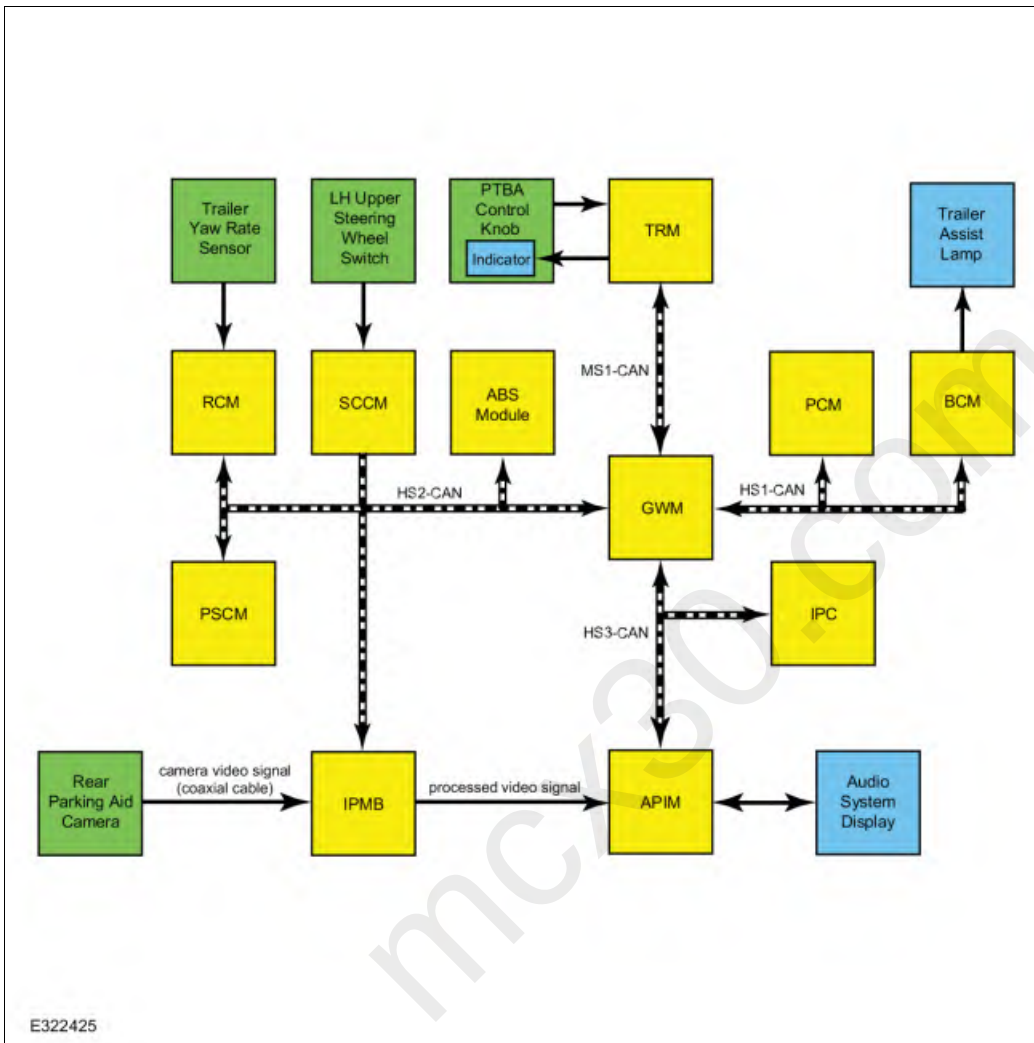


Parking Aid - System Operation and Component Description

System Operation

Pro Trailer Backup Assist

System Diagram



Item	Description
1	processed video signal
2	PCM
3	RCM
4	GWM
5	Audio system display
6	APIM
7	IPMB
8	IPC
9	SCCM
10	TRM
11	BCM
12	PTBA control knob

13	ABS module
14	PSCM
15	LH Upper Steering Wheel Switch
16	Trailer yaw rate sensor
17	Indicator
18	Trailer assist lamp
19	Rear parking aid camera
20	camera video signal (coaxial cable)

Network Message Chart

PSCM Network Input Messages

Broadcast Message	Originating Module	Message Purpose
Braking status	ABS	Used to provides a status of ABS ability to support the braking request from the PSCM.
Cancel request	APIM	Used to provide a cancel request from the APIM if it cannot support the PSCM display request.
Gear lever position	PCM	Used for PTBA feature activation and video display.
Power mode/ignition state	BCM	Used to ensure the ignition state is appropriate for PTBA operation.
Trailer backup assist enabled request	IPC	Used to enable the PSCM for PTBA operation for the trailer chosen by the user.
Trailer backup assist available	PCM	Used to provide the current PTBA control knob position and button status (pressed/not pressed).
Trailer backup assist switch request	TRM	Used to provide the current PTBA control knob position and button status (pressed/not pressed).
Trailer data	IPC	Used to provide the trailer data for the current active trailer. Includes the trailer ID and all the trailer measurements stored in the IPC.
Trailer speed limiting status	PCM	Used to provide the status of the PCM ability to support the speed limiting request from the PSCM.
Trailer target sticker data	IPMB	Used to provide the target sticker tracking data to the PSCM. Includes trailer angle data and the status of the IPMB ability to track the sticker.
Trailer yaw rate sensor data	RCM	Used to provide the trailer yaw rate data to the PSCM. Includes hitch angle data and the trailer yaw rate sensor ID.
Vehicle speed	ABS	Used as an input to the PTBA controller in the PSCM.
Wheel speed data	ABS module	Confirms vehicle movement and calculate distance traveled during PTBA maneuvers.
Wheel rotation data	ABS module	Confirms wheel rotation during PTBA maneuvers.
Wheel rotation direction	ABS module	Confirms wheel rotation direction during PTBA maneuvers.

IPMB Network Input Messages

Broadcast Message	Originating Module	Message Purpose
Power mode/ignition state	BCM	Used to command ignition position.
Trailer backup assist enabled	PSCM	Used to request trailer angle detection in the IPMB.
Image request	APIM	Request to the IPMB to cycle to the next available image.
Trailer backup assist text message request	PSCM	Used to provide PTBA centerstack infotainment display status to the IPMB.

Broadcast Message	Originating Module	Message Purpose
Trailer data	IPC	Used to broadcast the trailer data for the current active trailer. Includes the trailer ID and all the trailer measurements stored in the IPC.
Trailer yaw rate sensor data	RCM	Used to provide the trailer yaw rate data to the PSCM. Includes hitch angle data and the trailer yaw rate sensor ID.

IPC Network Input Messages

Broadcast Message	Originating Module	Message Purpose
Gear lever position	PCM	Input used for the park requirement for trailer set up in the message center.
Steering wheel switch status	SCCM	Used to provide the LH upper steering wheel switch status to the IPC.
Trailer backup assist text message request	PSCM	Used to provide the trailer information message displays in the message center.
Trailer target sticker data	IPMB	Used to provide trailer specific target data found during setup that must be stored in the IPC.
Trailer yaw rate sensor data	RCM	Used to provide the trailer yaw rate data to the PSCM. Includes hitch angle data and the trailer yaw rate sensor ID.

BCM Network Input Messages

Broadcast Message	Originating Module	Message Purpose
Trailer hitch lamp request	PSCM	Used to turn on the trailer hitch lamp.

TRM Network Input Messages

Broadcast Message	Originating Module	Message Purpose
Trailer backup status	PSCM	Used to illuminate the status indicator in the PTBA control knob button when system is on.

PCM Module Network Input Messages

Broadcast Message	Originating Module	Message Purpose
Powertrain Speed Limit Request	PSCM	Used to limit the vehicle speed and throttle response when PTBA is in use.
Trailer backup assist enabled	PSCM	Used to provide the current PTBA control knob position and button status (pressed/not pressed).

ABS Module Network Input Messages

Broadcast Message	Originating Module	Message Purpose
Brake request	PSCM	Used to activate the vehicle brakes to control speed during PTBA maneuvers.

APIM Network Input Messages

Broadcast Message	Originating Module	Message Purpose
Trailer backup assist text message request	PSCM	Used to generate messages on the centerstack infotainment display.

RCM Network Input Messages

Broadcast Message	Originating Module	Message Purpose
Trailer target sticker data	IPMB	Used to provide the trailer dimension data to the RCM. Includes the trailer length and the hitch position.

Pro Trailer Backup Assist

NOTE: The tailgate and doors must be fully closed for correct operation of the PTBA system.

NOTE: The trailer electrical connection status is irrelevant to the operation of the PTBA system.

NOTE: The rear audible parking aid system is disabled automatically while the PTBA system is active.

In order to utilize the PTBA system, each trailer must be set up once. Some measurements and trailer specifications have to be entered through the IPC message center trailer towing tab, using the LH upper steering wheel switch. The trailer information is stored in the IPC for easy recall and the IPC can store up to a maximum of 10 different conventional trailers. Refer to the Owner's Literature (Pro Trailer Backup Assist Quick Start Guide) to find the detailed steps and instructions required to properly position the vehicle and trailer in order to setup, calibrate and operate the PTBA system. The setup and calibration for fifth wheel and gooseneck trailers is different than conventional trailers. For best results, it is not recommended to calibrate the system with conventional trailer in low ambient light conditions. Refer to the Owner's Literature for tips to resolve warnings or difficulties that may occur during setup.

After the PTBA system is setup, the driver can adjust the curvature of the trailer path using the PTBA control knob located on the instrument panel. The PTBA control knob includes a button to enable and disable the system and the user rotates the knob to control the direction of the trailer while reversing. When the PTBA control knob button is pressed and a stored trailer is selected, the IPC message center and the centerstack infotainment display prompts the driver to shift to REVERSE (R) to activate the system. When the system is in use, releasing the PTBA control knob allows the knob to return to center or zero curvature and the vehicle follows the trailer path. Pressing and releasing the PTBA control knob button or turning the steering wheel at any time the system is active, disables the PTBA system. If the system is disabled by the operator after the system starts to control the steering, the centerstack infotainment display displays a PTBA canceled message followed by a warning chime.

The PSCM uses the hitch angle to determine the correct steering angle. The hitch angle is received from the rear parking aid camera for conventional trailers or for gooseneck and fifth wheel trailers, the system receives hitch angle from the RCM.

The PTBA system keeps the trailer angle and speed within reasonable operating limits enabling the driver to control the path of the trailer. Vehicle speed is always limited to below 10 km/h (6 mph) when the PTBA system is active and the feature deactivates if 10 km/h (6 mph) is exceeded. Vehicle brakes may be automatically applied and engine torque may be automatically reduced to limit speed. The target speed limit varies depending on operating conditions but can be as low as 3 km/h (2 mph).

Several modules communicate with each other to control the PTBA system functions. The TRM reads the PTBA control knob and button analog signals and sends them on the MS-CAN through the GWM to the PSCM on the HS-CAN2. For conventional trailers, the rear parking aid camera captures the trailer target sticker image on the trailer and sends the data to the IPMB over two video signal circuits. The IPMB reads the video signal from the rear parking aid camera and determines the tracking status and trailer angle based on the entered dimensions (if the trailer target sticker is detected). The trailer target sticker data is then sent from the IPMB to the PSCM over the HS-CAN2. For gooseneck or fifth wheel trailers, the RCM reads the trailer yaw rate sensor to determine the hitch angle and sends the information to the PSCM over the HS-CAN2. The PSCM uses all the data it receives from each interfacing module to control overall PTBA system operation. The following are outputs of the PTBA controller software in the PSCM:

- Request for warning or instructions to the driver to be displayed in the IPC and centerstack infotainment display.
- Steering wheel position to achieve the desired trailer curvature (indicated by the knob position).
- Braking and powertrain speed limiting requests.
- Activation and deactivation of the PTBA system.

Certain conditions can cause the PTBA to incorrectly align the vehicle and trailer (not backup straight):

- PTBA control knob concern.
- A spare tire installed on the vehicle or trailer.
- One of the tires on the vehicle or trailer has significantly more or less treadwear than the other tires.
- One of the tires on the vehicle or trailer is deflated or over inflated.
- Different tire sizes are used on the vehicle or trailer.
- The drawbar connection to the hitch receiver is inadequate.
- Trailer suspension concern.
- For conventional trailers - the rear parking aid camera, tailgate or tailgate handle is damaged.
- The trailer frame or tongue is damaged.
- The ground is irregular.
- For fifth wheel or gooseneck trailers - incorrect installation of trailer yaw rate sensor.

It is possible to compensate for the trailer drifting to the right or left by slowly turning the PTBA control knob until the trailer is following your desired path and then holding the knob in that position. Fixing the cause of the concern and as needed recalibrating the system is recommended for straight backing.

If an input module fault or other system malfunction is present, the PTBA system is disabled and a PTBA fault message is shown on the centerstack infotainment display and/or on the IPC message center display. In addition to possible vehicle faults, certain driver actions and vehicle operating conditions can cause the PTBA system to be temporarily disabled.

PTBA and Trailer Reverse Guidance Camera Views

When the ignition is ON, the PTBA control knob button is in the on position and reverse gear is selected, the camera system activates the PTBA and Trailer Reverse Guidance camera views that are shown on the FDIM. There are several camera views that are available in the PTBA and Trailer Reverse Guidance system. The different views are accessed by pressing the camera view soft button on the FDIM allowing the driver to cycle through the rear parking aid camera views. The following views are available:

View name	Description
Rear PTBA 360 + Rear Normal	Contains the normal rear parking aid camera view, shown next to a PTBA 360 degree camera view.
Rear Normal	Provides an image of what is directly behind the vehicle.
Rear Split	Shows 180 degree view of behind the vehicle.
Bed Camera	Shows the truck bed and can be used for 5th wheel or gooseneck trailers.
Trailer Aux	Shows a rear view camera image of what is behind the trailer. This camera needs to be purchased and separately installed.
Trailer reverse guidance	Shows you a view along the sides of your truck and your trailer. In auto mode, this view moves as your trailer moves so that you do not have to adjust the camera as you turn.
Straight backup mode	Use this view when you want to keep your trailer completely in line with your truck. In this mode, a steering wheel graphic shows you which way to turn your steering wheel to keep your trailer straight.
Straight backup mode	Use this view when you want to keep your trailer completely in line with your truck. In this mode, a steering wheel graphic shows you which way to turn your steering wheel to keep your trailer straight.
Hitch angle mode	The hitch angle view shows you a small, top-view representation of the truck and trailer.

When the ignition is ON, the PTBA control knob button is in the on position and reverse gear is selected, the rear PTBA camera view is shown on the audio system display. The rear PTBA camera view contains an icon representing a trailer attached to a truck on the right side of the display. This icon is called the trailer angle graphic icon. It shows the current trailer angle and the direction the trailer will go based on the PTBA knob input.

For additional information on the centerstack infotainment display,

Refer to: Parking Aid - Component Location (413-13C Parking Aid - Vehicles With: Trailer Back Up Assist (TBA), Description and Operation).

Camera Communication

To communicate with the cameras, two different methods are used:

- First - the IPMB using a LIN communicates with the high mount and/or trailer cameras.
- Second - the side and rear cameras communicate with the IPMB via the coaxial cable using a digital serial format communication LVDS.

For more information,

Refer to: Parking Aid - System Operation and Component Description (413-13B Parking Aid - Vehicles With: Parking Aid Camera, Description and Operation).

Hitch Angle Limiting

This is a feature enhancement that assists the driver in keeping the hitch angle less than the maximum controllable angle when using the PTBA system. This is accomplished with the PTBA steering control algorithm which adjusts the hitch angle limit to the trailer being used based on the trailer length and vehicle wheelbase. In most operating conditions, the PTBA system will limit the hitch angle below the maximum controllable angle. Under some operating conditions, it is possible for the hitch angle to exceed the maximum controllable angle. When the hitch angle exceeds the maximum, it is necessary to pull forward to reduce the hitch angle.

Reverse Speed Control

Reverse speed control is a feature enhancement used to control vehicle speed with brakes and powertrain control. It's purpose is to maintain a usable limit for speed given the trailer parameters while allowing the driver control of the brakes and limited control of the vehicle speed. The vehicle speed is always limited to below 10 km/h (6 mph) when the PTBA system is active and the feature deactivates if 10 km/h (6 mph) is exceeded. The vehicle brakes may be automatically applied and engine torque may be automatically reduced to limit speed to as low as 3 km/h (2 mph) under certain operating conditions.

PTBA Camera Alignment

The IPMB must align the camera image 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 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

The rear parking aid camera is located on the tailgate, above the tailgate release handle. The rear parking aid camera captures the trailer target sticker image on the trailer and sends the data to the IPMB.

For additional information on the rear parking aid camera,

Refer to: Parking Aid - Component Location (413-13C Parking Aid - Vehicles With: Trailer Back Up Assist (TBA), Description and Operation).

Trailer Assist Lamp

The trailer assist lamp is located on the tailgate, to the right of the release handle, and it is used to illuminate the trailer and the target sticker in low ambient light conditions.

For additional information on the trailer assist lamp,

Refer to: Interior Lighting - Overview (417-02 Interior Lighting, Description and Operation).

PTBA Control Knob

The PTBA control knob is located on the instrument panel below the 4x4 rotary control switch (if equipped) and is used to enable the PTBA system and control the direction of the trailer.

LH Upper Steering Wheel Switch

The LH upper steering wheel switch allows access to the truck application through the menus on the IPC message center. The LH upper steering

wheel switch is used to name a trailer, enter a trailer and PTBA trailer target sticker dimensions and select which trailer is being used.

For additional information on the LH upper steering wheel switch,

Refer to: Message Center - System Operation and Component Description (413-01 Instrumentation, Message Center and Warning Chimes, Description and Operation).

PTBA Trailer Target Sticker

The PTBA trailer target sticker is attached to the trailer during initial setup and used by the rear parking aid camera and IPMB to calculate the angle of the trailer based on the dimensions entered in the IPC.

Refer to the Owner's Literature (Pro Trailer Backup Assist, Quick Start Guide) to find the detailed instructions on how to properly position the PTBA trailer target sticker on the trailer.

NOTE: *Additional stickers can be ordered through a Ford dealer parts department.*

EPAS Control

The PSCM determines all operating modes for the PTBA system, it contains control for the powertrain speed requests, brake requests, trailer curvature control (through steering wheel position), trailer angle offset calibration and limits. The PSCM also sends out requests to the IPC and centerstack infotainment display indicating the appropriate message to be displayed for the operating condition.

For additional information on the EPAS system,

Refer to: Adaptive Steering (211-02 Power Steering, Diagnosis and Testing).

IPC

The IPC stores the trailer name and corresponding trailer measurements and communicates the trailer data to PSCM and IPMB. The IPC message center displays warnings and directions to setup and enter trailer information.

PMI is required if installing a new module.

For additional information on the IPC,

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

IPMB

The IPMB reads the image data from the rear parking aid camera and determines the sticker tracking status and trailer angle based on the entered dimensions if the sticker is detected.

The IPMB requires PMI when replaced.

When a new IPMB is installed, up to two camera alignment Diagnostic Trouble Codes (DTCs) can be stored until the 360 degree view camera alignment is successfully completed.

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

For additional information on the IPMB,

Refer to: Parking Aid - Component Location (413-13C Parking Aid - Vehicles With: Trailer Back Up Assist (TBA), Description and Operation).

RCM

For fifth wheel and gooseneck trailers, the RCM reads the trailer yaw rate data from the trailer yaw rate sensor. A function in the RCM calculates the trailer angle based on the vehicle yaw rate and trailer yaw rate. This function is only included in the RCM for vehicles equipped with PTBA.

Trailer Yaw Rate Sensor (If Equipped)

For fifth wheel and gooseneck trailers, the trailer yaw rate sensor detects the yaw rate of the trailer. The trailer yaw rate sensor is installed on the trailer by the customer and connected to the vehicle by a wire harness that plugs into the 12 pin trailer connector socket inside the truck bed.
