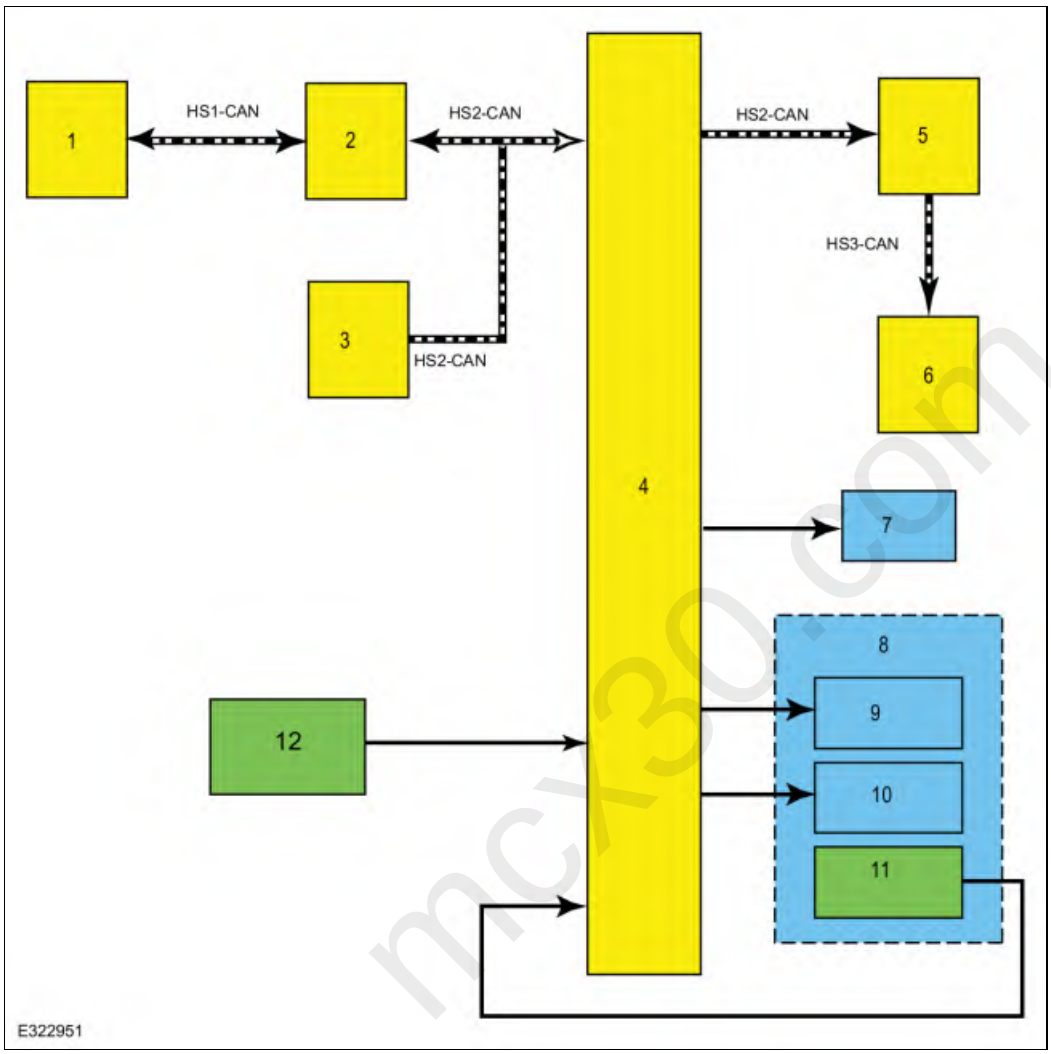
# Four-Wheel Drive Systems - System Operation and Component Description

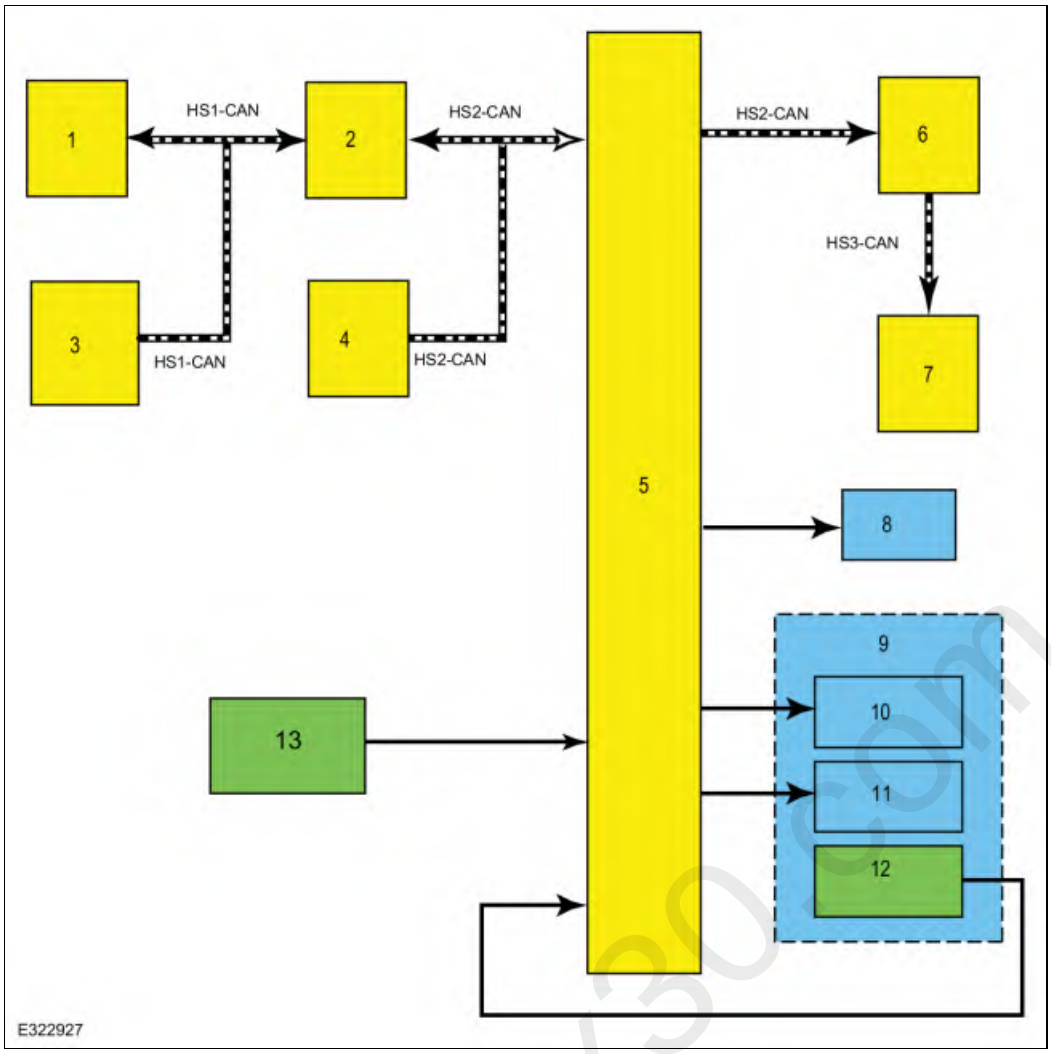
System Operation

**System Diagram for petrol engines**




| Item | Description |
|---|---|
| 1 | PCM |
| 2 | GWM |
| 3 | ABS module |
| 4 | TCCM |
| 5 | GWM |
| 6 | IPC |
| 7 | Continuous Vacuum Hublocks (CVH) solenoid |
| 8 | Transfer case |
| 9 | Clutch coil |
| 10 | Shift motor |
| 11 | Position sensors |
| 12 | MSS |

**System Diagram for diesel engines**

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**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 â€œShift in Progressâ€ 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.

| 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 | Open | Open | Closed | Closed |

**Front Driveline 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 MSS is switched from 2WD (2H) to 4WD (4H), 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.

**(2H) OPERATION**

When the MSS 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 MSS sends a 2WD (2H) mode status to the TCCM via a hardwired connection.
- The TCCM ground is open for the CVH solenoid.
- The TCCM outputs a 0% duty cycle to the synchronization clutch field coil.
- The shift motor is in the full counter clockwise 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 4H to 2H shift.

**(4H) OPERATION**

When 4WD (4H) is selected on the 4x4 Switch (MSS), 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 of the transfer case and CVH's engagements.

**Sequence to engage 4H from 2H:**

- The MSS selection of 4H is made. This selection has a electrical input to the TCCM.
- The TCCM outputs a 0% to 98% duty cycle to the transfer case clutch field coil.
- Clutch is Synchronizing the speed of the front driveline to the rear driveline (2H to 4H shifts).
- The shift motor rotates clockwise to the (4H) position. Refer to TRANSFER CASE SHIFT MOTOR STATUS in this section for further information.
- The TCCM then outputs a 0% duty cycle to de-energize the synchronization clutch field coil.

- The TCCM supplies the ground to the CVH solenoid to engage hub locks .
- 4H is then displayed in the message center.

**(4L) OPERATION**

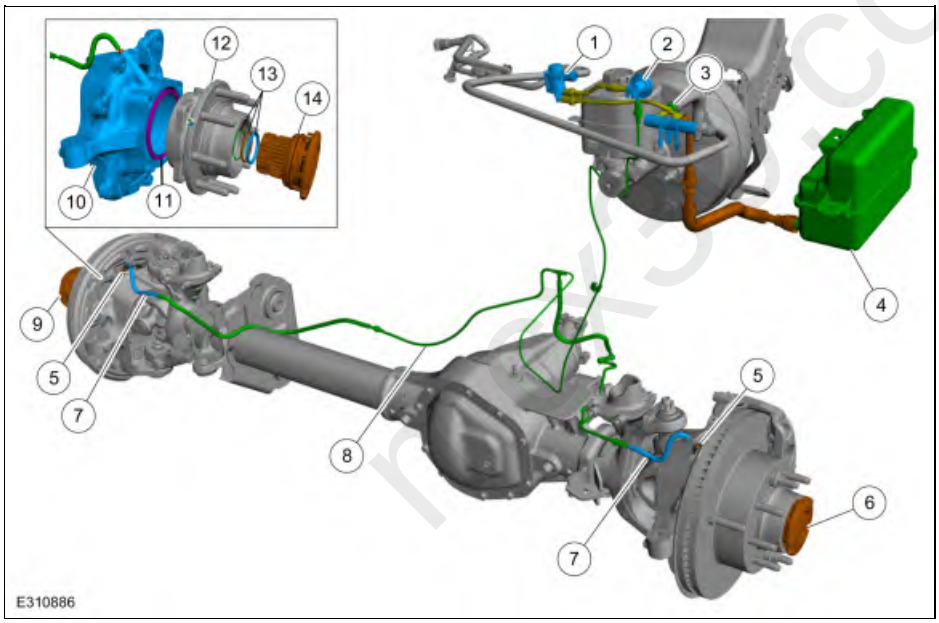
(4L) provides electronically locked four-wheel drive power to both the front and rear wheels for use on low traction surfaces but does so with an additional 2.64 gear reduction for increased torque multiplication. Intended only for off-road applications such as deep sand, steep grades or pulling heavy objects. (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.

**Sequence to engage 4L from 2H:**

- The 4x4 Switch selection of 4L is made. This switch selection has a electrical input to the TCCM.
- The TCCM outputs 0% duty cycle to the synchronization clutch field coil if below 1kph. (98% duty cycle to coil if above 1kph).
- The shift motor rotates to the full clockwise position of 4L. Refer to TRANSFER CASE SHIFT MOTOR STATUS in this section for further information.
- The TCCM supplies the ground for the CVH solenoid.
- 4L is displayed in the message center.

**Continuous Vacuum Hublocks (CVH)**




| Item | Description |
|---|---|
| 1 | Vacuum control solenoid. |
| 2 | Vacuum regulator valve. |
| 3 | Tube â€“ Source vacuum to solenoid and reservoir. Includes one way check and regulator valves. |
| 4 | Vacuum reservoir. |
| 5 | Vacuum tube nipple. |
| 6 | Front axle hublock - RH |
| 7 | Tube â€“ Vacuum tube to steering arm / knuckle. |
| 8 | Vacuum tube assembly. |
| 9 | Front axle hublock - LH. |
| 10 | Steering arm / knuckle. |

| | |
|---|---|
| 11 | â€œOâ€ Ring. |
| 12 | Wheel hub. |
| 13 | â€œOâ€ Ring Kit. |
| 14 | Front axle hublock. |

The continuous vacuum hublocks (CVH) system uses a vacuum solenoid and vacuum actuated hubs to engage or disengage the front wheel hubs from the front half shafts.

When the 4WD system is in 2WD (2H) mode, the TCCM does not supply the ground path to the CVH solenoid. Vacuum is not applied to the CVH. An internal spring keeps the CVH disengaged.

When operating in any 4WD mode, the TCCM supplies a ground path to the CVH solenoid to apply vacuum to the CVH thus engaging the front hubs to the front axle shafts. To maintain vacuum during all modes of engine operation, a one way vacuum check valve and a vacuum reservoir are positioned between the vacuum source and the CVH solenoid. The CVH require 6 inHg of vacuum to engage. A vacuum regulator valve positioned downstream from the CVH solenoid limits CVH vacuum to approximately 10 inHg. Some engines are equipped with a mechanical vacuum pump that supplies vacuum to the CVH vacuum reservoir.

The CVH may also be mechanically engaged by rotating the CVH dial to the LOCK position. In the LOCK position, the front hubs will be engaged to the front axle shafts regardless of vacuum supply.

**The TCCM has a strategy that affects CVH operation after initial key cycle:**

This strategy is used to warm up the front axle in cold temperatures to improve driveline synchronization. This cold strategy affects the CVH operation after initial key cycle below -15ÂºC. When ambient temperature is below 5F (-15ÂºC), CVHs engage after initial key cycle and a driven gear is selected. The hubs stay engaged regardless of the selected 4x4 mode until approximately 2 miles (3Km) have been traveled above 6 mph (10kph). Once the distance has been achieved, the CVHs disengage if the vehicle is in 2H. Distance traveled resets only if the temperature is below the calibrated threshold and another key cycle occurs or if the customer shifts to Park (P) and back to a driven gear within the same key cycle.

**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).

**Electronic Locking Differential (ELD) System**

The ELD system consists of the following components:

- ELD field coil in the rear differential.
- Rear differential with dog clutch.
- MSS (unique for ELD equipped vehicles, the ELD switch is integrated with the MSS ), located on instrument panel.

The optional ELD system allows the operator to lock the rear differential side gears on slippery and/or off road surfaces. ELD operation is requested by pulling out (4WD electronic shift vehicles) or turning the MSS to the on position ( 2WD vehicles).

**The operator can engage the electronic locking differential (ELD) per the charts below:**

The electronic locking differential (ELD) system engages/re-engages at or below the speeds noted.

**Electronic locking differential (ELD) Engagement Speeds â€” 4WD Vehicles**

| Switch Position | Engage | Disengage | Re-engage |
|---|---|---|---|
| 2H | 32 km/h (20 mph) | 41 km/h (25 mph) | 32 km/h (19 mph) |
| 4H | 32 km/h (20 mph) | 41 km/h (25 mph) | 32 km/h (19 mph) |

| | | | |
|---|---|---|---|
| 4L | 90 km/h (56 mph) | 100 km/h (62 mph) | 90 km/h (56 mph) |

**Electronic locking differential (ELD Engagement Speeds â€”2WD Vehicles**

| Switch Position | Engage | Disengage | Re-engage |
|---|---|---|---|
| Off | N/A | N/A | N/A |
| On | 32 km/h (20 mph) | 41 km/h (25 mph) | 32 km/h (20 mph) |