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Level Control Systems

Model: Level Control Systems

Production: E32 750iL 88-94 (Hydro-Pneumatic)
E32 740iL 93-94
E38 750iL 95-01
E38 740iL 95-01
E34 Touring 525iT, 530iT
E39 Touring 528iT, 540iT, 525iT (EHC I)
E53 X53.0i, X5 4.4i and X5 4.6is (EHC I)
E53 X5 3.0i, X5 4.4i (EHCII)
E66 745Li, 760Li from 03 EHC

Objectives:

After completion of this module you should be able to:

- Identify BMW Level Control Systems
-

Level Control Systems

Purpose of the System

The primary function of Level Control Systems is to maintain the height of the vehicle as closely as possible to a predetermined level under all load conditions.

This constant level allows the suspension system to maintain the alignment geometry. Camber and Toe in are minimally affected when the ride height is consistent. In addition, the headlight range stays consistent throughout the various operating conditions.

The Level Control System is designed to operate in the event of static changes such as when passengers are entering or exiting the vehicle or quasi-static such as s when the fuel tank is emptying while driving.

The Level Control System come in various configurations such as hydraulic (hydropneumatic) or pneumatic only systems.

Hydropneumatic systems use high pressure hydraulic fluid which is dampened by a gas cushion from a nitrogen charged accumulator. These system use and electro-hydraulic pump or an engine driven piston pump. These systems are installed as follows:

- **Hydropneumatic Level Control System with electro-hydraulic pump** - This type of system is used on the early 5 Series vehicles (E12 and E28), the 6 Series (E24) and the early 7 Series (E23). This system uses an electric motor, pump and an expansion tank which is connected by hydraulic lines to the rear spring struts. The rear spring struts are also connected to a pair of pressure accumulators which are “Nitrogen Charged”. There is a control switch which mounted on the rear axle which monitors the position of the stabilizer bar. Changes in ride height are detected and the system is regulated to maintain the correct level. During prolonged dynamic movements during acceleration and braking, the level control system is disabled by an acceleration sensor (mercury switch) and brake light input to the hydraulic control unit.

- **Hydropneumatic Level Control System with engine driven piston pump** - This system can be found on the 7 Series (E32 and E38) and the 5 Series Touring (E34). This configuration is similar in operation to the previous system with a few changes. There hydraulic pressure now comes from an engine driven piston pump. This pump is mounted in tandem with the power steering (radial type) pump. The pressurized fluid is sent to a control valve which distributes the fluid to the rear spring struts and pressure accumulators. The control valve is attached to the rear sway bar by a lever, changes in ride height will move the lever which will influence fluid flow to the spring struts.

The next generation of BMW Level Control Systems evolved into pneumatic only systems which are referred to as EHC. EHC will be discussed later in this module.

Hydropneumatic Rear Leveling System

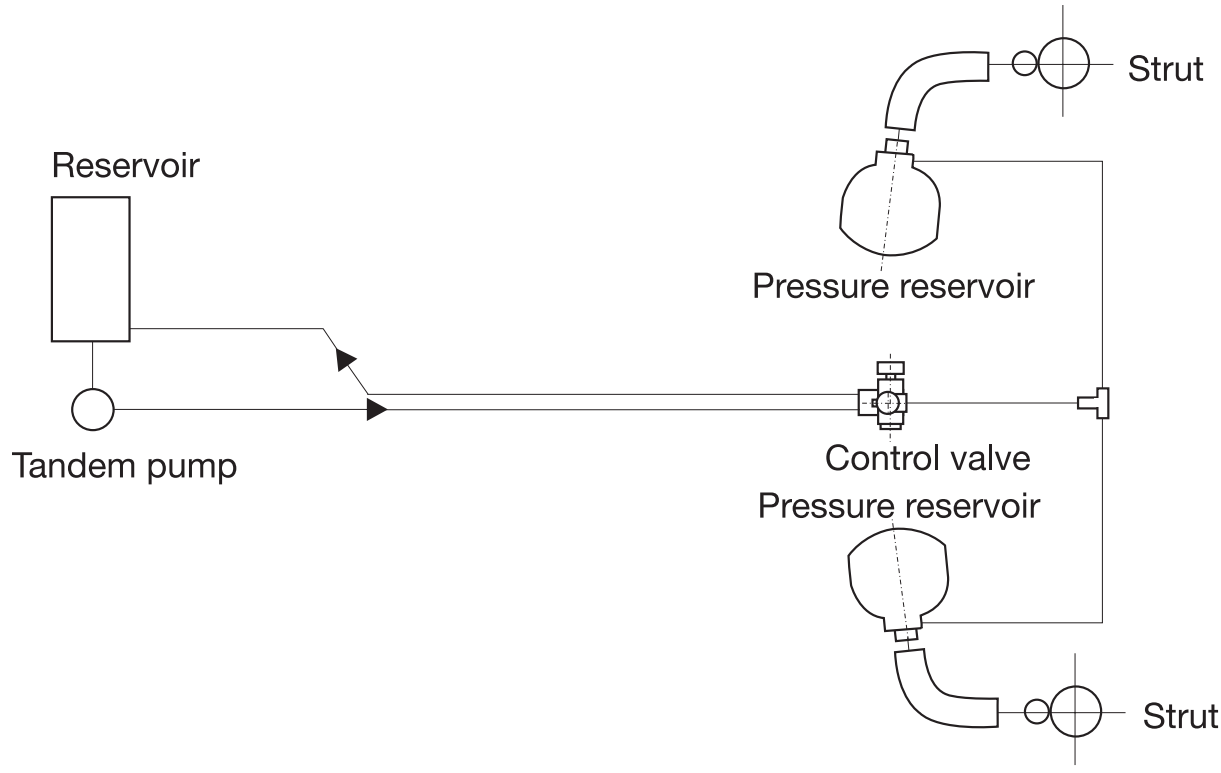
This module pertains to the hydropneumatic rear suspension system with the engine driven piston pump. The earlier system using the electro-hydraulic pump will not be discussed.

The self-leveling suspension system is designed to maintain vehicle ride height under loaded conditions.

The system is fully hydraulic, utilizing a tandem oil pump to supply pressure to both the suspension system and power steering system.

The system is installed on:

- E32 - 735 iL, 740iL and 750iL
- E34 - Touring 525i and 530i
- E38 - 740 iL and 750iL

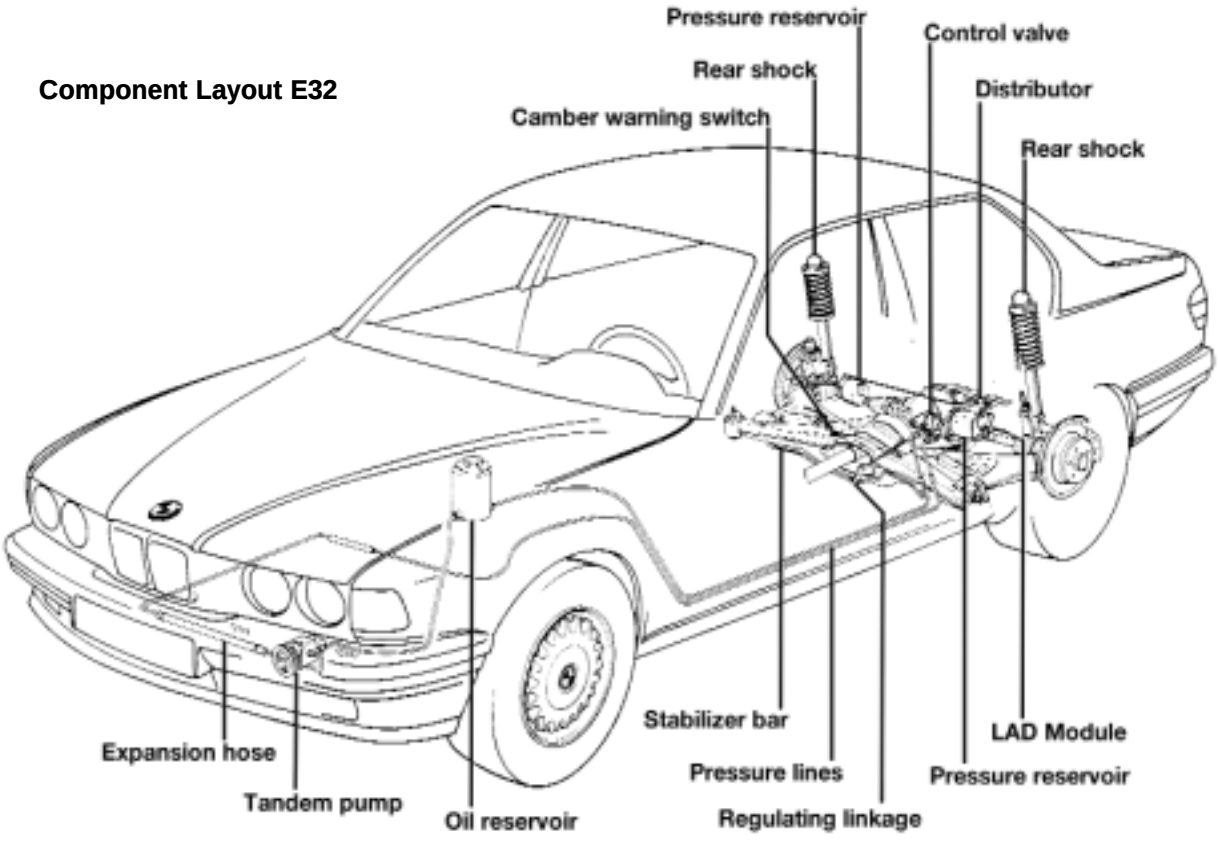


System Components

The system consists of the following components:

- Tandem Hydraulic Pump
- Oil Reservoir
- Pressure Reservoir (2)
- Control Valve with Regulating Linkage
- Camber Warning Switch (E32 and E34)
- Rear Shock with LAD Module
- Expansion Hose, Pressure Lines and Distribution block.

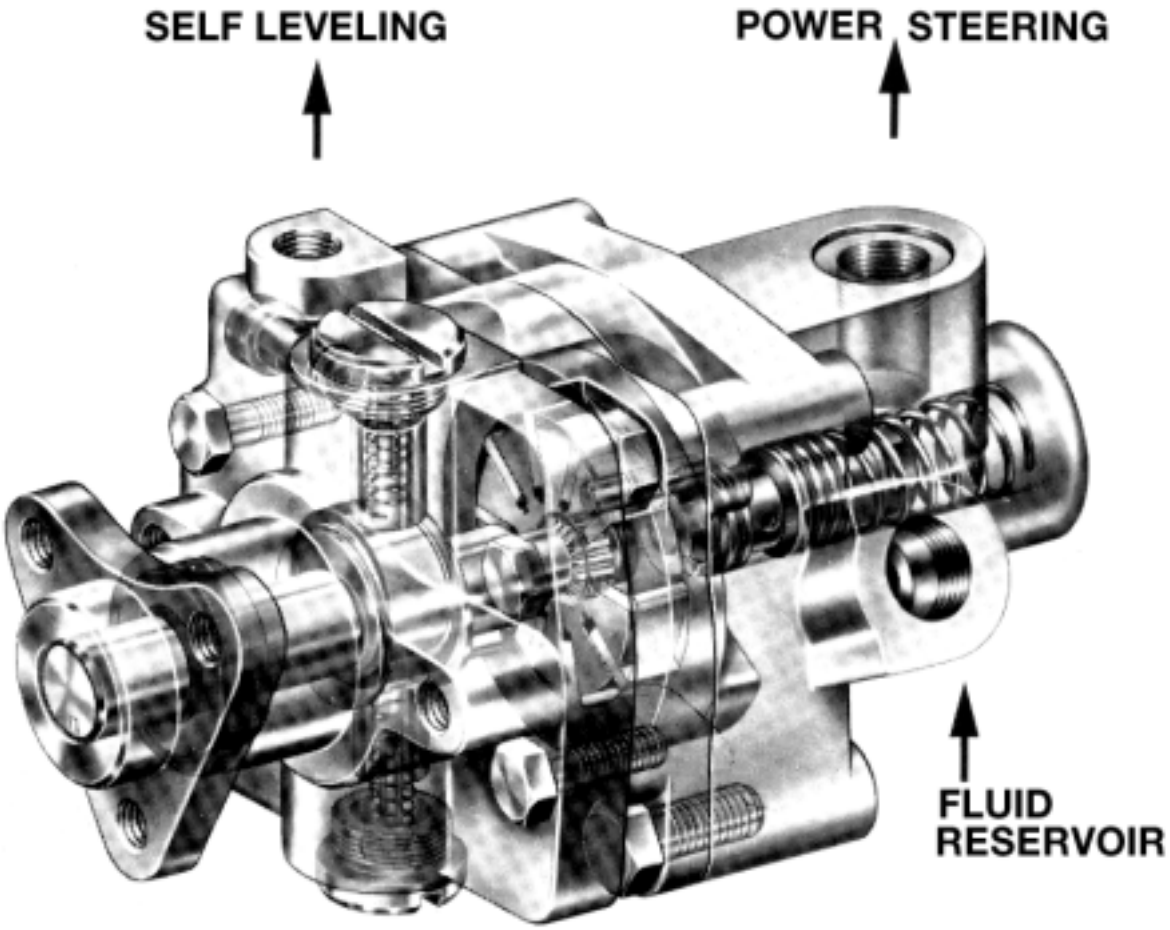
Component Layout E32



Tandem Pump

The tandem pump consists of a vane pump for power steering and a radial pump for self-leveling suspension. Both pumps are driven by the same shaft and have separate oil feeds for each system.

The radial pump has the capacity to pump 102 liters of oil per minute. The maximum pressure is limited to 1900 Psi (130bar) by the pressure regulator located on the control valve.



Oil Reservoir

The single reservoir stores fluid for both the self-leveling and power steering systems. Incorporated in the reservoir, is a reed type level warning switch. If the fluid level drops and the contact closes, a signal is sent to the check control module and a warning will be displayed in the instrument cluster matrix display.

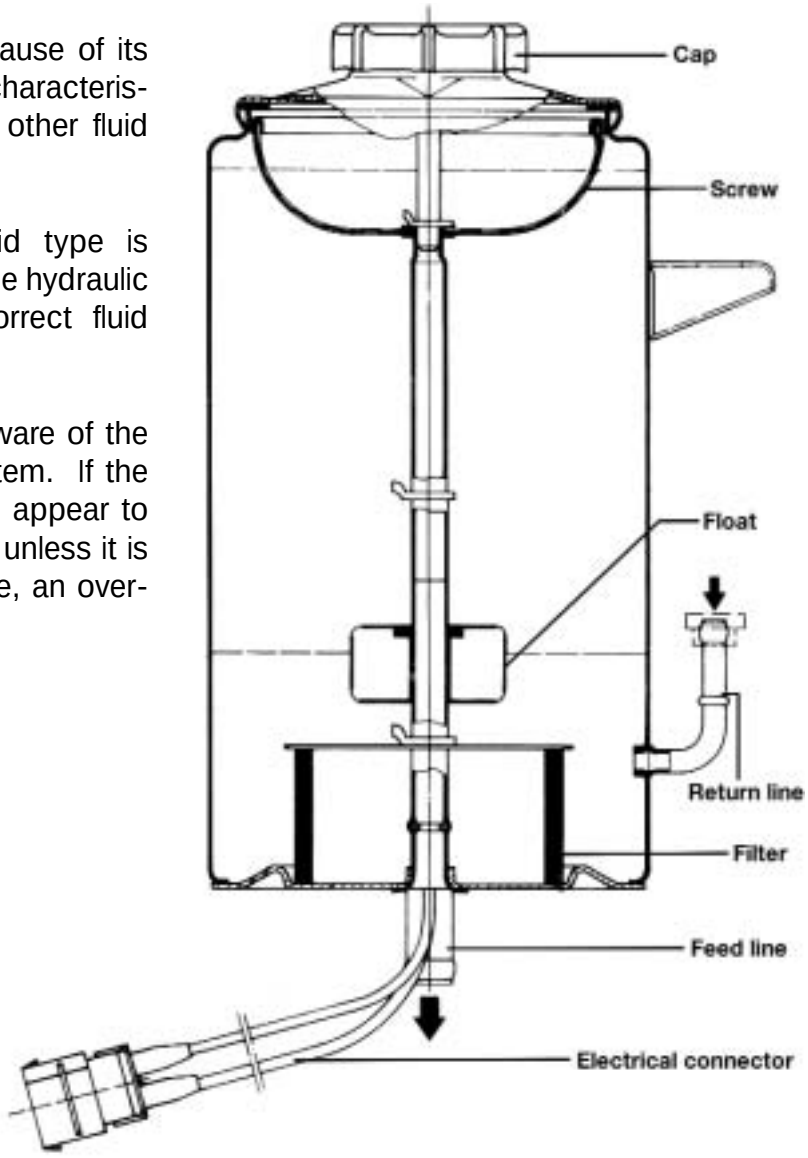
The hydraulic fluid required for the self-leveling suspension system varies between models and installed equipment. The following fluid is used:

- Pentosin CHF 7.1
- Pentosin CHF 11S
- Power Steering Fluid (BMW)

This type of fluid is used because of its low viscosity and low noise characteristics. It cannot be mixed with other fluid types.

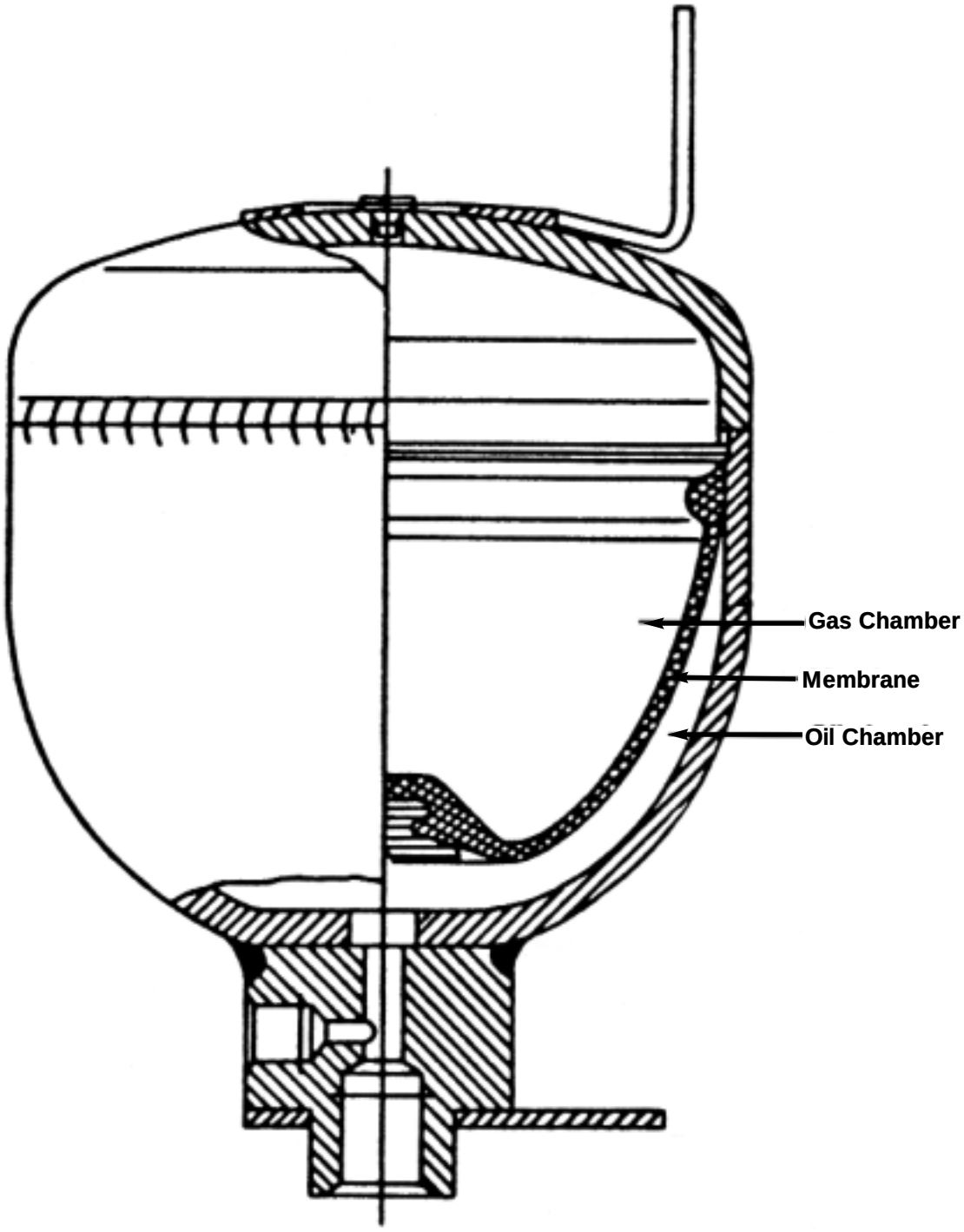
The self-leveling system fluid type is always marked on the top of the hydraulic reservoir. Always use the correct fluid never mix with another fluid.

When filling the system, be aware of the status of the level control system. If the vehicle is loaded, the level will appear to be low. Do not fill the system unless it is in the resting state. Otherwise, an overflow situation could result.



Pressure Reservoirs

The oil pressure reservoirs (2) on each strut incorporate a membrane and are nitrogen gas filled. They are designed to absorb the oil which is expelled from the struts during downward movement, the gas in the reservoirs is compressed and pushes the oil back into the struts during upward movement.



Control Valve

The rotary control valve located on the rear suspension has three positions:

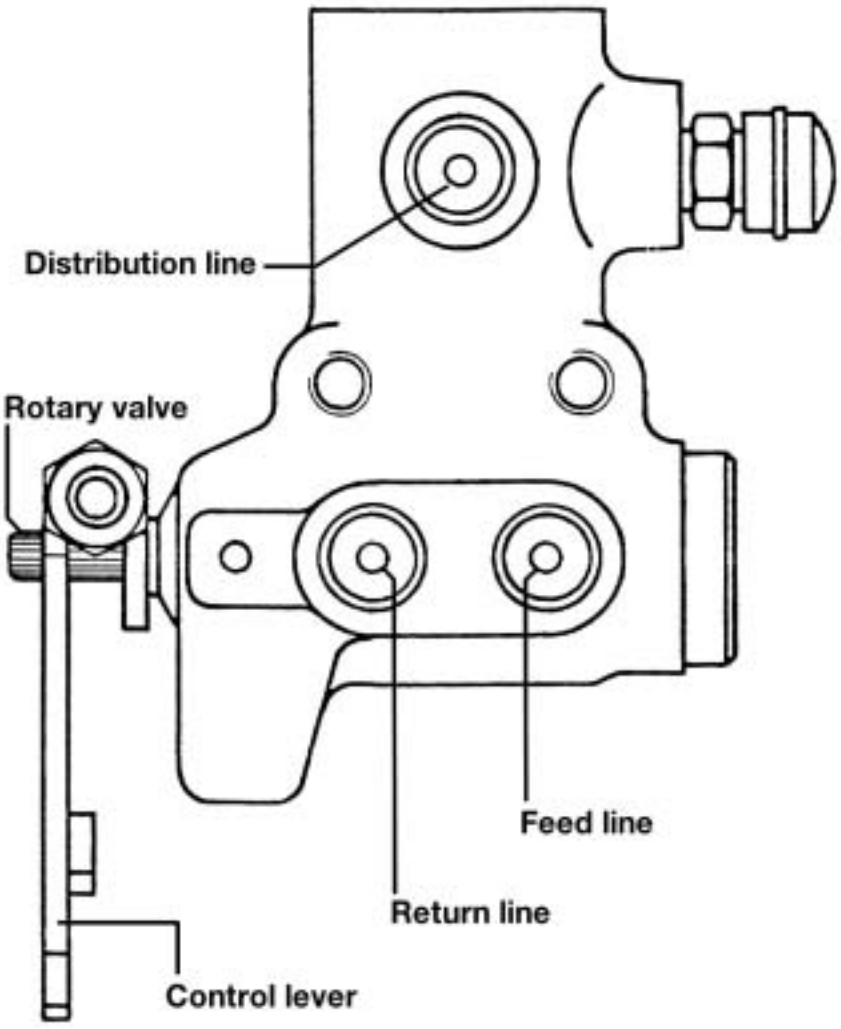
- Raise
- Level
- Lower

The control lever is attached to the rear stabilizer bar to sense vehicle loading. When the vehicle is loaded (passenger or luggage) the suspension drops and the stabilizer bar twists. The control lever is moved in the "raise" direction.

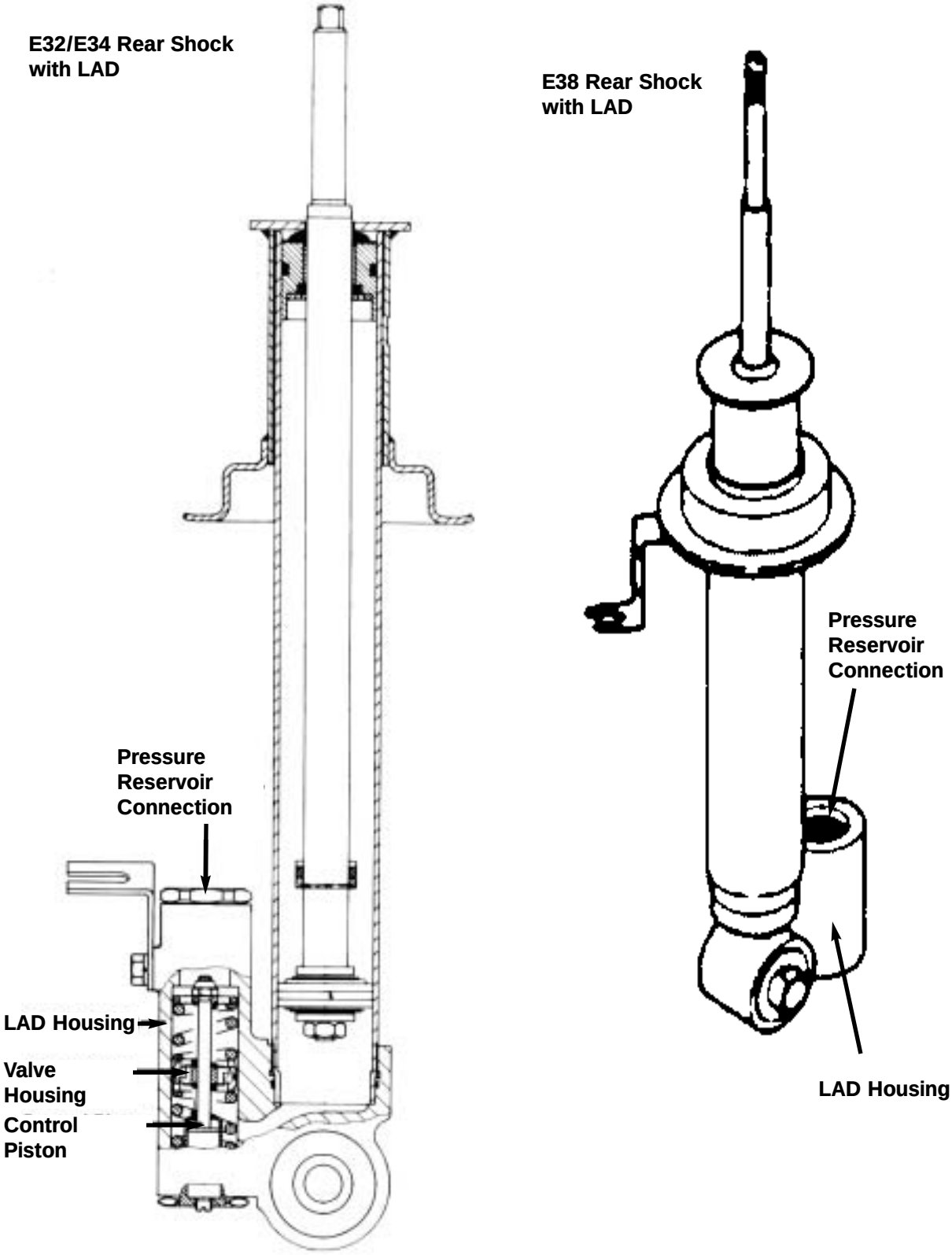
With the engine running, oil flows from the pump to the bottom of the rear struts. The body of the car is lifted and the control lever returns to the level position.

In the level position, the oil bypasses the valve and returns to the reservoir through the return line.

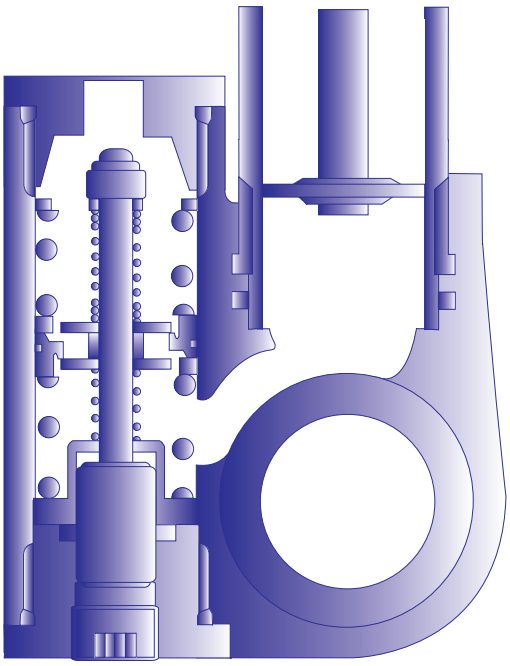
A minimum pressure of 440 Psi (30bar) is maintained at all times. If service is required, a bleed off valve is installed on the control valve to drain the systems pressure.



Rear Shocks With Load Dependent Module (LAD)

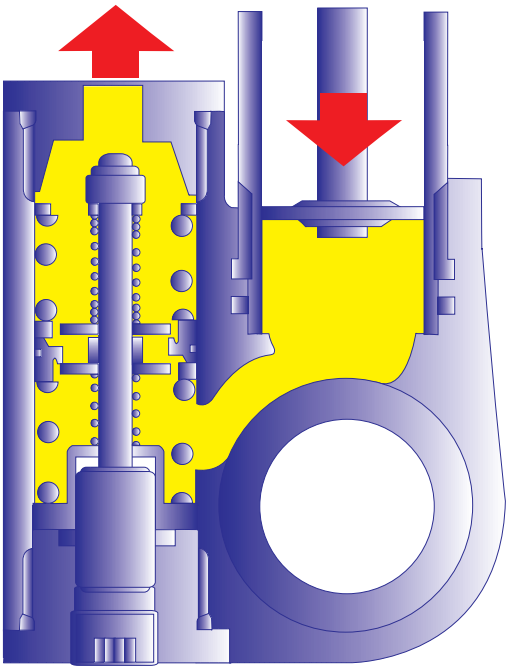


LAD Module

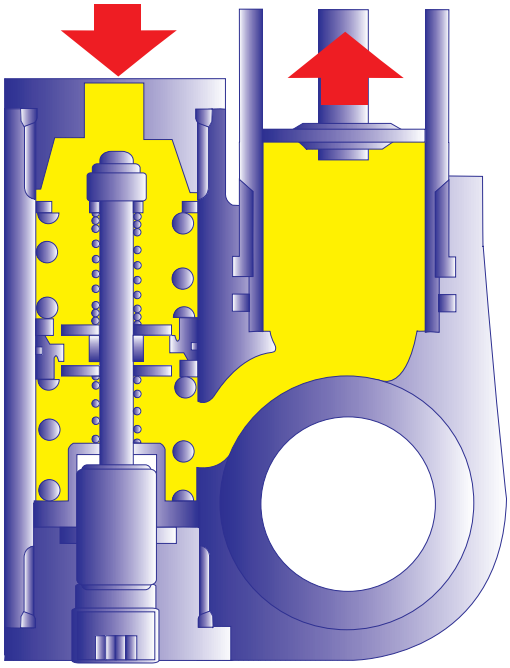


The load dependent module is a control valve that regulates the flow of oil between the strut and the pressure reservoir.

The control piston in the (LAD) moves in relation to the pressure applied from the pump. This movement will regulate the tension on the inner spring of the module. With only a low pressure applied, a small amount of tension will be applied to the spring. Little flow resistance will be developed between the strut and pressure reservoir. The damping force is soft.



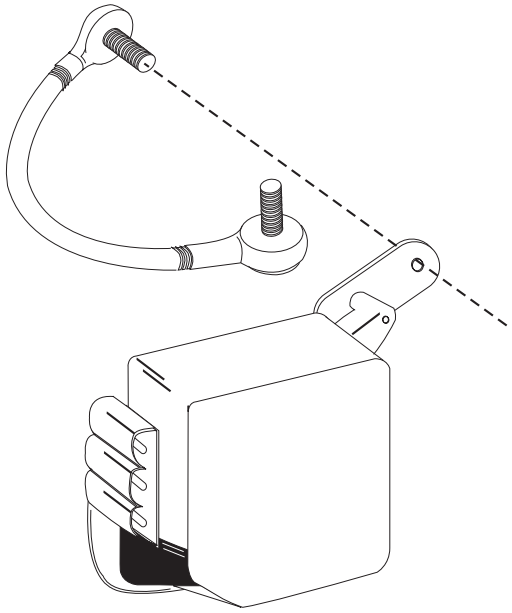
With a high pressure applied to the control piston, the flow resistance is high and the damping force will be stiff.



Camber Warning Switch (E32 AND E34 Touring)

The self-leveling suspension systems used in the E32 and the E34 Touring are equipped with a camber warning switch. The switch is mounted on the right rear axle support and connected through a rod to the semi-trailing arm.

The function of the switch is to warn the driver of an overload condition or an unsafe driving situation.



If the switch detects a rear wheel camber of -3.5 deg. A signal is sent to the check control module and displayed on the dash.

A time delay of 8 minutes is incorporated to prevent the warning from being displayed while driving through turns.

The E38 does not use the camber warning switch due to the design of the rear suspension.

Air Suspension Systems (EHC)

Purpose of the System

Air Suspension systems were first introduced on the 1999 E39 Sportwagon. Since then the E53 (X5) and E65/E66 (7Series) models were available with this new system. EHC are available is two configurations, the Single Axle Air Suspension System and the Dual Axle Air Suspension System. The Dual Axle (EHC II) system is only available on E53 X5 models from the 2002 model year.

EHC systems can be found on the following vehicles:

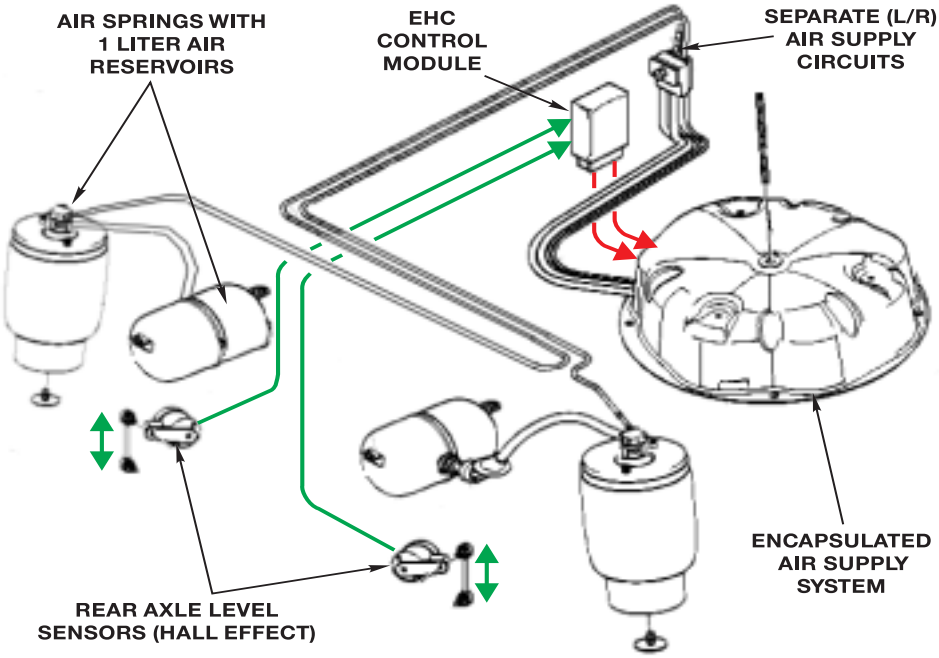
- E39 Sportwagon 528i, 525i and 540i from the 1999 Model Year (Single Axle)
- E53 X5 3.0i and 4.4i from the 2000 Model Year (Single Axle)
- E53 X5 4.6iS from 2002 (Single Axle)
- E53 X5 3.0i and 4.4i from 2002 (Dual Axle EHC II)
- E65/E66 from 2003 Model Year (Single Axle)

There are some functional changes with these systems. On EHC, the entire axle load is borne by the air suspension. The underlying control philosophy of EHC is “Control only when absolutely necessary”. This means that brief changes in the ride height are not compensated (such as potholes). This avoids any unnecessary control operations.

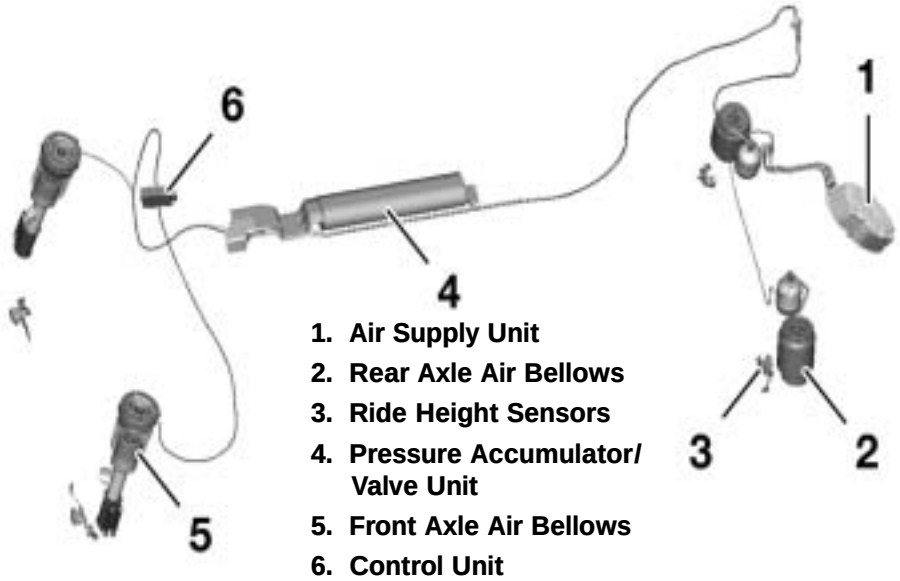
The advantages of air suspension are as follows:

- Control is independent of the vehicle engine
- Single-wheel control is possible
- Lateral locking is affected
- A distinction is made between load and drive states
- An inclined load is identified and corrected
- However, an inclination is not compensated
- Self diagnosis can be performed
- Diagnosis with DISplus or GT-1 is possible
- An automatic interruption of control takes place in case of cornering and wheel changes.

EHC System Overview



EHC I Single Axle Air Suspension E39/E53



1. Air Supply Unit
2. Rear Axle Air Bellows
3. Ride Height Sensors
4. Pressure Accumulator/ Valve Unit
5. Front Axle Air Bellows
6. Control Unit

EHC II Dual Axle Air Suspension E53

Single Axle EHC I System Components (E39/E53)

The EHC system consists of the following components:

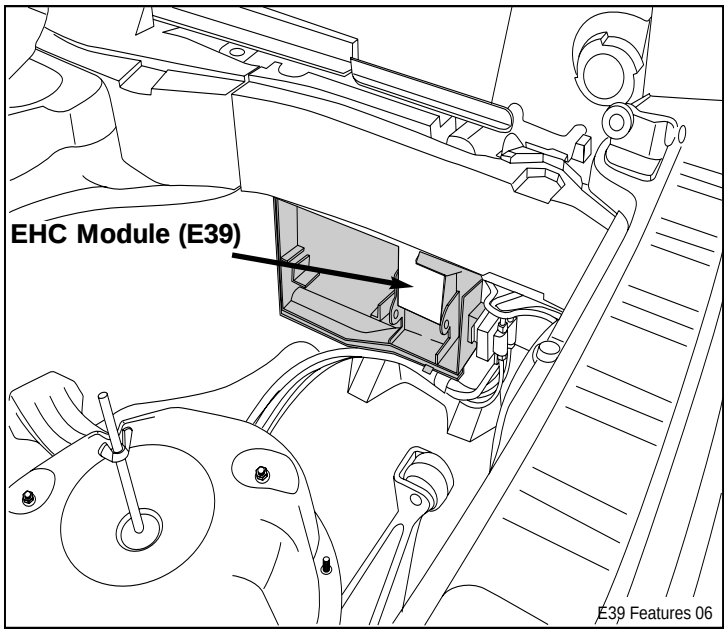
- EHC Control Module
- Air Springs (2) with Air Reservoirs
- Rear Axle Level Sensors
- Encapsulated Air Supply (LVA)
- Warning Indicator

Control Module

The Control Module is mounted in the module carrier box in the luggage compartment on the right side. It contains the processing electronics and final stages for operation of the EHC system.

The control module receives the following inputs for its processing functions:

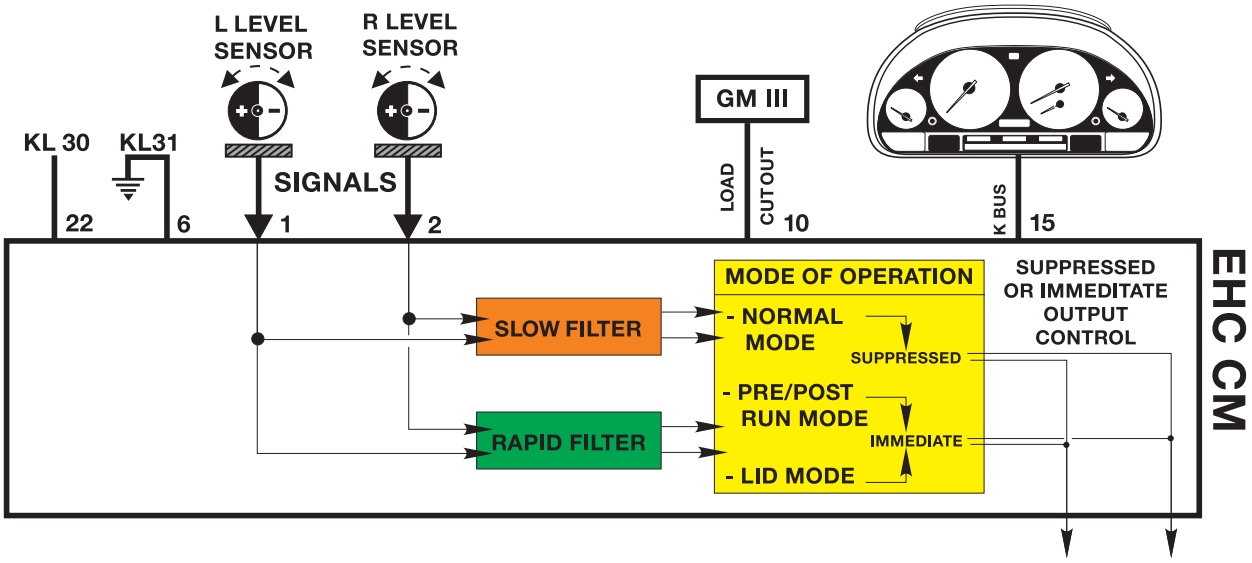
- KL 30 & 31 (Power/Ground)
- KL 15
- Left & Right Ride Height Sensors
- K Bus for;
  - Vehicle speed
  - Engine running
  - Door/tailgate - open/closed



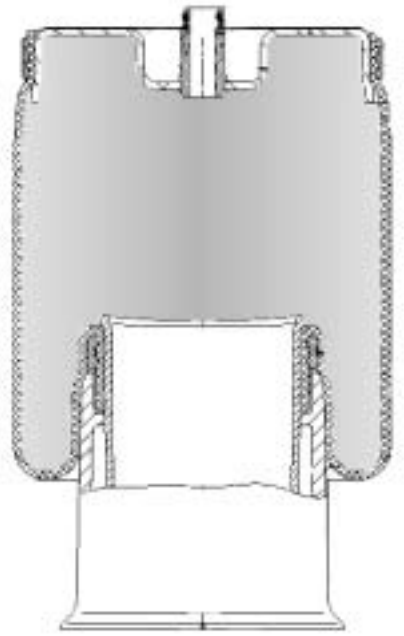
The control module incorporates two filters (slow/rapid) for processing the input signals from the ride height sensors. Depending on the operating mode, either the slow or rapid filter is used to check the need for a regulating sequence.

The slow filter is used during the normal operation mode to prevent normal suspension travel from causing the system to make adjustments.

The rapid filter is used during the pre-run and tailgate (LID) modes to ensure that the suspension is adjusted quickly while the vehicle is being loaded or checked prior to operation.



Air Springs



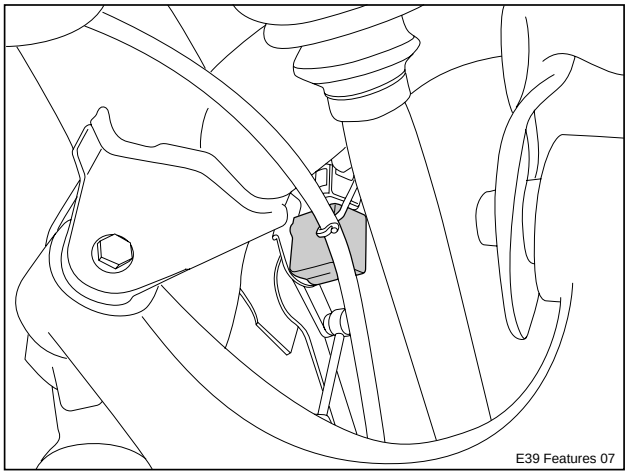
The air spring is made from a flexible rubber material. It forms an air tight cavity which provides the calculated spring rate required for the sport wagon.

As the spring compresses downward the bottom edge of the rubber material rolls along the vertical surface of the base mount cylinder.

Air is added or removed from the air spring through its top port. The top port of each spring is connected to a reservoir and the air supply pipes. The reservoirs are required to hold additional air due to the compact design of the springs.

Rear Axle Level Sensors

Hall effect sensors are mounted on the left and right sides of the rear suspension for ride height detection. They are pivoted by a coupling rod through the rear axle swing arms.



The hall sensors produce a varying voltage input to the control module as the suspension height changes.

If the vehicle is equipped with Xenon headlights the right side sensor contains an additional sensor for the automatic headlight level adjustment system.

Warning Displays

If the system is faulted and off-line or set in the transport mode, the following is displayed:

Basic Cluster: A warning lamp indicator is illuminated used on the basic cluster.

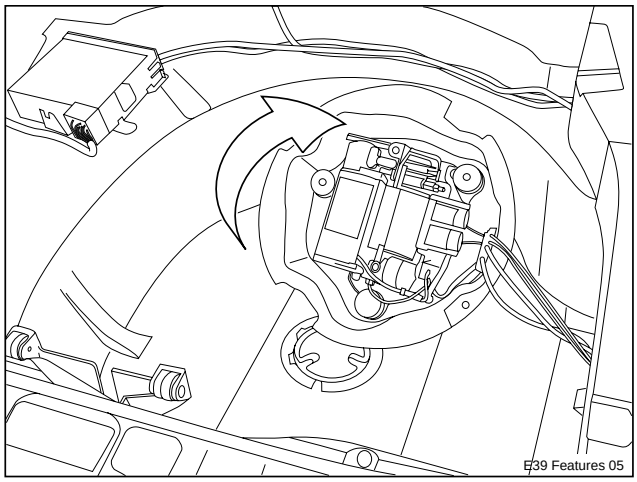
High Cluster: A message is posted in the high cluster matrix display.

Air Supply System (LVA)

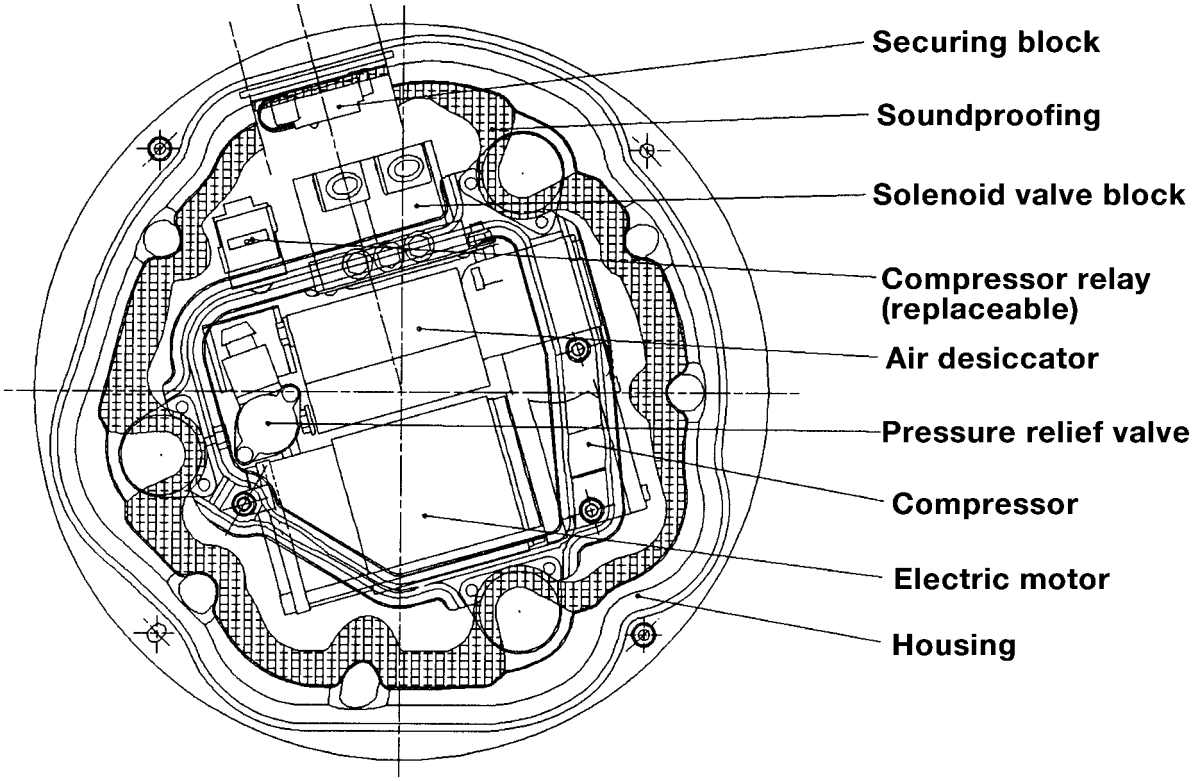
The air supply system is identified as the LVA in the diagnosis program and in the repair manual. It is mounted in the spare tire well compartment. The components are housed in a sound deadening carrier, through rubber bushings, to prevent operating noises from being transmitted through the vehicle's interior.

With the exception of the compressor relay, individual replacement parts for the air supply system are not available. If diagnosis determines a defect in any of the other air system components, complete replacement is necessary.

The air supply system consists of the following components:


E39 Features 05

- Compressor assembly with;
  - Piston compressor
  - Electric motor
  - Air dryer (desiccator)
  - Pressure relief solenoid valve
  - Pressure maintenance valve
  - Check valves
- Compressor Relay (Replaceable)
- Solenoid Valve Block (2 - two way valves)
- Lines - including distributor



Air Supply System (LVA) Operation

The single stage piston compressor produces a maximum pressure of 13.5 Bar. The compressor is maintenance free - provided it is used in a dust free environment. This includes the compressor's intake air filter.

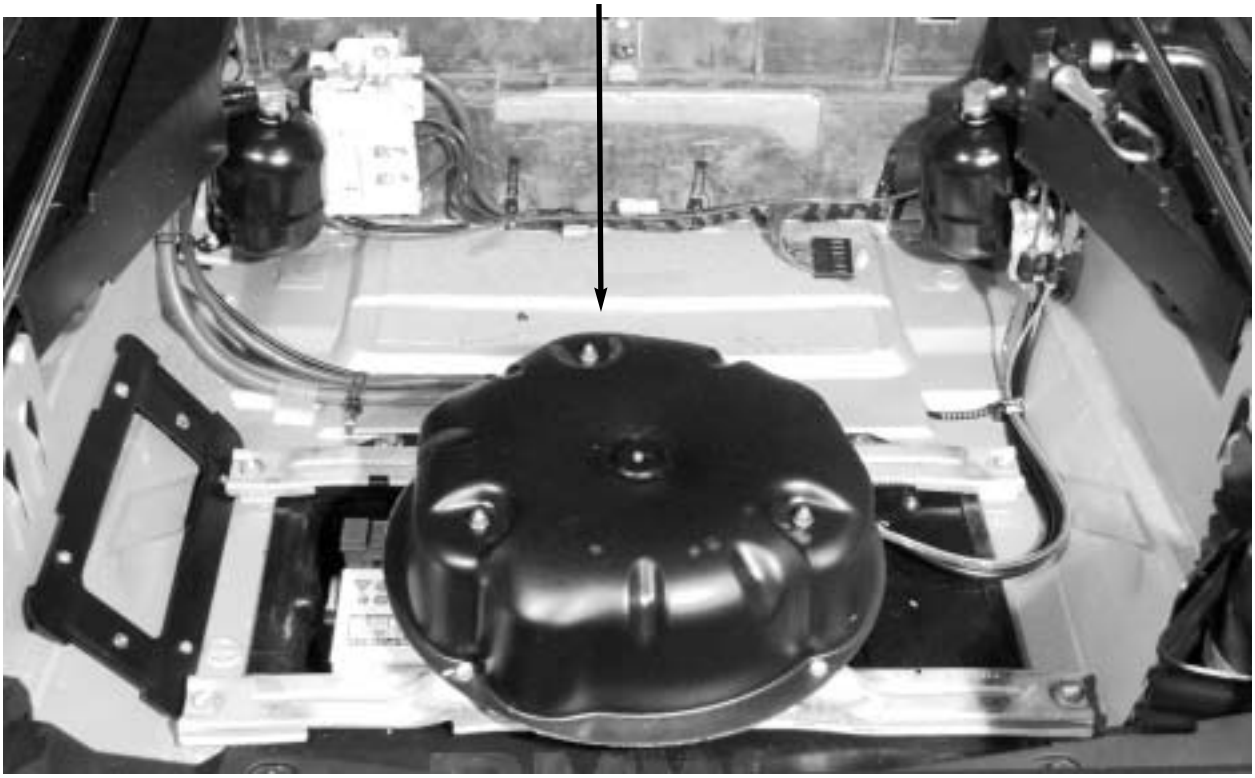
The compressor is driven by a DC motor that is controlled by the compressor relay through the control module.

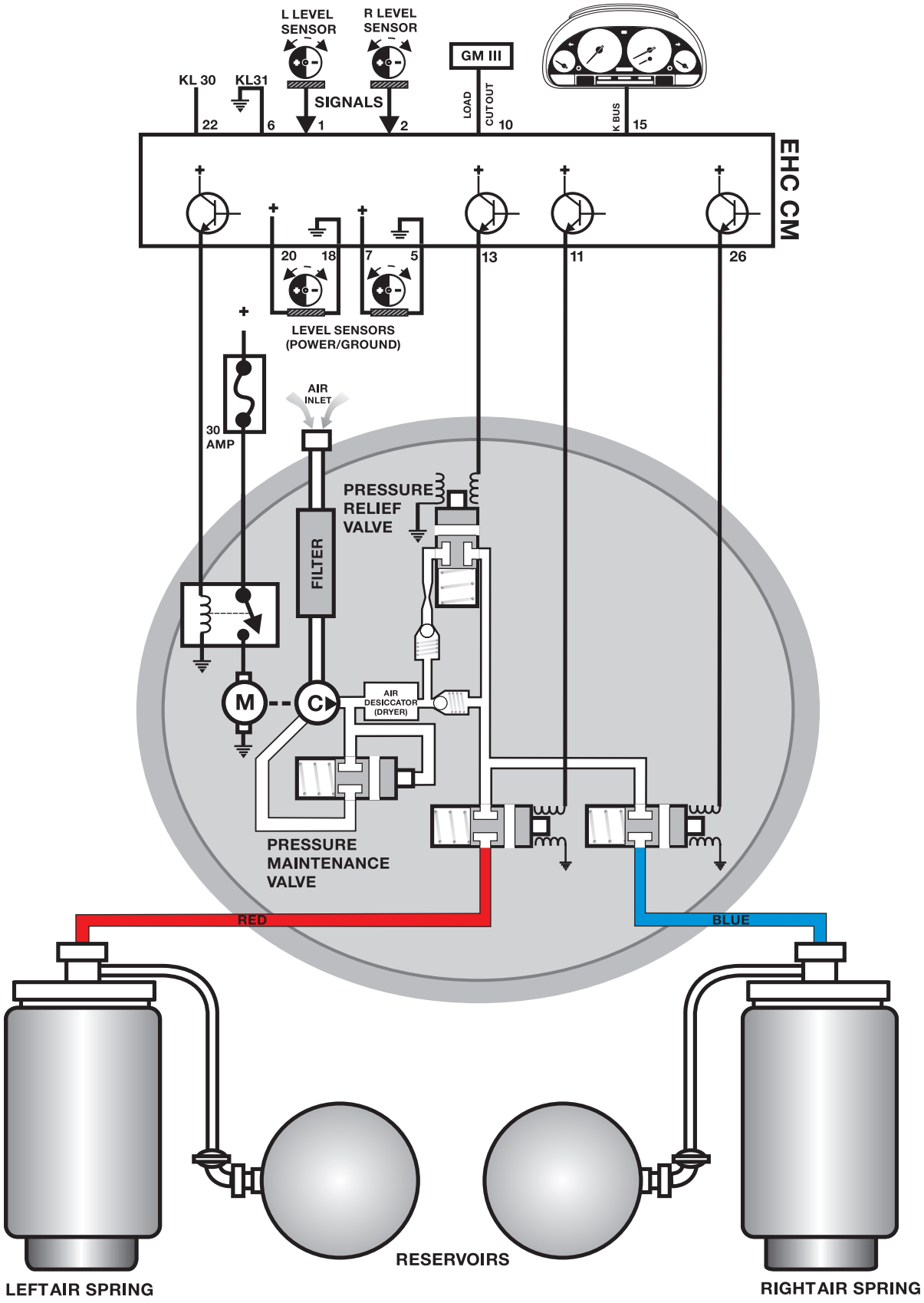
When the compressor is activated, the pressure builds up to a working pressure of 11.4 Bar (+0.8/-1.5 Bar). This is controlled through the pressure maintenance valve. The air under pressure is fed through the dryer and check valve to the solenoid valve block for the air springs.

There is one solenoid valve in the valve block for each air strut. This allows the system to compensate for uneven loads in the vehicle and maintain the vehicles ride height at all times.

Pressure is drained through the left or right solenoid valve (energized open) the pressure relief solenoid valve, restrictor, check valve and dryer back to the inlet side of the compressor pump.

LVA Location X5




L LEVEL SENSOR
R LEVEL SENSOR
GM III
KL 30
KL31
SIGNALS
LOAD
CUTOUT
K BUS
22
6
1
2
10
15
EHC CM
20
18
7
5
13
11
26
LEVEL SENSORS (POWER/GROUND)
AIR INLET
30 AMP
PRESSURE RELIEF VALVE
FILTER
M
C
AIR DESICCATOR (DRYER)
PRESSURE MAINTENANCE VALVE
RED
BLUE
RESERVOIRS
LEFTAIR SPRING
RIGHTAIR SPRING

EHC System Operation

A fully functional EHC system is controlled by one of three different modes of operation. The operation mode is selected by the control module based on current conditions provided by the monitored input signals. The main modes of operation are:

- **Pre-Run/Post-Run Mode**
- **Normal Mode**
- **Tailgate Mode**

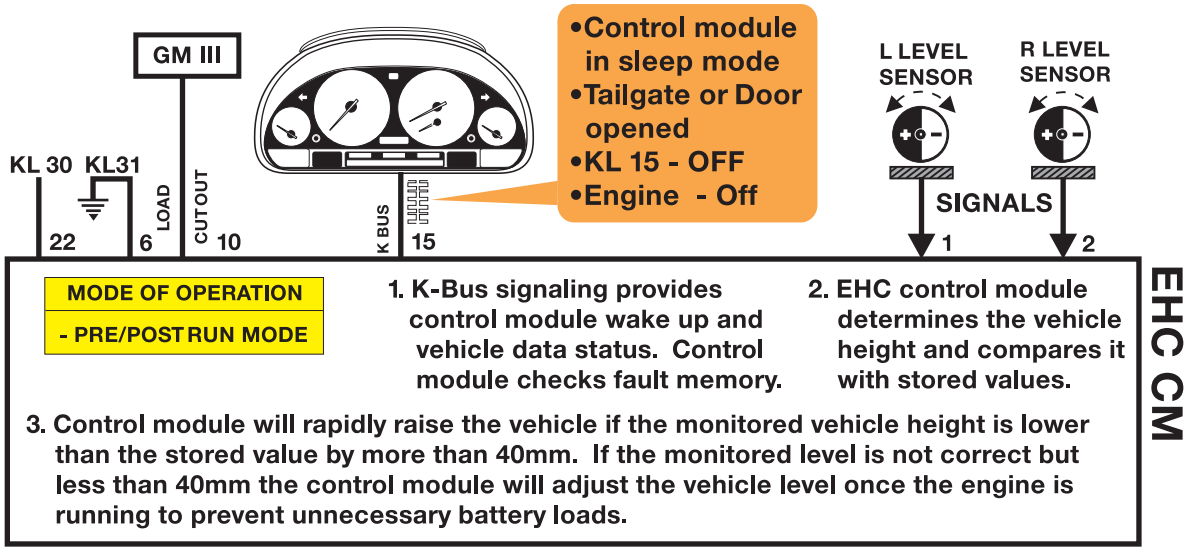
Two special operating modes are also included in the control module programming.

- **New/replacement mode** (pre ZCS encoded). This mode provides basic operation.
- **Transport Mode** - Transport mode is set at the factory and raises the vehicle 30mm to prevent vehicle damage during transportation. It must be deactivated with the DIS/ MoDiC prior to customer delivery.

Pre-Run / Post-Run Mode

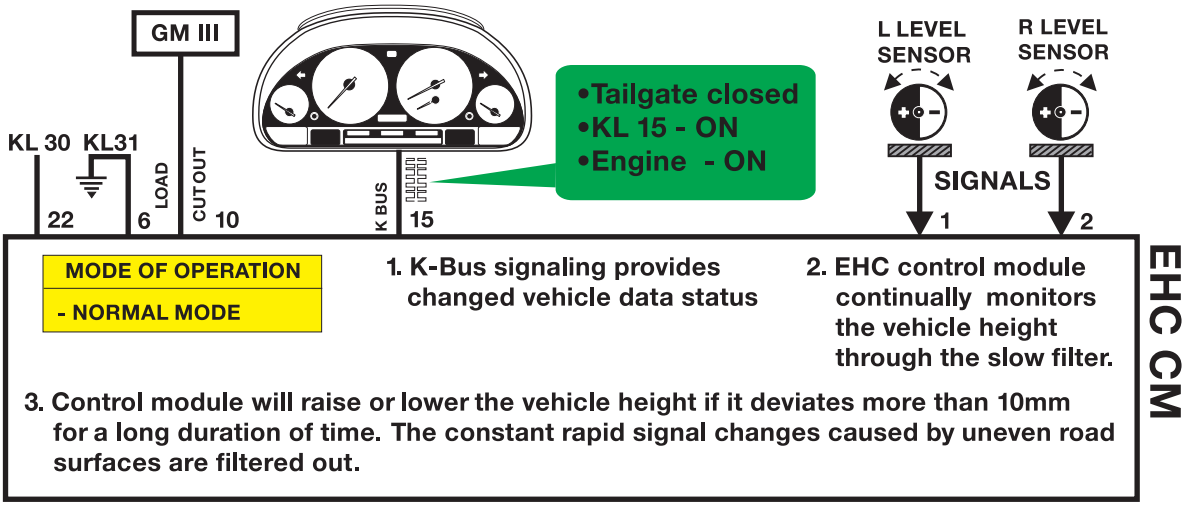
The Pre-Run mode is activated when the vehicle is parked and the control module is in the sleep mode. Opening a door or the tailgate initiates a system wake up and the control module comes on-line.

The control module performs a self-check of the control electronics and sensors. If no fault is found, the system will check the ride height and institute a rapid regulation if the height varies by more than 40mm.



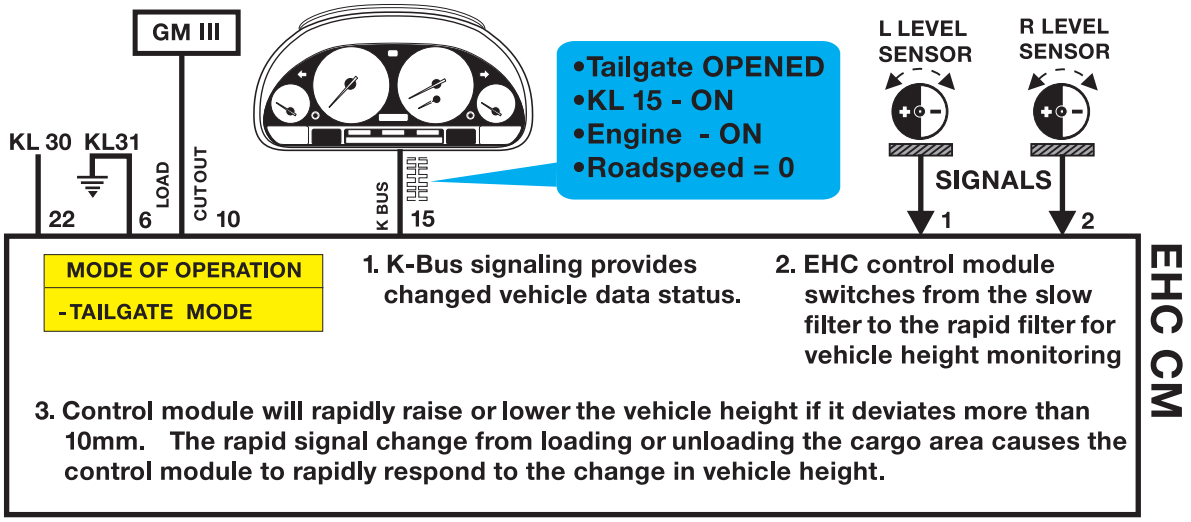
Normal Mode Operation

Once the rear lid is closed, KL 15 switched ON and the engine started, the system switches into the normal operation mode. In the normal mode, the control module will constantly monitor the input signals from the ride height sensors and will activate a correction if the ride height deviates by at least 10mm.



Tailgate Operating Mode

The tailgate operating mode is activated if the gate is opened with KL - 15 On and the engine running. The difference between this mode and the normal operating mode is the response time is rapid instead of slow .



Special Operating Modes

- **Assembly Line Mode (New control module)**

  The assembly line mode refers to control module manufacturing. New control modules are stored in a deactivated state. The control programming is not active and must first be ZCS encoded.

  After installing a replacement control module, it must be coded using the DIS or MoDiC. The instrument cluster fault display will remain illuminated until the control module is coded.

- **Transport Mode**

  The vehicle rolls off the factory assembly line with the EHC control module in the transport mode. The transport mode inflates the air springs to a higher position (approx. 30mm higher) than the normal mode in order to avoid damage during transit.

  The system will not respond to any inputs that would alter the height of the vehicle. The fault indicator (base cluster) is illuminated or instrument cluster matrix display (high cluster) provides the message “Leveling System” to draw attention to the transport mode setting.

  The Service Functions section of the diagnosis program is used to activate/deactivate the transport mode. Once the transport mode is deactivated, check the vehicle Ride Height Offset making sure the vehicle rear axle height is to specification.

Control Interrupts

Cornering

To prevent unnecessary suspension adjustments while driving through corners, a “control interrupt” is built into the system. Above 30MPH the control module monitors the left/right ride height sensors for a difference of 30mm. Exceeding this difference will put the system into a control interrupt and no adjustment will take place. The control interrupt last for a duration of 5 minutes.

Vehicle Lifting

The ride height control is interrupted when the vehicle is raised on a lift or with a jack. The system monitors the ride height sensor inputs and when the height limit of 90 mm is exceeded, the control is switched OFF until the vehicle is lowered again.

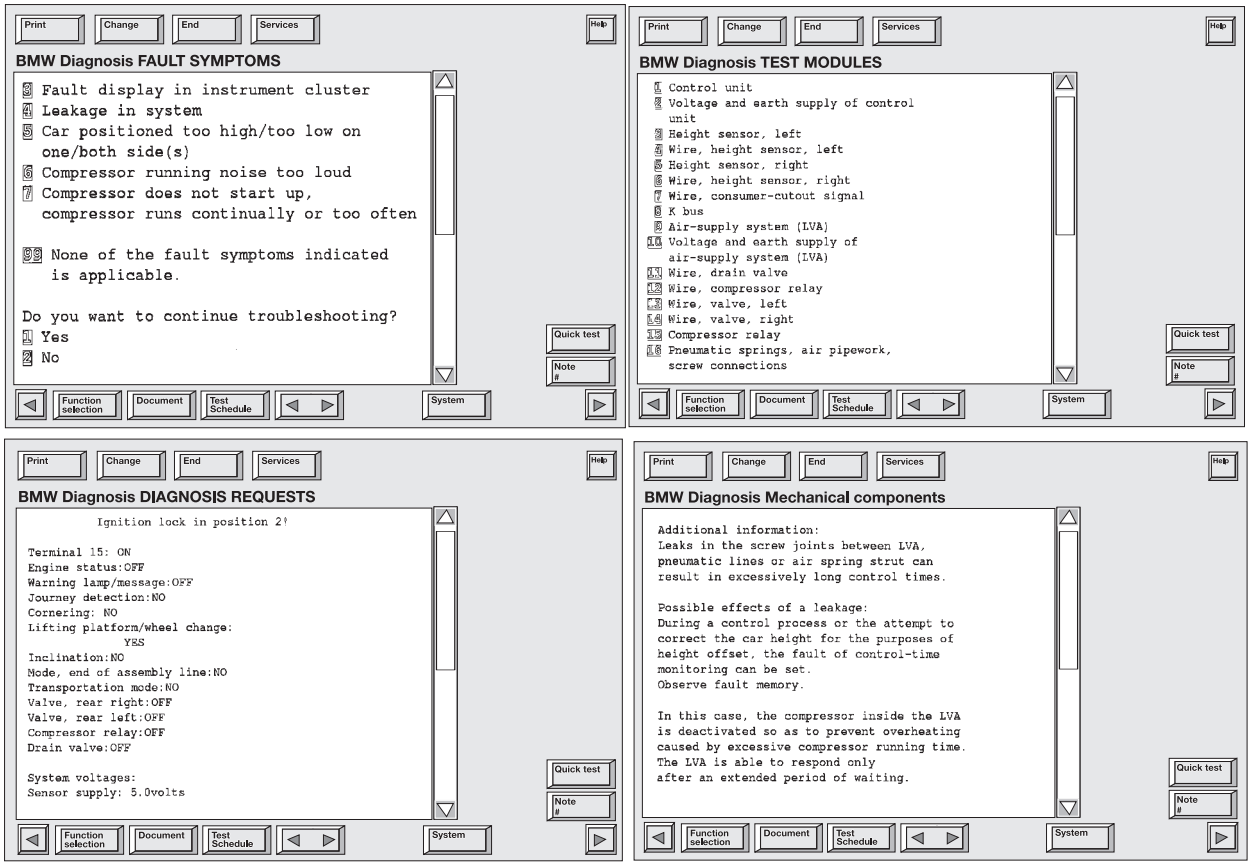
EHC Service Information

Diagnosis/Coding

- The EHC control module is connected to the diagnostic link. The EHC control module activates the fault display in the instrument cluster to alert the operator of the off-line status of the system. The EHC control module stores up to three electrical/electronic faults.

- Diagnosis/troubleshooting of EHC is carried out using the fault symptom troubleshooting program of the MoDiC or DIS. The EHC system has an extensive diagnosis program.

- Replacement control modules are shipped in the factory mode. The control modules must be ZCS encoded using the DIS or MoDiC to activate the operating parameters.



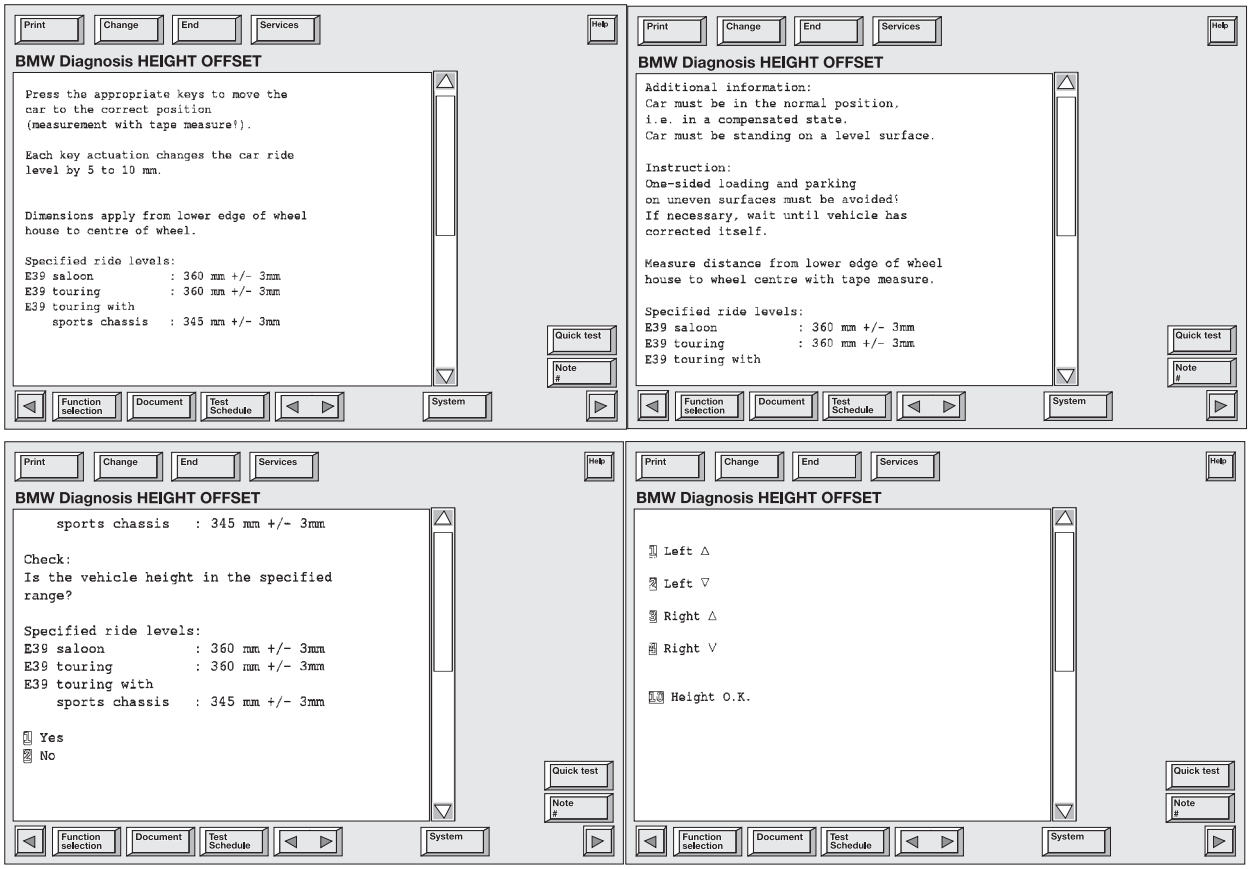
DISplus/GT-1 Service Functions Program

The Service Functions program of the DIS/MoDiC provides the Transport Mode activation/deactivation and Ride Height Offset functions (see next page).

Once the transport mode has been released, or if the system requires left to right side height adjustment, the ride height "OFFSET" must be carried out to ensure that the vehicles suspension has a base ride height level starting point.

The "HEIGHT OFFSET" is adjusted using the DIS or MoDiC. The procedure is as follows:

- Place the vehicle on a level surface unloaded.
- Access the Height Offset program in the service function menu.
- Measure the base ride height from the lower edge of the wheel housing to the center of the wheel hub.
- Check measured height against the specifications listed
- Use the DIS/MoDiC to correct the ride height if the value differs from the listed specification.



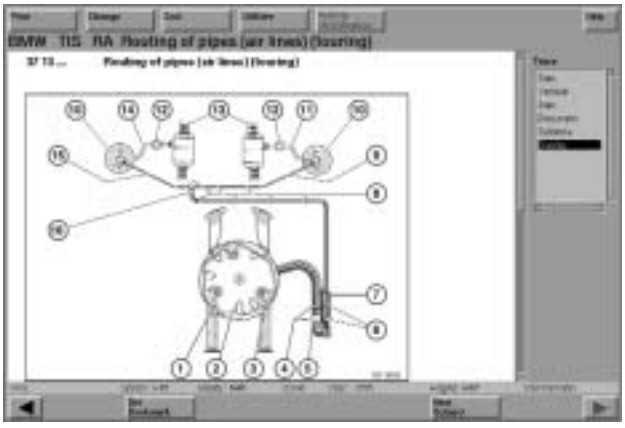
TIS Repair Manual Information

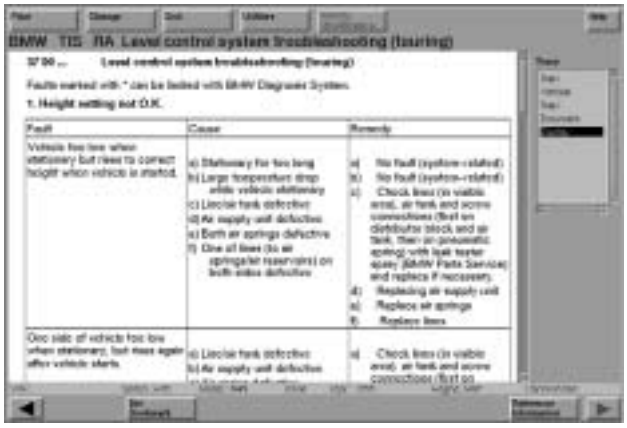
The repair manual contains the following EHC specific sub-group repair information:

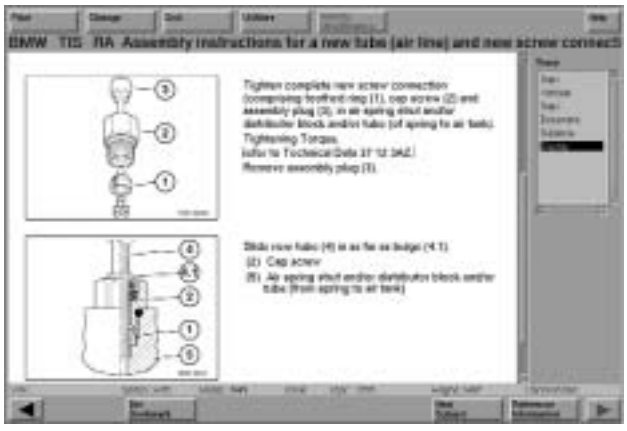
- 00 General (general information, overview routing of pipes, tubes and components)
- 12 Control and suspension system, rear (DIS referral, specific R&R procedures, etc.)
- 13 Connecting Lines (specific R&R procedures)
- 14 Electrical components (specific R&R procedures)
- 22 Pump assembly (LVA) with container (LVA R&R procedure)
- 90 Troubleshooting (system troubleshooting charts)

The troubleshooting charts provided an additional reference when used in conjunction with the DIS program.

The following screen samples are from the TIS repair manual section.







Two Axle Air Suspension (E53 EHC II)

Purpose of the System

The two axle air suspension system (EHC2) offers advantages over the single-axle air suspension with respect to ride comfort and off-road capability.

Lowering the entire body makes it easier to enter, exit, load and unload the vehicle.
The vehicle's off-road capability was improved by providing the possibility for increasing the ground clearance of the body.

The driver can now choose between three different ride levels which can be set with a rocker switch, as required. Automatic ride-height control for payload compensation and automatic inclination compensation continue to be fitted.

Deficits of the old system

The automatic payload compensation facility for the single-axle air suspension did not permit driver control. The driver could not actively control the system to make it easier to enter and exit or load the vehicle.

Ride level was compensated via the rear axle only.

Advantages of the new system

The new system allows the ride-height control system to be controlled actively by the driver.
The twin axle air suspension allows both axles to be lowered evenly and in parallel.
As a result, it is easier for the occupants to enter, exit, load and unload the vehicle.

On the E39, the load of the complete rear axle was born for the first time by air suspension in combination with the optional ride height control system. The system was controlled automatically under all operation conditions, and there was no possibility for driver intervention on the X5, the rear axle previously had single axle air suspension only. The air supply unit and the control unit were adopted from the E39. The air springs were adapted to the X5.

There is a standard version and a sports version.

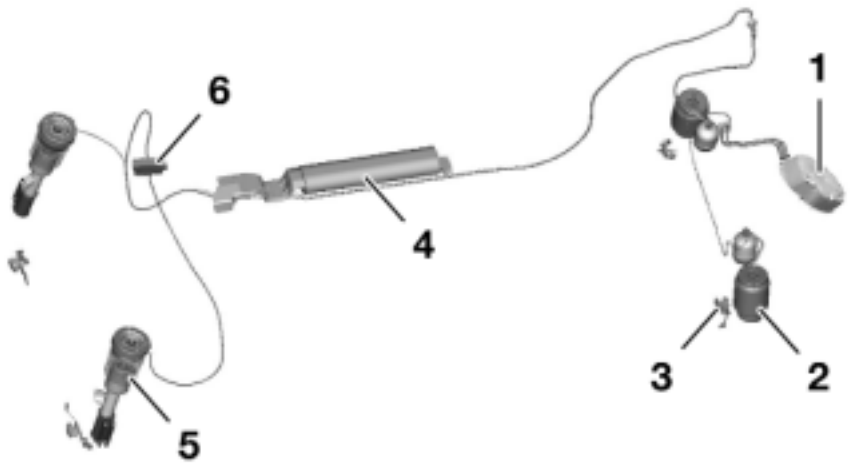
The ride-height control system (EHC) was supplied as standard in combination with the M62 engine and is available as an optional extra in combination with the M54 engine.

EHC2 is optional on both the M62 and M54 versions of the X5 and not available on the 4.6is X5.

System components

The X5 Two Axle Air Suspension System (EHC2) utilizes the air supply unit from EHC mounted in the luggage compartment, with the following components added or modified:

- Air Supply Unit (with redesigned compressor and drier)
- Pressure Accumulator
- Valve Unit
- Ride Height Sensor
- Air Suspension Strut
- Control Unit
- Switch Assembly



1. Air Supply Unit
2. Rear Axle Air Bellows
3. Ride Height Sensors
4. Pressure Accumulator/ Valve Unit
5. Front Axle Air Bellows
6. Control Unit

Pneumatic System of EHC2

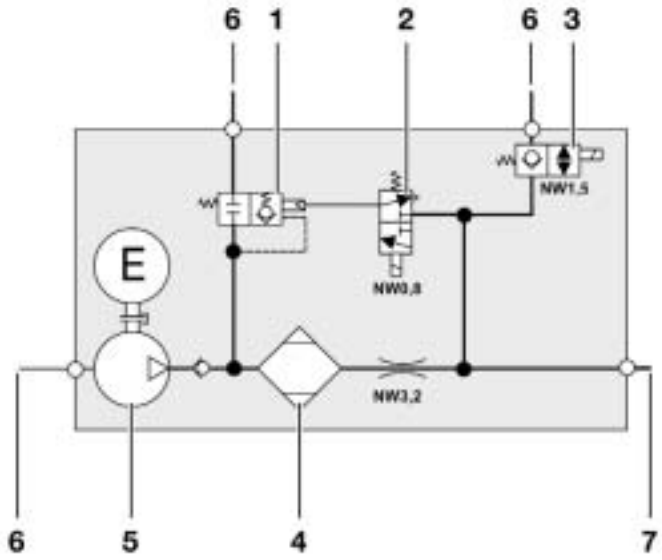
Air Supply Unit

As on vehicles with single axle air suspension, the air supply unit is located in the luggage compartment under the spare wheel. As with the single axle air suspension, the auxiliary tanks for the rear air spring bellows are located in the luggage compartment.

The air supply unit is configured similarly to the single axle air supply unit for the ride-height control system of the E39, which is currently in production.

The functions are implemented by activating a compressor and various valves in the air supply unit and on the air accumulator valve unit.

The maximum pressure of the air supply unit is 21 bar.



1. Pneumatic Drain Valve
2. Electric Pilot Control Valve
3. High Pressure Vent Valve
4. Air Drier
5. Compressor
6. Sintered filter
7. To Pressure Accumulator/Valve Unit NW Size of opening/tubing in mm.

Air Supply Unit

Pneumatic Drain Valve

The Pneumatic Drain Valve is activated pneumatically by pressure from the control valve. This causes the drain valve to open allowing the pressure supply line to vent to atmosphere. This design allows for large air volumes to be discharged quickly and eliminates the need for a solenoid valve with high current consumption.
The 21 bar pressure limiting valve is integrated in the drain valve.

Electric Pressure Relief Valve

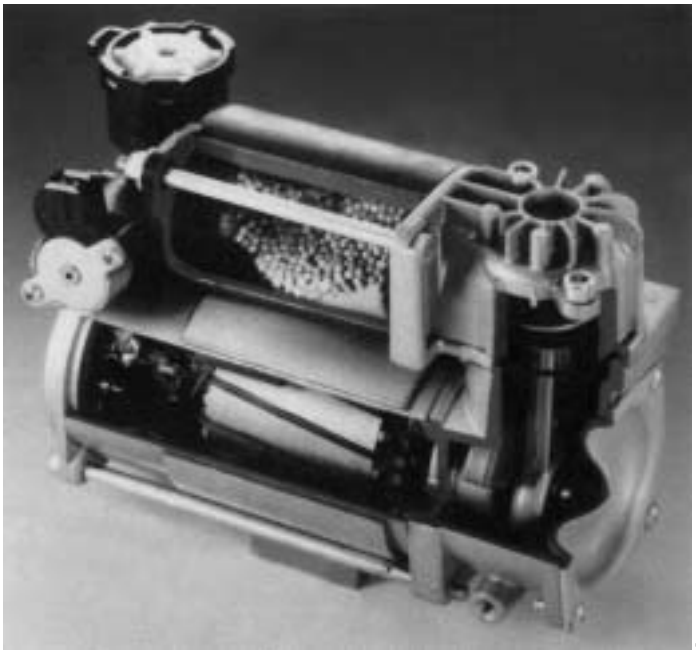
The electrically activated pressure relief valve controls normal system pressure. The control valve performs this function in conjunction with the drain valve.

HIgh Pressure Vent Valve

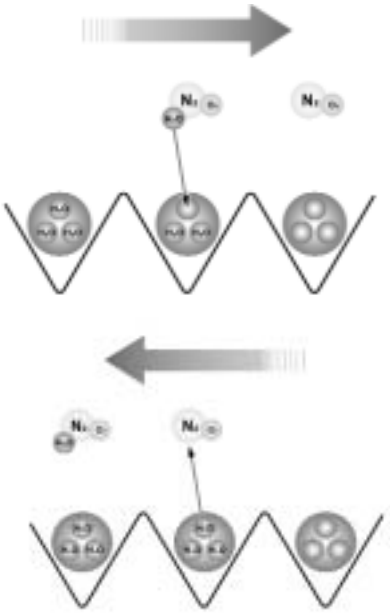
The High Pressure Vent Valve serves as a comfort valve and is used to release system pressure after the accumulator has closed and the compressor is still running. When the high pressure vent valve has opened the compressor can be stopped quietly.

Air Drier

In the air drier, the air which is drawn in passes over a water absorptive filter material in the form of filter nodules which extract moisture from the air. As long as the air contains more moisture than the filter material, the individual nodules absorb and accumulate the moisture. When the air flows back, it is drier than the filter material, with the result that the air is re-humidified and the moisture is discharged into the open air. The maximum
water storage capacity of the filter is 30 g.



Compressor with Drier



Top: Air Drying
Bottom: Dissipation of water to air

Compressor

Compressor operation is the same as in EHC with the following technical improvements:

- Addition of a temperature sensor (Located on the compressor cylinder head) Temperature sensor switches off the compressor at temperatures above 110°C.
- Extended compressor ON time (180 seconds)
- Redesigned air drier to compensate for additional air volume.

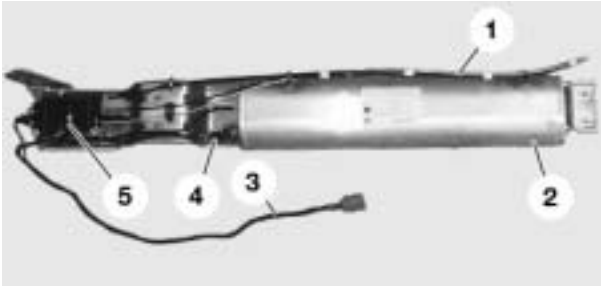
Pressure Accumulator

The twin axle air suspension system now features a pressure accumulator which forms an air accumulator valve unit in combination with the valve. The air accumulator valve unit is located beneath the vehicle floorpan in the right-hand sill area.

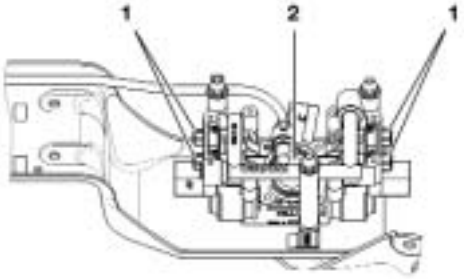
Pressure Accumulator Unit which includes:
Pressure Accumulator
Pressure Sensor
Valve Unit

Front

The pressure accumulator decreases the load on the compressor and significantly reduces the time required for large changes in ride height.
The EHC 2 control module monitors system pressure via a pressure sensor mounted on the accumulator. Normal system pressure is 15.7 +/- 0.7 bar. Minimum system pressure is 9 bar.
The pressure accumulator's charge is sufficient to fill the four suspension struts once from the Access position to the normal position and compensate for vehicle load up to maximum gross weight.



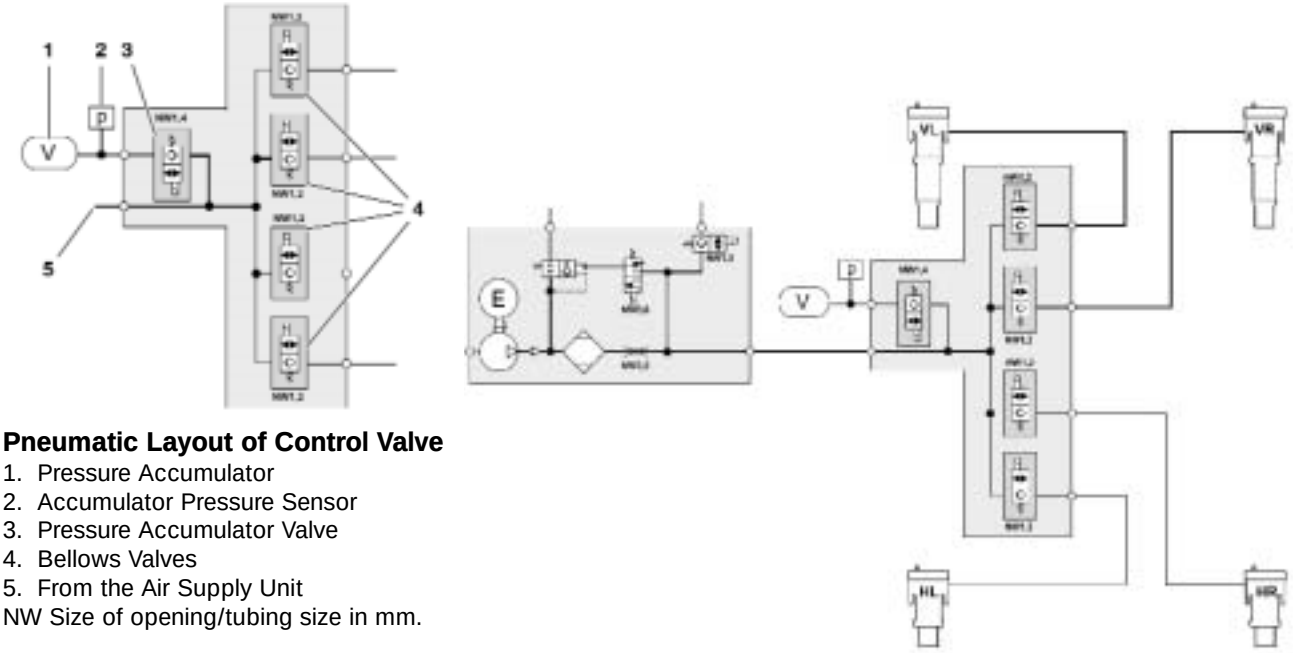
Accumulator/Valve Unit
1. Air Lines
   Yellow-Black Front
   Red-Blue Rear
2. Pressure Accumulator
3. Connecting Cable
4. Pressure Sensor
5. Valve Unit



Valve Unit
1. Connections for Air Lines
2. Pressure Accumulator valve

Valve Unit

In the valve unit, four bellows valves and the pressure accumulator valve are activated.
The bellows valves and the pressure accumulator valve are solenoid valves which are closed under spring pressure when de-energized.

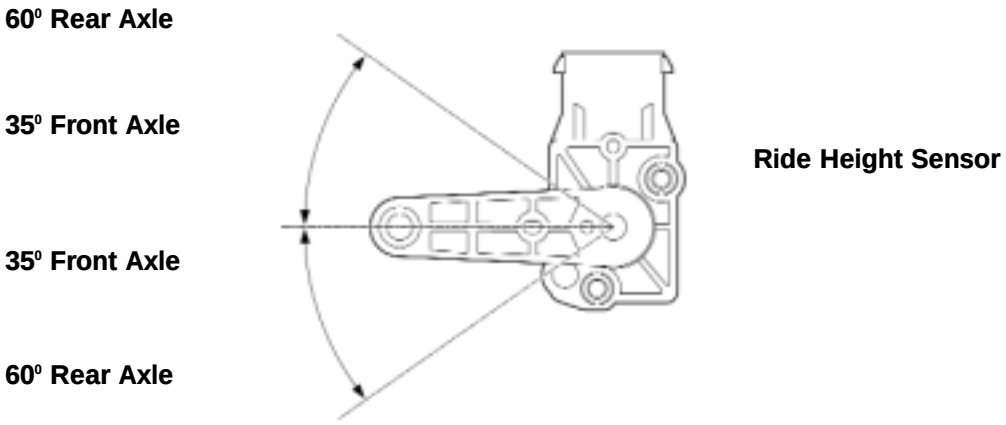


Pneumatic Layout of Control Valve
1. Pressure Accumulator
2. Accumulator Pressure Sensor
3. Pressure Accumulator Valve
4. Bellows Valves
5. From the Air Supply Unit

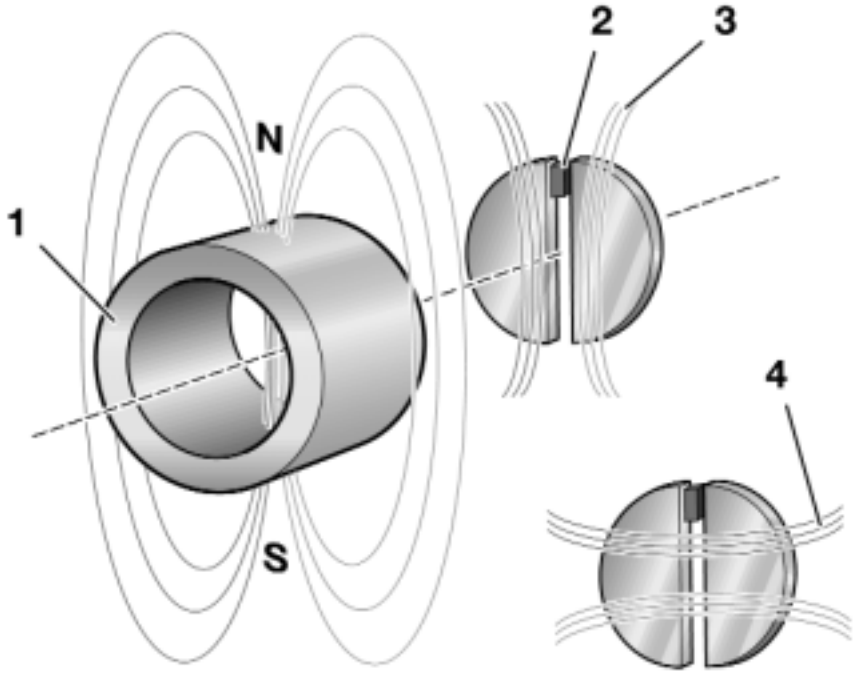
NW Size of opening/tubing size in mm.

Ride Height Sensor

The control unit obtains information about the ride height of the vehicle via a ride height sensor attached to each of the four wheels.



The ride height sensor is an angle Hall sensor which is activated by a ring magnet. The ring magnet is polarized vertically from north to south.
The magnetic field line of the ring magnets intersect a Hall cell. The Hall cell is arranged in such a way that only the horizontal components of the field lines are evaluated. This results in different field line strengths at different positions of the ring magnet. The Hall cell measures the field strength of the magnetic flux and converts it into an analog signal with a voltage level between 0.5 and 4.5 V.



Sensor Principle of Operation

1. Ring Magnet
2. Hall Cell
3. Longitudinal magnetic field lines, low voltage 0.5V
4. Transverse magnetic field lines, high voltage 4.5V

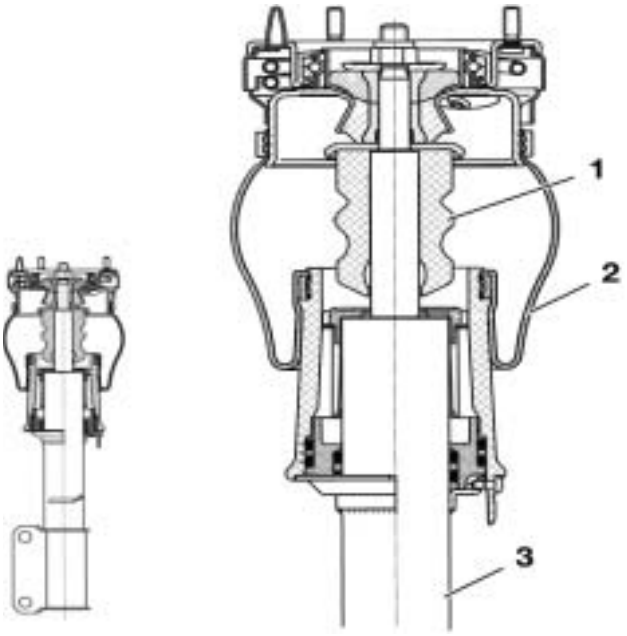
Air Suspension Strut

Rear

Minor modifications were made to the rear axle air springs. The air springs and the dampers are configured separately at the rear axle.

Front

The air suspension replaces the steel suspension at the front axle, i.e. the spring bellows is attached to the damper. The front air suspension strut and the impact absorber form a complete unit.



Air Suspension Strut
1. Auxiliary Spring
2. Air Bellows
3. Damper

Control Unit

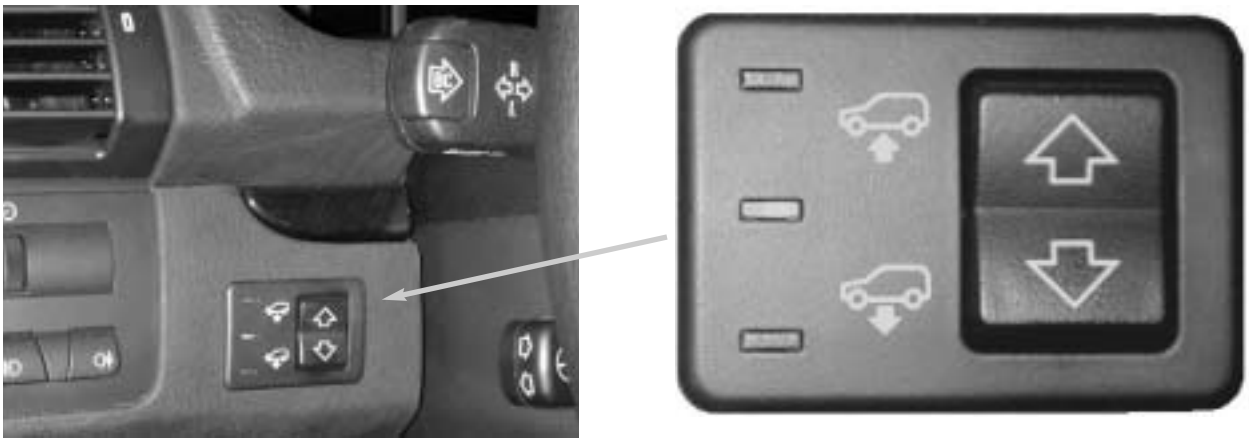
The EHC2 Control Unit is located behind the glovebox adjacent to the General Module. The connector is a black 54 pin connector.
Inputs received directly into the control unit are:

Ride Height Level Sensor (X4)
General Module (Load cutout signal)
K Bus Inputs
Compressor Temperature
Up and Down requests from the switch assy.
CAN Bus Inputs
Pressure Sensor

Outputs include:

Air Unit Control (Activation)
LED's for Switch Unit
Pressure Accumulator
Front and Rear Axle Valves
Compressor Relay

Switch Assembly



The dash mounted switch assembly supplies a momentary switched ground to the EHC2 Control Unit requesting a ride height change in the up or down direction. Three LED's provide current ride level selected and target ride level if a request for change has been made. The LED for the current ride height will always be illuminated. The LED for the target ride level will flash until the new ride level is reached.

Notes:

Principle of Operation

Ride Height Control Operations

In addition to the automatic ride-height control system for payload compensation, the driver can set three different vehicle ride heights.

- Off-road (+25 mm), high ground clearance to a max. speed of 50 km/h
- Standard (0 mm), normal ride level
- Access (-35 mm), for entry and exit, loading and unloading to a max. speed of 35 km/h or can be activated in Standard mode at road speeds < 25 km/h

The various heights are selected by scroll rocker. Light emitting diodes indicate the present ride height setting.

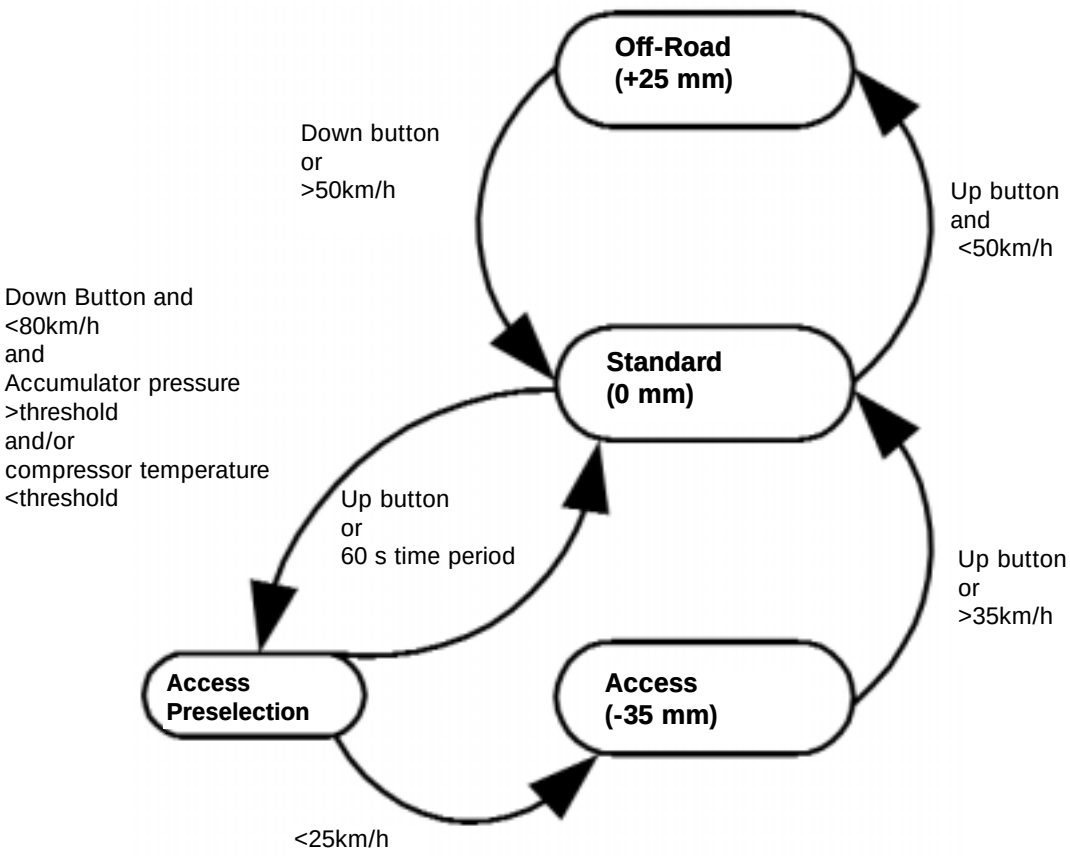
Ride height can be adjusted from terminal 15 and with the doors closed. The hood and tailgate may be open.

The system also controls inclination automatically, like the single axle air suspension.

All control operations are executed without stopping at intermediate levels. The vehicle is configured pneumatically in such a way that the front and rear axles can be lowered in parallel in any load situation. Depending on the load situation, either the front axle or the rear axle is slightly quicker. On account of the different control speeds, a difference in height between the two axles is possible during all control operations. If a max. permissible threshold is exceeded, the quicker axle is stopped briefly.

The various levels can be preselected while travelling. Changeover between ride levels is effected at the speed threshold values defined in the control unit. The control unit monitors the change-over.

As soon as the driver sets a new target ride level by pressing a button or when a changeover is initiated automatically by a specific driving condition, the LED for the current ride level remains lit and the LED for the target ride level begins to flash.
When the new level is reached, the LED for the previous level goes out and the LED for the new level reached stays lit permanently.



The various levels can be preselected while travelling. Changeover between ride levels is effected at the speed threshold values defined in the control unit. The control unit monitors the change-over.

As soon as the driver sets a new target ride level by pressing a button or when a change-over is initiated automatically by a specific driving condition, the LED for the current ride level remains lit and the LED for the target ride level begins to flash.

When the new level is reached, the LED for the previous level goes out and the LED for the new level reached stays lit permanently.

If a ride level selection is not allowed, the LED indicating the momentary ride level of the vehicle flashes for 3 seconds.

A special case is preselection of Access levels while travelling. The Access LED flashes and the LED for the original ride level is lit permanently. However, this does not mean that a control operation has already begun. The control operation does not actually begin until the speed threshold which the Access level allows is reached or undershot.

In addition to the LED indicator, the following text messages can be displayed in the instrument cluster:

- *TRAILER MODE*
  A coupled trailer is identified via the trailer connector. To avoid damaging the trailer and the vehicle, changes of vehicle level are generally avoided. The standard level is "frozen." If the trailer is coupled at a level other than the Standard level, the vehicle ride level is not changed to Standard unless a button is pressed or the speed threshold for automatic change-over is reached. The standard level is then "frozen" until the trailer connector is disconnected.
- *RIDE HEIGHT CONTROL INACTIVE*
  Faults in the system and on the control unit which are only identified by the instrument cluster, e.g. control unit disconnected
- *RIDE HEIGHT CONTROL INACTIVE + MAX. 60 km/h*
  For safety-critical faults (vehicle is too high or at inclination)

Control Modes

Sleep mode

If the vehicle is parked, it enters Sleep mode after 16 minutes. No further control operations are executed. A "watch dog" wakes up the control unit for a few minutes every 6 hours (wakeup mode) in order to compensate for possible inclination of the vehicle. (Vehicle height may only be corrected once as air supply unit only operates with engine running.)

Wake-up

In wake-up mode, the control unit is woken up for a set period of time in order to compensate for possible inclination of the vehicle. Inclination of the vehicle can be caused by large temperature differences or by minor leaks. Adjustments to the front and rear axles ensure that the vehicle is visually level. To minimize power consumption, the vehicle is lowered only. The nominal level of the lowest wheel serves as the nominal level for all other wheels. The lowest nominal level to which the vehicle is lowered is the Access level (-35 mm).
Exception: if the vehicle is parked at Access level, the vehicle is lowered to max. -50 mm in wake-up mode. If the vehicle is parked for a prolonged period of time and there is a leak in the system, further loss of pressure does not produce a change of ride level since the weight of the body is born by the auxiliary suspension and the residual tire pressure.

Advance /Overrun

When the vehicle is woken out of sleep mode by the load-cutout signal (VA), it normally enters advance / overrun mode. Since the engine is not (no longer) running in this mode, however, there are restrictions on the control operations that can be performed in order to conserve the battery. Ride level compensation is restricted to tolerance ranges of 20 mm and 25 mm in the up and down directions respectively. This serves to reduce the frequency of control operations.

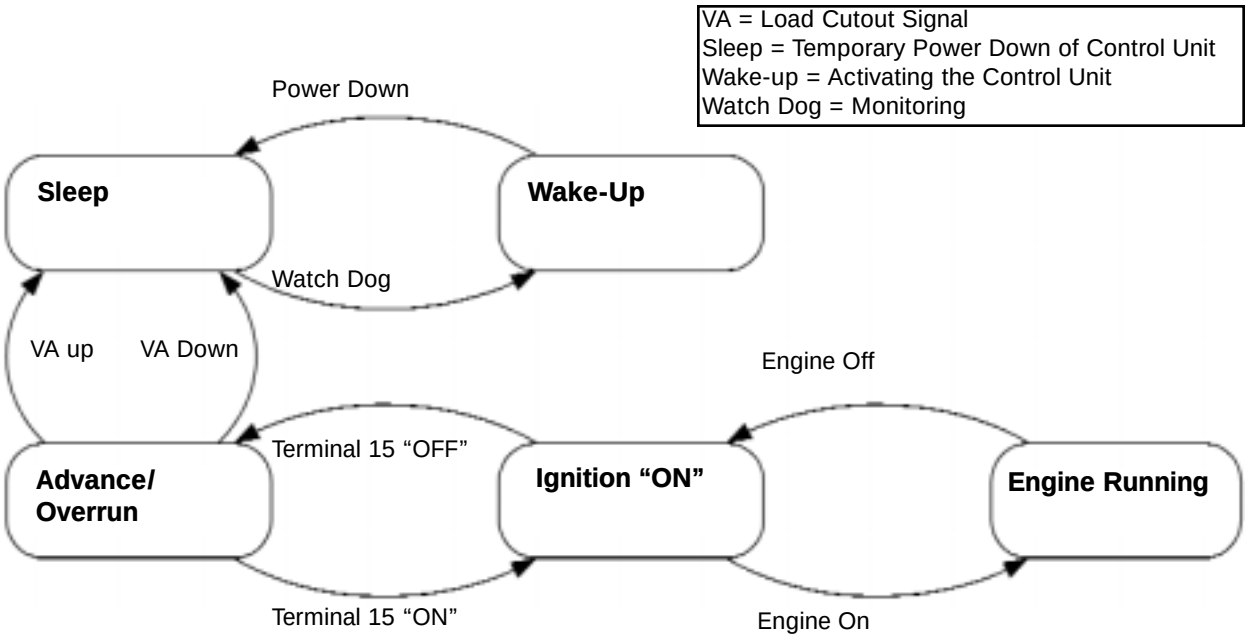
All control operations in advance / overrun mode are executed as long as pressure is available in the accumulator. When the accumulator is empty and the engine is turned off, control operations are directly driven by the compressor. User-activated changes of ride level and filling of the accumulator are not possible.

Terminal 15

As soon as the ignition is turned on (terminal 15), the user is allowed to lower the ride level as required.
However, it is still not possible to raise the ride level or fill the accumulator.
Ride level is compensated outside a narrow tolerance range of 10 mm upwards and 10 mm downwards.

Engine "on"

Ride level compensation, raising and lowering the vehicle's ride height as well as filling the accumulator are permitted when the engine is running. The compressor also starts up during every control operation.
Ride level is still compensated outside the narrow tolerance range of ±10 mm.
As long as the vehicle is stationary, high speed filtered ride level signals are used to detect a change of load. This allows the system to react immediately to changes in ride level.
As soon as the vehicle is travelling, it changes over to low speed filtered ride-level signals. The system no longer reacts to bump movements caused by road surface unevenness. A mean value is formed over a prolonged period of time, i.e. payload is only altered by the progressive emptying of the fuel tank.
The high speed filter is not used until the vehicle is stationary again and a lid is opened. If no lid is opened, the vehicle logically cannot be loaded or unloaded.



Workshop Hints

If a threshold level is exceeded on all 4 wheels when the vehicle is stationary, the control unit assumes that the vehicle has been raised on a workshop platform.
There are three possible reset conditions for workshop platform recognition:

- The original level values are undershot at all four wheels,
- A selection is made by button,
- A speed of >40 km/h is recognized for 3 s.

Vehicle jack

If the lowering speed at a wheel is too low during the lowering operation, the system assumes that the wheel is jacked up. However, the downward velocity must be less than a certain preprogrammed speed threshold. If the system detects a jacked wheel, it stores the height of this wheel.

Car jack recognition is reset when the stored ride height is again undershot. When a travelling speed of 40 km/h is maintained for at least 3 s, another control attempt is performed. The car jack recognition can also be reset by button selection.

Please note that the system also controls ride height in diagnostic mode. For this reason, Belt Mode must be activated before carrying out work on the system or before setting the vehicle ride height.

Belt Mode:

Heights are fixed and are not compensated. If Belt Mode is set, the function LED is off. The text message "ride-height control system inactive" appears in the instrument cluster.

Transport Mode:

The Transport Mode setting is for transportation purposes. When the ignition is turned on, the message "ride-height control system inactive" appears. Heights are increased or decreased depending on ignition key status, e.g. ride height is reduced when the vehicle is lashed to a ship or train and raised when the "Engine on" signal is generated and when the vehicle is transported on a transporter truck.

The correct ride height is set to ± 5 mm via "Activate components." The left and right ride levels are set separately at the rear axle. The ride levels are then set at the front axle. The left and right air springs are adjusted jointly for this purpose.
Following this, the new ride height for the front and rear axles is stored via the "Offset function."

Before replacing components, the system must be depressurized! This is done in the diagnostics via "control unit functions," "Component activation," "Pressure-relieve front axle/rear axle." Repeat the activation procedure 6 times.

If the fabric of the bellows is visible, then the bellows must be replaced.

Upon completion of repair work, the air suspension system of the vehicle raised on the workshop platform must be refilled with air via the diagnostics. The activation procedures must also be repeated 6 times. This prevents the bellows from being folded incorrectly.
The vehicle must with be set down on its wheels when the suspension struts are depressurized!

Important Workshop Hint
Similarly, a defective vehicle with leaky pneumatic system must not be raised on the workshop platform. If depressurized, the bellows would contract under suction forming incorrect folds. These folds could result in malfunctions later on.

Areas on the air bellows which can possibly become leaky are the O-ring at the piston rod and the seal carrier on the roll piston.

The connectors attached to all cables are identical to the connections on the single-axle air suspension. 6 mm cable is used. The tightening torque is 3±1 Nm throughout the system. Special care must be taken when handling breakage-prone plastic parts of air suspension elements.

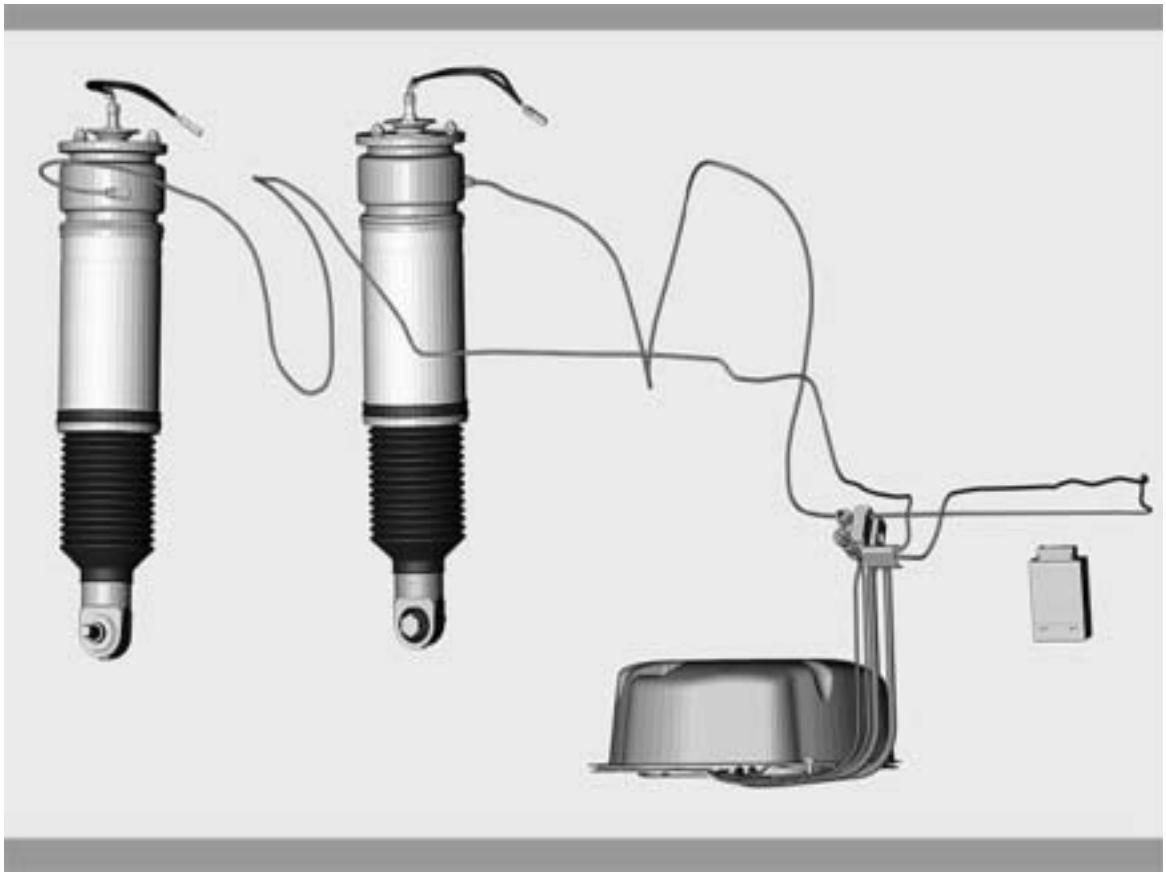
Upon completion of repair work, Belt mode must be deactivated via the diagnostics. The function LED on the button comes on. No text message appears in the instrument cluster. The system is OK and ready for operation.

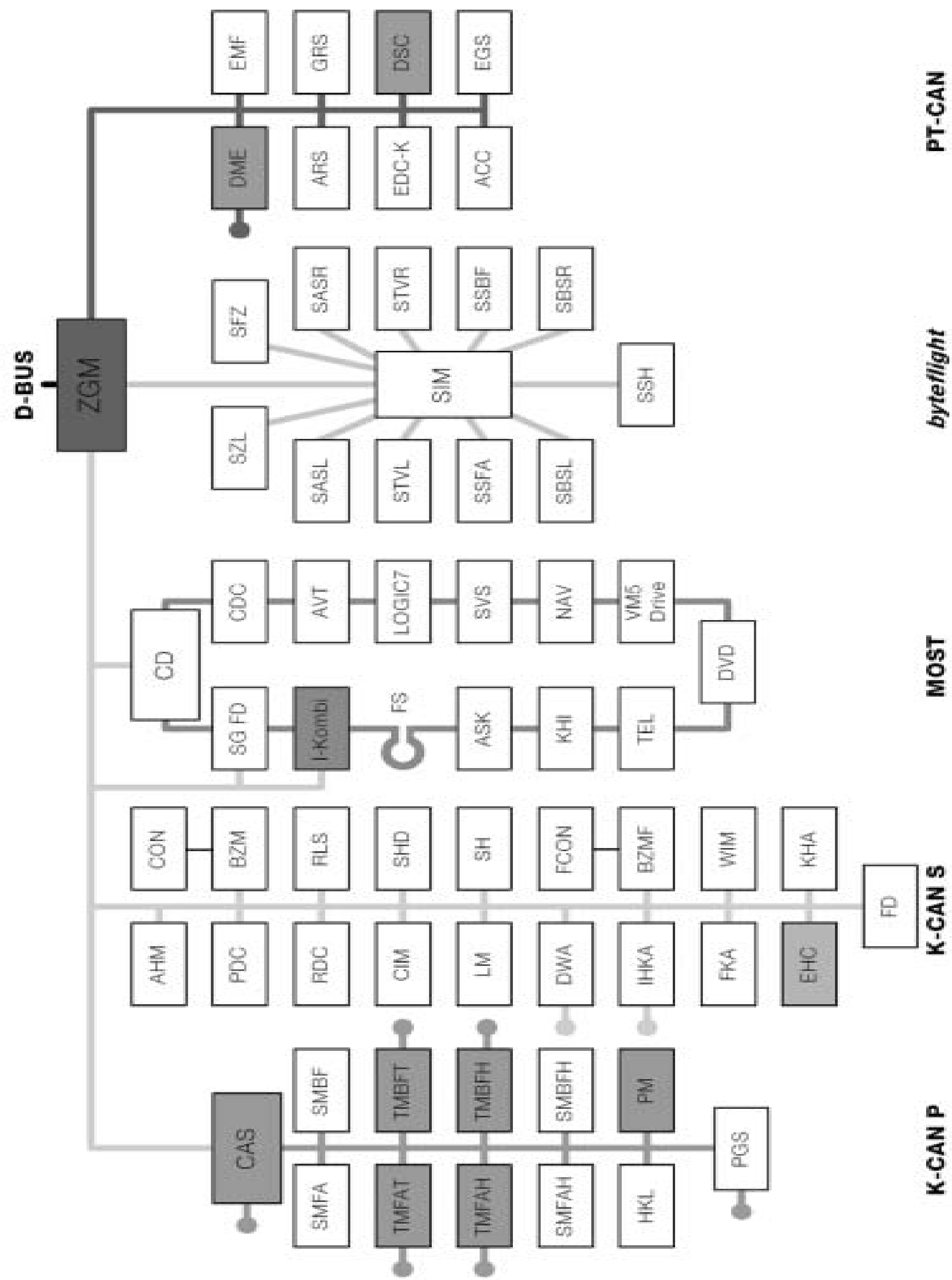
Single Axle Air Suspension (E65/E66)

Purpose of the System

The single axle air suspension system used on the the E65/E66 is a further enhancement of the previous single axle air suspension system used on the the E39 and X5. The components used are similar to the Single Axle EHC System on the E53. The E65/E66 Air suspension consists of the following components:

- Air Supply System (LVA)
- Control Unit (EHC)
- Two Air Springs
- Two Ride Height Sensors
- CC Display/Telltale Icon




D-BUS
ZGM
PT-CAN
DME
EMF
ARS
GRS
EDC-K
DSC
ACC
EGS
byteflight
SIM
SFZ
SZL
SASR
SASL
STVR
STVL
SSBF
SSFA
SBSR
SBSL
SSH
MOST
CD
CDC
AVT
LOGIC7
SVS
NAV
VM5 Drive
DVD
SG FD
I-Kombi
FS
ASK
KHI
TEL
K-CAN S
CON
BZM
RLS
SHD
SH
FCON
BZMF
WIM
KHA
FD
AHM
PDC
RDC
CIM
LM
DWA
IHKA
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EHC
K-CAN P
CAS
SMBF
SMFA
TMBFT
TMFAT
TMBFH
TMFAH
SMBFH
SMFAH
PM
HKL
PGS

Components (E65/E66)

Air Supply Unit (LVA)

The air supply unit is located in the spare tire recess and consists of the following components:

- Protective cover with internal acoustic insulation
- Lid
- Rubber-mounted component carrier
- Compressor Unit
- Compressor Relay
- Solenoid Valve Block

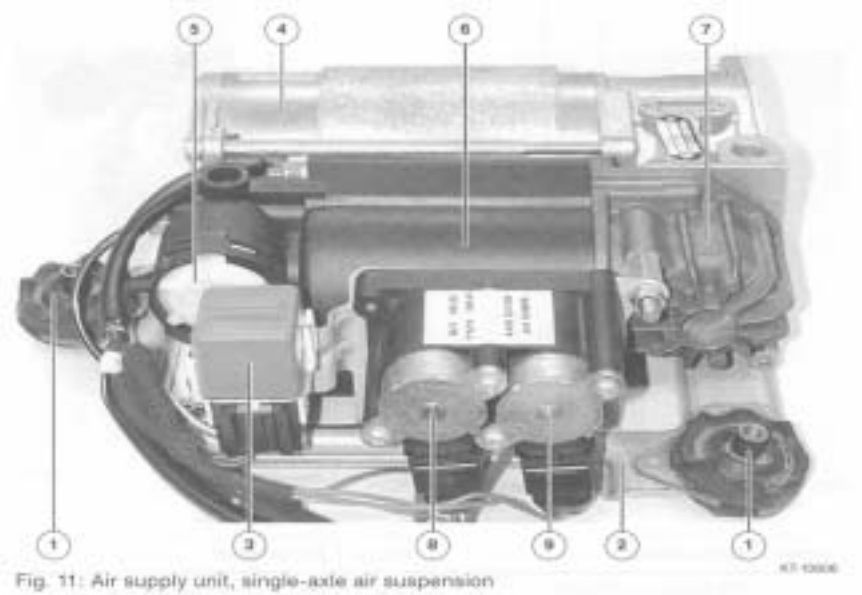


Fig. 11: Air supply unit, single-axle air suspension

Index	Explanation	Index	Explanation
1	Rubber Mount	**6**	Air Drier
2	Component Carrier	**7**	Compressor
3	Compressor Relay	**8**	Solenoid Valve, Right
4	Electric Motor	**9**	Solenoid Valve, Left
5	Air Cleaner		

Control Unit

The EHC control module is located in the right rear luggage compartment area in the module carrier next to the battery. On the E65/E66, the control module is connected to the K-CAN S. The EHC control module receives the following information:

- Vehicle Ride Height
- Load Cutout Signal
- Terminal 15 ON/OFF
- Vehicle Speed
- Lateral Acceleration
- “Engine Running” Signal
- Flap Status (Doors/Trunk)

EHC Module Location

The Control unit decides on a case by case basis whether a control operation is required in order to compensate changes in load. It prevents intervention in the case of other causes. This makes it possible to adapt the frequency, specified height, tolerance thresholds and battery load optimally by means of the control operation to the relevant situation.

In addition to handling the self levelling suspension, the control module monitors the system components as well as storing a displaying faults. The control module has full diagnostic capability.

The EHC module is a 26 pin module with an ELO type connector. The module is connected to the K CAN S. The majority of the input messages are from the K CAN S Bus.

Air Springs

An identifying feature of the E65/E66 air spring is the internally guided air bellows. Internally guided means that the bellows is guided in an aluminum casing. The bellows is supported on this casing. This prevents the compression forces from weighing heavily on the bellows.

This process allows the bellows to be manufactured from a thin, flexible diaphragm which can react to minimal shocks and in this way provide a more comfortable suspension.

The diaphragm is composed of only one fabric layer embedded in rubber. The fibers within the fabric run longitudinally along the spring strut. The bellows is therefore known as an axial air bellows.

The bottom end of the air spring strut is enclosed in a bellows in order to protect the diaphragm against the mechanical effects of fouling (sand, dirt etc.). The lower end of the bellows incorporates small holes for pressure compensation in the space between the roll piston and bellows. The action of the bellows rolling in this space produces pressure differences.

The bellows together with the roll piston contains a volume of air that is sufficient for optimum suspension.

A residual pressure holding valve on the air spring strut prevents it from being depressurized. The air spring strut remains under pressure in the event of a loss of pressure in the system. The residual pressure is 3.25 +/- 0.75 bar. This ensures that the bellows is not damaged when the car is still being moved.

The residual pressure holding valve is secured with Loctite and must **NOT** be removed.

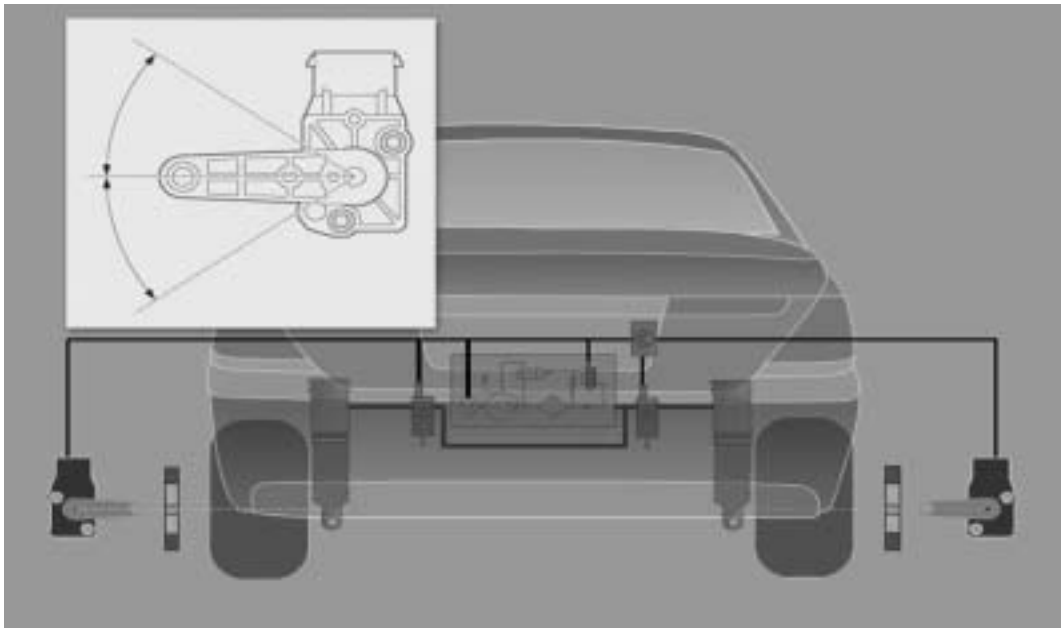
The air spring strut is initially filled at the manufacturer to 10 bar. This pressure is reduced to 3.5 bar when the spring strut is to be stored. Under this pressure, the strut is extended to maximum length.

The connection of the air spring struts to the air supply unit (distributor block) is located on the left of the luggage compartment under the flap on which the wheel nut wrench is mounted.

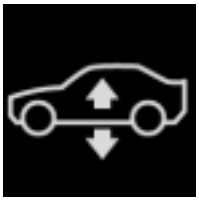
Ride Height Sensor

There are two ride height sensors, one for each rear wheel. The ride height sensor is actuated by a coupling rod and sends a signal to the EHC control unit.

The sensor is a hall sensor which sends a DC Analog output voltage to the EHC module. The voltage range is approximately .5 to 4.5 volts. The voltage increases with increasing vehicle height and the nominal voltage at normal ride height is approximately 2.5 volts. The right side rear sensor is a double sensor, the additional sensor is an input to the headlight leveling systemand has it's own power supply, ground and signal wires.

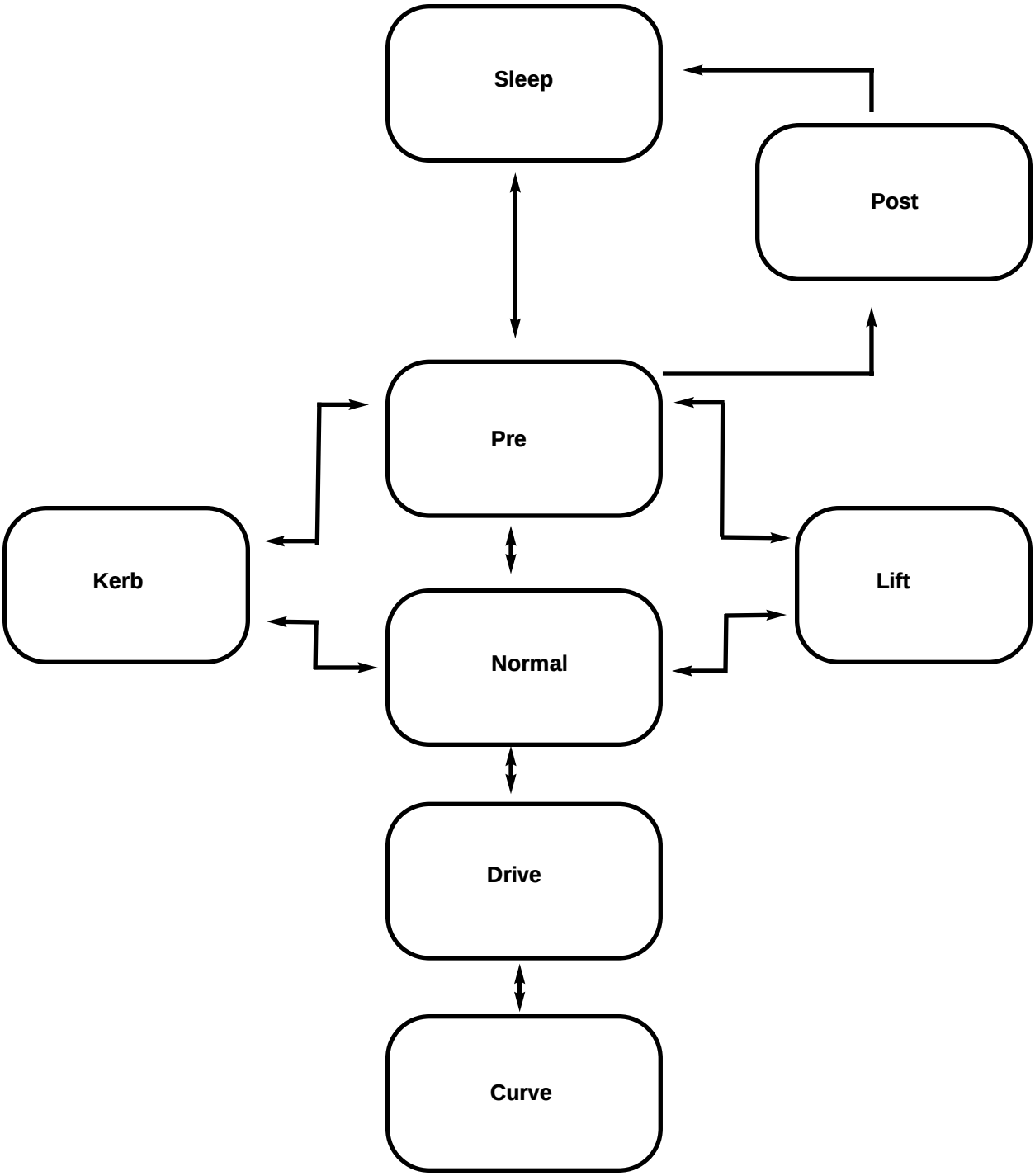


Check Control Messages

Control Unit	Cause	Variable Telltale Icon	Check Control Message	Information in Control Display
EHC	Alive failure or loss of functionality; transport or belt mode set		Level Control System failure	"Level Control system failure" Ground clearance and driving comfort reduced. Avoid high speed cornering. Have checked by BMW Service as soon as possible.
EHC	Level Control System sensor failure.		Level Control System Fault	"Level Control System fault" Possible reduction in driving comfort. Have problem checked by BMW Service.

Control Mode Flow Chart

The following chart demonstrates the control sequences of the E65/E66 with single axle rear air suspension.



Principle of Operation

Control Mode Overview

	E39/E53 EHC I (Single Axle)	E65/E66 (single Axle)	E53 EHC II (Dual Axle)
Sleep	X	X	X
Wake-up			X
Post		X	
Pre	X	X	X
Terminal 15 On			X
Normal	X	X	X
Drive	X	X	X
Kerb	X	X	X
Curve	X	X	X
Lift	X	X	X
Twist			X
Trailer			X
Off-Road			X
Access			X

Control Modes

Ongoing control operations are not affected by transitions from one mode to another. However, in the case of load cutout OFF, control operations are always concluded in order to safeguard system deactivation. The control unit then sets the Sleep Mode.

Sleep

The vehicle is in Sleep mode at the latest when it has been parked for longer than 16 minutes with a door, hood or rear lid/hatch being operated or the terminal status changing. This is the initial state of the control system. No control operation is being performed in Sleep mode.

The control system goes into Pre-mode when a wake-up signal is received by the control unit.

Post Mode

The Post-mode is adopted in order to compensate any inclination or to adjust the ride height after driving and between the Pre-mode and Sleep mode.

The Post-mode is limited in time to 1 minute. The Post-mode is only executed if the engine has been running before the system switches into this mode. If the engine has not been previously running, the system switches directly from Pre-mode into Sleep mode.

The control operation is performed in a narrow tolerance band of +/- 6mm and is terminated at +/- 4mm. The fast signal filter is used.

In the event of an inclination (Kerb Mode), the control operation takes place for the nominal heights applicable in this situation.

Pre-Mode

The Pre-mode is activated by the “Load Cutoff” signal (e.g. by opening the door or unlocking with the remote control). The Pre-mode then stays set for 16 minutes and is restarted with a change in status.

The ride height of the vehicle is monitored and evaluated with a wide tolerance band.

In Pre-mode, the vehicle is only controlled un to the nominal height if the level is significantly below the nominal height. The control tolerance band is -40mm from the mean value for the single axle air suspension and -20mm for the dual axle system. This control tolerance ensures that the vehicle is only controlled up in the case of large loads in order to increase the ground clearance prior to departure. Small loads give rise to small compression travel and this is compensated only when the engine is started. This control setting helps reduce the battery load.

With the single axle air suspension, the vehicle is controlled down when the mean value derived from both ride height signals is > 0mm and one side is in excess of +10mm. With twin axle air suspension, the vehicle is controlled down when one side is >15mm.

In this mode, only the mean value of the two height signals is considered when deciding whether there is an need for control operation.

The control operation is executed as long as pressure is available in the accumulator. When the accumulator is empty and the engine is turned off, the control operation is driven directly by the compressor. User-activated changes of ride level and filling of the accumulator are not possible.

Control operations which were started in other modes are continued with the inner tolerance bands applicable to these modes.

There is no inclination identification in Pre-mode.

Normal

The normal mode is the starting point for the vehicle's normal operating state. It is obtained by way of the engine running signal.

Ride level compensation, changing the vehicle's ride height and filling the accumulator are possible. The compressor starts up as required.

A narrower tolerance band than that in Pre-mode cab be used because the battery capacity does not have to be protected. The fast filter is used with a narrow tolerance band of +/- 10mm. In this way, ride level compensation takes place outside a narrow band of 10+/- 10mm. The faster filter allows the system to respond immediately to changes in ride level. Evaluation and control are performed separately for each wheel.

When a speed signal is recognized, the control unit switches into Drive mode. When the vehicle is stopped, the control unit remains in Drive mode. The system switches back into Normal mode when a door or the boot (trunk) lid is also opened. If none of the doors or the boot lid is opened, the vehicle cannot be loaded or unloaded.

This prevents a control operation happening when the vehicle (for example) is stopped at traffic lights and the ride height is above the mean axle due to the pitching motion on the rear axle.

Drive

The Drive mode is activated for E39/E53 single axle air suspension when a speed signal of >4km/h is recognized. The Drive mode is recognized from >1km/h for the E65/E66 single axle air suspension and for the E53 twin-axle air suspension system.

Low pass filters are used. In this way, only changes in ride height over a prolonged period of time (1000 seconds) are corrected. These are merely the changes in ride height, caused by vehicle compression and a reduction in vehicle mass due to fuel consumption. The high pass (fast) filter is used during the control operation. The slow filters are recognized at the end of the control operation. The slow filters are re-initialized at the end of the control operation. The markedly dynamic height signals caused by uneven road surfaces are filtered out.

Kerb (Curb) Mode

The Kerb mode prevents the inclination caused by the vehicle mounting an obstacle with ine wheel from being compensated. Compensation would cause a renewed inclination of the vehicle and result in a renewed control operation after the vehicle comes off the obstacle.

The Kerb Mode is activated when the height difference between the left and right sides of the vehicle is > 32mm for the E65/E66 with single axle air suspension and >24mm for the E39/E53 with single axle air suspension and lasts longer than 0.9s. Twisting (also over both axles) > 45mm must occur for the E53 with twin axle air suspension.
There must be no speed signal present. The system switches from single wheel control to axle control.

The Kerb mode is quit when the difference between the left and right sides of the vehicle is < 28mm for the single axle air suspension and lasts longer than 0.9s when the speed is greater than > 1km/h.

If the system switches from Kerb mode to Sleep mode, this status is stored in the EEPROM.

If the vehicle is loaded or unloaded in Kerb mode, the mean value of the axle is calculated by the control unit. The value is calculated in the control unit from the changes in ride level of the spring travel on the left and right sides.

A change in ride level is initiated if the mean value of compression or rebound at the axle is outside the tolerance band of +/- 10mm. The left and right sides of the vehicle are raised or lowered in parallel. The height difference between the two sides is maintained.

Curve

Since rolling motions have a direct impact on the measured ride level, an unwanted control operation would be initiated during longer instances of cornering with an appropriate roll angle in spite of the slow filtering of the Drive mode. The control operations during cornering would cause displacement of the air volume from the outer side to the inner side of the curve. Once the curve is completed, this would produce an inclination which would result in a further control operation. The Curve mode prevents this control operation whereby when cornering is recognized slow filtering is stopped and a potential control operation that has started is terminated.

The Curve mode is activated for the E65/E66 single axle EHC and for the E53 twin axle suspension for a lateral acceleration of > 2m/s^2 and deactivated at < 1.5 m/s$^{2.}$

The lateral acceleration is recorded by the rotation rate sensor.

Lift

The Lift mode is used to prevent control operations when a wheel is changed or during work on the vehicle while it is on a lifting platform.

This mode is recognized when the permitted rebound travel at one or more wheels is exceeded. For the E65/E66 the limit is > 55mm.

A “jack” situation is also recognized when the ride level is stored and the lowering speed drops below the value of 2 mm/s for 3 seconds.

If the vehicle has been raised slightly and the permitted rebound travel has not yet been achieved, the control operation attempts to readjust the ride height. If the vehicle is not lowered, a car jack situation is recognized after a specific period of time and this ride height is stored.

A reset is performed if the vehicle is again 10 mm below this stored ride height.

Transport

The Transport mode is set and cleared by means of a diagnosis activation. It serves to increase the ground clearance in order to ensure a safe transportation of vehicles on transporter trucks. The nominal height of the vehicle is raised in this mode by 30 mm.

When the Transport mode is activated, the air suspension symbol is indicated in the variable telltale in the instrument cluster and a text message is output in the Check Control Display.

Control operations do not take place in this mode because the vehicle mass does not change during transportation.

Belt

The Belt mode is set for mounting on the belt in order to avoid control operations.

When the Belt mode is activated, the air suspension symbol is indicated in the variable telltale in the instrument cluster and a text message is output in the Check Control display.

The Belt mode is cleared by means of a diagnostic activation only. The Belt mode can no longer be set.

New control units are supplied with the Belt mode set.

Control operations are not performed, the safety concept only operates with limited effect.

The Belt Mode is also known as “Band Mode” or “Assembly Line Mode”.

Operating Principle

Initialization/Reset Performance

When the control unit is powered up after a reset (such as an undervoltage < 4.5 V or by a load cutoff), different tests and initializations are performed. This system is only enabled after the tests have been successfully completed and starts to execute the control programs on a cyclical basis.

Occurring faults are stored and displayed.

Control Sequence

In an ongoing control operation, the high pass filter (fast filter) is always used to prevent the controlled height from overshooting the nominal value. If a low pass filter (slow filter) were used to calculate the ride height, brief changes of ride height would be consumed. The low-pass filter is used while the vehicle is driven. This type of filtering filters out vibrations which are excited by the road surface.

The high pass filter is used to respond quickly to ride level deviations from setpoint. These take place while the vehicle is stationary in the event of large load changes.

Both sides of the vehicle are controlled individually, i.e. even the setpoint/actual value comparison for both sides is carried out individually. Exception: check for undershooting of the minimum height in Pre-mode and Kerf mode: consideration of the left and right mean values in each case.

The following stipulations are applicable here:

- Raising before lowering
- Activation of all valves with control in the same direction
- Individual wheel deactivation

To ensure safe closing of the non-return valve in the air drier, the drain valve is actuated briefly for 200ms after the control operation has ended.

The permissible ON period of the components is monitored while control up operation are executed.

Safety Concept

The safety concept is intended to inhibit any system malfunction, particularly unintentional control operations, through monitoring of signals and function relevant parameters. If faults are detected, the system is switched over or shut down depending on the affected component. The driver is informed of existing faults via the display. Detected faults are stored for diagnostic purposes.

In order to ensure high system availability, existing faults, as far as possible, are cleared with terminal 15 ON. This is done by resetting the fault counter to zero. However, the fault memory content in the EEPROM is retained and can be read out for diagnostic purposes. The system is then operational again. The fast troubleshooting helps to detect existing faults before control operation can take place.

Only lowering is permitted if:

- The permissible supply voltage of 9 volts is undershot
- The permissible compressor running time of 480 seconds is exceeded.

A reset takes place if the voltage is in the OK range of 9 to 16 volts or after the compressor pause time of 100 seconds has elapsed.

Only raising is permitted if:

- The permissible control down period of 40 seconds is exceeded
- The reset takes place the next time the vehicle is driven or after the next control up operation.

No control operation takes place if:

- The permissible supply voltage of 16 volts is exceeded

The reset takes place as soon as the voltage is in the OK range.

Workshop Hints

Ride Height Measurement

When checking vehicle ride height with EHC, measure from the lower edge of the wheel opening to the center of the wheel hub.

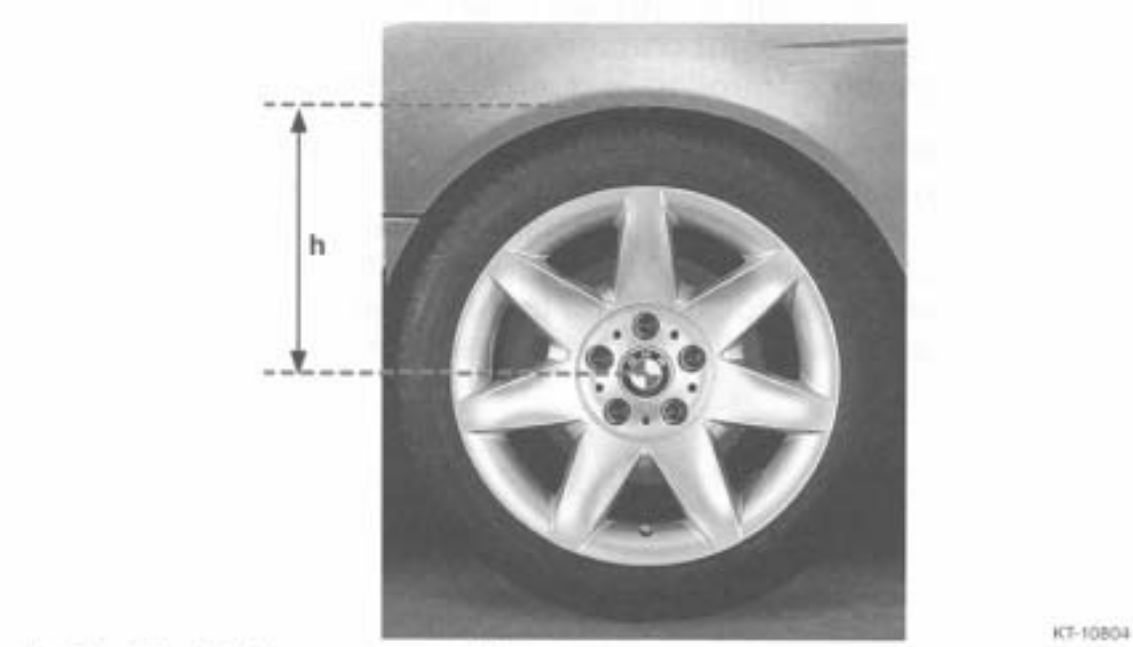


Fig. 23: Ride height measurement (h)

Diagnosis

Diagnostic items can be found in the “Control Unit Functions” path when using the DISplus or GT-1. The functions available are Identifcation (ID page), Read/Clear Fault Memory, Read Test Codes, Diagnosis Requests and Component Activation.

Service Functions

In the Diagnosis Program, there are numerous Service Functions that can be performed for the E65/E66 EHC system. By entering into the “Function Selection” program and following the “Chassis - Pneumatic Suspension” path all of the Service Functions are listed. The Service functions include Ride-Level Offset, Transport Mode and Band Mode.

Review Questions

1. The EHC control module on the E65/E66 is connected to the _____ Bus.
2. List the operating modes that are specific to the E65/E66 Air Suspension System:

3. Why is the accumulator needed on the dual axle EHC system?

4. List the components specific to the Dual Axle EHC system:

5. Which 2 Buses system are connected to the EHC control module on the Dual Axle EHC system?

6. What components are replaceable on the LVA?

7. What are the 3 possible ride height setting on the Dual Axle EHC system?

8. What type of sensor is used for ride height measurement?

9. How much pressure is in the rear air strut on the E66 when it is stored?

10. List the correct color for the air hoses on the EHC I system:

    Left _____ Right _____

11. The “Band Mode” is also known as _____

    and _____

12. What operating modes are specific to the Dual Axle EHC system?

13. What is the maximum system pressure on the EHC I system (E39/E53)?

14. What is unique about the rear air struts on the E66?

15. What is the maximum air pressure of the air supply unit on the E53 with Dual Axle Air Suspension?