Anti-Lock Brake System (ABS) and Stability Control - Raptor - Overview

Overview

The ABS and stability control systems are comprised of the following subsystems which assist the driver in maintaining control of the vehicle:

- ABS
- Brake fluid support
- EBD
- ESC
- Hill descent control™
- Hill start assist
- Hydraulic fade compensation
- RSC
- Side-wind stabilization
- Supplemental braking assist
- Supports adaptive cruise control
- Supports collision avoidance
- Terrain management system
- Traction control
- Trailer sway control
- Torque vectoring control

The ABS helps maintain steering control during hard braking by preventing wheel lock up. The ABS also includes a brake assist function which provides maximum brake system pressure during a severe braking situation.

Brake fluid support increases brake fluid flow to the wheel ends to help compensate for brake fade conditions.

The EBD system helps maintain vehicle control by keeping a balanced braking condition between the front and rear wheels.

The ESC system helps prevent skids or lateral slides by modulating brake fluid pressure to individual brake calipers and reducing engine torque.

The hill descent control™ feature helps to maintain a low vehicle speed while descending steep inclines on various surface conditions.

The hill start assist feature is designed to assist the driver during hill-starts. Using the ABS, the hill start assist system holds the vehicle on an incline for a short time, allowing the driver to release the brake pedal and press the accelerator pedal without needing to use the parking brake.

Hydraulic fade compensation counteracts brake fade by providing additional brake pressure at the wheel ends if the maximum achievable vehicle deceleration is not reached when the driver applies very high force to the brake pedal.

The RSC system helps prevent excessive vehicle roll by modulating brake fluid pressure to individual brake calipers and reducing engine torque.

The side-wind stabilization system helps to reduce the effect of a sudden gust of wind to the side of the vehicle.

The supplemental braking assist system uses the hydraulic pump motor and HCU to provide additional braking assist during a severe braking event or to compensate for a loss of vacuum in the brake booster.

The ABS supports the adaptive cruise control system by applying the brakes as necessary to maintain the distance gap set by the driver. For information on the adaptive cruise control system,
Refer to: Cruise Control (419-03 Cruise Control - Vehicles With: Adaptive Cruise Control) .

The ABS supports the collision avoidance system by monitoring information and precharging the brake system allowing the vehicle to stop in the shortest distance possible. For information on the collision avoidance system,
Refer to: Collision Warning and Collision Avoidance System (419-03 Collision Warning and Collision Avoidance System) .

The terrain management system helps maintain vehicle traction by adapting the responses of the engine, transmission, 4WD system, the ABS and the stability control system to the demands of the terrain. For additional information on the terrain management system,
Refer to: Four-Wheel Drive Systems - Raptor (308-07 Four-Wheel Drive Systems) .

The traction control system helps prevent loss of traction by reducing drive-wheel spin during acceleration.

The trailer sway control system helps maintain vehicle stability while towing a trailer by detecting and

aiding in the reduction of conditions causing trailer sway.

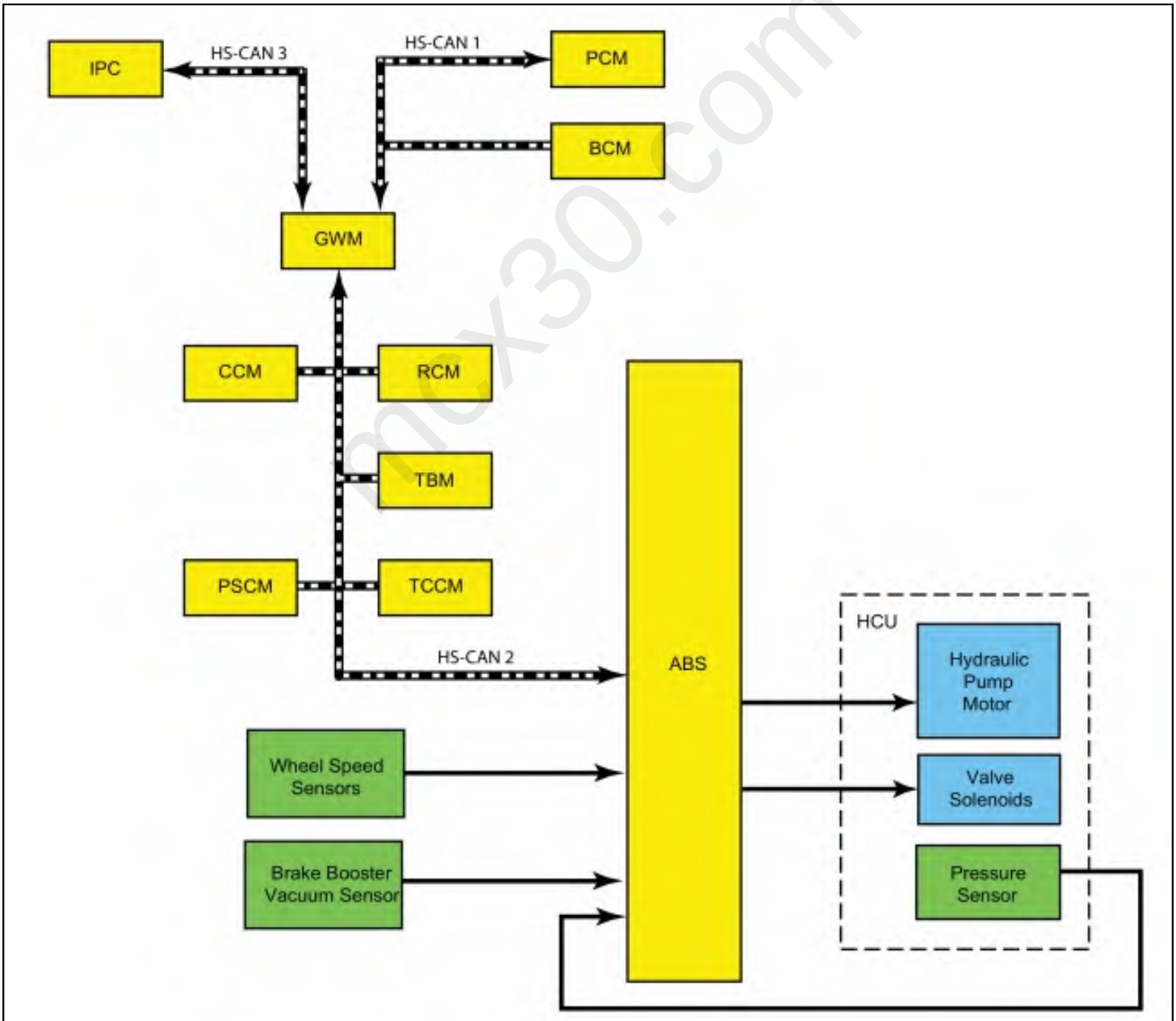
Torque vectoring control uses the rear brakes to adjust the speed between the driven wheels while accelerating through a corner, forcing the front end to hug the inside of the curve and improve tire grip.

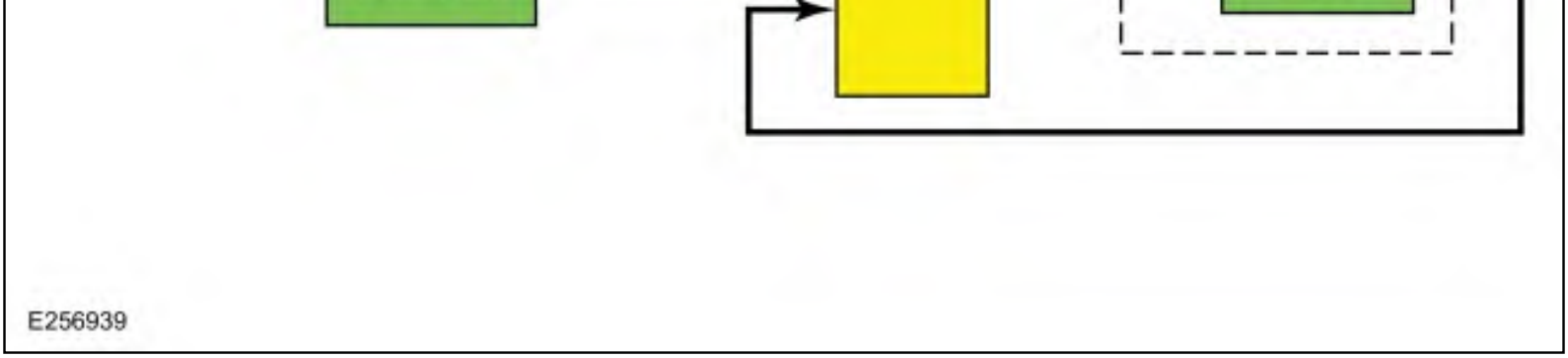
Some noise from the system and pulsations in the brake pedal are normal conditions during most ABS and stability control system activations. Longer than normal brake pedal travel may also be experienced immediately following an ABS or stability control system activation.

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

System Operation

System Diagram





Network Message Chart

Module Network Input Messages - ABS Module

Broadcast Message	Originating Module	Message Purpose
Accelerator pedal position	PCM	This message is sent to the GWM and then to the ABS module. This message provides the ABS module with the current accelerator pedal position and notifies the ABS module if the data is valid or invalid. The ABS module uses accelerator pedal position information for correct operation of the traction control, ESC, RSC and hill start assist systems.
Adaptive cruise control deceleration	CCM	This message contains the amount of deceleration currently required by the adaptive cruise control system to maintain the distance gap set by the driver.
Adaptive cruise control braking precharge	CCM	This message is sent by the CCM to request precharging of the brake system in preparation for adaptive cruise control deceleration from the ABS module.
Adaptive cruise control braking request	CCM	This message is sent by the CCM to request adaptive cruise control braking from the ABS module.
Ambient air temperature	PCM	This message is sent to the GWM and then to the ABS module. This message provides the ABS module with the current ambient air temperature. The ABS module uses this information for system monitoring.

Brake pedal applied	PCM	This message is sent to the GWM and then to the ABS module. Used to inform the ABS module the driver has pressed the brake pedal and notifies the ABS module if the data is valid or invalid. This message is used by the ABS module to check the brake pressure sensor located inside the HCU and for traction control, ESC, RSC and hill start assist operations.
Collision mitigation deceleration	CCM	This message contains the amount of deceleration currently required by the CCM to assist in collision avoidance.
Collision mitigation braking precharge	CCM	This message is sent by the CCM to request precharging of the brake system in preparation for collision mitigation deceleration from the ABS module.
Collision mitigation braking request	CCM	This message is sent by the CCM to request collision mitigation braking from the ABS module.
Cruise control status	PCM	This message is sent to the GWM and then to the ABS module. This message informs the ABS module of the current cruise control system status: off, denied, standby or active; and the current cruise control mode: not active, keeping speed, accelerating, decelerating, resuming high, resuming low, tap up waiting, tap down waiting.
Door ajar status	BCM	This message is sent to the GWM and then to the ABS module. This information is used by the ABS module for hill start assist operation.
Engine torque request	PCM	This message is sent to the GWM and then to the ABS module. This message informs the ABS module of the current amount of engine torque reduction available to assist with traction control, ESC and RSC.
Engine RPM	PCM	This message is sent to the GWM and then to the ABS module. Used to inform the ABS module of the current engine RPM. The ABS module uses this information for traction control, ESC, RSC and hill start assist operations.

Engine status	PCM	This message is sent to the GWM and then to the ABS module. This message informs the ABS module of the current engine status; engine on, engine off, engine auto stopped or not used.
Engine torque output	PCM	This message is sent to the GWM and then to the ABS module. This message informs the ABS module of the current engine torque output. This information is used for the traction control, hill start assist, ESC and RSC feature operation.
Hill descent control™ request	IPC	This message is sent to the GWM and then to the ABS module. This message informs the ABS module the driver has requested the hill descent control™ system to be activated or deactivated.
Ignition status	BCM	This message is sent to the GWM and then to the ABS module. This message informs the ABS module of the current ignition status; off, accessory, run, start, unknown or invalid.
Parking brake active	BCM	This message is sent to the GWM and then to the ABS module. This message provides the ABS module with the current parking brake status; applied or not applied. This information is used for hill start assist operation.
Powertrain drive mode status (Raptor only)	PCM	This message is sent to the GWM and then to the ABS module. This message informs the ABS module of the current driver selected terrain mode; normal, sport, wet-snow, mud-sand, baja, rock crawl or tow-haul.
Powertrain status	PCM	This message is sent to the GWM and then to the ABS module. This message informs the ABS module of the current powertrain status; powerpack off - torque not available, powerpack on - torque not available, start in progress - torque not available or powerpack on - torque available.

Rear differential lock status	TCCM	This message informs the ABS module of the current rear differential locked status; no fault, unspecified fault, differential failed open and differential failed closed. The ABS module requests rear differential unlocking during traction control, ESC and RSC operations.
Rear differential locking torque	TCCM	This message informs the ABS module of the current amount of torque being applied to the rear differential. The ABS module requests rear differential unlocking during traction control, ESC and RSC operations.
RCM serial number	RCM	This message is sent to the GWM and then to the ABS module. The ABS module stores the RCM serial number and verifies the serial number when the vehicle is started or the ignition is set to ON or ACC. Over time, the ABS module learns the offset of the stability sensors inside the RCM. When a new RCM serial number is found and the Interactive Vehicle Dynamics (IVD) Initialization procedure is carried out using a diagnostic scan tool, the ABS module resets the offset values learned for the yaw rate sensor, lateral accelerometer and roll rate sensor.
Stability-traction control mode request	IPC	This message is sent to the GWM and then to the ABS module. This message informs the ABS module the driver has requested a change to enable or disable the traction control, ESC or RSC.
Steering wheel angle	PSCM	The ABS module uses steering angle sensor information for ESC and RSC operation. This message provides the ABS module with the current steering wheel angle in degrees as well as the steering wheel angle count (number or revolutions).
Terrain mode request (Raptor only)	IPC	This message is sent to the GWM and then to the ABS module. This message informs the ABS module or the driver requested terrain mode; normal, sport, wet-snow, mud-sand, baja, rock crawl or faulty.

Trailer brake control connection	TBM	This message informs the ABS module a trailer is connected to the vehicle. The ABS module uses this information for trailer sway control operation.
Trailer sway control configuration	IPC	This message is sent to the GWM and then to the ABS module. This message informs the ABS module the driver has requested the trailer sway control system to be activated or deactivated.
Transfer case lock status	TCCM	This message informs the ABS module of the current transfer case locked status; OK, opened by command, inactive, fault, warning, disabled, fully locked by command, torque limited by command, under external torque control and undefined. The ABS module requests transfer case unlocking during traction control, ESC and RSC operations.
Transfer case locking torque	TCCM	This message informs the ABS module of the current amount of torque being applied to the transfer case. The ABS module requests transfer case unlocking during traction control, ESC and RSC operations.
Transfer case range	TCCM	This message informs the ABS module of the current transfer case range; low range locked, low range auto, low range 2wd, neutral, high range locked, high range auto or high range 2wd. The ABS module modifies the thresholds for traction control, ESC and RSC intervention based on the current transfer case range.
Transmission gear position	PCM	This message is sent to the GWM and then to the ABS module. This message informs the ABS module of which gear the transmission is currently using. This information is used for hill start assist, ESC and RSC operation. Hill start assist operates in forward and reverse gears. ESC and RSC do not operate when the transmission is in REVERSE.
Transmission gear lever position	PCM	This message is sent to the GWM and then to the ABS module. This message informs the ABS module of which gear the driver has selected. This information is used for hill start assist, ESC and RSC operation.

Transmission shift active	PCM	This message is sent to the GWM and then to the ABS module. This message informs the ABS module the transmission is currently changing gears. This information is used for traction control, ESC and RSC operation.
Vehicle configuration data	BCM	This message is sent to the GWM and then to the ABS module. This message provides the ABS module with the current optional and configured items such as tire size, axle ratio, manual or automatic transaxle, keyless entry and VIN.
Vehicle lateral acceleration data	RCM	This message provides the ABS module with the current vehicle lateral acceleration data and notifies the ABS module if the data is valid or invalid. The ABS module uses the lateral acceleration data for traction control, ESC and RSC feature operation.
Vehicle longitudinal acceleration data	RCM	This message provides the ABS module with the current vehicle longitudinal acceleration data and notifies the ABS module if the data is valid or invalid. The ABS module uses the longitudinal acceleration data for ESC and RSC feature operation.
Vehicle roll rate data	RCM	This message provides the ABS module with the current vehicle roll rate data and notifies the ABS module if the data is valid or invalid. The ABS module uses the longitudinal acceleration data for RSC feature operation.
Vehicle yaw rate data	RCM	This message provides the ABS module with the current vehicle yaw rate data and notifies the ABS module if the data is valid or invalid. The ABS module uses the yaw rate data for ESC and RSC feature operation.

Anti-Lock Brake System (ABS) Function

The ABS module continuously monitors brake pedal input, lateral vehicle motion and the rotational speed of each wheel. The PCM sends the brake pedal switch information to the GWM over the HS-CAN1, the GWM sends the information to the ABS module over the HS-CAN2. The RCM sends lateral acceleration sensor information directly to the ABS module over the HS-CAN2. Wheel speed information is retrieved by the ABS module using 4 active 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 calipers by opening and closing the appropriate solenoid valves inside the HCU while the hydraulic pump motor is activated. Once the affected wheel returns to the

desired speed, the ABS module deactivates the hydraulic pump motor and returns the solenoid valves to their normal position.

The ABS module has 2 self-test options, one uses a diagnostic scan tool and the other is carried out when the ABS module is initialized (ignition ON). During either self-test the ABS module 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 mph). Any malfunction detected in the system causes the ABS module to set a DTC, disable the ABS function and send a message over the HS-CAN2 to the GWM. The GWM then sends the message to the IPC over the HS-CAN3 to illuminate the ABS warning indicator. Diagnostic Trouble Codes (DTCs) which disable the ABS**do not** disable the base hydraulic power-assist braking system.

Electronic Brake Force Distribution (EBD)

On initial application of the brake pedal, full pressure is applied to the rear brakes. The ABS module 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 Diagnostic Trouble Codes (DTCs) being present in the ABS module, EBD continues to function unless the Diagnostic Trouble Codes (DTCs) are for wheel speed sensors or the HCU solenoid valves. When EBD is disabled, the ABS warning indicator, the red brake warning indicator and traction control indicator illuminate.

Supplemental Braking Assist

In addition to preventing wheel lock up during braking events, the ABS module is also able to provide supplemental hydraulic brake assist through the use of the hydraulic pump motor and the HCU. This is done in the event of a severe vacuum loss at the brake booster, to maintain the distance gap set by the adaptive cruise control system or to aid in the avoidance of forward collisions.

The ABS module utilizes the HCU and hydraulic pump motor to aid in bringing the vehicle to a safe, controlled stop in the event of severe vacuum loss at 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. If this 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 a deceleration request to the ABS module over the HS-CAN2 (either an adaptive cruise control deceleration request or a collision avoidance deceleration request). 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. After receiving the braking request message, the ABS module waits for brake pedal input and, once received, applies maximum braking assist using the hydraulic pump motor and the HCU.

For additional information on the adaptive cruise control system,
Refer to: Cruise Control (419-03 Cruise Control - Vehicles With: Adaptive Cruise Control) .

For additional information on the collision avoidance system,
Refer to: Collision Warning and Collision Avoidance System (419-03 Collision Warning and Collision Avoidance System) .

Hydraulic Fade Compensation and Brake Fluid Support

Hydraulic fade support provides a function to counteract faded brakes by supplying additional wheel brake pressure, if the maximum achievable vehicle deceleration is not reached, while the driver applies (very) high pedal force (driver brake request remains higher than booster run-out point). Brake fluid support provides a software function to increase fluid flow to the wheel end brakes in the event the brakes have faded to the extent the primary or secondary master cylinder circuits can no longer supply fluid to the brake system.

Vacuum On-Demand System

Vehicles equipped with a 3.5L engine have the capability of supplying additional vacuum to the brake booster. This is accomplished through the use of a valve solenoid and an aspirator in the brake booster vacuum tube. When the ABS module detects a low vacuum condition in the brake booster, a message is sent to the PCM requesting additional vacuum. The PCM responds by opening the valve solenoid which allows the engine to draw air from the brake booster and increase the vacuum in the booster. Once the vacuum in the booster has reached the required level, the ABS module stops sending the message and the PCM closes the valve solenoid.

AdvanceTrac

The AdvanceTrac system is comprised of the traction control and ESC features.

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 calipers 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 to the GWM over the HS-CAN2 which relays the message to the PCM over the HS-CAN1. The ABS module also sends a traction event message to the GWM over the HS-CAN2 which relays this message to the IPC over the HS-CAN3. 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). Once vehicle speed exceeds 100 km/h (62 mph), traction control is accomplished only through the PCM torque control.

The traction control system can be disabled by the driver using the stability-traction control switch. This is independent of ABS which cannot be disabled by the driver. The traction control switch is hard-wired to the IPC, when the driver presses the traction control switch, the switch sends a ground signal to the IPC. The IPC responds by illuminating the stability-traction control disabled indicator (sliding car OFF icon) and by sending a message to the GWM over the HS-CAN3. The GWM relays this message to the ABS module over the HS-CAN2. The ABS module takes no further action in regards to traction control until the driver presses the switch again in the same ignition cycle or until the ignition is cycled from OFF to ON. For additional information on disabling the traction control feature, refer to Disabling AdvanceTrac.

The ABS module disables traction control if there are any wheel speed sensor or solenoid valve Diagnostic Trouble Codes (DTCs) present in the ABS module. Traction control is also disabled if there is a communication error between the ABS module and the PCM. When traction control is disabled, the ABS module sends a message to the GWM over the HS-CAN2. The GWM relays this message to the IPC over the HS-CAN3 to illuminate the stability-traction control indicator (sliding car icon).

Electronic Stability Control (ESC)

The ABS module continuously monitors the vehicle motion relative to the intended course. This is done by using sensors to compare the steering wheel input and the yaw rate sensor input with the actual vehicle motion. The PSCM sends the steering wheel angle information to the ABS module over the HS-CAN2. The RCM sends yaw rate sensor and lateral accelerometer information to the ABS module also over the HS-CAN2. If the ABS module determines from the inputs the vehicle is unable to travel in the intended direction, it modulates brake pressure to the appropriate brake calipers 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 help stabilize the vehicle and sends this torque reduction message to the GWM over the HS-CAN2 which relays the message to the PCM over the HS-CAN1. The ABS module also sends a vehicle stability event message to the GWM over the HS-CAN2 which relays this message to the IPC over the HS-CAN3. 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 vehicle stability event 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).

The ESC can be disabled by the driver using the stability-traction control switch. This is independent of ABS which cannot be disabled by the driver. The stability-traction control switch is hard-wired to the IPC, when the driver presses the stability-traction control switch, the switch sends a ground signal to the IPC. The IPC responds by illuminating the stability-traction control disabled indicator (sliding car OFF icon) and by sending a message to the GWM over the HS-CAN3. The GWM relays this message to the ABS module over the HS-CAN2. The ABS

module takes no further action in regards to stability-traction until the driver presses the switch again in the same ignition cycle, the ignition is cycled from OFF to ON or vehicle speed exceeds 56 km/h (35 mph). For additional information on disabling the traction control feature, refer to Disabling AdvanceTrac.

ESC does not operate with the transmission in REVERSE or with the transfer case in 4WD low. The ABS module disables ESC if there are any wheel speed sensor, stability sensor or steering angle sensor Diagnostic Trouble Codes (DTCs) present in the ABS module. If there is a communication error between the ABS module and the PSCM or the ABS module and the RCM, ESC also is disabled. When ESC is disabled, the ABS module sends a message to the GWM over the HS-CAN2. The GWM relays this message to the IPC over the HS-CAN3 to illuminate the stability-traction control indicator (sliding car icon).

Disabling AdvanceTrac

AdvanceTrac is controlled by the stability-traction control switch in the following manner:

- Momentarily pressing the switch disables only traction control, ESC and RSC remain enabled.
- Pressing the switch and holding it pressed for more than 5 seconds disables traction control and ESC, RSC remains enabled.
- Pressing the switch after one or more features have been disabled enables all 3 features.

Switching the transfer case to 4WD low locked disables all 3 features; traction control, ESC and RSC.

Roll Stability Control (RSC)

The ABS module continuously monitors the vehicle motion relative to the intended course. This is done by using sensors to compare the steering wheel input, yaw rate sensor input, lateral accelerometer input and roll sensor input with the actual vehicle motion. The PSCM sends the steering wheel angle information to the ABS module over the HS-CAN2. The RCM sends yaw rate sensor, lateral accelerometer and roll rate sensor information to the ABS module also over the HS-CAN2. If the ABS module determines from the inputs the vehicle is becoming unstable, the ABS module modulates brake pressure to the appropriate brake calipers 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 help stabilize the vehicle and sends this torque reduction message to the GWM over the HS-CAN2 which relays the message to the PCM over the HS-CAN1. The ABS module also sends a vehicle stability event message to the GWM over the HS-CAN2 which relays this message to the IPC over the HS-CAN3. 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 vehicle stability event 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).

RSC does not operate with the transmission in REVERSE or with the transfer case in 4WD low. The ABS module disables RSC if there are any wheel speed sensor, stability sensor or steering angle sensor Diagnostic Trouble Codes (DTCs) present in the ABS module. If there is a communication error between the ABS module and the SASM or the ABS module and the RCM, RSC also is disabled. When RSC is disabled, the ABS module sends a

message to the GWM over the HS-CAN2. The GWM relays this message to the IPC over the HS-CAN3 to illuminate the stability-traction control indicator (sliding car icon).

Trailer Sway Control

Trailer sway is the undesirable yaw force a trailer can apply to the towing vehicle. Trailer sway control is a unique function of the stability control system that uses steering wheel angle information and yaw rate information to determine if a trailer sway event is taking place. The PSCM sends the steering wheel angle information to the ABS module over the HS-CAN2. The RCM sends yaw rate sensor and lateral accelerometer information to the ABS module also over the HS-CAN2. If the ABS module determines from the inputs a trailer sway event is taking place, the ABS module modulates brake pressure to the appropriate brake calipers 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 trailer sway and sends this torque reduction message to the GWM over the HS-CAN2 which relays the message to the PCM over the HS-CAN1. The ABS module also sends a trailer sway event message to the GWM over the HS-CAN2 which relays this message to the IPC over the HS-CAN3. 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 vehicle stability event message, it flashes the stability-traction control indicator (sliding car icon) and displays TRAILER SWAY REDUCE SPEED in the message center.

Once the trailer sway 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) and stops displaying the trailer sway message in the message center. Trailer sway control only activates when vehicle speed is greater than 65 km/h (40 mph). Any malfunction disabling RSC also disables trailer sway control.

The driver can enable and disable the trailer sway control feature using the message center and steering wheel controls. For additional information, refer to the Owner's Literature.

Torque Vectoring 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 input, the yaw rate sensor input, the lateral acceleration sensor input and the longitudinal acceleration sensor input with that of the actual vehicle motion. Steering wheel angle information is calculated by the PSCM and is sent to the ABS module over the HS-CAN2. Vehicle roll rate, yaw rate, lateral acceleration and longitudinal acceleration information are sent to the ABS module from the RCM also over the HS-CAN2. If the ABS module determines the vehicle is experiencing over-steer or under-steer, the module sends a torque vectoring control message over the HS-CAN2. The GWM relays this message to the PCM over the HS-CAN1 and to the IPC over the HS-CAN3. When the PCM receives this message, it assists with curve control by adjusting engine timing and decreasing fuel injector pulses. When the IPC receives this message, it flashes the stability-traction control indicator (sliding car icon). The ABS module continues to monitor the sensor inputs while the PCM assists with torque vectoring control. If the ABS module determines PCM intervention is insufficient to control the stability 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 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 sends another message over the HS-CAN2 indicating the event

has ended. The PCM returns engine timing and fuel injectors to normal operation and the IPC extinguishes the sliding car icon.

Hill Start Assist

When the vehicle is stopped on an incline greater than 2.86 degrees (approximately a 5% grade), 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 from the PCM through the GWM over the HS-CAN2 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 through the GWM over the HS-CAN2 informs the ABS module the vehicle is not parked. The stability sensor messages sent by the RCM over the HS-CAN2 enable the ABS module to determine if the vehicle is on an incline greater than 2.86 degrees (approximately a 5% grade). Once the above conditions have been met, hill start assist automatically engages. Before the driver releases the brake pedal, the ABS module commands the HCU to close the isolation valves which maintains the current brake system pressure, preventing the vehicle from rolling down the incline. Once the driver presses the accelerator pedal and the engine RPM increases, 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 accelerate the vehicle forward (or backward if reversing up the incline).

Hill Descent Control

When the Hill Descent Control switch is pressed, the IPC sends a hill descent braking assist message to the GWM over the HS-CAN3. The GWM relays this message to the ABS module over the HS-CAN2. Once the vehicle speed is between 5 km/h (3 mph) and 32 km/h (20 mph) and the transmission is in REVERSE or any forward gear, the ABS module uses the hydraulic pump motor and the HCU solenoid valves to maintain the vehicle speed set by the driver. If the vehicle speed is increased or decreased outside of the operational window, the system remains active but descent speed cannot be set or maintained.

The Hill Descent Control feature requires a cool down period after sustained use. The ABS module continually monitors the descent speed, angle of descent, pump motor run time and solenoid valve use. Once the ABS module determines a cool down period is needed, the module sends a message to the GWM over the HS-CAN2. The GWM relays the message to the IPC over the HS-CAN3 to display HILL DESCENT CONTROL OFF SYSTEM COOLING in the message center.

Hill descent control has 3 modes of operation:

- At speeds below 32 km/h (20 mph): when the hill descent control switch is pressed and conditions are correct for hill descent activation, the hill descent control system is enabled. The hill descent indicator illuminates solidly and the message center indicates hill descent control is active.
- At speeds below 32 km/h (20 mph): when the hill descent control switch is pressed and conditions are **not** correct for hill descent activation; the hill descent control system is enabled, the hill descent control indicator illuminates solidly and a message is displayed in the message center indicating the reason hill descent is not active.
- At speeds **above** 32 km/h (20 mph): when the hill descent control switch is pressed, the Hill Descent Control system is not enabled and the hill descent control indicator does not illuminate. Once the vehicle slows to below 32 km/h (20 mph), the hill descent control switch must be pressed again to enable the Hill

Descent Control system.

Terrain Management

The terrain management system optimizes drivability and comfort as well as maximizing traction while operating on different types of terrain. When the MODE button on the steering wheel is pressed, the SCCM sends out a terrain mode message on the HS-CAN2. The following modules receive the message and respond by altering their operation as follows:

- EPAS - adjusts steering effort and feel based on the selected mode.
- ABS module - adjusts the intervention thresholds for ESC and traction control based on the selected mode.
- PCM - adjusts throttle response to enhance powertrain response based on the selected mode.
- TCM - adjusts gear changes to enhance powertrain response based on the selected mode.
- TCCM - automatically engages specific 4WD modes and raises or lowers torque output based on the selected mode.
- ELD - engages and disengages automatically based on the selected mode.

The following terrain modes are available:

- **Normal Mode** - Used for normal, everyday on-road driving and towing. The Tow-Haul function can **only** be used in Normal mode.
- **Sport Mode** - Used for more spirited on-road driving, providing a higher intervention threshold for traction control and ESC. Can also be selected by shifting the automatic transmission into SPORT.
- **Wet-Snow Mode** - Also known as Weather Mode, used for confident driving on rain, snow and ice covered roads.
- **Mud-Sand Mode** - Used for deep sand or mud. Mud-Sand mode automatically commands the electronic locking differential to engage. This mode is for off-road use only.
- **Baja Mode** - Used for high speed off-road terrain.
- **Rock Crawl Mode** - Used when traveling slowly across drastically uneven surfaces, or climbing when maximum traction is desired. Rock Crawl mode automatically commands the TCCM into 4-LOW and engages the electronic locking differential. This mode is for off-road use only.

When Mud-Sand mode, Baja mode or Rock Crawl mode is activated, ESC and traction control operation is degraded and the stability-traction control warning indicator is illuminated.

For additional information on the Terrain Management system,
Refer to: Four-Wheel Drive Systems - Raptor (308-07 Four-Wheel Drive Systems) .

MyKey® Interaction

Through the MyKey® feature, traction control can be configured to be always on or to allow the driver to select the traction control function on or off. When the traction control function 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 the traction control function and does not send any traction control disable messages to the GWM. Refer to the Owner's Literature for additional information on the various MyKey® settings.

Stability-Traction Control Indicator (Sliding Car Icon)

One or both of the stability/traction control indicators may illuminate as a result of momentary sensor disturbances due to environmental or driving conditions (including severe vehicle maneuvers or extreme off road usage). Once Illuminated, the indicator remains illuminated until the environmental or driving condition is no longer present and the ignition is cycled from ON to OFF and then back to ON again. If there are no other customer concerns, symptoms, indicators or Diagnostic Trouble Codes (DTCs), the stability/traction control indicator may have been illuminated due to these environmental or driving conditions.

Refer to: Instrument Panel Cluster (IPC) (413-01 Instrumentation, Message Center and Warning Chimes) .

Stability-Traction Control Disabled Indicator (Sliding Car OFF Icon)

Refer to: Instrument Panel Cluster (IPC) (413-01 Instrumentation, Message Center and Warning Chimes) .

Component Description

Anti-Lock Brake System (ABS) Module

The ABS module is attached directly to the HCU and is the ECU for the ABS and stability control systems. The module monitors all sensor inputs and all HS-CAN messages relating to ABS and stability control, then directly controls the solenoid valves and the hydraulic pump motor in the HCU. The ABS module can be serviced separately from the HCU. When a new ABS is installed, the module must be programmed with the current vehicle configuration information. For additional information on module programming,
Refer to: Module Configuration (418-01 Module Configuration) .

When an ABS or stability control 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 which means the vehicle must be on a level surface and not moving. The calibration procedure (IVD Initialization) is carried out using a diagnostic scan tool.

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 0.3 volt to 4.7 volts, depending on the amount of vacuum in the booster.

Hill Descent Control Switch

The Hill Descent Control switch is a single-pole, momentary-contact switch and is part of a 2-switch pack containing the Hill Descent Control switch and the stability-traction control switch. The switch is wired directly to the IPC.

Hydraulic Control Unit (HCU)

The HCU contains the solenoid valves, the hydraulic pump motor and the pressure sensor used by the ABS for the ABS and stability control systems. While the ABS module can be serviced separately from the HCU, a new HCU comes with a new ABS module.

Stability Control Sensors

The stability control sensors for the traction control and ESC functions consist of the yaw rate sensor, lateral accelerometer, longitudinal accelerometer and roll rate sensor. The sensors are housed in the RCM which sends sensor information to the ABS module over the HS-CAN2. 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.
- The roll rate sensor measures the rate of rotation of the vehicle along the centerline of the vehicle from front to back.

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.

Stability-Traction Control Switch

The stability-traction control switch is a single-pole, momentary-contact switch and is part of a 2-switch pack containing the stability-traction control switch and the Hill Descent Control switch. The switch is wired directly to the IPC.

Wheel Speed Sensor

All 4 wheel speed sensors are active (magneto resistive) sensors that operate on the Hall-effect principle to generate a square wave signal proportional to the rotational speed of the wheel. Because these are active sensors, receiving voltage from the ABS module and 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.

The front wheel speed sensors are integrated into the front wheel bearing and wheel hub assembly and are serviced with the bearing and hub assembly.

The rear wheel speed sensors are mounted on the axle flange at the brake dust shield and can be serviced separately.

Wheel Speed Sensor Encoders

The wheel speed sensor encoders are magnetized, toothed rings used to create a Hall-effect switch when combined with the wheel speed sensor. The front wheel speed sensor encoders are integrated into the front wheel bearing and are serviced with the front wheel bearing. The rear wheel speed sensor encoders are pressed onto the rear wheel axle shaft and are serviced separately from the axle shaft.
