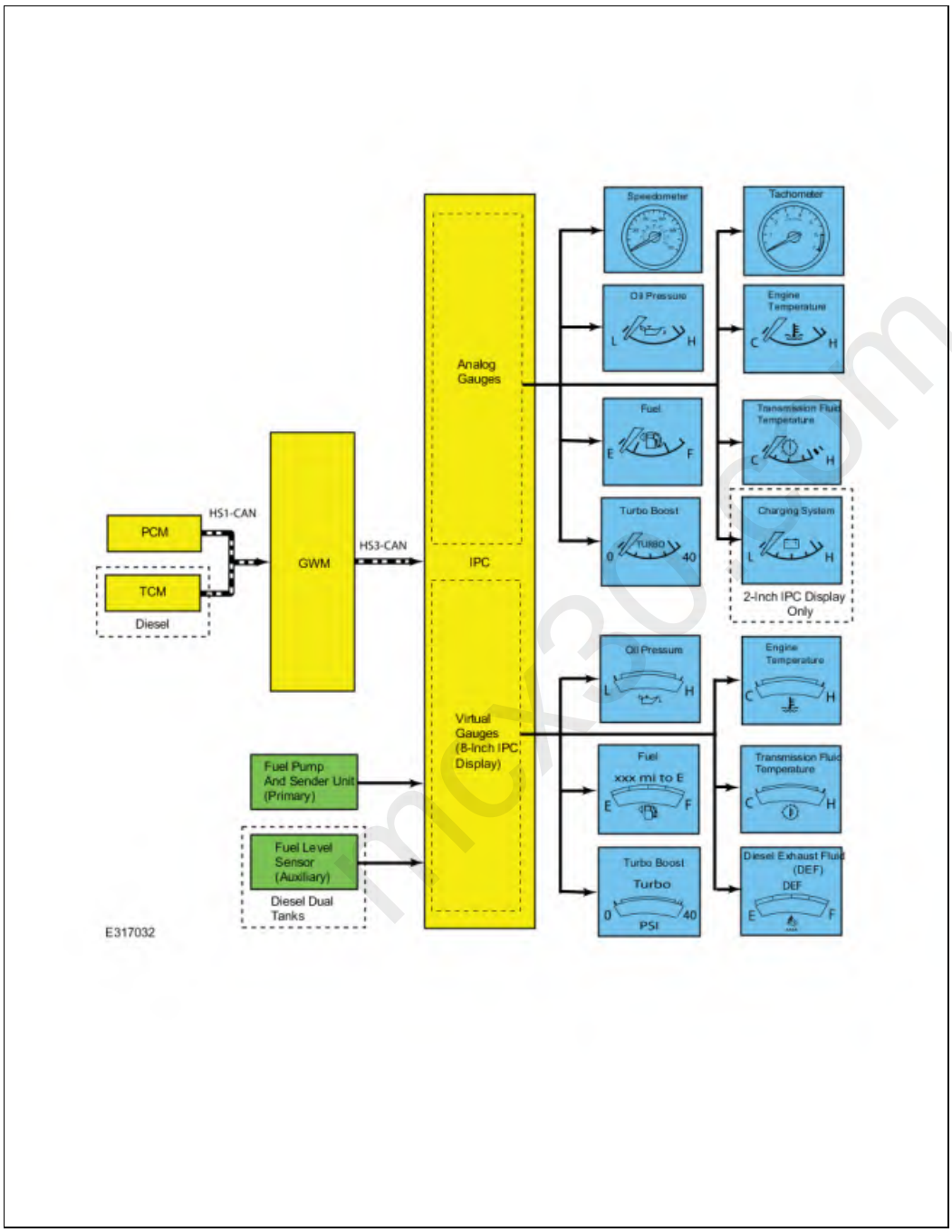
Instrument Panel Cluster (IPC) - System Operation and Component Description

System Operation

System Diagram - Gauges



Item	Description
1	GWM
2	TCM
3	Fuel pump and sender unit (primary)
4	IPC
5	Analog gauges

6	Virtual gauges (8-inch IPC display)
7	PCM
8	Speedometer
9	Tachometer
10	Oil pressure
11	Engine temperature
12	Fuel
13	Transmission fluid Ttemperature
14	Oil pressure
15	Transmission fluid temperature
16	Engine temperature
17	Fuel
18	Turbo boost
19	Charging system
20	2-inch IPC display only
21	Turbo boost
22	Fuel level sensor (auxiliary)
23	Diesel dual tanks
24	Diesel
25	Diesel exhaust fluid (DEF)

Network Message Chart - Gauges

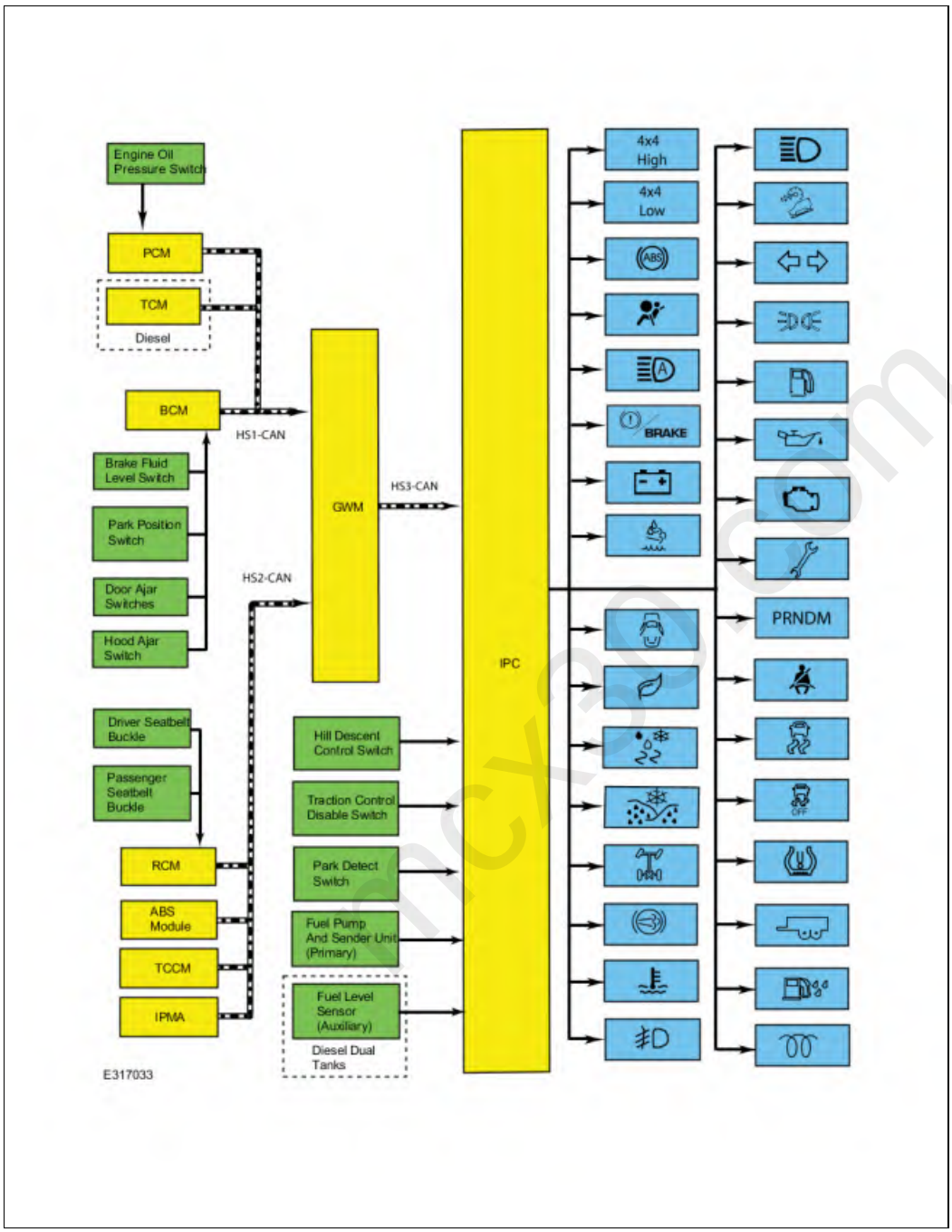
Module Network Input Messages - IPC

Broadcast Message	Originating Module	Message Purpose
Engine coolant temperature data	PCM	Input used to control the temperature gauge and the virtual temperature gauge.
Engine off status	BCM	Input provides the length of time the engine is off used to calculate the rate of change for the transmission temperature gauge.
Engine overheat indication request	PCM	Input used to send the temperature gauge to full hot.
Engine rpm data	PCM	• Input used to control the tachometer indication. • Input used to calculate the rate of change for the transmission temperature gauge.
Fuel level display	PCM	Input used to send the fuel level gauge pointer to the appropriate calculated fuel level.
Ignition status	BCM	Ignition RUN, START and accessory states required for the IPC operating modes and fault reporting.
Oil pressure warning indicator request	PCM	Input used to control the engine oil pressure gauge and the virtual engine oil pressure gauge.
Transmission fluid temperature data	PCM (gas engine) or TCM (diesel engine)	Input used to control the transmission temperature gauge and the virtual transmission temperature gauge.
Turbo boost data	PCM	Input used to control the virtual turbo boost gauge.
Vehicle speed	PCM	Vehicle speed data used for the speedometer indication.

Module Network Input Messages - PCM

Broadcast Message	Originating Module	Message Purpose
Fuel level data	IPC	Fuel level data obtained from the fuel pump and sender unit (hardwired to the IPC) and sent to the PCM to calculate the actual fuel level.

System Diagram - Indicators



Item	Description
1	RCM
2	ABS module
3	IPC
4	Brake fluid level switch
5	PCM
6	Park detect switch
7	GWM

8	BCM
9	Engine oil pressure switch
10	Traction control disable switch
11	Hill descent control switch
12	TCCM
13	Park position switch
14	Door ajar switches
15	Hood ajar switch
16	Fuel pump and sender unit (primary)
17	Fuel level sensor (auxiliary)
18	Diesel dual tanks
19	Diesel
20	Driver seatbelt buckle
21	Passenger seatbelt buckle
22	TCM
23	IPMA

Network Message Chart - Indicators

Module Network Input Messages - IPC

Broadcast Message	Originating Module	Message Purpose
4x4 low indicator request	TCCM	Input used to control the 4x4 low indicator.
4x4 high indicator request	TCCM	Input used to control the 4x4 high indicator.
4WD service required	TCCM	4WD input used for the powertrain malfunction (wrench) indicator.
Active drive mode status	ABS module	Input used to control the selectable drive mode indicator.
Airbag warning indicator status	RCM	Input used to control the airbag warning indicator.
ABS warning indicator request	ABS module	Input used to control the ABS indicator.
Auto high beam indication request	IPMA	Input used to control the auto high beam indicator.
Auto regen message display	PCM	Input used to control the DPF auto regen indicator (diesel only).
Battery low state of charge	BCM	Input used to control the charging system warning indicator.
Body service required	BCM	Input used to control the powertrain malfunction (wrench) indicator
Brake warning indicator request	BCM	Input for low brake fluid level used to control the brake warning indicator.
Brake (red) warning indicator request	ABS module	Input for ABS faults used to control the brake warning indicator.
Diesel exhaust fluid contaminated	PCM	Input used to control the diesel fluid level indicator.
Diesel exhaust fluid message display	PCM	Input used to control the diesel fluid level indicator.
Driver door ajar status	BCM	Input used to control the driver door ajar warning indicator.
Driver seatbelt buckle status	RCM	Input used to control the seatbelt warning indicator.
Engine exhaust brake indicator request	PCM	Input used to control the engine brake indicator
Engine coolant temperature data	PCM	Input used to control the engine over-temperature warning indicator.
Engine overheat indication request	PCM	Input used to control the engine over-temperature warning indicator.
Engine rpm data	PCM	Input used to control the oil pressure indicator.

Broadcast Message	Originating Module	Message Purpose
Engine service required	PCM	Input used to control the powertrain malfunction (wrench) indicator
Front fog lamp indicator request	BCM	Input used to control the fog lamp indicator.
Glow indication	PCM	Input used to control the wait to start indicator (diesel only).
Headlamp high beam status	BCM	Input used to control the high beam indicator.
Hill descent mode	ABS module	Input used to control the hill descent indicator.
Hood ajar status	BCM	Hood ajar input used to control the door ajar warning indicator.
Ignition status	BCM	• Ignition RUN, START and accessory states required for the IPC operating modes and fault reporting. • Input used to control the PRNDM display.
Left rear door ajar status	BCM	Input used to control the left rear door ajar warning indicator.
Left turn lamp on request	BCM	Input used to control the LH turn indicator.
MIL request	PCM	Input used to control the MIL.
Oil pressure warning indicator request	PCM	Input used to control the low oil pressure warning indicator.
Parking brake active status	BCM	Input used to control the parking brake indicator.
Parklamp status	BCM	Input used to control the lights on indicator.
Passenger door ajar status	BCM	Input used to control the passenger door ajar warning indicator.
Power shed level request	BCM	Input used to turn off the PRNDM when the vehicle power shed function is requesting battery conservation.
Powertrain drive mode status	PCM	Input used to control the tow haul indicator.
Rear differential lock indicator request	TCCM	Input used to control the ELD indicator.
Right rear door ajar status	BCM	Input used to control the right rear door ajar warning indicator.
Right turn lamp on request	BCM	Input used to control the RH turn indicator.
Selectable drive mode request	ABS module	Input used to control the selectable drive mode indicator.
Selectable drive mode status	ABS module	Input used to control the selectable drive mode indicator.
Stability-traction control indicator request	ABS module	Input used to control the stability/traction control (sliding car icon) indicator.
Stability-traction control disabled indicator request	ABS module	Input used to control the stability/traction control disabled (sliding car OFF icon) indicator.
Tire pressure warning indicator	BCM	Input used to control the TPMS indicator.
Transmission gear display	PCM (gas engine) or TCM (diesel engine)	Input used to control the select shift segment of the PRNDM indication.
Transmission gear display mode	PCM (gas engine) or TCM (diesel engine)	Input used to display or flash the PRNDM indication.
Transmission service required	PCM (gas engine) or TCM (diesel engine)	Input used to control the powertrain malfunction (wrench) indicator
Transport mode	BCM	Input used to control the PRNDM state upon vehicle entry and at key off to conserve battery voltage when in transport mode.
Vehicle speed	PCM	• Input used to increase or decrease the volume level based on vehicle speed for the LH and RH turn indicators. • Input used to confirm a park detect input concern for PRNDM indication.
Water in fuel	PCM	Input used to control the water in fuel indicator (diesel only).

Module Network Input Messages - PCM

Broadcast Message	Originating Module	Message Purpose
Auto regeneration request	IPC	Input used to turn off the DPF auto regen function (diesel only).

Networked Input Messages and Default States

NOTE: *Whenever a network message is suspected as missing and confirmed by a missing message DTC (U-code), it is important to look for other symptoms that can also be present in the IPC and throughout the vehicle. Once a DTC sets in the IPC, it is helpful to review the complete message list to determine which other modules also rely on the same message and run the self-test for those modules. If the message is missing from other modules, the same or similar lost communication DTC can also be set in those modules. Confirmation of missing messages common to multiple modules can indicate the originating module is the source of the concern or the communication network may be fault.*

For a list of all the network messages,
Refer to: Communications Network - System Operation and Component Description (418-00 Module Communications Network, Description and Operation).

The IPC uses input messages from other modules to control the gauges, informational indicators, warning indicators and message center message displays over the communication networks. The IPC receives all networked data over the HS-CAN3.

The vehicle uses 4 communication networks to transmit the data used by the IPC.

- HS-CAN1
- HS-CAN2
- HS-CAN3
- MS-CAN

For network overview information,
Refer to: Communications Network - System Operation and Component Description (418-00 Module Communications Network, Description and Operation).
For network system operation information, Refer to: Communications Network - System Operation and Component Description (418-00 Module Communications Network, Description and Operation).

All messaged inputs to the IPC from other networks are received from the GWM over the HS-CAN3. The GWM, as the name implies, acts as a gateway to convert messages from one of the other 3 networks to the HS-CAN3, which is recognized by the IPC.

Network messages can drop out or be missing for a variety of reasons, such as high network traffic on the bus. The IPC incorporates a defined strategy for handling missing network messages based on time. The required time for a network message to be missing differs between the various gauges, indicators and message center displays. The strategy is basically the same for all indication outputs (gauges, indicators or chimes), but differs in the length of time required for the network message to be missing. If a required network message is missing or invalid for less than the programmed length of time, the gauge, indicator or message center display that requires the network message remains at the last commanded state based upon the last network message received. If the messaged input is missing for longer than the programmed length of time, the IPC output (gauge, indicator etc.) reacts according to a pre-defined default action.

For example, if the stability-traction control indicator request network message is missing for less than 5 seconds, and the stability-traction control indicator (sliding car icon) was on, the indicator remains in the on state until the next network message is received. If the network message remains missing or invalid for more than 5 seconds, the IPC sets a U-code DTC and the IPC output becomes a default action for the indicator or gauge. The indicator may default on/off or the gauge may default to the rest position.

Each indicator or gauge utilizes a different default strategy depending on the nature of the indication. Refer to the diagnostic overview descriptions located before each pinpoint test for further descriptions of the default action specific to each indicator or gauge. If the missing messaged input to the IPC returns at any time, the normal function of the gauge, indicator or message center display resumes.

It is very important to understand:

- where the input originates.
- all the information necessary in order for a feature to operate.
- which module(s) receive(s) the input or command message.
- which module controls the output of the feature.
- whether the module that receives the input controls the output of the feature, or whether it outputs a message over the communication network to another module.

MyKeyÂ®

The MyKeyÂ® feature allows the customer to program a restricted driving mode that is tied to one or more keys known as a MyKeyÂ® key.

The following features are provided by the IPC when a MyKeyÂ® key is being used:

- At the beginning of vehicle start up, as part of the welcome strategy, the message center greets the MyKeyÂ® driver with MYKEY ACTIVE DRIVE SAFELY displayed in the message center. If the MyKeyÂ® speed limiter feature is turned on, the message center also displays the MyKeyÂ® administrator selected top speed setting message; SPEED LIMITED TO XXX KM/H (XX MPH). The MyKeyÂ® top speed selections are; 105, 110, 120 or 130 km/h (65, 70, 75, or 80 mph).
- The IPC provides a periodic Belt-MinderÂ® warning chime until the driver and passenger seatbelts are buckled. When the Belt-MinderÂ® is issued, the ACM is muted and the message center displays BUCKLE UP TO UNMUTE AUDIO.
- If the MyKeyÂ® speed limiter feature is turned on and the vehicle speed approaches the selected top speed (105, 110, 120 or 130 km/h [65, 70, 75, or 80 mph]), the message center displays NEAR VEHICLE TOP SPEED along with a chime.
- If the MyKeyÂ® speed limiter feature is turned on and the vehicle speed reaches the selected top speed (105, 110, 120 or 130 km/h [65, 70, 75, or 80 mph]), the message center displays TOP SPEED MYKEY SETTING along with a chime.
- If the speed warning is selected at one of the preset values (75, 90, 105 km/h [45, 55, 65 mph]) and the vehicle approaches the preset speed, the message center displays CHECK SPEED DRIVE SAFELY along with a chime.
- At approximately 1/8 tank of remaining fuel, the IPC illuminates the low fuel message center indicator and the message center displays FUEL LEVEL LOW along with a chime.
- Traction control, Emergency 911 AssistÂ® feature and the Do Not Disturb feature can be set to always on or user selectable in the MyKeyÂ® menu.
- If the traction control always on feature is turned on and the MyKeyÂ® driver attempts to disable the traction control, the message center displays ADVANCETRAC ON MYKEY SETTING.
- MyKeyÂ® miles driven by the MyKeyÂ® user can be found in the information display.
- The number of MyKeyÂ® programmed and administrator keys can be found in the MyKeyÂ® menu.
- The parking aid, Blind Spot Monitoring System/Cross Traffic Alert (BLISÂ® /CTA), lane departure alert and collision avoidance warning menus are disabled in the message center to force these features always on.
- The lane departure warning feature can be selected off when a MyKeyÂ® key is in use, but will automatically turn on with each key cycle.

When an administrator key is in use, the IPC provides:

- a menu in the message center guiding the user to create a MyKeyÂ®. When the maximum MyKeyÂ® limit is reached, the MyKeyÂ® creation menu is no longer available.
- a menu in the message center with options for setting 6 MyKeyÂ® features:
  - MyKeyÂ® speed limiter.
  - MyKeyÂ® pre-selected speed warning.
  - MyKeyÂ® radio volume limiter.
  - traction control always on or user selectable.
  - emergency 911 assist feature always on or user selectable.
  - do not disturb feature always on or user selectable.
- a menu in the message center with the option to clear all MyKeyÂ® programmed keys at once.
- MyKeyÂ® mileage driven by the MyKeyÂ® user can be found in system check function of the message center.
- the number of MyKeyÂ® programmed keys and administrator keys can be found in the system check function of the message center.

For information on the MyKeyÂ® features, refer to the Owner's Literature.

Startup-Shutdown

The IPC provides a startup/shutdown sequence also known as a welcome/goodbye strategy. The IPC initiates and follows a progressive strategy providing increasing IPC functionality from IPC wake up to ready to drive status. This sequence begins at RKE unlock or driver door open through the ignition RUN state. During this period, the IPC provides increasing functionality from backlighting or illuminating gauge rings, gauge pointers, illuminating the PRNDM, backlighting of the message center display, displaying a message center splash screen, gauge and LED prove out and finally normal IPC operation.

Dealer Test Mode

To enter the IPC engineering test mode or dealer test mode, begin with the ignition OFF. Press and hold the LH steering wheel switch OK button. Place the ignition ON and continue to hold the button for 5-8 seconds until the display indicates Engineering Test Mode. Press the up or down arrow buttons to navigate through each of the display windows. To exit the IPC dealer test mode, press and hold the OK button for 5-8 seconds or place the ignition in OFF. Each down arrow button press advances the viewing window to the next set of items.

Analog Gauges

NOTE: *It is important to view each of the cluster options in the Overview to identify which IPC uses a specific analog gauge.*

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

Charging System

The IPC provides a charging system gauge to inform the driver of current battery charge and charging system status. The IPC utilizes the B+

voltage input to generate a charging system gauge indication. When the voltage level is equal to or less than 8 volts, the charging system gauge displays in the low range. When the voltage is between 9.6 volts and 16.9 volts, the gauge displays in the normal range. When the voltage is greater than or equal to 18 volts, the gauge displays in the high range.

Engine Oil Pressure

The IPC uses the oil pressure warning indicator request network message to control the engine oil pressure gauge. The engine oil pressure switch is hardwired to the PCM. The PCM sends the oil pressure warning indicator request message to the GWM over the HS-CAN1. The GWM sends the oil pressure warning indicator request message to the IPC over the HS-CAN3.

Engine Temperature

The IPC uses 2 messages to control the temperature gauge. The first is the engine coolant temperature data, which provides the current engine temperature input to the PCM. The second message is the engine overheat indication request, which is sent by the PCM to the IPC when an engine overheating condition exists. When the IPC receives the engine overheat indication request message, the IPC sends the temperature gauge to full hot and turns on the over-temperature warning indicator.

The IPC receives all the temperature gauge inputs from the GWM over the HS-CAN3. The GWM receives the engine coolant temperature data and the engine overheat indication request messages from the PCM over the HS-CAN1.

Fuel

When equipped with a single fuel tank, the IPC receives the fuel level data from a single fuel level sender. The IPC sends a reference voltage to the fuel level sender. As the fuel level changes, a float actuates the variable resistor fuel level sender, raising or lowering the fuel level signal voltage. The IPC monitors the changes in voltage from the sender and sends a fuel level data message to the PCM through the GWM to calculate the fuel level.

The PCM calculates the fuel level based on current fuel in the fuel tank and the tank size. The PCM sends the fuel level display message to the IPC through the GWM to activate the needle in the fuel gauge.

When equipped with dual fuel tanks, the IPC receives fuel level data from both primary and auxiliary fuel level senders. The fuel pump operates a jet pump (part of the fuel pump and sender unit) that transfers fuel from the auxiliary fuel tank to the primary fuel tank. This functions similar to the saddle-type fuel tank design except that there are 2 separate fuel tanks that need to be refueled independent of one another. The primary fuel tank maintains a higher level of fuel due to the transfer function of the jet pump module. For additional information about the fuel pump and fuel transfer operation,
Refer to: Fuel System - Overview (310-00B Fuel System - General Information - 6.7L Power Stroke Diesel, Description and Operation).
The IPC sends a reference voltage to the fuel level senders. As the fuel level changes, a float actuates the variable resistor fuel level senders, raising or lowering the fuel level signal voltages. The IPC monitors the changes in voltage from both senders and sends a fuel level data message to the PCM through the GWM to calculate the fuel level.

The PCM calculates the fuel level based on current fuel in the fuel tank and the tank size. The PCM sends the fuel level display message to the IPC through the GWM to activate the needle in the fuel gauge.

In addition to the main fuel gauge, the message center provides virtual fuel gauges for each individual tank on all Instrument Panel Clusters (IPCs).

After a fuel fill up, the time for the fuel gauge to move from empty (E) to full (F) ranges from 2 seconds to 55 minutes depending on which operating mode the fuel gauge is in.

The IPC uses 4 different operating modes to calculate the fuel level:

- Anti-slosh (default mode)
- Key OFF fueling
- Key ON fueling
- Recovery

Anti-Slosh Mode

The default fuel gauge mode is called the anti-slosh mode. To prevent fuel gauge changes from fuel slosh (gauge instability due to changes in fuel sensor readings caused by fuel moving around in the tank), the fuel gauge takes approximately 40 minutes to go from empty (E) to full (F).

Key OFF Fueling Mode

The key OFF fueling mode (2 seconds to read empty [E] to full [F]) requires 3 conditions to be met:

- The ignition must be in the OFF mode when refueling the vehicle.
- At least 10% of the vehicle's fuel capacity must be added to the fuel tank.
- The IPC must receive a valid ignition ON fuel sensor reading within one second of the ignition being put into the RUN mode. The key ON sample readings are considered valid if the fuel sensor reading is between 10 ohms Â± 2 ohms and 180 ohms Â± 4 ohms.

If these conditions are not met, the fuel gauge stays in the anti-slosh mode, which results in a slow to read full (F) event.

Key ON Fueling Mode

In key ON fueling mode, a 30-second timer activates after the transmission is put into the PARK (P) or NEUTRAL (N) position. When the 30-second time has elapsed and at least 9% of the vehicle's fuel capacity has been added, the fuel gauge response time is 60 seconds to read from empty (E) to full (F). When the transmission is shifted out of PARK (P) or NEUTRAL (N), the fuel gauge strategy reverts to the anti-slosh mode. The key ON fueling mode prevents slow to read full events from happening if the customer refuels the vehicle with the ignition in the RUN mode.

The key ON fueling mode (approximately 60 seconds to read empty [E] to full [F]) requires the following conditions be met:

- The transmission is in PARK (P) or NEUTRAL (N).
- The ignition is in the RUN mode.
- At least 10% of the vehicle's fuel capacity must be added to the fuel tank

Speedometer

The IPC receives the vehicle speed data from the GWM over the HS-CAN3. The GWM receives the vehicle speed message from the PCM over the HS-CAN1. The PCM receives the wheel speed data from the ABS. The PCM uses axle ratio and tire size stored in the vehicle configuration file along with wheel speed inputs to generate a vehicle speed signal.

The IPC provides a tolerance that allows the speed indication to display between 3% below and 7% above the actual vehicle speed. This means that with an actual vehicle speed of 97 km/h (60 mph), the speedometer can indicate between 94-103 km/h (58-64 mph). Incorrect tire size or tire size configuration could potentially affect the speedometer accuracy.

Tachometer

The IPC receives the engine rpm data message from the GWM over the HS-CAN3. The GWM receives the engine rpm data message from the PCM over the HS-CAN1.

Transmission Temperature

The IPC uses a base transmission temperature message then filters the transmission fluid temperature signal based on engine rpm and the length of time the engine has remained in the off state to provide a more accurate gauge indication.

The IPC receives the transmission fluid temperature data, the engine rpm data and the engine off status messages from the GWM over the HS-CAN3. The GWM receives the transmission fluid temperature data, the engine rpm data and the engine off status messages from the PCM (gas engine) or TCM (diesel engine) over the HS-CAN1.

Turbo Boost Gauge (Diesel Only)

The turbo boost gauge provides the driver with the amount of engine boost pressure and ranges between 0-40 PSI (0-276 kPa). The IPC receives the turbo boost data message from the GWM over the HS-CAN3. The GWM receives the turbo boost data message from the PCM over the HS-CAN1.

Virtual Gauges

NOTE: *It is important to view each of the cluster options in the Overview to identify which IPC uses a specific virtual gauge.*

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

Diesel Exhaust Fluid Level

The diesel exhaust fluid level gauge provides the driver an indication of the level of diesel exhaust fluid. The IPC receives the diesel exhaust fluid level indicator message from the GWM over the HS-CAN3. The GWM receives the diesel exhaust fluid level indicator message from the PCM over the HS-CAN1.

Engine Oil Pressure

The IPC uses the oil pressure warning indicator request network message to control the engine oil pressure gauge. The engine oil pressure switch is hardwired to the PCM. The PCM sends the oil pressure warning indicator request message to the GWM over the HS-CAN1. The GWM sends the oil pressure warning indicator request message to the IPC over the HS-CAN3.

Engine Temperature

The IPC uses 2 messages to control the temperature gauge. The first is the engine coolant temperature data, which provides the current engine temperature input to the PCM. The second message is the engine overheat indication request, which is sent by the PCM to the IPC when an overheating condition exists. When the IPC receives the engine overheat indication request message, the IPC sends the temperature gauge to full hot and turns on the over-temperature warning indicator.

The IPC receives all the temperature gauge inputs from the GWM over the HS-CAN3. The GWM receives the engine coolant temperature data and the engine overheat indication request messages from the PCM over the HS-CAN1.

Fuel

When equipped with a single fuel tank, the IPC receives the fuel level data from a single fuel level sender. The IPC sends a reference voltage to the fuel level sender. As the fuel level changes, a float actuates the variable resistor fuel level sender, raising or lowering the fuel level signal voltage. The IPC monitors the changes in voltage from the sender and sends a fuel level data message to the PCM through the GWM to calculate the fuel level.

The PCM calculates the fuel level based on current fuel in the fuel tank and the tank size. The PCM sends the fuel level display message to the IPC through the GWM to activate the needle in the fuel gauge.

When equipped with dual fuel tanks, the IPC receives fuel level data from both primary and auxiliary fuel level senders. The fuel pump operates a jet pump (part of the fuel pump and sender unit) that transfers fuel from the auxiliary fuel tank to the primary fuel tank. This functions similar to the saddle-type fuel tank design except that there are 2 separate fuel tanks that need to be refueled independent of one another. The primary fuel tank maintains a higher level of fuel due to the transfer function of the jet pump module. For additional information about the fuel pump and fuel transfer operation,
Refer to: Fuel System - Overview (310-00B Fuel System - General Information - 6.7L Power Stroke Diesel, Description and Operation).
The IPC sends a reference voltage to the fuel level senders. As the fuel level changes, a float actuates the variable resistor fuel level senders, raising or lowering the fuel level signal voltages. The IPC monitors the changes in voltage from both senders and sends a fuel level data message to the PCM through the GWM to calculate the fuel level.

The PCM calculates the fuel level based on current fuel in the fuel tank and the tank size. The PCM sends the fuel level display message to the IPC through the GWM to activate the needle in the fuel gauge.

In addition to the main fuel gauge, the message center provides virtual fuel gauges for each individual tank on all Instrument Panel Clusters (IPCs).

After a fuel fill up, the time for the fuel gauge to move from empty (E) to full (F) ranges from 2 seconds to 55 minutes depending on which operating mode the fuel gauge is in.

The IPC uses 4 different operating modes to calculate the fuel level:

- Anti-slosh (default mode)
- Key OFF fueling
- Key ON fueling
- Recovery

Anti-Slosh Mode

The default fuel gauge mode is called the anti-slosh mode. To prevent fuel gauge changes from fuel slosh (gauge instability due to changes in fuel sensor readings caused by fuel moving around in the tank), the fuel gauge takes approximately 40 minutes to go from empty (E) to full (F).

Key OFF Fueling Mode

The key OFF fueling mode (2 seconds to read empty [E] to full [F]) requires 3 conditions to be met:

- The ignition must be in the OFF mode when refueling the vehicle.
- At least 10% of the vehicle's fuel capacity must be added to the fuel tank.
- The IPC must receive a valid ignition ON fuel sensor reading within one second of the ignition being put into the RUN mode. The key ON sample readings are considered valid if the fuel sensor reading is between 10 ohms Â± 2 ohms and 180 ohms Â± 4 ohms.

If these conditions are not met, the fuel gauge stays in the anti-slosh mode, which results in a slow to read full (F) event.

Key ON Fueling Mode

In key ON fueling mode, a 30-second timer activates after the transmission is put into the PARK (P) or NEUTRAL (N) position. When the 30-second time has elapsed and at least 9% of the vehicle's fuel capacity has been added, the fuel gauge response time is 60 seconds to read from empty (E) to full (F). When the transmission is shifted out of PARK (P) or NEUTRAL (N), the fuel gauge strategy reverts to the anti-slosh mode. The key ON fueling mode prevents slow to read full events from happening if the customer refuels the vehicle with the ignition in the RUN mode.

The key ON fueling mode (approximately 60 seconds to read empty [E] to full [F]) requires the following conditions be met:

- The transmission is in PARK (P) or NEUTRAL (N).
- The ignition is in the RUN mode.
- At least 10% of the vehicle's fuel capacity must be added to the fuel tank

Transmission Temperature

The IPC receives the transmission fluid temperature message from the GWM over the HS-CAN3. The GWM receives the transmission fluid temperature message from the PCM (gas engine) or TCM (diesel engine) over the HS-CAN1. The PCM (gas engine) or TCM (diesel engine) filters the transmission fluid temperature signal to remove fluctuations that could affect the stability of the transmission temperature gauge indication.

Turbo Boost Gauge (Diesel Only)

The turbo boost gauge is a configurable gauge that ranges between 0-40 PSI (0-276 kPa) and can be configured on through the message center controls. The IPC receives the turbo boost data message from the GWM over the HS-CAN3. The GWM receives the turbo boost data message from the PCM over the HS-CAN1.

Indicators

NOTE: *It is important to view each of the cluster options in the Overview to identify which IPC uses specific fixed location indicators.*

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

Prove-Out

The IPC carries out a display prove-out to verify the gauges function and all module controlled warning indicator lamps and monitored systems are functioning correctly within the IPC. Upon initiation of the prove-out, the gauges sweep from one stop to the other then return to the normal indication state based on the input received. The IPC also provides a timed prove-out of some indicators while other indicators illuminate upon engine start up or have no prove-out. When the ignition is cycled on, the indicators illuminate to prove-out according to the following table:

Indicator	Indicator Type	Prove-Out Duration
4x4 Low	Informational	3 seconds
4x4 High	Informational	3 seconds
Airbag	Warning	6 seconds
ABS	Warning	3 seconds
Brake	Warning	3 seconds
Charging	Warning	Engine start up
DPF filter cleaning (regen)	Informational	None
Diesel fluid level	Informational	3 seconds
Door ajar	Warning	None
ELD	Informational	None
Engine over-temperature	Warning	3 seconds
Front fog lamp	Informational	None
High beam	Informational	None
Hill descent control	Informational	None
Lights on	Informational	None
Low fuel	Informational	3 seconds
Low engine oil pressure	Warning	3 seconds
MIL	Informational	Engine start up
Powertrain malfunction (wrench)	Informational	3 seconds
Seatbelt	Informational	65 seconds if the seatbelt is unbuckled, turns off when the seatbelt is buckled
Stability-traction control (sliding car icon)	Warning	3 seconds
Stability-traction control disabled (sliding car OFF icon)	Informational	3 seconds
TPMS	Warning	3 seconds
Tow haul	Informational	None
Turn-hazard	Informational	None

Indicator	Indicator Type	Prove-Out Duration
Wait to start	Informational	None
Water in fuel	Informational	3 seconds

4x4 Low And 4x4 High Indicators (2-Inch Display IPC Only)

For the Electronic Shift On the Fly (ESOF) 4WD system, the IPC receives the 4x4 low indicator request and 4x4 high indicator request messages from the GWM over the HS-CAN3. The GWM receives the 4x4 low indicator request and 4x4 high indicator request messages from the TCCM over the HS-CAN2.

ABS/Brake/Stability-Traction Control System Indication

The brake/stability-traction control system indication is controlled in many instances by the ABS module. The ABS module can illuminate multiple indicators for various fault conditions. The following table provides a summary of the basic fault conditions and the indicators that are illuminated for each condition.

NOTE: *Refer to the Normal Operation and Fault Condition description before each brake/stability-traction control system indicator Pinpoint Test (PPT) for the IPC default action for network/missing message conditions.*

Event/Fault Condition	ABS Warning Indicator Status	Brake Warning Indicator Status	Stability-Traction Control Indicator (Sliding Car Icon) Status	Stability-Traction Control Disabled Indicator (Sliding Car OFF Icon) Status
Normal operation	Off	Off	Off	Off
Parking brake applied	Off	On	Off	Off
Wheel speed sensor faults	On	Off	On	On
Pump motor electrical fault	On	On	On	On
Invalid or missing PCM data	Off	Off	On	On
Steering wheel angle sensor fault	Off	Off	Flashing	On
Brake fluid level low	Off	On	Off	Off
RCM RAM fault	Off	Off	Flashing	On
Stability control EEPROM fault	Off	Off	Flashing	On
RCM sensor cluster lateral acceleration sensor failure	Off	Off	Flashing	On
RCM sensor cluster longitudinal acceleration sensor failure	Off	Off	Flashing	On
RCM sensor cluster yaw rate/lateral acceleration sensor failure	Off	Off	Flashing	On
RCM sensor cluster roll rate sensor signal failure	Off	Off	Flashing	On
Brake switch failure - pressure sensor offset learned (stability control only applications)	Off	Off	Flashing	On
Brake pedal switch failure - signal stuck high	Off	Off	N/A	On
Low brake booster vacuum below threshold	Off	On	Flashing	Off
Stability control event duration too long	On	Off	On	On
ABS control event duration too long	On	On	On	On
Traction control system/ESC mode switch stuck on	Off	Off	Flashing	Off
Brake booster vacuum sensor signal invalid	Off	On	Flashing	Off

Event/Fault Condition	ABS Warning Indicator Status	Brake Warning Indicator Status	Stability-Traction Control Indicator (Sliding Car Icon) Status	Stability-Traction Control Disabled Indicator (Sliding Car OFF Icon) Status
Traction control isolation valves over-temperature	Off	Off	Flashing	Off
Brake system evacuate and fill process not complete.	Off	Off	Off	Off
Valve relay general failure	On	On	On	On
Valve relay supply circuit short to ground	On	On	On	On
Wheel speed sensor incorrectly installed	On	Off	On	On
Wheel speed sensor signal wheel rotation direction plausibility failure	Off	Off	Flashing	Off
ABS control event plausibility failure	On	Off	On	On
Pressure sensor failure	On	On	N/A	On
CAN bus off failure	Off	Off	On	On
Lost communication with the PCM	Off	Off	On	On
Valves general electronic failure	On	On	On	On
Configuration not complete	Flashing	On	On	On
Calibration file not downloaded or flashed	On	Off	On	On
Configuration incompatible or not correct	On	On	On	On
Collision mitigation by braking event control request incorrect	Off	Off	Flashing	Off
Collision mitigation by braking deceleration plausibility failure	Off	Off	Flashing	Off
ACC deceleration plausibility failure	Off	Off	Flashing	Off
End of line configuration EEPROM failure	On	Off	On	On
RAM failure	On	On	On	On
EEPROM failure	On	On	On	On
Control module microcontroller failure	On	Off	On	On
Control module initialization failure	Off	Off	On	On
General electronic failure	On	On	On	On
Control module temperature over allowable limit	On	On	On	On
Vehicle Identification Number (VIN) HS-CAN2 data mismatch compared with the end of line configuration	On	Off	On	On
Control module voltage under limit	On	On	On	On

ABS Warning Indicator

The IPC receives the ABS warning indicator request message from the GWM over the HS-CAN3. The GWM receives the ABS warning indicator request message from the ABS module over the HS-CAN2. If a fault condition exists in the ABS, the ABS module sends the ABS warning indicator request message to either flash or illuminate the ABS warning indicator.

Refer to ABS/Brake/Stability-Traction Control System Indication description for information on the conditions when the ABS warning indicator is turned on.

Airbag Warning Indicator

The IPC receives the airbag warning indicator status from the GWM over the HS-CAN3. The GWM receives the airbag indicator status from the RCM over the HS-CAN2. If a SRS concern is detected, the RCM sets a DTC and the IPC illuminates the airbag warning indicator.

Auto High Beam Indicator

The IPC provides the auto high beam indicator to indicate the auto high beam is active. The IPC receives the auto high beam indication request message from the GWM over the HS-CAN3. The GWM receives the auto high beam indication request message from the IPMA over the HS-CAN2.

Brake Warning Indicator

The brake warning indicator informs the driver the brake fluid level is low, there is a failure in the base brake system or the park brake is applied. The IPC uses the following 3 messaged inputs to control the brake warning indicator.

Network Message	Condition
Brake (red) warning indicator request	Indicates a brake system concern from the ABS.
Brake warning indicator request	Indicates a low brake fluid level concern.
Park brake active status	Indicates the parking brake is applied.

The IPC receives all network messages required to operate the brake warning indicator from the GWM over the HS-CAN3.

The GWM receives the brake (red) warning indicator request from the ABS module over the HS-CAN2.

The GWM receives the brake warning indicator request and the park brake active status messages from the BCM over the HS-CAN1.

Refer to ABS/Brake/Stability-Traction Control System Indication description for information on the conditions when the brake warning indicator is turned on.

Charging System Warning Indicator

The charging system warning indicator is controlled by the IPC based upon the battery low state of charge message received from the GWM over the HS-CAN3. The GWM receives the battery low state of charge message from the BCM over the HS-CAN1. When a fault is detected in the charging system, the BCM sends the IPC the battery low state of charge message to illuminate the charging system warning indicator.

Diesel Exhaust Fluid Level

The diesel exhaust fluid level indicator uses the following messages to control the indicator.

- Diesel exhaust fluid message display
- Diesel exhaust fluid contaminated

The IPC provides the diesel exhaust fluid level indicator to inform the driver the diesel exhaust fluid level is low or a fault condition exists in the diesel exhaust fluid level indication system. The IPC receives the diesel exhaust fluid message display and the diesel exhaust fluid contaminated messages from the GWM over the HS-CAN3. The GWM receives the diesel exhaust fluid message display and the diesel exhaust fluid contaminated messages from the PCM over the HS-CAN1. When a fault condition exists or the diesel exhaust fluid level is low, the IPC flashes the diesel exhaust fluid level indicator to alert the driver and draw attention to the warning message displayed related to the fluid level status and engine status.

DPF Auto Regeneration

The IPC provides a menu selection to allow the user to turn off the DPF auto regeneration mode. The IPC receives the auto regeneration request message to the GWM over the HS-CAN3. The GWM sends the auto regeneration request message to the PCM over the HS-CAN1. If the PCM agrees to turn off the DPF auto regeneration control, the PCM sends the auto regen message display message back to the GWM over the HS-CAN1. The GWM sends the auto regen message display message to the IPC over the HS-CAN3 to illuminate the DPF auto regeneration indicator.

Door Ajar Or Hood Ajar Warning

The IPC provides a door ajar warning indicator along with message displays to indicate the status of the doors and hood. The IPC receives the driver door ajar, passenger door ajar, left rear door ajar, right rear door ajar and hood ajar status messages from the GWM over the HS-CAN3. The GWM receives the driver door ajar, passenger door ajar, left rear door ajar and the right rear door ajar and hood ajar status messages from the BCM over the HS-CAN1. The BCM monitors each of the ajar inputs and sends the specific door ajar status message to the IPC to display the ajar warning indicator and corresponding warning message.

ELD Indicator

The ELD indicator informs the driver the locking differential is engaged. The IPC receives the rear differential lock indicator request message from the GWM over the HS-CAN3. The GWM receives the rear differential lock indicator request message from the TCCM over the HS-CAN2.

Engine Brake

The IPC provides the engine brake indicator to inform the driver that the engine brake feature has been turned on. The IPC receives the engine exhaust brake indicator request from the GWM over the HS-CAN3. The GWM receives the engine exhaust brake indicator request from the PCM over the HS-CAN1.

Engine Over-Temperature

The IPC receives the engine overheat indication request and the engine coolant temperature data from the GWM over the HS-CAN3. The GWM receives the engine overheat indication request and the engine over-temperature message from the PCM over the HS-CAN1.

Front Fog Lamp Indicator

The fog lamp indicator informs the driver that the fog lamps are turned on. The IPC receives the front fog lamp indicator request from the GWM over the HS-CAN3. The GWM receives the front fog lamp indicator request from the BCM module over the HS-CAN1.

High Beam Indicator

The high beam indicator informs the driver that the high beams are turned on. The IPC receives the headlamp high beam status message from the GWM over the HS-CAN3. The GWM receives the headlamp high beam status message from the BCM module over the HS-CAN1.

Hill Descent Control Indicator

The hill descent control indicator informs the driver the hill descent function is turned on and may be in ready mode, active control mode or over-temperature mode. The IPC receives the hill descent mode message from the GWM over the HS-CAN3. The GWM receives the hill descent mode message from the ABS module over the HS-CAN2.

LH- RH Turn Signal/Hazard Indicator

When the multifunction switch is in the LH or RH turn position or if the hazard switch is on, the BCM sends the right turn lamp on request, the left turn lamp on request or both messages to the GWM over the HS-CAN1. The GWM sends the right turn lamp on request, the left turn lamp on request or both messages to the IPC over the HS-CAN3. Upon receipt of the applicable turn signal on/off data, the IPC flashes the turn signal indicator on and off.

Lights On Indicator

When the parking lamps are turned on, the BCM sends the parklamp status message to the GWM over the HS-CAN1. The IPC receives the parklamp status message from the GWM over the HS-CAN3 to illuminate the lights on indicator.

Low Fuel Indicator

To supplement the fuel gauge indication, the IPC provides the low fuel indicator. When the fuel level reaches approximately 120 km (75 miles) (MyKeyÂ® users only) and 80 km (50 miles), 40 km (25 miles), 20 km (10 miles) and 0 km (0 miles) for MyKeyÂ® and administrator key users, the IPC turns on the low fuel indicator.

Low Engine Oil Pressure Warning Indicator

The IPC uses the oil pressure warning indicator request and engine rpm data to control the low engine oil pressure warning indicator. Following the bulb prove-out, the low engine oil pressure warning indicator turns off with the engine off. When the engine rpm is above 400 rpm, the IPC turns on the low engine oil pressure warning indicator whenever a low engine oil pressure condition exists.

The engine oil pressure switch is hardwired to the PCM. The PCM provides the oil pressure warning indicator request and the engine rpm data to the GWM over the HS-CAN1. The GWM provides the oil pressure warning indicator request and engine rpm data to the IPC over the HS-CAN3.

MIL

The IPC receives the MIL request from the GWM over the HS-CAN3. The GWM receives the MIL request from the PCM over the HS-CAN1.

Powertrain Malfunction (Wrench) Indicator

The IPC provides a powertrain malfunction (wrench) message center indicator to indicate transmission, engine (such as Electronic Throttle Control [ETC]), 4WD, and BCM concerns.

The IPC receives all the required messages from the GWM over the HS-CAN3.

The GWM receives the transmission service required and engine service required messages from the PCM over the HS-CAN1.

The GWM receives the 4WD service required message from the TCCM over the HS-CAN2.

The GWM receives the body service required message from the BCM over the HS-CAN1.

PRNDM Indicator

The IPC uses the following messages to control the PRNDM:

- Power shed level request
- Transmission gear display
- Transmission gear display mode
- Transport mode
- Vehicle speed

The IPC receives all the required messages from the GWM over the HS-CAN3.

The GWM receives the transmission gear display and transmission shift mode display messages from the PCM (gas engine) or TCM (diesel engine) and the vehicle speed message from the PCM over the HS-CAN1. The GWM receives the transport mode and power shed level request messages from the BCM over the HS-CAN1.

When the vehicle is in transport mode, the PRNDM is not displayed upon entry or exit from the vehicle to prevent battery drain during longer periods of time when the vehicle is not in use, such as those experienced during vehicle transport.

The IPC also uses a park position detect switch (part of the selector lever) input to signal the IPC the shift lever is fully seated in the PARK (P) position. The park detect input controls the display of the "P". The IPC compares the park position detect switch input with the transmission gear display message sent from the PCM.

Selectable Drive Mode Indicator

The IPC provides the selectable drive mode indicator to indicate which drive mode is selected and active. The driver can select ECO mode for more economical driving, slippery mode or deep snow/sand mode for improved traction. The IPC receives the selectable drive mode status, selectable drive mode request and active drive mode status messages from the GWM over the HS-CAN3. The GWM receives the selectable drive mode status, selectable drive mode request and active drive mode status messages from the ABS module over the HS-CAN2.

Seatbelt Warning Indicator

The RCM monitors the driver seatbelt buckle status through the driver seatbelt buckle switch. The RCM provides the driver seatbelt buckle status message to the GWM over the HS-CAN2. The GWM provides the driver seatbelt buckle status message to the IPC over the HS-CAN3 to either turn on or turn off the seatbelt warning indicator.

Stability-Traction Control Indicator (Sliding Car Icon)

The stability-traction control indicator informs the driver the stability-traction control system is active by flashing the indicator or that a fault condition exists by illuminating the indicator steady.

The IPC receives the stability-traction control indicator request message from the GWM over the HS-CAN3. The GWM receives the stability-traction control indicator request message from the ABS module over the HS-CAN2.

Refer to ABS/Brake/Stability-Traction Control System Indication description for information on the conditions when the stability-traction control indicator (sliding car icon) is turned on.

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

When the driver enables or disables the stability-traction control system, the ABS module sends the stability-traction control disabled indicator request message to the GWM over the HS-CAN2. The GWM sends the stability-traction control disabled indicator request message to the IPC over the HS-CAN3 to illuminate or turn off the stability-traction control disabled indicator (sliding car OFF icon) based upon the system state.

Refer to ABS/Brake/Stability-Traction Control System Indication description for information on the conditions when the stability-traction control disabled indicator (sliding car OFF icon) is turned on.

When a MyKeyÂ® administrator has set the AdvanceTracÂ® feature to always on and a MyKeyÂ® programmed key is in use, the stability-traction control system cannot be disabled. The menu selection in the message center used to disable the stability-traction control system does not display when a MyKeyÂ® is in use, but remains active for the MyKeyÂ® administrator to select the AdvanceTracÂ® always on feature off. The stability-traction control indicator still functions normally to indicate a stability-traction control system fault and a stability-traction control active event.

Refer to ABS/Brake/Stability-Traction Control System Indication description for information on the conditions when the stability-traction control

indicator (sliding car icon) is turned on.

TPMS Warning Indicator

The IPC receives the tire pressure warning indicator message from the GWM over the HS-CAN3. The GWM receives the tire pressure warning indicator message from the BCM over the HS-CAN1.

If the BCM determines the tire pressure has exceeded the low tire pressure limits, the tire pressure warning indicator request message is sent to the IPC to illuminate the TPMS warning indicator.

If a TPMS monitor or sensor fault condition exists, the BCM sends the tire pressure warning indicator request message to the IPC to flash the TPMS warning indicator. The IPC flashes the TPMS warning indicator for 75 seconds then turns the indicator on solid.

Tow Haul

The tow haul indicator illuminates when the tow haul system has been engaged and is actively providing tow haul control for the vehicle. When the system is actively providing tow haul control, the PCM sends the powertrain drive mode status message to the GWM over the HS-CAN1. The IPC receives the powertrain drive mode status message from the GWM over the HS-CAN3.

Wait To Start

The IPC provides a wait to start indicator to inform the driver the diesel engine is preheating before attempting to start the engine. The IPC receives the glow indication message from the GWM over the HS-CAN3. The GWM receives the glow indication message from the PCM over the HS-CAN1.

Water In Fuel

The water in fuel indicator informs the driver that water has been detected in the fuel. The IPC receives the water in fuel message from the GWM over the HS-CAN3. The GWM receives the water in fuel message from the PCM over the HS-CAN1.

Component Description

Brake Fluid Level Switch

The brake fluid level switch is mounted in the master cylinder reservoir and is hardwired to the BCM through a signal circuit and grounded through a separate body ground circuit. The BCM provides a reference voltage to the brake fluid level switch. When the brake fluid level is low, the float drops, allowing the switch to close, pulling the reference voltage low. When the brake fluid level is high, the float lifts, opening the switch contacts, sending the reference voltage high on the signal circuit to the BCM.

The brake fluid level switch uses an internal resistor in parallel. This enables the BCM to differentiate between a disconnected brake fluid level switch connector and a full level condition.

Fuel Level Sender

The fuel level sender is mounted to the fuel pump and sender unit or the fuel level sensor. The fuel level sender is a dual sweep potentiometer style resistor connected to a float mechanism. The dual sweep design provides a second resistance measurement that reduces the intermittent loss of data due to corrosion between the resistor wires and the sweep arm. As the fuel level changes, the float rises or falls with the fuel level moving the sweep arm across the resistor wires. This movement either increases or decreases the resistance through the unit. The fuel level sensor resistance ranges from 180 ohms Â± 4 ohms at empty (E) to 10 ohms Â± 2 ohms at full (F). When the fuel level is low, the fuel level sensor resistance is high. When the fuel level is high, the fuel level sensor resistance is low.

Both the fuel pump and sender unit and fuel level sensor are hardwired to the IPC through separate signal and return circuits. The fuel level return circuits are grounded internally in the IPC. The IPC provides a reference voltage on the fuel level signal circuit. As the fuel level changes, the change in resistance raises or lowers the fuel level signal voltage depending on the resistance of the fuel level sender.

IPC

The IPC provides the driver with a system status and alerts the driver when certain conditions exist in the vehicle. The IPC receives the ignition status from the BCM through the GWM over the HS-CAN3. The IPC requires Programmable Module Installation (PMI) when the IPC is replaced.

Engine Oil Pressure Switch

The engine oil pressure switch is a normally open switch that is hardwired to the PCM through a single signal circuit. The ground is provided by the switch housing when it is mounted on the engine. The PCM provides a reference voltage to the engine oil pressure switch. When engine oil pressure is low, the engine oil pressure switch remains open, sending the reference voltage high. When the engine oil pressure is sufficient, the engine oil pressure switch closes, pulling the reference voltage low to the PCM.

Park Position Detect Switch

The park position detect switch is hardwired to the IPC through a single signal circuit and is grounded by a separate circuit through the selector lever. The IPC provides a reference voltage to the park position detect switch. When the selector lever is in PARK (P), the park position detect switch closes to ground, pulling the reference voltage low. When the selector lever is moved out of PARK (P), the park position detect switch opens to ground, sending the reference voltage high to the IPC.

Seatbelt Buckle Sensor

The seatbelt buckles contain integrated Hall-effect sensors. The seatbelt buckle sensors are serviced as one component with the seatbelt buckle.
