Engine Synchro Shift™ (ESS™) Transmission
With ZF Meritor’s Transmission Control Unit (TCU)

Maintenance and Diagnostics
Manual No. MM-9850
This publication provides maintenance and service procedures for ZF Meritor’s Engine Synchro Shift™ (ESS™) transmission with a transmission control unit (TCU). The information contained in this publication was current at the time of printing and is subject to revision without notice or liability.

1. You must understand all procedures and instructions before you begin maintenance and service procedures.

2. You must follow your company’s maintenance and service guidelines.

3. You must use special tools, when required, to avoid serious personal injury and damage to components.

Meritor uses the following notations to alert the user of possible safety issues and to provide information that will help to prevent damage to equipment and components.

- **WARNING**: A WARNING indicates a procedure that you must follow exactly to avoid serious personal injury.

- **CAUTION**: A CAUTION indicates a procedure that you must follow exactly to avoid damaging equipment or components. Serious personal injury can also occur.

- **NOTE**: A NOTE indicates an operation, procedure or instruction that is important for proper service. A NOTE can also supply information that will help to make service quicker and easier.

- **NOTE**: This symbol indicates that you must tighten fasteners to a specific torque.

Visit Our Web Site
Visit the Technical Library section of www.meritorauto.com for additional product and service information on Meritor’s heavy vehicle systems component lineup.

**Technical Electronic Library on CD**
The CD includes product and service information on Meritor’s component lineup. $20. Order TP-9853.

**Additional ESS™ Information**
- *Engine Synchro Shift™ Operator Manual* (TP-95130)
- *Engine Synchro Shift™ Operator Manual and On the Road with ESS™ audio tape* (TP-95130A)
- *Driving is Easy with ESS™ laminated card* (TP-96118)
- *Wiring Diagram for an ESS™ Transmission with Meritor’s Transmission Control Unit (TCU)* (TP-9851)

**Video**

**How to Order**
Call Meritor’s Customer Service Center at 800-535-5560.
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<tr>
<th>M</th>
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<th>F</th>
<th>10</th>
<th>C</th>
<th>E</th>
<th>18*</th>
<th>FPR</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZF Meritor</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>O = Overdrive</td>
<td>No Letter = D/D</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Design Platform**

- **M**: Manual
- **O**: Overdrive
- **D/D**: No Letter

**Torque Rating (lb-ft)**

- 11 = 1150
- 12 = 1250
- 13 = 1350
- 14 = 1450
- 15 = 1550
- 16 = 1650

**Ratio**

- **A**: 9-Speed
- **B**: 10-Speed
- **C**: 13-Speed

**Highest torque in top two gears**

- 16 = 1650 lb-ft
- 18 = 1850 lb-ft

**E = ESS™ (Meritor TCU)**

**D = ESS™ (DDC ECM)**

**S = SureShift™**

**M = Manual**

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*Progressive torque is an engine feature that requires a Torq-Z™ transmission. In models not featuring progressive torque, this number will be the same as the torque rating.*
Section 1
Introduction

Engine Synchro Shift™ (ESS™) Transmission Features

Synchronizes the Transmission

- The Engine Synchro Shift™ (ESS™) system automatically synchronizes the transmission by matching engine rpm to the vehicle's road speed.

Shifting Gears

- With the ESS™ system you only use the clutch pedal to START and STOP the vehicle or to shift into FORWARD or REVERSE. If you use the clutch while driving, the ESS™ system becomes inactive, and you will have manual control of the transmission.

Automated HIGH and LOW Range

- Range shifts are automatic, which means you do not have to preselect HIGH or LOW ranges.

Break Torque

- You can move the shift lever out of gear WITHOUT changing throttle position. The ESS™ system will automatically synchronize engine rpm to road speed.
- With the ESS™ system you can apply the service brake as you downshift through the gears when you are stopping the vehicle.
- On steep grades, the ESS™ system allows you to maintain throttle position WITHOUT using the clutch.

ESS™ System Components

- System switch
- Shift Intent switch
- Speed sensors for transmission input and output shafts
- NEUTRAL (N) position sensor
- Electropneumatic solenoids (located in the transmission)
- In gear position sensor

How ZF Meritor’s Engine Synchro Shift™ (ESS™) System Works

The ZF Meritor Engine Synchro Shift™ (ESS™) system collects and relays the following information to the transmission control unit (TCU):

- The positions of the system switch and the shift intent switch
- The speeds of the transmission input shaft and output shaft
- The position of the shift lever in the shift tower.

The TCU processes the information and relays the data to the engine control module (ECM). The ECM increases or decreases engine rpm to match the vehicle’s road speed. The TCU also controls the HIGH or LOW range selection in the auxiliary case on the rear of the transmission.
On the Shift Knob

The System Switch

The two-position system switch, the lowest switch on the operator’s side of the shift knob, turns the ESS™ system ON and OFF and displays the system status.

- When you slide the system switch DOWN, you see the word “ON.” This means that the ESS™ system is activated.
- When you slide the switch UP, you see the word “OFF.” This means that the ESS™ system is not activated, and you have manual control of the transmission.

The Shift Intent Switch

- The shift intent switch is a four-position rocker switch located above the system switch on the operator’s side of the shift knob.
- When the ESS™ system is turned ON, the shift intent switch signals the ECM that you will UPSHIFT or DOWNSHIFT, based on your input.
- You can also use the shift intent switch to release torque on the gears — break torque — just before you shift. Just press the switch all the way in to the end of its travel, and then release it without changing throttle position.
- When the ESS™ system is OFF (which means that system is inactive), you have manual control of the transmission. The shift intent switch acts as a range selector.
- To preselect range shifts: While in gear, press the TOP of the shift intent switch for HIGH range and the BOTTOM of the switch for LOW range.

How to Shift

**WARNING**

The transmission must be in the NEUTRAL (N) position when you start the vehicle. If you start the vehicle with the transmission in gear, the vehicle will suddenly move FORWARD or REARWARD. Serious personal injury and damage to the transmission can result.

To Start the Vehicle

1. Check that the shift lever is in the NEUTRAL (N) position.
2. Push the clutch pedal to the bottom of travel to engage the clutch brake.
3. Start the engine.
4. Slowly release the clutch pedal.
5. Allow the air pressure in the air system to reach the specified range on the gauge.
6. Release the parking brakes.
Shift Into a Starting Gear

1. Turn ON (activate) the ESS™ System:
   - Slide the two-position system switch (the lowest switch on the operator’s side of the shift knob) DOWN. You will see the word “ON,” which means that the ESS™ system is activated.

   **CAUTION**
   *Use the clutch brake only for initial gear engagement when the vehicle is stationary to avoid damage to the input shaft and/or the clutch brake.*

2. Disengage the Clutch:
   - Push the clutch pedal to the bottom of travel. (The clutch brake will touch the clutch release bearing.) Clutch disengagement stops the transmission for initial gear engagement.

   **CAUTION**
   *Always use the correct starting gear when you operate the transmission. Do not shift into NEUTRAL and coast. Damage to the transmission can result.

3. Shift Into a Starting Gear:
   - With the clutch pedal at the bottom of travel, move the shift lever into a starting gear.
   - Slowly release the clutch pedal to move the vehicle FORWARD.

   **The ESS™ System Safety Feature:**
   **The “Time-Out Sequence”**

   The ESS™ system has a built-in safety feature called the “time-out” sequence. If you do not complete a shift from NEUTRAL (N) within three seconds after you break torque, the system becomes inactive — or “times-out” — and returns the transmission to manual control.

   **To turn ON (reactivate) the ESS™ system so that you can continue to shift:**
   - Press the shift intent switch again. (Refer to the “Upshifting” and “Downshifting” sections in this manual for instructions on how to use the shift intent switch.)

Upshifting Into the Next Higher Gear

**NOTE:** Expect a DROP in rpm when you UPSHIFT.

1. Press the TOP of the shift intent switch once for first shift. This signals the ESS™ system that you will UPSHIFT. Then move UP through the gears without pressing the switch again. **Figure A.**

2. To break engine torque, continue to press the TOP of the shift intent switch all the way in to the end of its travel and then release it, which enables the shift lever to move freely out of gear. **Figure B.**

   **NOTE:** When you shift, do not rush or try to “beat” the system. If you experience “gear clashing,” you have shifted too fast. Just shift at a natural pace or speed.

3. **Immediately** move the shift lever into NEUTRAL (N) and pause for a second. The ESS™ system will slow down the engine to the correct rpm and synchronize the transmission to road speed.

4. Move the shift lever into the next HIGHER gear.

Upshifting Into the Rest of the Gears

1. Press the TOP of the shift intent switch all the way in to the end of its travel and then release it each time you move the shift lever. The range shift is automatic.

2. Repeat Steps 1 through 4.
If a Gear “Partially Engages”
1. Press the shift intent switch all the way in to the end of its travel and then release it.
2. Move the shift lever into the next HIGHER gear.

To “Skip Shift”

NOTE: “Skip shifting” causes a change in engine speed. Pause longer in NEUTRAL (N).
1. Pause longer in NEUTRAL (N) to let the ESS™ system synchronize the transmission.
2. Press the shift intent switch once for each gear you want to skip.

Downshifting Into the Next Lower Gear

NOTE: Expect a RISE in rpm when you DOWNSHIFT.
1. Press the BOTTOM of the shift intent switch once for first shift. This signals the ESS™ system that you will DOWNSHIFT. Then move DOWN through the gears without pressing the switch again. Figure C.
2. To break engine torque, continue to press the BOTTOM of the shift intent switch all the way in to the end of its travel and then release it, which enables the shift lever to move freely out of gear. Figure D.

NOTE: When you shift, don’t rush or try to “beat” the system. If you experience “gear clashing,” you have shifted too fast. Just shift at a natural pace or speed.
3. Immediately move the shift lever into NEUTRAL (N) and pause for a second. The ESS™ system will slow down the engine to the correct rpm and synchronize the transmission to road speed.
4. Move the shift lever into the next LOWER gear.

Downshifting Into the Rest of the Gears
1. Press the BOTTOM of the shift intent switch all the way in to the end of its travel and then release it each time you move the shift lever. The range shift is automatic.
2. Repeat Steps 1 through 4.

If a Gear “Partially Engages”
1. Press the shift intent switch all the way in to the end of its travel and then release it.
2. Move the shift lever into the next LOWER gear.

To “Skip Shift”

NOTE: “Skip shifting” causes a change in engine speed. Pause longer in NEUTRAL (N).
1. Pause longer in NEUTRAL (N) to let the ESS™ system synchronize the transmission.
2. Press the shift intent switch once for each gear you want to skip.
Shift Into REVERSE (R)

1. Turn ON (activate) the ESS™ System:
   - Slide the two-position system switch (the lowest switch on the operator’s side of the shift knob) DOWN. You will see the word “ON,” which means that the ESS™ system is activated.

   **CAUTION**
   *Use the clutch brake only for initial gear engagement when the vehicle is stationary to avoid damage to the input shaft and/or the clutch brake.*

2. Disengage the Clutch:
   - Push the clutch pedal to the bottom of travel. (The clutch brake will touch the clutch release bearing.) Clutch disengagement stops the transmission for initial gear engagement.

3. Shift Into REVERSE (R):
   - With the clutch pedal at the bottom of travel, move the shift lever into REVERSE (R).
   - Slowly release the clutch pedal to move the vehicle in the reverse direction.

Shift Into HIGH Range REVERSE

1. Turn OFF (Deactivate) the ESS™ System:
   - Slide the two-position system switch (the lowest switch on the operator’s side of the shift knob) UP. You will see the word “OFF,” which means that ESS™ is turned OFF, or deactivated.

2. Preselect HIGH Range:
   - With the shift lever in gear, press the TOP of the shift intent switch to put the transmission into HIGH range.

   **CAUTION**
   *Use the clutch brake only for initial gear engagement when the vehicle is stationary to avoid damage to the input shaft and/or the clutch brake.*

3. Disengage the Clutch:
   - Push the clutch pedal to the bottom of travel. (The clutch brake will touch the clutch release bearing.) Clutch disengagement stops the transmission for initial gear engagement.

4. Shift Into REVERSE (R):
   - With the clutch pedal at the bottom of travel, move the shift lever into REVERSE (R).
   - Slowly release the clutch pedal to move the vehicle in the reverse direction.
ESS™ Transmission Cab Shift Labels

⚠️ CAUTION ⚠️
Shift patterns vary by vehicle. You must use the correct shift pattern for the vehicle you operate to avoid damage to the transmission.

1. Refer to the shift pattern decal affixed to the sun visor or instrument panel when you shift the transmission.

2. If the decal is missing or unreadable, call Meritor’s Florence Distribution Center at 888-725-9355/Option #5 to order a new decal.

3. Install the new decal in the vehicle.
   - 9-speed standard models. Figure 1.1.
   - 9-speed R-Ratio models. Figure 1.2.
   - 10-speed models. Figure 1.3.

---

Figure 1.1

Figure 1.2

Figure 1.3
WARNING
To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

When you work on an electrical system, the possibility of electrical shock exists, and sparks can ignite flammable substances. You must always disconnect the battery ground cable before you work on an electrical system to prevent serious personal injury and damage to components.

Flash Codes and Volt-Ohm Meter (VOM) Diagnostics

The Transmission Control Unit (TCU) uses sequences of light flashes called flash codes to identify faults that the TCU detects and stores into memory. After you identify the fault by observing the flash code, use the VOM to test the area where the flash code indicates that the fault has occurred. An authorized Meritor distributor/dealer should repair the fault.

There are faults that can occur in the ESS™ system that flash codes will identify. Each fault has its own sequence of light flashes (flash code).

Questions and Answers About Flash Codes and System Faults

What are flash codes?

ZF Meritor’s transmission control unit (TCU) uses sequences of light flashes called flash codes to identify faults that the TCU detects and stores into memory.

What is a “fault”?

A “fault” is a problem that currently exists in the ESS™ system or system components.

Does each fault have its own flash code?

Yes. For example, Flash Code 36 identifies a voltage fault in the low range solenoid. Refer to the table in this section for a list of flash codes and fault descriptions.

How do you retrieve flash codes from the TCU?

Use the “Check Transmission” light and toggle switch, an optional OEM installation that is usually located on the dashboard near the check engine light. The toggle switch activates the “Check Transmission” light to identify ESS™ system faults.

In what order does the TCU store faults?

The TCU stores faults in the order that they occur.

When should you clear flash codes from TCU memory?

Repair all faults before you clear flash codes from TCU memory.

What happens if you repair a fault but do not clear it from TCU memory?

The fault will remain in the TCU as an inactive fault. The next time you perform flash code diagnostics:

- Test the area to confirm that the fault has been repaired. If there are other faults in TCU memory, repair the faults.
- Clear the repaired faults from TCU memory.

Who should repair a fault in the ESS™ system?

A ZF Meritor-authorized technician should repair the fault.

Activating TCU Flash Code Diagnostics

OEM-Installed “Check Transmission” Light and Toggle Switch

NOTE: If a “Check Transmission” light and toggle switch are not installed in the vehicle, call Meritor’s Customer Service Center at 800-535-5560 for assistance.

1. With the ignition OFF, PRESS and HOLD the ESS™ diagnostic toggle switch.
2. Turn the ignition ON, but do not start the engine.
3. Release the ESS™ diagnostic toggle switch three seconds after turning the ignition ON. The TCU activates and begins a self-diagnostic check of the system. The “Check Transmission” light will flash to verify that the system is operating correctly.
How the “Check Transmission” Light Displays Flash Codes

NOTE: The “Check Transmission” light continues to display flash codes until you turn the ignition OFF. Flash codes will remain in TCU memory until you clear them.

1. After the TCU checks the system, the “Check Transmission” light pauses for about three seconds.

2. The “Check Transmission” light then begins to consecutively display faults in two- or three-digit flash code sequences, with a short pause between each digit and a longer pause between each sequence.
   - An example of a two-digit fault is Flash Code 36, a fault in the low range solenoid. For this fault, the “Check Transmission” light would display the two-digit flash code as 3-6. Figure 2.1.

3. If the TCU has stored only one fault into memory: The “Check Transmission” light will continue to repeat the flash code sequence for that fault until you turn the ignition OFF.

4. If the TCU has stored more than one fault into memory: The “Check Transmission” light will continue to repeat the flash code sequences for all of the faults until you turn the ignition OFF.

5. After all of the flash codes have been displayed, the “Check Transmission” light will pause for two seconds and then continue to display the flash codes again until you turn the engine OFF. The faults will remain in TCU memory until you clear them.

---

Figure 2.1

Example: Flash Codes 36 and 226

Flash Code 36: Low Range Solenoid Voltage Fault

3 Flashes

6 Flashes

Flash Code 226: ESS™ Switch Assembly Fault

2 Flashes

2 Flashes

6 Flashes

CTL = CHECK TRANSMISSION LIGHT ON
Record the Flash Codes

1. Prepare to write down the flash code sequences that the “Check Transmission” light will display when you turn the ignition ON.

2. After you record the flash codes, turn the ignition OFF.

How to Read Flash Codes

1. Compare each two- or three-digit flash code sequence that you have recorded to the fault that corresponds in the table below.

2. Test each area where the “Check Transmission” light has identified a fault. Repair the fault. Clear the flash codes from TCU memory.

Flash Codes and Fault Descriptions

<table>
<thead>
<tr>
<th>Flash Codes</th>
<th>Flash Code Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>194</td>
<td>No codes</td>
</tr>
<tr>
<td>231</td>
<td>J-1939 communications link fault</td>
</tr>
<tr>
<td>254</td>
<td>Controller fault</td>
</tr>
<tr>
<td>251</td>
<td>Low voltage fault: Voltage below normal or shorted low</td>
</tr>
<tr>
<td>226</td>
<td>Neutral/in gear switch</td>
</tr>
<tr>
<td>227</td>
<td>Shift knob fault: Data erratic, intermittent or incorrect</td>
</tr>
<tr>
<td>227</td>
<td>Shift knob fault: Voltage above normal or shorted high</td>
</tr>
<tr>
<td>227</td>
<td>Shift knob fault: Voltage below normal or shorted low</td>
</tr>
<tr>
<td>35</td>
<td>High range solenoid: Voltage above normal or shorted high</td>
</tr>
<tr>
<td>35</td>
<td>High range solenoid: Voltage below normal or shorted low</td>
</tr>
<tr>
<td>36</td>
<td>Low range solenoid: Voltage above normal or shorted high</td>
</tr>
<tr>
<td>36</td>
<td>Low range solenoid: Voltage below normal or shorted low</td>
</tr>
<tr>
<td>191</td>
<td>Vehicle speed sensor fault: Data erratic, intermittent or incorrect</td>
</tr>
<tr>
<td>191</td>
<td>Vehicle speed sensor fault: Voltage above normal or shorted high</td>
</tr>
<tr>
<td>191</td>
<td>Vehicle speed sensor fault: Voltage below normal or shorted low</td>
</tr>
<tr>
<td>151</td>
<td>Stuck in gear fault</td>
</tr>
<tr>
<td>124</td>
<td>Transmission oil level sensor: Data valid but above normal operational range</td>
</tr>
<tr>
<td>124</td>
<td>Transmission oil level sensor: Data erratic, intermittent or incorrect</td>
</tr>
<tr>
<td>177</td>
<td>Transmission temperature sensor: Voltage above normal or shorted high</td>
</tr>
<tr>
<td>177</td>
<td>Transmission temperature sensor: Data erratic, intermittent or incorrect</td>
</tr>
</tbody>
</table>
How to Clear Flash Codes from TCU Memory

NOTE: The vehicle must be stationary to retrieve flash codes. Have a ZF Meritor-authorized technician repair all active faults before clearing flash codes.

1. Park the vehicle. Turn the engine OFF. Turn the ignition ON. The check transmission light must be displaying flash codes before you can clear the codes from TCU memory.
2. PRESS and HOLD the diagnostic toggle switch.
3. Turn the ignition OFF. Continue to hold the diagnostic toggle switch for about three seconds.
4. Release the diagnostic toggle switch. The flash codes will be cleared from TCU memory.

Testing ESS™ System Conditions That Do Not Have Flash Codes (NO ACTIVE CODE)

ZF Meritor’s Engine Synchro Shift™ (ESS™) transmission electronic control module (ECM) uses sequences of light flashes called flash codes to identify and display faults that the ECM detects and stores into memory. Each fault that is related to the ESS™ transmission has its own flash code sequence.

However, three conditions can occur that are not ESS™ system-related faults and, therefore, do not have flash codes (NO ACTIVE CODE): The two neutral/in gear switch circuits short and remain open, the cruise control pause switch short and remain open, and the OEM clutch switch assembly does not operate correctly. Refer to the table below for results of, and corrective actions for, these conditions.

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Results</th>
<th>Corrective Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>The two neutral/in gear switch circuits short and remain OPEN.</td>
<td>• The ECM deactivates the ESS™ system.&lt;br&gt;• The transmission will not complete ESS™ shifts or automatic range shifts, even if the ESS™ system switch is in the ON position.&lt;br&gt;• The ESS™ shift intent switch is deactivated, and the transmission will not complete manual range shifts.&lt;br&gt;• The transmission will operate under manual control.</td>
<td>Use a volt-ohm meter (VOM) to test the neutral/in gear switch to verify that the switch operates correctly. Replace as necessary.</td>
</tr>
<tr>
<td>The OEM clutch switch assembly does not operate correctly.</td>
<td>• The ECM deactivates the ESS™ system.&lt;br&gt;• The transmission will not complete an ESS™ shift.&lt;br&gt;• The transmission will operate under manual control.</td>
<td>Contact the original equipment manufacturer (OEM) for procedures on how to test the clutch switch assembly.</td>
</tr>
<tr>
<td>The cruise control pause switch shorts and remains OPEN.</td>
<td>• The ECM deactivates the ESS™ system when cruise control is ON.&lt;br&gt;• ESS™ functions properly when cruise control is OFF.&lt;br&gt;• The transmission will operate under manual control.</td>
<td>Verify that the cruise control pause switch does not operate correctly. Refer to Service Parts Instructions publication TP-9621, Shift-n-Cruise™ Tester 3256-B-1068 Instructions. Replace the cruise control pause switch if necessary. Refer to Transmission Bulletin No. 24 (publication TP-95187), Shift-n-Cruise™ Connector Instructions. For Shift-n-Cruise™, use the Shift-n-Cruise™ tester, part number 3256-B-1068, to determine if the pause switch has shorted and remains OPEN.</td>
</tr>
</tbody>
</table>
WARNING
To prevent serious eye injury, always wear safe eye protection when you perform maintenance or service.

When you work on an electrical system, the possibility of electrical shock exists, and sparks can ignite flammable substances. You must always disconnect the battery ground cable before you work on an electrical system to prevent serious personal injury and damage to components.

Wire Splicing Procedure

1. Remove 0.5-inch (12 mm) of insulation from each end of the wires that are to be connected. Figure 2.2.

CAUTION
Splices that are not sealed correctly can damage components. Always use the correct crimping tool required for the application to ensure that the splice connector tube will completely seal the wires.

2. Insert each end of the wire(s) into a self-sealing “butt splice” connector tube. Use the correct crimping tool to crimp each end of the tube. Figure 2.3.

WARNING
If used incorrectly, a heat gun can cause serious personal injury and damage to components. Always carefully follow the manufacturer’s instructions when you use a heat gun.

3. Use a heat gun to heat the connector until the ends of the connector seal the wire. Carefully follow the manufacturer’s instructions when you use the heat gun. Figure 2.4.

4. Pull the connector to verify that it is crimped correctly.

WARNING
Wire splices that are placed too close together can “short circuit” and cause serious personal injury and damage to components. Always position wire splices at least one inch (25 mm) apart.

5. Position wire splices at least one inch (25 mm) apart. Figure 2.5.
Apply Dielectric Grease to Range Solenoid Pin Connectors

To help prevent corrosion, ZF Meritor recommends that you apply dielectric grease to range solenoid pin connectors on ESS™ transmissions. Figures 2.6 and 2.7.

**Required Tools**
- Torque wrench — lb-in
- Torque wrench — lb-ft
- Standard Allen wrench set
- Small flat-blade screwdriver (pocket)
- Side cutter (wire cutter)
- Standard Phillips head screwdriver
- Gasket scraper
- Needlenose pliers
- Standard combination wrench set (3/8-inch – 1-1/2-inch)
- Standard 3/8-inch drive socket set (3/8-inch – 1-1/2-inch)
- Standard ratchet
- Air ratchet (optional)
- Digital volt-ohm meter (VOM)
NOTE: If erratic readings occur when you perform electrical circuit tests, verify that the connections are tight and the terminals are clean. Retest the circuit.

**Step 1**
Disconnect the thirty-pin TCU connector from the transmission harness.
- **GO TO THE NEXT STEP.**

**Step 2**
Check the resistance between TCU connector sockets J3 and K2 (shift knob circuit). Refer to the table above for the appropriate resistance specification.

<table>
<thead>
<tr>
<th>System</th>
<th>Shift Intent Switch</th>
<th>Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>FULL UP</td>
<td>42.3–44.1 k ohms</td>
</tr>
<tr>
<td>ON</td>
<td>UP</td>
<td>57.0–59.4 k ohms</td>
</tr>
<tr>
<td>ON</td>
<td>DOWN</td>
<td>24.5–25.5 k ohms</td>
</tr>
<tr>
<td>ON</td>
<td>FULL DOWN</td>
<td>9.8–10.2 k ohms</td>
</tr>
<tr>
<td>OFF</td>
<td>UP</td>
<td>123.8–128.8 k ohms</td>
</tr>
<tr>
<td>OFF</td>
<td>DOWN</td>
<td>91.2–95.0 k ohms</td>
</tr>
</tbody>
</table>

Is the resistance within specification?
- **YES → GO TO STEP 9.**
- **NO → GO TO THE NEXT STEP.**

**Step 3**
Remove the Phillips head screw that attaches the shift knob skirt to the shift knob housing.
- **GO TO THE NEXT STEP.**

**Step 4**
Separate the shift knob skirt from the shift knob assembly to expose the electrical connectors.
- **GO TO THE NEXT STEP.**
Section 2
VOM Diagnostics
Shift Knob Test

Step 5
Disconnect the two-pin shift knob wiring harness connector.

- GO TO THE NEXT STEP.

Step 6
Check resistance between shift knob wiring harness connector sockets A and B. The key is OFF for all RESISTANCE tests. Refer to the wiring diagram for pin assignments.

Refer to the table above. Is the resistance within specification?

- YES → CONNECT THE SHIFT KNOB. REPLACE THE WIRING HARNESS. (REFER TO SECTION 5.)

- NO → REPLACE THE SHIFT KNOB. (REFER TO SECTION 5.)

Step 7
Connect the electrical connectors at the base of the shift knob. Push the connectors together until the tabs are engaged.

- GO TO THE NEXT STEP.

Step 8
Replace the shift knob skirt. Replace and tighten the Phillips head screw.

- GO TO THE NEXT STEP.
Connect the thirty-pin TCU connector.
NOTE: If erratic readings occur when you perform electrical circuit tests, verify that the connections are tight and the terminals are clean. Retest the circuit.

**Step 1**

Disconnect the thirty-pin TCU connector from the transmission wiring harness.

- **GO TO THE NEXT STEP.**

**Step 2**

Check the resistance between TCU connector sockets A1 and B2 (high range solenoid circuit). Is the resistance 11-12 ohms?

- **YES → HIGH RANGE SOLENOID IS OKAY. GO TO STEP 6.**
- **NO → GO TO THE NEXT STEP.**

**Step 3**

Disconnect the two-pin HIGH range solenoid connector.

- **GO TO THE NEXT STEP.**
Section 2
VOM Diagnostics
Shift Solenoid Test

Step 4

Check the resistance at the HIGH range solenoid pins. The key is OFF for all resistance tests.

Is the resistance 11-22 ohms?

- YES → REPLACE THE WIRING HARNESS. (REFER TO SECTION 5.)
- NO → REPLACE THE HIGH RANGE SOLENOID. (REFER TO SECTION 5.)

NOTE: A diode can cause a solenoid to test at zero ohms, even when a solenoid is in good condition. If the solenoid tests at zero, switch the volt-ohm meter (VOM) leads and check for the following conditions:
  - Closed circuit zero ohms one way
  - 11-22 ohms with VOM leads switched

Step 5

Connect the two-pin HIGH range solenoid connector.

- GO TO THE NEXT STEP.

Step 6

Check the resistance between TCU connector sockets A1 and B1 (LOW range solenoid circuit).

Is the resistance 11-22 ohms?

- YES → LOW RANGE SOLENOID IS OKAY. GO TO STEP 10.
- NO → GO TO THE NEXT STEP.
Section 2  
VOM Diagnostics  
Shift Solenoid Test

Step 7  
Disconnect the two-pin LOW range solenoid connector.  
- GO TO THE NEXT STEP.

Step 8  
Check the resistance at the LOW range solenoid pins. The key is OFF for all resistance tests.  
Is the resistance 11-22 ohms?  
- YES → REPLACE THE WIRING HARNESS.  
  (REFER TO SECTION 5.)  
- NO → REPLACE THE LOW RANGE SOLENOID.  
  (REFER TO SECTION 5.)

Step 9  
Connect the two-pin LOW range solenoid connector.  
- GO TO THE NEXT STEP.

Step 10  
Connect the thirty-pin TCU connector.
NOTE: If erratic readings occur when you perform electrical circuit tests, verify that the connections are tight and the terminals are clean. Retest the circuit.

**Step 1**

Disconnect the thirty-pin transmission wiring harness to TCU.
- **GO TO THE NEXT STEP.**

**Step 2**

Put the transmission into NEUTRAL.
- **GO TO THE NEXT STEP.**

**Step 3**

Check the resistance between TCU connector sockets A3 and G1 (ESS™ NEUTRAL switch circuit). The key is OFF for all resistance tests.

Is the resistance at or below 0.5 ohms?
- **YES → GO TO STEP 10.**
- **NO → GO TO THE NEXT STEP.**

**Step 4**

Disconnect the four-pin NEUTRAL position switch harness connector.
- **GO TO THE NEXT STEP.**
Check the resistance between NEUTRAL position switch wiring harness connector sockets A and B. Is the resistance at or below 0.5 ohms?

- **YES** → REPLACE THE WIRING HARNESS. (REFER TO SECTION 5.)
- **NO** → GO TO THE NEXT STEP.

Remove the top cover. (Refer to Section 5.)

- GO TO THE NEXT STEP.

Remove and inspect the NEUTRAL check shaft and spring. (Refer to Section 5.) Is there damage?

- **YES** → REPLACE DAMAGED TOP COVER COMPONENTS. CHECK THE SYSTEM FOR CORRECT OPERATION.
- **NO** → REPLACE THE SWITCH ASSEMBLY. (REFER TO SECTION 5.) GO TO THE NEXT STEP.

Install the top cover. (Refer to Section 5.)

- GO TO THE NEXT STEP.
Section 2
VOM Diagnostics
Switch Assembly Test

Step 9
Connect the four-pin switch assembly connector.
• GO TO THE NEXT STEP.

Step 10
Put the transmission into gear.
• GO TO THE NEXT STEP.

Step 11
Check the resistance between TCU connector sockets A3 and G2 (ESS™ in gear switch circuit).
The key is OFF for all resistance tests.
Is the resistance at or below 0.5 ohms?
• YES → GO TO STEP 18.
• NO → GO TO THE NEXT STEP.

Step 12
Disconnect the four-pin switch assembly.
• GO TO THE NEXT STEP.
Section 2
VOM Diagnostics
Switch Assembly Test

Step 13

Check the resistance between in gear switch wiring harness connector sockets C and D. Is the resistance at or below 0.5 ohms?

- YES → REPLACE THE WIRING HARNESS. (REFER TO SECTION 5.)
- NO → GO TO THE NEXT STEP.

Step 14

Remove the top cover. (Refer to Section 5.)

- GO TO THE NEXT STEP.

Step 15

Remove and inspect the NEUTRAL check shaft and spring. (Refer to Section 5.) Is there damage?

- YES → REPLACE DAMAGED TOP COVER COMPONENTS. CHECK THE SYSTEM FOR CORRECT OPERATION.
- NO → REPLACE THE SWITCH ASSEMBLY. (REFER TO SECTION 5.) GO TO THE NEXT STEP.

Step 16

Install the top cover. (Refer to Section 5.)

- GO TO THE NEXT STEP.
Section 2
VOM Diagnostics
Switch Assembly Test

Connect the four-pin switch assembly connector.
- **GO TO THE NEXT STEP.**

Connect the thirty-pin TCU connector.
NOTE: If erratic readings occur when you perform electrical circuit tests, verify that the connections are tight and the terminals are clean. Retest the circuit.

 Disconnect the thirty-pin TCU connector from the transmission wiring harness.
  • GO TO THE NEXT STEP.

Step 2

Check the resistance between TCU connector sockets A3 and B3 (vehicle speed sensor circuit). The key is OFF for all RESISTANCE tests.

Is the resistance 2.7k-3.3k ohms?
  • YES → GO TO STEP 6.
  • NO → GO TO THE NEXT STEP.

Step 3

Disconnect the two-pin vehicle speed sensor connector from the wiring harness.
  • GO TO THE NEXT STEP.

Step 4

Check resistance across VSS pins. The key is OFF for all RESISTANCE tests. Refer to the wiring diagram for pin assignments.

Is resistance 2.7k-3.3k ohms?
  • YES → REPLACE THE WIRING HARNESS. (REFER TO SECTION 5.)
  • NO → REPLACE THE VEHICLE SPEED SENSOR. (REFER TO SECTION 5.)
Section 2
VOM Diagnostics
Vehicle Speed Sensor Test

Step 5
Connect the two-pin vehicle speed sensor connector.

- GO TO THE NEXT STEP.

Step 6
Connect the thirty-pin TCU connector.
NOTE: If erratic readings occur when you perform electrical circuit tests, verify that the connections are tight and the terminals are clean. Retest the circuit.

**Step 1**

Disconnect the thirty-pin TCU connector from the transmission wiring harness.

- **GO TO THE NEXT STEP.**

---

**Step 2**

Check the resistance between TCU connector sockets J3 and K2 (shift knob circuit). Refer to the chart for the appropriate resistance specification.

Refer to the table above. Is the resistance within specification?

- **YES → GO TO STEP 9.**
- **NO → GO TO THE NEXT STEP.**

---

**Step 3**

Remove the Phillips head screw that attaches the shift knob skirt to the shift knob housing.

- **GO TO THE NEXT STEP.**

---

**Step 4**

Separate the shift knob skirt from the shift knob assembly to expose the electrical connectors.

- **GO TO THE NEXT STEP.**
Disconnect the two-pin shift knob wiring harness connector.

- GO TO THE NEXT STEP.

Check resistance between shift knob wiring harness connector sockets A and B. The key is OFF for all RESISTANCE tests. Refer to the wiring diagram for pin assignments.

Refer to the table above. Is the resistance within specification?

- YES → CONNECT THE SHIFT KNOB. REPLACE THE WIRING HARNESS. (REFER TO SECTION 5.)
- NO → REPLACE THE SHIFT KNOB. (REFER TO SECTION 5.)

Connect the electrical connectors at the base of the shift knob. Push the connectors together until the tabs are engaged.

- GO TO THE NEXT STEP.

Replace the shift knob skirt. Replace and tighten the Phillips head screw.

- GO TO THE NEXT STEP.
Section 2
VOM Diagnostics
Wiring Harness Test

Step 9

Check the resistance between TCU connector sockets A1 and B2 (HIGH range solenoid circuit).
Is the resistance 11-22 ohms?
- YES → HIGH RANGE SOLENOID IS OKAY. GO TO STEP 13.
- NO → GO TO THE NEXT STEP.

Step 10

Disconnect the two-pin HIGH range solenoid connector.
- GO TO THE NEXT STEP.

NOTE: A diode can cause a solenoid to test at zero ohms, even when a solenoid is in good condition. If the solenoid tests at zero, switch the volt-ohm meter (VOM) leads and check for the following conditions:
- Closed circuit zero ohms one way
- 11-22 ohms with VOM leads switched

Step 11

Check the resistance at the HIGH range solenoid pins. The key is OFF for all resistance tests.
Is the resistance 11-22 ohms?
- YES → REPLACE THE WIRING HARNESS. (REFER TO SECTION 5.)
- NO → REPLACE THE HIGH RANGE SOLENOID. (REFER TO SECTION 5.)
Section 2
VOM Diagnostics
Wiring Harness Test

**Step 12**

Connect the two-pin HIGH range solenoid connector.
- **GO TO THE NEXT STEP.**

**Step 13**

Check the resistance between TCU connector sockets A1 and B1 (LOW range solenoid circuit).
Is the resistance 11-22 ohms?
- **YES → LOW RANGE SOLENOID IS OKAY. GO TO STEP 17.**
- **NO → GO TO THE NEXT STEP.**

**Step 14**

Disconnect the two-pin LOW range solenoid connector.
- **GO TO THE NEXT STEP.**

**Step 15**

Check the resistance at the LOW range solenoid pins. The key is OFF for all resistance tests.
Is the resistance 11-22 ohms?
- **YES → REPLACE THE WIRING HARNESS. (REFER TO SECTION 5.)**
- **NO → REPLACE THE LOW RANGE SOLENOID. (REFER TO SECTION 5.)**
Step 16

Connect the two-pin LOW range solenoid connector.
- GO TO THE NEXT STEP.

Step 17

Put the transmission into NEUTRAL.
- GO TO THE NEXT STEP.

Step 18

Check the resistance between TCU connector sockets A3 and G1 (NEUTRAL switch circuit). The key is OFF for all resistance tests.
Is the resistance at or below 0.5 ohms?
- YES → GO TO STEP 25.
- NO → GO TO THE NEXT STEP.

Step 19

Disconnect the four-pin NEUTRAL position switch wiring harness connector.
- GO TO THE NEXT STEP.
Section 2
VOM Diagnostics
Wiring Harness Test

Step 20
Check the resistance between NEUTRAL position switch wiring harness connector sockets A and B. Is the resistance at or below 0.5 ohms?

- **YES** → REPLACE THE WIRING HARNESS. (REFER TO SECTION 5.)
- **NO** → GO TO THE NEXT STEP.

Step 21
Remove the top cover. (Refer to Section 5.)
- **GO TO THE NEXT STEP.**

Step 22
Remove and inspect the NEUTRAL check shaft and spring. (Refer to Section 5.) Is there damage?

- **YES** → REPLACE DAMAGED TOP COVER COMPONENTS. CHECK THE SYSTEM FOR CORRECT OPERATION.
- **NO** → REPLACE THE SWITCH ASSEMBLY. (REFER TO SECTION 5.) GO TO THE NEXT STEP.

Step 23
Install the top cover. (Refer to Section 5.)
- **GO TO THE NEXT STEP.**
Connect the four-pin switch assembly connector.

- GO TO THE NEXT STEP.

Place the transmission into gear.

- GO TO THE NEXT STEP.

Check the resistance between TCU connector sockets A3 and G2 (in gear switch circuit). The key is OFF for all resistance tests.

Is the resistance at or below 0.5 ohms?

- YES → GO TO STEP 33.
- NO → GO TO THE NEXT STEP.

Disconnect the four-pin switch assembly.

- GO TO THE NEXT STEP.
Check the resistance between NEUTRAL position switch wiring harness connector sockets C and D. Is the resistance at or below 0.5 ohms?

- **YES** → REPLACE THE WIRING HARNESS. (REFER TO SECTION 5.)
- **NO** → GO TO THE NEXT STEP.

Remove the top cover. (Refer to Section 5.)

- **GO TO THE NEXT STEP.**

Remove and inspect the NEUTRAL check shaft and spring. (Refer to Section 5.) Is there damage?

- **YES** → REPLACE DAMAGED TOP COVER COMPONENTS. CHECK THE SYSTEM FOR CORRECT OPERATION.
- **NO** → REPLACE THE SWITCH ASSEMBLY. (REFER TO SECTION 5.) GO TO THE NEXT STEP.

Install the top cover. (Refer to Section 5.)

- **GO TO THE NEXT STEP.**
Connect the four-pin NEUTRAL position switch assembly connector.

- **GO TO THE NEXT STEP.**

Check the resistance between TCU connector sockets A3 and B3 (vehicle speed sensor circuit). The key is OFF for all resistance tests.

Is the resistance 2.7k-3.3k ohms?

- **YES → GO TO STEP 37.**
- **NO → GO TO THE NEXT STEP.**

Disconnect the two-pin vehicle speed sensor connector from the wiring harness.

- **GO TO THE NEXT STEP.**

Check resistance across VSS pins. The key is OFF for all resistance tests. Refer to the wiring diagram for pin assignments.

Is resistance 2.7k-3.3k ohms?

- **YES → REPLACE THE WIRING HARNESS. (REFER TO SECTION 5.)**
- **NO → REPLACE THE VEHICLE SPEED SENSOR. (REFER TO SECTION 5.)**
Step 36
Connect the two-pin vehicle speed sensor connector.
- **GO TO THE NEXT STEP.**

Step 37
Disconnect the two-pin J-1708 connector.
- **GO TO THE NEXT STEP.**

Step 38
Check continuity between wiring harness sockets E1 (TCU connector) and B (J-1708 connector).
Is there continuity?
- **YES** → **GO TO THE NEXT STEP.**
- **NO** → **REPLACE THE WIRING HARNESS. (REFER TO SECTION 5.)**

Step 39
Check continuity between wiring harness sockets E2 (TCU connector) and A (J-1708 connector).
Is there continuity?
- **YES** → **GO TO THE NEXT STEP.**
- **NO** → **REPLACE THE WIRING HARNESS. (REFER TO SECTION 5.)**
Section 2
VOM Diagnostics
Wiring Harness Test

Step 40
Connect the two-pin J-1708 connector.
- GO TO THE NEXT STEP.

Step 41
Disconnect the three-pin J-1939 connector.
- GO TO THE NEXT STEP.

Step 42
Check continuity between wiring harness sockets D3 (TCU connector) and C (J-1939 connector).
Is there continuity?
- YES → GO TO THE NEXT STEP.
- NO → REPLACE THE WIRING HARNESS.
  (REFER TO SECTION 5.)

Step 43
Check continuity between wiring harness sockets D2 (TCU connector) and B (J-1939 connector).
Is there continuity?
- YES → GO TO THE NEXT STEP.
- NO → REPLACE THE WIRING HARNESS.
  (REFER TO SECTION 5.)
Check continuity between wiring harness sockets D1 (TCU connector) and A (J-1939 connector).

Is there continuity?

- **YES** → GO TO THE NEXT STEP.
- **NO** → REPLACE THE WIRING HARNESS. (REFER TO SECTION 5.)

Disconnect the six-pin OEM power connector.

- **GO TO THE NEXT STEP.**

Check continuity between wiring harness sockets A1 (TCU connector) and B (OEM connector).

Is there continuity?

- **YES** → GO TO THE NEXT STEP.
- **NO** → REPLACE THE WIRING HARNESS. (REFER TO SECTION 5.)
Check continuity between wiring harness sockets A2 (TCU connector) and E (OEM connector).

Is there continuity?

- **YES → GO TO THE NEXT STEP.**
- **NO → REPLACE THE WIRING HARNESS. (REFER TO SECTION 5.)**

Check continuity between wiring harness sockets A3 (TCU connector) and D (OEM connector).

Is there continuity?

- **YES → GO TO THE NEXT STEP.**
- **NO → REPLACE THE WIRING HARNESS. (REFER TO SECTION 5.)**

Check continuity between wiring harness sockets E3 (TCU connector) and A (OEM connector).

Is there continuity?

- **YES → GO TO THE NEXT STEP.**
- **NO → REPLACE THE WIRING HARNESS. (REFER TO SECTION 5.)**

Connect the six-pin OEM connector.

- **GO TO THE NEXT STEP.**
Connect the thirty-pin TCU connector.
Shift Solenoid Test
Flash Codes 35 and 36

Disconnect the thirty-pin TCU wiring harness

Measure the resistance between A1 and B2

11-22 ohms?

YES

NO

Disconnect the two-pin HIGH range solenoid connector

Measure the resistance across the HIGH range solenoid

11-22 ohms?

YES

NO

Replace the HIGH range solenoid

Connect the two-pin HIGH range solenoid connector

Measure the resistance between A1 and B1

11-22 ohms?

YES

NO

Disconnect the two-pin LOW range solenoid connector

Measure the resistance across the LOW range solenoid

11-22 ohms?

YES

NO

Replace the LOW range solenoid

Connect the two-pin LOW range solenoid connector

Discard the wiring harness

Connect the thirty-pin TCU connector
Vehicle Speed Sensor Test
Flash Code 191

1. Disconnect the thirty-pin TCU harness.
2. Measure the resistance across pins A3 and B3.
3. If the resistance is 2.7k-3.3k ohms, disconnect the two-pin Vehicle Speed Sensor connector.
4. Measure the resistance across the VSS circuit.
5. If the resistance is 2.7k-3.3k ohms, replace the Wiring Harness.
6. If the resistance is not 2.7k-3.3k ohms, replace the VSS.
7. Connect the thirty-pin TCU harness.
8. Connect the two-pin VSS connector.
Switch Assembly Test
Flash Code 226

1. Disconnect the thirty-pin TCU connector.
2. Place the transmission into NEUTRAL.
3. Measure the resistance between A3 and G1.
4. If the resistance is 0.0-0.5 ohms:
   - Connect the thirty-pin TCU connector.
5. If the resistance is not 0.0-0.5 ohms:
   - Disconnect the switch assembly.
6. Measure the resistance between pins A and B.
7. If the resistance is 0.0-0.5 ohms:
   - Replace the wiring harness.
8. If the resistance is not 0.0-0.5 ohms:
   - Disconnect the switch assembly.
9. Measure the resistance between pins C and D.
10. If the resistance is 0.0-0.5 ohms:
    - Replace the wiring harness.
11. If the resistance is not 0.0-0.5 ohms:
    - Disconnect the switch assembly.
12. Check for damage to the neutral spring and shaft.
13. If there is damage:
    - Replace the switch assembly.
14. If there is no damage:
    - Install the top cover.
15. Connect the four-pin switch assembly.
16. Replace the damaged top cover components.
17. Replace the wiring harness.
18. Install the top cover.
19. Connect the thirty-pin TCU connector.
20. Place the transmission into NEUTRAL.
21. Measure the resistance between A3 and G1.
22. If the resistance is 0.0-0.5 ohms:
    - Replace the switch assembly.
23. If the resistance is not 0.0-0.5 ohms:
    - Disconnect the switch assembly.
24. Measure the resistance between pins A and B.
25. If the resistance is 0.0-0.5 ohms:
    - Replace the switch assembly.
26. If the resistance is not 0.0-0.5 ohms:
    - Disconnect the switch assembly.
27. Check for damage to the neutral spring and shaft.
28. If there is damage:
    - Replace the switch assembly.
29. If there is no damage:
    - Install the top cover.
30. Connect the four-pin switch assembly.
31. Replace the damaged top cover components.
32. Replace the wiring harness.
33. Install the top cover.
34. Connect the thirty-pin TCU connector.
35. Place the transmission into NEUTRAL.
36. Measure the resistance between A3 and G1.
37. If the resistance is 0.0-0.5 ohms:
    - Replace the switch assembly.
38. If the resistance is not 0.0-0.5 ohms:
    - Disconnect the switch assembly.
39. Measure the resistance between pins C and D.
40. If the resistance is 0.0-0.5 ohms:
    - Replace the wiring harness.
41. If the resistance is not 0.0-0.5 ohms:
    - Disconnect the switch assembly.
42. Check for damage to the neutral spring and shaft.
43. If there is damage:
    - Replace the switch assembly.
44. If there is no damage:
    - Install the top cover.
45. Connect the four-pin switch assembly.
46. Replace the damaged top cover components.
47. Replace the wiring harness.
48. Install the top cover.
49. Connect the thirty-pin TCU connector.
50. Place the transmission into NEUTRAL.
51. Measure the resistance between A3 and G1.
52. If the resistance is 0.0-0.5 ohms:
    - Replace the switch assembly.
53. If the resistance is not 0.0-0.5 ohms:
    - Disconnect the switch assembly.
54. Measure the resistance between pins C and D.
55. If the resistance is 0.0-0.5 ohms:
    - Replace the wiring harness.
56. If the resistance is not 0.0-0.5 ohms:
    - Disconnect the switch assembly.
57. Check for damage to the neutral spring and shaft.
58. If there is damage:
    - Replace the switch assembly.
59. If there is no damage:
    - Install the top cover.
60. Connect the four-pin switch assembly.
61. Replace the damaged top cover components.
62. Replace the wiring harness.
63. Install the top cover.
64. Connect the thirty-pin TCU connector.
Shift Knob Test
Flash Code 227

Disconnect the thirty-pin TCU harness

Measure the resistance across pins J3 and K2

In spec? Refer to Table 1

YES

NO

Replace the shift knob skirt retaining screw

Move the shift knob skirt down and away from the connectors

Disconnect the two-pin shift knob connector

Measure the resistance across the pins. Refer to Table 1

In spec? Refer to Table 1

YES

NO

Replace the wiring harness

Connect the two-pin shift knob connector

Replace the shift knob skirt and tighten the retaining screw

Replace the shift knob

Table 1

<table>
<thead>
<tr>
<th>System</th>
<th>Shift Intent Switch</th>
<th>Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>FULL UP</td>
<td>42.3–44.1 k ohms</td>
</tr>
<tr>
<td>ON</td>
<td>UP</td>
<td>57.0–59.4 k ohms</td>
</tr>
<tr>
<td>ON</td>
<td>DOWN</td>
<td>24.5–25.5 k ohms</td>
</tr>
<tr>
<td>ON</td>
<td>FULL DOWN</td>
<td>9.8–10.2 k ohms</td>
</tr>
<tr>
<td>OFF</td>
<td>UP</td>
<td>123.8–128.8 k ohms</td>
</tr>
<tr>
<td>OFF</td>
<td>DOWN</td>
<td>91.2–95.0 k ohms</td>
</tr>
</tbody>
</table>

Disconnect the two-pin shift knob connector

CONNECT THE THIRTY-PIN TCU CONNECTOR

SYSTEM SHIFT INTENT SWITCH RESISTANCE

ON FULL UP 42.3–44.1 k ohms
ON UP 57.0–59.4 k ohms
ON DOWN 24.5–25.5 k ohms
ON FULL DOWN 9.8–10.2 k ohms
OFF UP 123.8–128.8 k ohms
OFF DOWN 91.2–95.0 k ohms
Overview

ESS™ System Diagnostics Using the Pro-Link® 9000 Diagnostic Data Reader (DDR) with ZF Meritor’s ESS™ PCMCIA Card

Pro-Link® 9000 is a registered trademark of Micro Processor Systems, Inc. (MPSI).

The Pro-Link® 9000 diagnostic data reader (DDR) uses ZF Meritor’s ESS™ PCMCIA card.

1. Follow the manufacturer’s instructions when you use this tool.

2. Verify that you are using the correct PCMCIA card for the vehicle you will test. Check the PCMCIA card identification tag for the following information:
   - The vehicle systems the cartridge covers
   - The manufacturer’s name and address
   - The PCMCIA card model and serial number

Contact SPX Kent-Moore Heavy Duty Division at 800-328-6657 to order the following items:

- Pro-Link® 9000 diagnostic data reader (DDR) (part number J38500-1)
- Multi-protocol cartridge (MPC) (part number J38500-1500)
- ZF Meritor’s ESS™ PCMCIA card (part number J38500-4200)

Non-Volatile Memory Cartridge Means No Lost Data

The multi-protocol cartridge (MPC) has non-volatile memory, which means that stored data is not lost when you disconnect the Pro-Link® 9000 DDR from the vehicle’s power source.

When the Pro-Link® 9000 DDR is connected to an external power source, such as the vehicle’s cigarette lighter, the DDR does not communicate with the vehicle’s transmission control unit (TCU), but the FUNC key is still active. You can use this key to access and retrieve stored data for review and printing.

Stored Data That Is retrievable

- TCU operating data
- Diagnostic codes
- Calibration data
- Snapshot data

Readout Window

The readout window contains a liquid crystal display (LCD) that uses letters, numbers and special symbols.

Keypad and Key Functions

Keypad

The 16-character keypad is sealed against contamination from grease and fluids. Clean the keys with a damp cloth.
Ten Numeric Keys

Ten NUMERIC KEYS are arranged calculator-style. Each key is imprinted with a single digit.

Four Arrow Keys

- The ↑ and ↓ keys scroll one line at a time through the display.
- The ← and → keys move between choices given by the display. Depending on the cartridge you are using, these keys can also be used for other purposes.

Function Key (FUNC)

Use the FUNC key to select several operating modes and a printing mode.

ENTER Key

Use the ENTER key to make a selection, confirm an answer or instruct the Pro-Link® 9000 DDR to go to the next step.

Installing the Multi-Protocol Cartridge (MPC) Into the Pro-Link® 9000 DDR

1. Disconnect the 12V vehicle adaptor before you insert the MPC into the Pro-Link® 9000 DDR.
2. Hold the MPC straight and not at an angle. You can only insert the cartridge one way onto the Pro-Link® 9000 DDR.
3. Seat the MPC on the back of the Pro-Link® 9000 DDR. The connector (edgeboard) of the cartridge automatically lines up with the connector in the DDR.
4. Slide the MPC forward until it clicks into place.

Installing the PCMCIA Card Into the MPC

1. Disconnect the 12V vehicle adaptor before you insert the MPC into the Pro-Link® 9000 DDR. Securely hold the MPC and the DDR.
2. Insert the PCMCIA card into the MPC so that the arrows are visible and face TOWARD the MPC. Figure 3.1.
3. Slide the PCMCIA card FORWARD until it seats firmly.

Removing the PCMCIA Card

1. Press the EJECT button on the side of the PCMCIA card. Figure 3.1.
2. Carefully remove the PCMCIA card.

Display Data Line (DDL) Cable Connection

The Pro-Link® 9000 DDR receives information from the TCU through a connector called the display data line (DDL) cable.

Connect the Pro-Link® 9000 DDL Adaptor Plug to the DDL Cable

NOTE: The Pro-Link® 9000 DDL adaptor plug installs into the DDL cable one way only.

The Pro-Link® 9000 DDL CABLE has fifteen wires, a molded connector with fifteen pin sockets and does not connect directly to the DDL CONNECTOR in the vehicle.

1. Connect the DDL cable to the Pro-Link® 9000 DDR.
2. Connect the DDL adaptor plug onto the DDL CABLE. (The adaptor plug has fifteen pins on one side, with the other side customized for a specific application.)
3. Plug the adaptor into the DDL connector in the vehicle.
4. Turn the vehicle’s ignition ON. The engine does not have to be running. The Pro-Link® 9000 DDR will power up as soon as you plug the DDL adaptor plug into the DDL connector.
What to Check if the Pro-Link® 9000 DDR Does Not Power Up

The Pro-Link® 9000 DDR will power up as soon as you connect it to the vehicle’s electrical system. If the DDR does not power up, check the following:

1. Check that the ignition is ON.
2. Check that the MPC is connected to the DDR correctly: Slide the MPC out of the DDR and plug it into the DDR again.
3. Check that the PCMCIA card is connected to the MPC correctly: Remove and insert the PCMCIA Card.
4. Check the edgeboard for grease, oil or other contaminants. Use a soft cloth to carefully clean the edgeboard, if necessary. Do not use solvents to clean the edgeboard.

System Selection

System Selection Process

The Pro-Link® 9000 DDR communicates with the TCU to automatically determine which ESS™ system you are testing. The screen display will ask you to wait while this process is taking place.

Copyright Screen

When the Pro-Link® 9000 DDR powers up, the readout displays the copyright screen for several seconds, followed by the Data List screen.

Data Display

Data Readout

- If the Pro-Link® 9000 DDR cannot communicate with the TCU, the DDR displays the NO DATA screen:

  ![NO ESS DATA RECEIVED ENTER TO RETRY FUNC TO RECALL DATA](image)

- Press the ENTER key to try again to connect with the TCU.
- If the Pro-Link® 9000 DDR still cannot communicate with the TCU and the NO DATA screen disappears, refer to “Installing the PCMCIA Card Into the MPC” and “Connect the Pro-Link® 9000 DDR Adaptor Plug to the DDL Cable” in this section.

Recall Data

The MPC records and stores data from the last vehicle that you serviced. You can retrieve all stored data (such as Snapshot, etc.).

Press the FUNC key to recall data from memory. Refer to “How to Retrieve Data Stored in the Pro-Link® 9000 DDR Without Using the Vehicle’s DDL” in this section for instructions on how to access the Data List.

NO DATA Readout

If the NO DATA readout displays on the screen:

1. Check the vehicle cable at each terminal to verify that the connections are good. A broken wire in the vehicle cable or in the TCU can cause a faulty connection, and the system will display a NO DATA readout.
2. Check that the ignition key is turned ON. When the ignition is OFF, the system will display a NO DATA readout.
“Data Freeze” Function

You can view several operating parameters simultaneously (even though the parameters do not appear together on the Data List) by creating a custom Data List or by using the Data Freeze function. Refer to “To ‘Freeze’ a Line of Data” below for instructions on how to create a custom Data List.

- When you freeze a line of data using the “Data Freeze” function, you will not be able to scroll Data List items that you “freeze.” However, you can scroll the rest of the list.
- You cannot use “Data Freeze” with “Snapshot.”

To Freeze a Line of Data

**NOTE:** A black square next to a line of data indicates that a line is frozen.

1. You must display the Data List on the screen before you can freeze a line of data. The lines in the display are numbered 1 through 4.
2. Use the ↑ and ↓ keys to scroll the Data List.
3. Press the numerical key that corresponds to the line number where the item you want to freeze is located. A black square will appear next to that line to indicate that the line is frozen.
4. The following screen indicates that you have decided to freeze AXLE RATIO:
   - You have pressed numerical key 3, because AXLE RATIO data is displayed on LINE 3.
   - A black square appears next to LINE 3 to indicate that this line is frozen.

Scrolling the Data List When You Have Frozen a Line of Data

After you freeze a line of data, you can use the ↑ and ↓ keys to scroll the Data List.

In the screen below, LINE 3 is still frozen, but because you have scrolled the Data List, the value has changed from your previous choice, AXLE RATIO on LINE 3, to ENGINE RPM on LINE 3:

<table>
<thead>
<tr>
<th>ESS ENABLE</th>
<th>ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEUTRAL SW</td>
<td>ON</td>
</tr>
<tr>
<td><strong>ENGINE RPM</strong></td>
<td>1234</td>
</tr>
<tr>
<td>IN GEAR SW</td>
<td>OFF</td>
</tr>
</tbody>
</table>

Selecting Another Line to Freeze

The following screen indicates that you also have decided to freeze IN GEAR SW on LINE 4:

1. Use the ↑ and ↓ keys to scroll the Data List.
   - You will notice that your previous selection, LINE 3, remains frozen.
2. Scroll the Data List until IN GEAR SW appears on LINE 4. Press numerical key 4.
3. A black square appears next to LINE 4 to indicate that this line is frozen.

<table>
<thead>
<tr>
<th>ESS ENABLE</th>
<th>ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEUTRAL SW</td>
<td>ON</td>
</tr>
<tr>
<td><strong>ENGINE RPM</strong></td>
<td>1234</td>
</tr>
<tr>
<td>IN GEAR SW</td>
<td>OFF</td>
</tr>
</tbody>
</table>

4. Use this procedure until you have frozen data on all four lines.

To Unfreeze One Line of Data

Press the numerical key that corresponds to the line of data you want to unfreeze. The black square will disappear, which indicates that you have unfrozen the line. The line will now scroll when you use the ↑ and ↓ keys.

To Unfreeze All Lines at Once

Press the “0” numerical key. All black squares will disappear to indicate that you have unfrozen all of the lines.
How to Retrieve Data Stored in the Pro-Link® 9000 DDR Without Using the Vehicle’s DDL

The Pro-Link® 9000 DDR enables you to retrieve stored data after you remove the DDL adaptor plug from the DDL connector. You can only retrieve data that is stored from the previous vehicle.

1. Install the DDEC II and III cartridge onto the Pro-Link® 9000 DDR.
2. Secure the DDL cable to the Pro-Link® 9000 DDR.
3. Secure the DDL cable to the vehicle’s DDL connector (power cable).
4. Plug the DDL cable into the vehicle’s power outlet (cigarette lighter).
5. The MPSI COPYRIGHT screen will appear, followed by the NO DDEC DATA screen:

6. Press the FUNC key to display the Data List.

How to Open the ESS™ System Application

Install the MPC Application Card

Install the ESS application MPC card into the Pro-Link® 9000 diagnostic data reader (DDR). Refer to “Installing the PCMCIA into the MPC” in this section.

Connect the Pro-Link® 9000 DDR to the Vehicle’s Diagnostic Data Line (DDL) Cable

Connect the Pro-Link® 9000 DDR to the vehicle’s diagnostic data line (DDL). Refer to “Connect the Pro-Link 9000® DDL Adaptor Plug to the DDL Cable” in this section.

When the Pro-Link® 9000 DDR powers up, it displays the COPYRIGHT screen for several seconds:

After the DDR connects to ZF Meritor’s transmission control unit (TCU), the DDR displays the MPSI PRO-LINK MPC screen:

1. Use the ↑ and ↓ keys to select ZF MERITOR ESS.
2. Press the ENTER key. The DDR displays the FAULT CODES screen:
“ZF Meritor ESS” Menu Options

Ten options are available in the ZF MERITOR ESS menu. Refer to the glossary at the end of this section for a complete description of the options.

Table A: “ZF Meritor ESS” Menu Descriptions

<table>
<thead>
<tr>
<th>Fault Codes</th>
<th>Change ESS Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calibration ID</td>
<td>Torque Control</td>
</tr>
<tr>
<td>Performance Data</td>
<td>Component Tests</td>
</tr>
<tr>
<td>ESS Trip Data</td>
<td>Axle Ratio Options</td>
</tr>
<tr>
<td>View ESS Options</td>
<td>Change Password</td>
</tr>
</tbody>
</table>

How to Access “ZF Meritor ESS” Menu Options

“Fault Codes” Option

1. Use the ↑ and ↓ keys to select FAULT CODES from the ZF MERITOR ESS menu.

2. Press the ENTER key. The DDR displays the FAULT CODES screen, which enables you to select either ACTIVE CODES, INACTIVE CODES or CLEAR CODES.

3. Use the ↑ and ↓ keys to select ACTIVE CODES. Press the ENTER key.

4. If an active fault code does not exist in TCU memory: The DDR displays the NO ACTIVE CODES screen:

   ![NO ACTIVE CODES](image)

5. If an active fault code exists: The DDR displays the fault code information.

   ![J1939 COM LINK FAULT](image)

Table B: J1939 Com Link Screen Description

<table>
<thead>
<tr>
<th>J1939 COMMUNICATIONS LINK FAULT</th>
<th>General Fault Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAILURE MODE NOT IDENTIFIABLE</td>
<td>General Description of the FMI</td>
</tr>
<tr>
<td>A1</td>
<td>First active fault</td>
</tr>
<tr>
<td>A2</td>
<td>Second active fault</td>
</tr>
<tr>
<td>I1</td>
<td>First inactive fault</td>
</tr>
<tr>
<td>SID:231</td>
<td>J1587 code description = J-1939 Communications Link Fault</td>
</tr>
<tr>
<td>FMI:11</td>
<td>Failure mode identifier description</td>
</tr>
</tbody>
</table>
How to Clear Active and Inactive Fault Codes from TCU Memory

1. Use the ↑ and ↓ keys to select FAULT CODES from the ZF MERITOR ESS menu.

2. Press the ENTER key. The DDR displays the FAULT CODES screen, which enables you to select either ACTIVE CODES, INACTIVE CODES or CLEAR CODES. Use the ↑ and ↓ keys to select CLEAR CODES.

3. Press the ENTER key. The DDR displays the CLEAR CODES screen:

   **CLEAR CODES ARE YOU SURE?**
   YES ← → [NO]

4. Use the ← and → keys to select [YES]. Press the ENTER key.

5. If you select [NO]: The DDR will return to the FAULT CODES screen.

6. If you select YES: The DDR will display the CODES CLEARED screen:

   **CODES CLEARED [ENTER] TO CONTINUE**

7. Press the ENTER key to return to the FAULT CODES screen.

8. Press the FUNC key to return to the ZF MERITOR ESS screen.

“Performance Data” Option

The PERFORMANCE DATA option contains the following selections. Refer to the glossary at the end of this section for a complete description of the contents of the “Performance Data” list.

- Shift Knob Counts
- ESS Enable
- Neutral Switch
- In Gear Switch
- System Switch
- Shift Intent Switch
- Break Torque Switch
- Transmission Oil Temperature

1. From the ZF MERITOR ESS screen, use the ↑ and ↓ keys to select PERFORMANCE DATA.

2. Press the ENTER key. The DDR displays the PERFORMANCE DATA options menu:

   **SHIFT KNOB CTS 833**
   **ESS ENABLE ON**
   **NEUTRAL SW ON**
   **IN GEAR SW OFF**

3. Use the ↑ and ↓ keys to scroll through the list.

4. To return to the ZF MERITOR ESS screen press the FUNC key.
“Calibration Identification (ID)” Option

1. From the ZF MERITOR ESS screen, use the \( \uparrow \) and \( \downarrow \) keys to select CALIBRATION ID.

2. Press the ENTER key. The DDR displays the CALIBRATION ID menu:

   ZF MERITOR ESS
   \( \uparrow \)-----Selections-----\( \downarrow \)
   CALIBRATION ID

3. Press the FUNC key to return to the ZF MERITOR ESS screen.

Table C: Calibration Identification Screen Description

<table>
<thead>
<tr>
<th>Line</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Program file</td>
</tr>
<tr>
<td>2</td>
<td>Calibration file</td>
</tr>
<tr>
<td>3</td>
<td>Transmission serial number</td>
</tr>
<tr>
<td>4</td>
<td>Transmission model number</td>
</tr>
<tr>
<td>5</td>
<td>Torque limit profile (Contact Meritor’s Customer Service at 800-535-5560 for details.)</td>
</tr>
</tbody>
</table>

4. Press the FUNC key to return to the ZF MERITOR ESS screen.

“Component Tests” Option

Three selections are available in the COMPONENT TESTS option:

- “Self Test”
- “Reset TCU”
- “Range Solenoids”

1. From the ZF MERITOR ESS screen, use the \( \uparrow \) or \( \downarrow \) keys to select COMPONENT TESTS.

2. Press the ENTER key. The DDR displays the COMPONENT TESTS screen:

   ZF MERITOR ESS
   \( \uparrow \)-----Selections-----\( \downarrow \)
   COMPONENT TESTS

3. Press the FUNC key to return to the ZF MERITOR ESS screen.

“Self Test”

NOTE: When you select SELF TEST the TCU performs both a self-diagnostic test and a test of all ESS system components to verify that they function correctly.

1. From the COMPONENT TESTS screen, use the \( \uparrow \) and \( \downarrow \) keys to select SELF TEST.

2. Press the ENTER key. The DDR displays the SELF TEST screen:

   COMPONENT TEST
   \( \uparrow \)-----Selections-----\( \downarrow \)
   SELF TEST ETC

3. When the self test verifies that the TCU and ESS system components function correctly, the DDR displays the SELF TEST SUCCESSFUL screen:

   SELF TEST SUCCESSFUL
   [ENTER] TO CONTINUE

4. Press the FUNC key to return to the ZF MERITOR ESS screen.
“Reset TCU” Test
The RESET TCU test resets the TCU’s parameters. This is similar to turning the ignition key OFF and ON.

1. From the COMPONENT TESTS screen, use the ↑ and ↓ keys to select RESET TCU.
2. Press the ENTER key. When the TCU parameters are reset, the DDR displays the RESET TCU SUCCESSFUL screen:

   ![RESET TCU SUCCESSFUL][1]

   [ENTER] TO CONTINUE

3. Press the FUNC key to return to the ZF MERITOR ESS screen.

“Range Solenoids” Test
The “Range Solenoids” test cycles the range solenoids to verify that they are operating correctly.

1. From the COMPONENT TESTS screen, use the ↑ and ↓ keys to select RANGE SOLENOIDS.
2. Press the ENTER key. Once the range solenoids have cycled successfully, the DDR displays the RANGE SOLENOIDS SUCCESSFUL screen:

   ![RANGE SOLENOIDS SUCCESSFUL][2]

   [ENTER] TO CONTINUE

3. Press the FUNC key to return to the ZF MERITOR ESS screen.

“View ESS” Option
1. From the ZF MERITOR ESS screen, use the ↑ and ↓ keys to select VIEW ESS OPTIONS.

   ![VIEW ESS OPTIONS][3]

2. Press the ENTER key. The DDR displays the ESS OPTIONS menu:

   ![ESS OPTIONS][4]

   ESS ENABLE ON
   ENG BRK SHIFT EN ON
   LATE CHANGE EN ON
   2° CHANCE EN ON

Table D: ZF Meritor ESS Options
<table>
<thead>
<tr>
<th>Screen Description</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESS ENABLE</td>
<td>Turns the system ON or OFF from within the calibration file. Overrides the system switch on the shift knob.</td>
</tr>
<tr>
<td>ENG BRK SHIFT</td>
<td>Turns the engine brake (if equipped) ON or OFF during upshifts.</td>
</tr>
<tr>
<td>LATE CHANGE EN</td>
<td>Enables you to change from an upshift to a downshift while in NEUTRAL.</td>
</tr>
<tr>
<td>2° CHANCE EN</td>
<td>Enables you to resume a shift after the three-second “Time Out Sequence” has expired. Refer to Section 1 to read more about this ESS safety feature.</td>
</tr>
<tr>
<td>SKIP SHIFT EN</td>
<td>Enables you to skip shift during upshifts or downshifts.</td>
</tr>
</tbody>
</table>

3. Press the FUNC key to return to the ZF MERITOR ESS screen.
"Change ESS" Options
1. From the ZF MERITOR ESS screen, use the ↑ and ↓ keys to select CHANGE ESS™ OPTIONS.

![ZF MERITOR ESS
↑----Selections----↓
CHANGE ESS OPTIONS](image)

2. Press the ENTER key. The DDR displays the ENTER PASSWORD screen:

![ENTER PASSWORD
----------](image)

3. Enter the user password. Once the password is accepted, the DDR displays the ESS OPTIONS menu:

![ESS ENABLE ON
ENG BRK SHIFT ON
LATE CHANGE EN ON
2nd CHANCE ON

LATE CHANGE EN
SELECT NEW STATUS
↑-------OFF-------↓](image)

4. Use the ↑ and ↓ keys to select one of the options. Press the ENTER key. The following screen is an example of changing the status of the LATE CHANGE EN option:

![LATE CHANGE EN
SELECT NEW STATUS
↑-------OFF-------↓](image)

5. Use the ↑ and ↓ keys to select the appropriate ON or OFF status option.

6. Press the ENTER key to change the status of the LATE CHANGE EN option to OFF.

"ESS Trip Data" Options
1. From the ZF MERITOR ESS™ screen, use the ↑ and ↓ keys to select ESS TRIP DATA.

![ZF MERITOR ESS
↑----Selections----↓
ESS TRIP DATA](image)

2. Press the ENTER key. The DDR displays the ESS TRIP DATA screen. Select VIEW to view the shift counts:

![ESS TRIP DATA
↑----Selections----↓
VIEW](image)

3. Press the ENTER key. The DDR displays the ESS TRIP DATA menu:

![ESS SHIFTS 1000
ABORT SFT CNT 100
NON-ESS SHIFTS 500](image)

Table E: Trip Data Screen Description

<table>
<thead>
<tr>
<th>NUMBER SHIFTS</th>
<th>Number of ESS shifts = 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABORTED SFT CNT</td>
<td>Number of unsuccessful ESS shifts* = 100</td>
</tr>
<tr>
<td>MAN SHIFT CNT</td>
<td>Number of manual shifts** = 500</td>
</tr>
</tbody>
</table>

* Examples of an unsuccessful shift include using the clutch to shift or not completing a shift within the two-second “Time-Out Sequence” while ESS™ is active.

** A manual shift is a shift that you complete when the ESS™ system is inactive or the system is turned OFF.
How to Reset “ESS Trip Data”

1. From the ESS TRIP DATA screen, use the ↑ and ↓ keys to select the RESET option.

2. Press the ENTER key. The TCU resets the shift counters, and the DDR readout displays the RESET SUCCESSFUL screen:

   **ESS TRIP DATA**
   ↑----Selections----↓
   **RESET**

   **SHIFT COUNTER**
   **RESET SUCCESSFUL**
   [ENTER] TO CONTINUE

“Axle Ratio” Option

The AXLE RATIO OPTIONS screen enables you to reset axle ratio values by selecting either AXLE RATIO or AXLE RATIO LEARN. The TCU uses the axle ratio value to synchronize engine rpm to road speed.

Table F: Axle Ratio Screen Description

<table>
<thead>
<tr>
<th>Axle Ratio</th>
<th>Enables you to use the DDR numeric keyboard to manually enter the axle ratio value.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axle Ratio Learn</td>
<td>Enables the TCU to automatically “learn” the axle ratio value.</td>
</tr>
</tbody>
</table>

1. From the ZF MERITOR ESS screen, use the ↑ and ↓ keys to select AXLE RATIO OPTIONS. Press the ENTER key. The DDR displays the AXLE RATIO OPTIONS screen.

2. Press the ENTER key. The DDR displays the PASSWORD screen:

   Enter Password
   --------

3. Enter the OEM password. When the password is accepted, the DDR displays the AXLE RATIO menu:

   **SET AXLE RATIO**
   ↑----AXLE RATIO----↓

Entering an Axle Ratio

1. From the SET AXLE RATIO screen, use the ↑ and ↓ keys to select AXLE RATIO. The DDR displays the INPUT AXLE RATIO screen:

   **INPUT AXLE RATIO**
   __-__
   **RANGE** 2.00-7.99

2. Use the numeric keypad to enter an actual axle ratio.

3. Press the ENTER key. The DDR displays the RESET AXLE RATIO screen:

   **RESET AXLE RATIO**
   ARE YOU SURE?
   **YES** [NO]
4. Use the ← and → keys to select [YES] or [NO]. When the axle ratio is reset, the DDR displays the AXLE RESET SUCCESSFUL screen:

```
AXLE RATIO RESET
[ENTER] TO CONTINUE
```

5. This option automatically disables the AXLE RATIO LEARN function. Press the ENTER key to return to the ZF MERITOR ESS AXLE RATIO OPTIONS screen.

**Using the “Axle Ratio Learn” Function**

1. From the SET AXLE RATIO menu, use the ↑ and ↓ keys to select RESET AXLE RATIO LEARN.

2. Press the ENTER key. The DDR displays the AXLE RATIO LEARN screen:

```
RESET AXLE RATIO LEARN
ARE YOU SURE?
YES   [NO]
```

3. Use the ← and → keys to select [YES] or [NO].

4. If you select the [YES] option, AXLE RATIO LEARN is reset, and the DDR displays the AXLE RATIO LEARN RESET screen.

```
AXLE RATIO LEARN
RESET
[ENTER] TO CONTINUE
```

5. This option automatically disables the AXLE RATIO SET option. Press the ENTER key to return to the AXLE RATIO OPTIONS screen.

**“Torque Control” Option**

**Viewing Engine Torque Control Counters**

You can view three torque control counters when you select TORQUE CONTROL from the ZF MERITOR ESS screen:

- Total hours
- No Torque Control Hours
- Over Torque Limit Hours

1. From the ZF MERITOR ESS screen, use the ↑ and ↓ keys to select TORQUE CONTROL.

2. Press the ENTER key. The DDR displays the TORQUE CONTROL COUNTERS menu:

```
TOTAL HOURS 1000
NO TRQ CTRL HRS 100
OVER TQ LMT HRS 20
```

**Table G: Torque Control Counters Screen Description**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL HOURS</td>
<td>1000</td>
</tr>
<tr>
<td>NO TRQ CTRL HRS</td>
<td>100</td>
</tr>
<tr>
<td>OVER TQ LMT HRS</td>
<td>20</td>
</tr>
</tbody>
</table>

3. Press the FUNC key to return to the ZF MERITOR ESS screen.
Section 3
Pro-Link® 9000 Diagnostics

“Change Your Password” Option

1. From the ZF MERITOR ESS screen, use the ↑ and ↓ keys to select change password.

2. Enter your password at the prompt.
3. Press the ENTER key. The DDR will display the ENTER NEW PASSWORD screen:

4. Enter your new password. The DDR will display the CHANGE PASSWORD SUCCESSFUL screen when your new password is confirmed:

5. Press the ENTER key to return to the AXLE RATIO OPTIONS screen.

How to Use the Pro-Link® 9000 DDR to Test ESS™ Components

Open the ESS™ Application

Refer to the procedures in “How to Open the ESS™ System Application” at the beginning of this section.

Ten options are available in the ZF MERITOR ESS application screen. You will use the “Fault Code” and “Performance Data” options to test ESS™ components.

Table H: ZF Meritor ESS™ Application Options

<table>
<thead>
<tr>
<th>Fault Codes</th>
<th>Change ESS Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calibration ID</td>
<td>Torque Control</td>
</tr>
<tr>
<td>Performance Data</td>
<td>Component Tests</td>
</tr>
<tr>
<td>ESS Trip Data</td>
<td>Axle Ratio Options</td>
</tr>
<tr>
<td>View ESS Options</td>
<td>Change Password</td>
</tr>
</tbody>
</table>

Testing ESS™ Components

NOTE: If a system fault requires you to install a new ESS™ component, first verify that the wiring harness(es) that connects the component to the transmission control unit (TCU) is not pinched, frayed or cut. A damaged wiring harness will cause the TCU to register an active fault for the new component you install. Refer to Section 5 to replace the wiring harness.

Transmission Control Unit (TCU): Fault Code 254

NOTE: ZF Meritor’s ESS™ transmission control unit (TCU) is not serviceable. If a fault exists, replace the TCU.

One fault code applies to this component: Fault Code 254. Refer to Table I below.

Table I: Controller Fault Code 254

<table>
<thead>
<tr>
<th>*SID</th>
<th>**FMI</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>254</td>
<td>11</td>
<td>Internal Controller Fault</td>
</tr>
</tbody>
</table>

* Sub-system Identifier
** Failure Mode Indicator

1. To verify that this fault is an active fault, use the ↑ and ↓ keys to select FAULT CODES from the ZF MERITOR ESS screen.
2. Press the ENTER key. The DDR displays the FAULT CODES screen, which enables you to select either ACTIVE CODES, INACTIVE CODES or CLEAR CODES. Use the ↑ and ↓ keys to select ACTIVE CODES.

FAULT CODES
---SELECTIONS---
ACTIVE CODES

3. Press the ENTER key. If the DDR displays the following CONTROLLER FAULT screen, there is an active fault in the TCU. Contact Meritor’s Customer Service Center at 800-535-5560 for assistance. If you are instructed to replace the TCU, refer to Section 5 for instructions.

CONTROLLER FAULT
FAILURE MODE
NOT IDENTIFIABLE
↑ AOI SID:254 FMI:11 ↓

ESS™ Shift Knob: Fault Code 227

NOTE: The ESS™ shift knob is not serviceable. If a fault exists, replace the shift knob.

Fault Code 227 applies to the ESS™ shift knob and includes three fault code descriptions. Table J.

Table J: Shift Knob Fault Code 227

<table>
<thead>
<tr>
<th>*SID</th>
<th>**FMI</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>227</td>
<td>2</td>
<td>Shift knob data erratic, intermittent or incorrect</td>
</tr>
<tr>
<td>227</td>
<td>3</td>
<td>Shift knob voltage above normal or shorted high</td>
</tr>
<tr>
<td>227</td>
<td>4</td>
<td>Shift knob voltage below normal or shorted low</td>
</tr>
</tbody>
</table>

* Sub-system Identifier
** Failure Mode Indicator
How to Test the Shift Knob Using the SHIFT KNOB STATUS Option in the Performance Data List

The SHIFT KNOB STATUS option allows you to verify that the shift knob functions correctly.

1. From the ZF MERITOR ESS screen, use the ▲ and ▼ keys to select PERFORMANCE DATA.
2. Press the ENTER key. The DDR displays the PERFORMANCE DATA options screen.
3. If necessary, use the ▲ and ▼ keys to select the SHIFT KNOB STATUS option.
4. **Verify shift knob counts:** Refer to Table K to verify that the switches on the shift knob indicate the correct counts.
5. **If the shift knob counts do not correspond to those listed in Table K:**
   - Check the wiring harness.
   - Check the shift knob independently of the wiring harness.
   - Replace the shift knob. Refer to Section 5 for instructions.

### Table K: Shift Knob Counts

<table>
<thead>
<tr>
<th>Shift Knob Counts</th>
<th>System Switch Status</th>
<th>Shift Intent Switch Status</th>
<th>Break Torque Switch Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>469-484</td>
<td>Off (up)</td>
<td>Off (up)</td>
<td>Off</td>
</tr>
<tr>
<td>469-484</td>
<td>Off (up)</td>
<td>Off (up)</td>
<td>On (full up)</td>
</tr>
<tr>
<td>546-562</td>
<td>Off (up)</td>
<td>On (down)</td>
<td>Off</td>
</tr>
<tr>
<td>546-562</td>
<td>Off (up)</td>
<td>On (down)</td>
<td>On (full down)</td>
</tr>
<tr>
<td>662-676</td>
<td>On (down)</td>
<td>Off (up)</td>
<td>Off</td>
</tr>
<tr>
<td>727-742</td>
<td>On (down)</td>
<td>Off (up)</td>
<td>On (full up)</td>
</tr>
<tr>
<td>827-840</td>
<td>On (down)</td>
<td>On (down)</td>
<td>Off</td>
</tr>
<tr>
<td>933-942</td>
<td>On (down)</td>
<td>On (down)</td>
<td>On (full down)</td>
</tr>
</tbody>
</table>
ESS™ High and Low Range Shift Solenoids: Fault Codes 35 and 36

**NOTE:** ESS™ high- and low-range shift solenoids are not serviceable. If a fault exists, replace the solenoids.

Fault Codes 35 and 36 apply to ESS high- and low-range shift solenoids. Each fault code includes two fault code descriptions. **Table L.**

**Table L: Fault Codes 35 and 36**

<table>
<thead>
<tr>
<th>*SID</th>
<th>**FMI</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>3</td>
<td>High range solenoid voltage above normal or shorted high</td>
</tr>
<tr>
<td>35</td>
<td>4</td>
<td>High range solenoid voltage below normal or shorted low</td>
</tr>
<tr>
<td>36</td>
<td>3</td>
<td>Low range solenoid voltage above normal or shorted high</td>
</tr>
<tr>
<td>36</td>
<td>4</td>
<td>Low range solenoid voltage below normal or shorted low</td>
</tr>
</tbody>
</table>

* Sub-system Identifier  
** Failure Mode Indicator

1. To verify that this fault is an active fault, use the ↑ and ↓ keys to select FAULT CODES from the ZF MERITOR ESS screen.

2. Press the ENTER key. The DDR displays the FAULT CODES screen, which enables you to select either ACTIVE CODES, INACTIVE CODES or CLEAR CODES. Use the ↑ and ↓ keys to select ACTIVE CODES.

3. Press the ENTER key. If the DDR displays the RANGE SHIFT SOLENOID screen (refer to the sample screen below), an active fault exists in the shift knob. Refer to “How to Test the Shift Knob Using the HIGH SOLENOID and LOW SOLENOID Options in the Performance Data List.”

**LOW RANGE SOLENOID VOLTAGE ABOVE NORMAL**  
↑ A0I SID:36 FMI:3 ↓

**How to Test the Shift Knob Using the HIGH SOLENOID and LOW SOLENOID Options in the Performance Data List**

The HIGH SOLENOID and LOW SOLENOID options enable you to verify that the high- and low-range solenoids function correctly.

1. From the ZF MERITOR ESS screen, use the ↑ and ↓ keys to select PERFORMANCE DATA.
2. Press the ENTER key. The DDR displays the PERFORMANCE DATA screen.

**ZF MERITOR ESS**  
↑----Selections----↓  
PERFORMANCE DATA

3. If necessary, use the ↑ and ↓ keys to select the SOLENOID FAULT option simultaneously.

**SOLENOID FAULT**  
TCU VOLTAGE  
OUTPUT RPM  
ENGINE RPM

4. Verify that the low range and high range solenoids work correctly: If a solenoid fault exists, use the COMPONENT TESTS option to test both solenoids. Replace a solenoid only after testing it with a volt-ohm meter.
ESS™ Switch Assembly (Neutral and In Gear Switches): Fault Code 226

NOTE: The ESS™ neutral switch and in gear switch are not serviceable. If a fault exists in either switch, replace the entire switch assembly.

The neutral switch and the in gear switch are individual components built into a single housing called the ESS™ switch assembly. Table M.

1. To verify that this fault is an active fault, use the ↑ and ↓ keys to select FAULT CODES from the ZF MERITOR ESS screen.

How to Test the Neutral Switch and In Gear Switch Using the NEUTRAL SW and IN GEAR SW Options in the Performance Data List

The NEUTRAL SW and IN GEAR SW options enable you to verify that these switches function correctly.

1. From the ZF MERITOR ESS screen, use the ↑ and ↓ keys to select PERFORMANCE DATA.

2. Press the ENTER key. The DDR displays the NEUTRAL SW and IN GEAR SW options screen.

3. If necessary, use the ↑ and ↓ keys to select the NEUTRAL SW and IN GEAR SW options simultaneously.

4. Verify that the neutral switch and in gear switch operate correctly: Put the transmission in and out of gear while checking the display. The values must correspond to those listed in Table M.

5. If either the neutral switch or in gear switch values do not correspond to those in Table M: Replace the entire switch assembly. Refer to Section 5 for instructions.

Table M: Fault Code 226

<table>
<thead>
<tr>
<th>*SID</th>
<th>**FMI</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>226</td>
<td>11</td>
<td>ESS™ Switch Assembly Fault</td>
</tr>
</tbody>
</table>

* Sub-system Identifier
** Failure Mode Indicator
ESS™ Vehicle Speed Sensor (VSS): Fault Code 191

NOTE: The ESS™ vehicle speed sensor (VSS) is not serviceable. If a fault exists, replace the speed sensor.

Fault Code 191 applies to the ESS vehicle speed sensor (VSS) and includes three fault code descriptions. Refer to Table N below.

Table N: Fault Code 191

<table>
<thead>
<tr>
<th>*SID</th>
<th>**FMI</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>191</td>
<td>2</td>
<td>Speed sensor signal erratic, intermittent or incorrect</td>
</tr>
<tr>
<td>191</td>
<td>3</td>
<td>Speed sensor voltage above normal or shorted high</td>
</tr>
<tr>
<td>191</td>
<td>4</td>
<td>Speed sensor voltage below normal or shorted low</td>
</tr>
</tbody>
</table>

* Sub-system Identifier  ** Failure Mode Indicator

1. To verify that this fault is an active fault, use the ↑ and ↓ keys to select FAULT CODES from the ZF MERITOR ESS screen.

2. Press the ENTER key. The DDR displays the FAULT CODES screen, which enables you to select either ACTIVE CODES or CLEAR CODES. Use the ↑ and ↓ keys to select ACTIVE CODES.

3. Press the ENTER key. If the DDR displays the SPEED SENSOR FAULT screen (refer to the sample screen below), an active fault exists in the shift knob. Refer to “How to Test the Vehicle Speed Sensor (VSS) Using the ‘Output RPM’ Option in the Performance Data List.”

How to Test the Vehicle Speed Sensor (VSS) Using the “Output RPM” Option in the Performance Data List

The “Output RPM” option enables you to verify that the vehicle speed sensor operates correctly.

1. From the ZF MERITOR ESS screen, use the ↑ and ↓ keys to select PERFORMANCE DATA.

2. Press the ENTER key. The DDR displays the OUTPUT RPM options screen.

3. If necessary, use the ↑ and ↓ keys to select the OUTPUT RPM option.

4. Press the ENTER key.

5. Verify that the vehicle speed sensor operates correctly: Drive the vehicle in “direct drive.” Compare OUTPUT RPM and ENGINE RPM values to those listed in Table N. The vehicle speed sensor is operating correctly if both of these values are equal.

6. If the OUTPUT RPM and ENGINE RPM values do not equal one another: Replace the vehicle speed sensor. Refer to Section 5.
# Glossary

<table>
<thead>
<tr>
<th>Performance Data List Options</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shift Knob Status</strong></td>
<td>Verifies that the system switch and shift intent switch operate correctly. Refer to “ESS™ Shift Knob: Fault Code 227” in this section.</td>
</tr>
<tr>
<td><strong>Engine RPM</strong></td>
<td>Specifies engine speed.</td>
</tr>
<tr>
<td><strong>TCU Voltage</strong></td>
<td>Specifies the transmission control unit’s (TCU) power (voltage) supply.</td>
</tr>
<tr>
<td><strong>Axle Ratio</strong></td>
<td>Specifies axle ratio used by the transmission control unit (TCU).</td>
</tr>
<tr>
<td><strong>Trans Oil Level</strong></td>
<td>Specifies the transmission oil level. If a sensor is not installed, the “Trans Oil Level” option will be labeled “N/A.”</td>
</tr>
<tr>
<td><strong>Trans Oil Temp</strong></td>
<td>Specifies transmission oil temperature. If a sensor is not installed, the “Trans Oil Temp” option will be labeled “N/A.”</td>
</tr>
</tbody>
</table>
| **ESS Enable**                | ON: ESS™ system activated at the TCU  
OFF: ESS™ system not activated at the TCU |
| **Neutral Switch**            | ON: Transmission in NEUTRAL  
OFF: Transmission not in NEUTRAL |
| **In Gear Switch**            | ON: Transmission in gear  
OFF: Transmission not in gear |
| **System Switch**             | ON (Slide switch UP): Activates the ESS™ system at the shift knob  
OFF (Slide switch DOWN): Deactivates the ESS™ system at the shift knob |
| **Shift Intent Switch**       | Toggle the rocker switch UP: Activates the shift intent switch to signal the TCU that the next shifts will be UPSHIFTS  
Toggle the rocker switch DOWN: Activates the shift intent switch to signal the TCU that the next shifts will be DOWNSHIFTS |
| **Break Torque Switch**       | Press the rocker switch DOWN to end of travel or UP to end of travel: Activates break torque feature  
Rocker switch is not pressed DOWN to end of travel or UP to end of travel: Break torque feature is not activated |
| **Axle Ratio Learn**          | Specifies the method used by the transmission control unit (TCU) to calculate axle ratio. This ratio can be “learned” by the TCU, or you can enter an axle ratio into the diagnostic data reader (DDR).  
“Learned” by TCU: DDR displays “Enabled”  
User enters axle ratio into DDR: DDR displays “Disabled” |
| **Low Solenoid**              | ON (Activated): Vehicle in LOW range  
OFF (Not activated): Vehicle in HIGH range |
| **High Solenoid**             | ON (Activated): Vehicle in HIGH range  
OFF (Not activated): Vehicle in LOW range |
### Shift Knob

<table>
<thead>
<tr>
<th>Switch Positions</th>
<th>Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>System On-Off Switch</td>
<td>Shift Intent Switch</td>
</tr>
<tr>
<td>On</td>
<td>Overtake-Up</td>
</tr>
<tr>
<td>On</td>
<td>Up</td>
</tr>
<tr>
<td>On</td>
<td>Overtake-Down</td>
</tr>
<tr>
<td>Off</td>
<td>Up</td>
</tr>
<tr>
<td>Off</td>
<td>Down</td>
</tr>
</tbody>
</table>

### Speed Sensor Assembly

- **Resistance (Measured Across Pins):**
  - 2.7 k–3.3 k ohms

### Neutral/In Gear Switch Assembly

- **Resistance (Measured Across Pins):**
  - 11–21 ohms

### Range Solenoid

- **Resistance (Measured Across Pins):**
  - 0.5 ohms or less

### TCU 30-Way Connector

<table>
<thead>
<tr>
<th>PINS</th>
<th>In Neutral (Free State)</th>
<th>In Gear (Button Engaged)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A &amp; B</td>
<td>0.5 ohms or less</td>
<td>Open Circuit</td>
</tr>
<tr>
<td>C &amp; D</td>
<td>Open Circuit</td>
<td>0.5 ohms or less</td>
</tr>
</tbody>
</table>
WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

When you work on an electrical system, the possibility of electrical shock exists, and sparks can ignite flammable substances. You must always disconnect the battery ground cable before you work on an electrical system to prevent serious personal injury and damage to components.

Take care when you use Loctite® to avoid serious personal injury. Follow the manufacturer’s instructions to prevent irritation to the eyes and skin. If Loctite® gets into your eyes, flush them with water for 15 minutes. Have your eyes checked by a doctor as soon as possible.

TCU Removal

Step 1

Use a 1/4-inch socket.

Use a 1/4-inch socket to remove the fastener that secures the thirty-pin TCU connector to the TCU.

Step 2

Remove the thirty-pin TCU connector from the TCU.
Section 5  
Removal and Installation

**Step 3**
Use a 7/16-inch socket to remove the four 1/4-inch-20 x 2.75-inch fasteners and flat washers that secure the TCU to the mounting plate.

**Step 4**
Return the TCU to ZF Meritor for a core credit. Call Meritor’s Aftermarket Services in Florence, Kentucky, at 888-725-9355 for assistance.
TCU Installation

If necessary, obtain a replacement TCU from Meritor’s Aftermarket Services in Florence, Kentucky, at 888-725-9355.

**Step 1**

Insert the thirty-pin TCU connector into the TCU.

**Step 2**

Use a socket to fasten the TCU to the mounting plate with four 1/4-inch-20 x 2.75-inch fasteners and flat washers. Tighten the fasteners to 10 lb-ft (13 N•m).

**Step 3**

Use a 1/4-inch socket.

**Step 4**

Secure the thirty-pin TCU connector to the TCU. Use a 1/4-inch socket to tighten the fasteners to 100 lb-in (11.3 N•m).
Shift Knob Removal

Step 1
Use a Phillips head screwdriver to remove the screw that secures the skirt to the shift knob housing.

Step 2
Separate the skirt from the shift knob assembly.

Step 3
Disconnect the electrical connectors at the base of the shift knob.

Step 4
Loosen the jam nut at the base of the shift knob with a 3/4-inch wrench.
Step 5
Remove the shift knob from the lever by turning the shift knob COUNTERCLOCKWISE.

Step 6
Remove the shift knob skirt.
Shift Knob Installation

Step 1
Slip the shift knob skirt onto the shift lever.

Step 2
Install the shift knob on the lever by turning the shift knob CLOCKWISE.

Step 3
Position the knob as desired. Use a 3/4-inch wrench to tighten the jam nut at the base of the shift knob.

Step 4
Connect the three electrical connectors at the base of the shift knob to the wiring harness connectors by pushing them together.
Connect the skirt to the shift knob. Use a Phillips head screwdriver to tighten the fastener that secures the skirt to the shift knob housing.
Wiring Harness Removal

Step 1
Disconnect the TCU connector.

Step 2
Disconnect the J-1939 connector.

Step 3
Disconnect the shift knob connector.

Step 4
Disconnect the wiring harness from the vehicle speed sensor (VSS).
Section 5
Removal and Installation

Step 5
Disconnect the OEM power connector.

Step 6
Disconnect the harness connector from the neutral position switch connector.

Step 7
Disconnect the J-1708 connector.

Step 8
Disconnect the solenoid connectors.
Remove the wiring harness from the hold-down clips. Remove the wiring harness.
Wiring Harness Installation

**Step 1**

Connect the wiring harness connectors to the HIGH and LOW range cylinder solenoids. Connect one yellow and one red wire to the HIGH solenoid. Connect one blue and one red wire to the LOW solenoid.

**Step 2**

Connect the wiring harness to the J-1708 connector.

**Step 3**

Connect the wiring harness to the switch assembly.

**Step 4**

Connect the wiring harness to the OEM power connector.
Section 5
Removal and Installation

**Step 5**
Connect the wiring harness to the shift knob connector.

**Step 6**
Connect the wiring harness to the J-1939 connector.

**Step 7**
Connect the wiring harness to the vehicle speed sensor.

**Step 8**
Install the wiring harness into the hold-down clips.
Connect the wiring harness to the TCU.
Top Cover Removal

Step 1
Remove the wiring harness. (Refer to “Wiring Harness Removal” in this section.)

Step 2
Clean the top cover housing before removal.

Step 3
Remove the neutral position switch sensor from the top cover housing.

Step 4
Use a magnet to remove the neutral position switch sensor actuator pin from the bore in the top cover housing.
Section 5
Removal and Installation

Step 5
Remove the shift tower. For a standard cover, use tape to protect the detent springs if no dust cover was installed.

Step 6
Use a 9/16-inch socket to remove the sixteen 3/8-16 top cover housing capscrews.

Step 7
Remove jack hole plugs.

Step 8
Install two of the 3/8-16 capscrews into the threaded jack holes.
Use a hand or air ratchet to alternately turn the two 3/8-16 jackscrews until the top cover is separated from the case.

Remove the top cover housing from the transmission case assembly.

Use a scraper to remove all sealant from the surface of the top cover housing and transmission case assembly. The sealant you remove must not fall inside the transmission. Clean the mounting surface with Loctite® Safety Sealant.
Top Cover Installation

**Step 1**

Apply Loctite® Ultra Grey Adhesive/Sealant #18581 (Meritor part No. 2297-A-7021) onto the transmission case assembly.

**Step 2**

Place the top cover shift shafts in the neutral position. Place the shift collars in the neutral position. Install the top cover and align and engage the forks with the sliding clutch collars.

**Step 3**

Clean mounting capscrew threads. Apply Loctite® #242 (Meritor part number 2297-V-2430) or equivalent to the threads.

**Step 4**

Install the sixteen 3/8-16 mounting capscrews and washers for the top cover housing. Use a torque wrench to tighten the capscrews to 25-35 lb-ft (34-47 N·m).
Section 5
Removal and Installation

Step 5
Install the jack hole plugs.

Step 6
Install the neutral position switch sensor. Use a torque wrench to tighten the sensor to 150-210 lb-in (17-24 N•m).

Step 7
Install the neutral position switch sensor actuator pin into the bore in the top cover housing.

Step 8
Remove the tape from the detent springs. Install the shift tower.
NOTE: Only features unique to the ESS™ top cover are shown in this section. Refer to Maintenance Manual No. 26A, *Nine-Speed, Ten-Speed and Thirteen-Speed Transmissions*, for overhaul procedures not covered in this manual. To order a copy of this publication, call Meritor’s Customer Service Center at 800-535-5560.
Range Cylinder Solenoid Removal

**Step 1**
Disconnect the two range solenoid connectors.

**Step 2**
Remove the two Allen-head bolts that secure either the HIGH or LOW range cylinder solenoid, depending on which solenoid you are replacing.

**Step 3**
Remove either the HIGH or LOW range cylinder solenoid from the range housing. (The low side of the range housing is illustrated.)
Range Cylinder Solenoid Installation

Step 1
Lubricate the new range cylinder solenoid O-rings with Dow Corning® No. 111 Silicone Grease or equivalent. Install the O-rings onto the replacement range cylinder solenoid.

Step 2
Install the range cylinder solenoid into the range housing. Use an Allen wrench to install the two Allen-head bolts that secure the range cylinder solenoid. Tighten the bolts to 45-55 lb-in (5-6 N•m).

Engage the range cylinder solenoid connector.

Step 3
Connect the two solenoid connectors.
Section 5
Removal and Installation

Switch Assembly Removal

Step 1
Disconnect the harness connector from the neutral position switch connector.

Step 2
Clean top cover housing before removal.

Step 3
Remove the neutral position switch sensor from the top cover housing.
Switch Assembly Installation

Install the neutral position switch sensor. Use a torque wrench to tighten the sensor to 150-210 lb-in (17-24 N•m).

Connect the wiring harness connector to the neutral position switch connector.
Vehicle Speed Sensor Removal

Step 1

Use a one-inch wrench to remove the speedometer pickup sensor.

Vehicle Speed Sensor Installation

Step 1

Install the O-ring on the speedometer pickup sensor.

Step 2

Use a one-inch wrench to install the speedometer pickup sensor. Use a torque wrench to tighten the sensor to 15 lb-ft (20 N•m).
Neutral Check Shaft Removal

Step 1
Remove the top cover. Refer to “Top Cover Removal” in this section.

Step 2
Press and hold the spring-loaded neutral check shaft and remove the shift shafts.

Step 3
After you remove all of the shift shafts, remove the neutral check shaft from the top cover housing.

Step 4
Remove the neutral check shaft spring from the top cover housing.
Neutral Check Shaft Installation

**Step 1**
Install the neutral check shaft spring into the top cover housing. Install the neutral check shaft into the top cover housing.

**Step 2**
Press and hold the spring-loaded neutral check shaft. Install the shift shafts.

**Step 3**
Install the top cover. Refer to “Top Cover Installation” in this section.
Range Cylinder Removal

**Step 1**
Use a 7/16-inch socket to remove the two 7/16-inch air filter/regulator assembly capscrews.

**Step 2**
Remove the air filter/regulator assembly.
Step 3
Remove the air filter/regulator O-ring.

Step 4
Use a 5/32-inch Allen wrench to remove the four Allen-head bolts that secure the two range cylinder solenoids.

Step 5
Remove the range cylinder solenoids.

Step 6
Use a 9/16-inch wrench to remove the four 3/8-16 range cylinder cover bolts.
Remove the range cylinder cover.

Remove the large and small O-rings from the range cylinder cover.

Use a socket to remove the 11/16-inch range cylinder piston nut.

Remove the range cylinder piston housing.
Section 5
Removal and Installation

Step 11
Remove the range shaft O-ring from inside of the range housing shaft bore.

Step 12
Remove the piston from the housing.

Step 13
Remove the range cylinder piston O-ring.
Switch Assembly Removal

**Step 1**
Disconnect the harness connector from the neutral position switch connector.

**Step 2**
Clean the top cover housing before removal.

**Step 3**
Remove the neutral position switch sensor from the top cover housing.
Install the range shift shaft nut with an 11/16-inch socket. Use a torque wrench to tighten the nut to 35-50 lb-ft (47-68 N•m).

Lubricate the large and small O-rings with Dow Corning #111 Silicone Grease or equivalent. Install the range cylinder cover O-ring and the smaller O-ring.

Install the range cylinder cover. Clean the capscrew threads. Apply Loctite® #242 (Meritor part number 2297-V-2430) or equivalent to the capscrew threads. Use a torque wrench to tighten the four 3/4-16 capscrews to 35-45 lb-ft (47-61 N•m).

Lubricate the range cylinder solenoid O-rings with Dow Corning #111 Silicone Grease or equivalent.
Install the range cylinder solenoids onto the range housing.

Use a 5/32-inch Allen wrench to install the four range cylinder solenoid bolts. Tighten the bolts to 50 lb-in (6 N•m).

Lubricate the air filter/regulator O-ring with Dow Corning #111 Silicone Grease or equivalent. Install the O-ring.

Use a 7/16-inch wrench to install the two air filter/regulator capscrews. Use a torque wrench to tighten capscrews to 10-12 lb-ft (13.6-16 N•m).
## Torque Table

<table>
<thead>
<tr>
<th>Components</th>
<th>Fastener Sizes</th>
<th>lb-in</th>
<th>lb-ft</th>
<th>N-m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speedometer pickup sensor</td>
<td>—</td>
<td>150-210</td>
<td>—</td>
<td>17-24</td>
</tr>
<tr>
<td>Neutral interlock sensor</td>
<td>—</td>
<td>150-210</td>
<td>—</td>
<td>17-24</td>
</tr>
<tr>
<td>Detent threaded plug*</td>
<td>—</td>
<td>—</td>
<td>20-25</td>
<td>27-34</td>
</tr>
<tr>
<td>Air filter/regulator fasteners</td>
<td>1/4 x 20</td>
<td>85-115</td>
<td>—</td>
<td>10-13</td>
</tr>
<tr>
<td>Solenoid assembly</td>
<td>1/4 x 20</td>
<td>50</td>
<td>—</td>
<td>6</td>
</tr>
<tr>
<td>HIGH/LOW range cylinder housing cover</td>
<td>3/8 x 16 x 2-3/4</td>
<td>—</td>
<td>35-45</td>
<td>47-61</td>
</tr>
<tr>
<td>Range cylinder piston shift shaft</td>
<td>7/16 x 20</td>
<td>—</td>
<td>35-50</td>
<td>47-68</td>
</tr>
<tr>
<td>HIGH/LOW range piston housing threaded plugs</td>
<td>—</td>
<td>—</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>Shift tower to top cover housing</td>
<td>3/8 x 16</td>
<td>—</td>
<td>35-45</td>
<td>47-61</td>
</tr>
<tr>
<td>Top cover housing to main case*</td>
<td>3/8 x 16 x 1-1/4</td>
<td>—</td>
<td>25-35</td>
<td>34-47</td>
</tr>
<tr>
<td>Rocking lever assembly pin to top cover housing*</td>
<td>1/2 x 20</td>
<td>—</td>
<td>35-45</td>
<td>47-61</td>
</tr>
<tr>
<td>Oil scoop to top cover housing</td>
<td>1/4 x 20 x 1/2</td>
<td>—</td>
<td>10-12</td>
<td>13-16</td>
</tr>
<tr>
<td>Shift fork to shift rail</td>
<td>7/16 x 20</td>
<td>—</td>
<td>35-45</td>
<td>47-61</td>
</tr>
</tbody>
</table>

* Requires a new application of Loctite® 242 (Meritor part number 2297-V-2430) or equivalent on threads.