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**: Automatic
- **5**: Speed Transmission
- **S**: Overdrive Top Gear
- **440**: Maximum Torque Capacity (Nm)
- **Z**: Manufacturer

Jaguar Unit Shown

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

Figure 97
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.
### APPLICATION CHART

<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; BRAK</th>
<th>&quot;E&quot; BRAK</th>
<th>&quot;F&quot; BRAK</th>
<th>LOW 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>ON</td>
<td></td>
</tr>
<tr>
<td>REV</td>
<td></td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ON</td>
<td>4.10:1</td>
</tr>
<tr>
<td>NEUT</td>
<td></td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ON</td>
<td></td>
</tr>
<tr>
<td>D-1ST</td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>HOLD</td>
<td>3.57:1</td>
</tr>
<tr>
<td>D-2ND</td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ON</td>
<td>2.20:1</td>
</tr>
<tr>
<td>D-3RD</td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ON</td>
<td>1.51:1</td>
</tr>
<tr>
<td>D-4TH</td>
<td>ON</td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ON</td>
<td>1.00:1</td>
</tr>
<tr>
<td>D-5TH</td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ON</td>
<td>0.80:1</td>
</tr>
<tr>
<td>M-1</td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ON</td>
<td>HOLD 3.57:1</td>
</tr>
</tbody>
</table>

ZF-5HP-24 INTERNAL COMPONENT APPLICATION CHART

"A" CLUTCH
"B" CLUTCH
"C" CLUTCH
"D" BRAKE
"E" BRAKE
"F" BRAKE
LOW SPRAG

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AUTOMATIC TRANSMISSION SERVICE GROUP

TECHNICIAN'S DIAGNOSTIC GUIDE
BMW, AUDI, PORSCHE

INDEX
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:

| Selector Lever Position | P  R  N  D  4  3  2 |
| Actual Gear Obtained     | P  R  N  5  5  5  5 |
**MV 1, 2 AND 3**

**Solenoid "Off"**

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

**Solenoid "On"**

- Exhaust blocked
- MV 1, 2, 3
- From Dr. Red. V-1 open
- To SV 1, 2 or 3

**SUMMARY:**

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

---

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

**Solenoid "Off"**

- Exhaust
- EDS 2-5
- From Dr. Red. V-2 and clutch regulating valves

**Solenoid "On"**

- Exhaust blocked
- "Black"
- "O" Ring
- EDS 2-5
- From Dr. Red. V-2 to clutch regulating valves

**SUMMARY:**

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

---

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Figure 100

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**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 MOD-V.
NOTE: Some internal wire colors may vary.

Figure 102

AUTOMATIC TRANSMISSION SERVICE GROUP
**SOLENOID CHART LEGEND**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ON</strong></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><strong>EDS 1</strong></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><strong>EDS 2, EDS 3, EDS 4 and EDS 5</strong></td>
<td>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><strong>Soleno 1 &quot;OFF&quot; (hydraulic pressure low), then Soleno 1 &quot;ON&quot; (hydraulic pressure high).</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Soleno 2 &quot;ON&quot; briefly (hydraulic pressure high), then Soleno 2 &quot;OFF&quot; (hydraulic pressure low). The pressure acts briefly on regulator valves to cushion clutch application.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>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.</strong></td>
<td></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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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).

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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

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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.

Copyright © 2003 ATSG
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

Check Valve And Spring

No Checkballs

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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.
ZF 5HP-24 CHANNEL PLATE "UPPER SIDE"
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)
Figure 115

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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
PUMP AND PUMP PLATE

PUMP BODY

PUMP PLATE

OUTER PUMP GEAR LUBRICATION

PUMP PLATE INSTALLED ON PUMP BODY

Figure 118

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### UPPER VALVE BODY

<table>
<thead>
<tr>
<th>Spring</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>1.400&quot;</td>
<td>.031&quot;</td>
<td>.365&quot;</td>
</tr>
<tr>
<td>22. Clutch Valve &quot;E&quot; (KV-E)</td>
<td>1.551&quot;</td>
<td>.031&quot;</td>
<td>.365&quot;</td>
</tr>
<tr>
<td>23. Pressure Reducing Valve (DR-V1)</td>
<td>1.685&quot;</td>
<td>.042&quot;</td>
<td>.370&quot;</td>
</tr>
<tr>
<td>24. Pressure Reducing Valve (DR-V2)</td>
<td>1.942&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>.420&quot;</td>
</tr>
<tr>
<td>26. Holding Valve &quot;E&quot; (KV-E)</td>
<td>1.685&quot;</td>
<td>.042&quot;</td>
<td>.372&quot;</td>
</tr>
</tbody>
</table>

### LOWER "FRONT" VALVE BODY

<table>
<thead>
<tr>
<th>Spring</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>1.952&quot;</td>
<td>.042&quot;</td>
<td>.370&quot;</td>
</tr>
<tr>
<td>11. TCC Release Control Valve (WD-V)</td>
<td>2.052&quot;</td>
<td>.034&quot;</td>
<td>.438&quot;</td>
</tr>
<tr>
<td>12. Pressure Regulator Valve (HD-V)</td>
<td>3.780&quot;</td>
<td>.087&quot;</td>
<td>.686&quot;</td>
</tr>
<tr>
<td>13. Lubrication Valve (SCHM.-V)</td>
<td>1.710&quot;</td>
<td>.048&quot;</td>
<td>.485&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. Holding Valve, &quot;B&quot; Clutch (HV-B)</td>
<td>1.414&quot;</td>
<td>.031&quot;</td>
<td>.365&quot;</td>
</tr>
<tr>
<td>16. EDS 2, Accumulator Valve (D-2)</td>
<td>1.565&quot;</td>
<td>.042&quot;</td>
<td>.322&quot;</td>
</tr>
<tr>
<td>17. Holding Valve, &quot;D&quot; Clutch (HV-B)</td>
<td>1.681&quot;</td>
<td>.042&quot;</td>
<td>.375&quot;</td>
</tr>
</tbody>
</table>

### LOWER REAR VALVE BODY

<table>
<thead>
<tr>
<th>Spring</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-A)</td>
<td>3.067&quot;</td>
<td>.066&quot;</td>
<td>.595&quot;</td>
</tr>
<tr>
<td>2. Shift Valve Number 1 (SV-1)</td>
<td>1.755&quot;</td>
<td>.031&quot;</td>
<td>.367&quot;</td>
</tr>
<tr>
<td>3. Shift Valve Number 2 (SV-2)</td>
<td>1.770&quot;</td>
<td>.031&quot;</td>
<td>.367&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>1.396&quot;</td>
<td>.039&quot;</td>
<td>.300&quot;</td>
</tr>
<tr>
<td>6. Clutch Valve &quot;D&quot; Line-Up (KV-D)</td>
<td>1.800&quot;</td>
<td>.031&quot;</td>
<td>.360&quot;</td>
</tr>
</tbody>
</table>

### INDEX

- These spring locations shown on Page 121.
- These spring locations shown on Page 122.
- These spring locations shown on Page 123.