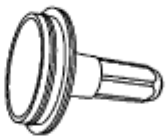
Your Vehicle: **2004 Ford Truck F 250 4WD Super Duty V8-6.0L DSL Turbo VIN P**

Four Wheel Drive (4WD) Systems - Electronic Shift

 ST2574-A	Flex Probe Kit 105-R025D or equivalent	 ST2852-A	Vacuum Test Plug, ABS Sensor 205-796
 ST3093-A	Fluke 77-IV Digital Multimeter FLU77-4 or equivalent	 ST2824-A	Vacuum Test Stand, Hub 205-795
 ST2823-A	Test Tool, Vacuum Hub 205-798	 ST2825-A	Vacuum Test Stand, Hub Bearing 205-794
 ST1176-A	Vacuum Pump 014-R1054 or equivalent	 ST2851-A	Vacuum Test Tool, Knuckle Seal 205-797
		 ST2332-A	Worldwide Diagnostic System (WDS) Vehicle Communication Module (VCM) with appropriate adapters, or equivalent diagnostic tool

Special Tool(s)

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Item	Specification
Premium Long-Life Grease XG-1-C or XG-1-K (Canada CXG-1-C)	ESA-M1C75-B

Material

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Principles of Operation - Electronic Shift on the Fly (ESOF) System

The electronic shift on the fly (ESOF) system is an electronic shift system that allows the operator to choose between 2 different 4x4 modes as well as 2-wheel drive. The operator can switch between 2H and 4H mode at speeds up to 88 km/h (55 mph). To engage or disengage 4L, the 4x4 generic electronic module (GEM) requires that the vehicle speed be less than 5 km/h (3 mph), the brake pedal pressed and the transmission in NEUTRAL (or clutch pedal applied on manual transmission vehicles). This system contains pulse vacuum hublocks (PVH). The selector on the hublock, when turned fully counterclockwise to the AUTO position, engages/disengages the hub depending on the driver-selected 4x4 mode of operation. The hublocks also contain a manual override. When the selector is rotated fully clockwise to the LOCK position, the 4x4 vacuum and electronic system used for coupling the front axle to the wheels is bypassed.

The transfer case is equipped with a dual-cone synchronous clutch. This clutch is used to synchronize the front driveline to the rear. All other internals operate in the same manner as the manual shift system. When the mode select switch (MSS) on the instrument panel is turned, the 4x4 module powers the transfer case shift motor, which activates a shift fork and engages the clutch. When the shift motor reaches the desired position, as determined by the encoder position inputs to the 4x4 module, power to the shift motor is removed. When the transfer case front and rear output shafts are synchronized, the lockup collar mechanically engages the mainshaft hub to the drive sprocket. At this point, the front axle PVHs are engaged. Instrument cluster "4x4" and "Low Range" indicator operation is controlled via hardwired outputs from the 4x4 module.

Electronic Shift Transfer Case

The New Venture Gear NV 273 electronic shift transfer case is a 3-piece aluminium design. The unit transfers engine power from the transmission to the front and rear axles. Under normal driving conditions the unit is in 2-wheel drive high (2H), but when desired, the operator may shift into 4-wheel drive high (4H) or 4-wheel drive low (4L). The transfer case is shifted electronically. The unit is lubricated by a positive displacement fluid pump that channels fluid flow through holes in the mainshaft.

The encoder assembly used for mode indication is of a Hall-effect type. The system uses a total of 4 independent transistors for mode recognition. Each transistor is associated with a specific range of motor movement. When the circuit to each transistor is closed, a ground path to any of the A, B, C or D encoder pins is accomplished. When the circuit to each transistor is open, the connection to any of the A, B, C or D encoder pins is pulled to voltage. Mode indication is "decoded" by the 4x4 module based on the varying combinations of signals coming from the transistors.

Pulse Vacuum Hublocks

The electronic shift-on-the-fly (ESOF) system has a feature which allows the driver to override the vacuum-operated hublocks. When the front hublock dials are manually turned to the LOCK position, the hublocks are locked through the dial at all times, regardless of the position of the instrument panel mode select switch (MSS).

When the front hublock dials are manually turned to the AUTO position, the hublocks use an internal spring-locking mechanism that is vacuum-operated by the ESOF system, and are locked with the MSS in the 4H or 4L position and unlocked with the MSS in 2H position. Refer to Hublock Operation in this section for additional AUTO hublock system operation.

Hublock Operation

With the hublocks in the AUTO position, the 4x4 ESOF system uses timed vacuum sequences to lock and unlock the wheel ends when switching the instrument panel MSS between 2WD and 4x4 modes. A high vacuum level (222 mm [8.75 in] Hg and greater) is applied to the hublocks to lock the internal spring mechanism that engages (locks) the hublocks for 4x4 mode, and a lower vacuum level (114 to 184 mm [5.9 to 7.1 in] Hg) is applied to unlock the spring mechanism that disengages (unlocks) the hublocks for 2WD mode. The vacuum signals are supplied to the hublocks by system components, including the 4WD control module or GEM, wiring harness, solenoid, vacuum harness and vacuum seals. As a first step in service, eliminate obvious items such as loose wiring connections, loose vacuum connections or damaged vacuum lines.

Hublock Engagement/Disengagement Time

With the hublock dials in the AUTO position, switching the instrument panel MSS to 4x4 HIGH or 4x4 LOW results in the high vacuum level being applied to the hublocks, which lasts for at least 51 seconds (including a venting cycle). The hublocks should engage during this time through the spring mechanism. Switching the MSS to 4x2 less than 51 seconds after the MSS has been switched to 4x4 HIGH or 4x4 LOW will not interrupt the high vacuum level; instead, the lower vacuum level will be applied after the high vacuum level cycle is completed.

With the hublock dials in the AUTO position, switching the MSS to 2WD results in the lower vacuum level being applied to the hublocks, which lasts for about 15 seconds. However, the actual time required for the hublocks to disengage by spring force can vary considerably due to the effects of driveline wind-up. Road bumps, vehicle speed, acceleration cycles or momentary reversal of direction can assist this process. Switching the MSS to 4x4 HIGH or 4x4 LOW always overrides the lower vacuum level cycle and results in an immediate high vacuum level and in locking of the hublocks.

Manual Override

The AUTO hublocks have a manual override selector dial, which, when turned to the LOCK position, will keep the hublocks locked (through the dial) at all times, regardless of the position of the instrument panel MSS. (Always set both hublock dials to the same position.) If the hublock dials are manually turned from the AUTO to the LOCK position, and the high vacuum level is applied to the hublocks (by switching the MSS from 2WD to 4x4 HIGH or 4x4 LOW), the hublocks will be locked through the dial as well as through the internal spring mechanism. In this case, turning the hublock dials back to the AUTO position will leave the hublocks in (spring) locked mode until the lower vacuum level is applied to the hublocks (by switching the MSS from 4x4 or 4x4 LOW to the 4x2). (This is not an issue if the hublock dials have been in the AUTO position and the MSS has been switched from 4x4 HIGH or 4x4 LOW to 2WD at least once.) Alternatively, the hublock mechanism can be reset to free mode at any time by turning the hublock dial from AUTO to LOCK to AUTO at least 2 times.

Electronic Shift On-the-Fly (ESOF) Automatic Hublock Operation

Hublock Operational State	Hublock Dial Switching Procedure
"Locked" position - Manual Override	Switch to the hublock dial to LOCK
"Free" Mode (for Troubleshooting or Recreational Towing)	Switch the hublock dial from AUTO to LOCK and back to AUTO to least 2 times
"Automatic" Operation via ESOF	Switch the hublock dial to AUTO
"Automatic" Vacuum Control with MSS in 4x4 HIGH or 4x4 LOW	NOTE: This cycle will always be completed and cannot be interrupted by switching the MSS to 2WD. If vehicle speed goes below 5 MPH during the 45-second cycle and the MSS remains in 4x4 HIGH or 4x4 LOW, the locking cycle will repeat. Switch the hublock dial to AUTO PVH solenoid activated for 45 seconds/vacuum at knuckle is 216 mm (8.5 in) Hg or more. PVH solenoid vents for 6 seconds.
"Automatic" Vacuum Control with MSS in 2WD	NOTE: Switching the MSS to 4x4 HIGH or 4x4 LOW will interrupt this cycle. Switch the hublock dial to AUTO PVH solenoid activated for 15 seconds/vacuum at knuckle is 150 to 180 mm (5.9 to 7.1 in) Hg.

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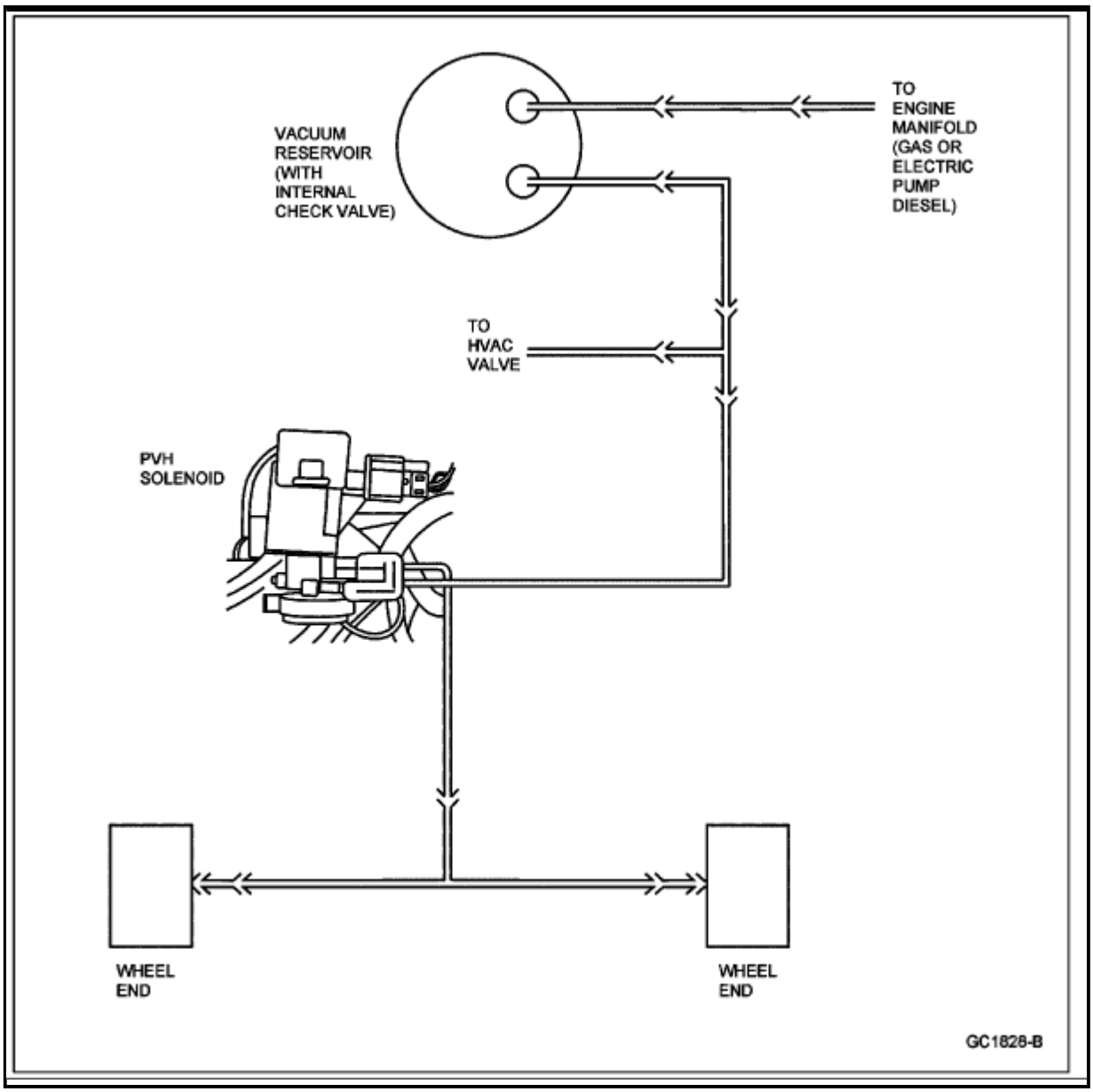
Hublock Replacement

NOTICE: Make sure to follow the Removal and Installation procedure exactly as instructed or damage to the hub may occur.

Left- and right-side hublocks are not connected, other than by the common vacuum supply line. If a malfunction in either hublock is diagnosed, it should be installed as an individual unit; there is no need to "balance" an axle with new hublocks on both sides. It is highly unlikely that both hublocks are malfunctioning at the same time on a vehicle. If both sides appear to be malfunctioning, be sure to verify upstream integrity before installing new hublocks on both sides.

Many system components are involved in the correct operation of the ESOF hubs. Before diagnosing the hublocks themselves as the cause of 4WD concerns, be sure to verify all related system components.

Electronic Shift Vacuum Schematic



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Feature Inputs:

- Mode select switch (MSS)
- Vehicle speed (hardwired to 4x4 module via ABS)
- Encoder position inputs A, B, C or D
- Transmission neutral position (automatic transmission)
- Clutch apply signal (manual transmission)
- Brake ON/OFF (BOO - hardwired from brake pedal switch)

Feature Outputs:

- Transfer case dual-cone synchronization clutch
- Transfer case shift motor and Hall-effect encoder assembly
- Transfer case shift motor relays
- Pulse vacuum hublock (PVH) solenoid assembly
- PVH vacuum pump (certain diesel applications only)
- Cluster indicators (hardwired to instrument cluster via 4x4 module)

During 4x4 Initialization at Startup:

- The 4x4 module will verify the MSS position
- If the transfer case is not in the desired mode, the 4x4 module will attempt to perform a range shift. If input conditions for 4L are not present, then the module will either shift to or remain in 4H
- Once the transfer case is engaged, or is already in the correct mode, the PVH lock/unlock and/or lock solenoids will be energized
- If the MSS position is 2H, the PVH lock/unlock solenoid will be commanded to energize ONLY at speeds below 8 km/h (5 mph). Once this speed threshold is met, the solenoid will be de-energized. This procedure is to prevent ratcheting induced by an attempt to unlock an already unlocked hub

For a Shift Attempt From 2H to 4H or 4L, the Following Sequence Occurs:

- MSS is switched from 2H to 4H or 4L
- For shift attempts into 4L:
- the brake must be applied.
- transmission must be in NEUTRAL (or clutch pedal applied).
- vehicle speed must be below 8 km/h (5 mph).
- Shift motor moves range fork in transfer case, which engages dual-cone synchronizers
- If a blocked shift condition occurs, the shift motor will perform 10 shift attempts (2H to 4H or 4H to 4L) totaling 5 clockwise movements and 5 counterclockwise movements with an approximate 1-second delay between each motor movement attempt
- If, after 10 attempts, a shift is not completed, then the module will command a shift motor rest time of 40 seconds, before it attempts any further shifts
- After the 40 seconds have expired, the motor will make 10 more attempts to complete the shift. The motor will continue to repeat this sequence a total of 6 times (60 shift attempts) before ceasing operation. No further shift attempts will be made, nor will any further MSS commands be recognized. The vehicle must be restarted for 4x4 function to be restored. If this occurs, DTC C1728 (for 2H to 4H attempts) or DTC C1729 (for 4H to 4L shift attempts) will be stored in memory
- If the vehicle is driven above 5 km/h (3 mph) during a 40-second rest period, the module will reattempt the shift strategy outlined previously. Generally, the transfer case will engage as the probability of gear teeth blockage is greatly reduced while rolling
- If no gear teeth blockage is present, the transfer case synchronizers bring the front driveshaft to same speed as rear driveshaft
- Shift fork completes movement and the "4x4" and (if 4L) "Low Range" lamp will illuminate. This ONLY occurs when the driveshafts are synchronized. If they are not, then the "4x4" lamp will not illuminate
- Once the 4x4 lamp is illuminated, the PVH lock and lock/unlock solenoids are energized for 45 seconds, with approximately 62 kPa (9 psi) of vacuum or more at the hubs. The PVH lock sequence cannot be overridden at any time (a mode shift change back to 2H)
- After 45 seconds have elapsed, the solenoids undergo a 6-second vent period, whereby no commands to either the lock or lock/unlock solenoids are allowed, regardless of MSS position
- If the vehicle is driven above 8 km/h (5 mph) the PVH lock and lock/unlock solenoids are re-energized in the same manner, regardless of whether the hubs are engaged or the original 45-second engagement timer has expired

For a Shift Attempt from 4L to 4H to 2H, the Following Sequence Occurs:

- 4x4 mode select switch is placed from 4H or 4L to 2H
- For shift attempts out of 4L:
- the brake must be applied.
- transmission must be in NEUTRAL (or clutch pedal applied).
- vehicle speed must be below 8 km/h (5 mph).
- Shift motor moves range fork in transfer case, which disengages dual-cone synchronizers
- If a blocked shift condition occurs, the shift motor will perform 10 shift attempts from 4H or 4L to 2H to 4H or 4L to 2H totaling 5 clockwise movements and 5 counterclockwise movements with an approximate 1-second delay between each motor movement attempt
- If, after 10 attempts, a shift is not completed, then the module will command a shift motor rest time of 40 seconds, before it attempts any further shifts
- After the 40 seconds have expired, the motor will make 10 more attempts to complete the shift. The motor will continue to repeat this sequence a total of 6 times (60 shift attempts) before ceasing operation. No further shift attempts will be made, nor will any further MSS commands be recognized. The vehicle must be restarted for 4x4 function to be restored. If this occurs, DTC C1728 (for attempts between 2H and 4H) or DTC C1729 (for attempts between 4H and 4L) will be stored in memory.
- If the vehicle is driven above 3 mph (5 km/h) during a 40-second rest period, the module will reattempt a shift (4H to 2H

only). Generally, the transfer case will disengage as the probability of torque trapping is lower while rolling
- If no torque trapping is present, the transfer case synchronizers decouple the front driveshaft
- Shift fork completes movement and de-energizes "4x4", and if 4L, "Low Range" lamps. Once the 4x4 lamp is de-energized, the PVH lock/unlock solenoid is energized for 15 seconds, pulling approximately 41 kPa (6 psi) of vacuum at the hubs
- The PVH unlock sequence can be overridden at any time such as a mode shift change back to 4H or 4L, relocking the hubs
- After 15 seconds, the solenoids undergo a 6-second vent period; the vent period can be overridden at any time by a shift attempt to 4H or 4L.