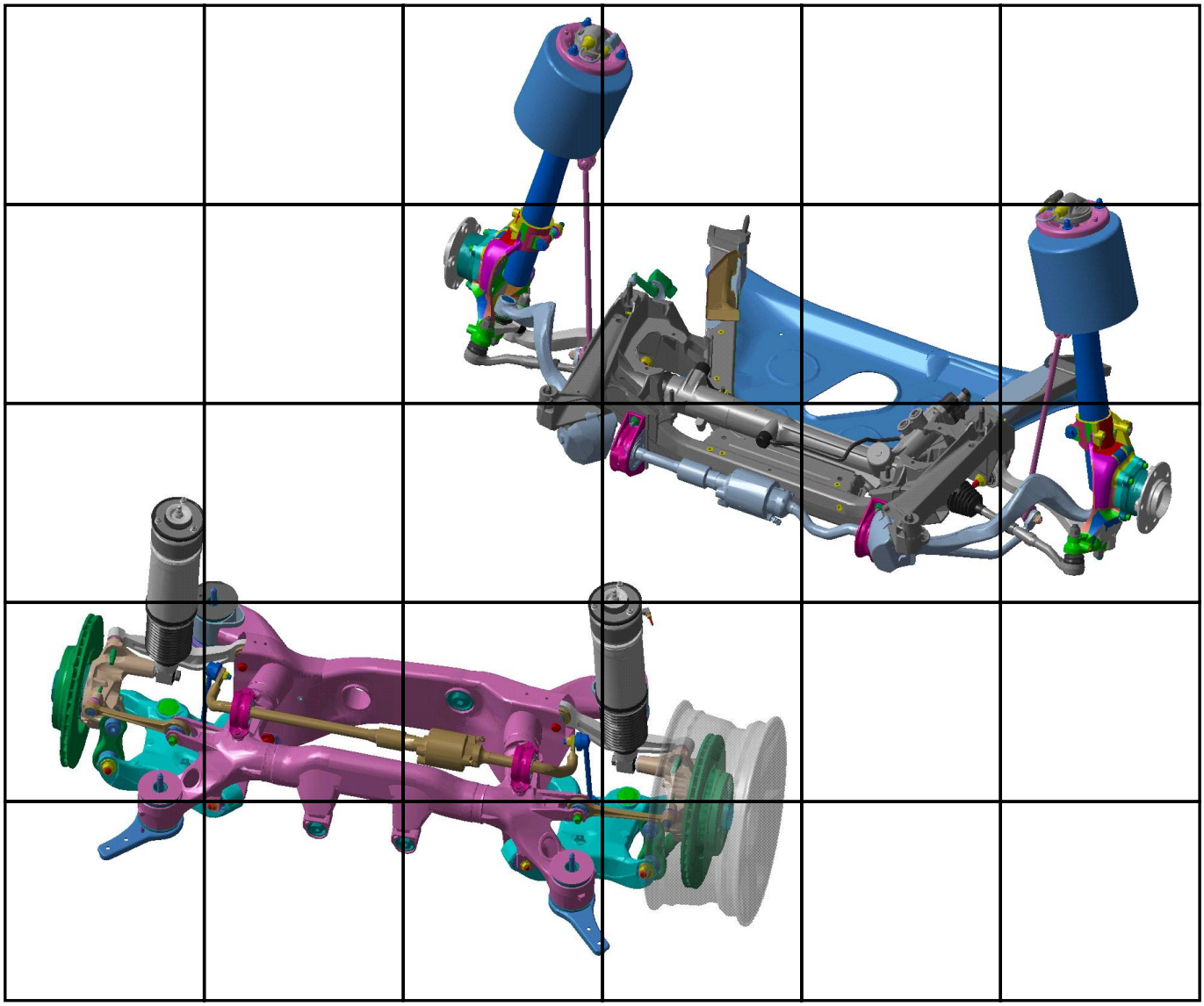
BMW
Service Training

E65 Chassis
Seminar Working Material



NOTE
The information contained in this training course manual is intended solely for participants of the BMW Service Training course.
Refer to the relevant "Technical Service" information for any changes/supplements to the Technical Data.

VS-42 MFP-HGK-BRK-E65_0400

Contents

Introduction

The reliable and as yet unsurpassed double joint spring strut axle with tension struts (based on the basic E39) is used as the front axle in the new E65.

The reworked and fine-tuned integral axle is once again used at the rear.

The weight of the unsprung masses has been reduced by approx. 30%.

The parking brake, also known as the electromechanical parking brake (EMF), is also new. It is an automated, convenience-oriented system which functions via the DSC hydraulics and an electromechanical control unit, which in turn acts on a Duo-Servo drum brake.

The E65 is steered by rack and pinion power steering with a variable transmission ratio.

The standard E65 rim is a lightweight forged wheel fitted with a trim.

Front axle

Introduction

The tried and tested double joint spring strut axle with tension struts is used. This is characterized by its excellent features:

- Almost complete track constancy over the entire compression and extension travel
- Definite camber change during compression
- Straight-ahead driving with 0 mm kingpin offset, although wide tyres are used
- Anti-dive control
- Few components (saving weight)

These reasons ensure that nothing has surpassed this design yet.

The unsprung mass is reduced which is of particular importance in vehicle construction. Nearly all the axle components are made of aluminium. This results in weight reduction of the chassis by about 30% compared to an axle made of steel components.

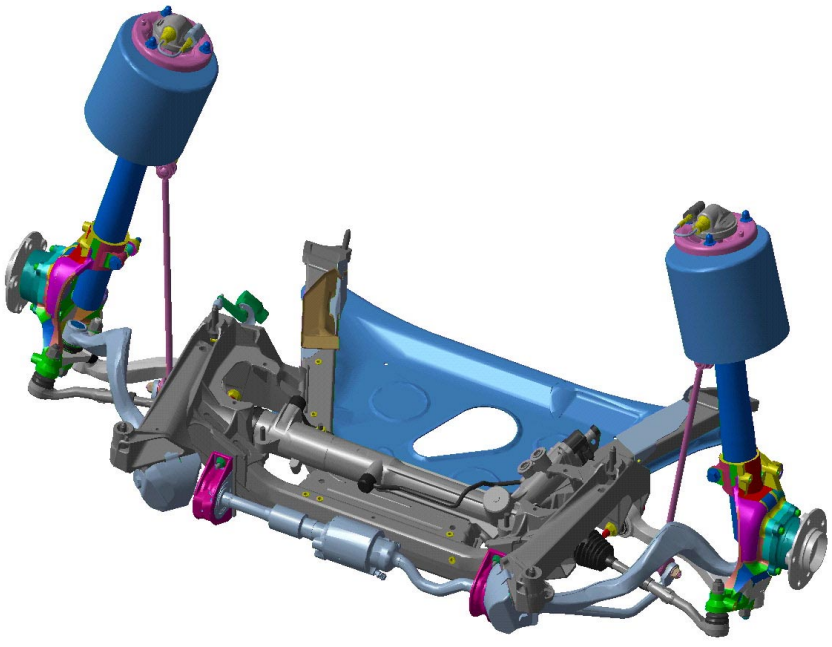


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Fig. 1: General overview of front axle

Front axle carrier

The front axle carrier is now also manufactured using light alloy. It consists of cast alloy preformed sections which are welded into the extruded sections.

A reinforcement plate is screwed on to increase the transversal rigidity of the front car. This has a positive effect on the handling, acoustics and crash performance.

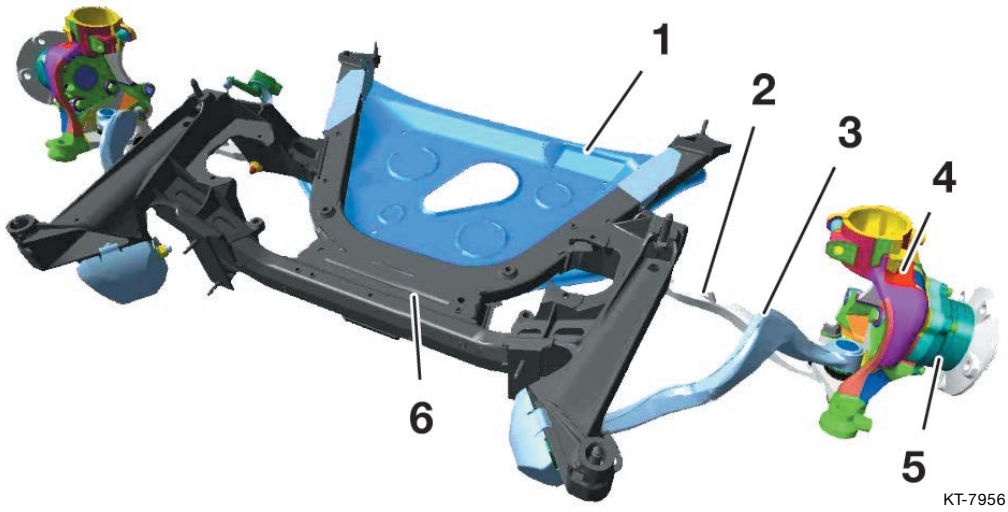

Fig. 2: Front axle carrier with wheel suspension

Index	Description	Index	Description
1	Reinforcement plate	4	Swivel bearing
2	Control arm	5	Wheel bearing
3	Tension strut	6	Axle carrier

For selected materials, a high elongation after fracture, as well as sufficiently high tensile strength and yield point, especially when there is strong load, is achieved.

Arms

The arms are located in accordance with the E39 basic axle with a wishbone and a tension strut containing a hydro mount at the front. The layout of the arms, combined with the track rods fitted in front of the wheel centre, guarantees balanced steering when cornering.

The hydro mount in the tension strut damps through its fluid filling wheel vibrations. Vibrations which are felt on the steering wheel are thus avoided.

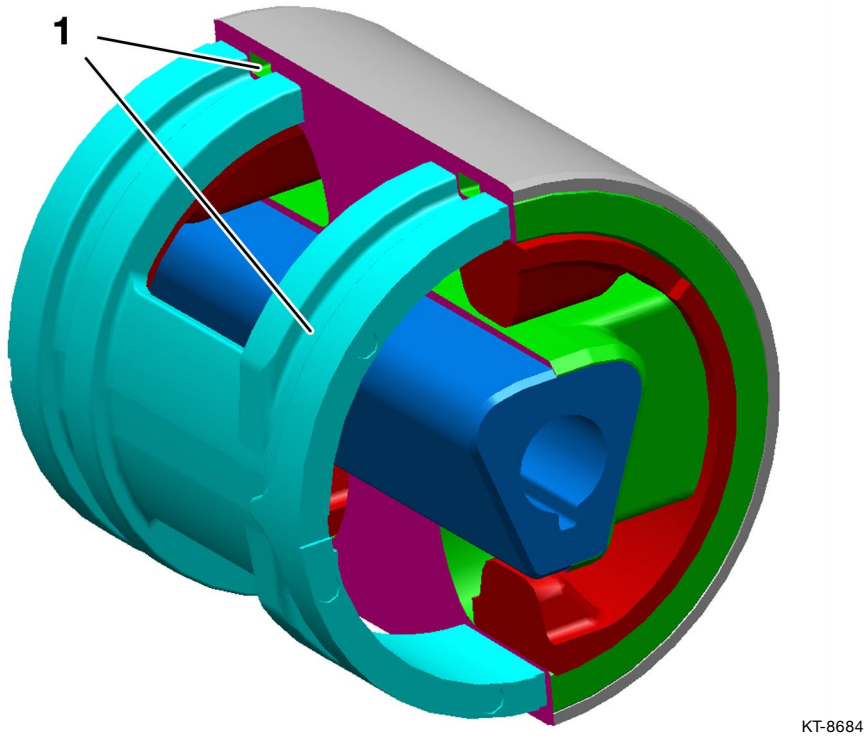

Fig. 3: Hydro mount in the tension strut

Index	Description
1	Fluid ducts

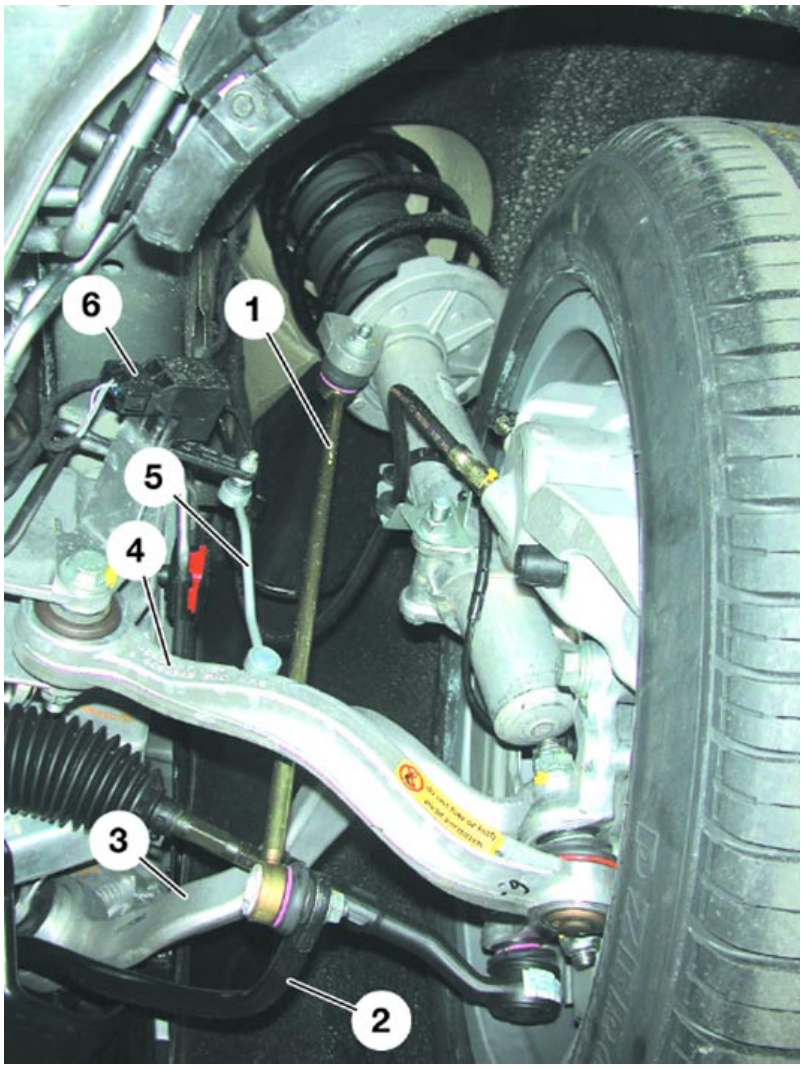

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Fig. 4: Wheel suspension

Index	Description	Index	Description
1	Pendulum support on stabilizer bar	4	Control arm
2	Stabilizer bar	5	Coupling rod for ride level sensor
3	Tension strut	6	Ride level sensor

Stabilizer bar

The standard stabilizer bar is designed as a tubular stabilizer bar, which minimizes the body tilt inclination. It is directly connected to the spring strut by means of stabilizer links to achieve the best performance level.

The high connection on the spring strut is selected so that when you are driving straight ahead and when driving over a bump on one side, nothing can cause the spring strut to turn. This would make driving straight ahead bumpy.

The active roll stabilizer bar (ARS), also known as Dynamic Drive, is available as an option.

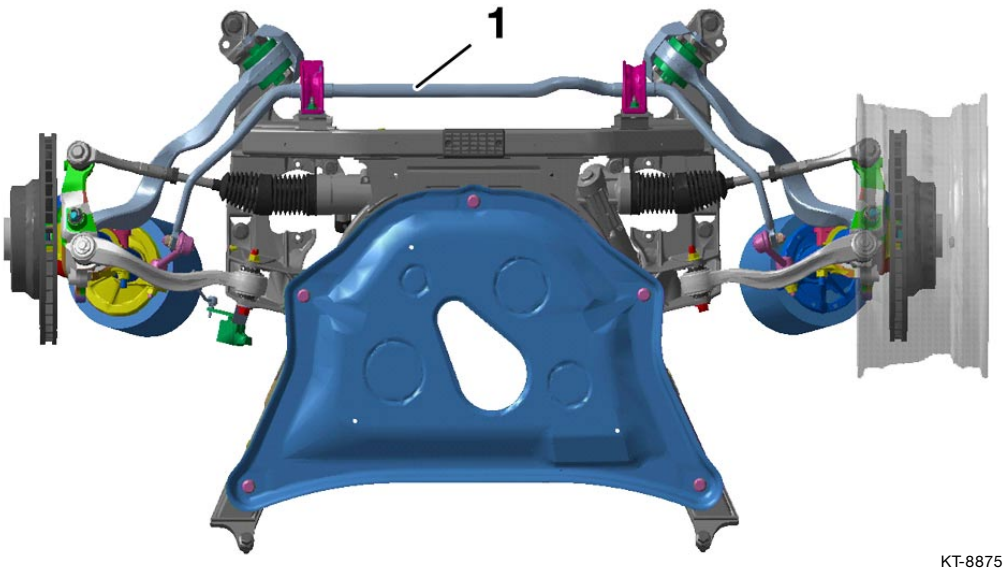

Fig. 5: General overview of front axle from below

Index	Description
1	Stabilizer bar

Spring strut, swivel bearing and wheel bearing

The support tube and the swivel bearing are two parts which are bolted together. The support tube is made of aluminium and has a special feature on the side which is used to fix it into the swivel bearing in the correct position. The support tube and swivel bearings are produced in left and right versions, and are identified by a sticker.

The wheel bearing/hub unit is bolted onto the swivel bearing.

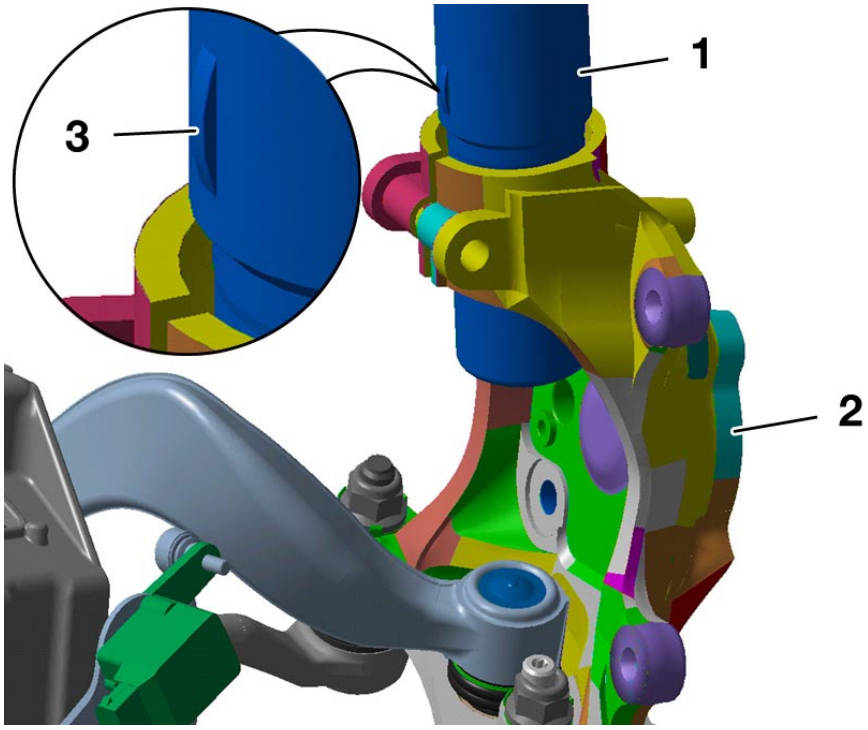

Fig. 6: Spring strut, swivel bearing

Index	Description	Index	Description
1	Support tube	3	Locating fixture
2	Swivel bearing		

Upper mount

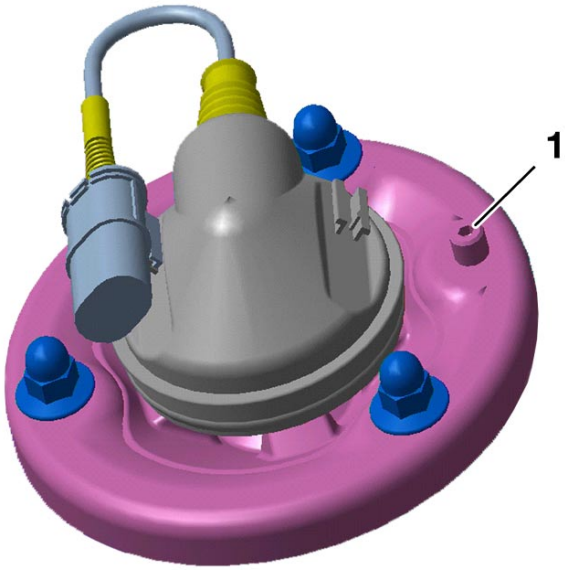

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Fig. 7: Upper mount

Index	Description
1	Centering pin

A laser measurement is carried out at the line end of the bodyshell production. Once the specific position of the spring strut towers has been determined and the values measured have been recorded, a centering hole is punched. The centering pin in the mount is inserted in this hole to ensure the correct camber and camber variation (delta value Δ) between the left and right hand sides with very low tolerances.

Technical data

The following table shows the technical data in relation to the wheel sizes.

Wheels	8 J x 17	8 J x 18
Caster angle	8° 7' ± 30'	
Caster offset (mm)	26	
Camber	-6' ± 20'	
Total toe-in	10' ± 8'	
Toe difference angle	1° 27' ± 30'	
Kingpin inclination	15° 26' ± 30'	
Rim offset (mm)	24	
Kingpin offset (mm)	0	
Track (mm)	1578	
Maximum steering wheel	Inner 40° 40' Outer 33° 26'	

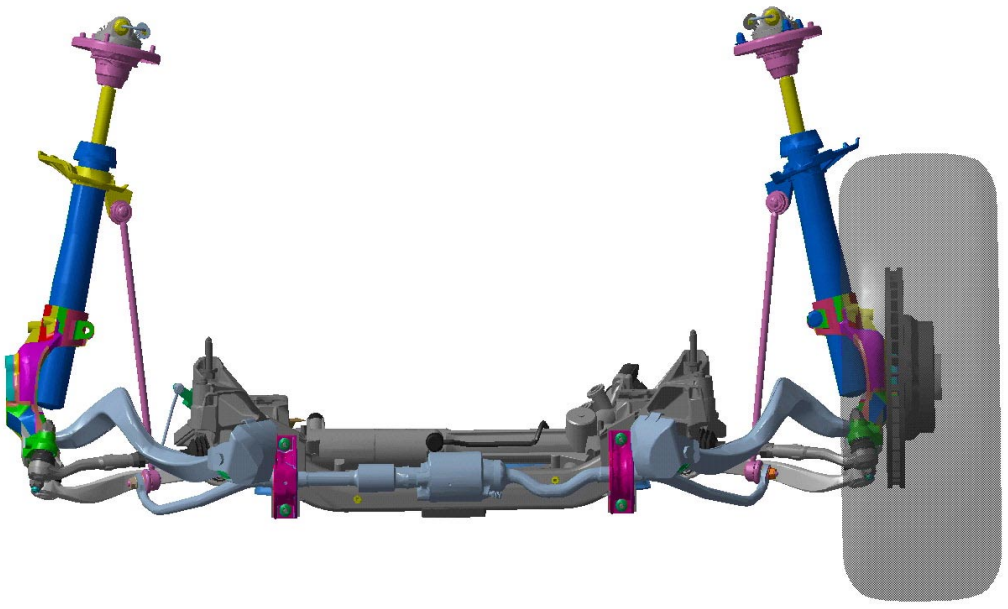

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Fig. 8: Front axle from the front

Notes on service

Toe adjustment

The track is set externally using a clamping device on the track rods.

Camber adjustment

The camber is set on the spring-strut support bearing. If it is necessary to set this in the workshop, the centering pin is removed and the camber correction is carried out using the slots in the spring strut tower. Therefore adjustments of ±30' are possible.

Rear axle

Introduction

A particular focal point of running gear development is weight reduction for the purpose of achieving optimum comfort and safety properties.

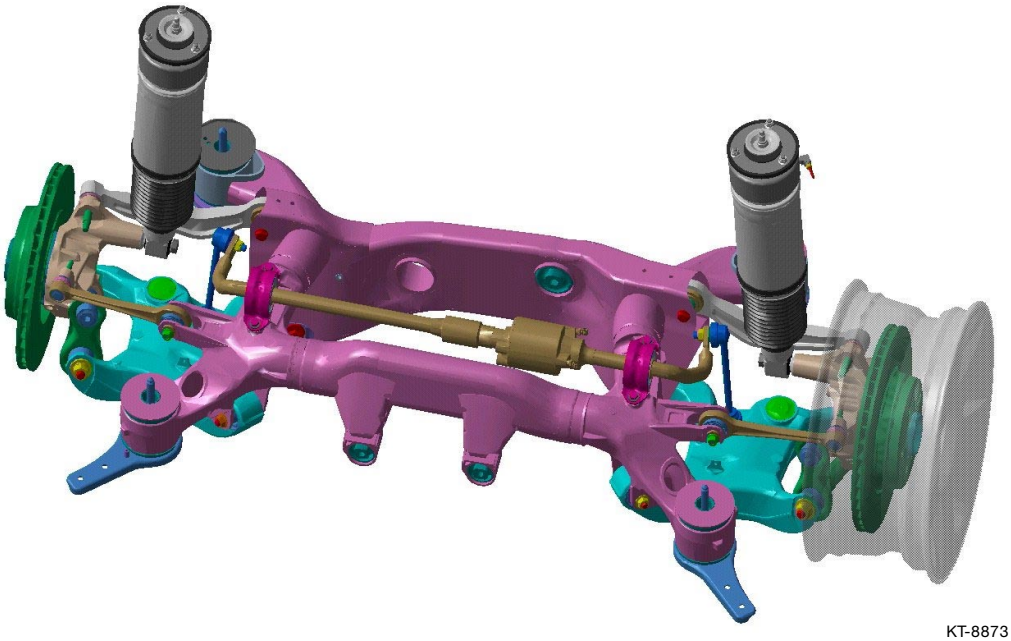

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Fig. 9: General view of rear axle

The rear axle is designed as a modified, kinematically and aerodynamically improved integral axle.

Rear axle carrier

The rear axle carrier is a welded structure made of hydraulically formed aluminium sections and cast aluminium joints or nodes. The rear axle bearings have larger dimensions than in the E38.

The rear axle differential (final drive) is mounted flexibly in the rear axle carrier, now with two mount points at the front and only one at the rear. This modification offers advantages with regard to the acoustics and vibration characteristics. The rear rubber mount features kidney-shaped recesses to allow for varying vibrations in horizontal or vertical direction.

Note:

Particular care must be taken to ensure that the rubber mounts are installed in the correct position.

The additional empty bush only serves the purpose of ensuring stability of the rear cross member cross section.

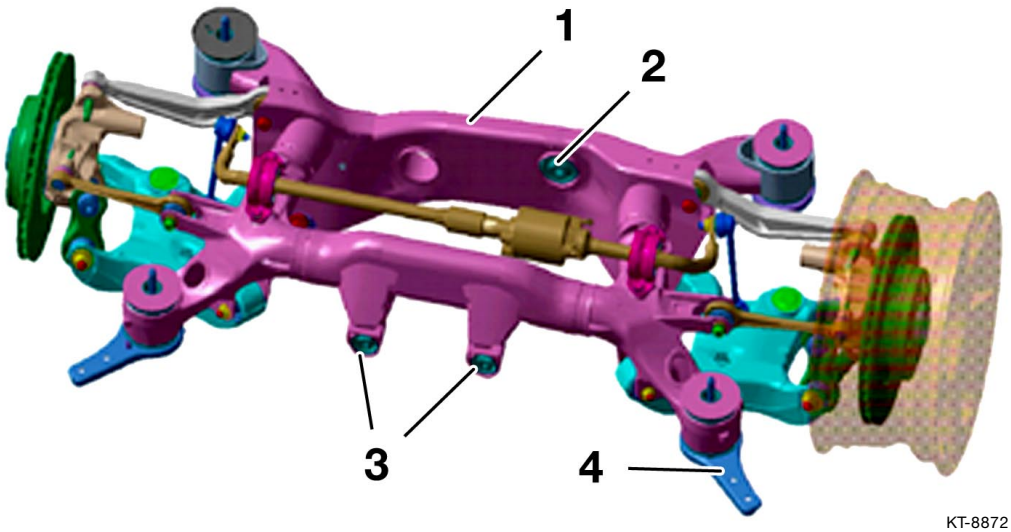

Fig. 10: View of rear axle

Index	Description	Index	Description
1	Rear cross member	3	Rear axle differential bearing bush, front
2	Rear axle differential bearing bush, rear	4	Thrust rod

Swinging arm and links

The swinging arm and links are made of aluminium and adapted geometrically to the driving requirements of the E65. Camber and toe curve at total spring compression and deflection, pitch compensation (anti-dive) and brake support angle are values that, as the result of slight changes to the individual link points, have a decisive influence on vehicle handling. When observed on the lifting hoist, the swinging arm has a very twisted appearance. Compressed in the normal position, it is aligned parallel to the road and creates an air guidance effect for favourable aerodynamic flow of the air to the rear area of the vehicle.

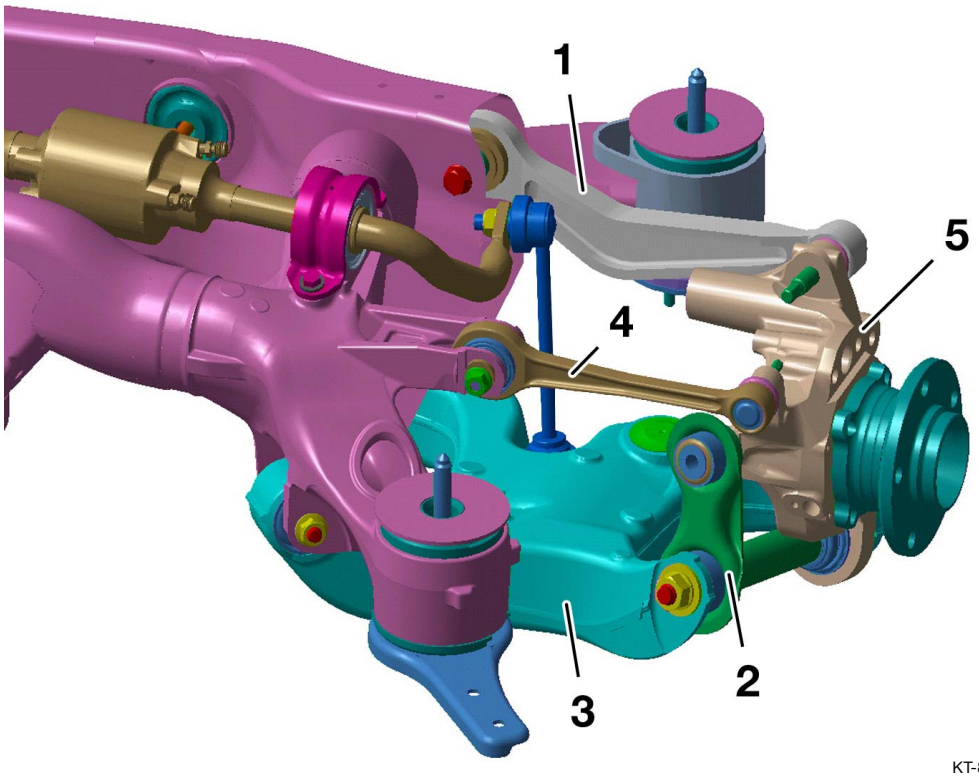

Fig. 11: Wheel suspension rear axle

Index	Description	Index	Description
1	Control arm	4	Upper traction strut
2	Integral link	5	Wheel carrier
3	Swinging arm		

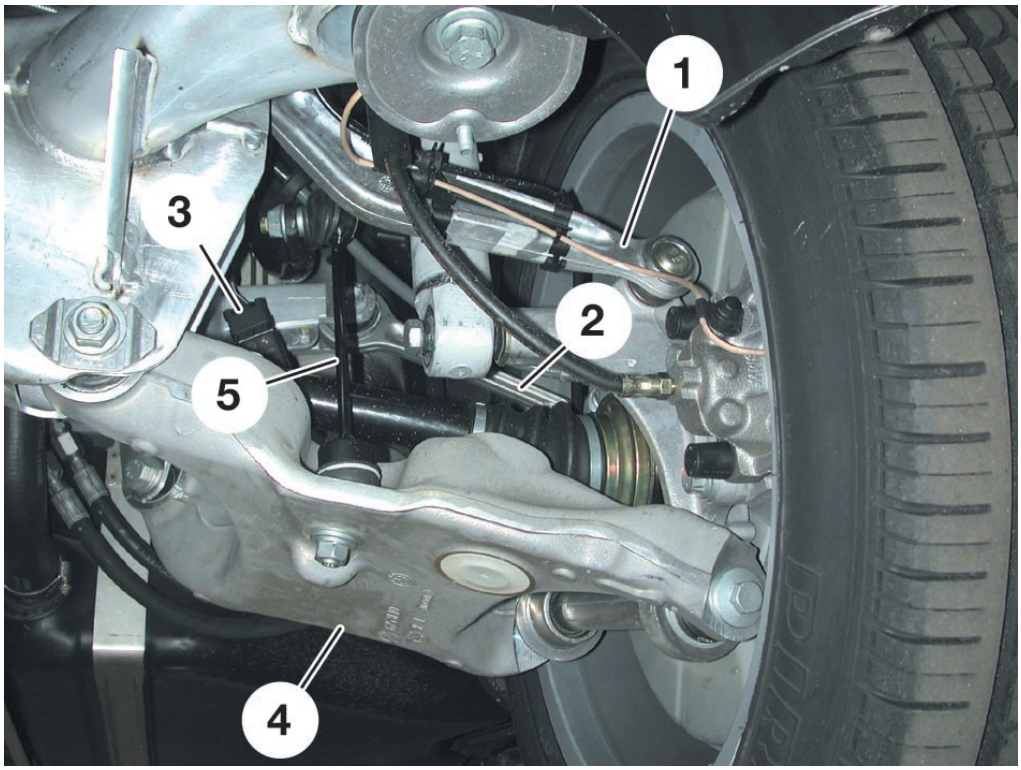

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Fig. 12: Wheel suspension

Index	Description	Index	Description
1	Traction strut	4	Swinging arm
2	Control arm	5	Stabilizer link
3	Level sensor		

Stabilizer bar

A stabilizer bar is always fitted on the rear axle. The stabilizer bar is connected by means of stabilizer links between the rear axle carrier and swinging arms.

The connection at the swinging arm is now designed as an axial ball joint. It is secured by means of a taper seat with nut and Torx socket head screw.

Technical data

	Steel spring
Wheel	8J x 17
Wheel	245/55 R17
Track width	1582
Total toe-in	18'±10'
Wheel axle angle	0°±12'
Level in normal position	620±1 mm
Vehicle inclination	0±1 mm
Camber in normal position	+1° 30'± 20'

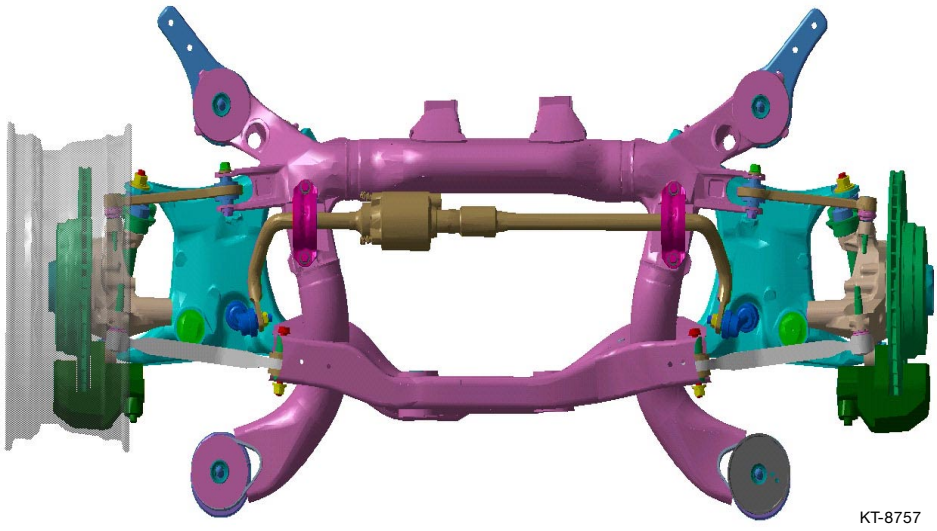

Fig. 13: General view of rear axle from above

Toe adjustment

The toe is adjusted by means of an eccentric element at the front upper traction strut.

Camber adjustment

The camber is adjusted by means of an eccentric element on the inner swinging arm at the connection to the axle carrier.

Suspension/Damping

- Suspension

The E65 features a conventional helical or coil compression spring as standard on the front and rear axle. It has a linear characteristic. Both at the front as well as at the rear axle, the springs are combined with the shock absorbers to form the spring strut (McPherson struts).

The optional pneumatic spring (standard on the 12-cylinder version) on the rear axle serves the purpose of adjusting the level at high payloads. It has the advantage of maintaining a constant level of the vehicle irrespective of the load status. As a result, the full spring compression and deflection travel range is made available.

A pneumatic spring is not fitted on the front axle as the load differences are not so great at this point.

Two-axle pneumatic springs will be used at BMW only if it is necessary to adapt the level of the vehicle to certain operating conditions. Example X5, model year 2002

- Damping

The E65 is equipped with two-tube gas pressurized shock absorbers as standard. As on the E39, the E65 features aluminium McPherson struts at the front at rear. A locking device/positioning aid is used on the front axle. The clamping area of the spring struts is shot-peened to increase the strength. In view of the improved response characteristics and in order to avoid cavitation, the low pressure dampers are filled with nitrogen at a pressure of 5 bar. An EDC-K in connection with or without dynamic drive can be ordered optionally.

EDC-K and dynamic drive are explained in separate chapters.

Wheels/Tyres

Introduction

The E65 is fitted as standard with light-alloy wheels. The spare wheel is designed in the same way as the road wheels.

The standard rim of the E65 is a weight-optimized forged wheel (Styling 90) which is partly covered by a glass-fibre-reinforced plastic trim. The object of this composite design is to minimise the unsprung, rotating masses while simultaneously achieving good aerodynamic properties and an attractive, stylish visual appearance.

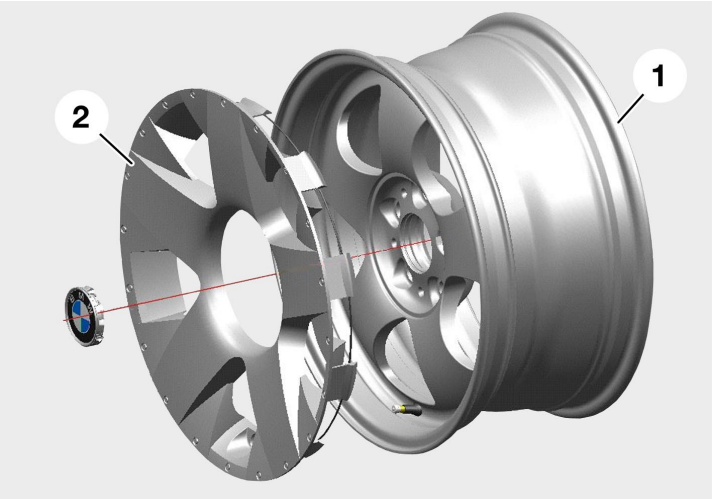

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Fig. 14: Lightweight forged wheel with trim

Index	Description	Index	Description
1	Lightweight forged wheel	2	Trim

Note:

For all regular operations, e.g. wheel removal and installation, tyre and valve removal, the trim can and should remain on the wheel.

The trim must be in place when the wheel is being balanced.

In the event of damage or heavy accumulation of dirt between the wheel and the trim, the latter can be easily removed and refitted by hand, without the aid of any tools.

The wheel studs are M14 x 1.5 mm hexagon-socket-head cap screws with 14 mm hexagon sockets. This has helped to reduce the material and thus the weight of the wheel. The studs are tightened to a torque of 140 Nm.

	Description	Weight
Conventional stud	M14 19 mm A/F	86 g
New stud	M14 hexagon socket 14 mm	69 g

Balance weights:

Adhesive weights are used on the E65 for balancing purposes. These weights are cut to length in series assembly as seamless weights as needed and stuck to the inside of the rim on the designated precision-cut areas for dynamic balancing.

KT-8459

Fig. 15: Cross-section of lightweight forged wheel with trim

Index	Description
1	Bonding surfaces for balance weights

Various light-alloy wheels are available as special equipment (SE).

Styling overview for wheels

Styling no.	Description	View
90	8J x 17 Forged wheel with trim	 KT-8437
91	8J x 18 Cast aluminium	 KT-8438
92	9J x 19 Front 10J x 19 Rear Forged wheel	 KT-8439
93	8J x 18 Cast aluminium	 KT-8440
94	8J x 18 Cast aluminium	 KT-8441

95	9J x 19 Front 10J x 19 Rear Cast aluminium	 KT-8442

Further wheels are available through the Parts Department as optional extras (OE).

For example:

Styling no.	Designation	View
89	9J x 19 Front 10J x 19 Rear Cast aluminium	 KT-8436
101	9J x 20 Front 10J x 20 Rear Alloy wheel screwed in 2 parts	 KT-8789
32 BR (Brilliant paint finish)	9J x 20 Front 10J x 20 Rear Cast aluminium	 KT-8790

Wheel/tyre combinations

Tyre	Wheel	LI	V cl.	RF	❄	Udyn mm	IS mm	730i***	730d *	735i	745i	740d**	760i **	745i US
Summer														
225/60 R17	7 1/5 J x 17 H2/EH2	99	W		x	2140	20	S	S	-	-	-	-	-
245/55 R17	8 J x 17 H2/EH2	102	W		x	2140	24	SE	SE	S	S	S	-	T
245/55 R17 **	8 J x 17 EH2	102	W	x	x	2140	24	SE	SE	S	S	S	-	T
245/50 R18	8 J x 18 H2/EH2	100	W		x	2140	24	SE	SE	SE	SE	SE	S	OE
245/50 R18 **	8 J x 18 EH2	100	W	x	x	2140	24	SE	SE	SE	SE	SE	S	OE
245/45 R19	9 J x 19 H2/EH2	98	W			2145	24	SE	SE	SE	SE	SE	SE	SE
275/40 R19	10 J x 19 H2/EH2	101	W			2145	24	SE	SE	SE	SE	SE	SE	SE
245/40 R20	9 J x 20 H2/EH2	95	Y			2145	24	OE	OE	OE	OE	OE	OE	OE
275/35 R20	10 J x 20 H2/EH2	98	Y			2135	24	OE	OE	OE	OE	OE	OE	OE
Winter														
225/60 R17 M+S	7 1/5 J x 17 H2/EH2	99	Q/T/H		x	2140	20	OE	OE	OE	-	-	-	-
245/55 R17 M+S	8 J x 17 H2/EH2	102	Q/T/H		x	2140	24	OE	OE	OE	OE	OE	-	OE
245/55 R17 M+S **	8 J x 17 EH2	102	Q/T/H	x	x	2140	24	OE	OE	OE	OE	OE	-	OE
245/50 R18 M+S	8 J x 18 H2/EH2	100	Q/T/H		x	2140	24	OE	OE	OE	OE	OE	OE	OE
245/50 R18 M+S **	8 J x 18 EH2	100	Q/T/H	x	x	2140	24	OE	OE	OE	OE	OE	OE	OE
All season														
245/50 R18 M+S	8 J x 18 H2/EH2	100	V		x	2140	24	-	-	-	-	-	-	S
245/50 R18 M+S **	8 J x 18 EH2	100	V	x	x	2140	24	-	-	-	-	-	-	S

Index	Description	Index	Description
*	From 03/02	RF	Runflat (tyre with flat-running properties) only in conjunction with DDS (RPA) or RDC
**	From 09/02	V cl.	Speed class
***	From 03/03	Udyn	Dynamic wheel diameter
LI	Load index	IS	Inset, wheel offset
❄	Snow chain possible		

Service brake

Introduction

The E65 features a hydraulic dual-circuit brake system with "black/white" distribution. One brake circuit for the front axle and one brake circuit for the rear axle. The brake power has been adapted to the weight and the increased driving performance. The gross weight rating of the 740i is 2520 kg and 2705 kg for the 760i. The brake system offers the high safety reserves characteristic of BMW. The weight-to-power ratio, service life of the brake pad and brake disc as well as the noise characteristics have been improved.

- Brake control

The brake system is controlled in the conventional manner with a vacuum booster and tandem master brake cylinder. The design is based on an 8"/9" aluminium brake booster with tandem master brake cylinder and brake fluid reservoir.

The brake booster is now smaller as brake power assistance is controlled by the engine in conjunction with a vacuum pump on the M57, M67, N62 and N73.

DOT4 brake fluid is used in all E65 models.

- Brake discs

All E65 vehicles will be equipped on the front and rear axle with inner-vented brake discs made of high carbon cast iron. The brake discs are coated with Geomet over the entire surface (EU Directive relating to freedom of chromium VI as from 7/2003).

The Geomet coating is a zinc-aluminium surface coating (microfine scaled surface pattern) that is sprayed on and baked at 300 °C. It is environmentally compatible and features outstanding corrosion protection properties. On the friction surface, the protective coating is worn down without any changes in the coefficient of friction at the brake pads. All other surfaces, e.g. wheel mount, brake disc nave and ventilation channels retain their corrosion-resistant surface over their entire service life.

Note:

An initial scraping sound is normal and will have disappeared after five to ten braking operations.

Brake guard

The ventilation-optimized brake guards on the front axle and rear axle are made of aluminium. They are shaped such that water can drain off most effectively.

The threaded connections of the guards at the swivel bearings are mounted in rubber to avoid noise. A rubber element that prevents noise transmission is also fitted between the guard plate and swivel bearing.

The sectional rubber element 1 on the rear axle serves the purpose of covering the duo-servo drum brake.

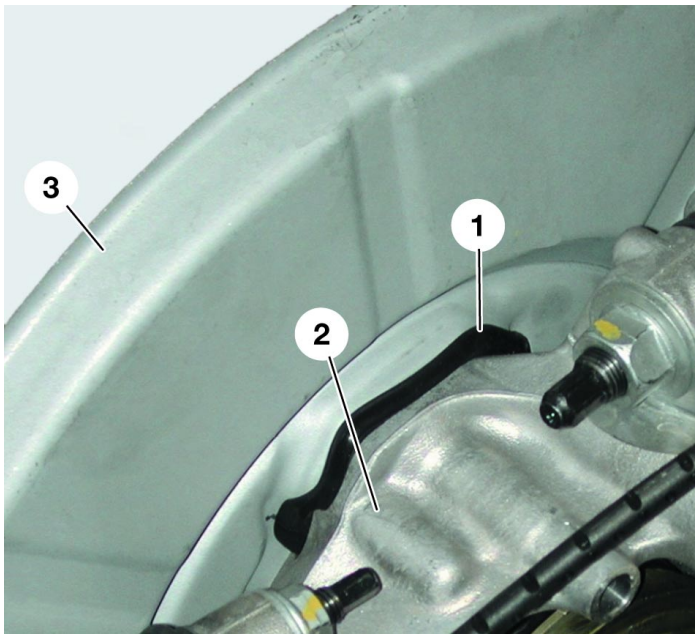

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Fig. 16: Brake guard on wheel carrier

Index	Description	Index	Description
1	Rubber element between wheel carrier and guard plate	3	Brake guard of rear axle
2	Wheel carrier		

Brake calipers

- Front brake calipers

The housing of the front axle brake calipers is made of aluminium. The frame surrounding the brake caliper prevents V-shaped spread of the brake caliper as the result of contact pressure on the brake disc.

The brake caliper holder is made of zinc-nickel coated spheroidal cast iron.

A cover has been fitted to improve the appearance of the brake caliper. The brake pad thickness can be measured in the usual way through the hole in the centre.

The retaining spring for fixing the brake caliper in position is firmly connected to the cover.

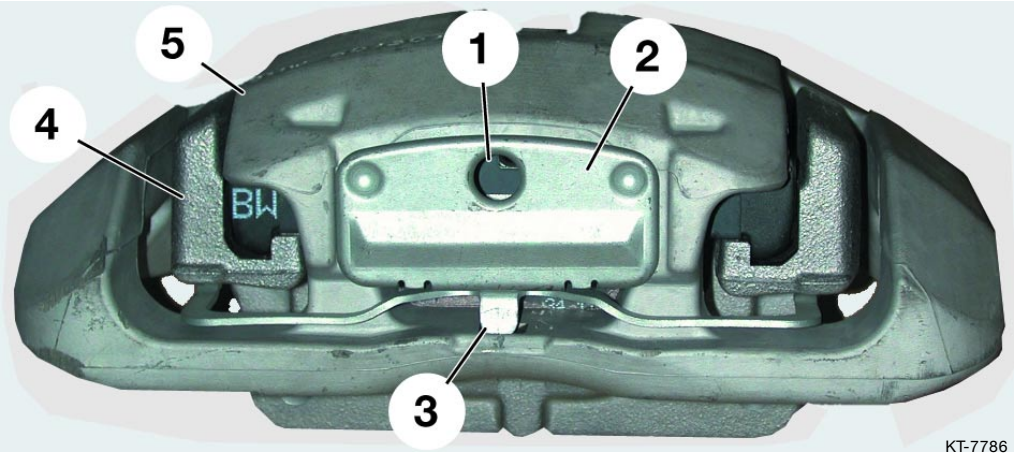


Fig. 17: Front axle brake caliper

Index	Description	Index	Description
1	Opening for measuring brake pad thickness	4	Spheroidal cast iron mounting bracket
2	Cover	5	Aluminium housing
3	Retaining spring		

3 different brake calipers will be installed on the front axle of the E65.

Brake caliper designation	Vehicle type	Minimum size of rim
1-piston floating caliper FNR-Al 60/30/324	730d, 730i, 735i	16", E65 axle concept (track rod head) 17"
1-piston floating caliper FNR-Al 60/30/348	740d, 745i, 760i (export)	17"
2-piston floating caliper FN 42/36/374	760i (Europe)	18"

In view of the high weight and the distinctly improved driving performance of the 760i and the thus associated higher demands made on the braking power, a 2-piston floating caliper is installed in the EU version.

- Rear brake calipers

The brake calipers on the rear axle are made of zinc-nickel coated spheroidal cast iron based on the known version.

A total of 3 different brake calipers will be installed on the rear axle.

Brake caliper designation	Vehicle type	Minimum size of rim
1-piston floating caliper FN 46/20/324	730d, 730i, 735i	16" E65 axle concept (track rod head, front axle) 17"
1-piston floating caliper FN 46/24/345	740d, 745i, 760i (export)	17"
1-piston floating caliper FN 46/24/370	760i (Europe)	18"

2-stage brake pad wear sensor

The 2-stage brake pad wear sensors at the front left and rear right relay their voltage signals to the DSC control unit where they are used for continuous calculation of the brake pad wear in the DSC control unit.

In the first stage, the brake pad wear indicator operates in the same way as on previous models. A resistor has now been additionally integrated in the second stage. The control unit is informed of the current wear status based on the changed voltage measurement.

The first stage of the wear indicator is activated at 6 mm remaining brake pad, the second stage at 4 mm remaining brake pad.

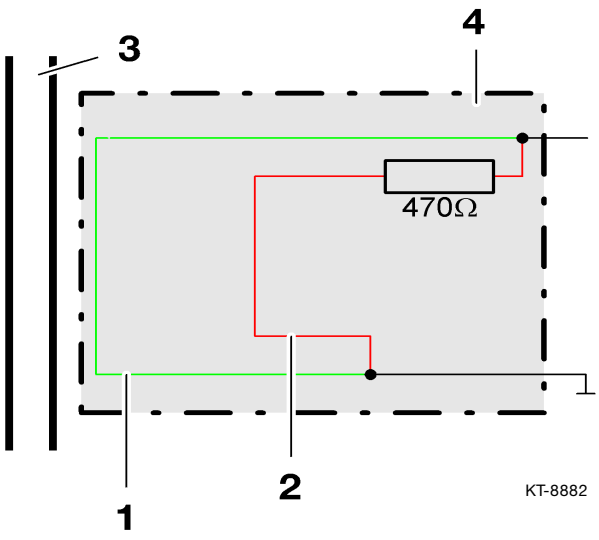


Fig. 18: Circuit diagram of brake pad wear sensor

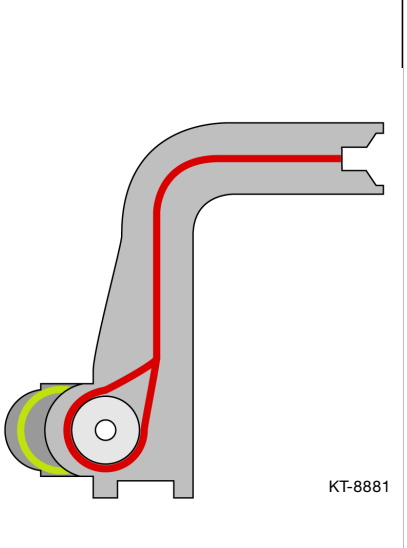


Fig. 19: Sectional view

Index	Description	Index	Description
1	Stage 1	3	Brake disc
2	Stage 2	4	Brake pad wear sensor

With these two different voltages, the probable total service life of the brake pads can be determined with the aid of a computing model in the control unit.

The remaining kilometrage of the brake pads can be shown as a kilometre reading in the control display as required. The remaining kilometrage is calculated from the input variables: wheel speed, distance, brake pressure, brake disc temperature and brake operating time.

After switching off the ignition, the calculated remaining kilometrage for the front axle and rear axle brake pads is stored in the DSC control unit and serves as a start value when the vehicle is placed into operation again.

The service proposals are shown separately in the control display for the front axle and rear axle. The brake pad thickness can be checked through the mounted wheel in the usual way using a special tool.

Wheel speed sensors

A new wheel speed sensor, that operates in accordance with the Hall principle, is used. A special feature of this sensor is that it detects forward and reverse movement.

The sensor contains three Hall-effect elements accommodated next to each other in a housing. The signals of the first and of the third Hall element form a differential signal for determining the signal frequency and the air gap (clearance) to the sensor wheel. Clockwise or anticlockwise rotation is detected by means of the temporal offset of the signal from the middle element with respect to the differential signal.

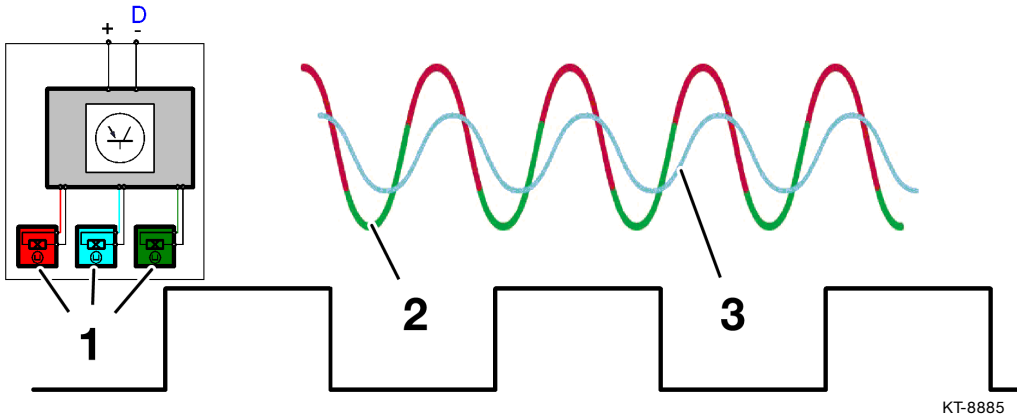


Fig. 20: Wheel speed sensor and signals

Index	Description	Index	Description
1	Hall-effect element	3	Signal of centre Hall element
2	Differential signal		

The additional signals of the air gap (clearance) and the direction of rotation are output via the pulse width of the digital signal.

The signals processed in the sensor are transferred via a combined ground and data line to the control unit. It is not the voltage level that is decisive on the data line but rather the flow of current. This gives rise to a reoccurring data telegram that uses two different amp ratings.

The 14 mA level contains the information - speed, direction of rotation and air gap.

The 7 mA level serves as an evaluation current for the fault memory.

In contrast to the previous sensors, when the vehicle is stationary, a pulse is sent every 740 ms thus indicating the sensor availability.

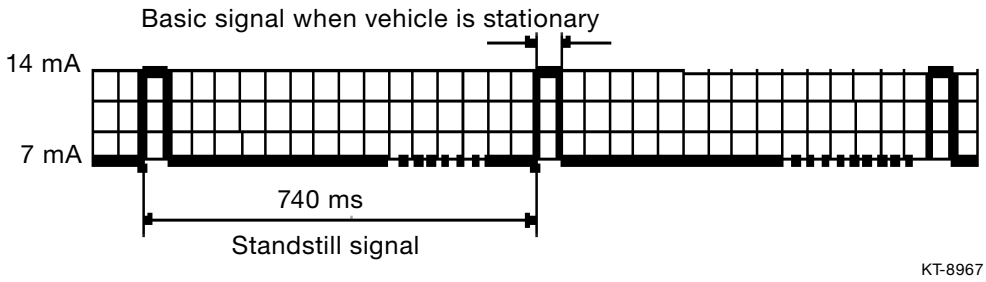


Fig. 21: Current flow data telegram

Notes on service

The tightening torque requirements of the fastening screws on the brake hoses and pipes have been changed (see TIS tightening torques).

After replacing the brake pads, the residual kilometrage stored in the DSC control unit must be reset to a new start value separately for each axle by means of the diagnosis tester.

When a DSC control unit is changed, the diagnosis tester can be used to enter the specified remaining kilometrage for the front axle and rear axle brake pads in the new control unit.

Parking brake

Introduction

Why a new system?

The parking brake, also termed as the electromechanical parking brake (EMF), will be used for the first time in series production in the E65.

In principle, the parking brake is used to secure the stationary vehicle to prevent it rolling away. It firmly brakes (locks) the vehicle when parked.

The new parking brake that replaces the previous handbrake or foot-operated parking brake is an automatic, comfort-oriented parking brake system with which the driver can apply and release the parking brake by pressing a push-button.

The system is realized in compliance with requirements characteristic of BMW:

- Exclusion of all safety-critical statuses
- Optimum functionality
- Maximum system availability
- Best comfort and convenience

KT-7993

Fig. 22: Parking brake push-button in instrument panel

The task of the system is to lock the vehicle mechanically when parked and, in addition to the service brake, to provide a further independent brake system as required by law. Added to this, the parking brake offers additional comfort and safety functions.

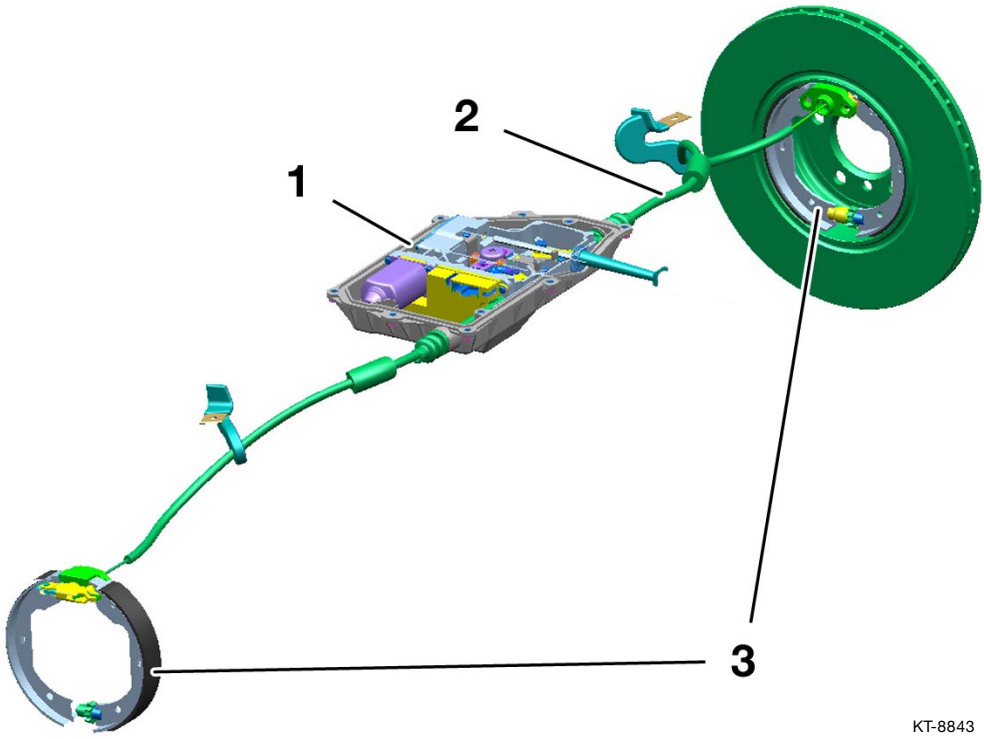


Fig. 23: Parking brake components

Index	Description	Index	Description
1	EMF actuator	3	Drum brake
2	Bowden cable		

Functional description

Basic functions

There are two different types of parking brake functions depending on the operating status of the vehicle.

1. Locking (brake applied):
    1. With the engine running or the vehicle rolling, with the aid of the DSC hydraulics, the parking brake acts on the disc brakes of the front axle and rear axle.
    2. When the engine is not running and the vehicle is stationary, with the aid of the electromechanical actuator in connection with bowden cables, the parking brake acts on the duo-servo drum brake of the rear axle. The actuator is located in the luggage compartment floor between the spare wheel recess and stiffener wall of the rear bench seat.

       The parking brake is always applied as defined in the control unit when the actuator is activated.

2. Dynamic braking:

   Defined braking (deceleration) takes place via the DSC system if the parking brake push-button is pressed while driving. The braking procedure is monitored by the ABS control function and takes place for as long as the push-button is pressed.

Comfort function

Automatic hold

With this comfort function that is selected via the controller, after braking down to a standstill, the vehicle is hydraulically held by the parking brake (DSC). The wheel brakes are released by pressing the accelerator pedal and the vehicle begins to move.

Automation of the hold and release function assists hill starts as it prevents the vehicle rolling back (hill hold).

Emergency release

A mechanical emergency release facility is provided in order to be able to release the parking brake in the event of the actuating unit failing or insufficient power supply. By way of direct manual intervention in the gear mechanism, it is possible to release the mechanical actuating unit and thus the duo-servo drum brake using an emergency release tool and open-ended spanner from the vehicle tool kit.

Special function

In order to increase the availability of the optimum duo-servo braking effect, the brake linings are bedded down at defined intervals during vehicle operation. The bedding down procedure is designed to eliminate any corrosion spots on the duo-servo brake shoes and on the brake drums. The brake lining bedding down procedure takes place approx. every 1000 km or once a month. 300 bedding down procedures result in brake shoe wear in the range from 0.3 to 0.5 mm.

The procedure takes place automatically and should be noticed by the driver as little as possible. The brake linings are bedded down by applying the parking brake actuating unit with reduced holding force. The braking force at the spindle during the brake lining bedding down procedure is 800 N (20% of the maximum actuating force).

Service functions

If the brake shoes of the drum brake are replaced as part of repairs or during servicing, the brake linings must be bedded down in order to ensure sufficient braking and holding effect. A "bedding down special routine" that can be called up via the DIS is incorporated in the software of the parking brake control unit.

Operation standby status or a system fault is signalled by indicator/warning lamps in the instrument cluster. Faulty signals are entered via the CAN-bus, if necessary, resulting in corresponding partial or complete shutdown. The control display provides the driver with additional information on possibly restricted functions.

Note

The vehicle can be rolled or pushed in gearbox setting "N" only. The neutral position normally remains engaged for max. 30 minutes. Once the vehicle has been parked for a longer period of time, the parking lock in the automatic gearbox is engaged automatically.

System structure

- The parking brake in the bus network

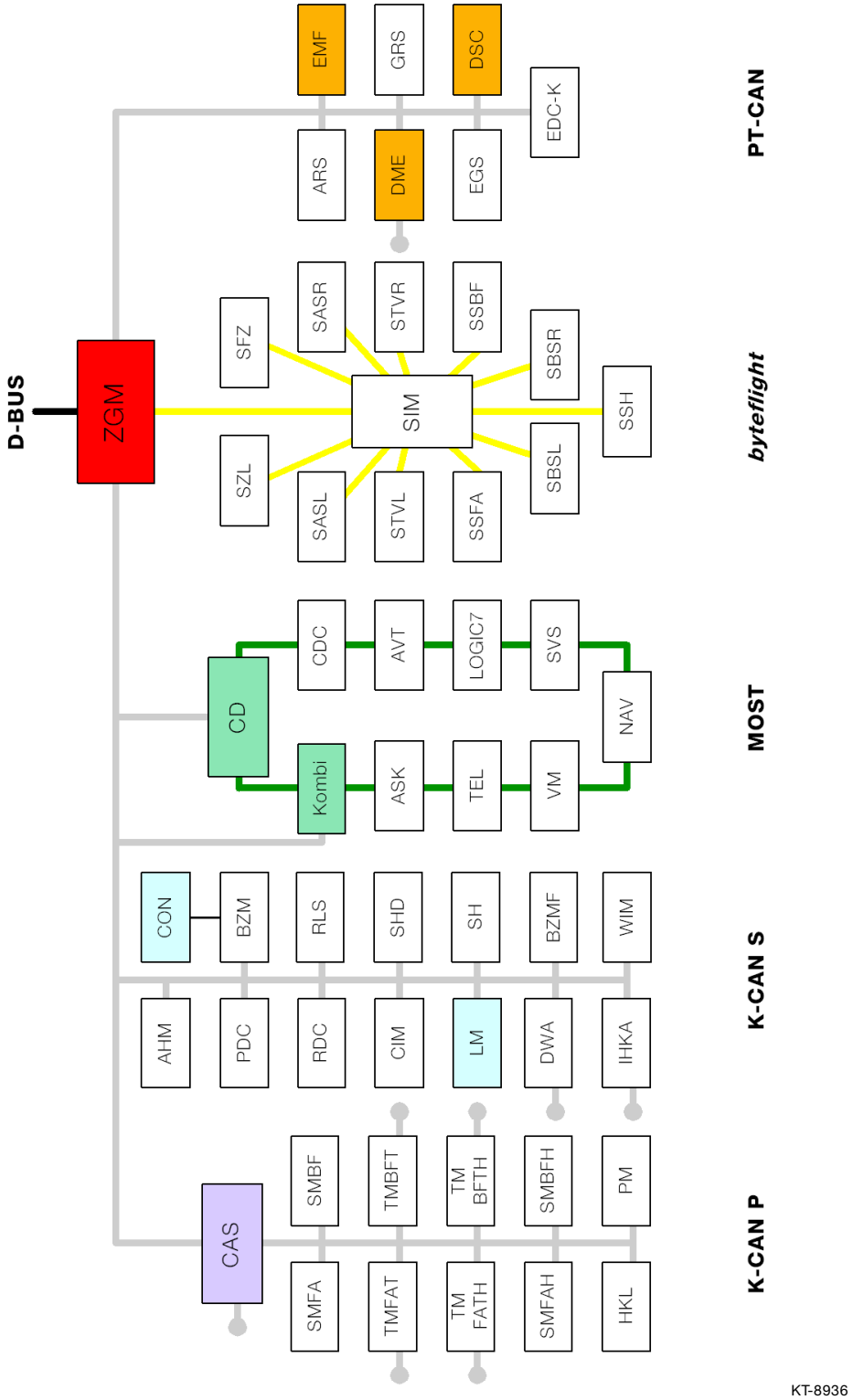


Fig. 24: Bus structure

- Components

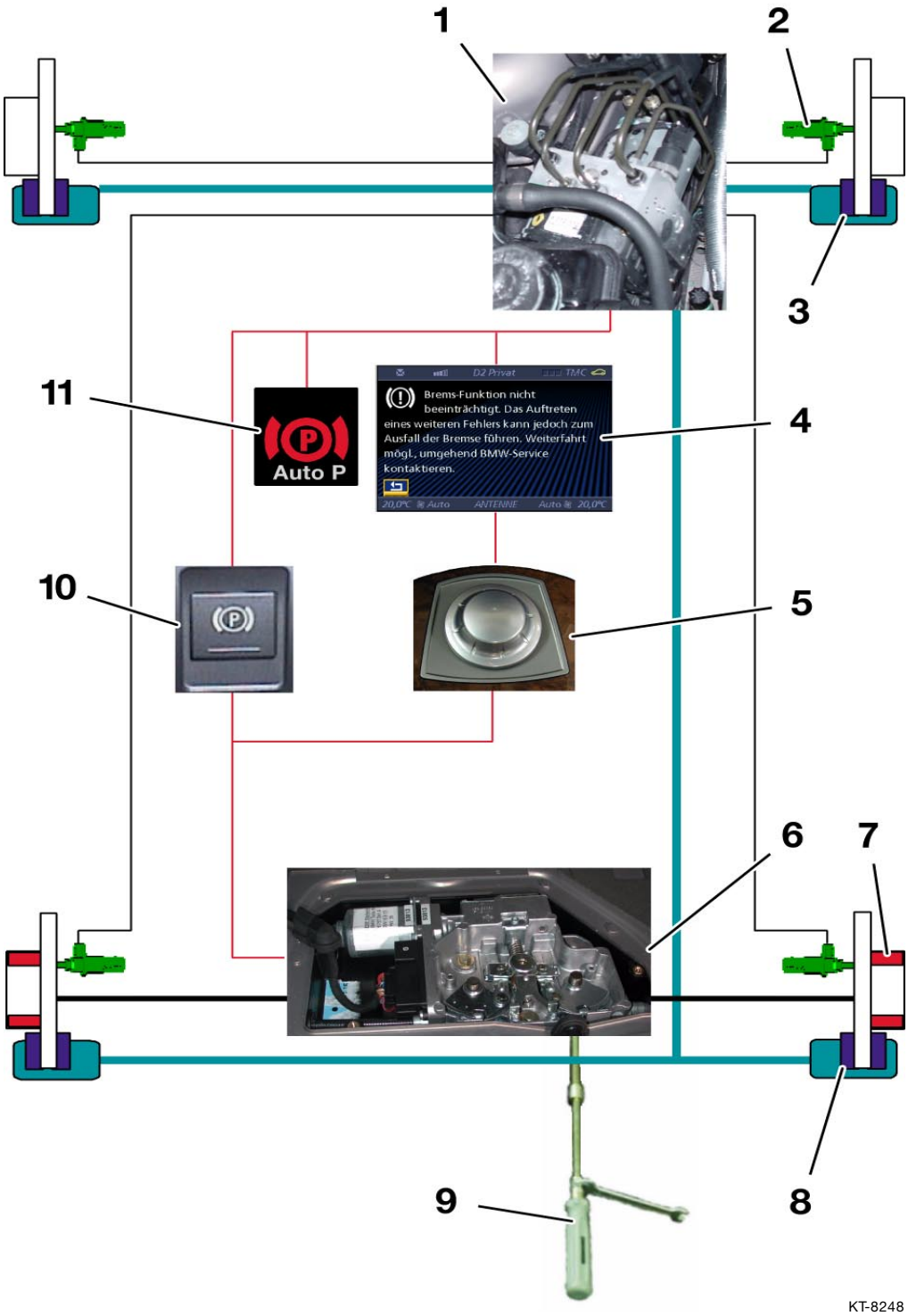


Fig. 25: Overview of parking brake system

Index	Description	Index	Description
1	DSC module	7	Parking brake
2	Wheel speed sensor	8	Service brake, rear axle
3	Service brake, front axle	9	Mechanical emergency release
4	Control Display	10	Parking brake push-button
5	Controller	11	Display in instrument cluster
6	Actuating unit		

Actuating unit

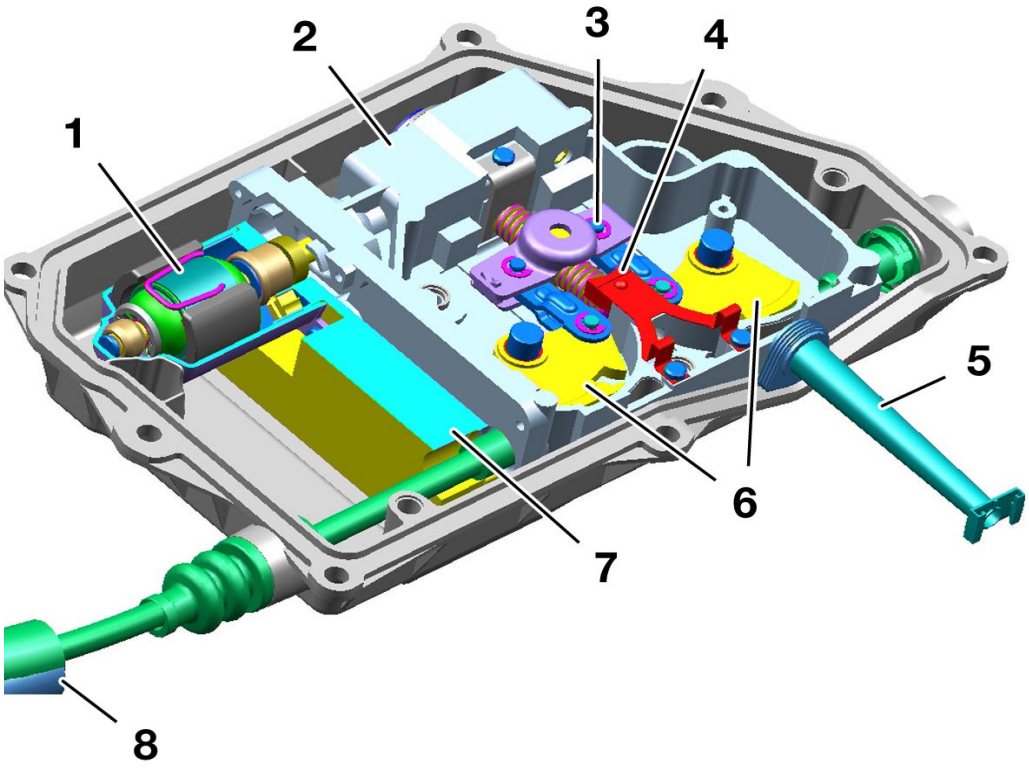


Fig. 26: Parking brake actuating unit

Index	Description	Index	Description
1	Actuator	5	Guide tube for emergency operation
2	Gear mechanism	6	Cable pulley
3	Balance arm	7	Control unit
4	End stop	8	Bowden cable

End stop

The end stop serves as the zero stop for standardizing the actuating position (this component raised is the set position for installing the brake bowden cable assemblies). The balance arm rests against the end stop the first time the brake is released after "ignition on." The control unit detects the zero stop by way of the increase in current. (Zero stop = Released position)

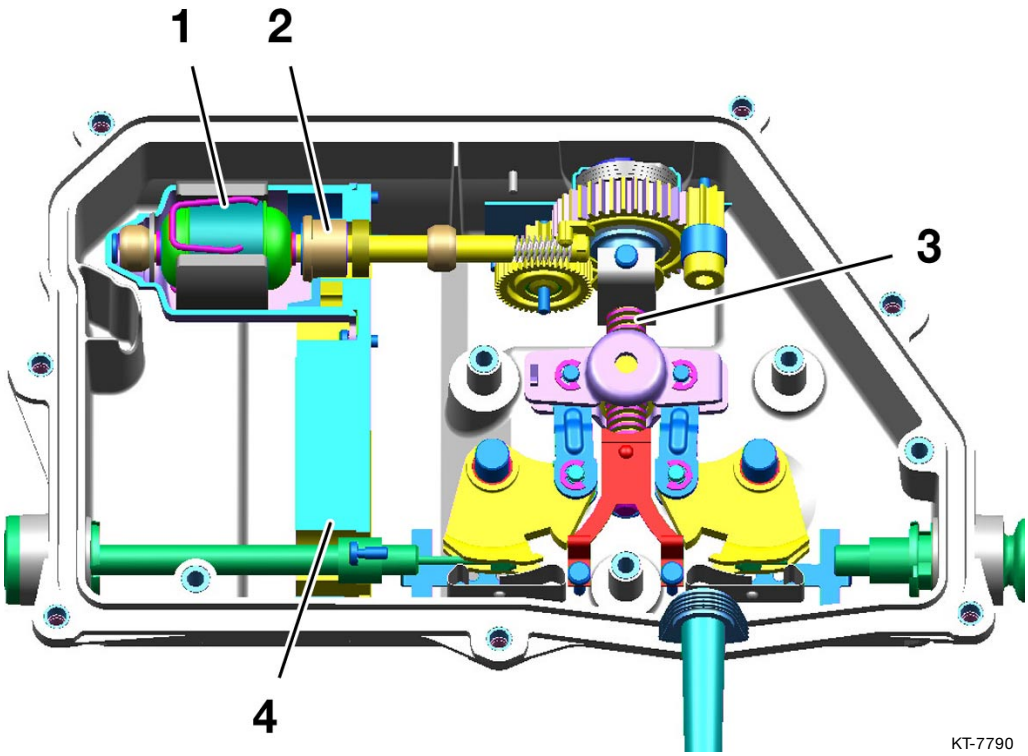


Fig. 27: Parking brake actuating unit

Index	Description	Index	Description
1	Electric motor	3	Spindle
2	Hall sensor	4	Control unit

Components and their functions

Electromechanical actuating unit:

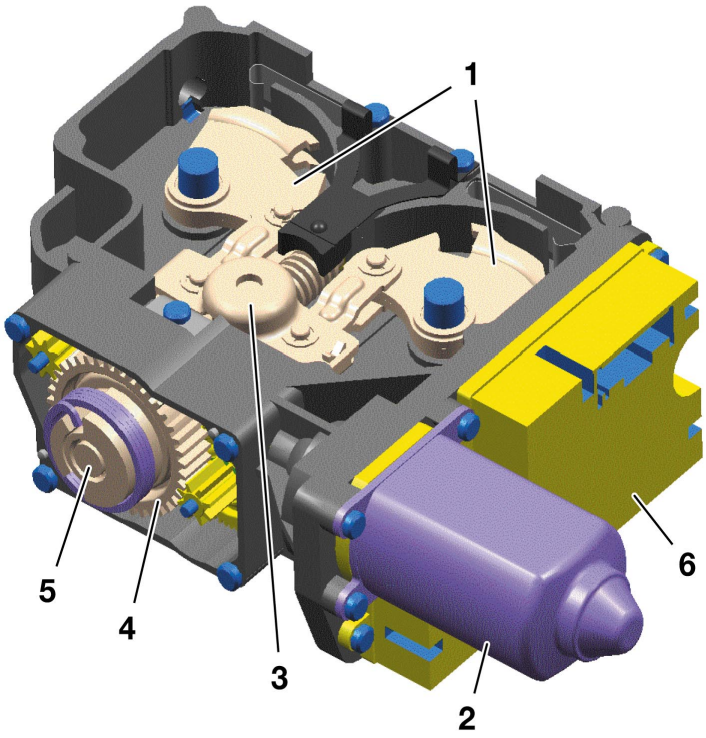


Fig. 28: Electromechanical actuating unit

Index	Description	Index	Description
1	Cable pulleys	4	Gear mechanism
2	Actuator	5	Spindle
3	Balance arm	6	Add-on control unit

The motor of the actuating unit turns the spindle via the gear mechanism. Driven by the spindle, the balance arm moves for the purpose of right-left compensation of the cable assemblies. With the aid of connecting levers, it pulls the cable pulleys corresponding to the direction of rotation of the spindle. The cable assemblies attached to the cable pulleys apply or release the duo-servo drum brake. The brake is released by means of return springs fitted in the duo-servo drum brake.

When the brake is released again, the spindle is driven by the gear mechanism such that it also carries the end of the wrap spring on the opposite side. This spring is released from the housing in that it is pulled inward and positioned on the spindle. The balance arm is pushed forward and, with the aid of connecting levers, turns the cable pulleys towards the outside. The bowden cable assemblies are now released.

The holding force for the parking brake is maintained by the wrapped spring mounted on the spindle. Once the hold position has been reached, the power flow of the spindle ensures the tractive force of the tensioned cables turns the spindle in the opposite direction. As a result, the first windings of the wrap spring are spread towards the outside. They press against the encompassing housing and hold the spindle in position. In this way, the holding force is enhanced by the wrap spring and not by the housing.

With the manual emergency release facility, the spindle can be turned via the gear mechanism, if necessary, and the spring tension released.

Gear mechanism with wrap spring:

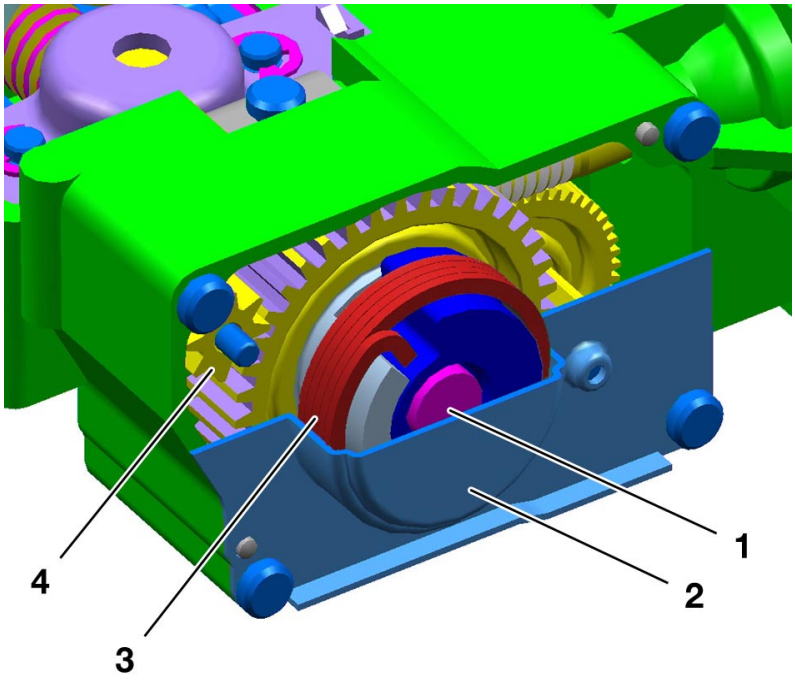


Fig. 29: Gear mechanism and wrap spring (cover half)

Index	Description	Index	Description
1	Spindle	3	Wrap spring
2	Wrap spring cover	4	Emergency release drive

This is designed as a three-stage step-down gear mechanism consisting of worm, spur gear and spindle.

As the gearwheels of the gear mechanism are made of plastic, the entire parking brake holding force is supported by the wrap spring in the housing cover of the spindle.

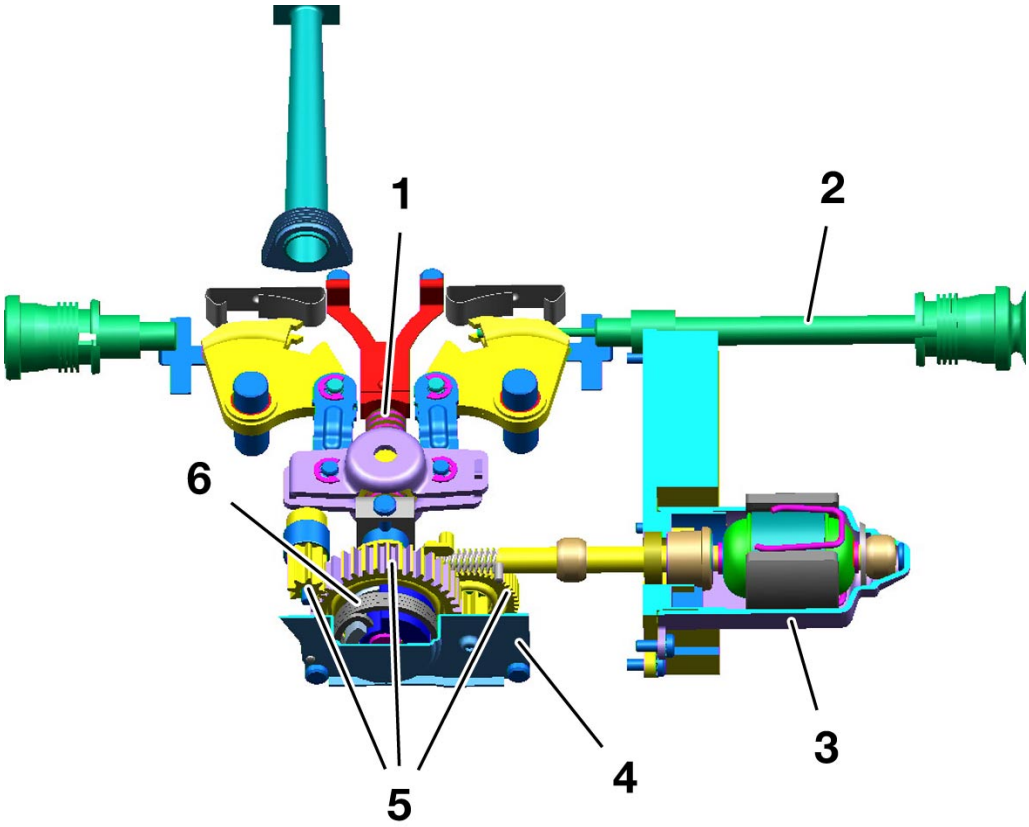


Fig. 30: EMF internal components

Index	Description	Index	Description
1	Spindle	2	Bowden cable
3	Electric motor	4	Wrap spring cover
5	Plastic gearwheels	6	Wrap spring

Emergency release:

It is possible to release the entire holding effect by way of direct intervention in the gear mechanism.

To release the brake, an extension rod, which is provided separately in the vehicle tool kit, is inserted through a guide into the emergency release gear wheel.

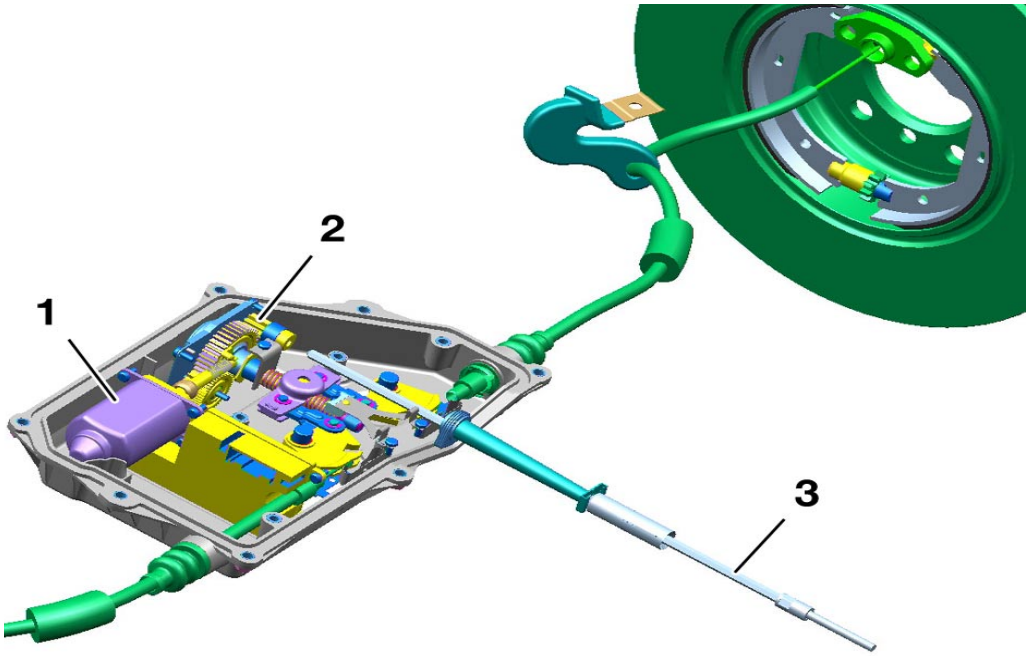


Fig. 31: Actuating unit in connection with the drum brake

Index	Description	Index	Description
1	Electric motor	3	Emergency release tool
2	Emergency release gearwheel		

The insertion direction is defined by a guide on the side of the housing opposite the gear mechanism.

The torque drive is provided by using an open-ended spanner and screwdriver handle provided in the vehicle tool kit.

The brake is released by turning in anticlockwise direction.

A release ring integrated in the brake release tool ensures that the tool is turned together with the brake if it is not removed by mistake.

Note:

After power failure, it may be possible that the vehicle can still not be moved after releasing the brake via the emergency release facility.

The parking lock of the automatic gearbox can still be engaged.

A manual emergency release facility for the gear mechanism is located in the left footwell. After opening a cover, a lever can be unfolded and locked in position by pulling a red tape. The vehicle can then be removed after releasing the brake.

On US vehicles, the cover is secured with a lock. It can only be opened with the ignition key.

Resuming operation after emergency release

Once the voltage supply has been restored after emergency release, the parking brake push-button must be pressed 3 times.

1st press	The control unit attempts to release the brake. However, since the brake has been released by means of the emergency release facility, the motor cannot run back and blocks. The control unit recognizes an implausible condition.
2nd press	The motor can move forward. The brake is applied. The control unit detects this situation.
3rd press	The motor can run backwards. The brake is released again. The correct operating status is reestablished.

This procedure is also described in the Owner's Handbook.

Control unit

The add-on parking brake control unit integrated in the actuating unit is linked to the DSC control unit and the vehicle periphery (instrument cluster, DME, transmission) via CAN.

The ECD interface (electronic controlled deceleration) is used in the DSC control unit for the purpose of hydraulic break activation. When the parking brake push-button is pressed with the engine running, a fixed brake pressure is requested which is then built up by the DSC hydraulic unit and transferred to the parking brakes.

The force applied at the spindle is calculated in the parking brake control unit. This is achieved by determining the current intake of the motor in connection with the temperature of the motor coil. The actuating force is calculated by evaluating the speed drop from the motor characteristic curve "speed as a function of torque."

A Hall sensor for sensing the speed and position is additionally mounted on the motor.

System overview:

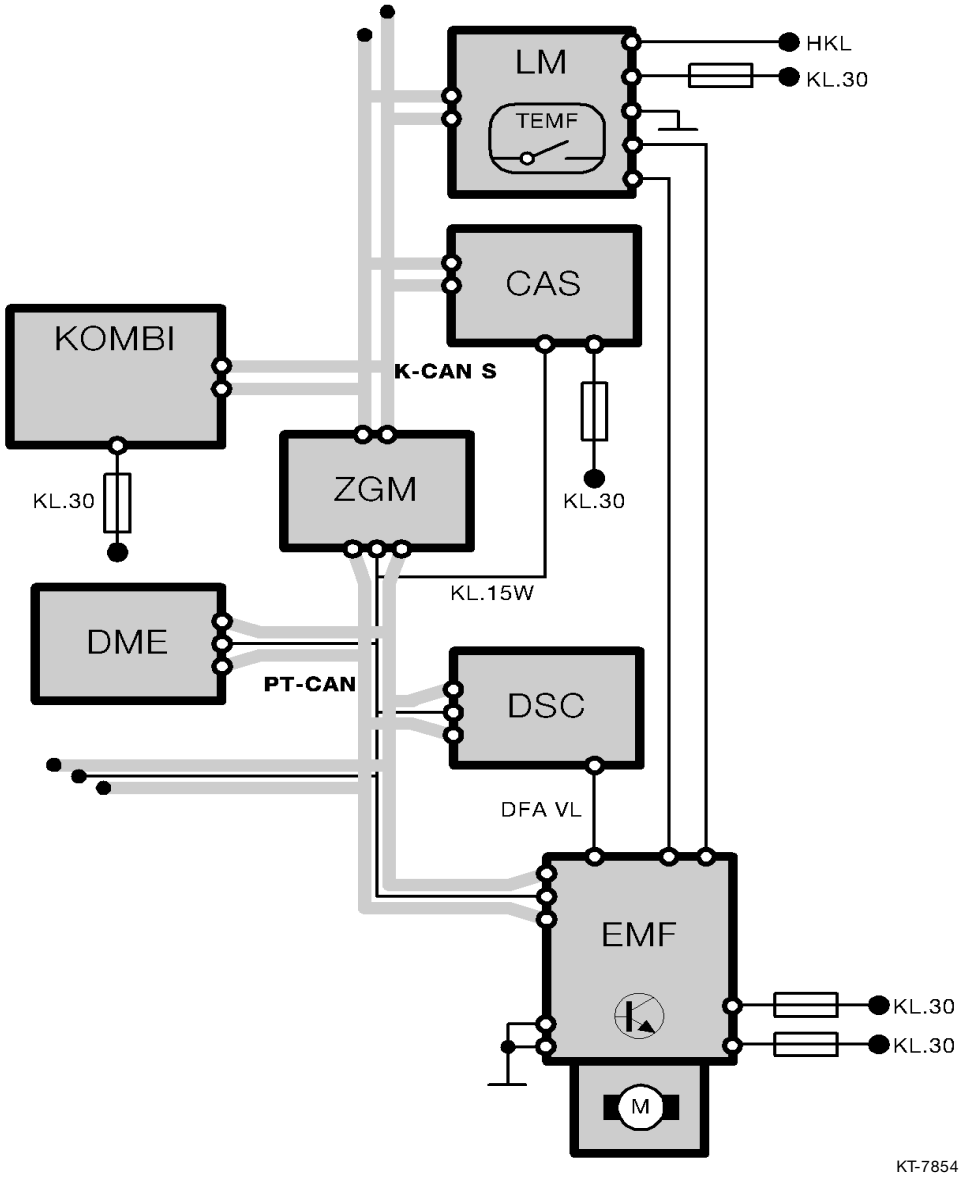


Fig. 32: System overview

Index	Description	Index	Description
LM	Light module	DSC	Dynamic stability control
TEMF	Parking brake push-button	DME	Digital motor electronics
CAS	Car Access System	ZGM	Central gateway module
DFA VL	Analog signal speed sensor (discrete), front left	HKL	Boot lid/tailgate lift

Operation

Parking brake push-button

Two separate controls are provided for operating the parking brake functions:

1. A push-button, see figure below, located in the instrument cluster to the left of the steering wheel is used to operate the basic parking function of apply/release when the vehicle is stationary and "dynamic braking" when the vehicle is driven dependent on the vehicle speed.

   In principle, it functions as an ON/OFF push-button. Only in dynamic braking mode, the brake is applied for as long as the button is pressed.

Fig. 33: Parking brake push-button

2. A second control is represented by an action field in the menu of the control display.

   The screen menu is activated and controlled by means of the controller. With this control facility, the parking brake comfort function "automatic hold" can be activated or deactivated according to the driver's choice.

Dynamic braking

2 control units are required by law for brake operation (previously brake pedal and handbrake lever). In the E65, in addition to the footbrake, the second control point is the push-button in the dashboard.

If the vehicle is moving and the engine is turned off, it is braked via the rear axle drum brakes when the push-button is permanently pressed at speeds below 3 km/h.

At speeds over 3 km/h the DSC return pump is started and braking is performed hydraulically at all four wheels.

Braking is performed for 0.8 s at 3 m/s^2 when the button is pressed while the engine is running during driving. For the next 2 seconds there is a ramp-based increase in the braking power to 5 m/s^2. This rate of deceleration is maintained for as long as the push-button is pressed.

Since braking takes place hydraulically at all four wheels, considerably higher deceleration rates are possible with minimum operating force (pushbutton) compared to conventional parking brakes. This controlled braking therefore contributes to increased vehicle safety.

For road safety reasons, the following traffic is warned when dynamic braking is active by the brake lights coming on.

This function should only be used as an emergency function and on no account should it replace normal operation of the service brake!

When the parking brake is released and the vehicle rolls, dynamic emergency braking can be activated from any situation (terminal 15, terminal R, terminal 30) by pressing the push-button.

Indicator lamps

The driver is constantly informed of the parking brake system status and of the system availability.

This is achieved by means of an indicator lamp in the instrument cluster and, in the case of a fault, by means of an additional action prompt in the control display. The parking brake control unit is linked with the instrument cluster and the control display via the CAN. The lamp bulb is checked as part of the pre-drive check when the ignition is switched on.

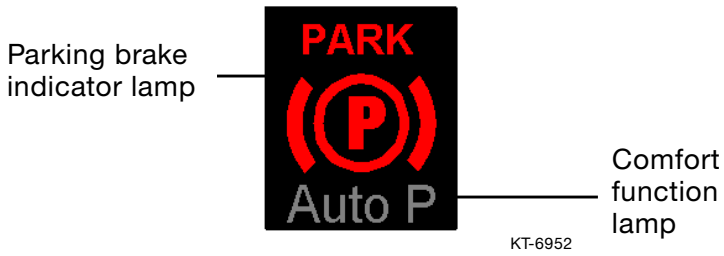


Fig. 34: Display in instrument cluster

Indication

In the basic function, application of the parking brake is indicated by a red LED in the brake symbol and by the letter P on the inside.

The letters "PARK" are illuminated in the indicator lamp for as long as the parking brake is applied. The P symbol signals that the requested status "released" or "applied" has been reached.

If the parking brake is operated while driving (dynamic braking), an acoustic warning signal is additionally activated (multiple gong).

Comfort indication (automatic hold)

Standby of the automatic hold functions is indicated by the green lettering "AUTO-P" integrated in the lamp.

The parking brake signal is additionally indicated if the automatic hold function is active and the vehicle is stopped.

The parking brake symbol lights up in green in this case (the hold function is now executed by the DSC with all 4 wheel brakes).

After the brake has been released automatically when starting off, the green parking brake symbol goes out and only the green standby indication "AUTO-P" remains active.

The transition from hydraulic to mechanical mode takes place automatically when the engine is turned off. The indicator lighting changes from green to red (applying parking brake and release of DSC).

Indicator lamp activation

System function	Indicator lamps
Parking brake released	 KT-8140
Parking brake applied	 KT-8141
Dynamic braking + acoustic signal (gong)	 KT-6950
Automatic hold standby	 KT-6948
Automatic hold active	 KT-6949
System fault	 KT-8139

Check control messages

Parking brake malfunctions are indicated by a yellow indicator lamp in the instrument cluster.

In addition, the same symbol is repeated with the variable indicator lamp and briefly explained by a text note.

In addition to the parking brake, the variable indicator lamp is also made available to other control units and can only be used from time to time by the parking brake control unit corresponding to a defined priority control. The variable indicator lamp can indicate all symbols and colours of a malfunction from the instrument cluster.

If the variable indicator lamp appears in the instrument cluster, this fault is explained in the check control display corresponding to the warning, accompanied by additional action information in the "control display."

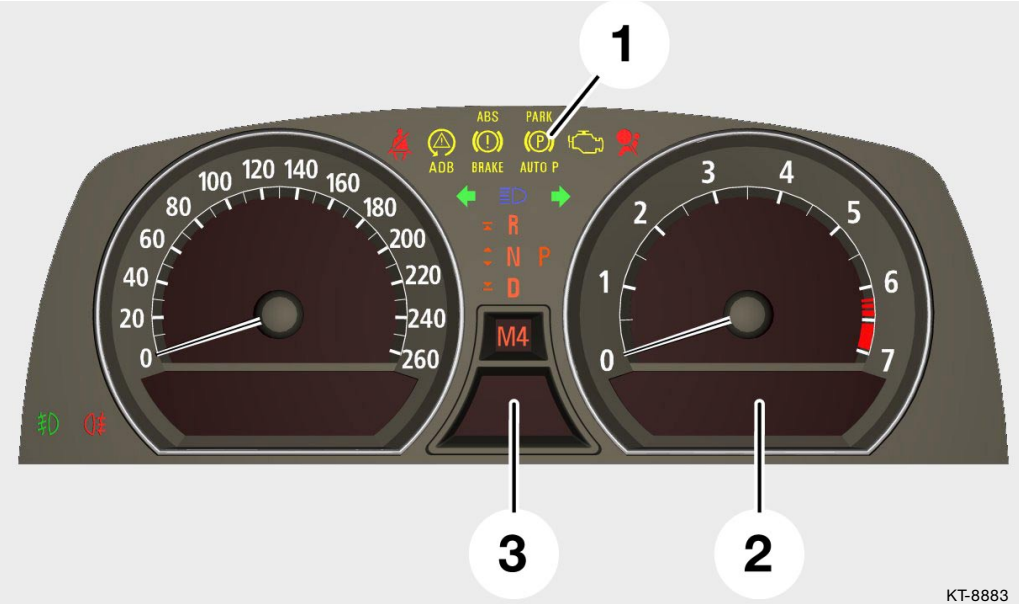


Fig. 35: Instrument cluster

Index	Description	Index	Description
1	Parking brake indicator lamp	3	Variable indicator and warning field
2	Check control display		

Safety control

Safety control of comfort function

Cutout of the automatic release function by pressing the accelerator pedal is based on two safety functions.

Situation: bonnet opened

Automatic release of the hydraulic brake when the accelerator pedal is pressed is inhibited when the bonnet is opened (CAN signal bonnet contact) while the engine is running. In this case, the brake can only be released by pressing the push-button (automatic mode deactivation). When the bonnet is closed again, if required, automatic hold must be activated again by the driver.

This situation also applies when the boot lid is opened and drive stage R is engaged.

Situation: the driver leaves the vehicle

If the driver leaves the vehicle with the engine running (CAN signal driver's seat occupancy), for safety reasons, automatic release of the hydraulic brake by pressing the accelerator pedal is inhibited. In this case, the mechanical parking brake actuating unit is additionally applied. The gearbox shifts automatically an engaged drive stage to P-position.

When the driver gets back into the car (CAN signal driver's seat occupancy), a drive stage must be actively engaged in order to drive off. It is necessary to press the brake pedal for this purpose (shift-lock). The signal from the brake light switch serves as a trigger for releasing the actuating unit. The automatic hold function must be reactivated.

Notes on service

The brake shoe of the parking brake is adjusted in the same way as before by turning the adjusting screw with a screwdriver through the threaded hole of the wheel hub.

Disassembly of bowden cables

To disassemble the bowden cables, it is necessary to raise the end stop with an auxiliary tool (or if necessary a special tool). Using the brake release tool, the balance arm is turned back up to the stop of the cable pulleys at the housing wall so that the bowden cables can be removed from the cable pulleys.

Parking brake initialization

The parking brake must be initialized after replacing the drum brake linings. This procedure can be carried out with the aid of the DIS or MoDiC. The new idle travel of the brake cables is learnt via the Hall sensor in the actuating unit. This function ensures that a subsequent cable brake can be reliability detected.

Bedding down linings of duo-servo brake

If the brake shoes of the duo-servo brake drum are replaced as part of repairs or servicing procedures, the brake shoes must be bedded down in order to achieve adequate holding effect.
A "special bedding down routine" that can be called up via the DIS is integrated in the parking brake software.

The parking brake indicator lamp flashing red in the instrument cluster signals to the workshop personnel the standby status of the brake bedding down program. If, after activating the program, the bedding down procedure is not carried out within 30 minutes or if the ignition is turned off before the procedure is carried out, the brake bedding down program will be terminated and the system will reassume the normal parking brake function.

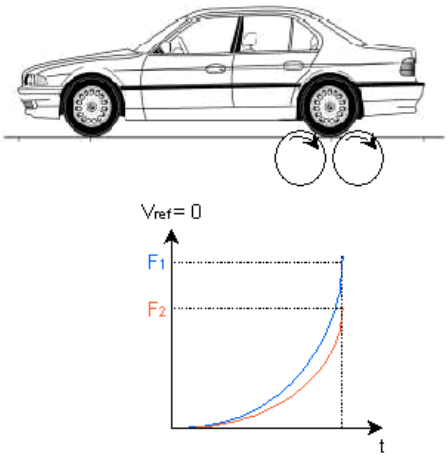
The bedding down procedure after changing the parking brake linings can also be carried out on the roller dynamometer.

Behaviour on the brake test rig

Operation of the E65 parking brake can be tested on the brake roller dynamometer.

For the MOT (road test) inspection, the rear axle test can be conducted with the engine running by pressing the parking brake push-button.

With the engine turned off, the rear axle test can also be triggered by testing the parking brake push-button. The actuating unit is quickly applied and the drum brake linings are locked. The vehicle normally jumps out of the test rig roller.



KT-8242

Fig. 36: Brake test rig

Index	Description	Index	Description
F1	Braking force, right	F2	Braking force, left

Steering

Introduction

All E65 models are equipped with rack and pinion power assisted steering.

The steering column is designed without a steering wheel lock. The legally stipulated antitheft requirement is fulfilled by the parking lock in the automatic transmission.

All 6-cylinder models are equipped as standard with the semi-electric steering column.

All other models are equipped as standard with the all-electric steering column.

The control for steering column adjustment is located on the left on the steering column trim.

KT-6991

Fig. 37: Control button for steering column adjustment

Index	Description	Index	Description
1	Push-button for semi-electric steering column adjustment	2	Control knob for all-electric steering column adjustment

As a driver protection feature, a newly designed telescopic crash element is mounted in the upper section of the steering column.

Servotronic is available as an optional extra.

Steering components

- Steering gear

The steering gear is rigidly bolted at 4 points to the axle carrier.

The gear ratio of the steering gear is variable from 47.0 to 59.0 mm rack movement per steering wheel revolution.

The gear ratio is variable in order to keep the number of total steering wheel revolutions when turning to full lock as low as possible. The greater the steering wheel lock the more direct the gear ratio.

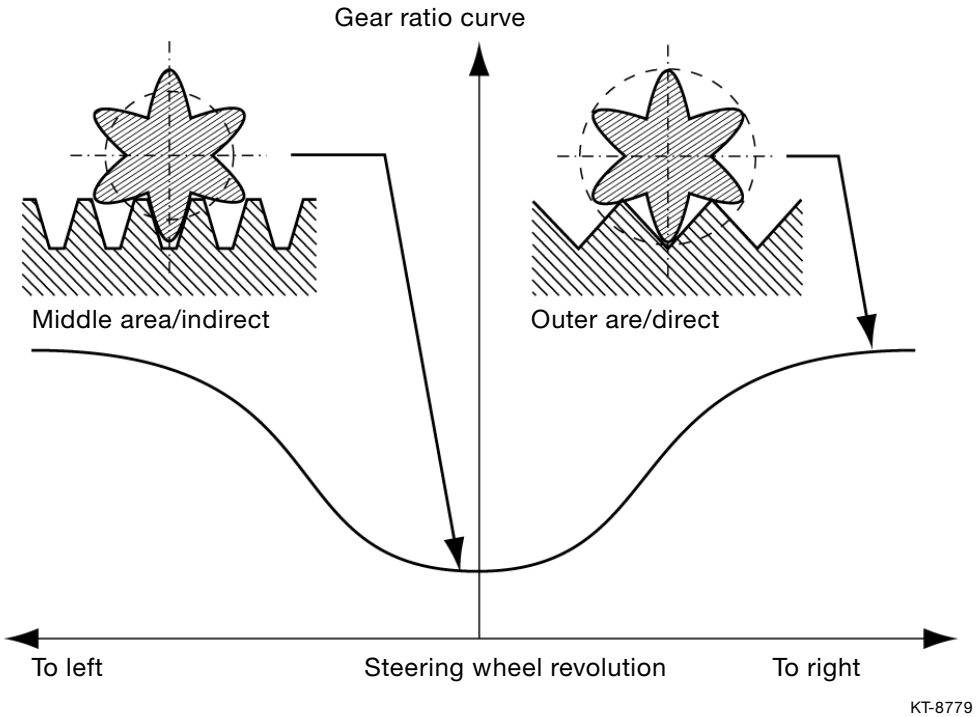


Fig. 38: Steering gear ratio curve

Turning circle (calculated)	12.13 m
Steering gear ratio when driving straight ahead	47 mm (indirect)
Steering gear ratio at maximum steering lock	59 mm (direct)

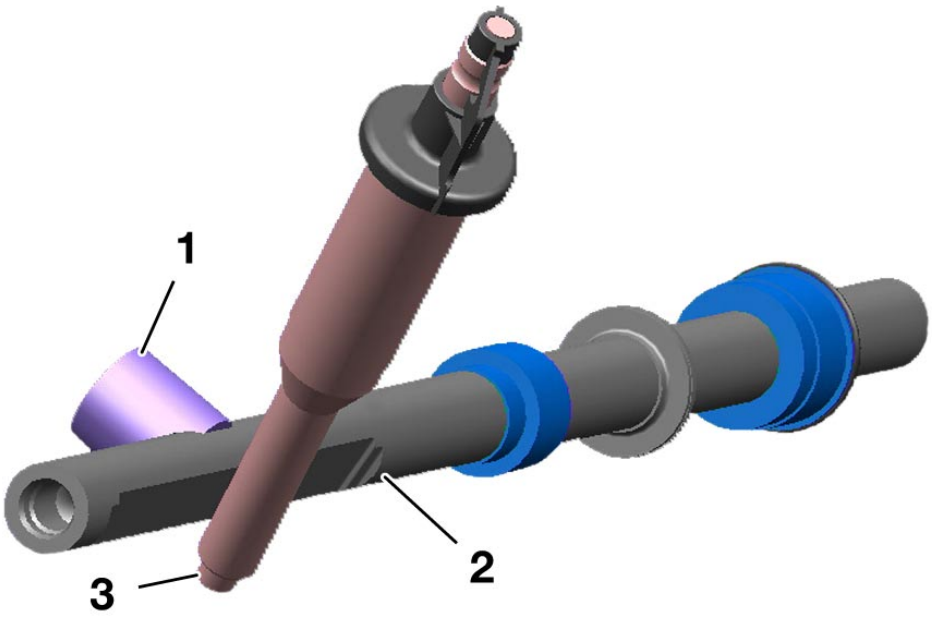


Fig. 39: Steering gear

Index	Description	Index	Description
1	Thrust piece	3	Steering shaft
2	Variable gear tooth pitch		

With its correspondingly greater dimensioning, the rack and pinion steering system can also be used for heavier vehicles.

The thrust piece required for automatic play compensation has been optimized with regard to its more uniform effect (lengthened, with more favourable stroke/bore ratio) and equipped with a stronger spring. Lubricating pockets in the slide film of the thrust piece additionally counteract the breakaway moment of the stick-slip effect and disturbing noise.

The gearing on the rack is tumble-forged (in this process, under gyratory movement, the gears are pressed into the shaft by a forging element) and is consequently considerably more resistant to stress than the rack previously used.

The rack is hollowed, allowing for air equalization between the right and left bellows in the rack thus rendering unnecessary a plastic tube outside the steering gear that was previously required for air equalization purposes.

The hole is made as large as possible to save weight. Thanks to a special process used to upset the end of the rack, this hole can even be larger than the subsequently applied track rod thread, thus achieving a further weight reduction of 280 g.

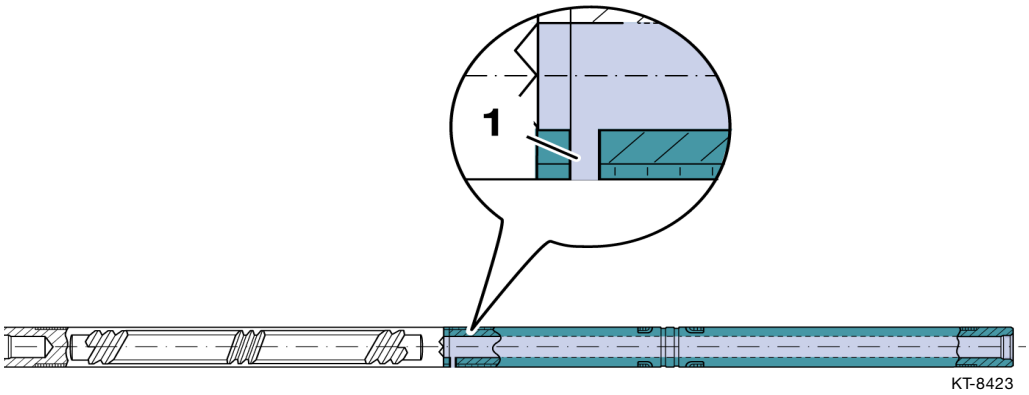


Fig. 40: Hollowed gear rack

Index	Description
1	Ventilation hole

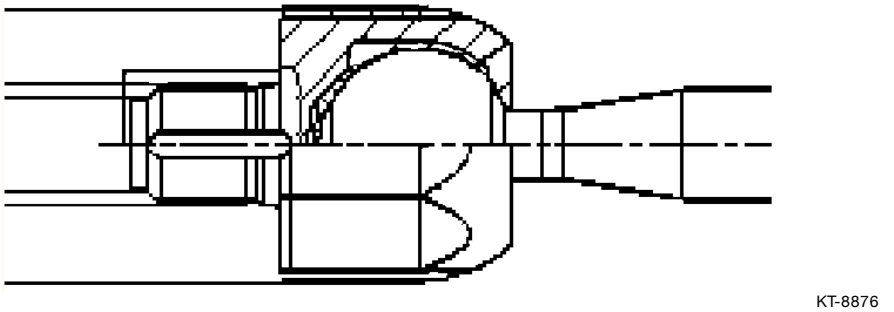


Fig. 41: Ball stud of track rod

- Track rod

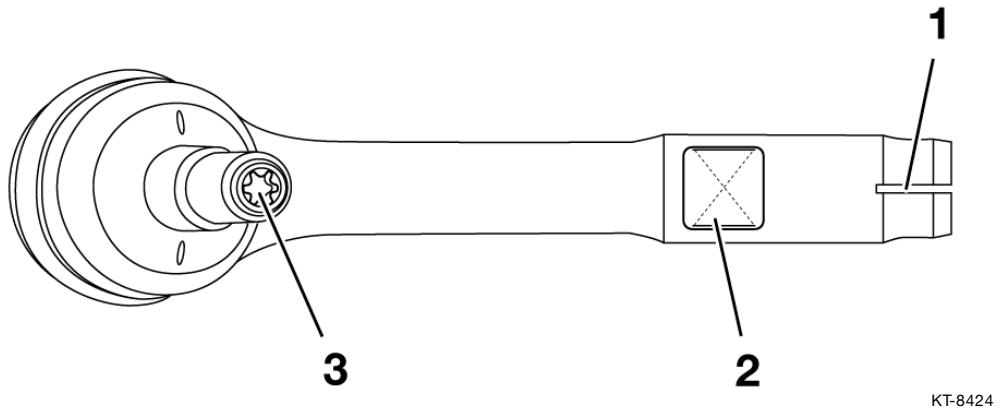


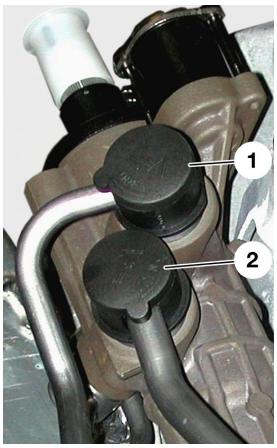
Fig. 42: Track rod

Index	Description	Index	Description
1	Thread clamp	3	Torx for bracing when loosening nut
2	2-edge area for bracing when releasing clamp		

The bellows were made from a newly developed material and are therefore harder to ensure greater resistance to rodent bites.

- Steering gear connections

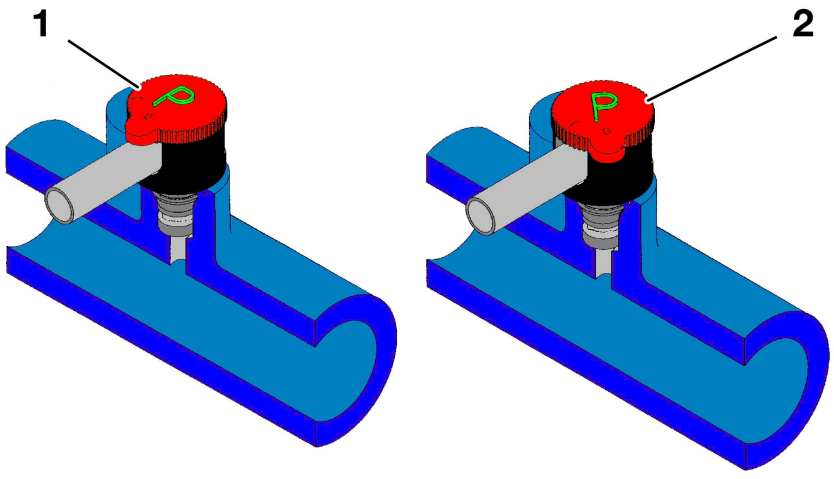
New threadless plug connections are used at the supply (1) and return (2) connections of the steering gear.



KT-8179

Fig. 43: FCD couplings on steering gear

These connections are designed as fast to connect and disconnect couplings (FCD) supplied by Aeroquip.



KT-7995

Fig. 44: FCD coupling

Index	Description	Index	Description
1	Operating position	2	Release position

To release the quick-action coupling, it is first released by turning the cap (position 2). The connection is released by pressing with the thumb while at the same time pulling the quick-action coupling.

Prior to reconnection, the cap must be reset to the locked operating position and should be plugged onto the connection only in this position. The lug on the cap must be aligned flush with the pipe connection. A special test gauge will be developed for the purpose of checking that the coupling is connected correctly.

- Power steering pump

Different power steering pumps are used depending on the vehicle equipment.

Vehicles without dynamic drive are equipped with only one vane pump. The oil reservoir is a standard reservoir.

A tandem pump is fitted if the vehicle is equipped with dynamic drive. This pump consists of a radial piston pump with a maximum output of 180 bar and a vane pump section with a maximum output of 135 bar. These vehicles are also equipped with large oil reservoirs with oil level monitoring.

- Steering column

Telescopic upper steering column with crash element

When the steering column is subject to driver load in the event of a crash, the upper steering shaft can be compressed telescopically by 70 mm. This telescopic action is controlled by a characteristic-controlled crash element made of glass fibre reinforced plastic.

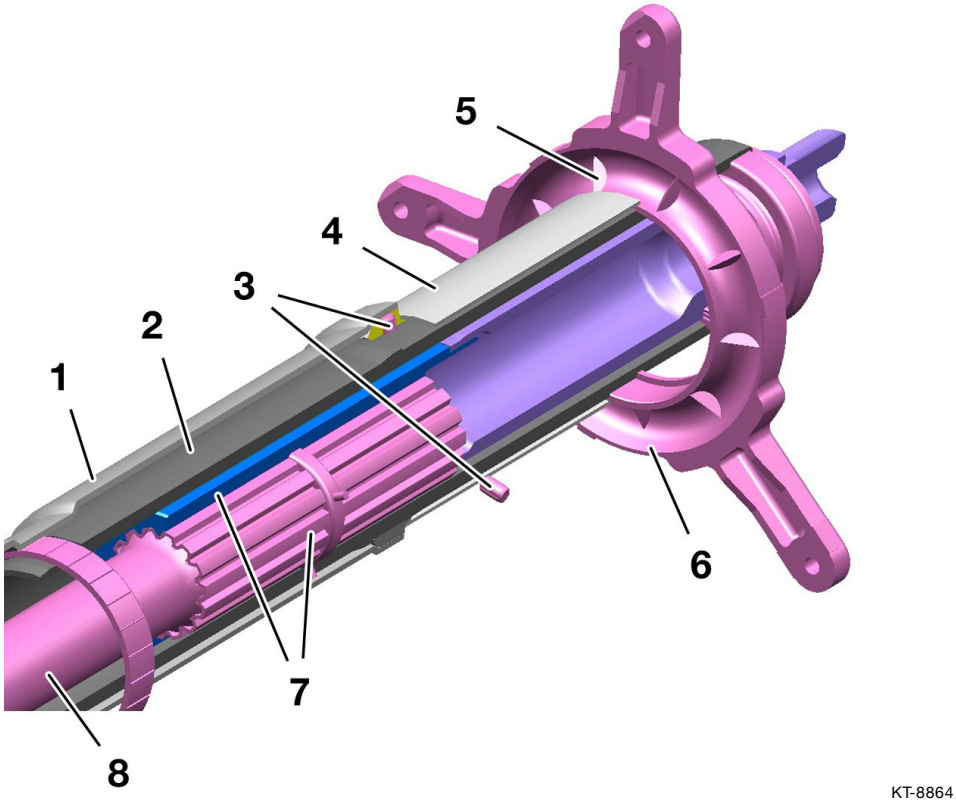


Fig. 45: Sectional view of upper steering column

Index	Description	Index	Description
1	Steering column tube	5	Webs
2	Slide tube	6	SLZ carrier
3	Shear pin	7	Forward/backward adjustment
4	Crash element	8	Steering column

This movement is triggered by three plastic pins shearing under an axial force of approx. 3 kN (misuse forces on the steering wheel amount to maximum 1.5 kN).

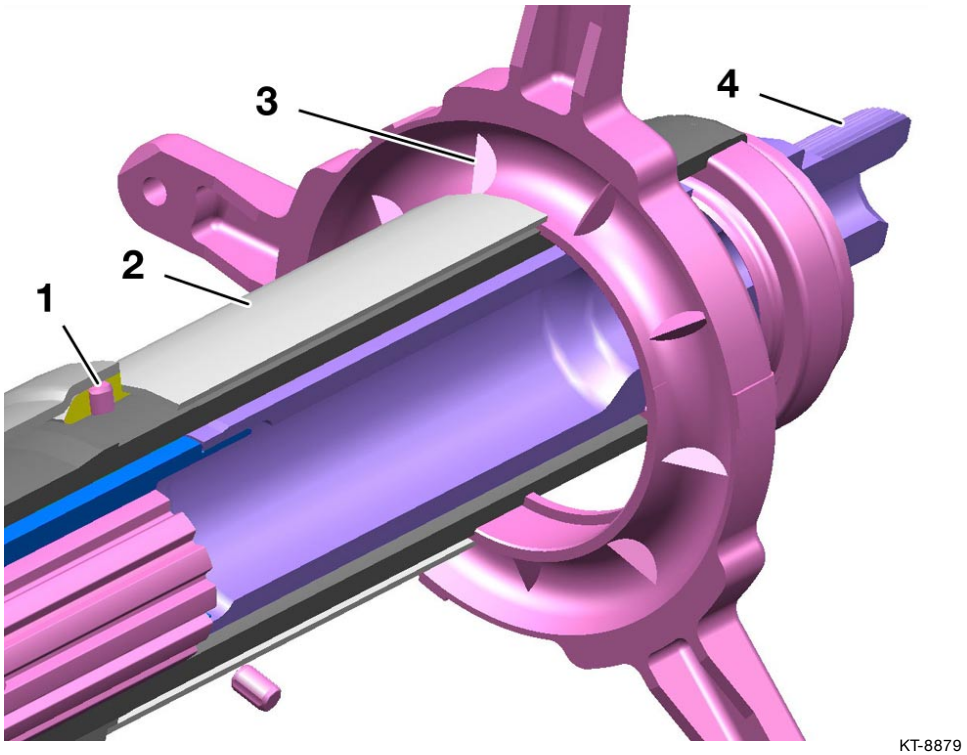


Fig. 46: Crash element

Index	Description	Index	Description
1	Shear pin	3	Webs
2	Crash element	4	Locking tooth

This makes it possible for two metal sleeves to slide together when the glass fibre reinforced plastic element surrounding the metal sleeves is broken over a defined length. This occurs at force application of 3 to 7 kN.

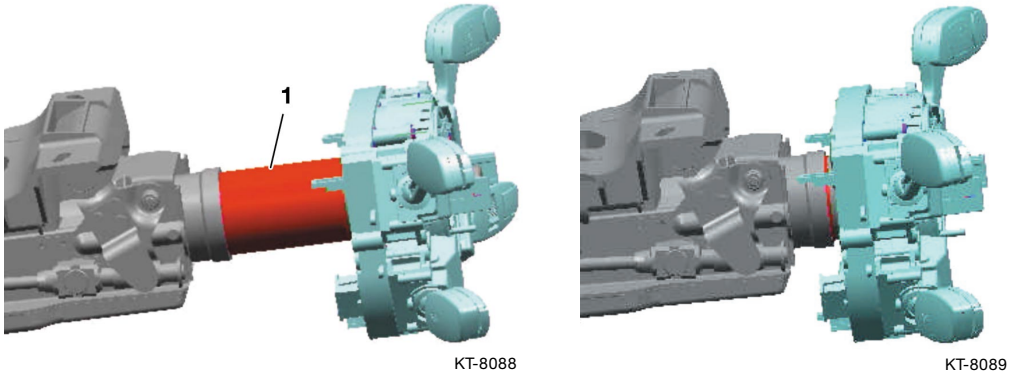


Fig. 47: Crash element (before and after crash situation)

Index	Description
1	Crash element

Note:

Never disassemble the steering column!
On no account work on the crash element!

In the event of a defect, remove the entire steering column. For this purpose, the steering wheel is removed when set in the straight ahead position. The steering column switch centre may also only be removed in the straight ahead position.

Mount the steering column switch centre only in straight ahead position. Observe the marking on the locking tooth when fitting the steering wheel!

- Steering column adjustment

All-electric steering column adjustment:

- The steering column can be adjusted electrically in up and down and forward/backward directions with the control button.
- The all-electric steering column is adjusted by means of two motor-gear units.
- Various stored positions can be defined via the seat memory.
- The steering column is moved into the uppermost front position to facilitate entry and exit (automatic easy entry).

The schematic circuit diagram of the information line from the push-button to the motors of the semi- and all-electrical steering column adjustment facility is described in the chapter "Electrical/electronic vehicle equipment."

Steering column switch centre (SZL)

The steering angle sensor is integrated in the steering column switch centre module. Its positions are transferred by means of CAN bus signals to other control units. These are:

- Dynamic drive: rapid activation of tilt motors
- EDC-K: rapid activation of dampers when turning in
- DSC: computer support for correct braking strategy
- LM: resetting of turn-signal flasher function
- ACC: support of distance calculation when cornering

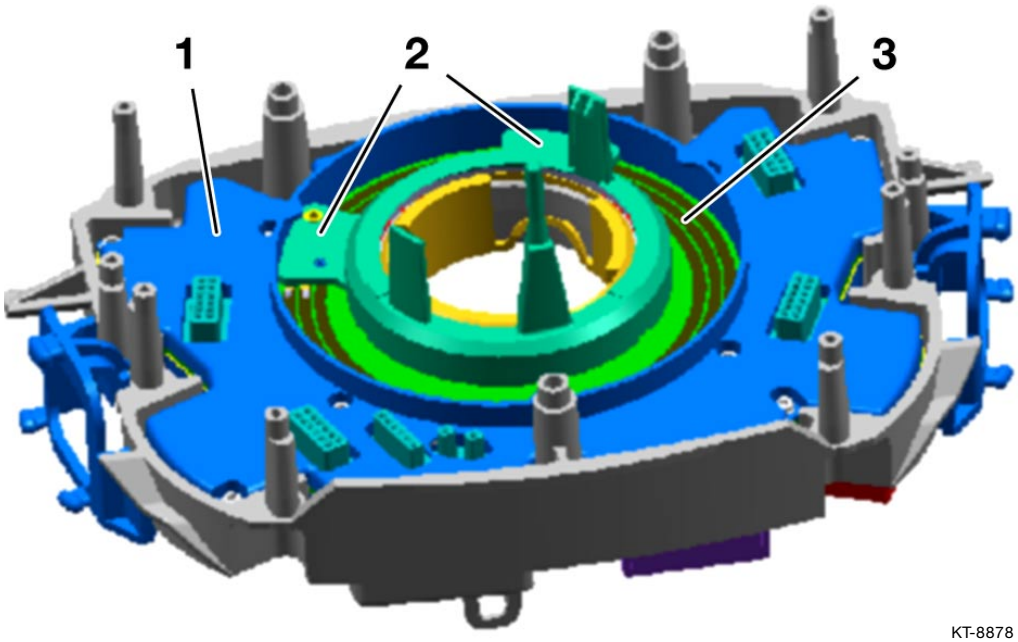


Fig. 48: Steering angle sensor in steering column switch centre

Index	Description	Index	Description
1	Control unit	3	Wiper tracks
2	Wipers		

- Steering angle sensor

The steering angle sensor is designed as a 3.4 kohm potentiometer with two wipers offset by 90 degrees. From the two wiper signals (U_1 and U_2) and a reference signal (U_N), the steering column switch centre control unit (SZL) calculates the steering angle sensor telegram that is transferred via bus signals to other control units.

The following positions

-720° to -361°, -360° to -0°, 0° to 360°, 361° to 720°

are calculated.

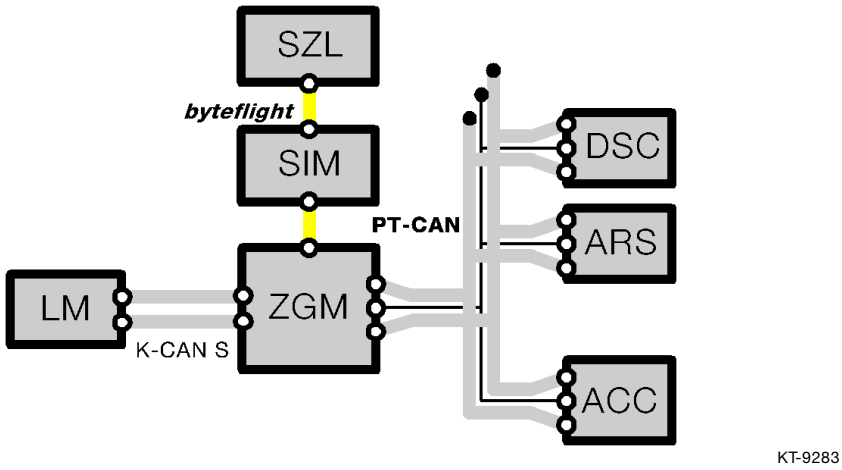


Fig. 49: Data line of steering angle telegram

Index	Description	Index	Description
SZL	Switch centre steering column	DSC	Dynamic stability control
SIM	Safety integration module	ARS	Dynamic drive
ZGM	Central gateway module	ACC	Active cruise control

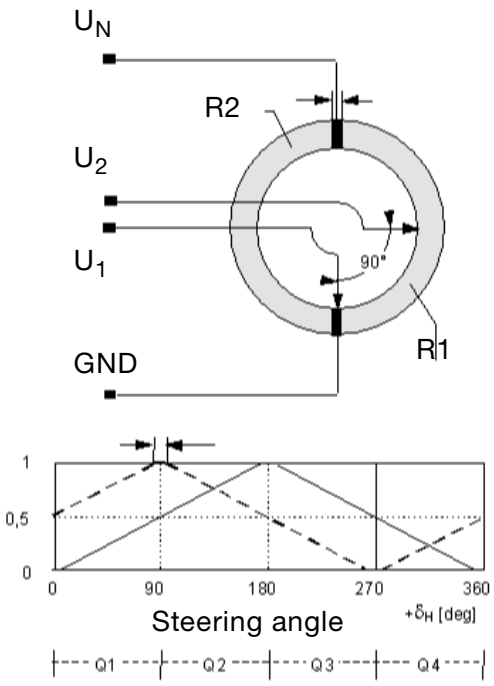


Fig. 50: Voltage curve steering angle sensor

Shorts to ground or supply are detected as faults.

Note:

When replacing the steering column switch centre (SZL) with integrated steering angle sensor, the coil spring cassette must be fitted in the centre position with the wheels set in the straight ahead position.

Since the wiper does not have an electrical reference point, steering angle matching must be carried out with the DIS on completion of repairs. For this purpose, particular care must be taken to ensure the wheels are set in the exact straight ahead position!

With this matching, the relative offset position to a 360° turn is determined for the sensor.

If the SZL control unit was at zero current, a self-learning effect (reset) ensures with the aid of the front wheel speed signals that the number of steering wheel turns is determined (from the straight ahead position the first or second steering wheel turn to the right or left). The number of steering wheel turns is necessary for the purpose of determining the absolute steering angle.

No further matching is required after the control unit has been reset!

Matching is only necessary after the SZL has been replaced or the steering wheel has been moved.

The corresponding status (“Reset occurred" or "Matching necessary") can be read out during diagnosis with the DIS.

Chassis integration module (CIM)

Two CIM control unit variants will be used up to 03/03:

Variant 1 of the CIM control unit contains following functions:

- Servotronic
- Steering column adjustment (LVS)

In addition to the functions of variant 1, variant 2 of the CIM control unit contains the function:

- Tyre defect indicator (RPA) (as option from 9/02, standard from 3/03)

A revised CIM control unit will be used as from 03/03.

The CIM is installed on the underside of the steering column. On right-hand drive vehicles it is turned through 180° due to the plug connections.

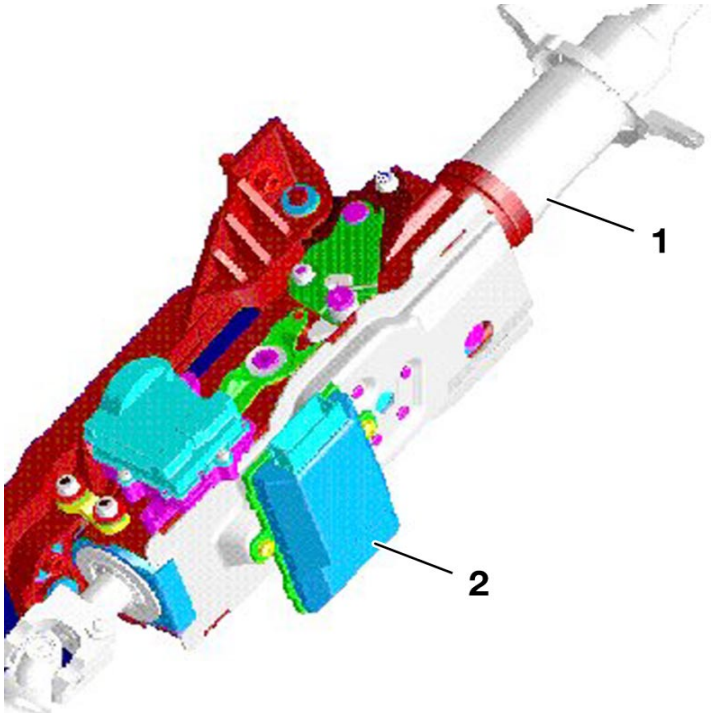


Fig. 51: CIM under steering column

Index	Description	Index	Description
1	Crash element	2	Control unit

The steering column adjustment system comprises the following components:

All-electric steering column:

- CIM control unit
- 2 adjustment drives for forward/backward and up/down adjustment
- Hall sensors for position recognition

Servotronic option:

- Servotronic valve

CIM in the bus network

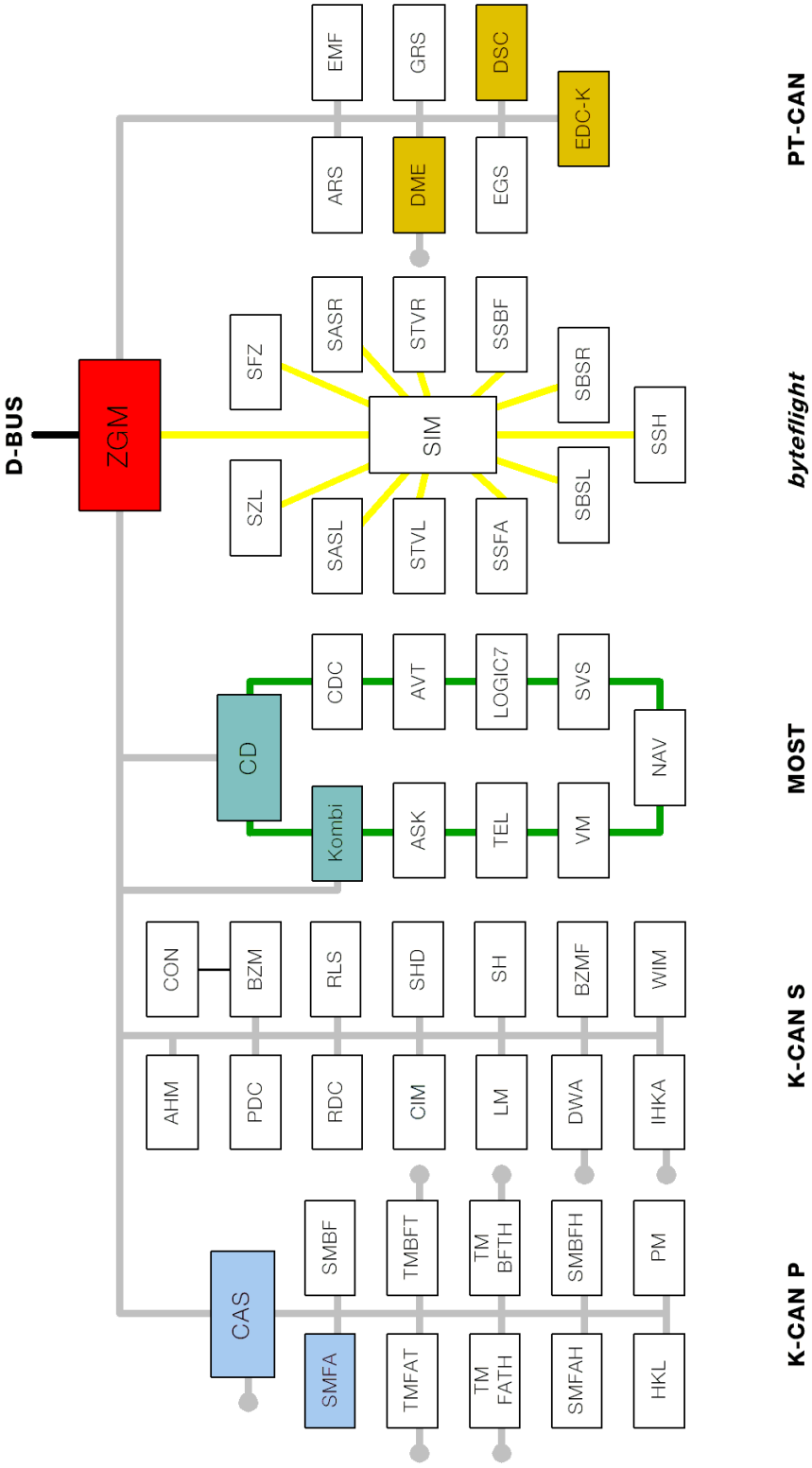


Fig. 52: CIM in the bus structure

CIM in the system network

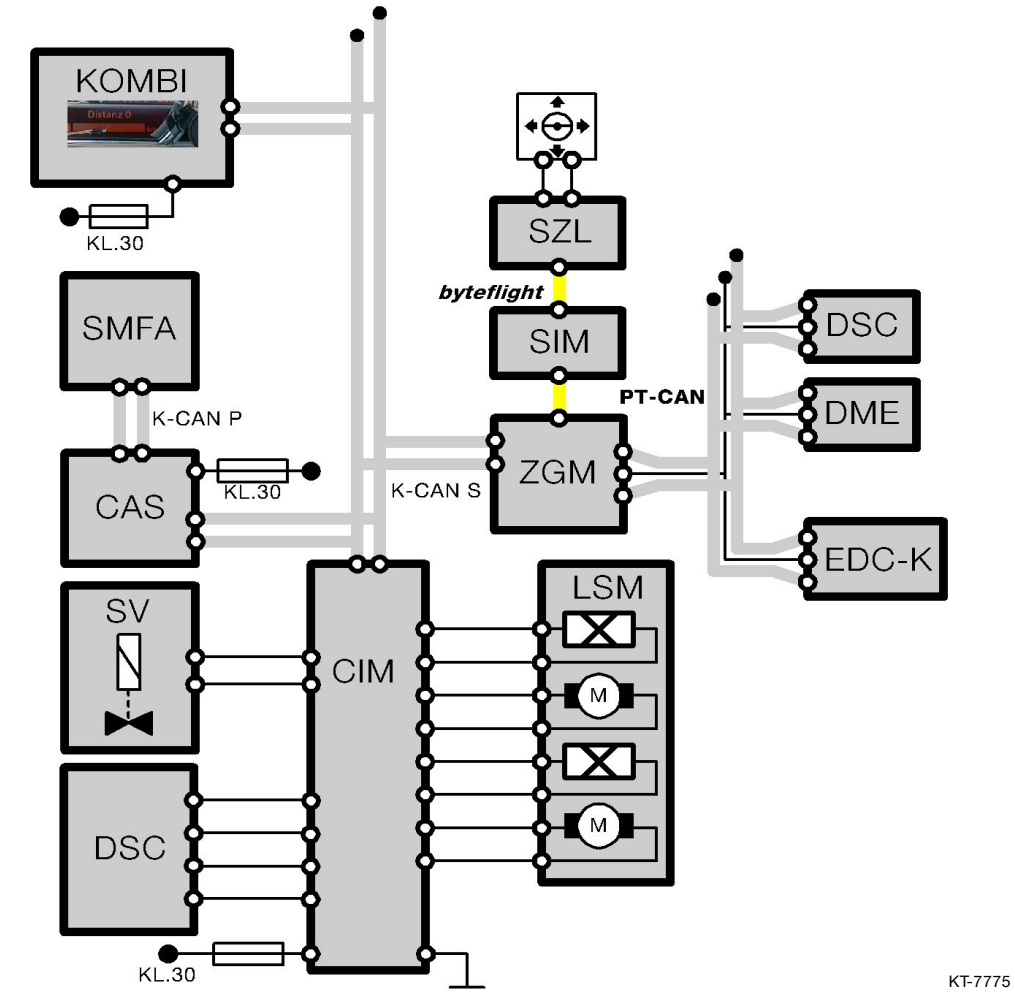


Fig. 53: CIM overview

Index	Description	Index	Description
SMFA	Seat memory, driver	SZL	Switch centre steering column
CAS	Car Access System	ZGM	Central gateway module
SV	Servotronic valve	LSM	Steering column motor
DSC	Dynamic stability control	CIM	Control unit
DME	Digital motor electronics	EDC-K	EDC-K control unit
SIM	Safety integration module		Steering column adjustment switch for all-electric steering column