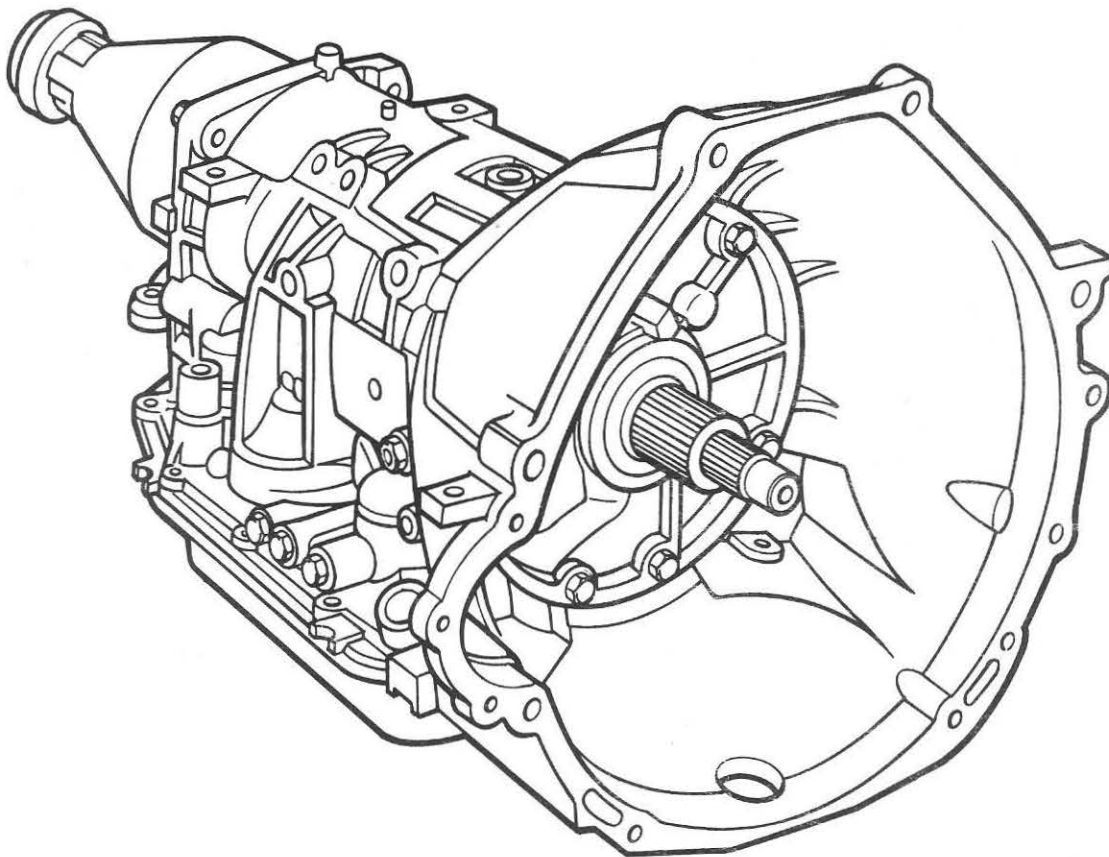




# **AODE/4R70W AUTOMATIC TRANSMISSION**

**THEORY/  
OPERATION**



**REFERENCE MANUAL**

PTB-606A

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## THEORY

### GENERAL DESCRIPTION

#### DESIGN

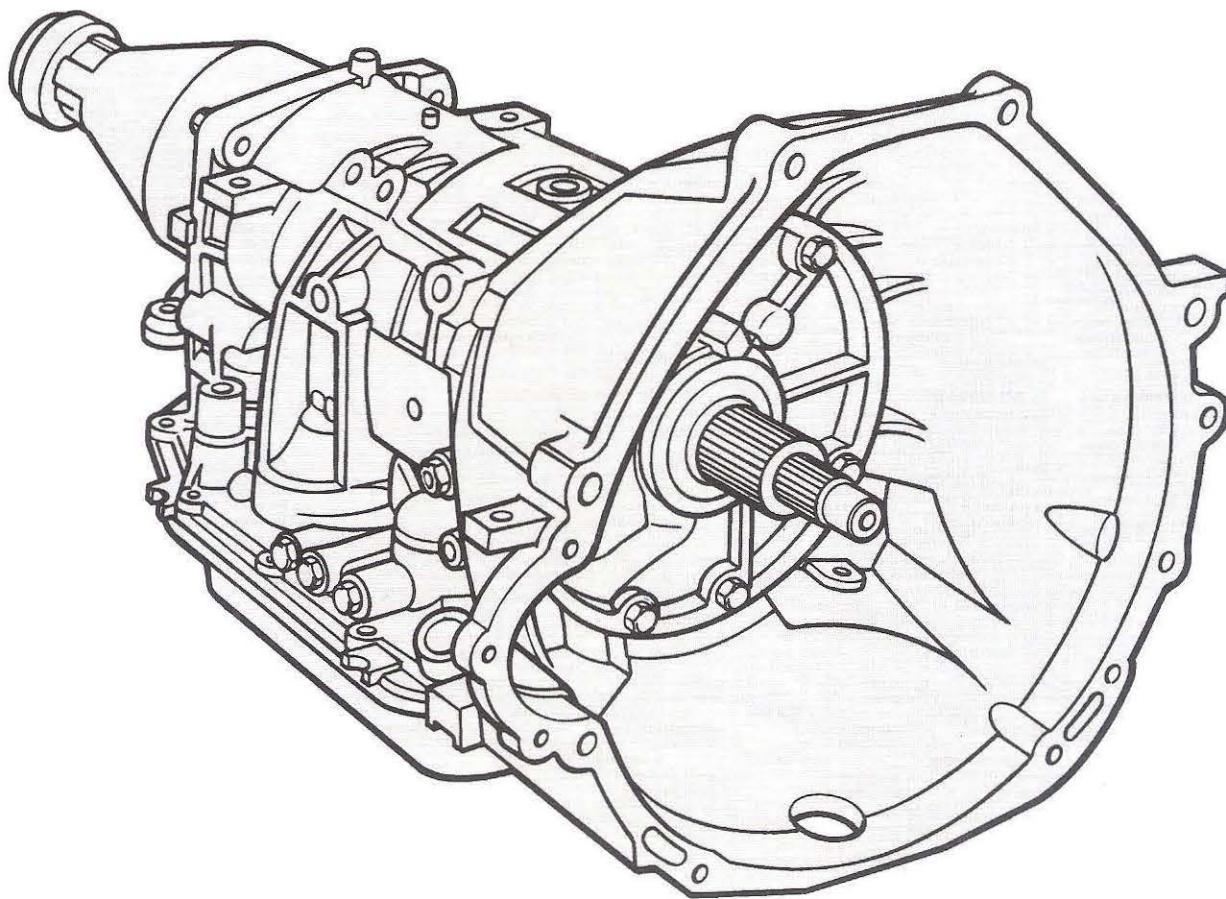
The Ford AODE and 4R70W automatic transmissions are four-speed units with electronic shift control. They are designed for operation in longitudinal powertrains for rear-wheel drive vehicles.

The AODE and 4R70W transmissions feature a four-element torque converter design that includes TCC (Torque Converter Clutch) and a gear train that includes a long-and-short pinion gearset of the Ravigneaux design.

The gearset of the AODE transmission provides different gear ratios than the gearset of the 4R70W transmission. Refer to page 14 for more information.

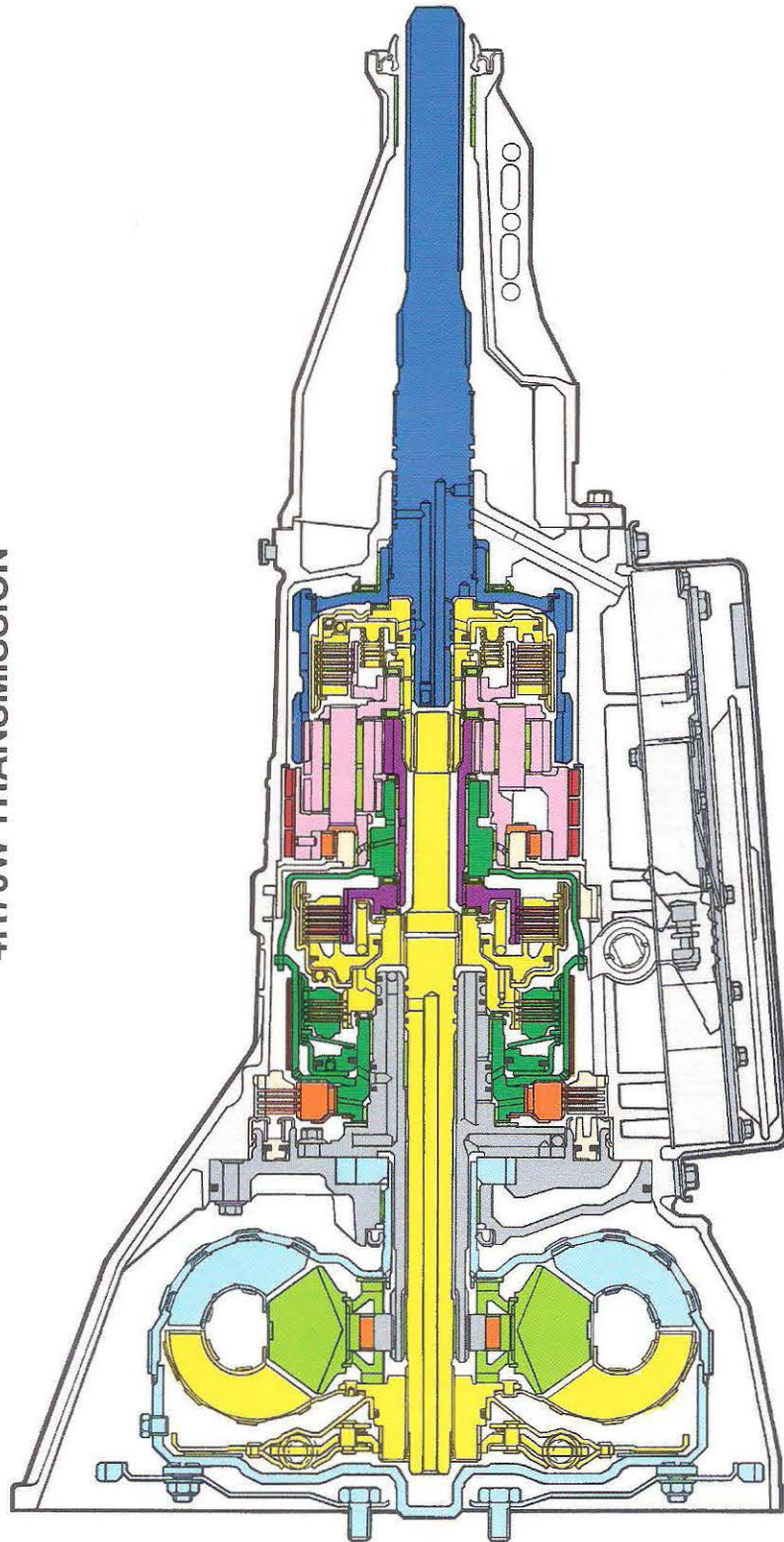
The hydraulic control systems of the AODE and 4R70W transmissions have four electronically controlled solenoids for:

- Shift feel (through line pressure control)
- Shift scheduling (through shift valve position control)
- Modulated TCC apply





4R70W TRANSMISSION



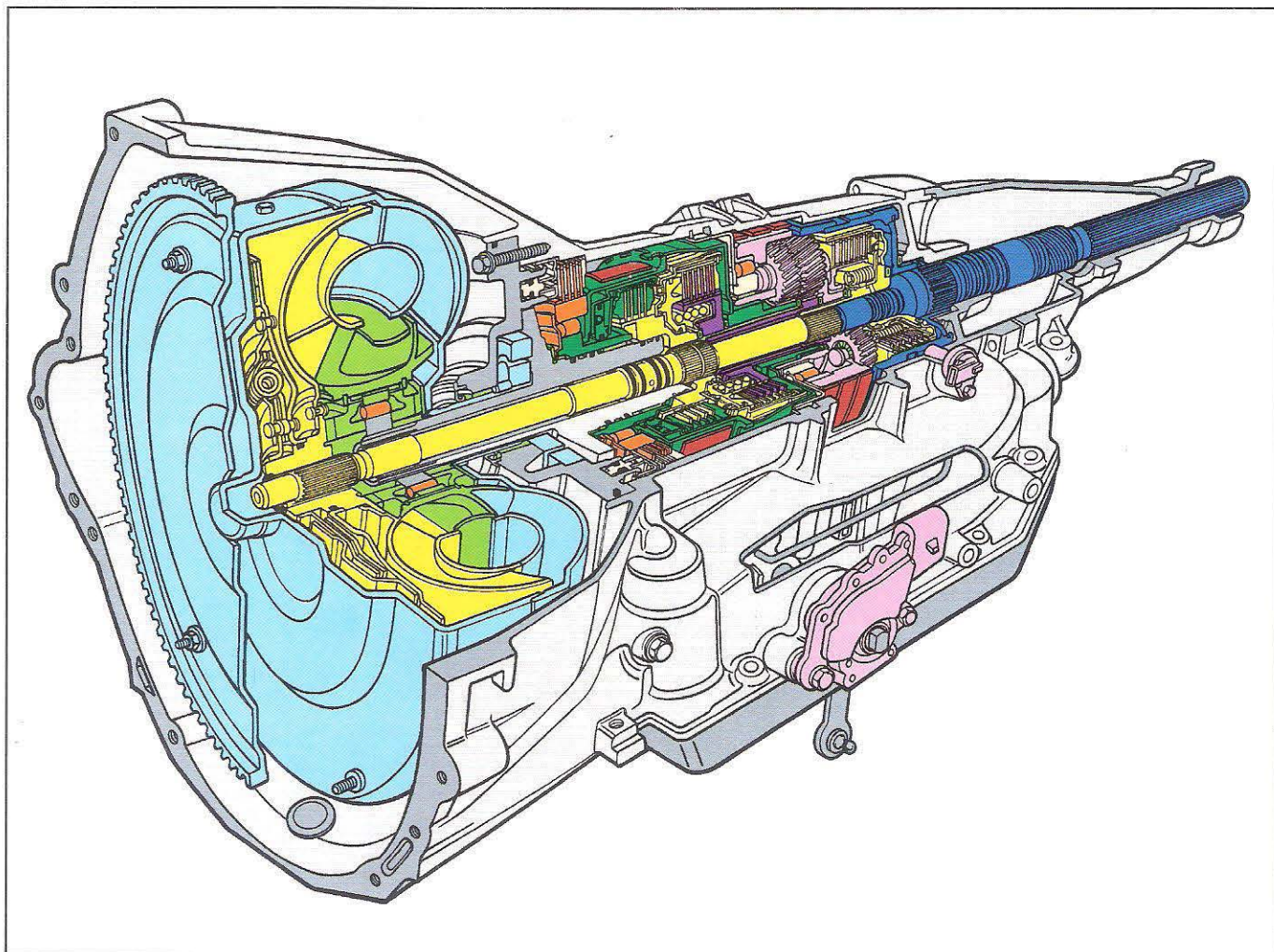
# THEORY

## GENERAL DESCRIPTION

### MAJOR COMPONENTS

The AODE and 4R70W transmissions have the following major components:

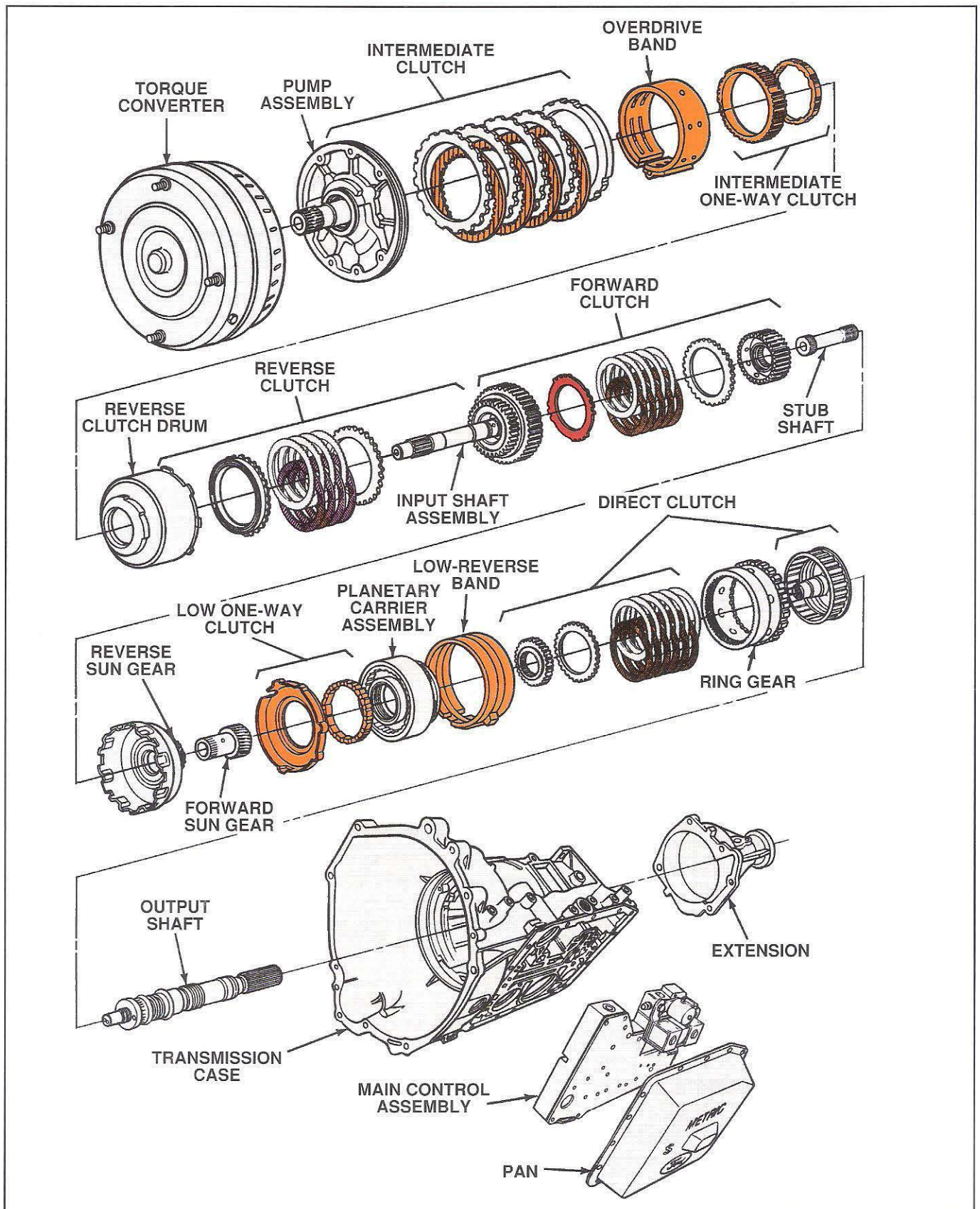
- Case with extension
- Torque converter
- Pump assembly
- Apply components:
  - Two friction bands:
    - Overdrive
    - Low-Reverse
  - Four friction clutches:
    - Intermediate
    - Reverse
    - Forward
    - Direct
- Two one-way clutches:
  - Intermediate
  - Low
- One long-and-short pinion planetary gearset
- Main control





# THEORY

## GENERAL DESCRIPTION





# THEORY

## GENERAL DESCRIPTION

### RATIOS

The planetary gearset of the AODE transmission provides the following ratios:

- 2.00:1 in Reverse
- 2.40:1 in 1st gear (low)
- 1.47:1 in 2nd gear (intermediate)
- 1.00:1 in 3rd gear (direct)
- 0.67:1 in 4th gear (overdrive)

The planetary gearset of the 4R70W transmission provides the following ratios:

- 2.32:1 in Reverse
- 2.84:1 in 1st gear (low)
- 1.55:1 in 2nd gear (intermediate)
- 1.00:1 in 3rd gear (direct)
- 0.70:1 in 4th gear (overdrive)

### SHIFT QUADRANTS AND PATTERNS

#### 1992 Vehicles

1992 vehicles equipped with the AODE transmission do not have a Transmission Control Switch (TCS). The shift quadrant has the following positions: **P**, **R**, **N**, **D**, and **1**.

**D** position provides 1-2-3-4 automatic upshifts and downshifts. Coast braking occurs in 3rd gear and 4th gear.

**D** position provides 1-2-3 automatic upshifts and downshifts. Coast braking occurs in 3rd gear.

**1** position provides a pull-in shift to 2nd gear with coast braking. After an automatic downshift, a 1st gear hold occurs with coast braking.

#### 1993-to-Present Vehicles

1993-to-present vehicles that are equipped with the AODE or 4R70W transmission have a Transmission Control Switch (TCS). The shift quadrant has the following positions: **P**, **R**, **N**, **D**, **2** and **1** (for AODE) or **P**, **R**, **N**, **D**, **2** and **1** (for 4R70W).

**D** or **D** position (TCS OFF) provides 1-2-3-4 automatic upshifts and downshifts. Coast braking occurs in 3rd gear and 4th gear.

**D** or **D** position (TCS ON) provides 1-2-3 automatic upshifts and downshifts. Coast braking occurs in 3rd gear.

**2** position provides a pull-in shift to 3rd gear with coast braking. After an automatic downshift, a 2nd gear hold occurs with coast braking.

**1** position provides a pull-in shift to 2nd gear with coast braking. After an automatic downshift, a 1st gear hold occurs with



### 1992 VEHICLES

MANUAL LEVER POSITION	MODE SELECT CAPABILITIES	
	AUTO OPERATION	COMMENT
Ⓓ	1 ↔ 2 ↔ 3 ↔ 4	Four gears operation.
D	1 ↔ 2 ↔ 3	Three gears operation, 4th gear is inhibited.
1	1 ← 2	1st gear hold. Transmission will shift to 1st gear automatically.

→ Upshifting  
 ← Downshifting  
 □ Desired steady-state gear

### 1993-TO-PRESENT VEHICLES

MANUAL LEVER POSITION	MODE SELECT CAPABILITIES		
	AUTO OPERATION	TCS	COMMENT
Ⓓ	1 ↔ 2 ↔ 3 ↔ 4	OFF	Four gears operation.
	1 ↔ 2 ↔ 3	ON	Three gears operation, 4th gear is inhibited.
2	2 ← 3	OFF or ON	2nd gear hold. Transmission will shift to 2nd gear automatically.
1	1 ← 2	OFF or ON	1st gear hold. Transmission will shift to 1st gear automatically.

→ Upshifting  
 ← Downshifting  
 □ Desired steady-state gear



## THEORY

### MECHANICAL COMPONENTS

#### TORQUE CONVERTER

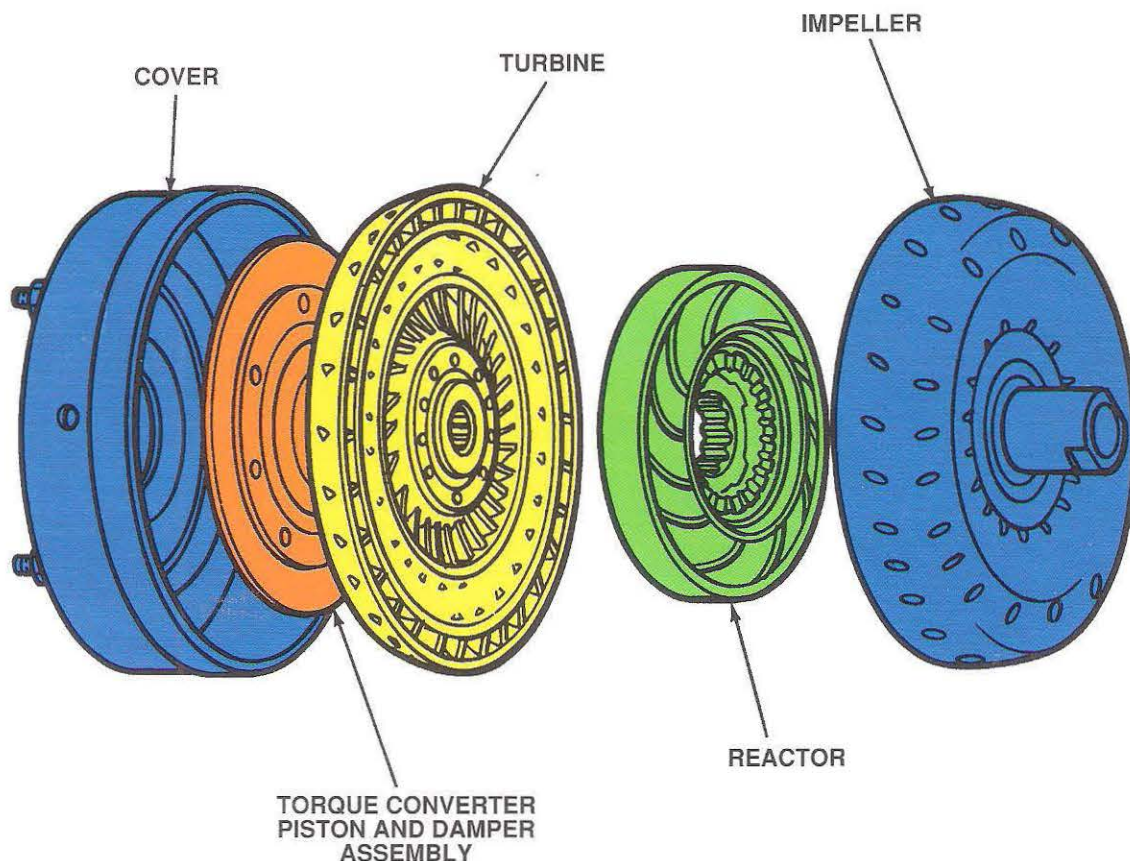
The AODE/4R70W torque converter is a four-element assembly. It contains an impeller, a turbine and a reactor, plus TCC (Torque Converter Clutch) for increased fuel economy.

The impeller and cover assembly drives the impeller blades and oil pump. It contains hydraulic fluid and provides a mating surface for the TCC piston and damper assembly.

The turbine is driven by fluid from the impeller and transmits power to the chain drive and planetary gearsets.

The reactor redirects fluid flow returned from the turbine to the impeller so that it rotates in the same direction as the impeller. This action assists in torque multiplication.

The reactor has a one-way clutch to hold the reactor stationary during torque multiplication (at lower vehicle speeds) and allow the reactor to rotate (at higher vehicle speeds).





## THEORY

### MECHANICAL COMPONENTS

TCC (Torque Converter Clutch) has the following features:

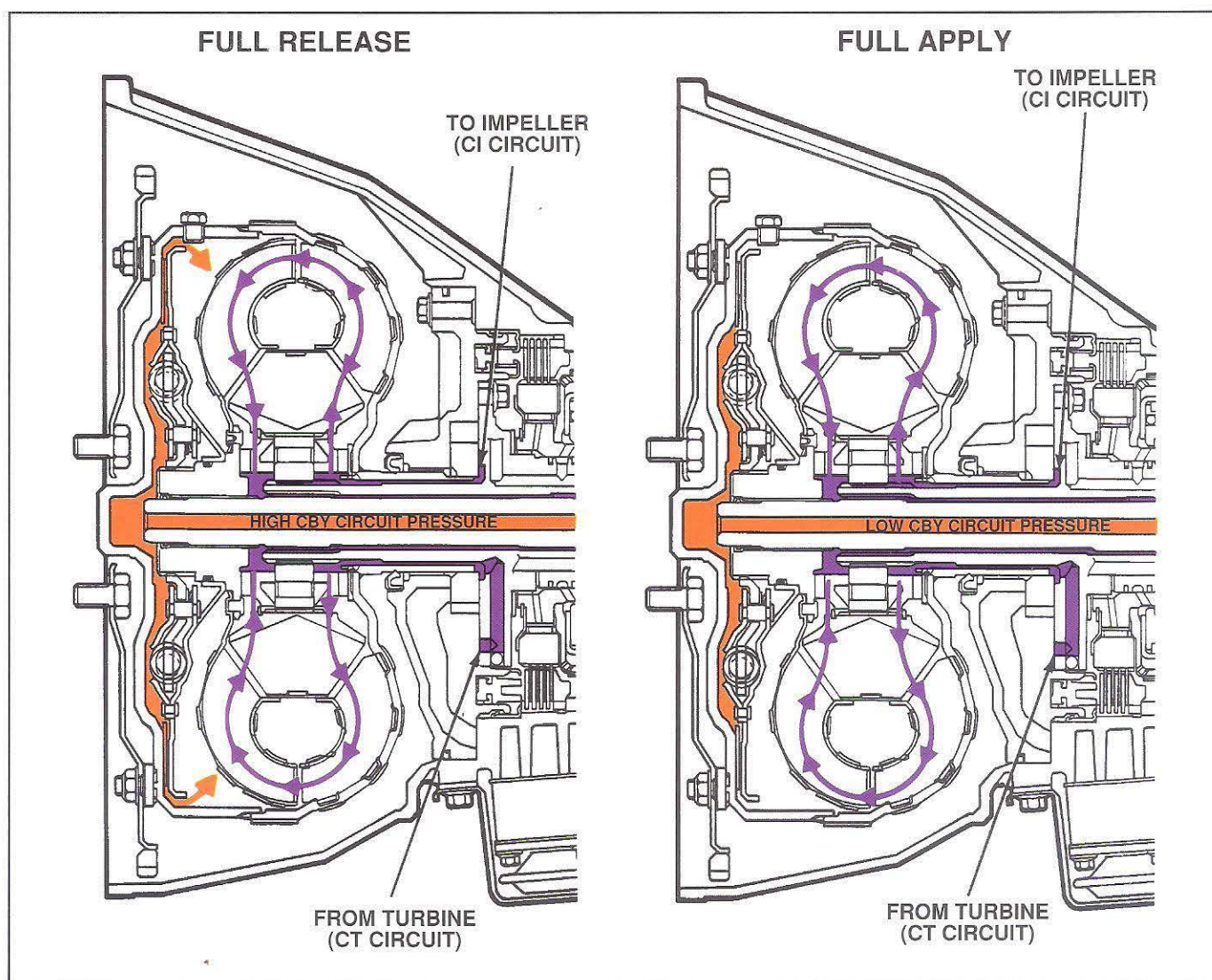
- A piston and damper assembly that mounts on the turbine shaft
- A friction paper surface on the torque converter cover that makes contact with the piston and damper assembly when TCC is applied
- Fluid under pressure in the hydraulic circuits **CI** and **CT** that flows through the impeller and turbine areas and pushes the TCC piston and damper assembly into contact with the cover
- Fluid under pressure in the hydraulic circuit **CBY** that pushes the TCC plate away from the cover

TCC operates in three stages:

- Full release
- Controlled modulation
- Full apply

The PCM (Powertrain Control Module) controls TCC operation, using the TCC solenoid.

TCC solenoid operation provides modulation of hydraulic circuit **CBY** pressure to change the position of the bypass clutch control valve. The TCC may be applied in 2nd, 3rd and 4th gear.



## THEORY

### MECHANICAL COMPONENTS

#### PLANETARY GEARSET

The AODE/4R70W transmission has one planetary gearset to provide operation in reverse and four forward speeds.

The gearset has the following parts:

- Reverse sun gear
- Forward sun gear
- Planetary carrier
- Ring gear

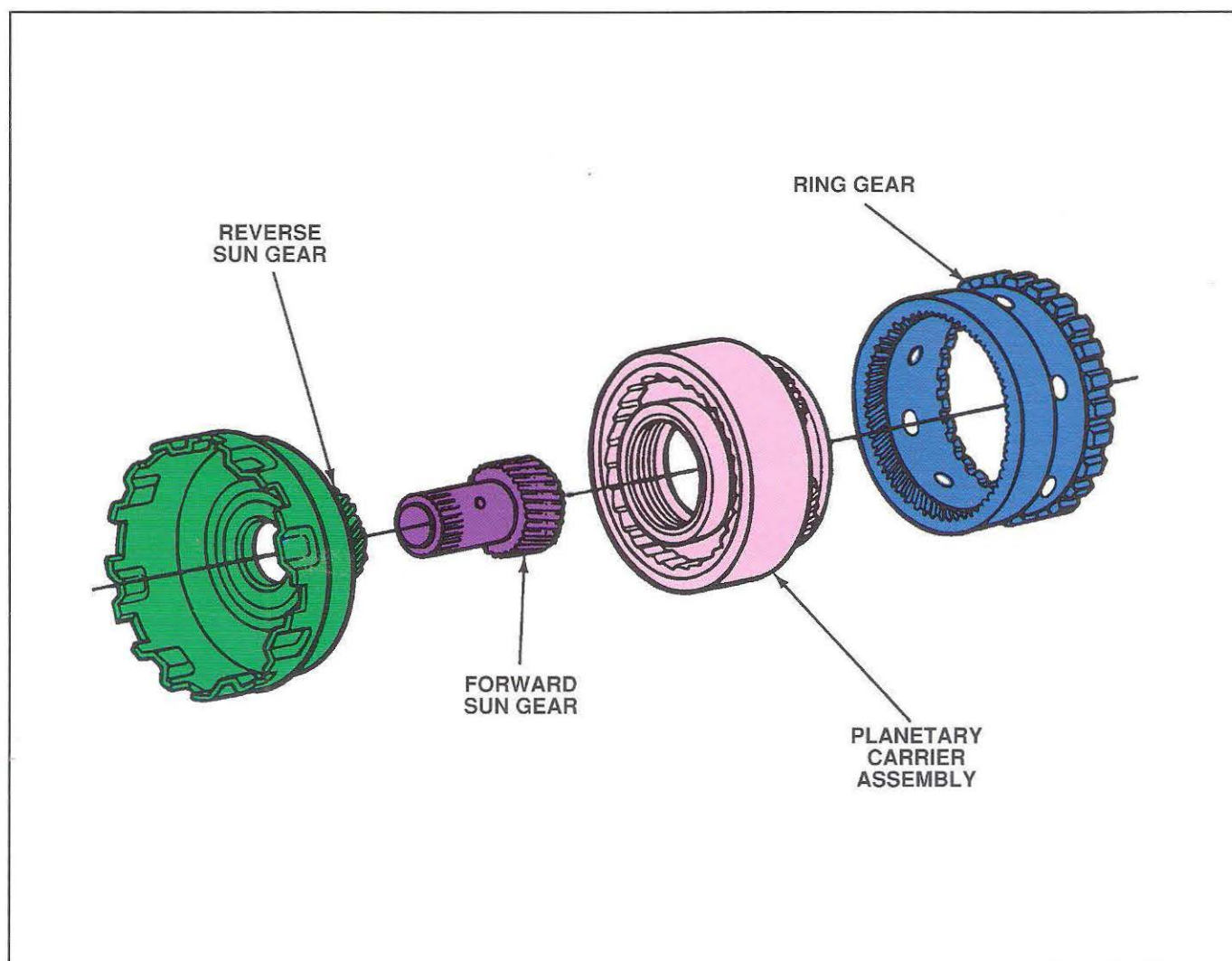
The planetary carrier has long pinion gears that mesh with the reverse sun gear and the ring gear.

The planetary carrier also has short pinion gears that mesh with the forward sun gear and the ring gear.

The input shaft rotates the reverse sun gear as a driving member in reverse during drive and coast operation, using the reverse clutch.

The transmission case holds the reverse sun gear stationary in 2nd gear during drive operation, using the intermediate clutch and intermediate one-way clutch.

In manual 2nd gear, the overdrive band assists the intermediate clutch and intermediate one-way clutch during drive and coast operation.





## THEORY MECHANICAL COMPONENTS

The transmission case holds the reverse sun gear stationary in 4th gear during drive and coast operation, using the overdrive band.

In 4th gear, the intermediate clutch and intermediate one-way clutch assist the overdrive band during drive operation.

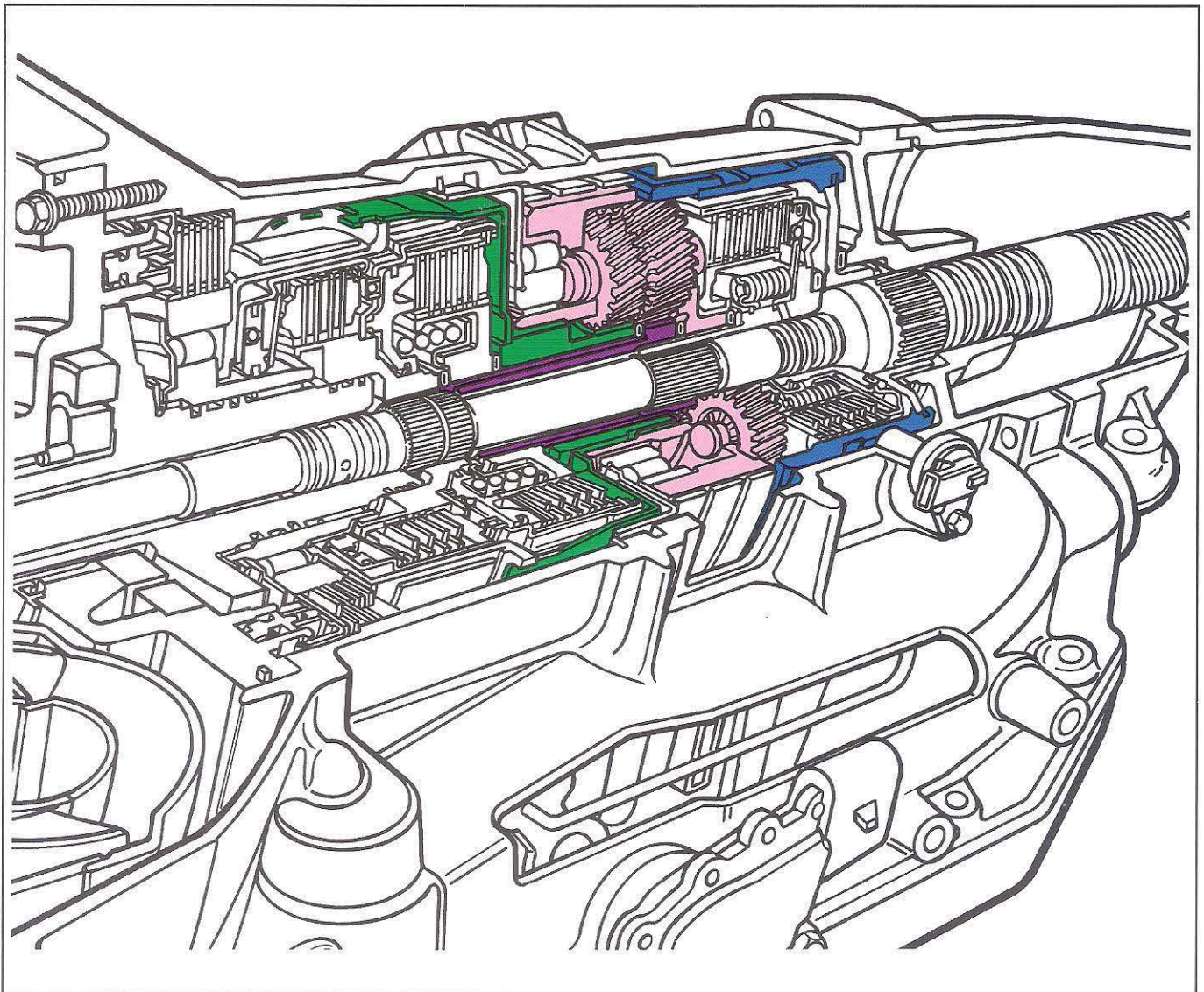
The input shaft rotates the forward sun gear as a driving member during drive and coast operation, using the forward clutch. This occurs in 1st gear, 2nd gear and 3rd gear, as well as in manual 1st gear and manual 2nd gear.

The transmission case holds the planetary carrier stationary in 1st gear during drive operation, using the low one-way clutch.

The transmission case holds the planetary carrier stationary in reverse and manual 1st gear during drive and coast operation, using the low-reverse band. In manual 1st gear, the low one-way clutch assists the low-reverse band during drive operation.

The input shaft rotates the planetary carrier as a driving member in 3rd gear and 4th gear during drive and coast operation, using the direct clutch.

The ring gear is the driven member of the planetary gearset. It connects to the output shaft.





# THEORY

## MECHANICAL COMPONENTS

### APPLY COMPONENTS

#### Clutch/Band Operation

The apply components of the AODE/4R70W transmission work together to provide a flow of power, as the chart below shows. Coast braking occurs in reverse, 3rd gear and 4th gear.

In manual 2nd gear, the holding action of the overdrive band provides coast braking. In manual 1st gear, the holding action of the low-reverse band provides coast braking.

A = APPLIED  
X = APPLIED/INEFFECTIVE  
H = HOLDING  
OR = OVERRUNNING

GEAR	POSITION	OVERDRIVE BAND		LOW-REVERSE BAND		INTERMEDIATE CLUTCH		REVERSE CLUTCH		FORWARD CLUTCH		DIRECT CLUTCH		INT ONE-WAY CLUTCH		LOW ONE-WAY CLUTCH	
		RS	PC	RS	PC	RS	PC	FS	PC	RS	PC	RS	PC	RS	PC	RS	PC
PARK	P																
REVERSE	R			A		A											
NEUTRAL	N																
1ST	OD, D							A								H	OR
2ND	OD, D					A		A		H	OR	OR	OR			OR	OR
3RD	OD, D, 2					X		A	A	OR	OR	OR	OR			OR	OR
4TH	OD, D	A		A				A	H								
M-2ND	2, 1	A		A				A		H						OR	OR
M-1ST	1			A				A								H	
PLANETARY COMPONENT		RS	PC	RS	PC	RS	PC	FS	PC	RS	PC	RS	PC	RS	PC	RS	PC

FS = FORWARD SUN GEAR  
RS = REVERSE SUN GEAR  
PC = PLANETARY CARRIER



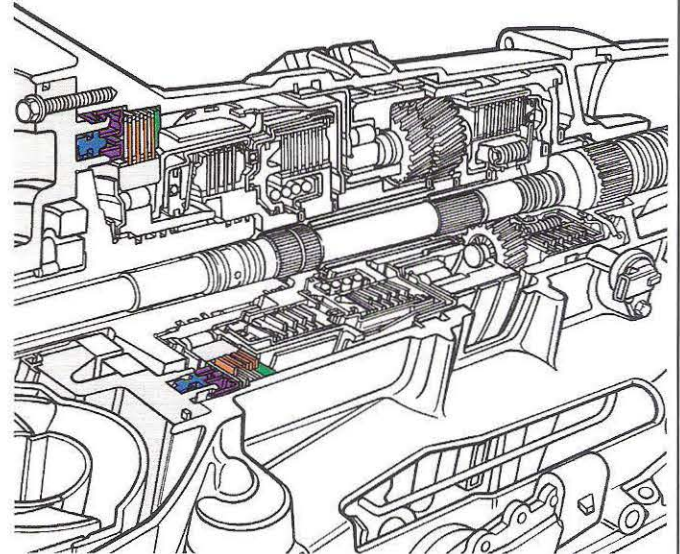
### Intermediate Clutch

The intermediate clutch connects the outer race of the intermediate one-way clutch to the transmission case.

The intermediate clutch is applied in 2nd gear, 3rd gear and 4th gear, as well as in manual 2nd gear.

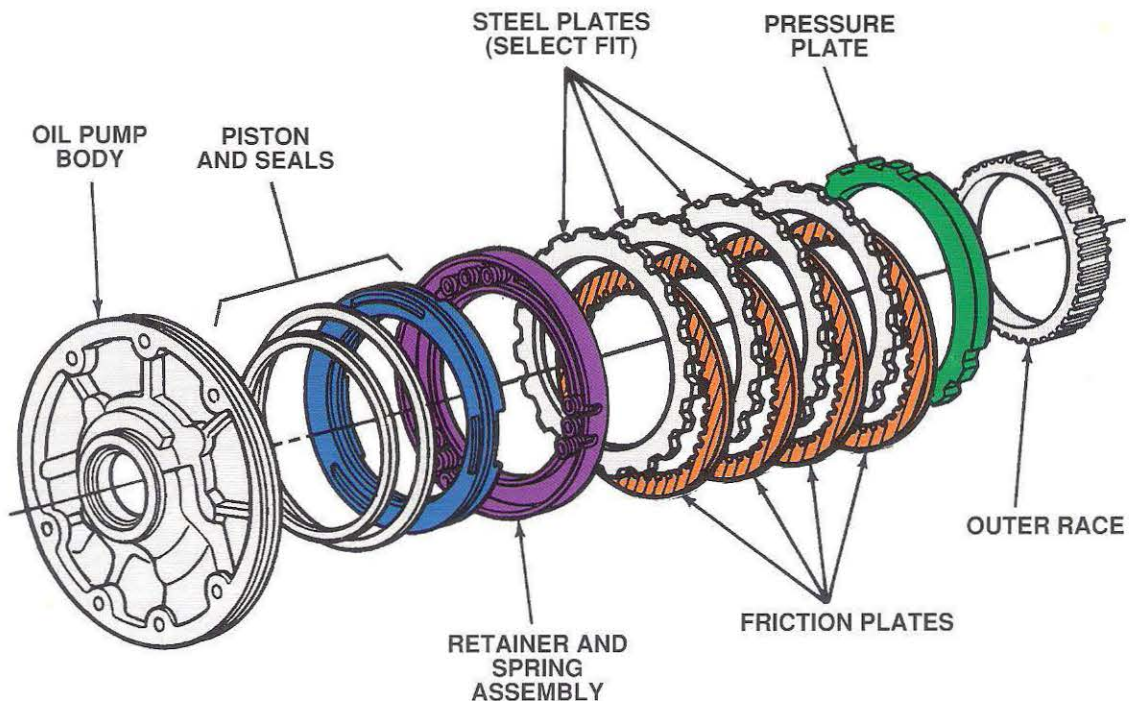
A = APPLIED  
X = APPLIED/  
INEFFECTIVE  
H = HOLDING  
OR = OVERRUNNING

GEAR	POSITION	OVERDRIVE BAND	LOW-REVERSE BAND	INTERMEDIATE CLUTCH	REVERSE CLUTCH	FORWARD CLUTCH	DIRECT CLUTCH	DRIVE	COAST	INT ONE-WAY CLUTCH	LOW ONE-WAY CLUTCH
PARK	P										
REVERSE	R	A	A								
NEUTRAL	N										
1ST	OD, D				A					H OR	
2ND	OD, D		A	A				H OR	OR	OR	OR
3RD	OD, D, 2		X	A	A			OR	OR	OR	OR
4TH	OD, D	A	A		A			H			
M-2ND	2, 1	A	A		A			H		OR	OR
M-1ST	1	A		A						H	



#### INTERMEDIATE CLUTCH APPLY:

- Fluid in the **INT CL** circuit pushes the clutch piston against return spring force.
- The piston pushes the clutch plates against a retaining ring.
- The outer race of the intermediate one-way clutch and transmission case are connected, due to friction.





# THEORY

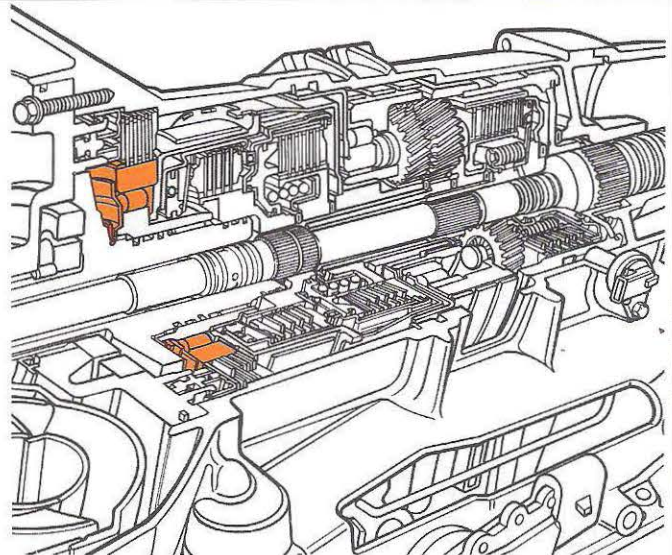
## MECHANICAL COMPONENTS

### Intermediate One-Way Clutch

The intermediate one-way clutch connects the reverse clutch drum to the intermediate clutch. The reverse clutch drum connects to the reverse sun gear.

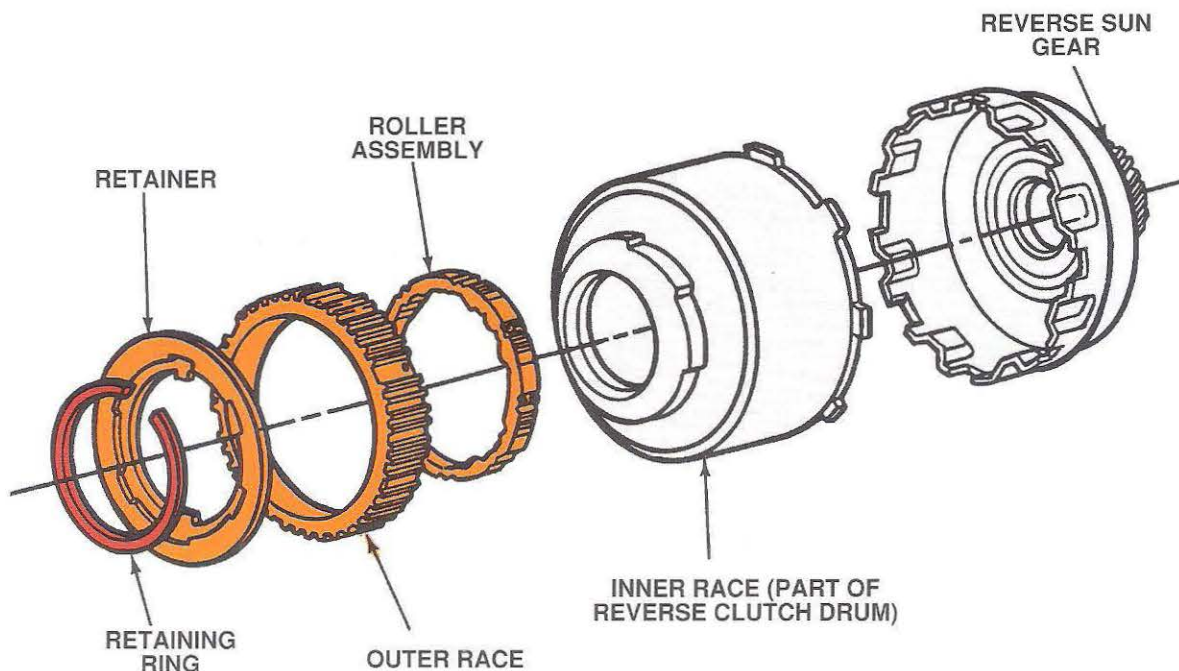
The intermediate one-way clutch transmits torque during drive operation in 2nd gear, 4th gear and manual 2nd gear.

GEAR	POSITION								
		OVERDRIVE BAND	LOW-REVERSE BAND	INTERMEDIATE CLUTCH	REVERSE CLUTCH	FORWARD CLUTCH	DIRECT CLUTCH	INT ONE-WAY CLUTCH	LOW ONE-WAY CLUTCH
PARK	P								
REVERSE	R	A	A						
NEUTRAL	N								
1ST	OD, D				A				H OR
2ND	OD, D		A	A		H OR	OR	OR	OR
3RD	OD, D, 2		X	A	A	OR	OR	OR	OR
4TH	OD, D	A	A		A	H			
M-2ND	2, 1	A	A	A		H		OR	OR
M-1ST	1	A		A				H	



#### INTERMEDIATE ONE-WAY CLUTCH HOLDING ACTION:

- The transmission case holds the outer race stationary when the intermediate clutch is applied.
- The inner race rotates along with the reverse sun gear.
- The inner race contacts the assembly of rollers, wedging them between the inner and outer races.
- The wedging action causes the reverse clutch drum and outer race to be connected.





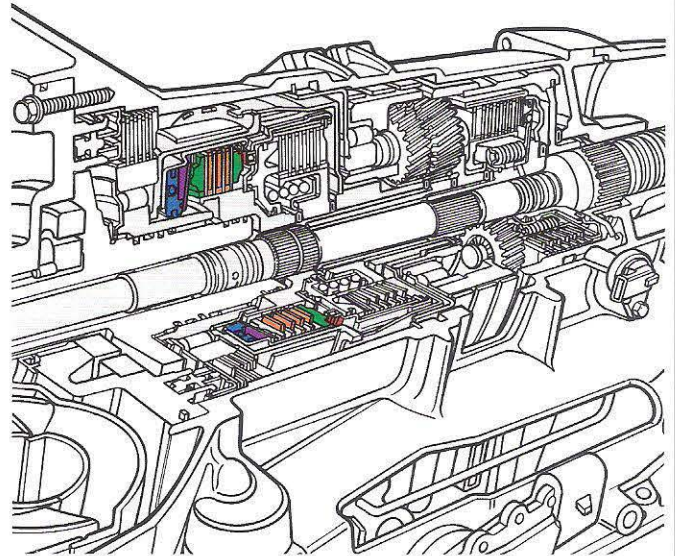
### Reverse Clutch

The reverse clutch connects the input shaft to the reverse clutch drum, which connects to the reverse sun gear.

The reverse clutch is applied when the transmission operates in the **R** position.

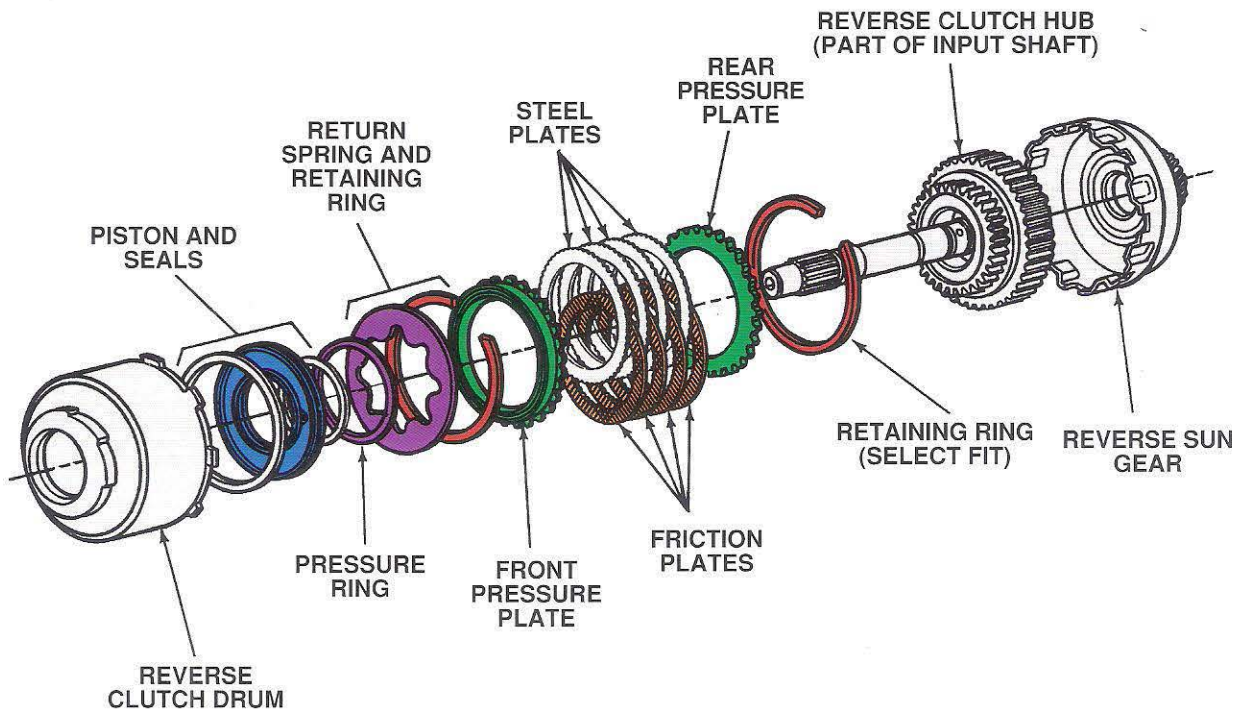
A = APPLIED  
X = APPLIED/INEFFECTIVE  
H = HOLDING  
OR = OVERRUNNING

GEAR	POSITION	OVERDRIVE BAND	LOW-REVERSE BAND	INTERMEDIATE BAND	REVERSE CLUTCH	FORWARD CLUTCH	DIRECT CLUTCH	DRIVE	COAST	INT ONE-WAY CLUTCH	LOW ONE-WAY CLUTCH
PARK	P										
REVERSE	R		A		A						
NEUTRAL	N										
1ST	OD, D					A				H OR	
2ND	OD, D			A		A		H OR	OR OR		
3RD	OD, D, 2			X		A	A	OR	OR OR		
4TH	OD, D	A					A	H			
M-2ND	2, 1	A		A		A		H	OR	OR	
M-1ST	1	A				A				H	



#### REVERSE CLUTCH APPLY:

- Fluid in the **R** circuit pushes the clutch piston against return spring force.
- The piston pushes the clutch plates against a retaining ring.
- The input shaft and the reverse clutch drum are connected, due to friction.





# THEORY

## MECHANICAL COMPONENTS

### Overdrive Band

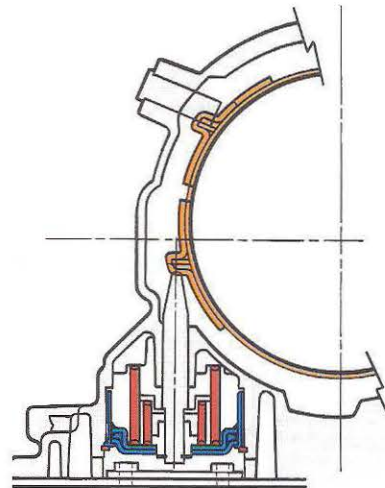
The overdrive band connects the reverse clutch drum to the transmission case. The reverse clutch drum connects to the reverse sun gear.

The overdrive band is applied in 4th gear and manual 2nd gear.

A = APPLIED  
X = APPLIED/INEFFECTIVE  
H = HOLDING  
OR = OVERRUNNING

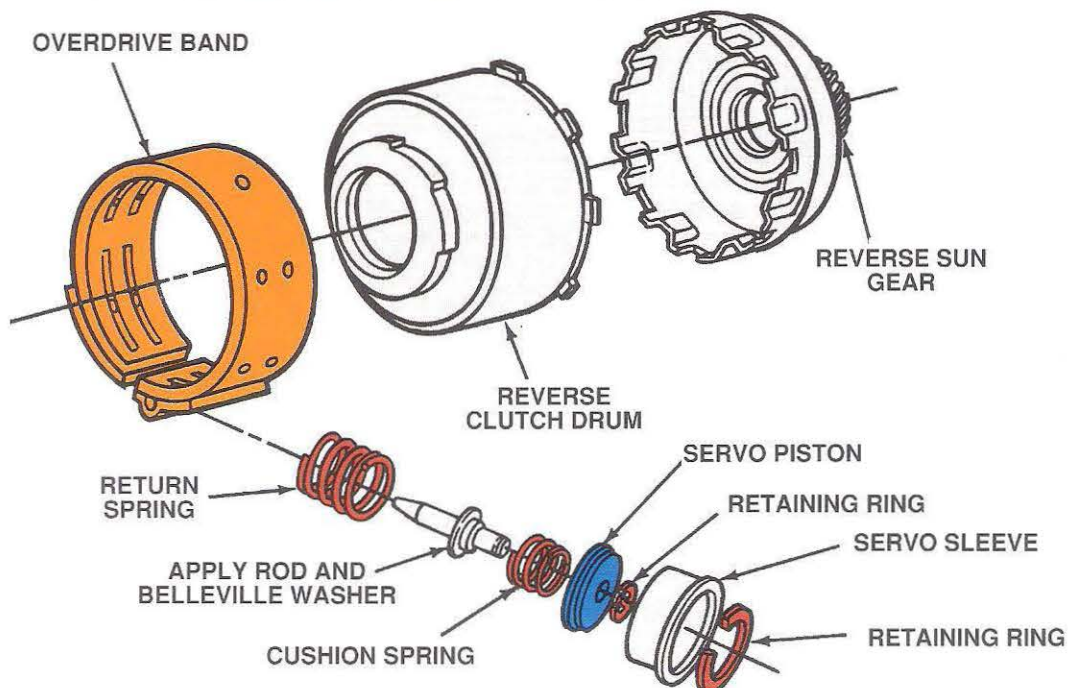
GEAR	POSITION	OVERDRIVE BAND	LOW-REVERSE BAND	INTERMEDIATE CLUTCH	REVERSE CLUTCH	FORWARD CLUTCH	DIRECT CLUTCH	DRIVE	COAST	INT ONE-WAY CLUTCH	LOW ONE-WAY CLUTCH
PARK	P										
REVERSE	R	A			A						
NEUTRAL	N										
1ST	OD, D					A				H OR	
2ND	OD, D			A	A			H OR	OR	OR	OR
3RD	OD, D, 2			X	A	A		OR	OR	OR	OR
4TH	OD, D	A		A		A		H			
M-2ND	2, 1	A		A		A		H		OR	OR
M-1ST	1	A			A					H	

OVERDRIVE BAND PARTS SECTION VIEW



#### OVERDRIVE BAND APPLY:

- Fluid in the **ODA** circuit pushes the servo piston and its apply rod against return spring force and fluid pressure in the **ODA** circuit.
- The apply rod pushes one end of the band, causing the band to squeeze around the reverse clutch drum.
- The overdrive band and reverse clutch drum are connected, due to friction.



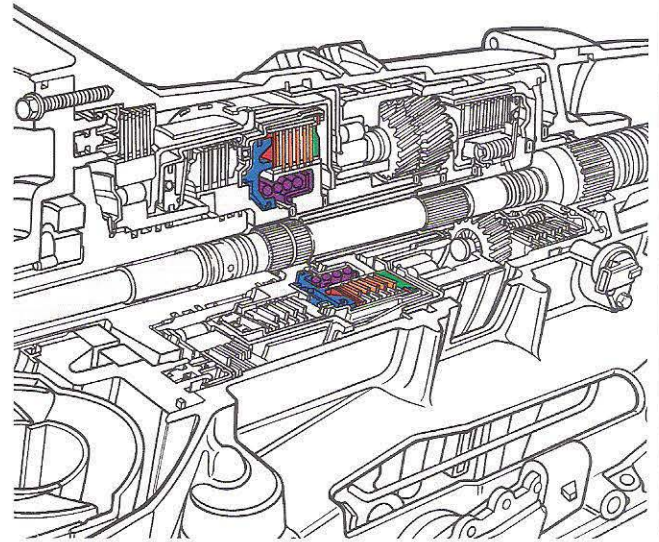
### Forward Clutch

The forward clutch connects the input shaft to the forward clutch hub, which connects to the forward sun gear.

The forward clutch is applied when the transmission operates in 1st gear, 2nd gear and 3rd gear, as well as in manual 1st gear and manual 2nd gear.

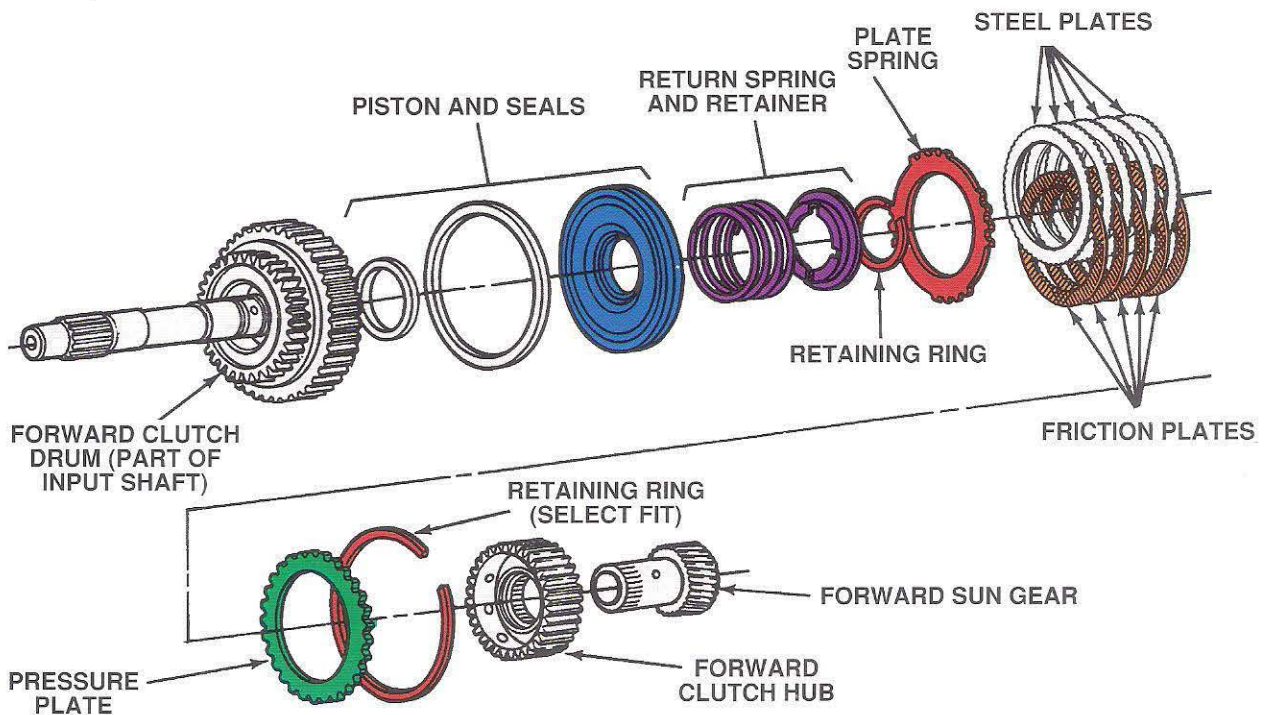
A = APPLIED  
X = APPLIED/INEFFECTIVE  
H = HOLDING  
OR = OVERRUNNING

GEAR	POSITION	OVERDRIVE BAND	LOW-REVERSE BAND	INTERMEDIATE CLUTCH	REVERSE CLUTCH	FORWARD CLUTCH	DIRECT CLUTCH	DRIVE	COAST	INT ONE-WAY CLUTCH	LOW ONE-WAY CLUTCH
PARK	P										
REVERSE	R	A	A								
NEUTRAL	N										
1ST	OD, D					A				H OR	
2ND	OD, D			A		A		H	OR OR	OR	
3RD	OD, D, 2		X	A	A	A		OR	OR OR	OR	
4TH	OD, D	A	A			A	H				
M-2ND	2, 1	A	A			A	H		OR	OR	
M-1ST	1	A				A				H	



#### FORWARD CLUTCH APPLY:

- Fluid in the **FC** circuit pushes the clutch piston against return spring force.
- The piston pushes the clutch plates against a retaining ring.
- The input shaft and forward clutch hub are connected, due to friction.





# THEORY

## MECHANICAL COMPONENTS

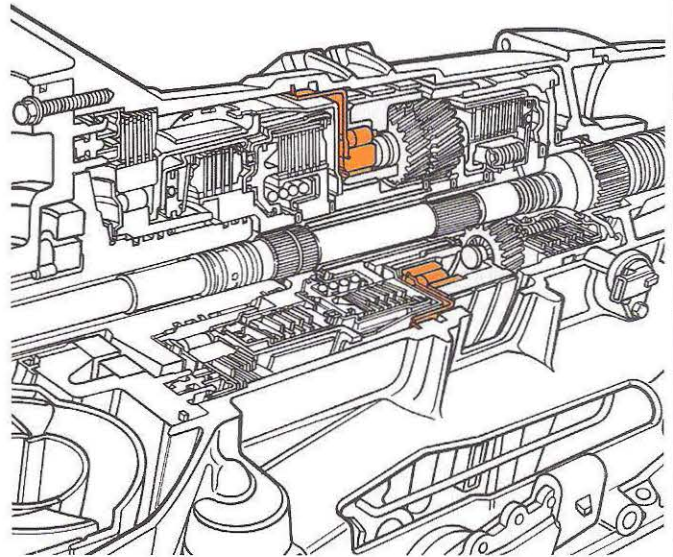
### Low One-Way Clutch

The low one-way clutch connects the planetary carrier to the transmission case.

The low one-way clutch transmits torque during drive operation in 1st gear and manual 1st gear.

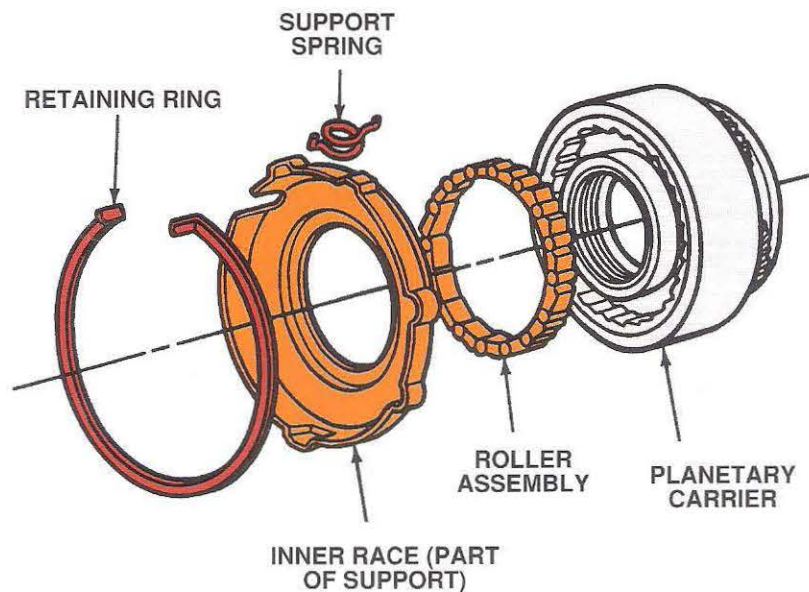
A = APPLIED  
X = APPLIED/  
INEFFECTIVE  
H = HOLDING  
OR = OVERRUNNING

GEAR	POSITION	OVERDRIVE BAND	LOW-REVERSE BAND	INTERMEDIATE CLUTCH	REVERSE CLUTCH	FORWARD CLUTCH	DIRECT CLUTCH	DRIVE	COAST	INT ONE-WAY CLUTCH	LOW ONE-WAY CLUTCH
PARK	P										
REVERSE	R	A	A								
NEUTRAL	N										
1ST	OD, D				A					H OR	
2ND	OD, D		A	A		H	OR	OR	OR		
3RD	OD, D, 2		X	A	A	OR	OR	OR	OR		
4TH	OD, D	A	A		A	H					
M-2ND	2, 1	A	A	A		H				OR	OR
M-1ST	1	A		A						H	



#### LOW ONE-WAY CLUTCH HOLDING ACTION:

- The outer race rotates along with the planetary carrier.
- The outer race contacts the assembly of rollers, wedging them between the inner and outer races.
- The wedging action causes the outer race and transmission case to be connected.



### Low-Reverse Band

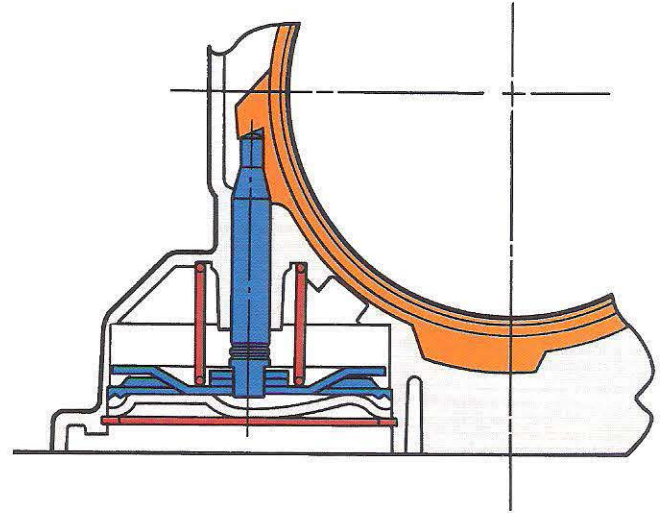
The low-reverse band connects the planetary carrier to the transmission case.

The low-reverse band is applied in reverse and manual 1st gear.

A = APPLIED  
X = APPLIED/INEFFECTIVE  
H = HOLDING  
OR = OVERRUNNING

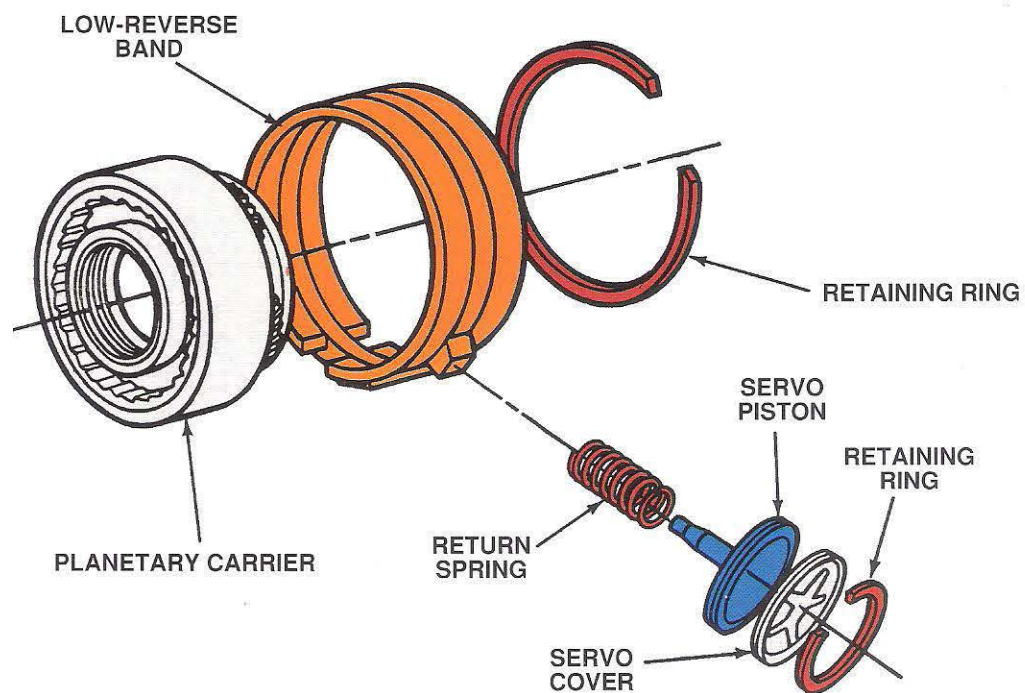
GEAR	POSITION	OVERDRIVE BAND	LOW-REVERSE BAND	INTERMEDIATE CLUTCH	REVERSE CLUTCH	FORWARD CLUTCH	DIRECT CLUTCH	DRIVE	COAST	INT ONE-WAY CLUTCH	DRIVE	COAST
PARK	P											
REVERSE	R		A	A								
NEUTRAL	N											
1ST	OD, D				A					H	OR	
2ND	OD, D		A	A				H	OR	OR	OR	OR
3RD	OD, D, 2		X	A	A	OR	OR	OR	OR			
4TH	OD, D	A	A		A	H						
M-2ND	2, 1	A	A	A		H		OR	OR			
M-1ST	1	A		A				H				

LOW-REVERSE BAND PARTS SECTION VIEW



#### LOW-REVERSE BAND APPLY:

- Fluid in the **LR** circuit pushes the servo piston and its apply rod against return spring force.
- The apply rod pushes one end of the band, causing the band to squeeze around the planetary carrier.
- The planetary carrier and transmission case are connected, due to friction.





# THEORY

## MECHANICAL COMPONENTS

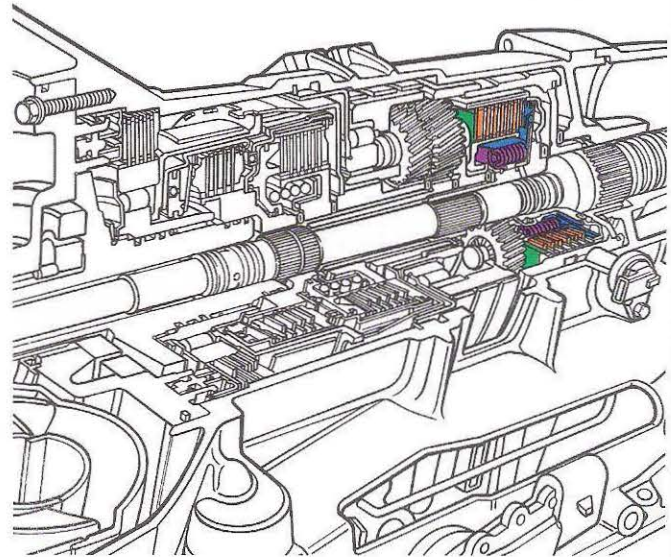
### Direct Clutch

The direct clutch connects the input shaft to the direct clutch hub, which connects to the planetary carrier.

The direct clutch is applied in 3rd and 4th gear.

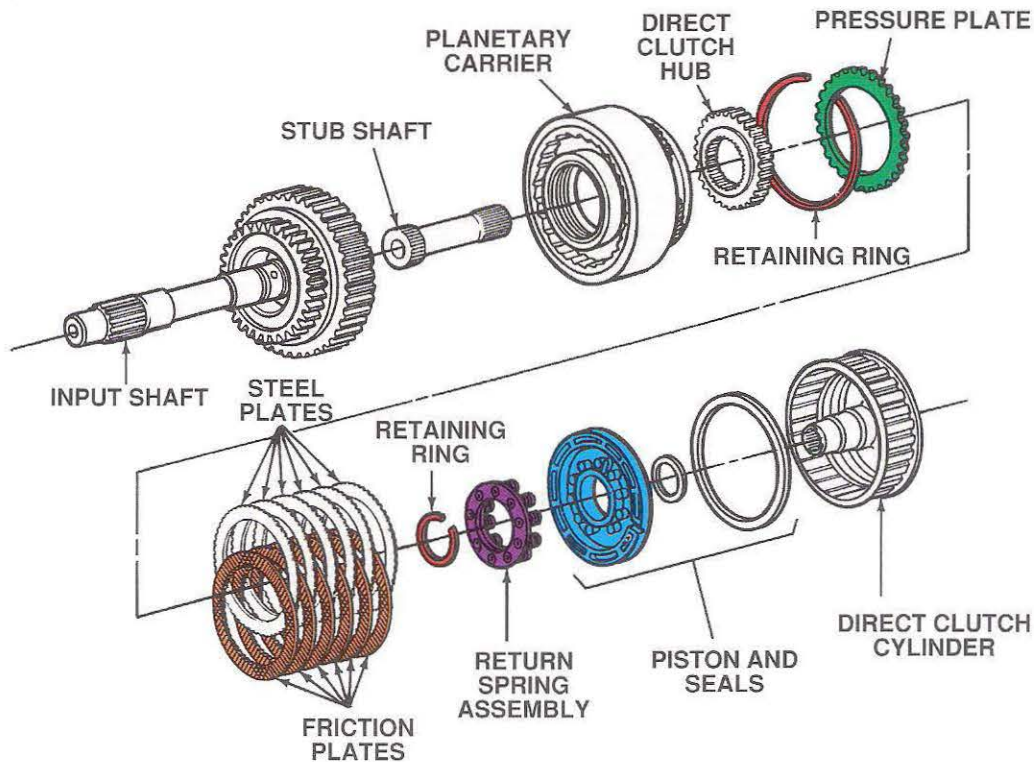
A = APPLIED  
X = APPLIED/INEFFECTIVE  
H = HOLDING  
OR = OVERRUNNING

GEAR	POSITION	OVERDRIVE BAND	LOW-REVERSE BAND	INTERMEDIATE CLUTCH	REVERSE CLUTCH	FORWARD CLUTCH	DIRECT CLUTCH	DRIVE	COAST	DRIVE	COAST
PARK	P										
REVERSE	R	A	A								
NEUTRAL	N										
1ST	OD, D				A					H OR	
2ND	OD, D			A	A			H OR	OR	OR	OR
3RD	OD, D, 2		X		A	A		OR	OR	OR	OR
4TH	OD, D	A	A			A		H			
M-2ND	2, 1	A	A		A					OR	OR
M-1ST	1		A			A				H	



#### DIRECT CLUTCH APPLY:

- Fluid in the **DIR CL** circuit pushes the clutch piston against return spring force.
- The piston pushes the clutch plates against a retaining ring.
- The input shaft and direct clutch hub are connected, due to friction.



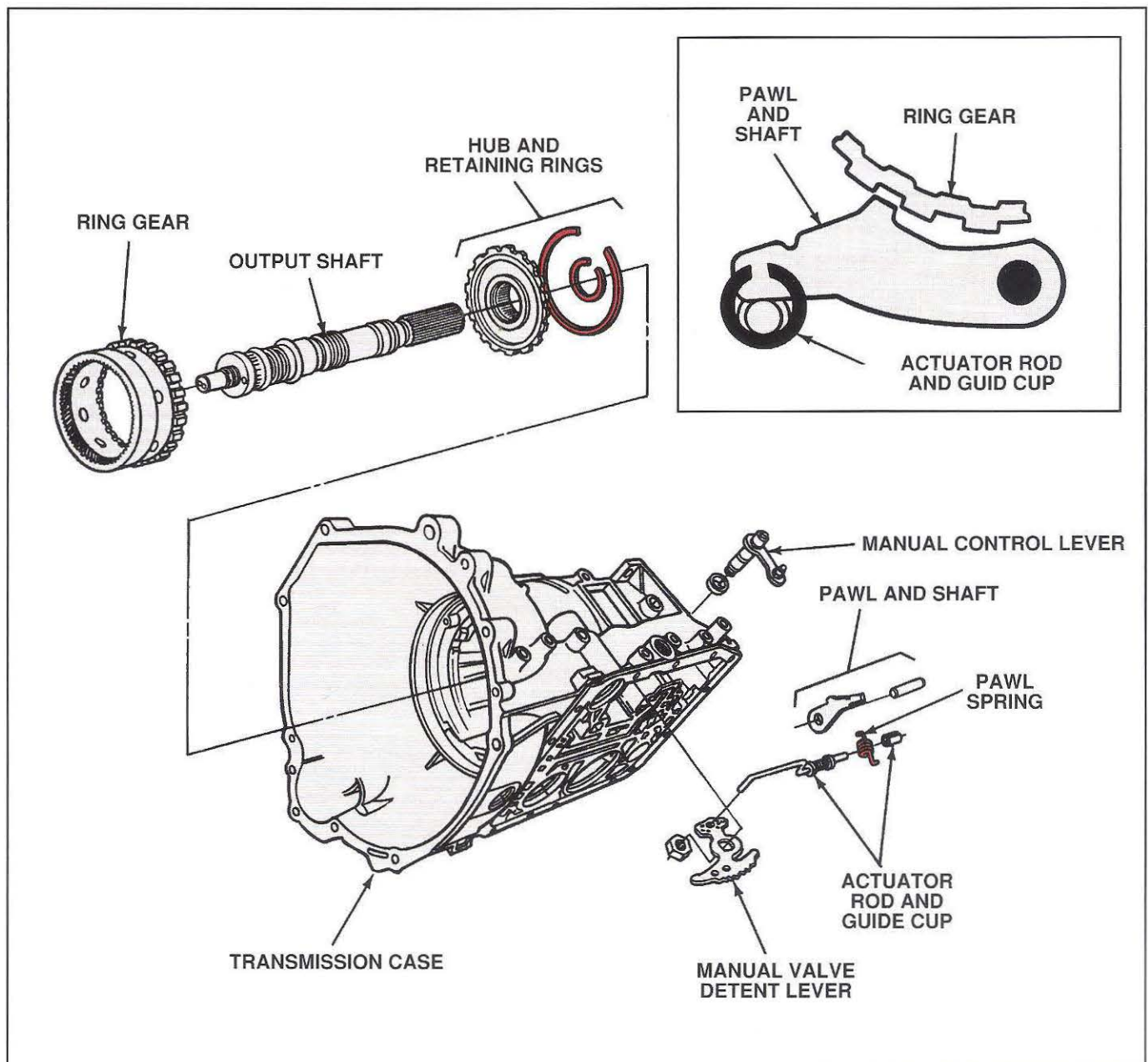
### PARKING LOCK

The ring gear is connected to the output shaft through a hub. The ring gear has lugs on its outer surface to allow the operation of the parking lock.

The parking lock prevents the vehicle wheels from rotating by allowing the transmission case to hold the output shaft stationary.

When the manual control lever is rotated to the **P** position, the parking lock works as follows:

- The manual valve detent lever (connected to the manual control lever) rotates, pushing a spring loaded actuator rod.
- The actuator rod pivots the parking pawl into alignment between the lugs of the ring gear.
- The parking pawl (connected to the transmission case) holds the ring gear.





## THEORY

### MECHANICAL COMPONENTS

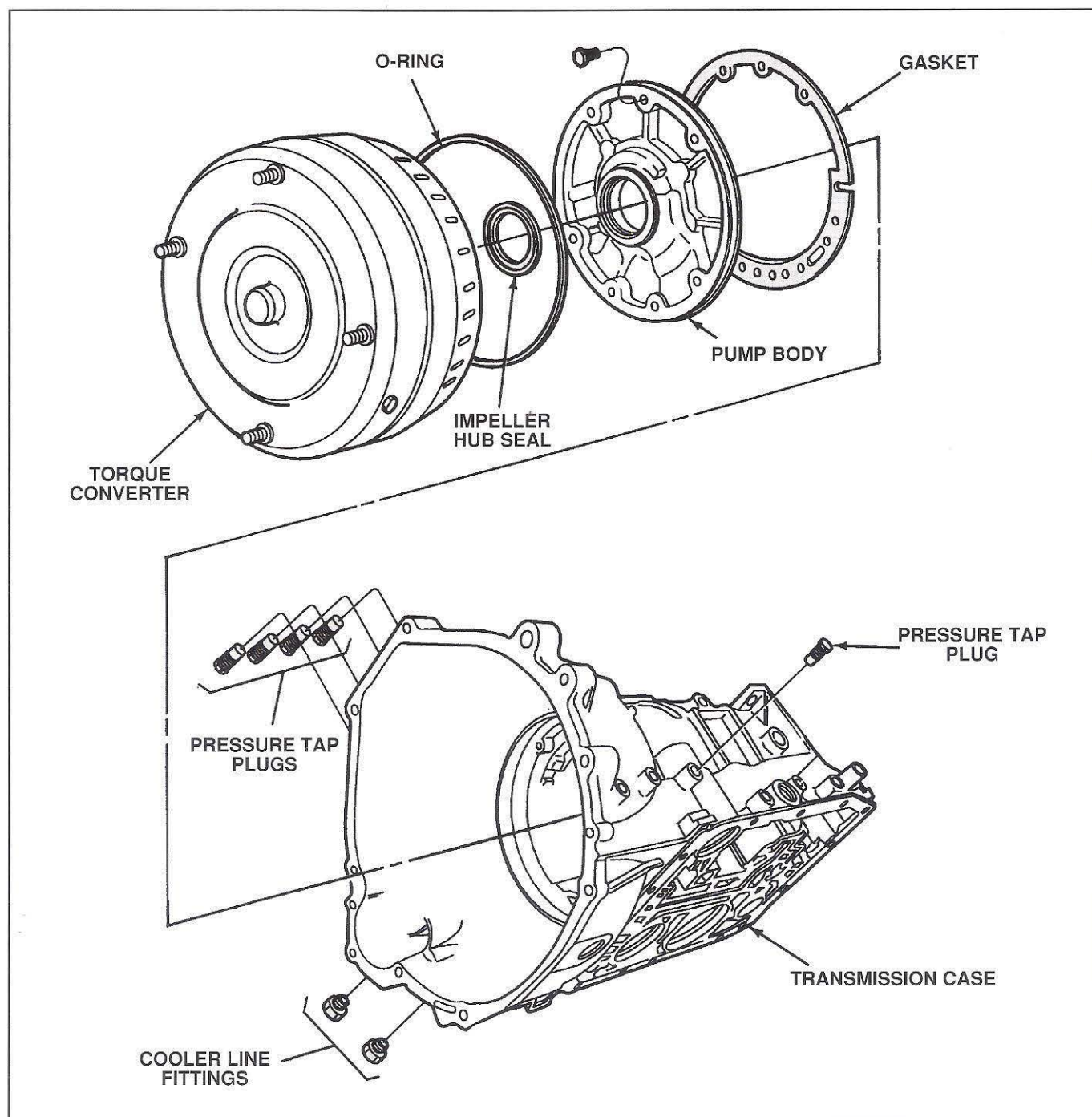
#### EXTERNAL SEALING

The torque converter has a drain plug that uses thread sealant. The pump body has a lip seal for the torque converter impeller hub.

The pump body uses a large O-ring and a gasket to seal its mounting in the transmission case.

Five pressure tap plugs thread into the sides of the transmission case, using thread sealant.

The two fittings for fluid cooler lines also thread into the transmission case and use thread sealant.



## THEORY MECHANICAL COMPONENTS

The bulkhead connector end of the internal wiring harness has two O-rings to seal its mounting in the transmission case.

The Output Shaft Speed (OSS) sensor has two O-rings to seal its mounting in the transmission case.

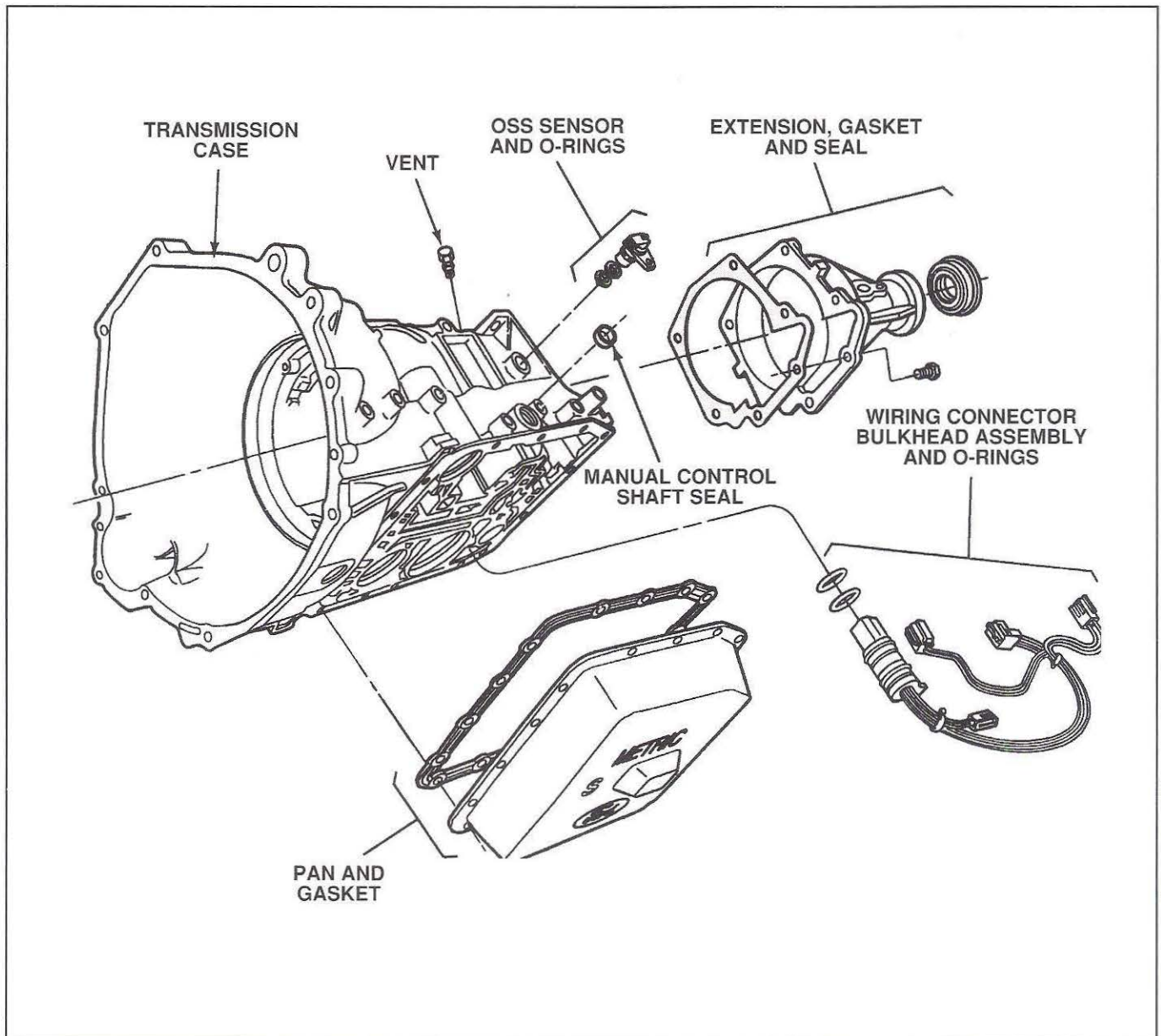
The manual control lever has a lip seal for its bore in the transmission case. The filler tube uses a grommet for sealing its bore in the transmission case.

The pan uses a gasket to seal its mounting to the bottom of the transmission case.

The case extension also has a gasket to seal its mounting surface on the rear of the transmission case.

Passenger cars and two-wheel drive trucks have a lip seal mounted in the case extension for the slip yoke of the rear axle drive shaft.

The vent for the transmission case mounts in a bore without the use of an additional seal.





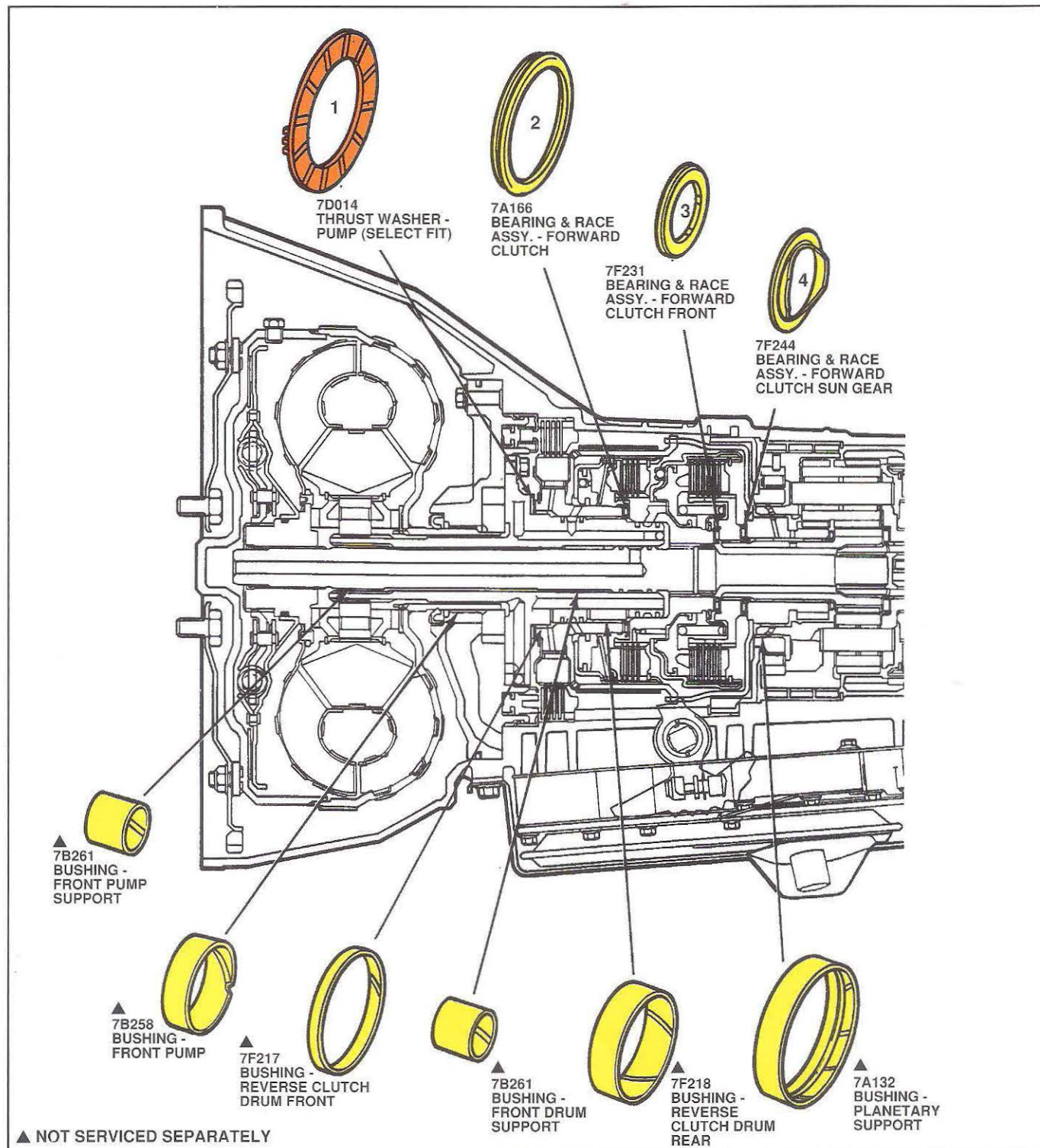
## THEORY

### MECHANICAL COMPONENTS

#### BUSHINGS, BEARINGS AND THRUST WASHERS

The AODE/4R70W transmission supports rotating components with bushings, bearing and thrust washers.

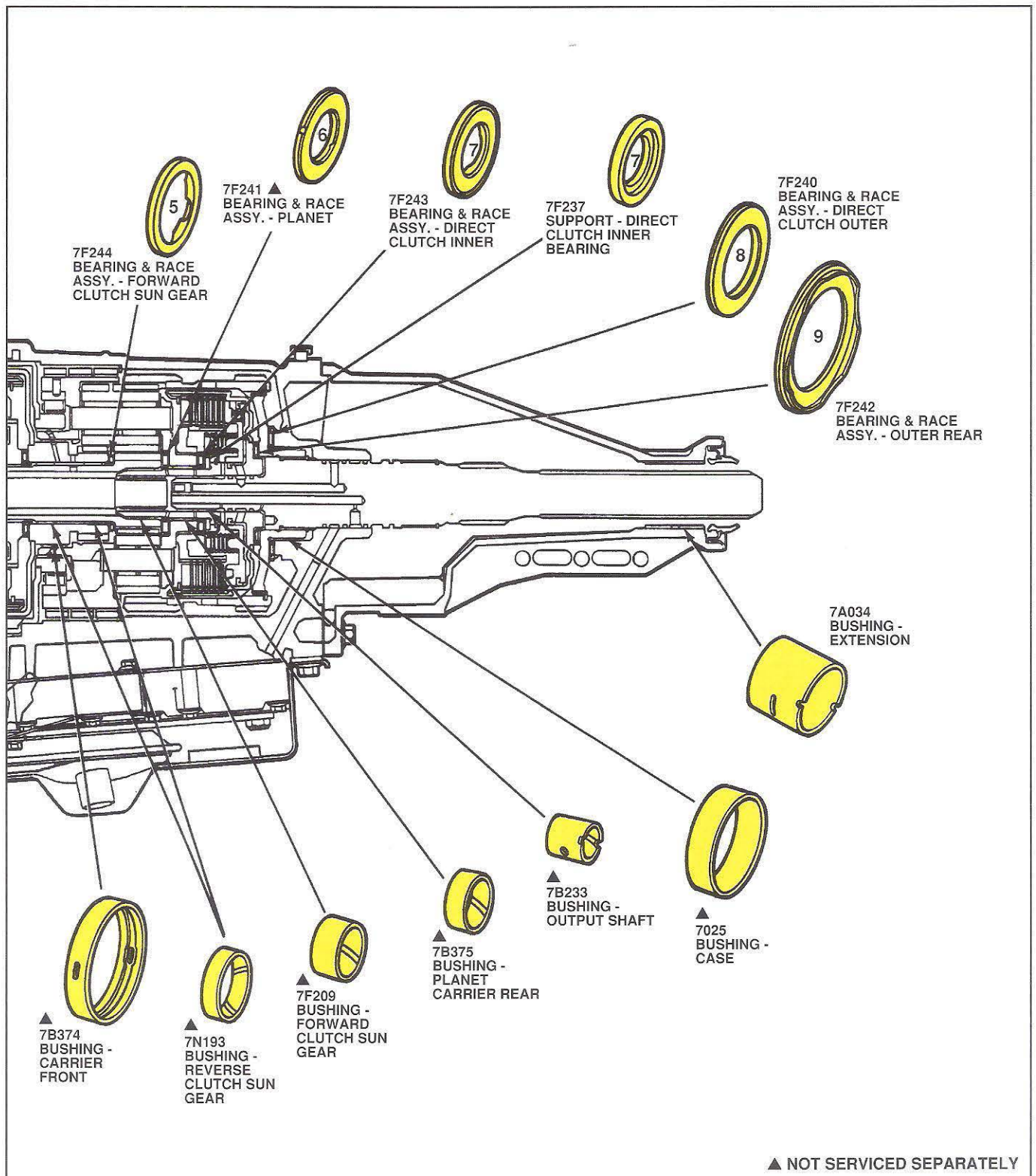
Most thrust bearings and thrust washers are available as service parts.



## THEORY MECHANICAL COMPONENTS

Bushings are not serviced separately with two exceptions: the case bushing and the extension bushing.

Component end play is controlled with the pump thrust washer, a select fit part.





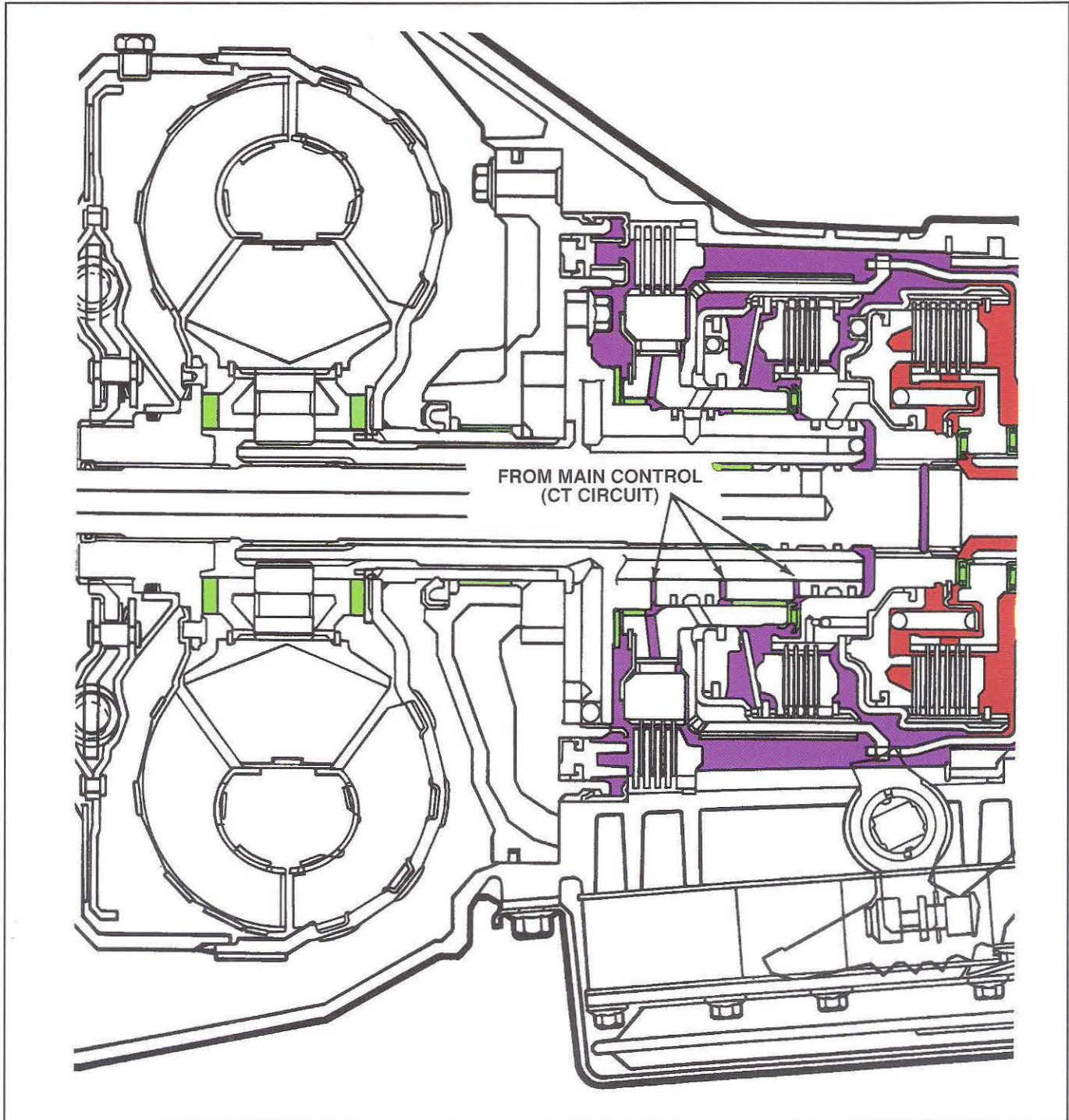
## THEORY

### MECHANICAL COMPONENTS

#### LUBRICATION

The AODE/4R70W transmission provides lubrication for rotating mechanical components through the line pressure/lube and torque converter/lube hydraulic circuits.

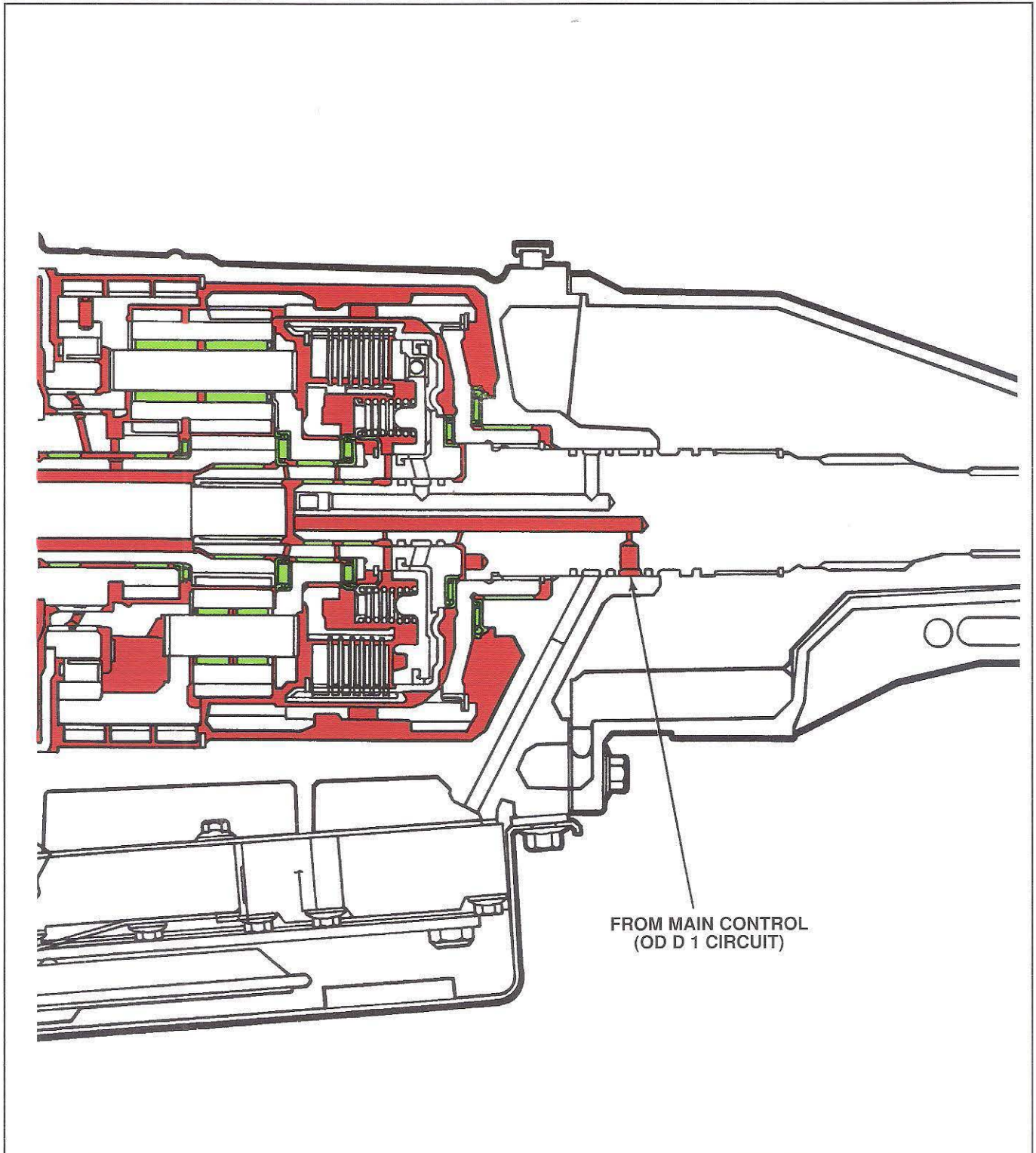
The **CT** hydraulic circuit sends fluid from the cooler through the pump support to the front of the internal rotating components. Refer to page 46 for more information about the **CT** hydraulic circuit.



## THEORY

### MECHANICAL COMPONENTS

The **OD D 1** hydraulic circuit sends fluid under line pressure to the rear of the internal rotating components. Refer to page 41 for more information about the **OD D 1** hydraulic circuit.





## THEORY

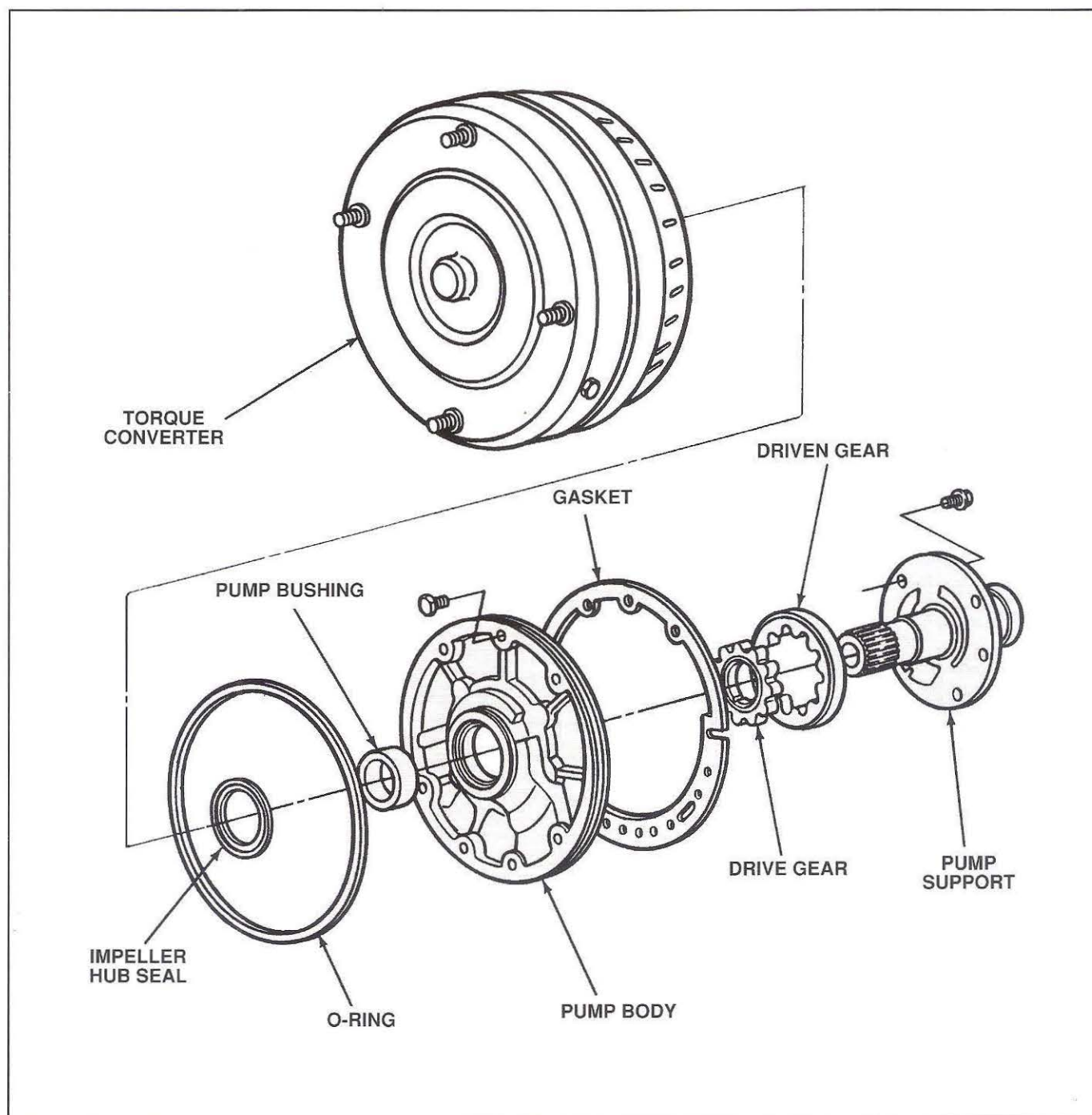
### HYDRAULIC COMPONENTS

#### PUMP

The AODE/4R70W transmission has a gerotor type pump that supplies fluid under pressure to the hydraulic system. The torque converter impeller hub rotates the drive gear of the pump.

The pump has the following parts:

- Body
- Support
- Drive gear
- Driven gear



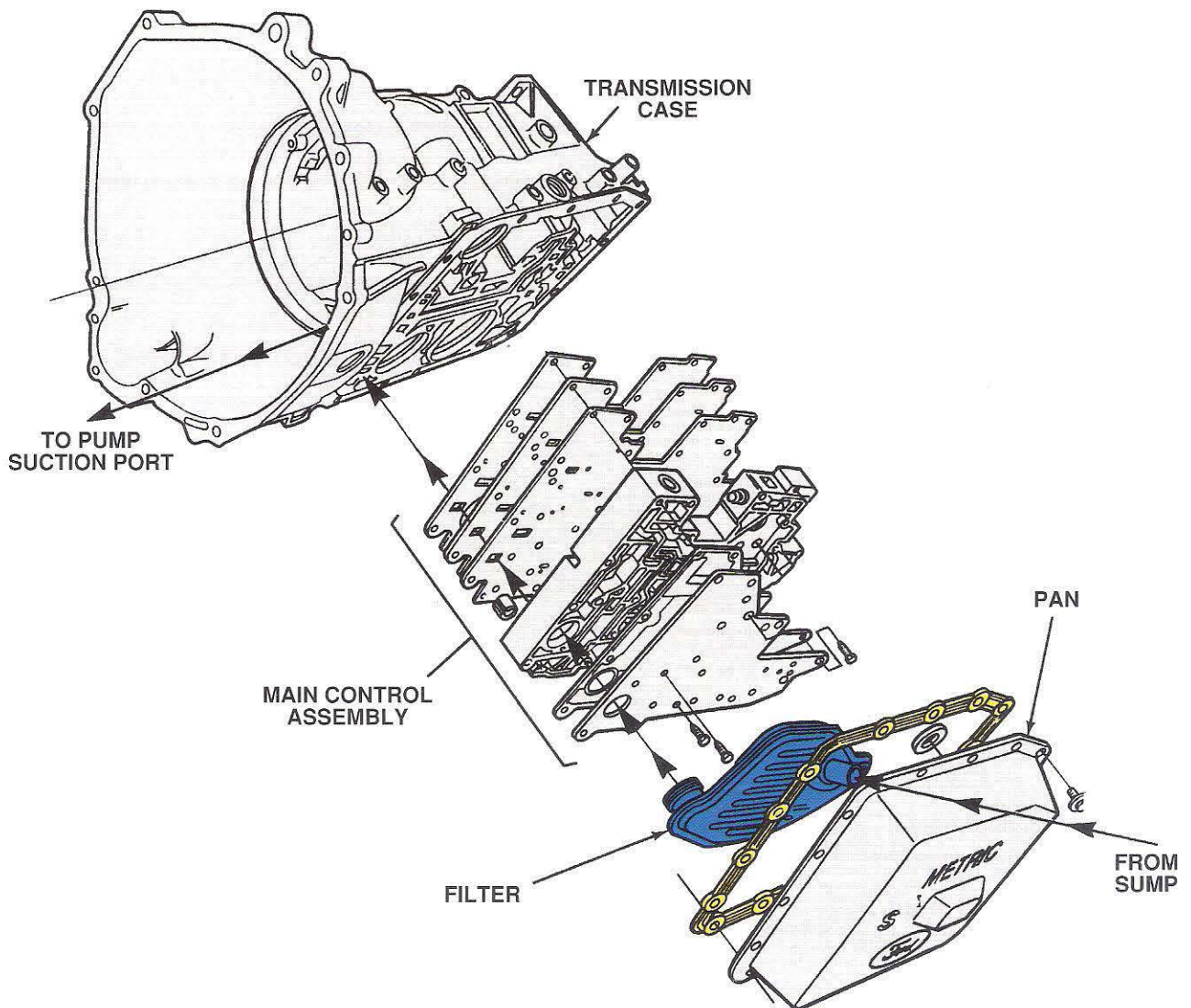
### FLUID LEVEL AND FILTER

Fluid in the sump area formed by the pan flows from a filter, through passages in the main control assembly and transmission case, to the suction port of the pump.

A magnet attached to the pan collects unwanted magnetic material.

A removable dipstick type fluid level indicator is located inside a tube mounted in an external transmission case bore.

The transmission fluid level check is correctly performed when fluid temperature is hot.





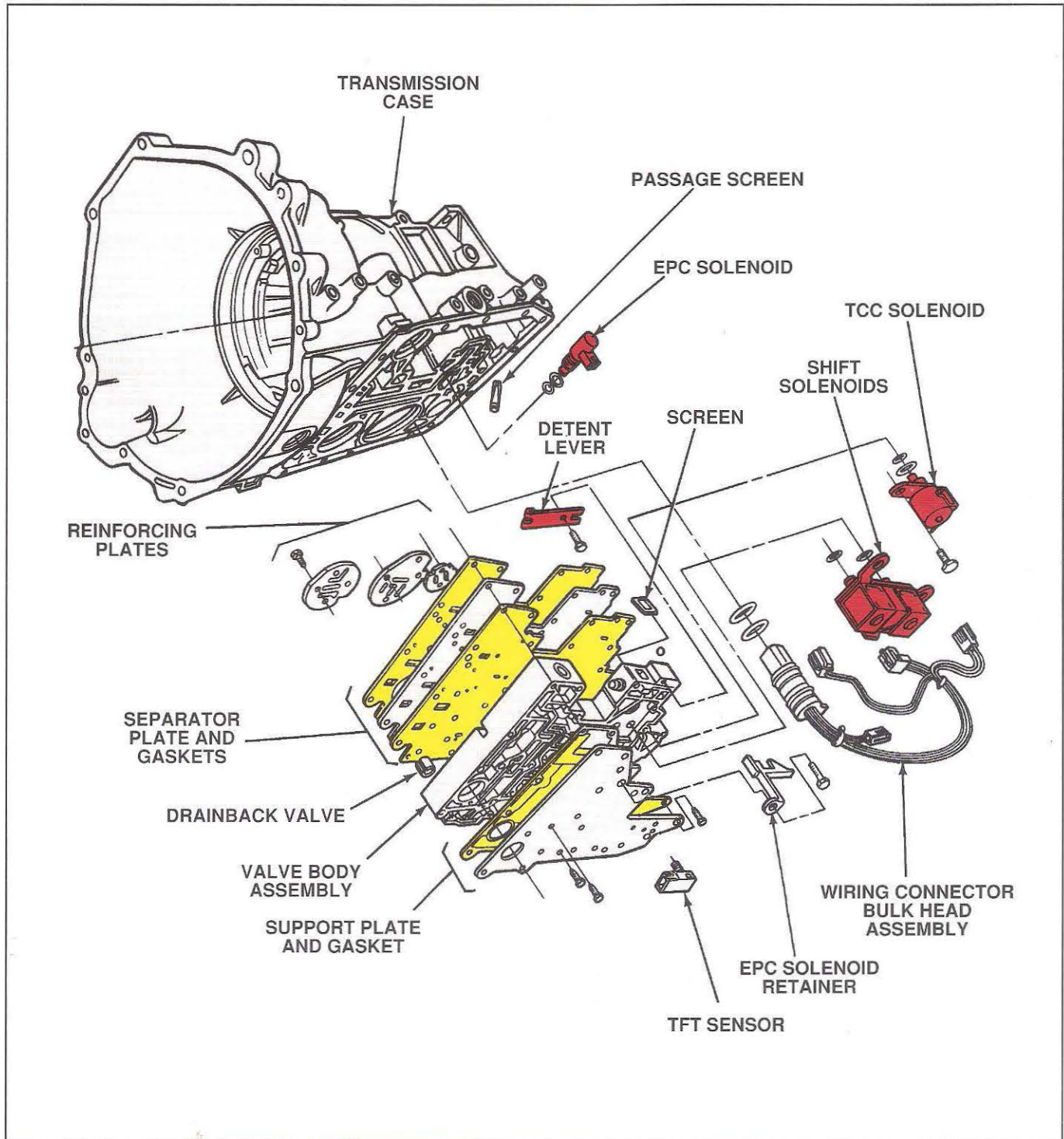
# THEORY

## HYDRAULIC COMPONENTS

### MAIN CONTROL

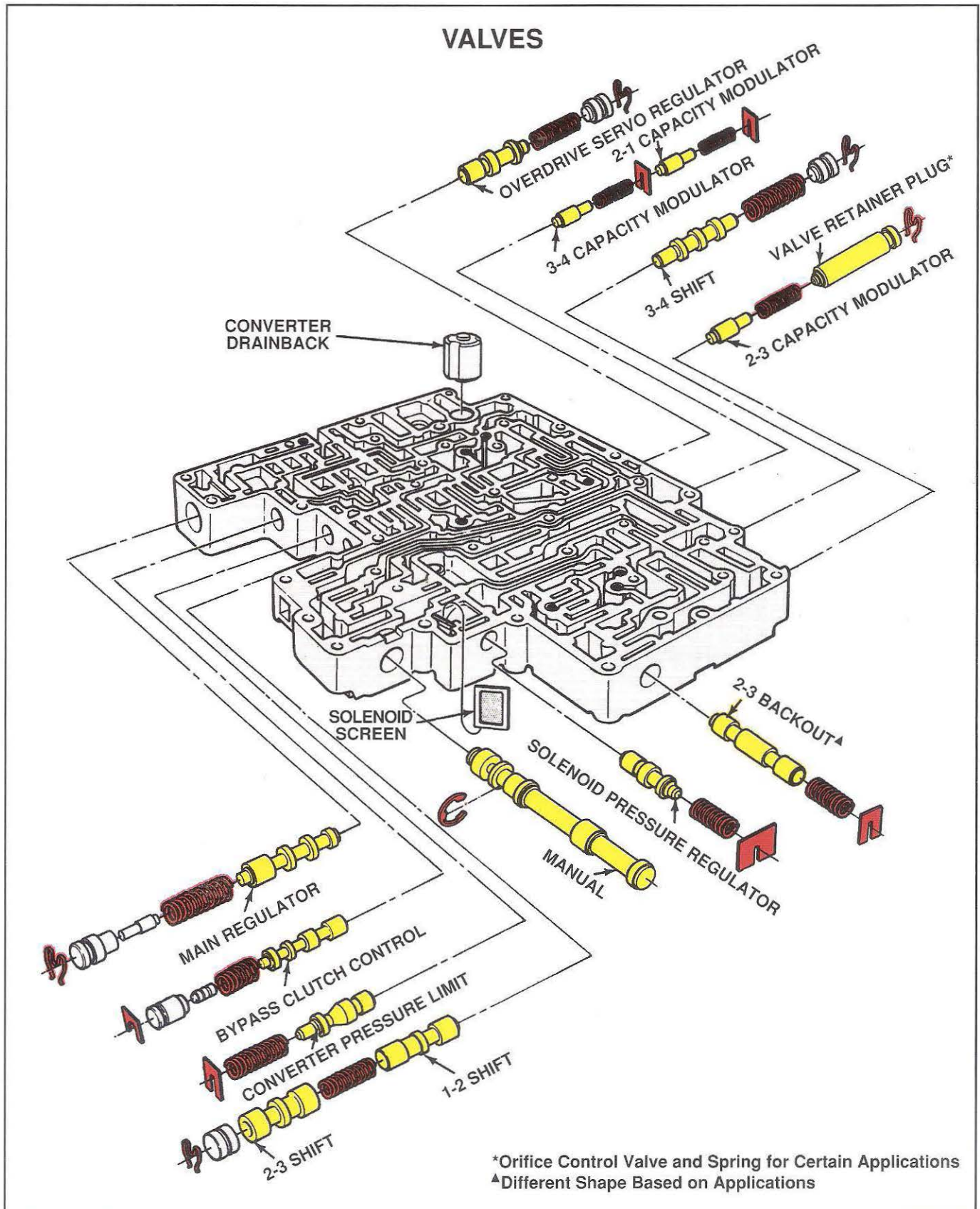
The hydraulic system has a main control assembly. The hydraulic control valves and electro-hydraulic actuators are located in the main control.

Gaskets are used for the separator plate between the valve body and transmission case. A gasket is used between the valve body and the cover plate.



# THEORY

## HYDRAULIC COMPONENTS





# THEORY

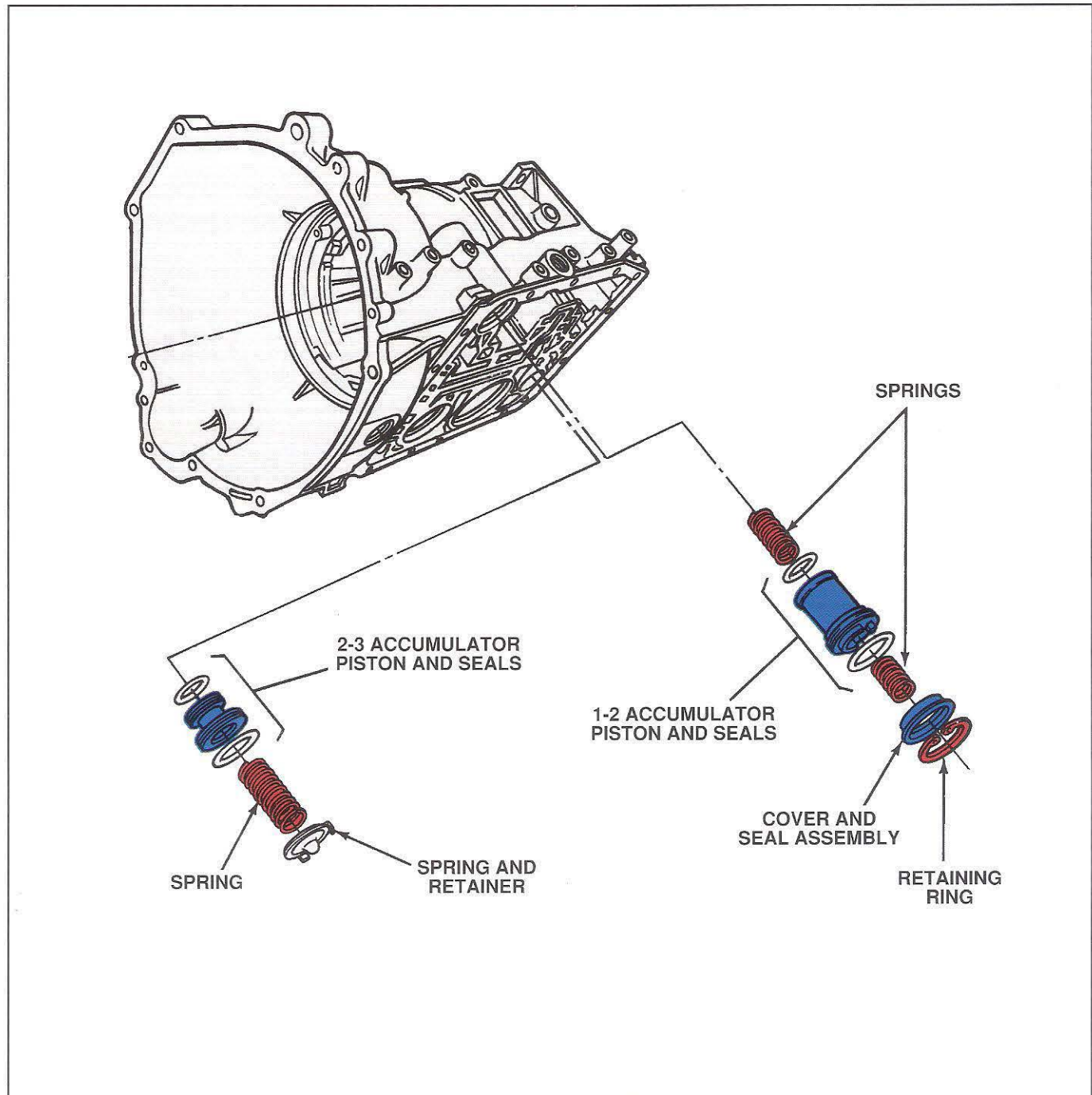
## HYDRAULIC COMPONENTS

### ACCUMULATORS

The hydraulic system has accumulators in circuits for two apply components. The transmission case has bores for the two accumulators:

- 1-2
- 2-3

The overdrive servo acts as an accumulator for the 3-4 shift. During the 3-4 shift, fluid under decreasing pressure on the release side of the servo provides backpressure as fluid under increasing pressure on the apply side pushes the servo piston to apply the band.



# THEORY

## HYDRAULIC COMPONENTS

### LINE PRESSURE/LUBE HYDRAULIC CIRCUITS

The Powertrain Control Module (PCM) controls line pressure with the Electronic Pressure Control (EPC) solenoid. This results in precise control of shift feel and efficient use of pressure for apply component operation.

Fluid under pressure in the circuit from the EPC solenoid controls the position of the main regulator valve. The main regulator valve controls the flow of fluid under pressure into the **BOOST** circuit that enters the pump suction port along with fluid from the sump and filter.

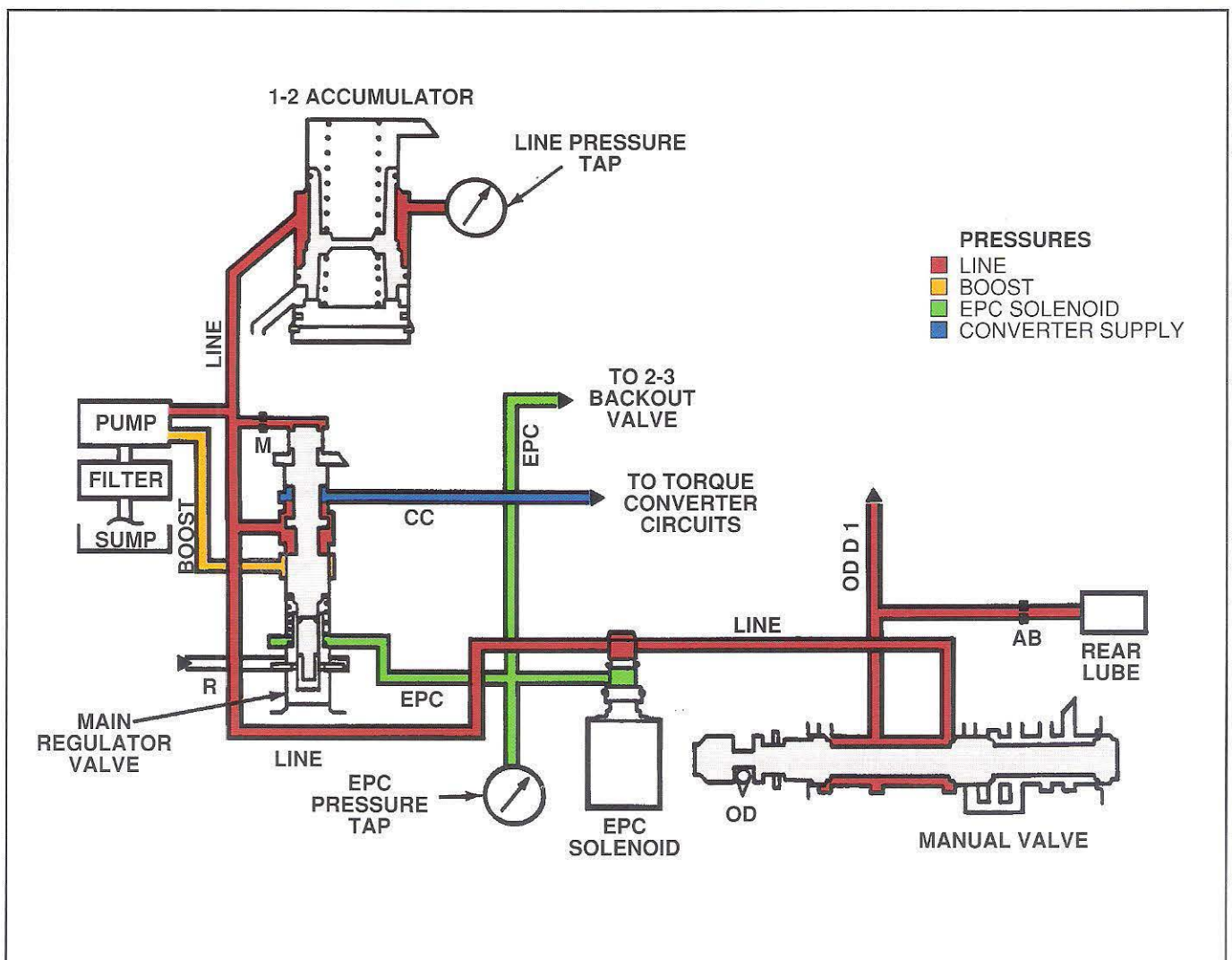
If the pump receives less fluid from the **BOOST** circuit, the action of the pump results in lower **LINE** circuit pressure.

If the pump receives more fluid from the **BOOST** circuit, the action of the pump results in higher **LINE** circuit pressure.

The position of the main regulator valve is also controlled by fluid under pressure in the **R** circuit. This provides a boost in line pressure when the transmission operates in the **R** position.

Fluid in the **LINE** circuit supplies the other hydraulic circuits. When the manual valve is in a position to provide forward speeds, the **LINE** circuit supplies the rear lube passages with fluid from the **OD D 1** circuit.

Refer to pages 58 and 59 for hydraulic circuit identification information.





## THEORY

### HYDRAULIC COMPONENTS

#### ACCUMULATOR HYDRAULIC CIRCUITS

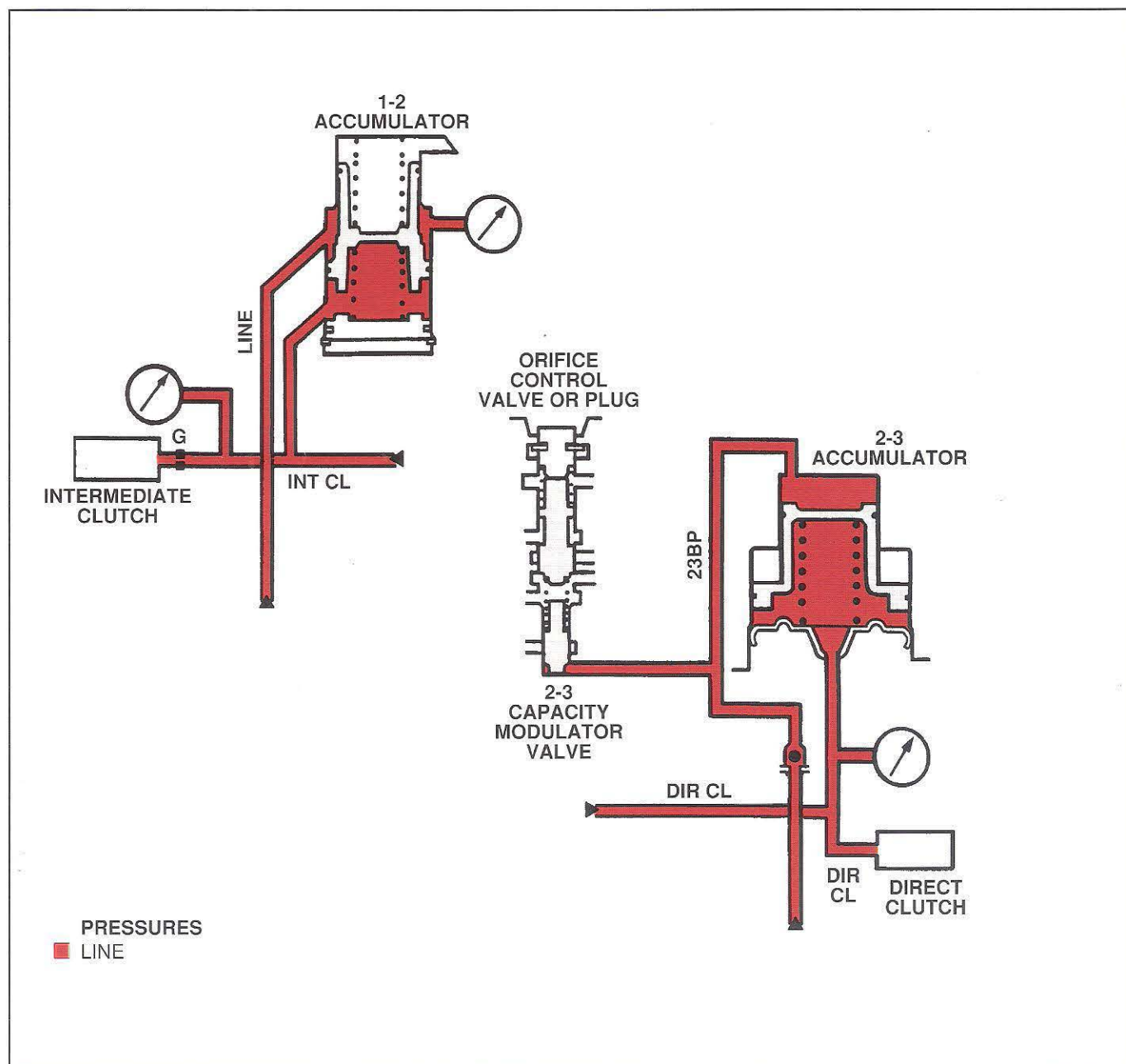
Fluid under pressure in the **LINE** circuit moves to the 1-2 accumulator, where it provides variable hydraulic back-pressure during the application of the intermediate clutch. This accumulator action occurs during a 1-2 shift.

When the forward clutch is applied, fluid under pressure enters the **23BP** circuit and moves to the 2-3 accumulator and 2-3 capacity modulator valve.

Fluid in the **23BP** circuit provides variable hydraulic back-pressure during the application of the direct clutch. This accumulator action occurs during a 2-3 shift.

When the forward clutch is released in 4th gear, a check ball seats to maintain pressure in the **23BP** circuit.

Refer to pages 58 and 59 for hydraulic circuit identification information.



### SHIFT SOLENOID HYDRAULIC CIRCUITS

#### Solenoid Feed Hydraulic Circuit

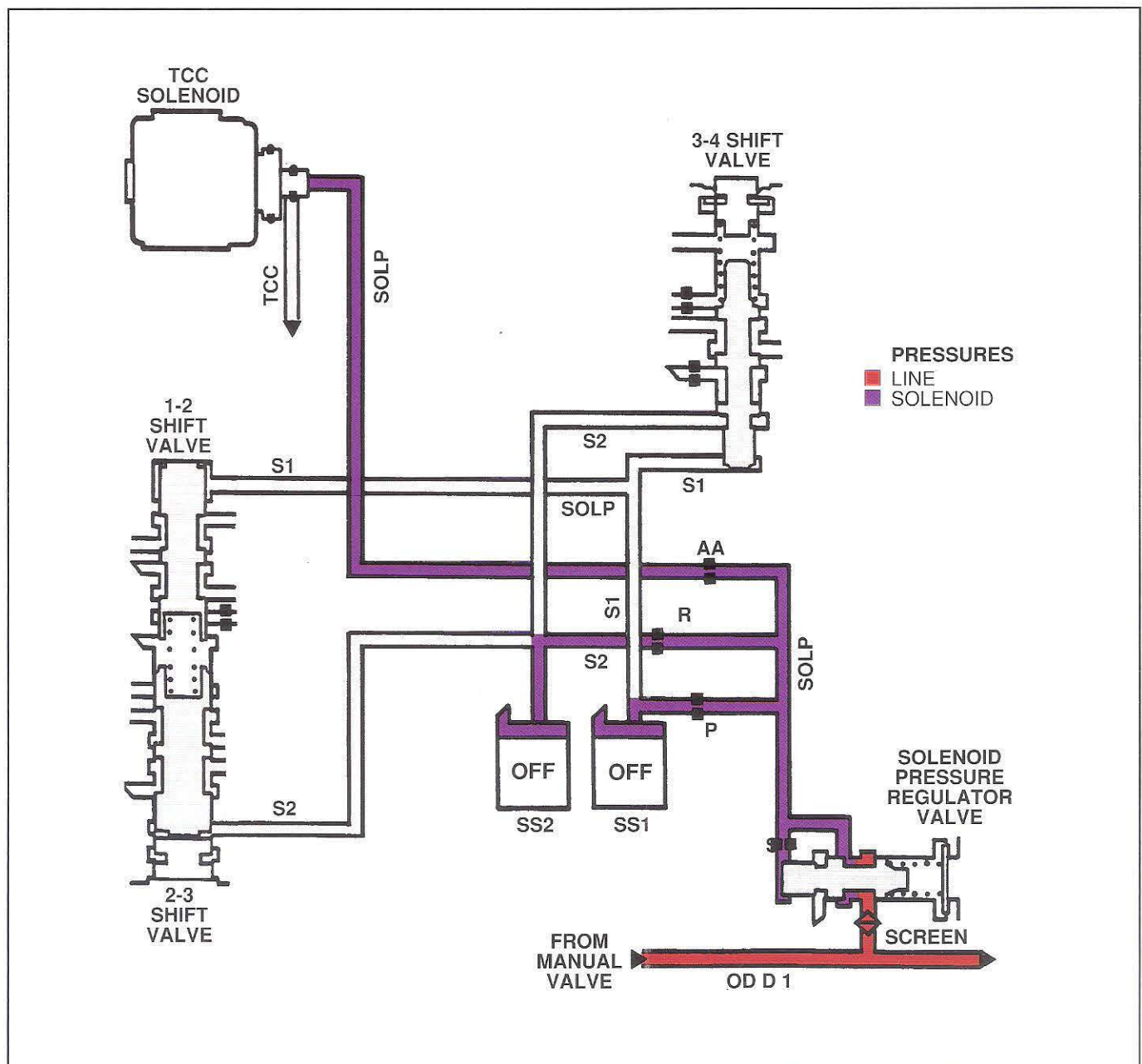
When the manual valve is in a position to provide forward speeds, fluid under line pressure in the **OD D 1** circuit moves to the solenoid pressure regulator valve, where it enters the **SOLP** circuit.

The **SOLP** circuit provides a source of fluid with a regulated maximum pressure.

Components receiving fluid in the **SOLP** circuit are as follows:

- Shift Solenoid #1 (SS1)
- Shift Solenoid #2 (SS2)
- Torque Converter Clutch (TCC) solenoid

Refer to pages 58 and 59 for hydraulic circuit identification information





## THEORY

### HYDRAULIC COMPONENTS

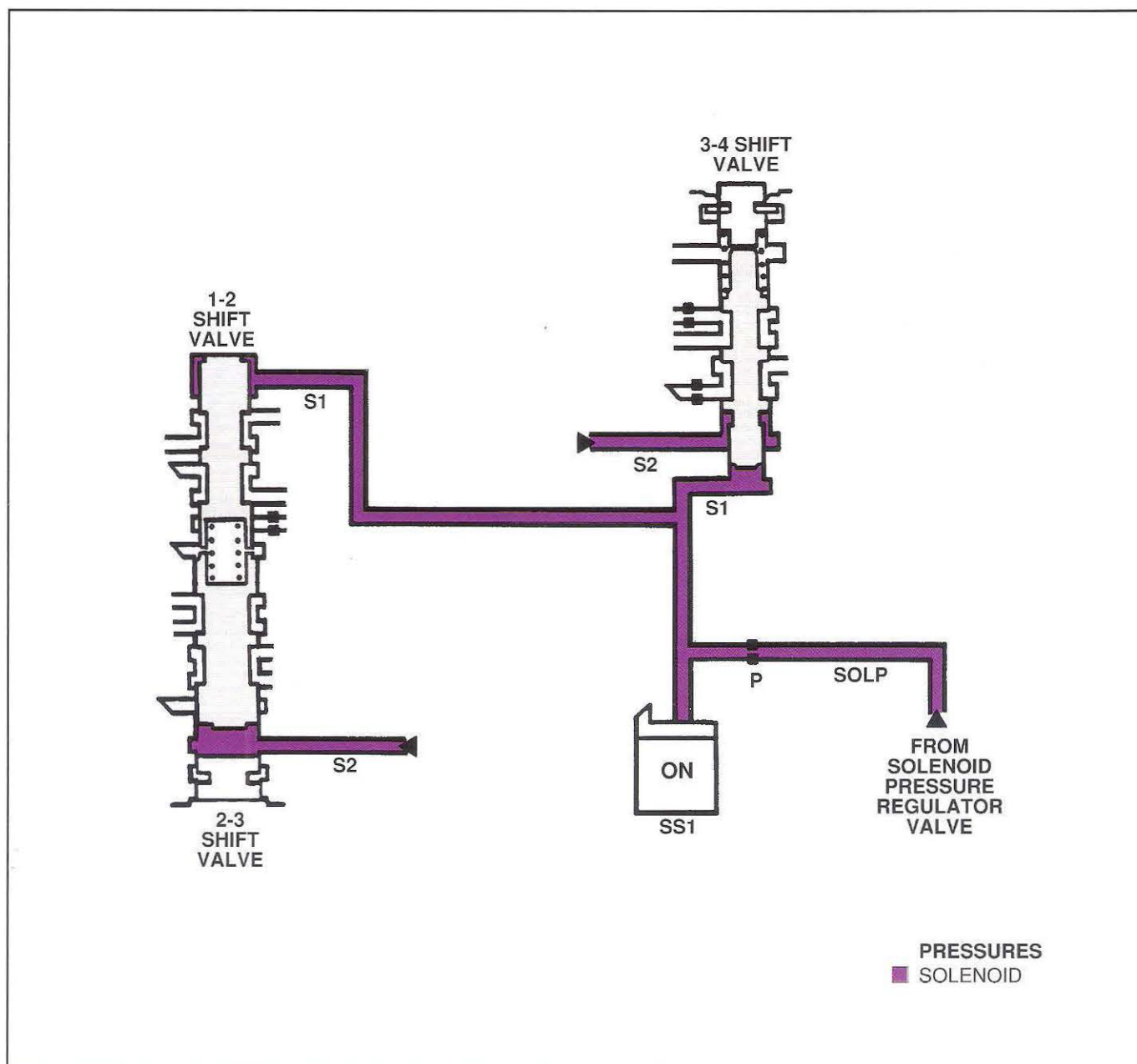
#### Shift Solenoid 1 (SS1) Hydraulic Circuit

Fluid under pressure in the **SOLP** circuit moves through SS1 into the **S1** circuit when the PCM turns it ON.

SS1 is ON in 1st gear and 4th gear. SS1 controls the position of the 1-2 shift valve, except in 3rd and 4th gear. In 3rd gear, fluid under pressure in the **S2** circuit moves the 2-3 shift valve, which contacts the 1-2 shift valve and prevents it from moving even if fluid under pressure in the **S1** circuit is present.

Fluid under pressure in the **S1** circuit is assisted by fluid under pressure in the **S2** circuit to move the 3-4 shift valve during a shift into 4th gear. During operation in 1st gear, opposing spring force acting on the 3-4 shift valve is greater than the force of **S1** circuit pressure.

Refer to pages 58 and 59 for hydraulic circuit identification information.



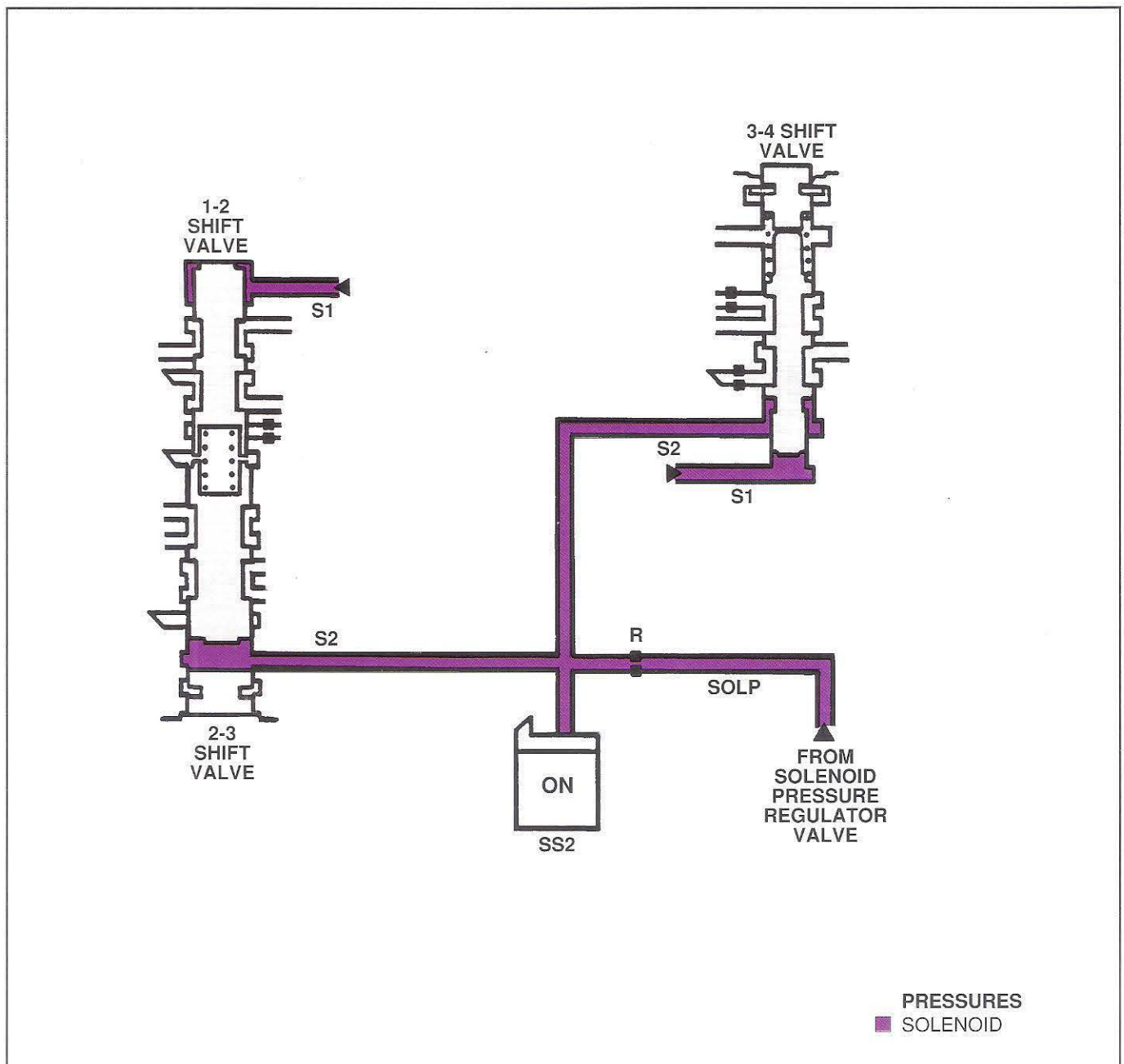
### Shift Solenoid 2 (SS2) Hydraulic Circuit

Fluid under pressure in the **SOLP** circuit moves through SS2 into the **S2** circuit when the PCM turns it ON.

SS2 is ON in 3rd and 4th gear. SS2 controls the position of the 2-3 shift valve.

Fluid under pressure in the **S2** circuit is assisted by fluid under pressure in the **S1** circuit to move the 3-4 shift valve during a shift into 4th gear. During operation in 3rd gear, opposing spring force acting on the 3-4 shift valve is greater than the force of **S2** circuit pressure.

Refer to pages 58 and 59 for hydraulic circuit identification information.





## TORQUE CONVERTER/LUBE HYDRAULIC CIRCUITS

**CCL** circuit fluid moves through the bypass clutch control valve and into the torque converter, using the **CI** circuit. As fluid exits the torque converter through the **CT** circuit, it moves through the cooler.

The **CT** circuit to the cooler and front lube passages has a drainback valve to prevent fluid flow from the torque converter when the transmission is not operating.

Refer to pages 58 and 59 for hydraulic circuit identification information.



## TORQUE CONVERTER CLUTCH SOLENOID HYDRAULIC CIRCUITS

When the transmission operates in forward speeds, fluid in the **SOLP** circuit provides the Torque Converter Clutch (TCC) solenoid a source of fluid with a regulated maximum pressure.

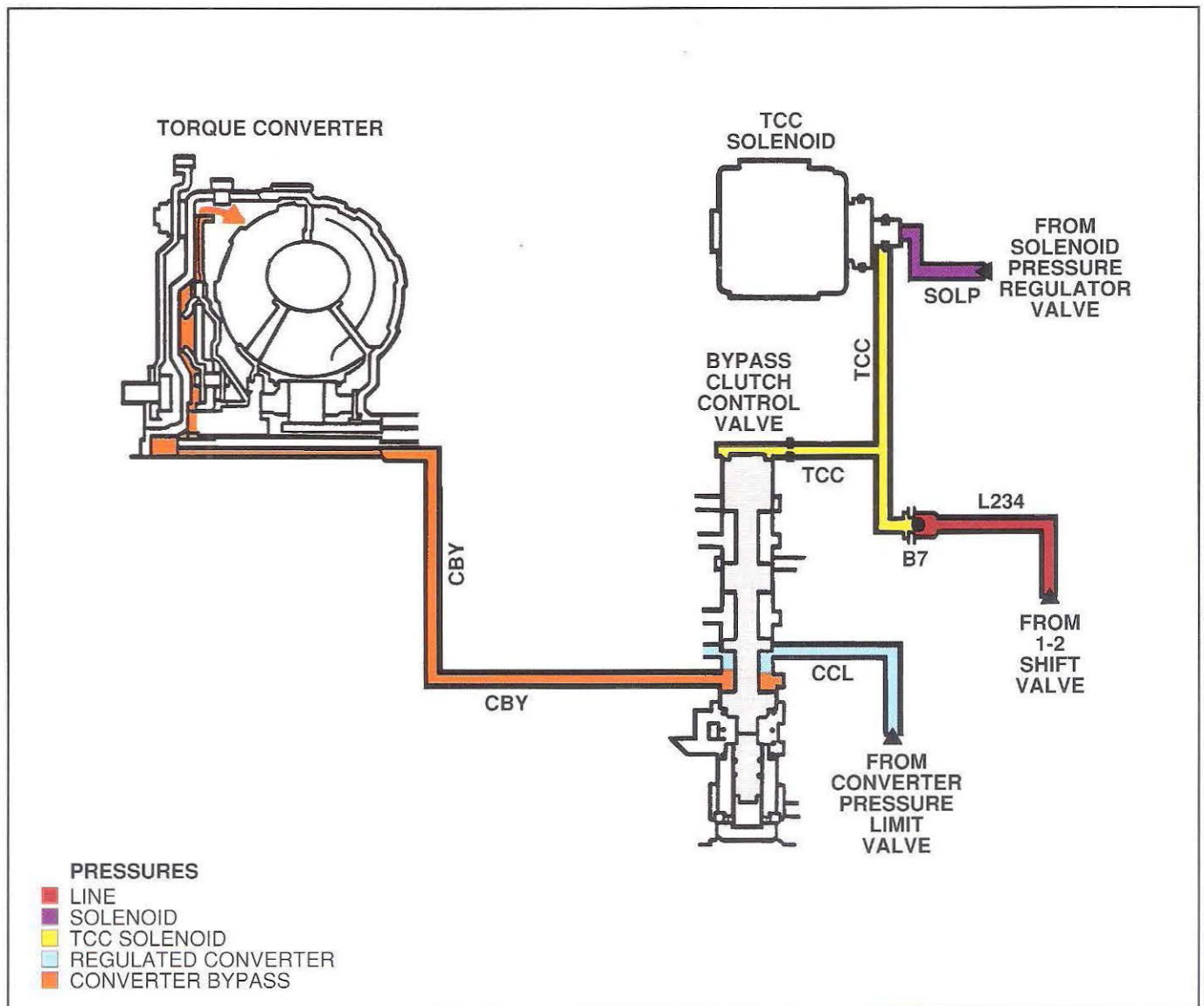
The Powertrain Control Module (PCM) varies the pulse-width (ON-time) of the electrical signal to the TCC solenoid to vary fluid pressure in the **TCC** circuit.

With a zero pulse-width electrical signal to the TCC solenoid, **TCC** circuit pressure is zero. This positions the bypass clutch control valve to result in TCC release.

With a high pulse-width electrical signal to the TCC solenoid, **TCC** circuit pressure is higher. This changes the position of the bypass clutch control valve to result in TCC apply.

With a moderate and varying pulse-width electrical signal to the TCC solenoid, **TCC** circuit pressure changes the position of the bypass clutch control valve to result in TCC controlled slip.

Refer to pages 58 and 59 for hydraulic circuit identification information.





## APPLY COMPONENT HYDRAULIC CIRCUITS

When the transmission operates in the **R** position, fluid under line pressure moves from the **LINE** circuit into the **R** circuit at the manual valve.

Fluid in the **R** circuit also moves through the B6 check ball, where it shuttles the check ball to block a path into the **LS MOD** circuit. Fluid continues to move from the B6 check ball into the **LR** circuit, where it applies the low-reverse servo.

Refer to pages 58 and 59 for hydraulic circuit identification information.



# THEORY

## HYDRAULIC COMPONENTS

### 1st Gear

When the manual valve is in a position to provide forward speeds, fluid from the **LINE** circuit under line pressure enters the **OD D 1** circuit. The PCM controls 1st gear operation by turning SS1 ON while SS2 is OFF.

Fluid in the **OD D 1** circuit moves through the 3-4 shift valve, where it enters the **FC** circuit. Fluid in the **FC** circuit moves through the orifice control valve into the **FC 12** circuit.

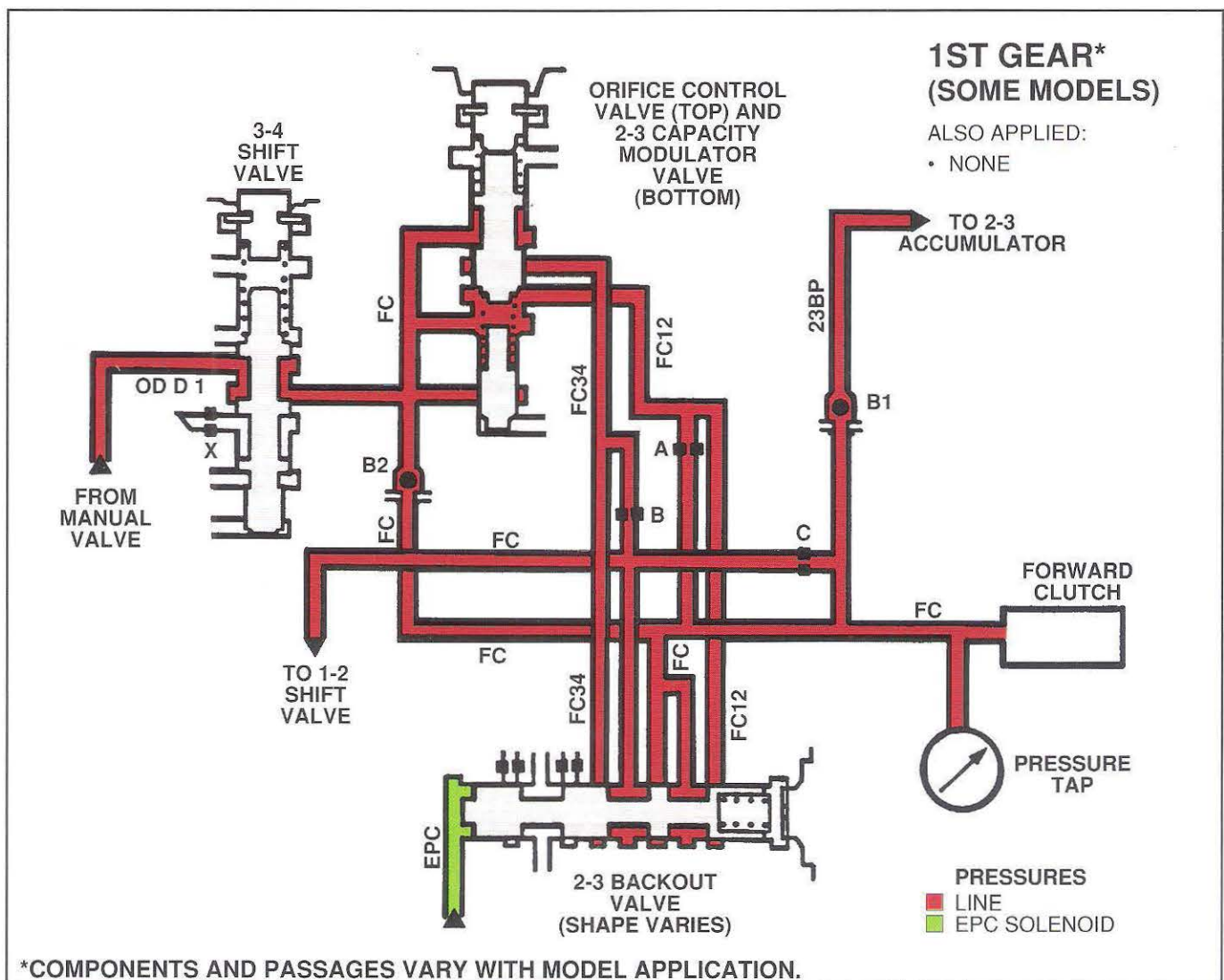
The path of fluid in the **FC 12** circuit includes a combination of fixed restrictions (orifices). The amount of restriction can vary, based on variable **EPC** circuit pressure acting on the 2-3 backout valve.

Under low input torque conditions, low EPC pressure causes the 2-3 backout valve to provide more total restriction for a slower forward clutch fill time. High input torque results in faster forward clutch fill time.

Fluid moving through the **FC 12** circuit enters the **FC** circuit to apply the forward clutch.

When the manual valve is in the **OD** or **D** (or **2**) position, fluid under line pressure in the **OD D** circuit moves through the 2-3 shift valve into the **ODR** circuit to ensure the release of the overdrive servo.

Refer to pages 58 and 59 for hydraulic circuit identification information.





# THEORY

## HYDRAULIC COMPONENTS

### 2nd Gear

In 2nd gear, the **FC** circuit continues to apply the forward clutch. TCC may be applied in 2nd gear.

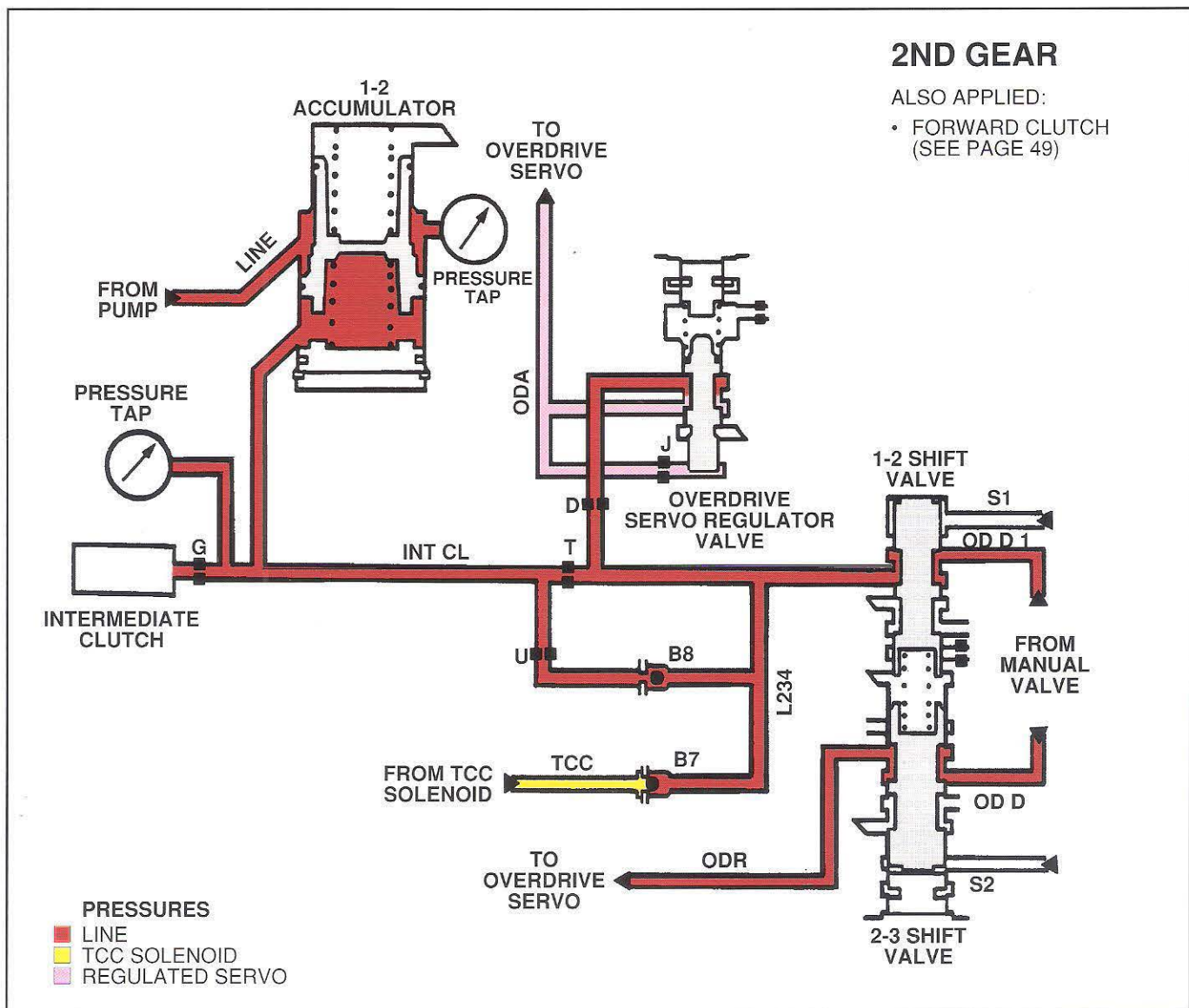
The PCM controls a 1-2 shift by turning SS1 OFF while SS2 remains OFF. The absence of **S1** circuit pressure causes spring force to move the 1-2 shift valve. When this occurs, fluid from the **OD D 1** circuit enters the **L234** circuit.

Fluid in the **L234** circuit moves into the **INT CL** circuit. **INT CL** circuit fluid applies the intermediate clutch and strokes the 1-2 accumulator piston.

During the shift, the B8 check ball seats to allow **INT CL** circuit fluid a restricted path through an orifice to the intermediate clutch.

Fluid in the **L234** circuit also moves through the overdrive servo regulator valve, where it enters the **ODA** circuit under regulated pressure. The overdrive servo is released with **ODR** circuit pressure (fed by the **OD D** circuit in 2nd gear).

Refer to pages 58 and 59 for hydraulic circuit identification information.



### 3rd Gear

In 3rd gear, the **FC** circuit continues to apply the forward clutch and the **INT CL** circuit continues to apply the intermediate clutch. TCC may be applied in 3rd gear.

As part of the 2-3 shift, the PCM turns SS2 ON while SS1 remains OFF. **S2** circuit pressure moves the 2-3 shift valve. This action allows fluid in the **OD D** circuit to move through the 2-3 shift valve into the **L34** circuit.

Fluid in the **L34** circuit moves through the 2-3 backout valve, where it enters the **DIR CL** circuit and seats the B3 check ball.

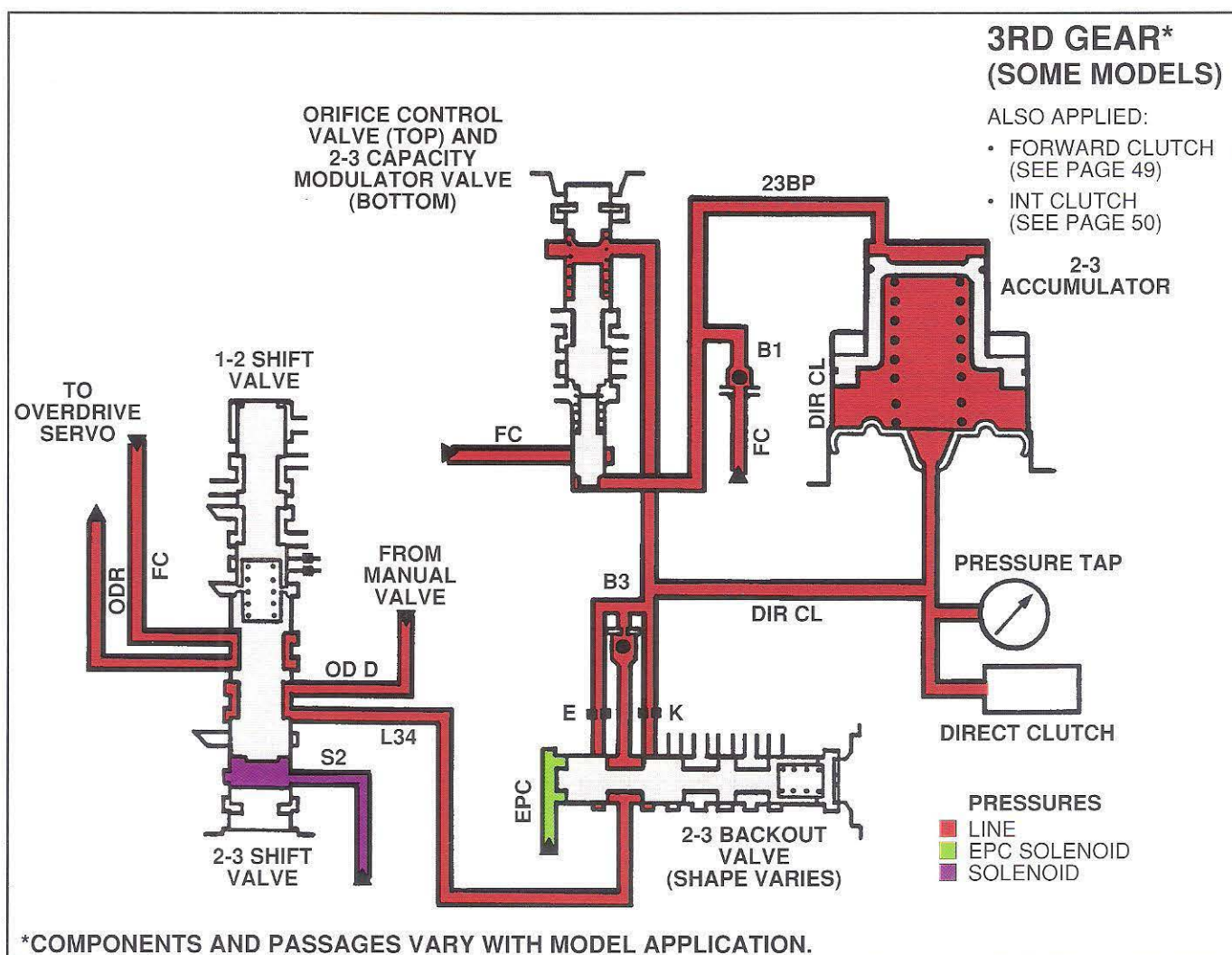
The path of fluid in the **DIR CL** circuit includes fixed restrictions (one of two orifices).

The total amount of restriction is based on variable **EPC** circuit pressure (similar to forward clutch application in 1st gear).

**DIR CL** circuit fluid applies the intermediate clutch and strokes the 2-3 accumulator piston. Accumulator back-pressure is controlled by the action of the 2-3 capacity modulator valve in the **23BP** circuit.

Fluid in the **L234** circuit continues to move through the overdrive servo regulator valve, and enter the **ODA** circuit under regulated pressure. The overdrive servo remains released with **ODR** circuit pressure (fed by the **FC** circuit in 3rd gear).

Refer to pages 58 and 59 for hydraulic circuit identification information.





# THEORY

## HYDRAULIC COMPONENTS

### 4th Gear

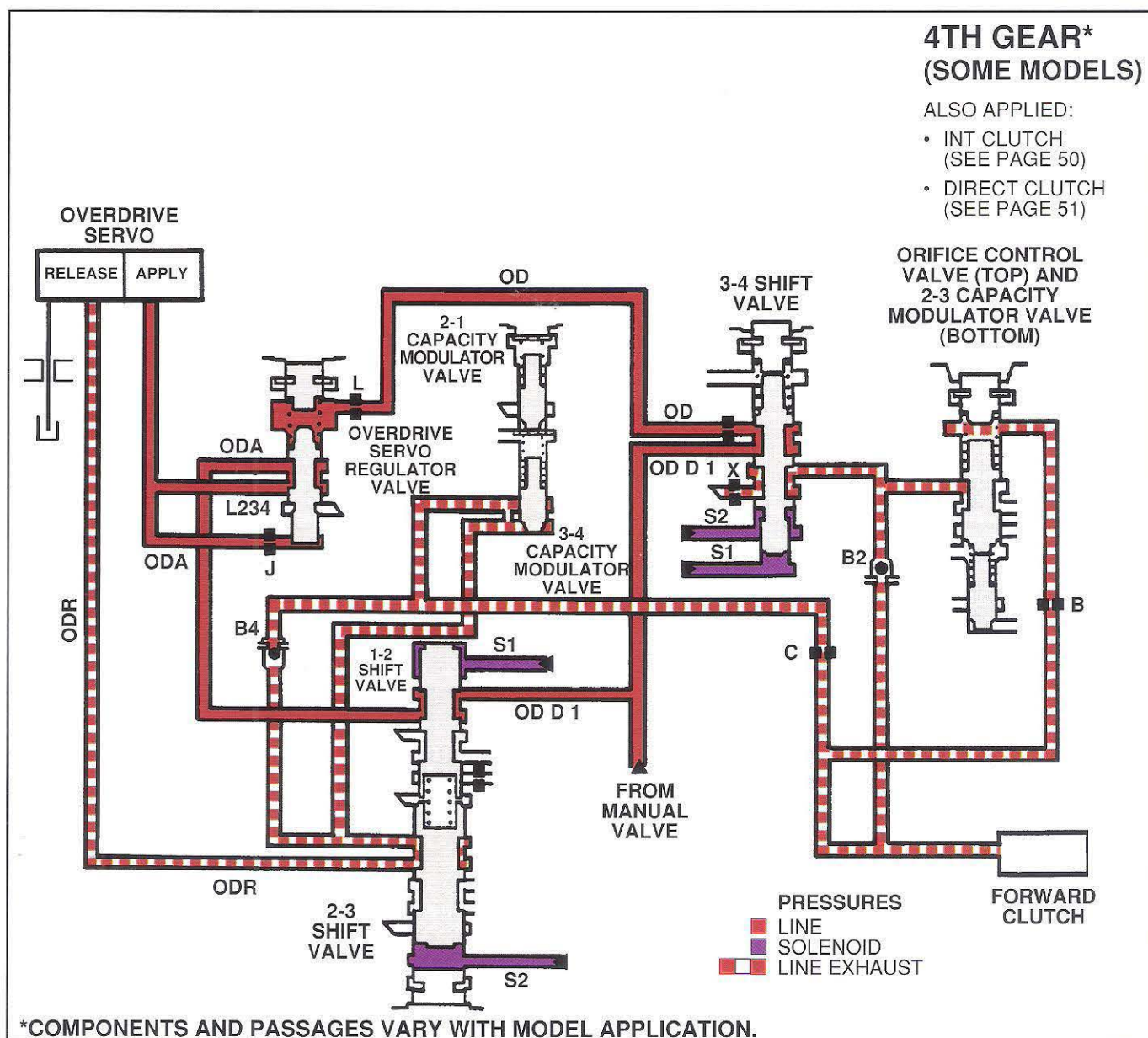
In 4th gear, the **INT CL** circuit continues to apply the intermediate clutch and the **DIR CL** circuit continues to apply the direct clutch. TCC may be applied in 4th gear.

The PCM controls the 3-4 shift by turning SS1 ON while SS2 remains ON. The 3-4 shift valve moves, causing the **FC** circuit to exhaust and the **OD** circuit to receive fluid under line pressure from the **OD D 1** circuit.

As the **FC** circuit exhausts, the forward clutch is released. The **ODR** circuit also exhausts through a bleed orifice and through the **FC** circuit at a controlled rate, due to the action of the 3-4 capacity modulator valve.

At the same time, **OD** circuit pressure acts on the overdrive servo regulator valve, causing the **ODA** circuit to be fed from the **L234** circuit with full line pressure.

Refer to pages 58 and 59 for hydraulic circuit identification information.



### Manual 2nd Gear

In manual 2nd gear, the following hydraulic circuits operate the same as in 2nd gear:

- The **FC** circuit applies the forward clutch.
- The **INT CL** circuit applies the intermediate clutch.

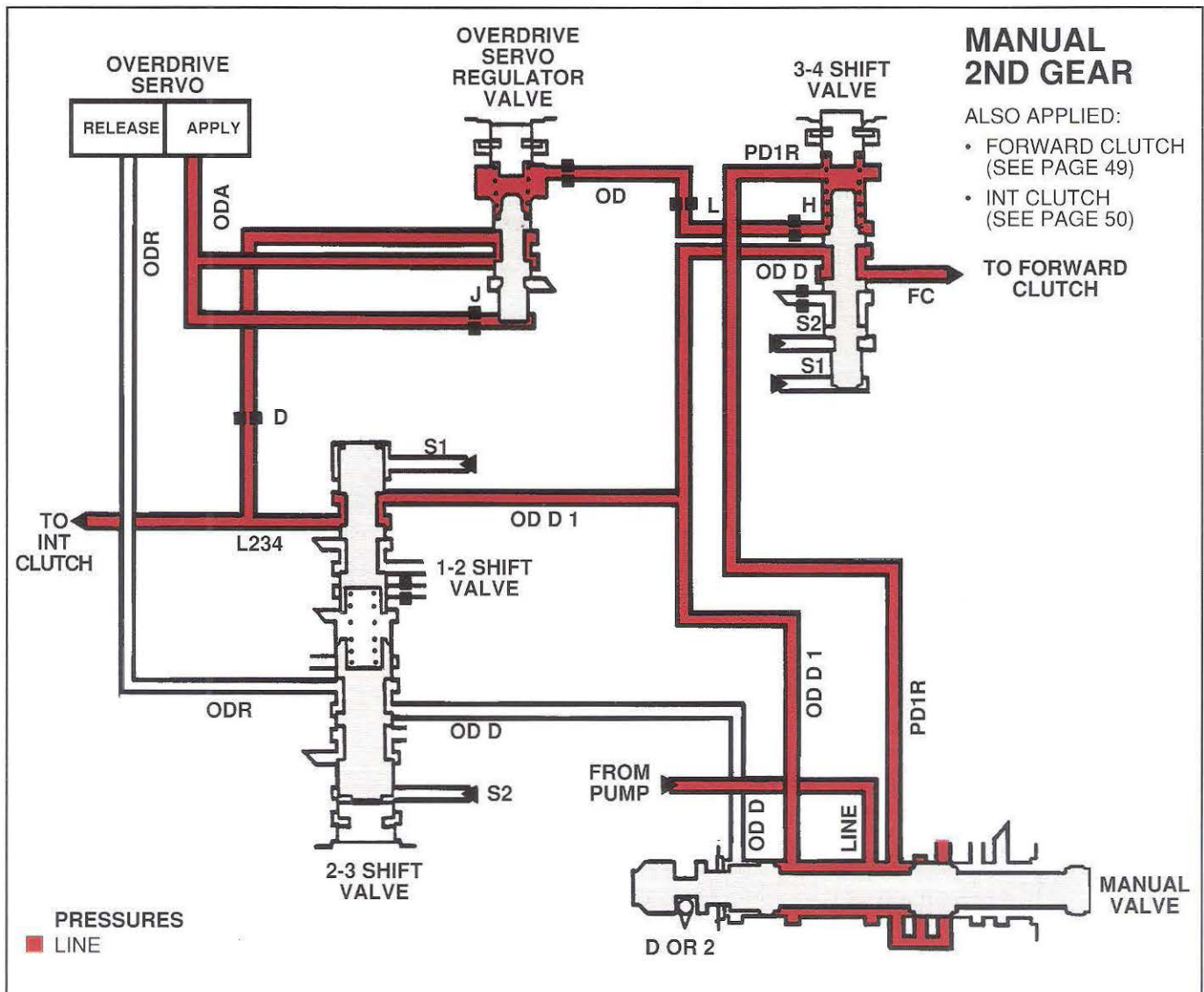
The PCM turns SS1 and SS2 OFF for manual 2nd gear operation. The PCM also operates the TCC solenoid for TCC release.

When the manual valve is moved to the **D** (or **2**) or **1** position, fluid from the **LINE** circuit enters the **PD1R** circuit. Fluid in the **PD1R** circuit moves the 3-4 shift valve and enters the **OD** circuit.

**OD** circuit pressure acts on the overdrive servo regulator valve, causing the **ODA** circuit to be fed from the **L234** circuit with full line pressure. This results in apply of the overdrive servo, even though fluid under line pressure in the **ODR** circuit on the release side of the servo may be present.

When the manual valve is in the **D** (or **2**) or **1** position, the **ODR** circuit exhausts through the **OD D** circuit.

Refer to pages 58 and 59 for hydraulic circuit identification information.





# THEORY

## HYDRAULIC COMPONENTS

### Manual 1st Gear

In manual 1st gear, the **FC** circuit applies the forward clutch in the same way as in 1st gear.

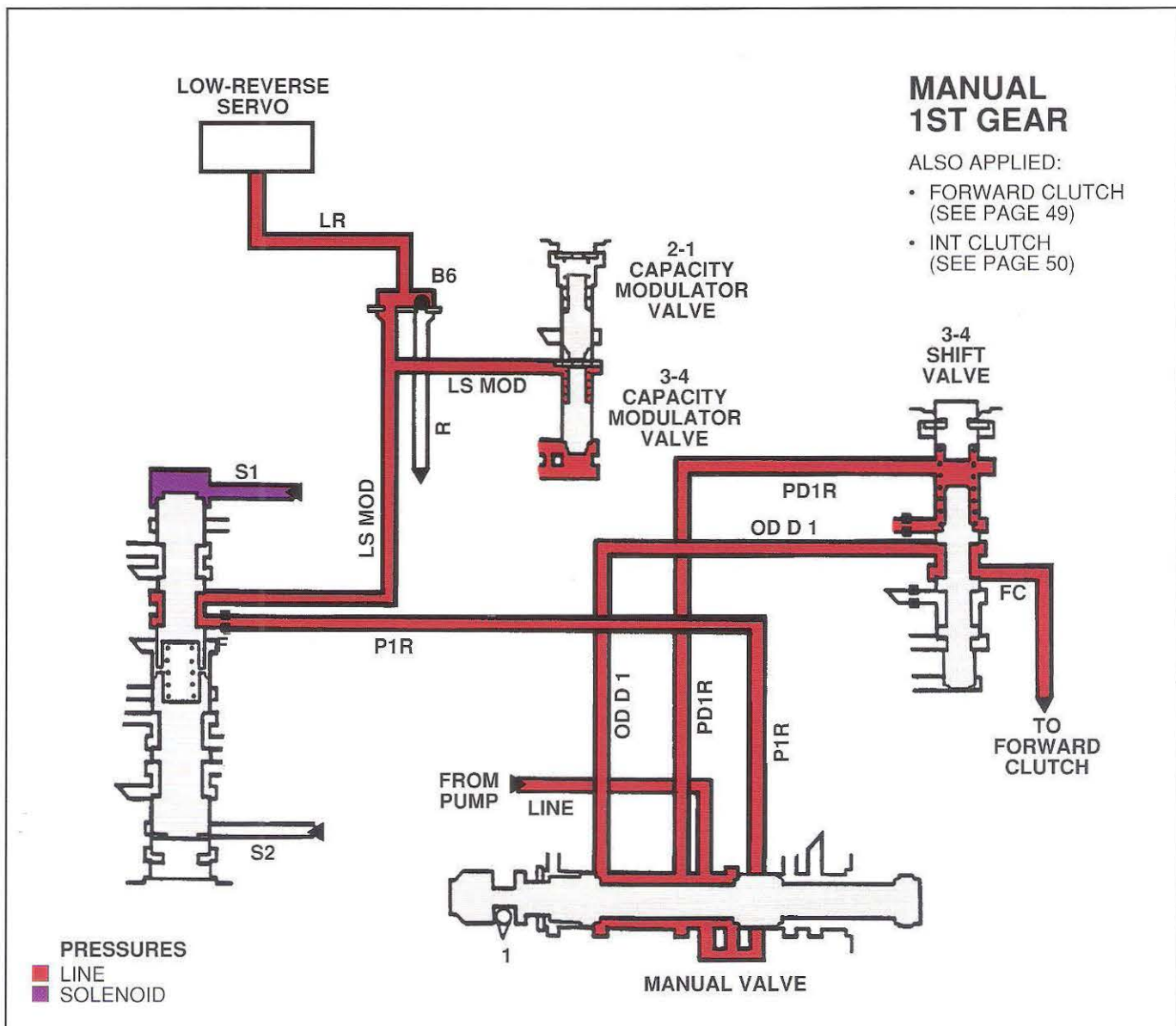
The PCM turns SS1 ON while SS2 is OFF for manual 1st gear operation.

When the manual valve is moved to the **1** position, fluid from the **LINE** circuit enters the **P1R** circuit. Fluid in the **P1R** circuit moves through the 1-2 shift valve and enters the **LS MOD** circuit.

Fluid in the **LS MOD** circuit moves through the B6 check ball where it shuttles the check ball to block a path into the **R** circuit. Fluid continues to move into the **LR** circuit, where it applies the low-reverse servo.

Fluid in the **LS MOD** circuit also moves to the 2-1 capacity modulator valve, which limits the maximum hydraulic pressure to apply the low-reverse servo.

Refer to pages 58 and 59 for hydraulic circuit identification information.



### 4-3 Throttle Downshift

When the transmission operates in the OD position, the PCM controls 4-3 throttle downshift by turning SS1 OFF while SS2 remains ON.

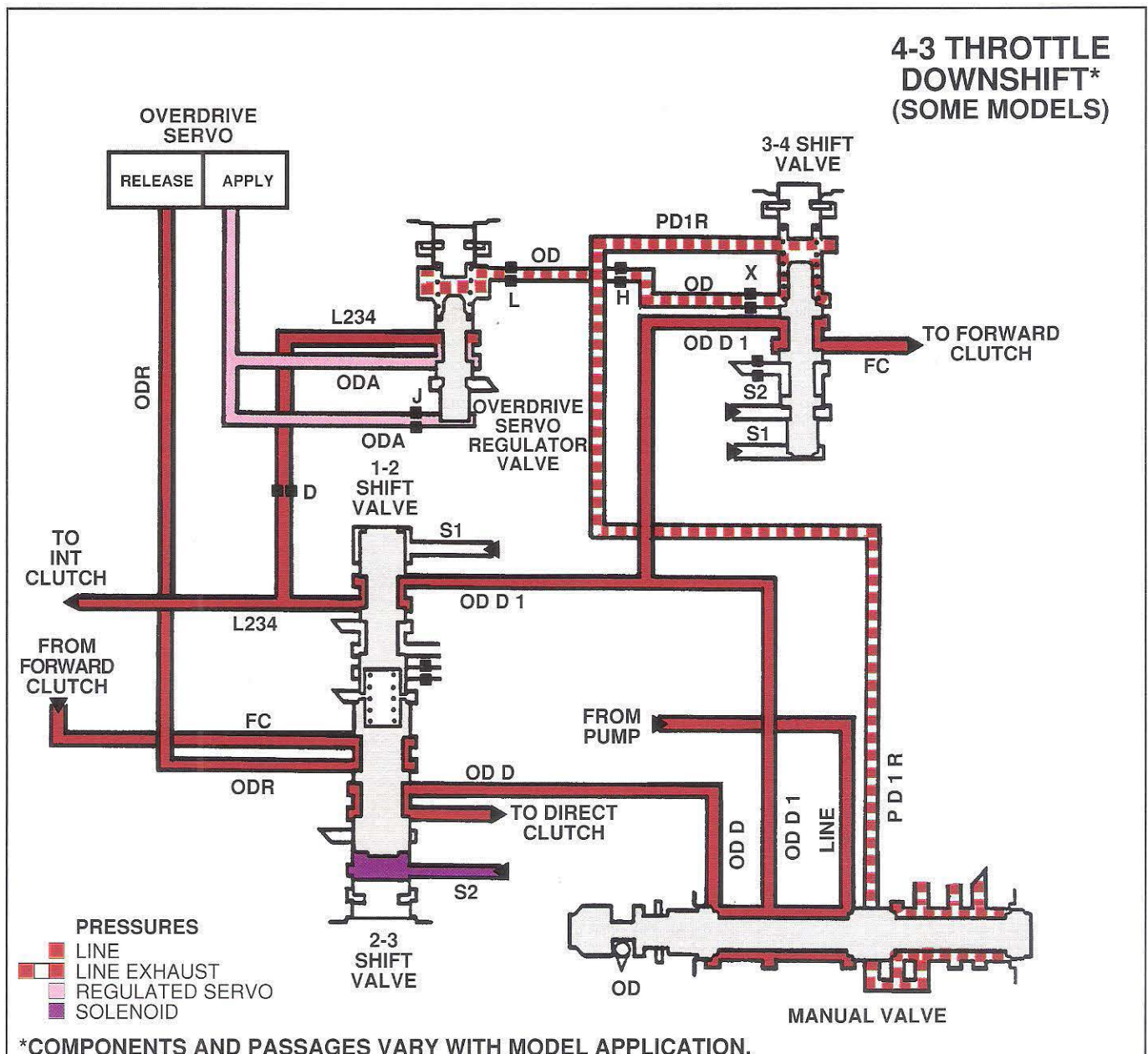
With SS1 OFF and no S1 circuit pressure present, spring force moves the 3-4 shift valve against S2 circuit pressure.

The 3-4 shift valve connects the OD circuit to an exhaust path through the PD1R circuit at the manual valve.

With no OD circuit pressure acting on the overdrive servo regulator valve, fluid in the L234 circuit moves through the valve and enters the ODA circuit under regulated pressure.

The overdrive servo is released with ODR circuit pressure (fed by the FC circuit in 3rd gear).

Refer to pages 58 and 59 for hydraulic circuit identification information.





# THEORY

## HYDRAULIC COMPONENTS

### 3-2 Downshift

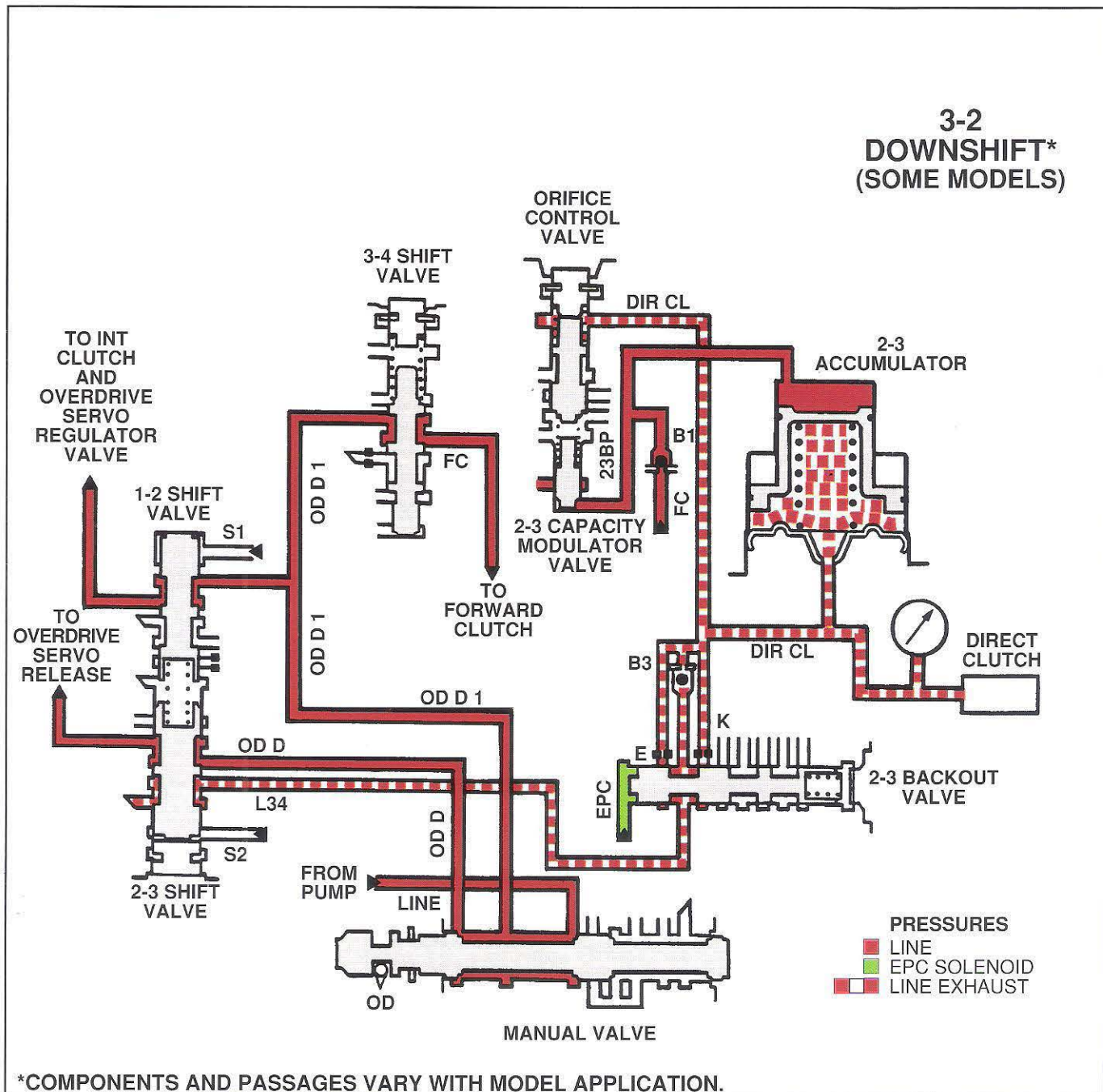
The PCM controls the 3-2 downshift by turning SS2 OFF while SS1 remains OFF.

With SS2 OFF and no S2 circuit pressure present, spring force moves the 2-3 shift valve.

The 2-3 shift valve provides an exhaust path for the direct clutch through the DIR CL circuit, the 2-3 backout valve and the L34 circuit.

During a 3-2 downshift, the 2-3 shift valve also blocks the path of the FC circuit into the ODR circuit for overdrive servo release. Instead, the 2-3 shift valve connects the OD D circuit to the ODR circuit for overdrive servo release.

Refer to pages 58 and 59 for hydraulic circuit identification information.



### 2-1 Downshift

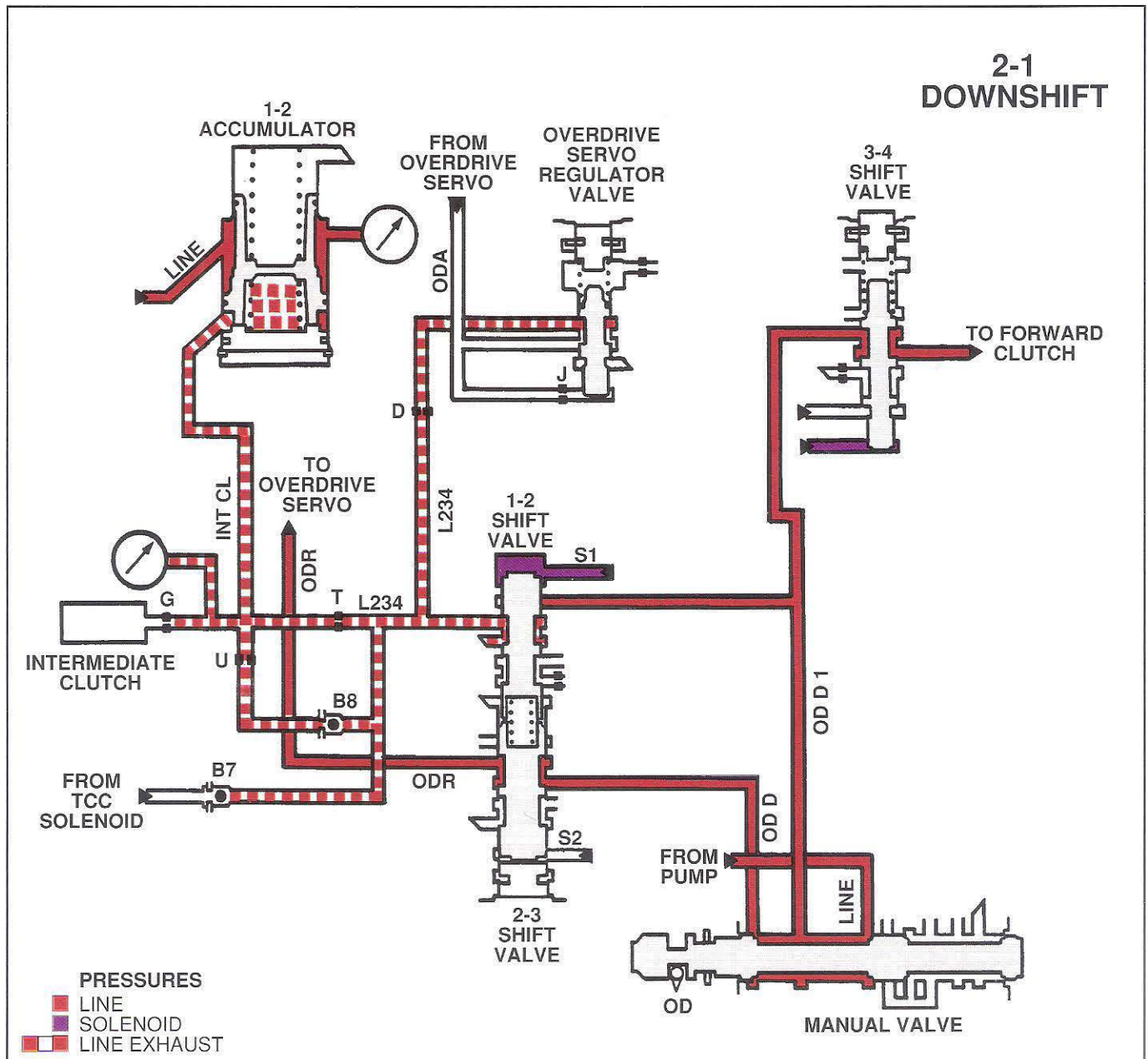
The PCM controls the 2-1 downshift by turning SS1 ON while SS2 remains OFF. With SS1 ON, **S1** circuit pressure moves the 1-2 shift valve.

The 1-2 shift valve provides an exhaust path for the intermediate clutch through the **INT CL** and **L234** circuits. With no **L234** circuit pressure present, the **TCC** circuit exhausts at the 1-2 shift valve through the unseated B7 check ball and **L234** circuit.

With no **L234** circuit pressure present, the **ODA** circuit also exhausts through the **L234** circuit at the 1-2 shift valve.

The 2-3 shift valve continues to connect the **OD D** circuit to the **ODR** circuit for overdrive servo release.

Refer to pages 58 and 59 for hydraulic circuit identification information.





# THEORY

## HYDRAULIC COMPONENTS

### HYDRAULIC CIRCUIT IDENTIFICATION

Circuit	Description
<b>BOOST</b>	Between the main regulator valve and the pump suction port
<b>CBY</b>	Between the bypass clutch control valve and the TCC piston and damper assembly
<b>CC</b>	Between the main regulator valve and the converter pressure limit valve
<b>CCL</b>	Between the converter pressure limit valve and the bypass clutch control valve
<b>CI</b>	Between the bypass clutch control valve and the torque converter impeller
<b>CT</b>	Between the torque converter turbine, the bypass clutch control valve, the converter drainback valve, the fluid cooler and front lube passages
<b>DIR CL</b>	Between the 2-3 backout valve, the 2-3 accumulator, the orifice control valve and the direct clutch
<b>EPC</b>	Between the EPC solenoid, the main regulator valve and the 2-3 backout valve
<b>FC</b>	Between the 3-4 shift valve, the orifice control valve, the 2-3 capacity modulator valve, the 2-3 backout valve, the B1 check ball, the forward clutch, the 3-4 capacity modulator valve and the 1-2 shift valve
<b>FC 12</b>	Between the orifice control valve and the 2-3 backout valve
<b>FC 34</b>	Between the orifice control valve and the 2-3 backout valve
<b>INT CL</b>	Between the orifice T, the B8 check ball, the 1-2 accumulator and the intermediate clutch
<b>LINE</b>	Between the pump, the main regulator valve, the manual valve, the EPC solenoid and the 1-2 accumulator
<b>LR</b>	Between the B6 check ball and the low-reverse servo
<b>LS MOD</b>	Between the 1-2 shift valve, the B6 check ball and the 2-1 capacity modulator valve



**HYDRAULIC CIRCUIT IDENTIFICATION**

<b>Circuit</b>	<b>Description</b>
<b>L234</b>	Between the 1-2 shift valve, the B7 and B8 check balls, orifice T and the overdrive servo regulator valve
<b>L34</b>	Between the 2-3 shift valve and the 2-3 backout valve
<b>OD</b>	Between the 3-4 shift valve and the overdrive servo regulator valve
<b>OD D</b>	Between the manual valve and the 2-3 shift valve
<b>OD D1</b>	Between the manual valve, the solenoid pressure regulator valve, the rear lube passages, the 1-2 shift valve and the 3-4 shift valve
<b>ODA</b>	Between the servo regulator valve and the apply side of the overdrive servo
<b>ODR</b>	Between the 2-3 shift valve and the release side of the overdrive servo
<b>PD1R</b>	Between the manual valve and the 3-4 shift valve
<b>P1R</b>	Between the manual valve and the 1-2 shift valve
<b>R</b>	Between the manual valve, the main regulator valve, the B5 and B6 check balls and the reverse clutch
<b>SOLP</b>	Between the solenoid pressure regulator valve, SS1, SS2 and the TCC solenoid
<b>S1</b>	Between SS1, the 1-2 shift valve and the 3-4 shift valve
<b>S2</b>	Between SS2, the 2-3 shift valve and the 3-4 shift valve
<b>TCC</b>	Between the TCC solenoid and the bypass clutch control valve
<b>23BP</b>	Between the B1 check ball, the 2-3 capacity modulator valve and the 2-3 accumulator



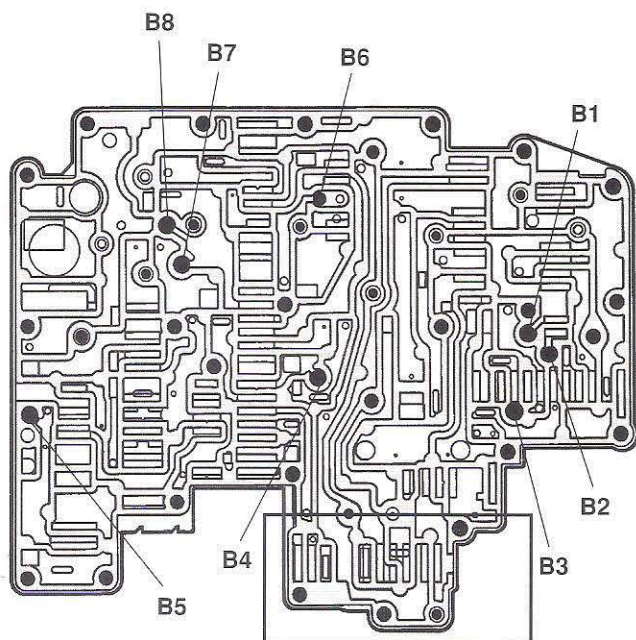
# THEORY

## HYDRAULIC COMPONENTS

### HYDRAULIC CIRCUIT CHECK BALL IDENTIFICATION

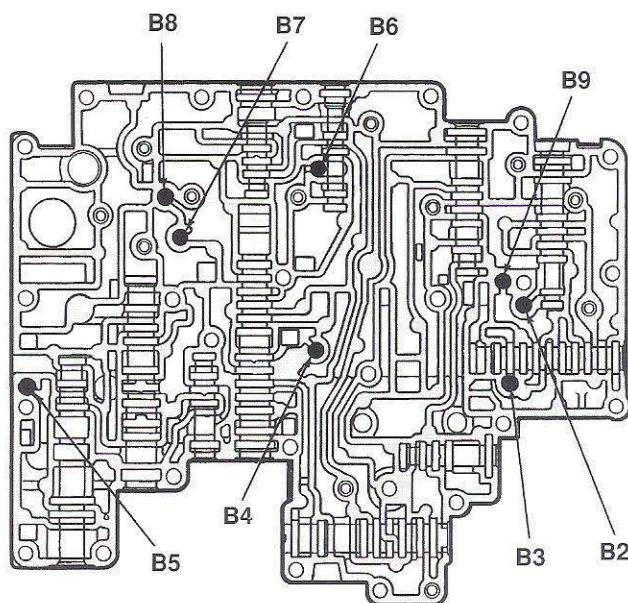
Check Ball	Description
<b>B1</b>	Between the <b>FC</b> circuit and the <b>23BP</b> circuit (1992-TO-1995)
<b>B2</b>	In the <b>FC</b> circuit near the 3-4 shift valve
<b>B3</b>	In the <b>DIR CL</b> circuit near the 2-3 backout valve
<b>B4</b>	In the <b>ODR</b> and <b>FC</b> circuits near the 1-2 shift valve
<b>B5</b>	In the <b>R</b> circuit near orifice 1
<b>B6</b>	Between the <b>R</b> , <b>LS MOD</b> and <b>LR</b> circuits
<b>B7</b>	Between the <b>L234</b> and <b>TCC</b> circuits
<b>B8</b>	Between the <b>L234</b> and <b>INT CL</b> circuits
<b>B9</b>	Between the <b>FC34</b> and <b>23BP</b> circuits (1996-TO-PRESENT)

1992-TO-1995



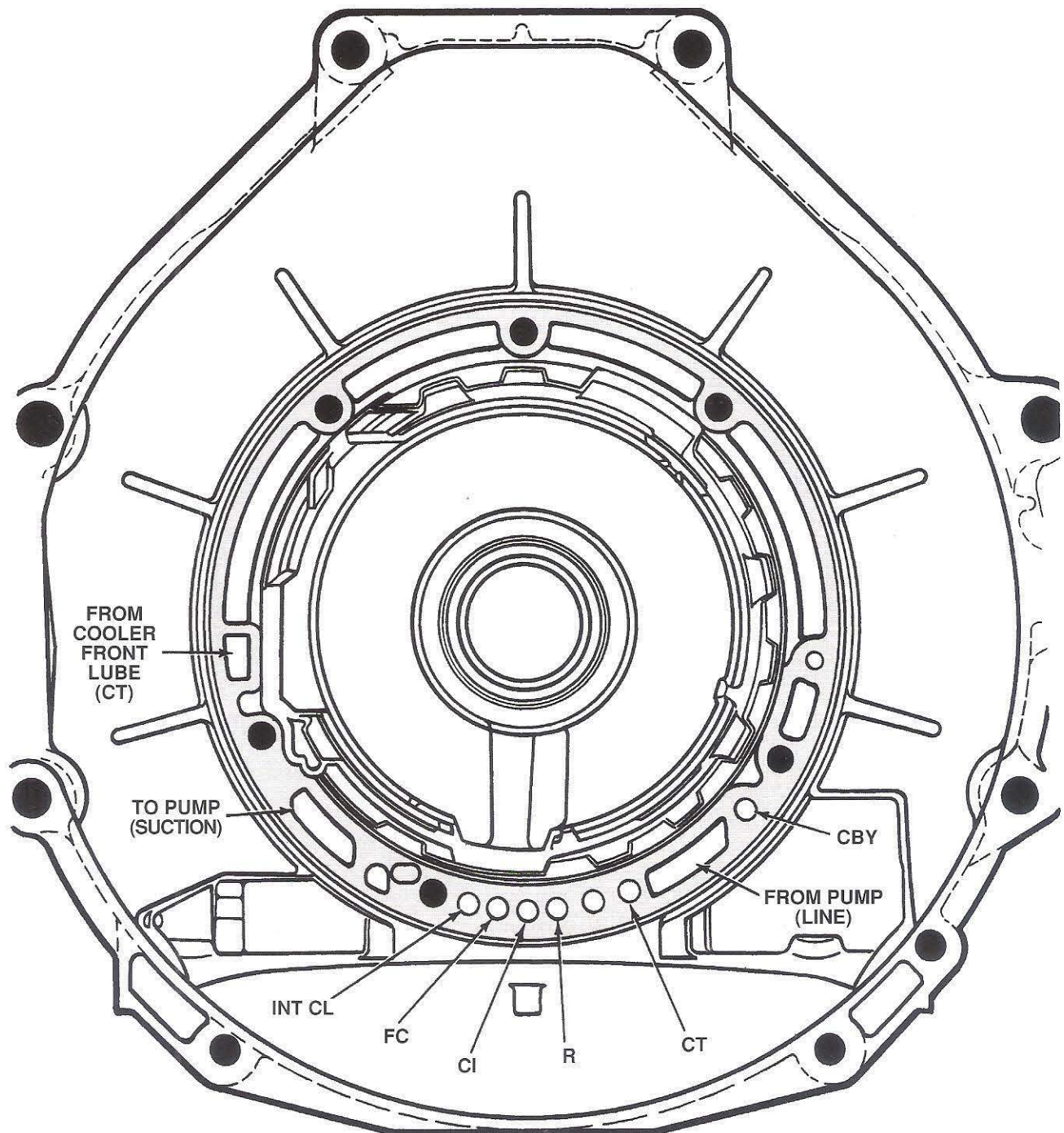
PASSAGES IN THIS AREA  
MAY VARY IN SHAPE.

1996-TO-PRESENT



**HYDRAULIC PASSAGE IDENTIFICATION**

**TRANSMISSION CASE (FRONT)**

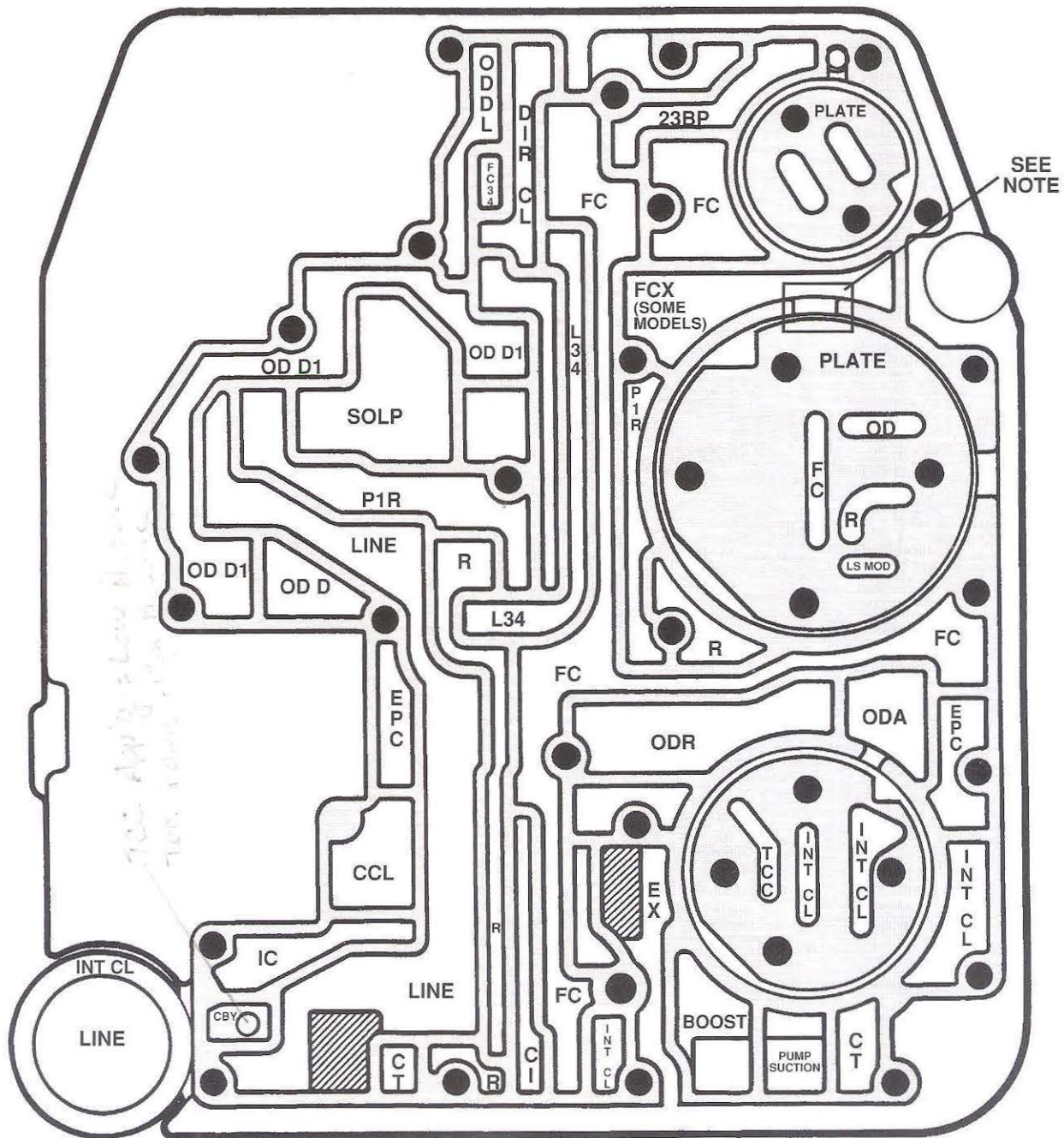




## HYDRAULIC COMPONENTS

## HYDRAULIC PASSAGE IDENTIFICATION

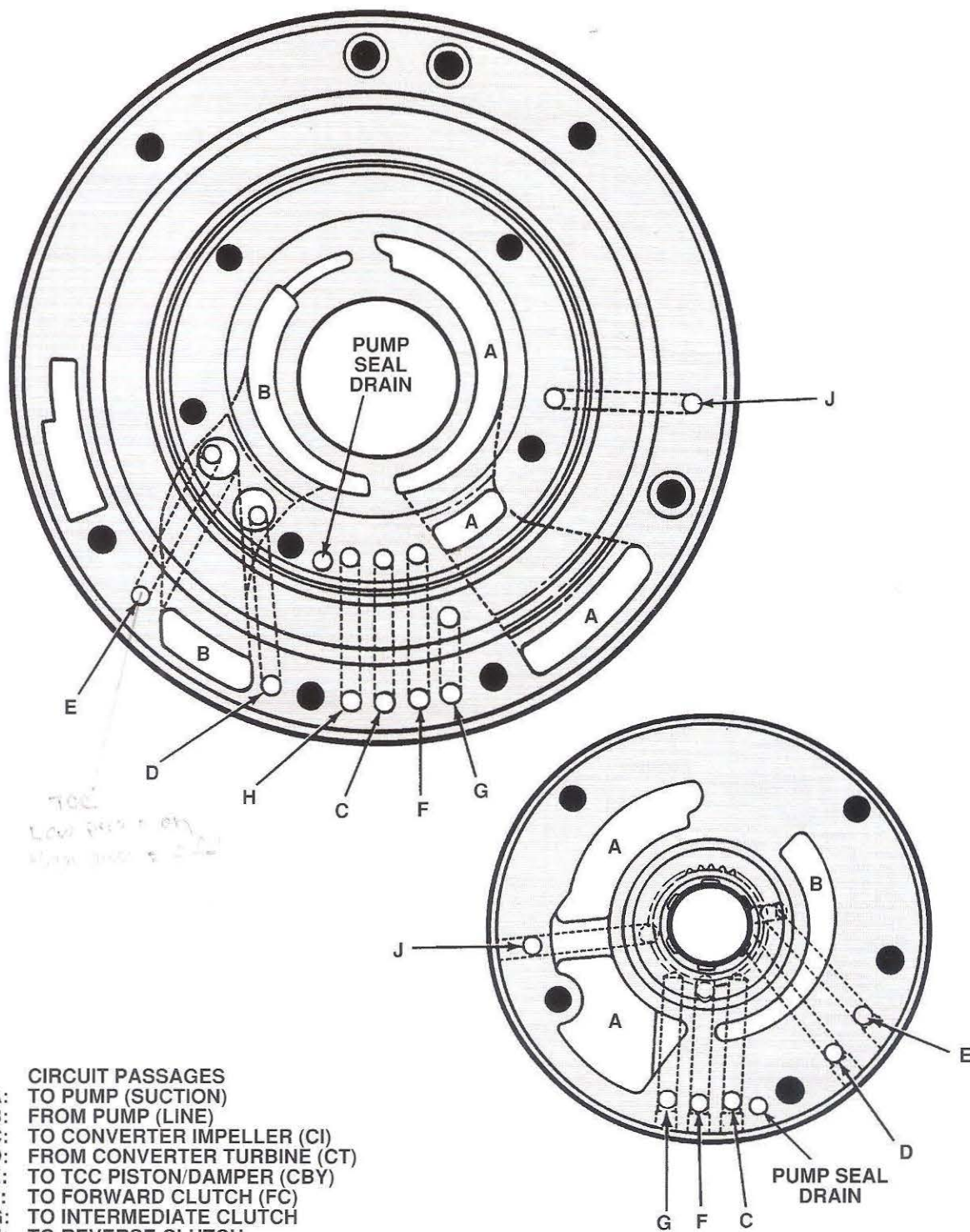
### TRANSMISSION CASE (BOTTOM)



**NOTE: SOME MODELS DO NOT HAVE THIS PASSAGE.**

HYDRAULIC PASSAGE IDENTIFICATION

PUMP BODY AND SUPPORT





# THEORY

## HYDRAULIC COMPONENTS

### HYDRAULIC PASSAGE IDENTIFICATION

#### VALVE BODY (TRANSMISSION CASE SIDE) – 1992-TO-1995

2-3 CAPACITY MODULATOR VALVE,  
ORIFICE CONTROL VALVE

2-3 BACKOUT VALVE

SOLENOID PRESSURE  
REGULATOR VALVE

MANUAL  
VALVE

3-4 SHIFT  
VALVE

2-1  
CAPACITY  
MODULATOR  
VALVE,  
3-4  
CAPACITY  
MODULATOR  
VALVE

OVERDRIVE  
SERVO  
REGULATOR  
VALVE

SEE  
NOTE

1-2 SHIFT VALVE,  
2-3 SHIFT VALVE

EPC  
CONVERTER PRESSURE  
LIMIT VALVE

BYPASS CLUTCH  
CONTROL VALVE

MAIN REGULATOR  
VALVE

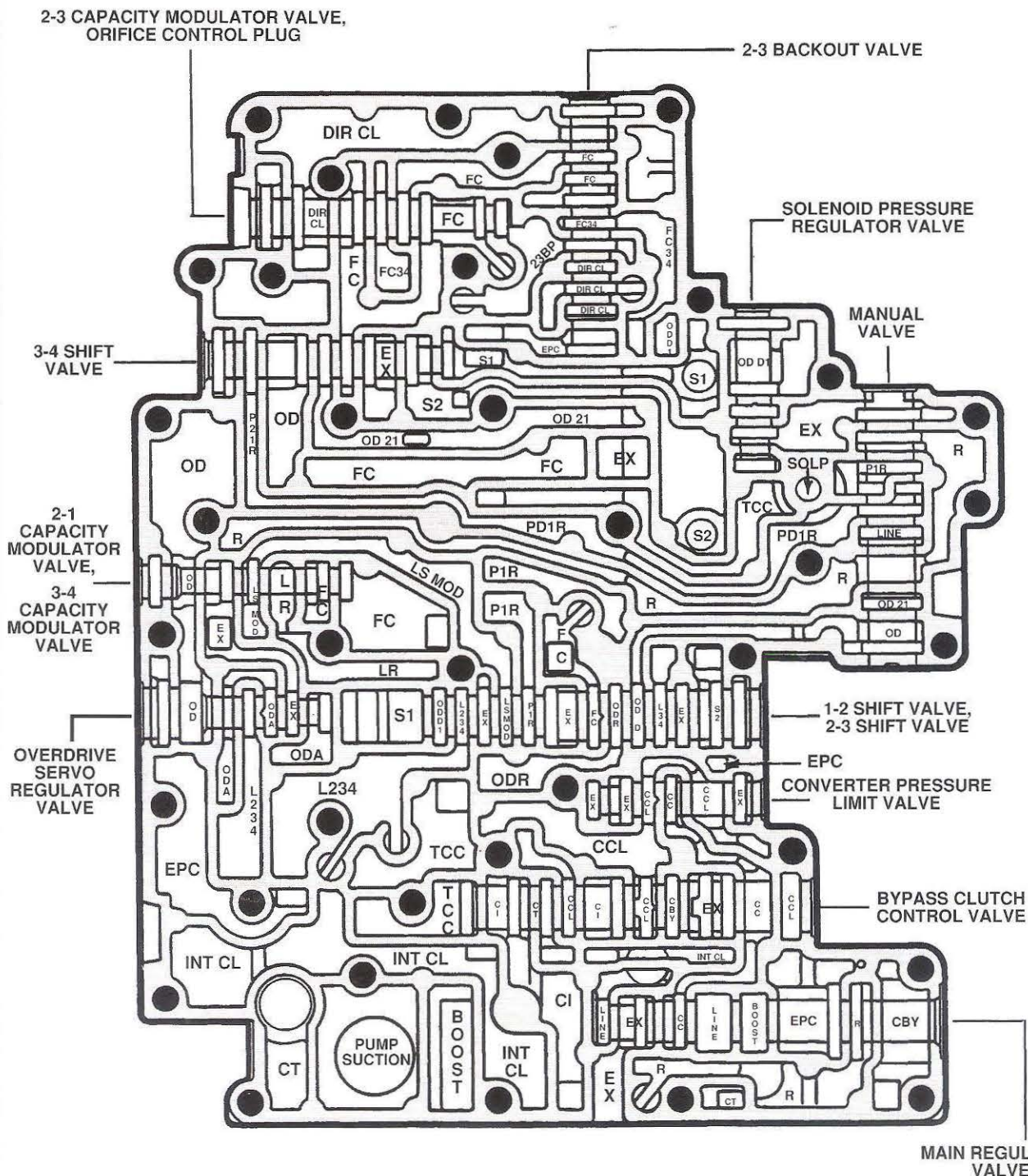
NOTE: SOME MODELS HAVE THE OD D AND OD CIRCUITS CONNECTED  
(SEE DOTTED LINES) TO FORM ONE OD CIRCUIT





## HYDRAULIC COMPONENTS

## VALVE BODY (TRANSMISSION CASE SIDE) – 1996-TO-PRESENT



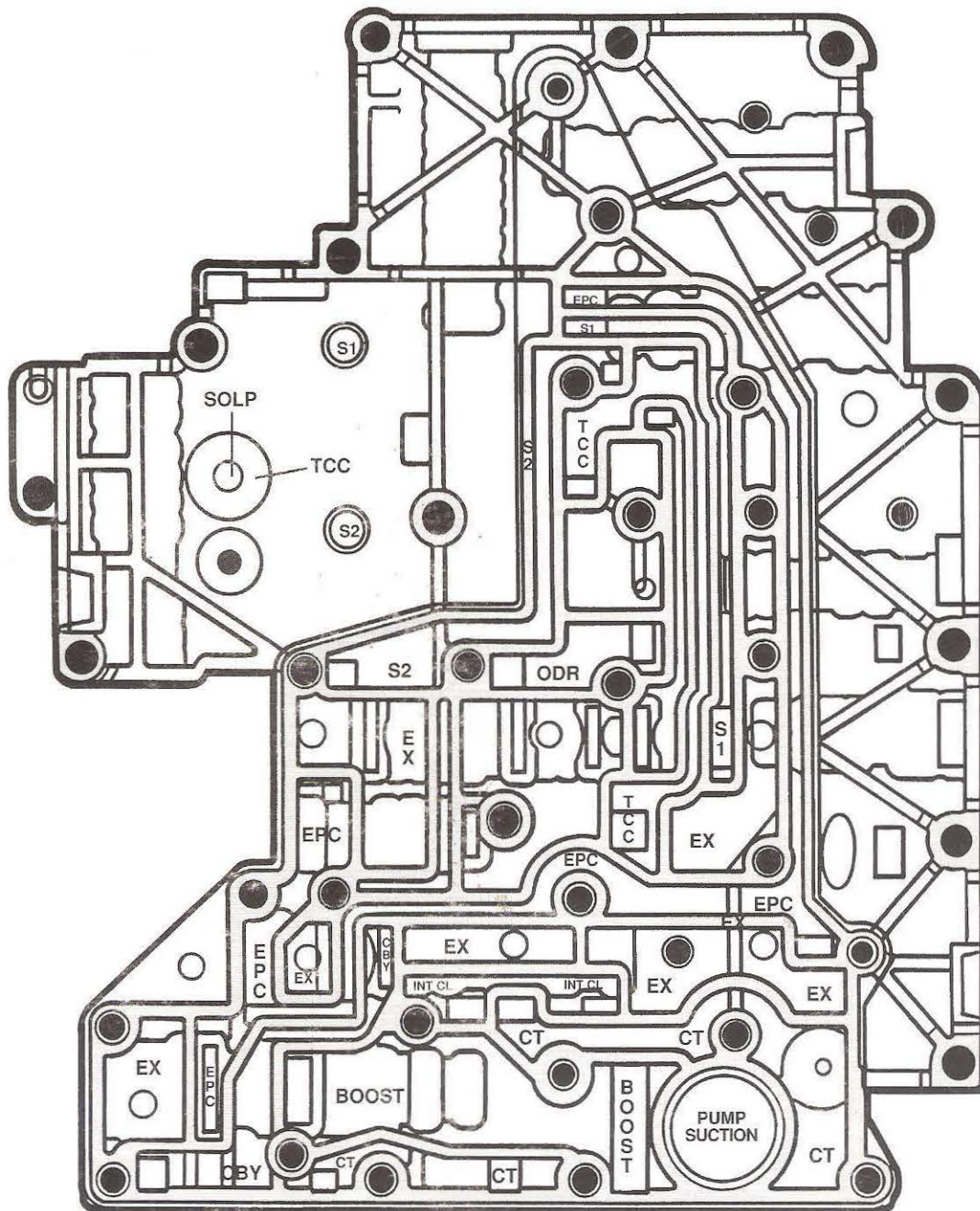


# THEORY

## HYDRAULIC COMPONENTS

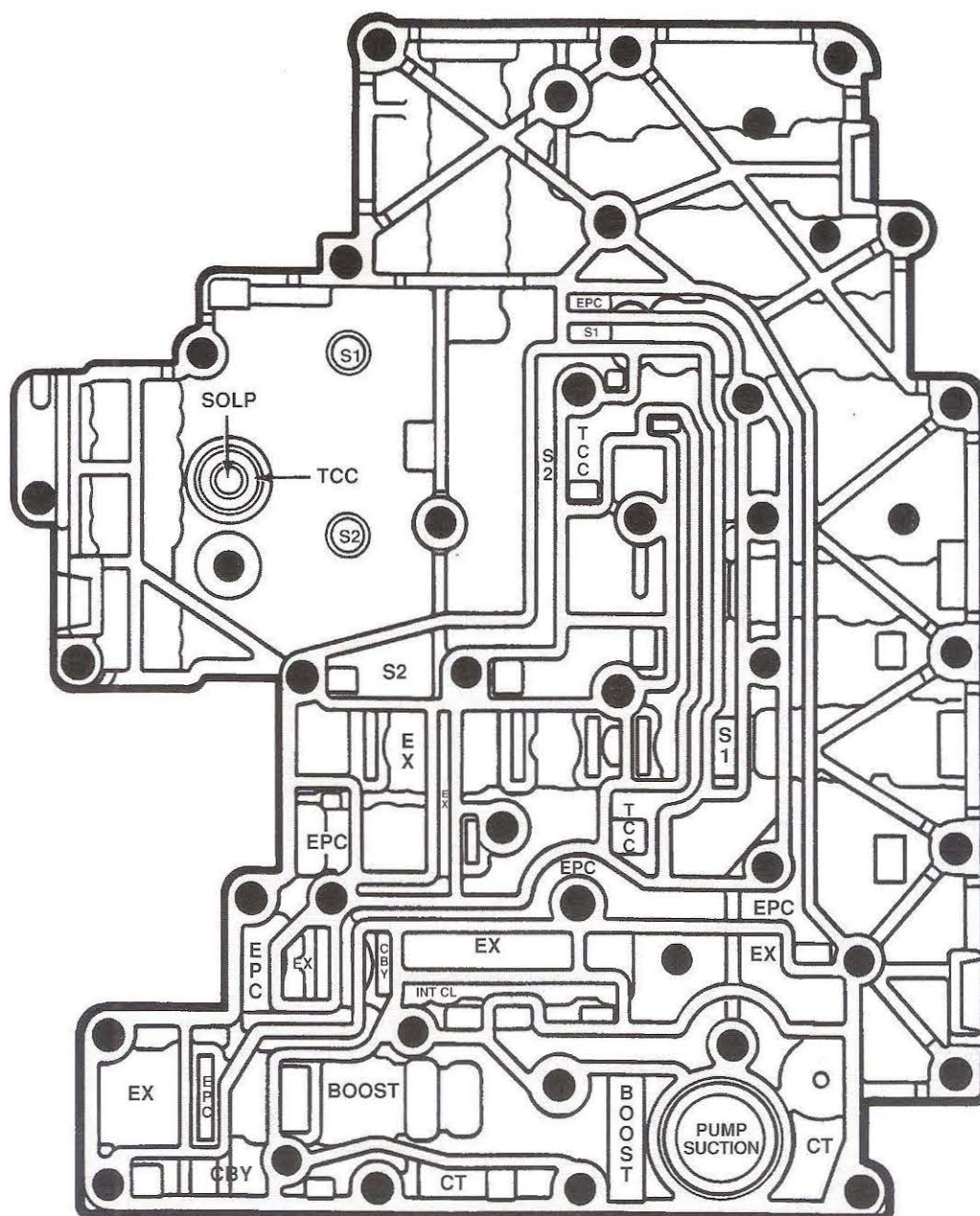
### HYDRAULIC PASSAGE IDENTIFICATION

VALVE BODY (COVER PLATE SIDE) – 1992-TO-1995



**HYDRAULIC PASSAGE IDENTIFICATION**

**VALVE BODY (COVER PLATE SIDE) – 1996-TO-PRESENT**

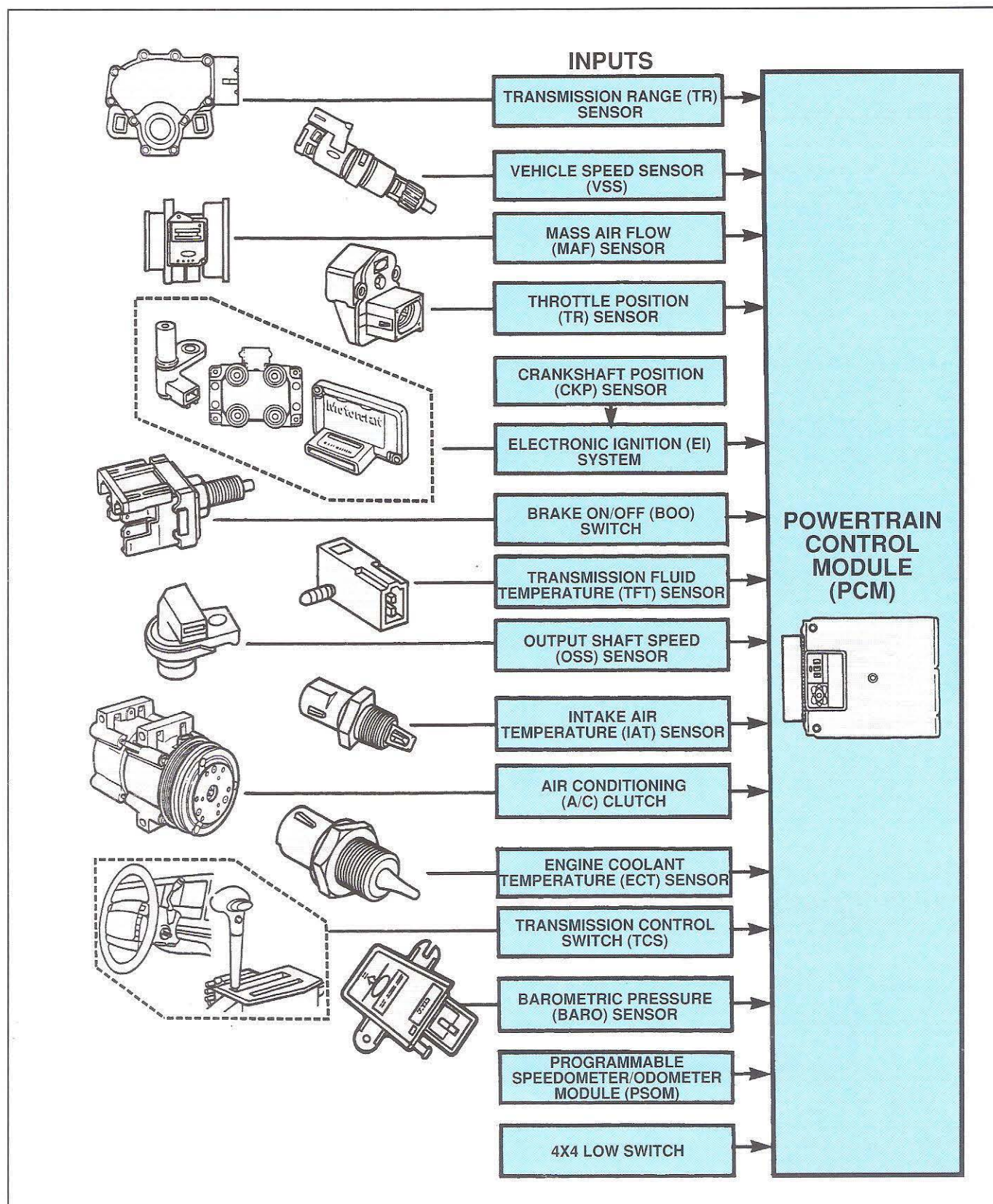




# THEORY

## ELECTRONIC COMPONENTS

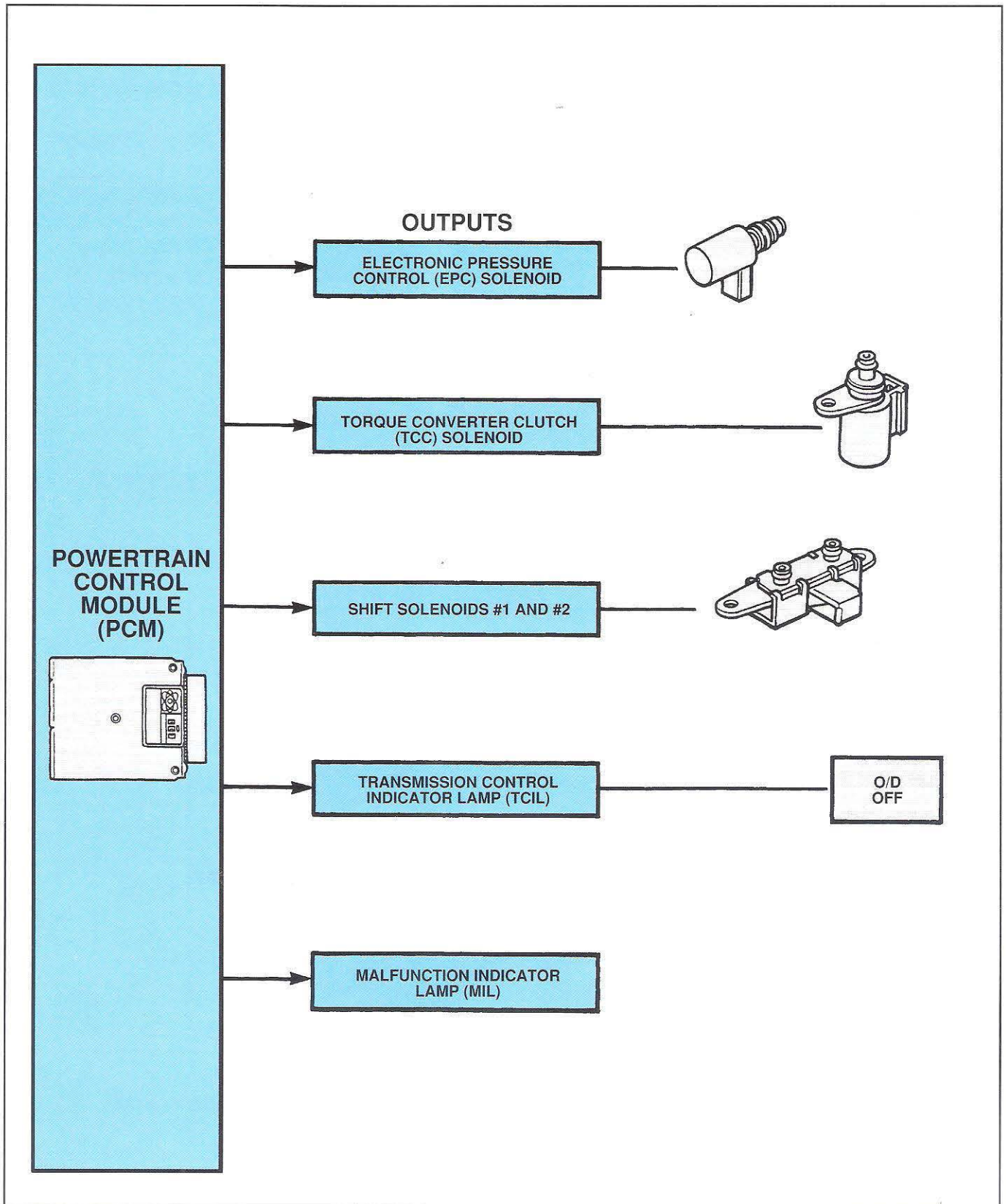
### COMPONENT OVERVIEW





# THEORY

## ELECTRONIC COMPONENTS





# THEORY

## ELECTRONIC COMPONENTS

### POWERTRAIN CONTROL MODULE

#### Description:

The Powertrain Control Module (PCM) controls various engine functions and provides control of the AODE/4R70W transmission.

The PCM responds to inputs and operates solenoids for electro-hydraulic control of line pressure, shift scheduling and TCC apply.

The chart on this page shows PCM strategy of AODE solenoid control for 1992 vehicles. The chart on the facing page shows PCM strategy of AODE and 4R70W solenoid control for 1993-to-present vehicles.

The PCM has the ability to:

- Monitor its input and output devices for the presence of faults.
- Store DTCs (Diagnostic Trouble Codes) related to detected faults.
- Alert the driver for some detected faults by turning ON the MIL (Malfunction Indicator Lamp) in the instrument cluster.
- Display information when a service technician connects diagnostic equipment.

#### 1992 VEHICLES

TRANSMISSION RANGE SELECTOR LEVER POSITION	POWERTRAIN CONTROL MODULE (PCM) GEAR COMMANDED	SHIFT SOLENOIDS		
		ENG BRAKE	SS1	SS2
P/N (PARK/NEUTRAL)	P/N	NO	ON <sup>A</sup>	OFF <sup>A</sup>
R (REVERSE)	R	YES	ON <sup>A</sup>	OFF <sup>A</sup>
D (OVERDRIVE)	1	NO	ON	OFF
	2	NO	OFF	OFF
	3	YES	OFF	ON
	4	YES	ON	ON
D (DRIVE)	1	NO	ON	OFF
	2	NO	OFF	OFF
	3	YES	OFF	ON
1 (MANUAL 1ST)	1	YES	ON	OFF
	2 <sup>B</sup>	YES	OFF	OFF

<sup>A</sup>Not contributing to powerflow.

<sup>B</sup>When a manual pull-in occurs above calibrated speed, the transaxle will not downshift from the higher gear until the vehicle speed drops below this calibrated speed.



## THEORY

### ELECTRONIC COMPONENTS

If the PCM detects an input signal fault, it may use FMEM (Failure Management and Effects Mode) strategy and provide a substitute signal or value.

#### Symptoms:

If the transmission loses electronic control, it will operate in a fail-safe mode with the following features:

- Functional **P**, **R** and **N** positions
- 2nd gear operation in **OD**, **D** (or **2**) position (with no coast braking)
- 2nd gear operation in **1** position (with coast braking)
- TCC release in all positions
- Maximum line pressure in all positions

#### 1993-TO-PRESENT VEHICLES

TRANSMISSION RANGE SELECTOR LEVER POSITION	POWERTRAIN CONTROL MODULE (PCM) GEAR COMMANDED	SHIFT SOLENOIDS		
		ENG BRAKE	SS1	SS2
P/N (PARK/NEUTRAL)	P/N	NO	ON <sup>A</sup>	OFF <sup>A</sup>
R (REVERSE)	R	YES	ON <sup>A</sup>	OFF <sup>A</sup>
Ⓢ (OVERDRIVE) OR D (DRIVE) TCS OFF	1	NO	ON	OFF
	2	NO	OFF	OFF
	3	YES	OFF	ON
	4	YES	ON	ON
Ⓢ (OVERDRIVE) OR D (DRIVE) TCS ON	1	NO	ON	OFF
	2	NO	OFF	OFF
	3	YES	OFF	ON
2 (MANUAL 2ND)	2	YES	OFF	OFF
	3 <sup>B</sup>	NO	OFF	ON
1 (MANUAL 1ST)	1	YES	ON	OFF
	2 <sup>B</sup>	YES	OFF	OFF

<sup>A</sup>Not contributing to powerflow.

<sup>B</sup>When a manual pull-in occurs above calibrated speed, the transaxle will not have engine braking or downshift until the vehicle speed drops below this calibrated speed.



# THEORY

## ELECTRONIC COMPONENTS

### SOLENOIDS

#### Electronic Pressure Control Solenoid

##### Description:

The Electronic Pressure Control (EPC) solenoid is a Variable Force Style solenoid. The VFS style solenoid is an electro-hydraulic actuator combining a solenoid and a regulating valve.

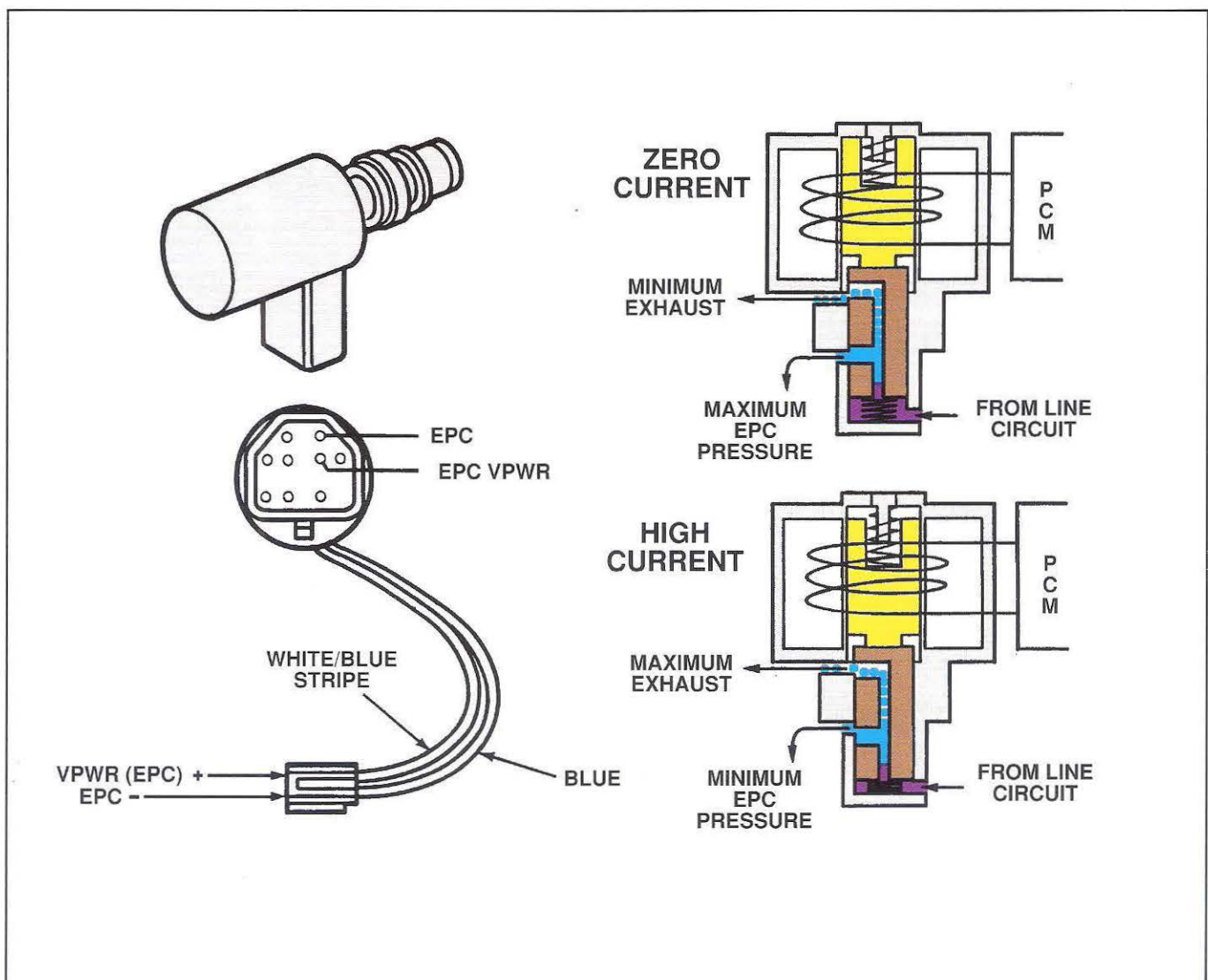
The PCM varies the current of the EPC solenoid, which varies pressure in the **EPC** hydraulic circuit. EPC pressure is used to control line pressure and the 2-3 backout valve position.

See page 41 for more information about the operation of the EPC solenoid in the line pressure hydraulic circuit.

##### Symptoms:

If the EPC solenoid fails ON, minimum **EPC** pressure results (minimum torque capacity). Under this condition, the PCM may turn ON the MIL.

If the EPC solenoid fails OFF, maximum EPC pressure results (harsh engagements and shifts).



### Shift Solenoids

#### Description:

Shift Solenoid 1 (SS1) and Shift Solenoid 2 (SS2) are electro-hydraulic actuators that allow fluid exhaust when OFF and block fluid exhaust when ON. SS1 and SS2 are part of one assembly.

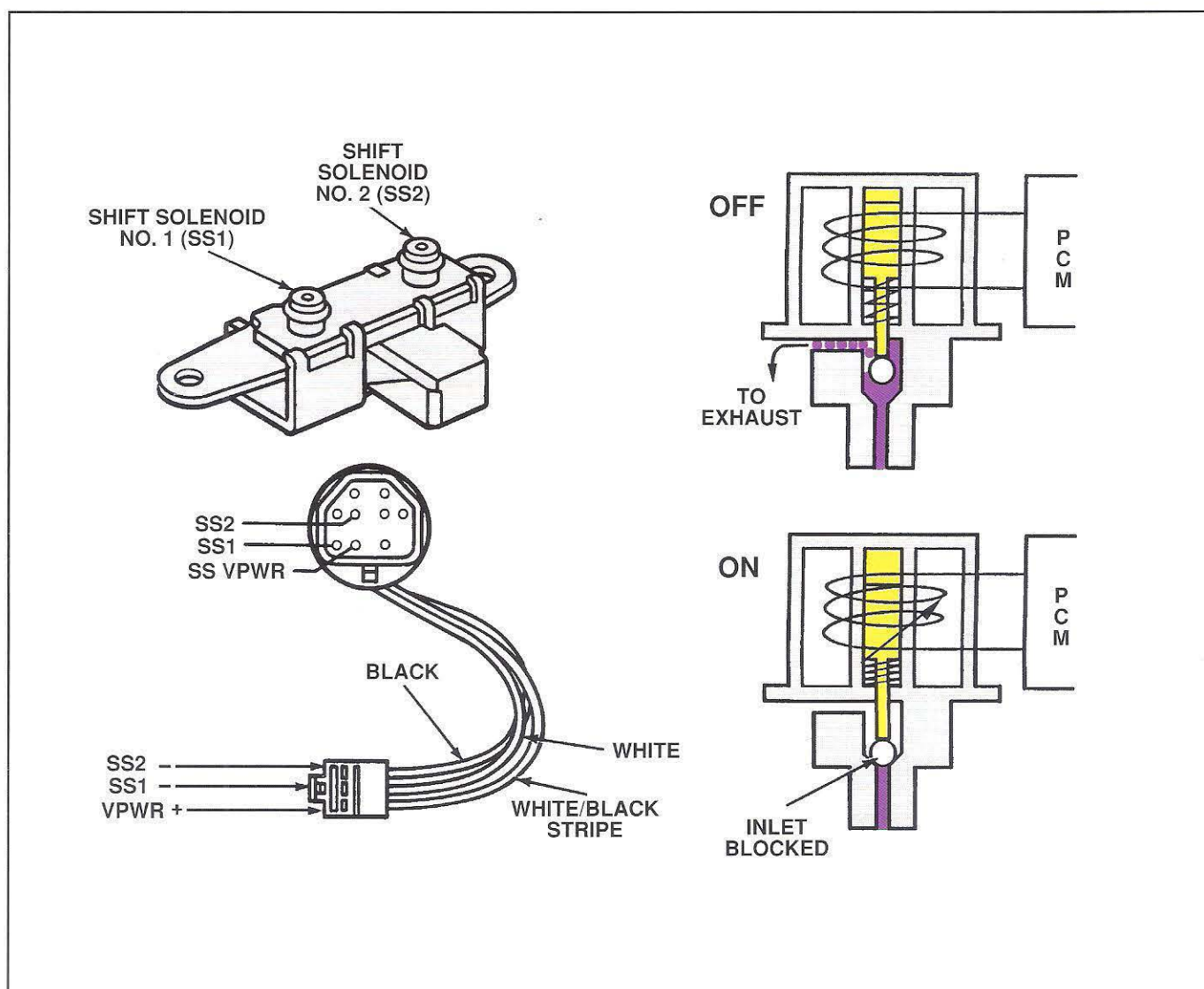
The PCM affects shift valve positions by determining when to turn the shift solenoids ON or OFF. This results in control of transmission operation in 1st, 2nd, 3rd and 4th gear.

See pages 44 and 45 for more information about the hydraulic circuit operation of the shift solenoids.

#### Symptoms:

If the shift solenoids fail ON or OFF, incorrect gear selection results, depending on failure mode and the position of the manual lever.

Refer to the charts on pages 70 and 71 for more information. Also, refer to the shift solenoid failure mode charts located in DIAGNOSTIC PROCEDURES.





## THEORY

### ELECTRONIC COMPONENTS

#### Torque Converter Clutch Solenoid

##### Description:

The Torque Converter Clutch (TCC) solenoid is an electro-hydraulic actuator that varies hydraulic pressure and is operated by electronic Pulse-Width Modulation (PWM) control.

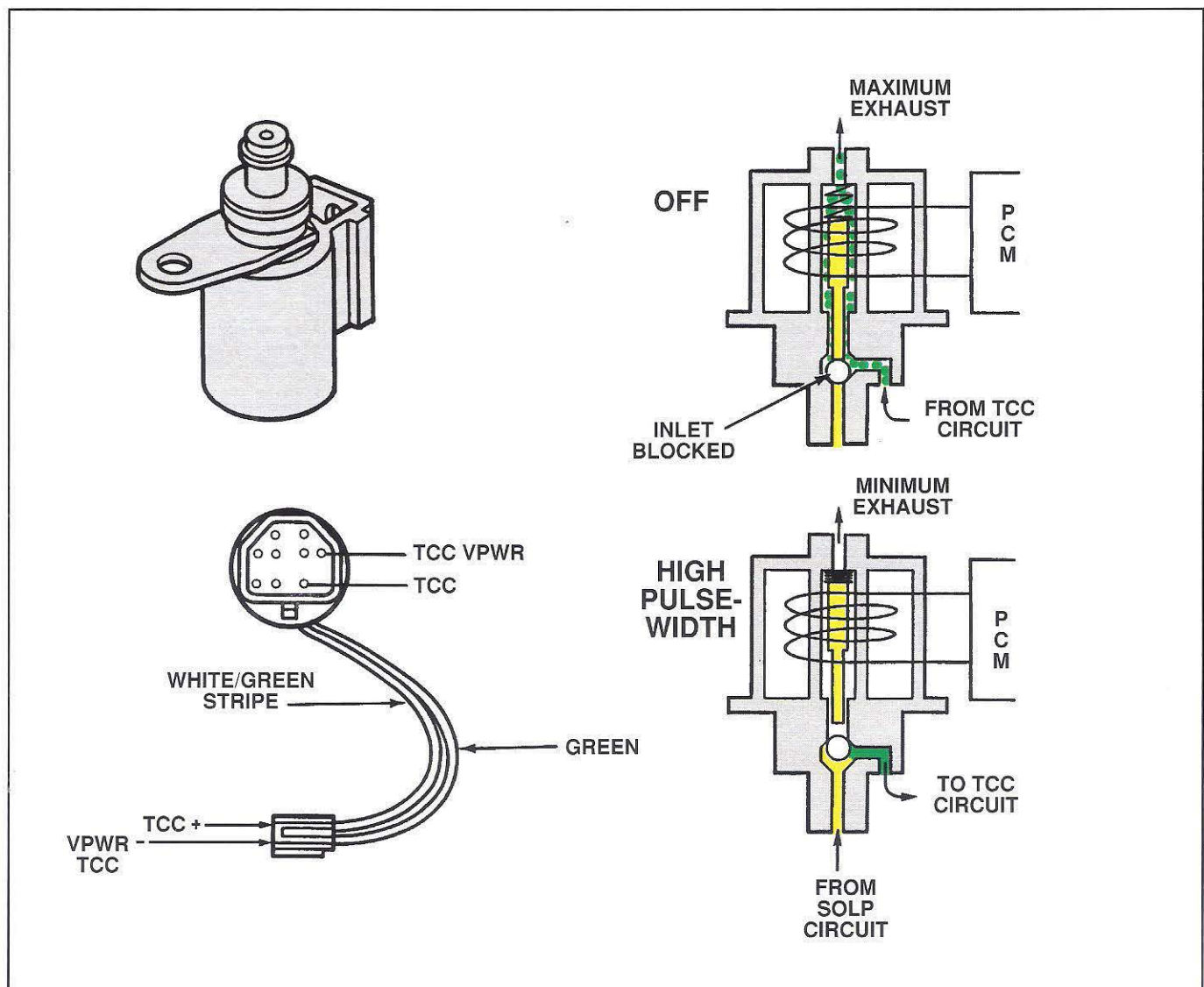
The PCM varies the pressure in the **TCC** hydraulic circuit to position the bypass clutch control valve. Bypass clutch control valve position determines whether TCC is fully applied, fully released or operating under controlled modulation.

See page 47 for more information about the hydraulic circuit operation of the TCC solenoid.

##### Symptoms:

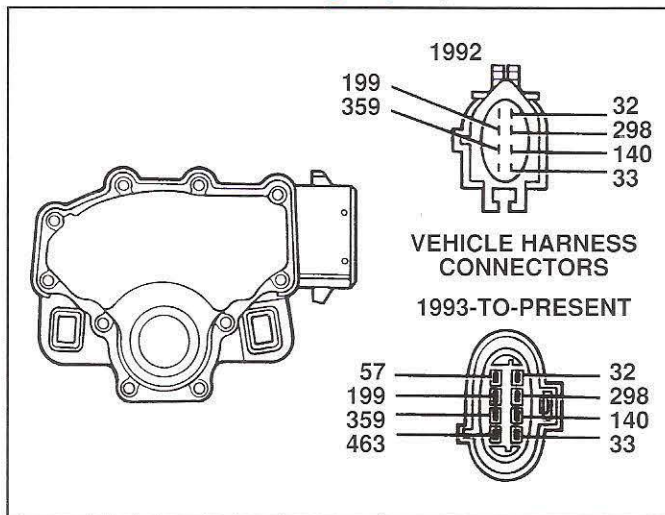
If the TCC solenoid fails ON, the engine runs rough and may stall at low speeds (1st, 2nd, 3rd or 4th gear). Also, vehicle shudder may result.

If the TCC solenoid fails OFF, poor fuel economy may occur. TCC will not be applied.



### INPUTS

#### Transmission Range (TR) Sensor



#### Description:

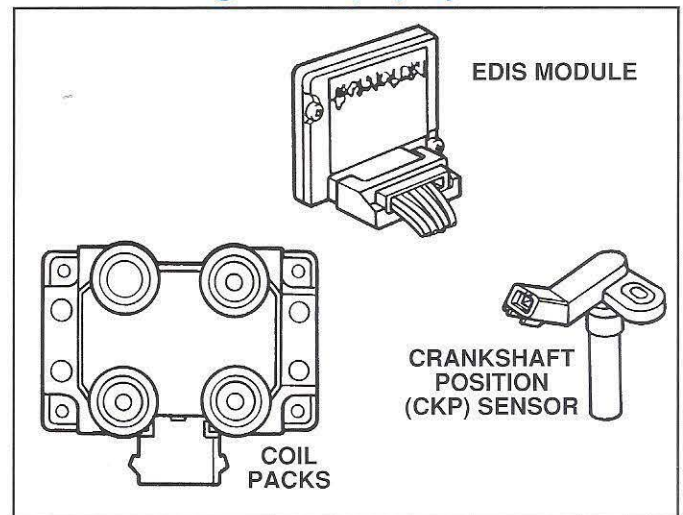
NOTE: See page 83 for information about the Digital Transmission Range (DTR) sensor.

The PCM sends a voltage signal to the Transmission Range (TR) sensor. The TR sensor incorporates a series of step-down resistors that act as a voltage divider. The PCM monitors this voltage, which corresponds to the position of the manual control lever. The TR sensor is located on the outside of the transmission at the manual control lever. The PCM uses the TR sensor to determine desired gear and EPC pressure. The TR sensor also contains the Park/Neutral Start, backup lamp and neutral sense (4x4 LOW) circuits.

#### Symptoms:

If the TR sensor fails, the driver experiences harsh engagements and firm shifts. The transmission may not operate in 4th gear or may downshift to a lower gear. The engine may not crank and the backup lights may not operate.

#### Electronic Ignition (EI) System



#### Description:

The Electronic Ignition (EI) system has a Crankshaft Position (CKP) sensor, Ignition Control Module (ICM) and coil packs. The CKP sensor sends crankshaft position information to the ICM, which sends an engine speed signal to the PCM. The PCM uses the RPM signal for EPC control strategy, shift scheduling (especially Wide-Open Throttle (WOT) shifts and TCC operation).

#### Symptoms:

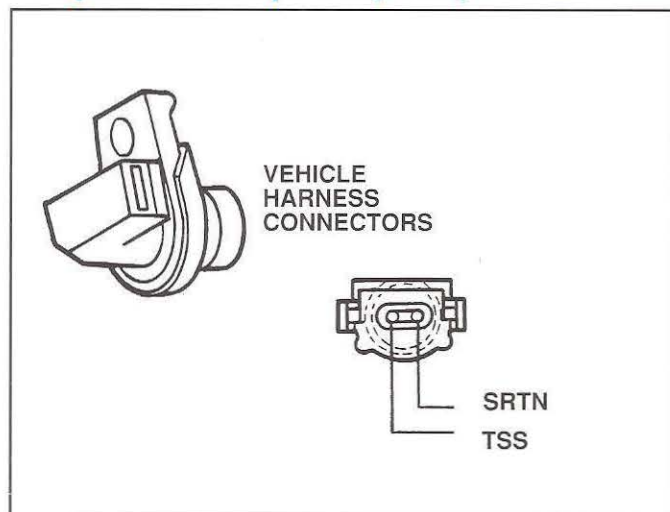
If the engine speed signal has a fault, harsh engagements and shifts may occur, WOT shifts may be late and TCC may not be applied.



## THEORY

### ELECTRONIC COMPONENTS

#### Output Shaft Speed (OSS) Sensor



##### Description:

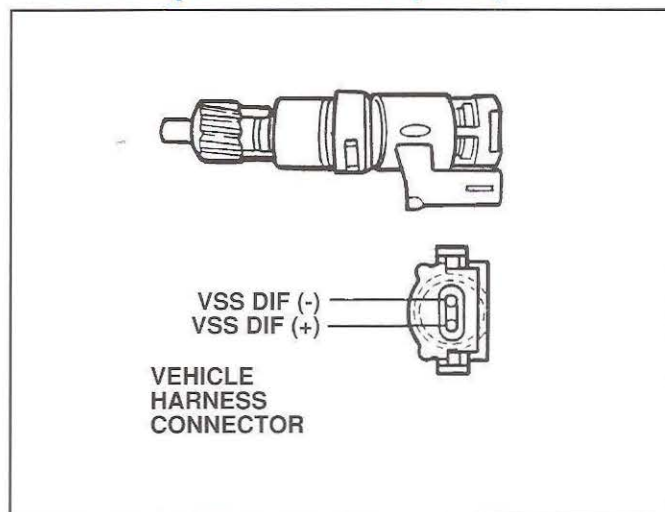
The Output Shaft Speed (OSS) sensor is a magnetic pickup located at the output shaft ring gear. The OSS sensor sends the PCM a signal indicating transmission output shaft speed.

The PCM uses the OSS sensor signal for EPC strategy, shift scheduling and TCC control.

##### Symptoms:

If the OSS sensor signal has a fault, the result may be harsh or abnormal shifts and no TCC operation.

#### Vehicle Speed Sensor (VSS)



##### Description:

The Vehicle Speed Sensor (VSS) is a magnetic pickup that sends the PCM a signal indicating vehicle speed.

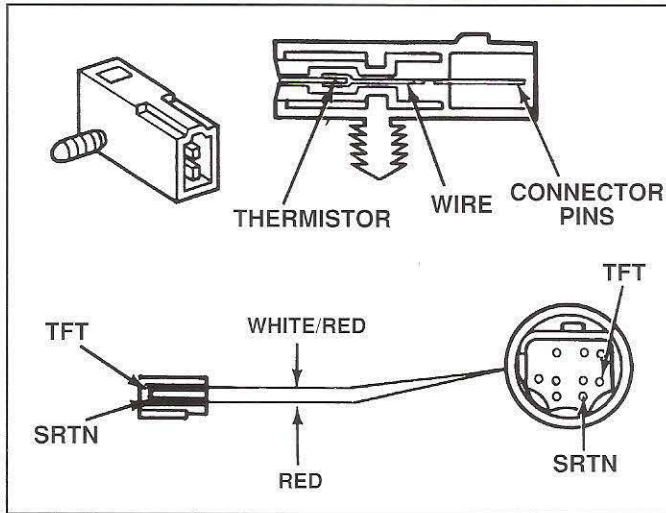
The PCM uses the VSS signal to modify upshift schedules.

##### Symptoms:

If the VSS signal has a fault, shift engagement/disengagement (hunting or busyness) may occur.



### Transmission Fluid Temp. (TFT) Sensor



#### Description:

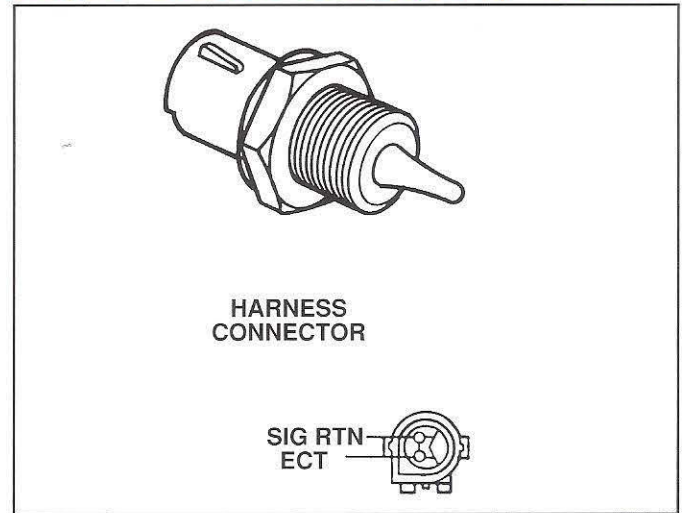
The Transmission Fluid Temperature (TFT) sensor is located on the transmission main control valve body. It is a temperature-sensitive device called a thermistor. The resistance value of the TFT sensor varies with temperature change. The PCM monitors the voltage across the TFT sensor to determine transmission fluid temperature.

The PCM uses the TFT sensor signal to determine whether a cold start shift schedule is necessary. The shift schedule is compensated when the transmission fluid temperature is cold. The PCM also inhibits TCC operation at cold fluid temperatures. The PCM corrects EPC pressures based on fluid temperature.

#### Symptoms:

If the TFT sensor signal has a fault, stabilized shift scheduling and TCC apply may occur too soon after a cold start.

### Engine Coolant Temp. (ECT) Sensor



#### Description:

The Engine Coolant Temperature (ECT) sensor detects the temperature of engine coolant and provides the PCM with input information.

The ECT sensor is threaded into the heater outlet fitting or cooling passage on the engine. The PCM uses the ECT sensor as an input for control of the engine functions of ignition timing, EGR flow and air-to-fuel ratio. Vehicles equipped with electronic instrument clusters use the ECT sensor for control of a coolant temperature indicator.

The PCM uses the ECT sensor as an input for TCC control strategy.

#### Symptoms:

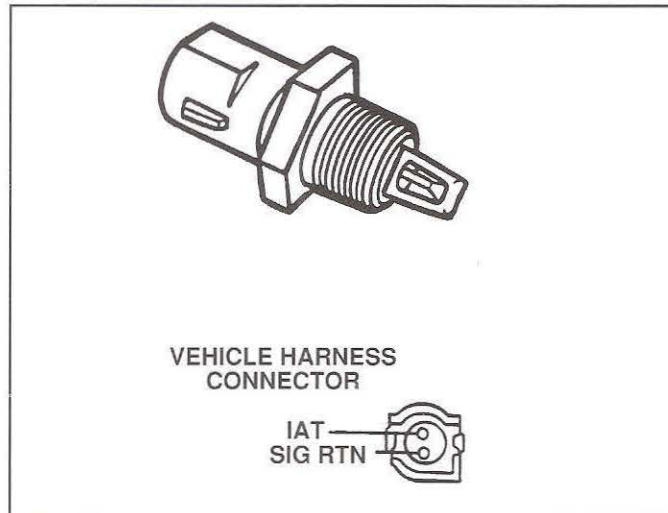
If the ECT sensor signal has a fault, no TCC apply will occur, resulting in poor fuel economy.



## THEORY

### ELECTRONIC COMPONENTS

#### Intake Air Temp. (IAT) Sensor



##### Description:

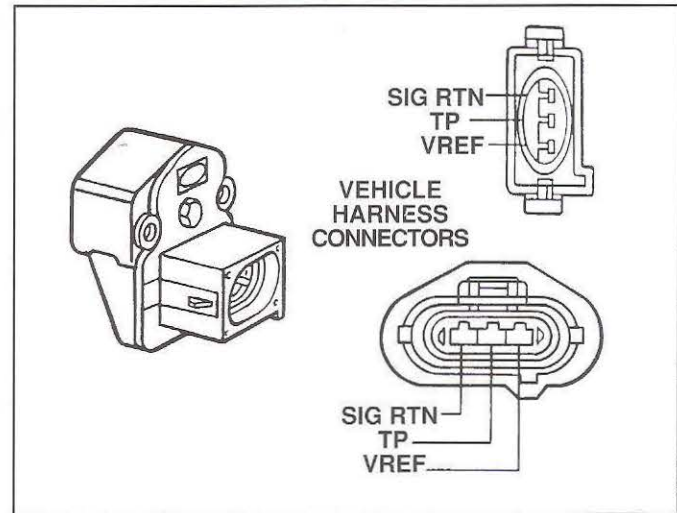
The PCM uses the Intake Air Temperature (IAT) sensor for mixture (fuel and air) temperature information in the control of engine fuel injection. The PCM also uses the IAT sensor to correct density for airflow calculation and to proportion cold enrichment fuel flow. This sensor is similar in construction to the Engine Coolant Temperature (ECT) sensor, except it is packaged to improve sensor response time. The sensor is installed in the engine air cleaner outlet tube.

The PCM uses the IAT sensor for EPC control strategy.

##### Symptoms:

If the IAT sensor signal has a fault, incorrect line pressure may result, causing either harsh or soft shifts.

#### Throttle Position (TP) Sensor



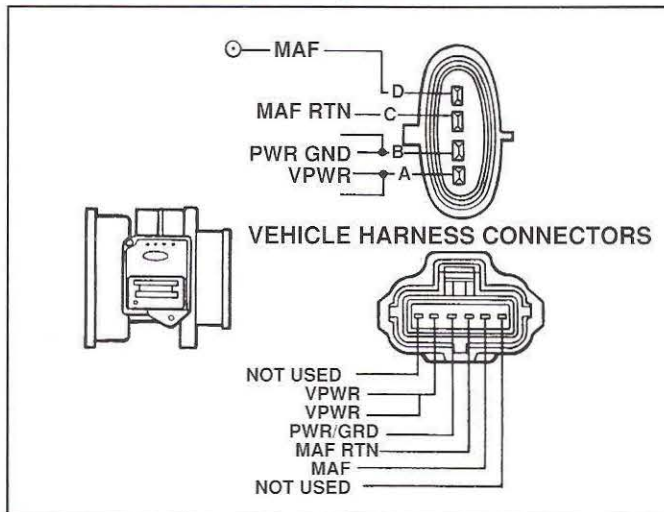
##### Description:

The Throttle Position (TP) sensor is a potentiometer mounted on the engine throttle body. The TP sensor detects the position of the throttle plate and sends this information to the PCM as a varying voltage signal. The PCM uses the monitored voltage level of the TP sensor for control of EPC strategy, shift scheduling and TCC operation.

##### Symptoms:

If the TP sensor circuit has a fault, harsh engagements, firm shift feel or abnormal shift schedules may occur. TCC may not be applied or may cycle.

### Mass Airflow (MAF) Sensor



#### Description:

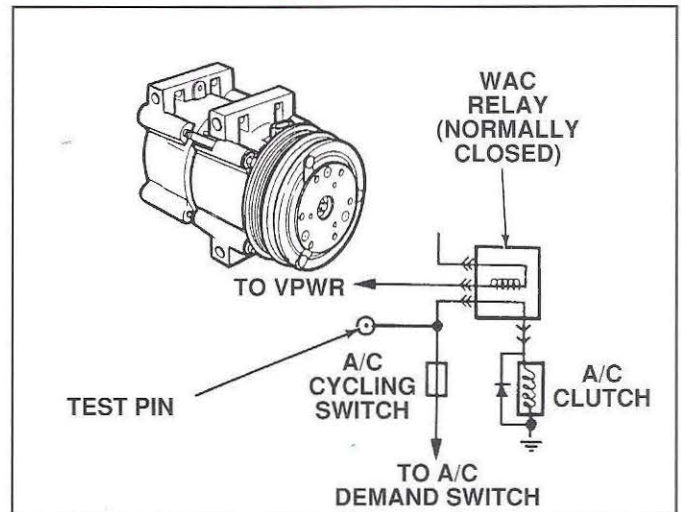
The Mass Air Flow (MAF) sensor directly measures the mass of air flowing into the engine. The sensor output is a DC (analog) signal ranging from about 0.5 volts to 5.0 volts. The PCM uses the MAF sensor signal to calculate fuel injector pulse width.

The PCM also uses the MAF sensor signal for EPC control strategy, shift scheduling and TCC scheduling.

#### Symptoms:

If the MAF sensor circuit has a fault, abnormal shift feel and scheduling may occur. Also, TCC operation may be erratic or disabled.

### Air Conditioning (A/C) Clutch Switch



#### Description:

The electro-magnetic Air Conditioning (A/C) clutch is energized when the A/C cycling switch closes. The switch is located on the suction accumulator/dryer. The closing of the switch completes the circuit to the clutch and draws it into engagement with the compressor driveshaft.

The PCM adjusts EPC pressure when the A/C clutch is engaged to compensate for additional load on the engine.

#### Symptoms:

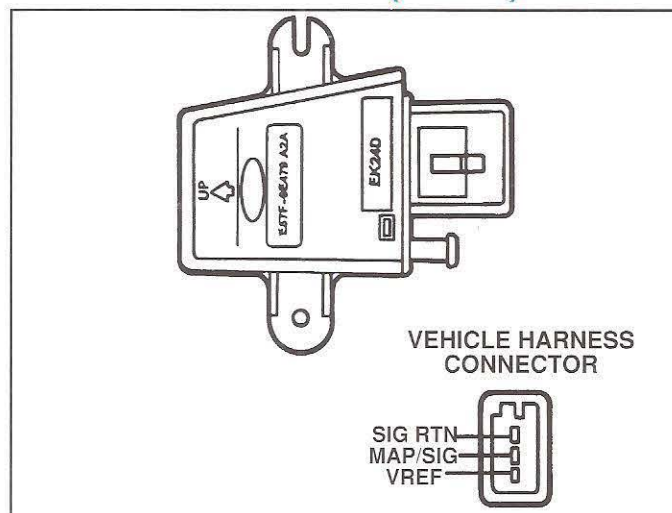
If the A/C switch fails ON, line pressure will be slightly low with air conditioning OFF. If the A/C switch fails OFF, line pressure will be slightly higher with air conditioning ON.



## THEORY

### ELECTRONIC COMPONENTS

#### Barometric Pressure (BARO) Sensor



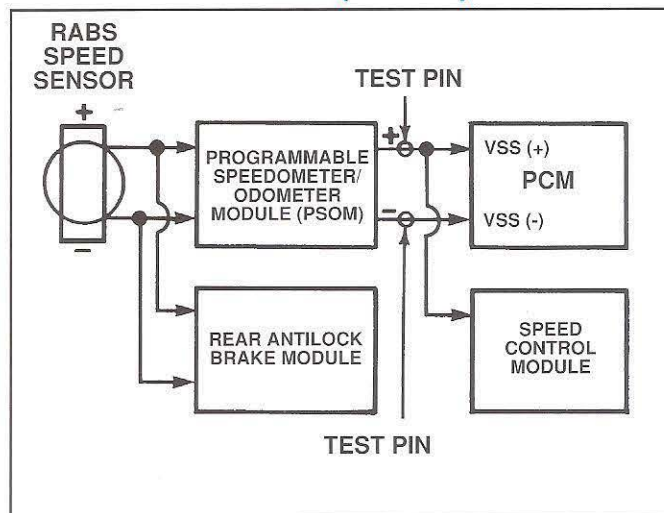
##### Description:

The Barometric Pressure (BARO) sensor measures atmospheric pressure and produces an electrical signal. The PCM uses this signal to determine the altitude at which the vehicle is operating. The PCM then adjusts EPC pressure and shift scheduling according to altitude.

##### Symptoms:

If the BARO sensor circuit has a fault, firm shift feel and late shift scheduling may occur at higher altitudes.

#### Programmable Speedometer/Odometer Module (PSOM)



##### Description:

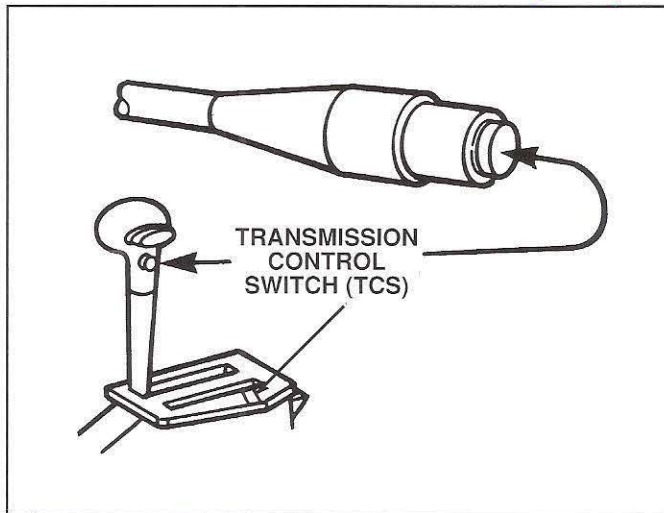
Vehicles equipped with the Rear Anti-Lock Brake System (RABS) have a speed sensor mounted on the differential housing. The RABS speed sensor sends an input signal to the Programmable Speedometer/Odometer Module (PSOM). The PSOM processes this signal and sends it to the Speed Control module and PCM. The PCM uses this signal to modify upshift schedules.

##### Symptoms:

If the PSOM fails, shift busyness may occur while the vehicle is climbing grades.



### Transmission Control Switch (TCS)



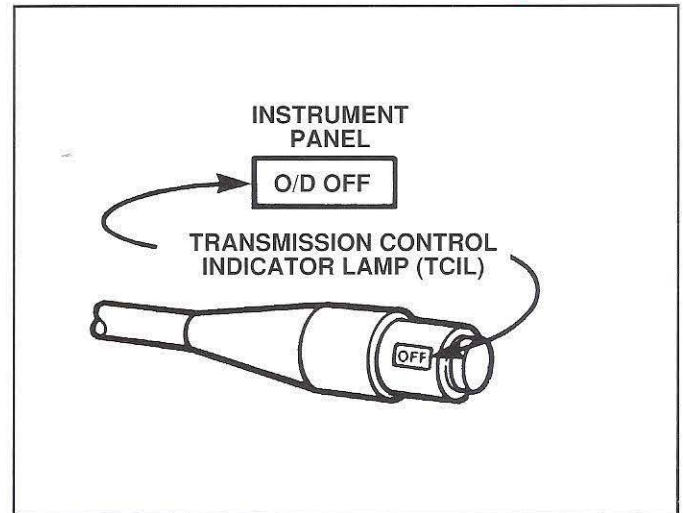
#### Description:

The Transmission Control Switch (TCS) is a momentary contact switch. When this switch is pressed, a signal is sent to the PCM to allow automatic shifts either from 1st gear through 4th gear or from 1st gear through 3rd gear. The PCM then turns ON the Transmission Control Indicator Lamp (TCIL) when the switch is off. The TCIL indicates overdrive cancel mode activated (lamp ON) and EPC circuit shorted or monitored sensor failure (lamp flashing)

#### Symptoms:

If the TCS fails, no TCIL operation or 4th gear cancelation occurs when the switch is cycled.

### Trans. Control Indicator Lamp (TCIL)



#### Description:

The Transmission Control Indicator Lamp (TCIL) is used in vehicle applications that use a Transmission Control Switch (TCS). The TCIL may be located in the instrument panel or on the shifter near the TCS. The PCM controls the operation of the TCIL when it receives an input signal from the Transmission Control Switch (TCS). If the driver wants to disengage or engage 4th gear, he/she presses the TCS, resulting in the PCM turning the TCIL ON or OFF. The TCIL is ON when overdrive is OFF.

The PCM will flash the TCIL when it detects a failure in the EPC solenoid or monitored sensors.

#### Symptoms:

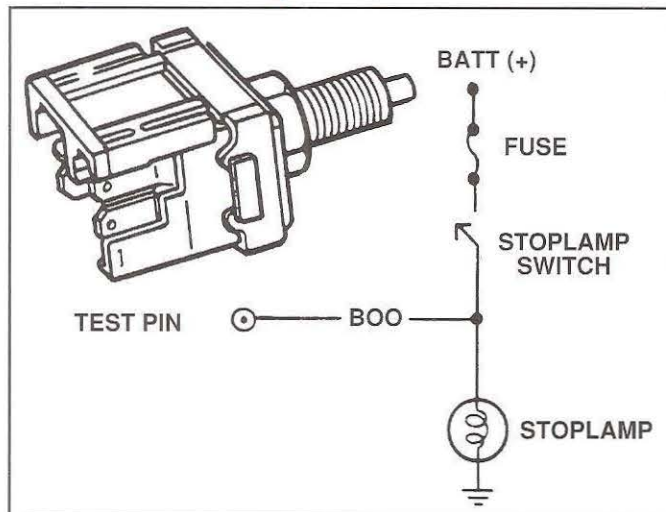
If the TCIL fails ON, overdrive cancel mode is always indicated and no flashing for monitored failures occurs. If the TCIL fails OFF, overdrive cancel mode is never indicated and no flashing for monitored failures occurs.



## THEORY

### ELECTRONIC COMPONENTS

#### Brake ON/OFF (BOO) Switch



##### Description:

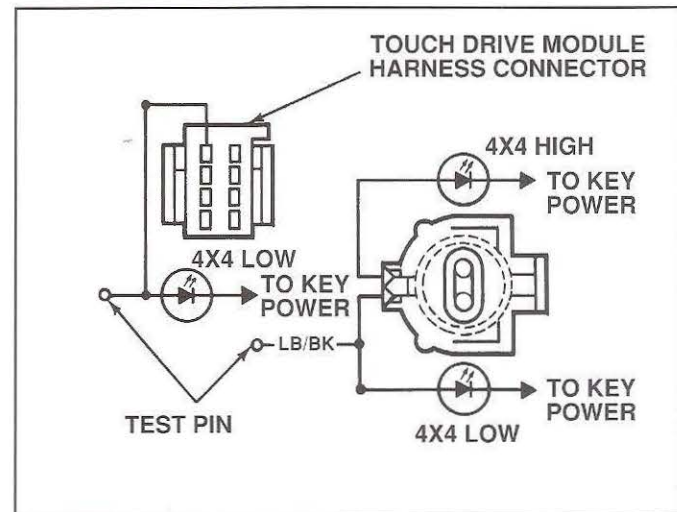
The Brake ON/OFF (BOO) switch is connected to the brake pedal. When the brake pedal is pressed, the BOO switch has closed contacts for allowing a voltage signal to the PCM.

The PCM releases TCC when the brakes are applied.

##### Symptoms:

If the BOO switch fails ON, TCC will not engage with less than 1/3 engine throttle opening. If the BOO switch fails OFF, TCC does not release during brake application.

#### 4x4 LOW Switch



##### Description:

Vehicles equipped with four-wheel drive have a 4x4 LOW switch to indicate that the transfer case gear system is operating in LOW range (4x4L). The PCM receives the 4x4 LOW switch input signal and modifies shift scheduling for the 4x4 LOW transfer case gear ratio. If the 4x4 LOW indicator light fuse is blown, the transmission will shift according to the 4x4 LOW shift schedule, regardless of transfer case position.

##### Symptoms:

If the 4x4 LOW switch fails ON, early shifts may occur when the transfer case gear system operates in 4x2 and 4x4H. If the 4x4 LOW switch fails OFF, delayed shifts may occur when the transfer case gear system operates in 4x4L.



### Digital Transmission Range (DTR) Sensor

#### Description:

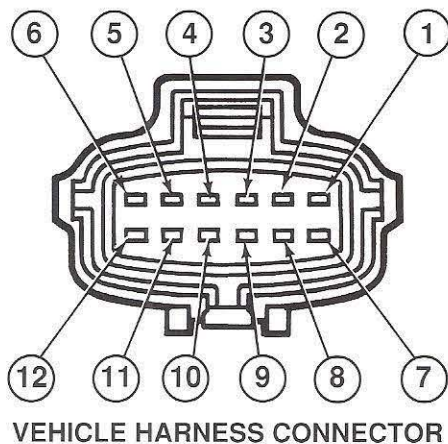
The Digital Transmission Range (DTR) sensor has a 12-pin electrical connector and is located on the outside of the transmission at the manual lever.

The DTR sensor completes the Start circuit in Park and Neutral, the Back-Up Lamp circuit in Reverse and the Neutral Sense circuit (4x4 vehicles only) in Neutral.

The DTR sensor also sends a digital output signal to the PCM that indicates the position of the manual lever (P, R, N, D, 2 or 1).

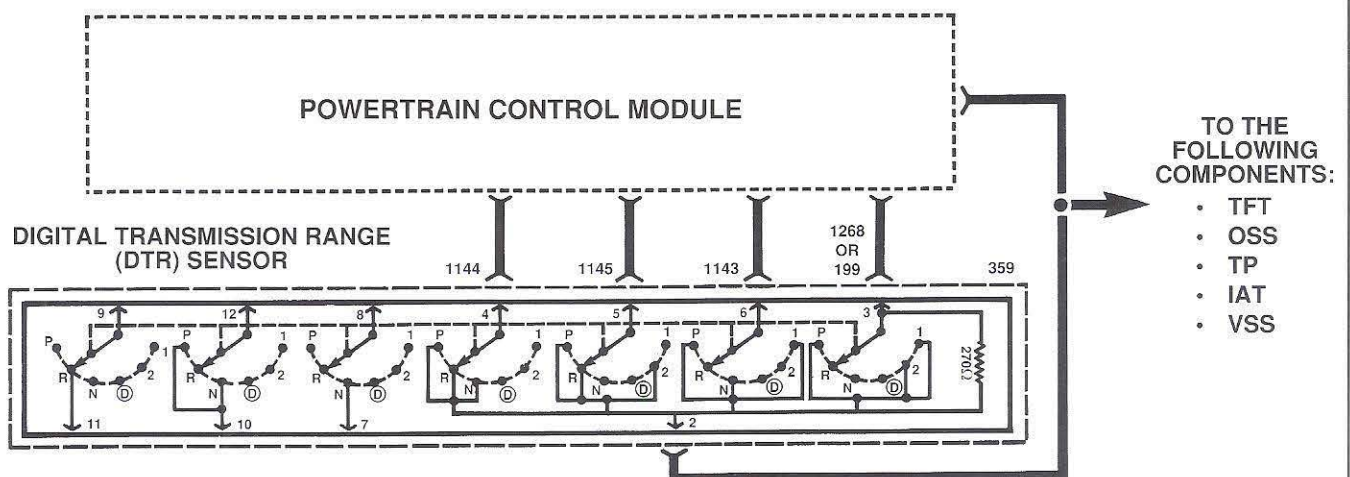
#### Symptoms:

If the digital output signal from the DTR sensor to the PCM has a fault, engagement concerns, operation in the wrong gear or no shifts will occur. Also, an increase in EPC pressure will result.



Pin No.	Function	Circuit No.	PCM Pin No.
1	Not Used	---	---
2	SIGRTN	359	91
3	TR3A	1268 or 199	64
4	TR1	1144	3* or 34*
5	TR2	1145	49
6	TR4	1143	50
7	GROUND	57	---
8	NEUTRAL	463	---
9	PWR Feed	298	---
10	STR CNTRL	32	---
11	BACK-UP	140	---
12	STR to INT	33	---

\* Vehicle Dependent

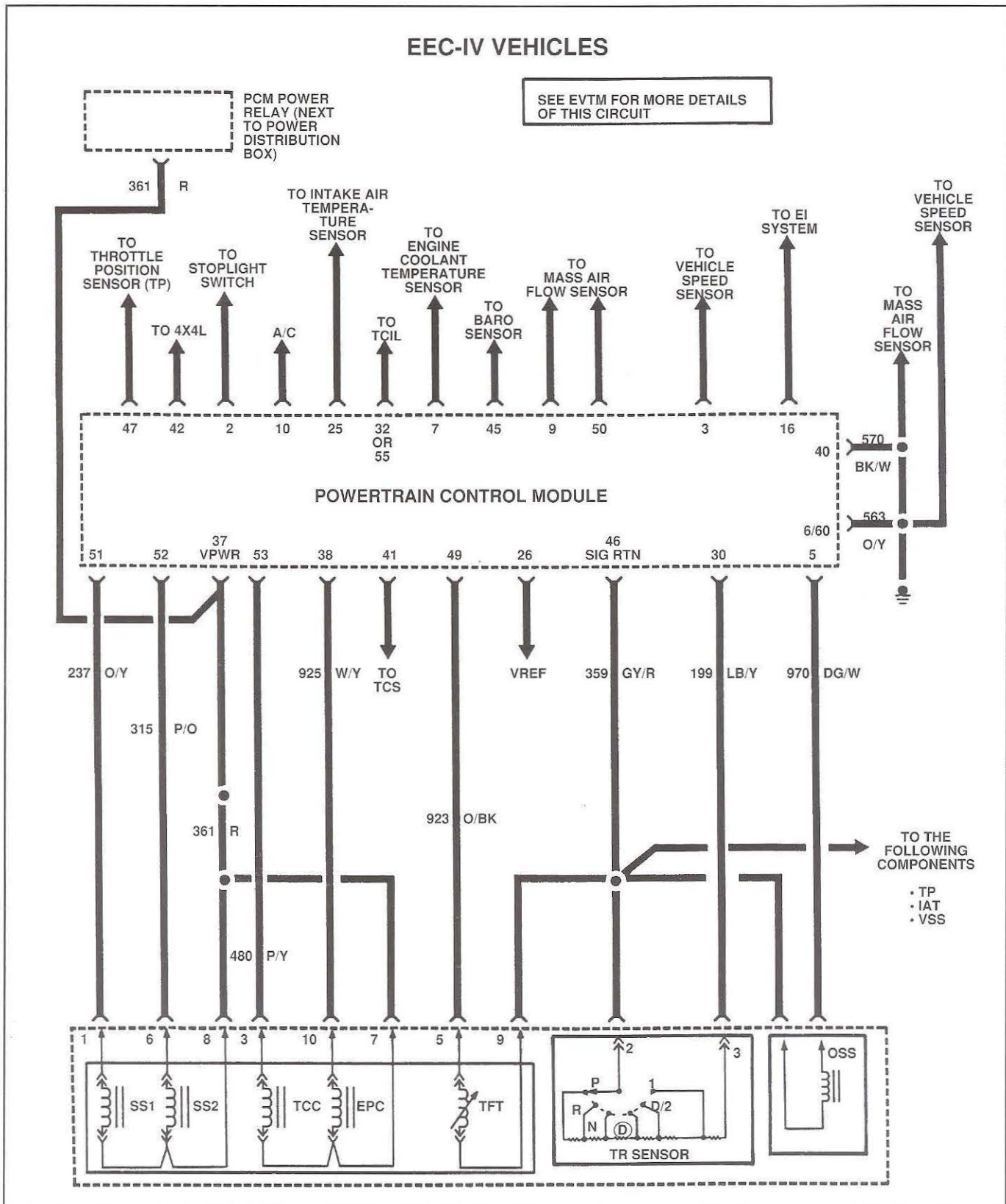




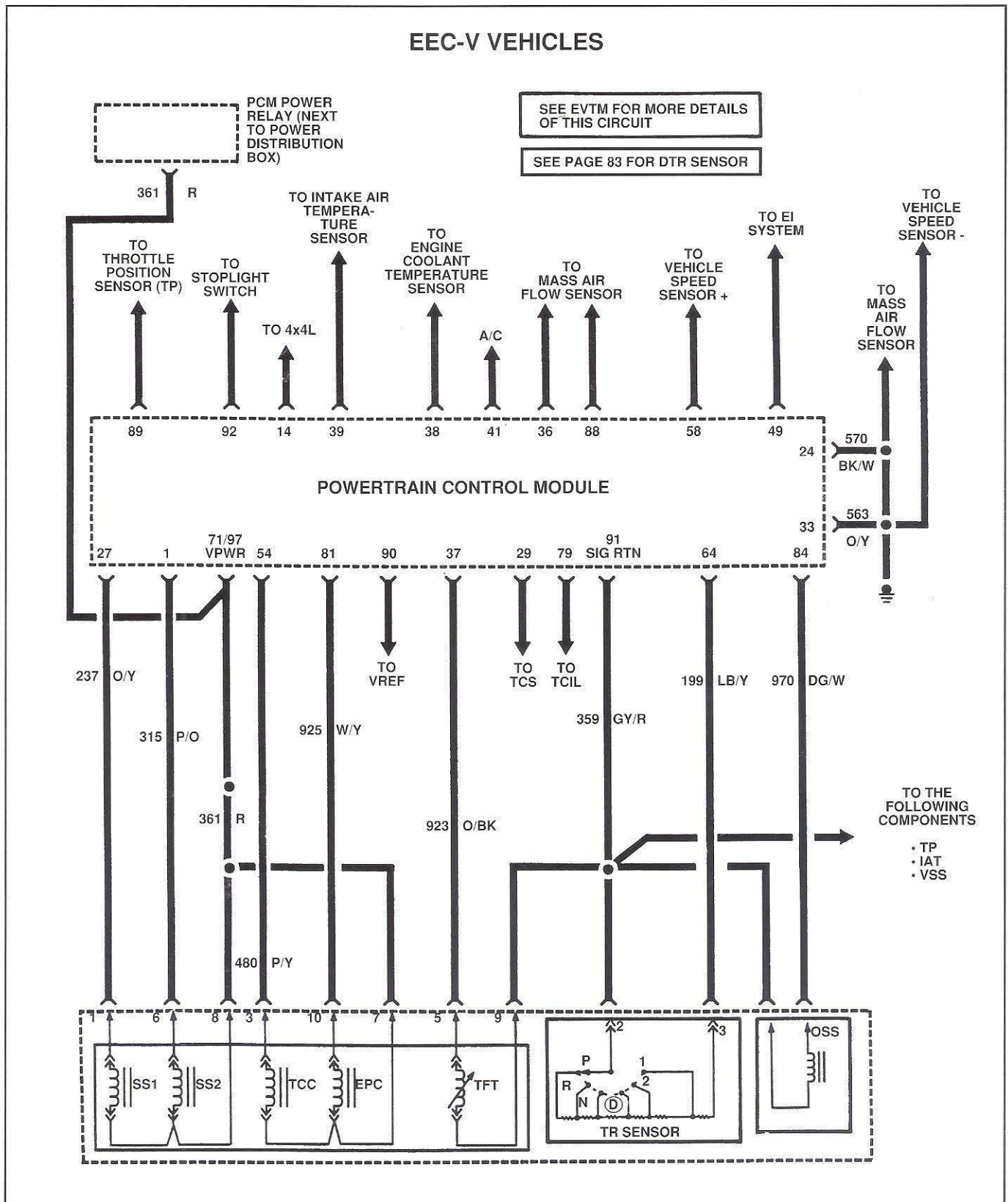
# THEORY

## ELECTRONIC COMPONENTS

### TRANSMISSION ELECTRICAL CIRCUITS



### TRANSMISSION ELECTRICAL CIRCUITS





### MECHANICAL OPERATION

The AODE/4R70W transmission uses a torque converter with the following elements:

- Impeller
- Turbine
- Stator (reactor)
- TCC (Torque Converter Clutch)

Operation of the AODE/4R70W transmission in four forward ratios and reverse involves the use of the following planetary gearset components:

- Forward sun gear
- Reverse sun gear
- Planetary carrier
- Ring gear

Planetary gearset operation is provided by the following apply components:

- Intermediate clutch
- Intermediate one-way clutch
- Reverse clutch
- Overdrive band
- Forward clutch
- Low one-way clutch
- Low-reverse band
- Direct clutch

Refer to pages 16 through 35 of the Theory section of this book for details about mechanical components.

### HYDRAULIC OPERATION

Control of the AODE/4R70W transmission involves the movement of fluid under various pressures in passages of the following components:

- Main control assembly
- Transmission case
- Pump assembly
- Torque converter
- Apply components

Refer to pages 36 through 65 of the Theory section of this book for details about hydraulic components.

### ELECTRONIC OPERATION

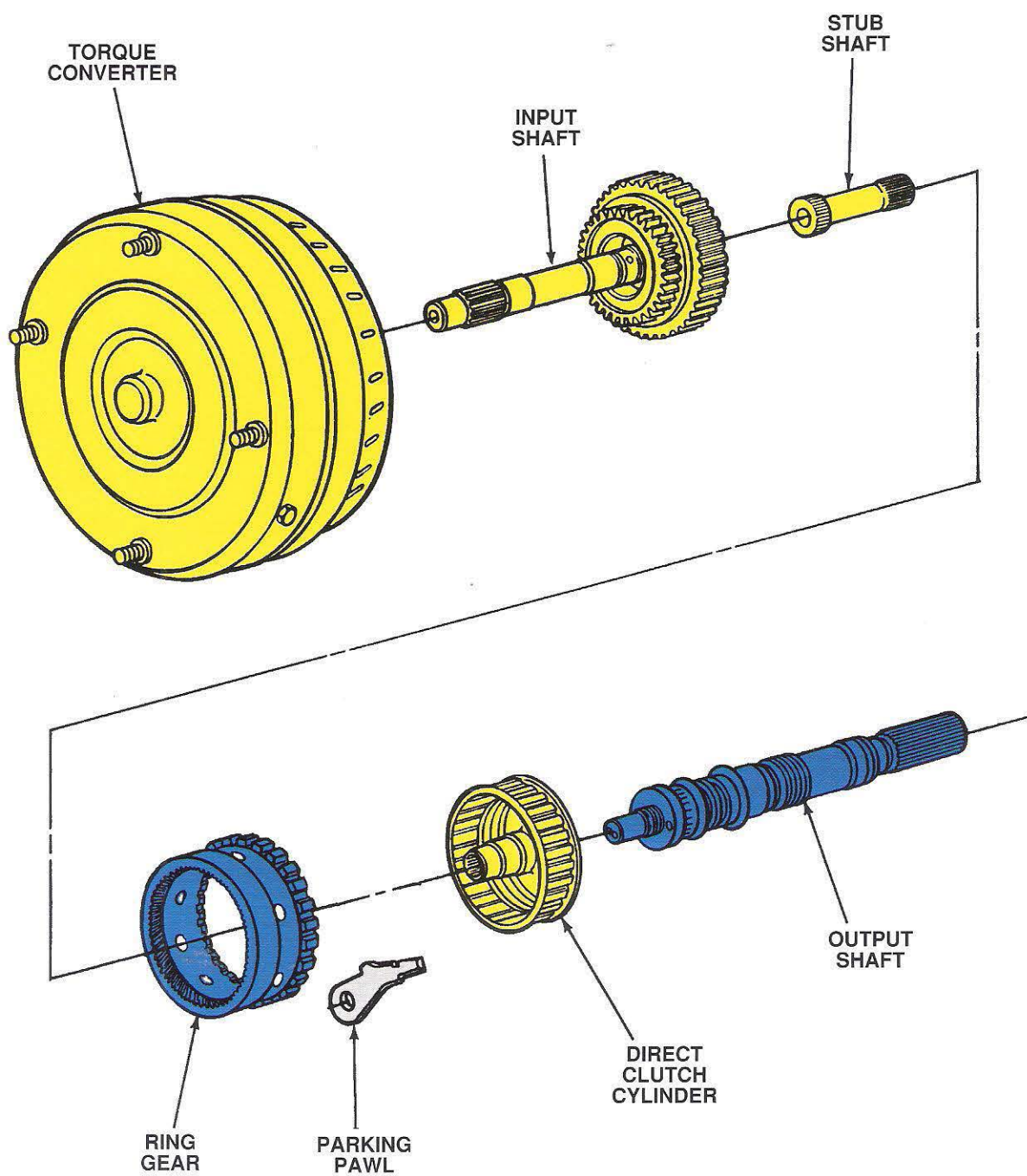
The PCM (Powertrain Control Module) controls the operation of the AODE/4R70W transmission by operating four solenoids:

- EPC (Electronic Pressure Control)
- SS1 (Shift Solenoid #1)
- SS2 (Shift Solenoid #2)
- TCC (Torque Converter Clutch)

Refer to pages 68 through 85 of the Theory section of this book for details about electronic components.

## OPERATION

### PARK POSITION





### MECHANICAL OPERATION

#### Apply Component Operation:

- No components applied

#### Planetary Gearset Operation:

- Driving member:
  - None
- Driven member:
  - None
- Held member:
  - None

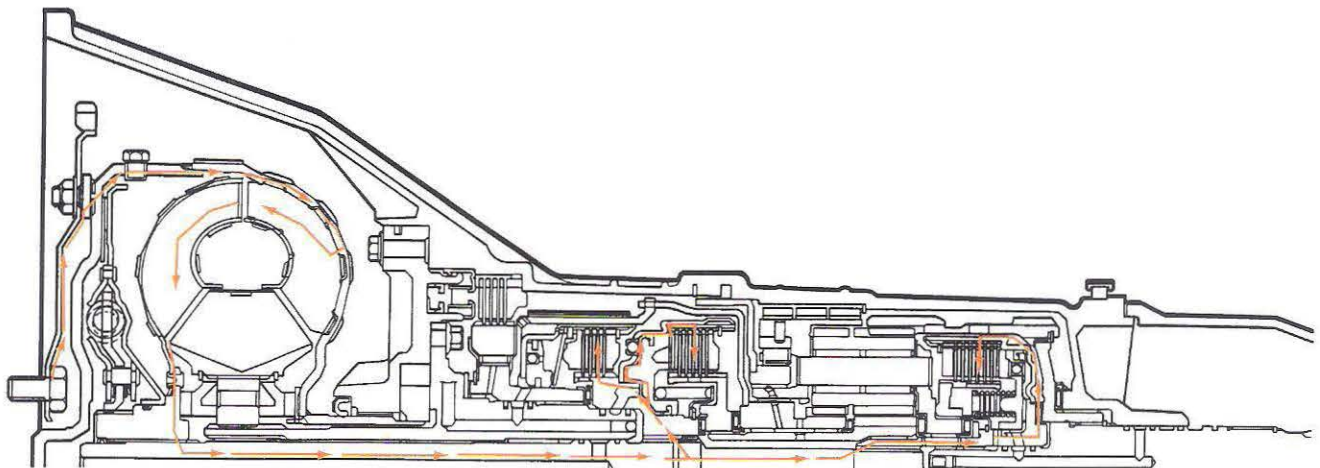
Refer to pages 20 through 28 for information about apply component construction and operation.

Refer to pages 18 and 19 for information about planetary gearset operation.

### PARK POSITION

A = APPLIED  
X = APPLIED/  
INEFFECTIVE  
H = HOLDING  
OR = OVERRUNNING

GEAR	POSITION	OVERDRIVE BAND	LOW-REVERSE BAND	INTERMEDIATE CLUTCH	REVERSE CLUTCH	FORWARD CLUTCH	DIRECT CLUTCH	DRIVE	COAST	INT ONE-WAY CLUTCH	LOW ONE-WAY CLUTCH
PARK	P										
REVERSE	R	A	A								
NEUTRAL	N										
1ST	OD, D				A					H OR	
2ND	OD, D		A	A				H	OR	OR	OR
3RD	OD, D, 2		X	A	A	OR	OR	OR	OR	OR	OR
4TH	OD, D	A	A		A	H					
M-2ND	2, 1	A	A	A		H		OR	OR		
M-1ST	1	A		A				H			



## OPERATION

### PARK POSITION

#### HYDRAULIC OPERATION

##### Hydraulic Circuit Operation:

- Line Pressure/Lube Circuits:
  - **LINE** circuit pressure is controlled by the main regulator valve, based on **EPC** circuit pressure from the EPC solenoid.
  - No line pressure for the rear lube circuit is present, since the manual valve exhausts the **OD D 1** circuit.
- Accumulator Circuits:
  - 1-2 accumulator backpressure is based on line pressure.
  - 2-3 accumulator backpressure is zero, since the forward clutch is released.
- Shift Solenoid Circuits:
  - **SOLP** circuit pressure to the shift solenoids is zero, since no pressure in the **OD D 1** circuit is present at the solenoid regulator valve.
- Torque Converter/Lube Circuits:
  - Fluid in the **LINE** circuit moves through the main regulator valve and enters the **CC** circuit.
  - Fluid in the **CC** circuit moves through the converter pressure regulator valve and enters the **CCL** circuit.
  - Fluid in the **CCL** circuit moves through the bypass clutch control valve and enters the **CI** circuit, where it enters the torque converter.
  - Fluid in the **CT** circuit exits the torque converter and moves through the cooler and front lube passages.
- TCC Solenoid Circuits:
  - **SOLP** circuit pressure to the TCC solenoid is zero, since no pressure in the **OD D 1** circuit is present at the solenoid regulator valve.
  - **CBY** circuit pressure for TCC release is controlled by the bypass clutch control valve, based on no **TCC** circuit pressure from the TCC solenoid.
- Apply Component Circuits:
  - Fluid under line pressure to the apply component hydraulic circuits is blocked at the manual valve and 1-2 shift valve.

Refer to pages 41 through 57 for information about hydraulic operation.

#### ELECTRONIC OPERATION

##### Solenoid Operation:

- |       |                                   |
|-------|-----------------------------------|
| • EPC | VARYING CURRENT                   |
| • SS1 | ON                                |
| • SS2 | OFF                               |
| • TCC | ZERO PULSE-WIDTH<br>(TCC release) |

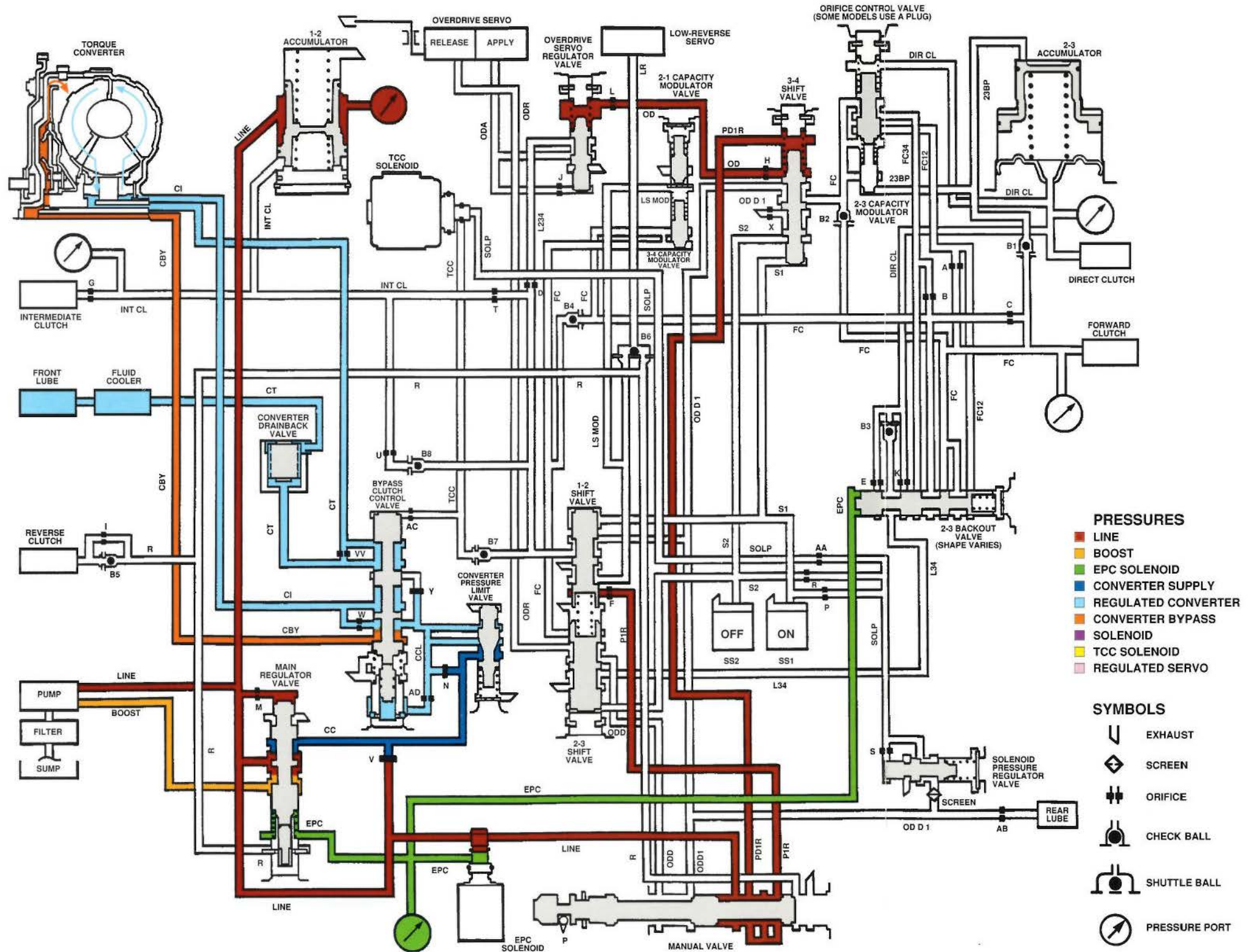
Refer to pages 72 through 74 for information about the electrical operation of solenoids.





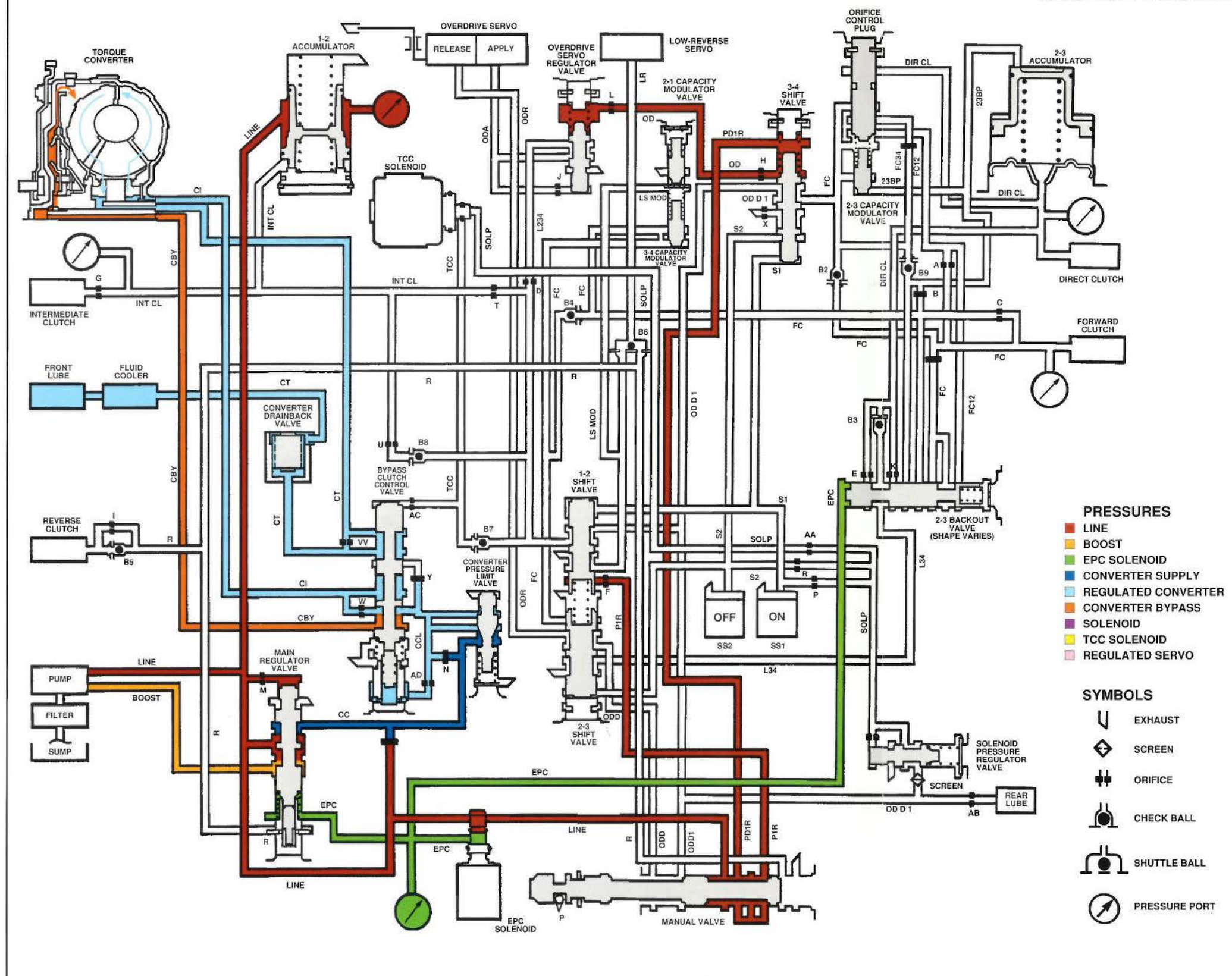
# OPERATION PARK POSITION

1992-TO-1995





1996-TO-PRESENT





## 1992-TO-1995





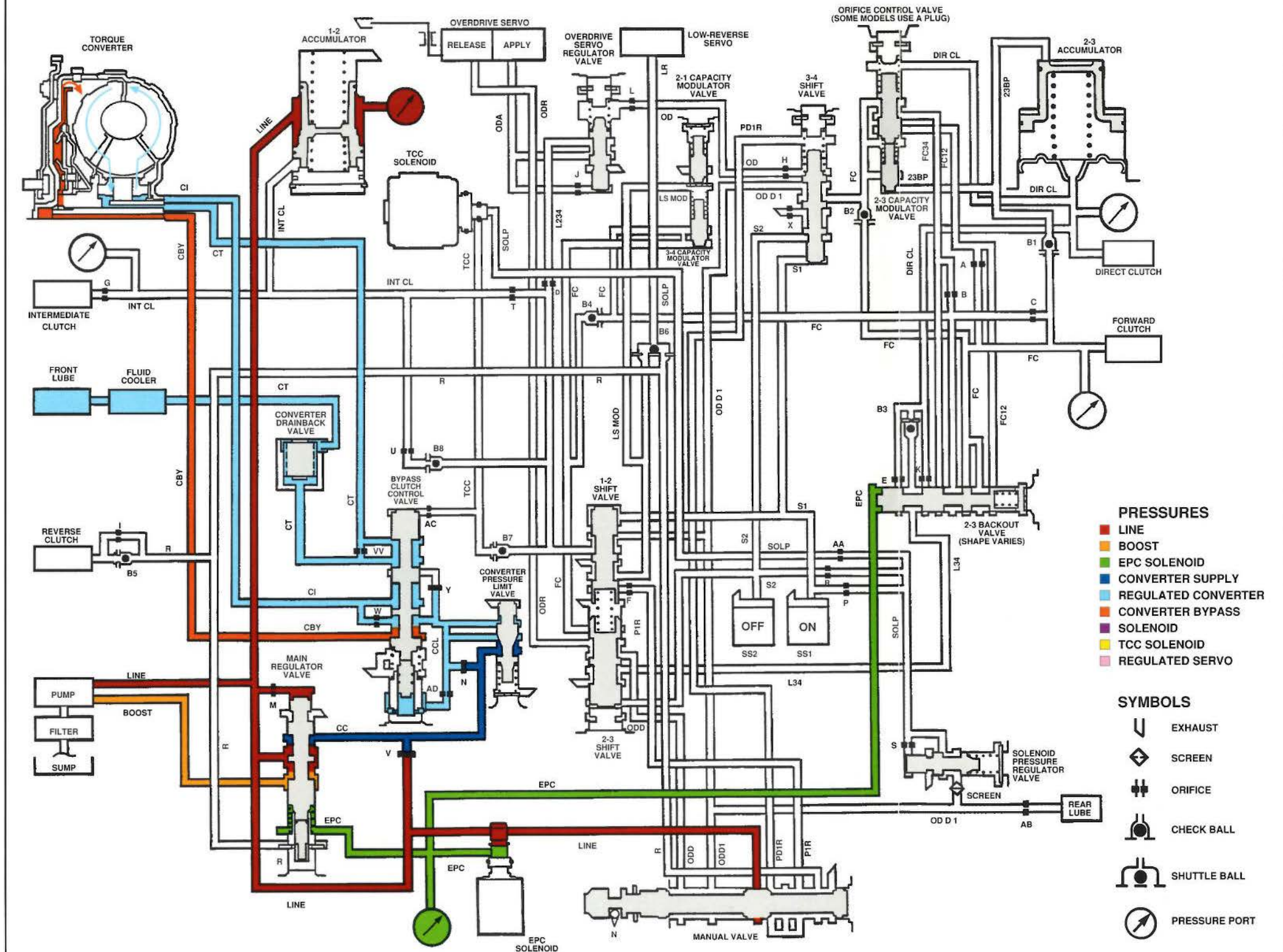
## 1996-TO-PRESENT





# OPERATION NEUTRAL POSITION

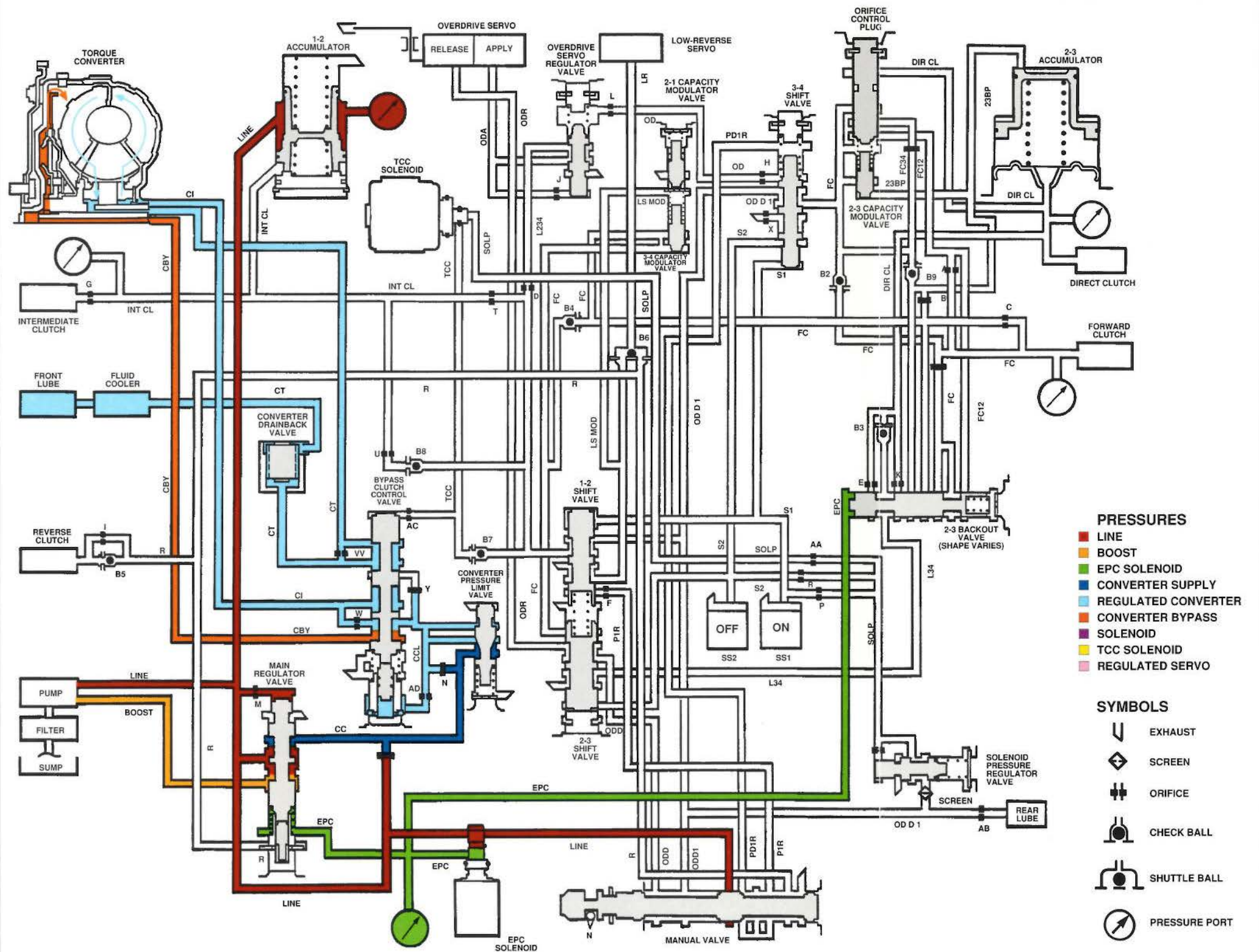
1992-TO-1995





# OPERATION NEUTRAL POSITION

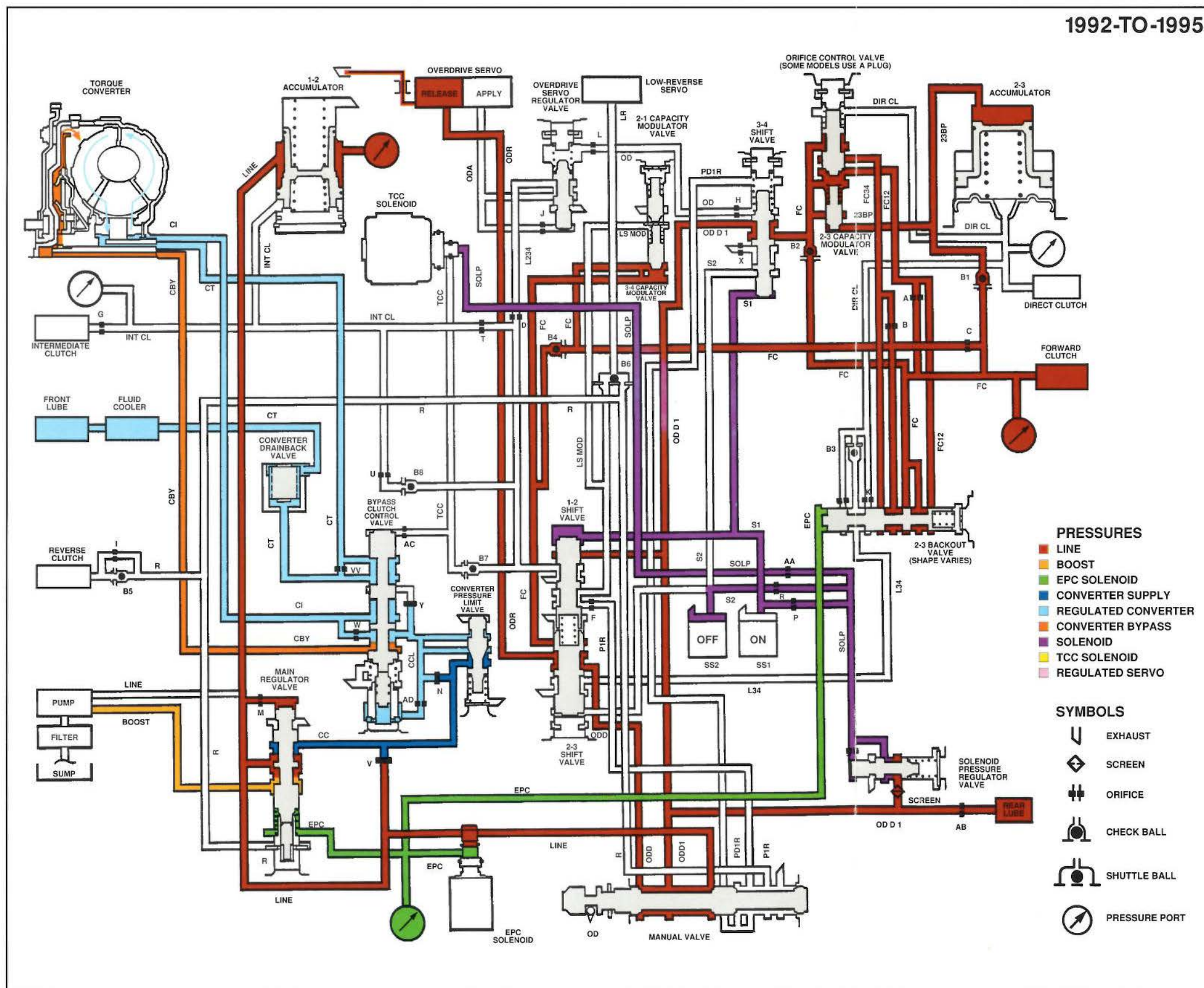
1996-TO-PRESENT





# OPERATION 1ST GEAR

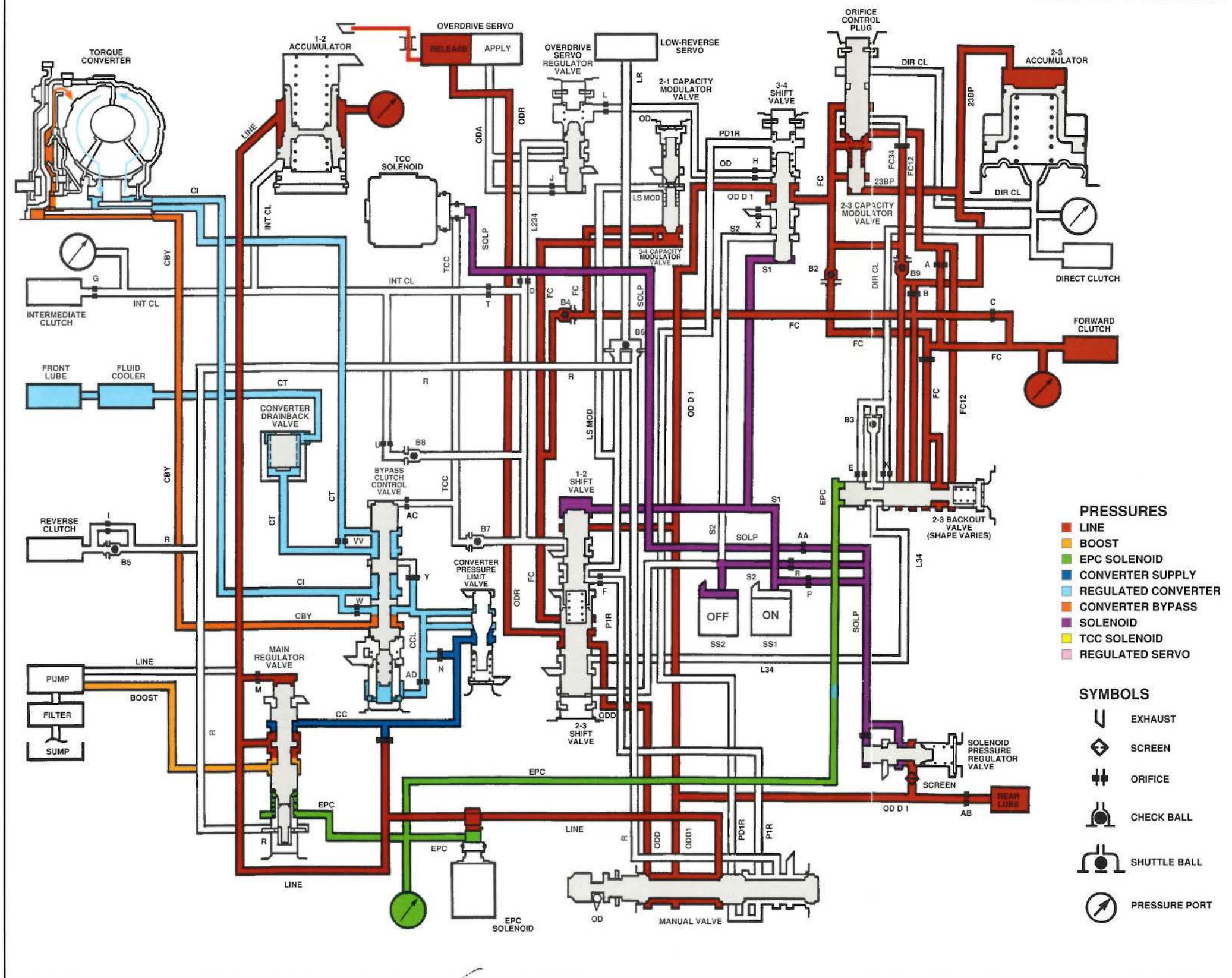
1992-TO-1995





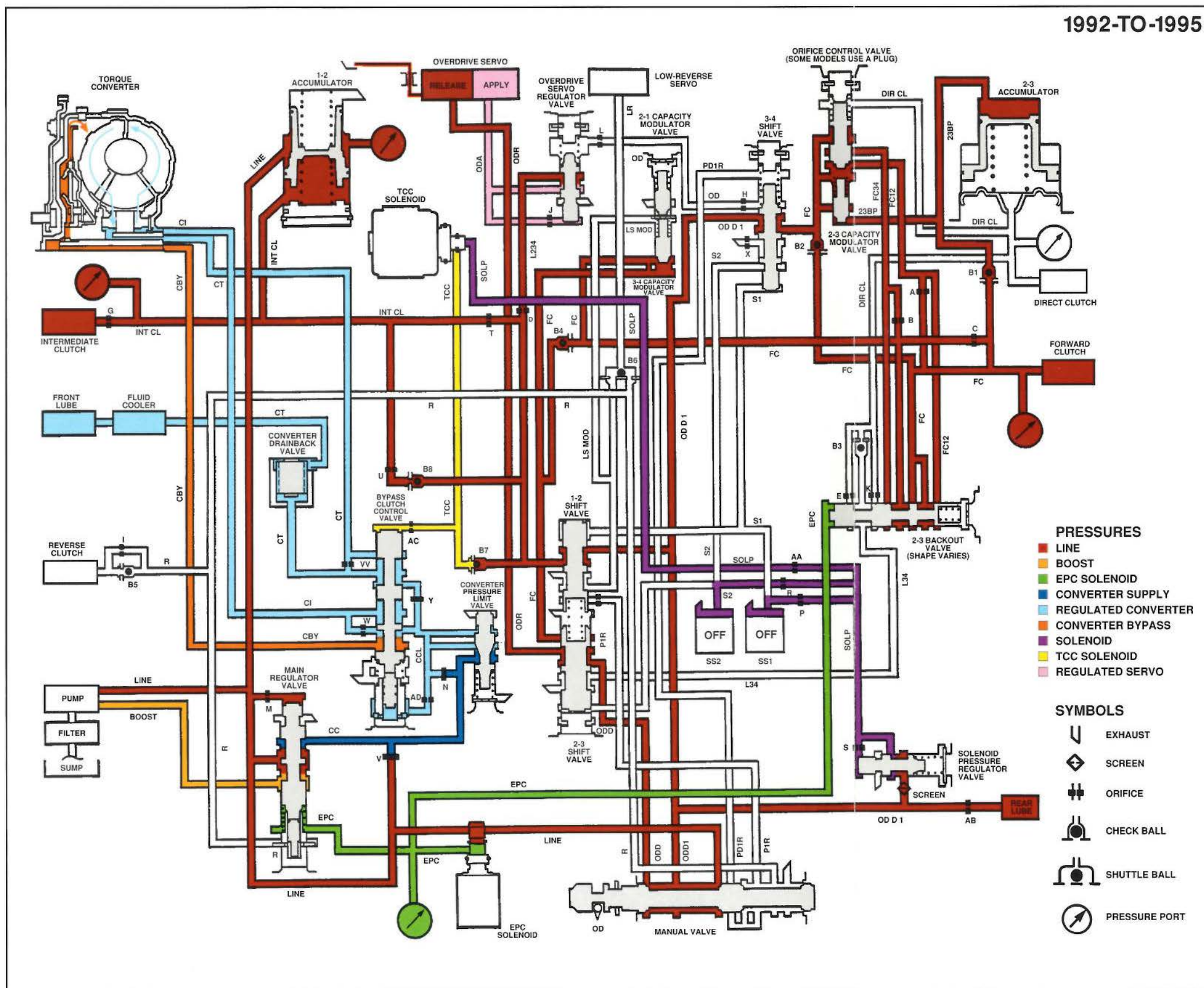
# OPERATION 1ST GEAR

1996-TO-PRESENT



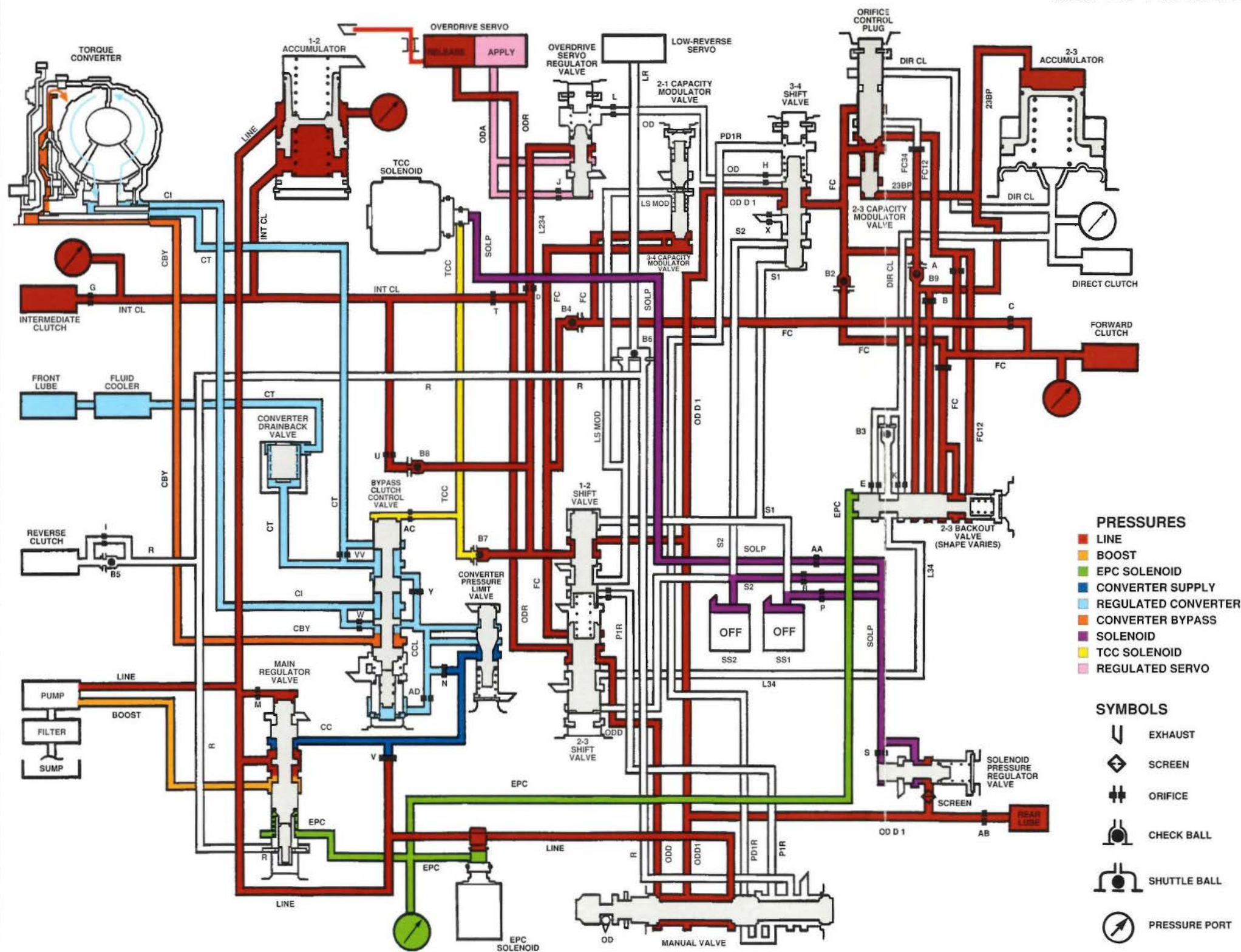


1992-TO-1995





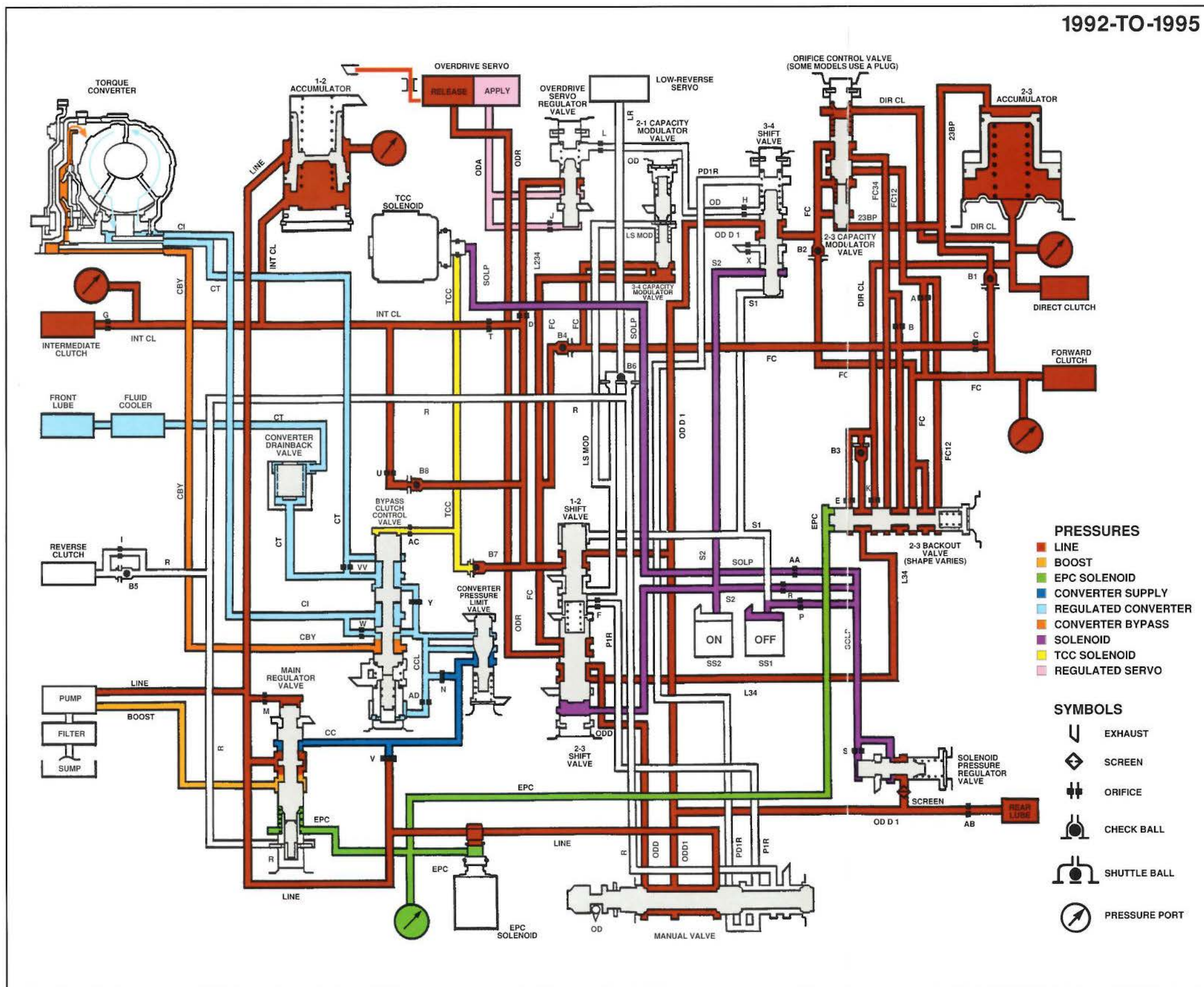
1996-TO-PRESENT





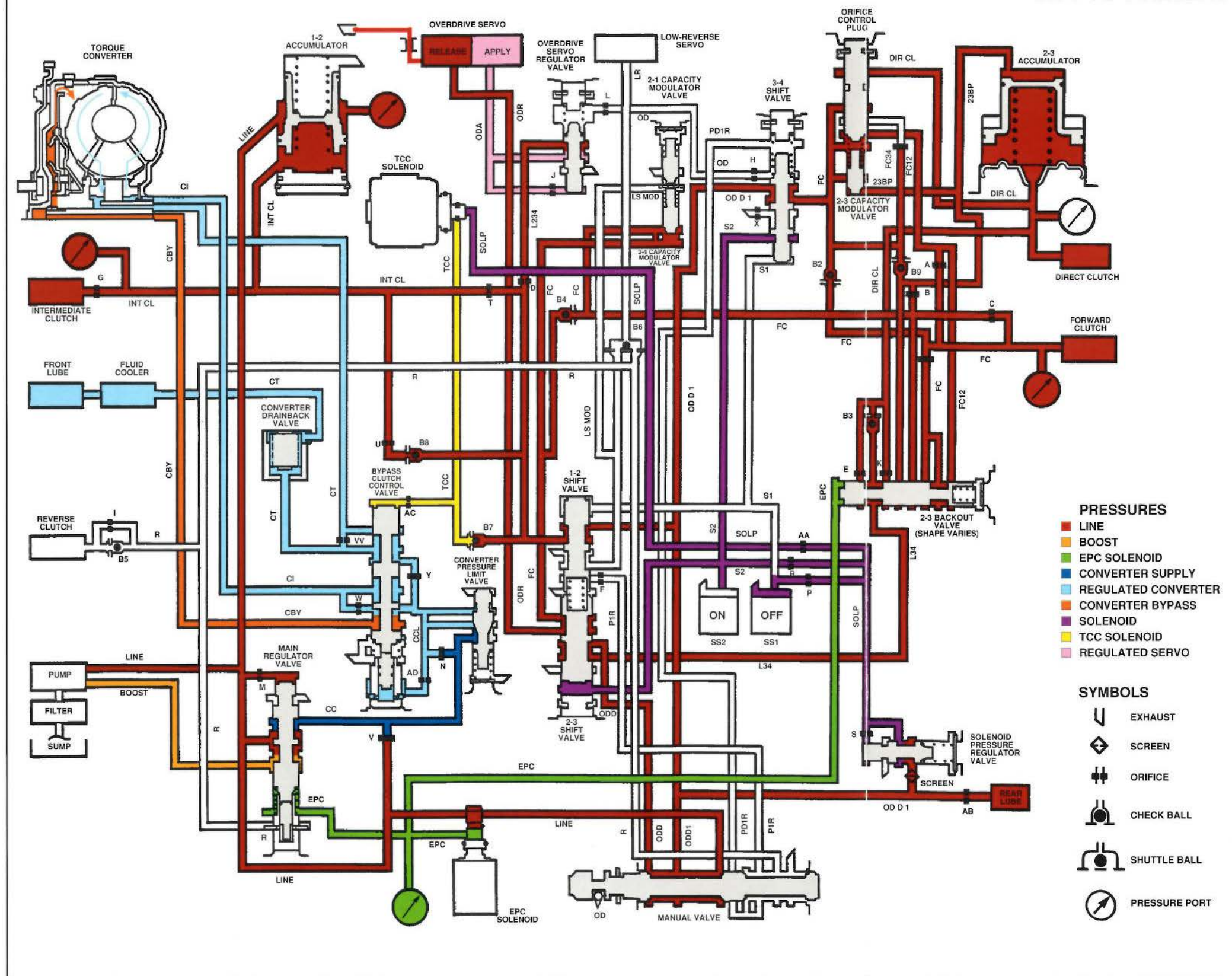
# OPERATION 3RD GEAR

1992-TO-1995





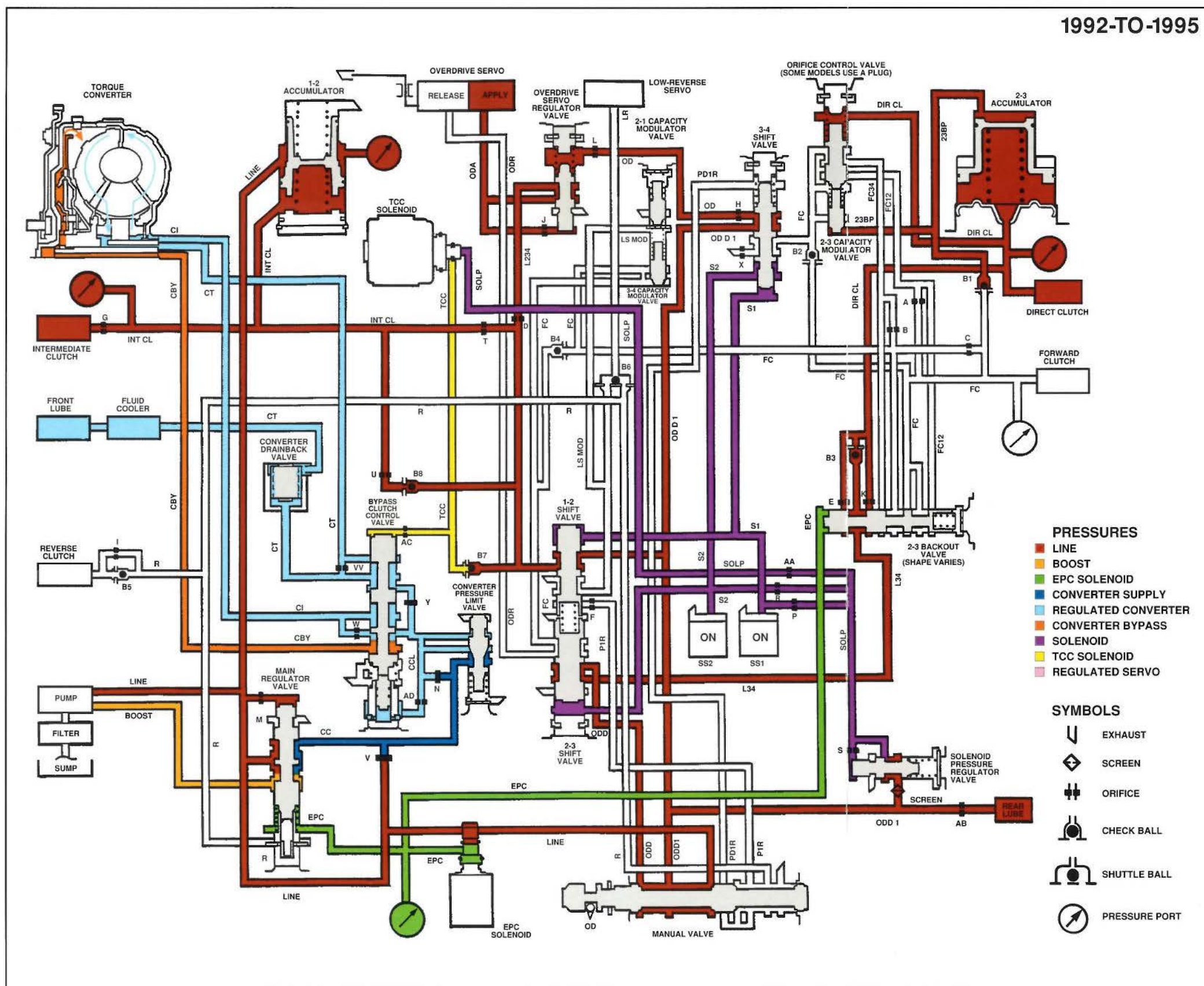
1996-TO-PRESENT





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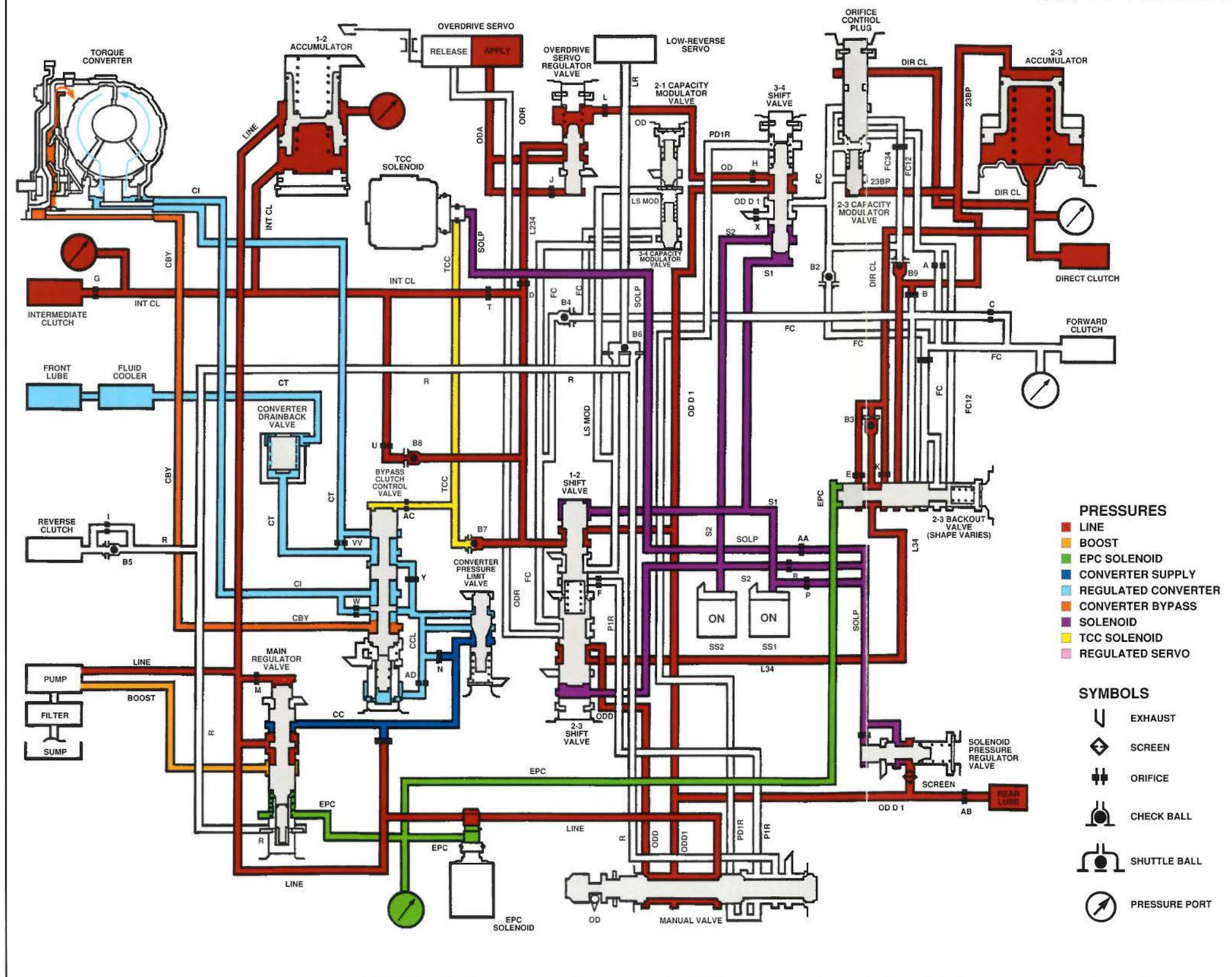
1992-TO-1995





# OPERATION 4TH GEAR

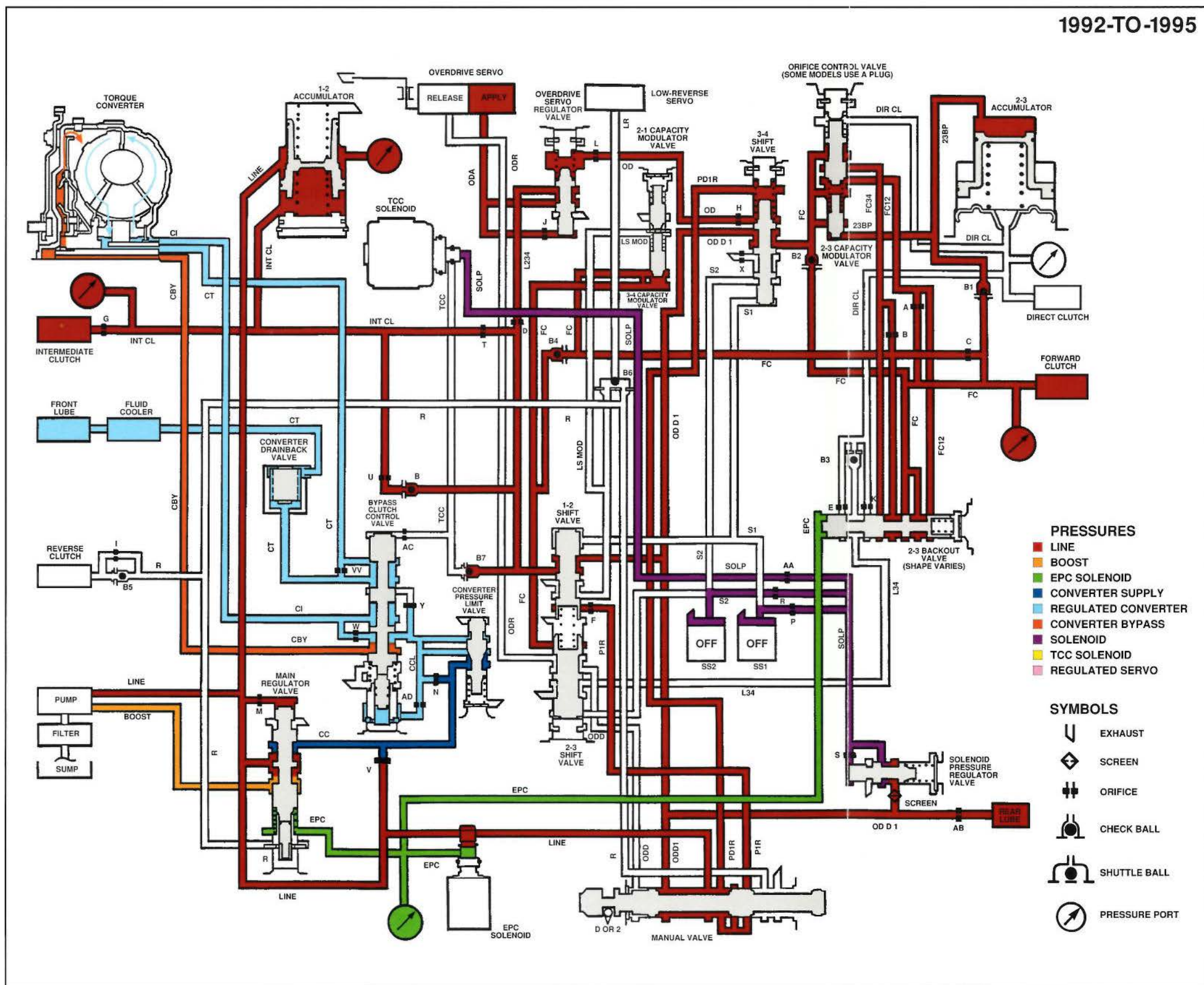
1996-TO-PRESENT





# OPERATION MANUAL 2ND GEAR

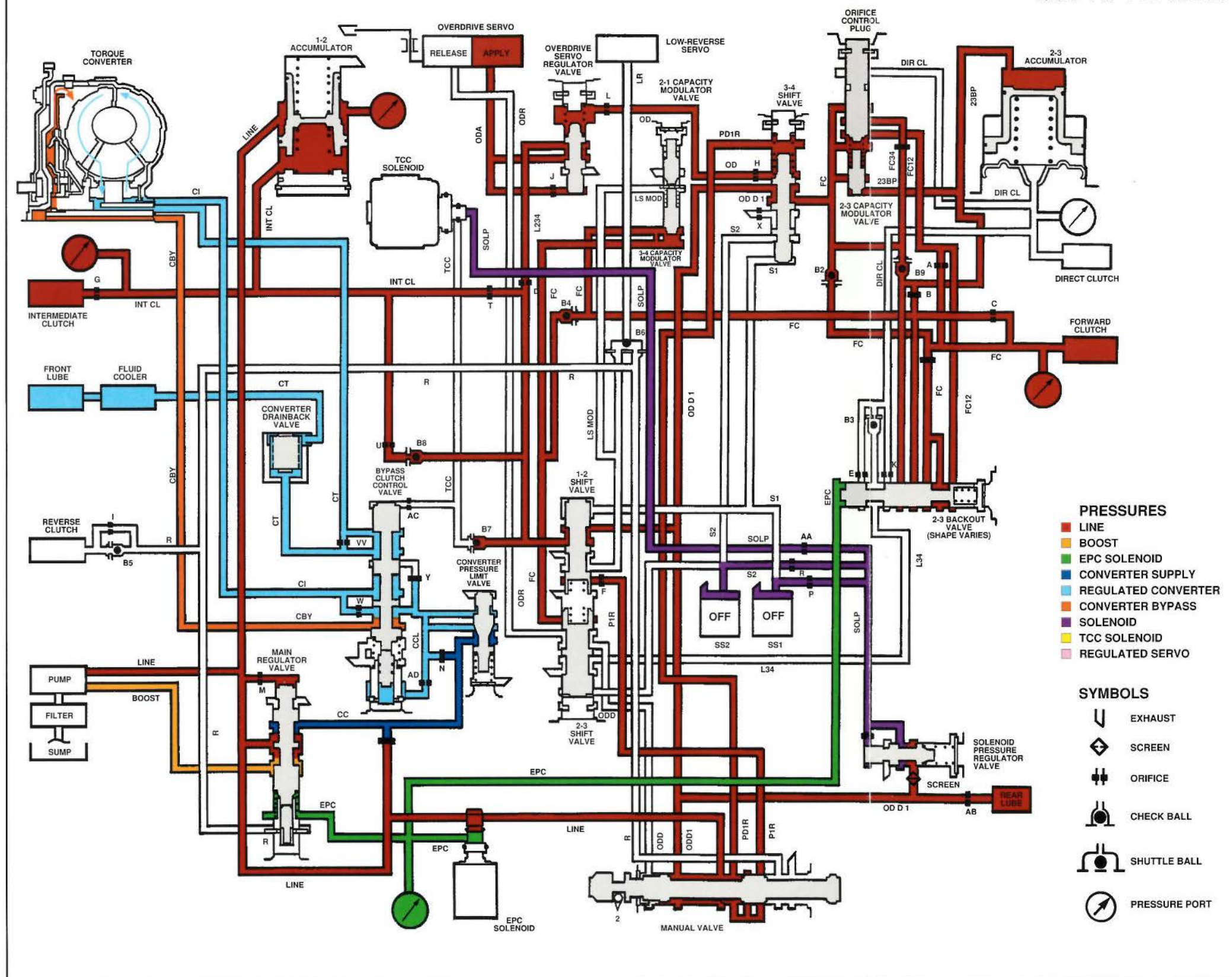
1992-TO-1995





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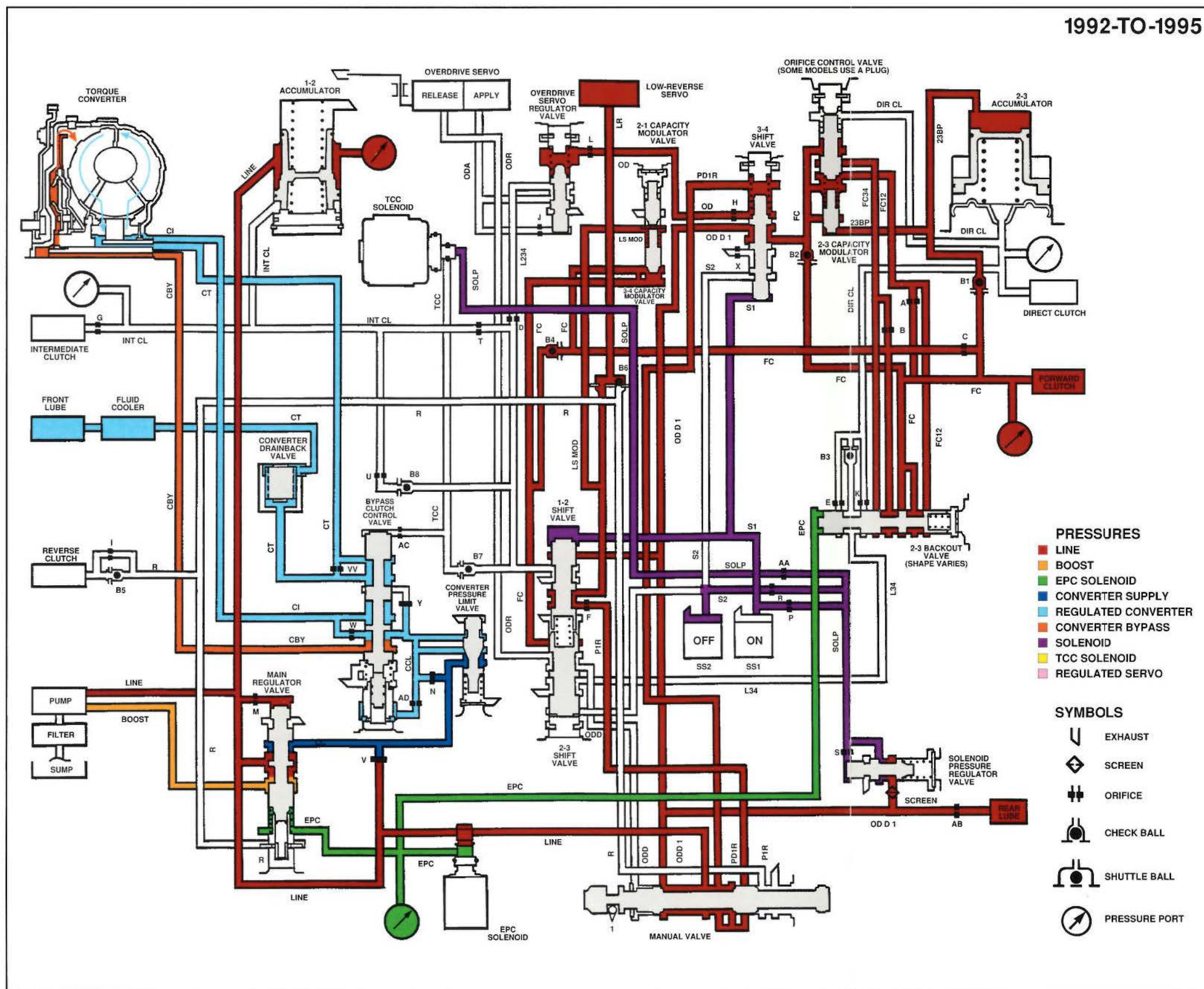
1996-TO-PRESENT





# OPERATION MANUAL 1ST GEAR

1992-TO-1995





# OPERATION MANUAL 1ST GEAR

1996-TO-PRESENT

