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Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



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DESCRIPTION AND OPERATION

Manual Transmission and Clutch

This section contains symptom based diagnosis and testing procedures. The symptom chart, and the inspection and verification procedures aid in the accurate diagnosis of transmission and clutch system related concerns.

DIAGNOSIS AND TESTING

Inspection and Verification

To guarantee an accurate diagnosis:

- get an accurate description of the condition.
- identify when the condition occurs; when hot or cold, during shifting, driving at a particular speed or in a particular gear.
- have the customer demonstrate the concern, if possible.
- refer to the Symptom Chart in this section for additional source information and suggested test procedures
- carry out the following Noise Evaluation procedures, as necessary.

Noise Evaluation

Note: Carry out this evaluation with the transmission cold and at normal operating temperature to listen for any change in noise as the transmission warms up.

1. Start the engine.
2. Evaluate the noise in NEUTRAL with the vehicle is parked.
3. Listen for any change in noise while depressing and releasing the clutch pedal.
4. Listen for any change in noise while changing the engine rpm.
5. Drive the vehicle and shift through all of the gear ranges, including reverse. Listen for any changes in noise in a particular gear.
6. Drive the vehicle in the gear in which the noise is most noticeable. Depress the clutch pedal and leave the gear engaged. Listen for any change in noise. The vibration of the engine may be amplifying the noise.
7. Drive the vehicle under the same conditions identified in the previous step. Depress the clutch pedal and shift the transmission into neutral. Release the clutch pedal and allow the vehicle to coast. Evaluate the noise as the rear axle assembly turns the mainshaft.

Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



ZF Industries

DIAGNOSIS AND TESTING (Continued)

Noise Evaluation for 4x4 Applications

- With the vehicle at a complete stop and the transfer case in NEUTRAL, shift the transmission through all of the gear ranges and evaluate the noise at different engine rpm. Check for any noise in NEUTRAL at different engine rpm.
- Check for any noise change when shifting the transfer case between 2H, 4H, 4L, and NEUTRAL.
- Refer to **SECTION 308-07A** for 4x4 system concerns.

Clutch Slippage Inspection and Verification

1. Check the wheels.
2. Apply the parking brake.
3. Depress and release the clutch pedal slowly to check if the pedal is binding.
 - If the clutch pedal is not binding, proceed to the next step in this procedure.
 - If the clutch pedal is binding, inspect, and install a new clutch pedal and support bracket assembly as necessary. Refer to **SECTION 308-02**. Test the system for normal operation. Proceed to the next step in this procedure, if necessary.
4. Depress the clutch pedal.
5. Start the engine.
6. Shift transmission to fourth gear.
7. Increase the engine rpm to 2000 and slowly release the clutch pedal. If the engine stalls within five seconds, the clutch is not slipping.
 - If the clutch is slipping, remove the clutch disc (7550) and pressure plate (7563). Refer to **SECTION 308-01**. Inspect the clutch disc and pressure plate for wear and damage. Refer to **Clutch Pressure Plate Check** and **Clutch Disc Check** in this section. Inspect the flywheel (6375) for glazing and damage. Check the clutch release hub and bearing for binding, and inspect the guide tube. Inspect the input shaft for wear and damage. Repair all components as necessary. Test the system for normal operation.

Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



ZF Industries

DIAGNOSIS AND TESTING (Continued)

Clutch Chatter or Shudder Inspection and Verification

1. Raise and support the vehicle. Refer to **SECTION 100-02**.
2. Inspect the engine and transmission mounts for looseness and damage.
 - If the mounts are OK, proceed to the next step in this procedure.
 - If the mounts are loose or damaged, tighten, or install new mounts as necessary. Test the system for normal operation. Proceed to the next step in this procedure, if necessary.
3. Check for loose bolts that retain the clutch pressure plate to the flywheel.
 - If the bolts are tightened to specification, proceed to the next step in this procedure.
 - If the bolts are loose, tighten the bolts to specification. Refer to **SECTION 308-01**. Test the system for normal operation. Proceed to the next step in this procedure, if necessary.
4. Remove the clutch disc and pressure plate. Refer to **SECTION 308-01**. Inspect the clutch disc and pressure plate for wear and damage, and check the clutch disc runout. Refer to **Clutch Pressure Plate Check** and to **Clutch Disc Check** in this section. Inspect the flywheel for glazing and damage. Check the flywheel runout. Refer to **Flywheel Runout Check** in this section. Inspect the input shaft for wear, damage and eccentricity. Repair all components as necessary. Test the system for normal operation.

Clutch Drag Inspection and Verification

1. Verify that the clutch hydraulic fluid reservoir is filled to the correct level.
 - If the fluid level is correct, proceed to the next step in this procedure.
 - If the fluid level is low, add fluid as necessary. Inspect the clutch hydraulic system for leaks, and repair as necessary. Refer to **SECTION 308-02**. Test the system for normal operation. Proceed to the next step in this procedure, if necessary.
2. Depress and release the clutch pedal to check for a spongy pedal.
 - If the pedal feels OK, proceed to the next step in this procedure.
 - If the pedal feels spongy, bleed the clutch hydraulic system. Refer to **Clutch System Bleeding - In-Vehicle** in this section. Test the system for normal operation. Proceed to the next step in this procedure, if necessary.
3. Remove the clutch disc and pressure plate. Refer to **SECTION 308-01**. Inspect the clutch disc and pressure plate for wear and damage, and check the clutch disc runout. Refer to **Clutch Pressure Plate Check** and to **Clutch Disc Check** in this section. Repair all components as necessary. Test the system for normal operation.

Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



ZF Industries

DIAGNOSIS AND TESTING (Continued)

Hard Shifting Inspection and Verification

1. Verify that the clutch hydraulic fluid reservoir is filled to the correct level.
 - If the fluid level is correct, proceed to the next step in this procedure.
 - If the fluid level is low, add fluid as necessary. Check the clutch hydraulic system for leaks, and repair as necessary. Refer to **SECTION 308-02**. Test the system for normal operation. Proceed to the next step in this procedure, if necessary.
2. Depress and release the clutch pedal to check for a spongy pedal.
 - If the pedal feels OK, proceed to the next step in this procedure.
 - If the pedal feels spongy, bleed the clutch hydraulic system. Refer to **Clutch System Bleeding - In-Vehicle** in this section. Test the system for normal operation. Proceed to the next step in this procedure, if necessary.
3. Remove the clutch disc and pressure plate. Refer to **SECTION 308-01**. Inspect the clutch disc and pressure plate for wear and damage. Refer to **Clutch Pressure Plate Check** and to **Clutch Disc Check** in this section. Check the clutch release hub and bearing for binding, and inspect the guide tube. Inspect the input shaft for wear and damage. If all of the components are OK, proceed to the next step in this procedure. Otherwise, repair all components as necessary. Test the system for normal operation.
4. Inspect the transmission housing, shafts, forks, and synchronizer assemblies. Refer to **SECTION 308-03A** (Model S5-47ZF Transmission) or **SECTION 308-03B** (ZF 6 Speed Transmission). Repair all components as necessary. Test the system for normal operation.

Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



ZF Industries

DIAGNOSIS AND TESTING (Continued)

Symptom Chart - Clutch and Transmission Operation

Condition	Possible Source	Action
<ul style="list-style-type: none"> Clutch Chatter or Shudder 	<ul style="list-style-type: none"> Engine/transmission mount loose/damaged. Bolts retaining clutch pressure plate to flywheel loose. Clutch pressure plate worn/damaged. Clutch disc facing oil coated. Clutch disc facing hardened/damaged. Clutch disc runout excessive. Flywheel surface glazed/damaged. Flywheel runout excessive. Transmission input shaft eccentric/not perpendicular. 	<ul style="list-style-type: none"> CARRY OUT the Clutch Chatter or Shudder Inspection and Verification procedure in this section.
<ul style="list-style-type: none"> Clutch Drag 	<ul style="list-style-type: none"> Insufficient clutch hydraulic system fluid. Clutch hydraulic system fluid leakage. Air in clutch hydraulic system. Clutch pressure plate worn/damaged. Clutch disc damaged. Clutch disc splines rusted/worn. Clutch disc runout excessive. 	<ul style="list-style-type: none"> CARRY OUT the Clutch Drag Inspection and Verification procedure in this section.
<ul style="list-style-type: none"> Clutch Pedal Pulsation 	<ul style="list-style-type: none"> Clutch pressure plate worn/damaged. Clutch disc damaged. Clutch disc runout excessive. Flywheel runout excessive. 	<ul style="list-style-type: none"> REMOVE the clutch disc and pressure plate. REFER to SECTION 308-01. INSPECT the clutch disc and pressure plate for wear and damage, and CHECK the clutch disc runout. REFER to Clutch Pressure Plate Check and to Clutch Disc Check in this section. CHECK the flywheel runout. REFER to Flywheel Runout Check in this section. REPAIR all components as necessary. TEST the system for normal operation.

DIAGNOSIS AND TESTING (Continued)

Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



ZF Industries

Symptom Chart - Clutch and Transmission Operation

Condition	Possible Source	Action
<ul style="list-style-type: none"> Clutch Related Vibrations 	<ul style="list-style-type: none"> Engine component grounding against frame. Accessory drive belt loose/damaged. Clutch release bearing worn/damaged. Bolts retaining clutch pressure plate to flywheel loose. Bolts retaining flywheel to engine loose. Flywheel runout excessive. Clutch pressure plate imbalance. 	<ul style="list-style-type: none"> CARRY OUT the Clutch Chatter or Shudder Inspection and Verification procedure in this section.
<ul style="list-style-type: none"> Hard Shifting 	<ul style="list-style-type: none"> Insufficient clutch hydraulic system fluid. Clutch hydraulic system fluid leakage. Air in clutch hydraulic system. Clutch not releasing. Transmission concern. 	<ul style="list-style-type: none"> CARRY OUT the Hard Shifting Inspection and Verification procedure in this section.
<ul style="list-style-type: none"> Excessive Noise 	<ul style="list-style-type: none"> Clutch disc damper damaged. Transmission input shaft pilot bearing (7120) worn/damaged. Crankshaft end play excessive. Release bearing worn/damaged. 	<ul style="list-style-type: none"> REMOVE the clutch disc and pressure plate. REFER to SECTION 308-01. INSPECT the clutch disc for damage. REFER to Clutch Disc Check in this section. INSPECT the transmission input shaft pilot bearing for wear and damage. REFER to Pilot Bearing Check in this section. CHECK the clutch release hub and bearing, and guide tube for wear and damage. REPAIR all components as necessary. TEST the system for normal operation.

Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



ZF Industries

DIAGNOSIS AND TESTING (Continued)

Symptom Chart - Clutch and Transmission Operation

Condition	Possible Source	Action
<ul style="list-style-type: none"> Note: While verifying the condition, determine whether the noise is gear roll-over noise, release bearing rub or some other transmission-related noise. Gear roll-over noise, inherent in manual transmission, is caused by the constant mesh gears turning at engine idle speed while the clutch is engaged and the transmission is in NEUTRAL. Release bearing rub is some-times mistaken for mainshaft bearing noise. Gear roll-over noise will disappear when the clutch is disengaged or when the transmission is engaged in gear. Release bearing rub will disappear when the clutch is engaged. In the event that a bearing is damaged, the noise is more pronounced while engaged in gear under load or coast than in NEUTRAL. Noisy in Forward Gears 	<ul style="list-style-type: none"> Lubricant level low/incorrect type. Components grounding out on transmission. Bolts retaining transmission to engine loose. Bearings/gears worn/damaged. 	<ul style="list-style-type: none"> ADD or REFILL with the specified lubricant. REFER to SECTION 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission). CHECK for screws, bolts, etc., of cab or other components grounding out. CORRECT as necessary. VERIFY that the bolts are tightened to specification. REFER to SECTION 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission). INSPECT the bearings, the gears, and the gear teeth for wear and damage. REPAIR as necessary. REFER to SECTION 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission).

Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



ZF Industries

DIAGNOSIS AND TESTING (Continued)

Symptom Chart - Clutch and Transmission Operation

Condition	Possible Source	Action
<ul style="list-style-type: none"> Gears Clash When Shifting From One Forward Gear to Another 	<ul style="list-style-type: none"> Transmission input shaft pilot bearing worn/damaged. Gear teeth/synchronizer damaged. Engine idle speed too high. 	<ul style="list-style-type: none"> INSPECT the transmission input shaft pilot bearing for wear and damage. REFER to Pilot Bearing Check in this section. REPAIR as necessary. INSPECT, and REPAIR as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission). REFER to the Powertrain Control/Emissions Diagnosis Manual¹.
<ul style="list-style-type: none"> Transmission Will Not Shift Into One Gear - All Others OK 	<ul style="list-style-type: none"> Reversing switch ball frozen in extended position. Internal components. 	<ul style="list-style-type: none"> INSPECT and REPAIR as necessary. For the gear in question, INSPECT the shift rail and fork, the synchronizer, and the gear clutch teeth for restricted travel. REPAIR as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission).
<ul style="list-style-type: none"> Transmission is Locked In One Gear and Will Not Shift Out of That Gear 	<ul style="list-style-type: none"> Internal components 	<ul style="list-style-type: none"> INSPECT the gears, the shift rails, the forks, and the synchronizer for wear and damage. REPAIR as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission).

¹ Can be purchased as a separate item.

Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



ZF Industries

DIAGNOSIS AND TESTING (Continued)

Symptom Chart - Clutch and Transmission Operation

Condition	Possible Source	Action
<ul style="list-style-type: none"> Transmission Jumps Out of Gear 	<ul style="list-style-type: none"> Gearshift lever boot installed incorrectly. Bolts retaining transmission to engine loose. Transmission input shaft pilot bearing. Axial clearance incorrect. Internal components damaged. Gear teeth worn/damaged. 	<ul style="list-style-type: none"> CHECK gearshift lever boot installation. REFER to Section 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission). TIGHTEN the bolts to specification. REFER to Section 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission). INSTALL a new transmission input shaft pilot bearing. REFER to SECTION 308-01. Check axial clearance. INSPECT the synchronizer sleeves for free movement on their hubs. INSPECT the synchronizer blocking rings for widened index slots, rounded teeth and smooth internal surface. CHECK the countershaft cluster gear for excessive end play. INSPECT the shift forks for wear. CHECK for loose shift forks on the shift rails. INSPECT the synchronizer sliding sleeve and the gear clutch teeth for wear and damage. REPAIR as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission). INSPECT and REPAIR as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission).

Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



ZF Industries

DIAGNOSIS AND TESTING (Continued)

Symptom Chart - Clutch and Transmission Operation

Condition	Possible Source	Action
<ul style="list-style-type: none"> Fluid Leaks 	<ul style="list-style-type: none"> Engine, power steering, transmission, clutch. Input shaft bearing retainer seal. Shift rail detent plug. Top cover gasket. Sand holes/cracks in case. 	<ul style="list-style-type: none"> REMOVE all traces of lubricant on the exposed transmission surfaces. VERIFY that the transmission vent is clear of foreign material. OPERATE the transmission. INSPECT for new leakage. REFER to the appropriate section for repair procedures. REFER to Section 211-02, Section 303-01A, Section 303-01B, Section 303-01C, Section 308-02, Section 308-03A, or Section 308-03B. INSPECT and REPAIR as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission). INSPECT and REPAIR as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission). INSPECT and REPAIR as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission). INSPECT and INSTALL a new case as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission).

Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



ZF Industries

DIAGNOSIS AND TESTING (Continued)

Symptom Chart - Clutch and Transmission Operation

Condition	Possible Source	Action
<ul style="list-style-type: none"> Fluid Leaks (Continued) 	<ul style="list-style-type: none"> Fill and drain plugs. 	<ul style="list-style-type: none"> INSPECT the plug, the O-ring, and the threads in the case. REPAIR as necessary. TIGHTEN the plug to specification. REFER to Section 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission).
<ul style="list-style-type: none"> Noise Occurs During Transfer Case Operations 	<ul style="list-style-type: none"> 4x4 system. 	<ul style="list-style-type: none"> REFER to Section 308-07A for diagnosis and testing procedures.
<ul style="list-style-type: none"> Transfer Case Jumps Out of Gear 	<ul style="list-style-type: none"> 4x4 system. 	<ul style="list-style-type: none"> REFER to Section 308-07A for diagnosis and testing procedures.

Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



ZF Industries

DIAGNOSIS AND TESTING (Continued)

Symptom Chart - Transmission Component Wear and Damage

Condition	Possible Source	Action
<ul style="list-style-type: none"> Case Breakage 	<ul style="list-style-type: none"> Shock loads/alternating loads. Jerky release of clutch. Bolt/size/length incorrect. Bolt threaded into hole incorrectly. Bolt not tightened to specification. 	<ul style="list-style-type: none"> INSTALL a new case. REPAIR the transmission as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission). DISCUSS vehicle operation with the customer. INSTALL a new case. REPAIR the transmission as necessary. REVIEW the transmission installation procedure. REFER to Section 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission).
<ul style="list-style-type: none"> Shaft Damaged by Brinelling 	<ul style="list-style-type: none"> Vibration. Driving at low road speed in a high gear. Engine related factors (such as crankshaft vibration damper damaged). Driveshaft imbalance. 	<ul style="list-style-type: none"> CORRECT the condition causing the vibration. REFER to Section 100-04 for NVH diagnosis. DISCUSS vehicle operation with the customer. CORRECT as necessary. Refer to the appropriate section in Group 303 for the procedure. CORRECT the driveshaft imbalance. REFER to Section 205-00.
<ul style="list-style-type: none"> Shaft Damaged by Fretting 	<ul style="list-style-type: none"> Lubricant thermally aged. Inadequate lubrication. Lubricant not meeting manufacturer's specification. Towing vehicle with driveshaft connected. 	<ul style="list-style-type: none"> DISCUSS transmission maintenance with the customer. DISCUSS vehicle towing procedure with the customer.
<ul style="list-style-type: none"> Gear Teeth Damaged by Scratches 	<ul style="list-style-type: none"> Dust and abrasive particles in lubricant. 	<ul style="list-style-type: none"> DISCUSS transmission maintenance with the customer.

Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



ZF Industries

DIAGNOSIS AND TESTING (Continued)

Symptom Chart - Transmission Component Wear and Damage

Condition	Possible Source	Action
<ul style="list-style-type: none"> • Gear Teeth Damaged by Abrasive Wear 	<ul style="list-style-type: none"> • Lubricant contamination resulting from wear or surface fatigue in other areas of transmission. • Foreign material entering transmission. 	<ul style="list-style-type: none"> • DISCUSS transmission maintenance with the customer.
<ul style="list-style-type: none"> • Gear Teeth Damaged by Scoring 	<ul style="list-style-type: none"> • Lubricant not meeting manufacturer's specification. • Temporary lack of lubricant. 	<ul style="list-style-type: none"> • DISCUSS transmission maintenance with the customer.
<ul style="list-style-type: none"> • Brinelling in Gear Teeth 	<ul style="list-style-type: none"> • Combination of inadequate lubrication, high flanks loads and low peripheral speeds. 	<ul style="list-style-type: none"> • DISCUSS transmission maintenance with the customer.
<ul style="list-style-type: none"> • Slight Pittings in Gear Teeth 	<ul style="list-style-type: none"> • High local contact pressures on gears not completely run-in. 	<ul style="list-style-type: none"> • DISCUSS vehicle operation with the customer. Continued run-in wear and a change in operating conditions may stop this type of pitting.
<ul style="list-style-type: none"> • Gear Teeth with Heavy Pitting Damage 	<ul style="list-style-type: none"> • Lubricant viscosity not meeting manufacturer's specification. • Lubricant temperature run too high. • Local sliding and rolling stresses exceed material specification. 	<ul style="list-style-type: none"> • DISCUSS transmission maintenance and vehicle operation with the customer.
<ul style="list-style-type: none"> • Gear Teeth Damaged by Spalling 	<ul style="list-style-type: none"> • Lubricant not meeting manufacturer's specification. • Lubricant temperature run too high. 	<ul style="list-style-type: none"> • DISCUSS transmission maintenance and vehicle operation with the customer.
<ul style="list-style-type: none"> • Overheating and Thermal Gear Deformation 	<ul style="list-style-type: none"> • Temporary or complete lack of lubricant. 	<ul style="list-style-type: none"> • DISCUSS transmission maintenance with the customer.
<ul style="list-style-type: none"> • Gear Change Damage 	<ul style="list-style-type: none"> • Clutching and shifting transmission incorrectly. 	<ul style="list-style-type: none"> • DISCUSS vehicle operation with the customer.
<ul style="list-style-type: none"> • Gear Tooth Corrosion 	<ul style="list-style-type: none"> • Water in lubricant. • Condensation forming due to unfavorable operating conditions. • Lubricant aging. 	<ul style="list-style-type: none"> • DISCUSS transmission maintenance with the customer.

Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



ZF Industries

DIAGNOSIS AND TESTING (Continued)

Symptom Chart - Transmission Component Wear and Damage

Condition	Possible Source	Action
<ul style="list-style-type: none"> • Idler Gear Damaged by Brinelling 	<ul style="list-style-type: none"> • Transmission rebuilt with bearing not meeting manufacturer's specification. 	<ul style="list-style-type: none"> • INSTALL a new anti-friction bearing meeting manufacture specification
<ul style="list-style-type: none"> • Synchronizer Ring Molybdenum Corrosion 	<ul style="list-style-type: none"> • Water in lubricant. 	<ul style="list-style-type: none"> • DISCUSS transmission maintenance with the customer.
<ul style="list-style-type: none"> • Synchronizer Ring Molybdenum Coat Destruction 	<ul style="list-style-type: none"> • Clutching and shifting transmission incorrectly. • Driving at low road speed in a high gear. • Engine related factors (such as crankshaft vibration damper damaged). • Driveshaft imbalance. 	<ul style="list-style-type: none"> • DISCUSS vehicle operation with the customer. • CORRECT as necessary. Refer to the appropriate section in Group 303 for the procedure. • CORRECT the driveshaft imbalance. REFER to Section 205-00.
<ul style="list-style-type: none"> • Synchronizer Ring Broken 	<ul style="list-style-type: none"> • Insufficient clutch hydraulic system fluid. • Clutch hydraulic system fluid leakage. • Air in clutch hydraulic system. • Clutch pressure plate worn/damaged. • Clutch disc damaged. • Clutch disc splines rusted/worn. • Clutch disc runout excessive. • Clutching and shifting transmission incorrectly. • Driving at low road speed in a high gear. 	<ul style="list-style-type: none"> • INSPECT the clutch disc and pressure plate for wear and damage, and CHECK the clutch disc runout. REFER to Clutch Pressure Plate Check and to Clutch Disc Check in this section. VERIFY that the clutch hydraulic fluid reservoir is filled to the correct level. ADD fluid as necessary. INSPECT the clutch hydraulic system for leaks, and REPAIR as necessary. REFER to Section 308-02. BLEED the clutch hydraulic system as necessary. REFER to Clutch System Bleeding - In-Vehicle in this section. TEST the system for normal operation. • DISCUSS vehicle operation with the customer.

Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



ZF Industries

DIAGNOSIS AND TESTING (Continued)

Symptom Chart - Transmission Component Wear and Damage

Condition	Possible Source	Action
<ul style="list-style-type: none"> Synchronizer Ring Broken (Continued) 	<ul style="list-style-type: none"> Engine related factors (such as crankshaft vibration damper damaged). Driveshaft imbalance. 	<ul style="list-style-type: none"> CORRECT as necessary. Refer to the appropriate section in Group 303 for the procedure. CORRECT the driveshaft imbalance. REFER to Section 205-00.
<ul style="list-style-type: none"> Synchronizer Friction Cone Slightly Worn 	<ul style="list-style-type: none"> Normal run-in wear. 	<ul style="list-style-type: none"> INSPECT the engaging teeth for wear if a severe, permanent grating condition exists.
<ul style="list-style-type: none"> Synchronizer Friction Cone Worn with Material Displaced 	<ul style="list-style-type: none"> Insufficient clutch hydraulic system fluid. Clutch hydraulic system fluid leakage. Air in clutch hydraulic system. Clutch pressure plate worn/damaged. Clutch disc damaged. Clutch disc splines rusted/worn. Clutch disc runout excessive. Clutching and shifting transmission incorrectly. 	<ul style="list-style-type: none"> INSPECT the clutch disc and pressure plate for wear and damage, and CHECK the clutch disc runout. REFER to Clutch Pressure Plate Check and to Clutch Disc Check in this section. VERIFY that the clutch hydraulic fluid reservoir is filled to the correct level. ADD fluid as necessary. INSPECT the clutch hydraulic system for leaks, and REPAIR as necessary. REFER to Section 308-02. BLEED the clutch hydraulic system as necessary. REFER to Clutch System Bleeding - In-Vehicle in this section. TEST the system for normal operation. DISCUSS vehicle operation with the customer.
<ul style="list-style-type: none"> Synchronizer Gear Shift Teeth Worn 	<ul style="list-style-type: none"> Clutching and shifting transmission incorrectly. 	<ul style="list-style-type: none"> DISCUSS vehicle operation with the customer.

Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



ZF Industries

DIAGNOSIS AND TESTING (Continued)

Symptom Chart - Transmission Component Wear and Damage

Condition	Possible Source	Action
<ul style="list-style-type: none"> Synchronizer Body External Tooth Splines Worn 	<ul style="list-style-type: none"> Driving at low road speed in a high gear. Engine related factors (such as crankshaft vibration damper damaged). Driveshaft imbalance. 	<ul style="list-style-type: none"> DISCUSS vehicle operation with the customer. CORRECT as necessary. Refer to the appropriate section in Group 303 for the procedure. CORRECT the driveshaft imbalance. REFER to Section 205-00.
<ul style="list-style-type: none"> Synchronizer Body Stops Broken 	<ul style="list-style-type: none"> Insufficient clutch hydraulic system fluid. Clutch hydraulic system fluid leakage. Air in clutch hydraulic system. Clutch pressure plate worn/damaged. Clutch disc damaged. Clutch disc splines rusted/worn. Clutch disc runout excessive. Clutching and shifting transmission incorrectly. 	<ul style="list-style-type: none"> INSPECT the clutch disc and pressure plate for wear and damage, and CHECK the clutch disc runout. REFER to Clutch Pressure Plate Check and to Clutch Disc Check in this section. VERIFY that the clutch hydraulic fluid reservoir is filled to the correct level. ADD fluid as necessary. INSPECT the clutch hydraulic system for leaks, and REPAIR as necessary. REFER to Section 308-02. BLEED the clutch hydraulic system as necessary. REFER to Clutch System Bleeding - In-Vehicle in this section. TEST the system for normal operation. DISCUSS vehicle operation with the customer.
<ul style="list-style-type: none"> Synchronizer Sliding Sleeve Stop Deformed 	<ul style="list-style-type: none"> Shift unit set incorrectly. 	<ul style="list-style-type: none"> INSPECT for interference between the shift unit and the vehicle. REPAIR as necessary.
<ul style="list-style-type: none"> Synchronizer Gear Shift Teeth Worn 	<ul style="list-style-type: none"> Clutching and shifting transmission incorrectly. 	<ul style="list-style-type: none"> DISCUSS vehicle operation with the customer.

Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



ZF Industries

DIAGNOSIS AND TESTING (Continued)

Symptom Chart - Transmission Component Wear and Damage

Condition	Possible Source	Action
<ul style="list-style-type: none"> Synchronizer Inner Ring Heat Discolored with Slight Material Displacement 	<ul style="list-style-type: none"> Normal synchronizer operation with high shift effort. 	<ul style="list-style-type: none"> INSPECT the clutch disc and pressure plate for wear and damage. REFER to Clutch Pressure Plate Check and to Clutch Disc Check in this section. CHECK the clutch release hub and bearing for binding, and INSPECT the guide tube. INSPECT the input shaft for wear and damage. VERIFY that the clutch hydraulic fluid reservoir is filled to the correct level. ADD fluid as necessary. INSPECT the clutch hydraulic system for leaks, and REPAIR as necessary. REFER to Section 308-02. BLEED the clutch hydraulic system as necessary. REFER to Clutch System Bleeding - In-Vehicle in this section. TEST the system for normal operation.
<ul style="list-style-type: none"> Synchronizer Inner Ring Material Displacement 	<ul style="list-style-type: none"> Insufficient clutch hydraulic system fluid. Clutch hydraulic system fluid leakage. Air in clutch hydraulic system. Clutch pressure plate worn/damaged. Clutch disc damaged. Clutch disc splines rusted/worn. Clutch disc runout excessive. Clutching and shifting transmission incorrectly. 	<ul style="list-style-type: none"> INSPECT the clutch disc and pressure plate for wear and damage, and CHECK the clutch disc runout. REFER to Clutch Pressure Plate Check and to Clutch Disc Check in this section. VERIFY that the clutch hydraulic fluid reservoir is filled to the correct level. ADD fluid as necessary. INSPECT the clutch hydraulic system for leaks, and REPAIR as necessary. REFER to Section 308-02. BLEED the clutch hydraulic system as necessary. REFER to Clutch System Bleeding - In-Vehicle in this section. TEST the system for normal operation. DISCUSS vehicle operation with the customer.

Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



ZF Industries

DIAGNOSIS AND TESTING (Continued)

Symptom Chart - Transmission Component Wear and Damage

Condition	Possible Source	Action
<ul style="list-style-type: none"> Synchronizer Outer Ring Heat Discolored with Slight Material Displacement 	<ul style="list-style-type: none"> Normal synchronizer operation with high shift effort. 	<ul style="list-style-type: none"> INSPECT the clutch disc and pressure plate for wear and damage. REFER to Clutch Pressure Plate Check and to Clutch Disc Check in this section. CHECK the clutch release hub and bearing for binding, and INSPECT the guide tube. INSPECT the input shaft for wear and damage. VERIFY that the clutch hydraulic fluid reservoir is filled to the correct level. ADD fluid as necessary. INSPECT the clutch hydraulic system for leaks, and REPAIR as necessary. REFER to Section 308-02. BLEED the clutch hydraulic system as necessary. REFER to Clutch System Bleeding - In-Vehicle in this section. TEST the system for normal operation.
<ul style="list-style-type: none"> Synchronizer Outer Ring Material Displacement 	<ul style="list-style-type: none"> Insufficient clutch hydraulic system fluid. Clutch hydraulic system fluid leakage. Air in clutch hydraulic system. Clutch pressure plate worn/damaged. Clutch disc damaged. Clutch disc splines rusted/worn. Clutch disc runout excessive. Clutching and shifting transmission incorrectly. 	<ul style="list-style-type: none"> INSPECT the clutch disc and pressure plate for wear and damage, and CHECK the clutch disc runout. REFER to Clutch Pressure Plate Check and to Clutch Disc Check in this section. VERIFY that the clutch hydraulic fluid reservoir is filled to the correct level. ADD fluid as necessary. INSPECT the clutch hydraulic system for leaks, and REPAIR as necessary. REFER to Section 308-02. BLEED the clutch hydraulic system as necessary. REFER to Clutch System Bleeding - In-Vehicle in this section. TEST the system for normal operation. DISCUSS vehicle operation with the customer.

Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



ZF Industries

DIAGNOSIS AND TESTING (Continued)

Symptom Chart - Transmission Component Wear and Damage

Condition	Possible Source	Action
<ul style="list-style-type: none"> General Bearing Wear 	<ul style="list-style-type: none"> Lubricant contaminated. Lubricant thermally aged. Lubricant not meeting manufacturer's specification. High mileage. 	<ul style="list-style-type: none"> DISCUSS transmission maintenance with the customer. REPAIR the transmission as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission).
<ul style="list-style-type: none"> Bearing Worn with Subsequent Damage 	<ul style="list-style-type: none"> Lubricant contaminated. Lubricant thermally aged. Lubricant not meeting manufacturer's specification. High mileage. Vehicle overloading. 	<ul style="list-style-type: none"> DISCUSS transmission maintenance with the customer. REPAIR the transmission as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission). DISCUSS vehicle operation with the customer.
<ul style="list-style-type: none"> Bearing Fatigue 	<ul style="list-style-type: none"> Lubricant contaminated. Lubricant thermally aged. Lubricant not meeting manufacturer's specification. High mileage. 	<ul style="list-style-type: none"> DISCUSS transmission maintenance with the customer. REPAIR the transmission as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission).
<ul style="list-style-type: none"> Bearing Collar Broken 	<ul style="list-style-type: none"> Seizure. Other transmission or driveline components damaged broken. Accident damage. Operator error. 	<ul style="list-style-type: none"> REPAIR the transmission as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission). DISCUSS vehicle operation with the customer.

Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



ZF Industries

DIAGNOSIS AND TESTING (Continued)

Symptom Chart - Transmission Component Wear and Damage

Condition	Possible Source	Action
<ul style="list-style-type: none"> Bearing Damaged by Fretting or Seizure 	<ul style="list-style-type: none"> Inadequate lubrication. Towing vehicle with driveshaft connected. Incorrect driveline angles. 	<ul style="list-style-type: none"> DISCUSS transmission maintenance with the customer. DISCUSS vehicle towing procedure with the customer. CHECK the driveline angles. REFER to Section 205-00.
<ul style="list-style-type: none"> Sealing Element Radial Shaft Sealing Ring Damaged 	<ul style="list-style-type: none"> Thermal overload. Lubricant not meeting manufacturer's specification. 	<ul style="list-style-type: none"> DISCUSS vehicle operation and transmission maintenance with the customer.
<ul style="list-style-type: none"> Sealing Element Sealing Lip Worn 	<ul style="list-style-type: none"> Effect of dirt from outside. Excessive temperatures. Case vent blocked. Vibration. High mileage. Radial shaft sealing ring not pushed in evenly during assembly. Shaft race damaged. 	<ul style="list-style-type: none"> DISCUSS vehicle operation and transmission maintenance with the customer. CORRECT the condition causing the vibration. REFER to Section 100-04 for NVH diagnosis. REPAIR the transmission as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission). REVIEW repair procedures. REFER to Section 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission).
<ul style="list-style-type: none"> Sealing Element Rectangular/Lipped Sealing Ring Sheared 	<ul style="list-style-type: none"> Incorrect seal installation. Damaged by assembly tool. Incorrect repair. 	<ul style="list-style-type: none"> INSPECT adjacent component contact surfaces, edges, insertion tapers, and REPAIR as necessary. REVIEW repair procedures. REFER to Section 308-03A (Model S5-47ZF Transmission) or SECTION 308-03B (ZF 6 Speed Transmission).

Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



ZF Industries

DIAGNOSIS AND TESTING (Continued)

Symptom Chart - Transmission Component Wear and Damage

Condition	Possible Source	Action
<ul style="list-style-type: none"> Sealing Element Worn/Hardened 	<ul style="list-style-type: none"> Clutch damage. Vehicle overloading. Inadequate cooling. Contaminants. Grooves on contact surfaces. 	<ul style="list-style-type: none"> INSPECT the clutch components, and REPAIR as necessary. DISCUSS vehicle operation and transmission maintenance with the customer. INSPECT component contact surfaces and REPAIR as necessary. REVIEW repair procedures. REFER to <i>Section 308-03A</i> (Model S5-47ZF Transmission) or <i>SECTION 308-03B</i> (ZF 6 Speed Transmission).
<ul style="list-style-type: none"> Gray Case Iron Rectangular Ring Worn/Burring 	<ul style="list-style-type: none"> Inadequate lubrication. Follow-on damage. 	<ul style="list-style-type: none"> DISCUSS vehicle operation and transmission maintenance with the customer. INSPECT adjacent component, and REPAIR as necessary. REVIEW repair procedures. REFER to <i>Section 308-03A</i> (Model S5-47ZF Transmission) or <i>SECTION 308-03B</i> (ZF 6 Speed Transmission).

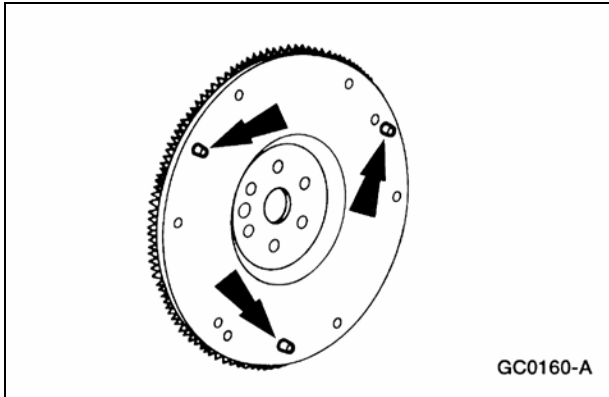
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ZF Industries

REMOVAL AND INSTALLATION

Clutch Pressure Plate Locating Dowels



Removal

1. **CAUTION: Do not damage the bore or the surrounding surface area.**

When installed in an open hole, use a drift to remove the dowel.

When installed in a blind hole, use locking pliers to remove dowel.

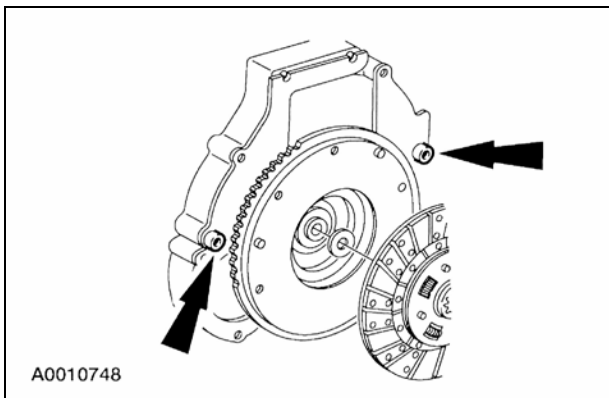
- There are two dowels on the diesel engine flywheel, and three dowels on the gasoline engine flywheel.

Installation

1. **CAUTION: Do not damage the bore or the surrounding surface area.**

Using a brass or plastic mallet, drive the dowels squarely into place until fully seated in the bore.

Clutch Housing Locating Dowels



Removal

1. **CAUTION: Do not damage the bore or the surrounding surface area.**

When installed in an open hole, use a drift to remove the dowel.

When installed in a blind hole, use locking pliers to remove dowel.

Installation

1. **CAUTION: Do not damage the bore or the surrounding surface area.**

Using a brass or plastic mallet, drive the dowels squarely into place until fully seated in the bore.

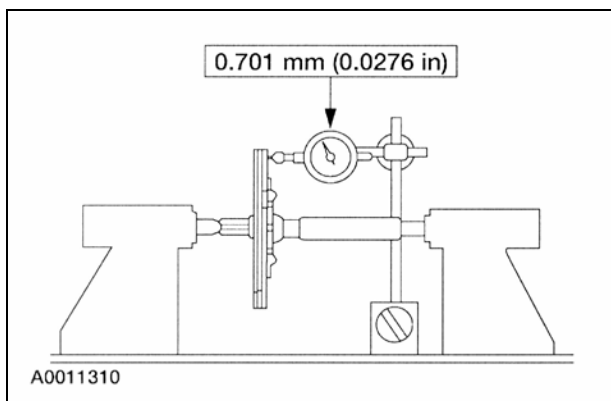
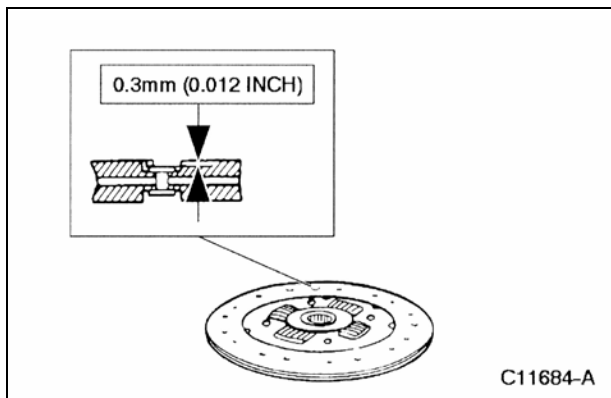
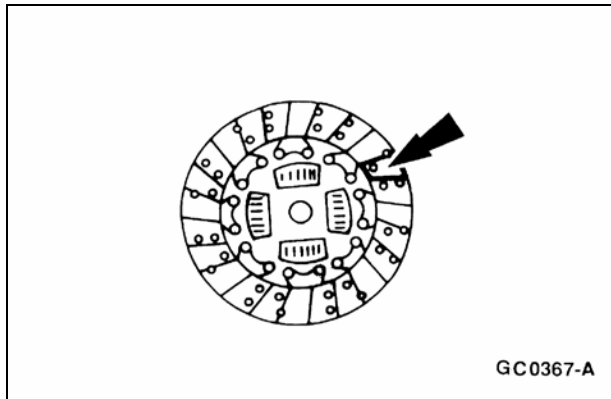
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ZF Industries

GENERAL PROCEDURES

Clutch Disc Check



1. **Note:** Use emery cloth to remove minor imperfections in the clutch disc friction surface. Inspect the clutch disc (7550) for:

- oil and grease saturation.
- worn and loose rivets at the hub.
- broken springs.
- wear and rust on the splines.
- Install a new clutch disc if any of these conditions are present.

2. Using a suitable slide caliper, measure the depth to the rivet heads.

- Install a new clutch disc if the measurement is less than the specification.

3. Using a suitable dial indicator, measure the clutch disc runout.

- Install a new clutch disc if the measurement is greater than the specification.

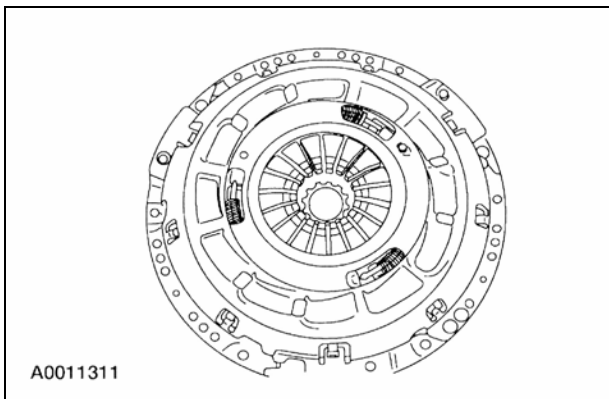
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ZF Industries

GENERAL PROCEDURES

Clutch Pressure Plate Check



1. **CAUTION: Do not use petroleum based cleaning solutions.**

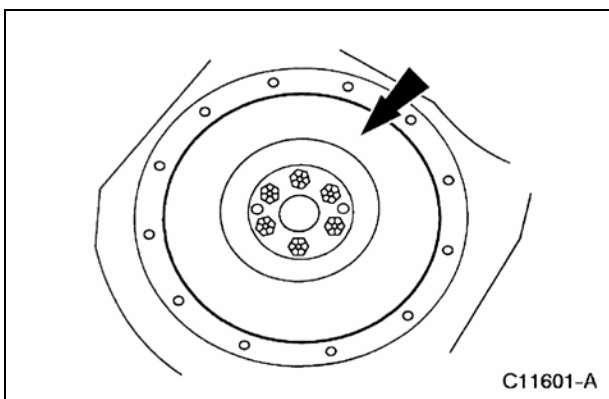
CAUTION: Do not immerse the clutch pressure plate (7563) in the cleaning solution.

If necessary, use a suitable cleaning solution to remove any oil film from the clutch pressure plate friction surface.

2. Inspect the clutch pressure plate levers for heavy wear associated with binding. Also, inspect for substantial difference in lever wear. Inspect the clutch pressure plate friction surface for scoring, burning, heat checking, distortion, warping, and dishing.

 - Install a new clutch pressure plate if any of these conditions are present.

Flywheel Check



1. Inspect the flywheel:
 - for cracks.
 - for heat checks and other damage.
 - machine friction surface or scoring and wear.

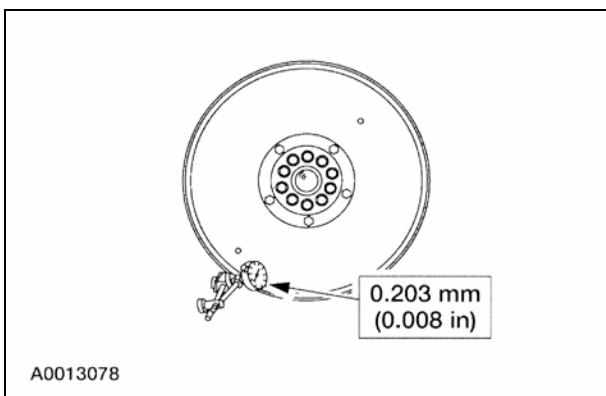
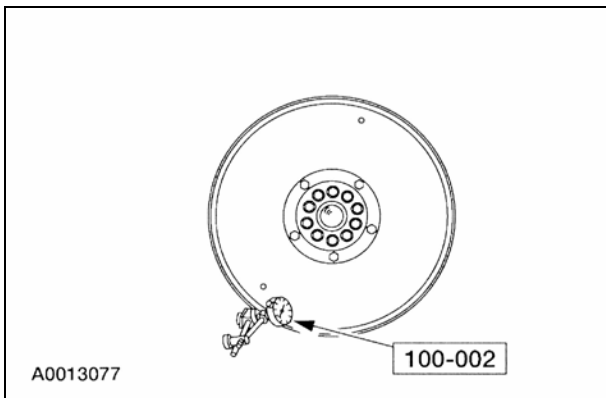
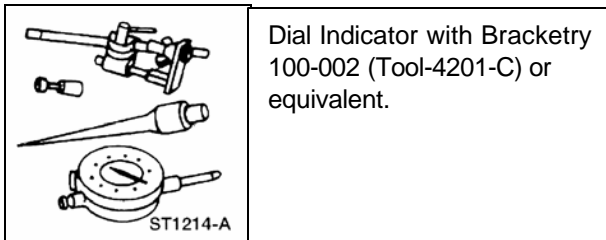
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ZF Industries

GENERAL PROCEDURES

Flywheel Runout Check



1. Push the flywheel forward.
2. Install the special tool against the flywheel face 25mm (1 in) from the outer edge of the flywheel. Zero the dial indicator.
3. Turn the flywheel one complete revolution while observing the total indicator runout (TIR). The flywheel TIR must not exceed the specification.
 - If the flywheel TIR does not exceed the specification, proceed to the next step in this procedure to check the ring gear runout.
 - If the flywheel TIR exceeds the specification, remove the flywheel. For additional information, refer to **Section 308-01**. Check for burrs between the flywheel and the crankshaft mounting flange. If burrs exist, remove them. Check the crankshaft flange runout.

Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



ZF Industries

GENERAL PROCEDURES (Continued)

Flywheel Runout Check (Continued)

- If the crankshaft flange TIR does not exceed specification, and no burrs were found between the flywheel and the crankshaft mounting flange, resurface the flywheel or install a new flywheel.
- If the crankshaft flange TIR does not exceed specifications, but burrs were found between the flywheel and the crankshaft mounting flange, reinstall the flywheel. For additional information, refer to **Section 308-01**. Recheck the flywheel runout. If the flywheel TIR exceeds the specification, resurface the flywheel or install a new flywheel.
- If the crankshaft flange TIR exceeds specification, repair as necessary. **Refer to the appropriate section in Group 303 for the procedure.** Reinstall the flywheel. For additional information, refer to **Section 308-01**. Recheck the flywheel runout. If the flywheel TIR exceeds the specification, resurface the flywheel or install a new flywheel.

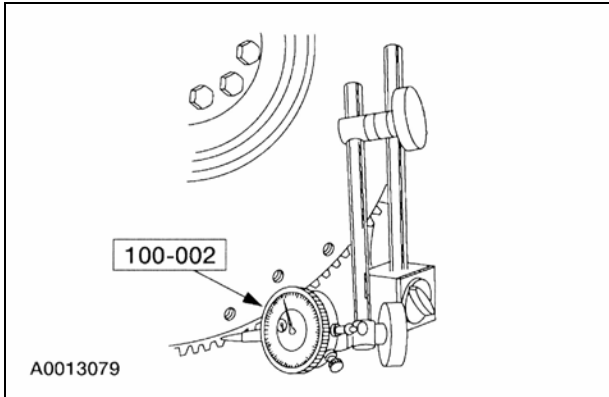
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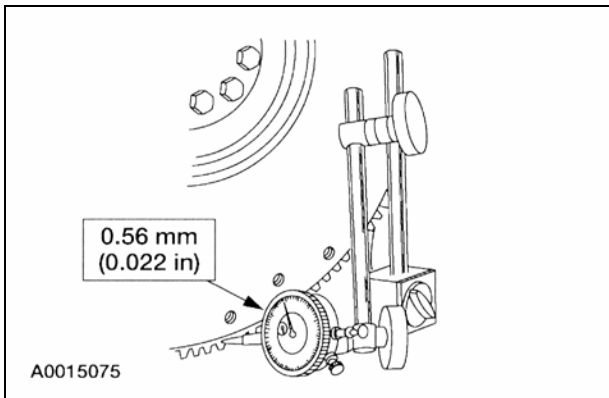
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GENERAL PROCEDURES (Continued)

Flywheel Runout Check (Continued)

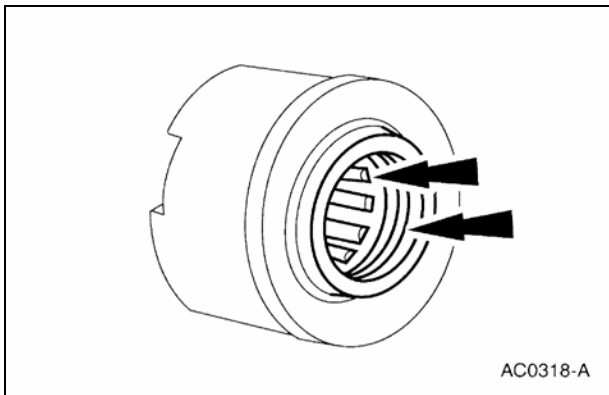


- Install the special tool against the ring gear face adjacent to the teeth. Zero the dial indicator.



- Turn the flywheel one complete revolution while observing the total indicator runout (TIR). The ring gear TIR must not exceed the specification.
- If the ring gear TIR exceeds the specification, install a new flywheel and ring gear assembly.

Pilot Bearing Check



1. Inspect the transmission input shaft pilot bearing:
 - for misalignment and looseness in the crankshaft (gasoline engine) or flywheel (diesel engine).
 - needle rollers for scoring, discoloration, wear, broken rollers, and inadequate lubricant.
 - seal for damage and lubricant leakage.
 - Install a new transmission input shaft pilot bearing (7120) if any of these conditions are present.

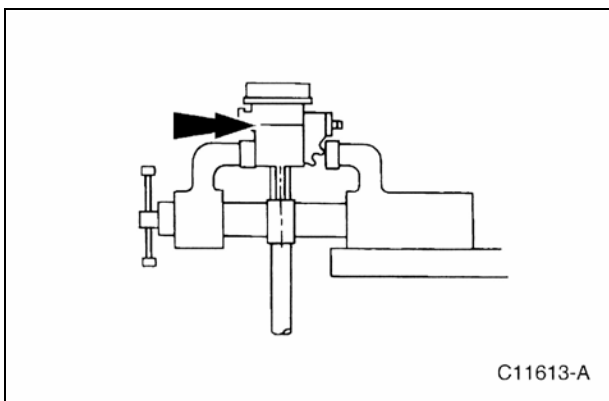
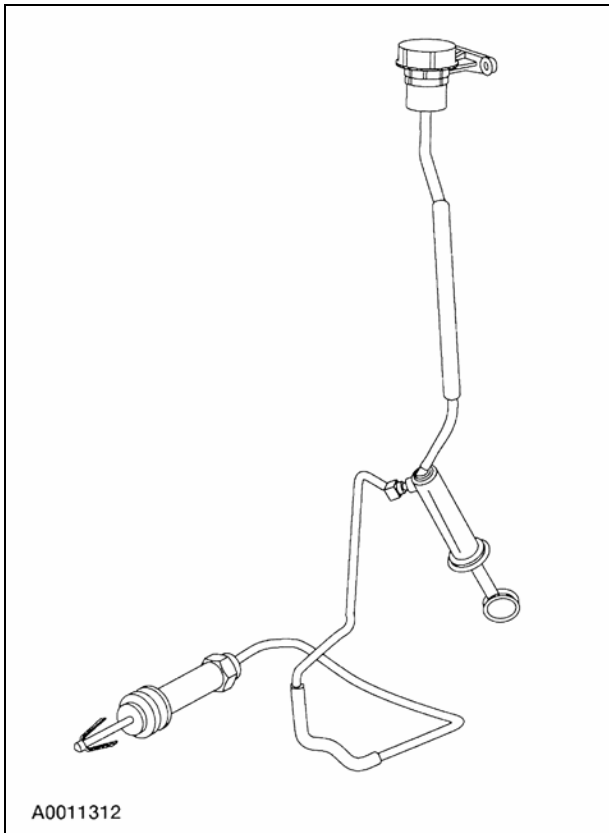
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ZF Industries

GENERAL PROCEDURES (Continued)

Clutch System Bleeding



1. **CAUTION:** So as not to trap air in the clutch hydraulic system, fill any disconnected component (such as master cylinder, slave cylinder) with the specified brake fluid before connecting it. Support the clutch hydraulic system components so that the reservoir is above the master cylinder and the slave cylinder is below the master cylinder.

2. Fill the clutch master cylinder reservoir to the full line with DOT 3 Brake Fluid.
 - Use Ford High Performance DOT 3 Motor Vehicle Brake Fluid C6AZ-19542-AB or equivalent meeting Ford specification ESA-M6C25-A.

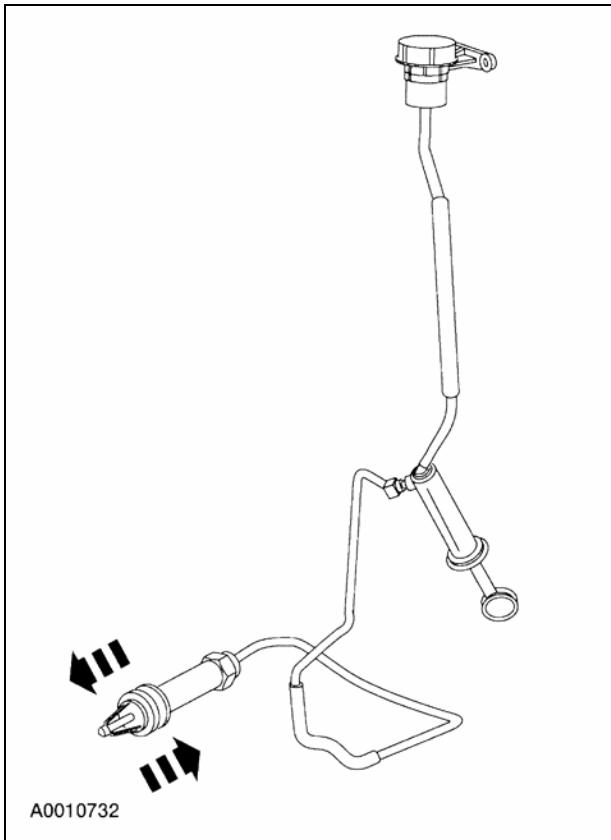
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GENERAL PROCEDURES (Continued)

Clutch System Bleeding (Continued)

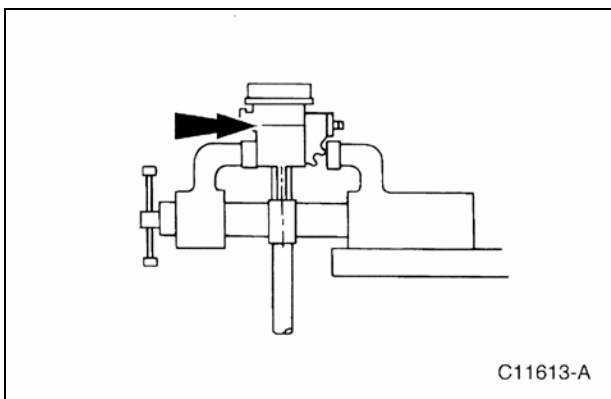


3. **CAUTION: Do not allow the clutch master cylinder reservoir to run dry.**

Purge the air from the clutch hydraulic system.

- Push the push rod slowly into the slave cylinder until it bottoms out the piston. Hold the push rod in this position for five to ten seconds to allow all trapped air to rise through the system. Look for air bubbles in the fluid in the clutch hydraulic reservoir. Very slowly, so that air is not drawn back into the slave cylinder, release the push rod (the spring in the slave cylinder will force the piston outward). Wait five to ten seconds for the air bubbles to rise. Repeat this process five to ten times to make sure that all air purged from the system.

4. Verify that the fluid level in the reservoir is correct, and install the cap.



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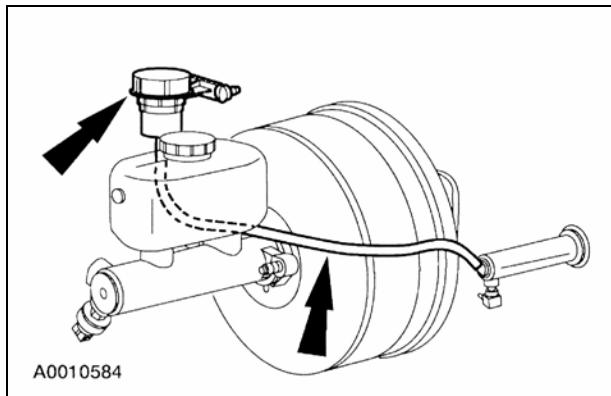


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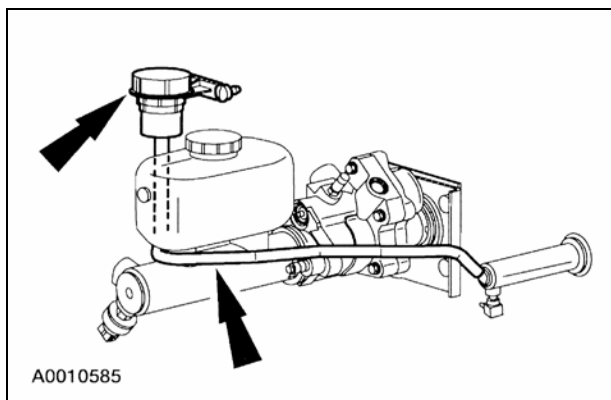
GENERAL PROCEDURES (Continued)

Clutch System Bleeding - In-Vehicle

1. Fill the clutch master cylinder reservoir to the full line with DOT 3 Brake Fluid.
 - Use Ford High Performance DOT 3 Motor Vehicle Brake Fluid C6AZ-19542-AB or DOT 3 equivalent meeting Ford specification ESA-M6C25-A.



2. Verify that the reservoir-to-master cylinder tube routing is as shown so as not to trap air in the clutch hydraulic system. Correct the routing as necessary.



3. Raise and support the vehicle. For additional information, refer to **Section 100-02**.

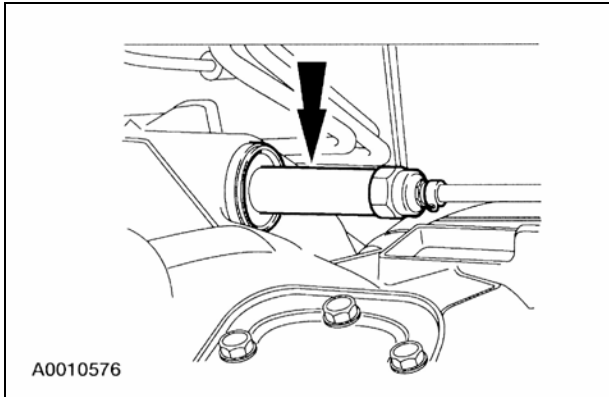
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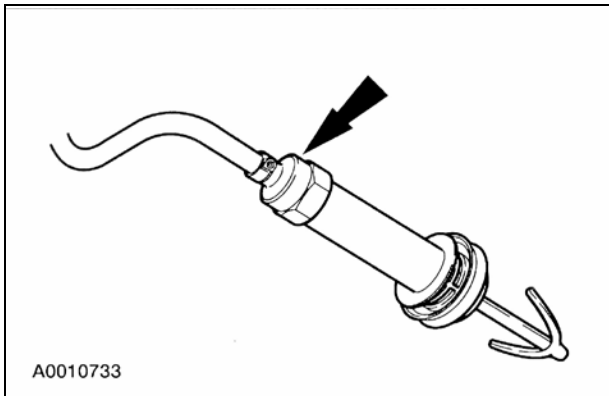
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GENERAL PROCEDURES (Continued)

Clutch System Bleeding - In-Vehicle (Continued)



4. Unlock, and remove the slave cylinder from the transmission.
 - Compress and twist the slave cylinder to unlock it from the transmission.



5. Disconnect the clutch hydraulic tube from the floor pan clip.
6. Position the slave cylinder and the hydraulic tube so that there are no high points that could trap air in the system.
 - Position the slave cylinder push rod downward. Route the hydraulic tube upward as straight as possible toward the master cylinder so that the air can flow freely to the fluid reservoir.

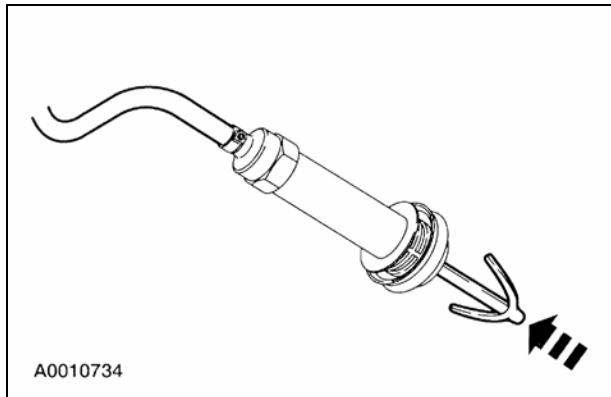
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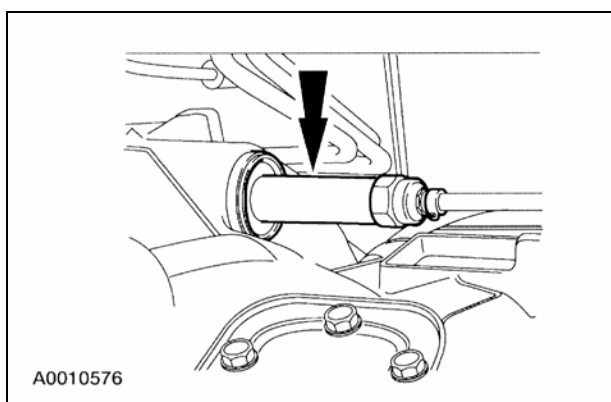
GENERAL PROCEDURES (Continued)

Clutch System Bleeding - In-Vehicle (Continued)



7. **CAUTION: Do not allow the clutch master cylinder reservoir to run dry.**
Purge the air from the clutch hydraulic system.
 - Push the push rod slowly into the slave cylinder until it bottoms out the piston. Hold the push rod in this position for five to ten seconds to allow all trapped air to rise through the system. Very slowly, so that air is not drawn back into the slave cylinder, release the push rod (the spring in the slave cylinder will force the piston outwards). Wait five to ten seconds for the air bubbles to rise. Repeat this process until all air purged from the system. Verify that the fluid in the reservoir is free of air bubbles.

8. Install the slave cylinder.
 - Compress and twist the slave cylinder to lock it onto the transmission.



Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



ZF Industries

GENERAL PROCEDURES (Continued)

Clutch System Bleeding - In-Vehicle (Continued)

9. Connect the clutch hydraulic tube to the floor pan pipe.
10. Lower the vehicle.
11. Slowly depress and release the clutch pedal five to ten times to bleed any air still trapped in the system. Verify that the fluid in the reservoir is free of air bubbles.
12. Verify that the fluid level in the reservoir is correct, and install the cap.

Transmission ZF S6-650/6S-750 Troubleshooting Guide-Service Tips



ZF Industries

SPECIFICATIONS

General Specifications

Item	Specification
Pressure Plate	
Pressure spring	Belleville
Sensor spring	Belleville
Total plate pressure KG (lbs.) 5.4l and 6.8l	1305 (2878)
Total plate pressure KG (lbs.) 7.3l diesel	1071 (2361)
Clutch disc	
Lining material 5.4l and 6.8l	F808 woven non-asbestos
Lining material 7.3l diesel	F808 MCC woven non-asbestos
O.S. diameter (approx.) mm (in) 5.4l	303 (11.9)
I.S. diameter (approx.) mm (in) 5.4l	213 (8.3)
O.S. diameter (approx.) mm (in) 6.8l	303 (11.9)
I.S. diameter (approx.) mm (in) 6.8l	174 (6.85)
O.S. diameter (approx.) mm (in) 7.3l	330 (12.9)
I.S. diameter (approx.) mm (in) 7.3l	210 (8.2)
Facing area sq. cm (sq. in) 5.4l	730 (112)
Facing area sq. cm (sq. in) 6.8l	967 (149)
Facing area sq. cm (sq. in) 7.3l	1018 (158)
Compressed thickness mm (in) 5.4l	9.1 (0.36)
Compressed thickness mm (in) 6.8l	8.9 (0.35)
Compressed thickness mm (in) 7.3l	8.4 (0.33)
Flywheel	
Flywheel TIR	0.203 mm (0.008 in)
Flywheel ring gear TIR	0.56 mm (0.022 in)
Fluid	
High Performance DOT 3 Motor Vehicle Brake Fluid C6AZ-19542-AB	ESA-M6C25-A