



# Technical Service Information

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## *BMW, AUDI, PORSCHE Technicians Guide*

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# INTRODUCTION

## BMW, AUDI, PORSCHE

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This booklet contains information that has not normally been available in most OEM repair manuals and can be used by the technician to diagnose electrical concerns, identify the location and direction of the valves, springs, retainers and bore plugs in the valve body. This information has been prepared from actual valve bodies and in some cases may vary from one model to another, but is invaluable when the need arises to diagnose and repair electrical and valve body concerns.

*This Manual covers the following models:*

- *ZF-4HP-18FLE/FLA Transaxle, found in Audi and Porsche.*
- *ZF-4HP-22/24 Series, Model "E7", "5 Solenoid" Valve Body found in various vehicles.*
- *ZF-4HP-22/24 Series, Model "E9", "4 Solenoid" Valve Body found in various vehicles.*
- *ZF-5HP-18 Series, found in various BMW models.*
- *ZF-5HP-19FL Transaxle, found in various BMW models.*
- *ZF-5HP-24 Series, found in various BMW models.*
- *ZF-5HP-30 Series, found in various BMW models and Rolls Royce.*

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*The information and part numbers contained in this booklet have been carefully compiled from industry sources known for their reliability, but ATSG does not guarantee its accuracy.*

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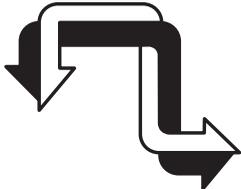
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# TECHNICIANS DIAGNOSTIC GUIDE BMW, AUDI, PORSCHE

## ZF-4HP-18FLE AND ZF-4HP-18FLA DIAGNOSTIC INFORMATION

The ZF-4HP-18FLE is mounted longitudinal in the front of the vehicle, and was produced in 2 Wheel Drive models (FLE) and All Wheel Drive (FLA) models, as shown in Figure 1. This unit is totally electronic controlled and is totally different than any 4-HP-18 unit that you are currently familiar with.

### *ZF-4HP-18FLE And ZF-4HP-18FLA Is Found In The Following Vehicles;*

<i>Audi - - - 100 Quattro, A6.....</i>	<i>1991-1997</i>
<i>Audi - - - A8.....</i>	<i>1994-1996</i>
<i>Porsche - - - 944.....</i>	<i>1991-1994</i>

There has been very little pertinent information published on these units. The information in this bulletin has been prepared from an actual transaxle and valve body, and has been formulated to provide you with the preliminary information needed to diagnose and repair electrical and valve body concerns.

*Refer to Figure 1 for illustrations of both the 4-HP-18FLE (2WD) and 4-HP-18FLA (AWD) models.*

*Refer to Figure 2 for internal component resistance charts and connector pin identification.*

*Refer to Figure 3 for complete wiring schematic with computer terminal identification and transaxle terminal identification, which makes it easier for electrical diagnosis.*

*Refer to Figure 4 for the solenoid application chart and component application chart.*

*Refer to Figure 5 for illustration of the complete valve body assembly.*

*Refer to Figure 6 for exploded view of oil filter and oil filter transfer plate.*

*Refer to Figure 7 for exploded view of the manual valve body.*

*Refer to Figure 8 for exploded view of the solenoid body, and notice that it provides you with the factory setting for the adjustment on the pressure regulator valve for EDS-1 solenoid. The Legend for Figure 8 which identifies the solenoid body components and solenoids is found on Page 13.*

*Refer to Figure 9 for exploded view of the valve body assembly components.*

*Refer to Figure 10 for exploded detail view of the "Rear Side" of the main valve body. The Legend for Figure 10 which identifies the main valve body components is found on Page 16.*

Continued on Page 5

### **SPECIAL NOTE:**

*All nomenclatures in this booklet are ATSG interpretations, not Audi's nor ZF.*

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## **TECHNICIANS DIAGNOSTIC GUIDE BMW, AUDI, PORSCHE**

Continued from Page 4.

*Refer to Figure 11 for exploded detail view of the "Front Side" of the main valve body.*

*Refer to Figure 12 for valve body spring specifications. The spring dimensions listed in Figure 12 were "Observations" from only one valve body, and may vary from one model to another.*

*Refer to Figure 13 for Solenoid Body screen and retainer locations, and to Figure 14 for the Manual Valve Body retainer locations.*

*Refer to Figure 15 for the Main Valve Body "Top Side" retainer locations, check valve and checkball locations, and the locations of the small flat disc orifices.*

*Refer to Figure 16 for the Main Valve Body "Bottom Side" check valve location, and the location of the small flat disc orifices.*

*Refer to Figure 17 for location of the small flat disc orifices in the channel plate.*

*Refer to Figure 18 for the two pressure tap locations on the back of case.*

*Refer to Page 22 for explanation of Safety Mode Valve operation.*

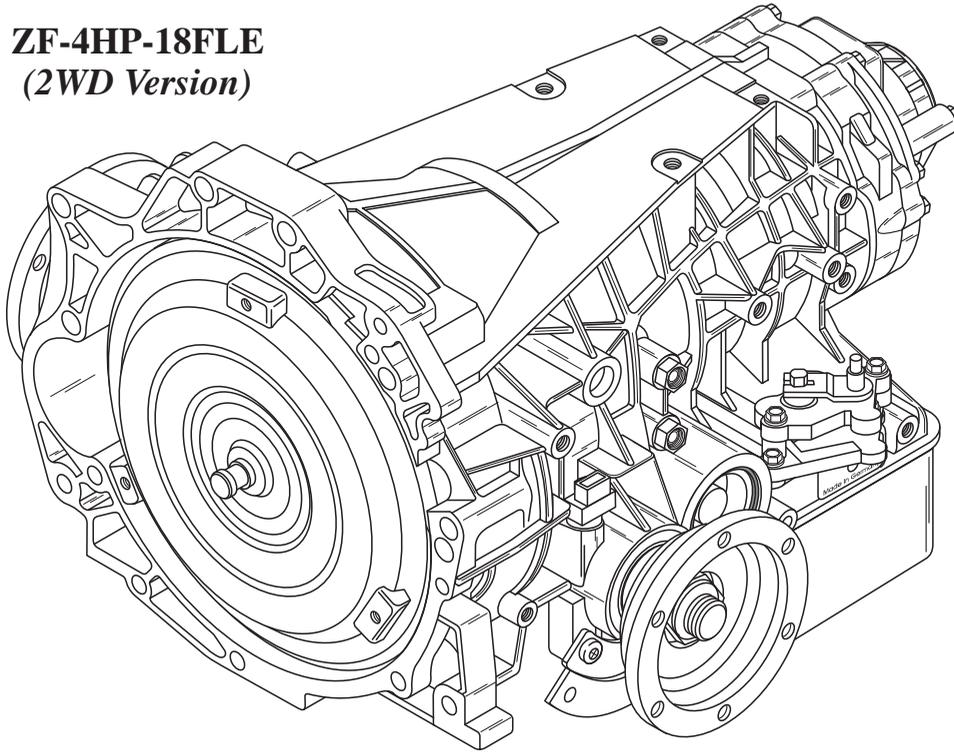
*Refer to Page 23 for complete color hydraulic schematic.*

### **SPECIAL NOTE:**

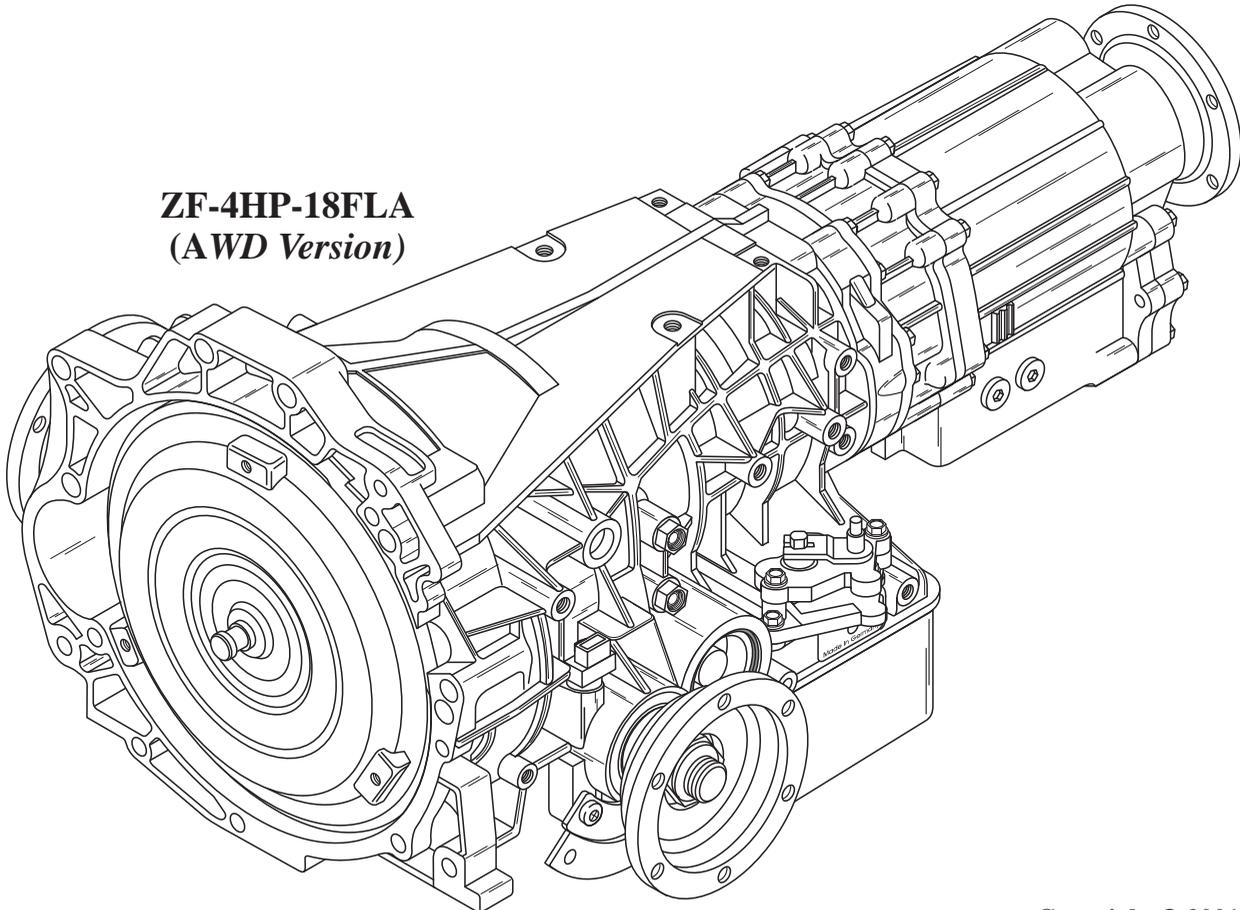
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**ZF-4HP-18FLE**  
*(2WD Version)*



**ZF-4HP-18FLA**  
*(AWD Version)*

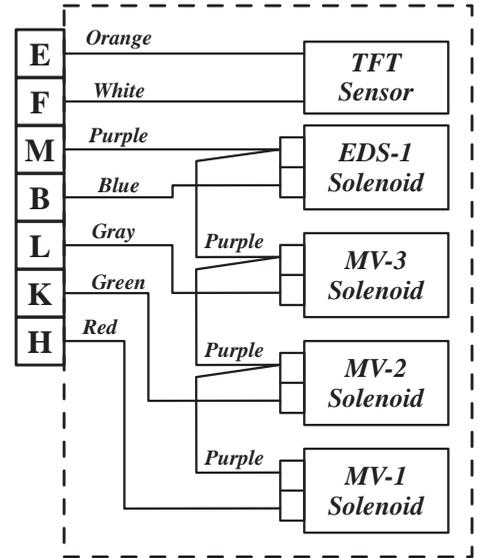


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Figure 1

### RESISTANCE CHARTS AND TERMINAL IDENTIFICATION

Internal Component	Connector Terminals	Resistance In Ohms
MV-1 Solenoid	M & H	30-40 Ohms @ 68°F (20°C)
MV-2 Solenoid	M & K	30-40 Ohms @ 68°F (20°C)
MV-3 Solenoid	M & L	30-40 Ohms @ 68°F (20°C)
EDS-1 Solenoid	M & B	5-8 Ohms @ 68°F (20°C)
TFT Sensor	E & F	920-960 Ohms @ 68°F (20°C)

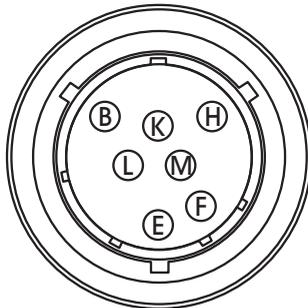


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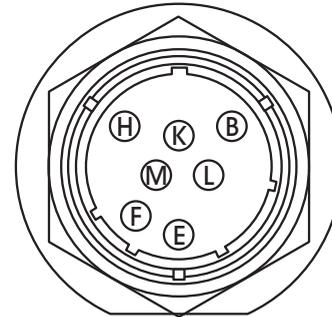
Solenoid nomenclatures are ATSG interpretations, not Audi's nor ZF.

### TRANSAXLE SOLENOID CONNECTOR TERMINAL IDENTIFICATION

View Looking Into Vehicle Harness Connector

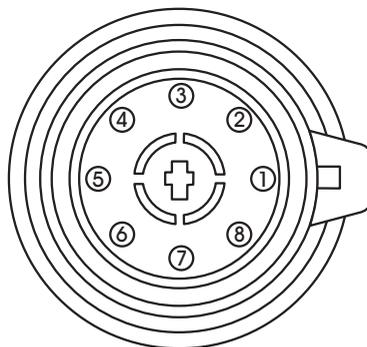


View Looking Into Transaxle Case Connector

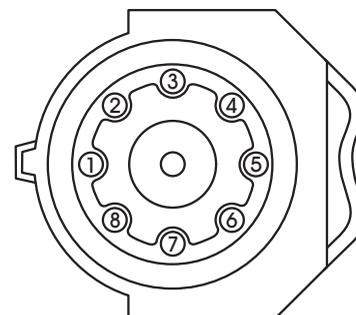


### TRANSAXLE RANGE SWITCH CONNECTOR TERMINAL IDENTIFICATION

View Looking Into Transaxle Range Switch Vehicle Harness Connector



View Looking Into Transaxle Range Switch Connector



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Figure 2



### ZF-4HP-18FLE SOLENOID AND COMPONENT APPLICATION CHART

RANGE	MV-1 Sol.	MV-2 Sol.	MV-3 Sol.	EDS-1 Sol.	"A" Clutch	"B" Clutch	2-4 Band	"C" Clutch	"D" Clutch	"E" Clutch
Park/Neut		ON	ON	**						
Reverse		ON	*	**		ON			ON	
Drive-1st			ON	**	ON					
Drive-2nd	ON		ON	**	ON		ON	ON		
Drive-3rd	ON			**	ON			ON		ON
Drive-4th				**			ON	ON		ON
Manual-1st			ON	**	ON				ON	
"Failsafe" ***				Max.	ON		ON	ON		

\* ON For Reverse Inhibit Feature.

\*\* Pressure Regulating.

\*\*\* Electrical failure while in 4th gear, vehicle remains in 4th gear until engine is turned off. When vehicle is once again started, transaxle will be in "Failsafe" 2nd gear. Refer to Page 22 for complete explanation of Safety Mode Valve Operation.

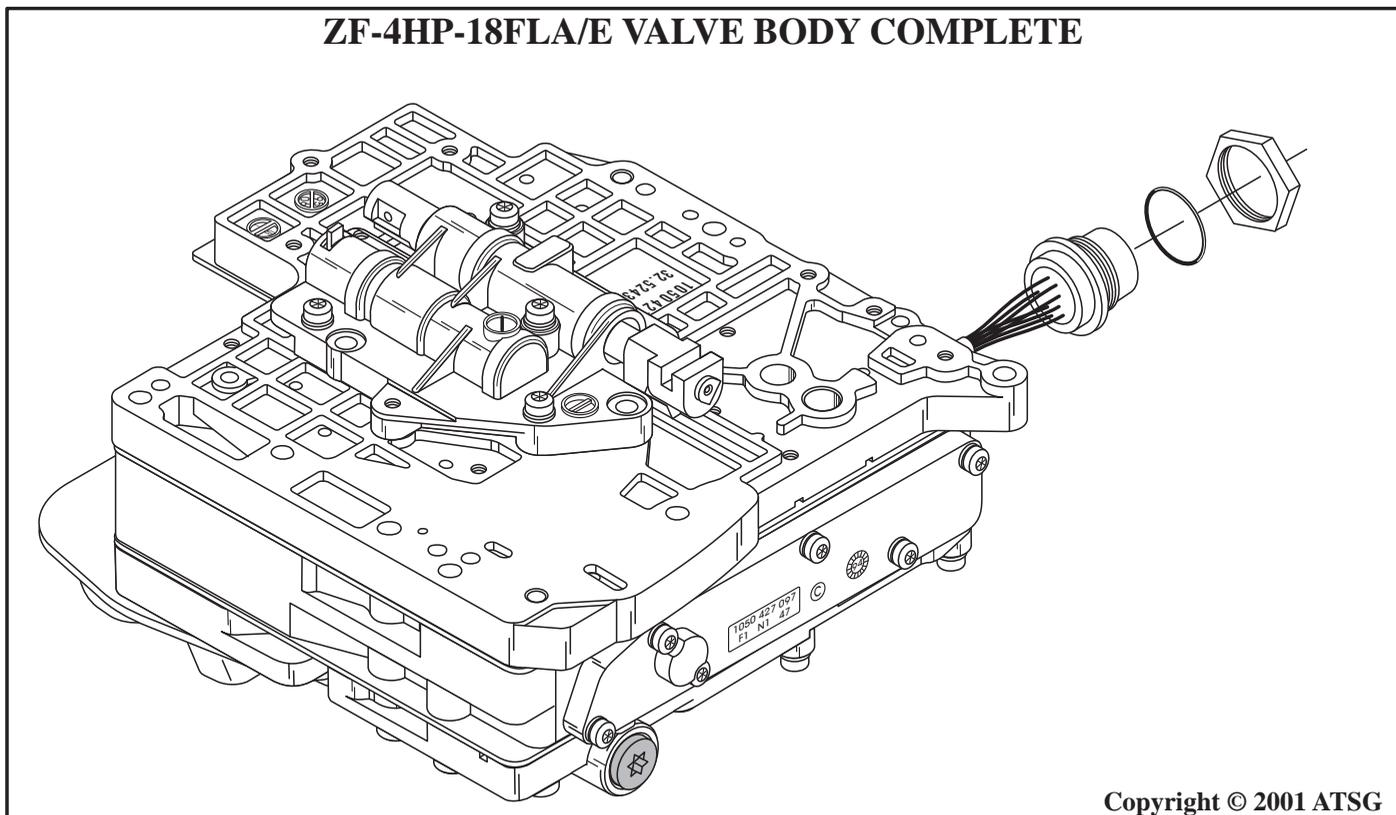
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Figure 4

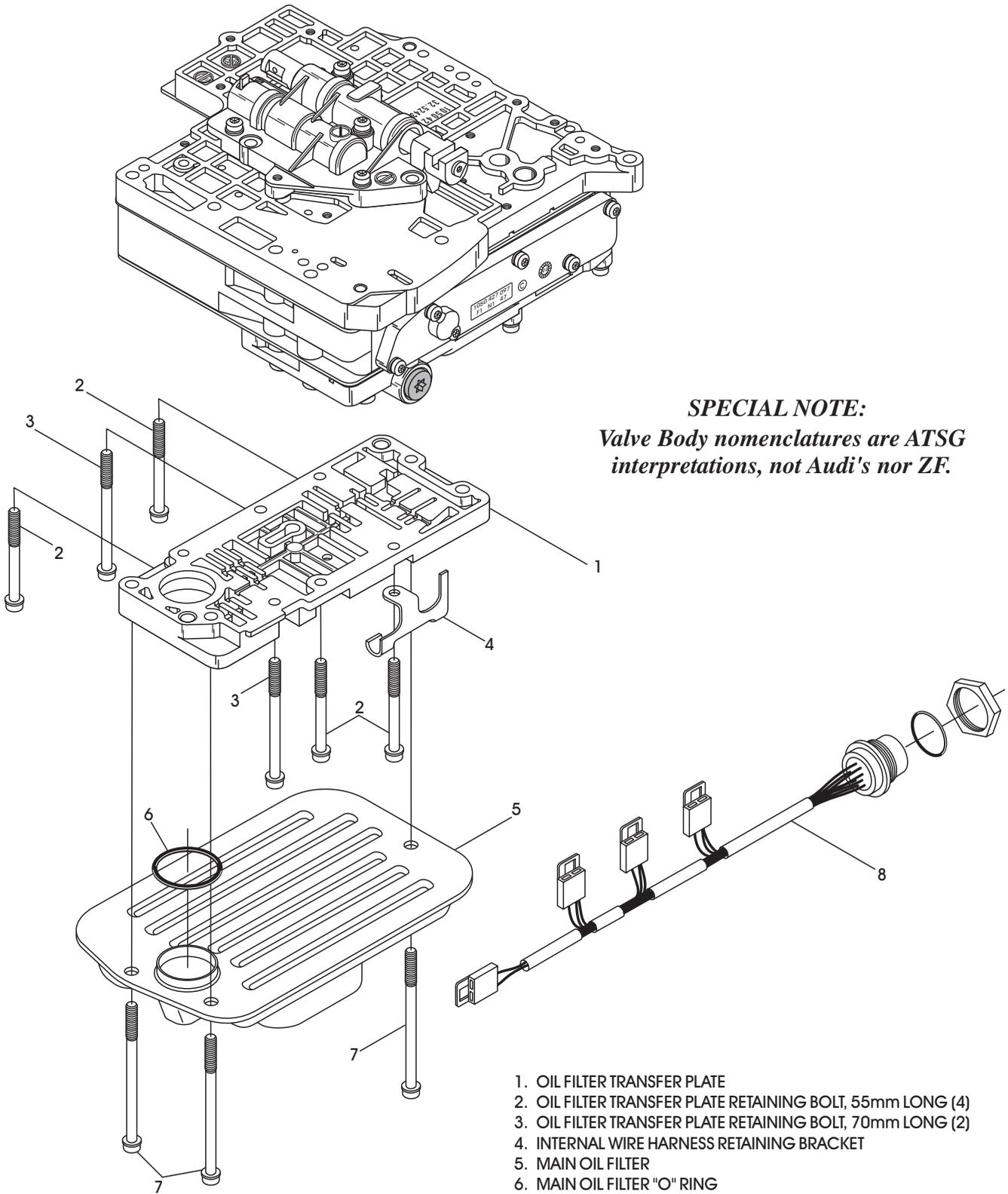
### ZF-4HP-18FLA/E VALVE BODY COMPLETE



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Figure 5

**ZF-4HP-18FLA/E OIL FILTER AND FILTER TRANSFER PLATE**



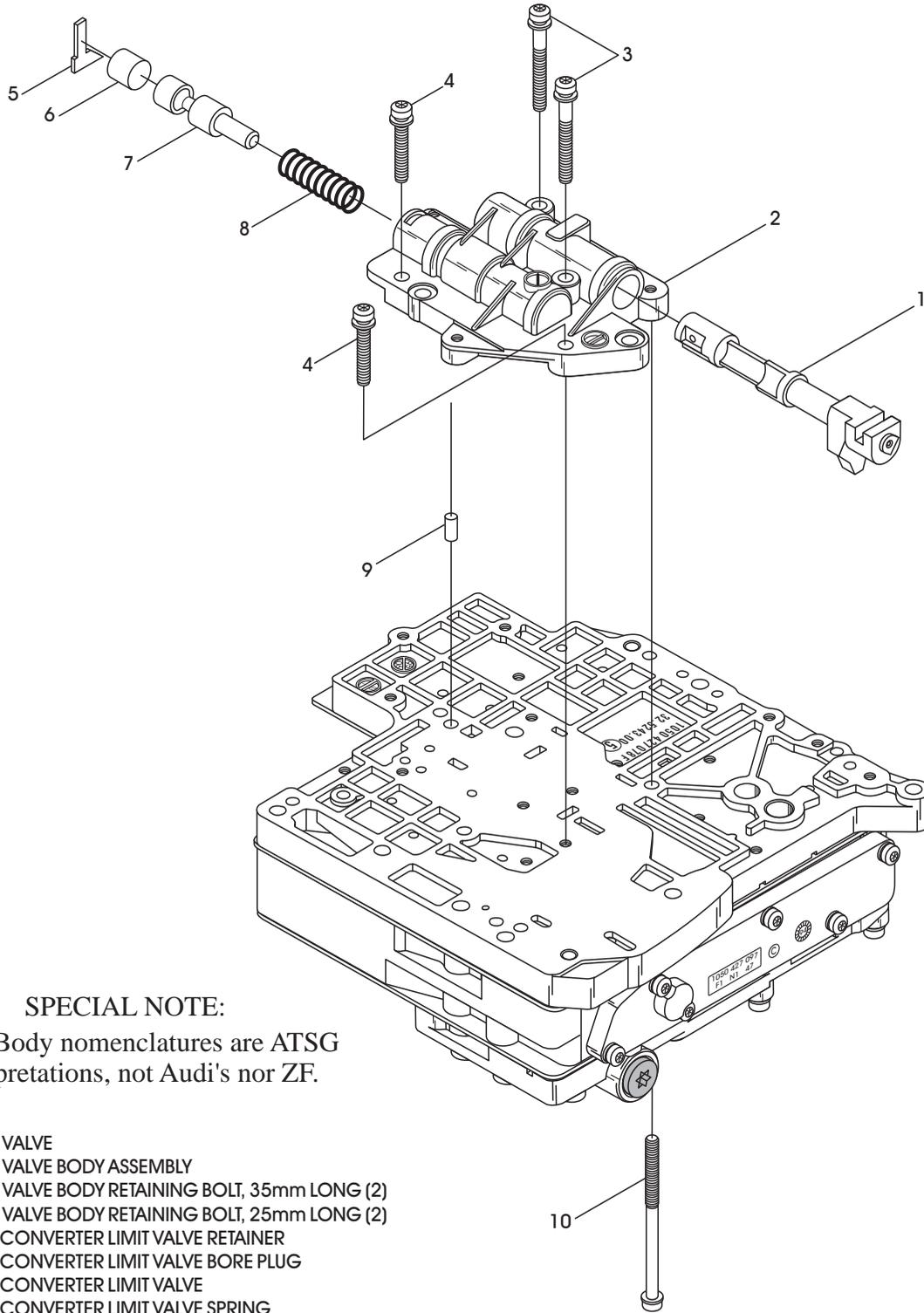
**SPECIAL NOTE:**  
*Valve Body nomenclatures are ATSG interpretations, not Audi's nor ZF.*

- 1. OIL FILTER TRANSFER PLATE
- 2. OIL FILTER TRANSFER PLATE RETAINING BOLT, 55mm LONG (4)
- 3. OIL FILTER TRANSFER PLATE RETAINING BOLT, 70mm LONG (2)
- 4. INTERNAL WIRE HARNESS RETAINING BRACKET
- 5. MAIN OIL FILTER
- 6. MAIN OIL FILTER "O" RING
- 7. FILTER AND VALVE BODY ASSEMBLY TO CASE RETAINING BOLTS

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Figure 6

**ZF-4HP-18FLA/E MANUAL VALVE BODY**



**SPECIAL NOTE:**

Valve Body nomenclatures are ATSG interpretations, not Audi's nor ZF.

1. MANUAL VALVE
2. MANUAL VALVE BODY ASSEMBLY
3. MANUAL VALVE BODY RETAINING BOLT, 35mm LONG (2)
4. MANUAL VALVE BODY RETAINING BOLT, 25mm LONG (2)
5. TORQUE CONVERTER LIMIT VALVE RETAINER
6. TORQUE CONVERTER LIMIT VALVE BORE PLUG
7. TORQUE CONVERTER LIMIT VALVE
8. TORQUE CONVERTER LIMIT VALVE SPRING
9. ALIGNMENT DOWEL PIN, .235" DIAMETER, .612" LONG
10. LOWER PLATE/MANUAL VALVE BODY BOLT, 65mm LONG (1)

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Figure 7

**ZF-4HP-18FLA/E SOLENOID VALVE BODY**

**SPECIAL NOTE:**  
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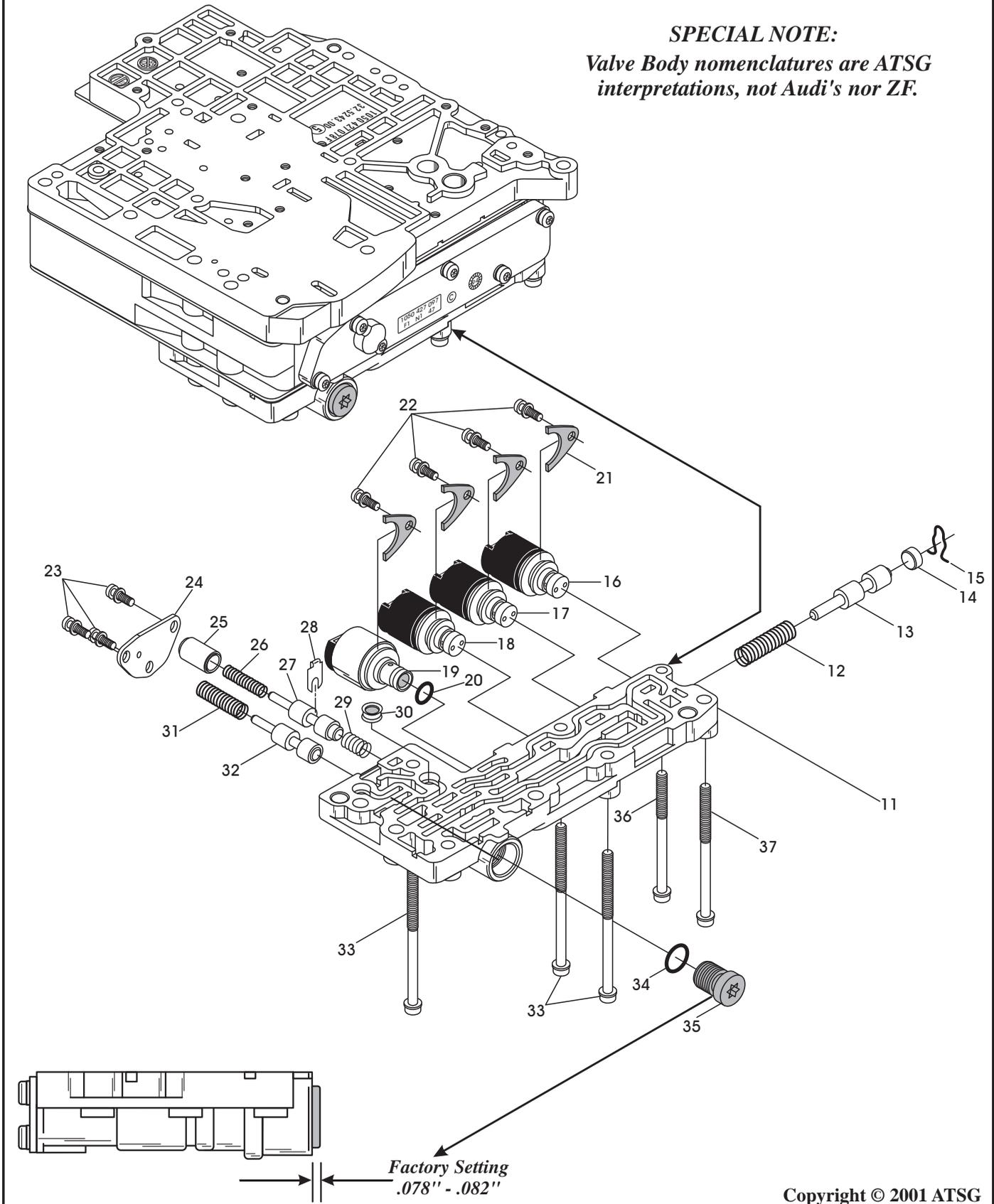


Figure 8

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## TECHNICIANS DIAGNOSTIC GUIDE BMW, AUDI, PORSCHE

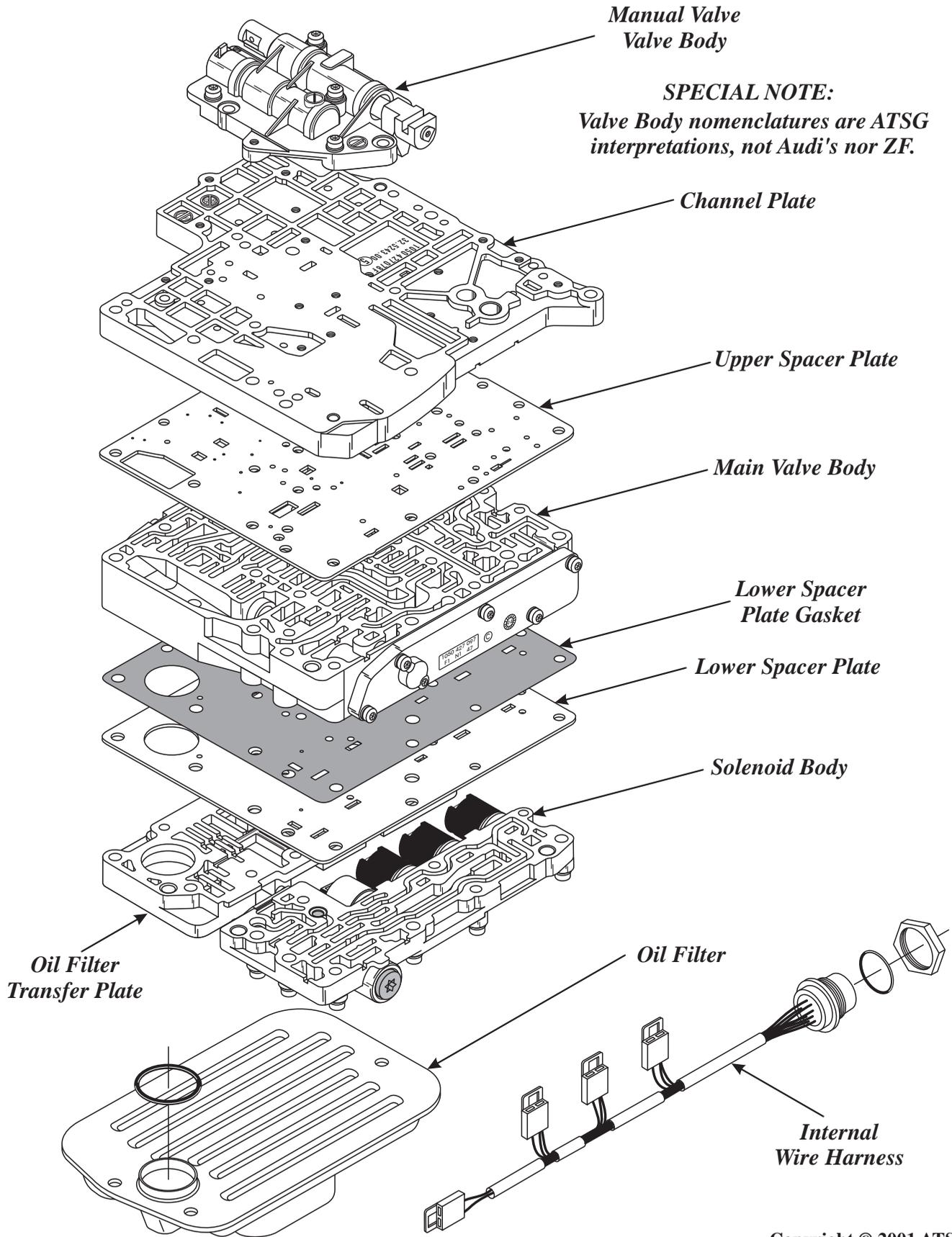
11. SOLENOID VALVE BODY CASTING
12. PRESSURE REGULATOR VALVE SPRING, MV-1 THRU MV-3 SOLENOIDS
13. PRESSURE REGULATOR VALVE, MV-1 THRU MV-3 SOLENOIDS
14. PRESSURE REGULATOR VALVE BORE PLUG, MV-1 THRU MV-3 SOLENOIDS
15. PRESSURE REGULATOR VALVE RETAINING CLIP, MV-1 THRU MV-3 SOLENOIDS
16. MV-1 SOLENOID, OEM PART NUMBER 0501 313 500 (SHIFT CONTROL)
17. MV-2 SOLENOID, OEM PART NUMBER 0501 313 500 (SHIFT CONTROL)
18. MV-3 SOLENOID, OEM PART NUMBER 0501 313 500 (SHIFT CONTROL)
19. EDS-1 SOLENOID, OEM PART NUMBER 0501 311 843 (LINE PRESSURE)
20. EDS-1 SOLENOID "O" RING
21. SOLENOID RETAINING BRACKET (4 REQUIRED)
22. SOLENOID RETAINING BRACKET BOLT, 12mm LONG (4 REQUIRED)
23. RETAINING PLATE BOLT, 12mm LONG (3 REQUIRED)
24. SOLENOID BODY RETAINING PLATE
25. MODULATING VALVE PLUNGER
26. MODULATING VALVE SPRING
27. MODULATING VALVE
28. MODULATING VALVE RETAINING CLIP
29. MODULATING VALVE BALANCE SPRING
30. EDS-1 SOLENOID SCREEN
31. PRESSURE REGULATOR VALVE SPRING, FOR EDS-1 SOLENOID
32. PRESSURE REGULATOR VALVE, FOR EDS-1 SOLENOID
33. SOLENOID VALVE BODY RETAINING BOLT, 70mm LONG (3 REQUIRED)
34. MODULATING VALVE ADJUSTING SCREW "O" RING
35. MODULATING VALVE ADJUSTING SCREW
36. SOLENOID VALVE BODY RETAINING BOLT, 60mm LONG (1 REQUIRED)
37. SOLENOID VALVE BODY RETAINING BOLT, 65mm LONG (1 REQUIRED)

**SPECIAL NOTE:**  
*Valve Body nomenclatures are ATSG  
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Figure 8 LEGEND

**ZF-4HP-18FLA/E COMPONENT ASSEMBLY**



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Figure 9

**ZF-4HP-18FLA/E MAIN VALVE BODY "REAR SIDE" DETAIL**

*Legend Found  
On Next Page.*

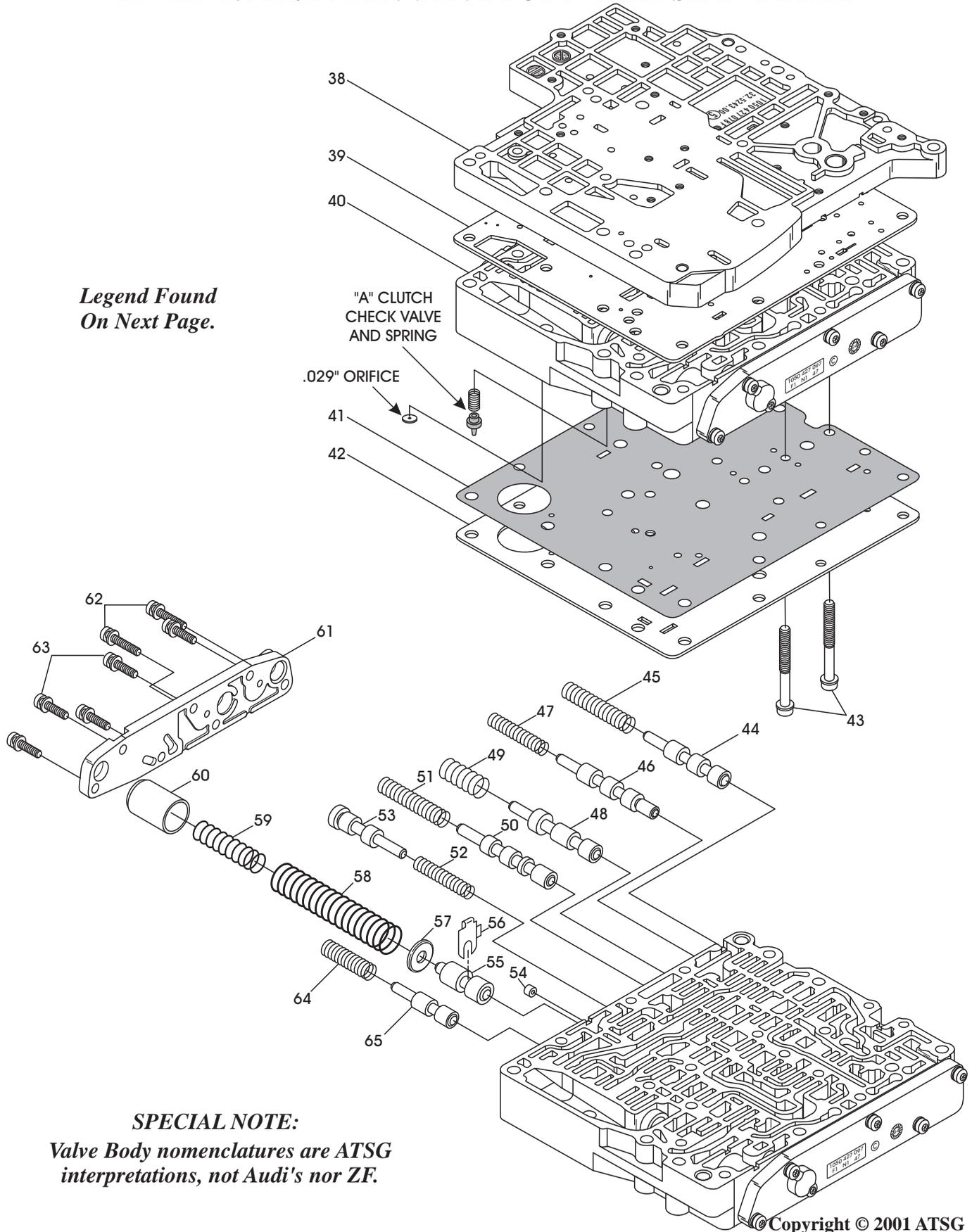
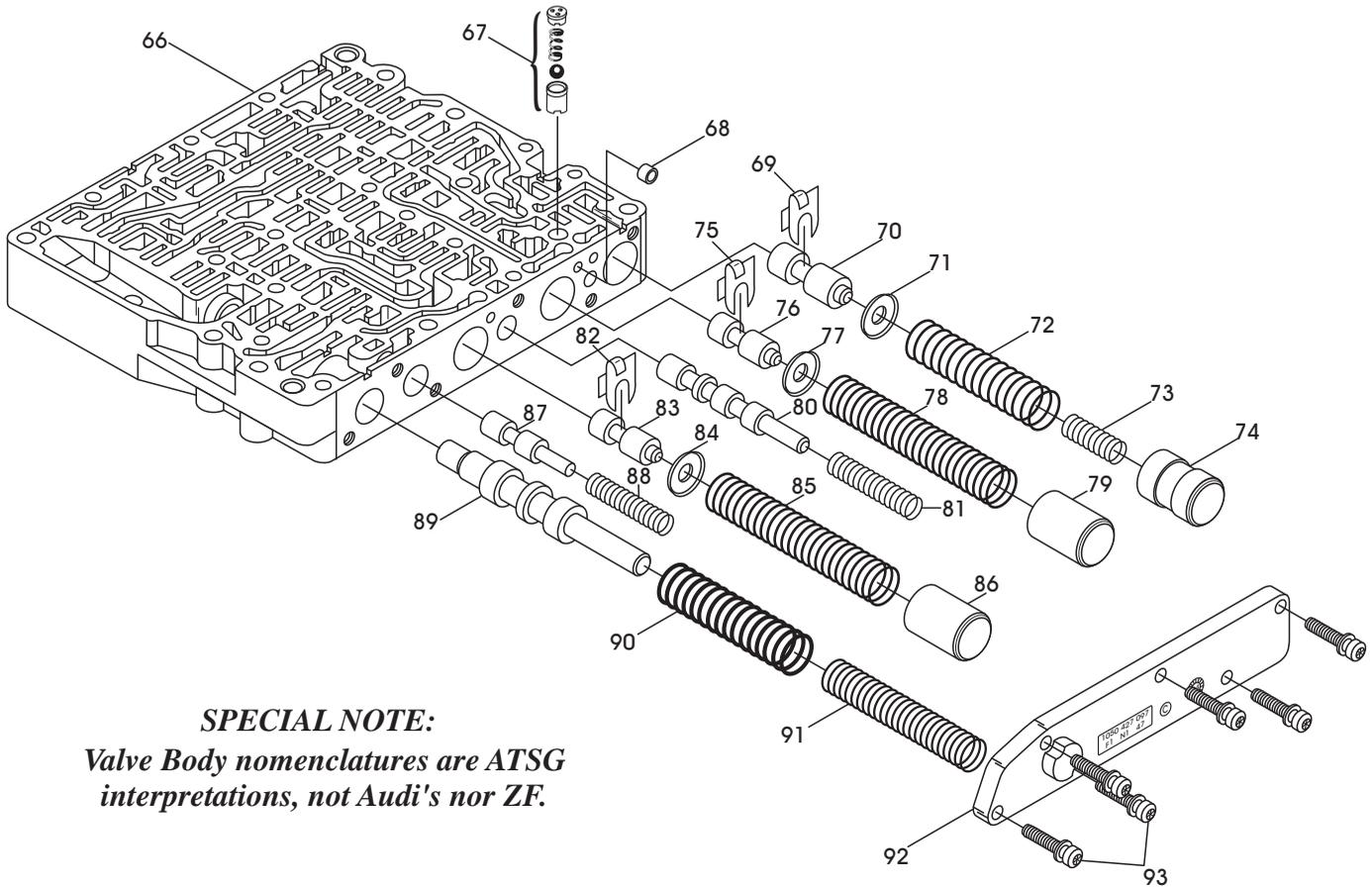


Figure 10

### ZF-4HP-18FLA/E MAIN VALVE BODY "FRONT SIDE" DETAIL



**SPECIAL NOTE:**  
*Valve Body nomenclatures are ATSG interpretations, not Audi's nor ZF.*

#### FIGURE 10 LEGEND

- 38. CHANNEL PLATE ASSEMBLY
- 39. UPPER SPACER PLATE
- 40. MAIN VALVE BODY ASSEMBLY
- 41. MAIN VALVE BODY TO LOWER SPACER PLATE GASKET
- 42. LOWER SPACER PLATE
- 43. SPACER PLATE TO CHANNEL PLATE BOLT, 50mm LONG (2)
- 44. SHIFT VALVE NUMBER ONE
- 45. SHIFT VALVE NUMBER ONE SPRING
- 46. SHIFT VALVE NUMBER TWO
- 47. SHIFT VALVE NUMBER TWO SPRING
- 48. SAFETY MODE VALVE
- 49. SAFETY MODE VALVE SPRING
- 50. SHIFT VALVE NUMBER THREE
- 51. SHIFT VALVE NUMBER THREE SPRING
- 52. 3-4 TRACTION VALVE SPRING
- 53. 3-4 TRACTION VALVE
- 54. .060" ORIFICED CUP PLUG IN VALVE BODY CASTING
- 55. "A" CLUTCH ACCUMULATOR VALVE
- 56. "A" CLUTCH ACCUMULATOR VALVE RETAINER
- 57. "A" CLUTCH ACCUMULATOR VALVE SPRING SEAT
- 58. "A" CLUTCH ACCUMULATOR OUTER SPRING
- 59. "A" CLUTCH ACCUMULATOR INNER SPRING
- 60. "A" CLUTCH ACCUMULATOR PLUNGER
- 61. REAR SIDE VALVE RETAINING COVER
- 62. REAR SIDE COVER RETAINING SCREWS, 22mm LONG (2)
- 63. REAR SIDE COVER RETAINING SCREWS, 18mm LONG (5)
- 64. "C" CLUTCH TRACTION VALVE SPRING
- 65. "C" CLUTCH TRACTION VALVE

#### FIGURE 11 LEGEND

- 66. MAIN VALVE BODY CASTING
- 67. "D" CLUTCH ONE-WAY CHECK VALVE, (.020" ORIFICE)
- 68. .070" ORIFICED CUP PLUG IN VALVE BODY CASTING
- 69. "D" CLUTCH ACCUMULATOR VALVE RETAINER
- 70. "D" CLUTCH ACCUMULATOR VALVE
- 71. "D" CLUTCH ACCUMULATOR VALVE SPRING SEAT
- 72. "D" CLUTCH ACCUMULATOR OUTER SPRING
- 73. "D" CLUTCH ACCUMULATOR INNER SPRING
- 74. "D" CLUTCH ACCUMULATOR PLUNGER
- 75. "C" CLUTCH ACCUMULATOR VALVE RETAINER
- 76. "C" CLUTCH ACCUMULATOR VALVE
- 77. "C" CLUTCH ACCUMULATOR VALVE SPRING SEAT
- 78. "C" CLUTCH ACCUMULATOR SPRING
- 79. "C" CLUTCH ACCUMULATOR PLUNGER
- 80. 1ST AND REVERSE VALVE
- 81. 1ST AND REVERSE VALVE SPRING
- 82. "E" CLUTCH ACCUMULATOR VALVE RETAINER
- 83. "E" CLUTCH ACCUMULATOR VALVE
- 84. "E" CLUTCH ACCUMULATOR VALVE SPRING SEAT
- 85. "E" CLUTCH ACCUMULATOR SPRING
- 86. "E" CLUTCH ACCUMULATOR PLUNGER
- 87. 4-3 TRACTION VALVE
- 88. 4-3 TRACTION VALVE SPRING
- 89. MAIN LINE PRESSURE REGULATOR VALVE
- 90. MAIN LINE PRESSURE REGULATOR VALVE OUTER SPRING
- 91. MAIN LINE PRESSURE REGULATOR VALVE INNER SPRING
- 92. FRONT SIDE VALVE RETAINING COVER
- 93. FRONT SIDE COVER RETAINING SCREWS, 18mm LONG (6)

Figure 11



# TECHNICIANS DIAGNOSTIC GUIDE

## BMW, AUDI, PORSCHE

### ZF 4HP-18FLA/E SPRING SPECIFICATIONS

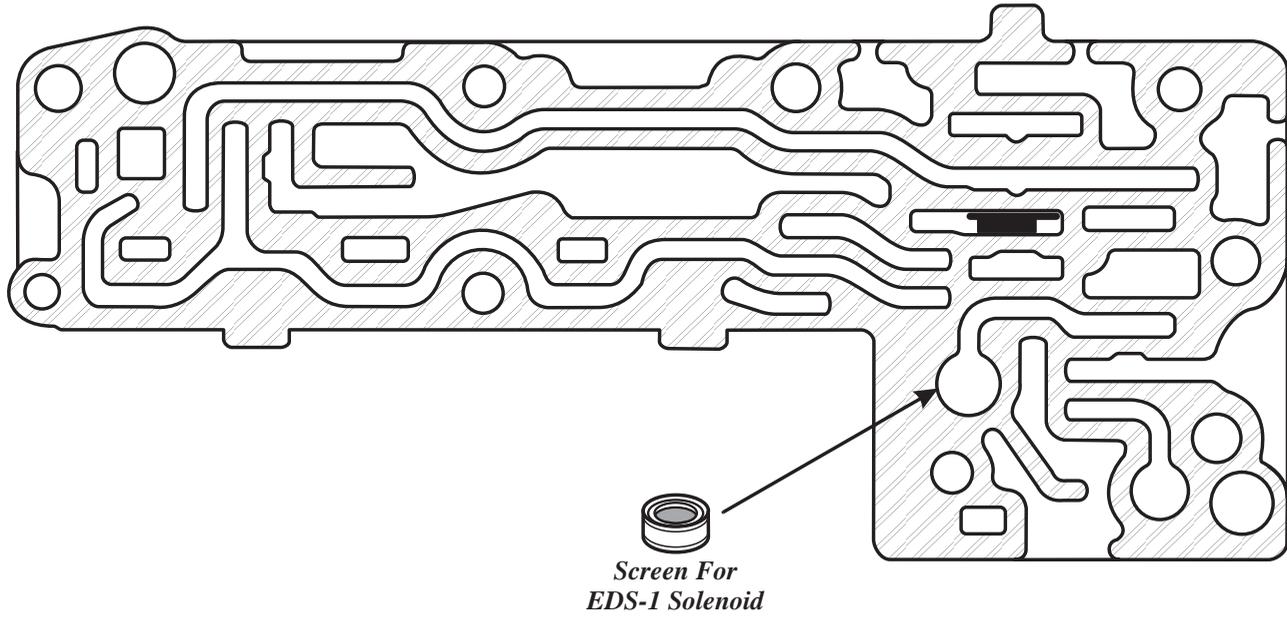
<i>Manual Valve Body</i>	<i>Solenoid Valve Body</i>	<i>Main Valve Body</i>	
		<i>"Back Side"</i>	<i>"Front Side"</i>
SPRING ILLUSTRATION NO. 8 FREE LENGTH = 1.618" SPRING DIAMETER = .495" WIRE DIAMETER = .062"	SPRING ILLUSTRATION NO. 12 FREE LENGTH = 1.688" SPRING DIAMETER = .375" WIRE DIAMETER = .042"	SPRING ILLUSTRATION NO. 45: FREE LENGTH = 1.865" SPRING DIAMETER = .382" WIRE DIAMETER = .035"	SPRING ILLUSTRATION NO. 72: FREE LENGTH = 2.860" SPRING DIAMETER = .612" WIRE DIAMETER = .048"
	SPRING ILLUSTRATION NO. 26 FREE LENGTH = 1.475" SPRING DIAMETER = .320" WIRE DIAMETER = .042"	SPRING ILLUSTRATION NO. 47: FREE LENGTH = 1.595" SPRING DIAMETER = .365" WIRE DIAMETER = .031"	SPRING ILLUSTRATION NO. 73: FREE LENGTH = 1.589" SPRING DIAMETER = .429" WIRE DIAMETER = .035"
	SPRING ILLUSTRATION NO. 29 FREE LENGTH = .760" SPRING DIAMETER = .370" WIRE DIAMETER = .028"	SPRING ILLUSTRATION NO. 49: FREE LENGTH = 1.194" SPRING DIAMETER = .443" WIRE DIAMETER = .031"	SPRING ILLUSTRATION NO. 78: FREE LENGTH = 3.530" SPRING DIAMETER = .575" WIRE DIAMETER = .039"
	SPRING ILLUSTRATION NO. 31 FREE LENGTH = 1.530" SPRING DIAMETER = .340" WIRE DIAMETER = .042"	SPRING ILLUSTRATION NO. 51: FREE LENGTH = 1.832" SPRING DIAMETER = .364" WIRE DIAMETER = .031"	SPRING ILLUSTRATION NO. 81: FREE LENGTH = 1.815" SPRING DIAMETER = .365" WIRE DIAMETER = .031"
		SPRING ILLUSTRATION NO. 52: FREE LENGTH = 1.289" SPRING DIAMETER = .298" WIRE DIAMETER = .027"	SPRING ILLUSTRATION NO. 85: FREE LENGTH = 3.530" SPRING DIAMETER = .575" WIRE DIAMETER = .039"
		SPRING ILLUSTRATION NO. 58: FREE LENGTH = 3.216" SPRING DIAMETER = .590" WIRE DIAMETER = .042"	SPRING ILLUSTRATION NO. 88: FREE LENGTH = 1.712" SPRING DIAMETER = .361" WIRE DIAMETER = .031"
		SPRING ILLUSTRATION NO. 59: FREE LENGTH = 1.592" SPRING DIAMETER = .432" WIRE DIAMETER = .035"	SPRING ILLUSTRATION NO. 90: FREE LENGTH = 2.909" SPRING DIAMETER = .605" WIRE DIAMETER = .066"
		SPRING ILLUSTRATION NO. 64: FREE LENGTH = 1.514" SPRING DIAMETER = .363" WIRE DIAMETER = .038"	SPRING ILLUSTRATION NO. 91: FREE LENGTH = 3.612" SPRING DIAMETER = .445" WIRE DIAMETER = .042"

***Special Note:***

*The spring dimensions listed above were "Observations" from only one valve body, and may vary from one model to another.*

Figure 12

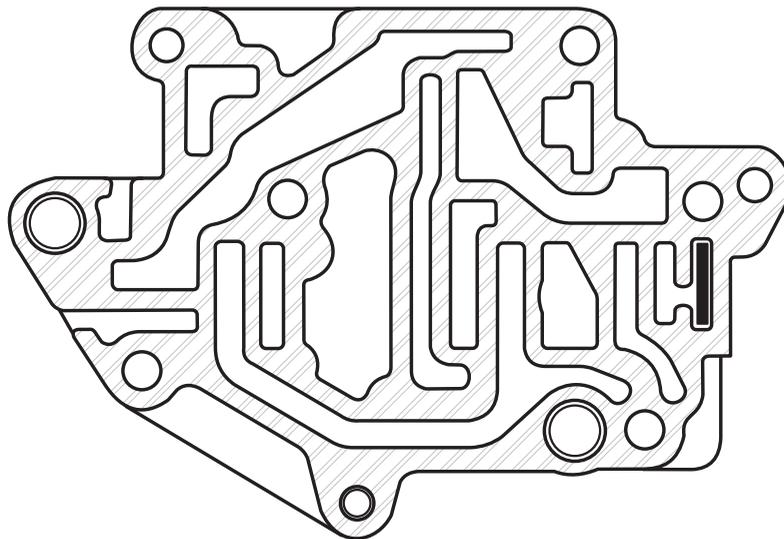
**ZF-4HP-18FLE/FLA  
SOLENOID BODY RETAINER AND SCREEN LOCATIONS**



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Figure 13

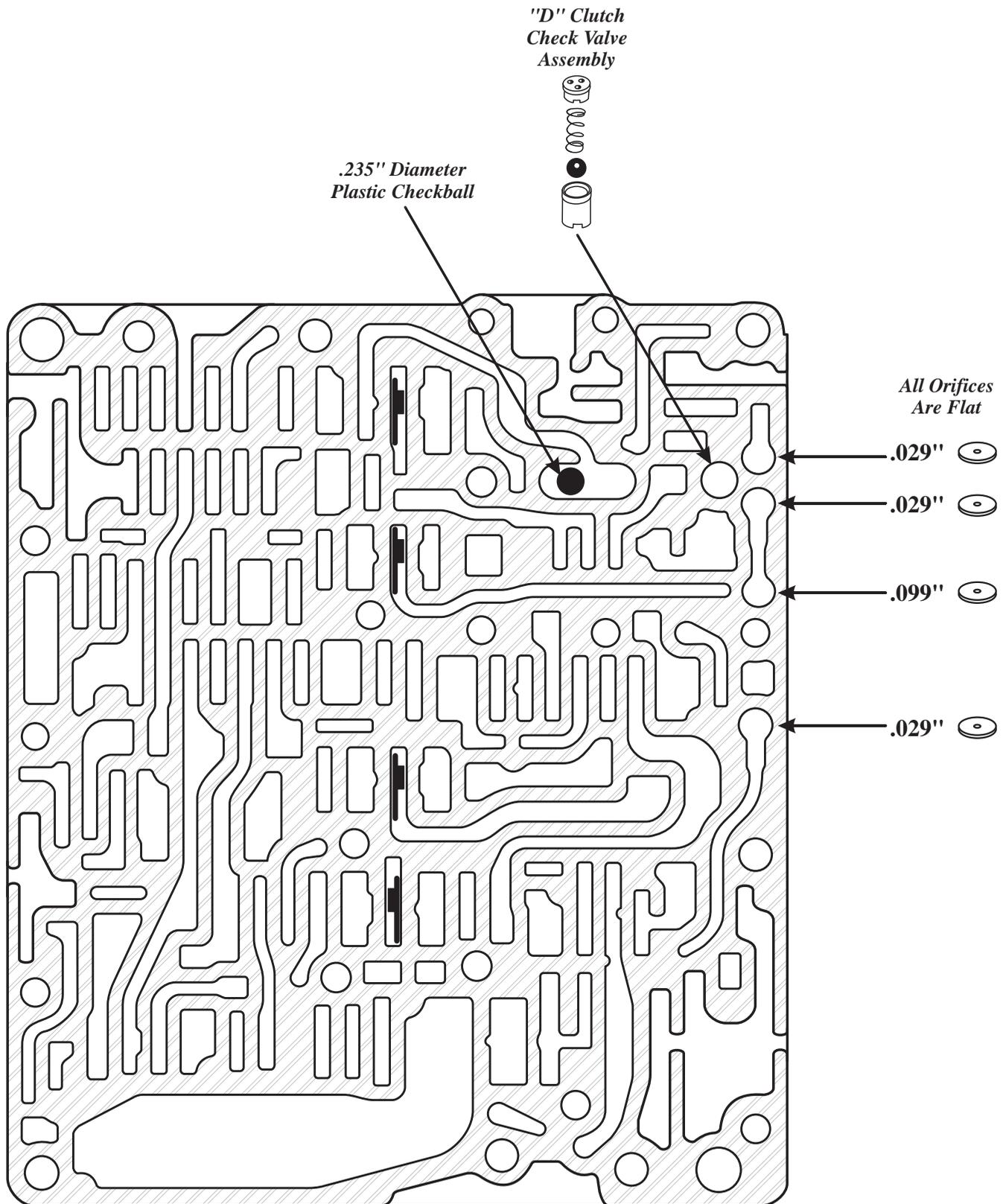
**ZF-4HP-18FLE/FLA  
MANUAL VALVE BODY RETAINER LOCATIONS**



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Figure 14

**ZF-4HP-18FLE/FLA**  
**MAIN VALVE BODY BODY "TOP SIDE" RETAINER AND ORIFICE LOCATIONS**



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Figure 15

**ZF-4HP-18FLE/FLA**

**MAIN VALVE BODY BODY "BOTTOM SIDE" VALVE AND ORIFICE LOCATIONS**

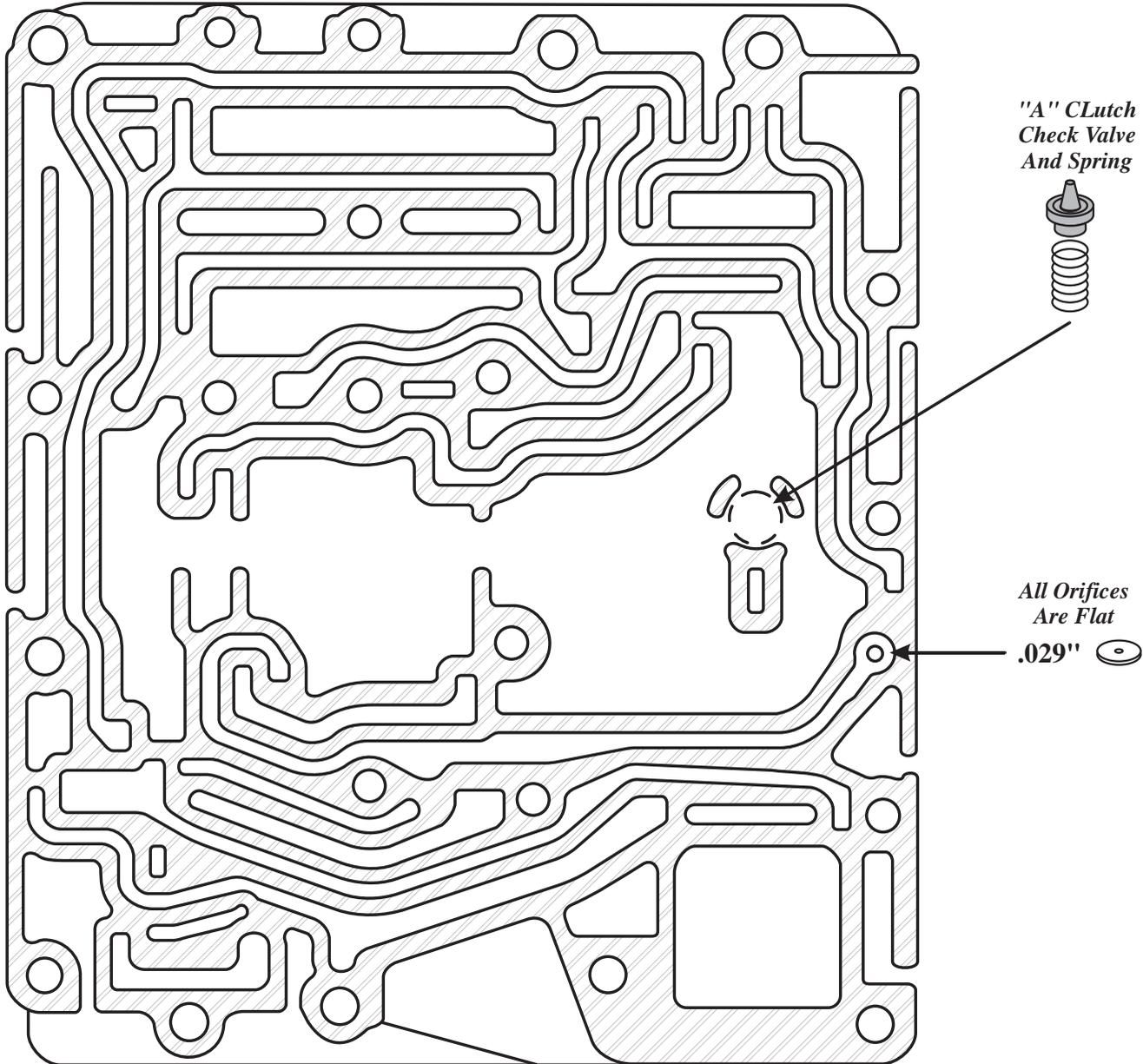
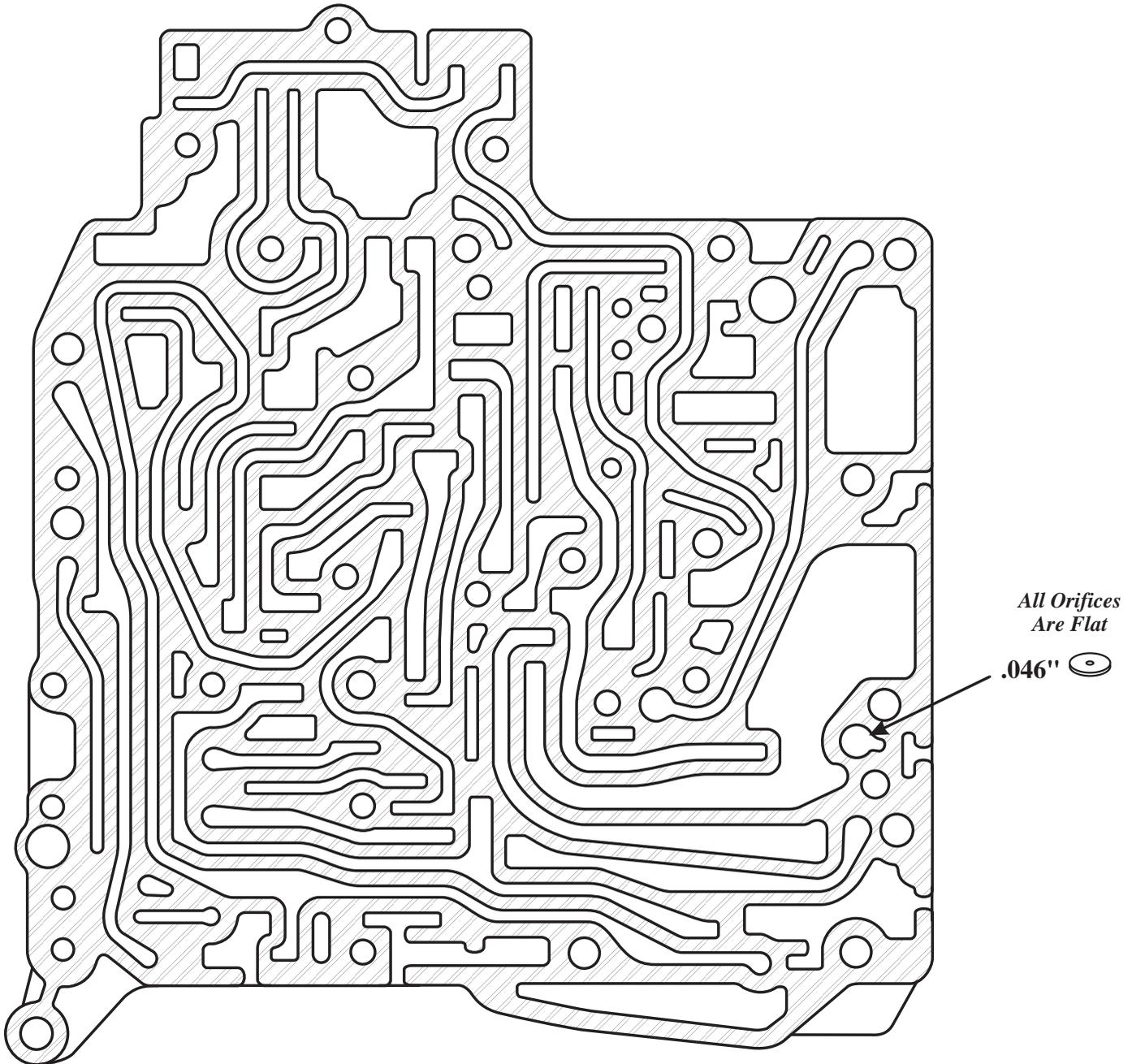


Figure 16

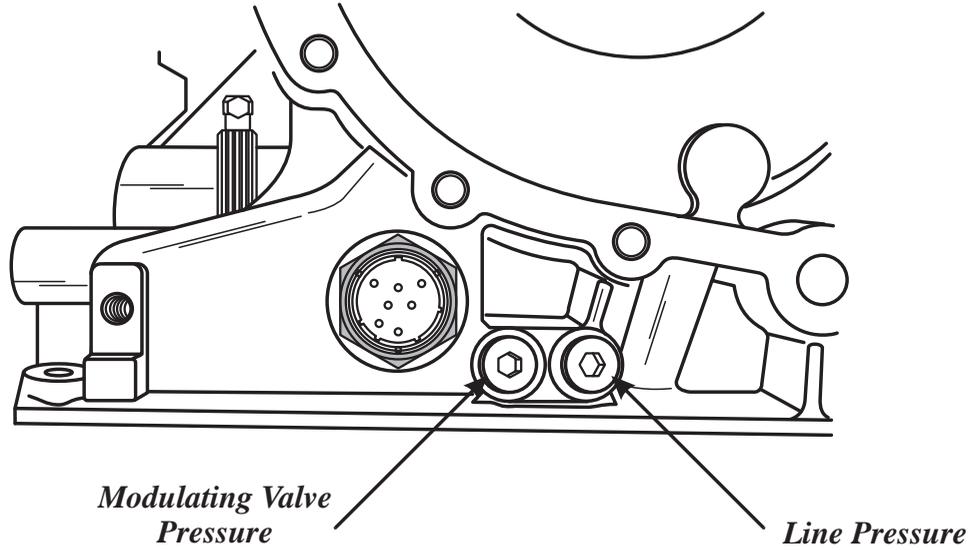
**ZF-4HP-18FLE/FLA  
CHANNEL PLATE ORIFICE LOCATIONS**



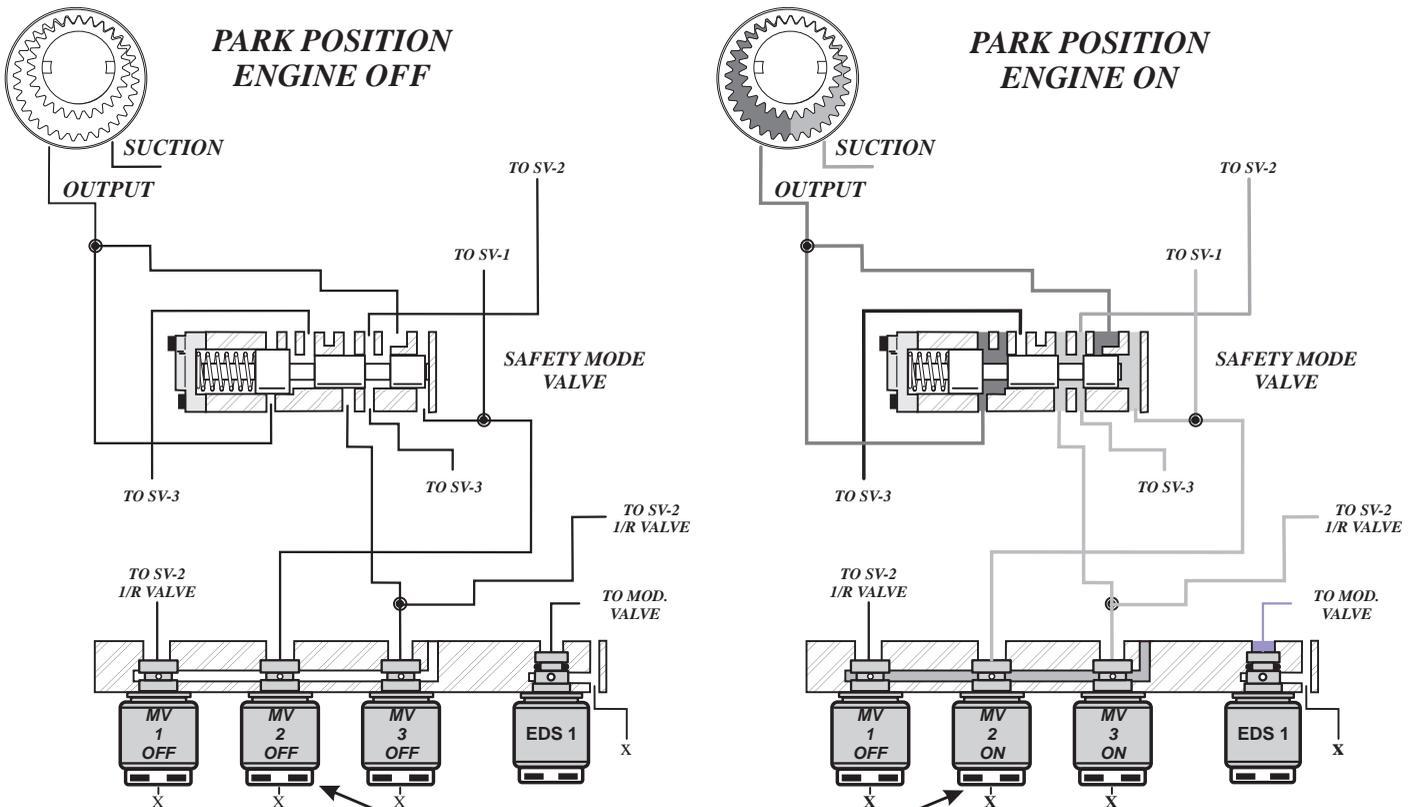
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Figure 17

### ZF-4HP-18FLE/FLA PRESSURE TAP LOCATIONS



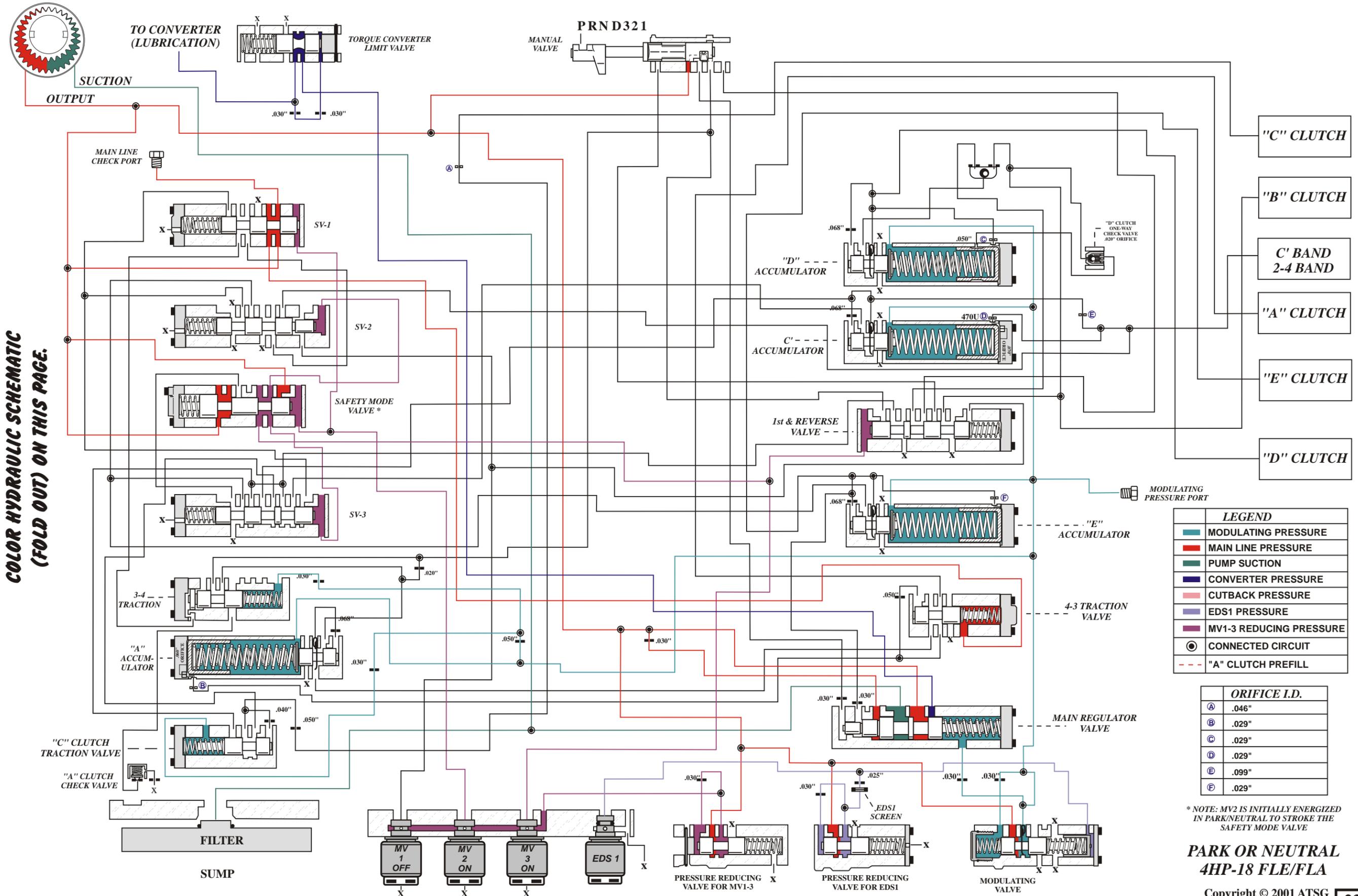
### SAFETY MODE VALVE OPERATION



**MV-2 IS TURNED "ON", ONLY TO STROKE THE SAFETY MODE VALVE. PUMP PRESSURE WILL KEEP THE SAFETY MODE VALVE STROKED, AS LONG AS THE ENGINE IS RUNNING**

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Figure 18



**COLOR HYDRAULIC SCHEMATIC  
(FOLD OUT) ON THIS PAGE.**

LEGEND	
<span style="color: blue;">█</span>	MODULATING PRESSURE
<span style="color: red;">█</span>	MAIN LINE PRESSURE
<span style="color: green;">█</span>	PUMP SUCTION
<span style="color: purple;">█</span>	CONVERTER PRESSURE
<span style="color: pink;">█</span>	CUTBACK PRESSURE
<span style="color: lightblue;">█</span>	EDS1 PRESSURE
<span style="color: magenta;">█</span>	MV1-3 REDUCING PRESSURE
⊙	CONNECTED CIRCUIT
- - -	"A" CLUTCH PREFILL

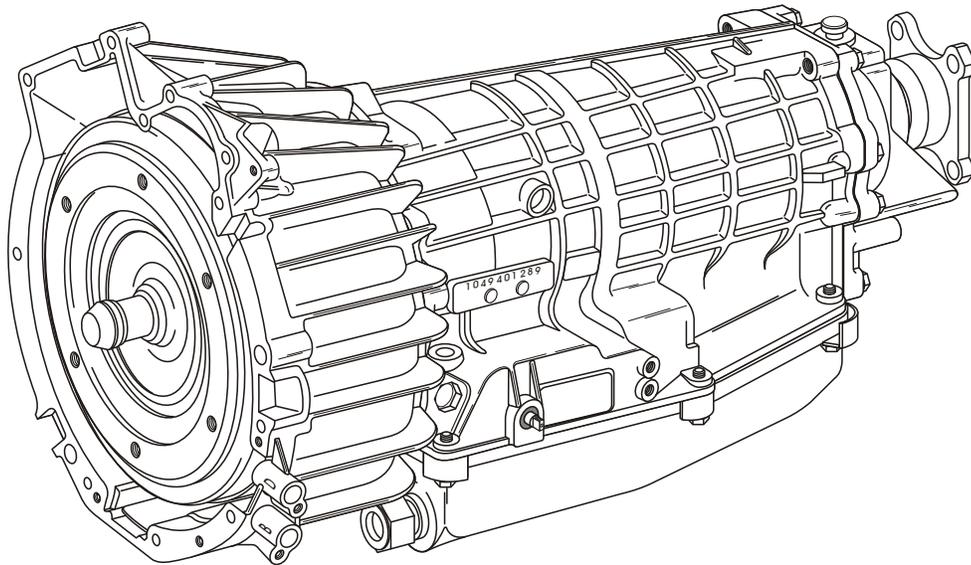
ORIFICE I.D.	
Ⓐ	.046"
Ⓑ	.029"
Ⓒ	.029"
Ⓓ	.029"
Ⓔ	.099"
Ⓕ	.029"

\* NOTE: MV2 IS INITIALLY ENERGIZED IN PARK/NEUTRAL TO STROKE THE SAFETY MODE VALVE

**PARK OR NEUTRAL  
4HP-18 FLE/FLA**

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**ZF 4HP-22/24 SERIES**  
**DIAGNOSTIC INFORMATION**



The Electronic Control system was first introduced in 1986 and was incorporated into the totally hydraulic 4HP-22 unit produced by ZF. It combines the hydraulic control of forward and reverse gear engagement, with electronic control for automatic upshifts from 1st thru 4th and automatic downshifts from 4th thru 1st gears. Three different versions of valve bodies have been used on BMW vehicles, with minor differences between them

The 1st version, *designated Early "E-7"*, has **5 solenoids** on the valve body, was introduced in 1986 and used up thru 1989. This version includes a solenoid for reverse lockout.

The 2nd version, *designated Late "E-7"*, has **5 solenoids** on the valve body, was introduced in 1988 and used up thru Mid-1989. This version includes a solenoid for reverse lockout.

The 3rd version, *designated "E-9"*, has **4 solenoids** on the valve body, was introduced in Mid-1989 and used up thru 1994. This version uses a shift solenoid for the reverse lockout function.

**MODEL YEAR USAGE CHART**

Valve Body Models	Model Year								
	86	87	88	89	90	91	92	93	94
<i>1st Version, Early "E-7", 5 Solenoid</i>									
<i>2nd Version, Late "E-7", 5 Solenoid</i>									
<i>3rd Version, "E-9", 4 Solenoid</i>									

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Figure 19



## **TECHNICIANS DIAGNOSTIC GUIDE BMW, AUDI, PORSCHE**

### **FOR ZF 4HP-22/24 SERIES VEHICLES**

*Refer to Figure 19 for model year usage of the "E7", 5 Solenoid and "E9", 4 Solenoid valve bodies.*

*Refer to Figure 20 for internal component application chart for all models.*

*Refer to Figure 21 for shift quadrant and mode switch differences between the different models.*

### **FOR MODEL "E7", "5 SOLENOID" VALVE BODY**

*Refer to Figure 22 for identification, location and function of the 5 solenoids, along with the shift solenoid firing order for the "E7" 5 solenoid models.*

*Refer to Figure 23 for internal wire schematic and case connector terminal identification, along with a resistance chart to check the internal electronic components.*

*Refer to Figure 24 for individual solenoid operation.*

*Refer to Figure 25 for valve body assembly exploded view.*

*Refer to Figure 26 for Lower Front Valve Body exploded view, with valve identification, and individual spring specifications, as observed in a used valve body.*

*Refer to Figure 27 for Lower Rear Valve Body exploded view, with valve identification, and individual spring specifications, as observed in a used valve body.*

*Refer to Figure 28 for MV-1 and MV-2 Shift Solenoid Body exploded view, with valve identification, and spring specifications, as observed in a used valve body.*

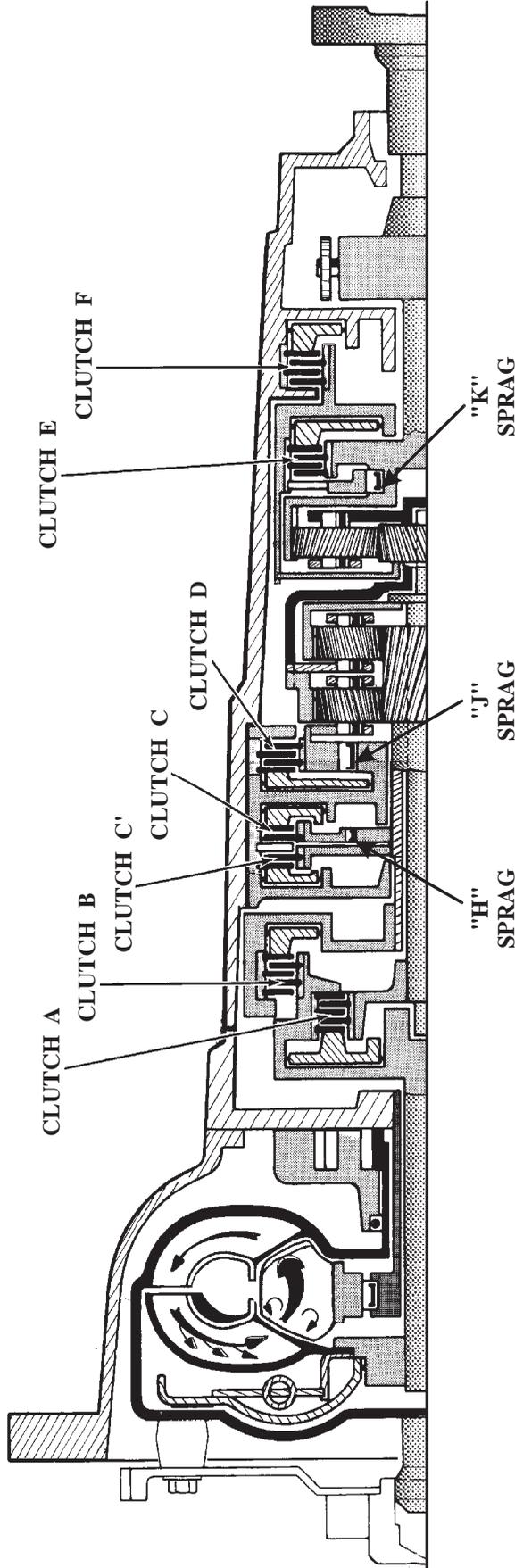
*Refer to Figure 29 for Pressure Control Solenoid Body exploded view, with solenoid identifications.*

*Refer to Figure 30 for Reverse Lockout Solenoid Body exploded view, with valve identifications, and spring specifications, as observed in a used valve body.*

*Refer to Figures 31, 32, 33, 34 for retainer, checkball, orifice and check valve and spring locations.*

### **FOR MODEL "E9", "4 SOLENOID" VALVE BODY REFER TO PAGE 43 IN THIS MANUAL**

**COMPONENT APPLICATION CHART FOR ZF 4HP-22/24 SERIES**



RANGE	"A" Clutch	"B" Clutch	"C" Clutch	"C" Clutch	"C" Clutch	"D" Clutch	"E" Clutch	"F" Clutch	"H" Sprag	"J" Sprag	"K" Sprag
Park											
Reverse		ON				ON	ON				Hold
Neutral											
"D"-1st	ON						ON			Hold	Hold
"D"-2nd	ON						ON		Hold		Hold
"D"-3rd	ON	ON			ON		ON				Hold
"D"-4th	ON	ON			ON			ON			
"3"	Same as above, Automatic Shift 1st thru 3rd, 4th gear is inhibited.										
"2"	Same as above, Automatic Shift 1st thru 2nd, 3rd and 4th gear are inhibited.										
"1"	Same as above, except "D" Clutch is applied for engine braking										

Figure 20

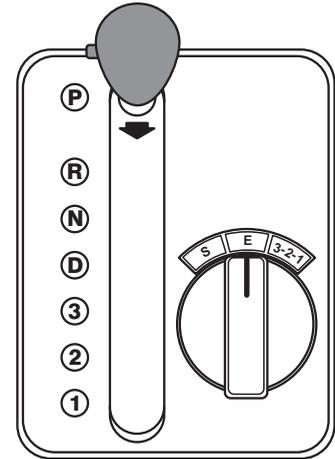
### SHIFT QUADRANTS FOR ZF 4HP-22/24 SERIES

#### *Early "E-7" Models Only (5 Solenoid)*

- (P)** = Parking Pawl Engaged
- (R)** = Reverse Gear
- (N)** = Neutral
- (D)** = Automatic Shifts 1st thru 4th Gears
- (3)** = Automatic Shifts 1st thru 3rd Gears.  
4th Gear is locked out.
- (2)** = Automatic Shifts 1st thru 2nd Gears.  
3rd and 4th Gear is locked out.
- (1)** = 1st Gear Only.  
2nd, 3rd and 4th Gear is locked out.

#### *Mode Switch Description*

A *rotary* switch with three fixed positions and an indicator light in the instrument cluster for the 3-2-1 (M) mode when selected

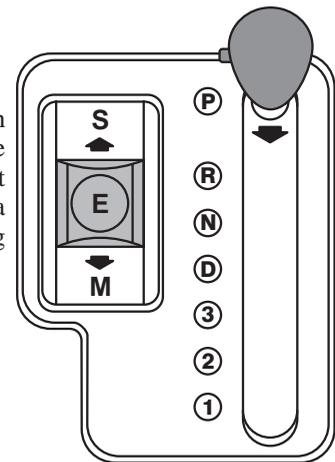


#### *Late "E-7" Models Only (5 Solenoid)*

- (P)** = Parking Pawl Engaged
- (R)** = Reverse Gear
- (N)** = Neutral
- (D)** = Automatic Shifts 1st thru 4th Gears
- (3)** = Automatic Shifts 1st thru 3rd Gears.  
4th Gear is locked out.
- (2)** = Automatic Shifts 1st thru 2nd Gears.  
3rd and 4th Gear is locked out.
- (1)** = 1st Gear Only.  
2nd, 3rd and 4th Gear is locked out.

#### *Mode Switch Description*

A *three* position slide switch with Digital display of the three individual positions in instrument cluster (E-S-M). The switch is a momentary contact and spring loaded to a neutral position.



#### *"E-9" Models Only (4 Solenoid)*

- (P)** = Parking Pawl Engaged
- (R)** = Reverse Gear
- (N)** = Neutral
- (D)** = Automatic Shifts 1st thru 4th Gears
- (3)** = Automatic Shifts 1st thru 3rd Gears.  
4th Gear is locked out.
- (2)** = Automatic Shifts 1st thru 2nd Gears.  
3rd and 4th Gear is locked out.
- (1)** = 1st Gear Only.  
2nd, 3rd and 4th Gear is locked out.

#### *Mode Switch Description*

A *two* position slide switch for the "A" mode (Economy and "M" mode (Manual). The Sport mode is selected with the range selector in position 3, 2, or 1 and "A" mode selected. The switch is a momentary contact and spring loaded to a neutral position.

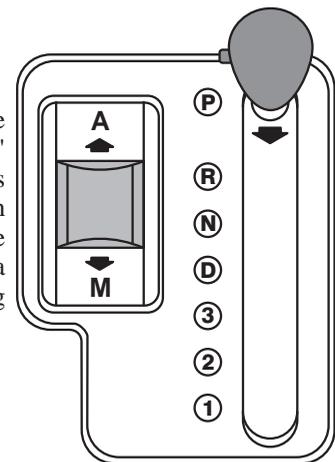
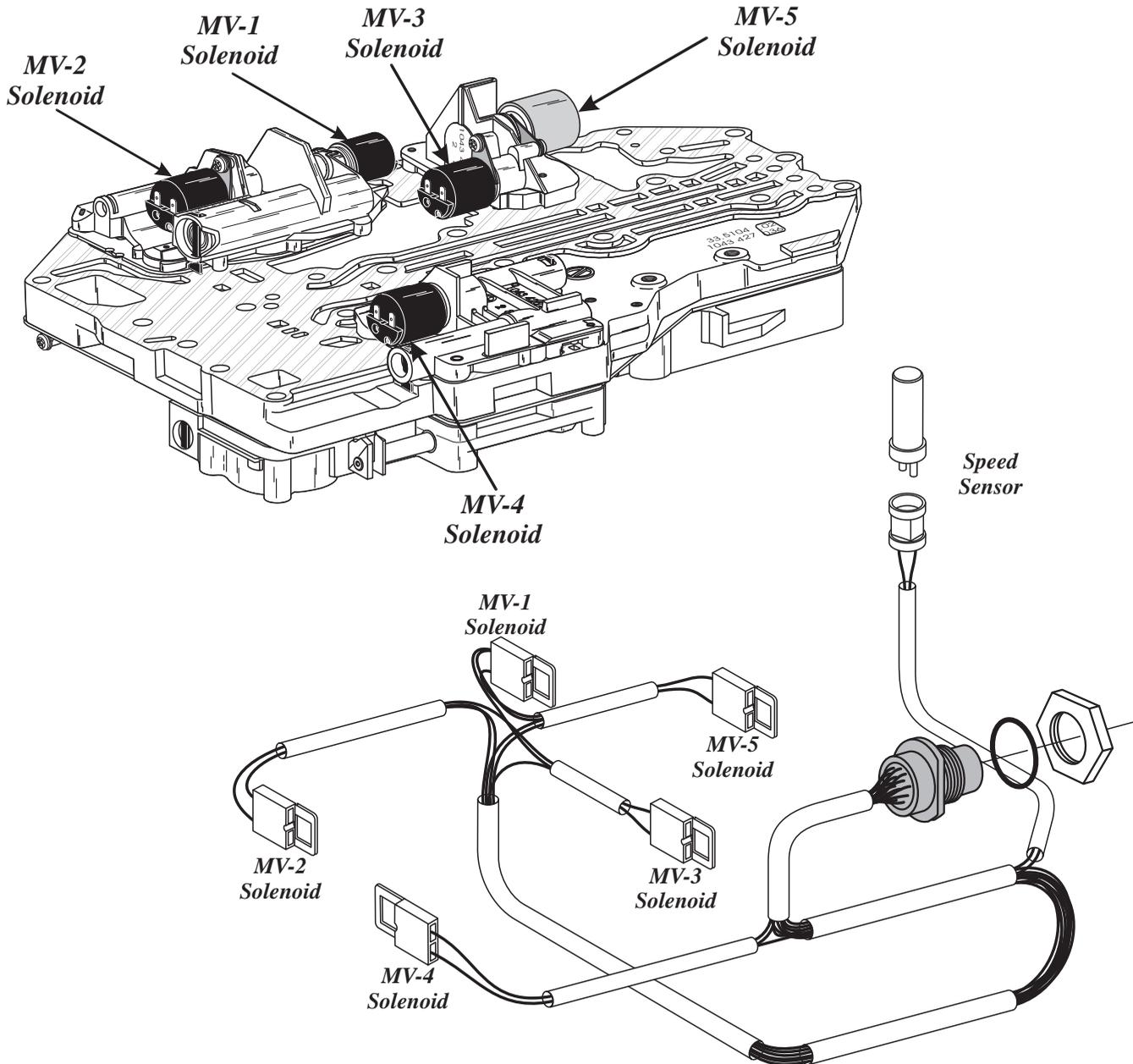


Figure 21

# TECHNICIANS DIAGNOSTIC GUIDE

## BMW, AUDI, PORSCHE

### ZF-4HP-22/24 MODEL "E-7", "5 SOLENOID" IDENTIFICATION, LOCATION AND FUNCTION



Solenoid	Function	Gear	MV-1	MV-2
MV-1	Shift Control	1st	ON	ON
MV-2	Shift Control	2nd	OFF	ON
		3rd	OFF	OFF
		4th	ON	OFF
MV-3	Lock-Up Control			
MV-4	Reverse Lockout			
MV-5	Line Pressure Control			

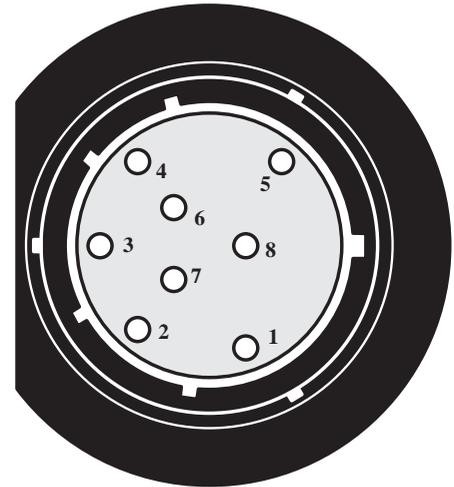
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Figure 22

## TECHNICIANS DIAGNOSTIC GUIDE BMW, AUDI, PORSCHE

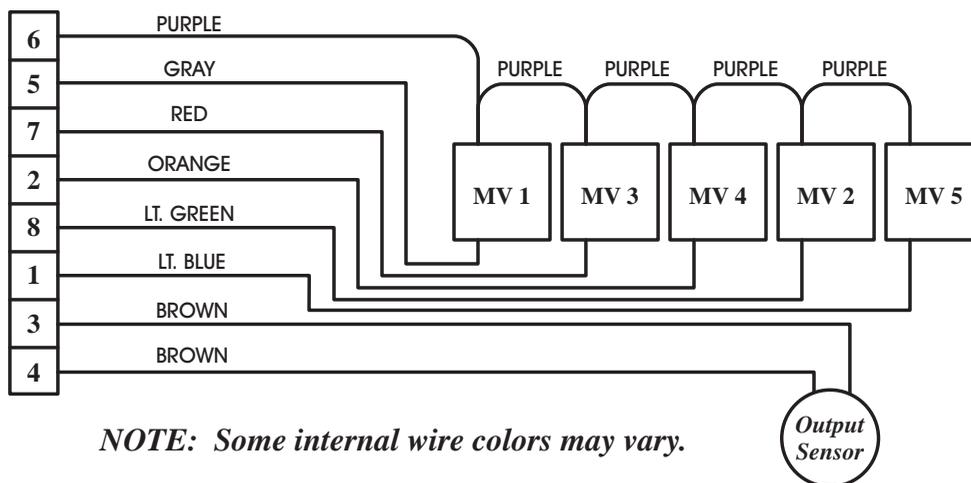
### ZF-4HP-22/24 MODEL "E-7", "5 SOLENOID" INTERNAL WIRE SCHEMATIC AND CONNECTOR TERMINAL IDENTIFICATION

*Note: The case connector on this unit is not numbered on connector for identification. ATSG has chosen the numbers you see so that you can use the chart below to do a resistance check on internal components.*



*View Looking Into  
Case Connector*

<i>COMPONENT</i>	<i>TERMINALS</i>	<i>RESISTANCE</i>	<i>PART NUMBER</i>
<i>MV 1 Solenoid</i>	<i>5 And 6</i>	<i>30 - 34 Ohms</i>	<i>0501 307 869</i>
<i>MV 2 Solenoid</i>	<i>8 And 6</i>	<i>30 - 34 Ohms</i>	<i>0501 307 869</i>
<i>MV 3 Solenoid</i>	<i>7 And 6</i>	<i>30 - 34 Ohms</i>	<i>0501 307 869</i>
<i>MV 4 Solenoid</i>	<i>2 And 6</i>	<i>30 - 34 Ohms</i>	<i>0501 307 869</i>
<i>MV 5 Solenoid</i>	<i>1 And 6</i>	<i>2.5 - 4.5 Ohms</i>	<i>0501 206 997</i>
<i>Output Speed Sensor</i>	<i>3 And 4</i>	<i>265 Ohms (72° F)</i>	<i>0501 311 086</i>

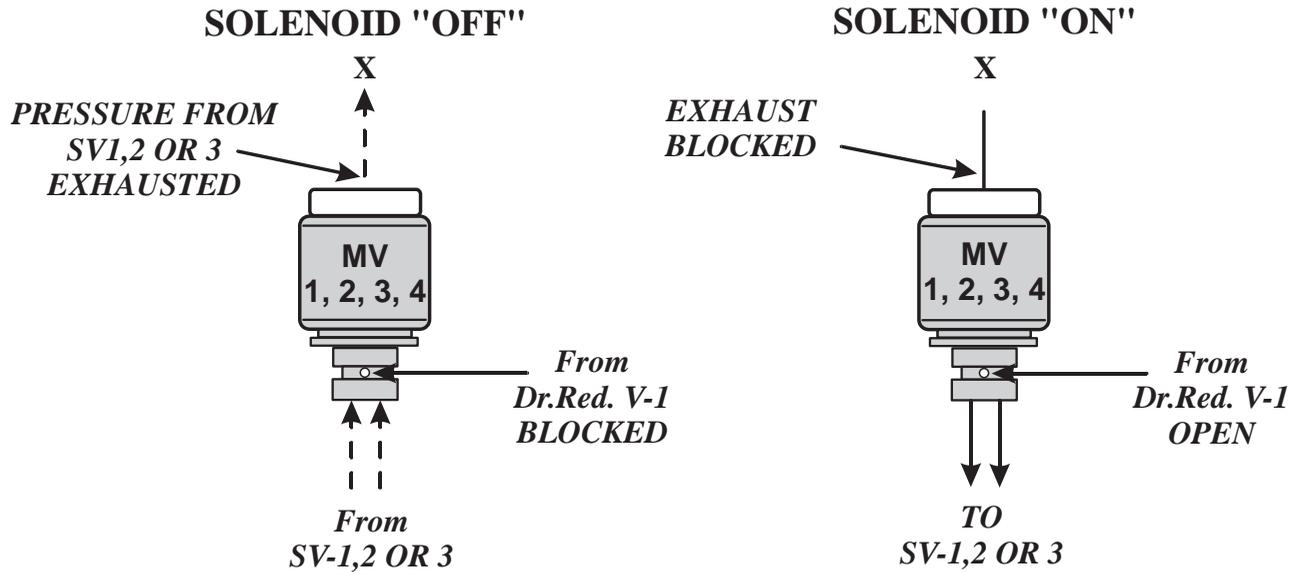


*NOTE: Some internal wire colors may vary.*

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Figure 23

### ZF-4HP-22 MODEL "E7", "5 SOLENOID" VALVE BODY, SOLENOID OPERATION MV1, 2, 3 AND 4 OPERATION

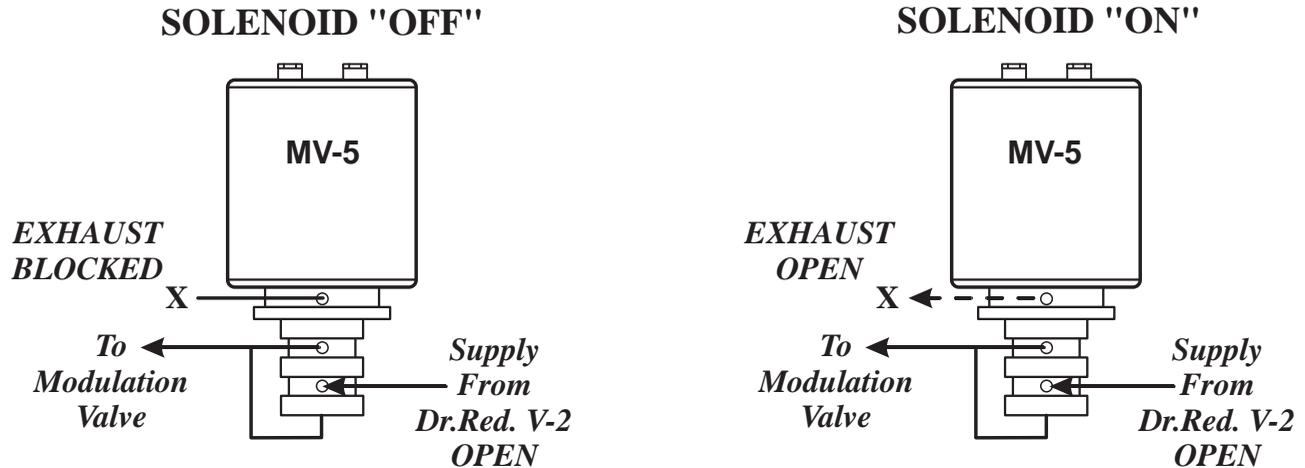


**SUMMARY:**

*When MV 1, 2, 3 or 4 is "OFF" Solenoid reducing pressure, from Dr.Red. V-1, is blocked by the solenoid and oil pressure from SV 1, 2 or 3 is exhausted at the rear of the solenoid.*

*When MV 1, 2, 3 or 4 is "ON" Solenoid reducing pressure, From Dr.Red. V-1, is open through the solenoid and is applied to SV 1, 2 or 3. The exhaust at the rear of the solenoid is closed.*

### MV-5 OPERATION (Line Pressure Solenoid)



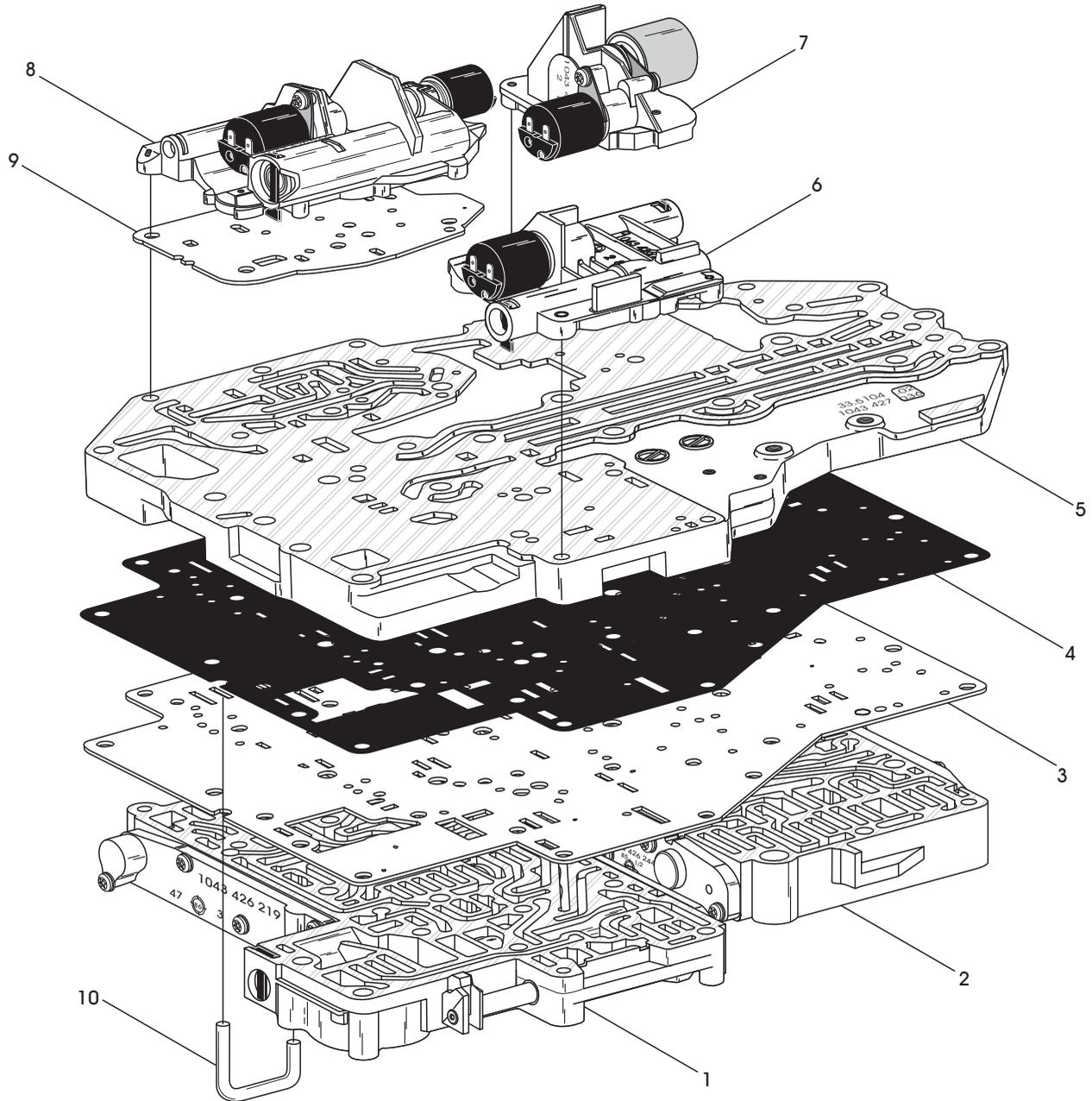
**SUMMARY:**

*When MV-5 solenoid is "OFF," solenoid reducing pressure, from Dr. Red. V-2, is high to MOD-V valve which creates high line pressure.*

*When MV-5 solenoid is "ON," solenoid reducing pressure, from Dr. Red. V-2, is low to MOD-V valve which creates low line pressure.*

Figure 24

**ZF-4HP-22/24 MODEL "E-7", "5 SOLENOID"  
 VALVE BODY ASSEMBLY**



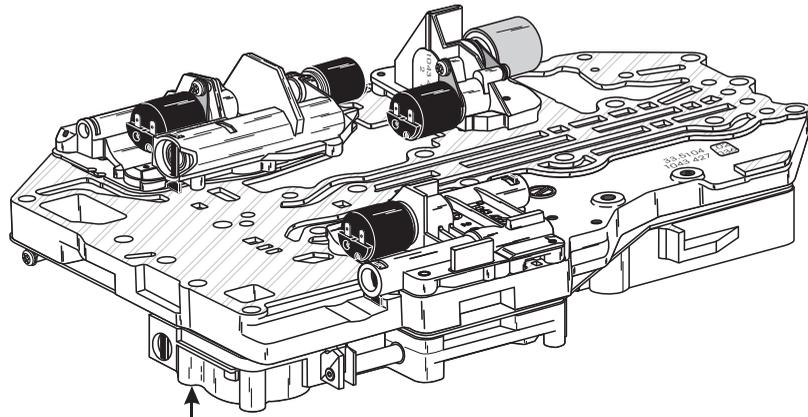
- 1 LOWER FRONT VALVE BODY ASSEMBLY
- 2 LOWER REAR VALVE BODY ASSEMBLY
- 3 VALVE BODY SPACER PLATE
- 4 SPACER PLATE TO CHANNEL PLATE GASKET
- 5 CHANNEL PLATE ASSEMBLY

- 6 MV-4 SOLENOID BODY ASSEMBLY
- 7 MV-3 AND MV-5 SOLENOID BODY ASSEMBLY
- 8 MV-1 AND MV-2 SOLENOID BODY ASSEMBLY
- 9 MV-1/MV-2 SOLENOID BODY TO CHANNEL PLATE SPACER PLATE
- 10 OIL PIPE, LOWER FRONT VALVE BODY TO CHANNEL PLATE

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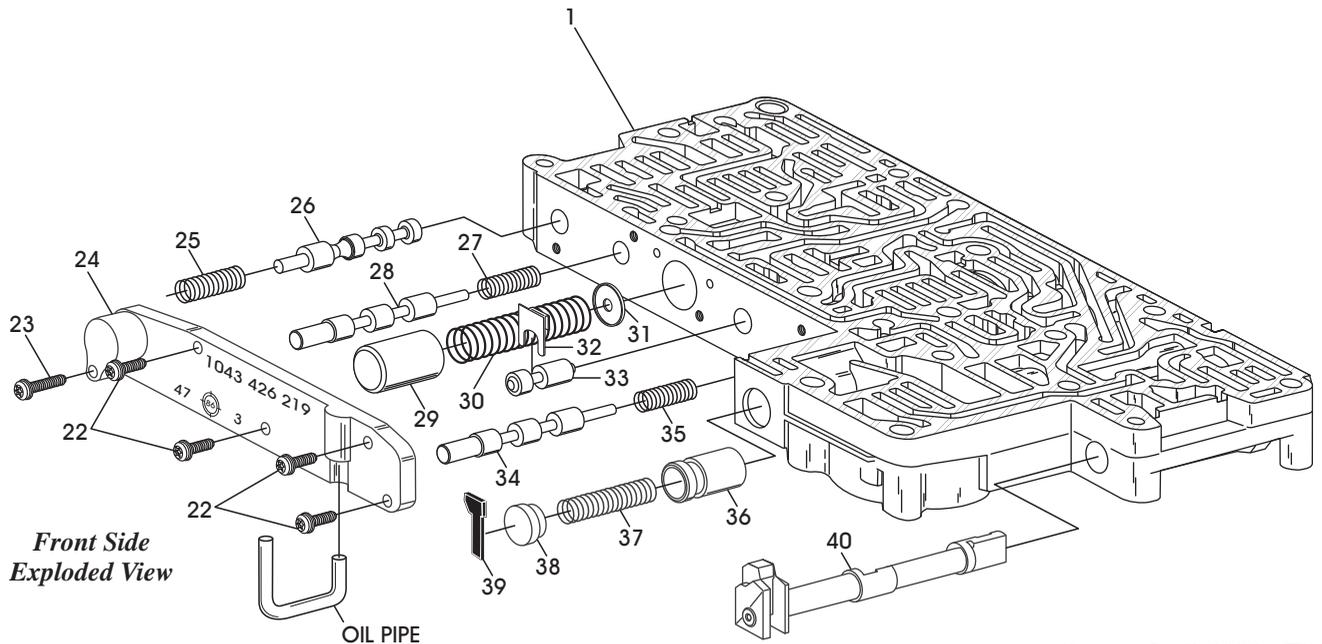
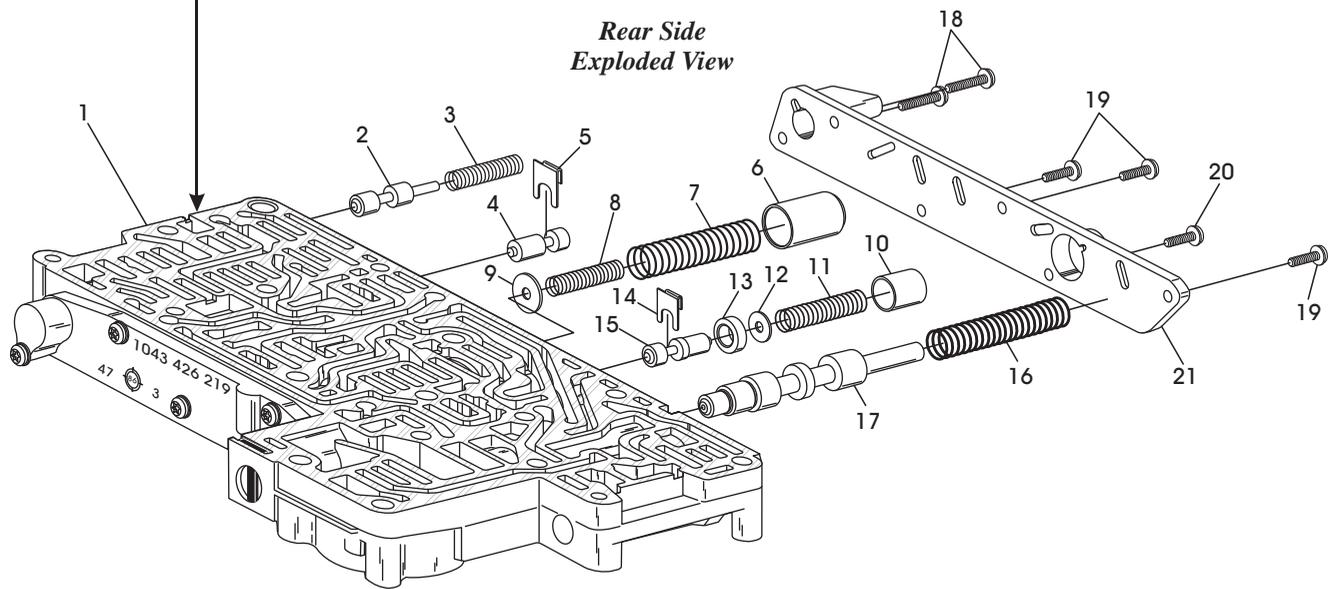
Figure 25

### ZF-4HP-22/24 MODEL "E-7", "5 SOLENOID" LOWER "FRONT" VALVE BODY



*Legend And Spring  
Specifications Found  
On Page 33.*

*Rear Side  
Exploded View*



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Figure 26

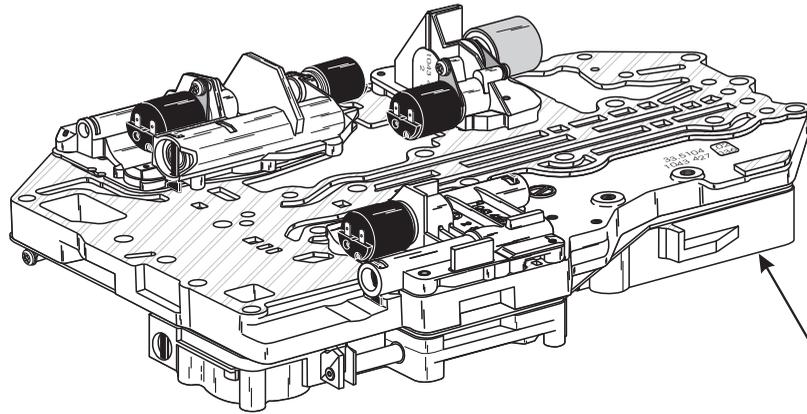
### FIGURE 26 LEGEND AND SPRING SPECIFICATIONS

<ul style="list-style-type: none"> <li>1 LOWER FRONT VALVE BODY CASTING</li> <li>2 "C" CLUTCH VALVE</li> <li>3 "C" CLUTCH VALVE SPRING</li> <li>4 "C" CLUTCH VALVE</li> <li>5 "C" CLUTCH VALVE RETAINER</li> <li>6 "B" CLUTCH DAMPER PISTON</li> <li>7 "B" CLUTCH DAMPER PISTON OUTER SPRING</li> <li>8 "B" CLUTCH DAMPER PISTON INNER SPRING</li> <li>9 "B" CLUTCH DAMPER PISTON SPRING SEAT</li> <li>10 "D" CLUTCH DAMPER PISTON</li> <li>11 "D" CLUTCH DAMPER PISTON SPRING</li> <li>12 "D" CLUTCH DAMPER PISTON SPRING SEAT</li> <li>13 "D" CLUTCH VALVE SLEEVE</li> <li>14 "D" CLUTCH VALVE RETAINER</li> <li>15 "D" CLUTCH VALVE</li> <li>16 PRESSURE REGULATOR VALVE SPRING</li> <li>17 PRESSURE REGULATOR VALVE</li> <li>18 REAR SIDE COVER RETAINING BOLT, 34 mm LENGTH (2)</li> <li>19 REAR SIDE COVER RETAINING BOLT, 17 mm LENGTH (3)</li> <li>20 REAR SIDE COVER RETAINING BOLT, 21 mm LENGTH (1)</li> <li>21 REAR SIDE COVER</li> <li>22 FRONT SIDE COVER RETAINING BOLT, 17 mm LENGTH (4)</li> <li>23 FRONT SIDE COVER RETAINING BOLT, 29 mm LENGTH (1)</li> <li>24 FRONT SIDE COVER</li> <li>25 TORQUE CONVERTER LOCK-UP VALVE SPRING</li> <li>26 TORQUE CONVERTER LOCK-UP VALVE</li> <li>27 2-3 SHIFT VALVE SPRING</li> <li>28 2-3 SHIFT VALVE</li> <li>29 "C" CLUTCH DAMPER PISTON</li> <li>30 "C" CLUTCH DAMPER PISTON SPRING</li> <li>31 "C" CLUTCH DAMPER PISTON SPRING SEAT</li> <li>32 "B" CLUTCH REGULATOR VALVE RETAINER</li> <li>33 "B" CLUTCH REGULATOR VALVE</li> <li>34 1-2 SHIFT VALVE</li> <li>35 1-2 SHIFT VALVE SPRING</li> </ul>	<ul style="list-style-type: none"> <li>36 "A" CLUTCH DAMPER PISTON</li> <li>37 "A" CLUTCH DAMPER SPRING</li> <li>38 "A" CLUTCH DAMPER PISTON SPRING SEAT</li> <li>39 "A" CLUTCH DAMPER SPRING SEAT RETAINER</li> <li>40 MANUAL SHIFT VALVE</li> </ul> <table border="0" style="width: 100%;"> <tr> <td style="width: 50%;"> <p>SPRING ILLUSTRATION NO. 3:            FREE LENGTH = 1.495"            SPRING DIAMETER = .360"            WIRE DIAMETER = .035"</p> </td> <td style="width: 50%;"> <p>SPRING ILLUSTRATION NO. 25:            FREE LENGTH = 1.830"            SPRING DIAMETER = .435"            WIRE DIAMETER = .040"</p> </td> </tr> <tr> <td> <p>SPRING ILLUSTRATION NO. 7:            FREE LENGTH = 3.160"            SPRING DIAMETER = .595"            WIRE DIAMETER = .044"</p> </td> <td> <p>SPRING ILLUSTRATION NO. 27:            FREE LENGTH = 1.660"            SPRING DIAMETER = .360"            WIRE DIAMETER = .036"</p> </td> </tr> <tr> <td> <p>SPRING ILLUSTRATION NO. 8:            FREE LENGTH = 1.560"            SPRING DIAMETER = .430"            WIRE DIAMETER = .040"</p> </td> <td> <p>SPRING ILLUSTRATION NO. 30:            FREE LENGTH = 3.160"            SPRING DIAMETER = .595"            WIRE DIAMETER = .044"</p> </td> </tr> <tr> <td> <p>SPRING ILLUSTRATION NO. 11:            FREE LENGTH = 1.653"            SPRING DIAMETER = .550"            WIRE DIAMETER = .044"</p> </td> <td> <p>SPRING ILLUSTRATION NO. 35:            FREE LENGTH = 1.660"            SPRING DIAMETER = .360"            WIRE DIAMETER = .036"</p> </td> </tr> <tr> <td> <p>SPRING ILLUSTRATION NO. 16:            FREE LENGTH = 3.575"            SPRING DIAMETER = .600"            WIRE DIAMETER = .080"</p> </td> <td> <p>SPRING ILLUSTRATION NO. 37:            FREE LENGTH = 2.515"            SPRING DIAMETER = .410"            WIRE DIAMETER = .050"</p> </td> </tr> </table>	<p>SPRING ILLUSTRATION NO. 3:            FREE LENGTH = 1.495"            SPRING DIAMETER = .360"            WIRE DIAMETER = .035"</p>	<p>SPRING ILLUSTRATION NO. 25:            FREE LENGTH = 1.830"            SPRING DIAMETER = .435"            WIRE DIAMETER = .040"</p>	<p>SPRING ILLUSTRATION NO. 7:            FREE LENGTH = 3.160"            SPRING DIAMETER = .595"            WIRE DIAMETER = .044"</p>	<p>SPRING ILLUSTRATION NO. 27:            FREE LENGTH = 1.660"            SPRING DIAMETER = .360"            WIRE DIAMETER = .036"</p>	<p>SPRING ILLUSTRATION NO. 8:            FREE LENGTH = 1.560"            SPRING DIAMETER = .430"            WIRE DIAMETER = .040"</p>	<p>SPRING ILLUSTRATION NO. 30:            FREE LENGTH = 3.160"            SPRING DIAMETER = .595"            WIRE DIAMETER = .044"</p>	<p>SPRING ILLUSTRATION NO. 11:            FREE LENGTH = 1.653"            SPRING DIAMETER = .550"            WIRE DIAMETER = .044"</p>	<p>SPRING ILLUSTRATION NO. 35:            FREE LENGTH = 1.660"            SPRING DIAMETER = .360"            WIRE DIAMETER = .036"</p>	<p>SPRING ILLUSTRATION NO. 16:            FREE LENGTH = 3.575"            SPRING DIAMETER = .600"            WIRE DIAMETER = .080"</p>	<p>SPRING ILLUSTRATION NO. 37:            FREE LENGTH = 2.515"            SPRING DIAMETER = .410"            WIRE DIAMETER = .050"</p>
<p>SPRING ILLUSTRATION NO. 3:            FREE LENGTH = 1.495"            SPRING DIAMETER = .360"            WIRE DIAMETER = .035"</p>	<p>SPRING ILLUSTRATION NO. 25:            FREE LENGTH = 1.830"            SPRING DIAMETER = .435"            WIRE DIAMETER = .040"</p>										
<p>SPRING ILLUSTRATION NO. 7:            FREE LENGTH = 3.160"            SPRING DIAMETER = .595"            WIRE DIAMETER = .044"</p>	<p>SPRING ILLUSTRATION NO. 27:            FREE LENGTH = 1.660"            SPRING DIAMETER = .360"            WIRE DIAMETER = .036"</p>										
<p>SPRING ILLUSTRATION NO. 8:            FREE LENGTH = 1.560"            SPRING DIAMETER = .430"            WIRE DIAMETER = .040"</p>	<p>SPRING ILLUSTRATION NO. 30:            FREE LENGTH = 3.160"            SPRING DIAMETER = .595"            WIRE DIAMETER = .044"</p>										
<p>SPRING ILLUSTRATION NO. 11:            FREE LENGTH = 1.653"            SPRING DIAMETER = .550"            WIRE DIAMETER = .044"</p>	<p>SPRING ILLUSTRATION NO. 35:            FREE LENGTH = 1.660"            SPRING DIAMETER = .360"            WIRE DIAMETER = .036"</p>										
<p>SPRING ILLUSTRATION NO. 16:            FREE LENGTH = 3.575"            SPRING DIAMETER = .600"            WIRE DIAMETER = .080"</p>	<p>SPRING ILLUSTRATION NO. 37:            FREE LENGTH = 2.515"            SPRING DIAMETER = .410"            WIRE DIAMETER = .050"</p>										

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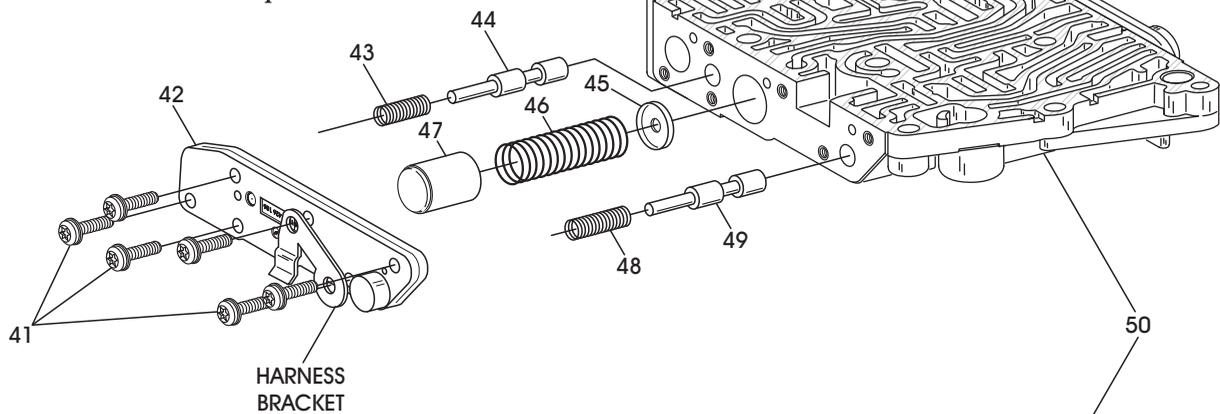
Figure 26 Legend

**ZF-4HP-22/24 MODEL "E-7", "5 SOLENOID"  
 LOWER "REAR" VALVE BODY**

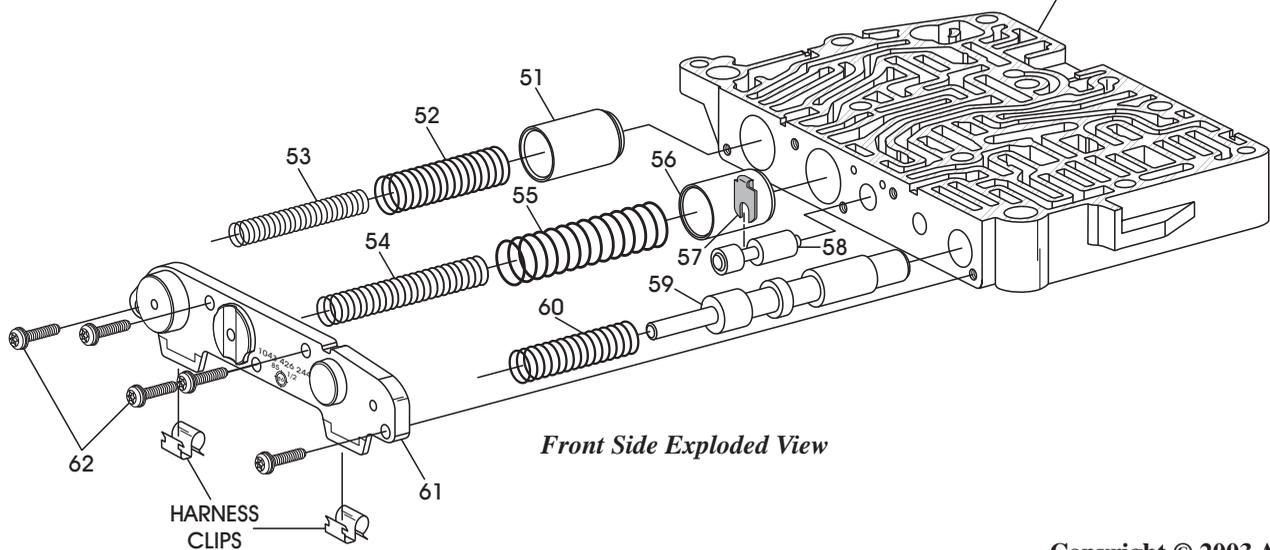


*Legend And Spring  
 Specifications Found  
 On Page 35.*

*Rear Side Exploded View*



*Front Side Exploded View*



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Figure 27



# TECHNICIANS DIAGNOSTIC GUIDE

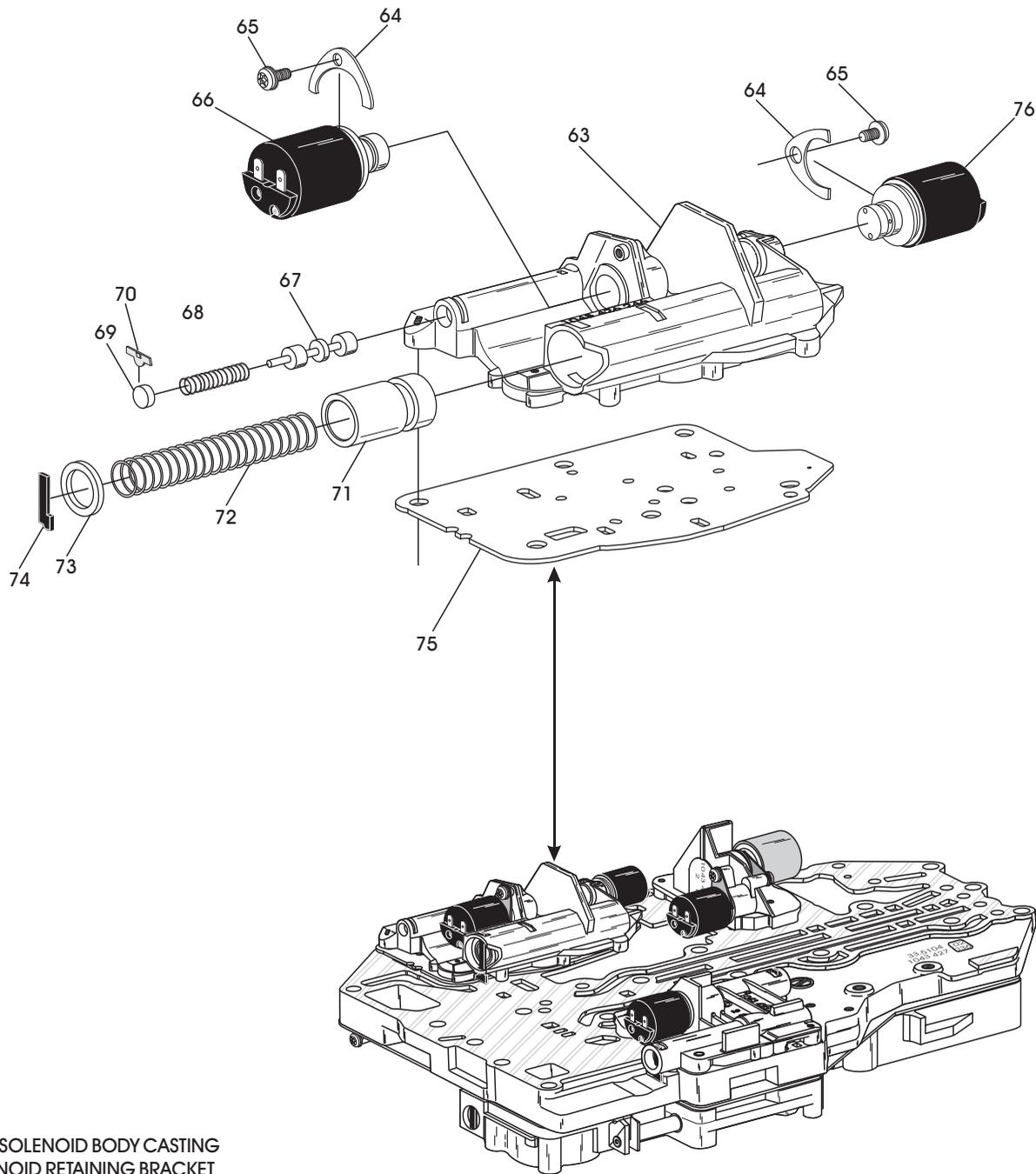
## BMW, AUDI, PORSCHE

### FIGURE 27 LEGEND AND SPRING SPECIFICATIONS

41 REAR SIDE COVER RETAINING BOLTS, 17 mm LENGTH (6)	SPRING ILLUSTRATION NO. 43: FREE LENGTH = 1.365" SPRING DIAMETER = .355" WIRE DIAMETER = .044"	SPRING ILLUSTRATION NO. 53: FREE LENGTH = 3.511" SPRING DIAMETER = .405" WIRE DIAMETER = .049"
42 REAR SIDE COVER		
43 PRESSURE REDUCING VALVE "2" SPRING		
44 PRESSURE REDUCING VALVE "2"		
45 "F" CLUTCH DAMPER PISTON SPRING SEAT		
46 "F" CLUTCH DAMPER PISTON SPRING	SPRING ILLUSTRATION NO. 46: FREE LENGTH = 3.290" SPRING DIAMETER = .600" WIRE DIAMETER = .043"	SPRING ILLUSTRATION NO. 54: FREE LENGTH = 4.556" SPRING DIAMETER = .510" WIRE DIAMETER = .037"
47 "F" CLUTCH DAMPER PISTON		
48 PRESSURE REDUCING VALVE "1" SPRING		
49 PRESSURE REDUCING VALVE "1"		
50 LOWER REAR VALVE BODY CASTING		
51 "C" CLUTCH DAMPER PISTON	SPRING ILLUSTRATION NO. 48: FREE LENGTH = 1.535" SPRING DIAMETER = .365" WIRE DIAMETER = .044"	SPRING ILLUSTRATION NO. 55: FREE LENGTH = 3.330" SPRING DIAMETER = .685" WIRE DIAMETER = .070"
52 "C" CLUTCH DAMPER PISTON OUTER SPRING		
53 "C" CLUTCH DAMPER PISTON INNER SPRING		
54 "E" CLUTCH DAMPER PISTON INNER SPRING		
55 "E" CLUTCH DAMPER PISTON OUTER SPRING		
56 "E" CLUTCH DAMPER PISTON	SPRING ILLUSTRATION NO. 52: FREE LENGTH = 2.945" SPRING DIAMETER = .600" WIRE DIAMETER = .066"	SPRING ILLUSTRATION NO. 60: FREE LENGTH = 2.445" SPRING DIAMETER = .472" WIRE DIAMETER = .040"
57 "F" CLUTCH VALVE RETAINER		
58 "F" CLUTCH VALVE		
59 3-4 SHIFT VALVE		
60 3-4 SHIFT VALVE SPRING		
61 FRONT SIDE COVER		
62 FRONT SIDE COVER RETAINING BOLTS, 17 mm LENGTH (5)		

Figure 27 Legend

### ZF-4HP-22/24 MODEL "E-7", "5 SOLENOID" SHIFT SOLENOID BODY



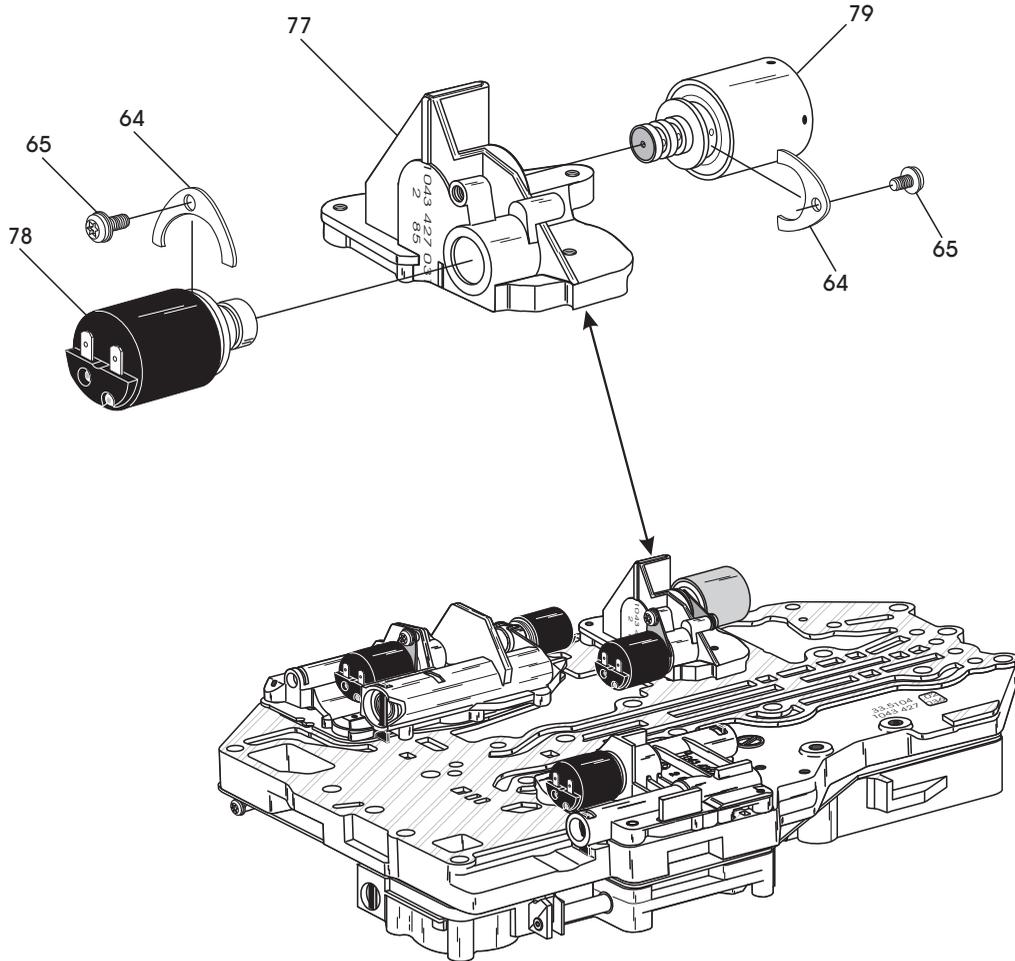
- 63 SHIFT SOLENOID BODY CASTING
- 64 SOLENOID RETAINING BRACKET
- 65 SOLENOID RETAINING BOLT, 11 mm LENGTH
- 66 MV-2 SHIFT SOLENOID ASSEMBLY
- 67 1-2 AND 3-4 SHIFT CONTROL VALVE
- 68 1-2 AND 3-4 SHIFT CONTROL VALVE SPRING
- 69 1-2 AND 3-4 SHIFT CONTROL VALVE BORE PLUG
- 70 1-2 AND 3-4 SHIFT CONTROL BORE PLUG RETAINER
- 71 T.C.C. LOCK-UP DAMPER PISTON
- 72 T.C.C. LOCK-UP DAMPER PISTON SPRING
- 73 T.C.C. LOCK-UP DAMPER PISTON SPRING SEAT
- 74 T.C.C. LOCK-UP DAMPER PISTON SPRING SEAT RETAINER
- 75 SOLENOID BODY TO CHANNEL PLATE SPACER PLATE
- 76 MV-1 SHIFT SOLENOID ASSEMBLY

SPRING ILLUSTRATION NO. 68:  
 FREE LENGTH = 1.542"  
 SPRING DIAMETER = .372"  
 WIRE DIAMETER = .035"

SPRING ILLUSTRATION NO. 72:  
 FREE LENGTH = 3.622"  
 SPRING DIAMETER = .422"  
 WIRE DIAMETER = .044"

Figure 28

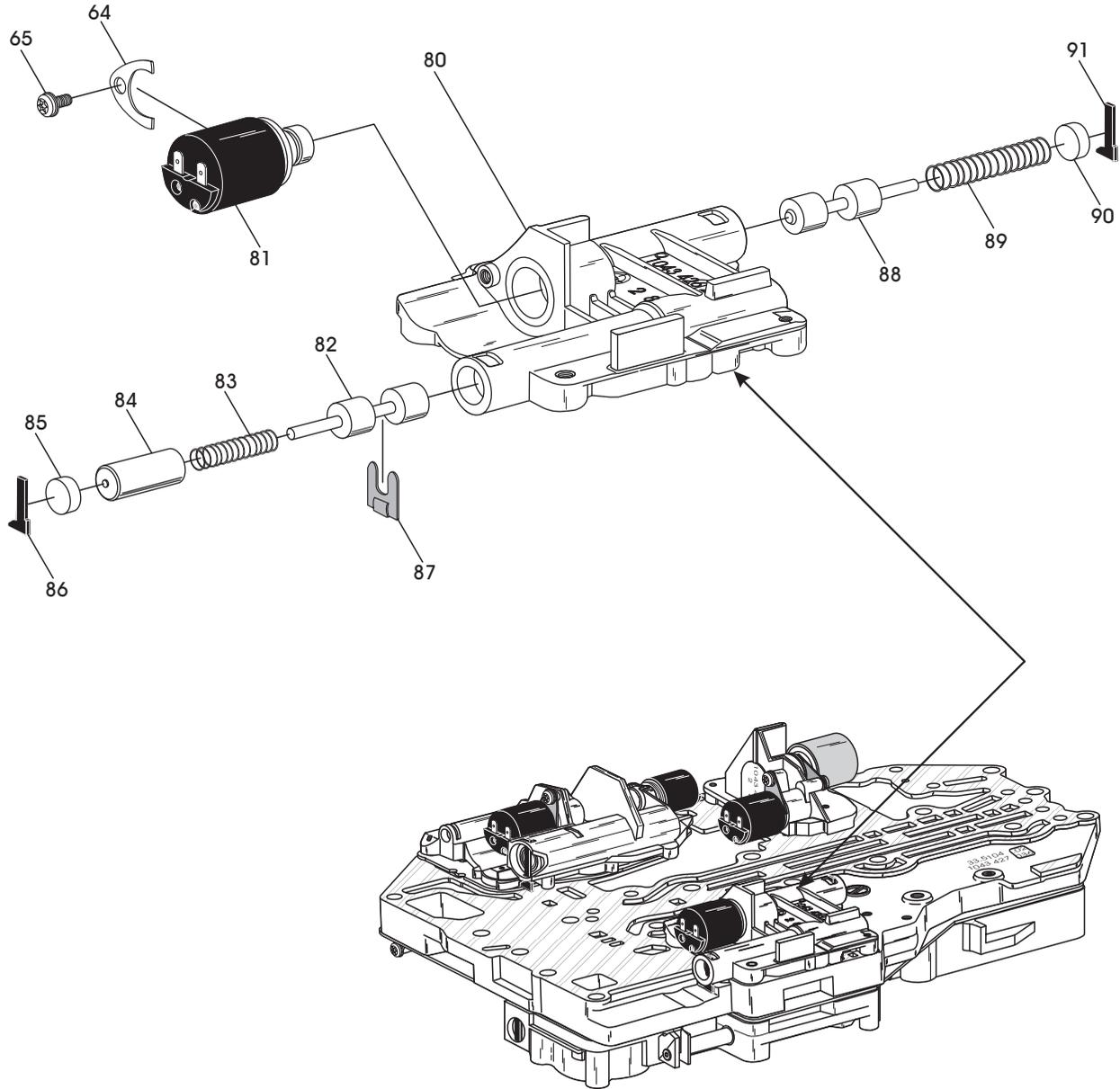
**ZF-4HP-22/24 MODEL "E-7", "5 SOLENOID"  
 PRESSURE CONTROL SOLENOID BODY**



- 64 SOLENOID RETAINING BRACKET
- 65 SOLENOID RETAINING BOLT, 11 mm LENGTH
- 77 PRESSURE CONTROL SOLENOID BODY CASTING
- 78 MV-3 LOCK-UP CONTROL SOLENOID ASSEMBLY
- 79 MV-5 PRESSURE CONTROL SOLENOID ASSEMBLY

Figure 29

**ZF-4HP-22/24 MODEL "E-7", "5 SOLENOID"  
 REVERSE LOCKOUT SOLENOID BODY**



- 64 SOLENOID RETAINING BRACKET
- 65 SOLENOID RETAINING BOLT, 11 mm LENGTH
- 80 REVERSE LOCKOUT SOLENOID BODY CASTING
- 81 MV-4 REVERSE LOCKOUT SOLENOID ASSEMBLY
- 82 MODULATION VALVE
- 83 MODULATION VALVE SPRING
- 84 MODULATION VALVE SLEEVE
- 85 MODULATION VALVE BORE PLUG
- 86 MODULATION VALVE BORE PLUG RETAINER
- 87 MODULATION VALVE RETAINER
- 88 REVERSE LOCKOUT VALVE
- 89 REVERSE LOCKOUT VALVE SPRING
- 90 REVERSE LOCKOUT VALVE SPRING SEAT
- 91 REVERSE LOCKOUT SPRING SEAT RETAINER

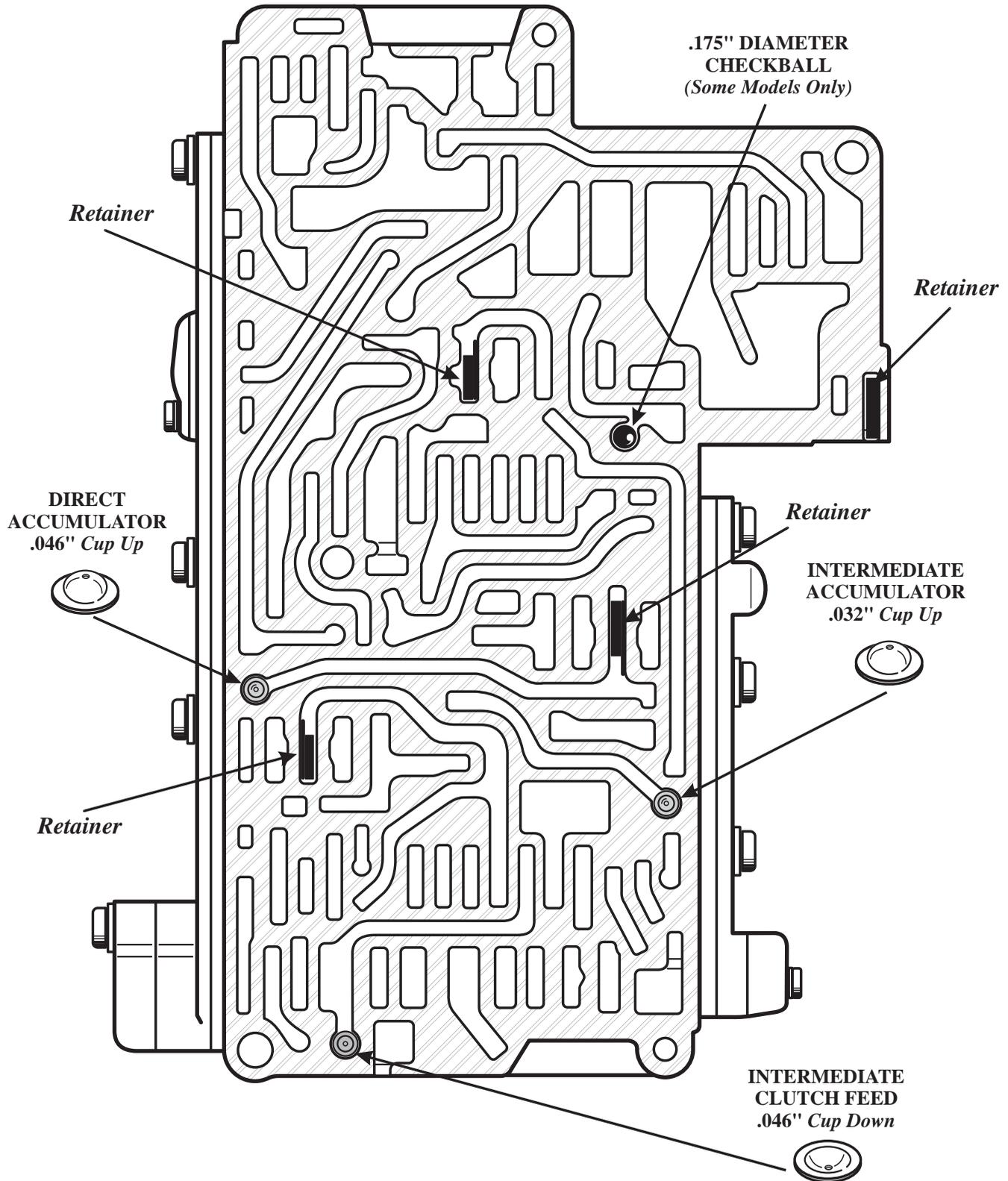
SPRING ILLUSTRATION NO. 83:  
 FREE LENGTH = 1.480"  
 SPRING DIAMETER = .310"  
 WIRE DIAMETER = .035"

SPRING ILLUSTRATION NO. 89:  
 FREE LENGTH = 1.870"  
 SPRING DIAMETER = .380"  
 WIRE DIAMETER = .035"

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Figure 30

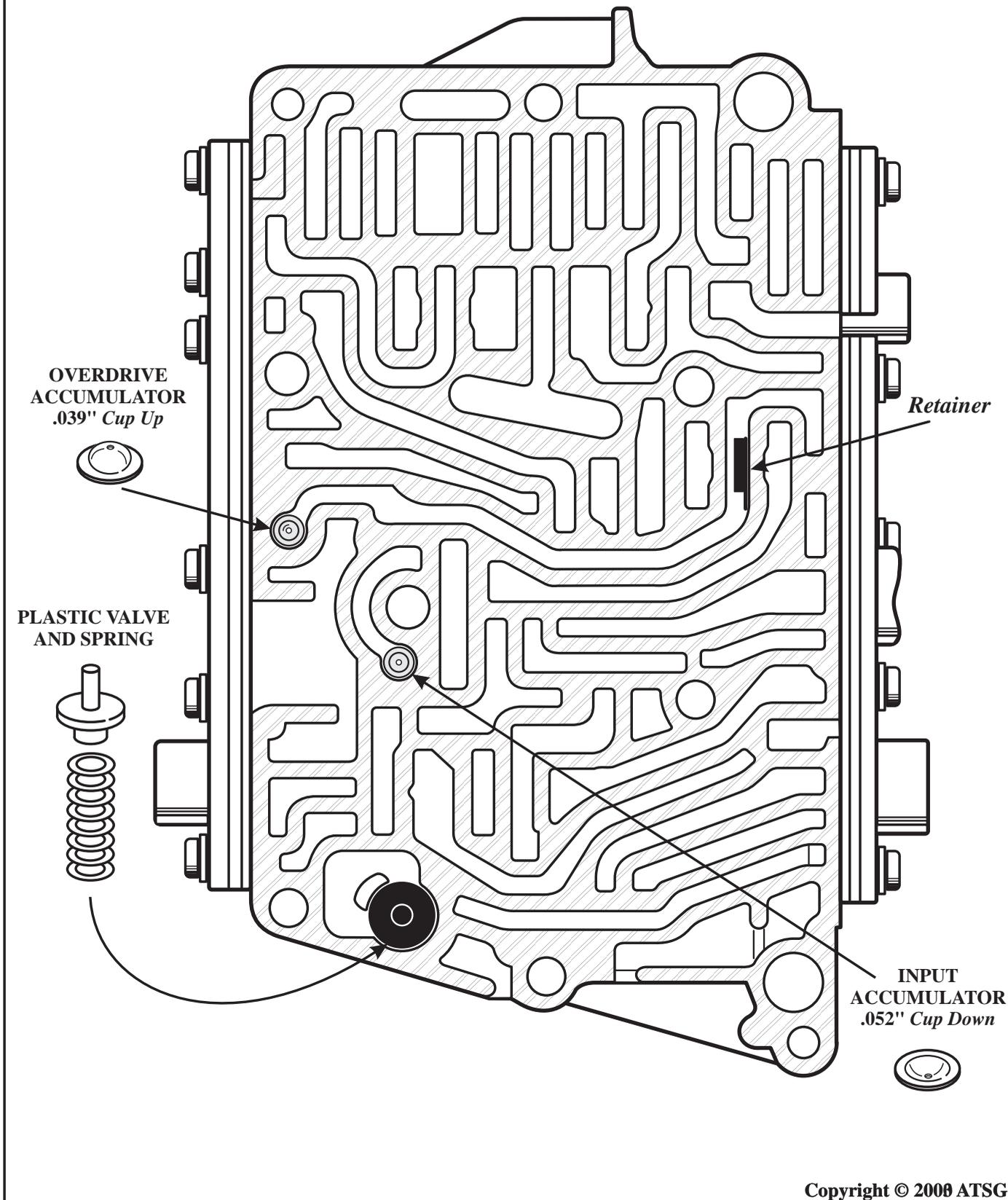
**ZF-4HP-22/24 MODEL "E-7", "5 SOLENOID"  
LOWER "FRONT" VALVE BODY**



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Figure 31

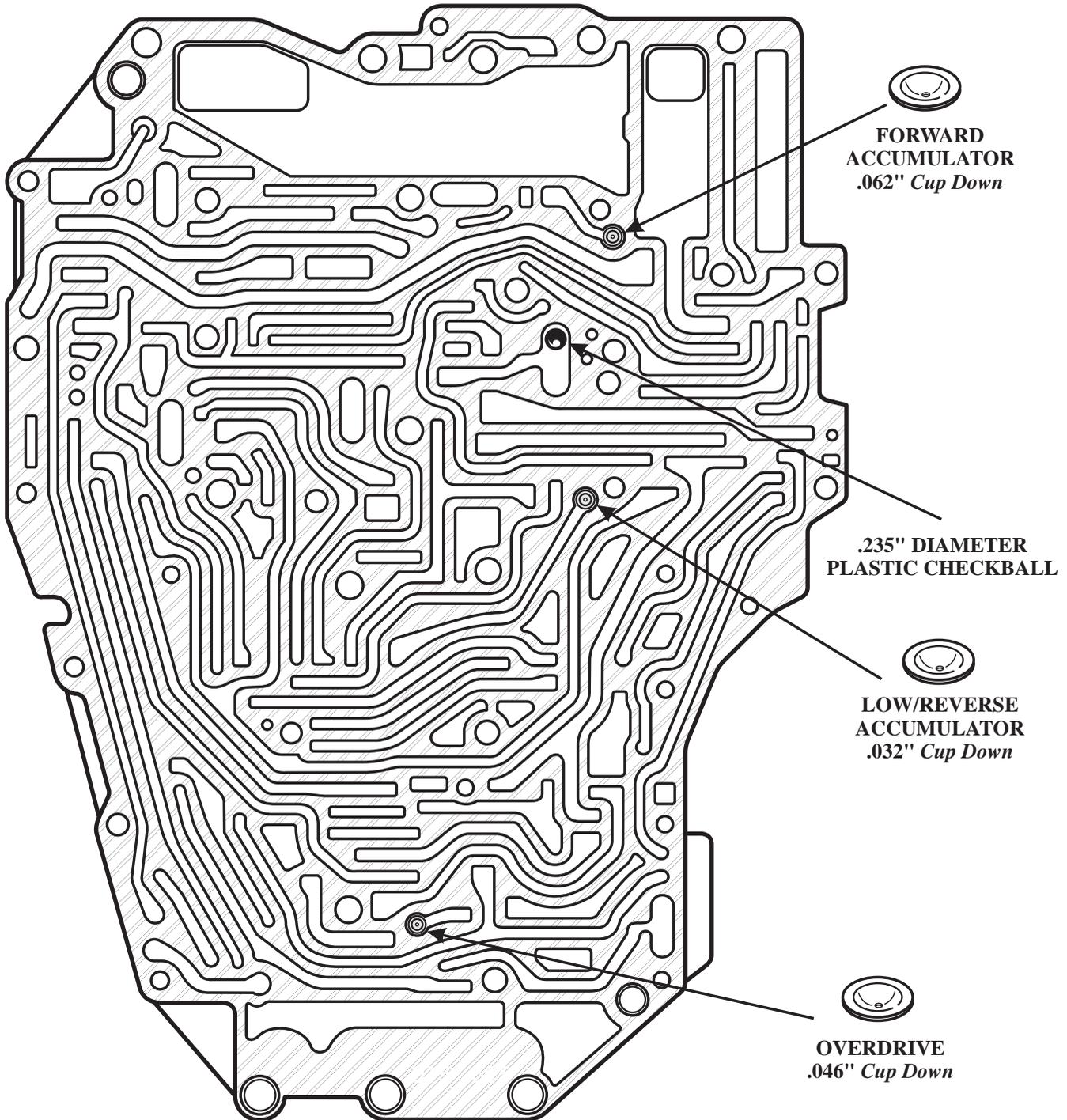
**ZF-4HP-22/24 MODEL "E-7", "5 SOLENOID"  
LOWER "REAR" VALVE BODY**



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Figure 32

**ZF-4HP-22/24 MODEL "E-7", "5 SOLENOID"  
CHANNEL PLATE**



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Figure 33

**ZF-4HP-22/24 MODEL "E-7", "5 SOLENOID"  
ALL SOLENOID BODIES**

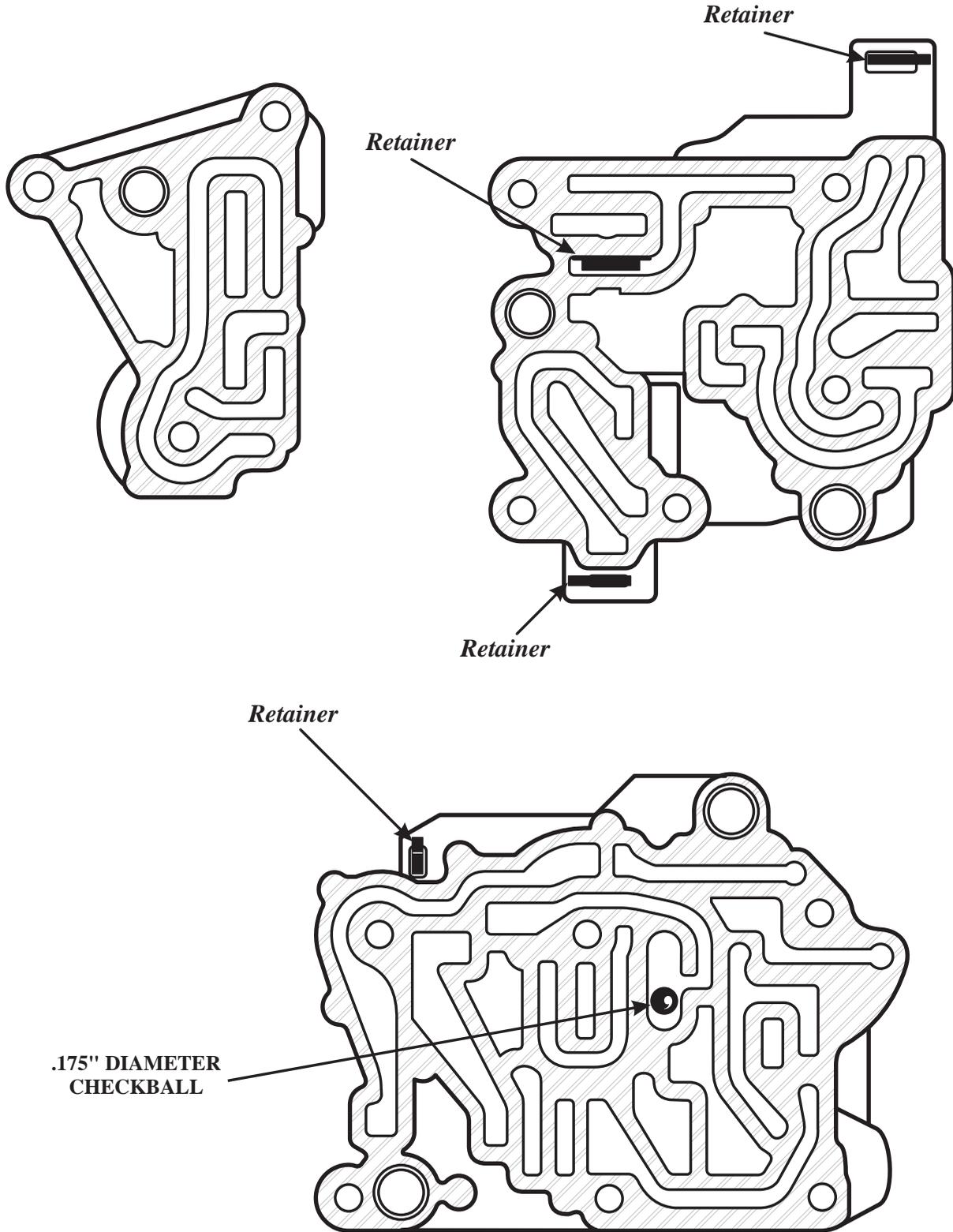


Figure 34

# TECHNICIANS DIAGNOSTIC GUIDE

## BMW, AUDI, PORSCHE

### ZF 4HP-22/24 SERIES DIAGNOSTIC INFORMATION

#### FOR MODEL "E9", "4 SOLENOID" VALVE BODY

*Refer to Figure 36 for identification, location and function of the 5 solenoids, along with the shift solenoid firing order for the "E9" 4 solenoid models.*

*Refer to Figure 37 for internal wire schematic and case connector terminal identification, along with a resistance chart to check the internal electronic components.*

*Refer to Figure 38 for individual solenoid operation.*

*Refer to Figure 39 for Complete Valve Body Assembly exploded view.*

*Refer to Figure 40 for Lower Front Valve Body exploded view, with valve identifications.*

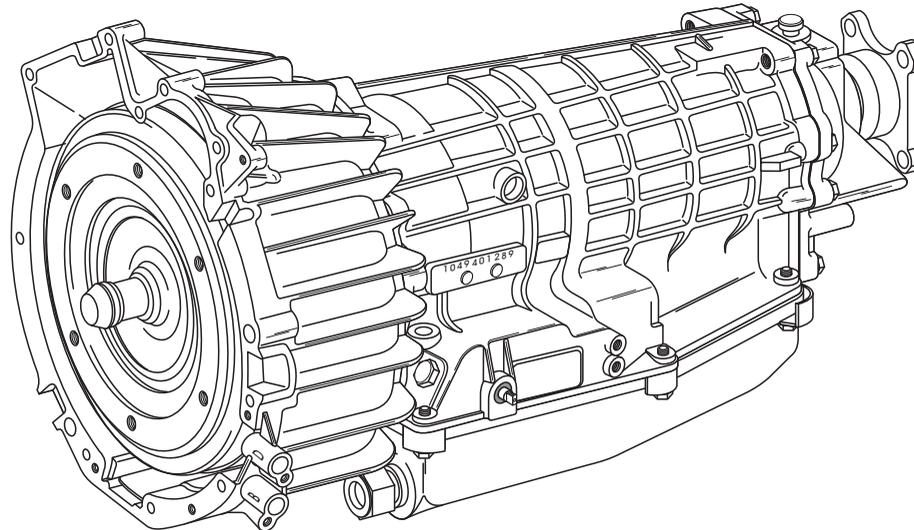
*Refer to Figure 41 for Lower Rear Valve Body exploded view, with valve identifications.*

*Refer to Figure 42 for MV-5 Solenoid Body exploded view, with valve identifications.*

*Refer to Figure 43 for MV-1 and MV-2 Solenoid Body exploded view, with valve identifications.*

*Refer to Figure 44 for MV-3 Lock-Up Solenoid Body exploded view, with identifications.*

*Refer to Figures 45, 46, 47 and 48 for retainer, checkball, and orifice locations.*



**MODEL YEAR USAGE CHART**

<i>Valve Body Models</i>	<i>Model Year</i>								
	86	87	88	89	90	91	92	93	94
<i>1st Version, Early "E-7", 5 Solenoid</i>									
<i>2nd Version, Late "E-7", 5 Solenoid</i>									
<i>3rd Version, "E-9", 4 Solenoid</i>									

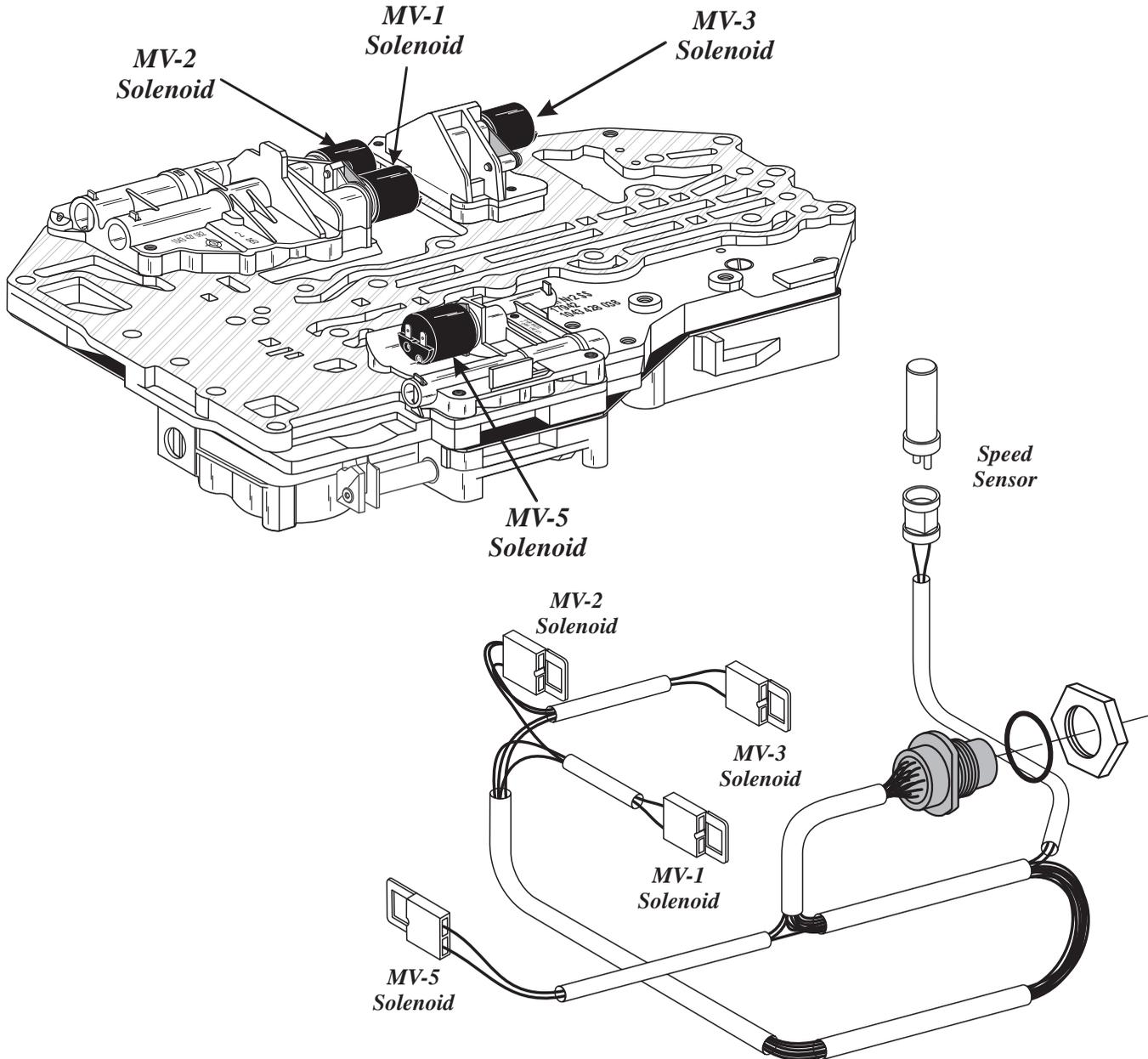
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Figure 35

# TECHNICIANS DIAGNOSTIC GUIDE

## BMW, AUDI, PORSCHE

### ZF-4HP-22/24 MODEL "E-9", "4 SOLENOID" IDENTIFICATION, LOCATION AND FUNCTION



Solenoid	Function	Gear	MV-1	MV-2
MV-1	Shift Control	1st	OFF	ON
MV-2	Shift Control	2nd	ON	ON
		3rd	ON	OFF
		4th	OFF	OFF
		Rev 0 mph	ON	OFF
		Rev Above 3 mph	OFF	ON
MV-3	Lock-Up Control			
MV-5	Line Pressure Control			

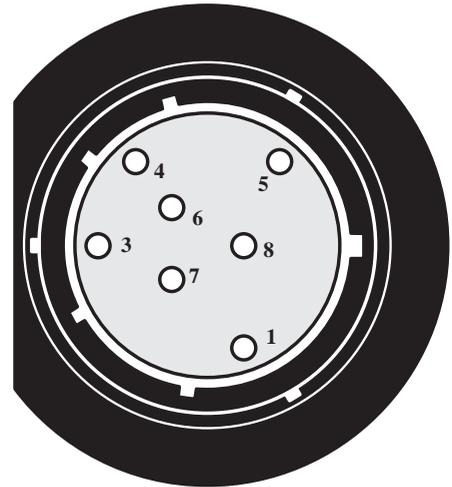
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Figure 36

## TECHNICIANS DIAGNOSTIC GUIDE BMW, AUDI, PORSCHE

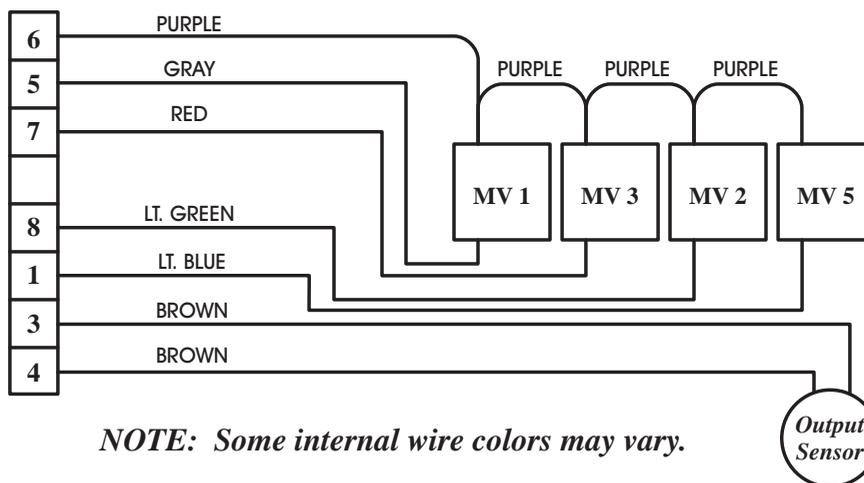
### ZF-4HP-22/24 MODEL "E-9", "4 SOLENOID" INTERNAL WIRE SCHEMATIC AND CONNECTOR TERMINAL IDENTIFICATION

*Note: The case connector on this unit is not numbered on connector for identification. ATSG has chosen the numbers you see so that you can use the chart below to do a resistance check on internal components.*



*View Looking Into  
Case Connector*

<i>COMPONENT</i>	<i>TERMINALS</i>	<i>RESISTANCE</i>	<i>PART NUMBER</i>
<i>MV 1 Solenoid</i>	<i>5 And 6</i>	<i>30 - 34 Ohms</i>	<i>0501 310 967</i>
<i>MV 2 Solenoid</i>	<i>8 And 6</i>	<i>30 - 34 Ohms</i>	<i>0501 310 967</i>
<i>MV 3 Solenoid</i>	<i>7 And 6</i>	<i>30 - 34 Ohms</i>	<i>0501 310 967</i>
<i>MV 5 Solenoid</i>	<i>1 And 6</i>	<i>4.5 - 6.5 Ohms</i>	<i>0501 311 500</i>
<i>Output Speed Sensor</i>	<i>3 And 4</i>	<i>265 Ohms (72° F)</i>	<i>0501 311 086</i>



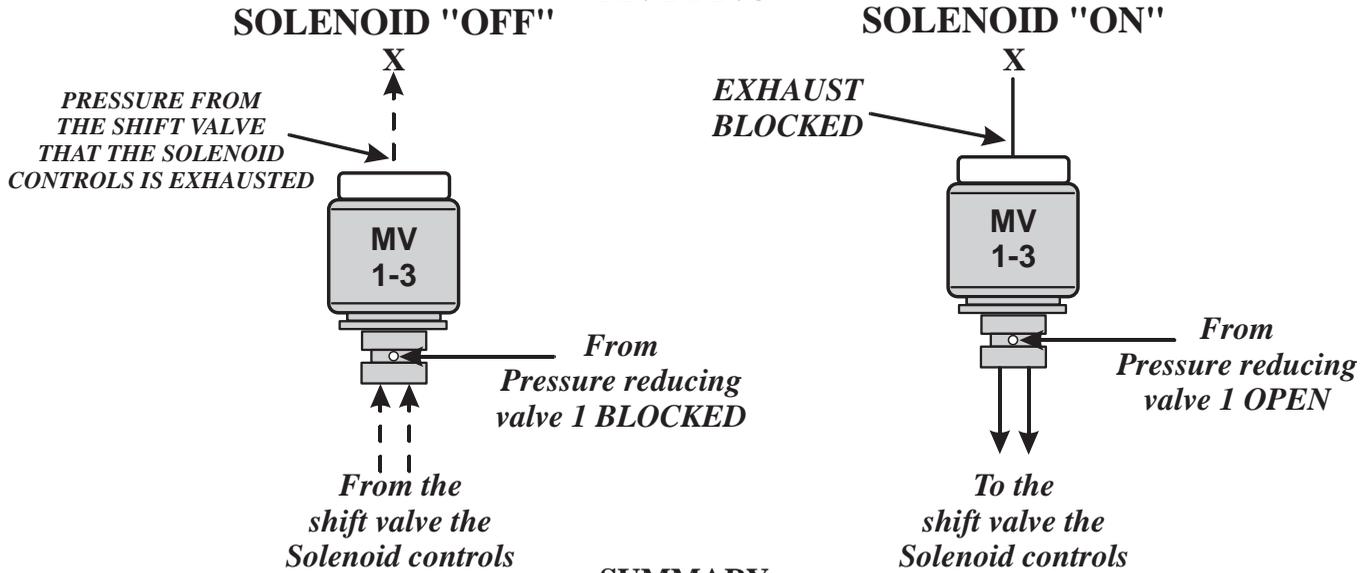
*NOTE: Some internal wire colors may vary.*

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Figure 37

### ZF-4HP-22/24 MODEL "E-9", "4 SOLENOID" VALVE BODY, SOLENOID OPERATION

#### MV1-MV3



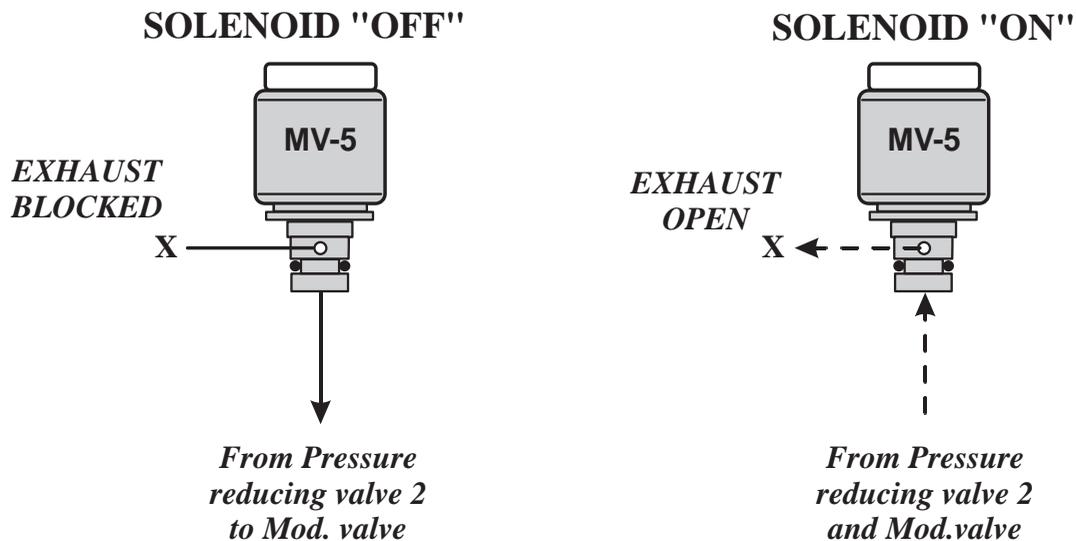
#### SUMMARY:

When MV 1 thru 3 is in the "OFF" state, Solenoid reducing pressure, from Pressure reducing valve 1, is blocked by the solenoid and oil pressure from the valve that the solenoid controls is exhausted at the rear of the solenoid.

When MV 1 thru 3 is in the "ON" state, Solenoid reducing pressure, from Pressure reducing valve 1, is open through the solenoid and is applied to the valve that the solenoid controls. The exhaust at the rear of the solenoid is closed.

#### MV-5

(Line Pressure Solenoid)



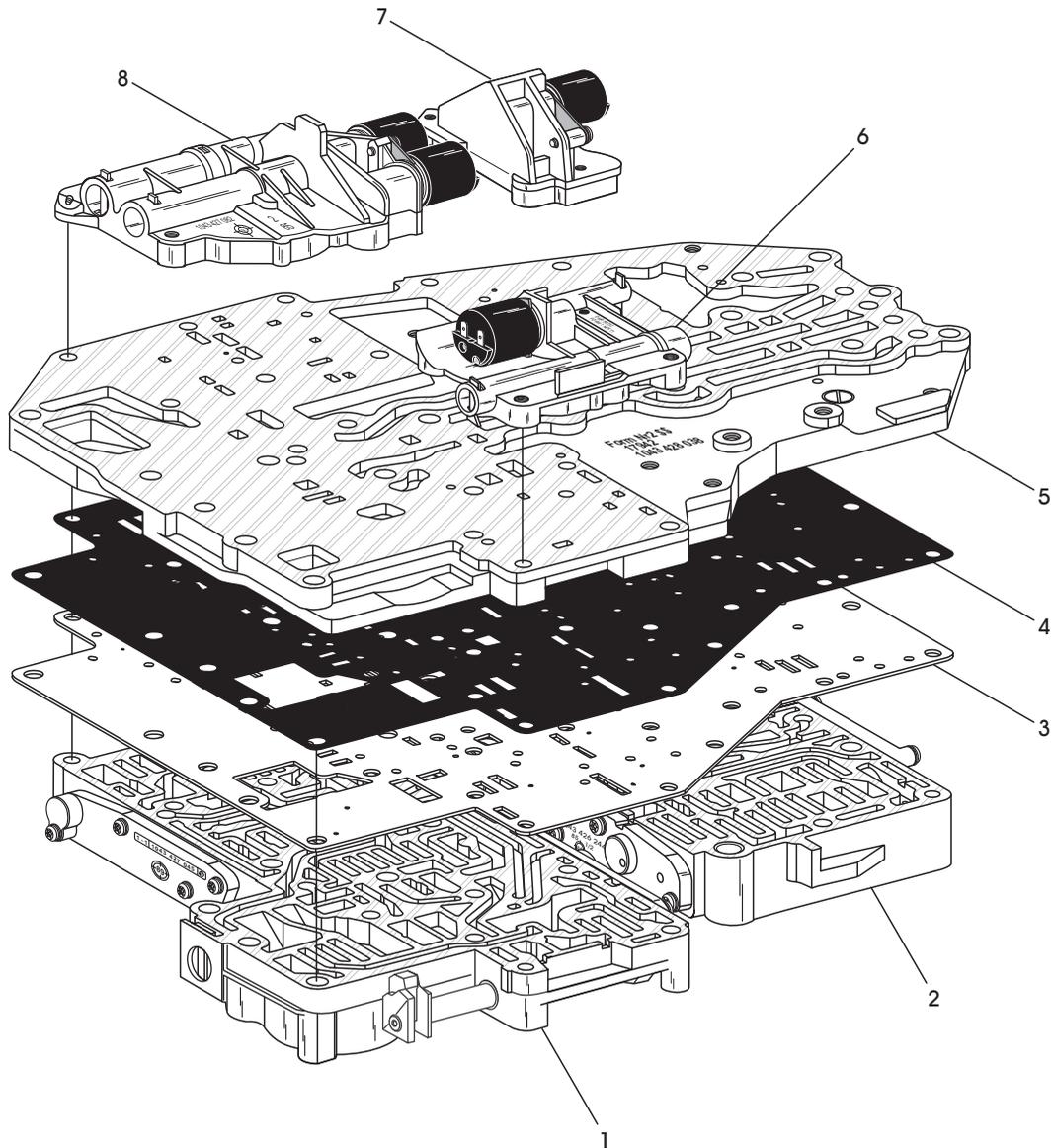
#### SUMMARY:

When MV-5 solenoid is "OFF," solenoid reducing pressure, from Pressure reducing valve 2, is high to the Modulating valve which creates high line pressure.

When MV-5 solenoid is "ON," solenoid reducing pressure, from Pressure reducing valve 2, is low to the Modulating valve which creates low line pressure.

Figure 38

**ZF-4HP-22/24 MODEL "E-9", "4 SOLENOID"  
 VALVE BODY ASSEMBLY**



- 1 LOWER FRONT VALVE BODY ASSEMBLY
- 2 LOWER REAR VALVE BODY ASSEMBLY
- 3 VALVE BODY SPACER PLATE
- 4 SPACER PLATE TO CHANNEL PLATE GASKET
- 5 CHANNEL PLATE ASSEMBLY

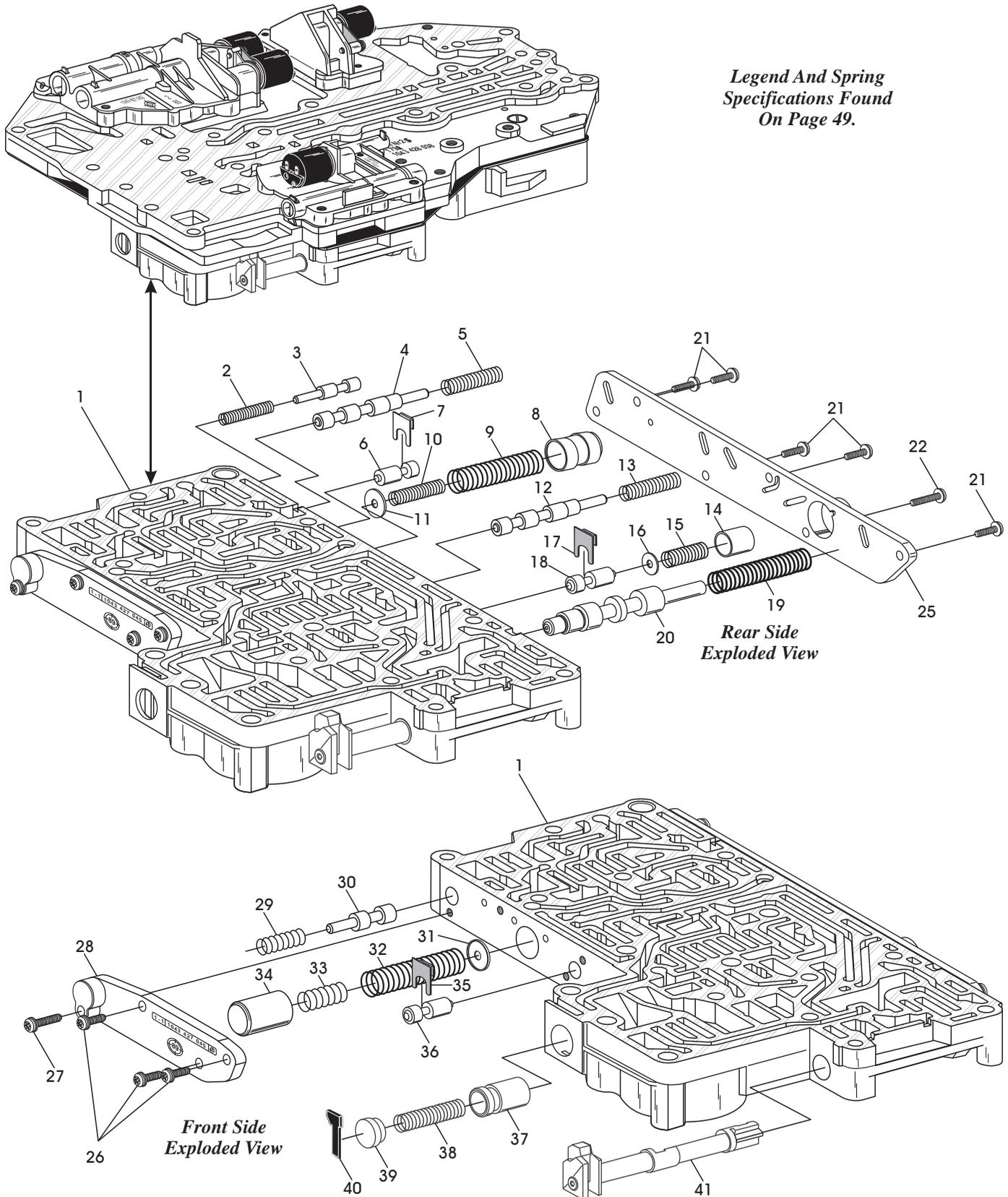
- 6 MV-5 SOLENOID BODY ASSEMBLY
- 7 MV-3 SOLENOID BODY ASSEMBLY
- 8 MV-1 AND MV-2 SOLENOID BODY ASSEMBLY

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Figure 39

**ZF-4HP-22/24 MODEL "E-9", "4 SOLENOID"  
 LOWER "FRONT" VALVE BODY**

*Legend And Spring  
 Specifications Found  
 On Page 49.*



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Figure 40

### FIGURE 40 LEGEND AND SPRING SPECIFICATIONS

<p>1 LOWER FRONT VALVE BODY CASTING          2 "C" CLUTCH VALVE SPRING          3 "C" CLUTCH VALVE          4 2-3 SHIFT VALVE          5 2-3 SHIFT VALVE SPRING          6 "C" CLUTCH VALVE          7 "C" CLUTCH VALVE RETAINER          8 "B" CLUTCH DAMPER PISTON          9 "B" CLUTCH DAMPER PISTON OUTER SPRING          10 "B" CLUTCH DAMPER PISTON INNER SPRING          11 "B" CLUTCH DAMPER PISTON SPRING SEAT          12 1-2 SHIFT VALVE          13 1-2 SHIFT VALVE SPRING          14 "D" CLUTCH DAMPER PISTON          15 "D" CLUTCH DAMPER PISTON SPRING          16 "D" CLUTCH DAMPER PISTON SPRING SEAT          17 "D" CLUTCH VALVE RETAINER          18 "D" CLUTCH VALVE          19 PRESSURE REGULATOR VALVE SPRING          20 PRESSURE REGULATOR VALVE          21 REAR SIDE COVER RETAINING BOLT, 17 mm LENGTH (5)          22 REAR SIDE COVER RETAINING BOLT, 24 mm LENGTH (1)          25 REAR SIDE COVER          26 FRONT SIDE COVER RETAINING BOLT, 17 mm LENGTH (3)          27 FRONT SIDE COVER RETAINING BOLT, 29 mm LENGTH (1)          28 FRONT SIDE COVER          29 TORQUE CONVERTER LOCK-UP VALVE SPRING          30 TORQUE CONVERTER LOCK-UP VALVE          31 "C" CLUTCH DAMPER PISTON SPRING SEAT          32 "C" CLUTCH DAMPER PISTON OUTER SPRING          33 "C" CLUTCH DAMPER PISTON INNER SPRING          34 "C" CLUTCH DAMPER PISTON          35 "B" CLUTCH REGULATOR VALVE RETAINER          36 "B" CLUTCH REGULATOR VALVE</p>	<p>37 "A" CLUTCH DAMPER PISTON          38 "A" CLUTCH DAMPER SPRING          39 "A" CLUTCH DAMPER PISTON SPRING SEAT          40 "A" CLUTCH DAMPER SPRING SEAT RETAINER          41 MANUAL SHIFT VALVE</p> <p>SPRING ILLUSTRATION NO. 2:          FREE LENGTH = 1.075"          SPRING DIAMETER = .280"          WIRE DIAMETER = .033"</p> <p>SPRING ILLUSTRATION NO. 5:          FREE LENGTH = 1.925"          SPRING DIAMETER = .363"          WIRE DIAMETER = .033"</p> <p>SPRING ILLUSTRATION NO. 9:          FREE LENGTH = 2.900"          SPRING DIAMETER = .594"          WIRE DIAMETER = .040"</p> <p>SPRING ILLUSTRATION NO. 10:          FREE LENGTH = 1.580"          SPRING DIAMETER = .432"          WIRE DIAMETER = .040"</p> <p>SPRING ILLUSTRATION NO. 13:          FREE LENGTH = 1.880"          SPRING DIAMETER = .367"          WIRE DIAMETER = .032"</p> <p>SPRING ILLUSTRATION NO. 15:          FREE LENGTH = 1.655"          SPRING DIAMETER = .560"          WIRE DIAMETER = .045"</p> <p>SPRING ILLUSTRATION NO. 19:          FREE LENGTH = 3.625"          SPRING DIAMETER = .600"          WIRE DIAMETER = .080"</p> <p>SPRING ILLUSTRATION NO. 29:          FREE LENGTH = 1.690"          SPRING DIAMETER = .443"          WIRE DIAMETER = .032"</p> <p>SPRING ILLUSTRATION NO. 32:          FREE LENGTH = 3.310"          SPRING DIAMETER = .585"          WIRE DIAMETER = .045"</p> <p>SPRING ILLUSTRATION NO. 33:          FREE LENGTH = 1.590"          SPRING DIAMETER = .442"          WIRE DIAMETER = .032"</p> <p>SPRING ILLUSTRATION NO. 38:          FREE LENGTH = 2.727"          SPRING DIAMETER = .400"          WIRE DIAMETER = .050"</p>
--	--

Figure 40 Legend

**ZF-4HP-22/24 MODEL "E-9", "4 SOLENOID"  
 LOWER "REAR" VALVE BODY**

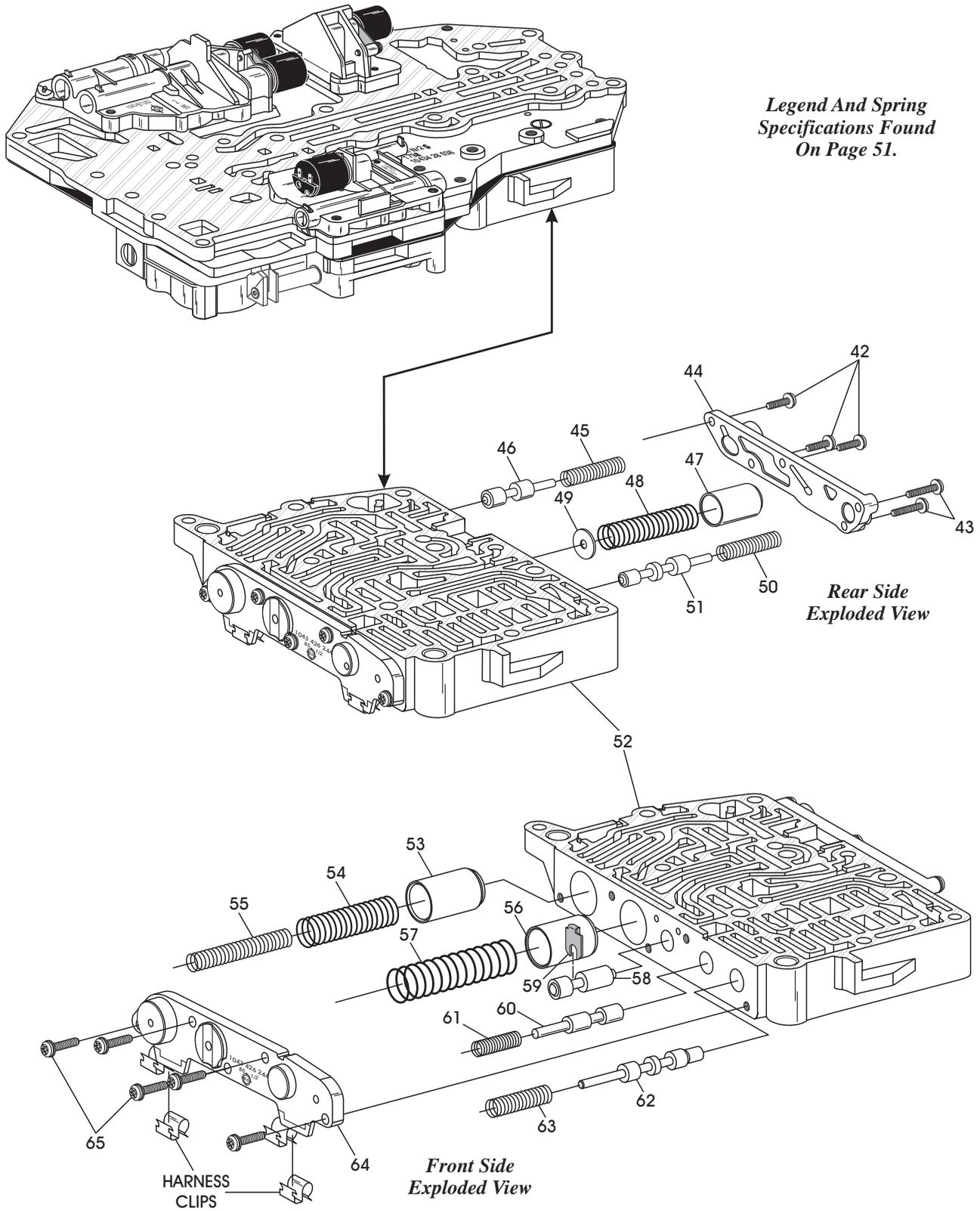


Figure 41



# TECHNICIANS DIAGNOSTIC GUIDE

## BMW, AUDI, PORSCHE

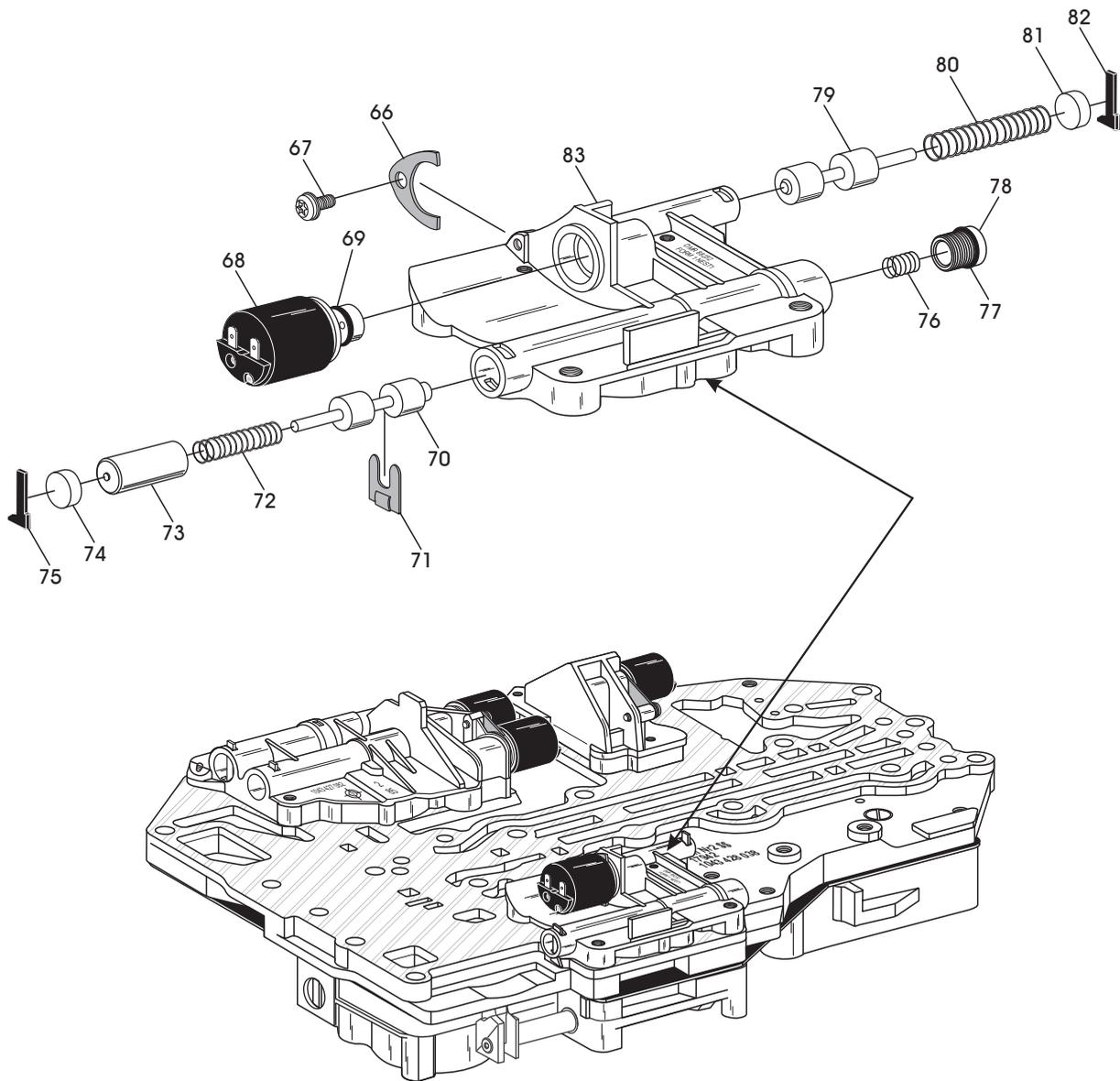
### FIGURE 41 LEGEND AND SPRING SPECIFICATIONS

42 REAR SIDE COVER RETAINING BOLTS, 17 mm LENGTH (3)		
43 REAR SIDE COVER RETAINING BOLTS, 21 mm LENGTH (2)		
44 REAR SIDE COVER		
45 PRESSURE REDUCING VALVE "1" SPRING	SPRING ILLUSTRATION NO. 45:	SPRING ILLUSTRATION NO. 55:
46 PRESSURE REDUCING VALVE "1"	FREE LENGTH = 1.395"	FREE LENGTH = 3.490"
47 "F" CLUTCH DAMPER PISTON	SPRING DIAMETER = .305"	SPRING DIAMETER = .408"
48 "F" CLUTCH DAMPER PISTON SPRING	WIRE DIAMETER = .040"	WIRE DIAMETER = .045"
49 "F" CLUTCH DAMPER PISTON SPRING SEAT		
50 SAFETY VALVE SPRING	SPRING ILLUSTRATION NO. 48:	SPRING ILLUSTRATION NO. 57:
51 SAFETY VALVE	FREE LENGTH = 3.160"	FREE LENGTH = 2.905"
52 LOWER REAR VALVE BODY CASTING	SPRING DIAMETER = .690"	SPRING DIAMETER = .614"
53 "C" CLUTCH DAMPER PISTON	WIRE DIAMETER = .044"	WIRE DIAMETER = .065"
54 "C" CLUTCH DAMPER PISTON OUTER SPRING		
55 "C" CLUTCH DAMPER PISTON INNER SPRING	SPRING ILLUSTRATION NO. 50:	SPRING ILLUSTRATION NO. 61:
56 "E" CLUTCH DAMPER PISTON	FREE LENGTH = 1.267"	FREE LENGTH = 1.515"
57 "E" CLUTCH DAMPER PISTON SPRING	SPRING DIAMETER = .315"	SPRING DIAMETER = .339"
58 "F" CLUTCH VALVE	WIRE DIAMETER = .025"	WIRE DIAMETER = .045"
59 "F" CLUTCH VALVE RETAINER		
60 PRESSURE REDUCING VALVE "2"	SPRING ILLUSTRATION NO. 54:	SPRING ILLUSTRATION NO. 63:
61 PRESSURE REDUCING VALVE "2" SPRING	FREE LENGTH = 2.900"	FREE LENGTH = 1.595"
62 3-4 SHIFT VALVE	SPRING DIAMETER = .603"	SPRING DIAMETER = .67"
63 3-4 SHIFT VALVE SPRING	WIRE DIAMETER = .065"	WIRE DIAMETER = .032"
64 FRONT SIDE COVER		
65 FRONT SIDE COVER RETAINING BOLTS, 17 mm LENGTH (5)		

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Figure 41 Legend

### ZF-4HP-22/24 MODEL "E-9", "4 SOLENOID" MV-5 SOLENOID BODY



- 66 SOLENOID RETAINING BRACKET
- 67 SOLENOID RETAINING BOLT, 11 mm LENGTH
- 68 MV-5 LINE PRESSURE SOLENOID ASSEMBLY
- 69 MV-5 LINE PRESSURE SOLENOID "O" RING
- 70 MODULATION VALVE
- 71 MODULATION VALVE RETAINER
- 72 MODULATION VALVE SPRING
- 73 MODULATION VALVE SPRING SLEEVE
- 74 MODULATION VALVE BORE PLUG
- 75 MODULATION VALVE BORE PLUG RETAINER
- 76 MODULATION VALVE BALANCE SPRING
- 77 MODULATION VALVE ADJUSTING PLUG "O" RING
- 78 MODULATION VALVE ADJUSTING PLUG
- 79 REVERSE LOCKOUT VALVE
- 80 REVERSE LOCKOUT VALVE SPRING
- 81 REVERSE LOCKOUT VALVE BORE PLUG
- 82 REVERSE LOCKOUT VALVE BORE PLUG RETAINER
- 83 MV-5 SOLENOID BODY CASTING

SPRING ILLUSTRATION NO. 72:  
 FREE LENGTH = 1.245"  
 SPRING DIAMETER = .302"  
 WIRE DIAMETER = .039"

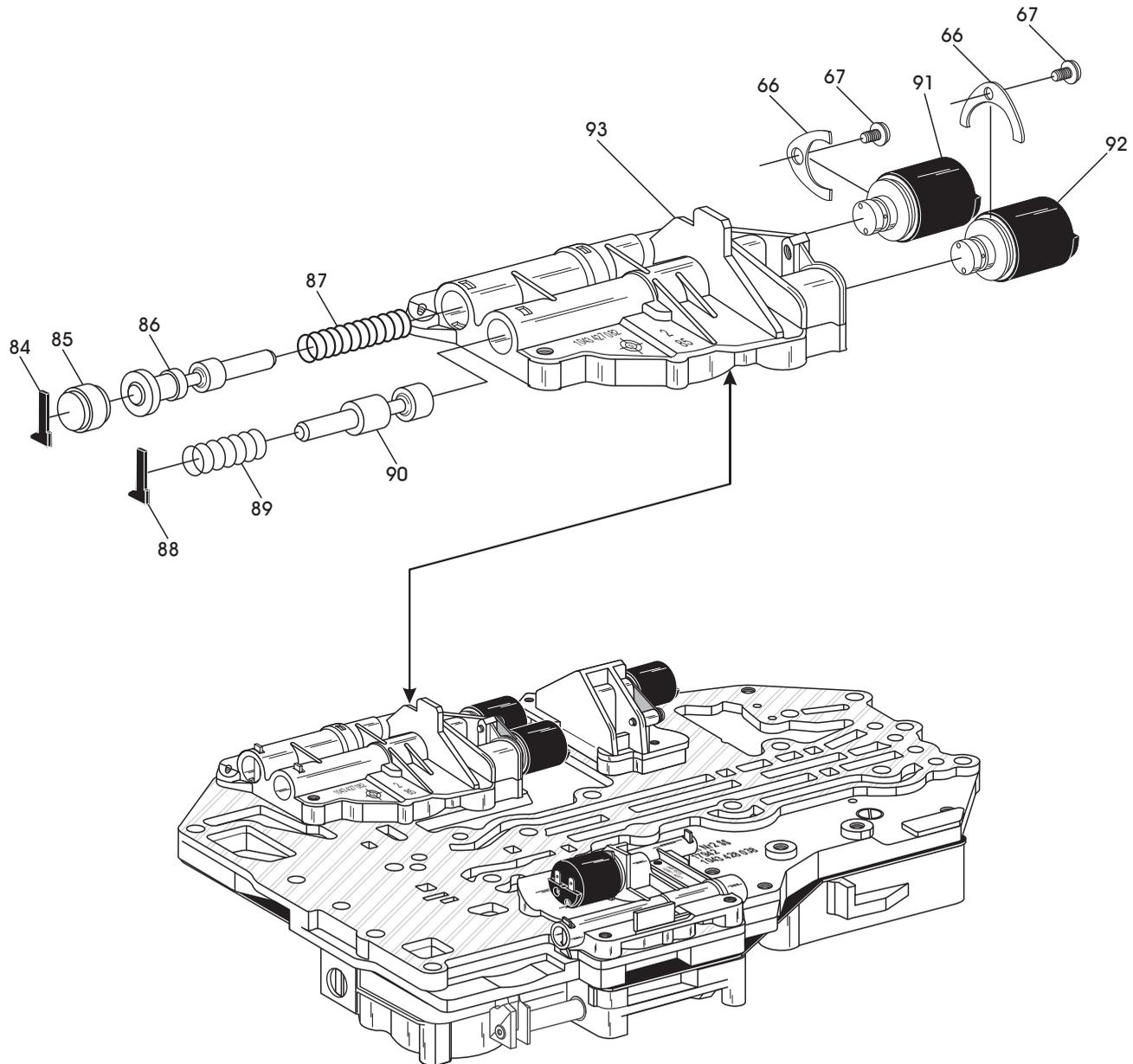
SPRING ILLUSTRATION NO. 76:  
 FREE LENGTH = .770"  
 SPRING DIAMETER = .377"  
 WIRE DIAMETER = .027"

SPRING ILLUSTRATION NO. 80:  
 FREE LENGTH = 1.835"  
 SPRING DIAMETER = .380"  
 WIRE DIAMETER = .035"

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Figure 42

**ZF-4HP-22/24 MODEL "E-9", "4 SOLENOID"  
MV-1 AND MV-2 SOLENOID BODY**



- 66 SOLENOID RETAINING BRACKET
- 67 SOLENOID RETAINING BOLT, 11 mm LENGTH
- 84 T.C.C. VALVE BORE PLUG RETAINER
- 85 T.C.C. VALVE BORE PLUG
- 86 TORQUE CONVERTER CLUTCH VALVE
- 87 TORQUE CONVERTER CLUTCH VALVE SPRING
- 88 LUBRICATION VALVE SPRING RETAINER
- 89 LUBRICATION VALVE SPRING
- 90 LUBRICATION VALVE
- 91 MV-2 SHIFT SOLENOID ASSEMBLY
- 92 MV-1 SHIFT SOLENOID ASSEMBLY
- 93 SHIFT SOLENOID BODY CASTING

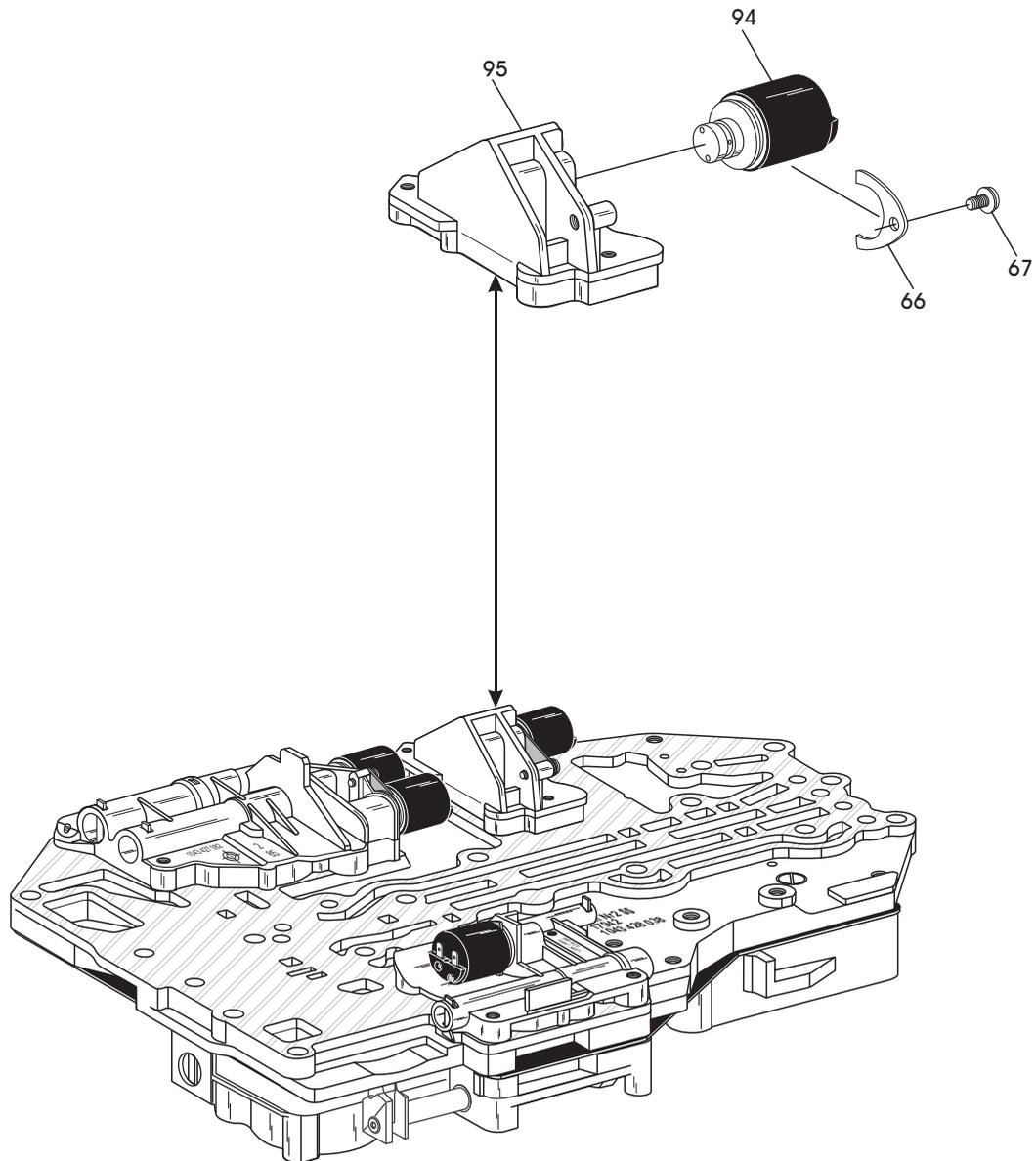
SPRING ILLUSTRATION NO. 87:  
FREE LENGTH = 1.570"  
SPRING DIAMETER = .430"  
WIRE DIAMETER = .039"

SPRING ILLUSTRATION NO. 89:  
FREE LENGTH = 1.545"  
SPRING DIAMETER = .440"  
WIRE DIAMETER = .031"

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Figure 43

**ZF-4HP-22/24 MODEL "E-9", "4 SOLENOID"  
MV-3 SOLENOID BODY**



- 66 SOLENOID RETAINING BRACKET
- 67 SOLENOID RETAINING BOLT, 11 mm LENGTH
- 94 MV-3 LOCK-UP SOLENOID ASSEMBLY
- 95 MV-3 SOLENOID BODY CASTING

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Figure 44

**ZF-4HP-22/24 MODEL "E-9", "4 SOLENOID"  
LOWER "FRONT" VALVE BODY**

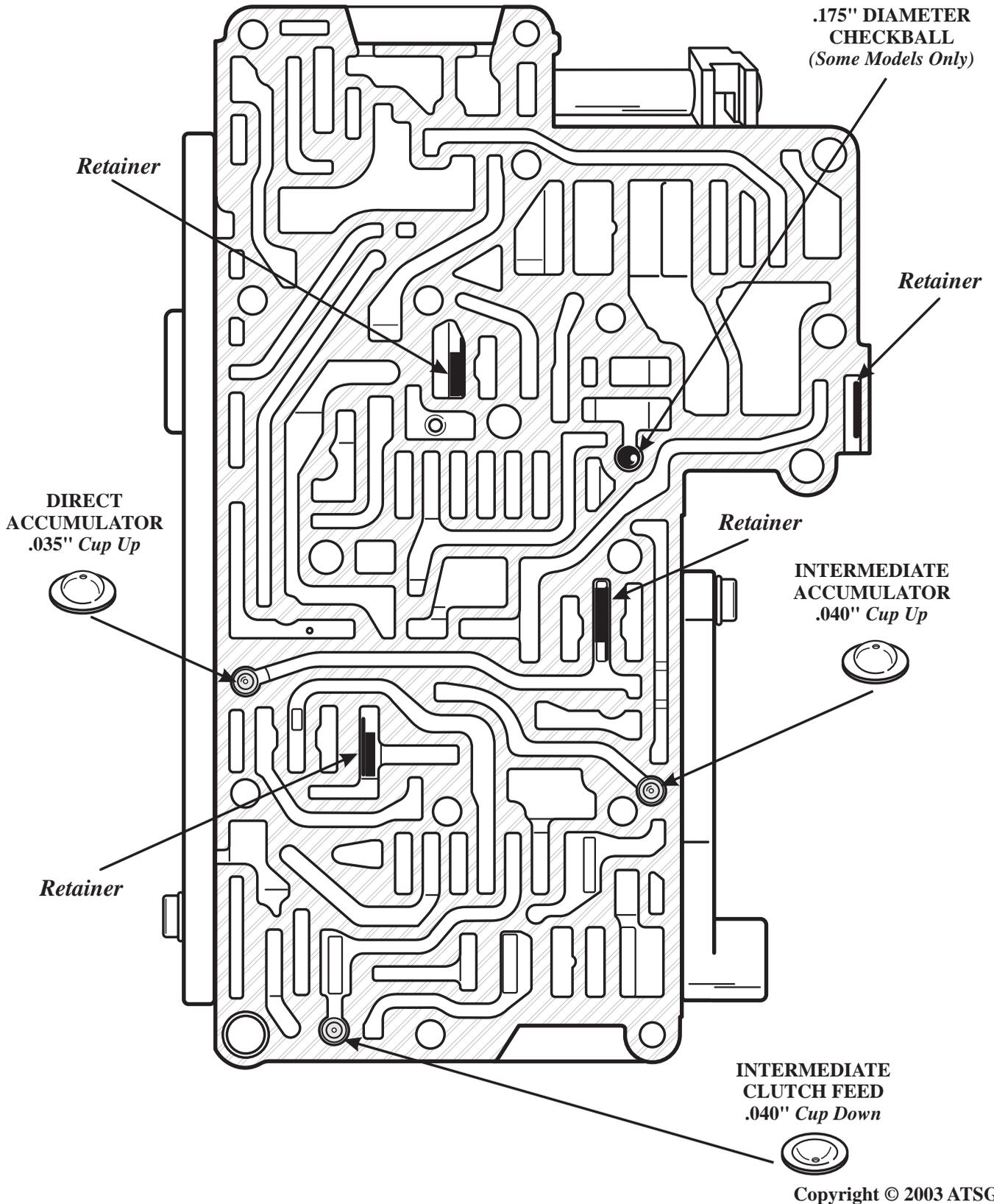
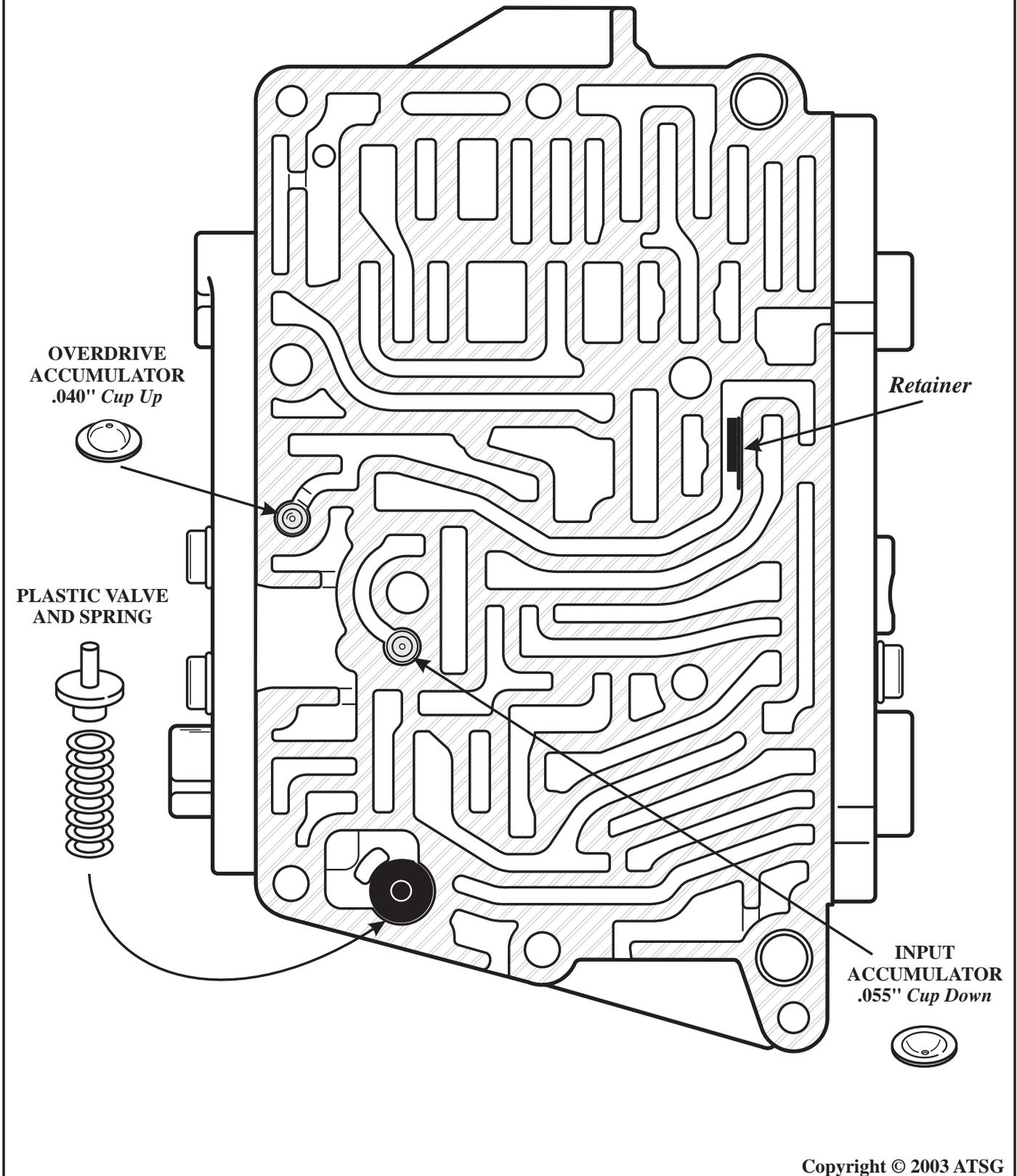


Figure 45

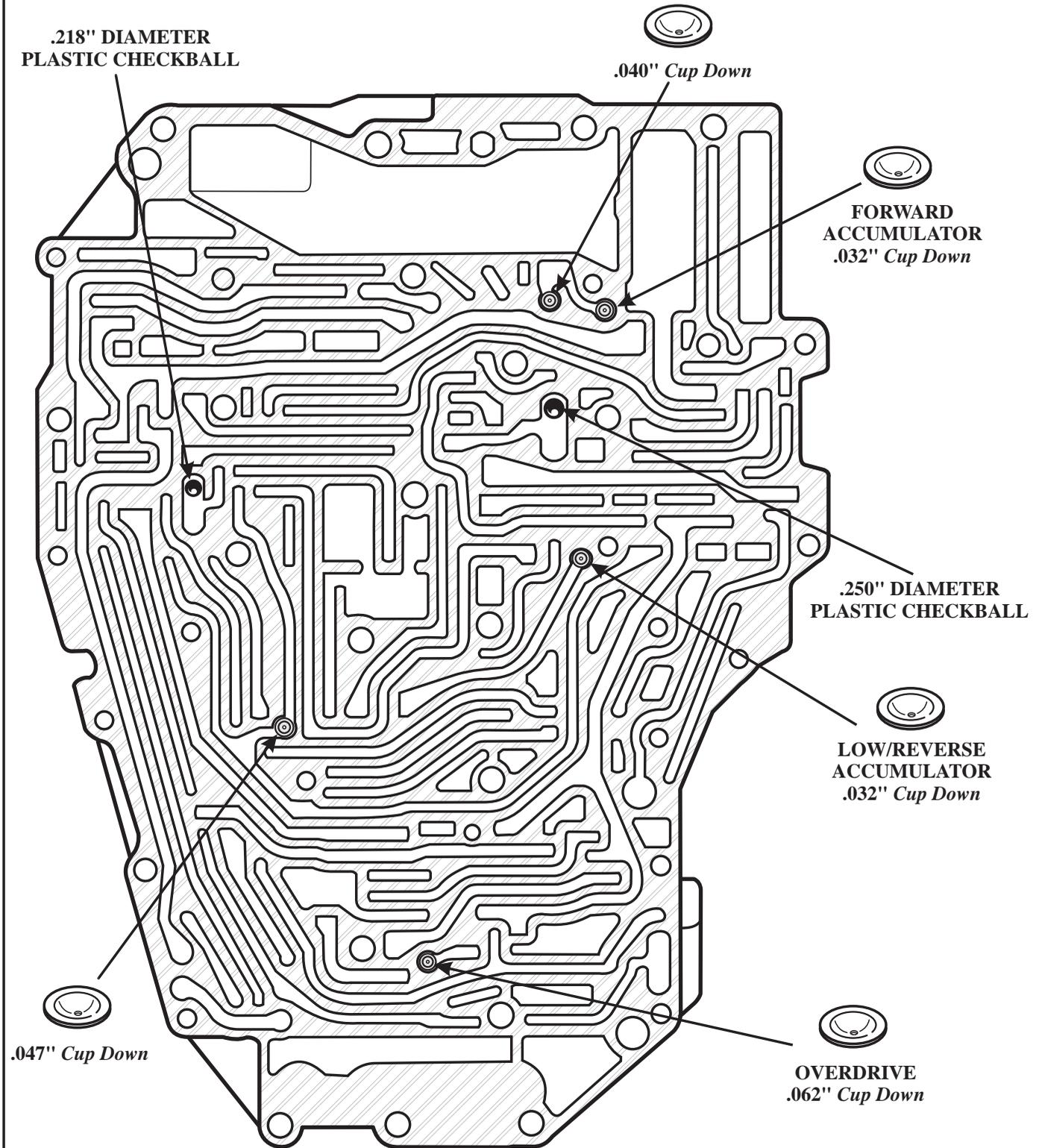
**ZF-4HP-22/24 MODEL "E-9", "4 SOLENOID"  
LOWER "REAR" VALVE BODY**



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Figure 46

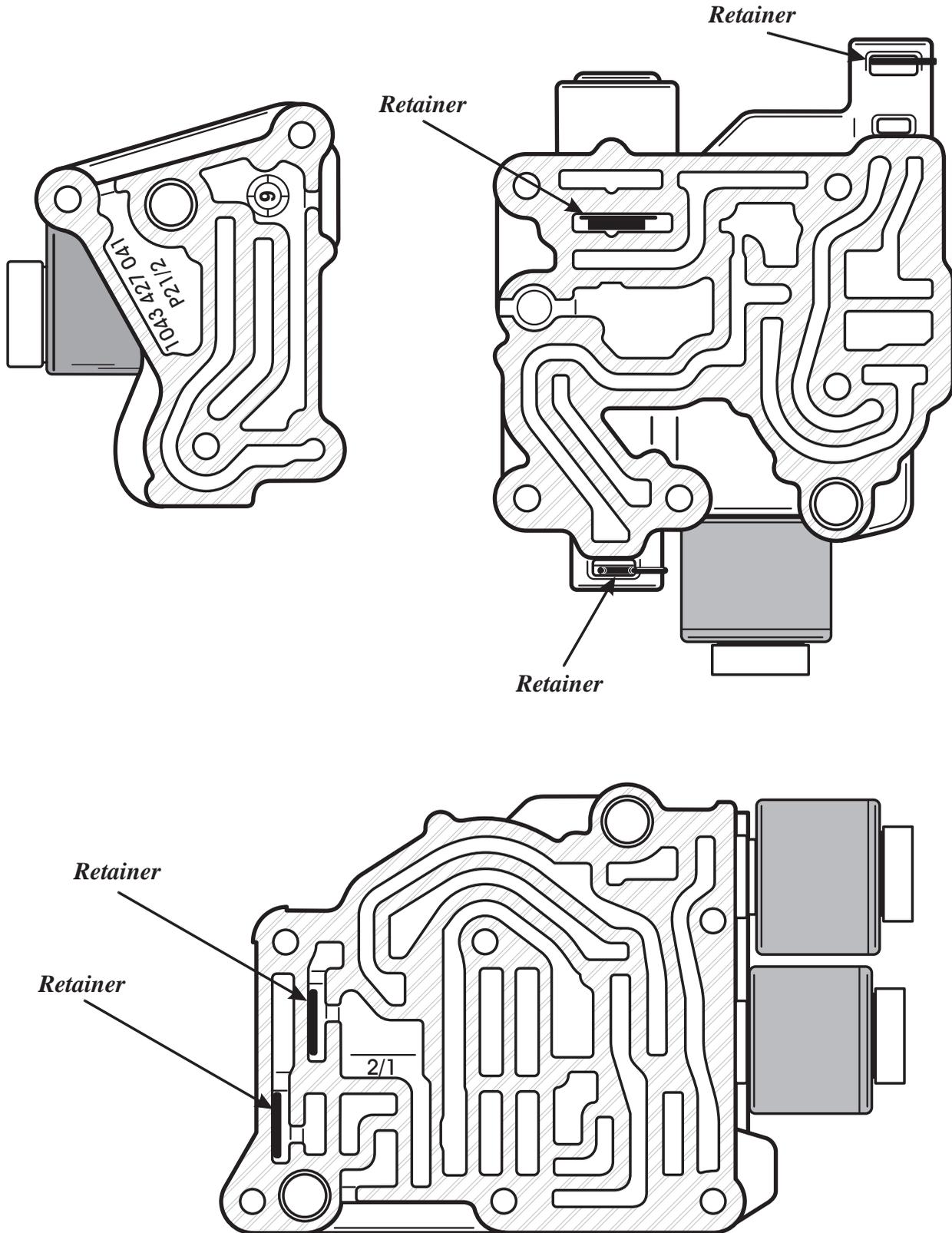
**ZF-4HP-22/24 MODEL "E-9", "4 SOLENOID"  
CHANNEL PLATE**



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Figure 47

**ZF-4HP-22/24 MODEL "E-9", "4 SOLENOID"  
ALL SOLENOID BODIES**



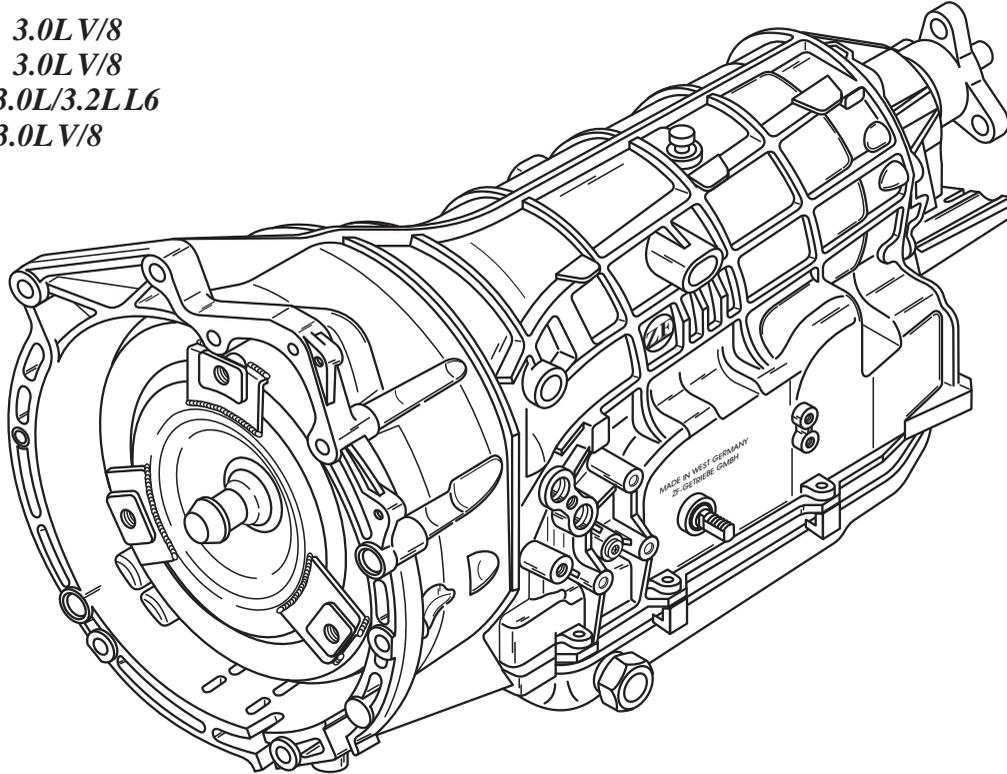
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Figure 48

**BMW ZF-5HP-18  
DIAGNOSTIC INFORMATION**

**FOUND IN:**

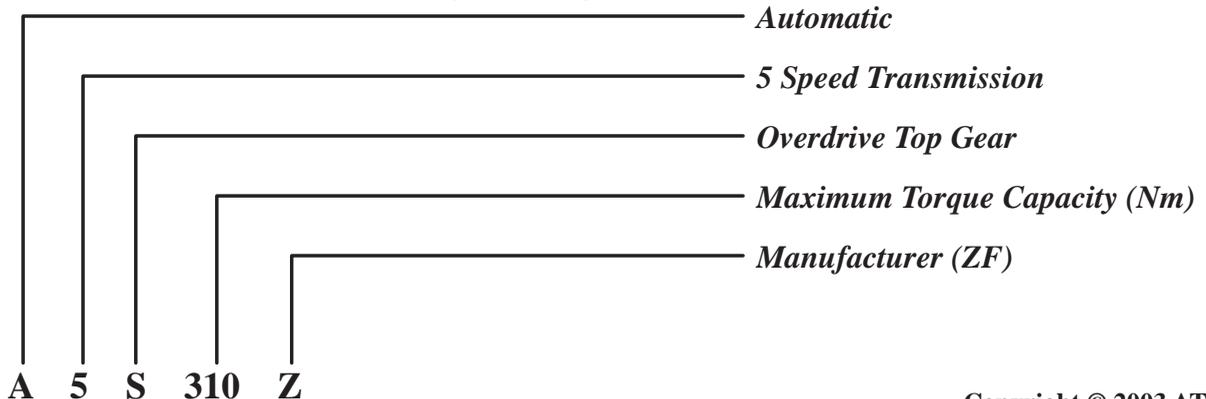
- 93-94 320i 3.0LV/8
- 93-95 530i 3.0LV/8
- 95-98 M3 3.0L/3.2LL6
- 730 3.0LV/8



*This transmission is manufactured in Germany by ZF and carries the BMW designation A5S 310Z.*

*The A5S 310Z (ZF-5HP-18) is an electronically controlled, five speed automatic transmission with a lock-up clutch type torque converter. Two planetary gear sets, one Ravigneaux gear set and one standard planetary gear set on the output side, four rotating multiple disc clutches, three multiple disc brake clutches, one brake band, and two sprag clutches (Freewheels) are used to provide the five forward speeds and reverse.*

**Key to designation:**



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Figure 49



## **TECHNICIANS DIAGNOSTIC GUIDE BMW, AUDI, PORSCHE**

*Refer to Figure 50 for Clutch and Band Application Chart.*

*Refer to Figure 51 for Manual Shift Lever Operation, Mode Switch Operation and location, and Failsafe Operation.*

*Refer to Figure 52 for both MV Solenoid Operation and EDS Solenoid Operation and Tests.*

*Refer to Figure 53 for Shift Solenoid Application chart and their locations. Notice that the MV 6 Solenoid is used only for Converter Clutch application and that it is identified by a White connector on the solenoid, where all the others are Black. Notice also that EDS 1 Solenoid is used for line pressure control. MV 4 and MV 5 Solenoids are used only for downshifts.*

*Refer to Figure 54 for wiring harness identification, internal wiring schematic, and transmission case connector pin identification and functions.*

*Refer to Figure 55 for identification and internal component resistance chart.*

*Refer to Figure 56 and 57 for retrieving trouble codes and the Trouble Code charts.*

*Refer to Figure 58 for Solenoid and Sensor resistance chart with the pins identified for both the case connector and the Transmission Control Unit connector.*

*Refer to Figure 59 for case passage identification to air check this unit before installation of the valve body assembly.*

*Refer to Figure 60 for pressure tap locations on the case, and notice that some cases you must drill and tap for access to a particular pressure.*

*Refer to Figure 61 for exploded view of the Upper Front Valve Body with valves identified.*

*Refer to Figure 62 for speed sensor locations on the channel plate.*

*Refer to Figure 63 for exploded view of the Solenoid Valve Body with valves identified. Notice that there is an "O" ring on the adjustment screw that goes in the groove.*

*Refer to Figure 64 for exploded view of the Lower Rear Valve Body with the valves identified.*

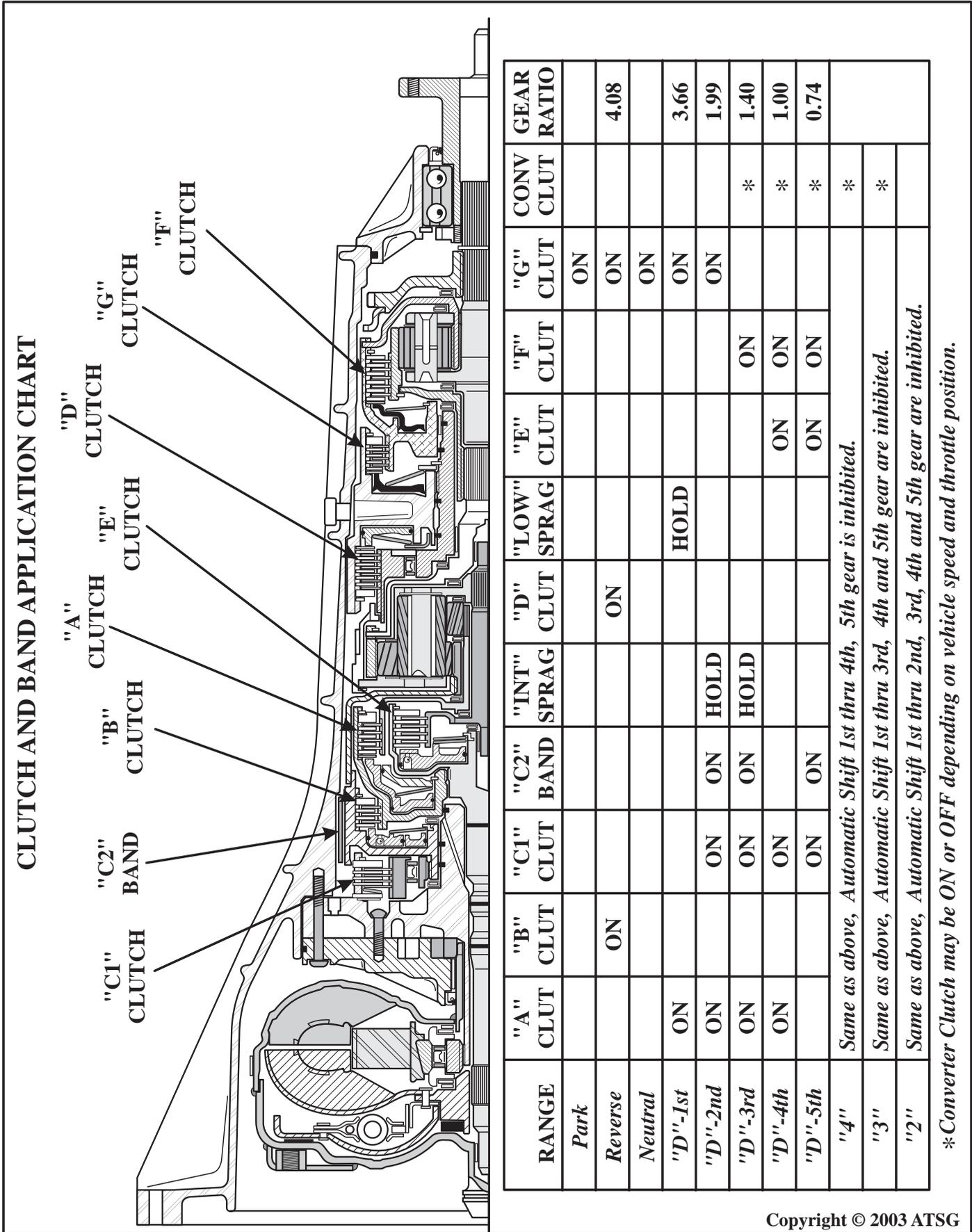
*Refer to Figure 65 for exploded view of the Lower Front Valve Body with the valves identified.*

*Refer to Figures 66 thru 69 for the retaining clip locations in the various valve bodies.*

*Refer to Figure 70 for the locations of the orifices, checkballs, screens, and the check valves and springs that are located in the channel plate.*

*Refer to Figure 71 for all valve body spring specifications, as observed in a used valve body.*

*Refer to Page 83 for "No Movement Or Delayed Engagement", and Refer to Page 86 for a "Bind-Up In 1st Gear, With Selector Lever In Manual 2 Position".*

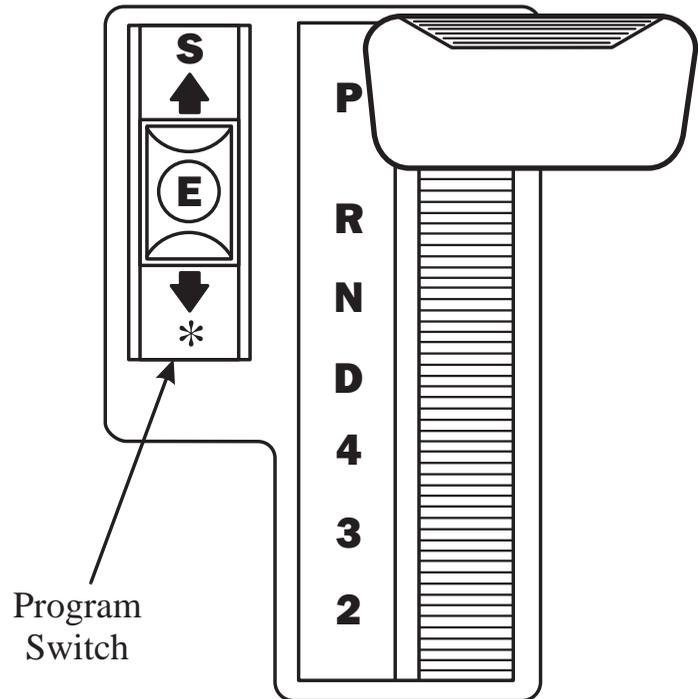


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Figure 50

### SELECTOR LEVER

- P** = Park
- R** = Reverse
- N** = Neutral
- D** = Automatic Shift 1st thru 5th gear.
- 4** = Automatic Shift 1st thru 4th gear.  
5th gear is locked out.
- 3** = Automatic Shift 1st thru 3rd gear.  
4th and 5th gear are locked out.
- 2** = Automatic Shift 1st thru 2nd gear.  
3rd, 4th and 5th gear are locked out.



*The "Program Switch" can be used to select one of three programs.*

**E** = **ECONOMY (Fuel Efficient Driving Style)**

The "E" program is activated every time the engine is started. Once the engine has been started, either Sport or Winter programs can be selected with the Program Switch. The transmission changes automatically from 1st thru 5th gear in any throttle position up to full throttle. When throttle position is in the kick-down range, the transmission changes automatically from 1st thru 4th gears. The change into 5th gear is a forced upshift and occurs just before engine speed reaches the upper limit for controlled cut-back.

**S** = **SPORT (Full Exploitation of Engine Performance)**

The "S" program is performance oriented and must be re-selected every time the engine is started. The transmission changes automatically from 1st thru 4th gear regardless of throttle position. The change into 5th gear is a forced upshift and occurs just before engine speed reaches the upper limit for controlled cut-back.

**\*** = **WINTER (Manual Shifts)**

The "Winter" program provides manual shifts and is designed for situations of driving on snow or ice, driving on mountain roads or towing a trailer. The driver has the same free choice of gears as with a manual transmission, as the transmission remains in the gear selected with the selector lever. This makes it possible to utilize the engines full braking power. The transmission never changes into 1st or 5th gears in the "Winter" mode.

**FAILSAFE OPERATION:**

When a system fault is detected which would impair normal reliable operation, the transmission control module interrupts the power supply to Pin 13 at the transmission case connector. The transmission control module also alerts the driver of any faults by signaling the vehicles "Check Control" system. To enable the vehicle to be driven to a repair shop, the following manual gear selections are permitted:

<i>Selector Lever Position</i>	<b>P R N D 4 3 2</b>
<i>Actual Gear Obtained</i>	<b>P R N 4 4 4 4</b>

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Figure 51

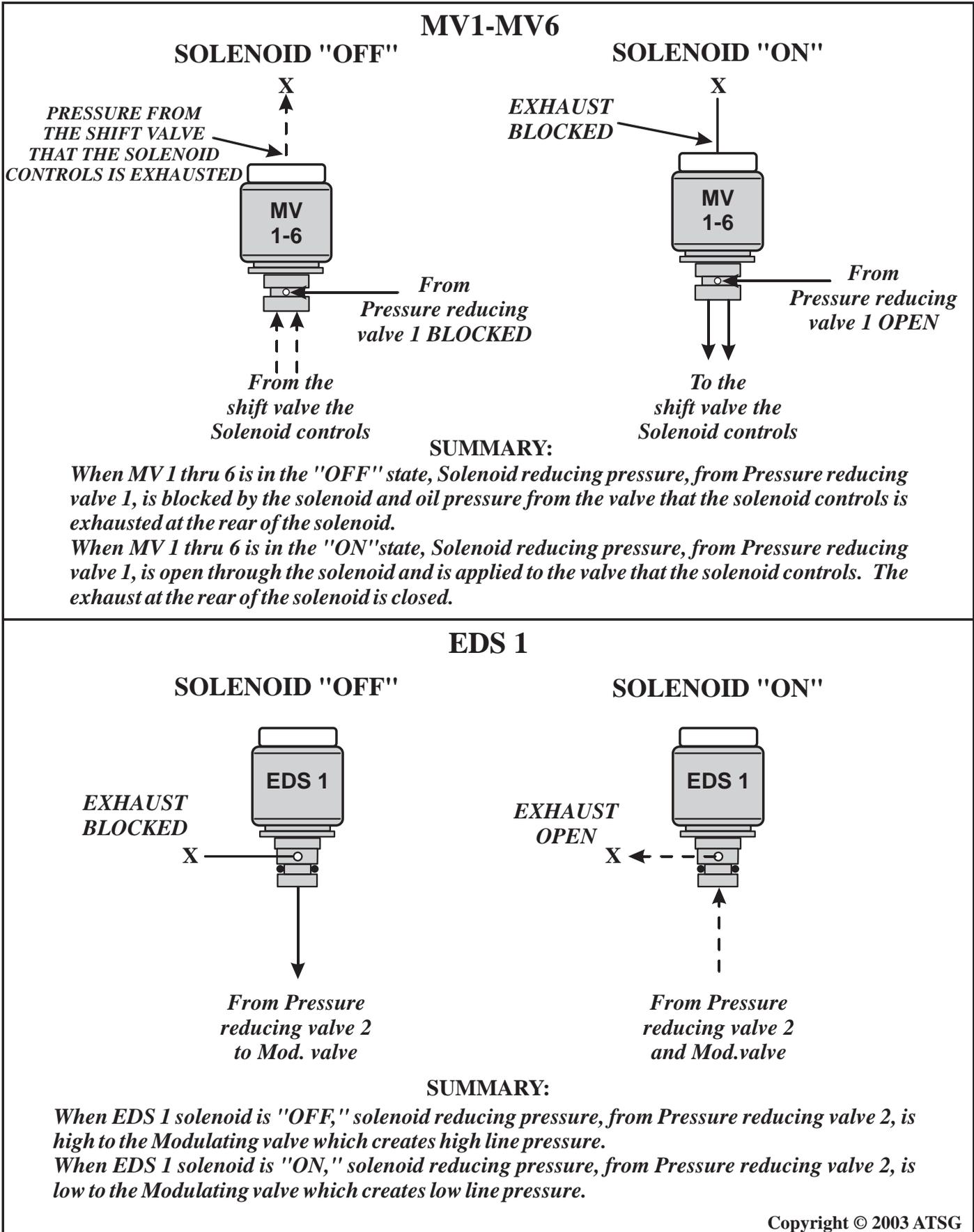
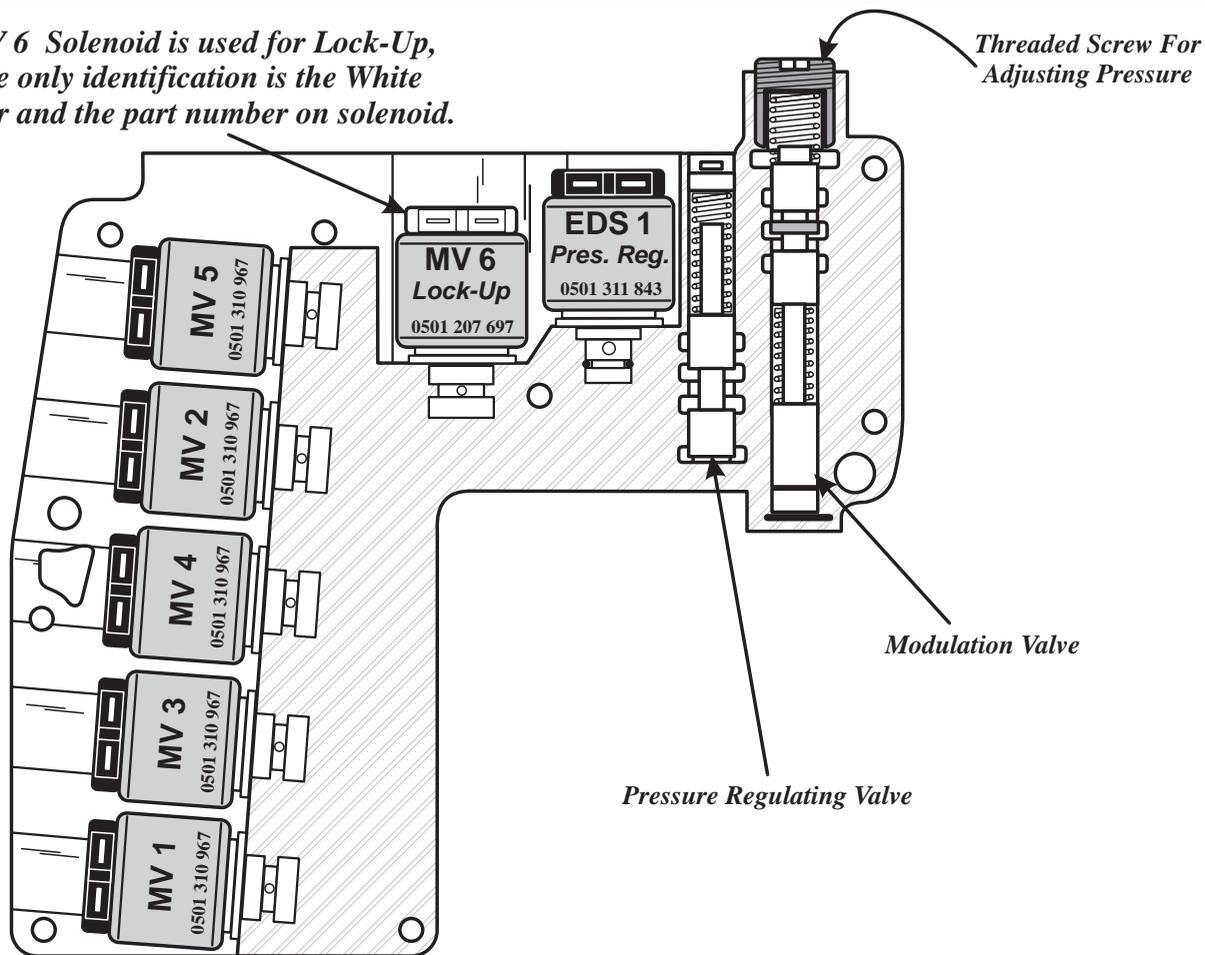


Figure 52

The MV 6 Solenoid is used for Lock-Up, and the only identification is the White connector and the part number on solenoid.



RANGE	SHIFT SOLENOID APPLICATION CHART							RATIO
	MV 1	MV 2	MV 3	MV 4	MV 5	MV 6	EDS 1	
<i>Park</i>	ON	ON	ON				**	
<i>Reverse</i>	ON	ON					**	4.08
<i>Neutral</i>	ON	ON	ON				**	
<i>"D"-1st</i>	ON	ON	ON				**	3.66
<i>"D"-2nd</i>		ON	ON				**	1.99
<i>"D"-3rd</i>			ON			*	**	1.40
<i>"D"-4th</i>						*	**	1.00
<i>"D"-5th</i>	ON					*	**	0.74
<i>"D", 3-2</i>				ON			**	
<i>"D", 5-4</i>					ON		**	
<i>"Failsafe"</i>	OFF	OFF	OFF	OFF	OFF	OFF	OFF	1.00

\* Converter Clutch may be ON or OFF depending on vehicle speed and throttle position.

\*\* Line Pressure is Modulating, depending on vehicle speed and throttle position.

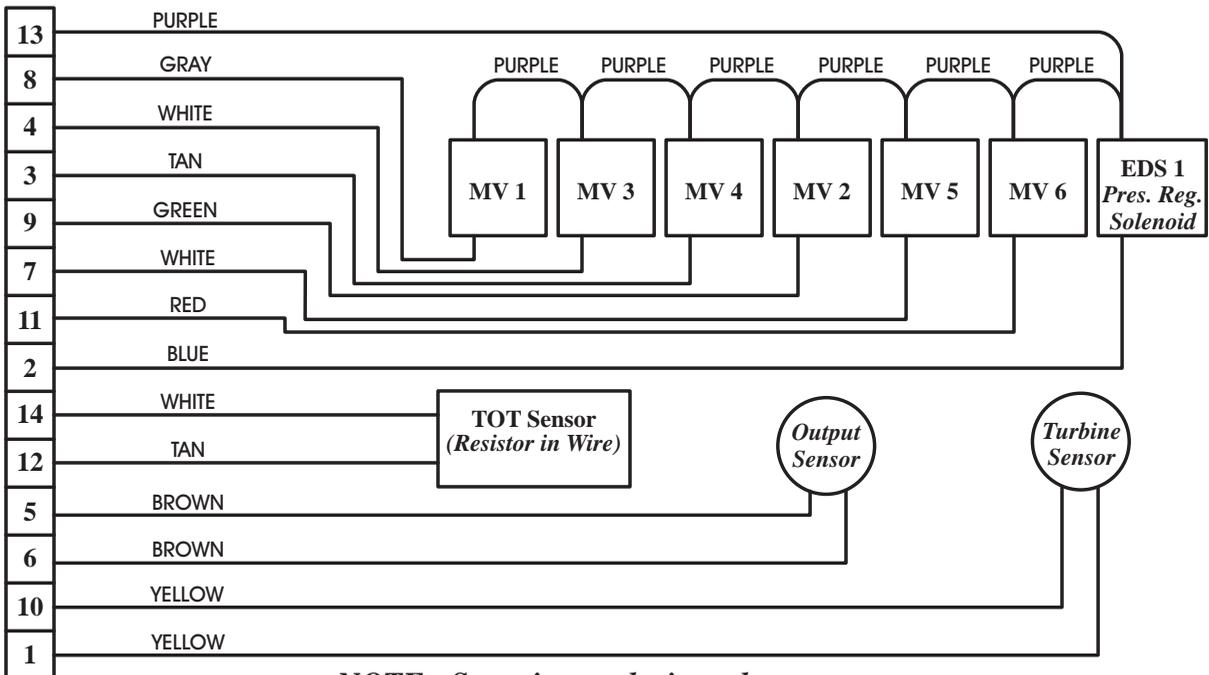
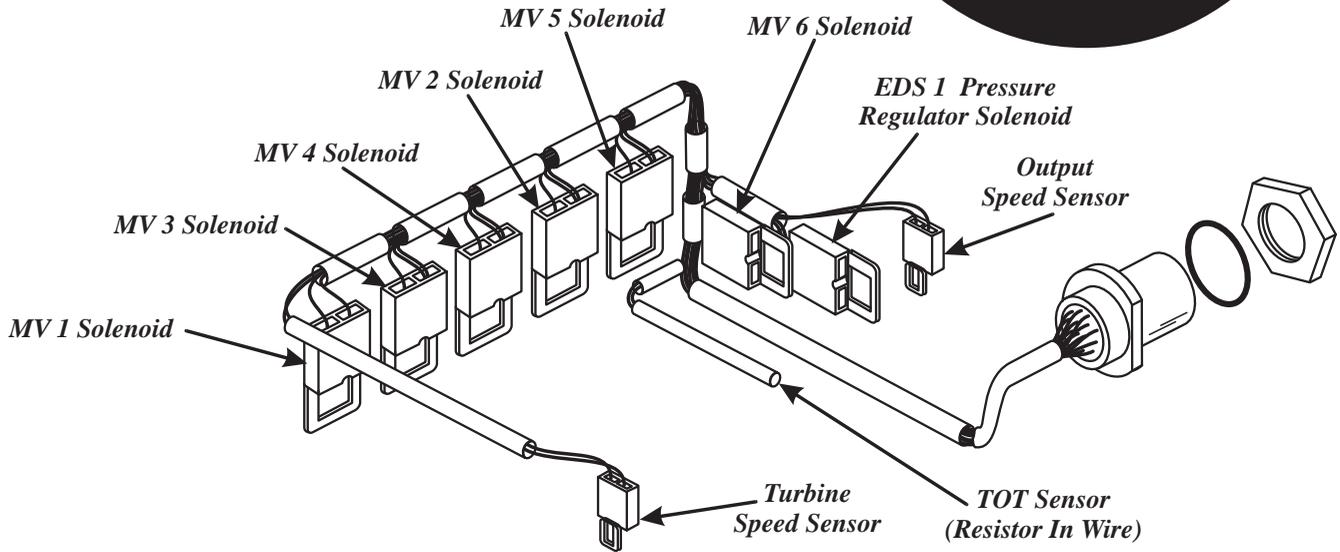
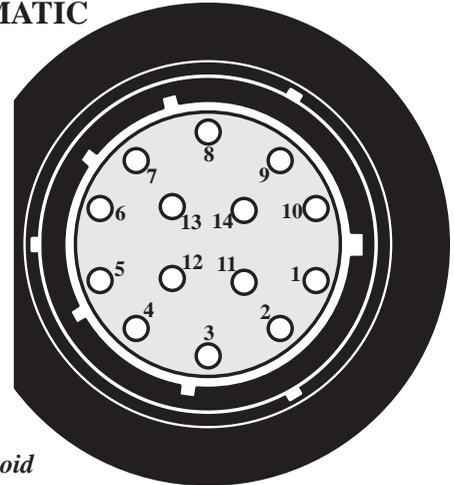
Note: MV 4 and MV 5 are used only on downshifts.

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Figure 53

### ZF-5HP-18 INTERNAL WIRE SCHEMATIC

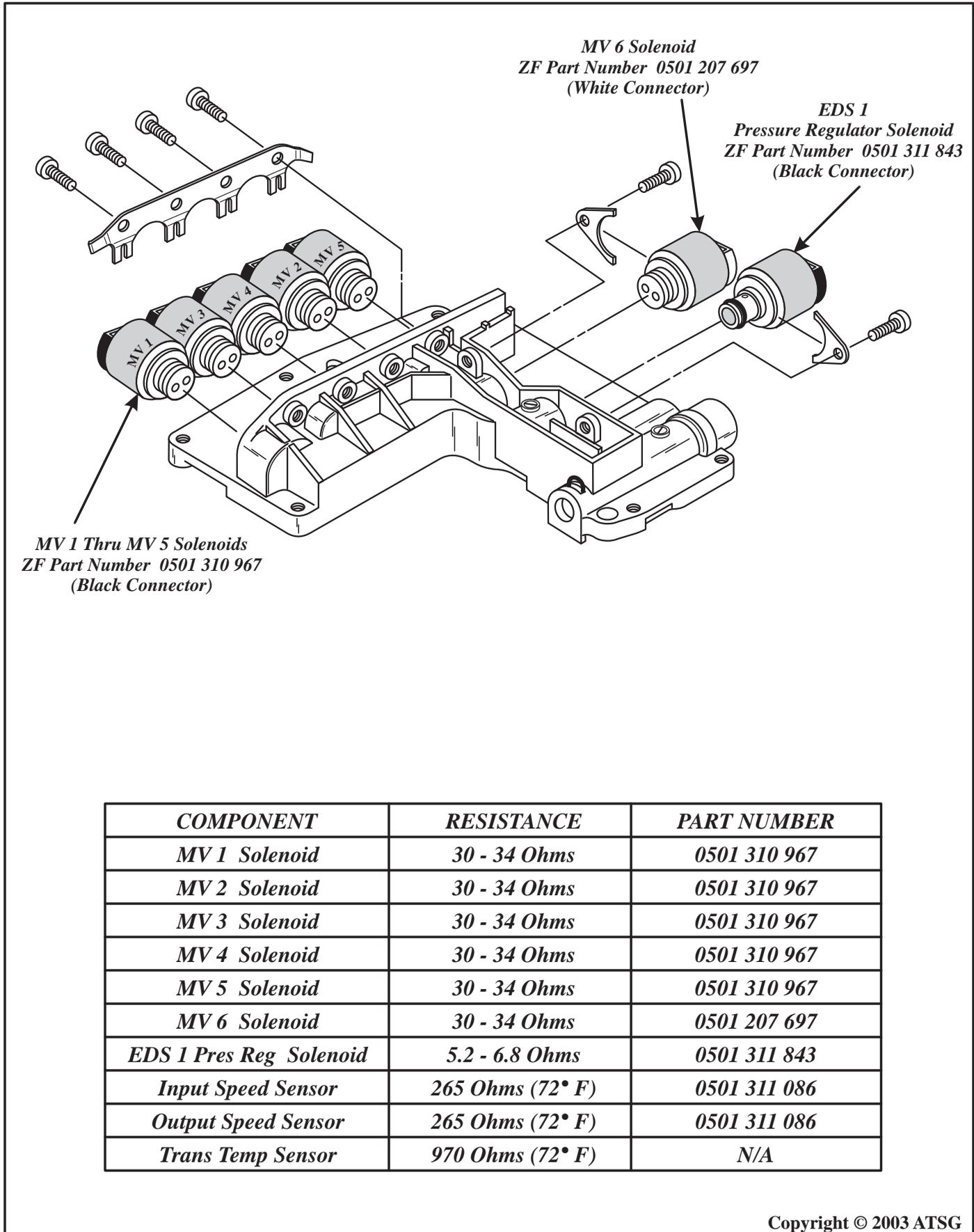
*View Looking Into Case  
Connector Setting In The vehicle*



**NOTE:** Some internal wire colors may vary.

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Figure 54



<i>COMPONENT</i>	<i>RESISTANCE</i>	<i>PART NUMBER</i>
<i>MV 1 Solenoid</i>	<i>30 - 34 Ohms</i>	<i>0501 310 967</i>
<i>MV 2 Solenoid</i>	<i>30 - 34 Ohms</i>	<i>0501 310 967</i>
<i>MV 3 Solenoid</i>	<i>30 - 34 Ohms</i>	<i>0501 310 967</i>
<i>MV 4 Solenoid</i>	<i>30 - 34 Ohms</i>	<i>0501 310 967</i>
<i>MV 5 Solenoid</i>	<i>30 - 34 Ohms</i>	<i>0501 310 967</i>
<i>MV 6 Solenoid</i>	<i>30 - 34 Ohms</i>	<i>0501 207 697</i>
<i>EDS 1 Pres Reg Solenoid</i>	<i>5.2 - 6.8 Ohms</i>	<i>0501 311 843</i>
<i>Input Speed Sensor</i>	<i>265 Ohms (72° F)</i>	<i>0501 311 086</i>
<i>Output Speed Sensor</i>	<i>265 Ohms (72° F)</i>	<i>0501 311 086</i>
<i>Trans Temp Sensor</i>	<i>970 Ohms (72° F)</i>	<i>N/A</i>

Figure 55



## TECHNICIANS DIAGNOSTIC GUIDE BMW, AUDI, PORSCHE

### RETRIEVING FAULT CODES

The BMW Diagnostic Tool is *required* to retrieve the fault codes that are stored in the control unit. The diagnostic tool has the ability to retrieve codes, clear codes and activate individual components, and is adaptable to 3 Series, 5 Series, 7 Series and 8 Series vehicles equipped with 4HP-22/24, 4L30-E, 5HP-18, 5HP-19, and 5HP-30.

### BMW ZF-5HP-18 FAULT CODE CHART

<i>Code</i>	<i>Description (Pin No's Refer To TCM)</i>	<i>Possible Causes</i>
<b>02</b>	Park-Neutral Lock Solenoid - Pin 2	Break or short in wiring, or defective solenoid
<b>03</b>	MV 5 Solenoid - Pin 3	Break or short in wiring, or defective solenoid
<b>04</b>	MV 6 Solenoid (Lock-Up) - Pin 4	Break or short in wiring, or defective solenoid
<b>05</b>	EDS 1 Solenoid (Pres. Reg.) - Pin 5	Break or short in wiring, or defective solenoid
<b>08</b>	Selector Lever Position L2 - Pin 8	Vehicle acceleration detected while selector lever in P or N position, or engine has been started even though trans control unit has not detected a selector lever position of P or N
<b>09</b>	Selector Lever Position L3/L4 - Pins 37 and 9	Engine has been started even though trans control unit has not detected a selector lever position of P or N
<b>0C</b>	Program Selector Switch - Pins 12, 13 and 45	Short in wiring, or more than one program selector switch input is applied to ground
<b>10</b>	Turbine Shaft Speed Sensor, Pins 16 and 44	No input, or incorrect engine speed information
<b>12</b>	Kickdown Switch - Pin 18	Shorted to Ground
<b>13</b>	ASC Monitoring - Pin 19	ASC operation has been detected while selector lever was in Park or Neutral position
<b>16</b>	TOT Sensor - Pins 21 and 22	Resistance of TOT Sensor not within permissible range
<b>1A</b>	Battery Voltage Supply - Pin 26	Break in wiring
<b>1E</b>	MV 1 Solenoid - Pin 30	Break or short in wiring, or defective winding in solenoid
<b>1F</b>	MV 4 Solenoid - Pin 31	Break or short in wiring, or defective winding in solenoid
<b>20</b>	MV 3 Solenoid - Pin 32	Break or short in wiring, or defective winding in solenoid
<b>21</b>	MV 2 Solenoid - Pin 33	Break or short in wiring, or defective winding in solenoid
<b>23</b>	Throttle Position Sensor - Pin 35	Break or short in wiring, or defective sensor
<b>24</b>	Selector Lever Position L1 - Pin 36	Break or short in wiring, or defective sensor
<b>2A</b>	Output Speed Sensor signal - Pins 13 and 42	No input, or incorrect output speed information
<b>2b</b>	Engine Speed Signal - Pin 43	Questionable signal, or break or short in wiring
<b>35</b>	Power Supply to transmission - Pin 52	Break or short in wiring, or defective TCU

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Figure 56

### BMW ZF-5HP-18 FAULT CODE CHART

Code	Description (Pin No's Refer To TCM)	Possible Causes
36	Power Supply - Pin 54	Power Supply less than 9 volts at engine speeds greater than 1600 RPM
64	Speed Monitoring	Faulty Speed Sensor signal, or slip in Transmission
65	EPROM - Checksum	Program memory in Transmission Control Unit faulty
66	Incorrect Program Checksum	Program memory in Transmission Control Unit faulty
67	Transmission Relay - Pin 52	Pickup and dropout times too long
68	Engine Temp Sensor - Pin 35	Break or Short in wiring, or defective CTS
69	Throttle Position Sensor - Pin 35	TCU detected questionable TPS signal
6E	Basic Data Record	TCU has not been programmed
96	CAN Timeout 1	CAN signal not sent during initialization (Ignition On)
97	CAN Timeout 2	CAN signal not sent during operation
98	CAN Bus monitoring	Values in CAN RAM are not updated
99	CAN status fault	Control units with different CAN statuses are installed on CAN bus
9A	CAN throttle valve information	DME detects faulty throttle valve signal
9B	CAN load signal information	DME detects faulty load signal
9C	CAN engine intervention	DME cannot carry out reduction in engine torque desire by the EGS, or DME has different requirements compared to other CAN users
9D	CAN engine temperature info	DME detects faulty engine temperature signal
9E	CAN engine speed information	DME detects faulty engine speed signal

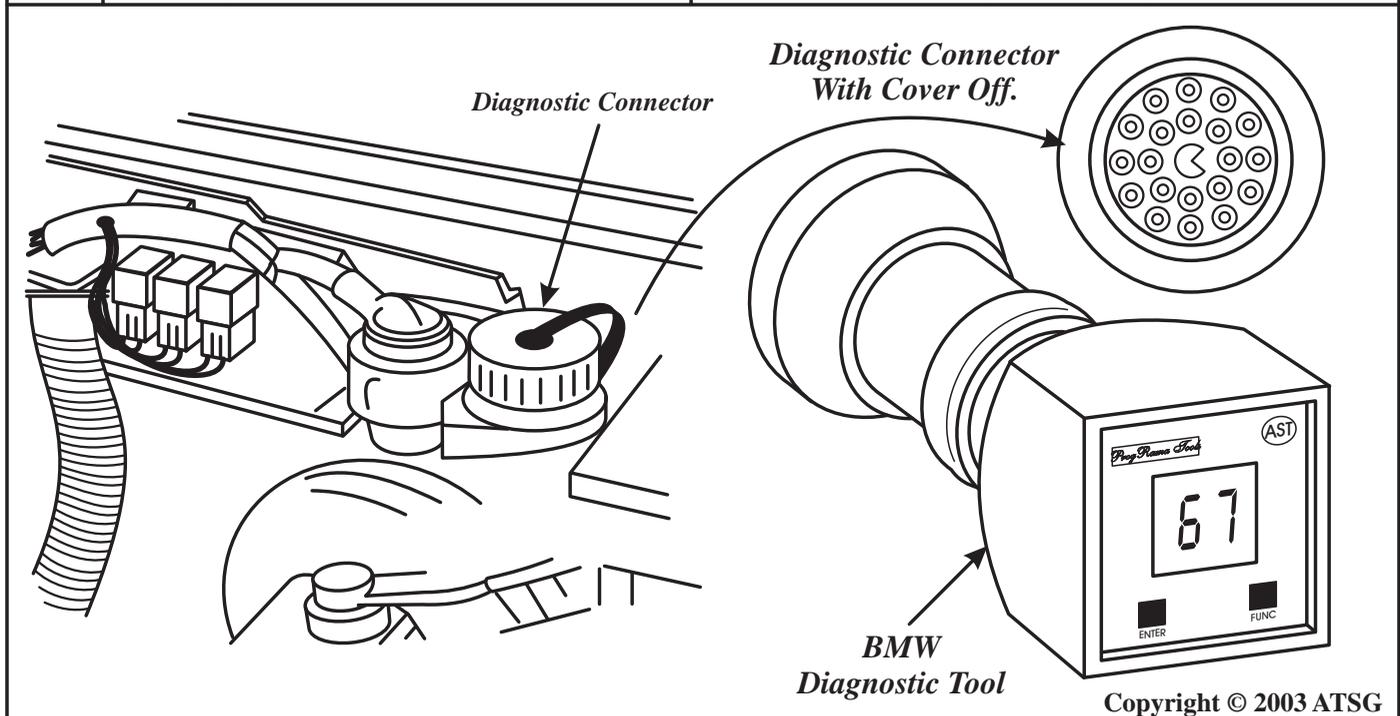


Figure 57

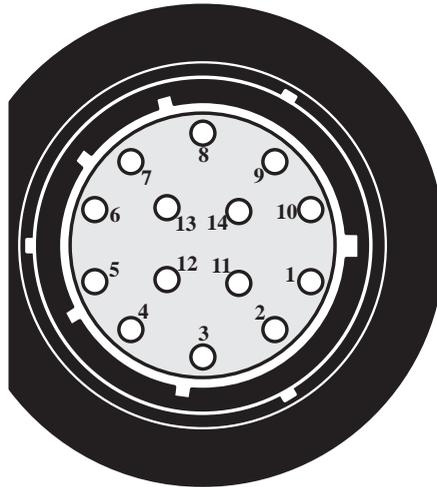
# TECHNICIANS DIAGNOSTIC GUIDE

## BMW, AUDI, PORSCHE

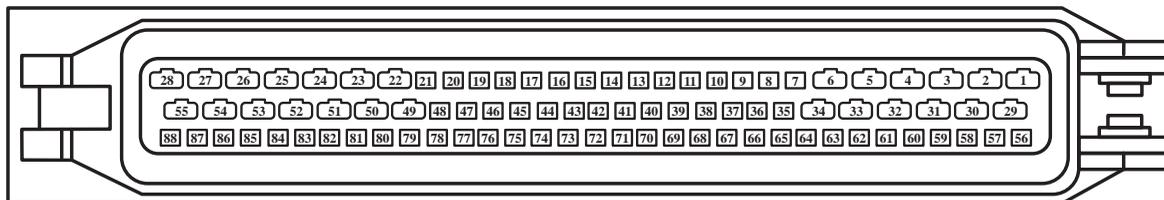
### SOLENOID AND SENSOR RESISTANCE CHART

Solenoid	Case Connector	Control Unit Connector	Resistance In Ohms
	Pin Numbers - +	Pin Numbers - +	
MV 1	8 and 13	30 and 52	30 - 34 Ω
MV 2	9 and 13	33 and 52	30 - 34 Ω
MV 3	4 and 13	32 and 52	30 - 34 Ω
MV 4	3 and 13	31 and 52	30 - 34 Ω
MV 5	7 and 13	3 and 52	30 - 34 Ω
MV 6	11 and 13	4 and 52	30 - 34 Ω
EDS 1	2 and 13	5 and 52	5.2 - 6.8 Ω
TOT	12 and 14	21 and 22	970 Ω at 72°F
TSS	1 and 10	44 and 16	265 Ω (72°F)
OSS	5 and 6	14 and 42	265 Ω (72°F)

*View Looking Into Case  
Connector Setting In The vehicle*



### *Electronic Control Unit Connector Pin Identification*



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Figure 58

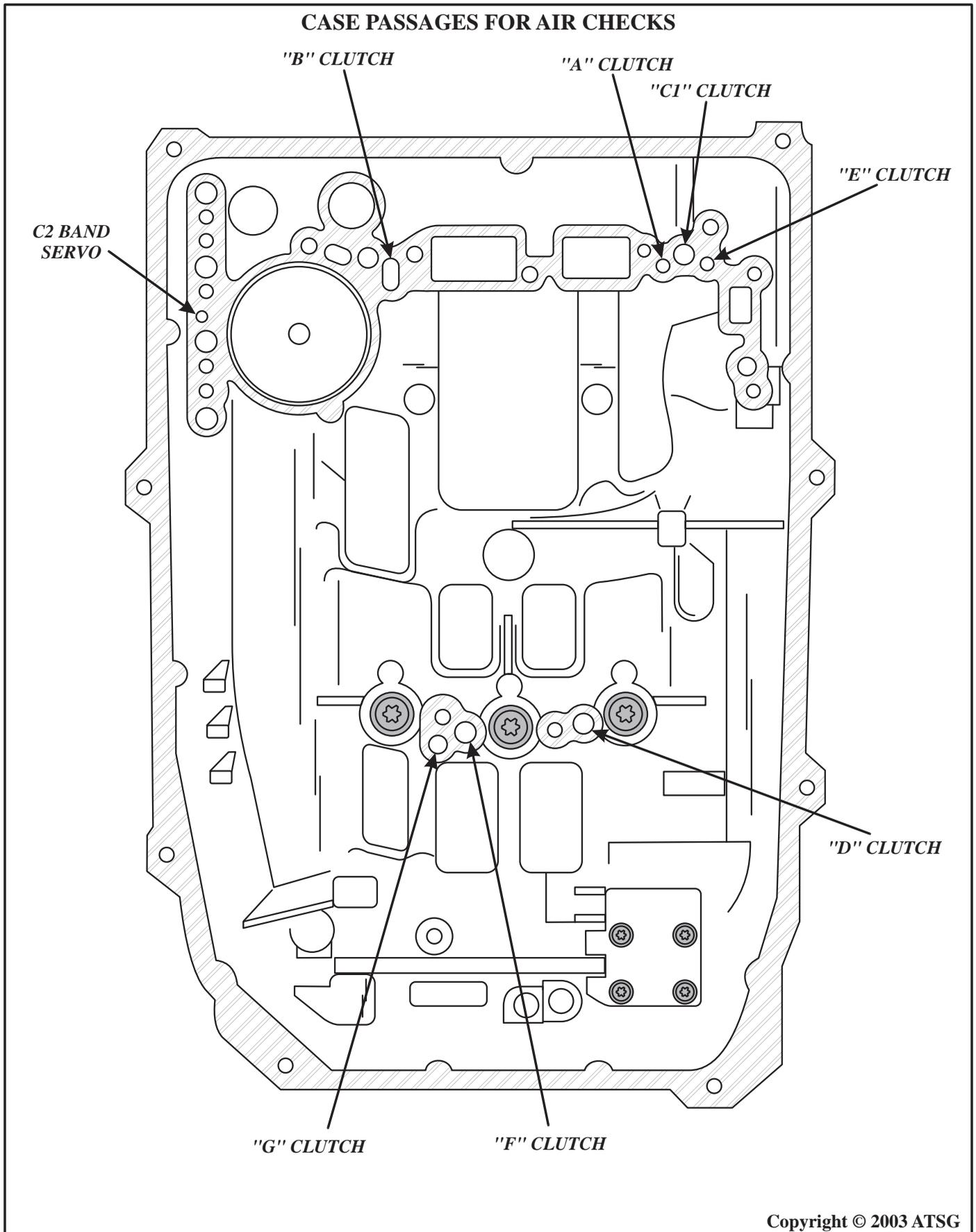


Figure 59

**PRESSURE TAP LOCATIONS**

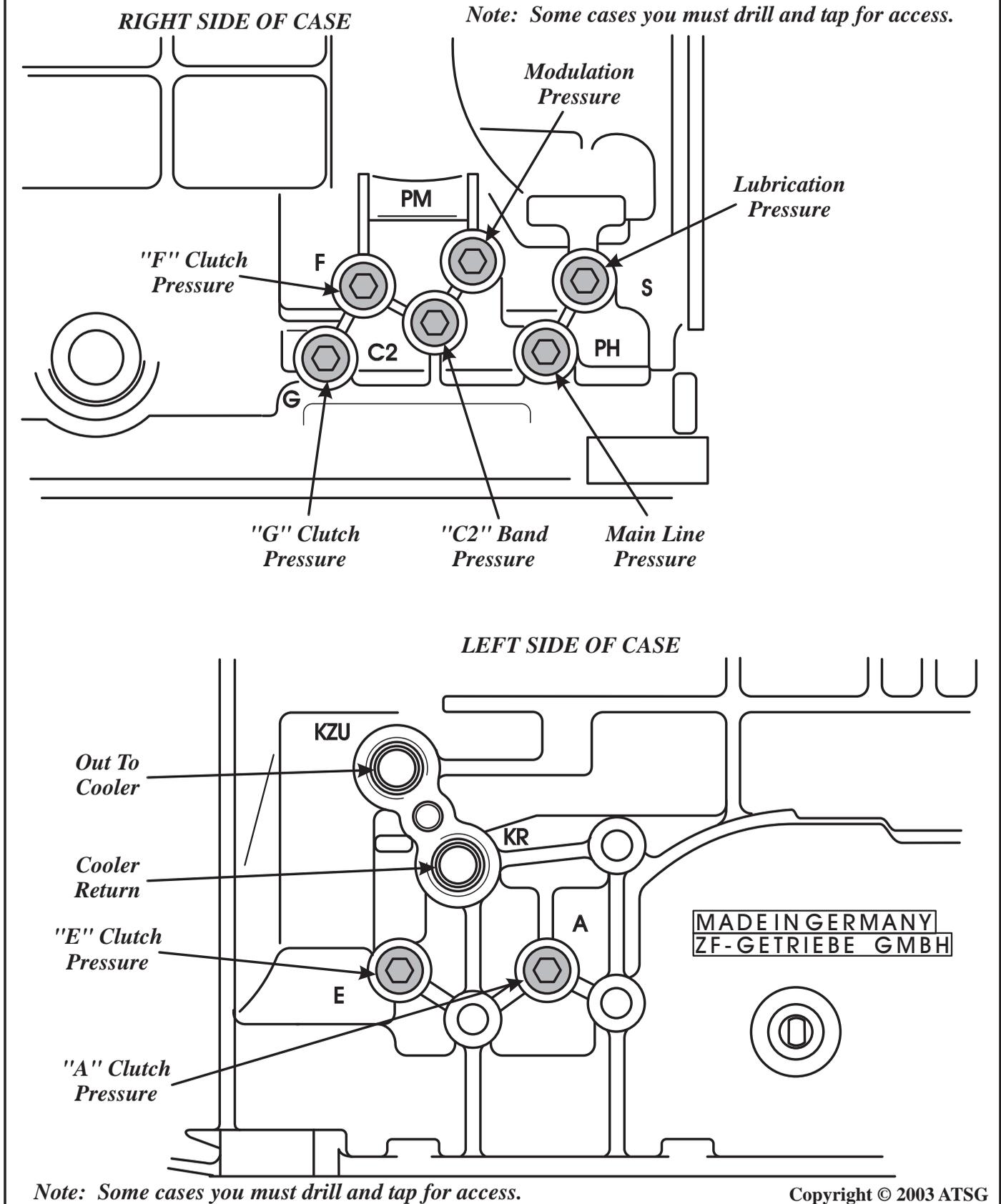
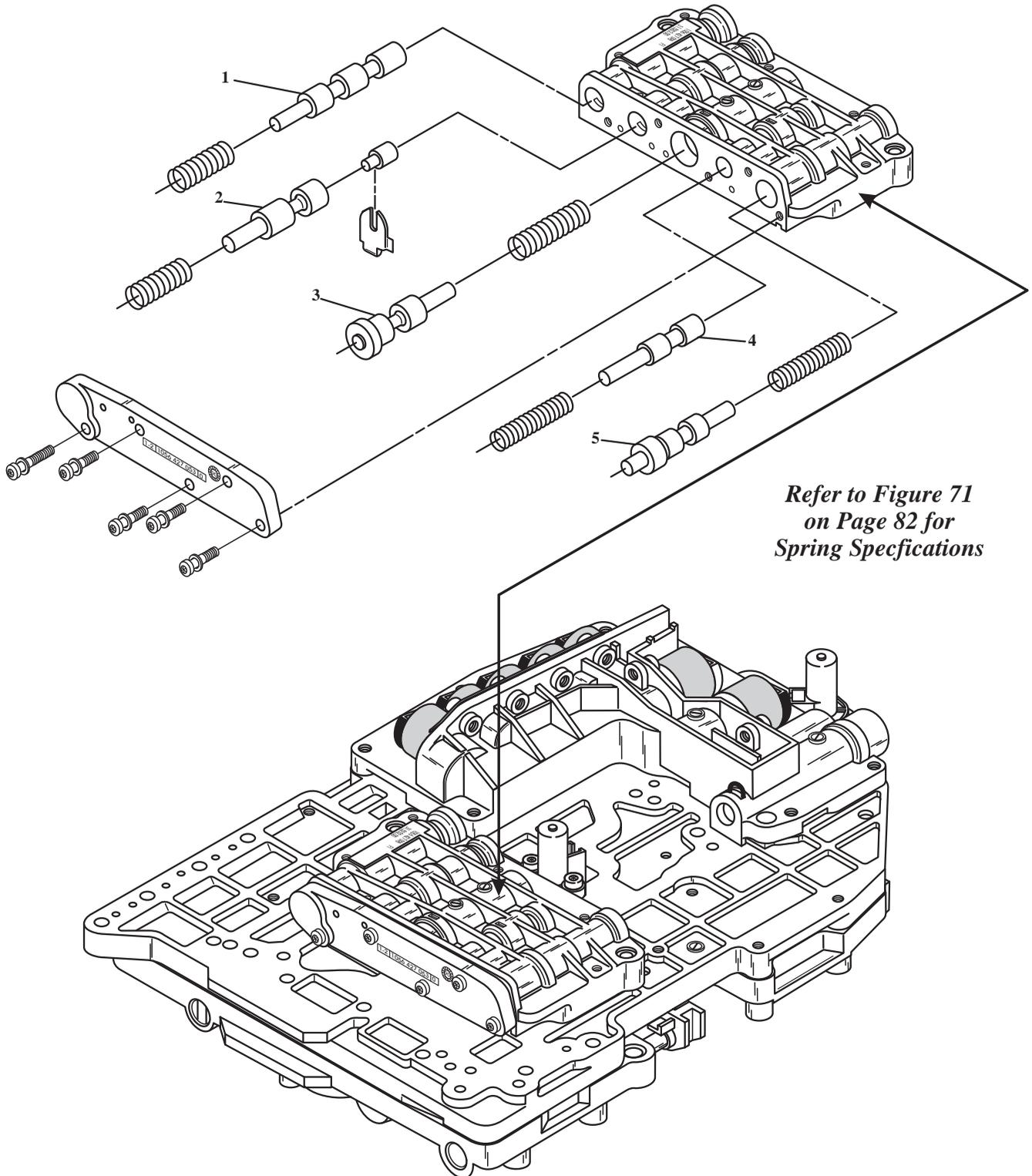


Figure 60

**UPPER FRONT VALVE BODY**



*Refer to Figure 71  
on Page 82 for  
Spring Specifications*

- 1. Torque Converter Valve
- 2. Lubrication Valve Train
- 3. Lock-Up Control Valve
- 4. 5-4 Traction Valve

Figure 61

**SOLENOID BODY, SPEED SENSORS AND CHANNEL PLATE**

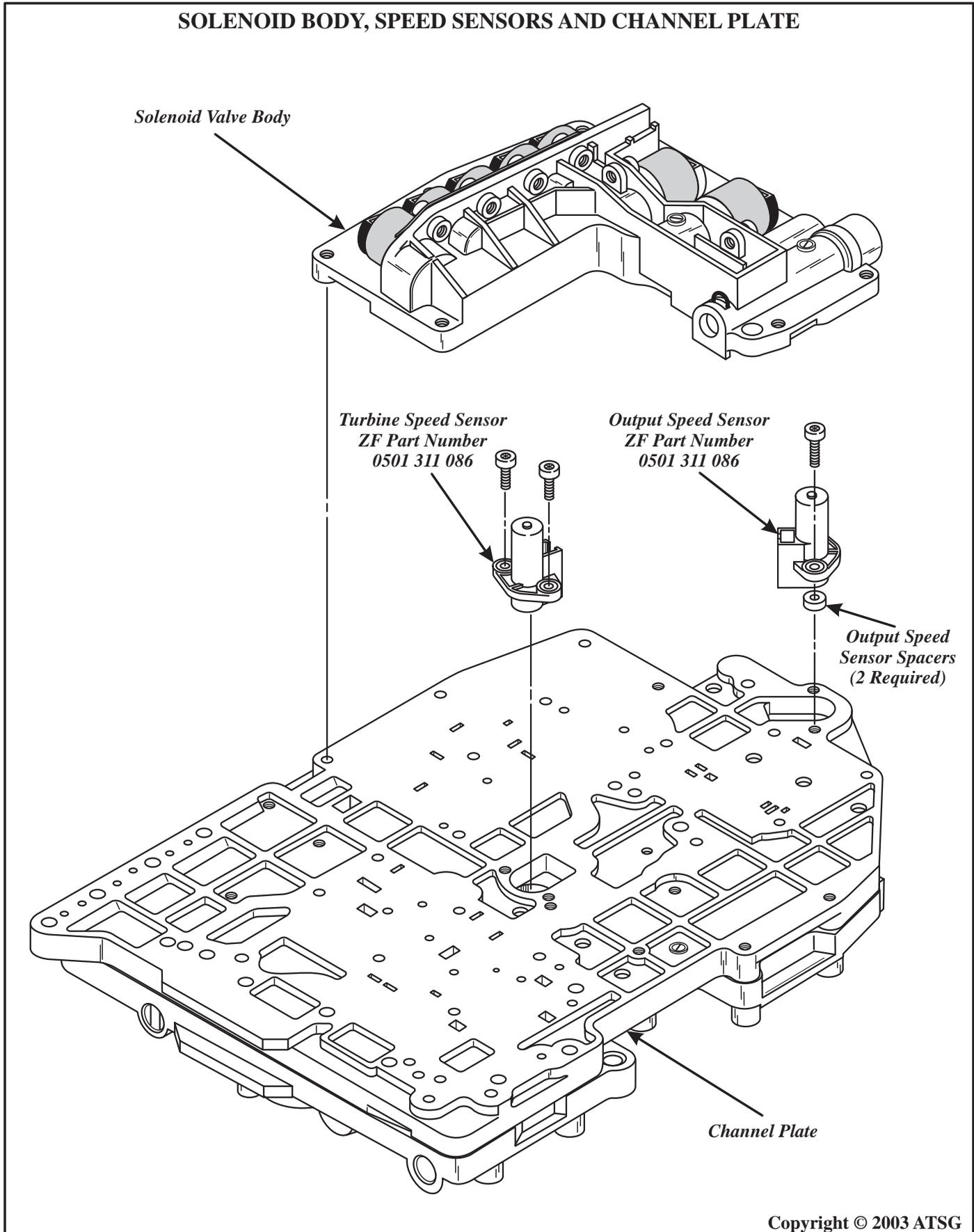
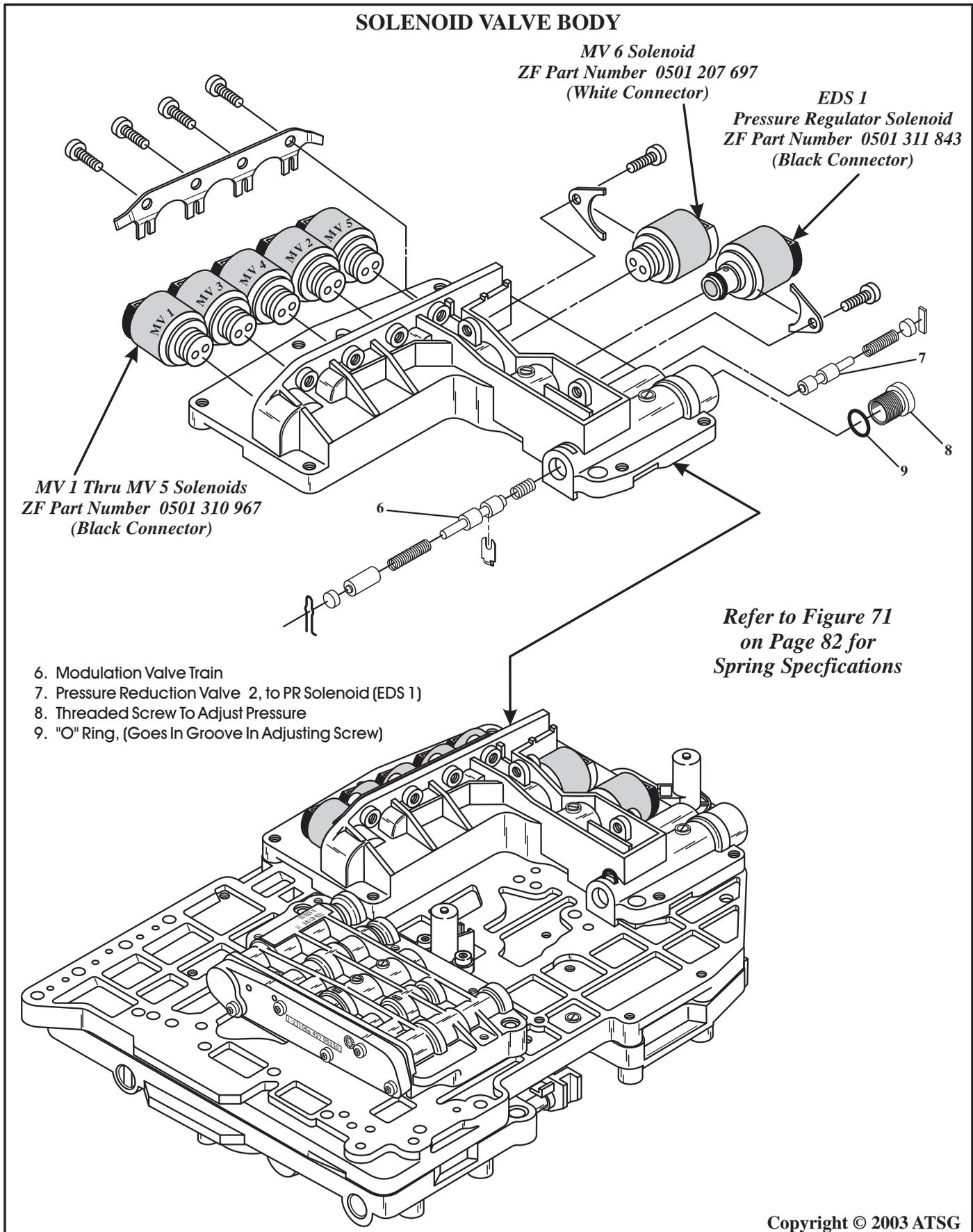


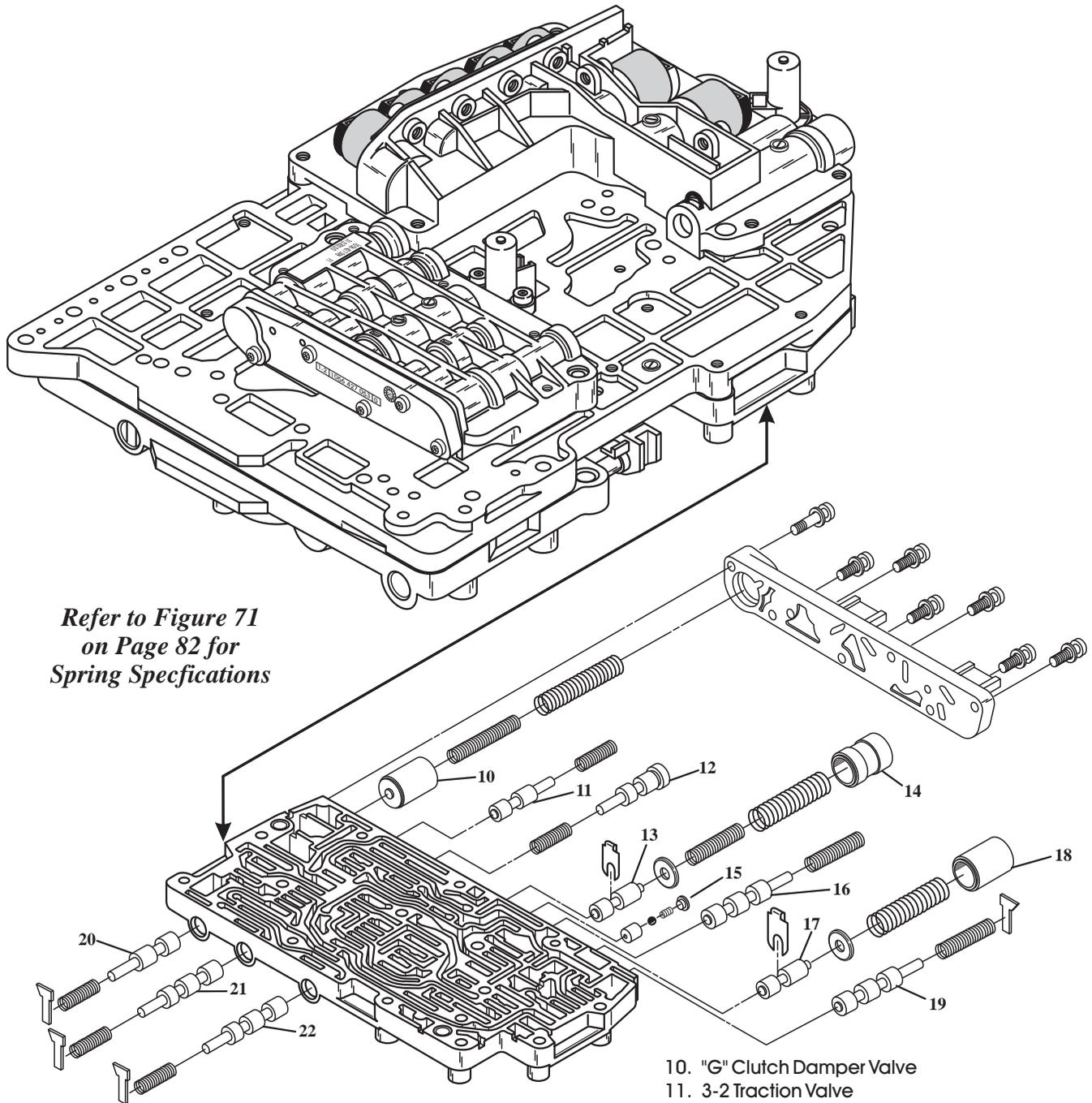
Figure 62



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Figure 63

**LOWER REAR VALVE BODY**



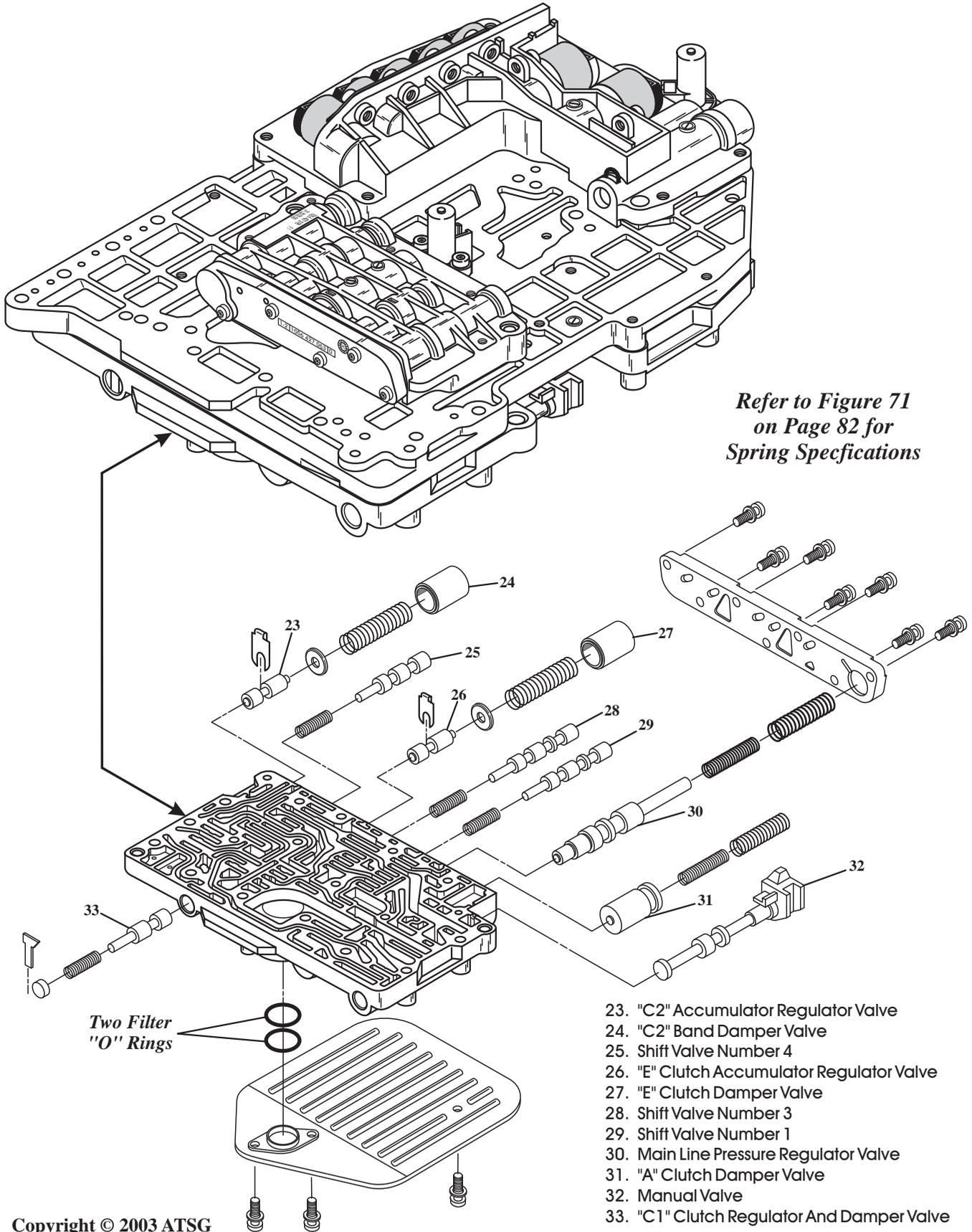
*Refer to Figure 71  
on Page 82 for  
Spring Specifications*

- 10. "G" Clutch Damper Valve
- 11. 3-2 Traction Valve
- 12. 2-3 Traction Valve
- 13. "D" Clutch Accumulator Regulator Valve
- 14. "D" Clutch Damper Valve
- 15. "D" Clutch One-Way Check Valve Assembly
- 16. Reverse Lock-Out Valve
- 17. "F" Clutch Accumulator Regulator Valve
- 18. "F" Clutch Damper Valve
- 19. Shift Valve Number 2
- 20. Pressure Reduction Valve For MV 1 thru MV 6
- 21. Traction Coast Valve Number 2
- 22. Traction Coast Valve Number 1

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Figure 64

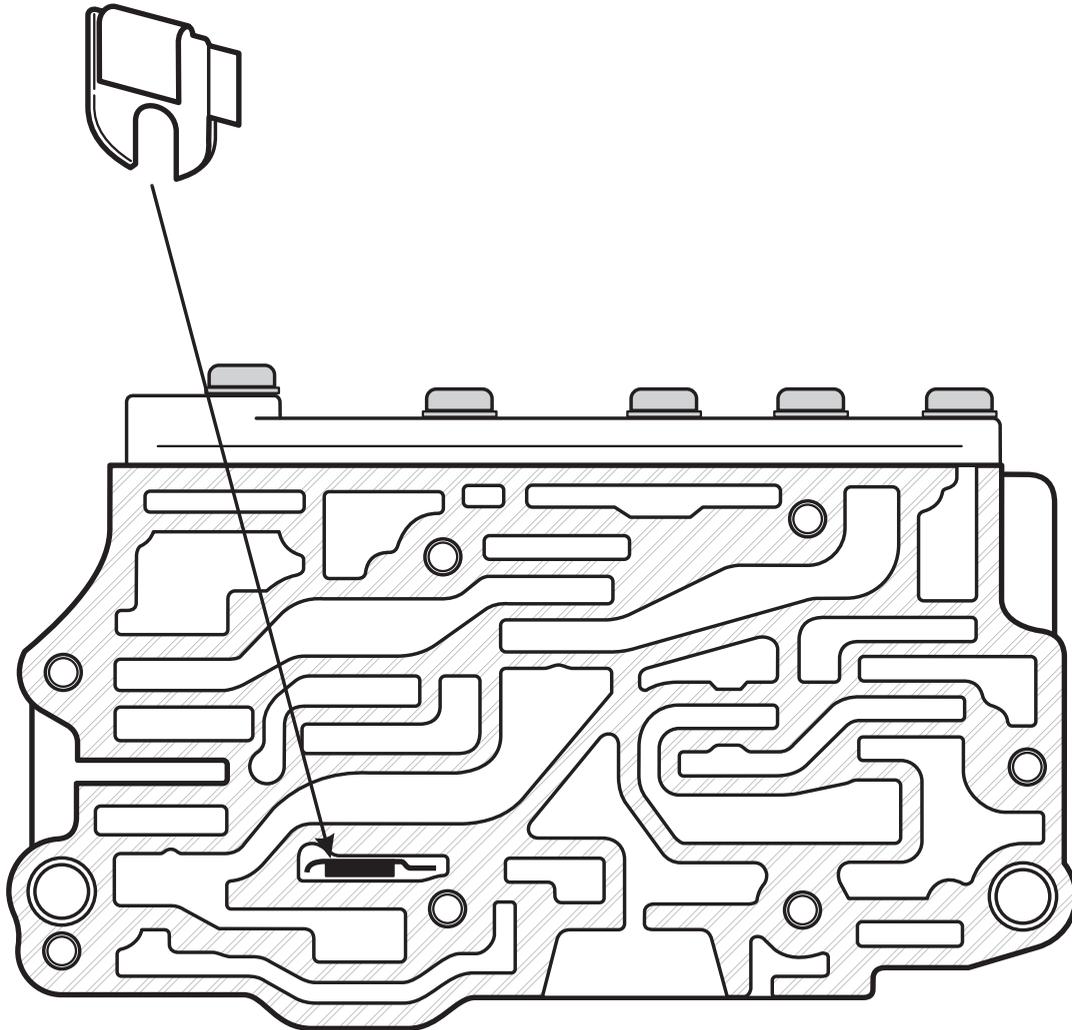
**LOWER FRONT VALVE BODY**



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Figure 65

**ZF 5HP-18  
UPPER FRONT VALVE BODY CLIP LOCATIONS**



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Figure 66

**ZF 5HP-18**  
**LOWER FRONT VALVE BODY CLIP LOCATIONS**

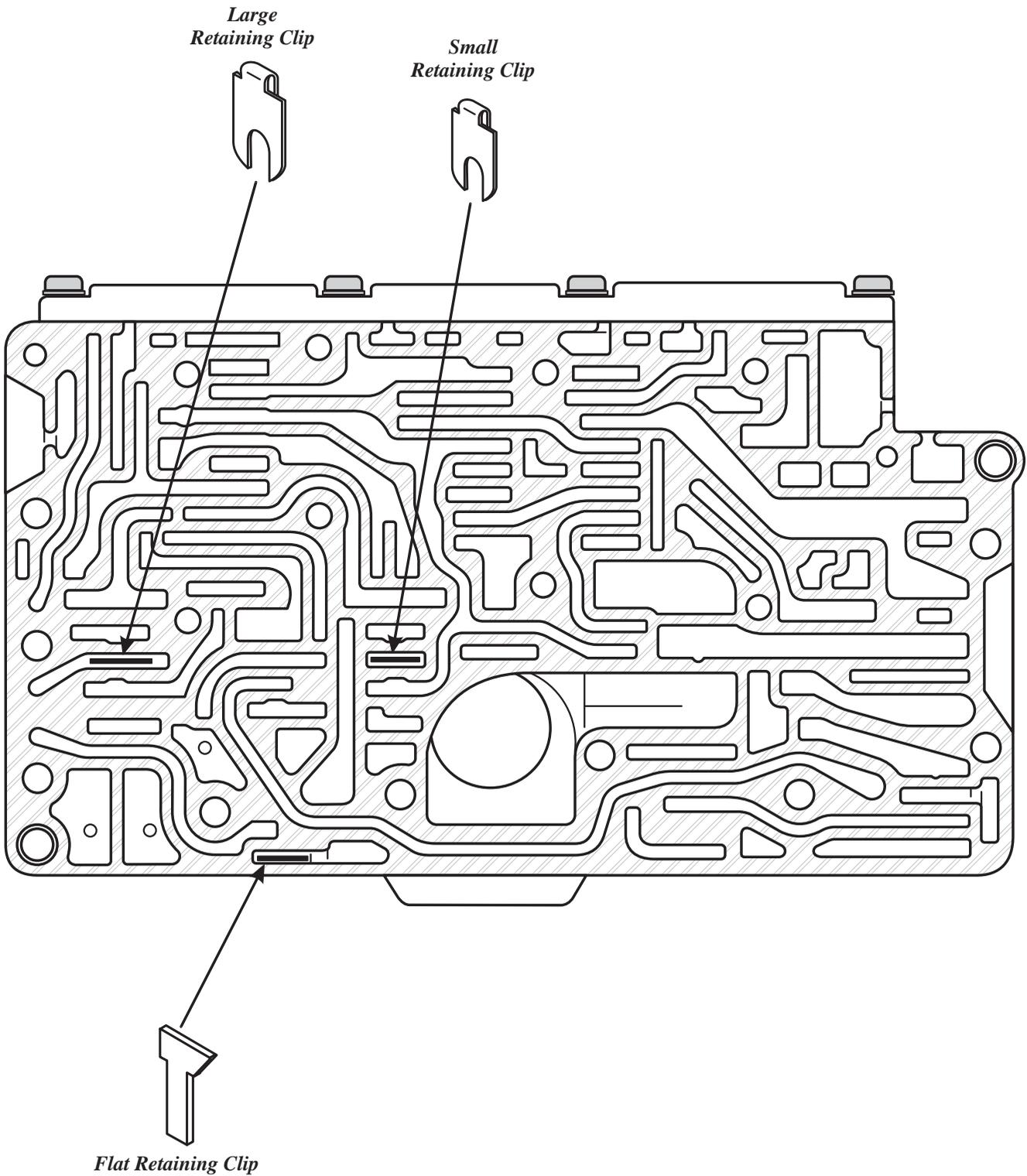


Figure 67

**ZF 5HP-18**  
**LOWER REAR VALVE BODY CLIP LOCATIONS**

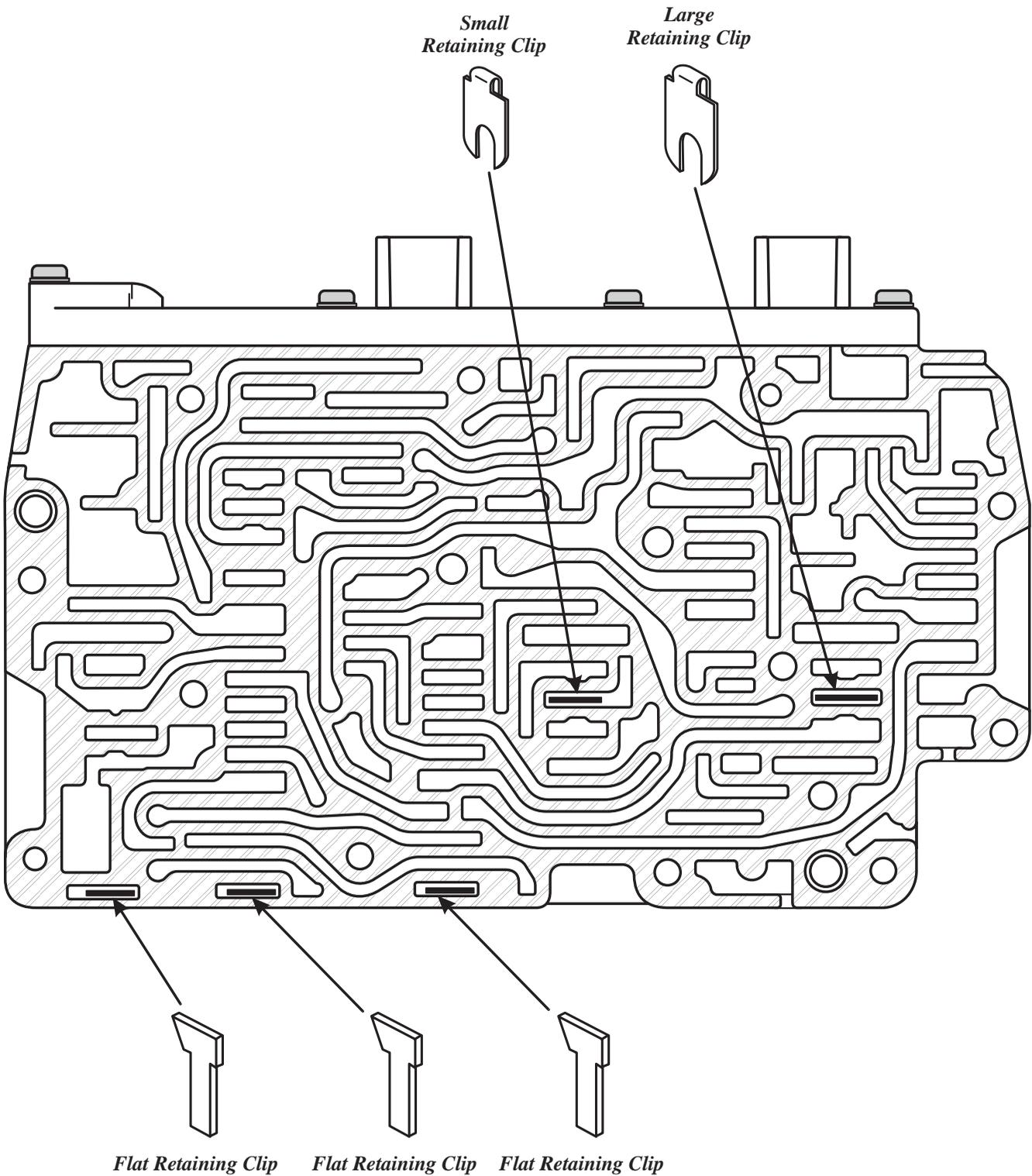


Figure 68

**ZF 5HP-18  
SOLENOID VALVE BODY CLIP LOCATIONS**

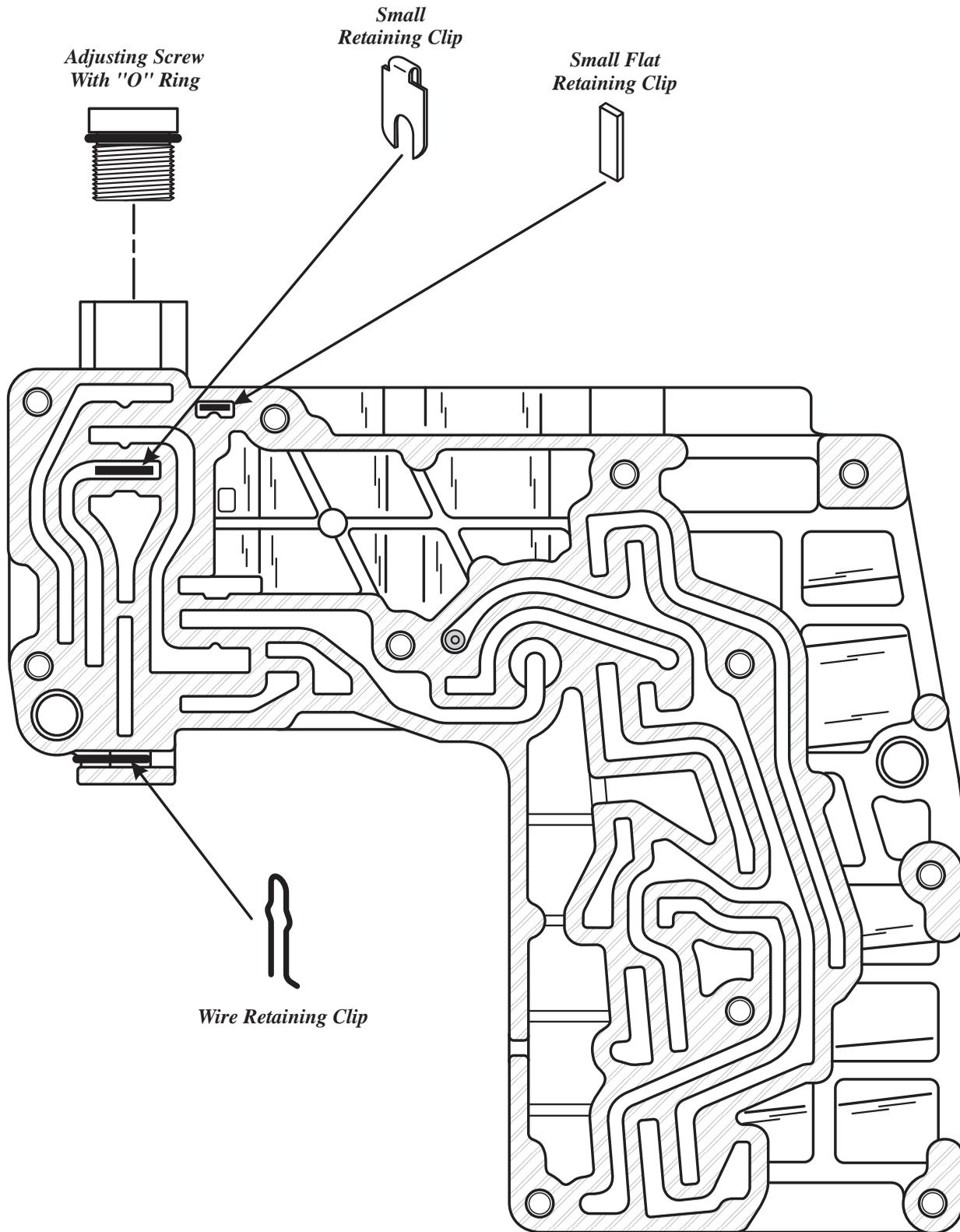


Figure 69

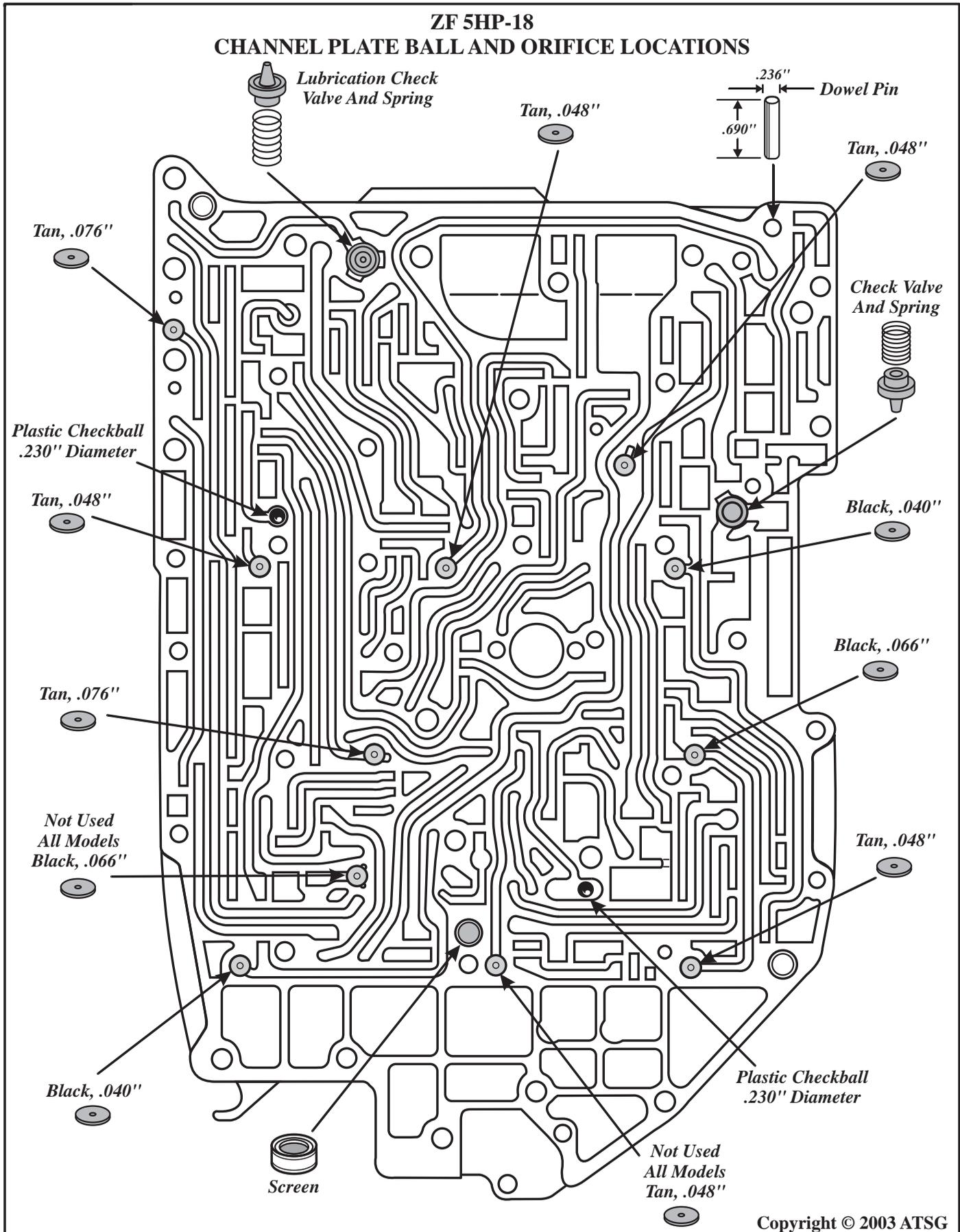


Figure 70

### ZF 5HP-18FL SPRING SPECIFICATIONS

#### UPPER FRONT VALVE BODY

(1) TORQUE CONVERTER VALVE  
FREE LENGTH = 1.710"  
SPRING DIAMETER = .430"  
WIRE DIAMETER = .030"

(2) LUBRICATION VALVE  
FREE LENGTH = 1.774"  
SPRING DIAMETER = .445"  
WIRE DIAMETER = .043"

(3) LOCK-UP CONTROL VALVE  
FREE LENGTH = 1.550"  
SPRING DIAMETER = .430"  
WIRE DIAMETER = .038"

(4) 5-4 TRACTION VALVE  
FREE LENGTH = 1.900"  
SPRING DIAMETER = .360"  
WIRE DIAMETER = .030"

(5) 4-5 TRACTION VALVE  
FREE LENGTH = 1.630"  
SPRING DIAMETER = .360"  
WIRE DIAMETER = .030"

#### SOLENOID VALVE BODY

(6) MODULATION VALVE  
FREE LENGTH = 1.400"  
SPRING DIAMETER = .305"  
WIRE DIAMETER = .038"

(6) MOD. VALVE (ADJUST SIDE)  
FREE LENGTH = .780"  
SPRING DIAMETER = .305"  
WIRE DIAMETER = .026"

(7) PRES REDUCING VALVE 2  
FREE LENGTH = 1.560"  
SPRING DIAMETER = .350"  
WIRE DIAMETER = .043"

#### LOWER REAR VALVE BODY

(10) "G" DAMPER PIST (INNER)  
FREE LENGTH = 3.900"  
SPRING DIAMETER = .368"  
WIRE DIAMETER = .028"

(10) "G" DAMPER PIST (OUTER)  
FREE LENGTH = 4.120"  
SPRING DIAMETER = .590"  
WIRE DIAMETER = .042"

(11) 3-2 TRACTION VALVE  
FREE LENGTH = 1.625"  
SPRING DIAMETER = .373"  
WIRE DIAMETER = .035"

(12) 2-3 TRACTION VALVE  
FREE LENGTH = 1.770"  
SPRING DIAMETER = .356"  
WIRE DIAMETER = .023"

(14) "D" DAMPER PIST (INNER)  
FREE LENGTH = 1.565"  
SPRING DIAMETER = .430"  
WIRE DIAMETER = .039"

(14) "D" DAMPER PIST (OUTER)  
FREE LENGTH = 2.925"  
SPRING DIAMETER = .592"  
WIRE DIAMETER = .043"

(16) REVERSE LOCKOUT VALVE  
FREE LENGTH = 1.820"  
SPRING DIAMETER = .440"  
WIRE DIAMETER = .039"

(18) "F" DAMPER PISTON  
FREE LENGTH = 3.475"  
SPRING DIAMETER = .568"  
WIRE DIAMETER = .039"

(19) SHIFT VALVE 2  
FREE LENGTH = 1.780"  
SPRING DIAMETER = .365"  
WIRE DIAMETER = .030"

(20) PRES REDUCING VALVE 1  
FREE LENGTH = 1.470"  
SPRING DIAMETER = .378"  
WIRE DIAMETER = .043"

(21) TRACTION VALVE 2  
FREE LENGTH = 1.780"  
SPRING DIAMETER = .360"  
WIRE DIAMETER = .031"

(22) TRACTION VALVE 1  
FREE LENGTH = 1.780"  
SPRING DIAMETER = .360"  
WIRE DIAMETER = .031"

*Note: The number in front of the name of the valve line-up is the illustration number in the ATSG illustrations in this manual.*

*Note: There is now available from ZF distributors a "Valve Body Kit" for the 5HP-18 that includes all new stock springs, all check balls, all orifices and screens. ZF part number "5HP-18 VBK".*

#### LOWER FRONT VALVE BODY

(24) "C2" DAMPER PISTON  
FREE LENGTH = 3.425"  
SPRING DIAMETER = .585"  
WIRE DIAMETER = .031"

(25) SHIFT VALVE 4  
FREE LENGTH = 1.780"  
SPRING DIAMETER = .366"  
WIRE DIAMETER = .031"

(27) "E" DAMPER PISTON  
FREE LENGTH = 3.500"  
SPRING DIAMETER = .554"  
WIRE DIAMETER = .040"

(28) SHIFT VALVE 3  
FREE LENGTH = 1.776"  
SPRING DIAMETER = .365"  
WIRE DIAMETER = .031"

(29) SHIFT VALVE 1  
FREE LENGTH = 1.766"  
SPRING DIAMETER = .365"  
WIRE DIAMETER = .031"

(30) PRESSURE REG (INNER)  
FREE LENGTH = 3.150"  
SPRING DIAMETER = .448"  
WIRE DIAMETER = .048"

(30) PRESSURE REG (OUTER)  
FREE LENGTH = 2.930"  
SPRING DIAMETER = .600"  
WIRE DIAMETER = .048"

(31) "A" DAMPER PIST (INNER)  
FREE LENGTH = 2.880"  
SPRING DIAMETER = .442"  
WIRE DIAMETER = .048"

(31) "A" DAMPER PIST (OUTER)  
FREE LENGTH = 3.078"  
SPRING DIAMETER = .577"  
WIRE DIAMETER = .042"

(33) "C1" REGULATOR VALVE  
FREE LENGTH = 1.975"  
SPRING DIAMETER = .380"  
WIRE DIAMETER = .035"

Figure 71

**ZF-5HP-18**  
**NO MOVE OR DELAYED ENGAGEMENT**

**COMPLAINT:** Vehicles equipped with ZF5HP18 may exhibit a No movement or a delayed engagement condition, before or after overhaul.

**CAUSE:** The cause may be, that the "Bypass Ball," located in the pump as shown in Figure 72, may have shrunken down and traveled back through the pump passage leading to the Torque Converter Valve, sticking the valve in the "stroked" position (See Figure 73). When this valve is stuck in this position it may cause the Torque Converter to drain-back after sitting for a prolonged period of time. When the vehicle is started after sitting, it may take 10 to 15 minutes for the Torque Converter to fill back up, and this all depends on the positioning of the stuck Torque Converter Valve.

**CORRECTION:** Locate the Torque Converter Valve, as shown in Figure 74, and free the valve up, removing the shrunken Bypass Ball from binding the valves movement. Replace the assembly in pump body with a new one from ZF, available under ZF part number 1056-210-143, *if the capsule can be removed* from the pump body.

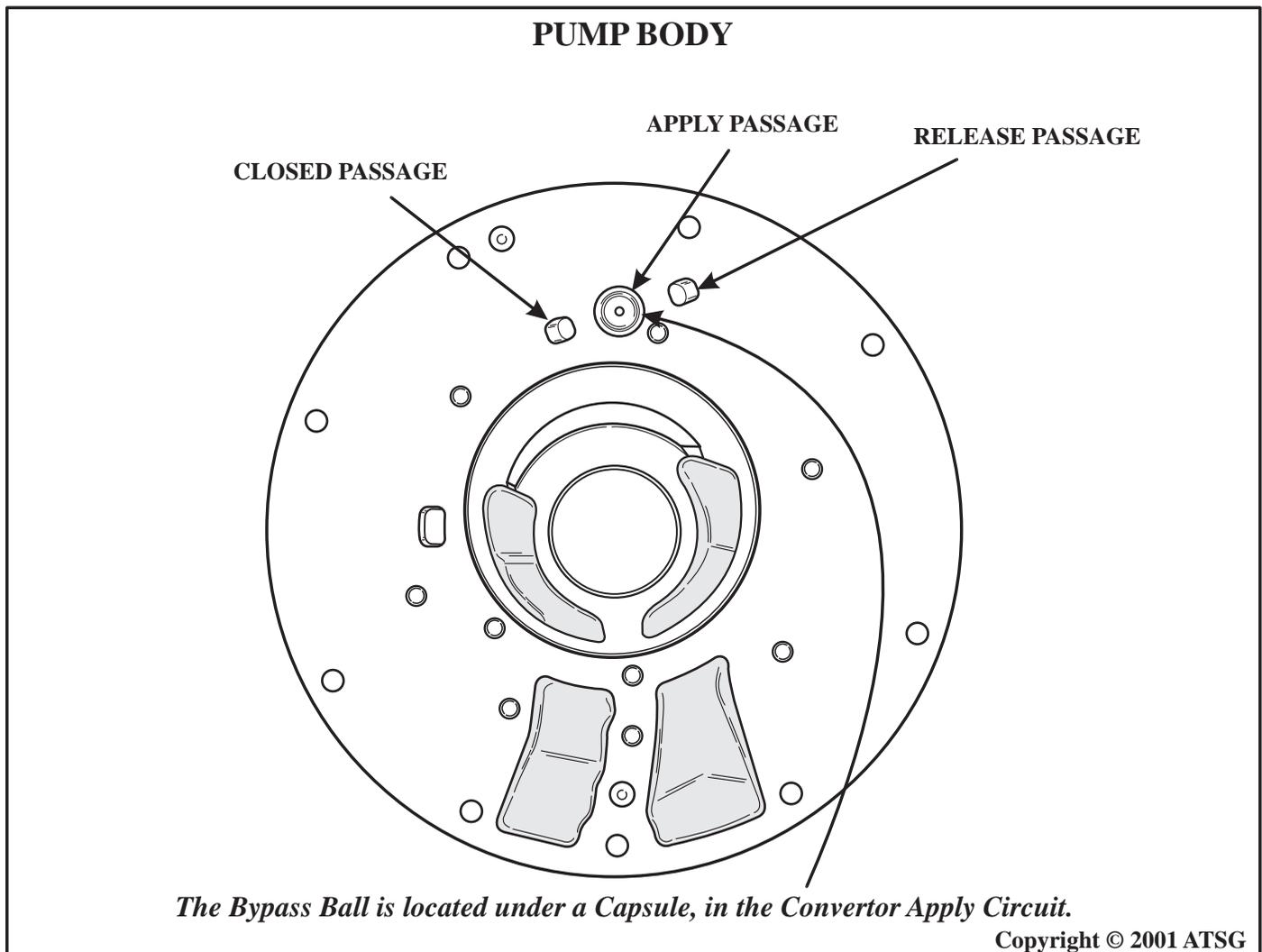
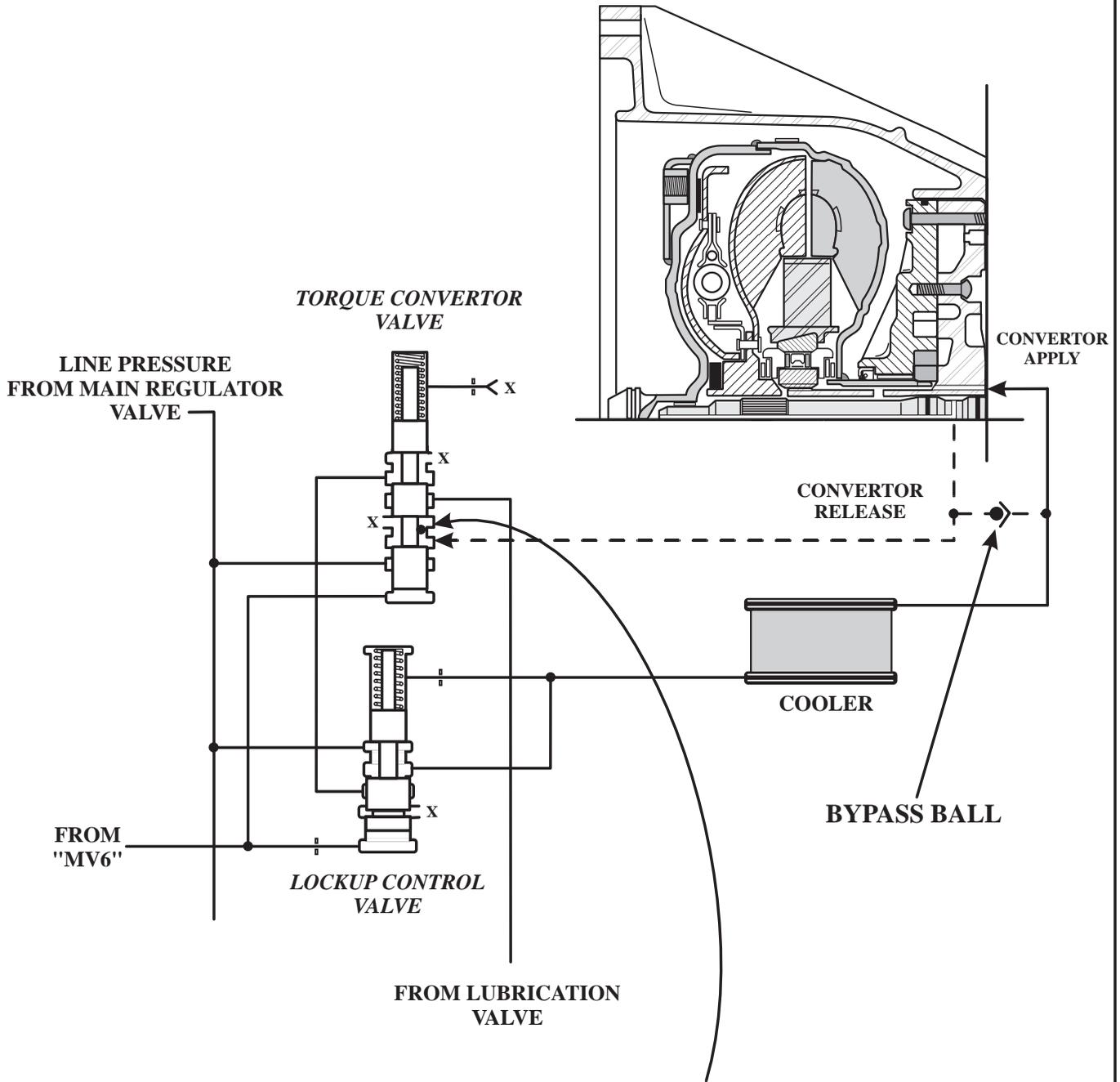


Figure 72

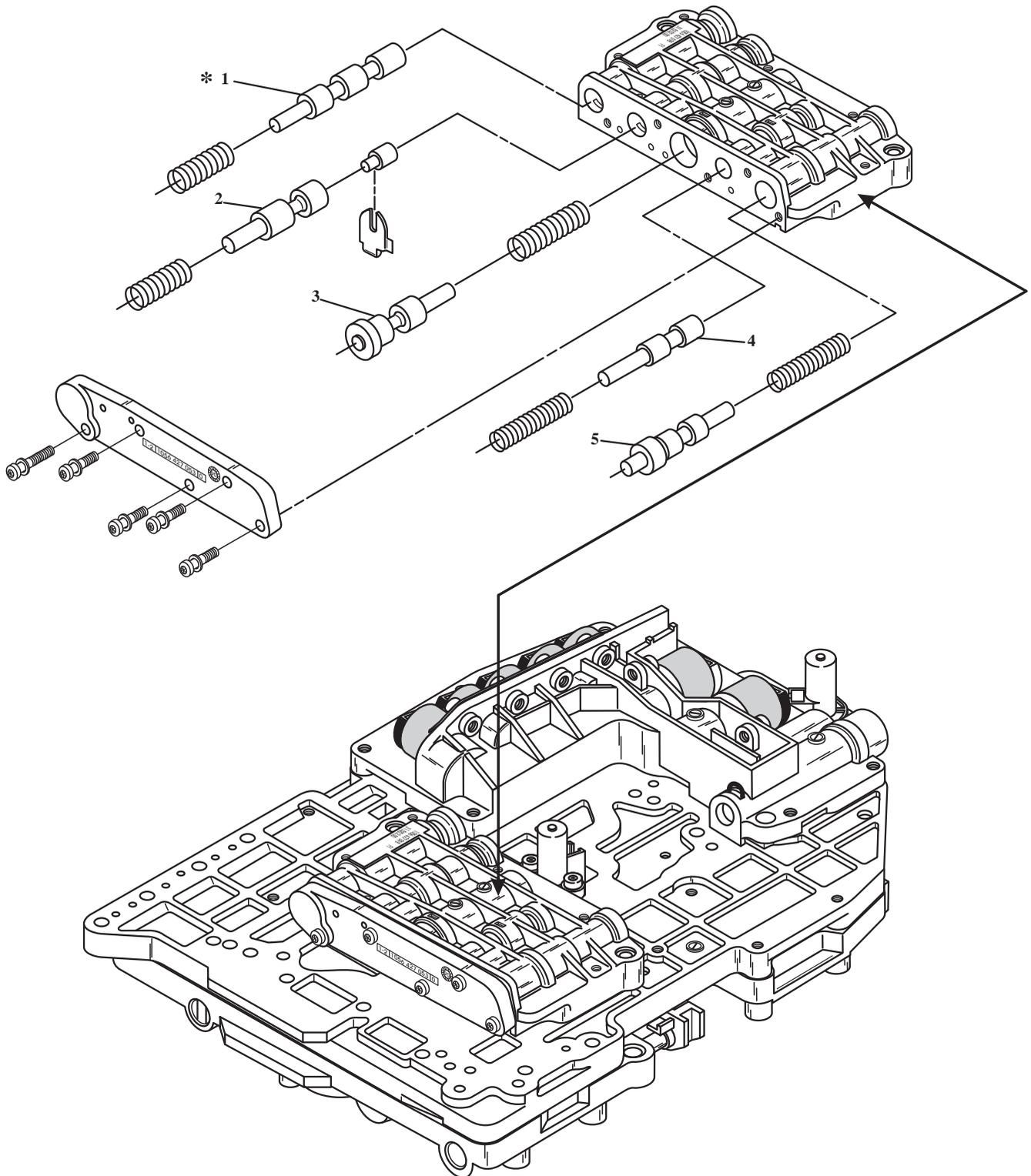
**LOCKUP HYDRAULIC CIRCUIT**



*The "Bypass Ball" shrinks and travels back through to the Torque Converter Valve and lodges itself in this passage, sticking the valve in this approximate position.*

Figure 73

**ZF-5HP-18 UPPER FRONT VALVE BODY**



- \*1. Torque Converter Valve
- 2. Lubrication Valve Train
- 3. Lock-Up Control Valve
- 4. 5-4 Traction Valve

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Figure 74

**ZF-5HP-18  
"BIND-UP" WITH SELECTOR IN  
MANUAL "2" POSITION, 1st GEAR**

**COMPLAINT:** Before or after overhaul, vehicles equipped with ZF-5HP-18, may exhibit a "Bind-Up" condition in the Manual "2" position, 1st gear.

**CAUSE:** The cause may be, the plastic "D" Clutch One-way Check Valve assembly located in the Lower Rear valve body, shown in Figure 76, may be broken allowing the "B" Clutch (Reverse Input Clutch) to be on while the "D" Clutch (Low/Reverse Clutch) is on in 1st gear.

**CORRECTION:** Replace the "D" Clutch One-way Check Valve assembly , as shown in Figure 75, with a new assembly, part number 1043 226 028 from ZF, or a new "Aluminum" check valve assembly offered by Mario Aristides. Phone (305) 666-3544 or Fax (305) 666-8238.

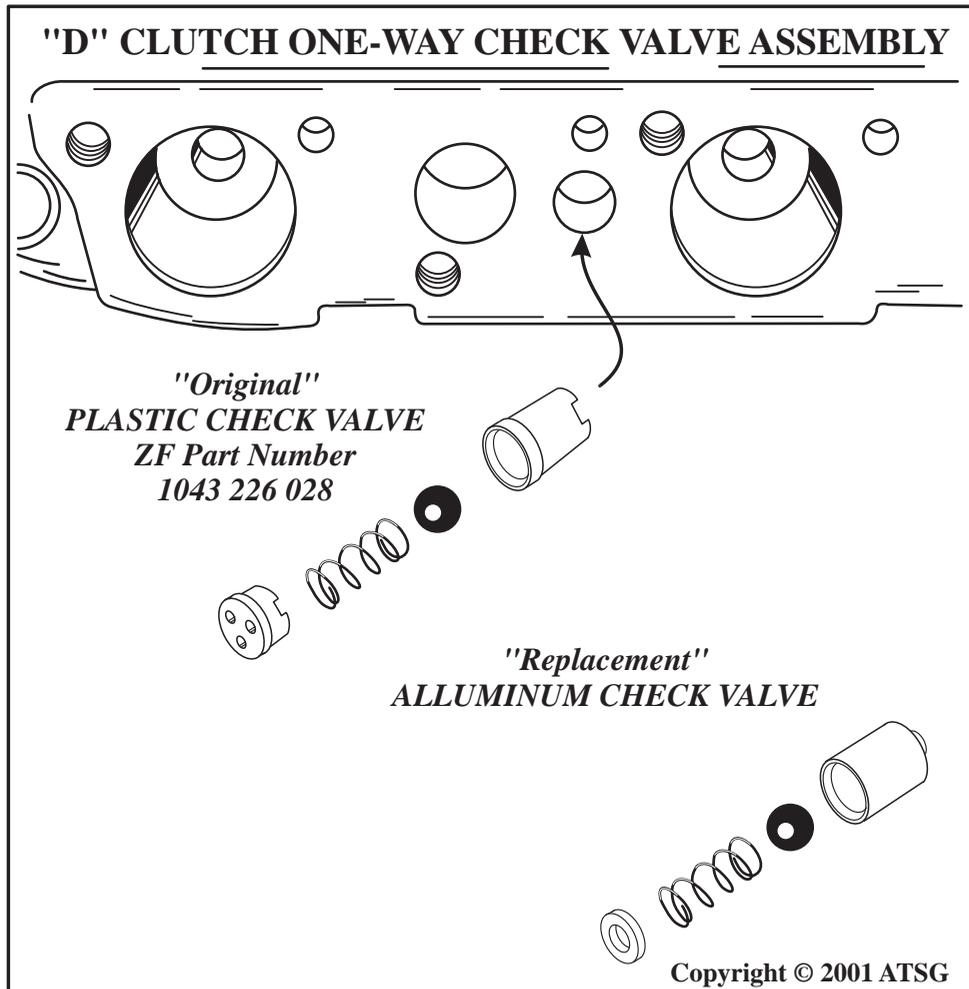
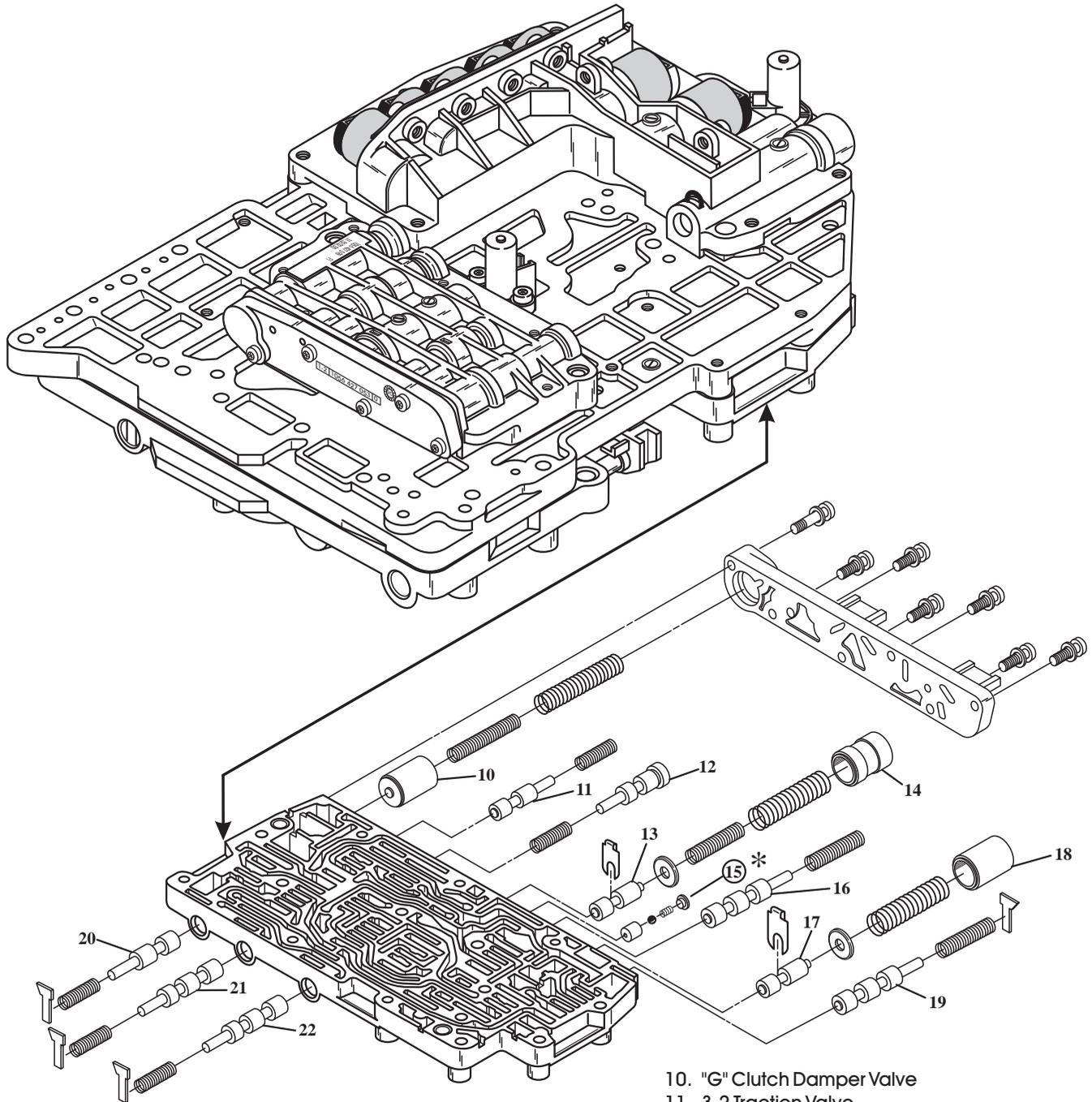


Figure 75

**LOWER REAR VALVE BODY**

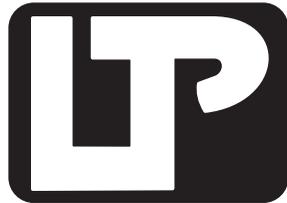


- 10. "G" Clutch Damper Valve
- 11. 3-2 Traction Valve
- 12. 2-3 Traction Valve
- 13. "D" Clutch Accumulator Regulator Valve
- 14. "D" Clutch Damper Valve
- \* 15. "D" Clutch One-Way Check Valve Assembly
- 16. Reverse Lock-Out Valve
- 17. "F" Clutch Accumulator Regulator Valve
- 18. "F" Clutch Damper Valve
- 19. Shift Valve Number 2
- 20. Pressure Reduction Valve For MV 1 thru MV 6
- 21. Traction Coast Valve Number 2
- 22. Traction Coast Valve Number 1

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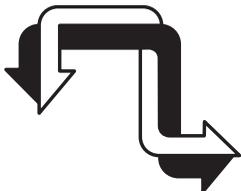
Figure 76

*We wish to thank the following for supplying the actual valve bodies that have made these illustrations possible.*



**LORY**  
**TRANSMISSION**  
**PARTS**

**2414 SW 8TH STREET**  
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**146 B ELM STREET**  
**OLD SAYBROOK, CT 06475**

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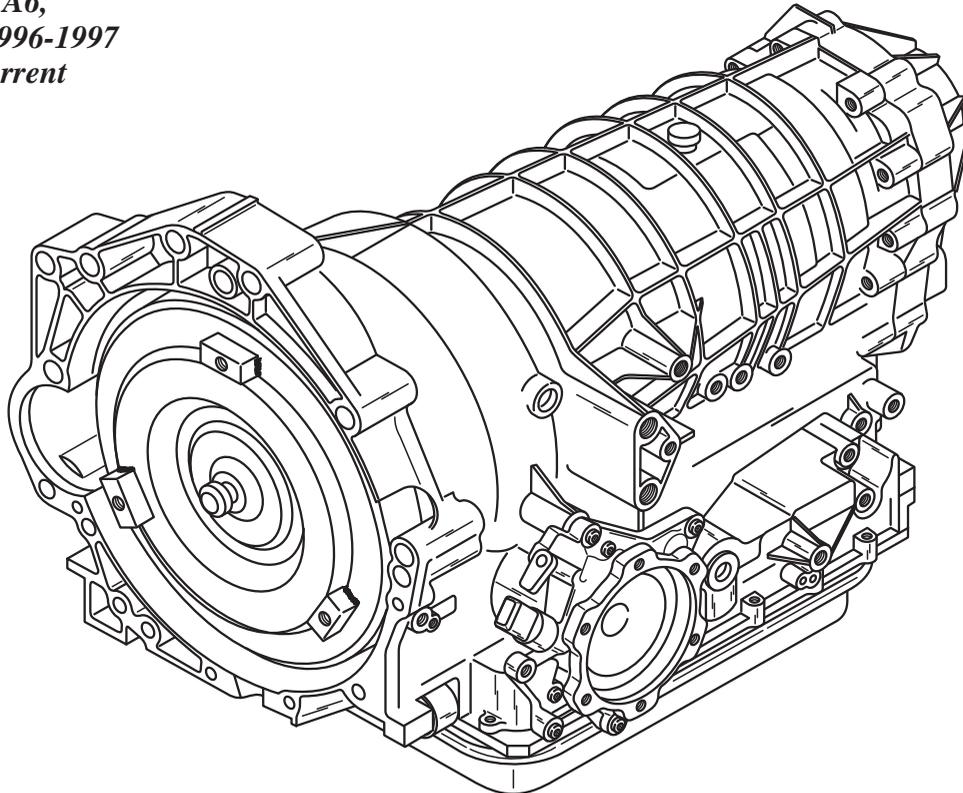
**INDEPENDENT TRANSMISSION SERVICE**  
**AND MARIO ARISTIDES**

**5846 SW 68TH STREET**  
**SOUTH MIAMI, FLORIDA 33143**  
**PHONE (305) 666-3544**  
**PHONE (305) 666-4208**  
**FAX (305) 666-8238**

**BMW ZF-5HP-19FL**  
**DIAGNOSTIC INFORMATION**

**FOUND IN:**

*BMW 97-Current, 3 Series E46, 5 Series E39, 7 Series E38.*  
*Audi 95-Current, A4, A8,*  
*Audi 97-Current, A6,*  
*Porsche Boxter 1996-1997*  
*VW Passat 96-Current*



*This transmission is manufactured in Germany by ZF and carries the designation ZF-5HP-19..*  
*The ZF-5HP-19 Series is an electronically controlled, five speed automatic transmission with a lock-up clutch type torque converter. Two planetary gear sets, one Ravigneaux gear set and one standard planetary gear set on the output side, four rotating multiple disc clutches, three multiple disc brake clutches, and one sprag clutch (Freewheel) are used to provide the five forward speeds and reverse.*

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Figure 77



## **TECHNICIANS DIAGNOSTIC GUIDE**

### **BMW, AUDI, PORSCHE**

*Refer to Figure 78 for Clutch and Band Application Chart.*

*Refer to Figure 79 and 80 for Manual Shift Lever Operation, and Failsafe Operation.*

*Refer to Figures 81, 82, and 83 for Solenoid identification and both MV Solenoid Operation and EDS Solenoid Operation and Tests.*

*Refer to Figure 84 for wiring harness identification, internal wiring schematic, and transmission case connector pin identification and functions.*

*Refer to Figure 85 for Shift Solenoid Application chart. Notice that EDS 1 Solenoid is used for line pressure control, and EDS 4 is used for converter clutch.*

*Refer to Figure 86 for internal components resistance chart, with the pins identified for both the transmission case connector and the Electronic Control Unit.*

*Refer to Figure 87 for Upper Front Valve Body exploded view and identification of valves.*

*Refer to Figure 88 for Upper Rear Valve Body exploded view and identification of valves.*

*Refer to Figure 89 for Lower Front Valve Body exploded view and identification of valves.*

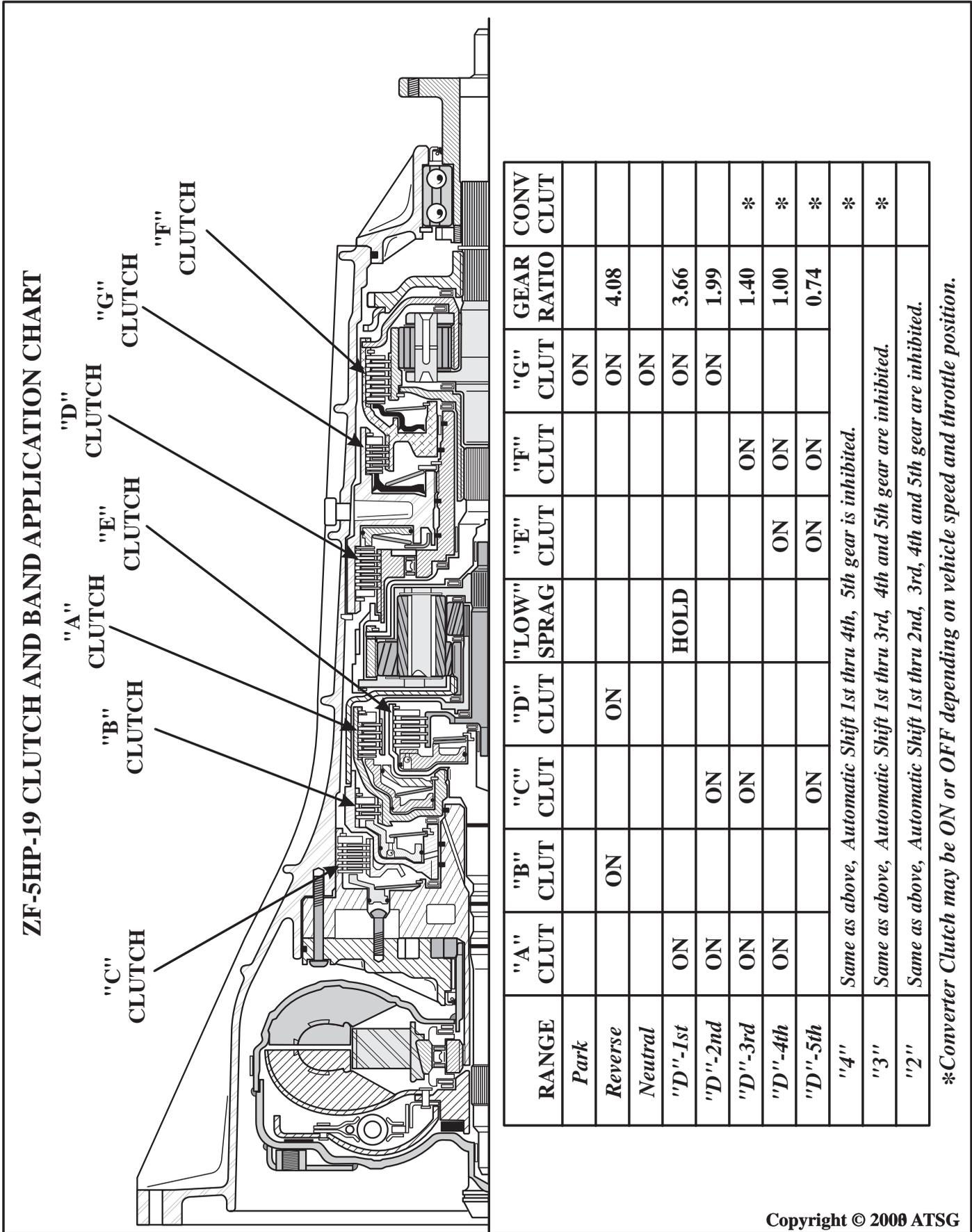
*Refer to Figure 90 for Lower Rear Valve Body exploded view and identification of valves.*

*Refer to Figure 91 for Channel Plate exploded view and turbine speed sensor location on the channel plate.*

*Refer to Figures 92, 93, and 94 for valve body retainer locations in the various valve bodies.*

*Refer to Figure 95 for the locations of the orifices, checkballs, screens, and the check valves and springs that are located in the channel plate.*

*Refer to Figure 96 for all valve body spring specifications, as observed in a used valve body.*

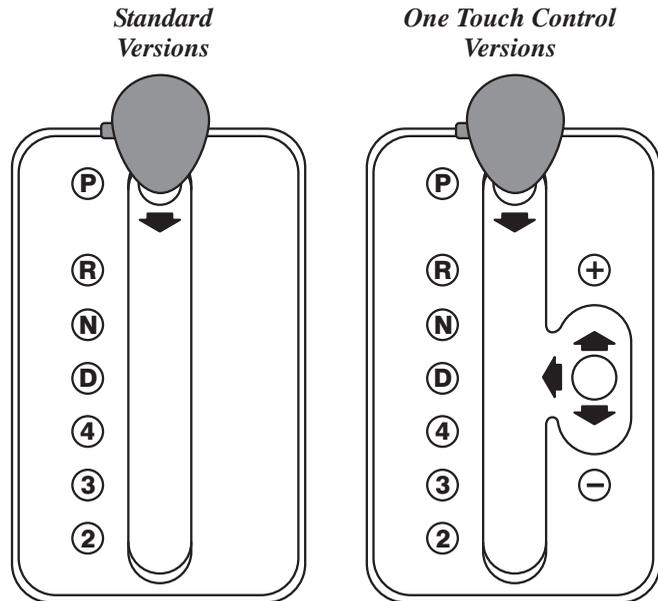


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Figure 78

### SHIFT QUADRANT

- P** = Parking Pawl Engaged
- R** = Reverse Gear
- N** = Neutral
- D** = Automatic Shifts 1st thru 5th Gears
- 4** = Automatic Shifts 1st thru 4th Gears. 5th Gear is locked out.
- 3** = Automatic Shifts 1st thru 3rd Gears. 4th and 5th Gear is locked out.
- 2** = Automatic Shifts 1st thru 2nd Gears. 3rd, 4th and 5th Gear is locked out.



*Note: 1st gear, which has an engine braking effect, is selected electronically, dependent on being in Manual Position 2 and at a suitable road speed.*

#### ONE-TOUCH CONTROL VERSIONS

Standard versions have a shift quadrant using only the left gate as shown above. The versions that are equipped with One-Touch Control, supplied as an option and model dependent, have a two section shift quadrant, also shown above. Positions P, R, N, D, 4, 3, 2, can be selected in the left-hand gate and all shifts are automatic depending on which selection was made. When the selector lever is placed in the right-hand gate, the transmission can be up-shifted manually, by tapping the lever in the direction of the "Plus" symbol, or down-shifted manually by tapping the lever in the direction of the "Minus" symbol. The separate program switch is no longer needed, as functions A and B have replaced it.

#### "A" Left-Hand Gate = DSP (Dynamic Shift Program)

With the selector lever in the left-hand gate, the Dynamic Shift Program (DSP) looks at the speed of accelerator pedal movement, engine speed, vehicle acceleration via output speed and other important parameters in the control unit.

The Electronic Control Unit (ECU) includes modules which will automatically modify the transmissions shift characteristics according to the driving style and the road conditions. These modules effectively replace the program switch.

If the engine temperature is below approximately 40°C (104°F) when it is started, the ECU control system enters a special warm-up program in order to shorten the catalytic converter's warming-up phase. This warm-up program is terminated after approximately 2 minutes of operation.

Continued on next Page

Figure 79

**"A" Left-Hand Gate = DSP (Dynamic Shift Program) (Cont'd)**

If the speed of the accelerator pedal movement is greatly varied, the shift points are modified for maximum fuel economy, or a more sporting driving style accordingly. There are three shift patterns for this purpose.

- 1. = Comfort Oriented, Economical Driving Style*
- 2. = Average Driving Style*
- 3. = Sports Oriented, High Performance Driving Style*

When the vehicle is started cold, it moves off in shift pattern number one, provided that the transmission temperature is above 40°C (104°F). This shift pattern places the emphasis on maximum fuel economy. If a more enthusiastic driving style is required, detected by the accelerator opening and closing more rapidly, the ECU switches between the shift patterns and adopting shift pattern three where necessary.

If a calmer driving style is resumed, the ECU returns to the lower shift pattern, and will once again place the emphasis on fuel consumption.

**"B" Right-Hand Gate = Manual Shift Program**

When the selector lever is moved to the right-hand gate, the current gear is retained, and the transmission can be shifted to a lower or higher gear using the one-touch function.

There are engine speed limits for each gear, as in the transmission can only be shifted down if the maximum engine speed will not be exceeded by doing so. No mandatory upshifts will take place.

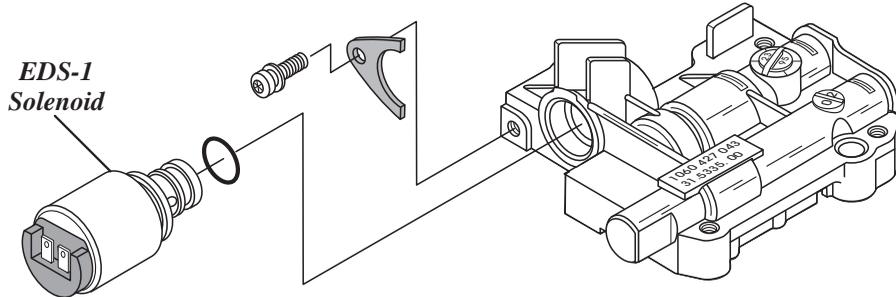
If the One-Touch feature is not used when the selector lever is in the right-hand gate, for durability concerns, the transmission is allowed to down-shift automatically to 1st gear.

**FAILSAFE OPERATION**

When a system fault is detected which could impair normal reliable operation, the ECU module interrupts the power supply to Pin 12 at the transmission case connector. The ECU module also alerts the driver of any faults by signaling the vehicles "check control" system. To enable the vehicle to be driven to a repair shop, the following manual gear selections are permitted:

<i>Selector Lever Position</i>	<i>P R N D 4 3 2</i>
<i>Actual Gear Obtained</i>	<i>P R N 4 4 4 4</i>

### ZF-5HP-19 SOLENOID IDENTIFICATION AND LOCATIONS



**SPECIAL NOTE:**

*EDS-1 Solenoid*  
 .650" Snout Diameter  
 Requires Green "O" Ring

*EDS-2, 3, 4 Solenoids*  
 .670" Snout Diameter  
 Requires Black "O" Ring

*MV-1, 2, 3 Solenoids*  
 Use NO "O" Rings

<i>ZF Part Numbers</i>	
<i>EDS-1 Solenoid</i>	<i>0501 209 875</i>
<i>EDS-2, 3, 4, Solenoid</i>	<i>0501 208 562</i>
<i>MV-1, 2, 3, Solenoid</i>	<i>0501 313 506</i>

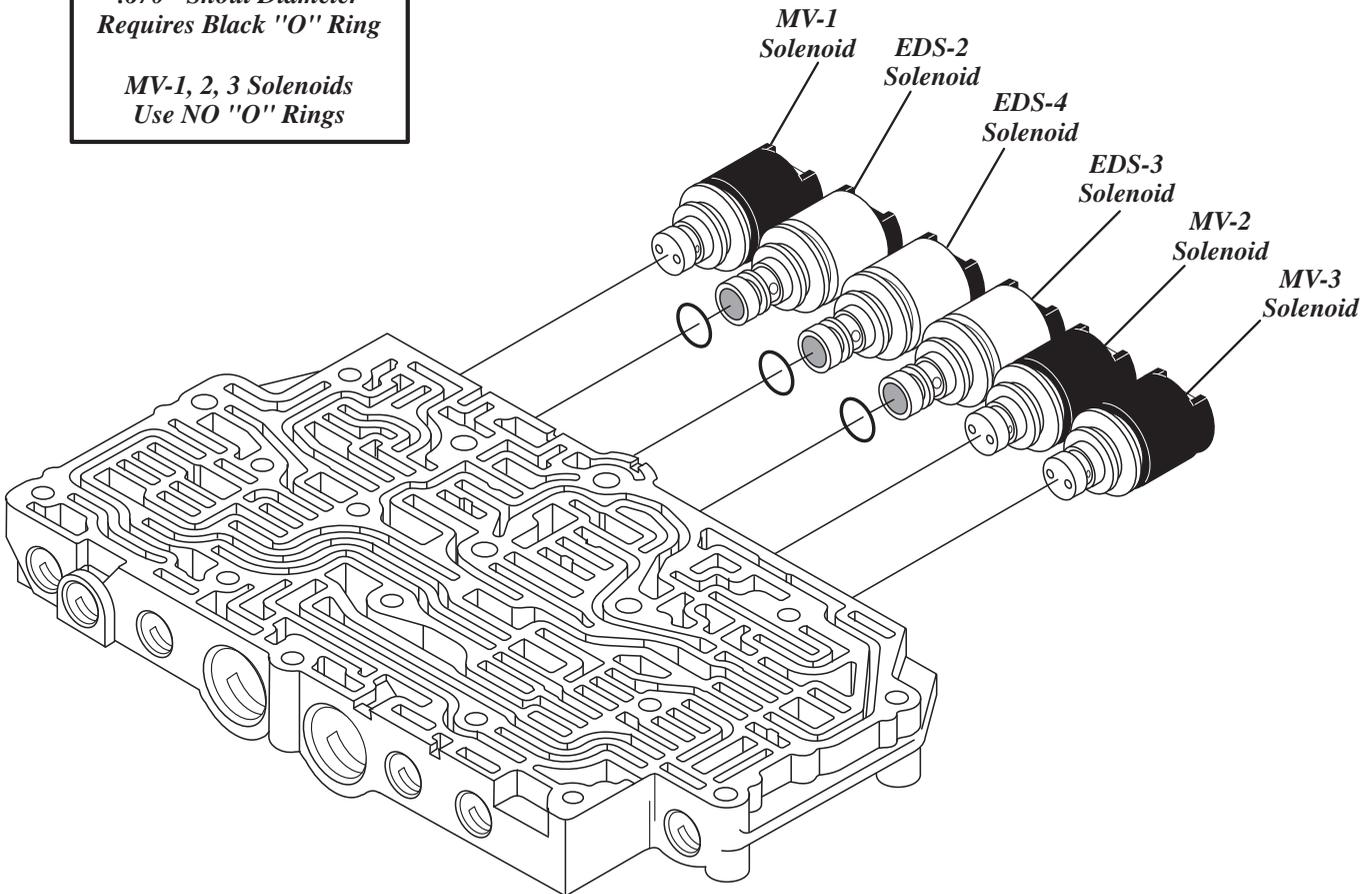
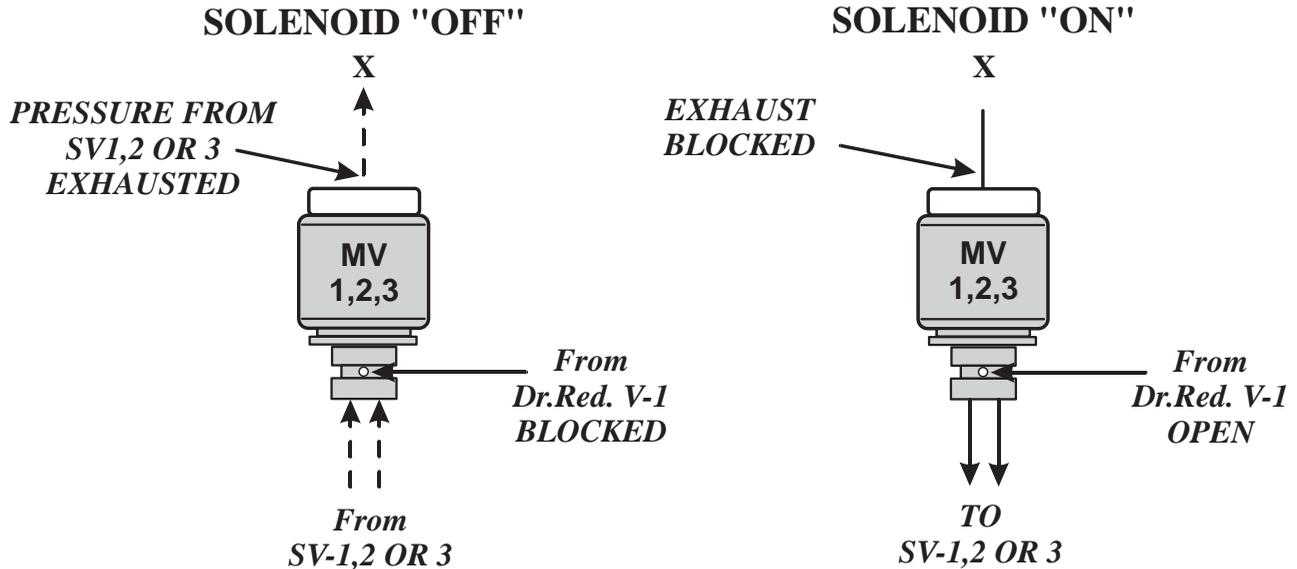


Figure 81

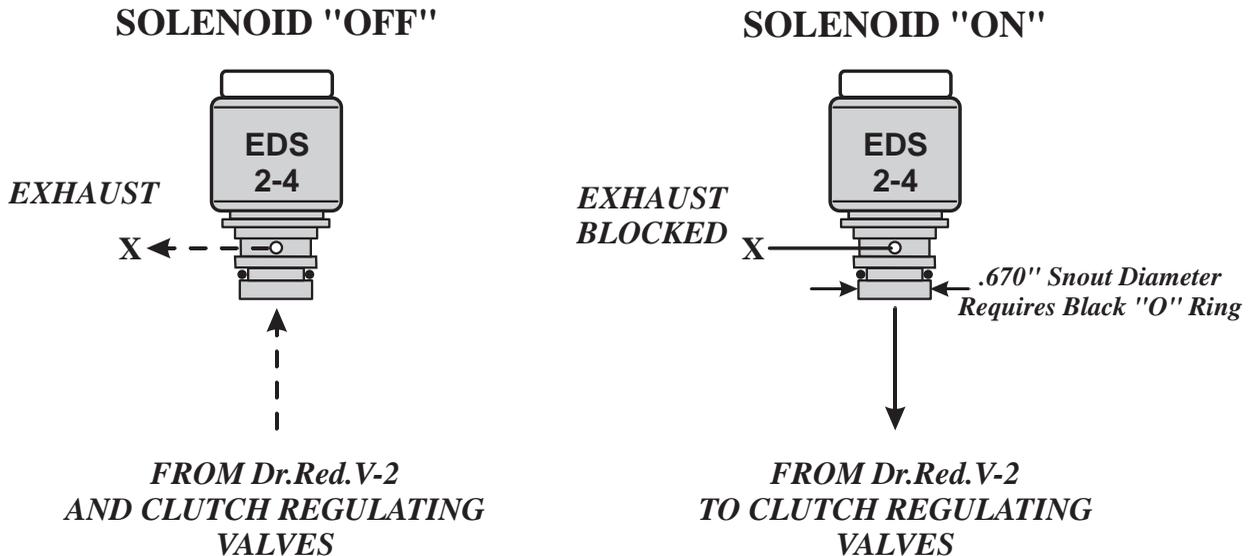
**MV1, 2 AND 3 OPERATION**



**SUMMARY:**

When MV 1, 2 or 3 is "OFF" Solenoid reducing pressure, from Dr.Red. V-1, is blocked by the solenoid and oil pressure from SV 1, 2 or 3 is exhausted at the rear of the solenoid.  
 When MV 1, 2 or 3 is "ON" Solenoid reducing pressure, From Dr.Red. V-1, is open through the solenoid and is applied to SV 1, 2 or 3. The exhaust at the rear of the solenoid is closed.

**EDS 2, 3 AND 4 OPERATION**

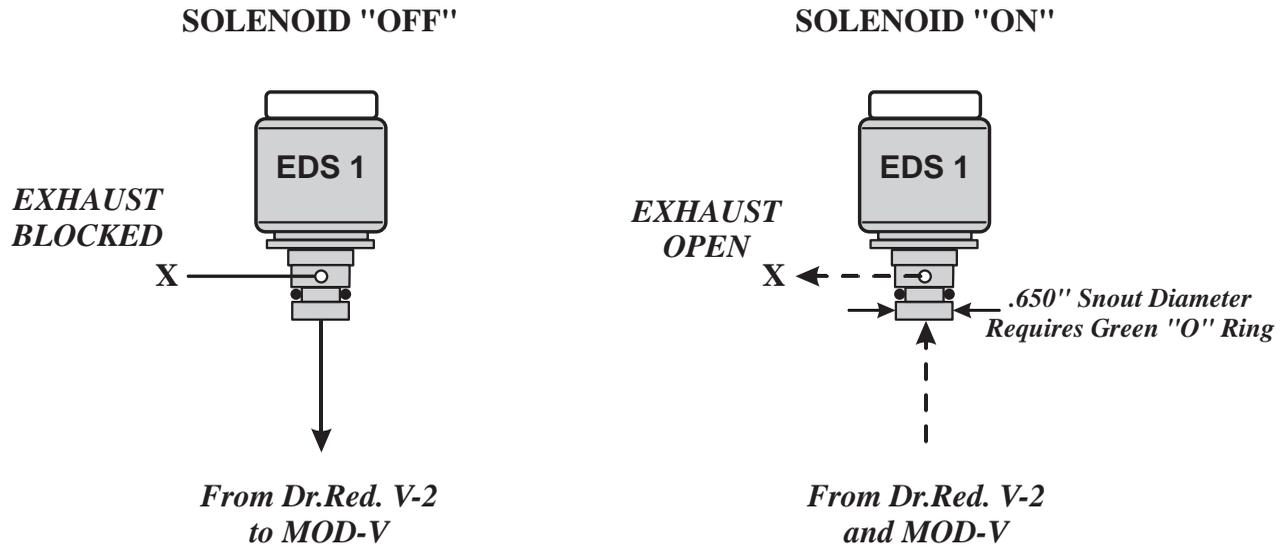


**SUMMARY:**

When EDS 2-4 solenoids are "OFF" they exhaust orificed solenoid reducing pressure, from Dr. Red. V-2, and the oil pressure from the clutch regulating valves releasing them.  
 When EDS 2-4 solenoids are "ON" the exhaust is blocked by the solenoid and solenoid reducing pressure, from Dr. Red. V-2, is applied to operate clutch regulating valves.

Figure 82

**EDS-1 OPERATION  
(Line Pressure Solenoid)**



**SUMMARY:**

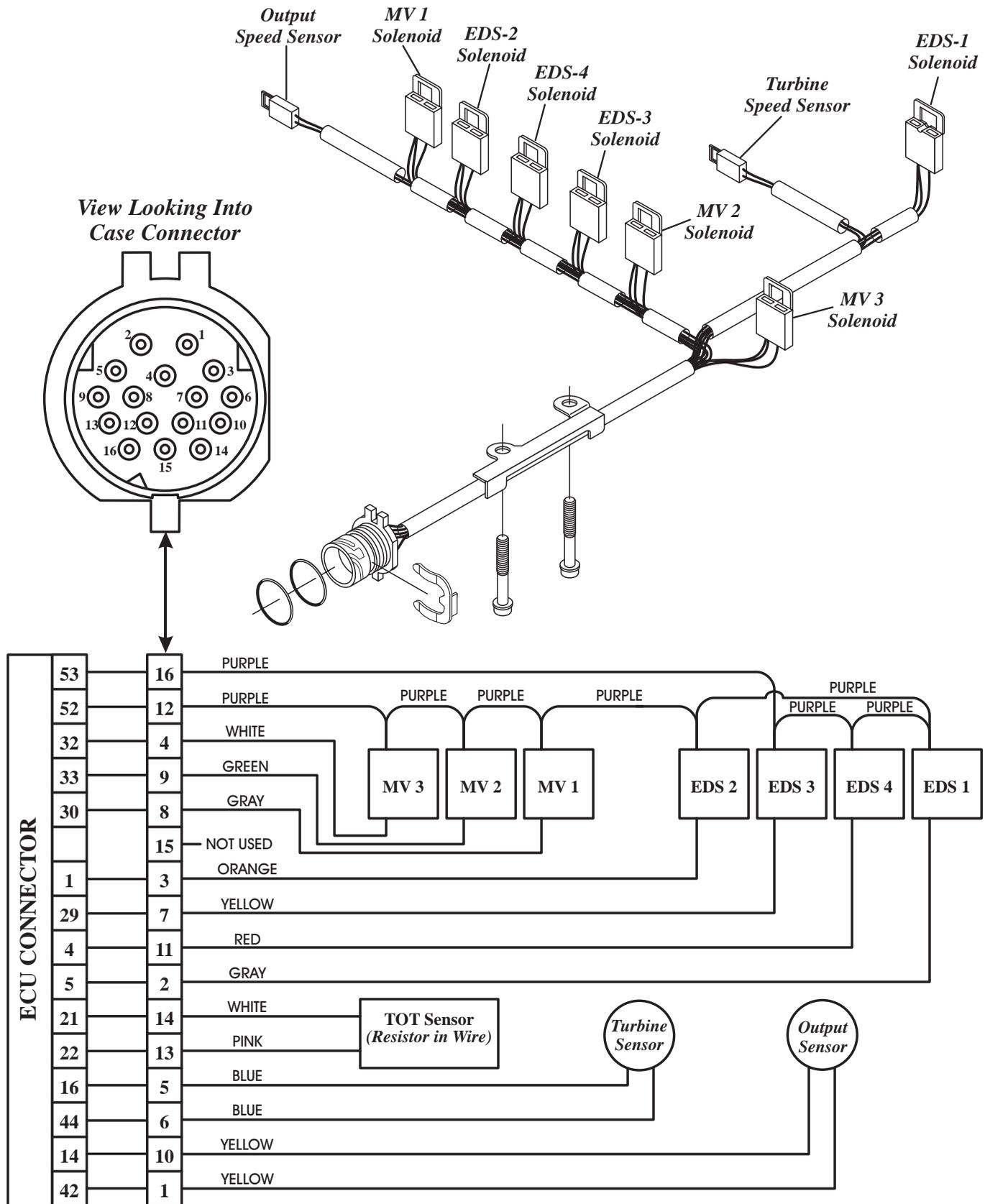
*When EDS 1 solenoid is "OFF," solenoid reducing pressure, from Dr. Red. V-2, is high to MOD-V valve which creates high line pressure.*

*When EDS 1 solenoid is "ON," solenoid reducing pressure, from Dr. Red. V-2, is low to*

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Figure 83

### ZF-5HP-19 INTERNAL WIRE SCHEMATIC



**NOTE:** Some internal wire colors may vary.

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Figure 84

### ZF-5HP-19 SOLENOID APPLICATION CHART

<i>Selector Lever Position</i>	<i>MV 1 Solenoid</i>	<i>MV 2 Solenoid</i>	<i>MV 3 Solenoid</i>	<i>EDS 1 Solenoid</i>	<i>EDS 2 Solenoid</i>	<i>EDS 3 Solenoid</i>	<i>EDS 4 Solenoid</i>	<b>GEAR RATIO</b>
<b>PARK</b>	ON			**				
<b>REVERSE</b>	ON		⊗	**		*		<b>4.08:1</b>
<b>NEUTRAL</b>	ON	ON		**		*		
<b>D-1ST</b>	ON	ON		**		*		<b>3.66:1</b>
<b>D-2ND</b>	ON	ON		**	*	*		<b>1.99:1</b>
<b>D-3RD</b>		ON		**	*		-*-	<b>1.40:1</b>
<b>D-4TH</b>				**			-*-	<b>1.00:1</b>
<b>D-5TH</b>			-*	**	*		-*-	<b>0.74:1</b>
<b>Failsafe (4th)</b>	OFF	OFF	OFF	OFF	OFF	OFF	OFF	<b>1.00:1</b>

### SOLENOID CHART LEGEND

<i>Symbol</i>	<i>Description</i>
<b>ON</b>	<i>MV 1, MV 2 and MV 3 Solenoids are energized by the Electronic Transmission Control unit and have two functions. They are Open or Closed. Energized (On), there is pressure in circuit.</i>
⊗	<i>MV 3 is turned "ON" if reverse is selected at a high vehicle speed, to inhibit reverse engagement.</i>
**	<i>EDS 1 is used for line pressure control only, and operates from 0 to 0.8 amps. When the solenoid is "OFF" (0 amps), pressure is high. EDS 1 pressure is "Lowered" as the solenoid is modulated by the control unit.</i>
*	<i>EDS 2, EDS 3, and EDS 4 Solenoids are also pulse modulated but are exactly the opposite of EDS 1 Solenoid. When these solenoids are "ON" oil pressure in the hydraulic circuit is high, and when they are "OFF" pressure in the hydraulic circuit is low.</i>
-*	<i>Solenoid "OFF" (hydraulic pressure low), then Solenoid "ON" (hydraulic pressure high).</i>
-*-	<i>EDS 4 Solenoid is used for Torque Converter Clutch apply and release only, and depends on throttle position and vehicle speed as to its application.</i>

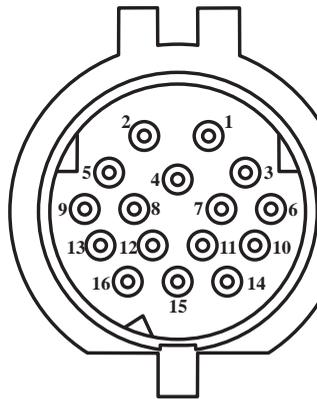
Figure 85

# TECHNICIANS DIAGNOSTIC GUIDE

## BMW, AUDI, PORSCHE

### ZF 5HP-19 SOLENOID AND SENSOR RESISTANCE CHART

<i>Solenoid</i>	<i>Case Connector Pin Numbers</i>		<i>Control Unit Connector Pin Numbers</i>		<i>Resistance In Ohms</i>
	<i>-</i>	<i>+</i>	<i>-</i>	<i>+</i>	
MV 1	8	12	30	52	30 - 34 Ω
MV 2	9	12	33	52	30 - 34 Ω
MV 3	4	12	32	52	30 - 34 Ω
EDS 1	2	12	5	52	5.2 - 6.8 Ω
EDS 2	3	12	1	52	6.2 - 7.8 Ω
EDS 3	7	12	29	52	6.2 - 7.8 Ω
EDS 4	11	12	4	52	6.2 - 7.8 Ω
TOT	13	14	21	22	1000 Ω at 25° C
OSS	1	10	14	42	292 - 358 Ω
TSS	5	6	44	16	292 - 358 Ω



*View Looking Into  
Case Connector*

#### *Electronic Control Unit Connector Pin Identification*

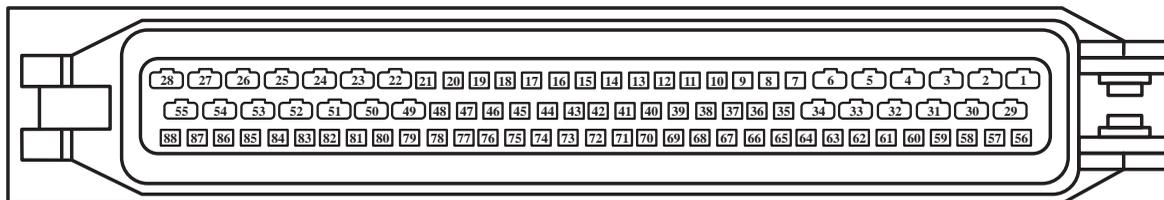
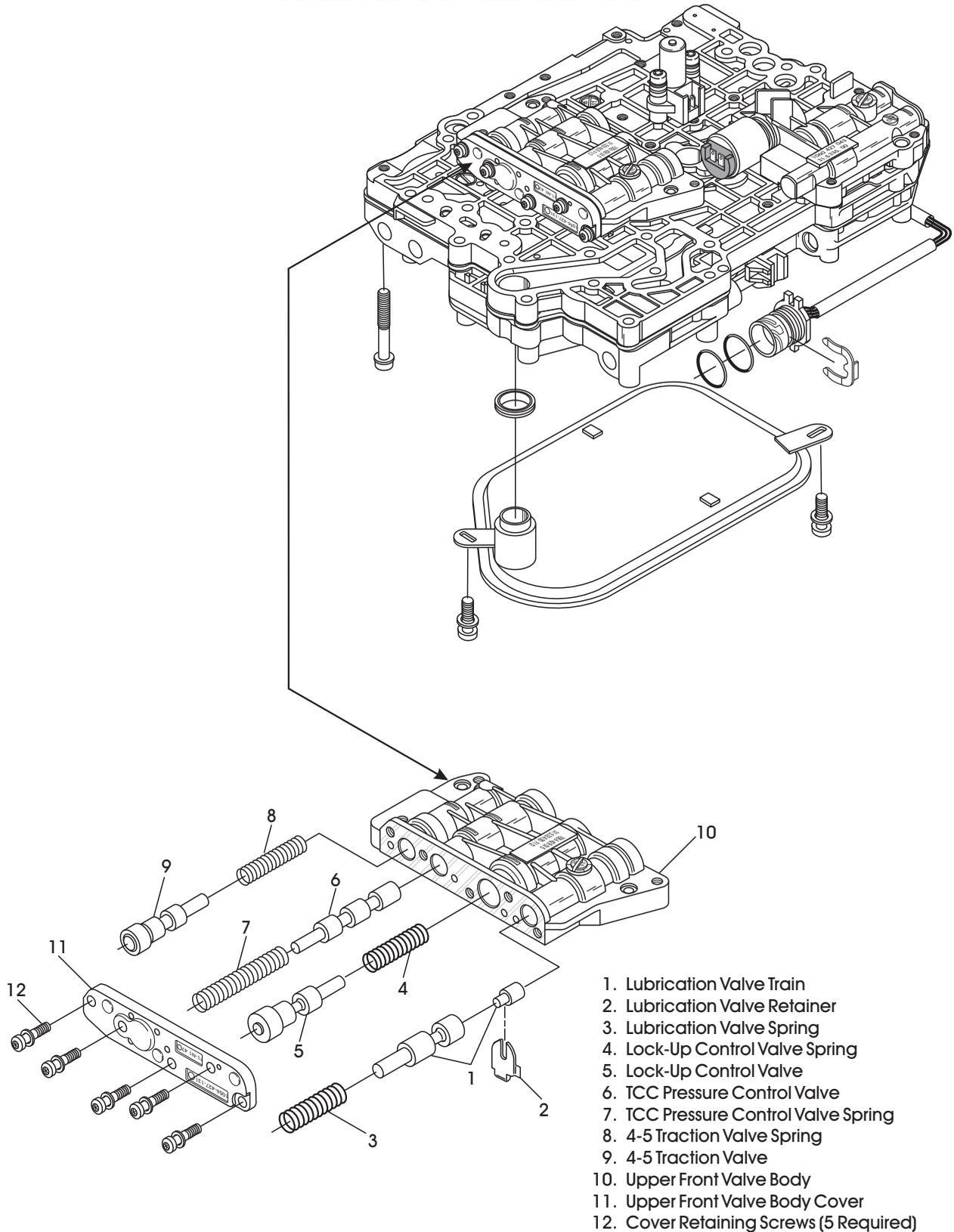


Figure 86

**ZF-5HP-19FL**  
**UPPER FRONT VALVE BODY**

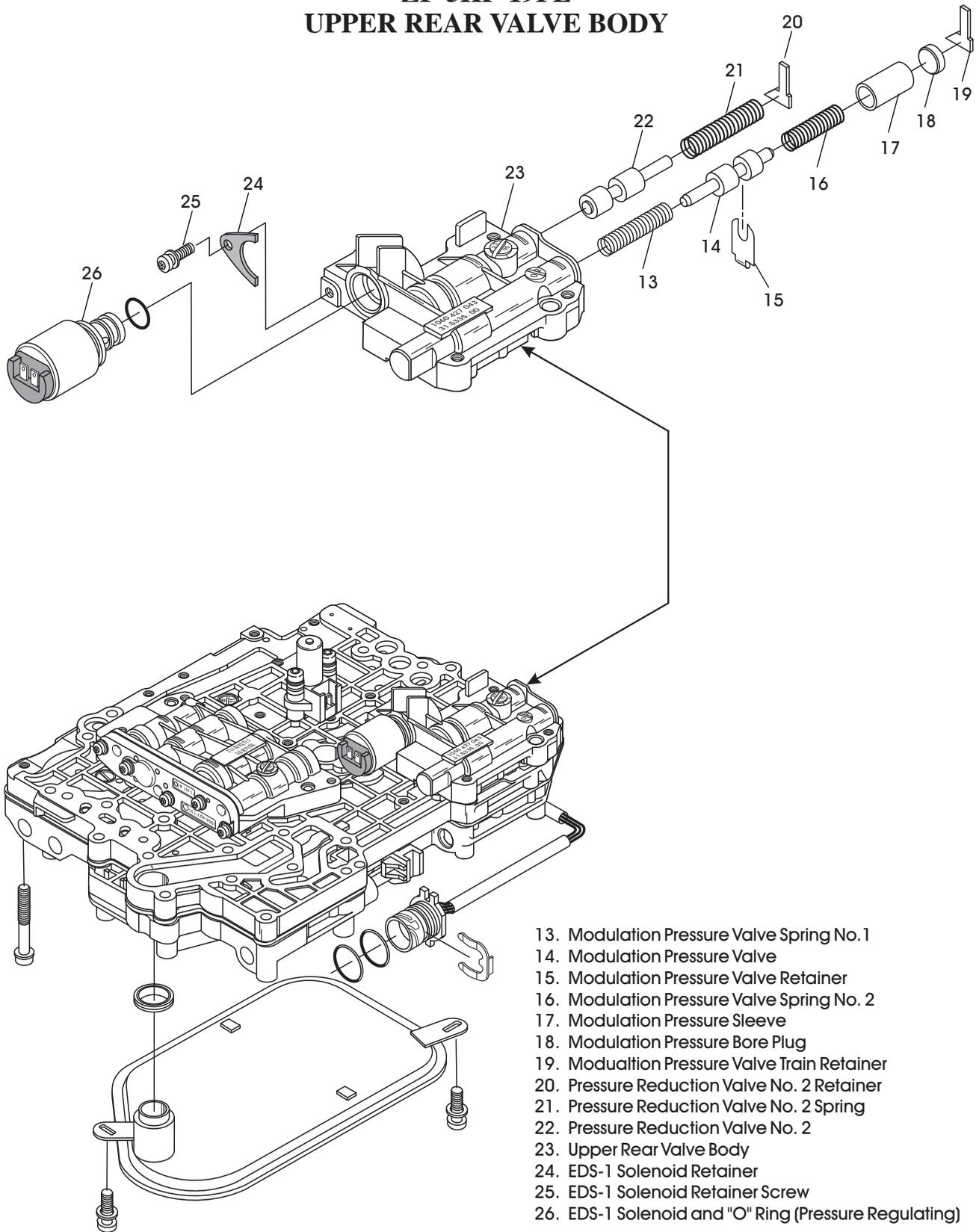


1. Lubrication Valve Train
2. Lubrication Valve Retainer
3. Lubrication Valve Spring
4. Lock-Up Control Valve Spring
5. Lock-Up Control Valve
6. TCC Pressure Control Valve
7. TCC Pressure Control Valve Spring
8. 4-5 Traction Valve Spring
9. 4-5 Traction Valve
10. Upper Front Valve Body
11. Upper Front Valve Body Cover
12. Cover Retaining Screws (5 Required)

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Figure 87

**ZF-5HP-19FL**  
**UPPER REAR VALVE BODY**

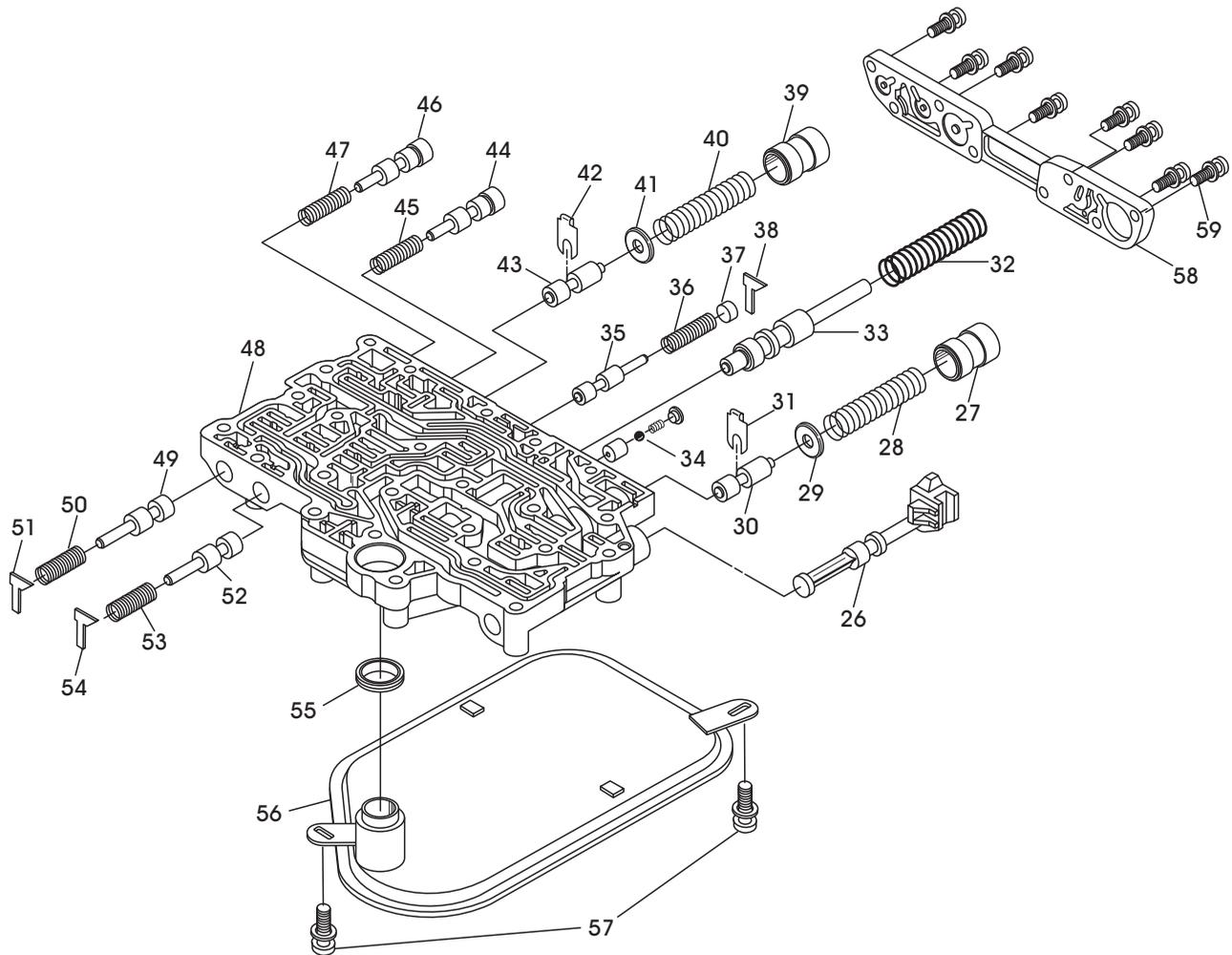


- 13. Modulation Pressure Valve Spring No.1
- 14. Modulation Pressure Valve
- 15. Modulation Pressure Valve Retainer
- 16. Modulation Pressure Valve Spring No. 2
- 17. Modulation Pressure Sleeve
- 18. Modulation Pressure Bore Plug
- 19. Modulation Pressure Valve Train Retainer
- 20. Pressure Reduction Valve No. 2 Retainer
- 21. Pressure Reduction Valve No. 2 Spring
- 22. Pressure Reduction Valve No. 2
- 23. Upper Rear Valve Body
- 24. EDS-1 Solenoid Retainer
- 25. EDS-1 Solenoid Retainer Screw
- 26. EDS-1 Solenoid and "O" Ring (Pressure Regulating)

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Figure 88

### ZF-5HP-19FL LOWER FRONT VALVE BODY

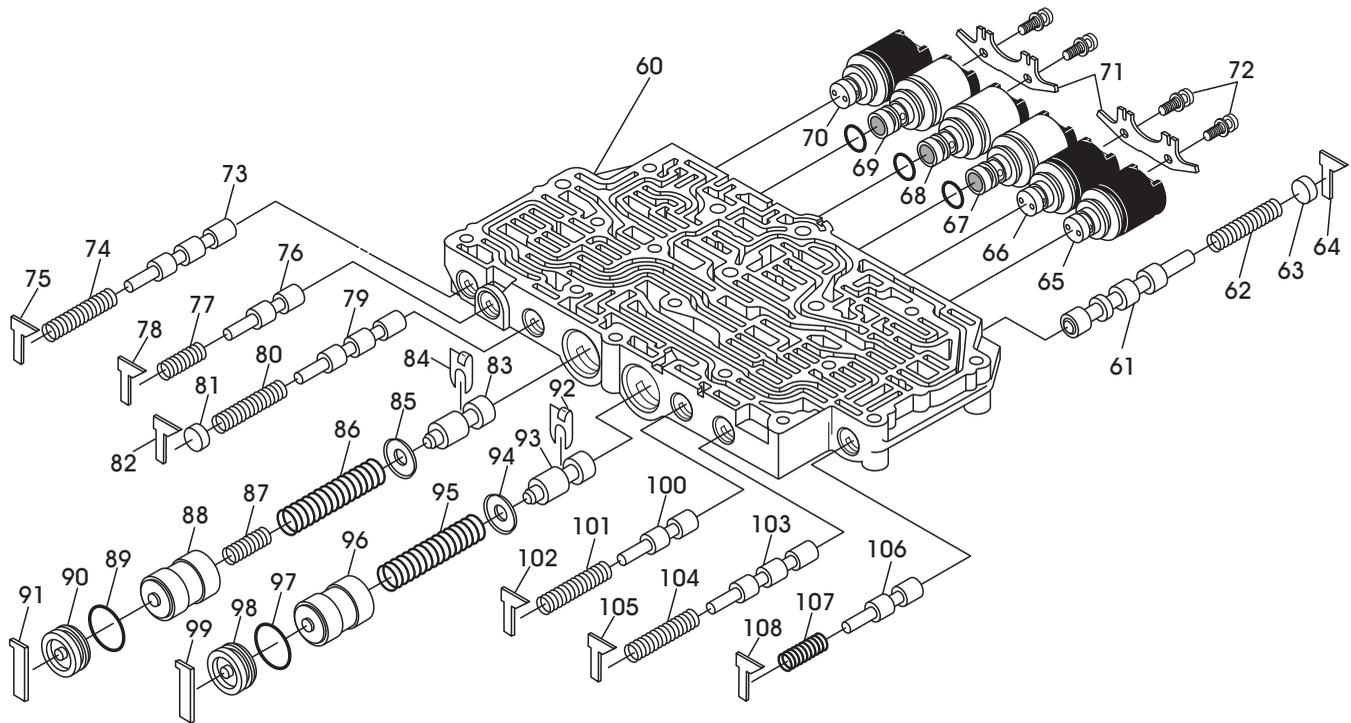


- |   |   |
|---|---|
| 26. Manual Shift Valve (W-S)                        | 43. "A" Clutch Accumulator Regulator Valve        |
| 27. "E" Clutch Damper Valve                         | 44. "G" Clutch Accumulator Regulator Valve        |
| 28. "E" Clutch Damper Valve Spring                  | 45. "G" Clutch Accumulator Regulator Valve Spring |
| 29. "E" Clutch Damper Valve Spring Seat             | 46. "C" Clutch Accumulator Regulator Valve        |
| 30. "E" Clutch Accumulator Regulator Valve          | 47. "C" Clutch Accumulator Regulator Valve Spring |
| 31. "E" Clutch Accumulator Regulator Valve Retainer | 48. Lower Front Valve Body                        |
| 32. Main Pressure Regulator Valve Spring            | 49. "C" Clutch Shift Valve                        |
| 33. Main Pressure Regulator Valve                   | 50. "C" Clutch Shift Valve Spring                 |
| 34. "D" Clutch One-Way Check Valve Assembly         | 51. "C" Clutch Shift Valve Retainer               |
| 35. 5-4 Traction Valve                              | 52. "G" Clutch Shift Valve                        |
| 36. 5-4 Traction Valve Spring                       | 53. "G" Clutch Shift Valve Spring                 |
| 37. 5-4 Traction Valve Bore Plug                    | 54. "G" Clutch Shift Valve Retainer               |
| 38. 5-4 Traction Valve Train Retainer               | 55. Filter Seal                                   |
| 39. "A" Clutch Damper Valve                         | 56. Oil Filter                                    |
| 40. "A" Clutch Damper Valve Spring                  | 57. Oil Filter Retaining Screws                   |
| 41. "A" Clutch Damper Valve Spring Seat             | 58. Lower Valve Body Cover                        |
| 42. "A" Clutch Accumulator Regulator Valve Retainer | 59. Lower Valve Body Cover Screws (8 Required)    |

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Figure 89

### ZF-5HP-19FL LOWER REAR VALVE BODY

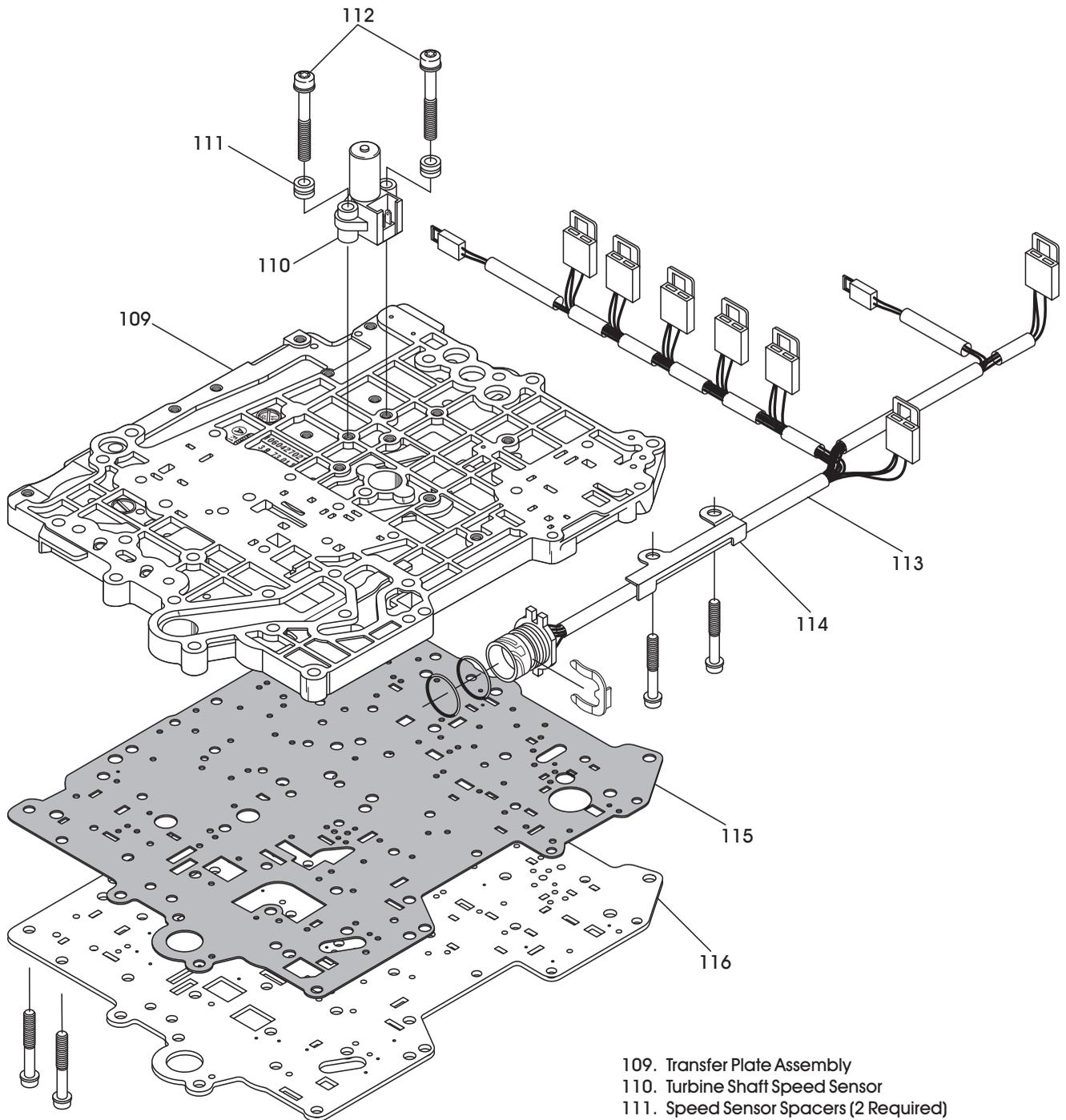


- |   |   |
|---|---|
| 60. Lower Rear Valve Body                             | 85. "D" Clutch Damper Valve Spring Seat             |
| 61. Number 1 Shift Valve                              | 86. "D" Clutch Damper Valve Outer Spring            |
| 62. Number 1 Shift Valve Spring                       | 87. "D" Clutch Damper Valve Inner Spring            |
| 63. Number 1 Shift Valve Bore Plug                    | 88. "D" Clutch Damper Valve                         |
| 64. Number 1 Shift Valve Retainer                     | 89. "D" Clutch Valve Train Bore Plug "O" Ring       |
| 65. MV-3 Solenoid (On-Off)                            | 90. "D" Clutch Valve Train Bore Plug                |
| 66. MV-2 Solenoid (On-Off)                            | 91. "D" Clutch Valve Train Bore Plug Retainer       |
| 67. EDS-3 Solenoid and "O" Ring (Pressure Regulating) | 92. "F" Clutch Accumulator Regulator Valve Retainer |
| 68. EDS-4 Solenoid and "O" Ring (Pressure Regulating) | 93. "F" Clutch Accumulator Regulator Valve          |
| 69. EDS-2 Solenoid and "O" Ring (Pressure Regulating) | 94. "F" Clutch Damper Valve Spring Seat             |
| 70. MV-1 Solenoid (On-Off)                            | 95. "F" Clutch Damper Valve Spring                  |
| 71. Solenoid Retaining Brackets (2 Required)          | 96. "F" Clutch Damper Valve                         |
| 72. Solenoid Retaining Bracket Screws (4 Required)    | 97. "F" Clutch Valve Train Bore Plug "O" Ring       |
| 73. Traction Coast Valve                              | 98. "F" Clutch Valve Train Bore Plug                |
| 74. Traction Coast Valve Spring                       | 99. "F" Clutch Valve Train Bore Plug Retainer       |
| 75. Traction Coast Valve Train Retainer               | 100. Reverse Gear Valve                             |
| 76. TCC Release Regulator Valve                       | 101. Reverse Gear Valve Spring                      |
| 77. TCC Release Regulator Valve Spring                | 102. Reverse Gear Valve Train Retainer              |
| 78. TCC Release Regulator Valve Train Retainer        | 103. Number 2 Shift Valve                           |
| 79. Number 3 Shift Valve                              | 104. Number 2 Shift Valve Spring                    |
| 80. Number 3 Shift Valve Spring                       | 105. Number 2 Shift Valve Train Retainer            |
| 81. Number 3 Shift Valve Train Bore Plug              | 106. Pressure Reduction Valve                       |
| 82. Number 3 Shift Valve Train Retainer               | 107. Pressure Reduction Valve Spring                |
| 83. "D" Clutch Accumulator Regulator Valve            | 108. Pressure Reduction Valve Train Retainer        |
| 84. "D" Clutch Accumulator Regulator Valve Retainer   |   |

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Figure 90

**ZF-5HP-19FL**  
**TRANSFER PLATE, SPACER PLATE, AND**  
**TURBINE SPEED SENSOR**

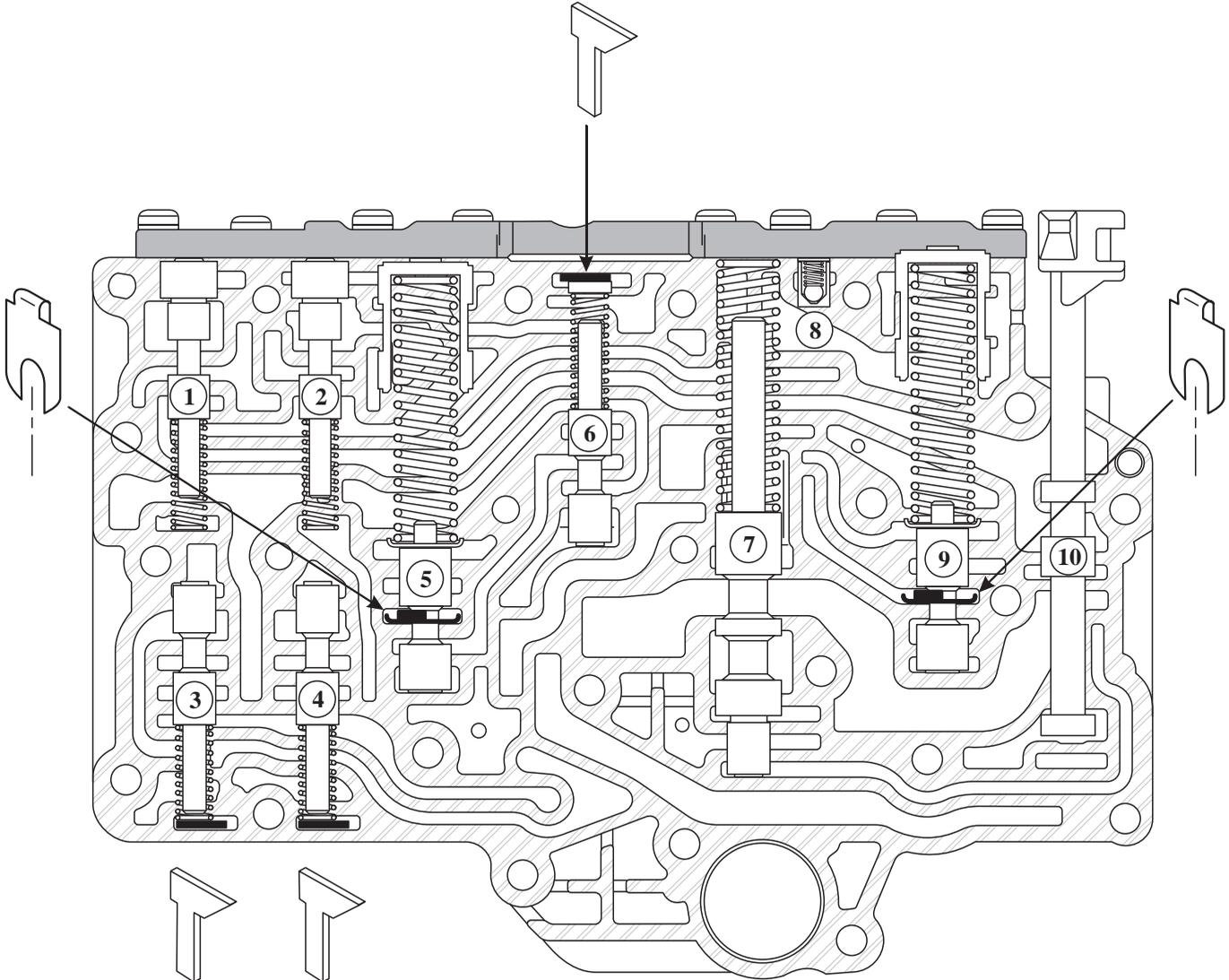


- 109. Transfer Plate Assembly
- 110. Turbine Shaft Speed Sensor
- 111. Speed Sensor Spacers (2 Required)
- 112. Speed Sensor Retaining Bolts (2 Required)
- 113. Internal Wiring Harness Assembly
- 114. Internal Wire Harness Retaining Bracket
- 115. Spacer Plate To Transfer Plate Gasket
- 116. Valve Body Spacer Plate

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Figure 91

**ZF-5HP-19FL**  
**LOWER FRONT VALVE BODY**

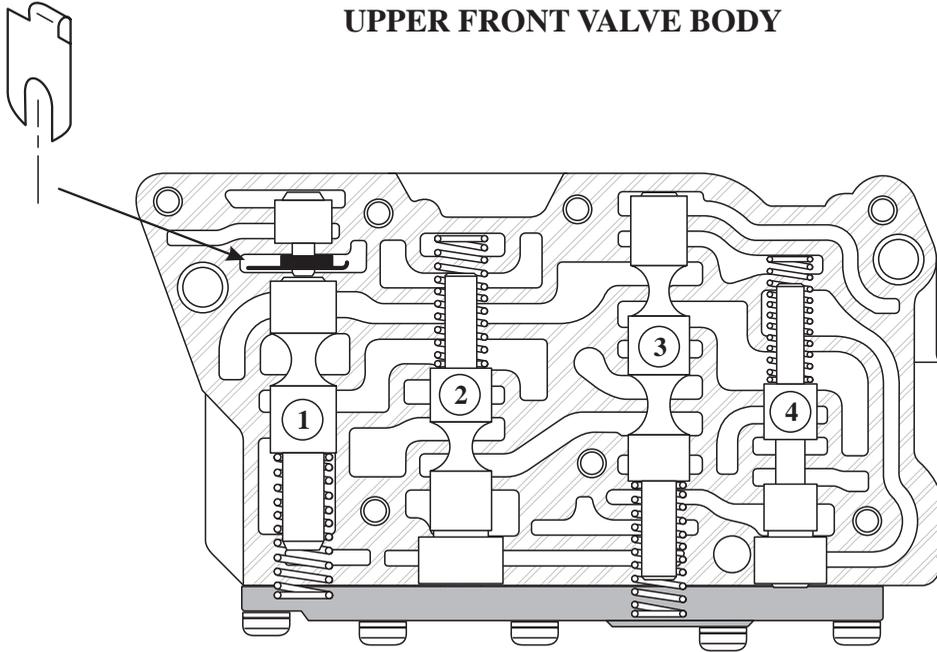


1. "C" CLUTCH ACCUMULATOR REGULATOR VALVE TRAIN LINE-UP.
2. "G" CLUTCH ACCUMULATOR REGULATOR VALVE TRAIN LINE-UP.
3. "C" CLUTCH SHIFT VALVE TRAIN LINE-UP.
4. "G" CLUTCH SHIFT VALVE TRAIN LINE-UP.
5. "A" CLUTCH ACCUMULATOR REGULATOR VALVE TRAIN LINE-UP.
6. 5-4 TRACTION VALVE TRAIN LINE-UP.
7. MAIN PRESSURE REGULATOR VALVE TRAIN LINE-UP.
8. "D" CLUTCH ONE-WAY CHECK VALVE ASSEMBLY.
9. "E" CLUTCH ACCUMULATOR REGULATOR VALVE TRAIN LINE-UP.
10. MANUAL SELECTOR SHIFT VALVE.

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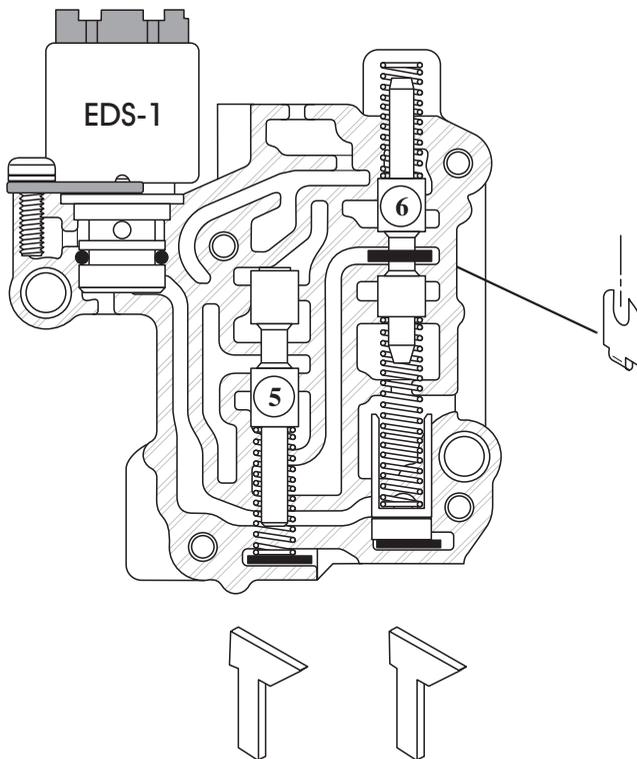
Figure 92

**ZF-5HP-19FL**  
**UPPER FRONT VALVE BODY**



1. LUBRICATION VALVE TRAIN LINE-UP.
2. LOCK-UP CONTROL VALVE TRAIN LINE-UP.
3. LOCK-UP PRESSURE CONTROL VALVE LINE-UP.
4. 4-5 TRACTION VALVE TRAIN LINE-UP.

**ZF-5HP-19FL**  
**UPPER REAR VALVE BODY**

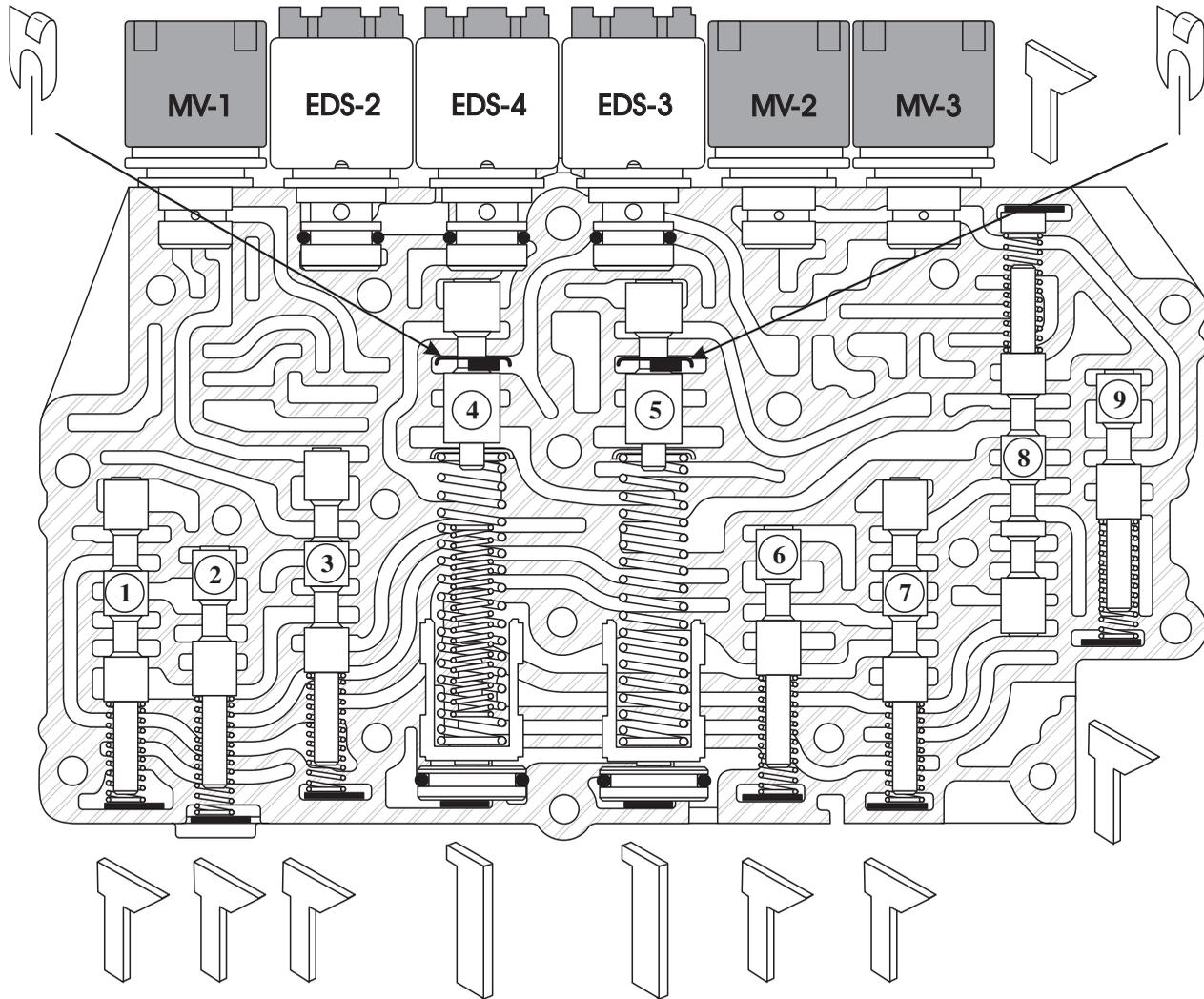


5. MODULATION PRESSURE VALVE TRAIN LINE-UP.
6. PRESSURE REDUCTION VALVE NUMBER TWO LINE-UP.

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Figure 93

**ZF-5HP-19FL**  
**LOWER REAR VALVE BODY**



1. TRACTION COAST VALVE TRAIN LINE-UP.
2. TCC RELEASE REGULATOR VALVE TRAIN LINE-UP.
3. NUMBER 3 SHIFT VALVE TRAIN LINE-UP.
4. "D" CLUTCH ACCUMULATOR REGULATOR VALVE TRAIN LINE-UP.
5. "F" CLUTCH ACCUMULATOR REGULATOR VALVE TRAIN LINE-UP.
6. REVERSE GEAR VALVE TRAIN LINE-UP.
7. NUMBER 2 SHIFT VALVE TRAIN LINE-UP.
8. NUMBER 1 SHIFT VALVE TRAIN LINE-UP.
9. PRESSURE REDUCTION VALVE TRAIN LINE-UP.

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Figure 94

### ZF-5HP-19FL CHANNEL PLATE LOCATIONS

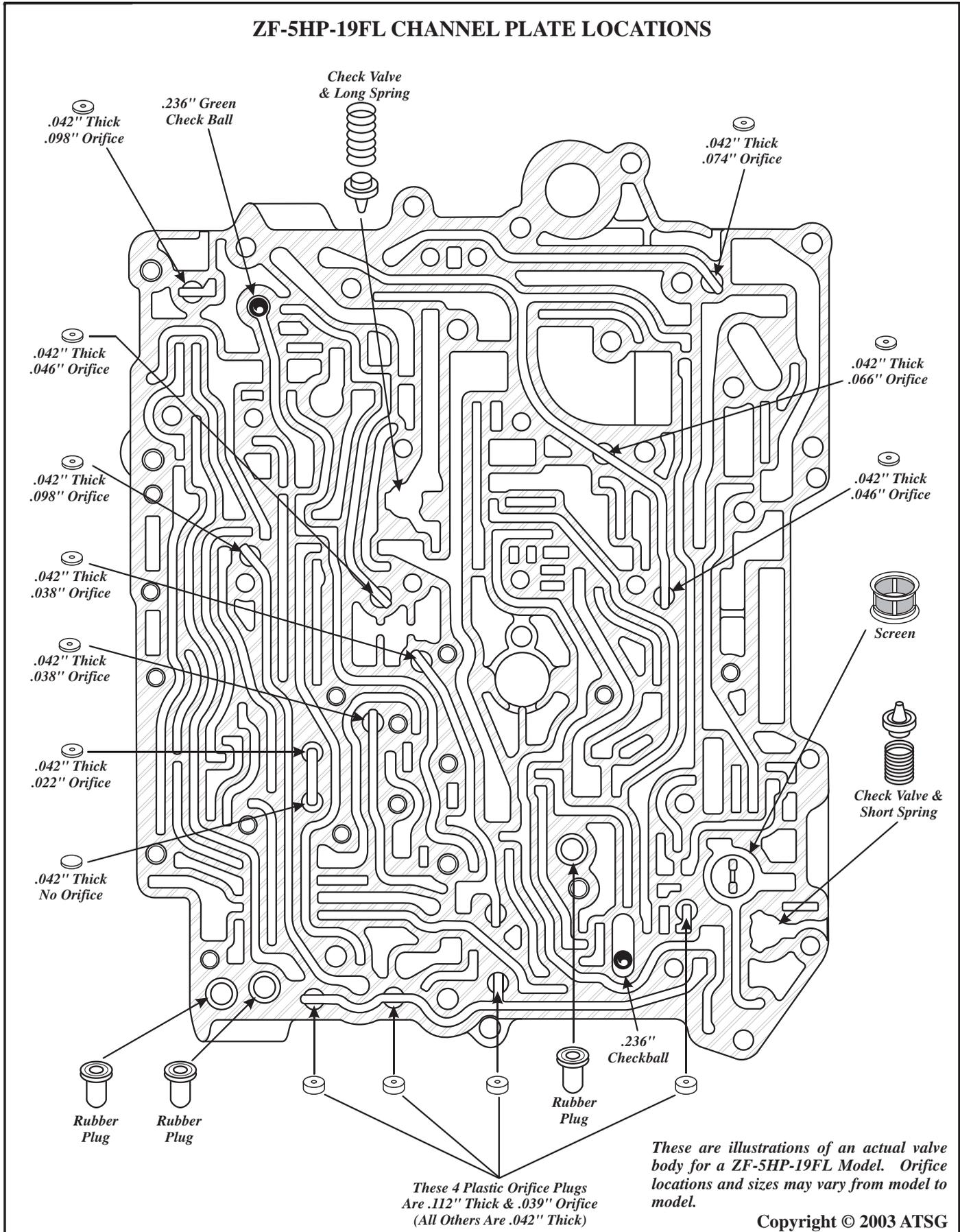


Figure 95



# TECHNICIANS DIAGNOSTIC GUIDE

## BMW, AUDI, PORSCHE

### ZF 5HP-19FL SPRING SPECIFICATIONS

#### UPPER FRONT VALVE BODY

SPRING ILLUSTRATION NO. 3:  
FREE LENGTH = 1.540"  
SPRING DIAMETER = .419"  
WIRE DIAMETER = .048"

SPRING ILLUSTRATION NO. 4:  
FREE LENGTH = 1.712"  
SPRING DIAMETER = .423"  
WIRE DIAMETER = .043"

SPRING ILLUSTRATION NO. 7:  
FREE LENGTH = 2.090"  
SPRING DIAMETER = .432"  
WIRE DIAMETER = .035"

SPRING ILLUSTRATION NO. 8:  
FREE LENGTH = 1.482"  
SPRING DIAMETER = .367"  
WIRE DIAMETER = .027"

#### UPPER REAR VALVE BODY

SPRING ILLUSTRATION NO. 13:  
FREE LENGTH = 1.632"  
SPRING DIAMETER = .300"  
WIRE DIAMETER = .027"

SPRING ILLUSTRATION NO. 16:  
FREE LENGTH = 1.462"  
SPRING DIAMETER = .315"  
WIRE DIAMETER = .046"

SPRING ILLUSTRATION NO. 21:  
FREE LENGTH = 1.987"  
SPRING DIAMETER = .375"  
WIRE DIAMETER = .042"

#### LOWER FRONT VALVE BODY

SPRING ILLUSTRATION NO. 28:  
FREE LENGTH = 3.438"  
SPRING DIAMETER = .567"  
WIRE DIAMETER = .038"

SPRING ILLUSTRATION NO. 32:  
FREE LENGTH = 3.730"  
SPRING DIAMETER = .606"  
WIRE DIAMETER = .077"

SPRING ILLUSTRATION NO. 36:  
FREE LENGTH = 1.702"  
SPRING DIAMETER = .365"  
WIRE DIAMETER = .031"

SPRING ILLUSTRATION NO. 40:  
FREE LENGTH = 3.102"  
SPRING DIAMETER = .590"  
WIRE DIAMETER = .042"

SPRING ILLUSTRATION NO. 45 & 47:  
FREE LENGTH = 1.430"  
SPRING DIAMETER = .365"  
WIRE DIAMETER = .031"

SPRING ILLUSTRATION NO. 50 & 53:  
FREE LENGTH = 1.690"  
SPRING DIAMETER = .375"  
WIRE DIAMETER = .042"

*Note: The spring illustration numbers refer to the ATSG illustrations in this manual.*

*Note: ZF is now working on a "Valve Body Kit" for the 5HP-19 that includes all new stock springs, all check balls, all orifices and screens, but was not ready at the time of this printing.*

#### LOWER REAR VALVE BODY

SPRING ILLUSTRATION NO. 62:  
FREE LENGTH = 1.825"  
SPRING DIAMETER = .367"  
WIRE DIAMETER = .031"

SPRING ILLUSTRATION 74:  
FREE LENGTH = 1.832"  
SPRING DIAMETER = .367"  
WIRE DIAMETER = .031"

SPRING ILLUSTRATION NO. 77:  
FREE LENGTH = 1.439"  
SPRING DIAMETER = .365"  
WIRE DIAMETER = .031"

SPRING ILLUSTRATION NO. 80:  
FREE LENGTH = 1.832"  
SPRING DIAMETER = .367"  
WIRE DIAMETER = .031"

SPRING ILLUSTRATION NO. 86:  
FREE LENGTH = 2.925"  
SPRING DIAMETER = .640"  
WIRE DIAMETER = .049"

SPRING ILLUSTRATION NO. 87:  
FREE LENGTH = 1.595"  
SPRING DIAMETER = .422"  
WIRE DIAMETER = .035"

SPRING ILLUSTRATION NO. 95:  
FREE LENGTH = 3.818"  
SPRING DIAMETER = .590"  
WIRE DIAMETER = .044"

SPRING ILLUSTRATION NO. 101:  
FREE LENGTH = 1.825"  
SPRING DIAMETER = .367"  
WIRE DIAMETER = .031"

SPRING ILLUSTRATION NO. 104:  
FREE LENGTH = 1.825"  
SPRING DIAMETER = .367"

SPRING ILLUSTRATION NO. 107:  
FREE LENGTH = 1.506"  
SPRING DIAMETER = .381"  
WIRE DIAMETER = .043"

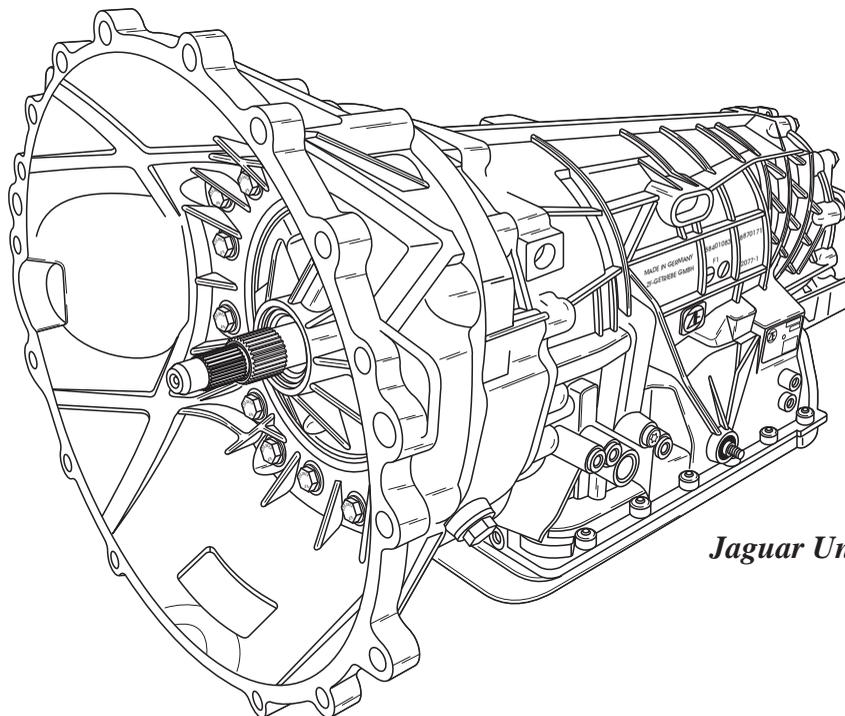
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Figure 96

**ZF-5HP-24**  
**DIAGNOSTIC INFORMATION**

**FOUND IN:**

- BMW 5 Series E39, 7 Series E38, 8 Series E31 ..... 95-Current*
- Jaguar XK8 (X100), ..... 96-Current*
- Jaguar XJ8 (X300), ..... 97-Current*
- Audi A8 (All Wheel Drive 5HP-24A) ..... 96-Current*



*Jaguar Unit Shown*

*This transmission is manufactured in Germany by ZF and carries the BMW designation A5S 440Z.*

*The A5S 440Z is an electronically controlled, five speed automatic transmission with a lock-up clutch type torque converter. Three planetary gear sets (Wilson Gearing), three rotating multiple disc clutches, three multiple disc brake clutches, and one sprag clutch (Freewheel) are used to provide the five forward speeds and reverse.*

**Key to designation:**

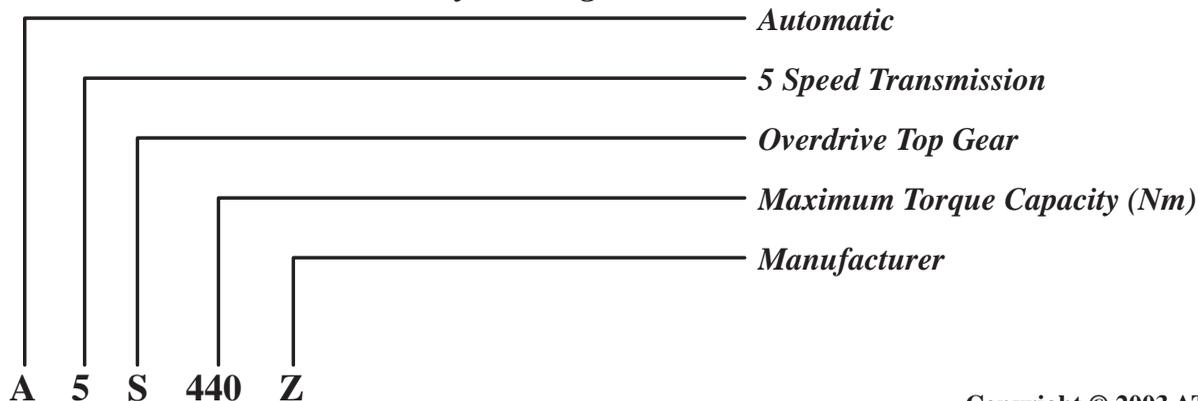


Figure 97



## **TECHNICIANS DIAGNOSTIC GUIDE**

### **BMW, AUDI, PORSCHE**

*Refer to Figure 98 for Clutch and Band Application Chart.*

*Refer to Figure 99 for Manual Shift Lever Operation, and Failsafe Operation.*

*Refer to Figures 100, and 101 for Solenoid identification and both MV Solenoid Operation and EDS Solenoid Operation and Tests.*

*Refer to Figure 102 for wiring harness identification, internal wiring schematic, and transmission case connector pin identification and functions.*

*Refer to Figure 103 for Shift Solenoid Application chart. Notice that EDS 1 Solenoid is used for line pressure control, and MV-4 is used for converter clutch.*

*Refer to Figure 104 for EDS Solenoid "Principles of Operation", as some are normally open and some are normally closed.*

*Refer to Figure 105 for internal components resistance chart, with the pins identified for both the transmission case connector and the Electronic Control Unit.*

*Refer to Figure 106 for Upper Valve Body exploded view and identification of valves.*

*Refer to Figure 107 for Lower Front Valve Body exploded view and identification of valves.*

*Refer to Figure 108 for Lower Rear Valve Body exploded view and identification of valves.*

*Refer to Figures 109, 110, and 111 for valve body retainer locations in the various valve bodies.*

*Refer to Figure 112 for Channel Plate screen location on the upper side.*

*Refer to Figure 113 for the locations of the orifices, checkballs, screens, and the check valves and springs that are located in the channel plate.*

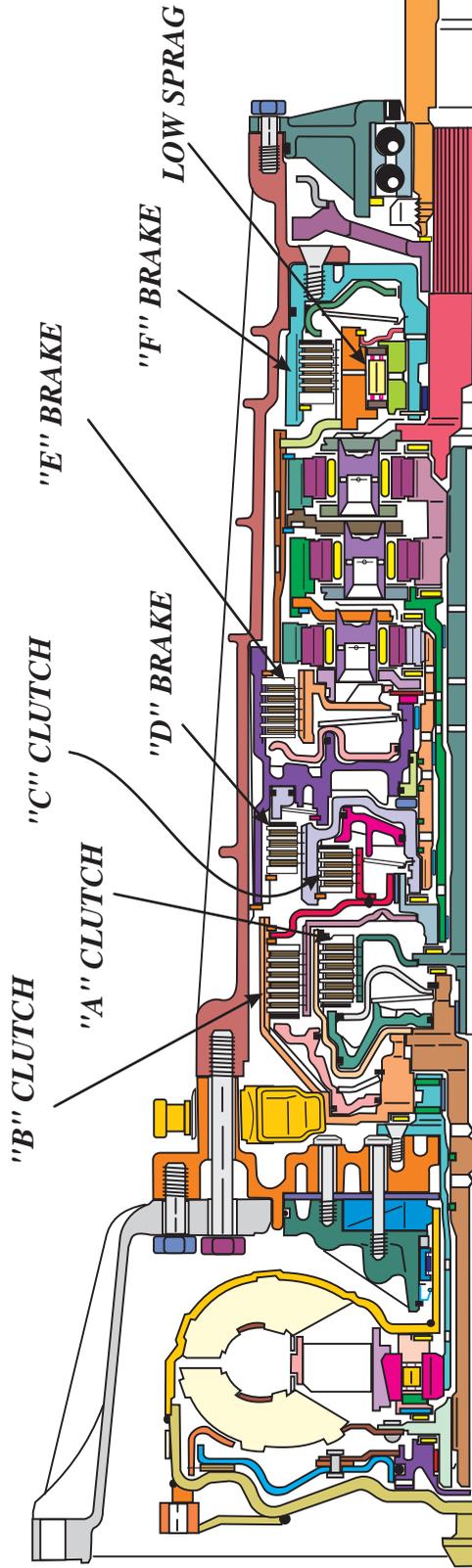
*Refer to Figure 114 for external pressure tap locations in the main case.*

*Refer to Figure 115 for Pump Volume Control Valve location, in the pump cover.*

*Refer to Figure 116 for explanation of Pump Volume Control Valve operation.*

*Refer to Figure 119 for all valve body spring specifications, as observed in a used valve body.*

**ZF-5HP-24 INTERNAL COMPONENT APPLICATION CHART**



**APPLICATION CHART**

GEAR	"A" CLUT	"B" CLUT	"C" CLUT	"D" BRAK	"E" BRAK	"F" BRAK	LOW SPRAG	GEAR RATIO
PARK			ON			ON		
REV						ON		4.10:1
NEUT						ON		
D-1ST	ON						HOLD	3.57:1
D-2ND	ON				ON			2.20:1
D-3RD	ON			ON				1.51:1
D-4TH	ON	ON						1.00:1
D-5TH		ON		ON				0.80:1
M-1	ON					ON	HOLD	3.57:1

Figure 98



## TECHNICIANS DIAGNOSTIC GUIDE BMW, AUDI, PORSCHE

### SELECTOR LEVER POSITIONS

**P** = *Park*, and should only be selected when the vehicle is at a standstill. First apply the hand brake, and then select the Park position with the manual lever. Refer to Figure 99.

**R** = *Reverse*, and should only be selected when the vehicle is at a standstill with engine at idle. Refer to Figure 99.

**N** = *Neutral*, and may be selected when the vehicle is at a standstill, but first applying the handbrake. May also be selected while vehicle is moving, to restart the engine or to counteract a skidding concern. Refer to Figure 99.

**D** = *Drive*, is the standard position for normal driving in the XE program (AGS) and provides automatic upshifts from 1st to 5th and automatic downshifts from 5th to 1st gear. The adaptive transmission control (AGS) system contains various driving programs such as Stop and Go, Trailer Towing, Mountain Driving, City Driving and Highway Driving (constant speed). These programs are selected by the Electronic Control Unit (ECU), which automatically modifies the transmissions shift characteristics according to rolling resistance, engine load, accelerator pedal movement and vehicle speed. The standard "Drive" position is position "1", as shown in Figure 99.

#### **"S" - Program**

The "S" Program is a performance oriented program, where the gear changing characteristics of the transmission are moved up to higher engine speeds. To select the "S" Program, the selector lever is shifted to the left-hand gate (position "2" in Figure 99), without moving shift lever towards plus or minus. The "S" Program provides automatic upshifts from 1st to 4th and automatic downshifts from 4th to 1st gear. 5th gear is inhibited when the "S" Program is selected.

#### **"M" - Program**

The "M" Program is a manual shift program which is activated by simply pushing the selector lever towards the minus sign for sequential downshifts and towards the plus sign for sequential upshifts, while the shift lever is in the left-hand gate (position "2" in Figure 99). It is possible to drive off in 1st gear, 2nd gear or 3rd gear, however, 4th gear can be manually selected only at a speed of approximately 40 km per hour and 5th gear at approximately 60 km per hour.

**4th Gear**, Select this position if the transmission tends to hunt between 5th-4th/4th-5th gears under certain driving conditions.

**3rd Gear**, Select this position if the transmission tends to hunt between 3rd and 5th gears under certain driving conditions. Also recommended for lengthy descents in mountainous areas.

**2nd Gear**, Select this position when driving over mountain passes with lengthy ascents and descents.

**1st Gear**, This position can be selected for engine braking effect, depending on vehicle speed.

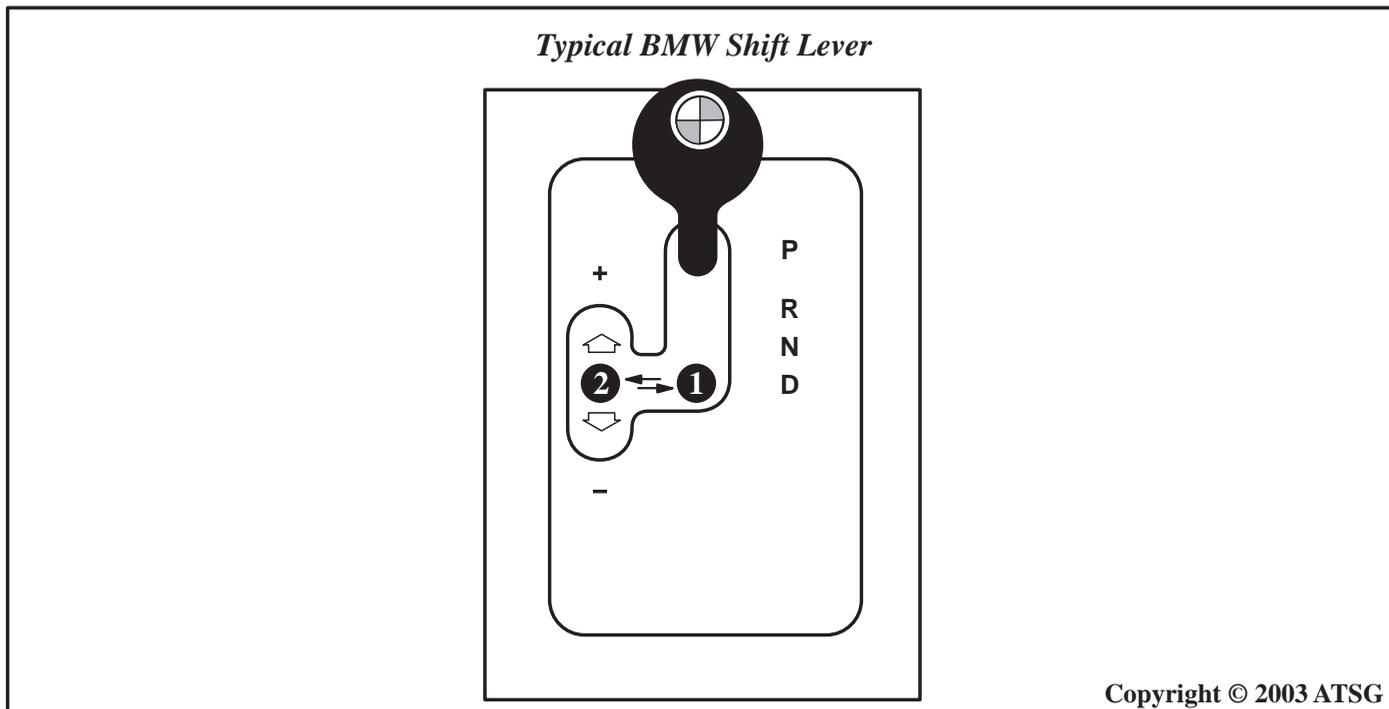


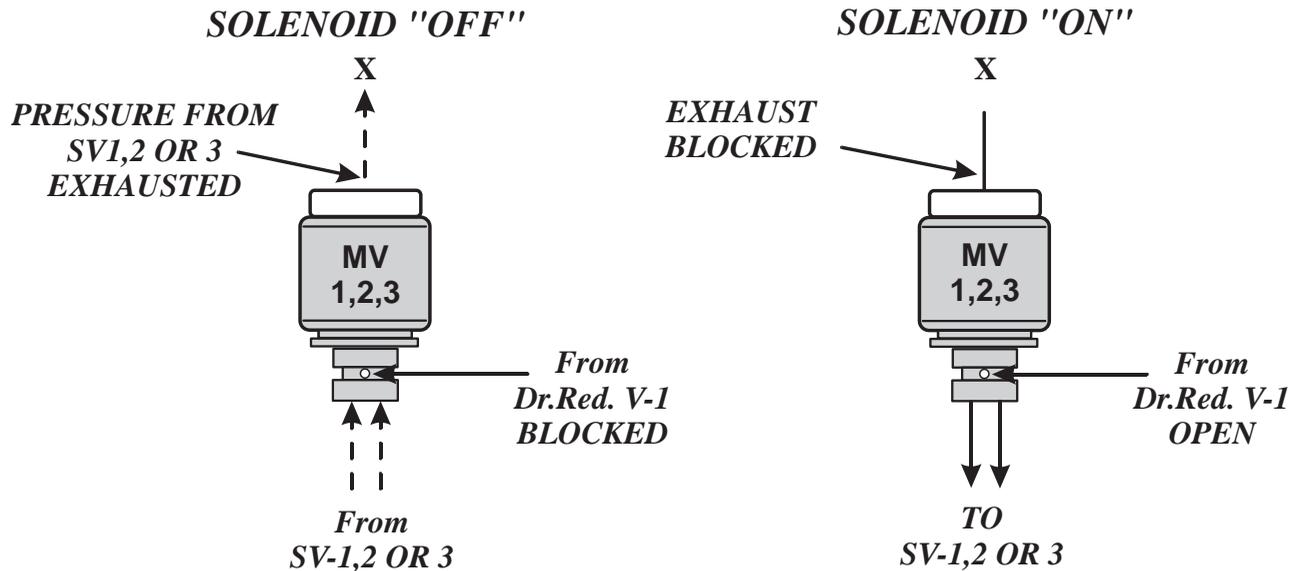
Figure 99

***FAILSAFE OPERATION:***

When a system fault is detected which would impair normal reliable operation, the transmission control module interrupts the power supply to Pin 12 at the transmission case connector. The transmission control module also alerts the driver of any faults by signaling the vehicle's "check control" system. To enable the vehicle to be driven to a repair shop, the following manual gear selections are permitted:

<i>Selector Lever Position</i>	<b>P R N D 4 3 2</b>
<i>Actual Gear Obtained</i>	<b>P R N 5 5 5 5</b>

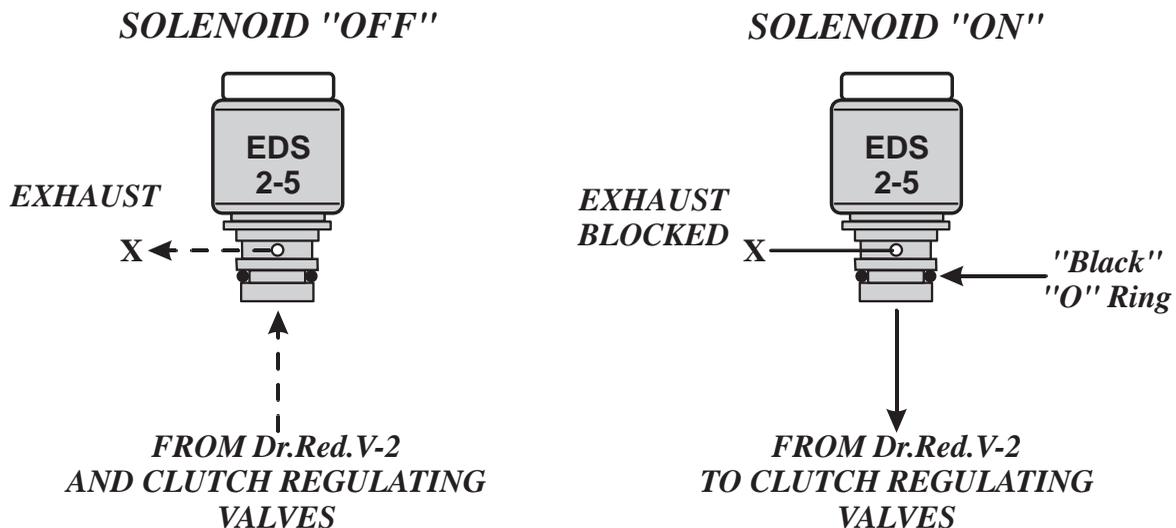
**MV1, 2 AND 3**



**SUMMARY:**

When MV 1, 2 or 3 is "OFF" Solenoid reducing pressure, from Dr.Red. V-1, is blocked by the solenoid and oil pressure from SV 1, 2 or 3 is exhausted at the rear of the solenoid.  
When MV 1, 2 or 3 is "ON" Solenoid reducing pressure, From Dr.Red. V-1, is open through the solenoid and is applied to SV 1, 2 or 3. The exhaust at the rear of the solenoid is closed.

**EDS 2, 3, 4, 5,**



**SUMMARY:**

When EDS 2 thru 5 solenoids are "OFF" they exhaust orificed solenoid reducing pressure, from Dr. Red. V-2, and the oil pressure from the clutch regulating valves releasing them.  
When EDS 2 thru 5 solenoids are "ON" the exhaust is blocked by the solenoid and solenoid reducing pressure, from Dr. Red. V-2, is applied to operate clutch regulating valves.

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Figure 100

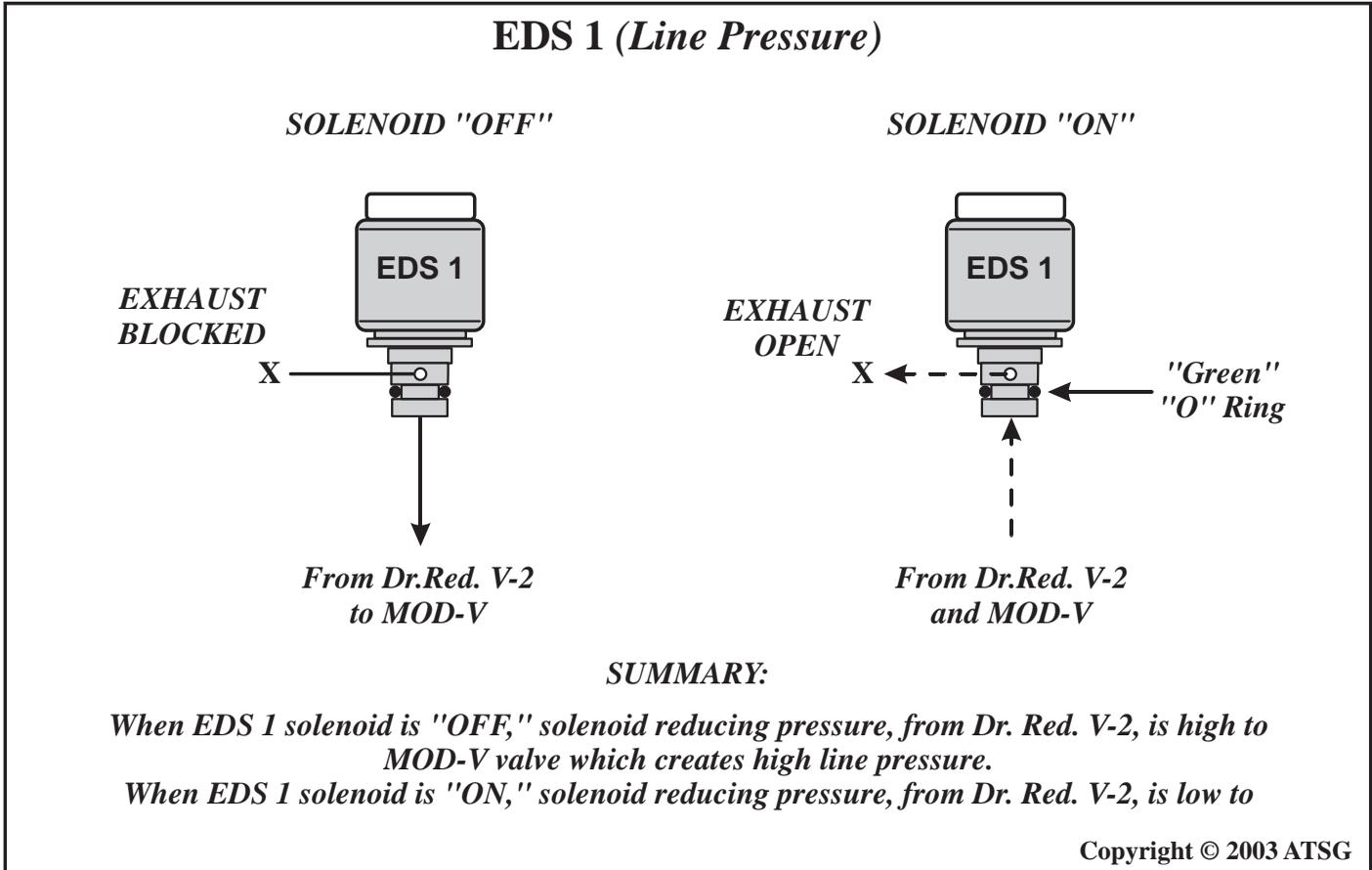
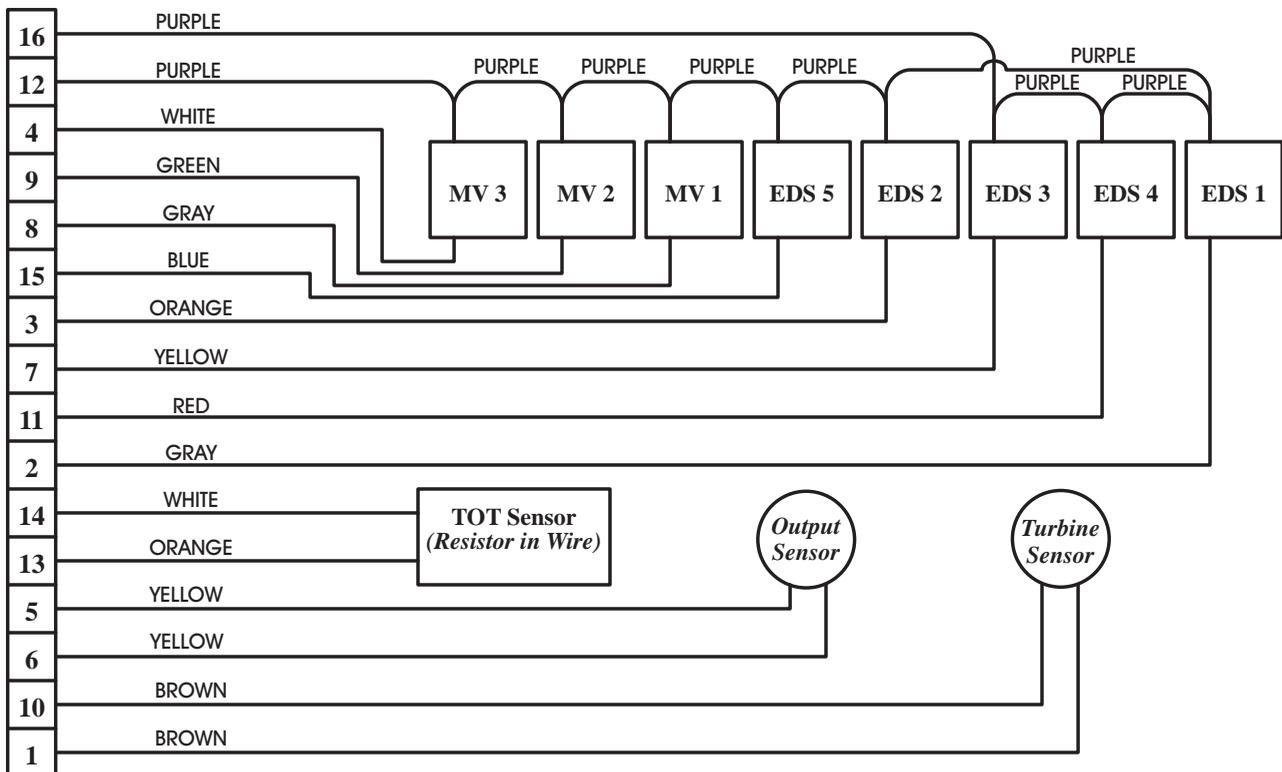
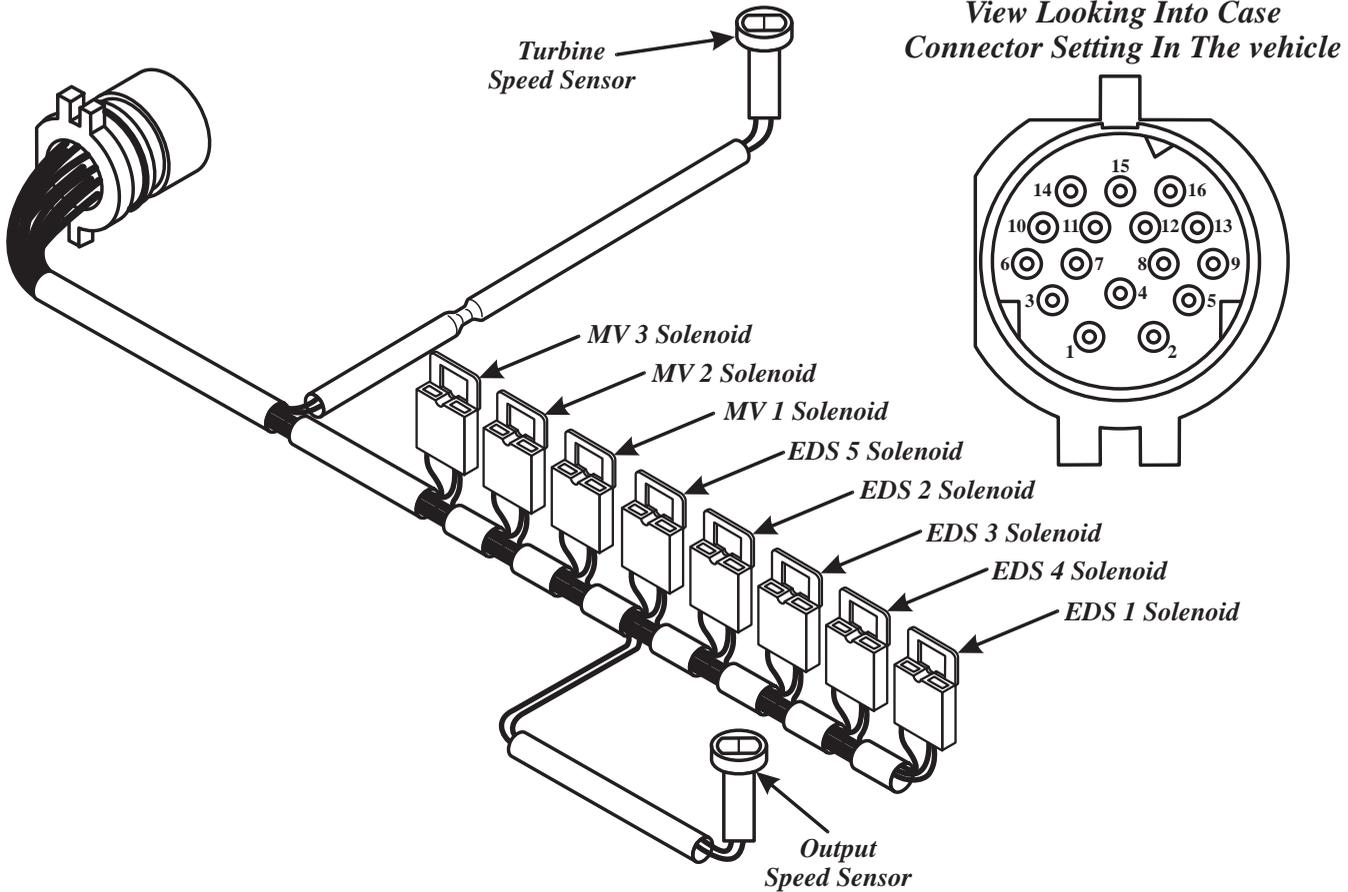


Figure 101

### ZF-5HP-24 INTERNAL WIRE SCHEMATIC



**NOTE:** Some internal wire colors may vary.

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Figure 102

### ZF-5HP-24 SOLENOID APPLICATION CHART

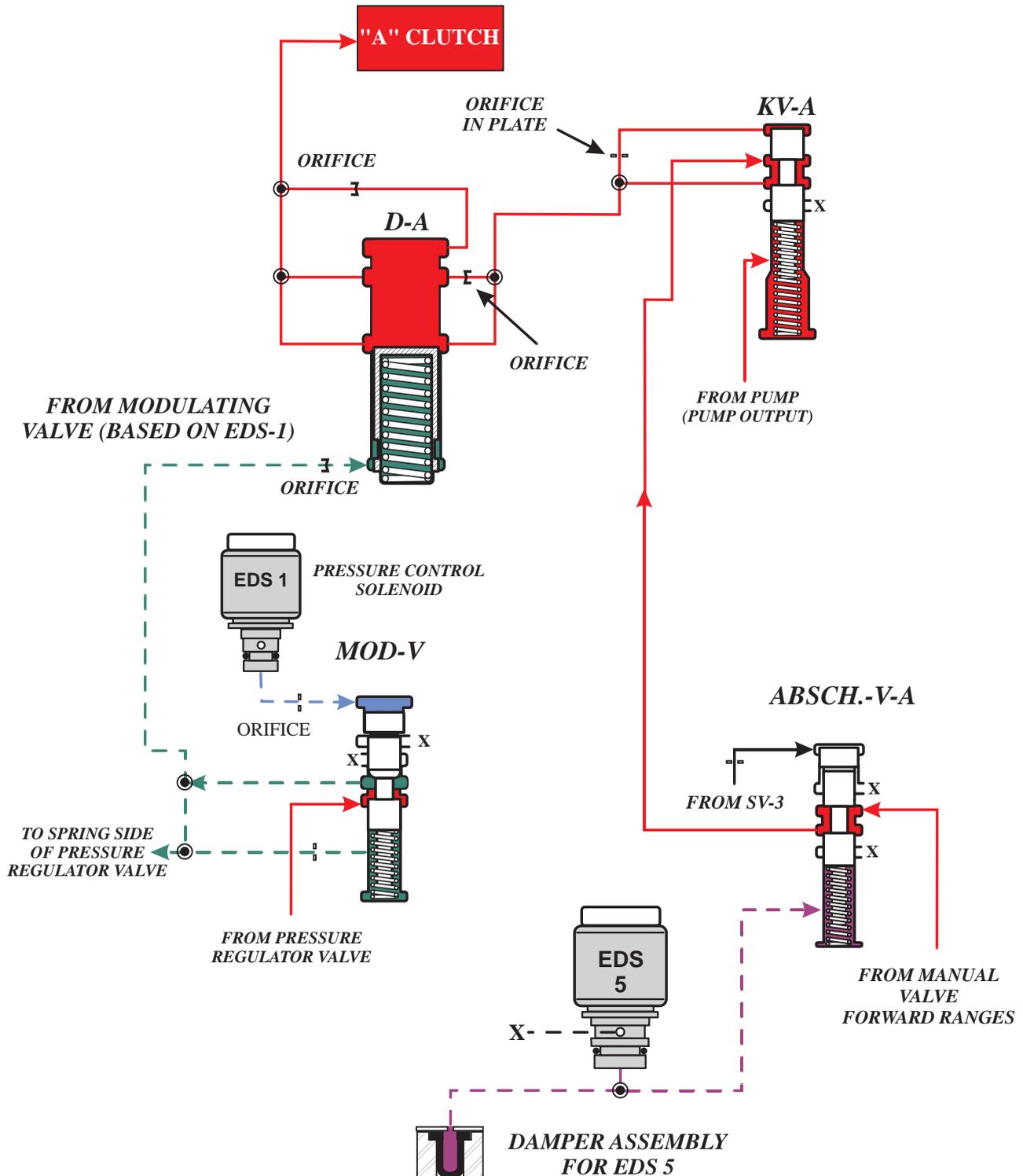
<i>Selector Lever Position</i>	<i>MV 1 Solenoid</i>	<i>MV 2 Solenoid</i>	<i>MV 3 Solenoid</i>	<i>EDS 1 Solenoid</i>	<i>EDS 2 Solenoid</i>	<i>EDS 3 Solenoid</i>	<i>EDS 4 Solenoid</i>	<i>EDS 5 Solenoid</i>	<b>GEAR RATIO</b>
<b>PARK</b>	ON		ON	**	-*	*		-*	
<b>REVERSE</b>		ON	⊗	**	*-	*		*-	<b>4.10:1</b>
<b>NEUTRAL</b>	ON		ON	**	-*	*		-*	
<b>D-1ST</b>	ON			**	*-	*		*-	<b>3.57:1</b>
<b>D-2ND</b>	ON	ON		**		*		*	<b>2.20:1</b>
<b>D-3RD</b>		ON		**		*			<b>1.51:1</b>
<b>D-4TH</b>		ON		**			-*-		<b>1.00:1</b>
<b>D-5TH</b>				**			-*-		<b>0.80:1</b>
<b>D-5TH "TCC"</b>				**			*		<b>0.80:1</b>

### SOLENOID CHART LEGEND

<i>Symbol</i>	<i>Description</i>
<b>ON</b>	<i>MV 1, MV 2 and MV 3 Solenoids are energized by the Electronic Transmission Control unit and have two functions. They are Open or Closed. Energized (On), there is pressure in circuit.</i>
⊗	<i>MV 3 is turned "ON" if reverse is selected at a high vehicle speed, to inhibit reverse engagement.</i>
**	<i>EDS 1 is used for line pressure control only, and operates from 0 to 0.8 amps. When the solenoid is "OFF" (0 amps), pressure is high. EDS 1 pressure is "Lowered" as the solenoid is modulated by the control unit.</i>
*	<i>EDS 2, EDS 3, EDS 4 and EDS 5 Solenoids are also pulse modulated but are exactly the opposite of EDS 1 Solenoid. When these solenoids are "ON" oil pressure in the hydraulic circuit is high, and when they are "OFF" pressure in the hydraulic circuit is low.</i>
-*	<i>Solenoid "OFF" (hydraulic pressure low), then Solenoid "ON" (hydraulic pressure high).</i>
*-	<i>Solenoid "ON" briefly (hydraulic pressure high), then Solenoid "OFF" (hydraulic pressure low). The pressure acts briefly on regulator valves to cushion clutch application.</i>
-*-	<i>EDS 4 Solenoid is used for Torque Converter Clutch apply and release only, and depends on throttle position and vehicle speed as to its application.</i>

Figure 103

### EDS-5 SOLENOID OPERATION



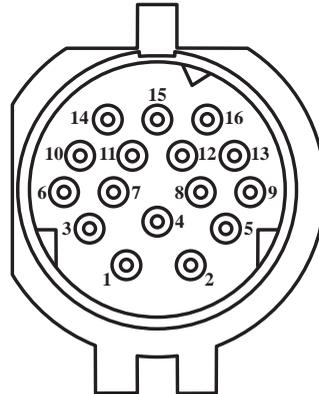
*EDS 5 is used to prevent the ABSCH.-V-A, which is the switch valve for the A clutch, from stroking against its spring. Its use is mainly for forward engagement and a 5-4 downshift.*

Figure 104

### SOLENOID AND SENSOR RESISTANCE CHART

<i>Solenoid</i>	<i>Case Connector Pin Numbers - +</i>	<i>Resistance In Ohms</i>
MV 1	8 and 12	30 - 34 Ω
MV 2	9 and 12	30 - 34 Ω
MV 3	4 and 12	30 - 34 Ω
EDS 1	2 and 12	5.2 - 6.8 Ω
EDS 2	3 and 12	6.2 - 7.8 Ω
EDS 3	7 and 12	6.2 - 7.8 Ω
EDS 4	11 and 12	6.2 - 7.8 Ω
EDS 5	15 and 12	6.2 - 7.8 Ω
TOT	13 and 14	1000 Ω at 25° C
TSS	1 and 10	292 - 358 Ω
OSS	5 and 6	292 - 358 Ω

*View Looking Into Case  
Connector Setting In The vehicle*



### *Electronic Control Unit Connector Pin Identification*

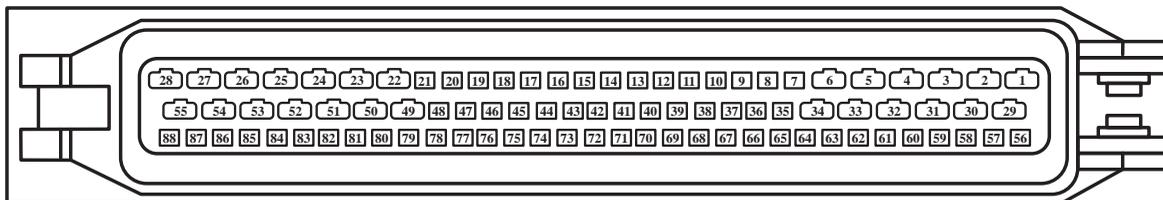
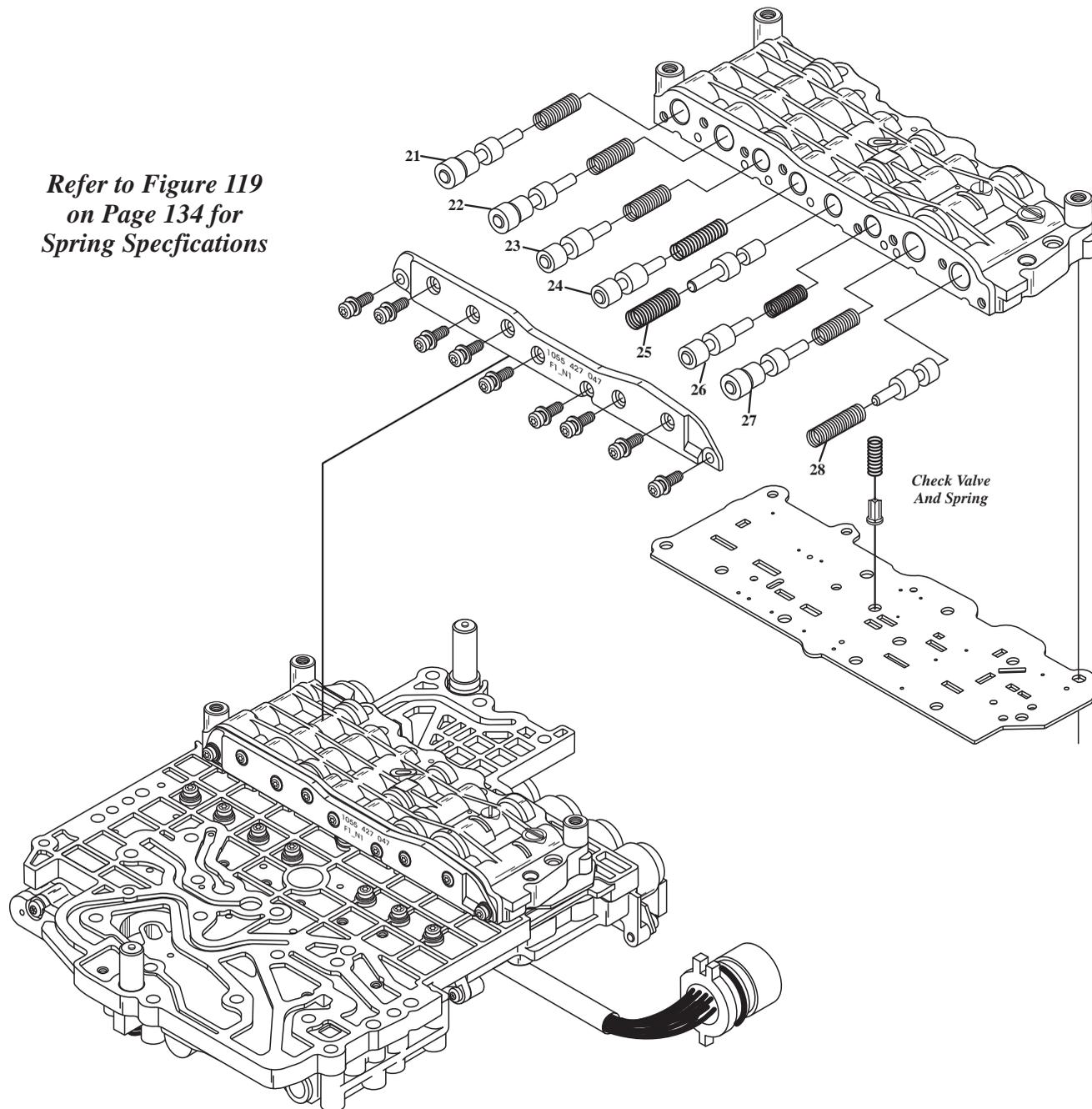


Figure 105

**ZF-5HP-24 UPPER VALVE BODY**

*Refer to Figure 119  
on Page 134 for  
Spring Specifications*



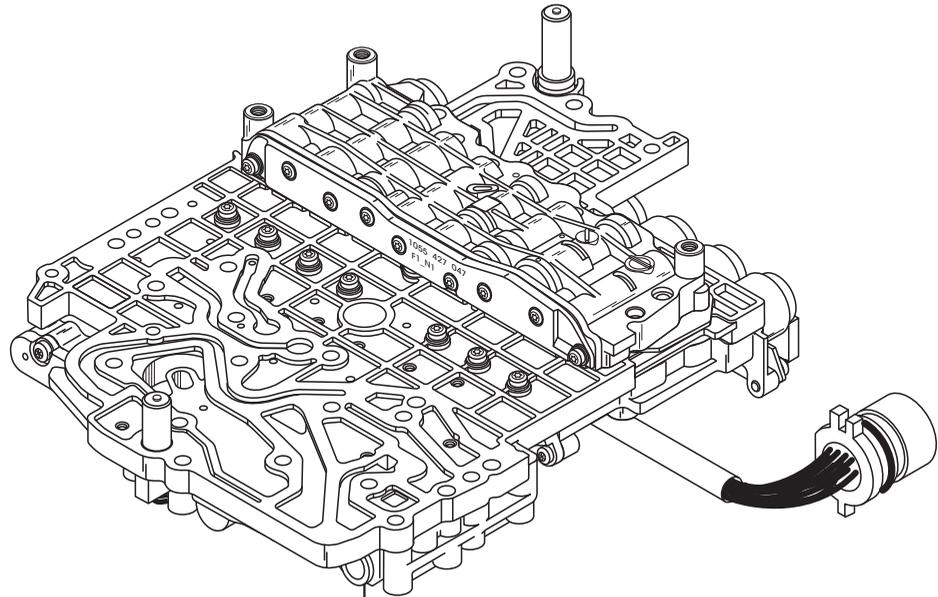
- 21. Clutch Valve "F" Line-Up (KV-F).
- 22. Clutch Valve "E" Line-Up KV-E).
- 23. Pressure Reducing Valve 1 (DR-V1).
- 24. Pressure Reducing Valve 2 (DR-V2).
- 25. Clutch Valve "B" Line-Up (KV-B).
- 26. Holding Valve "E" Line-Up (HV-E).
- 27. Switch Valve For "A" Clutch (ABSCH-V-A).

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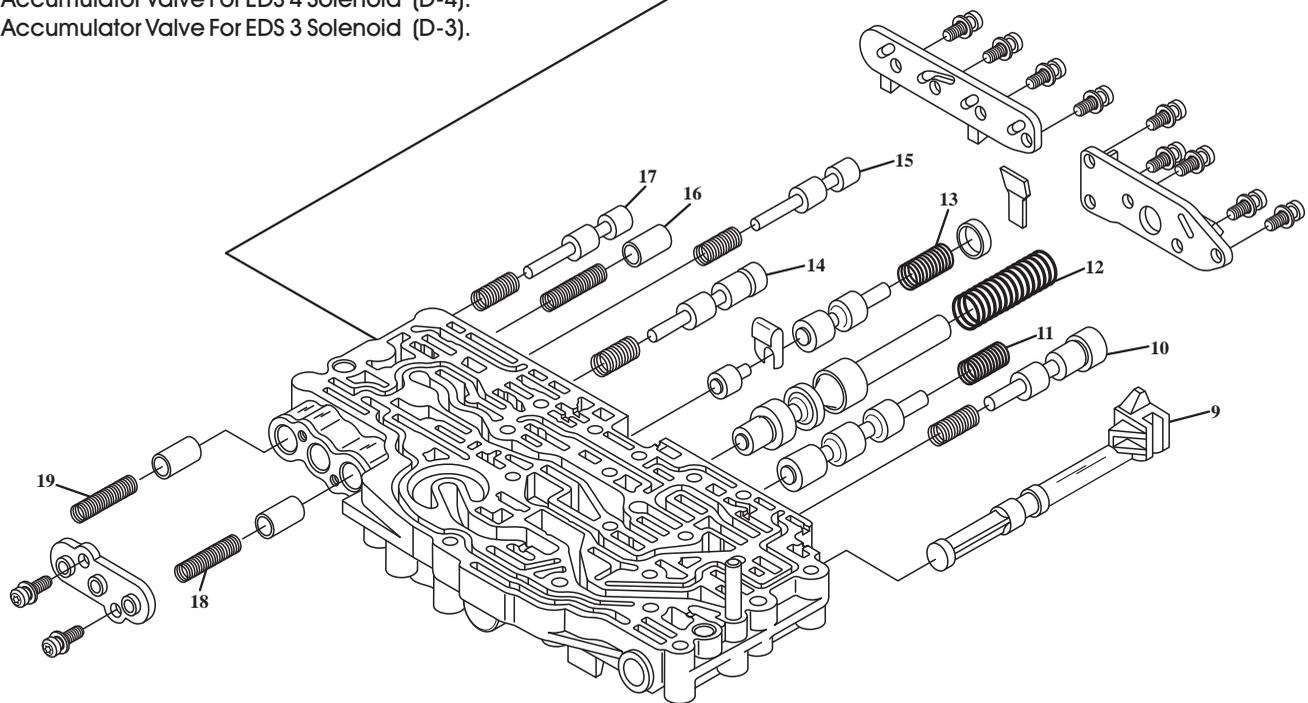
Figure 106

**ZF-5HP-24 LOWER FRONT VALVE BODY**

*Refer to Figure 119  
on Page 134 for  
Spring Specifications*



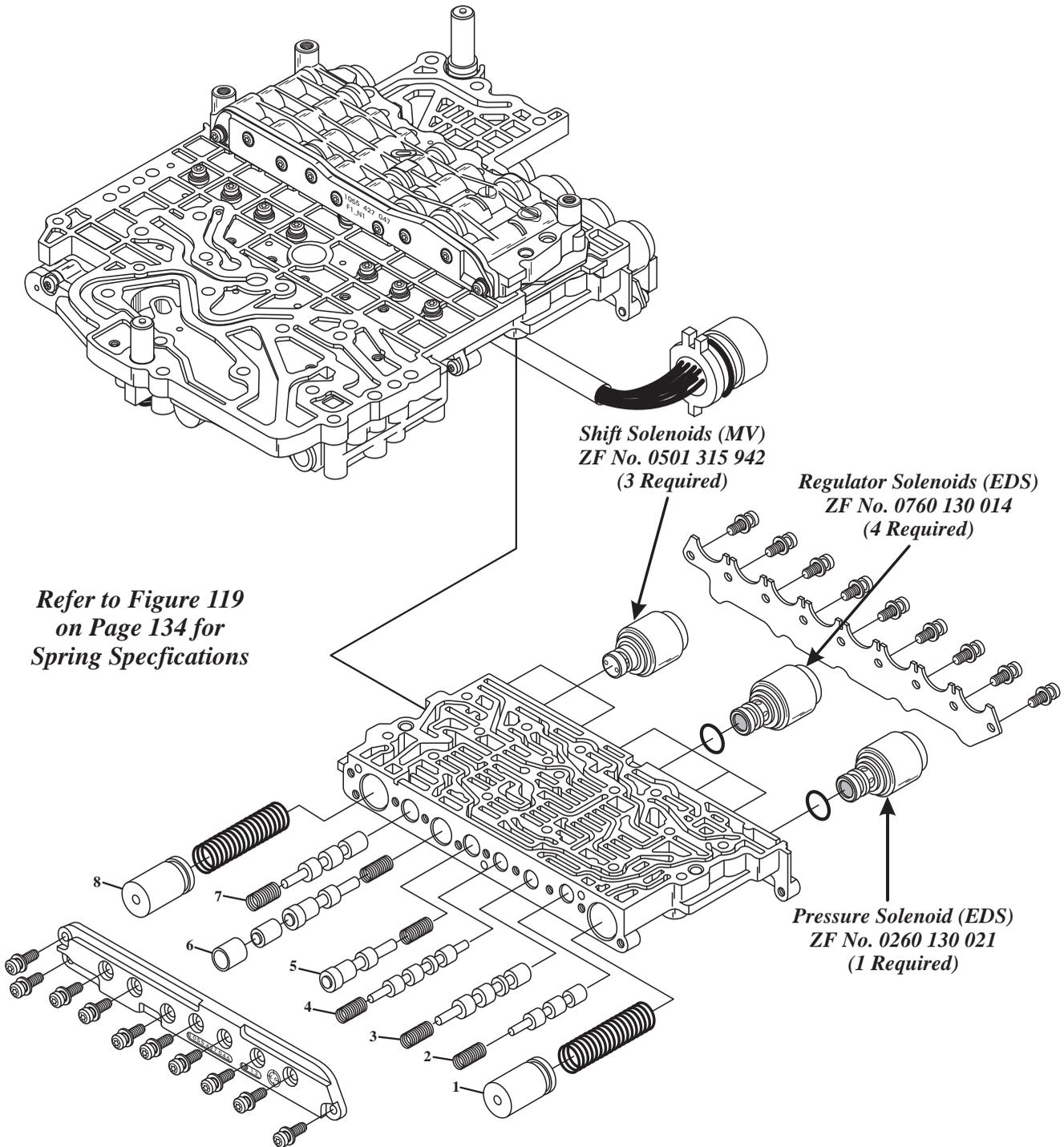
- 9. Manual Shift Valve (W-S).
- 10. Converter Clutch Apply Oil Control Valve (WK-V).
- 11. Converter Clutch Release Oil Control Valve (WD-V).
- 12. Main Pressure Regulator Valve Line-Up (HD-V).
- 13. Lubrication Valve (SCHM-V)
- 14. Modulating Valve Line-Up (MOD-V).
- 15. Holding Valve For "B" Clutch (HV-B).
- 16. Accumulator Valve For EDS 2 Solenoid (D-2).
- 17. Holding Valve For "D" Clutch (HV-D).
- 18. Accumulator Valve For EDS 4 Solenoid (D-4).
- 19. Accumulator Valve For EDS 3 Solenoid (D-3).



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Figure 107

**ZF-5HP-24 LOWER REAR VALVE BODY**



*Refer to Figure 119  
on Page 134 for  
Spring Specifications*

**Shift Solenoids (MV)**  
**ZF No. 0501 315 942**  
**(3 Required)**

**Regulator Solenoids (EDS)**  
**ZF No. 0760 130 014**  
**(4 Required)**

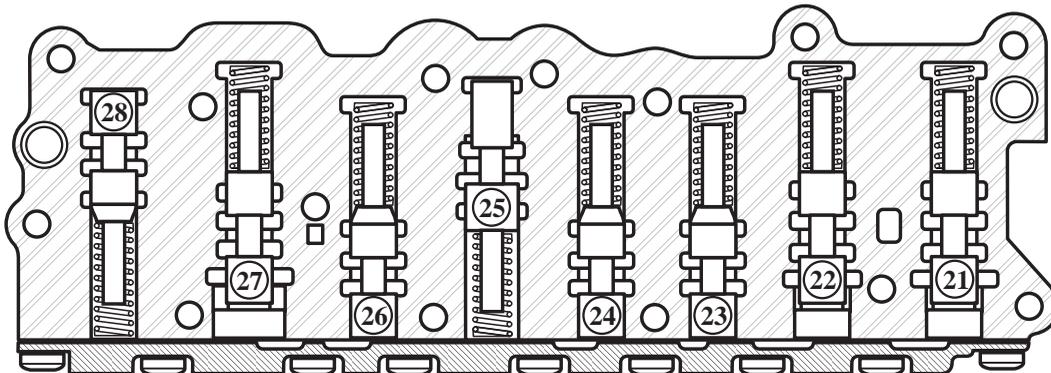
**Pressure Solenoid (EDS)**  
**ZF No. 0260 130 021**  
**(1 Required)**

1. "A" Clutch Accumulator Line-Up (D-A).
2. Shift Valve Number 1 (SV-1).
3. Shift Valve Number 2 (SV-2).
4. Shift Valve Number 3 (SV-3).
5. Switch Valve For "D" Clutch (ABSCH-V-D).
6. Clutch Valve "D" Line-Up (KV-D).
7. Reverse Gear Valve Line-Up (RG-V).

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Figure 108

**ZF 5HP-24 UPPER VALVE BODY**



- 21. Clutch Valve "F" Line-Up (KV-F).
- 22. Clutch Valve "E" Line-Up (KV-E).
- 23. Pressure Reducing Valve 1 (DR-V1).
- 24. Pressure Reducing Valve 2 (DR-V2).
- 25. Clutch Valve "B" Line-Up (KV-B).
- 26. Holding Valve "E" Line-Up (HV-E).
- 27. Switch Valve For "A" Clutch (ABSCH-V-A).

*Refer to Figure 119  
on Page 134 for  
Spring Specifications*

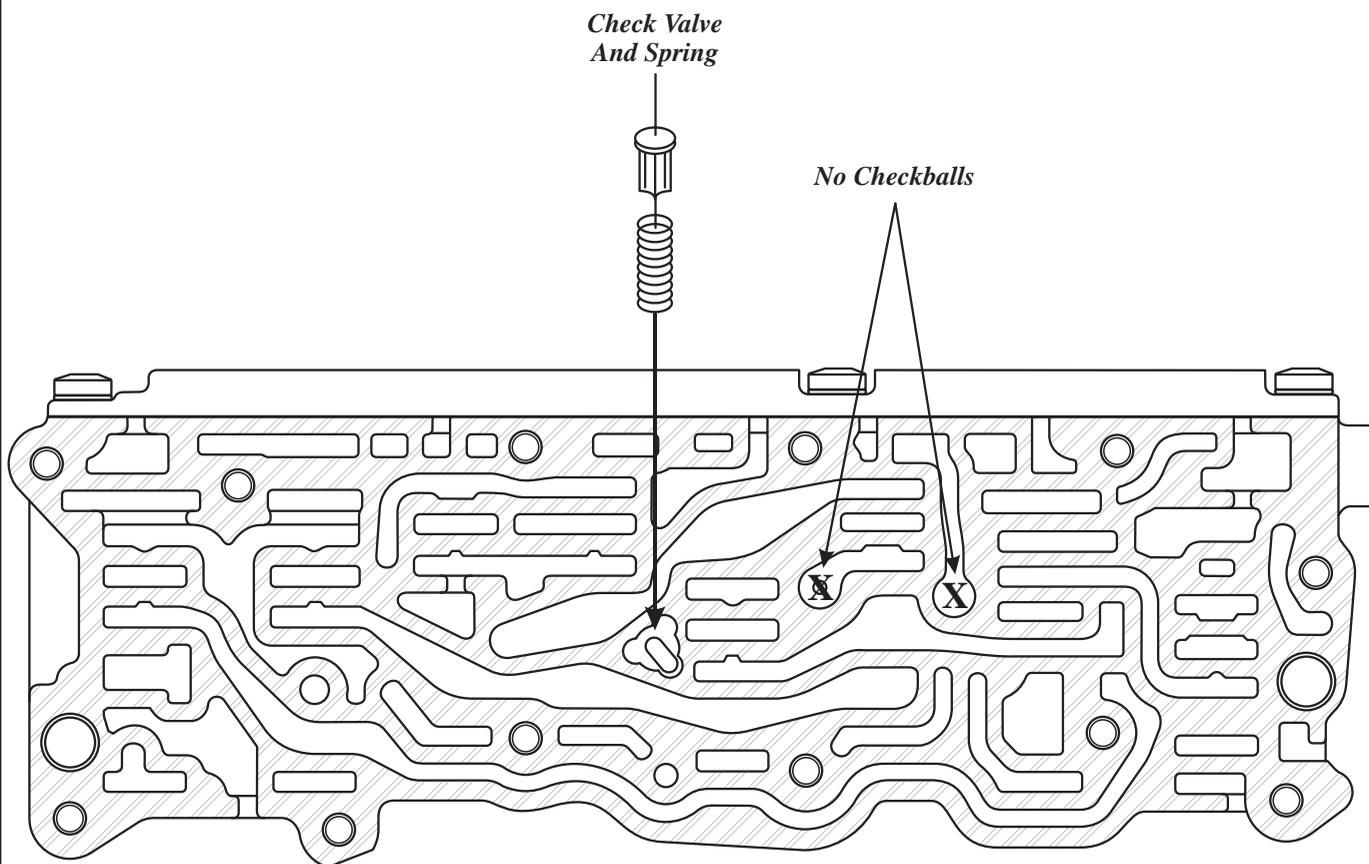


Figure 109

**ZF 5HP-24 LOWER FRONT VALVE BODY**

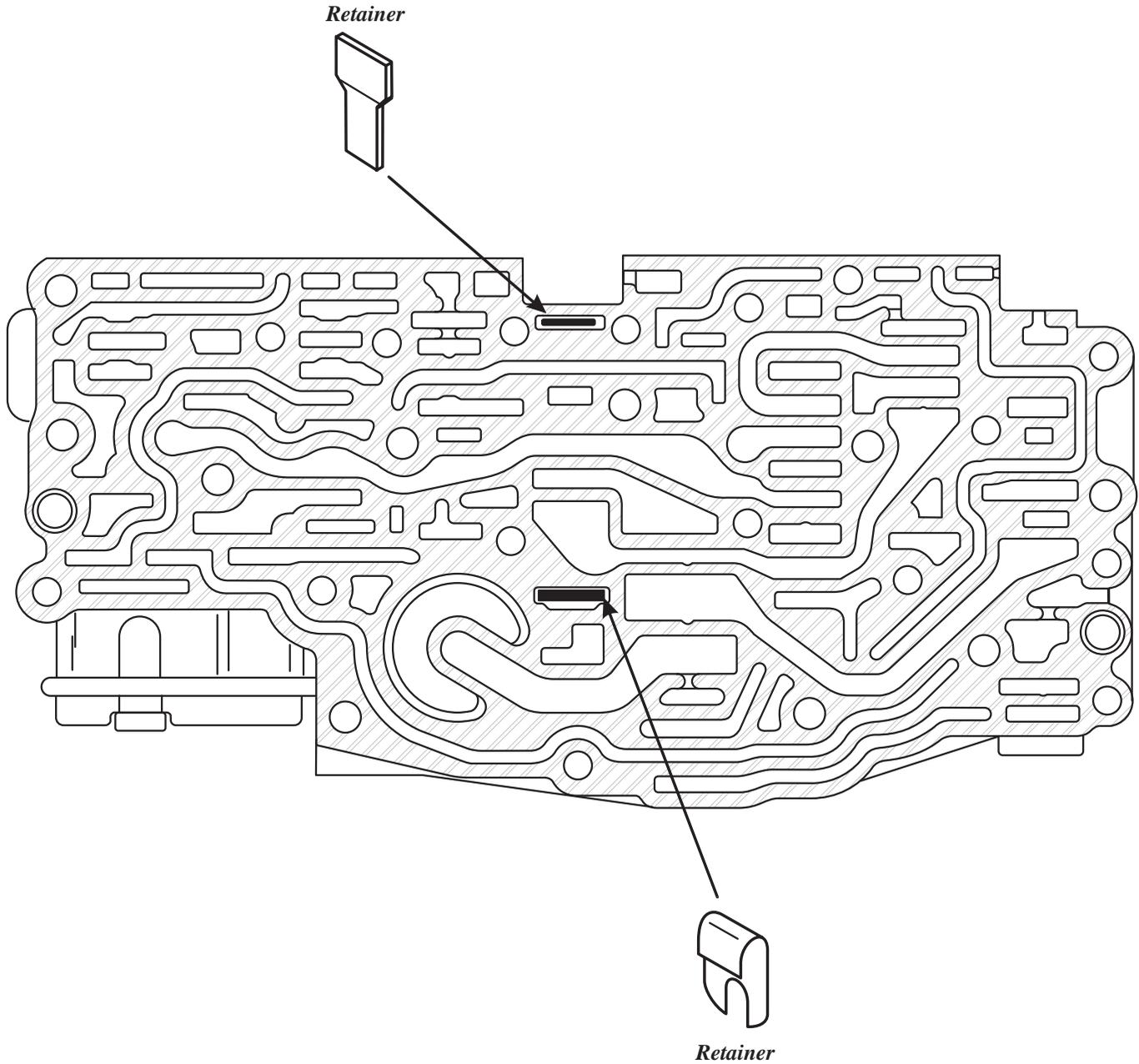


Figure 110

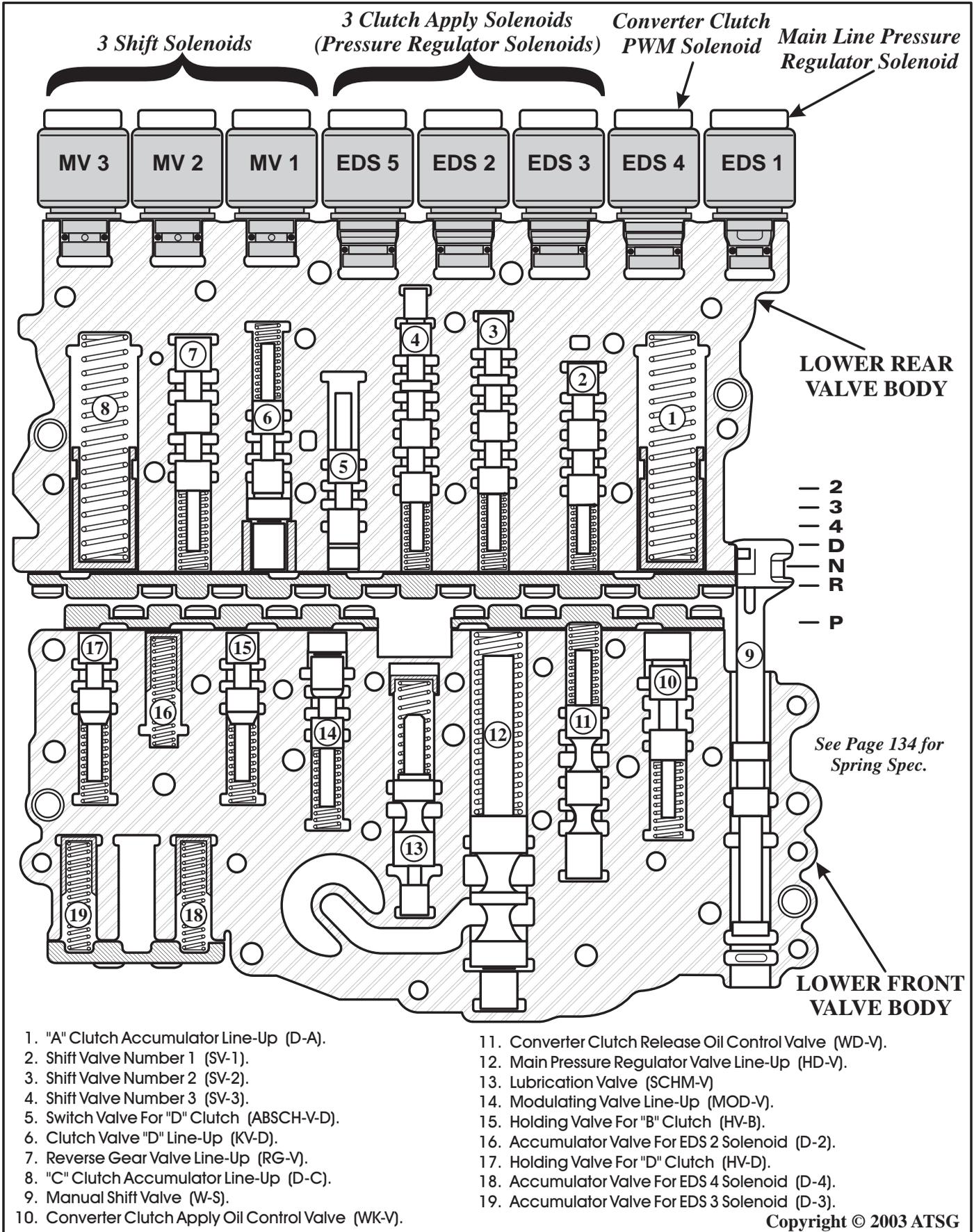


Figure 111

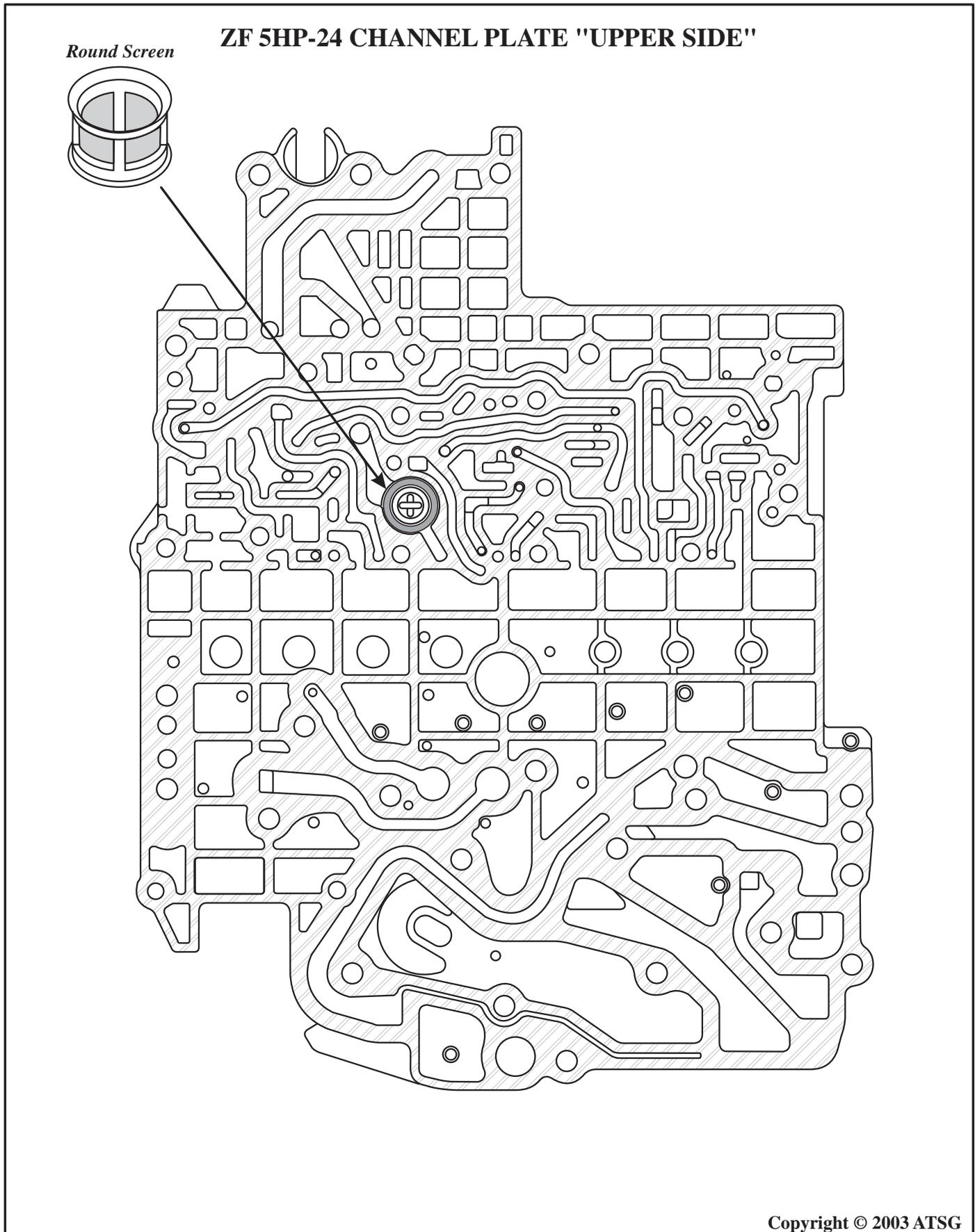
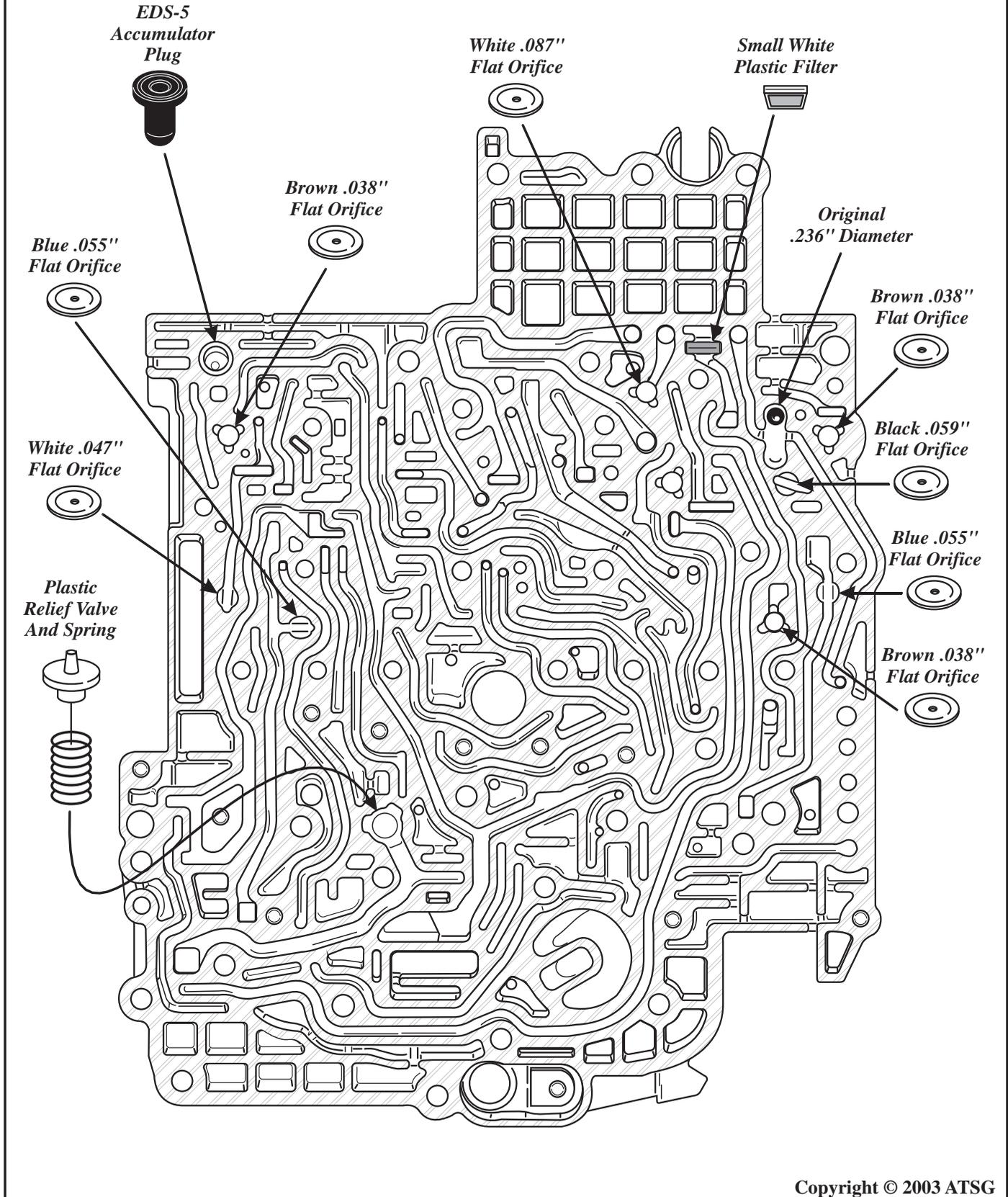


Figure 112

**ZF 5HP-24 CHANNEL PLATE "LOWER SIDE"**



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Figure 113

**PRESSURE TAP LOCATIONS AND IDENTIFICATION**

*Jaguar Model Shown*

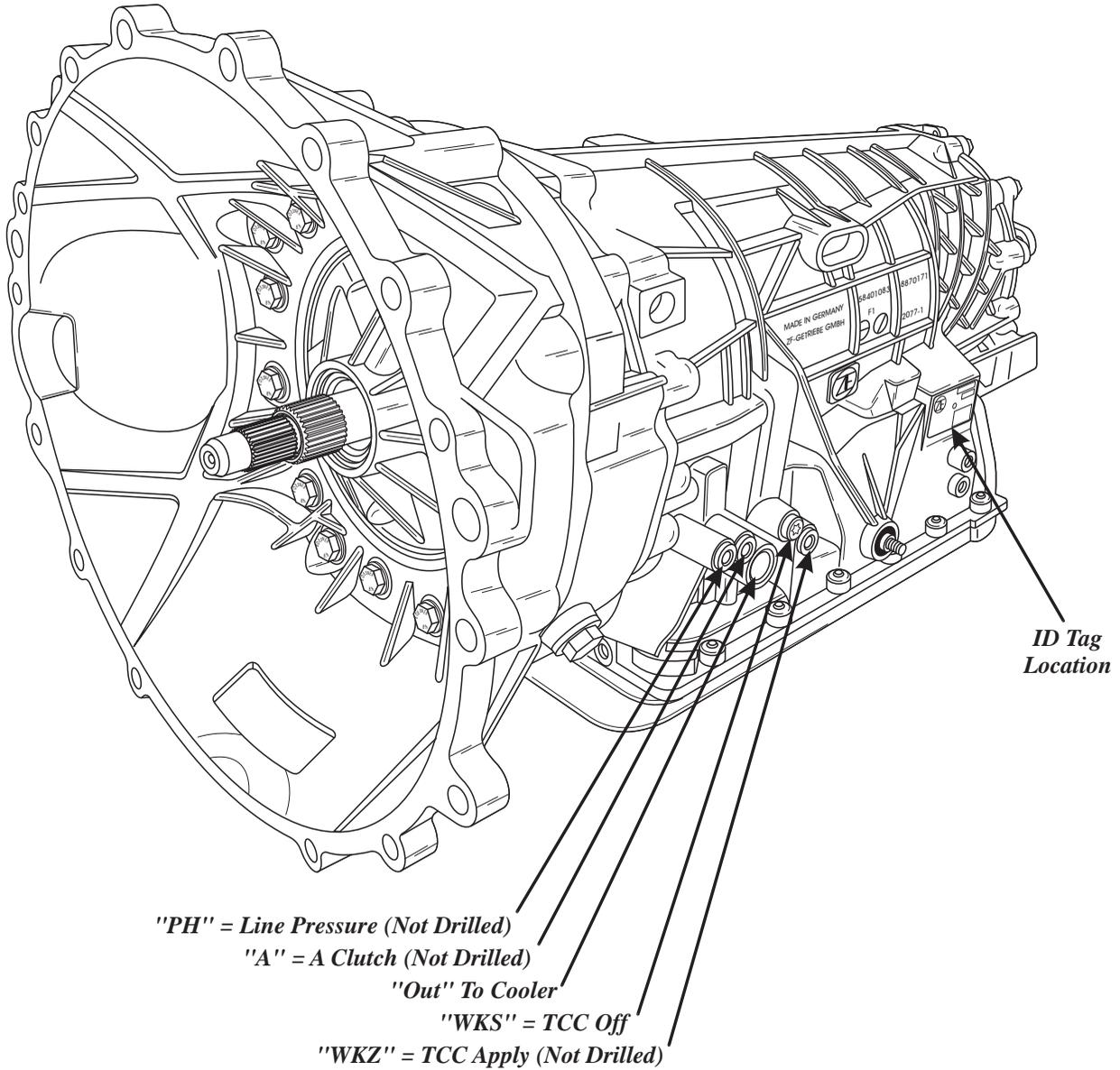
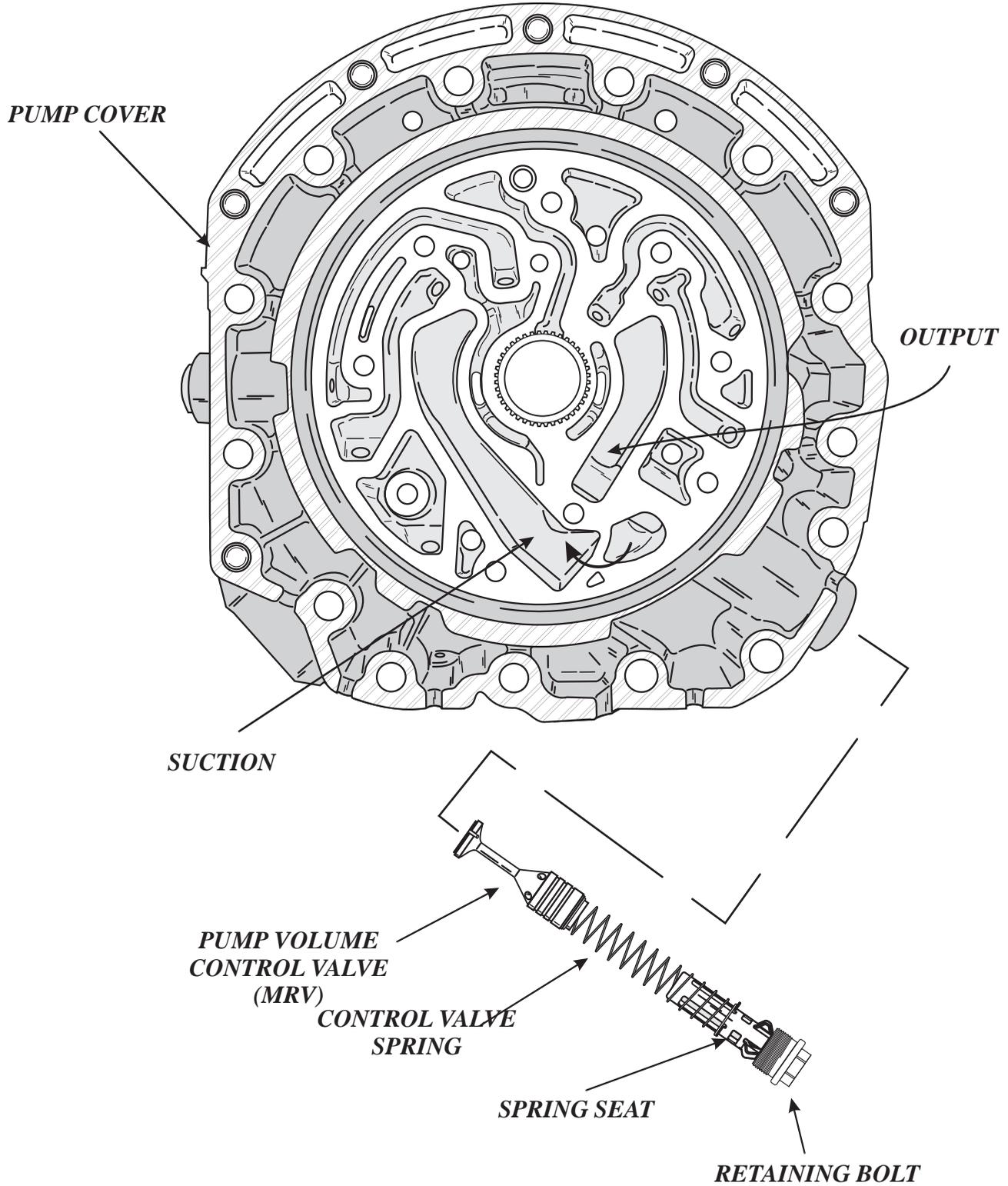


Figure 114

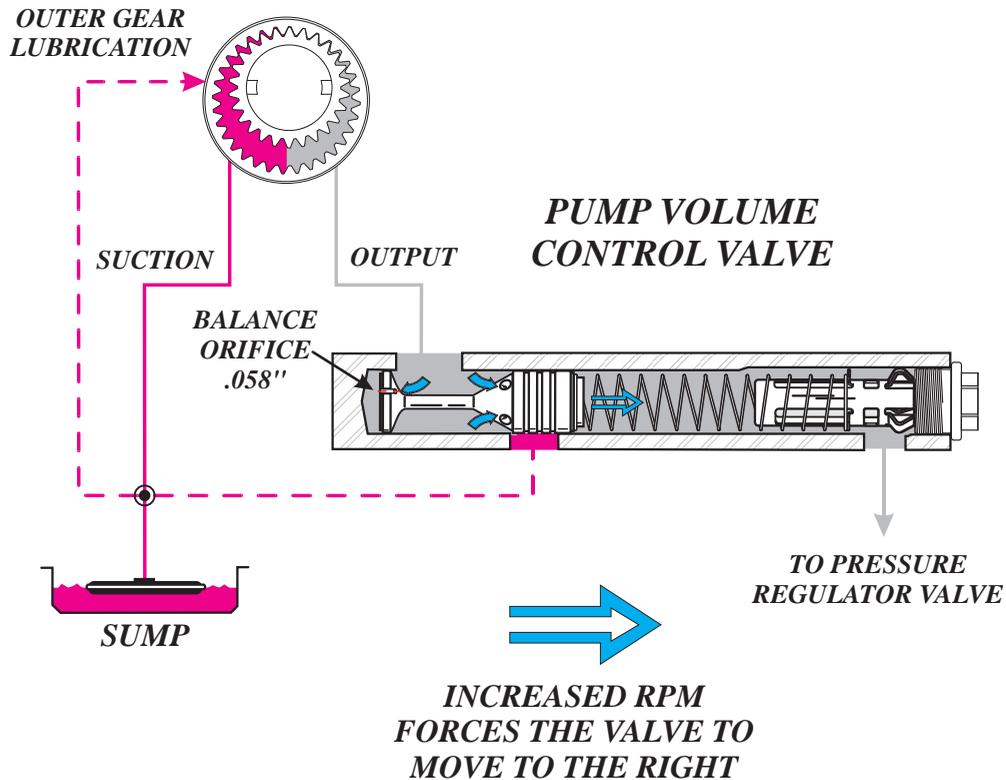
**PUMP VOLUME CONTROL  
VALVE LOCATION**



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Figure 115

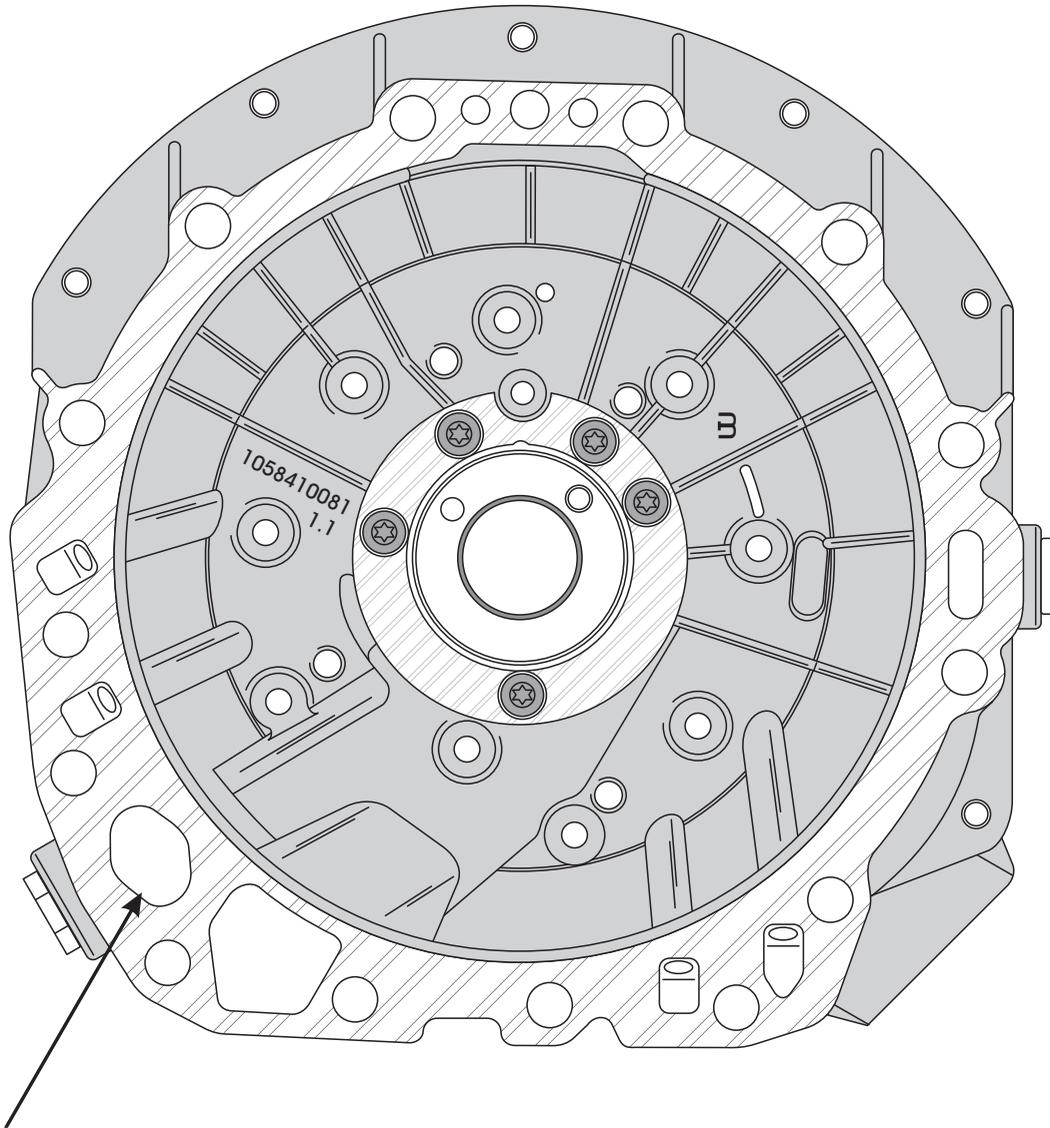
**PUMP VOLUME CONTROL  
VALVE OPERATION**



*The Pump Volume Control Valve regulates the amount of oil volume to the Pressure Regulator Valve. As engine rpm. increases, pump output increases and forces the Pump Volume Control Valve to move to the right. This allows excess pump output to return to the sump, and a consistent amount of volume to be sent to the Pressure Regulator Valve. The Pump Control Valve maintains 45 to 48 gallons per minute from 2000 to 6000 rpm.*

Figure 116

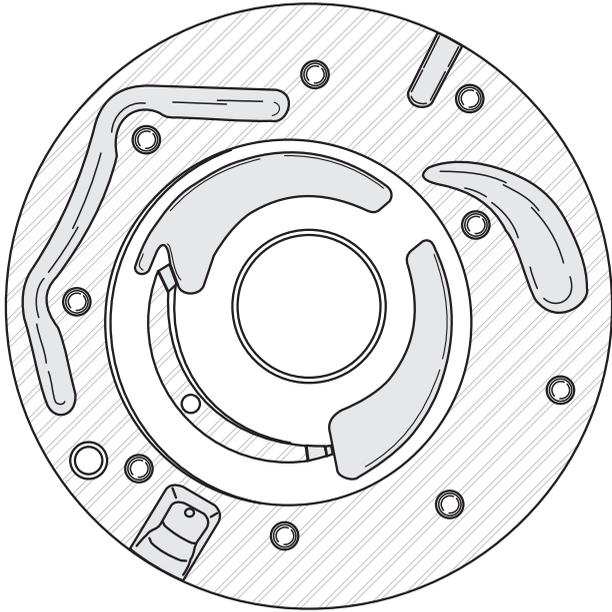
**ZF 5HP-24 PUMP COVER REAR VIEW**



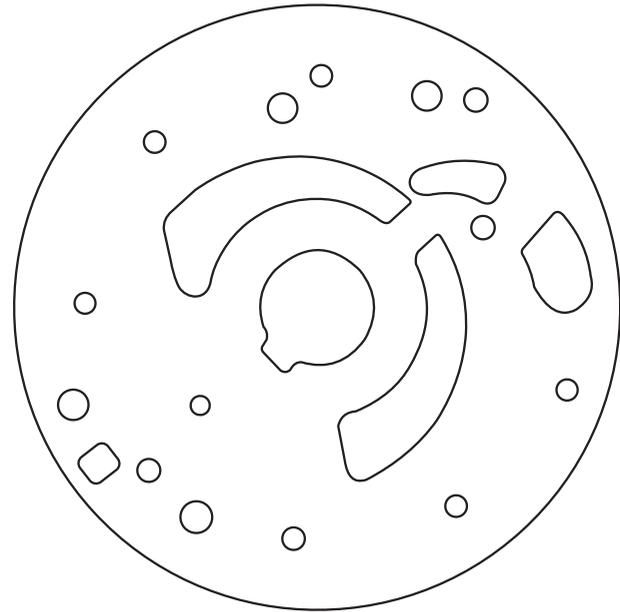
*Output to Pressure  
Regulator Valve*

Figure 117

**PUMP AND  
PUMP PLATE**

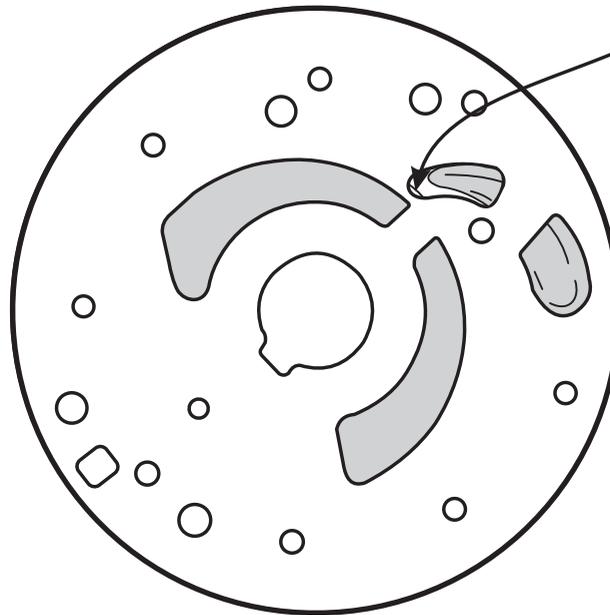


**PUMP BODY**



**PUMP PLATE**

**OUTER PUMP  
GEAR LUBRICATION**



**PUMP PLATE INSTALLED  
ON PUMP BODY**

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Figure 118

### ZF 5HP-24 VALVE BODY SPRING SPECIFICATIONS

#### UPPER VALVE BODY

- |  |  |  |
|--|--|--|
| <p>21. Clutch Valve "F" (KV-F)<br/>Free Length = 1.400"<br/>Wire Diameter = .031"<br/>Outside Diameter = .365"</p>         | <p>24. Pressure Reducing Valve (DR-V2)<br/>Free Length = 1.942"<br/>Wire Diameter = .045"<br/>Outside Diameter = .370"</p> | <p>27. A Clutch Swit Valve (ABSCH.V-A)<br/>Free Length = 1.455"<br/>Wire Diameter = .028"<br/>Outside Diameter = .365"</p> |
| <p>22. Clutch Valve "E" (KV-E)<br/>Free Length = 1.551"<br/>Wire Diameter = .031"<br/>Outside Diameter = .365"</p>         | <p>25. Clutch Valve "B" (KV-B)<br/>Free Length = 1.710"<br/>Wire Diameter = .042"<br/>Outside Diameter = .420"</p>         | <p>28. Clutch Valve "A" (KV-A)<br/>Free Length = 1.830"<br/>Wire Diameter = .028"<br/>Outside Diameter = .316"</p>         |
| <p>23. Pressure Reducing Valve (DR-V1)<br/>Free Length = 1.685"<br/>Wire Diameter = .042"<br/>Outside Diameter = .370"</p> | <p>26. Holding Valve "E" (KV-E)<br/>Free Length = 1.685"<br/>Wire Diameter = .042"<br/>Outside Diameter = .372"</p>        | <p><i>These spring locations<br/>shown on Page 121.</i></p>  |

#### LOWER "FRONT" VALVE BODY

- |   |   |   |
|---|---|---|
| <p>10. TCC Apply Control Valve (WK-V)<br/>Free Length = 1.952"<br/>Wire Diameter = .042"<br/>Outside Diameter = .370"</p>   | <p>14. Modulating Valve (MOD-V)<br/>Free Length = 1.493"<br/>Wire Diameter = .031"<br/>Outside Diameter = .365"</p>         | <p>18. EDS 4, Accumulator Valve (D-4)<br/>Free Length = 1.560"<br/>Wire Diameter = .042"<br/>Outside Diameter = .322"</p> |
| <p>11. TCC Release Control Valve (WD-V)<br/>Free Length = 2.052"<br/>Wire Diameter = .034"<br/>Outside Diameter = .438"</p> | <p>15. Holding Valve, "B" Clutch (HV-B)<br/>Free Length = 1.414"<br/>Wire Diameter = .031"<br/>Outside Diameter = .365"</p> | <p>19. EDS 3, Accumulator Valve (D-3)<br/>Free Length = 1.560"<br/>Wire Diameter = .042"<br/>Outside Diameter = .322"</p> |
| <p>12. Pressure Regulator Valve (HD-V)<br/>Free Length = 3.780"<br/>Wire Diameter = .087"<br/>Outside Diameter = .686"</p>  | <p>16. EDS 2, Accumulator Valve (D-2)<br/>Free Length = 1.565"<br/>Wire Diameter = .042"<br/>Outside Diameter = .322"</p>   | <p><i>These spring locations<br/>shown on Page 122.</i></p>   |
| <p>13. Lubrication Valve (SCHM.-V)<br/>Free Length = 1.710"<br/>Wire Diameter = .048"<br/>Outside Diameter = .485"</p>      | <p>17. Holding Valve, "D" Clutch (HV-B)<br/>Free Length = 1.681"<br/>Wire Diameter = .042"<br/>Outside Diameter = .375"</p> |   |

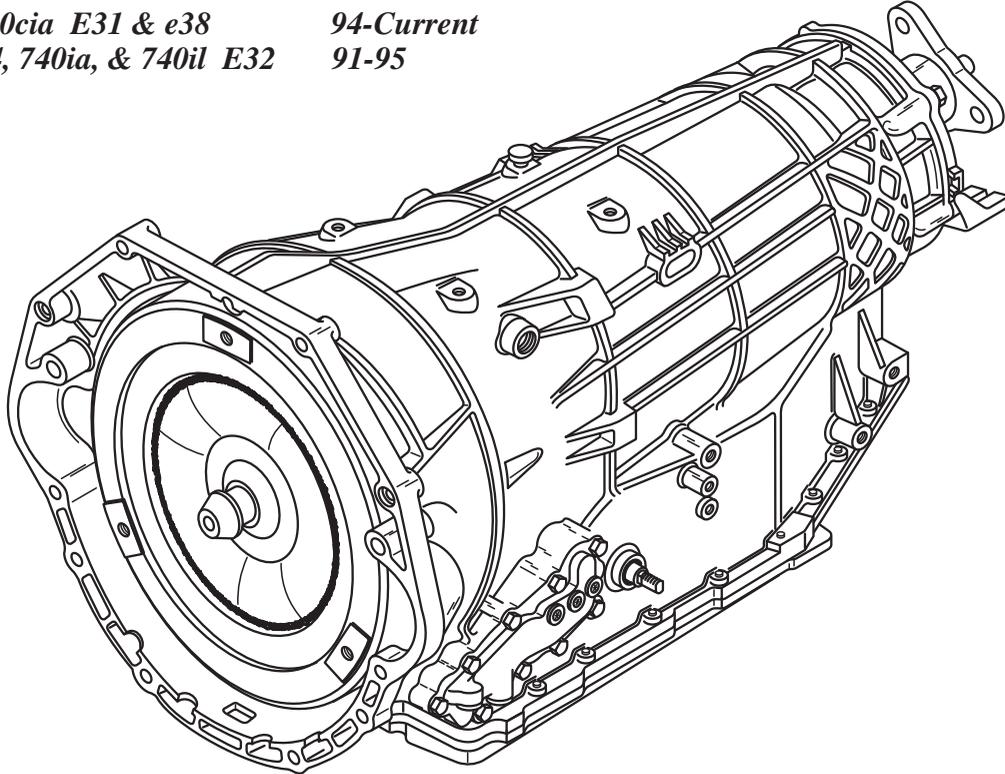
#### LOWER REAR VALVE BODY

- |  |   |  |
|--|---|--|
| <p>1. "A" Clutch Accumulator (D-A)<br/>Free Length = 3.067"<br/>Wire Diameter = .066"<br/>Outside Diameter = .595"</p> | <p>4. Shift Valve Number 3 (SV-3)<br/>Free Length = 1.640"<br/>Wire Diameter = .031"<br/>Outside Diameter = .366"</p>         | <p>7. Reverse Gear Valve (RG-V)<br/>Free Length = 1.800"<br/>Wire Diameter = .038"<br/>Outside Diameter = .435"</p>    |
| <p>2. Shift Valve Number 1 (SV-1)<br/>Free Length = 1.755"<br/>Wire Diameter = .031"<br/>Outside Diameter = .367"</p>  | <p>5. Switch Valve "D" Clutch (ABSCH.V-D)<br/>Free Length = 1.396"<br/>Wire Diameter = .039"<br/>Outside Diameter = .300"</p> | <p>8. "C" Clutch Accumulator (D-C)<br/>Free Length = 3.067"<br/>Wire Diameter = .066"<br/>Outside Diameter = .595"</p> |
| <p>3. Shift Valve Number 2 (SV-2)<br/>Free Length = 1.770"<br/>Wire Diameter = .031"<br/>Outside Diameter = .367"</p>  | <p>6. Clutch Valve "D" Line-Up (KV-D)<br/>Free Length = 1.800"<br/>Wire Diameter = .031"<br/>Outside Diameter = .360"</p>     | <p><i>These spring locations<br/>shown on Page 123.</i></p>  |

Figure 119

**BMW ZF-5HP-30**  
**DIAGNOSTIC INFORMATION**

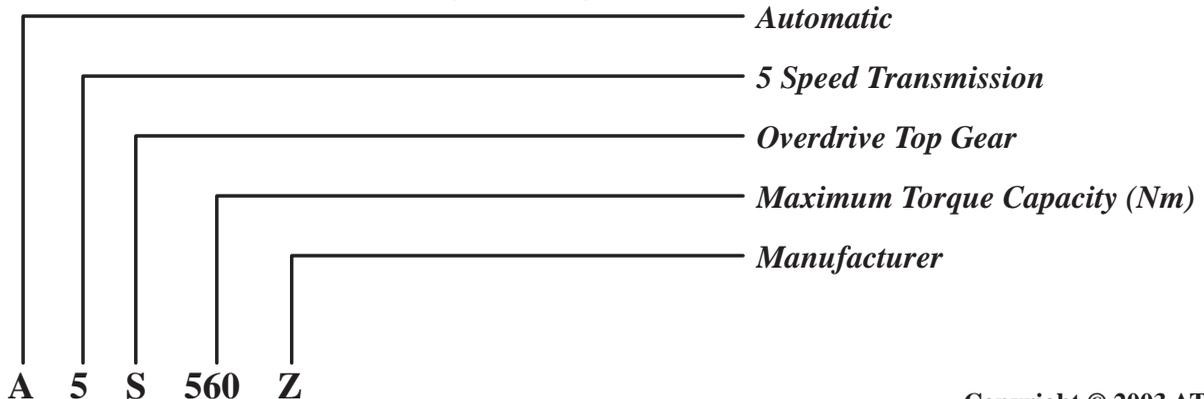
840cia E31	92-96
740ia & 740il E38	94-97
750il & 850cia E31 & e38	94-Current
540ia E34, 740ia, & 740il E32	91-95



*This transmission is manufactured in Germany by ZF and carries the BMW designation A5S 560Z.*

*The A5S 560Z is an electronically controlled, five speed automatic transmission with a lock-up clutch type torque converter. Three planetary gear sets (Wilson Gearing), three rotating multiple disc clutches, four multiple disc brake clutches, and two sprag clutches (Freewheels) are used to provide the five forward speeds and reverse.*

**Key to designation:**



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Figure 120



## **TECHNICIANS DIAGNOSTIC GUIDE**

### **BMW, AUDI, PORSCHE**

*Refer to Figure 121 for Internal Component Application Chart.*

*Refer to Figure 122 for Normal Operation, Adaptive Shift Control, and Failsafe Operation.*

*Refer to Figures 123, 124, and 125 for Solenoid identification and locations, and both MV Solenoid Operation and EDS Solenoid Operation and tests.*

*Refer to Figure 126 for wiring harness identification, internal wiring schematic, and transmission case connector pin identification.*

*Refer to Figure 127 for individual Solenoid Application Chart and definitions.*

*Refer to Figure 128 for internal components resistance chart, with the pins identified for both the transmission case connector and the Electronic Control Unit.*

*Refer to Figure 129 and 130 for Retrieving Fault Codes, a Fault Code Chart with code definitions and the Diagnostic Tool required.*

*Refer to Figure 131 for all pressure tap locations.*

*Refer to Figure 132 for Upper Rear Valve Body exploded view and identification of valves.*

*Refer to Figure 133 for Lower Front Valve Body exploded view and identification of valves.*

*Refer to Figure 134 for Lower Rear Valve Body explode view and identification of valves.*

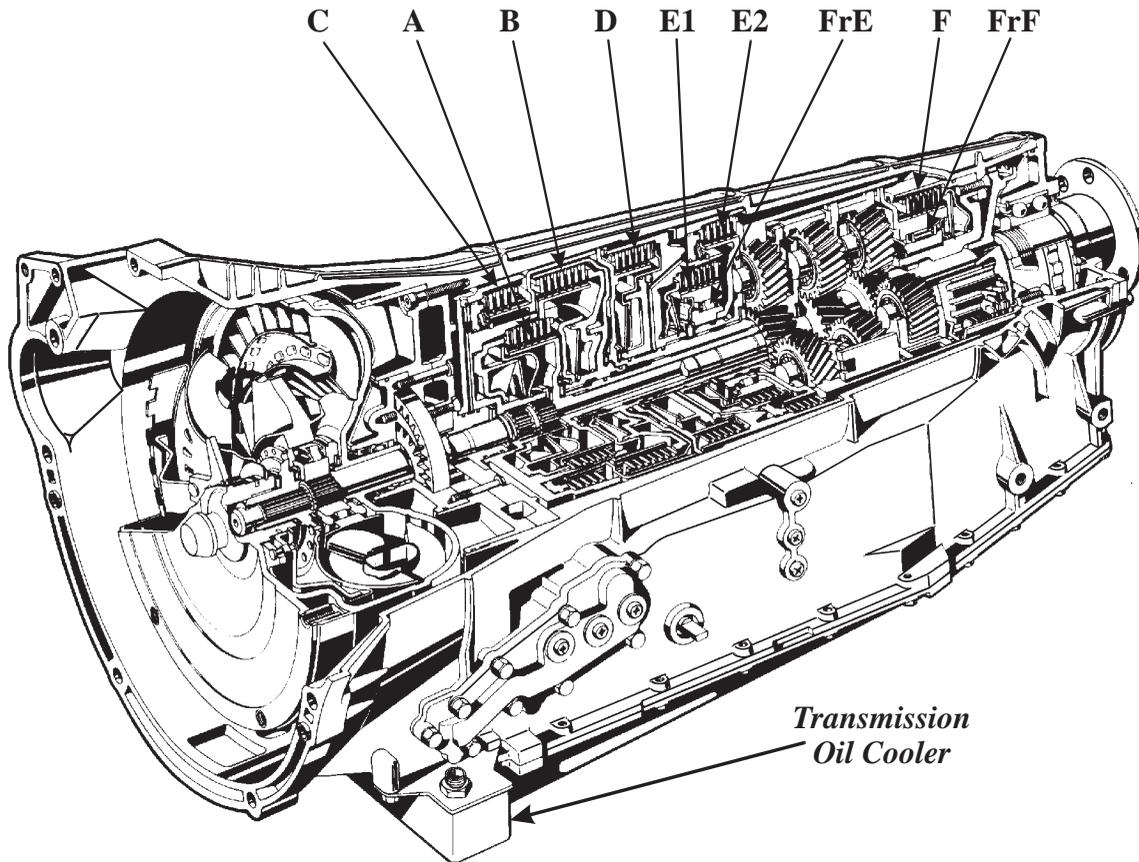
*Refer to Figures 135 and 136 for cut-away views and check ball locations in uppre rear valve body.*

*Refer to Figure 137 for all valve body spring specifications, as observed in a used valve body.*

*Refer to Figures 138 and 139 for the locations of the orifices, checkballs, screens and the check valves and springs that are located in the channel plate.*

*Refer to Page 156 for a condition of "No Reverse".*

**BMW ZF-5HP-30**



The oil cooler is a separate unit mounted on the underside of the transmission just ahead of the oil pan. The connections to the transmission oil supply are integrated into the mounting. The two external fittings visible are the supply and return lines for engine coolant. Full flow is maintained through the cooler at all times.

GEAR	"A" CLUT	"B" CLUT	"C" CLUT	"D" CLUT	"E1" CLUT	"E2" CLUT	"F" CLUT	"FrE" SPRAG	"FrF" SPRAG	GEAR RATIO
PARK							ON			
REV			ON	ON			ON			3.68:1
NEUT							ON			
D-1ST	ON								HOLD	3.55:1
D-2ND	ON				ON	ON		HOLD		2.24:1
D-3RD	ON			ON	ON					1.54:1
D-4TH	ON	ON			ON					1.00:1
D-5TH		ON		ON	ON					0.79:1
M-2	ON						ON			

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Figure 121

#### NORMAL OPERATION:

A console mounted tip switch allows the driver to select either the Automatic or Winter mode. The Winter mode is designated by an ice crystal symbol ( ) on the program switch. When in the Winter mode, the transmission starts off in 2nd gear and the upshifts are programmed to occur earlier to reduce the torque at the drive wheels and prevent wheel spin. The following chart explains the gear selection and each program mode based on the selector lever position.

SELECTOR LEVER POSITION	PROGRAM MODE	
	AUTOMATIC (A)	WINTER (*)
P	P	P
R	R	R
N	N	N
D	<i>D - Economy Program</i>	<i>D - Starts In 2nd, Early Upshifts 2-5</i>
4	<i>4 - Sport Program Delayed Upshifts 1-4</i>	<i>4 - Starts In 2nd, Early Upshifts 2-4</i>
3	<i>3 - Sport Program Delayed Upshifts 1-3</i>	<i>3 - Starts In 2nd, Early Upshifts 2-3</i>
2	<i>2 - Sport Program Delayed Upshifts 1-2</i>	<i>2 - Locked In 2nd</i>

#### ADAPTIVE SHIFT CONTROL:

##### *Stop and Go Function:*

When the transmission control module detects that the vehicle is being driven in a heavy traffic situation with many stops and starts at very low road speed, it will begin using 2nd gear when pulling away. Starting in 2nd gear and not downshifting to 1st gear when stopping eliminates the feeling of excessive load reversals, and provides a more comfortable driving style in this situation.

##### *Deceleration Rate:*

Typically, automatic transmission software programs will upshift to the highest gear possible when driven at a given road speed with no throttle application. The transmission control module on the A5S 560Z monitors the rate of change in throttle position when the throttle is released. If the throttle is released quickly, the transmission will stay in the present gear engaged, in anticipation of the drivers intent to slow down. If the throttle is gradually released, as when approaching desired road speed, the transmission will upshift to the next highest possible gear for that road speed.

#### FAILSAFE OPERATION:

When a system fault is detected which would impair normal reliable operation, the transmission control module interrupts the power supply to Pin 12 at the transmission case connector. The transmission control module also alerts the driver of any faults by signaling the vehicle's "check control" system. To enable the vehicle to be driven to a repair shop, the following manual gear selections are permitted:

<i>Selector Lever Position</i>	<b>P R N D 4 3 2</b>
<i>Actual Gear Obtained</i>	<b>P R N 4 4 4 4</b>

Figure 122

**ZF 5HP-30**  
**SOLENOID LOCATIONS AND IDENTIFICATION**

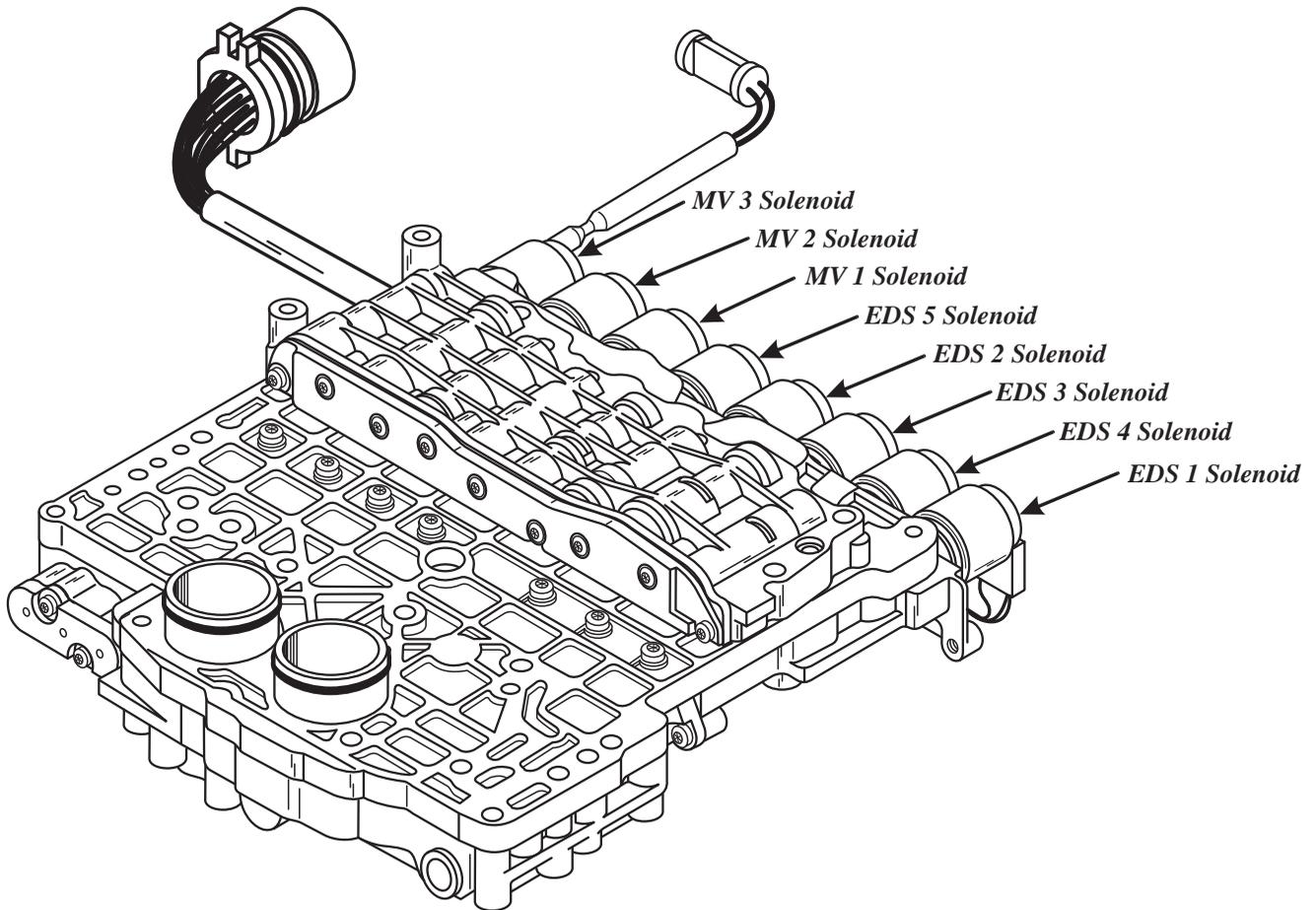
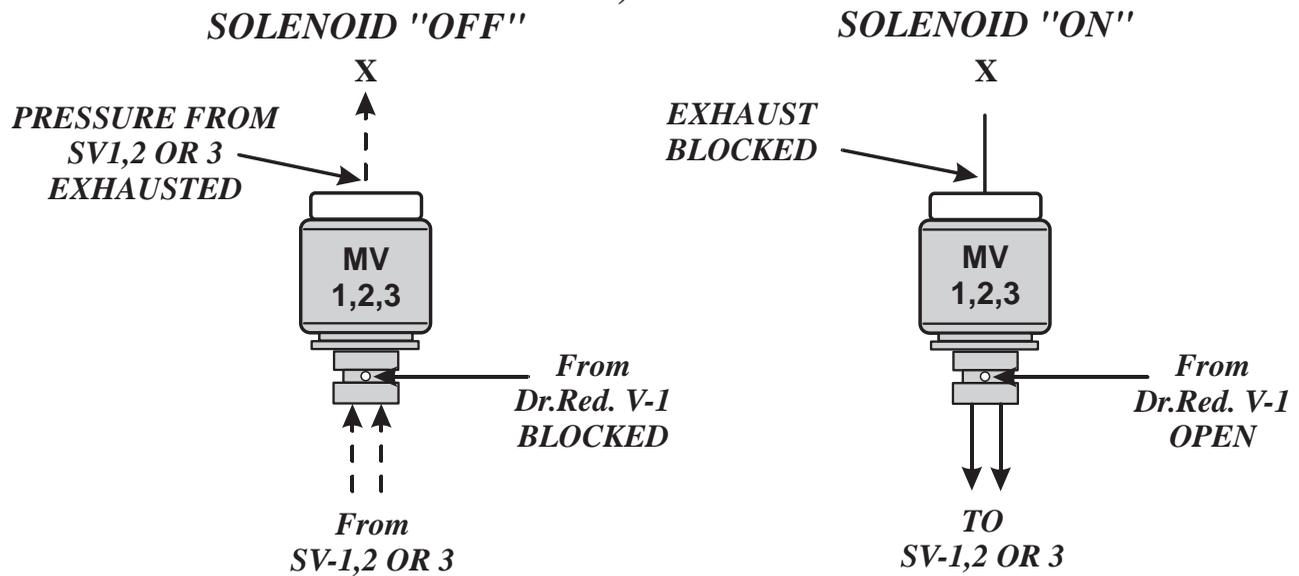


Figure 123

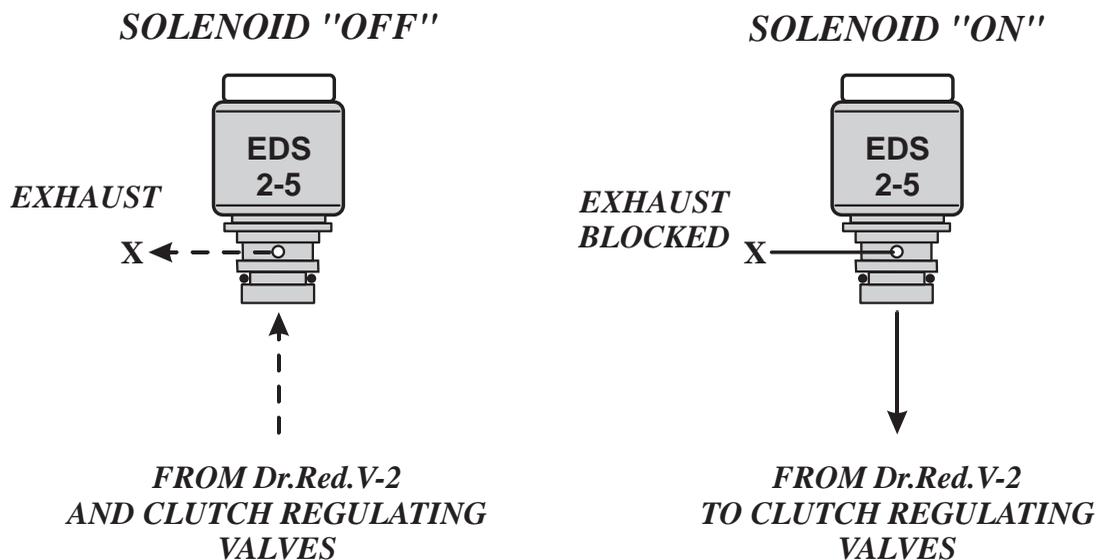
**MV1, 2 AND 3**



**SUMMARY:**

*When MV 1, 2 or 3 is "OFF" Solenoid reducing pressure, from Dr.Red. V-1, is blocked by the solenoid and oil pressure from SV 1, 2 or 3 is exhausted at the rear of the solenoid.  
When MV 1, 2 or 3 is "ON" Solenoid reducing pressure, From Dr.Red. V-1, is open through the solenoid and is applied to SV 1, 2 or 3. The exhaust at the rear of the solenoid is closed.*

**EDS 2 -5**



**SUMMARY:**

*When EDS 2-5 solenoids are "OFF" they exhaust orificed solenoid reducing pressure, from Dr. Red. V-2, and the oil pressure from the clutch regulating valves releasing them.  
When EDS 2-5 solenoids are "ON" the exhaust is blocked by the solenoid and solenoid reducing pressure, from Dr. Red. V-2, is applied to operate clutch regulating valves.*

Figure 124

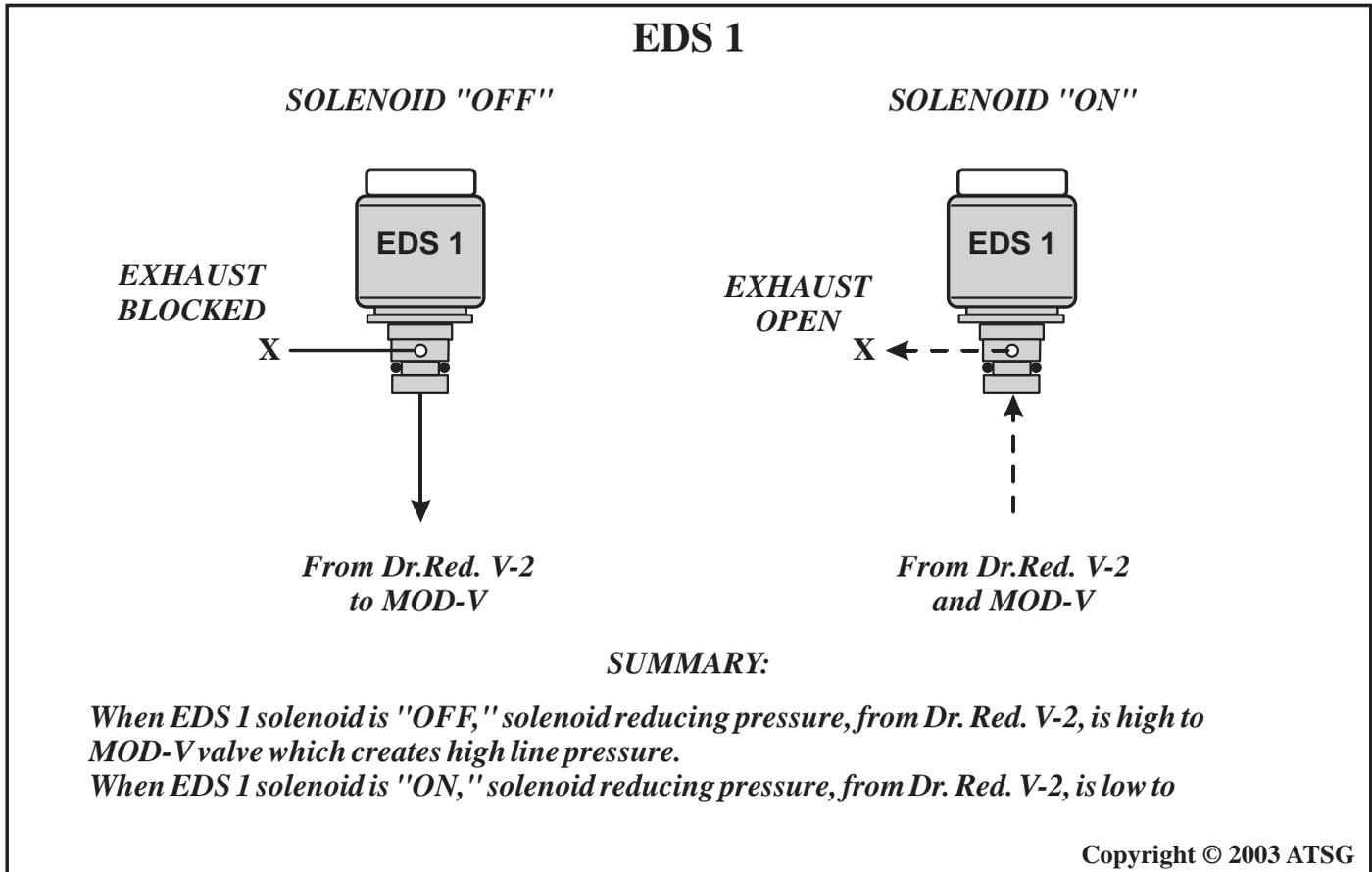
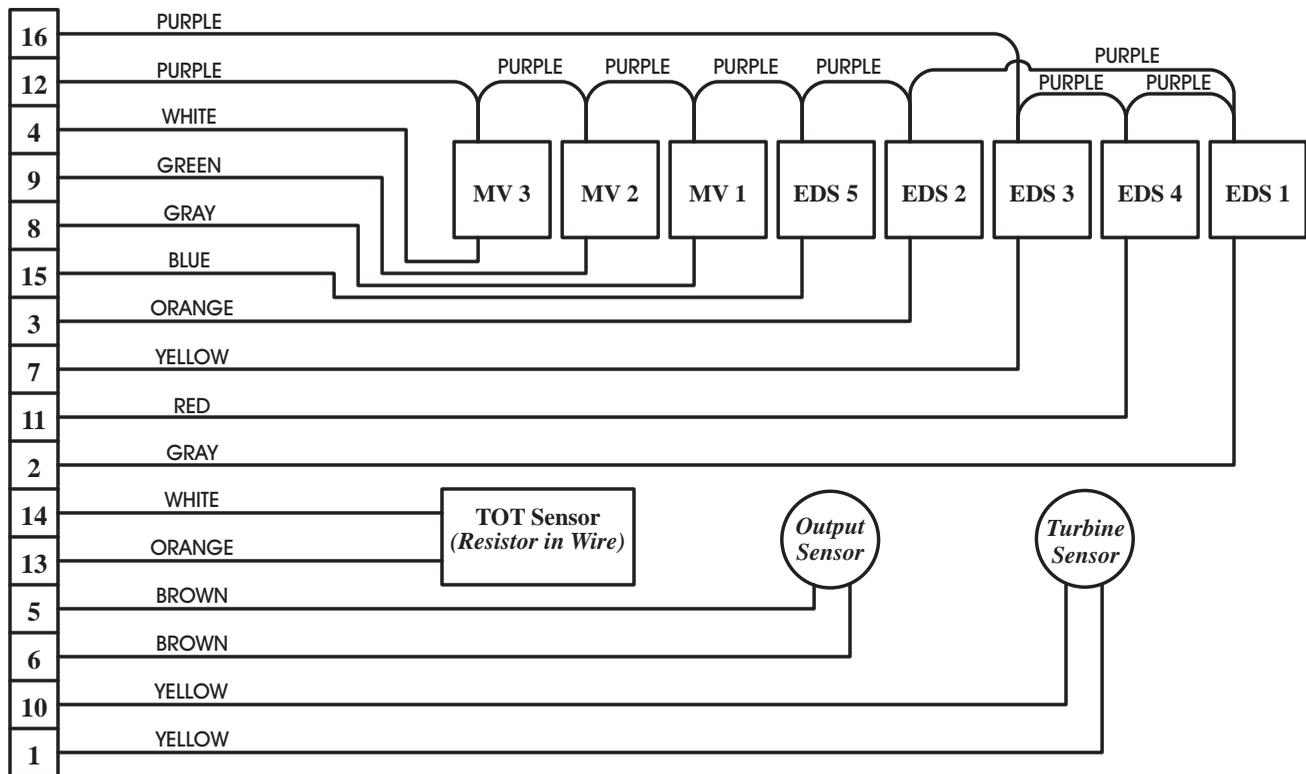
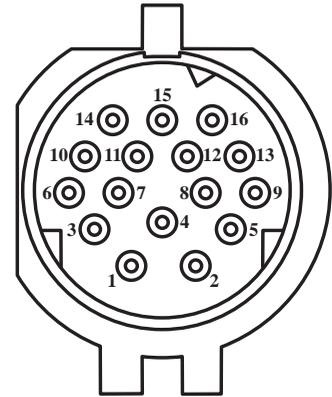
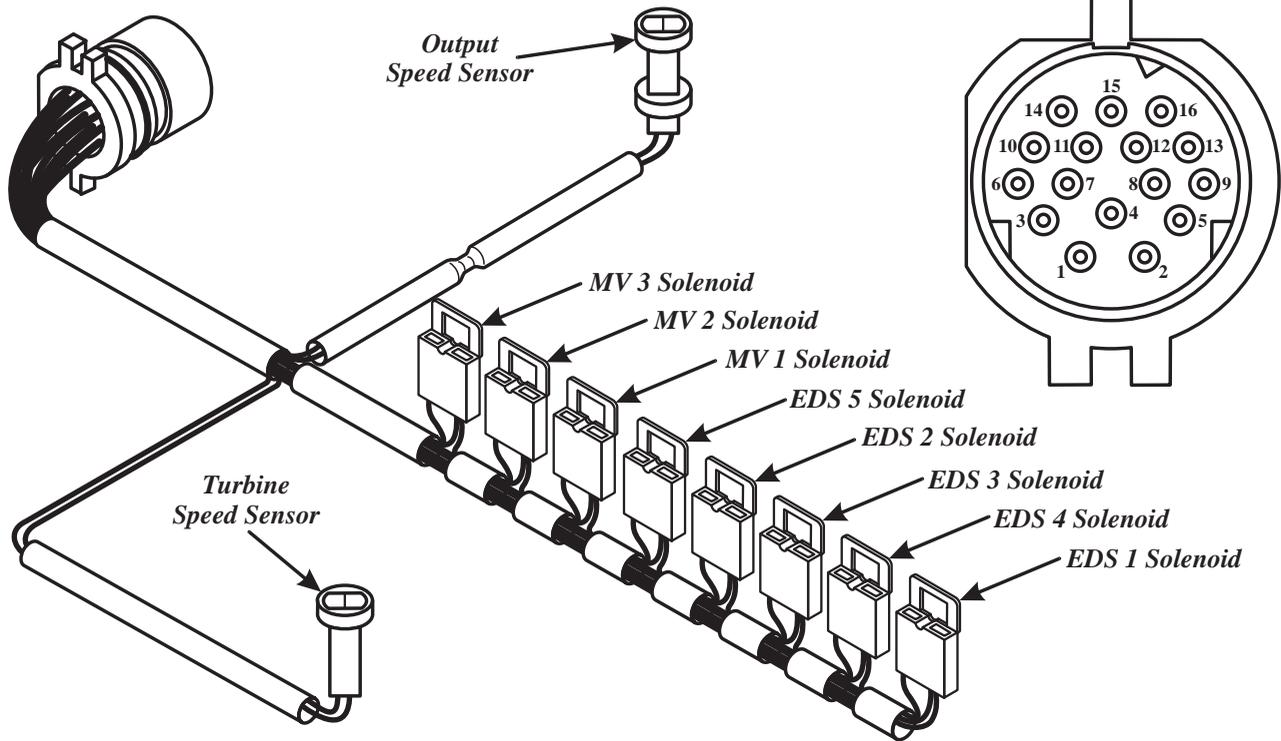


Figure 125

### ZF-5HP-30 INTERNAL WIRE SCHEMATIC

*View Looking Into Case  
Connector Setting In The vehicle*



**NOTE:** Some internal wire colors may vary.

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Figure 126

## TECHNICIANS DIAGNOSTIC GUIDE BMW, AUDI, PORSCHE

### ZF-5HP-30 SOLENOID APPLICATION CHART

<i>Selector Lever Position</i>	<i>MV 1 Solenoid</i>	<i>MV 2 Solenoid</i>	<i>MV 3 Solenoid</i>	<i>EDS 1 Solenoid</i>	<i>EDS 2 Solenoid</i>	<i>EDS 3 Solenoid</i>	<i>EDS 4 Solenoid</i>	<i>EDS 5 Solenoid</i>	<i>GEAR RATIO</i>
PARK	ON			**					
REVERSE		ON	⊗	**	*-	*		*-	3.68:1
NEUTRAL	ON			**					
D-1ST	ON			**	*-	*-		*-	3.55:1
D-2ND	ON	ON		**		*		*	2.24:1
D-3RD		ON		**	*	*		*	1.54:1
D-4TH		ON		**	*-		-*-	*-	1.00:1
D-5TH			-*	**	*		-*-	*-	0.79:1
Failsafe (4th)	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	1.00:1

### SOLENOID CHART LEGEND

<i>Symbol</i>	<i>Description</i>
ON	<i>MV 1, MV 2 and MV 3 Solenoids are energized by the Electronic Transmission Control unit and have two functions. They are Open or Closed. Energized (On), there is pressure in circuit.</i>
⊗	<i>MV 3 is turned "ON" if reverse is selected at a high vehicle speed, to inhibit reverse engagement.</i>
**	<i>EDS 1 is used for line pressure control only, and operates from 0 to 0.8 amps. When the solenoid is "OFF" (0 amps), pressure is high. EDS 1 pressure is "Lowered" as the solenoid is modulated by the</i>
*	<i>EDS 2, EDS 3, EDS 4 and EDS 5 Solenoids are also pulse modulated but are exactly the opposite of EDS 1 Solenoid. When these solenoids are "ON" oil pressure in the hydraulic circuit is high, and when they are "OFF" pressure in the hydraulic circuit is low.</i>
-*	<i>Solenoid "OFF" (hydraulic pressure low), then Solenoid "ON" (hydraulic pressure high).</i>
*-	<i>Solenoid "ON" briefly (hydraulic pressure high), then Solenoid "OFF" (hydraulic pressure low). The pressure acts briefly on regulator valves to cushion clutch application.</i>
-*-	<i>EDS 4 Solenoid is used for Torque Converter Clutch apply and release only, and depends on throttle position and vehicle speed as to its application.</i>

Figure 127

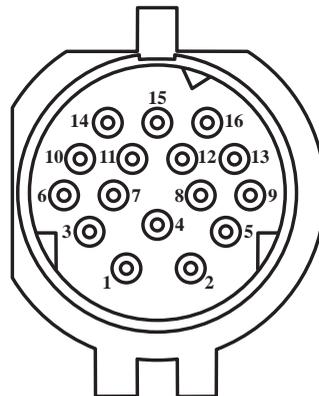
# TECHNICIANS DIAGNOSTIC GUIDE

## BMW, AUDI, PORSCHE

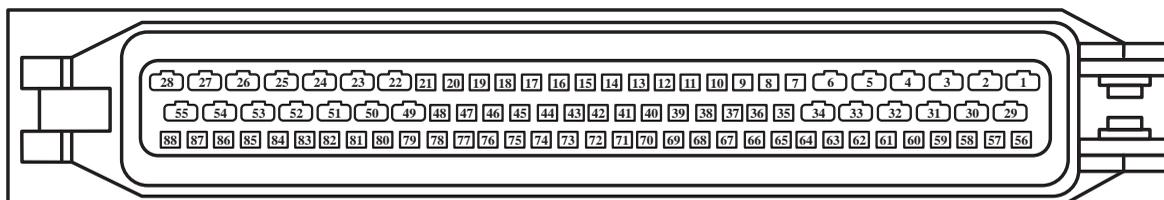
### SOLENOID AND SENSOR RESISTANCE CHART

Solenoid	Case Connector	Control Unit Connector	Resistance In Ohms
	Pin Numbers - +	Pin Numbers - +	
MV 1	8 and 12	30 and 52	30 - 34 Ω
MV 2	9 and 12	33 and 52	30 - 34 Ω
MV 3	4 and 12	32 and 52	30 - 34 Ω
EDS 1	2 and 12	5 and 52	5.2 - 6.8 Ω
EDS 2	3 and 12	1 and 52	6.2 - 7.8 Ω
EDS 3	7 and 12	29 and 52	6.2 - 7.8 Ω
EDS 4	11 and 12	4 and 52	6.2 - 7.8 Ω
EDS 5	15 and 12	51 and 52	6.2 - 7.8 Ω
TOT	13 and 14	21 and 22	1000 Ω at 25° C
TSS	1 and 10	44 and 16	292 - 358 Ω
OSS	5 and 6	14 and 42	292 - 358 Ω

*View Looking Into Case  
Connector Setting In The vehicle*



*Electronic Control Unit Connector Pin Identification*



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Figure 128



## TECHNICIANS DIAGNOSTIC GUIDE BMW, AUDI, PORSCHE

### RETRIEVING FAULT CODES

The BMW, Audi, Porsche Diagnostic Tool is *required* to retrieve the fault codes that are stored in the control unit. The diagnostic tool has the ability to retrieve codes, clear codes and activate individual components, and is adaptable to 3 Series, 5 Series, 7 Series and 8 Series vehicles equipped with 4HP-22/24, 4L30-E, 4HP-18FLE, 5HP-18, 5HP-19, and 5HP-30. The BMW, Audi, Porsche Diagnostic Tool can be purchased from:

*Assenmacher Specialty Tools, Inc*  
*Phone (303) 530-2424 Fax (303) 530-4720*

### BMW ZF-5HP-30 FAULT CODE CHART

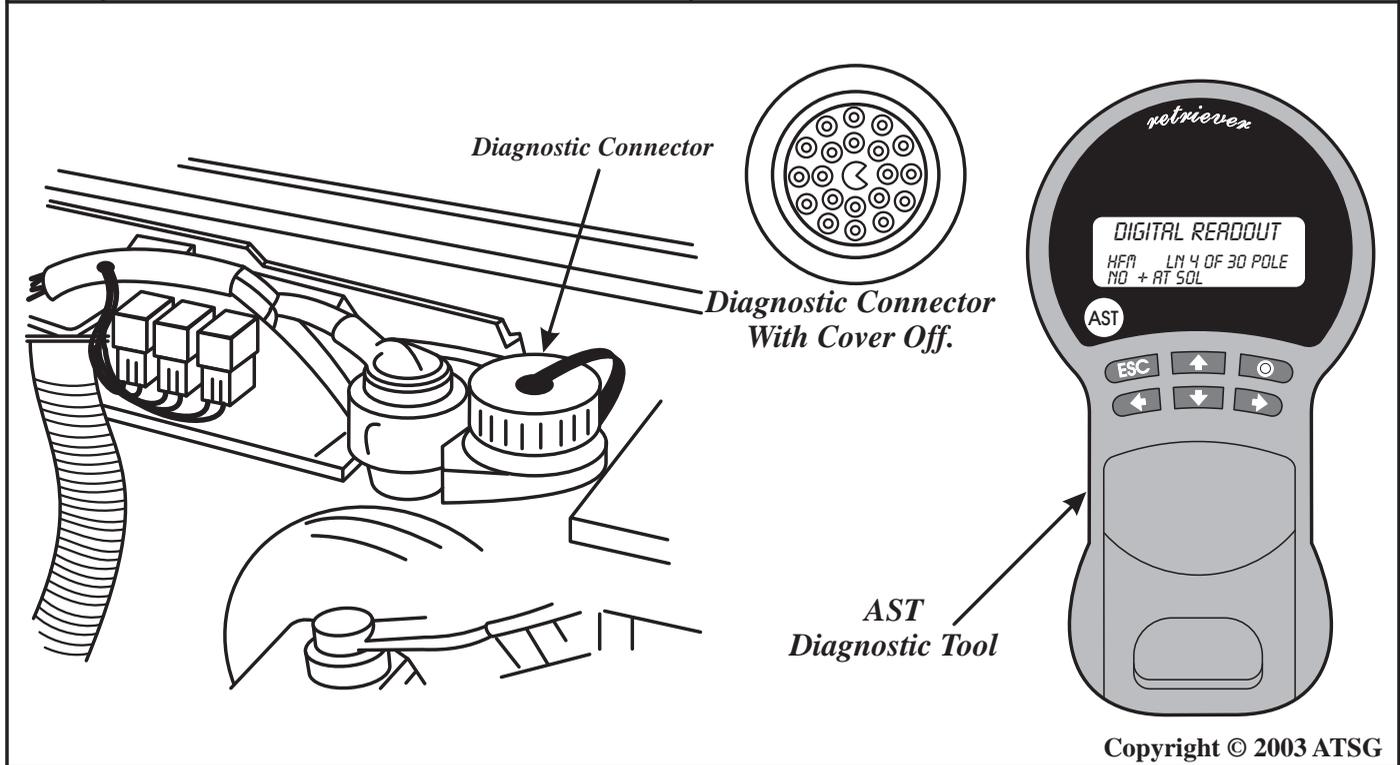
<i>Code</i>	<i>Description and TCM Terminal I.D.</i>	<i>Possible Causes</i>
<b>01</b>	Pressure Regulator, EDS 2 - Pin 1	Questionable signal, or break or short in wiring
<b>02</b>	Park-Neutral Lock Solenoid - Pin 2	Break or short in wiring
<b>04</b>	Pressure Regulator, EDS 4 - Pin 4	Questionable signal, or break or short in wiring
<b>05</b>	Pressure Regulator, EDS 1 - Pin 5	Questionable signal, or break or short in wiring
<b>08</b>	Selector Lever Position L2 - Pin 8	Vehicle acceleration detected while selector lever in P or N position, or engine has been started even though EGS control unit has not detected a selector lever position of P or N
<b>09</b>	Selector Lever Position L3/L4 - Pins 37 and 9	Engine has been started even though EGS control unit has not detected a selector lever position of P or N
<b>0C</b>	Program Selector Switch - Pins 12, 13 and 45	Short in wiring, or more than one program selector switch input is applied to ground
<b>10</b>	Rotational Speed Sensor, Turbocharger Pins 16 and 44	No input, or incorrect engine speed information
<b>12</b>	Kickdown Switch - Pin 18	Questionable signal
<b>13</b>	ASC Monitoring - Pin 19	ASC operation has been detected while selector lever was in Park or Neutral position
<b>16</b>	TOT Sensor - Pins 21 and 22	Resistance of TOT Sensor not within permissible range
<b>1A</b>	Battery Voltage Supply - Pin 26	Break in wiring
<b>1D</b>	Pressure Regulator, EDS 3 - Pin 29	Questionable signal, or break or short in wiring
<b>1E</b>	MV 1 Solenoid - Pin 30	Break or short in wiring, or defective winding in solenoid
<b>20</b>	MV 3 Solenoid - Pin 32	Break or short in wiring, or defective winding in solenoid
<b>21</b>	MV 2 Solenoid - Pin 33	Break or short in wiring, or defective winding in solenoid
<b>24</b>	Selector Lever Position L1 - Pin 36	Break or short in wiring, or defective sensor
<b>2A</b>	Output Speed Sensor signal and Stall Speed signal - Pins 13 and 42	No input, or incorrect engine speed information
<b>33</b>	Pressure Regulator, EDS 5 - Pin 51	Questionable signal, or break or short in wiring
<b>34</b>	Power Supply to transmission - Pin 52	Break or short in wiring

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Figure 129

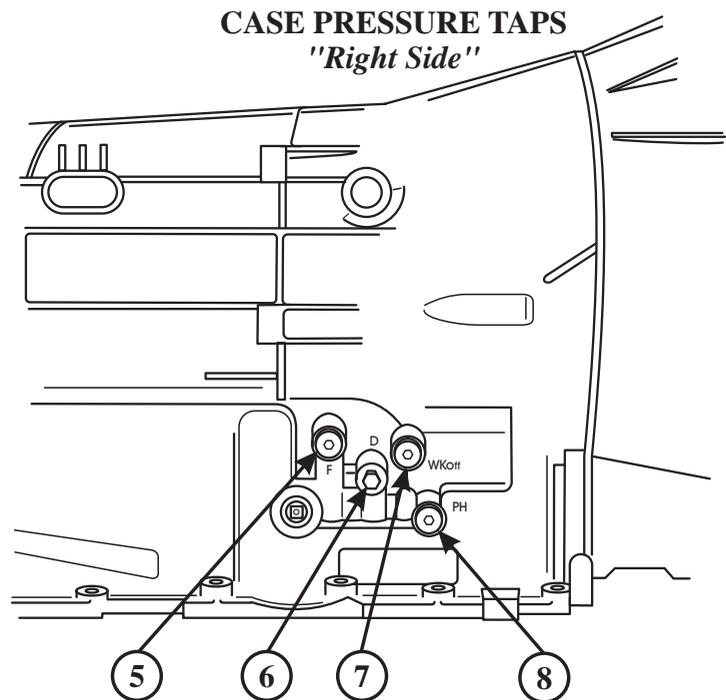
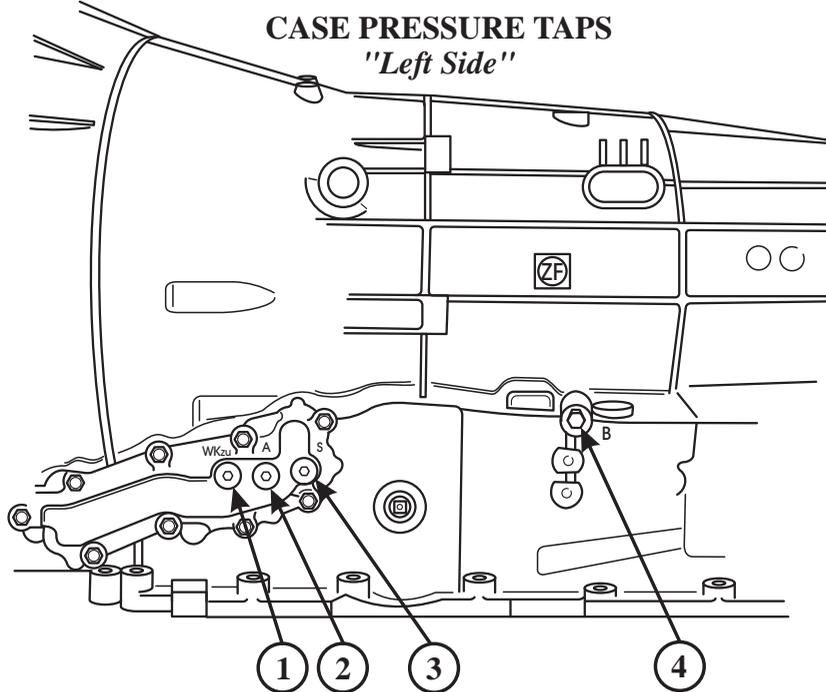
### BMW ZF-5HP-30 FAULT CODE CHART

Code	Description and TCM Terminal I.D.	Possible Causes
36	Power Supply - Pin 54	Power Supply less than 9 volts at engine speeds greater than 1600 RPM
64	Speed Monitoring	Faulty Speed Sensor signal, or slip in Transmission
65	EPROM - Checksum	Program memory in Transmission Control Unit faulty
66	Incorrect Program Checksum	Program memory in Transmission Control Unit faulty
67	Transmission Relay - Pin 52	Pickup and dropout times too long
68	Over-revving Lock	Engine RPM greater than 6816 has been detected
69	Speed Monitoring	Faulty Speed Sensor signal, or slip in Transmission
6A	Speed Monitoring	Faulty Speed Sensor signal, or slip in Transmission
96	CAN Timeout 1	CAN signal not sent during initialization (Ignition On)
97	CAN Timeout 2	CAN signal not sent during operation
98	CAN Bus monitoring	Values in CAN RAM are not updated
99	CAN status fault	
9A	CAN throttle valve information	DME detects faulty throttle valve signal
9B	CAN load signal information	DME detects faulty load signal
9C	CAN engine intervention	DME cannot carry out reduction in engine torque desire by the EGS, or DME has different requirements compared to other CAN users
9D	CAN engine temperature info	DME detects faulty engine temperature signal



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Figure 130

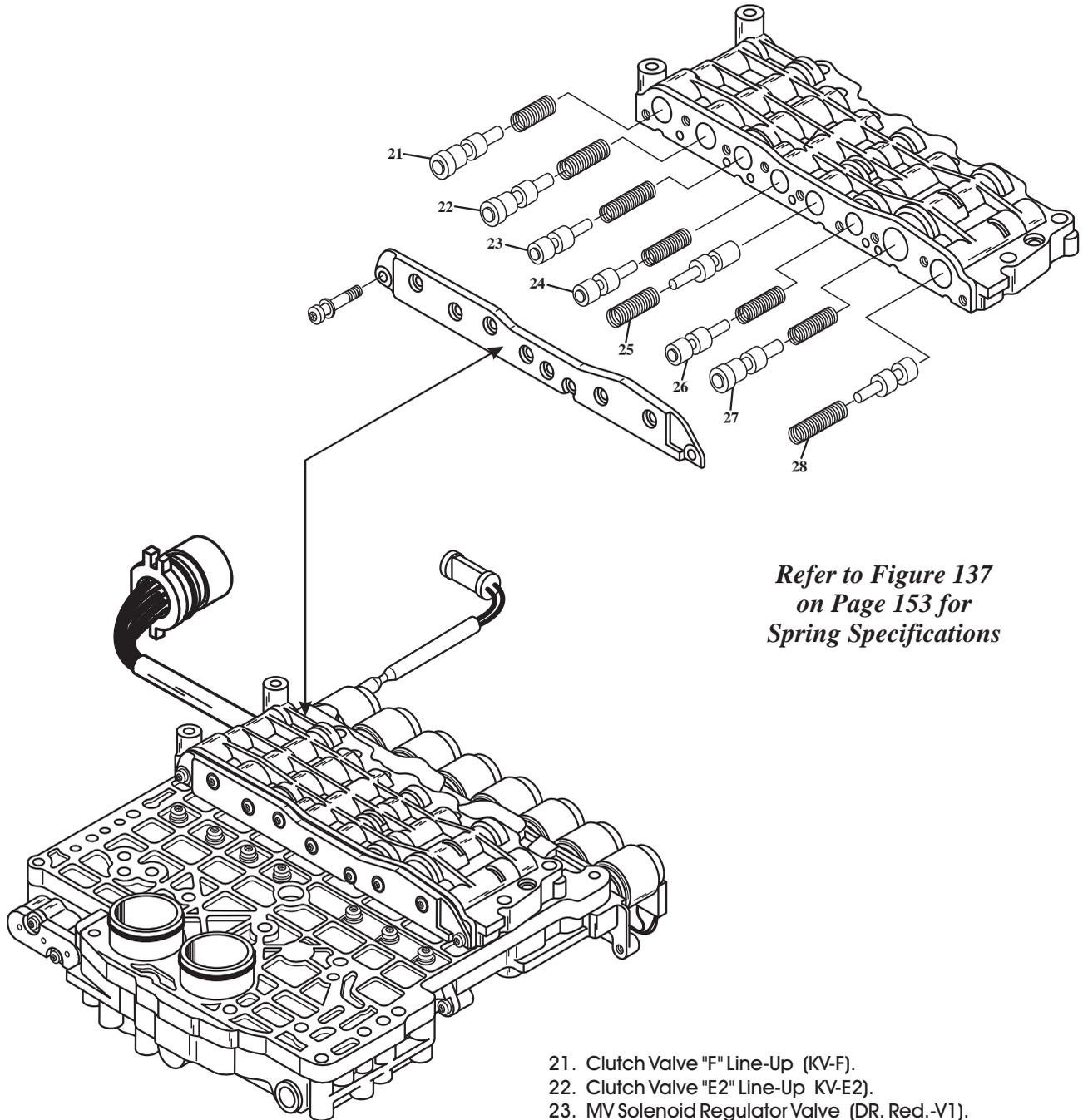


1. *WKzu = Converter Clutch ON Pressure.*
2. *A = "A" Clutch Pressure.*
3. *S = Cooler Pressure.*
4. *B = "B" Clutch Pressure (Must Drill and Tap for Access).*
5. *F = "F" Clutch Pressure.*
6. *D = "D" Clutch Pressure (Must Drill and Tap for Access).*
7. *WKoff = Converter Clutch OFF Pressure.*
8. *PH = Line Pressure.*

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Figure 131

**ZF-5HP-30**  
**UPPER REAR VALVE BODY**

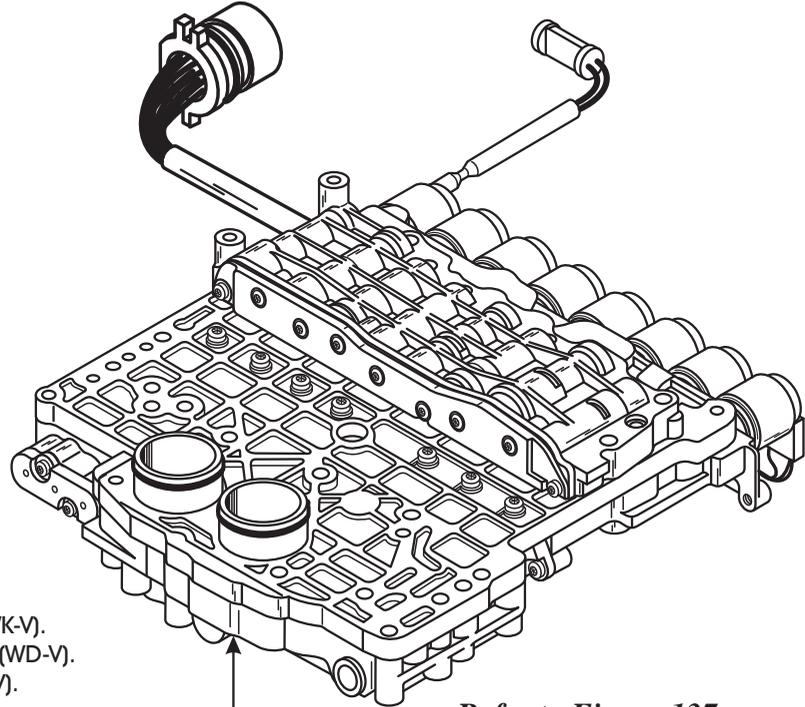


*Refer to Figure 137  
on Page 153 for  
Spring Specifications*

- 21. Clutch Valve "F" Line-Up (KV-F).
- 22. Clutch Valve "E2" Line-Up (KV-E2).
- 23. MV Solenoid Regulator Valve (DR. Red.-V1).
- 24. EDS Solenoid Regulator Valve (DR. Red.-V2).
- 25. Clutch Valve "B" Line-Up (KV-B).
- 26. Clutch Valve "E1" Line-Up (KV-E1).
- 27. Switch Valve For "A" Clutch (ABSCH-V-A).

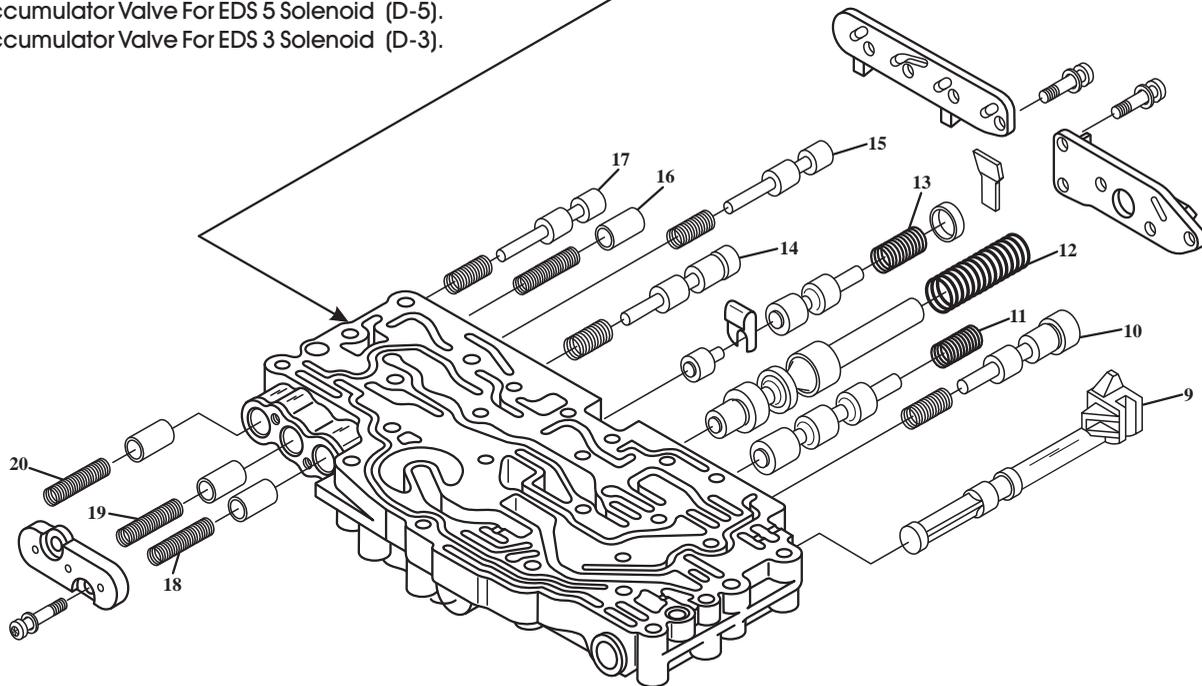
Figure 132

**ZF-5HP-30**  
**LOWER FRONT VALVE BODY**



- 9. Manual Shift Valve (W-S).
- 10. Converter Clutch Apply Oil Control Valve (WK-V).
- 11. Converter Clutch Release Oil Control Valve (WD-V).
- 12. Main Pressure Regulator Valve Line-Up (HD-V).
- 13. Lubrication Valve (SCHM-V)
- 14. Modulating Valve Line-Up (MOD-V).
- 15. Main Regulator Valve For "B" Clutch (HV-B).
- 16. Accumulator Valve For EDS 2 Solenoid (D-2).
- 17. Main Regulator Valve For "D" Clutch (HV-D).
- 18. Accumulator Valve For EDS 4 Solenoid (D-4).
- 19. Accumulator Valve For EDS 5 Solenoid (D-5).
- 20. Accumulator Valve For EDS 3 Solenoid (D-3).

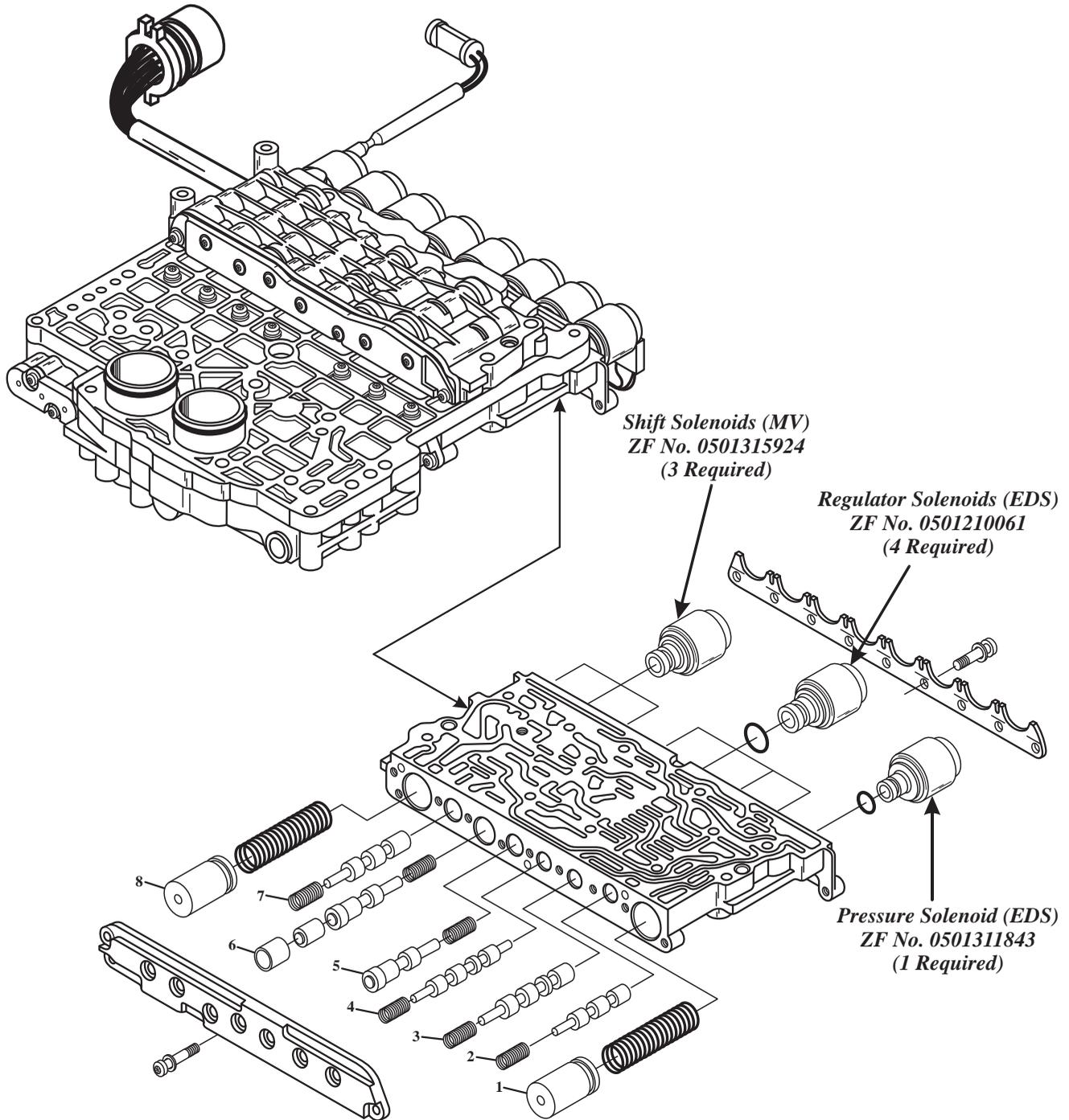
*Refer to Figure 137  
on Page 153 for  
Spring Specifications*



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Figure 133

**ZF-5HP-30**  
**LOWER REAR VALVE BODY**

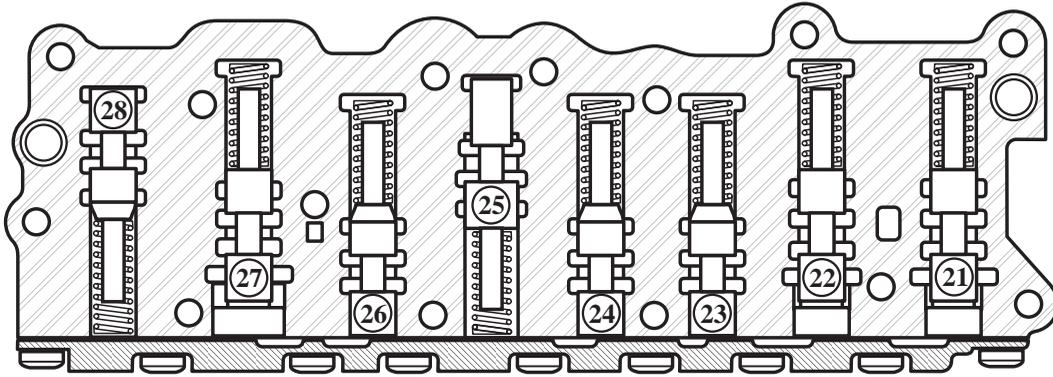


1. "A" Clutch Accumulator Line-Up (D-A).
2. Shift Valve Number 1 (SV-1).
3. Shift Valve Number 2 (SV-2).
4. Shift Valve Number 3 (SV-3).
5. Switch Valve For "D" Clutch (ABSCH-V-D).
6. Clutch Valve "D" Line-Up (KV-D).
7. Reverse Gear Valve Line-Up (RG-V).

*Refer to Figure 137  
on Page 153 for  
Spring Specifications*

Figure 134

**UPPER REAR VALVE BODY**



- 21. Clutch Valve "F" Line-Up (KV-F).
- 22. Clutch Valve "E2" Line-Up KV-E2).
- 23. MV Solenoid Regulator Valve (DR. Red.-V1).
- 24. EDS Solenoid Regulator Valve (DR. Red.-V2).
- 25. Clutch Valve "B" Line-Up (KV-B).
- 26. Clutch Valve "E1" Line-Up (KV-E1).
- 27. Switch Valve For "A" Clutch (ABSCH-V-A).

*Only One .250" (6.35mm) ball is located here.  
 Do Not install a ball in the pocket marked X.*

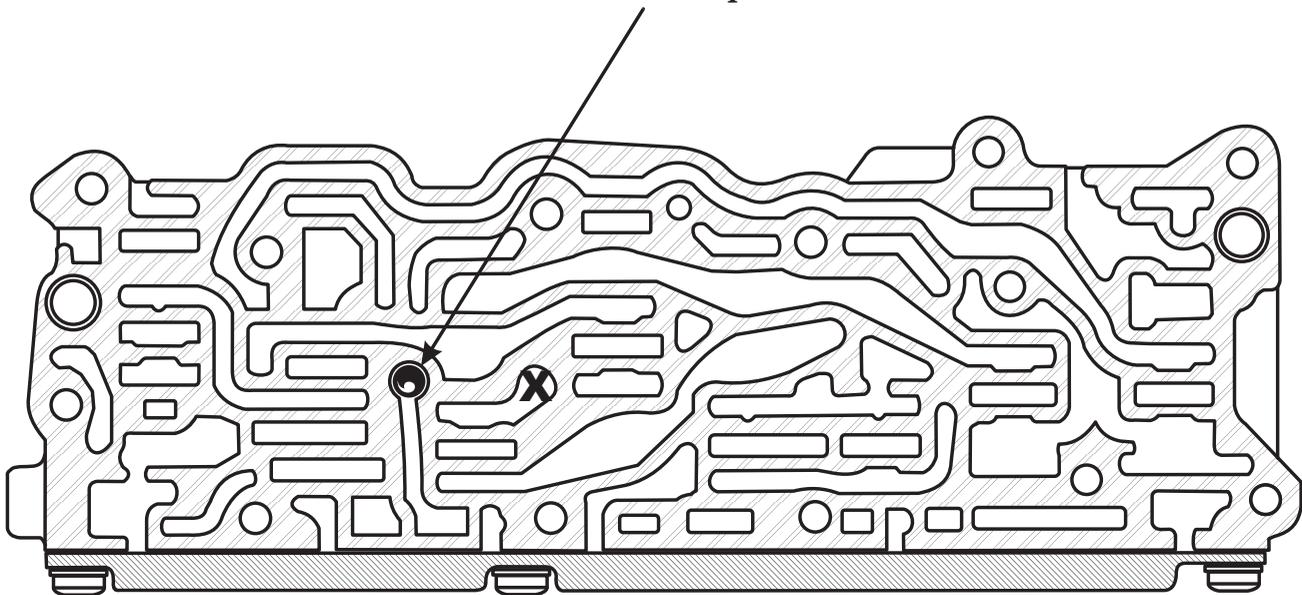


Figure 135

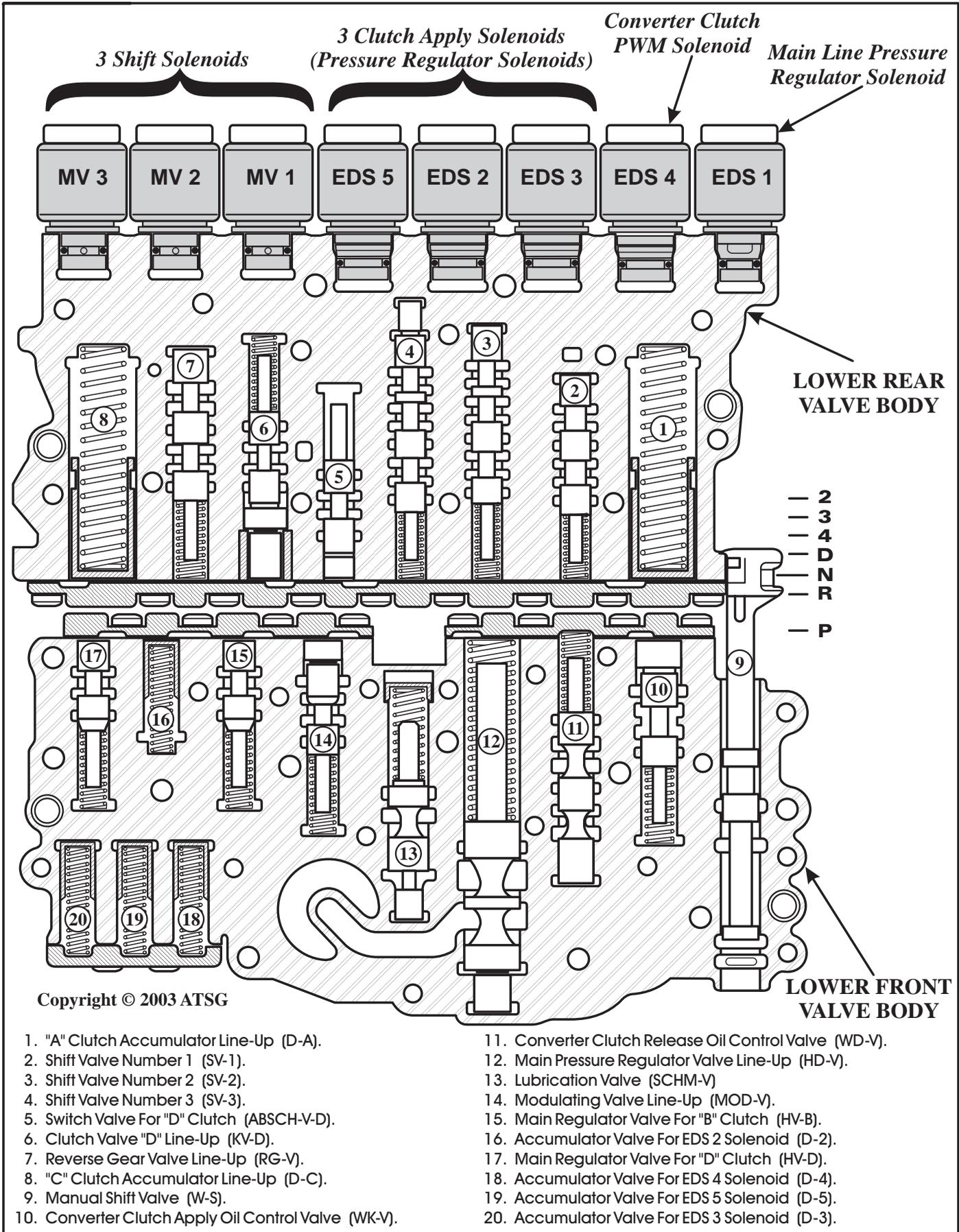


Figure 136

### ZF 5HP-30 VALVE BODY SPRING SPECIFICATIONS

#### UPPER REAR VALVE BODY

- |  |   |  |
|--|---|--|
| <p>21. Clutch Valve "F" (KV-F)<br/>Free Length = 1.370"<br/>Wire Diameter = .030"<br/>Outside Diameter = .365"</p>       | <p>24. EDS Solenoid Reg Valve (DR-V2)<br/>Free Length = 1.980"<br/>Wire Diameter = .045"<br/>Outside Diameter = .370"</p> | <p>27. A Clutch Swit Valve (ABSCH.V-A)<br/>Free Length = 1.692"<br/>Wire Diameter = .031"<br/>Outside Diameter = .365"</p> |
| <p>22. Clutch Valve "E2" (KV-E2)<br/>Free Length = 1.558"<br/>Wire Diameter = .031"<br/>Outside Diameter = .365"</p>     | <p>25. Clutch Valve "B" (KV-B)<br/>Free Length = 1.710"<br/>Wire Diameter = .042"<br/>Outside Diameter = .424"</p>        | <p>28. Clutch Valve "A" (KV-A)<br/>Free Length = 1.792"<br/>Wire Diameter = .031"<br/>Outside Diameter = .358"</p>         |
| <p>23. MV Solenoid Reg Valve (DR-V1)<br/>Free Length = 1.395"<br/>Wire Diameter = .038"<br/>Outside Diameter = .301"</p> | <p>26. Clutch Valve "E1" (KV-E1)<br/>Free Length = 1.742"<br/>Wire Diameter = .023"<br/>Outside Diameter = .352"</p>      | <p><i>These spring locations<br/>shown on Page 148.</i></p>  |

#### LOWER "FRONT" VALVE BODY

- |   |   |   |
|---|---|---|
| <p>10. TCC Apply Control Valve (WK-V)<br/>Free Length = 1.628"<br/>Wire Diameter = .048"<br/>Outside Diameter = .440"</p>   | <p>14. Modulating Valve (MOD-V)<br/>Free Length = 1.493"<br/>Wire Diameter = .031"<br/>Outside Diameter = .365"</p>       | <p>18. EDS 4, Accumulator Valve (D-4)<br/>Free Length = 1.530"<br/>Wire Diameter = .042"<br/>Outside Diameter = .322"</p> |
| <p>11. TCC Release Control Valve (WD-V)<br/>Free Length = 2.007"<br/>Wire Diameter = .034"<br/>Outside Diameter = .438"</p> | <p>15. "B" Clutch Reg Valve (HV-B)<br/>Free Length = 1.414"<br/>Wire Diameter = .030"<br/>Outside Diameter = .365"</p>    | <p>19. EDS 5, Accumulator Valve (D-5)<br/>Free Length = 1.530"<br/>Wire Diameter = .042"<br/>Outside Diameter = .322"</p> |
| <p>12. Pressure Regulator Valve (HD-V)<br/>Free Length = 3.548"<br/>Wire Diameter = .087"<br/>Outside Diameter = .686"</p>  | <p>16. EDS 2, Accumulator Valve (D-2)<br/>Free Length = 1.530"<br/>Wire Diameter = .042"<br/>Outside Diameter = .322"</p> | <p>20. EDS 3, Accumulator Valve (D-3)<br/>Free Length = 1.530"<br/>Wire Diameter = .042"<br/>Outside Diameter = .322"</p> |
| <p>13. Lubrication Valve (SCHM.-V)<br/>Free Length = 1.750"<br/>Wire Diameter = .048"<br/>Outside Diameter = .480"</p>      | <p>17. "D" Clutch Reg Valve (HV-D)<br/>Free Length = 1.543"<br/>Wire Diameter = .042"<br/>Outside Diameter = .348"</p>    | <p><i>These spring locations<br/>shown on Page 149.</i></p>   |

#### LOWER "REAR" VALVE BODY

- |  |   |  |
|--|---|--|
| <p>1. "A" Clutch Accumulator (D-A)<br/>Free Length = 2.929"<br/>Wire Diameter = .066"<br/>Outside Diameter = .608"</p> | <p>4. Shift Valve Number 3 (SV-3)<br/>Free Length = 1.640"<br/>Wire Diameter = .031"<br/>Outside Diameter = .366"</p>         | <p>7. Reverse Gear Valve (RG-V)<br/>Free Length = 1.836"<br/>Wire Diameter = .038"<br/>Outside Diameter = .435"</p>    |
| <p>2. Shift Valve Number 1 (SV-1)<br/>Free Length = 1.800"<br/>Wire Diameter = .031"<br/>Outside Diameter = .360"</p>  | <p>5. Switch Valve "D" Clutch (ABSCH.V-D)<br/>Free Length = 1.733"<br/>Wire Diameter = .023"<br/>Outside Diameter = .350"</p> | <p>8. "C" Clutch Accumulator (D-C)<br/>Free Length = 2.929"<br/>Wire Diameter = .066"<br/>Outside Diameter = .608"</p> |
| <p>3. Shift Valve Number 2 (SV-2)<br/>Free Length = 1.800"<br/>Wire Diameter = .031"<br/>Outside Diameter = .360"</p>  | <p>6. Clutch Valve "D" Line-Up (KV-D)<br/>Free Length = 1.763"<br/>Wire Diameter = .031"<br/>Outside Diameter = .360"</p>     | <p><i>These spring locations<br/>shown on Page 150.</i></p>  |

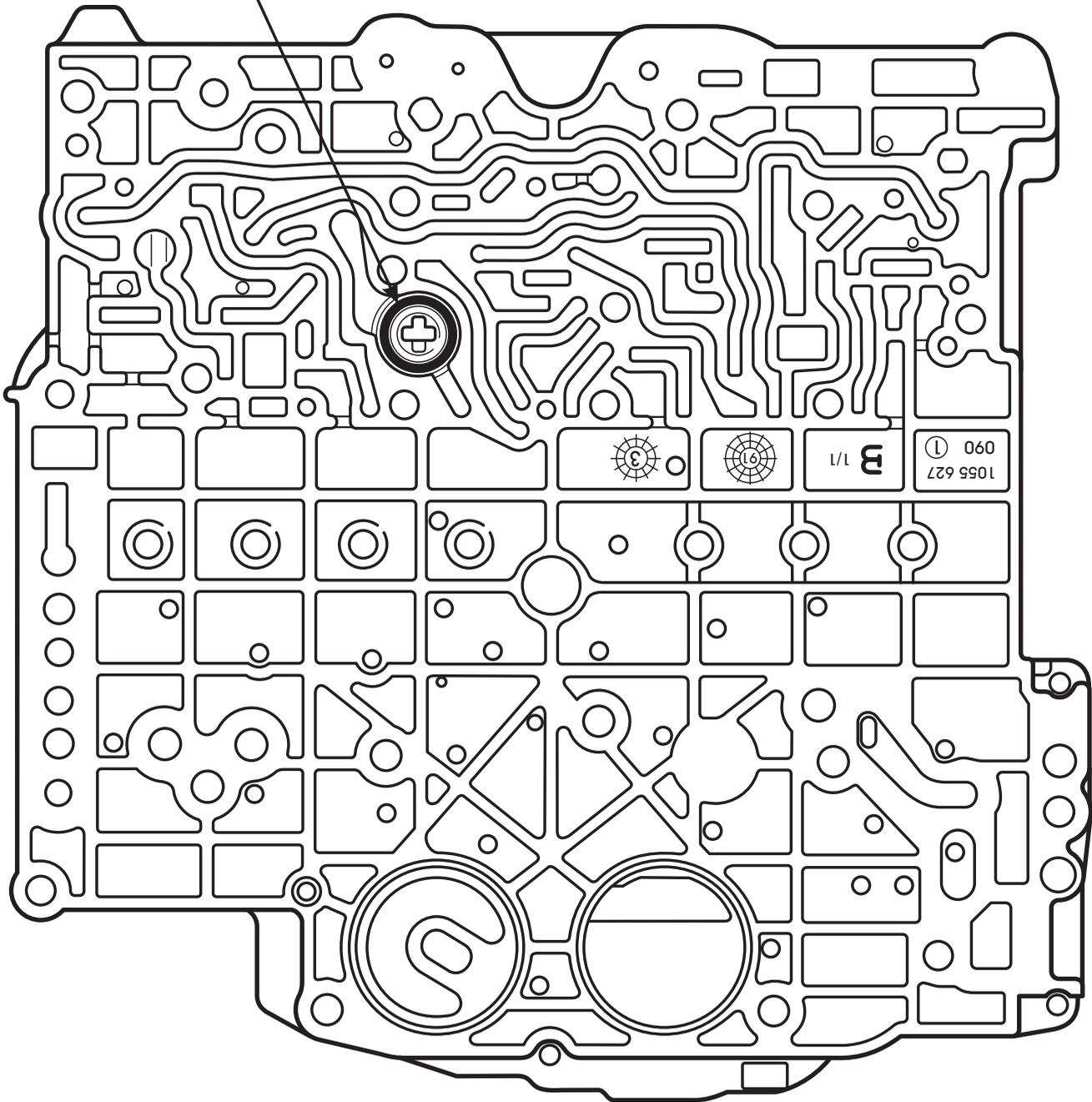
**Note:** There is now available from ZF distributors a "Valve Body Kit" for the 5HP-30 that includes all new stock springs, all check balls, all orifices and screens. ZF part number "5HP-30 VBK".

**Note:** The number in front of the name of the valve line-up is the illustration number in the ATSG illustrations in this manual.

Figure 137

**ZF-5HP-30 CHANNEL PLATE  
UPPER VALVE BODY SIDE**

*Round Screen*



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Figure 138

**ZF-5HP-30 CHANNEL PLATE  
LOWER VALVE BODY SIDE**

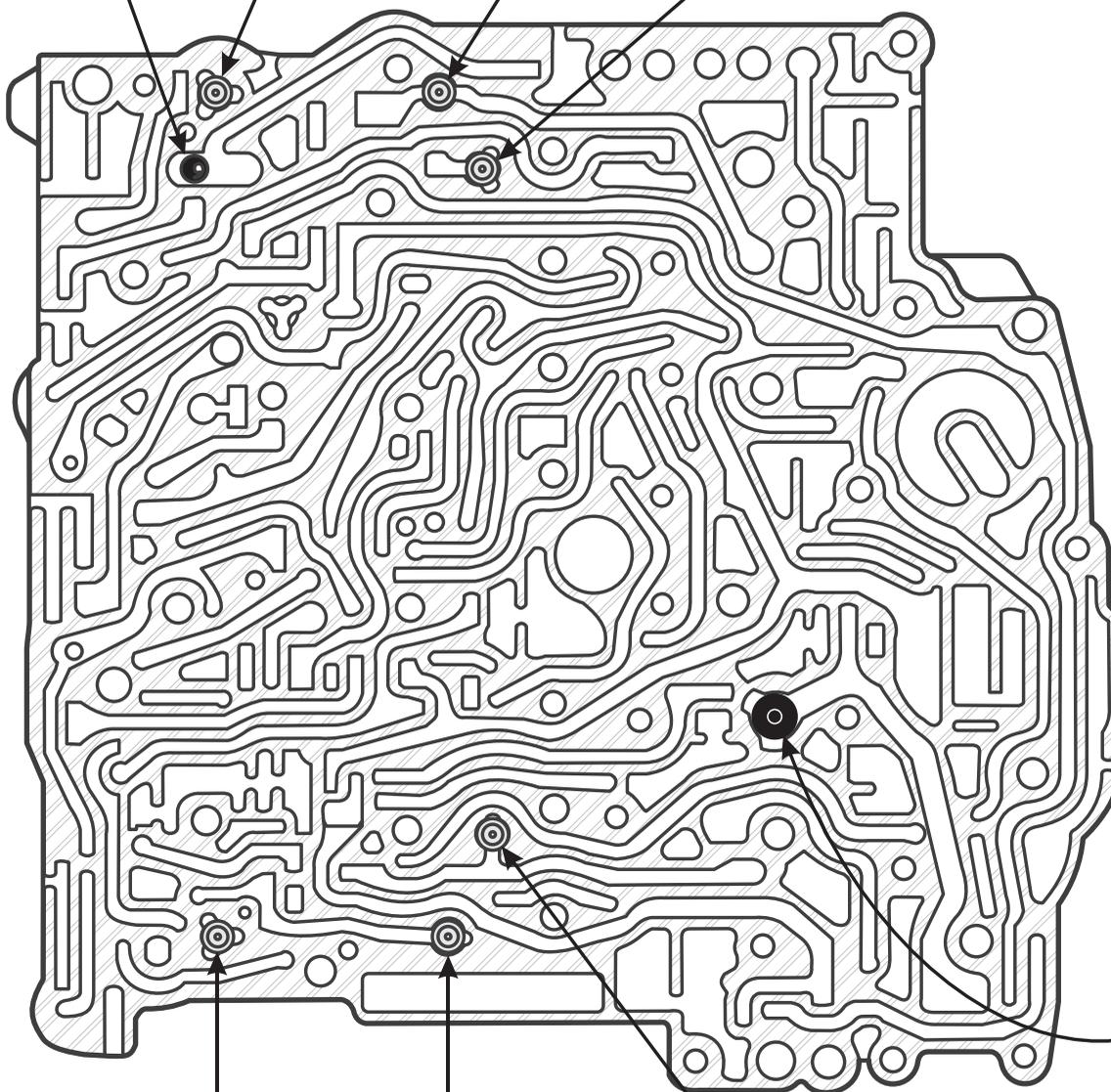
*Replace the original ball with  
a plastic .250" (6.35mm) ball.*

*Original  
.236" Diameter*

*.039"  
Flat Orifice*

*.048"  
Flat Orifice*

*.048"  
Flat Orifice*



**PLASTIC VALVE  
AND SPRING**

*.039"  
Flat Orifice*

*.048"  
Flat Orifice*

*.067"  
Flat Orifice*

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Figure 139



## TECHNICIANS DIAGNOSTIC GUIDE BMW, AUDI, PORSCHE

### BMW ZF 5-HP-30 NO REVERSE

**COMPLAINT:** 1991 and later BMW vehicles equipped with the ZF 5-HP-30 transmission may exhibit a no reverse condition, when the selector lever is placed into reverse.

**CAUSE:** The cause may be, the .236" diameter checkball located in the bathtub in the channel plate has blown through the spacer plate, which will now exhaust "F" clutch (Reverse) oil pressure.

**CORRECTION:** Install a .250" diameter plastic checkball into the bathtub in the channel plate as shown in Figure 140. The holes in the spacer plate over the bathtub measure .198" and the larger diameter checkball will greatly decrease the probability of this condition occurring again. There is also ample room in the bathtub for the increased diameter of the checkball to perform its duties. Refer to Figure 140. Figure 141 illustrates the location of the only other checkball in this unit and, *do not install checkball in the location marked "X"*.

**SPECIAL NOTE:** The checkball wearing and blowing through the spacer plate causing the loss of reverse, may also have caused some damage to the "C" Clutch, which is also on in reverse. This condition has also been known to create damage to the "A"/"C" Clutch Housing as well. If the clutch housing has been severely damaged, aluminum material will be evident in the bottom pan upon inspection.

When the unit is removed and the "A"/"C" Clutch Housing is dis-assembled, it is not uncommon for the unit to set for over a week waiting on parts. When re-assembling, it is *very easy to mis-assemble the "B" Clutch Hub* on top of the retaining snap ring for the "A" Clutch pack. This mis-assembly will allow the "B" clutch hub to move out of the A/C clutch housing and create a neutralizing on the 3-4 upshift, and the Trans light will begin flashing. *Ensure that you assemble the "B" Clutch Hub on top of the "A" Clutch stack, and then install the "A" Clutch Pressure Plate and snap ring, as shown in Figures 142 and 143.*

**ZF-5HP-30 CHANNEL PLATE**  
**LOWER VALVE BODY SIDE**

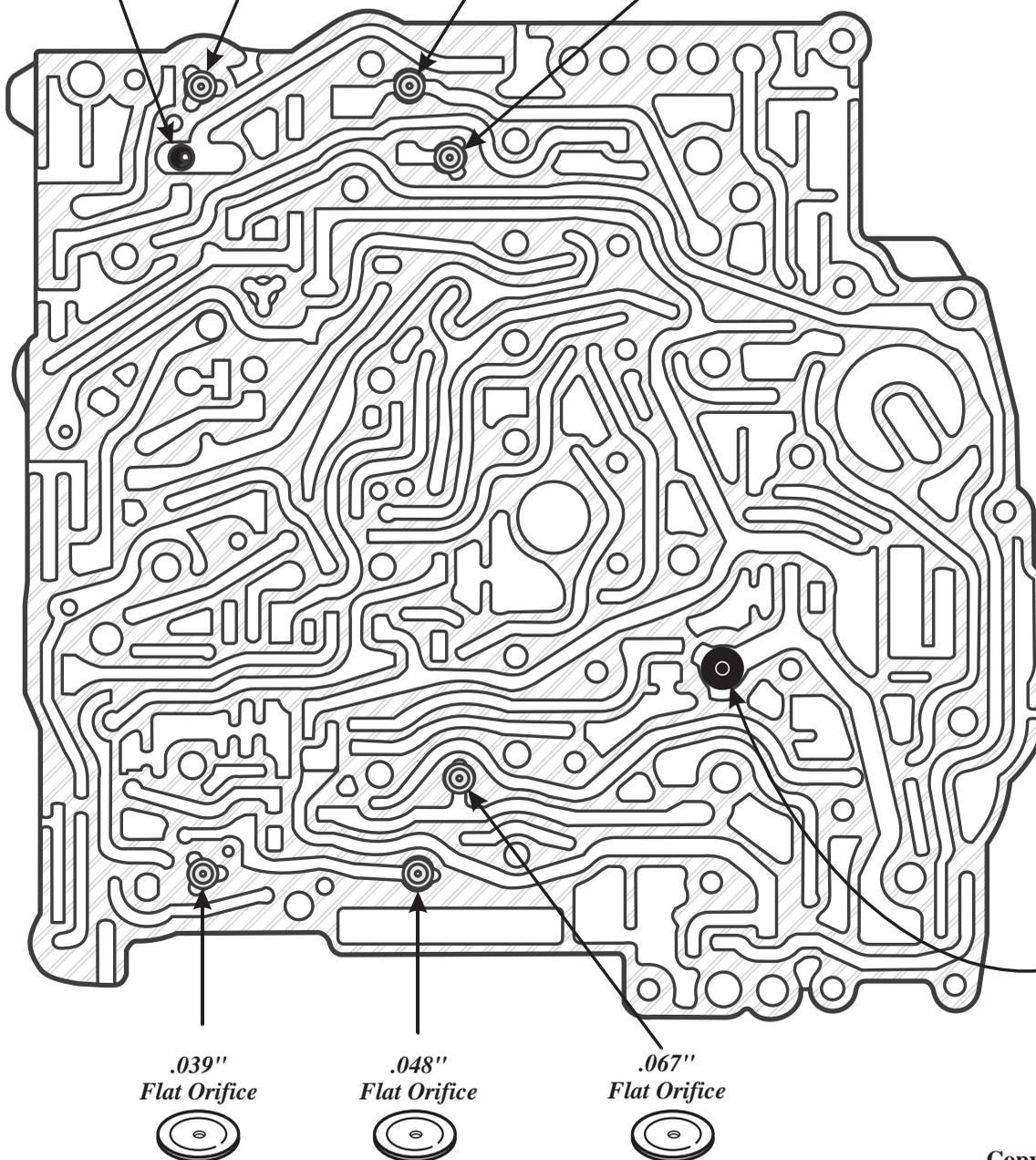
*Replace the original ball with  
a plastic .250" (6.35mm) ball.*

*Original  
.236" Diameter*

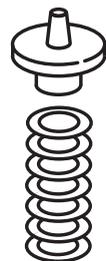
*.039"  
Flat Orifice*

*.048"  
Flat Orifice*

*.048"  
Flat Orifice*



**PLASTIC VALVE  
AND SPRING**



*.039"  
Flat Orifice*

*.048"  
Flat Orifice*

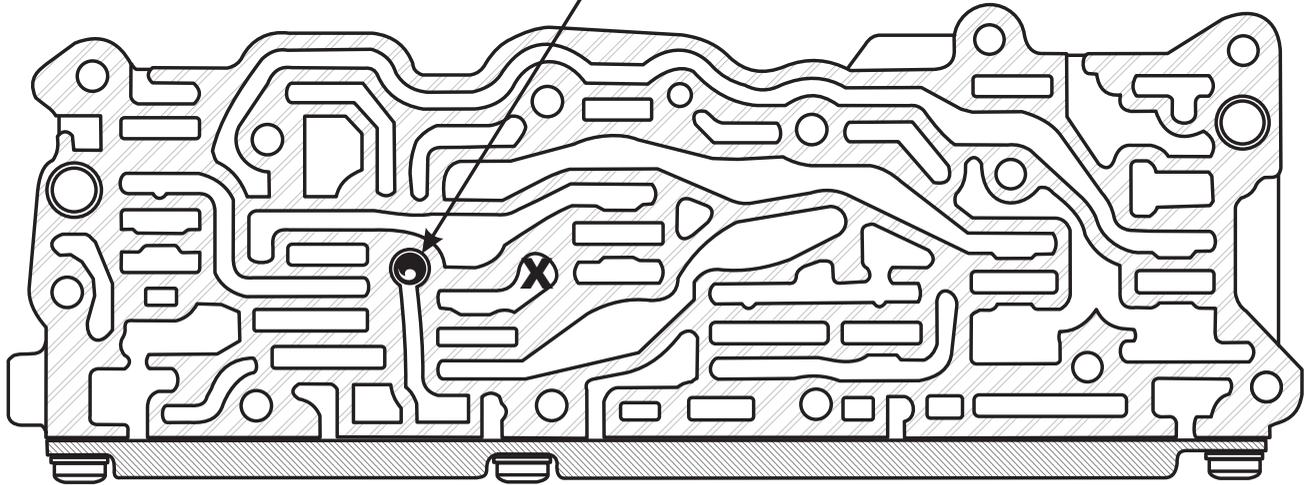
*.067"  
Flat Orifice*

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Figure 140

**UPPER REAR VALVE BODY**  
**CHECKBALL LOCATION**

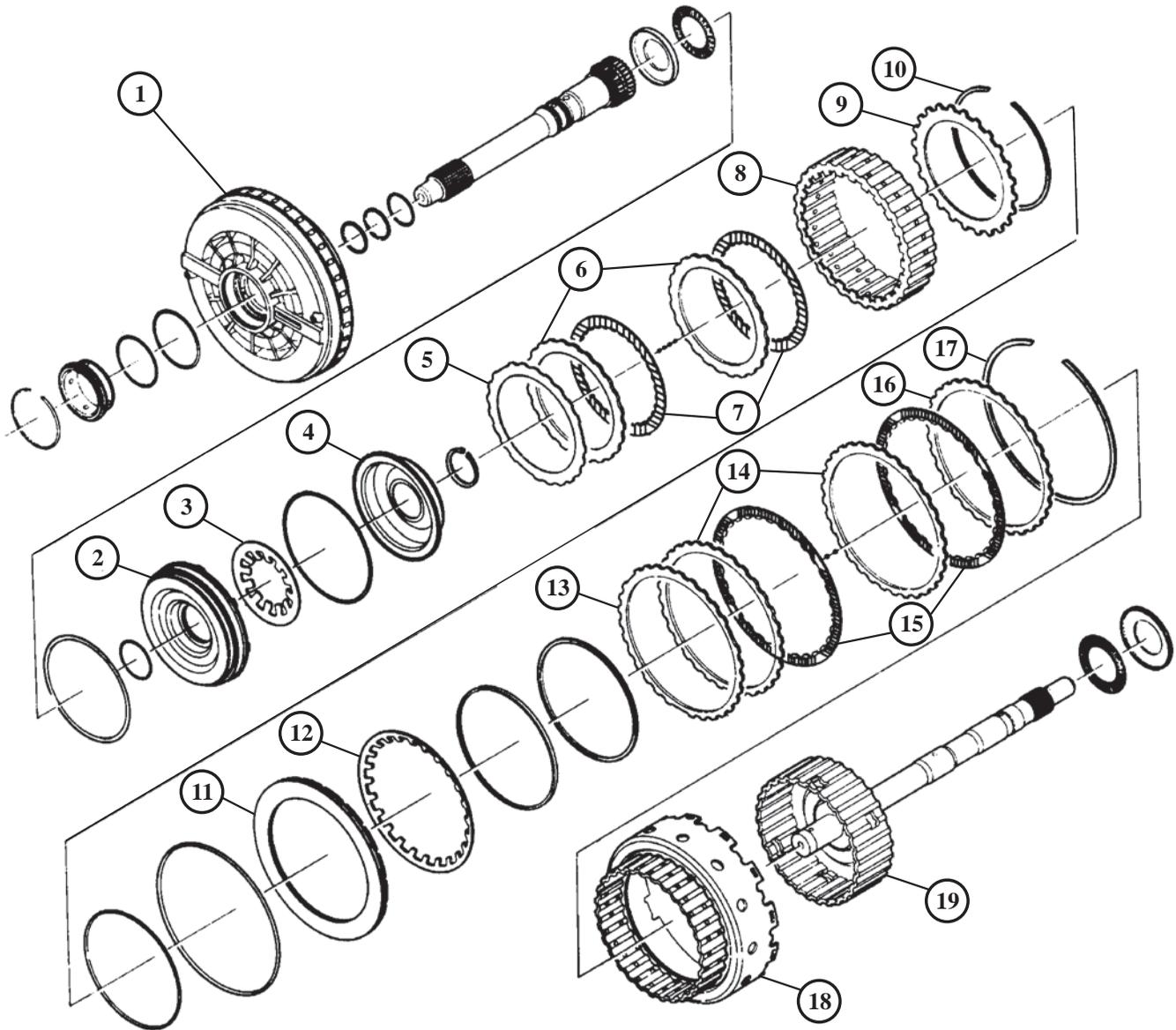
*Only One .250" (6.35mm) ball is located here.  
Do Not install a ball in the pocket marked X.*



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Figure 141

**"A"/"C" CLUTCH HOUSING COMPONENTS**



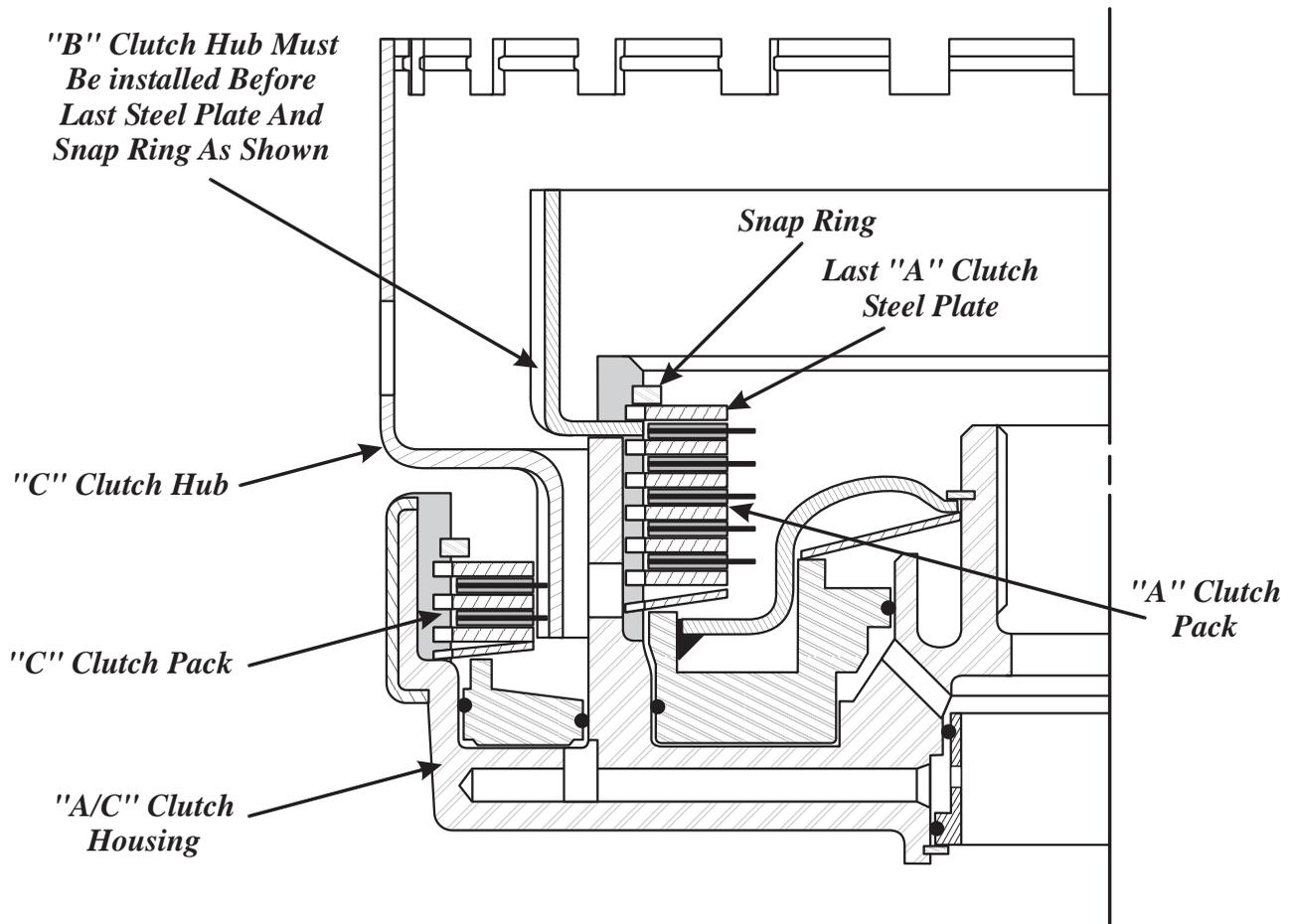
1. "A"/"C" Clutch Housing Assembly
2. "A" Clutch Apply Piston
3. "A" Clutch Bellville Return Spring
4. "A" Clutch Piston Oil Dam
5. "A" Clutch Cushion Plate
6. "A" Clutch Steel Plates (5 Required)
7. "A" Clutch Friction Plates (5 Required)
8. "B" Clutch Hub
9. "A" Clutch Pressure Plate
10. "A" Clutch Pressure Plate Snap Ring

11. "C" Clutch Apply Piston
12. "C" Clutch Apply Piston Return Spring
13. "C" Clutch Cushion Plate
14. "C" Clutch Steel Plates (3 Required)
15. "C" Clutch Friction Plates (3 Required)
16. "C" Clutch Pressure Plate
17. "C" Clutch Pressure Plate Snap Ring
18. "C" Clutch Hub
19. "A" Clutch Hub And Input Shaft

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Figure 142

**A/C CLUTCH HOUSING CUT-AWAY**



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Figure 143