Technical training.
Product information.

G12 Chassis and Suspension

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

Information status and national-market versions

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. Further differences may arise as the result of the equipment specification 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.

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

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G12 Chassis and Suspension

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1. Introduction

1.1. Development code

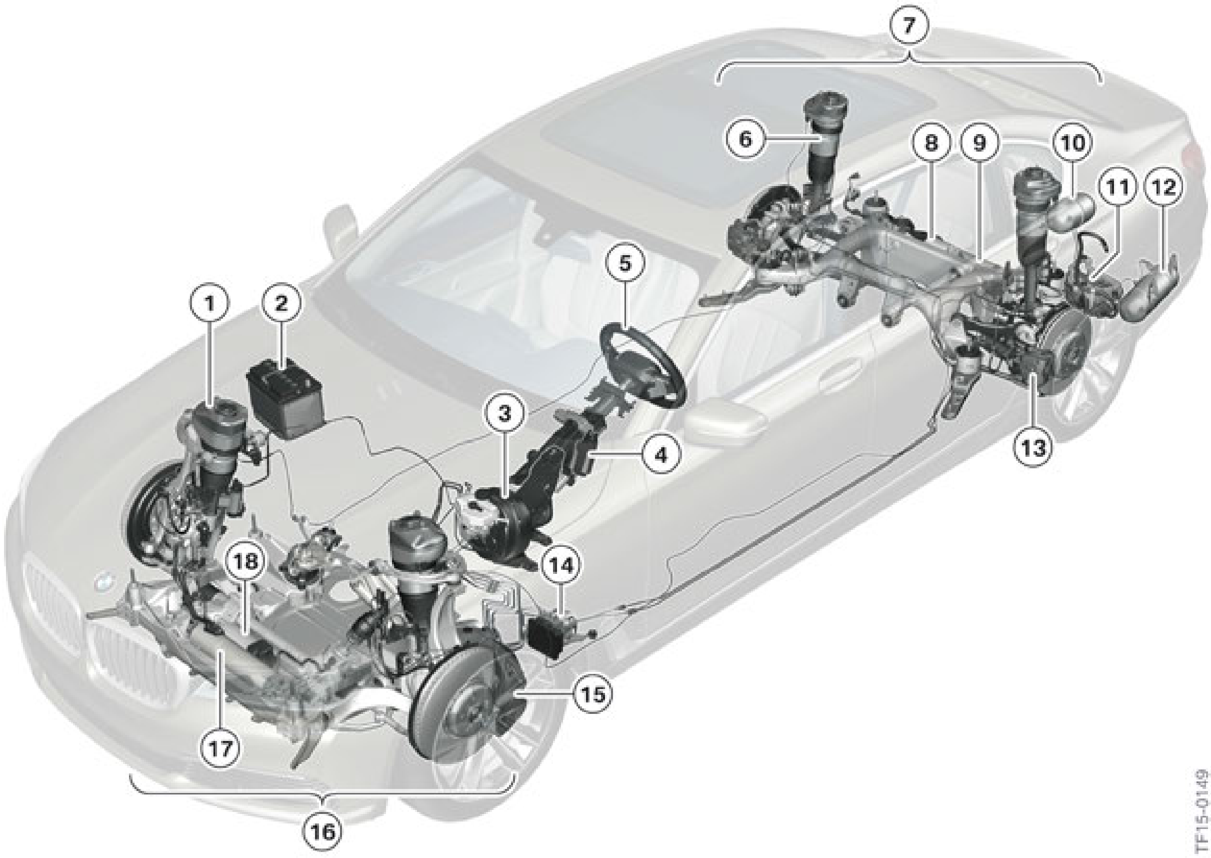
The new BMW 7 Series G12 will be launched on the market from October 2015.

In terms of the chassis and suspension, the new BMW 7 Series offers increased comfort without any compromises in driving dynamics.

1.2. Chassis and suspension comparison

Component	F01/F02	G12
Front axle	Double-wishbone front axle	Double-wishbone front axle
Front suspension	Steel springs	Air suspension
Front damping	Electronic Damper Control (EDC)	Electronic Damper Control (EDC)
Anti-roll bar, front	Conventional or hydraulic active stabilizer (ARS)	Conventional or electrical active stabilizer (EARSV)
Rear axle	Five-link rear suspension	Five-link rear suspension
Rear suspension	Steel springs or rear air suspension (optional equipment in the F01)	Air suspension 2 axle
Rear damping	Electronic Damper Control (EDC)	Electronic Damper Control (EDC)
Rear anti-roll bar	Conventional or hydraulic active stabilizer ARS	Conventional or electrical active stabilizer EARSV
Front brake	Brake discs up to dia. 348 mm	Brake discs up to dia. 395 mm
Rear brakes	Brake discs up to dia. 345 mm	Brake discs up to dia. 370 mm
Parking brake	Drum brakes with electromechanical parking brake EMF	Disc brakes with combined brake caliper for the electric parking brake
Wheels/tires	Run-flat tires (RSC)	Normal tires
Tire Pressure Monitor (RDC)	RDC	RDCi
Steering	Electronic Power Steering or Integral Active Steering	Electronic Power Steering or Integral Active Steering

1.3. Overview of chassis and suspension



Overview of chassis and suspension in the G12

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2	12 V battery (for EARSV)
3	Brake servo
4	Steering column adjustment
5	Steering wheel
6	Air suspension strut, rear axle
7	Five-link rear axle (HA5)
8	Rear axle slip angle control (HSR) (optional equipment)
9	Electric active roll stabilization rear EARSV (optional equipment)
10	Pressure accumulator 2 liters
11	Air supply system of two-axle ride level control
12	Pressure accumulator 4 liters
13	Disc brake with integrated parking brake for the rear axle

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1. Introduction

Index	Explanation
14	Dynamic Stability Control (DSC)
15	Disc brake for front axle
16	Double-wishbone front axle
17	Electric active roll stabilization front EARSV (optional equipment)
18	Electronic Power Steering (electromechanical power steering) (EPS)

The following table shows a comparison of the chassis and suspension on the G12.

	G12	
	Rear-wheel drive	**Four-wheel drive**
Wheelbase	3210 mm	3210 mm
Turning circle*	12.8 m	12,9 m
Ground clearance	135 mm	135 mm
Maximum vehicle height	1505 mm	1505 mm
Minimum vehicle height	1475 mm	1475 mm
Vehicle height at normal level	1485 mm	1485 mm
Vehicle height at high level	1505 mm	1505 mm
Vehicle height at sport level	1475 mm	1475 mm

*The turning circle values refer to vehicles with basic steering.

1.3.1. Highlights

The following table shows the different equipment specifications in the area of the chassis and suspension for the G12.

Systems	Basic chassis and suspension	Integral Active Steering	Active Comfort Drive
Electronic Power Steering (EPS)	X		
EPS with variable rack geometry		X	
Rear axle slip angle control (HSR)		X	
Two-axle ride level control	X		
Electronic Damper Control (EDC)	X		
Front axle anti-roll bar	X		
Rear axle anti-roll bar	X		
Electric active roll stabilization front (EARSV)			X
Electric active roll stabilization rear (EARSV)			X

G12 Chassis and Suspension
1. Introduction

Systems	Basic chassis and suspension	Integral Active Steering	Active Comfort Drive
Wheel acceleration sensors			X
Stereo KAFAS camera			X
Auxiliary battery (12 V)			X

The following optional equipment is available in addition to the basic chassis and suspension:

- Integral Active Steering
- Active Comfort Drive

Both equipment options can be combined with each other and are available for all drive variants (also xDrive). It was possible to reduce the carbon dioxide emissions and increase the control dynamics through complete electrification of the two optional equipment systems. In the customer's perception, this is expressed in a lower fuel consumption with increased comfort as well as a sportier driving feeling.

The driver can influence the control characteristics of the different suspension control systems by means of the driving experience switch. Further information on this is provided in the Technical Training Manual “G12 Driver Assistance Systems”.

G12 Chassis and Suspension

2. Axles

2.1. Front axle

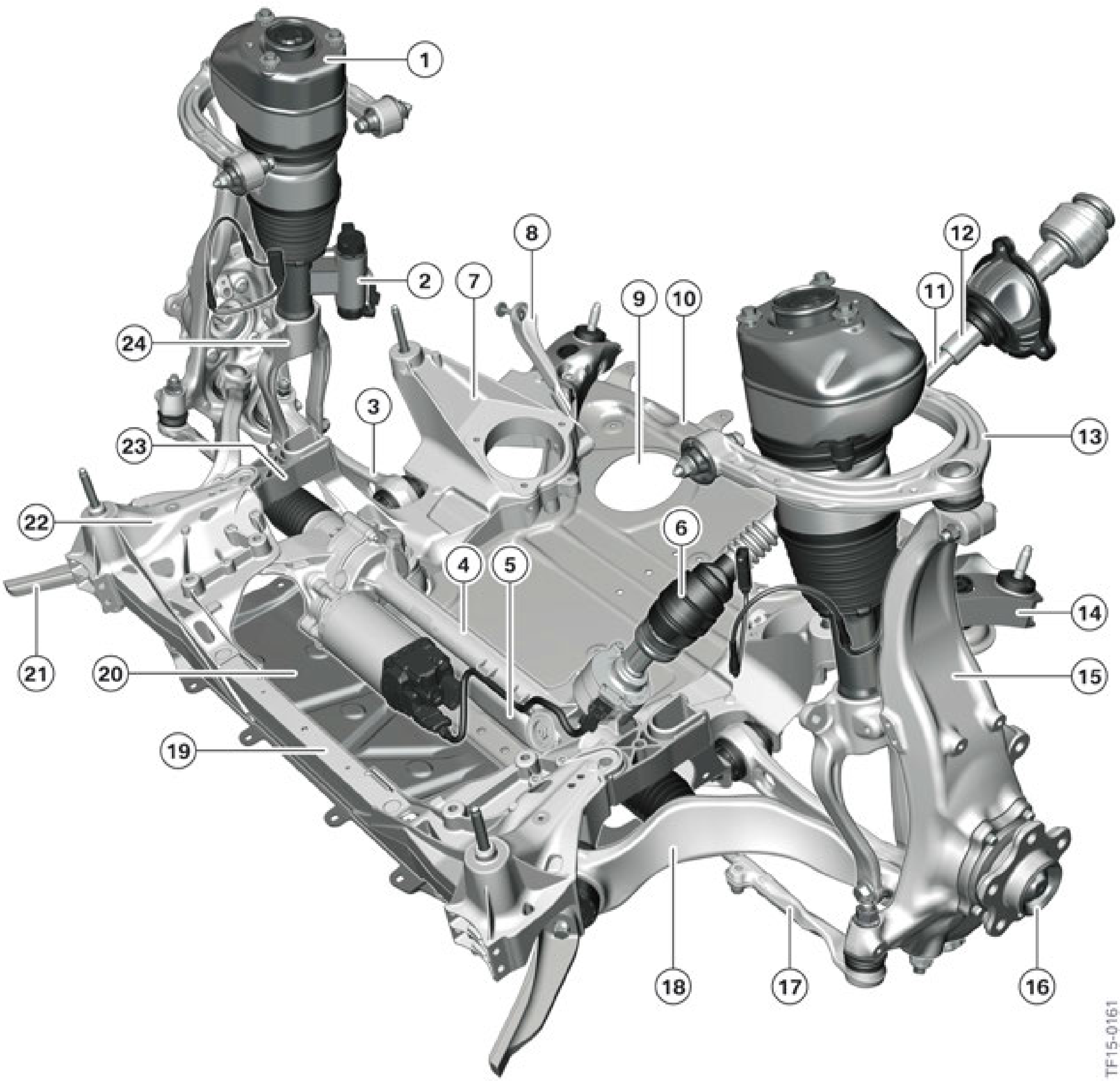
The double-wishbone front axle offers optimum alignment of the camber of the front wheels in relation to the roadway in every driving situation. During the compression and rebound movements, a wheel therefore always has exactly the camber value that guarantees optimum transfer of cornering forces in relation to the roadway. This ensures excellent tire contact with the road and the tire is able to transfer high lateral forces. The attainable high lateral acceleration forces are thus possible without the otherwise necessary firm chassis and suspension setup.

With the double-wishbone front axle, the shock absorber does not perform any wheel control tasks. This means that the shock absorber are practically free of lateral forces and can react sensitively to road bumps.

Since the double-wishbone front axle has a small kinematic lever arm, disturbance variables such as road joints or potholes generate only a small torque about the steering axis.

The sum of all advantages means that the double-wishbone front axle makes it possible to resolve the conflict of goals between comfort and sportiness.

2. Axles



Overview of front axle on G12 with xDrive

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3	Wishbone, bottom
4	Steering box
5	Cross member
6	Universal joint of steering shaft to steering gear
7	Cast side section
8	Strut

Index	Explanation
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10	Rear stiffening plate
11	Steering shaft
12	Universal joint of steering shaft to steering column
13	Triangle wishbone, top
14	Side member
15	Swivel bearing
16	Wheel bearing unit
17	Track rod head
18	Trailing link
19	Transverse tube
20	Front service flap
21	Lever
22	Cast corner
23	Cast corner connection
24	Spring strut holder

In order to achieve the lowest possible vehicle weight, the front axle components are made almost completely from aluminium.

The design of the double-wishbone front axle offers the following advantages:

- High agility due to absorption of high lateral acceleration forces.
- Outstanding roll stabilization when cornering without any reduction in ride comfort.
- Comfortable, good spring response of the axle and good directional stability.
- High comfort due to minimum influence of disturbance variables.

In addition to ensuring driving dynamics and ride comfort, the double-wishbone front axle also performs various crash functions. The front axle support is part of the crash structure of the body and forms an additional load path. This ensures that the increased requirements relating to pedestrian protection are met.

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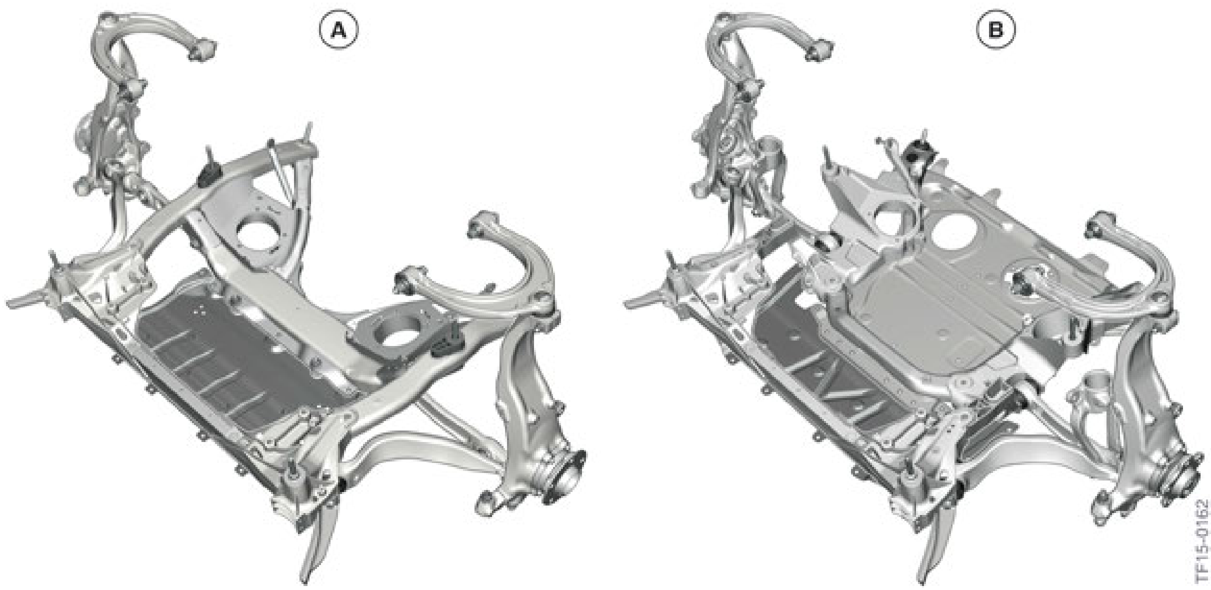
Driving without a stiffening plate is not permitted due to the resultant lack of vehicle stability.

G12 Chassis and Suspension

2. Axles

2.1.1. Versions of the front axle support

Two different front axle supports are used depending on the vehicle equipment.

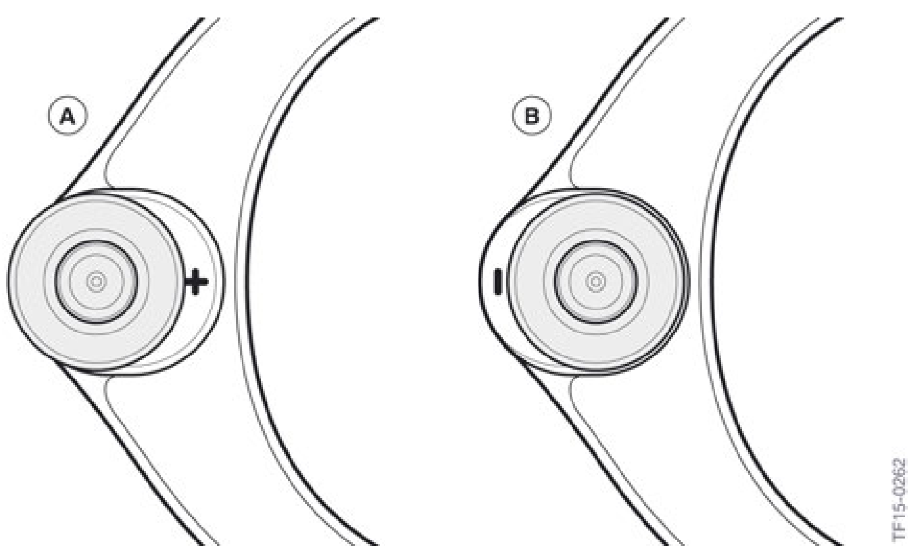


Versions of the front axle support in the G12

Index	Explanation
A	Rear-wheel drive sDrive
B	All-wheel drive xDrive

2.1.2. Notes for Service

Two different wishbones are available to Service for camber correction.



Camber correction by upper wishbone in the G12

Index	Explanation
A	Camber correction by upper wishbone +30 min
B	Camber correction by upper wishbone -30 min

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In order to avoid damage to the ball bearing on the upper wishbone, it must be ensured when performing disassembly or assembly work that the deflection angle of the ball joint does not exceed a value of 55°.

The following table shows when wheel alignment is necessary on the front axle when a component is replaced.

Replacement of a component on the front axle	Wheel alignment required
Front axle support	YES
Steering box	YES
Wishbone, bottom	YES
Rubber mount for wishbone, bottom	YES
Trailing link	NO
Rubber mount for trailing link	NO
Triangle wishbone, top	NO
Rubber mount for upper wishbone	NO
Track rod	YES
Swivel bearing	YES
Wheel bearing	NO
Air suspension strut	NO
Support bearing	NO

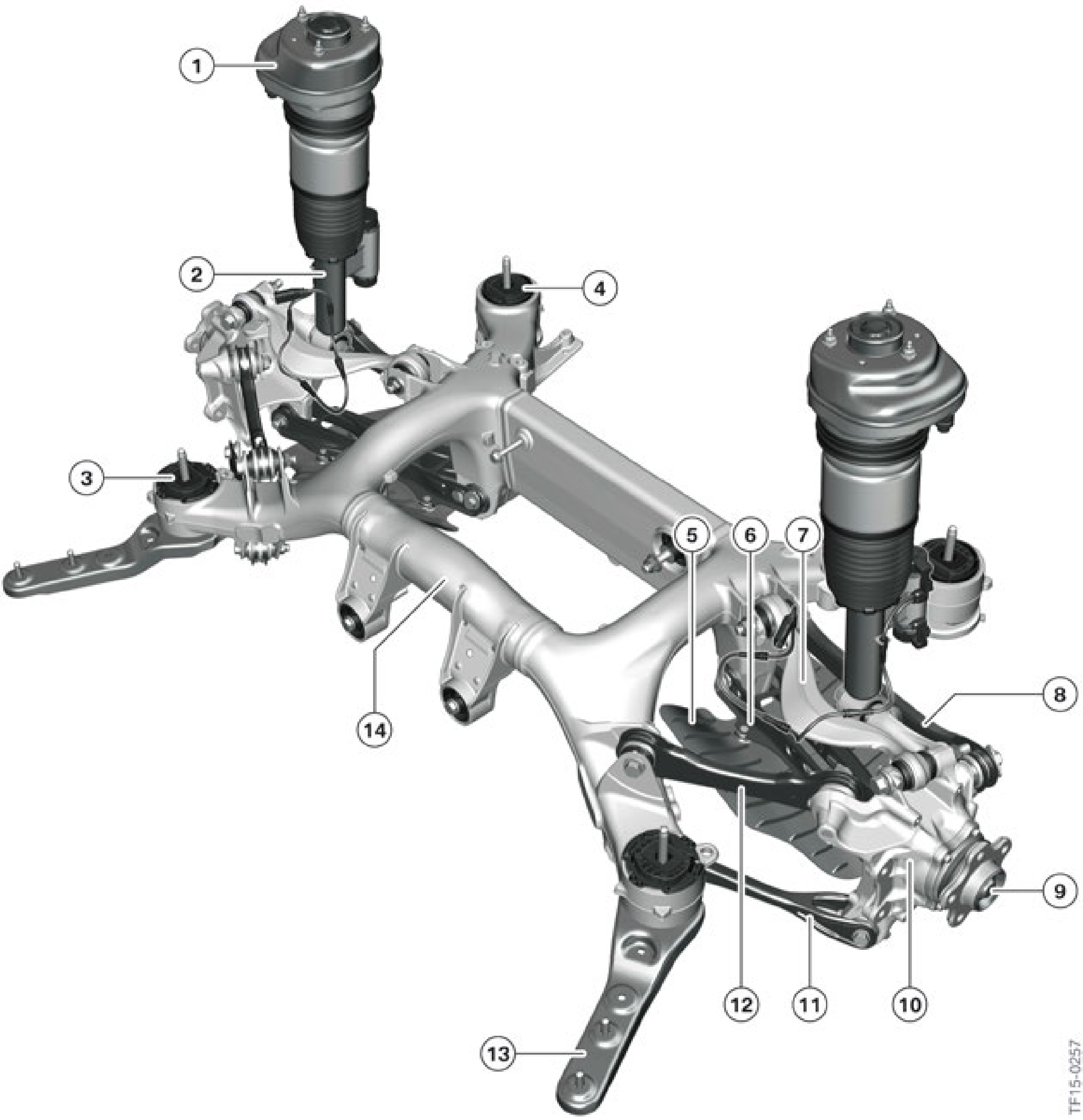
The following table shows when wheel alignment is necessary on the front axle when a component is undone.

Undoing the screw connection at the front axle	Wheel alignment required
Front axle support to body	NO
Steering box to front axle support	YES
Bottom wishbone to front axle support	YES
Bottom wishbone to swivel bearing	NO
Trailing link to front axle support	NO
Trailing link to swivel bearing	NO
Upper wishbone to body	NO

2. Axles

Undoing the screw connection at the front axle	Wheel alignment required
Upper wishbone to swivel bearing	NO
Track rod to steering box	NO
Track rod end to track rod	YES
Track rod end to swivel bearing	NO
Spring strut to bottom wishbone	NO
Support bearing to body	NO
Bottom steering shaft to steering box	NO
Upper steering shaft to steering column	NO

2.2. Rear axle



Overview of rear axle in the G12

Index	Explanation
1	Support bearing
2	Air suspension strut
3	Front rubber mount
4	Rear rubber mount
5	Air deflector

Index	Explanation
6	Camber control arm
7	Wishbone
8	Camber link
9	Wheel bearing unit
10	Wheel carrier
11	Trailing arm
12	Control arm
13	Compression strut
14	Axle support

The five-link rear axle of the G12 is characterized by precise wheel guidance, which comes into its own in various driving situations, such as during load reversals or the transition from cornering to straight-ahead driving. In addition, the five-link rear axle offers very high comfort in combination with sporty driving dynamics.

It was possible to resolve this conflict of goals by means of the following measures:

- Double flexible rear-axle rubber mounts
- High structural rigidity of the rear axle support
- Large support area of the rear axle support

It was possible to keep the unsprung masses of the five-link rear axle low through the use of an aluminium wheel carrier as well as various forged aluminium and sheet steel control arms.

Clever definition of the kinematic points as well as precise design of the ball joints and rubber mounts result in a large spring travel range in combination with optimum wheel guidance. The small acting lever arms ensure particularly good insensitivity to bumps in the road. The extremely rigid control arms as well as the torsion-free rear axle support and body connections realized by means of compression struts result in extremely precise wheel guidance.

The air deflectors under the control arms minimise swirl and thus increase the efficiency of the vehicle.

2.2.1. Notes for Service

The following table shows when wheel alignment is necessary on the rear axle when a component is replaced.

Replacement of a component on the rear axle	Wheel alignment required
Rear axle support	YES
Rubber mount for rear axle support	YES
Camber control arm	YES
Camber link	YES
Trailing arm	YES

Replacement of a component on the rear axle	Wheel alignment required
Wishbone	YES
Ball joint in the wheel carrier	YES
Control arm	YES
Wheel carrier	YES
Wheel bearing	NO
Air suspension strut	NO
Support bearing	NO

The following table shows when wheel alignment is necessary on the rear axle when a component is undone.

Undoing a component on the rear axle	Wheel alignment required
Rear axle support to body	YES
Front compression strut to body	NO
Camber link to rear axle support	YES
Camber control arm to wheel carrier	YES
Camber link to rear axle support	YES
Camber link to wheel carrier	NO
Trailing arm to rear axle support	YES
Trailing arm to wheel carrier	YES
Control arm to rear suspension subframe	YES
Control arm to hub carrier	NO
Wishbone to rear axle support	NO
Wishbone to wheel carrier	NO
Air suspension strut to wheel carrier	NO
Support bearing to body	NO

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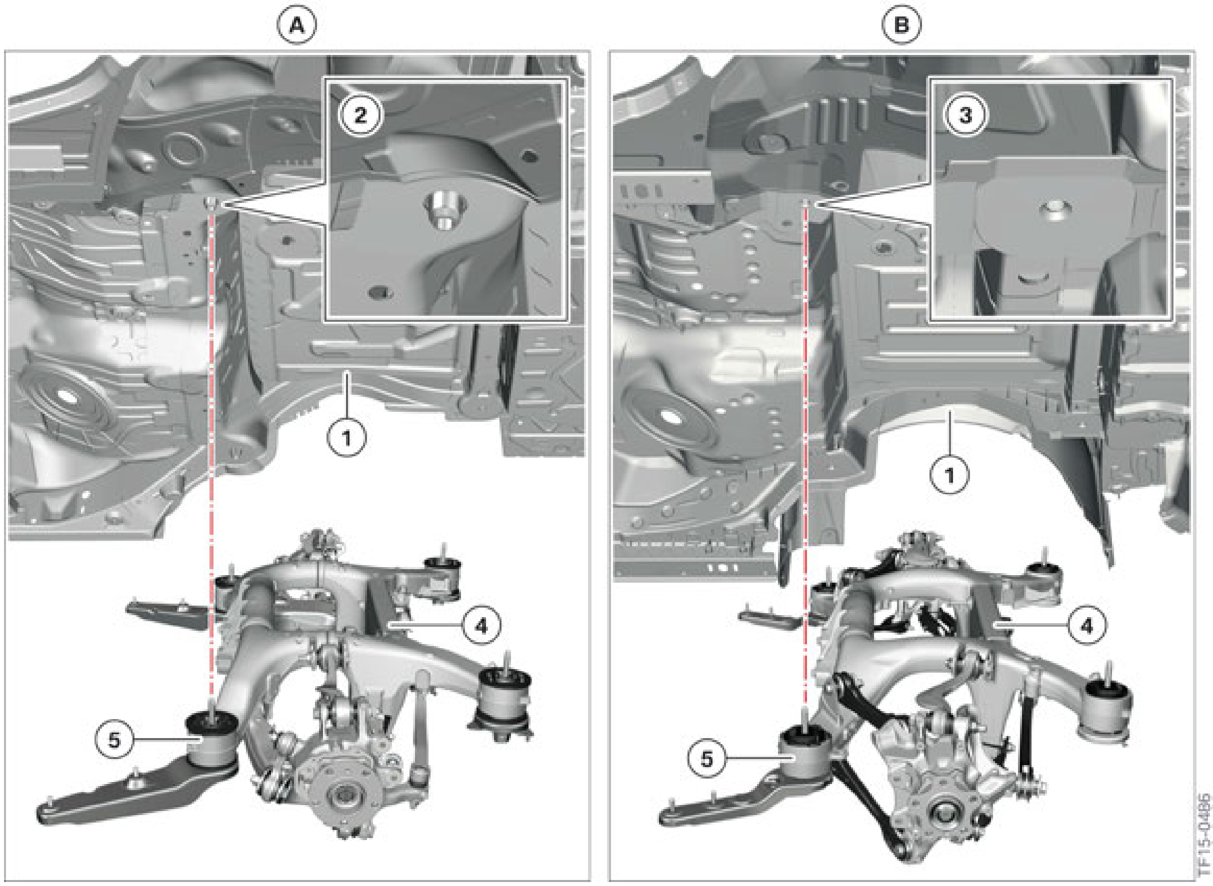
2. Axles

Rear axle positioning

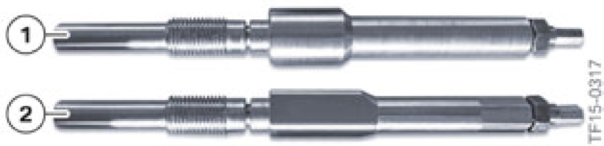


Comparison of rear axle on the F01/F02 with the G12

Index	Explanation
A	Rear axle of the F01/F02
B	Rear axle of the G12
1	Body
2	Centering mounting for rear axle support
3	Mounting for rear axle support
4	Rear axle support
5	Rubber mount of the rear axle support

On the G12, no centering mountings are used on the body for alignment of the rear axle. This makes it possible to ensure during assembly that the rubber mounts of the rear axle are screwed to the body completely without any tension. Bumps in the road are isolated and are not transmitted to the body due to direct contact of the rubber mounts.

New special tools are used for removal and assembly of the rear axle support. The rear axle support is held in the correct position for installation by means of 2 guide pins. For the detailed procedure, refer to the current repair instructions.



Centering tool for removing and installing the rear axle in the G12

Index	Explanation
1	Centering pin for longitudinal and transverse directions (x- and y axes)
2	Centering pin for longitudinal direction (y-axis)

Basic alignment of the rear axle support is ensuring by the centring pin for longitudinal and transverse directions. Due to the permitted production tolerances of the rear axle support, the support is positioned only in longitudinal direction by the second centring pin.

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An incorrect procedure for positioning the rear axle support can lead to problems during wheel alignment.

G12 Chassis and Suspension

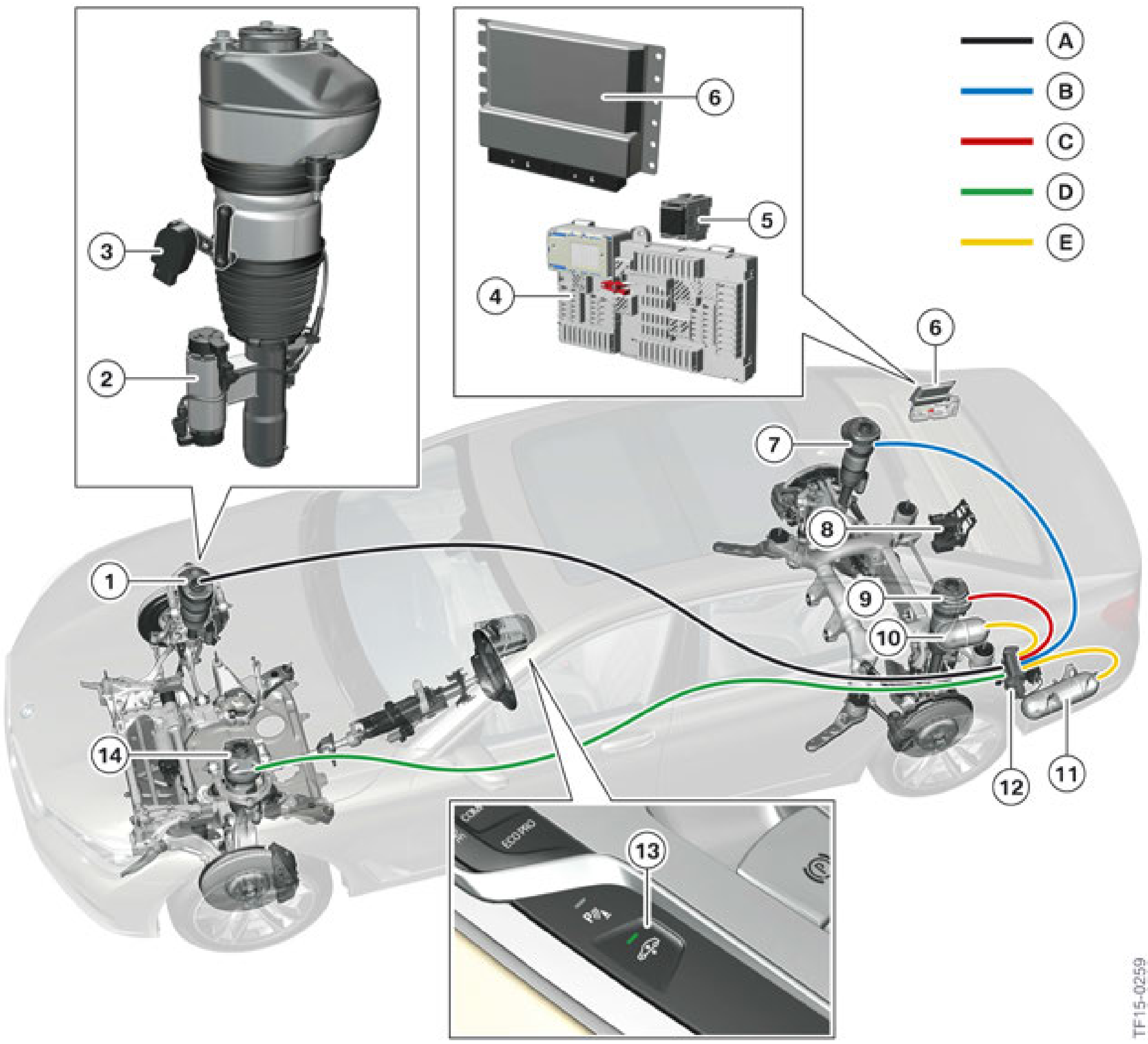
3. Air Suspension

In order to guarantee uniform ride comfort independently of the load status, the G12 is equipped as standard with air suspension on the front and rear axles. The two-axle ride level control of the G12 is offered only in combination with electrically controlled shock absorbers.

The air suspension increases the ride comfort. The system performs adjustment mainly at standstill, e.g. in order to compensate for a change in height due to the vehicle load. The inertia of the system means that it cannot react to driving dynamics disturbance variables, which may occur when the vehicle is driven quickly on twisting roads. Dynamic control when driving serves only to compensate for changes in height due to a falling fuel tank volume as well as temperature changes of the air in the air suspension struts.

The air suspension offers the following advantages:

- Increase in driving safety, since the self-levelling suspension automatically keeps the height of the vehicle body at a predefined nominal ride-level in all load states.
- High ride comfort due to automatic adaptation of the oscillation behavior to the vehicle weight.
- Increased customer benefit through manual level adjustment by means of the ride height selection switch.



System overview of two-axle ride level control in the G12

Index	Explanation
A	Compressed air line, front right (color code black)
B	Compressed air line, rear right (color code blue)
C	Compressed air line, rear left (color code red)
D	Compressed air line, front left (color code green)
E	Compressed air line for pressure accumulator (color code yellow)
1	Air suspension strut, front right
2	EDC valve, front right (Electronic Damper Control)
3	Ride height sensor, front right
4	Rear right power distribution box
5	Relay for air supply system

3. Air Suspension

Index	Explanation
6	Vertical Dynamics Platform (VDP) (central control unit)
7	Air suspension strut, rear right
8	Positive battery terminal distributor
9	Air suspension strut, rear left
10	Pressure accumulator 2 liter
11	Pressure accumulator 4 liter
12	Air supply system
13	Ride height selection switch
14	Air suspension strut, front left

The central control unit for controlling the air suspension is the Vertical Dynamics Platform (VDP). The Vertical Dynamics Platform (VDP) control unit reads in the current ride height values by means of the 4 ride height sensors. The Vertical Dynamics Platform (VDP) activates the solenoid valves of the solenoid valve block in order to perform control actions.

Control actions at standstill and at low vehicle speeds (0 – 20 km/h / 0– 12 mph) are achieved by using the storage volume of the two pressure accumulators. For control actions when driving (> 20 km/h / >12 mph), the required compressed air is not taken from the pressure accumulator, but is generated by the compressor and forwarded directly to the corresponding air suspension struts. In exceptional situations, the compressor can also be switched on when the vehicle is at standstill.

The increase in volume in the air suspension strut lifts the vehicle body. Achievement of the nominal ride-level height is detected by the 4 ride height sensors and activation of the corresponding solenoid valves is interrupted. Three-point control is used for processing in order to avoid frequent re-adjustment. The rear axle is controlled individually by means of both ride height sensors. In the case of the front axle, the corresponding ride height is adjusted on the basis of a mean value.

The compressed air lines have different colors in order to avoid confusion during servicing work on the solenoid valve block. The following table contains an overview of the color codes.

Color code	Component
Yellow	Pressure accumulator
Black	Air suspension strut, front right
Green	Air suspension strut, front left
Blue	Air suspension strut, rear right
Red	Air suspension strut, rear left

3. Air Suspension

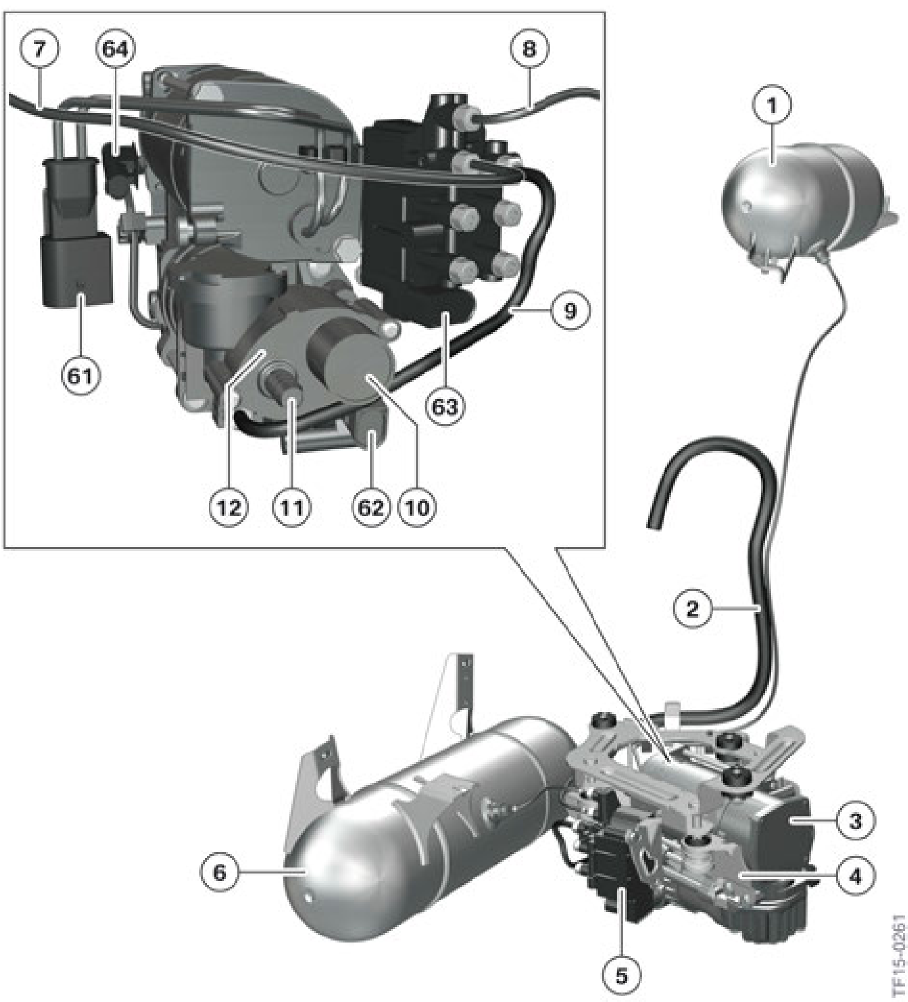
3.1. Air supply system

The air supply system is made up of the following components:

- Electrical compressor
- Solenoid valve block
- Holder with vibration damper

The air supply system has the task of generating the required compressed air and coordinating the air flows between the electrical compressor, pressure accumulators and the 4 air suspension struts corresponding to the requirements. The calculations required for this are performed by the Vertical Dynamics Platform (VDP).

For package reasons, the system comprises two separate pressure accumulators with a total volume of 6 liters and a maximum storage pressure of 17.5 bar. A total volume of 105 liters is available to the system at maximum pressure.



Air supply system of the G12

G12 Chassis and Suspension
3. Air Suspension

Index	Explanation
1	Pressure accumulator 2 liters
2	Air intake hose
3	Electrical compressor
4	Holder with vibration damper
5	Solenoid valve block
6	Pressure accumulator 4 liters
7	Compressed air line for pressure accumulator 2 liters
8	Compressed air line for pressure accumulator 4 liters
9	Compressed air line for air supply to solenoid valve block
10	Ventilation to atmosphere
11	Connection for air intake hose
12	Housing cover for air cleaner
61	Plug-in contact for electrical air compressor
62	Plug-in contact for electrical drain solenoid valve
63	Plug-in contact for solenoid valve block
64	Plug-in contact of temperature sensor

The electrical compressor is switched via a relay. The relay is activated by the Vertical Dynamics Platform (VDP). In order to prevent vibrations from being transmitted into the vehicle interior when the compressor is running, the air supply system is secured to the vehicle body by means of a holder with vibration dampers.

To prevent the driver from being irritated by the start-up noises of the compressor, this is switched on almost exclusively while driving. The compressor can also be switched on at vehicle standstill if the following preconditions are all met:

- Vehicle condition Residing/Awake
- Sufficient vehicle voltage
- Ride height – 40 mm of the initializes value
- Insufficient pressure in the pressure accumulator for control

The intake air is cleaned by the air cleaner upstream of the compressor and dried by the air drier downstream of the compressor. Cleaning is necessary so that the valves are protected against soiling. The water is extracted from the air in order to protect the valves against icing at low ambient temperatures. If the valves were to freeze due to excessively high air humidity in the air supply system, this would mean that level control by the air suspension would no longer be possible. To avoid this, the air drier is permanently cleaned or dried.

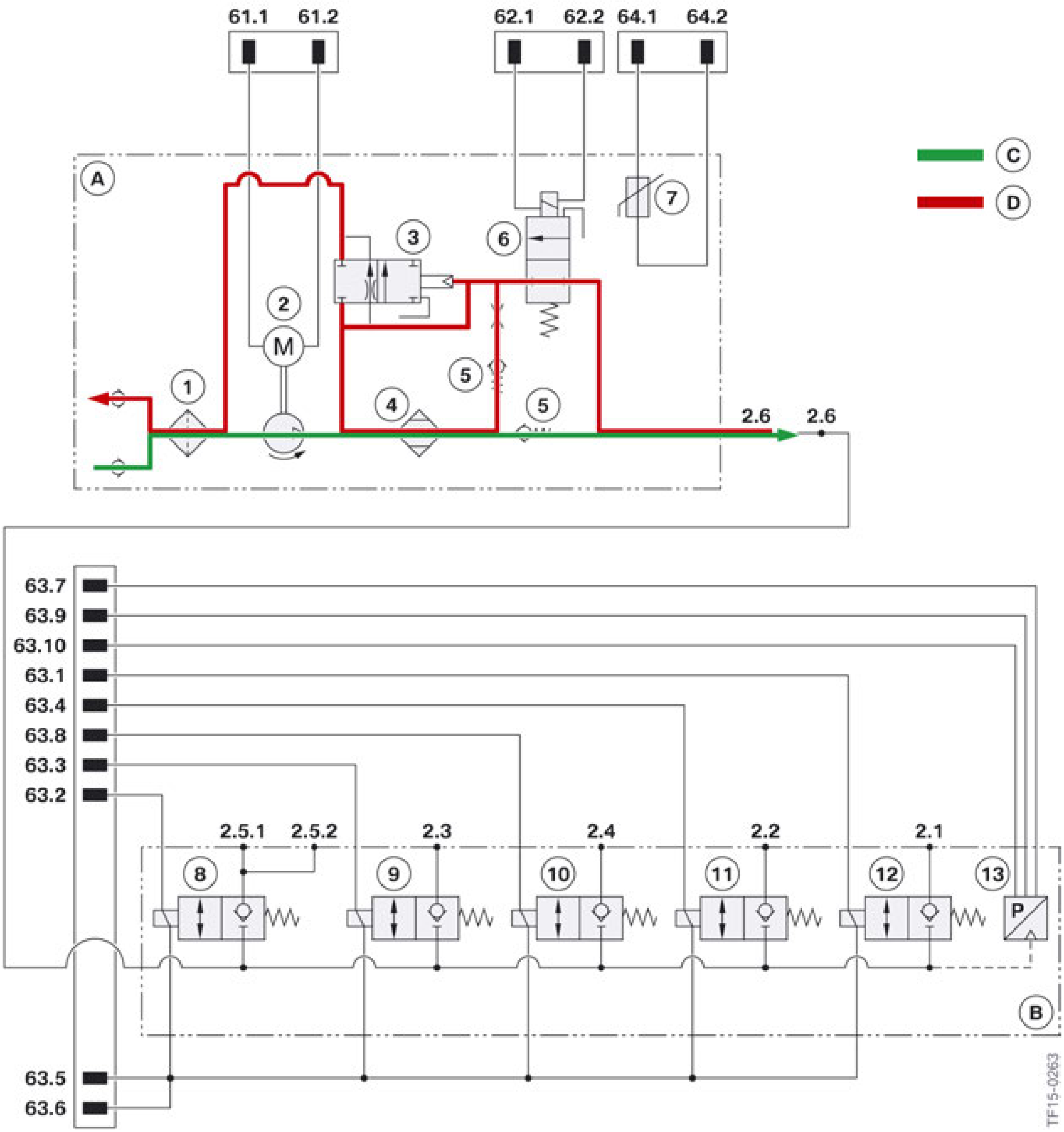
The granulate in the air drier absorbs moisture at high pressure and gives this off again at low pressure. The moisture is extracted from the air when air flows through the granulate when filling the system. When the vehicle height is lowered, the excess air with low pressure is routed through the air drier. The stored moisture is then give off to the air again as it flows past. This permanent regeneration of the air drier ensures fault-free operation of the system without the need for maintenance work.

3. Air Suspension

Pneumatic connections in compressed air systems are usually provided with standardised numbers. This serves the purpose of differentiation and is intended to exclude the possibility of the connections being mixed up. The following table provides an overview of the standardized number codes.

Number code	Meaning
0	Intake air connection
1	Energy supply
2	Energy outlet
3	Atmosphere

The following graphic shows a schematic illustration of the air supply system.



Schematic illustration of the air supply system in the G12

Index	Explanation
A	Air compressor
B	Solenoid valve block
C	Filling
D	Draining

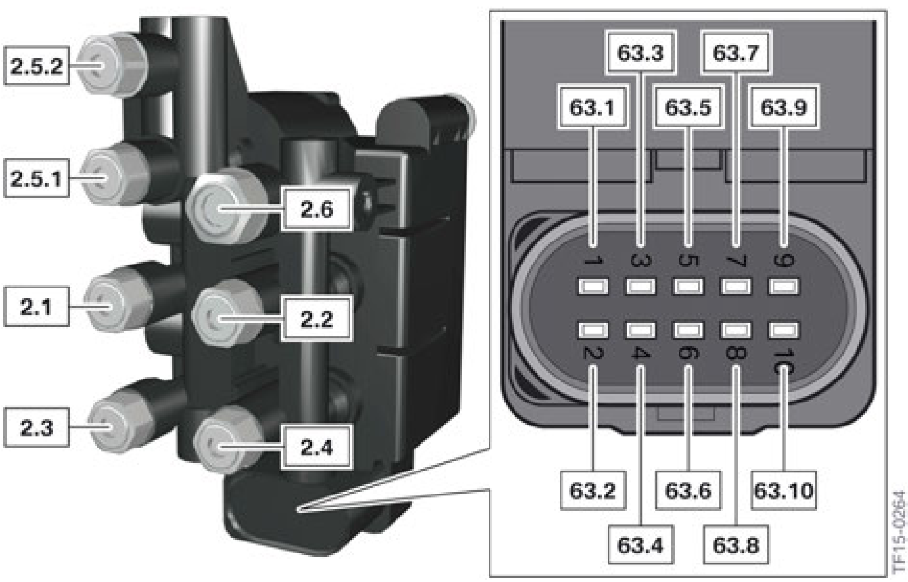
Index	Explanation
1	Air filter
2	Electric motor
2.1	Energy outlet, output 1 (air suspension strut, front left)
2.2	Energy outlet, output 2 (air suspension strut, front right)
2.3	Energy outlet, output 3 (air suspension strut, rear left)
2.4	Energy outlet, output 4 (air suspension strut, rear right)
2.5.1	Energy outlet, pressure accumulator 1
2.5.2	Energy outlet, pressure accumulator 2
3	Pneumatic discharge valve with pressure relief function
4	Air drier
5	Non-return valve
6	Electrical drain solenoid valve
7	Temperature sensor
8	Electrical solenoid valve of pressure accumulators
9	Electrical solenoid valve for rear left air suspension strut
10	Electrical solenoid valve for rear right air suspension strut
11	Electrical solenoid valve for front right air suspension strut
12	Electrical solenoid valve for front left air suspension strut
13	Pressure sensor

3.1.1. Technical data

	Compressor	Drain solenoid valve	Temperature sensor	Solenoid valve block
Supply voltage	12 V	12 V	5 V	12 V
Pickup current per valve	—	0.82 A6	—	0.8 - 1.0 A
Holding current per valve	—	0.55 A6	—	0.55 A6
Maximum starting current	110 A6	—	—	—

	Compressor	Drain solenoid valve	Temperature sensor	Solenoid valve block
Maximum continuous current	35 A6	2.5 A6	—	3.1 A6
Dynamic pressure control	22.5 bar	—	—	—
Resistance	—	9 Ω	5 kΩ at 25 °C / 77 °F	6.8 kΩ

3.1.2. Solenoid valve block



Solenoid valve block of the air supply in the G12

Index	Explanation
2.1	Energy outlet, output 1 (air suspension strut, front left)
2.2	Energy outlet, output 2 (air suspension strut, front right)
2.3	Energy outlet, output 3 (air suspension strut, rear left)
2.4	Energy outlet, output 4 (air suspension strut, rear right)
2.5.1	Energy outlet, pressure accumulator 2 l
2.5.2	Energy outlet, pressure accumulator 4 l
63.1	Activation of solenoid valve for front left air suspension strut
63.2	Activation of solenoid valve of pressure accumulators
63.3	Activation of solenoid valve for rear left air suspension strut
63.4	Activation of solenoid valve for front right air suspension strut
63.5	Ground

Index	Explanation
63.6	Ground
63.7	Sensor ground (pressure sensor)
63.8	Activation of solenoid valve for rear right air suspension strut
63.9	Sensor voltage supply (pressure sensor)
63.10	Sensor signal output (pressure sensor)

The different electrical solenoid valves are located in the solenoid valve block. These are used to forward the compressed air to the different components of the air suspension. The required calculations for control of the electrical solenoid valves take place in the Vertical Dynamics Platform (VDP) control unit.

The following control speeds can be achieved for axle-based changes in the ride height by the system:

- Control via the pressure accumulators ~ 10 mm/s
- Control via the electrical compressor ~ 2 mm/s

An advantage of the installation position of the pressure sensor is that the filling pressures of the pressure accumulators and air suspension struts can be read in with only one sensor depending on activation.

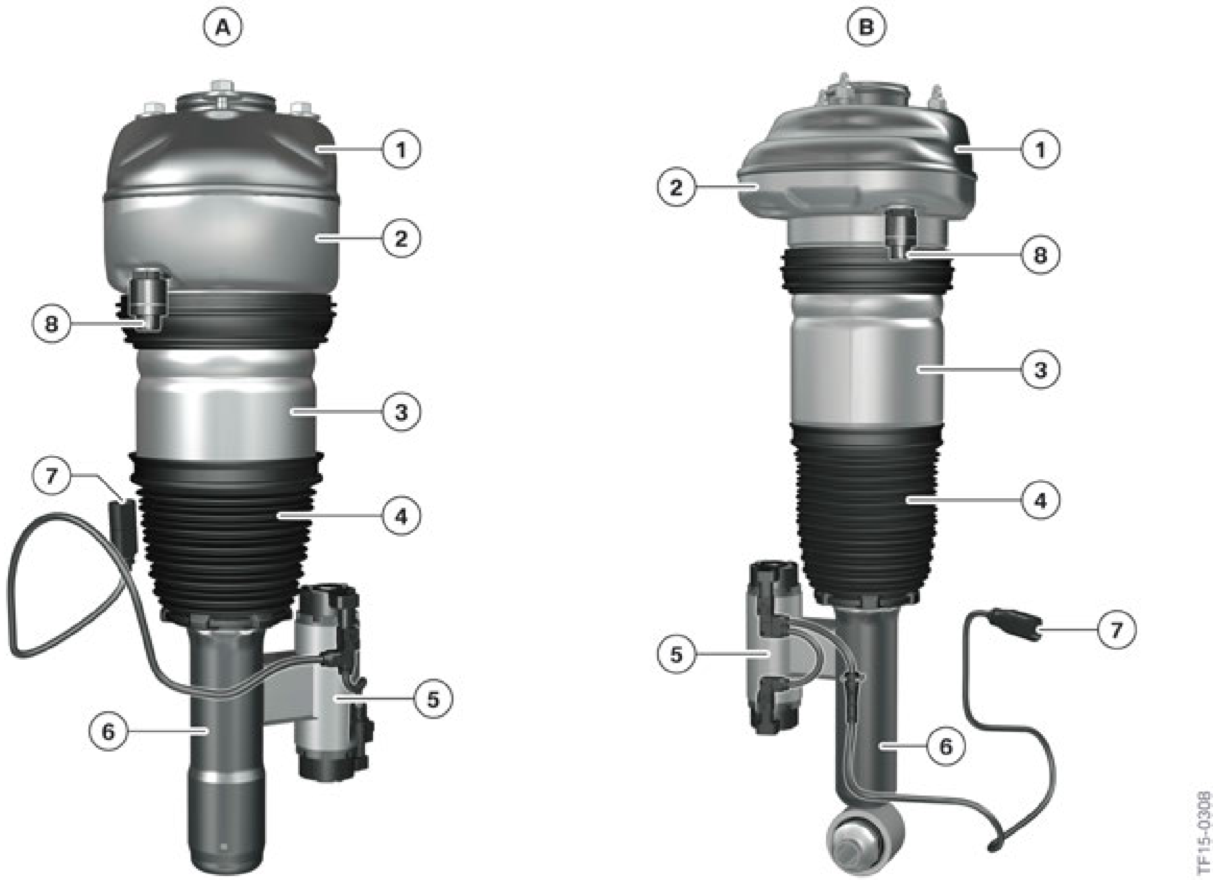
When the electrical solenoid valve of the pressure accumulators is activated, a pressure sensor supplies information about the current filling pressure of the system to the Vertical Dynamics Platform (VDP) control unit. If the stored pressure is not sufficient for a pending change in ride height, the Vertical Dynamics Platform (VDP) control unit switches on the compressor for pressure build-up. However, the compressor is switched on only subject to certain preconditions when the vehicle is at standstill so that comfort is not impaired (see Air supply system).

In the event of activation of the solenoid valves for operation of the air suspension struts, the pressure sensor supplies the filling pressures of the corresponding air suspension struts.

3.2. Air suspension strut

The height of the vehicle body is automatically controlled via the pressure in the air suspension strut in all load states. This prevents the vehicle body from sinking when the vehicle is loaded. The air supply for the air suspension struts is provided by an electrically driven compressor and 2 air accumulators. The air suspension thus functions independently of the operating condition of the combustion engine and can also compensate uneven loading (e.g. sloping load) by individual wheel control on the rear axle.

3. Air Suspension



Air suspension struts on front and rear axles in the G12

Index	Explanation
A	Air suspension strut on the front axle (illustration from all-wheel drive)
B	Air suspension strut on rear axle
1	Pot, upper part
2	Pot, lower part
3	Gaiter
4	Dust boot
5	Control valve of the Electronic Damper Control (EDC)
6	Damper tube
7	Electrical connection for damper adjustment
8	Pneumatic connection with integrated residual pressure holding valve

On the air suspension strut, the coil spring is replaced by a U-type bellows. The air is pressed into the air suspension strut via a compressed air connection. The U-type bellows of the air suspension strut unrolls as a result of the pressure increase and raises the vehicle body. When the air suspension strut is vented, the pressure falls and the U-type bellows rolls up again so that the vehicle body is lowered.

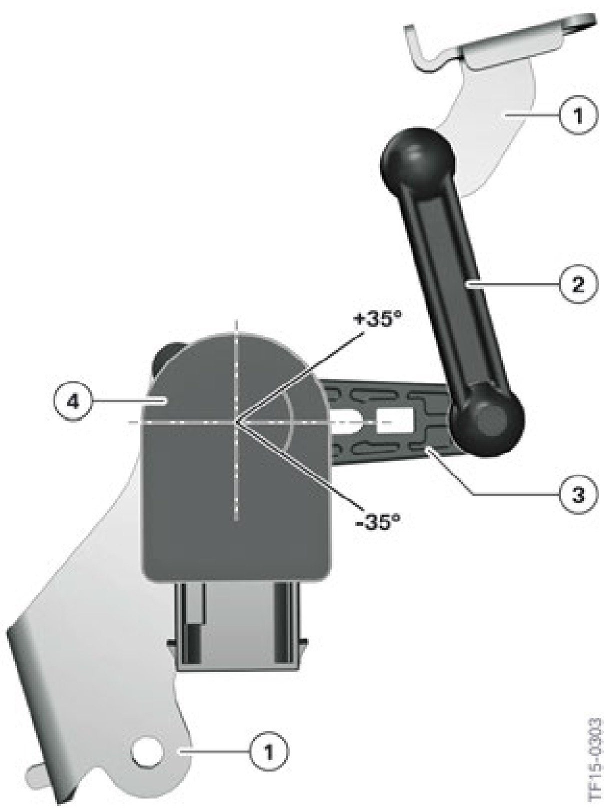
There is a residual pressure holding valve inside the pneumatic connections to prevent complete pressure reduction in the air suspension strut. A residual pressure of 1.8 – 2.7 bar is held when the compressed air lines are removed.

⚠

The pneumatic connections with integrated residual holding valve on the air suspension strut cannot be replaced separately. The air suspension strut will be damaged if it is attempted to removed the pneumatic connections with integrated residual pressure holding valve.

	Air suspension strut, front axle	**Air suspension strut, rear axle**
Air volume in normal position	2.87 L	2.85 L
Compression travel	65 mm	86 mm
Rebound travel	76 mm	106.4 mm
Filling pressure on delivery	1.8 - 2.7 bar	1.8 - 2.7 bar

3.3. Ride height sensor



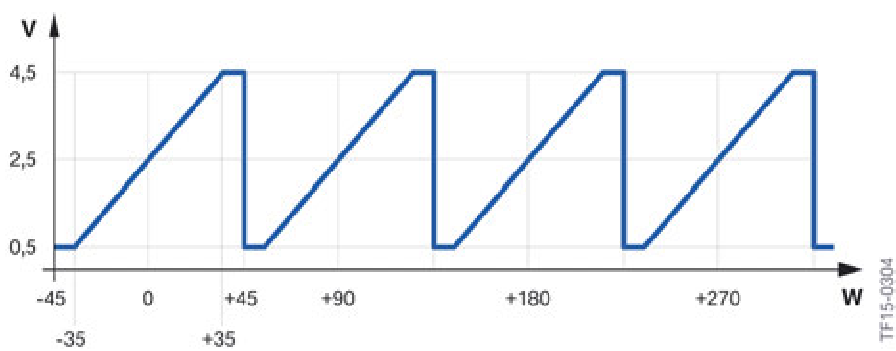
Ride height sensor in the G12

Index	Explanation
1	Holder
2	Articulated rod with ball socket
3	Deflection lever
4	Ride height sensor

The Vertical Dynamics Platform (VDP) control unit reads in the current ride height values of the vehicle body by means of the 4 ride height sensors. The maximum measuring range of the ride height sensor is 70°. The output is an analogue voltage signal between 0.5 V and 4.5 V.

The ride height sensor has the following electrical connections:

- Voltage supply (5 V)
- Ground connection
- Signal output (0.5 – 4.5 V)



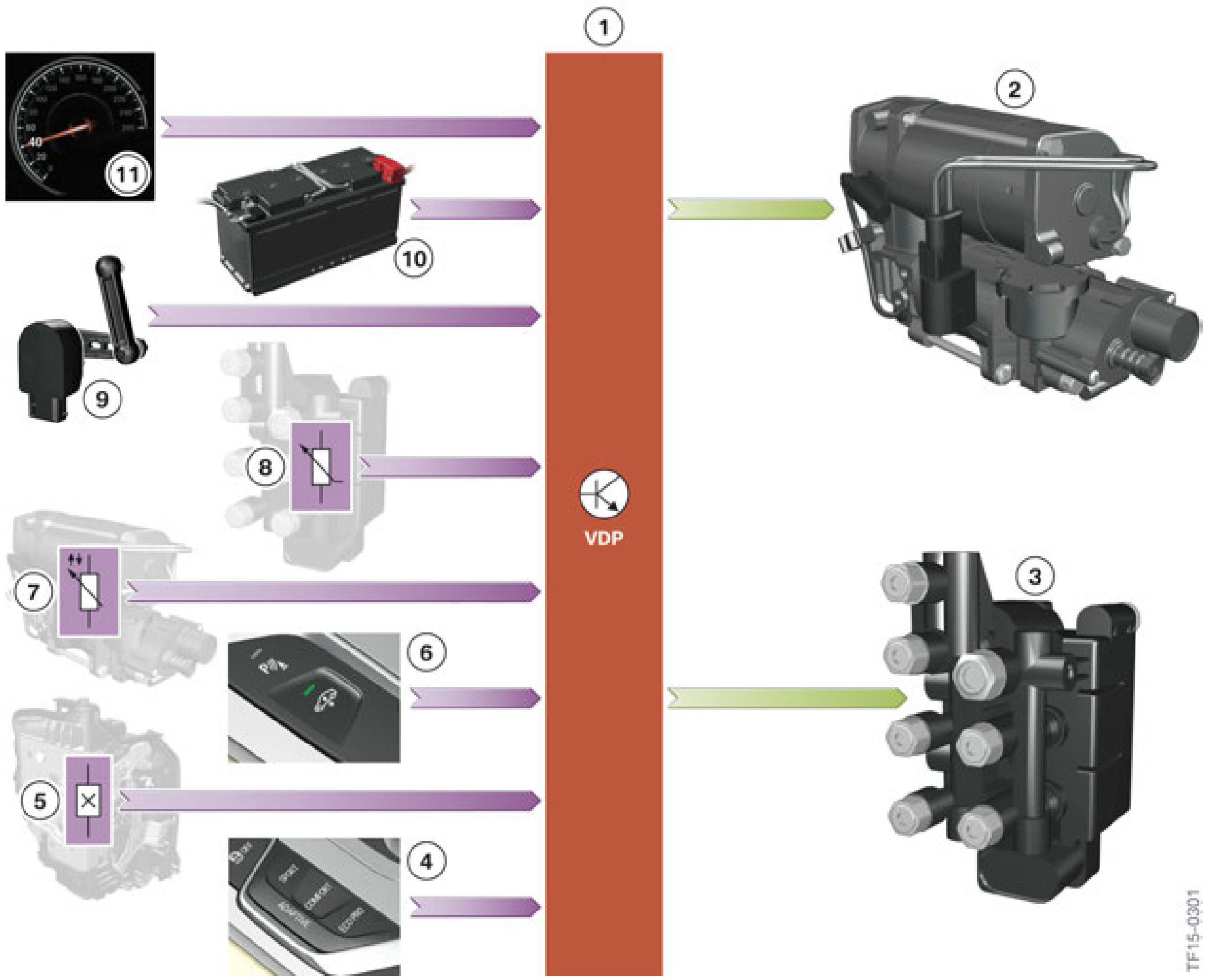
Ride height signal of the ride height sensors in the G12

Index	Explanation
V	Voltage in V
W	Angle

After renewal of one or more ride height sensors, the service function for ride height adjustment must be performed using the BMW diagnosis system ISTA.

The ride height values are stored in the Body Domain Controller. They are also used for level adjustment of the headlights.

3.4. Operating strategy



Input and output diagram of the air suspension in the G12

Index	Explanation
1	Vertical Dynamics Platform (VDP)
2	Compressor
3	Solenoid valve block
4	Driving experience switch
5	Door contact switch
6	Ride height selection switch
7	Temperature sensor (inside the compressor)

Index	Explanation
8	Pressure sensor (inside the solenoid valve block)
9	Ride height sensor
10	Vehicle electrical system voltage
11	Vehicle speed

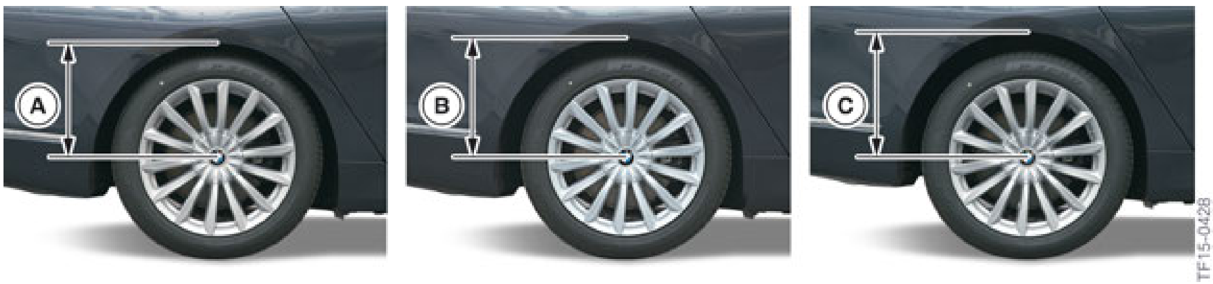
Configuration options of the air suspension in the G12

Index	Explanation
A	Normal level or Sport level activated
B	High level activated
1	SPORT button on the driving experience switch
2	Ride height selection switch

The ride height can be adjusted manually by means of the ride height selection switch and the driving experience switch. Three different ride heights are available.

G12 Chassis and Suspension

3. Air Suspension



Ride heights of the G12

Index	Explanation
A	Sport level (- 10 mm)
B	Normal level (+/- 0 mm)
C	High level (+ 20 mm)

Situation	High level	Normal level	Sport level
Ride height	+ 20 mm	+/– 0 mm	- 10 mm
Ride height activation	Ride height selection switch	—	1) Driving experience switch 2) Driving speed > ~ 140 km/h / > ~ 87 mph
Speed	0 – 40 km/h /0 – 25 mph	0 ~140 km/h / 0 ~87 mph	1) 0 km/h – final speed 2) ~ 140 km/h / ~ 87 mph – final speed

The following prerequisites must be met in order to perform manual adjustment in the ride height by means of the ride height selection switch:

- Driving readiness Residing/Awake or driving between 0 – 40 km/h / 0 – 25 mph
- Sufficient vehicle voltage
- Doors closed
- Pressure accumulator with sufficient filling pressure (only relevant for driving readiness Residing/Awake)

The following graphic shows the operating strategy of the air suspension in the G12.

Operating strategy of the air suspension in the G12

Index	Explanation
A	High level (+ 20 mm)
B	Normal level (+/- 0 mm)
C	Sport level (- 10 mm)
H	Ride height of the vehicle body
v	Vehicle speed
1	Ride height selection switch set to High level
2	Driving experience switch in Comfort position
3	Driving experience switch in Sport position

3.4.1. High level

Operating strategy of the air suspension in the G12 at High level

Index	Explanation
A	High level (+ 20 mm)
B	Normal level (+/- 0 mm)
C	Sport level (- 10 mm)
H	Ride height of the vehicle body
v	Vehicle speed
1	Ride height selection switch set to High level
2	Driving experience switch in Comfort position
3	Driving experience switch in Sport position

In the speed range between 0 – 40 km/h /0 – 25 mph, the High level (+ 20 mm) can be activated manually via the ride height selection switch. This ride height setting is intended to allow the driver to drive over shoulders or ramps with a large gradient angle without damaging the vehicle due to the increased ground clearance. The following ride heights are set automatically if this speed range is exceeded.

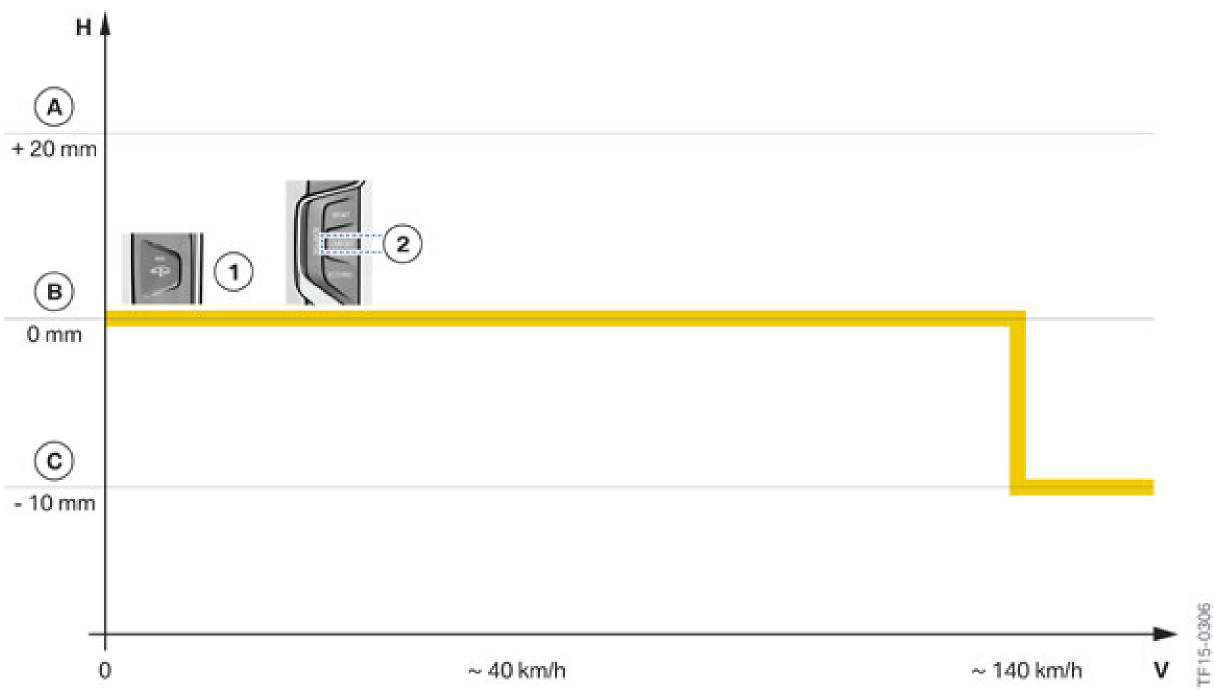
1 If the driving experience switch is in Comfort position, the ride height is lowered to Normal level (+/- 0 mm).

2 If the driving experience switch is in Sport position, the ride height is lowered to Sport level (- 10 mm).

When a driving speed of ~ 140 km/h / ~ 87 mph is exceeded, the vehicle body is automatically lowered from Normal level to Sport level (- 10 mm) independently of the respective switch settings. Lowering to Sport level offers the following advantages:

- Low vehicle center of gravity and thus increased driving dynamics.
- Improved aerodynamics and thus lower fuel consumption.

3.4.2. Normal level



Operating strategy of the air suspension in the G12 at Normal level

Index	Explanation
A	High level (+ 20 mm)
B	Normal level (+/- 0 mm)
C	Sport level (- 10 mm)
H	Ride height of the vehicle body
v	Vehicle speed
1	Ride height selection switch at Normal level
2	Driving experience switch in Comfort setting

Normal level (+/- 0 mm) can be set by means of the following switch positions.

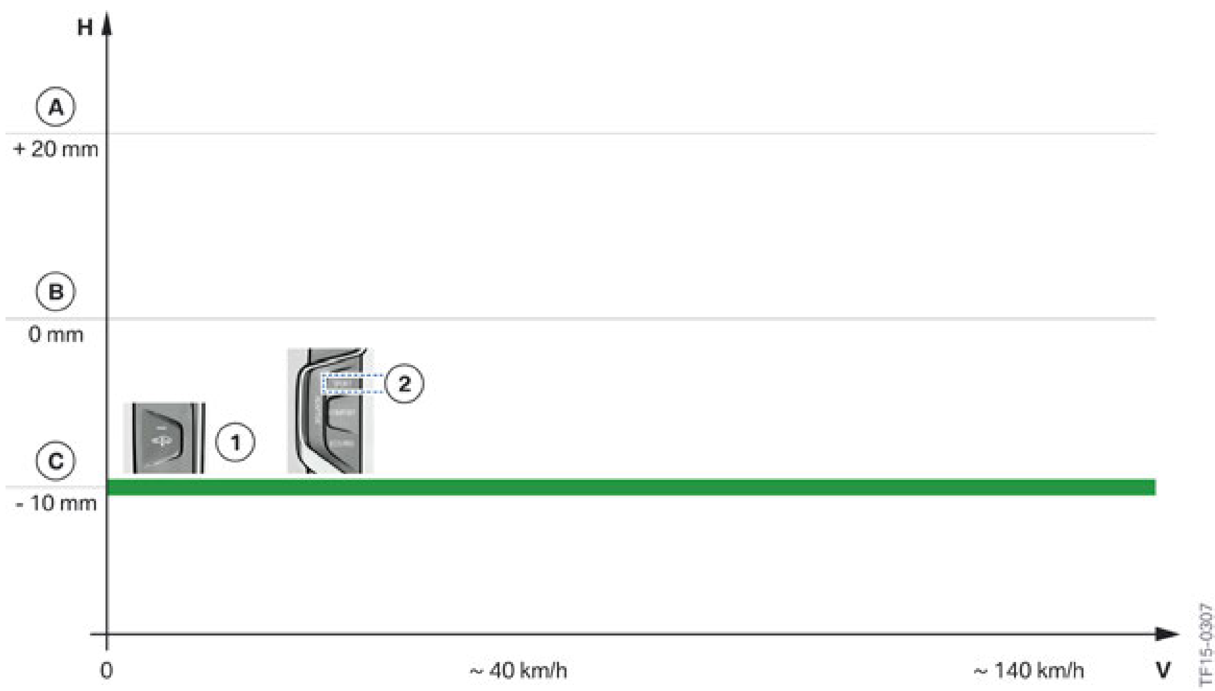
- Ride height selection switch in Normal position.
- Driving experience switch **not** in Sport position.

3. Air Suspension

When a driving speed of ~ 140 km/h / ~ 87 mph is exceeded, the vehicle body is automatically lowered from Normal level to Sport level (-10 mm) independently of the respective switch settings. Lowering to Sport level offers the following advantages:

- Low vehicle center of gravity and thus increased driving dynamics.
- Improved aerodynamics and thus lower fuel consumption.

3.4.3. Sport level



Operating strategy of the air suspension in the G12 at Sport level

Index	Explanation
A	High level (+ 20 mm)
B	Normal level (+/- 0 mm)
C	Sport level (- 10 mm)
H	Ride height of the vehicle body
v	Vehicle speed
1	Ride height selection switch at Normal level
2	Driving experience switch in Sport setting

Sport level (- 10 mm) can be set by means of the following switch positions.

- Ride height selection switch in Normal position.
- Driving experience switch in Sport position.

Sport level (- 10 mm) offers the highest driving dynamics of all ride heights due to the low vehicle center of gravity. The fuel consumption also falls due to the improved aerodynamics.

3.5. Notes for Service

Complete (100%) tightness of the air suspension cannot be guaranteed due to the numerous flexible compressed air lines with the corresponding compressed air connections. A defined low loss of compressed air is therefore permissible. If the vehicle is parked at Normal level, the ride height may be lowered by up to a maximum of – 2 mm after 24 hours. This means that the ride height may be lowered by up to - 60 mm for a vehicle that has been parked for 30 days without there being a fault caused by a leak.

Side view of the G12 with air suspension lowered to maximum extent

Since components do not all leak to the same extent for tolerance reasons, it is also possible that the vehicle will be sloping at an angle after a prolonged standstill time.

Low and sloping vehicle positions are automatically compensated by the air suspension after detection of the vehicle condition Residing/Awake. For this purpose, the missing compressed air is forwarded to the corresponding spring struts by the pressure accumulator. If the filling pressure of the pressure accumulators is too low, the lack of air is compensated by switching on the electrical compressor.

The following scenarios for activation of the electrical compressor are possible:

1 If the ride height is less than – 40 mm, the compressor will be switched on only when the engine is running.

2 If the ride height is more than – 40 mm and the vehicle electrical system has sufficient voltage, the compressor will already be switched on when the vehicle condition Residing/Awake is detected.

3.5.1. Lifting the vehicle

The air suspension has a jack detection function. This prevents control action of the air suspension when the vehicle is lifted.

3.5.2. Transport mode

The air suspension is in transport mode when new vehicles are delivered. A change in the ride height is not possible. Transport mode must be deleted using the BMW diagnosis system ISTA during the pre-delivery check. The different ride heights of the air suspension can be selected only after successful start-up of the air suspension (transport mode deleted).

3.5.3. Bleeding the air suspension

When working on components of the air suspension system, it is necessary to depressurize the system before undoing the various compressed air lines. This can be done using the BMW diagnosis system ISTA by means of a bleeding routine. Here, the various solenoid valves of the air suspension struts and the electrical drain solenoid valve are activated simultaneously. In order to protect the valves against overheating, the bleeding routine cannot be performed an arbitrary number of times in succession. However, the function is available again after a defined waiting period.

⚠

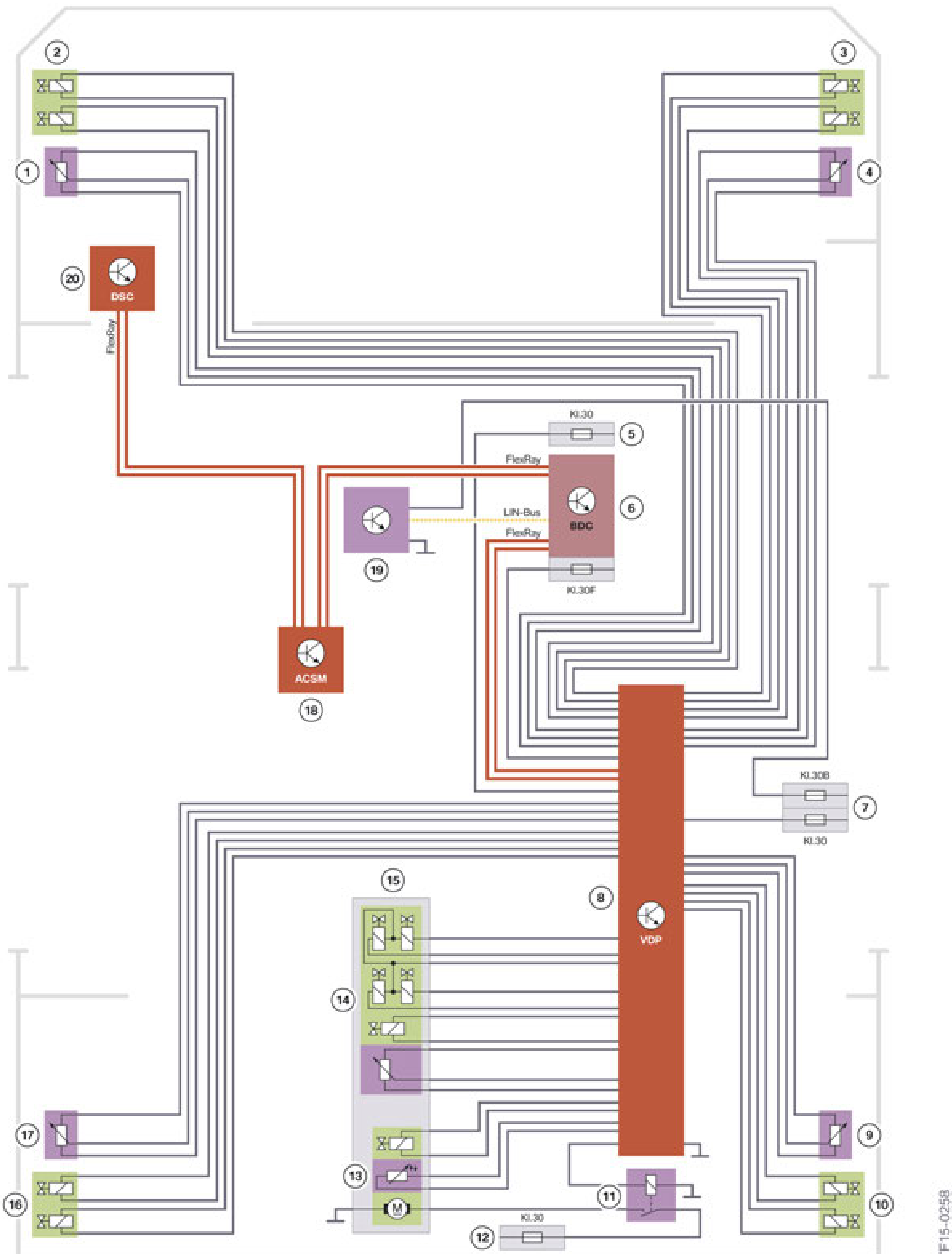
In order to avoid damage to the air suspension struts, the vehicle should be raised slightly using a vehicle hoist during the bleeding routine.

However, it is not recommended to completely lift the vehicle during the bleeding routine as this hampers complete emptying of the compressed air from the air suspension struts.

3.5.4. Filling the air suspension

The system is filled automatically via the vehicle's electrical compressor as soon as the marginal conditions for this are met. In order to perform a leakage test of the air suspension in Service, the electrical compressor can be switched on manually to fill the system using the BMW diagnosis system ISTA. If the air suspension is filled several times, the electrical compressor may be switched off to prevent the compressor from being damaged.

3.6. System wiring diagram



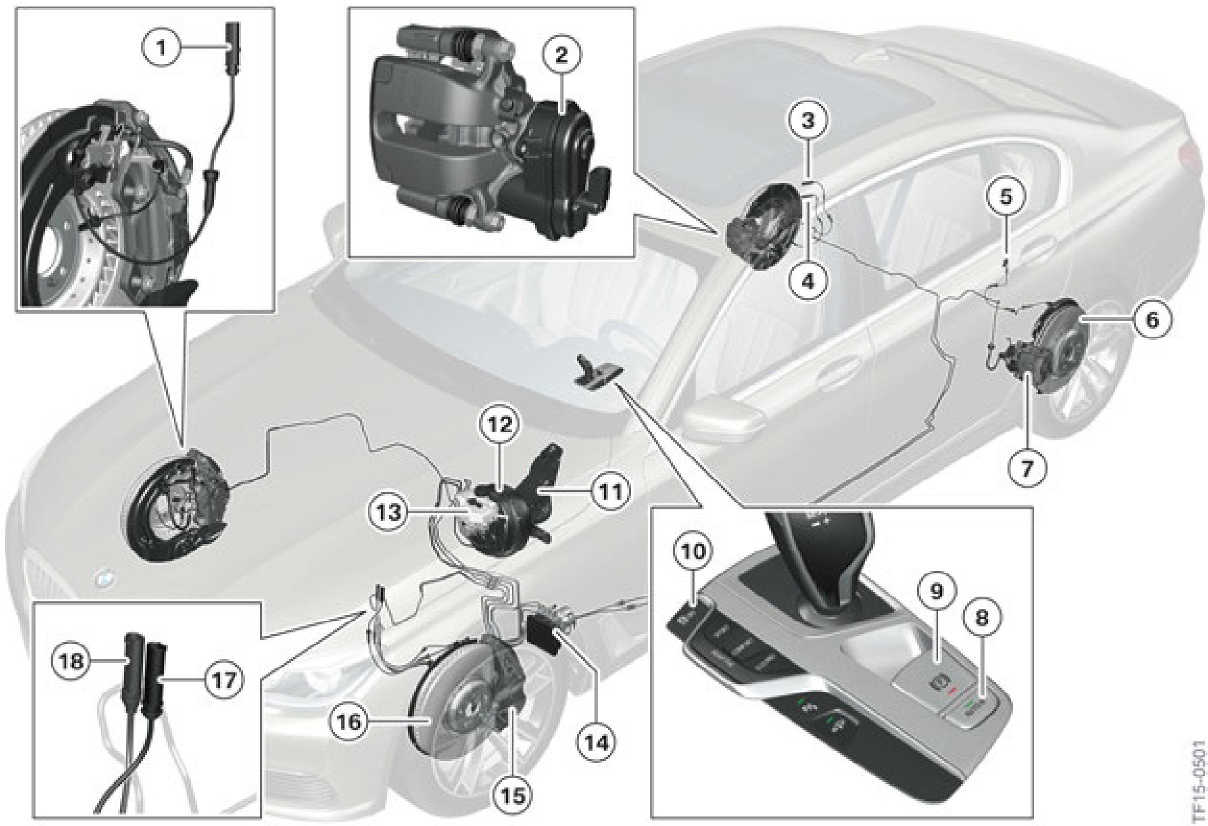
System wiring diagram of the two-axle ride level control in the G12

Index	Explanation
1	Ride height sensor, front left
2	EDC valve, front left (Electronic Damper Control)
3	EDC valve, front right (Electronic Damper Control)
4	DSC ride height sensor, front right
5	Power distribution box, front right
6	Body Domain Controller (BDC)
7	Rear right power distribution box
8	Vertical Dynamics Platform (VDP)
9	Ride height sensor, rear right
10	EDC valve, rear right (Electronic Damper Control)
11	Relay for air supply system
12	Positive battery terminal distributor
13	Compressor
14	Solenoid valve block
15	Air supply system
16	EDC valve, rear left (Electronic Damper Control)
17	Ride-height sensor, rear left
18	Crash Safety Module (ACSM)
19	Ride height selection switch
20	Dynamic Stability Control (DSC)

G12 Chassis and Suspension

4. Brakes

The following graphic provides an overview of the brake system of the G12.



Overview of brake system in the G12

Index	Explanation
1	Plug-in contact, wheel-speed sensor, front right
2	EMF actuator (electromechanical parking brake)
3	Plug-in contact, wheel speed sensor, rear right
4	Plug-in contact, brake pad wear sensor, rear right
5	Plug-in contact, wheel speed sensor, rear left
6	Brake disc, rear axle
7	Brake caliper, rear axle
8	Auto-Hold button
9	Parking brake button
10	DSC button
11	Bearing support, pedal mechanism
12	Brake servo
13	Brake fluid expansion tank
14	Dynamic Stability Control (DSC)

Index	Explanation
15	Brake caliper, front axle
16	Brake disc, front axle
17	Plug-in contact, wheel-speed sensor, front left
18	Plug-in contact, brake pad wear sensor, front left

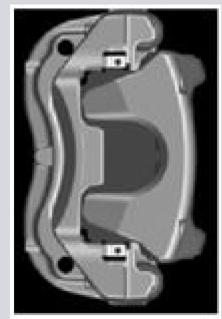
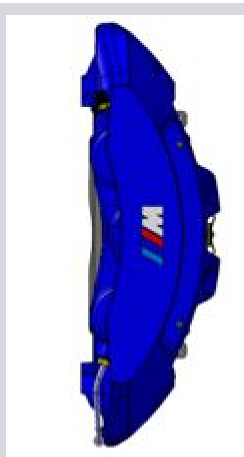
G12 Chassis and Suspension

4. Brakes

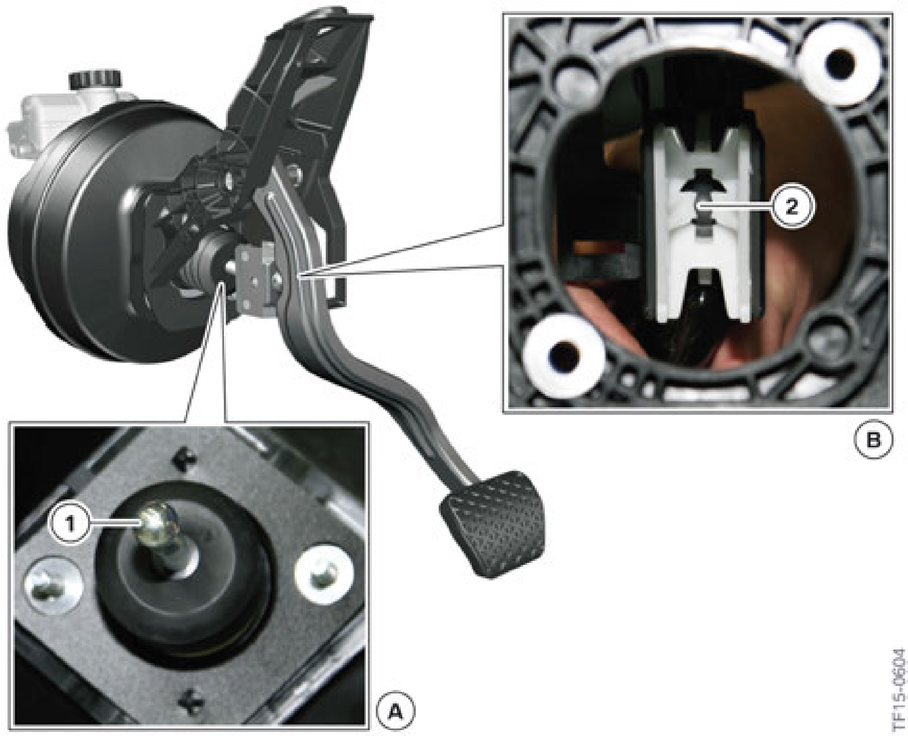
4.1. Service brakes

4.1.1. Brake design

In order to enhance the visual appearance of the brakes, Black painted calipers are optional in the "Autobahn Package" (ZAN).

Versions	Front axle	Rear axle
Standard caliper		
Autobahn Package with BMW logo print		
M Sport		

4.1.2. Pedal mechanism mounting



Mounting of the pedal mechanism on the brake servo linkage in the G12

Index	Explanation
A	Brake servo linkage
B	Pedal mechanism
1	Ball head
2	Plastic clip

A modified mounting is used in the G12 between the pedal mechanism and the brake servo linkage. Here, the ball head of the brake servo linkage is engaged in a plastic clip on the pedal mechanism.

A new special tool is needed to release this connection.

Part number 83 30 2 409 646

Special tool for removing the pedal mechanism

When removing the pedal mechanism, always observe the instructions in the current repair instructions.

4.2. Parking brake

The BMW E65/E66 (BMW 7 Series from 2001 – 2008) was the first production vehicle in the world with an electromechanical parking brake EMF. This was followed by many other BMW models with different electrical parking brake systems.

The following advantages result from the use of such a system:

- More storage space due to omission of a parking brake lever and parking brake Bowden cable.
- Contact pressure of brake pads correctly adjusted at all times.
- Various additional functions to assist the driver (e.g. automatic release when driving off).
- Higher braking power of auxiliary brake system.

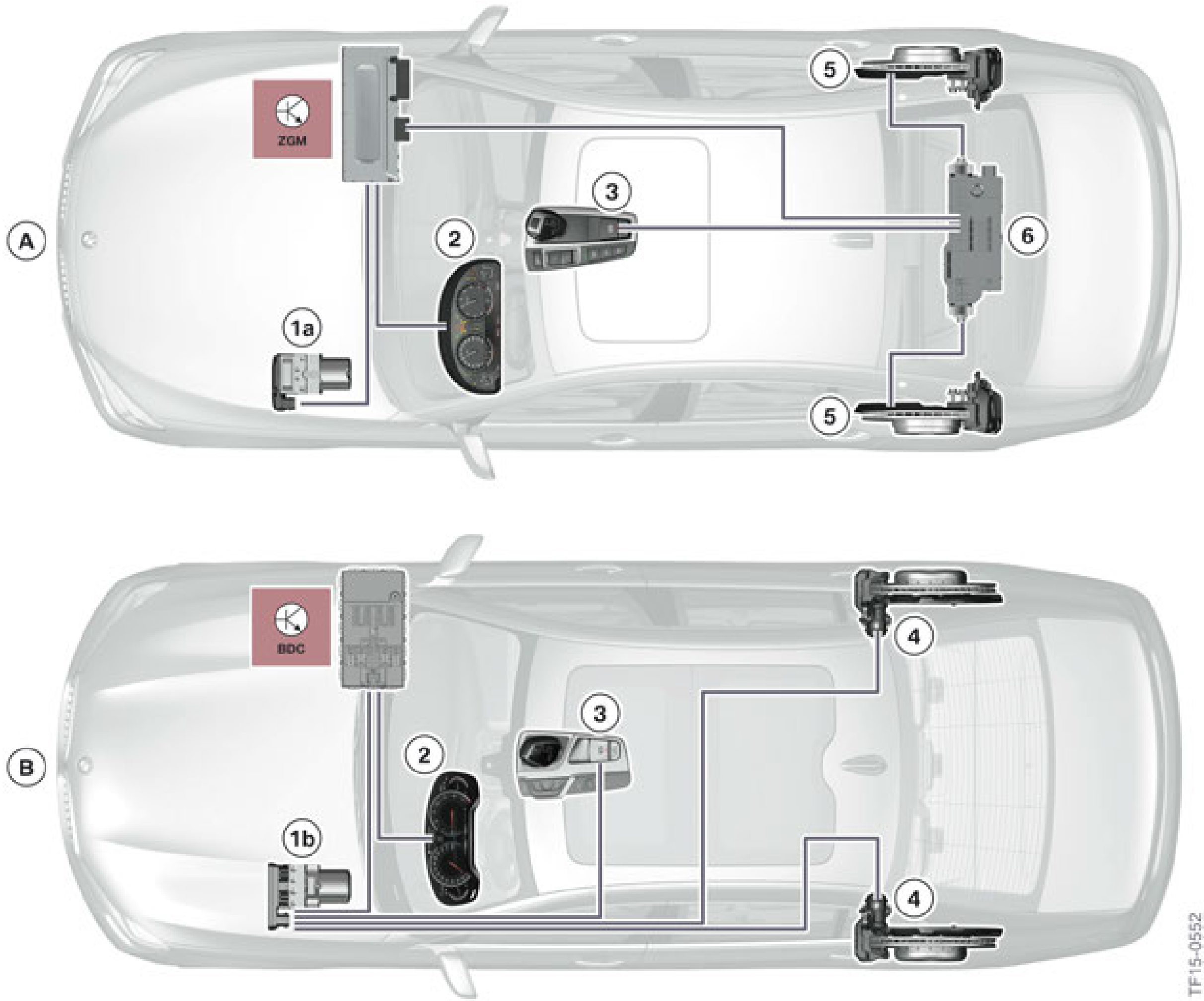
The following 2 different electrical systems are currently used at BMW:

- Electromechanical parking brake = Cable pull system via duo-servo parking brake (Küster system).
- Electric parking brake = Combined brake caliper (TRW/Continental system).

G12 Chassis and Suspension

4. Brakes

The following graphic shows a comparison of the two systems.



System comparison of the electromechanical parking brake in the F01/F02 with the electric parking brake of the G12

Index	Explanation
A	F01/F02 (BMW 7 Series from 2008 – 2015)
B	G12 (BMW 7 Series from 2015)
1a	DSC control unit (Dynamic Stability Control)
1b	DSC control unit with integrated parking brake function (Dynamic Stability Control)
2	Instrument panel (KOMBI)
3	Parking brake button
4	Electric parking brake via actuator at combined brake caliper

4. Brakes

Index	Explanation
5	Electromechanical parking brake via duo-servo parking brake
6	Electromechanical parking brake actuator unit with integrated control unit (electromechanical parking brake)
BDC	Body Domain Controller
ZGM	Central gateway module

In contrast to the cable pull system in the F01/F02, the electric parking brake system with a combined brake caliper familiar from the smaller series is used in the G12.

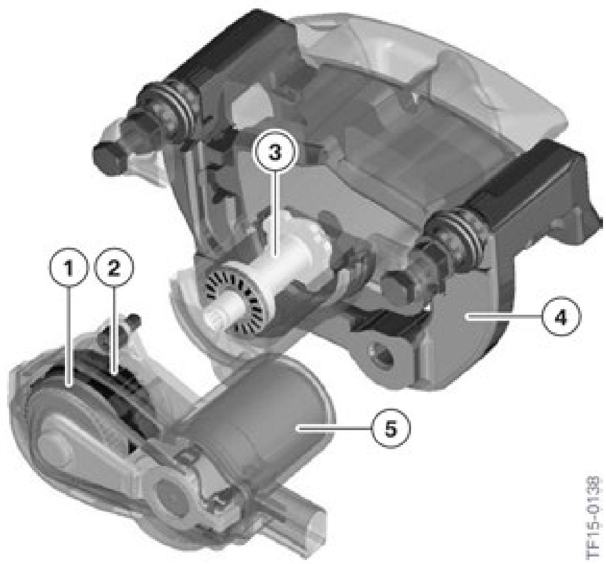
Previously, the parking brake was realized by means of a duo-servo parking brake in the heavy upper class vehicles. The advantage of this system is the high self-locking force of the brake pads when the parking brake is applied.

Due to the increase in the preload forces of the combined brake caliper with electric parking brake, it was possible to dispense with the previously used cable pull system in the G12. Omission of the associated components is beneficial for weight reduction and also for the repair friendliness of the G12.

The electric parking brake of the G12 is differentiated above all by the fact that there is no separate control unit. The electric parking brake is activated via the control unit of the Dynamic Stability Control (DSC). There is a parking brake button on the center console for activating or deactivating the electric parking brake. The driver is informed about the current system status via the instrument cluster KOMBI.

The brake pad is applied with a precisely calculated preload force via two actuators screwed onto the brake calipers. A temperature model is stored in the DSC control unit which makes it possible to draw conclusions about the brake disc temperatures. As the contact pressure decreases when the brake discs cool down, the system must adjust the brake pads as appropriate, particularly if the brake discs are hot. The time and frequency of the adjustment varies depending on the initial temperature calculated.

When the electric parking brake is opened, the actuators are moved back only until the brake pads have reached their correctly set clearance. Due to this readjustment function, the actuators must be moved back before exchanging the brake pads in Service. For the detailed procedure, refer to the current repair instructions.



Actuator for electric parking brake in the G12

Index	Explanation
1	Belt drive
2	Planetary gears
3	Spindle nut
4	Brake caliper
5	Electric motor (DC)

There is an electric motor with belt drive and planetary gear on the housing of the combined brake caliper with electric parking brake. When the electric motor is activated, the force is transmitted via the belt drive and planetary gear to the spindle nut. The spindle nut generates the required stroke to apply the brake pad. The control unit of the Dynamic Stability Control can determine the preload force on the basis of the rise in current of the electric motor.

When carrying out servicing work, an extended spindle nut can be travelled back to its initial position as follows:

- Special tool for mechanically turning back
- Service function “Workshop mode” in the BMW diagnosis system ISTA

4.2.1. Functions

Dynamic emergency braking

If the parking brake button is operated during the journey above a defined driving speed, the DSC unit initiates a dynamic emergency braking operation. A pressure build-up occurs in all 4 wheel brakes due to activation of the 6-piston pump and the changeover valves in the DSC unit. The slip limits of all wheels are monitored with the assistance of the four wheel speed sensors to ensure a stable braking operation until the vehicle comes to a standstill. The two actuators of the electric parking brake are activated as soon as the vehicle comes to a standstill. The vehicle is then secured to prevent it from rolling away only by means of the parking brake.

Automatic release of the parking brake

This function allows the driver to drive off when the parking brake is activated without operating the parking brake button to release the brake.

Prerequisites for releasing the electric parking brake:

- Driver's door is closed
- Vehicle condition DRIVING
- Electric parking brake actuated
- Drive position engaged
- Accelerator pedal operated

4.2.2. Brake test stand

The Dynamic Stability Control (DSC) has a roller mode so that the braking power of the electric parking brake can be checked on a brake test stand. When roller mode is activated, the vehicle is braked via the actuators of the electric parking brake when the parking brake button is pressed. A DSC pressure build-up in the 4 wheel brakes does not take place. This makes it possible to determine the brake forces of the electric parking brake.

In the G12, roller mode is automatically detected on the basis of a plausibility check (wheel speed comparison). The detection takes a maximum of 5 seconds (can be recognized by slow flashing of the red parking brake indicator light).

After activation of test stand mode the system is in test stand mode. This condition is acknowledged by the indicator light of the parking brake starting to flash at a frequency of 1 Hz. The parking brake can be applied in 5 stages using the parking brake button. In this case, the braking varies between the minimum braking power in the first stage and the maximum braking power once the parking brake button has been pressed five times. If the button is operated continuously, the system increases the braking power automatically incrementally up to the maximum braking power. The flashing frequency of the parking brake indicator light changes from 1 Hz to 3 Hz when the parking brake button is pressed in test stand mode.

The following points must be observed during the test:

- Do not press the accelerator
- Drive position N (neutral)
- Do not press the footbrake

4.3. Service information

4.3.1. Service brakes

The status of the brake pads cannot be read out permanently via the Central Information Display (CID).

The following graphic shows the vehicle status without and with information about the status of the brake pads on the Central Information Display (CID).

CID message on vehicle status in the G12

Index	Explanation
A	Brake pad wear sensor within limits
B	Brake pad wear sensor outside limits
1	Vehicle status
2	OK Engine oil
3	OK Brake fluid
4	OK § vehicle inspection
5	OK Vehicle check
6	▲ Brake pads rear (pad wear shortly before the wear limit)

The G12 is equipped with a one-stage brake pad wear sensor. No vehicle status about the current status of the brake pads is output as long as this sensor has not been ground by the brake disc.

Before the wear limit of the brake pad is reached, the sensor wire of the one-stage brake pad wear sensor is cut through by the rotating brake disc while driving. As from this point, the vehicle status of the brake pads can be checked on the Central Information Display (CID). The remaining distance until the wear limit of the brake pad is reached is 4000 - 5000 km / 2500 - 3100 miles, depending on driving style.

In addition, the driver is informed about the condition of the brake pads by means of the following warnings.

Remaining distance	Yellow Check Control message	Red Check Control message
< 2000 km / <1200 miles	X	
0 km / 0 miles		X

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The current repair instructions must always be observed in order to avoid interference noises after brake pad replacement.

4.3.2. Parking brake

Replacing brake pads

In order to replace the brake pads of the rear parking brake calipers, it is first necessary to turn back the drive spindle in the brake caliper. This can be done either manually using a special tool or using the BMW diagnosis system ISTA. The parking brake button is blocked to prevent use after activation of workshop mode via the BMW diagnosis system ISTA. This prevents injury during the brake service. The parking brake button is enabled again at the start of driving or after exiting workshop mode.

After enabling via the speed threshold of 3 km/h / 1.8 mph, the parking brake must be re-initialized by button operation (apply/release brake).

Emergency release

It is possible to mechanically turn back the drive spindle to release the parking brake after removing the actuator housing from the brake caliper. To prevent accidents, the vehicle must first be secured to prevent it from rolling away.

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Emergency release of the electric parking brake is permitted only by correspondingly trained personnel.

G12 Chassis and Suspension
5. Wheels / Tires

The G12 will be equipped in the standard equipment configuration with run-flat tires. A spare wheel is available as optional equipment.

Components	Standard equipment	Optional equipment
Run-flat tires	X	
Spare wheel (OE 300)		X

Tires of the G12

Index	Explanation
A	Tires without emergency running properties (Not for US)
B	Run-flat tires

In the event of tire pressure loss in a run-flat tire, the customer can still drive at a restricted speed (max. 80 km/h / 50 mph) for a remaining distance that is dependent on the vehicle load. On vehicles with the optional chassis and suspension package “Active Comfort Drive”, the vehicle weight is automatically distributed via the active electric stabilizers when driving with an unpressurised run-flat tire so that the unpressurised wheel (< 0.5 bar) is relieved to the maximum possible extent and the intact wheels loaded correspondingly. This ensures that the maximum possible remaining distance can be driven. The maximum permitted remaining distance with medium load is 80 kilometres / 50 miles.

Further information on the function of the active electric stabilizer is provided in the section “Autobahan Package”.

A damaged run-flat tire can also be replaced by a tire without emergency running properties in the event of tire failure. However, the tire without emergency running properties must be replaced at the earliest opportunity by a run-flat tire.

5. Wheels / Tires

5.1. Puncture detection systems

Depending on country, the G12 is equipped with the following systems for puncture detection:

- Tire pressure control (RDC)

5.2. Tire Pressure Monitor RDCi

System overview of tire pressure control RDCi in the G12

G12 Chassis and Suspension

5. Wheels / Tires

Index	Explanation
1	Wheel electronics, front right
2	Central Information Display (CID) (display of tire pressures possible)
3	Wheel electronics, rear right
4	Remote control receiver (FBD)
5	Wheel electronics, rear left
6	Instrument panel (KOMBI)
7	Dynamic Stability Control (DSC)
8	Wheel electronics, front left

The G12 is equipped with the RDCi already familiar from the F15. The RDCi is a system which performs direct measurement and which determines the real tire pressures by means of wheel electronics in each wheel. Unlike with the RDC low, a separate RDC control unit is not required for the RDCi. The functions of the RDCi are integrated into the Dynamic Stability Control (DSC) control unit. The remote control receiver (FBD) acts as a receiver for the sent reports of all wheel electronics. It then forwards this information via bus to the DSC control unit.

The previous RDCi systems were supplied by Continental. The system supplier of the RDCi in the G12 is the company Schrader. In order to ensure fault-free operation of the system, it is essential that only Schrader wheel electronics are used. It is not possible to assume any liability for malfunctions with third-party wheel electronics.

On the G12, the rest times required by the system before the new wheel electronics can be taught, have changed. Previously, a vehicle with RDCi had to be stationary for an uninterrupted period of at least 8 minutes independently of the terminal status before the DSC control unit accepted the IDs of the new wheel electronics.

On the G12, the vehicle condition is decisive for the times required by the system before the IDs of new wheel electronics are accepted and taught. The following table provides an overview of the different conditions.

Vehicle condition	5 minutes	17 minutes
Residing/Awake	X	
Driving		X

⚠

So that new wheel electronics can be taught by the Dynamic Stability Control (DSC), a standing time of at least 5 minutes (Residing/Awake) or 17 minutes (driving) must be observed after a wheel exchange.

If the standing time of at least 5 minutes (Residing/Awake) or 17 minutes (driving) was not reached before starting a journey with new wheel electronics, a Check Control message will be displayed to the driver after a certain time. In this case, the vehicle must only remain stationary for an uninterrupted period of longer than 5 minutes in Residing/Awake mode or 17 minutes in Driving mode. The new wheel electronics will then be automatically taught by the control unit of the Dynamic Stability Control (DSC).

The vehicle can also be in the vehicle condition Driving when the engine has been switched off by the automatic engine start-stop function MSA.

The system must be re-initialized in the event of changes in the tire pressures as well as after wheel exchange. Initialization of the new tire pressures can be performed using the controller on the Central Information Display (CID).

5.2.1. Wheel electronics

Wheel electronics from Schrader in the G12

The wheel electronics are in the following modes, depending on the system status:

- Sleep mode
- Teach-in mode
- Readiness mode

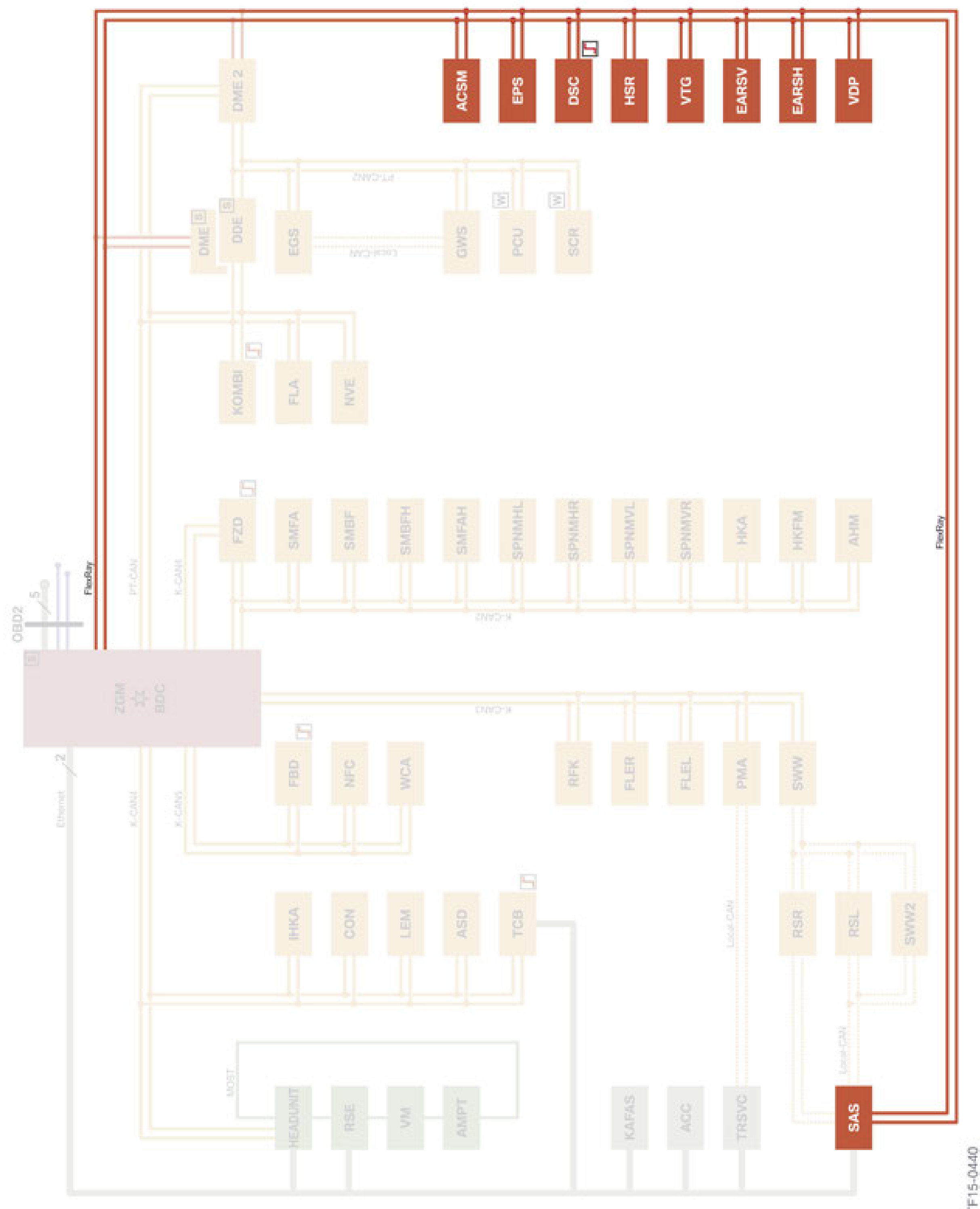
There are also changes in the transmission modes of the Schrader wheel electronics in comparison with the transmission modes of the wheel electronics from Continental. In order to guarantee the longest possible battery capacity, the wheel electronics require longer standing times before they switch to teach-in mode.

After 15 minutes in rest mode (wheel standstill), the wheel electronics start to transmit in teach-in mode as soon as they are accelerated to a speed faster than around 20 km/h. In teach-in mode, the reports are sent to the DSC control unit every 15 seconds for approximately 9 minutes (40 reports). Transmission in teach-in mode allows the DSC control unit to calculate the installation position of the respective wheel electronics. The wheel electronics will start to transmit in readiness mode if a wheel set was changed from one vehicle to another without the wheel set having been in rest mode (wheel standstill) for an uninterrupted period of more than 15 minutes. Teaching of the wheel electronics is not possible in readiness mode.

Balancing of the wheel set shortly before fitting on the vehicle is not a problem. Since only a small number of reports are transmitted in teach-in mode during balancing, the remaining reports are sufficient to reliably teach the wheel electronics.

The battery status of the wheel electronics can be read out via the BMW diagnosis system ISTA. The remaining battery life is specified in percent.

Detailed information on the operating principle of the RDCi is provided in the Training Reference Manual “I01 Complete Vehicle”.



Bus overview G12

G12 Chassis and Suspension
6. Driving Stability Control

Index	Explanation
ACC	Active cruise control
ACSM	Crash Safety Module
AHM	Trailer module (Not for US)
AMPT	Amplifier Top (top high fidelity amplifier)
ASD	Active Sound Design
BDC	Body Domain Controller
CON	Controller
DDE	Digital Diesel Electronics (Not for US)
DME	Digital Motor Electronics
DME2	Digital Engine Electronics 2
DSC	Dynamic Stability Control
EARSVH	Electric active roll stabilization rear
EARSVV	Electric active roll stabilization front
EGS	Electronic transmission control
EPS	Electromechanical Power Steering
FLA	High-beam assistant
FLER	Frontal Light Electronics Right
FLEL	Frontal Light Electronics Left
FZD	Roof function center
GWS	Gear selector
HEADUNIT	Head unit
HKA Rear climate control	Automatic rear air-conditioning and heating
HKFM	Tailgate function module
HSR	Rear axle slip angle control
IHKA	Integrated automatic heating / air conditioning
KAFAS	Camera-based driver support systems
KOMBI	Instrument panel
LEM	Light Effect Manager
NFC	Near Field Communication
NVE	Night Vision Electronics
PCU	Power Control Unit
PMA	Parking manoeuvring assistant
RFK	Reversing camera
RSE	Rear Seat Entertainment

G12 Chassis and Suspension
6. Driving Stability Control

Index	Explanation
RSL	Radar Sensor Left (avoidance assistant)
RSR	Radar Sensor Right (avoidance assistant)
SAS	Optional equipment system
SCR	Selective Catalytic Reduction control unit (Not for US)
SMBF	Seat module, passenger
SMBFH	Seat module, passenger, rear
SMFA	Seat module, driver
SMFAH	Seat module, driver, rear
SPNMHL	Seat pneumatics module back left
SPNMHR	Seat pneumatics module back right
SWW	Lane change warning (main)
SWW2	Lane change warning (secondary)
TCB	Telematic Communication Box
TRSVC	Control unit for rear view camera and SideView
VDP	Vertical Dynamic Platform
VM	Video Module (Not for US)
VTG	VTG control unit
WCA	Wireless charging tray
ZGM	Central gateway module

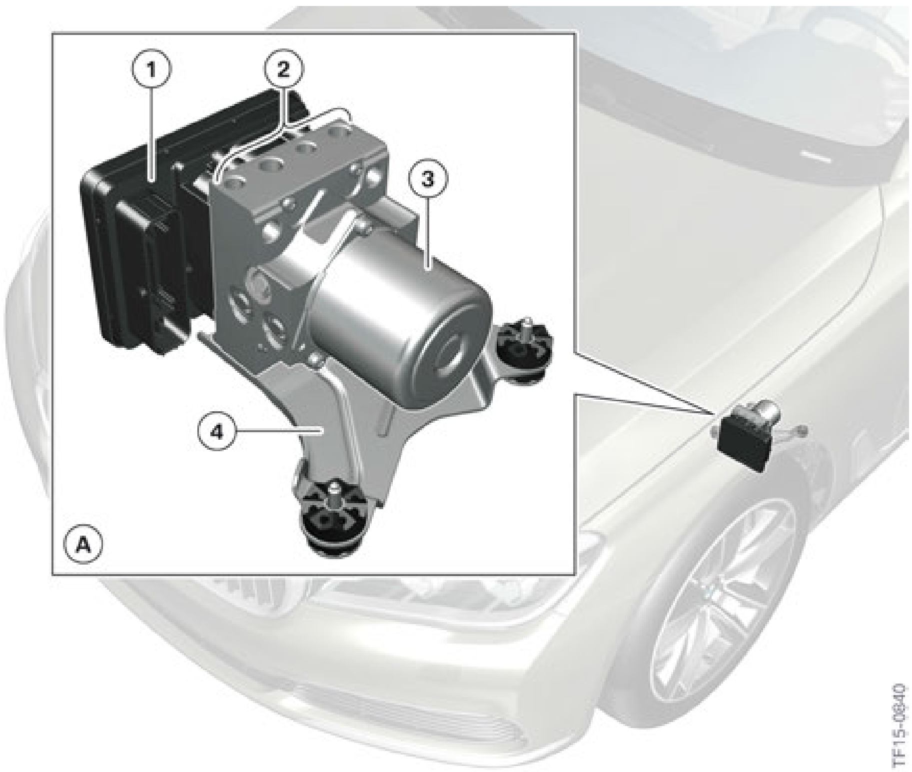
The control units that are relevant to driving dynamics are interconnected via the FlexRay bus. This bus is characterized above all by its high data transfer rate of 10 MBit/s.

The most important systems and their functions are described in more detail below.

6. Driving Stability Control

6.1. Dynamic Stability Control (DSC)

Alongside the Vertical Dynamics Platform (VDP) control unit, the Dynamic Stability Control (DSC) represents the core element of the driving dynamics control systems used to increase active safety. It optimizes driving stability in all driving conditions and also traction when driving off and accelerating. It also identifies unstable driving conditions such as understeering or oversteering and helps maintain the vehicle on a steady course.

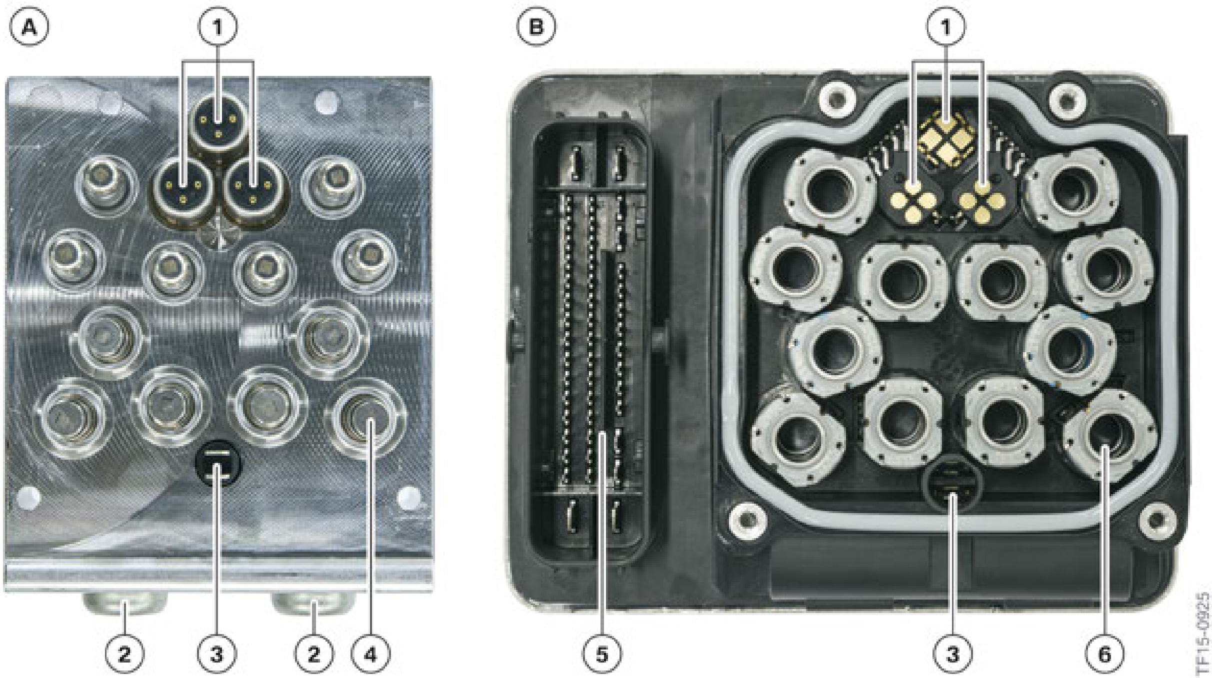


Installation position of Dynamic Stability Control (DSC) in the G12

Index	Explanation
A	DSC unit
1	DSC control unit
2	Brake line connections at the DSC hydraulic control unit
3	Return pump
4	Bracket

The Dynamic Stability Control (DSC) is located in the front lower area of the vehicle. The manufacturer designation is TRW DSC-EBC460. Due to the different connection diameters of the brake lines, channel confusion of the various hydraulic lines is not possible.

6. Driving Stability Control



DSC unit in the G12

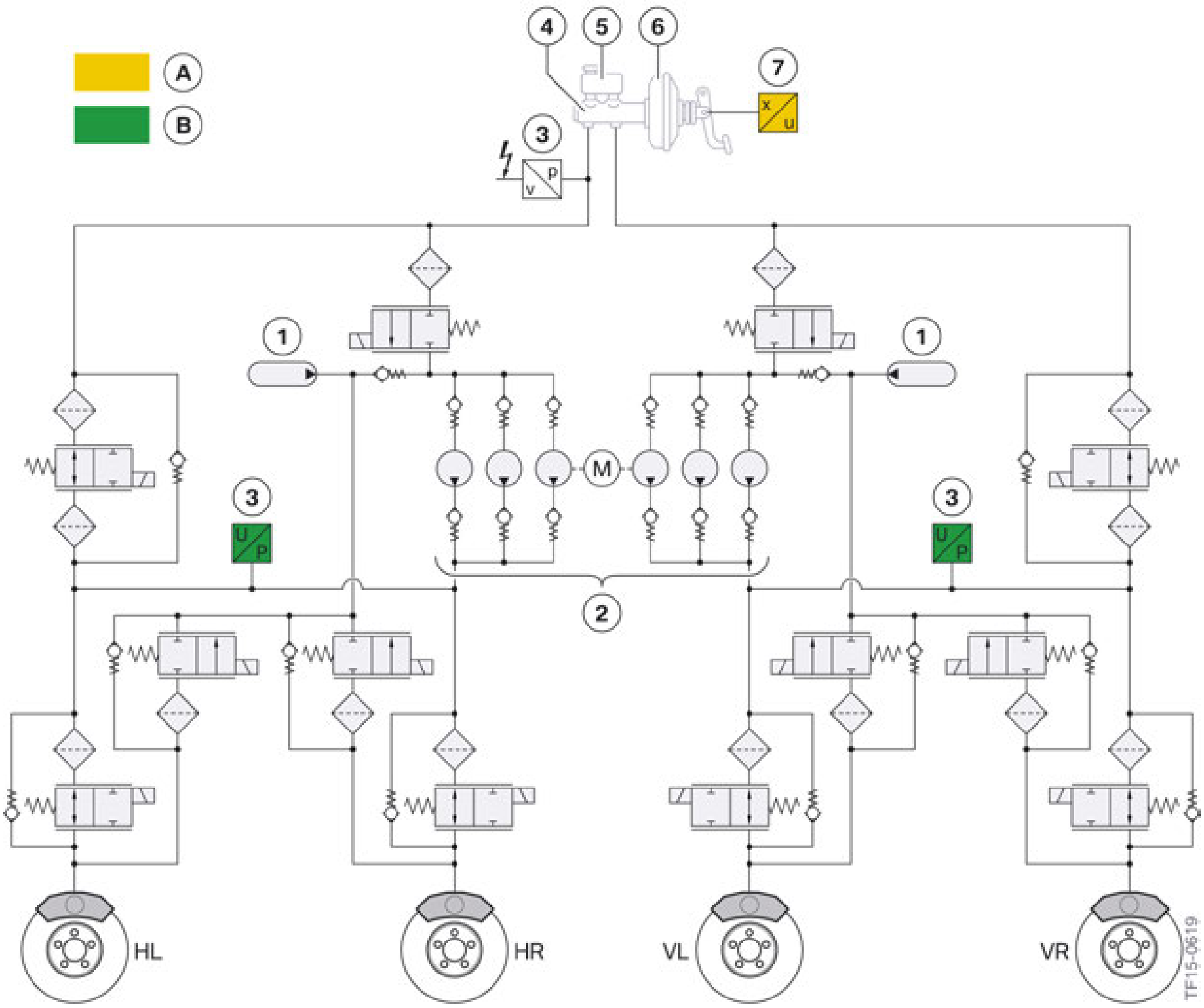
Index	Explanation
A	DSC hydraulic unit
B	DSC control unit
1	Pressure sensors
2	Hydraulic damping elements
3	Return pump activation
4	Solenoid valves (12x)
5	Control unit connector
6	Solenoid valve coils (12x)

The DSC control unit and the DSC hydraulic control unit are screwed together. The DSC control unit can be replaced individually to reduce servicing costs.

In older series, the different driving dynamics systems are connected via the Integrated Chassis Management (ICM) control unit. The control unit of the Dynamic Stability Control (DSC) in the G12 has an additional storage element (black box) in which some of the functions of the Integrated Chassis Management (ICM) are stored. The different driving dynamics control systems are coordinated perfectly by means of the algorithms stored in the black box.

The functions of the tire pressure control (RDC) and electric parking brake (EPB) were integrated in the DSC control unit.

6.1.1. Hydraulic circuit diagram



Hydraulic circuit diagram of TRW DSC-EBC460

Index	Explanation
A	Installed only on hybrid version
B	Only for optional equipment active cruise control with Stop & Go function
1	Hydraulic damping elements
2	6-piston pump
3	DSC pressure sensor
4	Brake master cylinder
5	Brake fluid expansion tank
6	Brake servo
7	Brake pedal travel sensor
AV	Exhaust valves

G12 Chassis and Suspension
6. Driving Stability Control

Index	Explanation
EV	Intake valves
HL	Rear axle on left
HR	Rear axle on right
TV	Separator valves
UPS	Changeover valves
VL	Front axle on left
VR	Front axle on right

Different DSC versions are used depending on the drive type and equipment range. In the hybrid version, there is an additional brake pedal travel sensor on the footbrake lever.

If the vehicle is equipped with the optional equipment “Active cruise control with Stop & Go function”, there are 2 additional pressure sensors in the hydraulic unit.

6.1.2. Functions

The following table provides an overview of the different functions of the DSC unit.

Function	Explanation
Antilock Brake System (ABS)	Prevents blocking of individual wheels when braking through targeted modulation of the brake pressures. Vehicle steerability is maintained.
Dynamic Stability Control (DSC)	If the vehicle starts to understeer or oversteer, it is stabilized by targeted brake interventions at individual wheels.
Dynamic Traction Control (DTC)	This is a special mode of the Dynamic Stability Control (DSC). In interaction with ASC and DSC, this mode features extended intervention thresholds and permits an even sportier driving style without interventions on normal surfaces as well as maximum propulsion on loose ground such as snow, sand or coarse gravel.
Cornering Brake Control (CBC)	Prevents the vehicle from turning in when it is braked lightly under high lateral acceleration forces by means of asymmetrical control of the brake pressure. The cornering stability is improved.
Automatic Stability Control (ASC)	Prevents the drive wheels from spinning by targeted braking of these wheels and adaptation of the drive torque delivered by the engine. Vehicle propulsion is optimized as a result and driving stability is maintained.
Dynamic Brake Control (DBC)	In the event of panic braking initiated by the driver, the system supports the driver by automatically immediately applying the maximum brake pressure to ensure the best possible deceleration.
Automatic Differential Brake (ADB-X)	Replicates the function of a differential lock. If a wheel displays a tendency to spin, this wheel is automatically braked so that propulsion can still be achieved via the other wheel of the driven axle.
Trailer stabilization control	Automatically detects when a vehicle with trailer is starting to snake, stabilizes the outfit by targeted brake interventions and simultaneously decelerates it to an uncritical speed for snaking.

Function	Explanation
Brake standby	Builds up a moderate brake pressure in the system when the driver takes his foot off the accelerator pedal very quickly. The brake pads are applied slightly as a result. The braking effect then acts more quickly if the driver then performs panic braking.
Dry by applying brake	Depending on operation of the wiper, applies the brake pads gently at intervals in order to dry the brake discs. The braking effect is significantly improved by this when the vehicle is braked.
Fading support	Supports the driver when braking if the brake temperature has become very high due to an extreme driving style and the desired deceleration can be achieved only by applying a higher brake force.
Drive-off assistant	Holds the vehicle for approximately 1.5 s on uphill gradients when the driver releases the brake to drive off. This allows the driver to drive off comfortably without the vehicle rolling away on its own.
Automatic Hold	Automatically holds the vehicle after it has come to a standstill without it being necessary to still press the brake when the drive position is selected. The brake is automatically released when the accelerator pedal is pressed and the vehicle drives away normally. The function can be switched on and off by means of a button.

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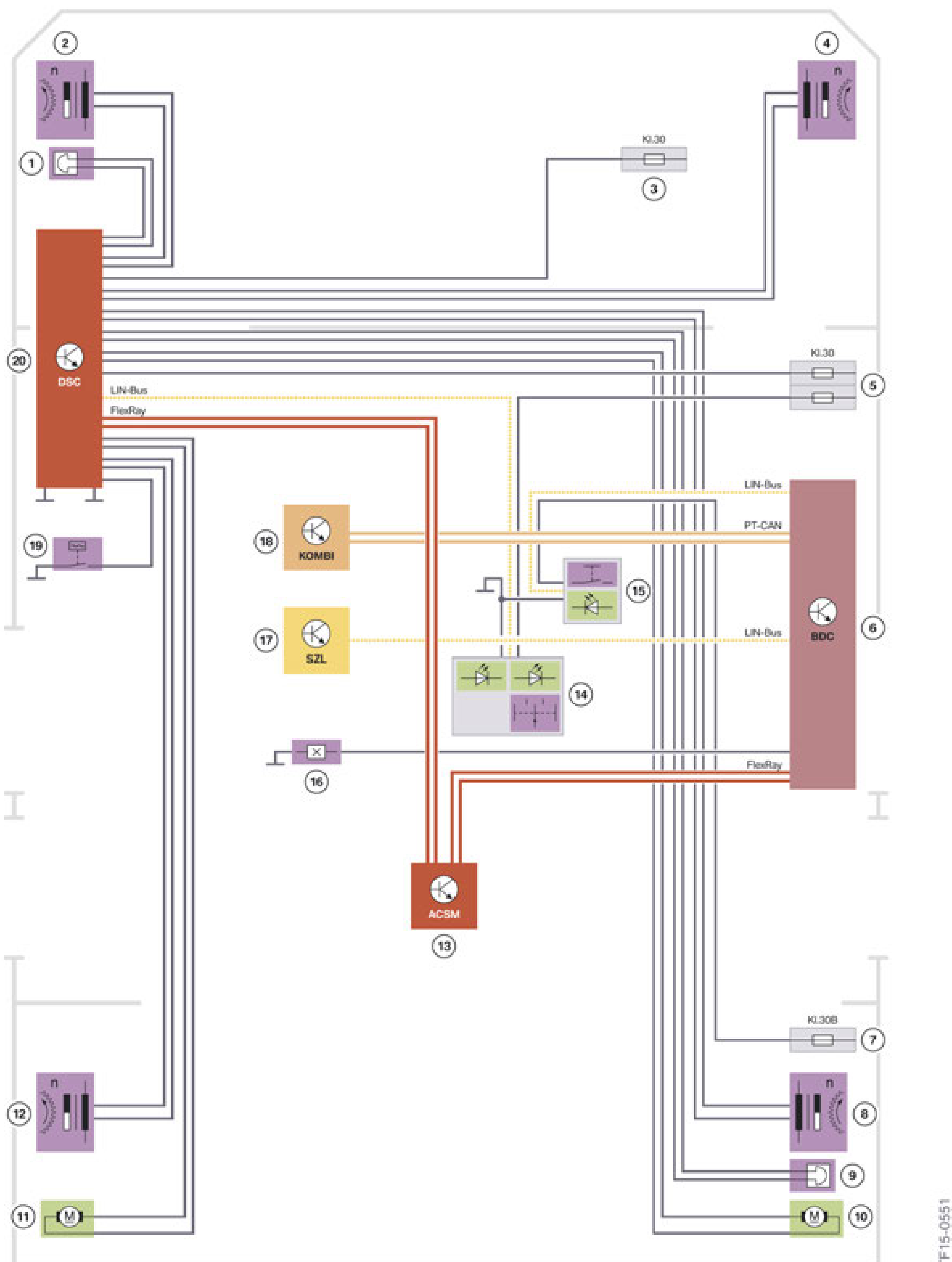
If a trailer tow hitch is retrofitted, the function “trailer stabilization logic” must be encoded in the DSC control unit.

6.1.3. System wiring diagram



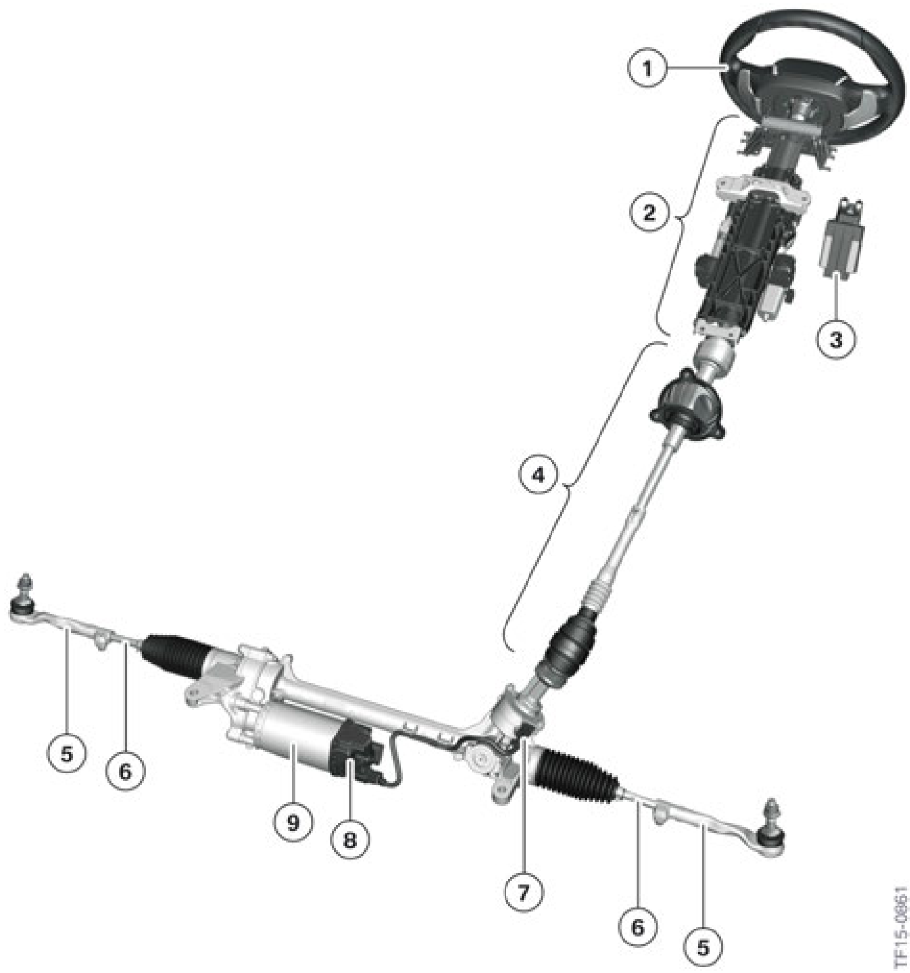
System wiring diagram for the Dynamic Stability Control (DSC) in the G12

Index	Explanation
1	Brake pad wear sensor, front left
2	Wheel-speed sensor, front left
3	Power distribution box, engine compartment
4	Wheel-speed sensor, front right
5	Power distribution box, front right
6	Body Domain Controller (BDC)
7	Rear right power distribution box
8	Wheel speed sensor, rear right
9	Brake pad wear sensor, rear right
10	Actuator, electric parking brake rear right
11	Actuator, electric parking brake rear left
12	Wheel speed sensor, rear left
13	Crash Safety Module (ACSM)
14	Button for electric parking brake and for Automatic Hold function
15	DSC button
16	Brake light switch
17	Steering column switch cluster
18	Instrument panel (KOMBI)
19	Brake fluid level switch
20	Dynamic Stability Control (DSC)

G12 Chassis and Suspension

6. Driving Stability Control

6.2. Steering



Overview of steering in the G12

Index	Explanation
1	Steering wheel
2	Upper steering column with steering column adjustment
3	Control unit for steering column adjustment
4	Lower steering column with sliding piece
5	Track rod end
6	Track rod
7	Steering-torque sensor
8	EPS control unit (Electronic Power Steering)
9	Electric motor for EPS (Electronic Power Steering)

In electric steering systems, the support torque is generated by means of an electric motor.

In addition to the pure support function, the front wheels can in principle be made to perform any steering movement independently of the manual torque applied at the steering wheel. This system is therefore a prerequisite for realization of a large number of assistance functions such as the Parking Manoeuvring Assistant (PMA).

The Electronic Power Steering (EPS) permits a reduction in the average fuel consumption of approximately 0.3 l per 100 km / 62 miles. A further advantage is that no oil is needed for steering assistance.

6.2.1. Steering wheel

It is possible to choose between 3 different steering wheel designs.

Steering wheel versions in the G12

Index	Explanation
A	Sports steering wheel with shift paddles
B	Luxury steering wheel
C	Standard steering wheel (Not for US)

In the luxury version, the leather rim features a wood inlay leather steering wheel. The driver can operate the various assistance and driver information systems by means of the multifunction switches.

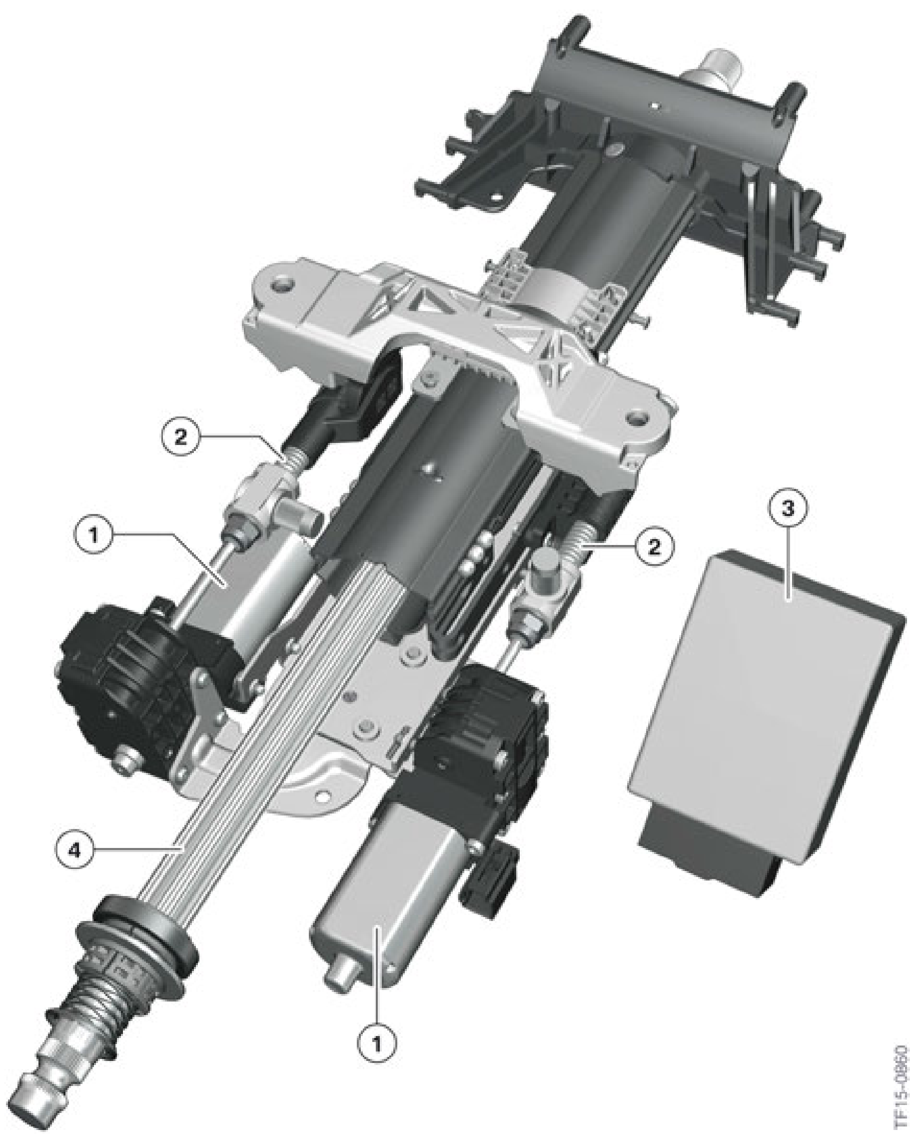
Steering wheel diameter of the different versions:

- Sports steering wheel = 382 mm
- Luxury steering wheel = 384 mm (Not for US)
- Standard steering wheel = 385 mm (Not for US)

Additional functions are optionally possible:

- Heated leather rim.
- Transmission of haptic vibrations (steering wheel vibration)
  For assistance systems such as lane departure or lane change warning.
- Hands-Off detection
  For the traffic jam assistant function.
- Shift paddles
  For the manual shift function with the automatic Sport transmission (SA 2TB).

6.2.2. Steering column adjustment



Steering column adjustment in the G12

Index	Explanation
1	Electric motor
2	Spindle
3	Control unit for steering column adjustment
4	Steering shaft

The steering column with electrical longitudinal and height adjustment allows the driver to assume an optimum sitting and driving position through seamless adjustment of the steering wheel position.

Adjustment range:

- Height adjustment = +/- 20 mm
- Forward/back adjustment = - 20 mm/+40 mm

6.2.3. Version overview

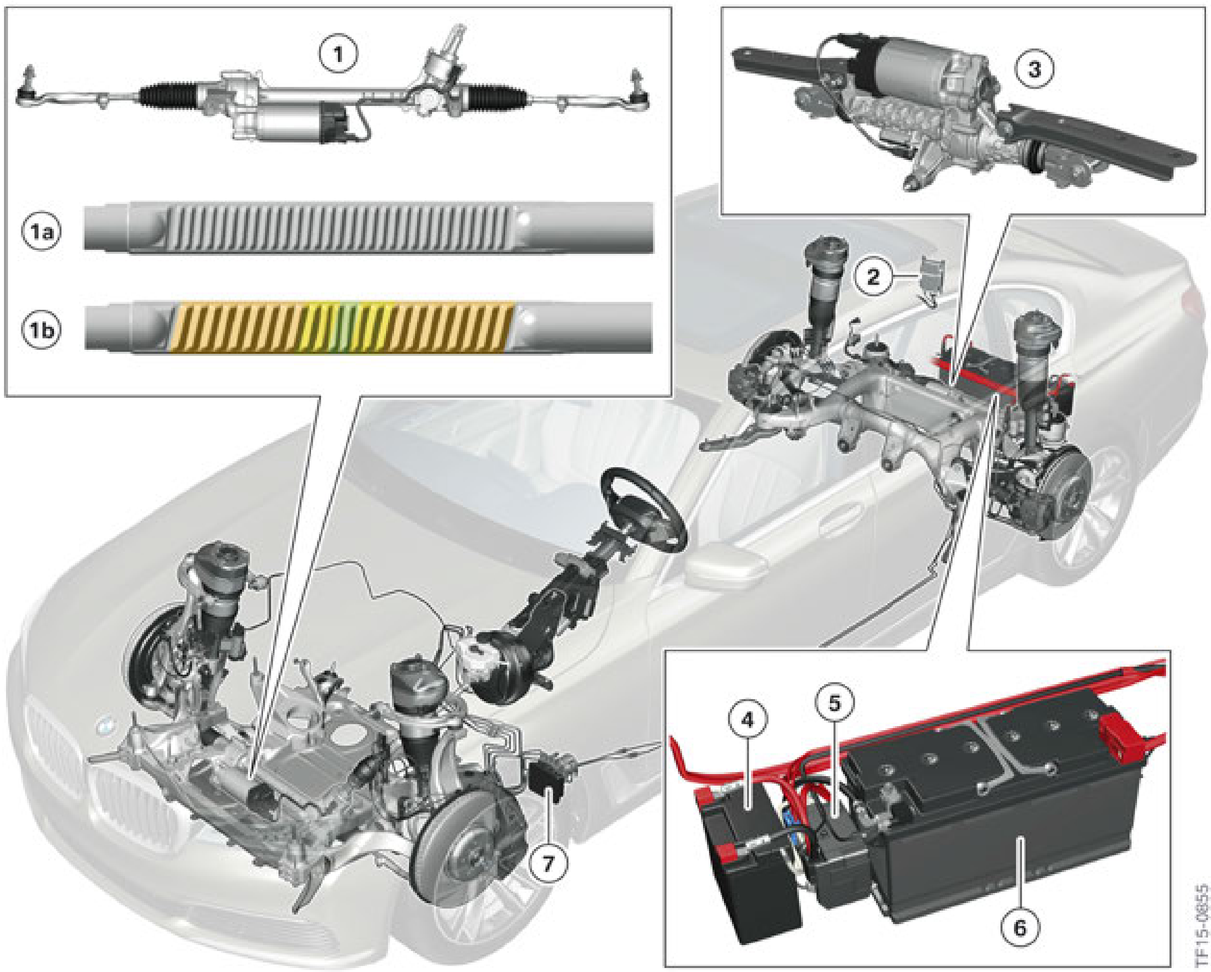
The G12 is equipped with the following different steering systems:

- Standard steering 12 V
- Integral Active Steering 12 V
- Integral Active Steering 24 V

Components	Standard steering 12 V	Integral Active Steering 12 V	Integral Active Steering 24 V
Electronic Power Steering with normal rack geometry	X		
Electronic Power Steering with variable rack geometry		X	X
12 V battery	X	X	X
12 V auxiliary battery			X
Power Control Unit (PCU) (DC/DC converter 150 W)			X
Rear axle slip angle control (HSR)		X	X

6. Driving Stability Control

The following graphic shows the installation positions of the different system components.



Overview of the steering systems of the G12

Index	Explanation
1	Electromechanical Power Steering
1a	Conventional rack geometry (standard steering)
1b	Variable rack geometry (Integral Active Steering)
2	Power Control Unit (PCU) (only for 24 V steering)
3	Rear axle slip angle control (HSR) (Integral Active Steering)
4	12 V auxiliary battery (only for 24 V steering)
5	Separating element (only for 24 V steering)
6	12 V battery
7	Dynamic Stability Control (DSC)

With the standard steering, the G12 is equipped with conventional electromechanical power steering (12 V) with normal rack geometry.

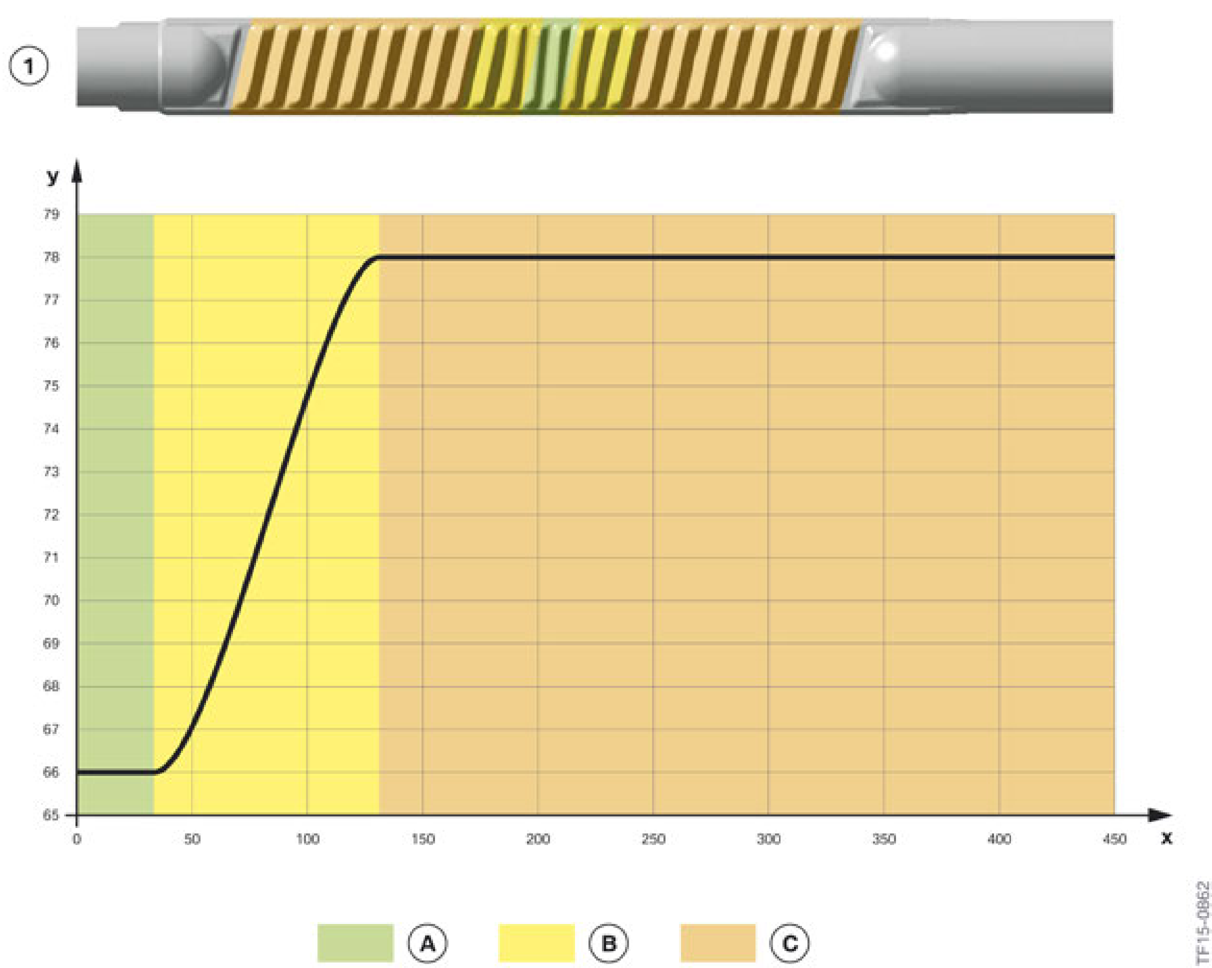
The optional equipment Integral Active Steering now no longer consists of an active steering system with variable ratio transmission, but has been replaced by an electromechanical power steering system with variable rack (sport steering) as well as rear axle slip angle control (HSR). Depending on the axle loads of the front vehicle end, a 12 V or 24 V steering system is used. The rear axle slip angle control (HSR) always operates with a 12 V voltage.

The following table provides an overview of the different voltage levels of the electric steering in the optional equipment Integral Active Steering.

Model	Engine	Rear-wheel drive with Integral Active Steering	All-wheel drive with Integral Active Steering
740i	B58	12 V	—
750(x)I	N63	24 V	24 V

6.2.4. Integral Active Steering

Front axle



Ratio of the variable rack geometry (OE Integral Active Steering) in the G12

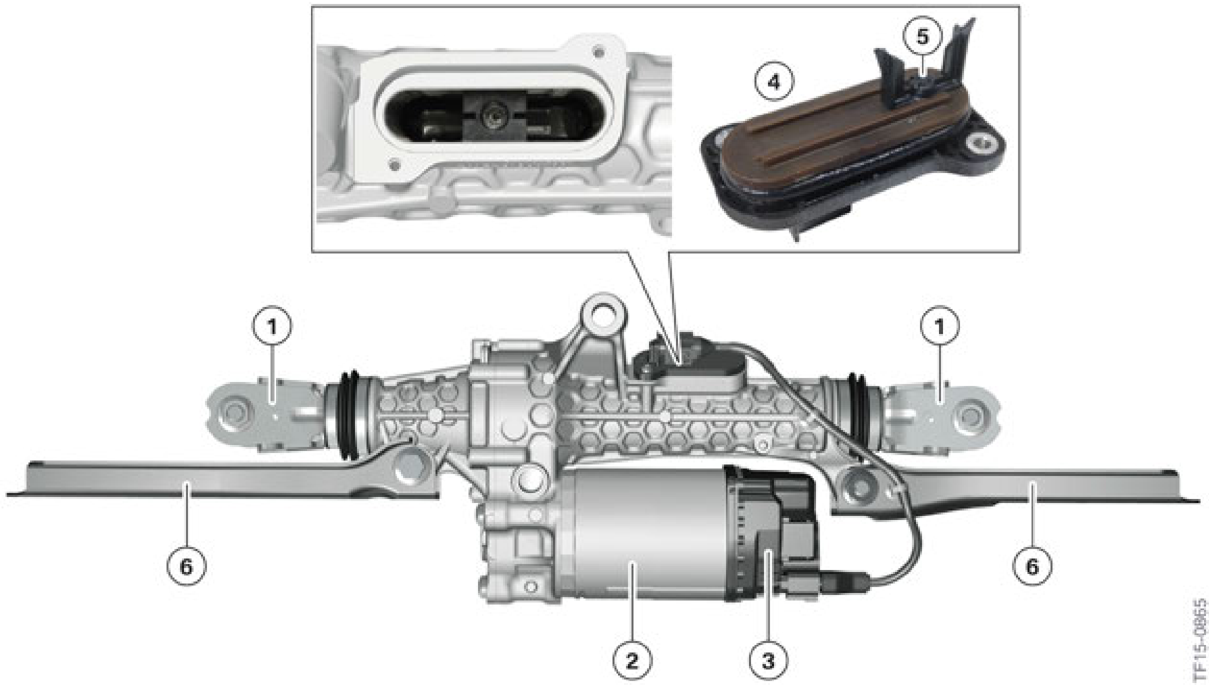
Index	Explanation
A	More indirect steering gear ratio in the center position of the variable rack (0° - 45°)
B	Transitional range (45° - 130°)
C	Direct steering gear ratio outside the center position of the variable rack (> 130°)
X	Steering angle in °
y	Steering gear ratio in mm/steering wheel turn
1	Variable rack geometry (Integral Active Steering)

The variable steering gear ratio in the optional equipment Integral Active Steering is accomplished by the geometry/pitch of the toothed gear of the rack. Around the center position of the steering gear, the steering system behaves accurately with steady directional stability. As the steering angle moves away from the center position, the ratio becomes increasingly more direct.

Steering angle of the Integral Active Steering on the front axle of the G12

Index	Explanation
A	More indirect steering gear ratio (variable rack geometry)
B	Direct steering gear ratio (variable rack geometry)

Rear axle



Rear axle slip angle control (HSR) in the G12

Index	Explanation
1	Track control arm mounts
2	Electric motor
3	HSR control unit (rear axle slip angle control)
4	Spindle position sensor (PLCD sensor)
5	Permanent magnet
6	Carrier plate

The rear axle slip angle control (HSR) mounted on the rear angle permits a maximum steering angle of the rear wheels of +/- 3°. As a result, it was possible to reduce the turning circle by approximately 1 m in comparison with vehicles without rear axle slip angle control (HSR). The rear axle slip angle control is available from a speed of approximately 5 km/h / 3 mph up to the maximum speed.

The request to adjust the steering angle at the rear axle is issued by the Dynamic Stability Control (DSC). A spindle drive inside the component is rotated via the electric motor. This produces a linear movement at the two track control arms. Using the position sensor, the control unit of the rear axle slip angle control (HSR) can determine the linear displacement and thus calculate the steering angle of the two rear axle wheels.

The spindle drive of the rear axle slip angle control (HSR) is self-inhibiting. This means that the vehicle has the identical drivability to a vehicle without rear axle slip angle control (HSR) in the event of system failure.

A special fixture is required for alignment in order to assemble the carrier plates. This is **not** available in Service. For this reason, the carrier plates on the rear axle slip angle control (HSR) must **not** be undone. If this is not observed, the wheel alignment on the rear axle will become incorrectly adjusted.

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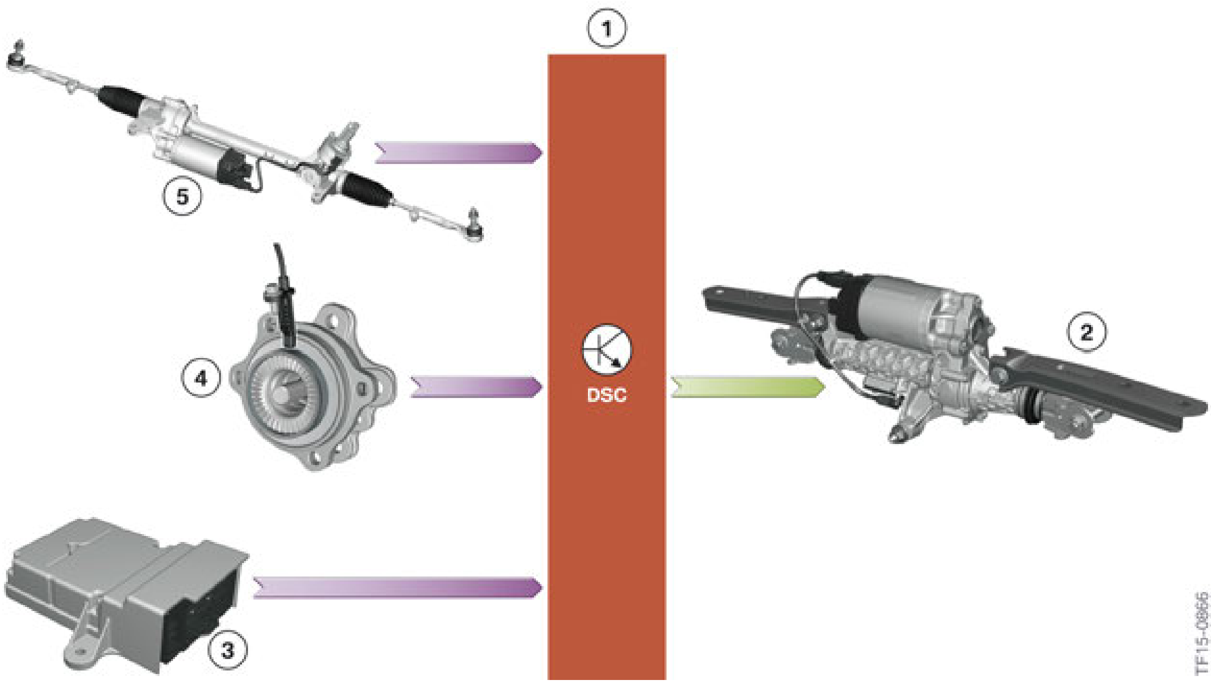
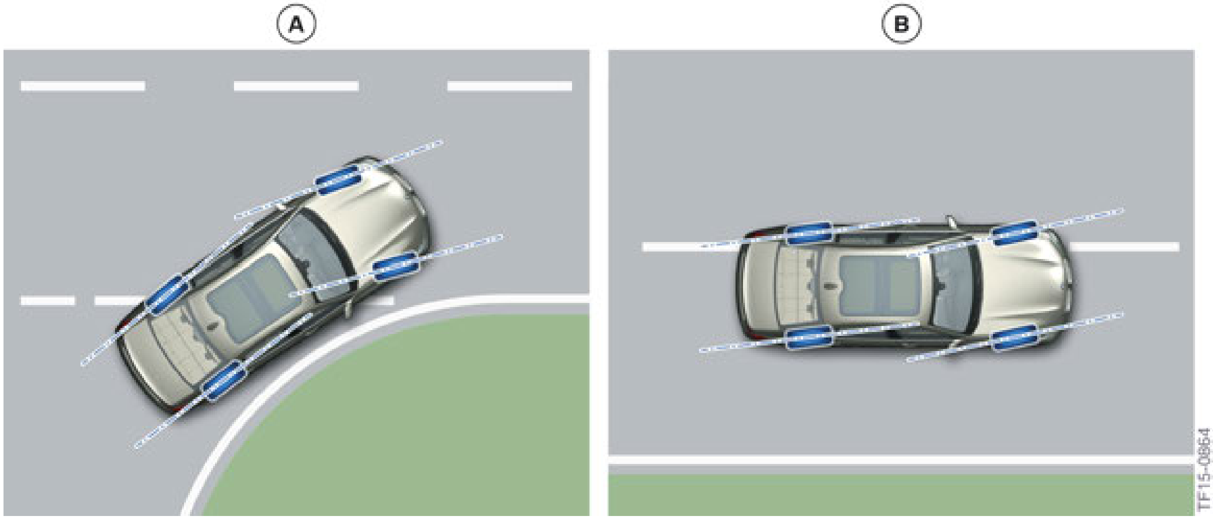
The carrier plates of the rear axle slip angle control (HSR) must **not** be undone in Service!

Operating strategy



Input and output diagram of the Integral Active Steering in the G12

Index	Explanation
1	Dynamic Stability Control (DSC)
2	Rear axle slip angle control (HSR)
3	Yaw rate and lateral acceleration (ACSM)
4	Wheel speeds
5	Steering angle (EPS)



Operating strategy of the Integral Active Steering in the G12

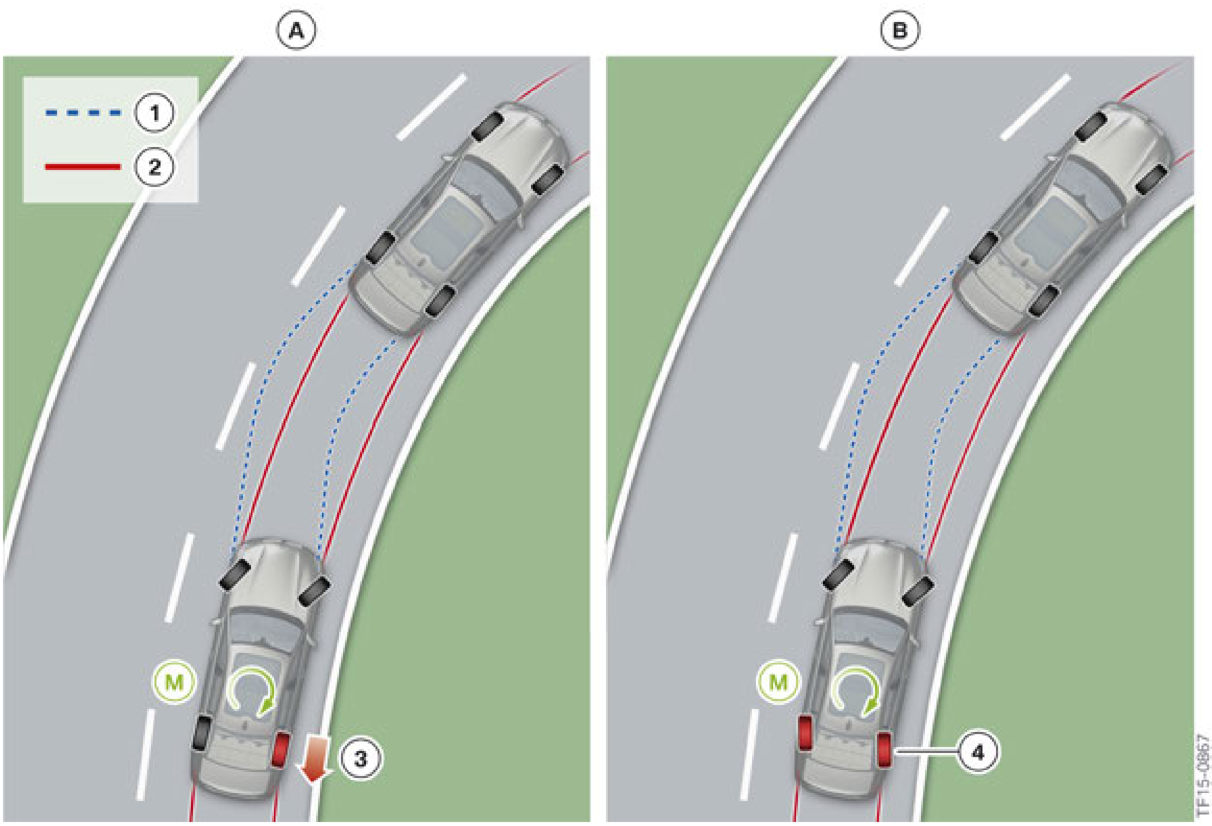
Index	Explanation
A	Opposite steering
B	Parallel steering

In the speed range up to approximately 60 km/h / 37 mph, the rear axle slip angle control (HSR) steers in the opposite direction to the steering angles of the front axle steering. This permits increased vehicle manoeuvrability.

As from the speed range of approximately 60 km/h / 37 mph, the rear axle slip angle control (HSR) steers in the same direction. This improves the directional stability of the vehicle.

Driving dynamics control interventions when cornering

When changing lanes quickly, all vehicles have a tendency to produce a significant yaw response and can sometimes start to oversteer. If the Dynamic Stability Control (DSC) detects a deviation between the driver wish and vehicle response, the vehicle is stabilized by means of a steering intervention at the rear axle. The speed of the stabilizing intervention is such that it is hardly discernible by the driver. It is possible to largely do without decelerating DSC brake interventions. As a result, the vehicle is more stable and the driving dynamics are preserved.



Possible driving dynamics interventions of the DSC and Integral Active Steering when cornering

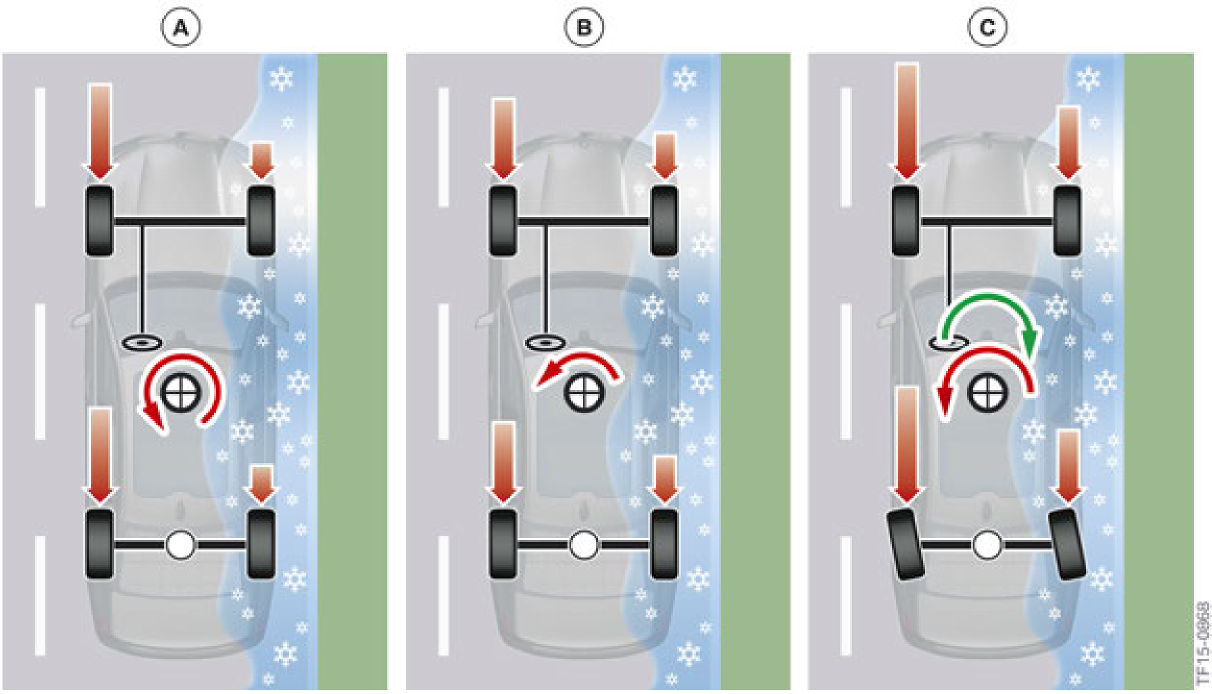
Index	Explanation
A	Prevention of understeer by brake interventions at individual wheels (DSC)
B	Prevention of understeer by steering interventions at the rear axle (HSR)
M	Yaw moment acting on the vehicle due to an intervention by the driving dynamics control
1	Course of an understeering vehicle
2	Course of a vehicle with neutral drivability
3	Individual brake modulation (DSC)
4	Steering intervention at the rear axle (HSR)

If the driver underestimates a bend when driving rapidly, he may be surprised by sudden understeer. The rear axle slip angle control (HSR) can also perform a corrective intervention in understeer situations and thus additional increases active safety.

6. Driving Stability Control

Driving dynamics control on different surfaces

Hard braking manoeuvres on roadways that are slippery on one side make the vehicle yaw to the vehicle side with more grip. In the event of emergency braking, the driver of a conventional vehicle must take corrective action. With this so-called μ-split braking, the Dynamic Stability Control (DSC) provides a stabilizing yaw moment via a steering intervention at the rear axle.



μ-split braking manoeuvres with different driving dynamics systems

Index	Explanation
A	Vehicle **without** DSC
B	Vehicle with DSC
C	Vehicle with DSC and rear axle slip angle control (HSR) (optional equipment Integral Active Steering SA 2VH)

Further to A) Without DSC

When braking with a vehicle without DSC, maximum brake force is supported on the dry side of the road and only low brake force on the wet or icy side. An anti-clockwise yaw moment is produced which can lead to the vehicle skidding to the right.

Further to B) With DSC

When braking with a vehicle equipped with DSC, the brake forces at the wheels are metered so that the yaw moment acting on the vehicle is reduced. The vehicle therefore remains controllable. The stopping distance may be increased slightly.

Further to C) With DSC and rear axle slip angle control (HSR)

When braking with a vehicle equipped with DSC and rear axle slip angle control (HSR) (optional equipment Integral Active Steering SA 2VH), the DSC control unit calculates the steering angle for the rear wheels. The actuators of the rear axle slip angle control (HSR) convert the calculated steering angle into an active steering angle at both rear wheels. The resultant stabilizing yaw moment allows the maximum brake forces to be applied in order to achieve the shortest possible stopping distance. The perfect interaction of steering and brake intervention therefore increases active safety and enhances the driving dynamics of the vehicle.

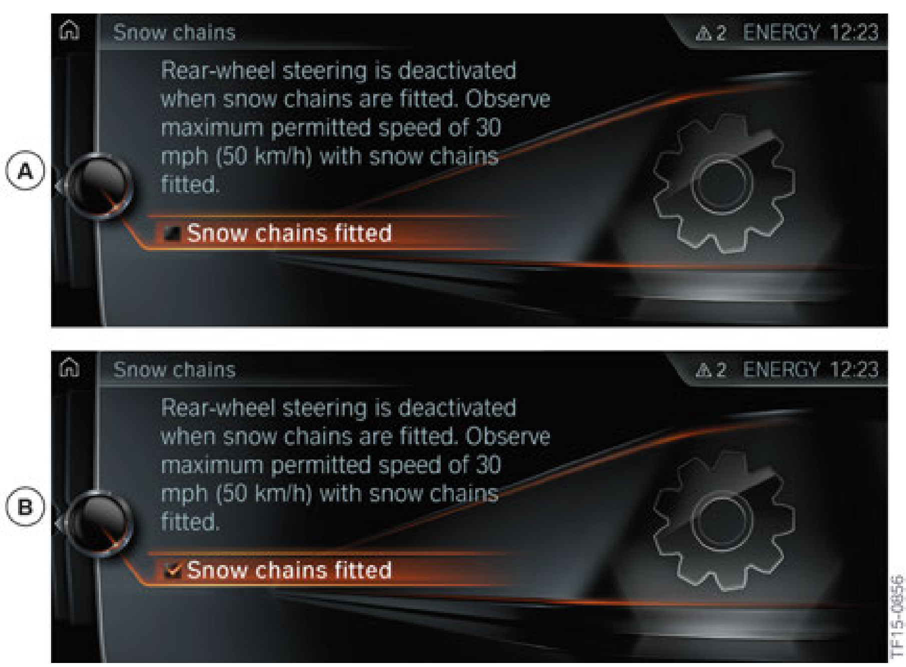
6.2.5. Service information

In the event of a repair, the steering gear can be fully lowered. This eliminates the need for complex axle disassembly and repair costs are reduced significantly.

Steering angle

The steering angle is calculated by the control unit of the electromechanical power steering using the rotor angle sensor. In the event of a loss of the voltage supply, this stored value is lost and must be taught again. This can be done statically by turning the wheels to the right and left with the engine running or dynamically when driving slowly.

Driving with snow chains



Setting menu for driving with snow chains in the G12

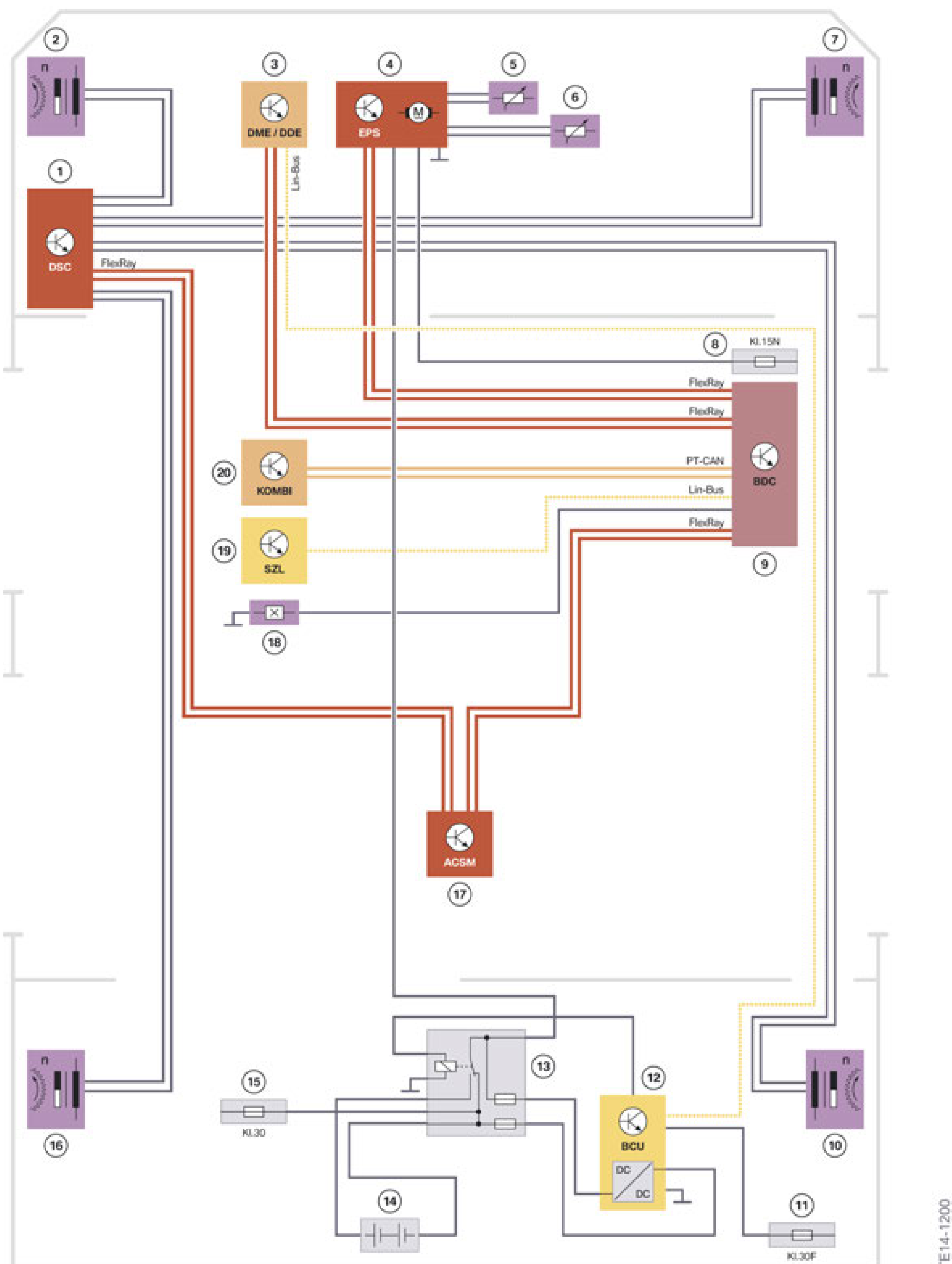
Index	Explanation
A	Snow chain mode deactivated
B	Snow chain mode activated

6. Driving Stability Control

In order to avoid damage to the wheel arches when driving with snow chains, the rear axle slip angle control (HSR) must be fixed in straight-ahead position. The driver can do this manually using the controller on the Central Information Display (CID). The maximum permitted speed is 50 km/h (31 mph) his speed is exceeded, the rear axle slip angle control (HSR) switches on again automatically.

6.2.6. System wiring diagram

24 V steering

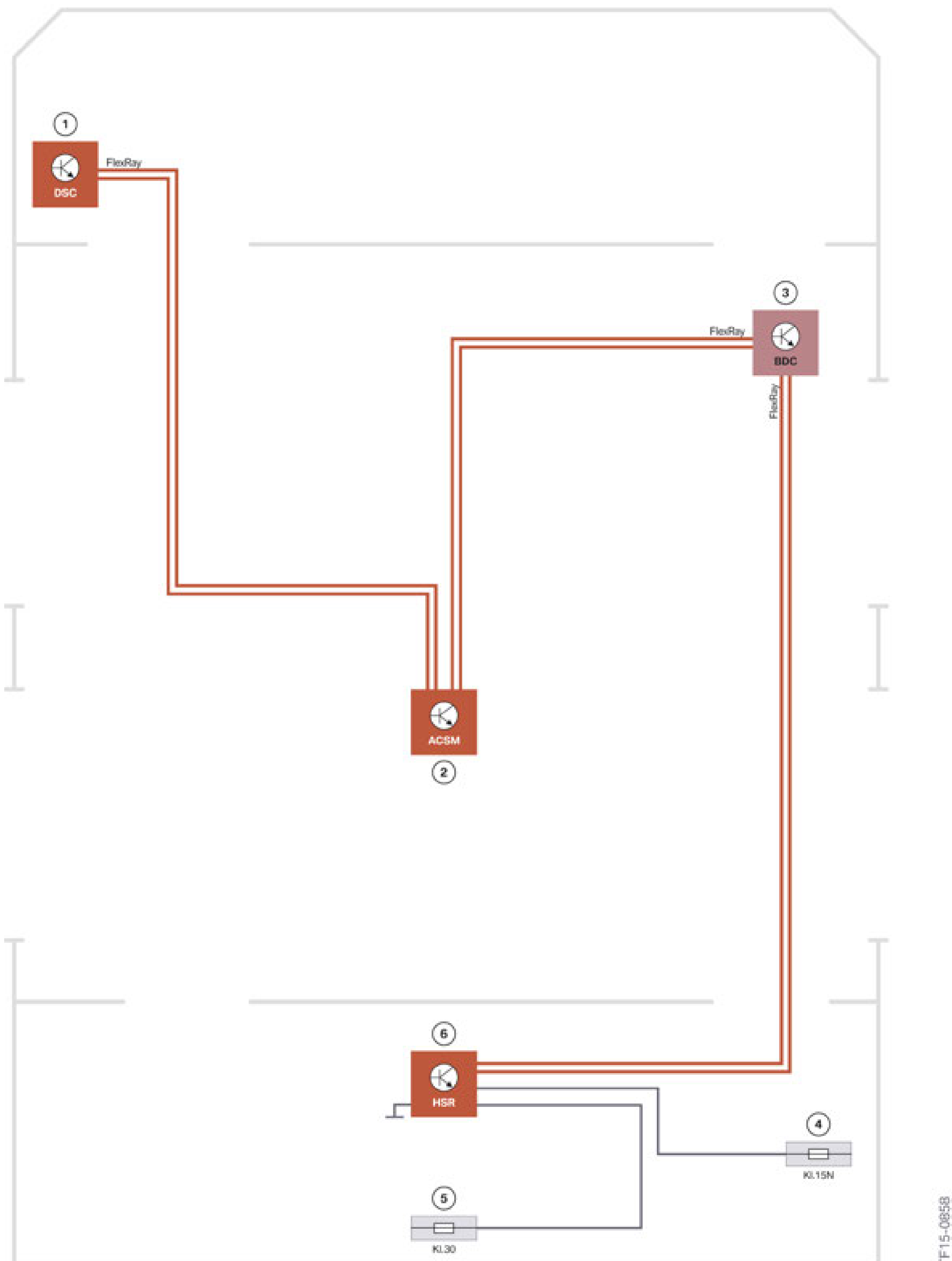


System wiring diagram for 24 V steering in the G12

Index	Explanation
1	Dynamic Stability Control (DSC)
2	Wheel-speed sensor, front left
3	Engine control unit (DME)
4	Electronic Power Steering (electromechanical power steering) (EPS)
5	Steering-torque sensor 1
6	Steering-torque sensor 2
7	Wheel-speed sensor, front right
8	Power distribution box, front right
9	Body Domain Controller
10	Wheel speed sensor, rear right
11	Rear right power distribution box
12	Power Control Unit PCU (DC/DC 150 W)
13	Separator
14	12 V auxiliary battery for 24 V steering
15	Positive battery terminal distributor
16	Wheel speed sensor, rear left
17	Crash Safety Module (ACSM)
18	Brake light switch
19	Steering column switch cluster (SZL)
20	Instrument panel (KOMBI)

6. Driving Stability Control

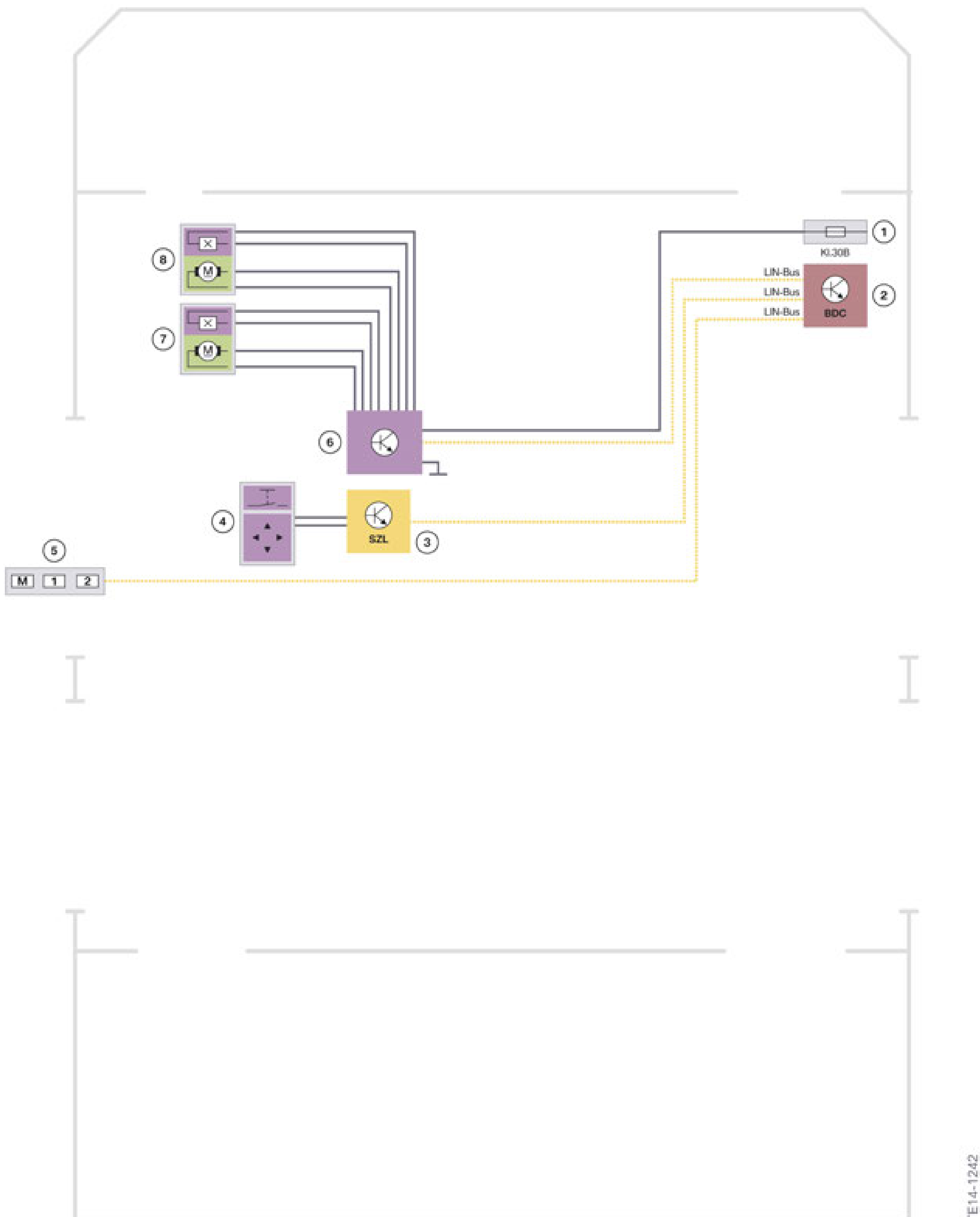
Rear axle slip angle control (HSR)



System wiring diagram for rear axle slip angle control (HSR) in the G12

Index	Explanation
1	Dynamic Stability Control (DSC)
2	Crash Safety Module (ACSM)
3	Body Domain Controller (BDC)
4	Rear right power distribution box
5	Positive battery terminal distributor
6	Rear axle slip angle control (HSR)

Electrically adjustable steering column



System wiring diagram for electrically adjustable steering column in the G12

Index	Explanation
1	Power distribution box, front right
2	Body Domain Controller (BDC)
3	Steering column switch cluster (SZL)
4	Button for steering column adjustment
5	Memory switch
6	Control unit for steering column adjustment
7	Electric motor (DC)
8	Electric motor (DC)

6.3. Electronic Damper Control (EDC)

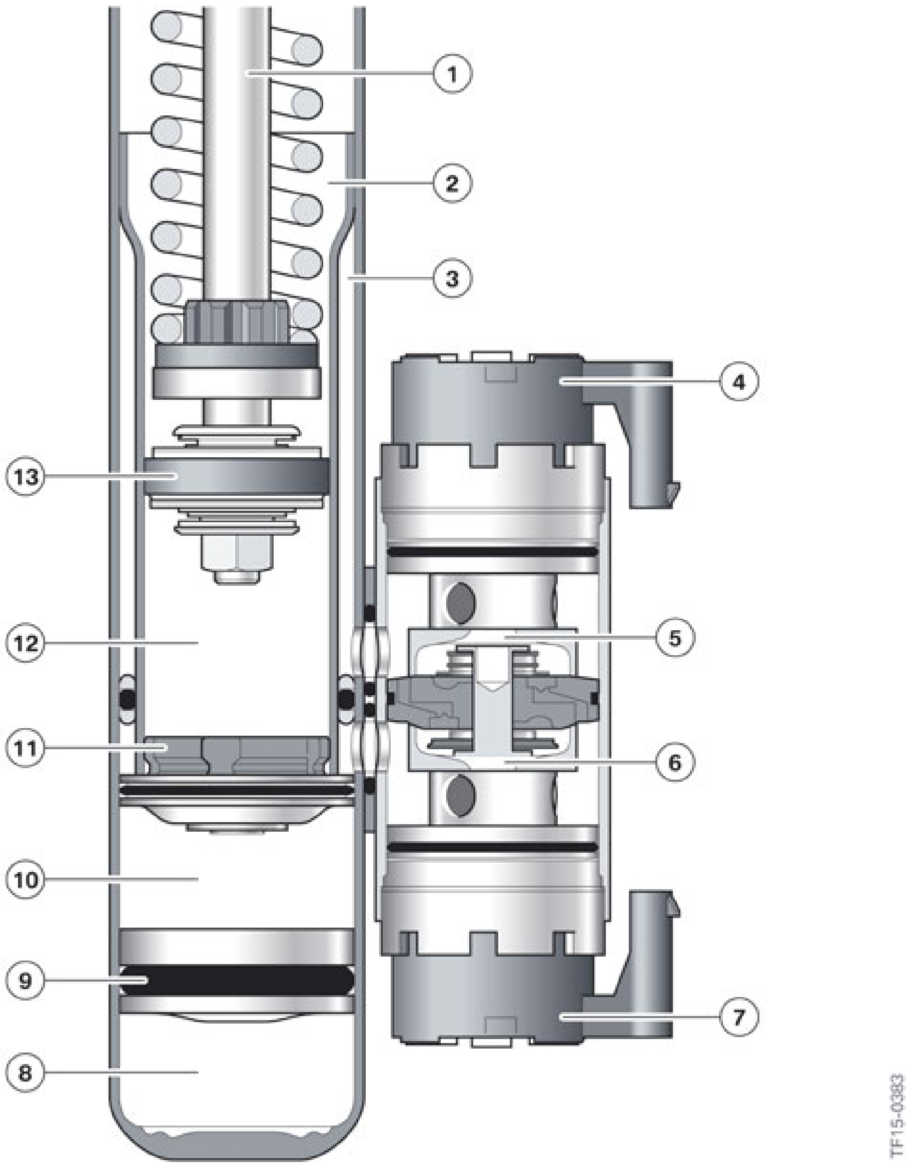
In order to meet the high customer demands with respect to comfort and driving dynamics, the G12 is equipped as standard with Electronic Damper Control (EDC). The electronically controlled shock absorbers form a unit with the respective air suspension strut and cannot be replaced separately. There are 2 electric control valves on each shock absorber which allow the compression and rebound stages of the regulated shock absorbers to be adjusted separately from each other. This makes it possible to perfectly counteract the vibrations of the body and wheels. This increases safety, comfort and driving dynamics.

6.3.1. Shock absorber design

The shock absorbers are single-tube gas-filled shock absorbers. The gas cushion consists of nitrogen at a pressure of 16.5 bar. This is pressed together and thus compressed further by the oil displaced when the piston rod is retracted. The high gas pressure prevents foaming of the oil under all operating conditions and thus guarantees optimum shock absorber operation. In addition, the high gas pressure ensures that the piston rod is pressed out with a force of approximately 400 N (~ 40 kg). Compression of the shock absorber by hand is therefore hardly possible.

The following graphic shows the internal design of an electrically regulated shock absorber.

6. Driving Stability Control



Design of EDC shock absorber in the G12

Index	Explanation
1	Piston rod
2	Working chamber
3	Overflow duct
4	Control valve, compression stage
5	Comfort valve, compression stage
6	Comfort valve, rebound stage
7	Control valve, rebound stage
8	Gas pressure chamber

Index	Explanation
9	Dividing piston
10	Balancing chamber
11	Bottom valve
12	Working chamber
13	Working piston

In order to permit a sporty driving style on good roads while still absorbing bumps on rough road surfaces as comfortably as possible, the oil flow inside the shock absorber can be variably adjusted. The changes in the oil flow change the forces acting on the shock absorber.

The shock absorber has 2 control valves, which allow separate adjustment of the damping force for rebound (rebound stage) and compression (compression stage).

The control valves adjust the damping force by changing a restrictor cross-section through which an oil flow is pressed. The following relationship exists between the restrictor cross-section and damping force:

- Large restrictor cross-section = low damping force.
- Small restrictor cross-section = high damping force.

The restrictor cross-section and thus the damping force can be adjusted seamless few milliseconds.

Compression stage

During compression, the shock absorber is pushed together telescopically and operated in the so-called compression stage.

Rebound

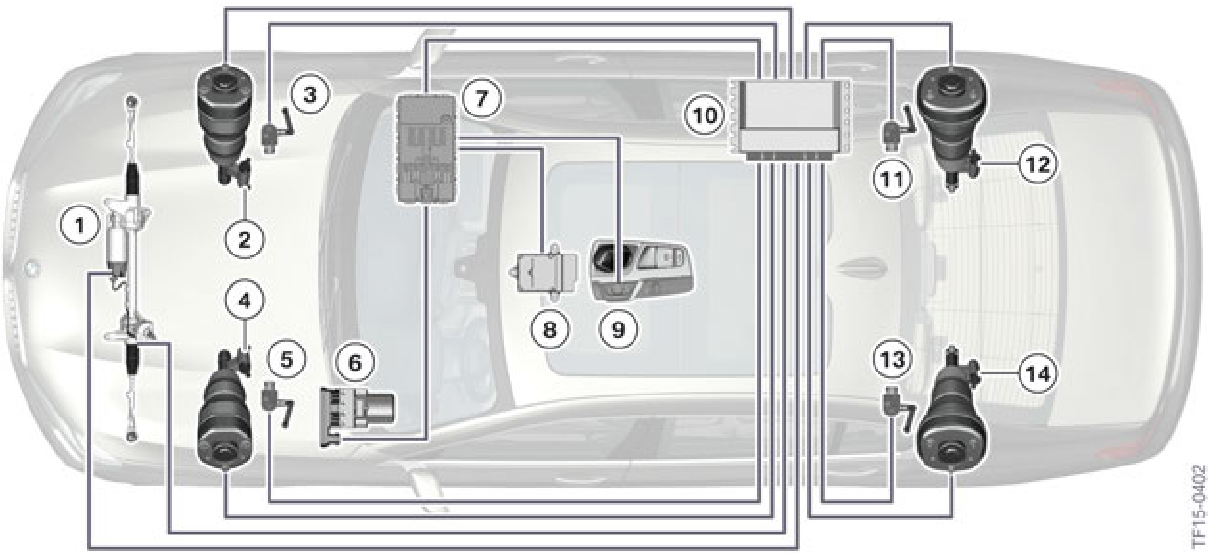
During rebound, the shock absorber is extended telescopically and operated in the so-called rebound stage.

6.3.2. System overview

The driving experience switch is used to configure the shock absorber adjustment setting.
It is possible to choose between a sportily firm or comfortably soft chassis and suspension setup.
The following table provides an overview of the setting options.

Driving mode	Characteristics
COMFORT PLUS	Comfortable
Comfort/ECO PRO	Balanced
Sport	Sports

6. Driving Stability Control



System overview of the Electronic Damper Control (EDC)

Index	Explanation
1	Electronic Power Steering (electromechanical power steering) (EPS)
2	Control valves for shock absorber adjustment, front right
3	Ride height sensor, front right
4	Control valves for shock absorber adjustment, front left
5	Ride height sensor, front left
6	Dynamic Stability Control (DSC)
7	Body Domain Controller (BDC)
8	Advanced Crash Safety Module (ACSM-High)
9	Driving experience switch
10	Vertical Dynamics Platform (VDP)
11	Ride height sensor, rear right
12	Control valves for shock absorber adjustment, rear right
13	Ride-height sensor, rear left
14	Control valves for shock absorber adjustment, rear left

The Electronic Damper Control (EDC) comprises the following components:

- 4 electrically controlled shock absorbers with 2 control valves each
- Vertical Dynamics Platform (VDP) control unit
- 4 ride height sensors for determination of wheel movement
- Sensor cluster for determination of body movement (lift, pitch and roll)

The Vertical Dynamics Platform (VDP) control unit uses various data such as body movement, transverse and longitudinal acceleration, steering angle and the road condition to calculate wheel-individual control commands for the electrical control valves in the shock absorbers. In this way, the damping force of the individual shock absorbers is continuously changed approximately 100 times per second. This means that demand-based adjustment of the damping force is always possible corresponding
to the driving situation.

Fewer vehicle body movements are permitted if a sportier driving mode is selected. The shock absorbers are adjusted to a hard setting more quickly and more often. This automatically results in a loss of comfort.

In the standard equipment configuration, information about the vertical body movements (pitch, roll and lift) is made available by the Crash Safety Module ACSM-High. The retraction and extension speeds of the shock absorbers are determined by means of the ride height sensors.

If the vehicle is equipped with the optional equipment “Active Comfort Drive” (SA 2VS), there are additional wheel acceleration sensors. These are used among other things for more precise regulation of the Electronic Damper Control (EDC).

The following table shows the different components used depending on the chassis and suspension package.

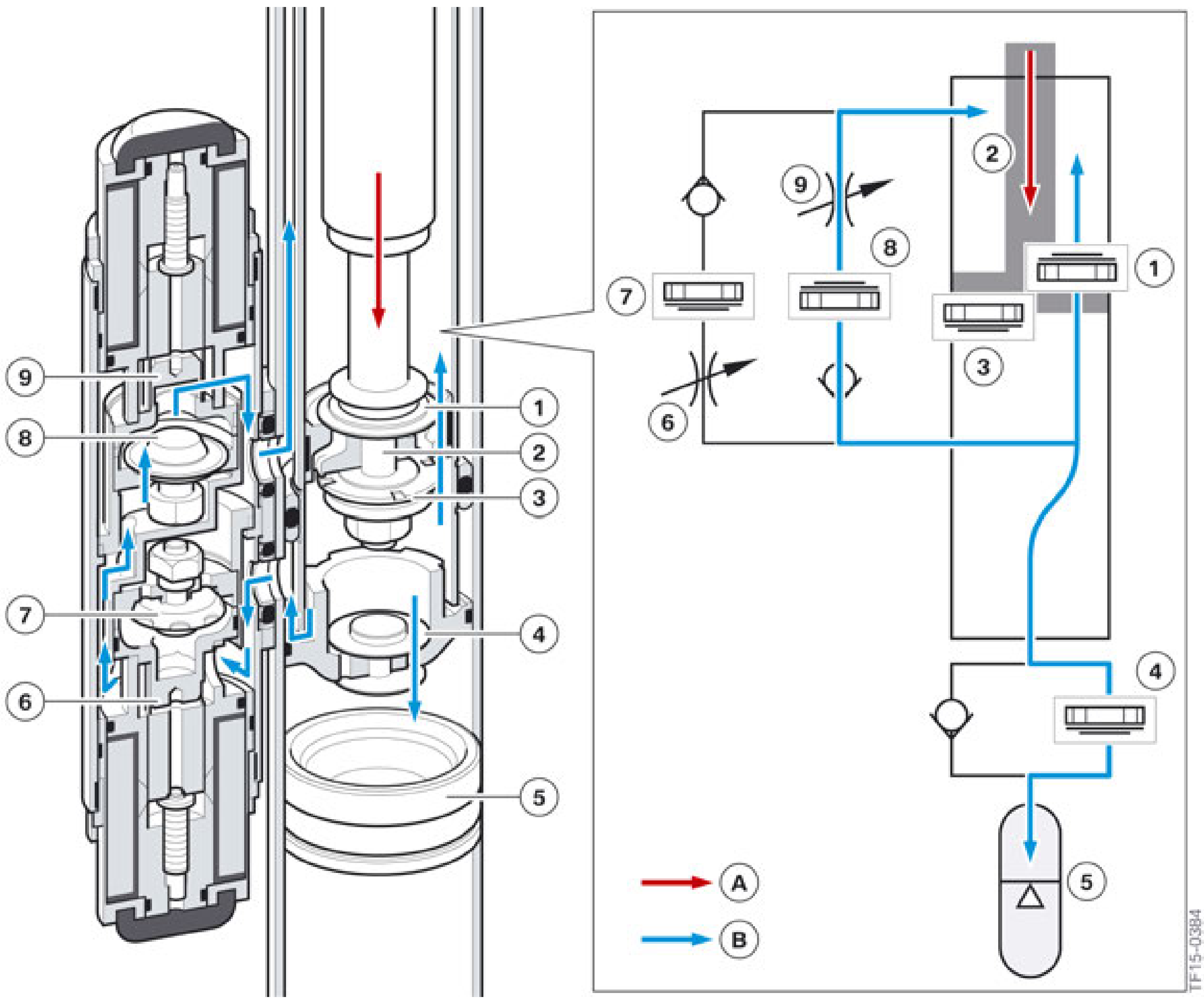
Component	Basic chassis and suspension	Active Comfort Drive
Wheel acceleration sensors	—	X
ACSM-High	X	—
ACSM-Low	—	X

A more detailed description of the optional equipment “Active Comfort Drive” (SA 2VS) is provided in a later chapter.

6.3.3. Electrical shock absorber control

The control valves of the rebound and compression stages are activated via pulse-width modulated signals from the Vertical Dynamics Platform (VDP) control unit. The control valves are open in de-energized condition. The shock absorber is in the maximum soft setting in this condition.

Control of the compression stage

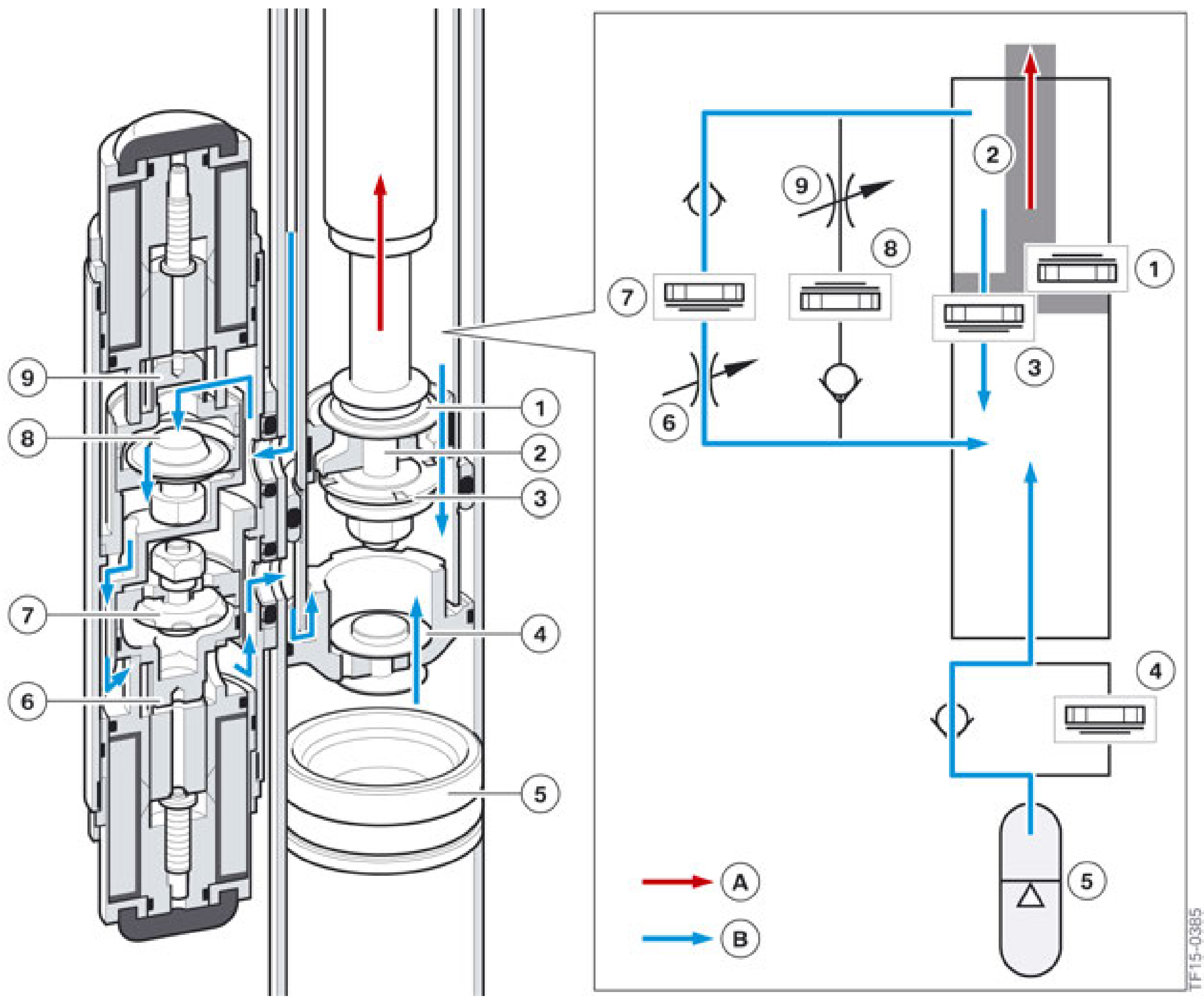


Control of compression stage on the shock absorber of the G12

Index	Explanation
A	Shock absorber movement
B	Oil flow
1	Main valve, compression stage
2	Working piston
3	Main valve, rebound stage
4	Bottom valve
5	Gas pressure chamber
6	Control valve, rebound stage
7	Comfort valve, rebound stage
8	Comfort valve, compression stage
9	Control valve, compression stage

When the piston rod is retracted, the oil volume displaced by the retracting piston is pressed through the bottom valve into the compensating reservoir and generates a damping force at the bottom valve in the process. The oil volume displaced by the working piston is pressed through the comfort and control valve of the compression stage and thus passes from the working chamber below the working piston into the working chamber above the piston. The restrictor cross-section in the control valve adjusts the damping force. The oil flow is forced through the main valve when the control valve is closed. The maximum possible damping force is then set.

Control of the rebound stage



Control of rebound stage on the shock absorber of the G12

Index	Explanation
A	Shock absorber movement
B	Oil flow
1	Main valve, compression stage
2	Working piston
3	Main valve, rebound stage

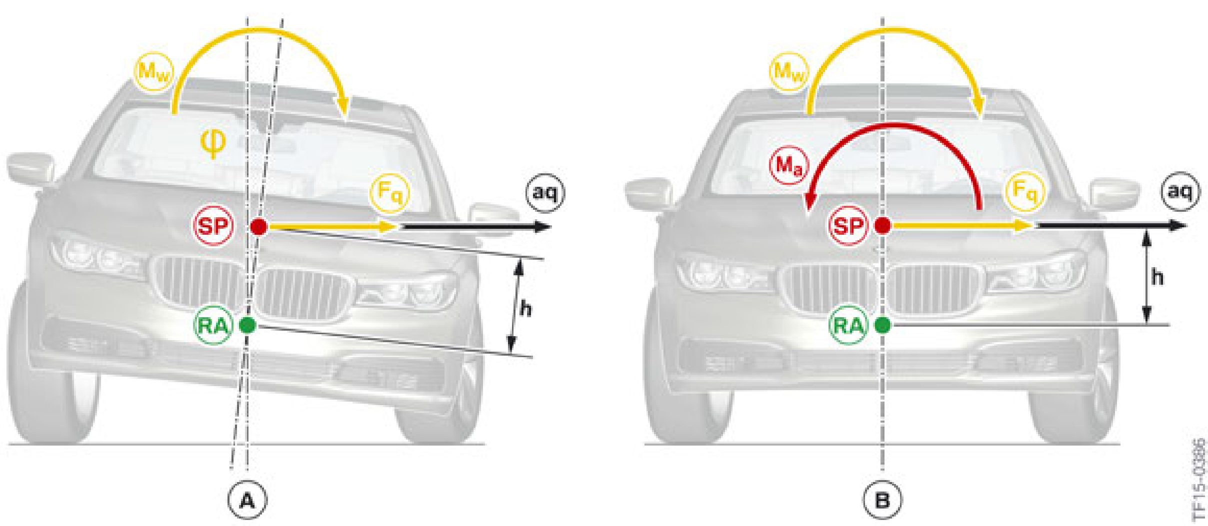
Index	Explanation
4	Bottom valve
5	Gas pressure chamber
6	Control valve, rebound stage
7	Comfort valve, rebound stage
8	Comfort valve, compression stage
9	Control valve, compression stage

When the piston rod is extended, the gas pressure forces the necessary compensation volume out of the compensating chamber through the bottom valve into the working chamber below the working piston. The oil volume displaced by the working piston is pressed through the comfort and control valve of the rebound stage and thus passes from the working chamber above the working piston into the working chamber below the piston. The restrictor cross-section in the control valve adjusts the damping force. The oil is forced through the main valve of the rebound stage when the control valve is closed. The maximum possible damping force is then set.

6.4. Anti-roll bar

The following anti-roll bars are used on the G12 depending on the vehicle equipment:

- Standard equipment
  Conventional anti-roll bar on front and rear axles.
- Optional equipment (“Active Comfort Drive” SA 2VS)
  Electric active roll stabilization on front and rear axle EARSVV/EARSVH.



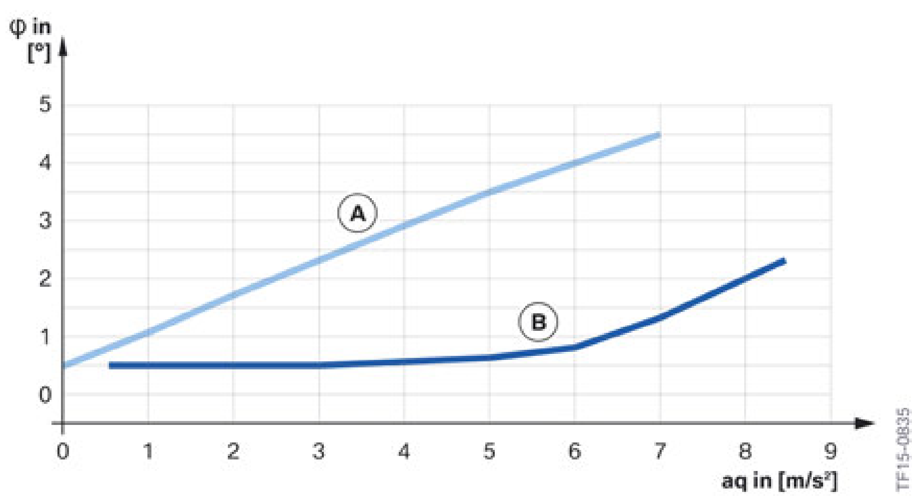
Comparison of conventional and active roll stabilization in stationary condition of the G12

Index	Explanation
A	Conventional passive roll stabilization
B	Active roll stabilization
aq	Lateral acceleration
Fq	Transverse force
h	Distance between roll axis and center of gravity (lever arm)
Ma	Moment of active stabilizer
Mw	Roll moment
RA	Roll axis
SP	center of gravity
φ	Roll angle

When cornering, the lateral acceleration (aq) acts at the vehicle center of gravity (SP). The body rolls about the roll axis (RA), which is defined by the kinematics of the front and rear axles. This results in the roll angle (φ).

On vehicles with the optional equipment "Active Comfort Drive" (SA 2VS), the roll moment (Mw) can be compensated solely by the active stabilizers up to a certain lateral acceleration. A roll angle (φ) builds up only when the roll moment (Mw) exceeds the counter-torque (Ma) set by the active stabilizer.

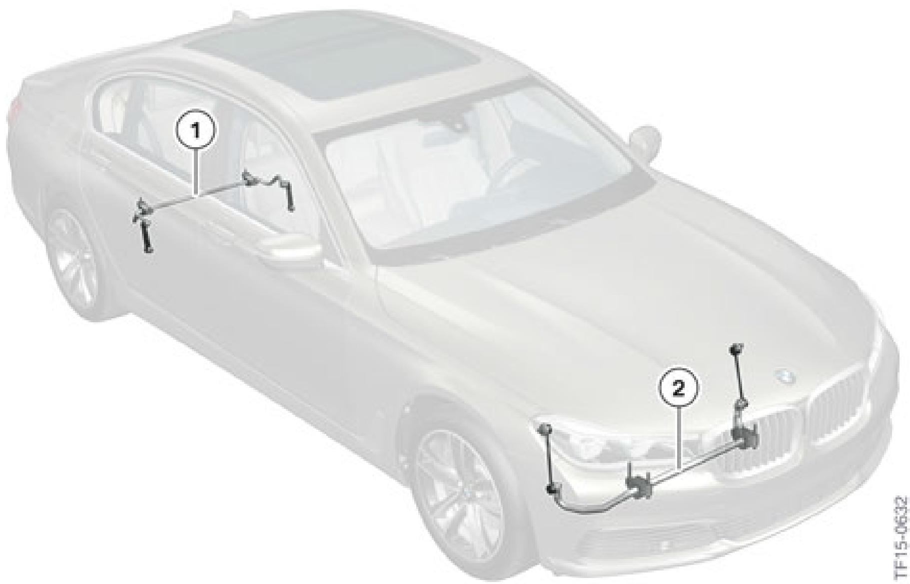
The following diagram shows a comparison of the different roll angles of both anti-roll bars as a function of the lateral acceleration.



Roll angle diagram of the conventional anti-roll bar and active stabilizer

Index	Explanation
A	Conventional roll stabilization
B	Active roll stabilization
aq in [m/s²]	Lateral acceleration in metres per second squared
φ in [°]	Roll angle in angular degrees

6.5. Standard suspension



Conventional anti-roll bar in the G12

Index	Explanation
1	Rear axle anti-roll bar
2	Front axle anti-roll bar

As standard, conventional anti-roll bars on the front and rear axles reduce the roll tendency of the body during fast cornering or fast avoidance manoeuvres. However, there are also comfort losses in the case of one-sided road bumps due to the torsion spring characteristics of a conventional anti-roll bar. If a conventional anti-roll bar is excited by a pulse at a wheel on one side, this leads to spring oscillations of the anti-roll bar so that the wheel at the other end of the anti-roll bar also performs or "copies" these oscillations. Since the anti-roll bar is pivot-mounted on the body, the driver also feels the roll oscillations caused by this so-called "copying".

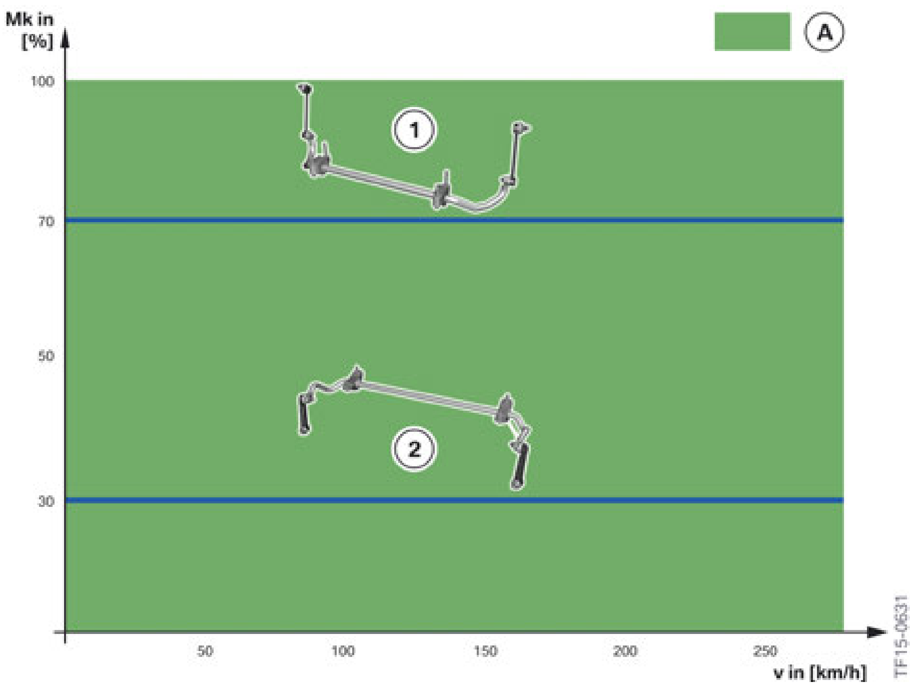
6.5.1. Chassis and suspension setup

Vehicle drivability when cornering can be greatly influenced by anti-roll bars on the front and rear axles. A decisive factor here is the roll moment ratio between the front and rear vehicle axles.
This ratio depends on the respective anti-roll bar moments of the two axles.

The following table provides an overview of the possible roll moment ratios and the resultant handling of the vehicle.

Anti-roll bar	Roll moment ratio	Understeer	Oversteer
Front axle soft/ rear axle hard	< 50 %		X
Front axle hard/ rear axle soft	> 50%	X	

The following graphic shows the percentage distribution of the anti-roll bar moments (roll moment ratio) of the front and rear axles when conventional anti-roll bars are used.



Percentage distribution of the anti-roll bar moments on a vehicle with conventional anti-roll bars

Index	Explanation
A	Understeering roll moment ratio
Mk in [%]	Moment distribution of conventional anti-roll bars in percent
v in [km/h]	Driving speed in kilometers per hour
1	Conventional anti-roll bar on the front axle
2	Conventional anti-roll bar on the rear axle

With a conventional anti-roll bar, the roll moment ratio is optimally adapted to the respective vehicle. It is aimed to achieve handling with slight understeer. For normal drivers, an oversteering vehicle is more difficult to control than an understeering vehicle.

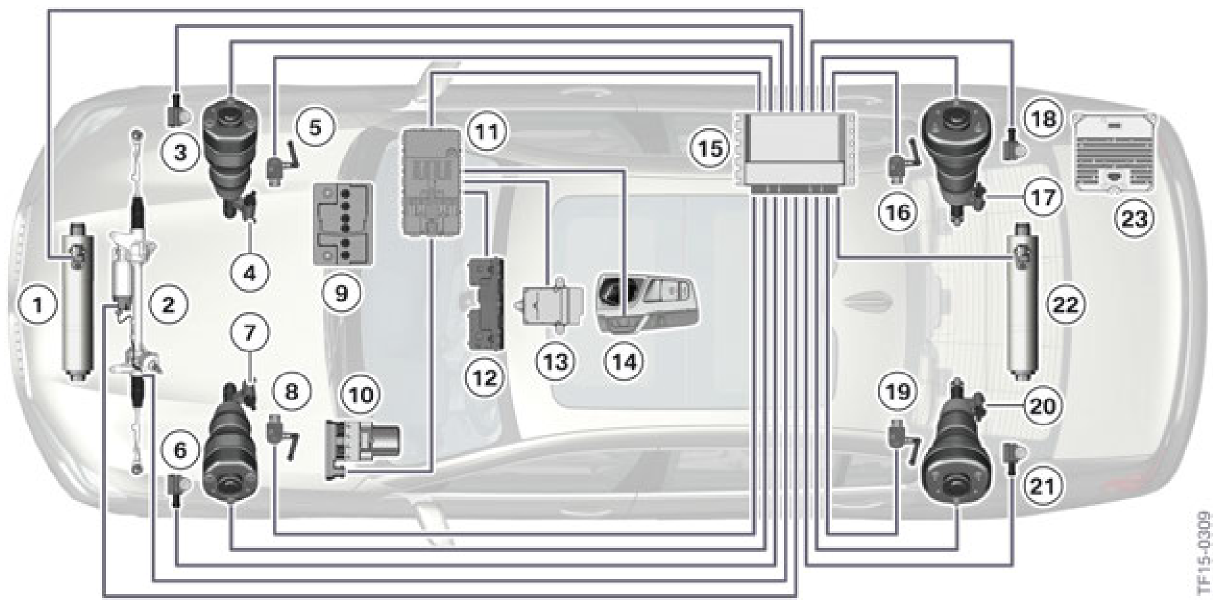
6.6. Active Comfort Drive

The previously known optional equipment Adaptive Drive is replaced in the G12 by the enhanced suspension control system “Active Comfort Drive”.

The various driving dynamics control systems are networked together in the optional chassis and suspension package “Active Comfort Drive” in order to achieve perfect driving dynamics combined with high ride comfort. Information is read in from a large number of sensors by the Vertical Dynamics Platform (VDP) control unit and the corresponding control commands are output to the different actuators. The aim is to above all detect road bumps and obstacles ahead as early as possible and to derive appropriate counter-measures.

6. Driving Stability Control

The following graphic provides an overview of the overall system.



System overview of the optional chassis and suspension package “Active Comfort Drive” in the G12

Index	Explanation
1	Electric active roll stabilization front EARSVV (optional equipment “Active Comfort Drive” SA 2VS)
2	Electronic Power Steering (electromechanical power steering) (EPS)
3	Wheel acceleration sensor, front right (optional equipment “Active Comfort Drive” SA 2VS)
4	Control valves for shock absorber adjustment, front right
5	Ride height sensor, front right
6	Wheel acceleration sensor, front left (optional equipment “Active Comfort Drive” SA 2VS)
7	Control valves for shock absorber adjustment, front left
8	Ride height sensor, front left
9	12 V battery (optional equipment “Active Comfort Drive” SA 2VS)
10	Dynamic Stability Control (DSC)
11	Body Domain Controller (BDC)
12	Stereo camera (optional equipment “Active Comfort Drive” SA 2VS)
13	Advanced Crash Safety Module (ACSM-Low)
14	Driving experience switch
15	Vertical Dynamics Platform (VDP)
16	Ride height sensor, rear right
17	Control valves for shock absorber adjustment, rear right

Index	Explanation
18	Wheel acceleration sensor, rear right (optional equipment "Active Comfort Drive" SA 2VS)
19	Ride-height sensor, rear left
20	Control valves for shock absorber adjustment, rear left
21	Wheel acceleration sensor, rear left (optional equipment "Active Comfort Drive" SA 2VS)
22	Electric active roll stabilization rear (EARSVH) (optional equipment "Active Comfort Drive" SA 2VS)
23	Power Control Unit (PCU) (optional equipment "Active Comfort Drive" SA 2VS)

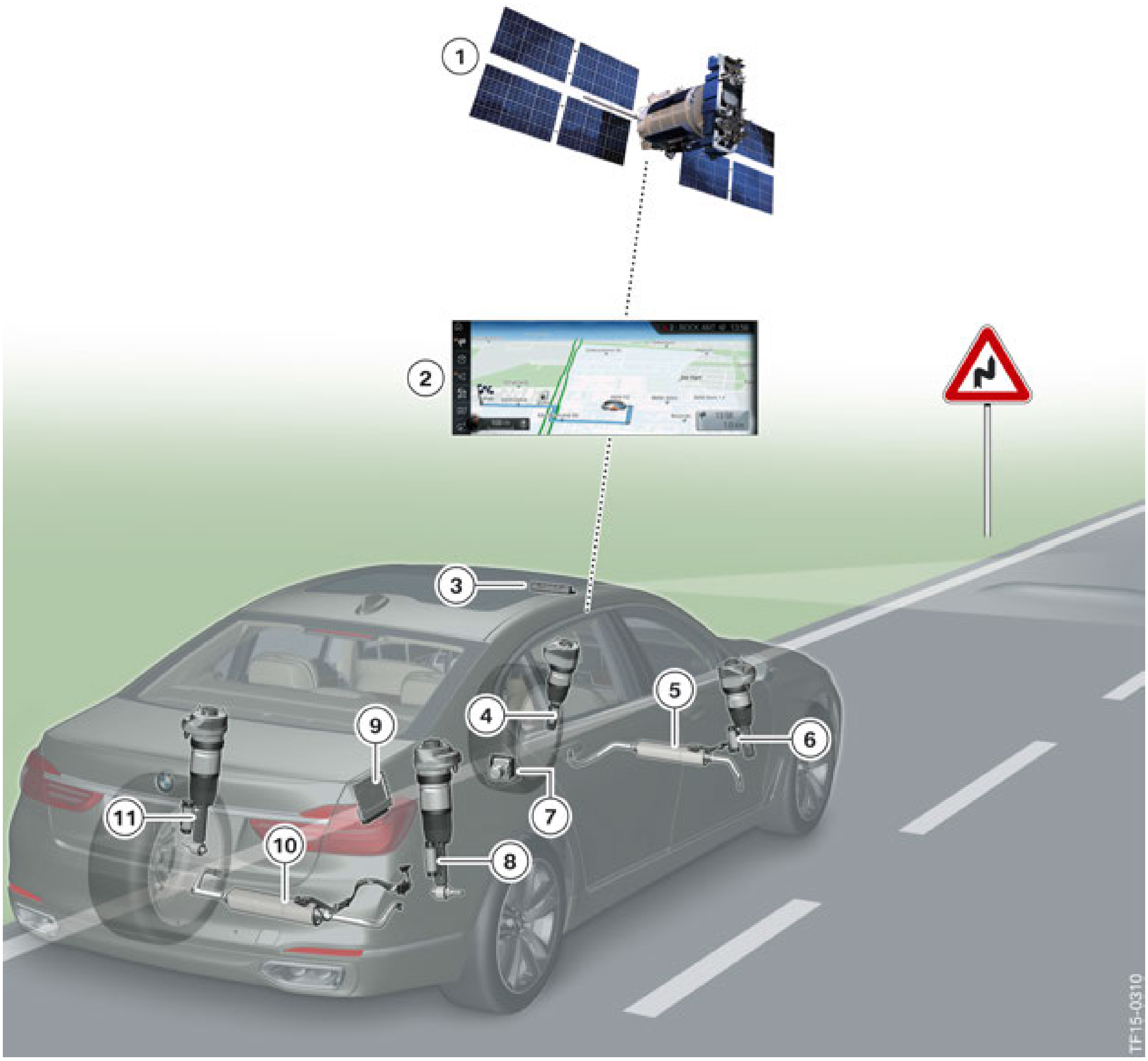
The optional chassis and suspension package "Active Comfort Drive" has the following additional components:

- Wheel acceleration sensors on all 4 wheel carriers
- Electric active stabilizers on the front and rear axles
- An additional 12 V battery as well as a DC/DC converter
- A stereo camera in the windscreen

Wheel acceleration sensors are used in the optional chassis and suspension package "Active Comfort Drive" for the following reasons:

- More precise disturbance variable control of the electric active stabilizers (EARSV) possible. Avoidance of so-called copying from one wheel to the other in the event of road bumps.
- Precise regulation of the Electronic Damper Control (EDC) is possible through detection of the wheel movement via the wheel acceleration sensors and the body movement via the ride height sensors.
  Processing of the two information sources allows use of a simplified control unit version of the Crash Safety Module (ACSM-Low).

6.6.1. Predictive control



Predictive control of the optional chassis and suspension package “Active Comfort Drive” in the G12

Index	Explanation
1	Satellite
2	Navigation data
3	Stereo camera (KAFAS camera 3)
4	Controllable shock absorber, front left
5	Electric active roll stabilization front (EARSVV)
6	Controllable shock absorber, front right
7	Dynamic Stability Control (DSC)

Index	Explanation
8	Controllable shock absorber, rear right
9	Vertical Dynamics Platform (VDP) control unit
10	Electric active roll stabilization rear (EARSVH)
11	Controllable shock absorber, rear left

In order to prepare the chassis and suspension for the different road conditions as early as possible, the following data is read in from various control units and processed to allow predictive control:

- If ADAPTIVE driving mode has been activated via the driving experience switch, the Dynamic Stability Control control unit processes the navigation data to analyses the route and influences the driving program to be activated if necessary. If the vehicle is approaching a sharp bend at high speed, for example, the Dynamic Stability Control (DSC) activates Sport mode without any action on the part of the driver. The Vertical Dynamics Platform (VDP) reads in this information and activates the corresponding chassis components for Sport mode. Conversely, an automatic change in driving program from Sport to Comfort is also possible. If the vehicle exits a twisting section of road through which it has been driven at speed and then drives at constant speed on a straight section, this results in automatic changeover to the Comfort driving program. This means that the optimum driving mode with respect to comfort (Comfort) and driving dynamics (Sport) is automatically set without manual operation of the driving experience switch depending on the driving style and probable route.
  Route guidance need not be activated for this.
- The Vertical Dynamics Platform (VDP) reads in the information of the stereo camera in the windscreen independently of the selected driving mode and processes this.

In addition, a large quantity of additional information such as the driving style analysis is read in by the Vertical Dynamic Platform (VDP) control unit and used for predictive control of the standard Electronic Damper Control (EDC) as well as the electric active stabilizers (EARSV).

Obstacles can therefore be overcome predictively and with even more comfort. The driver is even less aware of bumps. The body of the vehicle does not have to move vertically to the same extent since the chassis and suspension react intelligently and predictively to road bumps.

The optional chassis and suspension package “Active Comfort Drive” therefore offers the following advantages:

- Reduced compression and rebound (EDC).
- Reduced pitch movement (EDC).
- Faster decay of vehicle body reverberations (EDC).
- High driving dynamics when cornering thanks to active roll stabilization (EARSV).
- High comfort for straight-ahead driving due to decoupling of anti-roll bar halves and thus avoidance of road bump "copying" (EARSV).

The functions of the chassis and suspension package "Active Comfort Drive” are available in different forms in the following positions of the driving experience switch.

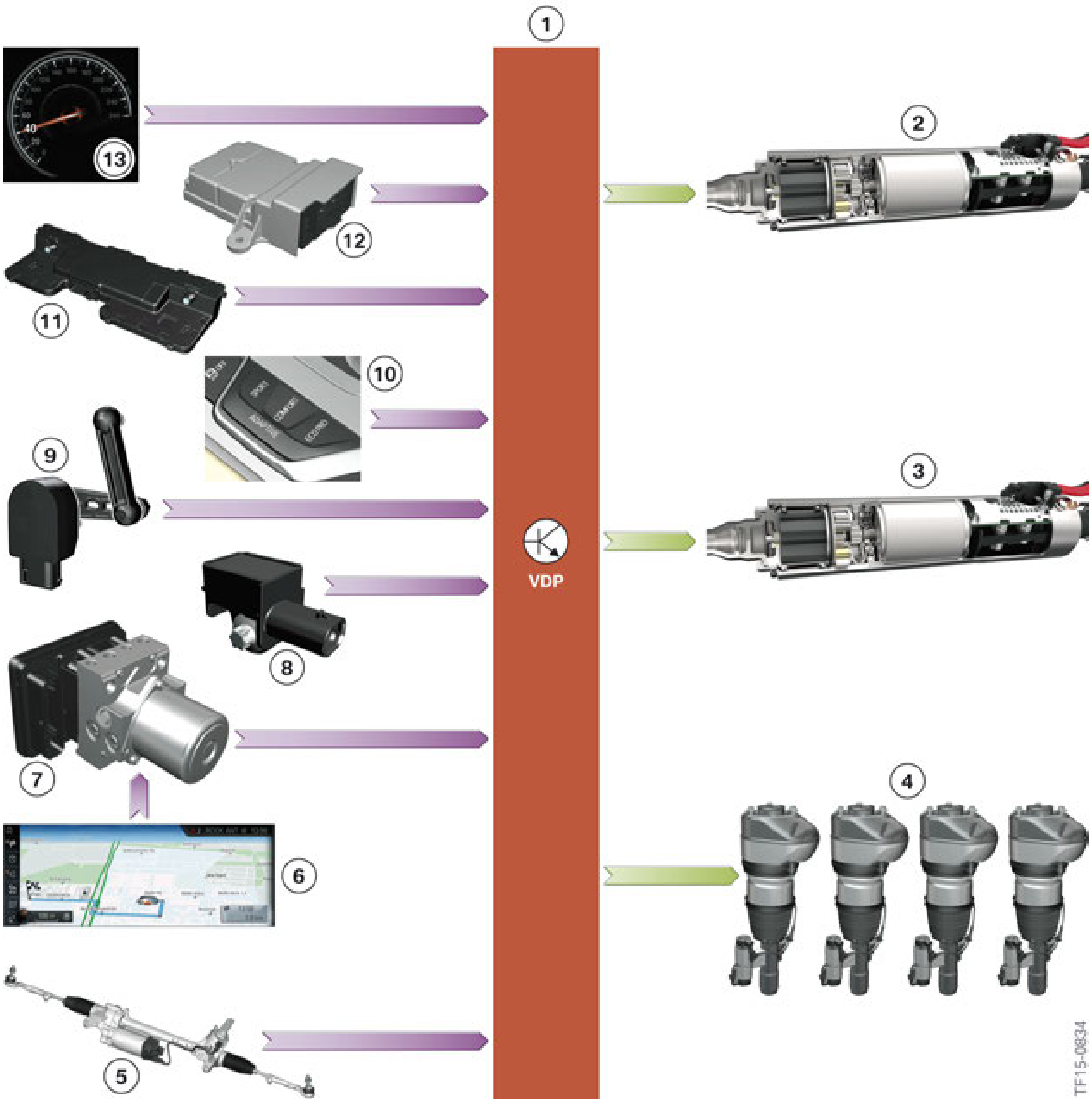
G12 Chassis and Suspension
6. Driving Stability Control

Driving experience switch position	Electric active roll stabilization EARSV	Electronic Damper Control (EDC)
COMFORT PLUS	Balanced	Comfortable
Comfort/ECO PRO	Balanced	Balanced
Sport	Sporty	Sporty

As a result of intelligent networking of the systems, failure of one sensor system, e.g. the stereo camera due to poor visibility, can be sufficiently compensated by the other available sensors. The ride comfort and driving dynamics thus remain at a very high level under all conditions.

The following graphic shows an input and output diagram of the various components for control of the optional chassis and suspension package “Active Comfort Drive” in the G12.

6. Driving Stability Control



Input and output diagram of the optional chassis and suspension package “Active Comfort Drive” in the G12

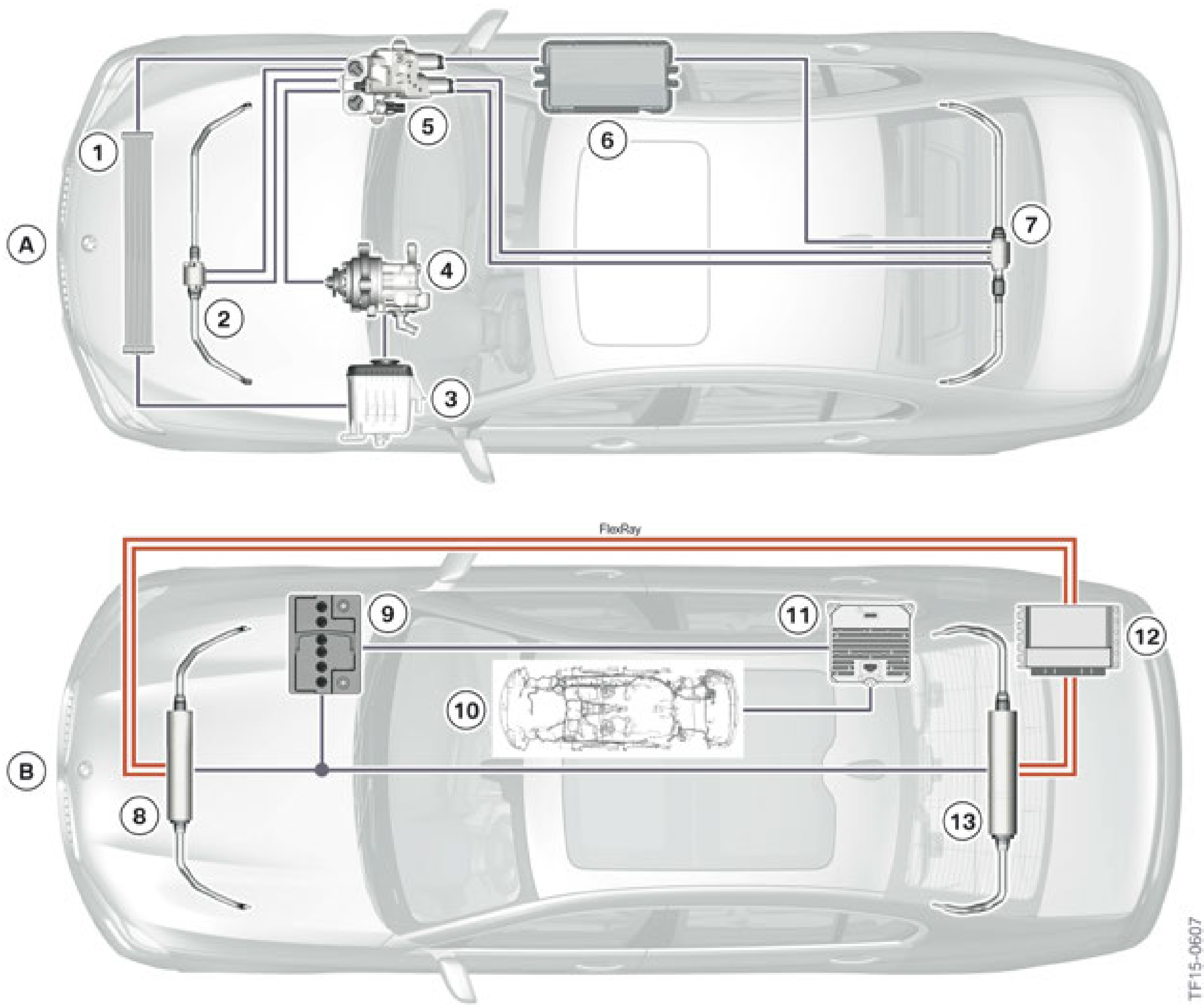
Index	Explanation
1	Vertical Dynamics Platform (VDP)
2	Electric active roll stabilization front (EARSVV)
3	Electric active roll stabilization rear (EARSVH)
4	Electronic Damper Control (EDC) (4x)
5	Steering angle (EPS)
6	Navigation data
7	Wheel speeds (DSC)

Index	Explanation
8	Wheel accelerations
9	Ride heights
10	Driving mode
11	Road profile (stereo camera)
12	Lateral and longitudinal acceleration and yaw rate (ACSM-Low)
13	Vehicle speed

6.6.2. Electric active roll stabilization (EARSV)

As the first vehicle manufacturer worldwide, BMW uses electric active stabilizers instead of the previously used hydraulic active stabilizers. The electric active stabilizers in the optional equipment “Active Comfort Drive” (SA 2VS) reduce the roll tendency of the body in bends by targeted application of mechanical moments on the stabilizer halves by means of an electric motor.

The following graphic shows a schematic system comparison between the active hydraulic stabilizer and the active electric stabilizer.



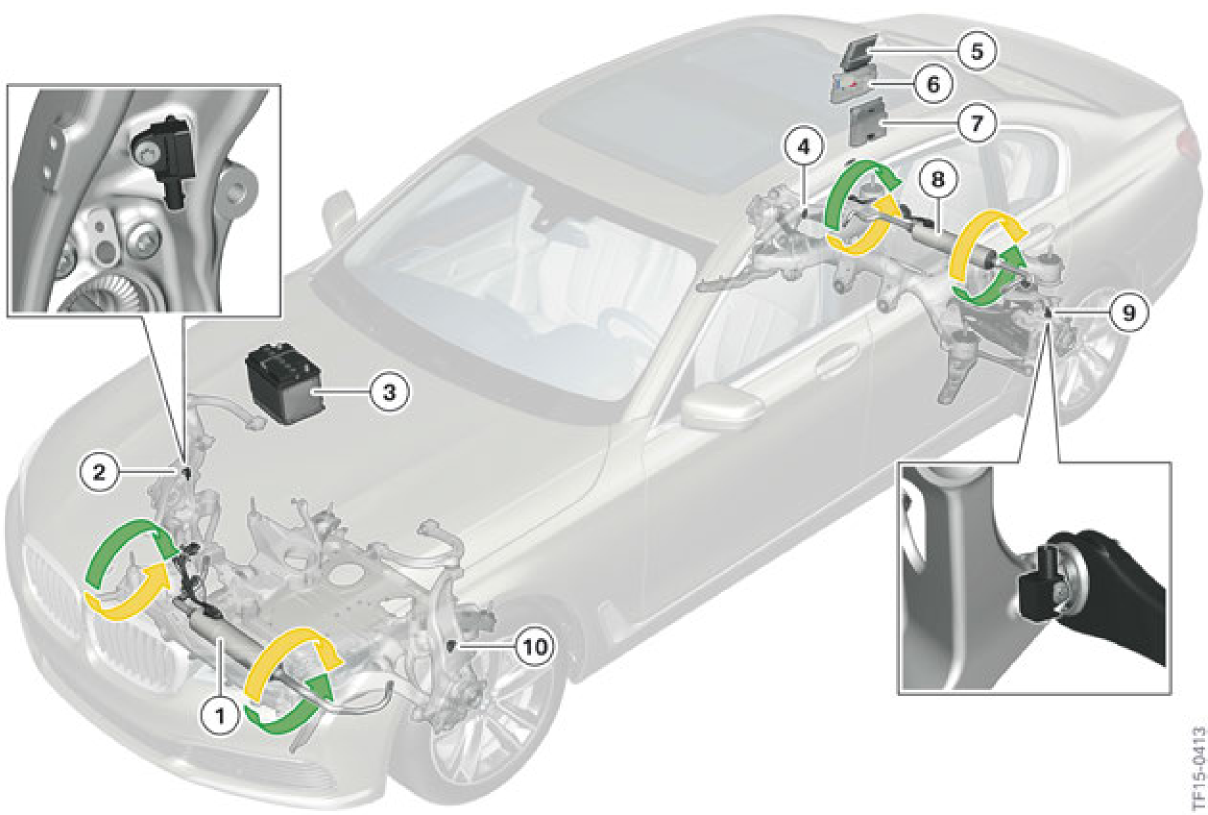
Schematic comparison of hydraulic active stabilizer and electric active stabilizer

Index	Explanation
A	Hydraulic active stabilizer ARS (F01/F02)
B	Electric active stabilizer EARSV (G12)
1	Engine oil cooler
2	Hydraulic active stabilizer front (ARS)
3	Expansion tank
4	Hydraulic pump
5	Valve block
6	Vertical Dynamics Management control unit (VDM)
7	Hydraulic active stabilizer rear (ARS)
8	Electric active roll stabilization front (EARSVV)
9	12 V battery (vehicle electrical system support)

Index	Explanation
10	Vehicle electrical system
11	Power Control Unit PCU (DC/DC converter 500 W)
12	Vertical Dynamics Platform (VDP) control unit
13	Electric active roll stabilization rear (EARSVH)

Electrification of the active stabilizer offers the following advantages:

- Simple integration in “full hybrid” drive systems
  Active roll stabilization is possible during purely electric driving.
- Simple decoupling of the stabilizer halves during straight-ahead driving
  Improved ride comfort due to prevention of road bump "copying"
- Increased efficiency
  Energy is required exclusively during the control actions and does not need to be kept permanently available like in a hydraulic system.
  Self-aligning forces which act on the electric motor in the stabilizer can be partially converted into electric current and fed back into the vehicle electrical system.



System overview of electric active roll stabilization EARSV

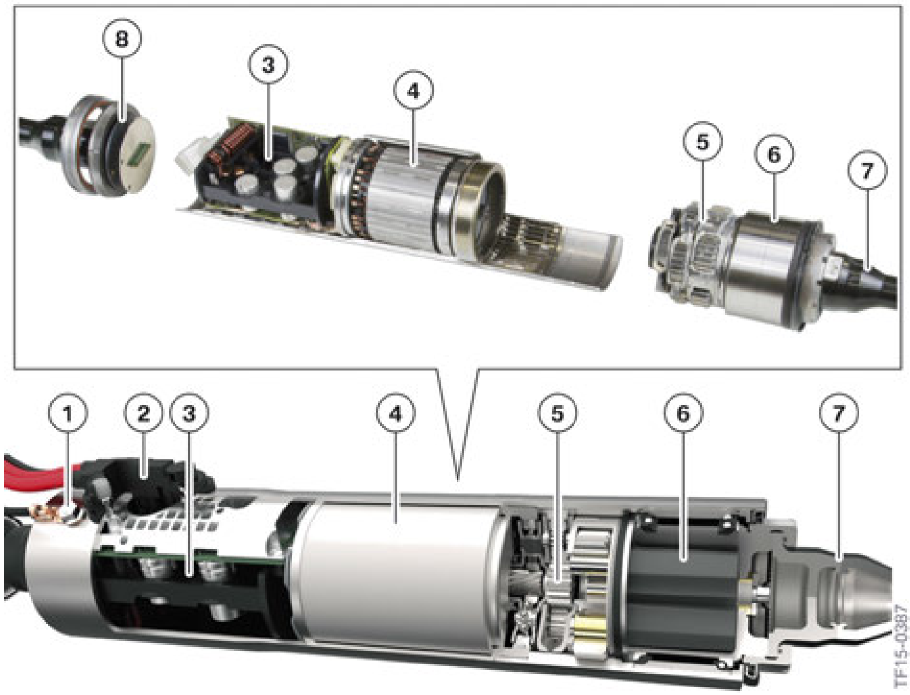
Index	Explanation
1	Electric active roll stabilization front (EARSVV)
2	Wheel acceleration sensor, front right
3	12 V battery in engine compartment (vehicle electrical system support)
4	Wheel acceleration sensor, rear right
5	Vertical Dynamics Platform (VDP)
6	Rear right power distribution box
7	Power Control Unit (PCU) (DC/DC converter 500 W)
8	Electric active roll stabilization rear (EARSVH)
9	Wheel acceleration sensor, rear left
10	Wheel acceleration sensor, front left

A particular advantage which contributes above all to increasing ride comfort is the prevention of so-called "copying". When the vehicle is driving straight-ahead and drives over road bumps, electric active roll stabilization EARSV permits practically full decoupling of the left and right sides to that copy vibrations are almost excluded. The electric active stabilizers therefore compensate for the disadvantages of conventional anti-roll bars.

The following variables are mainly used for calculation of the required activation of the electric active stabilizers.

- Current lateral and longitudinal acceleration
- Vehicle speed
- Steering angle
- Wheel acceleration
- Ride heights

The incipient roll moment (Mw) is rapidly counteracted by fast processing of the data and activation of electric active roll stabilization (EARSV).



Sectional view of an electric active stabilizer in the G12

Index	Explanation
1	Ground connection
2	Electrical connection
3	Control unit (EARSVV/EARSVH)
4	Electric motor
5	Planetary gear (three-stage)
6	Decoupling element
7	Anti-roll bar link
8	Torque sensor

The active stabilizers receive the control request from the Vertical Dynamics Platform (VDP) control unit. The bus telegrams are read in and processed by the control units of the two active stabilizers (EARSVV/EARSVH). The two stabilizer halves are twisted with respect to each other by activation of the electric motor. Central energy conversion takes place in the permanently excited synchronous motor, whose direction of rotation, torque and speed are controlled via the set rotating field.

Power transmission takes place via the three-stage planetary gear, which converts the torque of the electric motor to the required stabilizer output torsion torque with a ratio of 1:158. A maximum stabilizer torsion torque of 750 Nm is currently implemented in the G12. The system is designed for significantly higher torsion torques in order to also permit compensation of superposition effects due to road bumps.

The elastomer decoupling element between the planetary gear and stabilizer torsion spring has the task of decoupling highly dynamic, low-amplitude excitations from the road. This thus makes a further contribution to meeting the high comfort goals.

A torque sensor inside the component provides feedback on the current control torques to the control unit. A plausibility check of the data allows various faults to be detected and then stored in the form of a fault code entry. However, repair of the component is not possible. The active electric stabilizer must be replaced as a complete unit in the event of a mechanical component defect.

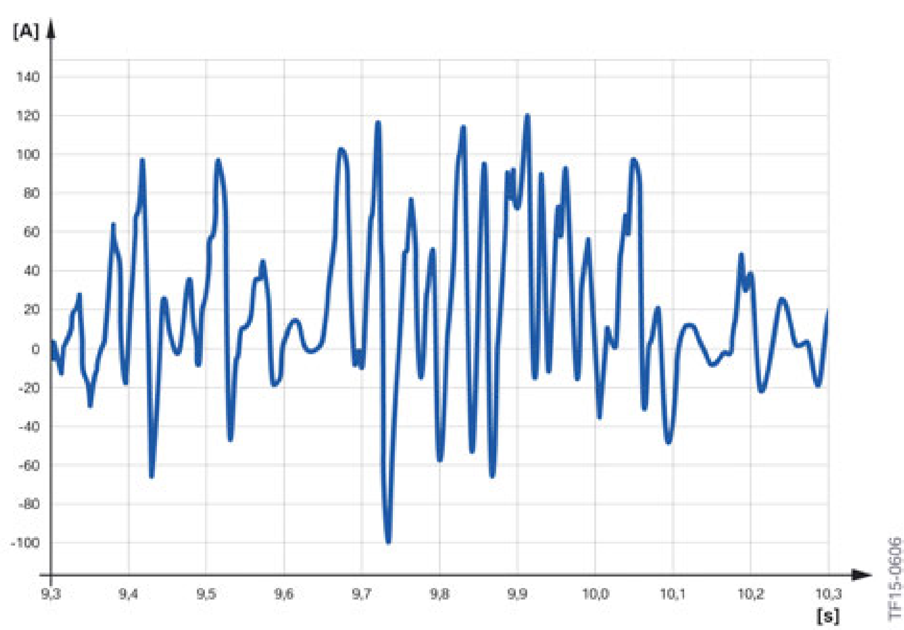
Since the electric active stabilizer will be available in other vehicle models in future, the control unit must be taught for the respective vehicle by means of version encoding after installation. This ensures that the electric active stabilizer provides the correct control torques for the vehicle in question.

Technical data

The following table provides an overview of the technical data of the electric active stabilizer.

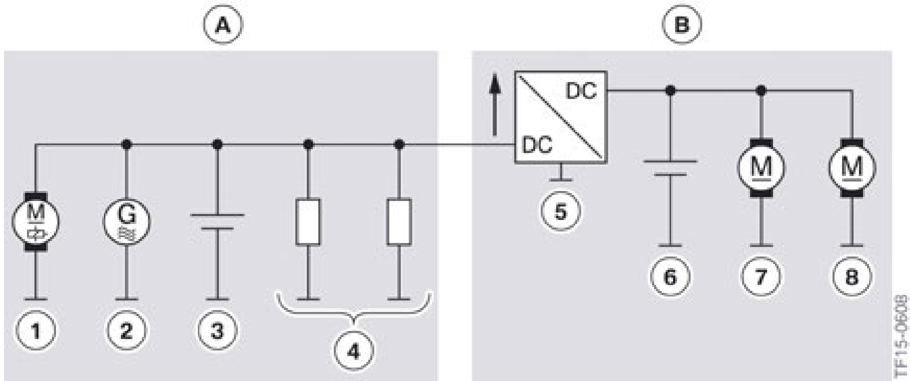
Electric active roll stabilization EARSV	Technical data
Weight	14 kg / 30 lbs
Maximum control unit temperature	120 °C / 248 °F
Maximum electric motor temperature	160 °C / 320 °F
Maximum electric motor torque	7.5Nm / 5.5 ft-lbs
Maximum stabilizer torque	750Nm / 553 ft-lbs
Maximum current consumption	120 A
Maximum current output	- 100 A

The values for maximum current consumption and maximum current output are the values that are possible for short-time operation.



Current consumption and current output of the electric active stabilizer in the G12

The above graphic shows the current consumption and output of the electric active stabilizer for a driving manoeuvre with approximately 30 % energy recovery. It must be noted that this diagram is just a snapshot representation. Depending on the driving manoeuvre, the activation power and energy recovery of the electric active stabilizer may differ considerably.



Function diagram of the DC/DC converter in the G12

Index	Explanation
A	12 V vehicle electrical system
B	Consumes of electric active stabilizers
1	Starter motor
2	Alternator
3	12 V battery
4	Consumers of the 12 V vehicle electrical system
5	Power Control Unit (PCU) (DC/DC converter 500 W)
6	12 V battery in engine compartment (vehicle electrical system support)
7	Electric active roll stabilization front (EARSVV)
8	Electric active roll stabilization rear (EARSVH)

In order to ensure that the consumers of the 12 V vehicle electrical system in the G12 are not influenced by the high load currents of the two electric active stabilizers, the stabilizers have been isolated from the basis vehicle electrical system by means of a DC/DC converter (500 W).

The require energy for activation is provided by an additional 12 V battery located in the engine compartment. This means that other consumers are not affected by the high energy consumption.

The battery is an auxiliary batter which supplies the vehicle electrical system with power depending on the vehicle equipment. For this reason, the battery may also be present even if the vehicle is not equipped with electric active stabilizers.

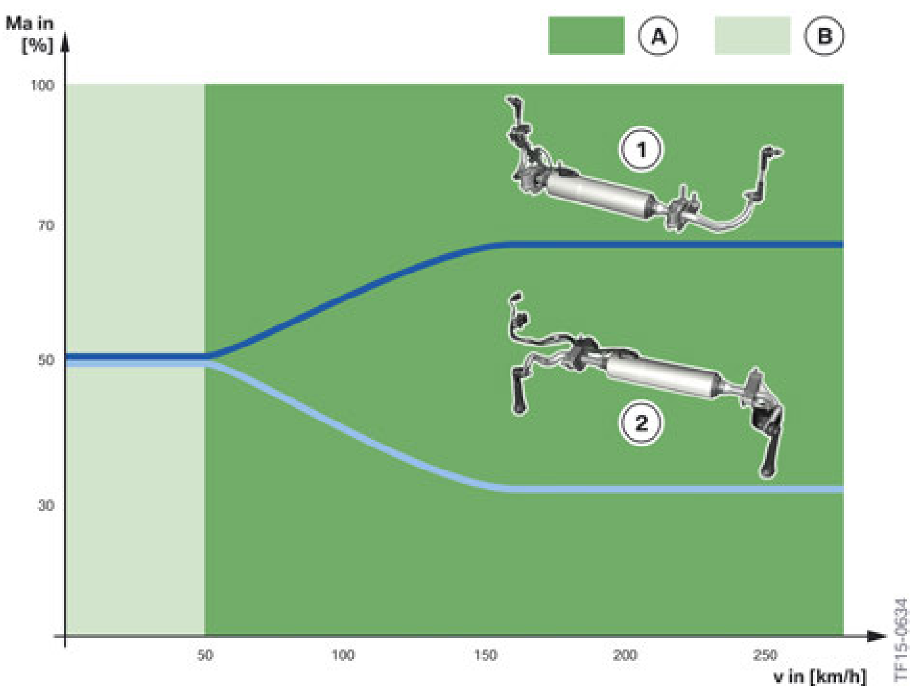
6.6.3. Control strategy

Vehicle drivability when cornering can be greatly influenced by anti-roll bars on the front and rear axles. A decisive factor here is the roll moment ratio between the front and rear vehicle axles. This ratio depends on the respective anti-roll bar moments of the two axles.

The following table provides an overview of the possible roll moment ratios and the resultant handling of the vehicle.

Anti-roll bar	Roll moment ratio	Understeer	Oversteer
Front axle soft/ rear axle hard	< 50 %		X
Front axle hard/ rear axle soft	> 50%	X	

The following graphic shows the percentage distribution of the stabilizer moments (roll moment ratio) of the active stabilizers on the two vehicle axles.



Characteristic curve of active stabilizer on front and rear axles

Index	Explanation
A	Understeering roll moment ratio
B	Neutral roll moment ratio
Ma in [%]	Moment distribution of active stabilizers in percent
v in [km/h]	Driving speed in kilometers per hour
1	Active stabilizer on the front axle
2	Active stabilizer on the rear axle

6. Driving Stability Control

The active stabilizer allows the roll moment ratio to be adapted to the respective driving situation in order to increase the driving dynamics. The roll moment ratio is 50 : 50 (neutral) in the lower speed range (0 ~ 50 km/h). The roll moment ratio is adjusted towards understeer with increasing speed.

Application of roll moments via the active stabilizer influences the cornering forces that can be transferred by the tires.

The following graphic shows the maximum cornering forces that can be transferred when cornering as a function of the applied stabilizer moments.

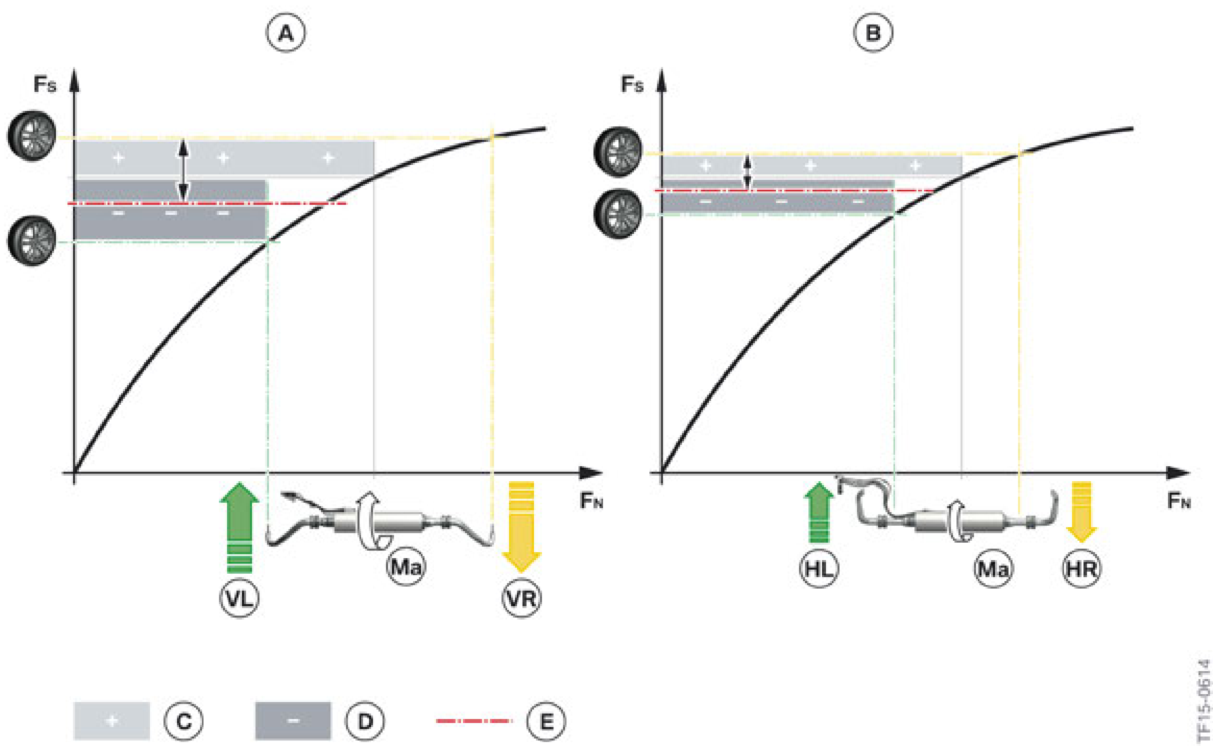


Diagram of a positive roll moment ratio through control via 2 active stabilizers

Index	Explanation
A	Large moment of the active stabilizer on the front axle
B	Low moment of the active stabilizer on the rear axle
C	Increase in transferable cornering force at the wheel
D	Reduction in transferable cornering force at the wheel
E	Resultant transferable cornering force at the wheels of an axle
FS	Transferable cornering force at the wheel
FN	Vertical wheel force
HL	Force of active stabilizer at rear left wheel

Index	Explanation
HR	Force of active stabilizer at rear right wheel
Ma	Active stabilizer moment
VL	Force of active stabilizer at front left wheel
VR	Force of active stabilizer at front right wheel

When cornering, a counter-torque (Ma) is applied by the active stabilizers to counteract the acting roll moment (Mw). The moments (Ma) applied depending on the action of the active stabilizers either increase or reduce the tire contact forces of the different wheels.

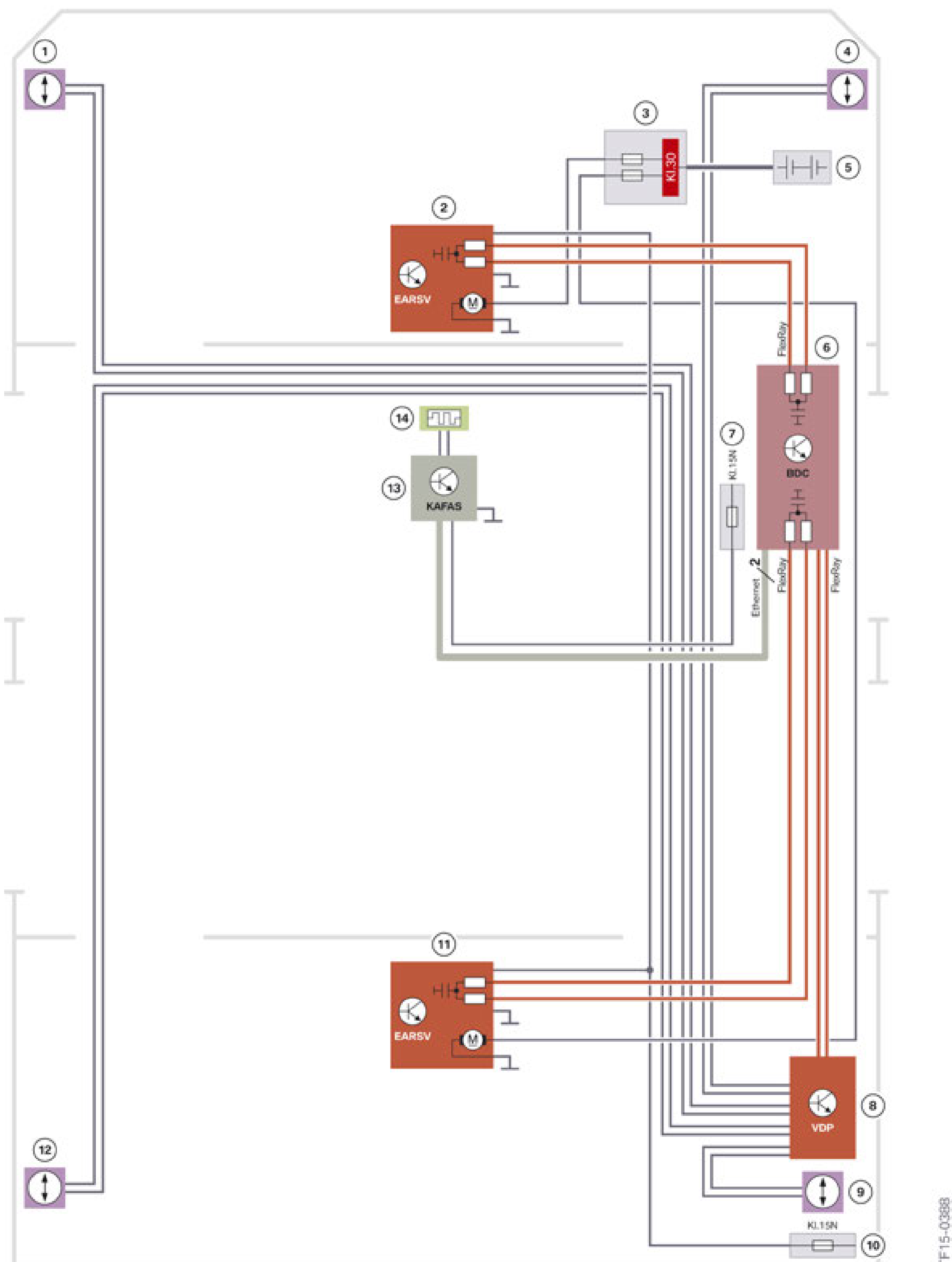
If a wheel is loaded with a particularly high force by the active stabilizer, its transferable cornering force increases due to the higher tire contact force. In contrast, the load on the opposite wheel is relieved, and its cornering force is thus reduced due to the lower tire contact force. The resultant tire contact forces characterise the transferable cornering forces of the wheels on an axle.

Since the reduction in the transferable cornering forces of the relieved wheel is proportionately higher than the increase in the transferable cornering forces of the loaded wheel as a result of increasing active stabilizer force, this means that there is a reduction in the resultant cornering force of the wheels on this axle.

In the direct comparison of the two axles in the above diagram, it can be seen that the rear axle can transfer a higher resultant transferable cornering force than the front axle. In the limit range, the vehicle would therefore push over the front wheels, i.e. understeer.

It is easier for an inexperienced driver to regain control over the vehicle again in this situation than if the vehicle were to oversteer (vehicle skids at the rear axle).

6.6.4. System wiring diagram of electric active roll stabilization EARSV



System wiring diagram of electric active roll stabilization EARSV in the G12

Index	Explanation
1	Wheel acceleration sensor, front left
2	Electric active roll stabilization front (EARSVV)
3	Power distribution box, engine compartment
4	Wheel acceleration sensor, front right
5	12 V battery in engine compartment (vehicle electrical system support)
6	Body Domain Controller (BDC)
7	Power distribution box, front right
8	Vertical Dynamics Platform (VDP)
9	Wheel acceleration sensor, rear right
10	Rear right power distribution box
11	Electric active roll stabilization rear (EARSVH)
12	Wheel acceleration sensor, rear left
13	KAFAS camera control unit
14	Stereo camera

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