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E90 Suspension & Chassis Components

Initial Print Date: 03/05 Revision Date: 06/05

Suspension & Chassis Components

Model: E90

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Identify the changes in the front axle
- Identify the changes in the rear axle
- Understand the changes to the steering column

Suspension

The chassis and suspension of E90 represent a new step forward in the mid-size class, both at the front axle as well as at the rear axle. The front axle utilizes a double pivot spring strut axle (MacPherson strut) in aluminium.

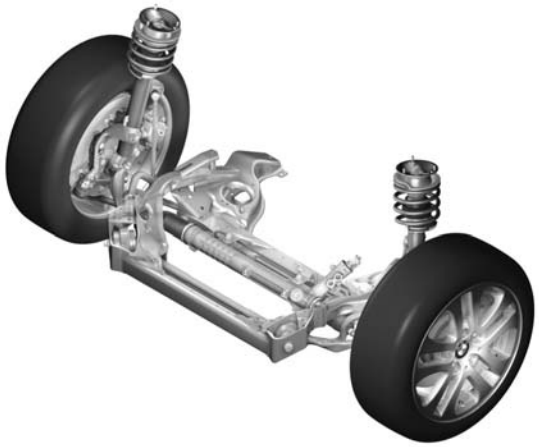
Front and rear axles in the E90

BMW has used the double pivot spring strut front axle design in several models since its initial introduction. The double pivot spring strut front axle design has previously been used on all 5, 7 and 8 series vehicles and will now be used on the new 3 series.

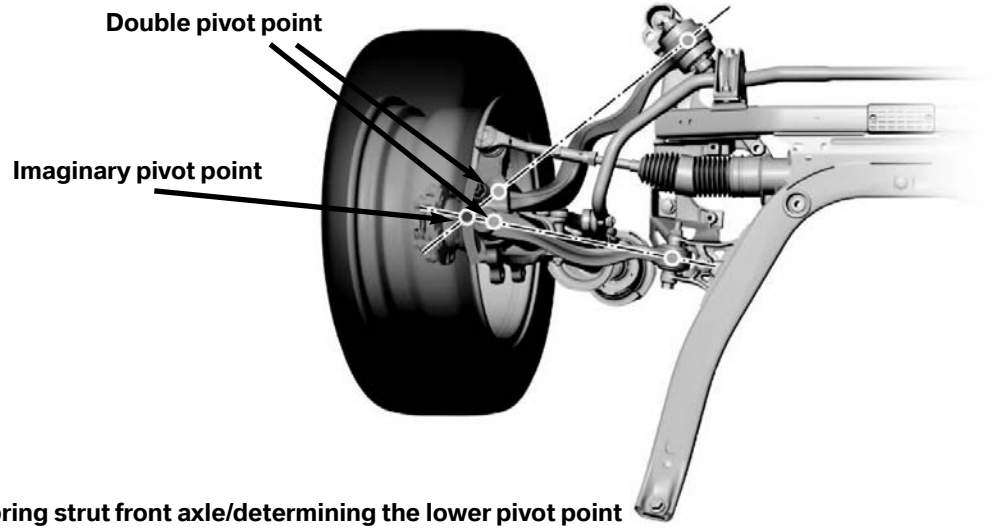
On the E90 the front axle design will see the addition of a new reinforcing strut. The balancing components - control arm and tension strut mounts plus the engine and transmission mounts have also been modified for application on the E90.

The rear axle has been completely redesigned as a five-link axle.

Double Pivot Spring Strut Front Axle



The double pivot system establishes a geometrical “axis” that is formed by the suspension links, which in turn create pivot points, one upper and two lower. Two lower pivot points (double pivot) established by the control arm and tension strut create a “imaginary” pivot point, that is extended further out on the wheel carrier. This design allows pivot points on the wheel carrier to be selected in order to effectively accommodate larger brakes.



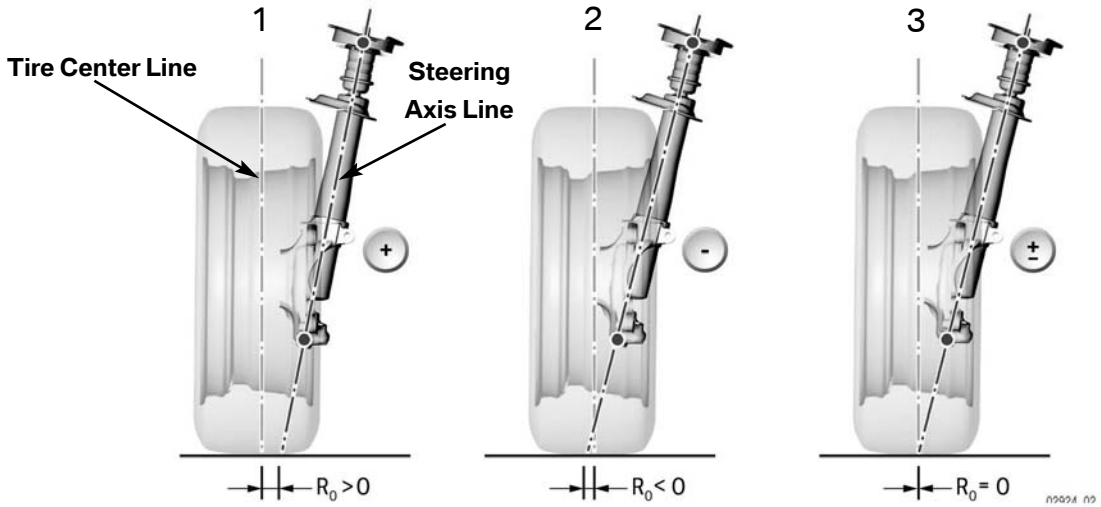
Double pivot spring strut front axle/determining the lower pivot point

Additional advantages of double pivot system are:

- Ability to reduce body roll while cornering.
- Reduces front end dive tendencies during severe braking situations.
- Utilization of a small positive steering offset, which offers improved handling if friction levels while braking is different on both wheels.
- Improved caster position, improving straight line stability at higher speeds, plus better steering return after small steering inputs.

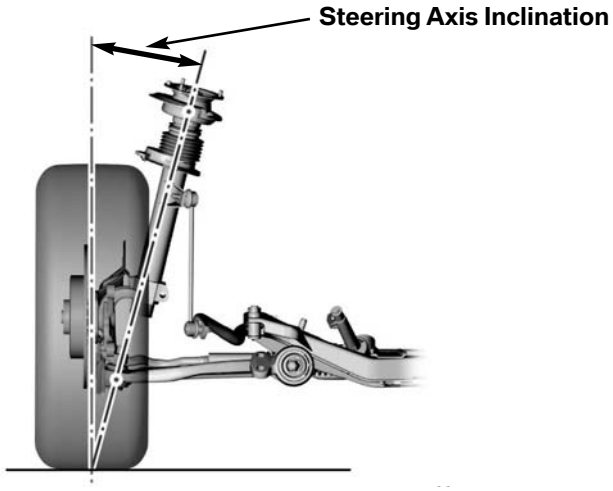
On the double pivot spring strut front axle the position of the control arm and tension strut, with respect to each other, determines the size of the Steering/Kingpin Offset (Steering Roll Radius) as well as the Steering Axis Inclination/kingpin angle.

The Steering Offset (R_0) is the distance between the projected line of contact for the steering axis at the road surface and the center line of a tires contact patch at the road surface.

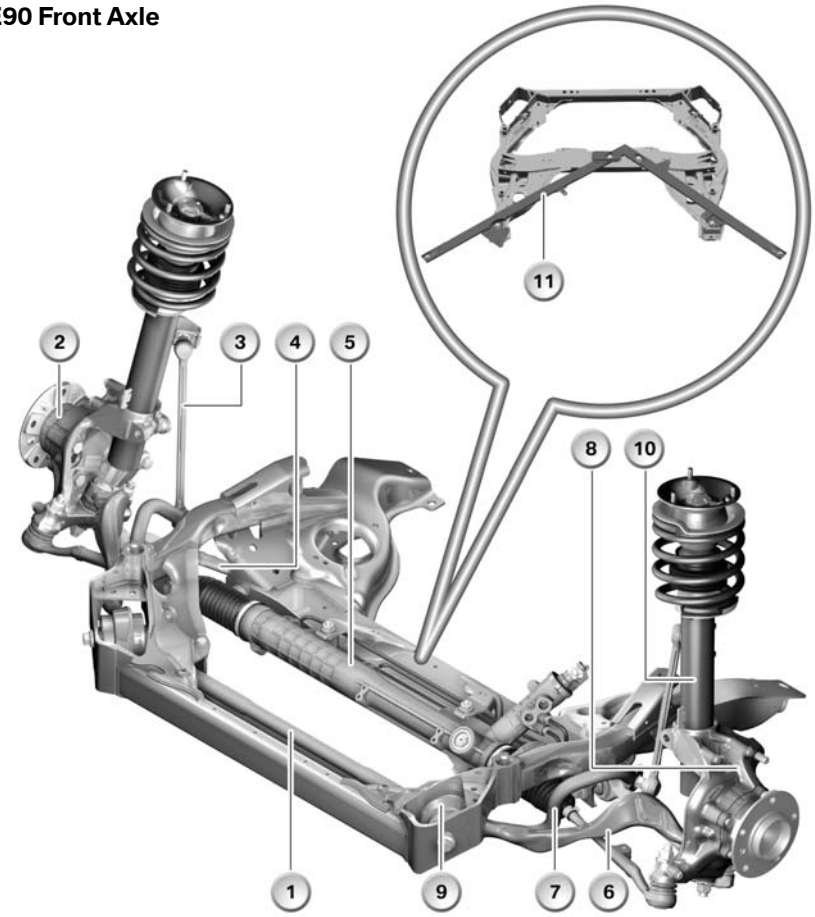


1. A positive Steering Offset (R_0) exists when the steering axis line is inside the center line of the tires contact patch.
2. A negative Steering Offset (R_0) exists when the steering axis line is outside the center line of the tires contact patch.
3. A zero Steering Offset (R_0) exists when the steering axis line is exactly on the center line of the tire contact patch.

Note: When using the double pivot spring strut front axle, a slightly positive Steering Offset is defined.



Components of E90 Front Axle



Index	Explanation	Index	Explanation
1	Front Axle Carrier	7	Stabilizer Bar
2	Wheel Hub	8	Swivel Bearing
3	Stabilizer Link	9	Hydro-Mount
4	Control Arm	10	Spring Strut
5	Rack-and-Pinion Steering	11	Reinforcing Strut
6	Tension Strut		

Both tension struts are mounted with hydraulic mounts in the front axle carrier.

The greater the distance of the tension strut and control arm pivot points at the swivel bearing the greater the steering “reset”force, force required to return wheels to straight head/center position.

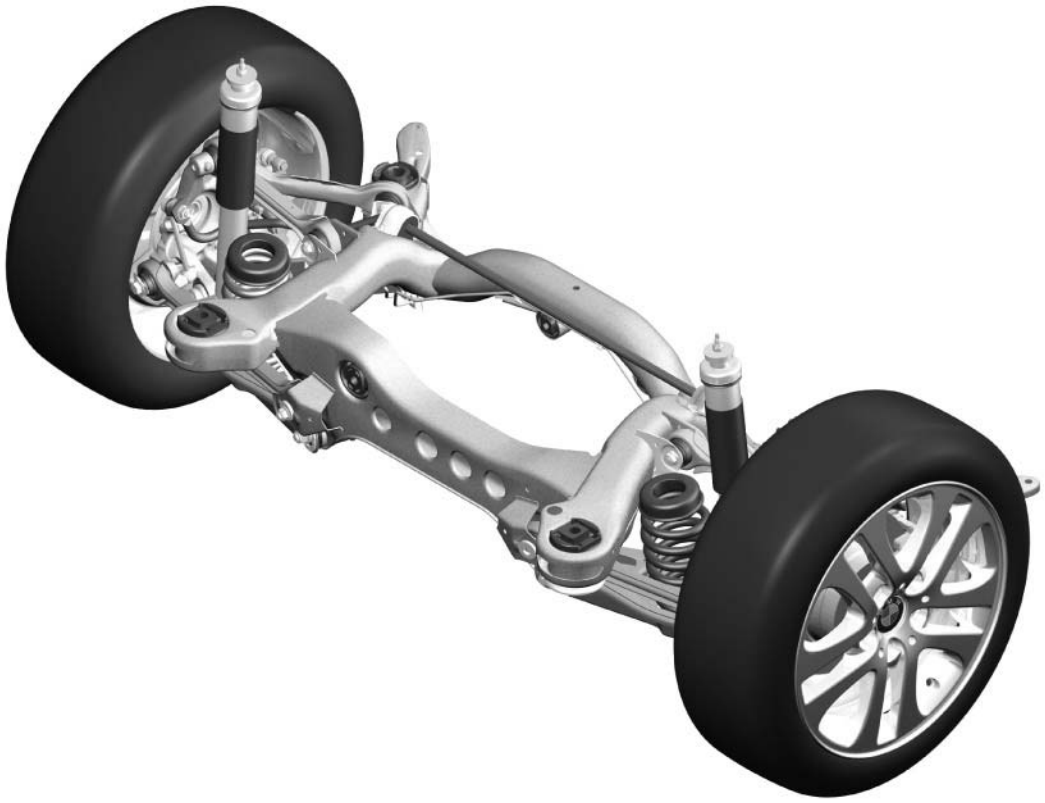
Technical Data
(Front Axle)

Explanation	Value	Explanation	Value
Total Toe-in	14’	Steering/Kingpin Offset	6,1 mm
Track Width	1500 mm	Wheel lock	41° 5’
Camber	-18’	Wheel lock, outer	33° 18’
Kingpin/Steering Axis Inclination	14° 7’	Offset	34 mm
Caster Angle	7° 5’	Tire Size	205/5 R 16
Caster	19.8 mm		

Rear Axle

The newly developed rear axle with the development designation "HA 5" was used for the first time in the E87 and is featured again in the E90.

It is designed as a multi-link independent rear suspension axle with 5 different link arms. The designation "HA 5" does not refer to the five links but rather represents the consecutive development designation used at BMW (refer to “Development of BMW Rear Axles” table at the back of this section).



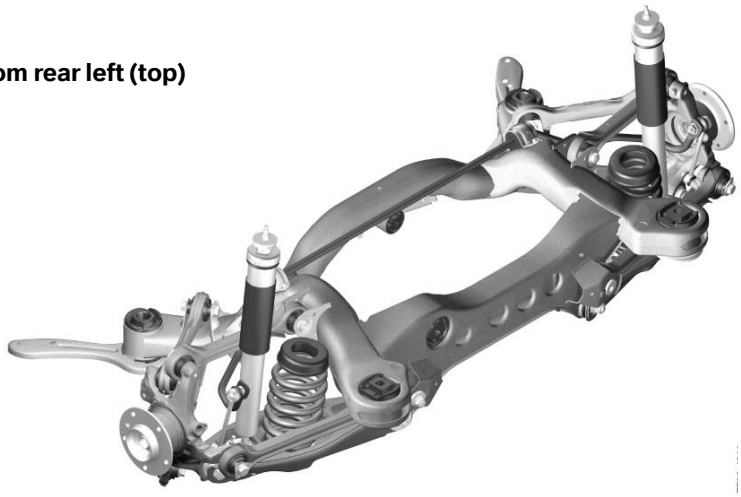
The rear axle carrier and the links are made from high strength steel. The wheel carrier is cast from GGG 40.

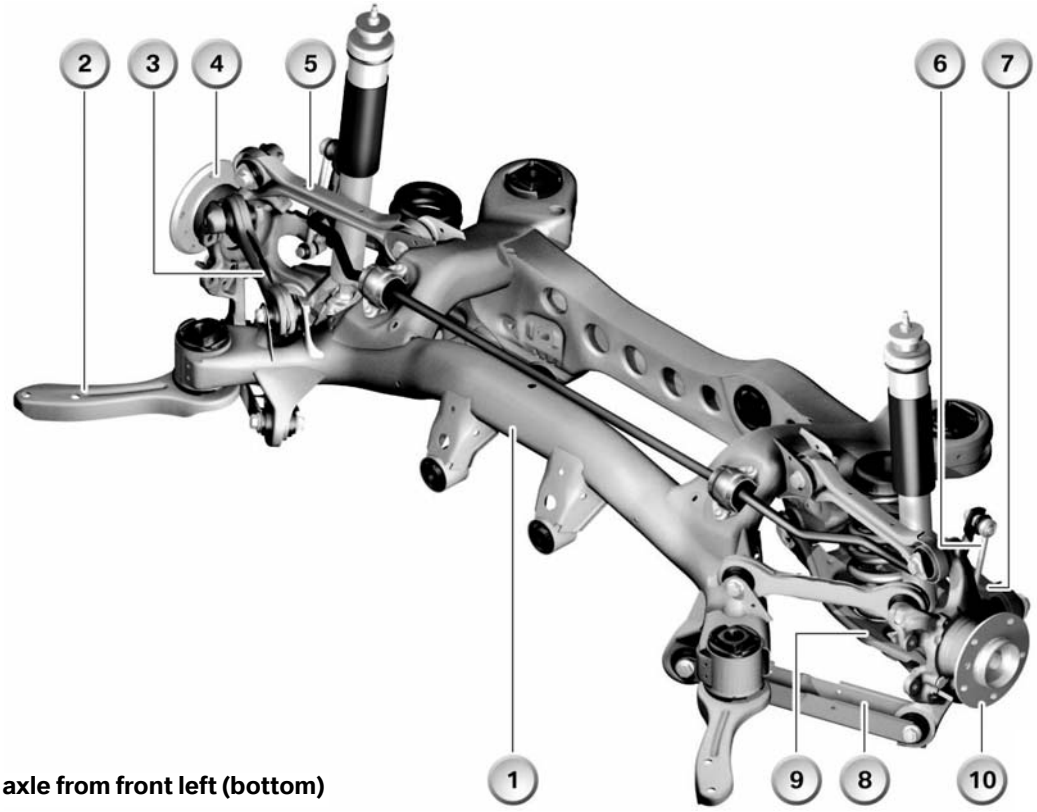
Minor differences exist between the HA 5 versions being used on the E90 variants.

- On the AWD version the wheel carrier is modified slightly as it utilizes bigger wheel bearings.
- In all variants the rear axle transmission mounting is matched to the relevant drivetrain.

Rear Axle Components

Rear axle from rear left (top)

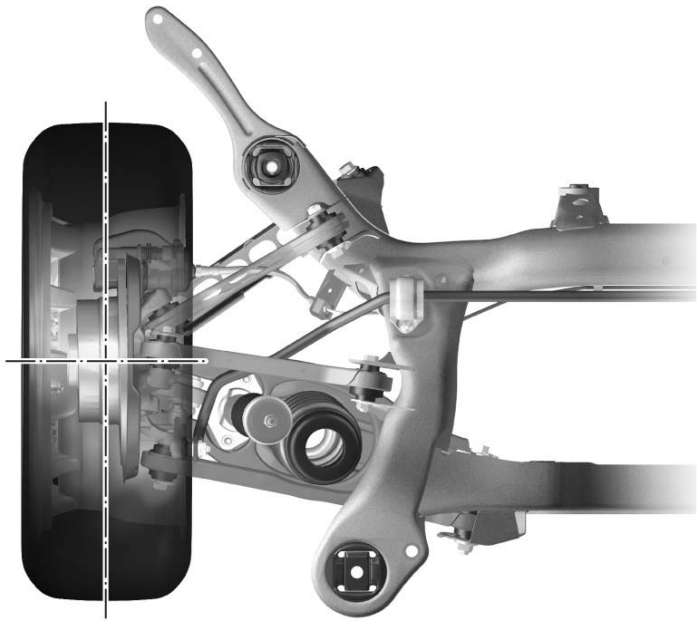




Rear axle from front left (bottom)

Index	Explanation	Index	Explanation
1	Rear Axle Carrier	6	Stabilizer Link
2	Thrust Rod	7	Toe Link
3	Traction Strut	8	Semi-Trailing Arm
4	Wheel Hub	9	Camber Link
5	Control Arm	10	Wheel Carrier

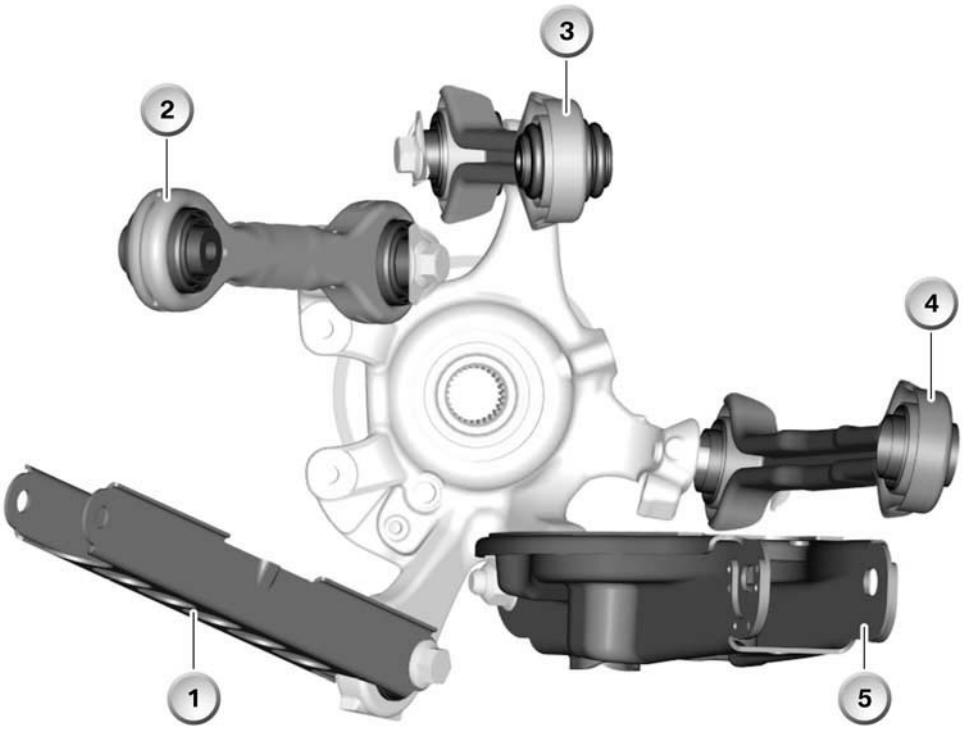
HA 5 Links



Top view of left rear axle

The two upper links (blue in the illustration) form a triangle in the top view as do the two lower links (purple in the illustration).

The rear link (orange in the illustration) represents the toe rod.



Index	Explanation	Index	Explanation
1	Semi-Trailing Arm	4	Toe Link
2	Traction Strut	5	Camber Link
3	Control Arm		

Advantages

Compared to previous rear axles the HA 5 offers the following advantages:

Manufacturing Costs

The lower costs are attributed to the fact that the use of high strength steel has made it possible to reduce the wall thicknesses of the rear axle carrier and the links.

Compared to the integral IV, a considerable cost saving measure has been utilized by manufacturing the entire axle from high strength steel plus the weight of the HA 5 rear axle is not excessively high.

Light Construction

A bending moment occurs only in the camber link, as it provides the support function for the spring and damper. The remaining four links are not subjected to moments of force thereby enabling a lightweight and rigid design.

Thanks to the straight design of the links and the connection by means of ball joints, except for the camber link, the wheel control with this axle is subject to only minimal elasticity and is very precise.

Production

The HA 5 rear axle can be completely preassembled and adjusted with the brake system as well as the suspension and damping.

Kinematics

The very small positive kingpin offset guarantees less sensitivity to longitudinal forces even in connection with wide tires.

The relatively large caster ensures a defined degree of lateral force understeering and therefore improves vehicle handling/stabilization and offers faster response.

The change in toe as part of the suspension action enables outstanding directional stability with a relatively short wheelbase and exceptional self-steering characteristics while cornering.

The change in camber as part of the suspension action is selected in order to establish an optimum camber with respect to the road surface while cornering.

The long toe link has a positive effect on the toe-in characteristics over the spring travel range.

A low roll center has a particularly beneficial effect on the rolling motion.

The "propping" effect while cornering has been largely minimized by improving the roll center change rate.

The braking support has been set to 70%. Racing cars generally have a support angle of 0% in order to constantly achieve maximum contact force. On these vehicles, the disadvantage of a dive motion while braking and starting off is compensated by the taut suspension. The braking support (anti-dive) realized on the E90 represents an optimum compromise between comfort, safety and driving dynamics requirements.

The use of five links enables free selection of the pivot axle for the design layout. This means that the movement of the wheel in interaction with the suspension can be optimized without compromise under braking, acceleration and lateral forces. This largely determines all important variables such as toe, camber, brake support (anti-dive) angle, roll center and roll center change rate.

Crash Requirements

The HA 5 rear axle permits a considerably more favorable progression of the side member, resulting in specific advantages particularly at low impact speeds.

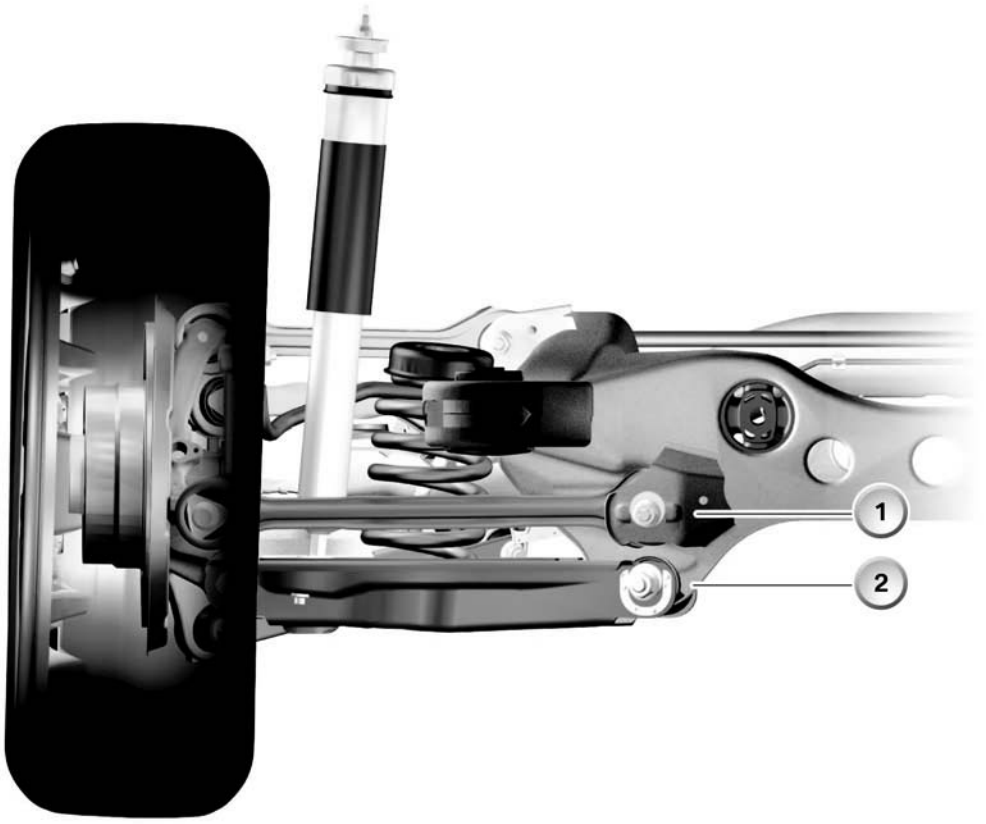
Added to this, the large rear axle carrier is connected directly to the rigid frame side member, allowing it to transmit the applied crash forces more favorably. The semi-trailing arm features crash beading (in the semi-trailing arm of the HA 5 rear axle) to ensure the fuel tank is not damaged.

Rigidity/Acoustics

The rear axle carrier of the HA 5 rear axle extends up to the rigid frame side members of the body with its axle mounting points and even up to the sill with its thrust rods. This provides a very large support face for the applied forces and moments. The resulting advantages include, considerably lower stress and strain on the body (rear axle breakaway) and the option of designing the rear axle bearing mounts relatively soft. This arrangement and the double flexible mounting, provide outstanding insulation against road noise and tire rolling noise.

Setting

Toe and Camber adjustment points:



Index	Explanation
1	Toe Adjusting Screw
2	Camber Adjusting Screw

Technical Data

(Standard Suspension 7Jx16)

Description	Explanation
Wheelbase	2760 mm
Track width	1513 mm
Offset	34 mm
Tire radius (static)	291 mm
Total toe-in	18'
Camber	-1° 30'

Development of BMW Rear Axles

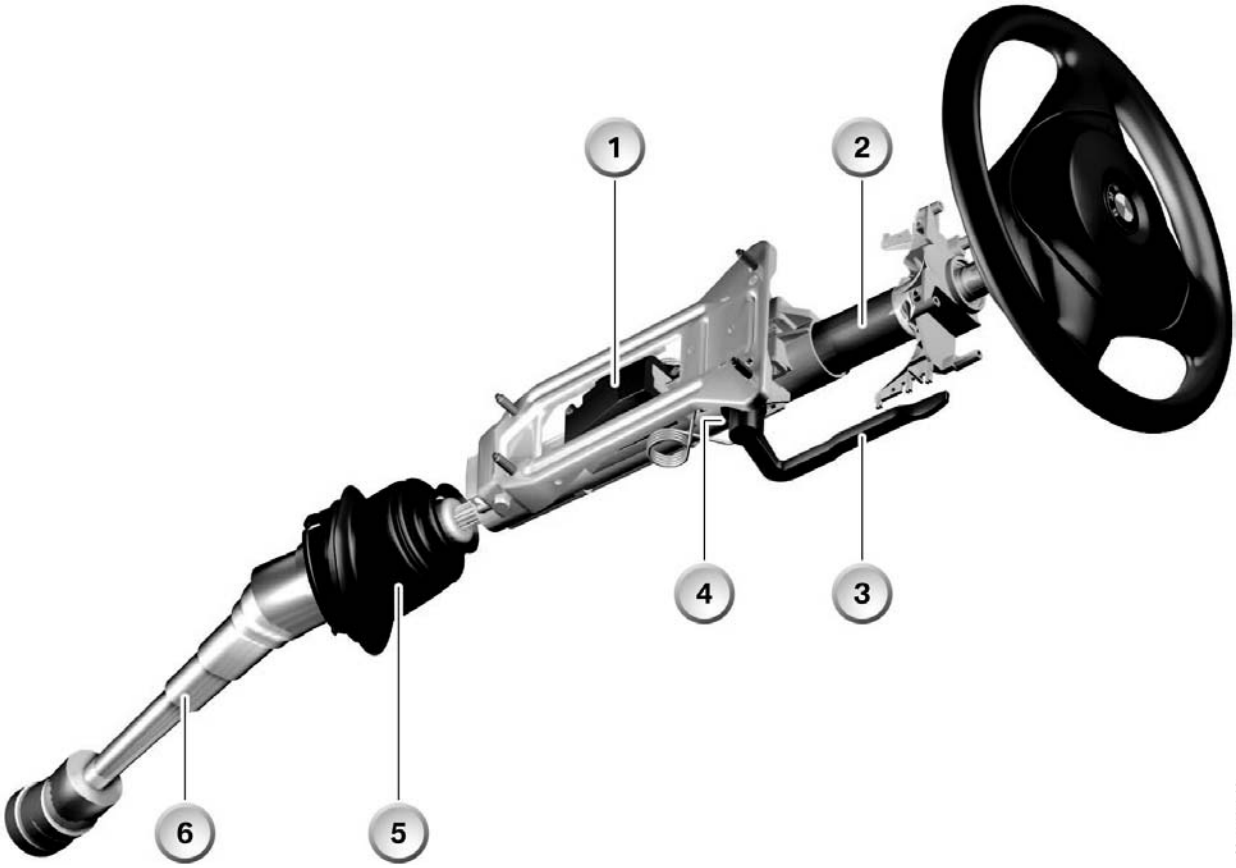
BMW chassis and suspension systems and therefore the sportive and dynamic character of the individual models have long been based on the special axle designs and, of course, on the integral optimum chassis and suspension tuning.

The following table shows the development history of BMW rear axles:

Explanation	Distinguishing Features	Model
HA 1	Semi-trailing arm axle	E3, E9, E12, E21, E28, E30, E36/5, E36/7, E114
HA 2	Screw-link axle	E23, E24, E32, E34
HA 3	Central-link rear axle	Z1, E36/2, E36/3, E36/4, E36/C, E46, E83, E85
	Double lateral control arm axle	E26
HA 4	Experimental study	
HA 5	Dispersed double control arm axle	E87, E90
Integral I	Experimental study	
Integral II	Experimental study	
Integral III		E31
Integral IV	Steel, spring, damper tower	E38
Integral IV	Aluminium, spring, damper tower	E39
Integral IV	Aluminium, spring on body and damper on axle carrier	E39/2
Integral IV	Steel axle carrier, aluminium link and steel wheel carrier, spring and damper separated but both supported on body	E53
Integral IV	Aluminium axle carrier with cast node technology and cast swing arm, spring strut shock absorber tower	E65
Integral IV	Aluminium axle carrier with cast node technology and cast swing arm, spring strut shock absorber tower	E6x

Steering Column

The steering column adjustment range has been extended plus the new adjustment unit now supports the airbag and the steering column. An integrated crash element (metal tube) located in the upper area of the steering column are designed as load bearing parts.



Index	Explanation	Index	Explanation
1	ELV	4	Catch for Steering Column Adjustment
2	Crash Element	5	Steering Sleeve
3	Adjusting Lever	6	Steering Spindle

The metal tube is pre-perforated in a defined longitudinal area at the upper end of the steering column. In the event of an impact, this metal tube begins to crack at the predefined points. This perforation is required for the purpose of converting energy in the event of an impact.

IMPORTANT: The steering column must always be replaced after an airbag has been triggered or the steering shaft is replaced!

The steering spindle sleeve or collar is also new. On the E46, this collar was held in position by the pedal assembly. The new collar is connected in the bulkhead and is double-sided, which results in a lower reset force for the steering column height adjustment.

Together with the Electric Steering Lock (ELV) System, the steering column forms one component and may only be replaced as a complete unit.

Electronic Steering Lock (ELV)

The system was first installed on the E52 (Z8) and consists of a start/stop button, a remote control, the Car Access 2 (CAS2) control module and the ELV. The ELV in turn consists of electronic and mechanical components.

Refer to to the General Vehicle Electrical section of this manual for additional information regarding ELV.

NOTES PAGE