

PUBLISHED: 24-MAR-2020
2020.0 DEFENDER (LE), 204-05

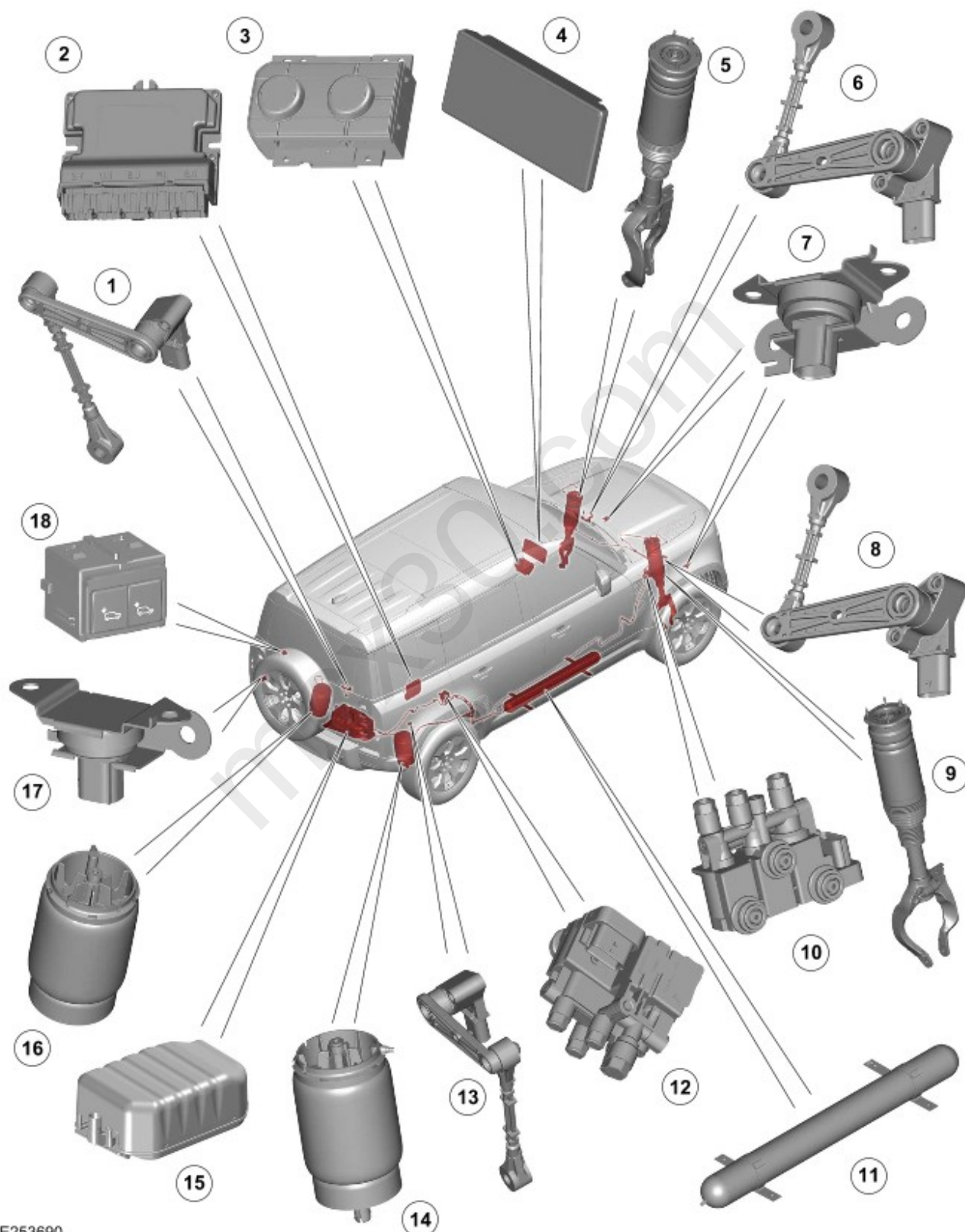
VEHICLE DYNAMIC SUSPENSION (G2341724)

mcx30.com

mcx30.com

COMPONENT LOCATION

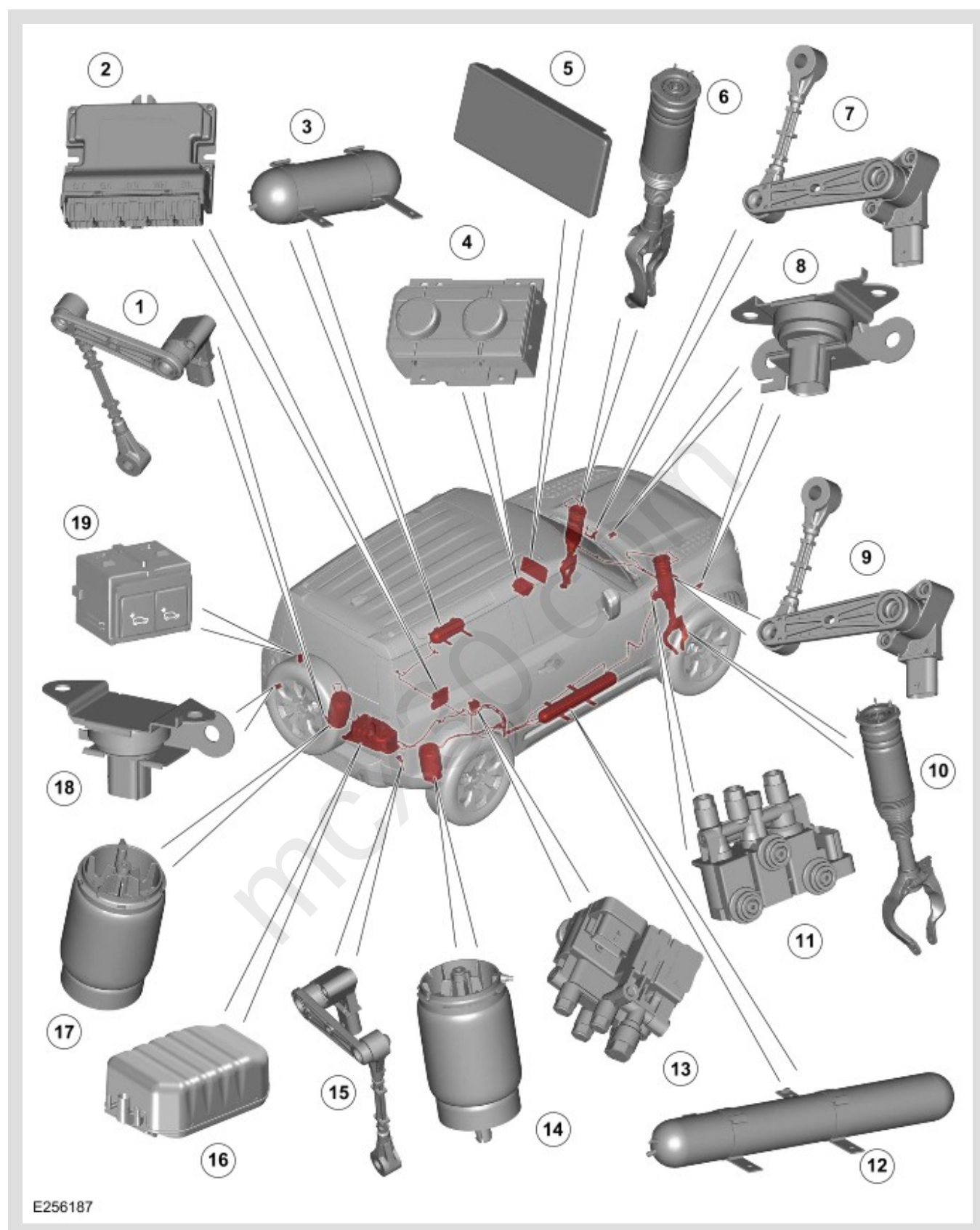
COMPONENT LOCATION 1 OF 2 – MODEL 110 VEHICLES



E253690

ITEM	DESCRIPTION
1	Rear left height sensor
2	Chassis Control Module (CHCM)
3	Interactive Control Interface Module 'A' (ICIMA)
4	Interactive Display Module 'A' (IDMA)
5	Front left air spring and damper
6	Front left height sensor
7	Front accelerometer (quantity 2)
8	Front right height sensor
9	Front right air spring and damper
10	Front valve block
11	Air reservoir
12	Rear valve block
13	Rear right height sensor
14	Rear right air spring
15	Suspension air supply unit
16	Rear left air spring
17	Rear accelerometer
18	Air suspension rear switchpack (Luggage compartment)

COMPONENT LOCATION 2 OF 2 - MODEL 90 VEHICLES



ITEM	DESCRIPTION
1	Rear left height sensor

ITEM	DESCRIPTION
2	CHCM
3	Air reservoir
4	ICIMA
5	IDMA
6	Front left air spring and damper
7	Front left height sensor
8	Front accelerometer (quantity 2)
9	Front right height sensor
10	Front right air spring and damper
11	Front valve block
12	Air reservoir
13	Rear valve block
14	Rear right height sensor
15	Rear right air spring
16	Suspension air supply unit
17	Rear left air spring
18	Rear accelerometer
19	Air suspension rear switchpack (Luggage compartment)

OVERVIEW

ADAPTIVE DAMPING

Adaptive Damping (AD) is an electronically controlled suspension system that continuously adjusts the damping characteristics of the suspension shock absorbers in reaction to the existing driving conditions.

The system is controlled by the CHCM.

The CHCM receives signals from 3 accelerometers, 4 height sensors and other vehicle systems to determine:

- Vehicle state
- Body and wheel motions
- Driver inputs.

These signals are used by the CHCM to continuously control the damping characteristics of each shock absorber to the appropriate level to provide the optimum body control and vehicle ride.

AIR SUSPENSION SYSTEM

The air suspension system is a 4 corner system, electronically controlled by the CHCM. The CHCM receives input signals from 4 height sensors. The CHCM operates a suspension air supply unit and 2 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 CHCM uses signals from the 4 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 CHCM operating the pneumatic control valves to increase or decrease the mass of air in the air springs.

The air suspension system has 4 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 through the instrument cluster message center and by audible warnings also transmitted by the Instrument Panel Cluster (IPC).

The air suspension can be controlled manually by the driver using the ICIMA to select the required height change.

For safety reasons, the lowering of the suspension is restricted when a door is open. Full suspension lowering may not be achievable until the door is closed.

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

The CHCM performs On-Board Diagnostics (OBD) functions to perform 'health checks' on the system. If faults are detected, codes are stored in the control module and can be retrieved using a Jaguar Land Rover (JLR) approved diagnostic system.

DESCRIPTION

SHOCK ABSORBERS

The adaptive shock absorbers are nitrogen gas and oil filled monotube units. The shock absorbers are continuously variable, which allows the damping force to be electrically adjusted when the vehicle is being driven. The shock absorbers provide the optimum compromise between vehicle control and ride comfort.

The shock absorbers have an electrical connector on the end of the piston rod, in the center of the top mount.

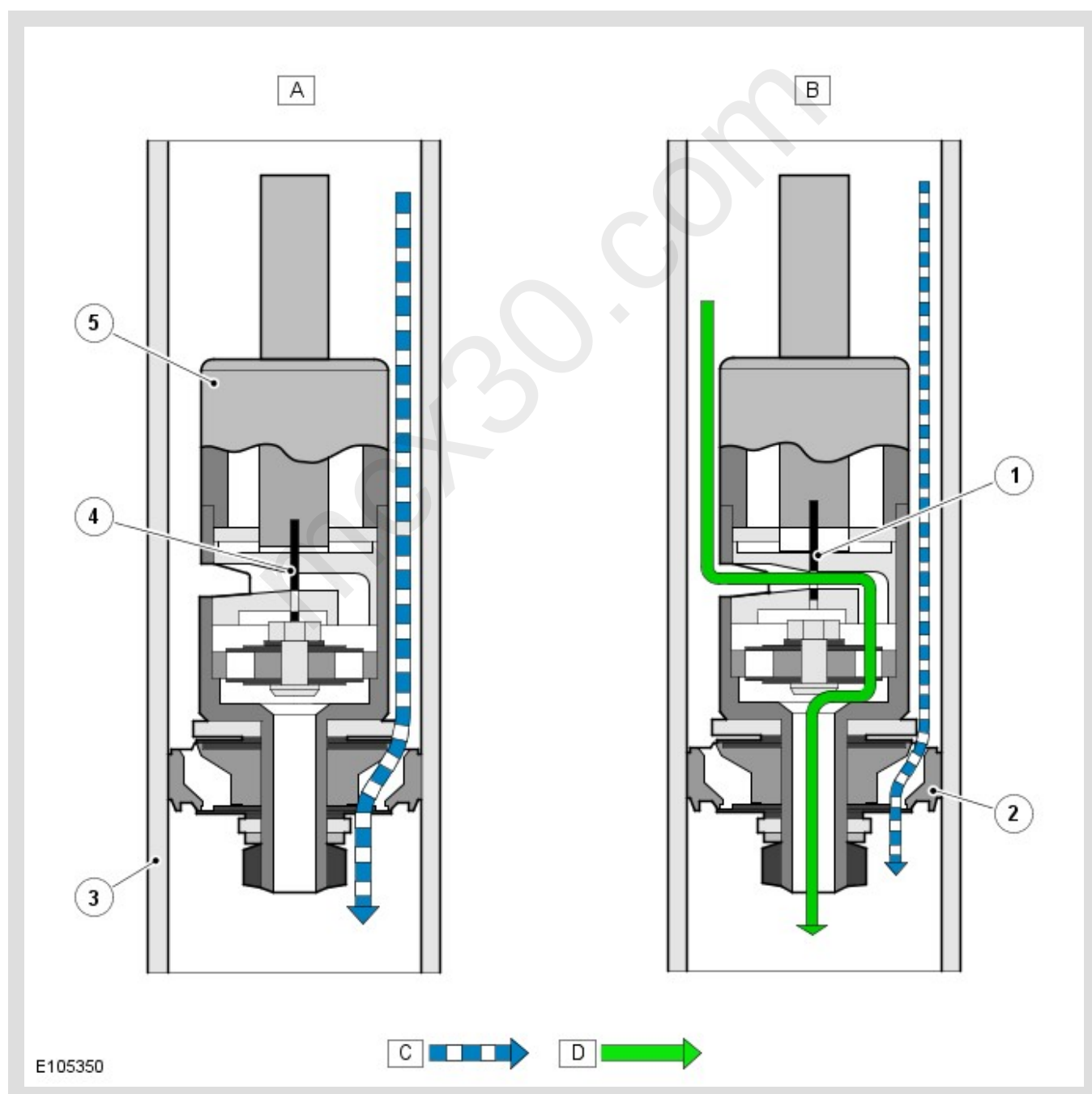
In each shock absorber, the damping adjustment is achieved by a variable orifice operated by a solenoid. The orifice is used to open up alternative paths to allow oil-flow within the shock absorber. When de-energized the bypass is closed and all the oil flows through the main (firm) piston. When energized the solenoid moves an armature and control blade, which work against a spring. The control blade incorporates an orifice which slides inside a sintered housing to open up the bypass as required. When the shock absorber is compressed the oil flows from the lower portion of the shock absorber then through a hollow piston rod, which is a separate soft (comfort) valve. The oil then

flows through the slider housing and orifice and into the upper portion of the shock absorber, thereby bypassing the main (firm) valve. In rebound the oil flows in the opposite direction.

In the firm setting oil flows through the main (firm) valve only, although when the bypass is opened by variable amounts, the oil flows through both valves to provide a pressure balance. When fully energized the solenoid moves the armature and therefore the slider to the maximum extension and opens the orifice completely. The shock absorber operates continuously between these 2 boundary conditions.

The solenoid in each shock absorber is operated by a 526 Hz Pulse Width Modulated (PWM) signal from the CHCM. The CHCM controls the PWM duty ratio to provide 1.5A to operate the shock absorber in the soft setting. When de-energized (0.0A) the shock absorber is in the firm setting. The current varies continuously as required to increase and decrease the damping individually in each of the shock absorbers.

Sectioned Views of Shock Absorber Operating States

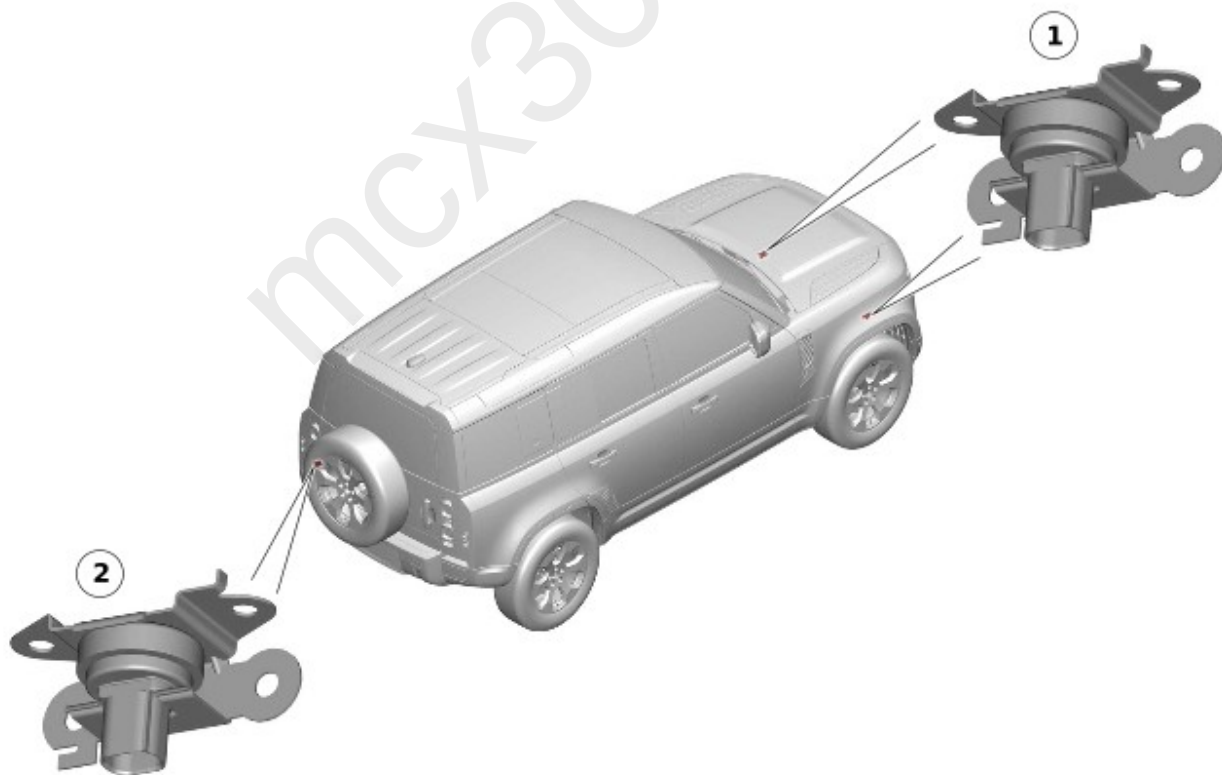


ITEM	DESCRIPTION
A	Firm setting
B	Soft setting
C	Main oil flow
D	Bypass oil flow
1	Bypass valve (open)
2	Main valve
3	Tube
4	Bypass valve (closed)
5	Piston and rod assembly

ACCELEROMETERS

△ NOTE:

Model 110 vehicle is shown, model 90 vehicle is similar.



E253692

ITEM	DESCRIPTION
1	Front accelerometers (quantity 2)
2	Rear accelerometer

There are 3 accelerometers used in the Adaptive Damping (AD) system, 2 at the front of the vehicle and 1 at the rear.

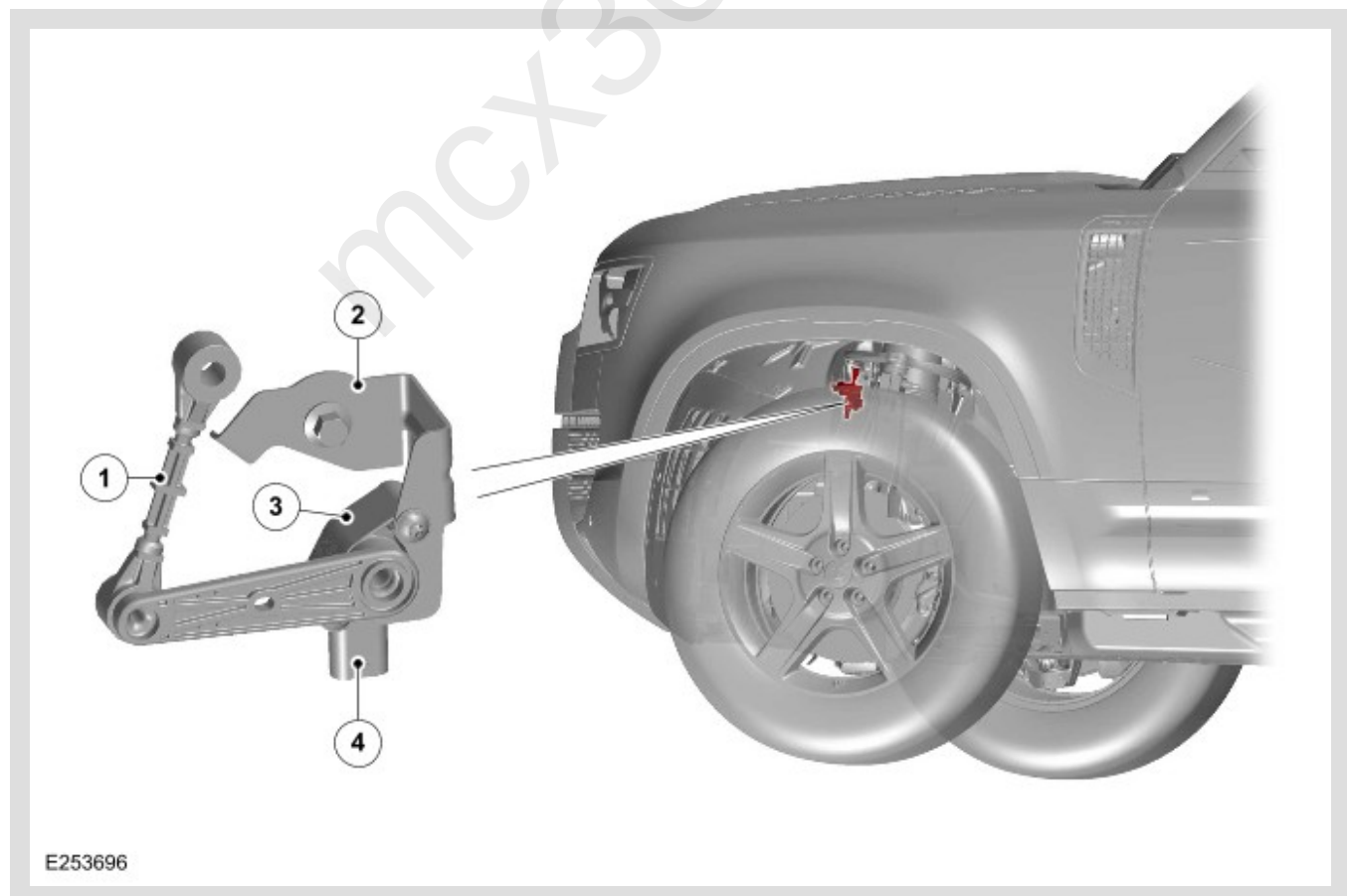
The accelerometers measure acceleration in the vertical plane and output a corresponding analog signal to the CHCM . The algorithms in the CHCM calculate the heave, pitch and roll motions of the vehicle, which are used to control body motion.

Each accelerometer is connected to the CHCM through 3 wires, which supply ground, 5V supply and signal return.

The sensing element comprises a single parallel plate capacitor, 1 plate of which moves relative to the other dependant 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 $1 \text{ V/g} \pm 0.05 \text{ V/g}$. When the vehicle is stationary, each accelerometer outputs approximately 2 volts.

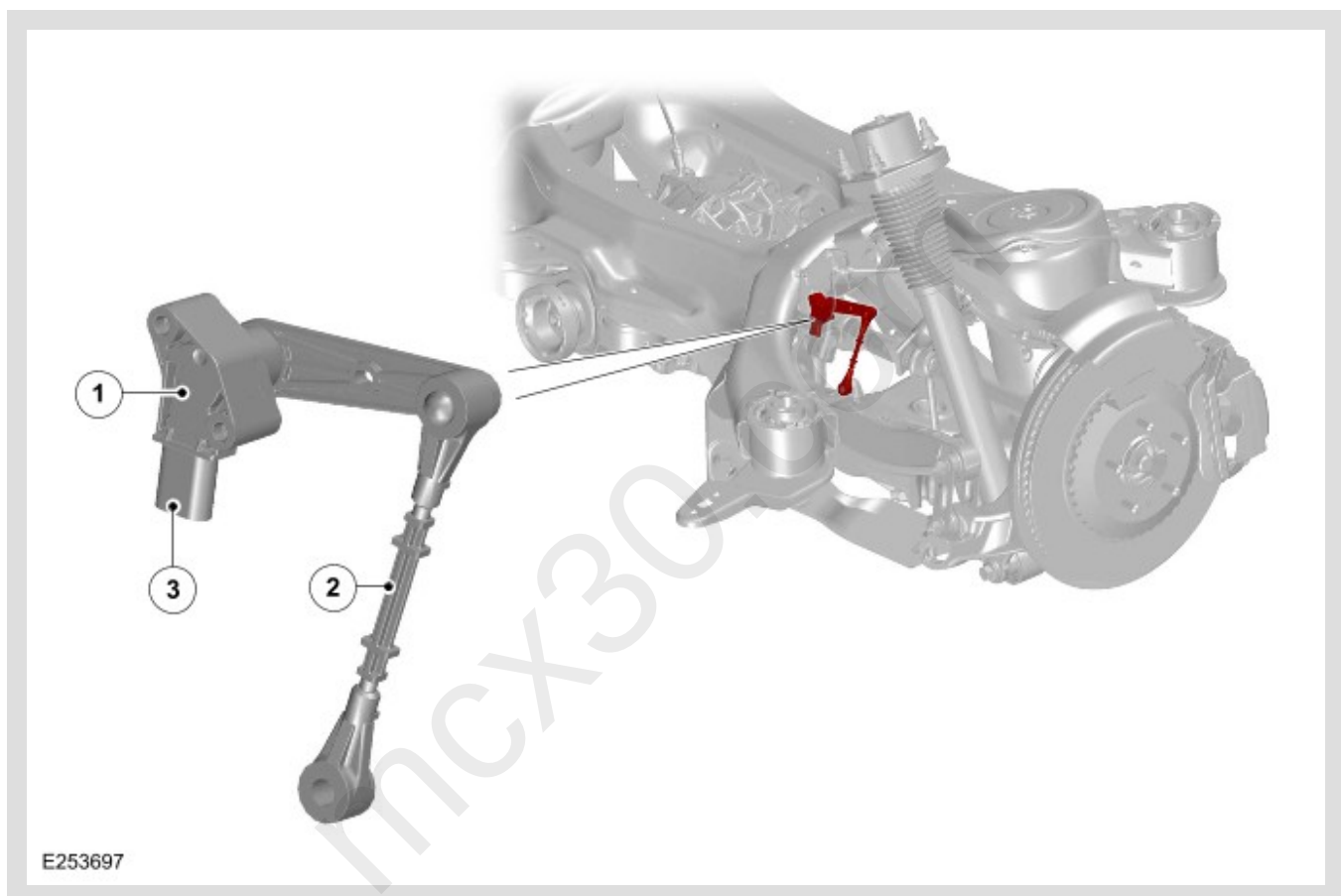
HEIGHT SENSORS

Front Height Sensor



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

Rear Height Sensor



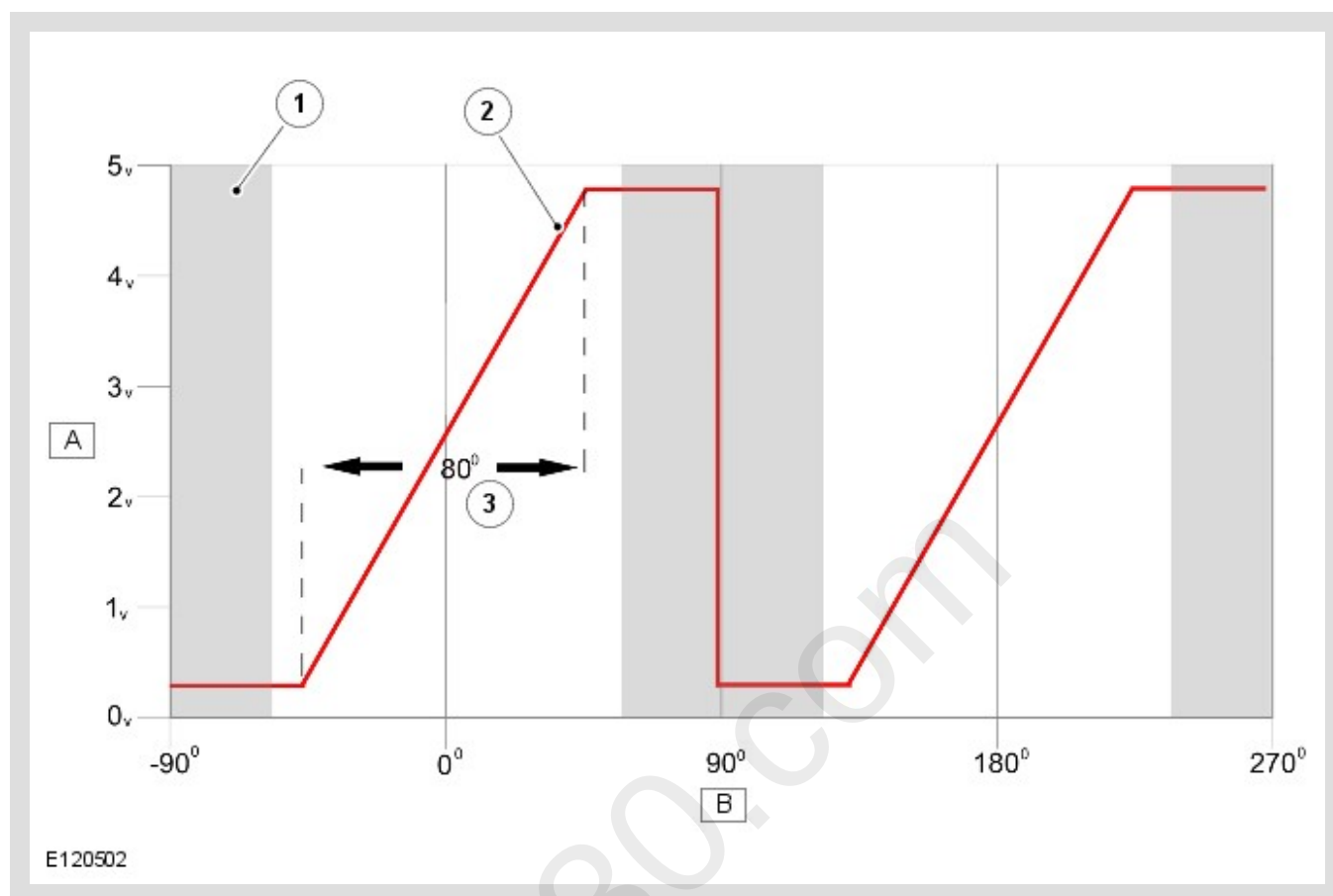
ITEM	DESCRIPTION
1	Sensor body
2	Lever arm
3	Electrical connector

There are 4 height sensors that are used in the air suspension system, 2 for the front suspension and 2 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.

The suspension height sensors measure suspension displacement at each corner of the vehicle and output a corresponding analog signal to the CHCM. The algorithms in the CHCM calculate the position, velocity and frequency

content of the signals. The output is used in the control of vehicle systems, for example air suspension, active damping or headlamp leveling.

Height Sensor Voltage



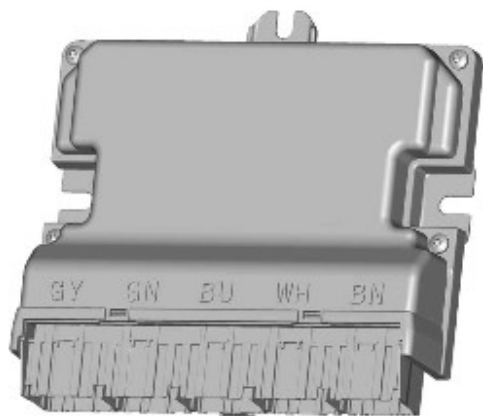
ITEM	DESCRIPTION
A	Sensor voltage
B	Angle of rotation
1	Outside measuring range
2	Voltage output
3	$\pm 40^\circ$ measuring range

CHASSIS CONTROL MODULE

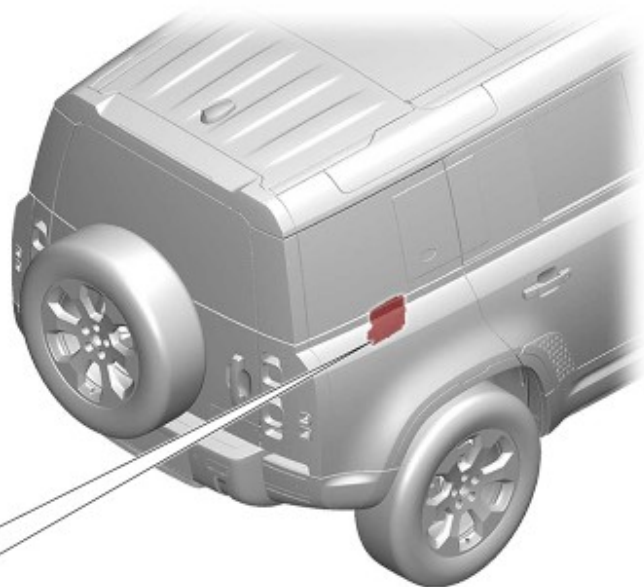


NOTE:

Model 110 vehicle is shown, model 90 vehicle is similar.



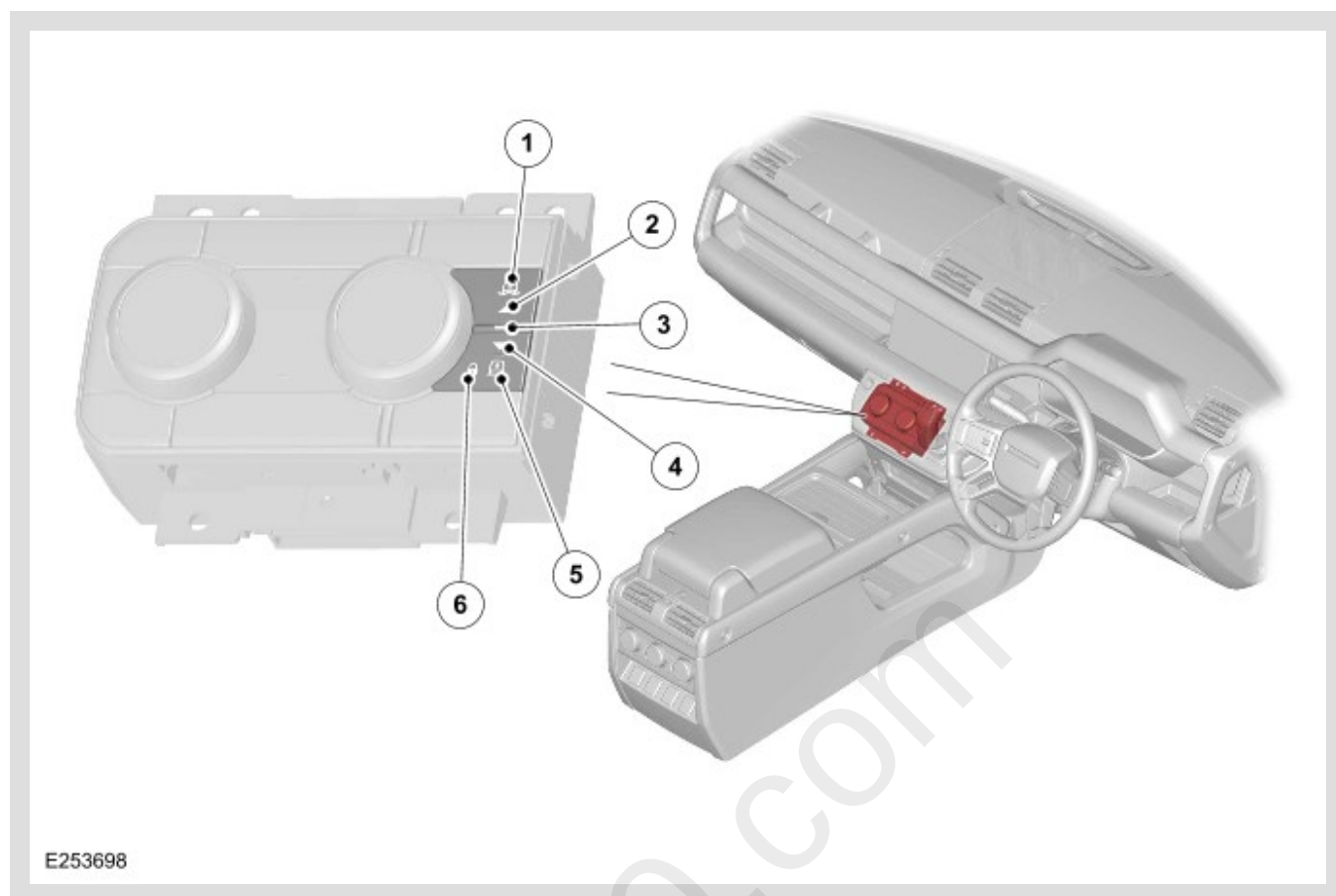
E253695



The CHCM is the main controller of the air suspension system. The CHCM monitors the height of each corner of the vehicle through 4 height sensors, which are mounted in-board of each road wheel. The CHCM is fixed to a bracket in the luggage compartment, behind the right side trim panel.

When a new CHCM is installed, the air suspension software must be loaded and the system calibrated using a JLR approved diagnostic equipment. The air suspension system does not operate until the calibration is completed.

AIR SUSPENSION SWITCHPACK – INTERACTIVE CONTROL INTERFACE MODULE 'A'



ITEM	DESCRIPTION
1	Off-road height indicator
2	Raise suspension height
3	Normal height indicator
4	Lower suspension height
5	Access height indicator
6	Suspension locked in access height - indicator

The air suspension control switch is a part of the ICIMA and located in the instrument panel.

The switch is a 3 position, non-latching switch which allows selection of the following driver selectable states:

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

The switch has 6 symbols which illuminate to show the current selected height state and the direction of movement. The raise and lower symbols flash and a warning tone is to be emitted from the instrument cluster sounder when a requested height change is not allowed. For example, when the vehicle speed is too fast or the air suspension system is in a waiting state.

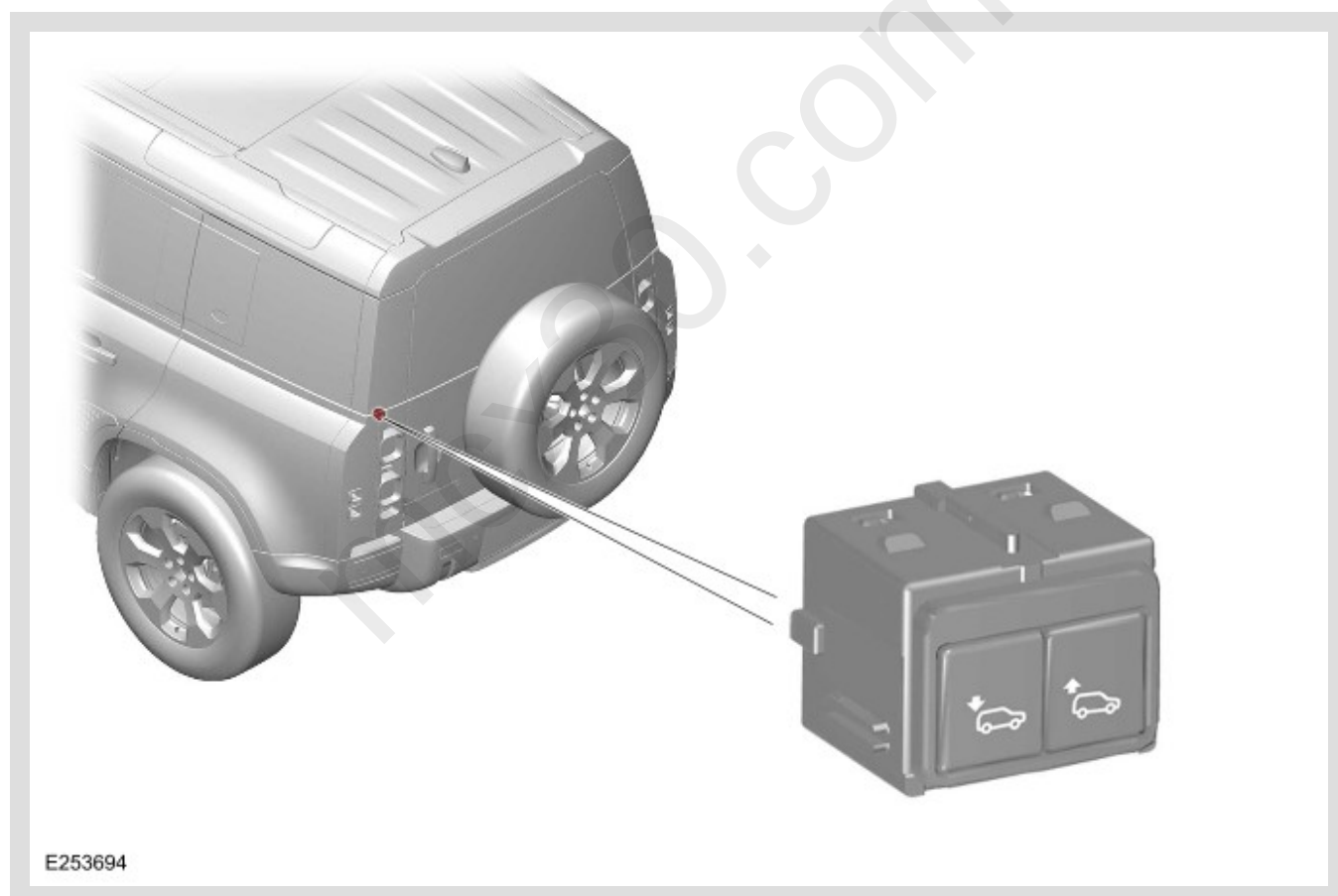
The air suspension system is in a waiting state or the system overrides the driver selection because the speed is approaching an automatic height change threshold.

The driver can also ignore the system warnings signals and allow the height to change automatically. For example, accelerate to more than 40 km/h (25 mph) when locked to access height. This makes the control module automatically change the ride height to on-road mode.

AIR SUSPENSION SWITCHPACK – LUGGAGE COMPARTMENT

NOTE:

Model 110 vehicle is shown, model 90 vehicle is similar.



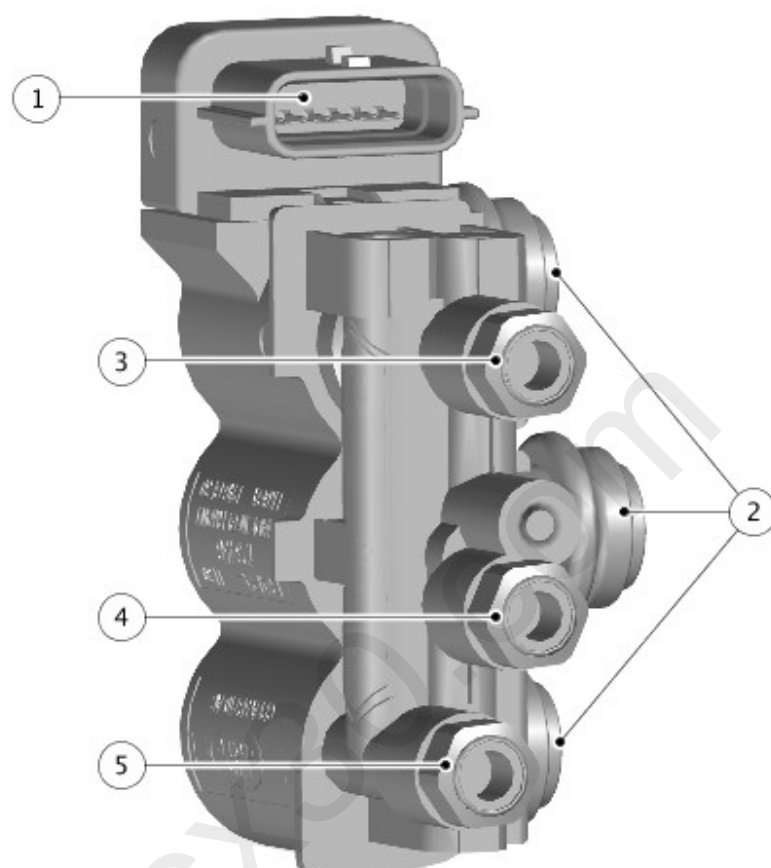
The rear switchpack is located in the left luggage compartment trim panel. The rear switchpack sends signals to the CHCM on hardwired connections.

Rear height adjust is useful when loading or unloading the vehicle, connecting or disconnecting a trailer, and when maneuvering a connected trailer.

The operation method of the rear switchpack is in the operation section below.

FRONT AND REAR VALVE BLOCKS

Front Valve Block

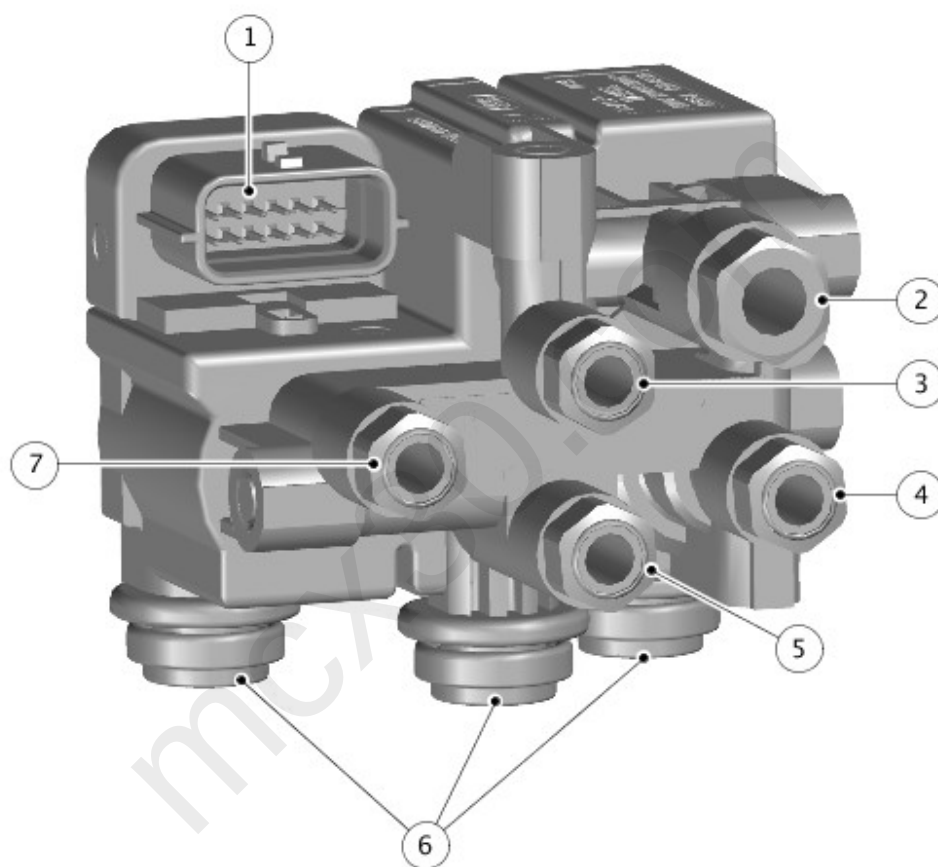


E194121

ITEM	DESCRIPTION
1	Electrical connector
2	Rubber bushes
3	Air pipe connection of the front right air spring
4	Air pipe connection of the rear valve block
5	Air pipe connection of the front left air spring

The front valve block controls the air supply and distribution to the front air springs. The front valve block contains 3 solenoid operated valves; 2 corner valves and 1 cross-link valve. The front valve block is located on the right side behind the secondary bulkhead panel and fixed with 3 rubber bushes to a bracket. The front valve block is controlled by the CHCM on hardwired connections.

Rear Valve Block



E194123

ITEM	DESCRIPTION
1	Electrical connector
2	Air pipe connection of the suspension air supply unit
3	Air pipe connection of the front valve block
4	Air pipe connection of the rear left air spring

ITEM	DESCRIPTION
5	Air pipe connection of the reservoir
6	Rubber bushes
7	Air pipe connection of the rear right air spring

The rear valve block is located behind the rear right wheel arch liner and fixed with 3 rubber bushes to a bracket.

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:

- The 2 corner valves
- 1 cross-link valve
- 1 reservoir valve
- And the system's pressure sensor.

Each of the valve solenoids is individually controlled by the CHCM.

The solenoids have the following resistance values:

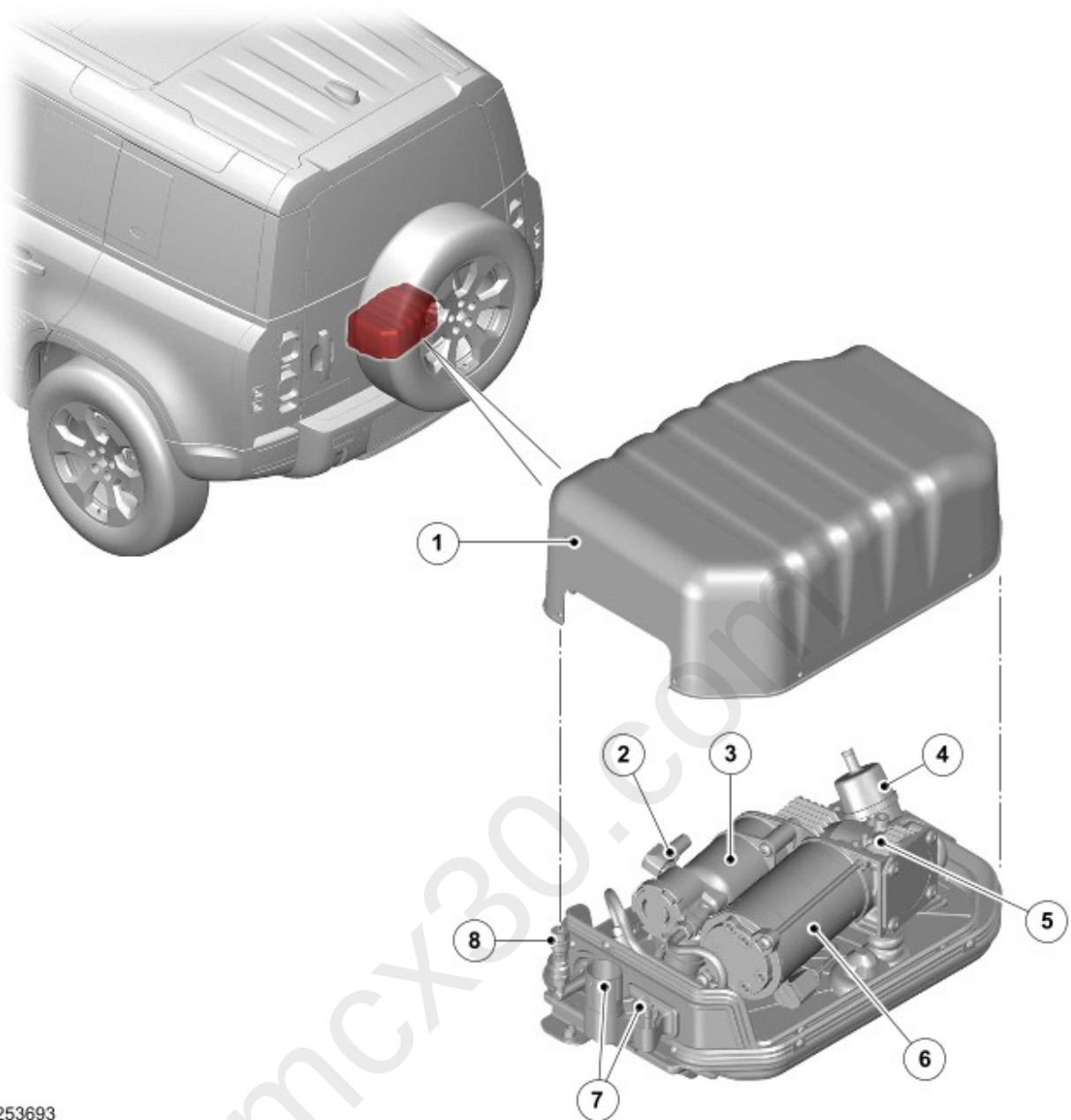
VALVE	RESISTANCE AT 25°C (±10%)
Front corner valves	6.8 Ohms
Front and rear cross link valves	3 Ohms
Rear corner valves and reservoir valve	3.6 Ohms

SUSPENSION AIR SUPPLY UNIT



NOTE:

Model 110 vehicle is shown, model 90 vehicle is similar.



E253693

ITEM	DESCRIPTION
1	Inner air supply housing cover
2	Exhaust silencer
3	Air drier
4	Intake air filter
5	Compressor
6	Electric motor
7	Electrical connectors
8	Air outlet

The suspension air supply unit comprises the following major components:

- A 2-stage piston compressor
- A 12V electric motor
- A solenoid operated exhaust pilot valve
- A pneumatically operated exhaust valve
- An air dryer unit
- A compressor temperature sensor.

The air supply housing surrounds the suspension air supply unit. The air supply housing is double layer box which is lined with insulating foam which suppresses the operating noise of the suspension air supply unit. Each layer of the box has a plastic moulded base and a pressed steel lid.

The suspension 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.
- By the opening of the reservoir valve in addition to the exhaust valve, which is part of the suspension air supply unit.

The compressor operates to pressurize either the reservoir or to inflate 1 or more of the air springs.

The compressor does not operate without the engine running, with the following exceptions:

- During remote operation or during rear height adjust operation to raise the vehicle to allow for the attachment of a trailer.
- When under control of the JLR approved diagnostic equipment.

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

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 2 -stage piston assembly is attached.

Air Compressor

The compressor comprises a motor driven 2-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, through the delivery valve, through the air dryer and into the air suspension system.

A temperature sensor is installed in the cylinder head. The sensor is connected to the CHCM 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 suspension air supply unit functions and the permitted compressor cylinder head operating temperatures.

OPERATING CONDITION	RESERVOIR FILLING	LEVELING
Switch OFF	125°C (257°F)	130°C (266°F)
Switch ON	105°C (221°F)	120°C (248°F)

Air Drier

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 making sure 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 make sure 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

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

The pilot exhaust valve is connected to the air delivery gallery, downstream of the air drier. 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. The exhaust valve plunger allows the pressurized air from the air suspension system to pass through the air drier to the atmosphere.

SUSPENSION AIR SUPPLY UNIT SPECIFICATIONS

DESCRIPTION	VALUE
Working pressure	17.5 bar gauge
Mechanical pressure relief range	22.0 to 27.0 bar gauge

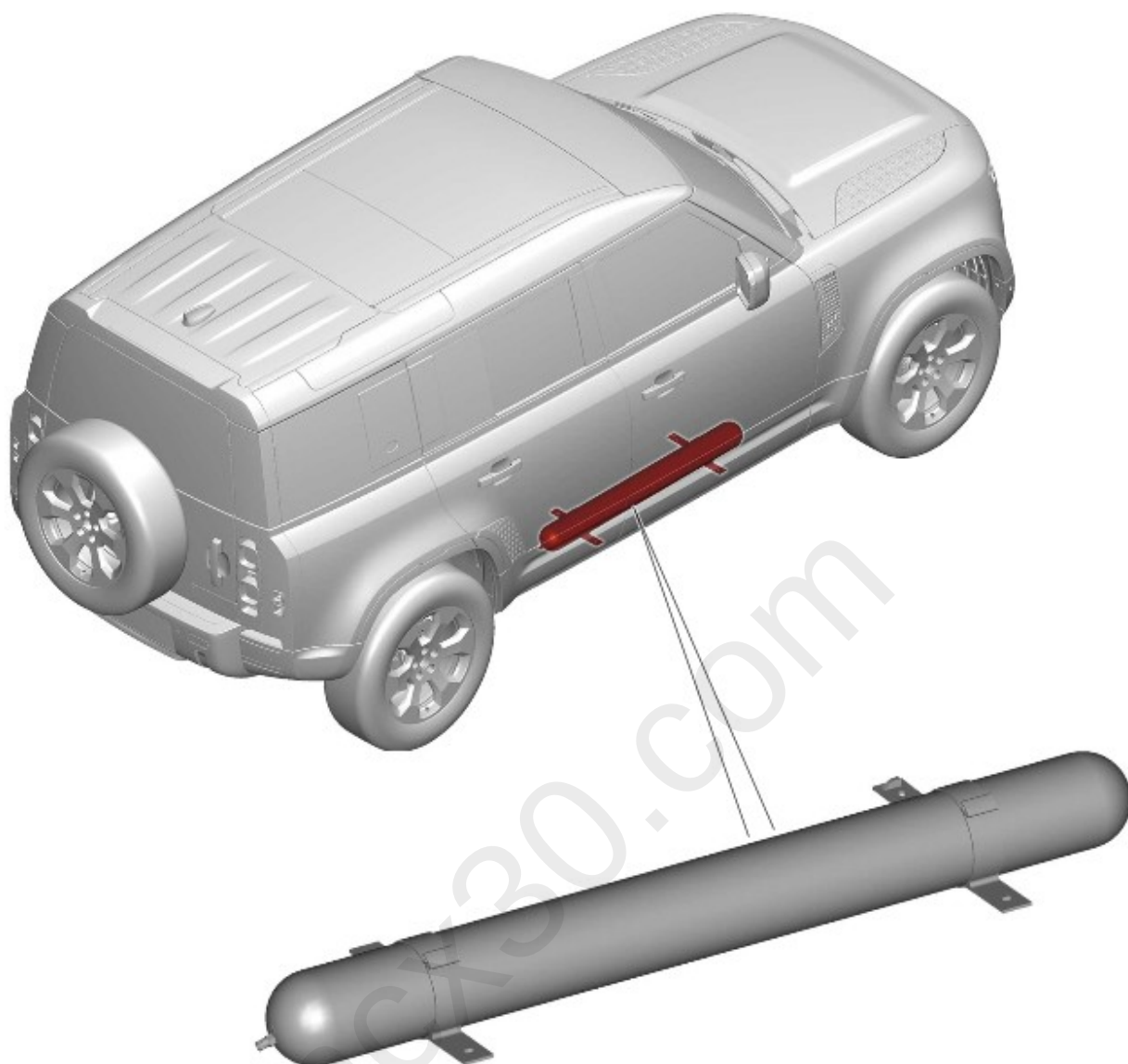
DESCRIPTION	VALUE
Operating voltage	10V to 16.5V (13.5V nominal)
Running current consumption	25-35A depending on load
Maximum start-up current	110A
Pilot Exhaust Valve - Solenoid valve resistance at 25°C (77°F)	15.7 Ohm ± 10%

Resistance values 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

The reservoir is an air storage vessel which provides faster air suspension lift times by the immediate availability of pressurized air into the system. The nominal working pressure of the reservoir is 17.5 bar gauge. The reservoir has a capacity of 11 liters.

For the model 110 vehicles there is 1 reservoir with a volume of 11 Liters.



E256189

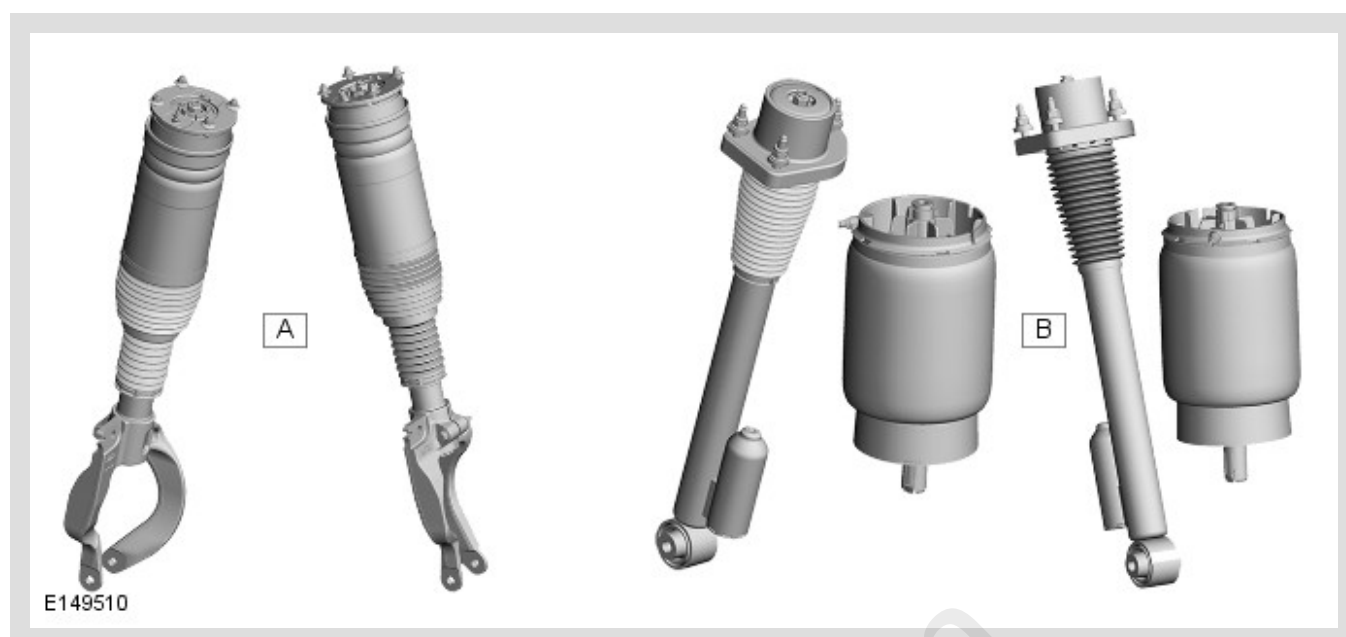
For the model 90 vehicles the 11 Liter volume is achieved by linking 2 reservoirs.



On Model 110 vehicles the rearward end of the reservoir has an air fitting which provides for the connection of the air hose between the reservoir and the rear valve block. On Model 90 vehicles the rearward end of both reservoirs has an air fitting which provides for the connection of the air hose connecting the reservoirs. The right reservoir has a second air fitting which provides for the connection of the air hose between the reservoir and the rear valve block.

The CHCM assumes the reservoir has sufficient pressure, which is measured before a vehicle raise is started. The CHCM then uses a software model to operate the compressor as required.

AIR SPRINGS



ITEM	DESCRIPTION
A	Front air spring and shock absorber assembly
B	Rear air springs (shock absorber 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 shock absorber
- The rear units are separate from the shock absorber.

The air springs are manufactured from a flexible rubber. 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 through a air line connector 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 needs to be depressurized. This is achieved using routines in the JLR 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 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.

CHASSIS CONTROL MODULE

The CHCM uses a combination of information from other system modules and data from the accelerometers and suspension height sensors to measure the vehicle and suspension states and driver inputs. Using this information, the CHCM applies algorithms to control the shock absorbers for the current driving conditions.

The CHCM receives the following signals over FlexRay from the stated system components:

- Brake Pressure - Anti-lock Brake System (ABS) control module
- Vehicle Speed - ABS control module
- Front Left Wheel Speed - ABS control module
- Front Right Wheel Speed - ABS control module
- Rear Left Wheel Speed - ABS control module
- Rear Right Wheel Speed - ABS control module
- Roll Stability Control Mode - ABS control module
- Steering Wheel Angle Speed - ABS control module
- Steering Wheel Angle Status - ABS control module
- Lateral Acceleration - ABS module
- Engine Speed - PCM
- Engine Torque - PCM
- Gear Position Target - Transmission Control Module (TCM)
- Torque Converter Slip - TCM
- Power Mode (Ignition Signal) - Body Control Module/Gateway Module (BCM/GWM)
- Terrain Mode Requested - BCM/GWM

The CHCM also outputs information on the High Speed (HS) Controller Area Network (CAN) buses and Flexray for use by other systems as follows:

- Fault Message
- Terrain Mode Change Status.

The CHCM monitors the input signals and operates the shock absorber solenoids. The input signals are used in control functions and a force required for each shock absorber, for each function, is calculated. An arbitrator monitors the force requirements from each function and apportions a force to a shock absorber. The force is converted to the appropriate current and sent to the shock absorber.

The control functions are as follows:

- Body Control - Uses CAN and accelerometer inputs. Calculates road induced body motions 100 times a second and sets each shock absorber to the appropriate level to maintain a flat and level body.
- Roll Rate Control - Uses CAN inputs. Predicts vehicle roll rate due to driver steering inputs 100 times a second and increases damping to reduce roll rate.
- Pitch Rate Control - Uses CAN inputs. Predicts vehicle pitch rate due to driver accelerate and brake inputs 100 times a second and increases damping to reduce pitch rate.
- Bump Rebound Control - Uses suspension height sensor inputs. Monitors the position of the wheel 500 times a second and increases the damping rate as the shock absorber approaches the end of its travel.
- Wheel Hop Control - Uses suspension height sensor and CAN inputs. Monitors the position of the wheel 500 times a second and detects when the wheel begins to vibrate at its natural frequency and increases the damping to reduce vertical wheel motion.

Under normal road conditions when the vehicle is stationary in Power Mode 7 (Engine running), the shock absorbers are set to the firm condition to reduce power consumption.

The CHCM receives power supply through a relay and fuse in the Rear Junction Box (RJB). The relay remains energized for a period of time after the ignition is Off. This allows the CHCM to record and store any Diagnostic Trouble Code(s) (DTC) relating to adaptive damping system faults. The CHCM receives ignition signal from the BCM /GWM.

AIR SUSPENSION SYSTEM OPERATION

NOTES:

- The suspension adjusts if the vehicle's doors are open, but the vehicle may not lower to its minimum setting.
- A time delay may be evident before the vehicle reacts to a suspension height request, through the buttons. The vehicle's systems need to be configured before each height adjustment.

Under normal operating conditions, the CHCM 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. The 'fast filter' 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 CHCM 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 CHCM detects that a corner is outside of the 'dead band', the CHCM operates the compressor and/or the valves to move that corner back into the target height.

RIDE HEIGHT TOLERANCE CONTROL

The CHCM has 2 ride height tolerance bands: normal tolerance and tight tolerance.

The CHCM 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 (0.35 in)
- Tight ± 3 mm (0.11 in).

The tight tolerance band is set by the JLR approved diagnostic system and only used in the following conditions:

- 1. Height calibration
- 2. Headlamp calibration suspension set-up
- 3. Suspension geometry set-up

The tight tolerance band also can be activated by the following procedure:

- 1. Start the engine.
- 2. Set the suspension to normal height.
- 3. Open the driver door.
- 4. Press the brake pedal lightly 3 times in quick succession.
- 5. Close the driver door within 10 seconds of the first brake pedal press.

If the procedure is successful, the Instrument Panel Cluster Control Module (IPC) emits 2 soft chimes about 1 second after the driver door is closed. Thereafter the IPC emits 2 soft chimes each time the driver door is closed to confirm that tight tolerance mode is still active.

The tight tolerance mode cancels when the engine is turned off or the vehicle speed exceeds 8 km/h (5 mph).

AIR SUSPENSION SWITCHPACK

The driver can manually select, using the air suspension switch, 1 of 4 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 is lower than the on-road height and provides easier access, agrees and the vehicle loading.
- 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.

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

A complete vehicle transit 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 transit mode.

If the CHCM senses that the vehicle has grounded and lost traction, the CHCM can temporarily raise the vehicle to maximize the available traction.

This is known as extended mode and to be indicated to the driver:

- by the height indicators flashing in the ICIMA
- and an 'EXTENDED MODE' message is displayed in the IPC.

If a fault is detected by the CHCM, the control module reduces the system functionality dependent on the type and severity of the fault. The control module also stores a fault code which can be retrieved using the JLR approved diagnostic system. If a severe fault occurs, the control module attempts to put the vehicle in a safe condition. A fault is relayed to the driver by the IPC message center and an audible warning emitted from the IPC.

All information messages are to be displayed for 4 seconds.

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 switch at any speed up to 70 km/h (43 mph). The message center displays OFF-ROAD HEIGHT SELECTED.

The Off-road height is dependent upon vehicle speed. The Off-road height selection is confirmed on the IDMA.

Off-Road 1 height is 40 mm (1.57 in) above normal height up to 80 km/h (50 mph).

Off-Road 2 height is 75 mm (2.95 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 switch when traveling less than 40 km/h (25 mph). To select normal height, press down on the lower switch 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 depends on the vehicle speed.

- If the vehicle speed is more than 20 km/h (12.5 mph), the CHCM wait for up to 1 minute for the vehicle speed to be reduced. The access mode indicator and the lowering indicator are flash while the CHCM waits for the vehicle speed to be reduced; the Normal height indicator remains illuminated. If the vehicle speed is not reduced sufficiently, the access height request is to be canceled after a minute.
- If the vehicle speed is less than 20 km/h (12.5 mph), the CHCM lower the suspension to a part lowered height and remains at this height for up to 1 minute. The normal height indicator extinguishes as the CHCM lowers the suspension to the part lowered height. The access height indicator and the lowering indicator illuminate. When part lowered is reached, the lowering indicator flashes. If the vehicle speed is not reduced to less than 8 km/h (5 mph) in the 1 minute period, the access height request is canceled.
- If the vehicle speed is less than 8 km/h (5 mph), the suspension is lowered to access height immediately. The access height indicator and the lowering indicator illuminates. When the access height is reached, the lowering indicator is 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 7km/h (4.3 mph) for 3s or 15 km/h (9.3 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 park with increased roof clearance.

When the vehicle is at access height and traveling speed is less than 35 km/h (22 mph), press down on the lower switch for longer than 1 second. The system lock indicator illuminates and SUSPENSION LOCKED AT ACCESS HEIGHT is displayed in the message center.

To cancel this mode, press up on the raise/lower switch for longer than 1second or increase the speed to 40 km/h (24 mph).

Automatic Height Change Warnings

When the suspension is locked at access height, the CHCM changes 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 IPC sounder emits a chime, a message is displayed in the message center and the normal height indicator and the raising indicator flashes.

The warning is removed when the vehicle speed is reduced.

Auto Access Height

Auto access height can be enabled or disabled, through the vehicle settings/set-up in the message center configuration menus.

If auto access height is enabled, the suspension to be lowered automatically to allow for easier access, when the vehicle is parked.

The following conditions are to be apply:

- The suspension has to be at the normal height setting.
- The transmission has to be engaged in high range.
- The Terrain response system has to be set to the Automatic setting, General program, Dynamic program or the Grass/Gravel/Snow program.



NOTE:

Auto access height operates more quickly and smoothly if the Electric Park Brake (EPB) is applied and the brake pedal is completely released.

Auto access height will initially lower the suspension up to 15 mm (0.59 in) below the normal height setting, during any of the following events:

- When the vehicle is stationary and any of the front or second row (not third row) occupied seatbelts are unbuckled.
- The ignition is switched off.

When a door is subsequently opened, after the initial lowering of the suspension, then auto access height lowers the suspension to the lowest setting. The lowest setting is 40 mm (1.57 in) below the normal height setting.



NOTE:

If a door is not subsequently opened, after the initial lowering of the suspension and the vehicle's speed exceeds 40 km/h (25 mph), then the suspension is return to the normal height setting.

Auto access height lowers the suspension to 30 to 35 mm (1.18 to 1.37 in) below the normal height setting, if a door is opened before any the following events occur:

- Before any of the occupied seatbelts are unbuckled.
- Before the ignition is switched off.

The air suspension system lowering button can be pressed to lower the vehicle to the full access height, if the air suspension system is still active.

Normal driving is automatically return the suspension from access height to the previous setting. Normal height can be selected by pressing the up arrow on the suspension system's raise/lower switch.

Auto access height can be activated up to 90 seconds after the vehicle becomes stationary.

Auto access height only operates when for each time the vehicle becomes stationary. If further operations are required while at the same location, use the message center menus to disable and then enable the feature again. Alternatively, drive the vehicle at a speed above 7 km/h (4 mph) for 3 seconds or at a speed of more than 15 km/h (9 mph).



NOTE:

This also applies in the event that the vehicle is stationary for more than 90 seconds without activating auto access height. If a door is opened after 90 seconds, then an 'Auto Access timed out' message is displayed in the message center.

Auto access height does not operate in the following conditions:

- The suspension has entered into extended mode.
- The vehicle is on a steep incline/decline, or on a very uneven surface.
- There are not sufficient air reserves in the air suspension system, to lower and raise the suspension. In this event, an 'Auto Access temporarily not available' message is displayed in the message center, when a door is next opened.

REAR HEIGHT ADJUST



NOTE:

The rear switchpack is disabled when the tailgate is closed.

This feature allows the user to alter the vehicle rear end ride height, using the switchpack in the luggage compartment to allow easier luggage compartment loading. The user can also alter the rear end ride height using the smart key. The adjustable rear height settings are also beneficial when hitching and un-hitching trailers.



CAUTION:

Care should be taken with all suspension height changes, especially when a trailer is attached to the vehicle. Incorrect suspension adjustments can result in serious damage to the vehicle.

To operate the suspension's rear height adjust through the rear switchpack, unlock the vehicle and open the tailgate.

Operate as follows:

- Press and hold the switch (1) to lower the rear suspension.
- Press and hold the switch (2) to raise the rear suspension.
- Simultaneously press and hold both switches to set the rear suspension to the normal height setting.

Rear height settings at the tow hitch:

- To drop 60 mm (2.36 in) for loading the luggage compartment
- To rise 90 mm (3.54 in) into assist hitching or unhitching.

PERIODIC WAKE-UP MODE

When the vehicle is parked, the CHCM 'wakes up' 2 hours after the ignition was last switched OFF and then every 24 hours thereafter. The vehicle height is checked and if the vehicle is not level within a pre-set tolerance, small downward height adjustments may be made automatically.

EXTENDED MODES

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 flash and the message center displays SUSPENSION IN EXTENDED MODE.

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

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

Extended mode cannot be selected manually.

TRANSIT MODE

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

When the engine is started, the CHCM causes the vehicle to rise allowing sufficient ground clearance for the vehicle to be loaded. While the height changes, all the indicators in the air suspension control switch flash and a chime is emitted by the Integrated Control Panel (ICP). When the correct height reached, all the indicators illuminate continuously and the chime stops.

When the engine is switched off, the CHCM causes the vehicle to lower, allow the vehicle to be strapped down. While the height changes, all the indicators in the air suspension control switch are flash. When the low height is reached, all the indicators illuminate continuously.

CALIBRATION MODE

This mode is used when the CHCM is replaced or a height sensor or suspension component are 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 Panel Cluster (IPC).

REMOTE OPERATION



E194266

ITEM	DESCRIPTION
1	Approach lamp switch
2	Tailgate opener switch
3	Unlock switch
4	Lock switch

**WARNING:**

The smart key can be operated from inside or outside of the vehicle. Make sure that the smart key is always kept safely out of children's reach, to avoid serious injury or death.

The switches 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.

Operate the smart key as follows:

- To lower the vehicle suspension, press and hold the switches 1 and 2 simultaneously.
- To raise the vehicle suspension, press and hold the switches 1 and 3 simultaneously.
- To return the vehicle to normal height, press and hold the switches 1 and 4 simultaneously.

The indicator lamps, on the electronic air suspension controls, indicate the current status of the rear suspension, after adjustment. If the rear suspension is currently above normal height, then both the normal height and off-road height indicator lamps illuminate. If the rear suspension is currently below normal height, both the normal height and access height indicator lamps illuminate.

LEAK DETECTION

Leak detection can be completed using a JLR 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 pipe fittings and the associated connections on the valve blocks, air springs and reservoir. Failure to correctly diagnose leakage results in unnecessary exchange of serviceable components and recurrence of the original problem.

SYSTEM INHIBITS

A number of conditions exist where a change in ride height is undesirable. To counter this, the CHCM is programmed with a number of system inhibits. If any of the conditions detailed below exist, the CHCM suspends height changes and height corrections.

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 CHCM will inhibit the compressor operation.

Cornering

If the CHCM 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 CHCM receives a message from Restraints Control Module (RCM) - incorporating the yaw rate lateral acceleration sensor over the Flexray from the Anti-Lock Brake System Control Module (ABS) for the applied cornering force.

Rapid Acceleration

If the CHCM 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 CHCM from a vehicle speed signal received through the HS CAN Underbody (UN) systems bus.

Rapid Deceleration

If the CHCM 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 through the HS CAN Underbody (UN) systems bus.

Door Open

The CHCM 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).

HEIGHT SENSOR CALIBRATION

A calibration routine is performed using the diagnostic system to calculate the offset for each corner of the vehicle. The offset is calculated from the relationship between the mechanical tolerances and the height sensor signals for each individual corner.

A calibration routine is performed using the JLR approved diagnostic equipment:

- to manually measure each corner of the vehicle
- to read the corresponding ECU heights for each corner of the vehicle
- to record the calculated height offsets into the CHCM memory.

When set, the calibration is not required to be performed unless:

- the CHCM is replaced
- the height sensor or its bracket is removed, disconnected or replaced
- the suspension arm to which the height sensor is connected is removed or replaced.

If the removed height sensor is subsequently reinstalled, the calibration procedure must be performed to make sure the integrity of the system.

If a replacement drop link is installed 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 $\pm 40^\circ$ around its nominal position and the nominal sensitivity is 57 mV/ $^\circ$ of shaft rotation.

DIAGNOSTICS

The CHCM can store DTCs which can be retrieved using a JLR approved diagnostic system. The diagnostics information is obtained through the diagnostic connector which is located below the instrument panel, above the driver's foot pedals.

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

Fault Messages

The air suspension has 2 methods which can use to inform the driver of a fault in the air suspension system:

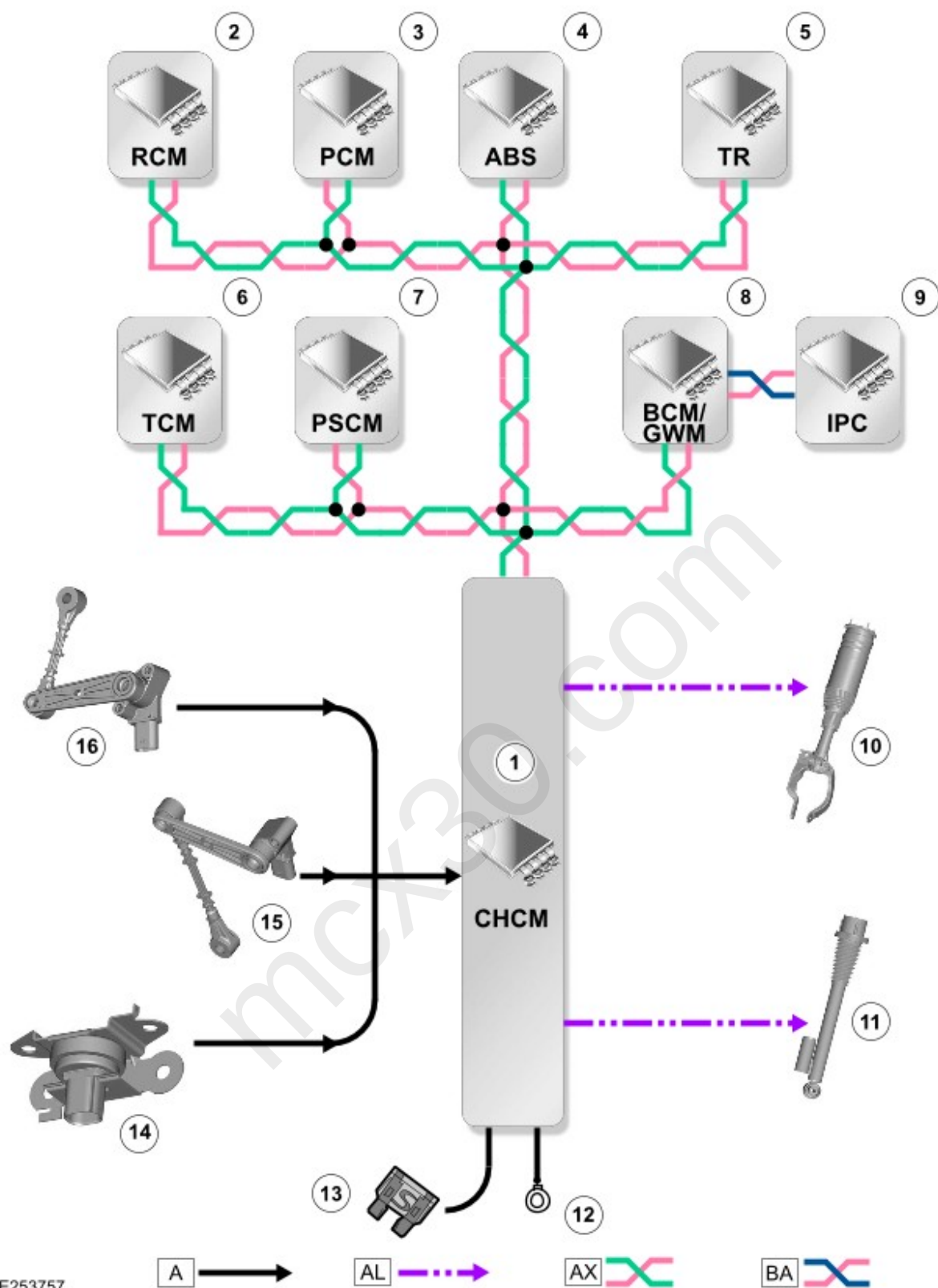
- The air suspension control switch indicators
- The Instrument Panel Cluster (IPC) message center.

If the CHCM suffers a major failure and there is no air suspension control, all the control switch indicators remain unlit.

If a fault occurs and the CHCM can determine the ride height and the vehicle is not above on-road height, a message appears in the message center. If the CHCM cannot determine the ride height, or the vehicle is above normal height and cannot be lowered, a message is displayed and accompanied with a maximum speed message.

CONTROL DIAGRAM

Control Diagram 1 of 2 - Adaptive Damping

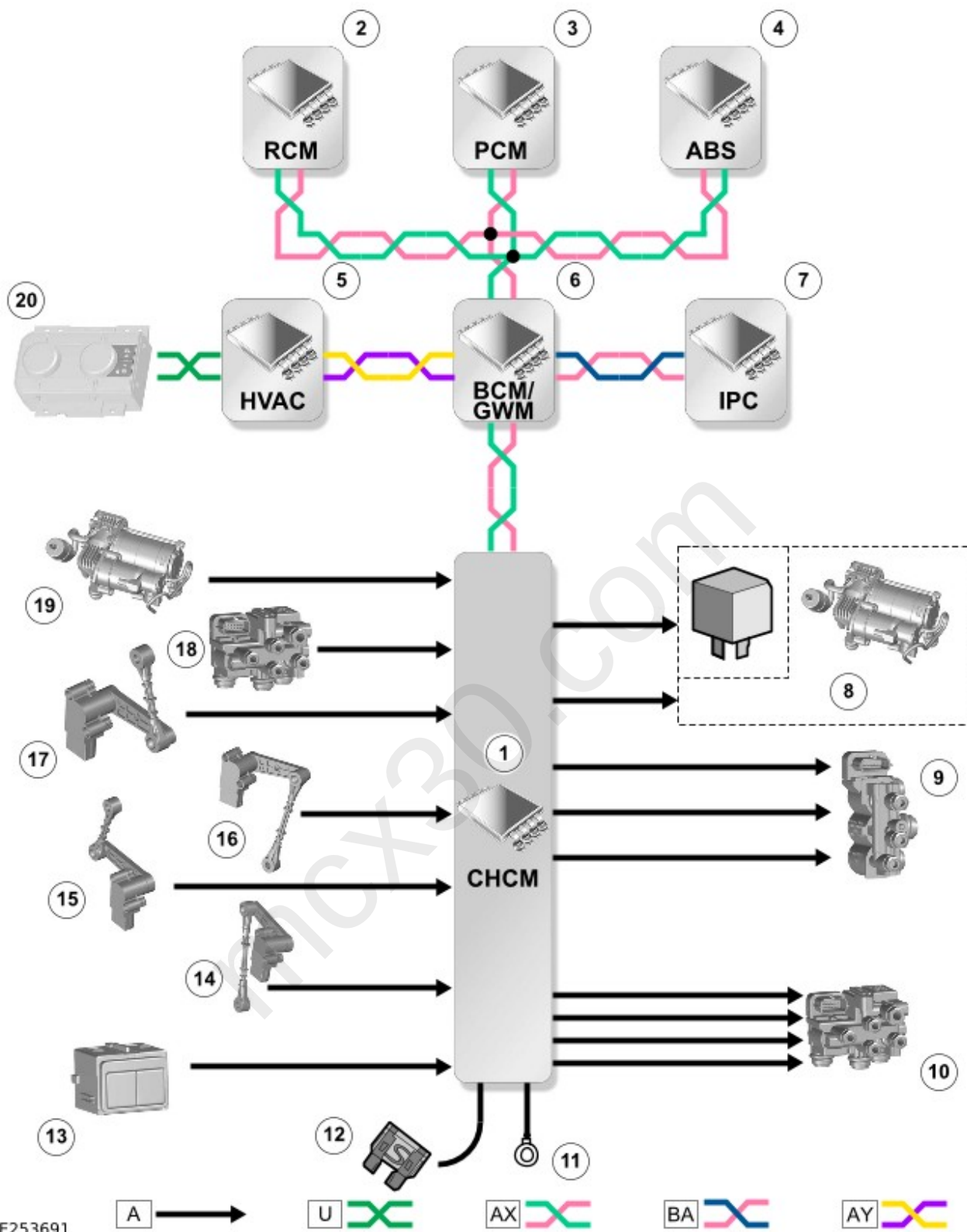


A = HARDWIRED: AL = PWM: AX = FLEXRAY: BA = HS CAN HUMAN MACHINE INTERFACE (HMI) SYSTEMS BUS.

ITEM	DESCRIPTION
1	CHCM

ITEM	DESCRIPTION
2	RCM
3	Powertrain Control Module (PCM)
4	ABS
5	Terrain Response switchpack (TR) control module
6	Transmission Control Module (TCM)
7	Power Steering Control Module (PSCM)
8	Body Control Module (BCM)/ Gateway Module A (GWM)
9	IPC
10	Front shock absorber (quantity 2)
11	Rear shock absorber (quantity 2)
12	Ground
13	Power supply
14	Accelerometer (quantity 3)
15	Air suspension rear height sensor (quantity 2)
16	Air suspension front height sensor (quantity 2)

Control Diagram 2 of 2 - Air Suspension



A = HARDWIRED: U = CAN PRIVATE SYSTEMS BUS: AX = FLEXRAY: AY = HS CAN POWER MODE ZERO SYSTEMS BUS BA = HS CAN HMI SYSTEMS BUS.

ITEM	DESCRIPTION
1	CHCM

ITEM	DESCRIPTION
2	RCM
3	PCM
4	ABS
5	HVAC Control Module (HVAC)
6	BCM/ GWM
7	IPC
8	Suspension air supply unit
9	Front valve block
10	Rear valve block
11	Ground
12	Power supply
13	Air suspension rear switchpack - luggage compartment
14	Rear right height sensor
15	Front right height sensor
16	Rear left height sensor
17	Front left height sensor
18	Pressure sensor - rear valve block
19	Temperature sensor - suspension air supply unit
20	Air suspension switchpack - ICIMA