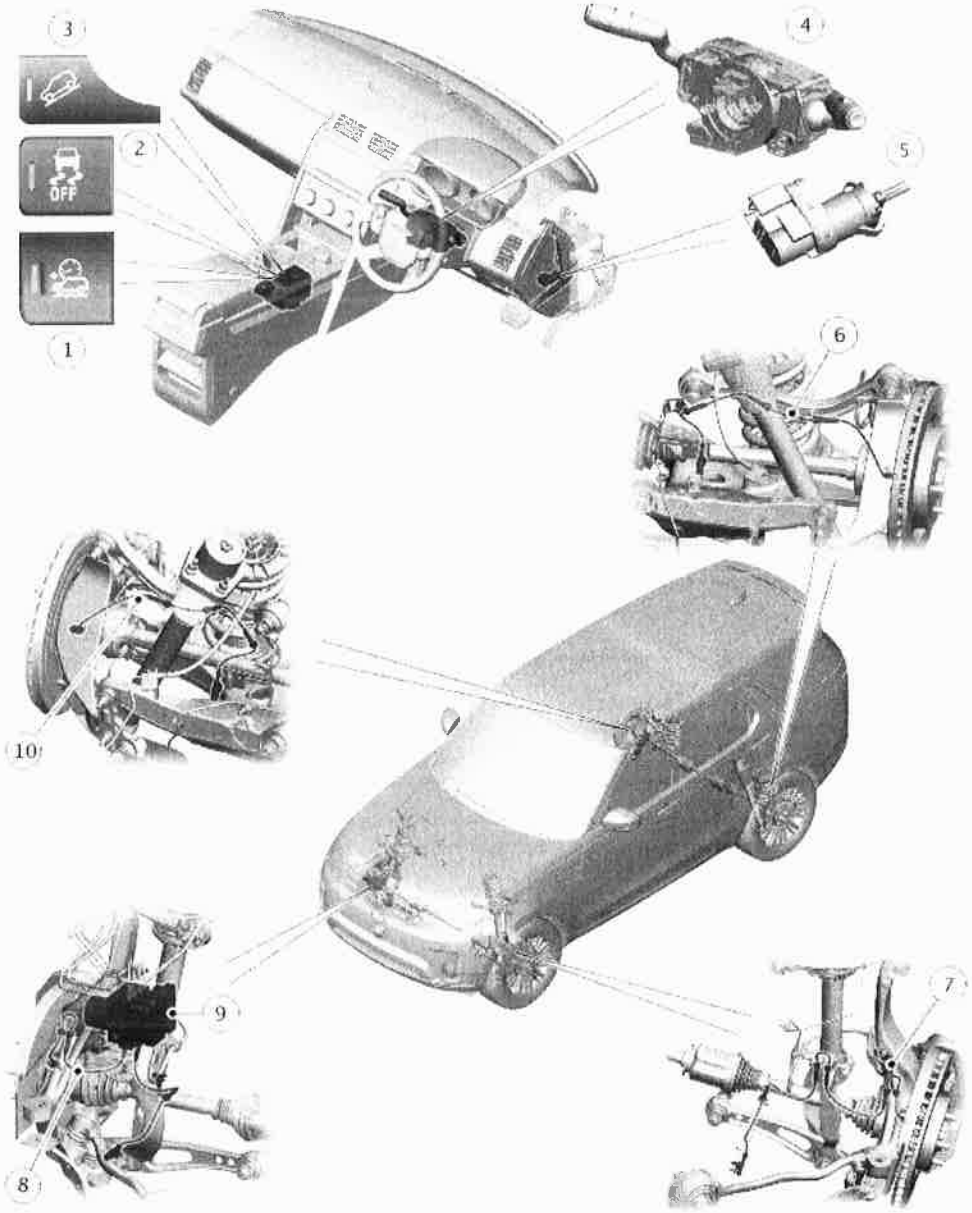


E195207

ITEM	DESCRIPTION
1	All Terrain Progress Control (ATPC) switch
2	Dynamic Stability Control (DSC) Switch
3	Hill Descent Control (HDC) Switch
4	Steering Angle Sensor Module (SASM)
5	Brake switch
6	Rear left wheel speed sensor
7	Front left wheel speed sensor

8	Body Control Module/Gateway Module (BCM/GWM) assembly
9	Powertrain Control Module (PCM)

OVERVIEW

BRAKING CONTROL SYSTEM

The braking control system features an integrated four-channel Hydraulic Control Unit (HCU) and an Anti-lock Brake System (ABS) control module.

The ABS control module is connected to the FlexRay and High Speed (HS) Controller Area Network (CAN) chassis systems buses. The ABS control module actively interacts with other vehicle system control modules and associated sensors to receive and transmit current vehicle operating information.

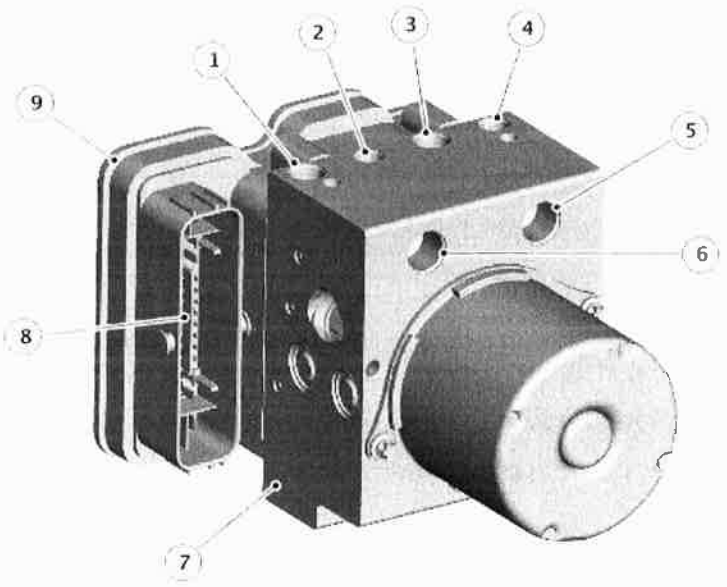
When required, the ABS will actively intervene and operate the HCU during braking or vehicle maneuvers to correct the vehicle attitude, stability, traction or speed. During incidents of vehicle correction, the ABS control module may also request the Powertrain Control Module (PCM) to control engine power in order to further stabilize and correct the vehicle.

To provide full system functionality, the braking control system comprises the following components:

- Anti-lock Brake System (ABS) control module with integrated HCU.
- Dynamic Stability Control (DSC) switch
- Hill Descent Control (HDC) switch
- Four wheel speed sensors
- Steering Angle Sensor Module (SASM) in the Steering Wheel Module
- Brake pedal switch.
- Instrument Cluster (IC) warning indicators
- All Terrain Progress Control (ATPC) switch.

△ NOTE:

Unlike some previous brake control systems, this system does not have a separate lateral acceleration and yaw rate sensor component to provide vehicle acceleration data. Instead, the Anti-lock Brake System control module receives vehicle acceleration data over a High Speed Controller Area Network chassis bus from the Restraints Control Module (RCM).



E194918

ITEM	DESCRIPTION
1	Rear right brake outlet port
2	Left front brake outlet port
3	Right front brake outlet port
4	Left rear brake outlet port
5	Primary circuit inlet port
6	Secondary circuit inlet port
7	Hydraulic Control Unit (HCU)
8	Electrical connector
9	Control module

The Anti-lock Brake System (ABS) control module consists of an integrated control module and four-channel Hydraulic Control Unit (HCU). The control module uses the HCU to modulate hydraulic pressure to the individual wheel brakes to control the brake functions.

The ABS control module is installed in the front corner of the engine compartment, on the driver side. A multi-pin electrical connector provides the electrical interface between

Initially, all of the solenoid-operated valves are de-energized. Operating the brake pedal produces a corresponding increase or decrease of pressure in the brakes, through the open pilot valves and inlet valves. If the Anti-lock Brake System (ABS) control module determines that Electronic Brake Force Distribution (EBD) is necessary, it energizes the inlet valves for both the rear brakes, to 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 Anti-lock Brake System (ABS) control module determines that ABS braking is necessary, it energizes the inlet and outlet valves of the related brake and starts the hydraulic return pump. The inlet valve closes to isolate the brake from pressurized fluid. The outlet valve opens to release pressure from the brake into the accumulator and the return pump circuit. The reduced hydraulic pressure allows the wheel to accelerate. The ABS control module then operates the inlet and outlet valves to modulate the pressure in the brake to apply the maximum braking effort without locking the wheel. 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 Anti-lock Brake System (ABS) braking modes.

For active braking, the ABS control module energizes the pilot valves and priming valves, starts the return pump and energizes all of the inlet valves. brake fluid, drawn from the reservoir through the master cylinder and priming valve, is pressurized by the hydraulic pump and supplied to the inlet valves. The ABS control module then operates the inlet valves and outlet valves, as required, to modulate the pressure in the individual brakes. Some noise may be generated during active braking.

Service Information

The Anti-lock Brake System (ABS) 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 only requires a conventional bleed of the system. There is no requirement to pressure bleed the system.

DYNAMIC STABILITY CONTROL SWITCH

pressed again, the ABS control module re-enables the DSC functions. The DSC switch must be pressed for a minimum of 0.3 s for the ABS control module to react. The DSC function is re-enabled at the beginning of each ignition cycle.

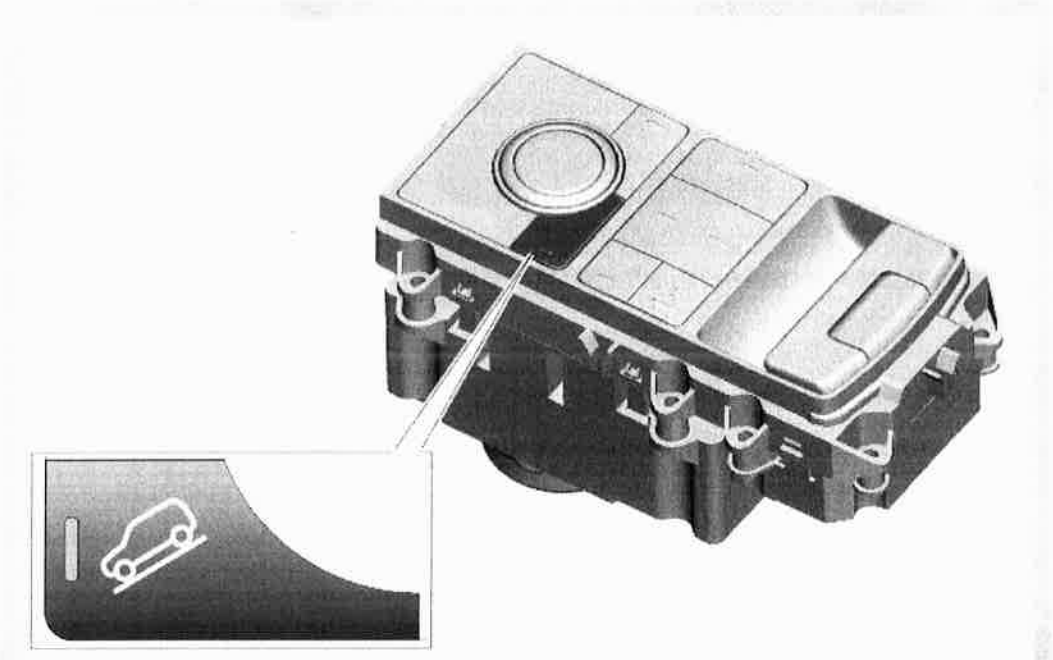
The status of the DSC switch selection is shown by the DSC OFF warning indicator. The DSC OFF warning indicator in the Instrument Cluster (IC) is extinguished while DSC is selected on and continuously illuminated while DSC is selected off.

A DSC switch request to disable DSC is ignored by the ABS control module if the air suspension system has failed, or is in off-road height at speeds above 55 km/h (34 mph).

To guard against incorrect operation or a broken switch, if the input from the DSC switch is held high for more than one minute, a Diagnostic Trouble Code (DTC) is stored in the ABS control module.

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

HILL DESCENT CONTROL SWITCH



E191477

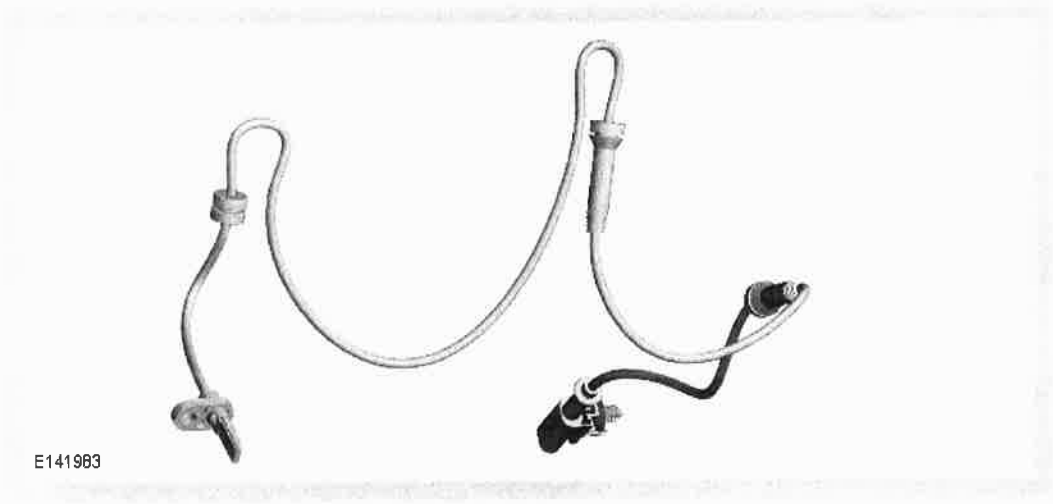
The Hill Descent Control (HDC) switch controls the selection of the HDC function.

The HDC switch is a non-latching switch installed in the Terrain Response® switchpack, in the floor console. Pressing and releasing the HDC switch produces a High Speed (HS) Controller Area Network (CAN) chassis bus message from the Terrain Response® switchpack to the Anti-lock Brake System (ABS) control module. With the first press

The Light Emitting Diode (LED) in the switch will illuminate. A warning lamp in the Instrument Cluster (IC) will also illuminate and a confirmation message will be displayed in the message center of the IC. A prompt to set the target speed will be displayed.

Press and release the ATPC switch again to disable the system. The LED will be extinguished and the warning light in the IC will also be extinguished. A confirmation message will displayed in the message center.

WHEEL SPEED SENSORS

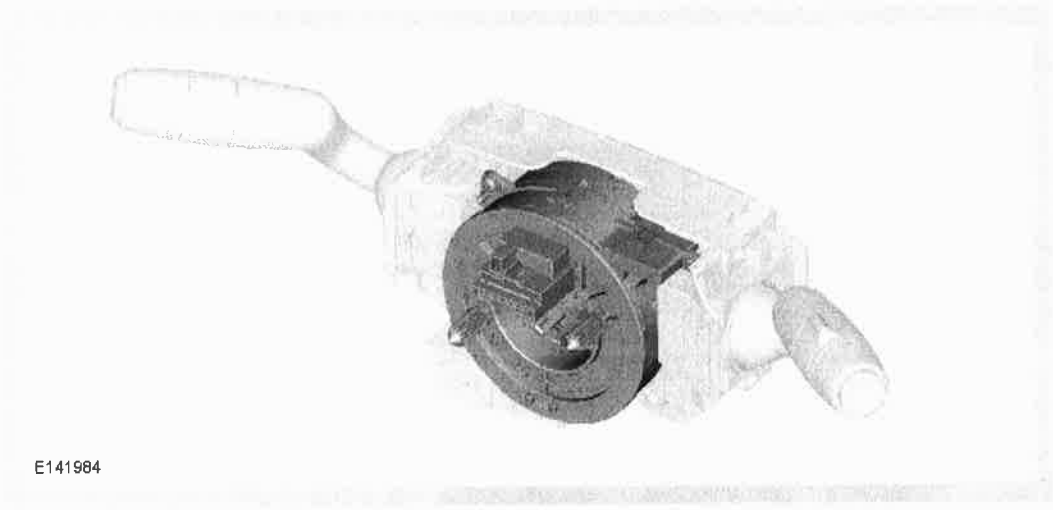


An active wheel speed sensor is installed in each wheel hub to provide the Anti-lock Brake System (ABS) control module with a rotational speed signal from each road wheel. The head of each wheel speed sensor is positioned close to a magnetic encoder incorporated into the seal of the wheel bearing. A 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 ABS control module. When in power mode 6, the ABS 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 ABS control module.

The ABS control module outputs the individual wheel speeds, the vehicle speed and the direction of travel on the High Speed (HS) Controller Area Network (CAN) chassis bus and the Flexray circuit for use by other systems. If all wheel speed signals are available to calculate vehicle speed from, 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'.

The ABS control module monitors the wheel speed sensor circuits for faults. If a fault is detected a Diagnostic Trouble Code (DTC) is stored in the ABS control module and illuminates the appropriate warning indicators, depending on the system functions affected, for example Dynamic Stability Control (DSC). A warning chime is also



E141984

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

The SASM is connected to the Steering Wheel Module (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 for use by the Anti-lock Brake System (ABS) control module and functions such as Dynamic Stability Control (DSC).

If a fault occurs within the steering angle sensor module, a Diagnostic Trouble Code (DTC) is stored in the SASM and the ABS control module. The ABS control module signals the Instrument Cluster (IC) 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 IC.

The SASM and ABS control module can be interrogated using Land Rover approved diagnostic equipment.

BRAKE PEDAL SWITCH

6	All Terrain Progress Control (ATPC)
7	Brake amber warning indicator - worn brake pads or Emergency Brake Assist (EBA) failure indicator - Rest of World (ROW)
8	Brake red warning indicator - Low brake fluid level or Electronic Brake Distribution (EBD) function failure is detected - Rest of World (ROW)
9	Dynamic Stability Control (DSC) warning indicator
10	Dynamic Stability Control (DSC) warning indicator

The Instrument Cluster (IC) 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, as a 'bulb' check.

OPERATION

ANTI-LOCK BRAKE SYSTEM

The Anti-lock Brake System (ABS) controls the speed of all road wheels to ensure 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.

ROLL STABILITY CONTROL

The Roll Stability Control function uses the brake system and engine torque control to attempt to restore vehicle stability if the vehicle is forced into such a harsh manoeuver that it risks tipping over.

The Anti-lock Brake System (ABS) control module monitors driver inputs and vehicle behavior using various powertrain signals and inputs from the wheel speed sensors, Steering Angle Sensor Module (SASM) and the Restraints Control Module (RCM) (roll rate, yaw rate and lateral acceleration data). These are compared with modelled behavior and if vehicle behavior reaches a given risk level, the ABS control module initiates a reduction in engine power, or brakes one or more wheels sufficiently to correct the vehicle stability and assist the driver to remain in control.

While in power mode 6 or 7, Roll Stability Control is permanently enabled, even when Dynamic Stability Control (DSC) is selected off.

CORNER BRAKE CONTROL

Corner Brake Control (CBC) influences the brake pressures, below the Dynamic Stability Control (DSC) and Anti-lock Brake System (ABS) thresholds, to counteract the

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.

EBD uses the Anti-lock Brake System (ABS) hardware to automatically optimize the pressure of the trailing axle brakes, below the point where ABS intervention is normally invoked. Only the trailing axle wheels are under EBD control.

ELECTRONIC BRAKE PREFILL

Electronic brake prefill senses any rapid throttle lift off, activating a small brake hydraulic pressure buildup of approximately 3 to 5 bar (43.5 to 72.5 lbf/in^2) in anticipation of the brakes being applied. This gives a quicker brake pedal response and consequently slightly shorter stopping distances.

When the Anti-lock Brake System (ABS) control module detects rapid throttle lift off (from the signals received from the Powertrain Control Module (PCM)), it applies a low brake pressure to all of the brakes to assist in a quicker brake application.

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 Anti-lock Brake System (ABS) control module also transmits a message to the Powertrain Control Module (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 Dynamic Stability Control (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 Transmission Control Module (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 two situations when the Anti-lock Brake System (ABS) control module will invoke EBA:

- Steering Angle Sensor Module (SASM) - Steering angle and rate of change.
- Restraints Control Module (RCM) - Lateral acceleration and yaw rate.
- Image Processing Module (IPM) - Collision risk detection.
- Anti-lock Brake System (ABS) control module - Braking control and vehicle speed.
- Powertrain Control Module (PCM) - Accelerator Pedal Position (APP) and torque control.
- Head Up Display (HUD) - Warning message.
- Instrument Cluster (IC) - Warning message.

This information is exchanged using the High Speed (HS) Controller Area Network (CAN) chassis bus and the FlexRay bus.

The AEB system uses a four stage sequence of which it operates:

- 1 . **Driver Warning** - Before braking is engaged, an audible warning is sounded and a visual warning is displayed in the Instrument Cluster (IC) indicating that a collision risk has been identified, but is still avoidable by the driver. The visual warning message is also displayed in the Head Up Display (HUD) if fitted.
- 2. **Brake Precharge** - If the time until collision becomes shorter, but still avoidable, the system applies a small amount of pressure on the brakes to fill the gap between the pads and discs, ensuring the best braking performance if the driver reacts to the warning.
- 3. **Collision Mitigation** - Having identified a collision risk, either static or traveling in the same direction, the function will apply the brakes, mitigating the collision. The operational speed range is between 5 and 80 km/h (3 mph and 50 mph).
- 4 . **Message on Instrument Cluster Post Braking** - The Instrument Cluster (IC) displays a message to confirm that the Intelligent Emergency Braking (IEB) function has been activated.

The Autonomous Emergency Braking (AEB) system will not operate if any the following are present:

- Poor camera visibility:
  - - Fog, heavy precipitation, soiled windscreen, etc.
- System fault detected.
- Forward collision warning velocity outside range: 30-80 km/h (18-50 mph).
- Intelligent Emergency Braking (IEB) velocity outside range: 5-80 km/h (3-50 mph).
- Dynamic Stability Control (DSC) is switched off.
- The vehicle is cornering sharply.

When the Anti-lock Brake System (ABS) control module detects the onset of understeer, it signals the Powertrain Control Module (PCM) to request a decrease in engine torque. If required, the ABS control module applies brake pressure to the inside rear wheel to correct the understeer. If the vehicle continues to understeer, Enhanced Understeer Control is activated and uses multiple brakes (maximum of three brakes) to rapidly reduce the vehicle speed.

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 throttle pedal dependant acceleration limit when the vehicle is moving in the intended direction of travel, for example:

- Descending an incline forwards, with Drive (D) selected.
- Descending an incline backwards, with Reverse (R) selected.

When the vehicle is moving against the intended direction of travel, for example: descending a slope, but facing uphill with D selected, gradient acceleration control will prevent the vehicle accelerating above 5 km/h (3 mph) for up to 20-30 seconds to help the driver re-establish control of the vehicle.

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 will become active (except in the Terrain Response®, 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 Anti-lock Brake System (ABS) and Dynamic Stability Control

During active braking for HDC, the ABS control module sends a message to the Body Control Module/ Gateway Module (BCM/GW) to operate the stop lamps. For additional information, refer to: Exterior Lighting (417-01, Description and Operation).

Applying the foot brake during active braking may result in a pulse through the brake pedal.

The target speed varies between the minimum and maximum values for each gear and transmission range, depending on driver input with the speed control + and - switches. For additional information, refer to: Speed Control (310-03 Speed Control - TDV6 3.0L Diesel, Description and Operation).

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.

Activation Of Stop Lamps

Operation of the vehicle stop lamps is controlled by the Body Control Module/Gateway Module (BCM/GWM) assembly. The Anti-lock Brake System (ABS) control module monitors the brake system hydraulic pressure and requests the BCM/GWM assembly, via the FlexRay bus, to energize the stop lamps during active braking for HDC. A pressure threshold and time filter prevents the stop lamps from flickering.

Stop/Start Vehicles

Activation of Hill Descent Control (HDC) will deactivate the stop/start system. If HDC is activated while the engine is shutdown in a stop/start cycle, the engine will automatically restart. For additional information, refer to: Starting System (303-06 Starting System - TDV6 3.0L Diesel, Description and Operation) / Starting System (303-06 Starting System - V6 S/C 3.0L Petrol, Description and Operation) / Starting System (303-06 Starting System - INGENIUM I4 2.0L Diesel, Description and Operation).

ALL TERRAIN PROGRESS CONTROL

The All Terrain Progress Control (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 ATPC switch illuminates when enabled and a warning lamp illuminates in the Instrument Cluster (IC).

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

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

When enabled, ATPC defaults to descent control mode, the system only limits the vehicle's 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.

Once full function has been activated the driver can adjust the target speed 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 is operated.

When the SET+ on the steering wheel is operated, a confirmation message ATPC Speed Set is displayed on the IC.

Once 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 ensure 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.

ATPC works in conjunction with Hill Start Assist , launches on inclines are therefore part of the ATPC benefits.

NOTES:

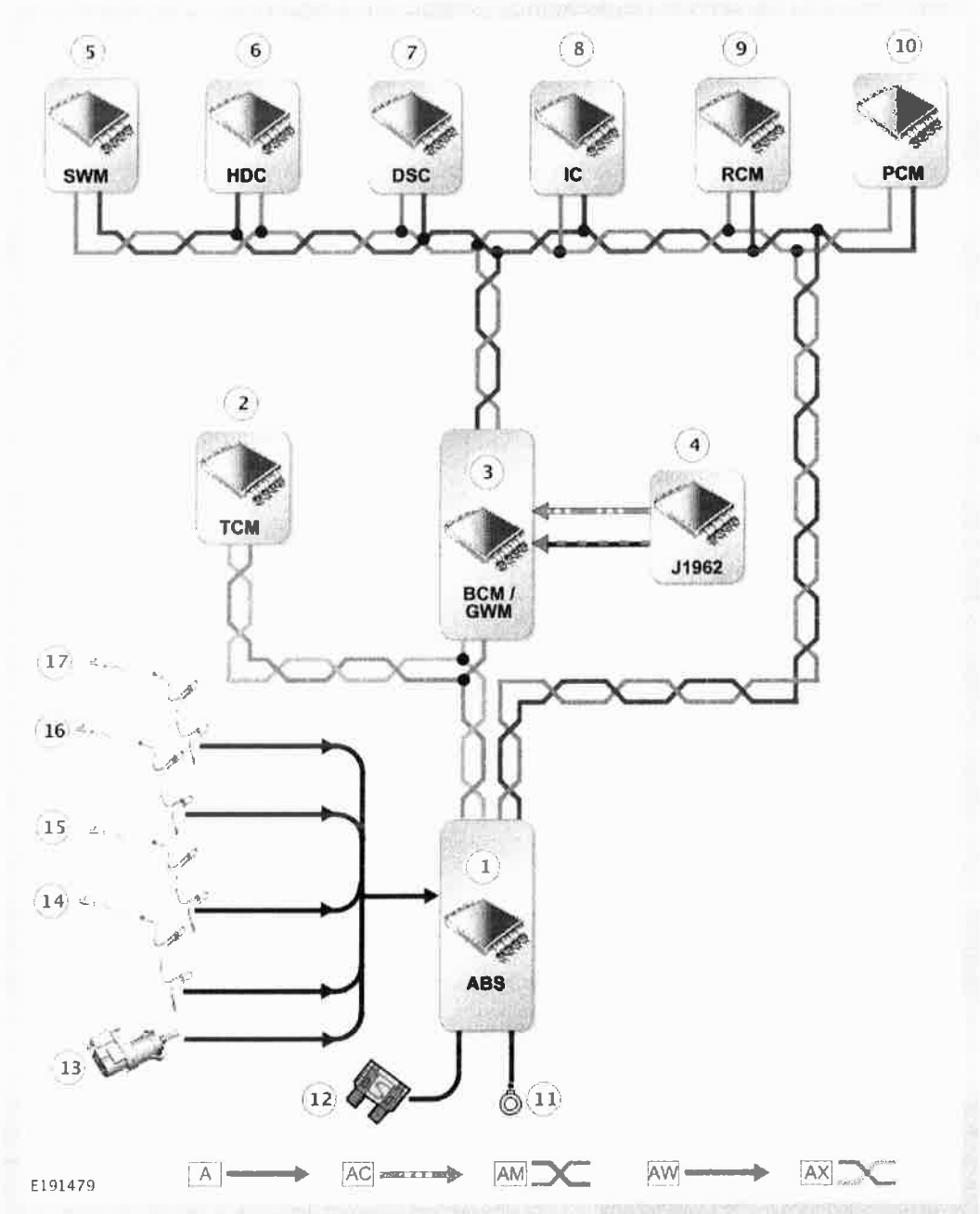
- The driver's seat belt must be buckled and all of the doors must be completely closed to enable ATPC to enter into full function mode. If these conditions are not met, a message is displayed in the message center
- When the vehicle is stationary, press and hold the brake pedal while using the SET+ switch.
- If the vehicle's speed exceeds 30 km/h (19 mph), ATPC operation is suspended. ATPC is then in standby mode, until the vehicle's speed is less than 30 km/h (18.6 mph). An ATPC override message is displayed in the message center.
- If the vehicle's speed exceeds 80 km/h (50 mph), ATPC is disabled. An ATPC off message is displayed in the message center. If required, ATPC will have to 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. In this event consult a retailer/authorised repairer.

HILL START ASSIST

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

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

The system will release 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.



A = HARDWIRED; AC = DIAGNOSTIC; AM = HIGH SPEED (HS) CONTROLLER AREA NETWORK (CAN) CHASSIS SYSTEMS BUS; AW = ETHERNET; AX = FLEXRAY.

ITEM	DESCRIPTION
1	Anti-lock brake system (ABS) control module