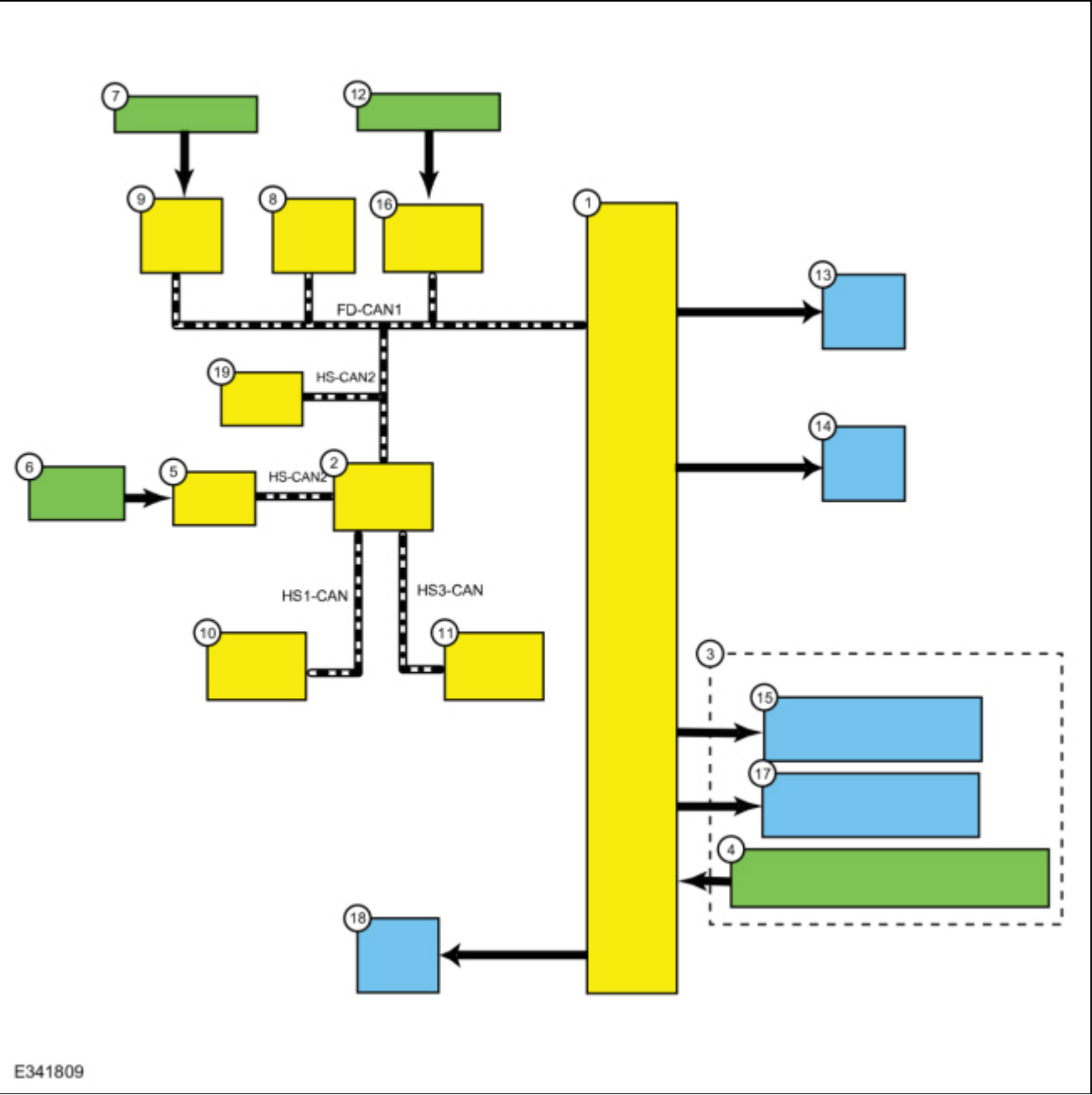


Rear Drive Axle and Differential - System Operation and Component Description

System Diagram

System Operation



Item	Description
1	TCCM
2	GWM
3	Transfer Case Assembly
4	Shift Motor Plate Position Sensors
5	ATCM
6	Drive Mode

7	Wheel Speed Data
8	<u>TCM</u> (Diesel engine only)
9	<u>EBB</u>
10	<u>BCM</u>
11	<u>IPC</u>
12	<u>APP</u>
13	<u>IWE LH</u>
14	<u>IWE RH</u>
15	Clutch Solenoid
16	<u>PCM</u>
17	Shift Motor
18	<u>ELD</u>

System Operation

Electronic Locking Differential (ELD) System

The ELD system consists of the following components:

- ELD field coil, located at the rear differential
- Rear differential with dog clutch
- ATCM
- TCCM
- MSS (unique for ELD equipped vehicles), located on the instrument panel

Neutral Flat Tow

NOTE: 2WD vehicles cannot be towed with any wheels on the ground as vehicle or transmission damage may occur.

NOTE: Failing to put the transfer case into the *NEUTRAL* position damages vehicle components.

Vehicles equipped with a 4WD system have neutral flat tow software in the TCCM. Following the neutral flat tow activation procedure commands the transfer case shift motor into a neutral position. Locking the transfer case in neutral prevents damage to the transmission while towing a 4WD vehicle on all 4 wheels (such as when being towed behind a motorhome).

Four Wheel Drive System Operation – Electronic Shift on the Fly (ESOF)

Principles of Operation

The ELD system allows the operator to lock the rear differential side gears. When the ELD is engaged both rear wheels turn at the same speed, providing added traction on slippery and/or off road surfaces. The operator can engage the ELD per the charts below:

ELD Engagement/Disengagement Speeds and Availability — 4WD Vehicles

Drive Modes (4WD Modes)	Maximum Engagement Speeds	Automatic Disengagement Speeds	Automatic Re-Engagement Speeds
Normal (2H/4A/4H)	30 km/h (20 mph) *	41 km/h (25 mph)	30 km/h (20 mph) *
Eco (2H/4A/4H)			
Sport (2H/4A/4H)			

Slippery (2H/4A/4H)			
Tow/Haul (2H/4A/4H)			
Deep Snow/Sand (4H/4L) **	No Speed Limit	No Speed Limit	No Speed Limit
Mud/Ruts (4H/4L) **			
Rock/Crawl (4L) **			
4WD (4L)			

* The ELD system engages/re-engages at or below the speed noted

** Automatically engages when these drive modes are selected. You have the ability to manually override the automatic engagement by pressing the electronic locking differential switch.

ELD Engagement/Disengagement Speeds and Availability — 2WD Vehicles

Drive Modes (2WD Modes)	Maximum Engagement Speeds	Automatic Disengagement Speeds	Automatic Re-Engagement Speeds
Switch Position Off	N/A	N/A	N/A
Switch Position On	30 km/h (20 mph) *	41 km/h (25 mph)	30 km/h (20 mph) *

* The ELD system engages/re-engages at or below the speed noted

When the operator activates the ELD, the ELD icon displays in the IPC message center. If the vehicle is driven above the disengage speed, the IPC message center no longer displays the ELD icon, alerting the operator that the ELD is disengaged. Once the vehicle speed drops below the re-engage speed, the IPC message center displays the ELD icon again. If there is a malfunction with the ELD system, a CHECK LOCKING DIFFERENTIAL message is displayed in the IPC message center, letting the operator know the ELD is not engaged.

Under certain conditions the ELD system has the ability to modulate powertrain torque output as well as system engagement/disengagement to protect internal ELD hardware.

The ELD feature allows the ABS to override the engage state during special events. When this condition occurs the ELD icon flashes on and off rapidly.

The differential locks when a PWM controlled magnetic field coil located inside the differential energizes. This locks the differential side gears and creates the locked differential.

The ELD system also informs the customer when there is too much wheel slip to safely engage the ELD by displaying TO ENGAGE LOCKING DIFFERENTIAL RELEASE ACCELERATOR PEDAL message in IPC message center. When the ELD is engaged, the TCCM sends PWM voltage to the ELD field coil located in the differential. This voltage is initially 98% duty cycle, and then tapers off after 30 seconds. In order for the TCCM to activate the ELD, certain conditions must be met.

- ELD MSS set to On.
- Wheel speed information via HS-CAN communication from ABS module)
- Operating range (voltage 11.5-16 volts)
- DTC setting range (voltage 10-15 volts)
- Ignition in the ON position
- TP

(2H) OPERATION

When the ATCM is in 2WD (2H), power is delivered to the rear wheels only. This mode is appropriate for normal on-road

driving on dry pavement and provides the best fuel economy. Torque is passed through the transfer case to the rear drive shaft at a 1:1 ratio. In 2WD (2H):

- The ATCM sends a 2WD (2H) mode status to the TCCM via a GWM.
- The IWE are disengaged.
- The TCCM outputs a 0% duty cycle to the synchronization clutch field coil (4WD_CLTCH_OUT # = 0.00%).
- The shift motor is in the full CCW position. Refer to TRANSFER CASE SHIFT MOTOR STATUS in this section for further information.
- (2H) will momentarily be displayed in the message center at key up and after a 4WD (4H) to 2WD (2H) shift.

NOTE: When shifting to (2H) mode in order for the IWE to completely disengage the vehicle steering wheel must be less than 90 deg and 5 seconds have elapsed since the shift to (2H) has been initiated.

(4H) OPERATION

When 4WD (4H) is selected on the ATCM, the 4WD system provides mechanically locked four-wheel drive with power delivered to all four wheels, for increased traction. 4WD (4H) is for use in off-road or winter conditions such as deep snow, sand or mud. This mode is not for use on dry pavement.

Shifts from 2WD (2H) to 4WD (4H) can be made at any speed. When performing this shift, release the accelerator pedal prior to the shift and wait until the Shift in Progress message disappears in the IPC before accelerating. This improves the shift performance as the transfer case and IWEs engage. In 4WD (4H):

- The ATCM sends a 4WD (4H) mode status to the TCCM via GWM.
- The TCCM outputs a 0% to 97% duty cycle to the synchronization clutch field coil (4WD_CLTCH_OUT # = x.xx%).
- The shift motor rotates CW to the 4WD (4H) position. Refer to TRANSFER CASE SHIFT MOTOR STATUS in this section for further information.
- The TCCM outputs a 0% duty cycle to the synchronization clutch field coil (4WD_CLTCH_OUT # = 0.00%).
- The IWE are engaged.
- 4WD (4H) is displayed in the message center.

(4L) OPERATION

(4L) 4WD provides mechanically locked four-wheel drive power to both the front and rear wheels for use on low traction surfaces, but does so with an additional 2.64 gear reduction for increased torque multiplication. Intended only for off-road applications such as deep sand, steep grades or pulling heavy objects. 4WD (4L) does not engage when your vehicle is moving above 3 mph (5 km/h); this is normal and should be no reason for concern.

Shifts to and from 4WD (4L) can only be made below 3 mph with the transmission in Neutral. When performing this shift, wait until the 4x4 Shift in Progress message disappears in the IPC before moving the selector lever back to Drive. If the vehicle speed or transmission range is not within parameters, the message center will indicate the necessary action needed to complete the shift.

In (4L):

- The ATCM sends a 4WD (4L) mode status to the TCCM via GWM.
- The IWE are engaged.
- The TCCM outputs a 0% duty cycle to the synchronization clutch field coil (4WD_CLTCH_OUT # = 0.00%).
- The shift motor rotates to the full CW position. Refer to TRANSFER CASE SHIFT MOTOR STATUS in this section for further information.
- 4WD (4L) is displayed in the message center.

ESOF Transfer Case Shift Motor

Vehicles equipped with the Electronic Shift on the Fly (ESOF) system use a shift motor to enter and exit 2WD (2H), 4WD

(4H), and 4WD (4L) modes.

The electric shift motor is mounted externally to the transfer case. It drives a rotary cam which moves the mode and range forks within the transfer case. The shift motor moves during shifts between 2WD (2H), 4WD (4H), and 4WD (4L). The TCCM directly controls the electric shift motor and can reverse motor polarity to reverse rotary cam/shift fork direction. The message center may display “Shift in Progress” while the shift motor is operating. The shift motor sense plate, an integral part of the shift motor assembly, informs the TCCM of the transfer case position. The sense plates are a set of 4 contacts that are opened and closed to represent each valid transfer case shift motor position. The mode and range forks are spring loaded so the motor can move to position regardless of the time it takes it takes for the transfer case internal shaft and hub splines to align and engage.

ESOF Transfer Case Shift Motor Status

Position	PLATE_A	PLATE_B	PLATE_C	PLATE_D
(2H)	Closed	Open	Closed	Closed
(4H)	Open	Closed	Closed	Open
(4L)	Open	Closed	Open	Closed
Neutral	Closed	Closed	Open	Open

Synchronization Clutch

The transfer case is equipped with an electronically controlled clutch which is located inside the case. This clutch is used to synchronize the speed of the front driveline with the rear driveline during 2WD (2H) to 4WD (4H) shifts. The clutch consists of a transfer case field coil, a field coil housing splined to the rear output shaft, and one steel clutch plate splined to the lock-up hub. When the ATCM is switched from 2WD (2H) to 4WD (4H) modes, the TCCM energizes the synchronization clutch. The magnetic field from the field coil pulls the lock-up hub clutch plate against the field coil housing. When the transfer case front and rear output shafts are synchronized, the spring-loaded lockup collar mechanically engages the 4WD drive sprocket to the field coil housing. After the shift to 4WD is completed, the synchronization clutch is deactivated.

Four Wheel Drive System Operation – 2 Speed Torque On Demand

(2H) OPERATION

When the ATCM is in 2WD (2H), power is delivered to the rear wheels only. This mode is appropriate for normal on-road driving on dry pavement and provides the best fuel economy. Torque is passed through the transfer case to the rear drive shaft at a 1:1 ratio. In 2WD (2H):

- The ATCM sends a 2WD (2H) mode status to the TCCM via GWM.
- The e IWE are disengaged.
- The TCCM outputs a 0% duty cycle to the clutch field coil (4WD_CLTCH_OUT # = 0.00%).
- The shift motor is in the full CCW position. Refer to TRANSFER CASE SHIFT MOTOR STATUS in this section for further information.
- 2WD (2H) will momentarily be displayed in the message center at key up and after a 4WD AUTO (4A) to 2WD (2H) shift.

NOTE: When shifting to (2H) mode in order for the IWE to completely disengage the vehicle steering wheel must be less than 90 deg and 5 seconds have elapsed since the shift to (2H) has been initiated.

AUTO (4A) and (4H) OPERATION

When 4WD AUTO (4A) or 4WD (4H) is selected on the ATCM, the 4WD system provides electronically controlled four-wheel drive with power delivered to all four wheels, as required, for increased traction. 4WD AUTO (4A) is appropriate for all

on-road driving conditions, such as dry road surfaces, wet pavement, light snow or gravel.

4WD (4H) provides electronically locked four-wheel drive power to both the front and rear wheels for use in off-road or winter conditions such as deep snow, sand or mud. This mode is not for use on dry pavement.

Shifts from 2WD (2H) to 4WD AUTO (4A)/(4H) can be made at any speed. When performing this shift, release the accelerator pedal prior to the shift and wait until the Shift in Progress message disappears in the IPC before accelerating, this improves the shift performance as the IWE engage. In 4WD AUTO (4A):

- The ATCM sends an AUTO (4A) 4WD mode status to the TCCM via GWM.
- The IWE are engaged.
- The TCCM outputs a 0% to 97% duty cycle to the clutch field coil (4WD_CLTCH_OUT # = x.xx%).
- In 4WD (4H), the TCCM outputs a constant 97% duty cycle to the clutch field coil.
- The shift motor is in the full CCW position. Refer to TRANSFER CASE SHIFT MOTOR STATUS in this section for further information.
- 4A or 4H is displayed in the message center.

In 4WD AUTO (4A), the TCCM continuously monitors conditions and driver input to send torque automatically to the front driveline by controlling the transfer case clutch, providing 4WD capability. The TCCM sends a duty cycle command to the transfer case clutch coil as a torque request based on combination of preemptive and wheel slip response algorithm. Preemptive response is based on steering wheel angle, vehicle speed, throttle positions and available powertrain torque. Wheel slip response is based on monitoring the average front and rear wheel speeds.

When 4WD is no longer needed (during cruising or steady state driving) system defaults back to RWD (rear wheel drive) mode by setting the duty cycle output to 0. The IWE remain engaged to allow seamless torque transfer to the front driveline when necessary.

TCCM increases the duty cycle to prevent or control slip under any of the following conditions:

- Slip is detected.
- Heavy acceleration (throttle position).
- Straight-ahead steering wheel angle.

TCCM decreases the duty cycle to prevent or reduce vehicle bind under any of the following conditions:

- Low speed.
- Low acceleration (throttle position).
- Tight turn steering wheel angle.

The TCCM has a thermal hardware protection strategy which monitors the amount of energy going through the clutch. This strategy has 2 levels of protections:

AUTOLOCK: If the system is in 4WD 4H and TCCM detects driving conditions that require greater 4WD performance, the TCCM temporarily turns on 4WD (4H) from 4WD AUTO (4A) after detecting driving condition and informs the customer via the message center indicating 4X4 TEMPORARILY LOCKED. The 4WD system automatically returns to 4WD AUTO (4A) after the system no longer detects these driving conditions and informs the customer via the message center indicating 4X4 RESTORED.

POWERTRAIN TORQUE PROTECTION: If the system is in 4WD AUTO (4A) and TCCM detects excessive stress or high energy going through the clutch (clutch is slipping excessively while the system is commanding max clutch torque), clutch output will be turned off and message center indicates 4x4 TEMPORARILY DISABLED. When the system had the ability to cool off, 4x4 operation will be automatically restored.

NOTE: *The 4x4 Temporarily Disabled message can be dismissed by the customer however it's advisable to let the TCCM clear the message itself, which indicates that the 4x4 system has resumed normal operation.*

(4L) OPERATION

4WD (4L) provides electronically locked four-wheel drive power to both the front and rear wheels for use on low traction surfaces, but does so with an additional 2.64 gear reduction for increased torque multiplication. Intended only for off-road applications such as deep sand, steep grades or pulling heavy objects. 4WD (4L) does not engage when your vehicle is

moving above 3 mph (5 km/h); this is normal and should be no reason for concern.

Shifts to and from 4WD (4L) can only be made below 3 mph with the transmission in Neutral. When performing this shift, wait until the 4x4 Shift in Progress message disappears in the IPC before moving the selector lever back to Drive. If the vehicle speed or transmission range is not within parameters, the message center will indicate the necessary action needed to complete the shift.

In 4WD (4L):

- The ATCM sends a 4WD (4L) mode status to the TCCM via GWM.
- The IWE are engaged.
- The TCCM outputs a 0% to 97% duty cycle to the clutch field coil (4WD_CLTCH_OUT # = x.xx%).
- The shift motor is in the full CW position. Refer to TRANSFER CASE SHIFT MOTOR STATUS in this section for further information.
- (4L) is displayed in the message center.

POWERTRAIN TORQUE PROTECTION: If the system is in 4WD 4L and TCCM detects excessive stress or high energy going through the clutch (clutch is slipping excessively while the system is commanding max clutch torque), clutch output will be turned off and message center indicates 4x4 TEMPORARILY DISABLED. When the system had the ability to cool off, 4x4 operation will be automatically restored.

2 Speed Torque On Demand Transfer Case Shift Motor

Vehicles equipped with the 2-speed torque-on-demand system use a shift motor to enter and exit 4WD (4L) mode.

The electric shift motor is mounted externally to the transfer case. It drives a rotary cam which moves the range fork within the transfer case. The shift motor moves during shifts to and from 4WD (4L), and to Neutral. It does not move during the shift between 2WD (2H) and 4WD AUTO (4A) or 4H. TCCM directly controls the electric shift motor and can reverse motor polarity to reverse rotary cam/shift fork direction. The message center may display "Shift in Progress" while the shift motor is operating. The shift motor sense plate, an integral part of the shift motor assembly, informs the TCCM of the transfer case position. The sense plates are a set of 4 contacts that are opened and closed to represent each valid transfer case shift motor position.

2 Speed Torque On Demand Transfer Case Shift Motor Status

Position	PLATE_A	PLATE_B	PLATE_C	PLATE_D
(2H)	Closed	Open	Closed	Closed
AUTO (4A)	Closed	Open	Closed	Closed
(4L)	Open	Closed	Open	Closed
Neutral	Closed	Closed	Open	Open

Torque-On-Demand Clutch

The transfer case is equipped with an electronically controlled clutch which is located inside the case. This clutch is used to transfer torque in 4WD AUTO (4A), 4H, and 4L modes.. The clutch consists of a transfer case field coil, ball and ramp or cam plate, and a multi-disc friction and steel clutch pack.
