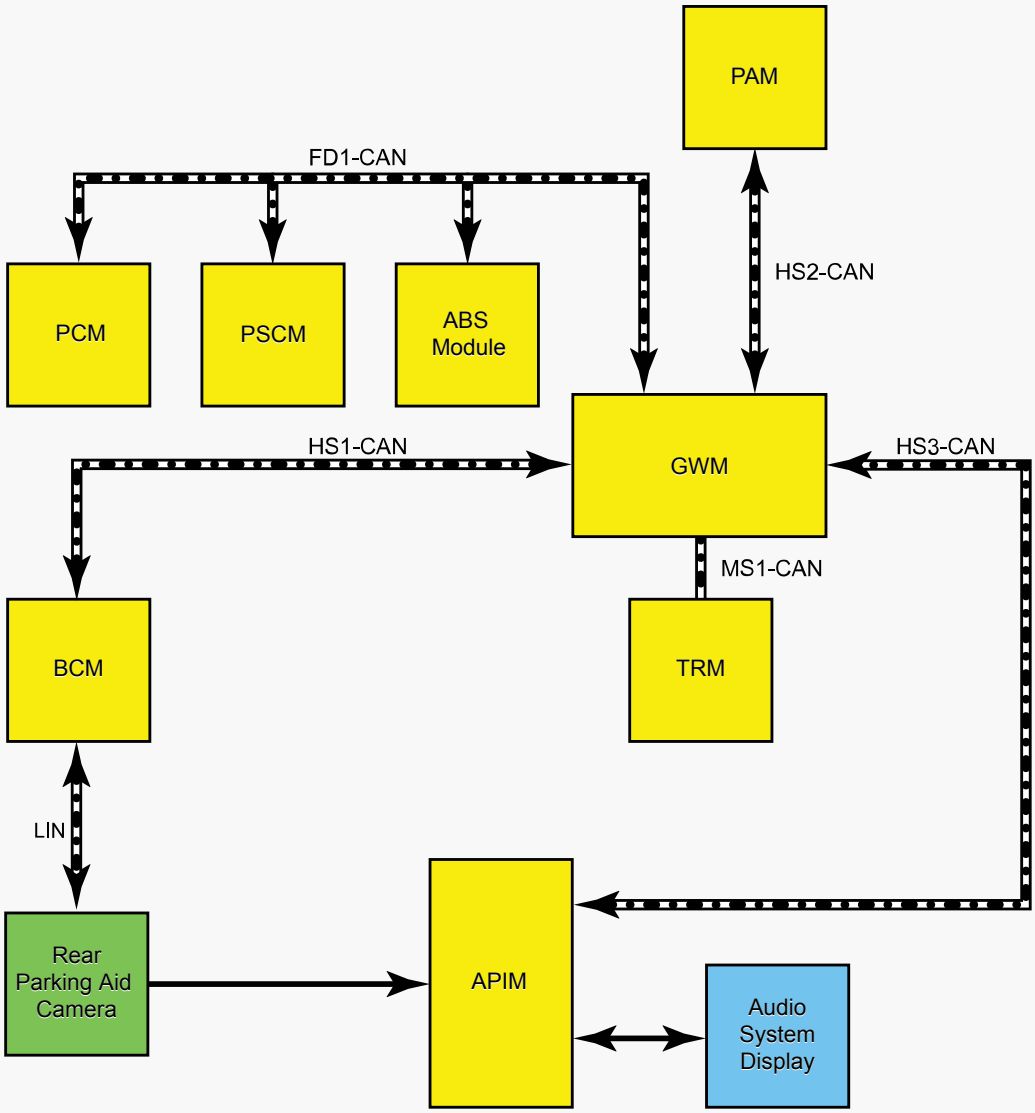
Parking Aid - System Operation and Component Description

System Operation

Rear Only Parking Aid Camera

System Diagram



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Network Message Chart

APIM Network Input Messages

Broadcast Message	Originating Module	Message Purpose

Gear lever position	PCM	Enables the video display when reverse is selected.
Parking aid sensor data	PAM	Generates the visual highlights in the zone where an object is detected by the rear parking aid system.
Rear camera on demand request	HVAC module	Commands the audio system display on when the rear camera on demand is requested.
Steering wheel angle	ABS module	Generates the intended vehicle path for the active guideline feature.
Vehicle speed	PCM	When the video delay feature is turned on, this message is used to turn the rear camera display off after the vehicle speed exceeds a preset threshold.

ABS Module Network Input Messages

Broadcast Message	Originating Module	Message Purpose
Steering angle	PSCM	The ABS module uses the steering angle sensor data to generate the steering wheel angle message that is sent to the BCM to support the active guideline feature.

Image Display

NOTE: *The tailgate must be fully closed for correct operation of the rear parking aid camera system.*

The rear parking aid camera image is displayed by the audio system display when reverse is selected. To determine the transmission gear position and enable the camera display, the PCM sends the gear position message to the GWM on the HS-CAN1 . The GWM then sends the message to the APIM via the HS-CAN3 .

The camera is on any time it receives voltage (when the ignition is on), but a video signal is only generated under certain conditions. When reverse is selected, the camera continuously generates a video signal. When any gear except reverse is selected, the

camera turns the video signal off when the vehicle speed reaches 16 km/h (10 mph), and turns the video signal on when vehicle speed falls below 8 km/h (5 mph). If the camera is not configured properly, some features may be inoperative. The camera sends the video signal through a coaxial cable to the APIM , which displays the image on the audio system display.

The following parking aid camera system features are driver selectable:

- Visual park aid alert — allows the driver to see the object causing the parking aid system to sound.
- Manual zoom — allows the driver to manually zoom the image.
- Video delay — allows the driver to see the image behind the vehicle after the vehicle is shifted out of reverse into any gear other than park.

The following camera system features are not driver selectable:

- Fixed guidelines — assists the driver with aligning the vehicle with an object.
- Active guidelines — displays the intended path of the vehicle based upon steering wheel input.

The audio system display settings menu turns the visual park aid alert and video delay on and off. The visual park aid alert and video delay features are generated within the APIM .

To turn the manual zoom feature on and off, the driver uses an on-screen button located on the audio system display while in reverse. The driver generated commands originate at the audio system display, which is hardwired to the APIM . The APIM sends the driver generated commands zoom command to the rear parking aid camera via the coaxial cable using a digital serial format communciation (LVDS). The zoom is generated by the rear parking aid camera.

The fixed and active guidelines are generated by the rear parking aid camera and are not selectable by the driver.

The messages sent from the APIM to the camera are:

- Camera configuration data
- Display manual zoom request
- Guideline on/off request
- Tailgate ajar status
- Steering angle
- Standby enable/disable request

The messages sent from the camera to the APIM are:

- Camera status
- Display zoom status
- Camera part number data
- Guideline status

Visual Park Aid Alert

NOTE: *The on-screen alert transitions may not match changes in the audible parking aid alert tone frequency.*

The visual park aid alert feature displays a visual highlight in the zone where an object has been detected by the rear parking aid system. This feature utilizes the parking aid sensor data from the PAM to generate the visual highlights on the video image. When reverse is selected and an object is detected by a rear parking aid sensor, the parking aid sensor data message from the PAM is used by the APIM to generate the alert.

If the visual park aid alert feature is enabled, the feature is still operational even if the rear parking aid system has been disabled by the driver.

Fixed Guidelines

NOTE: *The color-coded lines cannot indicate accurate or consistent distances between the rear of the vehicle and objects shown in the video image. This normal condition is due to variances in vehicle ride height including, but not limited to vehicle loading.*

The rear parking aid camera fixed guidelines feature displays guidelines on top of the video image to assist the driver with alignment of the vehicle. A dashed line on the displayed image represents the center of the vehicle and 3 color-coded lines identify different zones between the rear of the vehicle and objects. The rear parking aid camera generates the fixed guidelines over the video image.

The guidelines are not shown when reverse is not selected (video delay active).

Fixed guidelines are not shown when the tailgate is open.

Active Guidelines

NOTE: *If the battery has been disconnected or discharged, or a module is disconnected or replaced, the active guidelines may be inoperative until the vehicle is driven on a flat and smooth road at 32 km/h (20 mph) or more, with hands placed loosely on the steering wheel and minimal steering correction for approximately 30 seconds.*

If the guidelines remain inoperative, it may be necessary to disconnect the battery for 5 minutes with the driver's door open, then drive the vehicle for 8 kilometers (5 miles) in

normal city driving before performing the procedure described above.

The active guidelines feature displays dynamic guidelines that correspond to the projected path of vehicle travel, based on the current steering angle. Several modules are involved in generating the steering angle data used to support the active guidelines. The PSCM monitors the steering angle sensor and sends the steering wheel angle sensor data to the ABS module via the HS-CAN2 . The ABS module uses this message from the PSCM to generate the steering angle message that is sent to the GWM on the HS-CAN2 . The GWM then sends the message to the APIM via the HS-CAN3 . The APIM sends the steering angle data to the rear parking aid camera via the coaxial cable using a digital serial format communciation (LVDS). The rear parking aid camera uses this data to generate the active guidelines over the video image.

If the steering wheel is in the straight-ahead position or if the tailgate is open, the active guidelines are not shown.

The guidelines are not shown when reverse is not selected (video delay active).

Manual Zoom

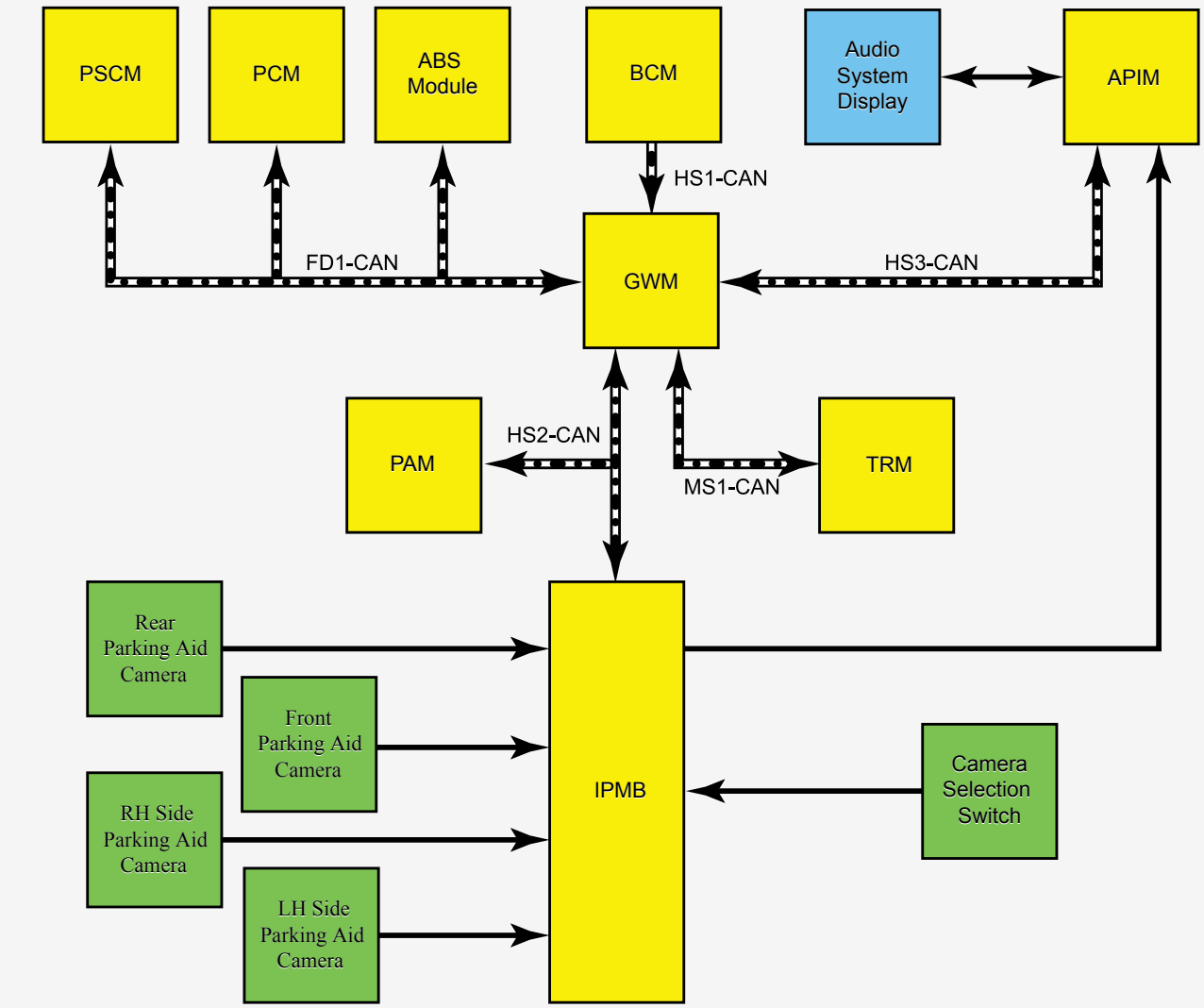
The manual zoom feature is generated by the rear parking aid camera and has one level of zoom. If the manual zoom feature is on and the vehicle is shifted out of reverse, the manual zoom feature is disabled and must be re-enabled the next time reverse is selected. When the driver turns the zoom on or off at the audio system display, the zoom command is sent to the rear parking aid camera via the coaxial cable using a digital serial format communciation (LVDS) and the camera turns the zoom on or off.

Video Delay

When the video delay is turned on the APIM keeps the rear video display enabled after the transmission is shifted out of reverse into any gear other than park, until the vehicle speed reaches 8 km/h (5 mph). With the delay off (default) the image displays until the transmission is shifted out of reverse.

360 Degree View Camera

System Diagram



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Network Message Chart

IPMB Network Input Messages

Broadcast Message	Originating Module	Message Purpose

Camera commands	APIM	Commands the visual park aid alert and zoom level on and off based on driver inputs through the audio system display.
Driver door ajar status	BCM	Generates the door ajar icon on the image when the LH front door is ajar.
Gear lever position	PCM	Enables the front or rear camera views based on the current gear selection.
Left rear door ajar status	BCM	Generates the door ajar icon on the image when the left rear door is ajar.
Tailgate ajar	BCM	Disables the guidelines and visual park aid alert when the tailgate is open.
Passenger door ajar status	BCM	Generates the door ajar icon on the image when the RH front door is ajar.
Reverse state	PCM	Enables the front or rear camera views based on the current gear selection.
Right rear door ajar status	BCM	Generates the door ajar icon on the image when the right rear door is ajar.
Steering wheel angle	ABS Module	Generates the intended vehicle path for the active guideline feature.
Trailer lamp connected	TRM	Disables the guidelines and visual park aid alert when a trailer is electrically connected to the vehicle. (if equipped with trailer tow)
Vehicle speed	PCM	Supports the front and rear camera standby mode. Turns the camera image output off when vehicle speed is 16 km/h (10 mph) or greater and turns the camera image output on when the vehicle speed is 12 km/h (8 mph) or less.

ABS Module Network Input Messages

Broadcast	Originating	Message Purpose

Message	Module	
Steering angle	PSCM	The ABS module uses the steering angle sensor data to generate the steering wheel angle message that is sent to the IPMB to support the active guideline feature.

APIM Network Input Messages

Broadcast Message	Originating Module	Message Purpose
Camera front display status	IPMB	Enables the video display when the camera selection switch is pressed.
Camera view status	IPMB	Indicates the active view that has been selected.
Camera zoom status	IPMB	Indicates the zoom view that has been selected.
Gear lever position	PCM	Enables and disables the video display based on the current gear selection.
Parking aid sensor data	IPMB	Generates the visual highlights in the zone where an object is detected by the rear audible parking aid system.
Rear camera on demand request	HVAC module	Used by the APIM to command the audio system display on when the rear camera on demand is requested.
Vehicle speed	PCM	When the video delay feature is turned on, this message is used to turn the rear camera display off after the vehicle speed exceeds a preset threshold.

Image Display

NOTE: *The tailgate and doors must be fully closed for correct operation of the 360 degree view camera system.*

The digital 360 degree view camera system is capable of generating several different views using the front, rear, LH side and RH side cameras, and the IPMB . All 4 cameras

are powered and communicate to the IPMB over coaxial cable. The IPMB processes the video signals from the 4 cameras and generates the appropriate views that are displayed on the audio system display. The views that are displayed are determined by the transmission gear selector position.

When the ignition is on and reverse is selected, the rear camera views are shown on the audio system display. The Rear 360 + Normal view is shown first. Using the audio system display on-screen camera selection buttons when reverse is selected the driver can cycle through the following rear camera views:

View name	Description
Rear 360 + Normal	Contains the normal rear camera view, shown next to a 360 degree camera view.
Rear Normal	Provides an image of what is directly behind the vehicle.
Rear Split View	Provides an extended wide angle image of what is behind the vehicle.

When the ignition is on and any gear **except** reverse is selected, the front camera and 360 degree views are shown on the audio system display when the camera selection switch is pressed. The front images are available until the vehicle speed reaches 10 km/h (6 mph). The Front 360 + Normal view is shown first. Using the audio system display on-screen camera selection buttons, in any gear **except** reverse, allows the driver to cycle through the following front camera views:

View name	Description
Front 360 + Normal	Contains the normal front camera view, shown next to a 360 degree camera view.
Front Normal	Provides an image of what is directly in front of the vehicle.
Front Split View	Provides an extended wide angle image of what is in front of the vehicle.

To enable the front and rear camera displays, the IPMB monitors the camera selection switch, gear position and vehicle speed messages. The PCM sends the gear position and vehicle speed messages to the GWM through the HS-CAN1 and the GWM then sends the messages to the IPMB via HS-CAN2 . The camera selection switch is hardwired to the IPMB .

All camera views are generated by the IPMB , using the video signals from one or more of the cameras. The video signals are sent from the cameras to the IPMB through coaxial cables. The IPMB processes the image(s) from the cameras and sends a single image with the desired view to the APIM . The IPMB creates the final video images seen at the display and applies video adjustments such as brightness and sharpness color.

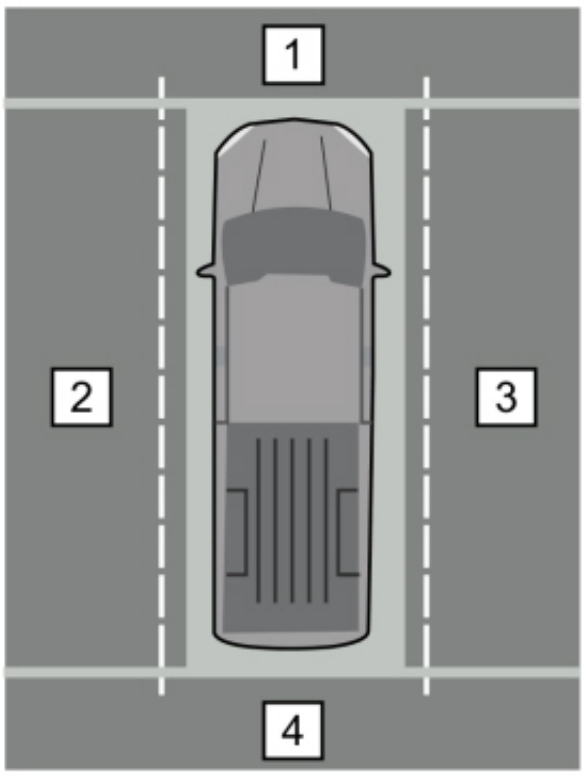
360 Degree Image Composition

To generate the 360 degree view, raw video is sent to the IPMB in serialized data format, and the IPMB combines and aligns the images from all 4 cameras to produce a single overhead view that is displayed on the audio system display along with a front or rear camera view.

NOTE: *When a camera or any body component that a camera is attached to is removed or adjusted, the 360 degree view camera alignment must be performed to create a 360 degree image.*

Refer to: **360 Degree View Camera Alignment** (413-13B Parking Aid - Vehicles With: Parking Aid Camera, General Procedures).

NOTE: *F-150 shown, other vehicles similar.*



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Item	Description
1	Front camera image
2	LH side camera image
3	RH side camera image
4	Rear camera image

Camera Image Generation

The front and rear cameras are on any time they receive voltage (when the ignition is on), but a video signal is only generated under certain conditions. When reverse is selected or

the camera selection switch is pressed, the IPMB sends an enable request message to the front and rear cameras over coaxial cables via LVDS to turn the video signal output on. When any gear except reverse is selected, the IPMB sends a disable request message to the cameras to turn the video signal off when the vehicle speed reaches 16 km/h (10 mph), and sends an enable request message to turn the video signal on when vehicle speed falls below 8 km/h (5 mph). If the IPMB is not configured properly, some features and views may be inoperative.

The LH and RH side cameras are on and generating a video signal any time they receive voltage from the IPMB . The IPMB sends an enable request message through coaxial cables via LVDS to the LH and RH side cameras when reverse is selected and the vehicle speed is below 8 km/h (5 mph) or the camera selection switch is pressed.

Camera Features

The following features are driver selectable:

- Visual park aid alert — allows the driver to see the objects causing the parking aid system to sound.
- Manual zoom — allows the driver to manually zoom the image.
- Video delay — allows the driver to see the image behind the vehicle after the vehicle is shifted out of reverse into any gear other than park.

The following features are not driver selectable:

- Fixed guidelines — displays guidelines to assist the driver with aligning the vehicle with an object.
- Active guidelines — displays the intended path of the vehicle based upon steering wheel input.

The system supports visual park aid alert on 360 + Normal and Normal views. Front and rear split view do not include visual park aid alert. For views that include the 360 degree overhead image, the visual park aid alert is generated by the IPMB . For views that do not include the 360 degree overhead image, the visual park aid alert feature is generated by the APIM .

To turn the manual zoom on and off, the driver generated commands originate at the audio system display, which is physically connected to the APIM . The commands are sent by the APIM to the IPMB via the HS-CAN3 , GWM and HS-CAN2 . The IPMB then sends the zoom command to the rear camera via a coaxial cable. The image is then zoomed in or out by the rear camera.

The video delay feature is controlled within the APIM .

The fixed and active guidelines are generated by the IPMB and are not selectable by the driver.

Visual Park Aid Alert

NOTE: *The on-screen alert transitions may not match changes in the audible parking aid alert tone frequency.*

NOTE: *The visual park aid alert is not available on Front Split View and Rear Split View camera views.*

The visual park aid alert feature displays a visual highlight in the zone where an object has been detected by the parking aid system. For views that include the 360 degree overhead image, the visual park aid alert is displayed as a color changing line around the perimeter of the 360 degree view overhead vehicle graphic. This visual park aid alert feature is generated by the IPMB . For views that do not include the 360 degree overhead image, the visual park aid alert feature is displayed as a vehicle icon in the upper part of the display. This icon is generated by the APIM . These features utilize the parking aid sensor data from the IPMB to generate the visual highlights on the video image.

If the visual park aid alert feature is enabled, the feature is still operational even if the rear parking aid system has been disabled by the driver.

Fixed Guidelines

NOTE: *The color-coded lines cannot indicate accurate or consistent distances between the rear of the vehicle and objects shown in the video image. This normal condition is due to variances in vehicle ride height including, but not limited to, vehicle loading.*

Fixed guidelines are only displayed on the rear camera image in Rear 360 + Normal and Rear Normal views.

The video camera fixed guidelines feature displays guidelines on top of the rear video image to assist the driver with alignment of the vehicle. A dashed line on the displayed image represents the center of the vehicle and 3 color-coded lines (red, yellow, green) identify different zones between the rear of the vehicle and objects. The IPMB generates the fixed guidelines over the video image.

Fixed guidelines are not shown when the tailgate is open.

Active Guidelines

NOTE: *If the battery has been disconnected or discharged, or a module is disconnected or replaced, the active guidelines may be inoperative until the vehicle is driven on a flat and*

smooth road at 32 km/h (20 mph) or more, with hands placed loosely on the steering wheel and minimal steering correction for approximately 30 seconds.

If the guidelines remain inoperative, it may be necessary to disconnect the battery for 5 minutes with the driver's door open, then drive the vehicle for 8 kilometers (5 miles) in normal city driving before performing the procedure described above.

Active guidelines are only displayed on the rear camera image in Rear 360 + Normal and Rear Normal views.

The active guidelines feature displays dynamic guidelines that correspond to the projected path of vehicle travel, based on the current steering angle. Several modules are involved in generating the steering angle data used to support the active guidelines. The PSCM monitors the steering angle sensor and sends the steering wheel angle sensor data to the ABS module via the HS-CAN2 . The ABS module uses this message from the PSCM to generate the steering angle message that is sent to the IPMB through the HS-CAN2 . The IPMB uses this data to generate the active guidelines over the video image.

When the steering wheel is in the straight-ahead position the active guidelines are not shown.

Active guidelines are not shown when the tailgate is open.

Manual Zoom

The manual zoom is only supported by the rear camera. The manual zoom is only available for Rear 360 + Normal and Rear Normal views.

The manual zoom feature has one level of zoom. If the manual zoom feature is on and the vehicle is shifted out of reverse, the manual zoom feature is disabled. The manual zoom feature must be re-enabled the next time reverse is selected. When the driver turns the zoom on or off at the audio system display, the command is sent from the APIM via the HS-CAN3 to the GWM . The GWM then sends the message to the IPMB through the HS-CAN2 . The IPMB sends the manual zoom request message to the rear parking aid camera via the coaxial cable to turn the zoom on or off.

Video Delay

When the video delay is turned on, the APIM keeps the rear normal view display enabled after the transmission is shifted out of reverse into any gear other than park, until the vehicle speed reaches 8 km/h (5 mph). With the delay off (default), the image displays until the transmission is shifted out of reverse.

360 Degree View Camera Alignment

To create a 360 degree overhead image from the 4 separate camera images, the IPMB must align the camera images to each other and to the vehicle. As the camera alignment is very sensitive, the alignment process is necessary any time a camera or any component that a camera is attached to is removed or adjusted.

The alignment process is completed using a diagnostic scan tool and the 360 degree view camera calibration mats.
Refer to: **360 Degree View Camera Alignment** (413-13B Parking Aid - Vehicles With: Parking Aid Camera, General Procedures).

Component Description

Rear Parking Aid Camera

NOTICE: Use caution when handling the coaxial cables. Damage may occur if the cable is bent at too sharp of an angle.

The rear parking aid camera is located in the center of the spare tire. The rear camera communicates with the BCM (on vehicles with a rear parking aid camera) or the IPMB (for vehicles with the 360 degree view camera) through a coaxial cable in a digital serial format (LVDS).

On vehicles equipped with the 360 degree view camera system, the 360 degree view camera alignment must be performed after the tailgate, the reversing lamp assembly or the rear camera is removed from the vehicle.

Front Parking Aid Camera (If Equipped)

NOTICE: Use caution when handling the coaxial cables. Damage may occur if the cable is bent at too sharp of an angle.

The front parking aid camera is located in the center of the front grille. The front parking aid camera communicates with the IPMB through a coaxial cable in a digital serial format (LVDS).

The 360 degree view camera alignment must be performed after the front grille or the front parking aid camera is removed from the vehicle.

LH And RH Side Camera

NOTICE: Use caution when handling the coaxial cables. Damage may occur if the cable is bent at too sharp of an angle.

The side parking aid cameras are located inside the LH and RH exterior rear view mirrors

and are serviceable separately from the mirrors. The LH and RH side cameras communicate with the IPMB through a coaxial cable in a digital serial format (LVDS).

The 360 degree view camera alignment must be performed after the LH or RH side camera or exterior mirror is removed from the vehicle.

Camera selection switch (If Equipped)

The camera selection switch is a momentary contact switch. When the ignition is on and any gear **except** reverse is selected, the front camera and 360 degree views are shown on the audio system display when the camera selection switch is pressed.

Front Camera Washer (If Equipped)

Washer solvent is directed to the front camera lens when the washer pump is active.

For additional information on the front camera washer,
Refer to: **Wipers and Washers - System Operation and Component Description** (501-16 Wipers and Washers, Description and Operation).

Audio System Display

The rear only parking aid camera system image and the 360 degree view camera system images are displayed on the audio system display.

For additional information on the audio system display,
Refer to: **Information and Entertainment System - System Operation and Component Description** (415-00 Information and Entertainment System - General Information, Description and Operation).

APIM (Vehicles Equipped With Rear Only Parking Aid Camera)

The APIM serves as a gateway between the rear parking aid camera and other modules on the vehicle networks.

The APIM requires PMI when replaced.
Refer to: **Module Configuration - System Operation and Component Description** (418-01A Module Configuration, Description and Operation).

IPMB (Vehicles Equipped With 360 Degree View Camera)

NOTICE: Use caution when handling the coaxial cables. Damage may occur if the cable is bent at too sharp of an angle.

For vehicles equipped with a 360 degree view camera system, all camera views are

produced by the IPMB using input from one or more camera(s). The processed video signals are sent from the IPMB to the APIM through a coaxial cable.

In addition to generating the camera views and providing power to the cameras, the IPMB receives the video signals from the front, rear, LH and RH parking aid cameras through coaxial cables and determines which image(s) are sent to the APIM to be displayed on the audio system display.

The IPMB requires PMI when replaced.
Refer to: **Module Configuration - System Operation and Component Description** (418-01A Module Configuration, Description and Operation).

NOTE: *When a new IPMB is installed, a camera alignment DTC is stored until the 360 degree camera alignment is successfully completed.*