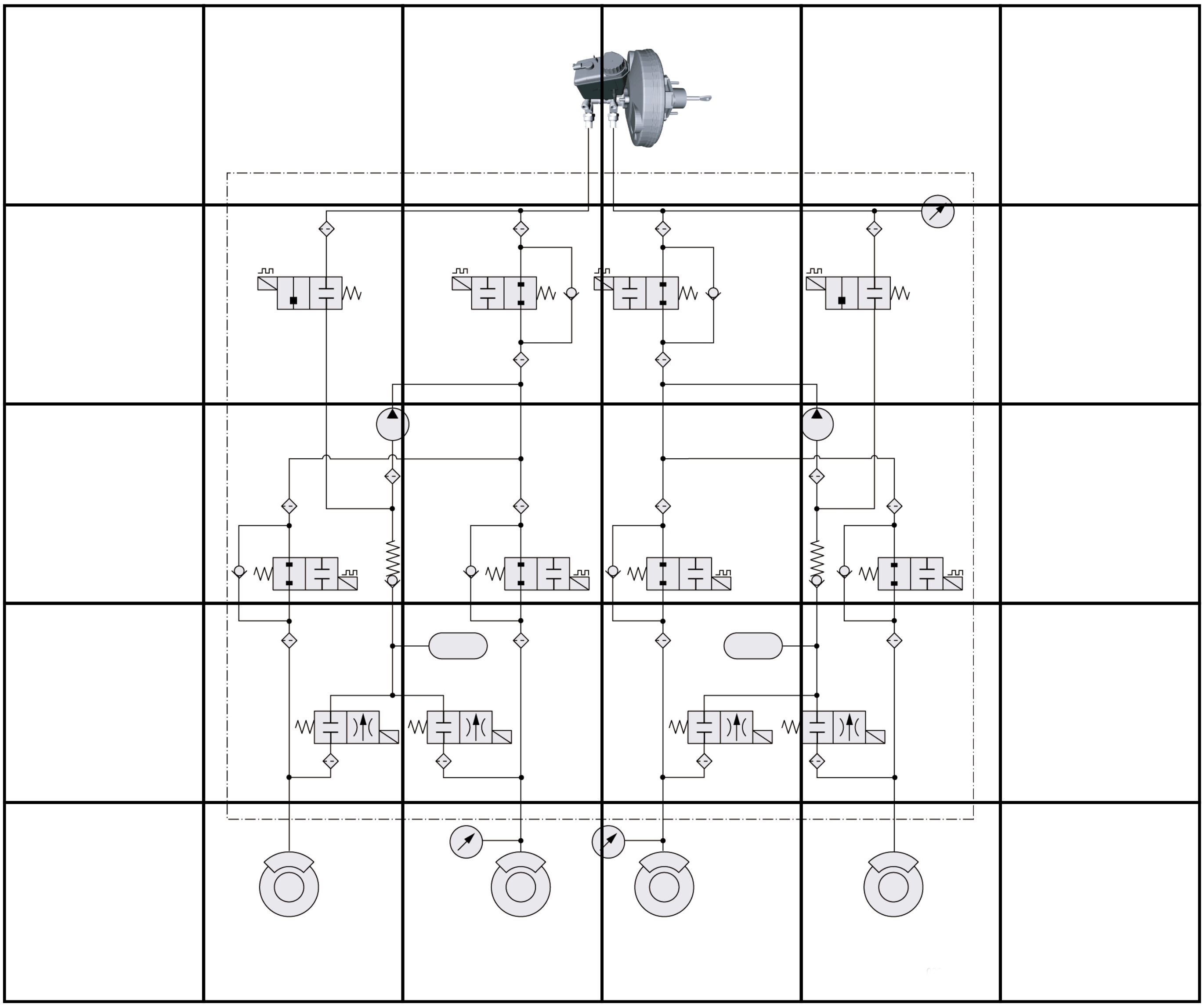
BMW Group
Aftersales Training

E60 Driving Dynamics Systems
Participant Manual



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

VS-42 MFP-HGK-BRK-0500

Contents

E60 Driving Dynamics Systems

Dynamic Stability Control DSC8 and DynamicDrive are used as driving dynamics systems in the E60.

Dynamic Stability Control DSC8

Dynamic Stability Control DSC8 manufactured by Bosch is used for the first time in the E60.

New system features

The hardware component of DSC8 is a newly developed component.

The electric precharging pump (eVLP) has now been omitted.

The DSC module is connected to the Powertrain CAN (PT-CAN) and to the Chassis CAN (F-CAN).

2 new pressure sensors are incorporated in the brake lines in the ACC optional extra.

Advantages of system over DSC5.7

DSC8 has the following advantages over DSC5.7:

- 25% lower structural volume
- 30% lighter (saving 700 g in the module, saving of 1.8 kg through omission of the electric precharging pump)
- Control-unit memory 768 kB ROM (previously 256 kB ROM)
- Processor computing cycle time 5 to 10 ms (previously 20 ms)

- System overview

Bus overview

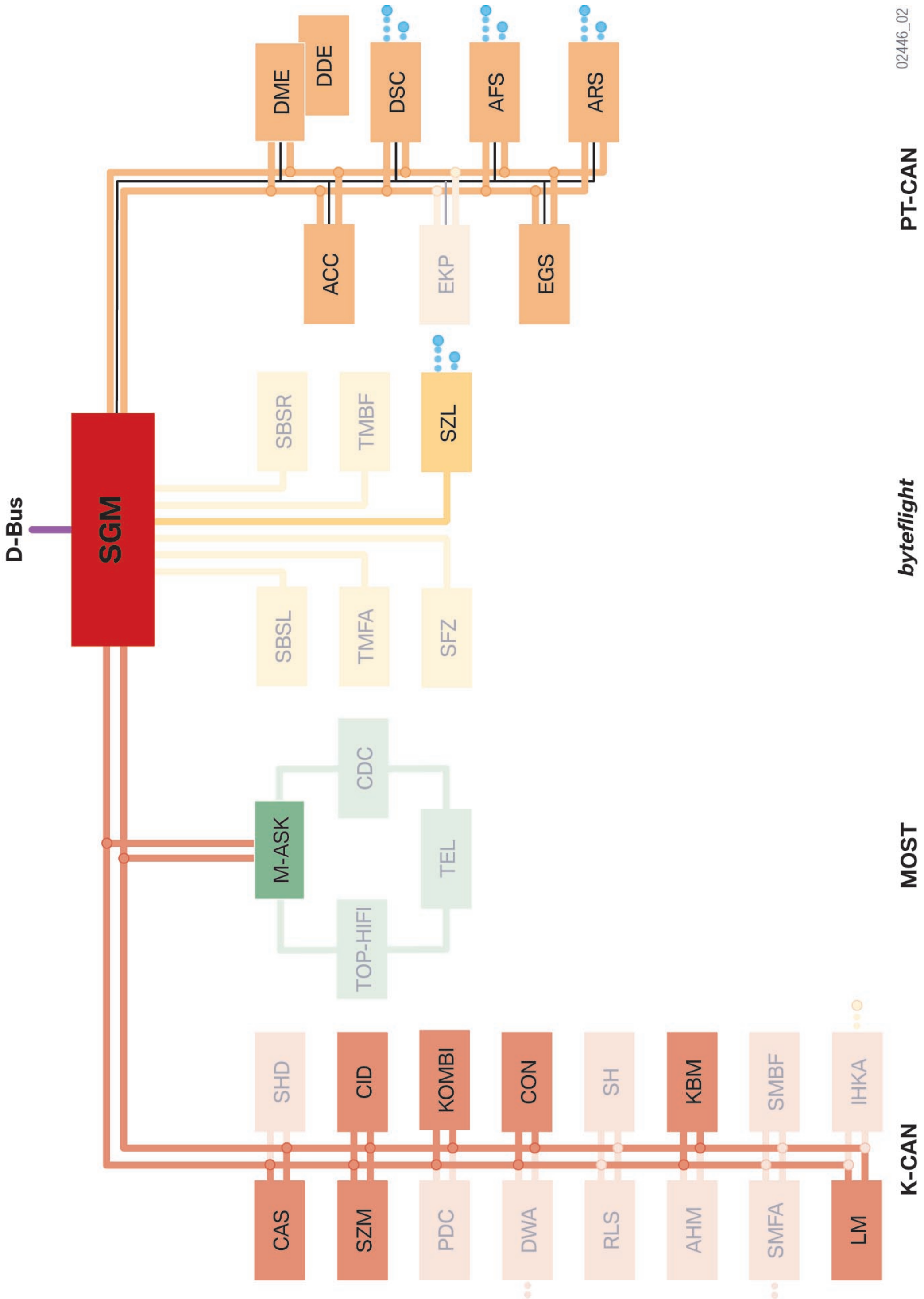


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Fig. 1: Control units in DSC8 system

Index	Explanation	Index	Explanation
CAS	Car Access System	TEL	Telephone
SZM	Switch centre, centre console	CDC	Compact Disc Changer
PDC	Park Distance Control	SGM	Safety and Gateway Module
DWA	Anti-theft alarm system	SBSL	Satellite, B-pillar, left
RLS	Rain/light sensor	TMFA	Door module, driver
AHM	Trailer module	SFZ	Satellite, vehicle centre
SMFA	Seat module, driver	SZL	Steering column switch cluster
LM	Light module	TMBF	Door module, passenger
IHKA	Integrated automatic heating/air conditioning	SBSR	Satellite, B-pillar, right
SMBF	Seat module, passenger	ACC	Active Cruise Control
KBM	Body basic module	EKP	Electric fuel pump
SH	Independent heating	DSC	Dynamic Stability Control
CON	Controller	EGS	Electronic transmission management
KOMBI	Instrument cluster	ARS	DynamicDrive
CID	Central Information Display	AFS	Active steering
SHD	Slide/tilt sunroof	DME	Digital Motor Electronics
M-ASK	Multi audio system controller	DDE	Digital Diesel Electronics
TOP-HIFI	Top HiFi amplifier		

Inputs/outputs

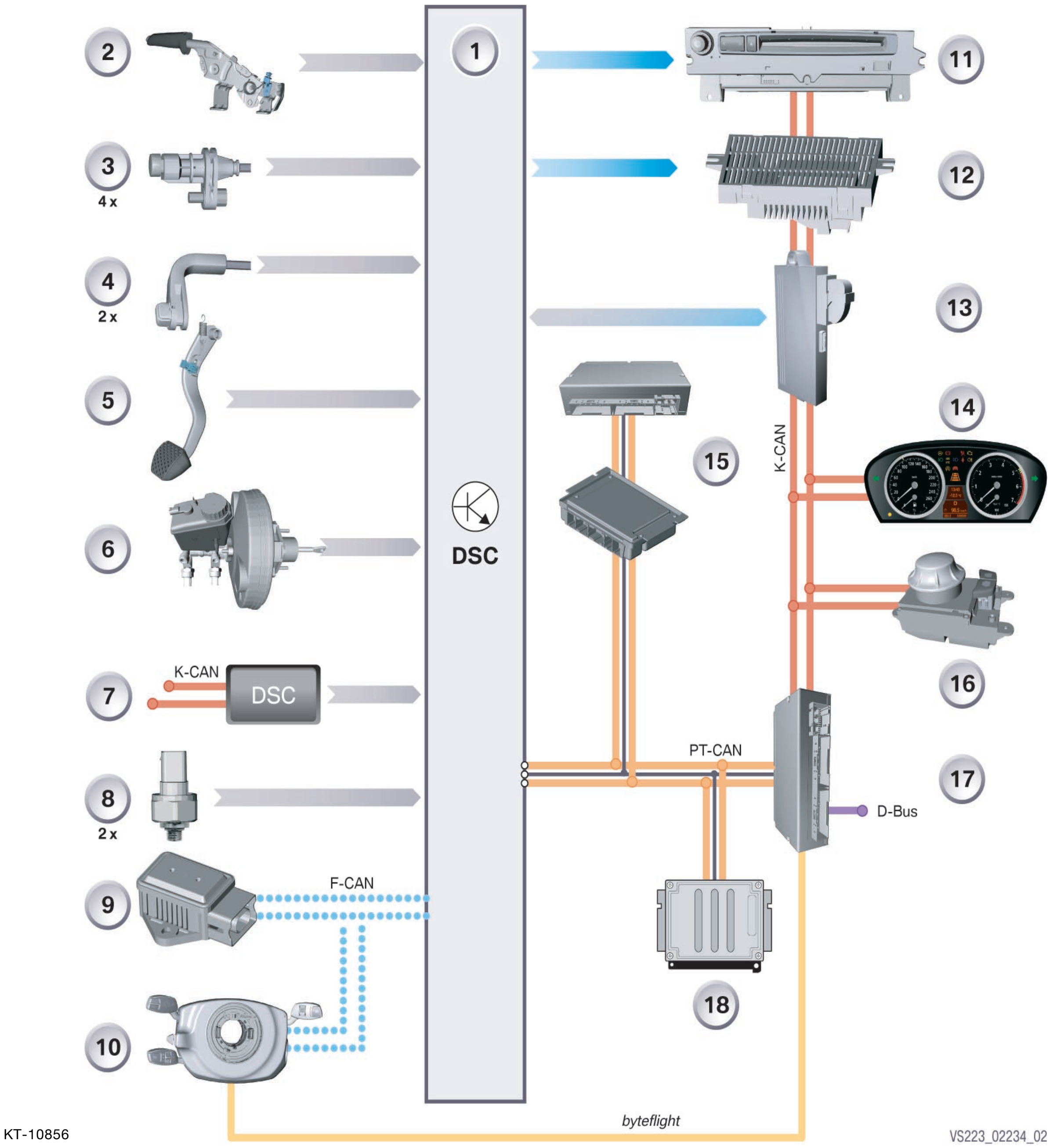

Fig. 2: System overview, inputs/outputs

Index	Explanation	Index	Explanation
1	DSC control unit	12	Light switch module
2	Handbrake switch	13	Car Access System
3	Wheel-speed sensor	14	Instrument cluster
4	Brake-pad wear sensors	15	Control units, electronic transmission management or sequential manual gearbox
5	Brake-light switch	16	Controller
6	Brake-fluid level switch	17	Safety and Gateway Module
7	DSC button	18	Digital Motor Electronics
8	Brake pressure sensors (only with ACC)	PT-CAN	Powertrain CAN
9	DSC sensor	K-CAN	Body CAN
10	Steering-angle sensor (SZL)	*byteflight*	*byteflight*
11	Multi audio system controller	D-Bus	Diagnosis bus

System schematic

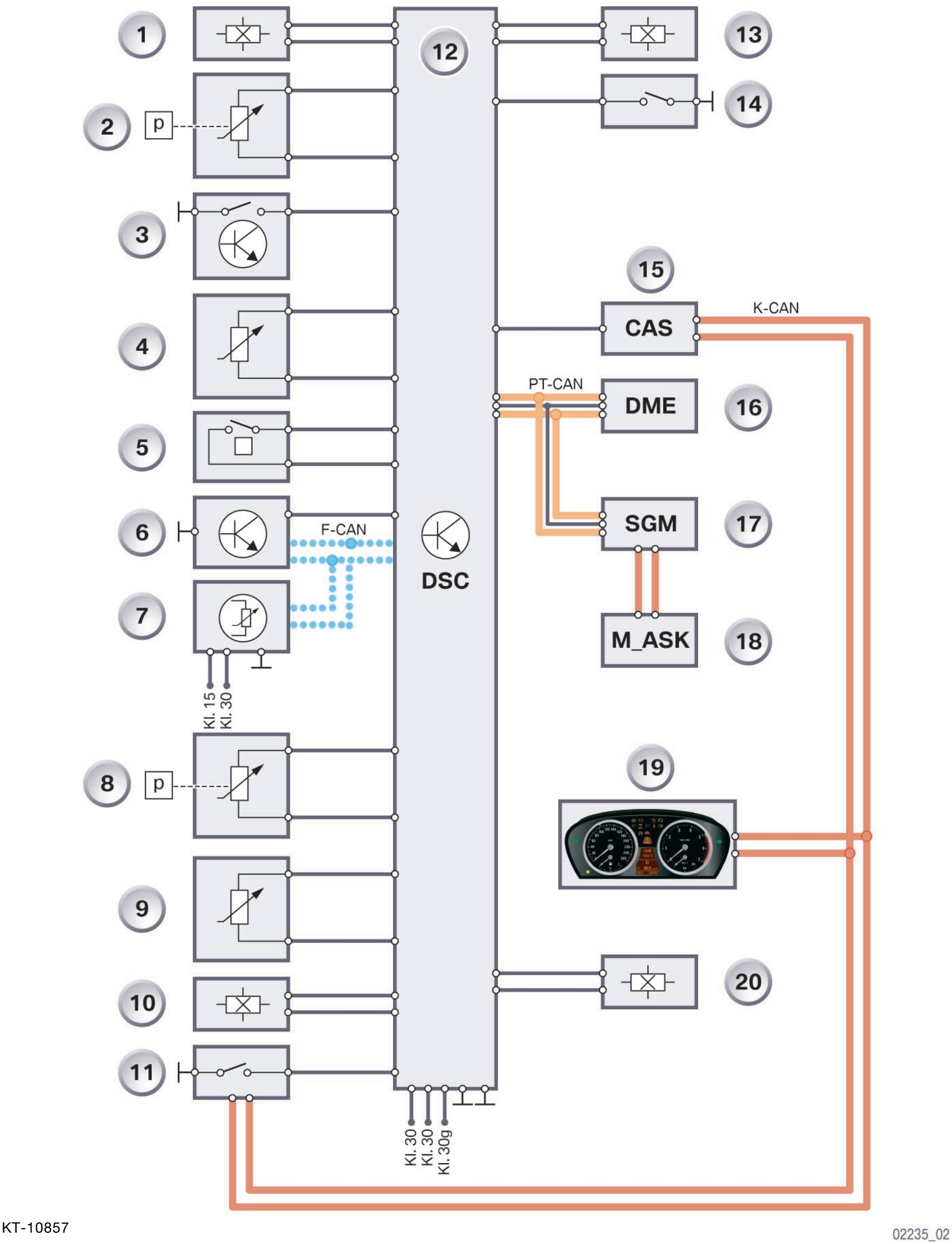

Fig. 3: DSC8 system schematic

Index	Explanation	Index	Explanation
1	Wheel-speed sensor, front left	14	Handbrake switch
2	Pressure sensor, front-axle brake circuit	15	Car Access System control unit
3	Brake-light switch	16	Digital Motor Electronics
4	Brake-pad wear sensor	17	Safety and Gateway Module
5	Brake-fluid level switch	18	Multi audio system controller
6	DSC sensor	19	Instrument cluster
7	Steering-angle sensor	20	Wheel-speed sensor, rear right
8	Pressure sensor, rear-axle brake circuit	F-CAN	Chassis CAN
9	Brake-pad wear sensor	PT-CAN	Powertrain CAN
10	Wheel-speed sensor, rear right	K-CAN	Body CAN
11	DSC button	Kl. 30	Terminal 30
12	DSC control unit	Kl. 30g	Terminal 30g
13	Wheel-speed sensor, front right		

Hydraulic schematic

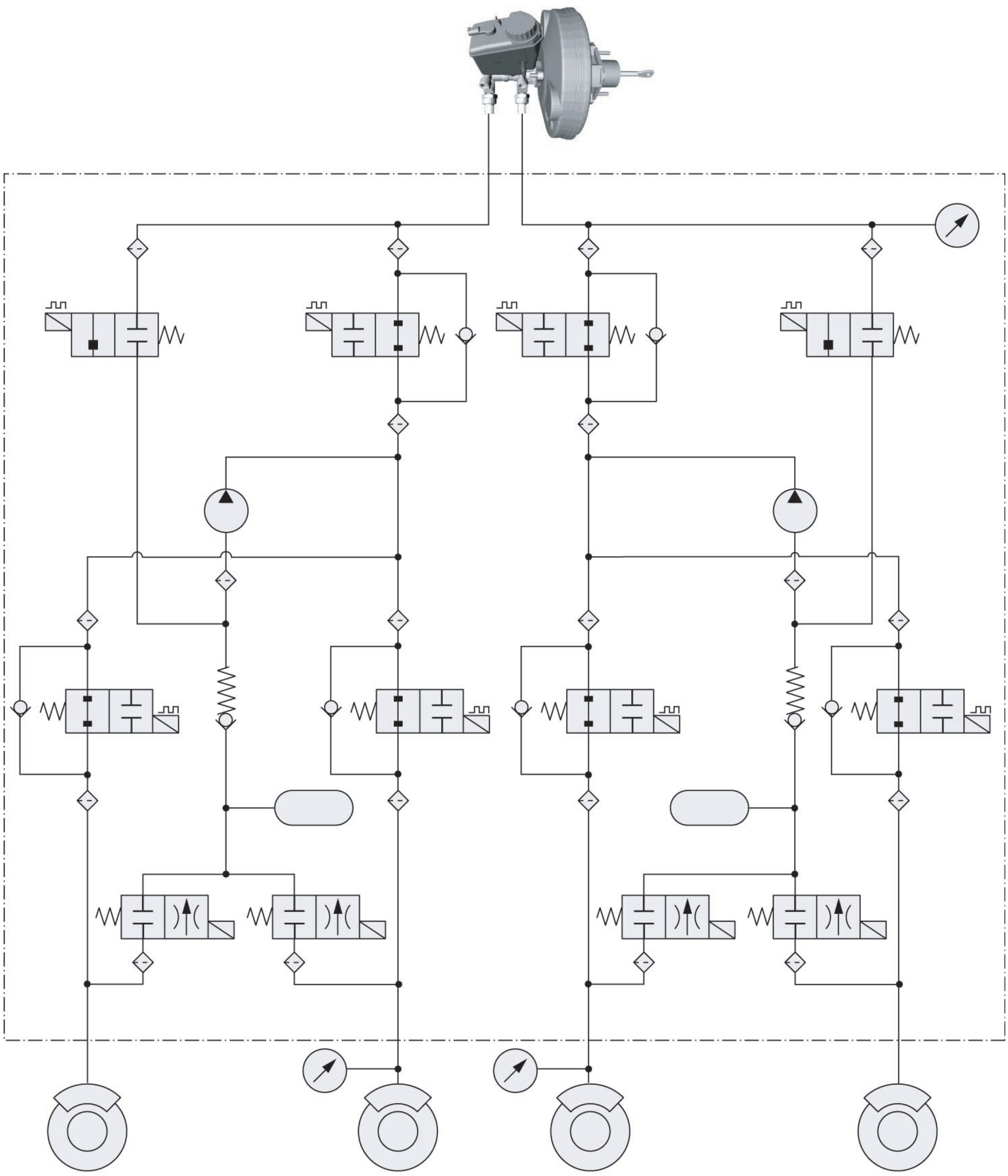

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Fig. 4: DSC hydraulic schematic

- Components

DSC module

The DSC module is located on the right side of the engine compartment between the coolant expansion tank and the cooling module.

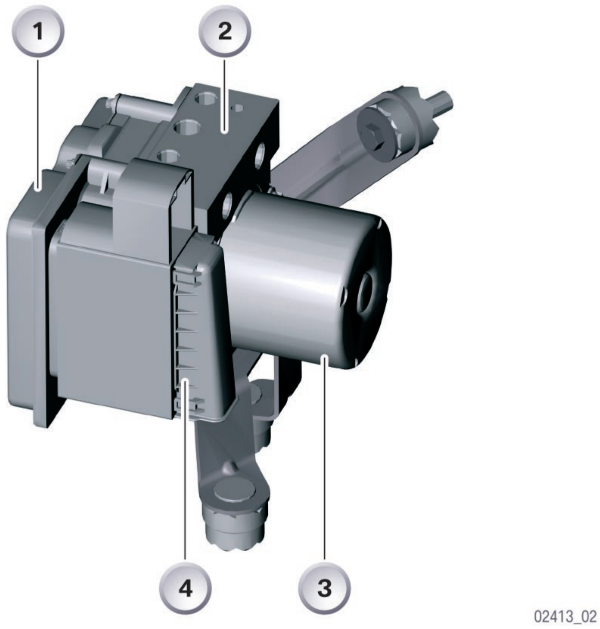

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Fig. 5: DSC module

Index	Explanation	Index	Explanation
1	DSC control unit	3	Electric motor/pump
2	Valve block	4	Plug connector

In a DSC control operation, the braking pressure is built up with the aid of an electric motor.
A pressure sensor integrated in the valve block senses the braking pressure established when the driver applies the brake.

Brake pressure sensors

If the car is equipped with ACC, the left front-axle and rear-axle brake lines each incorporate a brake pressure sensor.

The brake pressure sensor for the front-axle brake circuit is located on the front right wheel arch.

The brake pressure sensor for the rear-axle brake circuit is located on the left side of the engine compartment at the rear.

- System functions

DSC calculates the current driving status using sensor signals. DSC corrects identified instances of driving instability through active brake interventions. For example, in the event of vehicle oversteering, a stabilizing torque is effected by means of brake intervention at the outer cornering front wheel which counteracts the unstable torque. In the event of vehicle understeering, active interventions at the inner cornering wheels provide a stabilizing counter-torque.

Drive stabilization by DSC is performed in all driving situations, i.e. free-rolling, accelerating and (ABS) braking.

The system comprises the following functions:

- ABS Anti-lock Braking System
- ASC Automatic Stability Control
- MSR Engine drag-torque control
- DSC Dynamic Stability Control
- DBC Dynamic Brake Control
- CBC Cornering Brake Control
- ECD Electronically Controlled Deceleration (with ACC only)
- EBV Electronic brake-force distribution
- FLR Driving-performance reduction
- DTC Dynamic Traction Control
- BTM Brake Temperature Model
- RPA Tyre defect indicator
- BBV Brake-pad wear indication

Anti-lock Braking System (ABS)

ABS distinguishes between a full system and a fallback level.

Full ABS system:

- Full ABS system with intact system: The vehicle controller achieves through active braking-pressure increase at the individual wheels a stabilizing effect beyond the driver's choice.
- The formation of the speed reference is supported, in addition to the information of all the wheel speeds, by the information of the yaw rate and the steering angle.
- Especially in speed ranges < 60 km/h it is possible through individual control that meets requirements (control in relation to the wheel with the greater slip) to achieve shortening of the braking distance for different friction coefficients.

ABS fallback level:

- In the event of a drop-out of the yaw-rate, lateral-acceleration or steering-angle signal or a CAN fault, ABS adopts the so-called fallback level. In this case, the vehicle speed is only determined by way of the wheel-speed sensors.

  Differences from the full system:

- No supporting active interventions on brake application.
- On account of the lack of information from the additional sensors, there is a convergence with the Select Low control at the rear axle for the purpose of increasing stability.
- No ASC function.
- No MSR function.

Automatic Stability Control (ASC)

ASC prevents wheelspin during acceleration on all types of road surface.

Control is effected at a control threshold stored in the control unit. Brake interventions are performed as well as intervention in engine management for the purpose of reducing the tractive force.

The ASC function can be deactivated by pressing the DSC button for a longer period (3 s).

Engine drag-torque control (MSR)

The MSR function prevents the rear of the vehicle from swerving in the event of sudden throttle closure or unadapted downshifting to a lower gear by lessening heavy load changes through brief engine-torque increases.

The MSR function is only activated from a driving speed of 15 km/h.

Dynamic Stability Control (DSC)

The control unit uses the vehicle speed, steering angle and lateral acceleration signals to calculate the setpoint yaw angle of the vehicle while cornering. The DSC sensor supplies the actual value. A comparison is made in the control unit between the calculated yaw value and the actual yaw value. A DSC control operation is performed if a deviation is detected which is above the control threshold stored in the control unit.

A DSC control operation is performed depending on whether the vehicle is oversteering or understeering. The control operation consists of an intervention in engine management in order to reduce the tractive forces. Braking pressures are built up at the wheels which serve to stabilize the vehicle again.

The DSC function can be deactivated by means of the DSC button.

Dynamic Brake Control (DBC)

The DBC (Dynamic Brake Control) function is divided into 3 subfunctions:

- Dynamic Brake Support (DBS)
- Maximum Brake Support (MBS)
- Fading Brake Support (FBS)

Dynamic Brake Support (DBS):

DBS assists the driver in emergency-braking situations.

The DBS function is triggered by a sufficiently quick actuation of the brake pedal (6 bar per 1/1000 s). The braking pressure generated by the driver is increased by the hydraulic system to such an extent that the front and rear axle go into ABS control mode. The driver can thus achieve full deceleration with low pedal force.

Maximum Brake Support (MBS):

MBS assists the driver in normal, non-emergency braking situations. When the ABS control range is reached at the front axle, MBS increases the pressure at the rear axle until the ABS control limit is reached here as well. Optimum braking deceleration is thus achieved here as well as normally the driver stops pressing the brake in this situation.

Fading Brake Support (FBS):

If the driver is unable to make use himself of full vehicle deceleration on account of poor brake-pad friction coefficients, e.g. due to high thermal loads, he is supported by the FBS function.
The requirement is a high braking pressure with a simultaneously low vehicle deceleration and high brake-disc temperature.

The FBS function compensates for the brake-force loss through an increase in temperature.

The diminishing braking effect when brakes are hot requires the driver to press the brake pedal more firmly. This increase in pressure is now assumed by an activation of the hydraulic pump.

The brake-disc temperature is not measured but rather calculated by means of the following input variables:

- Wheel speed
- Individual wheel brake pressure
- Ambient temperature

Cornering Brake Control (CBC)

CBC is a subfunction of DSC.

The CBC function is activated at medium to high lateral acceleration.

If a vehicle goes into a curve as it is being braked and threatens to oversteer, an increase in stability is achieved through partial release of the inner cornering rear-wheel brake.

In the case of braking on bends, the pressure in the rear-axle wheel-brake cylinders is individually controlled. Essentially this prevents the vehicle from oversteering.

When decelerating on bends, CBC ensures the best possible directional stability by means of optimum brake-force distribution.

CBC

- performs its control function ahead of ABS or DSC
- also functions when DSC is deactivated
- is deactivated only in the event of an ABS failure

Electronically Controlled Deceleration (ECD)

ECD responds to the requests of the ACC (Active Cruise Control) signals.

DSC executes braking retardation when deceleration is requested by ACC.

This is performed by way of an automatic brake intervention at the four disc brakes, dependent on the vehicle speed, the distance and the speed of the vehicle travelling in front, with max. 3 m/s^2 deceleration.

On downhill gradients at a preselected driving speed, ECD maintains the driving speed continuously at the preset value by way of automatic brake intervention.

The new brake pressure sensors can guarantee more uniform braking at the front and rear axles. This allows longer activation without compromising on comfort or overheating of the brakes on one axle.

In the case of automatic braking, the brake lights are activated in line with legal requirements.

Only from a deceleration > 1 m/s^2 will a brake-light activation be performed by the light module (LM). This prevents the brake lights from coming on frequently and for brief periods.

Electronic brake-force distribution (EBV)

Electronic brake-force distribution prevents overbraking of the rear axle when the system is intact (rear-axle influencing function, HAB) and in the event of an ABS failure (EBV emergency operation). The HAB function prevents the rear wheels from going into ABS control mode before the front wheels when the vehicle is braked both in straight-ahead driving and with sufficiently high deceleration and also when cornering. This ensures a high level of vehicle stability.

The EBV emergency operation function prevents overbraking in the event of ABS failure under the following combinations:

- Effective until the failure of 2 wheel-speed sensors. The failure can occur in any order.
- Effective with intact pump-motor activation (pressure-holding function or pressure decrease meeting requirements at the rear axle).
- Effective even if the admission-pressure sensor fails.

In the event of system malfunctions or additional sensor faults, the driver is alerted by the red brake warning lamp in the instrument cluster.

Driving-performance reduction (FLR)

The FLR function protects the brakes against overloading in the event of misuse.

If a temperature in excess of 600 °C is determined, the engine power is reduced to a defined value (dependent on the type of vehicle) in order to limit the vehicle's accelerating performance.
When the temperature drops below a lower limit (typically 500 °C), the reduced engine torque is increased as a function of time on a ramp basis to the maximum torque again. Driving-performance reduction should only be active from a speed of 60 km/h.

This reduction of the engine torque is stored as a fault (driving-performance reduction active). Should the customer find fault with the lack of engine power, this can be established by the garage/workshop and explained as brake overloading.

Dynamic Traction Control (DTC)

The DTC function can be activated by means of the DSC button. The active DTC function increases the ASC slip thresholds for improving propulsion up to a speed of 70 km/h. Basically the permissible slip is doubled but there is a program map in the background. This function offers advantages when driving on poor roads and thick fresh snow. Driving is not safety- but rather traction-orientated. With increasing transversal dynamics, measured by the yaw-rate sensor, the slip thresholds are reduced back to the normal mode for stability reasons.

When the DTC traction mode is activated, the letters DTC are displayed in the instrument cluster.

Brake Temperature Model (BTM)

The BTM function determines by way of a calculation model integrated on a software basis in the DSC control unit the temperatures of all four brake discs as a function of the input variables:

- Wheel speed
- Individual wheel brake pressure
- Ambient temperature

If the critical brake-disc temperature is exceeded (t > 600 °C) at a wheel, DSC functions are limited as a function of the prevailing driving conditions:

- Locking interventions are reduced to zero for each individual wheel.
- Symmetrical braking torques on the corresponding axle are prohibited.
- The engine torque is limited temporarily via an algorithm for driving-performance reduction.

The restrictions are lifted again when the temperature drops below a further threshold (t < 500 °C).

Tyre defect indicator (RPA)

The RPA function is integrated in the DSC control unit.
The system uses the wheel speeds to compare the deviations in the rolling circumferences of the wheels.

In the event of the same pressure loss in a diagonal tyre pair, the wheel speeds change to the same extent and the pressure loss is not detected.

The RPA system does not monitor the uniform diffusion loss over all 4 tyres.
Customers must monitor tyre inflation pressures themselves on a regular basis.

Brake-pad wear indication (BBV)

The evaluation of the 2-stage brake-pad wear sensors is integrated in the DSC control unit.

- Operation

The DTC and DSC functions can be activated and deactivated by means of the DSC button in the centre-console switch centre (SZM). Briefly pressing the button activates the DTC function. Press the button for a longer period (approx. 3 s) deactivates the DSC function. The ABS function remains active however.
The activated DTC function and the deactivated DSC function are indicated by means of warning and telltale lamps in the instrument cluster.

If the DSC button is pressed for longer than 10 s, the DSC function is activated and cannot be deactivated until the next ignition ON. This is a safety function for such a scenario where an object placed on the centre console (e.g. a handbag) presses down on the DSC button.

- Notes for Service

Service information

An open circuit to the rotation-rate sensor is not detected.

After the battery has been disconnected, the steering-angle sensor must re-learn its offset.
The steering angle is only learnt by the DSC control unit when the vehicle is driven off. If the DSC control unit does not receive the steering-angle offset before the vehicle reaches 25 km/h, the DSC telltale in the instrument cluster lights up.

A different DSC control unit is used in vehicles equipped with active steering. The control units for vehicles with active steering and without active steering differ in the matching resistors they use.

Diagnosis

Diagnosis is performed by means of the PT-CAN.

Programming

Flash programming of the control unit is possible by means of the PT-CAN.

Coding

The DSC control unit detects automatically whether the relevant vehicle is fitted with ACC, DynamicDrive or Active Front Steering.

The RPA function must be coded.

DynamicDrive

The design of the DynamicDrive is the same as the system fitted in the E65. The function of the DynamicDrive in the E60 is identical to the function of the DynamicDrive in the E65.

The disadvantage of a passive stabilizer bar is that the basic suspension hardens in the case of straight-ahead driving and one-sided jouncing. This reduces comfort.

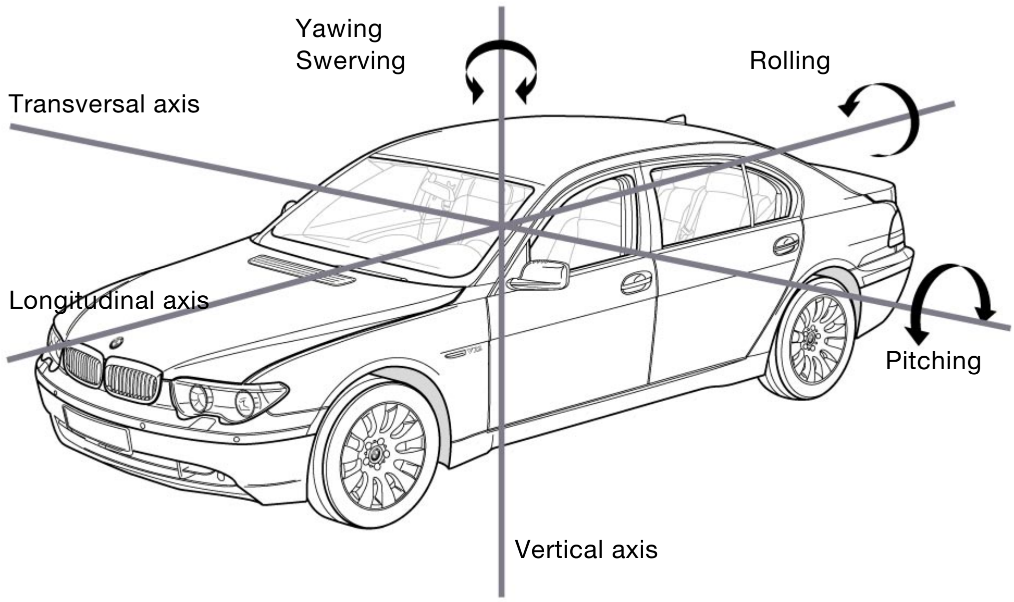

Fig. 6: Roll, yaw and pitch axis

DynamicDrive has two active stabilizer bars which have a positive effect on the roll tilt angle and handling.

Split stabilizer bars on the axles act as the basis of the DynamicDrive. The halves of the stabilizer bars are joined by way of a hydraulic oscillating motor. One half of the stabilizer bar is connected to the oscillating motor shaft while the other is connected to the oscillating motor housing.

When you are driving straight ahead, the system improves suspension comfort because the stabilizer bar halves are non-interacting and therefore do not harden the basic suspension when suspension is used on one side.

- System overview

Mechanical components

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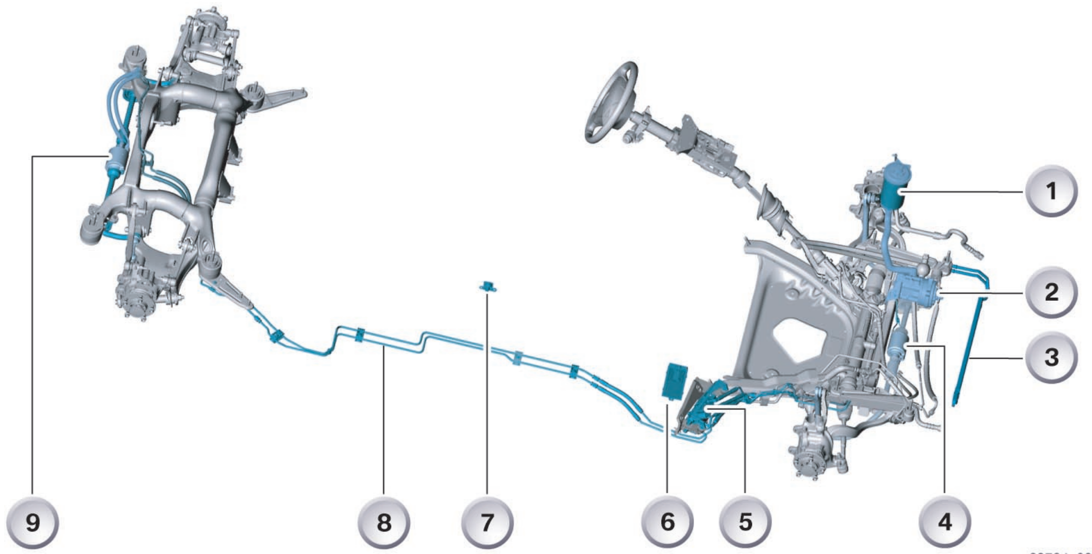

Fig. 7: DynamicDrive, overview of mechanical components

Index	Explanation	Index	Explanation
1	Hydraulic-fluid reservoir	6	Control unit
2	Tandem pump	7	Lateral-acceleration sensor
3	Hydraulic-fluid cooler	8	Hydraulic lines
4	Front oscillating motor	9	Rear oscillating motor
5	Valve block		

Bus overview

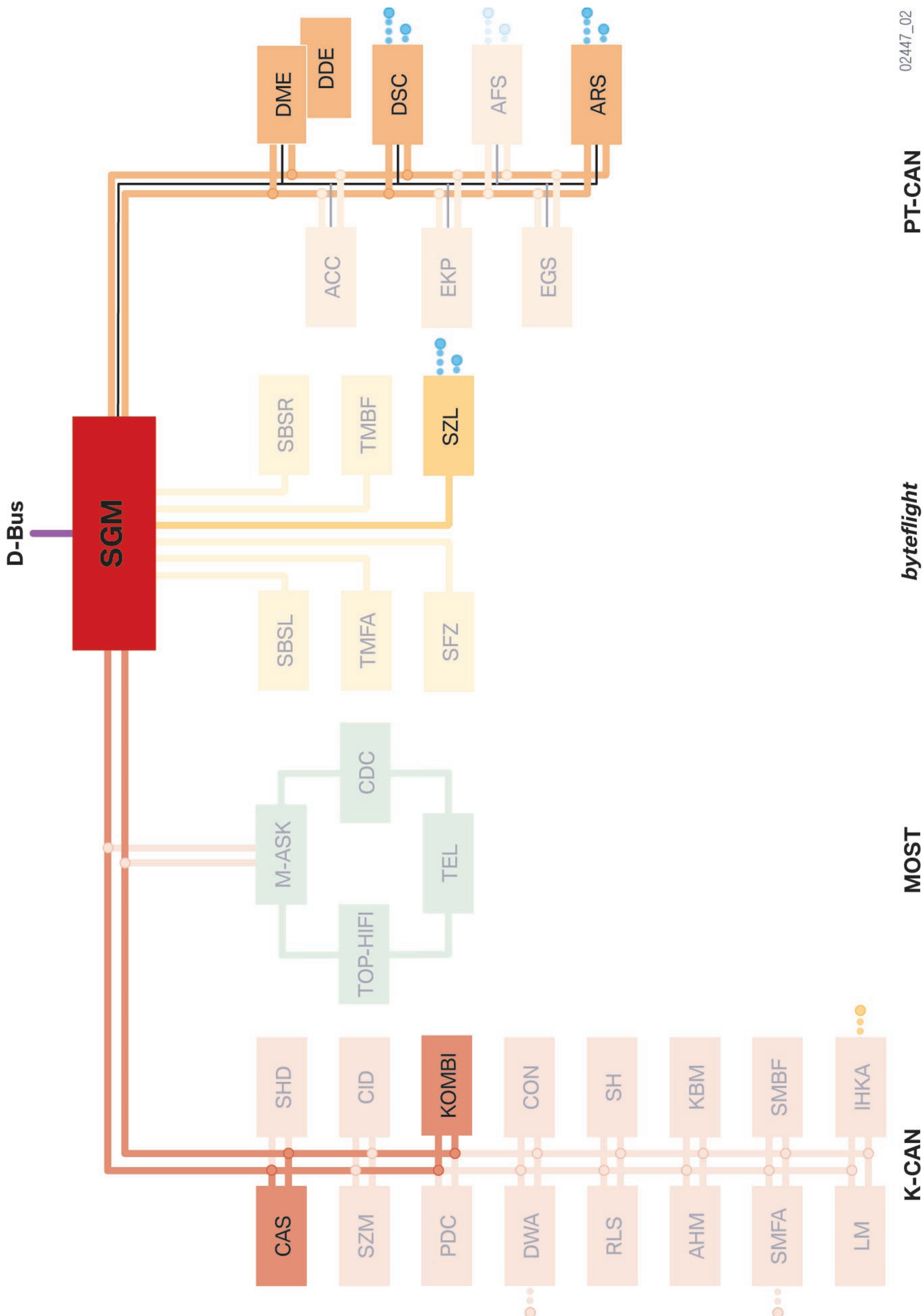

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Fig. 8: Control units in DynamicDrive

Index	Explanation	Index	Explanation
CAS	Car Access System	TEL	Telephone
SZM	Switch centre, centre console	CDC	Compact Disc Changer
PDC	Park Distance Control	SGM	Safety and Gateway Module
DWA	Anti-theft alarm system	SBSL	Satellite, B-pillar, left
RLS	Rain/light sensor	TMFA	Door module, driver
AHM	Trailer module	SFZ	Satellite, vehicle centre
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M-ASK	Multi audio system controller	DDE	Digital Diesel Electronics
TOP-HIFI	Top HiFi amplifier		

Inputs/outputs

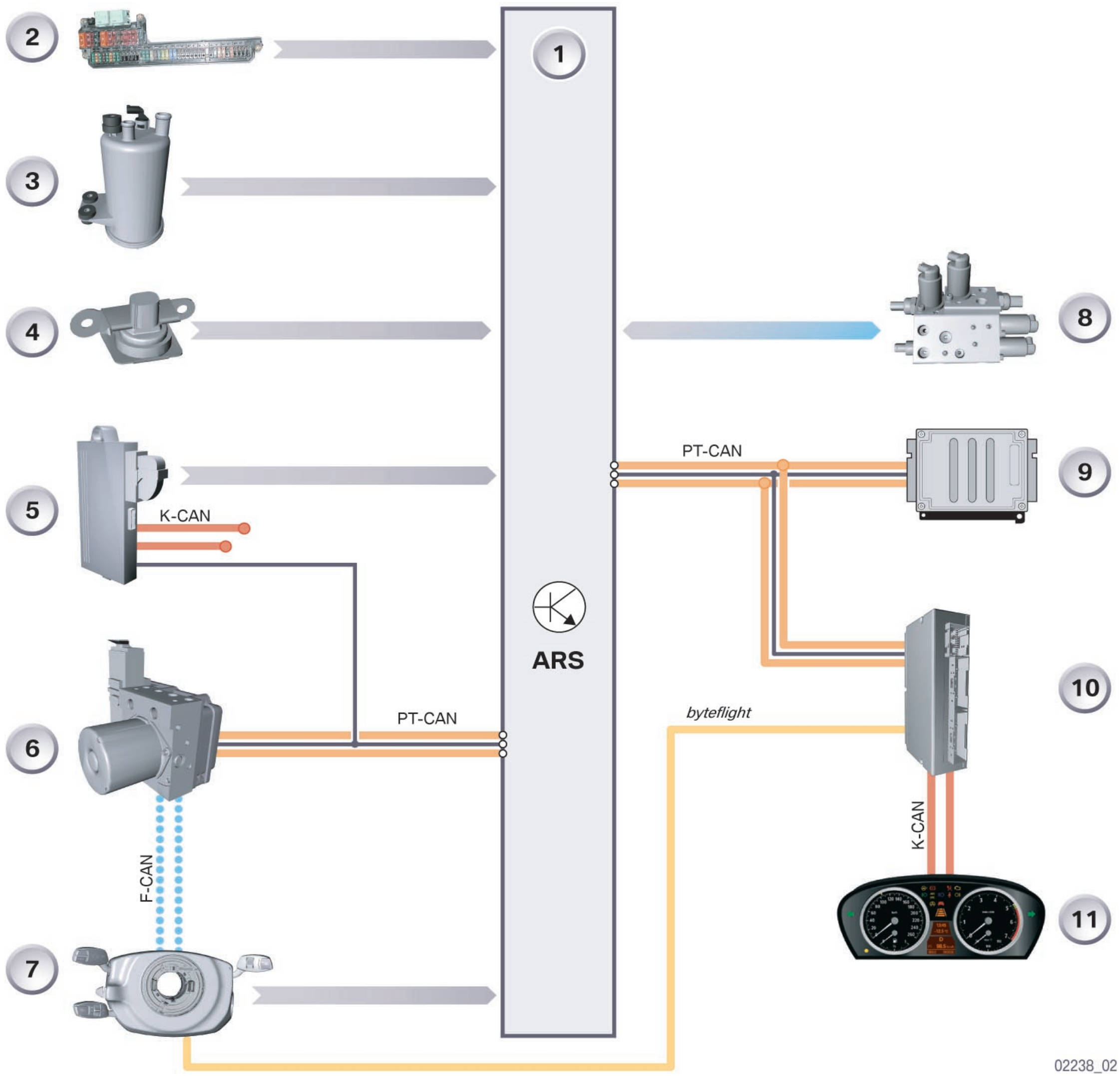

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Fig. 9: DynamicDrive system overview

Index	Explanation	Index	Explanation
1	DynamicDrive control unit	9	Digital Motor Electronics
2	Current distributor, front, power supply	10	Safety and Gateway Module
3	Hydraulic reservoir, fluid level	11	Instrument cluster
4	Lateral-acceleration sensor	*byteflight*	*byteflight*
5	DSC module	PT-CAN	Powertrain CAN
6	Car Access System control unit	K-CAN	Body CAN
7	Steering-angle sensor	F-CAN	Chassis CAN
8	DynamicDrive valve block		

System schematic

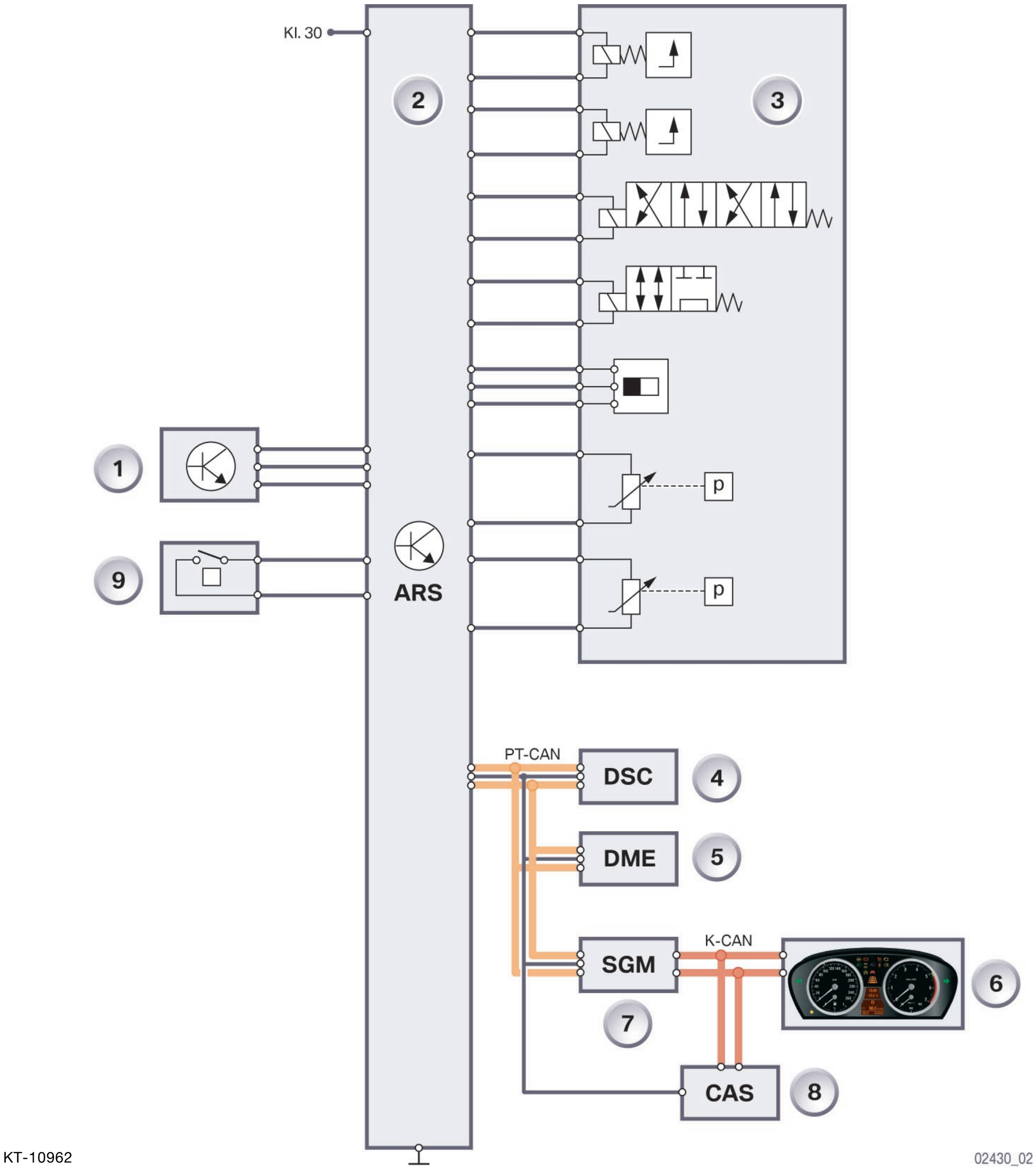

Fig. 10: System schematic

Index	Explanation	Index	Explanation
1	Lateral-acceleration sensor	7	Safety and Gateway Module
2	DynamicDrive control unit	8	Car Access System control unit
3	DynamicDrive valve block	9	Hydraulic-fluid level sensor
4	DSC control unit	F-CAN	Chassis CAN
5	Digital Motor Electronics	PT-CAN	Powertrain CAN
6	Instrument cluster	K-CAN	Body CAN

- Components

Lateral-acceleration sensor

The lateral-acceleration sensor supplies the main sensor signal. When cornering, it measures the vehicle's lateral acceleration up to a measuring range of ±1.1 g. It is mounted beneath the right-hand front seat on the floor plate.

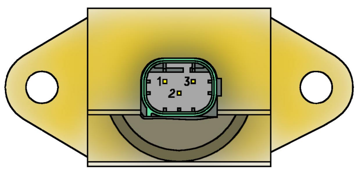

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Fig. 11: Lateral-acceleration sensor; natural colour connector, individual connector coding

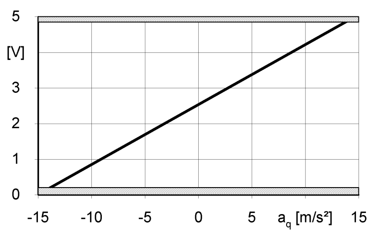

Fig. 12: Lateral-acceleration sensor, characteristic curve

Fluid level sensor

The fluid level sensor detects the fluid supply in the fluid reservoir.

The fluid level sensor is mounted on the fluid reservoir. Short circuits/ open circuits cannot be detected by the fluid level sensor. A line break is interpreted as a loss of fluid.

DynamicDrive control unit

The DynamicDrive control unit is located on the right side of the passenger compartment in the A-pillar area.

The control unit is supplied with power via terminal 30 and is protected by a 10 A fuse.

A vehicle authentication process takes place when the system is started. This compares the vehicle identification number from CAS with the vehicle identification number which is encoded in the DynamicDrive control unit.

Then the control unit's hardware and software is checked.

All the outputs (valve magnets) are subjected to a complex check for short circuits and breaks. If there is a fault, the system switches the actuators into a safe driving condition.

The control unit switches off if there is undervoltage or overvoltage.

The control unit learns the offset for the steering angle and the lateral acceleration during startup and during driving.

Active stabilizer bar

The active stabilizer bar consists of the oscillating motor and the halves of the stabilizer bar with press-fitted roller bearings which are mounted on the oscillating motor for connection to the axle carriers. The use of roller bearings ensures optimum comfort thanks to better response and reduced control forces.

The oscillating motor and the oscillating motor housing are joined by one half of the stabilizer bar.

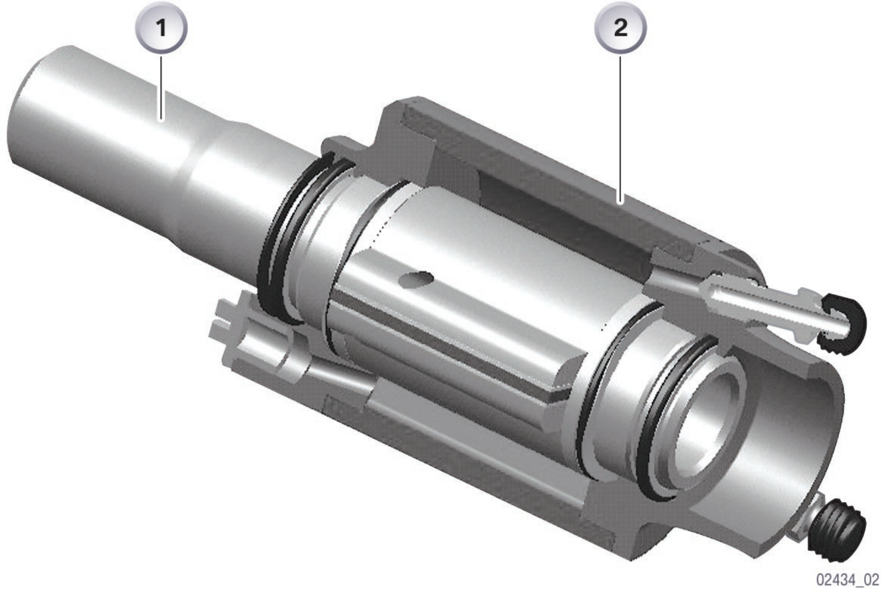

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Fig. 13: Oscillating motor

Index	Explanation	Index	Explanation
1	Oscillating motor shaft	2	Oscillating motor housing

The oscillating motor of the front-axle stabilizer bar is fitted with 2 pressure relief valves.

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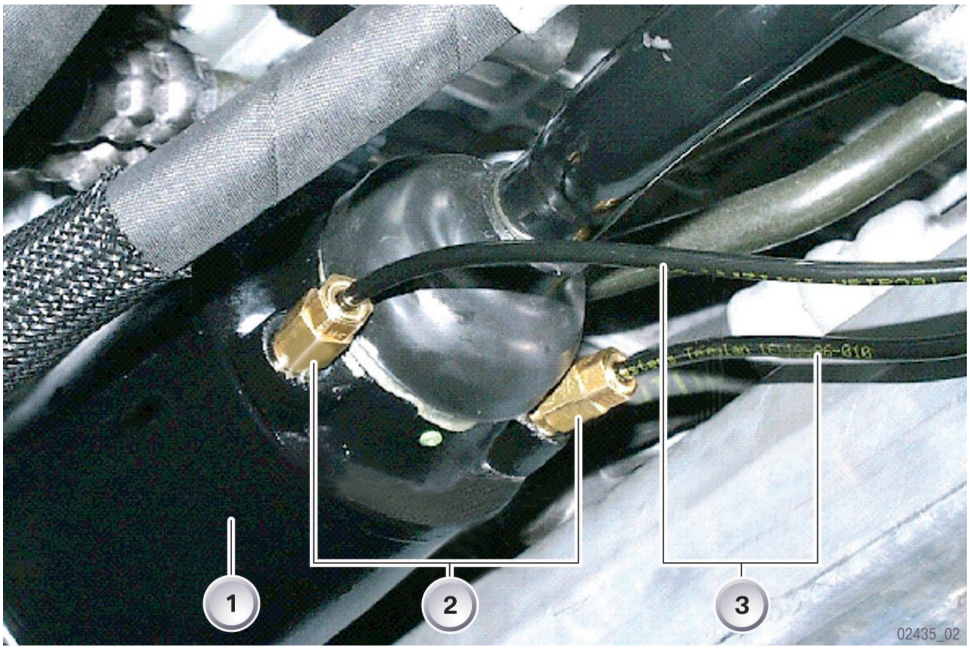

Fig. 14: Pressure relief valves on oscillating motor

Index	Explanation	Index	Explanation
1	Oscillating motor	3	Pneumatic lines
2	Pressure relief valves		

Pneumatic lines are connected to the pressure relief valves. These pneumatic lines end in a filter element (conventional fuel filter) which is inserted in the diagonal strut on the left wheel arch.

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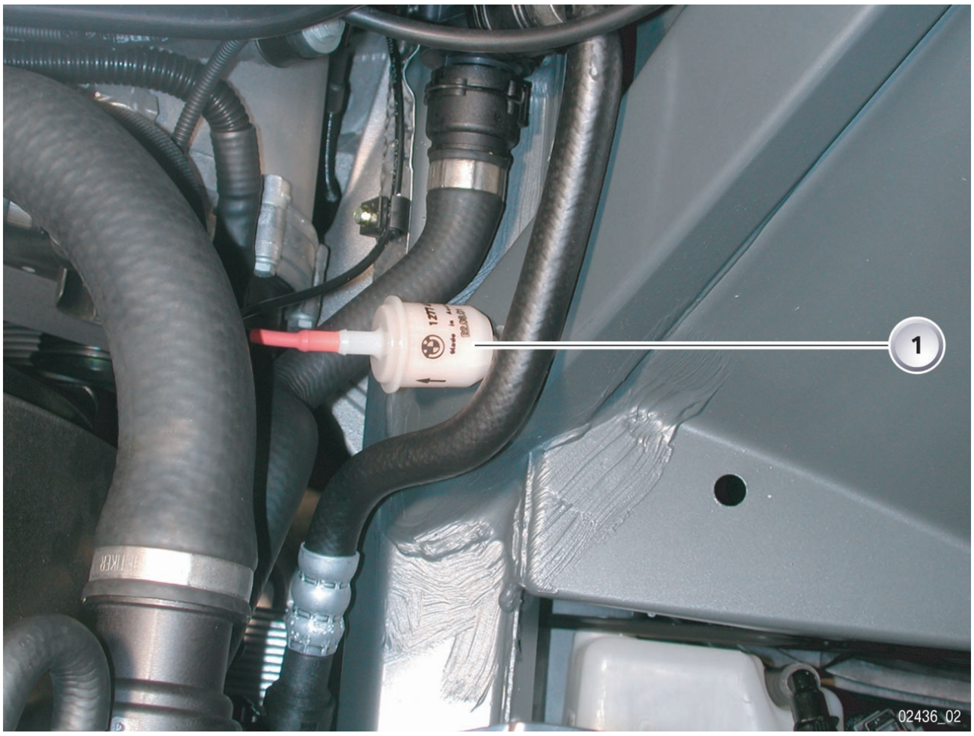

Fig. 15: Filter element in engine compartment

Index	Explanation
1	Filter element

The filter element is located in different positions in the engine compartment depending on the mounting position of the various engines.

The positions for the pressure relief valves are fitted with screw plugs on the oscillating motor of the rear-axle stabilizer bar.

Function of pressure relief valves

When the vehicle is driven on poor road surfaces, the stabilizer-bar movements give rise to brief vacuum pressures (cavitation) in the oscillating motors which in turn cause rattling noises.

Pressure relief valves have been fitted on the front oscillating motor in order to eliminate these noises. These pressure relief valves allow filtered air to flow into the oscillating motor through the connected pneumatic lines. This prevents cavitation.

This small quantity of air is absorbed by the hydraulic fluid (Pentosin) to form an emulsion, which is discharged during the next activations of the oscillating motor. The air is separated in the expansion tank.

Because no noises can be heard at the rear axle, the pressure relief valves have been omitted from the rear oscillating motor.

Operating principle of oscillating motors

The oscillating motor has three functions to perform:

- It guides the torque into the two halves of the stabilizer bar.
- It decouples the two halves of the stabilizer bar.
- In the event of system failure (failsafe mode), the front axle stabilizer bar creates sufficient damping via the oscillating motor hydraulic fluid (hydraulic locking). It now works like a conventional stabilizer bar.

  Exception: If the oscillating motor chambers no longer contain any fluid as a result of a leak, the front axle stabilizer bar can no longer create damping.

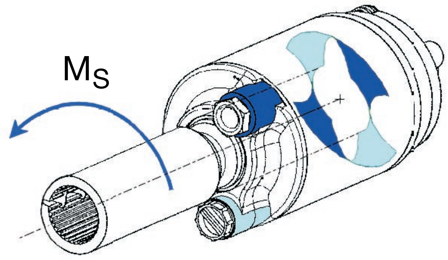

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Fig. 16: Oscillating motor, generation of M_S torque

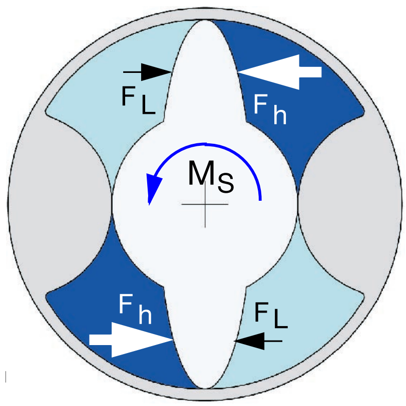


Fig. 17: Cross-section, Oscillating motor

Since one half of the stabilizer bar is connected to the shaft, and the other with the housing, the two halves turn in opposite directions.

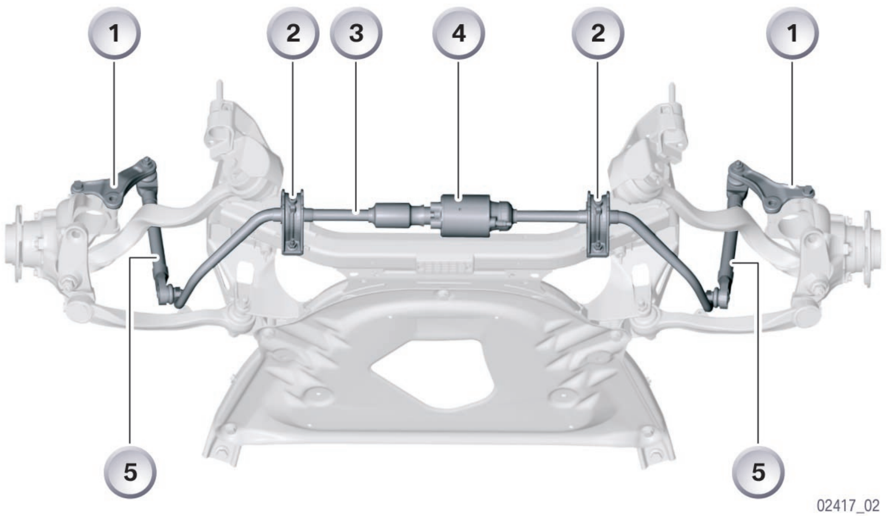
The shell is forced upwards on the outside of a curve, and dragged down on the inside of a curve.

The maximum body torque on the front and rear axle occurs when there is a high degree of lateral acceleration. The system pressure is then 180 bar at the front axle and 170 bar at the rear axle.

Front-axle stabilizer bar

The stabilizer bar is mounted on the front-axle carrier.

The stabilizer links are connected to the "goose-necks" of the swivel bearings.



KT-10905

Fig. 18: DynamicDrive stabilizer bar on front axle

Index	Explanation	Index	Explanation
1	Stabilizer-link connection to swivel bearing	4	Oscillating motor
2	Stabilizer-bar bracket	5	Stabilizer links
3	Stabilizer bar		

Rear-axle stabilizer bar

The stabilizer bar is mounted behind the rear-axle carrier.

The stabilizer links are connected to the rear-axle swinging arms.

KT-11346

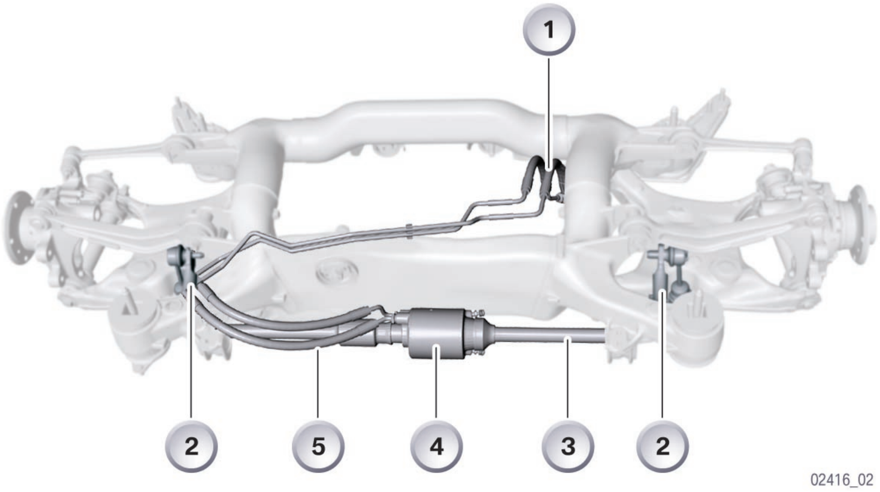


Fig. 19: DynamicDrive stabilizer bar on rear axle

Index	Explanation	Index	Explanation
1	Hydraulic lines from valve block	4	Oscillating motor
2	Stabilizer links	5	Hydraulic lines
3	Stabilizer bar		

Valve block

The valve block is located on the floor plate behind the front right wheel-arch trim.

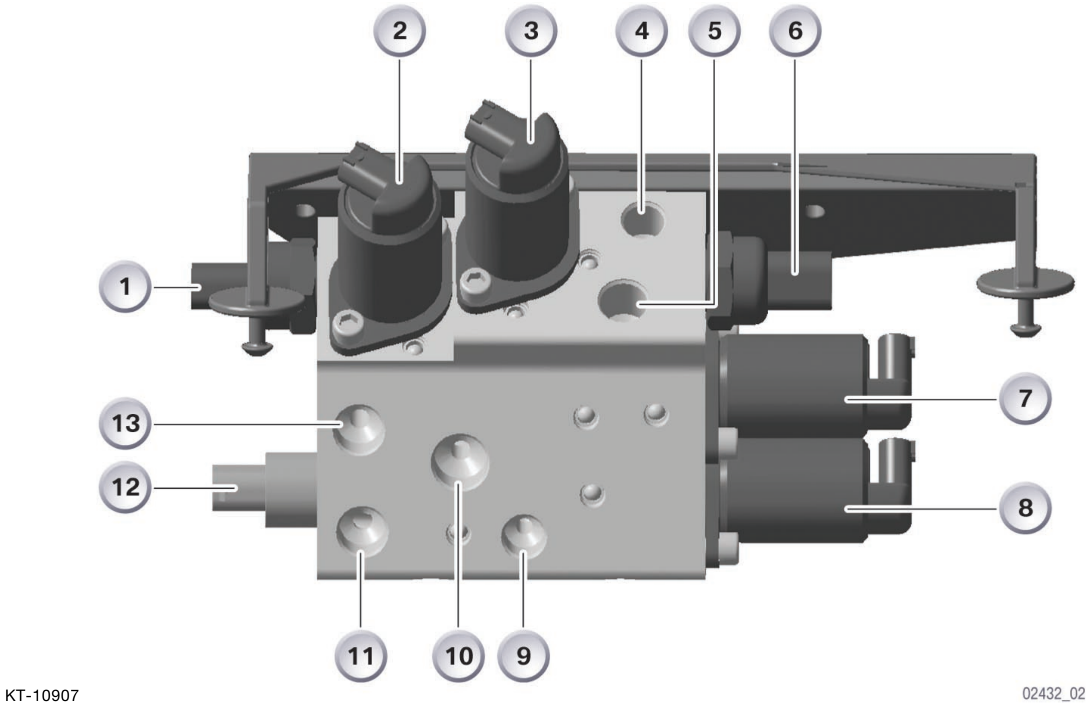


Fig. 20: Valve block

Index	Explanation
1	Rear-axle pressure sensor
2	Rear-axle pressure-limiting valve
3	Front-axle pressure-limiting valve
4	Line 1, front-axle oscillating motor
5	Front-axle pressure sensor
6	Line 2, front-axle oscillating motor
7	Failsafe valve
8	Directional valve
9	Line 1, rear-axle oscillating motor
10	Hydraulic reservoir
11	Line 2, rear-axle oscillating motor
12	Selector-position recognition sensor
13	Tandem pump

Pressure control valves

There is a pressure control valve on both the front and rear axles. They both adjust the actuation pressures for the front- and rear-axle stabilizer bars.

Directional valve

The directional valve is electrically actuated. It specifies the direction of the high-pressure fluid (active pressures) and the reservoir fluid for right-hand and left-hand bends.

Failsafe valve

The failsafe valve (safety valve) is electrically actuated.
The failsafe valve responds in the event of a power-supply failure or an identified fault in the system.
The failsafe valve shuts off the front-axle oscillating motor when de-energized. Thus the active stabilizer bar behaves like a normal mechanical stabilizer bar and brings about understeering.

Selector-position recognition sensor

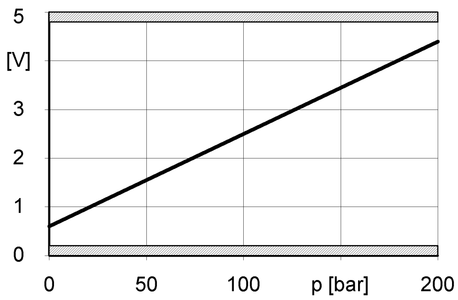
The task of this sensor is to detect the specific position of the directional valve.

2 positions can be detected:

- Left-hand control
- Right-hand control

Front-axle/rear-axle pressure sensors

The pressure sensors are responsible for detecting the front and rear axle stabilizer bar hydraulic pressures. The sensors are mounted on the valve block. The pressure sensor offset values are taught-in by the control unit once, during commissioning.



KT-6259

Fig. 21: Pressure sensor characteristic curve

Tandem pump

The tandem pump, which is driven by the engine via a ribbed V-belt, consists of a radial-piston part for the DynamicDrive and a vane part for the power steering.

When the engine is idling, the pump speed is approx. 750 rpm.

The pump's minimum fluid flow rate is 4.5 l/min at approx. 5 bar and 3.3 l/min at 200 bar. This means that sufficient system dynamics are also guaranteed when the engine is idling.

From a pumping speed of approx. 1165 rpm, the maximum fluid flow rate is limited to 7 l/min.

DynamicDrive and power steering have a joint fluid reservoir and fluid cooler.

Fluid reservoir

The fluid reservoir is identical on all vehicles, whether they have the DynamicDrive function or not. The reservoir incorporates a fluid filter. A fluid level sensor is provided for the minimum quantity.

Cooler

The cooler ensures a long-term fluid temperature of < 120 °C and a short-term fluid temperature of < 135 °C in all hydromechanical components under all conditions.

- System functions

The car sets lateral acceleration while cornering (aq) which affects the vehicle body at the centre of gravity (SP). The body rolls around the roll axis (RA) which is predefined by the front and rear axle kinematics. This sets the roll angle φ (max. 5°). This produces a maximum change in level on the wheel arch of ± 10 cm.

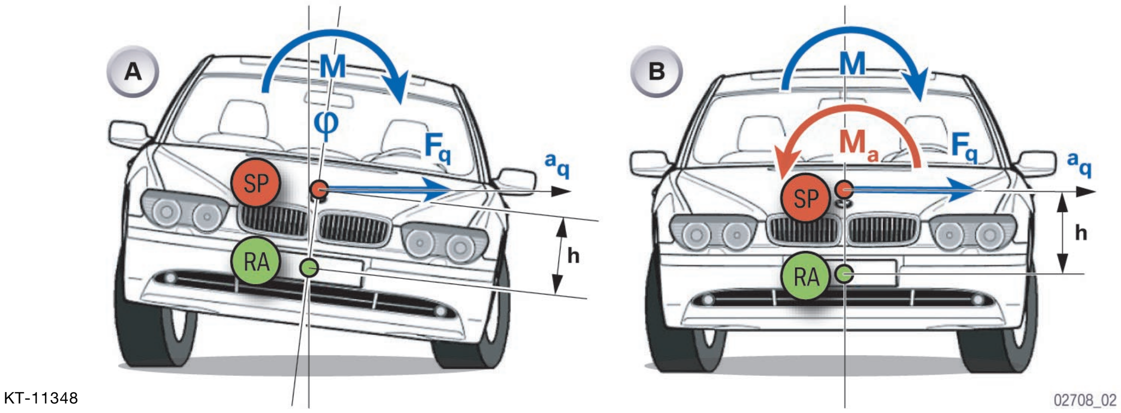


Fig. 22: Roll behaviour of cars without and with DynamicDrive

Index	Explanation	Index	Explanation
A	Car without DynamicDrive	M_a	Body torque
B	Car with DynamicDrive	SP	Centre of gravity
M	Rolling moment	RA	Roll axis
a_q	Lateral acceleration	F_q	Lateral force
φ	Roll angle	h	Lever arm centre of gravity height

In the vehicle with DynamicDrive, the rolling moment M can be compensated for by the active stabilizer bars up to a lateral acceleration aq of approx. 3 m/s^2 (0.3 g).

Note: The tyre suspension created by the rolling moment (M) is not compensated for.

Roll angle diagram:

KT-6186

KT-6187

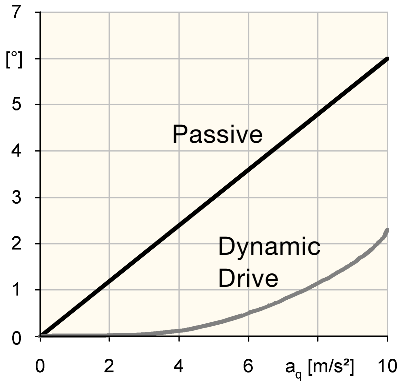


Fig. 23: Unladen vehicle

The roll angle shown is achieved when the vehicle is unladen and the driver is in the vehicle.

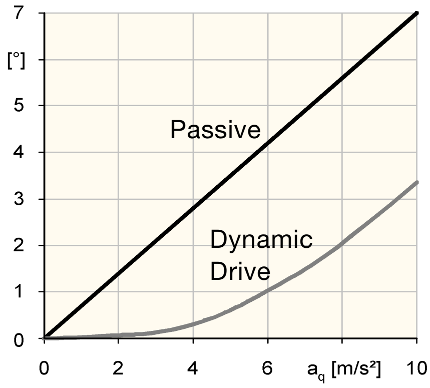


Fig. 24: Laden vehicle

When the vehicle is fully laden, the larger body mass effects a greater lateral force on the vehicle. Depending on the configuration of the vehicle load (in the vehicle or on the roof), this also results in a change to the lever arms h. The vehicle will in this case form a slightly larger roll angle than specified in the control curve.

A fully laden passive vehicle still forms a larger roll angle.

The distribution of the active body torque between the front and rear axle depends on the road speed.

Affect of the self-steering behaviour

The self-steering behaviour can be decisively influenced by the distribution of the stabilizing torque on the axles. The greater the stabilizing torque on an axle, the lower the lateral forces transmitted on this axle.

Two cases are described below with different distribution of stabilizing torque on the axles:

1. Identical stabilizing torque on both axles

Handling is "NEUTRAL."

The front wheels can apply about the same amount of lateral force on the road as the rear wheels without drive torque. The handling conditions are neutral.

A vehicle which is tuned to neutral handling conditions provides very agile handling, the steering reacts very quickly. The driver experiences precise handling.

Even an inexperienced driver can control a vehicle which is tuned to neutral handling very well at low speeds.

2. Larger stabilizing torque on the front axle

Handling is "UNDERSTEERING."

The front axle wheels cannot apply the same amount of lateral force on the road as the rear axle wheels. The vehicle suffers understeer.

A larger steering-wheel angle is required to be able to follow the desired course.

A vehicle with understeer can generally also be controlled well by an inexperienced driver at higher speeds and higher cornering speeds.

This very sensitive handling reduces the vehicle's agility.

DynamicDrive sets the stabilizing torque on the front and rear axles such that a different handling characteristic is produced for low and high speeds.

The passive vehicle is configured as slightly understeering irrespective of the speed range.

DynamicDrive is neutral in the low speed range. The driver has to steer less in order to negotiate the same bend. This results in optimum handling and agility.

In the upper speed range, both vehicles behave almost identically with regard to the required steering angle on the same bend.

The hydromechanical concept is designed so that a larger active stabilizing torque cannot occur on the rear axle than on the front axle under any circumstances. This means that mechanically and hydraulically the vehicle with DynamicDrive is safeguarded such that no oversteering and therefore for normal customers no critical handling characteristics can occur under any circumstances.

Comparison between the conventional stabilizer bar and the active stabilizer bar

Active stabilizer bars introduce fewer comfort-reducing forces into the body than passive stabilizer bars. In this case a differentiation must be made depending on the frequency with which the forces were introduced.

Road stimulus	Stabilizer bar behaviour
At approx. 1 Hz (body natural frequency)	At smaller strokes the active stabilizer bar is easier to turn than a conventional stabilizer bar. The forces introduced into the body are fewer, the vehicle becomes more comfortable and body sound is improved
From 8 Hz (wheel natural frequency)	Both stabilizer bars behave in a similar way. On a vehicle with an active stabilizer bar this is because the fluid is not displaced so quickly.

- Operating states

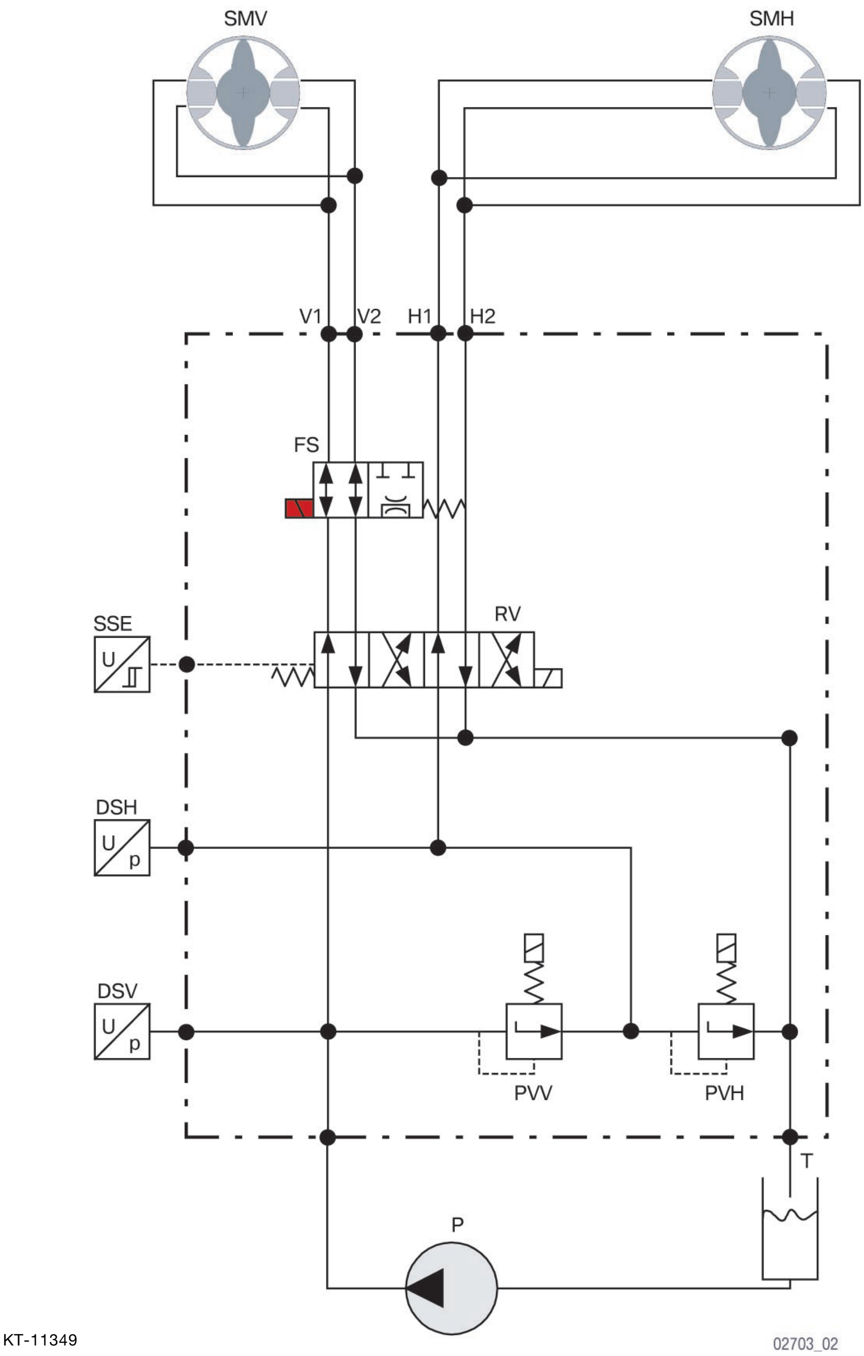


Fig. 25: Hydraulic schematic, normal function, failsafe valve energized

Index	Explanation	Index	Explanation
SMV	Front oscillating motor	RV	Directional valve
SMH	Rear oscillating motor	DSH	Rear-axle pressure sensor
V1	Front-axle hydraulic circuit 1	DSV	Front-axle pressure sensor
V2	Front-axle hydraulic circuit 2	PVV	Front-axle pressure valve
H1	Rear-axle hydraulic circuit 1	PVH	Rear-axle pressure valve
H2	Rear-axle hydraulic circuit 2	P	Tandem pump
FS	Failsafe valve	T	Fluid reservoir
SSE	Selector-position recognition sensor		

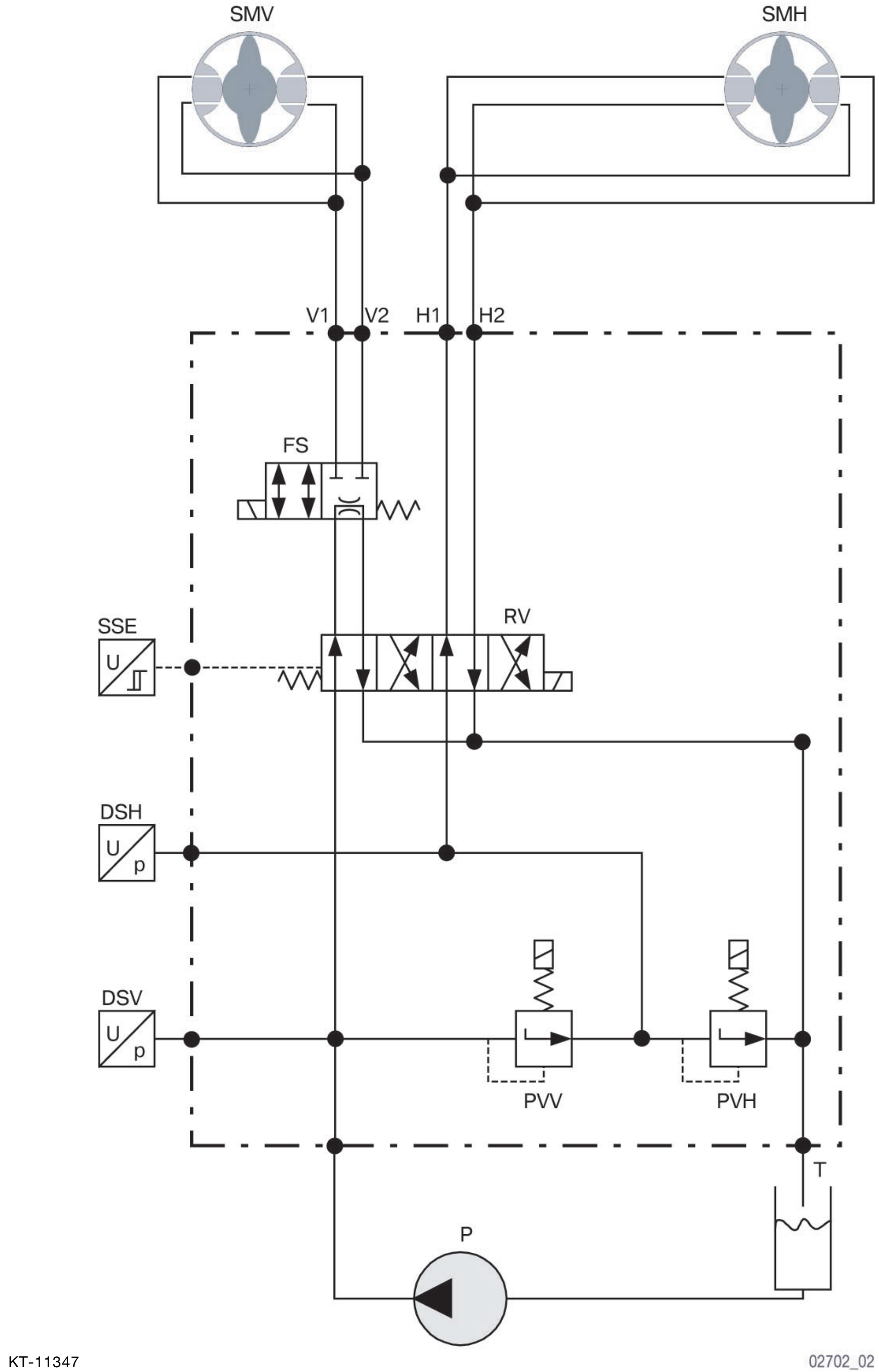


Fig. 26: Hydraulic schematic, failsafe function or rest position

Index	Explanation	Index	Explanation
SMV	Front oscillating motor	RV	Directional valve
SMH	Rear oscillating motor	DSH	Rear-axle pressure sensor
V1	Front-axle hydraulic circuit 1	DSV	Front-axle pressure sensor
V2	Front-axle hydraulic circuit 2	PVV	Front-axle pressure valve
H1	Rear-axle hydraulic circuit 1	PVH	Rear-axle pressure valve
H2	Rear-axle hydraulic circuit 2	P	Tandem pump
FS	Failsafe valve	T	Fluid reservoir
SSE	Selector-position recognition sensor		

- Notes for Service

Service information

If the DynamicDrive fails, DSC can no longer be deactivated or if it is already deactivated it does not switch back on automatically.

The connections for all the hydraulic components are designed in different dimensions and lengths so that they cannot be transposed.

A faulty acoustic transmission in the vehicle interior predominantly occurs through the assembly and cable connections. The cables must not appear on the surface, they must lie correctly in the supports without any slack or tension. They are covered by the underbody covering.

Steering-angle adjustment

After working on the steering, it is necessary to carry out a steering-angle adjustment with the steering-column switch cluster (SZL) control unit!

The DynamicDrive system is dependent on the exact zero balance of the steering angle! The maximum tolerance for a deviation is $\pm$ 1°.
Precise performance of a wheel-alignment check and adjustment is essential!
Steering-angle adjustment must always be performed on the KDS and in accordance with the BMW specifications!

Each time the DynamicDrive or SZL control unit is flashed results in a loss of the zero position!
A steering-angle adjustment is necessary!

DynamicDrive commissioning

The commissioning procedure must always be carried out once the system has been opened or a part has been replaced. This also applies after the lateral-acceleration sensor has been replaced.

The following conditions must be guaranteed for matching the lateral-acceleration sensor and the two pressure sensor offset values:

- The vehicle must be stand level on all four wheels
- The vehicle must be unladen
- The engine must be idling
- Rest status (doors closed, persons are not allowed in the vehicle)

No persons may remain within the vicinity of moving chassis parts during the commissioning (both in the works and the workshop). In addition you must ensure that the basic commissioning conditions (temperature range, constant engine speed etc.) are maintained. The ground clearance must not be limited and the doors must not be closed. The arms of the hoist may no longer be situated beneath the car.

The commissioning procedure is split into five stages which follow on from each other automatically:

I: direction valve test (from 3 to 3.4 s)	First the direction valve is tested by evaluating the signal of the selector-position recognition sensor.
II: low-pressure test (from 3.4 to 4.3 s)	The failsafe and direction valves are without power during this stage. Then tests are carried out with pressure control valves with and without power on the front and rear axle. The body is then tilted. The sides of the vehicle must be clear.
III: front-axle high-pressure test (from 4.3 to 9.9 s)	Pressure of 180 bar is applied to the front-axle oscillating motor. Air in the system, internal leaks and a blocked oscillating motor are detected.
IV: rear-axle high-pressure test (from 9.9 to 15 s)	Pressure of 170 bar is applied to the rear-axle oscillating motor. Air in the system, internal leaks and a blocked oscillating motor are detected.
V: pressure-control-valve test (from 15 to 25 s)	The characteristic curves of the front and rear axle are checked (setpoint/actual-value comparison). Faulty pressure control valves are detected.

DynamicDrive venting

A venting routine must be carried out using the diagnostic tester if the DynamicDrive system was opened hydraulically.

The venting operation is performed exclusively by way of the commissioning routine of the diagnostic tester and not at the pressure relief valves or at the screw plugs of the oscillating motors!

If the test still detects air in the system, a short movement trip should be made if necessary.

The commissioning routine must then be repeated after the short trip.

In the event of an extreme leak or suspected subfunction of the pressure relief valves (noticeable by the rattling noises in the front end), the pressure relief valves and the pneumatic lines must be replaced with new components.

Diagnosis

The following faults can be detected at the components:

Component	Fault type	Fault detection via:
Control unit	De-energized or faulty	Instrument cluster through absence of alive counter, VIN not recognized during authentication, watchdog
Pump	No pressure	Setpoint/actual-value comparison pressures
Directional valve	Stuck in "energized" position (spring break, swarf)	Directional-valve sensor
	Stuck in "de-energized" position (line break)	Directional-valve sensor and current monitoring
FA pressure control valve	Open (de-energized, p = pRA)	Setpoint/actual-value comparison, pressure, front axle, current measurement
	Closed (mechanical fault) (pFA = pmax)	Setpoint/actual-value comparison, pressure, front axle
RA pressure control valve	Open (de-energized) (p = 0)	Setpoint/actual-value comparison, pressure, rear axle, current measurement
	Closed (mechanical fault) (pRA and pFA = pmax)	Setpoint/actual-value comparison, pressure, rear axle,
Failsafe valve	Stuck open	Predrive check
	Stuck closed (line)	Current measurement
Actuator front/rear axle	Leaking (no torque)	Setpoint/actual-value comparison pressure
	Blocked	Setpoint/actual-value comparison pressure
CAN bus	Omitted completely (line disconnected)	CAN timeout
Steering angle, vCar, a_q, $\Psi^{\bullet}$	Implausible or omitted	Plausibility monitoring and fault detection, CAN bus signals

Component	Fault type	Fault detection via:
Sensor a_q	Omitted completely (line disconnected)	Voltage monitoring
	Incorrect signal	Check plausibility via CAN signals
Fluid level sensor	No signal (line)	
Front-axle pressure sensor	No signal (line)	Voltage monitoring
	Incorrect signal	Setpoint/actual-value comparison, pressure, front axle
Rear-axle pressure sensor	No signal (line)	Voltage monitoring
	Incorrect signal	Setpoint/actual-value comparison, pressure, RA
Directional-valve sensor	No signal	Voltage monitoring
	Incorrect signal	Setpoint/actual-value comparison, direction valve and selector-position recognition sensor

System shutdown (failsafe status)

Depending on the fault, the system displays one of the following responses.

The following faults result in system shutdown, i.e. all output stages are de-energized:

- Fault in the front-axle stabilizer bar
- Fault at the front-axle pressure sensor
- Fault in the pressure build-up (pump, pressure-limiting valve on the front axle)
- Fault in the control unit
- VIN is not sent via the CAS / omitted / incorrect
- Direction-valve position fault, faulty selector-position recognition sensor
- No PT-CAN signal

The de-energized failsafe valve shuts off the chambers of the active stabilizer bar. A fluid compensation is only performed by way of internal leakage of the oscillating motor and the valve block. The non-return valves in the valve block permit additional suction of fluid so that no cavitation occurs in the front-axle oscillating motor.

The chambers of the rear-axle oscillating motor must not be shut off.

The handling corresponds virtually to that of a conventional vehicle. The crossover to the failsafe status can also be controlled in the event of extreme manoeuvring.

<table>
<tr><td>Warning message
Cornering stability! Drive slowly around bends

KT-6182</td><td>Handling instruction
Driving-stability system not functioning, driving stability restricted. No high cornering speeds. Continued driving possible, contact BMW Service immediately</td></tr>
<tr><td colspan="2">In the event of a fluid loss in the DynamicDrive hydraulic system or in the steering circuit, the fluid level sensor in the fluid reservoir responds.
The driver is alerted so that damage to the tandem pump caused by continued driving is avoided.</td></tr>
<tr><td>Warning message
Fluid loss! Caution Stop, engine off

KT-6182</td><td>Handling instruction
Fluid loss in the chassis and steering systems. Continued driving not possible, contact BMW Service immediately</td></tr>
</table>

Restricted control comfort

A lateral acceleration is calculated from the road speed and steering-wheel angle from the CAN signals. This signal is faster than the actual lateral acceleration and compensates the time delay of the hydromechanical system. In the event of a fault in these two signals, the system responds with a delayed roll compensation. This arises only in the case of extremely quick steering manoeuvres and is barely noticeable in normal cornering manoeuvres.

In the event of a faulty lateral-acceleration sensor, the lateral acceleration is calculated exclusively from the CAN signals. No impairment of function can be detected by the customer.

In the event of a fault in the rear-axle circuit, i.e. a stabilization at the front axle only, the customer notices that the vehicle is subject to larger rolling motions.
Agility diminishes at road speeds < 120 km/h.

The system also responds if the fault "Failsafe valve stuck open" is detected in the predrive check.

An electrical fault in the rear-axle pressure sensor may result in minor failures in roll-angle compensation. To be on the safe side, slightly more stabilizing torque is exerted on the front axle than in normal operation. This can be felt by the driver.

Warning message	Handling instruction
Cornering stability slightly restricted	Chassis stabilization slightly restricted around bends. Continued driving possible, contact BMW Service at next opportunity

Restricted system monitoring

DynamicDrive receives via PT-CAN the following sensor signals from DSC and SZL:

- Lateral acceleration
- Yaw velocity
- Road speed
- Steering-wheel angle

These signals are used to check the lateral-acceleration sensor.

Drop-out of the engine-speed signal (DME) results in restricted control comfort.

In the event of a fault in the lateral acceleration and yaw velocity CAN signals, the system is lacking two items of redundant information. Since this information is used exclusively for checking the other signals, the DynamicDrive function is preserved with full control comfort.

Although the DynamicDrive function is not impaired, the driver receives the display "Chassis control comfort restricted." He/she is prompted to visit a garage/workshop at the next available opportunity.

Warning message	Handling instruction
Cornering stability slightly restricted	Chassis stabilization slightly restricted around bends. Continued driving possible, contact BMW Service at next opportunity

A "dynamic" driver will notice the absence of the steering-angle signal.

The warning messages must be acknowledged by the driver. Each warning message goes out only after it has been acknowledged.

Once the cause of the fault has been rectified, the control unit can be returned to full function.

There are two reset conditions depending on how fast a fault is to be detected:

- All faults which are no longer present are reset with "ignition off." It is necessary here to wait until the sleep mode has been obtained before "ignition on" is activated again.
- Sporadic faults which can mostly be traced back to communication faults in the CAN bus are then automatically reset while the vehicle is moving straight ahead or stationary provided they have only occurred briefly and rarely. In this case, the customer cannot detect the activation while the vehicle is moving or stationary.
- The associated faults with important additional information are stored in the fault memory. This additional information contains the kilometre reading/mileage at which the fault occurred, whether the fault is currently present and the frequency with which the fault in question has occurred. Thus, when the vehicle is brought into the garage/ workshop, it is possible to carry out a specific analysis of the currently present fault and also an analysis of a sporadic fault.

Programming

The DynamicDrive control unit is programmed.

Coding

The DynamicDrive control unit is coded.