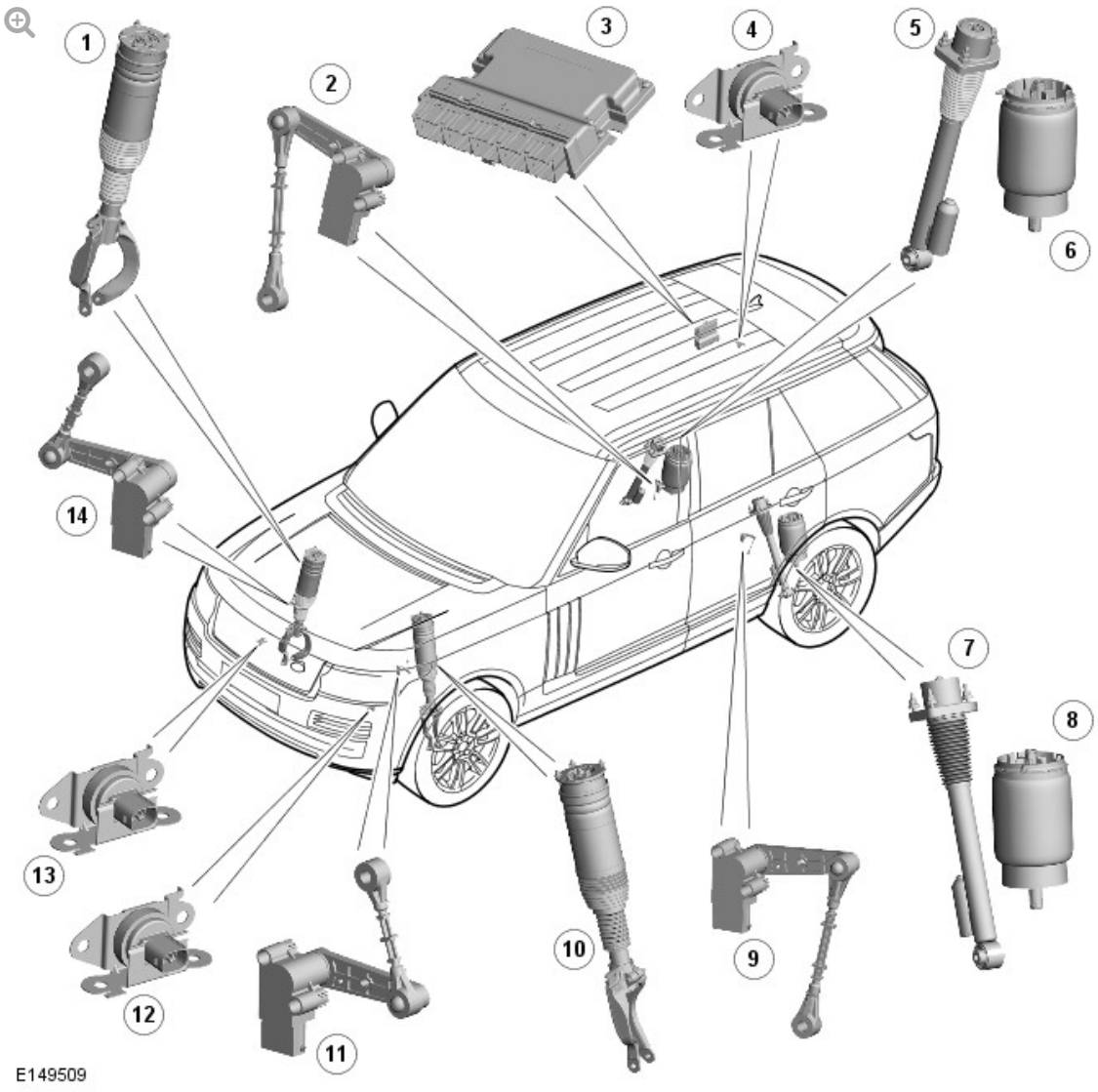
2016.0 RANGE ROVER (LG), 204-05

VEHICLE DYNAMIC SUSPENSION

DESCRIPTION AND OPERATION

ADAPTIVE DAMPING – COMPONENT LOCATION



ITEM	DESCRIPTION
1	Air spring and damper - front right
2	Height sensor – rear right
3	Integrated suspension control module
4	Accelerometer - rear
5	Damper - rear right
6	Air spring - rear right (shown for location only)
7	Damper – rear left
8	Air spring – rear left (shown for location only)
9	Height sensor – rear left
10	Air spring and damper – front left
11	Height sensor – front left
12	Accelerometer – front left
13	Accelerometer – front right
14	Height sensor – front right

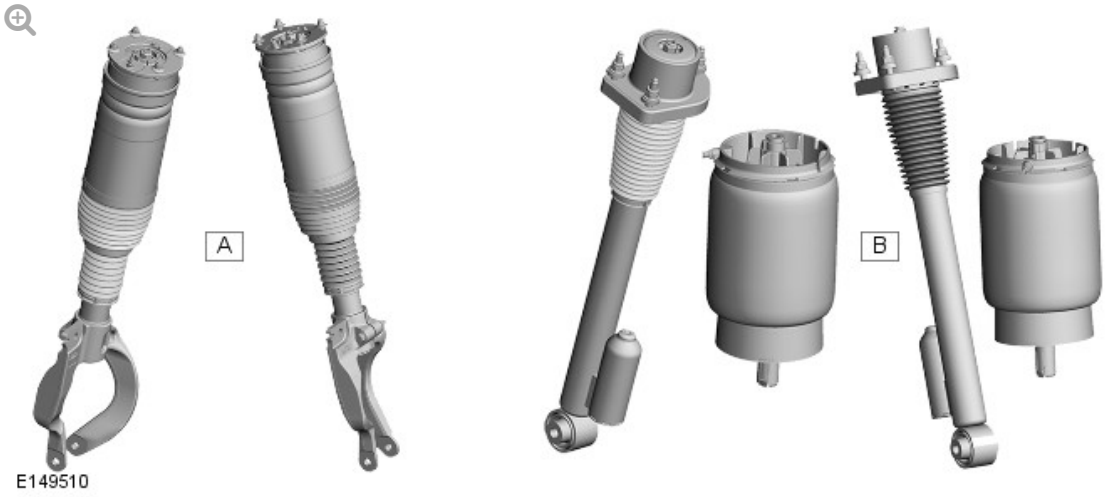
OVERVIEW

Adaptive damping is an electronically controlled suspension system which continuously adjusts the damping characteristics of the suspension dampers in reaction to the prevailing driving conditions.

The system is controlled by an Integrated Suspension Control Module. The module receives signals from three accelerometers, four suspension height sensors and other vehicle systems to calculate vehicle state, body and wheel motions and observe driver inputs. These signals are used by the control module to control the damping characteristics of each damper to the appropriate level, resulting in improved body control and vehicle ride.

DESCRIPTION

Dampers



ITEM	DESCRIPTION
A	Front damper and air spring assemblies.
B	Rear dampers (air springs shown for clarity).

The adaptive damping dampers are oil-filled, gas pressurised mono-tube units. To maintain wheel travel, the rear dampers feature an additional external accumulator. The damping force can be adjusted when the vehicle is being driven by an electronically controlled valve. These dampers provide an improved compromise between vehicle control and ride comfort than a typical passive damper. All the dampers have an electrical connector on the end of the piston rod, in the centre of the top mount.

In each damper, the damping adjustment is made by a solenoid controlled variable orifice, which opens up a secondary path for oil flow within the damper. When de-energized, the bypass is closed and all the oil flows through the main (firm) valve. When energized, the solenoid moves the armature and control blade. A spring returns the valve to its closed state when de-energized. The control blade incorporates an orifice which slides inside a housing to open up the bypass as required.

With the comfort valve energised and the damper moving into compression, some of the oil flows from the lower portion of the piston through:

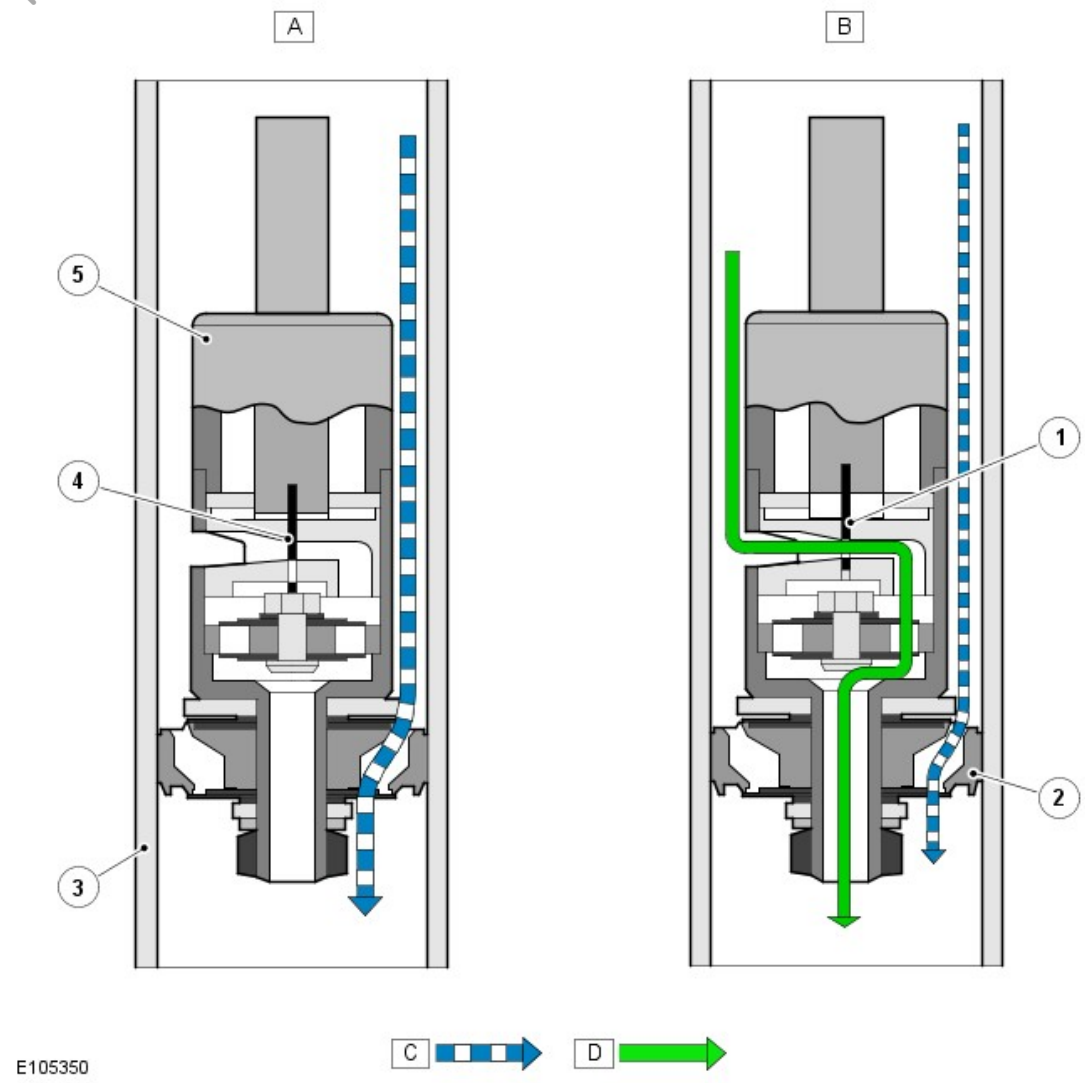
- a hollow piston rod,
- a separate soft (comfort) valve,
- a slider housing and orifice,

into the upper portion of the damper, thereby bypassing the main (firm) valve.

In rebound, the oil flows in the opposite direction. The two valves acting in parallel allow the damper to operate in a softer state.

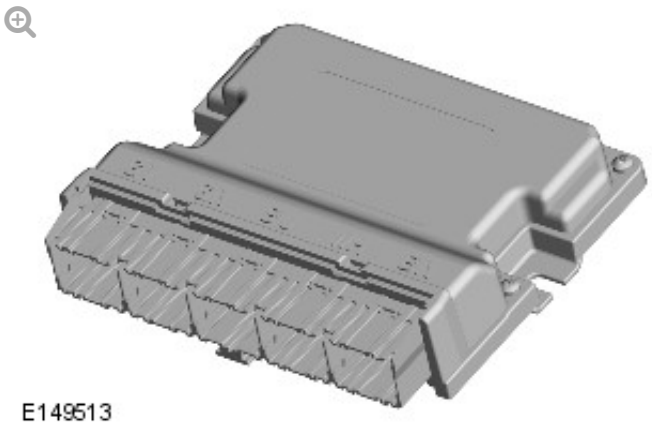
The damper operates between these two boundary conditions.

The solenoid in each damper is operated by a 526 Hz PWM (pulse width modulation) current demand from the Integrated Suspension Control Module. When fully energized, the control module applies a 1.5A current to operate the damper in the soft setting. When de-energized (0.0A), the damper transfers to the firm setting. The current varies continuously as required to increase and decrease the damping individually in each of the dampers.



ITEM	DESCRIPTION
A	Firm setting
B	Soft setting
C	Main oil flow
D	Bypass oil flow
1	Bypass valve (open)
2	Main valve
3	Tube
4	Bypass valve (closed)
5	Piston and rod assembly

INTEGRATED SUSPENSION CONTROL MODULE

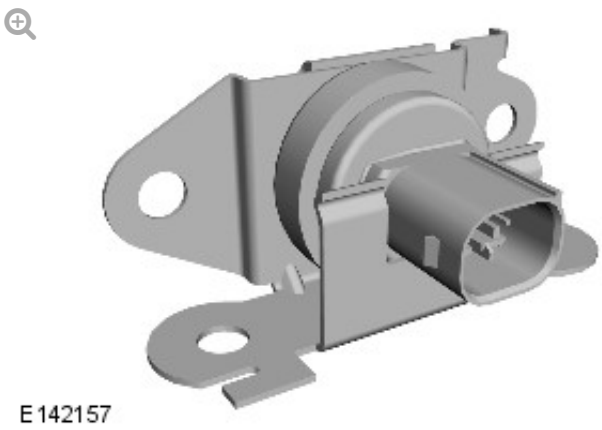


The Integrated Suspension Control Module is located in the right rear quarter panel.

ACCELEROMETERS

Three accelerometers are used in the adaptive damping system.

- Rear
- Front right
- Front left



Refer to component location graphic above.

The accelerometers measure acceleration in the vertical plane and output a corresponding analogue signal to the Integrated Suspension Control Module. The algorithms in the Integrated Suspension Control Module predict the heave, pitch and roll motions of the vehicle, which are used to

control body modes.

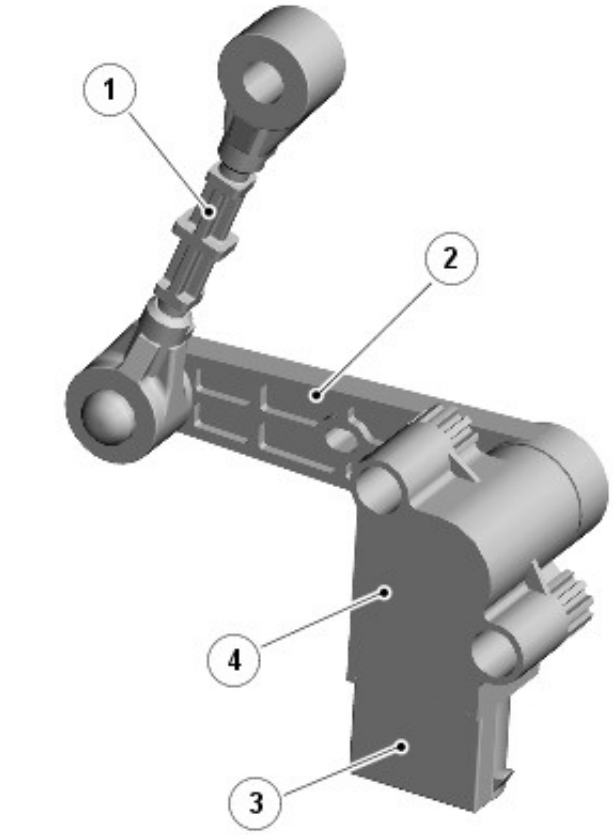
Each accelerometer is connected to the Integrated Suspension Control Module via three wires, which supply ground, 5 V supply and signal return.

The sensing element comprises a single parallel plate capacitor, one plate of which moves relative to the other dependent on the force (acceleration) applied. This causes the capacitance to change as a function of applied acceleration. This capacitance is compared with a fixed reference capacitor in a bridge circuit and the signal is processed by means of a dedicated integrated circuit to generate an output voltage that varies as a function of applied acceleration. The sensors output a signal voltage of approximately 1 V/g ± 0.05 V/g.

HEIGHT SENSORS

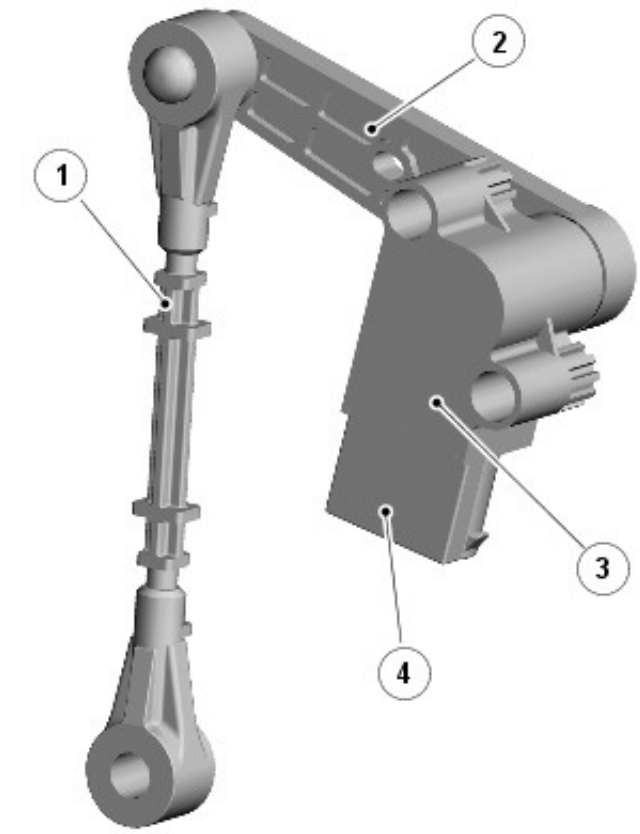
The four suspension height sensors that are used in the air suspension system also supply input to the adaptive damping system, two for the front suspension and two for the rear suspension. On each suspension height sensor, the sensor arm and sensor link convert linear movement of the suspension into rotary movement of the sensor shaft.

Front Height Sensor



ITEM	DESCRIPTION
1	Drop link
2	Lever arm
3	Electrical connector
4	Sensor body

Rear Height Sensor



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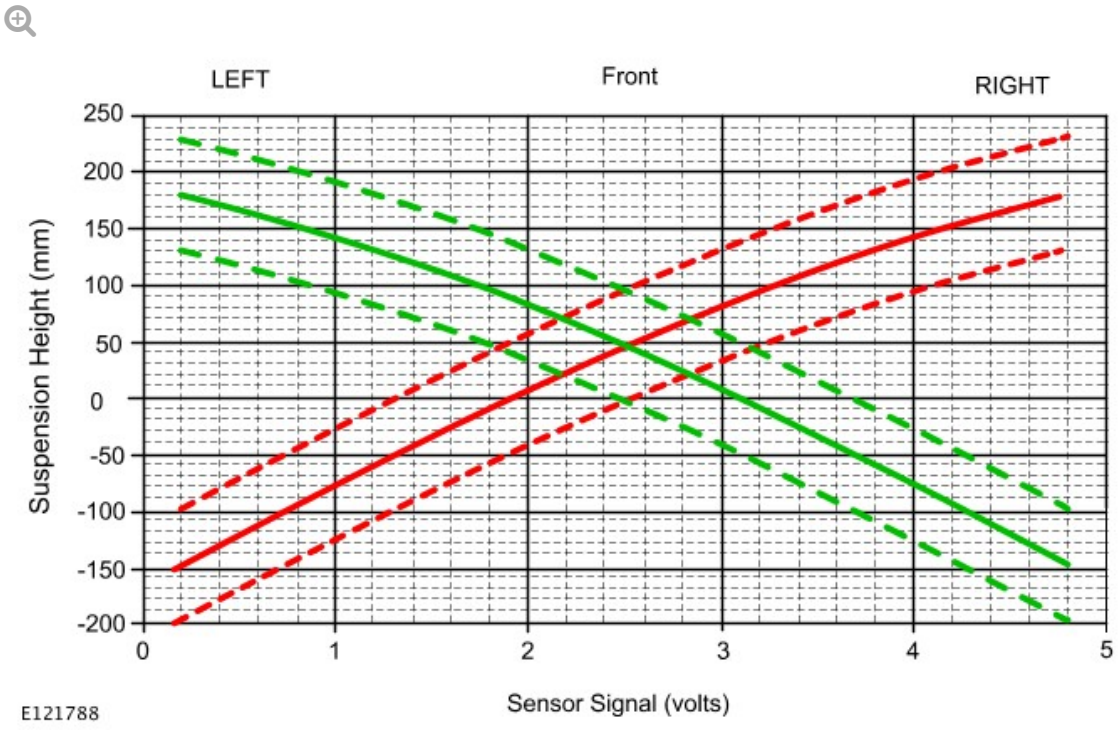
ITEM	DESCRIPTION
1	Drop link
2	Lever arm
3	Sensor body
4	Electrical connector

The suspension height sensors measure suspension displacement at each corner of the vehicle and output a corresponding analogue signal to the Integrated Suspension Control Module. The algorithms in the Integrated Suspension Control Module calculate the position, velocity and frequency content of the signals and use the results for wheel control.

The following graph shows the vehicle height displacement from normal against output voltage for the front height sensors. The centre line represents the "nominal" condition but depending on tolerances, the actual

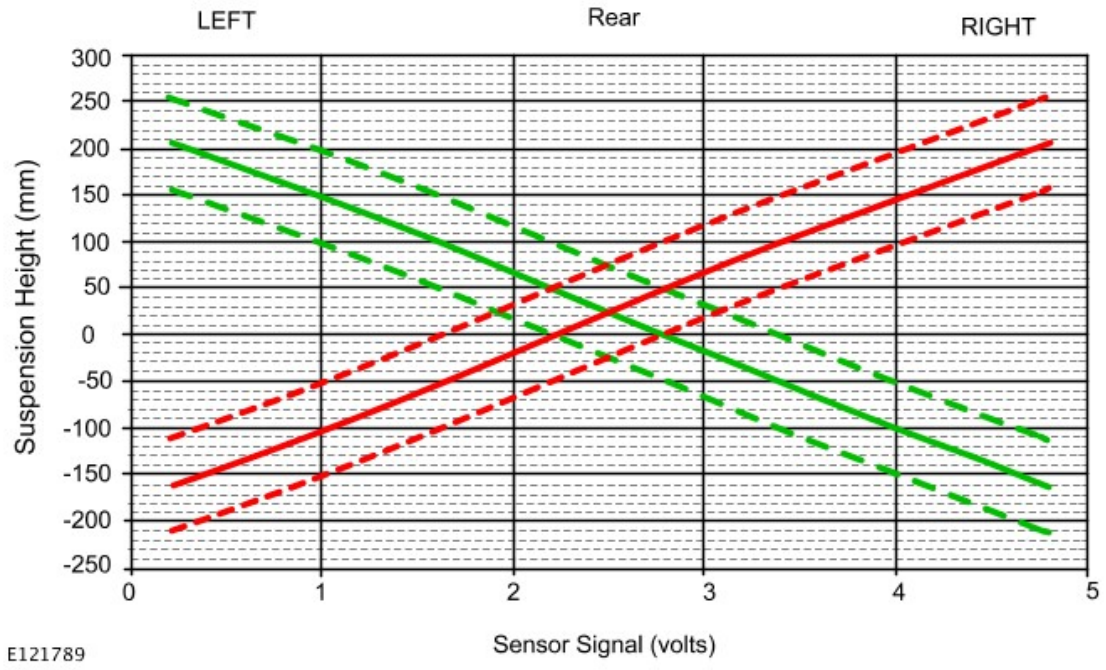
line may lie anywhere between the upper and lower lines.

Front Height Sensor



The following graph shows the vehicle height displacement from normal against output voltage for the rear height sensors. The centre line represents the "nominal" condition but depending on tolerances, the actual line may lie anywhere between the upper and lower lines.

Rear Height Sensor



Height Sensor Calibration

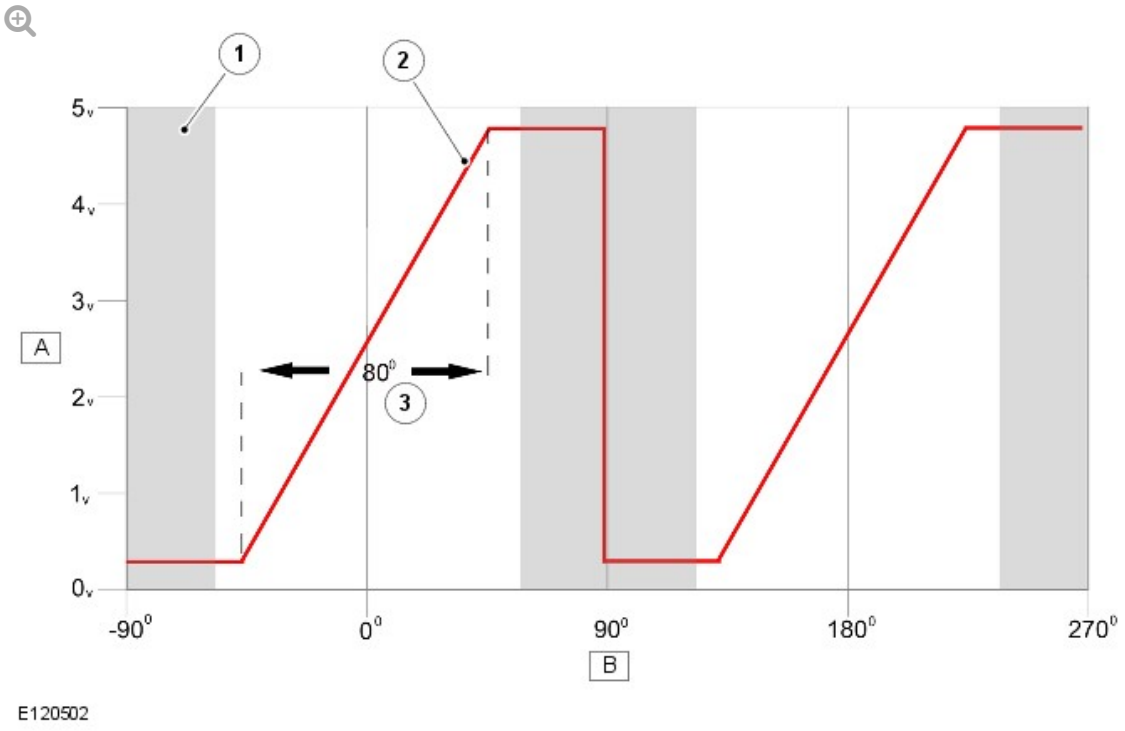
A calibration routine is performed using the Land Rover approved diagnostic system to read the position of each corner of the vehicle and record the settings in the control module memory. Once set, the calibration is not required to be performed unless the Integrated Suspension Control Module is removed or replaced, a height sensor is removed or replaced or a suspension arm to which the sensor is connected is removed or replaced. If the removed height sensor is subsequently refitted, the calibration procedure will have to be performed to ensure the integrity of the system.

If a replacement drop link is fitted calibration is required

The sensing element consists of an array of Hall-effect devices arranged to measure the direction of the magnetic field of a small magnet attached to the end of the sensor shaft. As the sensor shaft rotates, so do the lines of magnetic flux from the magnet. The signals from the Hall-effect elements are processed by means of a dedicated integrated circuit to generate an output voltage that varies as the sensor shaft is rotated. The sensor has a measurement range of ± 40° around its nominal position and the nominal sensitivity is 57 mV/° of shaft rotation. The graphic below describes the

repetition of the output signal as the sensor is rotated through and beyond 40°.

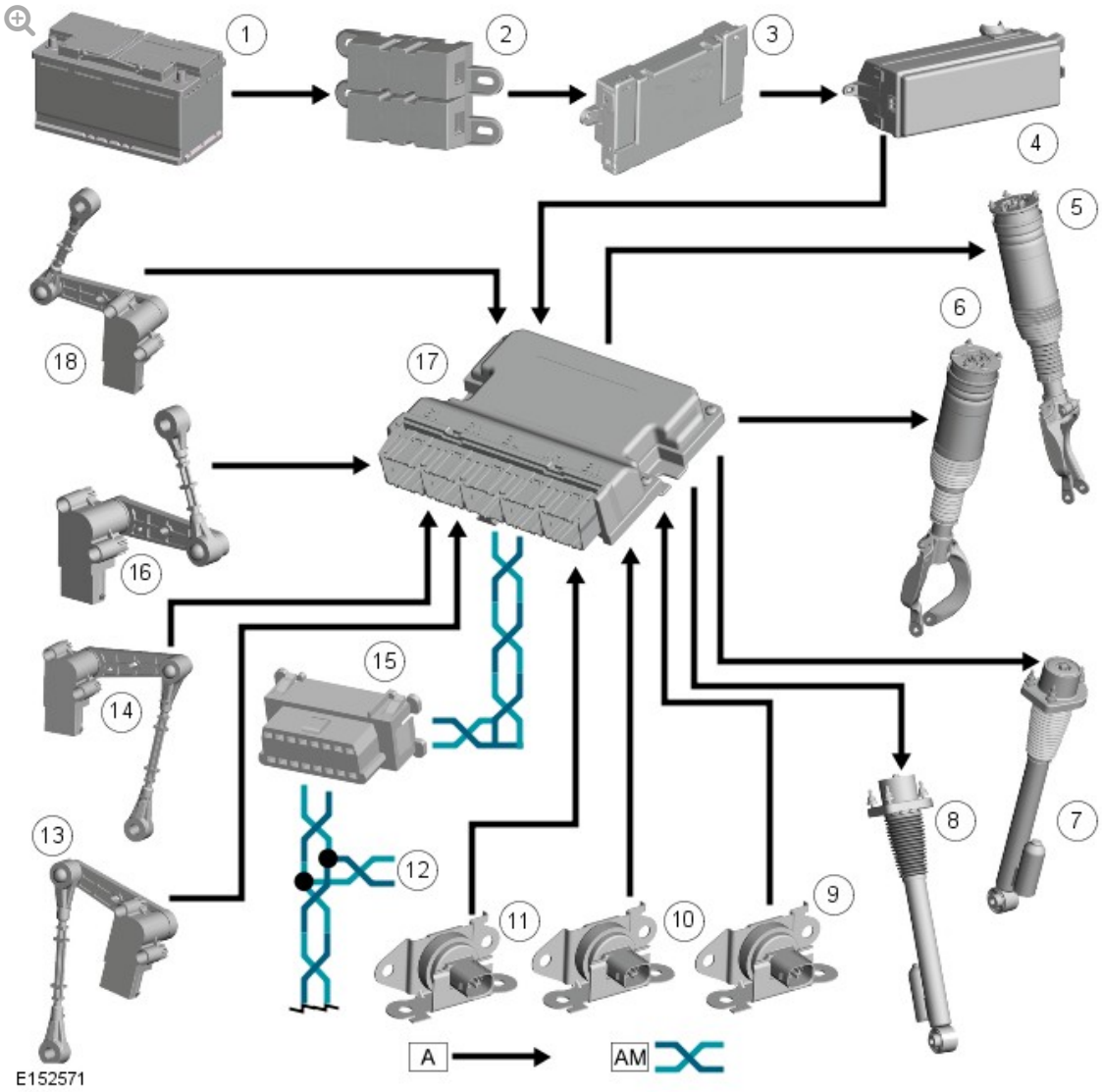
Height Sensor Voltage



ITEM	DESCRIPTION
A	Sensor voltage
B	Angle of rotation
1	Outside measuring range
2	Voltage output
3	+- 40 degree measuring range

OPERATION

CONTROL DIAGRAM – ADAPTIVE DAMPING

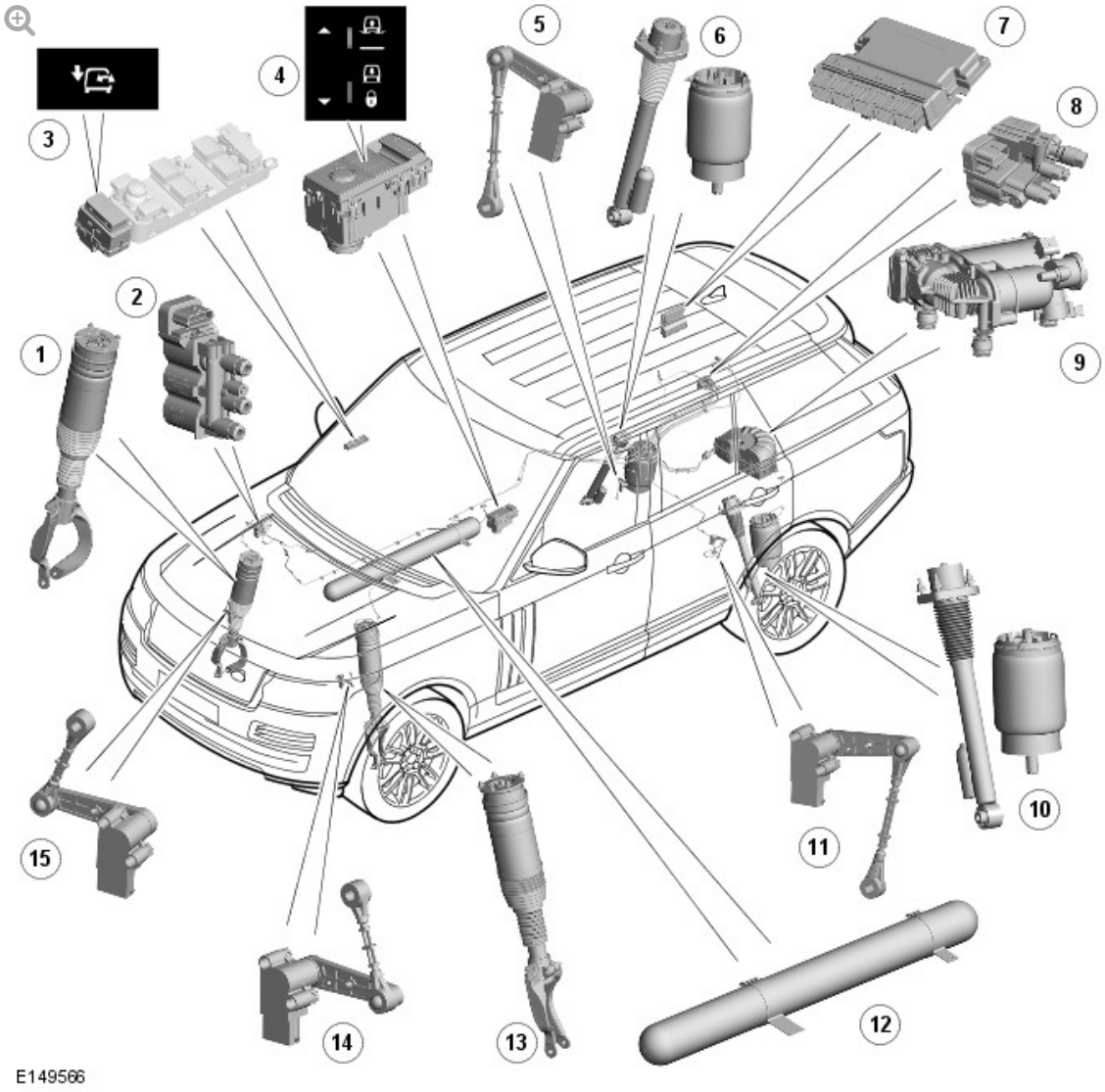


ITEM	DESCRIPTION
	A = Hardwired, AM = High speed CAN (Controller Area Network) Chassis bus.
1	Battery
2	Battery junction box- 2
3	Battery junction box
4	Rear junction box
5	Damper solenoid – right front
6	Damper solenoid – left front
7	Damper solenoid – right rear
8	Damper solenoid – left rear
9	Accelerometer – rear

10	Accelerometer – right front
11	Accelerometer – left front
12	High-speed CAN Chassis connection to other systems
13	Height sensor - right rear
14	Height sensor - left rear
15	Diagnostic connector
16	Height sensor – left front
17	Integrated suspension control module (ISCM)
18	Height sensor - right front

AIR SUSPENSION

Air Suspension - Component Location



ITEM	DESCRIPTION
1	Air spring and damper – right front
2	Valve block – front
3	Access mode switch (driver door switch pack)
4	Air suspension control switch
5	Height sensor – right rear
6	Air spring and damper – right rear
7	Integrated suspension control module
8	Valve block – rear
9	Air supply unit
10	Air spring and damper – left rear

11	Height sensor – left rear
12	Air reservoir
13	Air spring and damper – left front
14	Height sensor – left front
15	Height sensor – right front

OVERVIEW

The air suspension system is a four corner system, electronically controlled by an Integrated Suspension Control Module. The Integrated Suspension Control Module reacts to inputs from four height sensors and operates an air supply unit and valve blocks.

The air suspension system maintains the vehicle height under all operating conditions by controlling the mass of air in the air springs. The Integrated Suspension Control Module uses signals from the four height sensors to maintain the correct suspension height, irrespective of vehicle load. Additionally, the system allows the driver to request ride height changes to improve off-road performance or ease of access or loading. This is achieved by the Integrated Suspension Control Module functioning pneumatic control valves to increase or decrease the mass of air in the air springs.

The air suspension system has four driver selectable, pre-determined ride-height states. A driver interface indicates the selected ride state and height change movement. Additional information is also relayed to the driver via the instrument cluster message centre and by audible warnings also transmitted by the instrument cluster.

Most height changes can only be made when the engine is running and the driver's and passenger doors are closed.

The air suspension can be controlled manually by the driver using a switch on the floor console to select the required height change.

The system will temporarily inhibit height adjustments when the vehicle is subject to cornering, heavy acceleration or heavy braking. The inhibit function prevents unsettling of the vehicle.

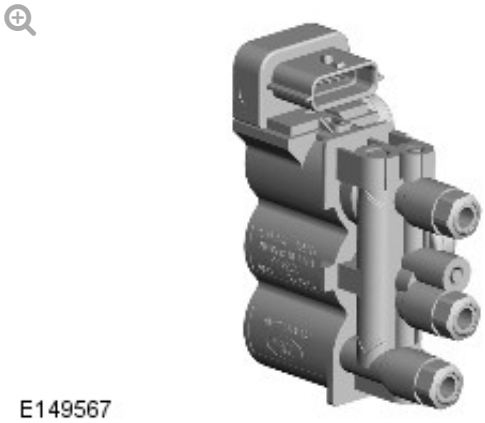
Height changes are also restricted for safety reasons, for example when a door is opened and the vehicle is stationary.

The air suspension system is controlled by the Integrated Suspension Control Module. The control module monitors the height of each corner of the vehicle via four height sensors, which are mounted in-board of each road wheel. The control module also performs an 'on-board diagnostic' function to perform 'health checks' on the system. If faults are detected, codes are stored in the control module and can be retrieved using a Land Rover approved diagnostic system.

DESCRIPTION

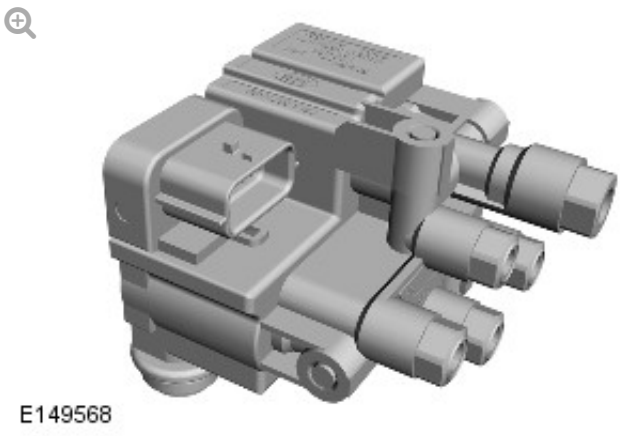
FRONT AND REAR VALVE BLOCKS

Front Valve Block



The front valve block controls the air supply and distribution to the front air springs. The front valve block contains three solenoid operated valves; two corner valves and one cross-link valve.

Rear valve block



The rear valve block controls the:

- air supply and distribution to the rear air springs, and
- controls air distribution to and from the air reservoir.

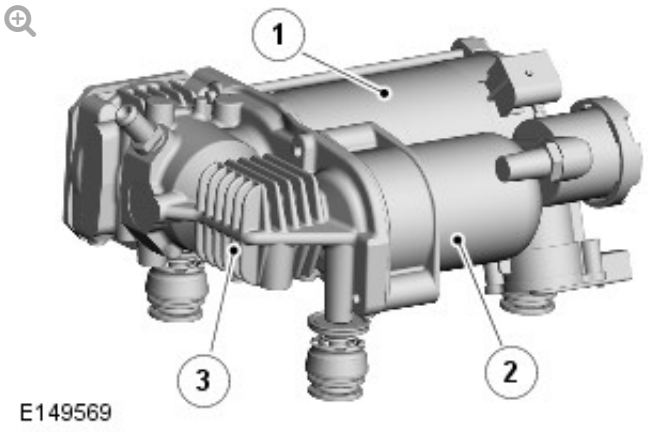
The rear valve block contains:

- two corner valves
- one cross-link valve
- one reservoir valve
- the system's pressure sensor.

Each of the valve solenoids is individually controlled by the Integrated Suspension Control Module. The solenoids have the following resistance values:

VALVE	RESISTANCE AT 25°C (±10%)
Front corner valves	6.8 Ohms
Front and rear cross link valves	3 Ohms
Rear corner valves and reservoir valve	3.6 Ohms

Air Supply Unit



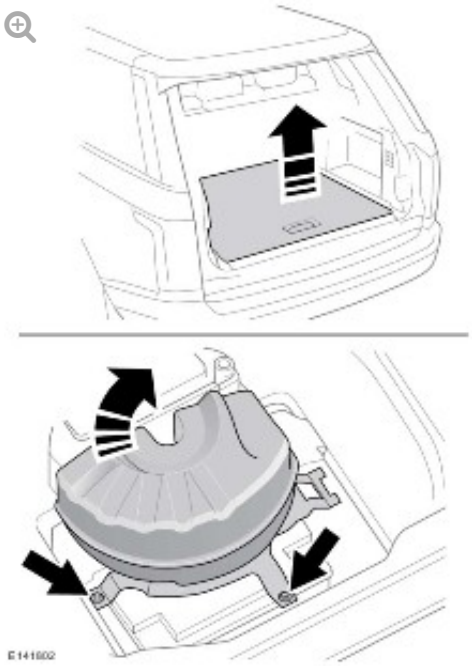
ITEM	DESCRIPTION
1	Electric motor
2	Air dryer
3	Compressor

The air supply unit comprises the following major components:

- A two-stage piston compressor
- A 12V electric motor
- A solenoid operated exhaust pilot valve
- A pneumatically operated exhaust slave valve
- An air dryer unit.

The air supply unit is protected by an acoustic box which tilts to allow access to the vehicle battery.

Air Supply Unit Access



The acoustic box, which comprises of two parts; upper and lower, surrounds the air supply unit. The acoustic box is a plastic moulding which is lined with insulating foam which suppresses the operating noise of the air supply unit.

The air supply unit supplies dry compressed-air into the air suspension system where it is directed into the air springs or the reservoir by solenoid operated valves. Air can be exhausted from the system when required by the opening of an air spring or reservoir valve in addition to the exhaust valve, which is part of the air supply unit.

The compressor operates to pressurize either the reservoir or to inflate one or more of the air springs. The compressor will not operate without the engine running, with the following exceptions:

- During remote operation to raise the vehicle to allow for the attachment of a trailer.
- When under control of a Land Rover approved diagnostic system.

There are a number of conditions that will inhibit operation of the air supply unit. It is vitally important that these system inhibits are not confused with a system malfunction. A full list of air supply unit inhibits are given in the compressor of this document.

Electric Motor

The electric motor is a 12 volt DC (direct current) motor with a nominal operating voltage of 13.5 volt. The motor drives a crank which has an eccentric pin to which the two-stage piston assembly is attached.

Compressor

The compressor is used to supply air pressure to the air suspension reservoir. The Integrated Suspension Control Module monitors the pressure within the reservoir and, when the engine is running, maintains a pressure of 16.5 bar gage.

The compressor comprises a motor driven two-stage piston assembly which operates in cylinders at opposite ends of the compressor body. The motor rotates a crank which moves the pistons up and down in their cylinder bores. The low-pressure cylinder delivers intermediate compressed air to the high-pressure cylinder on the down stroke. The high-pressure piston delivers fully compressed air with the up stroke which is passed, via the delivery valve, through the air dryer and into the air suspension system.

The cylinder head is fitted with a temperature sensor. The sensor is connected to the Integrated Suspension Control Module which monitors the cylinder temperature and can suspend compressor operation if an overheat condition occurs.

The following table shows the control module operating parameters for the differing air supply unit functions and the permitted compressor cylinder head operating temperatures.

OPERATING CONDITION	RESERVOIR FILLING	LEVELLING
Switch off	125°C	130°C
Switch on	105°C	120°C

Air Dryer

Attached to the compressor is the air dryer which contains a desiccant for removing moisture from the compressed air. Pressurized air is passed through the air dryer which removes any moisture in the compressed air before it is passed into the suspension system.

When the air springs are deflated, the exhaust air passes back through the air dryer, removing the moisture from the unit and regenerating the Desiccant.

The air dryer is an essential component in the system ensuring that only dry air is present in the system. If moist air is present, freezing can occur resulting in poor system operation or component malfunction or failure.

To ensure the air-dryer continues to perform correctly, it is essential during servicing, that

- the affected air springs are deflated using the correct deflation procedure
- air is removed from the air reservoir using the correct procedure.

Pilot Exhaust Valve

Attached to the air-dryer body is a solenoid operated exhaust pilot valve. This valve is opened when the air springs are to be deflated or when the system pressure needs to be reduced.

The pilot exhaust valve is connected to the air delivery gallery, downstream of the air dryer. The pilot valve, when opened, operates the slave exhaust valve, allowing air to exhaust the system.

When the solenoid is energized, pilot air moves the slave exhaust valve plunger, allowing pressurized air from the air springs and/or the reservoir to pass through the air dryer to atmosphere.

Slave Exhaust Valve

The exhaust valve operates when the pilot exhaust valve is opened, allowing air to be exhausted quickly.

The slave exhaust valve also provides the system pressure relief function which protects the air suspension system from over inflation. The valve is pneumatically operated, responding to air pressure applied to it to overcome force from its internal spring. The valve is connected into the main pressure gallery which is always subject to the system pressure available in either the air springs or the reservoir. The valve is controlled by a spring which restricts the maximum operating pressure to the specified limit.

The minimum pressure in the system is also controlled by the slave exhaust valve to ensure that, even when deflated, the air springs contain a positive pressure with respect to atmosphere. This protects the air spring by ensuring it can still 'roll' over the piston without creasing.

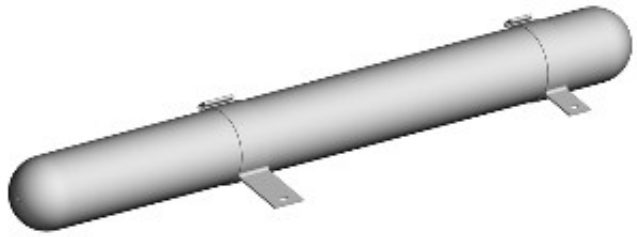
Air Supply Unit Specifications

DESCRIPTION	DESCRIPTION
Working pressure	16.5 bar gage
Mechanical pressure relief range	22.0 to 27.0 bar gage
Operating voltage	10 to 16.5 Volts (13.5 Volts nominal)
Running current consumption	25-35 Amps RMS depending on load
Maximum start-up current	110 Amps
Pilot Exhaust Valve - Solenoid valve resistance at 25°C (77°F)	15.7 Ohms ± 10%

NOTE:

Resistance values will vary with coil temperature. Resistance of test leads must be measured before any readings are taken. Resistance value of the test leads must be subtracted from final solenoid resistance value.

Air Reservoir



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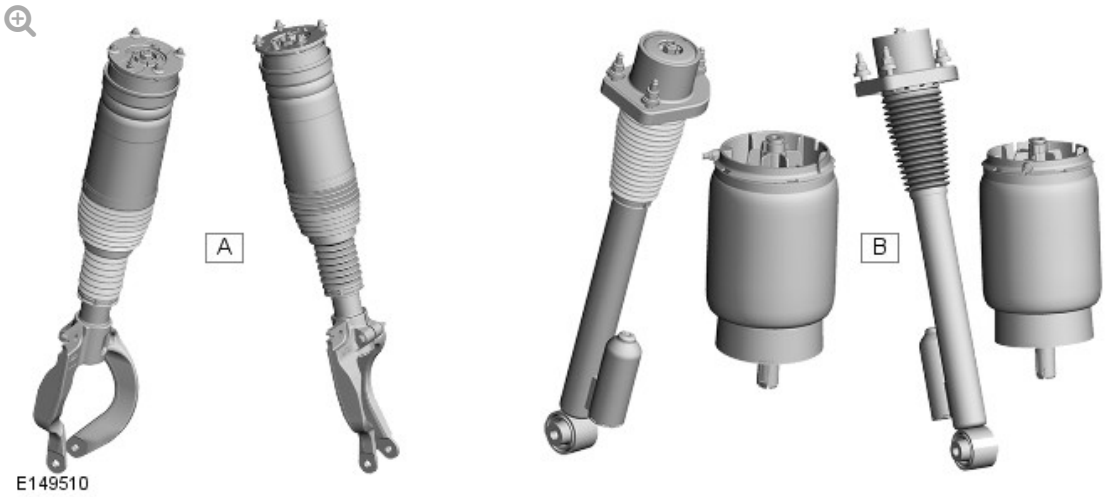
The reservoir is an air storage vessel which provides fast air suspension lift times by the immediate availability of pressurized air into the system.

The Integrated Suspension Control Module assumes the reservoir has sufficient pressure, which is measured before a vehicle raise is started. The control module then uses a software model to operate the compressor as required.

The rearward end of the reservoir has a 'Voss' air fitting which provides for the connection of the air hose between the reservoir and the rear valve block.

The reservoir has a capacity of 11 litres. The nominal working pressure of the reservoir is 16.5 bar gage.

Air Springs



ITEM	DESCRIPTION
A	Front air spring and damper assembly
B	Rear air springs (dampers shown for clarity)

The air springs work on the same principle but the front and rear components differ in construction:

- the front units are integral with damper
- the rear units are separate from the damper.

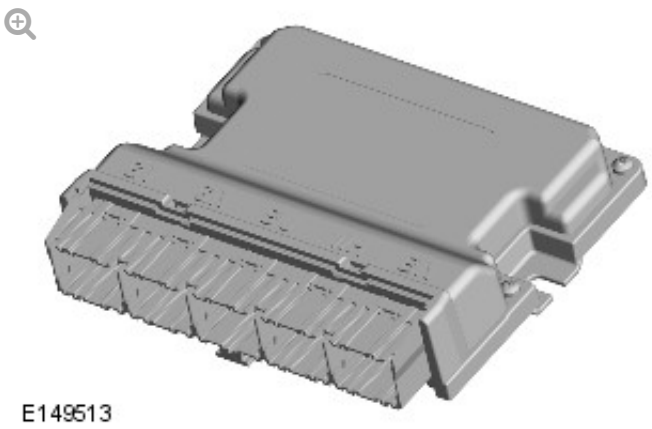
The air springs are manufactured from a flexible rubber and each air spring forms an air tight cavity which provides the required spring rate for each corner of the vehicle.

As the air spring is compressed, the rubber material rolls onto the air spring's piston, compressing the air inside. An air connection port is located on the top of each spring and allows air to be added or removed from each spring. The port is connected via a Voss connector and a plastic tube to the front or rear valve block.

Replacement of an individual air spring does not require a full depressurization of the air suspension system. Only the corner concerned need be depressurized. This is achieved using routines in the Land Rover approved diagnostic system.

When servicing of an air spring or a full system depressurization is required, the weight of the vehicle must be supported before the system is depressurized. On reassembly, the pipes between air springs and the valve blocks must be must be connected at both ends before the weight of the vehicle is applied to the air springs. Rear air springs must also be pressurized before the weight of the vehicle is applied to them.

Integrated Suspension Control Module



The air suspension system is controlled by the Integrated Suspension Control Module. The control module monitors the height of each corner of the vehicle via four height sensors, which are mounted in-board of each road wheel.

When a new Integrated Suspension Control Module is fitted, the air suspension system will not function until the air suspension software is loaded and the system calibrated using a Land Rover approved diagnostic system.

Calibration

A calibration routine is performed using the diagnostic system to access the position of each corner of the vehicle and record the settings in the control module memory. Once set, the calibration is not required to be performed unless the:

- Integrated Suspension Control Module is replaced
- height sensor or its bracket is removed, disconnected or replaced
- suspension arm to which the height sensor is connected is removed or replaced

Periodic Wake-Up Mode

When the vehicle is parked, the Integrated Suspension Control Module 'wakes up' two hours after the ignition was last switched off and once every twenty four hours thereafter. The vehicle height is checked and if the vehicle is not level within a pre-set tolerance, small downwards height adjustments may be made automatically.

Ride Height Tolerance Control

The Integrated Suspension Control Module has two ride height tolerance bands: normal tolerance and tight tolerance.

The control module considers the vehicle to be at target height if the current height is within the appropriate tolerance band. Height adjustments are not made until the vehicle height falls outside of the tolerance band for a pre-determined time. The time period is different depending on if the vehicle is moving or stationary. The tolerance bands are as follows:

- Normal ± 9 mm
- Tight ± 3 mm.

The tight tolerance band is only used in the following conditions:

- if set by the Land Rover approved diagnostic system for diagnostic purposes
- when the vehicle has been stationary for more than 15 minutes
- when the following procedure is applied:

1 Start the engine.

2 Set the suspension to Normal height.

3 Open the driver's door.

4 Depress the brake pedal lightly three times in quick succession.

5 Close the driver's door within 10 seconds of the first brake pedal depress.

If the procedure has been successful the instrument pack will emit two soft chimes about 1 second after the driver's door is closed. Thereafter the instrument pack will emit two soft chimes each time the driver's door is closed to confirm that tight tolerance mode is still active.

This tight tolerance mode will be cancelled when the engine is turned off or the vehicle speed exceeds 8 km/h (5 mph).

The driver can manually select, using the air suspension switch, one of four ride states:

- NORMAL - this height is the normal operating height of the vehicle.
- OFF-ROAD - this is higher than the on-road height and provides improved ground clearance, approach, departure and break-over angles up to speeds of 80 km/h (50 mph).
- ACCESS - this height is lower than the on-road height and makes entering and exiting the vehicle easier for the occupants.
- Locked at access - this allows the vehicle to be driven at the access height at speeds up to 40 km/h (25 mph) to provide increased roof clearance in low car parks, for example.

NOTE:

Vehicle height changes are restricted if the Integrated Suspension Control Module receives a 'Door Open' signal and the speed is less than 8 km/h (5 mph).

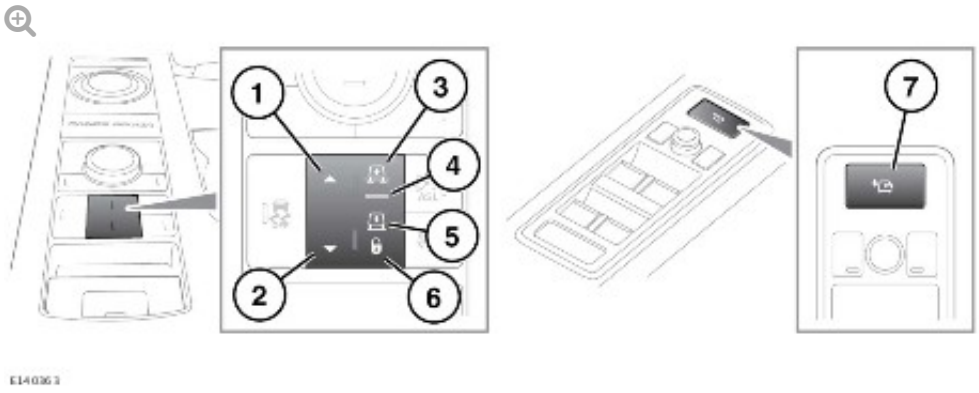
A complete vehicle delivery mode is available but is only selectable using the Land Rover approved diagnostic system. When this mode is active most vehicle systems, in addition to the air suspension, are inhibited or restricted to a minimal functionality. In this mode the air suspension is set to the transportation mode.

If the Integrated Suspension Control Module senses that the vehicle has grounded and lost traction, the control module can temporarily increase the volume of air supplied to the air springs to maximize the available traction. This is known as extended mode and will be indicated to the driver by the lamps on the air suspension switch flashing and an 'EXTENDED MODE' message being displayed in the instrument cluster.

If a fault is detected by the Integrated Suspension Control Module, the control module will reduce the system functionality dependent on the type and severity of the fault. The control module will also store a fault code which can be retrieved using the Land Rover approved diagnostic system. If a severe fault occurs, the control module will attempt to put the vehicle in a safe condition. A fault is relayed to the driver by the instrument cluster message centre and an audible warning emitted from the instrument cluster.

All information messages will be displayed for four seconds.

Air Suspension Switch Pack



ITEM	DESCRIPTION
1	Raise suspension height

2	Lower suspension height
3	Off-road height indicator
4	Normal height indicator
5	Access height indicator
6	Suspension locked in Access height – indicator
7	Access height switch (driver door switch pack)

The air suspension control switch is located in the floor console, behind the transmission selector. The switch is a three position, non-latching switch which allows selection of the following driver selectable states:

- Off-road mode
- Normal height
- Access height
- Locked at access height

NOTE:

> Access height can also be selected using the switch on the door-switch pack.

The switch has six symbols which illuminate to show the current selected height state and the direction of movement. The raise and lower symbols will flash and a warning tone will be emitted from the instrument cluster sounder when a requested height change is not allowed, for example, when the vehicle speed is too fast.

A flashing height symbol indicates that the air suspension system is in a waiting state or that the system will override the driver's selection because the speed threshold is too high.

The driver can also ignore the system's warnings signals and allow the

height to change automatically. For example, increasing the vehicle speed to more than 40 km/h (25 mph) when locked to access height will cause the control module to automatically change the ride height to on-road mode.

Normal Height

This is the normal ride height for the vehicle.

Off-Road Mode

Off-road height can be selected from normal height by pressing up on the raise/lower switch (1) at any speed up to 70 km/h (43 mph). The message centre will display OFF-ROAD HEIGHT SELECTED.

The Off-road height is dependent upon vehicle speed. The Off-road height selected will be confirmed with an Off-Road **(1)** or **(2)** icon in the Touch screen display when in the **4x4** info menu.

Off-Road 1 height is 40 mm (1.6 in) above normal height up to 80 km/h (50 mph).

Off-Road 2 height is 75 mm (2.9 in) above normal height up to 50 km/h (31 mph).

The suspension height can change automatically between these heights.

Off-Road 2 can be selected when at **Off-Road 1** height by pressing up on the raise/lower switch when travelling less than 40 km/h (25 mph). To select normal height, press down on the raise/lower switch (2) or increase the speed above 80 km/h (50 mph).

Off-Road 2 can be selected when at Off-Road 1 height by pressing up on the raise/lower switch when travelling less than 40 km/h (25 mph). To select normal height, press down on the raise/lower switch (2) or increase the speed above 80 km/h (50 mph).

Access Height

Access height provides easier entry, exit and loading of the vehicle.

Access height can be selected at any vehicle speed. When access height is selected, the response of the air suspension system will depend on the vehicle speed:

- If the vehicle speed is more than 20 km/h (12.5 mph), the Integrated Suspension Control Module will wait for up to one minute for the vehicle speed to be reduced. The access mode indicator and the lowering indicator will flash while the Integrated Suspension Control Module waits for the vehicle speed to be reduced; the Normal height indicator will remain illuminated. If the vehicle speed is not reduced sufficiently, the access height request will be cancelled after 1 minute.
- If the vehicle speed is less than 20 km/h (12.5 mph), the Integrated Suspension Control Module will lower the suspension to a part lowered height and will remain at this height for up to one minute. The Normal height indicator will extinguish as the Integrated Suspension Control Module lowers the suspension to the part lowered height. The access height indicator and the lowering indicator will illuminate. When part lowered is reached, the lowering indicator will flash. If the vehicle speed is not reduced to less than 8 km/h (5 mph) in the one minute period, the access height request will be cancelled.
- If the vehicle speed is less than 8 km/h (5 mph), the suspension will be lowered to access height immediately. The access height indicator and the lowering indicator will illuminate. When the access height is reached, the lowering indicator will be extinguished.

Access height may be selected up to 60 seconds after the ignition is turned off, provided that the driver's door has not been opened within this time.

The suspension will automatically rise from access height when the vehicle speed exceeds 10 km/h (6.2 mph). If access height was selected directly from off-road mode then the system will return to off-road mode when the vehicle speed exceeds 10 km/h (6.2 mph). Otherwise the system will lift the suspension to Normal height.

Selecting Access Height Directly from Off-Road Mode

When the suspension is in off-road mode height, pressing the 'Access' height change switch once, or pressing the lowering switch twice before the lowering indicator is extinguished, the control module will lower the suspension to access height. The control module will remember to return the suspension to off-road mode automatically if the vehicle speed increases above 10 km/h (6.2 mph).

Locked at Access Height

Locking the suspension at Access height allows the vehicle to be driven at low speeds with the suspension locked at the access height. This allows the vehicle to be driven in low car parks etc. with increased roof clearance.

When the vehicle is at Access height and travelling less than 35 km/h (22 mph), press down on the raise/lower switch (2), or press the driver's door Access height switch (7), for longer than 1 second. The system lock indicator (5) will illuminate and "SUSPENSION LOCKED AT ACCESS HEIGHT" will be displayed in the message centre. To cancel this mode, press up on the raise/lower switch (1) for longer than 1 second or increase the speed to 40 km/h (24 mph).

Automatic Height Change Warnings

When the suspension is locked at access height, the Integrated Suspension Control Module will change the suspension height automatically when the vehicle speed exceeds 40 km/h (24 mph). The control module issues a warning to advise the driver that the vehicle is approaching the speed threshold when the speed reaches 35 km/h (22 mph). The instrument cluster sounder will emit a chime, a message will be displayed in the message centre and the Normal height indicator and the raising indicator will flash.

The warning is removed when the vehicle speed is reduced.

SPECIAL MODES

Door Open Functionality

If one or more of the vehicle doors are opened during a height change when the vehicle is stationary, the Integrated Suspension Control Module will restrict further height change.

The indicator on the air suspension display for the target height will remain illuminated and the raising or lowering indicator will flash.

If all of the doors are closed within 90 seconds, the height change will resume. If the 90 second period is exceeded, the message 'CONFIRM REQUIRED SUSPENSION HEIGHT' will be displayed in the instrument cluster.

Extended Modes

Raise Inhibit Raise inhibit is a reactive mode invoked when the following conditions are satisfied, vehicle speed below 10 km/h (6 mph) and vehicle raising very slowly. Raise inhibit is normally invoked when vehicle is lifting against an obstacle, it can also be used when the vehicle is winching or is tethered down.

Jacking Jacking is a reactive mode invoked when the following conditions are satisfied, vehicle stationary, system attempts to level the vehicle down and rate of vehicle lowering is below a predefined threshold for a predefined time. Jacking mode is normally invoked under the following conditions, vehicle jacking or vehicle grounded and stationary.

Lower Inhibit Lower inhibit is a reactive mode invoked when the when rate of vehicle lowering is below a predefined threshold for a predefined time during a downward height change. Lower inhibit is normally invoked when the vehicle is lowered onto an obstacle.

Belly-Out Belly-Out is a pro-active mode invoked when the following conditions are satisfied, vehicle moving and speed is below 20 km/h (12.5 mph). Traction activity is induced on axle pairs for fixed period of time and wheel heights above a predetermined threshold on coinciding axle pairs for the same fixed period of time. Belly-Out is normally invoked under the

following condition, vehicle is attempting to move and with low levels of traction and supported by an obstacle.

If the vehicle body is raised, for example by a jack, or grounded in severe off-road conditions, the system may automatically enter Extended Mode. Indicators in the raise/lower switch will flash and the message centre will display "SUSPENSION IN EXTENDED MODE".

The suspension can rise automatically to assist in clearing the obstacle. Once extended mode height has been achieved, the driver may request additional lifting if required. This is achieved by pressing up and holding the raise/lower switch for longer than 3 seconds while pressing the brake pedal.

Extended mode is cancelled by pressing down on the raise/lower switch (2) or when the vehicle speed confirms that the body is no longer lifted or grounded.

NOTE:

Extended mode cannot be selected manually.

Periodic Re-levelling

When the vehicle is parked, the Integrated Suspension Control Module 'wakes up' two hours after the ignition was last switched off and then once every twenty four hours. The vehicle height is checked and if the vehicle is not level within a pre-set tolerance, small downwards height adjustments may be made automatically.

Transportation Mode

The suspension transportation mode is automatically set when the vehicle is configured for delivery mode using the Land Rover approved diagnostic system. Delivery mode also affects other vehicle systems which are inhibited or restricted to a minimal functionality.

When transportation mode is active, the air suspension switches are disabled. Periodic re-levelling is also disabled.

When the engine is started, the Integrated Suspension Control Module will cause the vehicle to rise allowing sufficient ground clearance for the vehicle to be loaded. While the height is changing, all the indicators in the air suspension control switch will flash and a chime will be emitted by the instrument cluster. When the sufficient height reached, all the indicators will illuminate continuously and the chime will stop.

When the engine is switched off, the Integrated Suspension Control Module will cause the vehicle to lower allowing the vehicle to be strapped down. While the height is changing, all the indicators in the air suspension control switch will flash. When the low height is reached, all the indicators will illuminate continuously.

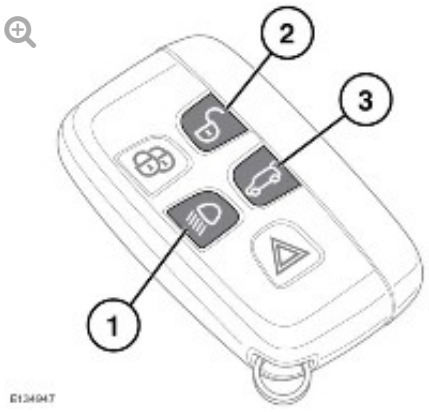
Calibration Mode

This mode is used when the Integrated Suspension Control Module has been replaced or a height sensor or suspension component has been dismantled or replaced.

The following conditions apply when the vehicle is in calibration mode:

- The ride height is set to tight tolerance.
- Fault reaction to VIN (vehicle identification number) mis-match with the Car Configuration File (CCF) is disabled.
- The raise, lower, access and hold switches are disabled.
- Message "Air suspension not in customer mode" is displayed in the instrument pack.

REMOTE OPERATION



The buttons on the Smart Key may be used to operate the air suspension system, allowing the vehicle to be raised or lowered remotely. This may be useful in attaching a trailer or loading the vehicle.

To change the suspension height using the Smart Key, the vehicle must be stationary, all the doors closed and the hazard warning lamps switched on.

To raise the vehicle suspension, press buttons 1 and 2 simultaneously.

To lower the vehicle suspension, press buttons 1 and 3 simultaneously.

LEAK DETECTION

Leak detection can be carried out using a Land Rover approved leak detection spray.

If the vehicle appears to be leaking, perform a leak check on all aspects of the system, for example, air spring hose fittings and the associated connections on the valve blocks, air springs and reservoir. Failure to correctly diagnose leakage will result in unnecessary exchange of serviceable components and recurrence of original problem.

OPERATION

Under normal operating conditions, the Integrated Suspension Control Module keeps the vehicle level at the 'current' ride height. The incoming height signals from the sensors are passed through filters to remove irregular signals produced by road noise or other irregularities. When the

vehicle is stationary or a height change is in progress, the signals are passed through a 'fast' filter, which tracks the true rate of change of height. When the vehicle is moving, the signals are passed through a 'slow' filter. The 'slow' filtered signals remove almost all road noise from the signals and output a true long term average for each corner height. The 'slow' filtered signals cannot be used to respond quickly during height changes.

The Integrated Suspension Control Module monitors each corner height signal using the fast filtered signals if the vehicle is stationary or the slow filtered signals if the vehicle is moving. If the height remains in a 'dead band' which is ±9 mm from the target height, the control module does not implement any height adjustment changes. When the control module detects that a corner has moved outside of the 'dead band', the control module operates the compressor and/or the valves to raise or lower the corresponding corner(s) back into the target height.

SYSTEM INHIBITS

A number of conditions exist where a change in ride height is undesirable. To counter this, the Integrated Suspension Control Module is programmed with a number of system inhibits. If any of the conditions detailed below exist, the Integrated Suspension Control Module will suspend height changes and height corrections.

AIR SUPPLY UNIT

System Pressure

The compressor will not start if the system pressure is greater than 4 bar.

Compressor Temperature

A temperature sensor is located within the compressor to prevent overheating. If the temperature of the compressor cylinder head rises above pre-set limits, the Integrated Suspension Control Module will inhibit the compressor operation.

Cornering

If the Integrated Suspension Control Module registers a cornering force greater than 0.2g it will inhibit all height changes and corrections. The system will remain inhibited until the cornering force falls to less than 0.15g. The Integrated Suspension Control Module receives a message from the restraints control module (incorporating the yaw rate lateral acceleration sensor) on the high speed CAN (Controller Area Network) chassis bus for the cornering force.

Rapid Acceleration

If the Integrated Suspension Control Module registers a rapid acceleration greater than 0.2g it will inhibit all height changes and corrections. The system will remain inhibited until the rapid acceleration falls to less than 0.15g. Acceleration is calculated by the Integrated Suspension Control Module from a vehicle speed signal received via the high speed CAN (Controller Area Network) chassis bus.

Rapid Deceleration

If the Integrated Suspension Control Module registers a rapid deceleration smaller than - 0.2g it will inhibit all height changes and corrections. The system will remain inhibited until the rapid deceleration rises above - 0.15g. Deceleration is calculated by the control module from a vehicle speed signal received via the high speed CAN (Controller Area Network) chassis bus.

Door Open

The Integrated Suspension Control Module will stop all height change requests while any of the doors are open. Vehicle levelling continues with a door open by keeping the vehicle at the height when the door was opened if the vehicle load changes. Door open status is ignored when the vehicle speed is above 8 km/h (5 mph).

DIAGNOSTICS

The Integrated Suspension Control Module can store fault codes which can be retrieved using a Land Rover approved diagnostic system. The

diagnostics information is obtained via the diagnostic socket which is located below the instrument panel, above the driver's foot pedals.

The diagnostic socket allows the exchange of information between the various control modules on the bus systems and the Land Rover approved diagnostic system. This allows the fast retrieval of diagnostic information and programming of certain functions using the Land Rover approved diagnostic system.

Fault Messages

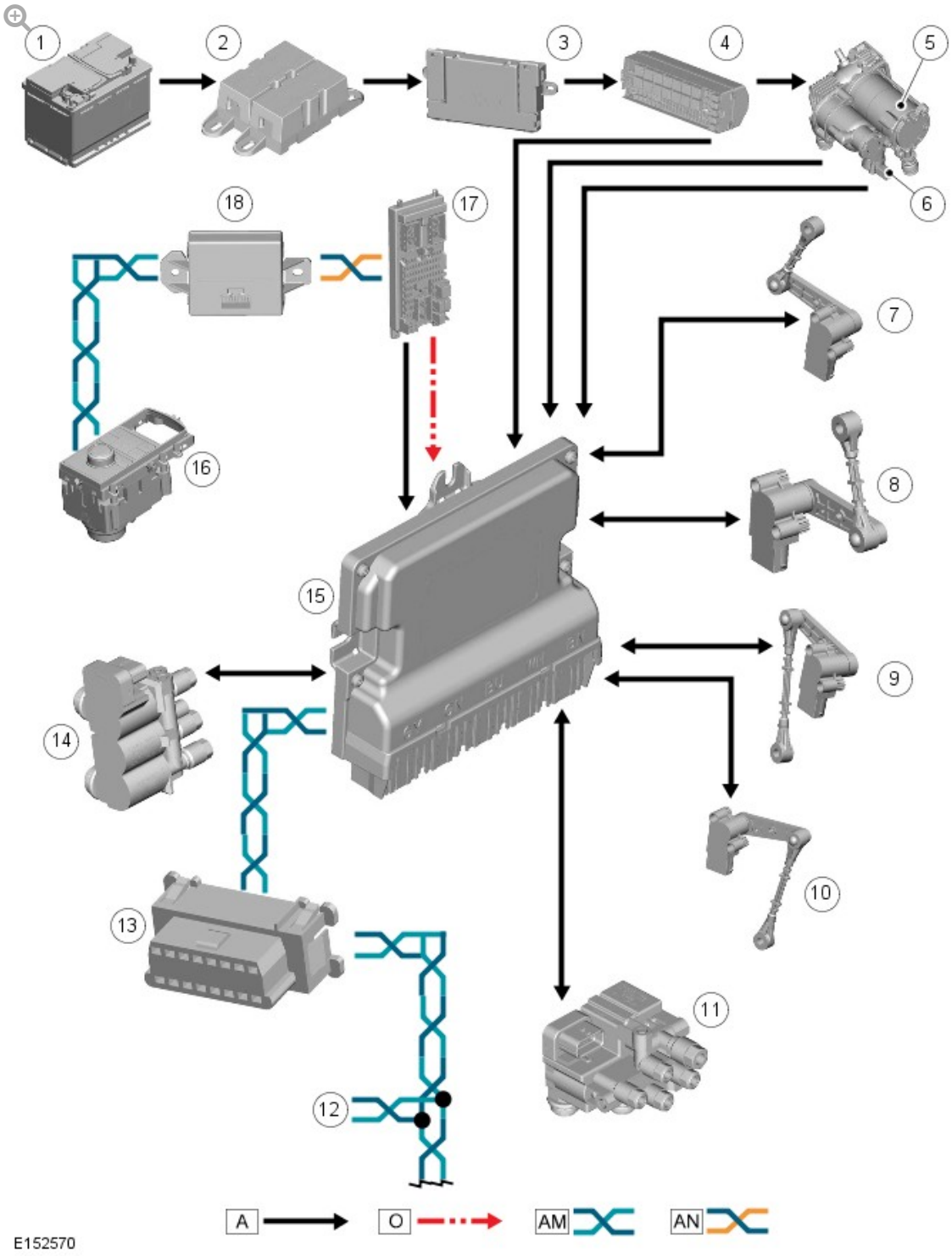
The air suspension has two methods which it can use to inform the driver of a fault in the air suspension system; the air suspension control switch indicators and the instrument cluster message centre.

If the Integrated Suspension Control Module suffers a major failure and there is no air suspension control, all the control switch indicators will remain unlit.

If a fault occurs and the control module can determine the ride height and the vehicle is not above on-road height, the driver will be notified via a message in the message centre. If the control module cannot determine the height of the vehicle, or the vehicle is above Normal height and cannot be lowered, a message is displayed and accompanied with a maximum speed message.

If a fault is detected within the DSC (dynamic stability control) the message 'SUSPENSION LOWERED FOR SAFETY' and a chime will be emitted. This is not a fault with the air suspension system. The fault should be investigated and rectified as soon as possible.
For additional information, refer to: Instrument Cluster (413-01 Instrument Cluster, Description and Operation).

CONTROL DIAGRAM – AIR SUSPENSION



ITEM	DESCRIPTION
	A = Hardwired, O = LIN (Local Interconnect Network) bus, AM = High speed CAN (Controller Area Network) Chassis bus, AN = High speed CAN Powretrain bus.
1	Battery
2	Battery junction box- 2
3	Battery junction box

4	Rear junction box
5	Air supply unit
6	Suspension air supply exhaust pilot valve connection
7	Height sensor front left
8	Height sensor front right
9	Height sensor rear right
10	Height sensor rear left
11	Valve block - rear
12	High speed CAN Chassis connection to other systems
13	Diagnostic connector
14	Valve block - front
15	Integrated Suspension Control Module (ISCM)
16	Air suspension control switch
17	Central junction box
18	Gateway module (GWM)