

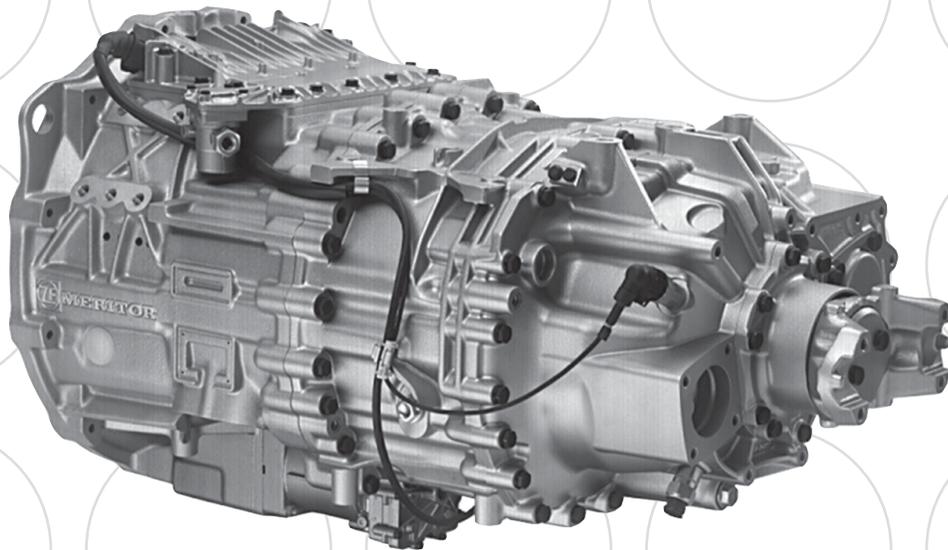
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# Maintenance and Diagnostics Manual MM-0150

## **ZF-FreedomLine Transmission**

Revised 06-09



# ZF-FreedomLine Transmission Maintenance and Diagnostics Manual MM-0150

## USING THIS MAINTENANCE MANUAL

This maintenance manual addresses maintenance, diagnostics and use issues that owners and users of ZF-FreedomLine transmissions may encounter. It is not intended as a discussion of every issue that may arise in those contexts but is illustrative of certain information that might be considered in conjunction with installation, maintenance, repair and use of the subject transmissions.

**Owners and users of ZF-FreedomLine transmissions are responsible for familiarizing themselves with the content of this maintenance manual and using the information (and following the warnings) contained herein for any function or condition covered. They are also responsible for communicating the information contained in this maintenance manual to any persons performing installation, maintenance or repair services with respect to the subject transmissions. Correct maintenance, diagnostics and use of the subject transmissions, and observance of the suggestions and directives contained in this maintenance manual, are integral requirements of continued warranty coverage for the subject transmissions.**

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THESE MATERIALS PROVIDE SUGGESTIONS, AS WELL AS CERTAIN REQUIREMENTS, WITH RESPECT TO THE INSTALLATION, MAINTENANCE, REPAIR AND USAGE OF ZF-FREEDOMLINE TRANSMISSIONS.

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## Before You Begin

This manual provides maintenance and diagnostic instructions for ZF-FreedomLine transmissions. Before you begin procedures:

1. Read and understand all instructions and procedures before you begin to service components.
2. Read and observe all Caution and Warning safety alerts that precede instructions or procedures you will perform. These alerts help to avoid damage to components, serious personal injury, or both.
3. Follow your company's maintenance and service, installation, and diagnostics guidelines.
4. Use special tools when required to help avoid serious personal injury and damage to components.

## Safety Alerts, Torque Symbol and Notes

 <b>WARNING</b>	A Warning alerts you to an instruction or procedure that you must follow exactly to avoid serious personal injury and damage to components.
	A torque symbol alerts you to tighten fasteners to a specified torque value.
<b>NOTE</b>	A Note provides information or suggestions that help you correctly service a component.

## Access Product and Service Information on Our Website

Visit Literature on Demand at [www.meritorhvs.com](http://www.meritorhvs.com) to access product, service, aftermarket, and warranty literature for ArvinMeritor's truck, trailer and specialty vehicle components.

## To Order Information

Call OnTrac at 866-668-7221 to order the following publications or visit ArvinMeritor's commercial vehicle website at [www.meritorhvs.com](http://www.meritorhvs.com) for free downloads. (Keyword Transmissions).

- ZF-FreedomLine Transmission (Operator Manual TP-20170) (French and Spanish versions available)
- ZF-FreedomLine Transmission (Parts Book PB-0127)
- ZF-FreedomLine Transmission Maintenance and Diagnostic Manual (MM-0150)
- ZF-FreedomLine Transmission Fault Code Diagnostics and Wiring Diagram (TP-01110)

## How to Order Tools Specified in This Manual

Call ArvinMeritor's Commercial Vehicle Aftermarket at 888-725-9355 to order Meritor tools.

SPX Kent-Moore, 28635 Mound Road, Warren, Michigan, 48092. Call the company's customer service center at 800-345-2233, or visit their website at [spxkentmoore.com](http://spxkentmoore.com).

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Information contained in this publication was in effect at the time the publication was approved for printing and is subject to change without notice or liability. ZF Friedrichshafen AG reserves the right to revise the information presented or to discontinue the production of parts described at any time.

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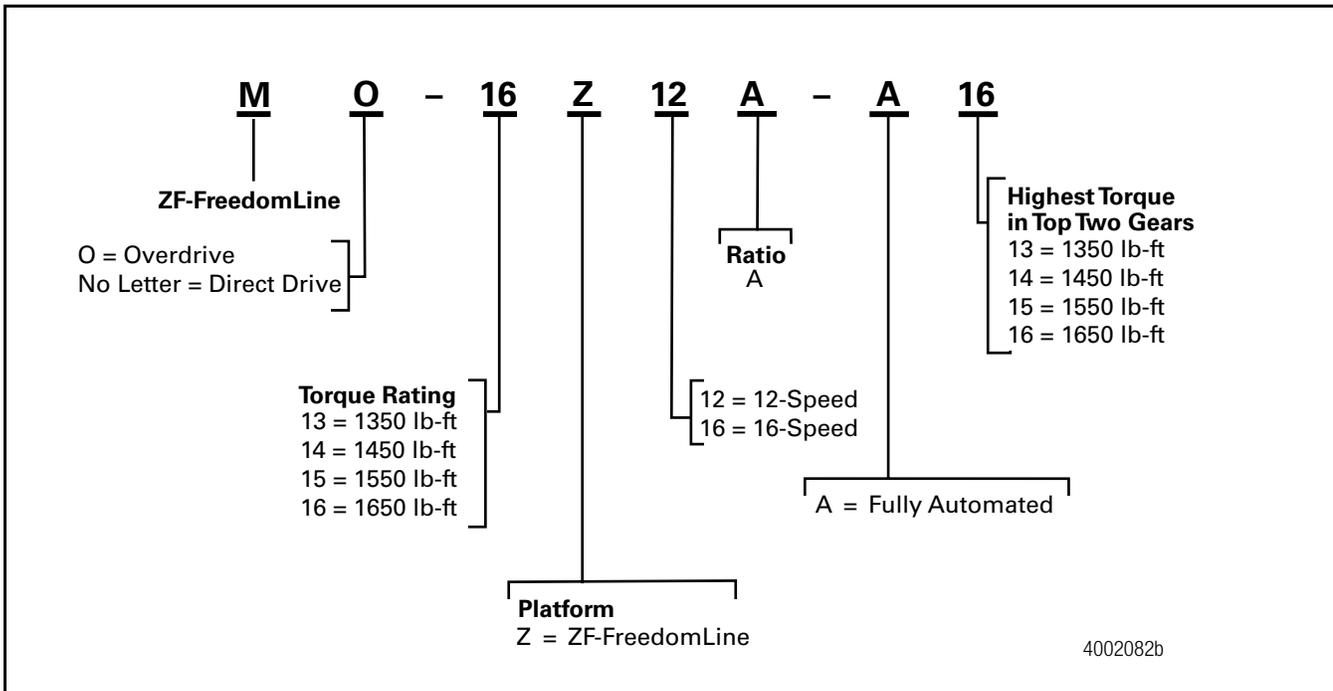
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## Regulatory Guidance

All persons working with, handling or exposed to the area where work on the transmission occurs, are warned to consult and comply with all applicable health, safety, medical or environmental standards and regulations governing non-asbestos fibers.

References to OSHA, NIOSH, MSHA, and EPA, which are regulatory agencies in the United States, are made to provide further guidance to employers and workers employed within the United States. Employers and workers employed outside of the United States should consult the regulations that apply to them for further guidance.

# Model Numbers and Ratios



## 12-Speed ZF-FreedomLine

Transmission Description	Model Number	Torque Rating lb-ft	Overall Ratio		Rev. L	Rev. H	Ratio and Percent Step																						
			FWD.	REV.			1 %	2 %	3 %	4 %	5 %	6 %	7 %	8 %	9 %	10 %	11 %	12 %											
12-Speed Direct Drive	M-13Z12A-A13	1,350	15.86	14.68	14.68	11.41	15.86	29	12.33	29	9.57	29	7.44	27	5.87	28	4.57	32	3.47	28	2.70	29	2.10	29	1.63	26	1.29	29	1.00
	M-14Z12A-A14	1,450																											
12-Speed Overdrive	MO-13Z12A-A13	1,350																											
	MO-14Z12A-A14	1,450	15.81	14.62	11.41	8.88	12.33	29	9.59	29	7.44	29	5.78	26	4.57	29	3.55	31	2.70	29	2.10	29	1.63	28	1.27	27	1.00	28	.78
	MO-15Z12A-A15	1,550																											
	MO-16Z12A-A16	1,650																											

## 16-Speed ZF-FreedomLine

Transmission Description	Model Number	Torque Rating lb-ft	Overall Ratio		Rev. L	Rev. H	Ratio and Percent Step																														
			FWD.	REV.			1 %	2 %	3 %	4 %	5 %	6 %	7 %	8 %	9 %	10 %	11 %	12 %	13 %	14 %	15 %	16 %															
16-Speed Overdrive	MO-13Z16A-A13	1,350																																			
	MO-14Z16A-A14	1,450	17.01	15.75	13.07	10.81	14.12	21	11.68	22	9.54	21	7.89	21	6.52	21	5.39	18	4.57	21	3.78	22	3.09	21	2.56	22	2.09	21	1.73	21	1.43	21	1.18	18	1.00	20	0.83
	MO-15Z16A-A15	1,550																																			
	MO-16Z16A-A16	1,650																																			

# Torque Specifications

## ZF-FreedomLine Fasteners Tightening Torque

Description	Size	Torque Specification	
		(lb-ft)	(N•m)
Drain plug	M24 x 1.5	44	60
Fill/Spill plug	M24 x 1.5	44	60
Fill plug (optional, located on the PTO cover)	M24 x 1.5	44	60
Neutral switch	M20 x 1.5	33	45
Output shaft speed sensor	M20 x 1.5	15	21
Air line fittings	M16 x 1.5	15	21
Cooler by-pass tubes	M30 x 1.5	36	50
Oil line fittings	M22 x 1.5	66	90
Bolt, clutch cover to flywheel (Cummins, Caterpillar and Mercedes engines)	7/16-14	Consult the OEM.	Consult the OEM.
Bolt, clutch cover to flywheel (Detroit Diesel, Volvo and Mack engines)	M10	Consult the OEM.	Consult the OEM.
Bolt, transmission case to flywheel housing	7/16-14	Consult the OEM.	Consult the OEM.
Bolt, fork to front cover	M12	85	115
Bolt, quill tube to front cover	M8	17	23
Bolt, clutch inspection cover to transmission case	M8	17	23
Nut, clutch actuator to transmission case	M8	17	23
Stud, clutch actuator to transmission case	M8	7	10
Vent plug, clutch actuator	M12 x 1.5	16	22
Bolt, TCU to transmission case	M8	17	23
Vent, TCU	M8	7	10
Bolt, bottom accessory bracket to case	M10	36	50
Bolt, bottom accessory bracket to case (rear-most position of configuration 2 only)	M12	58	79
Bolt, top accessory bracket to bottom accessory bracket	5/16-18	11	15
Stud, top accessory bracket to bottom accessory bracket	5/16-18 to M8	11	15
Bolt, ZMTEC to top accessory bracket	1/4-20	12	16
Bolt, voltage doubler to top accessory bracket	1/4-20	12	16
Bolt, lifting hook to housing	M12	58	79
Bolt, PTO cover to housing (International vehicles only)	M12	58	79
Bolt, output shaft seal retainer to transmission case	M10	34	46
Bolt, yoke retaining plate to output shaft	M12	89	120
Stud, transmission case (Volvo only)	M10 to M10	36	50
Bolt, oil cooler hose L bracket to housing (3 of 4)	M10	36	50
Bolt, oil cooler hose L bracket to housing (1 of 4)	M12	58	79
Bolt, oil cooler clip to L bracket	1/4-20	10	14
Bolt, oil cooler bottom mounting bracket to transmission case	M12	34	46
Bolt, oil cooler top mounting bracket to bottom mounting bracket	1/4-20	12	16
Bolt, transmission wiring harness to ZMTEC	1/4-20	7	9.5

# Acronyms

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## Acronyms Referenced in Manual

- ABS** – Anti-Lock Braking System
- ACC** – Accessory
- ASR** – Anti-Slip Regulation
- CAN** – Controller Area Network
- CCVS** – Cruise Control/Vehicle Speed
- EBC1** – Electronic Brake Controller #1
- ECM** – Engine Control Module
- ECU** – Electronic Control Unit
- EEC1** – Electronic Engine Controller #1
- EEC2** – Electronic Engine Controller #2
- EEPROM** – Electronically Erasable Programmable Read Only Memory
- ERC1** – Electronic Retarder Controller #1
- ETC1** – Electronic Transmission Controller #1
- ETC2** – Electronic Transmission Controller #2
- ISO** – International Standards Organization
- OEM** – Original Equipment Manufacturer
- PSI** – Pounds Per Square Inch
- PTO** – Power Take-Off
- SAE** – Society of Automotive Engineers
- TC1** – Transmission Controller #1
- TCU** – Transmission Control Unit
- WSI** – Wheel Speed Information
- ZMTEC** – ZF Meritor Electronic Transmission Controller

## ZF-FreedomLine Automated Two-Pedal Transmission

This manual provides maintenance and service information for the ZF-FreedomLine automated two-pedal transmission. To order information on other Meritor transmission models, refer to the Service Notes page at the front of this publication.

### Features

ZF-FreedomLine transmission models are available in 12-speed direct and overdrive, and 16-speed overdrive to meet a variety of application requirements.

ZF-FreedomLine transmissions are automated with integrated electronics for worry-free shifting. An operator can easily switch to manual control at any time.

The exclusive “no clutch pedal” design completely eliminates clutch pedal actuation for starts and stops, freeing operators from potential distractions and extending clutch life. The ZF-FreedomLine shift module enables less-experienced operators to shift as well as seasoned veterans.

Torque ratings range from 1,350 lb-ft to 1,650 lb-ft for today’s high torque, low rpm engines.

A twin countershaft with full helical gearing sets industry standards for quiet, long-life operation.

An aluminum case yields a weight savings of up to 132 pounds.

## ZF-FreedomLine Transmissions Use a Self-Adjusting Integral Clutch

### Clutch Features

The integral clutch is self-adjusting. The release bearing is permanently-lubricated and sealed for maintenance-free operation.

The clutch is air-operated and electronically-controlled.

Clutch adjustment and wear are continually monitored, so no clutch adjustment is necessary.

An in-cab display indicates when to replace the clutch.

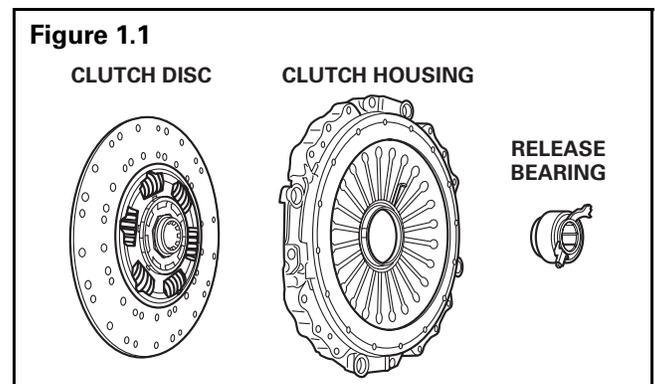
The clutch has a stamped housing and snap-in connection between the release bearing and diaphragm spring. The housing contains the shipment cups, diaphragm spring, pressure plate, spring straps, and snap-in bearing connection.

The single-plate clutch disc assembly has a cushioned, riveted organic facing material for smooth clutch engagement.

The clutch disc is designed with two torsional dampeners: A six-spring main dampener, which helps to reduce drivetrain wear that results from engine torsion; and a six-spring pre-dampener, which helps to reduce engine gear noise.

### How the Clutch Operates

The ZF-FreedomLine transmission control unit (TCU) controls the clutch actuator cylinder, which engages the clutch. The actuator checks clutch travel and adjusts clearances as required.



### Tools Used in This Manual

SPX Kent-Moore specifies the following tools in this manual. Refer to the Service Notes page on the inside front cover for instructions to order these tools.

- Seal Remover (part number J-24171-A)
- Yoke Puller (part number J-7804-01)
- Input Shaft Turning Tool (part number J-45556)
- Output Shaft Seal Installer (part number J-45247)

# Section 1 Introduction

## Approved Oil Lubricant Specifications for ZF-FreedomLine Transmissions

### WARNING

Use of inappropriate oil may damage the transmission.

Do not use multi-viscosity or EP (extreme pressure additive) oils.

**NOTE:** The ZF-FreedomLine transmission is designed to be used only with 50 weight synthetic oil.

**NOTE:** The following partial listing shows lubricants that have been approved for use with ZF-FreedomLine transmissions. If your intended lubricant is not listed, please contact OnTrac at 866-668-7221.

Specification
Cognis Emgard SAE 50 Synthetic Transmission Lube
BP Syn-Gear CD-50
Chevron Delo Synthetic Transmission Fluid SAE 50
Texaco Syn-Star TL SAE 50
Conoco Phillips Family Synthetic Transoil 50
Mobil Delvac Synthetic Transmission Fluid 50
Fleetrite Synthetic SAE 50 Transmission Oil
Kenworth SAE 50 Original Factory Fill Fluid
Shell Spirax® GSX SAE 50
Pennzoil® Long-Life™ Transmission Fluid EW-50
Valvoline HD Synthetic Trans Oil SAE 50

## Recommended Preventive Maintenance

### WARNING

When you install a fill plug and a drain plug into a transmission, first manually position the plug, and then install and tighten it by hand. When you've hand tightened the plug, use a torque wrench to tighten it to 44 lb-ft (60 N•m). Do not overtighten the plug. Damage to the aluminum housing can result. 

Item	Interval (Miles)
Lubricant level inspection	10,000
Visual leak inspection	10,000
Visual release bearing inspection	10,000
Clear the inactive codes	10,000

## ZF-FreedomLine Transmissions Fluid Capacities

Transmission	Oil Capacity (Quarts)
12 sp Direct Drive	12.7
12 sp Overdrive	12.7
16 sp Overdrive	13.5

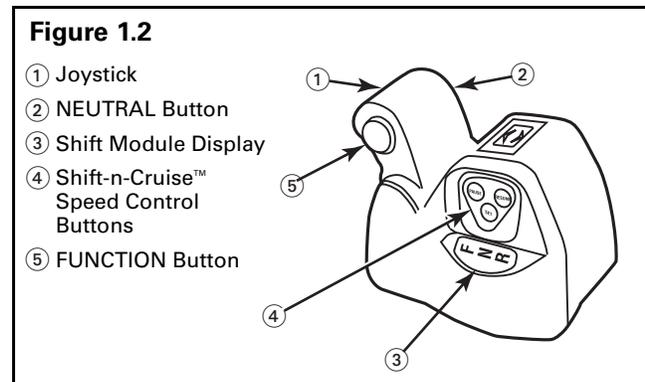
## How to Identify a ZF-FreedomLine Transmission

You can identify a ZF-FreedomLine transmission from the identification plate located on the left side of the transmission. Refer to Model Numbers and Ratios at the beginning of this manual.

## Shift Module and Joystick

The ZF-FreedomLine transmission's shift module, designed with a joystick, is located next to the driver's seat. The shift module replaces the standard shift lever, shift tower and shift knob. Move the joystick FORWARD to upshift and BACKWARD to downshift (manual mode only).

**Figure 1.2.**



### NEUTRAL Button

Press and release the NEUTRAL button at any time to shift into Neutral.

Press and hold the NEUTRAL and FUNCTION buttons at the same time to list active fault codes on the instrument panel display.

Press and hold the NEUTRAL button, FUNCTION button and service brake at the same time to list inactive fault codes on the instrument panel display.

## FUNCTION Button

Press and release the FUNCTION button to switch between automatic and manual mode, move into Reverse from a stop, and skip shift (manual mode only).

- Moving into reverse is FUNCTION button + DOWNSHIFT (pull back lever) at standstill.
- FUNCTION + UP/DOWNSHIFT results in a skip shift in manual mode at standstill and when driving.

Press and hold the FUNCTION button and NEUTRAL button at the same time to list active fault codes on the instrument panel display.

Press and hold the FUNCTION button, NEUTRAL button and service brake at the same time to list inactive fault codes on the instrument panel display.

## Shift-n-Cruise™ Speed Control



### WARNING

**Only use the Shift-n-Cruise™ speed control feature when you operate a vehicle under normal operating conditions. Do not use this feature in heavy traffic or on winding, wet or slippery roads. These conditions can affect cruise control performance, which can result in loss of vehicle control, serious personal injury and damage to components.**

**Only use your finger to press the Shift-n-Cruise™ speed control PAUSE, RESUME or SET buttons located on the shift knob. If you use a screwdriver, ballpoint pen or any sharp item, a button can stick in the switch assembly and affect speed control operation. Damage to components can result.**

Shift-n-Cruise buttons located on the shift module enable you to easily select speed control functions.

1. Press the SET button to select cruise speed.
2. Press the PAUSE button to temporarily deactivate speed control.
3. Press the RESUME button to return to the speed you selected at SET.

## Instrument Panel and Shift Module Displays

Both the instrument panel display and the shift module display illuminate to provide operating information, as well as alert you that a system malfunction has occurred.

### Instrument Panel Display

Status	Display
The system is performing a self-check.	CH
The transmission is in Neutral.	N
◆ = Automated mode (example shows 12th gear engaged)	◆ 12
No ◆ = Manual mode (example shows 12th gear engaged)	12
Reverse Low is engaged.	RL
Reverse High is engaged.	RH
<b>System Malfunction</b>	<b>SM</b>
System air is low.	AL
A clutch overload occurred.	CL
Clutch wear indicator (the clutch requires replacement)	CW
NO DATA (the SAE J1587 info is absent or possible loss of power to the transmission)	--
The display line between the main transmission control unit (main TCU) and the ZF-FreedomLine transmission electronic controller (ZMTEC) is faulty.	EE
PTO 1 is activated. The transmission is in Neutral.	▲ PN
PTO 1 and 2 are activated. Third gear is engaged as a starting gear.	◆ P3
<i>High Temperature: TCU temperature is above threshold or transmission oil temperature is above threshold.</i>	HT
<b>Neutral Shift Timeout</b> All truck OEMs except Freightliner LLC: The system was designed to react as follows when the vehicle idles for extended periods while in-gear: <ul style="list-style-type: none"> <li>• Between 0 and 14 minutes: no outward changes</li> <li>• Between 14 and 15 minutes: "NS" on the display, and you may have an audible alarm depending on vehicle configuration.</li> <li>• 15th minute: Transmission attempts an automated shift to neutral</li> </ul> Any changes to service brake, accelerator pedal, gearshift position, etc., reset the timer. Timer was designed to not run during PTO operation or in the event of certain critical faults.	NS

# Section 1

## Introduction

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### System Malfunction Warning



#### WARNING

If a system malfunction occurs, the instrument panel display illuminates “SM” for system malfunction and you may have an audible alarm depending on vehicle configuration. When this warning occurs, you may be unable to shift the transmission. Do not continue to operate the vehicle. Serious personal injury and damage to components can result. Safely move the vehicle to the side of the road and call for assistance.

The instrument panel display illuminates **SM** for system malfunction. The shift module emits a single beep.

“SM” indicates that an active fault has occurred in the transmission.

### What to do if a System Malfunction Occurs

Follow these procedures to move the vehicle to the side of the road and come to a safe stop.

1. Apply the brakes to slow the vehicle. Safely move the vehicle to the side of the road.

**NOTE:** In most cases the vehicle can still be driven in a Manual mode (No Auto shifts) or may only be driven in a starting gear.

**ATTENTION:** As some fault conditions lead to the transmission remaining in Neutral after coming to a Stop, be sure you are stopped in a safe place before determining if you can continue.

2. Stop the vehicle. Apply the parking brake.
3. Call OnTrac at 866-668-7221 for assistance.

### System Self-Check Status

“CH” will display on the instrument panel while the TCU performs a system self-check. A self-check is performed when the ignition is turned ON. Typically, the self-check continues until the engine is started, but can last longer if the TCU is being powered-up for the first time or there is not enough air pressure for the transmission to finish self check.

- **If the system self-check continues after the engine is started:** Contact OnTrac at 866-668-7221 and request a transmission specialist.

### System Air is Low



#### WARNING

If “AL” displays on the instrument panel, the transmission control unit (TCU) has determined that system air pressure is low. Apply the brakes and safely move to the shoulder of the road. Shift into neutral and idle to allow air pressure to build-up. Do not drive the vehicle with “AL” on the display. Serious personal injury and damage to components can result.

“AL” will display on the instrument panel if the TCU determines that system air pressure is low. Apply the brakes and safely move to the shoulder of the road. Shift into neutral and idle to allow air pressure to build-up. Do not drive the vehicle with “AL” on the display. Do not turn the ignition OFF with “AL” on the display. The vehicle may shut down in gear and not start until air pressure is built-up again.

### Clutch Overload Status



#### WARNING

If “CL” displays on the instrument panel, the transmission control unit (TCU) has determined that the clutch is hot. Apply the brakes and safely move to the shoulder of the road. Shift into neutral and idle to allow the clutch to cool. Do not drive the vehicle with “CL” on the display. Serious personal injury and damage to components can result.

“CL” will display on the instrument panel if the TCU determines that the clutch is hot. Apply the brakes and safely move to the shoulder of the road. Shift into neutral and idle to allow the clutch to cool. Do not drive the vehicle with “CL” on the display.

### Clutch Wear Warning



#### WARNING

If “CW” displays on the instrument panel, the transmission control unit (TCU) has determined that the clutch is worn. Replace the clutch. Do not drive the vehicle more than 1,000 miles (1610 km) with a worn clutch. Serious personal injury and damage to components can result.

“CW” will display on the instrument panel if the TCU determines that the clutch is worn. Replace the clutch. Do not drive the vehicle more than 1,000 miles (1610 km) with a worn clutch.



## WARNING

This vehicle is equipped with ZF-FreedomLine automated manual transmission. The vehicle can roll backward when stopped on a hill or grade, or when the vehicle is starting from a stop on a hill or grade. Serious personal injury and damage to components can result.

**WHEN STOPPED ON A HILL OR GRADE:** Press the brake pedal to keep the vehicle stationary.

**WHEN STARTING FROM A STOP ON A HILL OR GRADE:** Quickly move your foot from the brake pedal and firmly press the accelerator pedal.

## How to Shift the Transmission

1. Start the engine.
2. Allow air pressure in the system to reach the specified range on the gauge.

**NOTE:** When you shift from a forward gear to a reverse gear, or from a reverse gear to a forward gear, you must first shift into Neutral with the vehicle stationary. Depending on vehicle OEM (see your vehicle operator manual), you may be required to press the vehicle service brake before the system will allow a shift from neutral into gear. It is recommended to press the system brake whenever shifting from neutral into gear!

## Automatic Mode

### Switch Between Automatic and Manual Modes

Press and release the FUNCTION button without moving the joystick.

### Shift Into Neutral at any Time

Press and release the NEUTRAL button.

### To Prevent the Vehicle from Rolling Backward When Stopped on a Hill or Grade

Press the brake pedal to keep the vehicle stationary.

### To Prevent the Vehicle from Rolling Backward When Starting from a Stop on a Hill or Grade

Quickly move your foot from the brake pedal and firmly press the accelerator pedal.

### Shift Into a Forward Gear from Neutral at a Stop

Move the joystick FORWARD.

## Adjust the Starting Gear

1. Press and release the FUNCTION button as necessary to switch to manual mode.
2. Move the joystick FORWARD or BACKWARD.
3. Press and release the FUNCTION button to switch back to automatic mode.

## Shift Into Low Reverse from Neutral at a Stop

1. Press and hold the brake pedal.
2. Press and hold the FUNCTION button. Move the joystick BACKWARD.
3. Release the FUNCTION button and joystick.

## Shift Between Reverse Low and Reverse High While the Vehicle is Moving as Well as at Standstill

1. Move the joystick FORWARD to shift from Reverse Low to Reverse High.
2. Move the joystick BACKWARD to shift from Reverse High to Reverse Low.

## Upshift and Downshift

The transmission automatically shifts when in forward gears.

## Manual Mode

### Switch Between Manual and Automatic Modes

Press and release the FUNCTION button without moving the joystick.

### Shift Into Neutral at any Time

Press and release the NEUTRAL button.

### To Prevent the Vehicle from Rolling Backward When Stopped on a Hill or Grade

Press the brake pedal to keep the vehicle stationary.

### To Prevent the Vehicle from Rolling Backward When Starting from a Stop on a Hill or Grade

Quickly move your foot from the brake pedal and firmly press the accelerator pedal.

### Shift Into a Forward Gear from Neutral at a Stop

Move the joystick FORWARD.

# Section 1 Introduction

## Adjust the Starting Gear

1. Press and release the FUNCTION button as necessary to switch to manual mode.
2. Move the joystick FORWARD or BACKWARD.
3. Press and release the FUNCTION button to switch back to automatic mode.

## Shift Into Low Reverse from Neutral at a Stop

1. Press and hold the brake pedal.
2. Press and hold the FUNCTION button. Move the joystick BACKWARD.
3. Release the FUNCTION button.

## Shift Between Reverse Low and Reverse High While the Vehicle is Moving as Well as at Standstill

Move the joystick FORWARD to shift from Reverse Low to Reverse High.

Move the joystick BACKWARD to shift from Reverse High to Reverse Low.

## Shift Between Forward Gears

### Upshift One Gear

Move the joystick FORWARD.

### Upshift Two Gears

1. Press and hold the FUNCTION button while you move the joystick FORWARD.
2. Release the FUNCTION button.

### Downshift One Gear

Move the joystick BACKWARD.

### Downshift Two Gears

1. Press and hold the FUNCTION button while you move the joystick BACKWARD.
2. Release the FUNCTION button.

## Parking a Vehicle



### WARNING

**You must put the transmission into Neutral and follow the vehicle manufacturer's procedures when you park a vehicle. If the transmission is in gear when you start the vehicle, the vehicle can suddenly move forward. Serious personal injury and damage to components can result.**

1. Bring the vehicle to a stop.
2. Apply the parking brake. Refer to the vehicle manufacturer's instructions for the correct procedures.

## Shift Labels

1. Refer to the shift label affixed to the sun visor or instrument panel for instructions on how to shift the transmission.
2. If the label is missing or unreadable, call ArvinMeritor's Commercial Aftermarket at 888-725-9355 to order a new label. Install the new label in the vehicle.

**Operating ZF-FreedomLine Automated Transmission**

To Prevent the Vehicle from Rolling BACKWARDS on a Hill or Grade at a Stop: Press the brake pedal.

When starting from a Stop: Quickly move your foot from the brake pedal and firmly press the accelerator pedal.

<b>SHIFTING IN AUTOMATIC MODE</b> <b>Shift Into Neutral at any Time:</b> Press and release the NEUTRAL button. <b>Shift Into a Forward Gear from Neutral at a Stop:</b> Press and hold the brake pedal. Move the joystick FORWARD. <b>Shift Into Reverse from Neutral at a Stop:</b> Press and hold the brake pedal. Move the joystick BACKWARDS. Release the FUNCTION button.	<b>SHIFTING IN MANUAL MODE</b> <b>Shift Into Neutral at any Time:</b> Press and release the NEUTRAL button. <b>Shift Into a Forward Gear from Neutral at a Stop:</b> Press and hold the brake pedal. Move the joystick FORWARD. <b>Shift Into Reverse from Neutral at a Stop:</b> S as automatic mode. <b>Upshift One Gear:</b> Move the joystick FORWARD. <b>Downshift One Gear:</b> Move the joystick BACKWARDS. <b>Skip Shift:</b> Press the FUNCTION button while moving the joystick.
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ZF-FREEDOMLINE

Also refer to ZF-FreedomLine Operator Manual TP-20170. 2297-N-8463

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**WARNING**

This vehicle is equipped with a ZF-FreedomLine fully-automated manual transmission. The vehicle can roll BACKWARDS when stopped on a hill or grade, or when starting from a stop on a hill or grade. Serious personal injury and damage to components can result.

**WHEN STOPPED ON A HILL OR GRADE:** Press the brake pedal.

**WHEN STARTING FROM A STOP ON A HILL OR GRADE:** Quickly move your foot from the brake pedal and firmly press the accelerator pedal.

For more information, or to order ZF-FreedomLine Operator Mar TP-20170, call ArvinMeritor's Customer Service Center at 800-535-5560.

ZF-FREEDOMLINE

2297-Z-8346 (03-01)

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## **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.

### Before You Make a Warranty Repair on a ZF-FreedomLine Transmission

Call OnTrac at 866-668-7221 for approval. You'll be asked to provide the transmission's model number, mileage, in-service date, serial number, VIN number and the reason for the repair.

### Fault Codes and Volt-Ohm Meter (VOM) Diagnostics

ZF-FreedomLine transmission control unit (TCU) uses a series of fault codes to identify system malfunctions that the TCU detects and stores into memory.

After you retrieve a fault code from the instrument panel display and identify the fault, use a volt-ohm meter (VOM) to test the area where the fault code indicates that the malfunction has occurred. An authorized distributor/dealer should repair the fault.

#### Fault Codes

ZF-FreedomLine transmission control unit (TCU) uses a series of fault codes to identify system malfunctions that the TCU detects and stores into memory.

After you retrieve a fault code from the instrument panel display and identify the fault, use a volt-ohm meter to test the area where the fault code indicates that the malfunction has occurred. An authorized ZF-FreedomLine distributor or dealer should repair the fault.

### Test and Repair Faults

1. Retrieve the fault codes.
2. Use a Volt-Ohm meter to test the areas where the fault codes indicate that malfunctions have occurred in the system.
  - **Active Faults:** Have a ZF-FreedomLine-authorized technician repair the fault.
  - **Inactive Faults:** Have a ZF-FreedomLine-authorized technician verify that the fault was previously repaired. Repair faults, if necessary.
3. Clear all fault codes from TCU memory.

### How to Retrieve Active and Inactive SAE and ISO Fault Codes from the Instrument Panel Display Using the ZF-FreedomLine Transmission Shifter

**NOTE:** The vehicle must be stationary to retrieve active fault codes.

1. Park the vehicle and set the parking brake. Turn the engine OFF, but leave the ignition ON. Prepare to record the fault codes before you begin to retrieve them from the instrument panel display.
2. Use the following procedures to retrieve active and inactive SAE and ISO fault codes.

#### Active SAE and ISO Fault Codes

**NOTE:** All active fault codes will steadily display for approximately 1-1/2 seconds each. **Ignore fault codes that flash.** When the TCU has listed all active fault codes, the list will repeat.

Shifter	Active SAE Display Codes	Active ISO Display Codes
FreedomLine Transmission Shifter	Neutral + Function	Neutral + Function + Downshift

1. The TCU will begin to list the active fault codes on the instrument panel display.
2. Record the fault codes.

**NOTE:** ISO display codes may not be available on vehicles built prior to January 2006.

3. When you're finished retrieving fault codes, release the NEUTRAL and FUNCTION buttons. Turn the ignition OFF.

## Section 2 Fault Code Diagnostics

### Inactive Fault Codes

**NOTE:** All inactive fault codes will steadily display for approximately 1-1/2 seconds each. **Ignore fault codes that flash.** When the TCU has listed all inactive fault codes, the list will repeat.

Shifter	Inactive SAE Display Codes	Inactive ISO Display Codes
FreedomLine Transmission Shifter	"With brake pedal depressed" Neutral + Function	"With brake pedal depressed" Neutral + Function + Downshift

1. The TCU will begin to list the inactive fault codes on the instrument panel display.
2. Record the fault codes.

**NOTE:** ISO display codes may not be available on vehicles built prior to January 2006.

3. When you're finished retrieving fault codes, release the NEUTRAL and FUNCTION buttons, and the service brake. Turn the ignition OFF.

### To View Active or Inactive Fault Codes Again

Repeat the previous steps.

### How to Clear Inactive Fault Codes from TCU Memory

**NOTE:** Inactive faults are repaired active faults that have not been cleared from TCU memory.

1. The vehicle must be stationary to clear inactive fault codes. Park the vehicle and set the parking brake. Turn the engine OFF. Turn the ignition OFF.
2. Press and hold the NEUTRAL button and the FUNCTION button at the same time.
3. Turn the ignition ON. **Do not start the engine.** Count to three and release both buttons.
4. Count to three and press and hold the NEUTRAL button and the FUNCTION button at the same time.
5. Turn the ignition OFF. Count to three and release both buttons. The fault codes will be cleared from TCU memory.

### How to Retrieve Active and Inactive SAE and ISO Fault Codes from the Instrument Panel Display Using a Steering Column-Mount Shift Lever

**NOTE:** The vehicle must be stationary.

1. Park the vehicle and set the parking brake. Turn the engine OFF, but leave the ignition ON. Prepare to record the fault codes before you begin to retrieve them from the instrument panel display.
2. Use the following procedures to retrieve active and inactive SAE and ISO fault codes.

### Active Fault Codes

**NOTE:** All active fault codes will steadily display for approximately 1-1/2 seconds each. **Ignore fault codes that flash.** When the TCU has listed all active fault codes, the list will repeat.

Shifter	Active SAE Display Codes	Active ISO Display Codes
Analog Shifter (Freightliner and Sterling Vehicles Only)	Neutral + Manual + Up	Neutral + Manual + Down

1. The TCU will begin to list the active fault codes on the instrument panel display.
2. Record the fault codes. When you're finished, turn the ignition OFF.

**NOTE:** ISO display codes may not be available on vehicles built prior to January 2006.

- **To view the fault codes again:** Repeat Step 1.

### Inactive Fault Codes

**NOTE:** All inactive fault codes will steadily display for approximately 1-1/2 seconds each. **Ignore fault codes that flash.** When the TCU has listed all active fault codes, the list will repeat.

Shifter	Inactive SAE Display Codes	Inactive ISO Display Codes
Analog Shifter (Freightliner and Sterling Vehicles Only)	"With brake pedal depressed" Neutral + Manual + Up	"With brake pedal depressed" Neutral + Manual + Down

3. The TCU will begin to list the inactive fault codes on the instrument panel display.
4. Record the fault codes. When you're finished, turn the ignition OFF.
  - **To view the fault codes again:** Repeat Step 1.

**NOTE:** ISO display codes may not be available on vehicles built prior to January 2006.

### How to Clear Inactive Fault Codes from the Instrument Panel Display Using a Steering Column-Mount Shift Lever

1. Turn the ignition OFF.
2. Select Neutral and manual mode on the shift lever. Pull and hold the shift lever in the UPSHIFT position.
3. Turn the ignition ON. Wait three seconds. Release the shift lever. Wait three seconds.
4. Pull and hold the lever in the UPSHIFT position.
5. Turn the ignition OFF. Wait three seconds. Release the shift lever.
6. Check that the inactive fault codes have been cleared from the instrument panel display.
  - **If the fault codes have not cleared:** Repeat this procedure.

### How to Retrieve Active and Inactive ISO Fault Codes from the Instrument Panel Display Using SAE J1939 Push-Button Shift Lever

**NOTE:** The vehicle must be stationary.

1. Park the vehicle and set the parking brake. Turn the engine OFF, but leave the ignition ON. Prepare to record the fault codes before you begin to retrieve them from the instrument panel display.
2. Use the following procedures to retrieve active and inactive ISO fault codes.

**NOTE:** This shift lever does not retrieve SAE fault codes. ISO fault codes only.

### Active ISO Fault Codes

**NOTE:** All active fault codes will steadily display for approximately 1-1/2 seconds each. **Ignore fault codes that flash.** When the TCU has listed all active fault codes, the list will repeat.

Shift Lever Type	Active ISO Display Codes
SAE J1939 Push-Button (ITE Vehicles)	Press and hold up-shift button while lever is in Neutral

1. The TCU will begin to list the active fault codes on the instrument panel display.
2. Record the fault codes. When you're finished, turn the ignition OFF.
  - **To view the fault codes again:** Repeat Step 1.

### Inactive ISO Fault Codes

All active fault codes will steadily display for approximately 1-1/2 seconds each. **Ignore fault codes that flash.** When the TCU has listed all active fault codes, the list will repeat.

Shift Lever Type	Inactive ISO Display Codes
SAE J1939 Push-Button (ITE Vehicles)	With brake pedal depressed: Press and hold up-shift button while lever is in Neutral

1. The TCU will begin to list the active fault codes on the instrument panel display.
2. Record the fault codes. When you're finished, turn the ignition OFF.
  - **To view the fault codes again:** Repeat Step 1.

### How to Clear Inactive Fault Codes from the Instrument Panel Display Using SAE J1939 Push-Button Shift Lever

1. Turn the ignition "OFF".
2. Wait until all shift lever LEDs are off.
3. Turn ignition "ON" (do not start engine).
4. Wait until only Neutral LED is lit.
5. Immediately press up-shift button.
6. Wait 3 seconds.

## Section 2 Fault Code Diagnostics

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7. Release up-shift button.
8. Wait 3 seconds.
9. Press up-shift button.
10. Turn ignition "OFF".
11. Wait until all shift lever LEDs are off.
12. Release up-shift button.
13. Check that the inactive fault codes have been cleared from the instrument panel display.
  - **If the fault codes have not cleared:** Repeat this procedure.

## Section 2 Fault Code Diagnostics

### SAE Fault Code Repair Instructions

SAE J1587 Fault Code			Instrument Panel Display Fault Code	Fault Description	Repair Instructions
Fault	FMI	PID/SID			
20	3	SID	14	Short circuit to positive of the output ACC (power conversion enable signal for ZMTEC and continuation signal for voltage doubler and voltage supply to output speed sensor #2)	Complete the electrical requirements flowchart. Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
20	5	SID	14	Open circuit of the output ACC (power conversion enable signal for ZMTEC and continuation signal for voltage doubler and voltage supply to output speed sensor #2)	Complete the electrical requirements flowchart. Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
20	6	SID	14	Short circuit to ground of the output ACC (power conversion enable signal for ZMTEC and continuation signal for voltage doubler and voltage supply to output speed sensor #2)	Complete the electrical requirements flowchart. Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
21	0	PID	15	ECU temperature too high	If an ISO fault code 128 exists, address it first. Check for obstructions within the transmission cooler, cooler lines and by-pass valve. Check the oil level. Both low and high oil levels can lead to overheating.
21	2	PID	15	Error on ECU temperature sensor signal	The upper part of the transmission TCU requires replacement. Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
31	3	PID	1F	Short circuit to positive of the range position sensor	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
31	5	PID	1F	Open circuit of the range position sensor	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
31	6	PID	1F	Short circuit to ground of the range position sensor	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.

## Section 2 Fault Code Diagnostics

### SAE Fault Code Repair Instructions

SAE J1587 Fault Code			Instrument Panel Display Fault Code	Fault Description	Repair Instructions
Fault	FMI	PID/SID			
31	7	PID	1F	Range position sensor signal disengages during driving	<p><b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b></p> <p>Using TransSoft, verify that the engagement position sensor counts are outside of the nominal range: 80 to 120 or 530 to 580. The measured values should not drift or show signal disturbances after engagement shifting. Values outside range, exchange main transmission. If error occurs sporadically: When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. Out-of warranty, replace the lower part of TCU. For assistance, contact OnTrac at 866-668-7221 and ask for a transmission specialist.</p>
31	13	PID	1F	Self-adjustment fault of range position sensor	<p>If the TCU has not just been installed, complete the pneumatic requirements flowchart.</p> <p>If the TCU has just been installed, the range actuator did not correctly engage into the rail. Using TransSoft, verify that the range position sensor counts are outside of the nominal range: 80 to 130 or 490 to 590. If so, remove the TCU and reinstall it.</p>
32	3	PID	20	Short circuit to positive of the splitter position sensor signal	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b></p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
32	5	PID	20	Open circuit of the splitter position sensor signal	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b></p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
32	6	PID	20	Short circuit to ground of the splitter position sensor signal	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b></p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
32	7	PID	20	Splitter position sensor signal leaves engaged position during driving	<p>Using TransSoft, verify that the splitter position sensor counts are outside of the nominal range: 70 to 140 or 500 to 620. The measured values should not drift or show signal disturbances after splitter shifting. Values outside range, exchange main transmission. If error occurs sporadically: When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the lower part of TCU.</b></p> <p>For assistance, contact OnTrac at 866-668-7221 and ask for a transmission specialist.</p>

## Section 2 Fault Code Diagnostics

### SAE Fault Code Repair Instructions

SAE J1587 Fault Code			Instrument Panel Display Fault Code	Fault Description	Repair Instructions
Fault	FMI	PID/SID			
32	13	PID	20	<p>Splitter position sensor self-adjustment fault</p> <p><b>NOTE:</b> The gear engage position sensor is unable to cycle.</p>	<p><b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b></p> <p>If the TCU has not just been installed, complete the pneumatic requirements flowchart.</p> <p>If the TCU has just been installed, the splitter actuator did not correctly engage into the rail. Using TransSoft, verify that the splitter position sensor counts are outside of the nominal range: 70 to 140 or 500 to 650. If so, remove the TCU and reinstall it.</p>
33	2	PID	21	<p>Error on clutch cylinder position</p>	<p>Verify that the release bearing is correctly engaged to the clutch.</p> <p>Complete the pneumatic requirements flowchart: Verify air supply/air quality.</p> <p>Using TransSoft, under the clutch info tab, verify clutch absolute stroke: Engine must be running and transmission in neutral: Absolute clutch stroke &gt; 58-60 mm, replace clutch assembly: If absolute clutch stroke is not between 27-60 mm, replace the clutch actuator: If issue still not resolved, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
33	13	PID	21	<p>Error in clutch self-adjustment process</p> <p><b>NOTE:</b> The clutch is unable to cycle.</p>	<p>If error occurs immediately after engine startup, then check the clutch engagement hardware for issues such as a broken fork, jammed release bearing, failed release bearing, broken clutch retaining clip, possible glazed clutch disc, jammed clutch actuator rod, etc.). Address any issues as necessary. If nothing is found, grease the interface between the fork and the release bearing (this includes the tips of the forks as well as the side walls of the release bearing). If clutch actuator does not move when engine is started, replace clutch actuator.</p>
33	14	PID	21	<p>Clutch actuator position sensor voltage supply too high or too low</p>	<p>Unplug the clutch actuator connector at the TCU. Check for 4.6 to 5.8 VDC between pins 15 and 16 of the TCU. If the voltage level is within this range, replace the clutch actuator; if the voltage level is outside of this range, replace the upper part of the TCU.</p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
34	3	PID	22	<p>Short circuit to positive at output stage to the clutch actuator assembly solenoids</p>	<p>If possible, retrieve ISO fault code using TransSoft or if applicable, perform procedure for retrieving fault codes using the transmission shift lever. Follow the ISO fault code repair instructions. Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
34	5	PID	22	<p>Open circuit at output stage to the clutch actuator assembly solenoids</p>	<p>If possible, retrieve ISO fault code using TransSoft or if applicable, perform procedure for retrieving fault codes using the transmission shift lever. Follow the ISO fault code repair instructions. Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
34	6	PID	22	<p>Short circuit to ground at output stage to the clutch actuator assembly solenoids</p>	<p>If possible, retrieve ISO fault code using TransSoft or if applicable, perform procedure for retrieving fault codes using the transmission shift lever. Follow the ISO fault code repair instructions. Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>

## Section 2 Fault Code Diagnostics

### SAE Fault Code Repair Instructions

SAE J1587 Fault Code			Instrument Panel Display Fault Code	Fault Description	Repair Instructions
Fault	FMI	PID/SID			
34	7	PID	22	Mechanical failure of the clutch actuator assembly solenoids	If possible, retrieve ISO fault code using TransSoft or if applicable, perform procedure for retrieving fault codes using the transmission shift lever. Follow the ISO fault code repair instructions. Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
35	3	SID	23	Short circuit to positive at the output stage to the high range solenoid (Y9)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
35	5	SID	23	Open circuit at the output stage to the high range solenoid (Y9)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
35	6	SID	23	Short circuit to ground at the output stage to the high range solenoid (Y9)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
36	3	SID	24	Short circuit to positive at the output stage to the low range solenoid (Y8)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
36	5	SID	24	Open circuit at the output stage to the low range solenoid (Y8)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
36	6	SID	24	Short circuit to ground at the output stage to the low range solenoid (Y8)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.

## Section 2 Fault Code Diagnostics

### SAE Fault Code Repair Instructions

SAE J1587 Fault Code			Instrument Panel Display Fault Code	Fault Description	Repair Instructions
Fault	FMI	PID/SID			
37	3	SID	25	Short circuit to positive at the output stage to the splitter direct solenoid (Y2)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
37	5	SID	25	Open circuit at the output stage to the splitter direct solenoid (Y2)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
37	6	SID	25	Short circuit to ground at the output stage to the splitter direct solenoid (Y2)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
38	3	SID	26	Short circuit to positive at the output stage to the splitter indirect solenoid (Y3)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
38	5	SID	26	Open circuit at the output stage to the splitter indirect solenoid (Y3)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
38	6	SID	26	Short circuit to ground at the output stage to the splitter indirect solenoid (Y3)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
39	3	SID	27	Short circuit to positive at the output stage to the rail select #1 solenoid (Y4)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.

## Section 2 Fault Code Diagnostics

### SAE Fault Code Repair Instructions

SAE J1587 Fault Code			Instrument Panel Display Fault Code	Fault Description	Repair Instructions
Fault	FMI	PID/SID			
39	5	SID	27	Open circuit at the output stage to the rail select #1 solenoid (Y4)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
39	6	SID	27	Short circuit to ground at the output stage to the rail select #1 solenoid (Y4)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
40	3	SID	28	Short circuit to positive at the output stage to the gear engage #1 solenoid (Y6)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
40	5	SID	28	Open circuit at the output stage to the gear engage #1 solenoid (Y6)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
40	6	SID	28	Short circuit to ground at the output stage to the gear engage #1 solenoid (Y6)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
43	2	PID	2B	Error on "Ignition lock" signal (terminal 15)	Verify voltage at pin 6/7 of the doubler. Key on voltage should be 24 volts nominal. If < 18 volts, replace the transmission voltage doubler.  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
48	3	SID	30	Short circuit to positive of the gear engage position sensor signal	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.

## Section 2 Fault Code Diagnostics

### SAE Fault Code Repair Instructions

SAE J1587 Fault Code			Instrument Panel Display Fault Code	Fault Description	Repair Instructions
Fault	FMI	PID/SID			
48	5	SID	30	Open circuit of the gear engage position sensor signal	<p><b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b></p> <p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
48	6	SID	30	Short circuit to ground of the gear engage position sensor signal	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
48	7	SID	30	Gear engage position sensor signal leaves engaged position during driving	<p>Using TransSoft, verify that the engagement position sensor counts are outside of the nominal range: 80 to 120 or 530 to 580. The measured values should not drift or show signal disturbances after engagement shifting. Values outside range, exchange main transmission. If error occurs sporadically: When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the lower part of TCU.</b> For assistance, contact OnTrac at 866-668-7221 and ask for a transmission specialist.</p>
48	13	SID	30	Self adjustment error of gear engage position sensor <b>NOTE:</b> The gear engage position sensor is unable to cycle.	<p>If the TCU has not just been installed, complete the pneumatic requirements flowchart. When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b></p> <p>If the TCU has just been installed, the engagement actuator did not correctly engage into the rail. Using TransSoft, verify that the engagement position sensor counts are outside of the nominal range: 300 to 350. If so, remove the TCU and reinstall it.</p>
50	3	SID	32	Short circuit to positive at the output stage to the rail select #2 solenoid (Y5)	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>

## Section 2 Fault Code Diagnostics

### SAE Fault Code Repair Instructions

SAE J1587 Fault Code			Instrument Panel Display Fault Code	Fault Description	Repair Instructions
Fault	FMI	PID/SID			
50	5	SID	32	Open circuit at the output stage to the rail select #2 solenoid (Y5)	<p><b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b></p> <p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
50	6	SID	32	Short circuit to ground at the output stage to the rail select #2 solenoid (Y5)	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
51	3	SID	33	Short circuit to positive at the output stage to the gear engage #2 solenoid (Y7)	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
51	5	SID	33	Open circuit at the output stage to the gear engage #2 solenoid (Y7)	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
51	6	SID	33	Short circuit to ground at the output stage to the gear engage #2 solenoid (Y7)	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
54	3	SID	36	Short circuit to positive at the output stage to the inertia brake solenoid (Y1)	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
54	5	SID	36	Open circuit at the output stage to the inertia brake solenoid (Y1)	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>

## Section 2 Fault Code Diagnostics

### SAE Fault Code Repair Instructions

SAE J1587 Fault Code			Instrument Panel Display Fault Code	Fault Description	Repair Instructions
Fault	FMI	PID/SID			
54	6	SID	36	Short circuit to ground at the output stage to the inertia brake solenoid (Y1)	<p><b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b></p> <p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
55	7	SID	37	Clutch engagement/disengagement fault	<p>Complete the pneumatic requirements flowchart. Verify air supply/air quality.</p> <p>Remove and inspect clutch actuator filter screen for contamination.</p> <p>If the root cause of the issue is not found, then check the clutch engagement hardware for issues such as a broken fork, jammed release bearing, failed release bearing, broken clutch retaining clip, possible glazed clutch disc, jammed clutch actuator rod, etc. Address any issues as necessary. If the root cause is not identified, then obtain the ISO fault codes and address the appropriate repair instructions. If clutch actuator does not move when engine is started, replace clutch actuator.</p>
56	7	SID	38	Range shift engagement/disengagement fault	<p>Complete the pneumatic requirements flowchart.</p> <p>The range actuator did not correctly engage into the rail. Using TransSoft, verify that the range position sensor counts are outside of the normal range: 80 to 130 or 490 to 590. The measured values should not drift or show signal disturbances after range shifting. Values outside range, exchange main transmission. If error occurs sporadically: When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the lower part of TCU.</b> For assistance, contact OnTrac at 866-668-7221 and ask for a transmission specialist.</p>
57	2	SID	39	<p>Shift lever error</p> <p>ZF-FreedomLine shifter</p> <p>Analog shift lever (Freightliner and Sterling vehicles only)</p> <p>SAE J1939 push-button shift lever (ITE vehicles) fault description for SAE J1939 shift lever</p> <p>Error on "CAN TC1" message</p> <p>"Requested Gear"</p>	<p>First check all wiring harness connections between the shift lever and the ZMTEC and the ZMTEC and the GS3. If they look good (no damaged pins, correctly set home, etc.), then do the following.</p> <p>Check for continuity (0.0 to 0.5 ohms) between pins 1 and 8 of the shift lever harness connector (J10) and pin G3 of the ZMTEC connector (J3). Check for continuity between pin 3 of the shift lever harness connector (J10) and ground. Check for continuity between pin 7 of the shift lever harness connector (J10) and pin F1 of the ZMTEC connector (J3). Check for continuity between pin 9 of the shift lever harness connector (J10) and pin E3 of the ZMTEC connector (J3). Also check for shorts between these circuits and all other pins in the wiring harness. If these resistances check out okay and no short circuits exist, replace the shift lever assembly. For diagnostic procedures concerning the Freightliner SmartShift lever and the push-button shift lever for International trucks, contact the applicable OEM. For assistance, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>

## Section 2 Fault Code Diagnostics

### SAE Fault Code Repair Instructions

SAE J1587 Fault Code			Instrument Panel Display Fault Code	Fault Description	Repair Instructions
Fault	FMI	PID/SID			
57	14	SID	39	ZF CAN timeout	<p><b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b></p> <p>Unplug the ZMTEC only and check for 58.0 to 62.0 ohms resistance across pins D1 and D2 of the ZMTEC connector (J3). Now remove the transmission wiring harness and check for continuity (0.0 to 0.5 ohms) between pin 3 of the TCU connector (J1), pin D1 of the ZMTEC connector (J3), and pin A of the CAN terminator connector (J8). Check for continuity between pin 6 of the TCU connector (J1), pin D2 of the ZMTEC connector (J3), and pin B of the CAN terminator connector (J8).</p> <p>If any of these tests reveal issues with the wiring harness, replace the wiring harness. If these resistances check out okay and no short circuits exist, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
58	7	SID	3A	Main transmission engagement/disengagement fault	<p>Complete the pneumatic requirements flowchart:</p> <p>The engagement actuator did not correctly disengage from the rail. Using TransSoft, verify that the engagement position sensor counts are outside of the nominal range: 80 to 120 or 530 to 580.</p> <p>The measured values should not drift or show signal disturbances after engagement shifting. Values outside range, exchange main transmission. If error occurs sporadically: When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the lower part of TCU.</b></p> <p>For assistance, contact OnTrac at 866-668-7221 and ask for a transmission specialist.</p>
59	7	SID	3B	Rail select cylinder engagement/disengagement fault	<p>Complete the pneumatic requirements flowchart:</p> <p>The select cylinder does not change over to new gatel. Using TransSoft, verify that the select position sensor counts are outside of the nominal range: 70 to 120 or 500 to 580. The measured values should not drift or show signal disturbances after rail select shifting. Values outside range, exchange main transmission. If error occurs sporadically: When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the lower part of TCU.</b></p> <p>For assistance, contact OnTrac at 866-668-7221 and ask for a transmission specialist.</p>
60	3	PID	3C	Short circuit to positive of the rail select position sensor	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b></p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>

## Section 2 Fault Code Diagnostics

### SAE Fault Code Repair Instructions

SAE J1587 Fault Code			Instrument Panel Display Fault Code	Fault Description	Repair Instructions
Fault	FMI	PID/SID			
60	5	PID	3C	Open circuit of the rail select position sensor	<p><b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b></p> <p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b></p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
60	6	PID	3C	Short circuit to ground of the rail select position sensor	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b></p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
60	13	PID	3C	Gate select sensor self-adjustment error	<p>If the TCU has not just been installed, complete the pneumatic requirements flowchart.</p> <p>If the TCU has just been installed, the gate selector actuator did not correctly engage into the rail. Using TransSoft, verify that the gate selector position sensor counts are outside of the nominal range: 70 to 120 to 120 or 500 to 580. If so, remove the TCU and reinstall it.</p>
61	7	SID	3D	Splitter cylinder engagement/disengagement fault	<p>Complete the pneumatic requirements flowchart:</p> <p>The splitter group does not changeover to new position in defined time. Using TransSoft, verify that the splitter position sensor counts are outside of the nominal range: 70 to 140 or 500 to 620.</p> <p>The measured values should not drift or show signal disturbances after splitter shifting. Values outside range, exchange main transmission. If error occurs sporadically: When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the lower part of TCU.</b></p> <p>For assistance, contact OnTrac at 866-668-7221 and ask for a transmission specialist.</p>

## Section 2 Fault Code Diagnostics

### SAE Fault Code Repair Instructions

SAE J1587 Fault Code			Instrument Panel Display Fault Code	Fault Description	Repair Instructions
Fault	FMI	PID/SID			
63	14	SID	3F	<p>Error on output shaft speed sensor #2 (the lower one)</p> <p><b>NOTE:</b> Output shaft speed sensor #2 is a four wiring harness that plugs into the transmission wiring harness (the same one that is connected to the voltage doubler and ZMTEC). It is protected with convoluted tubing. Automatic mode is available, there are no system restrictions.</p>	<p><b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b></p> <p>Clear the faults first and switch the OSS #1 and OSS #2 connectors. Test drive the vehicle so that an OSS code is set. If the code stays with the same speed sensor (#1 or #2), then replace the appropriate wiring harness (either the transmission wiring harness or the clutch actuator wiring harness which is integrated into the clutch actuator). If the code switches to the other speed sensor (from #1 to #2 or from #2 to #1), replace the appropriate speed sensor. If these steps don't identify the inoperative component, move onto the next set of instructions.</p> <p>Remove and troubleshoot the transmission wiring harness. Pin 7 of the TCU connector (J1) and pin 3 of the output shaft speed sensor #2 connector (J5) should have continuity (resistance of 0.0 to 0.5 ohms) and not be shorted to any other circuit. If a short or open circuit is found, replace the wiring harness. If not, replace the output shaft speed sensor.</p>
106	0	PID	6A	Faulty transmission air pressure regulator valve	<p>Complete the pneumatic requirements flowchart.</p> <p>If the root cause is not found, use TransSoft to verify that the transmission's pressure reduction valve is regulating the air pressure to <math>102.5 \pm 4</math> psi. Replace the air pressure regulator as necessary.</p>
106	14	PID	6A	Error on pressure sensor signal (TCU internal)	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace the pressure sensor.</b></p>
150	7	SID	96	Engagement/disengagement fault of PTO 1 and/or PTO 2 (The transmission TCU has requested that the PTO turn on or off and it has not)	<p>Complete the PTO requirements flowchart.</p> <p>If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
150	14	SID	96	PTO 1 and/or PTO 2 fault acknowledgement (The PTO is active but the transmission hasn't requested it)	<p>Complete the PTO requirements flowchart.</p> <p>If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
151	14	SID	97	Plausibility error between transmission input speed and output speed (The actual speeds registered by the input shaft and output shaft speed sensors do not match the expected ratios)	<p>Using TransSoft, check the main TCU for programming mistakes (the programming is gear-dependent and must reflect the actual transmission model). For assistance, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist. If the programming is incorrect, an OnTrac representative will assist you.</p>
152	3	SID	98	Short circuit to positive at the output stage to the main solenoid (Y1)	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b></p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>

## Section 2 Fault Code Diagnostics

### SAE Fault Code Repair Instructions

SAE J1587 Fault Code			Instrument Panel Display Fault Code	Fault Description	Repair Instructions
Fault	FMI	PID/SID			
152	5	SID	98	Open circuit at the output stage to the main solenoid (Y1)	<p><b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b></p> <p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b></p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
152	6	SID	98	Short circuit to ground at the output stage to the main solenoid (Y1)	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b></p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
153	14	SID	99	Error on ISO 14230 communications line	Remove and troubleshoot the transmission wiring harness. Pin 2 of the TCU connector (J1) and pin F3 of the ZMTEC connector (J3) should have continuity (resistance of 0.0 to 0.5 ohms) and not be shorted to any other circuit. If a short or open circuit is found, replace the wiring harness; if not, replace the ZMTEC.
154	14	SID	9A	Error on both output speed signals	Inspect the output shaft speed sensors and corresponding wiring harnesses for obvious signs of damage including corrosion within the connectors. If nothing is found, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
161	14	PID	A1	Input shaft speed sensor fault	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b></p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
177	2	PID	B1	Oil temperature sensor fault	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b></p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>

## Section 2 Fault Code Diagnostics

### SAE Fault Code Repair Instructions

SAE J1587 Fault Code			Instrument Panel Display Fault Code	Fault Description	Repair Instructions
Fault	FMI	PID/SID			
191	14	PID	BF	<p>Output shaft speed sensor #1 faulty or both sources of vehicle speed are inoperative.</p> <p><b>NOTE:</b> Output shaft speed sensor #1 is a three wire sensor that plugs into the clutch actuator wiring harness. It does not have convoluted tubing.</p>	<p><b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b></p> <p>It is highly recommended that the ISO fault codes be retrieved and used for troubleshooting instead of SAE code PID 191 FMI 14. If the ISO fault codes are not available, then proceed as follows.</p> <p>Check the ABS, engine and VECU (if applicable) for fault codes that pertain to the SAE J1939 data bus. If none are found, then proceed to the next step.</p> <p>Clear the faults first and switch the OSS #1 and OSS #2 connectors. Test drive the vehicle such that an OSS code is set. If the code stays with the same speed sensor (#1 or #2) then replace the appropriate wiring harness (either the transmission wiring harness or the clutch actuator). If the code switches to the other speed sensor (from #1 to #2 or from #2 to #1), replace the appropriate speed sensor. If these steps don't identify the faulty component, then do the following.</p> <p>Remove and troubleshoot the clutch actuator wiring harness. Pin 11 of the driver side TCU connector and pin 4 of the lower output shaft speed sensor connector (sensor #1) should have continuity (resistance of 0.0 to 0.5 ohms) and not be shorted to any other circuit. If a short or open circuit is found, replace the clutch actuator, if not, replace the output shaft speed sensor #1.</p>
230	14	SID	E6	<p>Permanent idle signal</p> <p><b>NOTE:</b> The idle switch is built into the accelerator pedal and is d into the engine controller, not the transmission controller, or main TCU. The main TCU receives the status of the idle switch over the SAE J1939 bus. The transmission is receiving contradictory messages indicating that the idle switch is open (truck is idling) and the accelerator pedal is pressed (truck is not idling).</p>	<p>Using TransSoft, troubleshoot the idle switch and the status of the pedal. Refer to the OEM for details should repair work be necessary.</p>
231	7	SID	E7	<p>Engine does not react to torque intervention</p>	<p>The ECM did not react correctly to an SAE J1939 message. Follow your OEM's SAE J1939 diagnostic procedures to correct for a fault SAE J1939 data link.</p> <p>Check for engine codes that would cause the engine to go into derate mode.</p> <p>(Fuel restriction, air restriction, high temp, low coolant etc.)</p>
231	11	SID	E7	<p>The SAE J1939 bus is not functioning correctly.</p> <p>Can error frames or can queue overrun.</p> <p><b>NOTE:</b> The backbone of the SAE J1939 bus is terminated at each end with a 120 ohm resistor. Each component communicating over the bus must connect into the backbone.</p>	<p>Due to an issue with the vehicle's SAE J1939 data link, the TCU did not receive an expected SAE J1939 message. Follow your OEM's SAE J1939 diagnostic procedures to correct the issue.</p> <p><b>NOTE:</b> The resistance across pins C and D of the 9 pin diagnostic connector will be about 60 ohms if both terminating resistors are in place (120 ohms if only one is installed).</p>

## Section 2 Fault Code Diagnostics

### SAE Fault Code Repair Instructions

SAE J1587 Fault Code			Instrument Panel Display Fault Code	Fault Description	Repair Instructions
Fault	FMI	PID/SID			
231	14	SID	E7	The main TCU has not received expected SAE J1939 communications  From the engine ECM, body controller, or ABS ECU. This fault can occur when the message is faulty or missing.	<b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b>  Either there is an issue with the vehicle's SAE J1939 data link causing the TCU not to receive an expected SAE J1939 message or the TCU has received an SAE J1939 message with information that is not within specifications. Verify that the engine and ABS systems are approved with the ZF-FreedomLine transmission and that all settings are correct. If so, follow your OEM's SAE J1939 diagnostic procedures to correct the issue.
248	3	SID	F8	Short circuit to positive at output SD to display (The display will read "EE")	Troubleshoot the ZF-FreedomLine transmission wiring harness. Pin 9 of the TCU connector (J1) and pin F2 of the ZMTEC connector (J3) should all have continuity (resistance of 0.0 to 0.5 ohms) and not be shorted to any other circuit. If a short or open circuit is found, replace the wiring harness. If not, replace the ZMTEC.
248	6	SID	F8	Short circuit to ground at output SD to display (The display will read "EE")	Troubleshoot the ZF-FreedomLine transmission wiring harness. Pin 9 of the TCU connector (J1) and pin F2 of the ZMTEC connector (J3) should all have continuity (resistance of 0.0 to 0.5 ohms) and not be shorted to any other circuit. If a short or open circuit is found, replace the wiring harness. If not replace the ZMTEC. Should the ZMTEC not, resolve the issue, then replace the TCU top half.
251	0	SID	FB	High voltage (voltage doubler 24 volt output too high)	The transmission voltage doubler requires replacement.  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
251	1	SID	FB	Low voltage (vehicle electrical system or voltage doubler output too low).  If no issues are found with the vehicle electrical system, verify all inputs and outputs at the transmission voltage doubler.	Complete the electrical requirements flowchart.  If no issues are found with the vehicle electrical system, verify all inputs and outputs at the transmission voltage doubler.  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
253	14	SID	FD	EOL EEPROM fault	If the transmission has just been programmed, cycle the key (remain in the off position for 10 seconds)  If the transmission has not just been programmed, then the EOL parameters need to be updated. This can be accomplished with TransSoft. Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.  Should the EOL parameter values check out, and the code not clear, replace the upper part of the transmission TCU.
254	12	SID	FE	Cut-off relay in ECU does not switch off	The transmission TCU top half requires replacement.  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
254	13	SID	FE	No voltage supply at pin 30 or cut-off relay in ECU does not switch on	The transmission TCU top half requires replacement.  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.

## Section 2 Fault Code Diagnostics

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### SAE Fault Code Repair Instructions

SAE J1587 Fault Code			Instrument Panel Display Fault Code	Fault Description	Repair Instructions
Fault	FMI	PID/SID			
254	14	SID	FE	Main TCU fault	<p><b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b></p> <p>If issue occurs during transmission software upgrade, the TCU is incompatible with the level of software.</p> <p>Replace the upper part of the transmission TCU.</p> <p>Cycling the key off and then back on too quickly can cause this fault to log active</p> <p>Ensure that the key is left in the off position at least 5 seconds before turning it back on. If this does not resolve the issue, complete the electrical requirements flowchart</p> <p>If no issues are found, replace the upper part of the transmission TCU.</p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
255	11	SID	FF	ZMTEC does not recognize the ISO	<p>Troubleshoot the ZF Freedomline transmission harness.</p> <p>Check for open circuit between pin-2 of the TCU connector (J1) vehicle side and pin F3 of the ZMTEC connector (J3).</p> <p>Replace ZMTEC if no open circuit detected.</p>

## Section 2 Fault Code Diagnostics

### ISO Fault Code Diagnostics

**NOTE: ISO display codes may not be available on vehicles built prior to January 2006.**

ISO Fault Identifier	ISO Display Fault Codes (J587 Display)	Fault Description	<b>Repair Instructions</b> <b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b>
2	2	Short circuit to ground at the output stage to the splitter direct solenoid (Y2)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
3	3	Short circuit to ground at the output stage to the splitter indirect solenoid (Y3)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
4	4	Short circuit to ground at the output stage to the rail select #1 solenoid (Y4)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
5	5	Short circuit to ground at the output stage to the rail select #2 solenoid (Y5)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
6	6	Short circuit to ground at the output stage to the gear engage #1 solenoid (Y6)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
7	7	Short circuit to ground at the output stage to the gear engage #2 solenoid (Y7)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.

## Section 2 Fault Code Diagnostics

### ISO Fault Code Diagnostics

NOTE: ISO display codes may not be available on vehicles built prior to January 2006.

ISO Fault Identifier	ISO Display Fault Codes (J587 Display)	Fault Description	Repair Instructions <b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b>
8	8	Short circuit to ground at the output stage to the low range solenoid (Y8)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
9	9	Short circuit to ground at the output stage to the high range solenoid (Y9)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
10	A	Short circuit to ground at the output stage to the main solenoid (Y1)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
17	11	Short circuit to ground at the output stage to the inertia brake solenoid (Y1)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b> Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
18	12	Short circuit to ground at the output stage to slow disengagement clutch valve	Measure the resistance between pin 9 and pin 16 of clutch actuator connector. Nominal value should be 14-16 ohms. If resistance is < 14 ohms, exchange clutch actuator. If resistance is within correct range, exchange TCU top assembly.
19	13	Short circuit to ground at the output stage to slow engagement clutch valve	Measure the resistance between pin 7 and pin 16 of clutch actuator connector. Nominal value should be 14-16 ohms. If resistance is < 14 ohms, exchange clutch actuator. If resistance is within correct range, exchange TCU top assembly.
20	14	Short circuit to ground at the output stage to fast disengagement clutch valve	Measure the resistance between pin 12 and pin 17 of clutch actuator connector. Nominal value should be 14-16 ohms. If resistance is < 14 ohms, exchange clutch actuator. If resistance is within correct range, exchange TCU top assembly.

## Section 2 Fault Code Diagnostics

### ISO Fault Code Diagnostics

**NOTE: ISO display codes may not be available on vehicles built prior to January 2006.**

ISO Fault Identifier	ISO Display Fault Codes (J587 Display)	Fault Description	<b>Repair Instructions</b> <b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b>
21	15	Short circuit to ground at the output stage to fast engagement clutch valve	Measure the resistance between pin 8 and pin 17 of clutch actuator connector. Nominal value should be 14-16 ohms. If resistance is < 14 ohms, exchange clutch actuator. If resistance is within correct range, exchange TCU top assembly.
22	16	Short circuit to ground at the output ACC (power conversion enable signal for ZMTEC and continuation signal voltage doubler and voltage supply to output speed sensor #2)	Complete the electrical requirements flowchart. Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
25	19	Short circuit to ground at output SD to display <b>NOTE: The display will read "EE."</b>	Troubleshoot the ZF-FreedomLine transmission wiring harness. Pin 9 of the TCU connector (J1) and pin F2 of the ZMTEC connector (J3) should all have continuity (resistance of 0.0 to 0.5 ohms) and not be shorted to any other circuit. If a short or open circuit is found, replace the wiring harness. If not, replace the ZMTEC. Should the ZMTEC not resolve the issue, then replace the TCU top half.
26	1A	The main TCU has not received expected communications from the engine (CAN engine configuration timeout)	Due to an issue with the vehicle's SAE J1939 data link, the TCU did not receive an expected SAE J1939 message. Follow your OEM's SAE J1939 diagnostic procedures to correct the issue.
27	1B	The main TCU has not received expected communications from the engine (error on engine configuration message (engine configuration))	The TCU received the SAE J1939 message from the ECM, but the information within the message was not within specifications. Verify that the ECM software level is approved with the ZF-FreedomLine transmission and that all settings are correct.  If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
31	1F	The main TCU has not received expected communications from the engine (error on actual engine retarder-percent torque message ERC1_ER)	The TCU received the SAE J1939 message from the engine retarder, but the information within the message was not within specifications. Verify that the ECM software level is approved with the ZF-FreedomLine transmission and that all settings are correct.  If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
32	20	The main TCU has not received expected communications from the engine (error on engine retarder configuration message (engine retarder configuration))	The TCU received the SAE J1939 message from the engine retarder, but the information within the message was not within specifications. Verify that the ECM software level is approved with the ZF-FreedomLine transmission and that all settings are correct.  If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
33	21	The main TCU has not received expected communications from the engine (CAN engine retarder configuration timeout)	Due to an issue with the vehicle's SAE J1939 data link, the TCU did not receive an expected SAE J1939 message. Follow your OEM's SAE J1939 diagnostic procedures to correct the issue.

## Section 2 Fault Code Diagnostics

### ISO Fault Code Diagnostics

NOTE: ISO display codes may not be available on vehicles built prior to January 2006.

ISO Fault Identifier	ISO Display Fault Codes (J587 Display)	Fault Description	<b>Repair Instructions</b> <b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b>
34	22	Open circuit at the output stage to the splitter direct solenoid (Y2)	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b></p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
35	23	Open circuit at the output stage to the splitter indirect solenoid (Y3)	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b></p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
36	24	Open circuit at the output stage to the rail select #1 solenoid (Y4)	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b></p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
37	25	Open circuit at the output stage to the rail select #2 solenoid (Y5)	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b></p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
38	26	Open circuit at the output stage to the gear engage #1 solenoid (Y6)	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b></p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
39	27	Open circuit at the output stage to the gear engage #2 solenoid (Y7)	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b></p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>

## Section 2 Fault Code Diagnostics

### ISO Fault Code Diagnostics

**NOTE: ISO display codes may not be available on vehicles built prior to January 2006.**

ISO Fault Identifier	ISO Display Fault Codes (J587 Display)	Fault Description	<b>Repair Instructions</b> <b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b>
40	28	Open circuit at the output stage to the low range solenoid (Y8)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
41	29	Open circuit at the output stage to the high range solenoid (Y9)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
42	2A	Open circuit at the output stage to the main solenoid (Y1)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
49	31	Open circuit at the output stage to the inertia brake solenoid (Y1)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
50	32	Open circuit at output stage to small disengagement clutch valve	Additional fault codes 51/52/53 also active, verify connection of clutch actuator connector to TCU. Measure the resistance between pin 9 and pin 16 of clutch actuator connector.  Nominal value should be 14-16 ohms. If resistance is < 14 ohms, exchange clutch actuator. If resistance is within correct range, exchange upper part of TCU.
51	33	Open circuit at output stage to small engagement clutch valve	Additional fault codes 51/52/53 also active, verify connection of clutch actuator connector to TCU. Measure the resistance between pin 7 and pin 16 of clutch actuator connector.  Nominal value should be 14-16 ohms. If resistance is < 14 ohms, exchange clutch actuator. If resistance is within correct range, exchange upper part of TCU.

## Section 2 Fault Code Diagnostics

### ISO Fault Code Diagnostics

NOTE: ISO display codes may not be available on vehicles built prior to January 2006.

ISO Fault Identifier	ISO Display Fault Codes (J587 Display)	Fault Description	Repair Instructions <b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b>
52	34	Open circuit at output stage to large disengagement clutch valve	Additional fault codes 51/52/53 also active, verify connection of clutch actuator connector to TCU. Measure the resistance between pin 12 and pin 17 of clutch actuator connector. Nominal value should be 14-16 ohms. If resistance is < 14 ohms, exchange clutch actuator. If resistance is within correct range, exchange upper part of TCU.
53	35	Open circuit at output stage to large engagement clutch valve	Additional fault codes 51/52/53 also active, verify connection of clutch actuator connector to TCU. Measure the resistance between pin 8 and pin 17 of clutch actuator connector. Nominal value should be 14-16 ohms. If resistance is < 14 ohms, exchange clutch actuator. If resistance is within correct range, exchange upper part of TCU.
54	36	Open circuit of the output ACC (power conversion signal for ZMTEC and continuation signal for voltage doubler voltage doubler and voltage supply to output speed sensor #2)	Complete the electrical requirements flowchart. Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
59	3B	Acknowledge fault of PTO 1 <b>NOTE:</b> The PTO is active but the ZF-FreedomLine hasn't requested it.	Complete the PTO requirements flowchart. If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
60	3C	Acknowledge fault of PTO 2 <b>NOTE:</b> The PTO is active but the ZF-FreedomLine hasn't requested it.	Complete the PTO requirements flowchart. If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
61	3D	PTO 1 disengagement fault <b>NOTE:</b> The ZF-FreedomLine TCU has requested that the PTO turn OFF and it has not.	Complete the PTO requirements flowchart. If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
62	3E	PTO 2 disengagement fault <b>NOTE:</b> The ZF-FreedomLine TCU has requested that the PTO turn OFF and it has not.	Complete the PTO requirements flowchart. If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
63	3F	PTO 1 engagement fault <b>NOTE:</b> The ZF-FreedomLine TCU has requested that the PTO turn ON and it has not.	Complete the PTO requirements flowchart. If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
64	40	PTO 2 engagement fault <b>NOTE:</b> The ZF-FreedomLine TCU has requested that the PTO turn ON and it has not.	Complete the PTO requirements flowchart. If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.

## Section 2 Fault Code Diagnostics

### ISO Fault Code Diagnostics

**NOTE: ISO display codes may not be available on vehicles built prior to January 2006.**

ISO Fault Identifier	ISO Display Fault Codes (J587 Display)	Fault Description	<b>Repair Instructions</b> <b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b>
66	42	Short circuit to positive at the output stage to the splitter direct solenoid (Y2)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
67	43	Short circuit to positive at the output stage to the splitter indirect solenoid (Y3)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
68	44	Short circuit to positive at the output stage to the rail select #1 solenoid (Y4)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
69	45	Short circuit to positive at the output stage to the rail select #2 solenoid (Y5)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
70	46	Short circuit to positive at the output stage to the gear engage #1 solenoid (Y6)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
71	47	Short circuit to positive at the output stage to the gear engage #2 solenoid (Y7)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.

## Section 2 Fault Code Diagnostics

### ISO Fault Code Diagnostics

NOTE: ISO display codes may not be available on vehicles built prior to January 2006.

ISO Fault Identifier	ISO Display Fault Codes (J587 Display)	Fault Description	<b>Repair Instructions</b> <b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b>
72	48	Short circuit to positive at the output stage to the low range solenoid (Y8)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
73	49	Short circuit to positive at the output stage to the high range solenoid (Y9)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
74	4A	Short circuit to positive at the output stage to the main solenoid (Y1)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
81	51	Short circuit to positive at the output stage to the inertia brake solenoid (Y1)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
82	52	Short circuit to positive at output stage to small disengagement clutch valve	Measure the resistance between pin 9 and pin 16 of clutch actuator connector Nominal value should be 14-16 ohms If resistance is < 14 ohms, exchange clutch actuator If resistance is within spec, exchange upper part of TCU.
83	53	Short circuit to positive at output stage to small engagement clutch valve	Measure the resistance between pin 7 and pin 16 of clutch actuator connector Nominal value should be 14-16 ohms If resistance is < 14 ohms, exchange clutch actuator If resistance is within spec, exchange upper part of TCU.
84	54	Short circuit to positive at output stage to large disengagement clutch valve	Measure the resistance between pin 12 and pin 17 of clutch actuator connector. Nominal value should be 14-16 ohms. If resistance is < 14 ohms, exchange clutch actuator. If resistance is within spec, exchange upper part of TCU.

## Section 2 Fault Code Diagnostics

### ISO Fault Code Diagnostics

**NOTE: ISO display codes may not be available on vehicles built prior to January 2006.**

ISO Fault Identifier	ISO Display Fault Codes (J587 Display)	Fault Description	<b>Repair Instructions</b> <b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b>
85	55	Short circuit to positive at output stage to large engagement clutch valve	Measure the resistance between pin 8 and pin 17 of clutch actuator connector. Nominal value should be 14-16 ohms. If resistance is < 14 ohms, exchange clutch actuator. If resistance is within correct range, exchange upper part of TCU.
86	56	Short circuit to positive of the output ACC (power conversion enable signal for ZMTEC and continuation signal for voltage doubler voltage doubler and voltage supply to output speed sensor #2)	Complete the electrical requirements flowchart. Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
89	59	Short circuit to positive at output SD to display <b>NOTE: The display will read "EE."</b>	Troubleshoot the ZF-FreedomLine vehicle wiring harness. Pin 9 of the TCU connector (J1) and pin F2 of the ZMTEC connector (J3) should all have continuity (resistance of 0.0 to 0.5 ohms) and not be shorted to any other circuit. If a short or open circuit is found, replace the wiring harness. If not, replace the ZMTEC.
90	5A	Communication error between TCU 1 and TCU 2: ECU failure	The transmission TCU top half requires replacement. Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
91	5B	The main TCU has not received communication from the ABS. Timeout error: CAN EBC1	Due to an issue with the vehicle's SAE J1939 data link, the TCU did not receive an expected SAE J1939 message. Follow your OEM's SAE J1939 diagnostic procedures to correct the issue.  In conjunction with an active or logged ISO 199 fault code, verify that the ABS controller is connected properly to the SAE J939 Verify power and ground circuits to the ABS controller.
92	5C	The main TCU has not received communication from the ABS. ABS active message error: EBC1	The TCU received the SAE J1939 message from the ABS controller, but the information within the message was not within specifications. Verify that the ABS system is approved with the ZF-FreedomLine transmission, that all settings are correct, and wheel-end speed sensors are correctly installed.  If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
93	5D	The main TCU has not received communication from the ABS. ASR engine control active message error: EBC1	The TCU received the SAE J1939 message from the ABS controller, but the information within the message was not within specifications. Verify that the ABS system is approved with the ZF-FreedomLine transmission, that all settings are correct, and wheel-end speed sensors are correctly installed.  If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.

## Section 2 Fault Code Diagnostics

### ISO Fault Code Diagnostics

NOTE: ISO display codes may not be available on vehicles built prior to January 2006.

ISO Fault Identifier	ISO Display Fault Codes (J587 Display)	Fault Description	<b>Repair Instructions</b> <b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b>
94	5E	The main TCU has not received communication from the ABS. ASR brake control active message error: EBC1	<p>The TCU received the SAE J1939 message from the ABS controller, but the information within the message was not within specifications. Verify that the ABS system is approved with the ZF-FreedomLine transmission, that all settings are correct, and wheel-end speed sensors are correctly installed.</p> <p>If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
95	5F	The main TCU has not received communication from the engine. Cruise control active message error: CCVS	<p>The TCU received the SAE J1939 message from the ECM but the information within the message was not within specifications. Verify that the ECM software level is approved with the ZF-FreedomLine transmission and that all settings are correct.</p> <p>If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
96	60	The main TCU has not received communication from the engine. Cruise control set speed message error: CCVS	<p>The TCU received the SAE J1939 message from the ECM but the information within the message was not within specifications. Verify that the ECM software level is approved with the ZF-FreedomLine transmission and that all settings are correct.</p> <p>If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
97	61	The main TCU has not received communication from the engine. Engine speed message error: EEC1	<p>The TCU received the SAE J1939 message from the ECM but the information within the message was not within specifications. Verify that the ECM software level is approved with the ZF-FreedomLine transmission and that all settings are correct.</p> <p>If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
98	62	Input shaft speed sensor fault	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b></p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
99	63	Output shaft speed sensor #1 (the upper one) fault  <b>NOTE:</b> Output shaft speed sensor #1 plugs into the ZF-FreedomLine transmission wiring harness (the same one that is connected to the clutch actuator).	<p>Clear the faults first and switch the OSS #1 and OSS #2 connectors. Test drive the vehicle such that an OSS code is set. If the code stays with the same speed sensor (#1 or #2), then replace the appropriate wiring harness (either the transmission wiring harness or the clutch actuator). If the code switches to the other speed sensor (from #1 to #2 or from #2 to #1), replace the appropriate speed sensor. If these steps don't identify the faulty component, then do the following.</p> <p>Remove and troubleshoot the clutch actuator wiring harness. Pin 11 of the driver side TCU connector and pin 4 of the lower output shaft speed sensor connector (sensor #1) should have continuity (resistance of 0.0 to 0.5 ohms) and not be shorted to any other circuit. If a short or open circuit is found, replace the clutch actuator; if not, replace the output shaft speed sensor #1.</p>

## Section 2 Fault Code Diagnostics

### ISO Fault Code Diagnostics

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ISO Fault Identifier	ISO Display Fault Codes (J587 Display)	Fault Description	Repair Instructions
			<p><b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b></p>
100	64	<p>Error on output speed signal 2 (the lower one)</p> <p><b>NOTE:</b> Output shaft speed sensor #2 plugs into the ZF-FreedomLine vehicle wiring harness (the same one that is connected to the voltage doubler and ZMTEC).</p>	<p>Clear the faults first and switch the OSS #1 and OSS #2 connectors. Test drive the vehicle such that an OSS code is set. If the code stays with the same speed sensor (#1 or #2), then replace the appropriate wiring harness (either the transmission wiring harness or the clutch actuator). If the code switches to the other speed sensor (from #1 to #2 or from #2 to #1), replace the appropriate speed sensor. If these steps don't identify the faulty component, then do the following.</p> <p>Remove and troubleshoot the transmission wiring harness. Pin 7 of the TCU connector (J1) and pin 3 of the output shaft speed sensor #2 connector (J5) should have continuity (resistance of 0.0 to 0.5 ohms) and not be shorted to any other circuit. If a short or open circuit is found, replace the transmission wiring harness, if not, replace the output shaft speed sensor #2.</p>
101	65	Error on both output speed signals	<p>Inspect the output shaft speed sensors and corresponding wiring harnesses for obvious signs of damage including corrosion within the connectors.</p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
102	66	<p>Plausibility error between transmission input speed and output speed</p> <p><b>NOTE:</b> The actual speeds registered by the input shaft and output shaft speed sensors do not match the expected ratios.</p>	<p>Using TransSoft, check the main TCU for programming mistakes (the programming is gear-dependent and must reflect the actual transmission model). For assistance, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist. If the programming is incorrect, an OnTrac representative will assist you.</p>
103	67	The main TCU has not received communication from the engine. Wheel-based vehicle speed message error: CCVS	<p>The TCU received the SAE J1939 message from the ECM but the information within the message was not within specifications. Verify that the ECM software level is approved with the ZF-FreedomLine transmission and that all settings are correct.</p> <p>If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
104	68	High voltage (voltage doubler 24 volt output too high)	<p>The transmission voltage doubler requires replacement.</p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
105	69	Low voltage (vehicle electrical system or transmission voltage doubler output too low)	<p>Complete the electrical requirements flowchart.</p> <p>If not issues are found with the vehicle electrical system, verify all inputs and outputs at the transmission voltage doubler.</p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
107	6B	Clutch actuator position sensor voltage supply too low	<p>Unplug the clutch actuator connector at the TCU. Check for 4.6 to 5.8 VDC between pins 15 and 16 of the TCU. If the voltage level is within this range, replace the clutch actuator; if the voltage level is outside of this range, replace the upper part of the TCU.</p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>

## Section 2 Fault Code Diagnostics

### ISO Fault Code Diagnostics

NOTE: ISO display codes may not be available on vehicles built prior to January 2006.

ISO Fault Identifier	ISO Display Fault Codes (J587 Display)	Fault Description	<b>Repair Instructions</b> <b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b>
108	6C	Shift lever error ZF-FreedomLine shifter analog shift lever (Freightliner and Sterling vehicles only)	<p>First check all wiring harness connections between the shift lever and the ZMTEC and the ZMTEC and the GS3. If they look good (no damaged pins, correctly set home, etc.), then do the following.</p> <p>Check for continuity (0.0 to 0.5 ohms) between pins 1 and 8 of the shift lever harness connector (J10) and pin G3 of the ZMTEC connector (J3). Check for continuity between pin 3 of the shift lever harness connector (J10) and ground. Check for continuity between pin 7 of the shift lever harness connector (J10) and pin F1 of the ZMTEC connector (J3). Check for continuity between pin 9 of the shift lever harness connector (J10) and pin E3 of the ZMTEC connector (J3). Also check for shorts between these circuits and all other pins in the wiring harness. If these resistances check out okay and no short circuits exist, replace the shift lever assembly. For diagnostic procedures concerning the Freightliner SmartShift lever and the push-button shift lever for International trucks, contact the applicable OEM. For assistance, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
110	6E	ZF CAN timeout	<p>Unplug the ZMTEC only and check for 58.0 to 62.0 ohms resistance across pins D1 and D2 of the ZMTEC connector (J3). Now remove the transmission wiring harness and check for continuity (0.0 to 0.5 ohms) between pin 3 of the TCU connector (J1), pin D1 of the ZMTEC connector (J3), and pin A of the CAN terminator connector (J8). Check for continuity between pin 6 of the TCU connector (J1), pin D2 of the ZMTEC connector (J3), and pin B of the CAN terminator connector (J8).</p> <p>If any of these tests reveal issues with the wiring harness, replace the wiring harness.</p> <p>For assistance, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
114	72	Clutch engagement error <b>NOTE:</b> The clutch engaged unintentionally at a standstill with the gear engaged.	<p>Verify air supply into clutch actuator (system pressure should be 110-130 psi air supply within spec, replace clutch actuator.</p>
117	75	Error in clutch self-adjustment process <b>NOTE:</b> The clutch is unable to cycle.	<p>If error occurs immediately after engine startup, then check the clutch engagement hardware for issues such as a broken fork, jammed release bearing, failed release bearing, broken clutch retaining clip, possible glazed clutch disc, jammed clutch actuator rod, etc.). Address any issues as necessary. If nothing is found, grease the interface between the fork and the release bearing (this includes the tips of the forks as well as the side walls of the release bearing).</p> <p>If clutch actuator does not move when engine is started, replace clutch actuator.</p>

## Section 2 Fault Code Diagnostics

### ISO Fault Code Diagnostics

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ISO Fault Identifier	ISO Display Fault Codes (J587 Display)	Fault Description	<b>Repair Instructions</b> <b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b>
118	76	Clutch does not disengage	Complete the pneumatic requirements flowchart. Verify air supply/air quality. Remove and inspect clutch actuator filter screen for contamination. If the root cause of the issue is not found, then check the clutch engagement hardware for issues such as a broken fork, jammed bearing, failed release bearing, broken clutch retaining clip, possible glazed clutch disc, jammed clutch actuator rod, etc. Address any issues as necessary. If clutch actuator does not move when engine is started, replace clutch actuator.
119	77	Clutch does not engage/does not transmit engine torque	Complete the pneumatic requirements flowchart. Verify air supply/air quality. Remove and inspect clutch actuator filter screen for contamination. If the root cause of the issue is not found, then check the clutch engagement hardware for issues such as a broken fork, jammed release bearing, failed release bearing, broken clutch retaining clip, possible glazed clutch disc, jammed clutch actuator rod, etc. Address any issues as necessary. If clutch actuator does not move when engine is started, replace clutch actuator.
120	78	Mechanical failure of small clutch disengagement solenoid	Complete the pneumatic requirements flowchart. Verify air supply/air quality. Remove and inspect clutch actuator filter screen for contamination. If root cause of the issue is not found, check the clutch engagement hardware for issues such as a broken fork, jammed release bearing, failed release bearing, broken clutch retaining clip, jammed clutch actuator rod, etc. Address any issues as necessary. If clutch actuator does not move when engine is started, replace clutch actuator.
121	79	Mechanical failure of large clutch disengagement solenoid	Complete the pneumatic requirements flowchart. Verify air supply/air quality. Remove and inspect clutch actuator filter screen for contamination. If root cause of the issue is not found, check the clutch engagement hardware for issues such as a broken fork, jammed release bearing, failed release bearing, broken clutch retaining clip, jammed clutch actuator rod, etc. Address any issues as necessary. If clutch actuator does not move when engine is started, replace clutch actuator.

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### ISO Fault Code Diagnostics

NOTE: ISO display codes may not be available on vehicles built prior to January 2006.

ISO Fault Identifier	ISO Display Fault Codes (J587 Display)	Fault Description	<b>Repair Instructions</b> <b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b>
122	7A	Mechanical failure of small clutch engagement solenoid	<p>Complete the pneumatic requirements flowchart.</p> <p>Verify air supply/air quality.</p> <p>Remove and inspect clutch actuator filter screen for contamination.</p> <p>If root cause of the issue is not found, check the clutch engagement hardware for issues such as a broken fork, jammed release bearing, failed release bearing, broken clutch retaining clip, jammed clutch actuator rod, etc.</p> <p>Address any issues as necessary.</p> <p>If clutch actuator does not move when engine is started, replace clutch actuator.</p>
123	7B	Mechanical failure of large clutch engagement solenoid	<p>Complete the pneumatic requirements flowchart.</p> <p>Verify air supply/air quality.</p> <p>Remove and inspect clutch actuator filter screen for contamination.</p> <p>If root cause of the issue is not found, check the clutch engagement hardware for issues such as a broken fork, jammed release bearing, failed release bearing, broken clutch retaining clip, jammed clutch actuator rod, etc.</p> <p>Address any issues as necessary.</p> <p>If clutch actuator does not move when engine is started, replace clutch actuator.</p>
124	7C	Error on clutch actuator position sensor signal	<p>Complete the pneumatic requirements flowchart.</p> <p>Verify air supply/air quality.</p> <p>Using transsoft, under the clutch info tab, verify clutch absolute stroke.</p> <p>Engine must be running and transmission in neutral.</p> <p>Absolute clutch stroke &gt; 65 mm, replace the clutch assembly.</p> <p>If issue still not resolved, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
125	7D	Pressure reduction valve (TCU air filter regulator)	<p>Complete the pneumatic requirements flowchart.</p> <p>If the root cause is not found, use TransSoft to verify that the transmission's pressure reduction valve is regulating the air pressure to 102.5 ± 4 psi. Replace the air pressure regulator as necessary.</p>
126	7E	Pressure sensor signal fault	<p>The transmission TCU top half requires replacement.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace the pressure sensor.</b></p>
127	7F	TCU temperature sensor signal fault	<p>The transmission TCU top half requires replacement.</p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>

## Section 2 Fault Code Diagnostics

### ISO Fault Code Diagnostics

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ISO Fault Identifier	ISO Display Fault Codes (J587 Display)	Fault Description	<b>Repair Instructions</b> <b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b>
128	80	Oil temperature sensor fault	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace lower part of TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
129	81	Short circuit to positive of the gear engage position sensor signal	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
130	82	Short circuit to ground of the gear engage position sensor signal	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
131	83	Open circuit of the gear engage position sensor signal	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
132	84	Self adjustment error of gear engage position sensor  <b>NOTE: The gear engage position sensor is unable to cycle.</b>	If the TCU has not just been installed, complete the pneumatic requirements flowchart.  When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, purchase kit and rebuild the main engagement piston on the lower part of TCU or replace the lower part of TCU.</b>  If the TCU has just been installed, the engagement actuator did not correctly engage into the rail. Using TransSoft, verify that the engagement position sensor counts are outside of the nominal range: 300 to 350. If so, remove the TCU and reinstall it.

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### ISO Fault Code Diagnostics

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133	85	Short circuit to positive of the rail select position sensor	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b></p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
134	86	Short circuit to ground of the rail select position sensor	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b></p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
135	87	Open circuit of the rail select position sensor	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b></p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
136	88	Gate select sensor self-adjustment error	<p>If the TCU has not just been installed, complete the pneumatic requirements flowchart.</p> <p>If the TCU has just been installed, the gate selector actuator did not correctly engage into the rail. Using TransSoft, verify that the gate selector position sensor counts are outside of the nominal range: 70 to 120 or 500 to 580. If so, remove the TCU and reinstall it.</p>
137	89	No range change group sensor signal (short circuit to positive)	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b></p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
138	8A	No range change group sensor signal (short circuit to ground)	<p>When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b></p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>

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### ISO Fault Code Diagnostics

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139	8B	No range change group sensor signal (open circuit)	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
140	8C	Self-adjustment fault of range position sensor	If the TCU has not just been installed, complete the pneumatic requirements flowchart.  If the TCU has just been installed, the range actuator did not correctly engage into the rail. Using TransSoft, verify that the range position sensor counts are outside of the nominal range: 80 to 130 or 490 to 590. If so, remove the TCU and reinstall it.
141	8D	Short circuit to positive of the splitter position sensor signal	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
142	8E	Short circuit to ground of the splitter position sensor signal	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
143	8F	Open circuit of the splitter position sensor signal	When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace the sensor or replace the lower part of the TCU.</b>  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
144	90	Splitter position sensor self-adjustment fault  <b>NOTE: The gear engage position sensor is unable to cycle.</b>	If the TCU has not just been installed, complete the pneumatic requirements flowchart.  If the TCU has just been installed, the splitter actuator did not correctly engage into the rail. Using TransSoft, verify that the splitter position sensor counts are outside of the nominal range: 70 to 140 or 500 to 650. If so, remove the TCU and reinstall it.

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### ISO Fault Code Diagnostics

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145	91	Range shift disengagement error	Complete the pneumatic requirements flowchart. If no issues are found with the air system, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
146	92	Range shift changeover error	Complete the pneumatic requirements flowchart. The range actuator did not correctly engage into the rail. Using TransSoft, verify that the range position sensor counts are outside of the nominal range: 80 to 130 or 490 to 590. The measured values should not drift or show signal disturbances after range shifting. Values outside range, exchange main transmission. If error occurs sporadically: When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the lower part of TCU.</b> For assistance contact OnTrac at 866-668-7221 and ask for a transmission specialist.
147	93	Range shift engagement error	Complete the pneumatic requirements flowchart. The range actuator did not correctly engage into the rail. Using TransSoft, verify that the range position sensor counts are outside of the nominal range: 80 to 130 or 490 to 590. The measured values should not drift or show signal disturbances after range shifting. Values outside range, exchange main transmission. If error occurs sporadically: When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the lower part of TCU.</b> For assistance contact OnTrac at 866-668-7221 and ask for a transmission specialist.
148	94	Splitter selection fault; splitter cylinder does not disengage	Complete the pneumatic requirements flowchart. The splitter group does not leave the previous position within defined time. Using TransSoft, verify that the splitter position sensor counts are outside of the nominal range: 70 to 140 or 500 to 620. The measured values should not drift or show signal disturbances after splitter shifting. Values outside range, exchange main transmission. If error occurs sporadically: When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the lower part of TCU.</b> For assistance, contact OnTrac at 866-668-7221 and ask for a transmission specialist.

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### ISO Fault Code Diagnostics

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149	95	Splitter selection fault during the splitter selection procedure	Complete the pneumatic requirements flowchart.  The splitter group does not changeover to new position in defined time. Using TransSoft, verify that the splitter position sensor counts are outside of the nominal range: 70 to 140 or 500 to 620.  The measured values should not drift or show signal disturbances after splitter shifting. Values outside range, exchange main transmission. If error occurs sporadically: When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace the lower part of TCU.</b>  For assistance, contact OnTrac at 866-668-7221 and ask for a transmission specialist.
150	96	Splitter selection fault; splitter cylinder does not engage	Complete the pneumatic requirements flowchart.  The splitter actuator did not correctly engage into the rail. Using TransSoft, verify that the splitter position sensor counts are outside of the nominal range: 70 to 140 or 500 to 620.  The measured values should not drift or show signal disturbances after splitter shifting. Values outside range, exchange main transmission. If error occurs sporadically: When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace the lower part of TCU.</b>  For assistance, contact OnTrac at 866-668-7221 and ask for a transmission specialist.
151	97	Rail select cylinder does not disengage	Complete the pneumatic requirements flowchart.  The select actuator did not correctly disengage. Using TransSoft, verify that the splitter position sensor counts are outside of the nominal range: 70 to 120 or 500 to 580.  The measured values should not drift or show signal disturbances after rail select shifting. Values outside range, exchange main transmission. If error occurs sporadically: When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.  <b>Out-of-warranty only and/or no warranty claim submitted, replace the lower part of TCU.</b>  For assistance, contact OnTrac at 866-668-7221 and ask for a transmission specialist.

## Section 2 Fault Code Diagnostics

### ISO Fault Code Diagnostics

NOTE: ISO display codes may not be available on vehicles built prior to January 2006.

ISO Fault Identifier	ISO Display Fault Codes (J587 Display)	Fault Description	<b>Repair Instructions</b> <b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b>
152	98	Rail selection fault during the rail selection procedure	<p>Complete the pneumatic requirements flowchart.</p> <p>The select cylinder does not change over to new gatel. Using TransSoft, verify that the select position sensor counts are outside of the nominal range: 70 to 120 or 500 to 580.</p> <p>The measured values should not drift or show signal disturbances after rail select shifting. Values outside range, exchange main transmission. If error occurs sporadically: When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the lower part of TCU.</b></p> <p>For assistance, contact OnTrac at 866-668-7221 and ask for a transmission specialist.</p>
153	99	Rail selection fault; rail select cylinder does not engage	<p>Complete the pneumatic requirements flowchart.</p> <p>The select actuator did not correctly engage into the rail. Using TransSoft, verify that the range position sensor counts are outside of the nominal range: 70 to 120 or 500 to 580.</p> <p>The measured values should not drift or show signal disturbances after rail select shifting. Values outside range, exchange main transmission. If error occurs sporadically: When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the lower part of TCU.</b></p> <p>For assistance contact OnTrac at 866-668-7221 and ask for a transmission specialist.</p>
154	9A	Main transmission gear does not disengage	<p>Complete the pneumatic requirements flowchart.</p> <p>The engagement actuator did not correctly disengage from the rail. Using TransSoft, verify that the engagement position sensor counts are outside of the nominal range: 80 to 120 or 530 to 580.</p> <p>The measured values should not drift or show signal disturbances after engagement shifting. Values outside range, exchange main transmission. If error occurs sporadically: When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the lower part of TCU.</b></p> <p>For assistance contact OnTrac at 866-668-7221 and ask for a transmission specialist.</p>

## Section 2 Fault Code Diagnostics

### ISO Fault Code Diagnostics

**NOTE: ISO display codes may not be available on vehicles built prior to January 2006.**

ISO Fault Identifier	ISO Display Fault Codes (J587 Display)	Fault Description	<b>Repair Instructions</b> <b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b>
155	9B	Main transmission gear does not engage	<p>Complete the pneumatic requirements flowchart.</p> <p>The engagement actuator did not correctly engage into the rail. Using TransSoft, verify that the engagement position sensor counts are outside of the nominal range: 80 to 120 or 530 to 580.</p> <p>The measured values should not drift or show signal disturbances after engagement shifting. Values outside range, exchange main transmission. If error occurs sporadically: When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the lower part of TCU.</b></p> <p>For assistance contact OnTrac at 866-668-7221 and ask for a transmission specialist.</p>
156	9C	Engagement of wrong gear	<p>Using TransSoft, check the main TCU for programming mistakes (the programming is gear-dependent and must reflect the actual transmission model). For assistance, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist. If the programming is incorrect, an OnTrac representative will assist you.</p>
157	9D	Selector position sensor signal leaves engaged position during driving  <b>NOTE:</b> The selector position sensor has traveled out of the engage position without a shift being requested. This issue is most likely the result of a broken TCU but may be the result of programming or a mis-installation. If active, the transmission attempts to shift back into its previous gear. If in neutral, a suitable gear is selected. If the sensor is broken and relaying bad information to the TCU, the vehicle will stay in gear and not shift. At the next stop, the transmission will still be in gear with the clutch open and the vehicle unable to move.	<p>If the TCU has just been installed, the actuators and rails may not have engaged correctly. Use TransSoft to verify that the gate selector position sensor counts are outside of the nominal range: 70 to 120 or 500 to 580. If so, remove and reinstall the TCU.</p> <p>If the TCU has recently been installed, verify that the detent springs and detent balls were installed. If not, remove and reinstall the TCU correctly (with the detent springs and detent balls).</p>
158	9E	Gear engage position sensor signal leaves engaged position during driving	<p>Using TransSoft, verify that the engagement position sensor counts are outside of the nominal range: 80 to 120 or 530 to 580.</p> <p>The measured values should not drift or show signal disturbances after engagement shifting. Values outside range, exchange main transmission. If error occurs sporadically: When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the lower part of TCU.</b></p> <p>For assistance contact OnTrac at 866-668-7221 and ask for a transmission specialist.</p>

## Section 2 Fault Code Diagnostics

### ISO Fault Code Diagnostics

NOTE: ISO display codes may not be available on vehicles built prior to January 2006.

ISO Fault Identifier	ISO Display Fault Codes (J587 Display)	Fault Description	<b>Repair Instructions</b> <b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b>
159	9F	Range position sensor signal leaves engaged position during driving	<p>Using TransSoft, verify that the range position sensor counts are outside of the nominal range: 80 to 130 or 490 to 590.</p> <p>The measured values should not drift or show signal disturbances after range shifting. Values outside range, exchange main transmission. If error occurs sporadically: When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim. <b>Out-of-warranty only and/or no warranty claim submitted, replace the lower part of TCU.</b></p> <p>For assistance contact OnTrac at 866-668-7221 and ask for a transmission specialist.</p>
160	A0	Splitter position sensor signal leaves engaged position during driving	<p>Using TransSoft, verify that the splitter position sensor counts are outside of the nominal range: 70 to 140 or 500 to 620.</p> <p>The measured values should not drift or show signal disturbances after splitter shifting. Values outside range, exchange main transmission. If error occurs sporadically: When submitting a warranty claim under standard warranty conditions, the complete TCU should be replaced and the entire unit submitted with warranty claim.</p> <p><b>Out-of-warranty only and/or no warranty claim submitted, replace the lower part of TCU.</b></p> <p>For assistance, contact OnTrac at 866-668-7221 and ask for a transmission specialist.</p>
163	A3	Engine does not react to torque intervention	<p>The ECM did not react correctly to an SAE J1939 message. Follow your OEM's SAE J1939 diagnostic procedures to correct for a fault SAE J1939 data link. Check for engine codes that would cause the engine to go into derate mode. (Fuel restriction, air restriction, high temp, low coolant etc).</p>
164	A4	The main TCU has not received communication from the engine. Error on driver's demand engine percent torque message: EEC1	<p>The TCU received the SAE J1939 message from the ECM but the information within the message was not within specifications. Verify that the ECM software level is approved with the ZF-FreedomLine transmission and that all settings are correct.</p> <p>If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
165	A5	The main TCU has not received communication from the engine. Error on accelerator pedal position message: EEC2	<p>The TCU received the SAE J1939 message from the ECM but the information within the message was not within specifications. Verify that the ECM software level is approved with the ZF-FreedomLine transmission and that all settings are correct.</p> <p>If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>

## Section 2 Fault Code Diagnostics

### ISO Fault Code Diagnostics

**NOTE: ISO display codes may not be available on vehicles built prior to January 2006.**

ISO Fault Identifier	ISO Display Fault Codes (J587 Display)	Fault Description	Repair Instructions
			<b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b>
166	A6	Permanent idle signal  <b>NOTE:</b> The idle switch is built into the accelerator pedal and is wired into the engine controller, not the transmission controller or main TCU. The TCU receives the status of the idle switch over the SAE J1939 bus. The transmission is receiving contradictory messages indicating that the idle switch is open (truck is idling) and the accelerator pedal is pressed (truck is not idling).	Using TransSoft, troubleshoot the idle switch and the status of the pedal. Refer to the OEM for details should repair work be necessary.
167	A7	The main TCU has not received expected communications from the engine (error on percent load at current speed message EEC2)	The TCU received the SAE J1939 message from the ECM but the information within the message was not within specifications. Verify that the ECM software level is approved with the ZF-FreedomLine transmission and that all settings are correct.  If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
168	A8	No idle signal or error on idle validation switch signal (EEC2)  <b>NOTE:</b> The idle switch is built into the accelerator pedal and is wired into the engine controller, not the transmission controller, or main TCU. The main TCU receives the status of the idle switch over the SAE J1939 bus. The transmission is receiving contradictory messages indicating that the idle switch is closed (truck is not idling) and the accelerator pedal is not pressed (truck is idling).	Using TransSoft, troubleshoot the idle switch and the status of the pedal. Refer to the OEM for details should repair work be necessary.
169	A9	Cut-off relay in ECU does not switch off	The transmission TCU top half requires replacement. Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
170	AA	No voltage supply at pin 30 or cut-off relay in ECU does not switch on	The transmission TCU top half requires replacement. Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
171	AB	Error on "Actual engine percent torque" signal (EEC1)	The TCU received the SAE J1939 message from the ECM but the information within the message was not within specifications. Verify that the ECM software level is approved with the ZF-FreedomLine transmission and that all settings are correct.  If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
172	AC	The main TCU has not received communication from the engine. Permanent engine brake request message	The TCU received the SAE J1939 message from the ECM but the information within the message was not within specifications. Troubleshoot the engine brake switch. It is being reported as permanently depressed.  If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.

## Section 2 Fault Code Diagnostics

### ISO Fault Code Diagnostics

NOTE: ISO display codes may not be available on vehicles built prior to January 2006.

ISO Fault Identifier	ISO Display Fault Codes (J587 Display)	Fault Description	Repair Instructions <b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b>
173	AD	The main TCU has not received communication from the engine. Error on brake switch message: CCVS	The TCU received the SAE J1939 message from the ECM but the information within the message was not within specifications. Troubleshoot the brake switch. It is being reported as permanently depressed.  If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
175	AF	Error on "Ignition lock" signal (terminal 15)	Verify voltage at pin 6/7 of the doubler.  Key on voltage should be 24 volts nominal. If < 18 volts, replace the transmission voltage doubler.  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
177	B1	The main TCU has not received communication from the engine. Error: system CAN busoff	Due to an issue with the vehicle's SAE J1939 data link, the TCU did not receive an expected SAE J1939 message. Follow your OEM's SAE J1939 diagnostic procedures to correct the issue.
178	B2	The main TCU has identified CAN error frames not severe enough to cause a busoff situation	Due to an issue with the vehicle's SAE J1939 data link, the TCU did not receive an expected SAE J1939 message. Follow your OEM's SAE J1939 diagnostic procedures to correct the issue.
179	B3	The SAE J1939 bus is not functioning correctly  <b>NOTE:</b> The backbone of the SAE J1939 bus is terminated at each end with a 120 ohm resistor. Each component communicating over the bus must connect into the backbone.	Due to an issue with the vehicle's SAE J1939 data link, the TCU did not receive an expected SAE J1939 message. Follow your OEM's SAE J1939 diagnostic procedures to correct the issue.  <b>NOTE:</b> The resistance across pins C and D of the 9 pin diagnostic connector will be about 60 ohms if both terminating resistors are in place (120 ohms if only one is installed).
180	B4	The main TCU has not received communication from the engine (CAN EEC1 timeout)	Due to an issue with the vehicle's SAE J1939 data link, the TCU did not receive an expected SAE J1939 message. Follow your OEM's SAE J1939 diagnostic procedures to correct the issue.
181	B5	The main TCU has not received communication from the engine (CAN EEC2 timeout)	Due to an issue with the vehicle's SAE J1939 data link, the TCU did not receive an expected SAE J1939 message. Follow your OEM's SAE J1939 diagnostic procedures to correct the issue.
182	B6	The main TCU has not received communication from the engine (CAN CCVS timeout)	Due to an issue with the vehicle's SAE J1939 data link, the TCU did not receive an expected SAE J1939 message. Follow your OEM's SAE J1939 diagnostic procedures to correct the issue.
183	B7	The main TCU has not received communication from the engine (CAN ERC1_ER timeout)	Due to an issue with the vehicle's SAE J1939 data link, the TCU did not receive an expected SAE J1939 message. Follow your OEM's SAE J1939 diagnostic procedures to correct the issue.
188	BC	ECU fault — wrong interrupt	If issue occurs during transmission software upgrade, the TCU is incompatible with the level of software.  Replace the upper part of the transmission TCU.  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.
189	BD	ECU fault — stack watch	Replace the upper part of the transmission TCU.  Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.

## Section 2 Fault Code Diagnostics

### ISO Fault Code Diagnostics

**NOTE: ISO display codes may not be available on vehicles built prior to January 2006.**

ISO Fault Identifier	ISO Display Fault Codes (J587 Display)	Fault Description	<b>Repair Instructions</b> <b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b>
190	BE	EOL EEPROM parameter out of valid range	<p>The EOL parameters need to be updated. This can be accomplished with TransSoft. Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p> <p>Should the EOL parameter values check out, and the code not clear, replace the upper part of the transmission TCU.</p>
191	BF	EOL EEPROM parameter checksum error	<p>If the transmission has just been programmed, cycle the key (remain in the off position for 10 seconds)</p> <p>If the transmission has not just been programmed, then the EOL parameters need to be updated. This can be accomplished with TransSoft. Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p> <p>Should the EOL parameter values check out, and the code not clear, replace the upper part of the transmission TCU.</p>
192	C0	ECU fault – EEPROM access failure	<p>Verify that power is correctly supplied to the transmission and cycle the power. Cycling the key off and then back on too quickly can cause this fault to log active</p> <p>Ensure that the key is left in the off position at least 5 seconds before turning it back on.</p> <p>If this does not resolve the issue, complete the electrical requirements flowchart.</p> <p>If no issues are found replace the upper part of the transmission TCU.</p> <p>Contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
193	C1	ECU temperature too high	<p>If an ISO fault code 128 exists, address it first.</p> <p>Check for obstructions within the transmission cooler, cooler lines and by-pass valve. Check the oil level (both low and high oil levels may lead to overheating). Address any issue found as necessary.</p>
194	C2	Both sources of vehicle speed are faulty	<p>Due to an issue with the vehicle's SAE J1939 data link, the TCU did not receive an expected SAE J1939 message. Follow your OEM's SAE J1939 diagnostic procedures to correct the issue.</p>
197	C5	The main TCU has not received communication from the ABS. Error on front axle speed message: WSI	<p>The TCU received the SAE J1939 message from the ABS controller but the information within the message was not within specifications. Using the appropriate ABS diagnostic tool, verify active and inactive fault codes logged. Repair or replace associated wheel end speed sensors. If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>
198	C6	The main TCU has not received communication from the ABS. Error on relative wheel speeds message: WSI	<p>The TCU received the SAE J1939 message from the ABS controller but the information within the message was not within specifications. Using the appropriate ABS diagnostic tool, verify active and inactive fault codes logged. Repair or replace associated wheel-end speed sensors.</p> <p>If necessary, contact OnTrac at 866-668-7221 and request a ZF-FreedomLine transmission specialist.</p>

## Section 2 Fault Code Diagnostics

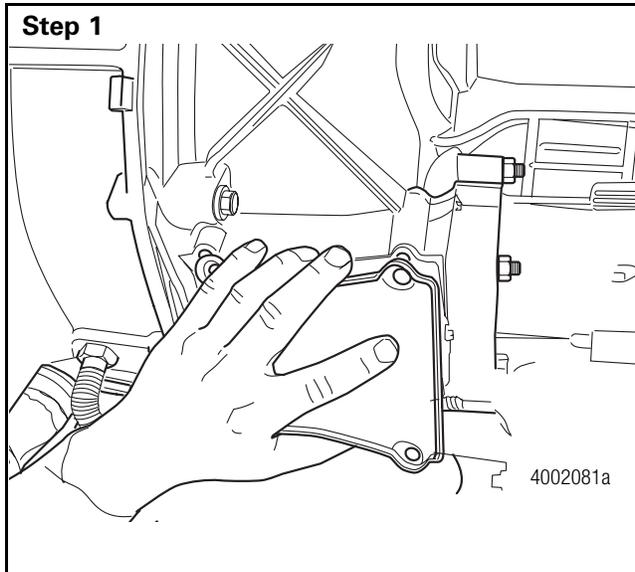
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### ISO Fault Code Diagnostics

**NOTE: ISO display codes may not be available on vehicles built prior to January 2006.**

ISO Fault Identifier	ISO Display Fault Codes (J587 Display)	Fault Description	<b>Repair Instructions</b> <b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact OnTrac at 866-668-7221 and request a transmission specialist.</b>
199	C7	The main TCU has not received communication from the ABS (CAN WSI timeout)	Due to an issue with the vehicle's SAE J1939 data link, the TCU did not receive an expected SAE J1939 message. Follow your OEM's SAE J1939 diagnostic procedures to correct the issue. In conjunction with an active or logged ISO 91 fault code, verify that the ABS controller is connected properly to the SAE J939. Verify power and ground circuits to the ABS controller.
211	D3	CAN TC1 timeout	Due to an issue with the vehicles SAE J1939 data link, the TCU did not receive an expected message from the SAE J1939 push-button shift lever. (CAN TC1 timeout) follow the OEM's SAE J1939 diagnostic procedures to correct the issue.

### Release Fork Greasing Procedure (Standard and Roller Fork Applications)



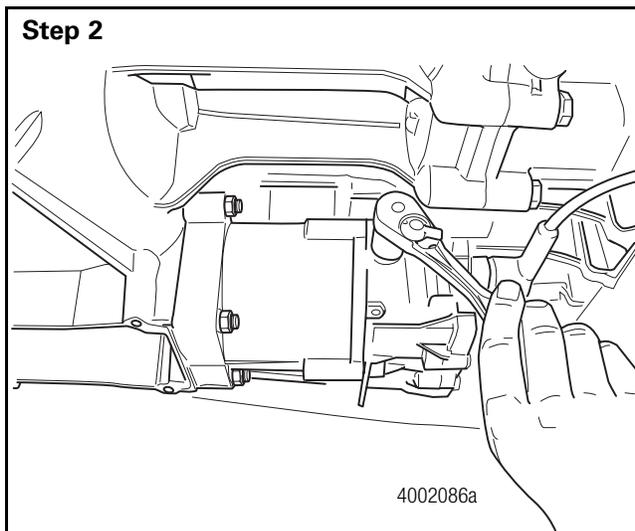
#### For Standard Fork Applications only

**NOTE:** The ZF-FreedomLine does not require a regular maintenance program. However, to ensure maximum performance and quality, ensuring that the release mechanism is lubricated in regular intervals is beneficial.

In most cases, lubricating the parts twice per year is sufficient. In some cases, however, lubricating the parts quarterly is normal. Thus if there is a bump noticed when going from neutral into gear at standstill or when coming to a stop, this is a signal that the lubrication is required.

Using a 13 mm wrench, remove the clutch inspection cover.

- **GO TO THE NEXT STEP.**



#### **WARNING**

The vent plug will vent the vehicle's air supply down to approximately 75 psi. Wear eye protection when completing this step.

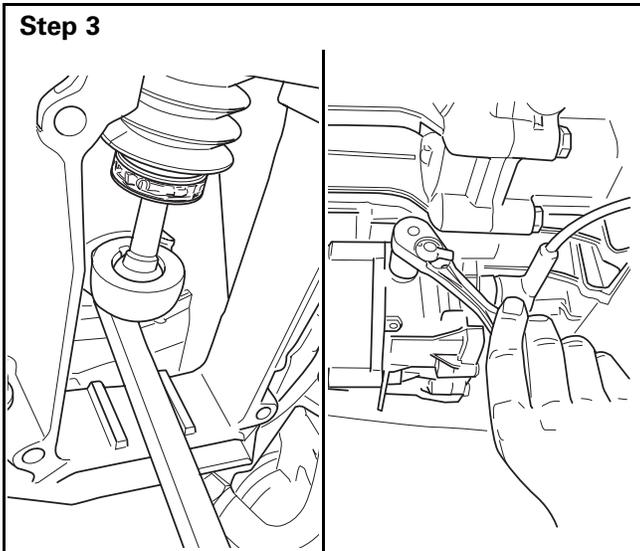
Using a 17 mm wrench, remove the clutch actuator vent plug.

- **GO TO THE NEXT STEP.**

## Section 3 Maintenance

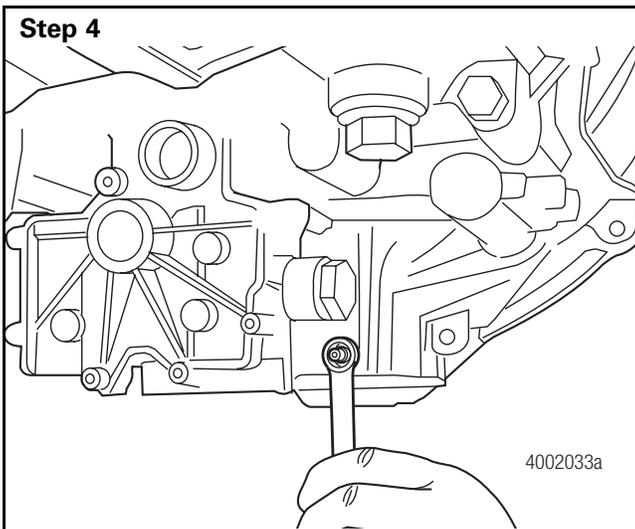
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### Release Fork Greasing Procedure (Standard and Roller Fork Applications)



With the clutch fork pried back, reinstall the vent plug. This will compress the return spring and eliminate the load on the fasteners.

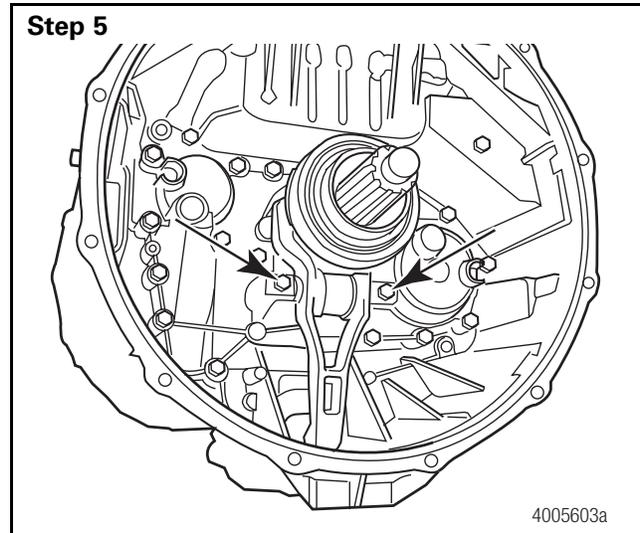
- **GO TO THE NEXT STEP.**



Using a 13 mm wrench, remove the four nuts that secure the clutch actuator to the transmission housing. Remove clutch actuator.

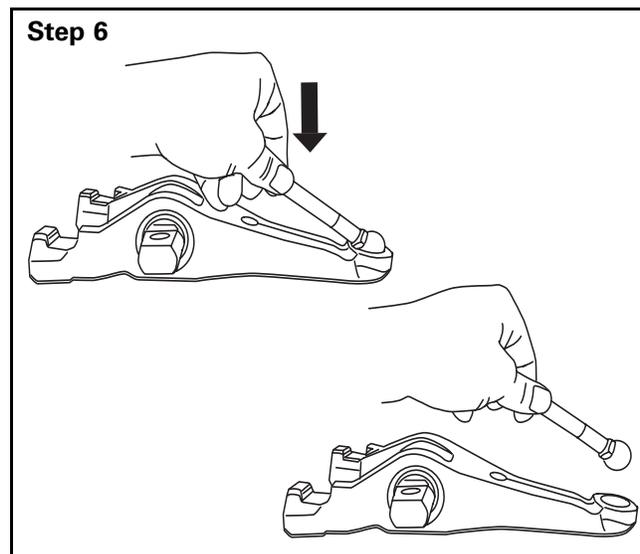
- **GO TO THE NEXT STEP.**

### Release Fork Greasing Procedure (Standard and Roller Fork Applications)



Working through the clutch inspection cover, use a 19 mm socket and ratchet to remove the two fasteners that secure the release fork assembly to the transmission.

- **GO TO THE NEXT STEP.**



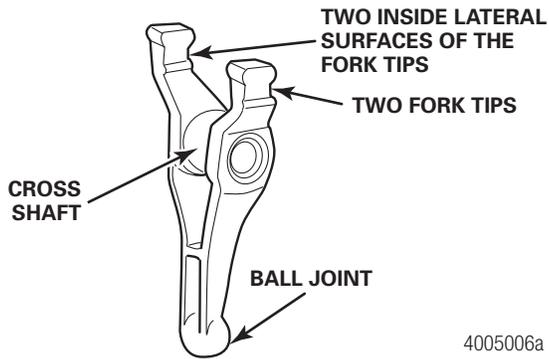
Remove the clutch actuator rod from the clutch fork.

- **GO TO THE NEXT STEP.**

## Section 3 Maintenance

### Release Fork Greasing Procedure (Standard and Roller Fork Applications)

#### Step 7



#### For Standard Fork Applications only

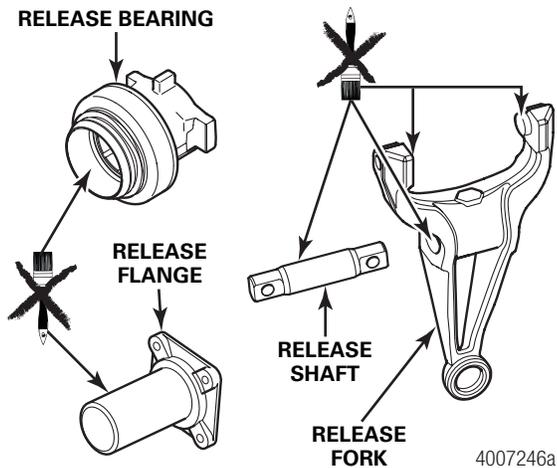
**NOTE:** This procedure is for standard fork applications only.

Lightly grease the fork in six locations using Optimol Olista Longime 3 EP grease. (ONLY USE APPROVED GREASE.) **NOTE:** If cross shaft is reused, clean thoroughly before applying grease.

Grease the two fork tips, the two inside surfaces of the fork (where the release bearing slides), the cross shaft, and the ball joint.

- **GO TO THE NEXT STEP.**

#### Step 7a



#### For Roller Fork Installations

#### **CAUTION**

Do not grease the following parts:

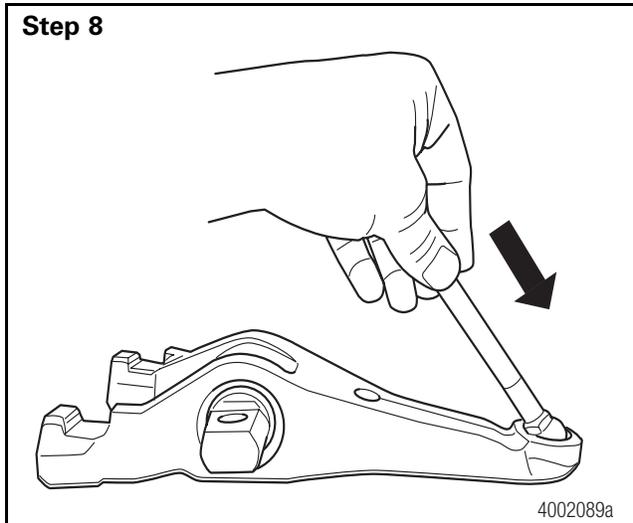
- Cam rollers on release fork
- Release flange
- Cross shaft (**NOTE:** The cross shaft in the bearing bushing has clearance.)
- Release bearing bushing

#### **WARNING**

This procedure is to be used for new installations only. No maintenance is required for roller fork applications already in service.

### Release Fork Greasing Procedure (Standard and Roller Fork Applications)

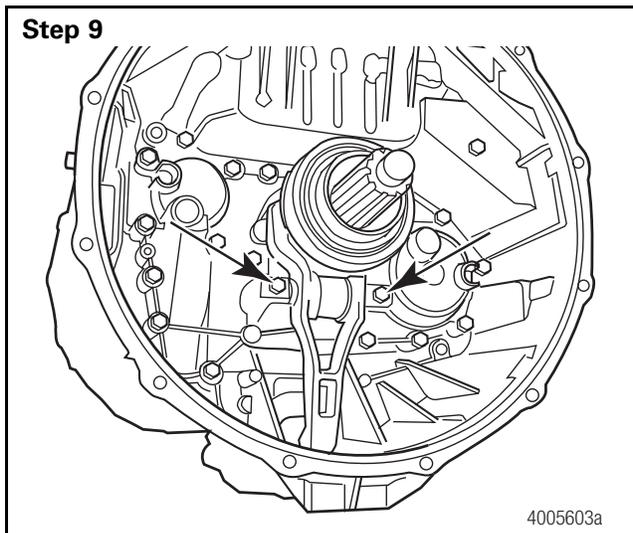
Step 8



Install the clutch actuator rod into the ball joint.

- **GO TO THE NEXT STEP.**

Step 9



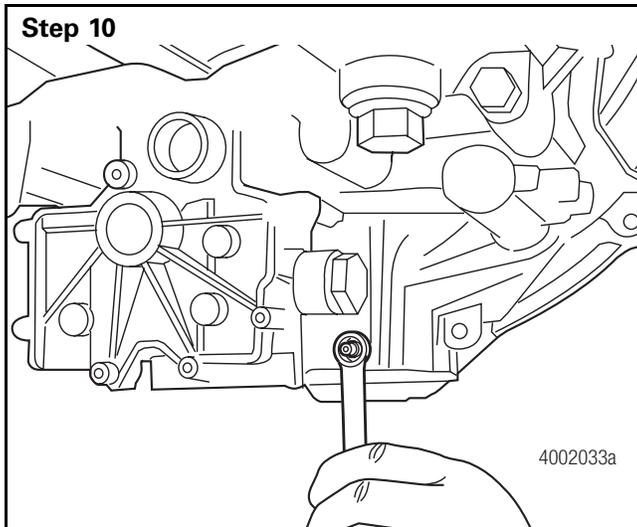
Working through the clutch inspection cover, use a 19 mm socket and torque wrench to tighten the fasteners to **85 lb-ft (115 N•m)**. 

**GO TO THE NEXT STEP.**

## Section 3 Maintenance

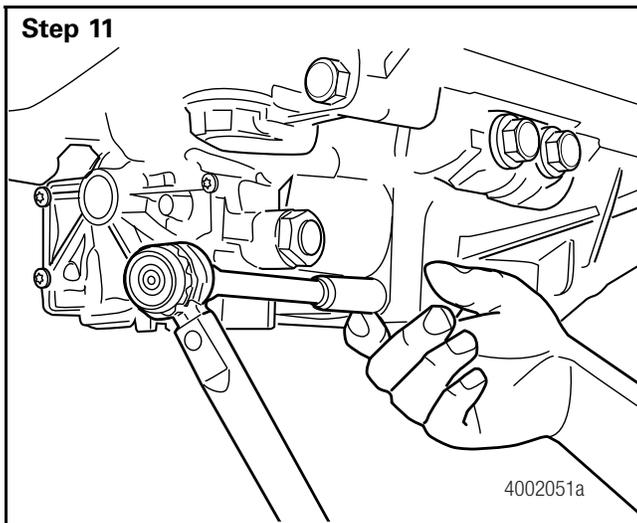
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### Release Fork Greasing Procedure (Standard and Roller Fork Applications)



Use a 13 mm wrench to install the clutch actuator housing onto the transmission case with four nuts and washers.

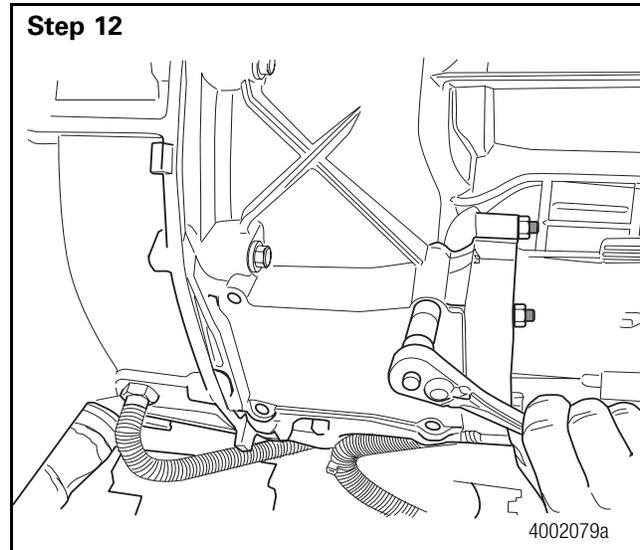
- **GO TO THE NEXT STEP.**



Use a 13 mm socket and torque wrench to tighten the fasteners to **17 lb-ft (23 N•m)**. 

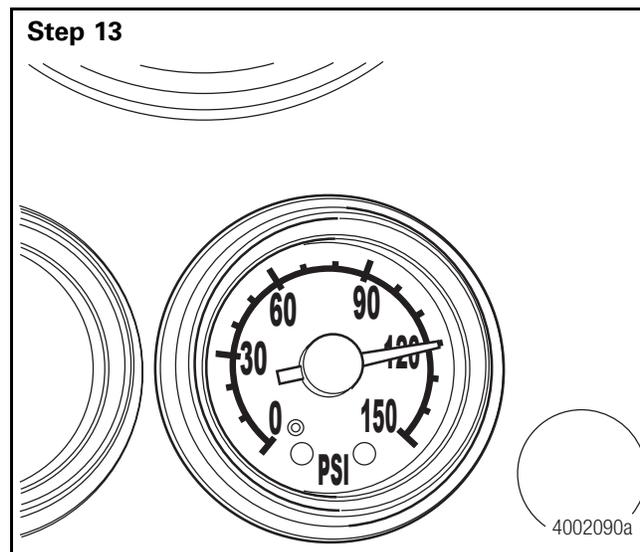
- **GO TO THE NEXT STEP.**

### Release Fork Greasing Procedure (Standard and Roller Fork Applications)



Use a 13 mm socket and torque wrench to tighten the fasteners to **17 lb-ft (23 N•m)**. 

- **GO TO THE NEXT STEP.**



Charge the air system to 120 psi.

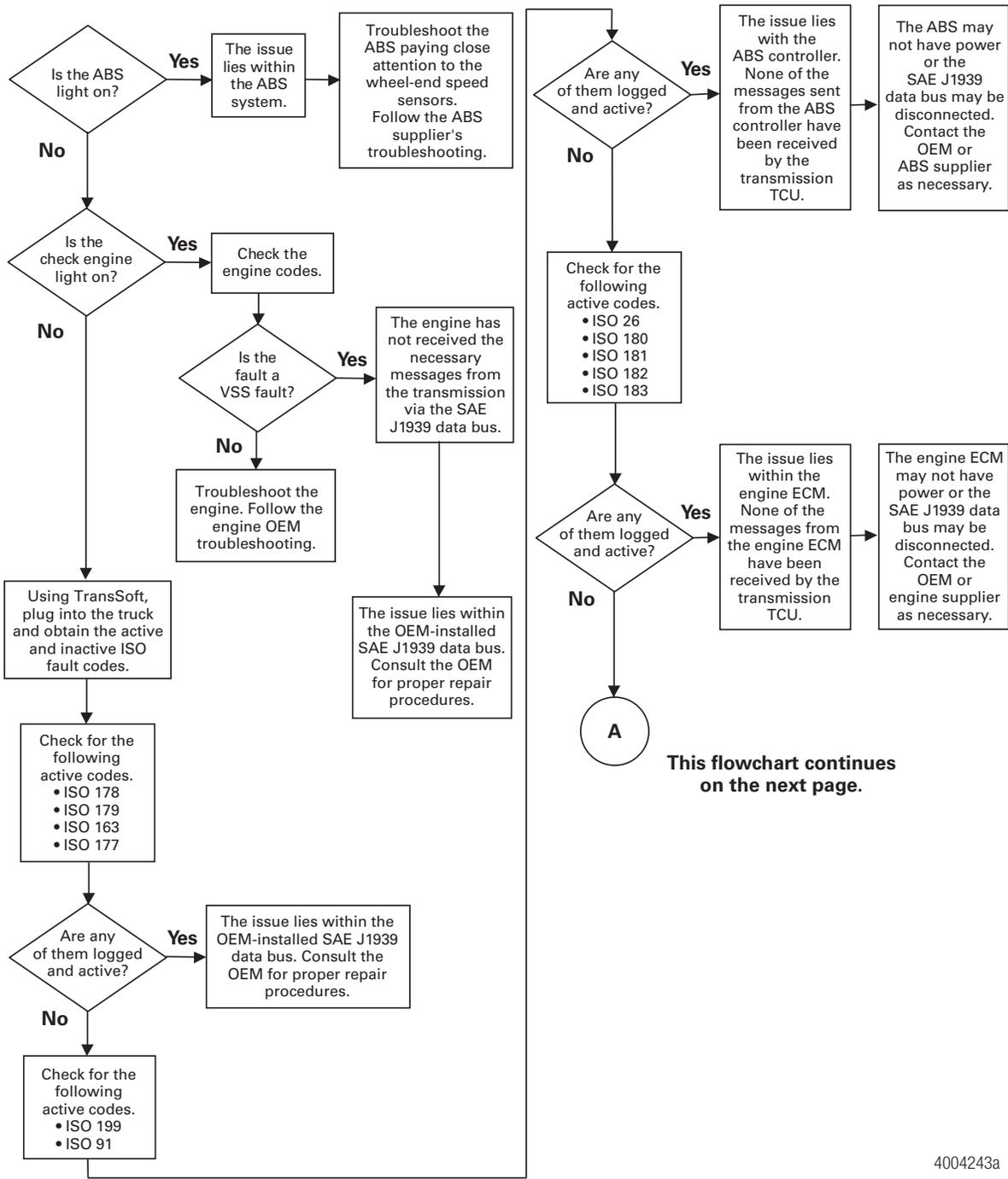
The vehicle may not start after draining the air system if transmission was in gear. Charging the system with shop air will correct this issue.

# Section 3 Maintenance

## SAE J1939 Requirements Flowchart

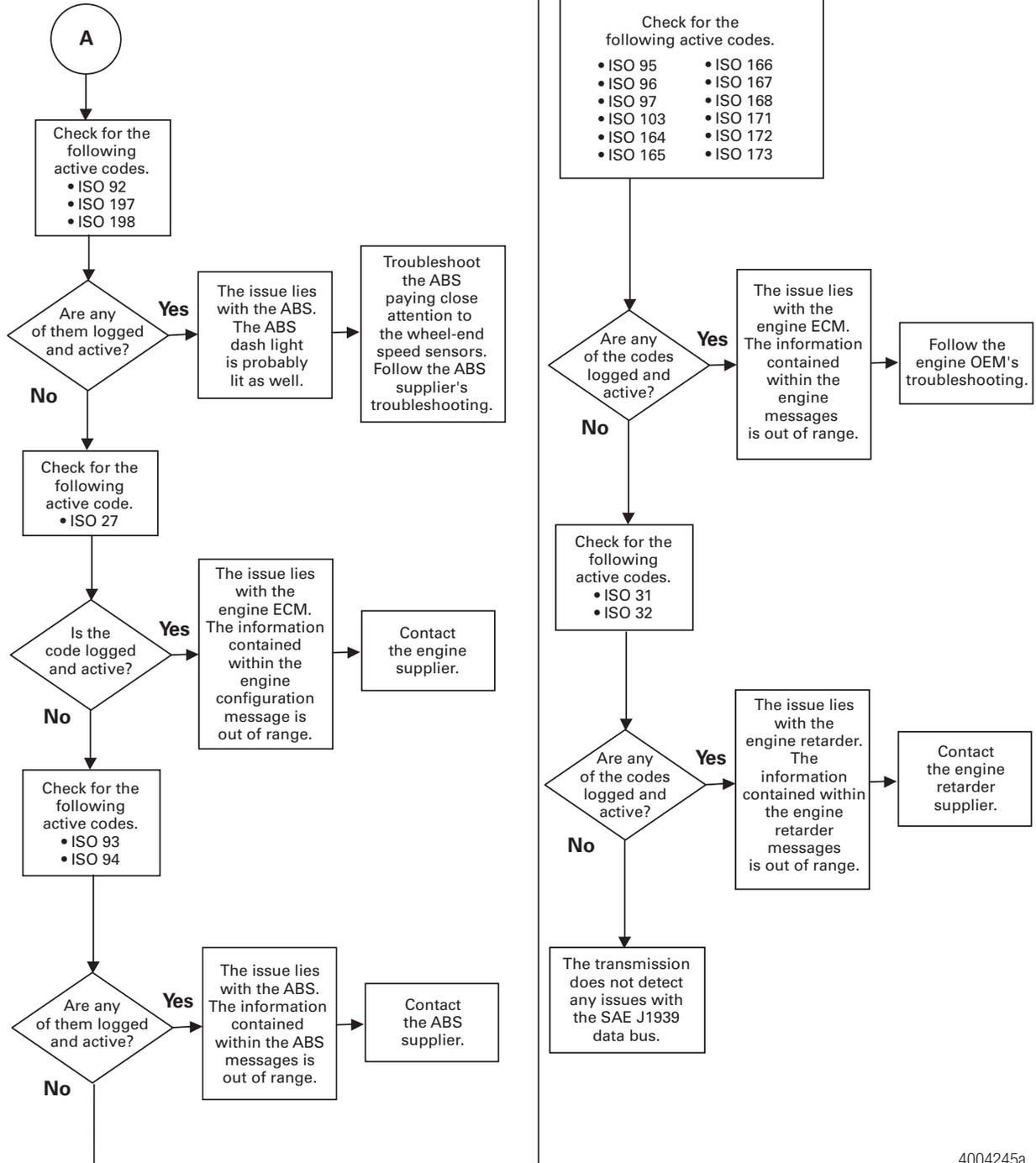
### Notice

The ZF-FreedomLine transmission actively diagnoses SAE J1939 data bus faults and reacts accordingly when the data bus or devices on the data bus, such as engine ECM, VECU (Vehicle Electronic Control Unit), and ABS, that FreedomLine depends on, are not operating properly. The ZF-FreedomLine transmission recognizes two types of SAE J1939 data bus faults, message faults and hardware faults. Message faults are triggered when an SAE J1939 message is either missing or contains information that is out of limits. Hardware faults are triggered when the SAE J1939 data bus fails. Hardware faults include shorted wires, open wires, and improper assembly.



## SAE J1939 Requirements Flowchart

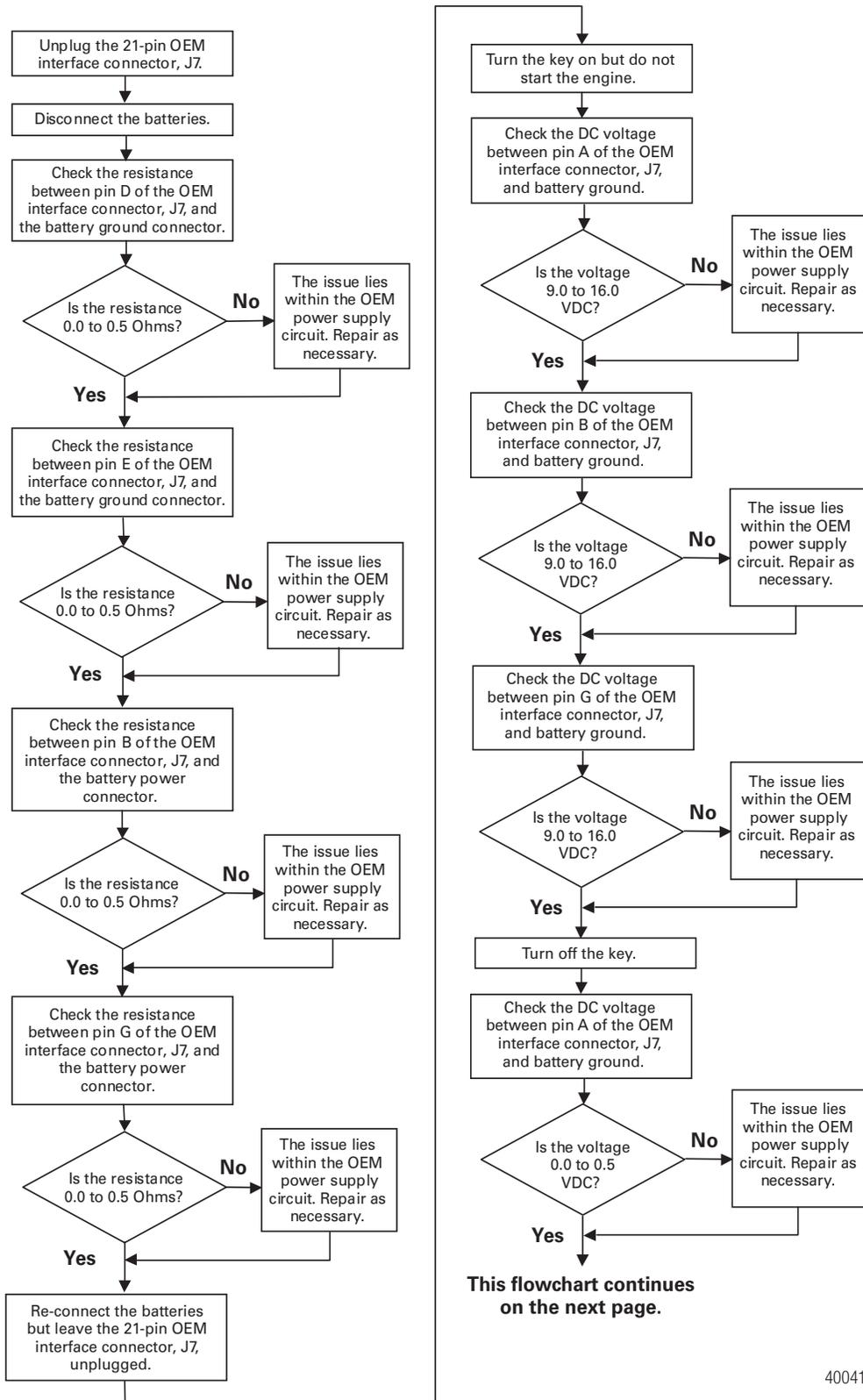
This flowchart continues from the previous page.



4004245a

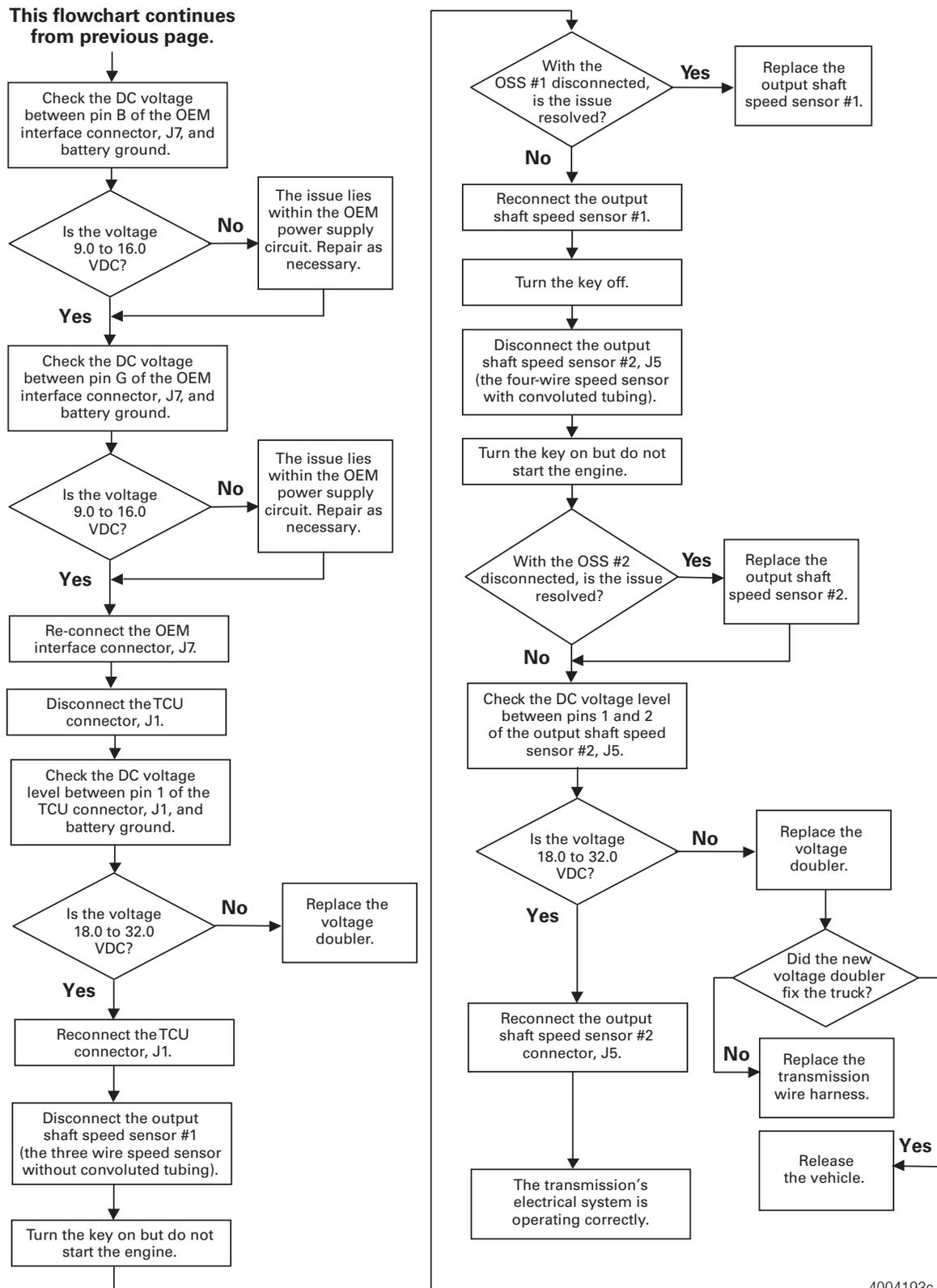
# Section 3 Maintenance

## Electrical Requirements Flowchart



4004157a

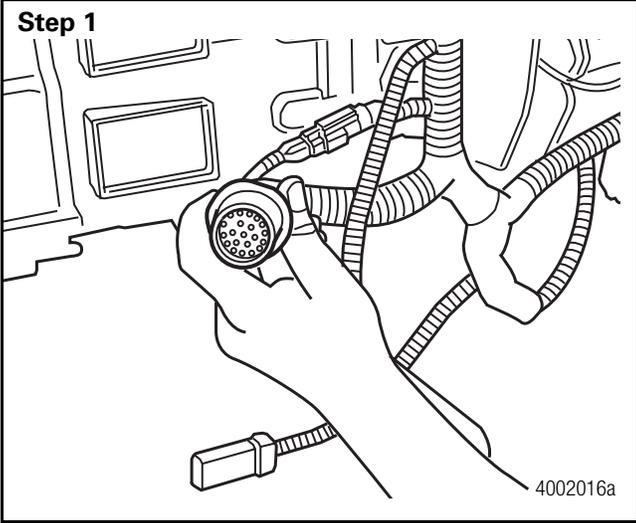
## Electrical Requirements Flowchart



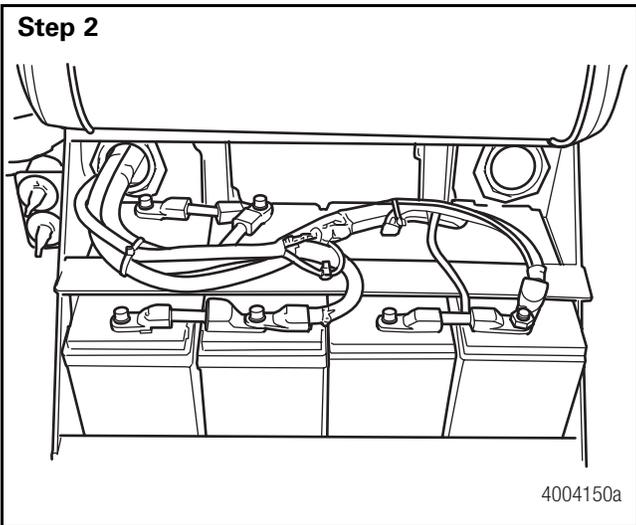
4004193c

# Section 3 Maintenance

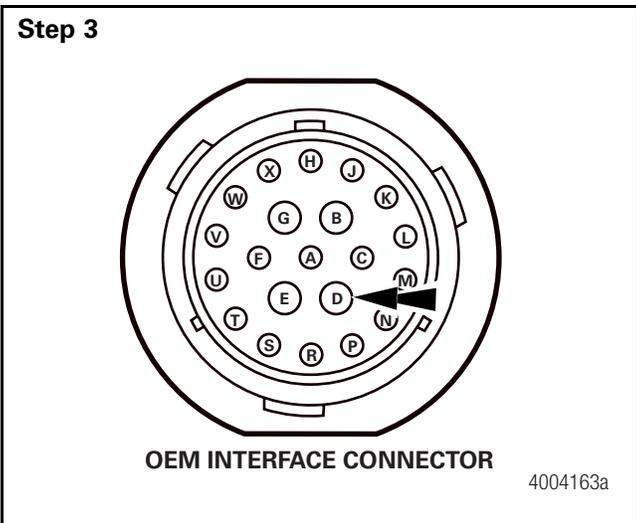
## Electrical Requirements



Unplug the 21-pin OEM interface connector, J7.



Disconnect the batteries. Use a disconnect switch if available.



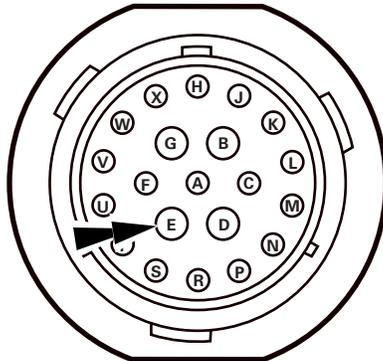
Check the resistance between pin D of the OEM interface connector, J7, and the battery ground connector.

Is the resistance 0.0-0.5 Ohms?

- **YES** → **GO TO STEP 4.**
- **NO** → **THE ISSUE LIES WITHIN THE OEM GROUND CIRCUIT. REPAIR AS NECESSARY.**

## Electrical Requirements

### Step 4



OEM INTERFACE CONNECTOR

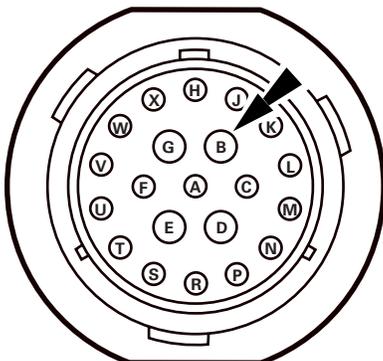
4004164a

Check the resistance between pin E of the OEM interface connector, J7, and the battery ground connector.

Is the resistance 0.0-0.5 Ohms?

- **YES** → GO TO STEP 5.
- **NO** → THE ISSUE LIES WITHIN THE OEM GROUND CIRCUIT. REPAIR AS NECESSARY.

### Step 5



OEM INTERFACE CONNECTOR

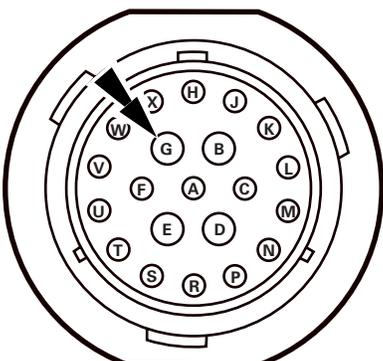
4004165a

Check the resistance between pin B of the OEM interface connector, J7, and the battery power connector.

Is the resistance 0.0-0.5 Ohms?

- **YES** → GO TO STEP 6.
- **NO** → THE ISSUE LIES WITHIN THE OEM 12V BATTERY + CIRCUIT. REPAIR AS NECESSARY.

### Step 6



OEM INTERFACE CONNECTOR

4004166a

Check the resistance between pin G of the OEM interface connector, J7, and the battery power connector.

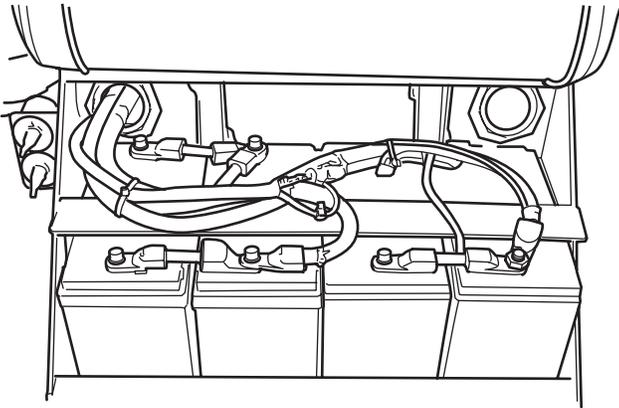
Is the resistance 0.0-0.5 Ohms?

- **YES** → GO TO STEP 7.
- **NO** → THE ISSUE LIES WITHIN THE OEM 12V BATTERY + CIRCUIT. REPAIR AS NECESSARY.

# Section 3 Maintenance

## Electrical Requirements

Step 7

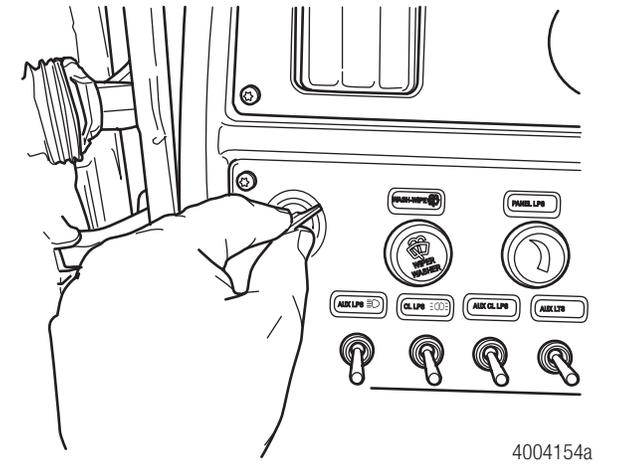


4004150a

**NOTE:** The voltage ranges referenced in the following steps are based on voltage ranges of a system with serviceable batteries. This procedure also assumes that a battery charger is not connected to the batteries.

Reconnect the batteries but leave the 21-pin OEM interface connector, J7, unplugged.

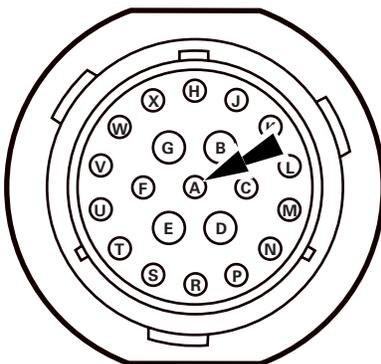
Step 8



4004154a

Turn the key on but do not start the engine.

Step 9



OEM INTERFACE CONNECTOR

4004167a

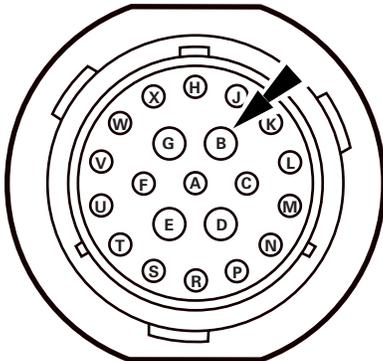
Check the DC voltage between pin A of the OEM interface connector, J7, and the battery ground connector.

Is the DC voltage 9.0 to 16.0 VDC?

- **YES** → GO TO STEP 10.
- **NO** → THE ISSUE LIES WITHIN THE OEM SUPPLY/IGNITION CIRCUIT. REPAIR AS NECESSARY.

## Electrical Requirements

### Step 10



OEM INTERFACE CONNECTOR

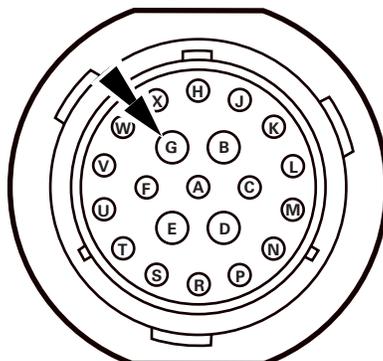
4004165a

Check the DC voltage between pin B of the OEM interface connector, J7, and the battery ground connector.

Is the DC voltage 9.0 to 16.0 VDC?

- **YES** → GO TO STEP 11.
- **NO** → THE ISSUE LIES WITHIN THE OEM BATTERY POSITIVE + CIRCUIT. REPAIR AS NECESSARY.

### Step 11



OEM INTERFACE CONNECTOR

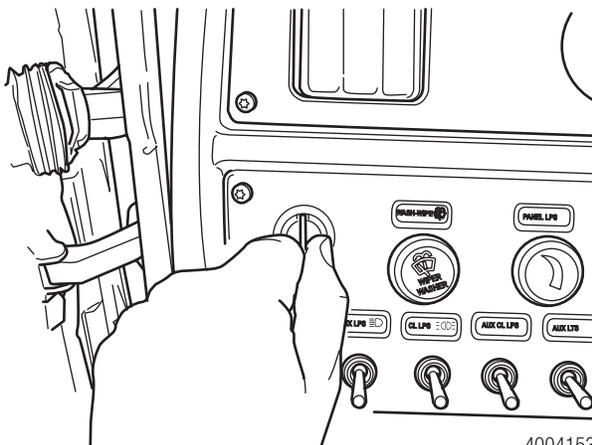
4004166a

Check the DC voltage between pin G of the OEM interface connector, J7, and the battery ground connector.

Is the DC voltage 9.0 to 16.0 VDC?

- **YES** → GO TO STEP 12.
- **NO** → THE ISSUE LIES WITHIN THE OEM BATTERY POSITIVE + CIRCUIT. REPAIR AS NECESSARY.

### Step 12



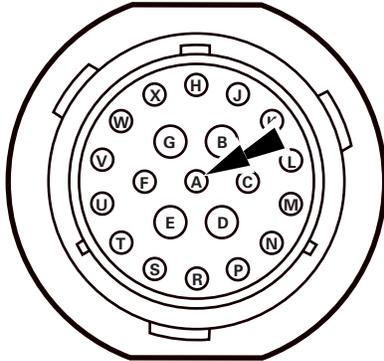
4004153a

Turn the key off.

## Section 3 Maintenance

### Electrical Requirements

#### Step 13



OEM INTERFACE CONNECTOR

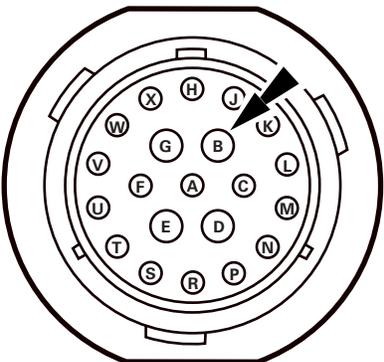
4004167a

Check the DC voltage between pin A of the OEM interface connector, J7, and the battery ground connector.

Is the DC voltage 0.0 to 0.5 VDC?

- **YES** → **GO TO STEP 14.**
- **NO** → **THE ISSUE LIES WITHIN THE OEM SUPPLY/IGNITION CIRCUIT. REPAIR AS NECESSARY.**

#### Step 14



OEM INTERFACE CONNECTOR

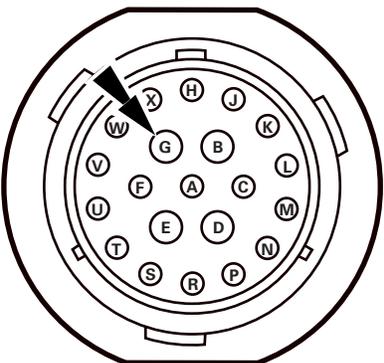
4004165a

Check the DC voltage between pin B of the OEM interface connector, J7, and the battery ground connector.

Is the DC voltage 9.0 to 16.0 VDC?

- **YES** → **GO TO STEP 15.**
- **NO** → **THE ISSUE LIES WITHIN THE OEM BATTERY + CIRCUIT. REPAIR AS NECESSARY.**

#### Step 15



OEM INTERFACE CONNECTOR

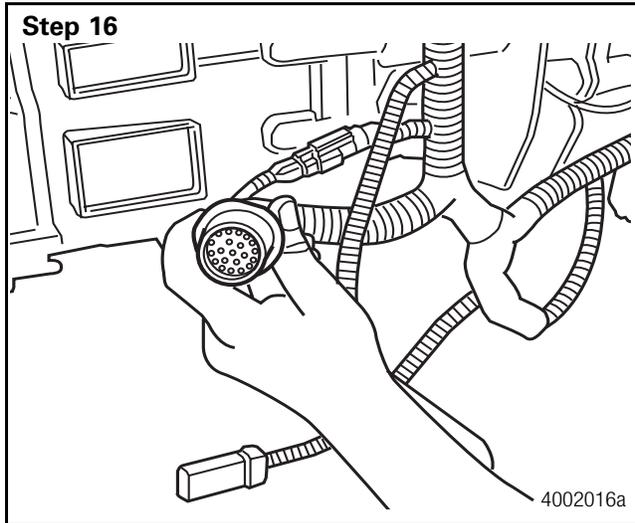
4004166a

Check the DC voltage between pin G of the OEM interface connector, J7, and the battery ground connector.

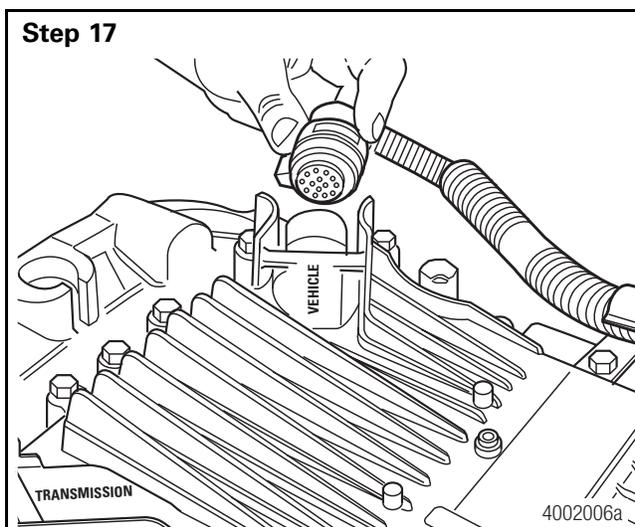
Is the DC voltage 9.0 to 16.0 VDC?

- **YES** → **GO TO STEP 16.**
- **NO** → **THE ISSUE LIES WITHIN THE OEM BATTERY POSITIVE + CIRCUIT. REPAIR AS NECESSARY.**

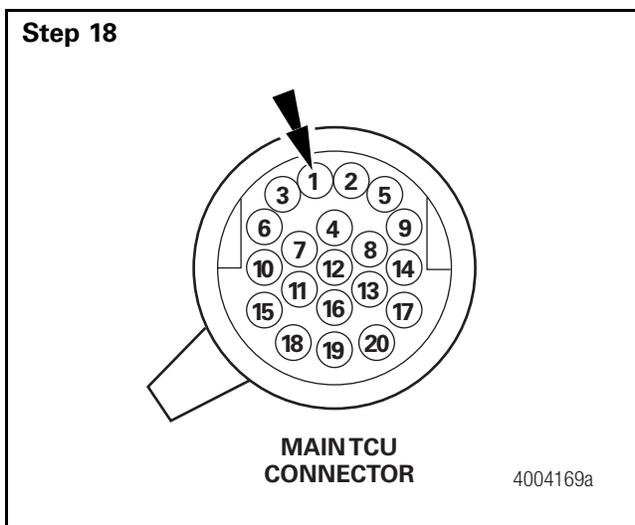
## Electrical Requirements



Reconnect the OEM interface connector, J7.



Disconnect the TCU connector, J1 (this connector is located on the passenger side of the TCU).



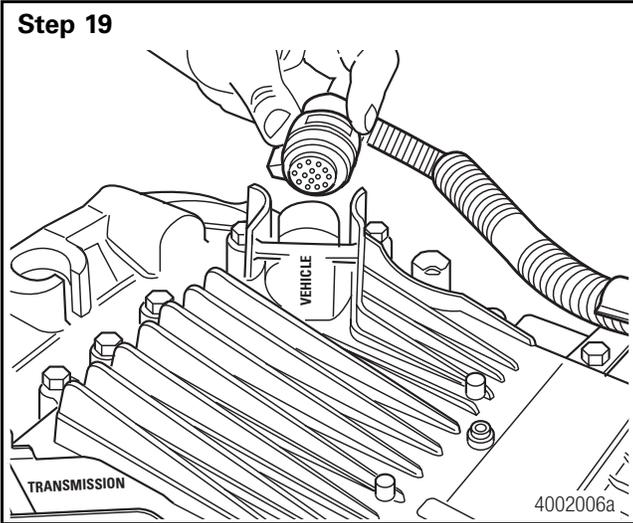
Check the DC voltage between pins 1, 4 and 5 of the TCU connector, J1, and the battery ground connector.

Is the DC voltage 18.0 to 32.0 VDC?

- **YES** → GO TO STEP 19.
- **NO** → REPLACE THE VOLTAGE DOUBLER IF THE VOLTAGE IS FROM 9.0 TO 16.0 VDC. REPLACE THE TRANSMISSION WIRING HARNESS IF THE VOLTAGE IS 0 VDC. IF THE VOLTAGE IS THE SAME AS BATTERY, REPLACE THE DOUBLER. IF NO VOLTAGE IS PRESENT, REPLACE TRANSMISSION HARNESS.

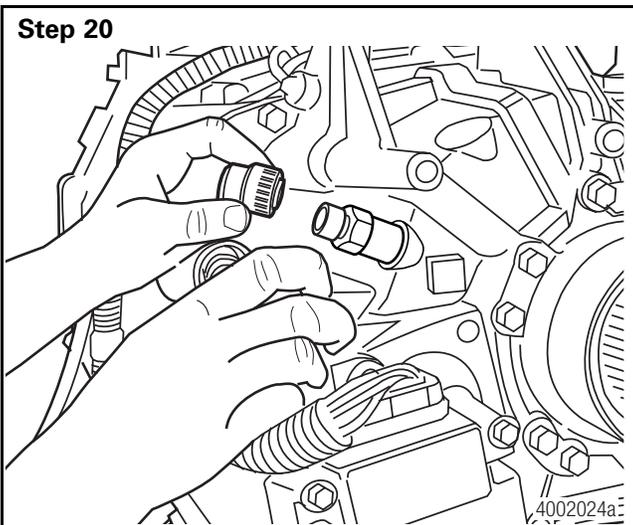
# Section 3 Maintenance

## Electrical Requirements

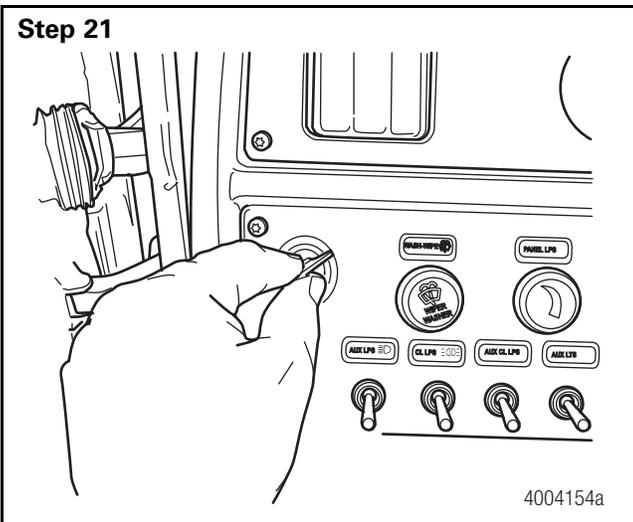


Reconnect the TCU connector, J1.

**GO TO STEP 20.**



Disconnect the output shaft speed sensor #1 (the three wire speed sensor without convoluted tubing).

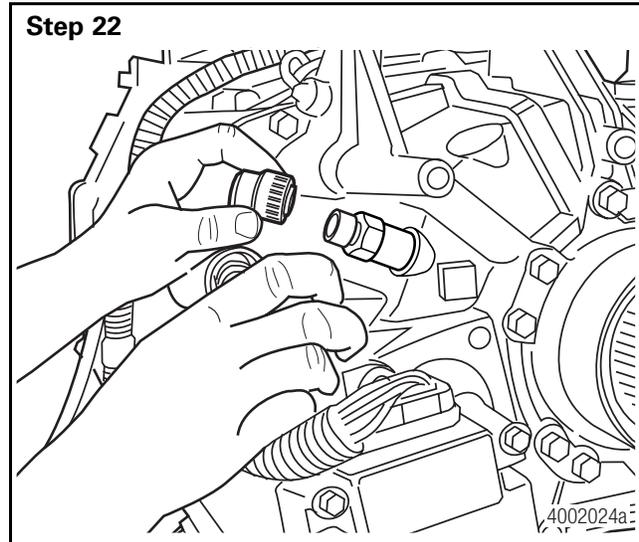


Turn the key on but do not start the engine.

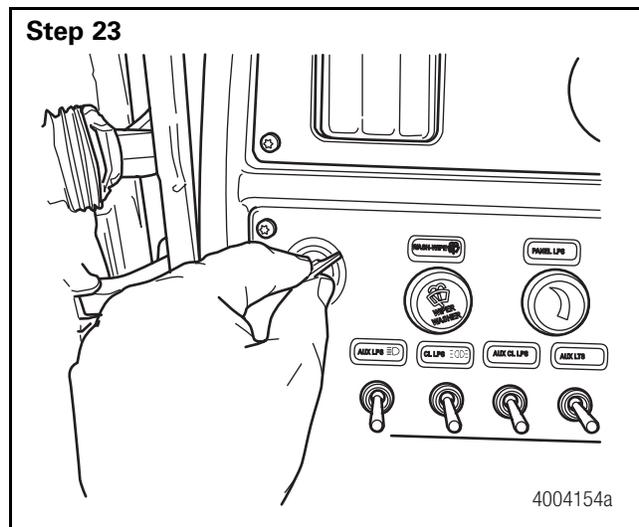
With the OSS #1 disconnected, is the issue resolved except for an active ISO 99?

- **YES** → **REPLACE THE OUTPUT SHAFT SPEED SENSOR #1.**
- **NO** → **GO TO STEP 22.**

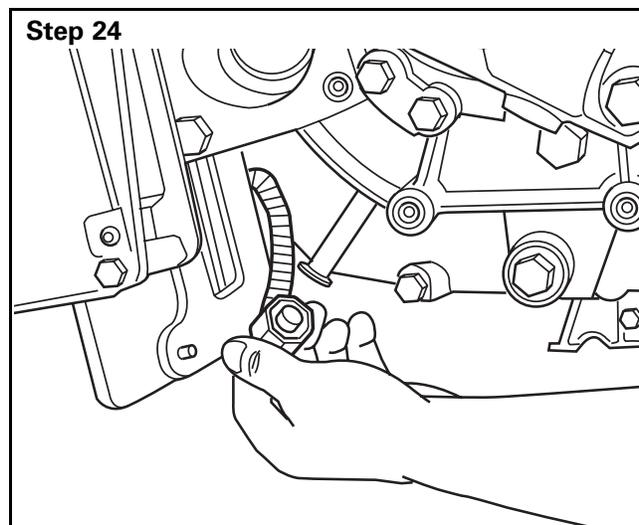
## Electrical Requirements



Reconnect the output shaft speed sensor #1.



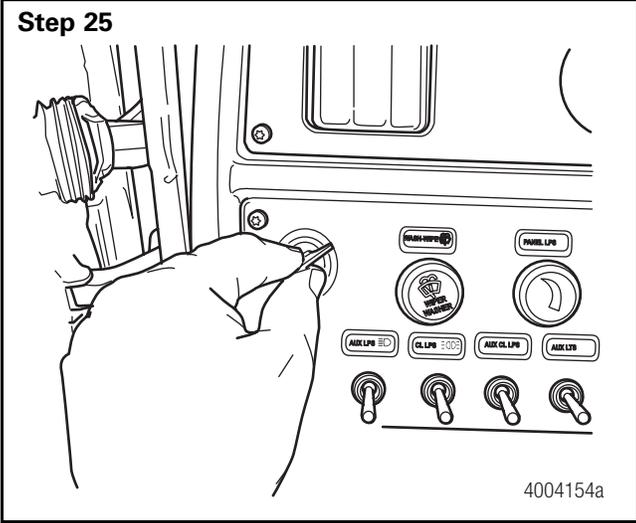
Turn the key off.



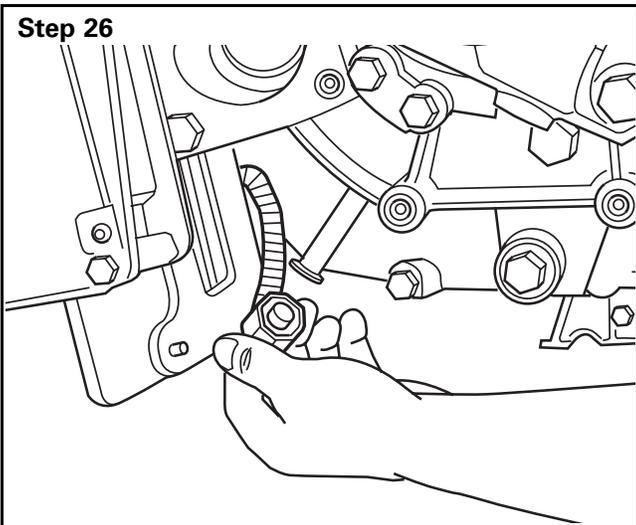
Disconnect the output shaft speed sensor #2, J5 (the four-wire sensor with convoluted tubing).

# Section 3 Maintenance

## Electrical Requirements

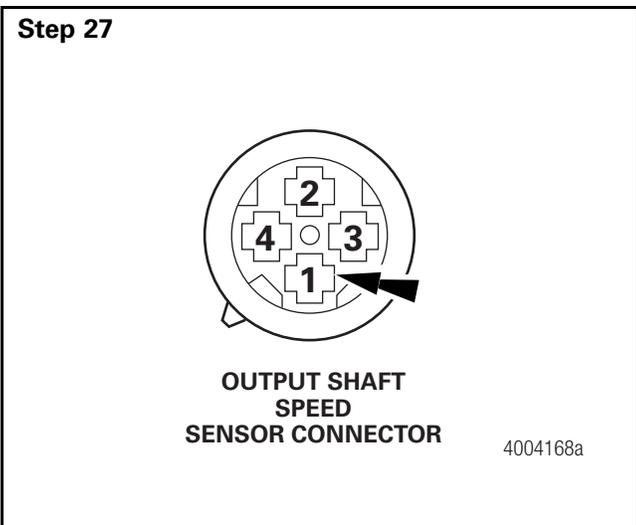


Turn the key on but do not start the engine.



With the output shaft speed sensor #2 disconnected, is the issue resolved except for an active ISO 100?

- **YES** → **REPLACE THE OUTPUT SHAFT SPEED SENSOR #2.**
- **NO** → **GO TO STEP 27.**

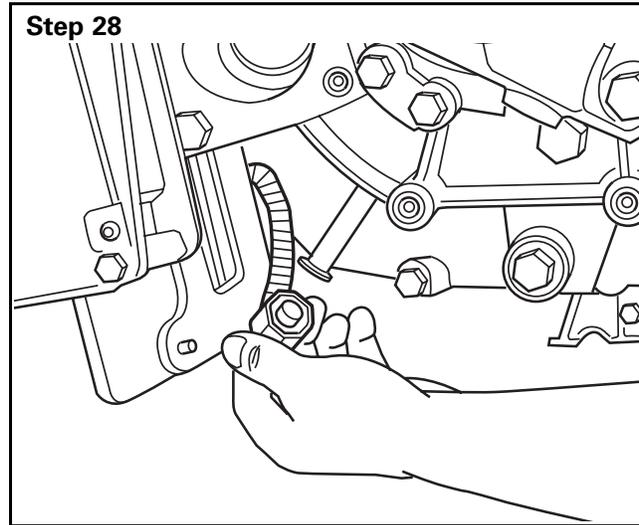


Check the DC voltage between pin 1 of the output shaft speed sensor #1, J5, and the battery ground connector.

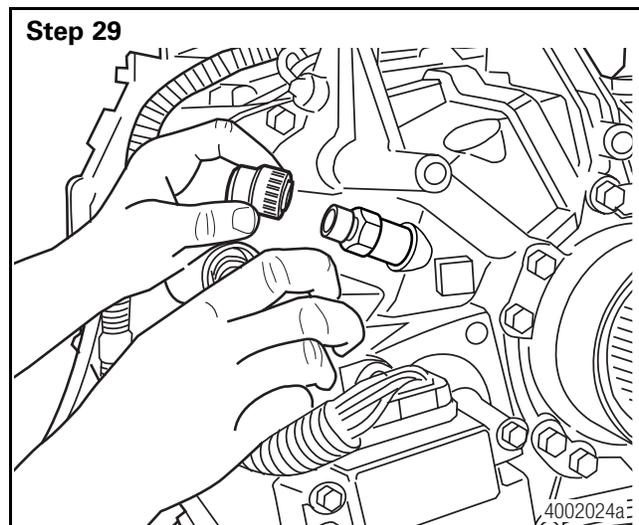
Is the DC voltage 18.0 to 32.0 VDC?

- **YES** → **GO TO STEP 29.**
- **NO** → **IF VOLTAGE IS < 6 VOLTS, REPLACE THE TRANSMISSION TCU TOP HALF.**

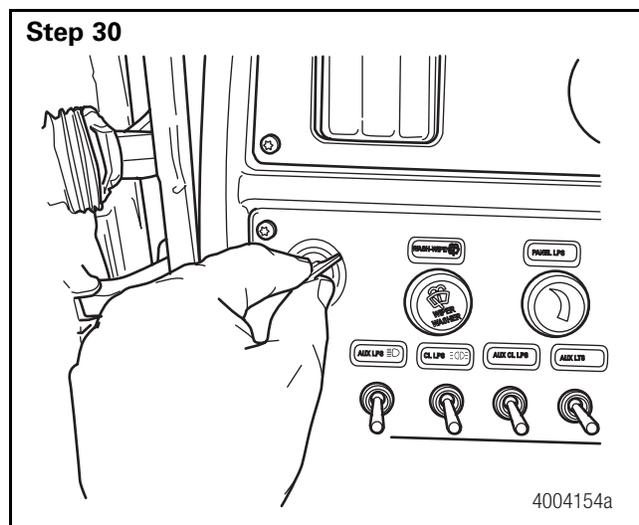
## Electrical Requirements



Reconnect the output shaft speed sensor #2, J5.  
The transmission's electrical system is operating correctly.



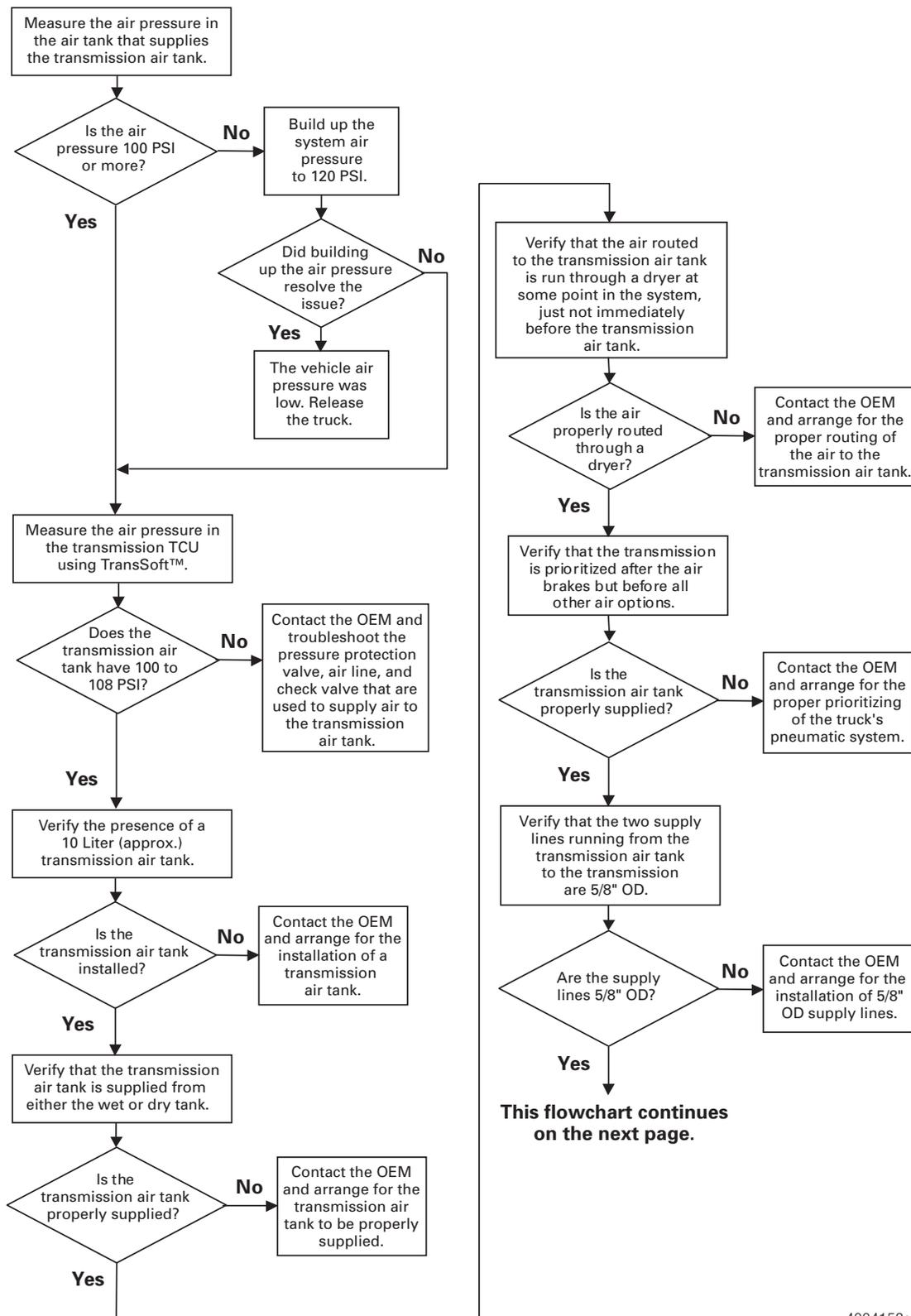
Reconnect the output shaft speed sensor #1.



Turn the key off.

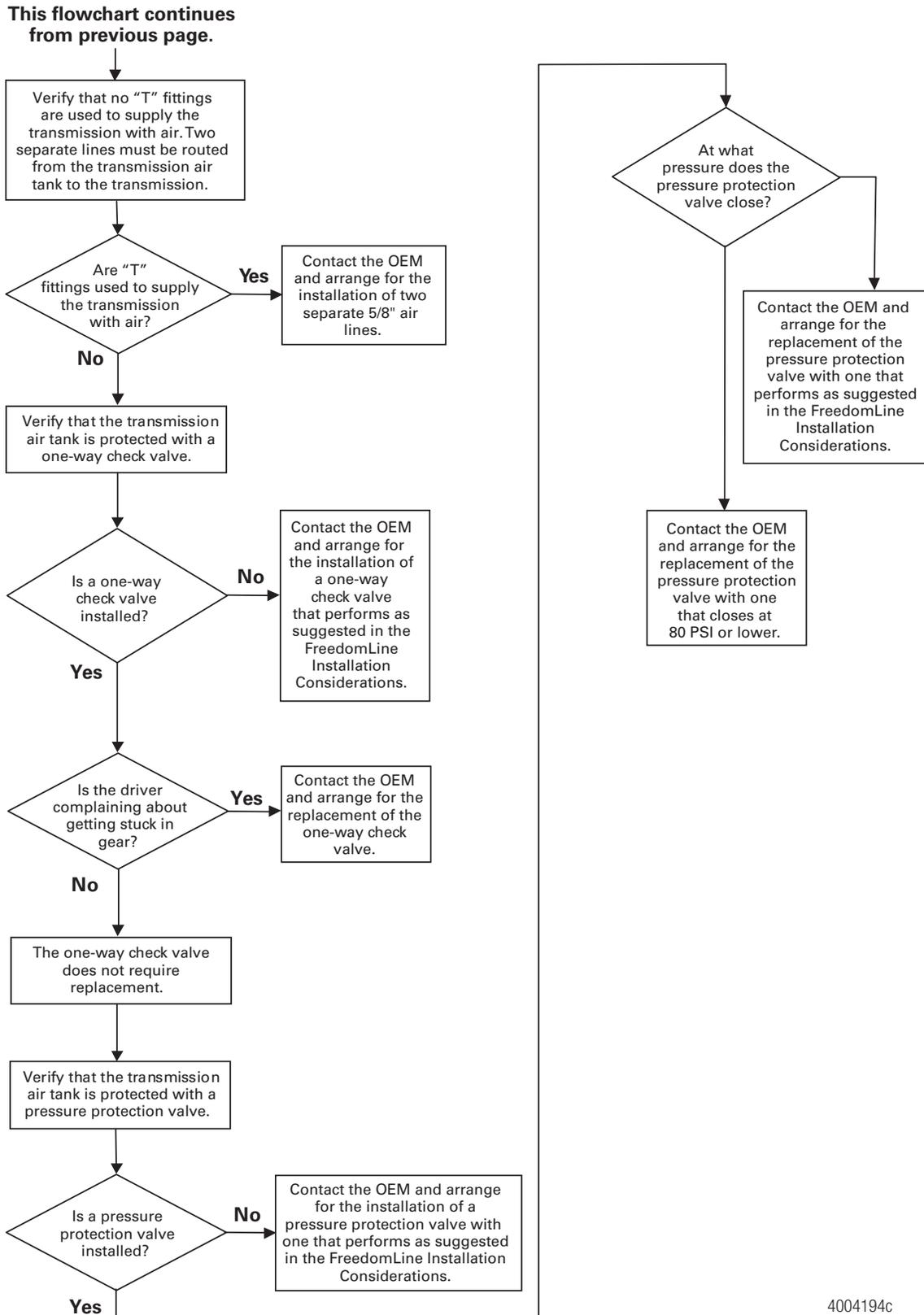
# Section 3 Maintenance

## Pneumatic Requirements Flowchart



4004158a

## Pneumatic Requirements Flowchart

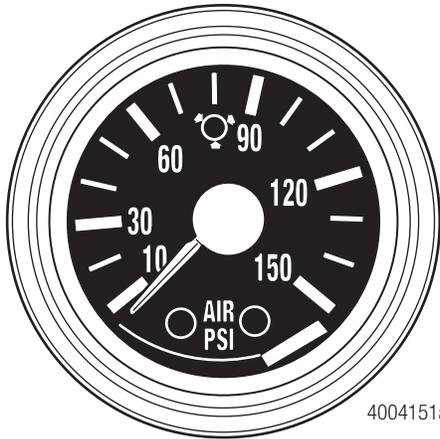


4004194c

# Section 3 Maintenance

## Pneumatic Requirements

### Step 1

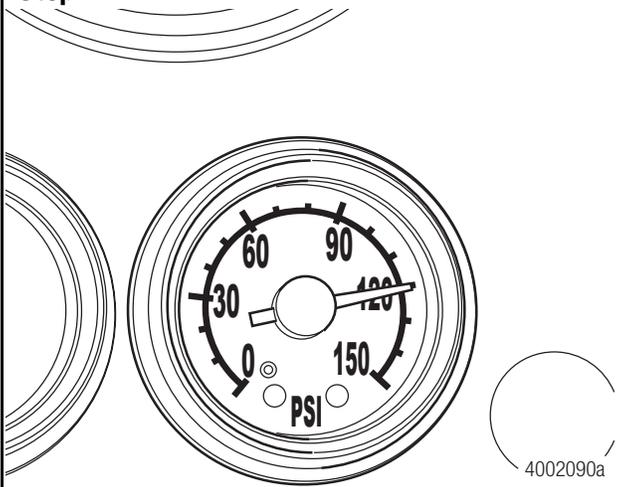


Measure the air pressure in the vehicle air tanks.

Is the air pressure 100 psi or more?

- YES → GO TO STEP 3.
- NO → GO TO STEP 2.

### Step 2

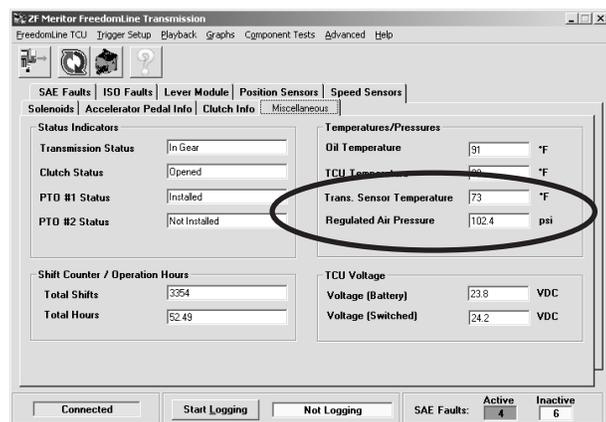


Build up the air pressure to 120 psi.

Does this resolve the issue?

- YES → RELEASE THE TRUCK.
- NO → GO TO STEP 3.

### Step 3



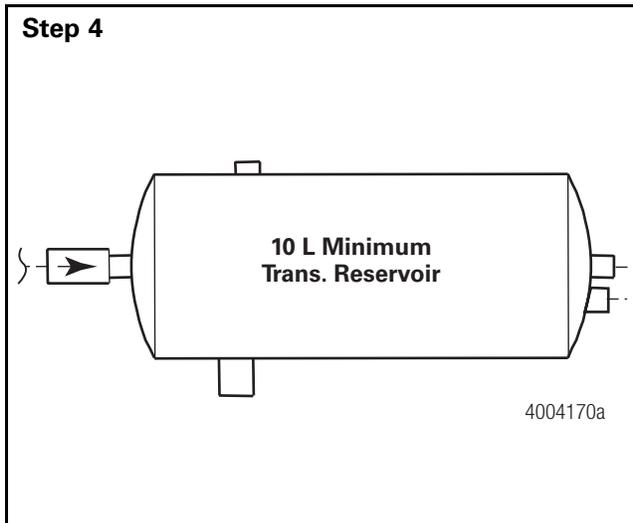
Measure the air pressure at the transmission using TransSoft™.

Is the air pressure 95 to 108 psi?

- YES → GO TO STEP 4.
- NO → CONTACT THE OEM AND TROUBLESHOOT THE PRESSURE PROTECTION VALVE, AIR LINE, AND CHECK VALVE THAT ARE USED TO SUPPLY AIR TO THE TRANSMISSION AIR TANK.

## Pneumatic Requirements

### Step 4



Verify the presence of a 10 L (approximately) transmission air tank.

Is the transmission air tank installed?

- **YES → GO TO STEP 5.**
- **NO → CONTACT THE OEM AND ARRANGE FOR THE INSTALLATION OF A TRANSMISSION AIR TANK.**

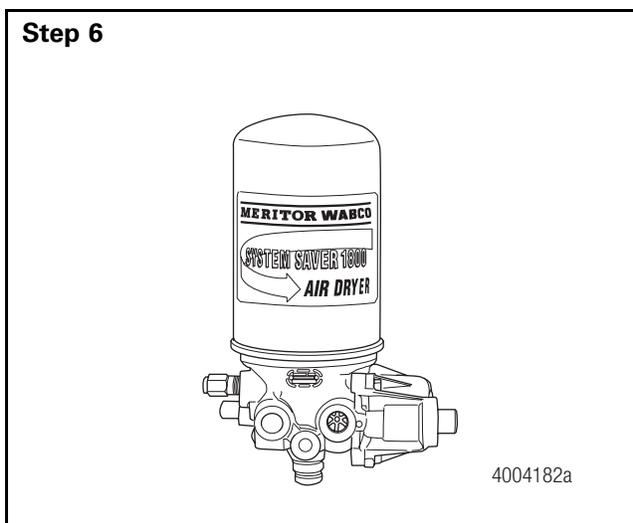
### Step 5

Verify that the transmission air tank is being supplied by either the wet or dry tank.

Is the air supply properly routed?

- **YES → GO TO STEP 6.**
- **NO → CONTACT THE OEM AND ARRANGE FOR THE TRANSMISSION AIR TANK TO BE PROPERLY SUPPLIED.**

### Step 6



Verify that the air routed to the transmission air tank is run through a dryer at some point in the system.

Is the air run through a dryer?

- **YES → GO TO STEP 7.**
- **NO → CONTACT THE OEM AND ARRANGE FOR THE PROPER ROUTING OF THE AIR TO THE TRANSMISSION AIR TANK.**

## Section 3 Maintenance

### Pneumatic Requirements

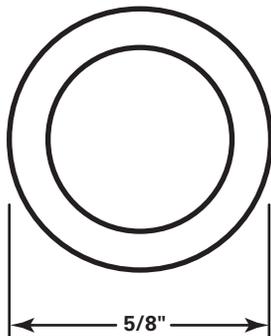
#### Step 7

Verify that the transmission is prioritized after the air brakes but before all other air options.

Is the transmission prioritized correctly?

- **YES** → **GO TO STEP 8.**
- **NO** → **CONTACT THE OEM AND ARRANGE FOR THE CORRECT PRIORITIZING OF THE TRUCK'S PNEUMATIC SYSTEM.**

#### Step 8



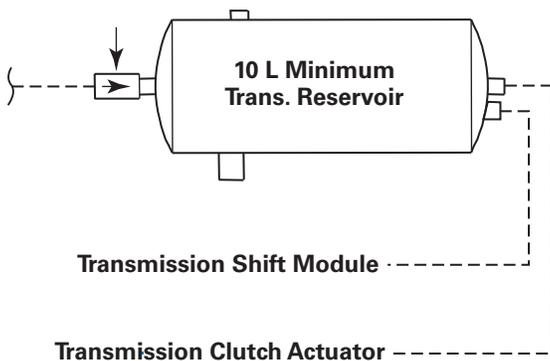
4004173a

Verify that the two supply lines running from the transmission air tank to the transmission are 5/8" OD.

Are the supply line 5/8" OD?

- **YES** → **GO TO STEP 9.**
- **NO** → **CONTACT THE OEM AND ARRANGE FOR THE INSTALLATION OF 5/8" OD AIR SUPPLY LINES.**

#### Step 9



4004174a

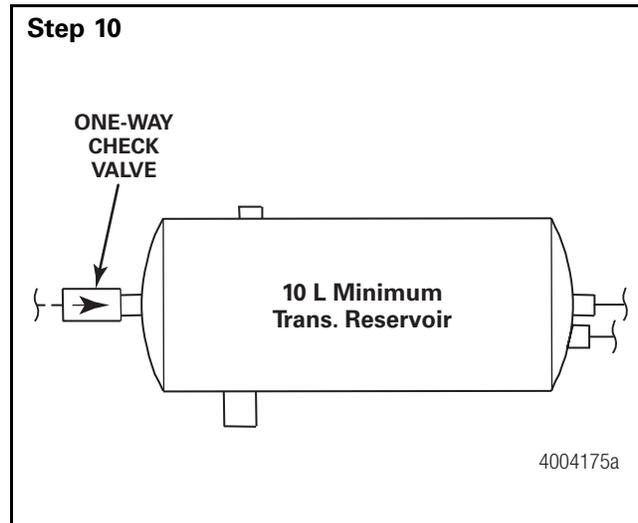
Verify that no "T" fittings are used to supply the transmission with air.

**NOTE: ZF does not recommend the use of a "T-fitting" between the dedicated air tank and the transmission air lines, instead the use of a separate line for the clutch actuator and for the transmission control unit is recommended.**

Are two separate lines installed?

- **YES** → **GO TO STEP 10.**
- **NO** → **CONTACT THE OEM AND ARRANGE FOR THE INSTALLATION OF TWO SEPARATE AIR SUPPLY LINES.**

## Pneumatic Requirements



Verify that the transmission air tank is protected with a one-way check valve.

Is a one-way check valve installed?

- **YES → GO TO STEP 11.**
- **NO → CONTACT THE OEM AND ARRANGE FOR THE REPLACEMENT OF THE PRESSURE PROTECTION VALVE WITH ONE THAT PERFORMS AS SUGGESTED IN THE FREEDOMLINE INSTALLATION CONSIDERATIONS.**

### Step 11

Is the driver complaining about getting stuck in gear?

- **NO → THE ONE-WAY CHECK VALVE DOES NOT REQUIRE REPLACEMENT. GO TO STEP 12.**
- **YES → CONTACT THE OEM AND ARRANGE FOR THE REPLACEMENT OF THE PRESSURE PROTECTION VALVE WITH ONE THAT PERFORMS AS SUGGESTED IN THE FREEDOMLINE INSTALLATION CONSIDERATIONS.**

### Step 13

Does the pressure protection valve function correctly?

- **CONTACT THE OEM TO DETERMINE WHAT THE CORRECT OPENING AND CLOSING VALUES ARE FOR THE INSTALLED VALVE.**

### Step 12

Verify that the vehicle's air tanks are protected with a pressure protection valve.

Is a pressure protection valve installed?

- **YES → GO TO STEP 13.**
- **NO → CONTACT THE OEM AND ARRANGE FOR THE REPLACEMENT OF THE PRESSURE PROTECTION VALVE WITH ONE THAT PERFORMS AS SUGGESTED IN THE FREEDOMLINE INSTALLATION CONSIDERATIONS.**

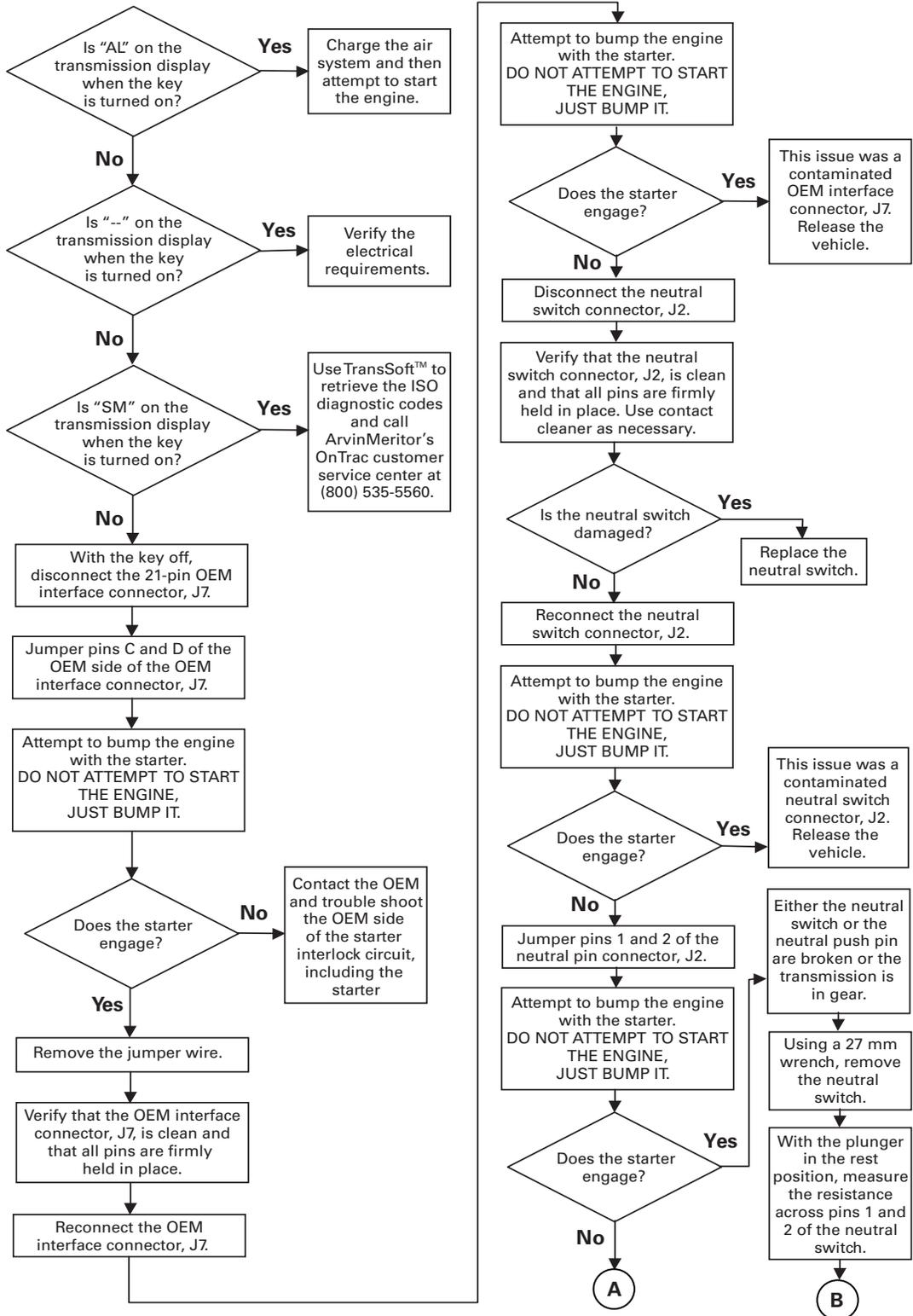
### Step 14

Is the driver complaining about getting stuck in gear?

- **NO → THE PRESSURE PROTECTION VALVE DOES NOT REQUIRE REPLACEMENT. THE VEHICLE'S AIR SUPPLY TO THE TRANSMISSION IS INSTALLED CORRECTLY.**
- **YES → CONTACT THE OEM AND ARRANGE FOR THE REPLACEMENT OF THE PRESSURE PROTECTION VALVE WITH ONE THAT PERFORMS AS SUGGESTED IN THE FREEDOMLINE INSTALLATION CONSIDERATIONS.**

# Section 3 Maintenance

## No-Start Troubleshooting Flowchart

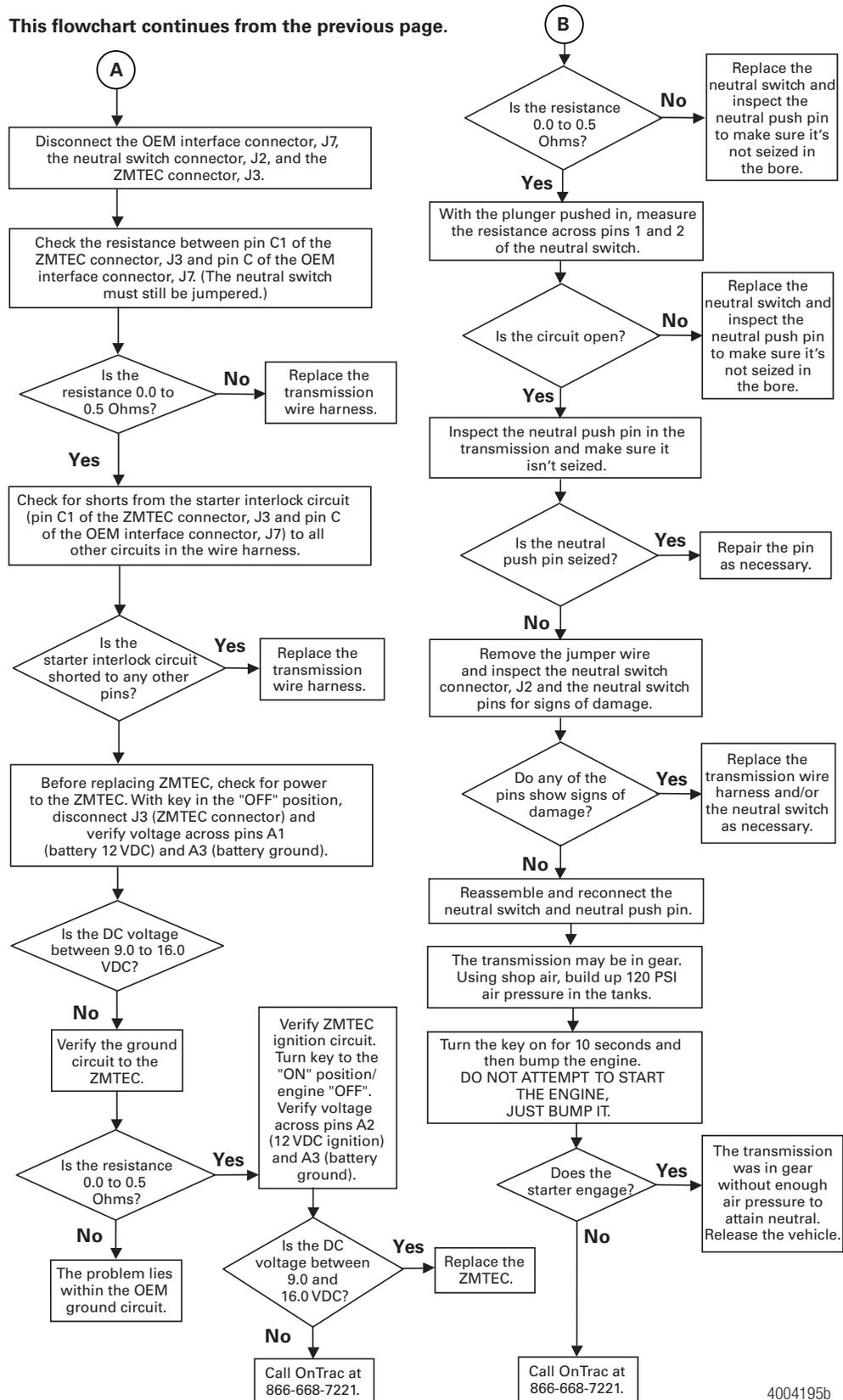


This flowchart continues on the next page.

4004159a

## No-Start Troubleshooting Flowchart

This flowchart continues from the previous page.



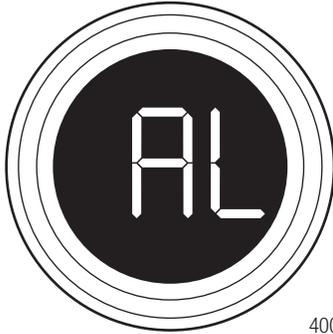
4004195b

## Section 3 Maintenance

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### No-Start Troubleshooting

#### Step 1

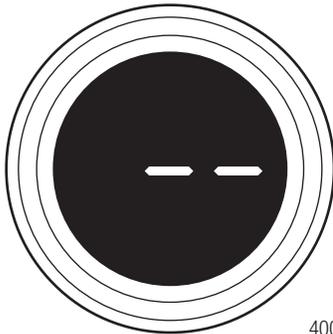


4004156a

Is "AL" on the transmission display when the key is turned on?

- **NO** → GO TO STEP 2.
- **YES** → CHARGE THE AIR SYSTEM AND THEN ATTEMPT TO START THE ENGINE.

#### Step 2



4004160a

Is "--" on the transmission display when the key is turned on?

- **NO** → GO TO STEP 3.
- **YES** → VERIFY THE ELECTRICAL REQUIREMENTS OF THE TRANSMISSION.

#### Step 3

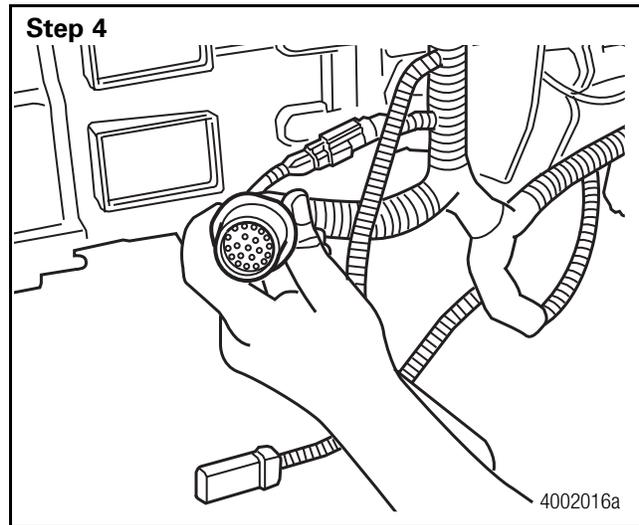


4004161a

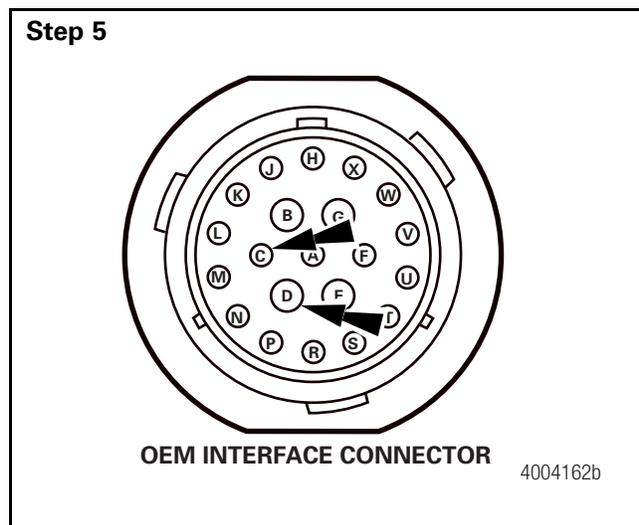
Is "SM" on the transmission display when the key is turned on?

- **NO** → GO TO STEP 4.
- **YES** → USE TRANSSOFT™ TO RETRIEVE THE ISO DIAGNOSTIC CODES AND TROUBLESHOOT ACTIVE FAULT CODES. IF ASSISTANCE IS NEEDED, CALL ONTRAC AT 866-668-7221.

## No-Start Troubleshooting



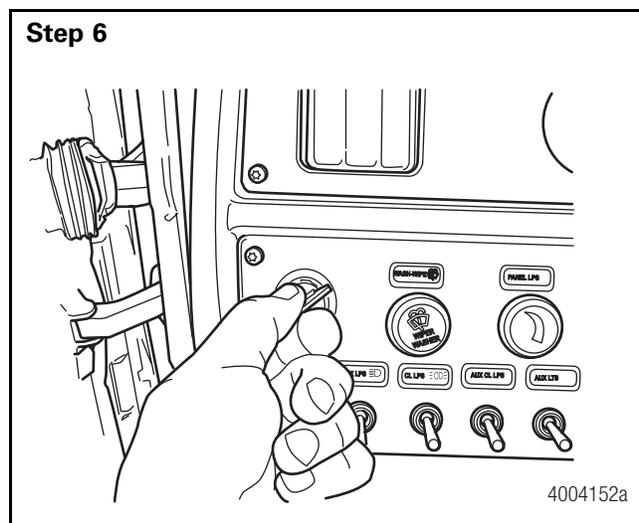
With the key off, disconnect the 21-pin OEM interface connector, J7.



### **WARNING**

Before performing this step, ensure that the transmission air system is working properly and that the transmission is in neutral.

Jumper pins C and D of the OEM side of the OEM interface connector, J7.



Attempt to bump the engine with the starter. **DO NOT ATTEMPT TO START THE ENGINE, JUST BUMP IT.**

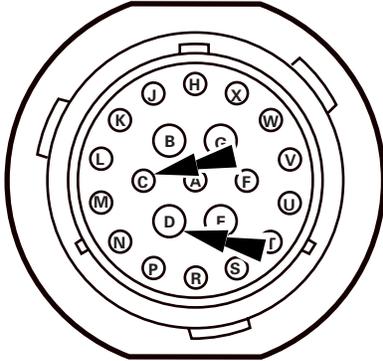
Does the starter engage?

- **YES** → **GO TO STEP 7.**
- **NO** → **CONTACT THE OEM AND TROUBLESHOOT THE OEM SIDE OF THE STARTER INTERLOCK CIRCUIT, INCLUDING THE STARTER.**

# Section 3 Maintenance

## No-Start Troubleshooting

Step 7

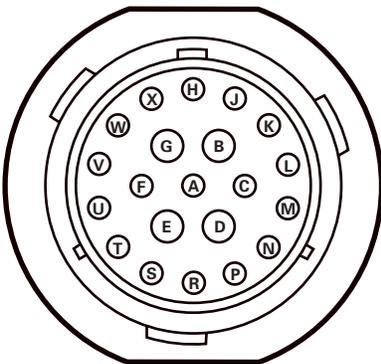


OEM INTERFACE CONNECTOR

4004162b

Remove the jumper wire from the OEM side of the OEM interface connector, J7.

Step 8

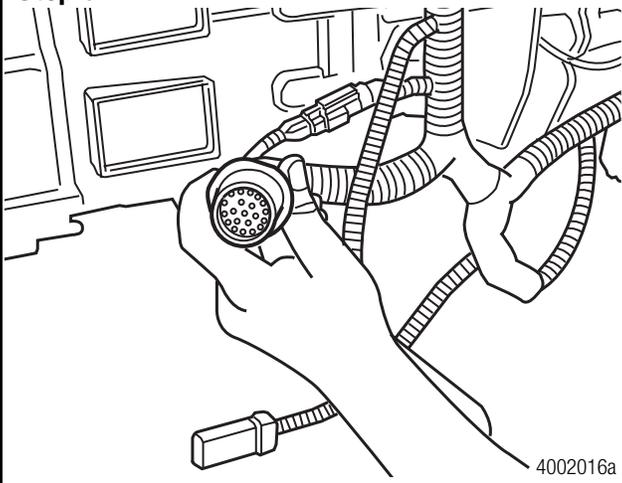


OEM INTERFACE CONNECTOR

4001982b

Verify that the OEM interface connector, J7, is clean and that all pins are firmly held in place. Use contact cleaner as necessary.

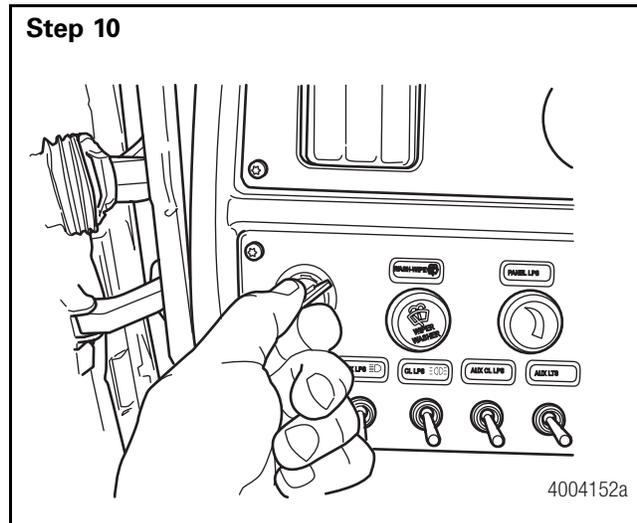
Step 9



4002016a

Reconnect the OEM interface connector, J7.

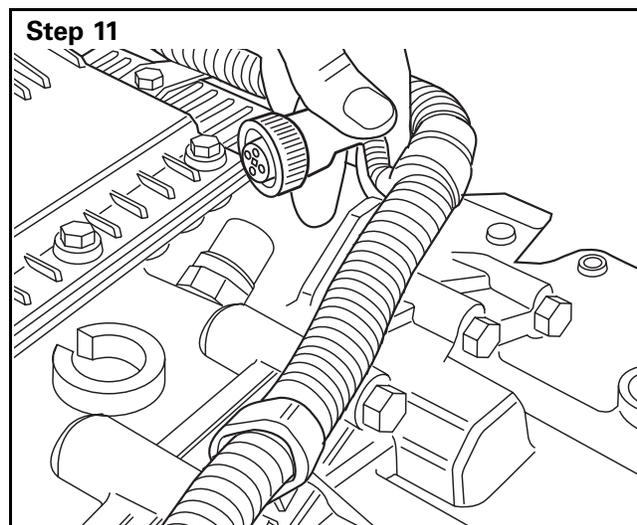
## No-Start Troubleshooting



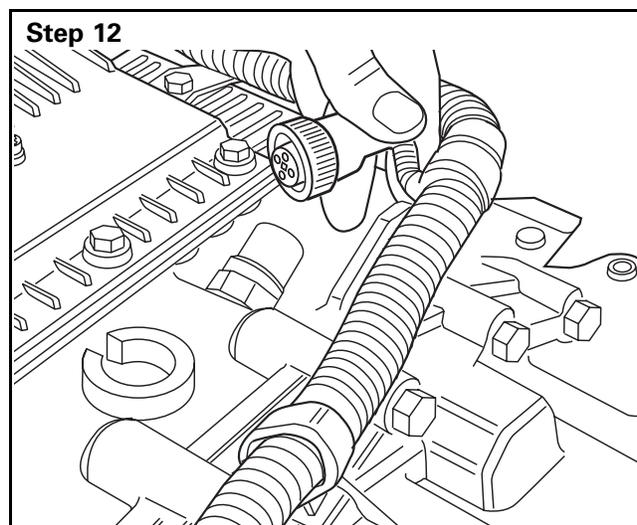
Attempt to bump the engine with the starter. **DO NOT ATTEMPT TO START THE ENGINE, JUST BUMP IT.**

Does the starter engage?

- **NO** → **GO TO STEP 11.**
- **YES** → **THE ISSUE WAS A CONTAMINATED OEM INTERFACE CONNECTOR, J7.**



Disconnect the neutral switch connector, J2.



Verify that the neutral switch connector, J2, and the neutral switch are clean and that all pins are firmly held in place.

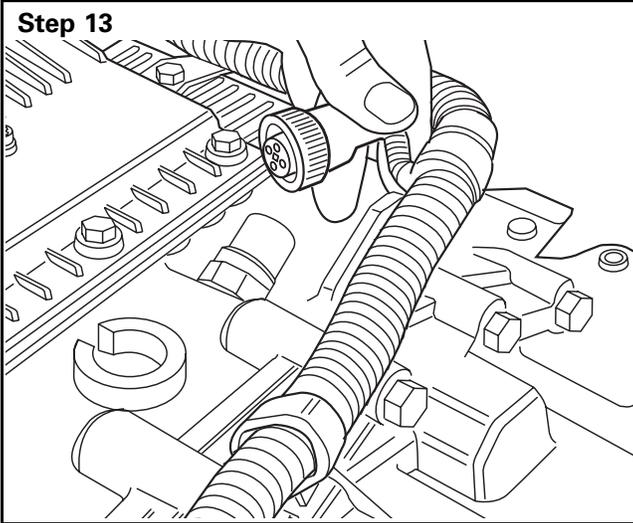
Use contact cleaner as necessary.

Do any of the pins show signs of damage?

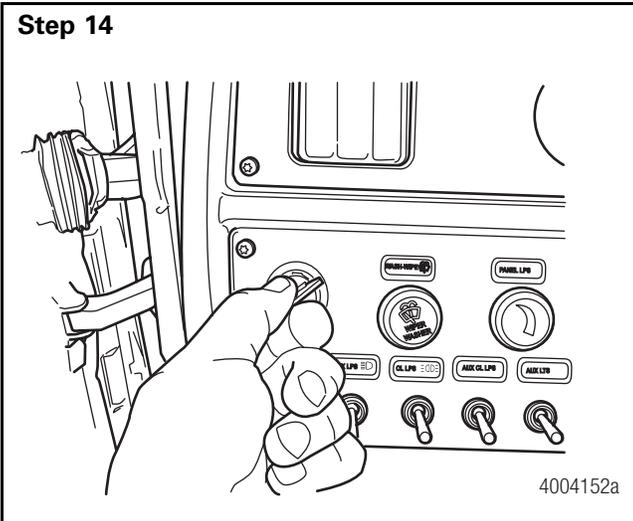
- **NO** → **GO TO STEP 13.**
- **YES** → **REPLACE THE TRANSMISSION WIRING HARNESS AND/OR THE NEUTRAL SWITCH AS NECESSARY.**

## Section 3 Maintenance

### No-Start Troubleshooting



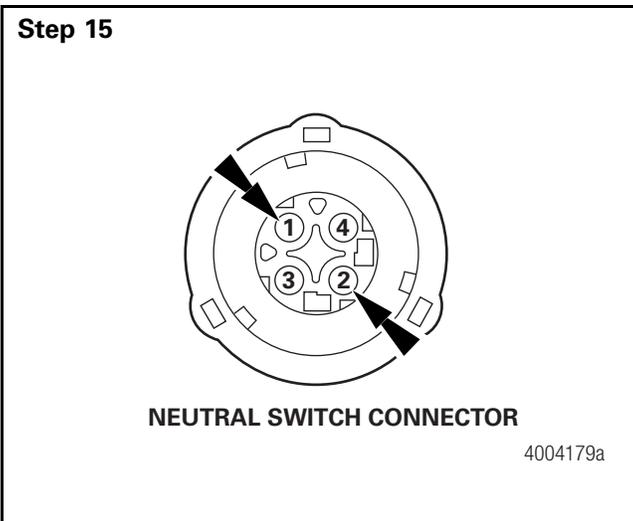
Reconnect the neutral switch connector, J2.



Attempt to bump the engine with the starter. **DO NOT ATTEMPT TO START THE ENGINE, JUST BUMP IT.**

Does the starter engage?

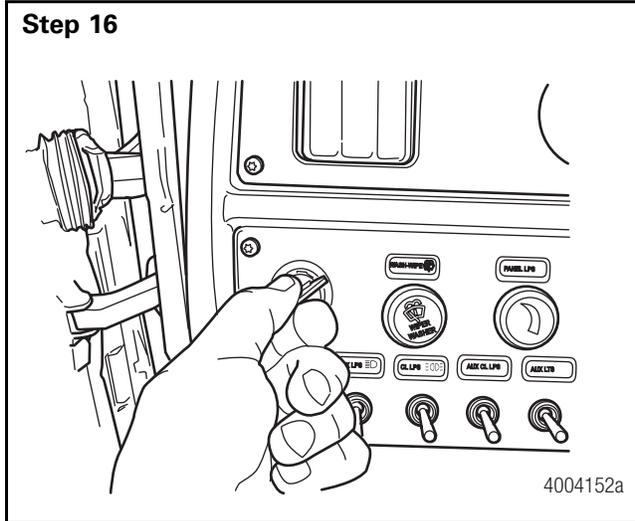
- **NO** → **GO TO STEP 15.**
- **YES** → **THE NEUTRAL SWITCH CONNECTOR AND/OR THE NEUTRAL SWITCH WAS CONTAMINATED.**



Jumper pins 1 and 2 of the neutral pin connector, J2.

## No-Start Troubleshooting

### Step 16

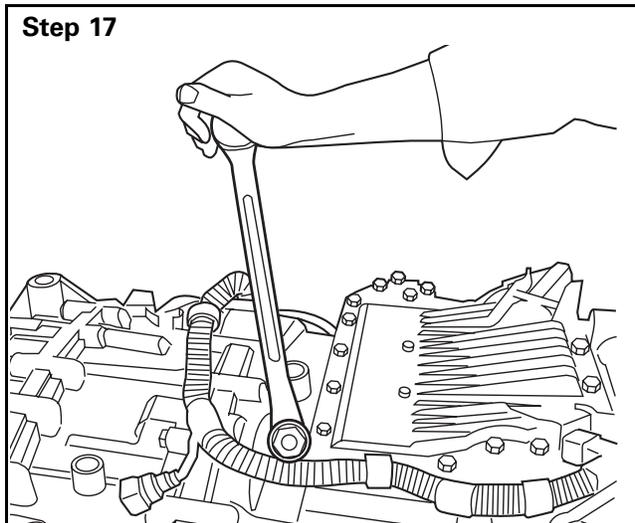


Attempt to bump the engine with the starter. **DO NOT ATTEMPT TO START THE ENGINE, JUST BUMP IT.**

Does the starter engage?

- **NO** → **GO TO STEP 12.**
- **YES** → **GO TO STEP 17.**

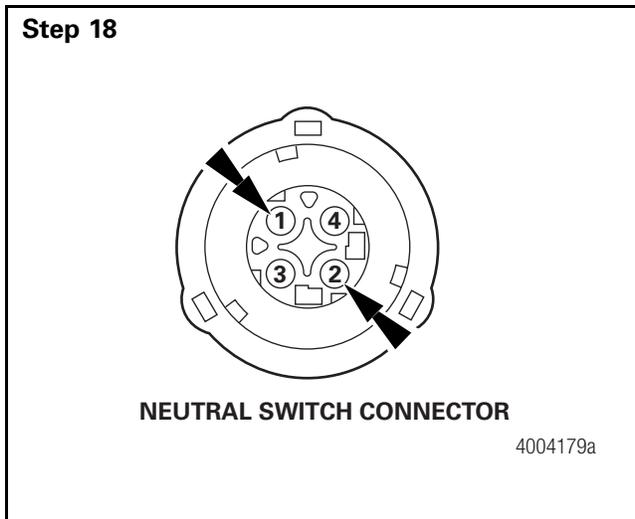
### Step 17



Either the neutral switch or the neutral push pin is broken.

Using a 27 mm 12 point wrench or chrome 12 point socket, remove the neutral switch.

### Step 18



With the plunger of the neutral switch in the rest position, measure the resistance across pins 1 and 2 of the neutral switch.

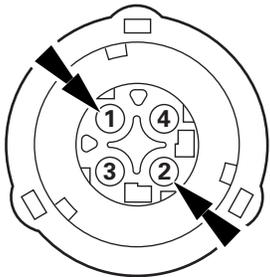
Is the resistance 0.0-0.5 Ohms?

- **YES** → **GO TO STEP 19.**
- **NO** → **REPLACE THE NEUTRAL SWITCH AND INSPECT THE NEUTRAL PUSH PIN TO MAKE SURE IT'S NOT SEIZED IN THE BORE.**

## Section 3 Maintenance

### No-Start Troubleshooting

#### Step 19



NEUTRAL SWITCH CONNECTOR

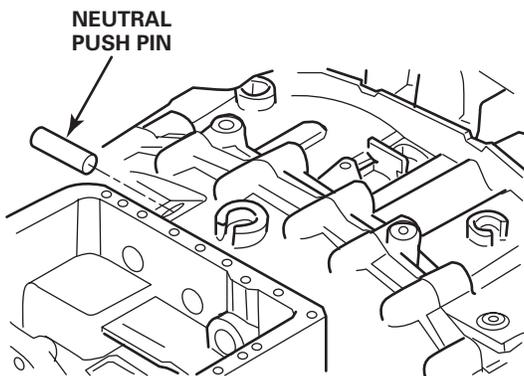
4004179a

With the plunger of the neutral switch pushed in, measure the resistance across pins 1 and 2 of the neutral switch.

Is the circuit open?

- **YES** → **GO TO STEP 20.**
- **NO** → **REPLACE THE NEUTRAL SWITCH AND INSPECT THE NEUTRAL PUSH PIN TO MAKE SURE IT'S NOT SEIZED IN THE BORE.**

#### Step 20



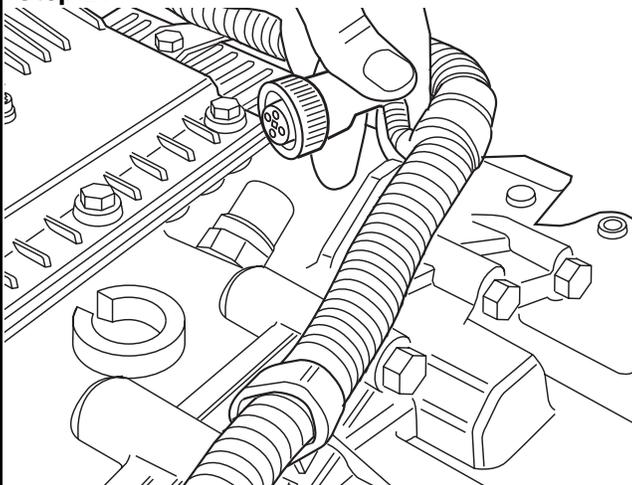
4004181a

Inspect the neutral push pin in the transmission and make sure it isn't seized.

Is the neutral push pin seized?

- **NO** → **GO TO STEP 21.**
- **YES** → **REPAIR THE PIN AS NECESSARY.**

#### Step 21

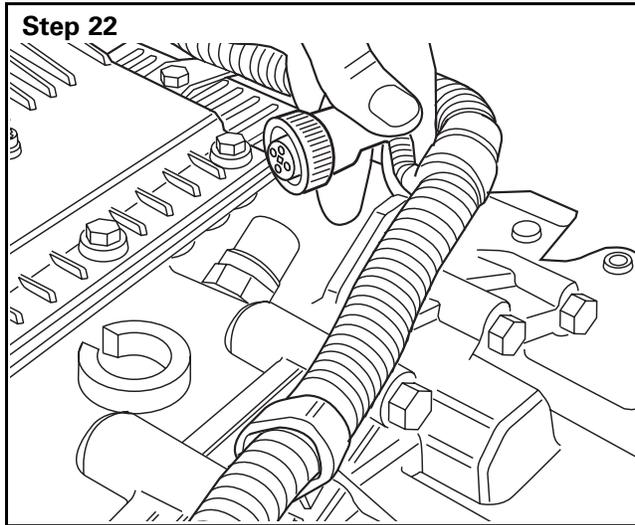


Remove the jumper and inspect the neutral switch connector, J2, and the neutral pins for signs of damage.

Do any of the pins show signs of damage?

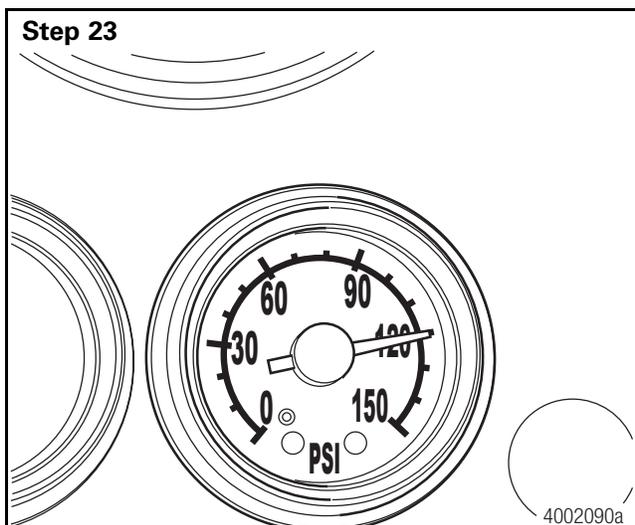
- **NO** → **GO TO STEP 22.**
- **YES** → **REPLACE THE TRANSMISSION WIRING HARNESS AND/OR THE NEUTRAL SWITCH AS NECESSARY.**

## No-Start Troubleshooting

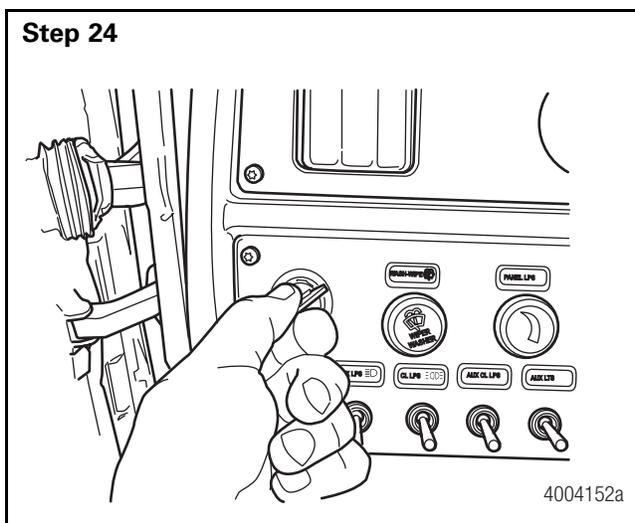


Reassemble and reconnect the neutral switch and neutral push pin.

Tighten the neutral switch to **37 lb-ft (50 N•m)** and make sure the sealing ring is installed. 



If not already done, build up the vehicle air pressure to 120 psi using shop air.



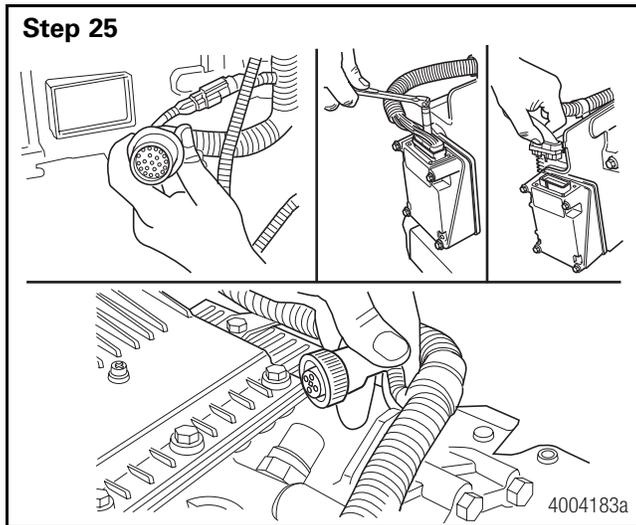
Attempt to bump the engine with the starter. **DO NOT ATTEMPT TO START THE ENGINE, JUST BUMP IT.**

Does the starter engage?

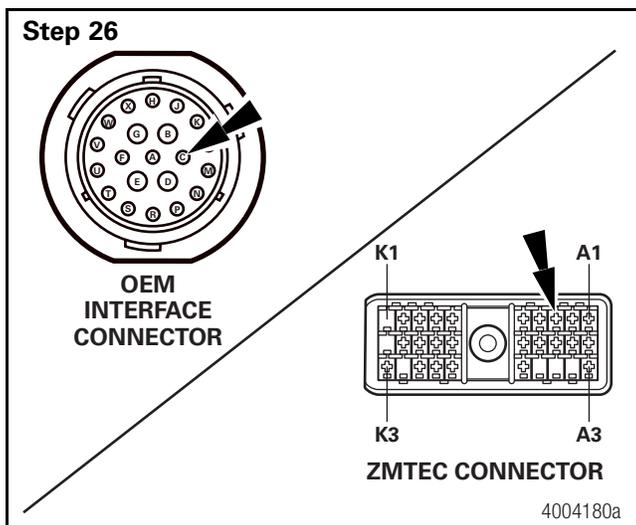
- **NO** → **GO TO STEP 25.**
- **YES** → **THE VEHICLE'S AIR PRESSURE WAS TOO LOW.**

## Section 3 Maintenance

### No-Start Troubleshooting



Disconnect the OEM interface connector, J7, the neutral switch connector, J2, and the ZMTEC connector, J3.



Check the resistance across pin C1 of the ZMTEC connector, J3 and pin C of the OEM interface connector, J7. (The neutral switch must still be jumpered.)

Is the resistance 0.0 to 0.5 Ohms?

- **YES** → **GO TO STEP 27.**
- **NO** → **REPLACE THE TRANSMISSION WIRING HARNESS.**

#### Step 27

Check for shorts from the starter interlock circuit (pin C1 of the ZMTEC connector, J3, and pin C of the OEM interface connector, J7) to all other circuits in the transmission wiring harness. Refer to the system schematic on page 93.

Is the wiring harness shorted?

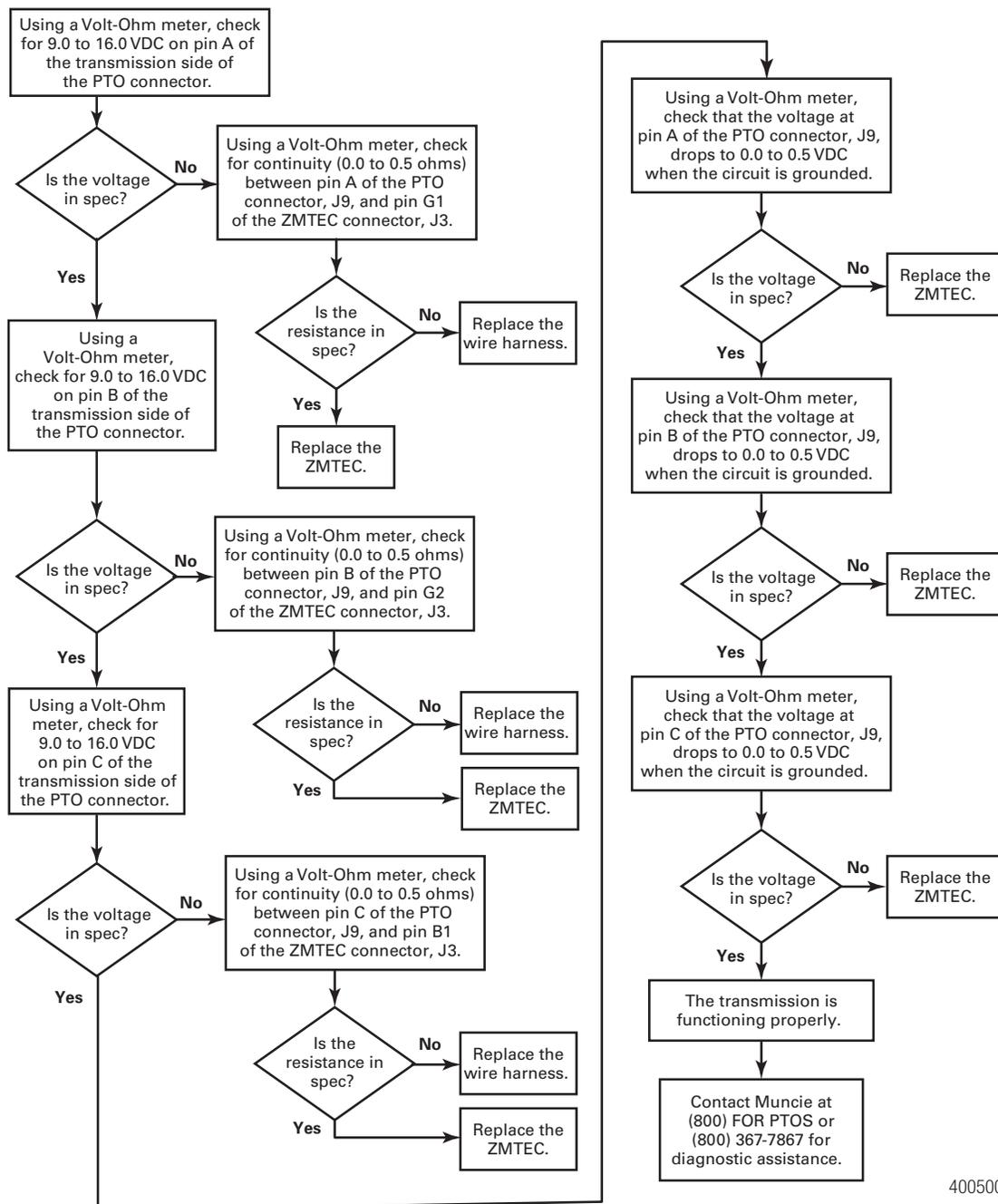
- **NO** → **REPLACE THE ZMTEC.**
- **YES** → **REPLACE THE TRANSMISSION WIRING HARNESS.**

## PTO Requirements Flowchart

### Notice

The ZF-FreedomLine transmission is delivered pre-programmed to accept both a stationary PTO (for use in neutral) and a non-stationary PTO (for use in the default PTO gear only). The installation of the PTO is the responsibility of the owner. An improperly installed PTO may damage the transmission gearing, requiring a transmission replacement.

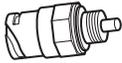
The Transmission Controller Unit (TCU) actively monitors the PTO and acts accordingly. Pin A of the PTO connector must be wired into the PTO switch. Pin C of the PTO connector must be wired into the series of relays that activate the PTO. Pin B of the PTO connector must be wired into the ball switch that acknowledges the engagement of the PTO.



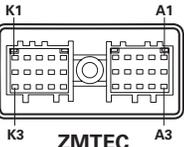
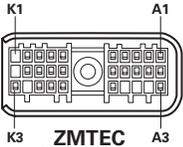
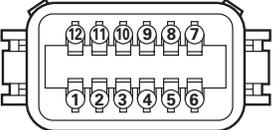
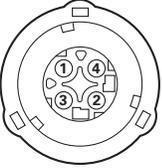
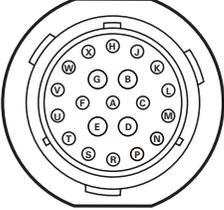
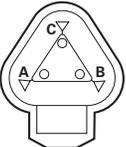
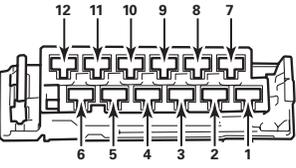
4005005b

# Section 4 Wiring/Pneumatic Diagrams

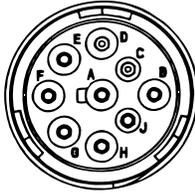
## Resistance Specifications

Component		Resistance (Measured Across Pins 1 and 2)	
		In Neutral	Not in Neutral
Neutral Switch		0.0-0.5 ohms	open circuit

## Connector Pin Assignments

 <b>Main TCU Connector (Both Harnesses)</b>	 <b>Output Shaft Speed Sensor Connector (Both Harnesses)</b>	 <b>ZMTEC Connector (New Style)</b>
 <b>ZMTEC Connector (Old Style)</b>	 <b>Voltage Doubler Connector</b>	
 <b>Neutral Switch Connector</b>	 <b>OEM Interface Connector</b>	
 <b>SAE J1939 Connector</b>	 <b>Private CAN Connector</b>	 <b>PTO Connector</b>
 <b>Shifter or Turtle Wire Harness Connector</b>		 <b>2-Pin Connector (J6) J1939 Deutsch DTM Series</b>

## Diagnostic Connector

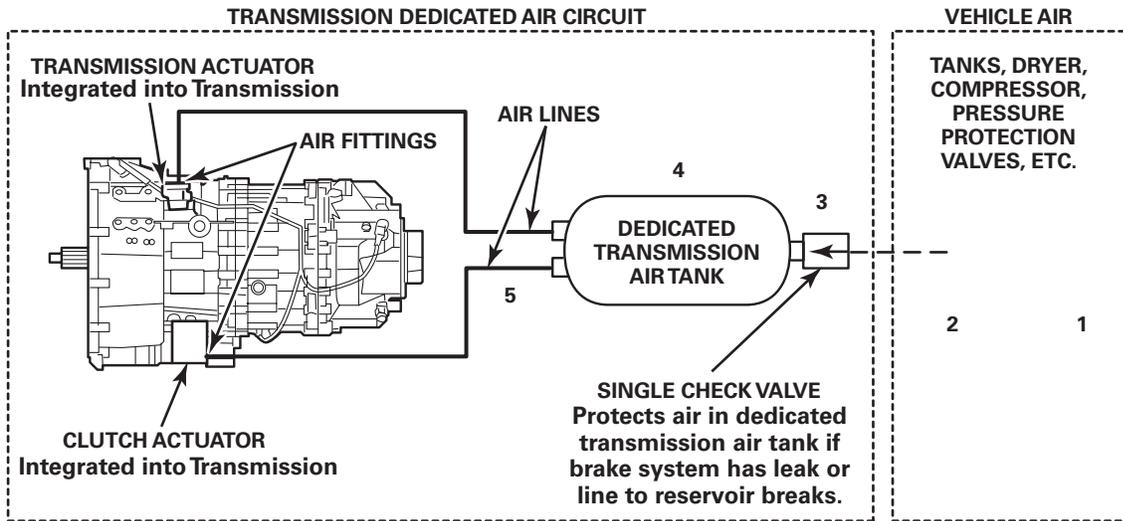
	Pin A	Battery (-)
	Pin B	Battery (+) Unswitched – with Unconditioned 10 A fuse
	Pin C	CAN_H Tractor Bus
	Pin D	CAN_L Tractor Bus
	Pin E	CAN_SHLD (for SAE J1939/11)
	Pin F	SAE J1708 (+)
	Pin G	SAE J1708 (-)
	Pin H	Proprietary OEM Use
	Pin J	Proprietary OEM Use

4005609a



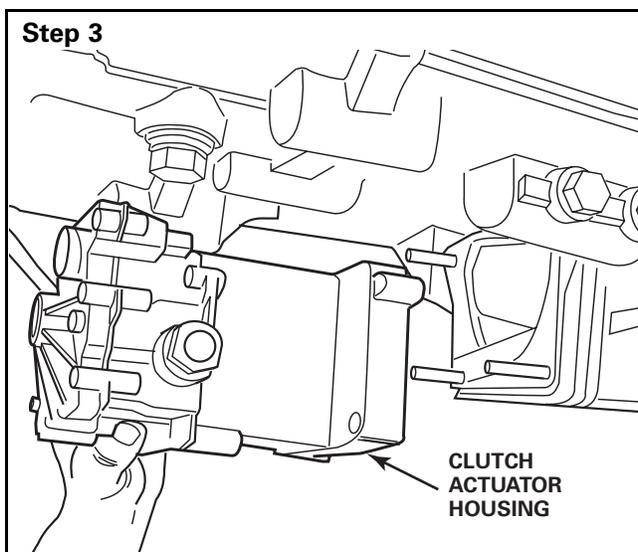
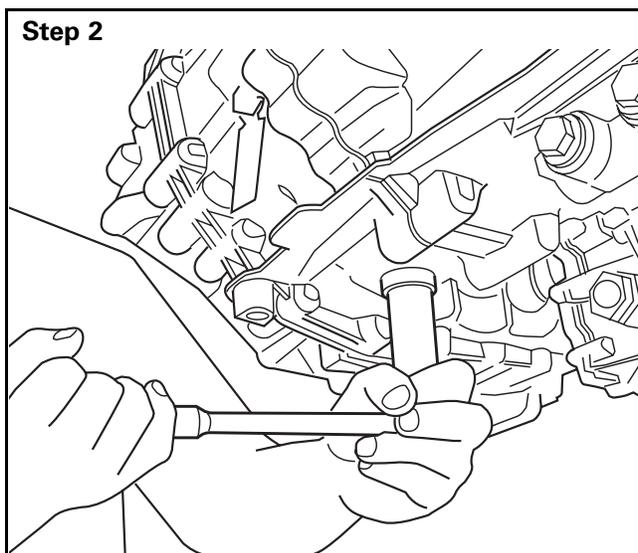
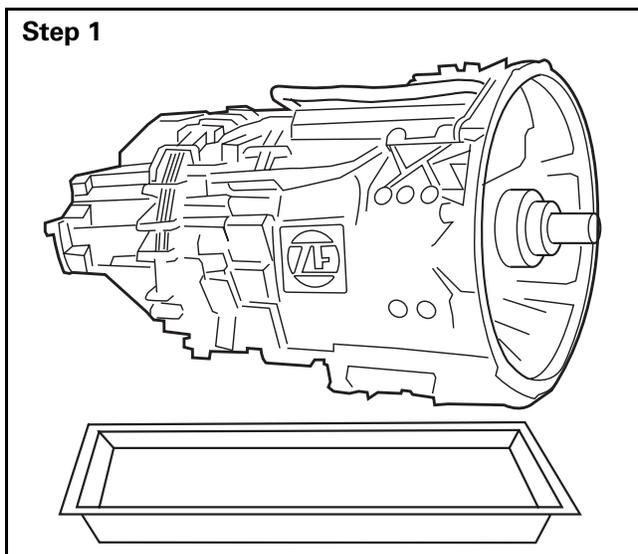
# Section 4 Wiring/Pneumatic Diagrams

## ZF-FREEDOMLINE AIR SYSTEM OVERVIEW



4005610a

## Section 5 Removal and Installation



**⚠ WARNING**

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

### Transmission

#### Removal

Place a pan beneath the transmission drain plug.

- GO TO THE NEXT STEP.

**⚠ WARNING**

When you install a fill plug and a drain plug into a transmission, first manually position the plug, and then install and tighten it by hand. When you've hand tightened the plug, use a torque wrench to tighten it to **44 lb-ft (60 N•m)**. Do not overtighten the plug. Damage to the aluminum housing can result. **T**

Use a 22 mm wrench to remove the drain plug. Drain the oil. Manually position the drain plug and install it into the transmission by hand. Hand tighten the plug, and then use a torque wrench to tighten the drain plug to **44 lb-ft (60 N•m)**. Do not overtighten the drain plug. **T**

- GO TO THE NEXT STEP.

**⚠ WARNING**

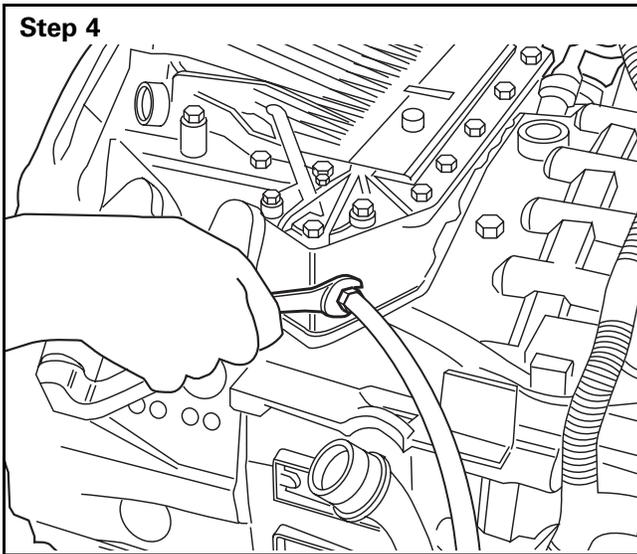
Always remove the clutch actuator housing **BEFORE** you remove the transmission, so that the transmission does not rest on the actuator housing. Damage to the transmission will result.

Remove the clutch actuator housing. Refer to Clutch Actuator Housing and Wiring Harness in this section.

- GO TO THE NEXT STEP.

## Section 5 Removal and Installation

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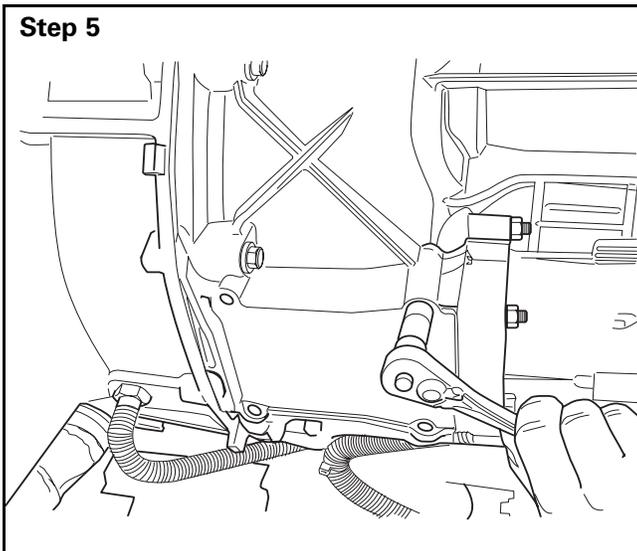


Disconnect the air supply line from the air filter regulator. Disconnect the cooler lines as required.

**⚠ WARNING**

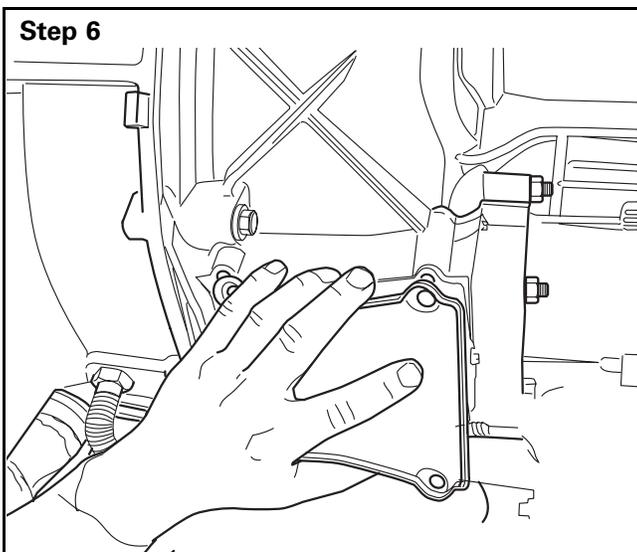
Use care when disconnecting the line as it still may be under pressure.

- GO TO THE NEXT STEP.



Use a 13 mm socket and ratchet to remove the four fasteners that secure the clutch inspection cover.

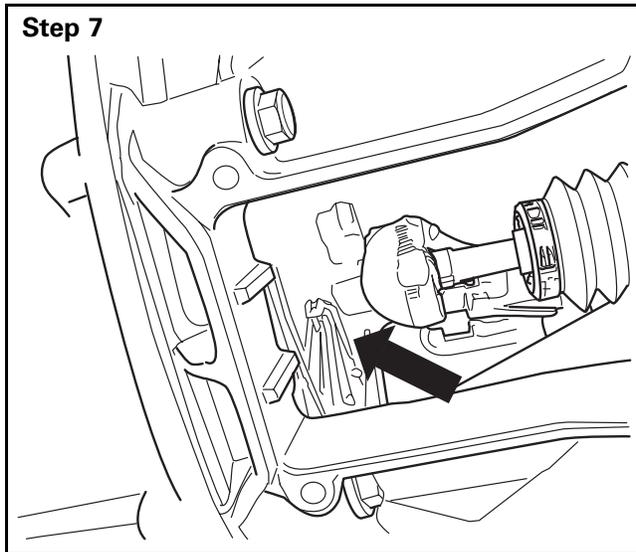
- GO TO THE NEXT STEP.



Remove the clutch inspection cover.

- GO TO THE NEXT STEP.

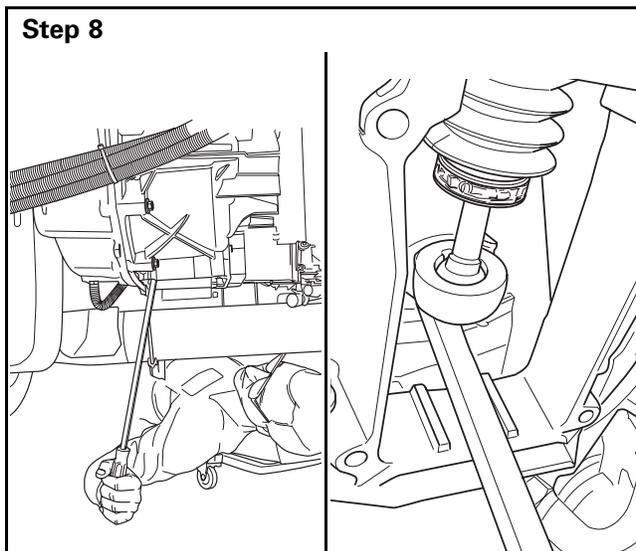
## Section 5 Removal and Installation



If the release bearing retainer clip is not visible, the starter may need to be bumped to turn clutch so that retainer clip is visible as shown in Step 7.

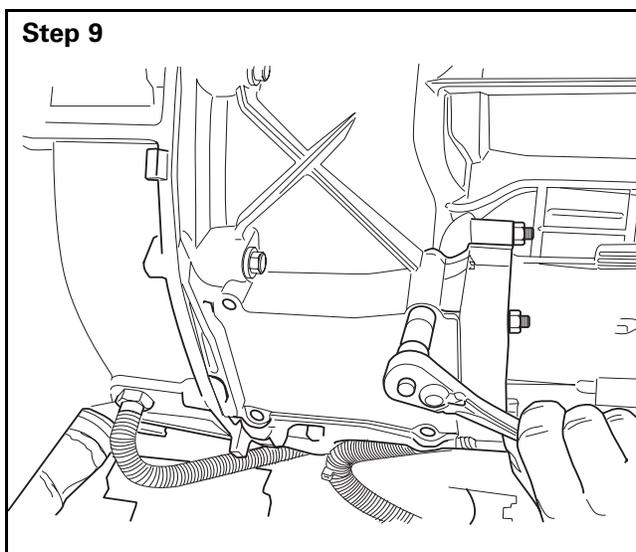
Unsnap the release bearing retainer clip.

- **GO TO THE NEXT STEP.**



Loosen the release bearing retainer clip by prying the release fork **BACKWARD**.

- **GO TO THE NEXT STEP.**

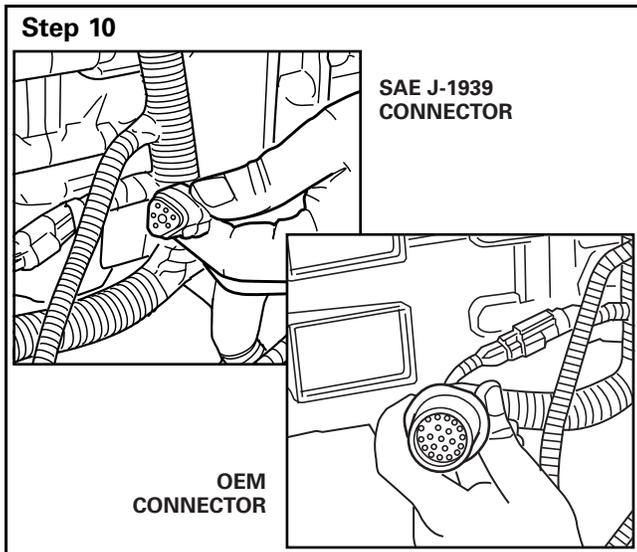


Use a 13 mm socket and ratchet to install the clutch inspection cover. Tighten the fasteners to **17 lb-ft (23 N•m)**. 

- **GO TO THE NEXT STEP.**

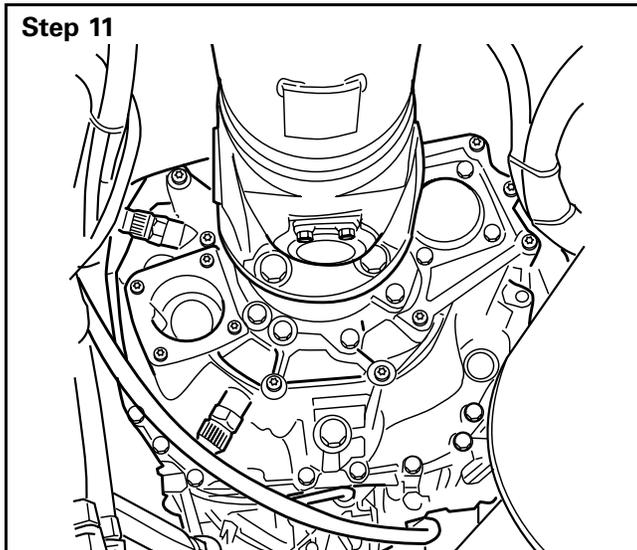
## Section 5 Removal and Installation

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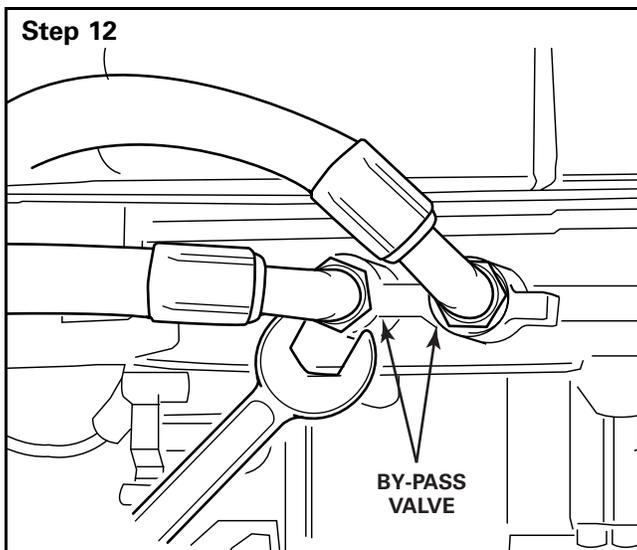
Disconnect the SAE J-1939 and the OEM connectors.

- **GO TO THE NEXT STEP.**



Remove the driveline. Follow the guidelines specified by both the original equipment manufacturer (OEM) and driveline manufacturer.

- **GO TO THE NEXT STEP.**

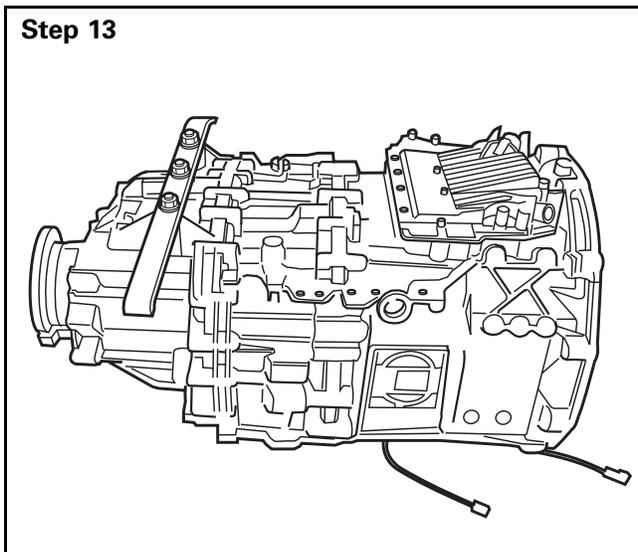


Remove the oil cooler lines if vehicle has OEM installed cooler.

- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation

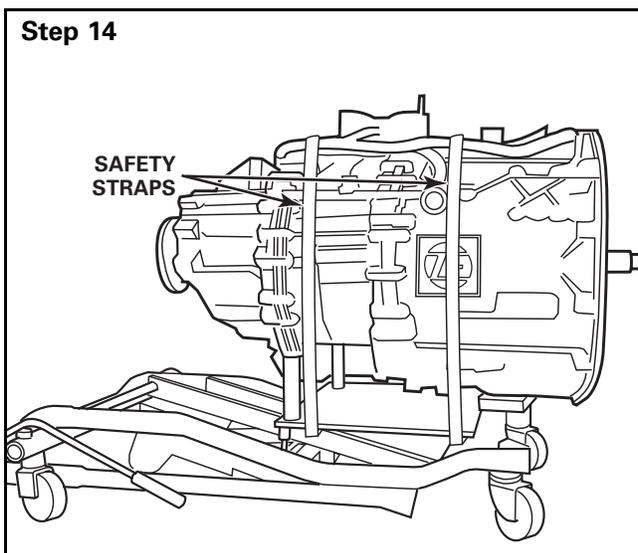
Step 13



Remove the rear support if one is installed.

- GO TO THE NEXT STEP.

Step 14



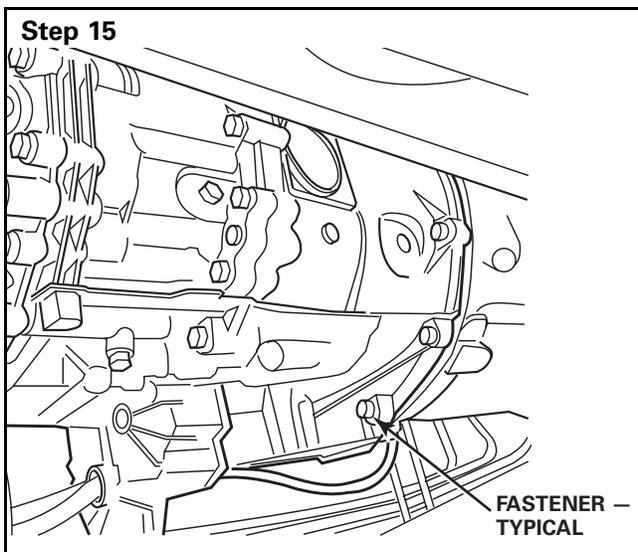
### WARNING

Support the transmission securely with a transmission jack and safety straps. If the transmission is not securely supported, it can fall. Serious personal injury and damage to components can result.

Support the transmission with a transmission jack and safety straps.

- GO TO THE NEXT STEP.

Step 15

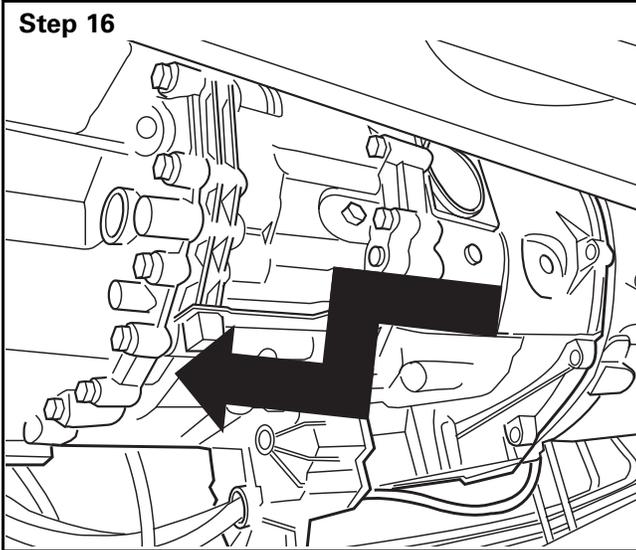


Remove the 12 fasteners that secure the transmission to the flywheel housing.

- GO TO THE NEXT STEP.

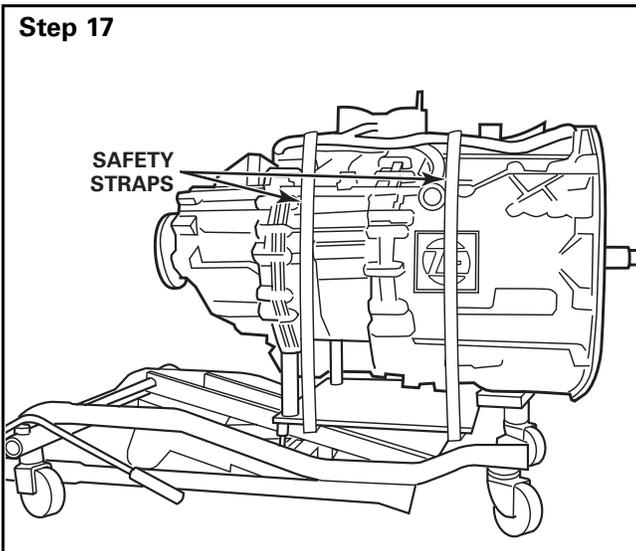
## Section 5 Removal and Installation

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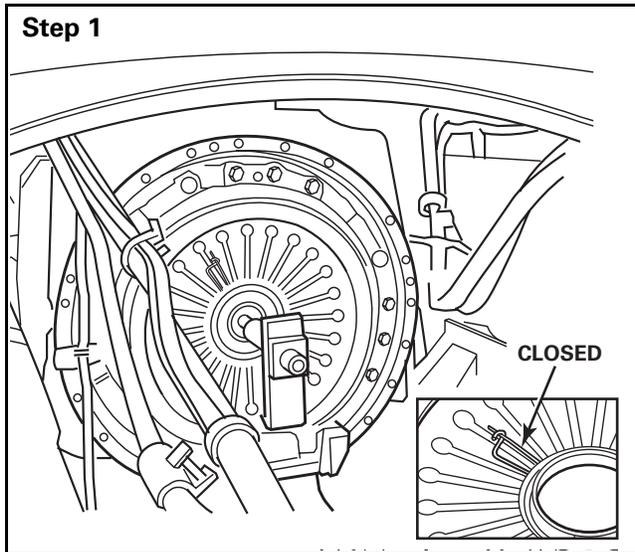
With the transmission supported by a transmission jack, remove the transmission by carefully pulling it straight back and lowering it out of the vehicle.

- **GO TO THE NEXT STEP.**



Roll the transmission out from under the vehicle.

## Section 5 Removal and Installation



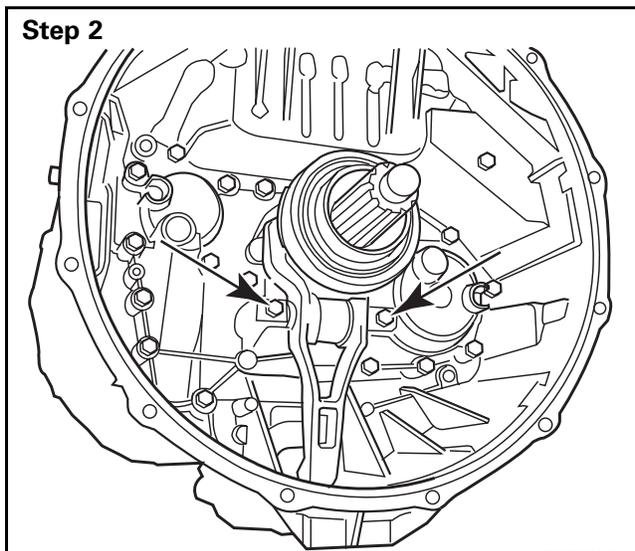
### **WARNING**

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

### **Installation**

Install the clutch. Refer to Clutch Actuator Housing and Wiring Harness in this section. Verify that the release bearing retainer clip is snapped.

- **GO TO THE NEXT STEP.**

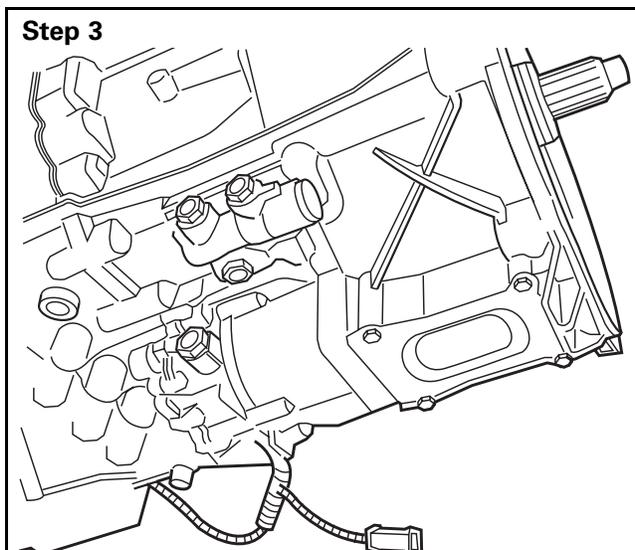


Inspect the release bearing and release fork assembly. Replace damaged components.

**NOTE:** Replace with new roller fork kit if standard fork is installed.

- A. Check that the release fork assembly turns freely and radial (side-to-side).
- B. Check that the release bearing slides freely on the release flange.

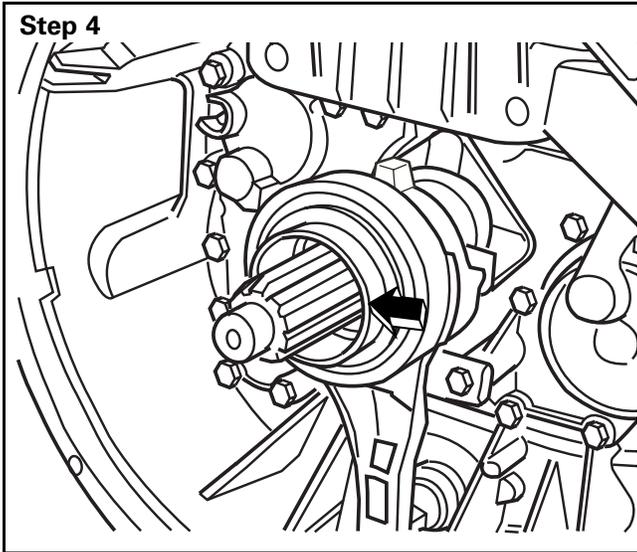
- **GO TO THE NEXT STEP.**



Check the bottom of the transmission for an inspection cover.

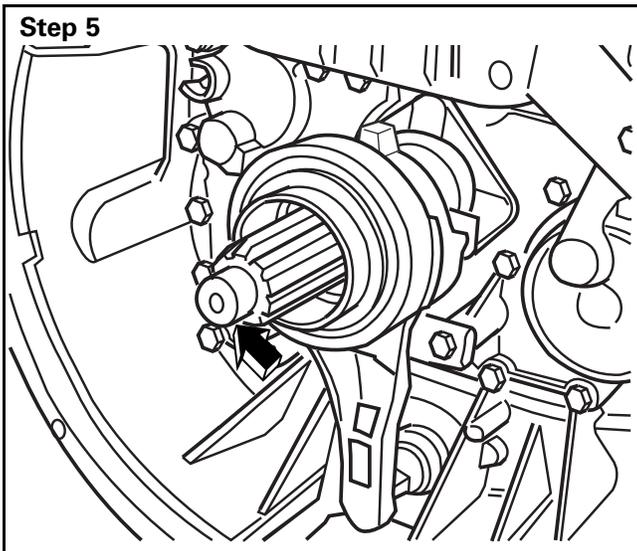
- **If an inspection cover is missing:** Install a cover to prevent dirt and contaminants from entering the clutch housing and damaging the clutch.
- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation



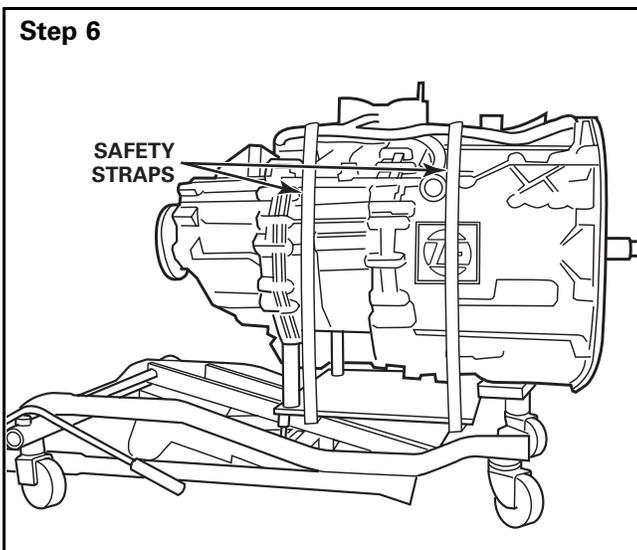
Inspect the splines on the input shaft for wear and damage. Use an emery cloth to remove small scratches from the input shaft.

- **GO TO THE NEXT STEP.**



Inspect the end of the input shaft where the pilot bearing is installed. Use an emery cloth to remove small scratches. Replace the pilot bearing as necessary.

- **GO TO THE NEXT STEP.**



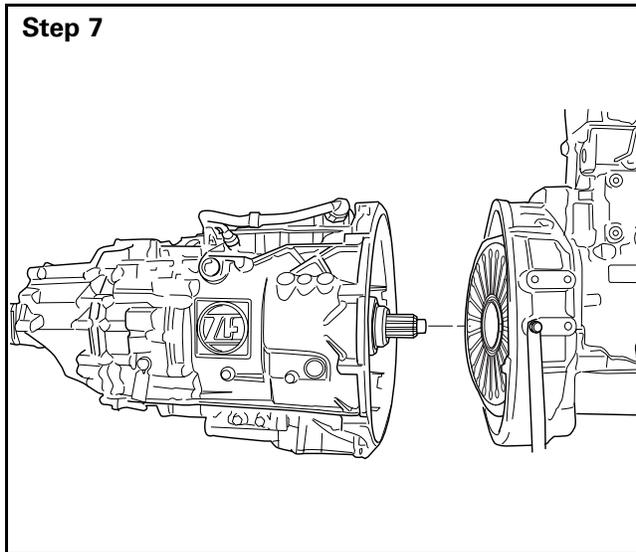
### **WARNING**

**Support the transmission securely with a transmission jack and safety straps. If the transmission is not securely supported, it can fall. Serious personal injury and damage to components can result.**

Support the transmission with a transmission jack and safety straps.

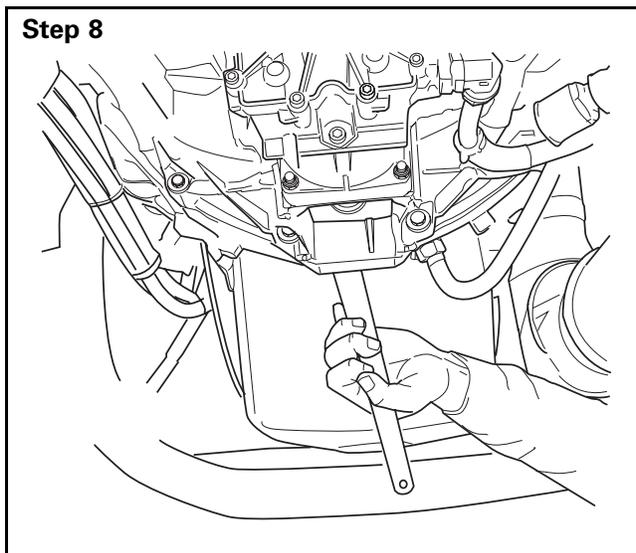
- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation



Position the transmission so that the input shaft aligns with the pilot bearing.

- **GO TO THE NEXT STEP.**



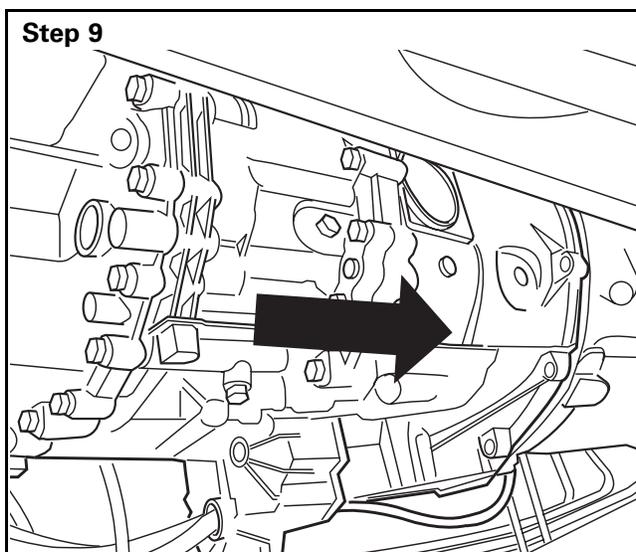
### **WARNING**

Carefully install the transmission input shaft into the clutch disc hub. Do not force or jam the input shaft into the hub. Damage to the clutch disc or clutch housing will result.

**NOTE:** When you install the transmission, you may have to slightly turn the input shaft. Use SPX Kent-Moore input shaft turning tool (part number J-45556). To obtain this tool, refer to the Service Notes page on the front inside cover of this manual.

Move the input shaft into the clutch housing and into the hub of the clutch disc.

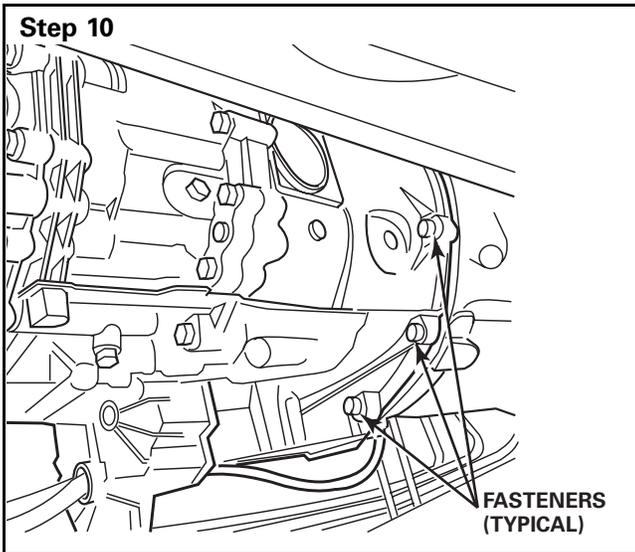
- **GO TO THE NEXT STEP.**



Push the transmission against the flywheel housing.

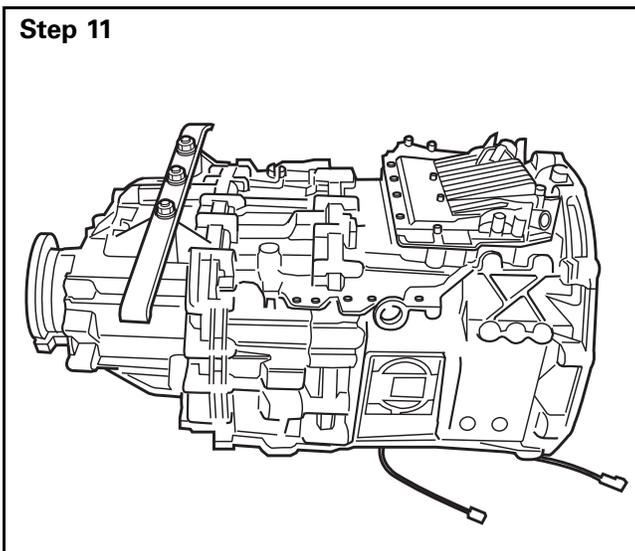
- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation



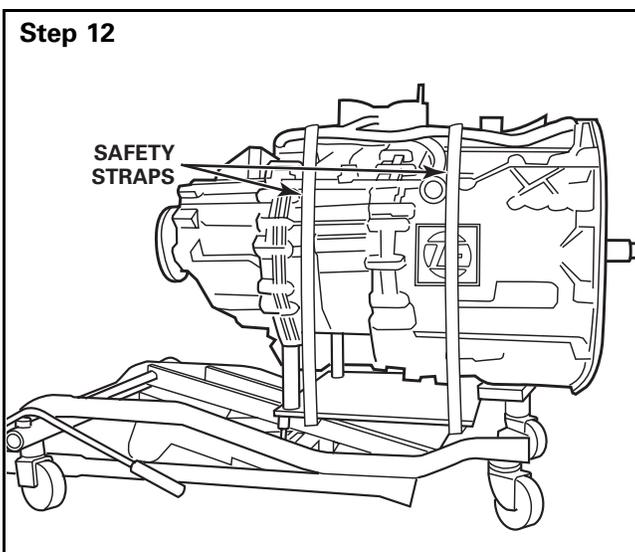
Use 12 fasteners to secure the transmission to the flywheel. Tighten them in a star pattern to OEM specifications.

- **GO TO THE NEXT STEP.**



If necessary, reinstall the rear support. Tighten the fasteners to **145 lb-ft (195 N•m)**. 

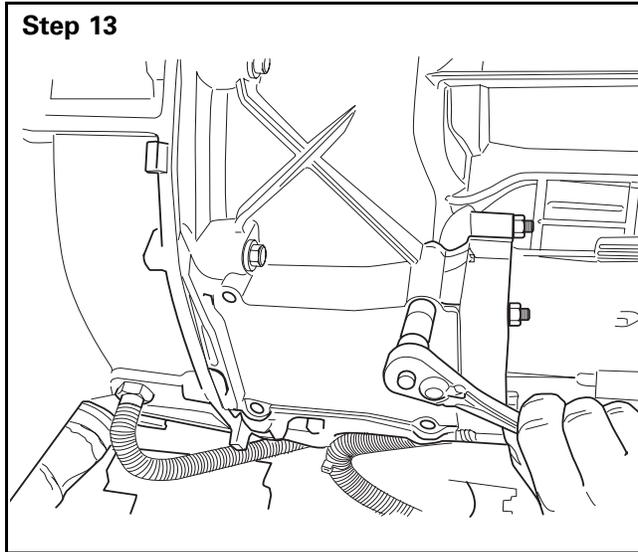
- **GO TO THE NEXT STEP.**



Remove the safety straps. Remove the transmission jack from the transmission.

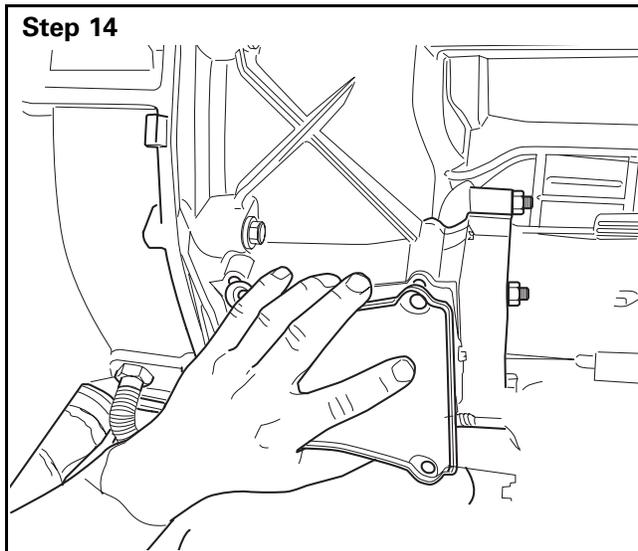
- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation



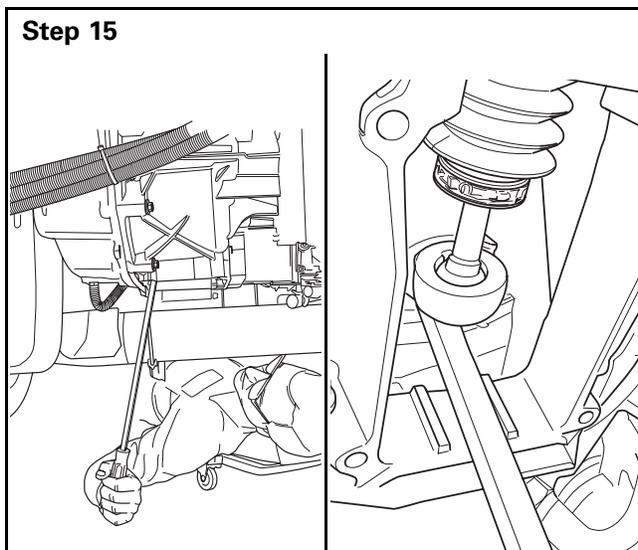
Use a 13 mm socket and ratchet to remove the four fasteners that secure the clutch inspection cover.

- **GO TO THE NEXT STEP.**



Remove the clutch inspection cover.

- **GO TO THE NEXT STEP.**



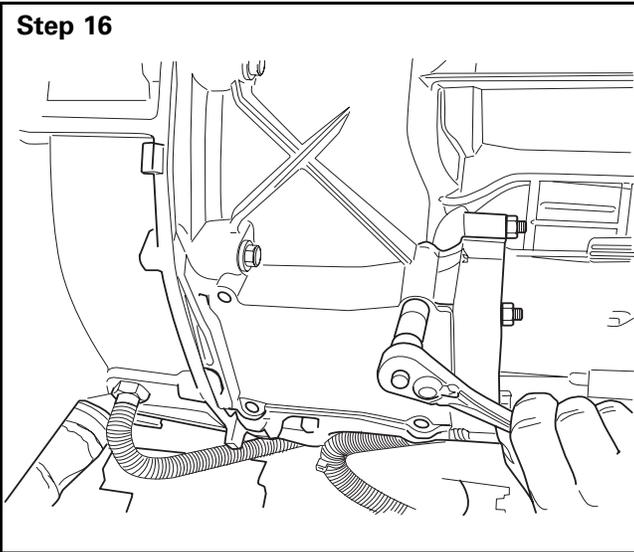
Secure the release bearing to the release bearing retainer clip by prying the release fork **BACKWARD**.

**NOTE:** Clutch actuator vent plug may need to be removed to vent air from the clutch actuator. Please refer to Step 8 in the Clutch Actuator Removal instructions.

- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation

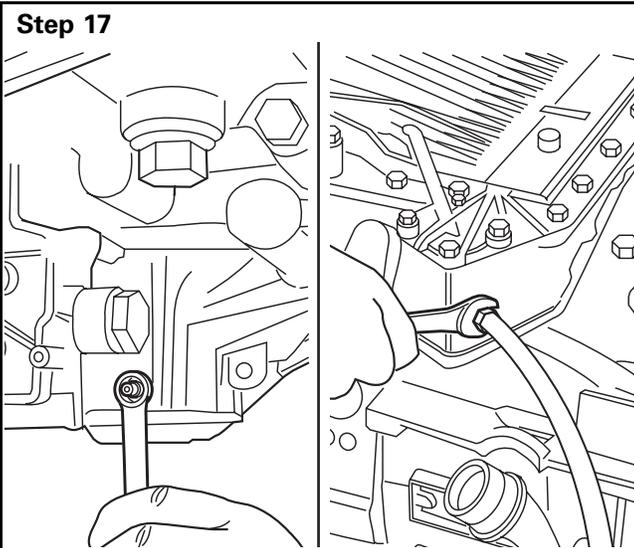
Step 16



Use a 13 mm socket and ratchet to install the clutch inspection cover. Tighten the fasteners to **17 lb-ft (23 N•m)**. 

- **GO TO THE NEXT STEP.**

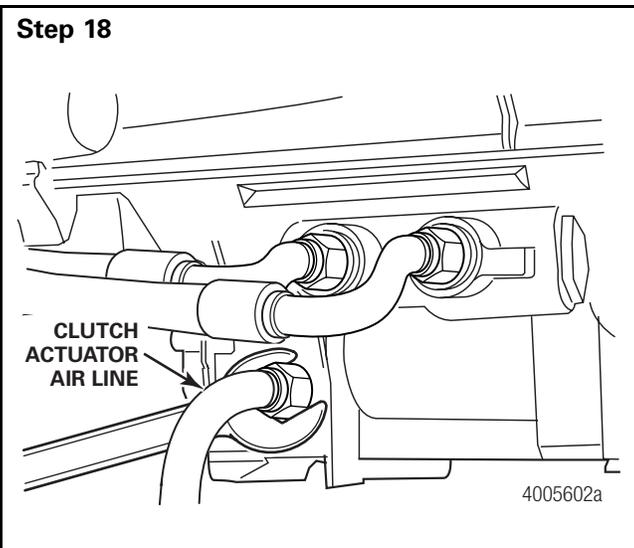
Step 17



Install the clutch actuator housing and connect the air supply line to the TCU air filter regulator. Refer to Clutch Actuator Housing and Wiring Harness installation instructions.

- **GO TO THE NEXT STEP.**

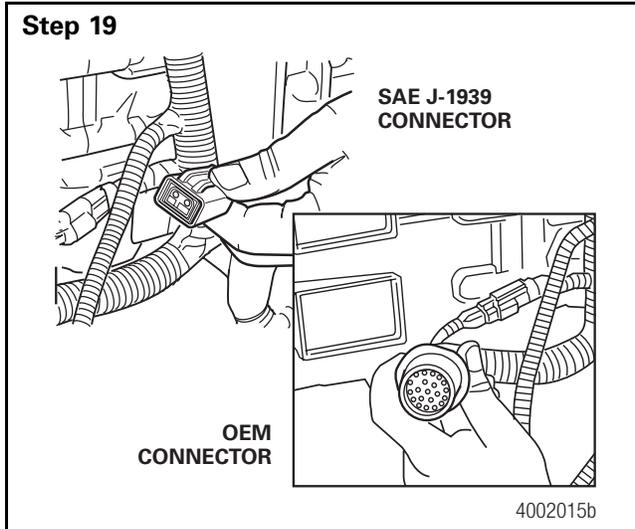
Step 18



Connect the air supply line to the clutch actuator housing.

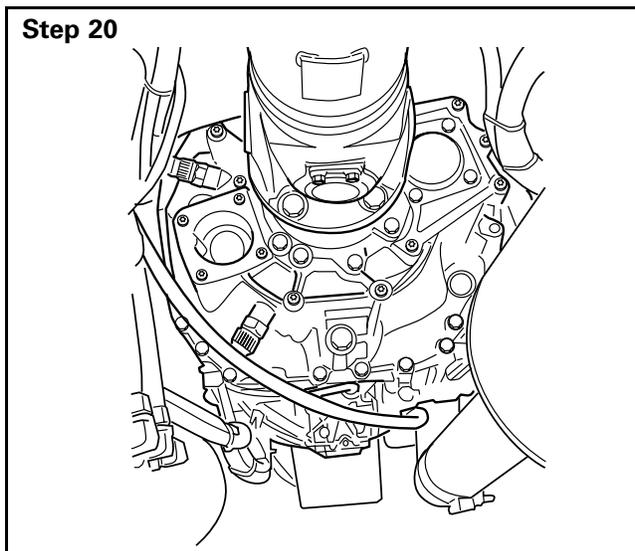
- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation



Connect the SAE J-1939 connector and the OEM connector to the transmission.

- **GO TO THE NEXT STEP.**

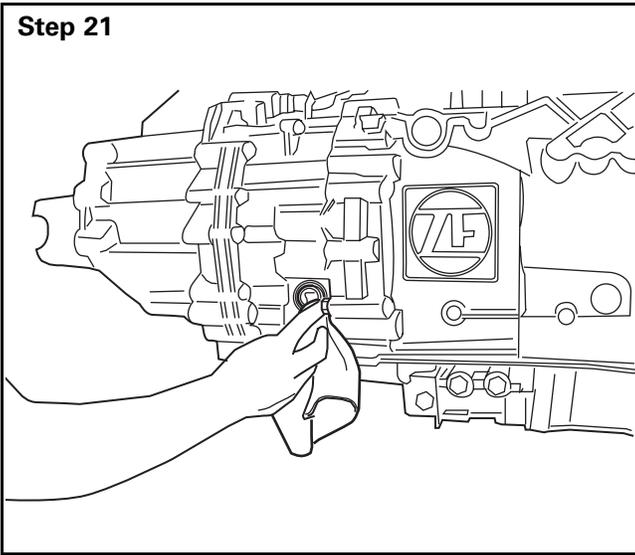


Connect the driveshaft to the output yoke on the transmission. Install and tighten the fasteners to the vehicle manufacturer's specifications.

- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation

Step 21



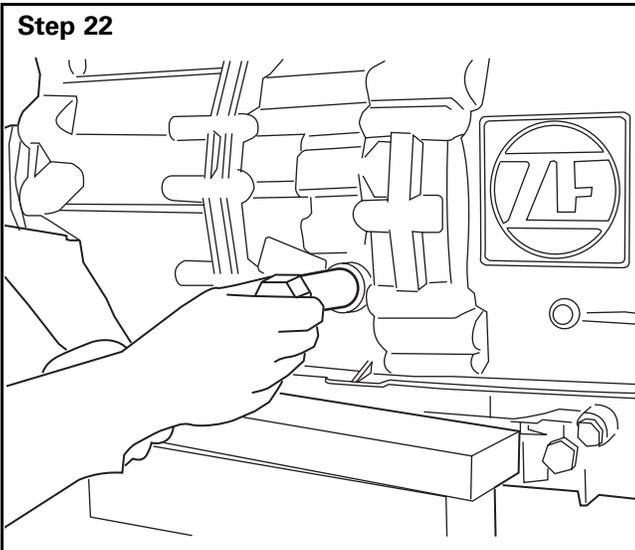
Use a 22 mm wrench to remove the fill plug from the transmission. Check that the oil is even with the bottom of the fill plug hole.

If necessary, add an approved full-synthetic oil through the fill plug hole until the oil is even with the bottom of the fill plug hole.

Manually position the fill plug and install it into the transmission by hand. Hand tighten the plug, and then use a torque wrench to tighten the fill plug to **44 lb-ft (60 N•m)**. Do not overtighten the plug. Start the engine and run it for 30 seconds. Use a 22 mm wrench to remove the fill plug. Check the oil level. Add oil as necessary. 

- GO TO THE NEXT STEP.

Step 22



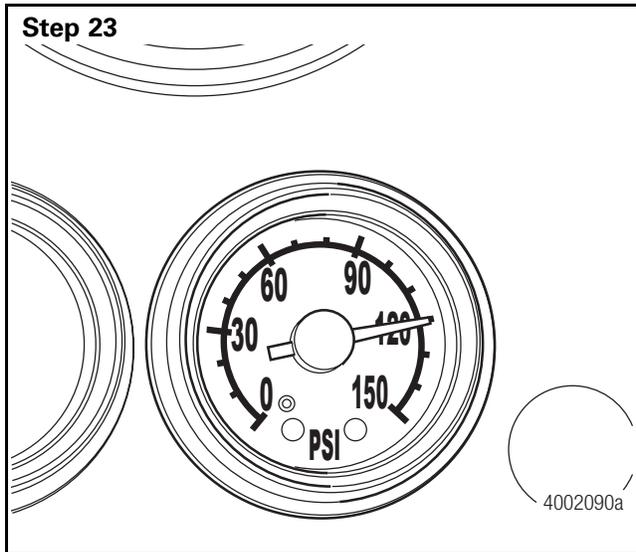
### WARNING

When you install a fill plug and a drain plug into a transmission, first manually position the plug, and then install and tighten it by hand. When you've hand tightened the plug, use a torque wrench to tighten it to **44 lb-ft (60 N•m)**. Do not overtighten the plug. Damage to the aluminum housing can result. 

Manually position the fill plug and install it into the transmission by hand. Hand tighten the plug, and then use a torque wrench to tighten the plug to **44 lb-ft (60 N•m)**. Do not overtighten the fill plug. 

- GO TO THE NEXT STEP.

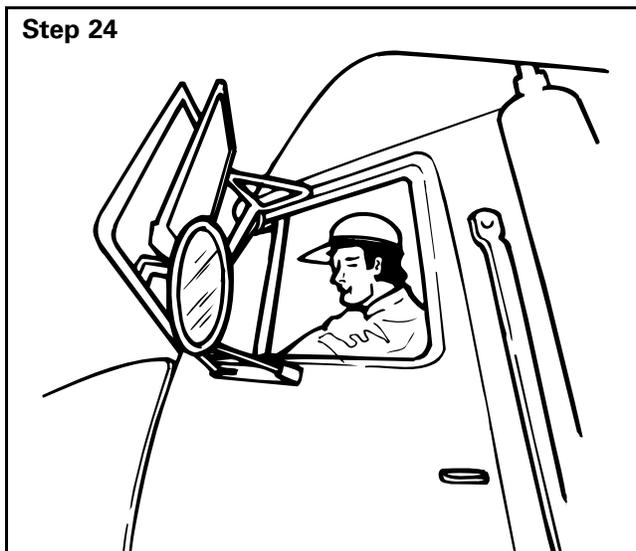
## Section 5 Removal and Installation



Charge the air system to 120 psi.

The vehicle may not start after installing the transmission due to low air pressure. Charge the system using shop air if necessary.

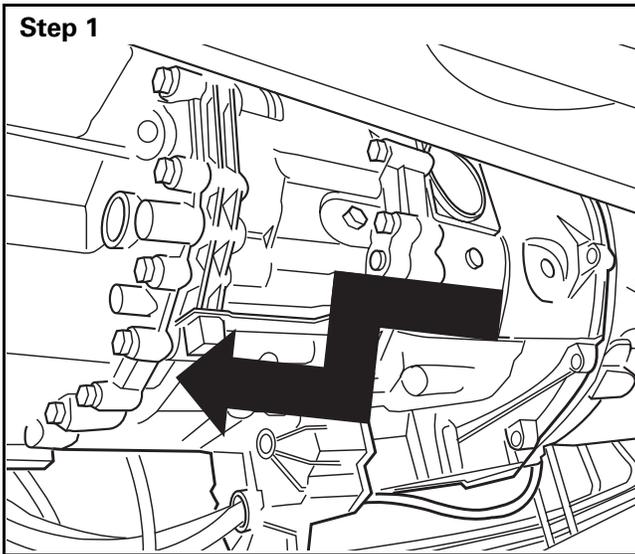
- **GO TO THE NEXT STEP.**



**NOTE:** If the display reads "CH" after the engine is started and the transmission will not engage, verify that the release bearing retainer clip is correctly installed and that the release bearing is engaged into it.

Operate the vehicle. Check for correct operation.

## Section 5 Removal and Installation

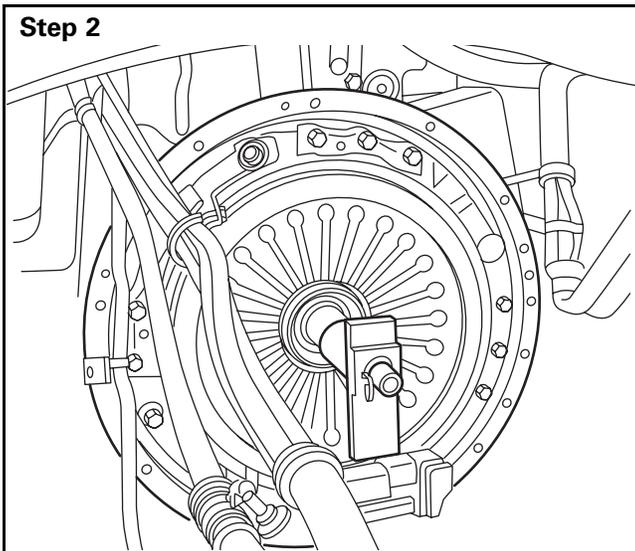


### Clutch

#### Removal

Remove the transmission. Refer to Transmission in this section.

- GO TO THE NEXT STEP.

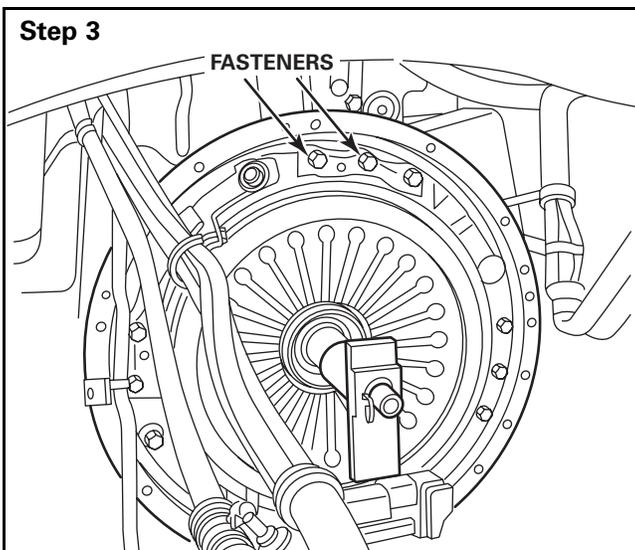


#### WARNING

Do not use an input shaft to support the clutch during removal. The clutch can fall from the input shaft, or the input shaft can damage the pilot bearing. Always use a clutch caddy or an equivalent device to prevent serious personal injury and damage to components.

Support the clutch with a clutch caddy or an equivalent device. Do not use the input shaft as a support. The clutch can fall, and the input shaft can damage the pilot bearing.

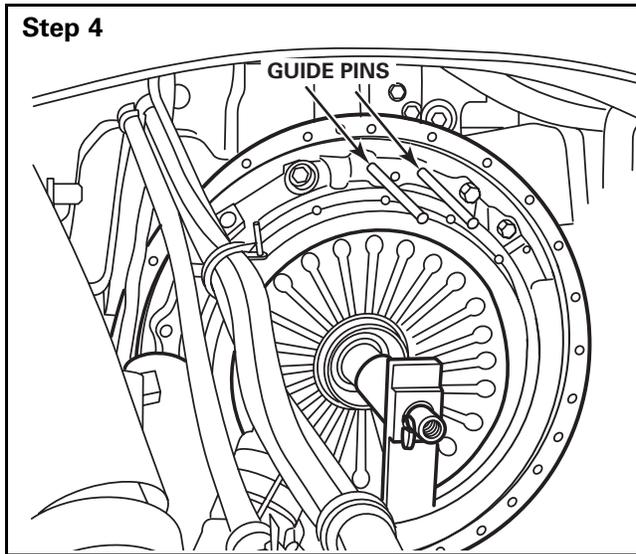
- GO TO THE NEXT STEP.



Remove the two top fasteners from the clutch housing cover.

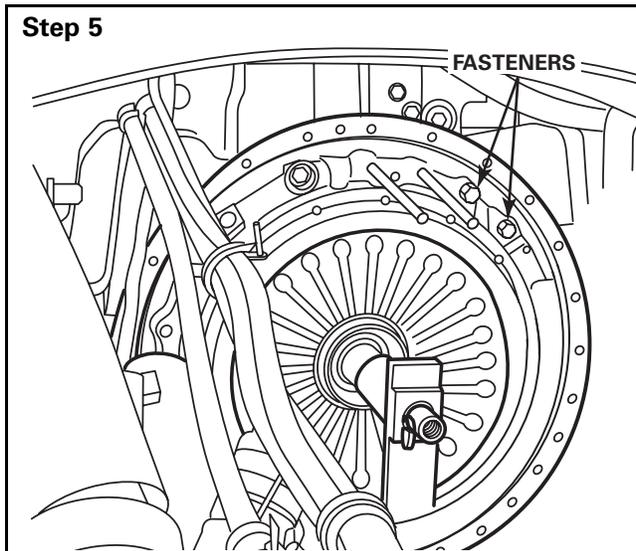
- GO TO THE NEXT STEP.

## Section 5 Removal and Installation



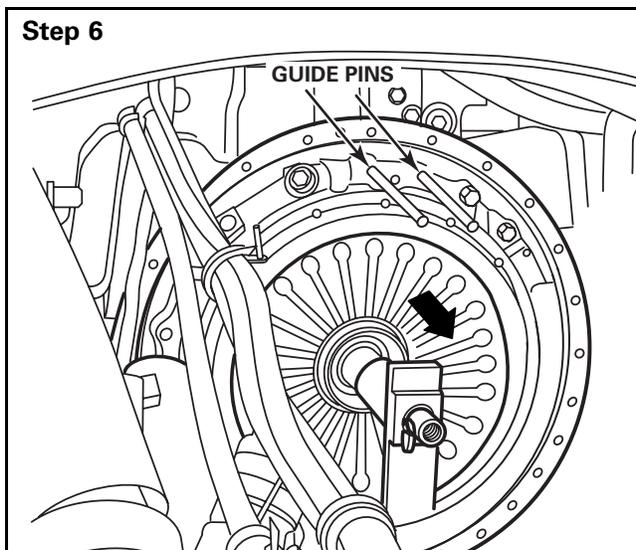
Install guide pins.

- **GO TO THE NEXT STEP.**



Remove the remaining fasteners from the clutch housing.

- **GO TO THE NEXT STEP.**

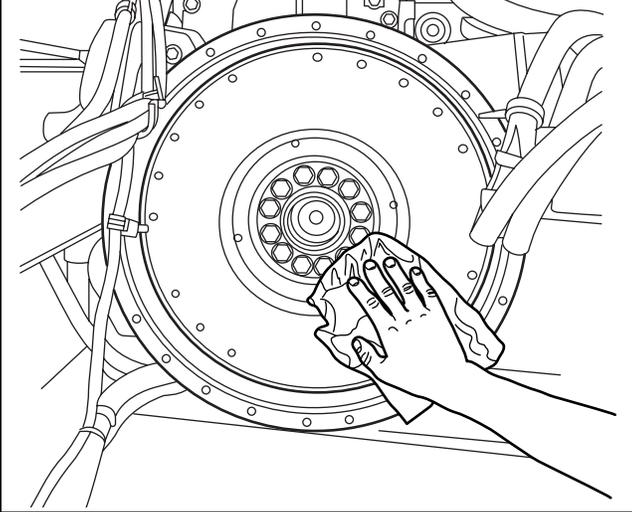


Remove the clutch by sliding it straight back and off the guide pins.

## Section 5 Removal and Installation

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**Step 1**

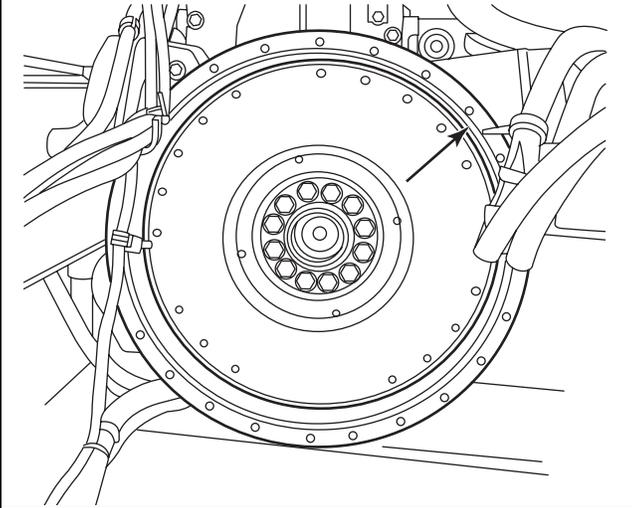


### **Installation**

Clean the flywheel and bell housing surface.

- **GO TO THE NEXT STEP.**

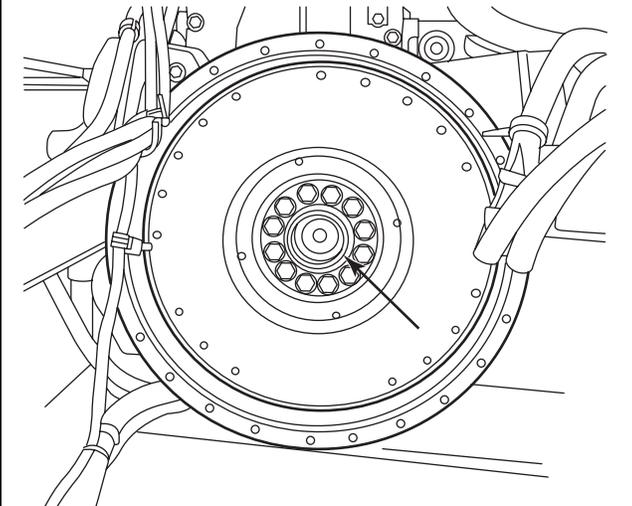
**Step 2**



Check the flywheel and centering shoulder for damage. Refer to the engine manufacturer's service procedures, if necessary.

- **GO TO THE NEXT STEP.**

**Step 3**

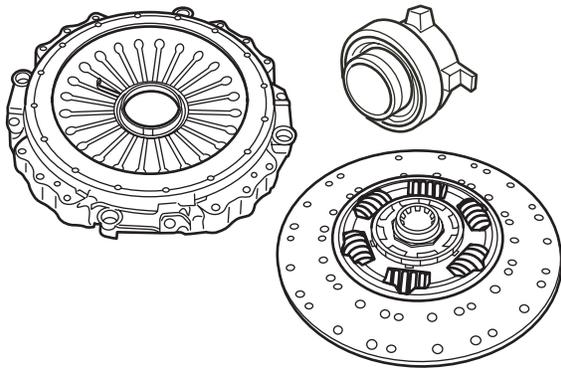


Replace the pilot bearing. Refer to the vehicle manufacturer's procedures.

- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation

### Step 4

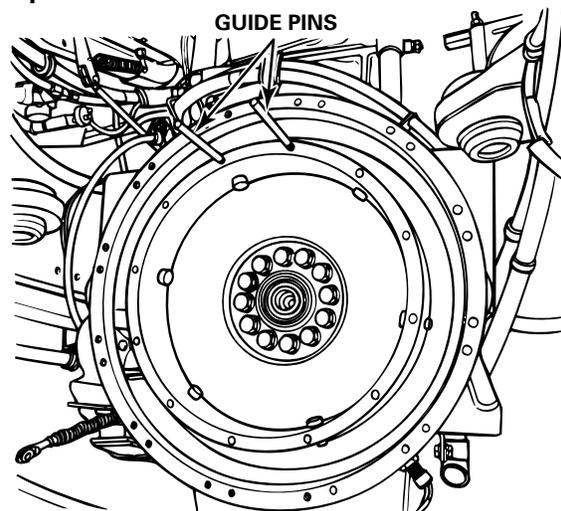


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Inspect the clutch housing, disc and release bearing for damage.

- **If the components are damaged:** Call OnTrac at 866-668-7221 for assistance.
- **GO TO THE NEXT STEP.**

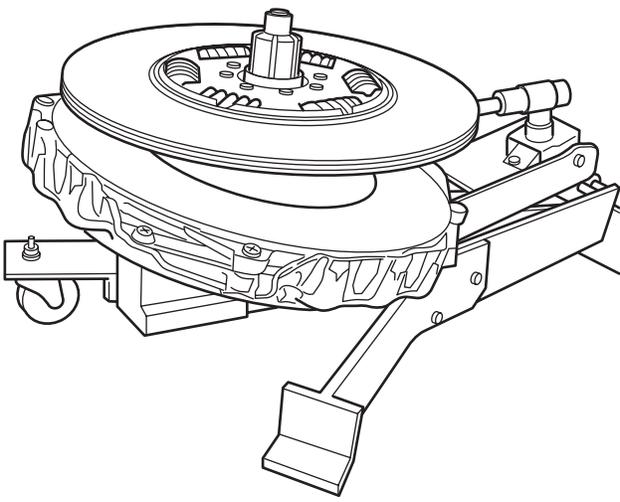
### Step 5



Install the guide pins into the TOP fastener holes.

- **GO TO THE NEXT STEP.**

### Step 6



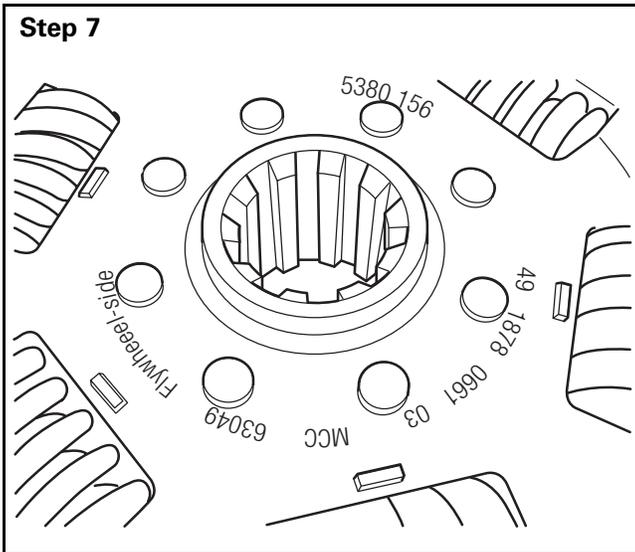
### **WARNING**

**Do not use the input shaft to support the clutch during installation. The clutch can fall from the input shaft, or the input shaft can damage the pilot bearing. Always use a clutch caddy or an equivalent device to prevent serious personal injury and damage to components.**

With the clutch supported by a clutch caddy or an equivalent device, install the clutch into the vehicle.

- **GO TO THE NEXT STEP.**

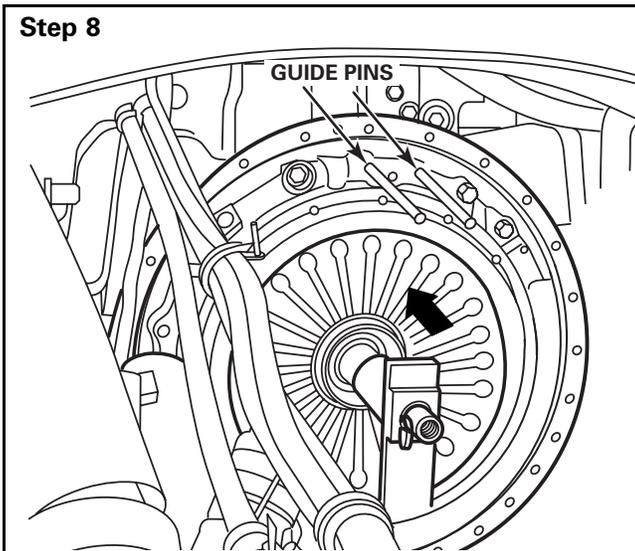
## Section 5 Removal and Installation



**NOTE:** The flywheel side of the clutch disc is marked "Flywheel-Side."

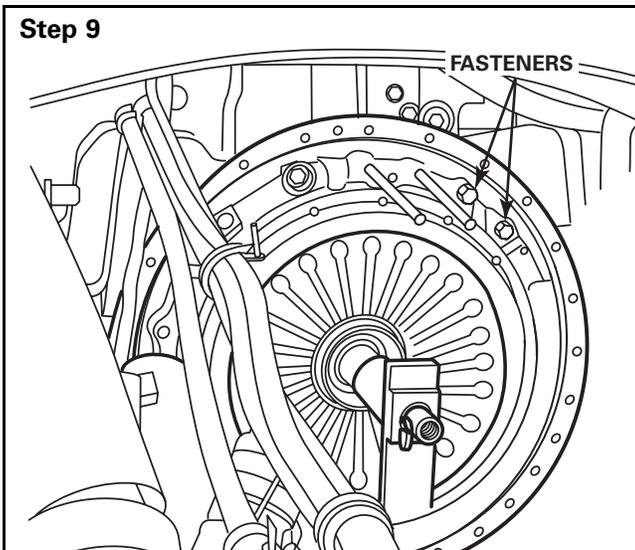
Verify that the flywheel side of the clutch disc faces **AWAY** from the clutch housing.

- **GO TO THE NEXT STEP.**



Install the clutch housing onto the guide pins. Ensure that clutch housing is fully seated on the flywheel.

- **GO TO THE NEXT STEP.**



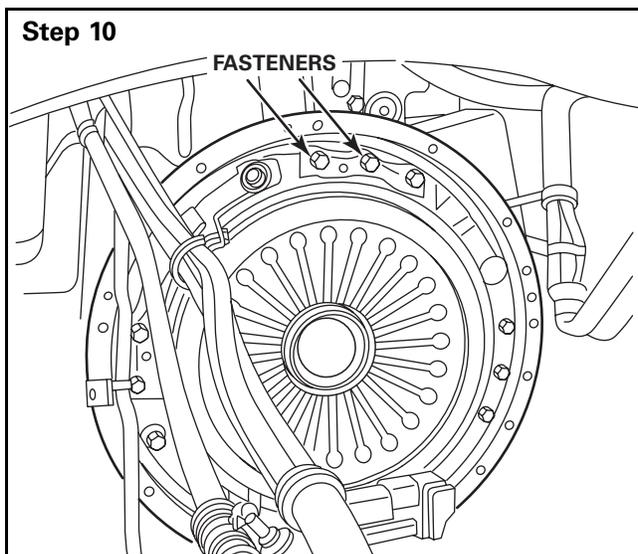
 **WARNING**

Take care when you use Loctite® adhesive to avoid serious personal injury. Read the manufacturer's instructions before using this product. Follow the instructions carefully to prevent irritation to the eyes and skin.

Apply Loctite® 222 liquid adhesive to the 12 clutch housing fasteners and/or use lock washers. Install and hand tighten the bolts.

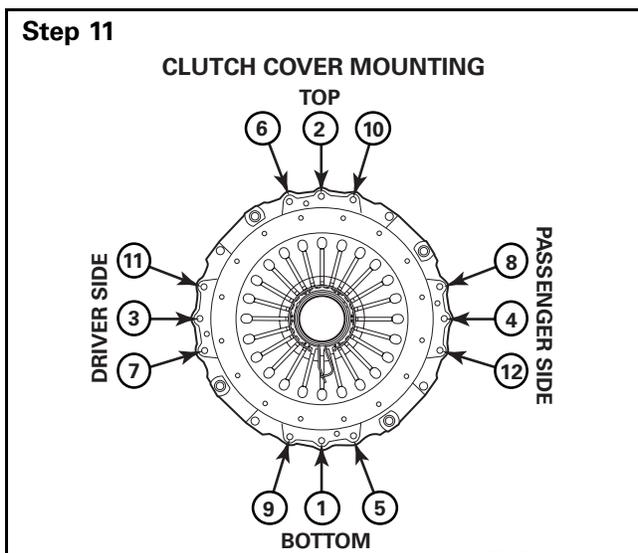
- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation



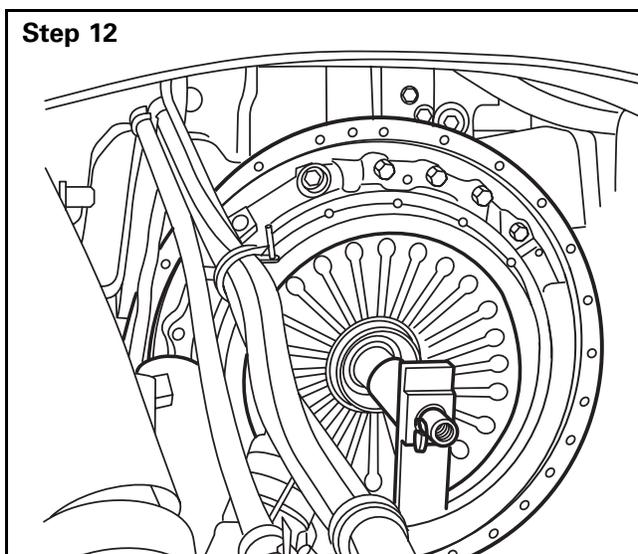
Remove the guide pins. Install the remaining fasteners.

- **GO TO THE NEXT STEP.**



Use a torque wrench to alternately tighten the 12 fasteners. Consult the OEM for exact tightening torque requirements.

- **GO TO THE NEXT STEP.**



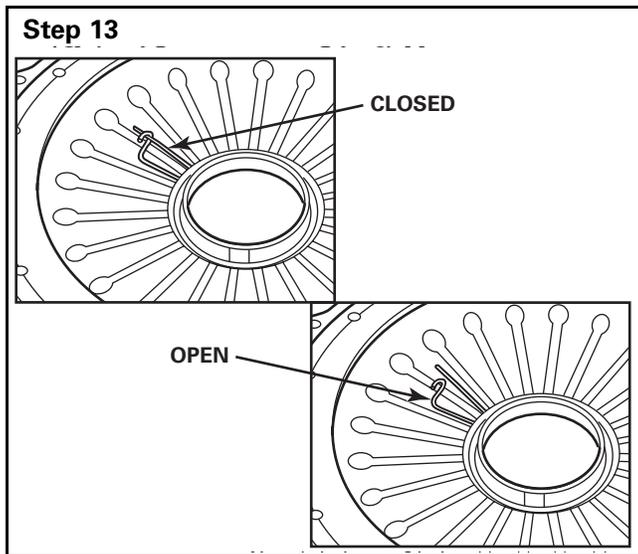
**NOTE:** The alignment shaft on the clutch caddy should slide out freely.

Remove the clutch caddy.

- **GO TO THE NEXT STEP.**

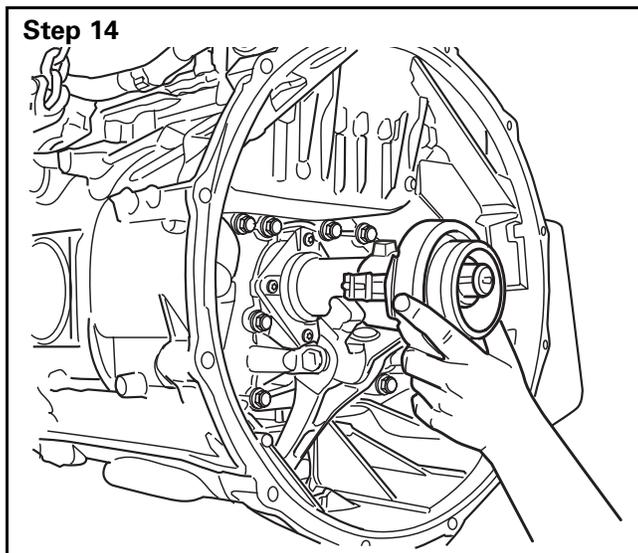
## Section 5 Removal and Installation

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Check that the release bearing retainer clip is closed before you install the transmission.

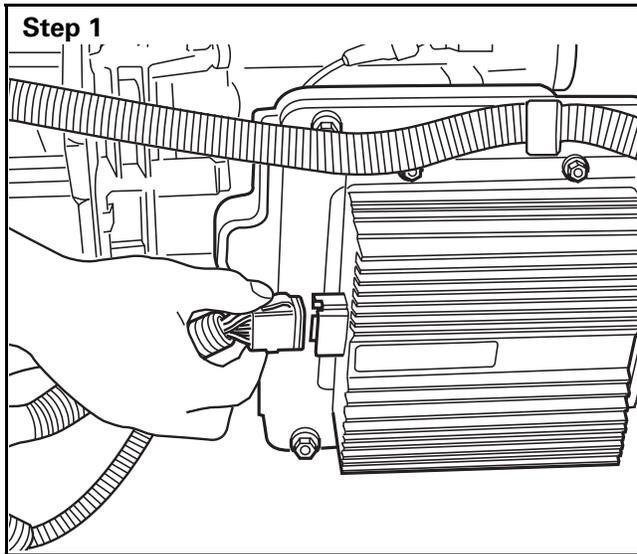
- **GO TO THE NEXT STEP.**



Install the release bearing onto the transmission input shaft. Refer to Release Bearing in this section.

**NOTE:** The transmission control unit (TCU) automatically adjusts the clutch. No further adjustment is required.

## Section 5 Removal and Installation

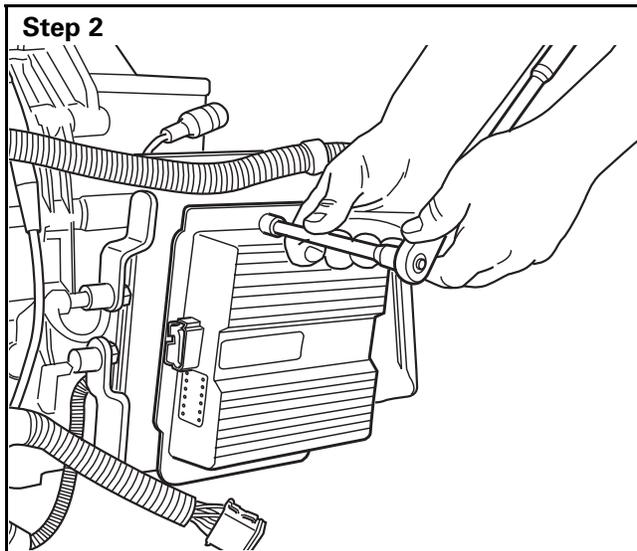


### Voltage Doubler

#### Removal

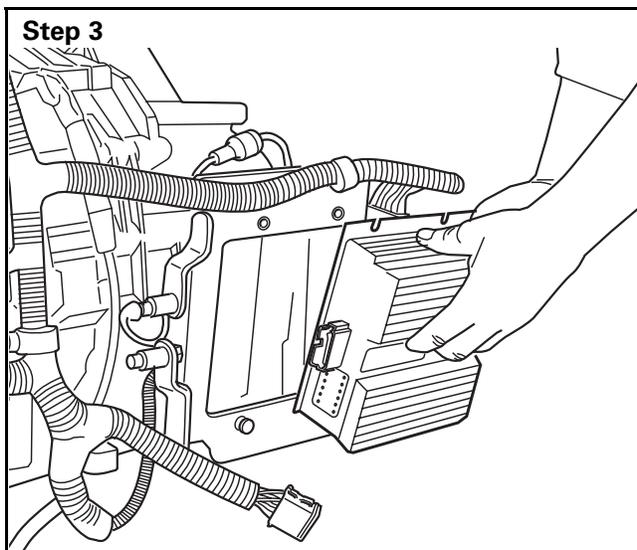
Unplug the voltage doubler connector.

- **GO TO THE NEXT STEP.**



Use a 7/16-inch socket and ratchet to remove the four fasteners.

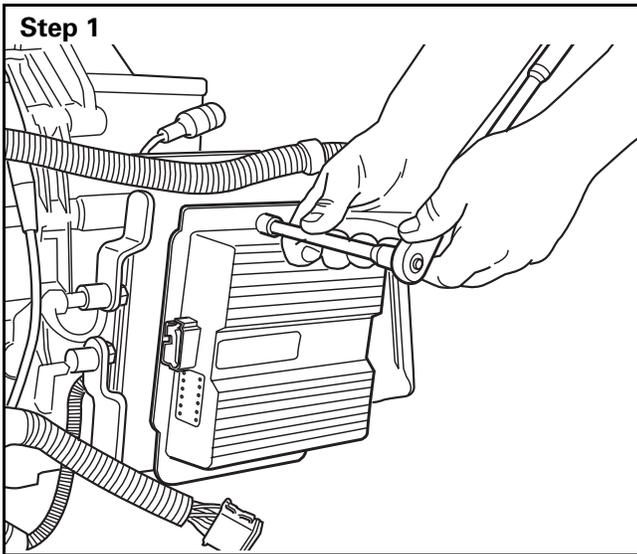
- **GO TO THE NEXT STEP.**



Remove the voltage doubler.

## Section 5 Removal and Installation

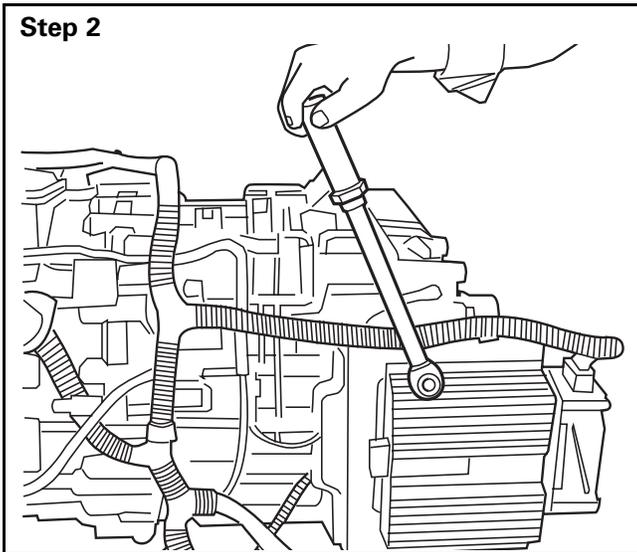
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### Installation

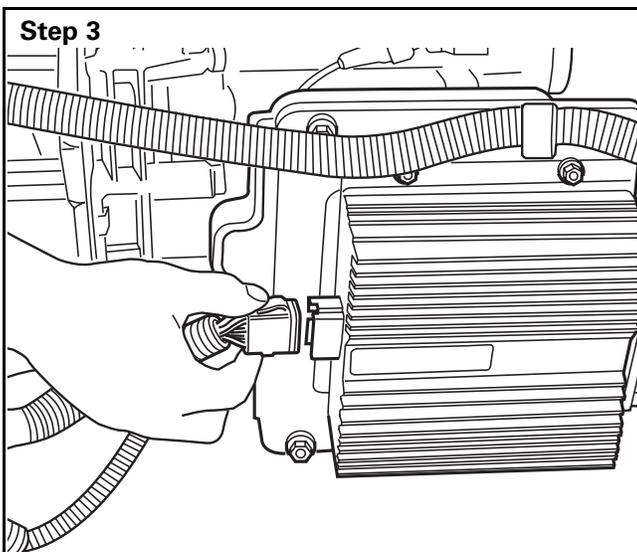
Use four fasteners with flat washers and a 7/16-inch socket and ratchet to install the voltage doubler to the component mounting plate.

- **GO TO THE NEXT STEP.**



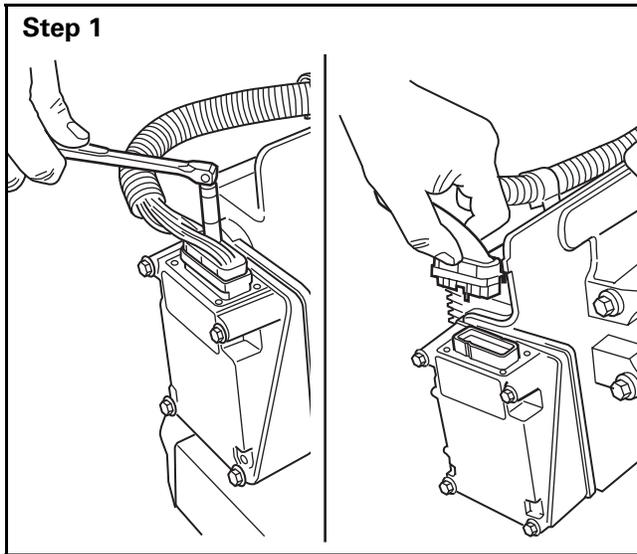
Tighten the fasteners to **12 lb-ft (16 N•m)**. 

- **GO TO THE NEXT STEP.**



Plug the electrical harness assembly into the voltage doubler connector.

## Section 5 Removal and Installation

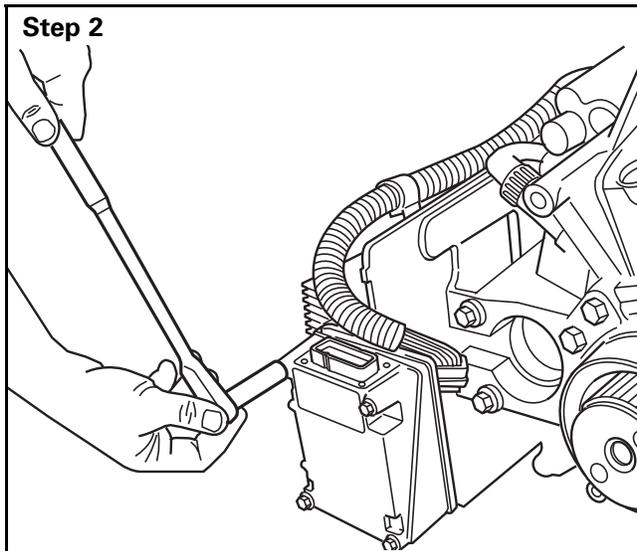


### ZF-FreedomLine Transmission Electronic Controller (ZMTEC)

#### Removal

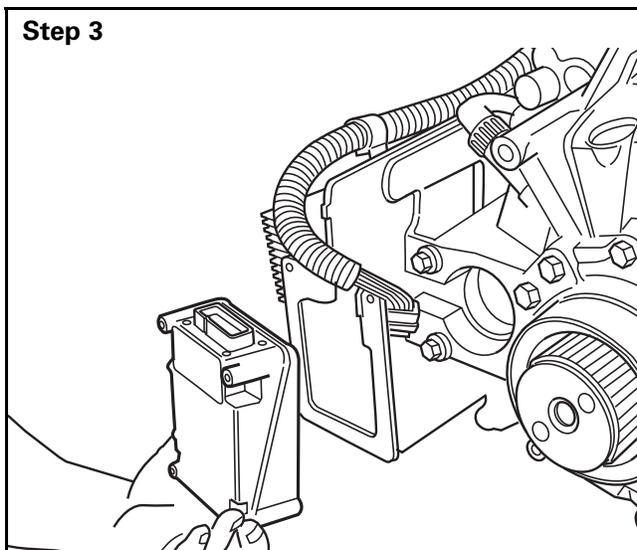
Use a 1/4-inch socket and ratchet to remove the ZMTEC connector.

- GO TO THE NEXT STEP.



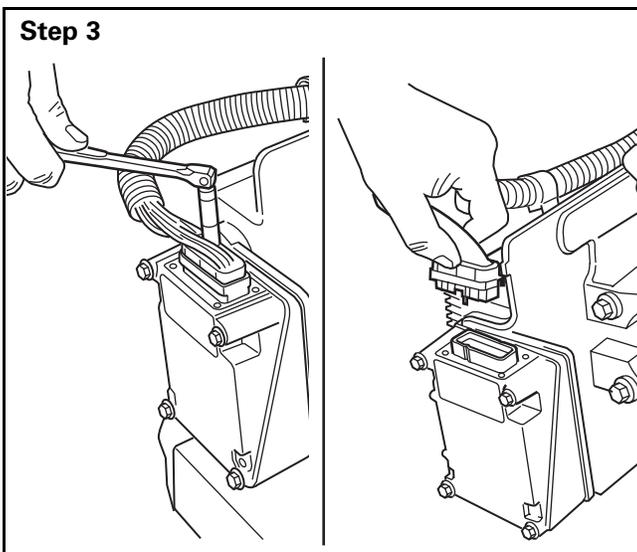
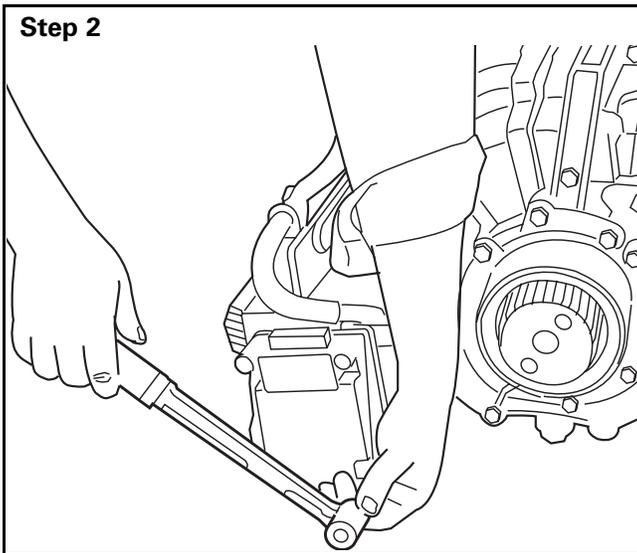
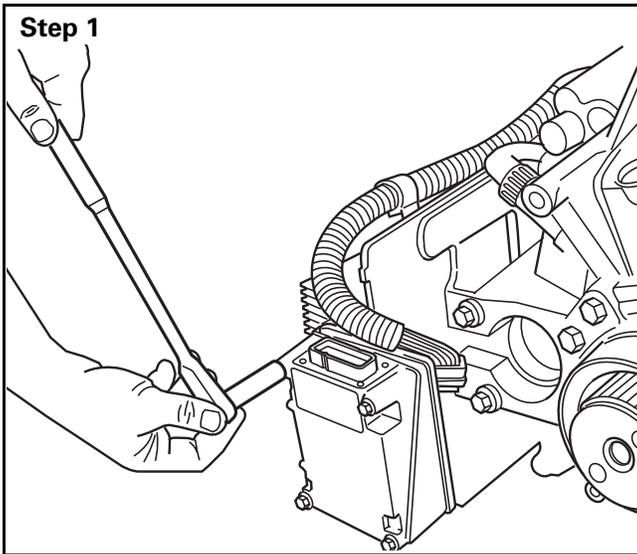
Use a 7/16-inch socket and ratchet to remove the four ZMTEC fasteners.

- GO TO THE NEXT STEP.



Remove the controller.

## Section 5 Removal and Installation



### Installation

Use four fasteners with flat washers and a 7/16-inch socket and ratchet to install the ZMTEC to the component mounting plate.

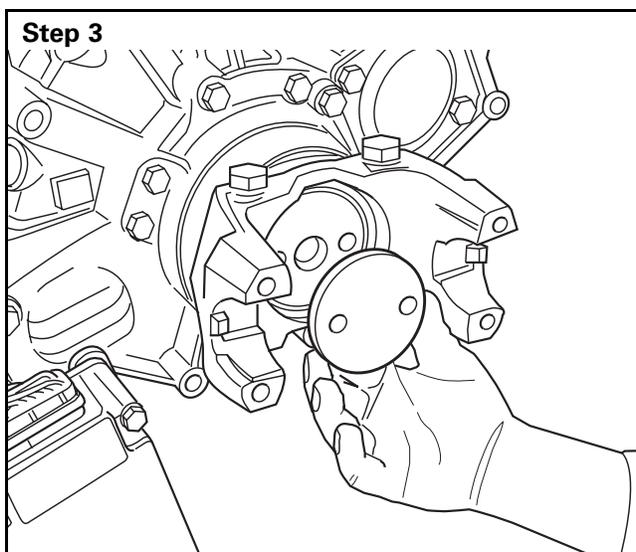
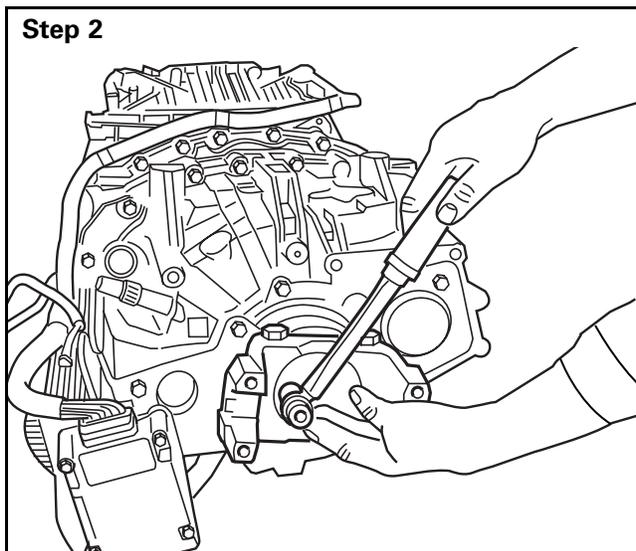
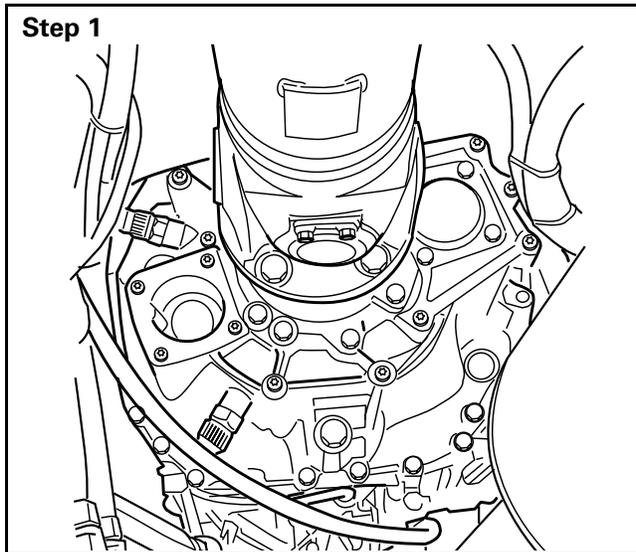
- **GO TO THE NEXT STEP.**

Tighten the fasteners to **12 lb-ft (16 N•m)**. 

- **GO TO THE NEXT STEP.**

Plug the electrical harness assembly into the ZMTEC. Tighten the 1/4-inch locking screw.

## Section 5 Removal and Installation



### Transmission Yoke

#### Removal

Follow the driveline manufacturer's instructions to remove the driveshaft from the transmission yoke.

- GO TO THE NEXT STEP.

Use a 19 mm socket and ratchet to remove the two fasteners that secure the retaining plate to the output shaft.

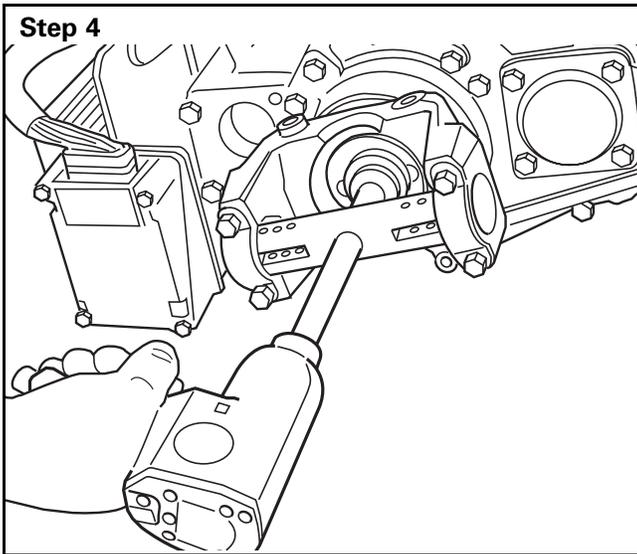
- GO TO THE NEXT STEP.

Remove the retaining plate and O-ring.

- GO TO THE NEXT STEP.

## Section 5 Removal and Installation

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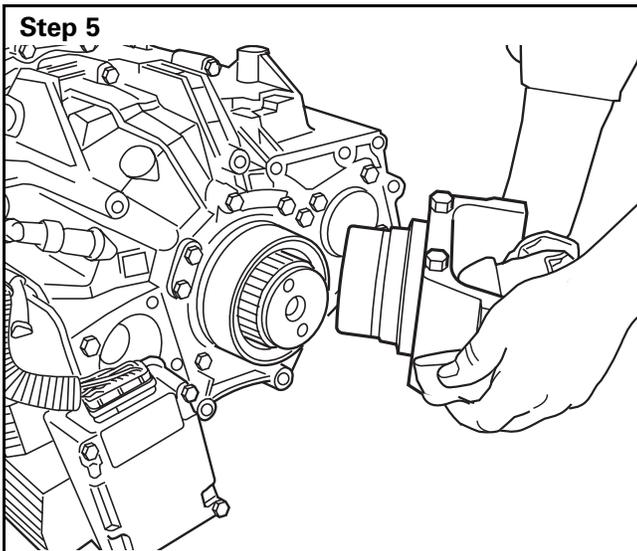
 **WARNING**

**Do not damage plug installed in center of output shaft!**

Refer to the Service Notes page on the front inside cover of this manual for instructions to order this tool.

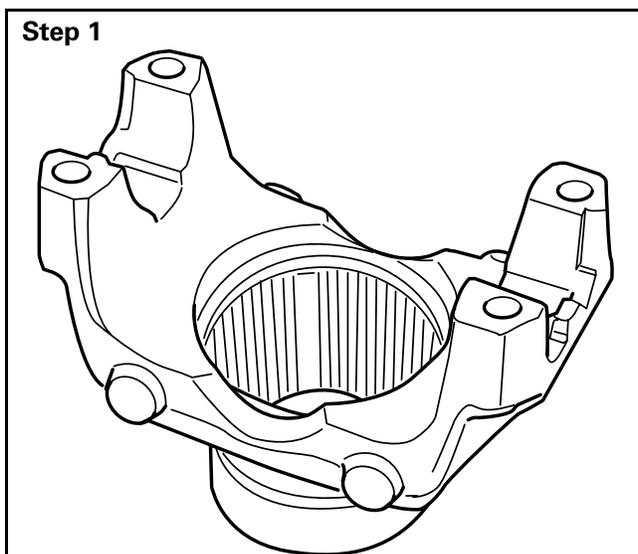
Remove the yoke using an SPX Kent-Moore puller (part number J-7804-01).

- **GO TO THE NEXT STEP.**



Remove the transmission yoke.

## Section 5 Removal and Installation



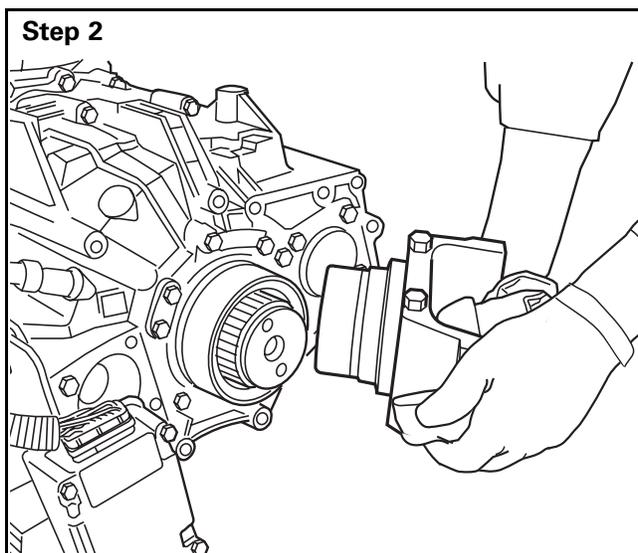
### Installation

**⚠ WARNING**

Do not overheat the yoke. Damage to the output shaft seal can result.

Heat the yoke to 175°F (79.4°C) in an oven.

- GO TO THE NEXT STEP.

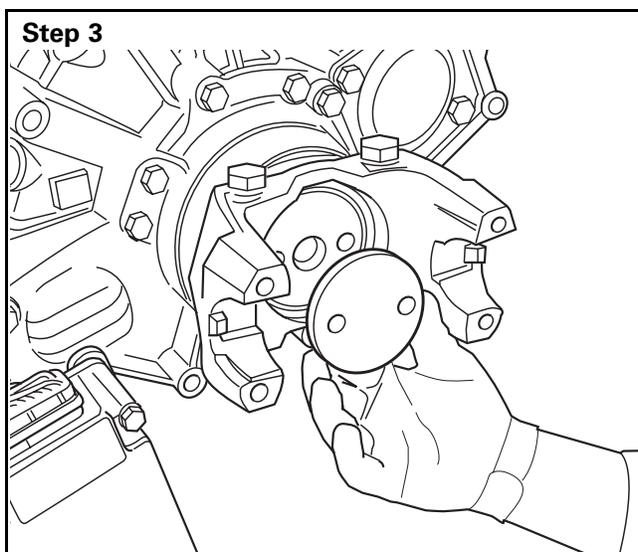


**⚠ WARNING**

The yoke will be hot when you install it onto the output shaft. Wear protective gloves to prevent serious personal injury.

Put on protective gloves. Install the yoke onto the output shaft, until the yoke contacts the output shaft bearing.

- GO TO THE NEXT STEP.



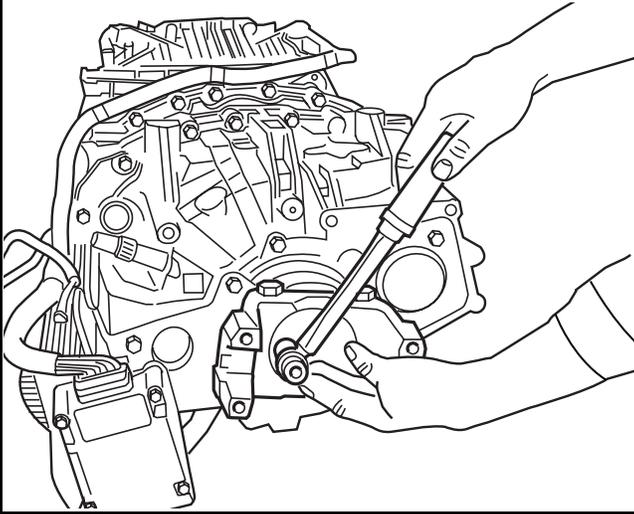
Use a 19 mm socket and ratchet to secure the retaining plate and O-ring onto the output shaft with two fasteners.

- GO TO THE NEXT STEP.

## Section 5 Removal and Installation

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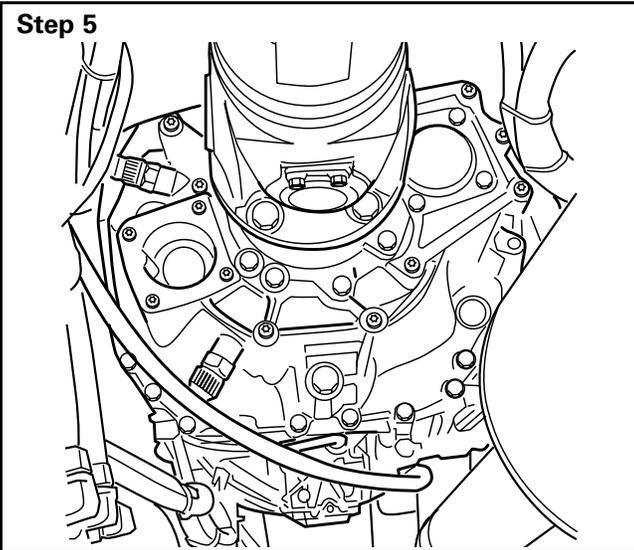
Step 4



Tighten the fasteners to **89 lb-ft (120 N•m)**. 

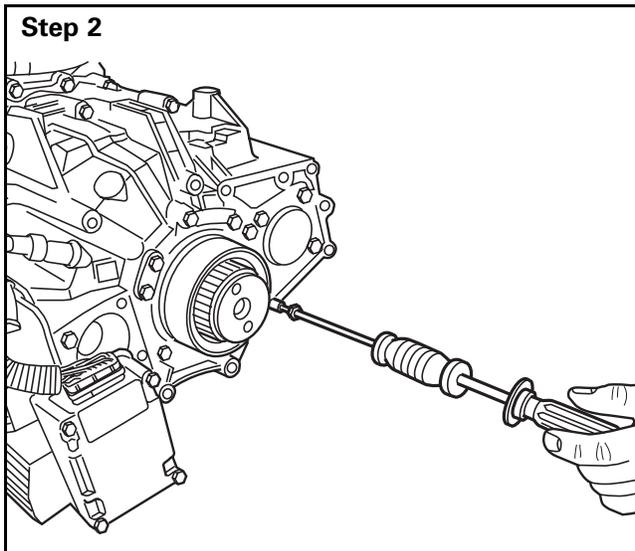
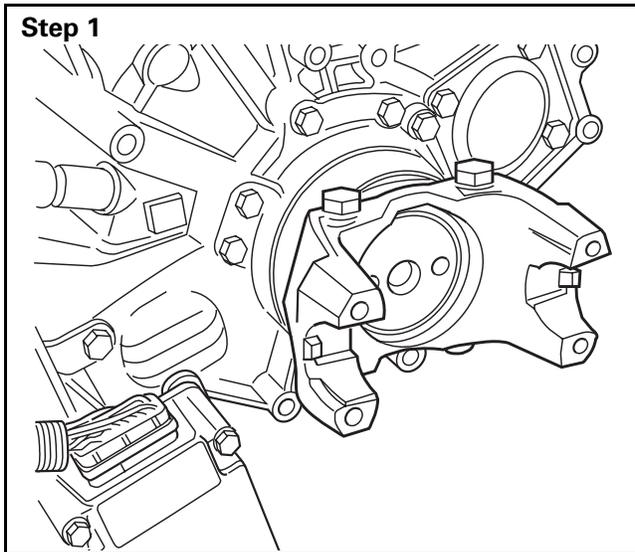
- **GO TO THE NEXT STEP.**

Step 5



Install the driveshaft. Refer to the manufacturer's instructions. Inspect for leaks.

## Section 5 Removal and Installation



### Output Shaft Seal

#### Removal

Remove the transmission yoke. Refer to Transmission Yoke in this section.

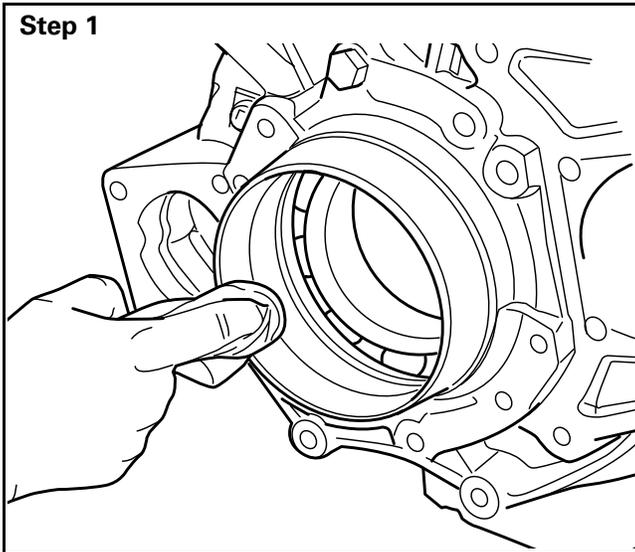
- **GO TO THE NEXT STEP.**

Refer to the Service Notes page on the front inside cover of this manual for instructions to order this tool.

Use an SPX Kent-Moore seal remover (part number J-24171-A or equivalent) to remove the output shaft seal. Do not reuse the output shaft seal after you remove it. Install a new seal.

## Section 5 Removal and Installation

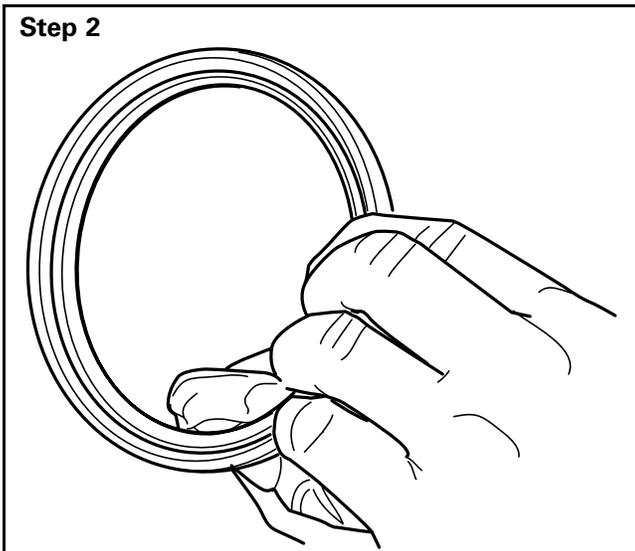
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### Installation

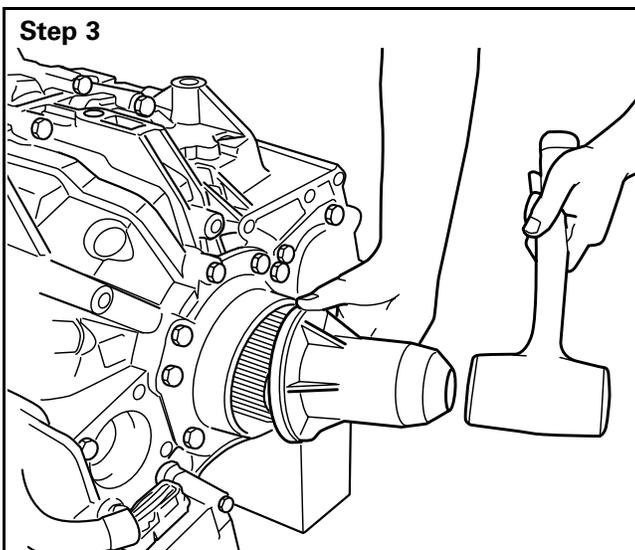
Clean all loose debris from the output shaft seal area.

- **GO TO THE NEXT STEP.**

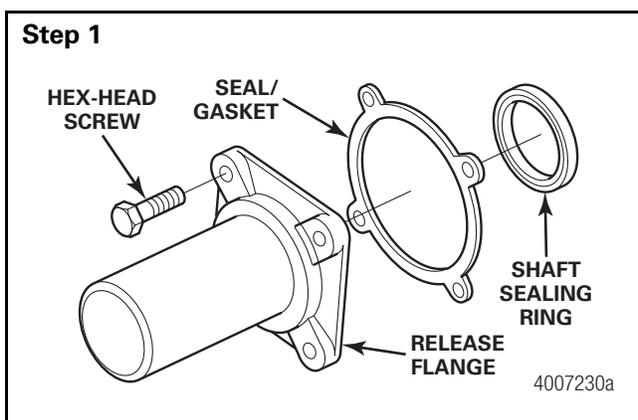


Apply a thin coat of transmission oil to the inner diameter of the seal.

- **GO TO THE NEXT STEP.**



Install the output shaft seal. Use SPX Kent-Moore output shaft seal installer (part number J-45247).



### Step 2

If necessary, remove the seal/gasket.

- **GO TO THE NEXT STEP.**

### Step 3

Use a suitable tool to remove the shaft sealing ring from the release flange.

## Input Shaft Seal

### Removal

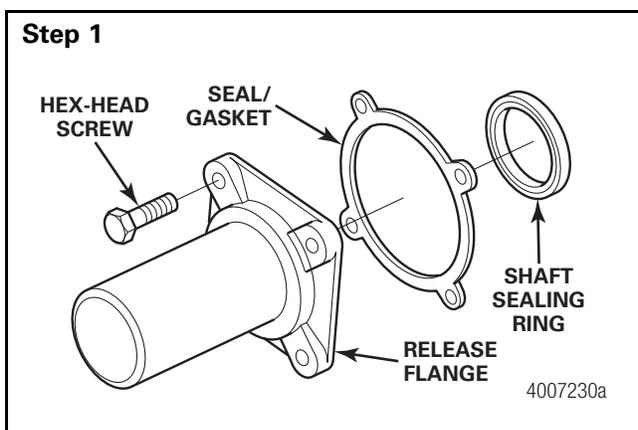
Remove the transmission: refer to Transmission Removal in this section. The release fork and bearing will need to be removed from the transmission to perform this procedure.

Remove the four M8 hex-head screws and lift off the release flange.

- **GO TO THE NEXT STEP.**

### Installation

Coat the sealing lip of the shaft seal with grease. Press the seal firmly into the flange. The sealing lip must point towards the transmission's interior. Install gasket/seal onto release flange.

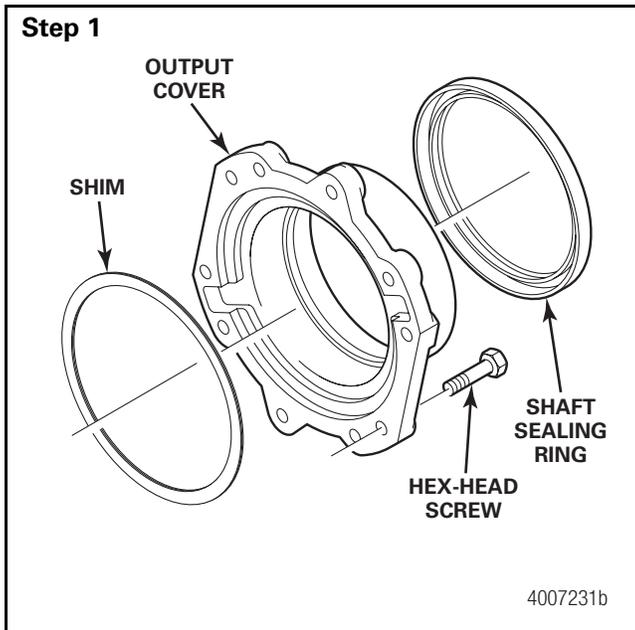


Use four M8 hex-head screws to secure the release flange. Tighten the screws to 17 lb-ft (23.05 N·m). 

## Section 5

# Removal and Installation

---



Remove transmission yoke: reference Transmission Yoke Removal in this section.

## Output Cover

### Removal

Remove the 10 M10 hex-head screws and lift off the output cover.

- **GO TO THE NEXT STEP.**

### Step 2

If necessary, remove the shim.

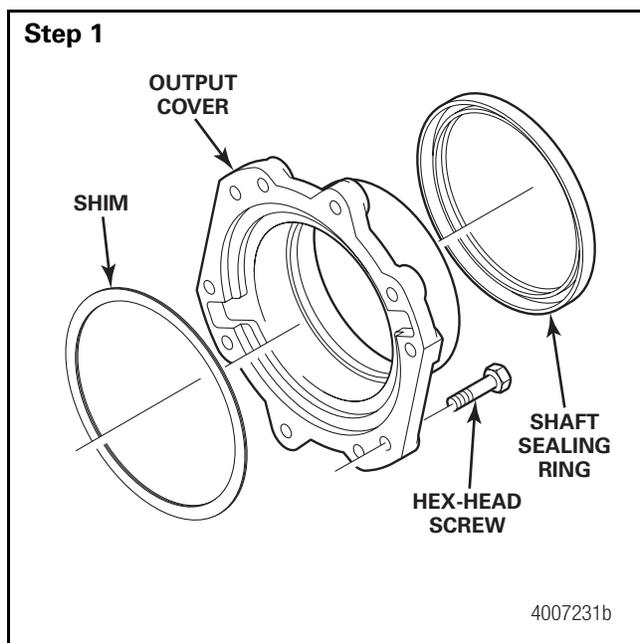
- **GO TO THE NEXT STEP.**

**NOTE:** The shim is no longer needed for newer transmissions since the output cover has been modified accordingly.

### Step 3

Use a suitable tool to remove the shaft sealing ring.

## Section 5 Removal and Installation



### Installation

Coat the outer circumference of the shaft sealing ring with grease. Use an appropriate driver to press the sealing ring into the output cover and ensure it is firmly seated. Slightly grease the sealing lip.

- **GO TO THE NEXT STEP.**

### Step 2

Coat the sealing surface of the output cover with Loctite® 574 or equivalent sealant.

- **GO TO THE NEXT STEP.**

### Step 3

**NOTE:** The sealing surfaces must be clean and free of oil and grease.

Fit the output cover with a shim, if necessary.

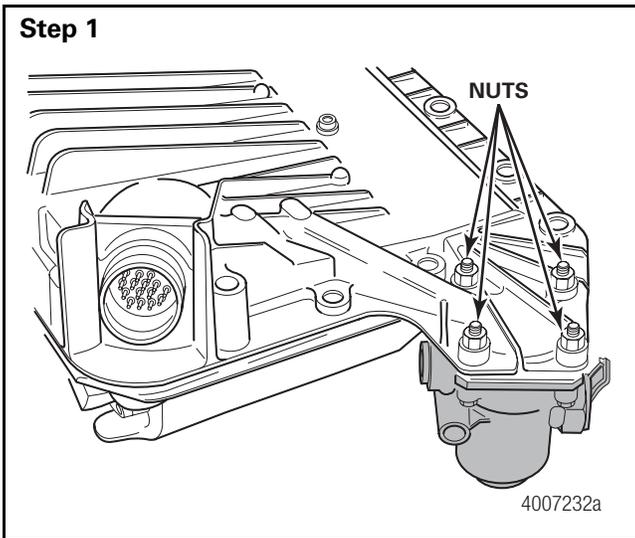
- **GO TO THE NEXT STEP.**

### Step 4

Place the output cover in position and secure it with the 10 M10 hex-head screws. Tighten the screws to 34 lb-ft (46 N•m). 

## Section 5 Removal and Installation

### Step 1



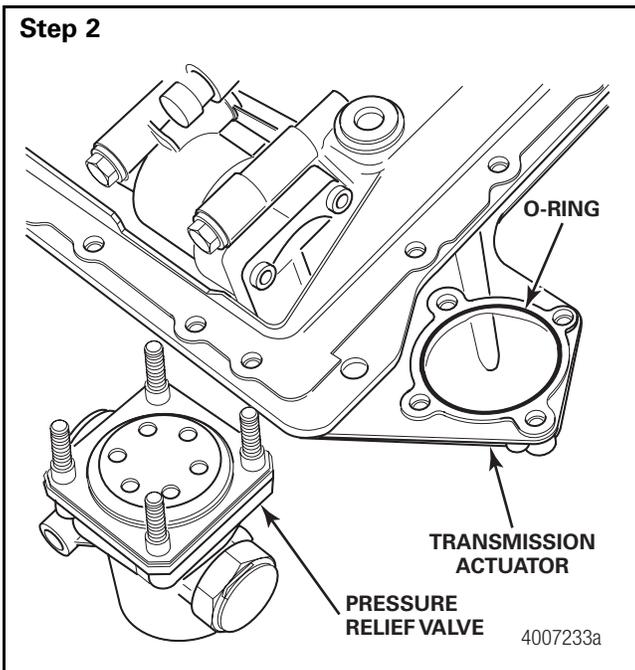
## Air Filter Regulator

**NOTE:** The repair kit contains four nuts, one O-ring and the air filter regulator. Before removing, mark the installation position of the air filter regulator for fitting later on.

### Removal

Remove the four nuts and take off the air filter regulator. Remove the O-ring.

### Step 2



### Installation

#### CAUTION

Do not use grease to fit the O-ring.

#### Step 1

Insert the new O-ring.

- GO TO THE NEXT STEP.

#### Step 2

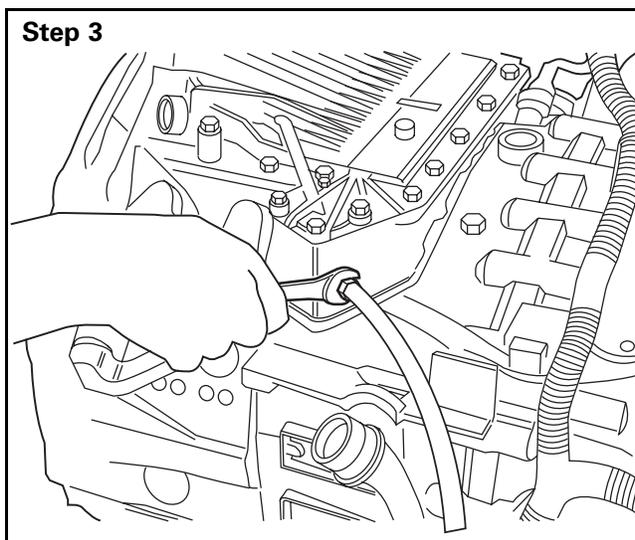
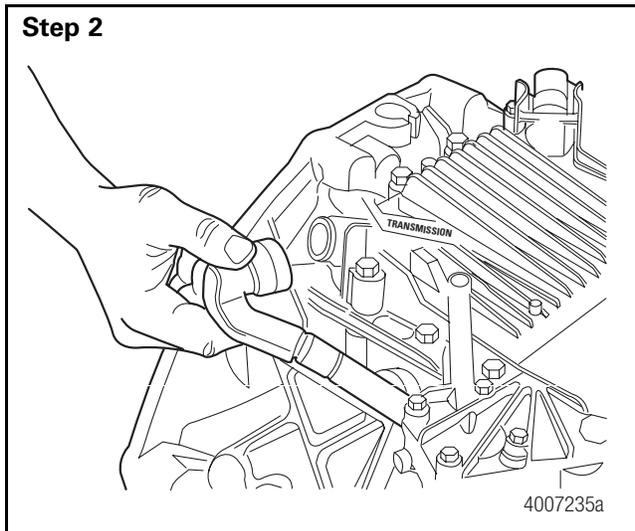
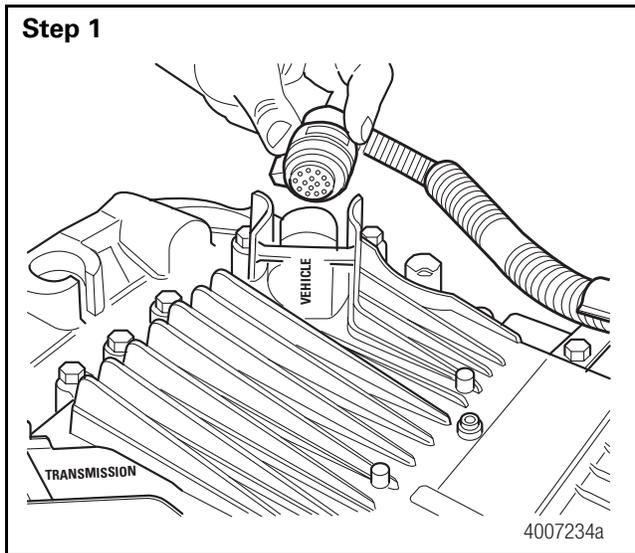
Install the air filter regulator as marked during removal.

- GO TO THE NEXT STEP.

#### Step 3

Install and tighten the four nuts to to 5 lb-ft (7 N•m). 

## Section 5 Removal and Installation



### TCU Top Half/Top Cover

#### Removal

Remove the electrical wiring harness from the TCU connector marked "vehicle":

- GO TO THE NEXT STEP.

Remove the electrical wiring harness from the TCU connector marked "Transmission":

- GO TO THE NEXT STEP.

Remove the air fitting from the air regulator.

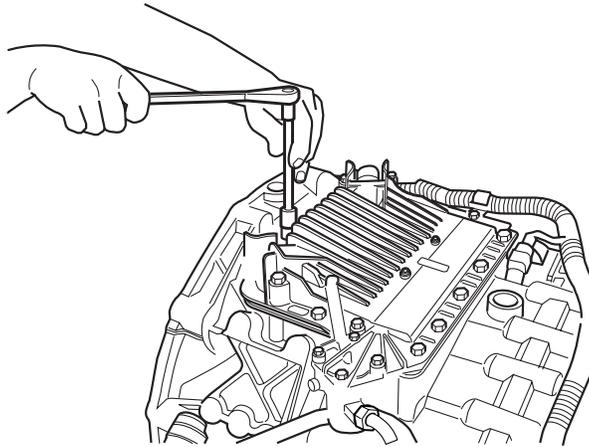
#### **WARNING**

Use caution when disconnecting the line as it still may be under pressure.

- GO TO THE NEXT STEP.

## Section 5 Removal and Installation

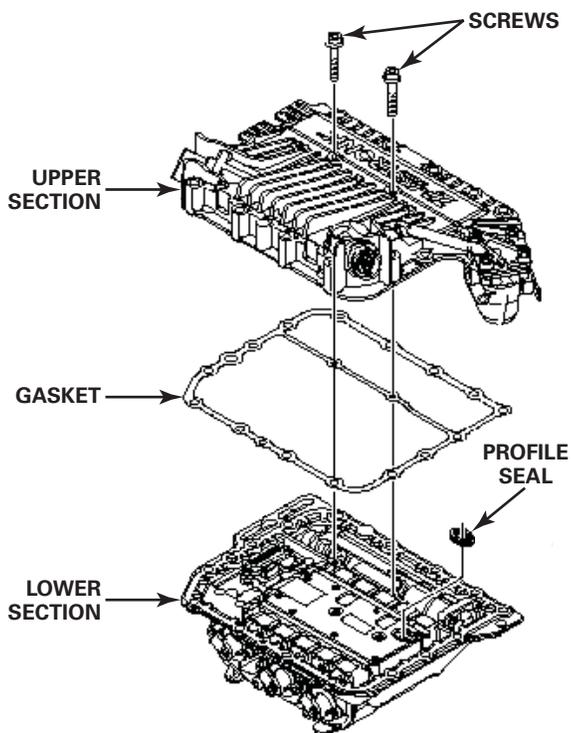
### Step 4



Use a 13 mm socket to remove the 15 fasteners that secure the TCU to the transmission.

- **GO TO THE NEXT STEP.**

### Step 5



Remove both screws with a T-30 Torx tool.

### Step 6

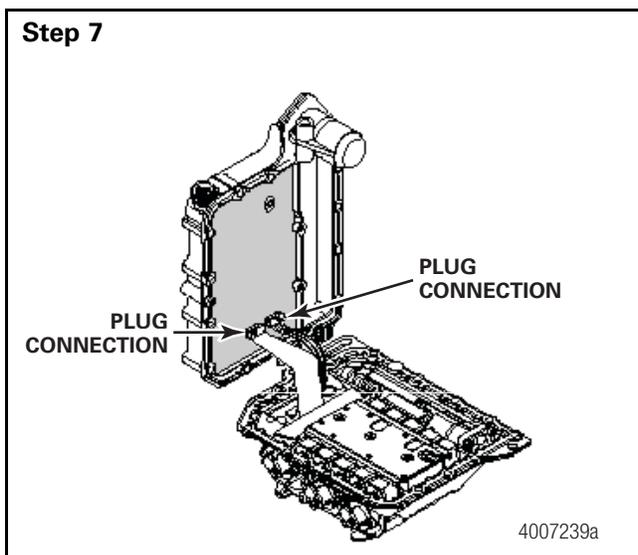
Raise the upper section.



**WARNING**  
Use caution when lifting upper section. Do not damage ribbon cables!

- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation



Disconnect the plug connections.

- **GO TO THE NEXT STEP.**

### **Step 8**

Ensure the profile seal remains in the bottom part of the TCU.

- **GO TO THE NEXT STEP.**

### **Step 9**

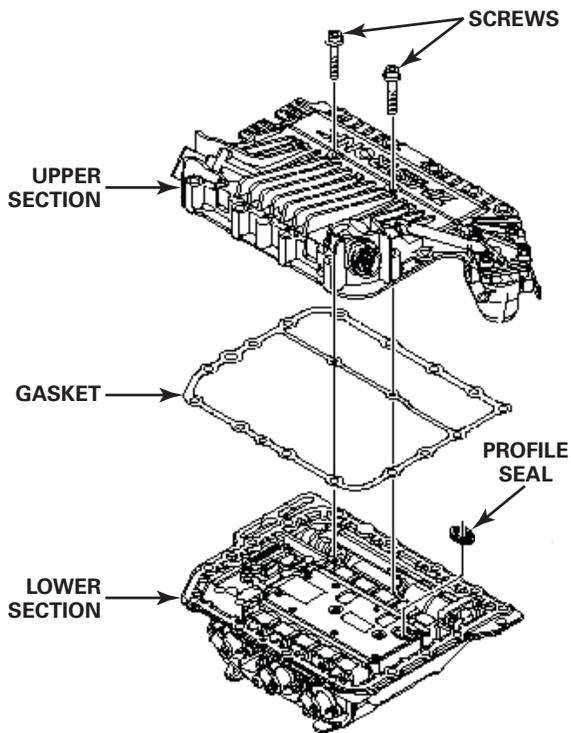
Remove the gasket.

- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation

---

### Step 1



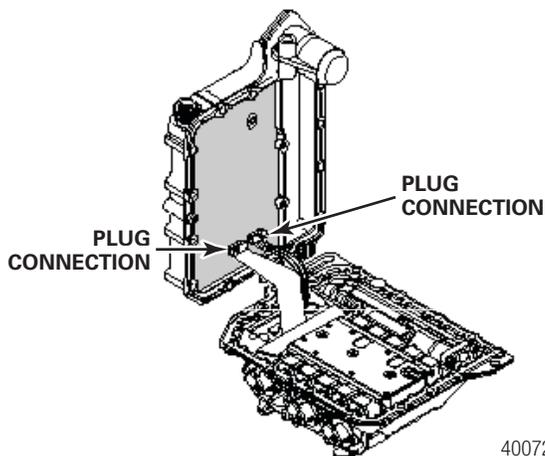
4007238a

### Installation

Place the new gasket seal on the upper section.

- GO TO THE NEXT STEP.

### Step 2



4007239a

Reconnect the plug connections.

- GO TO THE NEXT STEP.

## Section 5 Removal and Installation

### Step 3

Check that the plug connections are tight and secure.

- **GO TO THE NEXT STEP.**

### Step 4

Place the upper section on the lower section.

Ensure that the flat seal does not move. Fix the seal if necessary.

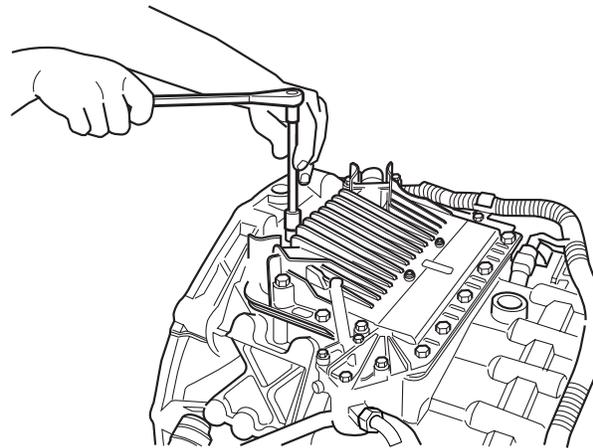
- **GO TO THE NEXT STEP.**

### Step 5

Install and tighten the two screws to 7.0 lb-ft (9 N•m). 

- **GO TO THE NEXT STEP.**

### Step 6



Use a 13 mm socket and ratchet to secure the TCU to the transmission with 15 fasteners. Secure the wiring harness clip to the transmission.

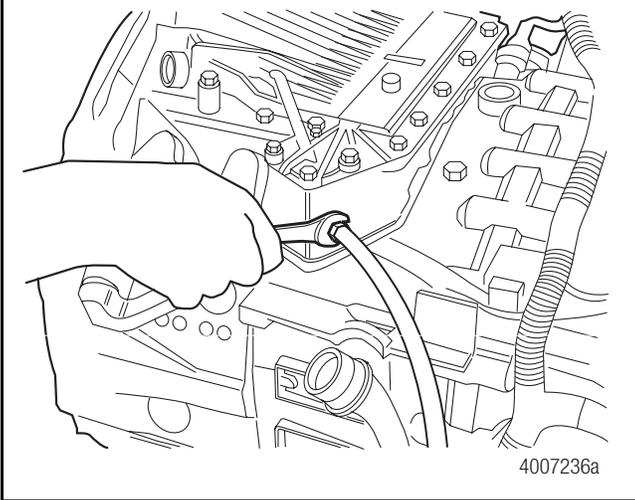
Tighten the fasteners to 17 lb-ft (23 N•m) using a star patten. 

- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation

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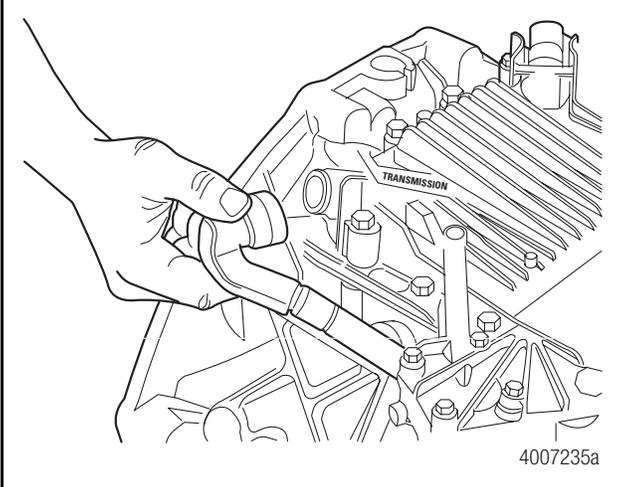
**Step 7**



Install the air fitting into the air regulator.

- **GO TO THE NEXT STEP.**

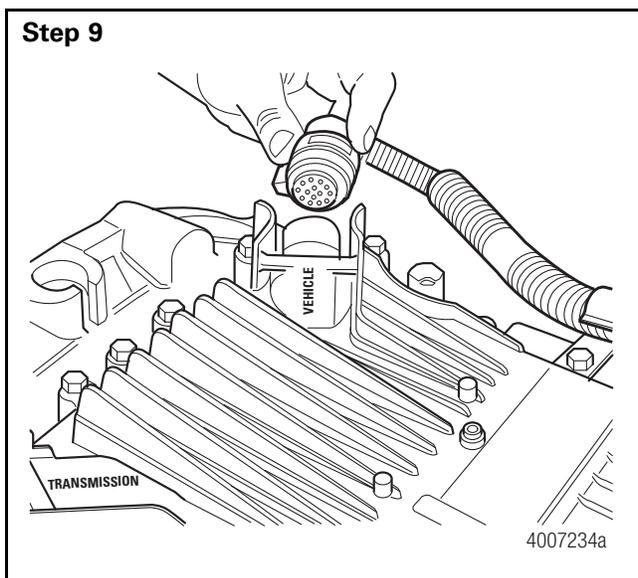
**Step 8**



Connect the electrical wiring harness into the TCU connector marked "Transmission".

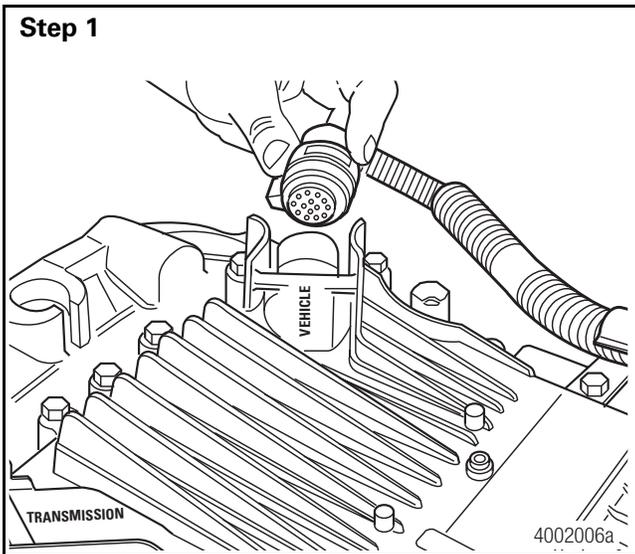
- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation



Connect the transmission vehicle wiring harness to the TCU port marked "Vehicle."

## Section 5 Removal and Installation

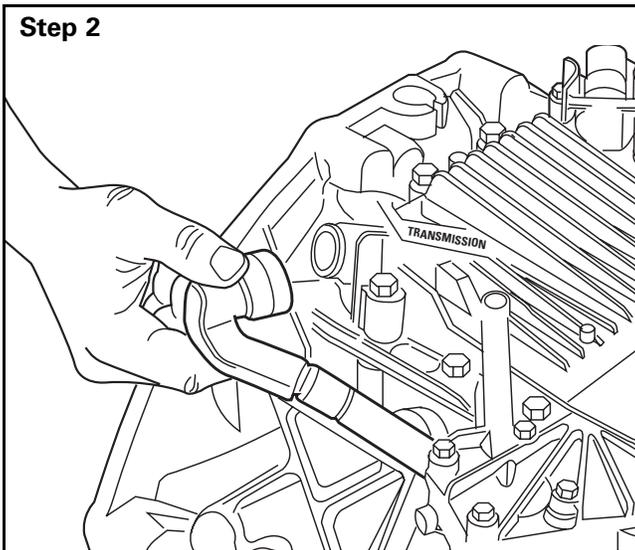


### Transmission Control Unit (TCU)

#### Removal

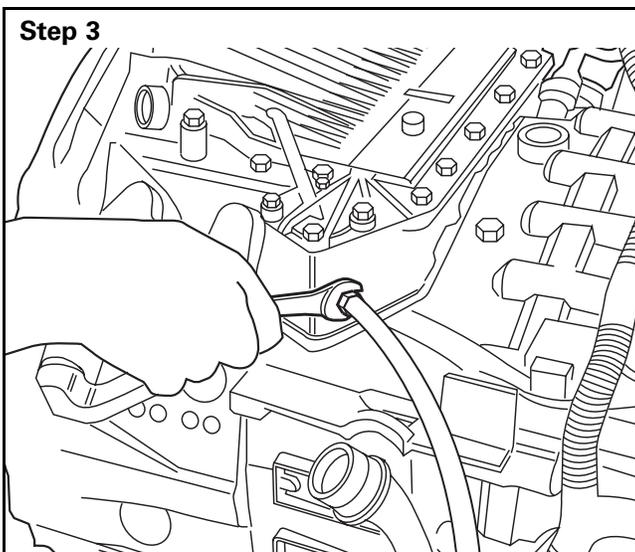
Unplug the electrical wiring harness assembly from the TCU port marked "Vehicle."

- GO TO THE NEXT STEP.



Remove the transmission wiring harness assembly from the port marked "Transmission."

- GO TO THE NEXT STEP.



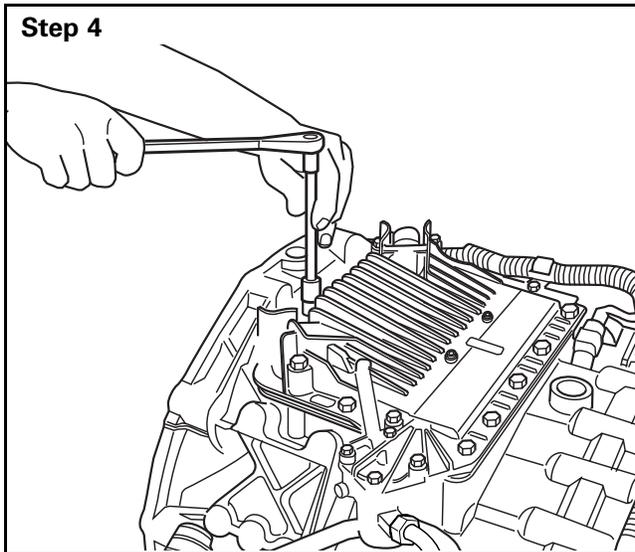
#### **WARNING**

Use caution when disconnecting the line as it still may be under pressure.

Disconnect the air supply line from the air filter regulator.

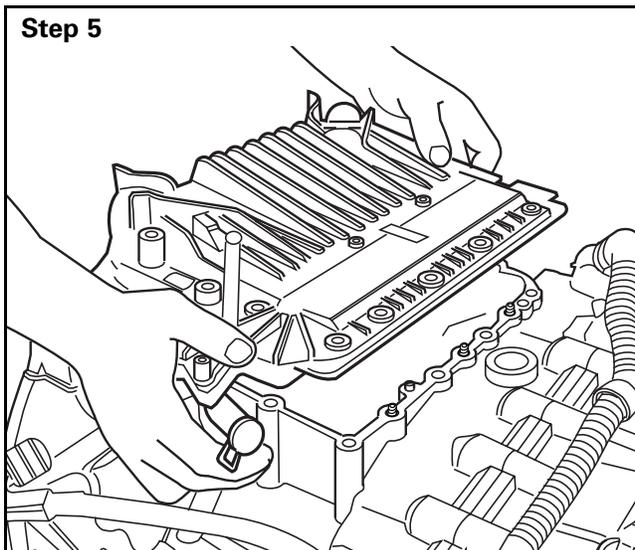
- GO TO THE NEXT STEP.

## Section 5 Removal and Installation



Use a 13 mm socket and ratchet to remove the 15 fasteners that secure the TCU to the transmission.

- **GO TO THE NEXT STEP.**



**⚠ WARNING**

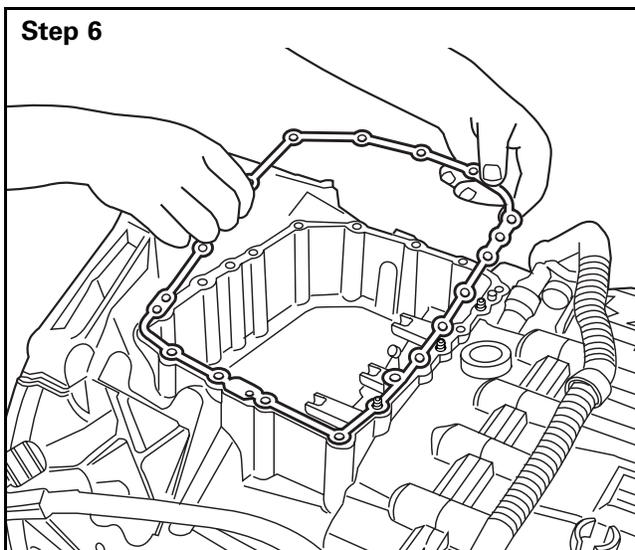
Do not rotate the transmission's three shift rails when you remove or install the transmission control unit (TCU). Damage to the transmission will result.

Remove the TCU by lifting it straight UP and OUT of the transmission.

**⚠ WARNING**

Do not move or bump shift rails. The settings of the rails will need to be transferred to the new TCU.

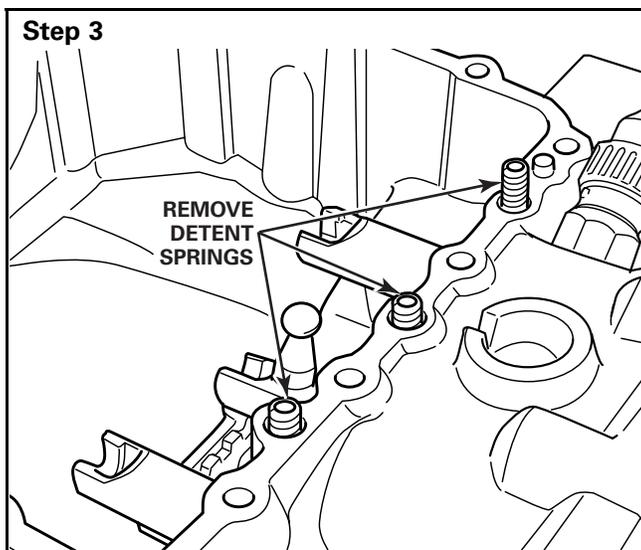
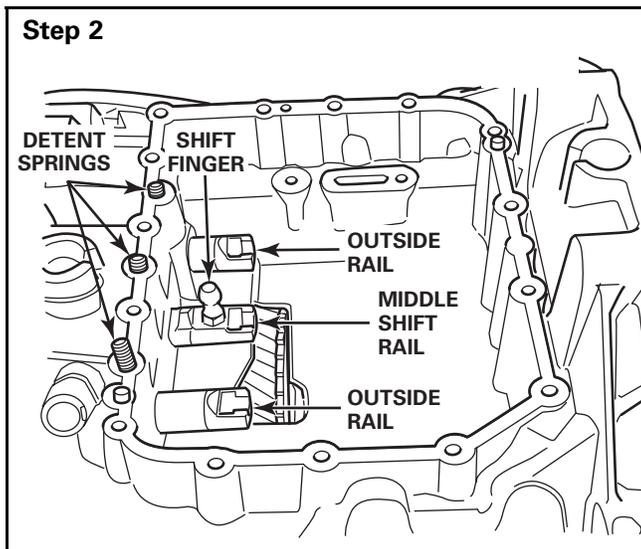
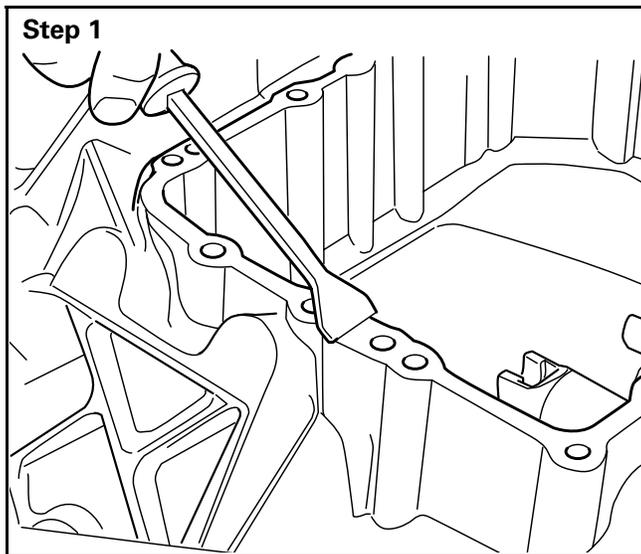
- **GO TO THE NEXT STEP.**



**NOTE:** The detent spring on the passenger side of the center shift rail is higher than the other two springs. However, the three detent springs are identical.

Remove and discard the TCU gasket. Do not reuse it.

## Section 5 Removal and Installation



### Installation

Inspect the sealing surfaces of the TCU and transmission for debris. If necessary, use a scraper to clean the surfaces.

- GO TO THE NEXT STEP.

### WARNING

Do not move the center rail forward or rearward, only rotate it such that the shift finger points straight up. Serious damage to the transmission could result.

Rotate the center rail such that the shift finger points straight up.

- GO TO THE NEXT STEP.

### WARNING

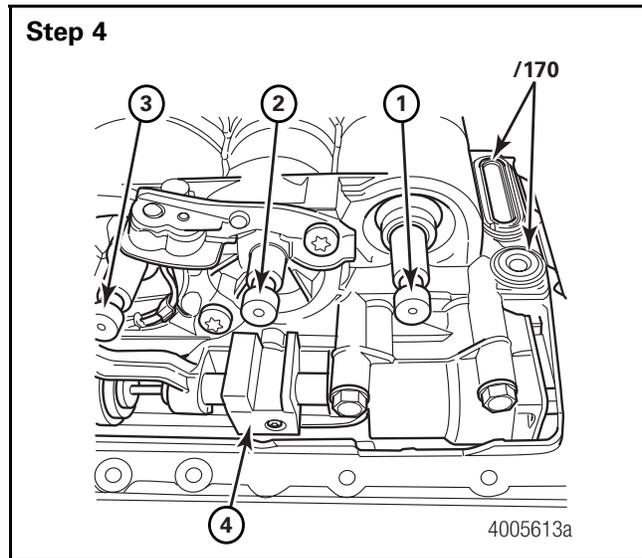
Use care not to drop springs into the transmission.

**NOTE:** The detent spring on the passenger side of the center shift rail is higher than the other two springs. However, the three detent springs are identical.

Remove the three detent springs.

- GO TO THE NEXT STEP.

## Section 5 Removal and Installation



### Legend

- ① Piston Rod = Shifts the splitter group (GV)
- ② Piston Rod = Shifts the basic transmission
- ③ Piston Rod = Shifts the range change group (GP)
- ④ Selector Gate = Selects the shift gate

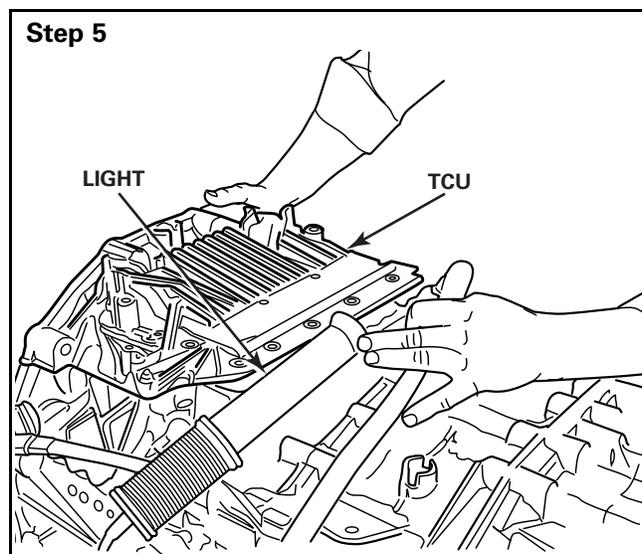
Transfer measurements for the shift rails from the removed transmission actuator to piston rods ①, ②, and ③ of the new transmission actuator.

Selector gate ④ and piston rod ② must be centered with the piston and groove inline.

Ensure that the profile seals (/170) on the transmission actuator are inserted.

**NOTE:** With the 12-speed versions built prior to 2004, do not slide the center shift rail ② too far into the transmission, otherwise the gearshift finger may fall into the transmission.

- **GO TO THE NEXT STEP.**

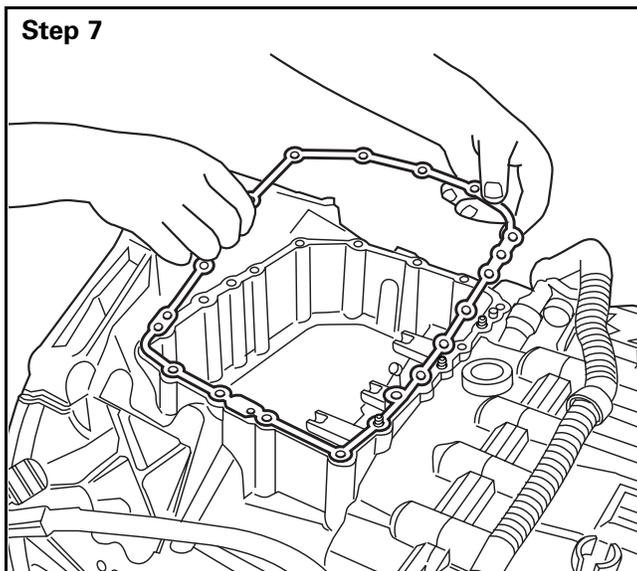
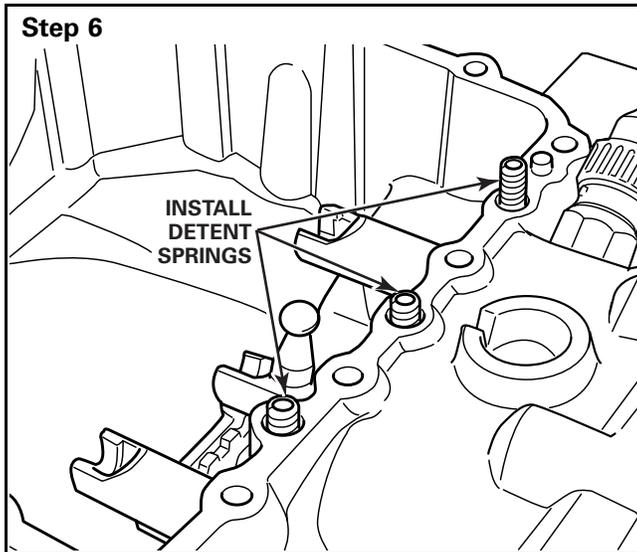


Place the shift module onto the transmission. The module should fully seat. Ensure that the shift module pistons connect correctly with the transmission shift rails.

- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation

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 **WARNING**

Use care not to drop springs into the transmission.

**NOTE:** The detent spring on the passenger side of the center shift rail is higher than the other two springs. However, the three detent springs are identical.

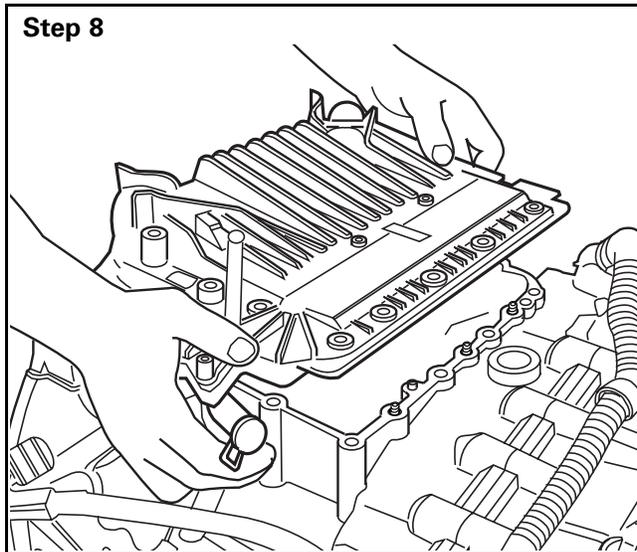
Remove the shift module from the transmission and reinstall the three detent springs.

- **GO TO THE NEXT STEP.**

Install a new gasket on the sealing surface.

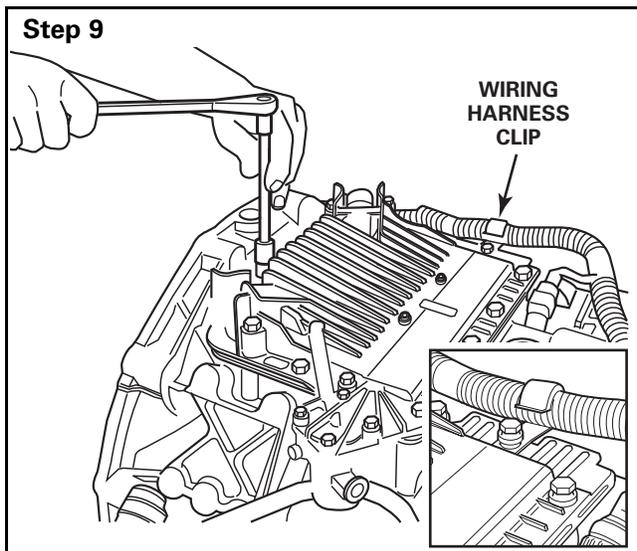
- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation



Place the shift module onto the transmission.

- **GO TO THE NEXT STEP.**



Use a 13 mm socket and ratchet to secure the TCU to the transmission with 15 fasteners. Press down the TCU while tightening fasteners.

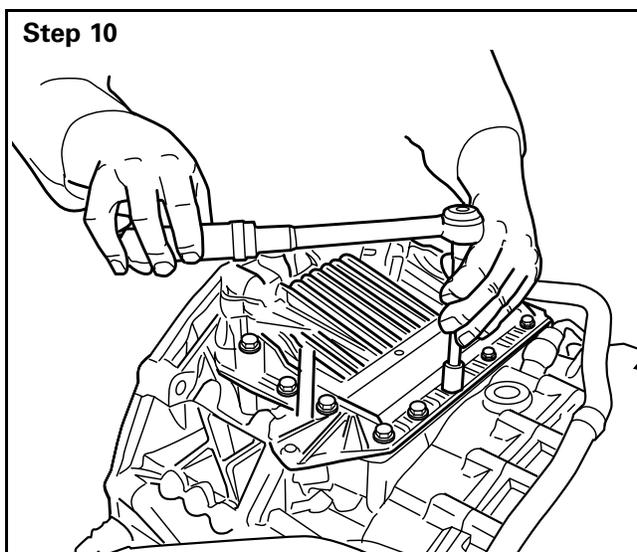
TCU must be able to touch the gasket on all sides while applying downward pressure with the hand.

 **WARNING**

**Do not force together by tightening the fasteners or damage to the TCU can result.**

Secure the wiring harness clip to the transmission.

- **GO TO THE NEXT STEP.**



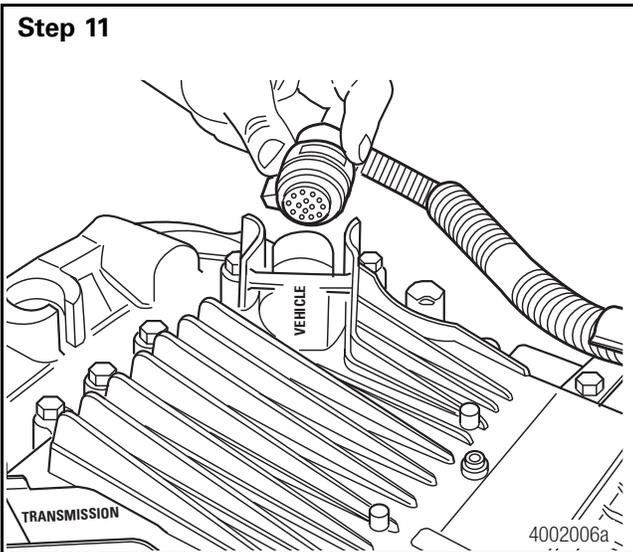
Tighten the fasteners to **17 lb-ft (23 N•m)** using a star pattern. 

- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation

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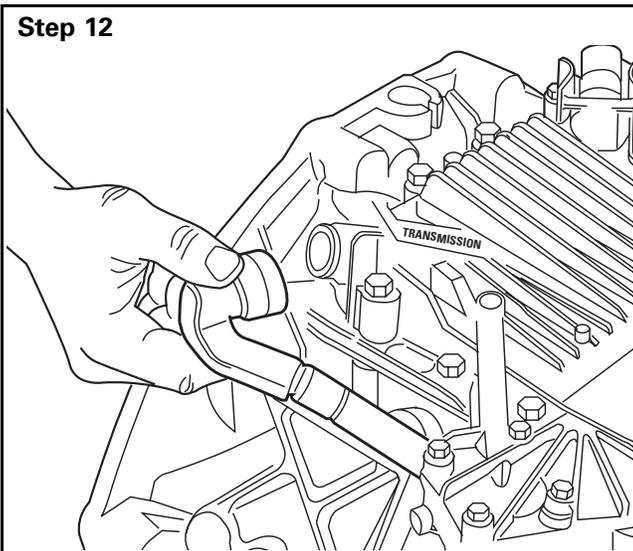
Step 11



Connect the transmission vehicle wiring harness to the TCU port marked "Vehicle."

- **GO TO THE NEXT STEP.**

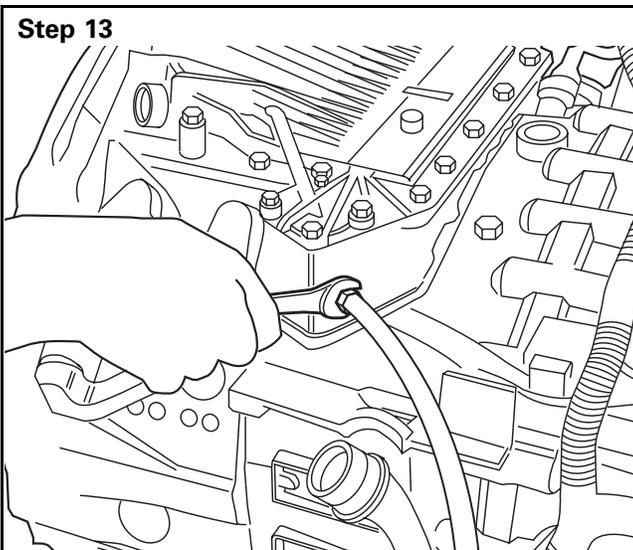
Step 12



Connect the transmission wiring harness assembly to the TCU.

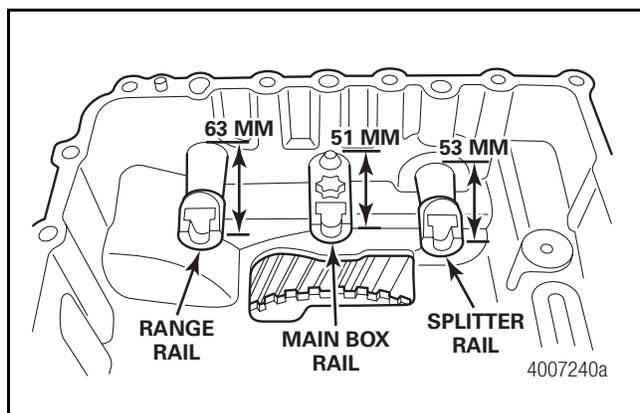
- **GO TO THE NEXT STEP.**

Step 13



Connect the air supply line to the TCU air filter regulator.

**NOTE:** If issues continue to occur with correctly aligning rails, go to the next step.



### Shift Rail/TCU Cylinder Adjustments for Installation

#### WARNING

This procedure should only be performed if pistons on the original TCU are moved or if the procedure starting on page 134 is unsuccessful.

Adjustment of the shift rails is necessary before installing the TCU. All three shift rails (i.e., range, main box and splitter) must be adjusted to a specific position.

#### Step 1

Adjust the range rail to 63 mm from the back of the cavity wall to the front of the shift rail.

- GO TO THE NEXT STEP.

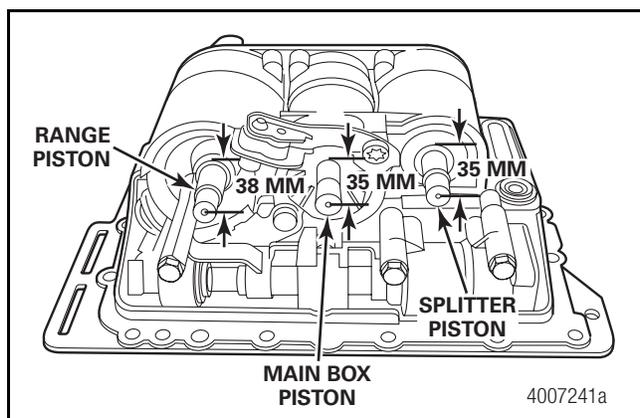
#### Step 2

Adjust the main box rail to 51 mm from the back of the cavity wall to the front of the shift rail.

- GO TO THE NEXT STEP.

#### Step 3

Adjust the splitter shift rail to 53 mm from the back of the half moon feature to the front of the shift rail.



### Adjust the Cylinder Pistons

Once all of the transmission shift rails have been correctly lined up, the TCU to be installed also must be adjusted. Each cylinder piston has to be set to a correct length as shown.

#### Step 1

Adjust the splitter cylinder piston to 38 mm from the cylinder bore entrance to the front of the piston.

- GO TO THE NEXT STEP.

#### Step 2

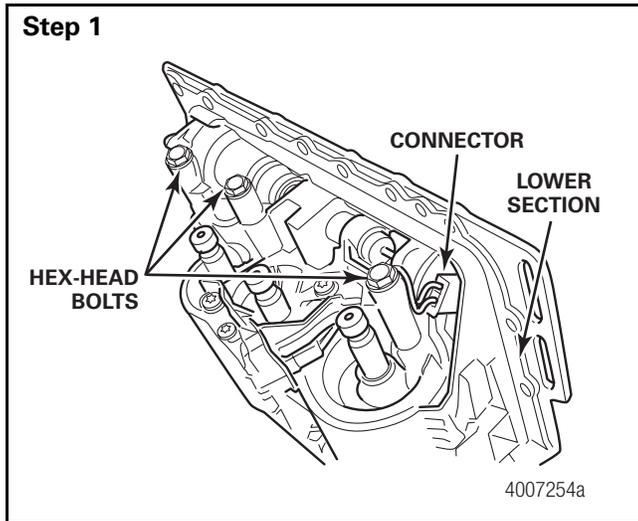
Adjust the main box cylinder piston to 35 mm from the cylinder bore entrance to the front of the piston.

- GO TO THE NEXT STEP.

#### Step 3

Adjust the range cylinder piston to 35 mm from the cylinder bore entrance to the front of the piston.

## Section 5 Removal and Installation



### Selector Cylinder

#### **⚠ WARNING**

This procedure is to be performed only with out-of-warranty cases. During warranty period, the complete TCU must be exchanged.

**NOTE:** The repair kit contains the selector cylinder and a profile seal.

#### Removal

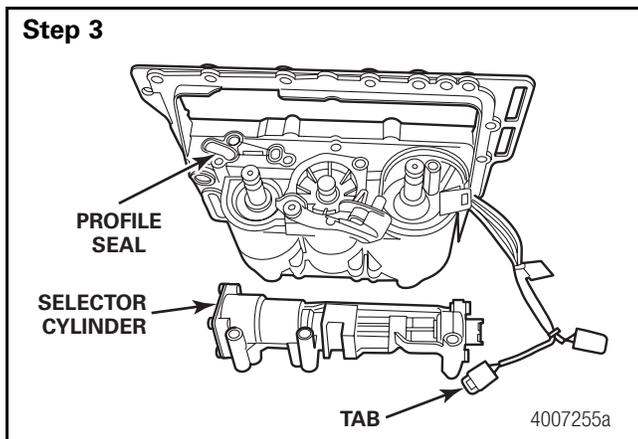
Carefully raise the tab and pull the connector off the sensor contact.

- GO TO THE NEXT STEP.

#### Step 2

Remove the three hex-head bolts.

- GO TO THE NEXT STEP.



Take out the selector cylinder and remove the profile seal.

- GO TO THE NEXT STEP.

#### Step 4

Inspect the parts and replace if necessary.

### Installation

#### Step 1

**NOTE:** Apply Uni-Silicon GLK112 grease to the sealing and sliding faces.

Insert the profile seal on the TCU's lower section.

- GO TO THE NEXT STEP.

#### Step 2

Place the selector cylinder on the TCU's lower section.

- GO TO THE NEXT STEP.

#### Step 3

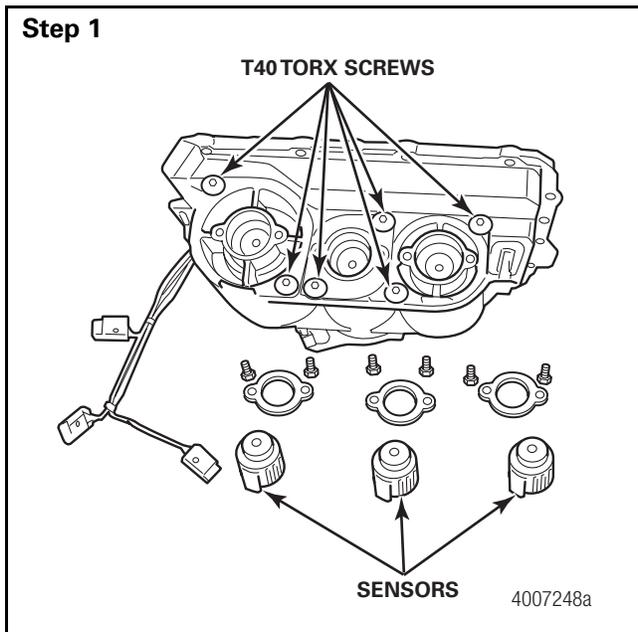
Install and tighten the three hex-head bolts to 17 lb-ft (23 N•m). **ⓘ**

- GO TO THE NEXT STEP.

#### Step 4

Plug the connector onto the sensor contacts.

## Section 5 Removal and Installation



### Disassembly Lower Section of TCU

#### **⚠ WARNING**

This procedure is to be performed only with out-of-warranty cases. During warranty period, the complete TCU must be exchanged.

**NOTE:** The main transmission piston is exchanged as a complete unit with separate kit.

Separate seal kit for range/splitter gear shift cylinders.

Remove the selector cylinder. Refer to the procedure in this section.

- GO TO THE NEXT STEP.

#### **Step 2**

Remove the three travel sensors. Refer to the procedure in this section.

- GO TO THE NEXT STEP.

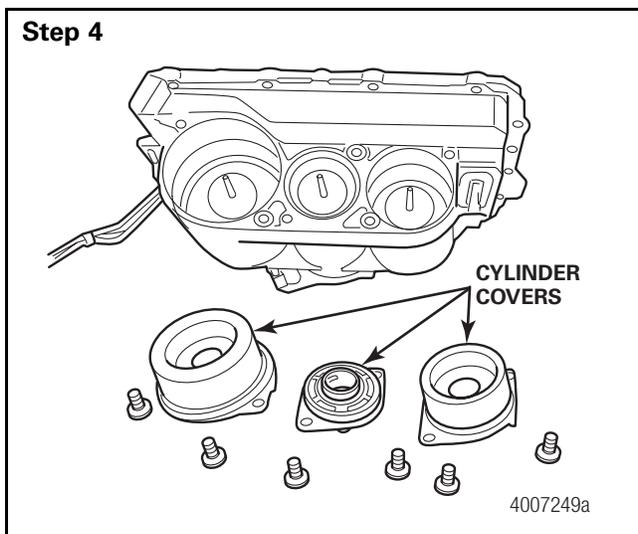
#### **⚠ CAUTION**

The cylinder covers are numbered. They have to be refitted in the same positions.

#### **Step 3**

Remove the T40 Torx screws from the cylinder covers.

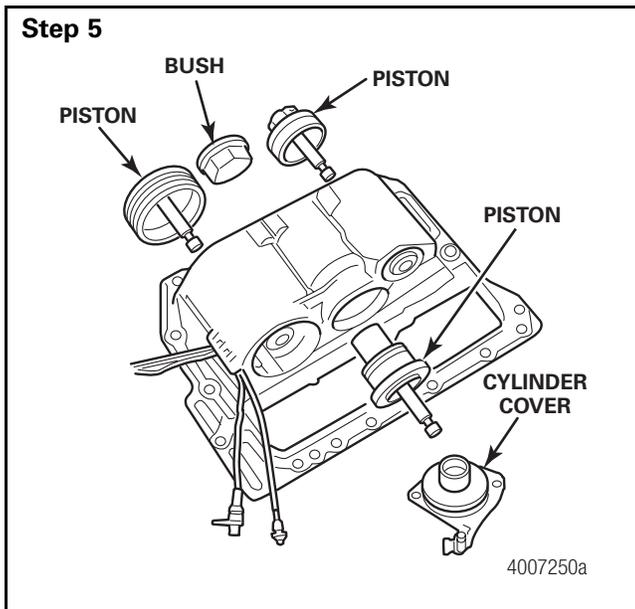
- GO TO THE NEXT STEP.



Use a suitable tool to raise the cylinder covers slightly and remove.

- GO TO THE NEXT STEP.

## Section 5 Removal and Installation



Use a suitable tool to raise the cylinder cover slightly and remove.

- **GO TO THE NEXT STEP.**

### Step 6

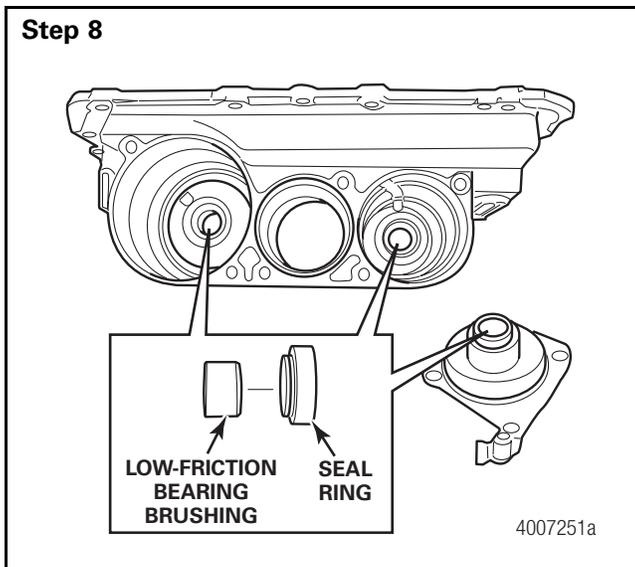
Take the pistons and bushings out.

- **GO TO THE NEXT STEP.**

### Step 7

Replace the O-rings and grooved rings on the components.

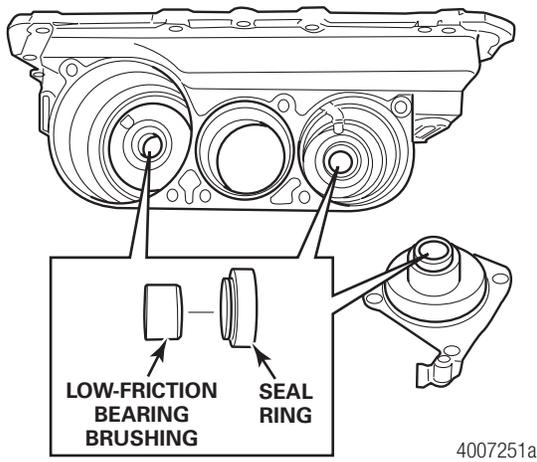
- **GO TO THE NEXT STEP.**



Use a suitable tool to remove the seal rings and low-friction bearing brushings.

# Section 5 Removal and Installation

## Step 1



## Assembly

Use a suitable tool to insert the low-friction bearing brushings flush with the bearing bore.

- **GO TO THE NEXT STEP.**

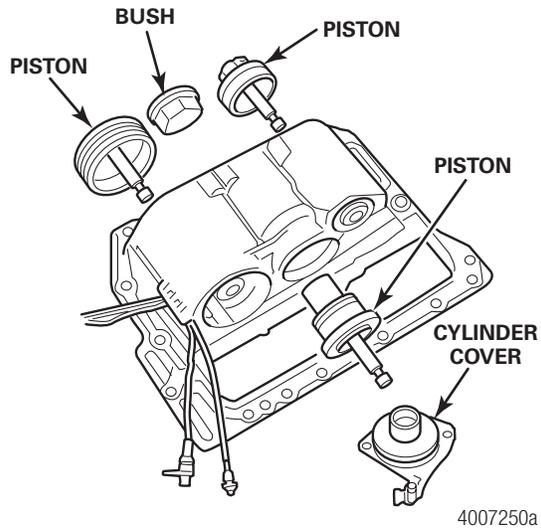
## Step 2

Use a suitable tool to insert the new sealing rings.

**NOTE:** Apply Uni-Silicon GLK 112 grease to the sealing and sliding faces.

- **GO TO THE NEXT STEP.**

## Step 3



Insert new O-rings and grooved rings on the components.

- **GO TO THE NEXT STEP.**

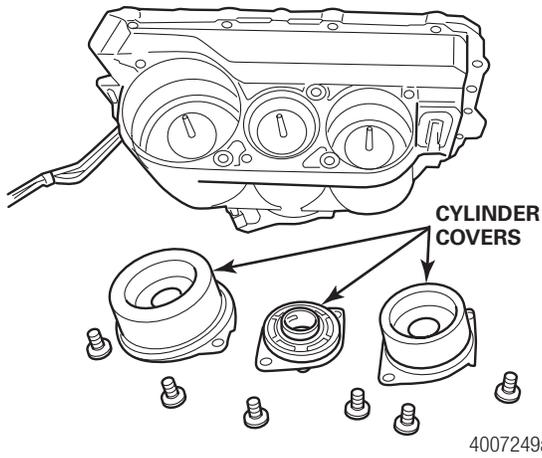
## Step 4

Insert the pistons and bushings in the transmission actuator's lower section.

- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation

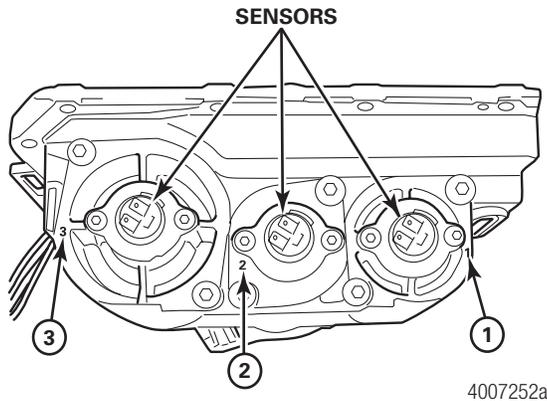
### Step 5



Fit the cylinder covers in the same position from which you previously removed them and secure each one with two T40 Torx screws tightening the screws to 13 lb-ft (17 N•m). 

- GO TO THE NEXT STEP.

### Step 6



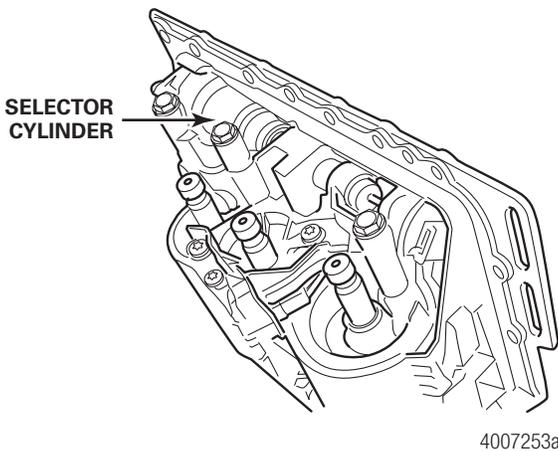
### Assembly Check

The cylinder covers are numbered for sensor installation position (refer to the arrows).

Install the sensors. Refer to the procedure in this section.

- GO TO THE NEXT STEP.

### Step 7

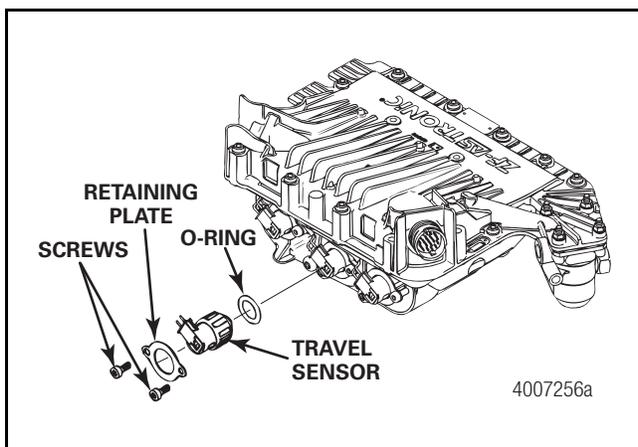


Install the selector cylinder.

- GO TO THE NEXT STEP.

### Step 8

Re-check that the connector are tight and secure.



## Travel Sensors Engage, Splitter, Range and Select

### **WARNING**

This procedure is to be performed only with out-of-warranty cases. During warranty period, the complete TCU must be exchanged.

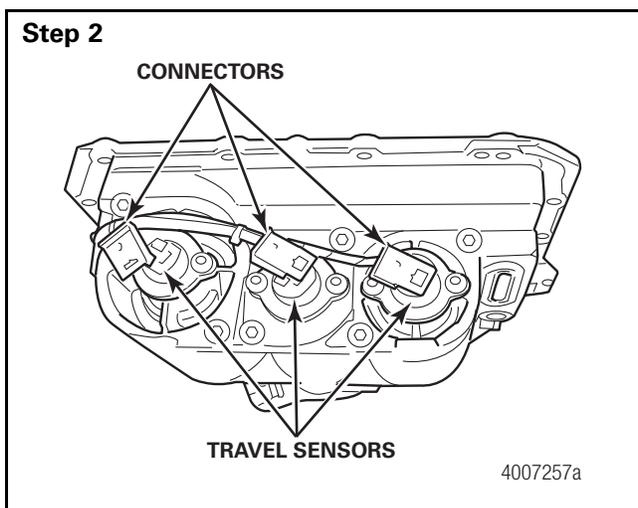
**NOTE:** The repair kit contains two screws, one retaining plate, one travel sensor and one O-ring.

### Removal

#### Step 1

Clean the area around the sensors.

- **GO TO THE NEXT STEP**



Carefully raise the tab and pull the connector off the sensor contact.

- **GO TO THE NEXT STEP**

#### Step 3

Remove the two screws and take off the retaining plate. Pull out the travel sensor complete with the O-ring.

- **GO TO THE NEXT STEP**

#### Step 4

Inspect the parts and replace if necessary.

**NOTE:** The sensors for the flange, splitter, main transmission and select cylinder are identical.

### Installation

**NOTE:** Apply Uni-Silicon GLK 112 grease to the sealing and sliding faces.

#### Step 1

Insert the O-ring on the travel sensor.

- **GO TO THE NEXT STEP**

#### Step 2

Insert the travel sensor complete with the O-ring.

- **GO TO THE NEXT STEP**

#### Step 3

Install and secure the retaining plate with two screws. Tighten the screws to 5 lb-ft (6.78 N•m).



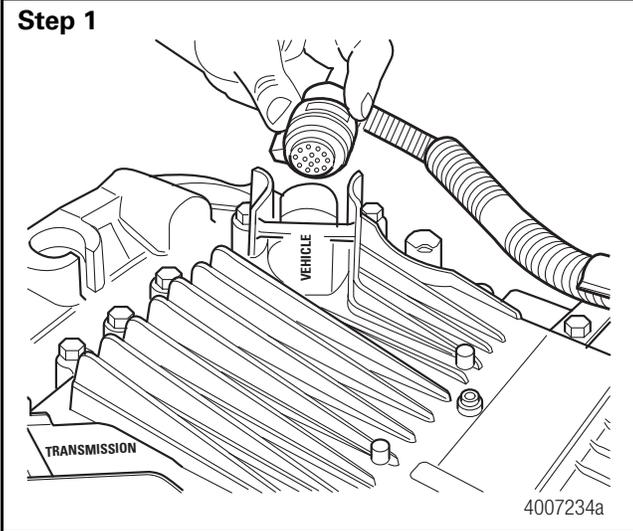
- **GO TO THE NEXT STEP**

#### Step 4

Plug the connector in to the sensor contacts.

## Section 5 Removal and Installation

Step 1



### Air Pressure Sensor

#### Removal

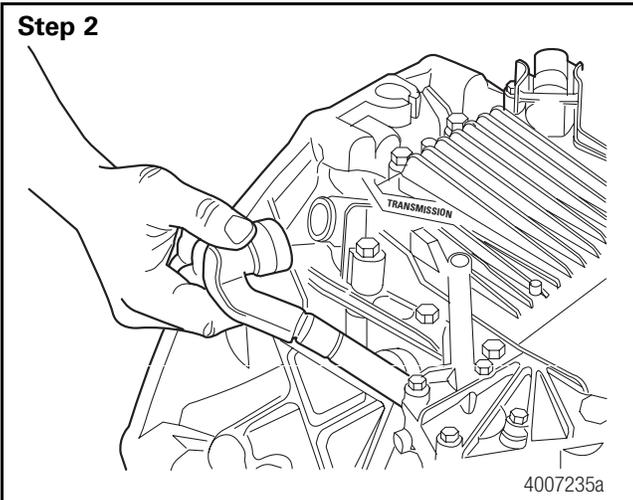
 **WARNING**

This procedure is to be performed only for out-of-warranty repairs. During warranty period, replace the TCU top half.

Remove the electrical wire harness from the TCU connector marked "vehicle".

- GO TO THE NEXT STEP.

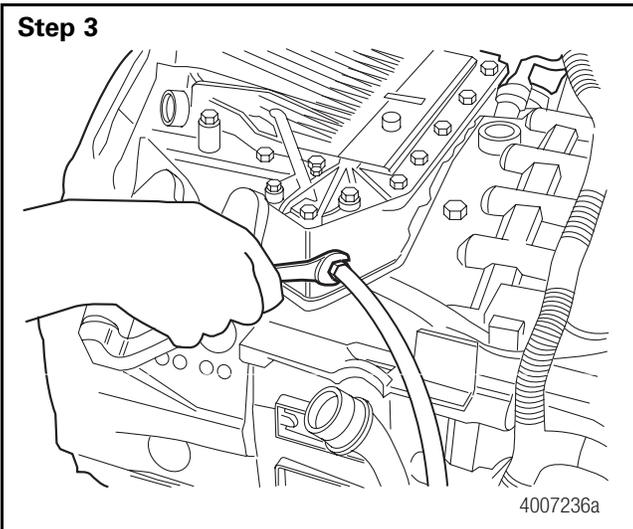
Step 2



Remove the electrical wire harness from the TCU connector marked "Transmission".

- GO TO THE NEXT STEP.

Step 3



Remove the air fitting from the air regulator.

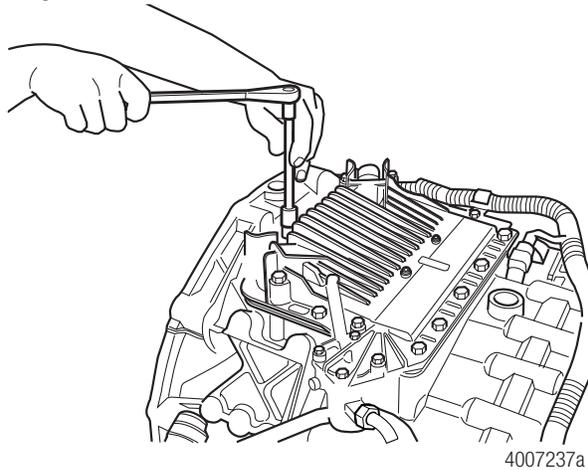
 **WARNING**

Use caution when disconnecting the air line as it still may be under pressure.

- GO TO THE NEXT STEP.

## Section 5 Removal and Installation

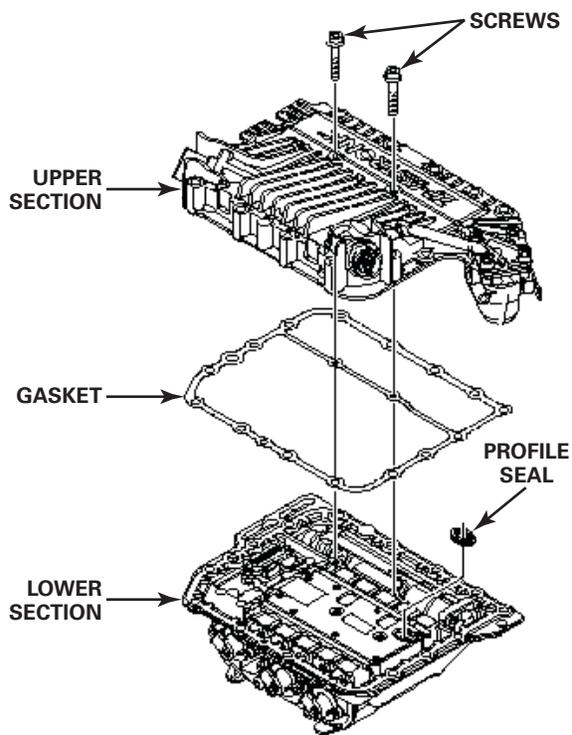
### Step 4



Use a 13 mm socket to remove the 15 fasteners that secure the TCU to the transmission.

- **GO TO THE NEXT STEP.**

### Step 5



Remove both screws with a T-30 Torx Tool.

- **GO TO THE NEXT STEP.**

### Step 6

Raise the upper section.

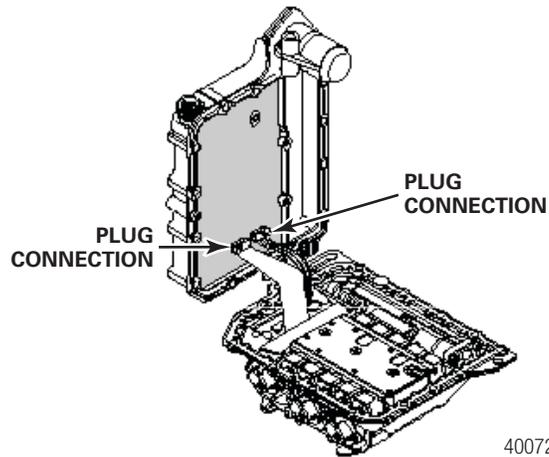


Use caution when lifting upper section. Do not damage ribbon cables!

- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation

### Step 7



Disconnect plug connections.

- GO TO THE NEXT STEP.

### Step 8

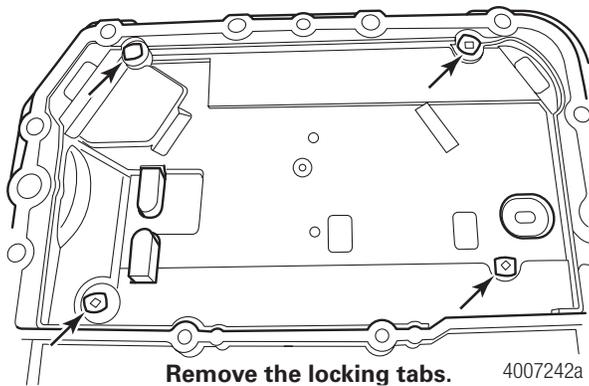
Ensure the profile seal remains in the bottom part of the TCU.

- GO TO THE NEXT STEP.

### Step 9

Remove the gasket.

### Step 10



Remove the four locking tabs as shown.

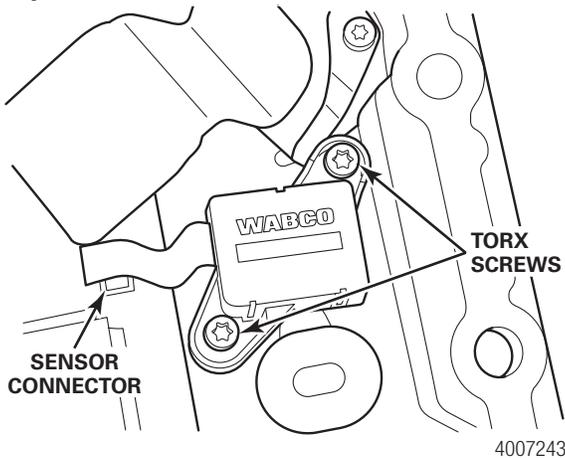
**⚠ WARNING**

**Do not damage or break studs.**

Remove the cover.

- GO TO THE NEXT STEP.

### Step 11



Remove the two T10 Torx screws.

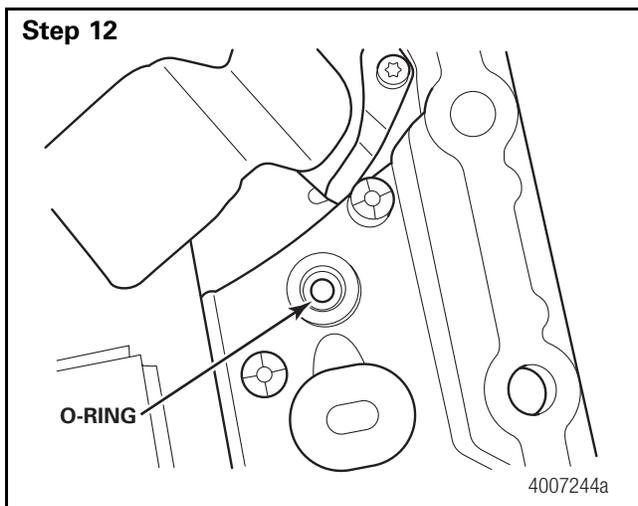
Carefully unplug the sensor connector from circuit board.

Remove the pressure sensor.

- GO TO THE NEXT STEP.

## Section 5 Removal and Installation

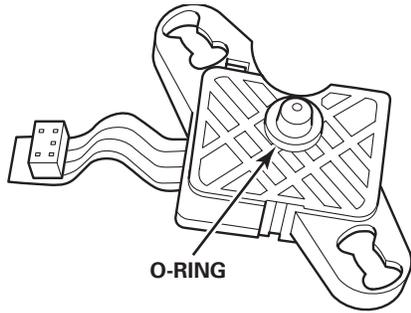
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Remove the old O-ring.

## Section 5 Removal and Installation

### Step 1



4007245a

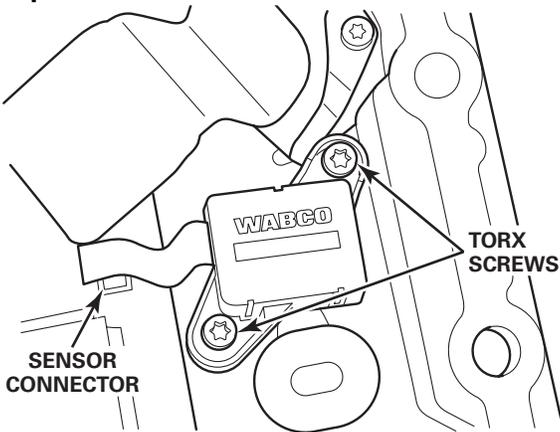
### Installation

Inspect the sensor and ensure the O-ring is installed.

Install the sensor.

- **GO TO THE NEXT STEP.**

### Step 2



4007243a

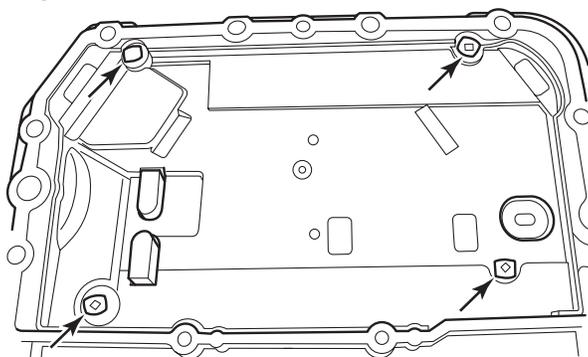
Install the two T-10 Torx screws.

Tighten the screws to 3 lb-ft (4 N•m). 

Connect the sensor ribbon connector to the circuit board.

- **GO TO THE NEXT STEP.**

### Step 3



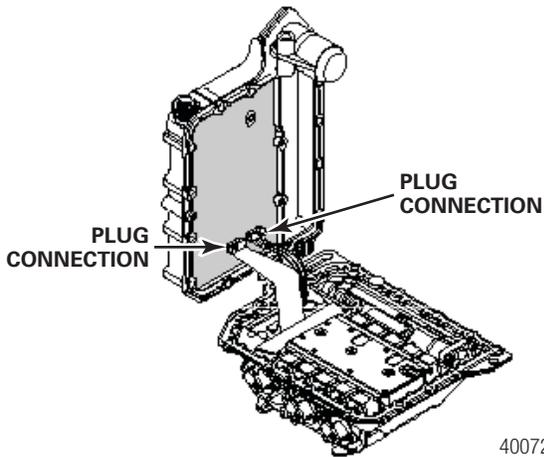
4007242a

Install the four locking tabs.

- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation

### Step 4

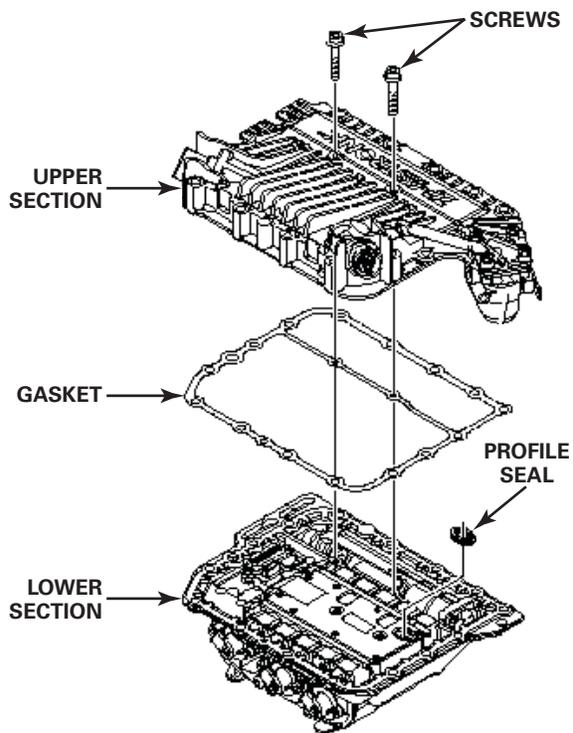


Reconnect the plug connections (7 and 8).

Check that the plug connections are tight and secure.

- **GO TO THE NEXT STEP.**

### Step 5



Place the new gasket seal on the upper section.

- **GO TO THE NEXT STEP.**

### Step 6

Place the upper section on the lower section.

Ensure that the flat seal does not move. Fix the seal if necessary.

- **GO TO THE NEXT STEP.**

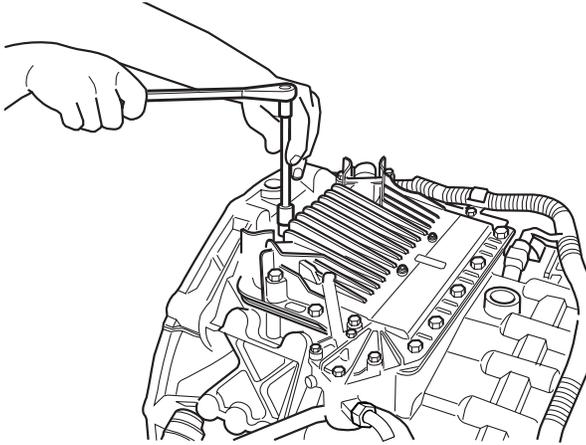
### Step 7

Tighten the two screws to 7.0 lb-ft (9 N•m). 

## Section 5 Removal and Installation

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Step 8



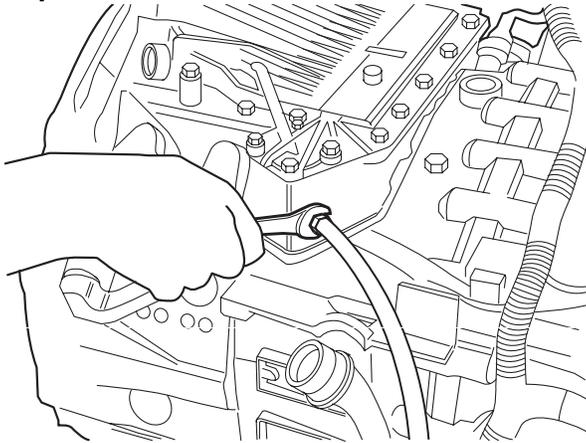
4007237a

Use a 13 mm socket and ratchet to secure the TCU to the transmission with 15 fasteners. Secure the wiring harness clip to the transmission.

Tighten the fasteners to 17 lb-ft (23 N•m) using a star pattern. 

- **GO TO THE NEXT STEP.**

Step 9

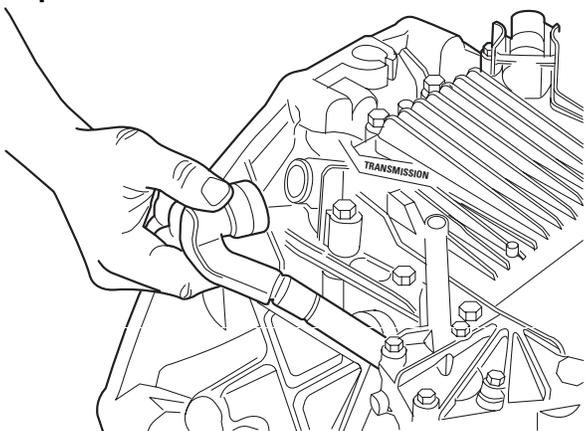


4007236a

Install the air fitting into the air regulator.

- **GO TO THE NEXT STEP.**

Step 10

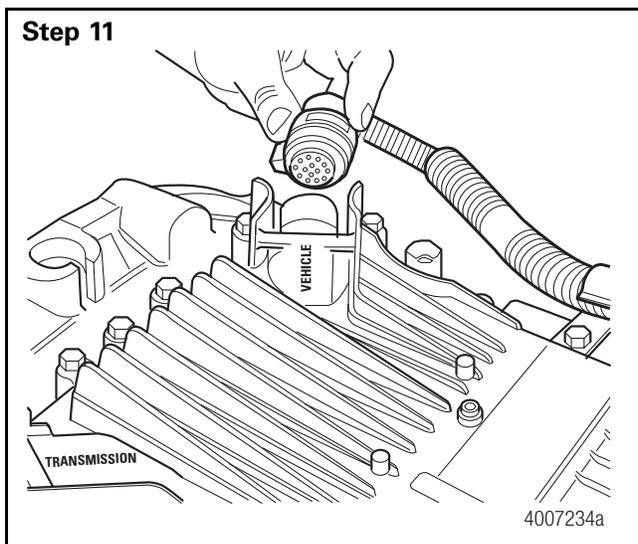


4007235a

Connect the electrical wire harness into the TCU connector marked "Transmission".

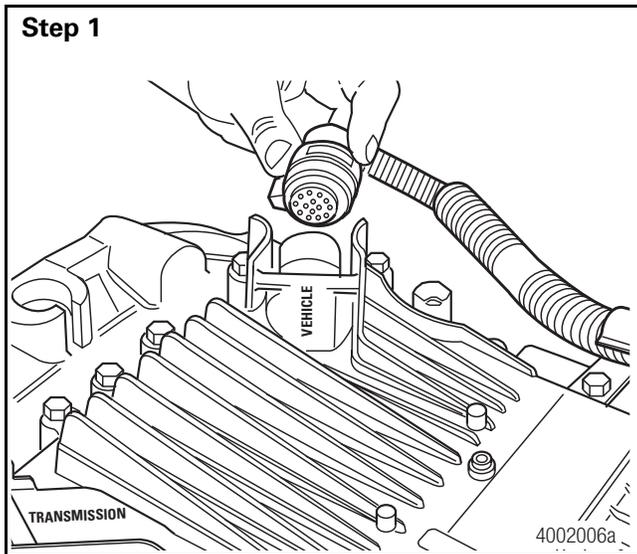
- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation



Connect the transmission vehicle wiring harness to the TCU port marked "Vehicle."

## Section 5 Removal and Installation

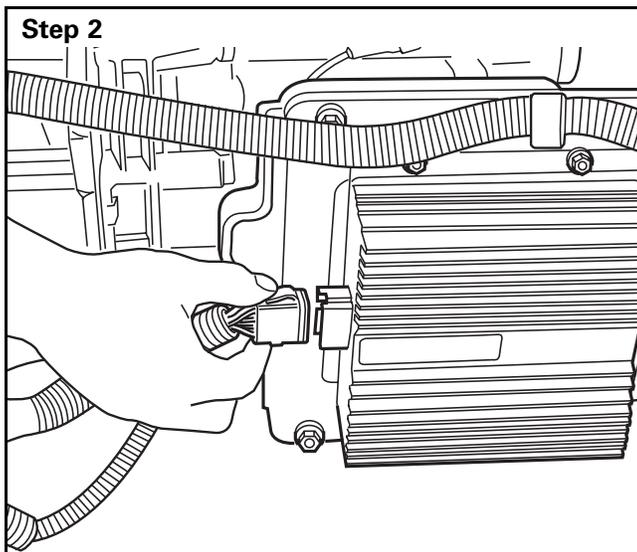


### Transmission Wiring Harness Assembly

#### Removal

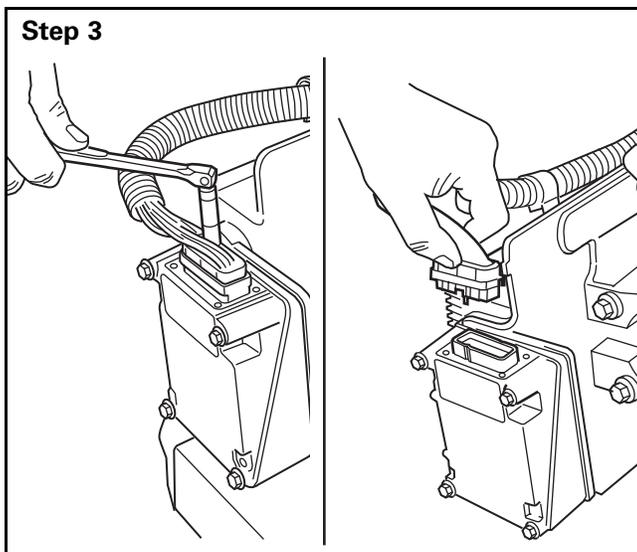
Unplug the wiring harness assembly from the TCU port marked "Vehicle."

- **GO TO THE NEXT STEP.**



Unplug the voltage doubler connector.

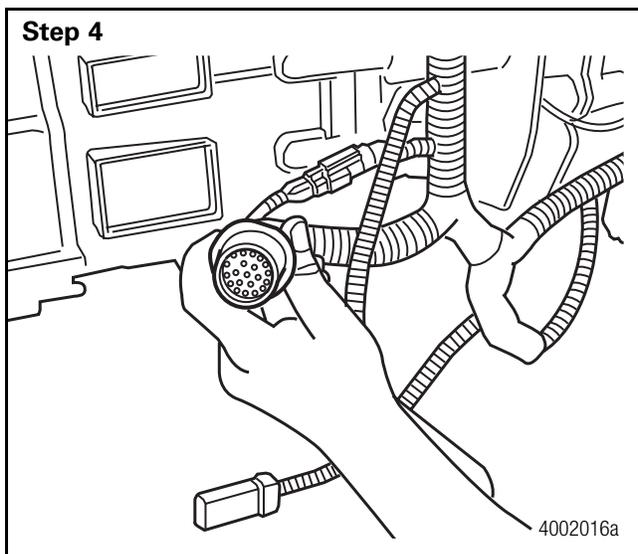
- **GO TO THE NEXT STEP.**



Use a 1/4-inch socket and ratchet or nut driver to remove the ZMTEC connector.

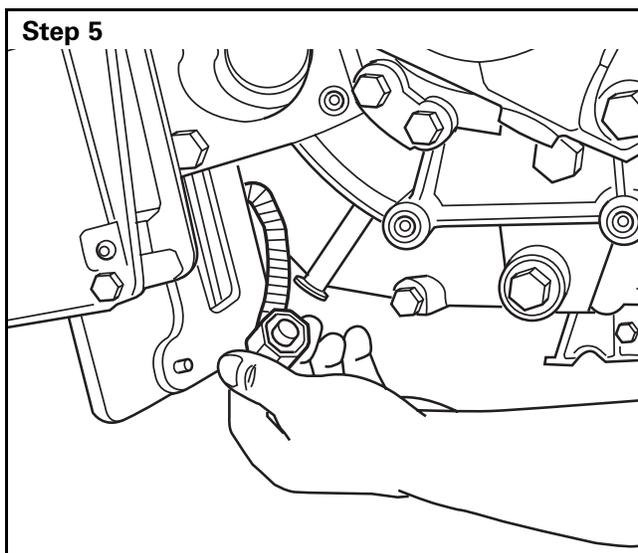
- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation



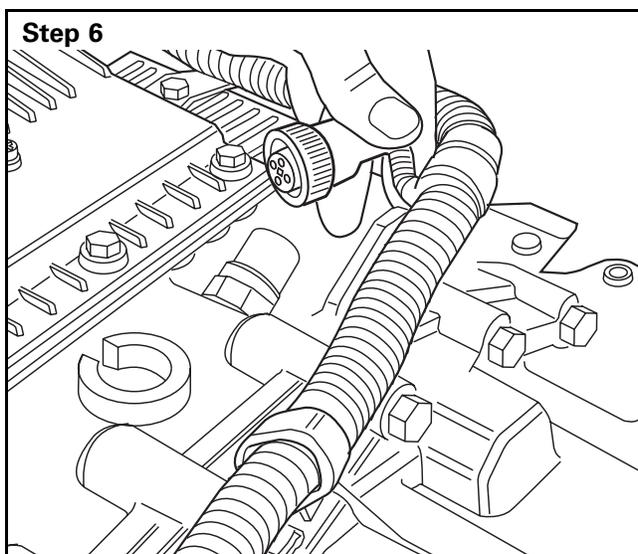
Unplug the OEM connector.

- **GO TO THE NEXT STEP.**



Unplug the output shaft speed sensor connector.

- **GO TO THE NEXT STEP.**

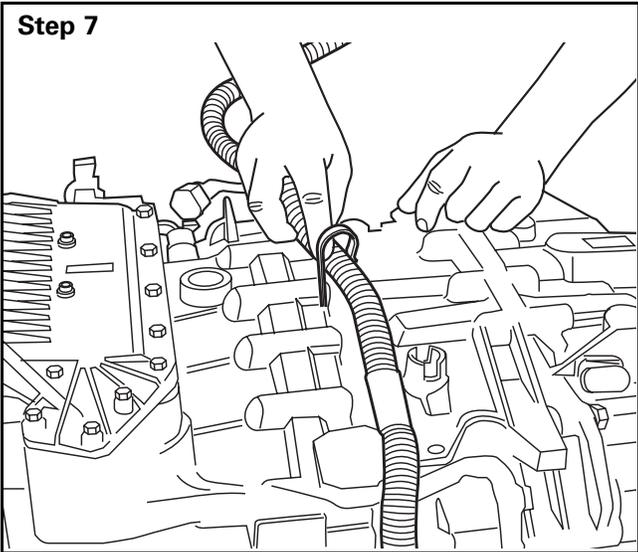


Unplug the Neutral switch connector.

- **GO TO THE NEXT STEP.**

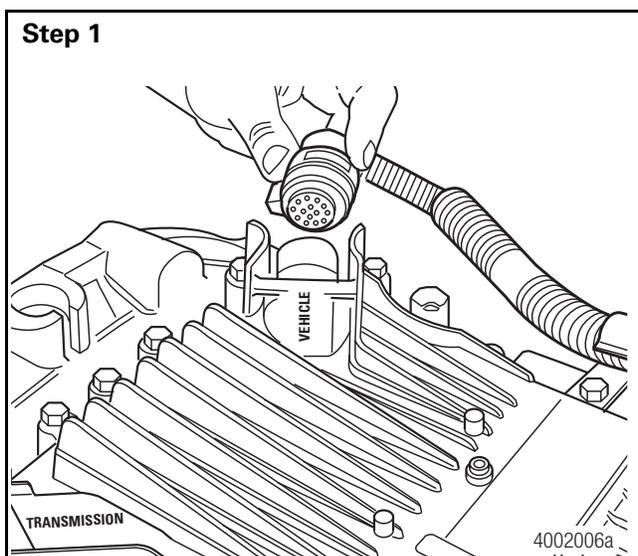
# Section 5 Removal and Installation

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Remove the wiring harness from the clips.

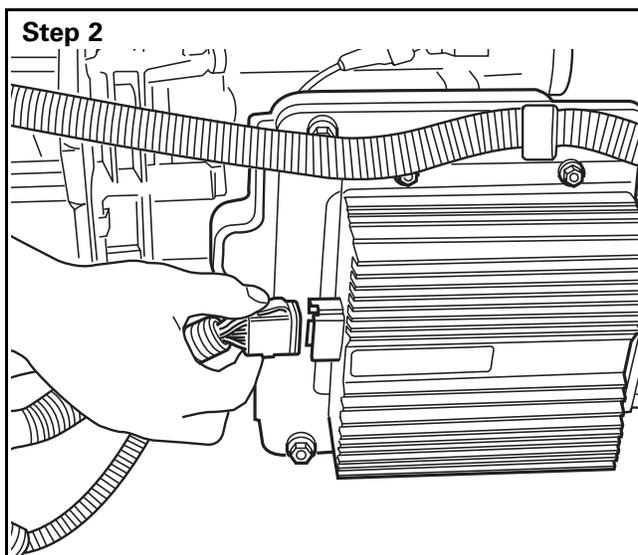
## Section 5 Removal and Installation



### Installation

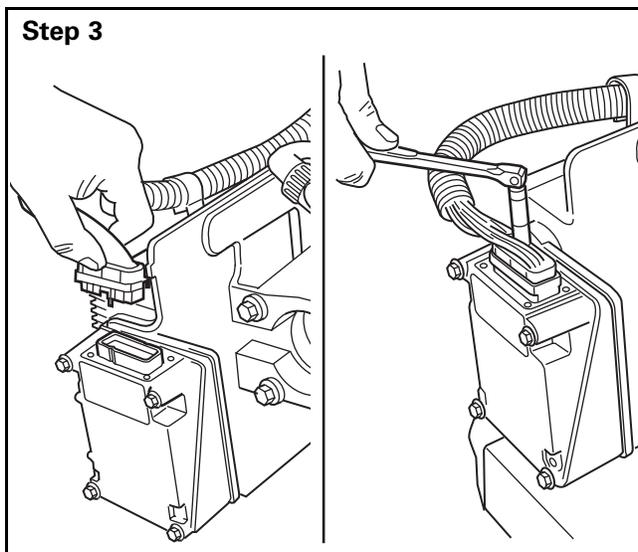
Connect the wiring harness assembly to the TCU at the connector port marked "Vehicle."

- GO TO THE NEXT STEP.



Connect the wiring harness assembly to the voltage doubler connector.

- GO TO THE NEXT STEP.

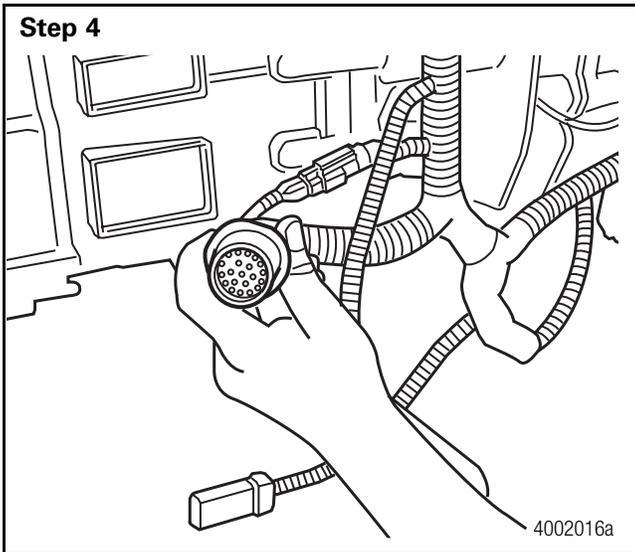


Connect the wiring harness assembly to the ZMTEC and secure the connection by tightening the 1/4-inch screw to **7.0 lb-ft (9.5 N•m)**. 

- GO TO THE NEXT STEP.

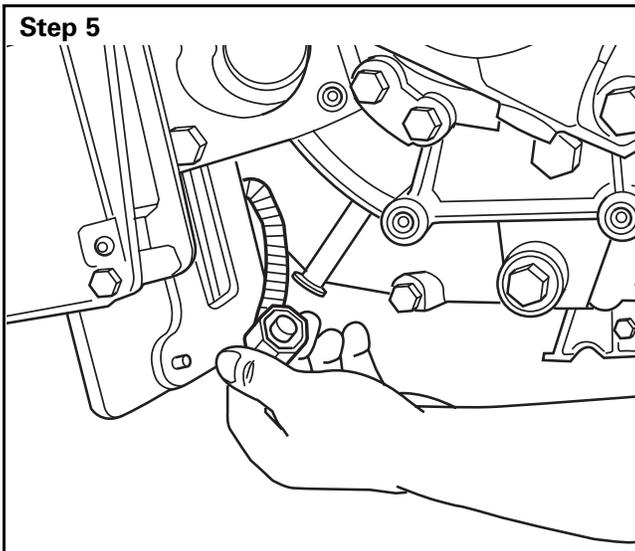
## Section 5 Removal and Installation

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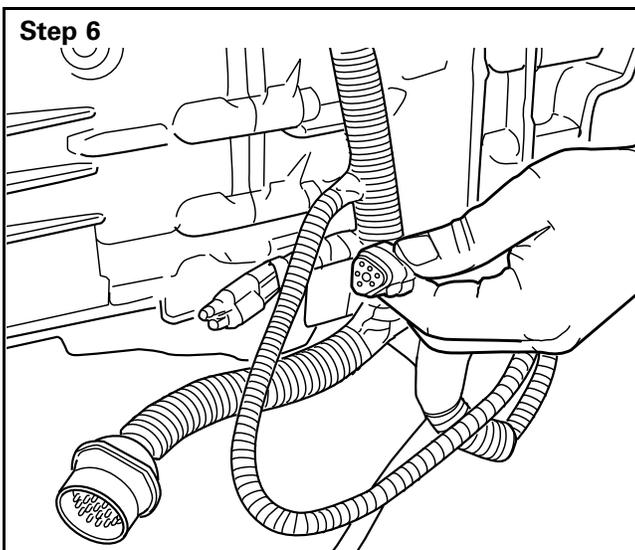
Connect the wiring harness assembly to the OEM wiring harness.

- **GO TO THE NEXT STEP.**



Connect the wiring harness assembly to the output shaft speed sensor connector.

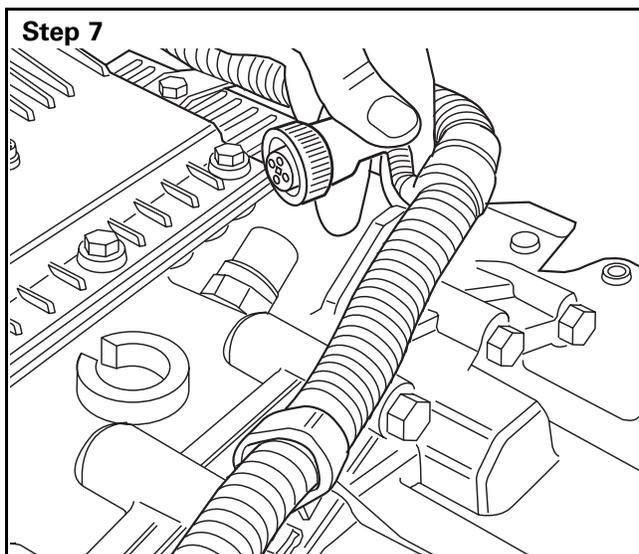
- **GO TO THE NEXT STEP.**



Connect the wiring harness assembly to the SAE J-1939 connector.

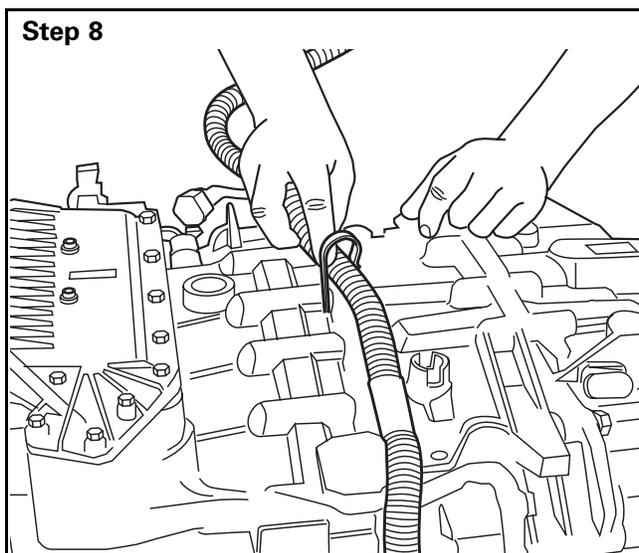
- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation



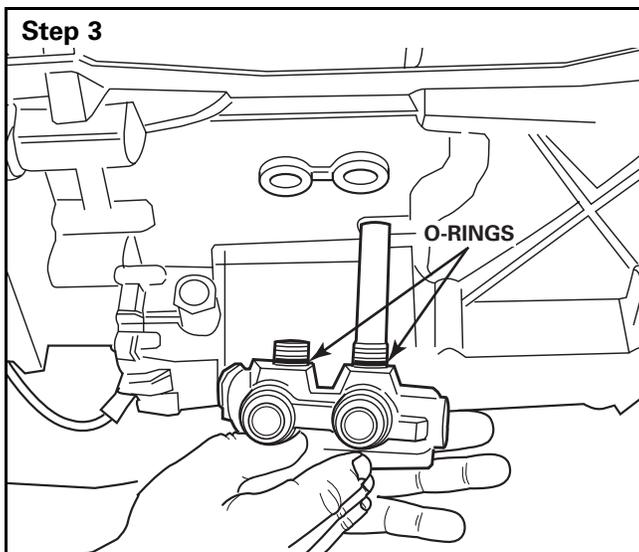
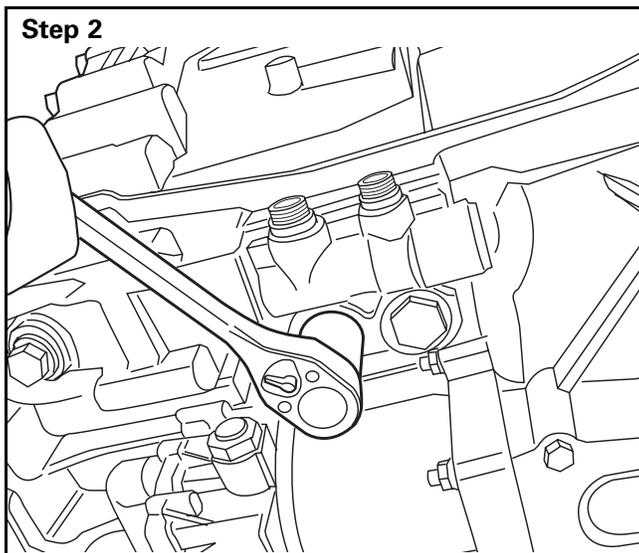
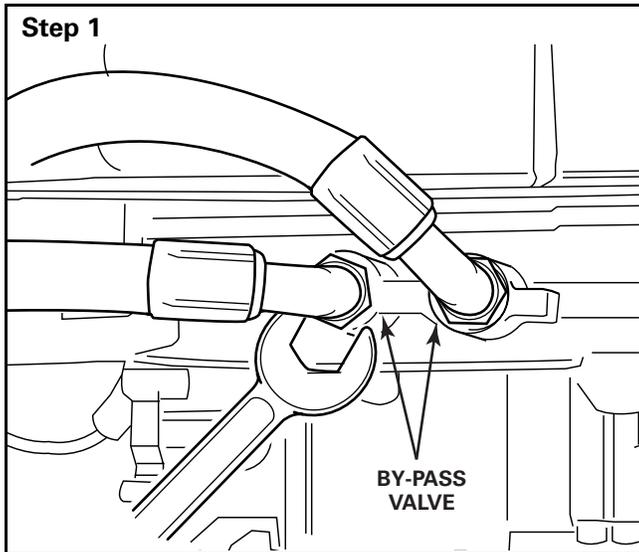
Connect the wiring harness assembly to the Neutral switch connector.

- **GO TO THE NEXT STEP.**



Secure the wiring harness assembly to the transmission clips.

## Section 5 Removal and Installation



### Cooler By-Pass Valve

#### Removal

Place a pan underneath the transmission to collect the oil. Remove the hoses from the by-pass valve.

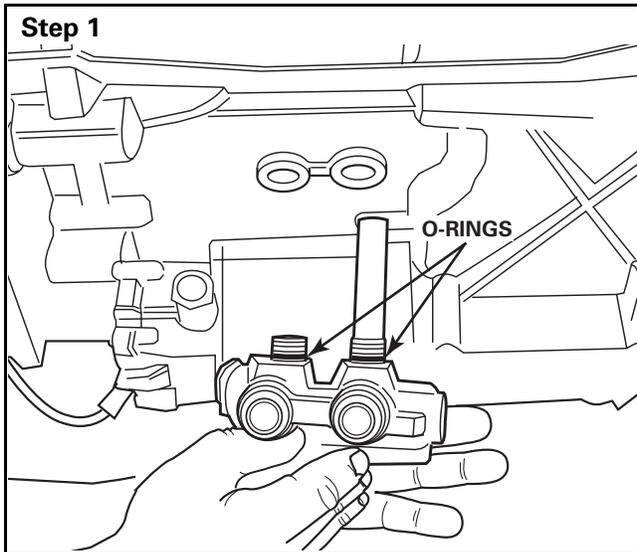
- **GO TO THE NEXT STEP.**

Use a 27 mm socket and ratchet to remove the two fasteners that secure the by-pass valve to the transmission.

- **GO TO THE NEXT STEP.**

Remove the by-pass valve.

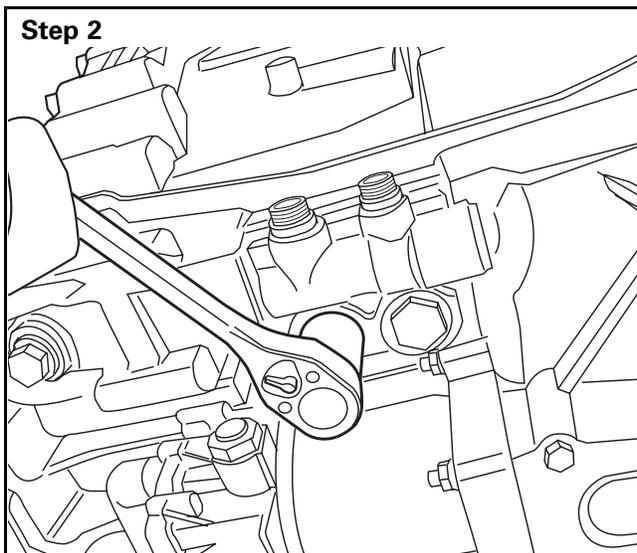
## Section 5 Removal and Installation



### Installation

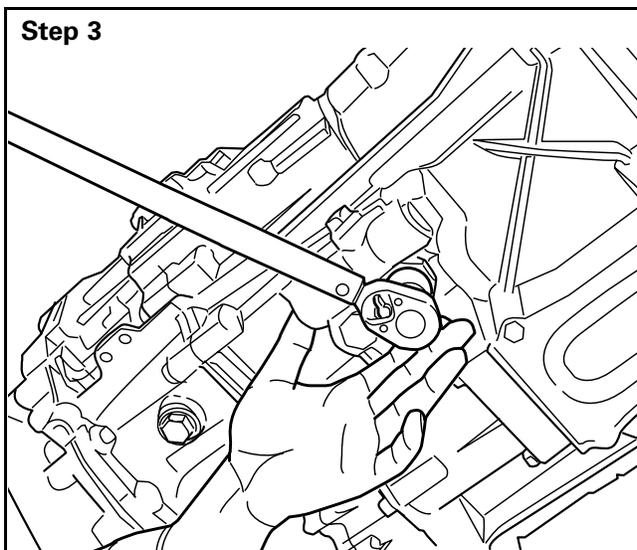
Install the cooler by-pass valve as shown.

- GO TO THE NEXT STEP.



Use a 27 mm socket and ratchet to secure the by-pass valve to the transmission with the two fasteners, sealing rings and O-rings.

- GO TO THE NEXT STEP.

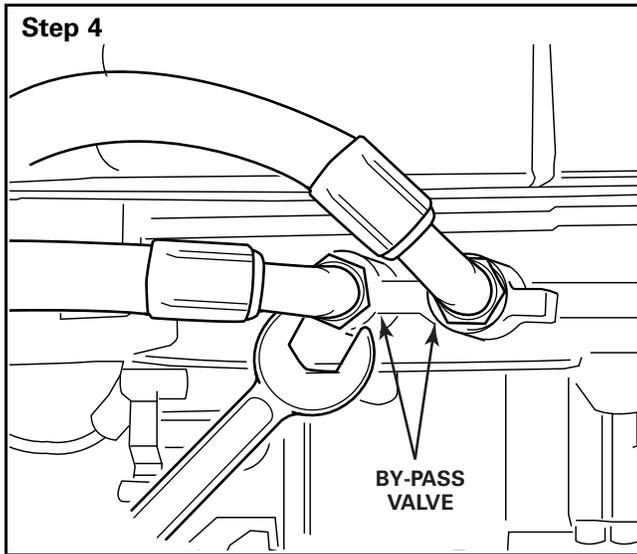


Tighten the two fasteners to **36 lb-ft (50 N•m)**. 

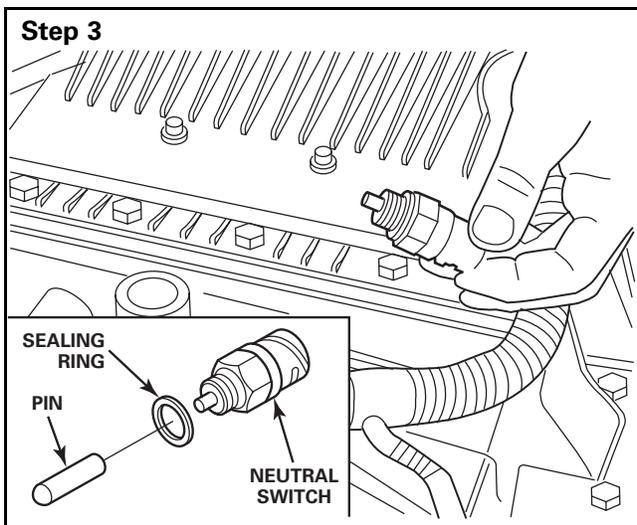
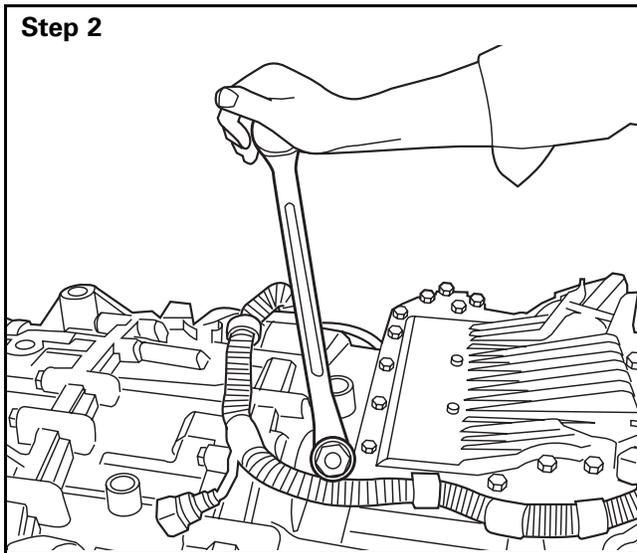
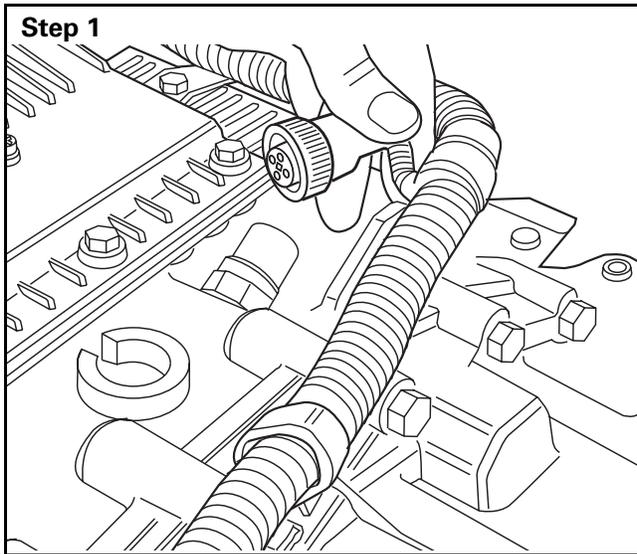
- GO TO THE NEXT STEP.

## Section 5 Removal and Installation

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Fasten the hoses to the by-pass valve. Using a torque wrench, tighten the oil line fitting to the cooler-bypass to **66 lb-ft (90 N•m)**. Tighten the cooler line to the fitting such that it does not leak. 



## Neutral Switch

### Removal

Unplug the Neutral switch connector.

- GO TO THE NEXT STEP.

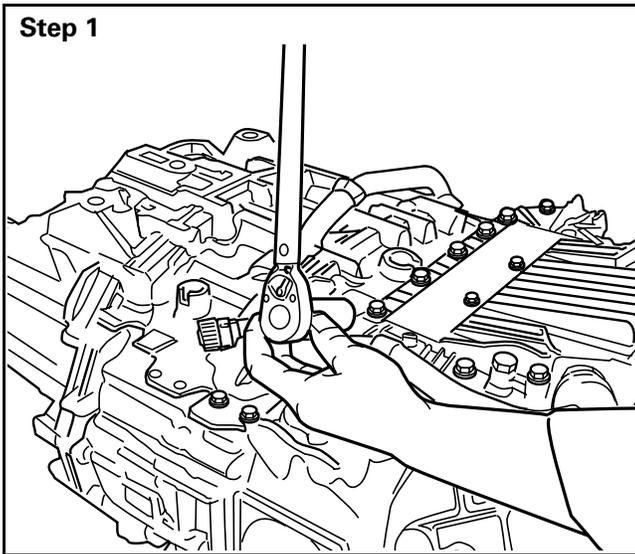
Use a 1-1/16-inch (27 mm) box end wrench to loosen the Neutral switch.

- GO TO THE NEXT STEP.

Remove the Neutral switch, sealing ring and pin.

## Section 5 Removal and Installation

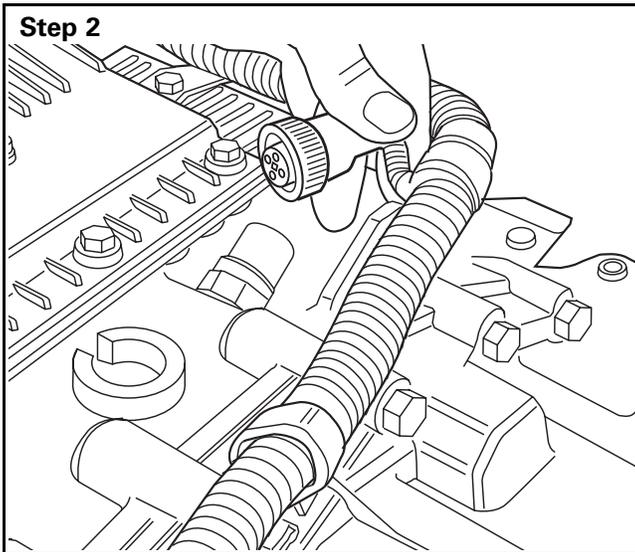
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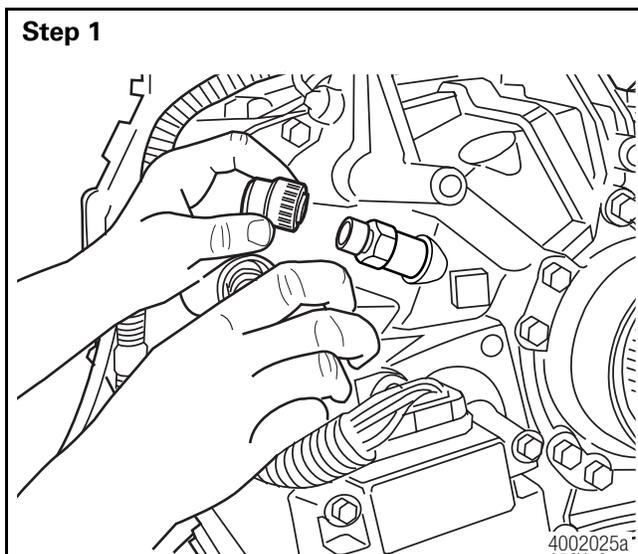
### Installation

Use a 1-1/16-inch (27 mm) socket and ratchet to install the Neutral switch and tighten to **33 lb-ft (45 N•m)**. 

- **GO TO THE NEXT STEP.**



Connect the electrical wiring harness to the Neutral switch connector.



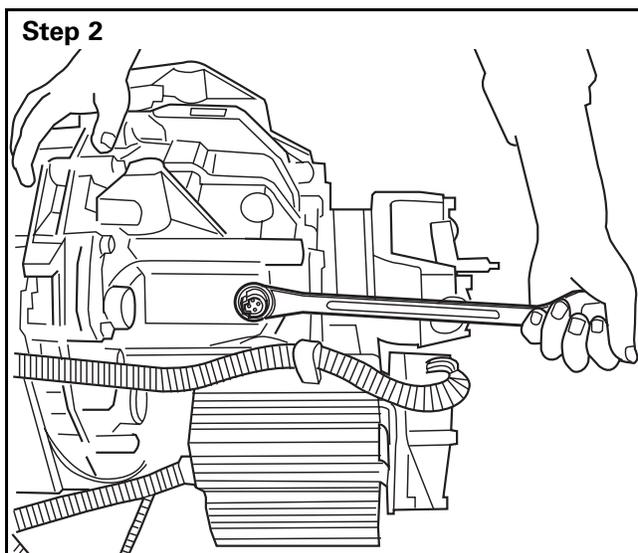
### Output Shaft Speed Sensor

#### Removal

**NOTE:** The transmission's upper and lower output shaft speed sensors are identical and use the same removal procedure. (Removal of the UPPER output shaft speed sensor is shown in Steps 1-3.) When removing lower speed sensor, use container to capture excess oil when sensor is removed.

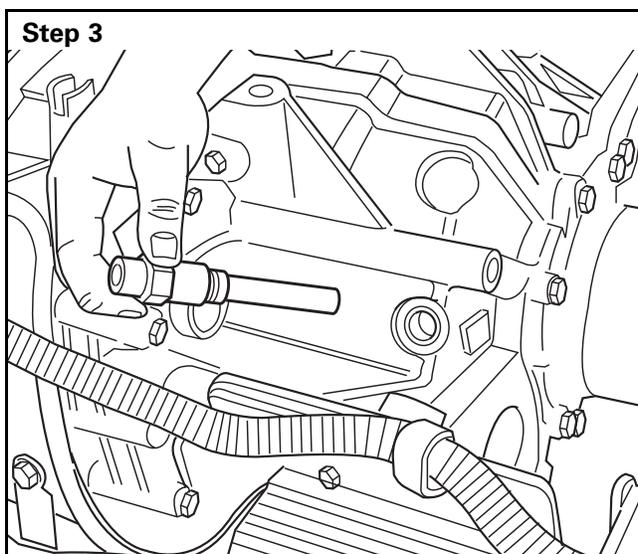
Unplug the output shaft speed sensor connector.

- **GO TO THE NEXT STEP.**



Use a 1-1/16-inch (27 mm) box end wrench to loosen the output shaft speed sensor.

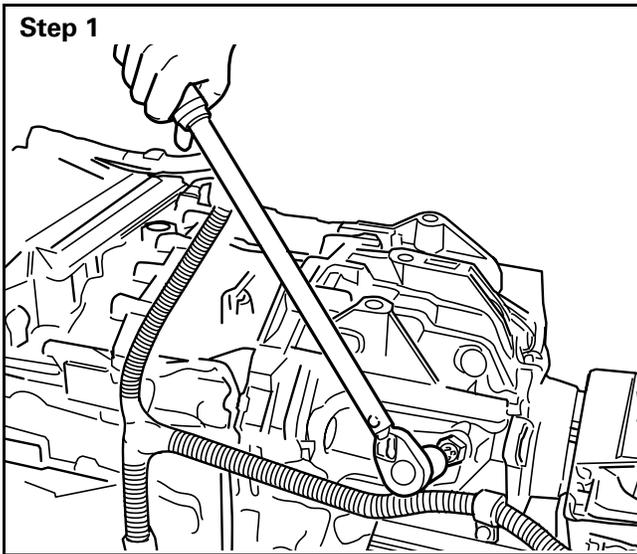
- **GO TO THE NEXT STEP.**



Remove the output shaft speed sensor.

## Section 5 Removal and Installation

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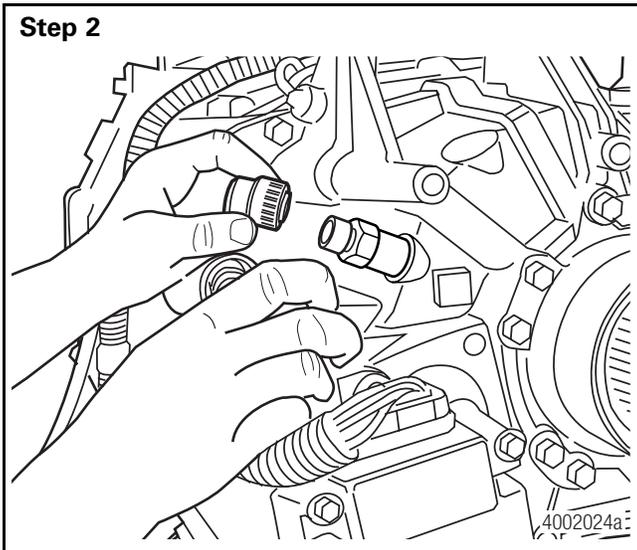


### Installation

**NOTE:** The transmissions upper and lower output shaft speed sensors are identical and use the same installation procedure (installation of the upper output shaft speed sensor is shown in Steps 1 and 2). When removing lower speed sensor, use container to capture excess oil when sensor is removed.

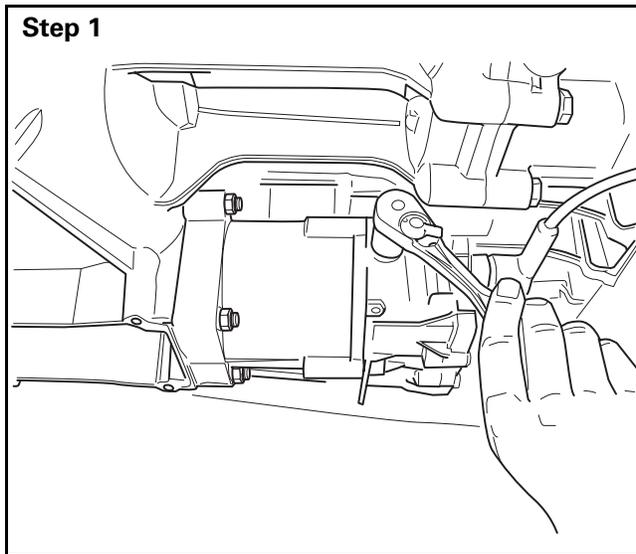
Use a 1-1/16-inch (27 mm) socket and ratchet to install the output shaft speed sensor and tighten to **15 lb-ft (21 N•m)**. 

- **GO TO THE NEXT STEP.**



Connect the wiring harness to the output shaft speed sensor connector.

## Section 5 Removal and Installation



 **WARNING**

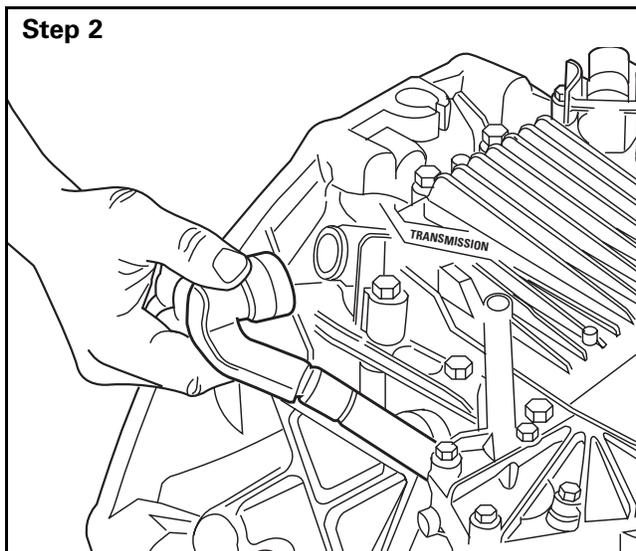
Always remove the clutch actuator housing **BEFORE** you remove the transmission, so that the transmission does not rest on the actuator housing. Damage to the transmission will result.

### Clutch Actuator Housing and Wiring Harness

#### Removal

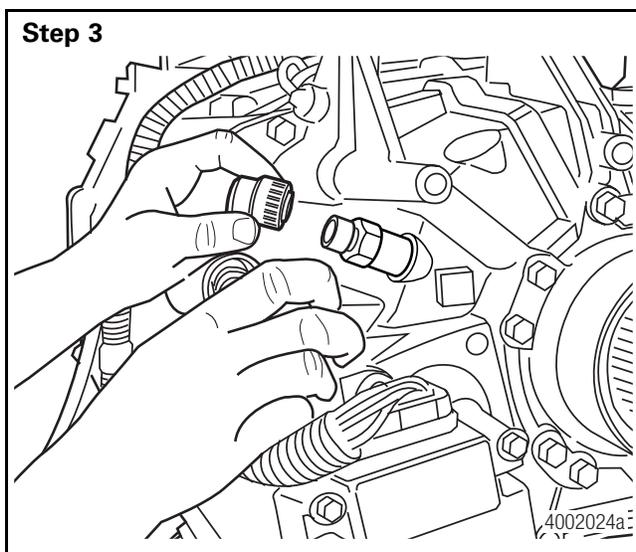
Use a 17 mm socket and ratchet to remove the vent plug.

- **GO TO THE NEXT STEP.**



Remove the transmission wiring harness assembly from the TCU port marked "Transmission."

- **GO TO THE NEXT STEP.**

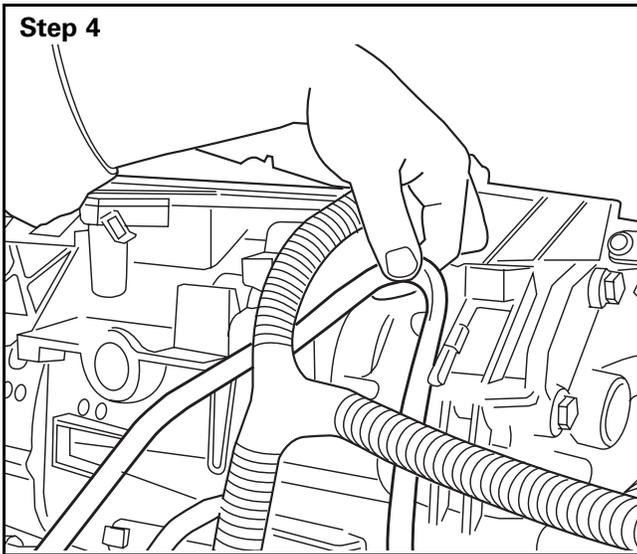


Unplug the output shaft speed sensor connector.

- **GO TO THE NEXT STEP.**

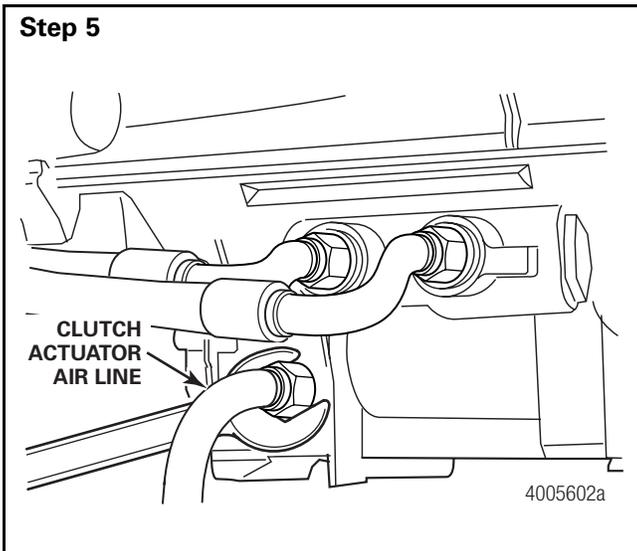
## Section 5 Removal and Installation

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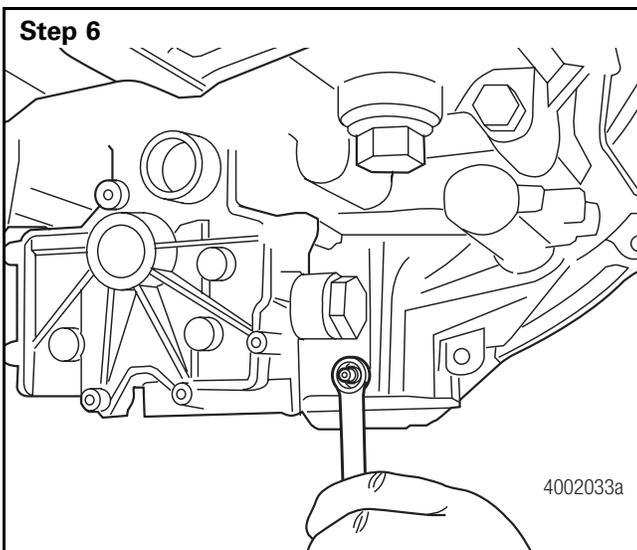
Remove the transmission wiring harness from the clips.

- **GO TO THE NEXT STEP.**



Remove the air supply line.

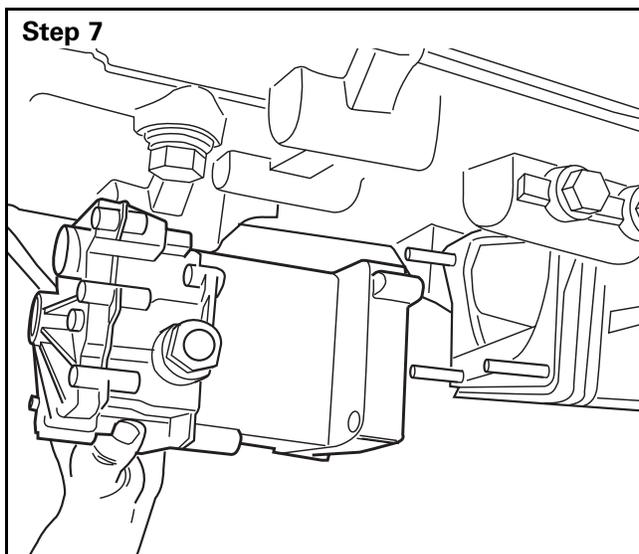
- **GO TO THE NEXT STEP.**



Use a 13 mm wrench to remove the four nuts that secure the clutch actuator housing.

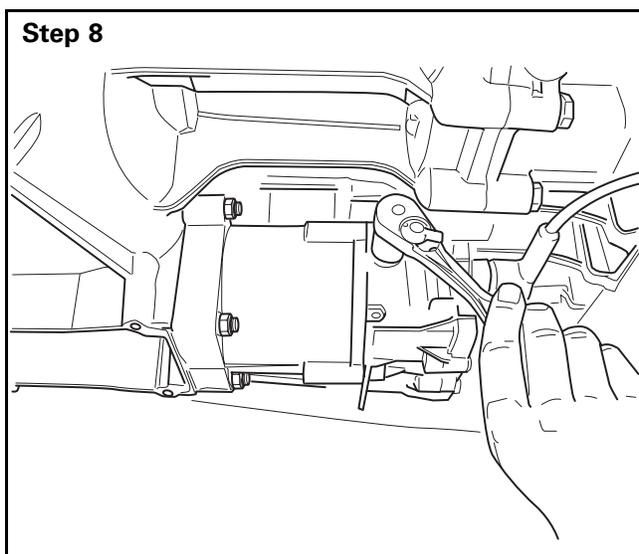
- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation



Remove the clutch actuator housing.

- **GO TO THE NEXT STEP.**

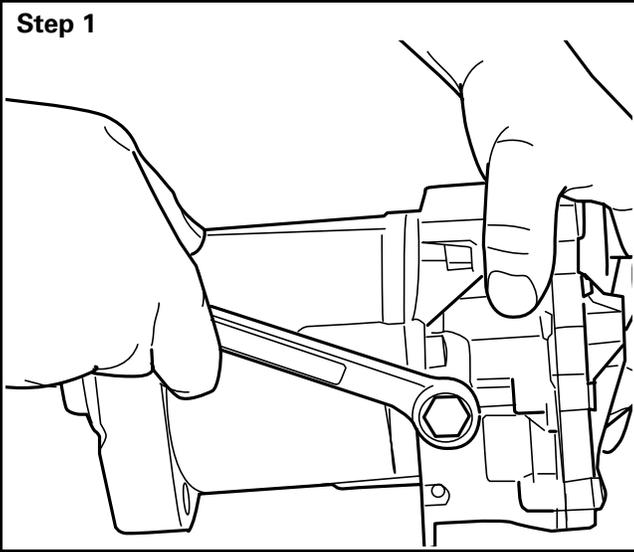


Use a 17 mm socket and ratchet to install the vent plug. Tighten the plug to **16 lb-ft (22 N•m)**. 

## Section 5 Removal and Installation

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Step 1

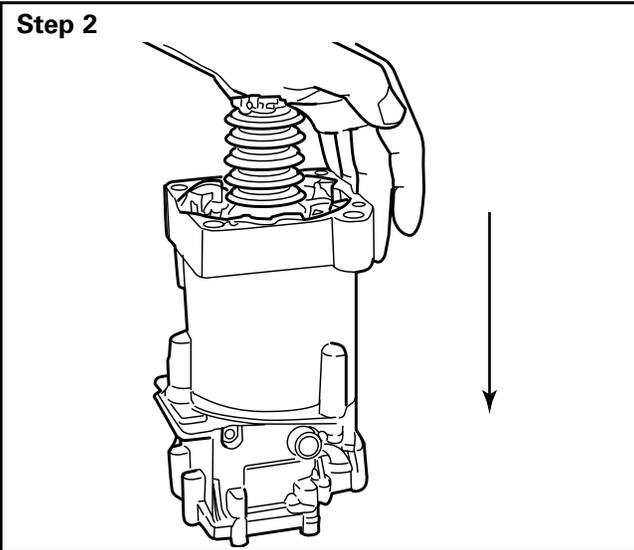


### Installation

Use a 17 mm wrench to remove the vent plug from the clutch actuator housing. The plug is opposite the air line connection.

- GO TO THE NEXT STEP.

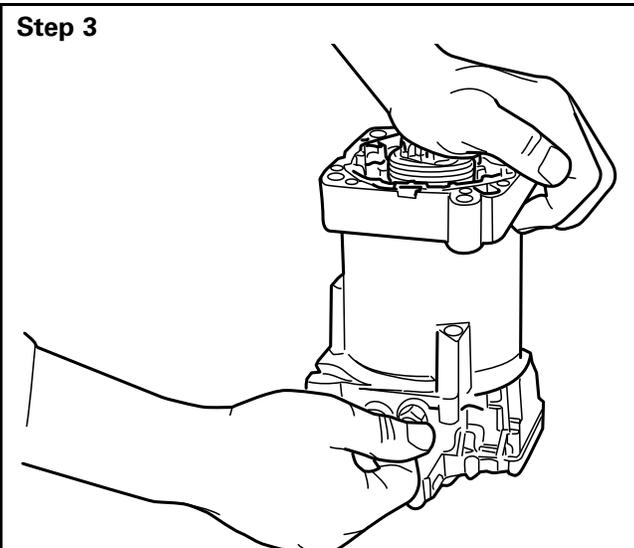
Step 2



Manually compress the air cylinder.

- GO TO THE NEXT STEP.

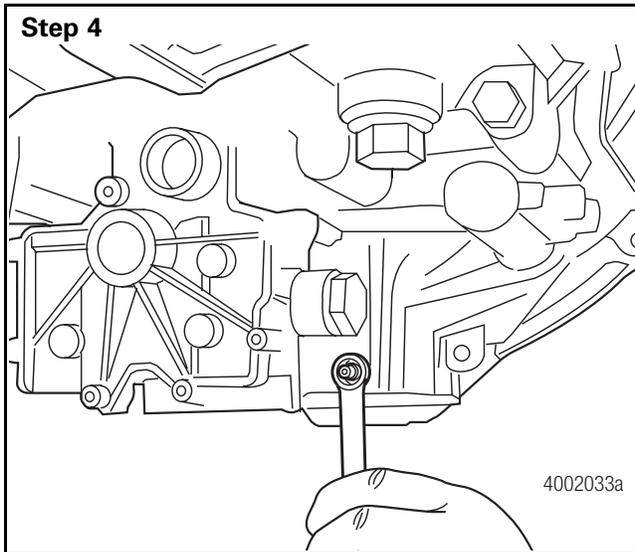
Step 3



With the air cylinder compressed, install the vent plug.

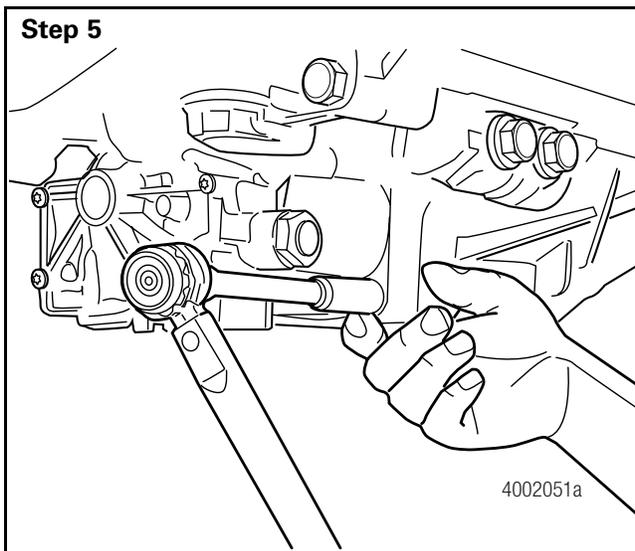
- GO TO THE NEXT STEP.

## Section 5 Removal and Installation



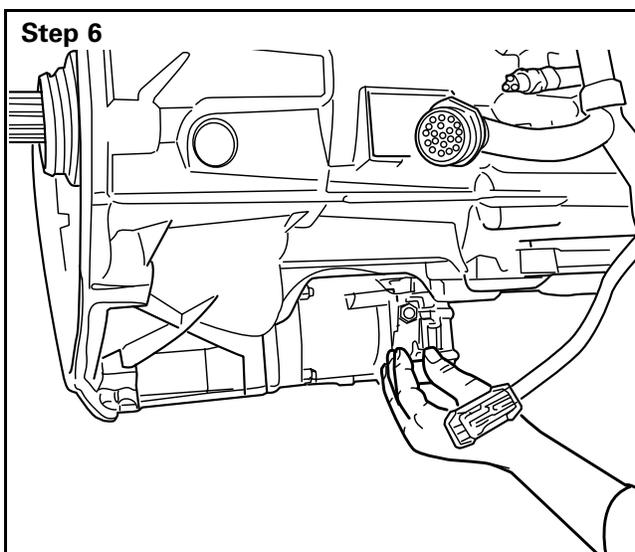
Use a 13 mm wrench to install the clutch actuator housing onto the transmission with four nuts and washers.

- **GO TO THE NEXT STEP.**



Use a torque wrench to tighten the fasteners to **17 lb-ft (23 N•m)**. 

- **GO TO THE NEXT STEP.**

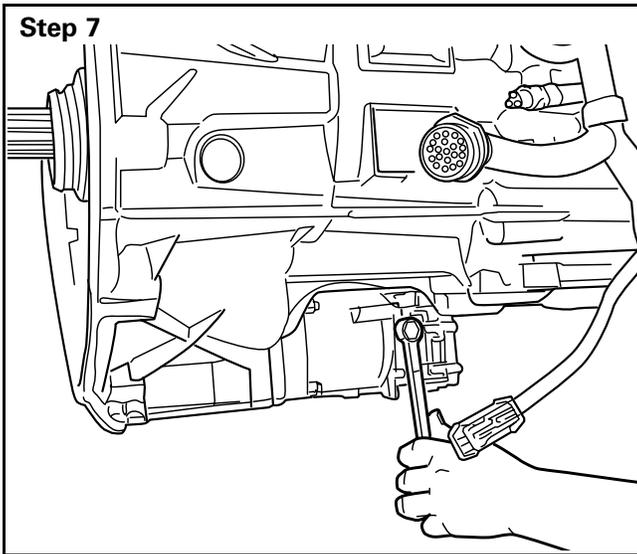


Remove the vent plug again. Allow the actuator to engage the push rod.

- **GO TO THE NEXT STEP.**

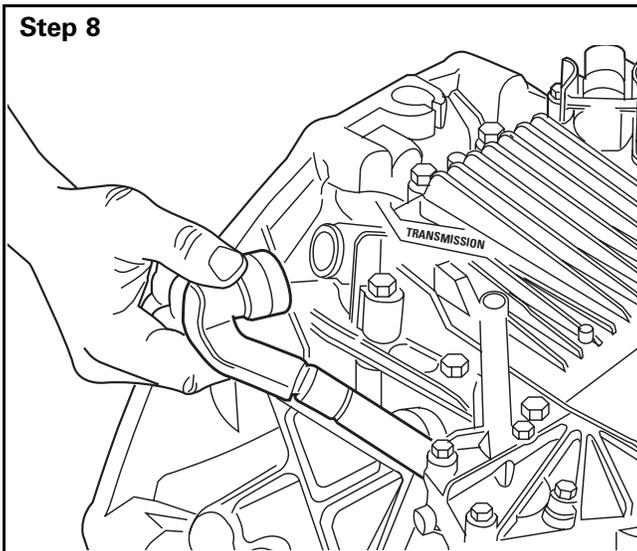
## Section 5 Removal and Installation

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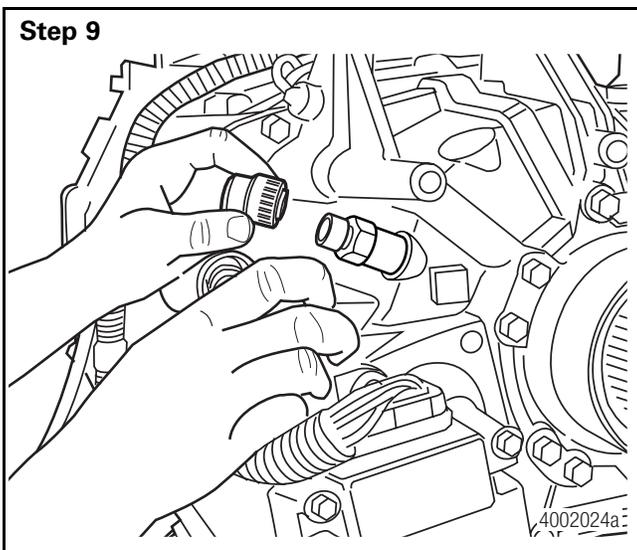
Use a 17 mm wrench to install the vent plug. Use a torque wrench to tighten the vent plug to **16 lb-ft (22 N•m)**. 

- **GO TO THE NEXT STEP.**



Connect the wiring harness to the TCU port marked "Transmission."

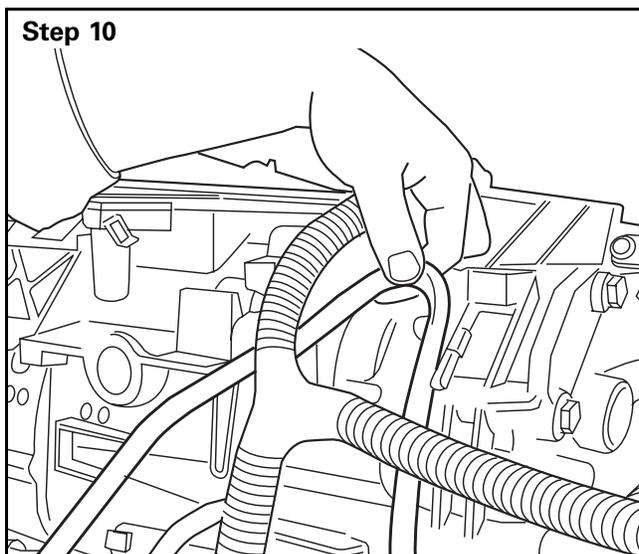
- **GO TO THE NEXT STEP.**



Connect the wiring harness to the output shaft speed sensor connector.

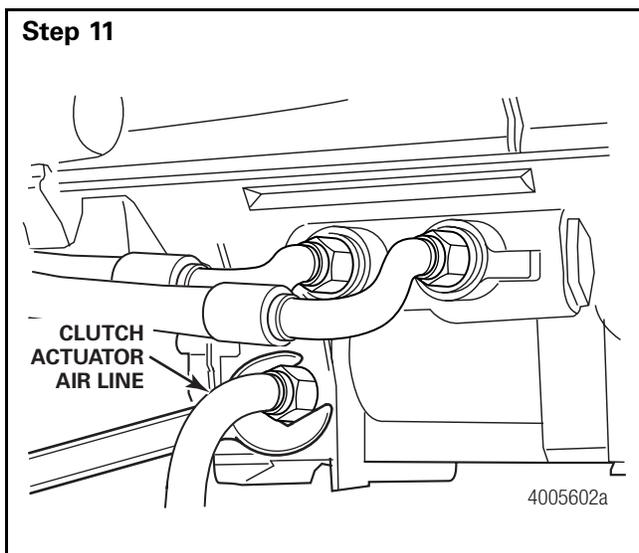
- **GO TO THE NEXT STEP.**

## Section 5 Removal and Installation



Secure the wiring harness to the wiring harness clips.

- **GO TO THE NEXT STEP.**

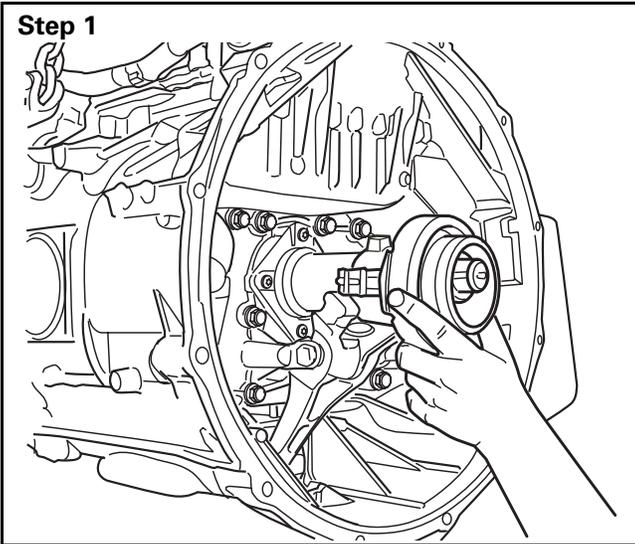


Secure the air supply line to the clutch actuator housing.

## Section 5 Removal and Installation

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Step 1



### Release Bearing

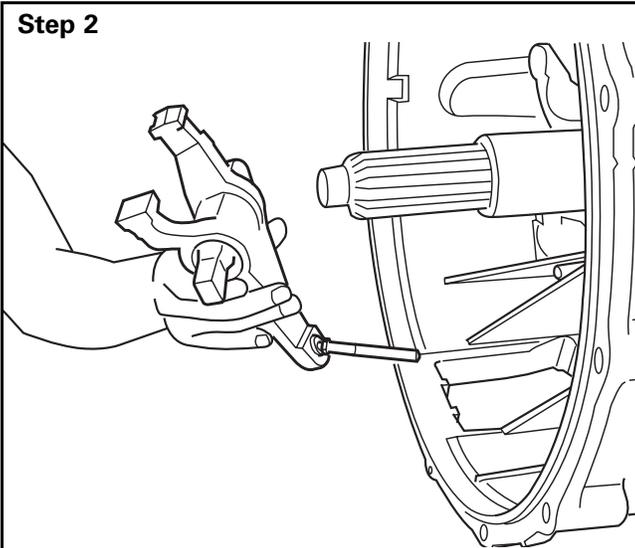
#### Removal

**NOTE:** YOU MUST REMOVE THE TRANSMISSION FROM THE VEHICLE TO REMOVE THE RELEASE BEARING ASSEMBLY.

**If the clutch actuator housing is removed:** Slide the release bearing off of the input shaft past the release fork assembly.

- GO TO THE NEXT STEP.

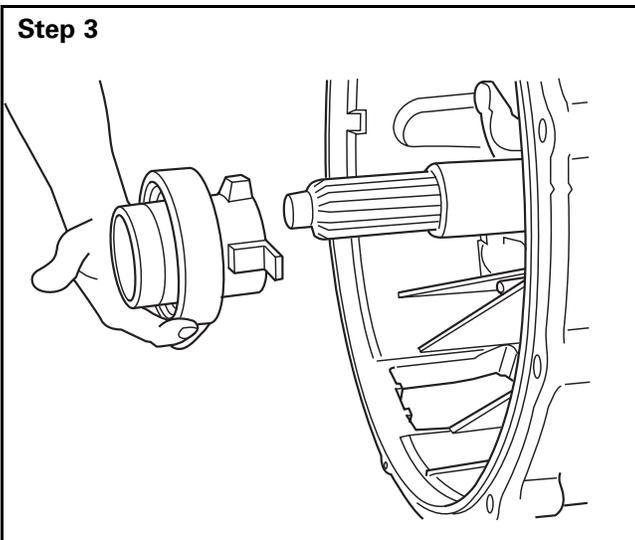
Step 2



**If the clutch actuator housing is not removed:** Remove the release fork assembly. Refer to Release Fork, Standard and Roller Fork in this section.

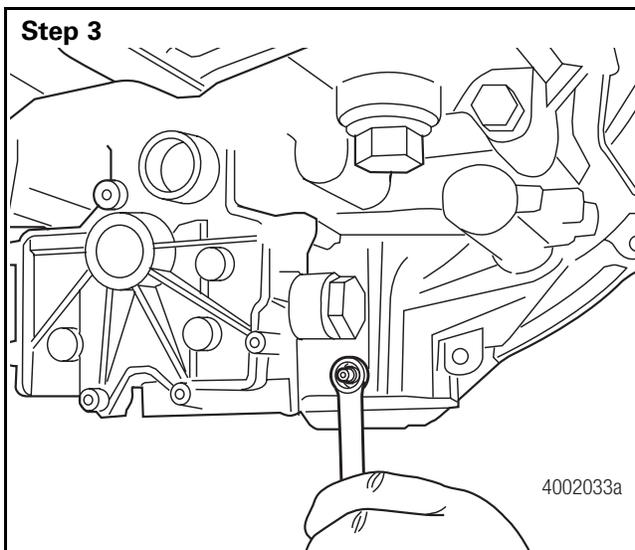
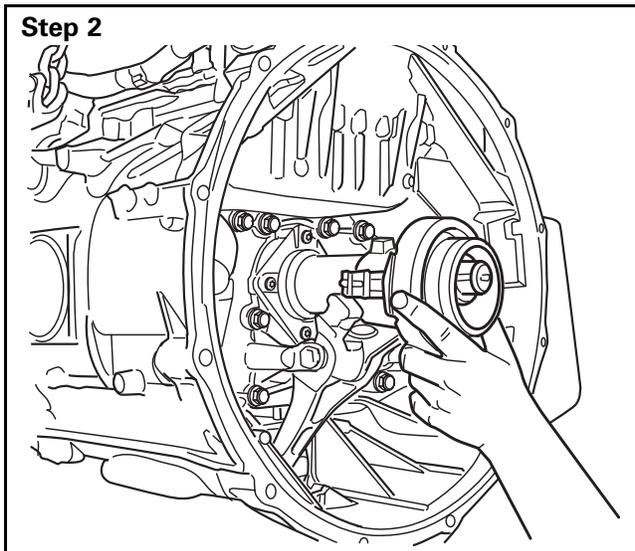
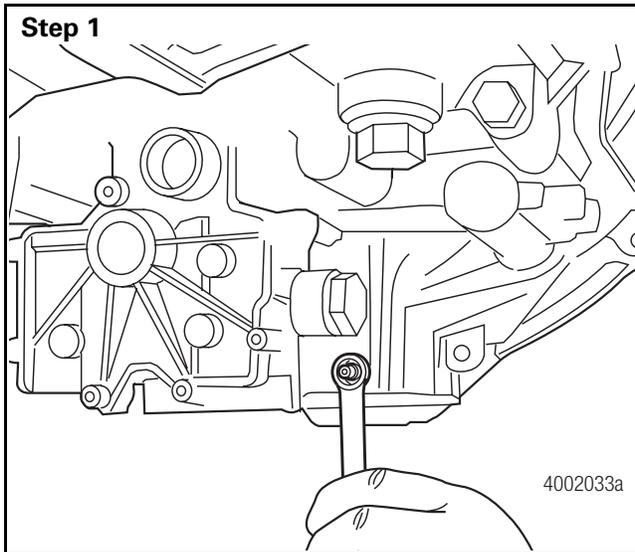
- GO TO THE NEXT STEP.

Step 3



Slide the release bearing off the input shaft.

## Section 5 Removal and Installation



### Installation

Remove the clutch actuator housing. Refer to Clutch Actuator Housing and Wiring Harness in this section.

- **GO TO THE NEXT STEP.**

Install the release bearing onto the input shaft without removing the release fork assembly.

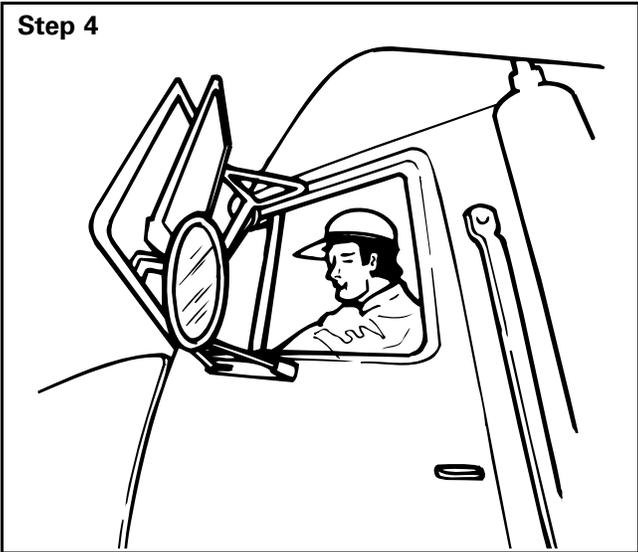
- **GO TO THE NEXT STEP.**

Install the clutch actuator housing onto the transmission. Refer to Clutch Actuator Housing and Wiring Harness in this section.

- **GO TO THE NEXT STEP.**

# Section 5 Removal and Installation

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Operate the vehicle. Check for correct operation.



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Printed in the USA

Revised 06-09