Technical Training.
Product Information.

E89 Chassis and suspension.

BMW Service

General information

Symbols used

The following symbol is used in this document to facilitate better comprehension or to draw attention to very important information:

contains important safety notes and information that needs to be observed strictly in order to guarantee the smooth operation of the system.

Information status and national variants

BMW Group vehicles meet the requirements of the highest safety and quality standards. Changes in requirements for environmental protection, customer benefits and design render necessary continuous development of systems and components. Consequently, there may be discrepancies between the contents of this document and the vehicles available in the training course.

This document basically relates to left-hand drive vehicles with European specifications. Some controls or components are arranged differently in right-hand drive vehicles than shown in the graphics in this document. Further differences may arise as the result of the equipment variations used in specific markets or countries.

Additional sources of information

Further information on the individual topics can be found in the following:

- Owner's Handbook
- Integrated Service Technical Application.

Contact: conceptinfo@bmw.de

The information contained in this document form an integral part of the technical training of the BMW Group and are intended for the trainer and participants of the seminar. Refer to the latest relevant information systems of the BMW Group for any changes/additions to the Technical Data.

Information status: **February 2009**
VH-23 / International Technical Training

E89 Chassis and suspension.
Content.

E89 Chassis and suspension.
1 Models.

1.1 Development of BMW rear axles

BMW chassis and suspension systems and thus the sportive and dynamic character of the individual vehicle models have long been based on special axle designs and on integral optimum chassis and suspension tuning.
The following table shows the development history of BMW rear axles:

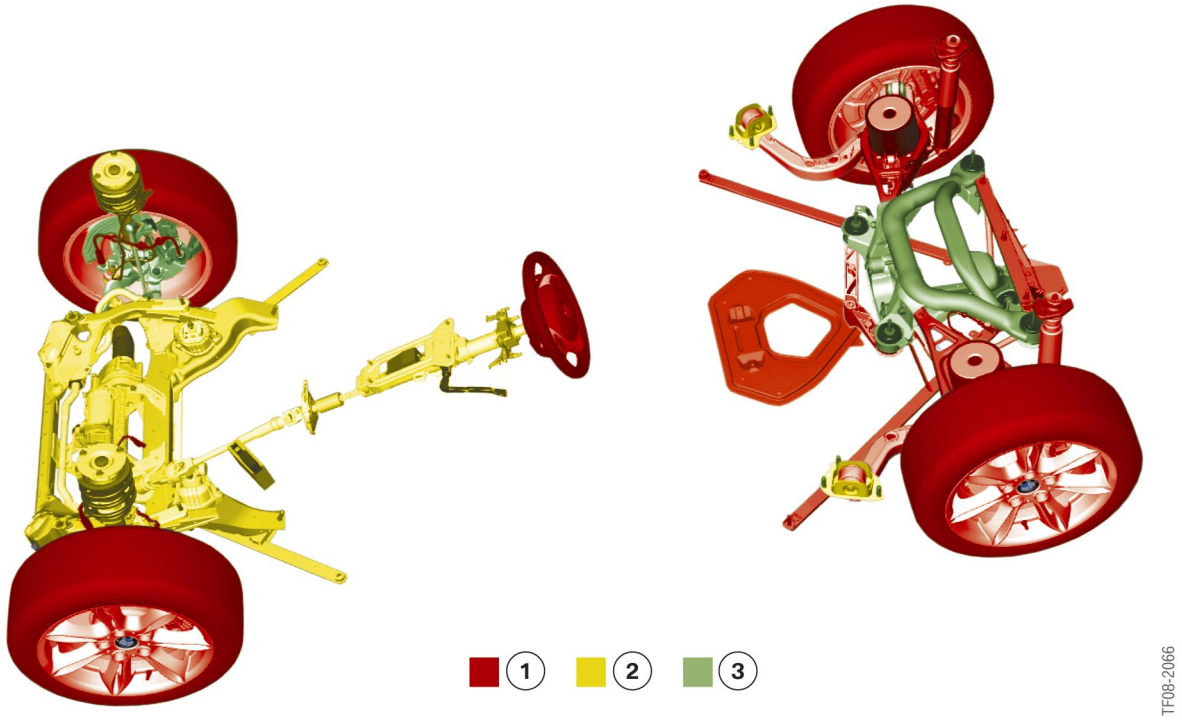
Designation	Differentiation	Model
HA 1	Semi-trailing arm rear axle	E3, E9, E12, E21, E28, E30, E36/5, E36/7
HA 2	Semi-trailing link rear axle	E23, E24, E32, E34
HA 3	Central link rear axle, cast aluminium semi-trailing arm and transverse control arm at top, steel transverse control arm at bottom	E30Z
HA 3	Central link rear axle, steel semi-trailing arm and transverse control arm	E83
HA 3	**Central link rear axle**, steel semi-trailing arm and transverse control arm at bottom, cast aluminium transverse control arm at top	E36/2, E36/3, E36/4, E36/C, E46, E85, E86, **E89**
HA 4	Experimental study	
HA 5	Five-link rear axle (distributed double wishbone axle)	E81, E82, E87, E88, E90, E91, E92, E93
Integral I	Experimental study	
Integral II	Experimental study	
Integral III	Steel axle carrier, semi-trailing arm, upper transverse control arm, lower transverse control arm, rear lower transverse control arm and wheel carrier, integral link joins semi-trailing arm and upper control arm	E31
Integral IV	Steel axle carrier, swinging arm, transverse control arm, control arm, integral link and wheel carrier, spring strut shock absorber	E38
Integral IV	Aluminium axle carrier, swinging arm, transverse control arm, control arm, integral link and wheel carrier, spring strut shock absorber	E39
Integral IV	Aluminium axle carrier, swinging arm, transverse control arm, control arm, integral link and wheel carrier, spring and shock absorber separate, spring supported on body and shock absorber on axle carrier	E39/2, E70, E71
Integral IV	Steel axle carrier and wheel carrier, aluminium swinging arm, transverse control arm, control arm and integral link, spring and shock absorber separate and supported on body	E53

E89 Chassis and suspension.
1 Models.

Designation	Differentiation	Model
Integral IV	Aluminium axle carrier (nodular casting), swinging arm, transverse control arm, control arm, integral link and wheel carrier, spring strut shock absorber	E60, E61, E63, E64, E65
Integral V	Aluminium axle carrier (nodular casting), swinging arm, transverse control arm, track rod, integral link and wheel carrier, spring strut shock absorber, new arrangement of swinging arm, transverse control arm and track rod (control arm) for rear axle slip angle control	F01, F02

E89 Chassis and suspension.
2 Introduction.

2.1 Chassis



E89 Chassis and suspension

Index	Description
1	New components (newly developed)
2	Modified components (developed with minimum expenditure)
3	Common parts E87 and E90

The graphic uses colours to show an overview of the common parts, modified components and new components in the E89 compared to the E85 and compared to the E9x and E8x models for the front axle. Some components have been fully adopted, others have been adapted and optimised to the changed conditions while other components are a complete new development. In the same way as the E8x and E9x models, the E89 is based on the well-known principle of the double--joint spring strut front axle. The well-proven principle of the central link rear axle from the E85 is retained for the rear axle.

2.2 Dynamic driving systems

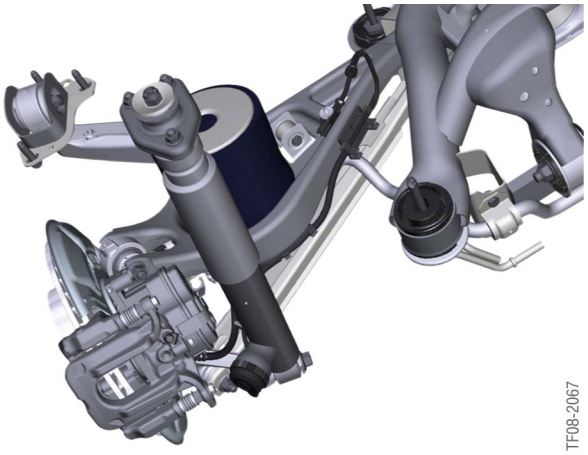
2.2.1 Differentiation

The dynamic driving systems are differentiated in three directions of action and are assigned to the individual dynamic systems corresponding to their main direction of action:

- Longitudinal dynamics systems
  - Dynamic stability control (DSC)
  - Electromechanical parking brake (EMF)
- Transverse dynamics systems
  - Electromechanical power steering (electronic power steering EPS)
- Vertical dynamics systems
  - Adaptive M chassis and suspension

2.2.2 Changes and new features

The parking brake on the E89 is designed as an electromechanical parking brake EMF. The EMF on the E89 differs from the known EMF systems in that it is integrated in the brake calliper. Competitors are already using this system in series production.



E89 Brake calliper with EMF actuator

E89 Chassis and suspension.
3 System components.

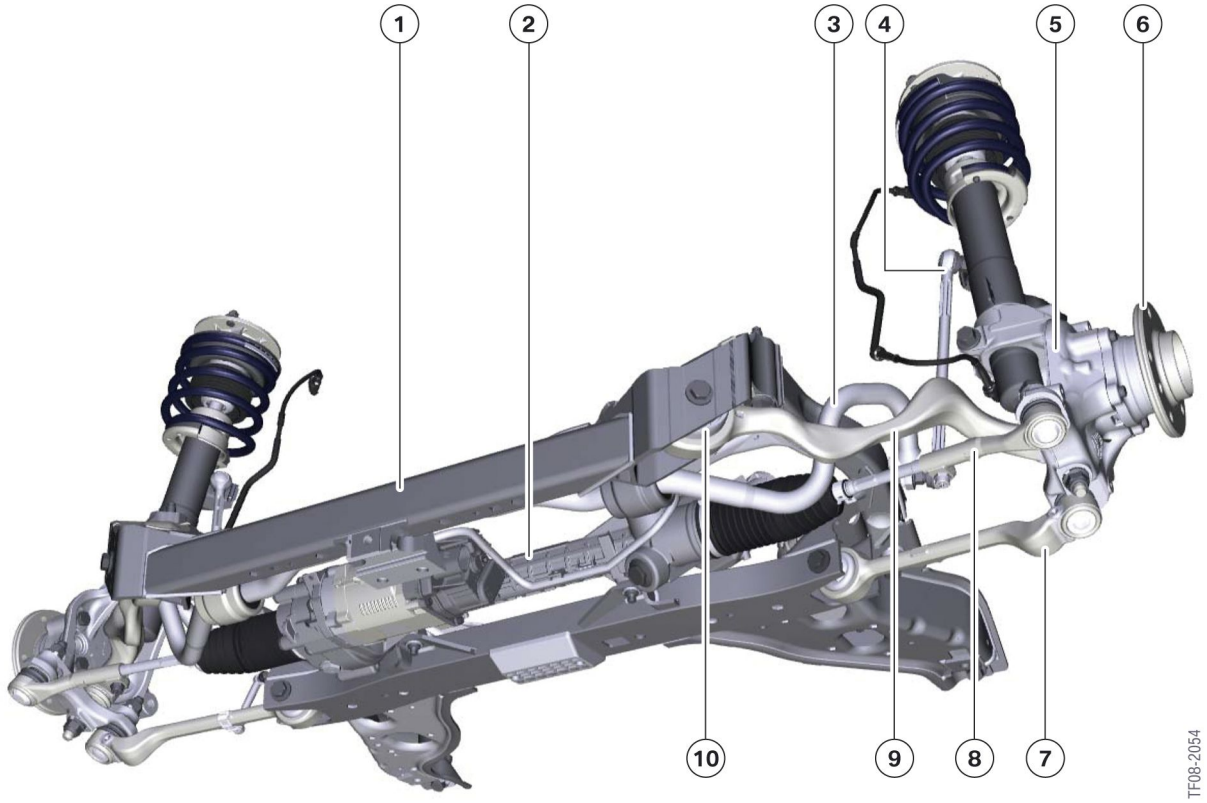
3.1 Chassis and suspension

The handling and agility of the E89 are o tstanding in this vehicle class. This is achieved by the rear wheel drive, an optimum steering response and outstanding traction in all load situations. It has been possible to optimally match the front axle kinematics and steering as no allowances had to be made for drive influences. An axle load distribution between 50:50 and 44:56 has been realised in all load situations.

3.1.1 Double-joint spring strut front axle

A modified version of the double-joint spring strut front axle known from the E8x and E9x series vehicles is used in the E89. Adaptations were necessary in view of the available package space and the modified suspension geometry.

E89 Chassis and suspension.
3 System components.



E89 Front axle

Index	Description
1	Front axle carrier
2	Electromechanical power steering
3	Stabilizer bar
4	Stabilizer link
5	Swivel bearing
6	Wheel hub
7	Control arm
8	Track rod
9	Tension strut
10	Hydraulic mount

The E85 was equipped with a single-joint spring strut front axle. To optimise the suspension properties, the E89 is equipped with a double-joint spring strut front axle. The reasons are explained in the following.

E89 Chassis and suspension.
3 System components.

Kingpin offset

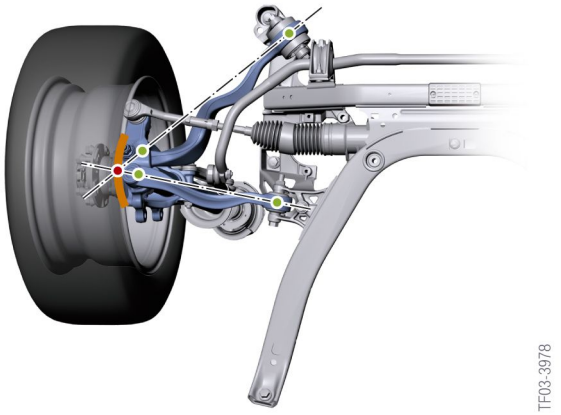
The kingpin offset (scrub radius) of the E89 is greater compared to that of the E85. The reason for this is that the front axle has been adopted from production line 2 (1 Series and 3 Series).

On the single-joint spring strut front axle of the E85 the position of the wheel control joint largely determines the size of the kingpin offset. Since the kingpin offset should be as small as possible, the wheel control joint must be located as far towards the outside as possible. This however results in problems concerning the package space for the brake disc and brake calliper. On the double-joint spring strut front axle the position of the control arm and tension strut with respect to each other determines the size of the kingpin offset.

The pivot points of the control arm or wishbone and tension strut at the swivel bearing can therefore be selected such that no space problems are encountered for the brake system.

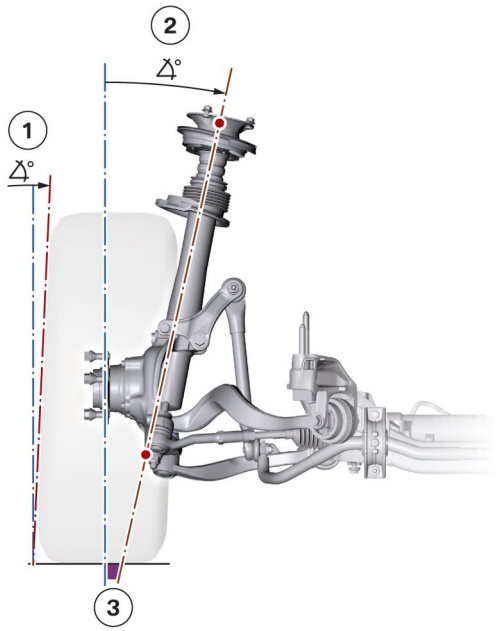
While these aspects still retain their validity, a larger kingpin offset than on the single-joint spring strut front axle is now used. The reason for this is that common parts from production line 2 are used as far as possible but the track width has increased compared to the 1 Series and 3 Series. Among other measures, this was achieved by changing the rim offset, thus, of course, also increasing the kingpin offset.

The effects of increased susceptibility to interference caused by a larger kingpin offset were eliminated by an optimised and modified elastokinematics system and tuned to such an extent that an improvement was achieved compared to the E85. As a result, the response of the E89 to steering movements is slightly more indirect at high speeds and very direct at speeds up to 100 km/h. The vehicle handling is very balanced up to the limit range and therefore has outstanding control properties.



Double-joint spring strut front axle, determining the lower pivot point

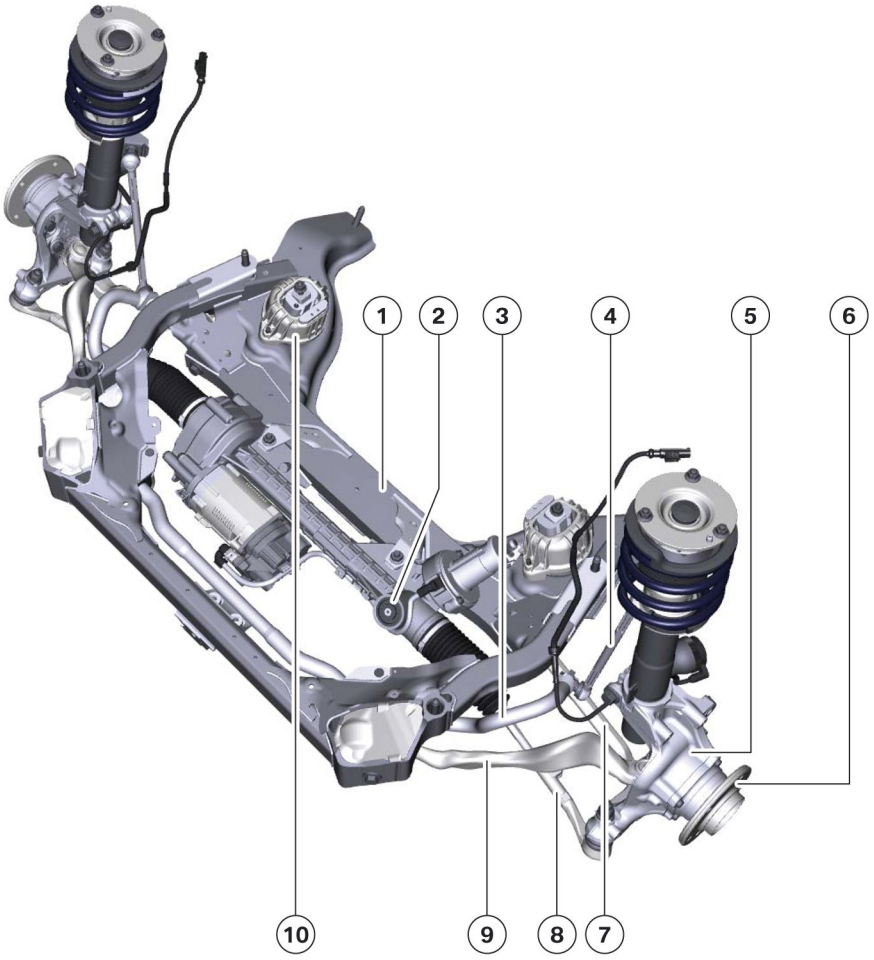
E89 Chassis and suspension.
3 System components.



Positive kingpin offset

Index	Description
1	Camber
2	Kingpin inclination
3	Kingpin offset

E89 Chassis and suspension.
3 System components.



E89 Front axle

Index	Description
1	Front axle carrier
2	Electromechanical power steering
3	Stabilizer bar
4	Stabilizer link
5	Swivel bearing
6	Wheel hub
7	Control arm
8	Track rod
9	Tension strut
10	Engine mount

E89 Chassis and suspension.
3 System components.

Both tension struts are mounted with hydraulic mounts on the front axle carrier. In addition, the distance of the tension strut and control arm pivot points at the swivel bearing largely determines the vertical force lever arm. The further the joints of the tension strut and control arm are from each other at the swivel bearing, the greater the recovery force initiated by the vehicle weight.

On the single-joint spring strut front axle, the distance is zero as the two joints of this axle have merged to form one. The resulting advantage of the double-joint spring strut front axle is improved directional stability in the high speed range and a lower tendency to steering instability in the lower speed range (less susceptible to torsional vibration in the steering wheel).

Compared to that of the control arm, the ball joint (guide joint) of the tension strut is raised at the swivel bearing, thus providing effective anti-dive control. A further advantage of this arrangement is that this tension strut mount on the axle carrier can be arranged at approximately the same level with respect to the mounting at the swivel bearing and does not have to be lowered. This is of particular benefit to a large overhang angle. In addition, it is possible to lower the control arm mount on the axle carrier side, thus enabling a lower roll centre.

The single-joint axle features only one type of cross brace as the axle carrier. The double-joint spring strut front axle on the other hand features a frame which additionally provides significant stiffening of the front end.

Technical data

Description	**E85**	**E89**
Total toe-in	14.4’	14.0’
Track width	1473.3 mm	1511.1 mm
Camber	-34.8’	-23.3’
Kingpin inclination	15.7	14.3
Castor angle	5.9	7.2
Castor offset	17.7 mm	20.7 mm
Kingpin offset	4.7 mm	9.6 mm
Steering angle, inner	43.1	37.7
Steering angle, outer	35.3	31.2
Rim offset ET/IS	47 mm	29 mm
Tyre size	225/50 R16 225/45 R17 225/40 R18	225/45 R17 225/40 R18 225/35 R19

E89 Chassis and suspension.
3 System components.

Steering

The E89 features electromechanical power steering with parallel arrangement of the electric motor (Electric Power Steering EPS) which was used for the first time at BMW on the E92. A speed-dependent torque-based power steering system (Servotronic) is optionally available. The option SA216 Servotronic provides greater steering power assistance while parking than when driving at high speeds. The electromechanical power steering system contributes to reducing CO_2 emissions. The E89 will only come with electromechanical power steering, active steering (hydraulic steering) is not planned. For further information on the electromechanical power steering system please refer to the Product Information Electromechanical Power Steering with Parallel Motor Arrangement EPS-APA.

3.1.2 Central-link rear axle

General information

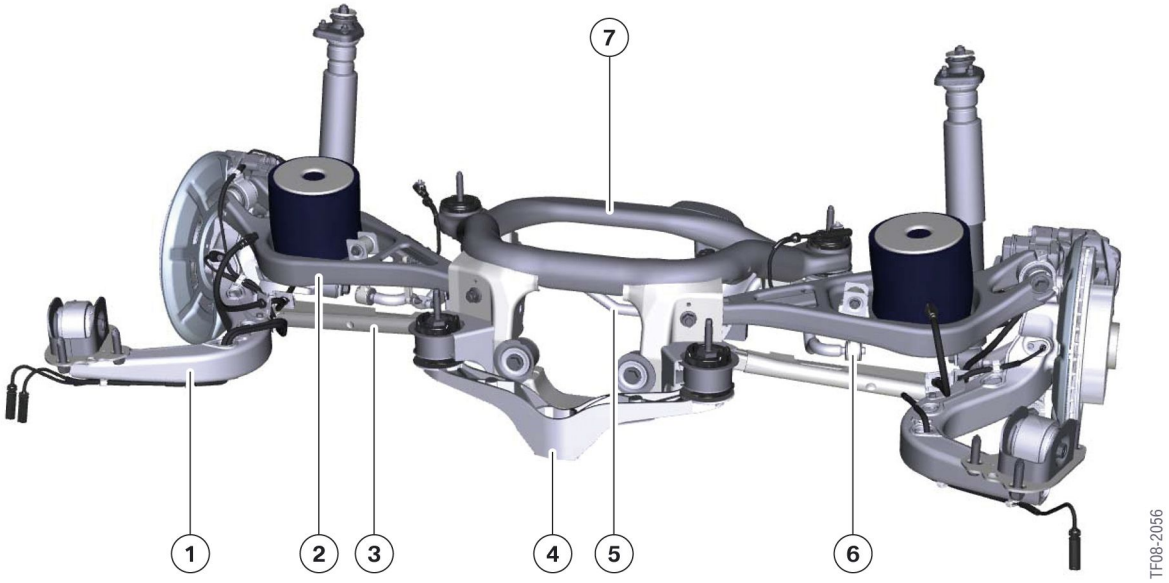
An adapted version of the rear axle known from the E85 with the development designation HA 3 is fitted in the E89.

The central link rear axle is an intricately constructed, weight and space saving, multilink rear axle. The wheels are controlled by two control arms and one semi-trailing arm that is mounted at the central point on the body. The precise interaction between the semi-trailing arm and control arm ensures that the wheels remain in the best possible position with respect to the road surface, thus providing outstanding directional stability. The flexible link bearings ensure exceptional driving stability while cornering, providing the vehicle with excellent rolling and acoustic comfort.

The designation HA 3 does not refer to the three links but rather is a continuation of the development designation at BMW. The central link rear axle optimises the following properties:

- Directional stability
- Alternating load response
- Self-steering response
- Lane change stability
- Transition response from cornering to straight ahead
- Rolling comfort.

E89 Chassis and suspension.
3 System components.



E89 Central link rear axle

Index	Description
1	Semi-trailing arm
2	Transverse control arm, top
3	Transverse control arm, bottom
4	Thrust strut
5	Stabilizer bar
6	Stabilizer link
7	Rear axle carrier

Technical data

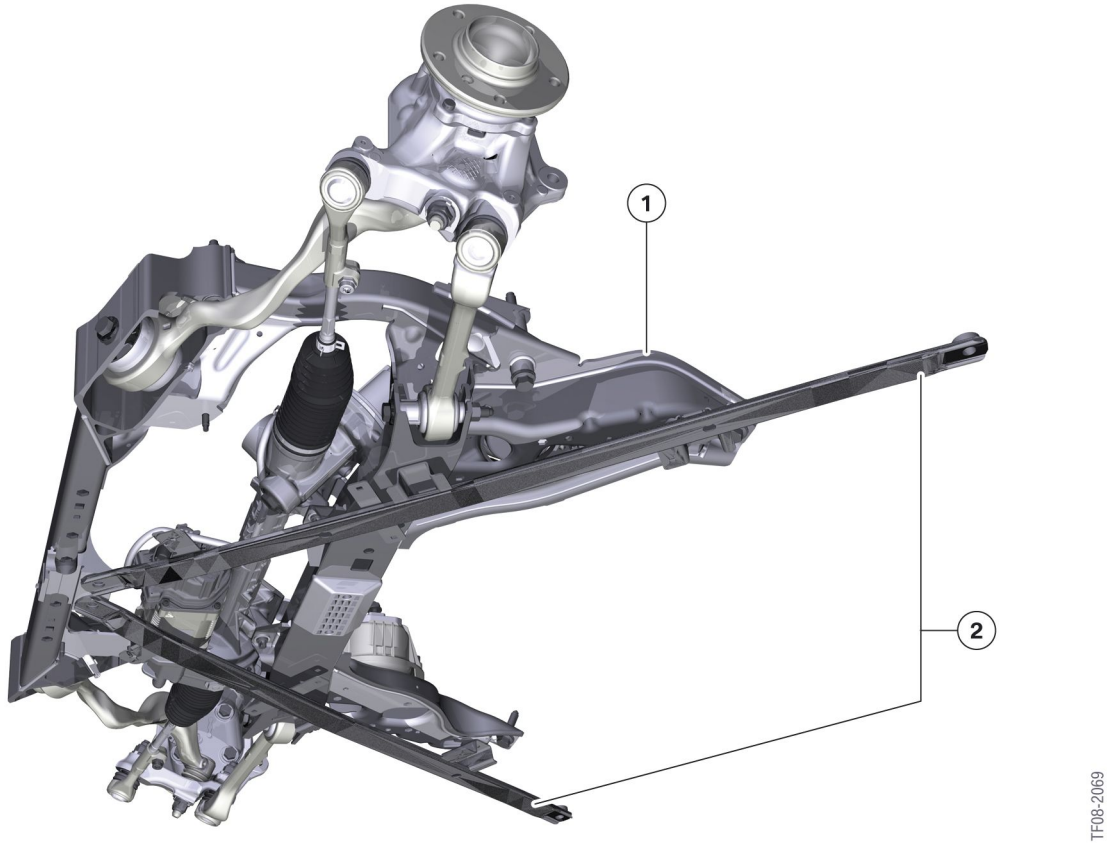
Description	E85	E89
Total toe-in (angle)	22’	18’
Track width	1521 mm	1562 mm
Camber	-2 15’	-2 20’
Wheelbase	2495 mm	2496 mm
Rim offset ET/IS	47 mm (50 mm*)	29 mm (40 mm*)
Tyre size	225/50 R16 225/45 R17 255/40 R17* 255/35 R18*	225/45 R17 255/40 R17* 255/35 R18* 255/30 R19*
*Mixed tyres		

E89 Chassis and suspension.
3 System components.

3.1.3 Struts in the chassis and suspension

Struts are fitted on the front axle and rear axle as well as a thrust panel additionally on the rear axle to increase the body rigidity and to optimise the transfer of forces into the body. These components distribute the force input into the body over the largest possible area.

Front axle

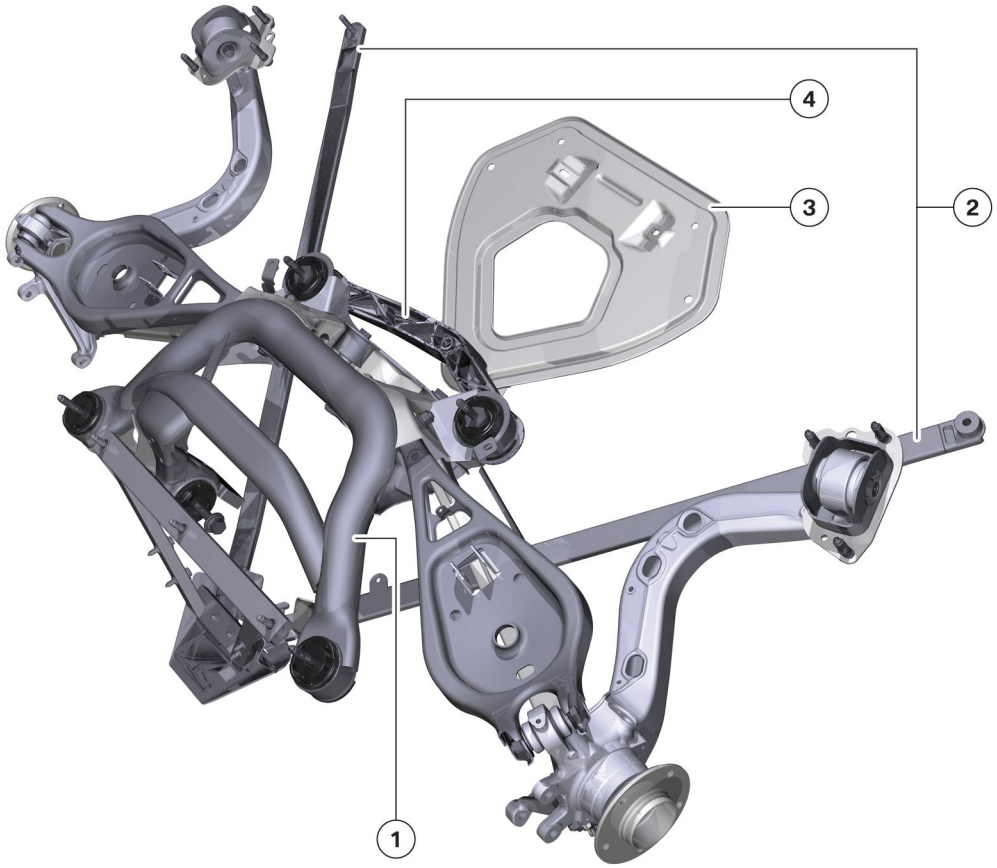


E89 Front axle carrier with struts

Index	Description
1	Front axle carrier
2	Struts

E89 Chassis and suspension.
3 System components.

Rear axle



E89 Rear axle carrier with tension struts and thrust panel

Index	Description
1	Rear axle carrier
2	Tension struts
3	Thrust panel
4	Thrust strut

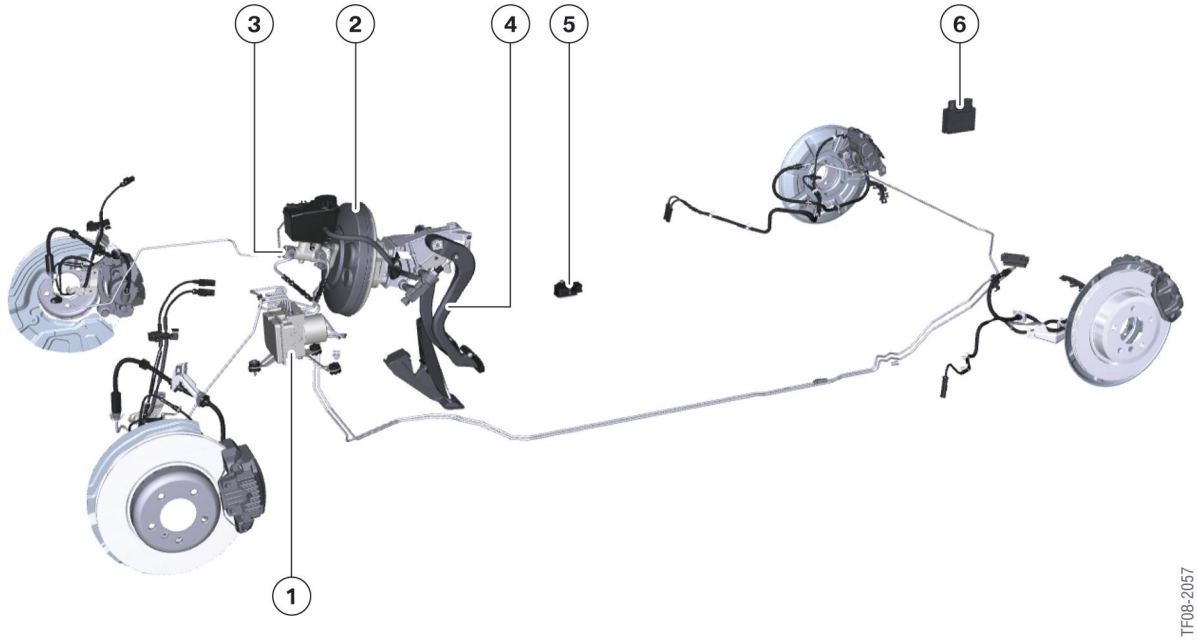
E89 Chassis and suspension.
3 System components.

3.2 Brakes

3.2.1 Service brake

Overview

The function and weight of the service brake have been optimised. Aluminium floating calliper brakes or aluminium frame calliper brakes (top models, sDrive30i, sDrive35i) are fitted on the front axle. Lightweight brake discs are used on the front axle of both top models. Outstanding stability was achieved by the corresponding dimensioning. The brake pad control principle as well as the brake callipers and brake discs secure the long-term properties in terms of surface protection, corrosion protection and unsusceptibility to soiling.



E89 Service brake

Index	Description
1	DSC unit
2	Brake booster
3	Master brake cylinder
4	Brake pedal
5	DSC sensor
6	EMF control unit

Technical data

Model	Type	Front brake disc in mm x thickness in mm	Rear brake disc in mm x thickness in mm
E85	Z4 2.0i Z4 2.5i Z4 2.5si Z4 3.0si	286 x 22* 286 x 22* 300 x 22* 325 x 25*	280 x 10 280 x 10 294 x 19 294 x 19*
E89	Z4 sDrive23i Z4 sDrive30i Z4 sDrive35i	300 x 24* 330 x 24* 348 x 30*	300 x 20* 300 x 20* 324 x 20*
* Internally ventilated brake disc			

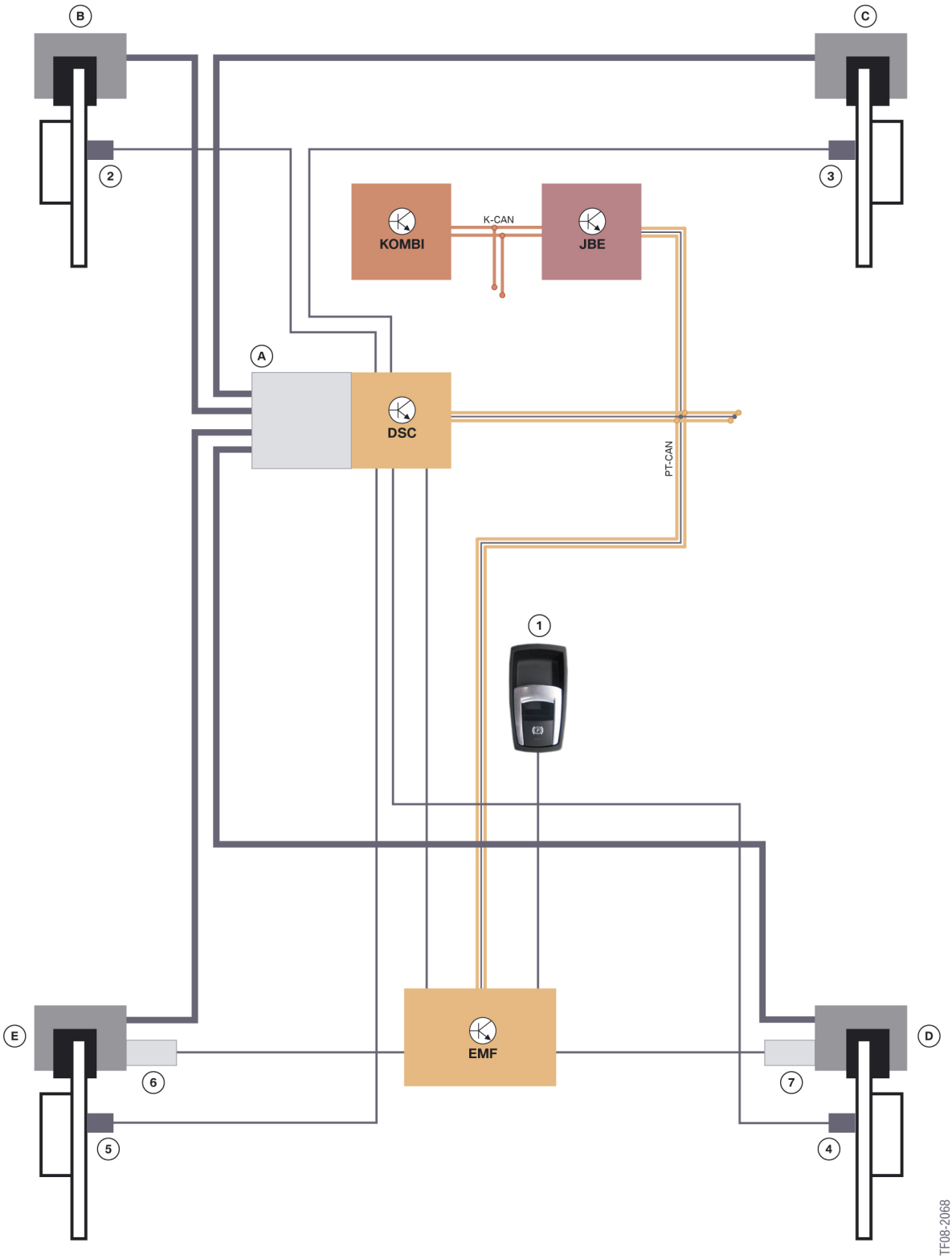
3.2.2 Parking brake

General information

For the first time at BMW, the E89 is equipped with an electromechanical parking brake integrated in the brake calliper. The use of the electromechanical parking brake offers the following advantages:

- Operation by means of a button ergonomically positioned in the centre console
- Reliable application and release of the electromechanical parking brake (EMF) under all conditions
- Dynamic emergency braking function also at low friction ensured by the control systems (ABS)
- No parking brake lever means additional storage space in the area of the centre console.

E89 Chassis and suspension.
3 System components.



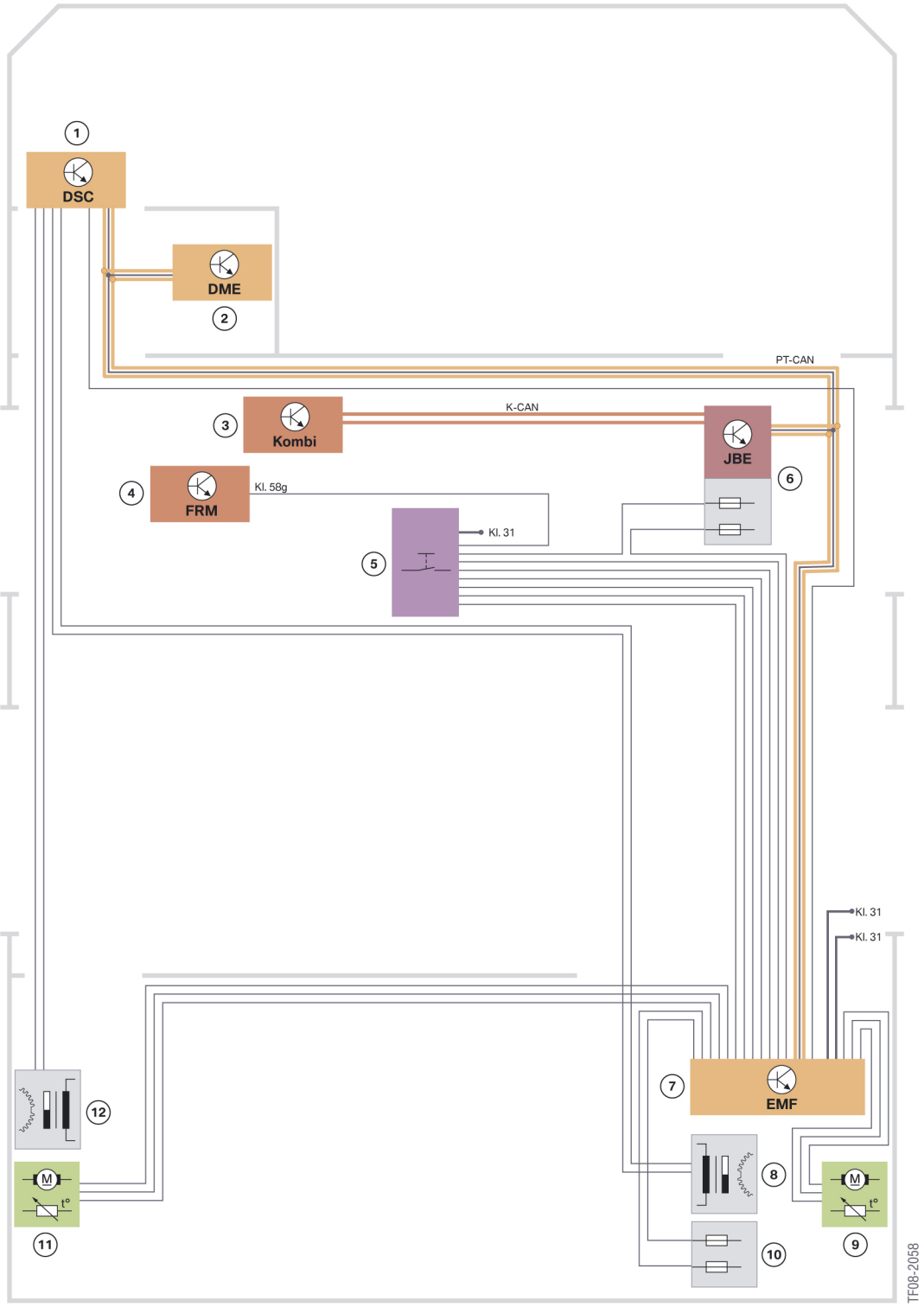
E89 Chassis and suspension.
3 System components.

E89 System overview - electromechanical parking brake

Index	Description
A	DSC unit
B	Brake calliper, front left
C	Brake calliper, front right
D	Brake calliper, rear right
E	Brake calliper, rear left
1	EMF button
2	Wheel speed sensor, front left (not used for EMF)
3	Wheel speed sensor, front right (not used for EMF)
4	Wheel speed sensor, rear right
5	Wheel speed sensor, rear left
6	EMF actuator, rear left
7	EMF actuator, rear right
EMF	Electromechanical parking brake
DSC	Dynamic stability control
JBE	Junction box electronics
KOMBI	Instrument cluster
PT-CAN	Powertrain-Controller Area Network

System circuit diagram

E89 Chassis and suspension.
3 System components.



E89 System circuit diagram - EMF

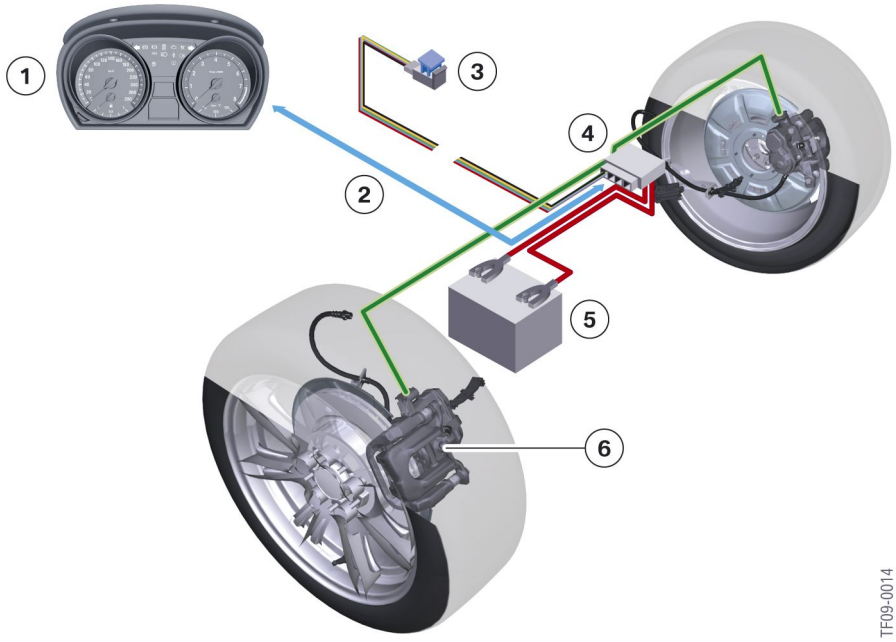
E89 Chassis and suspension.
3 System components.

Index	Description
1	DSC (Dynamic stability control)
2	DME (Digital motor electronics)
3	KOMBI (Instrument cluster)
4	FRM (Footwell module)
5	EMF button
6	JBE (Junction box electronics)
7	EMF (Electromechanical parking brake)
8	Wheel speed sensor, rear right
9	EMF actuator, rear right
10	Fuses
11	EMF actuator, rear left
12	Wheel speed sensor, rear left

Functional principle

The EMF control unit receives the driver's choice to apply the parking brake from the EMF button on the centre console. The vehicle status is determined via the link to the electrical system and the bus systems and the control unit decides whether all conditions for applying the brake are met. If this is the case, the two EMF actuators on the rear brake callipers are actuated.

E89 Chassis and suspension.
3 System components.



E89 EMF Functional principle

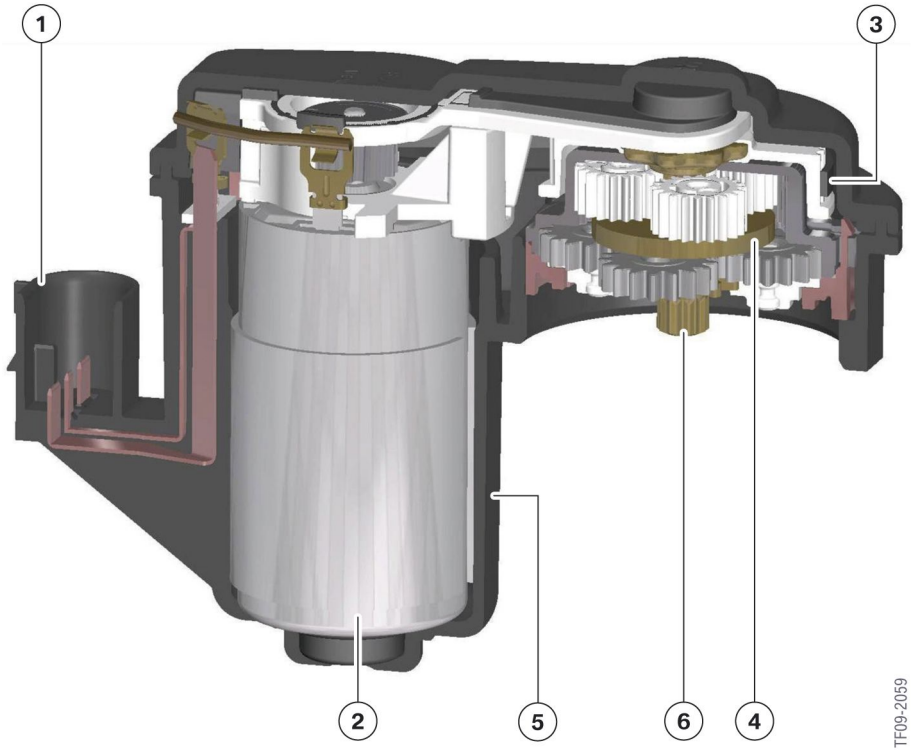
Index	Description
1	Instrument cluster
2	Information flow
3	EMF button
4	EMF control unit
5	Battery
6	EMF actuator

Due to the self-locking characteristics of the spindle, the tension is retained even when no power is applied, thus firmly holding the vehicle. On reaching the required force, the applied brake status is indicated by a red indicator lamp in the instrument cluster and an additional red LED in the EMF button.

Function of the EMF actuator

The EMF actuator is mounted on the brake calliper and acts directly on the brake piston.

E89 Chassis and suspension.
3 System components.

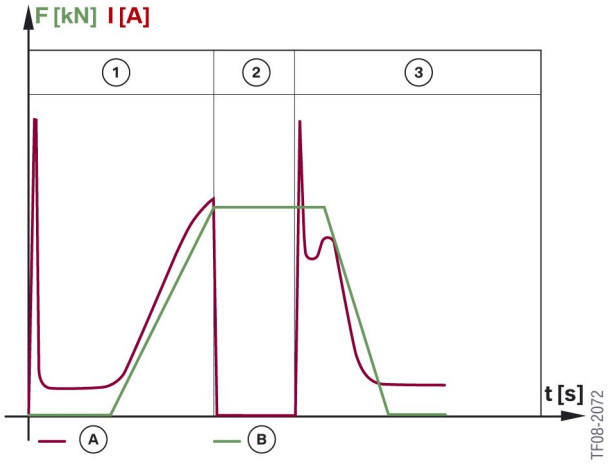


Design of EMF actuator

Index	Description
1	Plug connection
2	Electric motor
3	Drive belt
4	Planetary gear
5	Housing
6	Connection to spindle

The force is transmitted via electric motor (2) and drive belt (3) to a two-stage planetary gear train (4). Spindle (4) shown in the following graphic is driven by spindle connection (6). Spindle (4) in the spindle nut with anti-twist lock (2) in brake piston (3) provides the self-locking effect. The force is transmitted via the spindle and spindle nut with anti-twist lock to brake piston (3). As in hydraulically operated systems, the brake piston acts on the brake pads that are forced against the brake disc. Due to the self-locking effect of the spindle in the spindle nut with anti-twist lock, the tension is retained and the vehicle is held firmly even when no power is applied.

E89 Chassis and suspension.
3 System components.

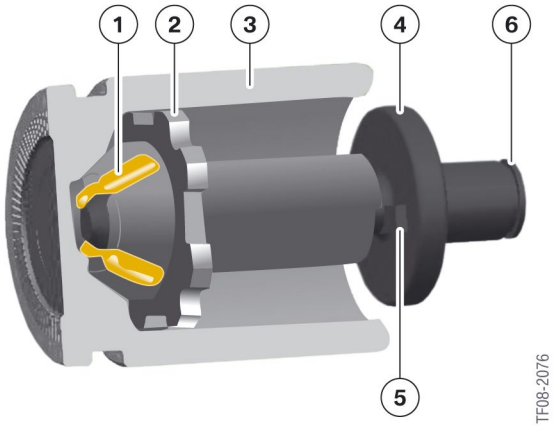


E89 EMF voltage and force curve

Index	Description
A	Force curve
B	Voltage curve
1	Applying EMF
2	EMF applied
3	Releasing EMF

Brake piston
The brake fluid can flow via grooves (1) past the spindle nut to ensure the brake system is completely bled. The screw-in travel is limited by spindle stop (5). This therefore prevents tightening and blocking when in open state.

E89 Chassis and suspension.
3 System components.

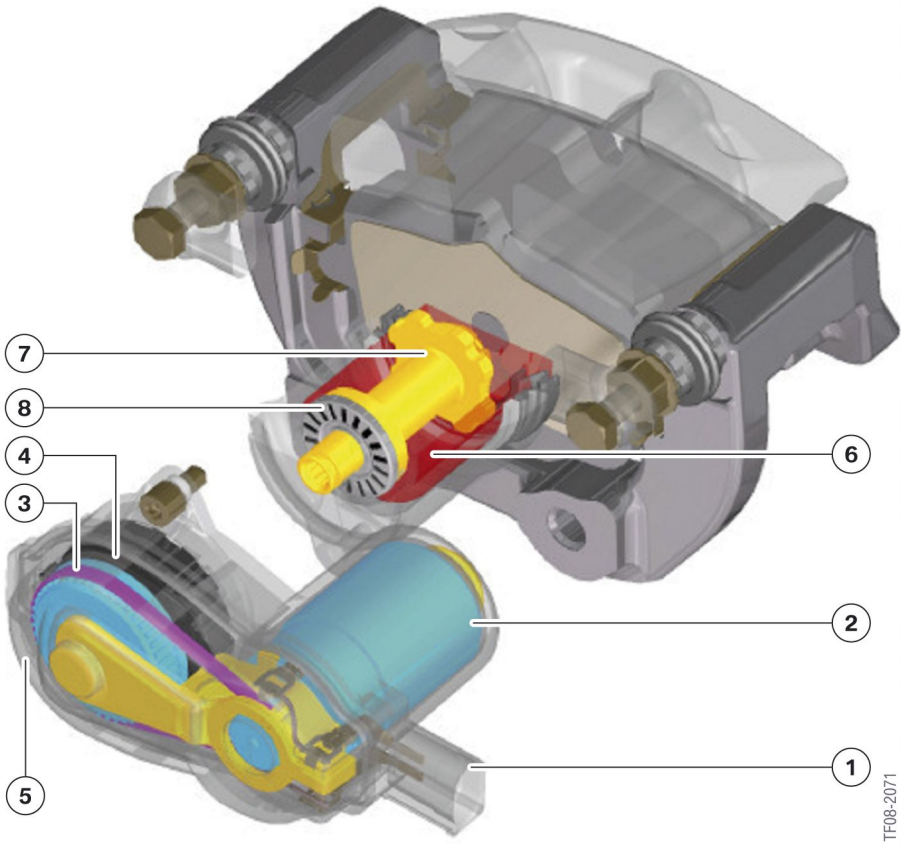


E89 Spindle and spindle nut in brake piston

Index	Description
1	Groove
2	Spindle nut with anti-twist lock
3	Brake piston
4	Spindle
5	Spindle stop
6	Connection to planetary gear

Brake calliper

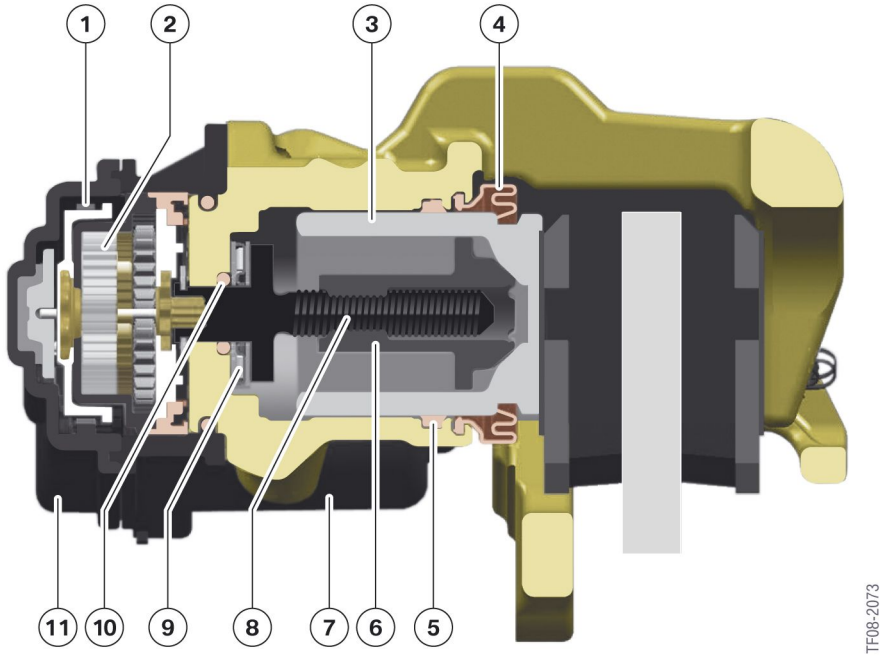
E89 Chassis and suspension.
3 System components.



Overview of EMF actuator with brake calliper

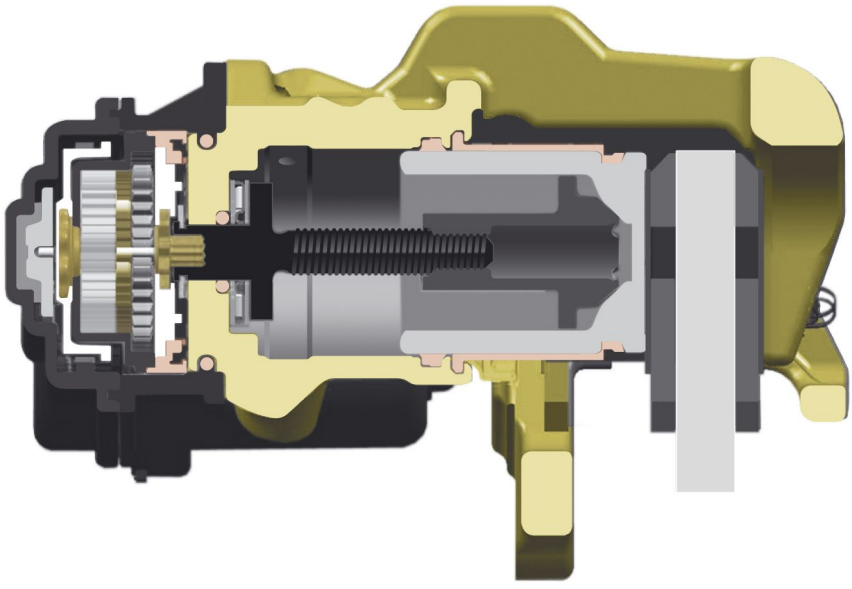
Index	Description
1	Plug connection
2	Electric motor
3	Drive belt
4	Planetary gear
5	Housing
6	Brake piston
7	Spindle with spindle nut
8	Roller bearing

E89 Chassis and suspension.
3 System components.

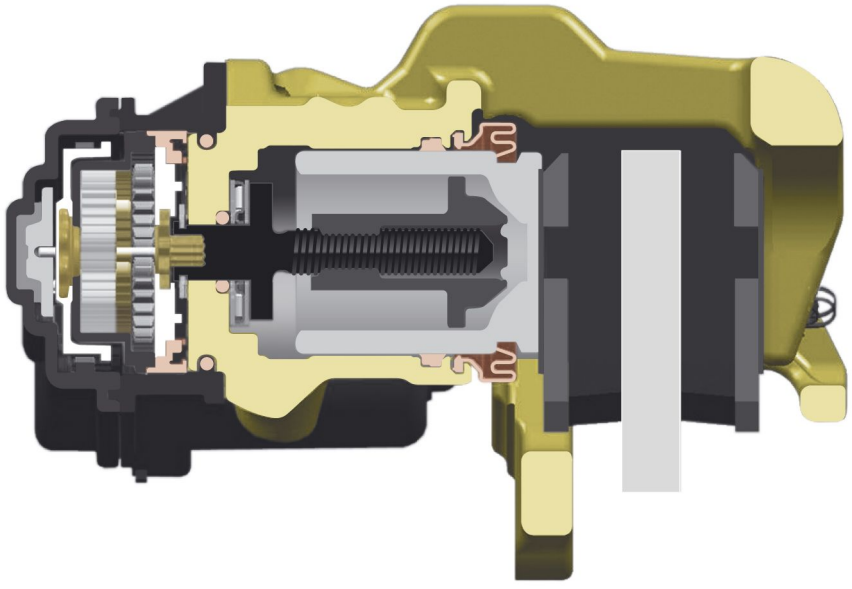


E89 Parking brake applied with new brake pads

Index	Description
1	Drive belt
2	Planetary gear
3	Brake piston
4	Dust sleeve
5	Seal
6	Spindle nut
7	Electric motor
8	Spindle
9	Roller bearing
10	Seal
11	Housing



E89 Parking brake applied with worn brake pads



E89 Parking brake released with new brake pads

Applying the parking brake

The driver can apply the parking brake by pulling the EMF button. The operating direction is the same as that of the mechanical handbrake lever.

The signal from the EMF button is read by the EMF control unit. The EMF control unit individually activates the EMF actuators at the wheel brake.

The parking brake can be applied in any logical terminal status. Applying the parking brake at terminal 0 is made possible by connecting terminal 30 to the EMF control unit. The EMF control unit is woken up when the driver operates the EMF button at terminal 0. In turn, the EMF control unit wakes the other control units in the vehicle. Only then does the EMF control unit receive the important information on the stationary status of the vehicle. In addition, the change status of the parking brake can be indicated after waking the control unit.

The parking brake applied status is indicated by a red LED in the EMF button and by the EMF indicator lamp in the instrument cluster. If the parking brake is already applied, pulling the EMF button again will have no effect.

E89 Indicator lamp, parking brake applied

Rolling monitor with parking brake applied

This monitoring function is designed to prevent the vehicle from rolling with the parking brake applied. The rolling monitor is always activated when the status of the parking brake changes from released to applied and ends after a defined period of time after this status change.

The function ends:

- when a fault occurs that prevents mechanical retensioning
- when the vehicle assumes sleep mode, the control unit is switched off or reset.

The DSC uses a signal as the input variable for rolling detection. The tension at the EMF actuators is immediately increased as soon as this signal indicates that the vehicle is starting to roll during rolling monitoring. During the retensioning phase, the tensioning force is increased until the vehicle no longer rolls or a maximum tensioning force is reached.

Temperature monitoring

The task of the temperature monitoring function is to compensate for the loss of force that occurs when the hot brake disc cools down. Temperature monitoring is activated when the temperature exceeds a defined value as the status of the parking brake changes from released to applied.

The DSC control unit calculates the brake disc temperature at the individual wheels and sends the corresponding value to the EMF control unit. During the status change, the higher temperature of the two brake discs is taken for the temperature monitoring function. A characteristic map contains the corresponding temperature ranges with the associated retensioning times.

The corresponding retensioning times in the characteristic map are activated depending on the temperature during the status change. The tension is increased once when the first retensioning time is reached. The tension is then increased again after the second retensioning time has elapsed and increased yet again after the third. The characteristic map may also contain the value 0 for one or several retensioning times. In these cases, the corresponding increase in tension does not take place. The function ends under following conditions:

- Occurrence of a fault that prevents retensioning
- The control unit is switched off or reset
- The last retensioning step has already been executed.

Releasing the parking brake

The EMF button is pushed down to release the parking brake. For the parking brake to actually release terminal 15 must additionally be on and at least one of the following conditions must apply:

- Brake pedal pressed or
- Parking lock of automatic gearbox engaged or clutch pedal pressed (only vehicle with manual gearbox).

This prevents the vehicle from inadvertently rolling if, for example, the EMF button is pressed by another occupant instead of the driver. The LED in the EMF button and the EMF indicator in the instrument cluster go out when the parking brake is released.

Activation of the EMF actuator causes the spindle to rotate. The rotation of the spindle causes the spindle nut to move a short defined distance from the brake piston.

Dynamic emergency braking

Two operating units for the brake are required by law. Besides the brake pedal, the second operating unit in the E89 is the EMF button in the centre console. Pulling the EMF button while driving triggers dynamic emergency braking with a defined sequence via the DSC system. This function is intended for emergencies when the driver can no longer slow down the vehicle using the brake pedal. Other occupants can also stop the vehicle in this way should, for example, the driver suddenly become unconscious.

During dynamic emergency braking, hydraulic braking pressure is built up at all four wheel brakes. The DSC functions are fully active and the brake lights come on. This is an important advantage compared to a manual parking brake.

Dynamic emergency braking takes place only for as long as the driver is pulling the EMF button. The deceleration initiated by the DSC is increased in ramps. The EMF indicator lamp in the instrument cluster is activated during dynamic emergency braking. In addition, a check control message is given together with an acoustic signal in order to warn the driver of this adverse situation.

The DSC control unit prioritises if the driver attempts to slow down the vehicle by simultaneously pressing the brake pedal and pulling the EMF button. The higher deceleration request is implemented. If dynamic emergency braking is continued until the vehicle comes to a stop, the parking brake will remain applied even after the EMF button is released. The EMF indicator lamp in the instrument cluster remains active. The driver can then release the parking brake (see Releasing the Parking Brake).

Parking brake fault

The EMF indicator lamp in the instrument cluster lights yellow to indicate a fault in the parking brake. A check control message is also output.

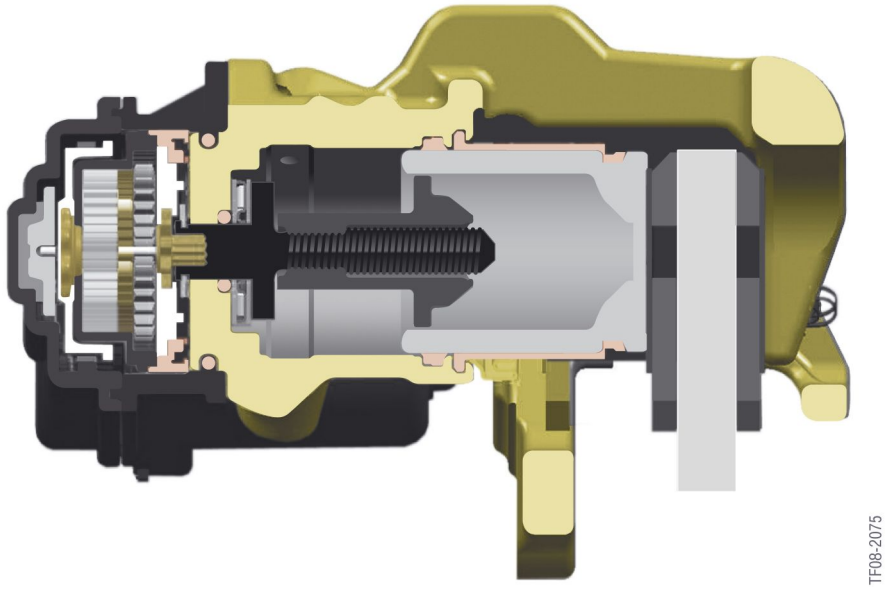
E89 Indicator lamp, parking brake fault

Emergency release

No parking brake emergency release function is provided for the customer. The parking brake can be released using the BMW diagnosis system or the EMF actuators are removed and the spindle is turned back manually.

Changing brake pads

To change the brake pads, the EMF actuator must be in the fully opened position so that the brake piston can be pushed back. The BMW diagnosis system can be used to actuate the EMF actuators and assume the fully opened position. This position is necessary to change the brake pads. Installation mode is set automatically on reaching the installation position.



E89 Parking brake with spindle nut in installation position for changing brake pads

⚠

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.

Installation mode can be cancelled in two ways:

- By carrying out the service function Reset Installation Mode with the aid of ISTA
- By driving the vehicle and exceeding a programmed minimum speed.

After being changed, the brake pads must be bedded-in. This is necessary to ensure the brake pad and brake disc pairing assumes the specified friction parameters. Only then will the required braking force be reached.

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

Brake test rig recognition

The EMF control unit recognises the brake test rig based on a plausibility check (wheel speed comparison) and assumes brake test rig mode. The following target positions are assumed in succession by pulling the EMF button several times:

- Brake pads applied
- Force 1 for brake test rig
- Force 2 for brake test rig
- Target force.

The EMF indicator lamp flashes slowly when brake test rig mode is activated and the EMF actuators are released.

The EMF indicator lamp begins to flash fast when brake test rig mode is activated and EMF actuators are partially applied.

The EMF indicator lamp lights permanently when brake test rig mode is activated and EMF actuators are fully applied.

The parking brake can be released on the brake test rig without pressing the brake pedal or clutch pedal. Brake test rig mode is automatically cancelled on exiting the brake test rig. The mode is also deactivated by pressing the EMF button or if a fault occurs.

E89 Chassis and suspension.
3 System components.

Check control messages

Description	Check control message	Central information display	General brake indicator lamp	Parking brake indicator lamp	Check control symbol
For safety reasons, the parking brake can only be released with the service brake pedal depressed	Additionally press foot brake **Manual gearbox:** Additionally press foot brake or clutch	-	-	-	
The driver must immediately be made aware of a fault in the EMF button	-	-	-		-
Parking brake applied mechanically	-	-	-		-
Redundant EMF button fault, workshop visit required as soon as possible	Parking brake fault!	Parking brake fault. Have checked by BMW Service dealer	-		
Mechanical application of parking brake no longer possible, dynamic emergency braking (emergency brake function) still available	Parking brake fault!	Parking brake fault. Not operative when vehicle stationary. Emergency braking function still possible. Have checked by nearest BMW Service dealer.	-		

Description	Check control message	Central information display	General brake indicator lamp	Parking brake indicator lamp	Check control symbol
Dynamic emergency braking (emergency brake function) no longer possible, mechanical brake application still possible	Parking brake fault!	Parking brake fault. No emergency braking function. Parking brake can be applied with vehicle stationary. Have checked by your BMW Service dealer.	-		
Parking brake completely failed, mechanical parking brake cannot be applied, no emergency braking function	Parking brake failed!	Parking brake failed. Secure vehicle to prevent it rolling away. Have checked by nearest BMW Service dealer.			
Warning when driving off - parking brake or dynamic emergency braking applied	Release parking brake	-	-		
Installation mode (only with EMF button operated)	-	-	-		-

3.3 Suspension and damping

3.3.1 Basic suspension setup

General information

The spring struts on the front axle are made of steel and are connected in a clamp arrangement to the aluminium wheel carrier. Two-tube gas-pressurised dampers are used. The piston rods on the front axle are hollow. The piston in the shock absorbers are coated with PTFE (colloquially also known as Teflon).

The shock absorbers have a degressive damper characteristic. As already known from other vehicles, the spring strut mount on the front axle is positioned by means of a precisely punched centring hole on the spring strut dome. In this way, all tolerances relevant to wheel camber are eliminated in the production process.

The coil springs on the front and rear axle are optimised in terms of their tension and weight. To ensure a constant ride height is achieved depending on the engine and vehicle equipment, as on all BMW vehicles, different springs are used that are adapted to the specific vehicle weight.

Stabiliser bars are used on the front and rear axles. For weight reasons, the stabiliser bar on the front axle is of a tubular design.

3.3.2 Adaptive M chassis and suspension

General information

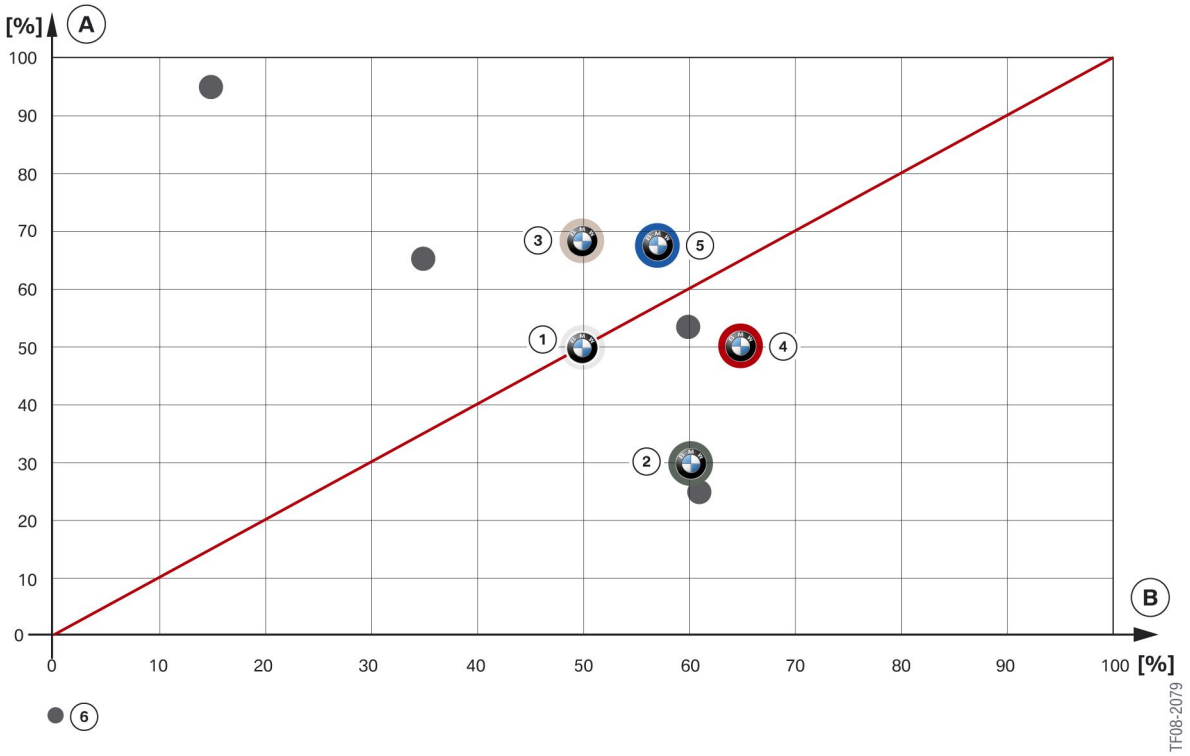
The adaptive M suspension setup is lower set by 10 mm. Four continuously adjustable shock absorbers in the optional Adaptive M chassis and suspension achieve variable damping forces to suit the driving situation by means of coupled tension/compression stage adjustment (continuous electronic damper control EDC-K). The shock absorbers are automatically set harder (more dynamic/sporty) or softer (more comfortable) corresponding to the driving situation.

In contrast to the E70/E71 and F01/F02 a bus system is not used in the E89 for data transfer. The VDM control unit is generally responsible for controlling the vertical movements. On the E89, the EDC-K function is integrated in the VDM control unit. the E89 does not feature any other vertical dynamics systems.

The EDC-K system on the E70/E71 and F01/F02 is known as vertical dynamics control. The designation was changed because the actuator units for the dampers are controlled by satellites on the shock absorbers and data transmission from the VDM control unit to the satellites takes place via FlexRay.

Also on the E89, the damper control can be influenced by means of the dynamic driving control switch on the centre console. Two characteristic curves are used, which, in addition to a comfortable characteristic (normal) additionally enable another distinctly sports-orientated characteristic (sport).

E89 Chassis and suspension.
3 System components.



Spring/shock absorber setup compared to competitors

Index	Description
A	Comfort
B	Sports
1	E85 Series
2	E85 Sports suspension
3	E89 Series
4	E89 Adaptive M suspension in Sports setup
5	E89 Adaptive M suspension in Comfort setup
6	Competitors

E89 Chassis and suspension.
3 System components.

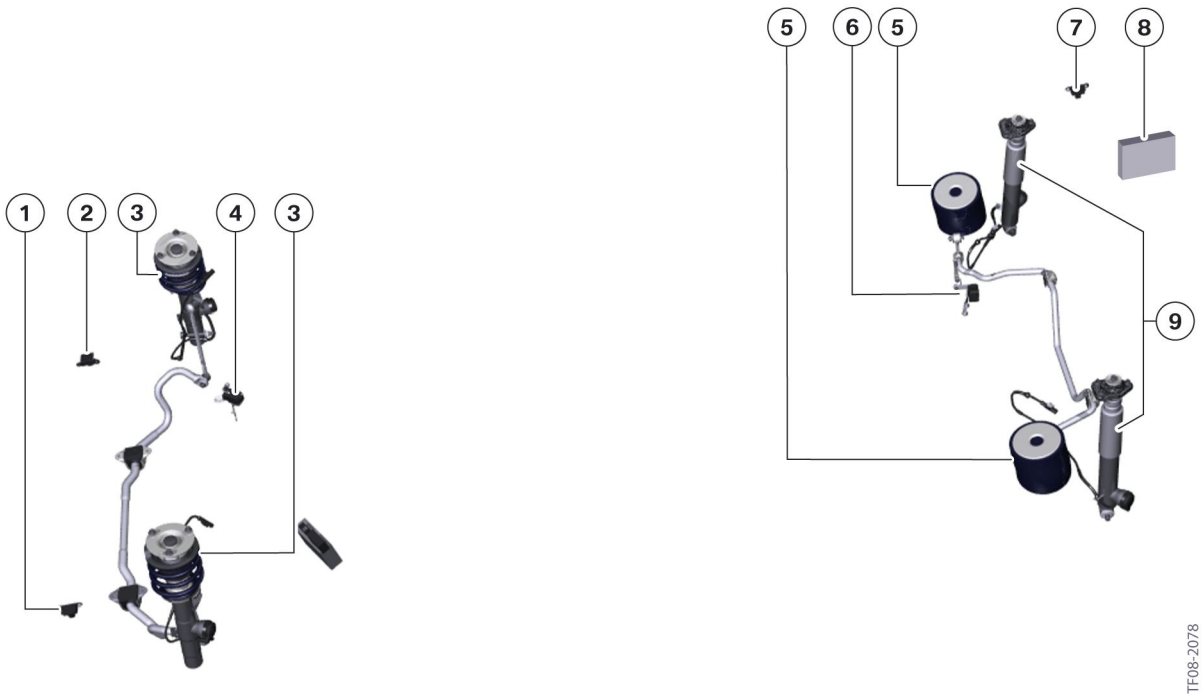
History

	EDC M3	EDC I	EDC II	EDC III	EDC-K	VDC I	VDC II	EDC
Model	E30	E32, E34	E24	E31, E32, E34 M5, E38, E39	E65, E66	E70, E71	F01, F02	E89
Introduction	1987	1987	1989	1990	2001	2006	2008	2009
Operation	Rotary switch	Rocker switch	Push-button	Rocker switch	Controller	Dynamic driving switch	Dynamic driving switch	Dynamic driving switch
Damper levels	Comfort, Normal, Sport	Comfort, Sport	Comfort, Sport	Comfort, Sport	Continuous	Continuous	Continuous	Continuous
Selection via control	Comfort, Normal, Sport	Comfort, Sport	Comfort, Sport	Comfort, Sport	Comfort, Sport	COMFORT, Sport	COMFORT, NORMAL, SPORT, SPORT+	NORMAL, SPORT, SPORT+
Additional sensors	None	None	1x Vertical*, 1x Steering angle	2x Vertical*, 1x Longitudinal*, 1x Steering angle	3x Vertical*,	4x EDC satellites, x Ride-height sensors	4x EDC satellites, 4x Ride-height sensors	3x Vertical* 2x Ride-height sensors
Gas pressurised shock absorber	Two-tube	Two-tube	Two-tube	Two-tube	Two-tube	Two-tube	Two-tube	Two-tube
Diagnostic capabilities	No	No	Yes	Yes	Yes	Yes	Yes	Yes
*Acceleration sensor								

E89 Chassis and suspension.
3 System components.

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

Design



E89 Adaptive M chassis and suspension

Index	Description
1	Acceleration sensor, front left
2	Acceleration sensor, front right
3	Spring strut, front
4	Ride-height sensor, front
5	Springs, rear
6	Ride-height sensor, rear
7	Acceleration sensor, rear right
8	VDM control unit
9	Shock absorber, rear

E89 Chassis and suspension.
3 System components.

Function

The input parameters such as road condition, vehicle load and driving style are registered directly by the system and used to activate the corresponding characteristic map as required. This results in optimised damping over a broad range with distinct comfort and safety advantages.

The aim of EDC is to clearly increase vibration comfort (vehicle movement) without compromising on driving characteristics (wheel-related movement) and safety. Three acceleration sensors register the driving dynamics of the vehicle and send the data each over a separate data line to the VDM control unit. Sensors register the following values:

- Vehicle speed
- Vertical acceleration
- Longitudinal acceleration and deceleration
- Steering angle
- Ride height.

The EDC valves are set to the hard position when no power is applied. The EDC valves are actuated by the VDM control unit and are set towards soft. The VDM control unit contains adaptive controllers with four output stages and converts the signals corresponding to a defined characteristic map. For this purpose, the four EDC valves on the shock absorbers are actuated independently (wheel-individual).

An EDC valve externally mounted on each shock absorber is responsible for controlling the oil flow in the tension and compression stages (damping). The shock absorbers are automatically set harder (increases dynamics) or softer (increased comfort) corresponding to the driving situation. In the event of the VDM control unit failing, the power supply to the EDC valves is disconnected and they are closed mechanically by springs, thus fixing the EDV valves in the hard position.

The dynamic driving switch makes it possible to additionally influence the control system.

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

Sensors

Additional sensors and information from existing systems are required to ensure the EDC operates correctly. For instance, the EDC receives information on the vertical acceleration as the springs compress and recoil from the three additionally installed acceleration sensors. The acceleration sensors are fitted on the front left, front right and rear right. The acceleration sensors on the front and rear axles make it possible to register the movement of the vehicle body with respect to the road surface.

The steering column switch cluster makes available the rate of change in the steering angle in the form of a signal on the PT-CAN. The signal for the front left and front right wheel speed is also made available on the PT-CAN. The signal is provided by the DSC control unit.

The DSC sensor makes available the longitudinal acceleration signal on the PT-CAN. The ride-height values are registered by a ride-height sensor on the front axle and on the rear axle and are also made available.

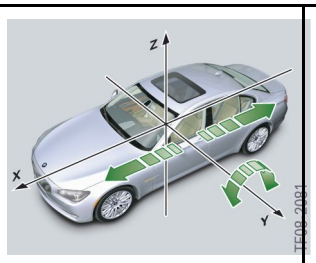
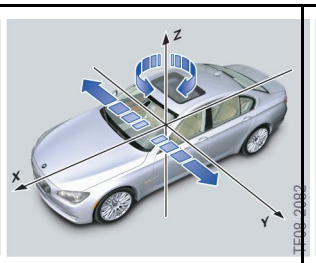
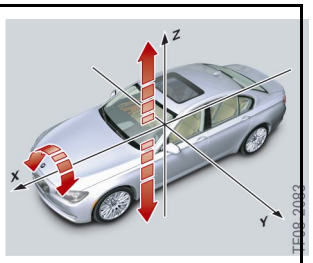
E89 Chassis and suspension.
3 System components.

3.4 Dynamic driving systems

3.4.1 Overview

Allocation

Fundamentally, the dynamic driving systems can be divided into three acceleration axes. The X-axis denotes the longitudinal dynamics, the Y-axis the transverse dynamics and the Z-axis the vertical dynamics. All dynamic driving systems act on one or several axes. The following overview shows the dynamic driving systems available for the E89 together with the effective axes.

Effective direction			
DSC	?	?	
EPS		?	
VDM			?
DCC	?		

Dynamic stability control DSC

The following table shows an overview of the subfunctions combined in the DSC.

Function	**Subfunction**	**Description**
ABS		Anti-lock brake system
	EBV	Electronic braking force distribution
	CBC	Cornering brake control (counteracts oversteer)
	DBC	Dynamic brake control
ASC		Automatic stability control
	MMR	Engine torque control
	MSR	Engine drag torque control
	BMR	Braking torque control
DSC		Dynamic stability control
	GMR	Yaw moment control
	SDR	Thrust differential control
	DTC	Dynamic traction control

Electronic power steering EPS

The electromechanical power steering system is already known from the E92 and is described in detail in the Product Information Electromechanical Power Steering with Parallel Motor Arrangement EPS-APA.

Vertical dynamics management VDM

Electronic damper control EDC is used as the vertical dynamic system in the E89. The EDC function is integrated in the VDM control unit. The sales designation for the E89 is Adaptive M suspension.

Dynamic cruise control DCC

The option SA544 Cruise Control with Brake Function is available for the E89. Technically, this option is also known as Dynamic Cruise Control.

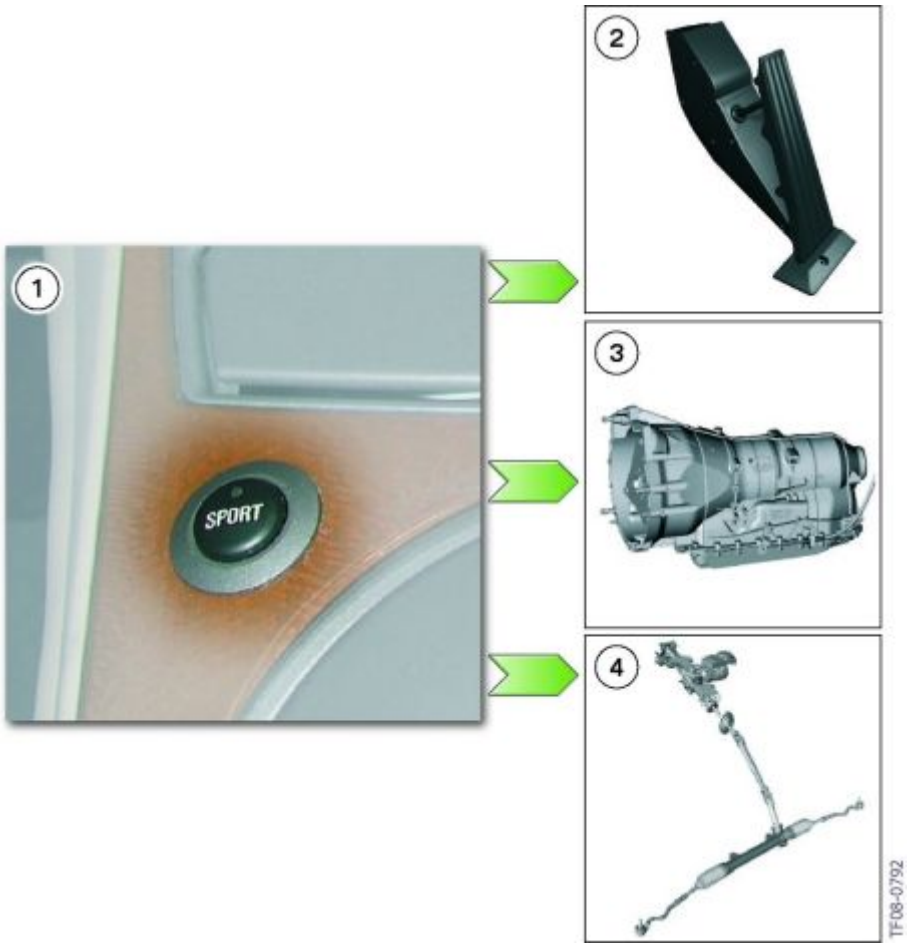
Cruise control with brake function is described in detail in the Participant's Manual E90 Dynamic Driving Systems.

3.4.2 Dynamic driving switch

General information

The E85/E86 was equipped for the first time with a SPORT button that influences several systems. The SPORT button switched the steering, automatic transmission and accelerator pedal between a standard mode and a sports mode. This made it possible to match these three systems more effectively in the two available modes. As a result, the customer experienced a vehicle trimmed to a sports driving style without compromise in sports mode.

E89 Chassis and suspension.
3 System components.



SPORT button in the E85/E86

Index	Description
1	SPORT button
2	Accelerator pedal
3	Automatic gearbox
4	Steering

Dynamic driving control in the E89

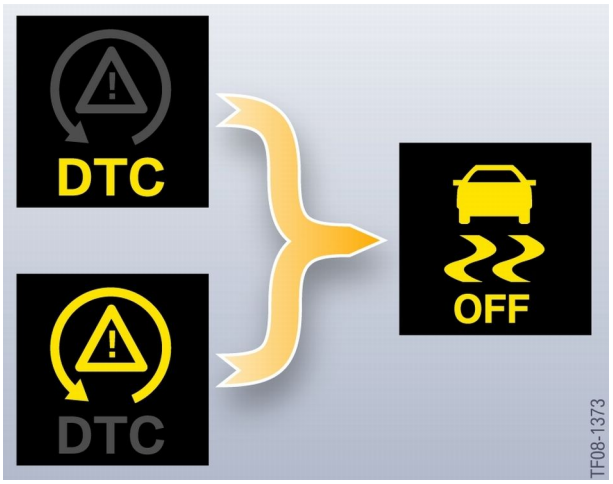
Compared to the E85/E86, the new dynamic control in the E89 has two new features:

- All dynamic driving systems available in the vehicle are switched in full.
- Three levels are available. The status of the dynamic stability control is also taken into account thus making two further levels possible.

E89 Chassis and suspension.
3 System components.

Dynamic driving control is activated by a new dynamic driving switch and the DTC button arranged directly in front of it. Dynamic driving control combines the activation of many vehicle drive and dynamic driving functions.

The overall vehicle then assumes the characteristics that the driver expects in the selected drive range. With this bundling of functions, the vehicle characteristic can be set considerably more pronounced and less compromising. In response, the large number of, in part, unfeasible individual combinations is avoided (for example: sports steering and comfort-orientated damping).



DSC and DTC symbols

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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.

This change is due to new legislation that requires all automobile manufacturers to use standardised indicators. The new requirements also stipulate that any restriction in the SDC function must be indicated by OFF in the indicator. This is the case in TRACTION and SPORT+ modes.

E89 Chassis and suspension.
3 System components.

DTC button and dynamic driving switch

Index	Description
1	DTC button
2	Dynamic driving switch

Central information display CID

In addition to the indicator in the instrument cluster, an assistance window also appears in the CID when the DTC button or dynamic driving switch is pressed. The newly selected mode is shown here and explained by an additional text.

Modes and their effects

The entire vehicle has a coherent response due to the fact that the individual systems are switched jointly and in a co-ordinated manner. This configuration avoids unfeasible combinations. For instance, this configuration rules out a sports accelerator pedal characteristic together with an extremely comfort-orientated shift program of the automatic transmission. The following table shows the possible combinations and the five available modes.

E89 Chassis and suspension.
3 System components.

	Dynamic driving switch									**DTC button**	
Mode	NORMAL			Sport			SPORT +			TRAC-TION	DSC OFF
Vehicle setup	Comfort			Sport			Sport			Com-fort	Com-fort
Drive systems											
Accelerator pedal characteristic	Comfort			Sport			Sport			Com-fort	Com-fort
Mode, automatic gearbox	D	DS	M	D	DS	M	D	DS	M	D	DS	M	D	DS	M
Gearshift program, automatic gearbox *1	XE	S	M	S	S	M	S	S	M	XE	S	M	XE	S	M
Gearshift speed, automatic gearbox *2	N	S	S	S	S	S+	S	S	S+	N	S	S	N	S	S
Vehicle Chassis, suspension and dynamic driving systems											
Power steering	Basic			Sport			Sport			Ba-sic	Ba-sic
DSC	DSC ON			DSC ON			DTC			DTC	DSC OFF
Vertical dynamics management	Basic			Sport			Sport			Ba-sic	Ba-sic

*1 XE = Extremely economical gearshift program, S = Sports gearshift program; M = Manual gearshift program
*2 N = Normal shift speed, S = Fast shift speed, S+ = Very fast shift speed;

The modes (D, DS, M) of the automatic gearbox selected via the selector switch and shift paddles.

As before, DS mode is engaged by shifting the selector lever to the left. The selector lever locks in this position. The sports program can only be engaged from D. The manual gearshift program M is selected by shifting the selector lever forward or back in the sports program. The manual gearshift program M is also selected by pressing the shift paddles in D or DS mode.

E89 Chassis and suspension.
4 Service information.

4.1 System components

4.1.1 Brakes

Parking brake

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.

4.1.2 Suspension and damping

Adaptive M chassis and suspension

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

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

4.1.3 Dynamic driving systems

Overview

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.

Bayerische Motorenwerke Aktiengesellschaft
Händlerqualifizierung und Training
Röntgenstraße 7
85716 Unterschleißheim, Germany