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ZF 4HP-18FLE AND ZF 4HP-18 FLA DIAGNOSTIC INFORMATION
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ZF 5HP-18 DIAGNOSTIC INFORMATION
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ZF 5HP-30 DIAGNOSTIC INFORMATION
INTRODUCTION
BMW, AUDI, PORSCHE

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

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FAX (305) 666-8238
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:

- Audi - - 100 Quatro, A6 ................................................................. 1991-1997
- Audi - - A8 .................................................................................. 1994-1996

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.
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:
All nomenclatures in this booklet are ATSG interpretations, not Audi’s nor ZF.
ZF-4HP-18FLE
(2WD Version)

ZF-4HP-18FLA
(AWD Version)
### RESISTANCE CHARTS AND TERMINAL IDENTIFICATION

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<tr>
<th>Internal Component</th>
<th>Connector Terminals</th>
<th>Resistance In Ohms</th>
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<tr>
<td>MV-1 Solenoid</td>
<td>M &amp; H</td>
<td>30-40 Ohms @ 68°F (20°C)</td>
</tr>
<tr>
<td>MV-2 Solenoid</td>
<td>M &amp; K</td>
<td>30-40 Ohms @ 68°F (20°C)</td>
</tr>
<tr>
<td>MV-3 Solenoid</td>
<td>M &amp; L</td>
<td>30-40 Ohms @ 68°F (20°C)</td>
</tr>
<tr>
<td>EDS-1 Solenoid</td>
<td>M &amp; B</td>
<td>5-8 Ohms @ 68°F (20°C)</td>
</tr>
<tr>
<td>TFT Sensor</td>
<td>E &amp; F</td>
<td>920-960 Ohms @ 68°F (20°C)</td>
</tr>
</tbody>
</table>

**SPECIAL NOTE:**
Solenoid nomenclatures are ATSG interpretations, not Audi’s nor ZF.

---

### TRANSAXLE SOLENOID CONNECTOR TERMINAL IDENTIFICATION

#### View Looking Into
- Vehicle Harness Connector
- Transaxle Case Connector

#### View Looking Into
- Transaxle Range Switch
- Vehicle Harness Connector
- Transaxle Range Switch Connector

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Figure 2

AUTOMATIC TRANSMISSION SERVICE GROUP
### ZF-4HP-18FLE SOLENOID AND COMPONENT APPLICATION CHART

<table>
<thead>
<tr>
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<td>Park/Neut</td>
<td>ON</td>
<td>ON</td>
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</tr>
<tr>
<td>Reverse</td>
<td>ON</td>
<td>*</td>
<td>**</td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Drive-1st</td>
<td>ON</td>
<td>**</td>
<td>ON</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drive-2nd</td>
<td>ON</td>
<td>**</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
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<td></td>
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</tr>
<tr>
<td>Drive-3rd</td>
<td>ON</td>
<td>**</td>
<td>ON</td>
<td>ON</td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>Drive-4th</td>
<td>**</td>
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<td></td>
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<tr>
<td>&quot;Failsafe&quot; ***</td>
<td>Max.</td>
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<td>ON</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 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.

**SPECIAL NOTE:**
Solenoid and Clutch nomenclature are ATSG interpretations, not Audi’s nor ZF.

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**Figure 4**

![ZF-4HP-18FLE SOLENOID AND COMPONENT APPLICATION CHART](ZF-4HP-18FLE.png)

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**Figure 5**

![ZF-4HP-18FLA/E VALVE BODY COMPLETE](ZF-4HP-18FLA-E.png)
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

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

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

Figure 8
<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
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<tbody>
<tr>
<td>11</td>
<td>SOLENOID VALVE BODY CASTING</td>
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<tr>
<td>12</td>
<td>PRESSURE REGULATOR VALVE SPRING, MV-1 THRU MV-3 SOLENOIDS</td>
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<tr>
<td>13</td>
<td>PRESSURE REGULATOR VALVE, MV-1 THRU MV-3 SOLENOIDS</td>
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<tr>
<td>14</td>
<td>PRESSURE REGULATOR VALVE BORE PLUG, MV-1 THRU MV-3 SOLENOIDS</td>
</tr>
<tr>
<td>15</td>
<td>PRESSURE REGULATOR VALVE RETAINING CLIP, MV-1 THRU MV-3 SOLENOIDS</td>
</tr>
<tr>
<td>16</td>
<td>MV-1 SOLENOID, OEM PART NUMBER 0501 313 500 (SHIFT CONTROL)</td>
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<tr>
<td>17</td>
<td>MV-2 SOLENOID, OEM PART NUMBER 0501 313 500 (SHIFT CONTROL)</td>
</tr>
<tr>
<td>18</td>
<td>MV-3 SOLENOID, OEM PART NUMBER 0501 313 500 (SHIFT CONTROL)</td>
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<tr>
<td>19</td>
<td>EDS-1 SOLENOID, OEM PART NUMBER 0501 311 843 (LINE PRESSURE)</td>
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<tr>
<td>20</td>
<td>EDS-1 SOLENOID &quot;O&quot; RING</td>
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<td>21</td>
<td>SOLENOID RETAINING BRACKET (4 REQUIRED)</td>
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<td>22</td>
<td>SOLENOID RETAINING BRACKET BOLT, 12mm LONG (4 REQUIRED)</td>
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<tr>
<td>23</td>
<td>RETAINING PLATE BOLT, 12mm LONG (3 REQUIRED)</td>
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<td>SOLENOID BODY RETAINING PLATE</td>
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<td>MODULATING VALVE PLUNGER</td>
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<td>MODULATING VALVE BALANCE SPRING</td>
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<td>EDS-1 SOLENOID SCREEN</td>
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<td>PRESSURE REGULATOR VALVE SPRING, FOR EDS-1 SOLENOID</td>
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<td>PRESSURE REGULATOR VALVE, FOR EDS-1 SOLENOID</td>
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<td>SOLENOID VALVE BODY RETAINING BOLT, 70mm LONG (3 REQUIRED)</td>
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<td>MODULATING VALVE ADJUSTING SCREW &quot;O&quot; RING</td>
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<td>35</td>
<td>MODULATING VALVE ADJUSTING SCREW</td>
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<td>36</td>
<td>SOLENOID VALVE BODY RETAINING BOLT, 60mm LONG (1 REQUIRED)</td>
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<td>37</td>
<td>SOLENOID VALVE BODY RETAINING BOLT, 65mm LONG (1 REQUIRED)</td>
</tr>
</tbody>
</table>

**SPECIAL NOTE:**
Valve Body nomenclatures are ATSG interpretations, not Audi's nor ZF.
ZF-4HP-18FLA/E COMPONENT ASSEMBLY

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

- Manual Valve Valve Body
- Channel Plate
- Upper Spacer Plate
- Main Valve Body
- Lower Spacer Plate
- Lower Spacer Plate Gasket
- Solenoid Body
- Oil Filter
- Oil Filter Transfer Plate
- Internal Wire Harness

Figure 9

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SPECIAL NOTE:
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Figure 10
SPECIAL NOTE:
Valve Body nomenclatures are ATSG interpretations, not Audi's nor ZF.
### ZF 4HP-18FLA/E SPRING SPECIFICATIONS

<table>
<thead>
<tr>
<th>Manual Valve Body</th>
<th>Solenoid Valve Body</th>
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<th>&quot;Front Side&quot;</th>
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**Special Note:**

The spring dimensions listed above were "Observations" from only one valve body, and may vary from one model to another.
Screen For EDS-1 Solenoid

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Figure 13

Figure 14
All Orifices Are Flat

"D" Clutch Check Valve Assembly

.235" Diameter Plastic Checkball

.029"

.029"

.099"

.029"
All Orifices Are Flat

"A" Clutch Check Valve And Spring

.029"
All Orifices Are Flat

0.046"
SAFETY MODE VALVE OPERATION

PARK POSITION
ENGINE OFF

SUCTION
OUTPUT

TO SV-2
TO SV-3
SAFETY MODE VALVE

TO SV-1
TO SV-2
1/R VALVE
TO MOD. VALVE

MV 1 OFF
MV 2 OFF
MV 3 OFF
EDS 1 OFF

X
X
X

PARK POSITION
ENGINE ON

SUCTION
OUTPUT

TO SV-2
TO SV-3
SAFETY MODE VALVE

TO SV-1
TO SV-2
1/R VALVE
TO MOD. VALVE

MV 1 OFF
MV 2 ON
MV 3 ON
EDS 1 OFF

X
X
X

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
AUTOMATIC TRANSMISSION SERVICE GROUP
The Electronic Control system was first introduced in 1986 and was incorporated into the totaly 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

<table>
<thead>
<tr>
<th>Valve Body Models</th>
<th>86</th>
<th>87</th>
<th>88</th>
<th>89</th>
<th>90</th>
<th>91</th>
<th>92</th>
<th>93</th>
<th>94</th>
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<tbody>
<tr>
<td>1st Version, Early &quot;E-7&quot;, 5 Solenoid</td>
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<td>2nd Version, Late &quot;E-7&quot;, 5 Solenoid</td>
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<td>3rd Version, &quot;E-9&quot;, 4 Solenoid</td>
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</tr>
</tbody>
</table>

Figure 19

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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

### TABLE

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<tr>
<td>&quot;D&quot;-2nd</td>
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<td>ON</td>
<td>ON</td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>&quot;D&quot;-3rd</td>
<td>ON</td>
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<td></td>
<td>ON</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>&quot;D&quot;-4th</td>
<td>ON</td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**"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.
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 a 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.
<table>
<thead>
<tr>
<th>Solenoid</th>
<th>Function</th>
<th>Gear</th>
<th>MV-1</th>
<th>MV-2</th>
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<tr>
<td>MV-1</td>
<td>Shift Control</td>
<td>1st</td>
<td>ON</td>
<td>ON</td>
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<tr>
<td>MV-2</td>
<td>Shift Control</td>
<td>2nd</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>MV-3</td>
<td>Lock-Up Control</td>
<td>3rd</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>MV-4</td>
<td>Reverse Lockout</td>
<td>4th</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>MV-5</td>
<td>Line Pressure Control</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Figure 22

AUTOMATIC TRANSMISSION SERVICE GROUP
**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.

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

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

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Figure 23
**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.

**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.
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 26 LEGEND AND SPRING SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Number</th>
<th>Component Description</th>
<th>Specification</th>
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<tbody>
<tr>
<td>1</td>
<td>LOWER FRONT VALVE BODY CASTING</td>
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</tr>
<tr>
<td>2</td>
<td>'C' CLUTCH VALVE</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>'C' CLUTCH VALVE SPRING</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>'C' CLUTCH VALVE SPRING SEAT</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>'C' CLUTCH VALVE RETAINER</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>'B' CLUTCH DAMPER PISTON</td>
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</tr>
<tr>
<td>7</td>
<td>'B' CLUTCH DAMPER PISTON OUTER SPRING</td>
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</tr>
<tr>
<td>8</td>
<td>'B' CLUTCH DAMPER PISTON INNER SPRING</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>'B' CLUTCH DAMPER PISTON SPRING SEAT</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>'D' CLUTCH DAMPER PISTON</td>
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</tr>
<tr>
<td>11</td>
<td>'D' CLUTCH DAMPER PISTON SPRING</td>
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<td>MANUAL SHIFT VALVE</td>
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*Figure 26 Legend*

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

Legend And Spring Specifications Found On Page 35.

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AUTOMATIC TRANSMISSION SERVICE GROUP
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<td>43</td>
<td>PRESSURE REDUCING VALVE '2' SPRING</td>
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<td>SPRING DIAMETER = .472'</td>
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<td>WIRE DIAMETER = .040'</td>
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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"

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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

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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
Figure 31

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

INTERMEDIATE CLUTCH FEED .046" Cup Down

INTERMEDIATE ACCUMULATOR .032" Cup Up

DIRECT ACCUMULATOR .046" Cup Up

RETAINER

.175" DIAMETER CHECKBALL (Some Models Only)
ZF-4HP-22/24 MODEL "E-7", "5 SOLENOID"
LOWER "REAR" VALVE BODY

INPUT ACCUMULATOR .052" Cup Down

OVERDRIVE ACCUMULATOR .039" Cup Up

PLASTIC VALVE AND SPRING

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

FORWARD ACCUMULATOR .062" Cup Down

LOW/REVERSE ACCUMULATOR .032" Cup Down

OVERDRIVE .046" Cup Down

.235" DIAMETER PLASTIC CHECKBALL

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AUTOMATIC TRANSMISSION SERVICE GROUP
ZF-4HP-22/24 MODEL "E-7", "5 SOLENOID"
ALL SOLENOID BODIES

Retainer

Retainer

Retainer

Retainer

.175" DIAMETER CHECKBALL

Figure 34
ZF 4HP-22/24 SERIES

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

<table>
<thead>
<tr>
<th>Valve Body Models</th>
<th>Model Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>86</td>
</tr>
<tr>
<td>1st Version, Early &quot;E-7&quot;, 5 Solenoid</td>
<td></td>
</tr>
<tr>
<td>2nd Version, Late &quot;E-7&quot;, 5 Solenoid</td>
<td></td>
</tr>
<tr>
<td>3rd Version, &quot;E-9&quot;, 4 Solenoid</td>
<td></td>
</tr>
</tbody>
</table>

Figure 35

AUTOMATIC TRANSMISSION SERVICE GROUP
<table>
<thead>
<tr>
<th>Solenoid</th>
<th>Function</th>
<th>Gear</th>
<th>MV-1</th>
<th>MV-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>MV-1</td>
<td>Shift Control</td>
<td>1st</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>MV-2</td>
<td>Shift Control</td>
<td>2nd</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3rd</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4th</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td></td>
<td>Rev 0 mph</td>
<td>ON</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rev Above 3 mph</td>
<td>OFF</td>
<td>ON</td>
<td></td>
</tr>
<tr>
<td>MV-3</td>
<td>Lock-Up Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MV-5</td>
<td>Line Pressure Control</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Figure 36
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.

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

NOTE: Some internal wire colors may vary.

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Figure 37
**SOLENOID "OFF"**

From Pressure reducing valve 1 BLOCKED

From Pressure reducing valve 1

To the shift valve the Solenoid controls

**SOLENOID "ON"**

From Pressure reducing valve 1 OPEN

To the shift valve the Solenoid controls

**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)

**SOLENOID "OFF"**

EXHAUST BLOCKED

From Pressure reducing valve 2 to Mod. valve

**SOLENOID "ON"**

EXHAUST OPEN

From Pressure reducing valve 2 and Mod. valve

**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.
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
Legend And Spring Specifications Found On Page 49.
## FIGURE 40 LEGEND AND SPRING SPECIFICATIONS

<table>
<thead>
<tr>
<th>Number</th>
<th>Component Description</th>
<th>Illustration No.</th>
<th>Free Length</th>
<th>Spring Diameter</th>
<th>Wire Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 LOWER FRONT VALVE BODY CASTING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2 'C' CLUTCH VALVE SPRING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3 'C' CLUTCH VALVE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4 2-3 SHIFT VALVE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5 2-3 SHIFT VALVE SPRING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>6 'C' CLUTCH VALVE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>7 'C' CLUTCH VALVE RETAINER</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>8 'B' CLUTCH DAMPER PISTON</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>9 'B' CLUTCH DAMPER PISTON OUTER SPRING</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>10 'B' CLUTCH DAMPER PISTON INNER SPRING</td>
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</tr>
<tr>
<td>11</td>
<td>11 'B' CLUTCH DAMPER PISTON SPRING SEAT</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>12 1-2 SHIFT VALVE</td>
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<td></td>
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</tr>
<tr>
<td>13</td>
<td>13 1-2 SHIFT VALVE SPRING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>14 'D' CLUTCH DAMPER PISTON</td>
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<td>15</td>
<td>15 'D' CLUTCH DAMPER PISTON SPRING</td>
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<tr>
<td>16</td>
<td>16 'D' CLUTCH DAMPER PISTON SPRING SEAT</td>
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<tr>
<td>17</td>
<td>17 'D' CLUTCH VALVE RETAINER</td>
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<tr>
<td>18</td>
<td>18 'D' CLUTCH VALVE</td>
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</tr>
<tr>
<td>19</td>
<td>19 PRESSURE REGULATOR VALVE SPRING</td>
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<td></td>
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<tr>
<td>20</td>
<td>20 PRESSURE REGULATOR VALVE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>21 REAR SIDE COVER RETAINING BOLT, 17 mm LENGTH (5)</td>
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<td></td>
<td></td>
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<tr>
<td>22</td>
<td>22 REAR SIDE COVER RETAINING BOLT, 24 mm LENGTH (1)</td>
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<tr>
<td>25</td>
<td>25 REAR SIDE COVER</td>
<td></td>
<td></td>
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<tr>
<td>26</td>
<td>26 FRONT SIDE COVER RETAINING BOLT, 17 mm LENGTH (3)</td>
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<tr>
<td>27</td>
<td>27 FRONT SIDE COVER RETAINING BOLT, 29 mm LENGTH (1)</td>
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<tr>
<td>28</td>
<td>28 FRONT SIDE COVER</td>
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<tr>
<td>29</td>
<td>29 TORQUE CONVERTER LOCK-UP VALVE SPRING</td>
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<tr>
<td>30</td>
<td>30 TORQUE CONVERTER LOCK-UP VALVE</td>
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<td></td>
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<td></td>
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<td>31</td>
<td>31 'C' CLUTCH DAMPER PISTON SPRING SEAT</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>32</td>
<td>32 'C' CLUTCH DAMPER PISTON OUTER SPRING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>33 'C' CLUTCH DAMPER PISTON INNER SPRING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>34 'C' CLUTCH DAMPER PISTON</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>35 'B' CLUTCH DAMPER PISTON RETAINER</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>36 'B' CLUTCH DAMPER PISTON</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>37 'A' CLUTCH DAMPER PISTON</td>
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</tr>
<tr>
<td>38</td>
<td>38 'A' CLUTCH DAMPER SPRING</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>39</td>
<td>39 'A' CLUTCH DAMPER PISTON SPRING SEAT</td>
<td></td>
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</tr>
<tr>
<td>40</td>
<td>40 'A' CLUTCH DAMPER PISTON SPRING SEAT RETAINER</td>
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</tr>
<tr>
<td>41</td>
<td>41 MANUAL SHIFT VALVE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Figure 40 Legend

Spring Illustration No. 2:
- Free Length: 1.075"
- Spring Diameter: .280"
- Wire Diameter: .033"

Spring Illustration No. 5:
- Free Length: 1.925"
- Spring Diameter: .363"
- Wire Diameter: .033"

Spring Illustration No. 9:
- Free Length: 2.900"
- Spring Diameter: .594"
- Wire Diameter: .040"

Spring Illustration No. 10:
- Free Length: 1.580"
- Spring Diameter: .432"
- Wire Diameter: .040"

Spring Illustration No. 13:
- Free Length: 1.880"
- Spring Diameter: .367"
- Wire Diameter: .032"

Spring Illustration No. 19:
- Free Length: 3.625"
- Spring Diameter: .600"
- Wire Diameter: .080"

Spring Illustration No. 29:
- Free Length: 1.690"
- Spring Diameter: .443"
- Wire Diameter: .032"

Spring Illustration No. 32:
- Free Length: 3.100"
- Spring Diameter: .585"
- Wire Diameter: .045"

Spring Illustration No. 33:
- Free Length: 1.690"
- Spring Diameter: .443"
- Wire Diameter: .032"
### Figure 41 Legend and Spring Specifications

<table>
<thead>
<tr>
<th>Component</th>
<th>Diagram No.</th>
<th>Free Length</th>
<th>Spring Diameter</th>
<th>Wire Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rear Side Cover Retaining Bolts, 17 mm Length (3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rear Side Cover</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure Reducing Valve '1' Spring</td>
<td>45</td>
<td>1.395&quot;</td>
<td>.305&quot;</td>
<td>.040&quot;</td>
</tr>
<tr>
<td>Pressure Reducing Valve '1'</td>
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<tr>
<td>'F' Clutch Damper Piston</td>
<td>47</td>
<td></td>
<td></td>
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<tr>
<td>'F' Clutch Damper Piston Spring</td>
<td>48</td>
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<tr>
<td>'F' Clutch Damper Piston Spring Seat</td>
<td>49</td>
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<td></td>
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<tr>
<td>Safety Valve Spring</td>
<td>50</td>
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<tr>
<td>Safety Valve</td>
<td>51</td>
<td></td>
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</tr>
<tr>
<td>Lower Rear Valve Body Casting</td>
<td>52</td>
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<tr>
<td>'C' Clutch Damper Piston</td>
<td>53</td>
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<tr>
<td>'C' Clutch Damper Piston Outer Spring</td>
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<tr>
<td>'C' Clutch Damper Piston Inner Spring</td>
<td>55</td>
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</tr>
<tr>
<td>'E' Clutch Damper Piston</td>
<td>56</td>
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<tr>
<td>'E' Clutch Damper Piston Spring</td>
<td>57</td>
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<tr>
<td>'F' Clutch Valve</td>
<td>58</td>
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<td>'F' Clutch Valve Retainer</td>
<td>59</td>
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<td>Pressure Reducing Valve '2'</td>
<td>60</td>
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<tr>
<td>Pressure Reducing Valve '2' Spring</td>
<td>61</td>
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</tr>
<tr>
<td>3-4 Shift Valve</td>
<td>62</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-4 Shift Valve Spring</td>
<td>63</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Front Side Cover</td>
<td>64</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Front Side Cover Retaining Bolts, 17 mm Length (5)</td>
<td>65</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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"

Figure 43

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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

Figure 44
Figure 46

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

OVERDRIVE ACCUMULATOR .040" Cup Up

PLASTIC VALVE AND SPRING

INPUT ACCUMULATOR .055" Cup Down

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

Retainer

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Figure 48

AUTOMATIC TRANSMISSION SERVICE GROUP
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 Ravingneaux 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:**

- Automatic
- 5 Speed Transmission
- Overdrive Top Gear
- Maximum Torque Capacity (Nm)
- Manufacturer (ZF)

**FOUND IN:**
- 93-94 320i 3.0L V/8
- 93-95 530i 3.0L V/8
- 95-98 M3 3.0L/3.2LL6
- 730 3.0L V/8

Figure 49
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".
CLUTCH AND BAND APPLICATION CHART

<table>
<thead>
<tr>
<th>RANGE</th>
<th>Park</th>
<th>Reverse</th>
<th>Neutral</th>
<th>&quot;D&quot;-1st</th>
<th>&quot;D&quot;-2nd</th>
<th>&quot;D&quot;-3rd</th>
<th>&quot;D&quot;-4th</th>
<th>&quot;D&quot;-5th</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;A&quot;</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>&quot;B&quot;</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>&quot;C1&quot;</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>&quot;C2&quot;</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>&quot;D&quot;</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>&quot;F&quot;</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
</tbody>
</table>

GEAR RATIO

<table>
<thead>
<tr>
<th>GEAR</th>
<th>4.08</th>
<th>3.66</th>
<th>1.99</th>
<th>1.40</th>
<th>1.00</th>
<th>0.74</th>
</tr>
</thead>
</table>

CONVERTER CLUTCH MAY BE ON OR OFF DEPENDING ON VEHICLE SPEED AND THROTTLE POSITION.
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:

<table>
<thead>
<tr>
<th>Selector Lever Position</th>
<th>P</th>
<th>R</th>
<th>N</th>
<th>D</th>
<th>4</th>
<th>3</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Gear Obtained</td>
<td>P</td>
<td>R</td>
<td>N</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

Figure 51
When MV 1 thru 6 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 6 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.

When EDS 1 solenoid is "OFF," solenoid reducing pressure, from Pressure reducing valve 2, is high to the Modulating valve which creates high line pressure.

When EDS 1 solenoid is "ON," solenoid reducing pressure, from Pressure reducing valve 2, is low to the Modulating valve which creates low line pressure.
The MV 6 Solenoid is used for Lock-Up, and the only identification is the White connector and the part number on solenoid.

### SHIFT SOLENOID APPLICATION CHART

<table>
<thead>
<tr>
<th>RANGE</th>
<th>MV 1</th>
<th>MV 2</th>
<th>MV 3</th>
<th>MV 4</th>
<th>MV 5</th>
<th>MV 6</th>
<th>EDS 1</th>
<th>RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Park</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>Reverse</td>
<td>ON</td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>** 4.08</td>
</tr>
<tr>
<td>Neutral</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>&quot;D&quot;-1st</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>** 3.66</td>
</tr>
<tr>
<td>&quot;D&quot;-2nd</td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>** 1.99</td>
</tr>
<tr>
<td>&quot;D&quot;-3rd</td>
<td></td>
<td></td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* ** 1.40</td>
</tr>
<tr>
<td>&quot;D&quot;-4th</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* ** 1.00</td>
</tr>
<tr>
<td>&quot;D&quot;-5th</td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* ** 0.74</td>
</tr>
<tr>
<td>&quot;D&quot;, 3-2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>&quot;D&quot;, 5-4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>&quot;FailSafe&quot;</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>1.00</td>
</tr>
</tbody>
</table>

* 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.
ZF-5HP-18 INTERNAL WIRE SCHEMATIC

View Looking Into Case
Connector Setting In The vehicle

MV 1 Solenoid
MV 2 Solenoid
MV 3 Solenoid
MV 4 Solenoid
MV 5 Solenoid
MV 6 Solenoid
EDS 1 Pressure Regulator Solenoid
Output Speed Sensor
Turbine Speed Sensor
TOT Sensor (Resistor In Wire)

13 8 4 3 9 7 11 12 2 14 12

PURPLE GRAY WHITE TAN GREEN WHITE

MV 1 Solenoid
MV 3 Solenoid
MV 4 Solenoid
MV 5 Solenoid
MV 6 Solenoid
EDS 1 Pressure Regulator Solenoid
Output Speed Sensor
Turbine Speed Sensor
TOT Sensor (Resistor In Wire)

NOTE: Some internal wire colors may vary.

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Figure 54

AUTOMATIC TRANSMISSION SERVICE GROUP
The diagram illustrates the solenoid components and their part numbers in BMW, Audi, and Porsche automatic transmissions. The table below provides the resistance values and part numbers for these components:

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

Figure 55

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RETREIVING 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

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

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

**Figure 57**

*Diagnostic Connector*

*Diagnostic Connector With Cover Off.*

*BMW Diagnostic Tool*
## SOLENOID AND SENSOR RESISTANCE CHART

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

View Looking Into Case
Connector Setting In The vehicle

Electronic Control Unit Connector Pin Identification

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Figure 58

AUTOMATIC TRANSMISSION SERVICE GROUP
CASE PASSAGES FOR AIR CHECKS

"B" CLUTCH

"A" CLUTCH

"C1" CLUTCH

"E" CLUTCH

"D" CLUTCH

"G" CLUTCH

"F" CLUTCH

C2 BAND SERVO

Figure 59

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AUTOMATIC TRANSMISSION SERVICE GROUP
PRESSURE TAP LOCATIONS

RIGHT SIDE OF CASE

Note: Some cases you must drill and tap for access.

"G" Clutch Pressure

"C2" Band Pressure

Main Line Pressure

"F" Clutch Pressure

Modulation Pressure

Lubrication Pressure

LEFT SIDE OF CASE

Note: Some cases you must drill and tap for access.

Out To Cooler

Cooler Return

"E" Clutch Pressure

"A" Clutch Pressure

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Figure 60

AUTOMATIC TRANSMISSION SERVICE GROUP
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 VALVE BODY

MV 6 Solenoid
ZF Part Number 0501 207 697
(White Connector)

EDS 1
Pressure Regulator Solenoid
ZF Part Number 0501 311 843
(Black Connector)

MV 1 Thru MV 5 Solenoids
ZF Part Number 0501 310 967
(Black Connector)

6. Modulation Valve Train
7. Pressure Reduction Valve 2, to PR Solenoid (EDS 1)
8. Threaded Screw To Adjust Pressure
9. "O" Ring, (Goes In Groove In Adjusting Screw)

Refer to Figure 71 on Page 82 for Spring Specifications
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

AUTOMATIC TRANSMISSION SERVICE GROUP
Refer to Figure 71 on Page 82 for Spring Specifications

23. "C2" Accumulator Regulator Valve
24. "C2" Band Damper Valve
25. Shift Valve Number 4
26. "E" Clutch Accumulator Regulator Valve
27. "E" Clutch Damper Valve
28. Shift Valve Number 3
29. Shift Valve Number 1
30. Main Line Pressure Regulator Valve
31. "A" Clutch Damper Valve
32. Manual Valve
33. "C1" Clutch Regulator And Damper Valve
ZF 5HP-18
UPPER FRONT VALVE BODY CLIP LOCATIONS
ZF 5HP-18
LOWER FRONT VALVE BODY CLIP LOCATIONS

Figure 67
ZF 5HP-18
LOWER REAR VALVE BODY CLIP LOCATIONS

Small Retaining Clip

Large Retaining Clip

Flat Retaining Clip

Figure 68

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AUTOMATIC TRANSMISSION SERVICE GROUP
ZF 5HP-18
SOLENOID VALVE BODY CLIP LOCATIONS

Adjusting Screw With "O" Ring

Small Retaining Clip

Small Flat Retaining Clip

Wire Retaining Clip

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### 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) 4-5 Traction Valve**
  - Free Length: 1.630"  
  - 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"

#### LOWER REAR VALVE BODY
- **(10) "G" Damper Pist (Inner)**
  - Free Length: 3.900"  
  - Spring Diameter: .368"  
  - Wire Diameter: .028"
- **(16) Reverse Lockout Valve**
  - Free Length: 1.820"  
  - Spring Diameter: .440"  
  - Wire Diameter: .039"
- **(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: .043"
- **(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"

#### LOWER FRONT VALVE BODY
- **(24) "C2" Damper Piston**
  - Free Length: 3.425"  
  - Spring Diameter: .585"  
  - Wire Diameter: .031"
- **(30) Pressure Reg (Inner)**
  - Free Length: 3.150"  
  - Spring Diameter: .448"  
  - Wire Diameter: .048"
- **(25) Shift Valve 4**
  - Free Length: 1.780"  
  - Spring Diameter: .366"  
  - Wire Diameter: .031"
- **(27) "E" Damper Piston**
  - Free Length: 2.880"  
  - 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"
- **(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"

---

**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".
**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 Convertor Valve, sticking the valve in the "stroked" position (See Figure 73). When this valve is stuck in this position it may cause the Torque Convertor 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 Convertor to fill back up, and this all depends on the positioning of the stuck Torque Convertor Valve.

**CORRECTION:** Locate the Torque Convertor 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*  
The Bypass Ball is located under a Capsule, in the Convertor Apply Circuit.
The "Bypass Ball" shrinks and travels back through to the Torque Convertor Valve and lodges itself in this passage, sticking the valve in this approximate position.
ZF-5HP-18 UPPER FRONT VALVE BODY

Figure 74

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

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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 76

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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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
MIAMI, FLORIDA 33135
TOLL FREE (800) 966-4621
PHONE (305) 642-4621
FAX (305) 541-1444

ERIKSSON INDUSTRIES
DIVISION OF WENTWORTH ENGINEERING, INC.
146 B ELM STREET
OLD SAYBROOK, CT 06475
TOLL FREE (800) 388-4418

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
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 Ravingneaux 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.
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.
The image contains a technical diagram and a table related to clutch and band application for ZF-5HP-19 transmission. The table outlines clutch and sprag clutch engagements for different ranges and gear shifts. The diagram illustrates the mechanical layout of the transmission components, including clutches labeled A, B, C, D, E, F, and G.

### Table: Clutch and Band Application Chart

<table>
<thead>
<tr>
<th>RANGE</th>
<th>&quot;A&quot;</th>
<th>&quot;B&quot;</th>
<th>&quot;C&quot;</th>
<th>&quot;D&quot;</th>
<th>&quot;E&quot;</th>
<th>&quot;F&quot;</th>
<th>&quot;G&quot;</th>
<th>GEAR CONV CLUT</th>
<th>CLUT</th>
<th>CLUT</th>
<th>RATIO CLUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Park</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>Reverse</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>Neutral</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>HOLD</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>&quot;D&quot;-1st</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>&quot;D&quot;-2nd</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>&quot;D&quot;-3rd</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>&quot;D&quot;-4th</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>&quot;D&quot;-5th</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
</tbody>
</table>

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

--

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\( \text{P} = \) Parking Pawl Engaged

\( \text{R} = \) Reverse Gear

\( \text{N} = \) Neutral

\( \text{D} = \) Automatic Shifts 1st thru 5th Gears

\( \text{4} = \) Automatic Shifts 1st thru 4th Gears. 5th Gear is locked out.

\( \text{3} = \) Automatic Shifts 1st thru 3rd Gears. 4th and 5th Gear is locked out.

\( \text{2} = \) 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
"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:

<table>
<thead>
<tr>
<th>Selector Lever Position</th>
<th>P R N D 4 3 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Gear Obtained</td>
<td>P R N 4 4 4</td>
</tr>
</tbody>
</table>
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

ZF Part Numbers
EDS-1 Solenoid  0501 209 875
EDS-2, 3, 4, Solenoid 0501 208 562
MV-1, 2, 3, Solenoid  0501 313 506
**MV1, 2 AND 3 OPERATION**

**SOLENOID "OFF"**

Pressure from SV1,2 OR 3 exhausted.

From Dr.Red. V-1 blocked.

**SOLENOID "ON"**

Exhaust blocked.

To SV1,2 OR 3 open.

**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**

**SOLENOID "OFF"**

Exhaust blocked.

From Dr.Red.V-2 and clutch regulating valves.

**SOLENOID "ON"**

Exhaust blocked.

.670" Snout Diameter Requires Black "O" Ring.

From Dr.Red.V-2 to clutch regulating valves.

**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.

Copyright © 2003 ATSG
EDS-1 OPERATION
(Line Pressure Solenoid)

SOLENOID "OFF"

EXHAUST BLOCKED

From Dr. Red. V-2 to MOD-V

SOLENOID "ON"

EXHAUST OPEN

.650" Snout Diameter Requires Green "O" Ring

From Dr. Red. V-2 and MOD-V

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
ZF-5HP-19 INTERNAL WIRE SCHEMATIC

View Looking Into Case Connector

NOTE: Some internal wire colors may vary.
### ZF-5HP-19 SOLENOID APPLICATION CHART

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

### SOLENOID CHART LEGEND

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>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.</td>
</tr>
<tr>
<td>**</td>
<td>MV 3 is turned &quot;ON&quot; if reverse is selected at a high vehicle speed, to inhibit reverse engagement.</td>
</tr>
<tr>
<td>*</td>
<td>EDS 1 is used for line pressure control only, and operates from 0 to 0.8 amps. When the solenoid is &quot;OFF&quot; (0 amps), pressure is high. EDS 1 pressure is &quot;Lowered&quot; as the solenoid is modulated by the control unit.</td>
</tr>
<tr>
<td>*</td>
<td>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 &quot;ON&quot; oil pressure in the hydraulic circuit is high, and when they are &quot;OFF&quot; pressure in the hydraulic circuit is low.</td>
</tr>
<tr>
<td>-</td>
<td>Solenoid &quot;OFF&quot; (hydraulic pressure low), then Solenoid &quot;ON&quot; (hydraulic pressure high).</td>
</tr>
<tr>
<td>-**</td>
<td>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.</td>
</tr>
</tbody>
</table>
# ZF 5HP-19 SOLENOID AND SENSOR RESISTANCE CHART

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

**View Looking Into Case Connector**

**Electronic Control Unit Connector Pin Identification**

---

Copyright © 2003 ATSG
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)
26. Manual Shift Valve (W-S)
27. "E" Clutch Damper Valve
28. "E" Clutch Damper Valve Spring
29. "E" Clutch Damper Valve Spring Seat
30. "E" Clutch Accumulator Regulator Valve
31. "E" Clutch Accumulator Regulator Valve Retainer
32. Main Pressure Regulator Valve Spring
33. Main Pressure Regulator Valve
34. "D" Clutch One-Way Check Valve Assembly
35. 5-4 Traction Valve
36. 5-4 Traction Valve Spring
37. 5-4 Traction Valve Bore Plug
38. 5-4 Traction Valve Train Retainer
40. "A" Clutch Damper Valve Spring
41. "A" Clutch Damper Valve Spring Seat
42. "A" Clutch Accumulator Regulator Valve Retainer
43. "A" Clutch Accumulator Regulator Valve
44. "G" Clutch Accumulator Regulator Valve
45. "G" Clutch Accumulator Regulator Valve Spring
46. "C" Clutch Accumulator Regulator Valve
47. "C" Clutch Accumulator Regulator Valve Spring
48. Lower Front Valve Body
49. "C" Clutch Shift Valve
50. "C" Clutch Shift Valve Spring
51. "C" Clutch Shift Valve Retainer
52. "G" Clutch Shift Valve
53. "G" Clutch Shift Valve Spring
54. "G" Clutch Shift Valve Retainer
55. Filter Seal
56. Oil Filter
57. Oil Filter Retaining Screws
58. Lower Valve Body Cover
59. Lower Valve Body Cover Screws (8 Required)
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

Figure 91

Copyright © 2003 ATSG
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

AUTOMATIC TRANSMISSION SERVICE GROUP
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.

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

Figure 93
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.

Figure 94

Copyright © 2003 ATSG
These 4 Plastic Orifice Plugs Are .112” Thick & .039” Orifice (All Others Are .042” Thick)
**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"

**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:** .365"
- **WIRE DIAMETER:** .031"

**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. 50 & 53:**
- **FREE LENGTH:** 1.690"
- **SPRING DIAMETER:** .375"
- **WIRE DIAMETER:** .042"

**SPRING ILLUSTRATION NO. 74:**
- **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. 62:**
- **FREE LENGTH:** 1.825"
- **SPRING DIAMETER:** .367"
- **WIRE DIAMETER:** .031"

**SPRING ILLUSTRATION NO. 87:**
- **FREE LENGTH:** 1.595"
- **SPRING DIAMETER:** .367"
- **WIRE DIAMETER:** .031"

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

**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"
- **WIRE DIAMETER:** .031"

**SPRING ILLUSTRATION NO. 107:**
- **FREE LENGTH:** 2.925"
- **SPRING DIAMETER:** .640"
- **WIRE DIAMETER:** .049"

**SPRING ILLUSTRATION NO. 108:**
- **FREE LENGTH:** 1.506"
- **SPRING DIAMETER:** .381"
- **WIRE DIAMETER:** .043"

---

**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.
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:**

- **A**
- **5**
- **S**
- **440**
- **Z**

**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

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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.
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.
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:

<table>
<thead>
<tr>
<th>Selector Lever Position</th>
<th>P R N D 4 3 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Gear Obtained</td>
<td>P R N 5 5 5 5</td>
</tr>
</tbody>
</table>
**MV1, 2 AND 3**

**Solenoid "OFF"**

- Pressure from SV1,2 or 3 exhausted
- From Dr. Red. V-1 blocked

**Solenoid "ON"**

- Exhaust blocked
- From Dr. Red. V-1 open

**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,**

**Solenoid "OFF"**

- Exhaust
- From Dr. Red. V-2 and clutch regulating valves

**Solenoid "ON"**

- Exhaust blocked
- "Black" "O" Ring

**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.
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 MOD-V valve which reduces line pressure.
ZF-5HP-24 INTERNAL WIRE SCHEMATIC

Turbine Speed Sensor

MV 3 Solenoid
MV 2 Solenoid
MV 1 Solenoid
EDS 5 Solenoid
EDS 2 Solenoid
EDS 3 Solenoid
EDS 4 Solenoid
EDS 1 Solenoid

Output Speed Sensor

NOTE: Some internal wire colors may vary.

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Figure 102

AUTOMATIC TRANSMISSION SERVICE GROUP
### ZF-5HP-24 SOLENOID APPLICATION CHART

<table>
<thead>
<tr>
<th>Selector Lever Position</th>
<th>MV 1 Solenoid</th>
<th>MV 2 Solenoid</th>
<th>MV 3 Solenoid</th>
<th>EDS 1 Solenoid</th>
<th>EDS 2 Solenoid</th>
<th>EDS 3 Solenoid</th>
<th>EDS 4 Solenoid</th>
<th>EDS 5 Solenoid</th>
<th>GEAR RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>PARK</td>
<td>ON</td>
<td>ON</td>
<td>**</td>
<td>--</td>
<td>*</td>
<td>*</td>
<td>--</td>
<td>--</td>
<td>1.00:1</td>
</tr>
<tr>
<td>REVERSE</td>
<td>ON</td>
<td>ON</td>
<td>**</td>
<td>--</td>
<td>*</td>
<td>*</td>
<td>--</td>
<td>--</td>
<td>4.10:1</td>
</tr>
<tr>
<td>NEUTRAL</td>
<td>ON</td>
<td>ON</td>
<td>**</td>
<td>--</td>
<td>*</td>
<td>*</td>
<td>--</td>
<td>--</td>
<td>3.57:1</td>
</tr>
<tr>
<td>D-1ST</td>
<td>ON</td>
<td>**</td>
<td>*</td>
<td>--</td>
<td>*</td>
<td>*</td>
<td>--</td>
<td>--</td>
<td>2.20:1</td>
</tr>
<tr>
<td>D-2ND</td>
<td>ON</td>
<td>**</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.51:1</td>
</tr>
<tr>
<td>D-3RD</td>
<td>ON</td>
<td>**</td>
<td>*</td>
<td>--</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.00:1</td>
</tr>
<tr>
<td>D-4TH</td>
<td>ON</td>
<td>**</td>
<td>--</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.80:1</td>
</tr>
<tr>
<td>D-5TH</td>
<td>**</td>
<td>--</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D-5TH &quot;TCC&quot;</td>
<td>**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### SOLENOID CHART LEGEND

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>MV1, MV2 and MV3 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.</td>
</tr>
<tr>
<td>⋄</td>
<td>MV3 is turned &quot;ON&quot; if reverse is selected at a high vehicle speed, to inhibit reverse engagement.</td>
</tr>
<tr>
<td>**</td>
<td>EDS 1 is used for line pressure control only, and operates from 0 to 0.8 amps. When the solenoid is &quot;OFF&quot; (0 amps), pressure is high. EDS 1 pressure is &quot;Lowered&quot; as the solenoid is modulated by the control unit.</td>
</tr>
<tr>
<td>*</td>
<td>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 &quot;ON&quot; oil pressure in the hydraulic circuit is high, and when they are &quot;OFF&quot; pressure in the hydraulic circuit is low.</td>
</tr>
<tr>
<td>--*</td>
<td>Solenoid &quot;OFF&quot; (hydraulic pressure low), then Solenoid &quot;ON&quot; (hydraulic pressure high).</td>
</tr>
<tr>
<td>**--</td>
<td>Solenoid &quot;ON&quot; briefly (hydraulic pressure high), then Solenoid &quot;OFF&quot; (hydraulic pressure low). The pressure acts briefly on regulator valves to cushion clutch application.</td>
</tr>
<tr>
<td>--**--</td>
<td>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.</td>
</tr>
</tbody>
</table>
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.
### SOLENOID AND SENSOR RESISTANCE CHART

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

**View Looking Into Case**

*Connector Setting In The vehicle*

**Electronic Control Unit Connector Pin Identification**

---

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Figure 105
ZF-5HP-24 UPPER VALVE BODY

Refer to Figure 119 on Page 134 for Spring Specifications

23. Pressure Reducing Valve 1 (DR-V1).
24. Pressure Reducing Valve 2 (DR-V2).
27. Switch Valve For "A" Clutch (ABSCH-V-A).
10. Converter Clutch Apply Oil Control Valve (WK-V).
12. Main Pressure Regulator Valve Line-Up (HD-V).
13. Lubrication Valve (SCHM-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).

Refer to Figure 119 on Page 134 for Spring Specifications
ZF-5HP-24 LOWER REAR VALVE BODY

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).

Refer to Figure 119 on Page 134 for Spring Specifications

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23. Pressure Reducing Valve 1 (DR-V1).
24. Pressure Reducing Valve 2 (DR-V2).
27. Switch Valve For "A" Clutch (ABSCH-V-A).

Refer to Figure 119 on Page 134 for Spring Specifications.
Figure 110

ZF 5HP-24 LOWER FRONT VALVE BODY
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).
10. Converter Clutch Apply Oil Control Valve (WK-V).
12. Main Pressure Regulator Valve Line-Up (HD-V).
13. Lubrication Valve (SCHM-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).

See Page 134 for Spring Spec.
Round Screen

ZF 5HP-24 CHANNEL PLATE "UPPER SIDE"

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Figure 112

AUTOMATIC TRANSMISSION SERVICE GROUP
ZF 5HP-24 CHANNEL PLATE "LOWER SIDE"

- EDS-5 Accumulator Plug
- White .087" Flat Orifice
- Small White Plastic Filter
- Original .236" Diameter
- Blue .055" Flat Orifice
- Black .059" Flat Orifice
- Plastic Relief Valve And Spring
- White .047" Flat Orifice
- Brown .038" Flat Orifice
- Brown .038" Flat Orifice
- Blue .055" Flat Orifice
- Brown .038" Flat Orifice

Figure 113

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AUTOMATIC TRANSMISSION SERVICE GROUP
PRESSURE TAP LOCATIONS AND IDENTIFICATION

*Jaguar Model Shown*

"PH" = Line Pressure (Not Drilled)
"A" = A Clutch (Not Drilled)
"Out" = To Cooler
"WKS" = TCC Off
"WKZ" = TCC Apply (Not Drilled)
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.
Output to Pressure Regulator Valve

Figure 117

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AUTOMATIC TRANSMISSION SERVICE GROUP
Figure 118

PUMP AND PUMP PLATE

PUMP BODY

PUMP PLATE

OUTER PUMP GEAR LUBRICATION

PUMP PLATE INSTALLED ON PUMP BODY

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AUTOMATIC TRANSMISSION SERVICE GROUP
### ZF 5HP-24 VALVE BODY SPRING SPECIFICATIONS

#### UPPER VALVE BODY

<table>
<thead>
<tr>
<th>Valve Type</th>
<th>Free Length</th>
<th>Wire Diameter</th>
<th>Outside Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clutch Valve “F” (KV-F)</td>
<td>1.400&quot;</td>
<td>.031&quot;</td>
<td>.365&quot;</td>
</tr>
<tr>
<td>Clutch Valve “E” (KV-E)</td>
<td>1.551&quot;</td>
<td>.031&quot;</td>
<td>.365&quot;</td>
</tr>
<tr>
<td>Pressure Reducing Valve</td>
<td>1.942&quot;</td>
<td>.045&quot;</td>
<td>.370&quot;</td>
</tr>
<tr>
<td>A Clutch Swit Valve</td>
<td>1.455&quot;</td>
<td>.028&quot;</td>
<td>.365&quot;</td>
</tr>
</tbody>
</table>

#### LOWER FRONT VALVE BODY

<table>
<thead>
<tr>
<th>Valve Type</th>
<th>Free Length</th>
<th>Wire Diameter</th>
<th>Outside Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCC Apply Control Valve</td>
<td>1.952&quot;</td>
<td>.042&quot;</td>
<td>.370&quot;</td>
</tr>
<tr>
<td>TCC Release Control Valve</td>
<td>2.052&quot;</td>
<td>.034&quot;</td>
<td>.438&quot;</td>
</tr>
<tr>
<td>EDS 4, Accumulator Valve</td>
<td>1.560&quot;</td>
<td>.042&quot;</td>
<td>.322&quot;</td>
</tr>
<tr>
<td>EDS 3, Accumulator Valve</td>
<td>1.560&quot;</td>
<td>.042&quot;</td>
<td>.322&quot;</td>
</tr>
</tbody>
</table>

#### LOWER REAR VALVE BODY

<table>
<thead>
<tr>
<th>Valve Type</th>
<th>Free Length</th>
<th>Wire Diameter</th>
<th>Outside Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;A&quot; Clutch Accumulator</td>
<td>1.067&quot;</td>
<td>.066&quot;</td>
<td>.595&quot;</td>
</tr>
<tr>
<td>Shift Valve Number 1</td>
<td>1.755&quot;</td>
<td>.031&quot;</td>
<td>.367&quot;</td>
</tr>
<tr>
<td>Shift Valve Number 2</td>
<td>1.770&quot;</td>
<td>.031&quot;</td>
<td>.367&quot;</td>
</tr>
<tr>
<td>Reverse Gear Valve</td>
<td>1.800&quot;</td>
<td>.031&quot;</td>
<td>.360&quot;</td>
</tr>
<tr>
<td>&quot;C&quot; Clutch Accumulator</td>
<td>3.067&quot;</td>
<td>.066&quot;</td>
<td>.595&quot;</td>
</tr>
</tbody>
</table>

These spring locations shown on Page 121.
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:

A 5 S 560 Z

Automatic
5 Speed Transmission
Overdrive Top Gear
Maximum Torque Capacity (Nm)
Manufacturer
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 upper 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".
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.

<table>
<thead>
<tr>
<th>GEAR</th>
<th>&quot;A&quot; CLUT</th>
<th>&quot;B&quot; CLUT</th>
<th>&quot;C&quot; CLUT</th>
<th>&quot;D&quot; CLUT</th>
<th>&quot;E1&quot; CLUT</th>
<th>&quot;E2&quot; CLUT</th>
<th>&quot;F&quot; CLUT</th>
<th>&quot;FrE&quot; SPRAG</th>
<th>&quot;FrF&quot; SPRAG</th>
<th>GEAR RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>PARK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REV</td>
<td>ON</td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.68:1</td>
</tr>
<tr>
<td>NEUT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D-1ST</td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>HOLD 3.55:1</td>
</tr>
<tr>
<td>D-2ND</td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>HOLD 2.24:1</td>
</tr>
<tr>
<td>D-3RD</td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.54:1</td>
</tr>
<tr>
<td>D-4TH</td>
<td>ON</td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.00:1</td>
</tr>
<tr>
<td>D-5TH</td>
<td>ON</td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.79:1</td>
</tr>
<tr>
<td>M-2</td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>SELECTOR LEVER POSITION</th>
<th>PROGRAM MODE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AUTOMATIC (A)</td>
</tr>
<tr>
<td></td>
<td>WINTER (❄️)</td>
</tr>
<tr>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>D</td>
<td>D - Economy Program</td>
</tr>
<tr>
<td>4</td>
<td>4 - Sport Program</td>
</tr>
<tr>
<td>3</td>
<td>3 - Sport Program</td>
</tr>
<tr>
<td>2</td>
<td>2 - Sport Program</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Selector Lever Position</th>
<th>P R N D 4 3 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Gear Obtained</td>
<td>P R N 4 4 4 4</td>
</tr>
</tbody>
</table>

Figure 122

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SOLENOID LOCATIONS AND IDENTIFICATION

Figure 123

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AUTOMATIC TRANSMISSION SERVICE GROUP
**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.

---

**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.
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 MOD-V.
View Looking Into Case
Connector Setting In The vehicle

NOTE: Some internal wire colors may vary.
# ZF-5HP-30 SOLENOID APPLICATION CHART

<table>
<thead>
<tr>
<th>Selector Lever Position</th>
<th>MV 1 Solenoid</th>
<th>MV 2 Solenoid</th>
<th>MV 3 Solenoid</th>
<th>EDS 1 Solenoid</th>
<th>EDS 2 Solenoid</th>
<th>EDS 3 Solenoid</th>
<th>EDS 4 Solenoid</th>
<th>EDS 5 Solenoid</th>
<th>GEAR RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>PARK</td>
<td>ON</td>
<td>**</td>
<td>***</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>3.68:1</td>
<td></td>
</tr>
<tr>
<td>REVERSE</td>
<td>ON</td>
<td>**</td>
<td>***</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>3.65:1</td>
<td></td>
</tr>
<tr>
<td>NEUTRAL</td>
<td>ON</td>
<td>**</td>
<td>***</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>2.24:1</td>
<td></td>
</tr>
<tr>
<td>D-1ST</td>
<td>ON</td>
<td>**</td>
<td>***</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>1.54:1</td>
<td></td>
</tr>
<tr>
<td>D-2ND</td>
<td>ON</td>
<td>ON</td>
<td>***</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>1.00:1</td>
<td></td>
</tr>
<tr>
<td>D-3RD</td>
<td>ON</td>
<td>**</td>
<td>***</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>0.79:1</td>
<td></td>
</tr>
<tr>
<td>D-4TH</td>
<td>ON</td>
<td>**</td>
<td>***</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>0.79:1</td>
<td></td>
</tr>
<tr>
<td>D-5TH</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>1.00:1</td>
<td></td>
</tr>
</tbody>
</table>

## SOLENOID CHART LEGEND

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>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.</td>
</tr>
<tr>
<td>**</td>
<td>MV 3 is turned &quot;ON&quot; if reverse is selected at a high vehicle speed, to inhibit reverse engagement.</td>
</tr>
<tr>
<td>***</td>
<td>EDS 1 is used for line pressure control only, and operates from 0 to 0.8 amps. When the solenoid is &quot;OFF&quot; (0 amps), pressure is high. EDS 1 pressure is &quot;Lowered&quot; as the solenoid is modulated by the 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 &quot;ON&quot; oil pressure in the hydraulic circuit is high, and when they are &quot;OFF&quot; pressure in the hydraulic circuit is low.</td>
</tr>
<tr>
<td>*</td>
<td>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 &quot;ON&quot; oil pressure in the hydraulic circuit is high, and when they are &quot;OFF&quot; pressure in the hydraulic circuit is low.</td>
</tr>
<tr>
<td>- *</td>
<td>Solenoid &quot;OFF&quot; (hydraulic pressure low), then Solenoid &quot;ON&quot; (hydraulic pressure high).</td>
</tr>
<tr>
<td>* - *</td>
<td>Solenoid &quot;ON&quot; briefly (hydraulic pressure high), then Solenoid &quot;OFF&quot; (hydraulic pressure low). The pressure acts briefly on regulator valves to cushion clutch application.</td>
</tr>
<tr>
<td>- * -</td>
<td>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.</td>
</tr>
</tbody>
</table>
### SOLENOID AND SENSOR RESISTANCE CHART

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

**View Looking Into Case**

**Connector Setting In The vehicle**

---

**Electronic Control Unit Connector Pin Identification**

---

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---

AUTOMATIC TRANSMISSION SERVICE GROUP
### RETREIVING 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

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

---

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Figure 129
## BMW ZF-5HP-30 Fault Code Chart

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

---

**Figure 130**

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AUTOMATIC TRANSMISSION SERVICE GROUP
1. WKzu = Converter Clutch ON Pressure.
3. S = Cooler Pressure.
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.
ZF-5HP-30
UPPER REAR VALVE BODY

23. MV Solenoid Regulator Valve (DR. Red.-V1).
24. EDS Solenoid Regulator Valve (DR. Red.-V2).
27. Switch Valve For "A" Clutch (ABSCH-V-A).

Refer to Figure 137 on Page 153 for Spring Specifications.
10. Converter Clutch Apply Oil Control Valve (WK-V).
12. Main Pressure Regulator Valve Line-Up (HD-V).
13. Lubrication Valve (SCHM-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
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).

Refer to Figure 137 on Page 153 for Spring Specifications.
Only One .250" (6.35mm) ball is located here.
Do Not install a ball in the pocket marked X.
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).
10. Converter Clutch Apply Oil Control Valve (WK-V).
12. Main Pressure Regulator Valve Line-Up (HD-V).
13. Lubrication Valve (SCHM-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).
## ZF 5HP-30 Valve Body Spring Specifications

### Upper Rear Valve Body

<table>
<thead>
<tr>
<th>Valve Name</th>
<th>Free Length</th>
<th>Wire Diameter</th>
<th>Outside Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>21. Clutch Valve &quot;F&quot; (KV-F)</td>
<td>1.370&quot;</td>
<td>.066&quot;</td>
<td>.608&quot;</td>
</tr>
<tr>
<td>22. Clutch Valve &quot;E2&quot; (KV-E2)</td>
<td>1.558&quot;</td>
<td>.031&quot;</td>
<td>.365&quot;</td>
</tr>
<tr>
<td>23. MV Solenoid Reg Valve (DR-V1)</td>
<td>1.395&quot;</td>
<td>.031&quot;</td>
<td>.365&quot;</td>
</tr>
<tr>
<td>24. EDS Solenoid Reg Valve (DR-V2)</td>
<td>1.980&quot;</td>
<td>.045&quot;</td>
<td>.370&quot;</td>
</tr>
<tr>
<td>25. Clutch Valve &quot;B&quot; (KV-B)</td>
<td>1.710&quot;</td>
<td>.042&quot;</td>
<td>.424&quot;</td>
</tr>
<tr>
<td>26. Clutch Valve &quot;E1&quot; (KV-E1)</td>
<td>1.742&quot;</td>
<td>.023&quot;</td>
<td>.352&quot;</td>
</tr>
<tr>
<td>27. A Clutch Swit Valve (ABSCH.V-A)</td>
<td>1.692&quot;</td>
<td>.031&quot;</td>
<td>.365&quot;</td>
</tr>
</tbody>
</table>

### Lower "Front" Valve Body

<table>
<thead>
<tr>
<th>Valve Name</th>
<th>Free Length</th>
<th>Wire Diameter</th>
<th>Outside Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. TCC Apply Control Valve (WK-V)</td>
<td>1.628&quot;</td>
<td>.048&quot;</td>
<td>.360&quot;</td>
</tr>
<tr>
<td>11. TCC Release Control Valve (WD-V)</td>
<td>2.007&quot;</td>
<td>.034&quot;</td>
<td>.438&quot;</td>
</tr>
<tr>
<td>12. Pressure Regulator Valve (HD-V)</td>
<td>3.548&quot;</td>
<td>.087&quot;</td>
<td>.686&quot;</td>
</tr>
<tr>
<td>13. Lubrication Valve (SCHM.-V)</td>
<td>1.750&quot;</td>
<td>.048&quot;</td>
<td>.480&quot;</td>
</tr>
<tr>
<td>14. Modulating Valve (MOD-V)</td>
<td>1.493&quot;</td>
<td>.031&quot;</td>
<td>.365&quot;</td>
</tr>
<tr>
<td>15. &quot;B&quot; Clutch Reg Valve (HV-B)</td>
<td>1.414&quot;</td>
<td>.030&quot;</td>
<td>.365&quot;</td>
</tr>
<tr>
<td>16. EDS 2, Accumulator Valve (D-2)</td>
<td>1.530&quot;</td>
<td>.042&quot;</td>
<td>.322&quot;</td>
</tr>
<tr>
<td>17. &quot;D&quot; Clutch Reg Valve (HV-D)</td>
<td>1.543&quot;</td>
<td>.042&quot;</td>
<td>.348&quot;</td>
</tr>
<tr>
<td>18. EDS 4, Accumulator Valve (D-4)</td>
<td>1.530&quot;</td>
<td>.042&quot;</td>
<td>.322&quot;</td>
</tr>
<tr>
<td>19. EDS 5, Accumulator Valve (D-5)</td>
<td>1.530&quot;</td>
<td>.042&quot;</td>
<td>.322&quot;</td>
</tr>
<tr>
<td>20. EDS 3, Accumulator Valve (D-3)</td>
<td>1.530&quot;</td>
<td>.042&quot;</td>
<td>.322&quot;</td>
</tr>
</tbody>
</table>

### Lower "Rear" Valve Body

<table>
<thead>
<tr>
<th>Valve Name</th>
<th>Free Length</th>
<th>Wire Diameter</th>
<th>Outside Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. &quot;A&quot; Clutch Accumulator (D-D)</td>
<td>2.929&quot;</td>
<td>.066&quot;</td>
<td>.608&quot;</td>
</tr>
<tr>
<td>2. Shift Valve Number 1 (SV-1)</td>
<td>1.800&quot;</td>
<td>.031&quot;</td>
<td>.360&quot;</td>
</tr>
<tr>
<td>3. Shift Valve Number 2 (SV-2)</td>
<td>1.800&quot;</td>
<td>.031&quot;</td>
<td>.360&quot;</td>
</tr>
<tr>
<td>4. Shift Valve Number 3 (SV-3)</td>
<td>1.640&quot;</td>
<td>.031&quot;</td>
<td>.366&quot;</td>
</tr>
<tr>
<td>5. Switch Valve &quot;D&quot; Clutch (ABSCH.V-D)</td>
<td>1.733&quot;</td>
<td>.023&quot;</td>
<td>.350&quot;</td>
</tr>
<tr>
<td>6. Clutch Valve &quot;D&quot; Line-Up (KV-D)</td>
<td>1.763&quot;</td>
<td>.031&quot;</td>
<td>.360&quot;</td>
</tr>
<tr>
<td>7. Reverse Gear Valve (RG-V)</td>
<td>1.836&quot;</td>
<td>.038&quot;</td>
<td>.435&quot;</td>
</tr>
<tr>
<td>8. &quot;C&quot; Clutch Accumulator (D-C)</td>
<td>2.929&quot;</td>
<td>.066&quot;</td>
<td>.608&quot;</td>
</tr>
</tbody>
</table>

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

Round Screen

Figure 138
Replace the original ball with a plastic .250" (6.35mm) ball.
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 occuring 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 severly 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.
Replace the original ball with a plastic .250" (6.35mm) ball.

Original .236" Diameter

.039" Flat Orifice

.048" Flat Orifice

.048" Flat Orifice

.067" Flat Orifice

PLASTIC VALVE AND SPRING

Figure 140
Only One .250" (6.35mm) ball is located here. Do Not install a ball in the pocket marked X.
"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

Figure 142

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"B" Clutch Hub Must Be installed Before Last Steel Plate And Snap Ring As Shown