERICA, INC.

After installation

- Turn steering wheel in both directions to full lock. The airbag warning lamp must not light up in the process.
- Carry out **STEERING ANGLE SENSOR ADJUSTMENT**
- Check directional stability of car

32 31 082 REMOVING AND INSTALLING/REPLACING STEERING ANGLE SENSOR

NOTE: Steering angle sensor is integrated in **STEERING-COLUMN SWITCH CLUSTER** .

After installation

- Replacement only: Carry out programming/coding
- Carry out **STEERING ANGLE SENSOR ADJUSTMENT**

32 31 090 REMOVING AND INSTALLING/REPLACING STEERING COLUMN

Necessary preliminary tasks:

- Remove **STEERING WHEEL**
- Remove steering column trims See **3231020 REMOVING AND INSTALLING/REPLACING LOWER SECTION OF STEERING COLUMN TRIM** or **3231003 REMOVING AND INSTALLING/REPLACING UPPER SECTION OF STEERING COLUMN TRIM**
- Remove **PANEL** for pedal assembly
- Release **STEERING SPINDLE** from steering column (in engine compartment)

- Disconnect plug connection on electric steering column lock
- Remove wiring harnesses from steering column

Secure steering column against falling out.

Release screws (1).

Tightening torque **32 31 3AZ** .

Remove steering column towards rear.

Installation:

Check steering column sleeve.

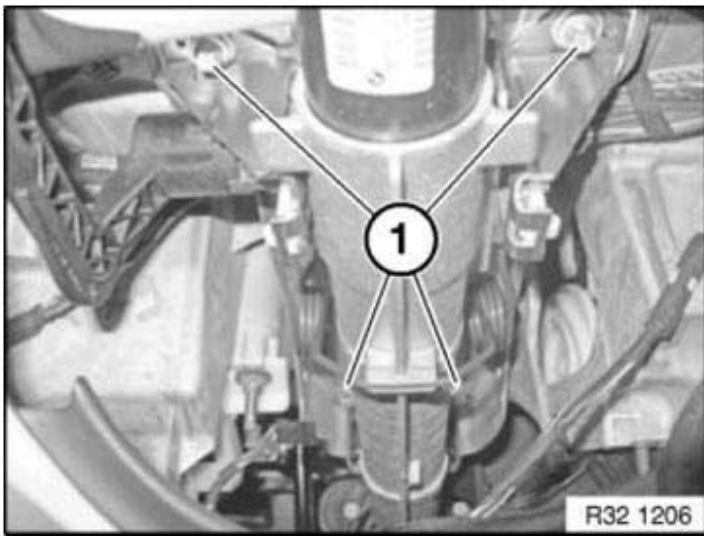


Fig. 49: Identifying Steering Column Screws
 Courtesy of BMW OF NORTH AMERICA, INC.

Replacement

- Modify **STEERING-COLUMN SWITCH CLUSTER**

After installation

- Replacement: Lock and unlock electric steering column lock and clear fault memory in Car Access System (CAS)
- Replacement: Turn steering wheel in both directions to full lock. The airbag warning lamp must not light up in the process.
- Carry out **STEERING ANGLE SENSOR ADJUSTMENT**

32 31 003 REMOVING AND INSTALLING/REPLACING UPPER SECTION OF STEERING COLUMN TRIM

Move steering column into "lower" and "extended" position.

Lever out upper section of steering column trim (1) with special tool 51 1 110 in direction of arrow towards top.

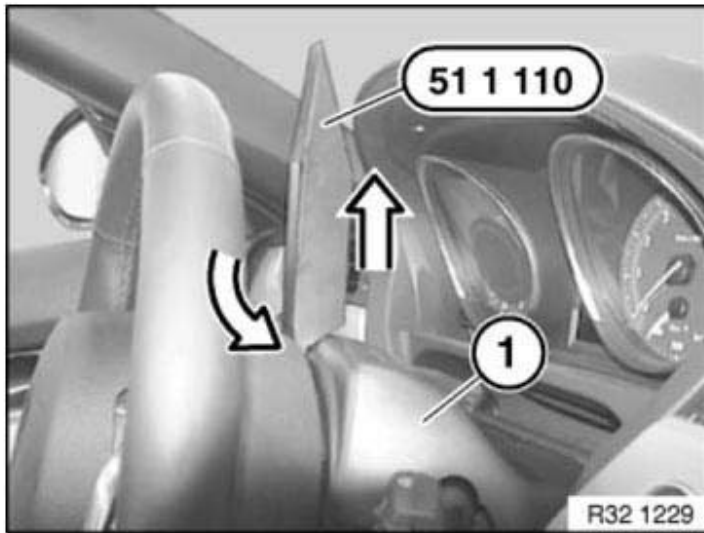


Fig. 50: Removing Upper Section Of Steering Column Trim Using Special Tool (51 1 110)
Courtesy of BMW OF NORTH AMERICA, INC.

Tilt steering column trim (1) towards front.

Unclip steering column gap cover (2) from steering column trim.

Installation:

Tilt steering column trim towards rear, align by way of lock to lower section (of steering column trim) and press down.

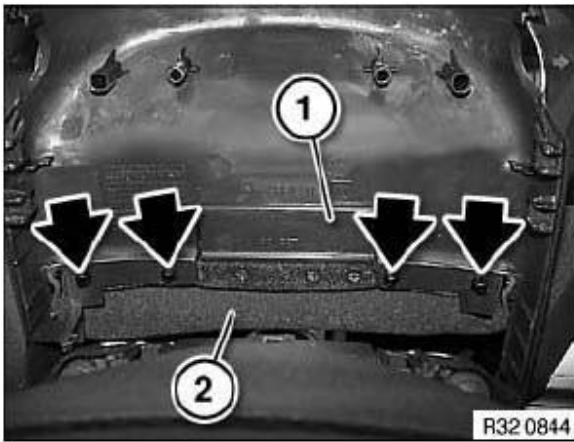


Fig. 51: Identifying Steering Column Trim And Gap Cover
 Courtesy of BMW OF NORTH AMERICA, INC.

Tilt steering column trim forwards.

Unclip gap cover from steering column trim.

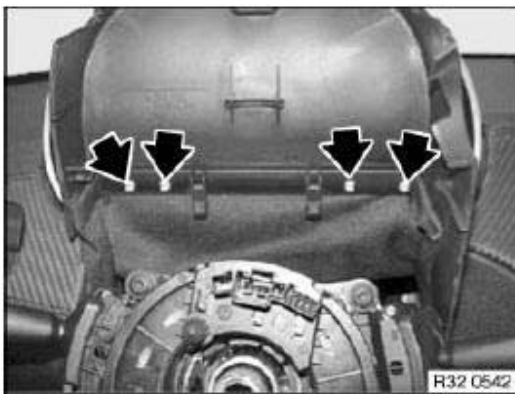


Fig. 52: Locating Steering Column Trim Screws
 Courtesy of BMW OF NORTH AMERICA, INC.

32 31 241 REPLACING ADJUSTING LEVER FOR STEERING COLUMN

Necessary preliminary tasks

- Remove **STEERING COLUMN**

If necessary, remove cable duct from steering column.

Unclip adjusting lever.

Installation:

Align adjusting lever to steering column and attach straight to prevent the locks from being damaged.

Check locks after attachment, replace adjusting lever if necessary.

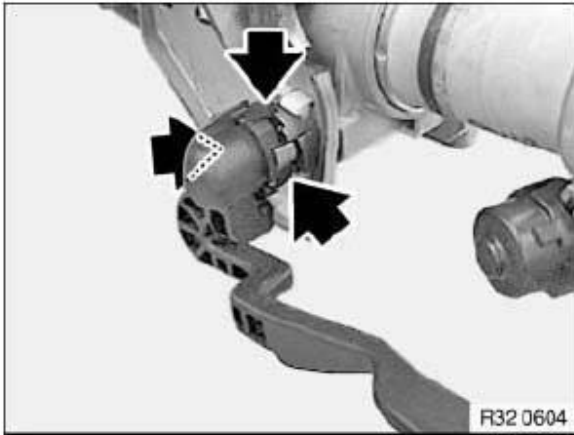


Fig. 53: Locating Adjusting Lever Of Steering Column
Courtesy of BMW OF NORTH AMERICA, INC.

32 31 102 REPLACING STEERING SPINDLE SLEEVE

Necessary preliminary tasks

- Release **STEERING SPINDLE** from steering column (in engine compartment)
- Move steering column into "upper" and "extended" position
- Remove **PANEL FOR PEDAL ASSEMBLY**

Press release (1) downwards and remove sleeve.

Installation:

First feed sleeve at top into guide and clip into place at bottom.

Sleeve must snap audibly into place!

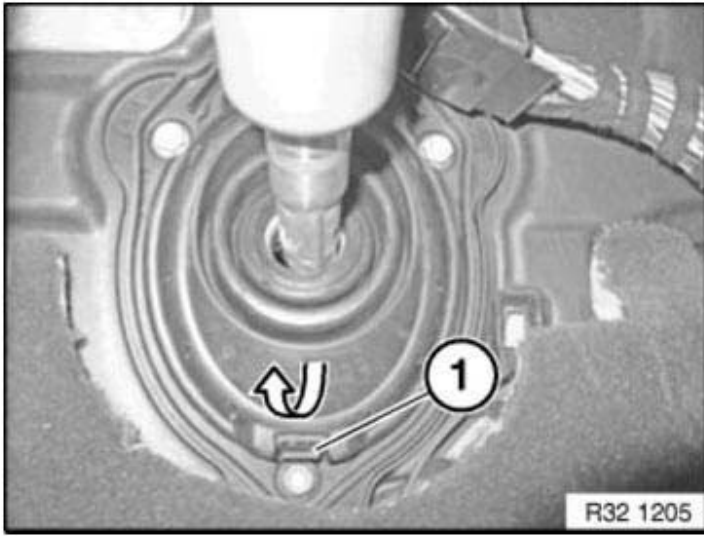


Fig. 54: Pressing Release
Courtesy of BMW OF NORTH AMERICA, INC.

After installation

- Carry out **STEERING ANGLE SENSOR ADJUSTMENT**

3233 STEERING WHEEL

32 33 010 REMOVING AND INSTALLING/REPLACING SPORT STEERING WHEEL

NOTE: **Wheel/chassis alignment is not necessary after the steering wheel has been removed and installed or replaced.**

Necessary preliminary tasks

- Remove **AIRBAG UNIT**

Move wheels/steering wheel into straight-ahead position.

Unlock plug connections (1) and (2) and disconnect.

Release screw (3) and remove steering wheel.

Installation:

Make sure connecting lead(s) is/are correctly laid.

Tightening torque **32 33 1AZ** .

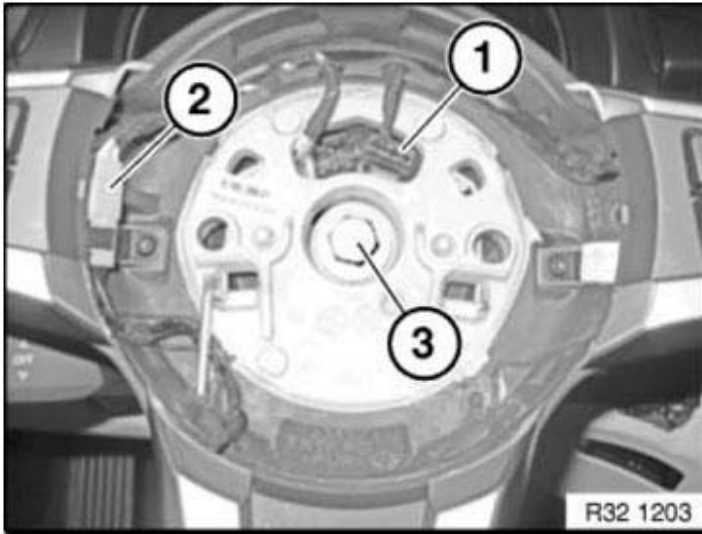


Fig. 55: Identifying Plug Connections And Screws On Steering Wheel
 Courtesy of BMW OF NORTH AMERICA, INC.

Installation:

Align steering wheel using markings (arrows) to steering column and attach.

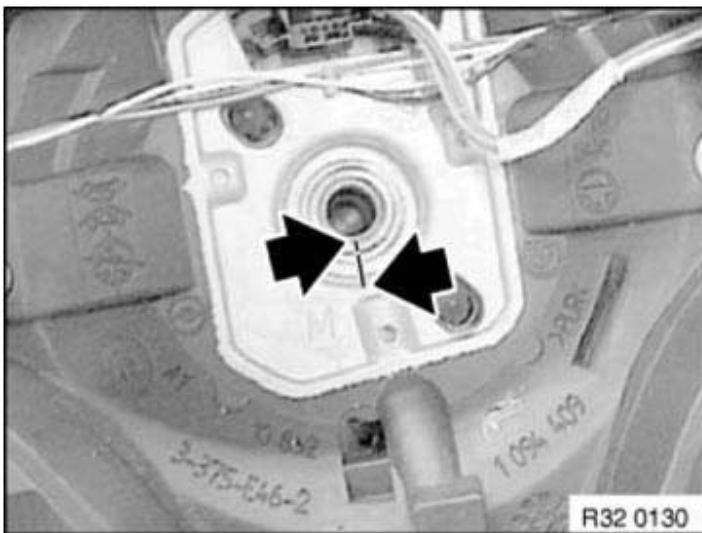


Fig. 56: Locating Steering Wheel Aligning Marking
 Courtesy of BMW OF NORTH AMERICA, INC.

Replacement

- If necessary, modify **SHIFT PADDLES**
- If necessary, modify **MULTIFUNCTION STEERING WHEEL SWITCH**

32 33 ... REPLACING SPOKE COVERS FOR STEERING WHEEL

Necessary preliminary tasks

- Remove AIRBAG UNIT

Release screws (1) and unclip spoke covers towards top.

Installation:

Make sure connecting cables are correctly routed.

Check installation position of spoke covers, correct if necessary.

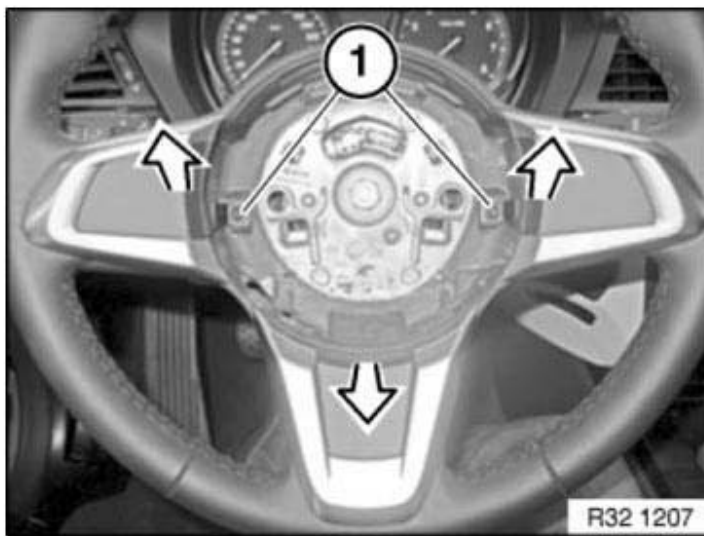


Fig. 57: Removing Spoke Cover

Courtesy of BMW OF NORTH AMERICA, INC.

3234 STEERING WHEEL FOR AIRBAG

72 12 ... PROCEDURE AFTER AIRBAG TRIGGERING AS RESULT OF AN ACCIDENT

Check and/or replace following components after airbag triggering:

Satellites (control unit + sensor)

- Components
 - Satellite, A-/B-pillar, left/right
 - Satellite, front door
 - Satellite, rear seat
 - Satellite, driver's/front passenger seat

- Satellite, vehicle center
- Procedure
 - Inspect visually for mechanical damage
 - Read fault memory
 - Disconnect battery and observe waiting period
 - Rectify faults
 - Connect battery and observe waiting period (at least 10 seconds)
 - Delete fault memory
 - Turn off ignition and wait at least 2 minutes (no consumers may be switched on during this period such as e.g. inside lights, radio, etc.)
 - Switch on ignition (wait at least 10 seconds)
 - Clear fault memory and if necessary rectify faults

Cables and plugs

- Components and procedure
 - Check cables and plugs for damage, replace if necessary.

(e. g. corrosion, correct engagement, bent pin)

Belt system

- Components
 - Retractor mechanism
 - Belt buckle tensioner
 - Seatbelt height adjustment
 - Anchor fitting tensioner
- Procedure
 - Check components, replace if necessary

Seats

- Components
 - Seat
 - Airbag module
 - Active head restraint
- Procedure
 - Check seats (function check of seat mechanism), replace if necessary
 - Check seat screw/bolt connections
 - Replace gas generator, active head restraint system

If the severity of the impact has not caused any other damage to the seat, only the triggered gas generator needs to be replaced.

External feature: The triggered head restraint is folded forwards and engaged.

The repair work can be carried out in the car with the rear panel removed. The entire system can be pushed back into its original position and the new gas generator installed.

The gas generator can be replaced up to 5 times.

- Replace airbag module and, if necessary, seat cover with padding

Driver's airbag

- Components
 - Airbag module
 - Steering Wheel
 - Steering column (if damaged)
- Procedure
 - Replace faulty components
 - Replace steering wheel

Front-passenger airbag

- Components
 - Airbag module
 - Trim, instrument panel
 - Supporting tube (if damaged)
- Procedure
 - Check components; replace if necessary

Side airbag, front/rear

- Components
 - Airbag module
 - Door panel
 - Door in white
 - Seat
- Procedure
 - Check components; replace if necessary

Head airbag

- Components
 - Airbag module
 - Trim, A-pillar
 - Roofliner
 - Trim, B-pillar (if damaged)
 - Trim, C-pillar (if damaged)
 - Connection/mounting (on side frame)
- Procedure
 - Check components; replace if necessary

Knee airbag

- Components
 - Panel (driver's side)
 - Lower section of glovebox
 - Active knee protector (driver's and passenger sides)
- Procedure
 - Replace faulty components

Passive knee protector

- Components
 - Trim panels (driver's side)
 - Glovebox incl. knee protector (passenger side)
- Procedure
 - Replace faulty components
 - Check fastening elements

32 34 030 REMOVING AND INSTALLING/REPLACING AIRBAG UNIT

WARNING: Observe the following instructions to avoid any risk of injury by the airbag unit.

- Comply with **SAFETY REGULATIONS** for handling components with gas generators.
- Do not exert any force on the airbag unit.
- Use only specified tools for releasing the airbag unit.

NOTE: Incorrect handling may result in triggering of the airbag unit and thereby cause serious injury.

**IMPORTANT: STEERING WHEEL must be replaced if airbag unit has been triggered!
Follow PROCEDURE AFTER AIRBAG TRIGGERING .**

Necessary preliminary tasks

- Disconnect **BATTERY NEGATIVE LEAD**
- If necessary, remove **SHIFT PADDLES** (TCT/automatic transmission)

Slide T20 Torx screwdriver (1) from below vertically into concealed opening on reverse side of steering wheel up to stop (2).

Press Torx screwdriver in direction of arrow outwards in order to press spring clip (3) inwards and to release airbag unit.

Repeat procedure on other side.

Installation:

Make sure electrical leads are correctly positioned.

Snap airbag unit with uniform pressing force plane-parallel in direction of steering column shaft into steering wheel.

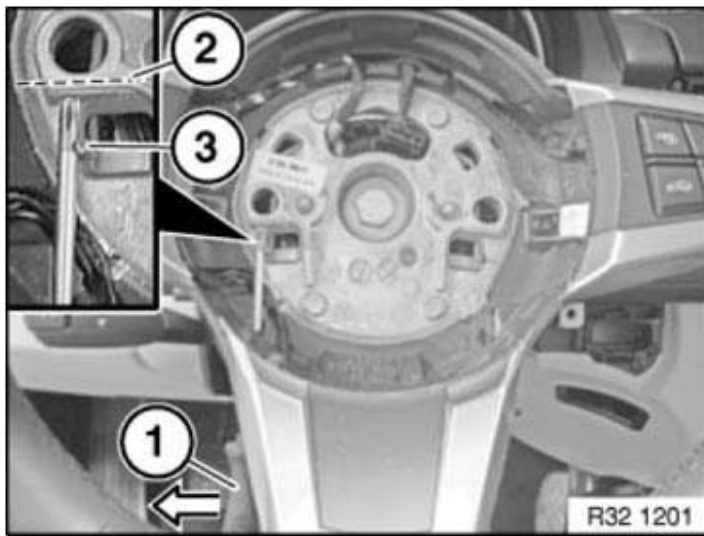


Fig. 58: Pressing Out Torx Screwdriver
Courtesy of BMW OF NORTH AMERICA, INC.

WARNING: Risk of injury!

Airbag unit may only be set down with the airbag itself facing upwards.

Tilt airbag unit forwards.

Disconnect plug connection (1) and remove airbag unit.

Installation:

Connect plugs to connections of same colour on airbag unit.

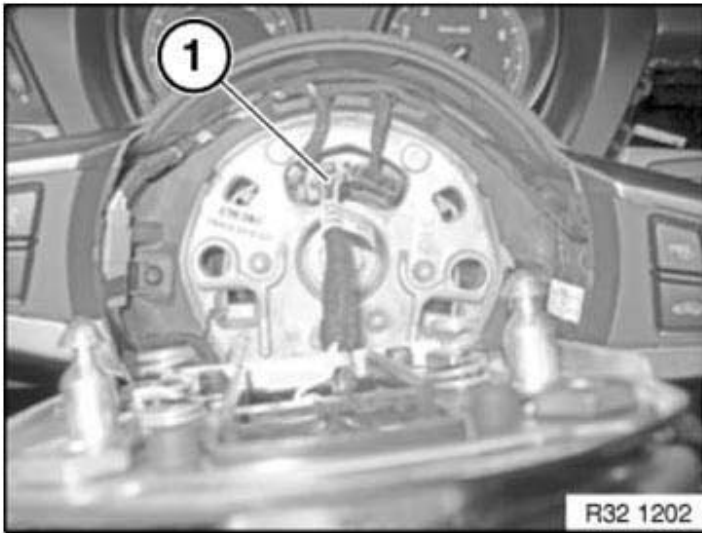


Fig. 59: Identifying Plug Connection

Courtesy of BMW OF NORTH AMERICA, INC.

72 00 ... SAFETY REGULATIONS FOR HANDLING COMPONENTS WITH GAS GENERATORS

It is essential to comply with the regulations as specified in the law relating to the use of explosives when working on airbag units and seat belt tensioners.

Airbags, seat belt tensioners etc. are pyrotechnical objects. Pyrotechnical objects are assigned to different danger classes on the basis of the quantity of propellant that they contain. The assignment can be ascertained from the identification marking on the product:

IMPORTANT: Failure to comply with the warning notices and repair instructions for gas generator components can cause accidental deployment and result in injury and vehicle damage!

This applies in particular to the following components:

- Airbag modules (driver's/front passenger airbags, side airbags)
- Buckle/belt tensioner
- Head airbag
- Active knee protection
- Active head restraint

- Safety battery terminal

1. Regulations

The regulations quoted in the following refer to the Federal Republic of Germany.

In all other countries, the relevant legislation and regulations must be observed in each case. Country-specific legal regulations that go beyond this information or court decisions based thereon must be followed in each case or given precedence over these regulations.

The following components used by BMW:

- Pyrotechnical restraint systems are subject to danger class PT1
- Gas generators are pyrotechnical objects belonging to danger class T1.

Handling, transporting and storing non-fired gas generators are subject to the "Explosive Materials Act".

The relevant trade supervisory authority must be notified at least 2 weeks before pyrotechnical objects are handled for the first time. Here the relevant authority must be notified in writing of the person responsible (e.g. dealership owner, holder of general power of attorney or if necessary workshop supervisor). A certificate of qualification, i.e. specific training, is not required for the person responsible.

2. Disassembly and assembly

- Inspection, testing and installation work may only be carried out by expert trained personnel in BMW Service.
- Work on components of the airbag system should only ever be carried out with the battery disconnected, the negative terminal post covered and the plug connection of the cable leading to the gas generator disconnected. If only the battery is disconnected, the following prescribed waiting period must be observed without fail:
 - 30 minutes for vehicles up to 9/93;
 - 1 minute for vehicles from 9/93
- In the event of breaks in work, a component with a gas generator that has been removed must be secured against access by other persons.
- Individual components must never be repaired. Instead, always replace them.
- Do not treat airbag system components with cleaning agents or grease.
- Components of the airbag system must not be exposed to temperatures in excess of 75 °C.
- Airbag system components, including electronic diagnostic components, which have been dropped from heights in excess of 0.5 m must not be reinstalled in the vehicles.
- Before installing, subject components such as housing, connector pins etc. (including electronic diagnostic components) to a visual inspection for damage and replace if necessary.
- Airbag system components may only be electrically tested while they are installed and only with the BMW ISTA.
- **Danger of injury:** The airbag module may only be set down with the airbag itself facing upwards.

Otherwise the generator will be thrown upwards if it is fired.

- Do not point the firing pellet of a gas generator at other persons.
- Components with gas generators must not be fired while they are removed. They must be disposed of by special disposal companies or returned to BMW in the packaging of the new components.
- When carrying out straightening and welding work with an electric welder:
 - Disconnect battery
 - Cover negative terminal (post)
- Avoid all contact with the skin when removing a fired airbag module - wear gloves. Wash with water after contact with the skin.

3. Transport

- Components with gas generators must be sent off in the packaging of the new components.

4. Storage

- Observe the regulations of the relevant trade supervisory authority and the applicable national regulations.

3241 PUMP AND OIL SUPPLY

32 41 ... INSTRUCTIONS FOR REMOVING AND INSTALLING EAR CLIPS

NOTE: **The work steps are shown on assorted components.
Ear clip must always be replaced.**

To remove an ear clip, place special tool 32 1 260 at right angles to ear and cut ear open.

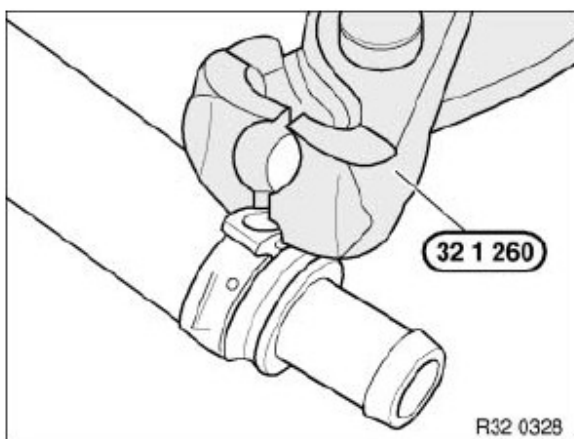


Fig. 60: Removing Ear Clip Using Special Tool (32 1 260)
Courtesy of BMW OF NORTH AMERICA, INC.

The ear clip can be fitted not only axially but also radially after the hook fastener has been opened.

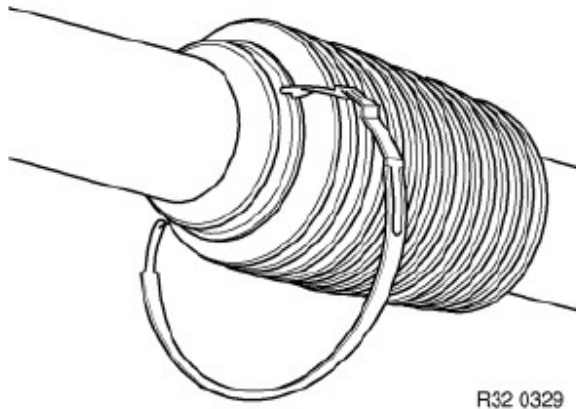


Fig. 61: Identifying Hook Fastener On Ear Clip
Courtesy of BMW OF NORTH AMERICA, INC.

Attach hook fastener and press ear together with special tool 32 1 260.

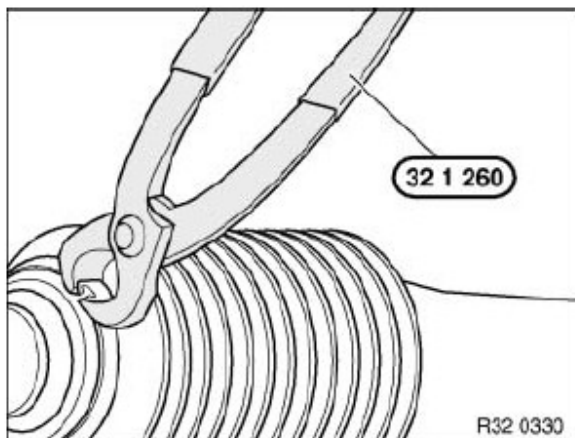


Fig. 62: Pressing Ear Clip Using Special Tool (32 1 260)
Courtesy of BMW OF NORTH AMERICA, INC.

Side cutter of special tool 32 1 260 can be used in areas which are difficult to access.

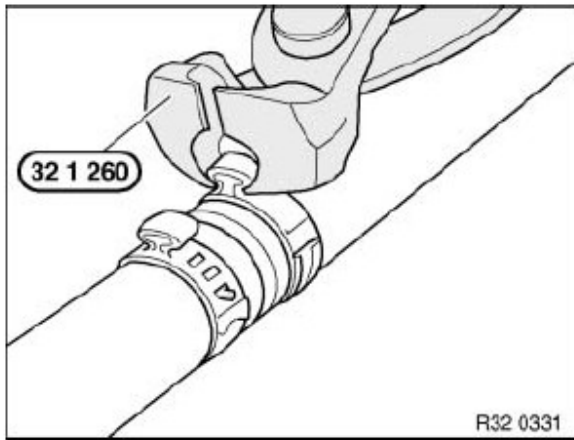


Fig. 63: Identifying Special Tool (32 1 260)
 Courtesy of BMW OF NORTH AMERICA, INC.

IMPORTANT: Gap (A) max. 1 mm!

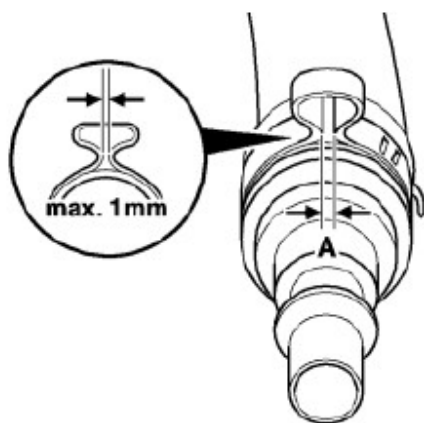


Fig. 64: Identifying Ear Clip Gap
 Courtesy of BMW OF NORTH AMERICA, INC.

SUSPENSION

Steering and Wheel Alignment - Special Tools - Z4

32 STEERING AND WHEEL ALIGNMENT

32-0000 GAUGE

Gauge MW

NOTE: For vertical adjustment of the front axle

SI number

01 09 09 (532)

Consisting of:

1 = 0496677 Gauge

NOTE: Left

2 = 0496678 Gauge

NOTE: Right

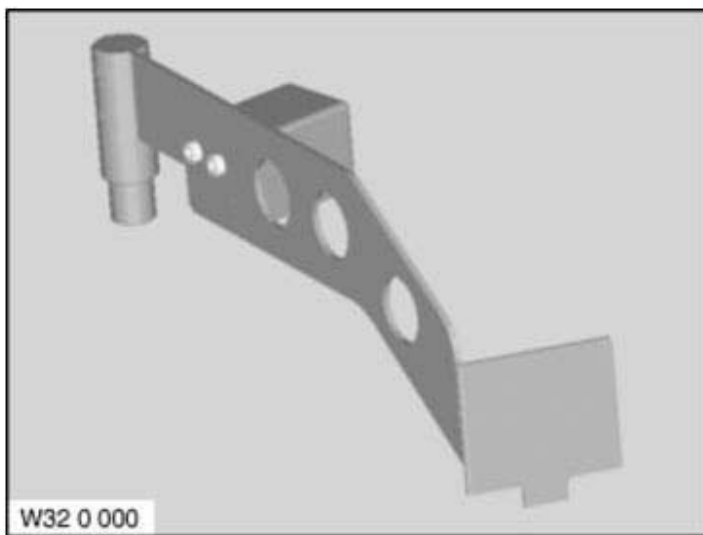


Fig. 1: Identifying Gauge (32-0000)
Courtesy of BMW OF NORTH AMERICA, INC.

32-2120 GAUGE

Gauge MW

Replaced by: 0492036

NOTE: (Test gauge) For measuring the drop arm - Replaced by 32 2 140.(0 492 036)

Consisting of:

1 = 0492030 Spindle

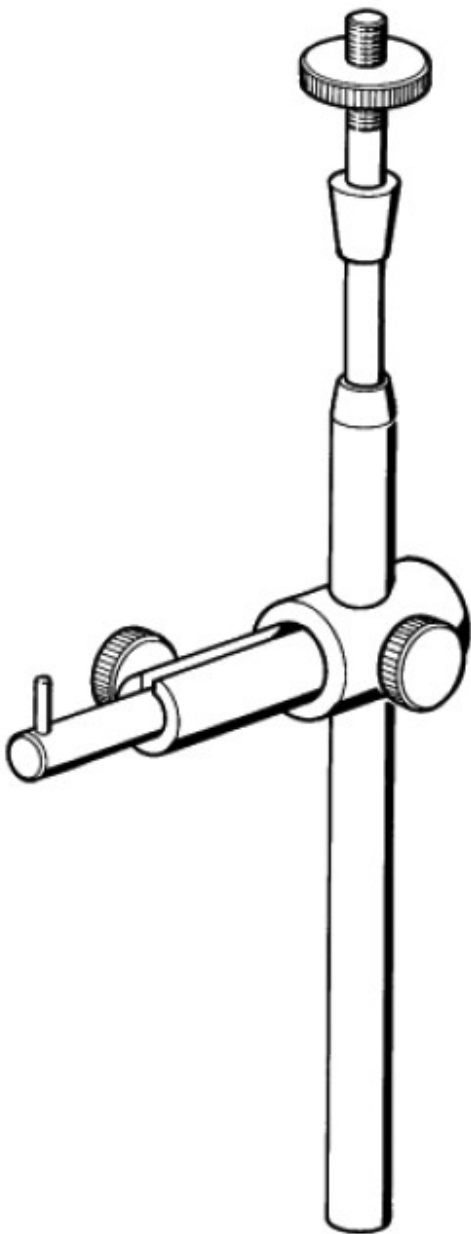
NOTE: Discontinuation and replaced by 32 2 140.(0 492 036)

2 = 0492031 Shaped part

NOTE: (Shaped part) Discontinuation and replaced by 32 2 140.(0 492 036)

3 = 0492032 Bolt

NOTE: (Measuring bolt) Discontinuation and replaced by 32 2 140.(0 492 036)



W32 2 120

Fig. 2: Identifying Gauge (32-2120)
Courtesy of BMW OF NORTH AMERICA, INC.

32-3200 OPEN-END WRENCH INSERT

Open-end wrench insert MW

NOTE: (Open-end wrench insert) SW34 For releasing and tightening down track rod connection to steering gear (rack)

Storage Location

A84

SI number

01 01 04 (065)



Fig. 3: Identifying Open-End Wrench Insert (32-3200)
Courtesy of BMW OF NORTH AMERICA, INC.

32-1270 PLUG

Plug Minimum set: Mechanical tools MW

NOTE: (Plugs (set)) 27-piece, 3x per size - For sealing off hydraulic lines for brakes, steering etc.

SI number

01 14 01 (766)



Fig. 4: Identifying Plug (32-1270)
Courtesy of BMW OF NORTH AMERICA, INC.

32-3140 TOOL

Tool Minimum set: Mechanical tools MW

NOTE: (Adjustment tool) For adjusting the front camber.

Storage Location

B8

SI number

01 15 05 (200)

Consisting of:

5 = 0493765 Spindle

NOTE: Replaced by 32 3 146 (0 495 355)

3 = 0494384 Ring

NOTE: (Support ring) Replaced by 32 3 145 (0 494 181)

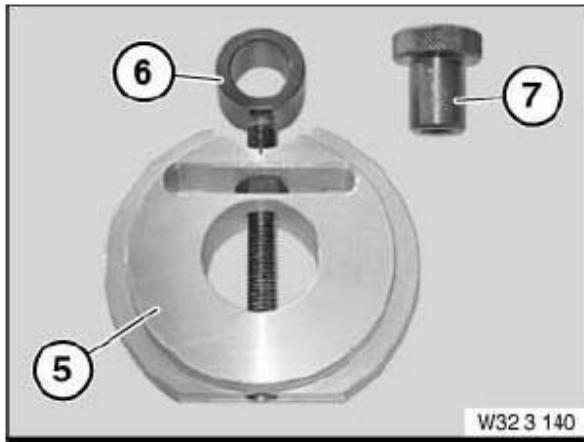


Fig. 5: Identifying Tool (32-3140)

Courtesy of BMW OF NORTH AMERICA, INC.

2 = 0493558 Ring

NOTE: (Support ring) Replaced by 32 3 145 (0 494 181)

2 = 0493559 Holder

NOTE: Replaced by 32 3 146 (0 495 355)

5 = 0494181 Washer

NOTE: For adjusting the camber on the front axle.

6 = 0495355 Spindle

7 = 0495356 Bolt

NOTE: (Knurled screw)

32-3030 TOOL

Tool Minimum set: Mechanical tools MW

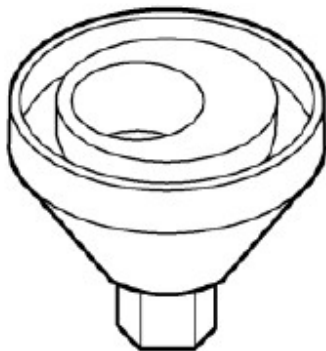
NOTE: (adjusting tool) For setting toe-in on rear axle - rear axle with KDS

Storage Location

B5

SI number

01 02 98 (302)



W32 3 030

Fig. 6: Identifying Tool (32-3030)
Courtesy of BMW OF NORTH AMERICA, INC.

SUSPENSION

Steering and Wheel Alignment - Technical Data - Z4

CHASSIS/WHEEL ALIGNMENT - NORMAL POSITION E89

32 00 CHASSIS/WHEEL ALIGNMENT - NORMAL POSITION E89

CHASSIS/WHEEL ALIGNMENT - NORMAL POSITION SPECIFICATION

Car loaded down to normal position	Vehicle with complete equipment for normal operation with: 2 x 68 kg on front seats (seats in central position); 1 x 14 kg in luggage compartment (centre) and full fuel tank.
------------------------------------	---

WHEEL ALIGNMENT

32 00 WHEEL ALIGNMENT E89

WHEEL ALIGNMENT SPECIFICATION

<u>OBSERVE TEST CONDITIONS!</u>		
Front axle:		
Total toe-in		0° 14' ± 12'
Adjustment ⁽¹⁾ total toe		0° 14' ± 4'
Toe difference ⁽²⁾ single wheel between left/right		max. 12'
Camber (difference between left/right max. 30')		- 23' ± 30'
Adjustment ⁽¹⁾ camber		- 23' ± 25'
Toe angle difference with 20° lock on inside wheel		(difference between left/right max. 30')
with 20° lock on inside wheel		-2° 04' ± 30'
Castor		(difference between left/right max. 30')
Front wheel offset		0° ± 15'
Maximum wheel lock		
Inner cornering wheel	approx. °	37° 39'
Outer cornering wheel	approx. °	31° 10'
Rear axle:		
Total toe-in		0° 18' ± 12'
Adjustment ⁽¹⁾ total toe		0° 18' ± 4'
Camber (difference between left/right max. 30')		-2° 20' ± 25'
Adjustment ⁽¹⁾ camber		-2° 20' ± 5'
Geometrical driving axis		0° ± 12'
(1) To minimize adjusting errors (measuring inaccuracies), use a narrower tolerance for adjusting toe/camber.		

(2) Toe difference front axle = criterion for steering wheel inclination		
--	--	--

WHEEL ALIGNMENT

32 00 WHEEL ALIGNMENT E89 VDC FAHRWERK

WHEEL ALIGNMENT SPECIFICATION

<u>OBSERVE TEST CONDITIONS!</u>		
Front axle:		
Total toe-in		0° 14' ± 12'
Adjustment ⁽¹⁾ total toe		0° 14' ± 4'
Toe difference ⁽²⁾ single wheel between left/right		max. 12'
Camber (difference between left/right max. 30')		- 33' ± 30'
Adjustment ⁽¹⁾ camber		- 33' ± 25'
Toe angle difference with 20° lock on inside wheel		(difference between left/right max. 30')
with 20° lock on inside wheel		-2° 08' ± 30'
Castor		(difference between left/right max. 30')
Front wheel offset		0° ± 15'
Maximum wheel lock		
Inner cornering wheel	approx. °	37° 25'
Outer cornering wheel	approx. °	31° 55'
Rear axle:		
Total toe-in		0° 18' ± 12'
Adjustment ⁽¹⁾ total toe		0° 18' ± 4'
Camber (difference between left/right max. 30')		-2° 20' ± 25'
Adjustment ⁽¹⁾ camber		-2° 20' ± 5'
Geometrical driving axis		0° ± 12'
(1) To minimize adjusting errors (measuring inaccuracies), use a narrower tolerance for adjusting toe/camber.		
(2) Toe difference front axle = criterion for steering wheel inclination		

SUSPENSION

Steering and Wheel Alignment - Tightening Torques - Z4

DROP ARM

32 21 DROP ARM

TIGHTENING TORQUE SPECIFICATION - DROP ARM

		Type	Thread	Tightening specifications	Dimension
1AZ	Track rod/axial joint to rack	E89			100 +10 Nm
2AZ	Track rod to swivel bearing	E89	M14	Replace nut.	165 Nm
3AZ	Clamping bolt, track rod	E89	M10	Replace screw.	40 Nm

STEERING

32 00 STEERING

TIGHTENING TORQUE SPECIFICATION - STEERING

		Type	Thread	Tightening specification	Measure
1AZ	Steering gear to front axle carrier	E89	M10	Replace screws & nuts Jointing torque Torque angle	56 Nm 90 °
2AZ	Heat shield to steering gear	E89	M6		4.5 Nm

STEERING COLUMN

32 31 STEERING COLUMN

TIGHTENING TORQUE SPECIFICATION - STEERING COLUMN

		Type	Thread	Tightening specification	Measure
1AZ	Steering spindle to steering column	E89		Replace clamping screw Clean thread	21 Nm
2AZ	Steering spindle to steering gear	E89		Replace clamping screw Clean thread	21 Nm

3AZ	Steering column to support tube	E89	M8		21 Nm
-----	---------------------------------	-----	----	--	-------

STEERING WHEEL

32 33 STEERING WHEEL

TIGHTENING TORQUE SPECIFICATION - STEERING WHEEL

		Type	Thread	Tightening specification	Measure
1AZ	Steering wheel to steering column	E89,			62.5 Nm

STEERING

System Components - Z4

SYSTEM COMPONENTS

The main components of the EPS system are the:

- Steering torque sensor
- EPS control unit
- Electric motor with position sensor
- Reduction gear
- Steering rack

STEERING TORQUE SENSOR

The steering torque sensor provides the EPS control unit with information about the steering torque applied by the driver in the form of an input signal. The EPS control unit uses that signal and other input signals to calculate the power assistance torque and operates the electric motor accordingly. The torque produced by the electric motor is added by way of the reduction gear to the steering torque applied by the driver. The total torque is converted by the steering rack into steering force at the front wheels.

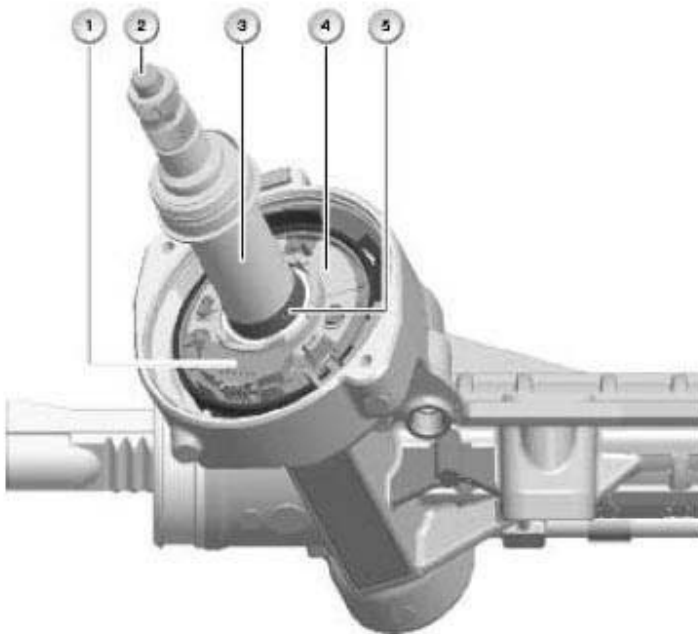


Fig. 1: Identifying Steering Torque Sensor
Courtesy of BMW OF NORTH AMERICA, INC.

INDEX EXPLANATION REFERENCE CHART

Index	Explanation
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1	Sensor unit with analyzer circuitry
2	Torsion bar (top end) 5 Ring magnet
3	Input shaft
4	Coil spring
5	Ring magnet

Rotation of the input shaft (3) and ring magnet (5) is detected and electronically analysed by the sensor unit (1). The fundamental sensing principle applied is called the Hall effect.

As the rigidity of the torsion bar (2) inside the input shaft is known, the electronic circuitry can calculate the amount of torque applied from the degree of twist.

The steering torque is then digitally transmitted to the EPS control unit via a direct cable connection.

The sensor signal is provided with redundant back-up (a second identical sensor) so that system availability in the event of sensor failure is improved. If an unacceptable degree of divergence between the two sensors is detected during operation, the system continues to operate on the basis of the more plausible of the two signals and full EPS functionality is maintained.

If the fault status remains present at the end of the driving cycle, a fault memory entry is generated and the EPS does not operate when the next driving cycle starts.

EPS CONTROL UNIT

As well as the control circuitry, the EPS control unit also contains the power electronics for operating the electric motor.

The power electronics includes a multiple output relay that turns off the power supply to the motor windings in the event of a fault. Breaking the circuit allows the motor shaft to rotate freely. Fault conditions in which the motor would electrically lock up are avoided.

There is a temperature sensor integrated in the control unit that is required for detecting overload situations.



Fig. 2: Identifying EPS Control Unit And Electric Motor Housing Components
 Courtesy of BMW OF NORTH AMERICA, INC.

INDEX EXPLANATION REFERENCE CHART

Index	Explanation
1	Electric motor housing
2	Steering torque sensor lead connection
3	Bus connection
4	Cable to steering torque sensor
5	Power supply connection
6	Diaphragm made of Goretex
7	EPS control unit housing

The housing of the EPS control unit (and the electric motor) is located in a position exposed to large temperature fluctuations and high external moisture levels. Therefore, there is a diaphragm made of Goretex on the housing that equalizes the pressure difference between the inside and outside of the housing but still prevents moisture intrusion at that point.

On the EPS control unit and electric motor housing there are also the following EPS electrical connections:

- Power supply for the EPS
- Bus connection (PT-CAN inc. wake-up line)
- Power supply and signal line for steering torque sensor

ELECTRIC MOTOR WITH POSITION SENSOR

The essential function of the electric motor is to generate the required torque calculated by the EPS control unit.

The type of electric motor used is a brushless DC motor (made by Siemens).

Although it is powered by direct current, its method of operation is based on that of an AC synchronous motor.

The power electronics in the EPS control unit convert the power supply voltage (DC voltage) into phase voltages so as to produce a rotating field at the phase windings.

Only this type of motor combines the following characteristics that are decisive for use in an EPS system:

- High efficiency
- Long service life
- Small external dimensions
- Low wear
- High thermal load capacity
- Constantly high torque over a wide speed range

The electric motor is almost exclusively operated in the speed range throughout which its torque is constant. Only in rare cases involving extremely high rates of steering angle change applied by the driver does the speed briefly reach the point at which the torque curve falls away with increasing motor speed. Very aware drivers may perceive this as reduction of power steering assistance. In contrast with hydraulic power steering, where the drop is noticeable as an abrupt stiffening, the change is progressive with EPS, which is generally perceived as more pleasant.

The maximum power consumption (transient) is 85 A so that at a rated voltage of 12 V a peak output of approximately 1 kW results. The fuse in the trunk that protects the power circuit against shorting has an appropriately high rating for that high current draw.

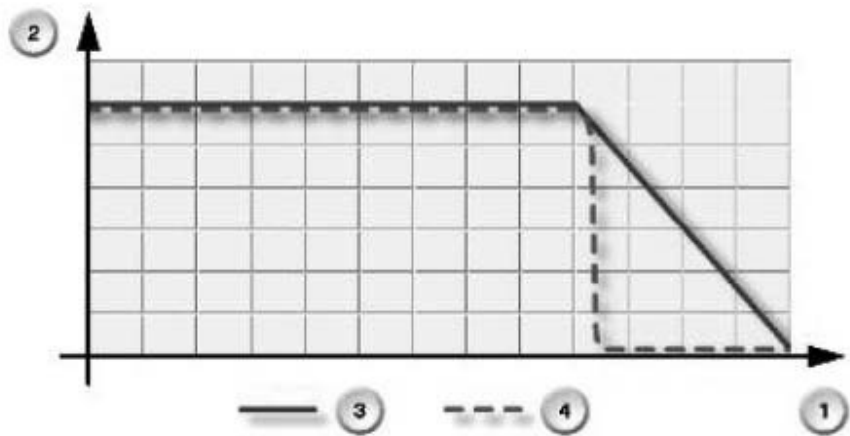


Fig. 3: Torque Versus Rate Of Change Of Steering Angle Graph (EPS Vs. Hydraulic Power Steering)
 Courtesy of BMW OF NORTH AMERICA, INC.

INDEX EXPLANATION REFERENCE CHART

Index	Explanation
1	Speed of electric motor, equates to rate of change of steering angle
2	Torque
3	EPS electric motor - relationship of torque to motor speed
4	Hydraulic power steering pump - relationship of torque to steering angle rate of change

In contrast with the peak output, the average output required for delivery of EPS functions is very low. It is only between approx. 20 W and 40 W (depending on driving profile) because the electric motor is only supplied with power on demand, e.g. when cornering but not when travelling in a straight line (without having to use the steering).

Demand-based operation of the electric motor is the main reason why the fuel consumption of vehicles with EPS is around 0.2 l/100 km less than that of vehicles with hydraulic power steering. And on the other hand, the power that would otherwise be required to constantly drive the power steering pump is now almost entirely available as additional motive power for the vehicle. Depending on the situation, there can be a linear dynamics gain of up to 2 kW.

A second important component is actually on the circuit board of the EPS control unit but is located directly adjacent to the electric motor shaft: the motor position sensor. In that way the motor position sensor can directly signal the electric motor's rotor position to the EPS control unit. As the electric motor is rigidly connected to the steering rack by means of the reduction gearing, the EPS control unit can deduce the position of the roadwheels and the steering angle from the rotor position.

After first calibrating the straight-ahead position with the aid of the signal from the steering angle sensor, the motor position sensor signal is subsequently used for the EPS functions (e.g. "active steering-wheel return"). The reason for this is the higher resolution of the motor position sensor signal.

The sensing principle applied by the motor position sensor is identical with that used by the steering torque sensor. Both consist of Hall-effect sensor units adjacent to which there is a rotating magnet. The steering torque sensor is designed to detect small degrees of twist, while the motor position sensor must detect large amounts of rotation (a complete revolution must be measurable). The motor position sensor is also duplicated, though in this case the duplicate unit has a different resolution in order to be able to pick up both fast and slow movements effectively.

REDUCTION GEAR

The reduction gearing transmits the torque generated by the electric motor to the steering rack, thereby applying steering force to the front wheels.

The overall transmission ratio is approximately 20 revolutions of the electric motor to one revolution of the steering wheel. That low gearing ratio combined with the high torque of the electric motor makes it possible to generate the required steering rack forces.

The low ratio combined with the rotating mass of the electric motor also has a damping effect on feedback from the road and roadwheels (as described in the section "Active damping").

The reduction gearing consists of the belt drive and reciprocating ball (screw) drive.

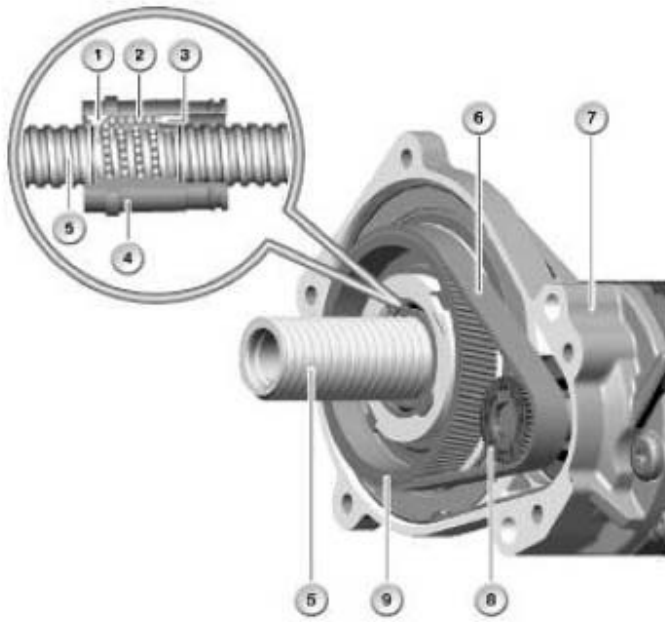


Fig. 4: Identifying Reduction Gearing For EPS With APA
Courtesy of BMW OF NORTH AMERICA, INC.

INDEX EXPLANATION REFERENCE CHART

Index	Explanation
1	Ball bearing outfeed mechanism
2	Ball bearing return channel
3	Ball bearing infeed mechanism
4	Nut of ball screw drive
5	Ball screw thread on steering rack
6	Toothed drive belt
7	Reduction-gear housing
8	Small gear wheel
9	Large gear wheel

The electric motor shaft drives the small gear wheel (8) of the belt drive directly. Via the toothed drive belt (6) and the large gear wheel (9), the nut (4) of the ball screw drive is made to rotate.

That nut contains a return channel (2) and mechanisms at either end of the bearing race for feeding the ball bearings into (3) and out of (1) the ball screw thread of the steering rack (5). Thus, the ball bearings circulate within a "closed system".

As the nut cannot move along the steering rack, the ball bearings moving along the ball screw thread exert an axial force on the steering rack.

The reduction gearing is inseparably attached to the electric motor. Repairs or adjustments to it as a separate component are not possible.

The reduction gearing and its components (including the drive belt) are designed to last for the life of the vehicle.

If the gaiter at the end of the steering rack is damaged, water can get into the reduction gear housing and therefore into the steering gear as well. That water will cause corrosion and, over time, loud noises when steering.

Nevertheless, power steering assistance from the EPS continues to be provided even in such cases.

In order that large amounts of water do not remain in the steering gear (e.g. after driving through deep water), a water drain valve has been fitted at the lowest point of the reduction gear.

NOTE: If a defective bellows (boot) is discovered, it should be replaced so as to prevent water entering the steering gear. At the same time as replacing the gaiter, the water drain valve at the lowest point of the reduction gear should also be replaced and is included in the repair kit.

STEERING RACK

The steering rack of the EPS system has the same function as that of a hydraulic power steering system.

It converts the steering force applied by the driver combined with the power steering assistance provided by the EPS into a force applied to the track rods. Ultimately, that results in steering movements by the front wheels.

The design and dimensions of the steering rack are such that the design of the other vehicle components only required marginal adjustments in order to enable the use of electric power steering.

In particular, the points of attachment to the wheels by way of the track rods and with the steering column are absolutely identical with those used up to now with the hydraulic power steering.

The track rod also has the same gearing ratio.

Accordingly, the gearing ratio of the steering system as a whole is identical regardless of the power assistance method used.

As with hydraulic power steering systems, there is a thrust piece at the point where the pinion engages in the rack. It guides the rack and also serves as a means of adjusting the entire unit at the factory.

The thrust piece in this EPS system acts purely as a spring mechanism without a hydraulic bearing.

NOTE: Adjustment of the steering rack and pinion using the thrust piece is a once-only operation carried out during production. That adjustment cannot and must not be performed at a dealership!

STEERING

System Overview - Z4

SYSTEM OVERVIEW

MECHANICAL DESIGN

The electric power steering is an absolutely identical fit with the previously used hydraulic power steering as far as the connections between it and the vehicle are concerned.

For comparison, a hydraulic power steering system and the new EPS with parallel mounted motor are illustrated below.



Fig. 1: Identifying Hydraulic Power Steering Components (Typical Installation Configuration)
Courtesy of BMW OF NORTH AMERICA, INC.

INDEX EXPLANATION REFERENCE CHART

Index	Explanation
1	Hydraulic-fluid reservoir
2	Steering column
3	Torsion bar and valve actuator
4	Track rod
5	Hydraulic power steering pump
6	Steering rack

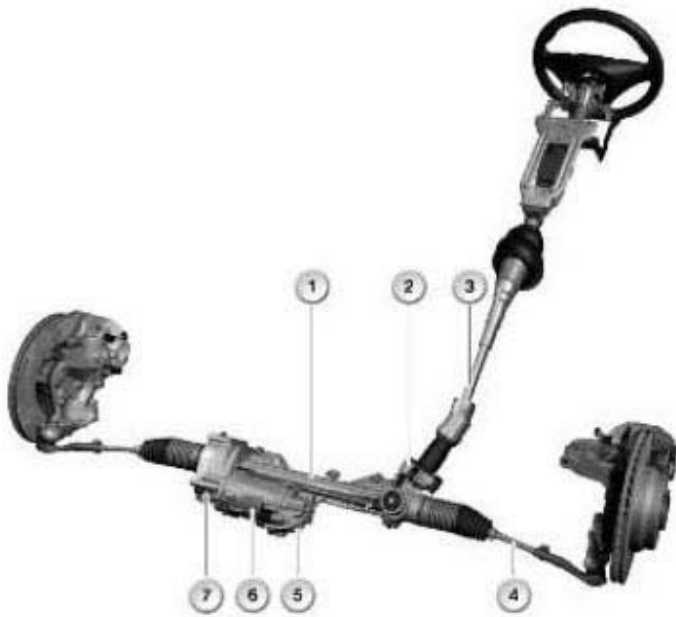


Fig. 2: Identifying Electric Power Steering Components With Parallel-Mounted Motor
 Courtesy of BMW OF NORTH AMERICA, INC.

INDEX EXPLANATION REFERENCE CHART

Index	Explanation
1	Steering rack
2	Steering torque sensor
3	Steering column
4	Track rod
5	EPS control unit
6	Electric motor with position sensor
7	Reduction gear

The EPS system essentially consists of the following components:

- Steering torque sensor
- EPS control unit
- Electric motor with position sensor
- Reduction gear
- Steering rack

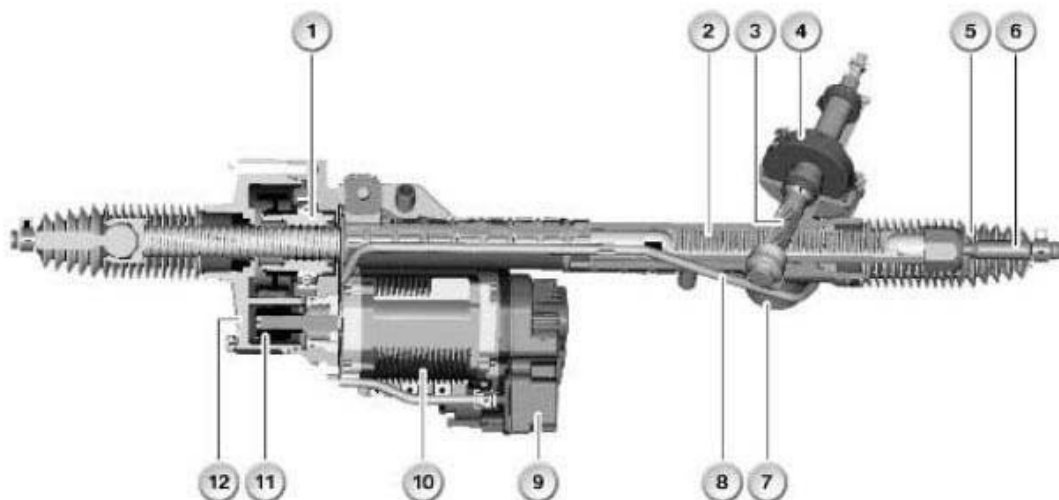


Fig. 3: Identifying EPS Rack-And-Pinion Steering Box Components With Parallel-Mounted Electric Motor
 Courtesy of BMW OF NORTH AMERICA, INC.

INDEX EXPLANATION REFERENCE CHART

Index	Explanation
1	Ball-screw drive (part of reduction gearing)
2	Rack
3	Pinion
4	Steering torque sensor
5	Gaiter
6	Track rod
7	Thrust piece
8	Signal and power lead for steering torque sensor
9	EPS control unit
10	Electric motor
11	Toothed-belt drive (part of reduction gearing)
12	Reduction-gear housing

NOTE: These components form a preassembled unit (often referred to as "EPS steering rack assembly") that can only be replaced as a complete unit. To do so, the unit has to be disconnected from the tie rods and the lower end of the steering column.

EPS SYSTEM CIRCUIT DIAGRAM

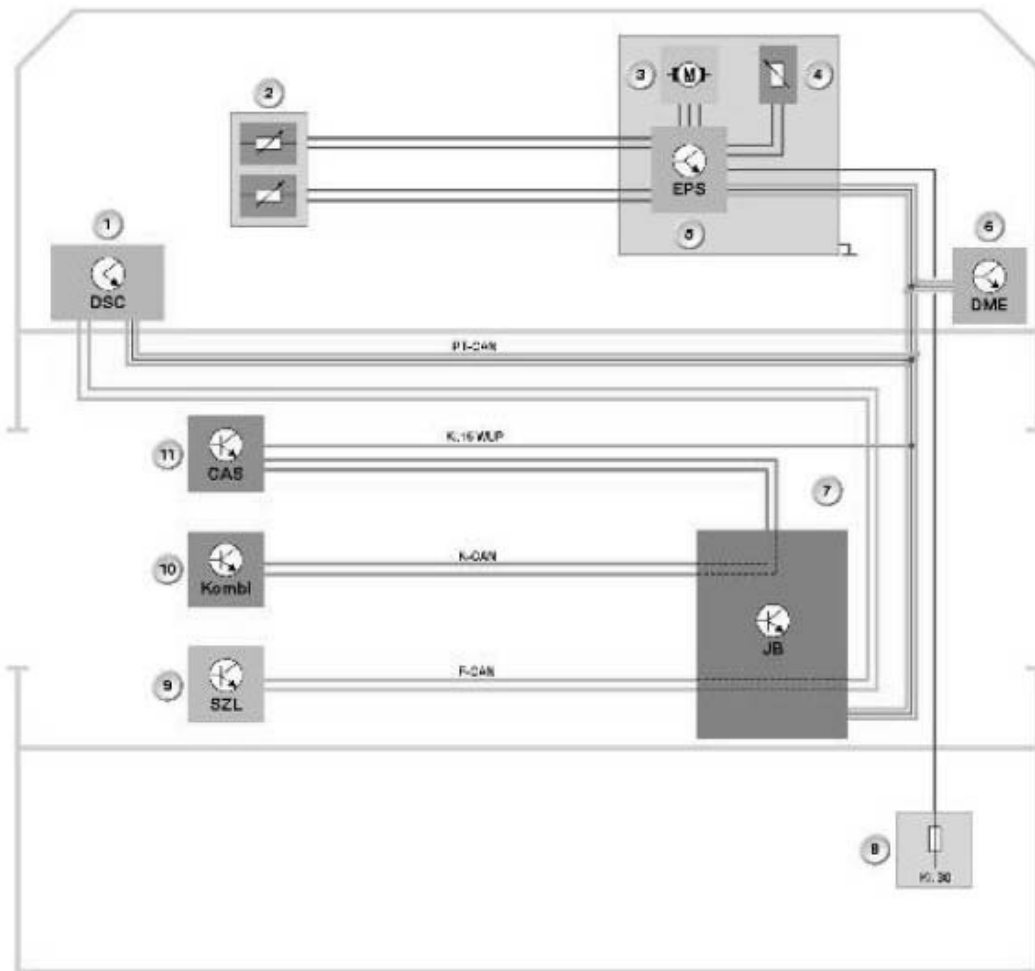


Fig. 4: EPS System Circuit Diagram
 Courtesy of BMW OF NORTH AMERICA, INC.

INDEX EXPLANATION REFERENCE CHART

Index	Explanation
1	DSC control module
2	Steering torque sensor with redundant back-up
3	Electric motor
4	Motor position sensor
5	EPS control unit
6	DME control unit
7	Junction box
8	Fuse in boot (power supply for EPS)
9	Steering column switch cluster with steering-angle sensor
10	Instrument cluster
11	CAS control unit