SERVICE TRAINING COURSE NP04

JAGUAR

TRAINING PROGRAM

2004 MODEL YEAR NEW XJ TECHNICAL INTRODUCTION

NP 04

Excerpt: AIR SUSPENSION & ECATS

PUBLICATION CODE – NP04

AIR SUSPENSION

System overview

The new air suspension system offers the best ride, handling characteristics and assists in reducing ride float.

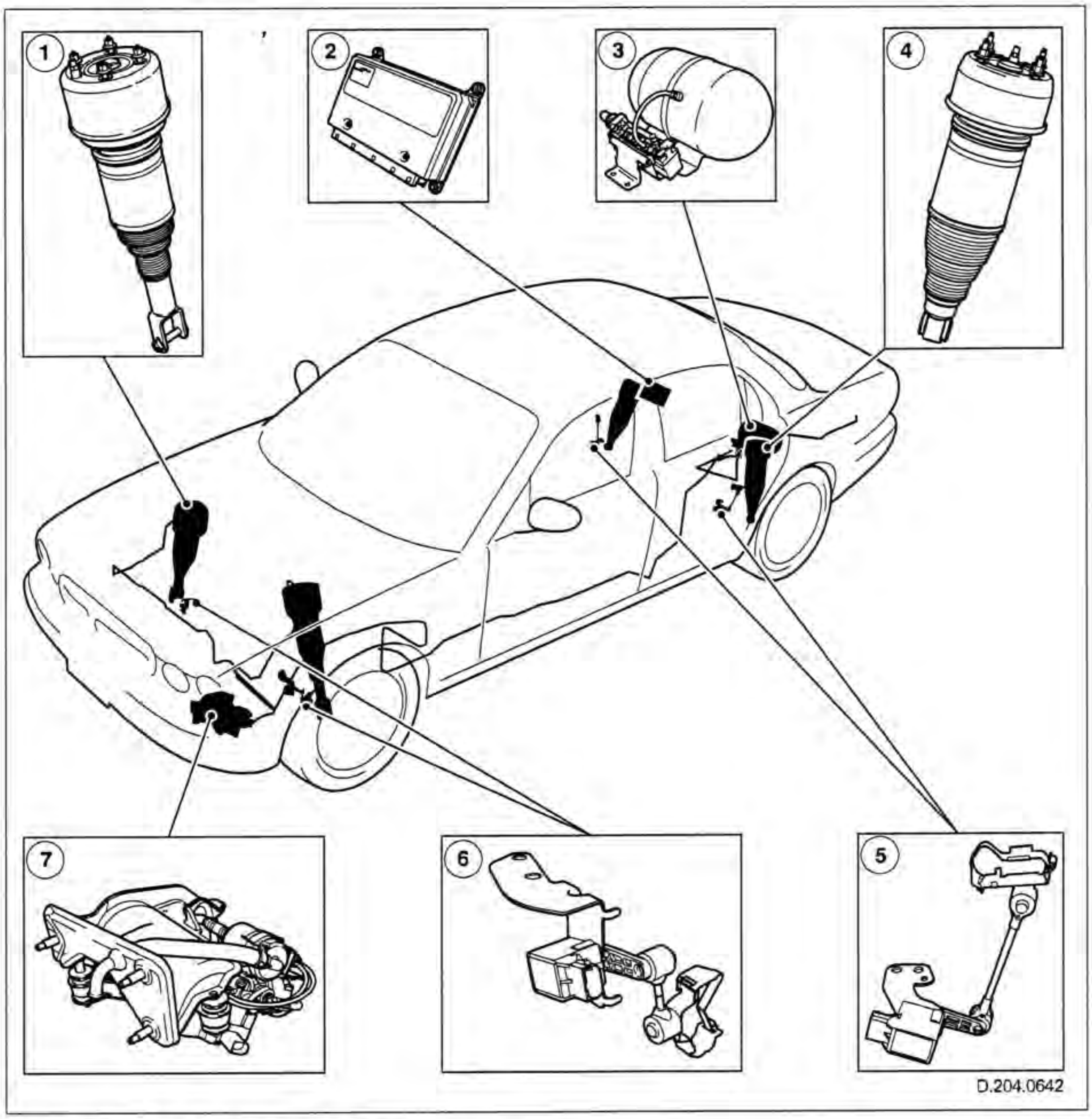


Fig. 221 Air Suspension Components

1. Front air spring and damper assembly
2. Air Suspension Module (ASM) assembly
3. Air reservoir and valve block
4. Rear air spring and damper assembly
5. Rear height sensor
6. Front height sensor
7. Air compressor

The low weight of the X'350 means its payload is a higher percentage of the total vehicle weight. To cope with a large payload a coil sprung vehicle would need either a high wheel rate or an increase in unladen height. The compromises in ride height need by conventional steel sprung suspension systems do not exist with the X350's air suspension system.

The XJ air suspension system is not an active suspension system but a system in which the air bladders replace the conventional coil springs.

AIR SUSPENSION COMPONENTS

System Components

The system components consist of the follow items:

- Control Module
- Air Compressor
- Height Sensors
- Reservoir and valve block
- Valve Block
- Air spring and Damper
- Air Harness

Control Module

The CM is unique to The new XJ range and is located behind the RHR seat back.

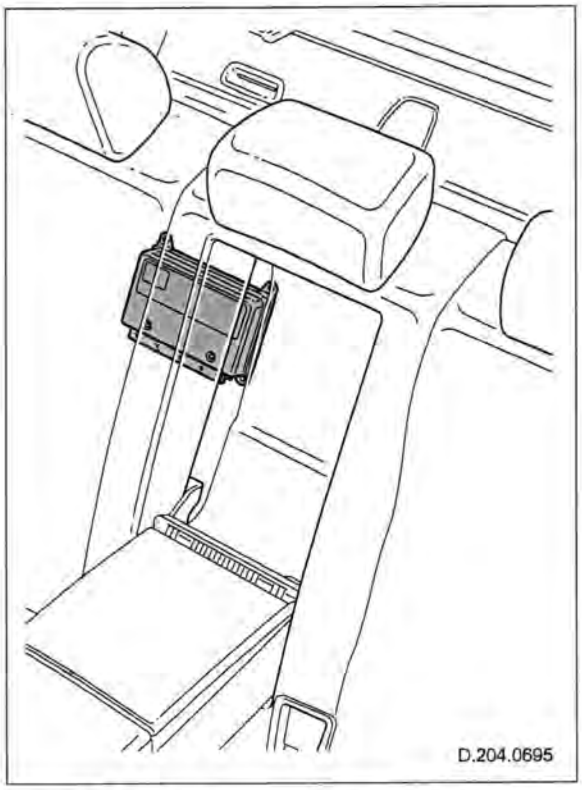


Fig. 222 Air suspension module

The control module can be recognized by the four individually colored harness connectors and the manufacturer logo (WABCO) on the case.

Adaptive damping (ECATS) and air suspension operation is controlled via the air suspension control module.

Module calibration is required when either a replacement module is fitted, or if any height sensor is removed and refitted or replaced.

Calibration involves the measurements from each corner of the vehicle to be entered into WDS and then a calculation of the correct height is evaluated from the input data.

The calibrated trim height (standard ride height) is taken from the road wheel centre to the wheel arch eyebrow.

WDS is used for ride height checks and requires a procedure to be performed prior to checking the ride height datum points.

The control module voltage requirement is between 9-16 volts with a typical operation voltage being around 12-14 volts.

Air Compressor

The single piston high pressure air supply compressor pump is located forward of the left front wheel arch behind the bumper beam assembly.

The compressor assembly has an intake air filter, an integral regenerative air drier element and an air exhaust solenoid valve.

Nominal pressure developed by the compressor system is 15 bar (218 psi).

A compressor pressure relief valve is fitted and set at 17.5 bar (254 psi).

The compressor system is mounted on an isolated subframe to ensure the quietest possible system operation.

A pressure retaining valve (PRV) ensures a minimum pressure of 3 bar (43.5 psi) is maintained within the air supply system.

NOTE:

It is important to understand that the compressor operation only occurs whilst the engine is running.

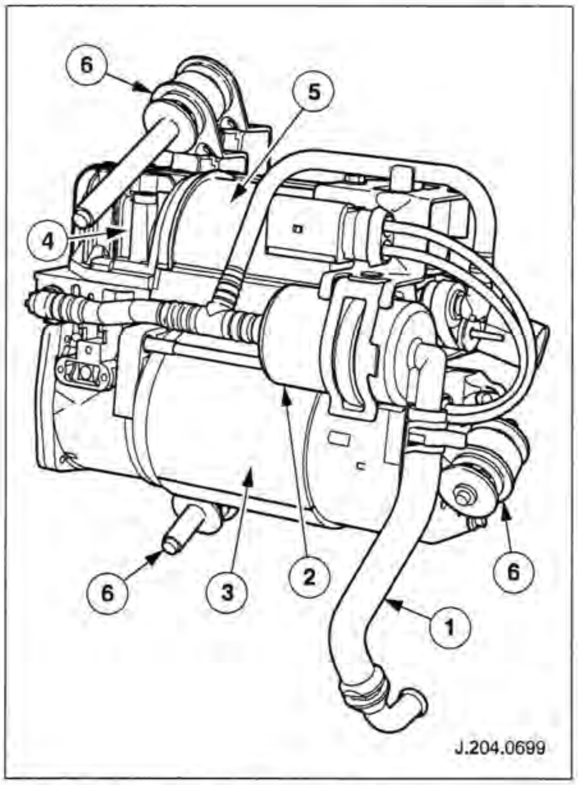


Fig. 223 Air compressor

1. Air intake/outlet snorkel
2. Filter
3. Motor
4. Piston cylinder head
5. Air drier
6. Mountings

Compressor Cooling

Another important point to remember is that the compressor only operates for a maximum of two minutes to control piston and cylinder head temperature.

In the majority of cases the compressor will only run when the vehicle is moving above 25 m.p.h. (40 km/h) and will be inhibited when the vehicle speed is lower than 18mph (30km/h).

An algorithm based on compressor run time versus temperature generated per second is used to guard against compressor overheat conditions. The ambient temperature sensor signal is used in the calculation of compressor temperature.

Should the algorithm dictate the temperature has exceeded a pre-determined value and is too hot, then the compressor is shut down to allow it to cool.

The time limit before being allowed to re-run depends on vehicle activity and is generally around 30-40 seconds but no longer than 120 seconds maximum.

There are times when the engine management system will request an air suspension inhibit. This is via the ECM load management feature thereby protecting battery load being too excessive.

The above should only be for a few seconds whilst cranking and normally the compressor only runs when the vehicle is moving unless the vehicle ride height is low.

Height sensors

The Hall effect (using a ring magnet design), single channel height sensors.

There are four height sensors per vehicle and these are mounted on the front and rear subframe assemblies.

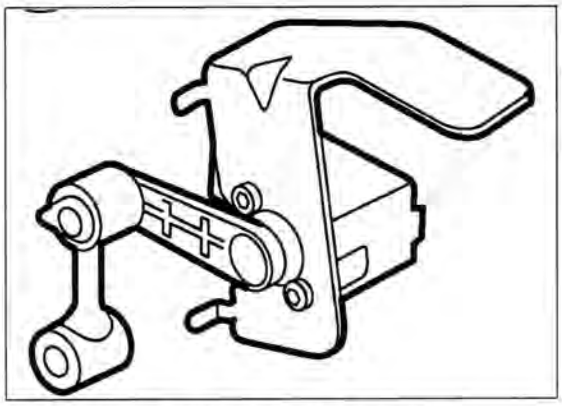


Fig. 224 Front height sensor

The height sensor is linked to the suspension arm by a drop link connection and spring clip secured.

Height sensor brackets are handed and therefore can only be fitted in one position due to the 'Poke Yoke' design.

Each height sensor uses 3 pins for height sensing; supply, ground and feedback. The remaining three pins are for dual channel sensors.

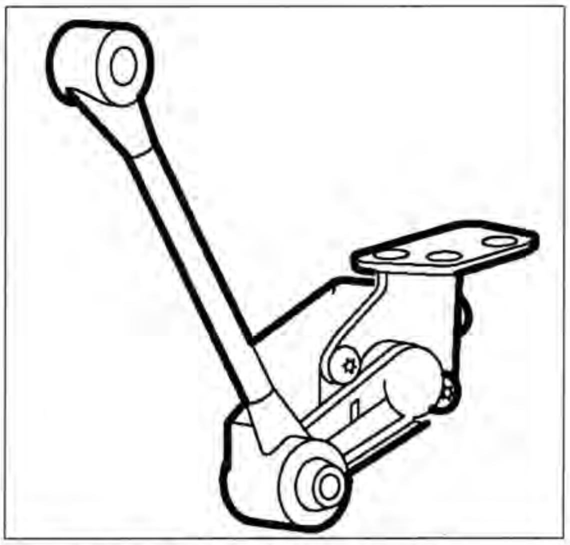


Fig. 225 Rear height sensor

Height sensing for HID is sent from the Wabco control module to the HID circuit.

The air suspension control module supplies height sensor with 5 volts in pairs diagonally.

Height sensor feedback voltage range to the air suspension control module is between 0.5v - 4.5v.

Although the readings from the sensors are in 0 - 5v range the voltages are inversed between the axle sets, i.e. one side will read 0.5 - 4.5 volts range whilst the opposite will display 4.5 - 0.5 volts range.

This means the voltage values are the same diagonally. The inverse voltage effect occurs due to the mounting position of the sensor.

The arm operates through a 35° arc either side of zero (2.5 volts approximately).

NOTE:

Height sensors require calibration if removed and refitted or replaced.

Height sensor circuit has software filters for different operating characteristics, e.g. at times fast changes are required to respond to changes in levelling, whilst at other times very small changes take place over a long distance.

These two differences can be thought of as loading or un-loading the vehicle (fast filter) or fuel level being emptied (slow filter).

NOTE:

When checking geometry a procedure has to be invoked via WDS prior to any ride height measurements being taken.

Once the control module drops out of setting mode the system will automatically level to the standard ride height.

Reservoir and valve block

The valve block and reservoir units are both located in the luggage compartment within the spare wheel well and situated underneath the spare wheel.

These components are contained under a cover for protection. This cover also aids reducing valve block noise and therefore should be in place at all times.

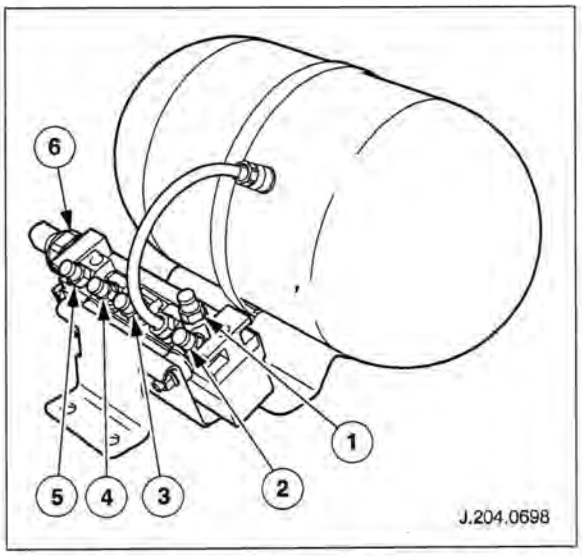


Fig. 226 Reservoir and valve block

1. Air compressor port
2. Air spring port — LH rear
3. Air spring port — LH front
4. Air spring port — RH rear
5. Air spring port — RH front
6. Pressure sensor

WARNING:

Do not work on any pressurized system components unless the system is allowed to depressurize before performing any repairs. Re-pressurization can be accomplished using WDS. Failure to follow this could lead to body injuries.

Reservoir

The reservoir has a volume of 4.5 liters with a maximum design pressure of 15 bar (217 psi).

When fully charged the reservoir is capable of at least one full vehicle lift at G.V.W.

The air supply compressor is used to recharge the reservoir once the pressure has been depleted to its lower limit. The recharging process should take no longer than two minutes.

The air suspension system does not deplete the reservoir contents below 9 bar (145 Psi) under normal operating conditions.

This means that the system is operating within a pressure range. This is done to prevent the air pressure held in the air springs from being transferred into the reservoir.

Valve Block

The valve block (serviceable as a complete unit) contains five individual solenoid valves. One for each of the four air springs and one for the reservoir.

A pressure sensor is incorporated into the valve block manifold and monitors system pressure.

The pressure sensor is not a serviceable component and requires a complete replacement valve block assembly if faulty.

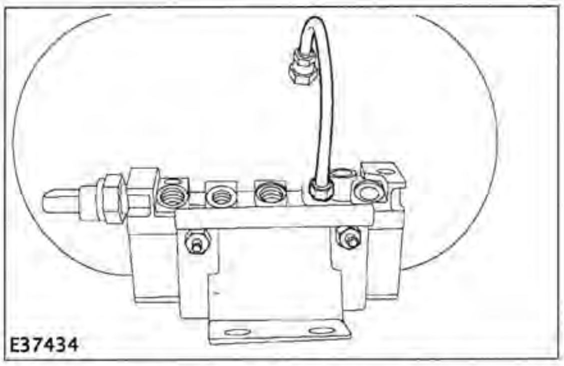


Fig. 227 Valve block with air hose

The valve block is mounted on serviceable rubber isolators which assists in reducing solenoid valve operation noise.

Replacement pipe connections are provided as service items for the front and rear air spring units, reservoir, valve block and air compressor unit.

Air spring ports and pipe work are 6mm diameter for front air springs and 4mm for rear air spring and air compressor units.

Each pipe connection is color coded to the air harness for ease of identification.

Air Spring and Damper

Vehicle attitude is controlled by operation of four Bilstein air spring and damper units via the use of various operating modes.

There are two derivatives of the air spring:

- Comfort - Higher volume = softer
- Sport - Lower volume = stiffer

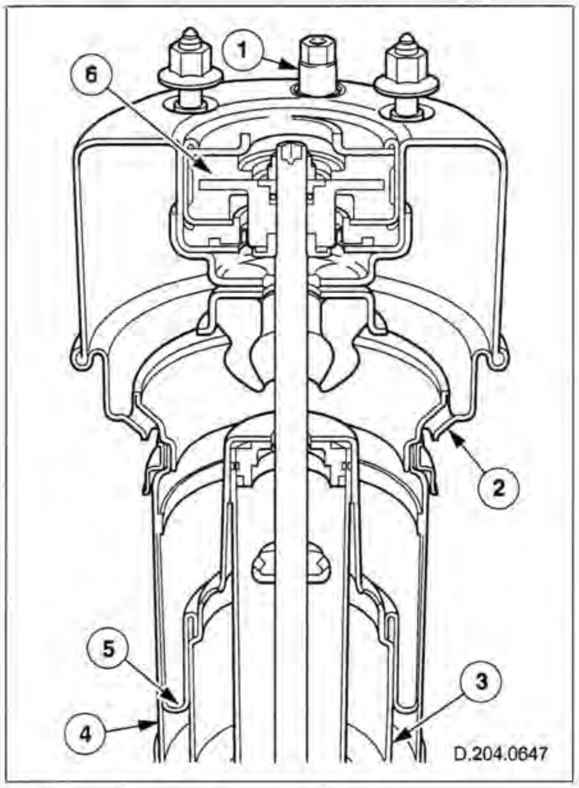


Fig. 228 Air Spring cut-away

1. Retaining valve
2. Isolator
3. Piston
4. Outer sleeve
5. Rolling bellows membrane
6. Top mount

The air spring burst pressure is around 40 bar (580 psi) with normal running pressure around 7-9 bar (101.5-130.5 psi).

Maximum 'full bump' spring pressure at gross vehicle weight (GVW) is in the region of 20 bar (290 psi).

Utmost care is required when removing and refitting air spring and damper units so as not to damage the top mount diaphragm seal.

Whilst working with the air spring and damper assembly ensure no twisting between the air spring top pot and damper clevis occurs as this will result in damage to the sleeve.

The air spring has a pressure retaining valve (PRV). The purpose of the valve is to retain 3 bar (43.5 psi) within the air spring at all times which offers protection to the air spring membrane by preventing it from creasing.

Depressurization using WDS is required prior to any service work being carried out.

Re-pressurization via WDS is also required after the work has been completed.

Air spring assemblies outside of warranty requires a manual process for releasing the retained air pressure. Refer to JTIS.

Air Harness

The pipe tubing is manufactured from Polyamid (Nylon) which has good properties for abrasion resistance.

Front air spring and air compressor unit pipe work is routed under floor from the spare wheel well to the left hand front wheel arch and air spring tops under bonnet.

Removal of the under floor air harness requires the fuel tank and rear suspension subframe removing from the vehicle.

The rear air spring pipework is routed inside the electrical Telematics harness within the luggage compartment.

Localized damage can be repaired using sectional replacement tubing and in-line connectors. It is important to ensure that pipework is kept away from any potential heat source.

Any pipework needing repair has to be cut square to the tube using a guillotine type cutter, part number LRT 60-002 (Snap-On part number YA1000A).

Pipe burring or deformation and any length wise scoring or scratches must be avoided at all cost as this could lead to a potential leak.

CAUTION:

Pipes are color coded to match valve block. Once the pipe is cut this color match is lost. Care must be taken to identify the correct pipe to the correct valve block port.

Air lines color identification

- Left rear — Blue
- Left front — Brown
- Right rear — Red
- Right front — Yellow

AIR SUSPENSION OPERATION

The air suspension control module receives vehicle attitude signals from four Hall effect height sensors connected to the individual suspension control arms.

From this information the control module will decide whether to raise or lower the vehicle body to maintain a level attitude.

Load changes mainly occur when the vehicle is stationary before or after a driving period.

Loads do not normally change whilst driving apart from fuel usage over a long distance.

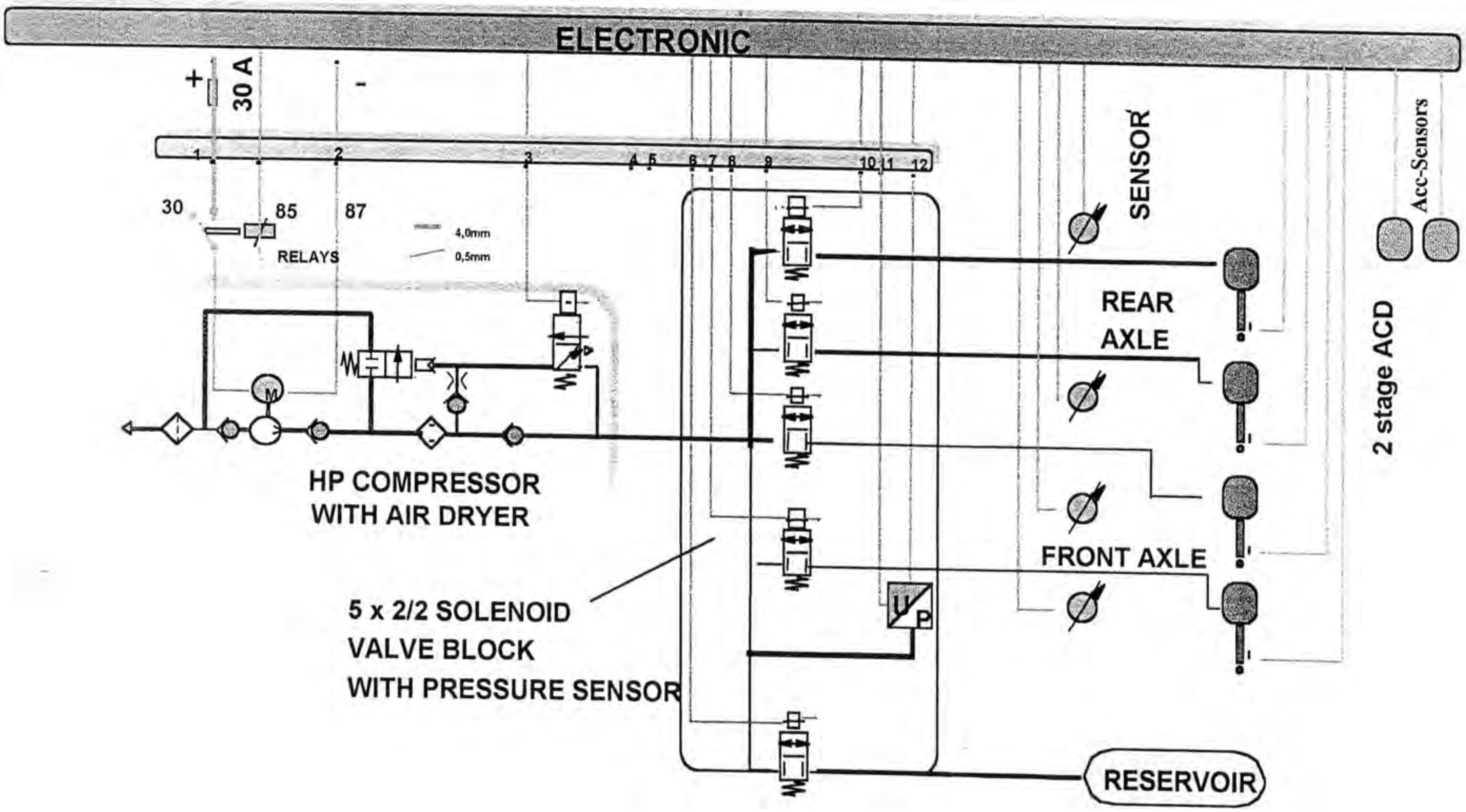
Should the vehicle require raising, then the system utilizes the reserve air supply contained within the reservoir if below 25 m.p.h. (40 km/h).

However if the reservoir is unable to supply demand then in extreme cases the compressor will be activated, i.e. Vehicle Too Low.

In normal circumstances the compressor only operates at vehicle speeds above 25 m.p.h. (40 km/h). Below this speed threshold the residual pressure held in the reservoir is utilized.

If reservoir pressure is insufficient then the levelling action is inhibited until the vehicle speed of 25 m.p.h. (40 km/h) is acquired. At this point the air compressor will raise the vehicle and then the reservoir will be replenished once vehicle levelling has been completed.

X350 Air Suspension
Circuit Diagram



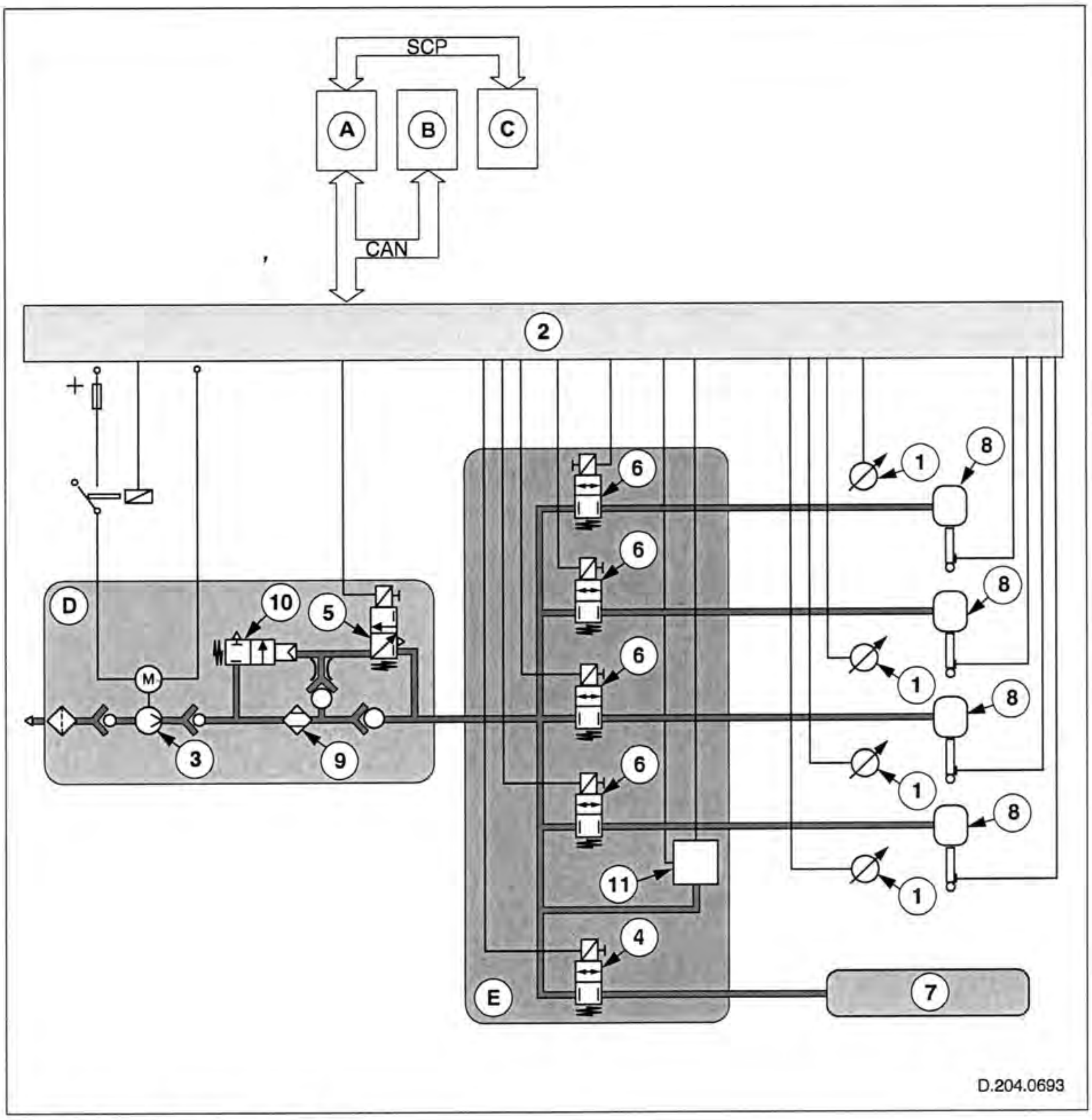


Fig. 229 System diagram

A. Instrument cluster — provides signals of system status
B. ABS modules — provides vehicle speed signal
C. REM — provides trailer tow signal, brake switch on/off status, and system switch power signals
D. Air compressor unit
E. Valve block

1. Height Sensors
2. Air suspension module
3. Air Compressor assembly
4. Reservoir solenoid
5. Vent solenoid
6. Air spring solenoid valves
7. Reservoir
8. Air springs
9. Air drier
10. Relay valve
11. Pressure sensor

Compressor Operation

Air in:

- Inlet pipe through filter
- Piston pump chamber
- Through drier
- To valve block

Valve block air venting:

- Air spring solenoid valve
- Compressor exhaust valve

Under normal circumstances front air springs operate as a pair whilst the rear units operate individually.

This is due to how the vehicle is loaded. The front loading remains fairly constant whilst at the rear loads can change quite dramatically with side to side loading being completely different.

When lifting a vehicle, the rear air springs are operated first, followed by the front units until a level vehicle is indicated.

This is because occupants do not like the front of the vehicle rising before the rear. This lifting and lowering method achieves a preferred condition.

Should in extreme cases where the vehicle height is very low, then the system will alternate between rear and front until level.

Trailer Towing

The connection of a camper or vehicle transporter to a Jaguar trailer pack disables the speed lowering strategy but will allow vehicle levelling functionality.

Levelling

The system will not attempt to level whilst braking, accelerating and cornering. Signals are:

- Braking - Pressure Transducer and Switch
- Cornering - Lateral Accelerometer (Teves)
- Acceleration - Engine Torque Signal

OPERATIONAL MODES

The air suspension system has a number of different modes of operation; these are as follows:

- Sleep mode
- Preliminary mode
- Post Mode
- Stance mode
- Drive mode
- Speed lowering mode
- Transportation mode
- Jacking mode
- Inclination mode
- Trailer mode
- Curve mode
- Geometry mode
- Vehicle too low mode
- G.V.W. mode

Sleep Mode

Sleep mode is invoked approximately ~~40~~ 30 minutes after key off and the last door or luggage compartment activity Switch System Power (SSP) has been detected.

The system will wake up periodically (24 hours) and monitor vehicle height and adjust if required. Adjustments will have been made because of temperature changes.

In sleep mode only lowering corrections are permitted which balances the vehicle height to the lowest corner.

Preliminary Mode

The preliminary mode uses quite a wide tolerance band for height control.

This mode is activated when luggage compartment, door or ignition activity is detected on the SCP bus.

Lift correction is via reservoir source only and lowering corrections are permitted.

The fast filter strategy is employed for vehicle levelling.

Post Mode

Post mode is used because ride height will change with temperature. As the air cools towards ambient the vehicle will lower.

Under these circumstances the system will correct the ride height to compensate for the change.

Stance Mode

The stance mode uses a tighter tolerance band for control of vehicle height than used in the preliminary mode.

This mode occurs when the is engine running and a zero road wheel speed is detected.

Lifting correction is from the reservoir supply. However if the vehicle is too low, compressor operation is permitted for corrective action.

Fast filter strategy is employed, and therefore the system reacts quickly to changes in vehicle height, i.e. luggage in or out.

Drive Mode

In drive mode the tolerance band is tighter than the previous two modes.

Slow filter application is used where the vehicle is moving above 0.62 m.p.h. (1.0 km/h) and the system increases the filter time to avoid unnecessary corrections to height changes.

NOTE:

Although the slow filter is applied whilst in drive mode, should a height correction be required, then the fast filter strategy is invoked.

The same applies if a braking or acceleration signal is detected. The system will not attempt to correct the body attitude, i.e. not an active suspension system.

Speed lowering mode

Speed lowering is where the vehicle is automatically lowered to a predetermined amount at specific road speeds. This improves vehicle aerodynamics and in return enhances fuel consumption.

- 0-105 m.p.h. (0-170 km/h) (Standard height)
- >105 m.p.h. (170 km/h) (Standard height -15mm)

Reducing the speed to below 80 m.p.h. (130 km/h), the vehicle will automatically default to the standard ride height.

Transportation Mode

In this mode the vehicle will be raised to a preset transportation height 20mm above standard ride height to allow secure vehicle transportation. Vehicles will require setting into customer ride level mode at PDI using WDS.

Transportation mode is ignition key initiated, engine running for normal ride height and key-off for transportation height. Whilst in transportation mode the Air Suspension Fault message will be illuminated and a DTC will be logged.

NOTE:

Vehicles should be flat bed transported and tied down using the road wheels not the body.

Jacking Mode

The system recognizes customer vehicle jacking and vehicle ramp operation.

The result of detecting either condition is to inhibit any corrective action from height changes where no response is detected.

System inhibit is to prevent problems occurring with the vehicle lowering and a possibility of the jack or vehicle becoming stuck.

The system monitors height changes at the corner being jacked up.

If the system lowers the air suspension but no reduction in height is achieved, the system will time out at approximate 10 seconds.

If all four height sensors change by preset values, the system will recognize the vehicle is being lifted on a hoist and initializes the inhibit function.

Inhibit mode will continue to exist unless the vehicle height returns to normal or a wheel speed signal 2 m.p.h. (3 km/h) is detected.

The above events are triggered by either the height sensor arm change in position or a wheel speed message on the CAN bus.

Inclination Mode

This occurs where the vehicle is parked on a kerb and the system provides corrective action using an average of left and right ride height values thus avoiding vehicle lean when driven away and damaging the vehicle.

Trailer mode

Trailer mode is activated when towing and inhibits the vehicle speed lowering functionality. However, this only occurs when a Jaguar tow bar kit is fitted.

Curve mode

Curve mode occurs when the system recognizes the vehicle is cornering and consequently does not compensate for body roll through the corner.

Vehicle too low Mode

Should the warning message "VEHICLE TOO LOW" appear when stationary, do not attempt to drive the vehicle until the warning message has gone. The system may take several seconds to reach its standard ride height from cold.

G.V.W. mode

Gross Vehicle Weight (G.V.W.) mode is carried out when the ASM conducts a spring pressure check every time the vehicle levels. G.V.W. is set at a pressure of 13–14 bar (allowing for tolerances).

If the pressure recorded is at G.V.W. threshold, it will lower the vehicle 15 mm. This is to provide the customer with visualization perspective which should generally signal to the customer that the vehicle is overloaded and that no more weight should be added.

Checking vehicle ride height

All ride height measurements are carried out with a special tool (204–484) is required to check vehicle ride height.

In addition, WDS will be needed to perform this procedure which required if any components such as struts, height sensors or ASM are replaced.

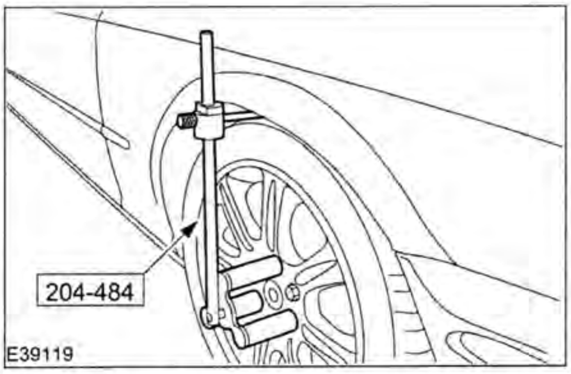


Fig. 230 Checking ride height with tool 204–484

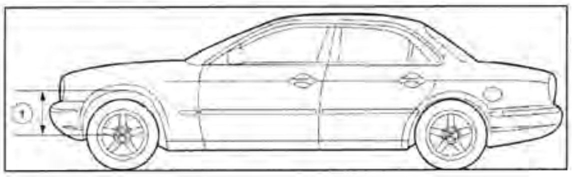


Fig. 231
1. Front Ride Height Measurement

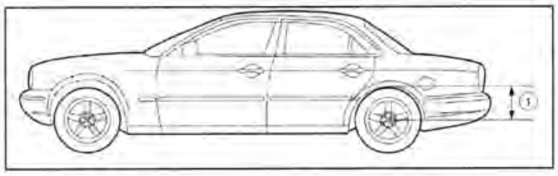


Fig. 232
1. Rear Ride Height Measurement

Mode Summary

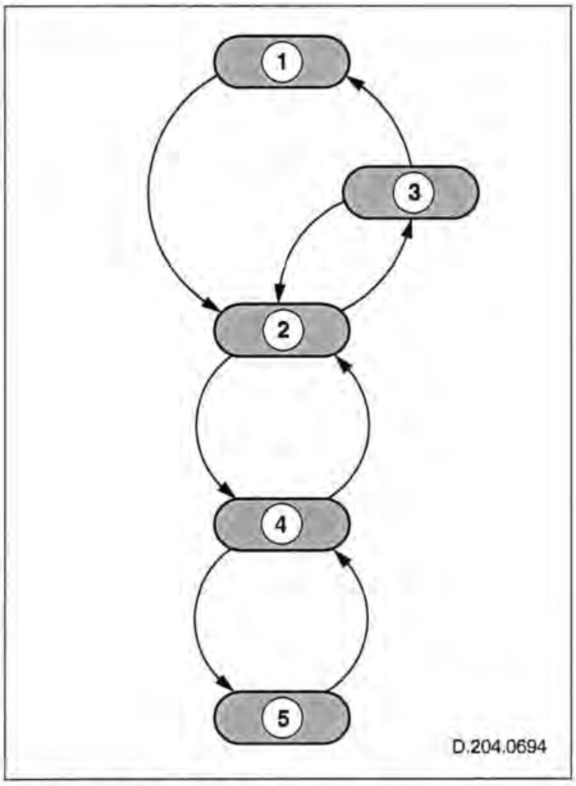


Fig. 233 Mode change process

1. Sleep mode
2. Preliminary mode
3. Post mode
4. Stance mode
5. Drive mode

Table 33 Mode Summary

MODE	VEHICLE CONDITION	SENSOR CRITERIA	COMPRESSOR STATUS	NOTES
Sleep	Static or parked with no occupant or luggage compartment loading	SSP signal low, Post mode time out occurred and compressor duty cycle algorithm has finished	Un-powered	Only lowering allowed
Prelimi-nary	Static or parked with occupant entry or luggage compartment loading activity under way	SSP signal high or preliminary time out not occurred	Un-powered, lifting via reservoir	Vehicle levelled to standard height with preliminary tolerance gaps
Post	Static or parked with no occupant luggage compartment loading	SSP signal low and preliminary time out occurred	Un-powered, lifting via reservoir	Vehicle levelled to standard height with post tolerance gaps
Stance	Static or parked	SSP signal high and engine speed signal greater than the minimum engine rpm for air suspension compressor to run	Un-powered, lifting via reservoir (compressor enabled if reservoir pressure below minimum pressure for raising and vehicle below compressor activation height)	Vehicle levelled to standard height with stance tolerance gaps
Drive	Driving	Vehicle speed limit greater than speed limit drive	Vehicle speed: <Speed limit for compressor activation 25 m.p.h. (40 km/h), un-powered lifting via reservoir. Compressor enabled if reservoir pressure below: Minimum pressure for raising and vehicle below compressor activation height. Vehicle speed: >Speed limit for compressor activation 25 m.p.h. (40 km/h). Compressor is used for lifting vehicle and filling the reservoir.	Vehicle levelled to standard height or speed lowering height with drive tolerance gaps

Table 34 Lifting Table

Mode	Tolerance	Vehicle Height <-40mm		Vehicle Height <-40 to -30mm		Vehicle Height <-30 to -10mm		Ride Height Filter
Reservoir Volume		Charged	Not Charged	Charged	Not Charged	Charged	Not Charged	
Pre	+15 to -30 mean figure	Reservoir Lift	No Lift	Reservoir Lift	No Lift	No Lift	No Lift	Fast
Stance	±9mm	Reservoir Lift	Compressor Lift	Reservoir Lift	No Lift	Reservoir Lift	No Lift	Fast
Drive: <compressor activation speed	±9mm	Reservoir Lift	Compressor Lift	Reservoir Lift	No Lift	Reservoir Lift	No Lift	Slow
Drive: >compressor activation speed	±9mm	Compressor Lift	Compressor Lift	Compressor Lift	Compressor Lift	Compressor Lift	Compressor Lift	Slow
Post	±6mm	Reservoir Lift	No Lift	Reservoir Lift	No Lift	Reservoir Lift	No Lift	Fast

Key Parameters

- Tolerances: Pre, Stance, Drive and Post
- Compressor activation height = -40mm
- Compressor activation speed = 25 m.p.h. (40 km/h)
- Minimum engine speed for compressor = 400 rpm

The above and any other figure quoted within this workbook can be subject to change.

WORKSHEET – AIR SUSPENSION WDS OPERATIONS

This worksheet introduces the WDS operations and looks at the transportation mode, geometry mode and calibration mode.

- Check vehicle ride height
- Switch on ignition, and run the engine, observe vehicle height and after 2 minutes record vehicle height measurements ~~410~~ LF - 404 RR - 380 RF - 386 LR - 381
- Turn off the ignition and observe vehicle height and after 2 minutes record vehicle height measurements LF - 407 RR - 390 RF - 387 LR - 380

1. What occurred with the ignition on and engine running?

The car lowered itself from transport to customer mode.

2. What occurred with the ignition off?

The front went up.

3. How should a vehicle be towed?

By the front tow eyelits

- Connect WDS to the vehicle and select the Air Suspension function
- Select the Transportation option
- Place the air suspension system into Customer Mode
- Remove WDS

Check that the vehicle operates normally and transportation mode has been removed successfully.

WORKSHEET – AIR SUSPENSION GEOMETRY MODE

1. Why do you think a geometry mode is required?

To perform alignments

- Connect WDS to the vehicle
- Select the Vehicle Height / Geometry option and follow any on screen instructions (these will be limited)
- Once completed observe the vehicle height
- Record the measurement at the maximum vehicle height
- Return the vehicle back to its standard condition and remove WDS

LF - 395 RF - 381
LR - 376 RR - 380

2. What occurred when geometry mode was initiated?

The car leveled itself

3. What do you think is the purpose for this procedure?

To make the car level
No mater what is in the
car

WORKSHEET – AIR SUSPENSION CALIBRATION MODE

In this worksheet, WDS will be used to calibrate the height sensors or control module when they are replaced or removed and refitted.

- Connect WDS to the vehicle
- Select the Air Suspension Calibration option
- Follow the on-screen instructions and note down the individual height measurements at each corner of the vehicle
- Enter the detail into WDS when requested
- Remove WDS when instructed to complete the function

1. What do you think WDS is attempting to achieve?

air system test.

2. Why is it necessary to calibrate after removing and refitting height sensors or control module?

If you replace ~~the~~ any of the air system components, this recalibrates it.

ECATS

This section will cover the changes to the CATS system, but will also cover any relevant care points as required.

ECATS is the new name for the updated CATS system.

The 'E' in ECATS means Enhanced and the system principles and operation are carry over from the 2003MY S-TYPE.

Although the system is visibly not that much different, a number of changes have occurred in the background for enhanced ride handling and customer comfort during braking and cornering events.

Accelerometers

Front vertical accelerometer location is behind right front wheel arch liner, towards the rear.

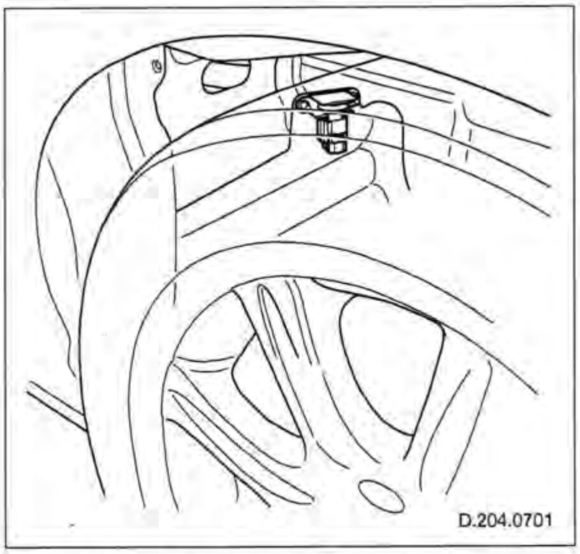


Fig. 234 Front accelerometer

Rear vertical accelerometer position in the rear luggage compartment to the right of the Telematic stack.

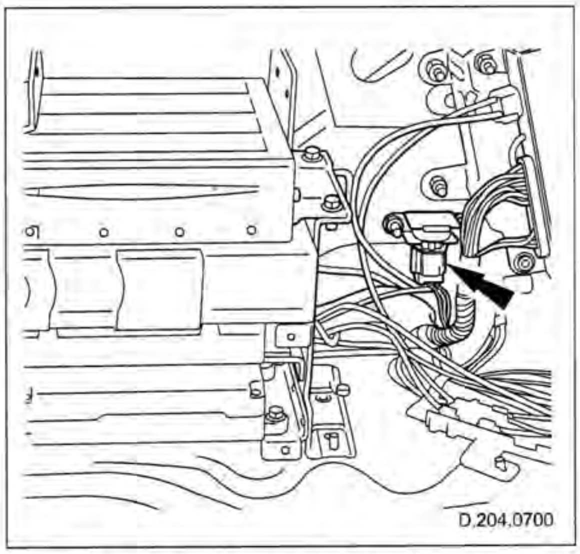


Fig. 235 Rear vertical accelerometer

The sensor location provides the CM with a good level of detection to changes in vehicle attitude.

Lateral acceleration data is provided by the Teves Mk25 control module over the CAN bus network.

ECATS Operation

The adaptive damping ride control is part of the Air Suspension Control Module (ASCM) which is located behind the rear seat back.

ASCM operating voltage is between 7 - 20 volts and has reverse voltage protection.

The vertical accelerometer signal input to the ADCM is from two Texas Instruments accelerometers, in the form of a variable voltage between 0.25v (high 'g') - 4.75v (low 'g').

The vertical accelerometers receive a 5v supply from the ASCM and the voltage output is relative to the vehicle 'g' force.

Within each accelerometer an internal contact closes under pressure by the vehicles inertia forces, the pressure acting on the contacts increases the electrical capacitance in the circuit and subsequently reduces voltage output to the ADCM.

The changing voltage to the ADCM from the accelerometers decides the strategy of the damper switching, which now has enhanced functionality.

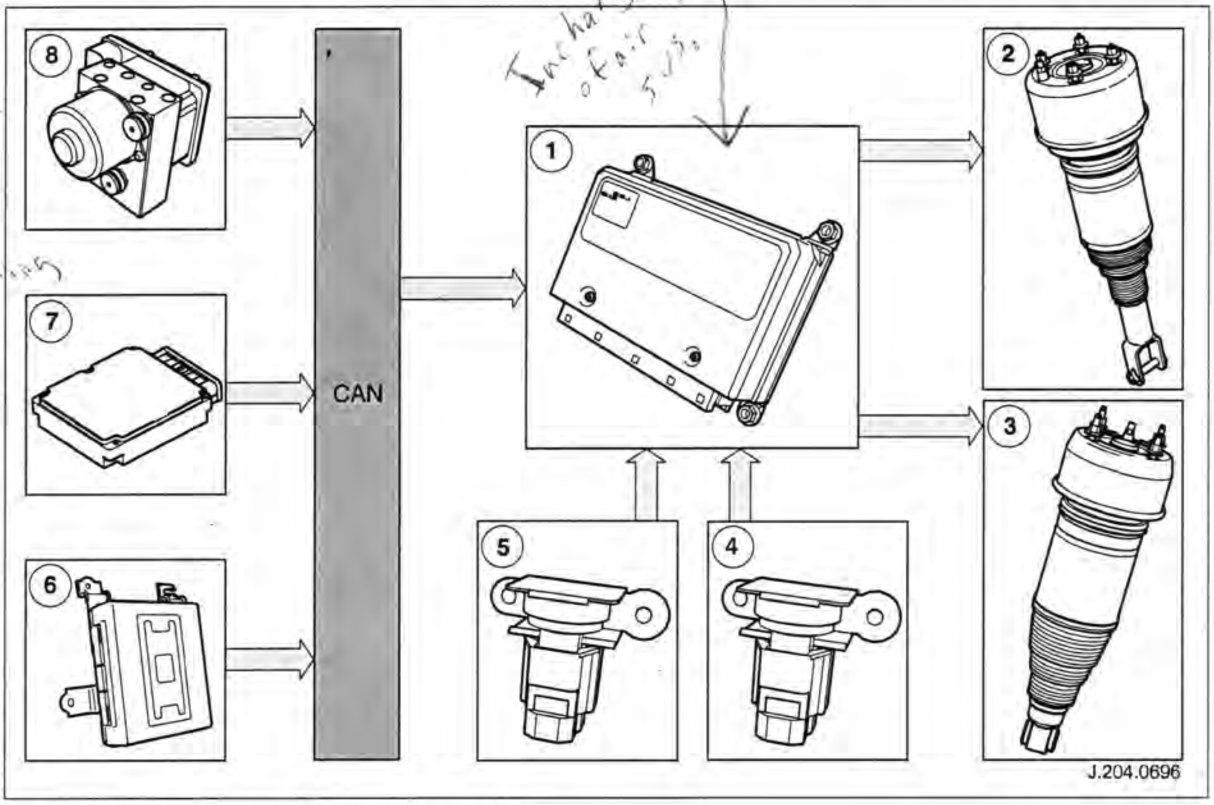


Fig. 236 Control system operation

1. Air suspension module
2. Front damper
3. Rear damper
4. Front vertical accelerometer
5. Rear vertical accelerometer
6. Climate control module
7. Engine control module
8. ABS module

When working with the accelerometers, care must be taken when handling the units as shock will damage the internal micro-mechanical components.

CAUTION:

Orientation of the sensors is very important, just 1-2° out will have adverse effects.

Damper Switching

Some of the main changes to the ECATS system is governed by the adaptive damping software and its control over the damper solenoid switching.

The damper operation and design are carry over, each unit having a 400Hz PWM, two stage (open / closed) 5.4 ohm solenoid.

Control over damper solenoid switching can be one of the following:

- All Firm
- All Soft
- Front Soft / Rear Firm
- Front Firm / Rear Soft

General Functionality

At system start-up the dampers are set to firm. This is also the default condition should an electrical fault occur within the system.

Below a predefined lower threshold speed, the setting will be switched to firm. However, above this pre-set threshold the dampers are switched to soft for vehicle ride comfort.

Above the pre-determined upper threshold speed the system is switched back to firm.

This provides vehicle stability for higher road speeds and reduces the wallow effect that a comfort setting would have at these increased road speeds.

Longitudinal

The front and rear switching is to assist in resisting anti-dive and anti-squat characteristics as the vehicle accelerates and subsequently brakes.

Inputs required to provoke this switching action are: brake switch, brake pressure (Longitudinal decceleration) and engine torque rate (Longitudinal acceleration) via the CAN bus with the appropriate vehicle speed message.

Long Wave

This is a carry over function and follows a situation where the vehicle is on a long fast straight section of road and there are undulations in the road surface.

This function is activated when both vertical accelerometers detect a balanced sinusoidal input, at which time the dampers will be switched to firm to counteract vertical body oscillations.

ECATS Switching

This is the new part of the ECATS system and involves a new strategy for controlling the damper switching between front dampers or rear dampers as an axle set, as required by the vehicle condition.

Front - Rear

The Front-Rear switching improves the behavior of the car during cornering.

At low speeds the rear dampers are switched to firm slightly ahead of the front dampers. This reduces transient understeer.

At high speeds, the dampers are switched to firm in reverse order to increase transient understeer.