Part Number

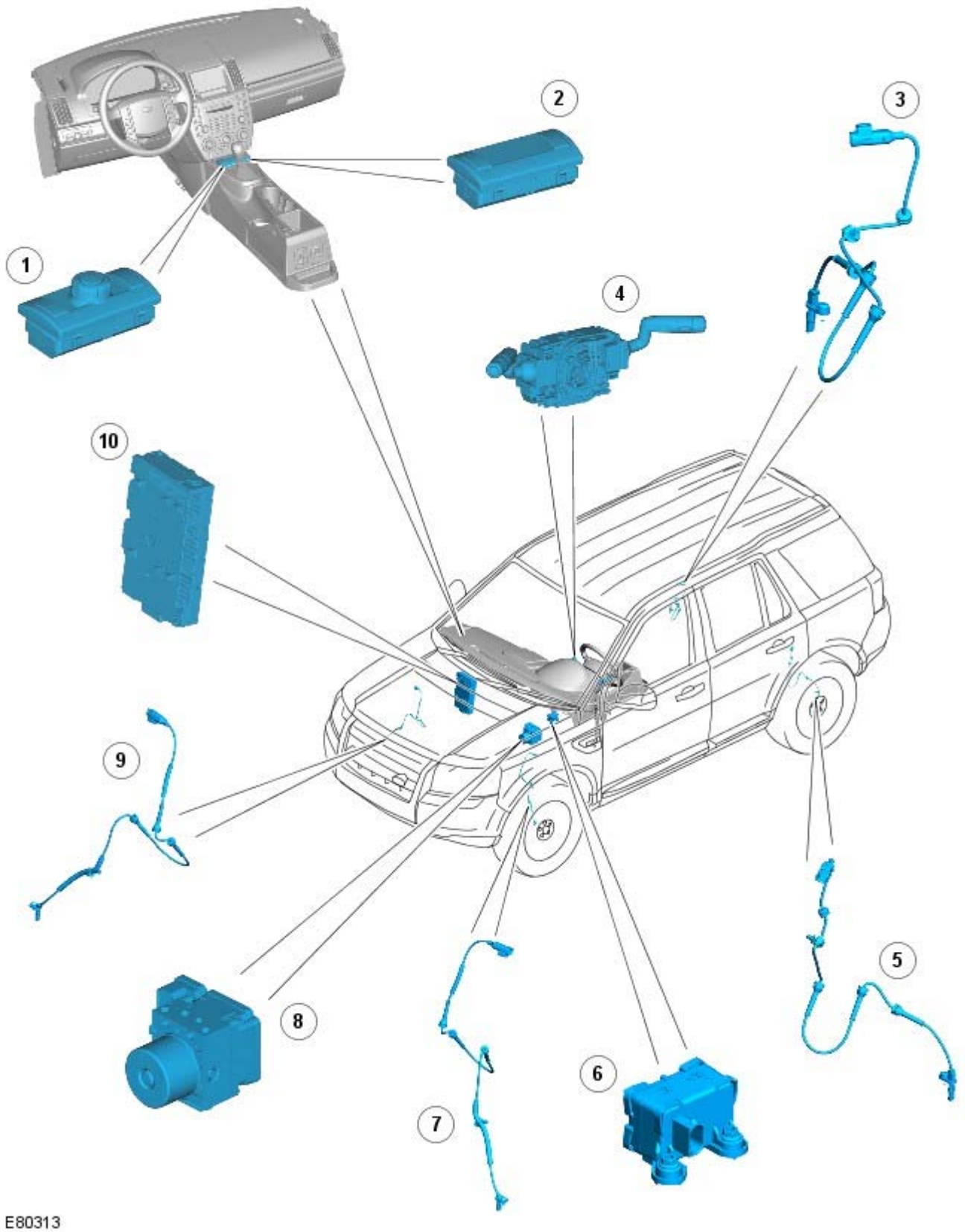
Published: 11-May-2011

Anti-Lock Control - Stability Assist - Anti-Lock Control - Stability Assist

Description and Operation

COMPONENT LOCATION

NOTE: Left-Hand Drive (LHD) shown; Right-Hand Drive (RHD) similar.



Item	Part Number	Description
	-	Hill Descent Control (HDC) and Dynamic Stability Control (DSC) switches (with Terrain

1		Response™)
	2	HDC and DSC switches (without Terrain Response™)
3		Right-Hand (RH) rear wheel speed sensor
4		Steering wheel module (including steering angle sensor)
5		Left-Hand (LH) rear wheel speed sensor
6		Sensor cluster
7		LH front wheel speed sensor
8		Integrated Anti-lock Brake System (ABS) module and Hydraulic Control Unit (HCU)
9		RH front wheel speed sensor
10		Central Junction Box (CJB)

OVERVIEW

The vehicle ABS and stability control system features a Continental Teves Mk25E1 module, with an integral 4-channel HCU. The integrated ABS module and HCU is located on the rear LH side of the engine compartment, and is installed in the brake hydraulic circuit between the brake master cylinder and the 4 brake calipers.

The ABS module is connected to the high speed Controller Area Network (CAN) bus, and actively interacts with other vehicle system control modules and associated sensors to receive and transmit current vehicle operating information.

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

To provide full system functionality, the ABS and DSC systems comprise the following components:

- DSC switch
- HDC switch
- 4 wheel speed sensors
- Sensor cluster
- Steering angle sensor
- Instrument cluster indicator lamps
- Integrated ABS module and HCU.

The ABS system also provides brake functions that are designed to assist the vehicle or aid the driver. The following functions are detailed in the section 'Principles of Operation':

- Anti-lock Brake System (ABS)
- Corner Brake Control (CBC)
- Dynamic Stability Control (DSC)
- Electronic Brake Force Distribution (EBD)
- Electronic Traction Control (ETC)
- Emergency Brake Assist (EBA)
- Engine Drag-Torque Control (EDC)
- HDC (with gradient release control)
- Roll Stability Control (RSC)
- Terrain Response™ system integration.

All the brake functions listed, apart from HDC, are automatically active when the ignition is in power mode 6 (ignition) and the engine is running.

DYNAMIC STABILITY CONTROL SWITCH

The DSC switch allows the DSC function to be selected off. The DSC switch is non-latching and is installed in the floor console, forward of the gear selector lever. Pressing the DSC switch connects an ignition power feed to the ABS module. With the first press of the DSC switch, the ABS module disables the DSC functions. When the DSC switch is pressed again, the ABS module re-enables the DSC functions. The DSC switch must be pressed for a minimum of 0.3 second for the ABS module to react. The DSC function is re-enabled at the beginning of each ignition cycle.

To confirm that the DSC function is selected off, the amber colored DSC warning indicator lamp located in the instrument cluster, is continuously illuminated. On vehicles installed with a high-line instrument cluster, a message is also displayed in the message center to confirm that DSC is selected off.

For additional information, refer to:

Instrument Cluster (413-01 Instrument Cluster, Description and Operation),
Information and Message Center (413-08 Information and Message Center, Description and Operation).

When the DSC function is selected on, the DSC warning indicator lamp is extinguished.

Although Land Rover recommend that DSC is selected on for all normal driving conditions, it may be beneficial to de-select DSC in order to maximize traction under the following conditions:

- To rock the vehicle out of a hollow or a soft surface.
- When driving on loose surfaces or with snow chains installed.
- When driving in deep sand, snow or mud.
- When driving on tracks with deep longitudinal ruts.

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

To prevent mis-use of, or in the event of a broken DSC switch, a Diagnostic Trouble Code (DTC) is stored in the ABS module memory if the input from the DSC switch is held high for more than 1 minute.

HILL DESCENT CONTROL SWITCH

The HDC switch controls the selection of the HDC function.

The HDC switch is non-latching and is installed in the floor console, forward of the gear selector lever. Momentarily pressing and releasing the HDC switch connects an ignition power feed to the ABS module. With the first press and release of the HDC switch, the ABS module enables operation of the HDC function. When the HDC switch is pressed and released again, the ABS module disables operation of the HDC function.

To prevent mis-use of, or in the event of a broken HDC switch, if the switch is pressed for more than 10 seconds no change of state occurs. A DTC is stored in the ABS module memory if the input from the HDC switch is held high for more than 1 minute.

HDC Activating Stoplamps

Operation of the vehicle stoplamps during HDC is controlled by the CJB. The ABS module monitors the brake system hydraulic pressure and requests the CJB, via the high speed CAN bus, to energize the stoplamps during active braking.

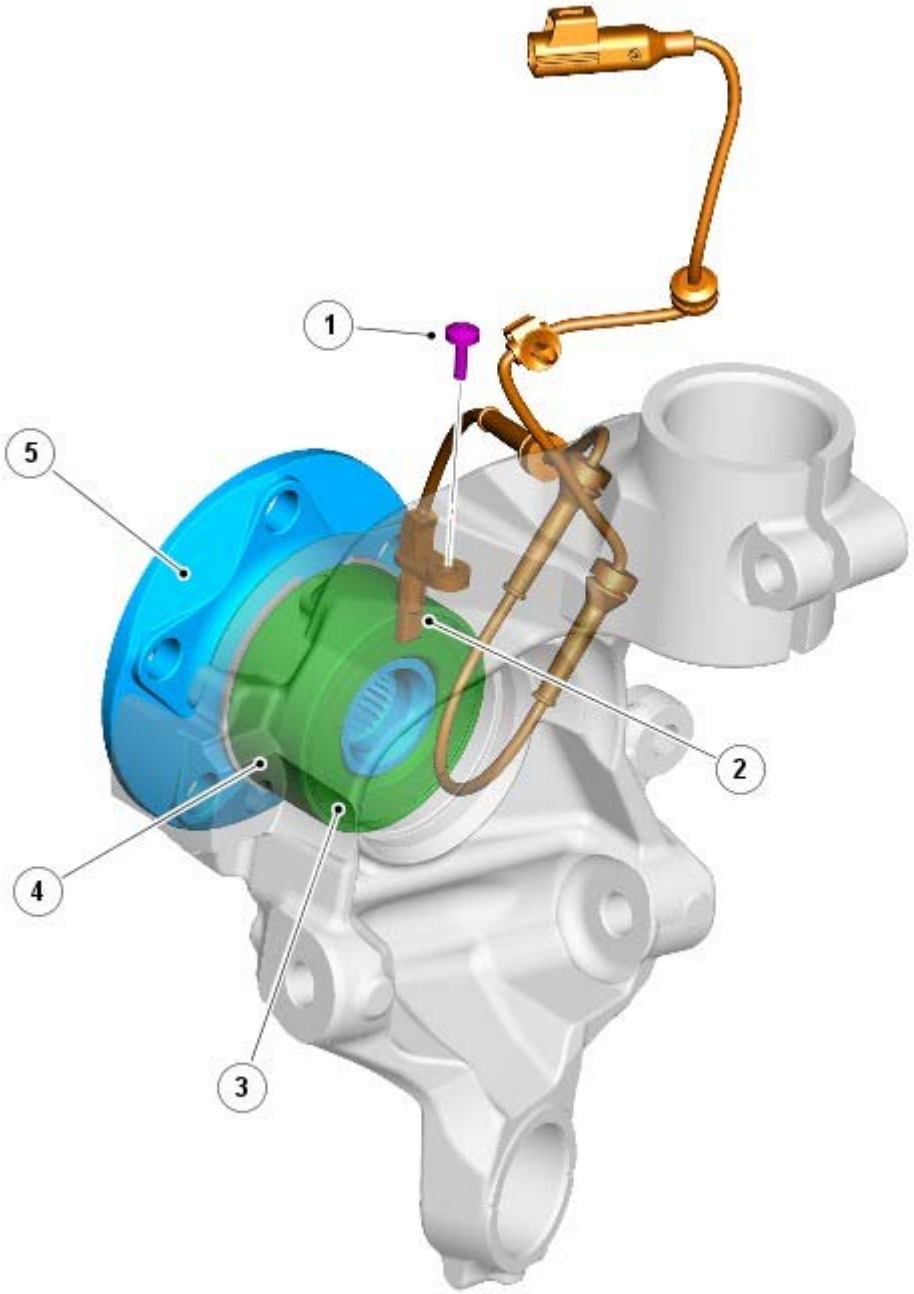
A pressure threshold and time filter prevents the stoplamps from flickering while HDC is braking.

Stop/Start Vehicles - From 2010 MY

Activation of Hill Descent Control will deactivate the Stop/Start system. However, if Hill Descent Control is activated when the engine is shutdown in a Stop/Start cycle the engine will automatically restart. If during this event the Stop/Start system cannot detect the driver's occupancy, for example either the driver's safety belt or door is unlatched, the engine will not restart. The Stop/Start system will request the driver to depress the clutch to restart the engine. The driver will be informed of this by 'RESTART REQUIRED PRESS CLUTCH' being displayed in the message center.

The driver must respond to this request within a limited time period, or otherwise a conventional engine restart using the ignition switch will be required.
For additional information, refer to: Starting System (303-06C Starting System - TD4 2.2L Diesel, Vehicles Built From: 01-03-2009, Description and Operation).

WHEEL SPEED SENSORS



E82690

Item		Description
1		Retaining screw
2		Wheel speed sensor
3		Bearing seal and magnetic encoder ring
4		Wheel bearing
5		Wheel hub

An active wheel speed sensor is installed in each wheel knuckle, and provides the ABS 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. Each front axle bearing encoder contains 44 north and south poles; each rear axle bearing encoder contains 48 pole pairs. A fly lead connects each sensor to the vehicle harness.

The wheel speed sensor is supplied with a power supply and a signal connection from the ABS module. When the ignition switch is in power mode 6 (ignition), the ABS module supplies power to the wheel speed sensors and monitors the return signals. Rotation of the wheels induces current fluctuations in the speed sensor return signals. The ABS module subsequently converts the return signals into individual wheel speeds, and the overall vehicle speed.

The ABS module outputs the individual wheel speeds, and vehicle speed on the high speed CAN bus for use by other systems. The quality of the vehicle speed signal is also broadcast on the high speed CAN bus. 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 are inoperative, the quality of the vehicle speed signal is set to 'accuracy outside specification'.

The ABS module monitors the wheel speed sensor circuits for faults. If a fault is detected the ABS module stores a related

DTC in memory and illuminates the appropriate warning indicator lamps, depending on the system functions affected (DSC/ETC, ABS, EBA/EBD, HDC). A warning chime is also sounded to alert the driver to the fault condition.

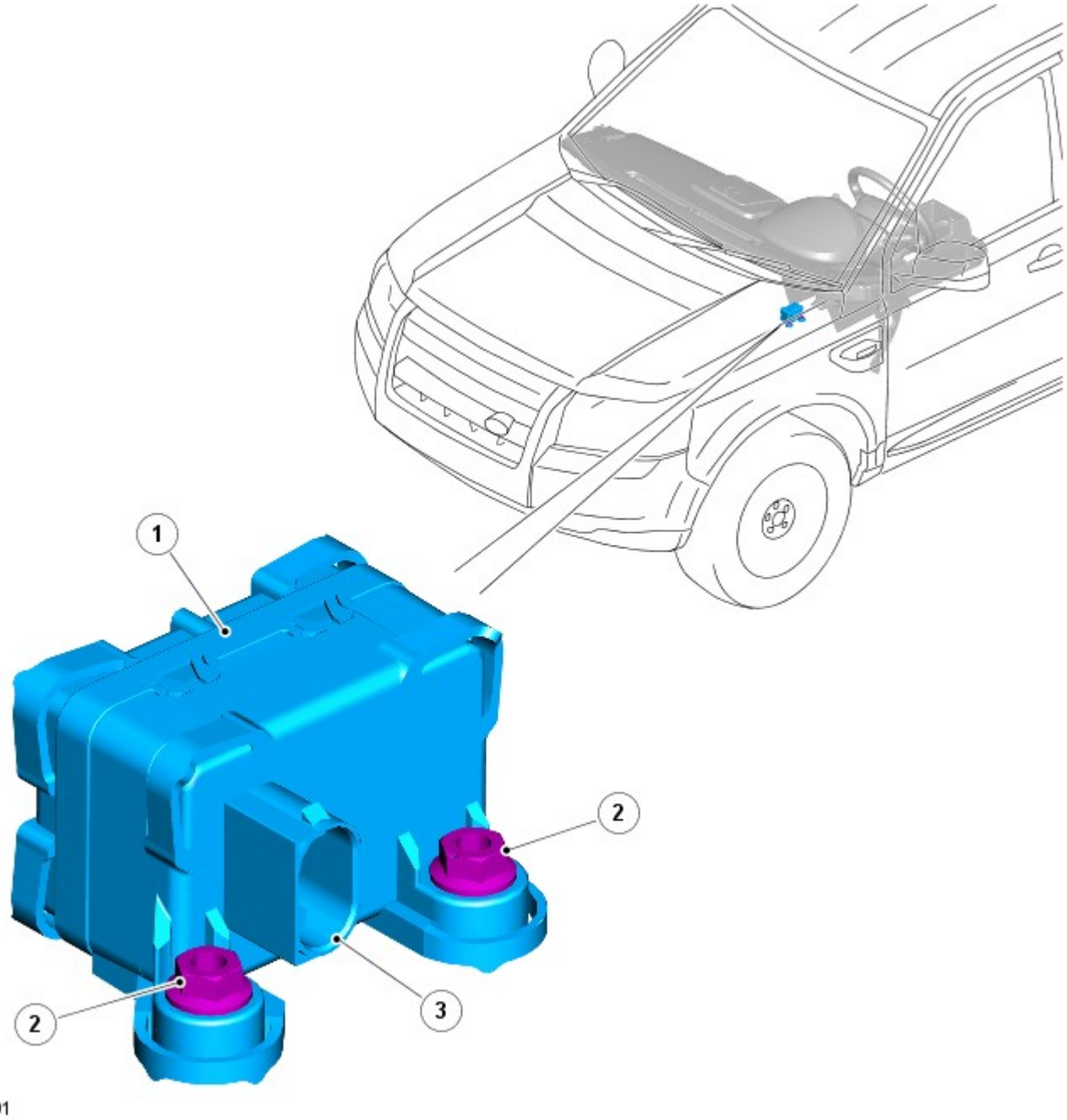
For vehicles installed with a high-line instrument cluster, a message is displayed in the message center, only if the fault affects the HDC function.

For additional information, refer to:

Instrument Cluster (413-01 Instrument Cluster, Description and Operation),
Information and Message Center (413-08 Information and Message Center, Description and Operation).

As the wheel speed sensors are active devices, a return signal is available when the road wheels are not rotating. This enables the ABS module to check the condition of the speed sensors while the vehicle is stationary.

SENSOR CLUSTER



E82691

Item		Description
1		Sensor cluster
2		Retaining stud and nut (2 off)
3		Electrical connector

The sensor cluster is installed beneath the center console and is secured to the transmission tunnel with 2 studs and nuts. The sensor cluster is a compact unit that provides the ABS module with inputs of yaw rate, roll rate, longitudinal and lateral acceleration. The ABS module broadcasts the input values on the high speed CAN bus for use by other systems.

When the ignition is in power mode 6 (ignition), the sensor cluster receives an ignition power feed from the ABS module. The sensor cluster is also connected to the ABS module via a private CAN bus.

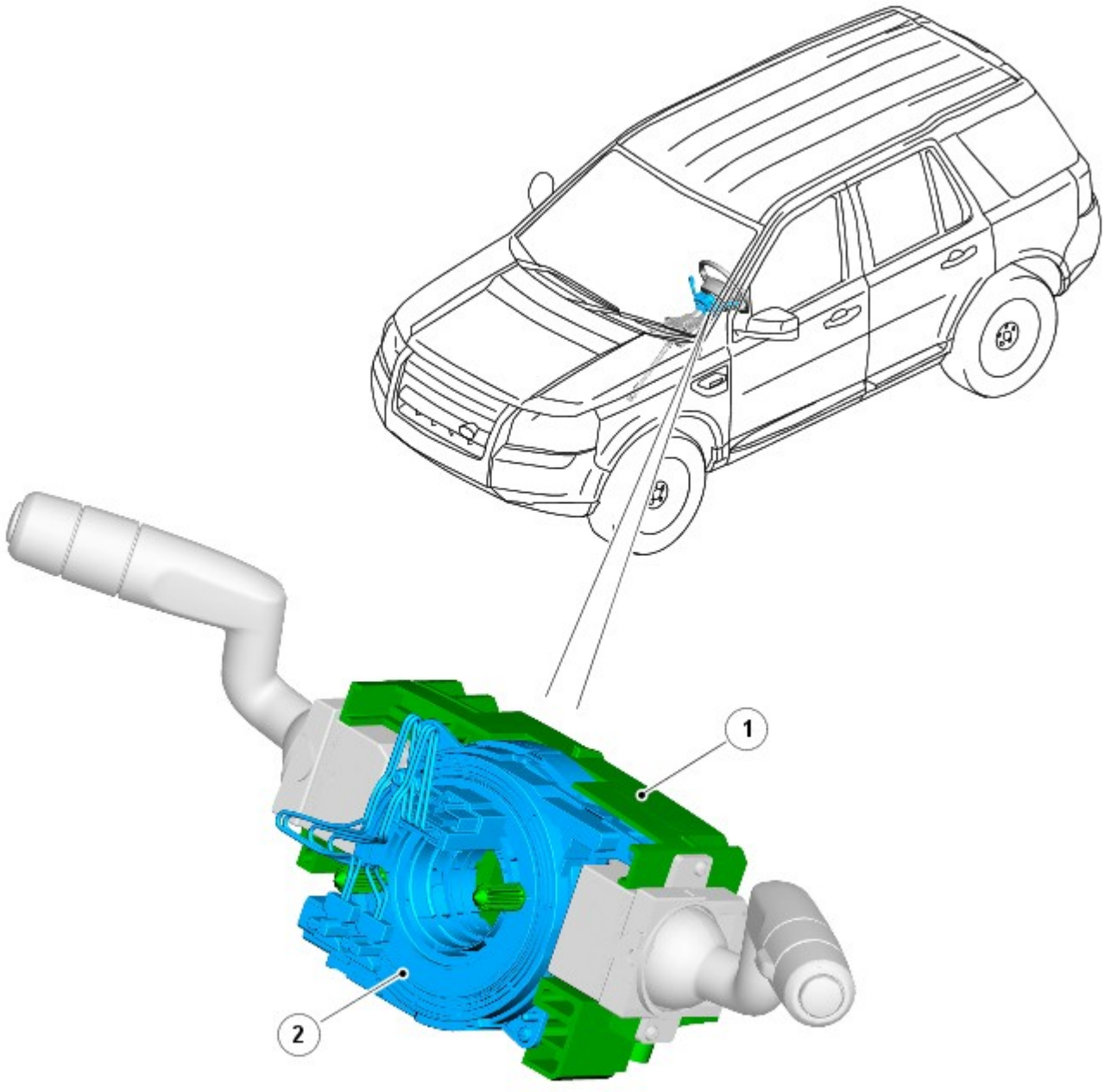
The sensor cluster is diagnosed by the ABS module. If a sensor fault is detected the ABS module stores a related DTC in memory and illuminates the appropriate warning indicator lamps, depending on the system functions affected (DSC/ETC, ABS, EBA/EBD, HDC). A warning chime is also sounded to alert the driver to the fault condition.

For vehicles installed with a high-line instrument cluster, a message is displayed in the message center, only if the fault affects the HDC function.

For additional information, refer to:

Instrument Cluster (413-01 Instrument Cluster, Description and Operation),
Information and Message Center (413-08 Information and Message Center, Description and Operation).

STEERING WHEEL MODULE



E82692

Item		Description
1		Steering wheel module
2		Clockspring and steering angle sensor

The steering wheel module contains the steering angle sensor, clockspring and steering column multifunction switches to form an integral component. The steering angle sensor is connected directly to the clockspring.

The steering wheel module is mounted to the upper steering column with 2 screws, and receives an electrical supply from the

main harness via a 4-pin connector located on the side of the unit. The module provides the location and electrical connection for the 2 multifunction switches.

Input signals from the steering angle sensor are received and processed by the steering wheel module to calculate the steering wheel angle, and steering wheel angle speed. The information is transmitted on the high speed CAN bus for use by the ABS module.

Steering Angle Sensor

The steering angle sensor is connected to the steering wheel with 2 dowels. The steering angle sensor monitors steering wheel rotation, and provides information of the steering wheel angle and rate of speed of steering wheel movements.

A code wheel and 16 optical digital sensors are installed inside the steering wheel angle sensor. Rotation of the code wheel is read by the optical-digital sensors to produce steering wheel rotational speed signals. The steering angle sensor is able to measure a rotation range of +/- 720 degrees, although the steering mechanism will only allow the steering wheel to rotate a maximum of +/-540 degrees.

Signals from the steering angle sensor are transmitted on the vehicle high speed CAN bus, and received and processed by other systems such as DSC. The transmitted information includes details of steering wheel angle and steering wheel rotational speed, along with signal integrity information.

If a fault occurs within the steering angle sensor, a DTC will be set and stored in the steering angle sensor memory. The steering angle sensor fault is also stored in the ABS module memory that illuminates the appropriate warning indicator lamps, depending on the system functions affected (DSC/ETC, ABS, EBA/EBD, HDC). A warning chime is also sounded to alert the driver to the fault condition.

For vehicles installed with a high-line instrument cluster, a message is displayed in the message center, only if the fault affects the HDC function.

For additional information, refer to:

Instrument Cluster (413-01 Instrument Cluster, Description and Operation),
Information and Message Center (413-08 Information and Message Center, Description and Operation).

The steering angle sensor and ABS module are able to be interrogated using the Land Rover approved diagnostic equipment.

Clockspring

The clockspring is a rotary coupling that provides the electrical connection between the fixed steering wheel module, and the steering wheel mounted controls and Supplemental Restraint System (SRS) driver's airbag.

A colored indicator is provided within the clockspring and is visible through a transparent perspex cover when the steering wheel is removed, and the steering angle sensor is aligned to the central position. The indicator makes sure the steering angle sensor and steering system are correctly aligned following repairs to the steering mechanism.

Service Information

Before separating the steering components from the connecting steering column, the clockspring must be aligned to the center position (indicator visible) and the wheels pointing straight ahead. The clockspring is retained in the central position with a locking screw.

INSTRUMENT CLUSTER INDICATOR LAMPS

Item		Description
1		Brake warning indicator lamp – all except North American Specification (NAS)
2		ABS warning indicator lamp
3		Brake warning indicator lamp - NAS vehicles
4		HDC warning indicator lamp (low line instrument cluster)
5		DSC warning indicator lamp
6		HDC information indicator lamp

The instrument cluster contains 2 types of indicator lamps to display the operating status of the selected anti-lock control - stability assist functions. The indicator lamps provide a visual notification of either a system warning or information indication to the driver. There are 4 indicator lamps on vehicles with a high-line instrument cluster; 5 indicator lamps on vehicles with a low-line instrument cluster.

The following anti-lock control - stability assist indicator lamps are installed in the instrument cluster:

- ABS warning indicator lamp
- Brake warning indicator lamp
- DSC warning indicator lamp
- HDC warning indicator lamp
- HDC information indicator lamp.

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

ANTI-LOCK BRAKE SYSTEM MODULE

The ABS module controls the brake functions by operating the HCU to modulate hydraulic pressure to the individual wheel brakes.

The ABS module is attached to the HCU and forms an integral component. A 47-pin connector provides the electrical interface between the ABS module and the vehicle wiring. The ABS module may be interrogated using the Land Rover approved diagnostic equipment.

HYDRAULIC CONTROL UNIT

The HCU is a 4 channel unit that modulates the supply of hydraulic pressure to the brakes, under the control of the ABS module.

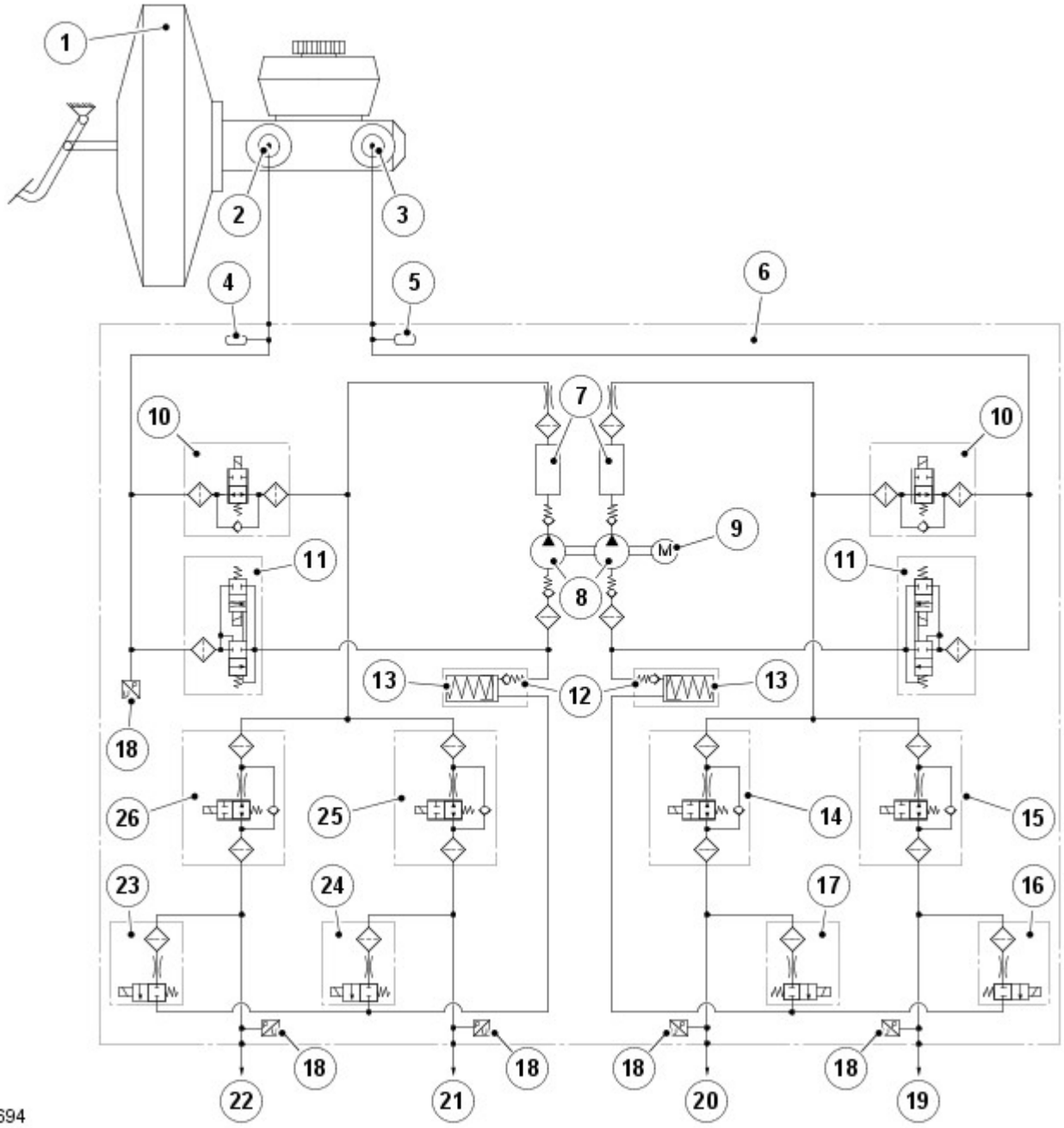
The master cylinder primary and secondary circuit outlets are connected to the HCU primary and secondary circuits.
For additional information, refer to: Hydraulic Brake Actuation (206-06 Hydraulic Brake Actuation, Description and Operation).
Each of the HCU circuits contains the following components 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.

The primary circuit also incorporates a pressure sensor to provide the ABS module with a hydraulic pressure signal.

Contact pins on the HCU mate with contacts on the ABS module to provide the electrical connections from the ABS module to the dual circuit hydraulic pump motor, and the pressure sensor. The solenoids that operate the valves are installed within the ABS module.

HCU Schematic Diagram



Item		Description
1		Brake booster
2		Primary hydraulic circuit
3		Secondary hydraulic circuit
4		Pulsation damper
5		Pulsation damper
6		HCU
7		Damping chamber
8		Dual circuit hydraulic pump
9		D.C. motor
10		Solenoid-operated pilot valve (2 off)
11		Solenoid-operated priming valve (2 off)
12		Check valve
13		Low-pressure accumulator (2 off)
14		Solenoid-operated inlet valve (RH rear brake)
15		Solenoid-operated inlet valve (LH front brake)
16		Solenoid-operated outlet valve (LH front brake)

17		Solenoid-operated outlet valve (RH rear brake)
18		Pressure sensor (5 off)
19		LH front brake (secondary circuit)
20		RH rear brake (secondary circuit)
21		LH rear brake (primary circuit)
22		RH front brake (primary circuit)
23		Solenoid-operated outlet valve (RH front brake)
24		Solenoid-operated outlet valve (LH rear brake)
25		Solenoid-operated inlet valve (LH rear brake)
26		Solenoid-operated inlet valve (RH front brake)

The HCU features 3 operating modes:

- Normal braking/ EBD
- ABS braking
- Active braking.

Normal Braking/EBD Mode

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 ABS module determines that EBD is necessary, it energizes the inlet valves for both the rear brakes, to isolate the brakes from any further increase in hydraulic pressure.

NOTE: Only the rear brakes are controlled by the EBD function.

ABS Braking Mode

If the ABS 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 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 Normal and ABS braking, for example RSC, DSC, EBA, ETC, HDC.

For active braking, the ABS 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 return pump and supplied to the inlet valves. The ABS 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.

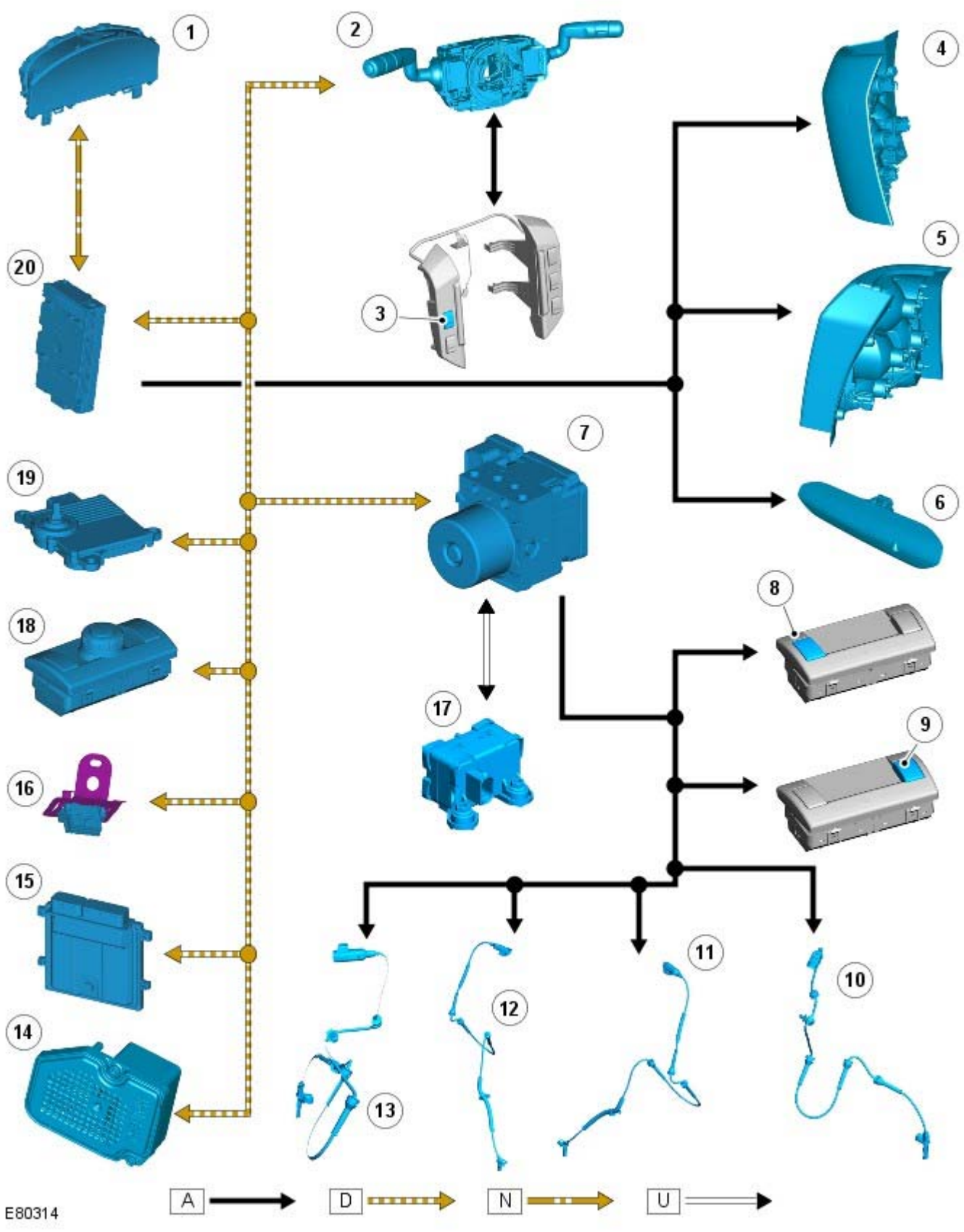
Service Information

The ABS module comprises an HCU and an Electronic Control Unit (ECU) that must not be separated. The ABS module and HCU assembly is supplied as a single component and arrives in a pre-filled state.

NOTE: The ABS module, HCU and the sensor cluster are fragile components and must be discarded if dropped or damaged.

CONTROL DIAGRAM

NOTE: **A** = Hardwired; **D** = High Speed CAN bus; **N** = Medium Speed CAN bus; **U** = Private CAN bus



Item		Description
1		Instrument cluster
2		Steering wheel module (steering angle sensor)
3		Speed control '+' and '-' switches
4		RH stoplamp
5		LH stoplamp
6		High mounted stoplamp
7		ABS module

8		HDC switch
9		DSC switch
10		LH rear wheel speed sensor
11		RH front wheel speed sensor
12		LH front wheel speed sensor
13		RH rear wheel speed sensor
14		Active On-Demand Coupling module
15		ECM
16		Diagnostic socket
17		Sensor cluster
18		Terrain Response™ control module
19		Transmission Control Module (TCM) - automatic transmission models only
20		CJB

PRINCIPLES OF OPERATION

Anti-Lock Brake System

ABS controls the speed of all road wheels to ensure optimum wheel slip when braking at the adhesion limit. The wheels are prevented from locking to retain effective steering control of the vehicle.

The front brake pressures are modulated separately for each wheel. The rear brake pressures are modulated by select low. Select low applies the same pressure to both rear brakes, with the pressure level being determined by the wheel on the lower friction surface. This maintains rear stability on split friction surfaces.

Corner Brake Control

CBC influences the brake pressures, below and within ABS thresholds, to counteract the yawing moment produced when braking in a corner. CBC produces a correction torque by limiting the brake pressure on one side of the vehicle.

Dynamic Stability Control

DSC uses brakes and powertrain torque control to assist in maintaining the lateral stability of the vehicle. While the ignition is energized the DSC function is permanently enabled, unless selected off using the DSC switch. Even if DSC is deselected, driving maneuvers with extreme yaw or lateral acceleration may trigger RSC activity to assist the vehicle stability.

DSC enhances driving safety in abrupt maneuvers and in under-steer or over-steer situations that may occur in a bend. The ABS module monitors the yaw rate and lateral acceleration of the vehicle, steering input, and then selectively applies individual brakes and signals for powertrain torque adjustments to reduce under-steer or over-steer.

In general:

- In an under-steer situation; the inner wheels are braked to counteract the yaw movement towards the outer edge of the bend.
- In an over-steer 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 module monitors the tracking stability of the vehicle using inputs from the wheel speed sensors, the steering angle sensor, and the yaw rate and lateral acceleration sensor. The tracking stability is compared with stored target data. Whenever the tracking stability deviates from the target data, the ABS module intervenes by applying the appropriate brakes.

The following interactions occur in an intervention situation:

- High speed CAN signal to the ECM, to reduce engine torque.
- High speed CAN signal to the Active On-demand Coupling module, to open the locking torque of the center coupling.
- Application of braking to the appropriate corner of the vehicle.

Electronic Brake Force Distribution

EBD limits the brake pressure applied to the rear wheels. When the brakes are applied, the weight of the vehicle transfers forwards, reducing the ability of the rear wheels to transfer braking effort to the road surface. This may cause the rear wheels to slip and make the vehicle unstable.

EBD uses the anti-lock braking hardware to automatically optimize the pressure of the rear brakes, below the point where ABS is normally invoked.

NOTE: Only the rear brakes are controlled by the EBD function.

Electronic Traction Control

ETC attempts to optimize forward traction by reducing engine torque, or by applying the brake of a spinning wheel until

traction is regained.

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 brake is applied to the spinning wheel, allowing the excess torque to be transmitted to the non-spinning wheels through the drive line. If necessary, the ABS module also sends a high speed CAN bus message to the ECM to request a reduction in engine torque.

When the DSC function is selected off using the DSC switch, the engine torque reduction feature is disabled.

Emergency Brake Assist

EBA assists the driver in emergency braking situations by automatically maximizing the applied braking effort. There are two situations when the ABS module will invoke EBA:

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

When the brake pedal is rapidly pressed, the ABS module increases the hydraulic pressure to all of the brakes until the threshold for ABS operation is reached. This action applies the maximum braking effort for the available traction. The ABS module monitors for the sudden application of the brakes, using inputs from the brake pedal switch and from the pressure sensor within the HCU. With the brake pedal pressed, if the rate of increase of hydraulic pressure exceeds the predetermined limit, the ABS module invokes emergency braking.

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

EBA operation continues until the driver releases the brake pedal, sufficiently for the hydraulic pressure in the HCU to drop below a threshold value stored in the ABS module.

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.
- The sudden engagement of the clutch after a downshift on manual transmission vehicles.
- A downshift using the CommandShift function on automatic transmission vehicles.

When the ABS module detects the onset of wheel slip without the brakes being applied, the ABS module signals the ECM via the high speed CAN bus to request a momentary increase in engine torque.

Hill Descent Control

HDC uses engine braking and brake intervention to control the vehicle speed and acceleration during low speed off-road descents, and in low grip on-road conditions. Generally, equal pressure is applied to all 4 brakes, but pressure to individual brakes may be modified by the ABS and DSC functions to retain the vehicles stability. Selection of the HDC function is controlled by the HDC switch located on the floor console. HDC operates 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. Pressing the clutch pedal and/or 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 clutch pedal is pressed or the transmission is in the 'Neutral' position. It is not recommended to drive the vehicle further than is absolutely necessary with HDC selected, and the clutch pedal pressed/ or the transmission in 'Neutral'.

On manual transmission vehicles, HDC may be used in first and reverse gears only. Once the vehicle is moving, the clutch pedal is to be fully released. The vehicle is not recommended to be driven with HDC active and the transmission in 'Neutral'.

On automatic transmission vehicles, HDC may be used in 'D' drive, 'R' reverse and CommandShift '1' only. When in 'D', the TCM will automatically select the most appropriate gear. The vehicle is not recommended to be driven with HDC active and the transmission in 'Neutral'.

HDC is able to 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 information indicator lamp is permanently illuminated if a valid gear is selected.
- At speeds between 50 to 80 km/h (31 to 50 mph), the HDC information indicator lamp flashes and on vehicles with the high line instrument cluster, a message advising that the speed is too high is displayed in the message center. If the HDC switch is pressed while the vehicle speed is greater than 80 km/h (50 mph), the HDC information indicator lamp will not illuminate and HDC will not be selected.
- If the speed reaches 80 km/h (50 mph) or more, a warning chime is sounded, the HDC function is switched off, the information indicator lamp is extinguished and, on vehicles with the high line instrument cluster, a message advising that HDC has been switched off is displayed in the message center.

For additional information, refer to:

Instrument Cluster (413-01 Instrument Cluster, Description and Operation),
Information and Message Center (413-08 Information and Message Center, Description and Operation).

When HDC is enabled, the ABS module calculates a target speed and compares this with the actual vehicle speed. The ABS module then operates the HCU in the active braking mode as required, to achieve and maintain the target speed. Operation of the vehicle stoplamps during HDC is controlled by the CJB.

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

The target speed varies between minimum and maximum values for each gear and transmission range, depending on driver inputs through the foot pedals. If the foot pedals are not operated, the ABS module adopts a default target speed:

HDC Target Speeds

	Automatic Transmission Gear		Manual Transmission Gear	
Target Speed	**1st and Drive**	**Reverse**	**1st**	**Reverse**
Default	10 km/h (6 mph)	3.5 km/h (2.2 mph)	10 km/h (6 mph)	8 km/h (5 mph)
Minimum	6 km/h (3.7 mph)	3.5 km/h (2.2 mph)	7.5 km/h (4.7 mph)	8 km/h (5 mph)
Maximum	20 km/h (12.4 mph)	3.5 km/h (2.2 mph)	20 km/h (12.4 mph)	8 km/h (5 mph)

The target speed is varied between the minimum and maximum values using the accelerator pedal, or by pressing the speed control '+' and '-' buttons (dependant on vehicle specification). The HDC Target speed will also vary depending on the Terrain Response™ mode selected.

During changes of target speed, the ABS module limits vehicle deceleration and acceleration to -0.5 meters per second squared (m/s^2) (-1.64 feet per second squared (ft/s^2)); and +0.5 m/s^2 (+1.64 ft/s^2) respectively.

To provide a safe transition from active braking to brakes off, the ABS 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 is detected during active braking:

- HDC is selected off using the HDC switch.
- Failure of a component used by HDC, but not critical to fade out function.
- Accelerator pedal pressed when transmission is in neutral.
- Brakes overheat.

If fade out is invoked because of HDC de-selection or component failure, the HDC function is cancelled by the ABS 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/s^2 (1.64 ft/s^2), until the maximum target speed is reached, or until no active braking is required for 0.5 second. 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 is sounded and the HDC information indicator lamp is extinguished. The HDC warning indicator lamp is then illuminated (on low-line instrument cluster), or a message advising of the fault is displayed in the message center (on high-line instrument cluster).

For additional information, refer to:

Instrument Cluster (413-01 Instrument Cluster, Description and Operation),
Information and Message Center (413-08 Information and Message Center, Description and Operation).

When fade out is invoked because of brake overheat, on vehicles with the high-line instrument cluster, a message advising that HDC is temporarily unavailable is displayed. On vehicles with the low-line instrument cluster, the HDC warning indicator lamp flashes. At the end of fade out, the HDC information indicator flashes. The flashing warning and information indicator lamps, and/or displayed message continue while HDC remains selected, until the brakes have cooled.

For additional information, refer to:

Instrument Cluster (413-01 Instrument Cluster, Description and Operation),
Information and Message Center (413-08 Information and Message Center, Description and Operation).

To monitor for brake overheat, the ABS 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 module invokes the fade out strategy. After the fade out cycle, the HDC function is re-enabled when the ABS module estimates that all of the brake temperatures are at less than 64% of the preset temperature limit.

Roll Stability Control

The RSC function uses the brakes and the engine to attempt to restore vehicle stability, if the vehicle is forced into a harsh maneuver that risks it tipping over.

The ABS module monitors driver inputs and vehicle behavior using various powertrain signals and the inputs from the wheel speed sensors, the steering angle sensor, the roll rate sensor, yaw rate and lateral acceleration sensors. These inputs are

compared with modeled behavior and, if the vehicle behavior reaches a given risk level, the ABS module cuts the engine power, or brakes one or more wheels sufficiently to allow the vehicle to regain stability and help the driver remain in control.

While the ignition is energized, RSC is permanently enabled even if the DSC function is selected off.

Terrain Response™ System Integration

The Terrain Response™ function integrates the ABS and other vehicle system control modules to assist the vehicle when driving off-road or during difficult surface conditions. Terrain Response is activated when the rotary control switch is set to a Terrain Response special program.

When a Terrain Response special program is activated, the ABS 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).

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Anti-Lock Control - Stability Assist - Anti-Lock Control - Stability Assist

Diagnosis and Testing

Principles of Operation

For a detailed description of the Anti-lock Control - Stability Assist system, refer to the relevant Description and Operation section in the workshop manual.
REFER to: Anti-Lock Control - Stability Assist (206-09C Anti-Lock Control - Stability Assist, Description and Operation).

Inspection and Verification

CAUTION: Diagnosis by substitution from a donor vehicle is **NOT** acceptable. Substitution of control modules does not guarantee confirmation of a fault, and may also cause additional faults in the vehicle being tested and/or the donor vehicle.

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection

Mechanical	Electrical
• Steering wheel rotation sensor installation/fixings	• Fuses • Wheel speed sensors • Connectors/Pins • Harnesses • Steering wheel rotation sensor

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step
4. If the cause is not visually evident, check for Diagnostic Trouble Codes (DTCs) and refer to the DTC Index.

DTC Index

NOTE: If the control module or a component is suspect and the vehicle remains under manufacturer warranty, refer to the Warranty Policy and Procedures manual (section B1.2), or determine if any prior approval programme is in operation, prior to the installation of a new module/component.

NOTE: Generic scan tools may not read the codes listed, or may read only five digit codes. Match the five digits from the scan tool to the first five digits of the seven digit code listed to identify the fault (the last two digits give additional information read by the manufacturer approved diagnostic system).

NOTE: When performing voltage or resistance tests, always use a digital multimeter (DMM) accurate to three decimal places, and with an up-to-date calibration certificate. When testing resistance always take the resistance of the DMM leads into account.

NOTE: Check and rectify basic faults before beginning diagnostic routines involving pinpoint tests.

NOTE: Inspect connectors for signs of water ingress, and pins for damage and/or corrosion.

NOTE: If DTCs are recorded and, after performing the pinpoint tests, a fault is not present, an intermittent concern may be the cause. Always check for loose connections and corroded terminals.

For a complete list of all Diagnostic Trouble Codes (DTCs) that could be logged on this vehicle, please refer to Section 100-00.

REFER to: Diagnostic Trouble Code (DTC) Index - DTC: Steering Angle Sensor Module (SASM) (100-00 General Information, Description and Operation).

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Anti-Lock Control - Stability Assist - Accelerometer

Removal and Installation

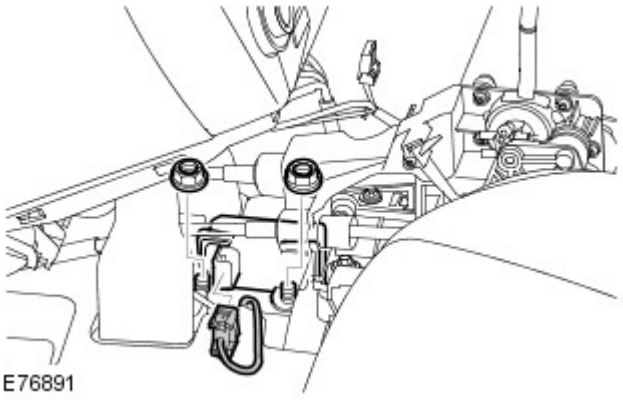
Removal

1. Disconnect the battery ground cable.

   Refer to: Specifications (414-00 Battery and Charging System - General Information, Specifications).

2. Remove the floor console.

   Refer to: Floor Console (501-12 Instrument Panel and Console, Removal and Installation).



3. *Torque:* 6 Nm

Installation

1. To install, reverse the removal procedure.

2. If a new component has been installed, configure using Land Rover approved diagnostic equipment.