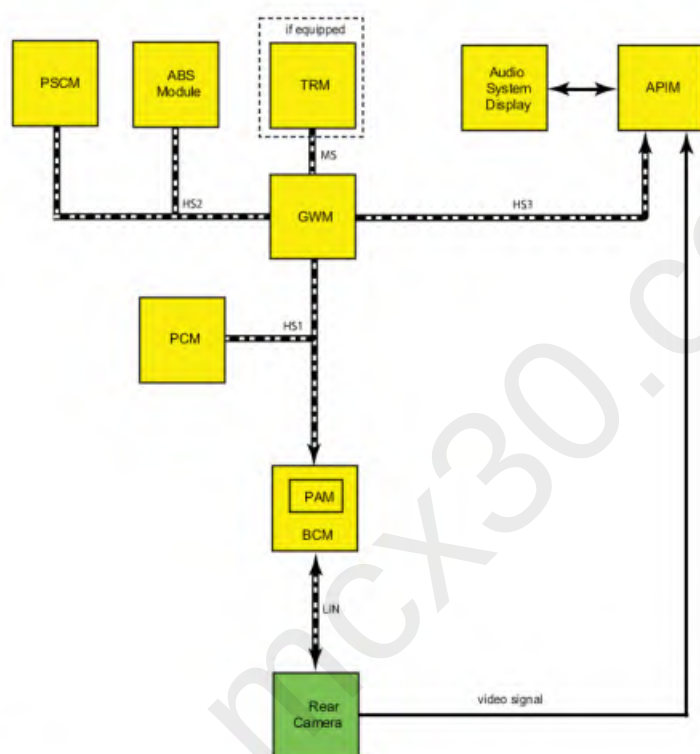


Parking Aid - System Operation and Component Description

System Operation

Rear Only Parking Aid Camera

System Diagram



Item	Description
1	video signal
2	BCM
3	Rear camera
4	PAM
5	PCM
6	APIM

7	Audio system display
8	ABS module
9	PSCM
10	GWM
11	TRM
12	if equipped

Network Message Chart

BCM Network Input Messages

Broadcast Message	Originating Module	Message Purpose
Camera commands	APIM	Used to command the zoom level on and off based on driver inputs through the centerstack infotainment display.
Gear lever position	PCM	Used to support the rear parking aid camera standby mode. Turns the camera image output on when reverse gear is selected.
Parking aid sensor data	PAM	Used to generate the visual highlights in the zone where an object is detected by the rear parking aid system.
Steering angle	ABS module	Used to generate 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 factory trailer tow).
Vehicle speed	PCM	Used to support the rear parking aid 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 8 km/h (5 mph) or less.

ABS Module Network Input Messages

Broadcast Message	Originating Module	Message Purpose
Steering wheel angle sensor data	SCCM (vehicles without adaptive steering)	The ABS module uses the steering angle sensor data to generate the steering angle message that is sent to the BCM to support the active guideline feature.
Steering wheel angle sensor data	SASM (vehicles with adaptive steering)	

APIM Network Input Messages

Broadcast Message	Originating Module	Message Purpose
Camera status	BCM	Used to display the current status for active guidelines and visual park aid alert.
Gear lever position	PCM	Used to enable the video display when reverse gear is selected.
Parking aid sensor data	PAM	Used to generate the visual highlights in the zone where an object is detected by the rear parking aid system.

Broadcast Message	Originating Module	Message Purpose
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 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 gear is selected. To determine the selector lever position and enable the camera display on all other vehicles, 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 gear 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 on shielded twisted pair wires directly to the display.

The following parking aid camera system features are driver selectable:

- Visual park aid alert “ assists the driver to visually see the object causing the parking aid system to sound. (centerstack infotainment display only)
- Manual zoom “ allows the driver to manually zoom the image. (centerstack infotainment display only)
- 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.

On vehicles equipped with a centerstack infotainment display, the display settings menu is used to turn 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 while reverse gear is selected. The driver generated commands originate at the audio system display (which is hardwired to the APIM). The APIM sends the driver generated commands over the HS-CAN3 to the GWM. The GWM then sends the commands to the BCM on the HS-CAN1. The BCM sends the zoom command to the rear parking aid camera via the LIN circuit. 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.

LIN Communication

The BCM and the rear parking aid camera communicate via a LIN circuit which is a dedicated single wire communication network. The BCM is the master module on the LIN, and it sets and stores Diagnostic Trouble Codes (DTCs) for the rear parking aid camera and the communication network.

The messages sent from the BCM to the camera are:

- Camera configuration data
- Display manual zoom request
- Guideline on/off request
- Liftgate ajar status
- Trailer connection status (if equipped with factory trailer tow)
- Steering angle
- Standby enable/disable request

The messages sent from the camera to the BCM 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 gear 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 video 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 (red, yellow, green) identify different zones between the rear of the vehicle and objects.

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

If the vehicle is equipped with a factory TRM, the fixed guidelines are not shown when a trailer is electrically connected to the vehicle.

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 SCCM (vehicles without adaptive steering) or SASM (vehicles with adaptive steering) 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 to generate the steering angle message that is sent to the GWM on the HS-CAN2. The GWM then sends the message to the BCM via the HS-CAN1. The BCM sends the steering angle data to the rear parking aid camera via the LIN circuit. The 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 liftgate is open, the active guidelines are not shown.

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

If the vehicle is equipped with a factory TRM, the active guidelines are not shown when a trailer is electrically connected to the vehicle.

Manual Zoom

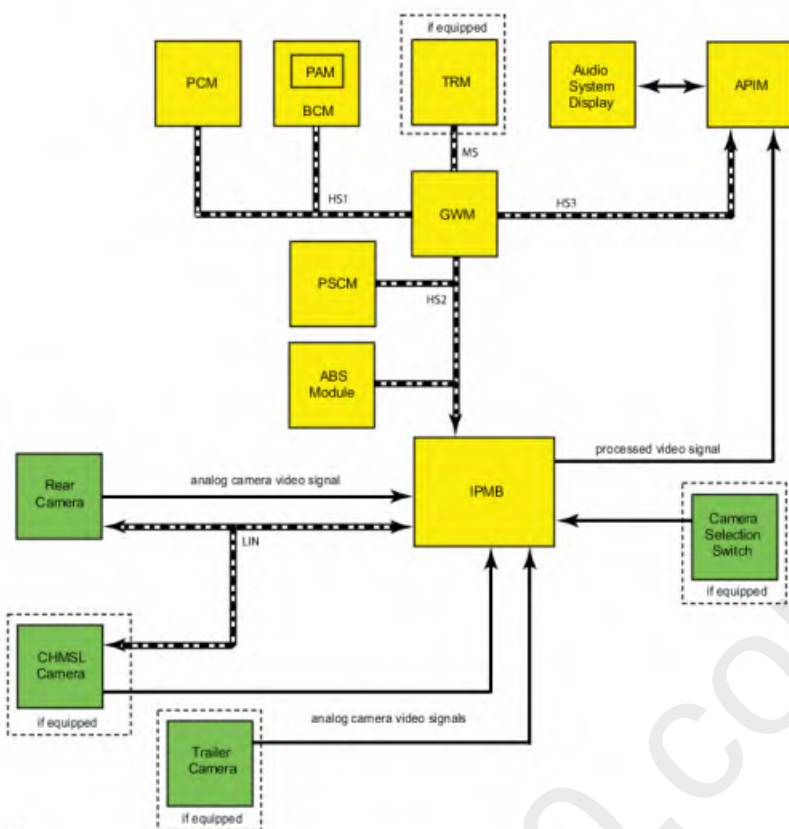
The manual zoom feature is generated by the rear parking aid camera and has one level of zoom. If the manual zoom feature is on and the vehicle is shifted out of reverse gear, the manual zoom feature is disabled and must be re-enabled the next time reverse gear is selected. When the driver turns the zoom on or off at the display, the zoom command is sent from the APIM through HS-CAN3 to the GWM then over HS-CAN1 to the BCM. The BCM then sends the manual zoom request message to the rear parking aid camera via the LIN circuit.

Video Delay

When the video delay is turned on, the display keeps the rear video display enabled after the transmission is shifted out of reverse gear 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 gear.

Rear Parking Aid Camera And CHMSL Camera Or Trailer Camera (2 Camera System)

System Diagram



E322722

Item	Description
1	analog camera video signal
2	analog camera video signals
3	BCM
4	processed video signal
5	Rear camera
6	Trailer camera
7	CHMSL camera
8	PAM
9	PCM
10	APIM
11	Audio system display
12	ABS module
13	PSCM
14	IPMB

15	GWM
16	TRM
17	Camera selection switch
18	if equipped
19	if equipped
20	if equipped
21	if equipped

Network Message Chart

IPMB Network Input Messages

Broadcast Message	Originating Module	Message Purpose
Camera commands	APIM	Used to command the visual park aid alert and zoom level on and off based on driver inputs through the centerstack infotainment display.
Gear lever position	PCM	Used to support the camera standby mode. Turns the camera image output on when reverse gear is selected.
Parking aid sensor data	PAM	Used to generate the visual highlights in the zone where an object is detected by the rear parking aid system.
Steering angle	ABS module	Used to generate 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 factory trailer tow).
Vehicle speed	PCM	Used to support the 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 8 km/h (5 mph) or less.

ABS Module Network Input Messages

Broadcast Message	Originating Module	Message Purpose
Steering wheel angle sensor data	SCCM (vehicles without adaptive steering)	The ABS module uses the steering angle sensor data to generate the steering angle message that is sent to the BCM to support the active guideline feature.
Steering wheel angle sensor data	SASM (vehicles with adaptive steering)	

APIM Network Input Messages

Broadcast Message	Originating Module	Message Purpose
Camera status	IPMB	Used to display the current status for active guidelines and visual park aid alert.
Gear lever position	PCM	Used to enable the video display when reverse gear is selected.
Parking aid sensor data	PAM	Used to generate the visual highlights in the zone where an object is detected by the rear parking aid system.

Broadcast Message	Originating Module	Message Purpose
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 must be fully closed for correct operation of the rear parking aid camera system.*

The 2 camera system is capable of displaying different camera views to visually aid the driver.

The rear parking aid camera image is displayed by the audio system display when reverse gear is selected. To determine the selector lever 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.

While reverse gear is selected, the camera selection switch or on-screen button is used to cycle between the rear parking aid camera view and the CHMSL camera or trailer camera view.

The 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 gear is selected, the cameras continuously generate a video signal. When any gear except reverse is selected, the cameras turn the video signal off when the vehicle speed reaches 16 km/h (10 mph), and turn the video signal on when vehicle speed falls below 8 km/h (5 mph). If the cameras are not configured properly, some features may be inoperative. The camera sends the video signal on shielded twisted pair wires directly to the display.

The following rear parking aid camera features are driver selectable:

- Visual park aid alert “” assists the driver to visually see the object causing the parking aid system to sound. (centerstack infotainment display only)
- Manual zoom “” allows the driver to manually zoom the image. (centerstack infotainment display only)
- 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 rear parking aid camera 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 centerstack infotainment display settings menu is used to turn 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 while reverse gear is selected. The driver generated commands originate at the audio system display (which is hardwired to the APIM). The APIM sends the driver generated commands over the HS-CAN3 to the GWM. The GWM then sends the commands to the IPMB on the HS-CAN2. The IPMB sends the zoom command to the rear camera or CHMSL camera via the LIN circuit. The zoom is generated by the camera.

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

The fixed centerline is generated by the CHMSL camera and is not selectable by the driver.

LIN Communication

The IPMB communicates with the rear parking aid camera and CHMSL camera via a LIN circuit, which is a dedicated single wire communication network. The IPMB is the master module on the LIN, and it sets and stores Diagnostic Trouble Codes (DTCs) for the rear camera, CHMSL camera, and the LIN.

The messages sent from the IPMB to the cameras are:

- Camera configuration data
- Display manual zoom request
- Guideline on/off request
- Trailer connection status (if equipped with factory trailer tow)
- Steering angle (rear camera only)
- Standby enable/disable request

The messages sent from the camera to the IPMB 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 on the rear camera video image 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 gear 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 video camera fixed guidelines feature displays guidelines on top of the rear camera 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 guidelines are not shown when reverse is not selected (video delay active).

If the vehicle is equipped with a factory TRM, the fixed guidelines are not shown when a trailer is electrically connected to the vehicle.

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 on top of the rear camera image 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 SCCM (vehicles without adaptive steering) or SASM (vehicles with adaptive steering) 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 to generate the steering angle message that is sent to the IPMB on the HS-CAN2. The IPMB sends the steering angle data to the rear parking aid camera via the LIN circuit. The 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 liftgate is open, the active guidelines are not shown.

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

If the vehicle is equipped with a factory TRM, the active guidelines are not shown when a trailer is electrically connected to the vehicle.

Manual Zoom

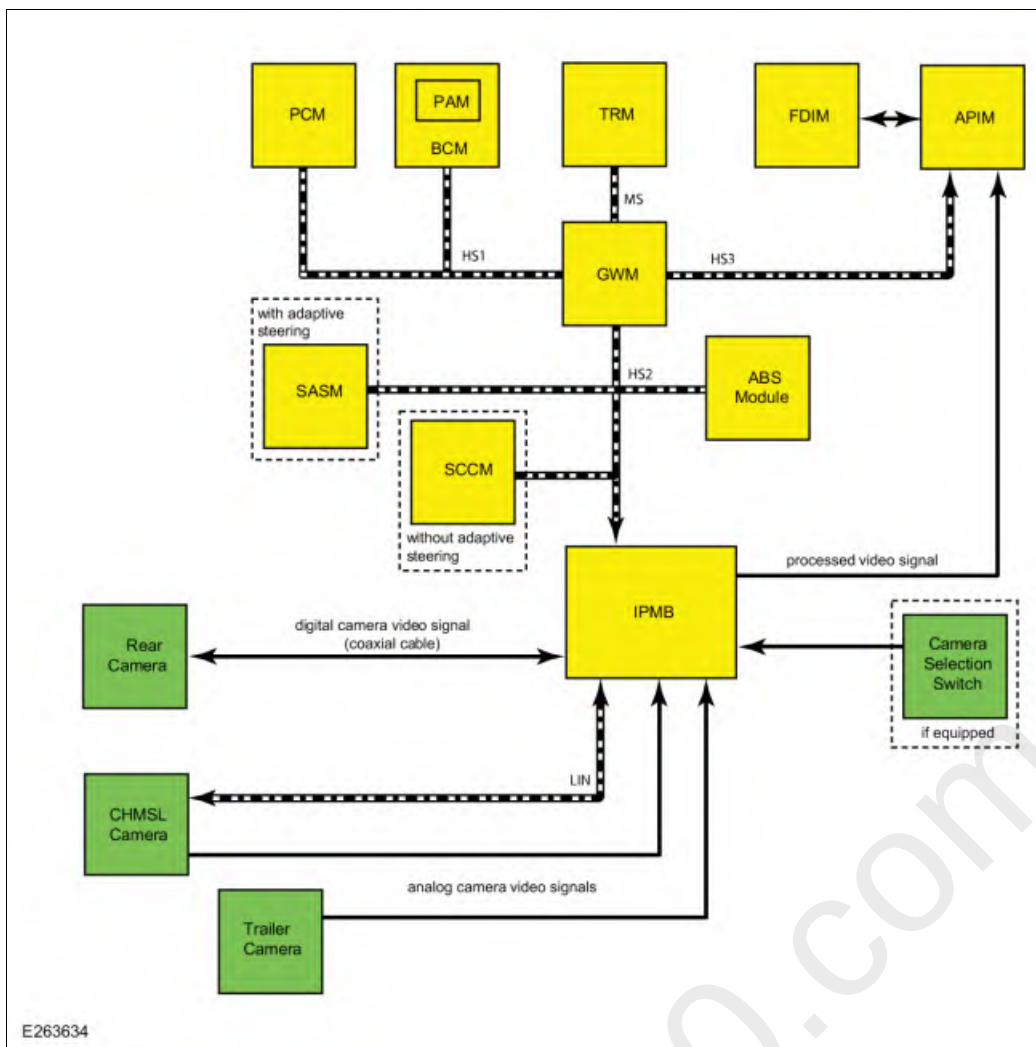
The manual zoom feature is generated by the rear parking aid camera and has one level of zoom. If the manual zoom feature is on and the vehicle is shifted out of reverse gear, the manual zoom feature is disabled and must be re-enabled the next time reverse gear is selected. When the driver turns the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

Video Delay

When the video delay is turned on, the display keeps the rear video display enabled after the transmission is shifted out of reverse gear 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 gear.

Rear Parking Aid Camera, CHMSL Camera, And Trailer Camera (3 Camera System)

System Diagram



Item	Description
1	SASM
2	With adaptive steering
3	SCCM
4	Without adaptive steering
5	Analog camera video signals
6	BCM
7	Processed video signal
8	Rear camera
9	Trailer camera
10	CHMSL camera
11	PAM
12	PCM
13	APIM
14	FDIM
15	ABS Module
16	IPMB
17	GWM
18	TRM
19	Camera selection switch
20	If equipped
21	Digital camera video signal (coaxial cable)

Network Message Chart

IPMB Network Input Messages

Broadcast Message	Originating Module	Message Purpose
Camera commands	APIM	Used to command the visual park aid alert and zoom level on and off based on driver inputs through the centerstack infotainment display.
Gear lever position	PCM	Used to support the camera standby mode. Turns the camera image output on when reverse gear is selected.
Parking aid sensor data	PAM	Used to generate the visual highlights in the zone where an object is detected by the rear parking aid system.
Steering angle	ABS module	Used to generate 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 factory trailer tow).
Vehicle speed	PCM	Used to support the 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 8 km/h (5 mph) or less.

ABS Module Network Input Messages

Broadcast Message	Originating Module	Message Purpose
Steering wheel angle sensor data	SCCM (vehicles without adaptive steering)	The ABS module uses the steering angle sensor data to generate the steering angle message that is sent to the BCM to support the active guideline feature.
Steering wheel angle sensor data	SASM (vehicles with adaptive steering)	

APIM Network Input Messages

Broadcast Message	Originating Module	Message Purpose
Camera status	IPMB	Used to display the current status for active guidelines and visual park aid alert.
Gear lever position	PCM	Used to enable the video display when reverse gear is selected.
Parking aid sensor data	PAM	Used to generate the visual highlights in the zone where an object is detected by the rear parking aid system.
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 must be fully closed for correct operation of the rear parking aid camera system.

The 3 camera system is capable of displaying different camera views to visually aid the driver.

The rear parking aid camera image is displayed by the audio system display when reverse gear is selected. To determine the selector lever 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.

While reverse gear is selected, the camera selection switch or on-screen button is used to cycle between the rear parking aid camera view, CHMSL camera view, and trailer camera view.

The rear and CHMSL 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 gear is selected, the cameras continuously generate a video signal. When any gear except reverse is selected, the cameras turn the video signal off when the vehicle speed reaches 16 km/h (10 mph), and turn the video signal on when vehicle speed falls below 8 km/h (5 mph). If the cameras are not configured properly, some features may be inoperative. The camera sends the video signal on shielded twisted pair wires directly to the display.

The trailer camera is ON any time it receives voltage.

The following rear parking aid camera features are driver selectable:

- Visual park aid alert “” assists the driver to visually see the object causing the parking aid system to sound. (centerstack infotainment display only)
- Manual zoom “” allows the driver to manually zoom the image. (centerstack infotainment display only)
- 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 rear parking aid camera 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 centerstack infotainment display settings menu is used to turn 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 while reverse gear is selected. The driver generated commands originate at the audio system display (which is hardwired to the APIM). The APIM sends the driver generated commands over the HS-CAN3 to the GWM. The GWM then sends the commands to the IPMB on the HS-CAN2. The IPMB sends the zoom command to the rear camera or CHMSL camera. The zoom is generated by the camera.

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

The fixed centerline is generated by the CHMSL camera and is not selectable by the driver.

LIN Communication

The IPMB communicates with the CHMSL camera via a LIN circuit, which is a dedicated single wire communication network.

The messages sent from the IPMB to the CHMSL camera are:

- Camera configuration data
- Guideline on/off request
- Standby enable/disable request
- Trailer connection status (if equipped with factory trailer tow)

The messages sent from the CHMSL camera to the IPMB are:

- Camera 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 on the rear camera video image 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 gear 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 video camera fixed guidelines feature displays guidelines on top of the rear camera 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 guidelines are not shown when reverse is not selected (video delay active).

If the vehicle is equipped with a factory TRM, the fixed guidelines are not shown when a trailer is electrically connected to the vehicle.

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 on top of the rear camera image 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 SCCM (vehicles without adaptive steering) or SASM (vehicles with adaptive steering) 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 to generate the steering angle message that is sent to the IPMB on the HS-CAN2. The IPMB sends the steering angle data to the rear parking aid camera via the coaxial cable. The 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 liftgate is open, the active guidelines are not shown.

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

If the vehicle is equipped with a factory TRM, the active guidelines are not shown when a trailer is electrically connected to the vehicle.

Manual Zoom

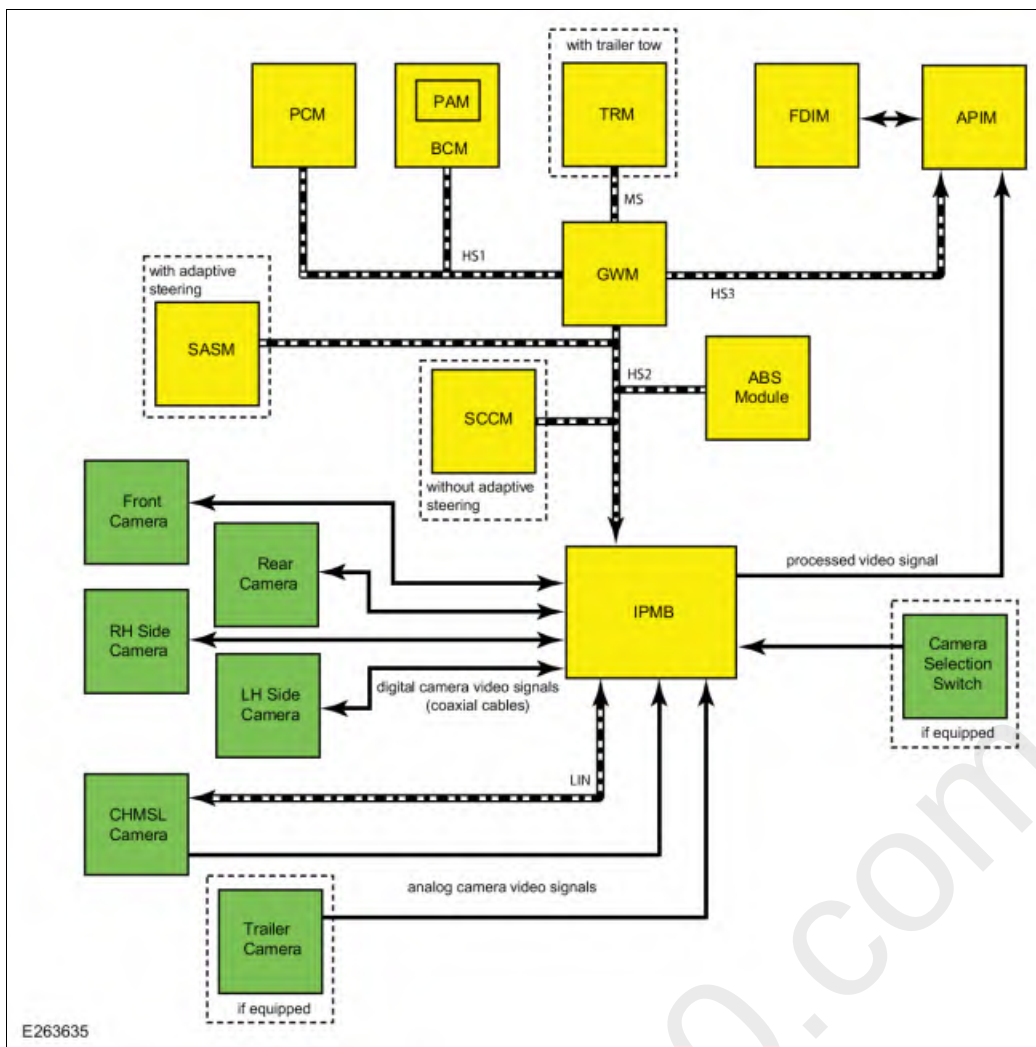
The manual zoom feature is generated by the rear parking aid camera and has one level of zoom. If the manual zoom feature is on and the vehicle is shifted out of reverse gear, the manual zoom feature is disabled and must be re-enabled the next time reverse gear is APIM through HS-CAN3 to the GWM, then over HS-CAN2 to the IPMB. The IPMB then sends the manual zoom request message to the CHMSL camera via the LIN circuit or the rear camera via the coaxial cable.

Video Delay

When the video delay is turned on, the display keeps the rear video display enabled after the transmission is shifted out of reverse gear 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 gear.

360 Degree View Camera

System Diagram



Item	Description
1	IPMB
2	Front camera
3	SASM
4	With adaptive steering
5	SCCM
6	Without adaptive steering
7	Analog camera video signals
8	BCM
9	Processed video signal
10	Rear camera
11	LH side camera
12	Trailer camera
13	RH side camera
14	CHMSL camera
15	PAM
16	PCM
17	APIM
18	FDIM
19	ABS Module
20	GWM
21	TRM

22	With trailer tow
23	If equipped
24	Camera selection switch
25	If equipped
26	Digital camera video signals (coaxial cables)

Network Message Chart

IPMB Network Input Messages

Broadcast Message	Originating Module	Message Purpose
Camera commands	APIM	Used to command the camera selection, visual park aid alert, and zoom level on and off based on driver inputs through the audio system display.
Camera selection switch status	FCIM	Used to switch the 360 degree views or rear parking aid camera views dependent upon the transmission gear selection.
Driver door ajar status	BCM	Used to generate the door ajar icon on the image when the LH front or rear door is ajar.
Gear lever position	PCM	Used to enable the front or rear camera views based on the current gear selection.
Liftgate ajar status	BCM	Disables the guidelines and visual park aid alert when the liftgate is open.
Parking aid sensor data	PAM	Used to generate the visual highlights in the zone where an object is detected by the parking aid system.
Passenger door ajar status	BCM	Used to generate the door ajar icon on the image when the RH front or rear door is ajar.
Steering angle	ABS module	Used to generate 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 factory trailer tow).
Vehicle speed	PCM	Used to support standby mode for all cameras. 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 8 km/h (5 mph) or less.

ABS Module Network Input Messages

Broadcast Message	Originating Module	Message Purpose
Steering wheel angle sensor data	SCCM (vehicles without adaptive steering)	The ABS module uses the steering angle sensor data to generate the steering angle message that is sent to the BCM to support the active guideline feature.
Steering wheel angle sensor data	SASM (vehicles with adaptive steering)	

APIM Network Input Messages

Broadcast Message	Originating Module	Message Purpose
Camera status	IPMB	Used to enable the video display when the camera selection switch is pressed.
Gear lever position	PCM	Used to enable and disable the video display based on the current gear selection.
Parking aid sensor data	PAM	Used to generate the visual highlights in the zone where an object is detected by the rear audible parking aid system.
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 360 degree view camera system is capable of generating several different views using the front, rear, LH side, RH side, CHMSL, and trailer cameras (if equipped), and the IPMB. The IPMB processes the video signals from the 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 gear is selected, the rear camera views are shown on the audio system display. The Rear 360 + Normal view is shown first. Subsequent presses of the camera selection switch or on-screen buttons when reverse gear is selected allow the driver to 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.
Rear High View	Provides an image of the truck bed and can be used to align the vehicle with a fifth wheel or gooseneck trailer
Auxiliary View (if equipped)	Provides a rear view image from the back of a connected trailer while reversing
Trailer Reverse Guidance View (if equipped)	Provides a rear view image behind the vehicle using the side cameras, useful when reversing with a trailer.

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. Subsequent presses of the camera selection switch allow 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 is what is in front of the vehicle.

To enable the front or rear camera displays, the IPMB monitors the camera selection switch (if equipped) or on-screen button status from the APIM, 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 APIM sends the on-screen camera selection button status message to the GWM through the HS-CAN3. The GWM then sends the messages to the IPMB via HS-CAN2.

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.

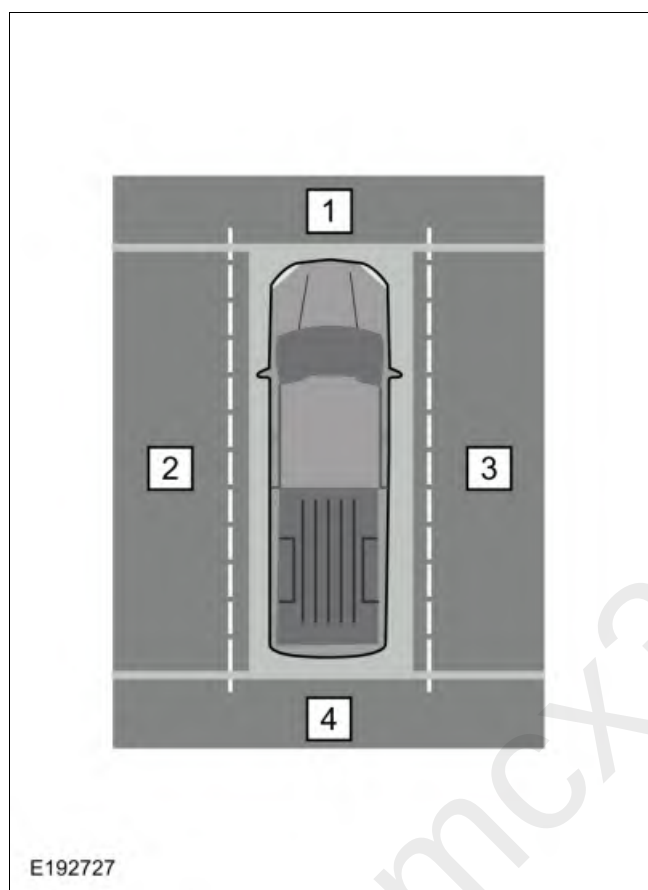
360 Degree Image Composition

To generate the 360 degree view, 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-Series shown, other vehicles similar.



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 gear is selected or the camera selection switch is pressed, the IPMB sends an enable request message to the front and rear cameras 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 front or rear camera 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 supplies voltage to the LH and RH side cameras when reverse gear is selected or the camera selection switch is pressed.

LIN Communication

The IPMB communicates with the CHMSL camera via a LIN circuit, which is a dedicated single wire communication network.

The messages sent from the IPMB to the CHMSL camera are:

- Camera configuration data
- Guideline on/off request
- Standby enable/disable request
- Trailer connection status (if equipped with factory trailer tow)

The messages sent from the CHMSL camera to the IPMB are:

- Camera status
- Camera part number data
- Guideline status

Camera Features

The system supports several rear camera features to assist the driver.

The following features are driver selectable:

- Visual park aid alert “visually alerts the driver to 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 APIM then zooms the image in or out.

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 rear camera 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 PAM 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.

A fixed center guideline is also shown by the CHMSL camera to assist the driver in locating the centerline of the vehicle.

The rear 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.

Fixed rear guidelines are not shown when the tailgate is open.

If the vehicle is equipped with a factory TRM, the fixed guidelines are not shown when a trailer is electrically connected to the vehicle.

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 SCCM (vehicles without adaptive steering) or SASM (vehicles with adaptive steering) 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 to generate the steering angle message that is sent to the IPMB through the HS-CAN2. The IPMB sends the steering angle data to the rear parking aid camera via the LIN circuit. The camera 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 liftgate is open.

If the vehicle is equipped with a factory TRM, the active guidelines are not shown when a trailer is electrically connected to the vehicle.

Manual Zoom

If the manual zoom feature is on and the camera view is changed or the camera system is turned off, the manual zoom feature is disabled. The manual zoom feature must be re-enabled the next time the camera view is selected. When the driver turns the zoom on or off at the audio system display, the APIM zooms the camera image.

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 gear, 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 gear.

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

BCM (Vehicles Equipped With Rear Only Parking Aid Camera)

The BCM serves as a gateway between the rear parking aid camera and other modules on the HS-CAN1. It communicates with the rear parking aid camera via the LIN and stores Diagnostic Trouble Codes (DTCs) for the camera and the LIN in the event of a concern.

The BCM requires PMI when replaced.

Refer to: Module Configuration - System Operation and Component Description (418-01 Module Configuration, Description and Operation).

Camera selection switch (If Equipped)

The camera selection switch is a momentary contact switch that is serviceable separately from the FCIM. When pressed, the switch provides ground to the IPMB via a hardwired circuit.

CHMSL Camera (If Equipped)

The CHMSL camera is located inside the CHMSL assembly and is serviceable separately from the CHMSL.

The CHMSL camera is analog and sends video signals to the IPMB through shielded, twisted pair circuits. The CHMSL camera communicates with the IPMB through a LIN circuit.

Front Parking Aid Camera (If Equipped)

The front parking aid camera located in the center of the front grille. The front parking aid camera communicates with the IPMB through a coaxial cable using LVDS.

The front camera is digital and sends video signals to the IPMB through a coaxial cable. The front camera also communicates with the IPMB through the coaxial cable using LVDS.

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

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

IPMB (Vehicles Equipped With 2 Or More Cameras)

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 2 or more cameras, 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 on shielded, twisted pair circuits.

The IPMB receives the video signals from the front, rear, LH and RH parking aid cameras through coaxial cables, and from the CHMSL camera and trailer camera (if equipped) on shielded, twisted pair circuits. The IPMB determines which image(s) are sent to the APIM to be displayed on the audio system display.

In addition to generating the camera views, the IPMB serves as a gateway between all cameras (except the trailer camera) and other modules on the HS-CAN2. It communicates with the front, rear, LH, and RH cameras via coaxial cables and with the CHMSL camera via the LIN.

The IPMB requires PMI when replaced.

Refer to: Module Configuration - System Operation and Component Description (418-01 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.*

LH And RH Side Camera (If Equipped)

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

The side cameras are digital and send video signals to the IPMB through coaxial cables. The side cameras also communicate with the IPMB through the coaxial cables using LVDS.

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

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

Rear Parking Aid Camera

The rear parking aid camera is located on the tailgate.

On vehicles equipped with the rear only parking aid camera system, the rear camera communicates with the BCM through a LIN circuit. On vehicles with 2 camera systems or the rear only parking aid camera system, the rear parking aid camera must be configured using a diagnostic scan tool after replacement in order for all features to operate properly.

On vehicles with 2 cameras, the rear parking aid camera is analog and sends video signals to the IPMB through shielded, twisted pair circuits. The rear camera communicates with the IPMB through a LIN circuit.

On vehicles equipped with a 3 or more cameras, the rear camera is digital and sends video signals to the IPMB through a coaxial cable. The rear camera also communicates with the IPMB through the coaxial cable using LVDS.

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

If the vehicle is equipped with the 360 degree view camera system, the 360 degree view camera alignment must be performed after the tailgate or the rear camera is removed from the vehicle.

Trailer Camera (If Equipped)

The trailer camera is designed to be installed on the back of a customer trailer using the included wiring harness.

The trailer camera is analog and sends video signals to the IPMB through shielded, twisted pair circuits. The trailer camera is ON any time it receives voltage and it does not communicate with the IPMB.

Video Display

The parking aid camera uses the audio system display.

For additional information,

Refer to: Information and Entertainment System (415-00 Information and Entertainment System - General Information, Diagnosis and Testing).

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