

# 8-Speed Automatic Transmission Diagnosis and Repair



**Student Workbook**

# SAFETY NOTICE

This publication's purpose is to provide technical training information to individuals in the automotive trade. All test and repair procedures must be performed in accordance with manufacturer's service and diagnostic manuals. All *warnings*, *cautions*, and *notes* must be observed for safety reasons. The following is a list of general guidelines:

- Proper service and repair is critical to the safe, reliable operation of all motor vehicles.
- The information in this publication has been developed for service personnel, and can help when diagnosing and performing vehicle repairs.
- Some service procedures require the use of special tools. These special tools must be used as recommended throughout this Technical Training Publication, the diagnostic manual, and the service manual.
- Special attention should be exercised when working with spring- or tension-loaded fasteners and devices such as E-Clips, Cir-clips, snap rings, etc. Careless removal may cause personal injury.
- Always wear safety goggles when working on vehicles or vehicle components.
- Improper service methods may damage the vehicle or render it unsafe.
- Observe all *warnings* to avoid the risk of personal injury.
- Observe all *cautions* to avoid damage to equipment and vehicles.
- *Notes* are intended to add clarity and should help make your job easier.

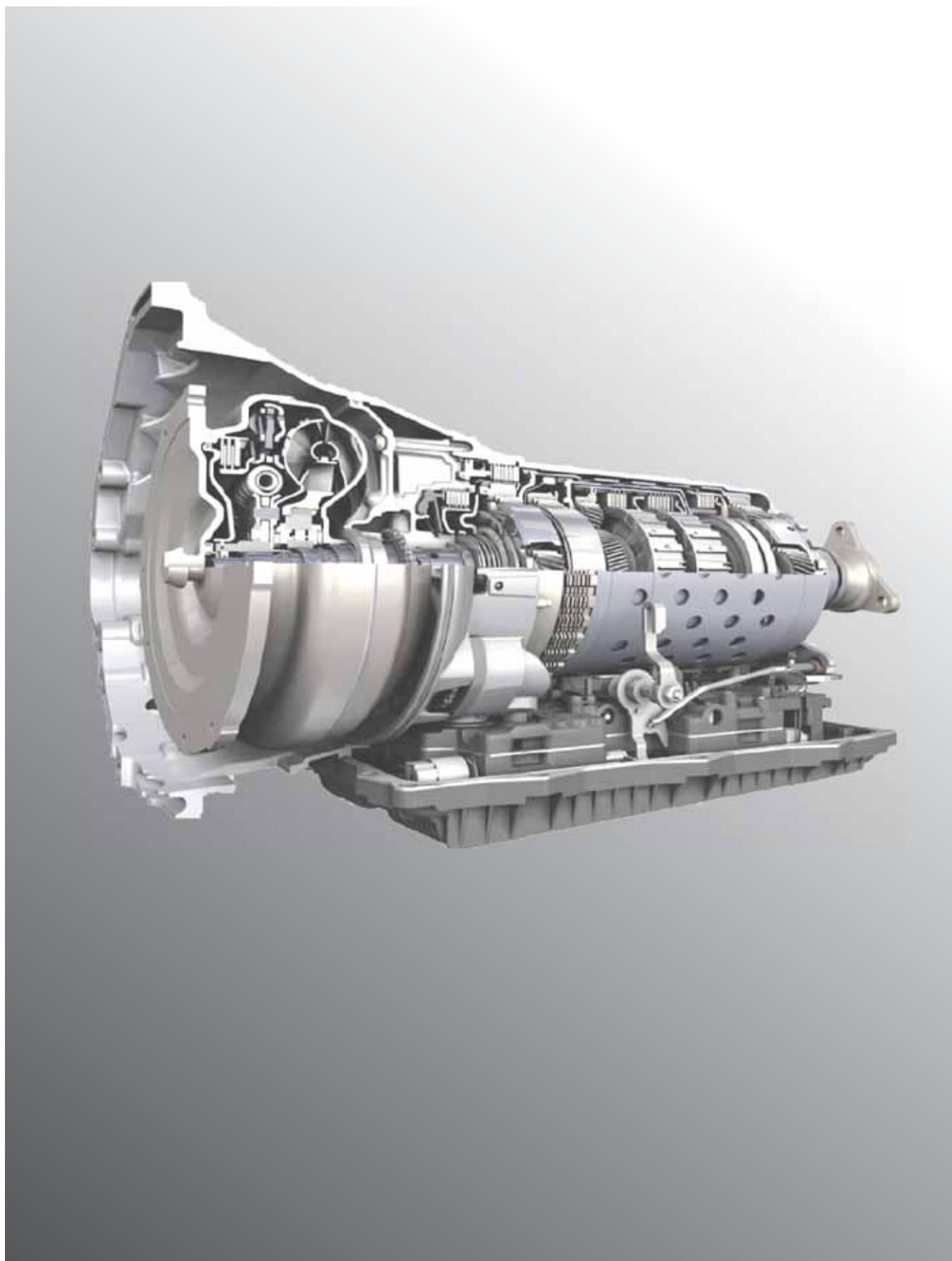
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# TABLE OF CONTENTS

<b>INTRODUCTION</b> .....	<b>1</b>
<b>COURSE OBJECTIVES</b> .....	<b>1</b>
<b>ACRONYMS</b> .....	<b>2</b>
<b>LESSON 1 8-SPEED OVERVIEW AND LIGHT MAINTENANCE</b> .....	<b>5</b>
8-SPEED GENERAL SPECIFICATIONS.....	5
8-Speed Overview .....	5
Introduction to Shifters .....	6
Conventional Lever Shifter Design .....	7
Conventional Lever Shifter Assembly.....	8
Rotary Shifter Assembly .....	9
Park Lock System.....	10
Manual Park Release.....	11
8-SPEED MAINTENANCE AND LIGHT SERVICE .....	12
Valve Body Assembly .....	12
Stop/Start Fluid Accumulator.....	13
Fluid Type and Pan Design .....	14
Fluid Level Check and Fill.....	15
Oil Cooler and Temperature Bypass Valve .....	16
Transmission Heater.....	17
<b>DEMONSTRATION 1 8-SPEED FEATURES OVERVIEW</b> .....	<b>19</b>
PART ONE: 8- AND 9-SPEED TRANSMISSION FLUID AND FLUID CHECK OVERVIEW.....	19
PART TWO: MANUAL PARK RELEASE.....	21
PART THREE: CONVENTIONAL LEVER SHIFTER OPERATION .....	22
PART FOUR: ROTARY SHIFTER OPERATION .....	23
<b>LESSON 2 8-SPEED PRELIMINARY DIAGNOSIS</b> .....	<b>25</b>
GENERAL DIAGNOSTIC ASSESSMENT .....	25
Clutch Application Chart.....	25
Solenoid Application Chart.....	26
Solenoid Control Chart.....	27
Line Pressure Solenoid Facts.....	27
Normally-Closed Solenoids (A, B, and TCC) .....	27
Normally-Open Solenoids (C, D, and E).....	27
<b>ACTIVITY 1 PERFORM DTC/SYMPTOM-BASED DIAGNOSTICS</b> .....	<b>29</b>
TASK ONE: CLUTCH APPLICATION CHARTS .....	29
TASK TWO: FLIGHT RECORDING ANALYSIS - NORMAL OPERATION.....	30
TASK THREE: FLIGHT RECORDING ANALYSIS (CONTINUED).....	38

<b>LESSON 3 8-SPEED HYDRO-MECHANICAL SYSTEMS OPERATION</b> .....	<b>43</b>
INTERNAL COMPONENTS AND SUB-ASSEMBLIES .....	43
Torque Converter .....	43
Valve Body Alignment Pins .....	44
Electrical Harness Insulator .....	45
TCMA Sensors .....	46
Oil Pump Cover .....	47
Oil Pump Housing Assembly .....	48
Geartrain Components .....	49
P4 Annulus Drum Snap Ring .....	50
Clutches .....	51
Geartrain Endplay Measurement .....	52
POWER FLOW .....	53
Power Flow Components .....	53
Clutch and Solenoid Charts .....	54
Holding Clutches .....	55
Rotating Clutches .....	56
1st Gear .....	57
2nd Gear .....	58
3rd Gear .....	59
4th Gear .....	60
5th Gear .....	61
6th Gear .....	62
7th Gear .....	63
8th Gear .....	64
Reverse Gear .....	65
HYDRAULIC OPERATION .....	66
Hydraulic Schematic Legend .....	66
Hydraulic Schematic .....	67
Oil Pump Operation .....	68
TCC Release .....	69
TCC Apply .....	70
C Clutch Hydraulic Operation .....	71
B2 Clutch Hydraulic Release .....	72
B1 Clutch Hydraulic Apply .....	73
Park Lock Hydraulic Operation .....	74
Position Valve Operation .....	75
Default Operation .....	76



Priming Circuit .....	77
<b>DEMONSTRATION 2 8-SPEED HYDRO-MECHANICAL SYSTEMS ANALYSIS .....</b>	<b>79</b>
PART ONE: TRANSMISSION DISASSEMBLY .....	79
PART TWO: TRANSMISSION ASSEMBLY .....	80
PART THREE: CLUTCH INTERACTION .....	82
<b>LESSON 4 8-SPEED ELECTRICAL OPERATION .....</b>	<b>85</b>
ELECTRICAL INPUTS .....	85
Transmission Control Module (TCM) .....	86
Speed Sensors .....	87
Temperature Sensor .....	88
Park Position Sensor .....	89
ELECTRICAL OUTPUTS .....	90
Solenoid Operation .....	90
MODULE COMMUNICATION AND CONTROL STRATEGIES .....	91
Module Communications .....	91
Adaptive Strategies .....	93
<b>ACTIVITY 2 8-SPEED ELECTRICAL SYSTEMS ANALYSIS AND DIAGNOSIS .....</b>	<b>97</b>
ANALYZE COMMUNICATION CIRCUITS .....	97
<b>LESSON 5 8-SPEED REPAIR PROCEDURES .....</b>	<b>101</b>
SERVICEABLE COMPONENTS .....	101
<b>APPENDIX .....</b>	<b>117</b>
ZF 8-SPEED AUTOMATIC TRANSMISSION DIAGNOSTIC WORKSHEET .....	117
SPECIAL TOOLS .....	118
8-Speed Transmission .....	118
8HP45 Cross Section .....	121
8HP45 Disassembled View .....	122
8-Speed Valve Body Exploded View .....	123
Valve Body Valves - Inner Half .....	124
<b>GLOSSARY .....</b>	<b>127</b>





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## INTRODUCTION

This course is designed to train dealership technicians in the operational concepts of 8-speed automatic transmission. The course design allows students to develop the skills needed to perform accurate diagnosis and timely repairs using the proper diagnostic tools.

## COURSE OBJECTIVES

After completing this course, the technician will be able to:

- Identify the general specifications and design characteristics of the 8-speed transmission
- Identify a preliminary diagnosis strategy for the 8-speed automatic transmission
- Identify the operation of hydro-mechanical systems
- Identify 8-speed electrical system operation and diagnosis
- Identify the repair procedures for the 8-speed automatic transmission

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## ACRONYMS

The following is a list of acronyms used throughout this publication:

4WD	Four-Wheel Drive
APPS	Accelerator Pedal Position Sensor
ATF	Automatic Transmission Fluid
AWD	All-Wheel Drive
BTSI	Brake Transmission Shift Interlock
CAN	Controller Area Network
CS	Controlled Clutch Slip
CS-V	Converter Switching Valve
CV-B1	Clutch Valve B1
CV-B2	Clutch Valve B2
CV-C	Clutch Valve C
DTC	Diagnostic Trouble Code
ESC	Electronic Stability Control
ESD	ElectroStatic Discharge
FWD	Front-Wheel Drive
HP	Hydraulic Planetary
HV-B1	Holding Valve B1
HV-B2	Holding Valve B2
HV-C	Holding Valve clutch C
ISS	Input Speed Sensor
LC-V	Lockup Clutch Valve
LPS	Line Pressure Solenoid
Lu-V	Lubrication Valve
NC	Normally-Closed solenoid
NIC	Neutral Idle Control
NO	Normally-Open solenoid
NVH	Noise, Vibration, and Harshness
OSS	Output Speed Sensor
P1	Planetary gear set #1
P2	Planetary gear set #2
P3	Planetary gear set #3
P4	Planetary gear set #4
Park Cyl	Park release Cylinder
Park-V	Park release Valve
PCM	Powertrain Control Module

PCV	Park Cylinder Valves
PDC	Power Distribution Center
PosD-V	Position Default Valve
Pos-V	Position Valve
PR-LC	Pressure Regulator Lock-up Clutch
PRNDL	Park Reverse Neutral Drive Low
PRNDS	Park Reverse Neutral Drive Sport
PR-V	Pressure Reducing Valve
PTU	Power Transfer Unit
PWM	Pulse-Width Modulated
RDM	Rear Driveline Module
RFHM	Radio Frequency Hub Module
rpm	revolutions per minute
SBW	Shift-By-Wire
SCCM	Steering Column Control Module
SISP	Spontaneous Increase of Shift Point
SNA	Signal Not Available
SOL C	SOLenoid clutch C
SOL Park	SOLenoid Park
SP-V	System Pressure Valve
SVD	Spontaneous Vehicle Deceleration
SV-SP	Switching Valve for System Pressure
SV-TC	Switch Valve Torque Converter
TCC	Torque Converter Clutch
TCC-V	Torque Converter Clutch apply Valve
TCH1-V	Torque Converter primary pressure retention Holding Valve
TCH2-V	Torque Converter secondary pressure retention Holding Valve
TCM	Transmission Control Module
TCMA	Transmission Control Module Assembly
TC-V	Torque Converter pressure regulating Valve
TRS	Transmission Range Sensor



## LESSON 1 8-SPEED OVERVIEW AND LIGHT MAINTENANCE

### 8-SPEED GENERAL SPECIFICATIONS

#### 8-Speed Overview

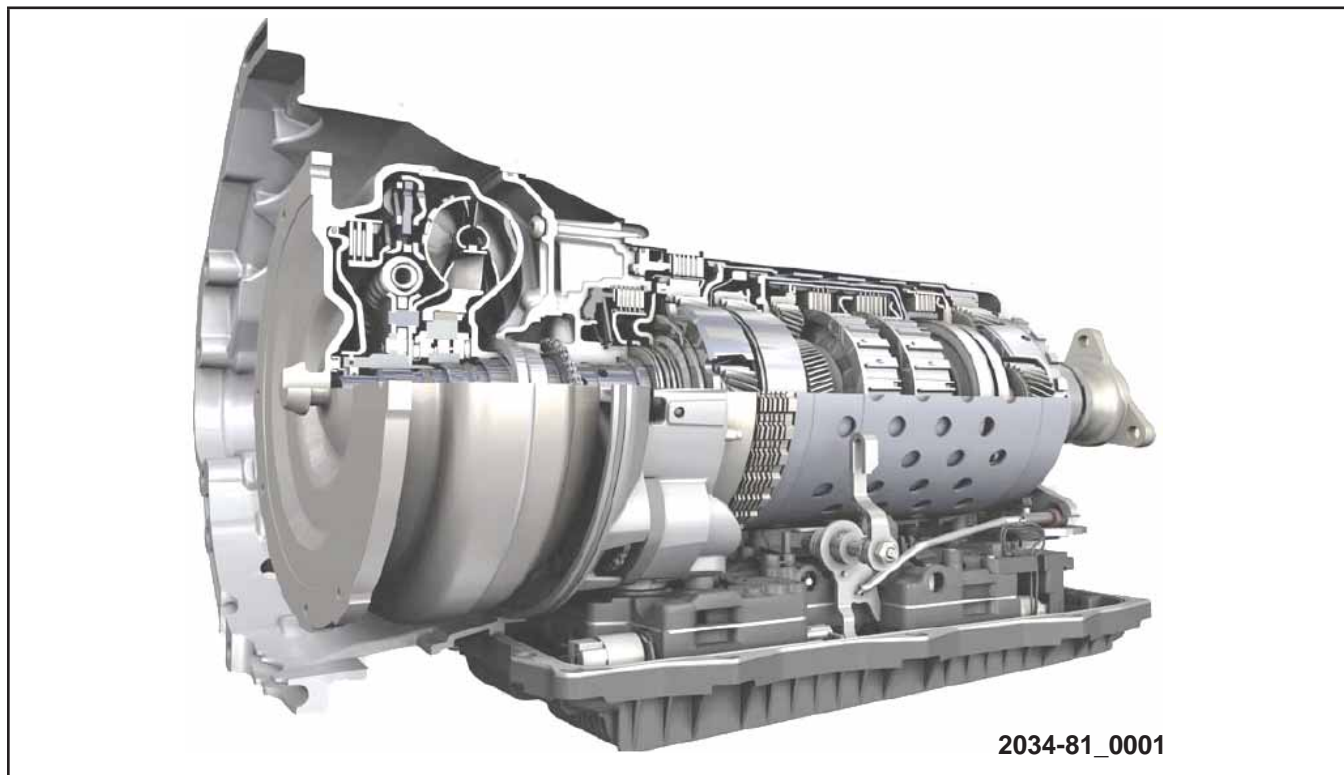


Figure 1 Transmission Overview

The 8HP45 is an electronic, 8-speed, automatic transmission that incorporates state-of-the-art technology. The transmission control module assembly (TCMA), which is integrated into the valve body, provides fully synchronized clutch-to-clutch shifting through four planetary gear sets. The valve body assembly contains all the sensors and solenoids required for operation completely inside the transmission. This 8-speed transmission offers distinct advantages over 6-speed transmissions by providing additional ratios for even quicker acceleration and shorter shift intervals. Eight speeds allow the engine to maintain its optimal rpm range, increasing fuel economy and performance.

# 8-Speed Overview and Light Maintenance

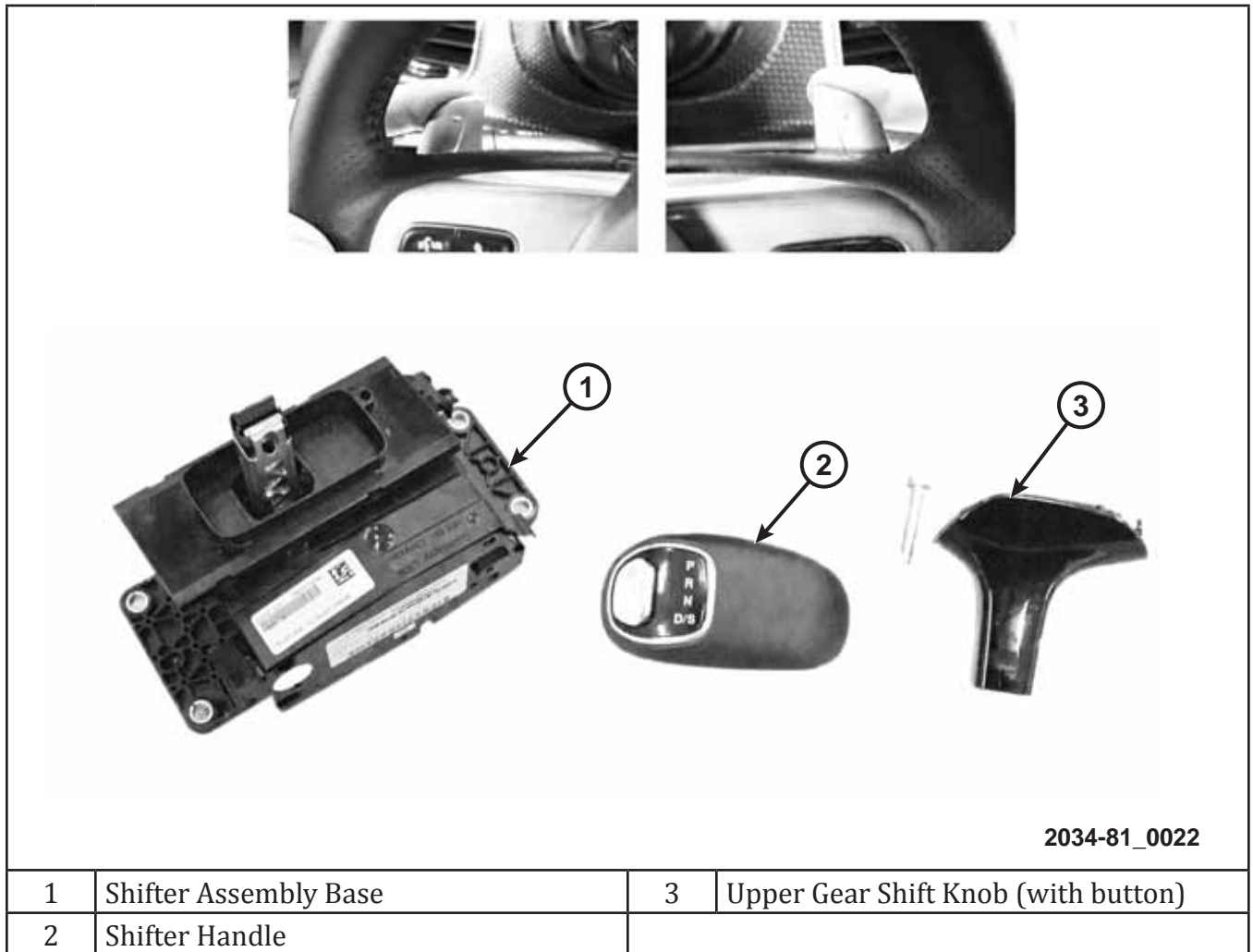
## Introduction to Shifters



Figure 2 Shifter Designs

There are two main shifter designs used with the 8-speed automatic transmission: conventional and rotary. Both shifter designs are shift-by-wire and park-by-wire. There is no mechanical connection between the transmission and the shifter. Range selection is provided to the transmission control module (TCM) over a CAN network. Both shifter designs can be equipped with AutoStick. Park-by-wire parking pawl control is provided by a combination of hydraulic and electrical solenoids. Because these shifters are not mechanically connected to the transmission, a manual park release is provided.

## Conventional Lever Shifter Design



1	Shifter Assembly Base	3	Upper Gear Shift Knob (with button)
2	Shifter Handle		

Figure 3 Electronic Shifter Assembly

Gear range selection on the 8-speed automatic transmission is accomplished using an electronic shifter. The electronic shifter system uses sensors and network communication with the TCM instead of a traditional cable. The image shows current serviceable parts for the conventional lever electronic shifter.

The base shifter displays a typical PRNDL pattern, where the low position limits the top gear and provides additional engine braking.

The up-level shifter displays a PRNDS pattern, where the S stands for sport. In the sport position, a more aggressive feeling shift pattern is applied. The sport shifter is always paired with paddle-shift buttons on the steering wheel that operate similar to AutoStick. The paddle-shift switches communicate through the steering column control module (SCCM) on the CAN-C network.

Vehicles equipped with the 8-speed automatic transmission are also equipped with a brake transmission interlock (BTSI). The BTSI requires the driver to apply the brakes before the vehicle can be shifted out of park.



## 8-Speed Overview and Light Maintenance

### Conventional Lever Shifter Assembly

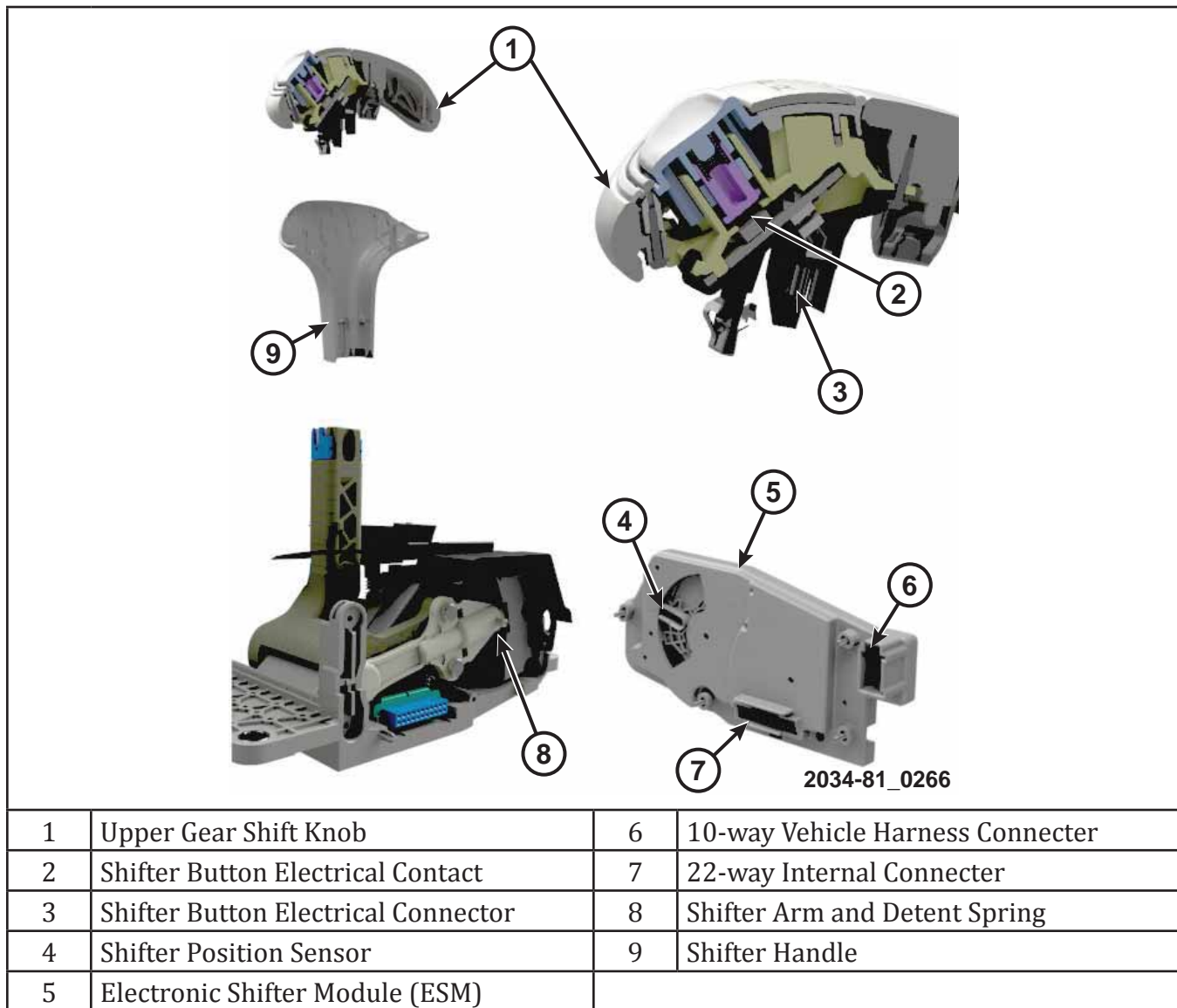


Figure 4 Shifter Cut Away View

#### **Shifter in Drive Position**

The transmission functions automatically until the paddles are used. The TCM responds to paddle requests. After a certain amount of time, or coming to a stop, the TCM returns to fully automatic mode.

#### **Shifter in Sport Position**

The transmission functions automatically with a more aggressive shift schedule. After the first press of either paddle, the transmission functions like AutoStick, waiting for a command before shifting. The driver can return to fully automatic mode by pressing and holding the + shifter paddle or shifting to a different gate.

### Rotary Shifter Assembly



Figure 5 Rotary Shifters

The rotary e-shifter operates similarly to the conventional lever shifter. The rotary e-shifter is an all-in-one switch and module that includes provisions for the brake transmission shifter interlock (BTSI). The rotary e-shifter can be dash- or console-mounted. The use of this shifter requires the use of a mechanical release for service and towing. Current shifter position will be indicated on the rotary shifter by an illuminated LED as well as shown in the instrument panel cluster. The LEDs on the rotary shifter will also flash in the event of certain malfunctions.

### Park Lock System

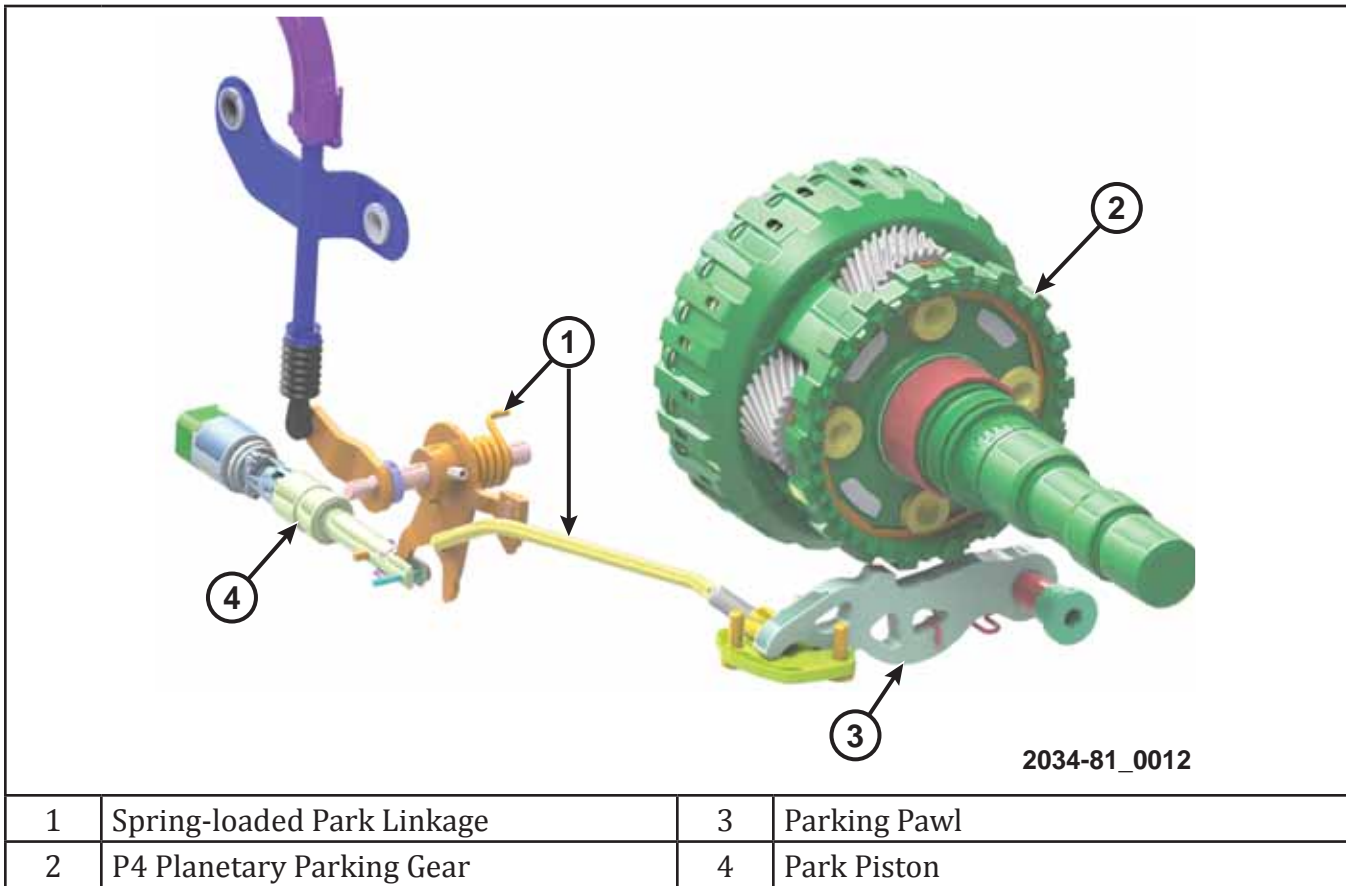


Figure 6 Park Lock System

The transmission uses a shift-by-wire system, so there is no mechanical connection between the shifter and the transmission. The transmission uses a park lock piston to control the position of the parking pawl. The park linkage inside the transmission is similar to previous designs; however, this linkage is spring-loaded to default into the park position. The parking pawl engages into the teeth of the parking gear on the P4 carrier to prevent movement.

Manual Park Release

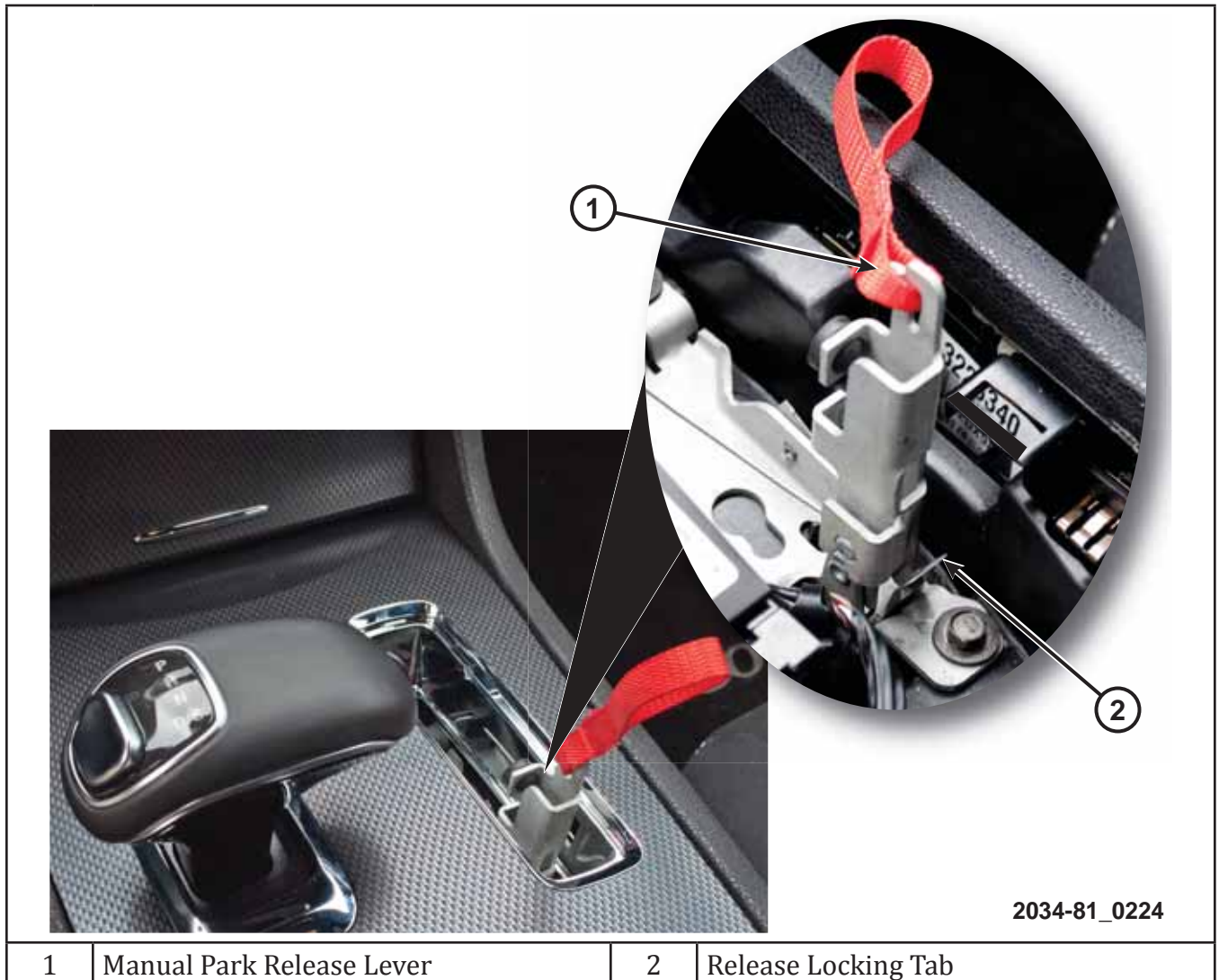


Figure 7 Manual Park Release Operation

In the event of a complete transmission electrical failure, the transmission park pawl is engaged when the engine is off. For this reason, the transmission is equipped with a manual park release lever.

Pictured above is the manual park release for a Chrysler 300. Refer to service information for the location of the manual park release for other vehicles. The lever is located under the shift console and can be accessed by removing the storage tray to the right of the shifter. When the cable is pulled, the release cable pulls upward on the release lever, which releases the park lock spring jack and allows the park pawl to disengage from the parking gear.

## 8-Speed Overview and Light Maintenance

### 8-SPEED MAINTENANCE AND LIGHT SERVICE

#### Valve Body Assembly

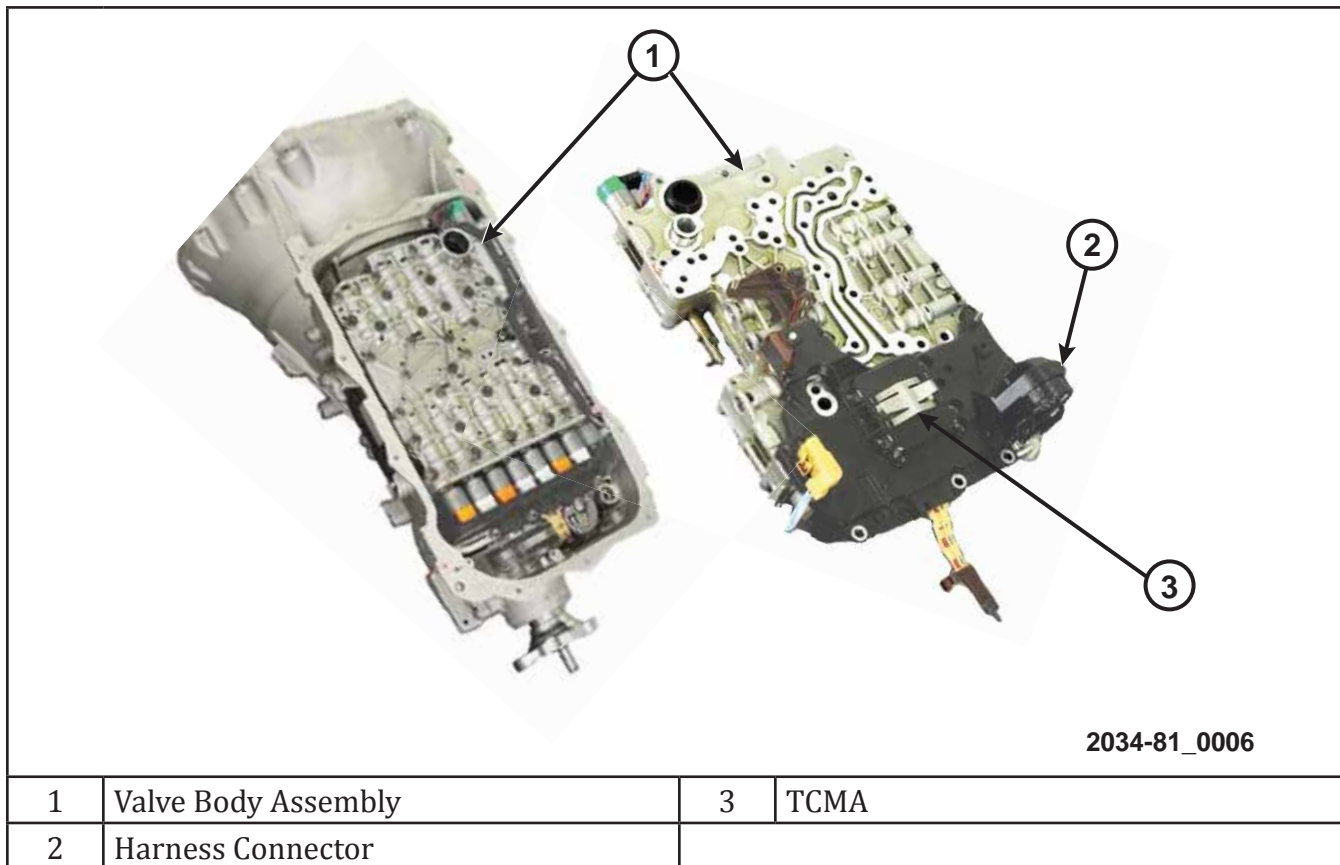


Figure 8 Valve Body Assembly

The valve body assembly is comprised of the valve body and the transmission control module assembly (TCMA). The valve body and TCMA are serviced as an assembly.

## Stop/Start Fluid Accumulator

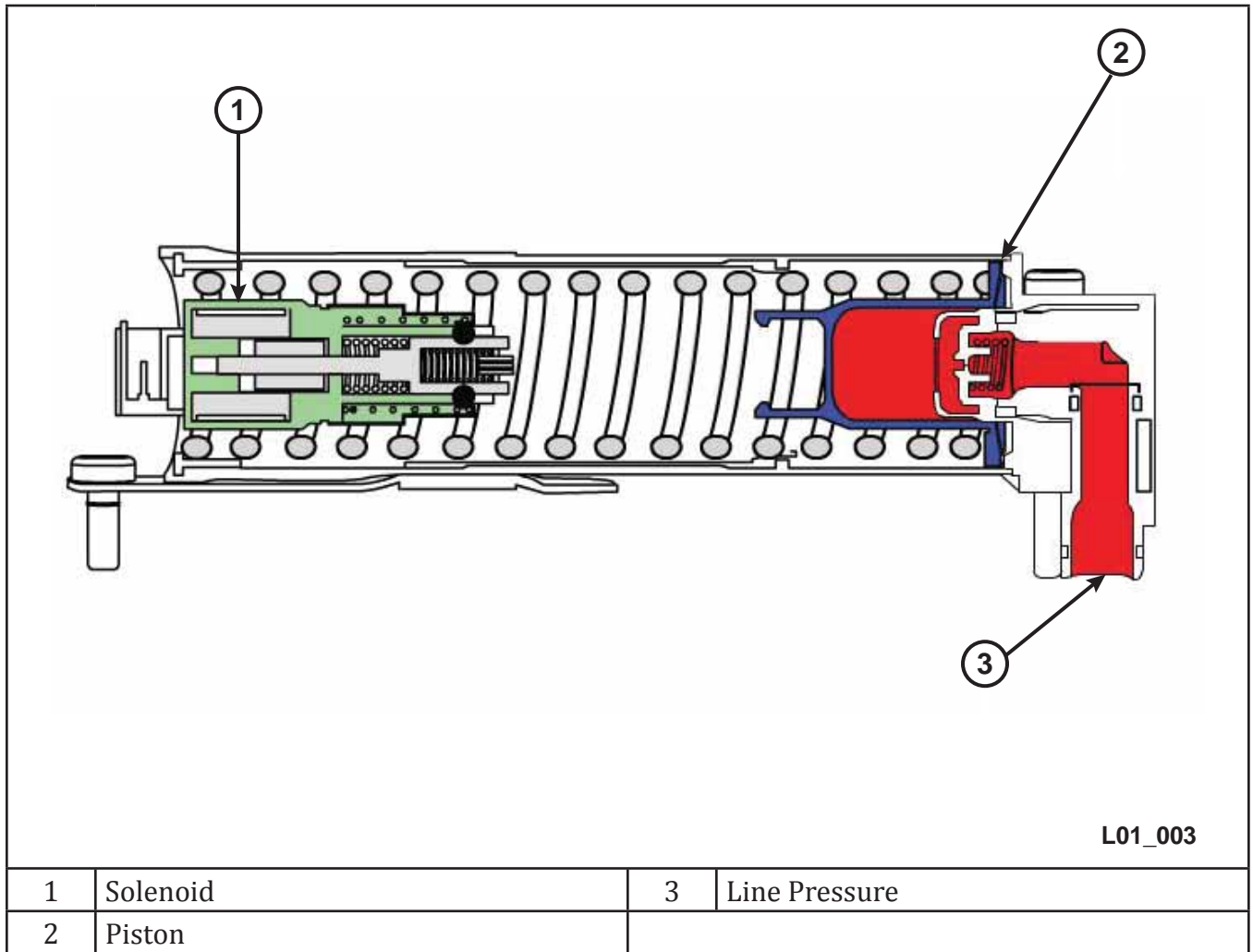


Figure 9 Stop/Start Fluid Accumulator

Vehicles equipped with an 8-speed transmission can be equipped with stop/start technology. If an 8-speed transmission is equipped with the start/stop feature, a hydraulic impulse storage (HIS) accumulator is integrated in the valve body to support the stop/start feature. When the engine is stopped, a conventional transmission loses hydraulic pressure; additional time is then needed to restore transmission operating pressure after the engine restarts. The hydraulic accumulator stores pressurized oil, supplements the pump, and maintains transmission pressures, eliminating pressure buildup time and clutch engagement delay. The HIS oil storage unit utilizes a spring piston accumulator charged by the oil pump. When the accumulator is fully charged, an electronic solenoid holds pressurized fluid until the TCM commands the solenoid to release the fluid. When the engine auto starts, the oil charge is promptly released, supplying the hydraulic valves and clutches with pressurized oil, and the vehicle is ready to move instantly. Without the HIS, a detectable delay in vehicle acceleration would exist, leading to a loss in driving dynamics.



## 8-Speed Overview and Light Maintenance

### Fluid Type and Pan Design

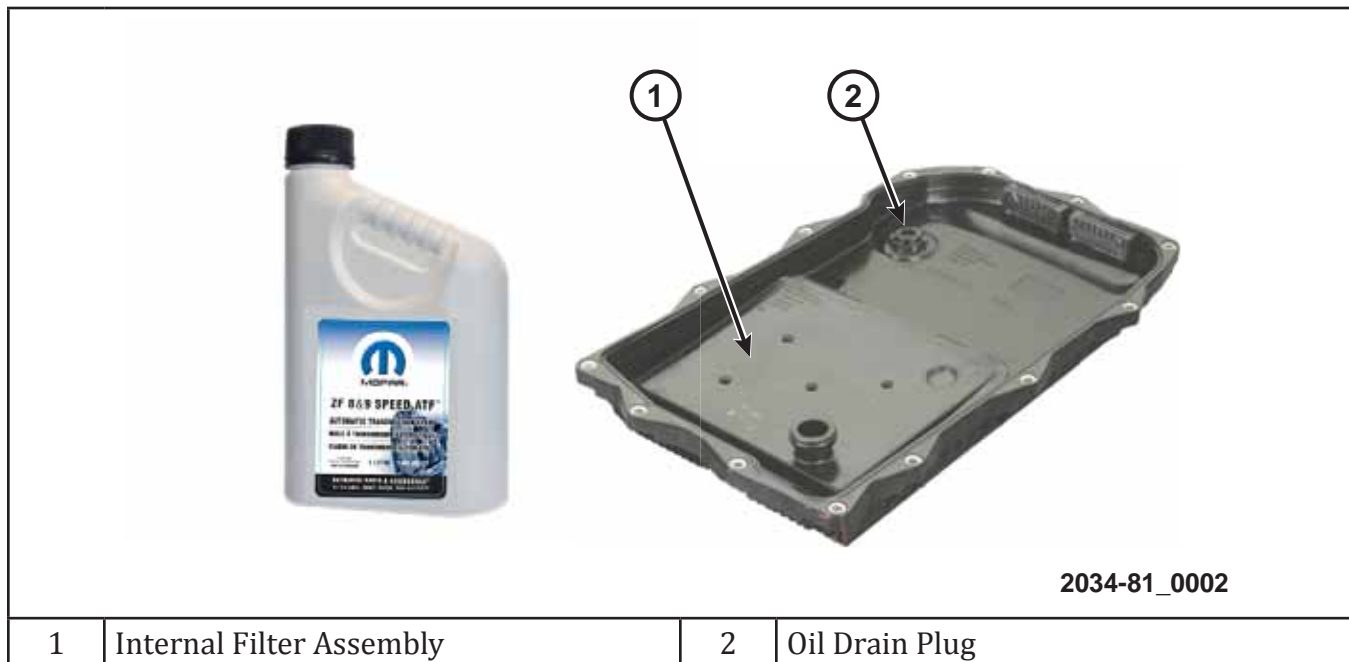


Figure 10 Fluid Type

A special automatic transmission fluid (ATF) is required, and a unique oil fill procedure must be followed to properly add fluid after transmission service. ATF+4 is NOT compatible with the 8-speed automatic transmission and should not be used under any circumstance.

The 8-speed automatic transmission has a filled-for-life transmission fluid strategy. The transmission is filled at the factory once and, under normal operating conditions, it is not necessary to check the fluid level or change the fluid and filter. Be aware that there may be fluid service requirements for severe duty applications, such as taxi or fleet vehicles. Refer to service information for the maintenance schedule.

**NOTE:** Mopar oil leak dye has not been approved for use with the 8- and 9-speed automatic transmission fluid. Do not add any fluid other than the approved ATF. Unless otherwise specified, use leak trace powder as an alternative.

The fluid filter is an integral part of the oil pan and cannot be replaced separately. The filter is only replaced when performing repairs to the transmission.

**CAUTION:** To avoid damage to the plastic oil pan, do not support the weight of the transmission in the center of the oil pan. The supports for the jack should be placed around the edge of the pan or rail.



## Fluid Level Check and Fill

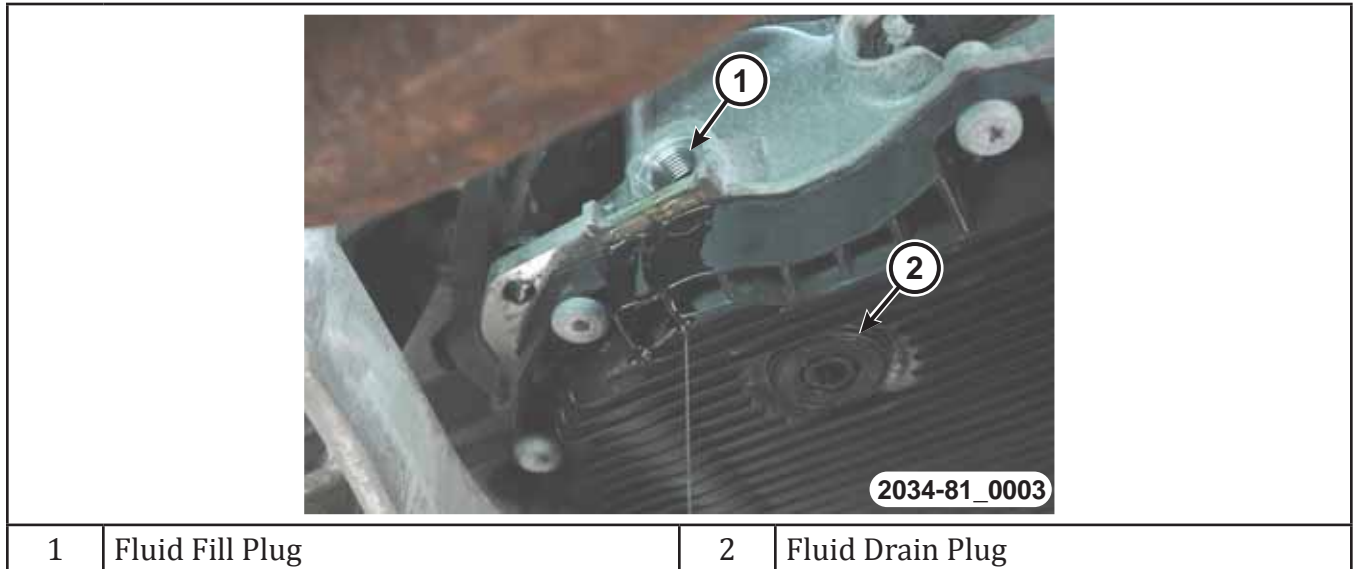


Figure 11 Fluid Level Check

A fluid fill tube and indicator are not provided on this transmission. The oil level is only checked or adjusted when the customer has shift quality concerns, fluid leaks are present, or transmission service is required. The procedure involves the use of a scan tool to monitor transmission fluid temperature. Because a fluid fill tube and indicator are not provided, all work is performed under the vehicle while raised on a hoist.

### Oil Cooler and Temperature Bypass Valve

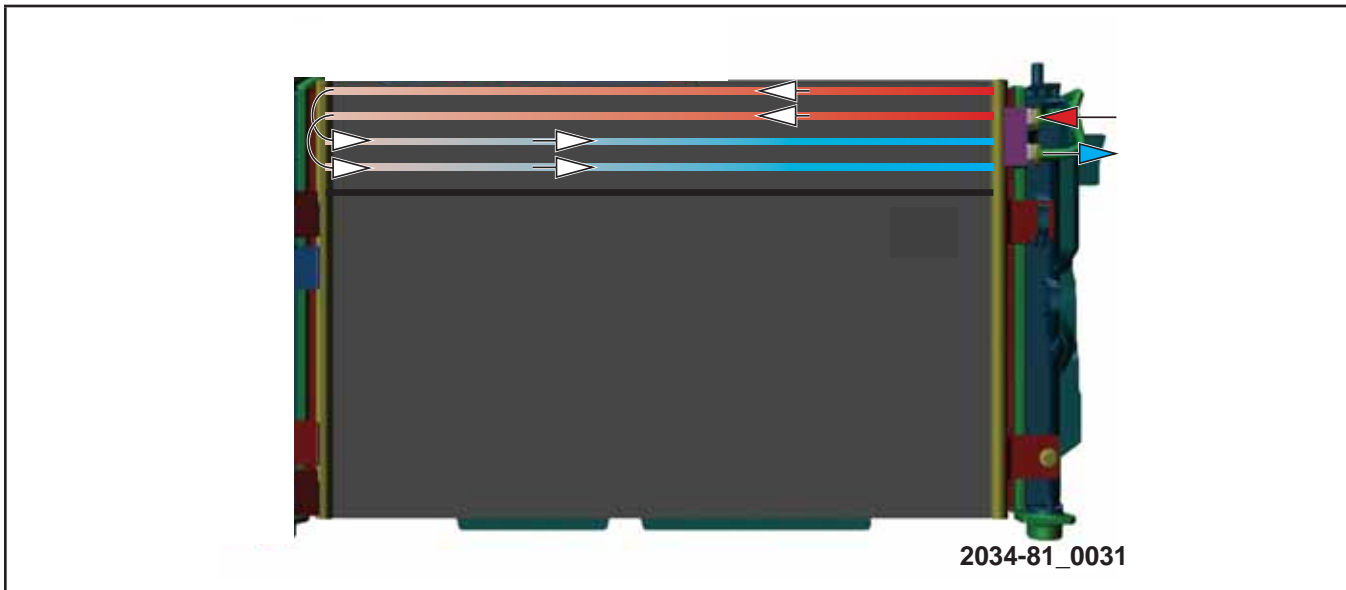


Figure 12 Transmission Cooler and Bypass Valve

The 8-speed automatic transmission uses a combination double pass oil-to-air cooler located in the top of the A/C condenser.

The bypass valve operates based on temperature and pressure to bypass the cooler and direct fluid back to the transmission lubrication circuit.

The bypass valve directs fluid back to the transmission lubrication circuit until the fluid temperature reaches 90 °C (194 °F). When the fluid temperature reaches this threshold, the bypass valve opens and allows fluid to flow through the cooler, then return to the transmission.

In the event of a plugged or restricted cooler, the bypass valve also has the ability to redirect fluid back to the transmission lubrication circuit when the cooler circuit pressure exceeds 482.6 kPa (70 psi).

## Transmission Heater

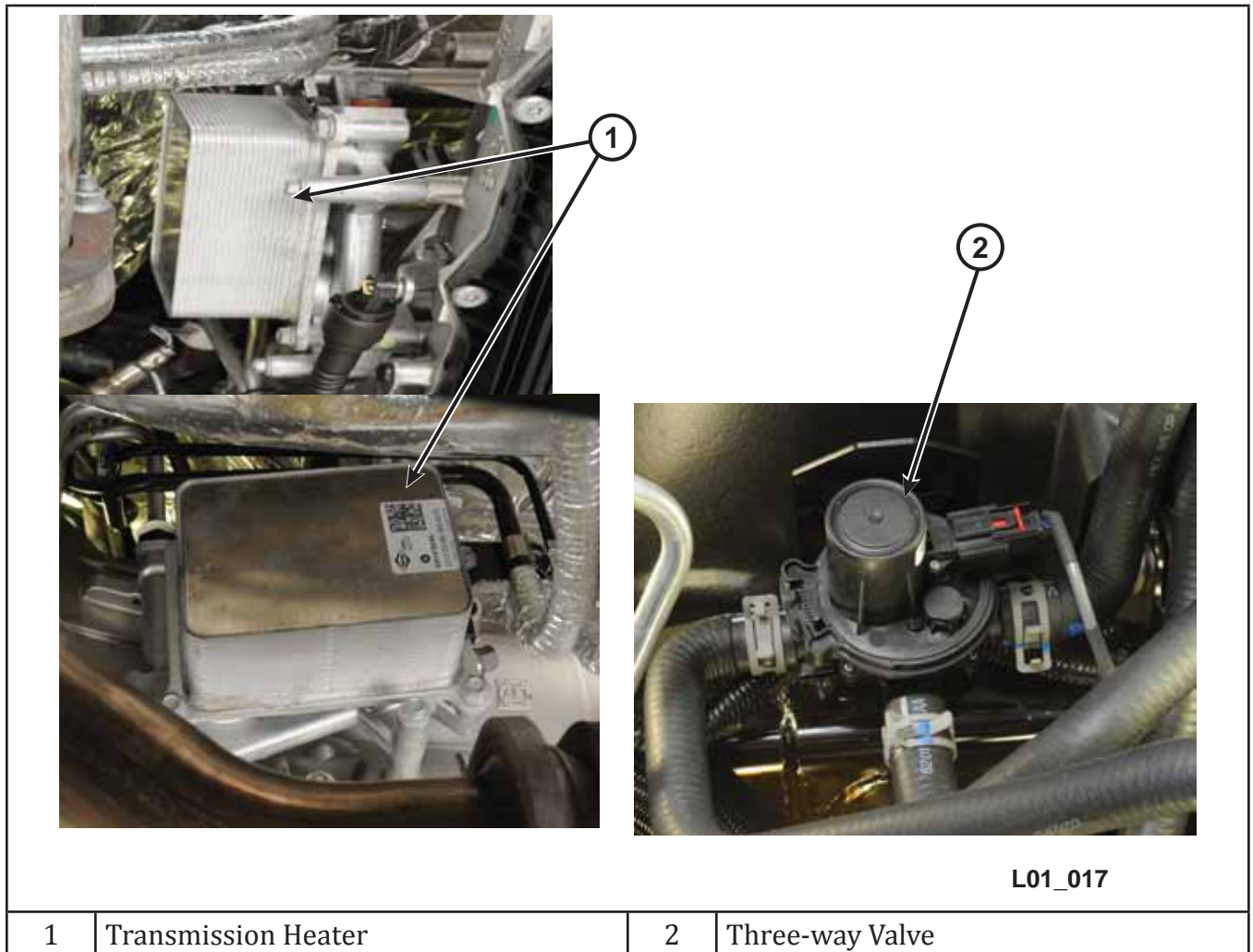


Figure 13 Transmission Heater

Some vehicles may be equipped with a transmission heater. If equipped, the transmission heater is located on the left side of the transmission. The transmission heater is an assembly containing an oil-to-water heat exchanger and also incorporates a thermal bypass valve (TBV). The coolant travels from a three-way valve to the transmission heater. The heated coolant quickly warms the transmission fluid to an ideal operating range. The thermal management system then maintains the optimum operating temperature.

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## 8-Speed Overview and Light Maintenance

Notes: \_\_\_\_\_

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DEMONSTRATION 1 8-SPEED FEATURES OVERVIEW

Instructions: Use the space below to take notes as the instructor demonstrates the following procedures.

PART ONE: 8- AND 9-SPEED TRANSMISSION FLUID AND FLUID CHECK OVERVIEW

- 1. The fluid used in the 8-speed transmission is luminescent when looked at with a black light and yellow glasses. No extra fluid dye is needed or recommend to assist in finding the source of fluid leaks.

Ruled area for taking notes, consisting of multiple horizontal lines.



**PART TWO: MANUAL PARK RELEASE**

Instructions:     Locate the manual park release using service information, and perform the manual park release procedure.

1.     In what two locations can you find instructions on how to operate the manual park release?

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2.     Where is the manual park release located on the vehicle?

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3.     Is there a release that must be activated before pulling the handle?

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## 8-Speed Features Overview

### PART THREE: CONVENTIONAL LEVER SHIFTER OPERATION

Instructions: Identify normal shifter operation.

1. With no power to the shifter (ignition OFF and all LEDs off), how many detents can the handle move in each direction? You may need to allow the cluster to go to sleep after opening the door.  

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2. With the ignition in the RUN position and the engine off, how many detents can the handle move in each direction?  

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3. With the ignition still in the RUN position, press the brake pedal and the shifter button. How many detents are allowed now?  

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4. Locate and operate the manual park release lever. What gear position is displayed in the cluster? On the shifter?  

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Instructions: Answer the following questions if the vehicle is equipped with sport mode.

5. Apply the parking brake.
6. Start the vehicle and place the transmission in drive. From this position, what action places the transmission in low/sport mode?  

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7. In low/sport mode, what action returns the transmission to drive?  

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### PART FOUR: ROTARY SHIFTER OPERATION

Instructions: Identify normal shifter operation.

1. With no power to the shifter (ignition off and all LEDs off), how many detents can the rotary knob move in each direction?
- 

2. With the ignition in the RUN position and the engine off, how many detents can the rotary knob move in each direction?
- 

3. With the ignition still in the RUN position, press the brake pedal and move the rotary shifter. How many detents can the shifter move now?
- 
- 

4. Remove the trim cover to the left of the steering column and operate the manual park release. What gear position is displayed in the cluster? On the shifter?
- 
- 





## LESSON 2 8-SPEED PRELIMINARY DIAGNOSIS

### GENERAL DIAGNOSTIC ASSESSMENT

#### Clutch Application Chart

- Clutches are listed across the top.
  - Two braking and three rotating/driving
- Gears are listed down the left side.
- X = clutch is applied.
- Gear ratios are listed down the right side.

Table 1 Clutch Application Chart

Gear	Braking		Rotating			Ratio
	A	B	C	D	E	
1st	X	X	X			4.69:1
1st (NIC)	X	CS	X			NIC
2nd	X	X			X	3.13:1
3rd		X	X		X	2.10:1
4th		X		X	X	1.67:1
5th		X	X	X		1.29:1
6th*			X	X	X	1.00:1
7th	X		X	X		0.84:1
8th	X			X	X	0.67:1
Reverse	X	X		X		3.30:1
Park	X	X				

\* = 6th gear is limp-home gear

## 8-Speed Preliminary Diagnosis

### Solenoid Application Chart

- Solenoids are listed across the top.
- Gears are listed down the left side.
- X = the solenoid is energized.
- +/- = the current solenoid is variable (PWM).
- TCC represents the torque converter clutch solenoid.
- LPS represents the line pressure solenoid (LPS).
- X\* = touch point pressure = the solenoid is energized briefly to fill the clutch circuit in anticipation of upcoming full clutch application.
- NC = normally-closed
  - When the solenoid is electrically off, the clutch is off.
- NO = normally-open
  - When the solenoid is electrically off, the clutch is on.

Table 2 Solenoid Application Chart

Gear	Solenoid							
	Park (NC)	A (NC)	B (NC)	C (NO)	D (NO)	E (NO)	TCC (NC)	LPS (NO)
P		X	X*	X	X	X		
N	X	X	X*	X	X	X		
R	X	X	X	X		X		+/-
1st	X	X	X		X	X	+/-	+/-
2nd	X	X	X	X	X		+/-	+/-
3rd	X		X		X		+/-	+/-
4th	X		X	X			+/-	+/-
5th	X		X			X	+/-	+/-
6th	X						+/-	+/-
7th	X	X				X	+/-	+/-
8th	X	X		X			+/-	+/-

### Solenoid Control Chart

- The solenoids are listed across the top row.
- The far left column lists the current through the solenoids (either high or low).
- Solenoids are controlled by current flow in milliamps. This is displayed on the scan tool.
- Although solenoids can be controlled in a wide range of amperage, the chart shows the high and low extremes.

Table 3 Solenoid Control Chart

Solenoid Current	Solenoids				
	Pressure Control	A/B	C/D/E	TCC	Park
<b>High (mA)</b>	Low Line Pressure	Clutch On	Clutch Off	Clutch On	Park Released
<b>Low (mA)</b>	High Line Pressure	Clutch Off	Clutch On	Clutch Off	Park Engaged

mA =milliampere

### Line Pressure Solenoid Facts

- When the mA is high (on), the line pressure is low. When the mA is low (off), the line pressure is high (inversely proportional).

### Normally-Closed Solenoids (A, B, and TCC)

- When the mA is high (on), the clutch is on. When mA is low (off), the clutch is off.

### Normally-Open Solenoids (C, D, and E)

- These solenoids are similar to the line pressure solenoid. When the mA is high (on), the clutch is off. When the mA is low (off), the clutch is applied.



## **ACTIVITY 1 PERFORM DTC/SYMPTOM-BASED DIAGNOSTICS**

### **TASK ONE: CLUTCH APPLICATION CHARTS**

Instructions: Use the Clutch Application Chart and the Solenoid Application Chart to answer the following questions.

1. A vehicle with an 8-speed attempts to upshift from 1st to 2nd gear, but fails and reverts back to 1st gear. Which clutch could be responsible?

---

2. A vehicle has an 8-speed transmission that is slipping when shifted into reverse and a shift flare when shifting into 4th gear. Which clutch could be responsible and how could a solenoid cause the issue?

---

---

3. A vehicle with an 8-speed is brought into service with a concern of a noise during normal driving. Upon test driving the vehicle, the technician discovers that a noise occurs when the TCM performs a 7-8 upshift, and continues in 8th gear. Which clutch could be related to the concern and why?

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---



## Perform DTC/Symptom-Based Diagnostics

### TASK TWO: FLIGHT RECORDING ANALYSIS - NORMAL OPERATION

1. Use flight recording A\_2014 DS Garage Shifts to answer the following questions. Use the data at approximately seven seconds in the flight recording for questions a through d.

a. What is the current transmission gear?

---

b. Is the vehicle moving? Which data parameters are used to determine this?

---

c. Are the brakes applied? What is the level of brake application?

---

d. According to the solenoid application chart, when is the park solenoid energized?

---

2. In the flight recording, what are the names of the solenoids associated with control of the park pawl?

---

a. Describe the operation of the park sensors.

---

b. Is the vehicle speed negative in reverse?

---

c. Is the transmission output speed negative in reverse?

---

d. What is the Pressure Control Solenoid current in park?

---

e. What is the Pressure Control Solenoid current in reverse?

---

f. Based on this information, is the line pressure higher in park or reverse? Why?

---

---



3. Use flight recording (B\_2014 DS Upshifts) to answer the following questions.

a. According to the Clutch Application Chart, in what gears is the A clutch applied?

---

b. Graph and compare the Shift Solenoid A Current to the Current Gear. Is the A clutch applied through the entire 2nd gear?

---

c. Add the Target Gear graph. At what point does the TCM begin de-energizing the A solenoid and why?

---

d. Which other clutches change state during the 2-3 shift, according to the Clutch Application Chart?

---

e. Add the Shift Solenoid C Current graph. During the 2-3 shift, which solenoid change of state results in 3rd gear becoming the current gear?

---

## Perform DTC/Symptom-Based Diagnostics

4. Answer the following questions using the data at approximately 58 seconds in the flight recording.

a. In what gear is the transmission, according to the Current Gear?

---

b. Use the shift solenoids to determine the actual gear. Based on the shift solenoids, what is the actual gear?

---

5. Graph the Pressure Control Solenoid current, Target Gear, and Current Gear to answer the following questions.

a. Just before the TCM changes the Target Gear during the 4-5 shift, what happens to the Pressure Control Solenoid current and why?

---

b. Just after the transmission achieves 5th gear, what happens to the Pressure Control Solenoid current and why?

---

c. Does this action occur with all of the upshifts?

---

d. When is the TCC first applied?

---



6. Use the flight recording (C\_2014 DS Downshifts) to answer the following questions.
- a. During this flight recording, what is the maximum and minimum accelerator angle?  

---
  - b. What is causing the increases (spikes) in engine speed, especially in the first 10 seconds of the flight recording?  

---
  - c. When is the brake applied?  

---
  - d. In what gear does the TCM turn off the TCC?  

---
  - e. In general, is the line pressure high or low during this flight recording?  

---
  - f. When is the line pressure increased?  

---



7. Use flight recording D\_2014 DS Kickdown Shifts 1 at approximately 14 seconds to answer the following questions.
- a. What prompted the rapid down shift?  

---
  - b. Which gears (if any) were skipped during the downshift?  

---
  - c. What was the final downshift gear before the transmission started to upshift again?  

---
8. Observe the State of Kickdown Switch. When does the data parameter change to Kickdown?  

---

---

## Perform DTC/Symptom-Based Diagnostics

9. Compare the Throttle Position to the Pressure Control Solenoid Current and answer the following questions.

a. What is the pressure control solenoid current when the throttle is closed?

---

b. What is the lowest current through the pressure control solenoid and what is the position of the throttle at that point?

---

c. Is the graph pattern of the pressure control solenoid current roughly proportional or inversely proportional to the trace of the throttle position?

---

d. Why is the pressure control solenoid amperage decreased when the load is higher?

---

---

e. During the last wide open throttle downshift, does the transmission skip any gears?

---

---

---



10. Use the flight recording (E\_2014 DS Kickdown Shifts 2) to answer the following question.

a. During the second kickdown, what downshift is performed and which gears are skipped?

---

---



11. Answer the following questions using the data at approximately 12 seconds in the flight recording (F\_2014 DS TCC 1).

a. In what gear is the transmission? Is the TCC solenoid on?

---

b. What is the difference between the engine speed and turbine speed?

---

c. Why is the turbine speed 0 rpm?

---

12. Answer the following questions using the data at approximately 20 seconds in the flight recording.

a. In what gear is the transmission? Is the TCC solenoid on?

---

b. What is the difference between the engine speed and turbine speed?

---

c. Is the vehicle moving?

---

d. Why is there a speed difference between engine and turbine speed?

---

---

13. Answer the following questions using the data at approximately 30 seconds in the flight recording.

a. What gear is the transmission in and is the TCC solenoid on?

---

b. What is the difference between the engine speed and turbine speed?

---

c. Why are the speeds so close?

---

## Perform DTC/Symptom-Based Diagnostics

14. Answer the following questions using the data from approximately 41 to 48 seconds in the flight recording.

a. What is the speed difference between the engine speed and turbine speed at 41 seconds?

---

b. What is the speed difference between the engine speed and turbine speed at 48 seconds?

---

c. Why is the speed difference getting smaller?

---

15. Answer the following questions using the data at approximately 55 seconds in the flight recording.

a. What is the difference between the engine speed and turbine speed?

---

b. Why are they so close?

---



16. Use the flight recording (G\_2014 DS TCC 2) to answer the following questions.

a. What gears are shown in this flight recording?

---

b. When is the TCC solenoid on in this flight recording?

---

c. How is it possible for the TCC to be in 1st gear without stalling the engine?

---

d. Compare the engine speed to the turbine speed. In general, do the two graphs match?

---

e. Compare the Accelerator Pedal Position to the Torque Converter Clutch Current. How do they compare and why?

---

---





## Perform DTC/Symptom-Based Diagnostics

### TASK THREE: FLIGHT RECORDING ANALYSIS (CONTINUED)

Instructions: Use the provided Flight Recording to diagnose the fault.

Customer concern:

- A vehicle has been towed into the dealer. The following are the results of the initial inspections:
  - P1D90-00 Incorrect Gear Ratio—Clutch 2 Defective
  - P1D96-00 Incorrect Gear Ratio—Clutch A or B Defective
  - Transmission does not shift in drive
  - Vehicle does not move in reverse
  - MIL on
  - R on the IPC is flashing
  - LED over R on the shifter is flashing

1. Answer the following questions using the data from approximately -20 to -17 seconds in the flight recording (H\_2014 DS Initial Flight Recording).

a. What is occurring to the vehicle speed during this time frame?

---

b. What is occurring with the transmission gears during this time frame?

---

c. Is this normal?

---

d. What does this information indicate about the transmission?

---

2. Answer the following questions using the data at approximately -15 seconds in the flight recording.

a. What gear is the TCM commanding?

---

b. Do the shift solenoid currents match this gear?

---

c. At 0.042 second, the line pressure is increased as all the solenoids are turned off. Why would the TCM increase the line pressure?

---

---

d. Is the TCC applied at any point during this flight recording? Is this normal?

---

---

e. Does this flight recording information match the information from the initial inspections?

---

---

---

---

## Perform DTC/Symptom-Based Diagnostics

- f. At this point, do you have enough information to determine the root cause?

---

---

---

---



3. Use the data in the flight recording (I\_2014 DS Flight Recording after DTC Clear) to answer the following questions.
- a. The initial inspections indicated that the transmission would not operate in the reverse. Does this flight recording provide this information? How did you determine it?

---

---

---

---

- b. Prior to 15 seconds, does the TCM have control of the shift solenoids? How can you determine this?

---

---

---

---

- c. Compare the turbine speed to the vehicle speed while the transmission is commanded to 1st through 3rd gear. Does anything appear strange in the data?

---

---

---

---

4. Based on the Clutch Application Chart and the current analysis, which clutch is at fault?

---

---

5. Is the root cause of this fault electrical?

---

6. If this transmission was going to be overhauled, what types of faults would you look for?

---

---

---

7. Based on the data, is the Current Gear parameter showing the actual detected gear ratio? Why or why not?

---

---

---

---

8. List any missing data parameters that would have been helpful during the review of flight recordings for this scenario.

---

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## LESSON 3 8-SPEED HYDRO-MECHANICAL SYSTEMS OPERATION

### INTERNAL COMPONENTS AND SUB-ASSEMBLIES

#### Torque Converter

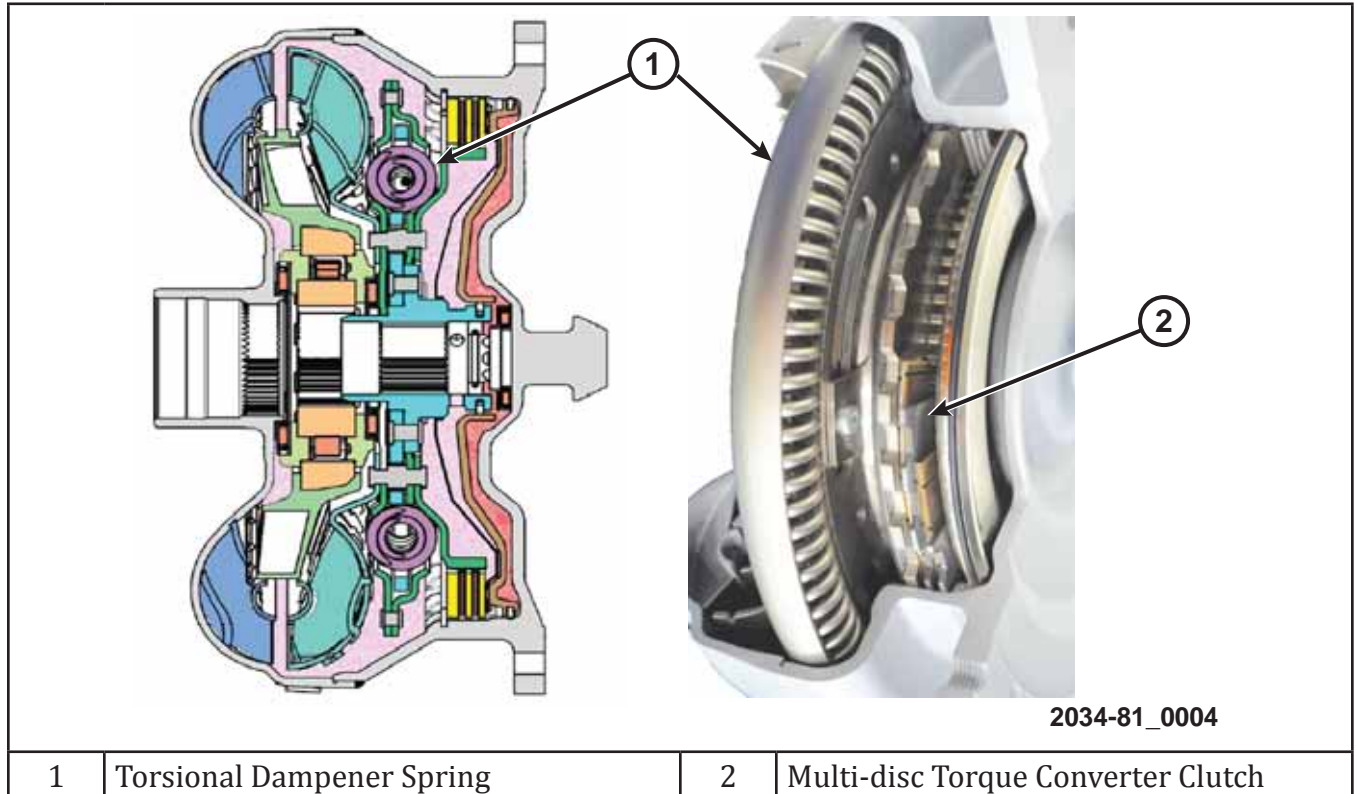


Figure 14 Torque Converter

The 8-speed automatic transmission has a unique housing shape to incorporate the multi-disc torque converter clutch (TCC).

A multi-disc torque converter clutch system improves durability and the holding pressure in the lock-up circuit.

The TCC is allowed to engage in any of the eight forward gears.

A turbine dampening system suppresses torsional vibrations from the engine to ensure optimal shift quality and reduce noise, vibration, and harshness (NVH) concerns.

## Valve Body Alignment Pins

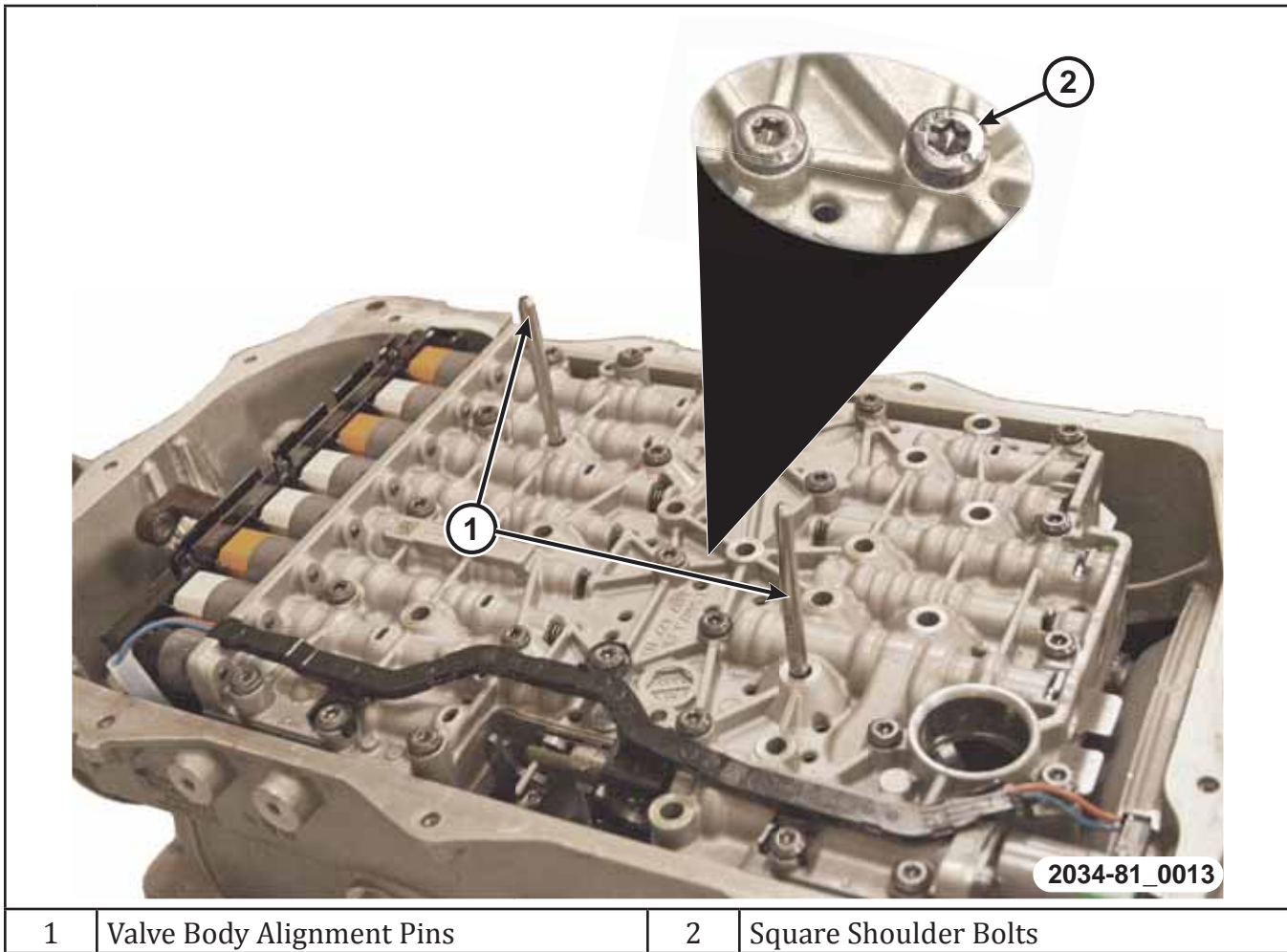


Figure 15 Valve Body Alignment Pins

The valve body alignment pins guide and align the valve body assembly during installation. These alignment pins are especially useful when installing the valve body assembly while the transmission is still in the vehicle. When the alignment pins are in place, the valve body assembly slides over the pins and aligns to the bolt holes. The alignment pins allow one hand to hold the valve body in place while starting the mounting bolts with the other hand.

Only the square shoulder bolts need to be taken out to remove the valve body.

## Electrical Harness Insulator

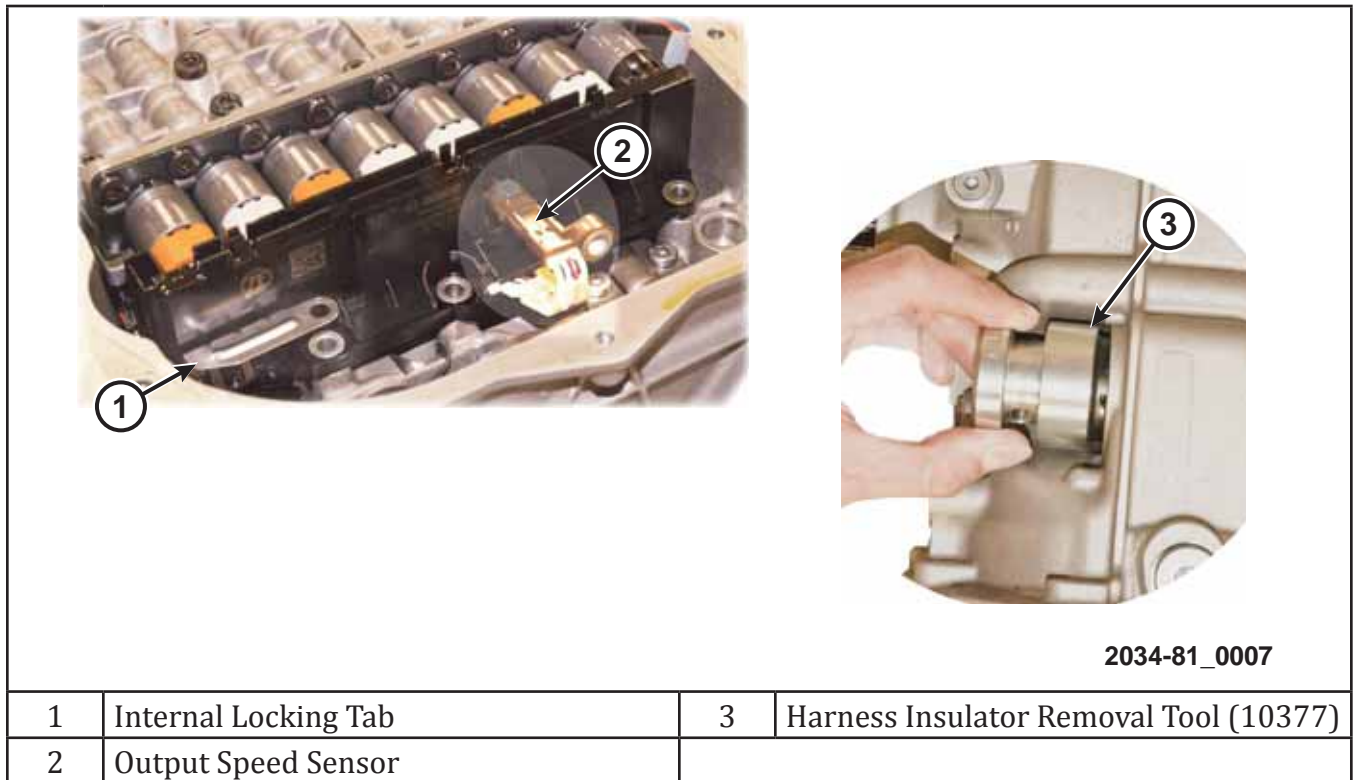


Figure 16 Electrical Harness Insulator

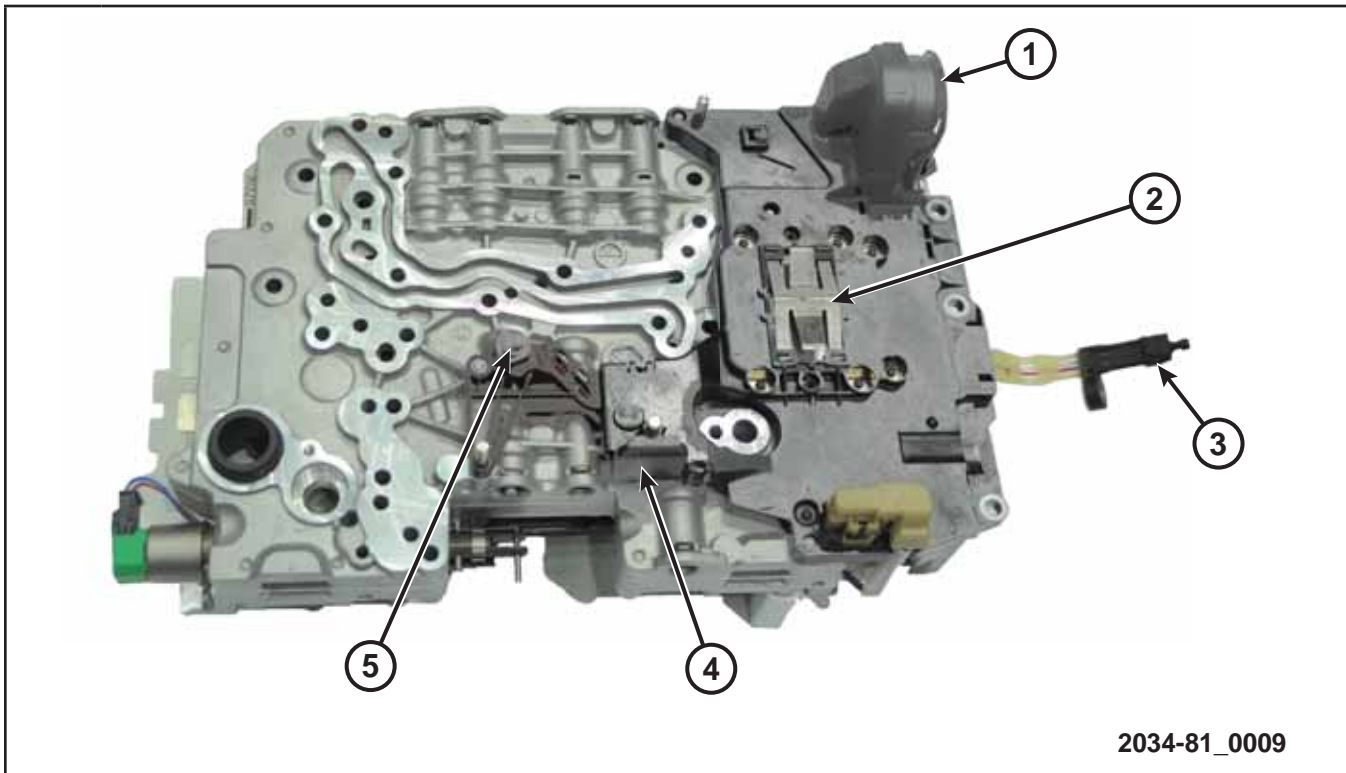
The electrical harness insulator must be removed from the outside of the case before removing the valve body. A special tool has been developed to pull the insulator out after the internal locking tab has been released. This tool works well with the in-vehicle valve body removal procedure.

To help protect the output speed sensor during valve body removal, the sensor is pulled out and folded back so that the tip of the sensor slides into a slot in the center of the molded plastic solenoid frame.



## 8-Speed Hydro-Mechanical Systems Operation

### TCMA Sensors



1	TCMA Harness Connector	4	Park Position Sensor
2	TCM Heat Sink Spring	5	Input Speed Sensor
3	Output Speed Sensor		

Figure 17 TCMA Sensors

The TCMA includes four transmission sensors that are hard-wired to the TCM. The input and output speed sensors are Hall-effect sensors. The transmission oil temperature sensor is a thermistor. The park position sensor is a three-wire, digital sensor that reports the position of the park lock mechanism.

The TCM uses a heat sink to dissipate heat from the TCM to the transmission case. The heat sink acts like a spring and causes the valve body to pop up when installing.

**CAUTION:** The TCM can be damaged by electrostatic discharge (ESD). Always take precautions to avoid ESD when handling a valve body assembly. A wrist band grounding device is the most reliable method of diverting electrostatic discharge.

## Oil Pump Cover

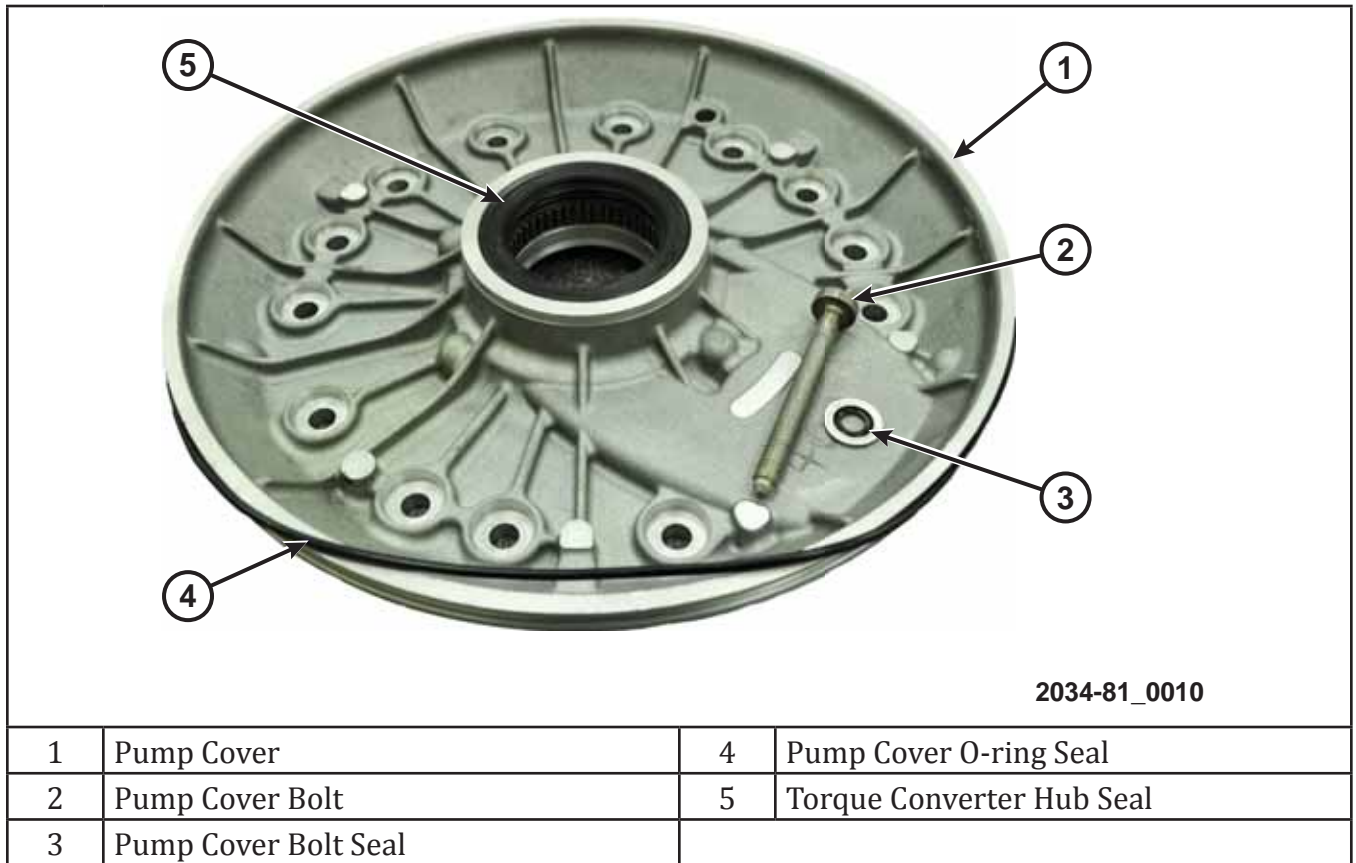


Figure 18 Oil Pump Cover

There are several leak points at the front of the transmission in the converter bellhousing area. Because components in this area are concealed and not visible without transmission removal, it can be difficult to diagnose the leaks that appear at the bottom of the bellhousing. Leaks in this area require transmission and torque converter removal. The converter hub seal, the oil pump cover O-ring, and the bolts are possible leak points at the front of the transmission.

**NOTE:** The oil pump cover bolts are made of lightweight aluminum alloy. These bolts **MUST** be replaced each time they are removed.

## 8-Speed Hydro-Mechanical Systems Operation

### Oil Pump Housing Assembly

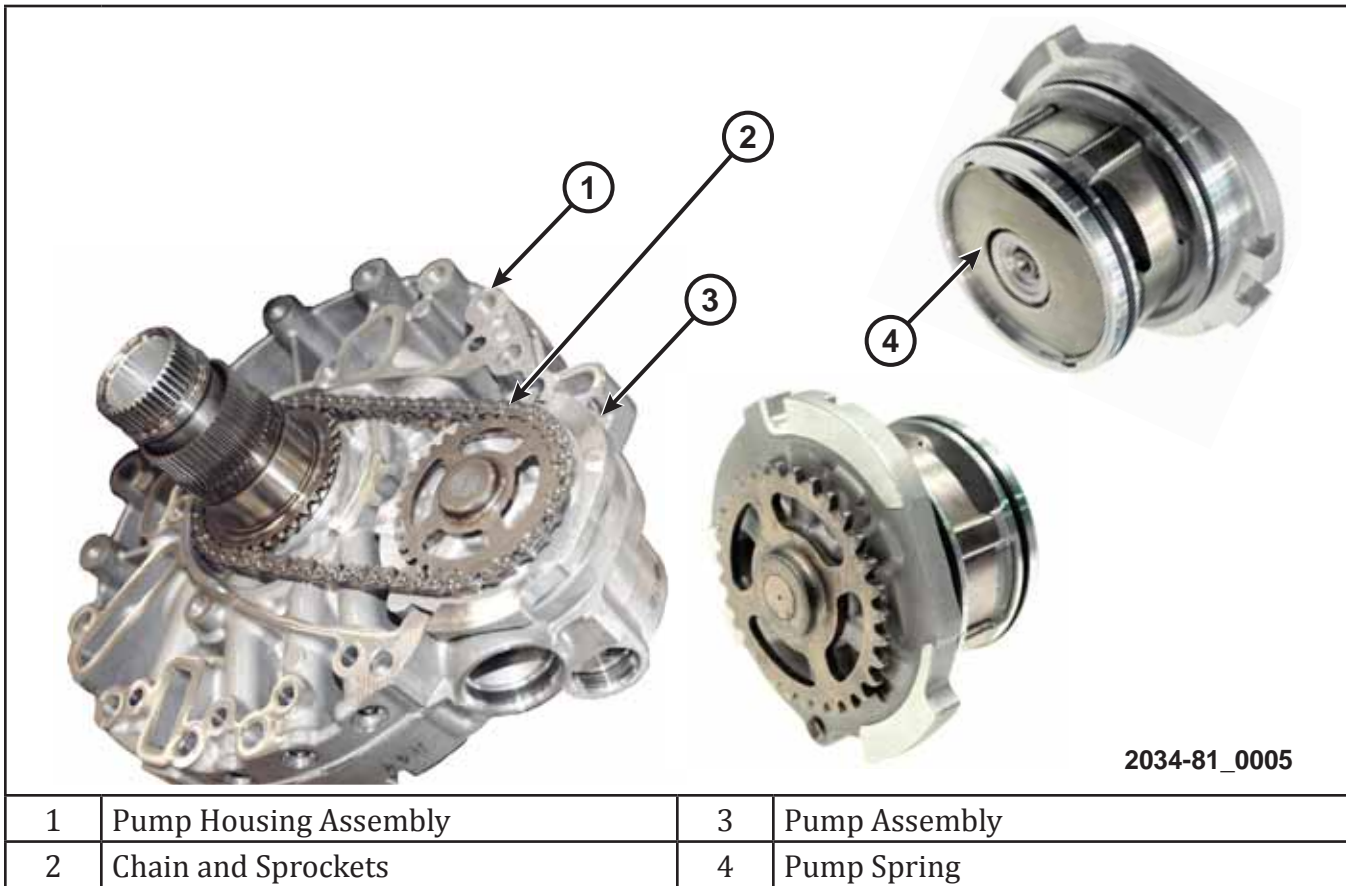
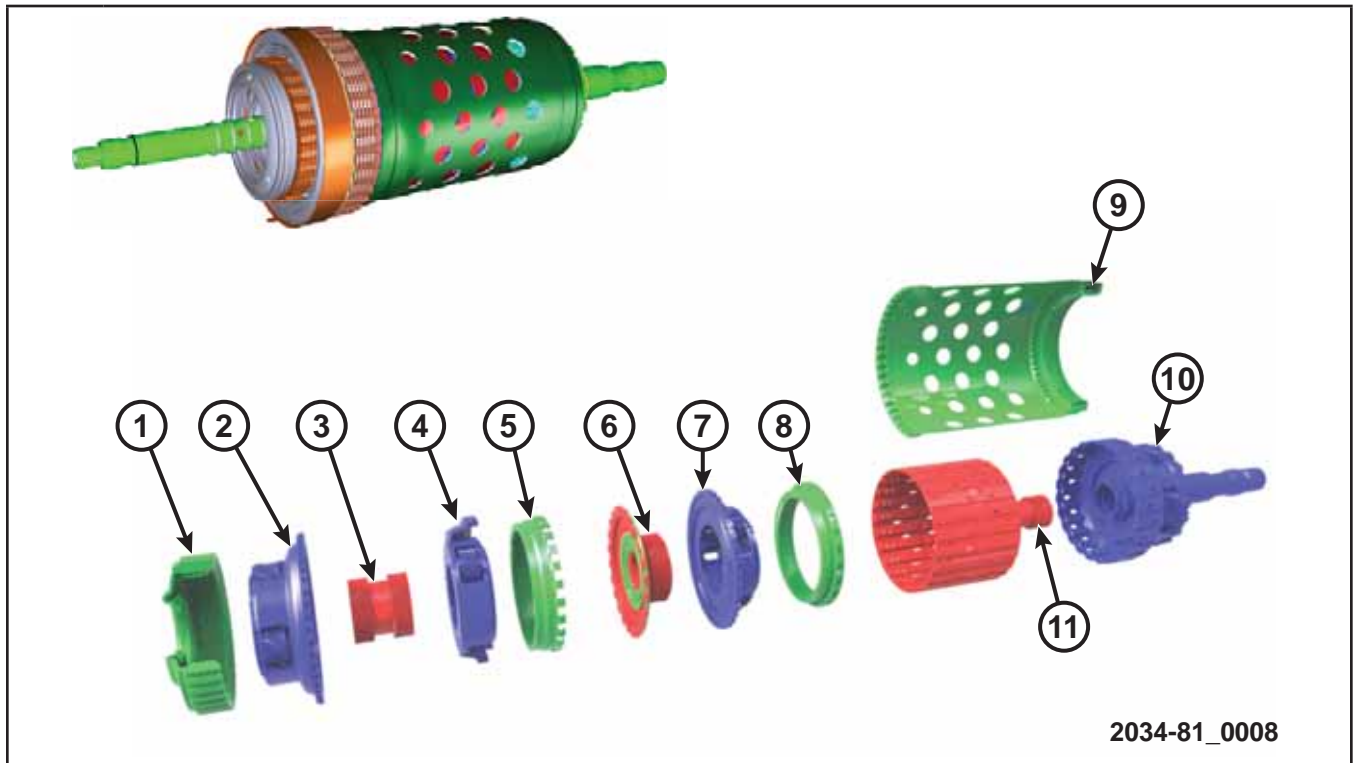


Figure 19 Pump Housing Assembly

The oil pump is located just behind the torque converter, between the pump housing and cover assemblies. The torque converter drives the pump assembly using a chain and sprockets. The oil pump is a double-stroke vane pump. The pump has two inlet ports, two pumping chambers, and two outlet ports, allowing it to produce the fluid volume necessary for all operating conditions.

## Geartrain Components



2034-81\_0008

1	P1 Annulus Gear	7	P3 Planet Carrier
2	P1 Planet Carrier	8	P3 Annulus Gear
3	P1/P2 Sun Gear	9	P4 Annulus Gear
4	P2 Planet Carrier	10	P4 Planet Carrier
5	P2 Annulus Gear	11	P4 Sun Gear
6	P3 Sun Gear		

Figure 20 Geartrain Components

The transmission uses four planetary gear sets. The P1 and P2 planetary sets share a common sun gear. This is typically classified as a Simpson gear set. The P3 planetary is a simple planetary gear set and is the third planetary in line. The P4 is another simple planetary gear set and the carrier is part of the output shaft. The P4 carrier is always the final output member in all ranges.

## P4 Annulus Drum Snap Ring

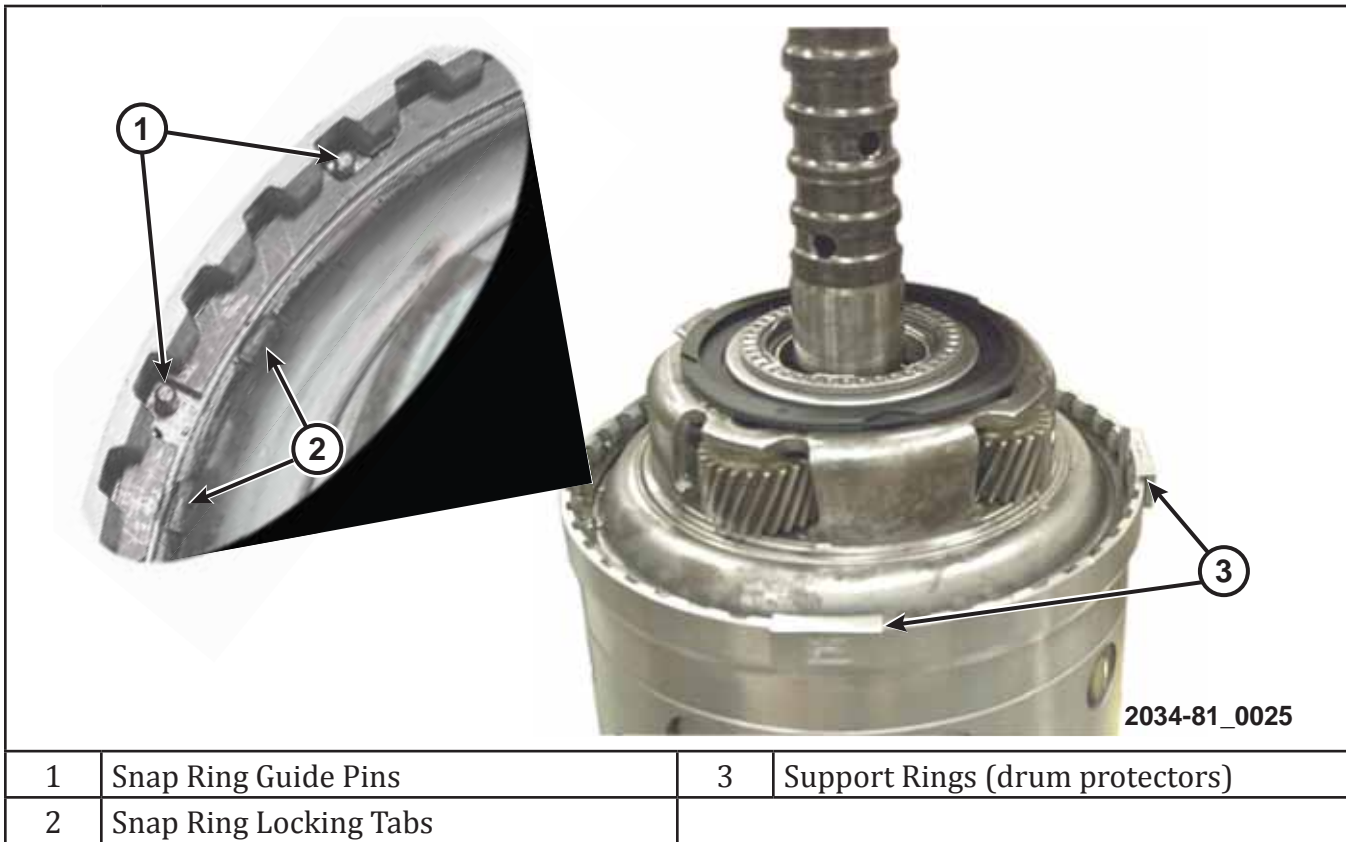


Figure 21 P4 Annulus Drum and Snap Rings

Removing the snap rings within the geartrain assembly requires the use of special support ring tools. Because the aluminum drums rotate at extremely high speeds in the upper gear ranges, the drums are precisely balanced to eliminate vibration. When removing the snap rings, the support rings protect the edge of the drums and snap ring grooves from nicks that remove material from the drum.

**NOTE:** The snap rings must be replaced whenever they are removed.

**CAUTION:** The aluminum drums must be handled with care. Do not drop or dent the drums during service. Always inspect the drum carefully for excessive loss of metal around the snap ring retainer groove and for deformation.



## Clutches

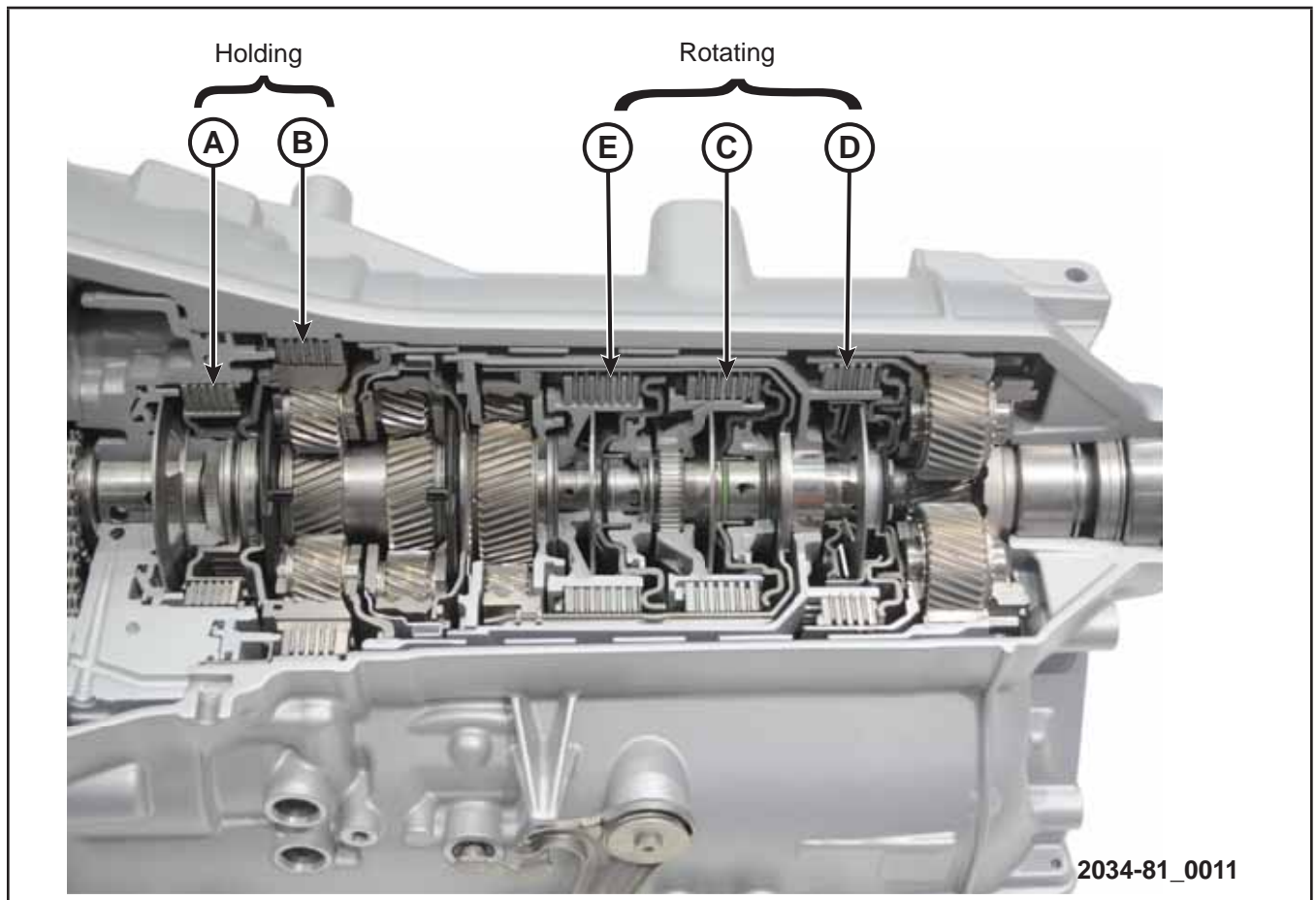


Figure 22 Clutches

This transmission uses five multi-disc clutch packs to control the power flow through the four planetary gear sets. Combinations of any three clutches are applied in each gear range.

- The A and B clutches are holding clutches.
- The B clutch has two hydraulic chambers, one on each side of the apply piston; clutch release is controlled by hydraulic pressure and not a return spring.
- The E, C, and D clutches are driving or rotating clutches.

## 8-Speed Hydro-Mechanical Systems Operation

### Geartrain Endplay Measurement

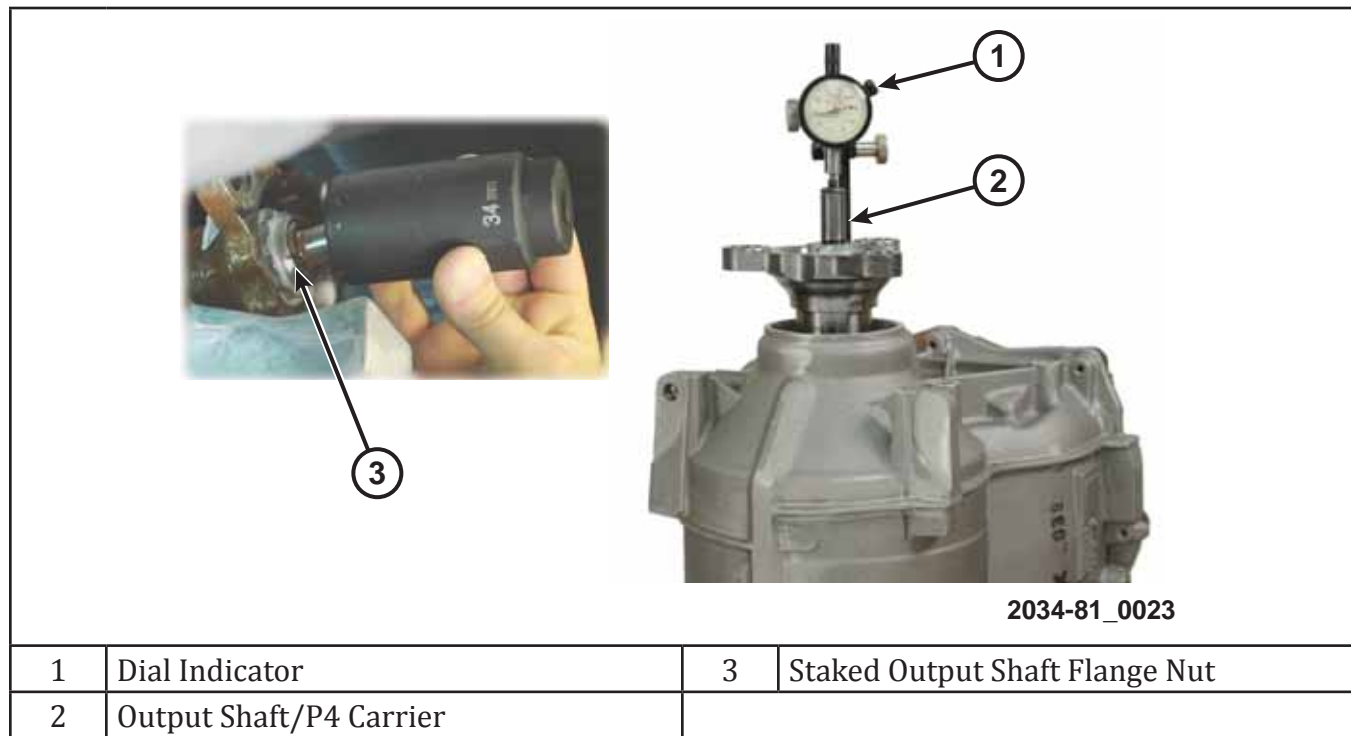
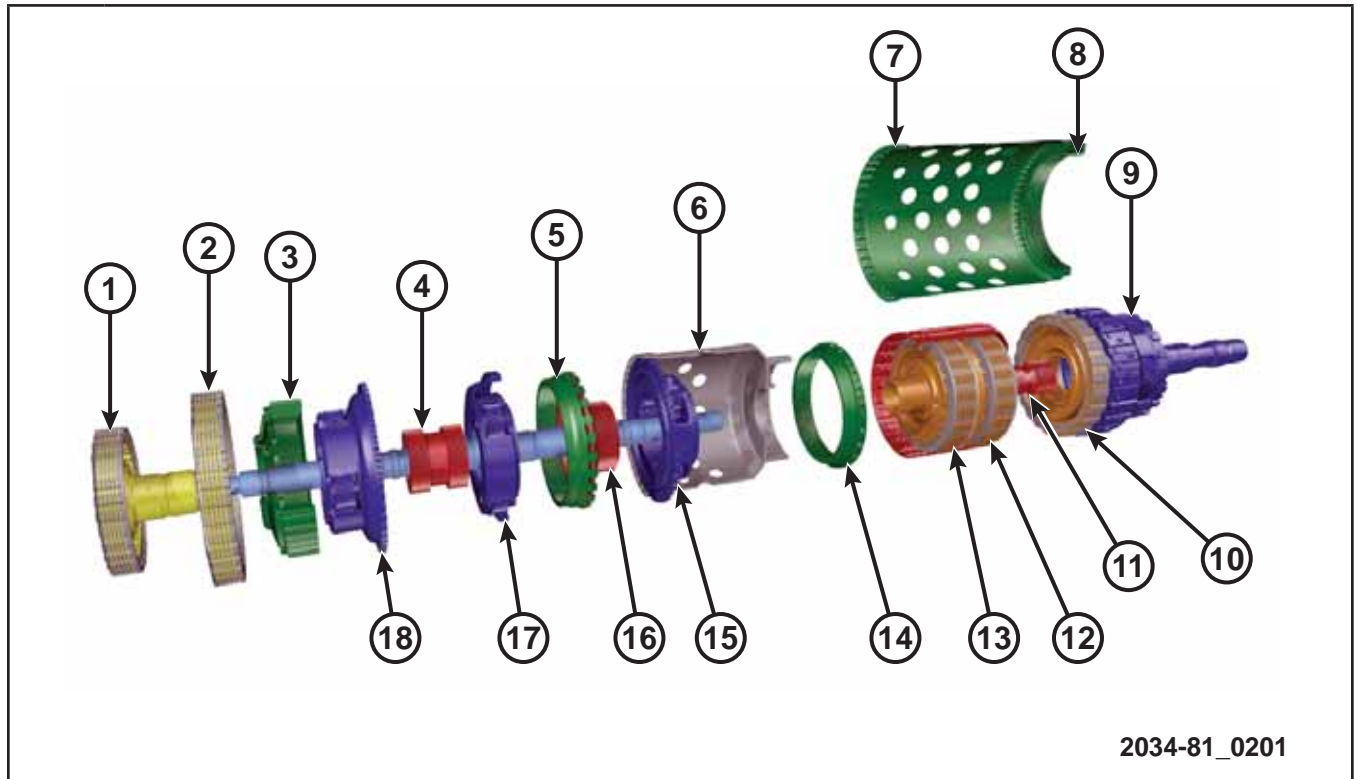


Figure 23 Geartrain Endplay Measurement

**NOTE:** The output shaft flange nut used on RWD models requires a 34-mm 12-point socket.

## POWER FLOW

### Power Flow Components



2034-81\_0201

1	A Clutch	10	D Clutch
2	B Clutch	11	P4 Sun Gear
3	P1 Annulus Gear	12	C Clutch
4	P1/P2 Sun Gear	13	E Clutch
5	P2 Annulus Gear	14	P3 Annulus Gear
6	D Clutch Drum	15	P3 Carrier
7	P4 Annulus Drum	16	P3 Sun Gear
8	P4 Annulus Gear	17	P2 Carrier
9	P4 Carrier	18	P1 Carrier

Figure 24 Power Flow Components

The 8HP45 transmission achieves eight forward gear ranges and reverse by using four planetary gear sets and five multi-disc clutches. The gear sets are identified as P1, P2, P3, and P4. Clutches are identified as clutch A, B, E, C, and D (from the front of the transmission to the rear). The P1/P2 sun gear is a one-piece gear with teeth on each end.



# 8-Speed Hydro-Mechanical Systems Operation

## Clutch and Solenoid Charts

Table 4 Clutch Application Chart

Gear	Brake		Clutch			Ratio
	A	B	C	D	E	
1st	X	X	X			4.69:1
1st (NIC)	X	CS	X			NIC
2nd	X	X			X	3.13:1
3rd		X	X		X	2.10:1
4th		X		X	X	1.67:1
5th		X	X	X		1.29:1
6th*			X	X	X	1.00:1
7th	X		X	X		0.84:1
8th	X			X	X	0.67:1
Reverse	X	X		X		3.30:1
Park	X	X				

X = Applied

\* = 6th gear is limp-home gear

Table 5 Solenoid Application Chart

Gear	Solenoid							
	Park (NC)	A (NC)	B (NC)	C (NO)	D (NO)	E (NO)	TCC (NO)	LPS (NO)
P		X	X*	X	X	X		
N	X	X	X*	X	X	X		
R	X	X	X	X		X		+/-
1st	X	X	X		X	X	+/-	+/-
2nd	X	X	X	X	X		+/-	+/-
3rd	X		X		X		+/-	+/-
4th	X		X	X			+/-	+/-
5th	X		X			X	+/-	+/-
6th	X						+/-	+/-
7th	X	X				X	+/-	+/-
8th	X	X		X			+/-	+/-

X = Electrically Energized

X\* = Contact Point Pressure

+/- = Variable Pressure

## Holding Clutches

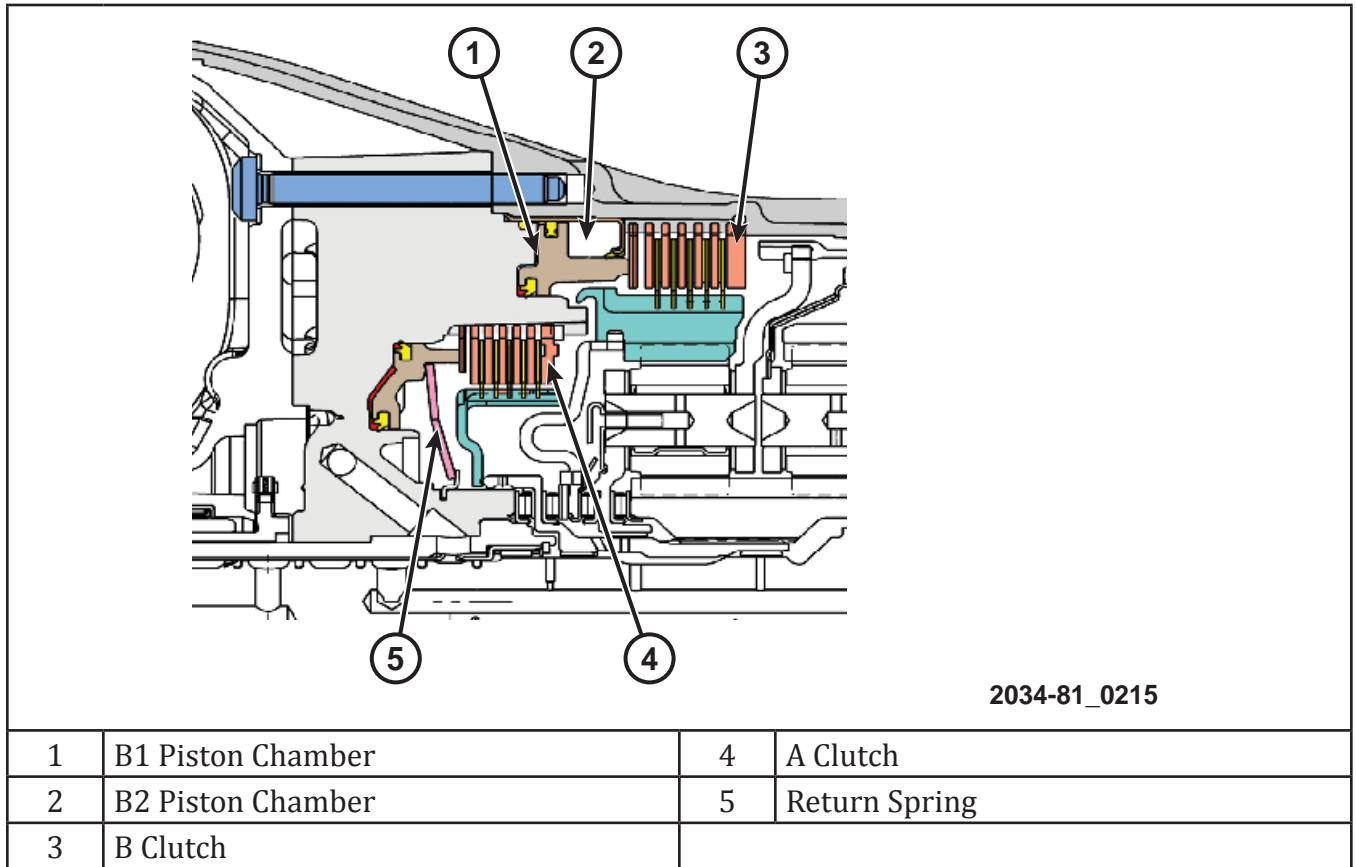


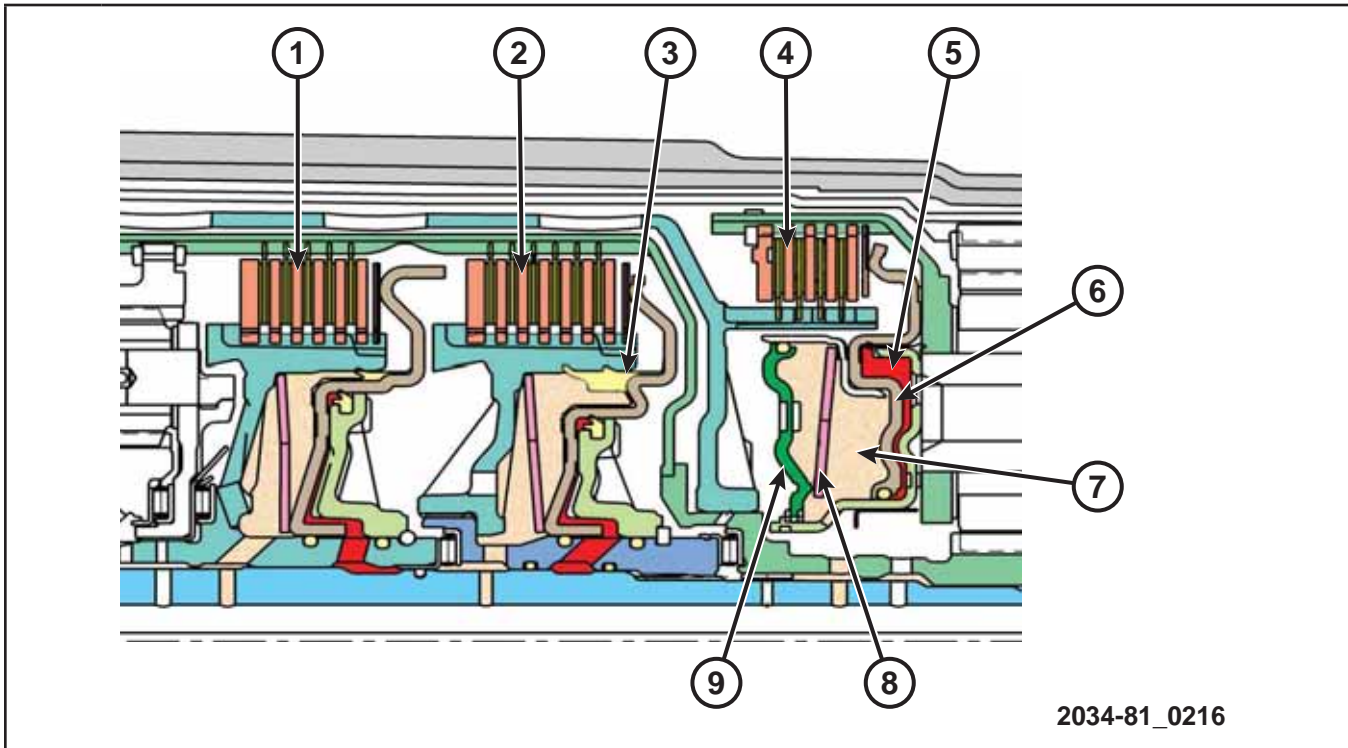
Figure 25 Holding Clutches

The 8HP45 transmission uses two multi-disc holding clutches (A and B). Every gear shift on the 8HP45 is a synchronous shift: one of the clutches must continue to transmit the torque at lower pressure until the other clutch is able to accept the input torque.

- The A clutch is splined to the P1/P2 sun gear.
- The B clutch is splined to the P1 annulus gear.

# 8-Speed Hydro-Mechanical Systems Operation

## Rotating Clutches



1	E Clutch	6	Piston
2	C Clutch	7	Balance Piston Chamber
3	Double Lip Seal	8	Cup Spring
4	D Clutch	9	Baffle Plate
5	D Clutch Pressure Chamber		

Figure 26 Rotating Clutches

Rotating clutches E, C, and D supply power from the engine to the planetary gear train. All clutches are engaged hydraulically. All rotating clutches use a balance piston to keep the clutch from dragging when released.

## 1st Gear

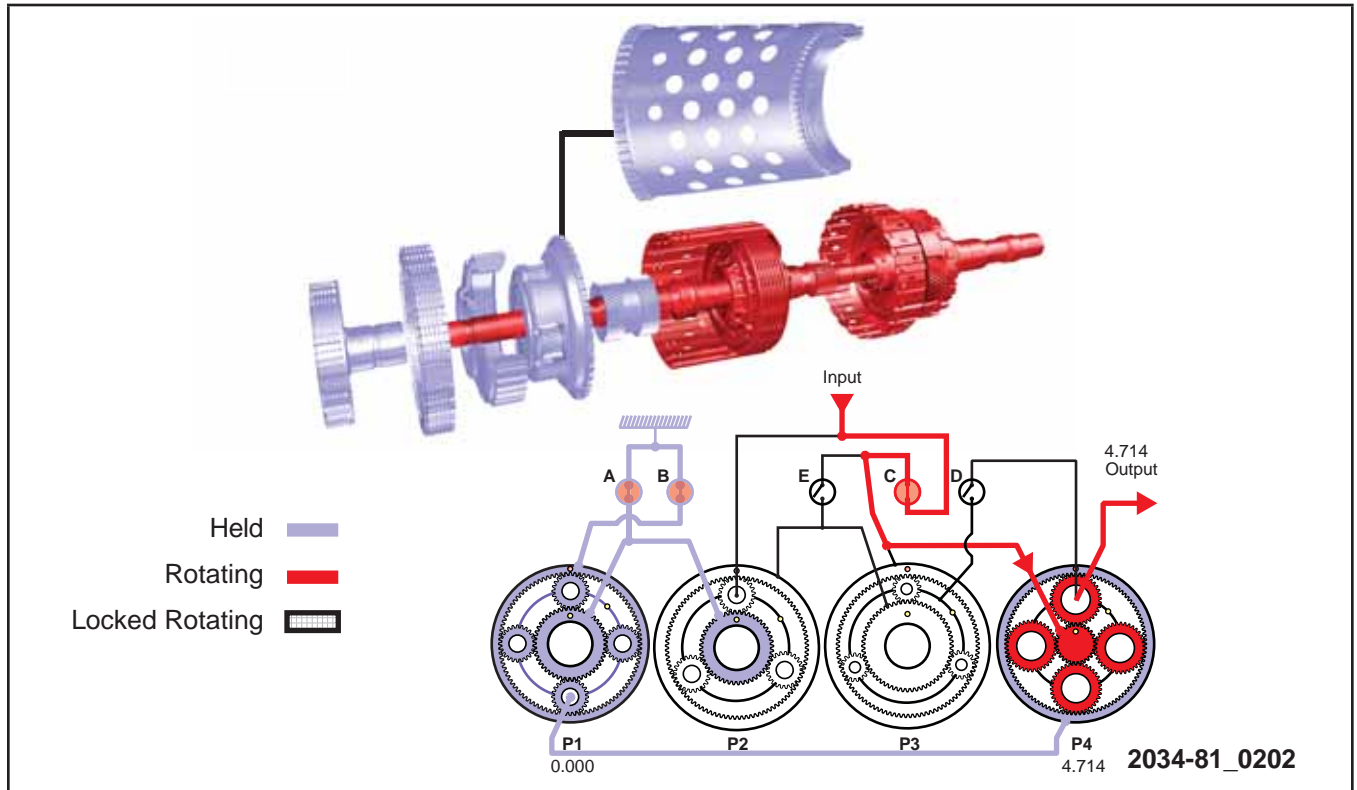


Figure 27 1st Gear

In 1st gear, the A clutch holds the P1/P2 sun gear and the B clutch holds the P1 annulus. Because two members of the same gear set are held, the entire P1 gear set is stationary. The stationary P1 carrier is connected to the P4 annulus and holds the annulus.

The input shaft drives the C clutch, and the C clutch drives the P4 sun gear. The P4 sun gear drives the P4 carrier, whose pinions walk around the held P4 annulus.

# 8-Speed Hydro-Mechanical Systems Operation

## 2nd Gear

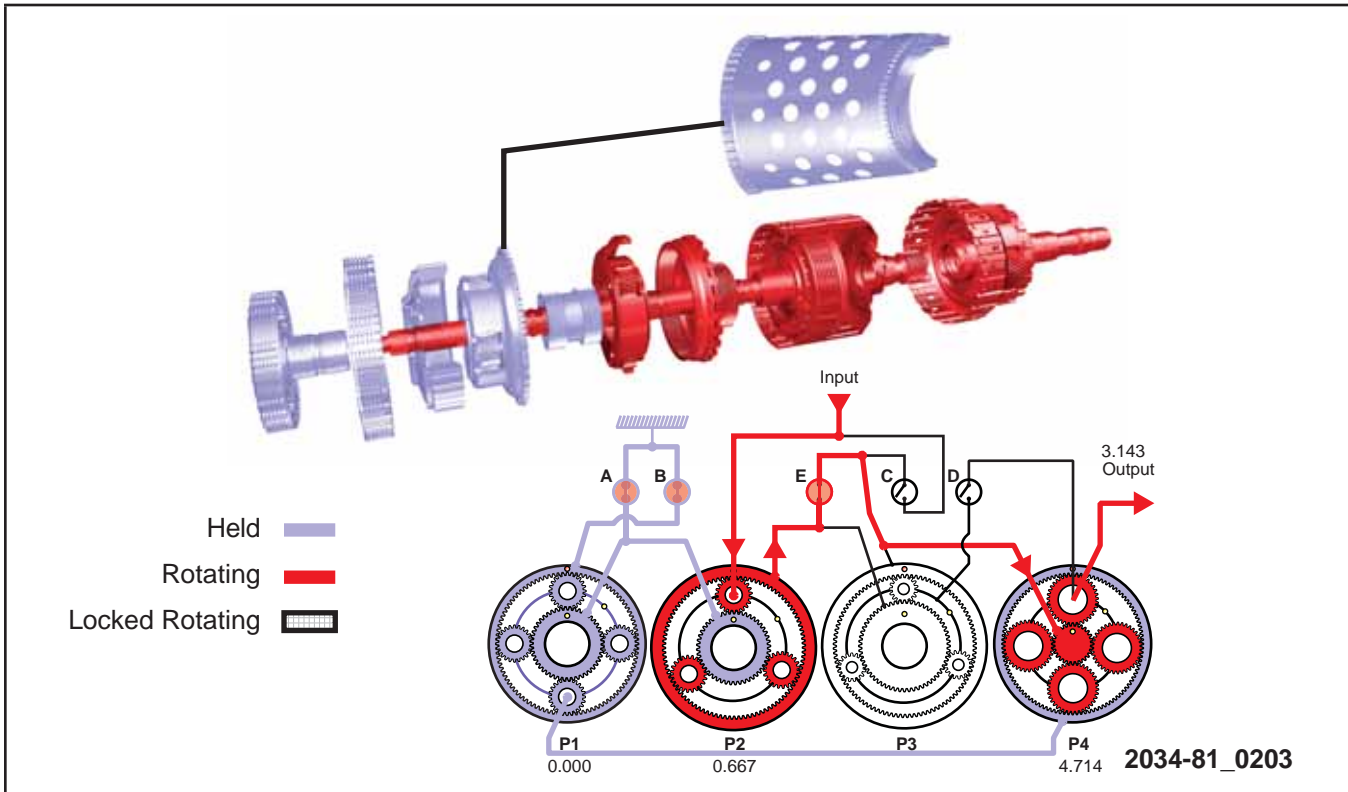


Figure 28 2nd Gear

In 2nd gear, the A clutch holds the P1/P2 sun gear and the B clutch holds the P1 annulus. As with 1st gear, the entire P1 gear set is stationary. The stationary P1 carrier is connected to the P4 annulus and holds the annulus.

The input shaft drives the P2 carrier. The P2 carrier drives the P2 annulus. The P2 annulus drives the E clutch through the P3 sun gear connection. The E clutch then drives the P4 sun gear. The P4 sun gear drives the P4 carrier, whose pinions walk around the held P4 annulus.

## 3rd Gear

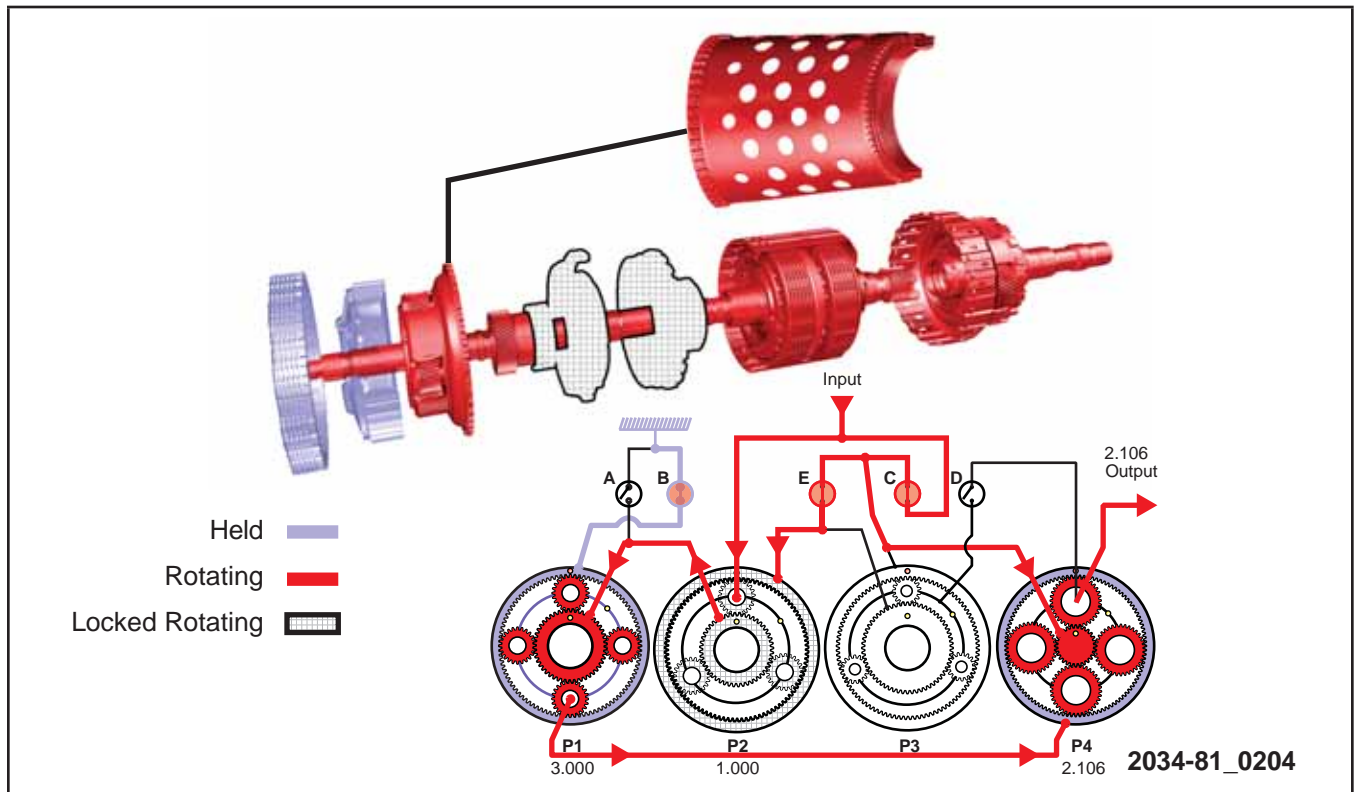


Figure 29 3rd Gear

In 3rd gear, the B clutch holds the P1 annulus.

The input shaft drives the C clutch, which drives the P4 annulus. The C clutch also drives the E clutch, which drives the P2 annulus. Because the P2 carrier and the P2 annulus are both driven at input shaft speed, the P2 gear set is locked at input shaft speed.

The P1/P2 sun gear drives the P1 carrier, and the P1 carrier drives the P4 annulus.

# 8-Speed Hydro-Mechanical Systems Operation

## 4th Gear

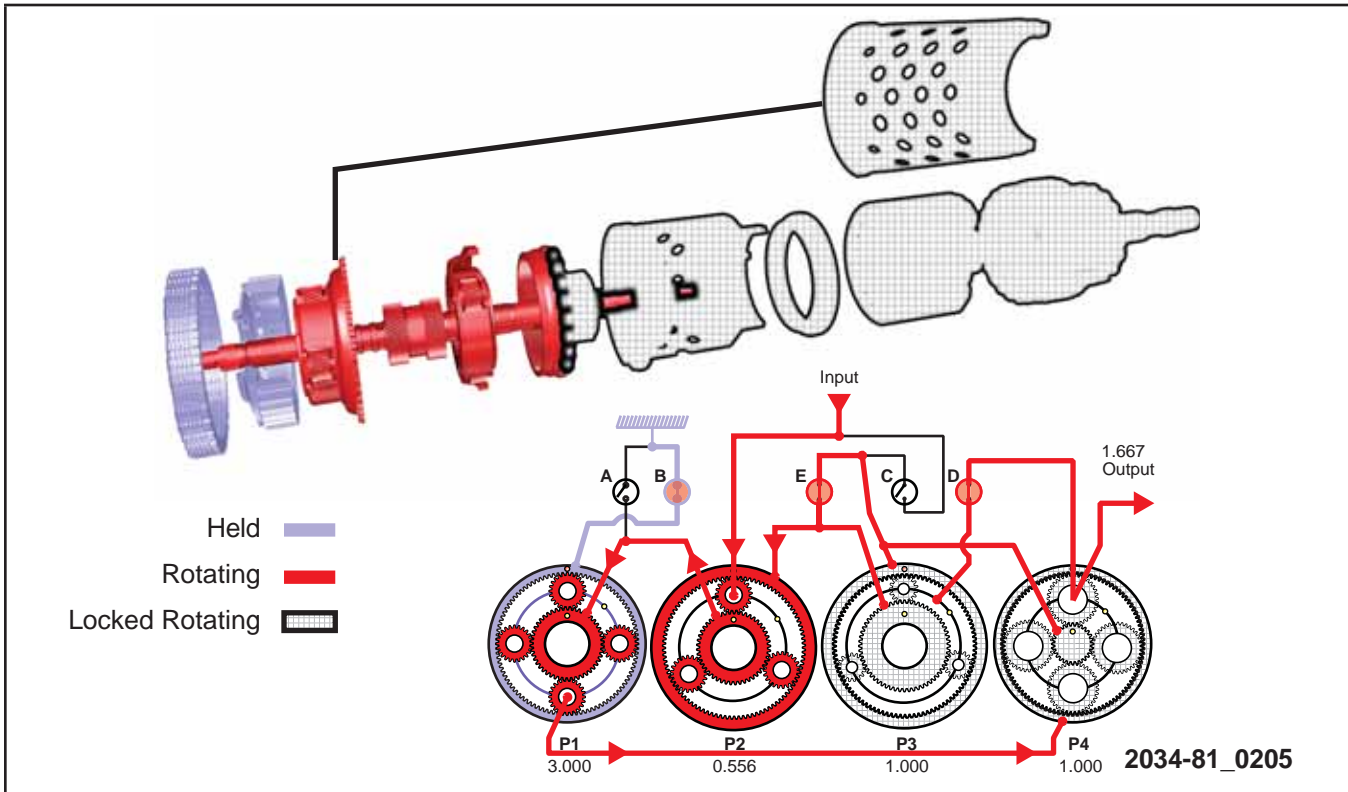


Figure 30 4th Gear

In 4th gear, the B clutch holds the P1 annulus. With the E and D clutches applied, all components of the P3 and P4 gear sets are locked together to rotate at the same speed.

The input shaft drives the P2 carrier, which drives the P1/P2 sun gear. The P1/P2 sun gear drives the P1 carrier. The P1 carrier drives the P4 gear set through the P4 annulus.



## 5th Gear

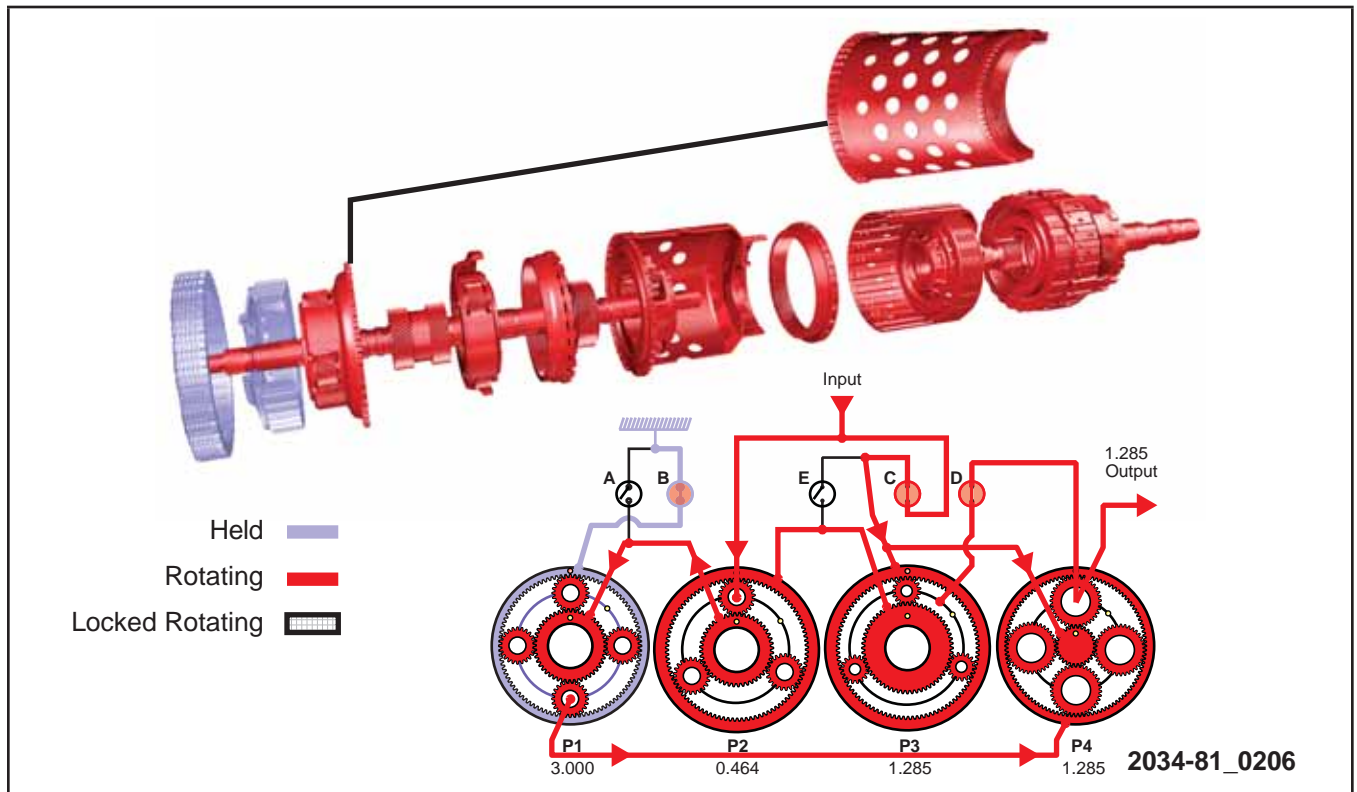


Figure 31 5th Gear

In 5th gear, the B clutch holds the P1 annulus. The input shaft always drives the P2 carrier. Because the C clutch is applied, the P3 annulus and P4 sun gear are also driven at input shaft speed. The D clutch is applied to connect the P3 carrier with the P4 carrier.

The P2 carrier drives the P1/P2 sun gear, which drives the P1 carrier. The P1 carrier walks around the held P1 annulus and drives the P4 annulus. Gear reduction is achieved between the P4 sun gear rotating at input shaft speed and the P4 annulus rotating at a reduced speed.



# 8-Speed Hydro-Mechanical Systems Operation

## 6th Gear

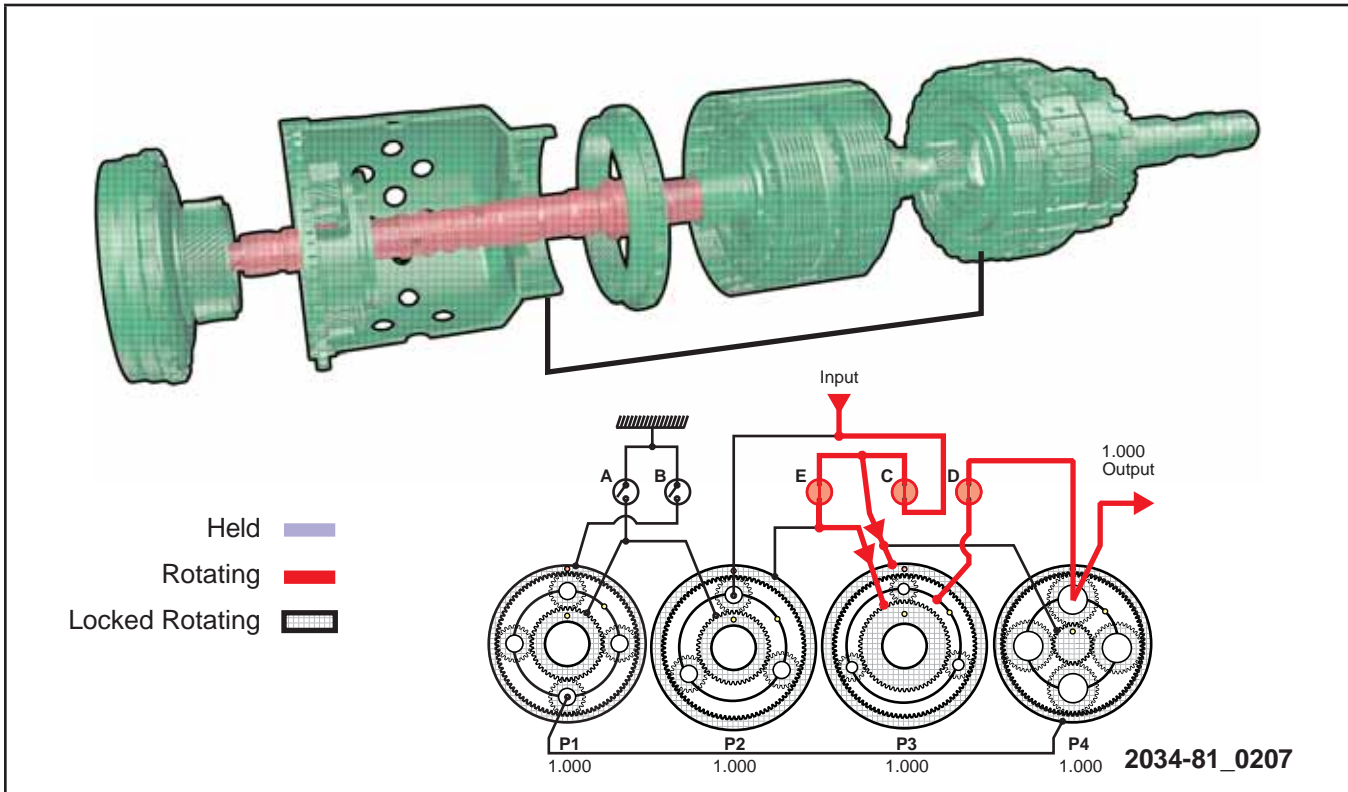


Figure 32 6th Gear

In 6th gear, the C clutch drives the P3 annulus at input shaft speed and the E clutch drives the P3 sun gear at input shaft speed. Because two components of the same gear set are driven at the same speed, the entire gear set is locked in rotation. The D clutch connects the P3 carrier to the P4 carrier and the output shaft.

## 7th Gear

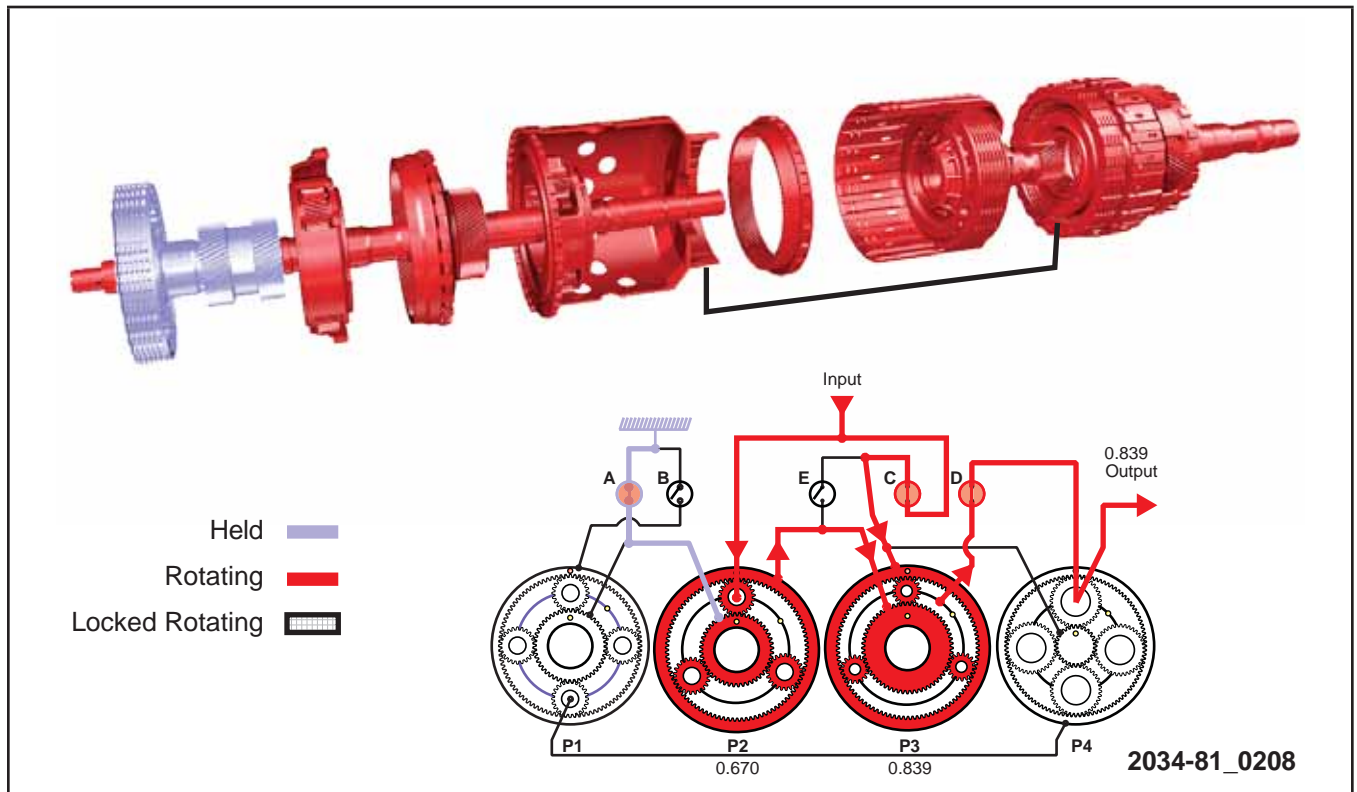


Figure 33 7th Gear

In 7th gear, the A clutch holds the P1/P2 sun gear stationary. The input shaft drives the P2 carrier, which drives the P2 annulus, increasing the speed of the P3 sun gear and creating overdrive.

The C clutch drives the P3 annulus at input shaft speed. The P3 sun gear spins at a faster speed than the P3 annulus, and the P3 carrier is the output of the gear set. This results in a reduction that offsets the overdrive of the P2 gear set.

The D clutch connects the P3 carrier to the P4 carrier and the output shaft.

# 8-Speed Hydro-Mechanical Systems Operation

## 8th Gear

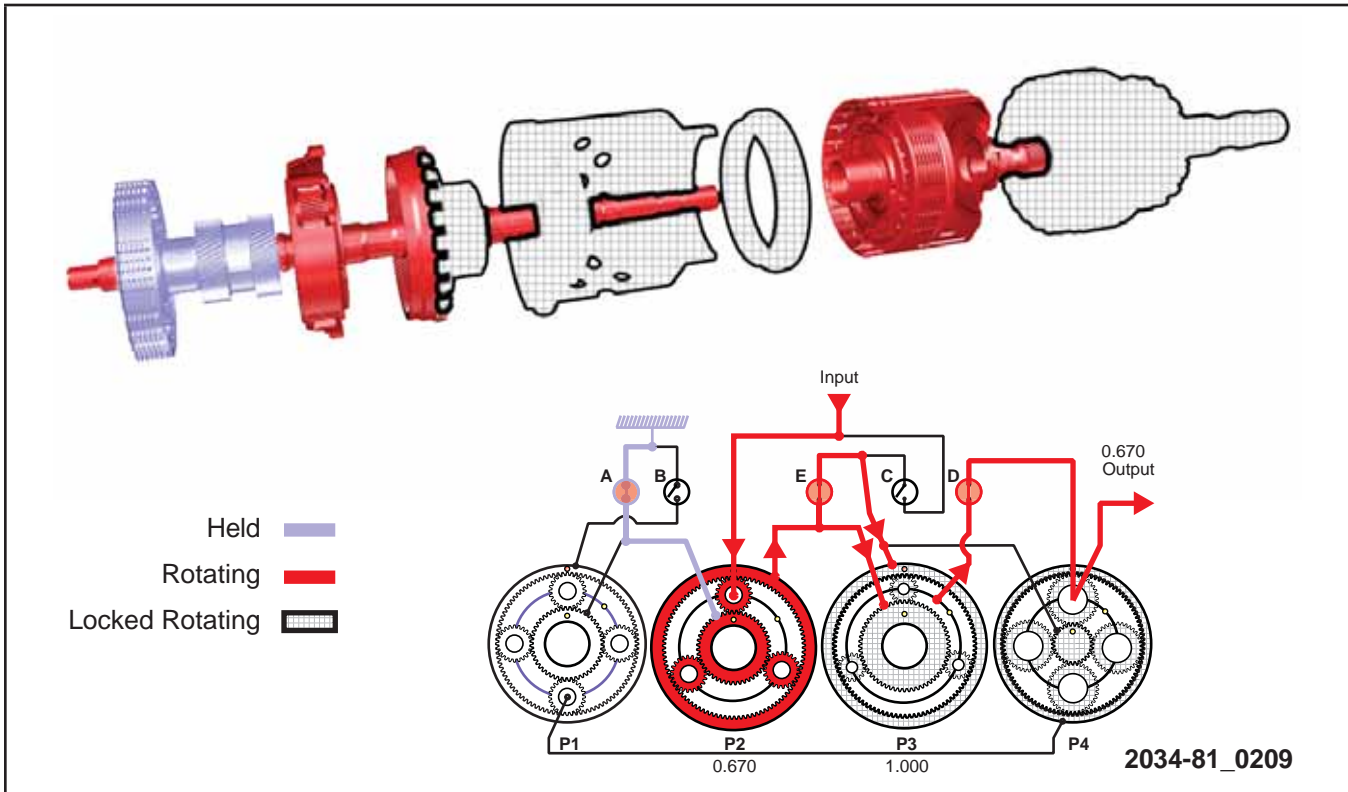


Figure 34 8th Gear

In 8th gear, the A clutch holds the P1/P2 sun gear stationary. As with 7th gear, the P2 gear set creates an overdrive ratio. However, the E clutch applies, which holds the P3 gear set together and eliminates any torque multiplication from the P3 gear set.

The overdrive created by P2 is transferred by the D clutch to the output shaft.

## Reverse Gear

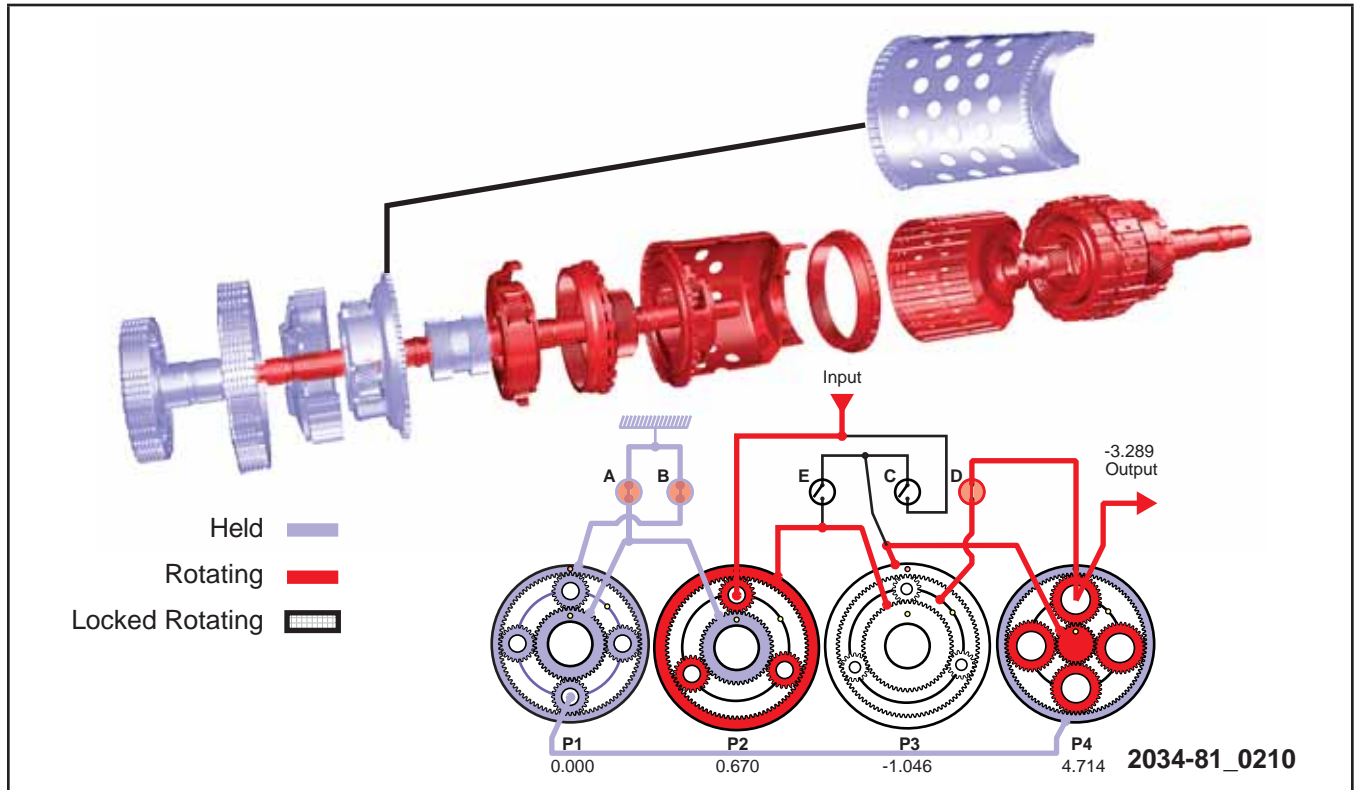


Figure 35 Reverse Gear

In reverse, the A and B clutches apply, holding the P1/P2 sun gear and the P1 annulus gear.







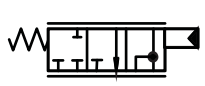
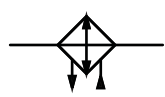


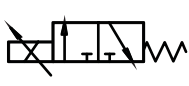

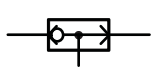





The input shaft drives the P2 carrier, which produces an overdrive ratio from the P2 gear set, driving the P3 sun gear in the same direction as the engine. The P3 carrier is connected to the output shaft by the D clutch. This holds the carrier, reversing the direction and multiplying torque. The P3 annulus is connected to the P4 sun gear, which drives the P4 gear set opposite of engine direction and multiplies torque again.

# 8-Speed Hydro-Mechanical Systems Operation

## HYDRAULIC OPERATION

### Hydraulic Schematic Legend

Table 6 Hydraulic Schematic Legend

	Pressure Regulating Valve		Pump
	Hydraulic Piston		Sump Filter
	Hydraulically-controlled Directional Control Valve (2 Positions/3 Channels)		In-line Filter
	Spring-loaded Hydraulically-controlled Valve (3 Positions/3 Channels)		Fluid Cooler
	Spring-loaded Directional Control Valve (2 Positions/5 Channels)		Torque Converter
	Electrical Solenoid Valve (2 Positions/3 Channels)		Pressure Retention Valve (Spring-loaded Check Ball)
	Rocker Ball Valve (Shuttle Valve)		Return to Sump
	Check-ball-controlled Orifice		Accumulator
	Orifice		One-way Orifice

## Hydraulic Schematic

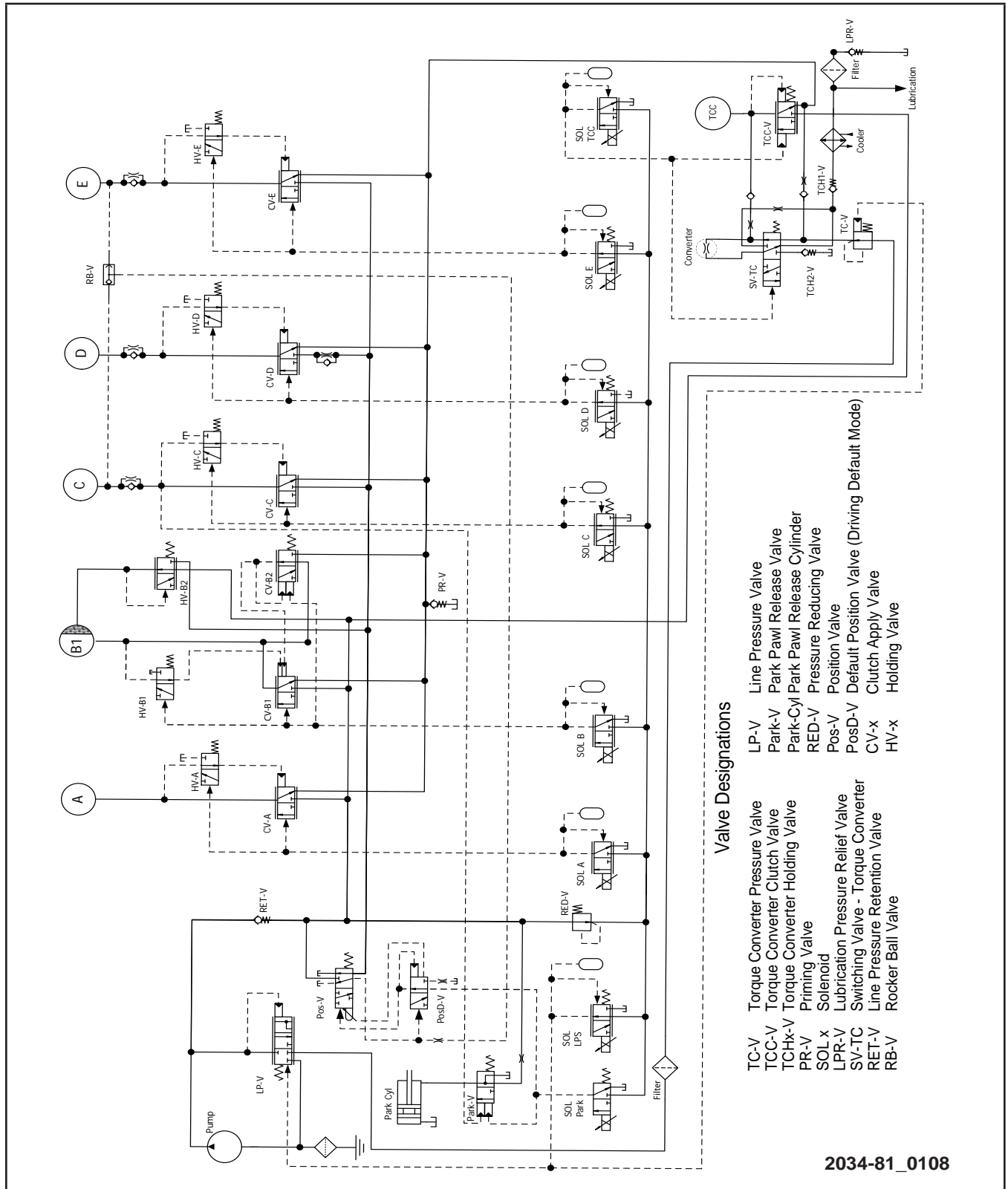


Figure 36 Hydraulic Schematic

# 8-Speed Hydro-Mechanical Systems Operation

## Oil Pump Operation

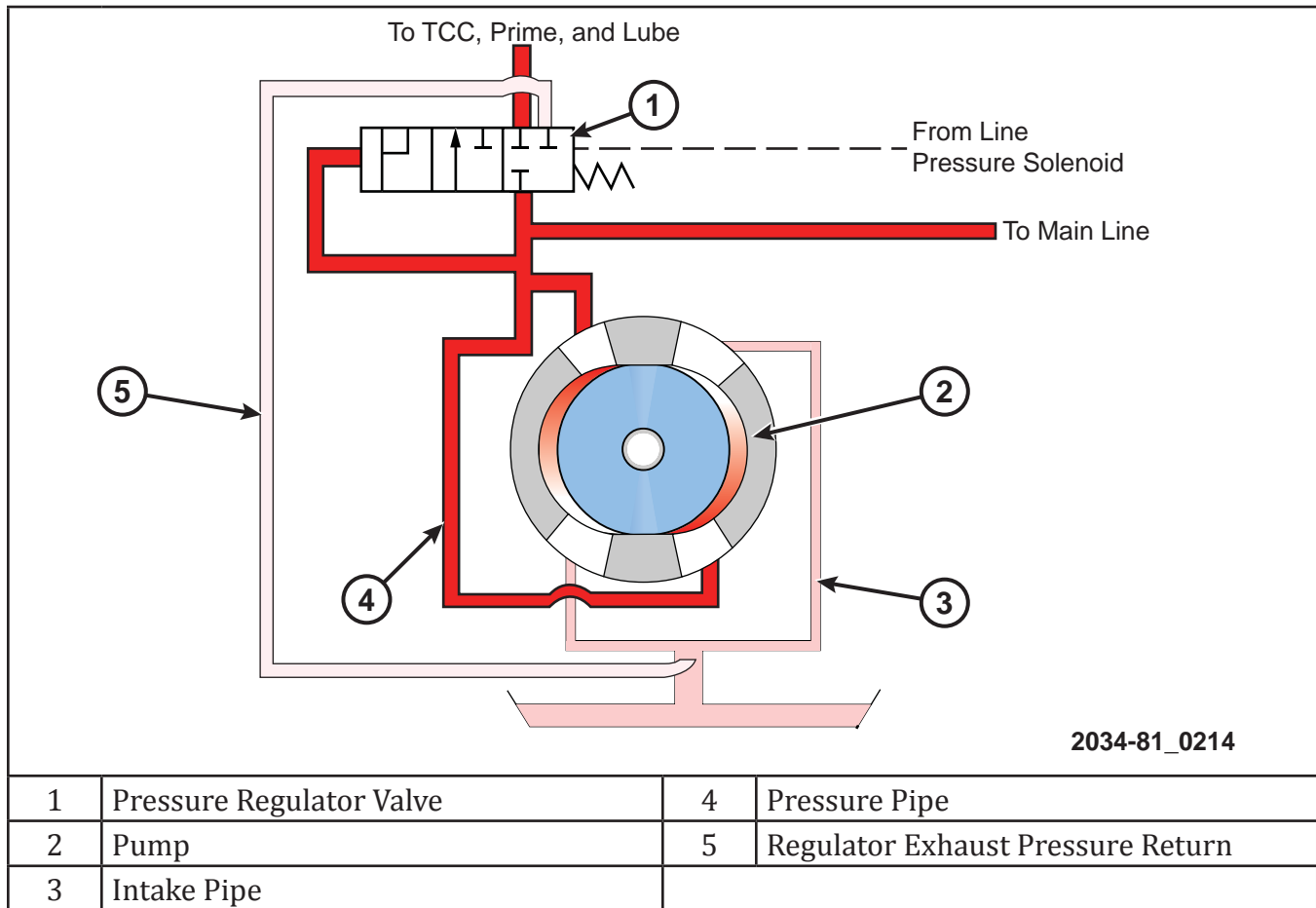


Figure 37 Oil Pump Operation

The transmission oil pump is driven by a chain and sprocket. The oil pump has two intake ports and two exhaust ports. The pump draws fluid through a filter and pressurizes the fluid as the pump rotates. After the fluid is pressurized, it exits the pump through two exhaust ports that feed the system pressure valve. The system pressure valve maintains fluid pressure and allows excess pressure to be returned to the pump. This reduces cavitation and noise.

## TCC Release

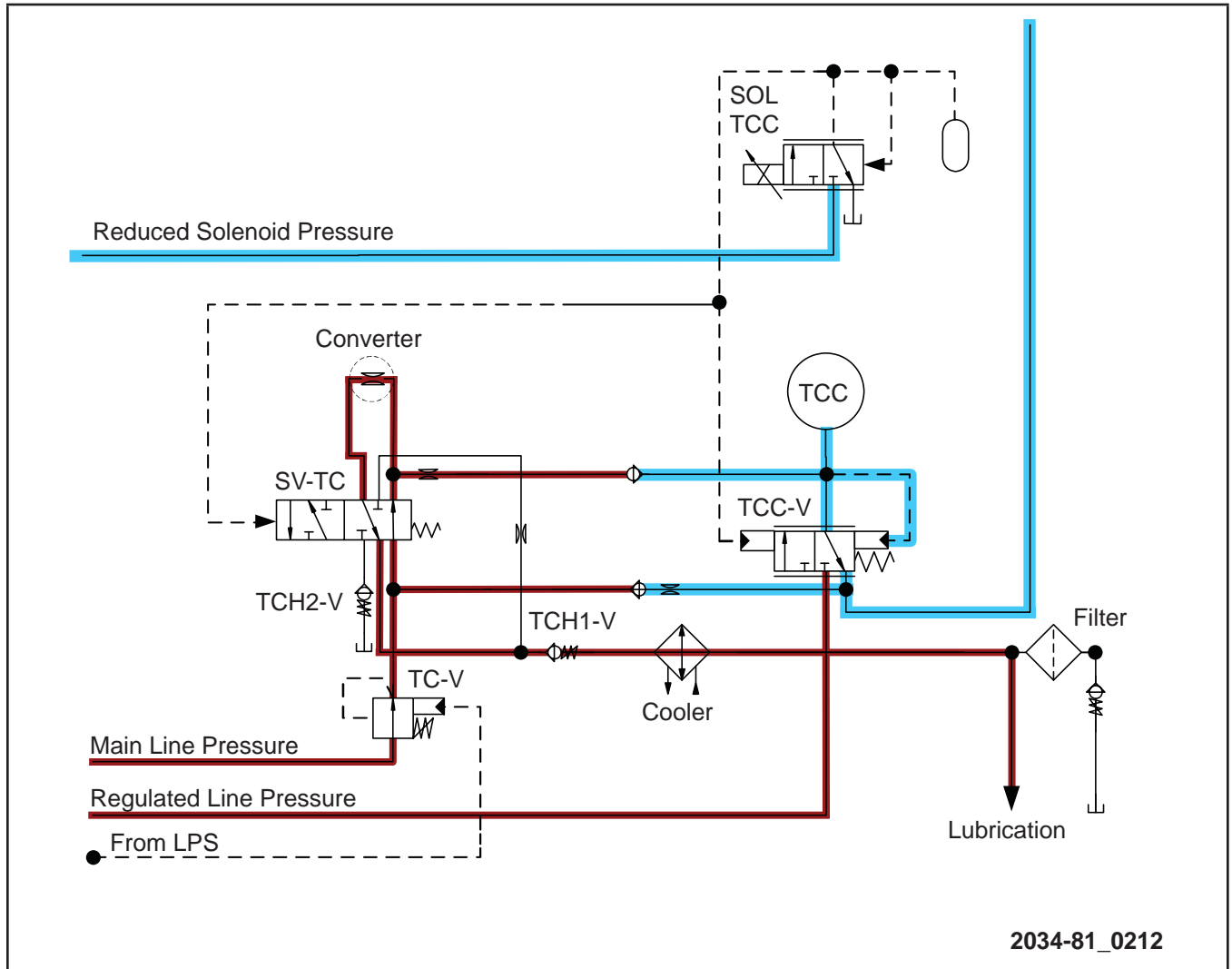


Figure 38 TCC Release

The torque converter clutch (TCC) is engaged and released by the transmission control module assembly (TCMA). The TCC can be engaged and controlled in any forward gear from 1st through 8th.

When the TCC is open, the TCC piston is pushed to its default position by torque converter chamber pressure. The torque converter switch valve (SV-TC) provides pressure for torque converter operation that has been regulated by the torque converter pressure valve (TC-V). After exiting the torque converter, fluid moves into the cooling and lubrication circuits. The converter pressure retention valve (TCH1-V) ensures the torque converter pressure is a minimum of 0.35 bar (5 psi) when the TCC is open.



# 8-Speed Hydro-Mechanical Systems Operation

## TCC Apply

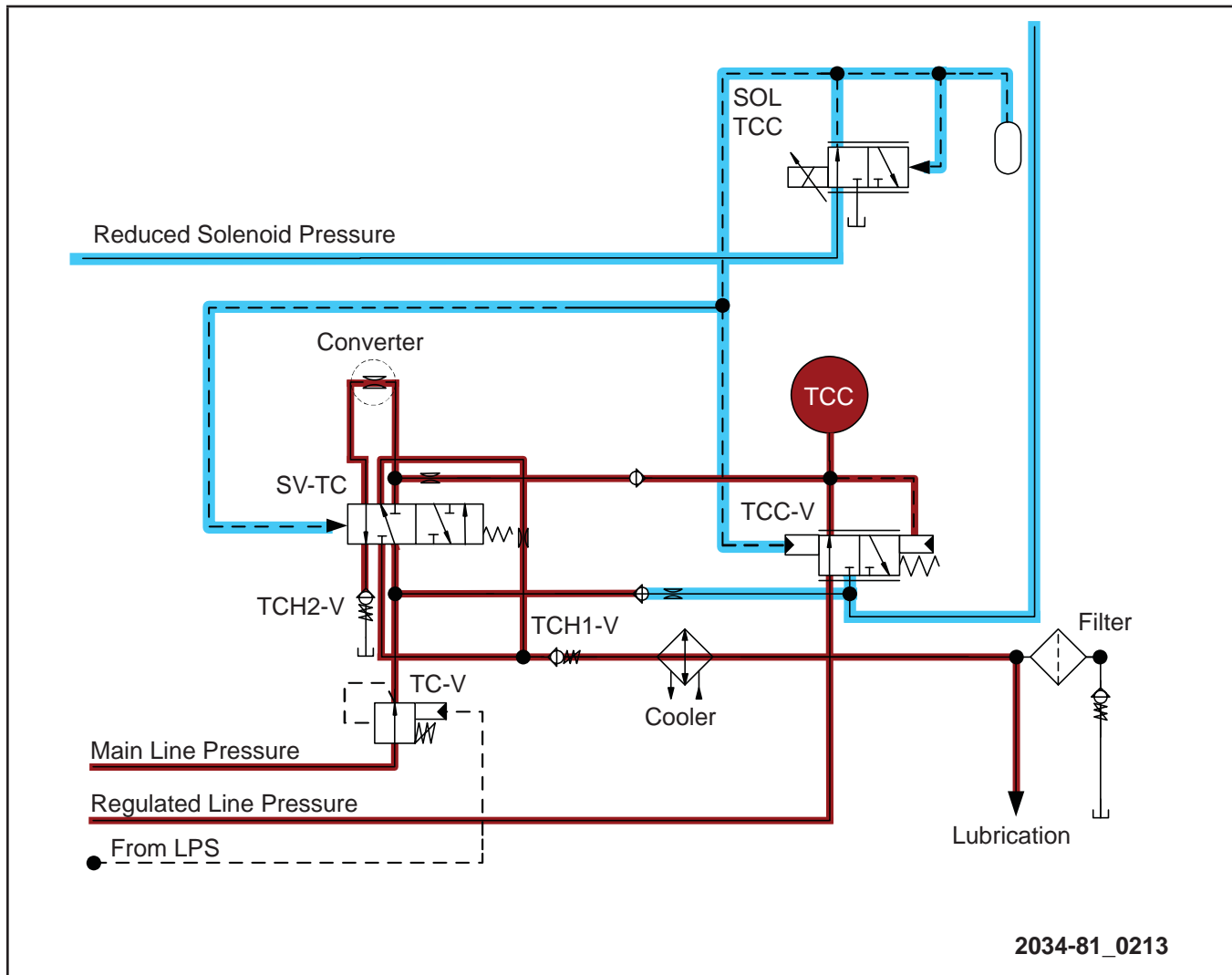


Figure 39 TCC Apply

When the TCC solenoid is energized, fluid is directed to the torque converter switch valve (SV-TC) and TCC lockup valve (TCC-V). The TCC lockup valve directs fluid to the TCC and torque converter chamber. The torque converter switch valve directs fluid exiting the converter chamber to a secondary pressure retention valve (TCH2-V) that is calibrated to retain 1.0 bar (14.5 psi) of pressure in the converter. The torque converter switch valve also directs line pressure to the cooler and lubrication circuit.

## C Clutch Hydraulic Operation

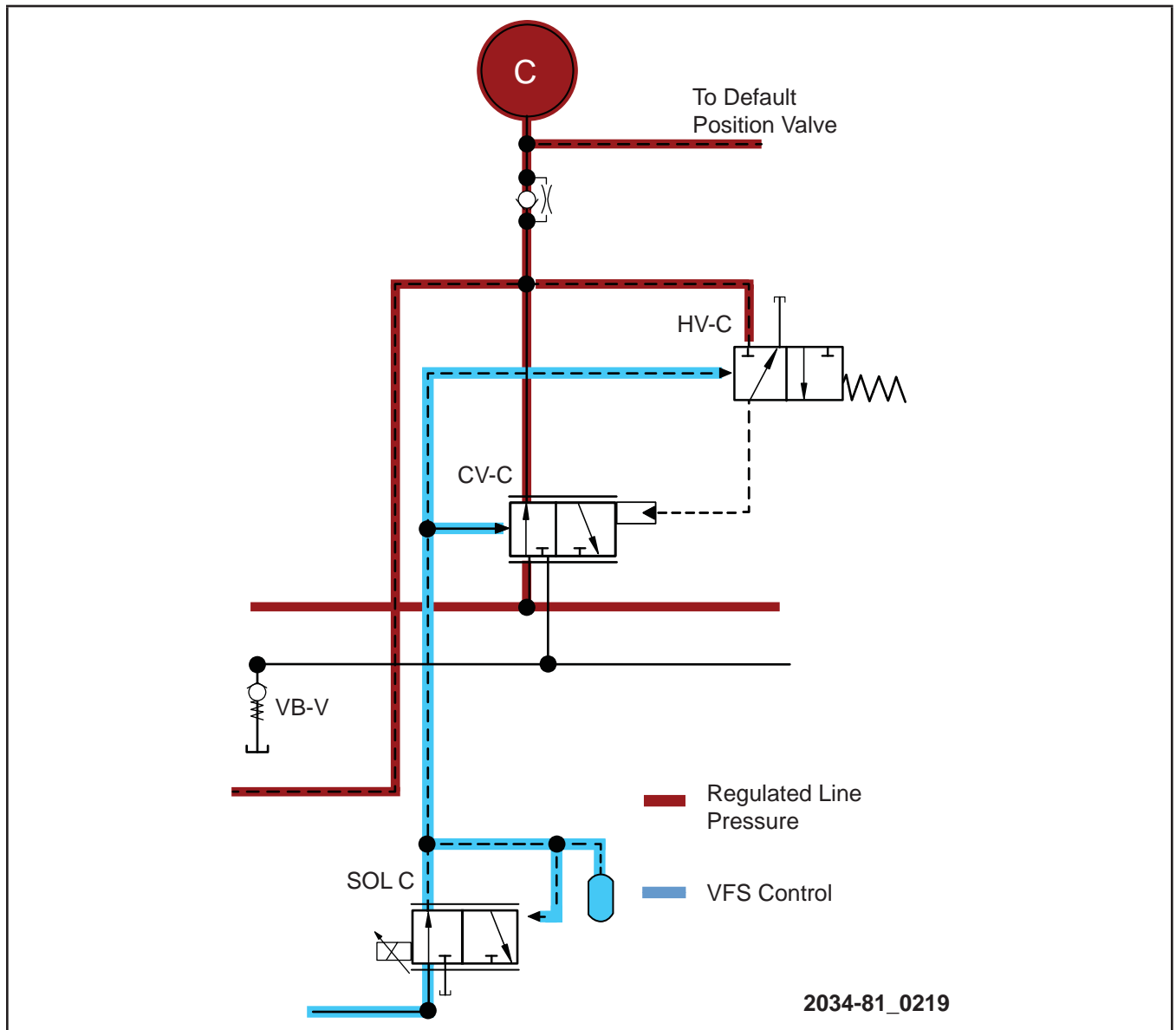


Figure 40 C Clutch Hydraulic Operation

Clutches C, D, and E all operate in a similar manner. Regulated solenoid pressure is available at the C clutch shift solenoid (SOL C) and regulated line pressure at the clutch valve (CV-C).

When the shift solenoid is de-energized, fluid flows through the shift solenoid and applies pressure to the clutch valve. During the shift, pressure moves the clutch valve, which begins to apply the clutch. Pressure from the holding valve (HV-C) regulates the opening of the clutch valve, softening the shift. Above a set threshold, the holding valve seats and allows the clutch valve to open completely.

## 8-Speed Hydro-Mechanical Systems Operation

### B2 Clutch Hydraulic Release

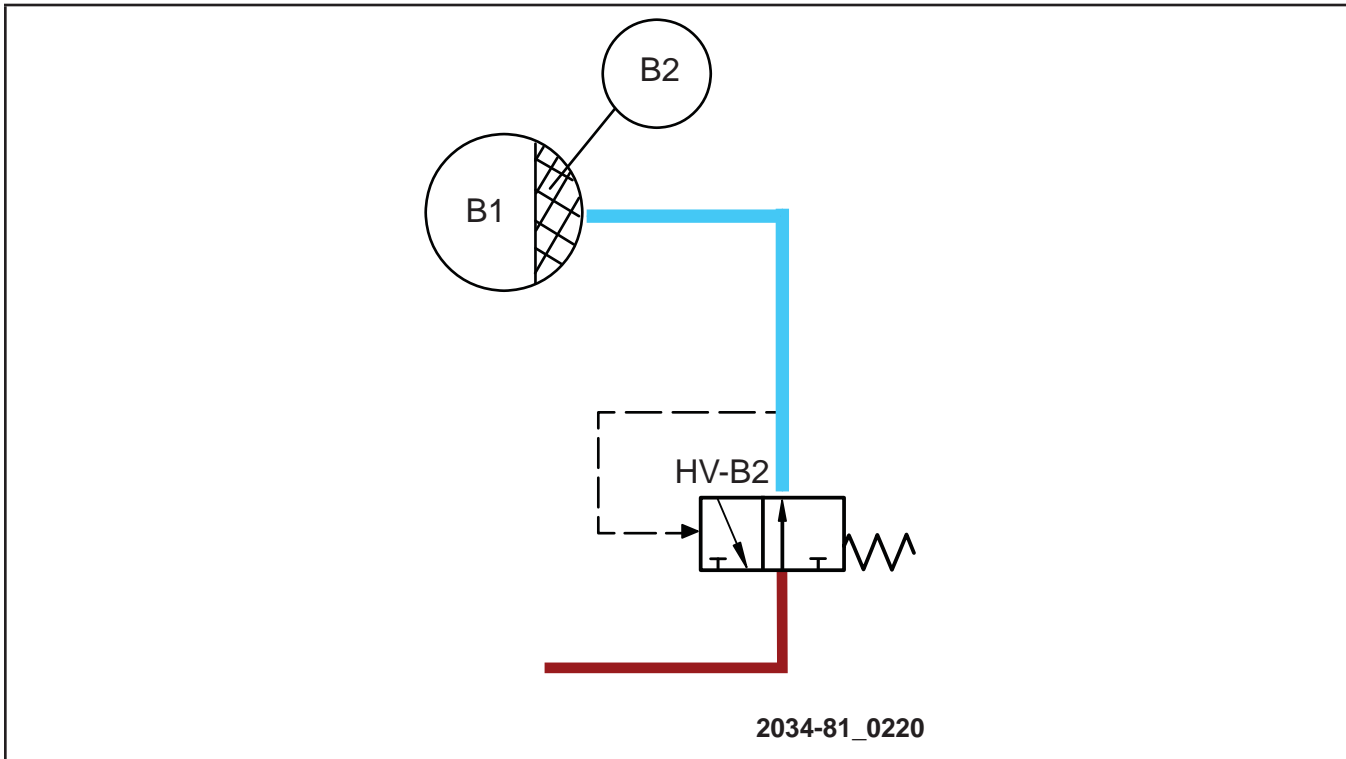


Figure 41 B2 Clutch Hydraulic Release

The B clutch includes two hydraulic chambers: B1 and B2. B1 is the B clutch apply circuit and B2 is the release circuit.

The holding valve (HV-B2) maintains regulated pressure against the release side of the B clutch. B2 fluid pressure remains constant at around 1.9 bar (27.6 psi) during normal operation. This constant pressure works against the B1 apply circuit pressure. The B2 circuit eliminates the need for a return spring. By using a hydraulic return instead of a spring return, the TCM has more accurate control of the B clutch slip during neutral idle control (NIC).

## B1 Clutch Hydraulic Apply

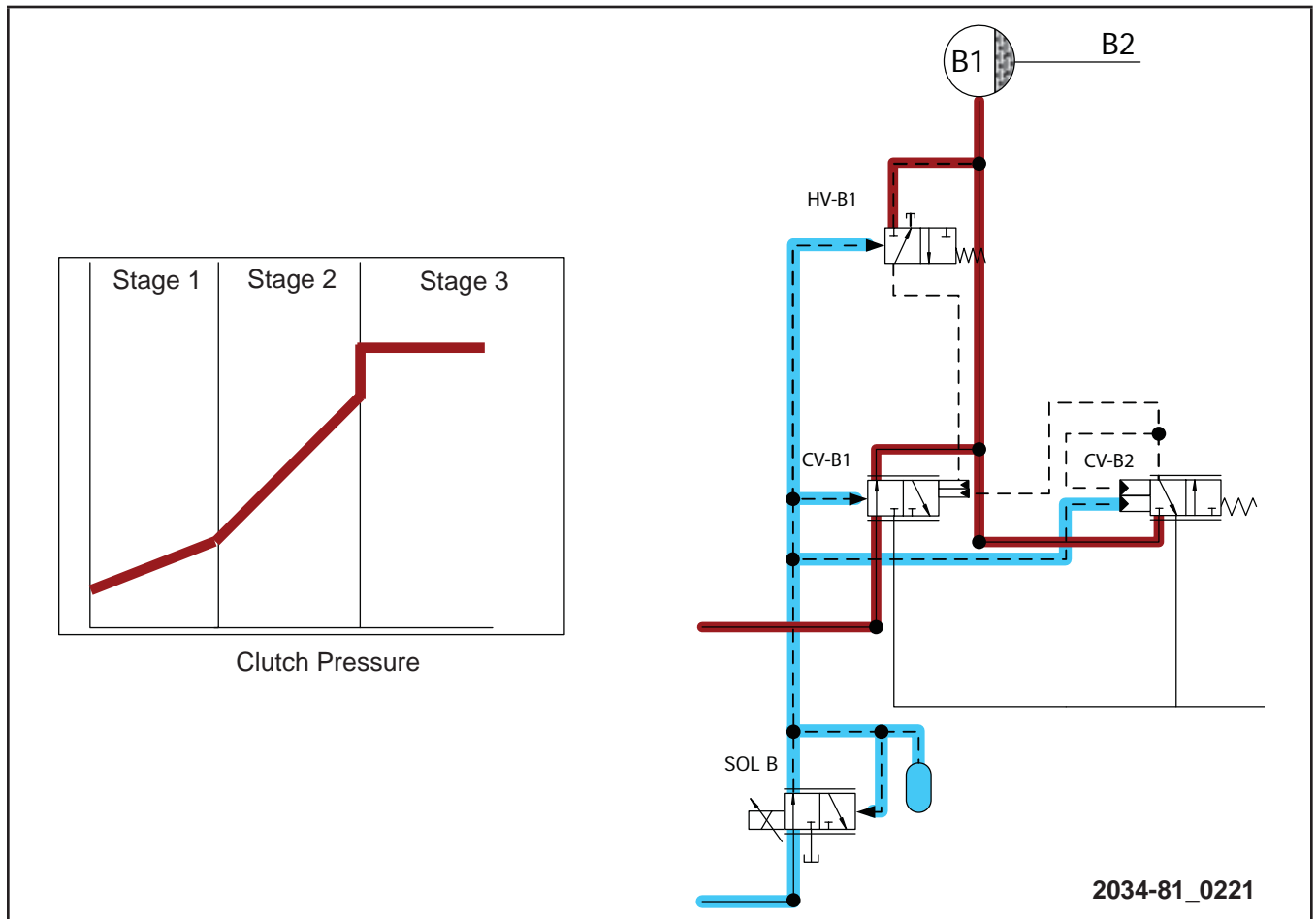


Figure 42 B1 Clutch Hydraulic Apply

When solenoid B is energized, regulated pressure flows through the solenoid and actuates the B1 clutch valve (CV-B1), B2 clutch valve (CV-B2), and B1 holding valve (HV-B1).

During stage 1, the B1 clutch valve opens, directing line pressure to the B1 side of the piston. The B2 clutch valve maintains pressure against the back side of the B1 clutch valve to control the initial engagement of the B clutch.

During stage 2, the B2 clutch valve seats and allows pressure in the B1 circuit to rise.

During stage 3, the B1 holding valve seats and allows full line pressure to keep B clutch applied.

## Park Lock Hydraulic Operation

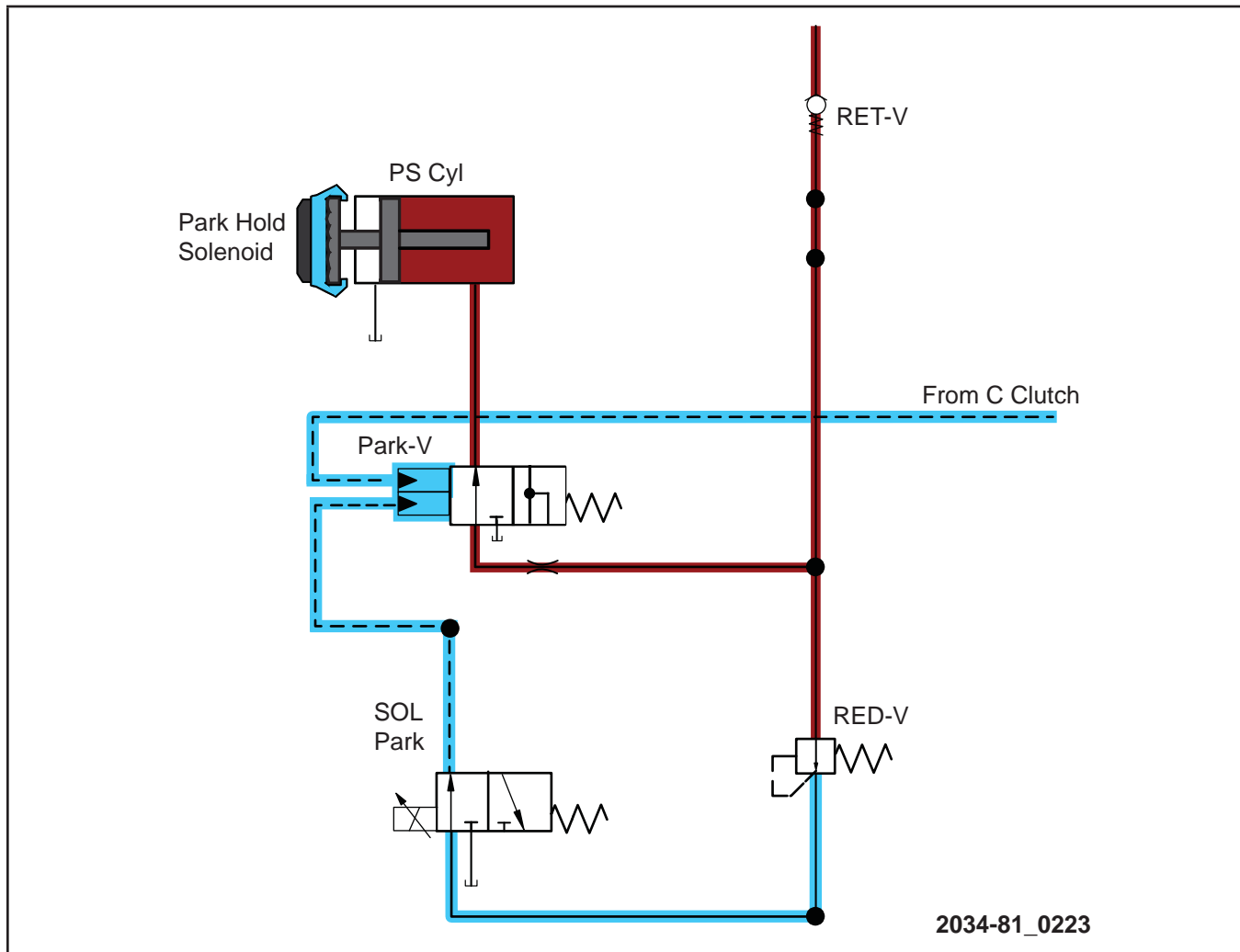


Figure 43 Park Lock Hydraulic Operation

In the default position, the park pawl is engaged. When the shifter is moved out of park, the park release solenoid (SOL Park) is energized and directs pressure to the park release valve (Park-V). The park release valve directs main line pressure to the park release cylinder (Park Cyl), releasing the park pawl.

In addition, the park hold solenoid is energized and holds the park release piston mechanically. The mechanical solenoid remains energized to hold the transmission out of park. This action is necessary because the fluid pressure drops as a result of the pump not operating with the engine off.

## Position Valve Operation

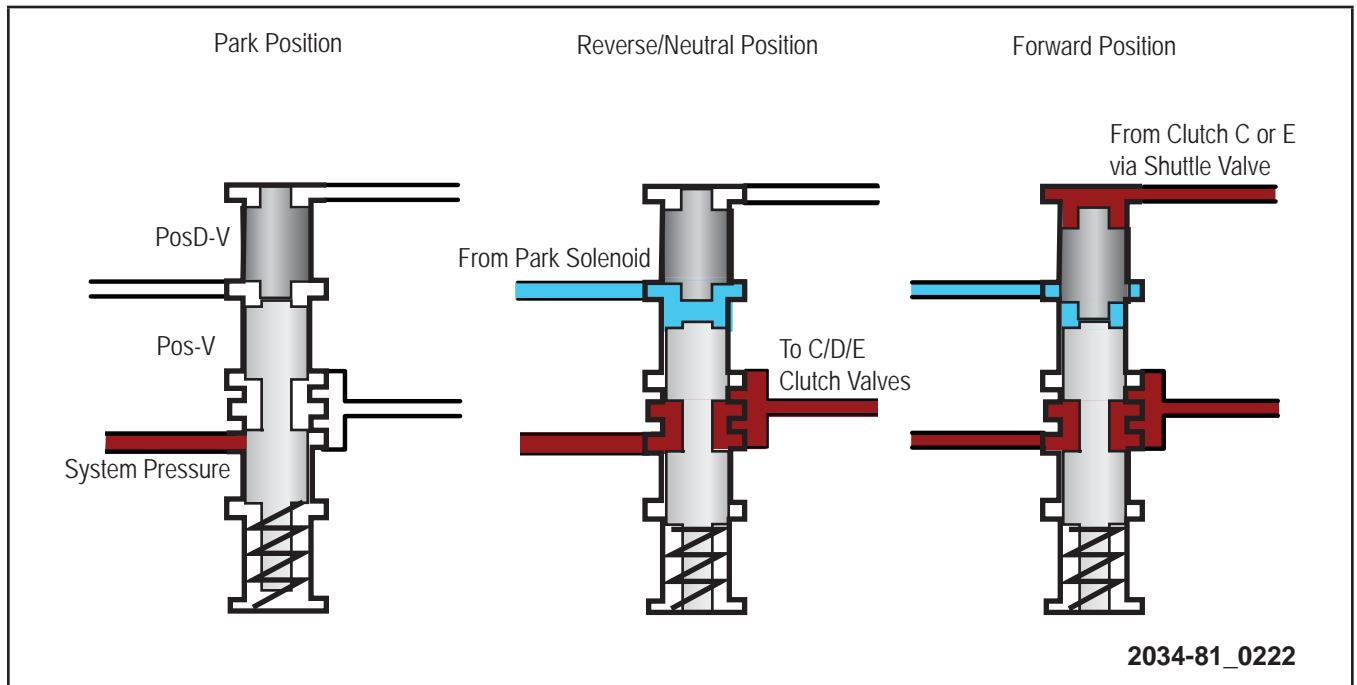


Figure 44 Position Valve Operation

Two position valves are used in the valve body. These valves supply the pressure to the C, D, and E clutch valves. The position valves are designed to supply pressure to the driving clutches and to maintain pressure in the driving clutch circuits if an electrical failure occurs.

When the shifter is moved to neutral or reverse, the park release solenoid supplies regulated pressure to the position valve (Pos-V). The position valve seats and supplies pressure to the driving clutch circuits.

When the shifter is moved to drive, clutch pressure from the C and E clutches is shared with a circuit that acts on the default position valve (PosD-V). When the default position valve is seated, pressure is maintained by the C and E clutches. This ensures that forward motion can be maintained even if the park release solenoid fails.

# 8-Speed Hydro-Mechanical Systems Operation

## Default Operation

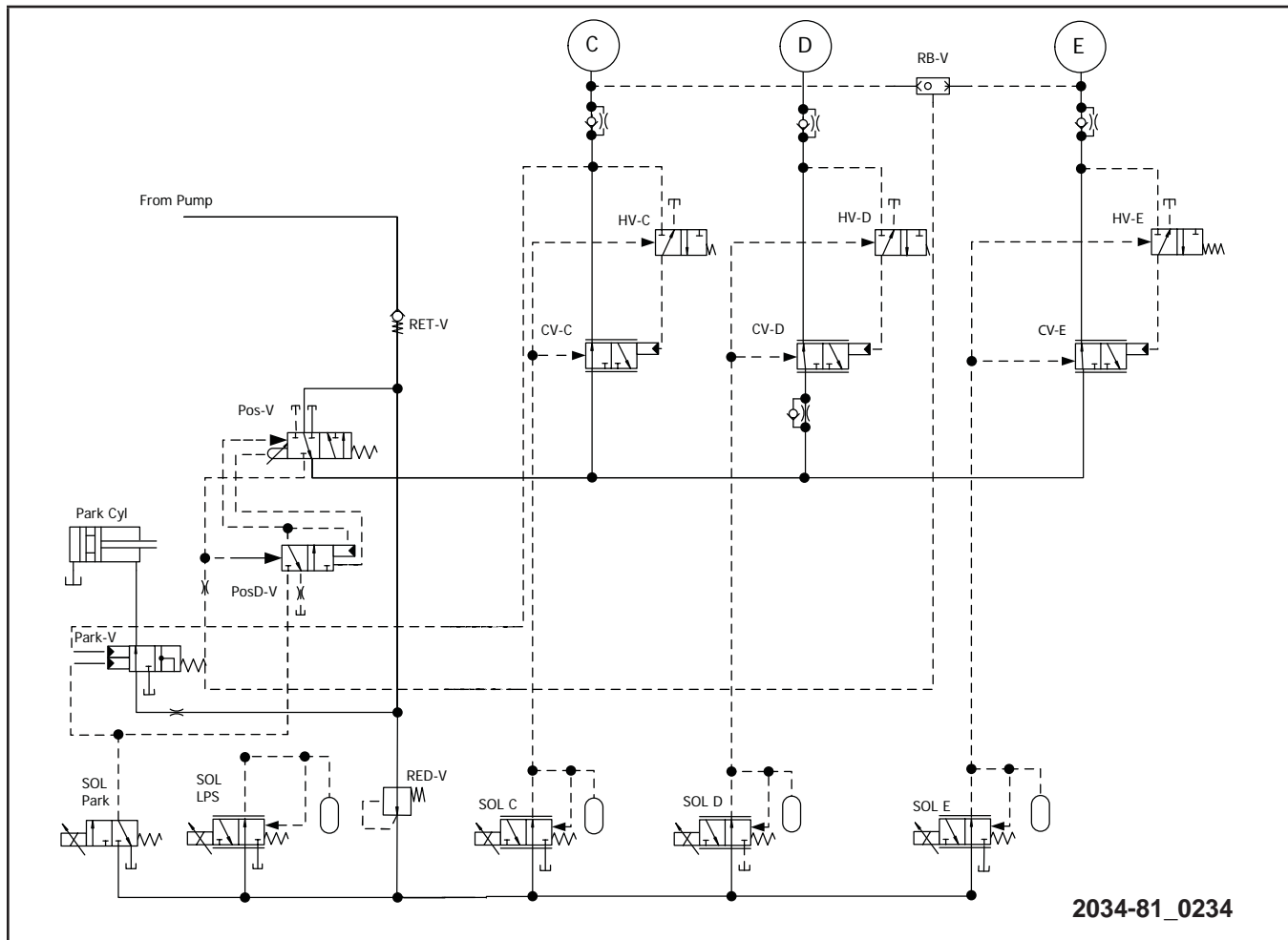


Figure 45 Default Operation

If a TCM failure occurs (or complete solenoid power loss) while driving in a forward gear, the C or E clutch circuit maintains hydraulic pressure against the park release valve. Pressure from either the C or E clutch circuit through the rocker ball valve (RB-V) keeps the default position valve (PosD-V) and position valve (Pos-V) open. The position valves maintain fluid pressure to the C, D, and E clutches, and 6th gear is engaged.

If the vehicle is turned off and a TCM failure is still present, the vehicle will not be able to move. This is because the fluid that feeds the C, D, and E solenoids cannot be supplied through the POS-V.

## Priming Circuit

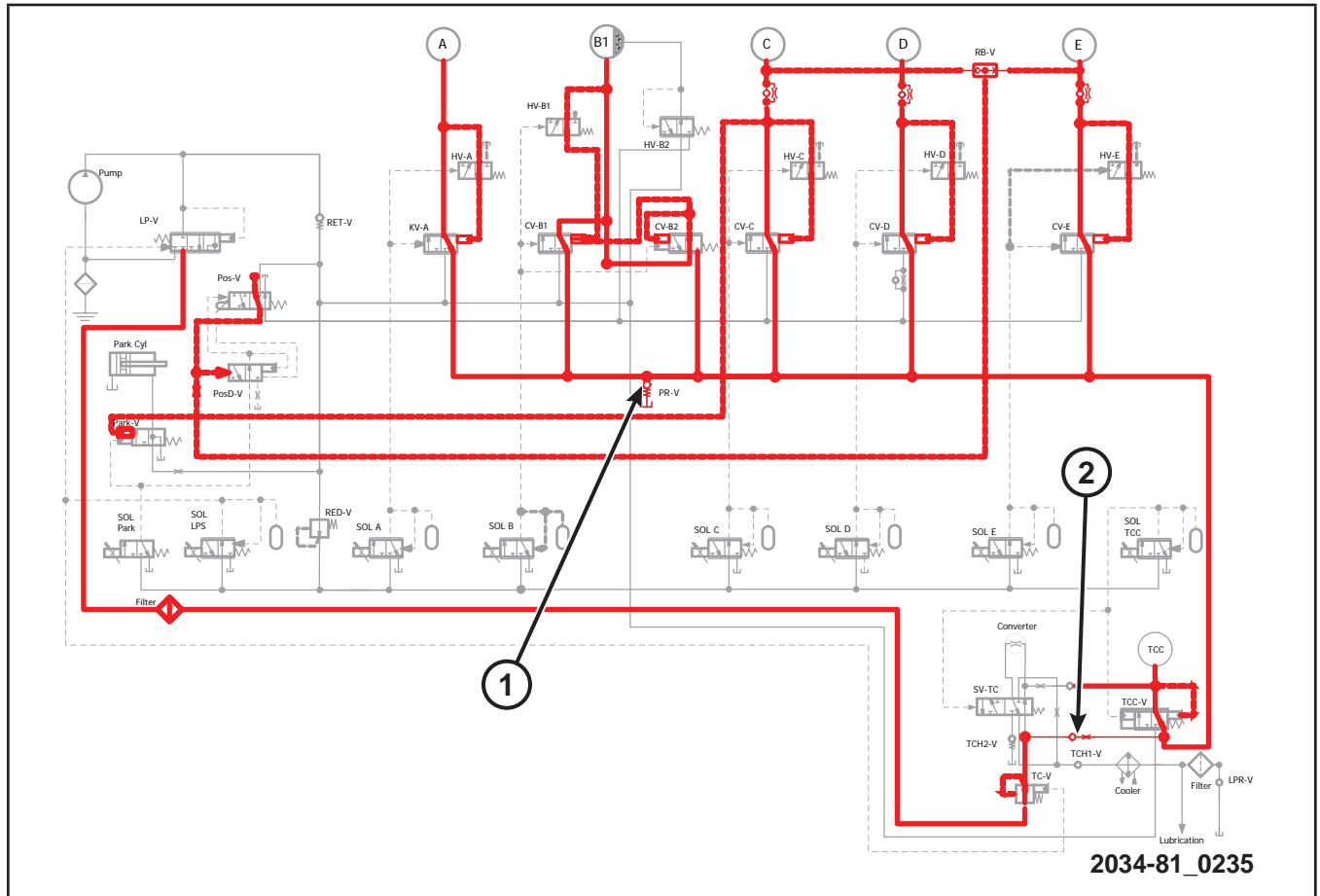


Figure 46 Priming Circuit

The priming circuit pre-fills the clutches with low-pressure fluid and resets the apply and holding valves to their default position.

The priming circuit is fed through a check ball and orifice from the torque-converter-regulated pressure circuit. The priming valve (PR-V) ensures that pressure remains low enough to prevent the clutches from engaging.





## DEMONSTRATION 2 8-SPEED HYDRO-MECHANICAL SYSTEMS ANALYSIS

### PART ONE: TRANSMISSION DISASSEMBLY

1. Endplay:

- a. Only output endplay can be measured on this unit.
  - b. The output flange must be loosened before measuring endplay.
- 
- 

2. Valve body area:

- a. The electrical harness sleeve requires special tool #10377 Guide Sleeve Remover/ Installer.
  - b. Only the square shoulder bolts need to be removed to remove the valve body from the transmission. The valve body bolts are reusable.
  - c. Always place the valve body assembly in a plastic bag, if it is removed for service, to keep debris out.
  - d. The parking mechanism is under spring tension. Watch the parking pawl piston when removing or installing the valve body. The park release lever must be removed and rotated 180 degrees opposite of the locator tab.
  - e. Secure the output speed sensor (OSS) to the valve body to protect the sensor during service.
  - f. If the OSS or harness is damaged, a complete valve body assembly replacement is required.
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3. Oil pump:

- a. When removing the oil pump assembly, place your hand on the front of the input shaft to keep it in place, while the pump assembly comes out.
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## 8-Speed Hydro-Mechanical Systems Analysis

4. Internal components:
    - a. When removing the main gear stack, the transmission must be vertical. Do not allow the sides of the aluminum drums to hit against anything. These drums are precision machined to allow for high speed rotation with tight tolerances.
    - b. When removing the P4 annulus snap ring, special too #10378 Support Rings must be used to avoid damage to the aluminum drums.
    - c. The P2 carrier outer ring contains a magnet trigger for the input speed sensor.
    - d. Do not bang or dent the P2 carrier ring. If the ring is damaged it must be replaced.
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### **PART TWO: TRANSMISSION ASSEMBLY**

1. Internal components:
    - a. When installing the B clutch plates, the wave plate faces towards the B clutch piston.
    - b. The D clutch has four large lugs that serve as alignment features for the snap ring.
    - c. The two snap rings retainers in the P4 sun gear/C/E clutch are identical and interchangeable.
    - d. Care must be taken to make sure that the P4 annulus snap ring is not installed upside down.
    - e. After the input shaft/P2 carrier is installed, the snap ring must be seated using needle nose pliers.
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2. Valve body:

- a. During installation, the TCM heat sink causes the valve body to float and appear as if it is not fully seated.

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3. Oil pump:

- a. The oil pump bolts are aluminum and must be replaced after they are removed.
- b. If the oil pump is removed from the assembly, when the pump is installed, there will be a 2-mm gap between the pump and the housing; this is normal.

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4. Endplay measurements:

- a. Perform the endplay measurement with the original oil pump bolts and omit the pump cover o-ring and the bolt seals. Install the new bolts and seals on the final assembly, after the correct endplay shim has been selected.

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# 8-Speed Hydro-Mechanical Systems Analysis

## PART THREE: CLUTCH INTERACTION

Instructions: This is an instructor-led demonstration. Follow the directions from the instructor and answer the questions as each clutch is discussed.

1. What components does the A clutch interact with?

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2. What components does the B clutch interact with?

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3. What components does the C clutch interact with?

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4. What components does the D clutch interact with?

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5. What components does the E clutch interact with?

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6. Which clutch is identified by the instructor and what would happen if this clutch was burnt and slipping?

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7. Which clutch is identified by the instructor and what would happen if it did not apply?

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a. Does this situation seem similar?

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LESSON 4 8-SPEED ELECTRICAL OPERATION

ELECTRICAL INPUTS

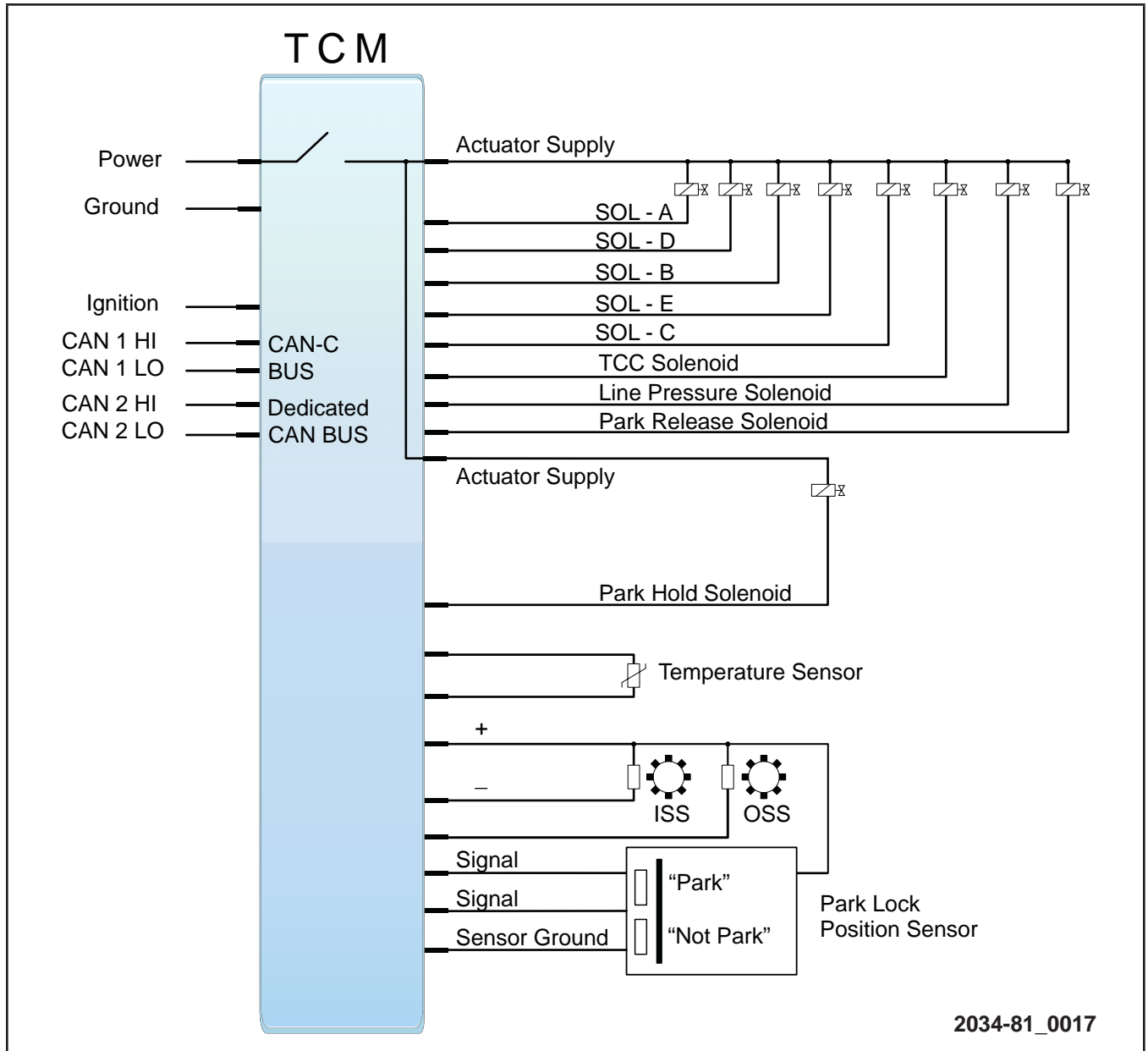


Figure 47 Transmission Control Module (TCM)



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## *8-Speed Electrical Operation*

### **Transmission Control Module (TCM)**

The TCM receives drivability data from the powertrain control module (PCM) and other modules over the CAN-C network. It also receives shift lever position information from the electronic shifter over a dedicated transmission CAN network. The TCM uses four sensors that are integrated into the valve body assembly. The TCM processes this input data and controls operation of the torque converter clutch, park lock system, solenoid valves, and pressure regulating valves.

Speed Sensors

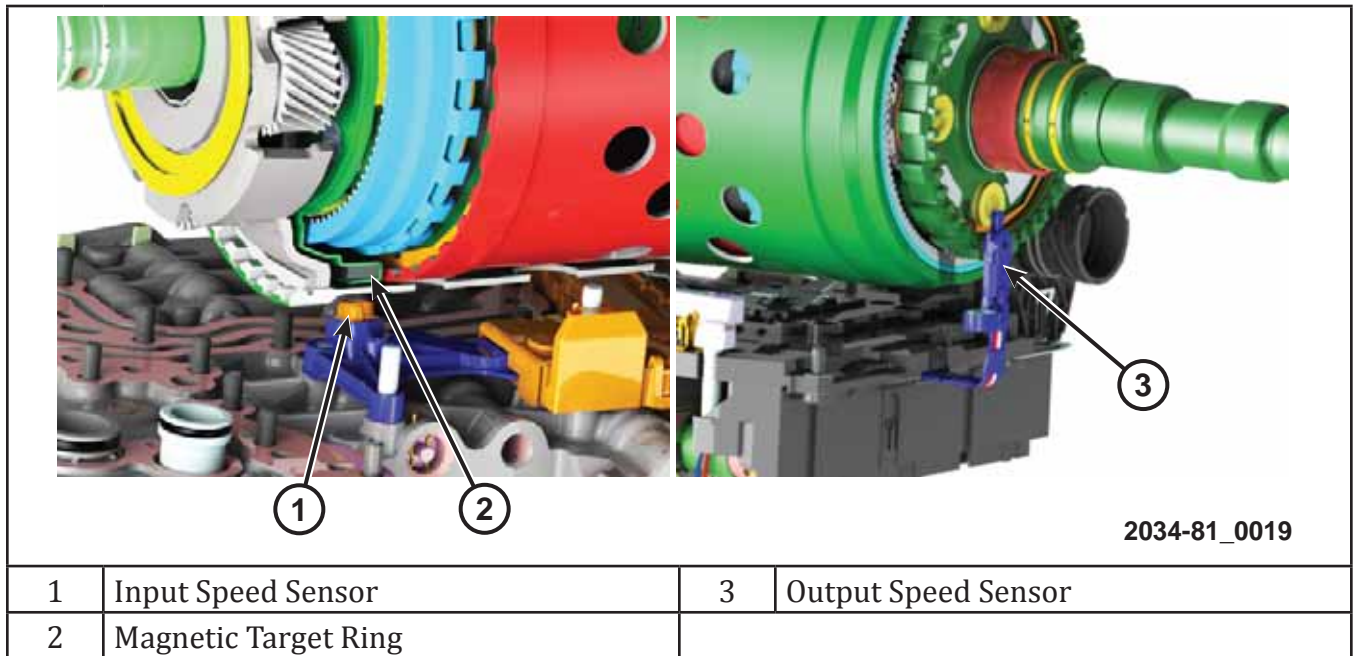


Figure 48 Speed Sensors

The input speed sensor (ISS) and output speed sensor (OSS) are Hall-effect sensors that measure shaft rotational speed.

The ISS is located at the front of the TCMA and reads input shaft speed from the magnetic ring on the P2 carrier.

The OSS is located at the back of the TCMA and reads output shaft speed from the P4 carrier.

### Temperature Sensor

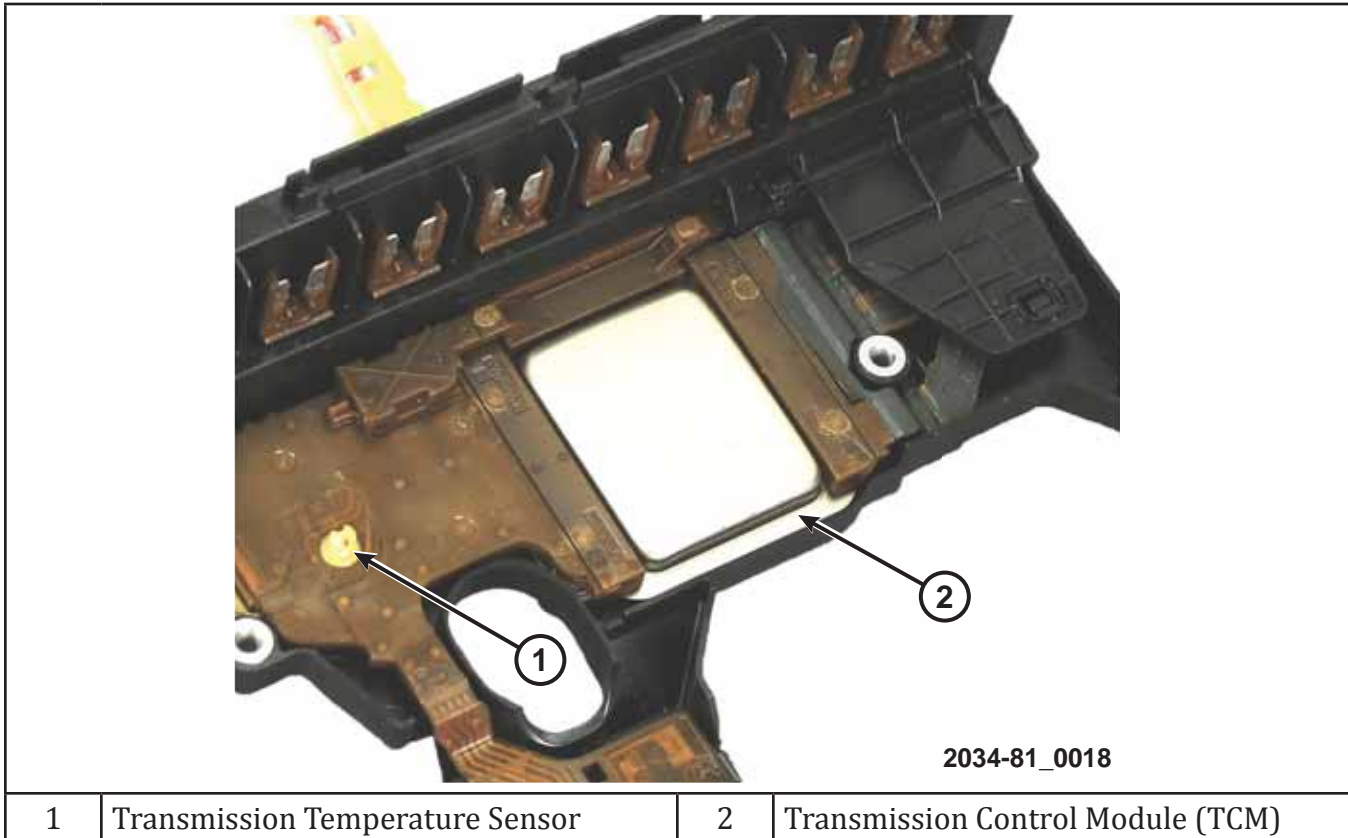


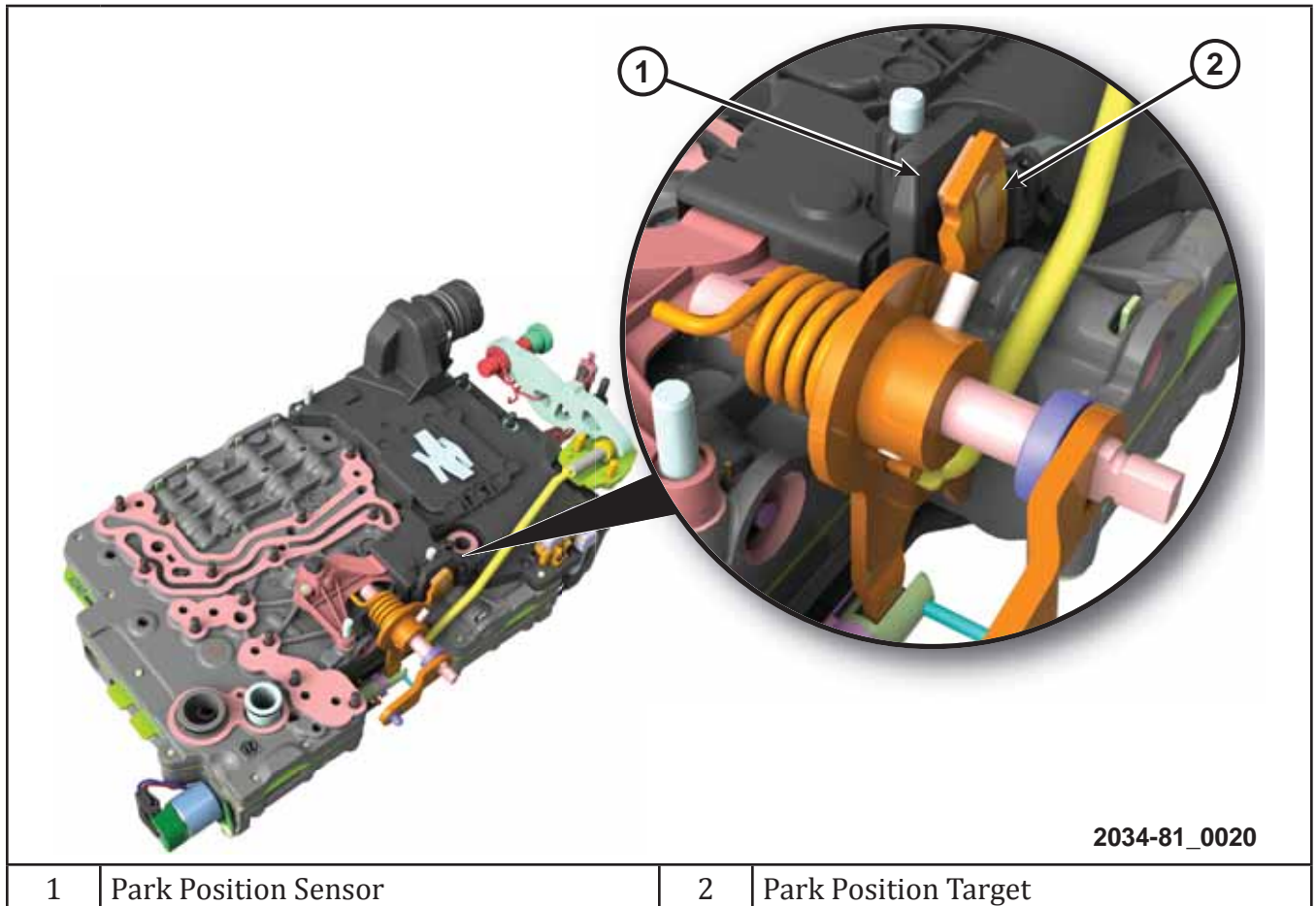
Figure 49 Temperature Sensor

The transmission oil temperature sensor is a thermistor that measures the temperature of the transmission fluid in the case. The transmission oil temperature sensor is mounted under the solenoids on the TCMA.

The TCM also contains an internal temperature sensor. The TCM compares the internal temperature reading with the fluid temperature sensor to determine hot mode strategy.

**NOTE:** The TCM internal temperature sensor can be viewed on the scan tool.

Park Position Sensor



2034-81\_0020

1	Park Position Sensor	2	Park Position Target
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Figure 50 Park Position Sensor

The park position sensor is a digital sensor that monitors the position of the park pawl linkage. The sensor target is located on the park selector shaft. There are two digital Hall-effect sensors built into the TCMA that monitor the position of the target on the park selector shaft.

## 8-Speed Electrical Operation

### ELECTRICAL OUTPUTS

#### Solenoid Operation

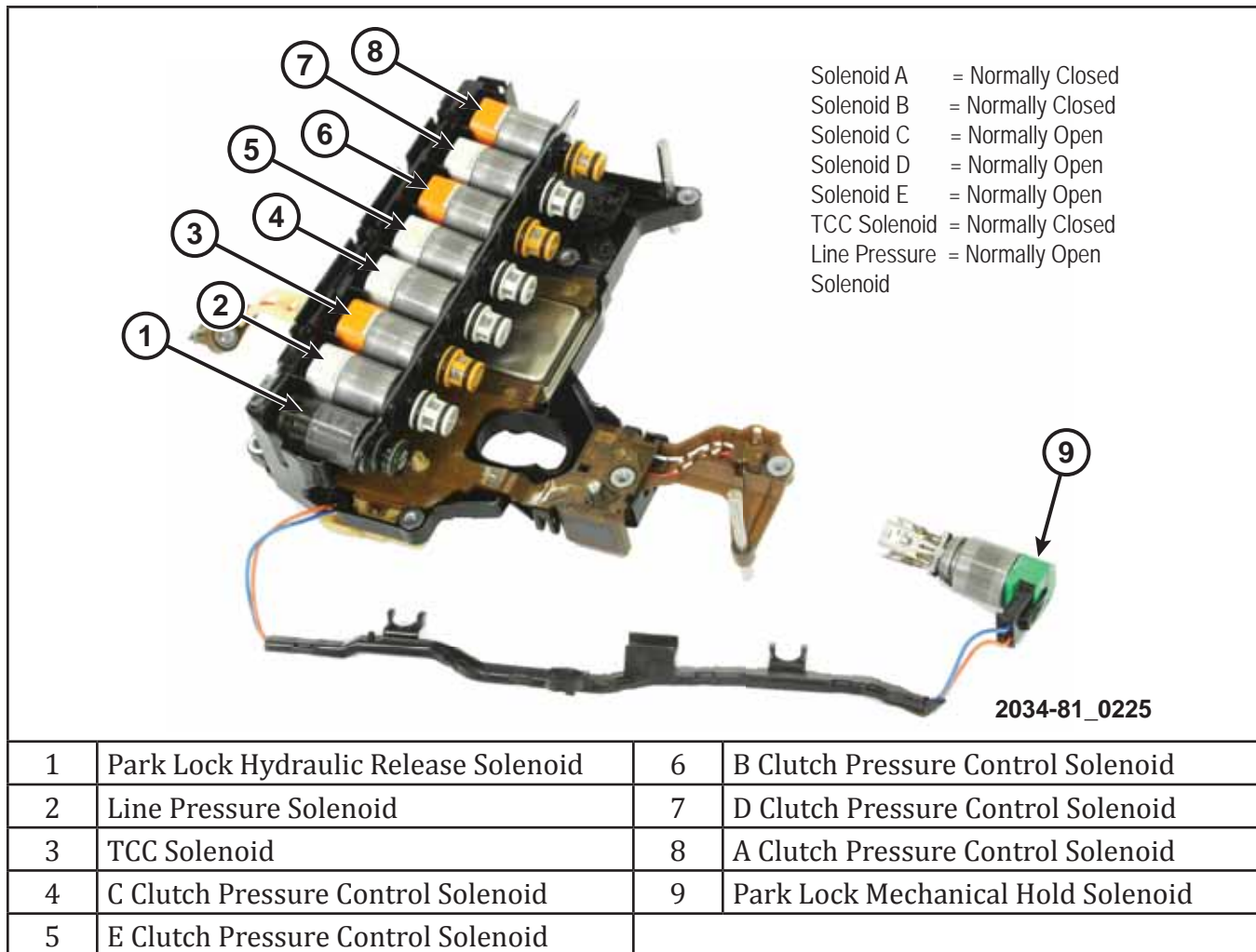


Figure 51 Solenoid Operation

Shift solenoids A through E, the TCC solenoid, and the line pressure solenoid are all variable force solenoids that are controlled by the TCM via pulse-width-modulated signals. Variable force solenoids allow the TCM to control the amount of fluid pressure in the hydraulic circuit. These solenoids are identified as normally-open (NO) or normally-closed (NC) based on their hydraulic position when de-energized.

The park release solenoid is a normally-closed, ON/OFF solenoid. When the park release solenoid is energized, it directs fluid pressure to the park release cylinder to disengage the parking pawl.

The park hold solenoid is an ON/OFF, mechanical solenoid. When the park hold solenoid is energized, the mechanical claws of the park hold mechanism grab the end of the park release piston and hold it to prevent the park lock pawl from engaging. The park hold solenoid is energized any time the engine is running and the shift lever is in any position except park. In addition, the park hold solenoid remains energized if the engine is turned off while the shifter is in neutral (car wash function).

MODULE COMMUNICATION AND CONTROL STRATEGIES

Module Communications

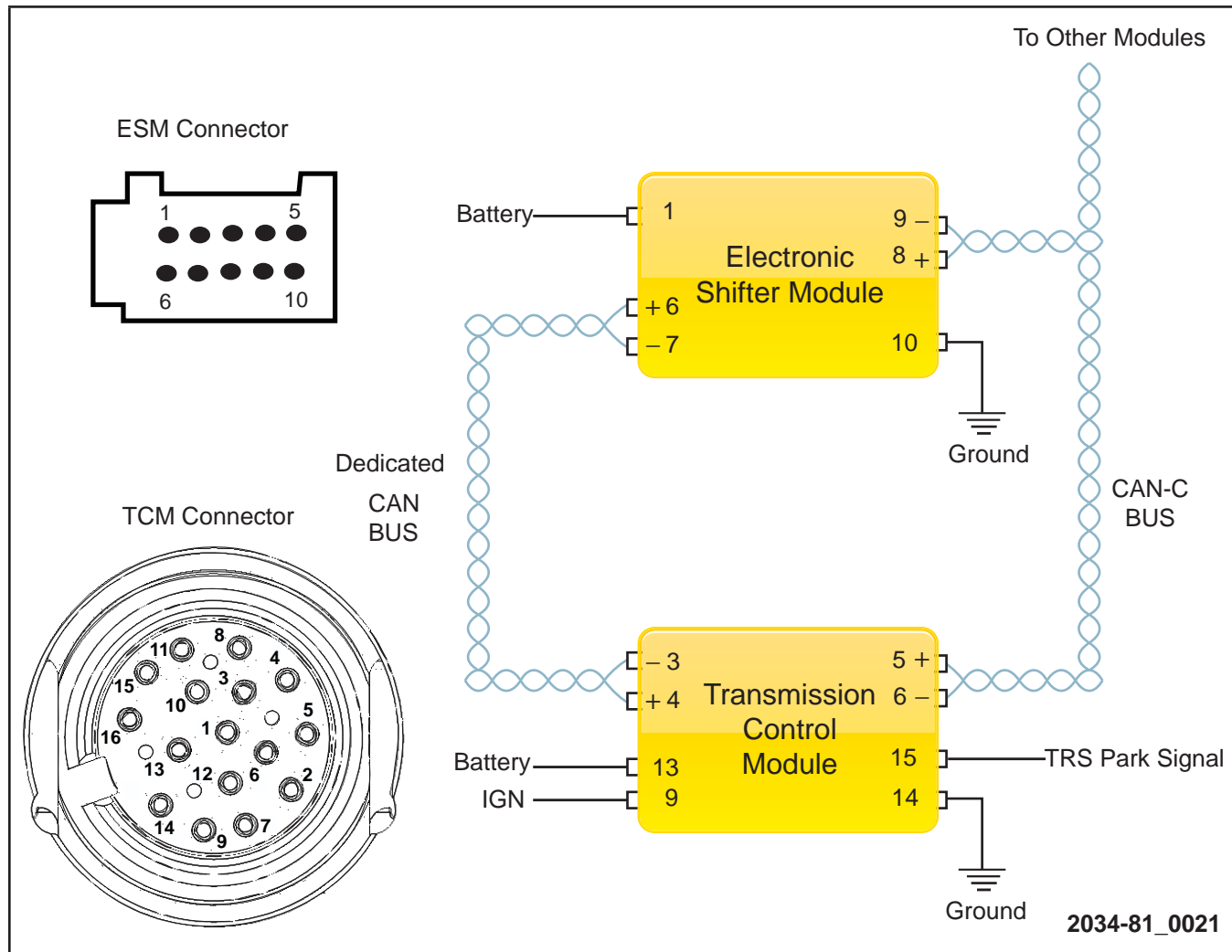
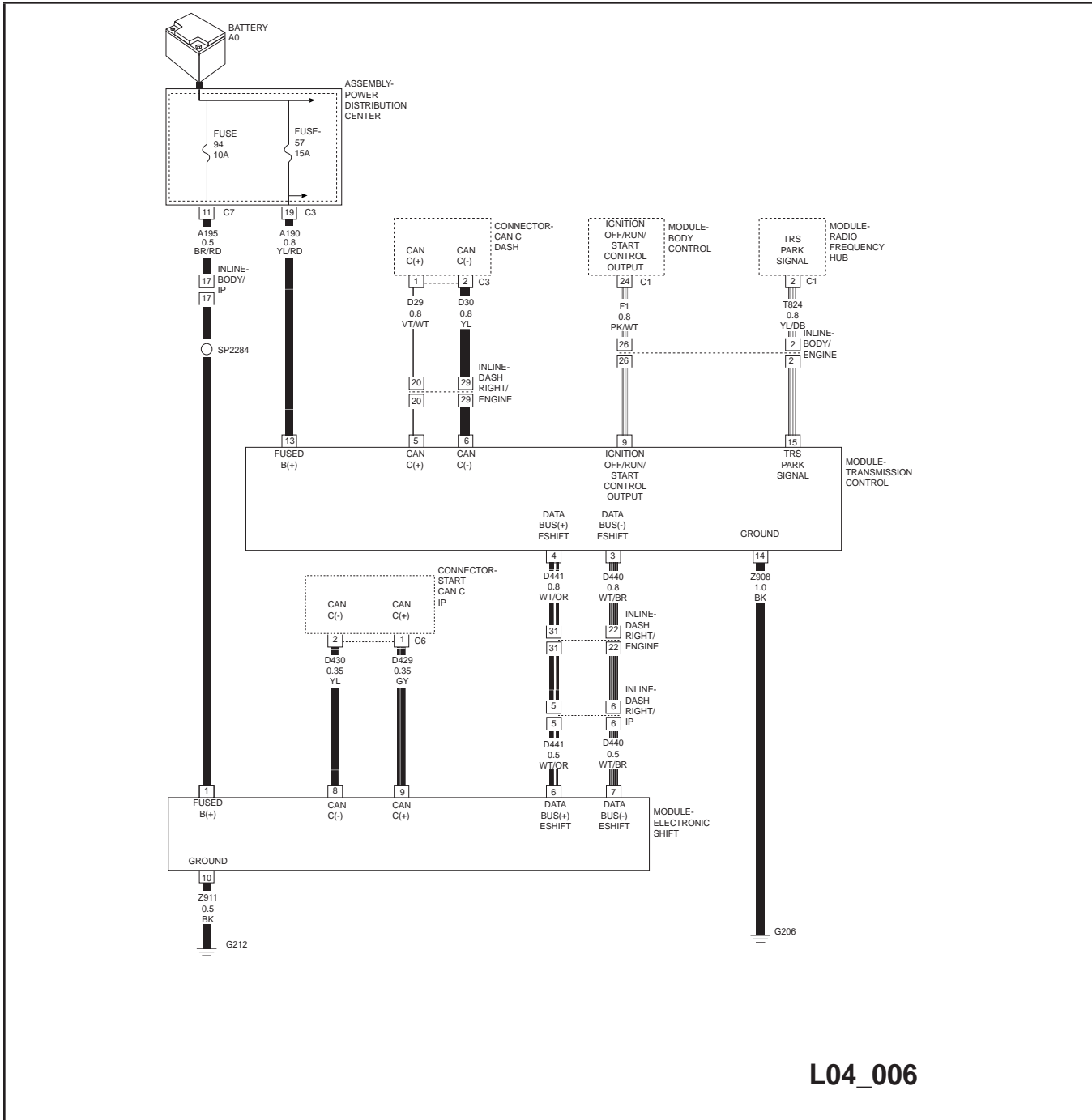


Figure 52 Module Communication

The 8HP45 transmission uses a shift-by-wire system with an electronic shifter. The electronic shifter includes battery voltage and ground circuits, CAN-C network circuits, and dedicated CAN circuits for direct communication of requested shift lever position to the TCM.

The messages communicated on the dedicated CAN network are redundant to messages also sent over the CAN-C network. This helps maintain the integrity of the system during certain failures.

# 8-Speed Electrical Operation



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Figure 53 8-speed Wiring Diagram



Adaptive Strategies

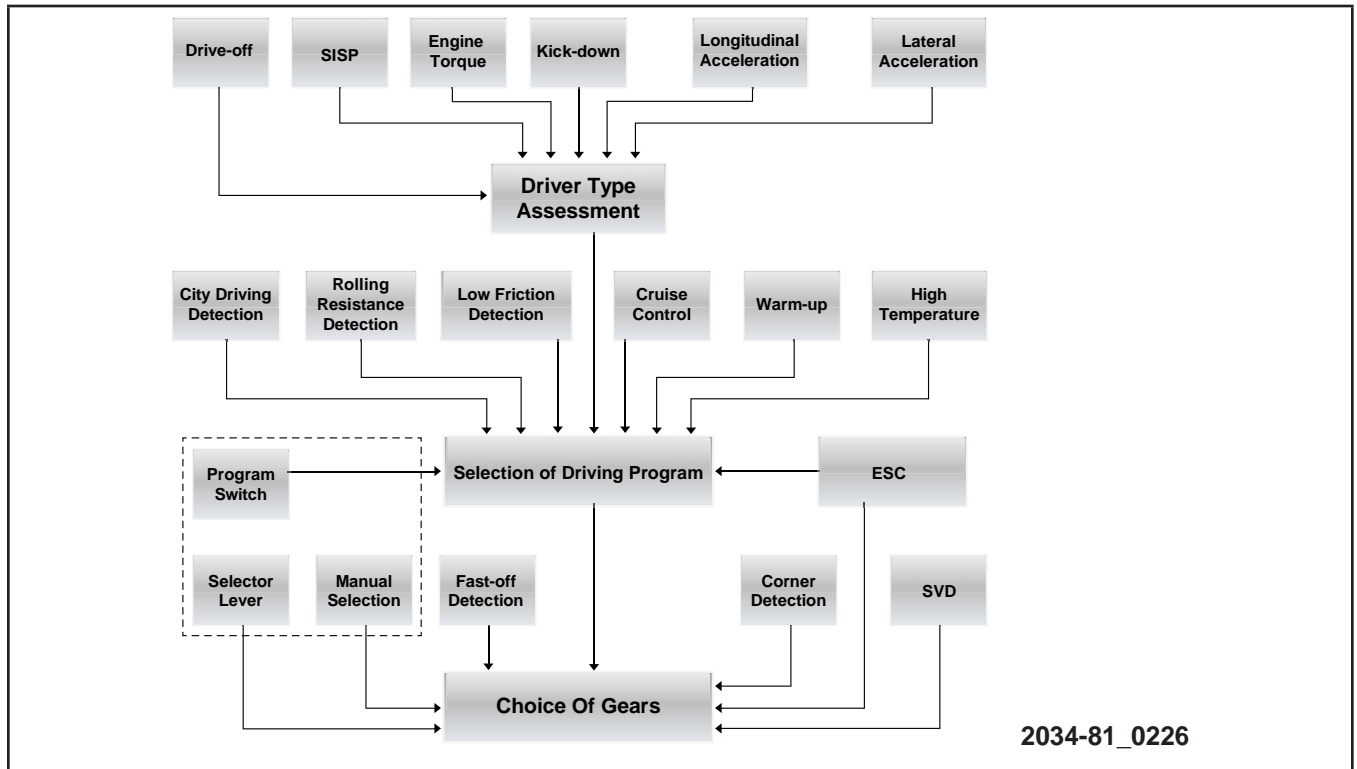


Figure 54 Adaptive Strategies

The TCM evaluates driving styles and current conditions and compares this data to stored shift programs. The TCM controls transmission shift operation dynamically by choosing an appropriate strategy. The TCM can calculate the amount of drag to determine shift programs based on ascending, descending, or level driving.



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## *8-Speed Electrical Operation*

### ***Neutral Idle Control***

Neutral idle control (NIC) is a transmission strategy that disengages the transmission when the vehicle is stopped with the transmission in a forward gear range. Disengaging the transmission at a standstill is accomplished by allowing a controlled slip of the B clutch. The amount of slip is determined by calculating the difference between engine speed and transmission turbine speed. To ensure that the vehicle can drive off without delay, the power flow is not completely disengaged. A small amount of torque is always transmitted. In addition, the C clutch is closed to accept power flow before the driver accelerates. When combined, these strategies also minimize the risk of rolling backwards on hills.

If a predetermined accelerator pedal angle value is exceeded, rotation of the output shaft is detected, or the brake pedal is released, neutral idle control is deactivated.

### ***Drag Recognition Strategy***

The calculation of drag is based on a balance between engine torque and friction on the drive wheels. Tire rolling resistance, vehicle weight, wind resistance, and gradient resistance all play a role in the drag calculation. The TCM uses drag calculations to adjust transmission shift points for all conditions that increase or decrease the apparent load.

### ***Cruise Control Strategy***

When cruise control is selected, the set driving speed is held constant and the TCM utilizes the drag calculation to determine the correct strategy to maintain the set speed.

### ***Warm-Up Strategy***

The warm-up strategy is selected when engine coolant temperature is below 30 °C (86 °F). During warm-up, neither the driver-type evaluation nor drag calculation are active. The warm-up strategy is disabled temporarily when driving downhill or when kickdown is necessary.

### ***High Temperature Strategy***

The high temperature strategy is enacted when transmission oil temperature rises above 120 °C (248 °F). When the high temperature strategy is active, the red transmission control indicator illuminates and the temperature level is central to the calculation of shift points.

The high temperature strategy includes delaying shifts and changing the torque converter clutch lockup strategy to help provide a non-slip direct-drive in the transmission for as long as possible to assist in transmission fluid cooling.

### ***Low Friction Strategy***

When low friction road surfaces are detected, the TCM selects a higher gear. In addition, when low friction surfaces are detected at higher speeds, the TCM will avoid downshifting to minimize the risk of shift-induced traction loss. The TCM also receives wheel slip data and can immediately change gear without driver interaction.

### ***Stability Control Strategy***

In addition to wheel spin control, the TCM also adjusts shift strategies based on stability control signals from the ABS module and the PCM. The TCM can suppress gear shifts or alter shift characteristics to assist in controlling vehicle slide.

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# 8-Speed Electrical Operation

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**ACTIVITY 2 8-SPEED ELECTRICAL SYSTEMS ANALYSIS AND DIAGNOSIS**

**ANALYZE COMMUNICATION CIRCUITS**

Instructions: With the shifter network circuits already back probed, answer the following questions. Measure CAN-C network voltages using an oscilloscope or the peak min/max feature on the Series V digital multimeter.

1. What is the voltage of the CAN-C+?

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2. What is the voltage of the CAN-C-?

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3. What happens when the CAN-C circuits are shorted together?

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4. What happens when the CAN-C- circuits are shorted to ground?

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5. What happens when CAN-C+ is shorted to ground?

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6. What happens when CAN-C- has a short to power?

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## 8-Speed Electrical Systems Analysis and Diagnosis

7. What happens when CAN-C+ is shorted to power?

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8. Measure peak Min/Max voltages of the e-shift circuit.

b. What is the voltage measurement on the e-shift + circuit?

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c. What is the voltage measurement on the e-shift - circuit?

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9. What happens when the e-shift circuits are shorted together?

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10. What happens when CAN-C is shorted to one leg of the e-shift circuit?

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Notes:

Lined area for taking notes.



## LESSON 5 8-SPEED REPAIR PROCEDURES

### SERVICEABLE COMPONENTS

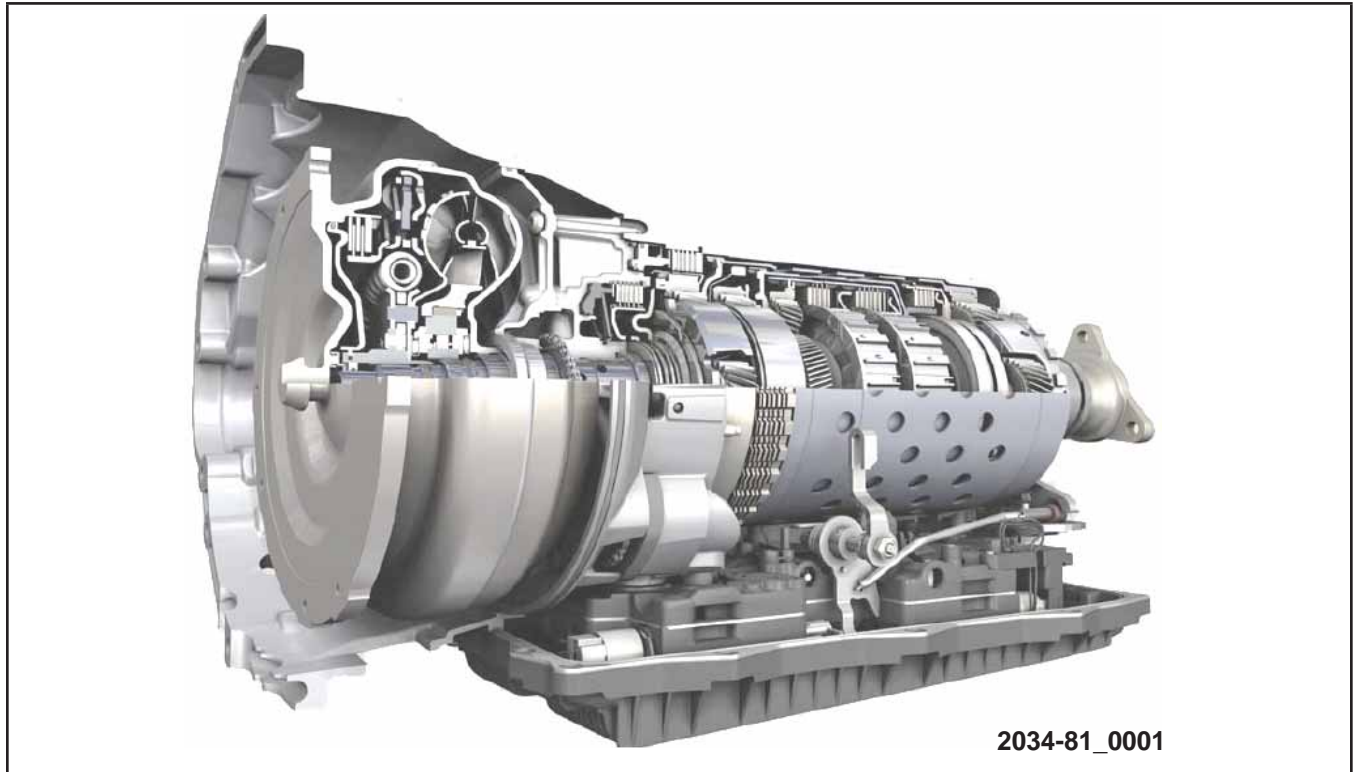


Figure 55 8-speed Serviceable Components

The components of the 8-speed automatic transmission that are available for repair will vary depending on whether the repair is covered under warranty or is considered customer pay. Always check with the service advisor and parts department before making any repair on the 8-speed automatic transmission.





## APPENDIX

## ZF 8-SPEED AUTOMATIC TRANSMISSION DIAGNOSTIC WORKSHEET

Print Form

### ZF 8 Speed Automatic Transmission Diagnostic Worksheet

Dealer Name:	<input type="text"/>	Contact Name:	<input type="text"/>
Dealer Code:	<input type="text"/>	Phone # & Fax #:	<input type="text"/>
Date of Complaint:	<input type="text"/>	Last 8 Digits of VIN:	<input type="text"/>
RO #:	<input type="text"/>	Mileage:	<input type="text"/>
Repeat Complaint:	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Vehicle Model:	<input type="text"/>	Vehicle Build Date:	<input type="text"/>
		Vehicle Sale Date:	<input type="text"/>
Transmission Software Level:	<input type="text"/>	Engine Software Level:	<input type="text"/>
		Transmission Serial No:	<input type="text"/>
Transmission Identification Plate: Is engraved onto the Left Hand side of the transmission casing			
Transmission Model No. 1090	<input type="text"/>	<input type="text"/>	
(e.g. 1090 010 020)			

## Customer Complained Of:

- |  |                                    |                                |
|--|------------------------------------|--------------------------------|
| <input type="checkbox"/> Shift Quality | <input type="checkbox"/> Noise     | <input type="checkbox"/> Leak  |
| <input type="checkbox"/> Function      | <input type="checkbox"/> Limp Mode | <input type="checkbox"/> Other |

Defect Details:

Transmission / Vehicle Fault Codes Registered:  Yes     No

Codes Registered:

## ZF - APPROVAL CONFIRMATION:

Approval Number:	<input type="text"/>
Approval Date:	<input type="text"/>
Component to be Dispatched:	<input type="text"/>
Component Dispatch Date:	<input type="text"/>

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# Appendix

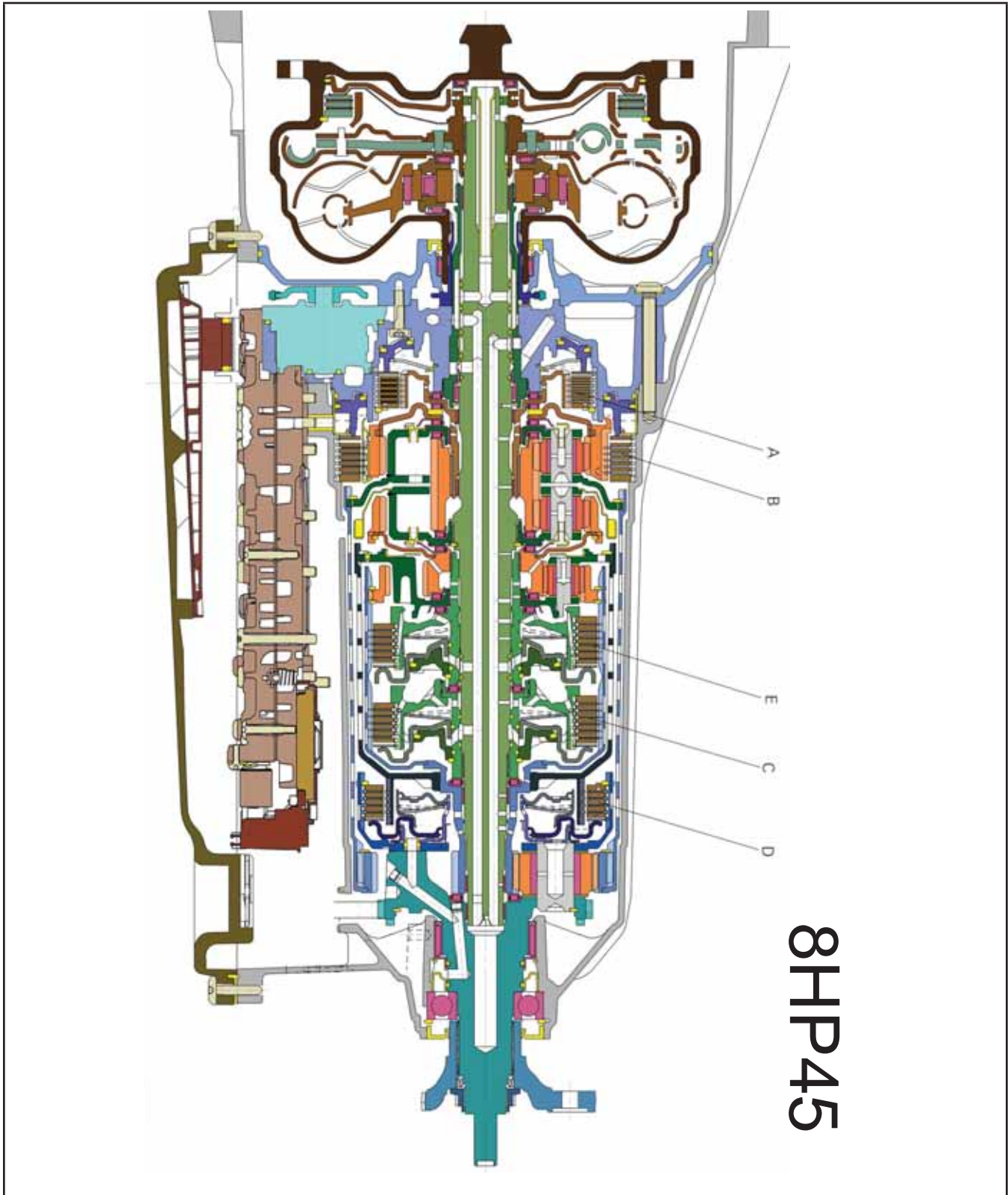
## SPECIAL TOOLS

### 8-Speed Transmission

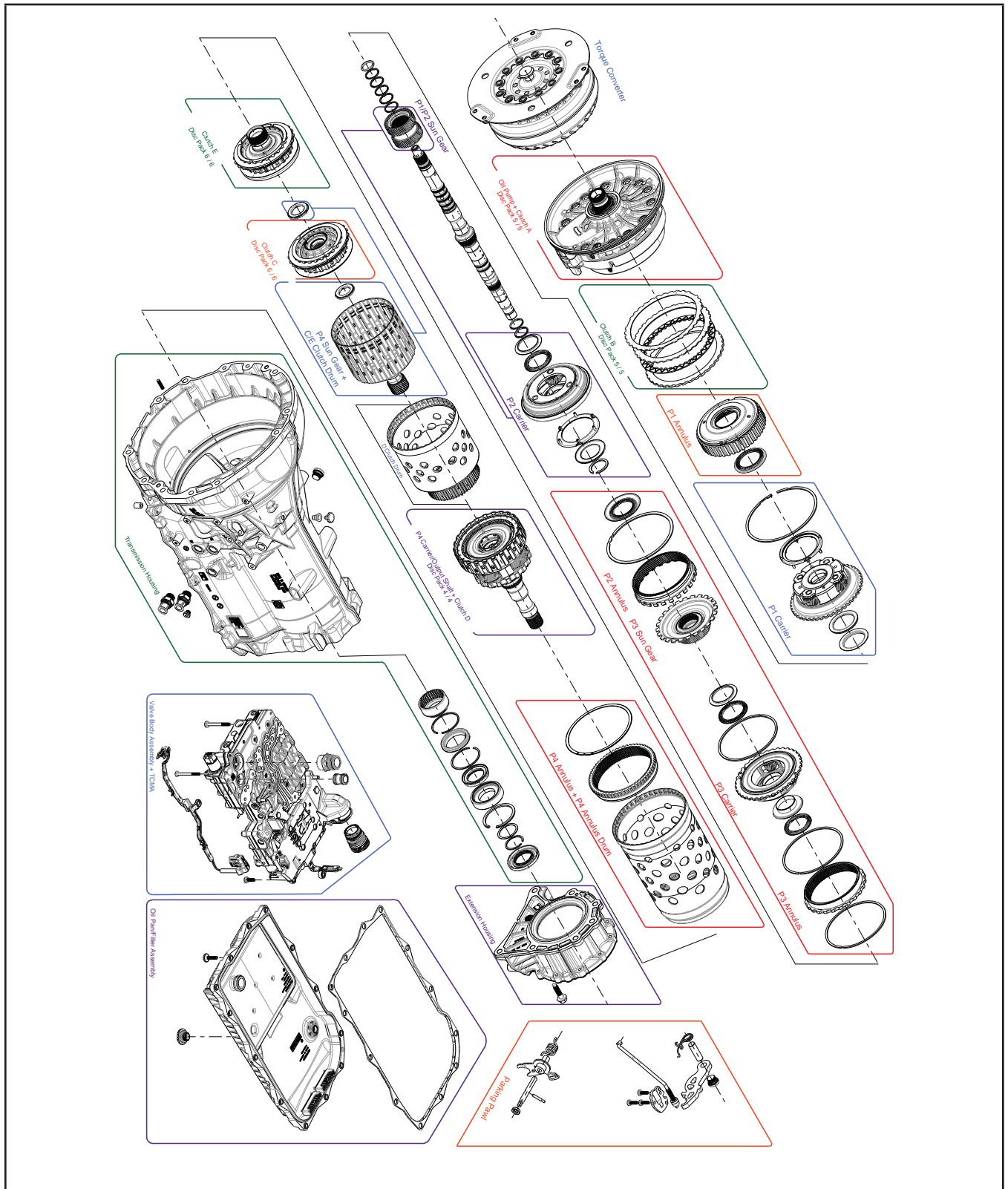
- C-3281 Flange Folder
  - Originally shipped in kit number(s) 9202, 9202A-CAN, 9202CC, 9299, 9299CC, 9299CC, 9300A-CAN.
- 10377 Guide Sleeve
  - Originally shipped in kit number(s) 10394, 10394A, 10394B
- 8285 Spring Compressor
  - Originally shipped in kit number(s) 8283, 8283CC, 8527, 8527CC, 8575, 8575CC, 9975.
- 8925-3 Press Fixture Assembly
  - Originally shipped in kit number(s) 8998, 8998CC.
- 1130 Bearing Splitter
  - Originally shipped in kit number(s) 6745, 6947, 6949, 9202, 9202A-CAN, 9202CC, 9299.
- 10378 Support rings
  - Originally shipped in kit number(s) 10394, 10394A, 10394B.
- 10379 Valve Body Alignment Pins
  - Originally shipped in kit number(s) 10394, 10394A, 10394B.
- 8901A Pressing Tool
  - Originally shipped in kit number(s) 8901A.
- 10426 Force Gauge
  - Originally shipped in kit number(s) 10419.
- 9667 Seal Remover
  - Originally Shipped In Kit Number(s) 9961.
- C- 3752 Slide Hammers
  - Originally Shipped In Kit Number(s) 9202, 9202A-CAN, 9202-CAN, 9202CC.
- 6787A Bearing Cup Remover
  - Originally Shipped In Kit Number(s) 6784, 6809.
- 9585 Bearing Cup Remover
  - Originally Shipped In Kit Number(s) 9691.
- 9664 Bearing Cup Remover
  - Originally Shipped In Kit Number(s) 9675, 9685, 9695.
- C- 637 Universal Slide Hammer
  - Originally Shipped In Kit Number(s) 9202.

- 10373A – Output Needle Bearing/Rear Oil Dam Installer
  - Originally Shipped In Kit Number(s) 10394A.
- C – 4171 Universal Driver Handle
  - Originally Shipped In Kit Number(s) 9202, 9202A-CAN, 9202CC, 9299, 9299CC, 9299CC, 9300A-CAN .
- 6936 – Spacer
  - Originally Shipped In Kit Number(s) 6945, 6946, 6947, 6948.
- 10376 – Input Shaft Needle Bearing Installer
  - Originally Shipped In Kit Number(s) 10394A, 10394-UPD.
- 10382 – Oil Pump Housing Needle Bearing Installer
  - Originally Shipped In Kit Number(s) 10394A, 10394-UPD.
- 10375 - Oil Pump Cover Seal Installer
- 10377 - Guide Sleeve Remover/Installer
- 8481 –Gear Installer
  - Originally Shipped In Kit Number(s) 8708, 8708CC.

8HP45 Cross Section

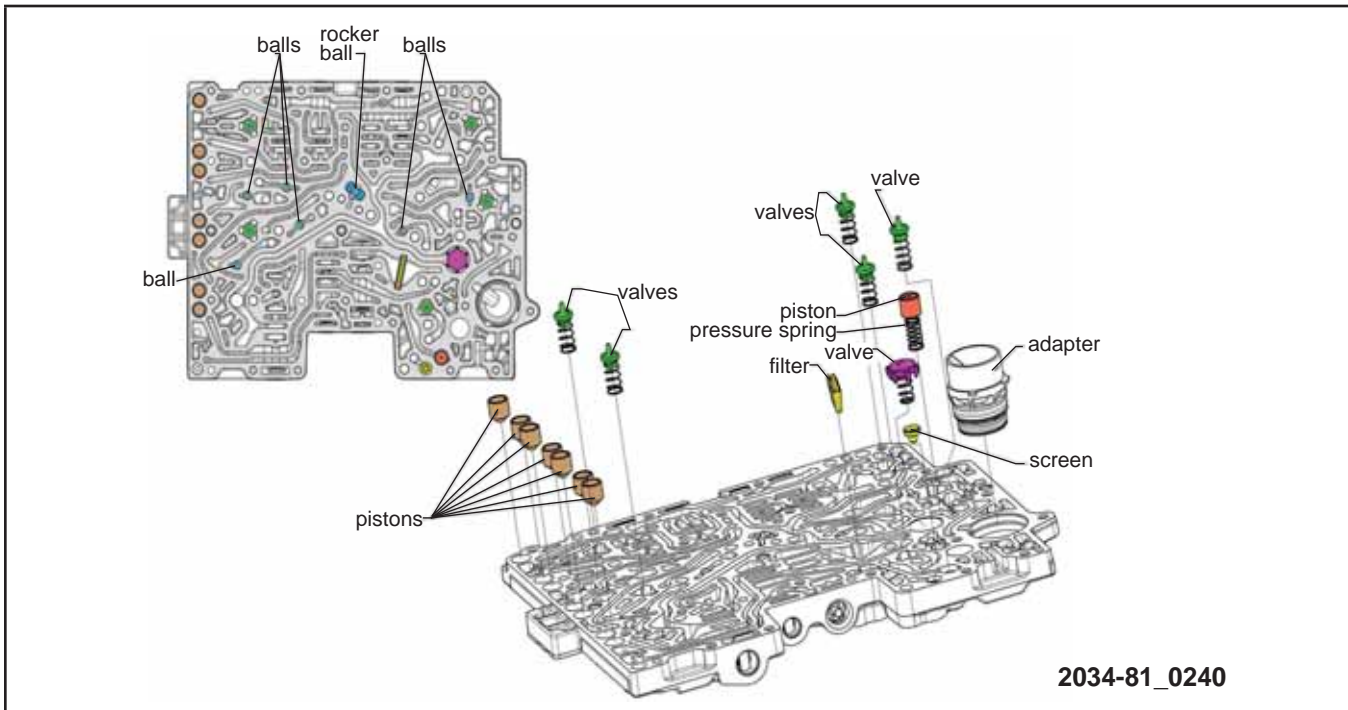


8HP45 Disassembled View

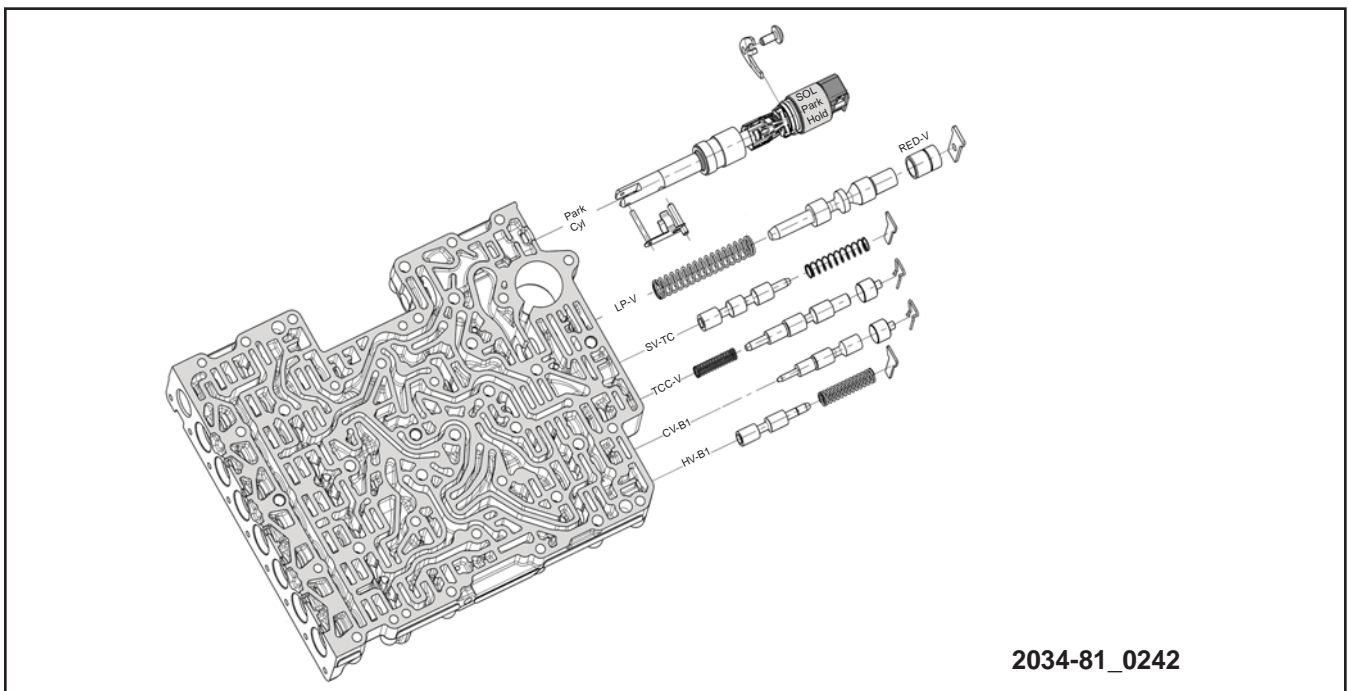




## 8-Speed Valve Body Exploded View

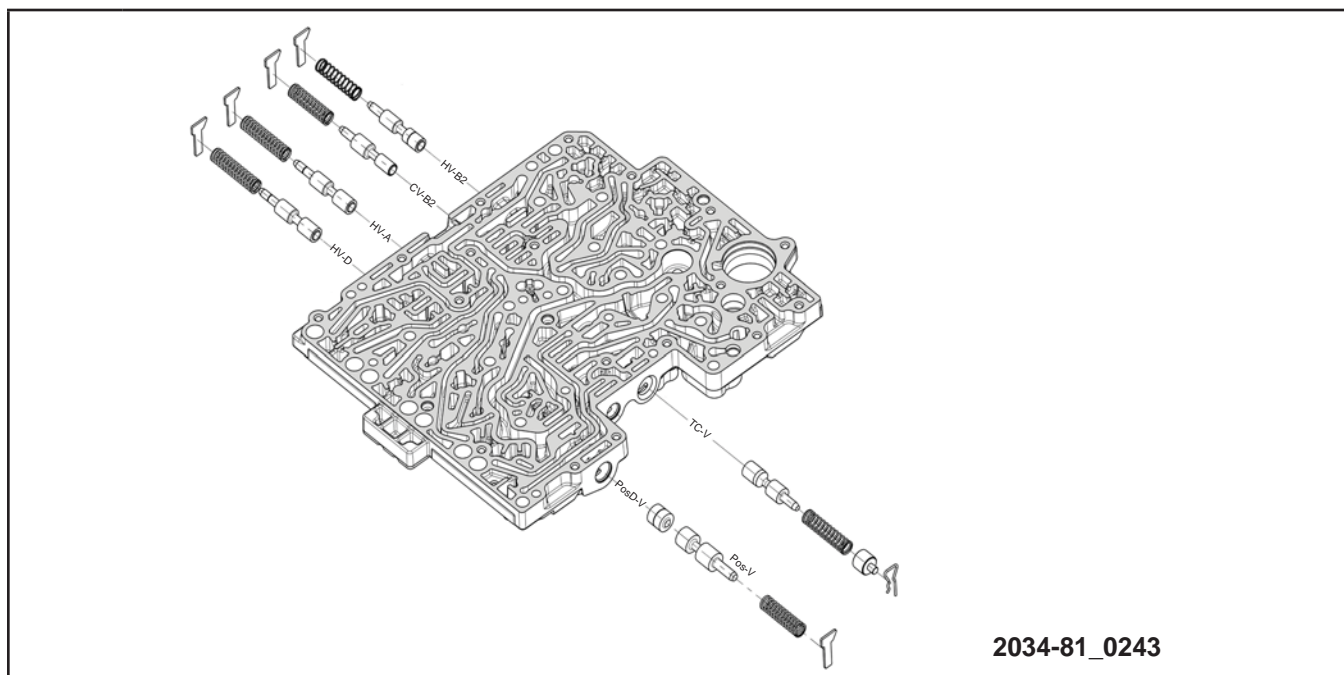


## 8-Speed Valve Body Solenoids



Park Cyl	Parking Pawl Release Piston	TCC-V	Torque Converter Clutch Valve
LP-V	Line Pressure Valve	CV-B1	Clutch Valve-B Clutch Apply
RED-V	Pressure Reducing Valve (Solenoids)	HV-B1	Holding Valve-B Clutch Apply
SV-TC	Switching Valve-Torque Converter		

Valve Body Valves - Inner Half



2034-81\_0243

HV-B2	Holding Valve-B Clutch Release	TC-V	Torque Converter Pressure Valve
CV-B2	Clutch Valve-B Clutch NIC	Pos-V	Position Valve
HV-A	Holding Valve-A Clutch	PosD-V	Default Position Valve
HV-D	Holding Valve-D Clutch		





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## GLOSSARY

adaptive strategies	Dynamic control over shift operation based on driving conditions and driver input.
car wash function	A strategy to keep the park lock disengaged when the engine is shut off with the electronic shifter in neutral.
cavitation	The formation of cavities or bubbles in a fluid that is being pumped. This occurs when the fluid level is too low and the inlet pipe draws air into the pumping system. This can also occur when the fluid level is too high and contacts the rotating components of the gear train (think of beating an egg with a whisk).
contact point pressure	The pressure necessary to fill the B1 clutch piston to allow it to just touch the release point.
controlled slip	Regulated amount of slip on the B clutch in neutral idle control.
de-energized	Meaning that an electrical solenoid is not being supplied any current.
double-stroke vane pump	A dual inlet and outlet chambered positive-displacement pump that consists of vanes mounted to a rotor that turns inside of a cavity.
electronic shifter	The electronic shifter system that uses sensors and bus communication instead of a traditional shift cable to control direction of movement.
electrostatic discharge	The human body, if electrically charged but not properly grounded, discharges an electrostatic spark (this endangers electronic components).
filled-for-life	Transmission fluid maintenance strategy stating: under normal operating conditions it is not necessary to check the fluid level or change the fluid and filter.
gear reduction	The input speed is higher than the output speed, increasing torque.
Hall-effect sensor	A transducer that varies its output voltage in response to a magnetic field.
holding clutch	A clutch that is splined to the case. When applied, the clutch causes a member of the gear set to stop rotating.
holding valve	Regulates the opening of the clutch valve to control shift feel.
molded lead frame	Molded plastic formed to the valve body that contains the internal harness and sensors.
multi-disc clutch pack	Type of clutch that has several driving members stacked with several driven members. Consisting of alternating steel and friction discs.
neutral idle control	A transmission strategy that disengages the transmission from engine torque when the vehicle is at a stop in a forward gear range.
position valve	Supplies hydraulic pressure to the driving clutches and maintains pressure in the driving clutch circuits if an electrical failure occurs.
rotating clutch	A clutch that is housed in a rotating drum or housing and provides input torque to the gear train.
Simpson gear set	A planetary gear set consisting of two planetary gear sets that share a common sun gear.

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torsional vibrations	Angular vibration of an object, such as the components transmitting the torque, can generate non-smooth or alternating torques. The components in the transmission are not infinitely stiff, these alternating torques cause vibration around the axis of rotation.
transmission control module assembly (TCMA)	The TCMA includes the transmission control module, the molded internal wire harness, and the four input sensors.
variable force solenoid	A solenoid that is controlled by a pulse-width-modulated signal to control the amount of fluid pressure in a hydraulic circuit.



FIAT CHRYSLER AUTOMOBILES

## WORLDWIDE

The special service tools referred to herein are required for certain service operations. These special service tools or their equivalent, if not obtainable through a local source, are available through the following outlet:

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