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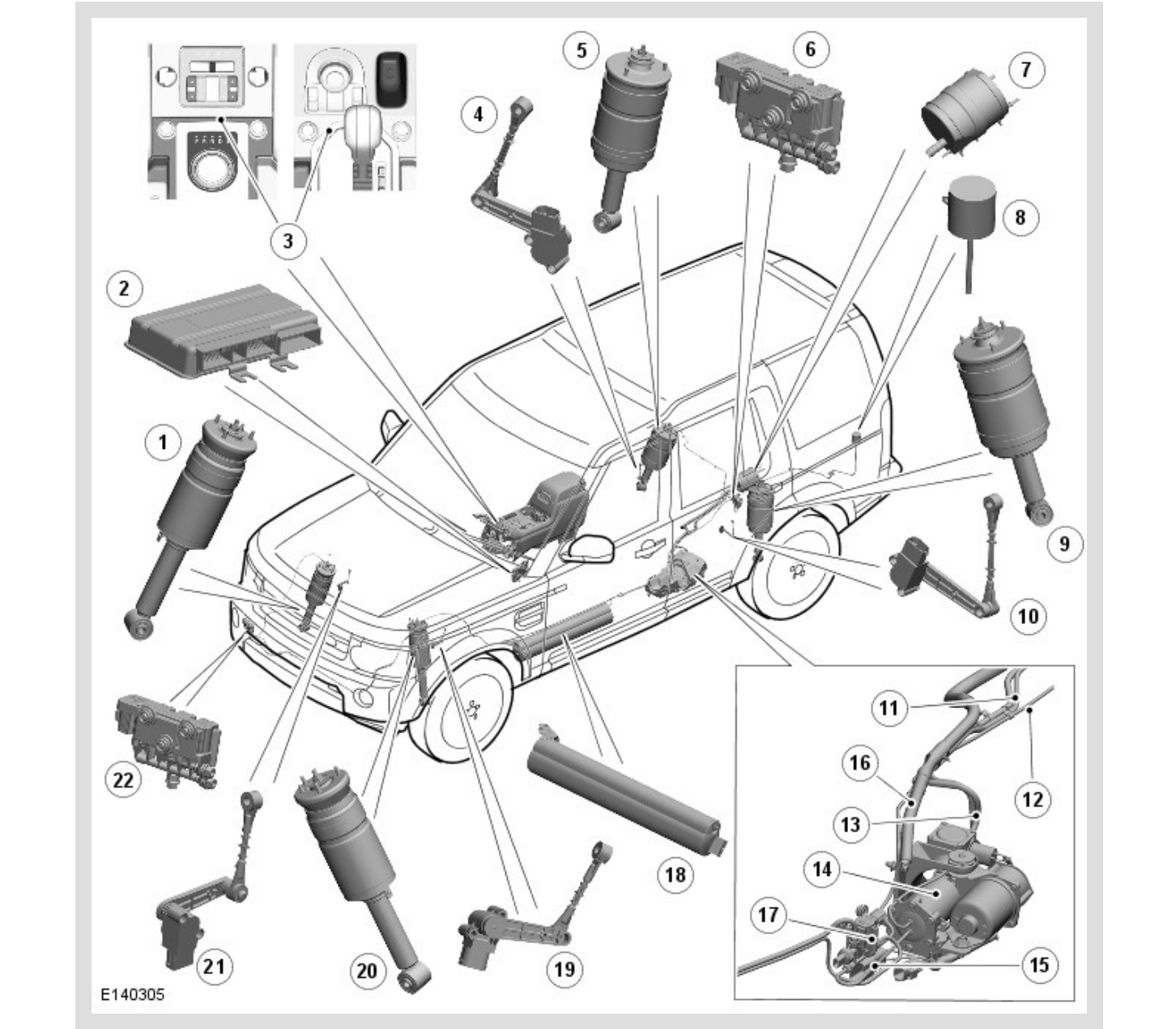
2012.0 DISCOVERY 4 / LR4 (LA), 204-05

VEHICLE DYNAMIC SUSPENSION

(G1454079)

DESCRIPTION AND OPERATION

Air Suspension - Component Location



ITEM	DESCRIPTION
1	right-hand (RH) air spring damper module
2	Air suspension control module
3	Air suspension control switch

ITEM	DESCRIPTION
4	Rear <u>RH</u> height sensor
5	Rear <u>RH</u> air spring damper module
6	Rear axle valve block
7	Air supply unit silencer
8	Air supply unit filter
9	Rear left-hand (LH) air spring damper module
10	Rear <u>LH</u> height sensor
11	Pipe - Compressor inlet
12	Pipe - Reservoir valve block to rear axle valve block
13	Pipe - Compressor exhaust
14	Air supply unit
15	Pipe - Air supply unit to reservoir valve block
16	Reservoir valve block
17	Pipe - exhaust
18	Air reservoir
19	Front <u>LH</u> height sensor
20	Front <u>LH</u> air spring damper module
21	Front <u>RH</u> height sensor
22	Front axle valve block

AIR SUSPENSION

GENERAL INFORMATION

The air suspension system is a four corner system which is fitted to all models.

The system is electronically controlled by an air suspension control module which controls the air supply unit, reacts to inputs from four height sensors and distributes air around the system via valve blocks.

The main air suspension system components are:

- Air suspension control module
- Air supply unit
- Four height sensors

- Three valve block assemblies
- Reservoir
- Air harness
- Two front struts incorporating air spring damper modules
- Two rear struts incorporating air spring damper modules
- Air Suspension Switch

The four corner air suspension system maintains the vehicle height under all operating conditions by controlling the mass of air in the air springs. The air 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 access or loading. The system automatically adjusts the ride height to improve the vehicle handling and dynamics when speed increases or decreases. This is achieved by operating pneumatic control valves to increase or decrease the mass of air in the air springs.

The air suspension system has three driver selectable, pre-determined ride heights and an automated high speed ride height. A driver interface indicates the selected ride height and height change movement. Additional information is also relayed to the driver via the instrument cluster message center 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, when a door is opened and the vehicle is stationary for example.

The air suspension system is controlled by the air suspension control module which is located on the driver side 'A' pillar. 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 the Land Rover approved diagnostic system.

RIDE HEIGHT TOLERANCE CONTROL

The air 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 ± 10 mm
- Tight ± 3 mm.

The tight tolerance band is only used if set by the Land Rover approved diagnostic system for diagnostic purposes or when the vehicle has been stationary for more than 5 minutes.

OPERATING MODES

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

- ON-ROAD - this height is the normal operating height of the vehicle
- OFF-ROAD - this height is higher than the on-road height and provides improved ground clearance, approach, departure and breakover angles
- ACCESS - this height is lower than the on-road height and makes entering and exiting the vehicle easier for the occupants
- CRAWL (Locked at access) - this mode allows the vehicle to be driven at the access height at low speeds to provide increased roof clearance in low car parks etc.

HIGH SPEED - A non-selectable, automatic high speed mode is provided which lowers the vehicle height to improve vehicle handling.

NOTE:

Vehicle height changes are restricted if the air suspension control module receives a 'Door Open' signal and the speed is less than 5 mph (8 km/h).

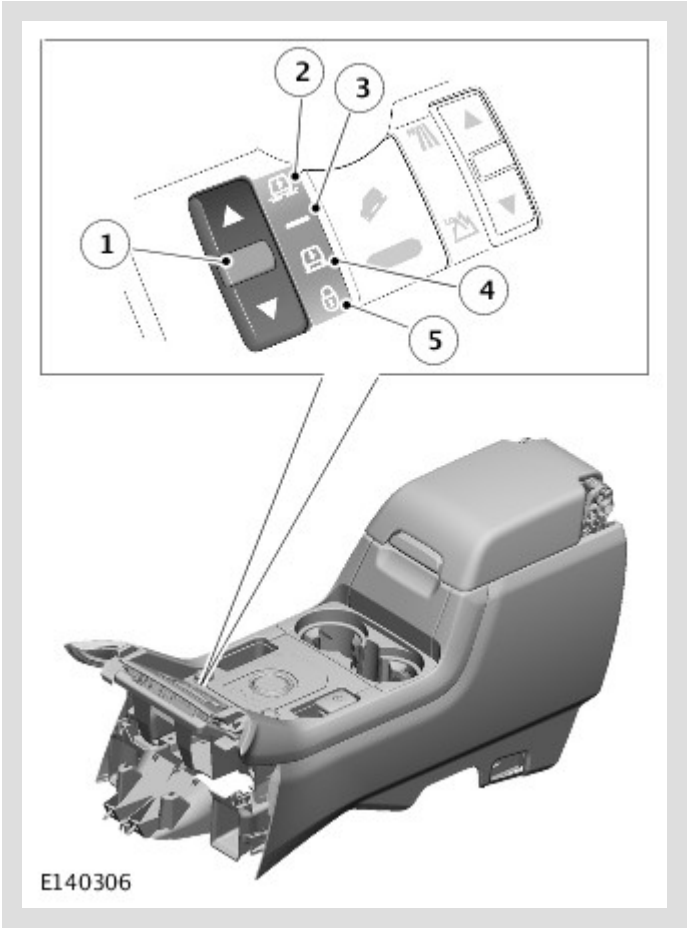
A complete vehicle delivery mode is available but is only selectable using the Land Rover approved diagnostic system. When this mode is active most vehicle systems, in addition to the air suspension, are inhibited or restricted to a minimal functionality. In this mode the air suspension is set to the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

If the air suspension control module senses that the vehicle has grounded and lost traction, the control module can temporarily increase and/or redistribute the volume of air supplied to the affected air spring(s) 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 air 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 center 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/lower switch
2	Off-Road Mode
3	On-Road Mode
4	Access Mode
5	Crawl (Locked at Access) Mode

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 modes:

- Off-road mode
- On-road mode
- Access mode
- Crawl (locked at access) mode.

The air suspension switch can be rocked from its central position. The switch is non-latching and returns to the central position when released. The switch completes an earth path to the air suspension control module when operated. This earth path is completed on separate wires for the raise and lower switch positions, allowing the control module to determine which selection the driver has made.

The switch has six symbols which illuminate to show the current selected height 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, i.e. vehicle speed too fast.

A flashing 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 25 mph (40 km/h) when locked to access height will cause the control module to automatically change the ride height from access mode to on-road mode.

ON-ROAD MODE

This is the normal ride height for the vehicle.

OFF-ROAD MODE

Off-road mode will only be selectable if the vehicle speed is less than 25 mph (40 km/h). The vehicle will be raised 55mm (2.2 inches) to provide additional body clearance and improved approach, departure and breakover angles. If the vehicle speed exceeds 31 mph (50 km/h), the air suspension control module will automatically lower the vehicle to the on-road mode height. At 25 to 28 mph (40 to 45 km/h) a message is displayed in the message center to warn the driver to slow down or the vehicle will lower.

ACCESS MODE

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

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

- If the vehicle speed is more than 12.5 mph (20 km/h), the air suspension control module will wait for up to one minute for the vehicle speed to be reduced. The access mode light emitting diode (LED) and the lowering LED will flash while the air suspension control module waits for the vehicle speed to be reduced, the on-road mode lamp will remain illuminated. If the vehicle speed is not reduced sufficiently, the access mode request will be cancelled after 1 minute.
- If the vehicle speed is less than 12.5 mph (20 km/h), the air suspension control module will lower the suspension to a part lowered height and will remain at this height for up to one minute. The on-road mode lamp will extinguish as the air suspension control module lowers the suspension to the part lowered height. The access mode lamp and the lowering LED will illuminate. When part lowered is reached, the lowering LED will flash. If the vehicle speed is not reduced to less than 5 mph (8 km/h) in the one minute period, the access mode request will be cancelled.
- If the vehicle speed is less than 5 mph (8 km/h), the suspension will be lowered to access mode immediately. The access mode LED and the lowering LED will illuminate. When the access mode height is

reached, the lowering LED will be extinguished.

Access height may be selected up to 40 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 mode when the vehicle speed exceeds 6.2 mph (10 km/h). If access mode was selected directly from off-road mode then the system will return to off-road mode when the vehicle speed exceeds 6.2 mph (10 km/h). Otherwise the system will lift the suspension to On-road height.

Selecting Access Mode 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 LED is extinguished, the control module will lower the suspension to access mode height. The control module will remember to return the suspension to off-road height automatically if the vehicle speed increases above 6.2 mph (10 km/h).

CRAWL (LOCKED AT ACCESS) MODE

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

Crawl mode can be selected up to 21.7 mph (35 km/h) with a long press of the switch in a down direction. The access mode lamp and the crawl mode lamp will be illuminated. When the control module is in crawl mode, on-road mode height will be selected automatically if the vehicle speed exceeds 24.8 mph (40 km/h). At 18.6 to 21.7 mph (30 to 35 km/h) a message is displayed in the message center to warn the driver to slow down or the vehicle will rise. Crawl mode can also be manually cancelled by moving the switch in the up direction for 1 second. The crawl mode lamp will now be extinguished.

HIGH SPEED MODE

High speed mode is a non-selectable, automatic mode which lowers the vehicle height to improve vehicle handling. This feature is fully automated and is 'invisible' to the driver.

If the vehicle speed exceeds 100 mph (160 km/h) for more than five seconds, the air suspension control module initiates the high speed mode. When the vehicle speed reduces to less than 80 mph (130 km/h) for more than 30 seconds, the vehicle returns to the On-Road height. This function is cancelled if a trailer is connected to the trailer socket.

AUTOMATIC HEIGHT CHANGE WARNINGS

When the suspension is in off-road mode, access mode or crawl mode height, the air suspension control module will change the suspension height automatically when the vehicle speed exceeds a predetermined threshold.

When the suspension is at off-road mode or crawl mode height, the control module issues a warning to advise the driver that the vehicle is approaching the speed threshold. The instrument cluster sounder will emit a chime, a message will be displayed in the message center and the on-road mode LED and either the raising or lowering LED will flash.

The off-road mode or crawl mode height speed 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 air suspension control module will restrict further height change.

The LED on the air suspension LED display for the target mode height will remain illuminated and the raising or lowering LED 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 10kph 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 following conditions are satisfied, vehicle stationary, rate of vehicle lowering is below a predefined threshold for a predefined time. Lower inhibit is normally invoked under the following conditions, vehicle lowered onto an obstacle during a height change.

Belly-Out Belly-Out is a pro-active mode invoked when the following conditions are satisfied, vehicle moving and speed is below 50kph, 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 becomes grounded and the traction control becomes operational, the air suspension control module automatically increases the mass of air in the air springs to raise the vehicle clear of the obstruction. Extended mode is activated automatically and cannot be selected manually.

When the air suspension control module has activated the extended mode, the off-road mode lamp will flash if the suspension is above off-road mode height. The off-road mode and on-road mode lamps will flash if the suspension is between off-road mode and on-road mode heights. The on-road mode and access mode lamps will flash if the suspension is between on-road mode and access mode. A message will also be displayed in the message center.

To exit the extended mode, press the air suspension switch briefly in the up or down position or alternatively drive the vehicle at a speed of more than 2 mph (3 km/h) for 45 seconds.

ADDITIONAL LIFT IN EXTENDED MODE

When extended mode has been invoked and the automatic lifting of the vehicle is complete, the driver can request an additional lift of the vehicle. This can be particularly useful when extended mode has been activated on soft surfaces.

The additional lift can be requested once the height change LED has extinguished. Press and hold the air suspension switch in the up position for 3 seconds whilst simultaneously depressing the brake pedal. A chime from the instrument cluster will sound to confirm that the request has been accepted. The raising LED will be illuminated while the vehicle is being lifted.

PERIODIC RE-LEVELING

When the vehicle is parked, the air 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

Transportation mode is a factory set mode which locks the suspension to enable the vehicle to be safely lashed to a transporter. 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 the ignition switch is switched off, the vehicle will be lowered to access mode. This ensures that the securing straps do not become loose should air leak from the air springs.

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

When the engine is started, the air 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 LED's 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 LED's will illuminate continuously and the chime will stop.

When the engine is switched off, the air suspension control module will cause the vehicle to lower allowing the vehicle to be strapped down. While the height is changing, all the LED's in the air suspension control switch will flash. When the height of -50mm is reached, all the LED's will illuminate continuously.

CALIBRATION MODE

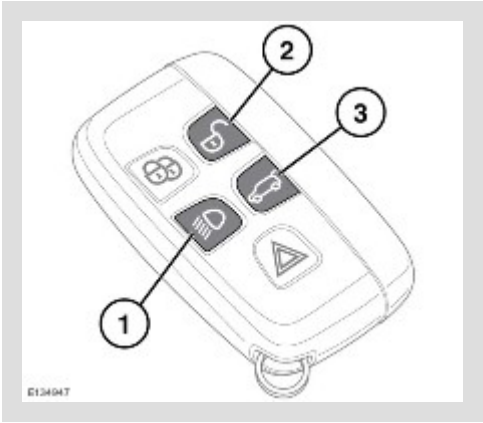
This mode is used when the air suspension control module has been replaced or a height sensor or suspension component has been dismantled or replaced.

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

- The ride height is set to tight tolerance

- Fault reaction to vehicle identification number (VIN) 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



ITEM	DESCRIPTION
1	Hold
2	Raise vehicle
3	Lower vehicle

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 buttons 1 and 2 to are to be press simultaneously.

To lower the vehicle suspension buttons 1 and 3 to are to be press simultaneously

AIR HARNESS

The air harness comprises ten separate nylon pipes which are connected between the system components with Voss connectors. The pipes have the following diameters:

PIPE	DIAMETER
High pressure pipes	6 mm
Compressor inlet pipe	8 mm
Inlet filter to silencer	8 mm
Compressor exhaust pipe	10 mm

PIPE	DIAMETER
Silencer exhaust pipe	19 mm

If a pipe becomes damaged, an in-line connector is available for repair purposes. The pipes are secured to the body and chassis with a number of plastic clips.

LEAK DETECTION

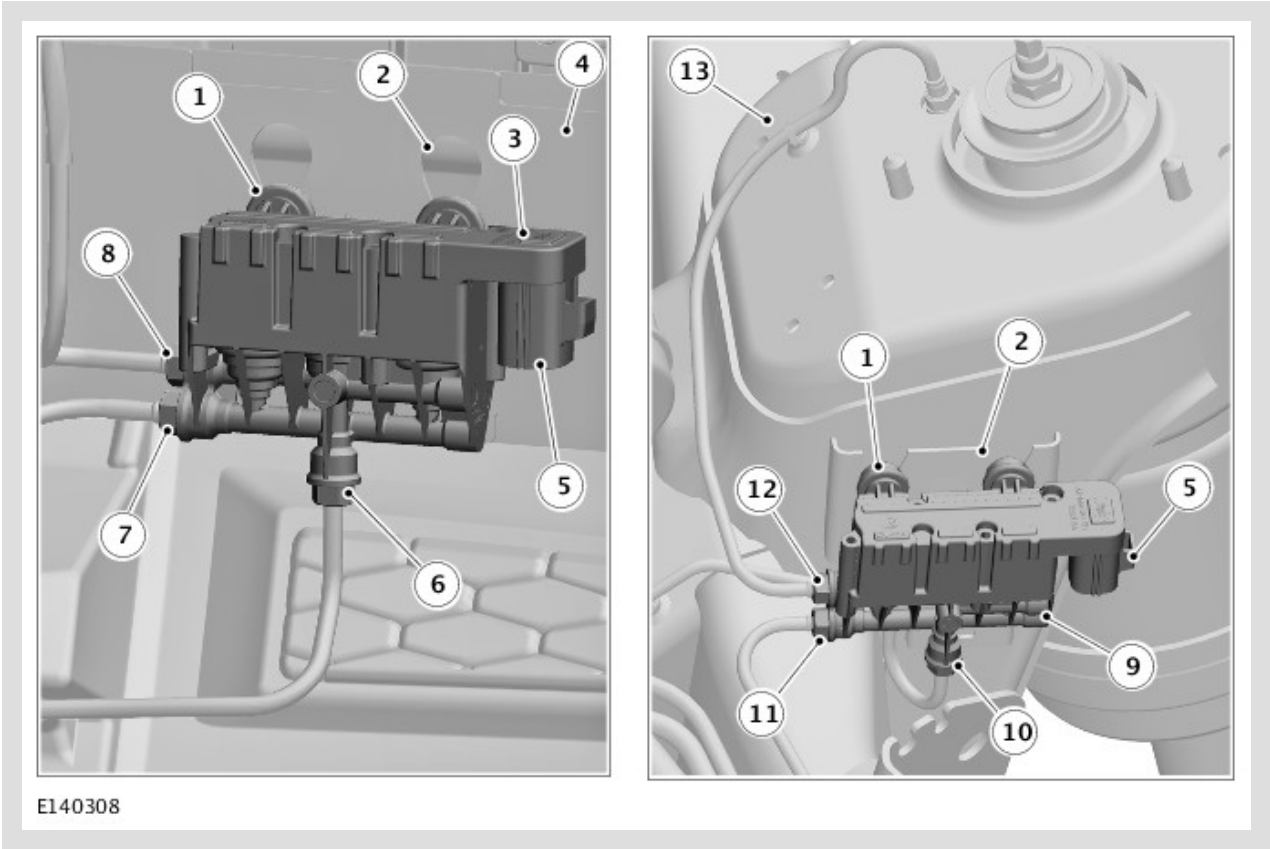
Leak detection can be carried out using a Land Rover approved leak detection spray.

If the vehicle appears to be leaking, perform a leak check on all aspects of the system, i.e.; 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.

AIR SUSPENSION COMPONENTS

VALVE BLOCKS

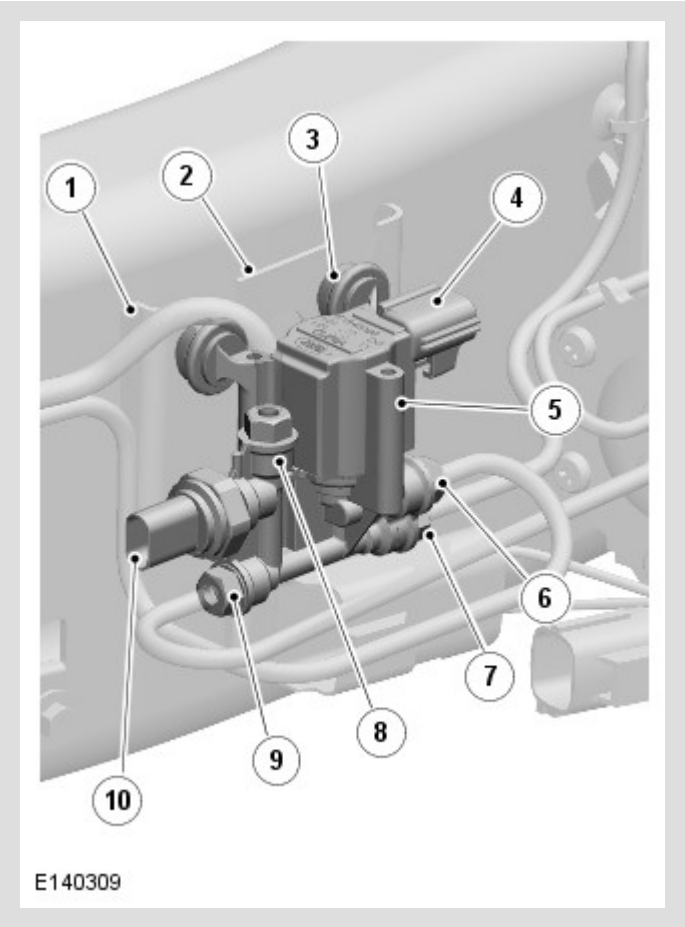
Front and Rear Valve Blocks



ITEM	DESCRIPTION
1	Isolation rubber mounts (3 off)

ITEM	DESCRIPTION
2	Location slots
3	Front valve block, valves and solenoid assembly
4	Front bumper armature
5	Electrical connector
6	LH air spring damper module air harness connection
7	Air inlet/outlet connection
8	RH air spring damper module air harness connection
9	Rear valve block, valves and solenoid assembly
10	RH air spring damper module air harness connection
11	Air inlet/outlet connection
12	LH air spring damper module air harness connection
13	Rear suspension turret

Reservoir Valve Block



ITEM	DESCRIPTION
1	Chassis mounting bracket

ITEM	DESCRIPTION
2	Location slot
3	Isolation rubber mounts (3 off)
4	Electrical connector
5	Reservoir valve block, valves and solenoid assembly
6	Reservoir connection
7	Rear valve block connection
8	Front valve block connection
9	Air supply unit connection
10	Pressure sensor

Front and Rear Valve Blocks

The front and rear axle valve blocks are similar in their design and construction and control the air supply and distribution to the front or rear pairs of air spring damper modules respectively. The difference between the two valves is the connections from the valve block to the left and right hand air spring damper modules and the valve size. It is important that the correct valve block is fitted to the correct axle. Fitting the incorrect valve block will not stop the air suspension system from functioning but will result in slow raise and lower times and uneven raising and lowering between the front and rear axles.

The front valve block is attached to the RH end of the front bumper armature assembly. The valve block has three attachment lugs which are fitted with isolation rubber mounts. The rubber mounts locate in slots in the armature. The valve lugs locate in the holes above the slots and are pushed downwards into positive location in the slots.

The rear valve block is located on the forward face of the left hand rear suspension turret. The valve block has three attachment lugs which are fitted with isolation rubber mounts which locate in a bracket with three slotted holes. The bracket is attached to the left hand side of the chassis. The isolation rubber mounts locate in the 'V' shaped slots and are pushed downwards into positive location in the slots.

The front and rear valve blocks each have three air pipe connections which use 'Voss' type air fittings. One connection is an air pressure inlet/outlet from the reservoir valve block. The remaining two connections provide the pressure connections to the left and right hand air springs.

Each valve block contains three solenoid operated valves; two corner valves and one cross-link valve. Each of the valve solenoids is individually controlled by the air suspension control module. The solenoids have a resistance value of 2 Ohms at a temperature of 20°C (68°F).

Reservoir Valve Block

The reservoir valve block is attached to a bracket on the outside of the left hand chassis rail, between the reservoir and the air supply unit. The valve block is located within the air supply unit acoustic box to protect it from dirt ingress and damage from stones. The valve block has three attachment lugs which are fitted with

isolation rubber mounts. The rubber mounts locate in the chassis bracket which has three corresponding 'V' shaped slots. The rubber mounts are pushed downwards into positive location in the slots.

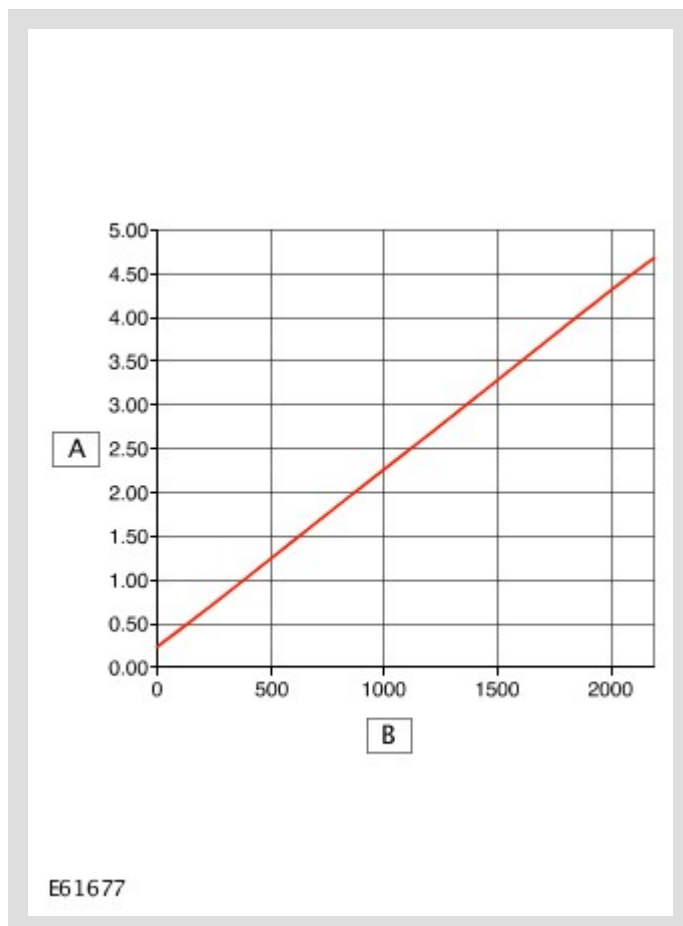
The reservoir valve block controls the storage and distribution of air from the reservoir. The reservoir valve block also contains the system's pressure sensor.

The valve block has four air pipe connections which use 'Voss' type air fittings. The connections provide for air supply from the air supply unit, air supply to and from the reservoir and air supply to and from the front and rear valve blocks. The connections from the air supply unit and the front and rear control valves are all connected via a common gallery within the valve and therefore are all subject to the same air pressures.

The valve block contains a solenoid operated valve which is controlled by the air suspension control module. The solenoid valve controls the pressure supply to and from the reservoir. The solenoid has a resistance value of 2 Ohms at a temperature of 20°C (68°F). When energized, the valve spool moves allowing air to pass to or from the reservoir.

The valve block also contains a pressure sensor which can be used to measure the system air pressure in the air springs and the reservoir. The pressure sensor is connected via a harness connector to the air suspension control module. The control module provides a 5V reference voltage to the pressure sensor and monitors the return signal voltage from the sensor.

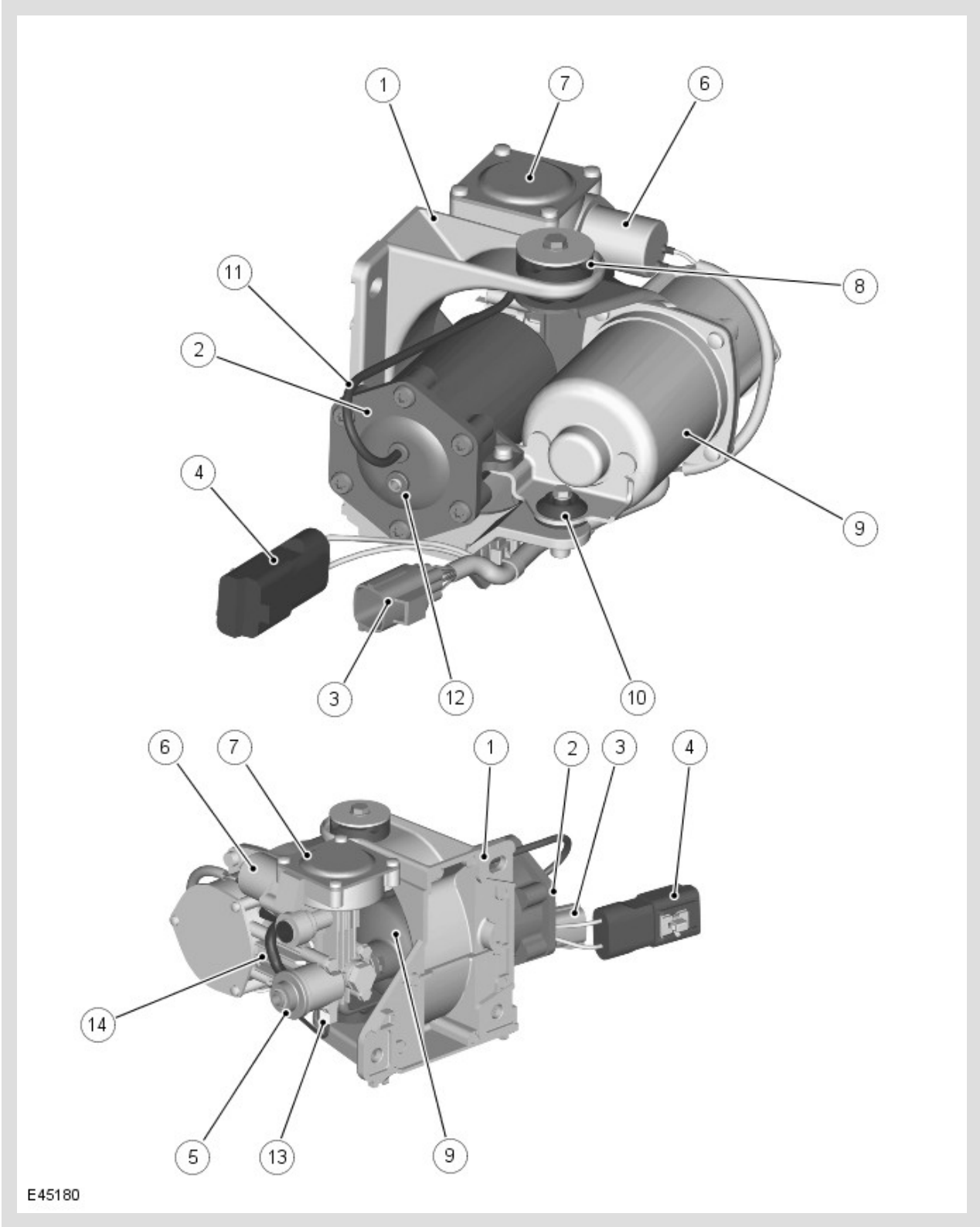
Using this sensor, the control module controls the air supply unit operation and therefore limits the nominal system operating pressure to 244 lbf/in² (16.8 bar gage).



ITEM	DESCRIPTION
A	Output voltage (V)
B	Pressure (kPa)

Removal of the reservoir valve block will require full depressurization of the reservoir. The valve block is a non-serviceable item and should not be disassembled other than for replacement of the pressure sensor.

AIR SUPPLY UNIT

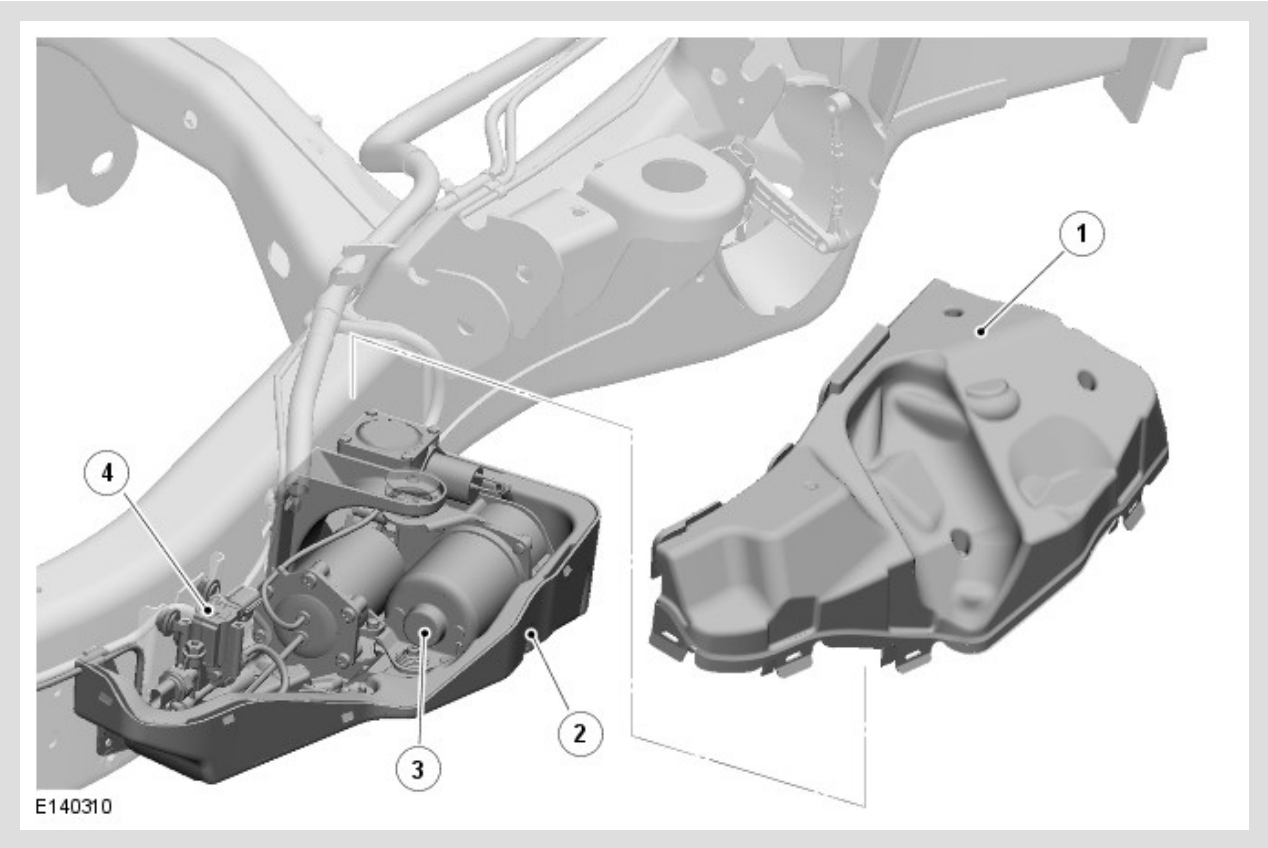


ITEM	DESCRIPTION
1	Mounting bracket
2	Air dryer
3	Pilot exhaust valve solenoid and temperature sensors harness connector
4	Motor harness connector

ITEM	DESCRIPTION
5	Intake port
6	Pilot exhaust valve
7	Exhaust valve
8	Isolation mounting rubber (2 off)
9	Electric motor
10	Isolation mounting rubber (1 off)
11	Pilot air pipe
12	High pressure supply to the air suspension system
13	Compressor cylinder head temperature sensor
14	Compressor

The air supply unit is located on the outside of the left hand chassis rail, forward of the upper control arm. The unit is attached to the chassis rail with three bolts and is protected by an acoustic box.

Acoustic Box



ITEM	DESCRIPTION
1	Upper cover
2	Lower cover
3	Air supply unit

ITEM	DESCRIPTION
4	Reservoir valve block

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 an insulating foam which controls the operating noise of the air supply unit. The reservoir valve block is also located in the acoustic box, forward of the air supply unit.

The air supply unit comprises the following major components:

- A piston compressor
- A 12V electric motor
- A solenoid operated pilot valve
- An exhaust valve
- An air dryer 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. Height changes of less than 20 mm are achieved using the compressor alone. Height changes of more than 20 mm are achieved using the reservoir and the compressor. The compressor cannot 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.

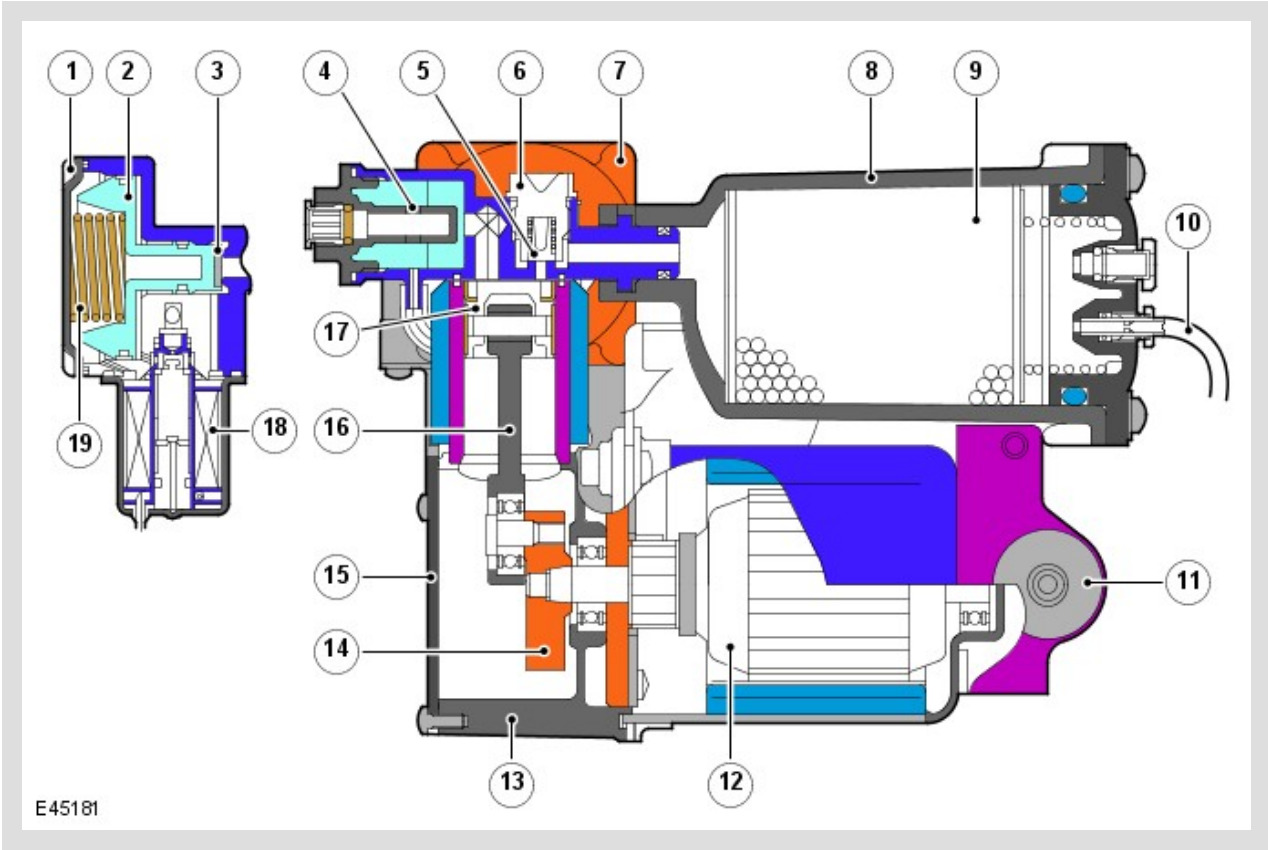
The air supply unit can be serviced in the event of component failure, but is limited to the following components; air dryer, pilot exhaust pipe and the rubber mounts.

The air supply unit is attached to a bracket which is bolted to the chassis. The unit is mounted to the bracket with flexible isolation mounting rubbers which assist with preventing operating noise being transmitted to the chassis.

Removal of the air supply unit does not require the whole air suspension system to be depressurized. The front and rear valve blocks and the reservoir valve block are normally closed when de-energized, preventing air pressure in the air springs and the reservoir escaping when the unit is disconnected.

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 section of this document.

Air Supply Unit - Sectional View



ITEM	DESCRIPTION
1	Exhaust valve cap
2	Plunger
3	Valve seat
4	Intake silencer port
5	Delivery valve
6	Valve guide
7	Cylinder head
8	Dryer case
9	Desiccant
10	Pilot exhaust line
11	Isolation rubber mount
12	Motor assembly
13	Crankcase
14	Crank
15	Crankcase cover
16	Connecting rod


ITEM	DESCRIPTION
17	Piston
18	Pilot exhaust valve
19	Spring - pressure relief

Electric Motor

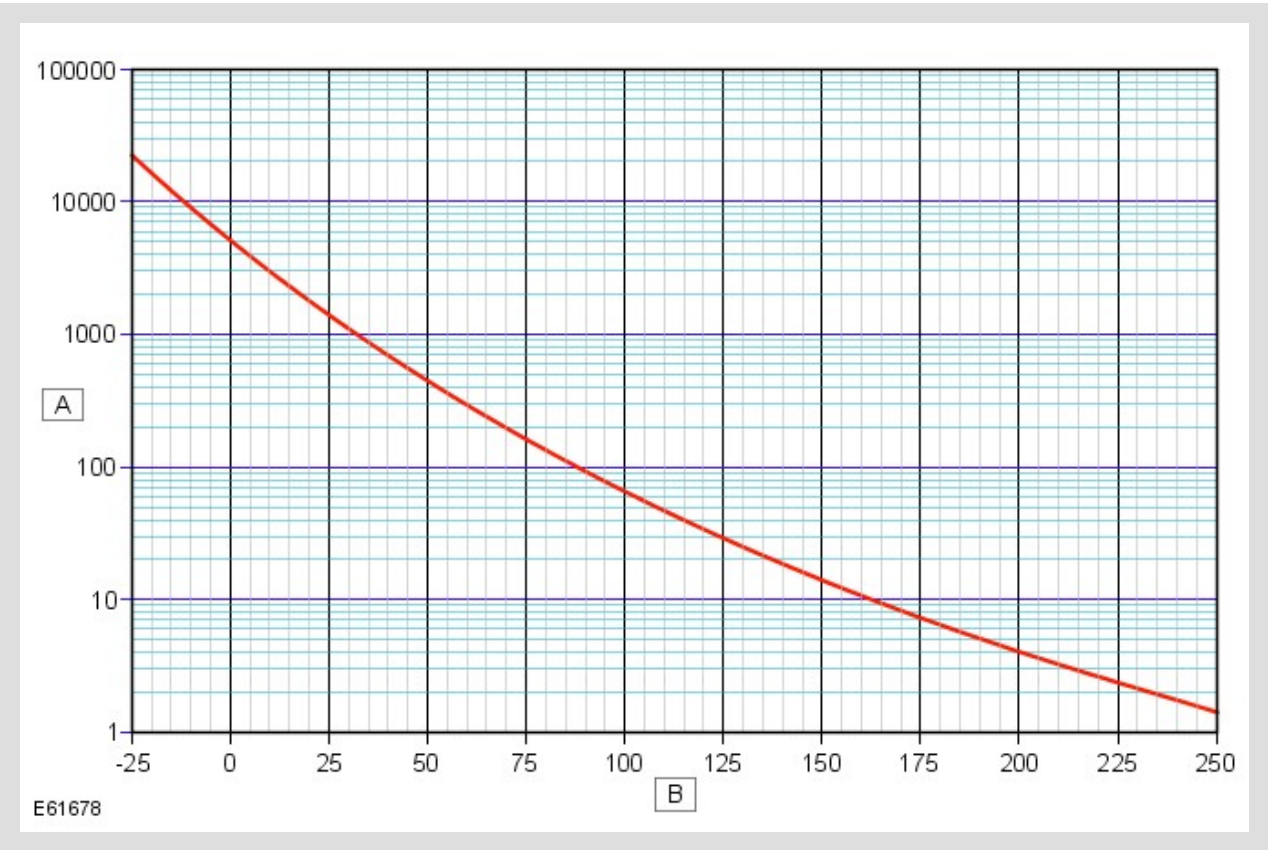
The electric motor is a 12V direct current (DC) motor with a nominal operating voltage of 13.5V. The motor drives a crank which has an eccentric pin to which the compressor connecting rod is attached.

The motor is fitted with a temperature sensor on the brush Printed Circuit Board (PCB) assembly. The sensor is connected to the air suspension control module which monitors the motor temperature and can suspend motor operation if the operating thresholds are exceeded.

The following graph shows motor temperature sensor resistance values against given temperatures.


 **NOTE:**

This graph is also applicable for the compressor cylinder head temperature sensor.



ITEM	DESCRIPTION
A	Resistance (kOhms)
B	Temperature (°C)

The following graph shows air suspension control module output voltages against motor temperature sensor temperatures.

 **NOTE:**

This graph is also applicable for the compressor cylinder head temperature sensor.



ITEM	DESCRIPTION
A	Control module input voltage (V)
B	Temperature sensor (°C)

Compressor

The compressor is used to supply air pressure to the air suspension reservoir. The air suspension control module monitors the pressure within the reservoir and, when the engine is running, maintains a pressure of 16.8 bar gage (244 lbf/in ²).

The compressor comprises a motor driven connecting rod and piston which operate in a cylinder with a separate cylinder head. The motor rotates the crank moving the piston up and down in the cylinder bore. The air in the cylinder is compressed with the up stroke and is passed via the delivery valve through the air dryer and into the system.

The cylinder head is fitted with a temperature sensor. The sensor is connected to the air suspension control module which monitors the cylinder temperature and can suspend motor and compressor operation if an

overheat condition occurs.

The compressor will not be allowed to start if the pressure sensor reads greater than 4 bar (absolute).

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

Compressor Cylinder Head Operating Temperatures

	LEVELING	RESERVOIR FILLING
OFF	140°C (284°F)	130°C (266°C)
ON	120°C (248°F)	110°C (230°F)

Refer to the motor temperature sensor graph for compressor cylinder head temperature sensor resistance values and the air suspension control module output voltage / temperature sensor graph.

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 reservoir and/or the system.

When the air springs are deflated, the exhaust air also passes 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.

Pilot Exhaust Valve

Attached to the cylinder head 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 compressor exhaust valve allowing the air springs to be deflated.

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

Exhaust Valve


The exhaust valve operates when the pilot exhaust valve is opened, allowing air returning from the air springs and/or the reservoir to be exhausted quickly.

The pilot exhaust valve also provides the system pressure relief function which protects the air springs from over inflation. The valve is pneumatically operated, responding to air pressure applied to it to overcome pressure 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 between 22 to 27 bar gage (319 to 391 lbf/in ²).

The minimum pressure in the system is also controlled by the 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

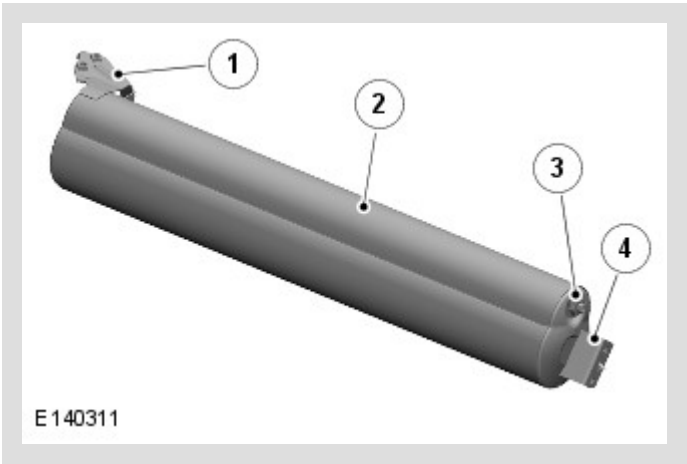
DESCRIPTION	VALUE
Working pressure	16.8 bar gage
Maximum pressure (stabilized)	22.0 to 27.0 bar gage
Operating voltage	10 to 16.5 Volts (13.5 Volts nominal)
Running current consumption	20-50 Amps depending on load
Maximum start-up current	120 Amps
Pilot Exhaust Valve - Solenoid valve resistance at 20°C (68°F)	4 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.

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

RESERVOIR



ITEM	DESCRIPTION
1	Front bracket
2	Reservoir
3	Air hose connection to reservoir valve block
4	Rear bracket

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 reservoir is a steel fabrication and is located on the outside of the left hand chassis rail, in front of the air supply unit. The reservoir has a bracket at each end which attach to the body mounting brackets on the chassis.

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 reservoir valve block.

The reservoir has a capacity of 9 liters (550 in ³0). The nominal working pressure of the reservoir is 16.8 bar gage (243.6 lbf/in ²), with a maximum pressure of 35 bar gage (507 lbf/in ²).

AIR SPRINGS

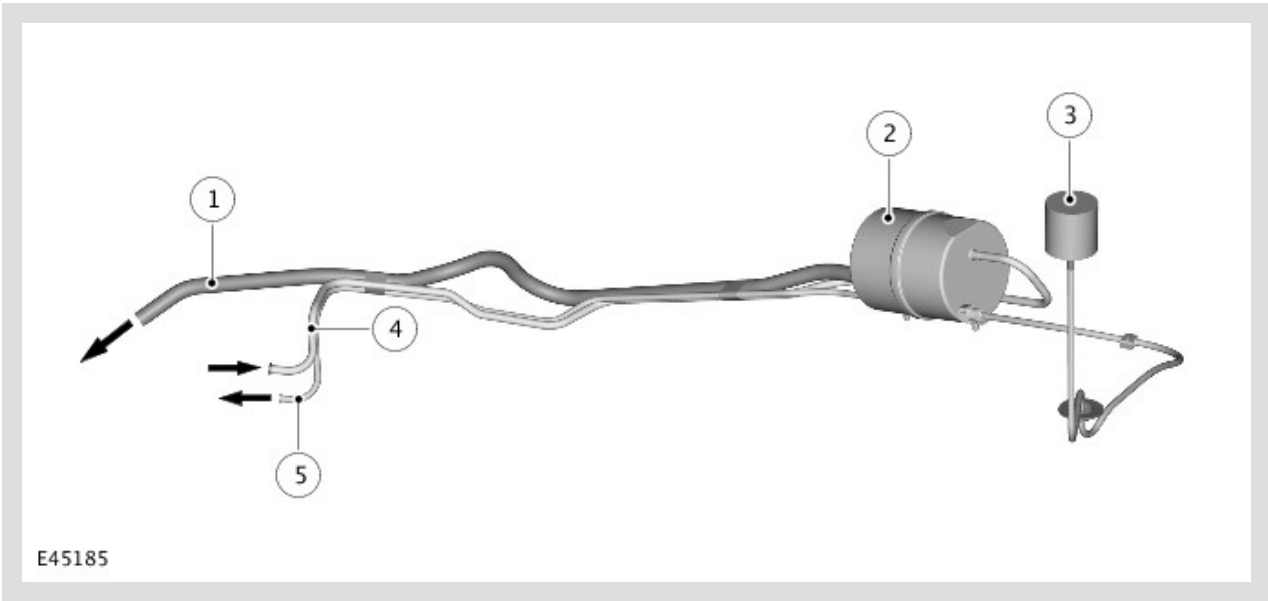
The air springs on the front and rear suspension are similar in construction. The air springs are manufactured from a flexible rubber and each air spring forms an air tight cavity which provides the required spring rate for each corner of the vehicle.

As the air spring is compressed, the rubber material compresses and rolls down the side of the vertical housing (piston) below the spring. 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 axle 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 a routine 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 air spring must be fully pressurized before the weight of the vehicle is applied to it.

AIR SILENCER AND INLET AIR FILTER



ITEM	DESCRIPTION
1	Exhaust (to atmosphere)
2	Inlet and exhaust silencer
3	Air inlet filter
4	Exhaust air from air supply unit
5	Air inlet supply to air supply unit

The air silencer is required to limit any noise produced from the air supply unit during inflation or deflation of the air springs.

The silencer comprises two plastic molded cans, which are bonded together. A silencing foam in the large internal chamber forms the exhaust silencer. A pipe connection is molded onto each end of the silencer and provides for the attachment of the exhaust air to atmosphere pipe and the exhaust air pipe from the air supply unit.

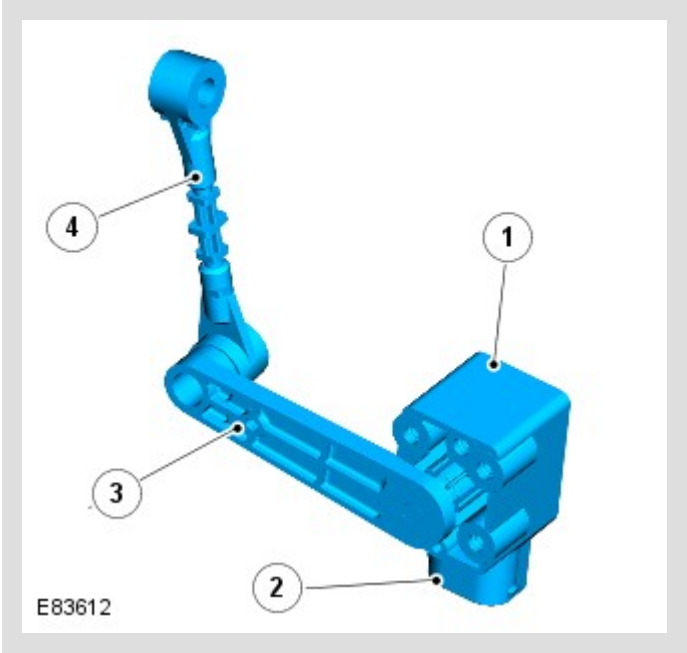
A secondary chamber, located around the outside of the exhaust chamber forms the silencer for the inlet air. Pipe connections are molded onto each end of the intake silencer and provide for the attachment of the air inlet pipe from the inlet air filter and the air inlet pipe to the air supply unit. The intake air silencer is a hollow chamber with no noise reduction foam filling.

The air intake filter is connected via a pipe to the intake silencer chamber of the air silencer unit. The filter is located in the rear left hand corner of the body, away from possible sources of dirt and moisture.

The filter contains a foam element which removes particulate matter from the inlet air before it reaches the silencer or the air supply unit.

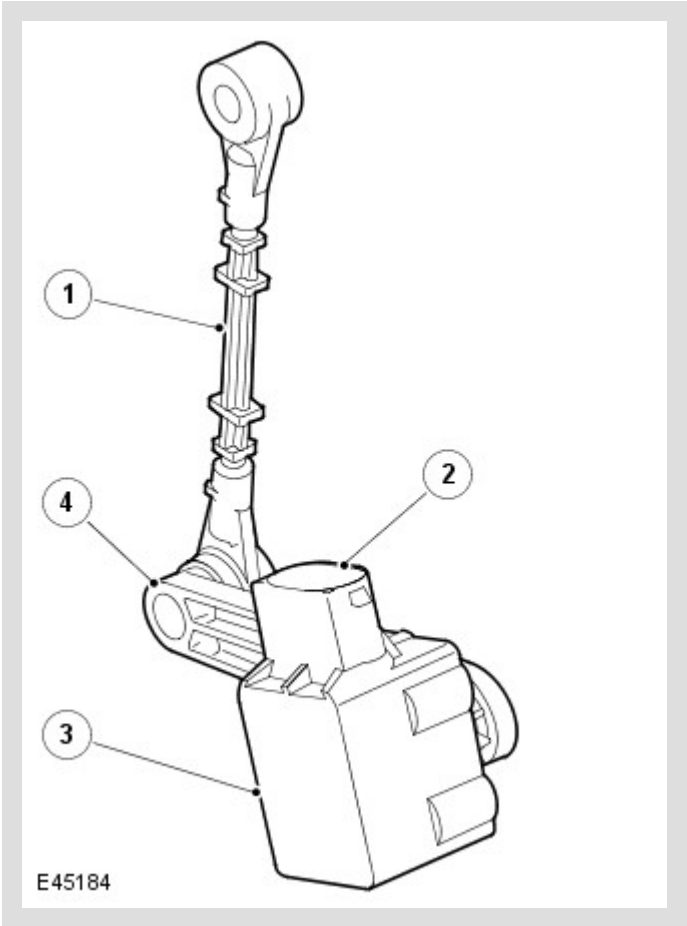
HEIGHT SENSORS

Front Height Sensor



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

Rear Height Sensor



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

A height sensor is fitted in each corner of the vehicle to monitor the ride height of the vehicle. The sensors are mounted on the chassis, with a mechanical link to the suspension upper arms.

If a height sensor is removed from its mounting position for servicing or replacement, the Land Rover approved diagnostic system must be used to recalibrate the system. Calibration will also be required if the suspension arm to which the sensor is connected is removed or replaced.

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 air 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.

The height sensors are attached to brackets on the chassis and are connected to the upper arms by links. The links allow articulation of the arm to allow for suspension travel. Each sensor is connected by a multiplug.

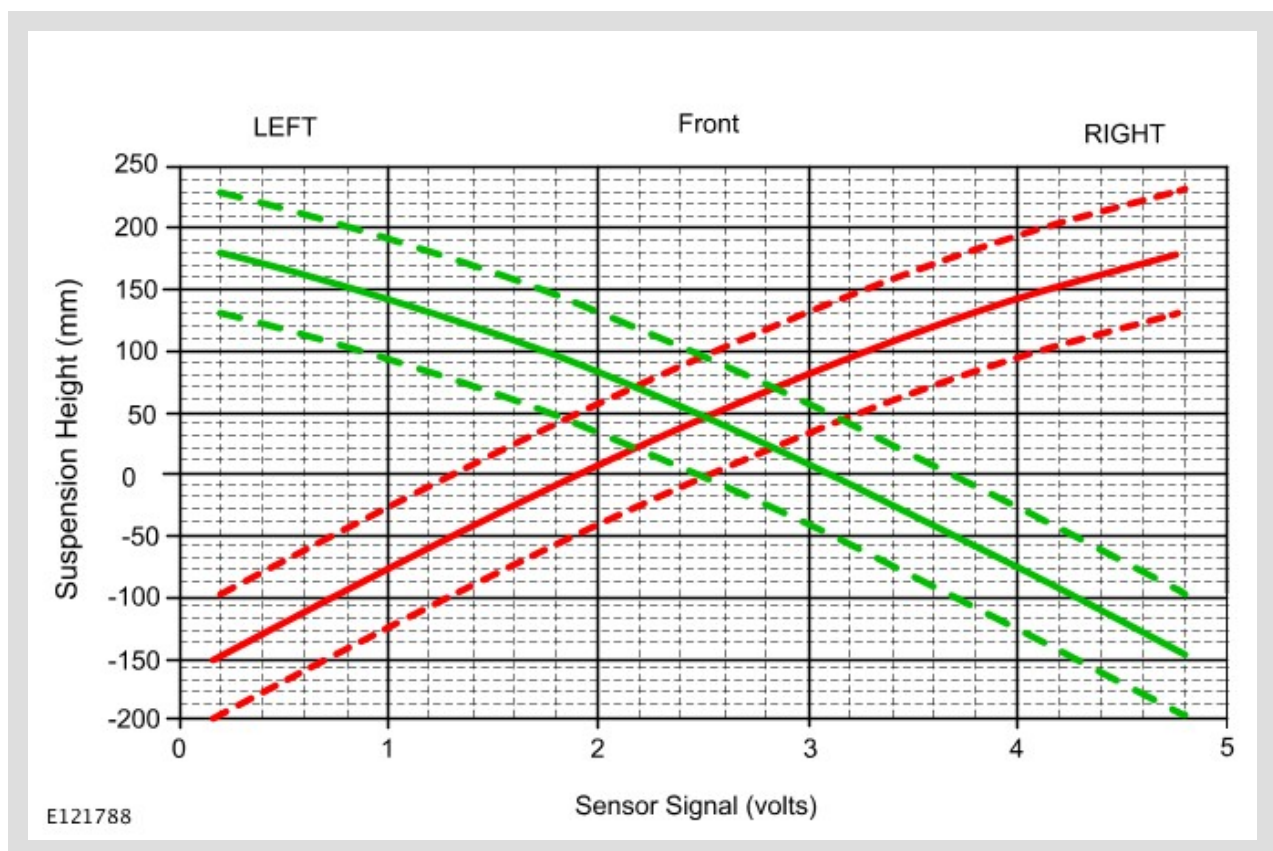
The four suspension height sensors that are used in the air suspension system also supply input to the adaptive dynamics system, two for the front suspension and two for the rear suspension. A front suspension height sensor is attached to each side of the chassis and connected by a sensor arm and sensor link to the related upper lateral arm of the front suspension. A rear suspension height sensor is attached to each side of the chassis and connected by a sensor arm and sensor link to the related upper control arm of 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.

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

The sensors can be checked by applying 5V across the positive and negative terminals and measuring output signal which should be a nominal 57mV \pm 3% per degree of sensor arm movement.

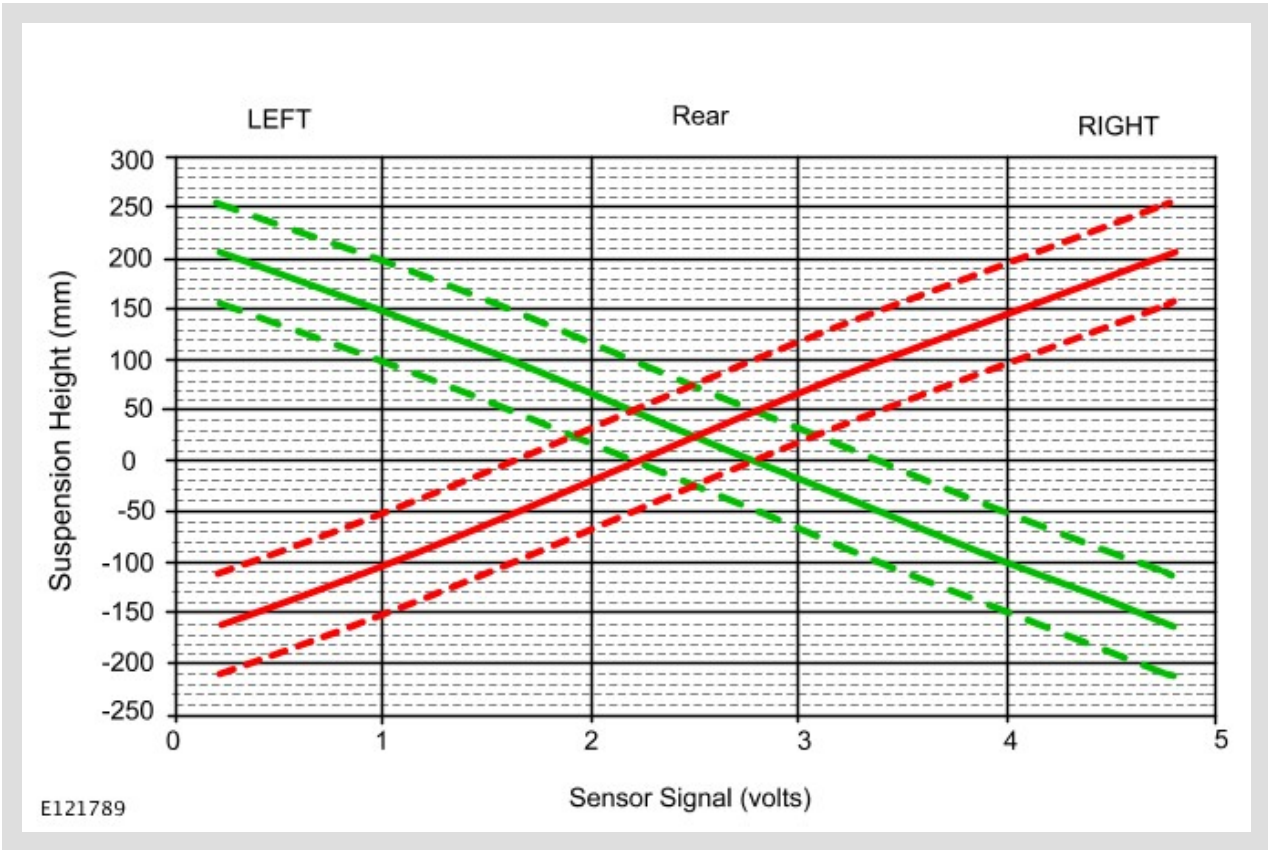
The following graph shows the vehicle height displacement from normal against output voltage for the front height sensors. The center line represents the "nominal" condition but depending on tolerances, the actual line may lie anywhere between the upper and lower lines.

Front Height Sensor

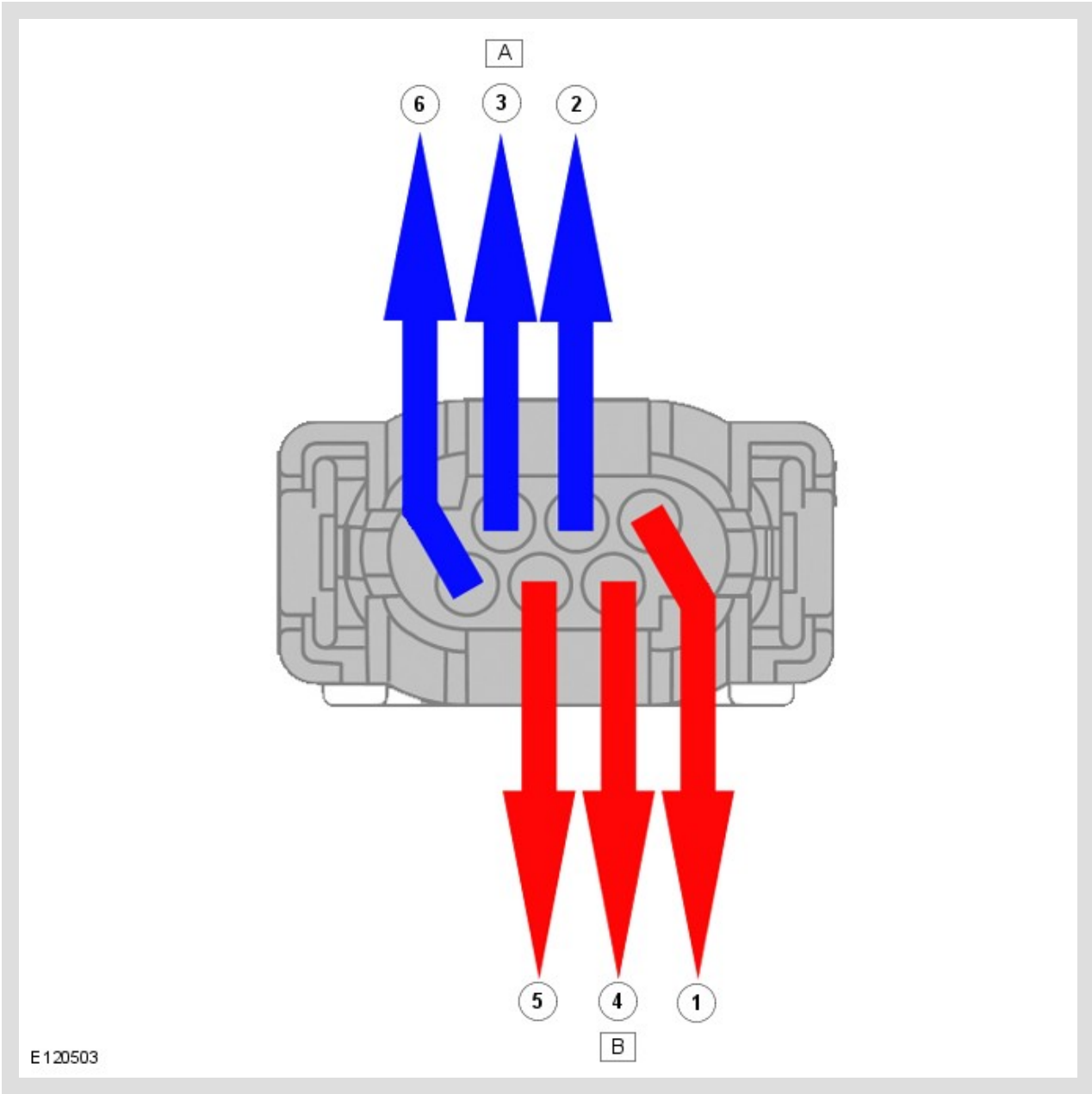


The following graph shows the vehicle height displacement from normal against output voltage for the rear height sensors. The center line represents the "nominal" condition but depending on tolerances, the actual line may lie anywhere between the upper and lower lines.

Rear Height Sensor



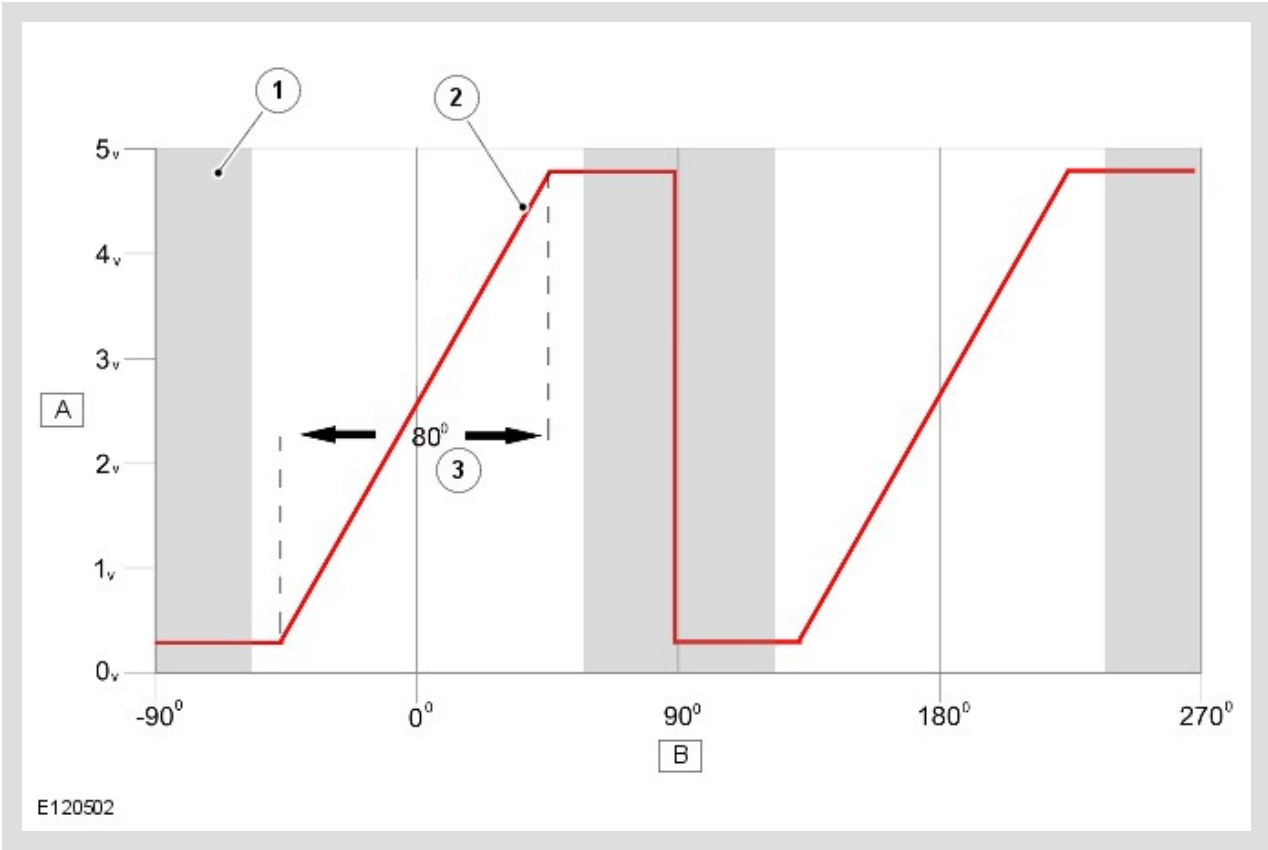
HEIGHT SENSOR WIRING



ITEM	DESCRIPTION
A	Adaptive Damping Module
B	Air Suspension Module
1	Ground
2	Ground
3	5v Supply
4	Signal Output (Air Suspension)
5	5v Supply
6	Signal Output (ADM)

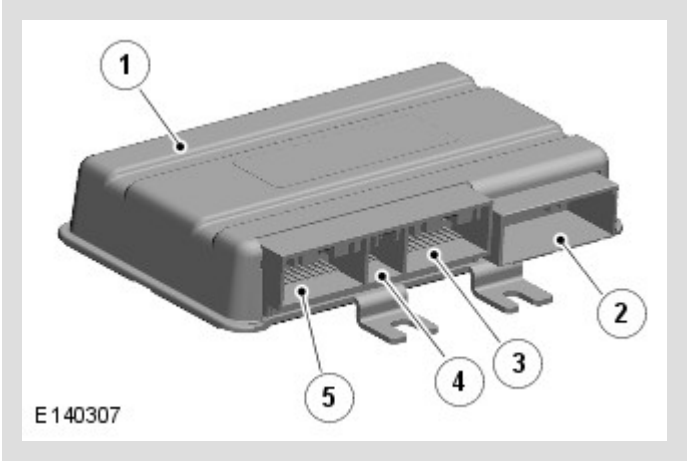
The sensing element consists of an array of hall effect devices arranged to measure the direction of the magnetic field of a small magnet attached to the end of the sensor shaft. As the sensor shaft rotates, so do the lines of magnetic flux from the magnet. The signals from the Hall effect elements are 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 $\pm 40^\circ$ around its nominal position and the nominal sensitivity is 57 mV/ $^\circ$ of shaft rotation. The graphic below [Fig:9] 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

AIR SUSPENSION CONTROL MODULE



ITEM	DESCRIPTION
1	Air suspension control module
2	Connector C2321
3	Connector C2320
4	Connector C2030
5	Connector C0867

The air suspension system fitted is controlled by the air suspension control module which is located behind the instrument panel, on the driver's side 'A' pillar.

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 has the following modes of operation:

- Calibration
- Normal
- Periodic Wake-Up.

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

CALIBRATION

A calibration routine is performed using the Land Rover approved 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 air suspension control module or adaptive damping module is removed or replaced, a height sensor or bracket is removed, replaced or disturbed 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 the air supply unit, the reservoir, a valve block, a damper module or the air harness is removed or replaced, the system will not require recalibration.

PERIODIC WAKE-UP MODE

When the vehicle is parked, the air 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.

SYSTEM OPERATION

Under normal operating conditions, the air 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 air 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 ± 10 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 air suspension control module is programmed with a number of system inhibits. If any of the conditions detailed below exist, the air suspension control module will suspend height changes and height corrections.

COMPRESSOR

System Pressure

The compressor will not start if the system pressure is greater than 4 bar (gage)

Compressor Temperature

Two temperature sensors are located within the compressor to prevent overheating. If the temperature of the motor brush assembly or the compressor cylinder head rise above pre-set limits, the air suspension control

module will inhibit the compressor operation. The limits are detailed in tables in the Air Supply Unit section of this manual.

CORNERING

If the air 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 air suspension control module receives a message from the lateral acceleration sensor (which is an integral part of the anti-lock brake system (ABS) yaw rate sensor) on the high speed controller area network (CAN) bus for the cornering force.

RAPID ACCELERATION

If the air 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 control module from a vehicle speed signal received via the high speed CAN bus.

RAPID DECELERATION

If the air 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 bus.

VEHICLE JACK

The air suspension control module will inhibit all height changes and corrections if it detects a corner lowering too slowly for more than 1.2 seconds. This is interpreted as the corner identified as moving too slowly being supported on a jack. In this situation, the corner height will not change when air is released from the air spring because the jack acts as a mechanical prop.

The system will remain inhibited until any of the following conditions exist:

- The air suspension rotary switch is moved to the up or down position
- The vehicle speed rises to more than 3 km/h (2 mph) for more than 45 seconds.

DOOR OPEN

The air suspension control module will stop all height change requests while any of the doors are open. Vehicle leveling 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 air suspension control module can store fault codes which can be retrieved using the 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 socket is protected by a hinged cover.

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 LED's and the instrument cluster message center.

If the air suspension control module suffers a major failure and there is no air suspension control, all the control switch LED's 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 center. If the control module cannot determine the height of the vehicle, or the vehicle is above on-road 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: [Information and Message Center](#) (413-08 Information and Message Center, Description and Operation).

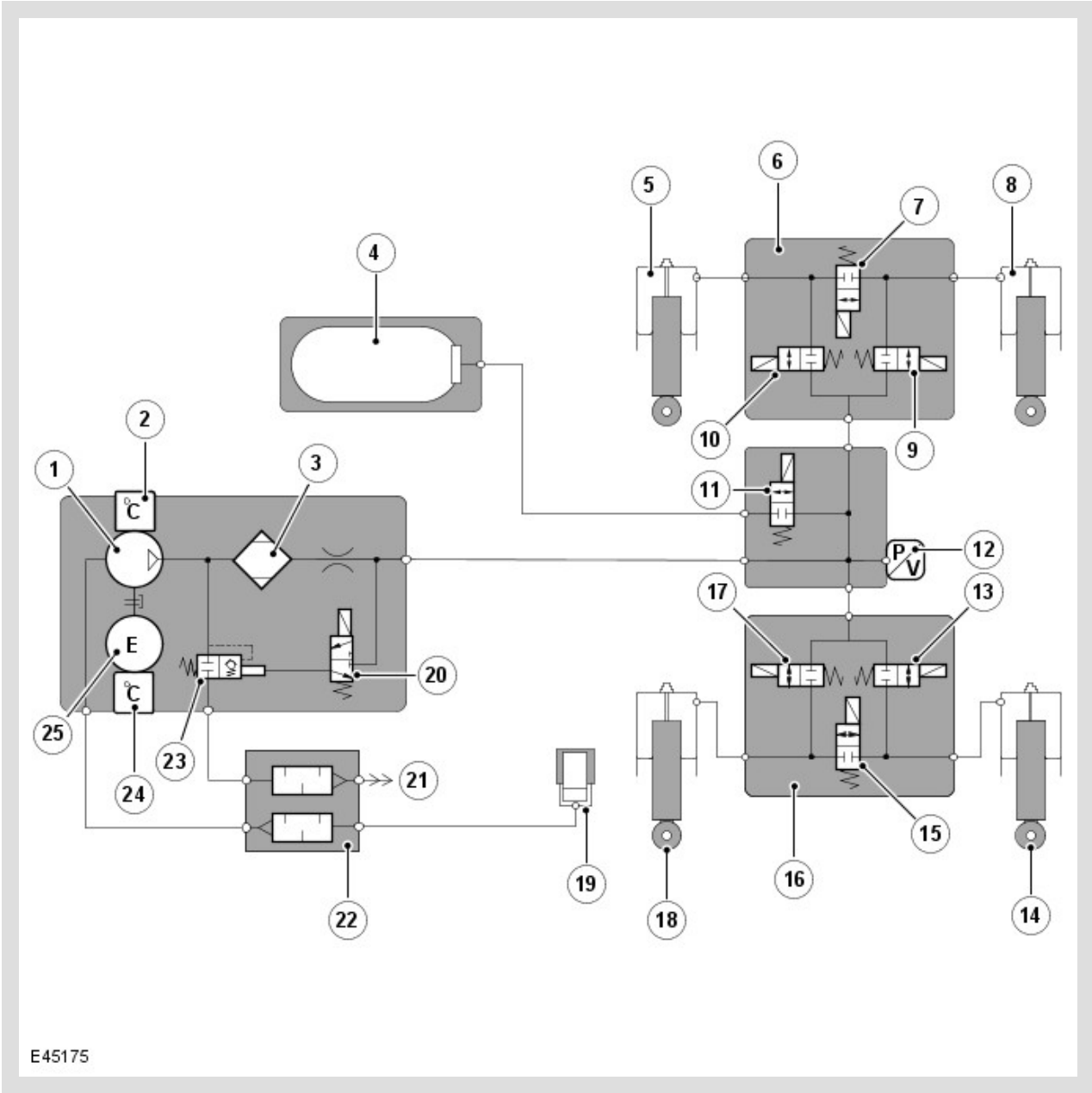
RESERVOIR

The air 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.

SYSTEM PNEUMATIC CIRCUIT

The following schematic diagram shows the connection relationship between the air supply unit, the reservoir, the reservoir valve block, the cross-link valves and the air springs.

Schematic Pneumatic Circuit



ITEM	DESCRIPTION
1	Compressor
2	Compressor temperature sensor
3	Air dryer
4	Reservoir
5	Front LH air spring damper module
6	Front valve block
7	Cross link valve
8	Front RH air spring damper module
9	Front RH corner valve
10	Front LH corner valve

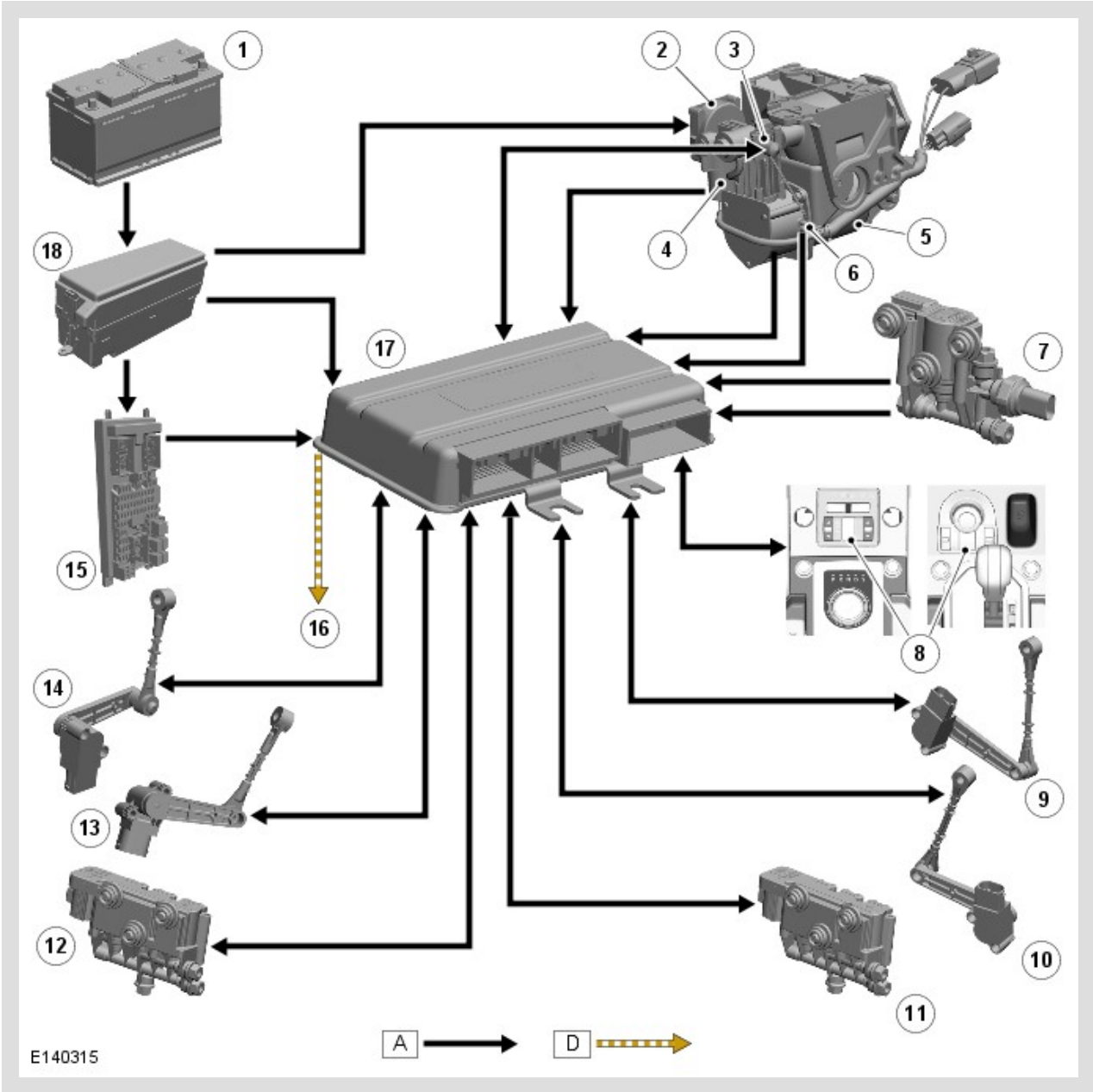
ITEM	DESCRIPTION
11	Reservoir control valve
12	Pressure sensor
13	Rear RH corner valve
14	Rear RH air spring damper module
15	Cross link valve
16	Rear valve block
17	Rear LH corner valve
18	Rear LH air spring damper module
19	Inlet air filter
20	Pilot exhaust valve
21	Exhaust
22	Air silencer
23	Pressure relief and exhaust valve
24	Motor temperature sensor
25	Electric motor

CONTROL DIAGRAM - AIR SUSPENSION



NOTE:

A = Hardwired; D = High Speed CAN bus



ITEM	DESCRIPTION
1	Battery
2	Air supply unit
3	Compressor temperature sensor
4	Motor temperature sensor
5	Motor
6	Exhaust valve solenoid
7	Reservoir control valve
8	Air suspension switch
9	<u>RH</u> front height sensor
10	<u>RH</u> rear height sensor

ITEM	DESCRIPTION
11	Rear control valve
12	<u>CAN</u> connection to other systems
13	Front control valve
14	<u>LH</u> rear height sensor
15	<u>LH</u> front height sensor
16	central junction box (CJB)
17	battery junction box (BJB)
18	Air suspension control module

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