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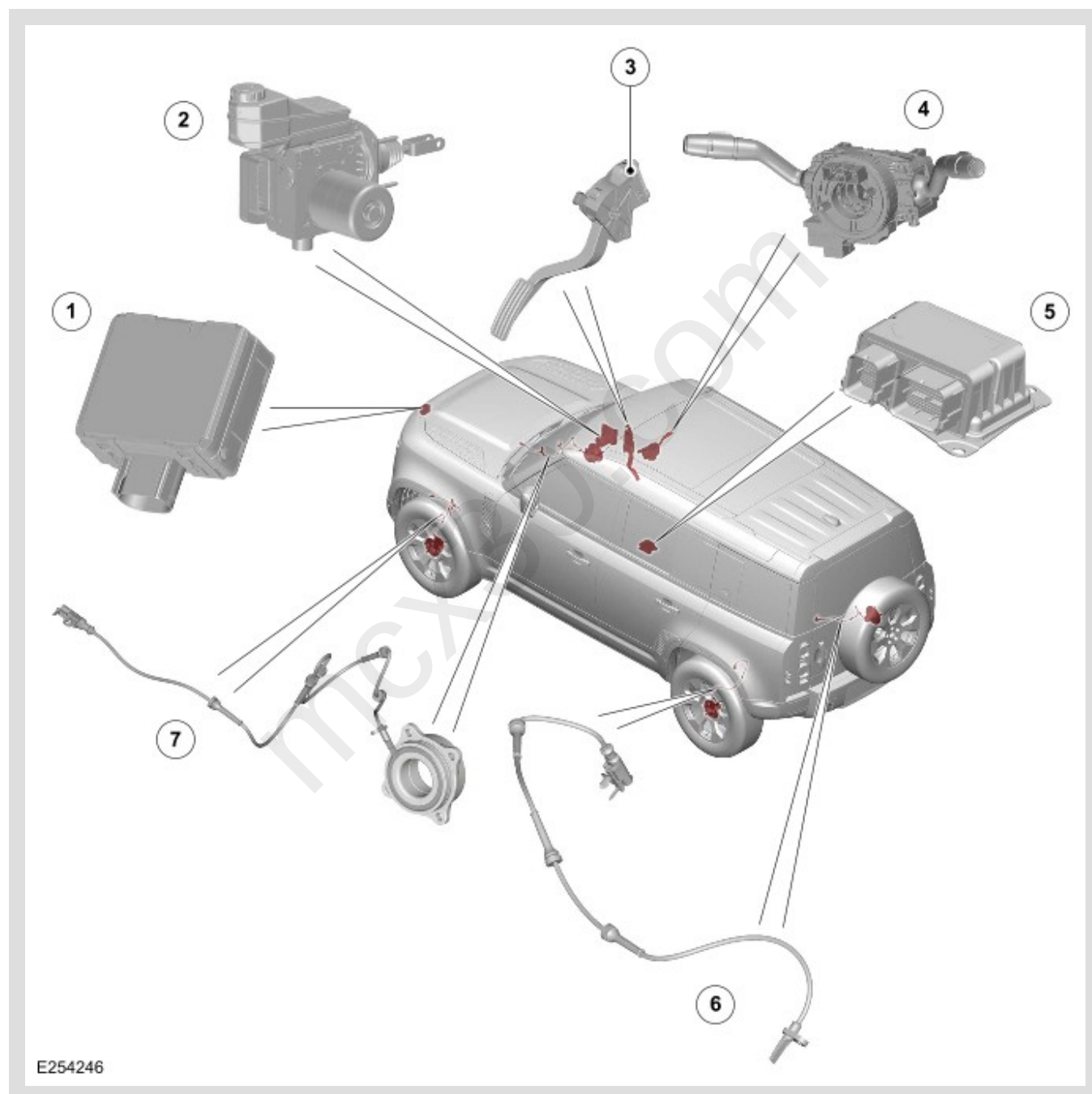
BRAKE CONTROLS AND ACTUATION

ANTI-LOCK CONTROL (G2415755)

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COMPONENT LOCATION

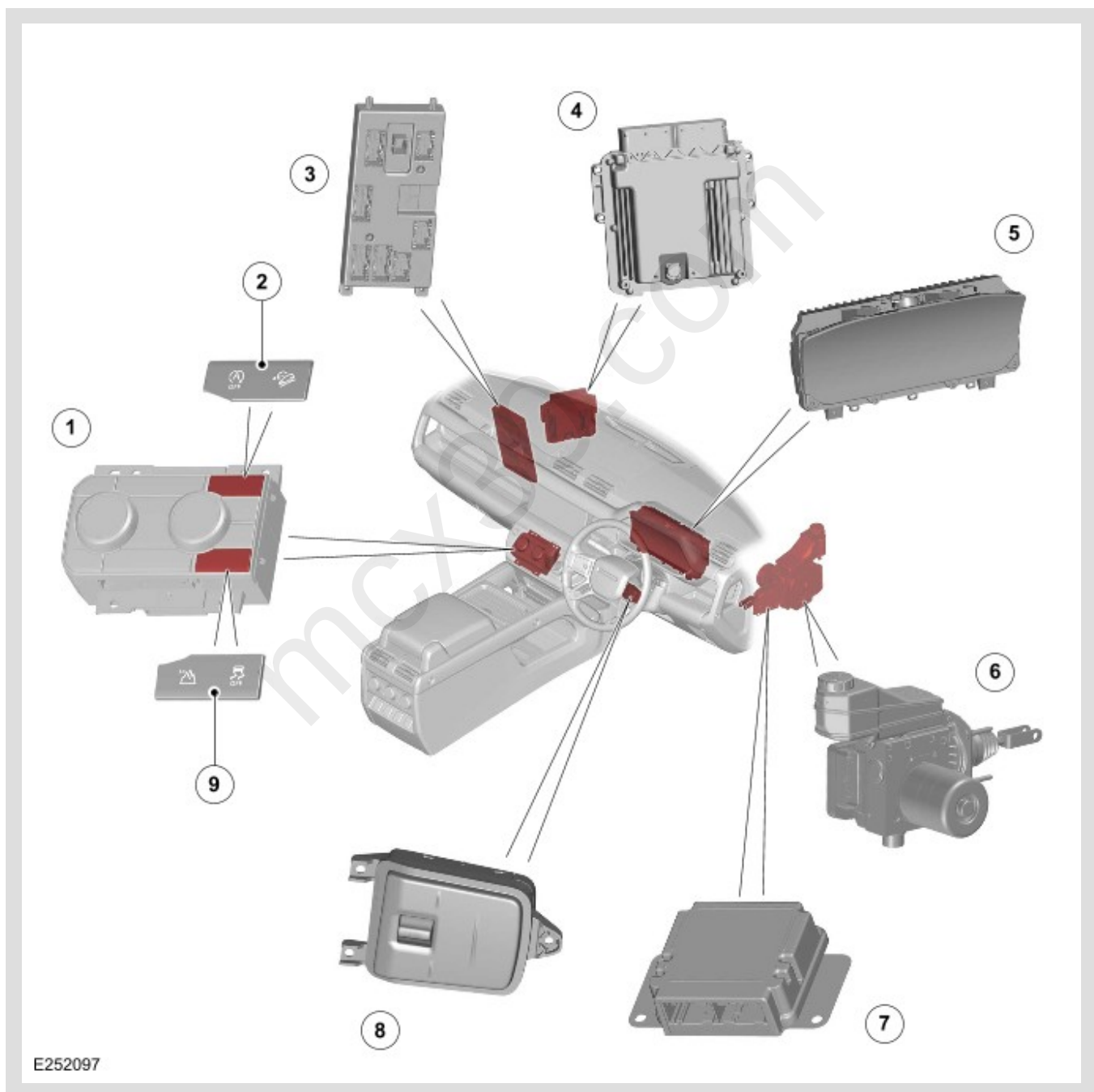
COMPONENT LOCATION - 1 OF 2



ITEM	DESCRIPTION
1	Cruise Control Module (CCM)
2	Integrated Power Brake

ITEM	DESCRIPTION
3	Accelerator Pedal Position (APP)
4	Steering Angle Sensor Control Module (SASM)
5	Restraints Control Module (RCM)
6	Rear wheel speed sensors (quantity 2)
7	Front wheel speed sensors (quantity 2)

COMPONENT LOCATION - 2 OF 2



ITEM	DESCRIPTION
1	Integrated Control Panel (FCIM)

ITEM	DESCRIPTION
2	Hill Descent Control (HDC)/ All Terrain Progress Control (ATPC) switch
3	Body Control Module (BCM)/ Gateway Control Module (GWM)
4	Powertrain Control Module (PCM)
5	Instrument Panel Cluster (IPC) control module
6	Integrated Power Brake
7	Driver Assistance Domain Controller (DADC)
8	Steering wheel switch
9	Dynamic Stability Control (DSC) switch

OVERVIEW

The braking control is applied by the Integrated Power Brake system. The system is an electro-mechanical brake system which combines actuation and modulation.

In the event of a vehicle electrical power net failure, the Integrated Power Brake system is still able to provide deceleration. This is by a mechanical push-through, based on a direct connection between the pedal and the master cylinder. The pedal stroke might be longer and the pedal forces higher to reach the deceleration levels compared to by-wire mode.

For additional information, refer to: [Integrated Power Brake System](#) (206-08 Brake Controls and Actuation, Description and Operation).

To provide full system functionality, the Integrated Power Brake system comprises the following components and programs:

- The Integrated Power Brake
- The DSC switch
- The combined Hill Descent Control (HDC) and ATPC switch
- The 4 wheel speed sensors
- SASM
- PCM
- RCM
- DADC
- The BCM/ GWM
- IPC warning indicators.

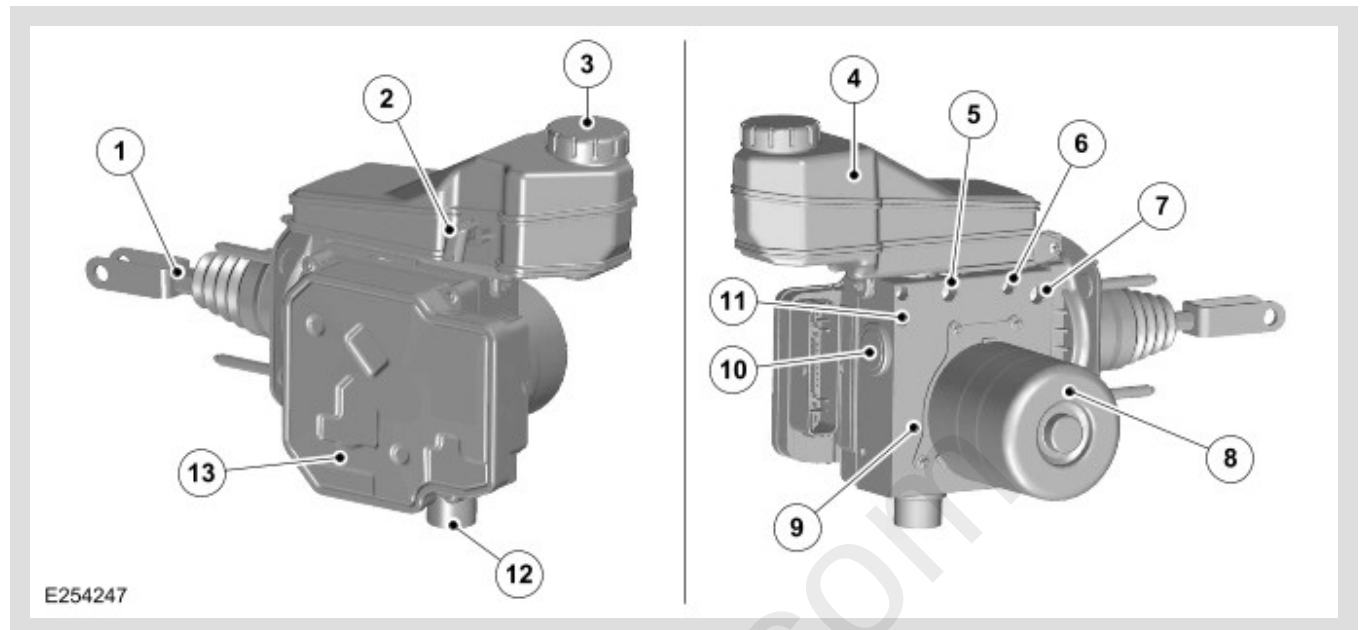
The braking control system provides the following brake functions that are designed to assist the vehicle or aid the driver:

- Anti-Lock Brake System Control Module (ABS)
- Roll Stability Control (RSC)
- Corner Brake Control (CBC)
- DSC
- Electronic Brake Force Distribution (EBD)
- Electronic brake prefill
- Electronic Traction Control (ETC)
- Emergency Brake Assist (EBA)
- Autonomous Emergency Braking (AEB)
- Engine Drag-torque Control (EDC)
- Enhanced Understeer Control
- Gradient acceleration control
- Gradient release control
- Terrain Response (TR) system integration
- Hill Descent Control (HDC)
- Hill launch assist
- Trailer stability assist.

The HDC function is enabled either manually using the combined HDC/ ATPC switch, or automatically by the TR system in Power Mode 6 (Ignition ON) or above. All of the other brake functions are automatically enabled in Power Mode 6 (Ignition ON) or above. The DSC function can be selected OFF using the DSC switch.

DESCRIPTION

INTEGRATED POWER BRAKE



ITEM	DESCRIPTION
1	Input rod and pedal interface
2	Brake fluid level sensor electrical connector
3	Brake fluid reservoir cap
4	Brake fluid reservoir
5	Front left brake outlet port
6	Front right brake outlet port
7	Rear left brake outlet port
8	Electric motor
9	Hydraulic Control Unit (HCU)
10	Internal brake master cylinder
11	Rear right brake outlet port
12	Pedal feel simulator
13	Integrated Power Brake control module

The Integrated Power Brake control module uses the Hydraulic Control Unit (HCU) to modulate hydraulic pressure to the individual wheel brakes to control the brake functions.

The ABS is a function of the Integrated Power Brake control module as an internal software.

The ABS controls the speed of all road wheels to make sure optimum wheel slip when braking at the adhesion limit. This prevents the wheels from locking in order to retain effective steering control of the vehicle.

The brake pressure is modulated separately for each wheel in order to maintain vehicle stability.

When required, the ABS actively intervenes and operates the HCU during braking or vehicle maneuvers to correct the vehicle attitude, stability, traction or speed. During incidents of vehicle correction, the Integrated Power Brake control module may also request the PCM to control engine power in order to further stabilize and correct the vehicle.

The Integrated Power Brake control module processes the information received from the sensors according to defined mathematical procedures (control algorithms). The results of these calculations are sent to the Hydraulic Control Unit (HCU). The HCU increases and decreases the pressure in the brakes of the vehicle according to the functional requirements.

Pressure sensors in the Simulator and Plunger circuits provides the Integrated Power Brake control module with hydraulic pressure signals. Contact pins on the HCU mate with contacts on the ABS control module to provide the electrical connections from the Integrated Power Brake control module to:

- the plunger motor
- and the pressure sensors.

The Integrated Power Brake may reduce the system brake pressure to a pressure level lower than requested by the driver during certain maneuvers. In specific driving conditions, driving on snow or ice, the driver may press the brake pedal more than necessary. Pressing the brake pedal more than necessary generates a large amount of brake pressure. On such road conditions this results in a faster wheel lock and requires the ABS algorithm to intervene and reduce the high brake pressure. A specific amount of brake fluid must be moved from the brakes to the reservoir. The movement of brake fluid reduces the brake pressure and allows the wheels to begin to rotate freely again. In such cases, the base brake pressure may also be reduced by the Integrated Power Brake.

Unlike previous DSC modulators, brake fluid is not recycled back to the driver applied pressure, but is returned direct to the reservoir. This means that the pedal pulsations usually associated with ABS function are not felt by the driver with this system. The Integrated Power Brake plunger which generates the brake pressure at the wheel continues to actuate as fluid is returned from each wheel. In the rare case of extended ABS function on long stops on very low grip surfaces, the actuator can return to its starting position without releasing brake effort from the wheels.

SERVICE INFORMATION

The Integrated Power Brake control module and the Hydraulic Control Unit (HCU) form a single component and must not be separated. The ABS control module and HCU assembly is supplied in a prefilled state.

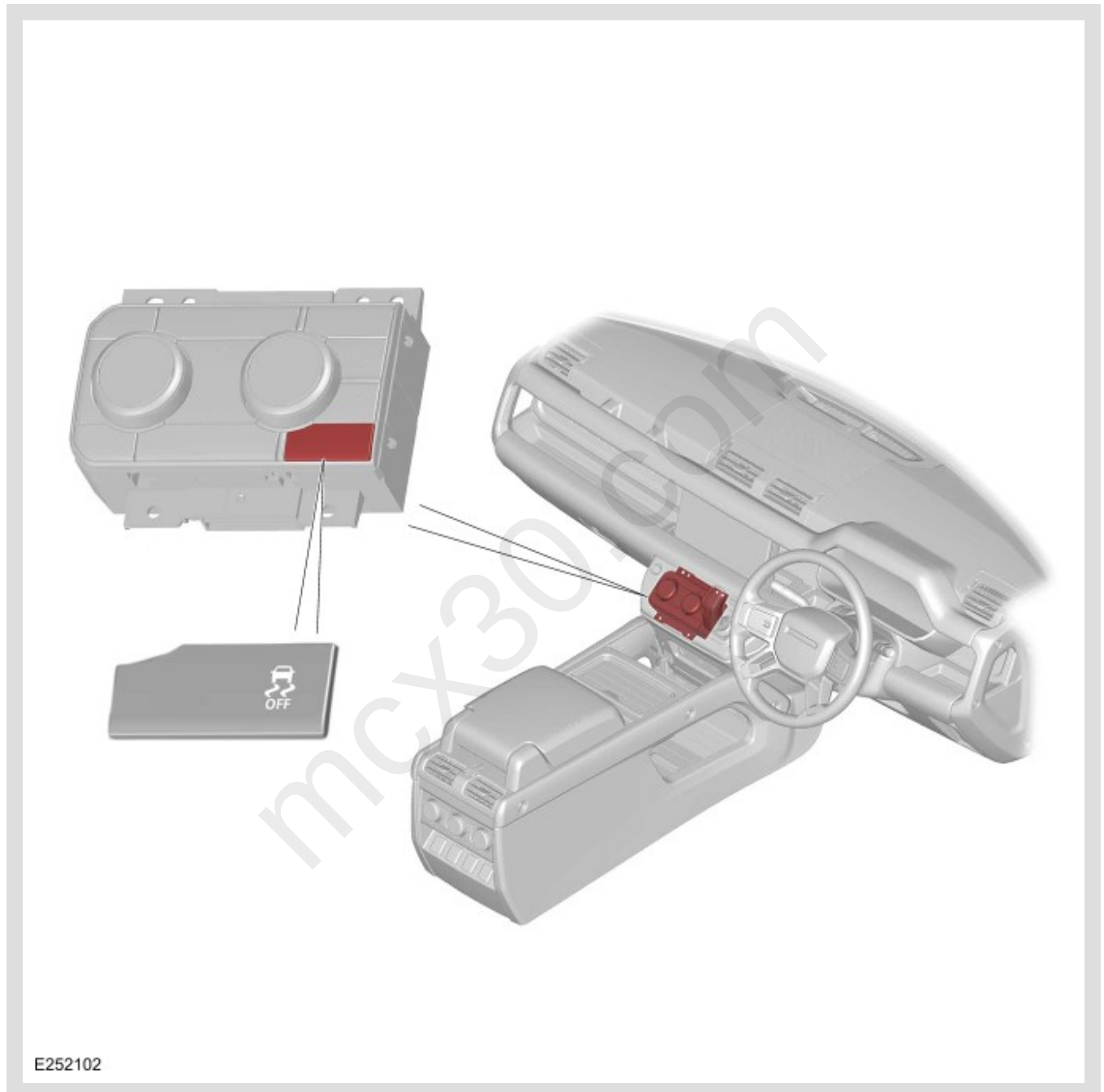
After installation, the hydraulic brake system requires use of the Jaguar Land Rover (JLR) Diagnostic equipment to:

- Check the brake system for presence of air
- Calibrate

- And clear its Assembly Mode.

The Integrated Power Brake control module monitors the presence of air in the brake circuits, either in the driver simulator circuit or the wheel circuits. If a fault is detected, this must be cleared after bleeding by using the diagnostic tester Leakage and Air Test routine.

DYNAMIC STABILITY CONTROL SWITCH



The DSC switch allows the DSC function to be selected OFF. Although Land Rover recommend that DSC is selected ON for all normal driving conditions, it may be beneficial to deselect DSC to maximize traction under the following conditions:

- If the vehicle needs to be rocked out of a hollow or a soft surface.
- Driving on loose surfaces or with snow chains. (Grass, Gravel and Snow, optimized for these conditions)

- Driving in deep sand, snow or mud. (Grass, Gravel and Snow, Mud and Ruts optimized for these conditions)
- On tracks with deep longitudinal ruts. (Mud and Ruts optimized for these conditions)

The DSC switch is a non-latching switch installed in the FCIM in the floor console. Pressing the DSC switch produces a High Speed (HS) Controller Area Network (CAN) private bus message. This message is sent from the FCIM to the Heating, ventilation, and air conditioning (HVAC). The HVAC forward the message to the BCM/ GWM on the HS CAN power mode zero systems bus. The BCM/ GWM then transmits the message to the Integrated Power Brake control module through FlexRay.

With the first press of the DSC switch, the Integrated Power Brake control module disables the DSC functions. When the DSC switch is pressed again, the Integrated Power Brake control module re-enables the DSC functions. The DSC switch must be pressed for a minimum of 0.3 s for the Integrated Power Brake control module to react. The DSC function is re-enabled at the beginning of each ignition cycle.

The status of the DSC switch selection is shown by the DSC OFF warning indicator. The DSC OFF warning indicator in the IPC is extinguished while DSC is selected ON and continuously illuminated while DSC is selected OFF.

The DSC system works in conjunction with the Terrain Response (TR) system. When operational, the TR system automatically adjusts DSC to suit the current driving program selection.

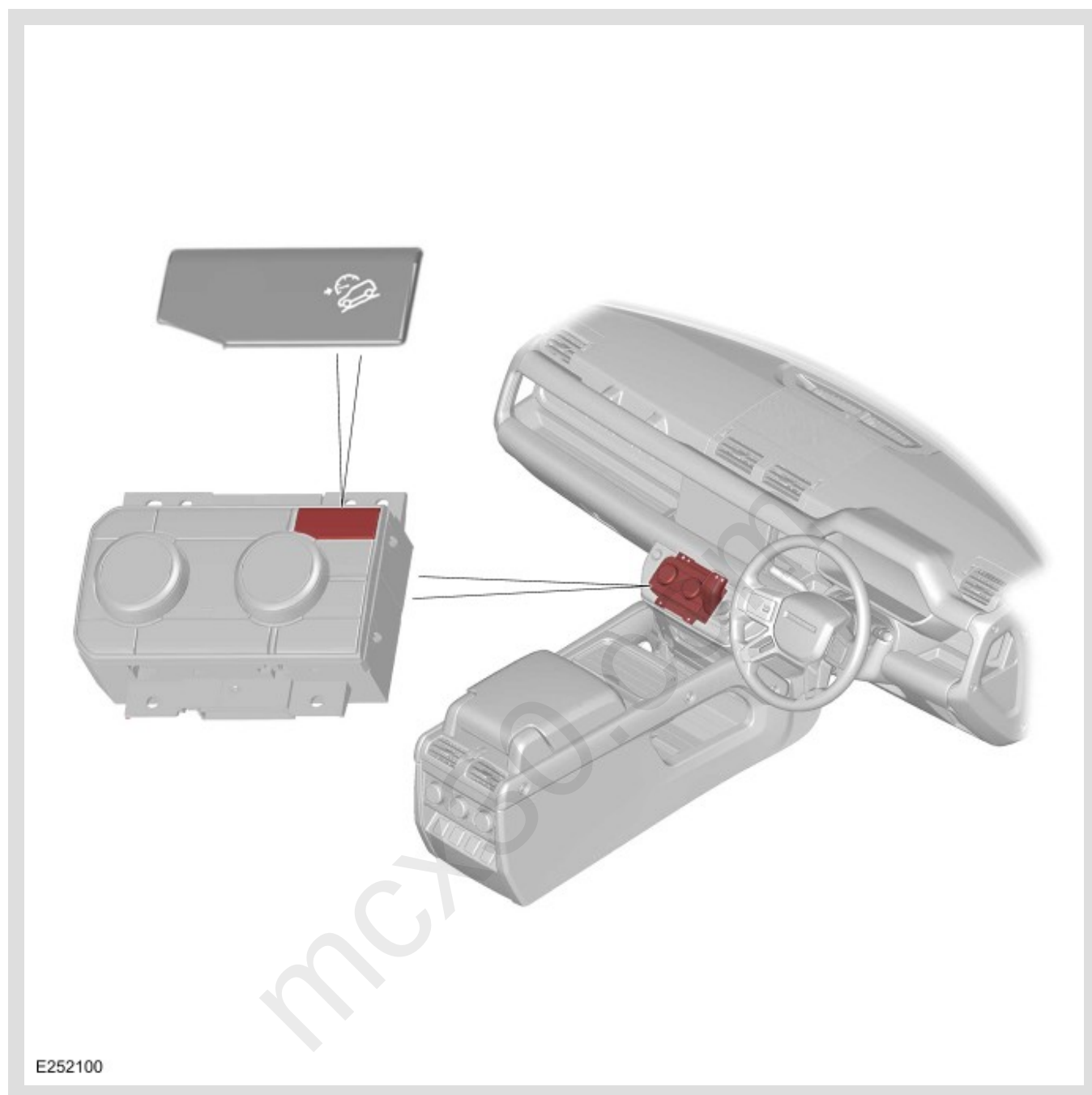
A DSC switch request to disable DSC is ignored by the Integrated Power Brake control module:

- if the air suspension system has failed
- or the vehicle is in off-road height at speeds above 55 km/h (34 mph).

If the input from the DSC switch is held high for more than 1 minute, a Diagnostic Trouble Code(s) (DTC) is stored. The DTC is stored in the Integrated Power Brake control module. The time is used to guard against an incorrect operation or a broken switch.

Even if DSC is deselected, driving maneuvers with extreme yaw or lateral acceleration may trigger DSC activity to assist vehicle stability.

COMBINED HILL DESCENT CONTROL AND ALL TERRAIN PROGRESS CONTROL SWITCH



The combined Hill Descent Control (HDC) and ATPC switch enables the selection of the ATPC function. The HDC/ ATPC switch is a non-latching switch installed in the FCIM in the floor console. Press and release the switch to enable ATPC.

A confirmation message is displayed in the message center on IPC.

The HDC/ ATPC switch controls the selection of the Hill Descent Control (HDC) function.

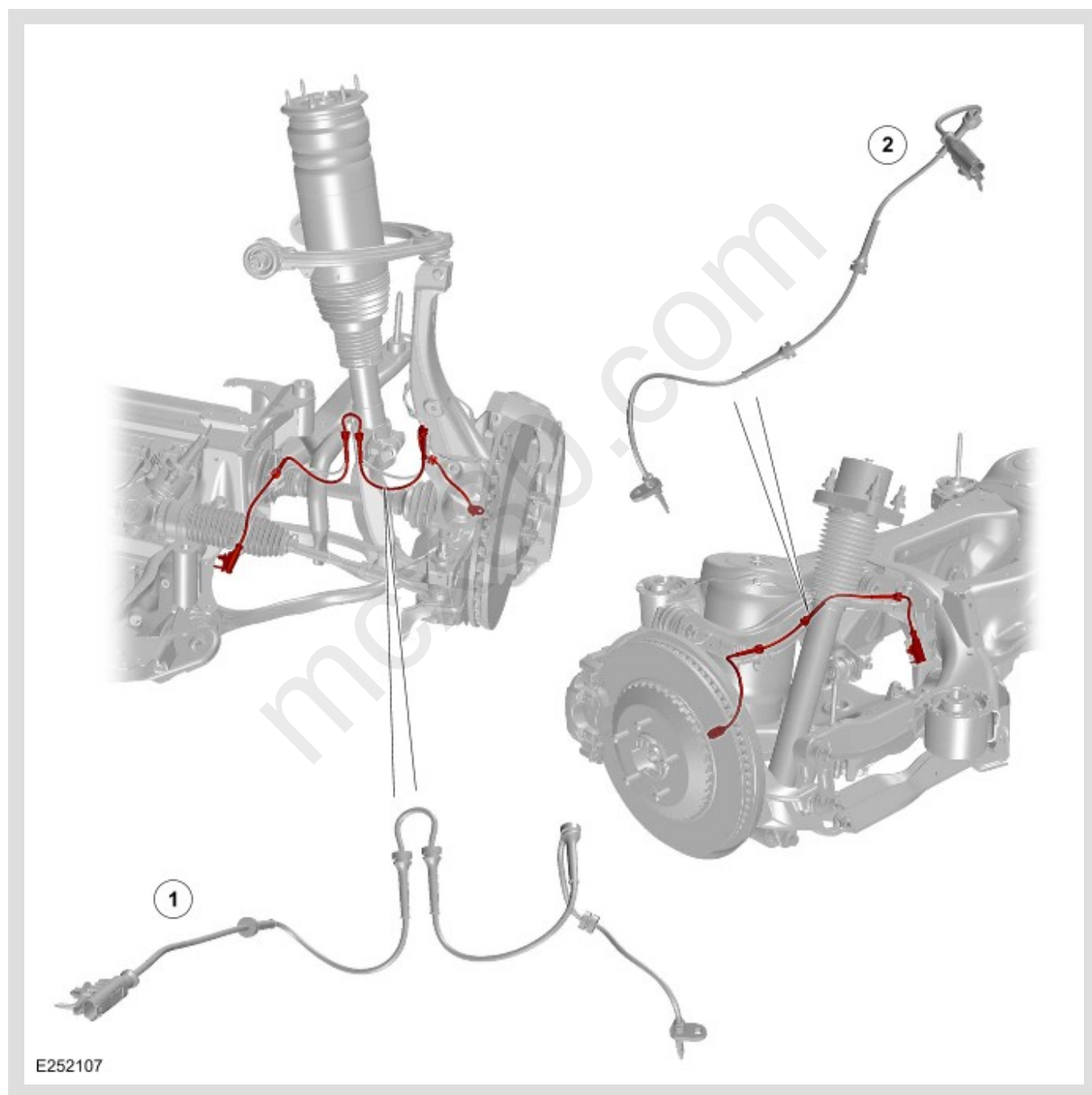
The HDC restricts the vehicle speed to a set limit when the vehicle travels downhill. The HDC is automatically selected by some Terrain Response (TR) driving programs.

Pressing the HDC/ ATPC switch produces a HS CAN private bus message. This message transmitted from the FCIM to the HVAC. The HVAC forward the message to the BCM/ GWM on the HS CAN power mode zero systems bus. The

BCM/ GWM then transmits the message to the ABS control module through the FlexRay. With the first press and release of the HDC/ ATPC switch, the Integrated Power Brake control module enables operation of the HDC function. When the HDC/ ATPC switch is pressed and released again the ATPC is enabled. With the third press, the Integrated Power Brake control module disables operation of the HDC/ ATPC functions.

To guard against incorrect operation or a broken switch, if the switch is pressed for more than 10 seconds no change of state occurs. If the input from the HDC/ ATPC switch is held high for more than one minute, a DTC is stored in the Integrated Power Brake control module.

WHEEL SPEED SENSORS



ITEM	DESCRIPTION
1	Rear wheel speed sensor (quantity 2)

ITEM	DESCRIPTION
2	Front wheel speed sensor (quantity 2)

An active wheel speed sensor is installed in each wheel hub to provide a rotational wheel speed signals for the Integrated Power Brake control module. The head of each wheel speed sensor is positioned close to a magnetic reluctor ring incorporated into the seal of the wheel bearing. A flying lead connects each sensor to the vehicle wiring.

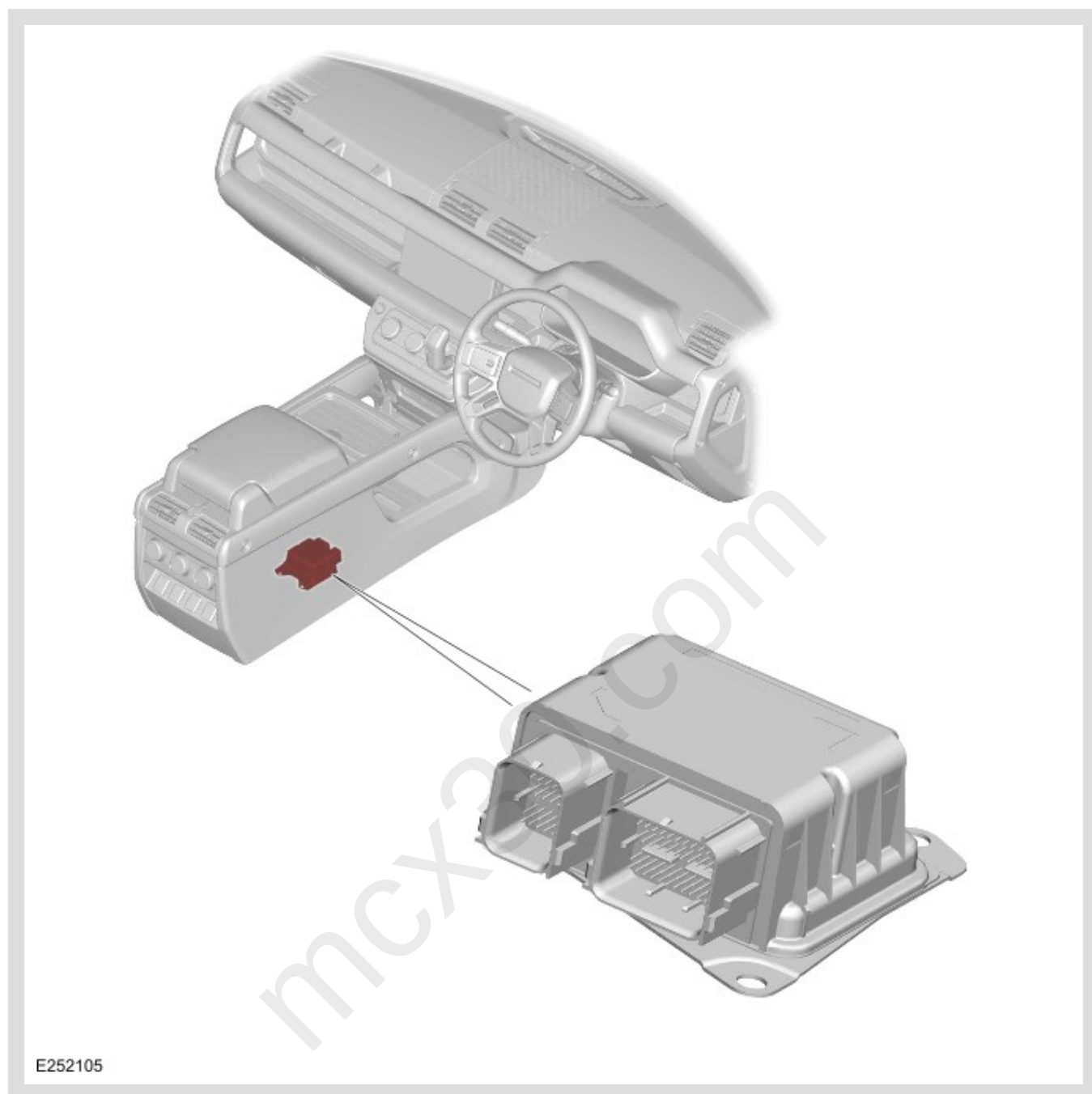
The wheel speed sensors each have a power supply connection and a signal connection with the Integrated Power Brake control module. In Power Mode 6 (Ignition ON), the Integrated Power Brake control module supplies power to the wheel speed sensors and monitors the return signals. The return signals are converted into individual wheel speeds and the overall vehicle speed by the Integrated Power Brake control module.

The Integrated Power Brake control module outputs the individual wheel speeds, the vehicle speed and the direction of travel for use by other systems. Signals are sent on the HS CAN Human Machine Interface (HMI) systems bus and the FlexRay circuit. When all wheel speed signals are available to calculate vehicle speed, the quality of the vehicle speed signal is set to 'data calculated within specified accuracy'. If one or more wheel speed sensors is faulty, the quality of the vehicle speed signal is set to 'accuracy outside specification'.

Since the wheel speed sensors are active devices, a return signal is available when the road wheels are not turning. This enables the Integrated Power Brake control module to check the sensors while the vehicle is stationary. In addition, the direction of travel of each wheel can be sensed.

The Integrated Power Brake control module monitors the wheel speed sensor circuits for faults. If a fault is detected a DTC is stored in the control module and illuminates the appropriate warning indicators. The warning indicator depends on the system functions affected, for example DSC. A warning chime is also sounded and a related message is shown in the message center in the IPC.

RESTRAINTS CONTROL MODULE



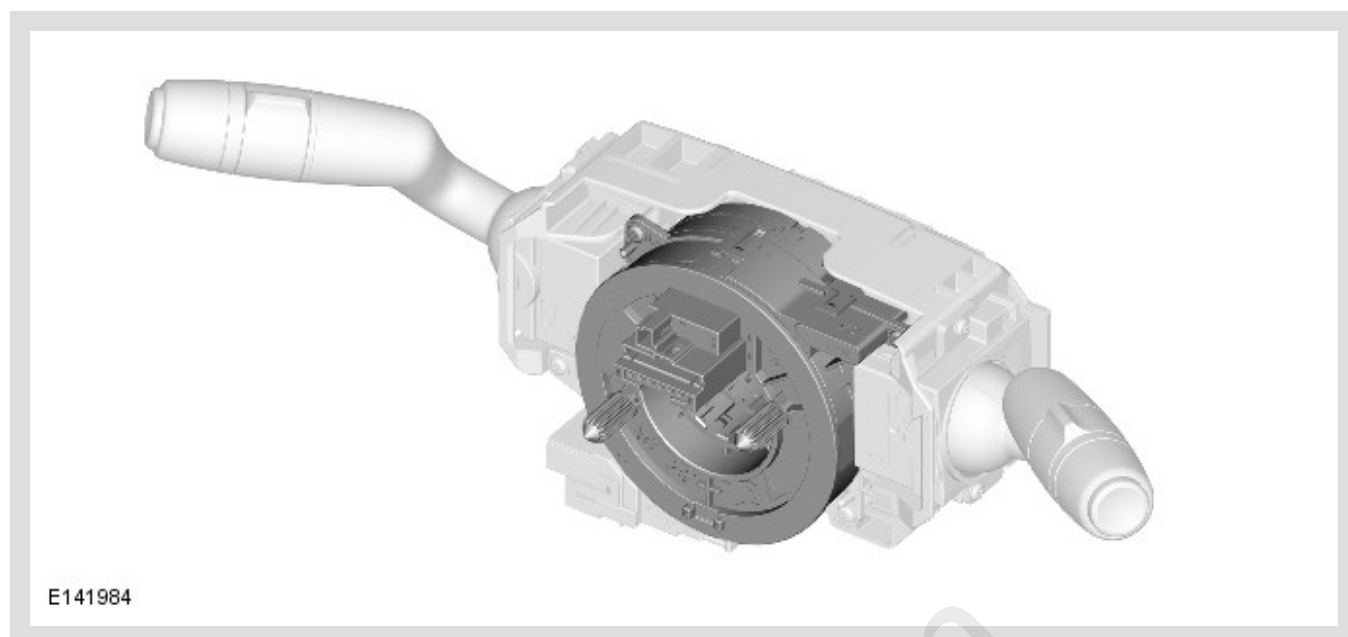
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The RCM is located under the floor console.

In Power Mode 6 (Ignition On) the RCM receives a supply from the BCM/ GWM. The acceleration sensor in the RCM measures yaw rate, roll rate, longitudinal and lateral acceleration providing values to the Integrated Power Brake control module.

When the Integrated Power Brake control module detects a sensor fault, the message center displays a warning message and the DSC warning indicator illuminates.

STEERING ANGLE SENSOR MODULE



The SASM is integrated into the Steering Wheel Module (SWM) on the steering column and is able to measure steering wheel rotation from lock to lock.

The SASM is connected to the SWM by a hardwired connection.

Steering angle sensor signals are processed in the clockspring to calculate the steering wheel angle and the steering wheel angle speed. These values, together with signal integrity information, are transmitted through the FlexRay, for use by the Integrated Power Brake control module functions.

If a fault occurs within the steering angle sensor module, a DTC is stored in the SASM and the Integrated Power Brake control module. The Integrated Power Brake control module signals the IPC to illuminate the appropriate warning indicators, depending on the brake functions affected. A warning chime sounds to alert the driver to the fault condition. If the fault affects the Hill Descent Control (HDC) function a message is displayed in the message center in the IPC.

The SASM and Integrated Power Brake control module can be interrogated using JLR approved diagnostic equipment.

INSTRUMENT PANEL CLUSTER WARNING INDICATORS



ITEM	DESCRIPTION
1	Hill Descent Control (HDC) warning indicator
2	Brake amber warning indicator - Worn brake pads or Emergency Brake Assist (EBA) failure indicator - North American Specification (NAS)
3	Brake red warning indicator - Low brake fluid level or Electronic Brake Distribution (EBD) function failure is detected - North American Specification NAS
4	ABS amber warning indicator - NAS
5	ABS amber warning indicator - Rest of World (ROW)
6	ATPC

ITEM	DESCRIPTION
7	Brake amber warning indicator - worn brake pads or Emergency Brake Assist (EBA) failure indicator - (ROW)
8	Brake red warning indicator - Low brake fluid level or Electronic Brake Distribution (EBD) function failure is detected - (ROW)
9	DSC OFF warning indicator
10	DSC warning indicator
11	Brake Hold green warning indicator

The IPC contains various warning indicators for the braking control functions. The warning indicators provide a visual indication of either a system fault or system operating status. Except for Hill Descent Control (HDC), the warning indicators illuminate briefly in Power Mode 6 (Ignition On), as a 'bulb' check.

OPERATION

ANTI-LOCK BRAKE SYSTEM

The Integrated Power Brake control module is connected to the FlexRay and HS CAN systems buses. The Integrated Power Brake control module actively interacts with other vehicle system control modules and associated sensors to receive and transmit current vehicle operating information.

The Integrated Power Brake system does not require the Brake Pedal Switch in the pedal box. This function is performed by the Integrated Power Brake control module. The Integrated Power Brake control module outputs 2 12V signals when the pedal is pressed to replicate the outputs of the pedal switch. These outputs go to the PCM and the BCM/ GWM. The PCM and BCM/ GWM then forward the brake signal toward to all related control modules through the FlexRay circuit.

On vehicles with Integrated Power Brake system the driver gear selection requests from the Gear Shift Control Module (GSM)

- Is sent to the Integrated Power Brake control module through the HS CAN underbody systems bus
- The Integrated Power Brake forward the request to the Transmission Control Module (TCM) through the FlexRay circuit.

The Integrated Power Brake control module processes the information received from the sensors according to defined mathematical procedures (control algorithms). The results of these calculations form the basis for the control signals sent to the Hydraulic Control Unit (HCU). The HCU increases and decreases the pressure in the brakes of the vehicle according to the functional requirements.

The HCU assists to the Integrated Power Brake control module with three operating modes:

- Normal braking/Electronic Brake Force Distribution (EBD)
- ABS braking

- Active braking.

Normal Braking/Electronic Brake Force Distribution Mode

Initially, all of the solenoid-operated valves are de-energized. Actuation of the plunger in Brake By-Wire mode produces a corresponding increase or decrease of pressure in the brakes, through the open plunger separation valves. If the Integrated Power Brake control module determines that Electronic Brake Force Distribution (EBD) is necessary, it energizes the inlet valves for the rear brakes. The energized inlet valves isolate the brakes from any further increase in hydraulic pressure. Only the rear brakes are controlled by the EBD function.

Anti-lock Brake System Braking Mode

If the Integrated Power Brake control module determines that ABS braking is necessary, it energizes the inlet and outlet valves of the related brake. The inlet valve closes to isolate the brake from pressurized fluid. The outlet valve opens to release pressure from the brake into the accumulator which returns fluid direct to the brake fluid reservoir. The reduced hydraulic pressure allows the wheel to accelerate. The Integrated Power Brake control module then operates the inlet and outlet valves to modulate the pressure in the brakes. The pressure applies the maximum braking effort without locking the wheels. Control of the valves for each wheel takes place individually.

Active Braking Mode

The active braking mode is used to generate and control hydraulic pressure to the brakes for functions other than the normal/Electronic Brake Force Distribution (EBD) and ABS braking modes.

This is done using the Integrated Power Brake plunger as for normal braking.

The Integrated Power Brake control module operates the inlet valves and outlet valves, as required, to modulate the pressure in the individual brakes.

ROLL STABILITY CONTROL

The RSC function uses the brake system and engine torque control to attempt to restore vehicle stability if the vehicle is forced into such a harsh manoeuvre.

The ABS control module monitors driver inputs and vehicle behavior using the following signals:

- APP data from the PCM
- The wheel speed sensor signals.
- The SASM signal.
- The roll rate, yaw rate and lateral acceleration data from the RCM.

These are compared with modeled behavior. When the vehicle behavior reaches a given risk level, the Integrated Power Brake initiates a reduction in engine power, or brakes one or more wheels sufficiently. All these can correct the vehicle stability and assist the driver to remain in control.

In Power Mode 6 or 7, the RSC is permanently enabled, even when DSC is selected OFF.

CORNER BRAKE CONTROL

The Corner Brake Control (CBC) influences the brake pressures, below the DSC and ABS thresholds. Limits the brake pressure helps to counteract the yawing moment produced when braking in a corner. The CBC produces a correction torque by limiting the brake pressure on one side of the vehicle. This can assist the vehicle in achieving the turn radius the driver requests.

DYNAMIC STABILITY CONTROL

DSC uses the brakes and engine torque control to help maintain the lateral stability of the vehicle.

The ABS monitors the yaw rate and lateral acceleration of the vehicle and the steering input. The ABS then selectively applies individual brakes and signals for engine torque adjustments to reduce understeer or oversteer.

In general:

- In an understeering situation, the inner wheels are braked to counteract the yaw movement towards the outer edge of the bend.
- In an oversteering situation, the outer wheels are braked to prevent the rear end of the vehicle from pushing towards the outer edge of the bend.

The ABS control module monitors the tracking stability of the vehicle using the following signals:

- Acceleration Pedal Position data from the PCM
- The wheel speed sensor signals.
- The SASM signal.
- The roll rate, yaw rate and lateral acceleration data from the RCM.

The tracking stability is compared with stored target data. Whenever the tracking stability deviates from the target data, the ABS control module intervenes by applying the appropriate brakes.

When the DSC function is active, the ABS control module also signals to the:

- TCM to prevent gear shifts
- And the IPC to flash the DSC warning indicator.

If necessary, the ABS control module also signals to:

- The PCM, to reduce engine torque.
- The Transfer Case Control Module (TCCM), to adjust the locking torque of the center differential.
- The Rear Differential Control Module (RDCM), to adjust the locking torque of the rear differential.

The DSC function overrides the differential locking torque requests from the Terrain Response system.

If DSC is selected OFF, a DSC system off message is displayed in the message center in the IPC.

For additional information, refer to: Instrument Cluster (413-01, Description and Operation).

ELECTRONIC BRAKE FORCE DISTRIBUTION

Electronic Brake Force Distribution (EBD) limits the brake pressure applied to the brakes of the trailing axle. When the brakes are applied, the weight transfer of the vehicle reduces the adhesion of the trailing axle wheels on the road surface. This may cause the wheels to slip and make the vehicle unstable.

The EBD uses the ABS hardware to automatically optimize the pressure of the trailing axle brakes. Only the rear wheels are under EBD control.

ELECTRONIC BRAKE PREFILL

The ABS module monitors the accelerator pedal position and applying speed. This signal is sent by the PCM on the FlexRay circuit.

When the ABS control module detects rapid accelerator pedal release,

- A brake hydraulic pressure build up of approximately 3 to 5 bar (43.5 to 72.5 psi) in anticipation of the brakes being applied.
- The ABS applies a low brake pressure to all of the brakes to assist in a quicker brake application.

This gives a quicker brake pedal response and consequently slightly shorter stopping distances.

ELECTRONIC TRACTION CONTROL

Electronic Traction Control (ETC) attempts to optimize forward traction by reducing engine torque or braking a spinning wheel until traction is restored.

ETC is activated if an individual wheel speed is above that of the vehicle reference speed (positive slip) and the brake pedal is not pressed. The spinning wheel is braked, allowing the excess torque to be transmitted to the non spinning wheels through the drive line. If necessary, the ABS control module also transmits a message to the PCM requesting a reduction in engine torque.

Torque reduction requests are for either a slow or fast response. A slow response requests a reduction of throttle angle; a fast response requests an ignition cut-off.

When the DSC function is selected OFF with the DSC switch, the engine torque reduction feature is disabled.

When the ETC function is active the ABS control module also signals the TCM to prevent gear shifts.

EMERGENCY BRAKE ASSIST

Emergency Brake Assist (EBA) assists the driver during emergency braking situations by automatically maximizing the braking effort.

There are 2 situations when the ABS control module invokes EBA:

- When the brake pedal is pressed rapidly.

- When the brake pedal is pressed hard enough to bring the front brakes into ABS operation.

When the brake pedal is pressed rapidly, the ABS control module increases the hydraulic pressure to all of the brakes until the threshold for ABS operation is reached. This applies the maximum braking effort for the available traction. With the brake pedal pressed, if the rate of increase of hydraulic pressure exceeds the predetermined limit, the ABS control module invokes emergency braking.

The ABS control module monitors for the rapid application of the brakes using:

- The pedal pressure sensor within the Hydraulic Control Unit (HCU).

When the brake pedal is pressed hard enough to bring the front brakes into ABS operation, the ABS control module increases the hydraulic pressure to the rear brakes up to the ABS threshold.

EBA operation continues until the vehicle deceleration and sensor input levels fall below a pre-determined threshold value stored in the ABS control module.

During emergency braking, if vehicle deceleration exceeds a stored value, the ABS control module sends a message to the BCM/ GWM. The BCM/ GWM then automatically activates the hazard warning lamps at a faster rate than normal (approximately 4Hz). If the vehicle speed reduces below 5 km/h (3 mph), the hazard warning lamps remain active, but switch to the normal rate of the operation.

Emergency braking activation of the hazard warning lamps is canceled when one of the following occurs:

- The vehicle deceleration falls below a second (lower) stored value.
- The DSC OFF mode is selected.
- The left or right turn signal indicators are selected.

For additional information, refer to: [Exterior Lighting](#) (417-01 Exterior Lighting, Description and Operation).

AUTONOMOUS EMERGENCY BRAKING

The AEB system operates when the DADC determines that a collision is unavoidable, even with driver intervention.

The AEB function operates at vehicle speeds down to zero, and still operates, even when forward alert and the adaptive speed control are switched off.

If the AEB feature is disabled for any reason, a related message is displayed in the IPC message center.

If the DADC determines a collision is unavoidable, it signals the ABS control module to apply emergency brake pressure to all of the brakes.

The AEB system can be operated by enabling and disabling the system through the IPC menu. The AEB system also becomes operational when the vehicle is in the forward motion at speeds between 5 km/h (3 mph) and 80 km/h (50 mph).

The AEB system interacts with other vehicle systems for key data and functionality, relying on data communication exchanges between the following modules:

- SASM - Steering angle and rate of change.
- RCM - Lateral acceleration and yaw rate.
- DADC - Collision risk detection.
- ABS control module - Braking control and vehicle speed.
- PCM - APP and torque control.
- Head Up Display (HUD) - Warning message.
- IPC - Warning message.

This information is exchanged using the HS CAN HMI systems bus and the FlexRay.

The AEB system uses a four stage sequence when operates:

- 1. **Driver Warning** - Before braking is engaged, an audible warning is sounded and a visual warning is displayed in the IPC. The message indicates that a collision risk is identified, but is still avoidable by the driver. The visual warning message is also displayed in the HUD, if equipped.
- 2. **Brake Precharge** - If the time until collision becomes shorter, but still avoidable, the system applies a small amount of pressure on the brakes. This pressure minimizes the gap between the pads and discs, to allow the best braking performance if the driver reacts to the warning.
- 3. **Collision Mitigation** - When identified a collision risk, either static or traveling in the same direction, the function apply the brakes, mitigating the collision. The operational speed range is between 5 km/h - 80 km/h (3 mph - 50 mph).
- 4. **Message on Instrument Panel Cluster** - The IPC displays a message to confirm that the AEB function is activated.

The AEB system does not operate if any the following are present:

- Poor camera visibility:
 - - Fog, heavy precipitation, soiled windshield, etc.
- System fault detected.
- Forward collision warning velocity outside range: 30 km/h - 80 km/h (18 mph - 50 mph).
- The AEB velocity outside range: 5 km/h - 80 km/h (3 mph - 50 mph).
- DSC is switched OFF.
- The vehicle is cornering sharply.

ENGINE DRAG-TORQUE CONTROL

Engine Drag-torque Control (EDC) prevents wheel slip caused by any of the following:

- A sudden decrease in engine torque when the accelerator is suddenly released.
- A downshift the transmission in Command Shift mode selected.

When the ABS control module detects wheel slip without the brakes being applied, the ABS signals the PCM. A signal is a request for a momentary increase in engine torque. When the driver is braking and the ABS module has reduced brake pressure, but the wheels have not accelerated to the vehicle reference speed quickly enough, EDC requests to increase engine torque to accelerate the wheels up to reference speed and regain stability.

GRADIENT ACCELERATION CONTROL

Gradient acceleration control is an automatic feature and is always available when Hill Descent Control (HDC) is not selected.

When HDC is not selected, gradient acceleration control will intervene to limit downhill acceleration on a steep descent.

The feature uses generated brake pressure to control acceleration in situations where the driver could lose control of the vehicle on a steep incline.

Gradient acceleration control keeps the vehicle to a speed and accelerator pedal dependant acceleration limit when the vehicle is moving in the intended direction of travel.

- Descending an incline forward, with Drive (D) selected.
- Descending an incline backward, with Reverse (R) selected.

GRADIENT RELEASE CONTROL

Gradient release control is an automatic feature which is always available when Hill Descent Control (HDC) is selected.

If the vehicle is brought to a standstill on a slope using the foot brake, gradient release control is become active (except in the Terrain Response (TR), sand and rock, crawl program).

When descending a hill, a brake hold and gradual release is employed to provide a smooth transition into HDC. Gradient release control operates in forward and reverse gears and requires no driver intervention.

HILL DESCENT CONTROL

Hill Descent Control (HDC) uses brake intervention to control vehicle speed and acceleration during low speed descents in off-road and low grip on-road conditions. Generally, equal pressure is applied to all four brakes, but pressure to individual brakes can be modified by the ABS and DSC functions to retain stability.



WARNING:

Incorrect use of the HDC function may compromise the stability of the vehicle, resulting in a dangerous and uncontrolled hill descent. Driving with the transmission in neutral while HDC is active will prevent engine braking from assisting the vehicle. The brakes can overheat and induce the HDC fade out strategy. In this condition there is no control over the vehicle during a descent.

**NOTE:**

With the HDC function selected, HDC is operative even when the transmission is in neutral. It is not recommended to drive the vehicle further than is absolutely necessary with HDC selected and the transmission in neutral.

The HDC may be used in Drive (D), Reverse (R) and all Command Shift gears. When in D, the TCM automatically selects the most appropriate gear.

The HDC only be enabled at speeds below 50 km/h (31 mph).

When HDC is selected:

- At speeds up to 50 km/h (31 mph), the HDC warning indicator in the IPC is permanently illuminated if a valid gear is selected.
- At speeds from between 50 km/h to 80 km/h (31 mph to 50 mph) the HDC warning indicator flashes and a message advising that the speed is too high is displayed in the message center. If the HDC switch is pressed while vehicle speed is more than 80 km/h (50 mph), the HDC warning indicator does not illuminate and HDC is not selected.
- If the speed increases to 80 km/h (50 mph), the HDC function is switched OFF and the warning indicator is extinguished. At the same time a warning chime sounds and a HDC is switched OFF message is displayed in the message center.

When HDC is enabled, the ABS control module calculates a target deceleration value by comparing the set speed to the actual vehicle speed. The ABS control module then operates the Hydraulic Control Unit (HCU) in the active braking mode as required to achieve and maintain the target speed.

LOW RANGE TARGET SPEEDS

TARGET SPEED	SPEEDS, KM/H (MPH)							
	R	D	1ST	2ND	3RD	4TH	5TH	6TH-8TH
Default	3.5 (2.2)	6 (3.7)*	3.5 (2.2)	5 (3.1)	8 (5.0)	10 (6.2)	13 (8.1)	16 (10.0)
Minimum	3.5 (2.2)	3.5 (2.2)	3.5 (2.2)	5 (3.1)	8 (5.0)	10 (6.2)	13 (8.1)	16 (10.0)
Maximum	25 (15.5)	25 (15.5)	25 (15.5)	25 (15.5)	25 (15.5)	25 (15.5)	25 (15.5)	25 (15.5)

**NOTE:**

* Default speed may be modified depending on Terrain Response® program and gear selection.

High Range Target Speeds and vehicles with Single Range Transmission

TARGET SPEED	SPEED, KM/H (MPH)							
	R	D	1ST	2ND	3RD	4TH	5TH	6TH-8TH
Default	3.5 (2.2)	10 (6.2)*	6 (3.7)	9 (5.6)	13 (8.1)	17 (10.5)	22 (13.7)	28 (17.4)
Minimum	3.5 (2.2)	6 (3.7)	6 (3.7)	9 (5.6)	13 (8.1)	17 (10.5)	22 (13.7)	28 (17.4)
Maximum	35 (21.7)	35 (21.7)	35 (21.7)	35 (21.7)	35 (22.0)	35 (17.5)	35 (17.5)	35 (17.5)



NOTE:

* Default speed may be modified depending on Terrain Response® program and gear selection.

During changes of target speed, the ABS control module limits deceleration and acceleration to -0.5 m/s^2 (-1.65 ft/s^2) and $+0.5 \text{ m/s}^2$ ($+1.65 \text{ ft/s}^2$) respectively.

To provide a safe transition from active braking to brakes off, the ABS control module invokes a fade out strategy that gradually releases the braking effort during active braking. The fade out strategy occurs if any of the following conditions are detected during active braking:

- Hill Descent Control (HDC) selected off with the HDC switch.
- Failure of a component used by HDC, but not critical to the fade out function.
- Accelerator pedal pressed when the transmission is in neutral.
- Brake overheat.

If fade out is invoked because of deselection or component failure, the HDC function is canceled by the ABS control module. If fade out is invoked, the HDC function remains in standby and resumes operation when the accelerator pedal is released or the brakes have cooled.

The fade out strategy increases the target speed, at a constant acceleration rate of 0.5 m/s^2 (1.65 ft/s^2). Acceleration continues until the maximum target speed is reached or until no active braking is required for 0.5 s. If the accelerator pedal is positioned within the range that influences target speed, the acceleration rate is increased to 1.0 m/s^2 (3.3 ft/s^2).

When fade out is invoked because of component failure, a warning chime sounds, the HDC warning indicator extinguishes and a fault message is displayed in the message center.

When fade out is invoked because of brake overheat, a message advising that HDC is temporarily unavailable is displayed. At the end of fade out, the HDC warning indicator flashes. The message and flashing warning indicator remain on, while HDC remains selected, until the brakes have cooled.

To monitor for brake overheat, the ABS control module monitors the amount of braking activity and, from this, estimates the temperature of each brake. If the estimated temperature of any brake exceeds a preset limit, the ABS control module invokes the fade out strategy. After the fade out cycle, the HDC function is re-enabled when the ABS control module estimates that all of the brake temperatures are at less than 64% of the temperature limit.

Activation Of Stop Lamps

Operation of the vehicle stop lamps is controlled by the BCM/ GWM assembly. The ABS control module monitors the brake system hydraulic pressure and requests the BCM/ GWM assembly, through the FlexRay, to energize the stop lamps during active braking.

Stop/Start Vehicles

Activation of Hill Descent Control (HDC) has deactivate the stop/start system. If HDC is activated while the engine is shutdown in a stop/start cycle, the engine is automatically restart.

For additional information, refer to: [Starting System](#) (303-06C Starting System - INGENIUM I6 3.0L Petrol, Description and Operation).

ALL TERRAIN PROGRESS CONTROL

The ATPC can help the driver to maneuver on slippery surfaces. The system operates in either a forward or a reverse direction at low speeds, for example, pulling away from standstill, ascending or descending an incline, and driving on unstable/slippery driving surfaces.

The HDC/ ATPC switch illuminates when enabled and a warning lamp illuminates in the IPC.

There is also a confirmation message in the message center of the IPC.

When ATPC is disabled a confirmation message is displayed in the IPC and the switch and IPC indications are extinguished.

When enabled, ATPC defaults to descent control mode, the system only limits the vehicle downhill speed, using the brakes.

When ATPC enters in to descent control mode, the ATPC Descent Braking Only message is displayed in the message center to confirm.

When full function has been activated the driver can adjust the target speed. The target speed is from a minimum of 1.8 km/h (1.2 mph) in low range and 3.6 km/h (2.2 mph) in high range. The ATPC maintains these speeds unless the accelerator or brake is pressed or the **SET+** switch on the Steering Wheel Switch is operated.

When the SET+ on the Steering Wheel Switch is operated, a confirmation message ATPC Speed Set is displayed on the IPC.

When a set speed has been selected ATPC will endeavor to maintain that target speed over any terrain that lies in front (or behind if R is selected) of the vehicle. The ABS control module controls the amount of brake torque and engine torque at all times to maintain the vehicle speed selected, overcome obstacles, negotiate any inclines or

descents and make sure as smooth an operation as possible. The set speed can be adjusted at any time. The resume 'RES' switch can be used to re-adopt the previous set speed after driver braking.



NOTES:

- The driver seatbelt must be buckled and all of the doors must be completely closed to enable ATPC to enter into full function mode. If these conditions are not met, a message is displayed in the message center.
- When the vehicle is stationary, press and hold the brake pedal while using the SET+ switch.
- If the vehicle speed exceeds 30 km/h (19 mph), ATPC operation is suspended. ATPC is then in standby mode, until the vehicle speed is less than 30 km/h (18.6 mph). An ATPC override message is displayed in the message center.
- If the vehicle speed exceeds 80 km/h (50 mph), ATPC is disabled. An ATPC off message is displayed in the message center. If required, ATPC can be switched on again.
- If an ATPC fault is detected, an ATPC not available message is displayed in the message center when the ATPC switch is pressed.

ATPC works in conjunction with hill launch assist, launches on inclines are therefore part of the ATPC benefits.

HILL LAUNCH ASSIST

Hill launch assist is an automatic feature that aids smooth transition from foot brake to moving away on hill ascents. Hill launch assist operates regardless of Hill Descent Control (HDC) selection.

On steep slopes, hill launch assist will hold a portion of the driver generated brake pressure for a short time (2 to 3 seconds). This brake pressure allows the driver to move their foot from the brake pedal to the accelerator pedal without the vehicle rolling back.

The system releases the brake pressure in a controlled manner, either after the timer has expired or if the driver has generated sufficient drive-torque to move the vehicle forward up the hill.

The feature is not driver selectable and there is no indication to the driver when in operation.

BRAKE HOLD

The brake hold functions maintain the vehicle in a standstill position without the brake pedal being pressed continuously. When a brake hold function is active, the IPC illuminates the brake HOLD lamp.

The driver can select:

- On Demand - To hold the vehicle on any gradient of slope without creeping forward.
- Enhanced Hill Hold - To apply the brakes automatically, preventing vehicle roll back on steep slopes.

Brake hold function operates in Reverse (R), Neutral (N), Drive (D) and Sport (S). Brake hold function maintains hydraulic brake pressure in the brake system until the accelerator pedal is applied.

The brake hold functions can be deactivated manually by pressing the brake pedal and pull the Electric Park Brake (EPB) switch to the release position.

The brake hold functions apply the EPB and then deactivate if:

- The brake hold function has been active for more than 5 minutes.
- The driver seatbelt is unbuckled while a brake hold function is active.
- The driver door is opened while a brake hold function is active.

The brake hold functions are unavailable if:

- The driver's seatbelt is unbuckled or the driver's door is opened.
- The vehicle is engaged in P.
- The EPB is applied.
- Hill Descent Control (HDC) is active.
- ATPC is active.
- Adaptive cruise control queue assist is active.
- The engine is switched off manually.

The brake hold functions does not operate if there is a fault with:

- DSC
- The brake system
- The EPB system.

On Demand Hold

To activate On Demand Hold, the vehicle must be at a standstill and the driver must give the brake pedal an additional firm press. The On Demand Hold can be activated in any gear except Park (P). The On Demand Hold function continues to hold the vehicle on the brakes if the driver selects an alternative gear. On Demand Hold operates in R, N, D and S and maintains hydraulic brake pressure in the braking system until the accelerator pedal is applied.

The engine may auto stop while On Demand Hold is active. When driving away, there is a slight delay after the accelerator pedal is pressed, while the engine restarts.

The driver can disable and re-enable the On Demand Hold at any time, through the touchscreen:

- 1** Press the settings icon.
- 2** Select Vehicle.
- 3** Select Convenience.
- 4** Select Brake Hold.

- 5 Touch the On Demand Hold toggle.

The function can be deactivated by pressing the brake pedal and disabling the function by touching the toggle.

Enhanced Hill Hold

The Enhanced Hill Hold function applies the brakes automatically to prevent the vehicle rolling back down steep slopes. If the vehicle is brought to rest on a steep incline with little or no brake pressure, additional brake pressure may be generated to hold it stationary.

The Enhanced Hill Hold function releases the brakes if the driver selects an alternative gear.

Enhanced Hill Hold is unavailable if the vehicle is engaged in Neutral (N) or Park (P).

To allow an auto stop while Enhanced Hill Hold is active, the driver can transfer to on demand hold. The driver must give the brake pedal an additional firm press to activate on demand hold.

The driver can disable and re-enable the Enhanced Hill Hold at any time, through the touchscreen:

- 1 Press the settings icon.
- 2 Select Vehicle.
- 3 Select Convenience.
- 4 Select Brake Hold.
- 5 Touch the Enhanced Hill Hold toggle.

The function can be deactivated by pressing the brake pedal and disabling the function by touching the toggle.

TERRAIN RESPONSE SYSTEM INTEGRATION

The Terrain Response (TR) system integrates the ABS and other vehicle system control modules to assist the vehicle when driving off-road or during difficult surface conditions. the TR system integration is activated when a TR special program is selected.

When a TR special program is selected, the ABS control module, along with other vehicle system control modules, operate in accordance with programed software maps. The software maps allow the ABS system to function with a threshold that will assist the selected TR special program.

For additional information, refer to: [Ride and Handling Optimization](#) (204-06 Ride and Handling Optimization, Description and Operation).

TRACTION LAUNCH CONTROL

Traction launch control is automatically enabled when either the sand or grass/gravel/snow special program is selected on the Terrain Response system.

When pulling away from stationary on sand or other dry, yielding ground, excessive wheel spin can cause the wheels to dig downward preventing forward movement. On surfaces with low grip, excessive wheel spin can lead to vehicle instability and reduced vehicle acceleration.

Traction launch control uses the Electronic Traction Control (ETC) function to limit the amount of wheel spin. Traction launch control allows a gradual controlled pull away even if full throttle is applied until the vehicle has gained speed.

ROCK CRAWL PRECHARGE

Rock crawl precharge is automatically enabled when the rock crawl special program is selected on the Terrain Response (TR) system.

Rock crawl precharge applies a small amount of brake pressure to each brake caliper during low speed driving. This improves brake and traction control response times helping to reduce forward/backward vehicle roll when cresting an obstacle or releasing the accelerator pedal.

TRAILER STABILITY ASSIST

When the trailer electrical socket is connected, trailer stability assist operates automatically to enhance the existing DSC and Terrain Response functions. The system detects sway movements caused by trailer oscillations at speeds in excess of 60 km/h (37 mph) and acts to eliminate them. The system does this through braking and engine management. Braking management counterbalances the sway movement through symmetric and asymmetric braking, thereby slowing the vehicle and eliminating the oscillations. Engine management adapts engine torque output to support the braking management in stabilizing the vehicle and trailer.

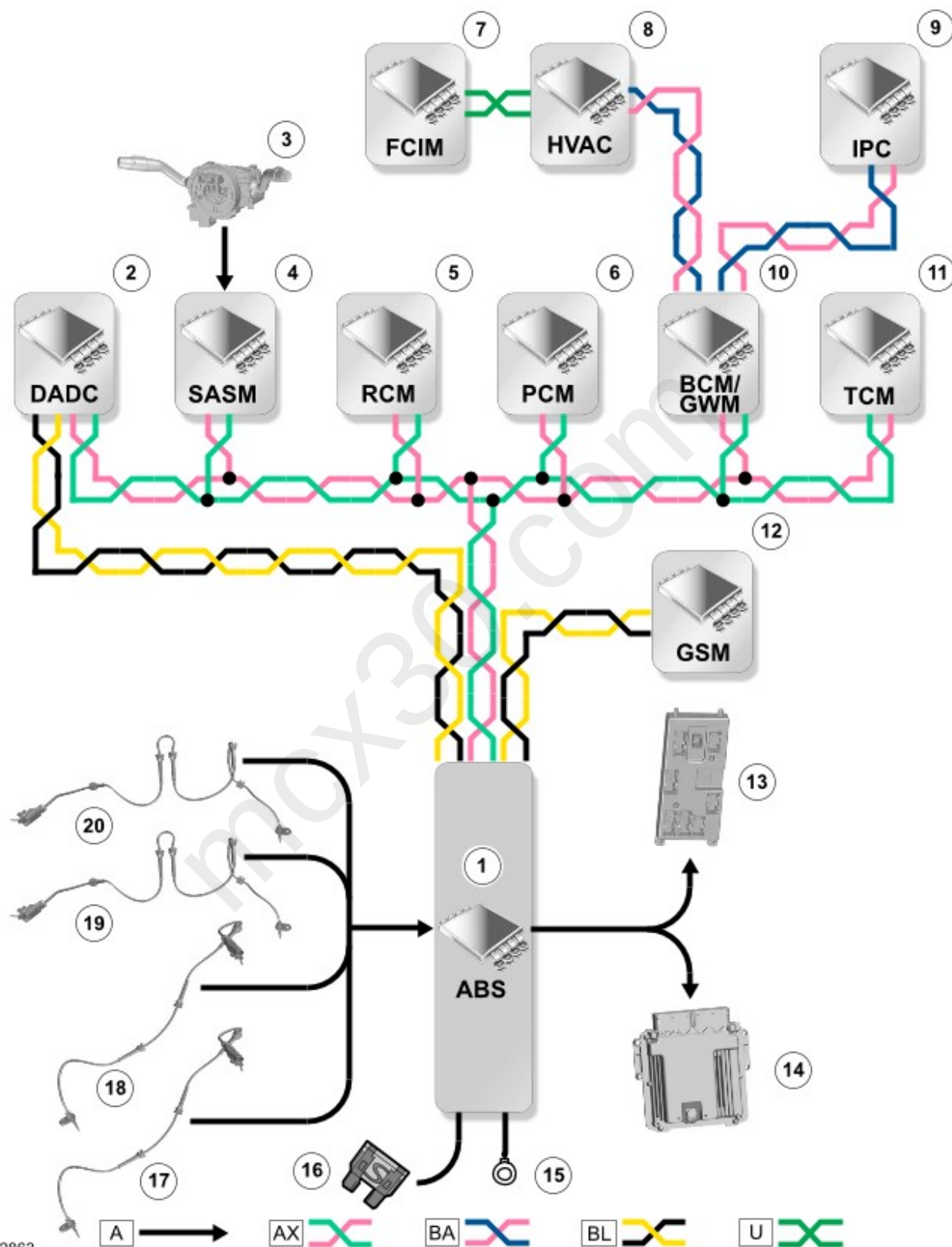
Typical conditions when sway can occur include:

- Changing highway lanes.
- Traversing a lengthy bend.
- Acceleration.
- Braking.
- Incorrectly laden trailers.

The trailer stability assist keeps the vehicle and trailer under safe control. The capability of trailer stability assist to respond early to the beginning of trailer-sway makes the system almost unnoticeable under normal driving conditions. Trailer stability assist requires no input from the driver and operates up to the maximum vehicle speed.

Trailer stability assist does not operate while DSC is switched OFF.

CONTROL DIAGRAM



E252863

A = HARDWIRED: AX = FLEXRAY: BA = HS CAN HMI SYSTEMS BUS: BL = HS CAN UNDERBODY SYSTEMS BUS: U = HS CAN PRIVATE BUS.

ITEM	DESCRIPTION
1	Integrated Power Brake control module (ABS)
2	DADC
3	Steering Wheel Module (SWM)
4	SASM
5	RCM
6	PCM
7	FCIM
8	HVAC
9	IPC
10	BCM/ GWM
11	TCM
12	GSM
13	Brake pedal activation signal - BCM/ GWM
14	Brake pedal activation signal - PCM
15	Ground
16	Power supply
17	Rear left wheel speed sensor
18	Rear right wheel speed sensor
19	Front left wheel speed sensor
20	Front right wheel speed sensor