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BRAKE CONTROLS

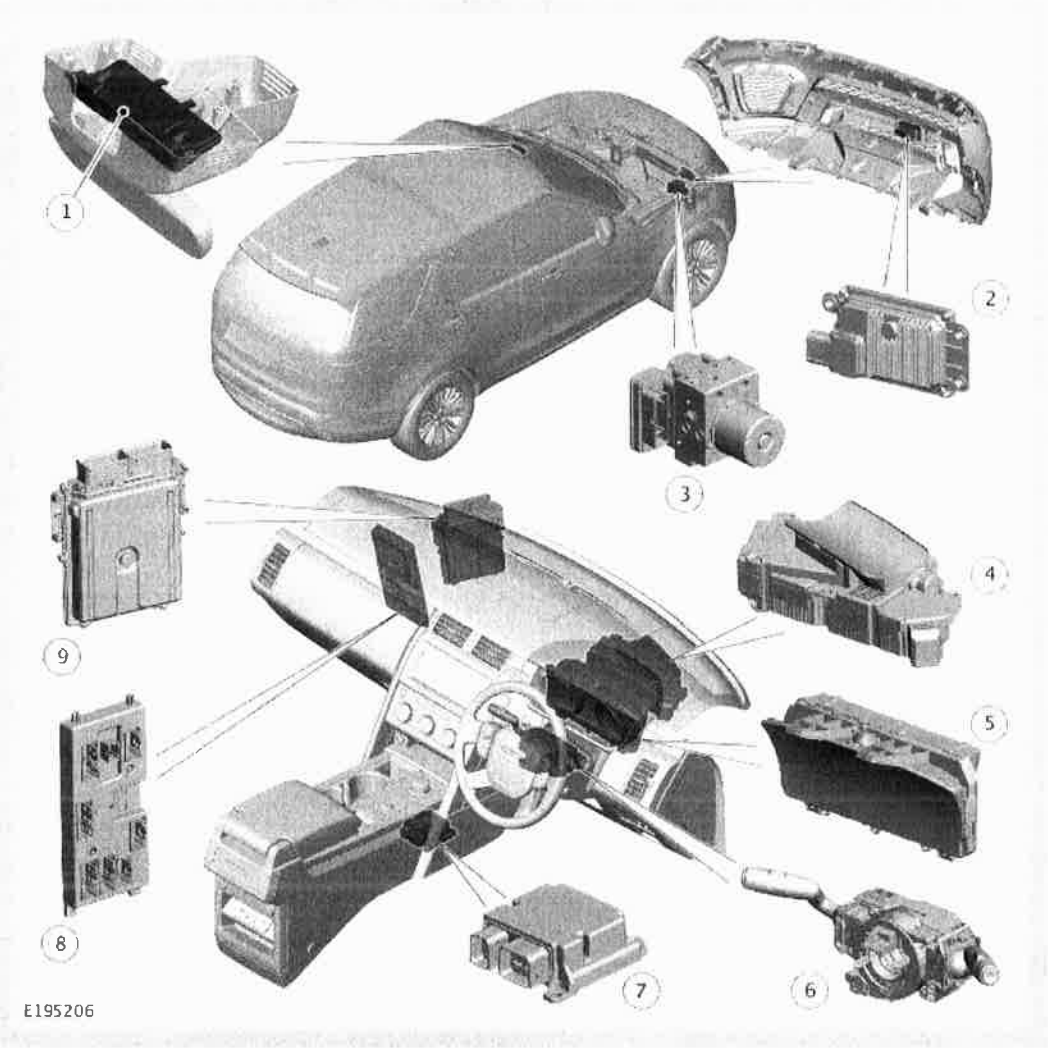
DESCRIPTION AND OPERATION

COMPONENT LOCATION

COMPONENT LOCATION - 1 OF 2

8	Front right wheel speed sensor
9	Anti-lock Brake System (ABS) control module
10	Rear right wheel speed sensor

COMPONENT LOCATION - 2 OF 2 - AUTONOMOUS EMERGENCY BRAKING



ITEM	DESCRIPTION
1	Image Processing Module (IPM)
2	Adaptive Speed Control Module (ASCM)
3	Anti-lock Brakes System Control Module (ABS)
4	Head Up Display (HUD)
5	Instrument Cluster (IC)
6	Steering Wheel Module (SWM)
7	Restraint Control Module (RCM)

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

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

The HDC function is enabled either manually using the HDC switch, or automatically by the Terrain Response® system, in the ignition on and engine running power modes. All of the other brake functions are automatically enabled in the ignition on and engine running power modes. The DSC function can be selected off using the DSC switch.

DESCRIPTION

ANTI-LOCK BRAKE SYSTEM CONTROL MODULE

the control module and the vehicle wiring. Hydraulic pipes and hoses connect the HCU to the master cylinder and the brake calipers. The primary and secondary outlets of the master cylinder are connected to the primary and secondary circuits within the HCU. The primary circuit in the HCU has separate outlet ports to the front brakes. The secondary circuit in the HCU has separate outlet ports to the rear brakes.

HYDRAULIC CONTROL UNIT

The Hydraulic Control Unit (HCU) is a four channel unit that modulates the supply of hydraulic pressure to the brakes, under the control of the Anti-lock Brake System (ABS) control module.

The master cylinder primary and secondary circuit outlets are connected to the HCU primary and secondary circuits.

Each of the HCU circuits contains the following components to control the supply of hydraulic pressure to the brakes:

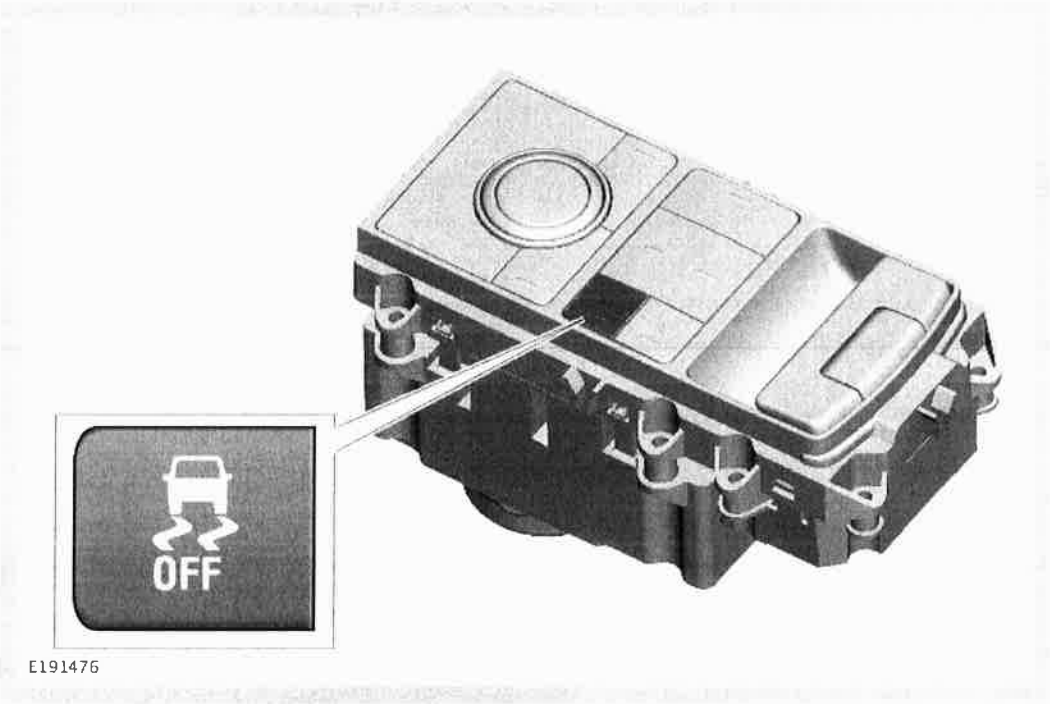
- A normally open, solenoid-operated pilot valve, to enable active braking.
- A normally closed, solenoid-operated priming valve, to connect the brake fluid reservoir to the dual circuit hydraulic pump during active braking.
- A hydraulic pump, to generate hydraulic pressure for active braking and return brake fluid to the reservoir.
- Normally open, solenoid-operated inlet valves and normally closed, solenoid-operated outlet valves, to modulate the hydraulic pressure in the individual brakes.
- An accumulator and a relief valve, to allow the fast release of pressure from the brakes.
- Filters, to protect the internal components from contamination.

A pressure sensor in the primary circuit provides the ABS 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 ABS control module to the dual circuit hydraulic pump motor and the pressure sensors. The solenoids that operate the valves are installed within the ABS control module.

The Hydraulic Control Unit (HCU) features three operating modes:

- Normal braking/Electronic Brake Force Distribution (EBD)
- Anti-lock Brake System (ABS) braking
- Active braking.

Normal Braking/Electronic Brake Force Distribution Mode



E191476

The Dynamic Stability Control (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:

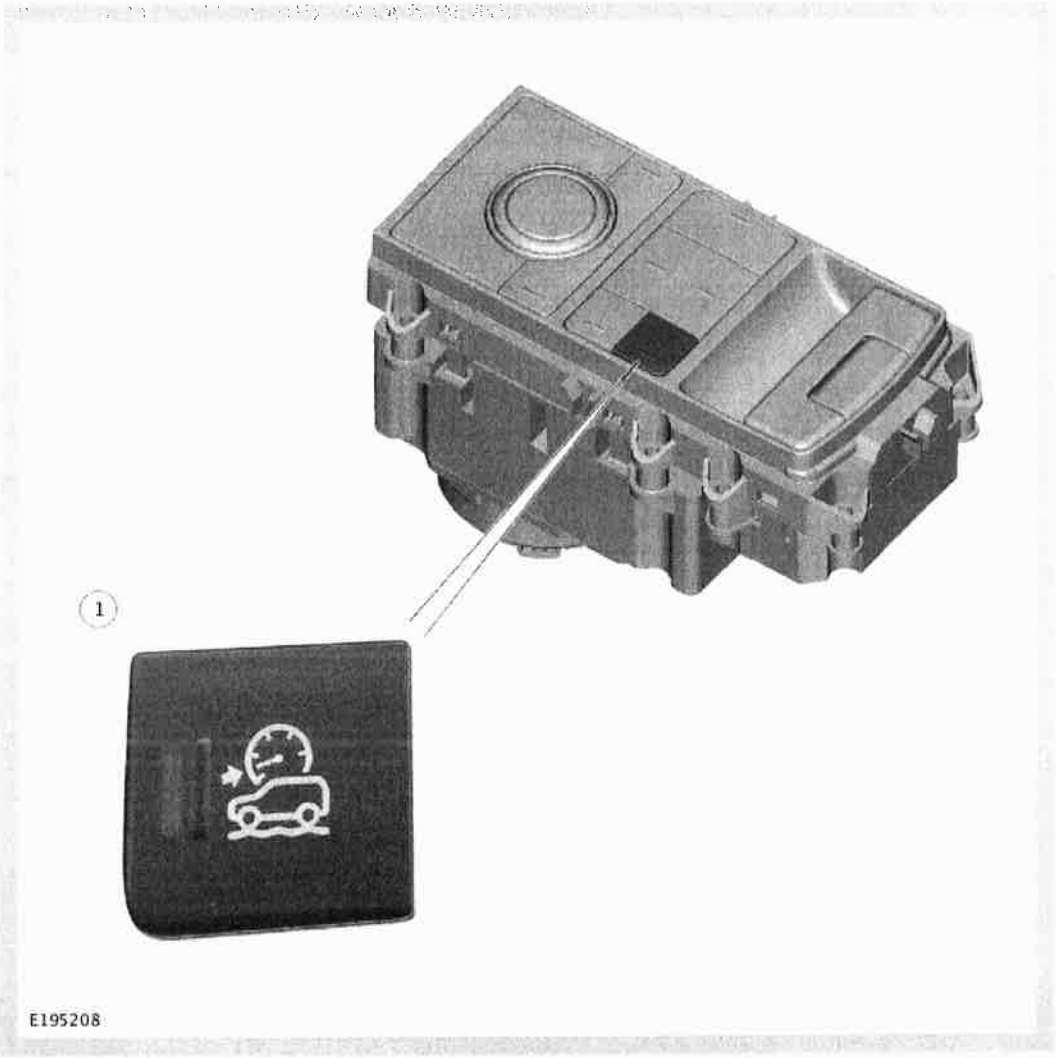
- If the vehicle needs to be rocked out of a hollow or a soft surface.
- Driving on loose surfaces or with snow chains.
- Driving on loose surfaces or with snow chains. (Grass, Gravel and Snow, optimized for these conditions)
- Driving in deep sand, snow or mud. (Grass, Gravel and Snow, Mud and Ruts optimized for these conditions)
- On tracks with deep longitudinal ruts. (Mud and Ruts optimised for these conditions)

The DSC switch is a non-latching switch installed in the Terrain Response® switchpack, in the floor console. Pressing the DSC 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 of the DSC switch, the ABS control module disables the DSC functions. When the DSC switch is

and release of the HDC switch, the ABS control module enables operation of the HDC function. When the HDC switch is pressed and released again, the ABS control module disables operation of the HDC function.

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 switch is held high for more than one minute, a Diagnostic Trouble Code (DTC) is stored in the ABS control module.

ALL TERRAIN PROGRESS CONTROL



ITEM	DESCRIPTION
1	All Terrain Progress Control (ATPC) switch

The All Terrain Progress Control (ATPC) switch controls the selection of the ATPC function. The ATPC switch is a non-latching switch installed in the Terrain Response® switchpack, in the floor console. Press and release the switch to enable ATPC.

sounded to alert the driver to the fault condition and a related message is shown in the message center in the Instrument Cluster (IC). For additional information, refer to Instrument Cluster.

Since the wheel speed sensors are active devices, a return signal is available when the road wheels are not turning, which enables the ABS control module to check the sensors while the vehicle is stationary. In addition, the direction of travel of each wheel can be sensed. This information is broadcast on the HS CAN chassis bus and Flexray circuit for use by other systems.

RESTRAINTS CONTROL MODULE

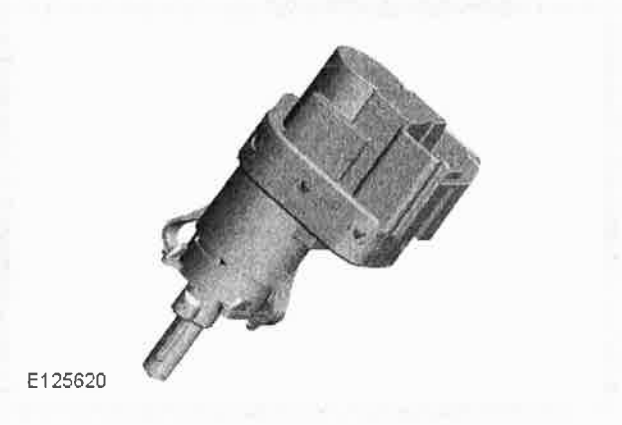
E135956

The Restraints Control Module (RCM) is located under the floor console.

In power mode 6 (ignition on) the RCM receives a supply from the Body Control Module /Gateway Module (BCM/GWM). The lateral acceleration sensor in the RCM measures yaw rate, roll rate, longitudinal and lateral acceleration providing values to the Anti-lock Brake System (ABS) control module.

If a sensor fault is detected by the ABS control module, a warning message will be displayed in the message center and the Dynamic Stability Control warning indicator will illuminate.

STEERING ANGLE SENSOR MODULE

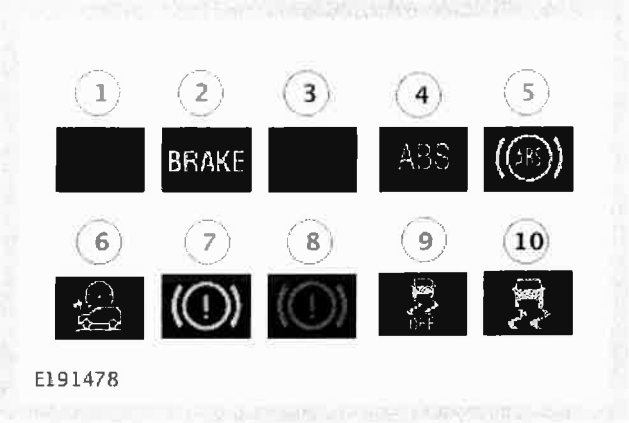


E125620

The brake pedal switch is a two pole switch mounted in the brake pedal bracket and operated by the brake pedal. The Powertrain Control Module (PCM) compares the signals from the two poles to confirm the status of the brake pedal switch.

The brake pedal switch output from both poles is also connected to the Body Control Module/Gateway Module (BCM/GWM).

INSTRUMENT CLUSTER WARNING INDICATORS



E191478

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	Anti-lock Brake System (ABS) amber warning indicator - North American Specification NAS
5	Anti-lock Brake System (ABS) amber warning indicator - Rest of World (ROW)

yawing moment produced when braking in a corner. CBC produces a correction torque by limiting the brake pressure on one side of the vehicle, to assist the vehicle in achieving the turn radius the driver is requesting.

DYNAMIC STABILITY CONTROL

Dynamic Stability Control (DSC) uses the brakes and engine torque control to help maintain the lateral stability of the vehicle. While in power mode 6 or 7, the DSC function is permanently enabled unless selected off by the DSC switch. Even if DSC is deselected, driving maneuvers with extreme yaw or lateral acceleration may trigger DSC activity to assist vehicle stability.

DSC enhances driving safety in abrupt maneuvers and in understeer or oversteer situations that may occur in a bend. The Anti-lock Brake System (ABS) control module monitors the yaw rate and lateral acceleration of the vehicle and the steering input, 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 inputs from the wheel speed sensors, the Steering Angle Sensor Module (SASM) and the Restraints Control Module (RCM) (yaw rate and lateral acceleration data). 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 the Transmission Control Module (TCM) to prevent gear shifts and the Instrument Cluster (IC) to flash the DSC warning indicator.

If necessary, the ABS control module also signals:

- The Powertrain Control Module (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 Instrument Cluster (IC). For additional information, refer to: Instrument Cluster (413-01, Description and Operation).

- 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. The ABS control module monitors for the rapid application of the brakes using the brake pedal switch status from the Powertrain Control Module (PCM) and from a pressure sensor within the Hydraulic Control Unit (HCU). With the brake pedal pressed, if the rate of increase of hydraulic pressure exceeds the predetermined limit, the ABS control module invokes emergency braking.

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 driver releases the brake pedal enough for the hydraulic pressure in the HCU to 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 Body Control Module/Gateway Module (BCM /GWM) which 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 cancelled when one of the following occurs:

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

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

AUTONOMOUS EMERGENCY BRAKING

The Autonomous Emergency Braking (AEB) system can be operated by enabling and disabling the system via the Instrument Cluster (IC) menu. The AEB system also becomes operational when the vehicle is in the forward motion at speeds between 5 kph (3 mph) and 80 kph (50 mph).

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

INTELLIGENT EMERGENCY BRAKING

(ASCM) determines that a collision is unavoidable, even with driver intervention. It is not designed to prevent accidents from occurring. Typical activation of intelligent emergency braking is approximately 0.8 second before impact. During this 0.8 second period the speed of the sensing vehicle is reduced, thus reducing the impact energy.

If the ASCM determines a collision is unavoidable, it signals the Anti-lock Brake System (ABS) control module to apply emergency brake pressure to all of the brakes. On vehicles without active seatbelts, emergency brake pressure is 50bar (725lbf/in²) maximum. On vehicles with active seatbelts, emergency brake pressure is 100bar (1450lbf/in²) maximum.

When IEB is initiated the ASCM also signals the Restraints Control Module (RCM) to fire the front seatbelt retractors.For additional information, refer to: Seatbelt System (501-20 Seatbelt System, Description and Operation).

After the IEB function has activated, it is then disabled, as the vehicle is assumed to be damaged. After the vehicle has been repaired, the IEB function can be re-enabled using Land Rover approved diagnostic equipment.

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

If the IEB feature is disabled for any reason, a related message is displayed in the Instrument Cluster (IC) message center.

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 using CommandShift™.

When the Anti-lock Brake System (ABS) control module detects the onset of wheel slip without the brakes being applied, it signals the Powertrain Control Module (PCM) to request 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 will increase engine torque to accelerate the wheels up to reference speed and regain stability.

ENHANCED UNDERSTEER CONTROL

Enhanced Understeer Control monitors the vehicle for understeer by comparing signals of yaw rate and lateral acceleration, from the Restraints Control Module (RCM), with signals from the steering angle sensor and wheel speed sensors.

(DSC) functions to retain stability. Selection of the HDC function is controlled by the HDC switch and the Terrain Response® switchpack in the floor console. HDC operates in both high and low ranges, at vehicle speeds up to 50 km/h (31 mph).

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 will overheat and induce the HDC fade out strategy. In this condition there will be 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.

HDC may be used in Drive (D), Reverse (R) and all CommandShift™ gears. When in D, the Transmission Control Module (TCM) will automatically select the most appropriate gear.

HDC can be selected at speeds up to 80 km/h (50 mph), but will 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 Instrument Cluster (IC) is permanently illuminated if a valid gear is selected.
- At speeds from between 50 to 80 km/h (31 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 will not illuminate and HDC will not be selected.
- If the speed increases to 80 km/h (50 mph), the HDC function is switched off, the warning indicator is extinguished, a warning chime sounds and a message advising that HDC has been switched off 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 HCU in the active braking mode as required to achieve and maintain the target speed.

During changes of target speed, the Anti-lock Brake System (ABS) control module limits deceleration and acceleration to -0.5 m/s² (-1.65 ft/s²) and +0.5 m/s² (+1.65 ft /s²) 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 cancelled by the ABS control module. If fade out is invoked because the accelerator pedal is pressed with the transmission in neutral, or because of brake overheat, 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/s² (1.65 ft/s²), 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/s² (3.3 ft/s²).

When fade out is invoked because of component failure, a warning chime sounds, the HDC warning indicator is extinguished and a message advising there is a fault 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.

When HDC is selected off, the Instrument Cluster (IC) message center temporarily displays a system off message.

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

TERRAIN RESPONSE® SYSTEM INTEGRATION

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

When a Terrain Response® special program is selected, the ABS control module, along with other vehicle system control modules, will operate in accordance with programmed software maps. The software maps allow the ABS system to function with a threshold that will assist the selected Terrain Response® 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 downwards 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, allowing 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® system.

Rock crawl precharge applies a small amount of brake pressure to each brake calliper 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.

ALL TERRAIN COACH

The All Terrain Coach is accessed via the Touch Screen (TS).

The system is a menu driven aid to provide:

- available features
- written tutorials

- video tutorials
- guidance on recognizing the type of terrain
- recommendations on the vehicle features to be selected
- enabling the features if instructed to.

The system is designed to assist the driver to drive in different conditions and improve the confidence of inexperienced drivers.

TRAILER STABILITY ASSIST

When the trailer electrical socket is connected, trailer stability assist operates automatically to enhance the existing Dynamic Stability Control (DSC) and Terrain Response® functions of the vehicle when towing. The system detects sway movements caused by trailer oscillations at speeds in excess of 60 km/ h (37 mph) and acts to eliminate them. It 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 capability of trailer stability assist to respond early to the beginning of trailer-sway makes the system almost unnoticeable under normal driving conditions and keeps the vehicle and trailer under safe control. Trailer stability assist requires no input from the driver and operates up to the maximum vehicle speed.

Trailer stability assist will not operate while DSC is switched off.

CONTROL DIAGRAM

2	Transmission Control Module (TCM)
3	Powertrain Control Module (PCM)
4	Brake switch
5	Body Control Module/Gateway Module (BCM/GWM) assembly
6	Diagnostic connector (J1962)
7	Steering Angle Sensor Module (SASM)
8	Steering Wheel Module (SWM)
9	Hill Descent Control (HDC) Switch
10	Dynamic Stability Control (DSC) switch
11	Terrain Response switchpack
12	Instrument Cluster (IC)
13	Restraints Control Module (RCM)
14	Adaptive Speed Control Module (ASCM)
15	Ground
16	Power supply
17	Wheel speed sensor
18	Wheel speed sensor
19	Wheel speed sensor
20	Wheel speed sensor