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DRIVING DYNAMICS SYSTEMS

Model: E65 - 745i

Production Date: 11/2001

Objectives of The Module

After Completing this module, you will be able to:

- List the Driving Dynamics Systems.
- Demonstrate how to deactivate Dynamic Traction Control.
- Explain how EDC-K influences hydraulic damper operation.
- Identify the correct EDC-K solenoid valve resistance value.
- Describe the Dynamic Drive influence on the stabilizer bars.
- Name the Dynamic Drive components and locations.
- Understand the Valve Block sub-components and functions.
- Explain the Oscillating Motors hydraulic/mechanical operation.
- Describe “Failsafe” hydraulic flow.
- Demonstrate Dynamic Drive Commissioning.

Driving Dynamics Systems

Purpose of The Systems

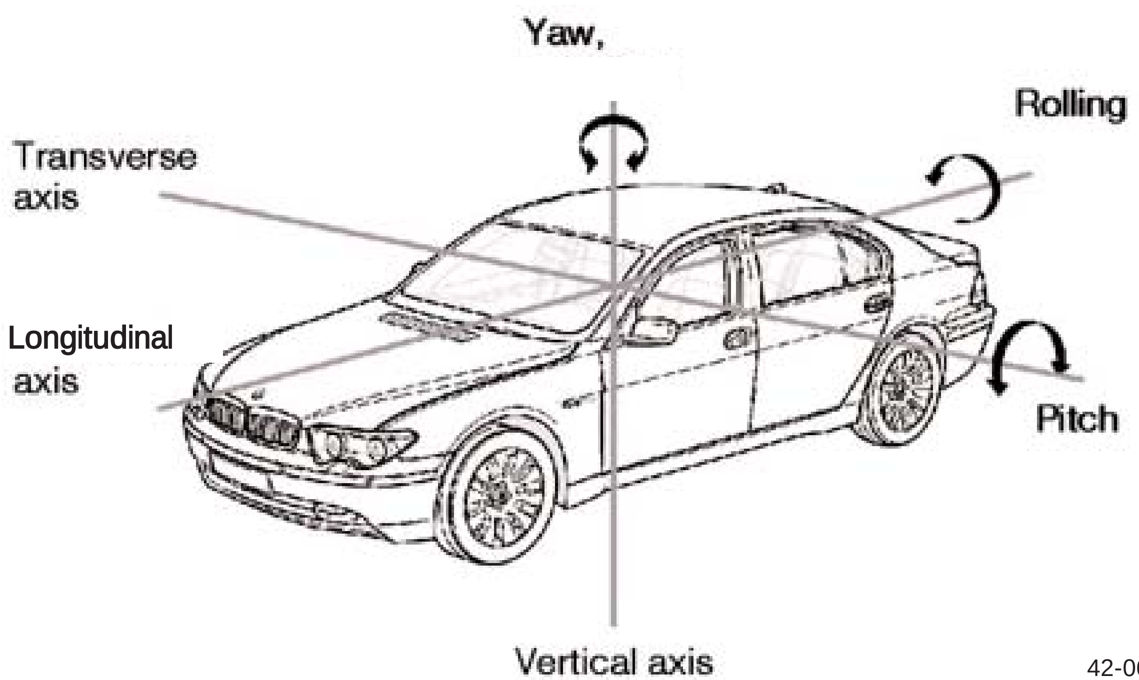
The E65 chassis offers the driver optimum ride comfort, driving safety, good agility and excellent handling. The chassis also adapts to changes in road conditions: traffic, ice, snow etc. Vehicle speed and changes in the direction of travel generate forces that have an effect on the chassis which requires the driver to react correctly to maintain safe driving.

The following forces occur while driving:

- Vertical forces - uneven road surfaces, bumps and potholes
- Lateral forces - centrifugal forces during cornering and crosswinds
- Longitudinal forces - acceleration, deceleration and braking

The following vehicle structure movements occur as a result of these forces:

- Around the transverse axis: pitch
- Around the longitudinal axis: roll
- Around the vertical axis: yaw



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Active Driving Dynamics Systems are integrated in the E65 chassis which support the driver both actively and passively by suppressing the effects of these forces as much as possible. The Driving Dynamics Systems include:

- Dynamic Stability Control (DSC) with subsystems

- Electronic Damping Control (EDC-K) continually adjustable system

- Dynamic Drive active roll stabilizer bar (ARS)

The Driving Dynamics Systems monitor the driving conditions using sensors. The sensor signals are transmitted to the control modules that interpret and evaluate the driving conditions. The control modules send output signals to actuators that will counter these forces providing adaptation for the road and driving situations.

Systems Indications

The indicator/warning lamps, Check Control, On-board Computer messages and Control Displays as well as the respective activation are described in the iDrive display and controls.

Dynamic Stability Control (DSC)

The DSC controls the vehicle stability in all driving conditions, counteracting the driving dynamics forces by using brake intervention or engine load control depending on the situation. DSC consists of the following subsystems:

- ABS Anti-Lock Braking System
- ASC Automatic Stability Control
- MSR Engine Drag Torque Reduction
- DBC Dynamic Brake Control
- CBC Cornering Brake Control

The following are new in the E65:

- FBS Fading Brake Support
- FLR Driving Performance Control
- DTC Dynamic Traction Control
- Parking Brake (hydraulic service brakes)

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Electronic Damping Control (EDC-K)

The continuous Electronic Damping Control (EDC-K) absorbs vertical forces while driving and dampens these forces to the chassis. The forces are measured by two vertical acceleration sensors on the front axle (left and right) and one at the rear axle (right). The front sensors are located in the wheel housings and the rear on the trunk tray underneath the trunk ventilation ports. The dampening characteristics are mapped in the control module to continuously regulate the EDC-K providing maximum comfort.

The EDC-K works with infinitely variable valves in the dampers to regulate the hydraulic fluid flow using electromagnetic control valves. EDC-K provides the actual damping force required at any time.

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The steering angle sensor is used along with the front wheel speed sensors to determine the lateral acceleration. The controller provides the opportunity to select from two basic settings: Comfort or Sports.

Dynamic Drive

Dynamic Drive controls two active stabilizer bars based on the lateral acceleration. The active stabilizers are split with a hydraulic actuator in between them so that the left and right sides can be turned in opposing directions. These active stabilizers set the stabilizing torque using hydraulic actuators so that:

- The rolling motion of the body is minimized or eliminated while cornering.
- The extent to which the body rolls on straight, uneven road surfaces is reduced.
- A high degree of agility and precision adjustment is achieved using the full speed range.
- An optimum self steering characteristic is produced.

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Dynamic Stability Control (DSC)

History

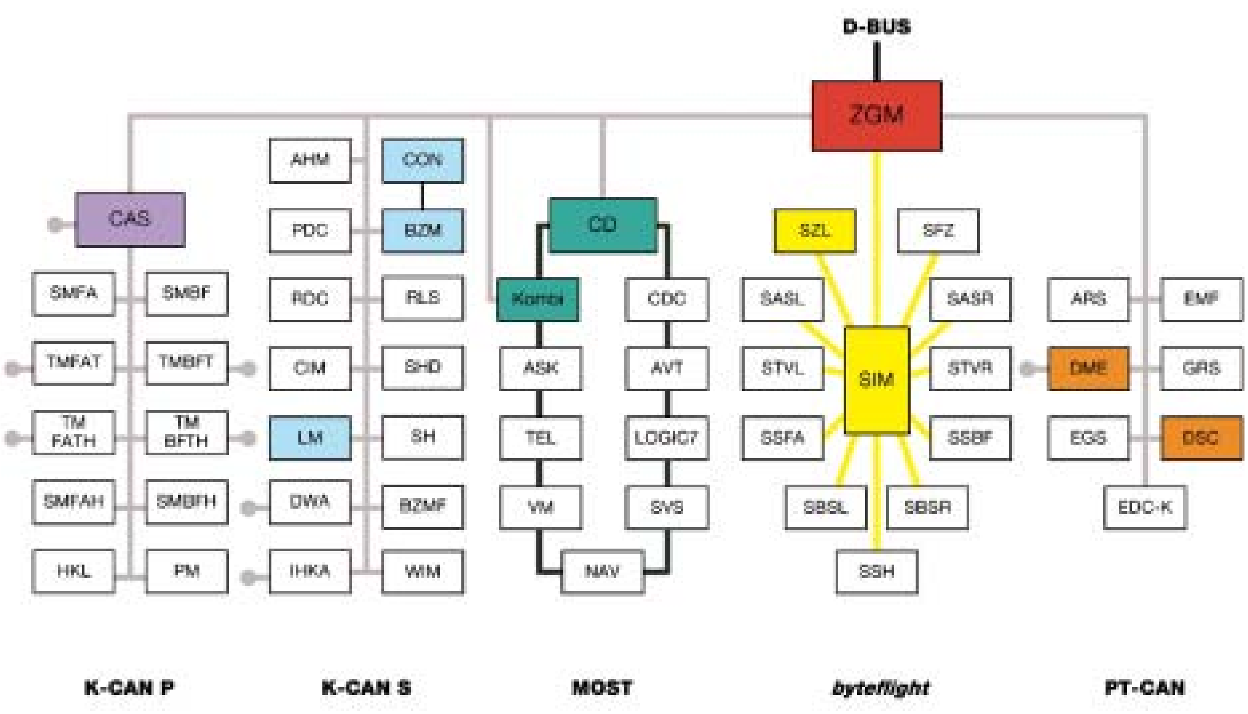
The history of wheel slip control systems used in BMWs is covered in the Chassis Dynamics course (ST056). DSC III was technically modified (deletion of the pre-charging unit), the functions were extended and renamed DSC 5.3. The DSC 5.3 was further developed into DSC 5.7 by adding these functions:

- Dynamic Brake Control (DBC)
- Dynamic Brake Support (DBS)
- Maximum Brake Support (MBS)

These functions have been used in Bosch systems since 1999. For the E65, DSC 5.7 is further developed and expanded to include the software functions to achieve improved system operation:

- FBS Fading Brake Support
- FLR Driving Performance Control
- Parking Brake (hydraulic service brakes)
- DTC Dynamic Traction Control

In addition, the evaluation of the 2-stage brake lining wear sensors is integrated in the DSC control module. The DSC system is connected to the PT-CAN Bus.



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Principle of Operation

DSC

DSC calculates the current driving conditions and corrects detected driving instability through active brake interventions. For example, in the event of vehicle oversteer, DSC initiates brake intervention at the front wheel furthest from the curve to create a stabilizing, opposing torque.

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In the event of vehicle understeer, active interventions at the wheels nearest to the curve provide a stabilizing counter torque. DSC stabilization is performed in all driving situations: normal running, acceleration and braking.

The DSC control module is combined with the hydraulic unit and is located on the right front strut tower in the engine compartment.

The DSC function can be deactivated by the Controller in the Control Display menu and the DSC light in the instrument cluster will illuminate to alert the driver. DSC can be reactivated by the Controller or automatically when the ignition is cycled.

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Anti-Lock Braking System (ABS)

The ABS system will operate under a full or failsafe state:

- ABS full system: the control module achieves a stabilizing effect on the driver's requests through active brake pressure increase at the individual wheels. Information from the wheel speed sensors, the yaw rate and steering angle sensors determine the vehicle speed. At vehicle speeds <60 km/h an individual control operation matching each situation shortens the braking distance.

- ABS failsafe level: the ABS adopts the failsafe level in the event of a sensor failure or a CAN Bus fault. In this case, the vehicle speed is determined by the wheel speed sensors. In addition, the “select low” control for rear axle stabilization will be applied and the active interventions during brake activation and MSR will be deactivated.

Automatic Stability Control (ASC)

ASC prevents the wheels from spinning during acceleration on all types of road surface. The ASC function is the same as models currently in use.

Engine Drag Torque Control (MSR)

When the accelerator pedal is abruptly released or in the event of unadapted downshifting to a lower gear, the MSR function maintains stability on the rear of the vehicle.

The MSR function is activated at vehicle speeds above 15 km/h to decrease strong load changes through a brief engine torque increase by increasing the Valvetronic lift, advancing the ignition timing, increasing the injected amount of fuel, etc.

Dynamic Brake Control (DBC)

The DBC function is designed to provide the maximum braking force available during rapid (panic) braking situations and includes the following subfunctions.

Dynamic Brake Support (DBS): DBS assists the driver in panic braking situations. This function is triggered by a sufficiently fast actuation of the brake pedal.

The brake pressure generated by the driver is increased by the hydraulic pump to the extent that the front and rear axles go into ABS control mode. The driver can achieve a full deceleration with low pedal force.

Fading Brake Support (FBS): FBS is a new subfunction of DBC that compensates for the brake force loss from an increase in brake temperature. The diminishing braking effect due to hot brakes requires the driver to press the brake pedal more firmly.

This increase in pressure is assumed by an activation of the DSC hydraulic pump. The temperature measurement is a virtual value which is calculated by the DSC control module based on wheel speed, brake pressure, braking time (length) and ambient temperature.

Cornering Brake Control (CBC)

The CBC function is activated in the event of medium to high lateral acceleration. If a vehicle drives into a curve under braking and threatens to oversteer, an increase in stability is achieved through a partial release of the rear wheel brake nearest the curve.

During corner braking, CBC provides the best possible directional stability through optimum brake force distribution. The hydraulic pressure in the rear brake calipers is controlled individually to prevent the vehicle from oversteering.

CBC controls the vehicle prior to ABS or DSC intervention. CBC also operates even when DSC is deactivated and CBC is deactivated in the event of an ABS failure.

Driving Performance Control (FLR)

FLR is a new subfunction of DSC that protects the brakes against overloading (misuse). When a temperature of over 600 ºC is determined, the engine power is reduced (max. engine torque 330 Nm) by the ECM. This engine torque reduction is stored as a fault (driving performance control active).

Dynamic Traction Control (DTC)

To improve propulsion, the ASC slip thresholds can be increased up to a speed of 45 mph (70 km/h). The permissible slip is doubled which offers advantages when driving on poor roads and in heavy snow (increased rear wheel spin is permissible).

When chassis dynamics increase as measured by the yaw rate sensor, the slip thresholds are reduced back to the normal mode for stability reasons.

The DTC function can be activated/deactivated by the Controller in the Control Display menu.

When the DTC traction mode is activated, the "DTC" light is illuminated above the DSC safety light (in the instrument cluster).

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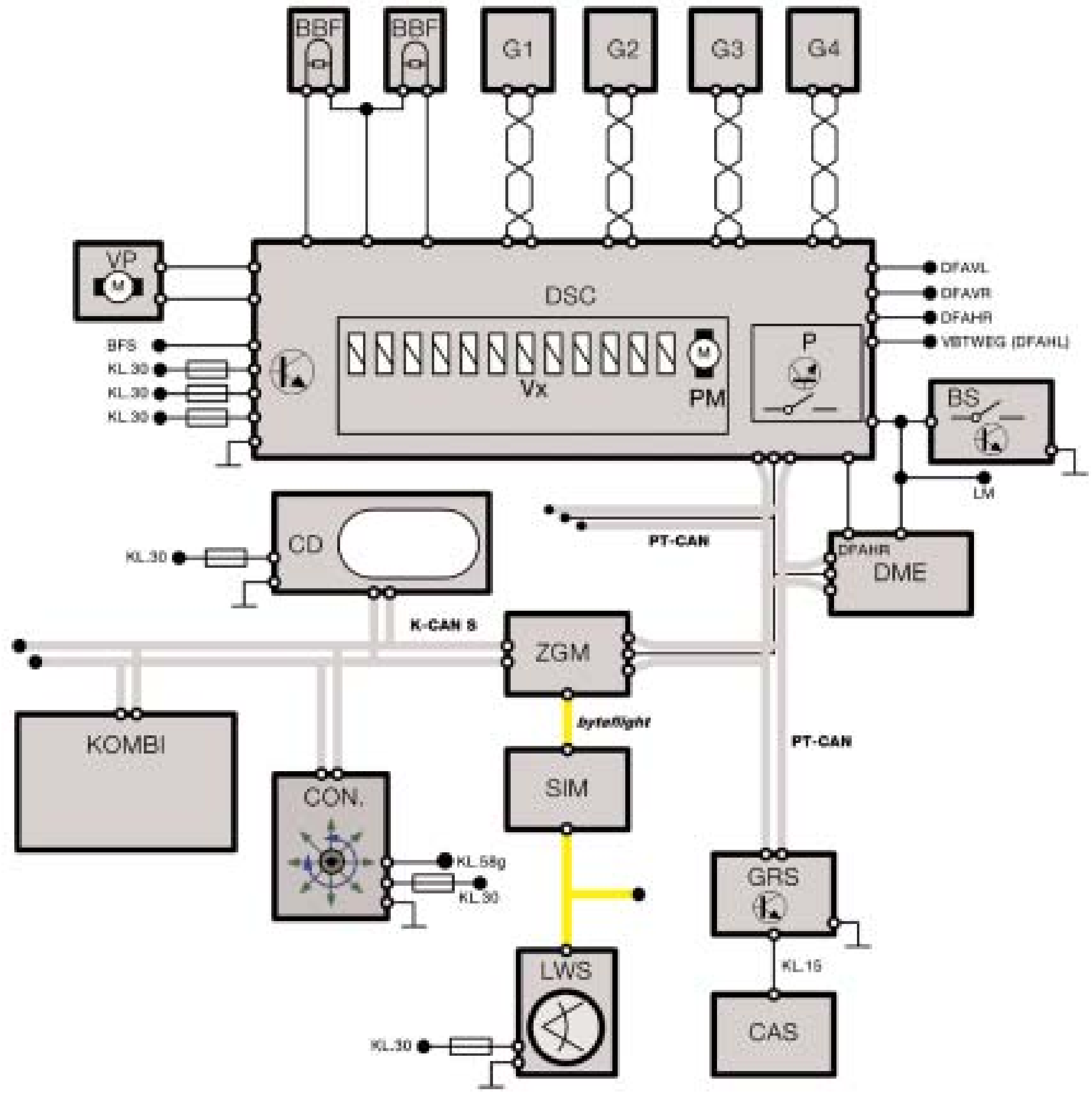
Parking Brake (Hydraulic Section)

DSC controls the hydraulic function of the Parking Brake. The "Automatic Hold" and "Dynamic Braking" functions affects a hydraulic braking operation on the front and rear service brakes (refer to the E65 Brakes Section).

System Components

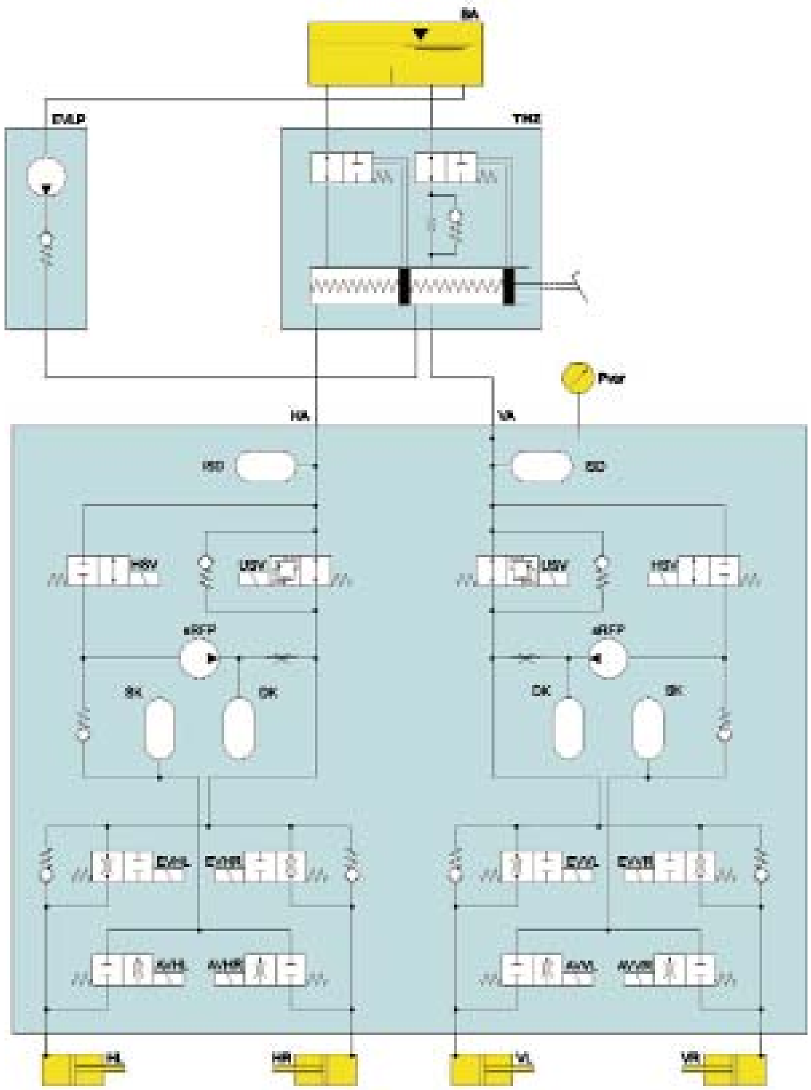


DSC Components

BBF - Brake lining sensors
VP - Precharging pump
DSC - DSC control module
Vx - Hydrualic control valves
VBTWEG - Mileage signal
CD - Control Display
ZGM - Central gateway module
Kombi - Instrument cluster
CAS - Car Access System
GRS - Yaw rate sensor with integrated transversal acceleration sensor

G1- G4 - Wheel speed sensors
BFS - Brake-fluid sensor
P - Pressure sensor
DFA - Speed-sensor output
BS - Brake-light switch
DME - Digital Motor Electronics (ECM)
SIM - Safety Information Module
CON.- Controller
LWS - Steering angle sensor

Hydraulic System Components



Hydraulic System Components

BA - Brake fluid reservoir
THZ - Tandem brake master cylinder
HA - Rear axle
VA - Front axle
Pvor - Pressure sensor
DK - Damper chamber
EVLP - Single precharging pump
Kombi - Instrument cluster
GRS - Yaw-rate sensor
CAS - Car Access System
HSV - High pressure switching valve
USV - Changeover valve
SK - Accumulator Chamber

sRFP - Self priming return pump
ISD - Integrated flow damper
EVHL - Inlet valve, left rear
EVHR - Inlet valve, right rear
EVVL - Inlet valve, left front
EVVR - Inlet valve, right front
AVHL - Outlet valve, left rear
AVHR - Outlet valve, right rear
AVVL - Outlet valve, left front
AVVR - Outlet valve, right front
HL/HR - Left rear / right rear
VL/VR - Left front / right front

Sensors

The DSC 5.7 receives input signals from the following sensors:

- Wheel speed sensors (4 active wheel speed sensors with direction of rotation detection)
- Steering angle sensor (located in the SLZ), made available over the PT-CAN Bus
- Brake fluid level warning switch (level monitoring in brake fluid reservoir)
- Brake light switch (BS)
- Rotation rate sensor - yaw (satellite of DSC on PT-CAN Bus)
- Transversal acceleration sensor (integrated in rotation rate sensor)

  The Rotation rate (yaw) sensor is located under the carpet in front of the passenger's seat in the passenger compartment.

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- Pressure sensor (installed at the inlet of front brake circuit)

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Notes:

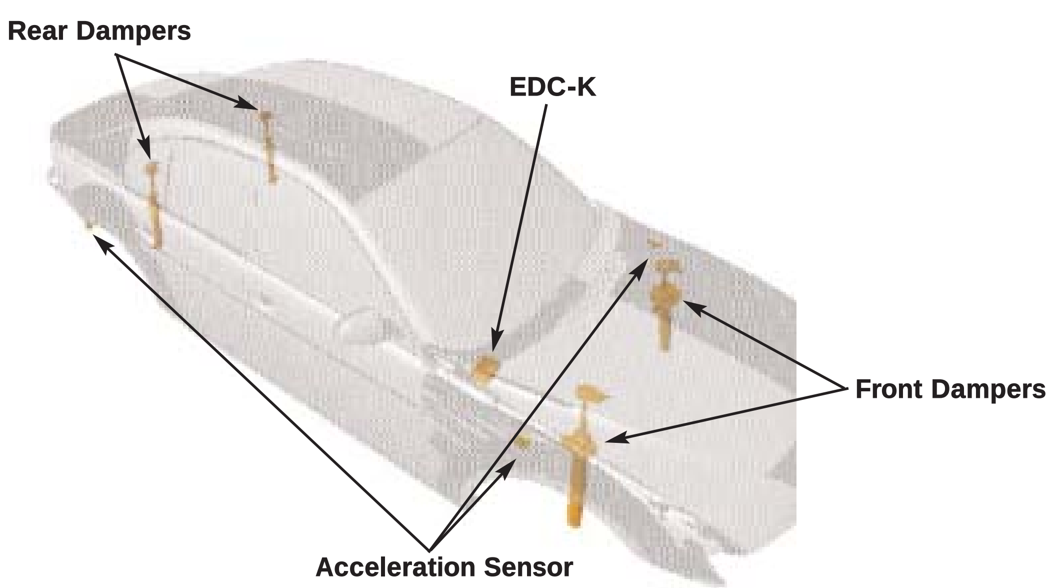
Electronic Damper Control - Continuous (EDC-K)

History

With EDC I in the 1987 E32, BMW AG was the first European manufacturer to introduce a fully automatic electronically adjustable damper system. EDC I provided manual selection during driving between hard, sport and soft damping. Since the market launch, this 2-stage system has been continuously enhanced and evolved into EDC III, it has set the standard for adjustable damper systems in the 5 and 7 Series.

EDC III evaluates the status of the road surface, vehicle load, driving speed and driver's request to automatically activate one of three damper programs: soft, medium or hard. The driver also has the option of selecting a comfort or sports program.

EDC-K is a further development of EDC III. The German abbreviation "K" stands for continuous damping force adjustment. The major change from EDC III is the damper valves and the activation control.



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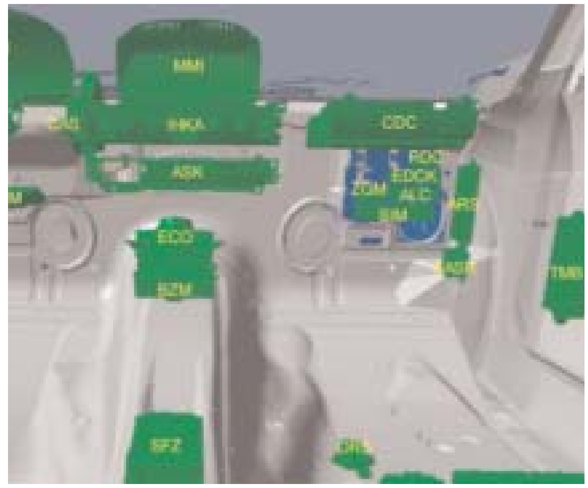
EDC-K operates with a continuously adjustable valve in each damper. The damping force is adjusted for individual piston speed. The damping force adapts continuously to the low frequency movement of the vehicle body, resulting in a significant increase in driving comfort. The driver has the option to select a comfort or sports setting by using the Controller in the Control Display menu.

The EDC-K system is an option offered under the Adaptive Ride Package.

System Components

EDC-K Control Module: The control module is located in front of the glovebox and is powered by B+, operating within a voltage range of 9 to 16V. In the event of undervoltage, the EDC-K system shuts down to prevent excessive battery draw.

The control module incorporates various control functions that determines the current applied to the damper valves.



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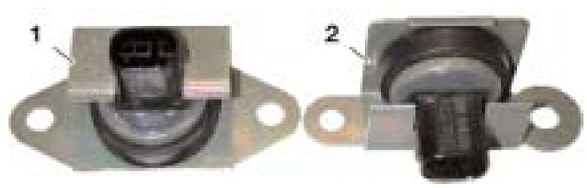
Vertical Acceleration Sensors: The three vertical acceleration sensors provide a varying voltage signal (0.2 - 4.5V) to the control module indicating the speed of body movement. The three sensors are identical and have a measuring range of ± 2.5 g.

The front sensors (1) are mounted on the inside top of the wheel archs and the rear sensor (2) is mounted on the side of the rear wheel arch.



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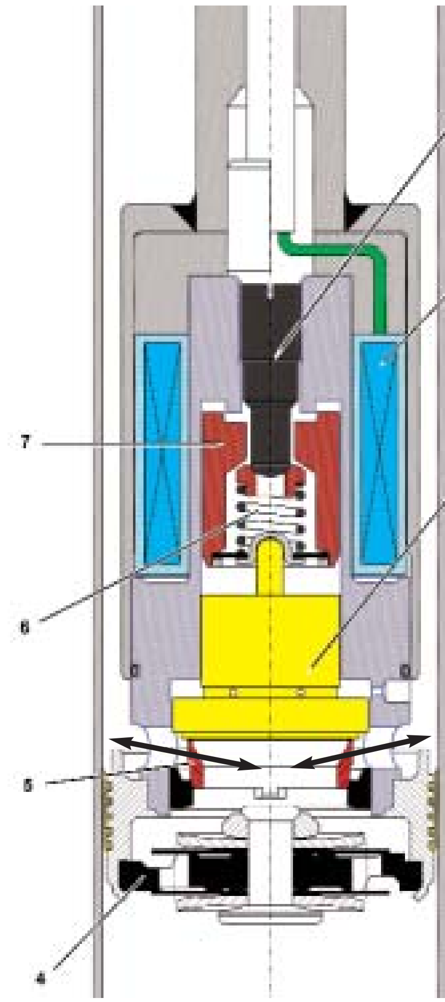
Electronically Adjustable Dampers: The front and rear axles are equipped with twin tube gas pressurized dampers supplied by Mannesmann Sachs Boge. The fully variable dampers are map controlled and do not have fixed stages.

Each damper incorporates an adjustable proportioning control valve on the piston. The wiring harness for this valve is routed through the hollow piston rod. Damper oil flows through this valve during compression and rebound. The control valve generates a pressure drop between the lower and upper chambers depending on the oil flow volume.

The front and rear axles are separately activated to achieve an optimum response for vibrations in all driving conditions. The valves are deactivated in the event of a control module failure or when the ignition is switched "OFF". The dampers automatically rest in the hardest setting (without power). On vehicles equipped with Dynamic Drive, the spring struts have different valve configurations on the front and rear axles. The dampers are de-energized when the vehicle is stationary. They are energized initially from 5 km/h.

1. Pre-tensioning screw
2. Solenoid coil
3. EDC-K Damper valve
4. Primary valve
5. Floating seat ring
6. Valve spring
7. Armature



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EDC-K Damper Valve - Detail

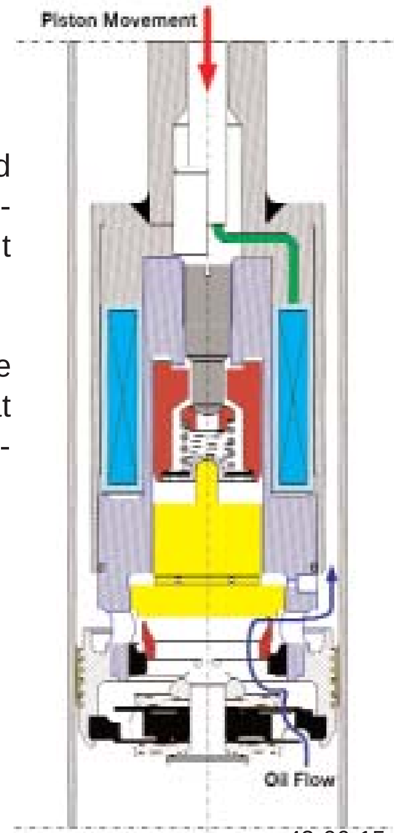
Infinitely Variable Control Valve: Without power, the maximum hydraulic resistance is set by the screw (1), which pre-tensions the valve spring (6). This is the hardest damper setting, also known as the failsafe (rest) setting.

The valve spring provides maximum tension on the armature (7), which presses down on the EDC-K Damper valve (3). This in turn presses down on the floating seat ring (5) which offers resistance to the oil flow by restricting the orifices (indicated by arrows).

When the solenoid coil (2) is energized by the EDC-K control module, the armature is magnetically pulled upwards against the valve spring tension. The armature will exert less pressure on the EDC-K Damper valve. The tension is decreased on the floating seat ring decreasing the orifice restriction. The oil flow will increase, resulting in softer damping.

When the solenoid coil receives maximum power, the effect will be the lightest tension on the floating seat ring. The orifices are unrestricted, providing the softest damping.

Damper Valve - Hydraulic Details



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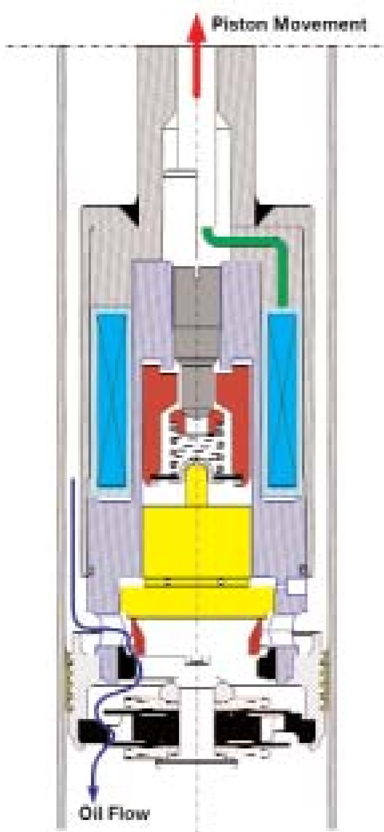
Compression Stage: The rod and attached piston is forced downwards in the damper cylinder. The oil in the cylinder provides lubrication and resistance to the piston movement (shown to the right).

The oil is forced through the primary valve which pushes the EDC-K Damper valve upwards. The floating seat ring rests at the bottom and the oil will flow through the orifices which control the rate (direction indicated by the arrow).



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Rebound Stage: The rod and attached piston is forced upwards in the damper cylinder. The oil in the cylinder provides resistance to the piston movement (shown to the left).

The oil will flow through the orifices forcing the floating seat ring up against the EDC-K Damper valve. The oil continues to flow through the primary valve to control the rate (direction indicated by the arrow).

The armature is controlled (electronically) by the EDC-K control module to regulate the EDC-K Damper valve and floating seat ring positions which varies the resistance to oil flow by restricting the orifices.

Principle of Operation

EDC-K is a microprocessor controlled damper adjusting system. The system consists of mechanical, hydraulic and electrical/electronic subsystems. Acceleration sensors record the driving/road surface conditions and the control module receives the sensor frequency signals for evaluation. The sensor signals are compared with each other for plausibility. The control module logic activates the damper valves according to internal programmed maps to dampen body and wheel movement as needed.

The driver can use the Controller and Control Display menu to select between comfort and sports programs. The system is diagnosable with the DISplus. In the event of sensor faults, the system is switched to a "safe state" by supplying fixed power to the damper valves. In the event of a system failure (no power), the dampers are mechanically sprung to the firmest setting.

The EDC-K function is divided into 3 blocks:

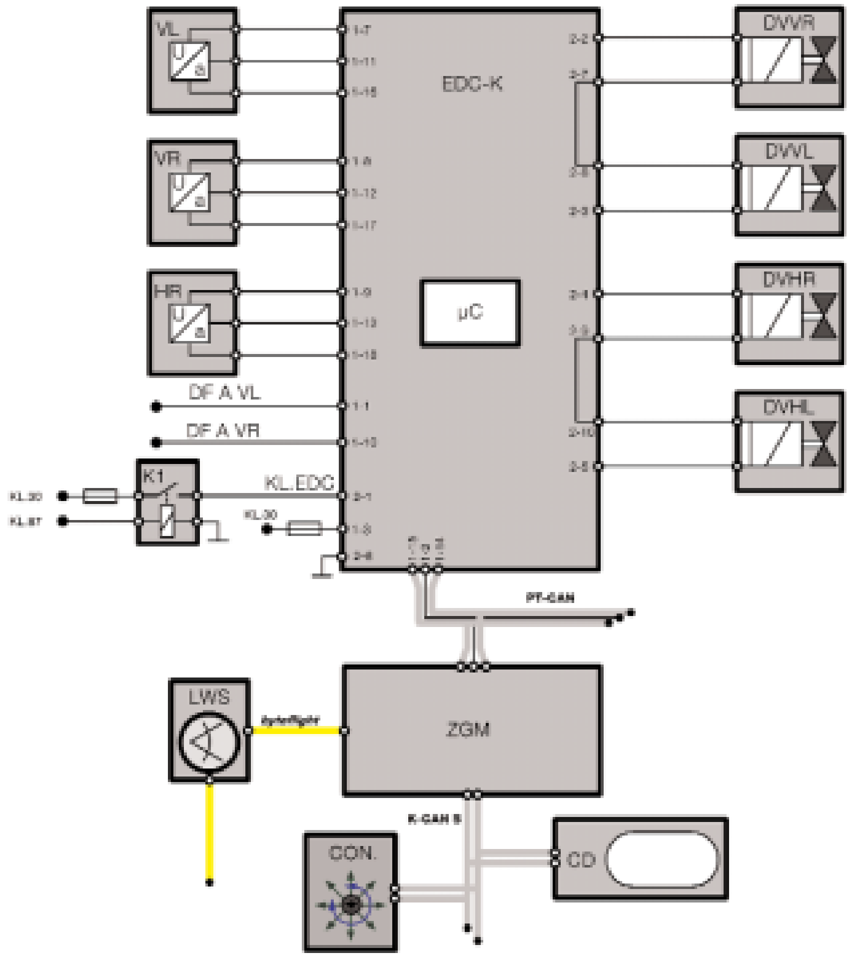
- Control Module
- Sensors and program selection option
- Actuators - 4 electronically adjustable dampers

The input signals for the system are generated by:

Sensor/Switch	Signal	Calculated Variable	Location
Acceleration sensors front axle, rear axle	Vertical acceleration front, rear	Vertical velocity, Compression/rebound travel	Sprint-strut dome FR, FL, RR
Steering angle sensor	Steering angle	Steering angle velocity	SZL
Wheel speed sensors FL/FR	Wheel speed	Driving speed, acceleration/braking	Wheel hubs FL/FR
Program selection	Comfort/sports program		Controller

In addition to the forces calculated in each measured movement, there are vertical, longitudinal, transversal, copy and tolerance control logic.

EDC-K Electronic System Overview



EDC-K Components

VL - Front left acceleration sensor	CD - Control Display
VR - Front right acceleration sensor	DVVR - Damper valve, front right
HR - Rear right accelerator sensor	DVVL - Damper valve, front left
DF A - Front left wheel speed sensor	DVHR - Damper valve, rear right
Con. - Controller	DVHL - Damper valve, rear left
LWS - Steering angle sensor	ZGM - Central gateway module

Vertical Dynamics Control

Vertical Dynamics Control responds to vertical (up/down) body movements based on wheel/body acceleration and speed. A distinction is made between a low frequency body vibration (approx. 1 Hz) and a high frequency wheel vibration (approx. 10 to 15 Hz). Because the body speed cannot be measured, a characteristic value is calculated from the acceleration signals. This value is adapted based on the vehicle speed, frequency ranges and road surfaces.

The higher frequency vibrations of the axle are calculated as the wheel dynamics value based on the wheel speed signal inputs. The value is determined from the irregularities of the wheel rotation when driving over bumps. This control operation takes place separately for both axles.

Longitudinal Dynamics Control

The Longitudinal Dynamics Control responds to acceleration and braking body movements (forward/backward). The vehicle speed signals are monitored by the control module: two direct wheel speed inputs from the DSC control module and three digital inputs from the PT-CAN Bus. Two of the signals on the PT-CAN Bus correspond to the 2 wheel speed signals from DSC and the third signal is the averaged vehicle speed.

The EDC-K control module assesses the plausibility of these signals. A Longitudinal Dynamics value is calculated from the wheel speed signal, which represents the level of acceleration or deceleration. The dampers are adjusted (on both axles) to the harder setting to counter act the longitudinal movement.

Transversal Dynamics Control

The Transversal Dynamics Control responds to transversal movement (dive and squat - front to back roll). This value is calculated from the steering angle sensor and the vehicle speed signals. The onset of “yaw” movement is detected very early from the steering angle sensor signal. A harder damper setting to support the vehicle as it enters a curve is activated at an early stage. The front and rear axles are separately controlled.

Copy Control

The Copy Control function responds to the compression and rebound of the body (encountering bounces on one side of the vehicle) while driving straight ahead. Through comfortable damper tuning, EDC-K responds to one sided unevenness due to the road surface. This prevents a side to side rolling motion while driving straight ahead.

Once vehicle "copying" is detected, a harder damping combination is applied to the front and rear axles. Detection is based on the evaluation of the right and left vertical acceleration signals from the front axle.

Tolerance Adaptation

The damper force is diminished as part of the operating time function. Diminishing damper forces are compensated by current (amperage) reductions which are calculated by the tolerance control. This also individually compensates for mechanical damper wear on each axle.

Control Strategy

All of the dampers are controled simultaneously until a single damper control in particular is required. For stability reasons, the smallest desired output current of the four damper controls (hardest damper setting) is set.

Plausibility Monitoring and Safety Concept

The EDC-K inputs and outputs are checked for plausibility. Depending on the type of fault, restricted operation of the damper control system will occur while a high degree of safety and comfort is maintained.

The control display informs the driver when an EDC-K system fault has occurred. There are two different shutdown options in the event of faults.

- In partial operation, medium damping is set by a fixed current at the front and rear axle valves.

- When the entire system is shut down, the de-energized valves instantly switch (spring loaded) and remain in the "hard damping" setting.

In the event of system faults, the chassis and suspension is set to a safe condition that is acceptable to the driver. The valves, sensors, electric circuits and EDC-K control module are fault monitored.

Notes:

System Faults and Reactions

Malfunction	Fault response
CAN steering angle signal correction Deviation > 10º	Fixed current, fault in memory, gong at end of trip
Acceleration sensors (front, left, right, rear)	Fixed current output for front axle, rear axle Fault in memory, gong at end of trip
Wheel speed front left/right	1) Control operation with replacement sensor 2) Fixed current output for front and rear axles
External voltage supply fault fluctuation (nominal should be 5 V +/- 10%)	Fixed current output for front axle, rear axle Fault in memory, gong at end of trip
Voltage supply to EDC control module between 2 V and 8 V	Valves de-energized, fault in memory, gong During trip
Valve failure	Valves de-energized, fault in memory, gong during trip
Voltage wake up, <2V standing & wake up>7V	Valves de-energized, fault in memory, gong during trip
No vehicle speed via CAN Bus	Fixed current, fault in memory, gong at end of trip
Control module EEPROM faulty	Fixed current, fault in memory
Control module - no alive message from EDC-K	Valves de-energized, fault in memory, gong during trip

CAN Interface

The steering angle value is prepared and is transmitted by the SZL over the CAN Bus. Both of the front wheel speed signals (including the direct DSC wheel speed signal), the vehicle speed reference value and the mileage reading are provided by the DSC control module over the CAN Bus to the EDC-K control module.

Power Supply

Low current supply to the damper valves results in hard damping and a high current results in soft damping. The EDC-K control module determines the setpoints and outputs pulse-width modulated (PWM) signals to the damper valves to regulate the current flow. Current flow limitation is ensured by an overcurrent detection and deactivation. All of the analog inputs are protected by diodes against positive and negative overvoltage. The following analog signals are processed by the EDC-K control module:

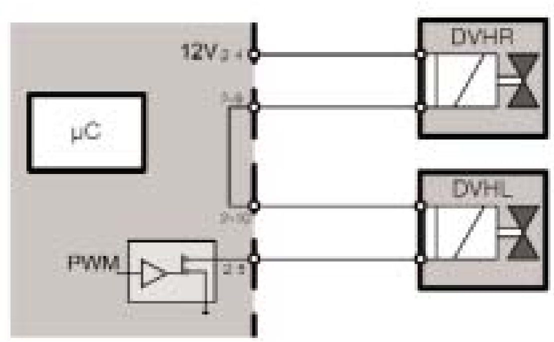
- Vehicle supply voltage
- EDC-K switched output voltage
- Damper valve voltage and current

Valve Activation/Output Stage Circuit

The solenoid valves have low resistance, approximately 2.2 ohms per valve at room temperature because high current is needed at a low voltage. The current is set in the 0 to 2 Amps range depending on the desired damping force. The setpoint value will not exceed 2 Amps to avoid valve damage. The solenoid valves are connected in series for each axle and are supplied with a ground (PWM for continuous adjustment) from the EDC-K control module.

Rear Axle EDC-K Valves Series Connection

uC = Microcontroller (EDC-K control module)
PWM = Pulse width modulation (output signal)
DVHR = Right rear damper valve
DVHL = Left rear damper valve



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Controller and Control Display Operation

Sports program: The driver can activate/deactivate the sports program by the Controller in the Control Display menu.

A firmer damping is set when the EDC-K request is set to "SPORT". EDC-K always reverts back to the comfort program each time the engine is restarted.

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Notes:

Workshop Hints

Diagnosis

System monitoring and plausibility: For safety reasons, faults with one damper valve will result in deactivation of all damper valves. Fault detection takes place on each axle. To pinpoint which valve is faulty, use the DISplus to measure the resistance of the individual valves (per axle). The resistance of a good valve is 2.2 ohms ±10% at room temperature (20 ºC).

Acceleration sensors: The EDC-K control module does not distinguish individual malfunctions between the sensors. The power supply to the three sensors is connected in parallel in the control module (without isolation). A short circuit in the supply voltage to one of the sensors will also affect the supply to the other sensors.

A maximum of seven different faults can be stored for the acceleration sensors. The coding data will indicate the functions of the control module (vehicle and country specific).

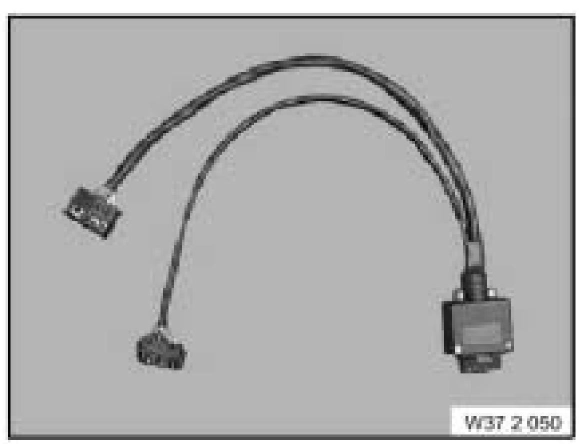
Notes on Service

When the steering angle sensor is removed, the steering wheel must be manually positioned to the straight ahead position and this position re-initialized in the SZL. The steering wheel straight ahead position is permanently monitored while driving.

EDC-K diagnosis detects electronic damper faults on the complete axle only. Mechanical testing of individual dampers can be carried out in the damper test. Mechanical wear causes the dampers to weaken over the service life, therefore a running time memory adapts the damper curves towards a harder setting (over time). Faulty dampers must be replaced together (in pairs) on a single axle. After a replacement, the running time memory for the front or rear axle must be reset with the DISplus.

A 10 Pin Adapter Cable is available to adapt the MFK cables to the EDC-K control module when using the DISplus (Test Plan).

Special Tool #90 88 6 372 050



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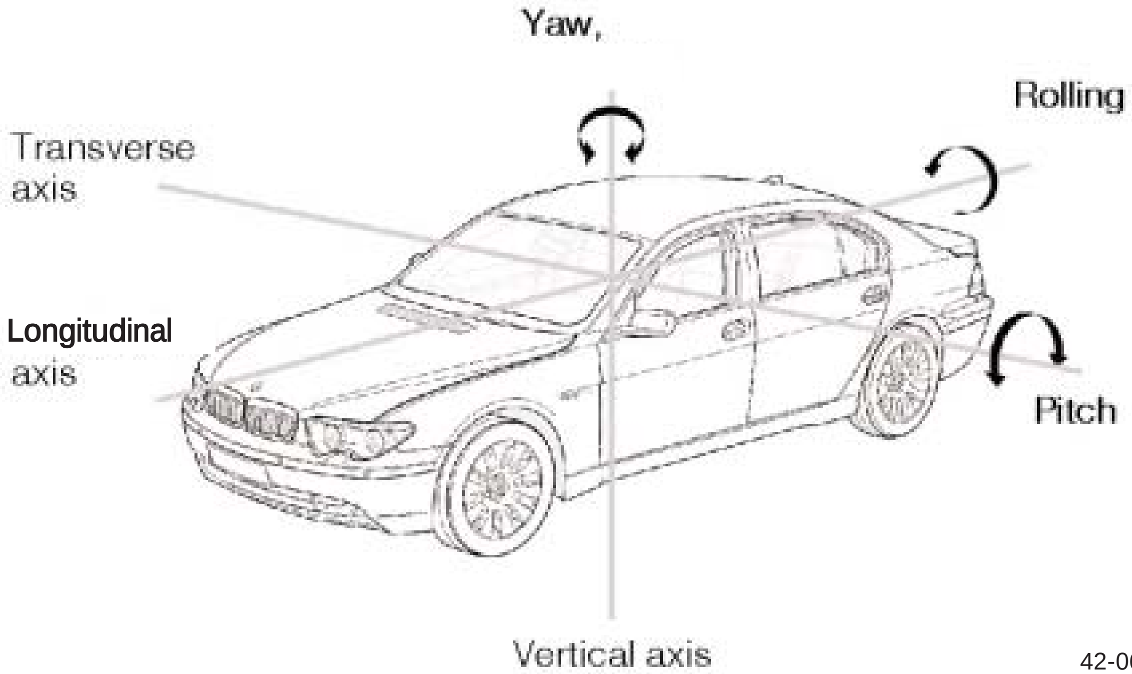
Dynamic Drive - Active Roll Stabilizer Bar (ARS)

Stabilizer Bars on the Front and Rear Axles

Body roll is built up over the vehicle's longitudinal axis as a result of the centrifugal force at the center of gravity. This force causes the vehicle body to lean towards the outside wheels while cornering and quickly draws the vehicle closer to the limits of driving dynamics. The tilt angle of the body and the increased wheel load is counteracted by the use of stabilizer bars.



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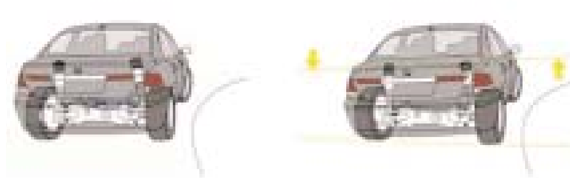
When cornering, the wheel on the outside of the corner compresses the spring, and the inner wheel extends the spring which causes the the stabilizer bar to turn (twist).

The forces on the mounting points of the stabilizer bar generate a torque that counteracts the body angle providing better load distribution on both wheels on the same axle.



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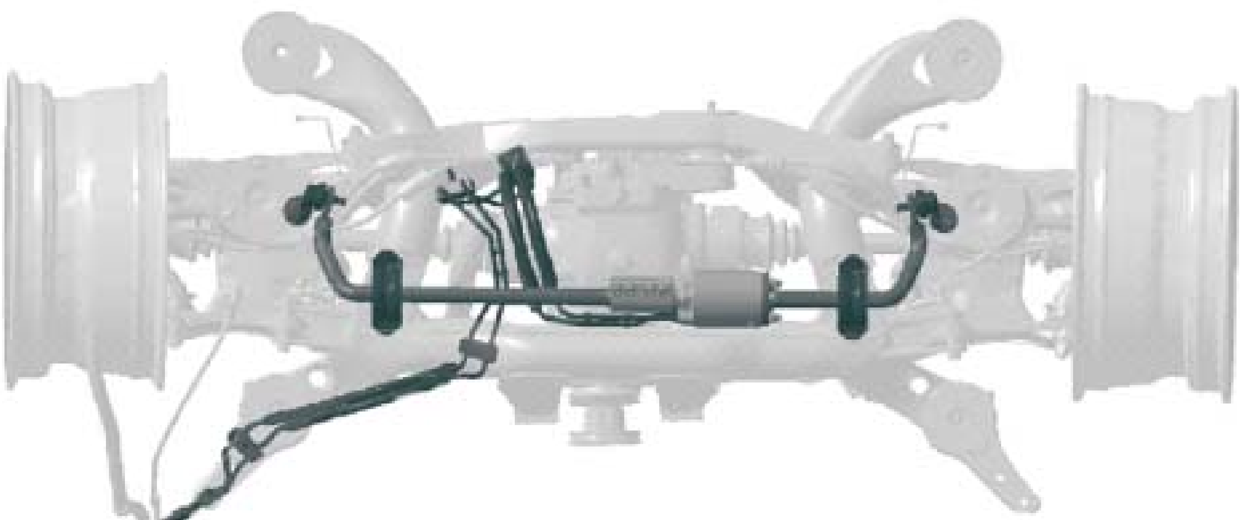
The suspension is firmer with a solid stabilizer bar. The disadvantage is that when you are driving straight ahead during a one-sided compression (bounce), this transmits a "copying" effect through the suspension, which reduces comfort.

Purpose of the System

The Dynamic Drive - Active Roll Stabilizer Bar (ARS) is a revolutionary step for chassis technology. ARS goes a long way towards removing the conflict between handling/agility and comfort. ARS has two stabilizer bars that have a positive effect on the body roll and handling, allowing softer springs and dampers to increase comfort.

Active Stabilizer Bar on the Rear Axle



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Dynamic Drive controls two active stabilizer bars on the axles depending on the lateral acceleration.

Oscillating Motor

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The two separate stabilizer bars on each axle are mounted in roller bearings and are connected by a hydraulic oscillating motor.

One half of the stabilizer bar is connected to the oscillating motor shaft and the other is connected to the oscillating motor housing.

Active stabilizer bars introduce fewer forces into the body as compared to solid stabilizer bars-because the separate “halves” will not copy one sided suspension compressions (bounces).

The active stabilizer bars set the stabilizing torque, resulting in:

- Minimizing or completely eliminating body roll while cornering
- Reduction in the “copying effect” of the vehicle
- A high degree of agility and precision throughout the entire speed range
- Produces optimum self steering characteristics
- Improved suspension comfort (when driving straight ahead) because the stabilizer bar halves are independent and do not stiffen the basic suspension during a one-sided compression.

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

Self Steering Affect

The self steering affect is influenced by the distribution of the stabilizing torque on the axles. The greater the stabilizing torque on an axle, the lower the lateral forces will be that are transmitted on this axle. Two situations are described below with a different distribution of stabilizing torque on the axles:

Identical stabilizing torque on both axles: Handling is "NEUTRAL". The front wheels will apply about the same amount of lateral force to the road as the rear wheels (without drive torque). A vehicle that is tuned to neutral handling provides very agile handling and the steering reacts very quickly. The driver experiences precise handling.

Larger stabilizing torque on the front axle: Handling is "UNDERSTEERING". The front wheels cannot apply the same amount of lateral force to the road as the rear axle wheels. The vehicle tends to go straight requiring an increase in steering to make the vehicle turn.

Dynamic Drive sets the stabilizing torque on the front and rear axle to create a different handling characteristic for low and high speeds.

Road Speed	Handling
Low	Neutral
High	Understeer

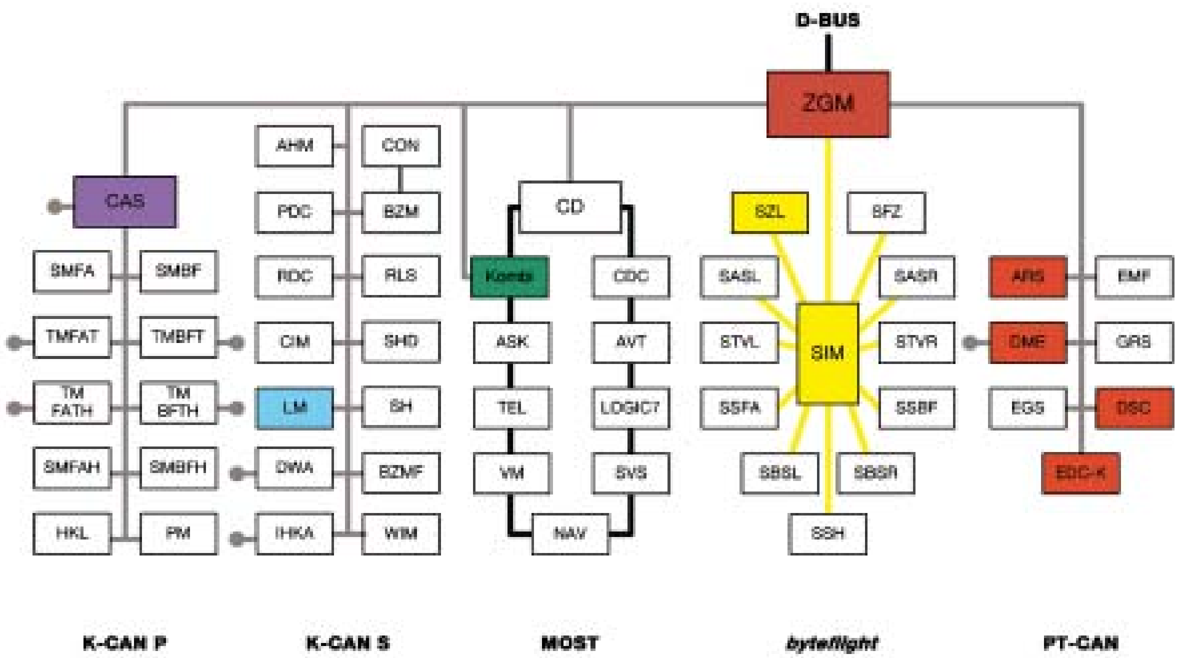
Passenger vehicles are designed for slight understeer depending on the speed range. Dynamic Drive is tuned to neutral in the lower speed range, requiring less steering to go around the same corner. This produces optimum handling and agility. In a higher speed range, Dynamic Drive is designed so that a larger active stabilizing torque will occur on the front axle as compared to the rear axle. ***This means that the vehicle with Dynamic Drive reduces over sensitive steering a higher speeds to enhance handling characteristics.***

System Dynamics

When the vehicle changes lanes, corners or changes direction quickly (winding roads), Dynamic Drive reacts very quickly. The system dynamics reaction time is shown in the following steps:

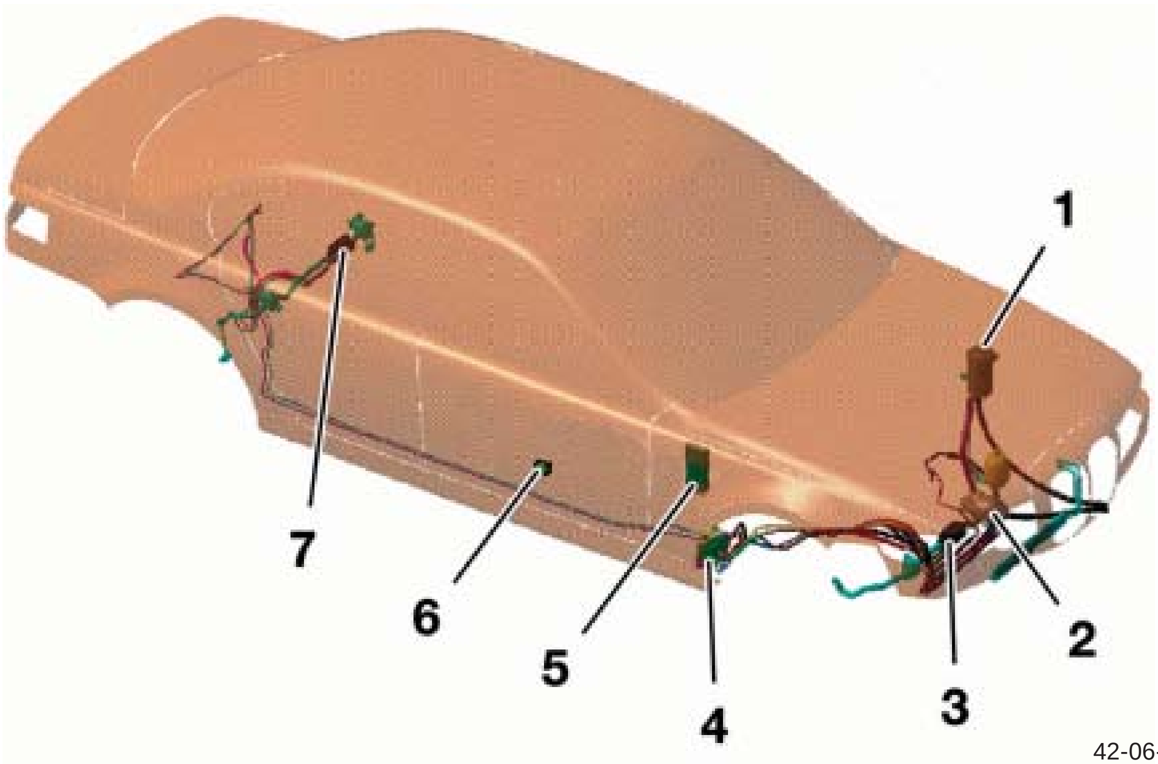
Process	**Time**
Signal detection by sensors, processing of sensor signals and valve control.	approx. 10 ms
Change of direction, switching over the torque direction, direction valve.	approx. 30 ms
Pressure build up (force per wheel).	
0 to 30 bar (0 to 350 N)	approx. 120 ms
0 to 180 bar (0 to 2100 N)	approx. 400 ms

Dynamic Drive Bus Structure



System Components

Dynamic Drive (ARS) consists of the following components:



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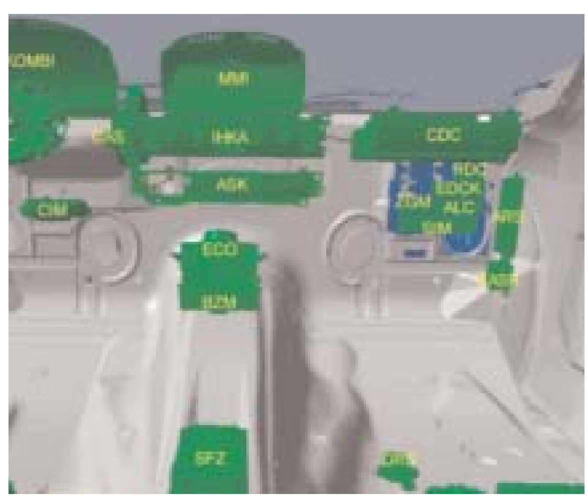
Dynamic Drive (ARS)

1. Fluid reservoir
2. Tamdem pump
3. Front oscillating motor
4. Valve block
5. Control module
6. Transverse acceleration sensor
7. Rear oscillating motor

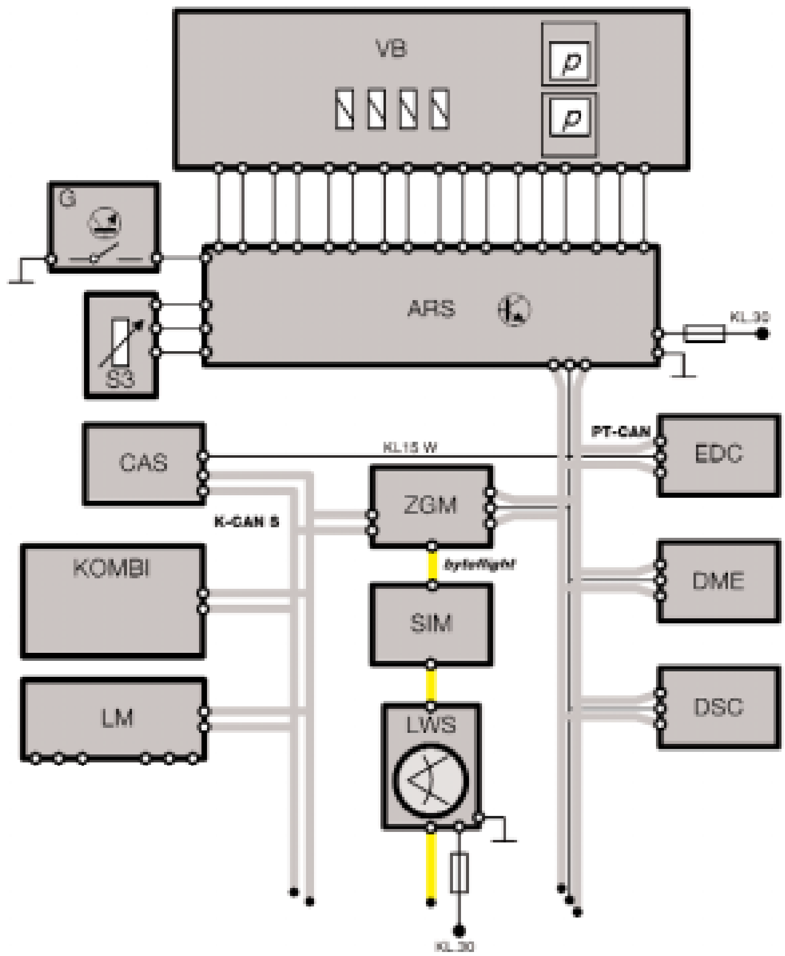
ARS Control Module: The control module is located on the right side “A” pillar in front of the glovebox and is powered by B+ through a 10 Amp fuse. The control module is activated by a CAN alarm lead from the CAS module when the ignition is switched “ON”.



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 ARS control module.

After the ignition is switched "ON", the ARS hardware and software is self-checked. All of the outputs (magnetic valves) are checked for short circuits and breaks. When there is a fault, ARS switches the actuators to a safe driving condition. The control module will switch off in the event of undervoltage or overvoltage.

Dynamic Drive (ARS) Component Overview:



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Dynamic Drive Component Overview

ARS - Control module
VB - Valve block
P - Pressure sensors
G - Rotational rate (yaw) sensor
CAS - Car Access System
KOMBI - Instrument cluster
LM - Light switch center
LWS - Steering angle sensor
SIM - Safety integration module
ZGM - Central gateway module
EDC - Electronic damping module
DME - Digital engine electronics
DSC - Dynamic stability control
S3 - Lateral acceleration sensor

Inputs: The ARS control module requires dynamic driving input signals to calculate the required activation. The following input signals are monitored and checked for plausibility:

- Lateral acceleration
- PT-CAN Bus
- Front axle ARS circuit pressure
- Rear axle ARS circuit pressure
- Selector position recognition sensor (SSE)
- Fluid level sensor signal

The PT-CAN provides additional information about lateral dynamics:

- Vehicle speed signal (DSC)
- Steering wheel turning angle (Steering Angle Sensor)
- Yaw velocity - Transversal acceleration (Roational Rate Sensor)

These inputs allow the ARS control module to determine the stabilization requirement at the appropriate inertia moments. The reaction time is decreased by using the vehicle speed and steering angle inputs.

Outputs: All of the outputs are check by diagnostics and are short circuit protected. The outputs (and control) include the following:

- Pressure control valves for the front and rear axle ARS
- Directional valve
- Failsafe valve
- 5 V sensor voltage supply

The valves are controlled by pulse width modulation current. The individual coil current requirements are constantly checked for plausibility. The current measurements allows the pressures to be precisely set and electrical monitoring of the hydraulic the shift valves.

The PT-CAN sends a message to the ECM indicating how much engine power is required to drive the tandem hydraulic pump to activate the ARS stabilizer bars.

An “alive” data signal is provided and monitored by other control modules to detect the system status. All signal faults are permanently stored. Output faults include short circuits (B+ and ground) and open circuits.

Sensor System

Lateral Acceleration Sensor: The lateral acceleration sensor is located under the carpet in front of the passenger's seat (1). While cornering, the vehicle's lateral acceleration is measured (range is ±1.1 g).

Transversal acceleration (yaw velocity) is provided by the Rotation Rate Sensor (2) via the DSC control module.

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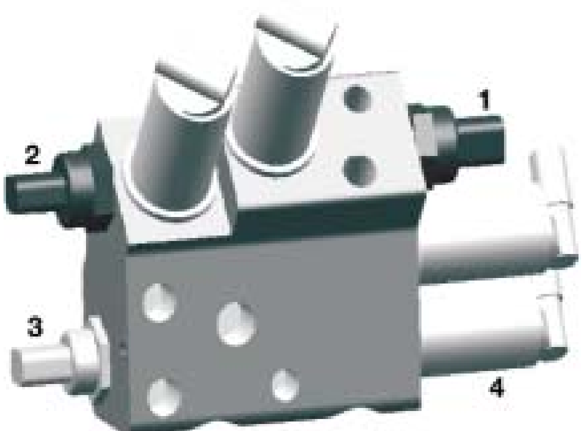
Front and Rear Axle Stabilizer Bar Pressure Sensors: The pressure sensors provide the ARS control module with the front (1 below left) and rear (2 below left) axle stabilizer bar hydraulic operating pressures. The sensors are mounted on the valve block assembly and the pressure values are initialized in the control module (during assembly line commissioning). The voltage value is proportional to the operating pressure (in bar shown below right).



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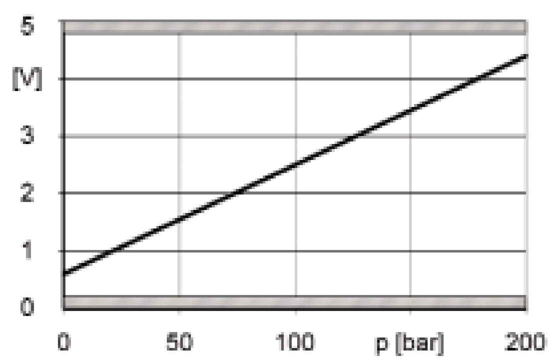

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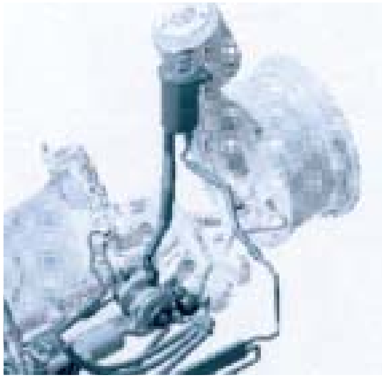
Selector Position Recognition Sensor (SSE): The SSE is mounted on the valve block assembly (3 above left). This sensor allows the ARS control module to detect the specific position of the directional valve (4 above left). The 2 positions detected are:

- Left hand control (direction of torsional twist)
- Right hand control (direction of torsional twist)

Fluid Level Sensor: The fluid level sensor allows the ARS control module to detect the fluid supply level in the reservoir (power steering reservoir) for the tandem pump. The fluid level sensor indicates when the fluid drops below the minimum level and triggers a warning message.

Normal fluid movement (slosh) will not trigger the sensor. Short/open circuits are not detected by the fluid level sensor circuit and a circuit break is interpreted as a loss of fluid.



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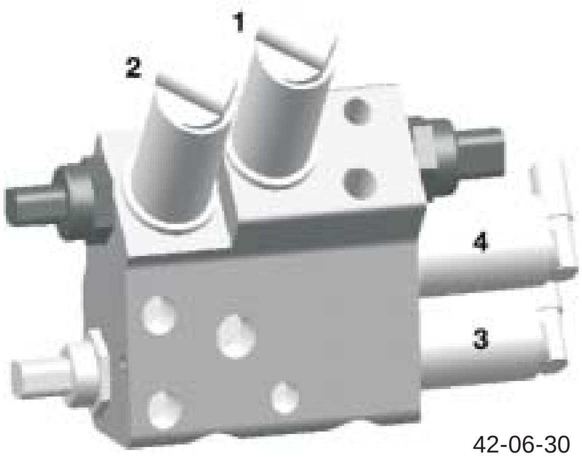
Actuator System

Pressure Control Valves: There is a pressure control valve for both the front (1 below) and rear (2 below) axle hydraulic circuits. The valves adjust the front and rear axle stabilizer bar actuation pressures. When driving straight ahead, the pressure control valves are de-energized opening the valve diameters allowing the fluid to return to the reservoir (circulating).

When cornering, the valves are energized to readily increases the pressure in the oscillating motors to the setpoint value.

Depending on the lateral acceleration and the vehicle speed, the pressures for the front axle are regulated between 5 to 180 bar and 5 to 170 bar for the rear axle.



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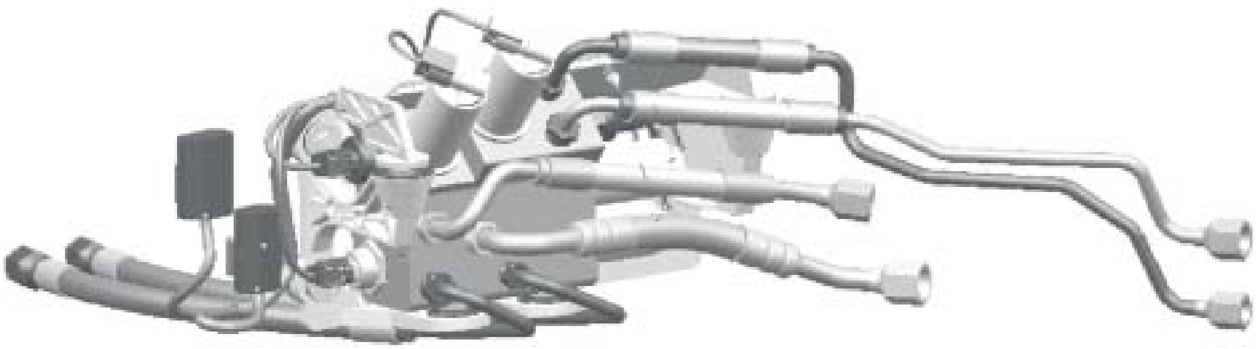
Directional Valve: The directional valve (3 above right) is electrically actuated by the ARS control module to control the direction of the hydraulic pressure for right and left hand twists.

Failsafe Valve: The failsafe valve (4 above right) is electrically actuated by the ARS control module to open the front axle hydraulic circuit to the oscillating motor. The circuit is closed when the failsafe valve is de-energized, decreasing the system pressure (circulating).

Check Valves: The check valves (internal in the valve block) allow the hydraulic fluid to be drawn from the reservoir preventing cavitation in the oscillating motor.

Valve Block: The valve block is an electrically controlled hydraulic distribution assembly and is located behind the right front wheel housing panel (at the base of the A-pillar).



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Valve Block Functions

- ***Distribution of hydraulic fluid flow to the oscillating motors:*** The pressure at the front axle oscillating motor is greater than or equal to the pressure at the rear axle oscillating motor.

- ***Measuring the actual pressure of the high pressure hydraulic fluid:*** There is a pressure sensor for both the front and rear axle oscillating motor hydraulic circuits on the valve block.

- ***Fast and precise regulation via the pressure control valves:*** Introduced pressure changes as a result of uneven roads are passively regulated to reduce noise as much as possible.

- ***Adjustment of the volume flow direction (left hand/right hand twist) via a directional valve:*** The directional valve position is detected by a selector position recognition sensor (SSE).

- ***Switch to Failsafe mode in the event of power supply failure or a fault is detected in the system:*** The front axle oscillating motor hydraulic circuit is closed off and hydraulic flow is diverted to the reservoir. The check valves will open to allow the hydraulic fluid to be drawn from the reservoir. The rear axle oscillating motor hydraulic circuit is also deactivated and hydraulic flow is diverted to the reservoir.

- ***Limiting the system pressure in the event of a fault:*** The Failsafe valve causes the circuit to close when de-energized, decreasing the system pressure (circulating).

Valve Block Sub-Components:

Components	Description
Pressure control valves	The pressure control valves are electrically actuated. They set the active pressure for the front and rear axle stabilizer bars. When driving straight ahead, the pressure control valves are de-energized and the valve diameters are open. The fluid can flow freely to the reservoir. The valves are energized when the vehicle is cornering. The pressure in the oscillating motors increases rapidly and is regulated to the setpoint value.
Directional valve	The directional valve is electrically actuated. It specifies the direction of the high pressure fluid (active pressure) and the return fluid pressure for the right hand and left hand twists.
SSE	There is a selector position recognition sensor (SSE) for monitoring the directional valve position in the directional valve.
Failsafe valve	The Failsafe valve is electrically actuated. It closes the front axle oscillating motor circuit, when de-energized. The system pressure is limited by the circulation position and causes a circulating flow.
Check valves	The check valves are located in the valve block. They allow the fluid to be drawn from the reservoir to prevent cavitations in the oscillating motor.
Pressure sensors	The stabilizer bar pressure sensor signals are used to monitor the hydromechanics. In addition, the pressure control pressure signals are used.

Active Stabilizer Bar (one assembly per axle): The active stabilizer bar consists an oscillating motor and two stabilizer bar halves with press fit roller bearings to mount the assembly to the axle carrier.

The oscillating motor and the oscillating motor housing joins the two halves of the stabilizer bar.

The rear axle Active Stabilizer Bar is shown on the right.

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The Active Stabilizer Bar assembly has three tasks:

- The oscillating motor decouples the two halves of the stabilizer bar.
- The oscillating motor guides the torque into the two halves of the stabilizer bar.
- In the event of system failure (Failsafe mode), the front axle stabilizer bar creates sufficient damping from the oscillating motor hydraulic fluid (hydraulic locking) to work like a conventional stabilizer bar.

Exception: If the oscillating motor chambers do not contain any fluid as a result of a leak, the front axle stabilizer bar will not dampen and rely on the spring strut assemblies.

Oscillating Motors: The oscillating motors are split chamber hydraulically controlled rotary actuators. This motor contains a total of four chambers, opposing chambers are connected with one another and receive the same hydraulic pressure.

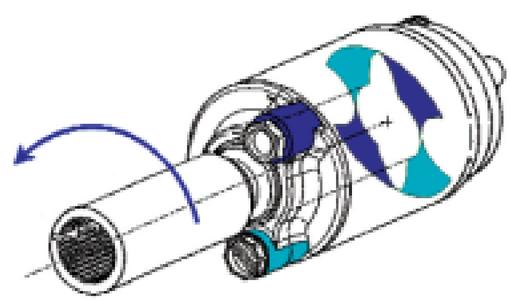
Two chambers are supplied with high pressure through an internal connection and the other two chambers are connected to the reservoir return line.

The pressure and drain (return) is switched between the two pairs for right or left hand torsional twists.

The different pressures result in the high and low forces that apply torque. One half of the stabilizer bar is connected to the shaft and the other half is connected to the housing.

The two halves will turn in opposite directions. As a result, the shaft will turn in an opposite direction of the housing.

The stabilizer bar is mounted to the axle carrier. The torque generated while cornering will force the body upwards on the outside of the curve and pull it down on the inside of the curve.



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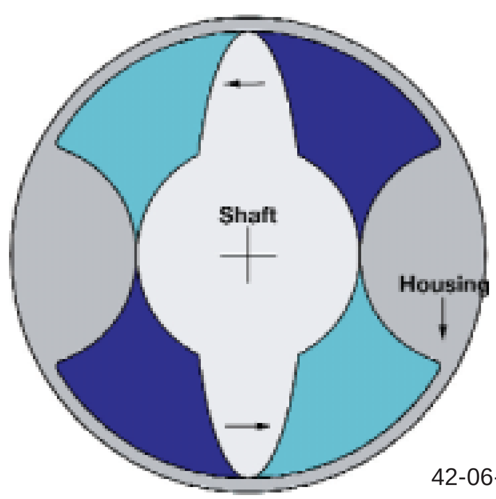

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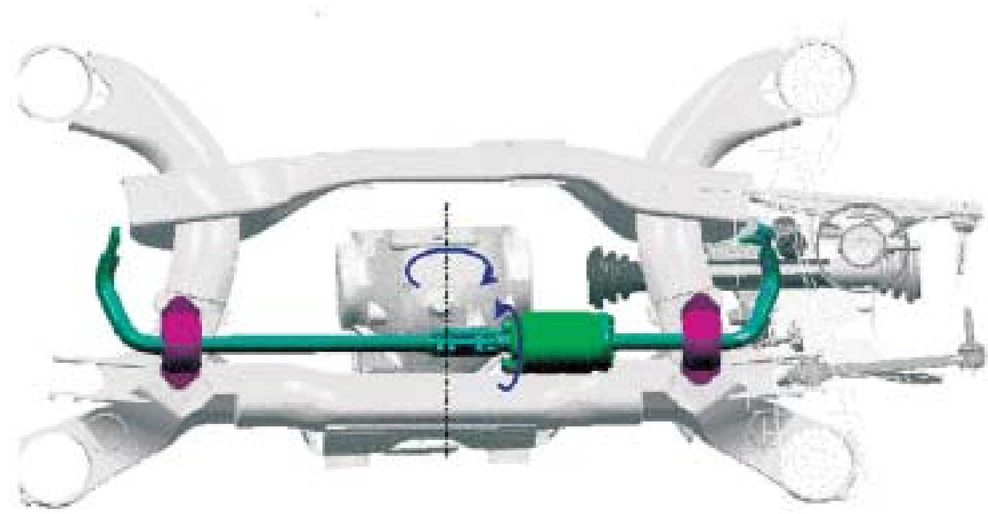

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The maximum torque influence on the front and rear axle occurs when there is a high degree of lateral acceleration (producing body roll). During this situation, the system pressure is 180 bar at the front axle and 170 bar at the rear axle. The front oscillating motor is smaller than the rear one and builds up a force of 600 Nm at 180 bar. The rear oscillating motor builds up a force of 800 Nm at 170 bar. The oscillating motors also act as torsional vibration dampers (hydraulic cushion).

During torsional twists, the fluid is displaced from two chambers returning through the lines and the valve block to the reservoir. The return path has a slight hydraulic resistance which creates damping. With failsafe (hydraulic blocking), the oscillating motor will turn as a unit because of the closed circuit hydraulic locking occurring internally (like a conventional stabilizer bar).

Tandem Pump: The tandem pump mounted on the engine and is driven by the ribbed V-belt. The pump assembly consists of a radial piston pump for Dynamic Drive and a vane pump for the power steering.

When the engine is idling, the pump speed is approx. 750 rpm providing a minimum flow rate of 4.5 l/min at 0 - 5 bar and 3.3 l/min at 180 bar.

This volume and pressure provides sufficient system dynamics when the engine is idling. At a pump speed of approx. 1165 rpm, the flow rate is limited to 7 l/min. Dynamic Drive and power steering share the fluid reservoir and fluid cooler.

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Fluid Reservoir: The fluid reservoir is identical on all E65 vehicles, whether equipped with Dynamic Drive or not. The fluid reservoir also supplies the power steering hydraulic circuit.

The reservoir contains a fluid filter (as on models in current use) and a fluid level sensor to detect when the fluid level drops below the minimum amount.

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Fluid Cooler: The cooler ensures a long term fluid temperature of < 120 ºC and a short term fluid temperature of < 135 ºC in all hydromechanical components under all operating conditions.

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Hydraulic Lines and Hoses: The hydraulic lines and hoses are designed for extremely high pressures. The hydraulic component connections and fittings are designed with different dimensions and lengths to avoid improper installation.

Hydraulic noises transmitted to the vehicle interior predominantly occurs through the assemblies and connections. The lines and hoses must be properly positioned through the mounting supports (noise insulation) and not touch the body surface. The supply hose in the engine compartment has excess loops (and length) to also reduce hydraulic noise.

Principle of Operation

Dynamic Drive System Pre-drive Procedure

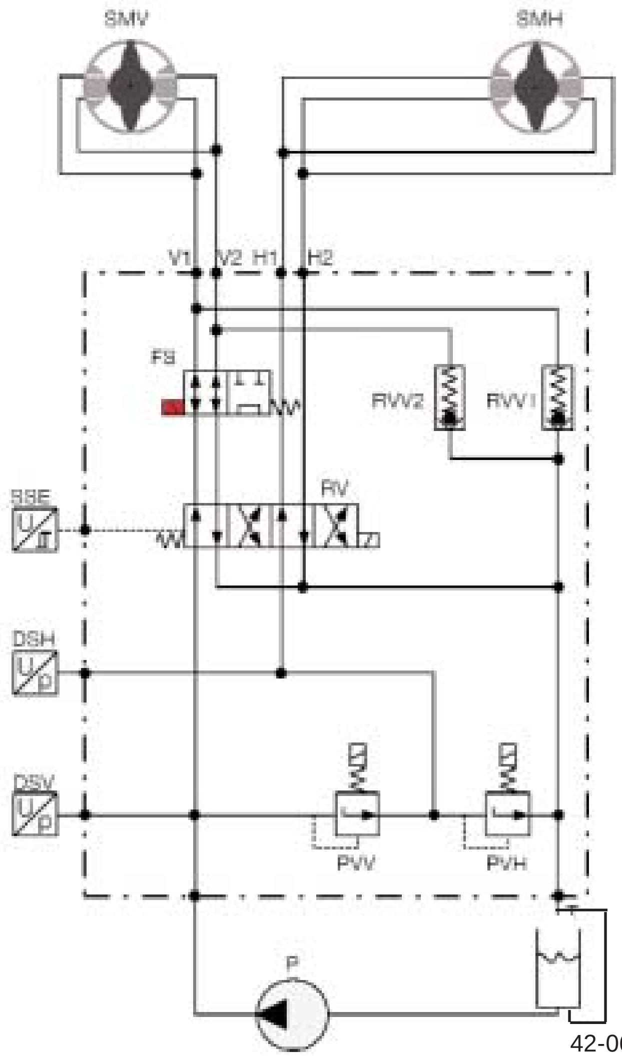
When the ignition is switched “ON”, the ARS control module self test is first performed. The electrical valve functions are conducted to detect short/open circuits in the valve solenoid coils, connectors and harness. The sensors are checked for short/open circuits in the harness, connectors or the internal electronics.

Finally, the hydraulic safety functions are checked before the vehicle moves as part of the "Pre-drive Check".

A test pressure (<60 bar) is set between the pump and the failsafe valve. This allows the ARS control module to check if the failsafe valve is actually in the de-energized failsafe position. When in this position, the system pressure is decreased (circulating).

When the failsafe valve is energized (FS as shown to the right) by the ARS control module, the front axle hydraulic circuit is open providing pressure to the oscillating motor (SMV).

The front axle pressure control valve function is tested simultaneously. If pressure does not build up at the front axle stabilizer bar, the Predrive Check criteria will not be met.



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The Dynamic Drive function is deactivated when the vehicle is stationary (inertia is not present) and all the valves are de-energized. This also applies when the vehicle is at a standstill on an incline (one sided load). Even though the lateral acceleration sensor provides a signal, the vehicle speed signal is not present.

When the vehicle speed is >15 km/h, the ARS function is started.

Straight Ahead Driving

When the engine is running, the tandem pump supplies hydraulic fluid to the system at a pressure of 3 to 5 bar. The front and rear axle stabilizer bar pressure valves are de-energized (open) and pressure is not applied to the oscillating motors. The hydraulic fluid circulates directly back to the reservoir for as long as the vehicle is driven straight ahead.

Cornering

When cornering, the signals from the lateral acceleration sensor are conveyed to the ARS control module. The control module outputs a pulse width modulated signal (PWM) to the front and rear axle stabilizer bar pressure valves. The stronger the lateral acceleration, the greater the signal (current flow). The increasing valve current will progressively close the valves forming a higher pressure in the stabilizer bar oscillating motors.

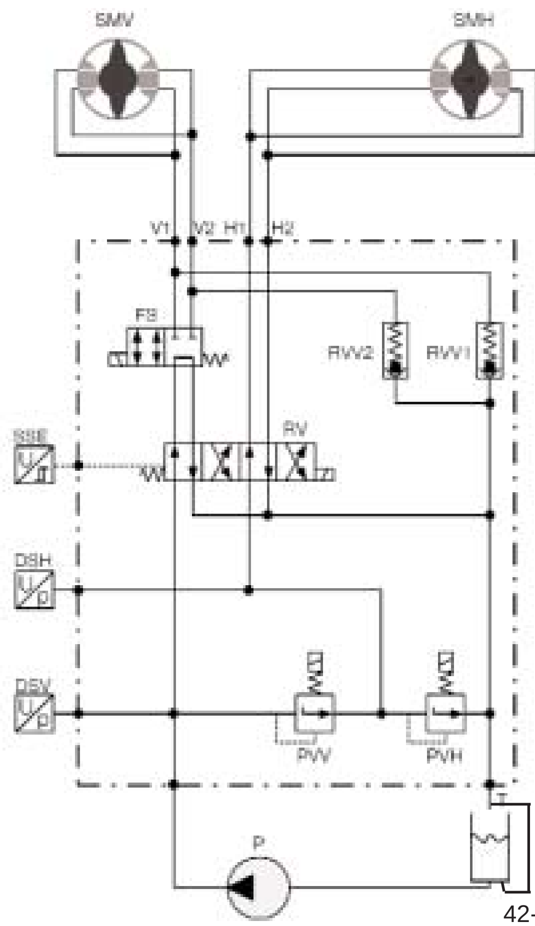
The pressure sensors provide the ARS control module with the stabilizer bar oscillating motor pressures. To direct the buildup pressure according to the corner (left hand or right hand twist), the directional valve is actuated by the control module. The SSE sensor detects the directional valve selector position.

Restricted Function

The system reverts to failsafe mode when a fault is detected. The control module stores the fault and indicates failsafe mode in the instrument cluster. The failsafe situation is shown to the right in the hydraulic overview diagram.

In the event of system failure, the failsafe valve (FS) is de-energized and sprung closed. The hydraulic fluid in the front stabilizer bar is sealed in, ensuring the stability and understeer effect of a conventional stabilizer bar.

The check valves (RVV1, RVV2) allow the hydraulic fluid to be drawn from the reservoir preventing cavitation in the oscillating motor when the vehicle is driven straight.



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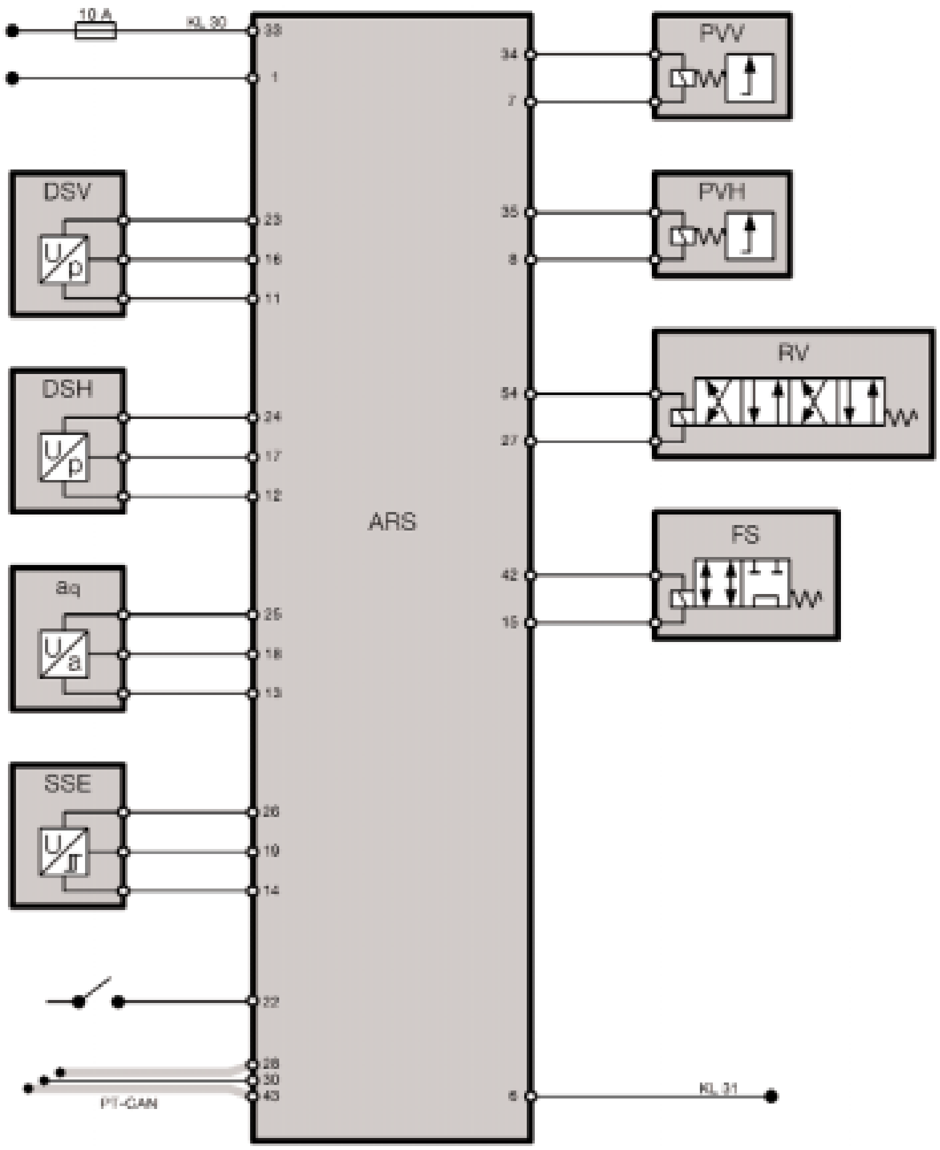
External Leakage

External leakage is detected by the front or rear pressure sensors and the ARS control module will deactivate Dynamic Drive (system failure).

ARS Block Diagram



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ARS

aq Lateral acceleration
ARS Active roll stabilizer bar control unit
SSE Selector position recogniton sensor
DSV Front axle pressure sensor
DSH Rear axle pressure sensor

PVV Front axle pressure control valve
PVH Rear axle pressure control valve
RV Directional valve
FS Fail-safe valve

Workshop Hints

Diagnosis

The following component faults can be detected:

Component	Type of fault	Fault detection via:
ARS control module	De-energized or faulty	Instrument cluster via omission of the Alive-Counter, vehicle identification number with authentication not recognized, watchdog
Pump	No pressure	Target-performance comparison pressures
Directional valve	Stuck in the ”energized” position (wire break) Stuck in the “de-energized” position (wire break)	Directional valve sensor
Pressure control valve	Open (de-energized) Closed (mechanical fault)	Front axle target-performance comparison pressure, current Measurement Front axle target-performance comparison pressure
Pressure control valve	Open (de-energized) Closed (mechanical fault)	Rear axle target-performance comparison pressure and current measurement. Rear axle target-performance comparison pressure
Failsafe valve	Stuck open Stuck closed	Predrive-Check Current measurement
Actuator Front/rear axle	Leaking (no moment) Blocked	Target-performance compliance pressure Target-performance comparison pressure
CAN bus	Completely omitted (line out)	CAN-timeout
Steering angle	Implausible, or omitted	Plausible monitoring and fault detection CAN bus signals
Sensor	Completely omitted (line out) Incorrect signal	Voltage monitoring Check plausibility via CAN signals
Fluid level sensor	No signal (line)	
Front axle Pressure sensor	No signal (line) Incorrect signal	Front axle target-performance comparison pressure
Rear axle pressure sensor	No signal (line) Incorrect signal	Voltage monitoring Target-performance comparison pressure
Directional valve sensor	No signal Incorrect signal	Voltage monitoring SSE directional valve target – performance comparison

Depending on the fault, the system exhibits one of the reactions listed below:

System shut down (Failsafe mode)

The following faults lead to system shutdown and all output stages are de-energized

- Fault in the front axle stabilizer bar
- Fault on the front axle pressure sensor
- Fault with pressure build up (pump, pressure relief valve on the front axle)
- Fault in the control module
- Vehicle identification number is not conveyed by the CAS/is missing/is incorrect
- Directional valve positioning fault, faulty SSE
- Omitted PT-CAN signal

The de-energized failsafe valve blocks the chambers of the active stabilizer bar on the front axle. The fluid is only equalized via the internal oscillating motor and valve block leakage. The check valves in the valve block make it possible

Warning message	Handling instructions
Cornering stability. Take corners slowly 	Directional stability system with unlimited Directional stability. No high road speeds When cornering. Drive on, contact BMW Center immediately

If there is a fluid loss in the ARS or the steering circuit, the fluid level sensor in the fluid level sensor in the fluid reservoir responds to this.

The driver is informed in order to avoid damaging the tandem pump by driving on.

Warning message	Handling instructions
Fluid loss. Stop carefully, switch off the engine 	Fluid loss in the chassis and steering system. Do not drive on, contact BMW Center immediately

A 12 Pin Adapter Cable, ***Special Tool # 90 88 6 372 040*** is used in conjunction with the DISplus to adapt the MFK cables when diagnosing the ARS system.

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Restricted Control Comfort

Lateral acceleration is calculated from the vehicle speed and steering wheel angle (CAN signals). This signal is faster than the actual lateral acceleration and compensates for the hydromechanics time delay. If there is a fault with these two signals, the system reacts with delayed rolling compensation. This only happens with extremely fast steering, when cornering normally it is barely detectable.

If the lateral acceleration senor is faulty, the lateral acceleration is calculated solely from the can signals. The driver will not feel any restriction in function.

If there is a fault in the rear axle circuit and there is stabilizing on the front axle only, the driver feels that the vehicle is making larger rolling movements. Agility is reduced at road speeds <120 km/h.

The system also reacts this way if the Pre-drive Check brings up the "failsafe valve stuck open" message.

In the event of an electrical fault on the rear axle pressure sensor, there may be roll angle compensation defects. To be on the safe side, slightly more stabilization torque is transferred to the front axle than in the normal operating mode (this can be felt by the driver).

Warning message	Handling instructions
Cornering stability slightly restricted	Chassis stability slightly restricted when cornering. Drive on, contact BMW Center as soon as possible

Restricted System Monitoring

Dynamic Drive receives the following sensor signals from the DSC and SZL via the PT CAN Bus:

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

These signals are used to check the lateral acceleration sensors.

Control comfort is restricted if the engine speed signal (DmE) fails.

In the event of a fault with the CAN signals and the yaw velocity, the system is missing two pieces of information. Since this information is used solely to check the other signals, the ARS function remains available with full control.

Although there is no restriction of the Dynamic Drive function, the driver will be shown the "chassis control comfort" display. The driver is instructed to drive to the workshop if possible.

Warning message	Handling instructions
Cornering stability slightly restricted	Chassis stability slightly restricted when cornering. Drive on, contact BMW Center as soon as possible.

A "dynamic" driver will notice the loss of the steering angle signal and the warning messages will be acknowledged. The warning message will disappear once it has been acknowledged. When the cause of the fault is corrected, the ARS control module will have full capacity.

Depending on how fast a fault is detected, there are two reset opportunities:

- When the ignition is off, all faults which have been corrected will be reset. You must wait until the sleep mode has been activated before switching the ignition back on.

- Faults that occur sporadically and can generally be traced back to CAN bus communication malfunctions, are automatically reset when driving straight ahead or when stationary. In this case, the driver may not be aware of the re-activation when driving or when the car is stationary.

  The faults are stored in memory with important additional information. The additional information includes the mileage when the fault occurred, details of whether the fault is present and the frequency of the fault occurance.

Note: When there is a Dynamic Drive failure, the DSC can not be deactivated or if it is already deactivated it will not switch back on automatically.

Dynamic Drive Commissioning

The commissioning procedure must be carried out using the DISplus after the hydraulic system was opened or a component was replaced (in particular the lateral acceleration sensor). This procedure is found under ***Service Functions - Chassis - Dynamic Drive - Start Startup - Test Plan*** and follow the on screen instructions. The following criteria must be met for matching the lateral acceleration sensor and the two pressure sensor offset values:

- The vehicle must stand level on all four wheels (on the ground).
- The vehicle must be unloaded.
- The engine must be idling at operating temperature.
- The doors must be closed and ***occupants are not allowed in the vehicle.***

Note: Stay clear of the moving chassis parts during the commissioning! The ground and side to side clearance must not be limited or obstructed and the doors must be closed. The arms of the lift hoist must not be situated underneath the vehicle. Vehicle will not be able to be driven (transmission will remain in “Park” during this procedure).

The commissioning is performed in five steps that are automatically carried out during the procedure:

1. Direction valve test (from 3 to 3.4 seconds)	First the direction valve is tested by evaluating the SSE signals.
2. Low pressure test (from 3.4 to 4.3 seconds)	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.
3. Front axle high pressure test (from 4.3 to 9.9 seconds)	Pressure of 180 bar is applied to the front axle oscillating motor. Air in the system, internal leaks and a blocked oscillating motor is detected.
4. Rear axle high pressure test (from 9.9 to 15 seconds)	Pressure of 170 bar is applied to the rear axle oscillating motor. Air in the system, internal leaks and a blocked oscillating motor is detected.
5. Pressure control valve test (from 15 to 25 seconds)	The characteristic curves of the front and rear axle are checked. (Target/actual value comparison) Faulty pressure control valve is detected.

Dynamic Drive Bleeding

After all work on the Dynamic Drive and the steering system in which hydraulic lines have been opened, the steering system must be bled and initial operation of the Dynamic Drive (commissioning) must be performed with the DISplus.

Procedure:

1. Check fluid level in the powersteering reservoir; if necessary, top up to the “MAX” level while the engine is stopped.

2. Start the engine. Turn the steering wheel left and right to the full lock twice.

3. Check the fluid level with the engine stopped; if necessary, top up to the “MAX” level.

4. Start the engine, connect vehicle to the DISplus.

5. Start the Commissioning procedure which is found under ***Service Functions - Chassis - Dynamic Drive - Start Startup - Test Plan*** and follow the on screen instructions.

Note: Refer to the Repair Instructions for details on the Dynamic Drive bleeding procedure.

Review Questions

1. What identifies the correct installation of the twin tube gas pressurized shock absorbers?

2. Explain the Crash Element function.

3. List the correct wheel bolt torque value.

4. Following a brake pad replacement, what must be performed to properly complete the repair?

5. How is the "Auto Hold" parking brake function activated?

6. Explain how the EMF applies the parking brake.

7. List the procedures to resume operation after an EMF emergency release.

8. Explain how EDC-K influences hydraulic damper operation.

9. Describe the Dynamic Drive influence on the stabilizer bars.

10. Describe "Failsafe" hydraulic flow (for the front axle).