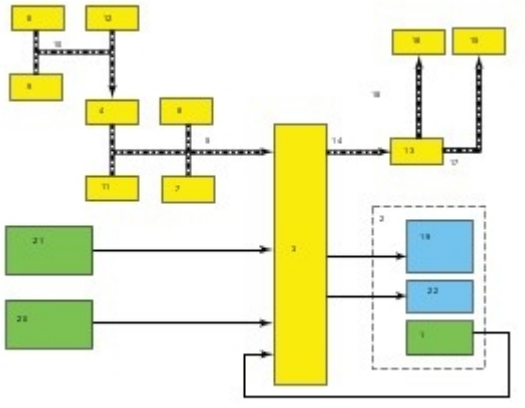
Anti-Lock Brake System (ABS) and Stability Control - Anti-Lock Brake System (ABS) and Stability Control - System Operation and Component Description

Print

Description and Operation

System Operation

System Diagram



Item	Description
1	Pressure Sensor
2	HCU (hydraulic control unit)
3	ABS (anti-lock brake system) module
4	GWM (gateway module A)
5	HS-CAN (high-speed controller area network) 2
6	RCM (restraints control module)
7	PSCM (power steering control module)
8	TCM (transmission control module)
9	BCM (body control module)
10	HS-CAN 1
11	CCM (cruise control module)
12	PCM (powertrain control module)
13	GWM
14	HS-CAN 2
15	PCM
16	IPC (instrument panel cluster)
17	HS-CAN 1
18	HS-CAN 3
19	Hydraulic pump motor
20	Brake booster vacuum sensor
21	Wheel speed sensors
22	Valve solenoids

ABS

The ABS module continuously monitors brake pedal input, longitudinal vehicle motion and the rotational speed of each wheel. The ABS module receives the brake pedal input from the PCM and the longitudinal acceleration sensor information from the RCM. Both the PCM and the RCM send the information to the GWM over the HS-CAN1.

The GWM then relays the information to the ABS module over the HS-CAN2. Wheel speed information is received by the ABS module using 4 wheel speed sensors.

When the ABS module detects an impending wheel lock during a braking event, the ABS module modulates brake

pressure to the appropriate brake caliper(s) by opening and closing the appropriate solenoid valves inside the HCU while the hydraulic pump motor is activated. Once the affected wheel(s) return to the desired speed, the ABS module returns the solenoid valves in the HCU to their normal position.

When the ABS module is initialized (ignition ON), it carries out a preliminary electrical check of the system sensors and activates the hydraulic pump motor for approximately one-half second. During this time, a buzzing or humming noise may be heard and a vibration may be felt in the brake pedal and is a normal condition. During the module initialized self-test, the pump motor check is carried out at approximately 10 km/h (6.2 mph). Any malfunction detected in the system causes the module to set a DTC (diagnostic trouble code), disable the ABS function and send a message over the HS-CAN 2 to the GWM. The GWM then sends a message to the IPC over the HS-CAN 3 to illuminate the ABS warning indicator. The base hydraulic power assist braking system functions normally.

EBD (electronic brake force distribution)

On initial application of the brake pedal, full pressure is applied to the rear brakes. The ABS module then uses wheel speed sensor inputs to evaluate rear wheel slip. Once the rear wheel slip exceeds a predetermined threshold, the ABS module commands the HCU to close the appropriate isolation valves to hold the rear brake pressure constant while allowing the front brake pressure to build. This creates a balanced braking condition between the front and rear wheels. If the rear wheel slip continues and exceeds a second predetermined threshold, the ABS module commands the HCU to open the dump valves to decrease the rear brake pressure and allow the rear wheels to recover. A slight bump sensation may be felt in the brake pedal when EBD is active.

If the ABS is disabled due to a DTC being present in the ABS module, EBD continues to function unless the DTC is for wheel speed sensors or the HCU. When EBD is disabled, the ABS warning indicator, the red brake warning indicator and stability/traction control indicator (sliding car icon) illuminate.

Traction Control

The ABS module continuously monitors and compares the rotational speed of the drive wheels in relation to the non-driven wheels. When the drive wheels begin to spin faster than the non-driven wheels, the ABS module modulates brake pressure to the appropriate brake caliper(s) by opening and closing the appropriate solenoid valves inside the HCU while the hydraulic pump motor is activated. At the same time, the ABS module calculates how much engine torque reduction is required to eliminate the wheel slip and sends this torque reduction message along with a traction event message to the GWM over the HS-CAN 2.

The GWM sends the engine torque reduction message to the PCM over the HS-CAN 1 and the traction event message to the IPC over the HS-CAN 3. When the PCM receives the torque reduction message, it adjusts engine timing and decreases fuel injector pulses to reduce the engine torque to the requested level. When the IPC receives the traction event message it flashes the stability/traction control indicator (sliding car icon).

Once the driven wheel speed returns to the desired speed, the ABS module returns the solenoid valves in the HCU to their normal position, deactivates the hydraulic pump motor and stops sending the traction event and torque reduction messages. The PCM returns engine timing and fuel injectors to normal operation and the IPC extinguishes the stability/traction control indicator (sliding car icon). After the vehicle speed exceeds 100 km/h (62.1 mph), traction control is accomplished only through the PCM torque control.

Traction control can be disabled through the menu in the message center, refer to the Owner's Literature for instructions on disabling traction control. This is independent of the ABS and Electronic Stability Control (ESC), which cannot be disabled by the driver. When the driver disables traction control, the IPC communicates traction control status to the GWM along the HS-CAN 2. The GWM sends the message to the ABS module along the HS-CAN 2. The ABS module takes no further action in regards to traction control until the driver activates the function or until the ignition is cycled from OFF to ON.

Traction control is disabled if there is a wheel speed sensor or solenoid valve DTC present in the ABS module. Traction control is also disabled if there is a communication error between the ABS module and the GWM. When traction control is disabled, the ABS module sends a message to the GWM along the HS-CAN 2 which gateways the message to the IPC over the HS-CAN 3 to illuminate the stability/traction control OFF indicator (sliding car OFF icon).

Electronic Stability Control

The ABS module continuously monitors the vehicle motion relative to the intended course. This is done by using sensors to compare the steering wheel sensor messages and the yaw rate sensor messages with the actual vehicle motion. The ABS module receives the steering wheel sensor messages from the PSCM and the yaw rate sensor

messages from the RCM, both messages are sent along the HS-CAN 2. If the ABS module determines from the inputs the vehicle is unable to travel in the intended direction, it modulates the brake pressure to the appropriate brake caliper(s) by opening and closing the appropriate solenoid valves inside the HCU while the hydraulic pump motor is activated.

At the same time the ABS module calculates how much engine torque reduction is required to reduce vehicle speed to help stabilize the vehicle and sends this torque reduction message, along with an Electronic Stability Control (ESC) event message, to the GWM over the HS-CAN 2. The GWM sends the torque reduction message to the PCM over the HS-CAN 1 and the Electronic Stability Control (ESC) event message to the IPC over the HS-CAN 3.

When the PCM receives the torque reduction message, it adjusts engine timing and decreases fuel injector pulses to reduce the engine torque to the requested level. When the IPC receives this message, it flashes the stability/traction control indicator (sliding car icon). Once the vehicle instability has been corrected, the ABS module returns the solenoid valves in the HCU to their normal position, deactivates the hydraulic pump motor and stops sending the traction event and torque reduction messages. The PCM returns engine timing and fuel injectors to normal operation and the IPC extinguishes the stability/traction control indicator (sliding car icon).

Electronic Stability Control (ESC) does not operate with the transmission in REVERSE. Electronic Stability Control (ESC) is disabled if there is a wheel speed sensor, RCM stability sensor or steering angle sensor DTC present in the ABS module. Electronic Stability Control (ESC) is also disabled if there is a communication error between the ABS module and the PSCM or the ABS module and the RCM. When Electronic Stability Control (ESC) is disabled, the ABS module sends a message to the GWM along the HS-CAN 2 which gateways the message to the IPC over the along the HS-CAN 3 to illuminate the stability/traction control OFF indicator (sliding car OFF icon).

Hill Start Assist

When the vehicle is stopped on an incline the ABS module holds the brake pressure for approximately 1.5 seconds while the driver transitions from the brake pedal to the accelerator pedal. This is accomplished by monitoring several HS-CAN messages and several sensors to determine if the vehicle is stopped and not parked, and if the vehicle is on an appropriate incline. The brake pedal message sent by the PCM and the wheel speed sensor inputs allow the ABS module to determine the vehicle has come to a complete stop.

The transmission selector lever message sent by the PCM informs the ABS module the vehicle is not parked. The stability sensor messages sent by the RCM enable the ABS module to determine if the vehicle is on an incline greater than 1.5 degrees (approximately a 3% grade). Once the above conditions have been met, the hill start assist function automatically engages. As the driver releases the brake pedal, the ABS module commands the HCU to close the isolation valves which maintain the current brake system pressure, preventing the vehicle from rolling down the incline.

Once the driver presses the accelerator pedal and the torque produced by the engine reaches a specific level, the ABS module gradually releases the brake pressure to make sure the vehicle is neither rolling back nor driving off until there is sufficient driving torque to move the vehicle forward (or backward if reversing up the incline). For vehicles with an automatic transmission the incline must be greater than 3.5 degrees (approximately a 6% grade), for vehicles with a manual transmission the incline must be greater than 1.5 degrees (approximately a 3% grade) and for vehicles equipped with the stop/start feature (regardless of transmission) the incline must be greater than 0.5 degrees (approximately a 1% grade).

Supplemental Braking Assist

The ABS module uses the HCU and hydraulic pump motor to help bring the vehicle to a safe, controlled stop in the event of severe vacuum loss in the brake booster. The ABS module continually monitors the vacuum in the brake booster through the use of a vacuum sensor. When the vacuum sensor indicates vacuum is below a predetermined level, a DTC is set in the ABS module.

The ABS module sends a message to the GWM over the HS-CAN 2 to illuminate the red brake warning indicator, the GWM relays this message to the IPC over the HS-CAN 3. If a low vacuum condition occurs during a braking event or if the driver attempts to stop the vehicle with a low vacuum condition in the brake booster, the ABS module activates the hydraulic pump motor in the HCU to assist with vehicle braking.

On vehicles equipped with adaptive cruise control, the CCM monitors the area forward of the vehicle. When an object enters this area and closes the distance gap set by the driver, the CCM sends either an adaptive cruise control deceleration request or a collision avoidance deceleration request to the ABS module over the HS-CAN 2. When the deceleration request message is received, the ABS module activates the hydraulic pump motor and

solenoid valves in the HCU to slow the vehicle down to maintain the distance gap set by the driver. Once the distance gap set by the driver is achieved, the CCM stops sending the deceleration request message and the ABS module deactivates the hydraulic pump motor and solenoid valves in the HCU.

If the CCM determines the amount of braking provided by the ABS module is insufficient, the CCM sends a forward collision avoidance braking request message to the ABS module and warns the driver, both audibly and visually, through the use of the HUD (head up display). After receiving the braking request message, the ABS module waits for brake pedal input and at that time applies maximum braking assist using the hydraulic pump motor and the HCU.

MyKey® Interaction

Through the MyKey® feature, traction control can be configured to be always on or to allow the driver to select traction control on or off. When MyKey® traction control feature is configured to be always on and a MyKey® restricted key is in use, the IPC ignores any requests made by the driver to disable traction control and does not send any traction control disable messages to the ABS module. Refer to the Owner's Literature for additional information on the MyKey® feature and settings. Refer to the Owner's Literature for additional information on the MyKey® feature and settings.

Component Description

ABS

The ABS module is attached directly to the HCU and is the electronic control unit for all of the ABS and stability control systems. The ABS module monitors all sensor inputs and all CAN (controller area network) messages that relate to ABS and stability control, then directly controls the solenoid valves and the hydraulic pump motor in the HCU.

When a new ABS module is installed, it must be programmed with the vehicle configuration information and programmed with the latest level of module software.

When an ABS or stability control system fault has been corrected or a new component has been installed, the ABS module must be calibrated. The calibration procedure is required for the stability control sensors to learn the zero-position of the vehicle. The calibration procedure requires the vehicle to be on a level surface and not moving. The calibration procedure (IVD Initialization) is carried out using a diagnostic scan tool.

The ABS module controls the EPB (electric parking brake) system. When a new ABS module has been installed the EPB Apply and Release routine must be carried out using a diagnostic scan tool. This routine allows the new ABS module to initialize and calibrate the parking brakes.

HCU

The HCU contains the solenoid valves, the hydraulic pump motor and the pressure sensor used by the ABS module for the various stability control systems. The ABS module and the HCU are attached directly together.

Wheel Speed Sensor

On vehicles not equipped with active park assist, all 4 wheel speed sensors are active (magneto resistive) sensors that operate on the Hall-effect principle to generate a square wave signal that is proportional to the rotational speed of the wheel. Because these are active sensors, receiving voltage from the ABS module and then sending a varying voltage back to the ABS module, they are able to detect much lower rotational speeds than passive (magnetic inductive) sensors. Each wheel speed sensor is connected to the ABS module by 2 circuits. One circuit provides voltage for sensor operation and the other circuit provides sensor input to the ABS module.

On vehicles equipped with active park assist, both **rear** wheel speed sensors are active, bi-directional sensors. Each of the 2 sensors contain 2 sensing elements mounted side-by-side. Because the 2 sensing elements are mounted next to each other the 2 voltage signals are slightly out of phase, which causes one element to generate a voltage signal before the other element. This allows the ABS module to not only determine wheel speed, but also wheel direction for active park assist.

Wheel Speed Sensor Encoders

The wheel speed sensor encoders are several magnets arranged in a circle around one side of the wheel bearing in alternating poles. As the bearing rotates the wheel speed sensor is exposed to alternating north-south magnetic

fields. The encoder is part of the wheel bearing and is serviced with the bearing.

Stability Control Sensors

The stability control sensors for the vehicle dynamic system consist of the yaw rate sensor, lateral accelerometer and longitudinal accelerometer. The sensors are housed in the RCM which sends sensor information to the ABS module over a HS-CAN 2. If any of the sensors are defective, a new RCM must be installed.

- The yaw rate sensor measures the yaw angle which is the difference between the direction the vehicle is pointing when cornering and the direction the vehicle is actually moving.
- The longitudinal accelerometer measures the acceleration and deceleration of the vehicle as it moves forward and backward.
- The lateral accelerometer measures the force created when a vehicle corners that tends to push a vehicle sideways.

Lateral acceleration has 2 forms. The first is the centrifugal acceleration that is generated when the vehicle travels around in a circle. The second is the acceleration due to gravity. On level ground there is no lateral acceleration due to gravity. However, if the vehicle is parked sideways on a bank or incline, the sensor measures some lateral acceleration due to gravity, even though the vehicle is not moving.

Steering Wheel Rotation Sensor

The steering wheel rotation sensor is part of the EPAS (electronic power assist steering) gear assembly. The steering wheel rotation speed, angle and direction of travel is calculated by the PSCM and is sent to the ABS module over the HS-CAN 2.

Brake Booster Vacuum Sensor

The brake booster vacuum sensor is a piezoelectric device used by the ABS module to monitor the vacuum in the brake booster. The sensor is hardwired to the ABS module by 3 circuits. One circuit is for the 5 volt sensor supply, one circuit is for sensor ground and one circuit is for sensor output. The sensor output ranges from 0.2 volt to 4.9 volts, depending on the amount of vacuum in the booster.