

SECTION 07: TRANSMISSION

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1. DESCRIPTION

XL2 Series vehicles may be provided with either an Allison World automatic transmission or a ZF-AsTronic transmission.

1.1 ALLISON AUTOMATIC TRANSMISSION

The B500(R) World Transmission has 6 speeds with two top range (fifth and sixth) overdrives. Total coverage is determined by dividing the highest gear ratio by the lowest gear ratio. Total coverage expresses the transmission gear ratio versatility. Transmissions with larger total coverage number have a wider variety of available ratios.

An electronic control allows the transmission to shift at exactly the right point on the engine's fuel consumption curve for best economy. Early lockup maintains the highest possible mechanical efficiency through the closely-spaced gear steps, culminating in two overdrive ratios. This combination allows progressive shifting techniques, where engine speeds are reduced for higher efficiency and lower fuel consumption.

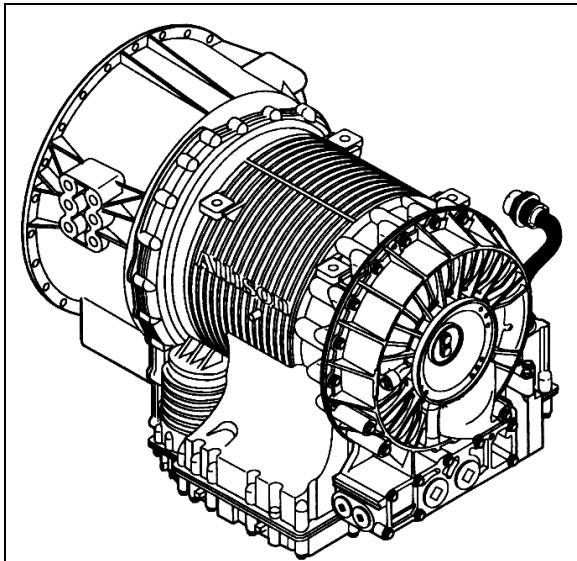


FIGURE 1: WORLD TRANSMISSION

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Gear selection and torque converter modes are controlled by a microcomputer-based electronic transmission management system. It is fed information regarding throttle position, operator range selection, engine speed, turbine speed, transmission output speed and various system pressures from special electronic sensors. With this information, it computes shift points and clutch pressures to meet immediate needs.

Using closed loop adaptive logic, the electronic control looks at a number of parameters during the shift, and makes minute adjustments to match the shift to desired profile stored in its memory. It then looks at these adjustments and resets the parameters, which allow the transmission to quickly compensate for variations in load, terrain or environment and to adjust for clutch wear and engine power changes. A Diagnostic Data Reader can be connected to the electronic control unit to provide a self-check of all systems in the transmission. Four-digit trouble codes greatly reduce the time it takes to pinpoint potential problems. (Refer to heading "10. TROUBLESHOOTING" in this section).

1.1.1 Retarder (if applicable)

This optional auxiliary braking device for the automatic transmission is integrated into the basic envelope of the transmission and transmits its braking force directly to the propeller shaft. It requires no additional length and adds only 75 pounds (34 kg) of weight. Operation of the retarder is controlled electronically by the driver's use of the brake and/or by hand control lever.

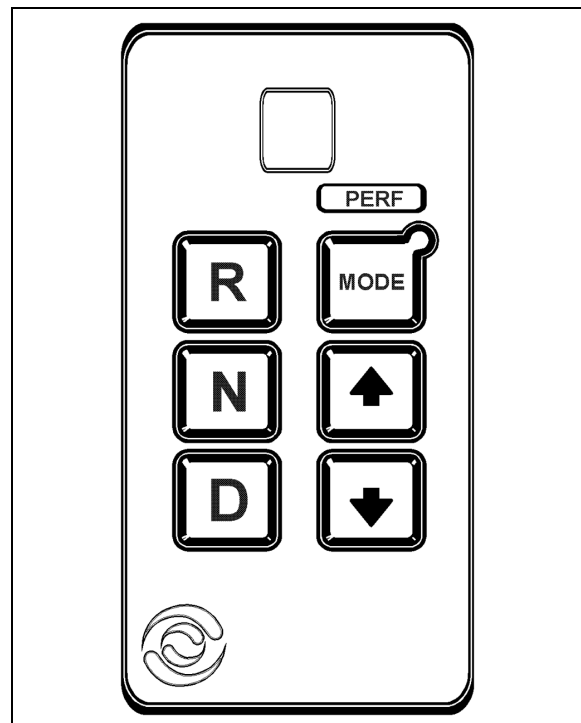


FIGURE 2: WORLD TRANSMISSION CONTROL PAD

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When activated, fluid enters a cavity and provides resistance to the turning of rotor blades revolving with the output shaft. This effectively slows the

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vehicle to the point where the service brakes are needed only for final stopping. The retarder is fully modulated and is compatible with ABS.

1.2 ZF-ASTRONIC TRANSMISSION

The AS TRONIC gear shift system is a combination of an electro-pneumatically shifted constant-mesh gearbox and an automated dry clutch.

If the AS TRONIC transmission system is to be used, the vehicle must have an electronic engine control unit as well as CAN communication. Since the clutch is automated (clutch pedal no longer fitted), the driver no longer has to activate the clutch.

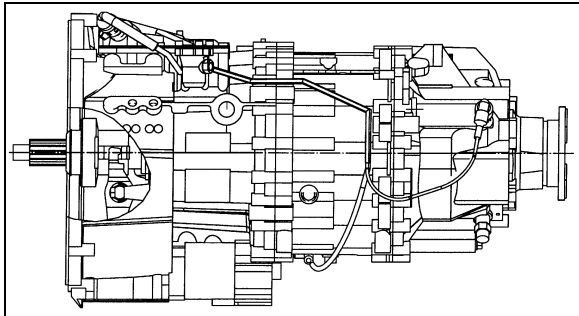


FIGURE 3: ZF-ASTRONIC TRANSMISSION 07078

The actual shift procedure is performed by the electronic transmission control unit. The driver has the option of driving the vehicle in both semi-automatic mode as well as fully automatically. When in semi-automatic mode, manual shifting with the range selector is made easier.

When in fully automatic mode, gears are selected and shifts made by the electronic control unit. The driver can still intervene if he wishes to. All system functions required are shown on the display, e.g. neutral, gear change, clutch overload and diagnosis information.

2. WELDING PROCEDURES

These procedures are intended only for vehicles equipped with transmission electronic controls. When frame or other welding is required on the vehicle, precautions are to be taken to protect the electronic control components. Refer to section 00: GENERAL INFORMATION, paragraph 3: "Precautions to be observed before welding" for complete procedure.

3. MAINTENANCE

3.1 WORLD TRANSMISSION

To gain access to the dipstick, open the engine compartment rear doors; dipstick is located on the radiator side of the engine (Fig. 4).

To check the transmission oil level, a cold check and a hot check must be performed. A cold check must be made between 60°F (16°C) and 140°F (60°C). The transmission oil temperature gauge indicates the operating temperature; it is located in the MCD dashboard integrated Liquid Crystal Display and can be viewed when selecting the Gauge Mode (refer to "Operator's Manual" for added information).

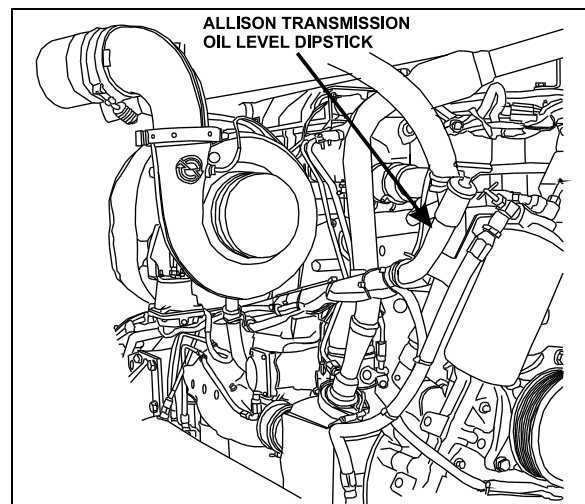


FIGURE 4: OIL LEVEL DIPSTICK (AUTO. TRANS.) 07033

NOTE

Perform the cold check first to verify the transmission oil level before performing the hot check.

The hot check can be performed when the transmission oil reaches the normal operating temperature of 160°F (71°C) to 200°F (93°C).

Clean all dirt from around the end of the oil filler tube before removing the dipstick. Dirt or foreign matter must not be permitted to enter the oil system since it will cause valves to stick, undue wear of transmission parts, and clogged passages. Check the oil level in accordance with the following procedures and record any abnormal level on your "Maintenance Records".

WARNING

When checking the oil level, be sure that the parking brake and/or emergency brakes are set and properly engaged, and the wheels are chocked. Unexpected and possible sudden vehicle movement may occur if these precautions are not taken.

- **Special care must be taken not to touch the engine coolant tubing and/or exhaust pipe, since this could cause severe burns.**
- **Do not wear loose clothing and, stay away from rotating parts during procedure; personal injury could occur.**

Always check the oil level reading at least twice when the engine is running. Consistency is important in maintaining the accuracy of the reading. If inconsistent readings persist, check the transmission breather to ensure it is clean and free of debris.

3.1.1 Cold Check

The purpose of the **Cold Check** is to determine if the transmission has enough fluid to be operated safely until a **Hot Check** can be made.

1. If the engine has been shut down for an extended period of time, park the vehicle on a level surface and apply the parking brake.

⚠ CAUTION ⚠

The oil level rises as sump temperature increases. DO NOT fill above the "Cold Run" band if the transmission oil is below normal operating temperature.

2. Run the engine for at least one minute. Shift to Drive (D) and operate the engine for 30 seconds at 1000-1500 rpm; then shift to Reverse (R) to clear the hydraulic system of air. Finally shift to Neutral (N) and allow the engine to idle (500 - 800 rpm).
3. While the engine is running, remove the dipstick from the tube and wipe it clean (Figs. 5 & 6).

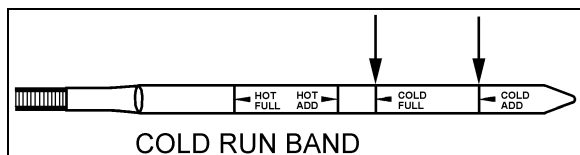


FIGURE 5: COLD CHECK

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4. Insert the dipstick into the tube and then remove, checking the oil level reading (Fig. 5). Repeat the check procedure to verify the reading. If the oil reading is within the "Cold Run" band, the level is satisfactory for operating the transmission until the oil is hot enough to perform a "Hot Run" check. If the oil reading is not within the "Cold Run" band, add or drain oil as necessary to bring the level within the "Cold Run" band.
5. Perform a **Hot Check** at the first opportunity after the normal operating temperature of 160°F (71°C) to 200°F (93°C) is attained.

⚠ CAUTION ⚠

An accurate fluid level check cannot be made unless the engine is idling (500-800 rpm) in Neutral, the transmission fluid is at the proper temperature, and the vehicle is on a level surface.

3.1.2 Hot Check

⚠ CAUTION ⚠

The oil must be hot to ensure an accurate check for this procedure. The oil level rises as temperature increases.

1. Operate the transmission in Drive (D) range until normal operating temperature is reached 160°F (71°C) to 200°F (93°C).
2. Park the vehicle on a level surface and shift to Neutral (N). Apply the parking brake and allow the engine to idle (500 - 800 rpm).
3. While the engine is running, remove the dipstick from the tube and wipe it clean.
4. Insert the dipstick into the tube and then remove, checking the oil level reading. Repeat the check procedure to verify the reading.

The safe operating level is anywhere within the "Hot Run" band on the dipstick (Fig. 6).

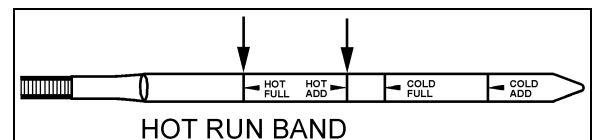


FIGURE 6: HOT CHECK

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If the oil level is not within the "Hot Run" band, add or drain oil as necessary to bring the oil level within the band.

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NOTE

The Cold Check is more appropriate for verifying the oil level after the first fill-up. In case of conflict, the Hot Check has priority over the Cold Check; the automatic system of verification via the shift selector has priority over the Hot Check.

3.1.3 Readout of the Oil Level Sensor

The optional Oil Level Sensor (OLS) is designed to measure transmission oil level only when the following combination of operating conditions exists:

1. Engine must be at idle;
2. **NEUTRAL** must be selected;
3. Zero output speed;
4. Transmission oil must be within a "normal" temperature band (160-250°F; 70-120°C), and;
5. Once the first four (4) conditions are met, there must be a "waiting" period (approx. 2 min., to facilitate consistent oil drainback) before oil level measurement begins.

Oil Level Sensor (OLS) Codes

<u>CODE</u>	<u>CAUSE OF CODE</u>
OL-OK	Oil Level Is Correct
LO-01	One Quart Low
LO-02	Two Quarts Low
HI-01	One Quart High
HI-02	Two Quarts High
OL-50	Engine Speed (RPM) Too Low
OL-59	Engine Speed (RPM) Too High
OL-65	Neutral Must Be Selected
OL-70	Sump Oil Temperature Too Low
OL-79	Sump Oil Temperature Too High
OL-89	Output Shaft Rotation
OL-95	Sensor Failure

To enter OLS readout mode (after meeting the conditions noted above), simultaneously press the UPSHIFT and DOWNSHIFT arrows on the shifter. If the five (5) conditions noted above are present, the display will immediately enter the reading mode. If the "waiting" period has not elapsed, the left digit of the display will become a "chasing" digit and the right digit will count down from (8) to (1) until the waiting period is complete.

After attaining the reading mode, the display will flash "OL-OK", "LO-01", "HI-02", etc., where the suffix "01" or "02" indicates the volume of oil (in quarts) either low or high.

At any time in this sequence, simultaneously pressing the UPSHIFT and DOWNSHIFT arrows directs the ECU to enter the transmission diagnostic mode as described under "10. Troubleshooting" in this section.

D, N, or R may also be selected on the shifter at any time - the OLS mode will abort and normal transmission will commence. Shifts are not inhibited.

3.1.4 Keeping Oil Clean

Oil must be handled in clean containers, fillers, etc., to prevent foreign material from entering the transmission. Place the dipstick on a clean surface area while filling the transmission.

⚠ CAUTION ⚠

Containers or fillers that have been used to handle antifreeze or engine coolant must NEVER be used for handling transmission fluid. Antifreeze and coolant solutions contain ethylene glycol that, if introduced into the transmission, can cause the clutch plates to fail.

3.1.5 Oil Recommendations

Hydraulic oils used in the transmission have an important influence on transmission reliability and durability. In order of preference Castrol TranSynd Synthetic Fluid, DEXRON-III/VI, MIL-L-2104D, and type C-4 oils (Allison approved SAE 10W or SAE 30) are recommended. Type C-4 oil is the only oil approved for use in off-highway applications. Use type SAE 30 where ambient temperature is consistently above 86°F (30°C). Some DEXRON-III/VI oils are also qualified as type C-4 oils and may be used in off-highway applications. However, a DEXRON-III/VI fluid which is not qualified type C-4 oil must never be used in off-highway applications. Consult your local Allison dealer or distributor to determine if DEXRON-III/VI oil is also qualified type C-4 oil.

Before using type C-4 oils, consult the vehicle manufacturer to ensure that materials used in tubes, hoses, seals, etc., are compatible with type C-4 oils. Also, consult your local Allison dealer or distributor to determine if the oil you have selected is approved type C-4 oil. Ford Motor Company specification oils M2C33-F, M2C138-CJ and M2C166-H may be used and may be intermixed with DEXRON-III/VI oil.

OIL SPECIFICATIONS AND AMBIENT TEMPERATURE OPERATING CONDITIONS	
Oil type	Ambient temperature
MIL-L-2104D, DEXRON-III/VI, TranSynd TES 295, C-4	120°F (48°C) to -25°F (-32°C)
MIL-L-46167	-25°F (-32°C) to -60°F (-51°C)

The use of an arctic preheat kit is recommended at temperatures below -25°F (-32°C). If a preheat kit is not available, the ECU will restrict full operation until the sump temperature is increased. The chart below shows the temperature ranges in which the transmission will operate. It should be noted that at lower sump temperature, the transmission's operation may be restricted.

Transmission Oil Temperature	"DO NOT SHIFT" Light	Operation
Below -26°F (-32°C)	ON	Neutral only
-24°F (-31°C) to +19°F (-7°C)	OFF	Start with neutral and reverse, normal upshifts
+20°F (-6°C) to 260°F (126°C)	OFF	Full operation in all ranges
Above 260°F (126°C)	ON	Inhibits 5th and 6th ranges

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3.1.6 Oil Contamination

At each oil change, examine the drained oil for evidence of dirt or water. A nominal amount of condensation will emulsify during operation of the transmission. However, if there is evidence of water, check the cooler (heat exchanger) for other signs of leakage. This, however, may also indicate leakage from the engine oil system.

3.1.7 Metal Particles

Metal particles in the oil (except for minute particles normally trapped in the oil filter) indicate damage has occurred in the transmission. When these particles are found in the sump, the transmission must be disassembled and closely inspected to find the source. Metal contamination will require complete disassembly of the transmission and cleaning of all internal and external circuits, coolers, and all other areas where the particles could lodge.



If excessive metal contamination has occurred, replacement of the oil cooler and replacement of all bearings within the transmission is recommended.

3.1.8 Coolant Leakage

If engine coolant leaks into the transmission oil system, immediate action must be taken to prevent malfunction and possible serious damage. The transmission must be completely disassembled, inspected, and cleaned. All traces of the coolant contamination must be removed. Friction clutch plates contaminated with ethylene glycol must be replaced.

TABLE 1: Recommended Fluid and Filter Change Intervals (Non-TranSynd™/Non-TES 295/Mixture)

Coaches or MTH equipped with retarder				Coaches or MTH without retarder			
Fluid	Filters			Fluid	Filters		
	Main	Internal	Lube/ Auxiliary		Main	Internal	Lube/ Auxiliary
	Initial Break-in 5,000 miles (8,000 km)				Initial Break-in 5,000 miles (8,000 km)		
12,000 Miles (20 000 km) 6 Months	12,000 Miles (20 000 km) 6 Months	Overhaul	12,000 Miles (20 000 km) 6 Months	25,000 Miles 40 000 km 12 Months	25,000 Miles 40 000 km 12 Months	Overhaul	25,000 Miles (40 000 km) 12 Months

TABLE 2: Recommended Fluid and Filter Change Intervals (TranSynd™/TES 295 Approved Fluid)
2 inch Control Module (1.75 approximately) – Requires filter kit P/N 29540493

Coaches or MTH equipped with retarder				Coaches or MTH without retarder			
Fluid	Filters			Fluid	Filters		
	Main	Internal	Lube/ Auxiliary		Main	Internal	Lube/ Auxiliary
	Initial Break-in 5,000 miles (8,000 km)				Initial Break-in 5,000 miles (8,000 km)		
50,000 Miles (80 000 km) 24 Months	50,000 Miles (80 000 km) 24 Months	Overhaul	50,000 Miles (80 000 km) 24 Months	150,000 Miles 240 000 km 48 Months	50,000 Miles 80 000 km 24 Months	Overhaul	50,000 Miles (80 000 km) 24 Months

3.1.9 Oil and Filter Change

Allison transmissions are now factory fill with TranSynd fluid. Oil change must be performed with the vehicle on a flat and level surface and with parking brake applied. Oil and oil filter change frequency is determined by the severity of service and operating conditions of the transmission and by the filter equipment installed. See "Table 1 and 2" for oil and filter change intervals. More frequent changes may be required when operations are subject to high levels of contamination or overheating.

The procedure for changing the transmission oil and oil filters is as follows:

Drain

1. The transmission should be at an operating temperature of 160°F (71°C) to 200°F (93°C) when the oil is drained. This will ensure quicker and more complete fluid drainage.

NOTE

Remove transmission protective panel located underneath transmission for easier access.

2. Remove the drain plug from under the transmission (Fig.7) and allow the oil to drain into a suitable container. Check the condition of the oil as described previously.
3. To replace the integral filters, remove twelve bolts (6 on each cover), two filter covers, two O-rings, two square cut seals and the two filters from the bottom of the control module (Fig. 7).
4. To install filters, pre-lube and install the two O-rings, the two square cut seals followed by the filters (lube the O-ring in filter cartridge only) into the filter compartment. Index each filter/cover assembly to holes in channel plate/sump. Push the cover assembly in by hand to seat the seals.

CAUTION

Do not use bolts to draw the cover to sump. This can damage the cover, seal, or sump.

5. Install twelve bolts and both covers, and then tighten to 38-45 lbf-ft (51-61 Nm).
6. Inspect the drain plug and O-ring. Replace if necessary. Reinstall the drain plug and tighten to 18-24 lbf-ft (25-32 Nm).
7. Reinstall transmission protective panel

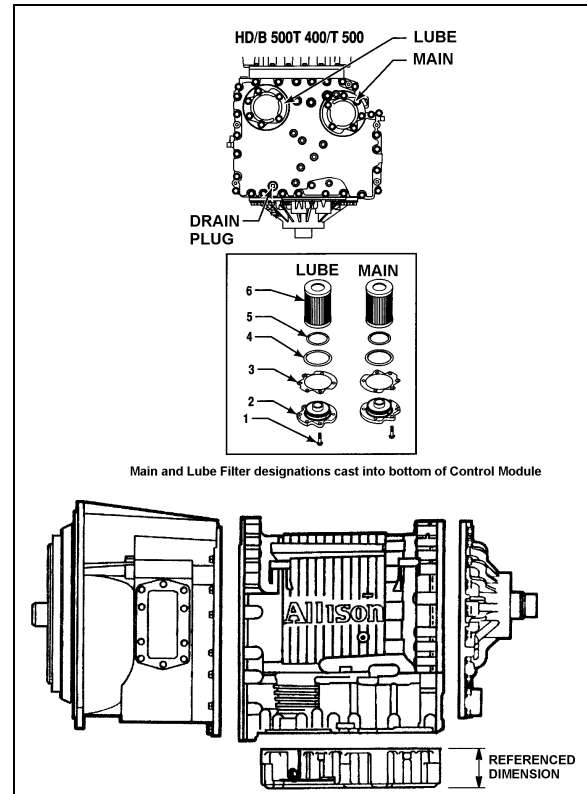


FIGURE 7: DRAIN PLUG AND FILTERS

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Refill

Using the oil level dipstick filler tube, refill with 24 US qts (23 liters) [28 US qts (26.5 liters) if equipped with retarder] and check the oil level using the previously described procedure. The refill amount is less than the initial filling because some of the oil remains in the external circuits and transmission cavities.

3.2 ZF AS-TRONIC TRANSMISSION

All information needed for the removal/installation or maintenance of the ZF transmission is included in the documents annexed at the end of this section.

3.2.1 ZF AS-TRONIC / SACHS Clutch Installation Procedure

Important Note:

The clutch hub splines, input shaft, release bearing, clutch fork, and clutch push rod ends all come pre-lubed from the factory.

- Clean the flywheel, clutch disc, and pressure plate surfaces, removing any grease prior to assembly.

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- Slide the clutch disk onto the transmission input shaft to check for smooth engagement. Remove clutch disk.
- Apply a very thin coating of Optimol Olista Longtime synthetic grease to the transmission input shaft. Slide the clutch disk along the full length of the input shaft to transfer grease to the clutch hub splines. Remove clutch disc, and remove any excess grease from the exterior of the clutch disc hub. **It is very important that no excess grease is left on the exterior of the clutch hub or clutch disk!**
- Install two temporary pilot studs (7/16-14, 3" long), placing them on the same diameter, 180° apart. These are used to aid in the alignment of the clutch pressure plate.
- Verify that the pilot bearing is seated properly in the flywheel. Insert a clutch alignment tool (SAE 2" DIA, 10 Spline) through the clutch disc and into the pilot bearing. PLEASE NOTE: the direction matters – the large side of the hub should face the clutch pressure plate. The clutch disc hub should be marked "flywheel side" – this side should face the flywheel.
- Use the clutch alignment tool to keep the clutch disc in the proper position and align the clutch cover with the two studs. Push the cover in place in the direction of the flywheel and start installing the clutch bolts. Use Lock-Tite for each bolt. Install, but do not torque, the 10 bolts. Remove the two pilot studs and in their place install the remaining 2 bolts.
- When the bolts are hand tight, be sure that the clutch cover fits into the flywheel centering ring. Tighten each bolt a little at a time, in a crisscross pattern, until the pressure plate cover contacts the flywheel face. Once the cover has touched the face of the flywheel, torque the clutch bolts to 55 ft-lbs, again in a crisscross fashion.
- Remove the clutch alignment tool. If the installation was successful, it should slide out smoothly.
- Ensure that the release bearing retaining clip (located on the "fingers" of the pressure plate) is closed. Refer to figure 8.
- Remove the Clutch Inspection Cover from the bottom of the transmission.
- The transmission should have been shipped in gear. This will allow the installer to rotate the output shaft in order to align the input shaft with the clutch disc hub. If the transmission is in neutral, a "strap wrench" (with a rubber or leather strap) can be used to align the input shaft. Do not use a wrench

of the "chain" variety, as damage to the input shaft may result. When aligned, push the transmission towards the engine. Be sure that the bell housing contacts the flywheel housing.

Warning!

- Insure that the transmission moves in a straight line. It can very easily go off center relative to the clutch disc and pilot bearing.
- Insure that the bell housing interfaces evenly with the flywheel housing. Even surface contact should be attained before tightening bolts.
- Do not try to correct relative position of the bell housing and flywheel housing by pulling the transmission into place with the bell housing bolts. The transmission bell housing should seat into the flywheel housing freely.
- When the bell housing and flywheel housing surfaces and bolt holes are aligned, install the transmission bolts. Only hardened steel flat washers should be used, **SERRATED LOCK WASHERS ARE NOT ALLOWED.** Torque the transmission bolts to 55 ft-lbs. in a crisscross fashion.
- From underneath, push the clutch release bearing forward (in the direction of flywheel) using the release fork. Use force to snap the bearing into the retaining clip located on the "fingers" of the pressure plate. The installer should be able to both hear and feel the bearing seat into place. Refer to figure 8.

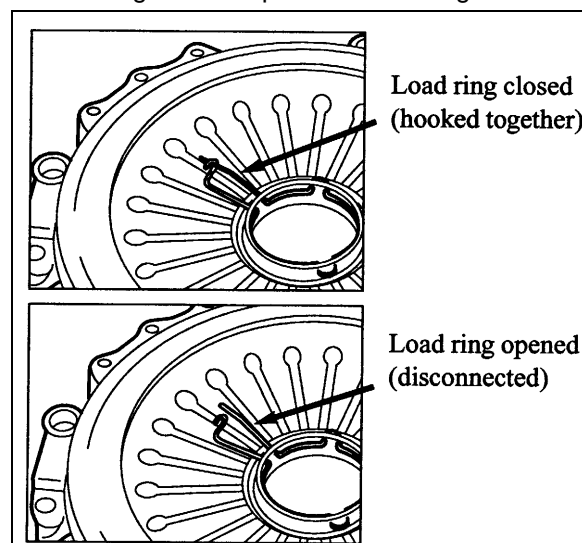


FIGURE 8: RELEASE BEARING RETAINING CLIP 07112

- Install the Clutch Actuator inspection cover.
- The clutch/transmission installation is now complete.

4. INSTALLATION OF ZF OR ALLISON TRANSMISSION BRACKETS

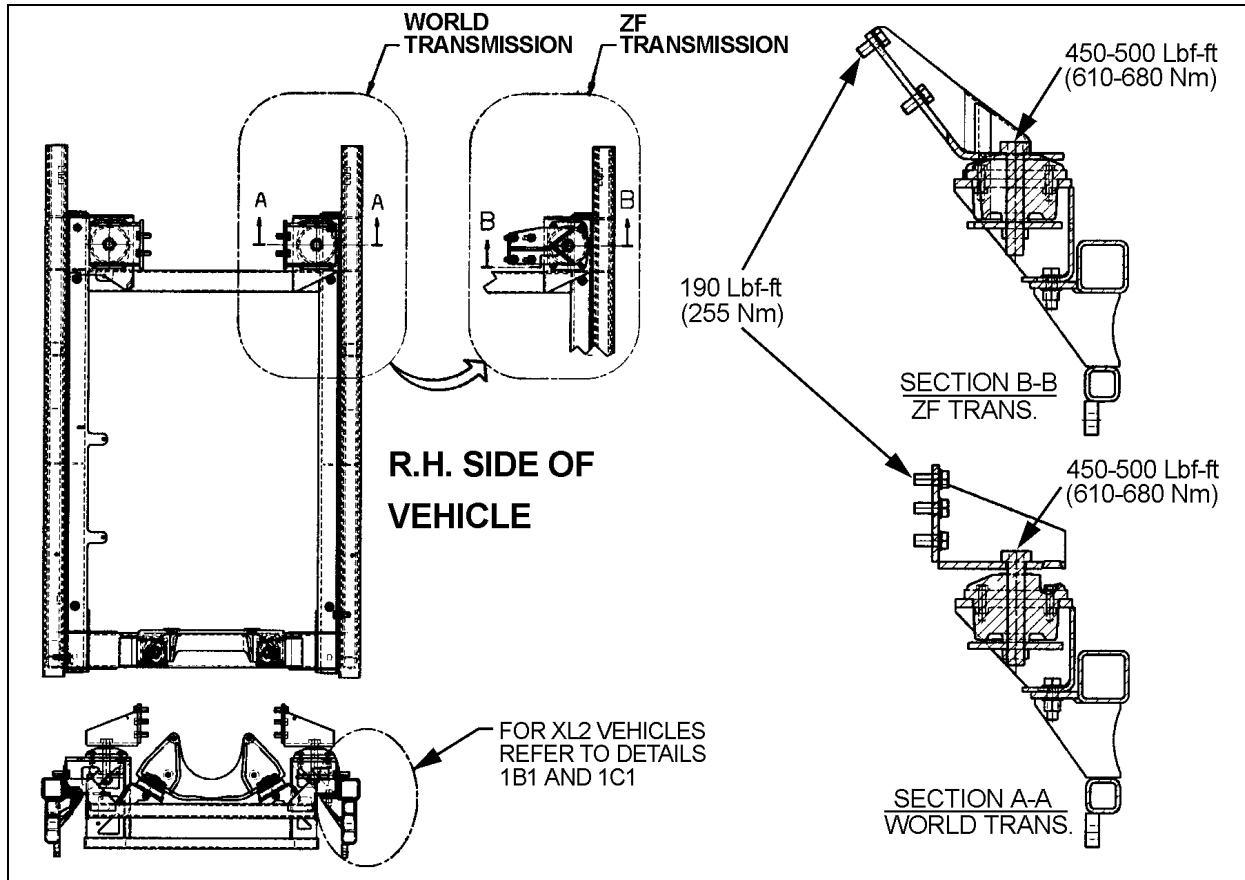


FIGURE 9: ZF OR ALLISON TRANSMISSION BRACKETS

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5. ALLISON TRANSMISSION REMOVAL

The following procedure deals with the removal of the Allison transmission without removing the power plant cradle from vehicle. The methods used to support the transmission and engine depend upon conditions and available equipment.

1. Select transmission's "NEUTRAL" position, apply parking brake, then set battery master switch to the "OFF" position.
2. Jack up vehicle, then place safety supports underneath body.



Only the recommended jacking points must be used as outlined in Section 18, "BODY".

NOTE

For more clearance between the tag axle and transmission, the tag axle may be unloaded and jacked up or retracted (if applicable).

3. Remove engine splash guards and protective panels surrounding transmission.
4. Remove cross member from under transmission.
5. Remove the transmission drain plug and allow oil to drain. Inspect the drain plug washer and replace it if necessary. Reinstall the drain plug and tighten to 33-41 lbf-ft (45-56 Nm) (see "3.2.9 Oil and Filter Change" in this section).



It is better to drain oil when it is still warm. Avoid contact with oil since it can be very hot and cause personal injury.

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6. Remove transmission dipstick and filler tube.
7. Disconnect propeller shaft from transmission and remove its safety guard. Refer to Section 09, "PROPELLER SHAFT".
8. Disconnect the two oil cooler hoses from transmission. Cover hose ends and fittings to prevent fluid contamination.

⚠ WARNING ⚠

A significant amount of oil may drain from oil lines when they are disconnected.

9. Disconnect all sensors on L.H. side of the transmission.
10. Disconnect main wiring harness.
11. Disconnect the air supply line (steel-braided hose) from retarder control valve (if applicable).
12. Remove any locking tie, clamp and bracket that may interfere with the removal of transmission.
13. Support transmission using a suitable transmission jack.
14. Remove the access plug from the flywheel housing on the R.H. side below starter. From access plug, remove the 12 converter-to-flexible plate attaching screws. Cranking the engine to gain access to the attaching screws may be done by turning the crankshaft pulley using a suitable adapter (fig. 11).

⚠ CAUTION ⚠

Do not rotate alternator shaft clockwise to avoid removing tension on belt.

15. Remove the 12 screws retaining the torque converter housing to the flywheel housing.

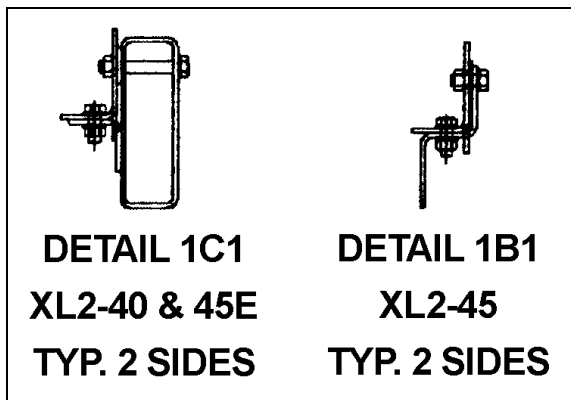


FIGURE 10: DETAILS FOR XL2 VEHICLES

07116

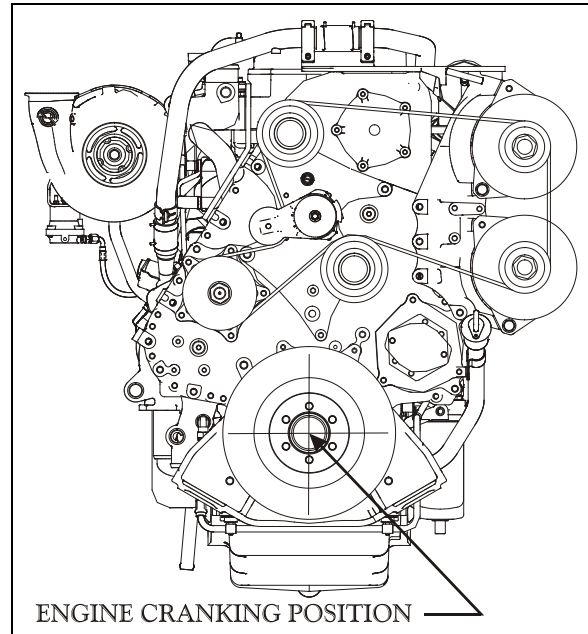


FIGURE 11: ENGINE CRANKING POSITION

01153

⚠ CAUTION ⚠

Make sure transmission-to-engine alignment is maintained when removing screws to avoid damaging torque converter housing.

16. Remove the transmission rubber mount above transmission by removing the nut, bolt and washer over the rubber and its support. Remove the bracket from transmission (only if the vehicle is equipped with a retarder).
17. Slowly pull transmission straight out to clear the engine.
18. Remove the transmission.

6. TRANSMISSION OIL COOLER REMOVAL

6.1 TRANSMISSION WITHOUT RETARDER

Stop engine and allow engine to cool. Close both heater line shutoff valves (refer to Section 05 "Cooling").

To drain the cooling system, proceed as per Section 05 "Cooling", paragraph 5: Draining. If the cooling system is contaminated, flush system as per Section 05 "Cooling", paragraph 7: Flushing.

1. Disconnect and remove the engine air intake duct mounted between the air cleaner housing and the turbocharger inlet.

⚠ CAUTION ⚠

To avoid damage to turbocharger, cover the turbocharger inlet opening to prevent foreign material from entering.

2. Disconnect the two transmission hoses from oil cooler. Cover hose ends and fittings to prevent fluid contamination.

⚠ WARNING ⚠

A significant amount of oil may drain from oil lines when they are disconnected.

3. Unfasten the constant-torque hose clamps and remove the two hoses.

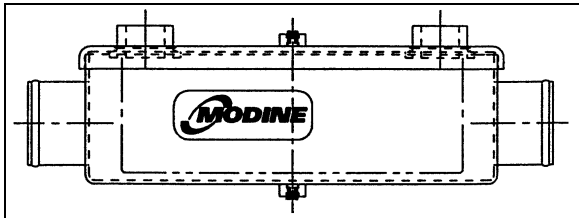


FIGURE 12: MODINE OIL COOLER 07072

4. Unscrew the four holding nuts and remove the U-bolts, remove the oil cooler from engine compartment.
5. Reinstall transmission oil cooler by using reverse procedure.

6.2 TRANSMISSION WITH RETARDER

Stop engine and allow engine to cool. Close both heater line shutoff valves (refer to Section 05 "Cooling").

1. To drain the cooling system, proceed as per Section 05 "Cooling", paragraph 5: Draining. If the cooling system is contaminated, flush system as per Section 05 "Cooling", paragraph 7: Flushing.
2. Disconnect and remove the engine air intake duct mounted between the air cleaner housing and the turbocharger inlet.

⚠ CAUTION ⚠

To avoid damage to turbocharger, cover the turbocharger inlet opening to prevent foreign material from entering.

3. Disconnect the transmission hoses from oil cooler. Cover hose ends and fittings to prevent fluid contamination.

⚠ WARNING ⚠

A significant amount of oil may drain from oil lines when they are disconnected.

4. Unfasten the constant-torque hose clamps and remove the two hoses.
5. Unscrew the holding bolts and nuts and remove the oil cooler from engine compartment.

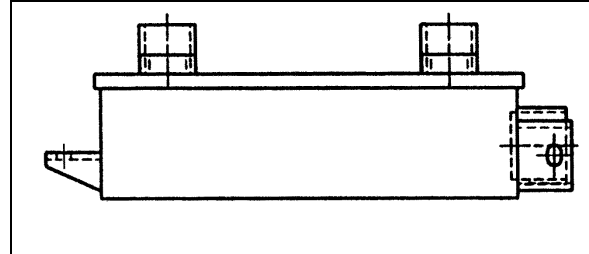


FIGURE 13: COOLER WITH RETARDER 07073

6. Reinstall transmission oil cooler by using reverse procedure.

7. CLEANING AND INSPECTION OF THE TRANSMISSION

7.1 ALLISON AUTOMATIC TRANSMISSION

The exterior of the transmission should be cleaned and inspected at regular intervals. The length of service and severity of operating conditions will determine the frequency of such inspections. Inspect the transmission for:

1. Loose bolts (transmission and mounting components);
2. Oil leaks (correct immediately);
3. Loose, dirty, or improperly adjusted throttle sensor linkage;
4. Damaged or loose oil lines;
5. Worn or frayed electrical harnesses, improper routing;
6. Worn or out of phase drive line U-joint and slip fittings.

⚠ CAUTION ⚠

DO NOT pressure wash the transmission electrical connectors. Water and detergent will cause the contacts to corrode or become faulty.

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7.1.1 Breather

The breather is located on the engine, flywheel side near the valve cover. It serves to prevent pressure build-up within the transmission and must be cleaned to keep the passage opened. The prevalence of dust and dirt will determine the frequency at which the breather requires cleaning. Use care when cleaning the engine. Spraying steam, water or cleaning solution directly at the breather can force the water or solution into the transmission. Always use care when removing the hose connector from transmission to prevent the entry of foreign matter.

8. ALLISON TRANSMISSION INSTALLATION

NOTE

For more clearance between the tag axle and transmission, the tag axle may be unloaded and jacked up, or retracted (if applicable).

1. With the access plug removed, align one of the 12 attaching screw holes in the flexible plate with the access opening (starter side).
2. Place the transmission on a transmission jack.
3. Install a headless guide bolt into one of the 12 threaded holes for flexible plate attaching screws in the flywheel.
4. Lubricate the flywheel center pilot boss with molybdenum disulfide grease (Molycote G, or equivalent).
5. Raise transmission and position the flywheel pilot boss into the flexible plate adapter. Align the guide bolt previously installed in the flywheel with the flexible plate hole facing the access opening in the flywheel housing.

⚠ WARNING ⚠

Severe damages and/or personal injury can occur if transmission is not adequately supported.

6. Seat the transmission against the engine flywheel housing. **NO FORCE IS REQUIRED.** If interference is encountered, move the transmission away from engine, then investigate the cause.

⚠ CAUTION ⚠

The torque converter housing must be seated against the flywheel housing prior to tightening any screws. DO NOT USE SCREWS TO SEAT THE HOUSING.

7. Start all torque converter housing screws, and then tighten four of them gradually and in a criss-cross sequence around the housing. Tighten the 12 remaining screws. Recommended torque is between 42-50 lbf-ft (57-68 Nm).

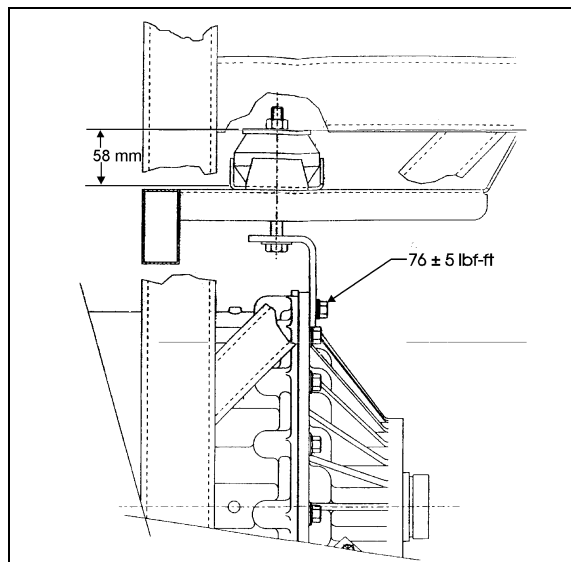


FIGURE 14: NUT TOLERANCE

07014

8. Remove the guide bolt through the access opening in the flywheel housing. Replace it with a self-locking screw, finger-tighten then start the remaining screws; tighten to 17-21 lbf-ft (23-28 Nm). Place a wrench on the crankshaft pulley attaching screw to turn the converter to gain access to the threaded holes.
9. Reinstall the access plug.
10. If the vehicle is equipped with a retarder; install the bracket on the transmission and tighten the bolt to 71-81 lbf-ft (96-110 Nm). Install the transmission rubber mount between the rubber support and the frame with a bolt, nut and washer. Tighten the nut until the tolerance of 58 ± 2 mm is met (Fig. 14).
11. Remove jack from under transmission.
12. Connect all sensors.
13. Connect the main wiring harness.
14. Connect the air supply line (steel-braided hose) to the retarder control valve (if applicable).
15. Connect the two transmission oil cooler hoses as they were previously.

16. Reinstall clamps and brackets, and replace locking ties previously removed during removal procedure.
17. Install propeller shaft and its safety guard. Refer to Section 09, "PROPELLER SHAFT".
18. Install transmission dipstick and filler tube.
19. Install cross member under transmission.
20. Install engine splash guards.
21. Adjust the retarder pressure to 80 ± 3 psi with the air pressure regulator. For more information refer to Section 12, "BRAKE AND AIR SYSTEM", under heading "AIR PRESSURE REGULATOR". The air pressure regulator is located at back of engine compartment, on R.H. side (Fig. 15) or in the R.H. side rear service compartment.
22. Make sure that the drain plug is in place, and then remove the transmission dipstick and pour approximately 24 US quarts (23 L) of automatic transmission fluid through the filler tube. Check and adjust oil level.



Do not overfill the transmission. Overfilling can cause oil aeration (milky appearance) and overheating. If overfilling occurs, drain oil as required to bring it to the proper level.

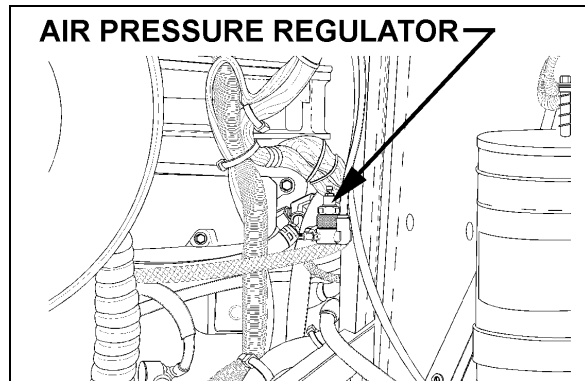


FIGURE 15: AIR PRESSURE REGULATOR (TYPICAL) 07037

9. ALLISON TRANSMISSION PRINCIPLES OF OPERATION

Refer to "Allison Transmission, MD Series, Principles of Operation, SA 2454".

10. TROUBLESHOOTING

10.1 ALLISON AUTOMATIC TRANSMISSION

Refer to "Allison Transmission, MD Series, Troubleshooting Manual, SA 2158A".

10.1.1 WTEC/Electronic Control Unit

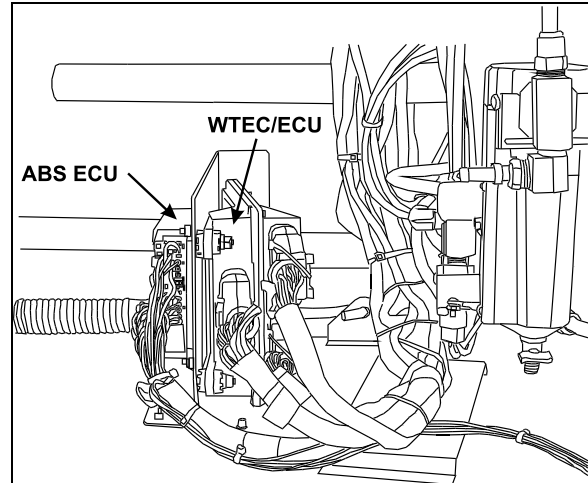


FIGURE 16: WTEC / ELECTRONIC CONTROL UNIT 07075

The "World" automatic transmission has a new Electronic Control Unit (ECU) which involves specific diagnostic incident codes. The ECU transmission unit is located in the coach front service compartment.

WTEC/ECU Replacement

The automatic transmission ECU is a non-serviceable electronic device. When it fails, it must be replaced using the following procedure:

- ◆ Open the coach front service compartment in order to get access to the ECU;
- ◆ Remove the electrical cable connectors;
- ◆ Unscrew the WTEC/ECU unit;
- ◆ Replace by reversing the procedure.



Place the battery master switch to the "OFF" position.

10.1.2 WTEC/Troubleshooting

For complete information about WTEC/Troubleshooting, refer to "Allison Transmission, MD Series, Troubleshooting Manual, SA2978" March 1997, pages D-9 and D-10.

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10.1.3 Diagnostic Code Memory

Diagnostic codes are logged in a list in memory (sometimes referred to as the queue), positioning the most recently occurring code first and containing up to five codes. The codes contained in the list have the information recorded as shown in the chart below. Access to the code list position, main code, sub code and active indicator is available through either the shifter display or the Pro-Link Diagnostic Data Reader (DDR). Access to the ignition cycle counter and event counter is obtained through the DDR only.

Code List Position	Main Code	Sub Code	Active Indicator	Ignition Cycle Counter	Event Counter
d1	21	12	YES	00	10
d2	41	12	YES	00	04
d3	23	12	NO	08	02
d4	34	12	NO	13	01
d5	56	11	NO	22	02
Displayed on shifter display and DDR			YES= ACTIVE= "MODE ON"	Ignition cycle counter and event counter are not available on shifter display	
NOTE					
<i>All information is available with a diagnostic tool (DDR).</i>					

The following paragraphs define the different parts of the code list.

Code List Position

The position (1 through 5) which a code occupies in the code list in memory. Positions are shown as "d1" (Diagnostic Code #1) through "d5."

Main Code

The general condition or area of fault detected by ECU.

Sub Code

The specific area or condition under the main code in which the condition was detected.

Active Indicator

Will be turned "On" when a fault condition is active (shifter will display "MODE ON" or the DDR will display "YES"). Will be set to "Off" when conditions exist to indicate fault condition is gone.

Ignition Cycle Counter

Used to clear diagnostic codes that are inactive from the code list in memory. A counter is incremented each time a normal ECU power down occurs following clearing of the Active Indicator. A code will be cleared from the list when the counter exceeds 25.

Event Counter

Used to count the number of occurrences of a diagnostic code that occurs prior to the incident being cleared from the code list. The most recent code will be in position "d1". If the most recent

code is one which is already in the code list, that code will be moved to position "d1", the Active Indicator will be turned "On" (shifter will display "MODE ON" or the DDR will display "YES"), the Ignition Cycle Counter is cleared and "1" is added to the Event Counter.

Clearing the Active Indicator and code Records from the Code List in Memory

If the conditions causing a diagnostic code to be set are cleared, the Active Indicator can be manually cleared by holding the "MODE" button down continuously for 3 seconds until a tone is heard from the shifter.

To clear code records from the list, hold the "MODE" button down continuously for ten seconds until a second tone sounds. All diagnostic records in the list that are not active will then be cleared and the remaining records will be moved up the list.

Code Reading and Code Clearing Procedures

Diagnostic codes can be read and cleared by two methods: by using the Pro-Link 9000 DDR plugged in the receptacle located on L.H. lateral console (Shells)/L.H. side control panel (Coaches) or by using the shifter display. The use of the Pro-Link 9000 DDR is described in the instruction manual supplied with each tool. The method for reading and clearing codes described in this section refers only to entering of the Diagnostic Display Mode by the proper button selection.

The Diagnostic Display Mode may be entered for viewing of codes at any speed. Codes can only be cleared when the output speed = 0 and no output speed sensor failure is active.

The following descriptions explain how to use the shifter to read and clear codes.

10.1.4 Reading Codes

1. Enter the diagnostic display mode by pressing the "▲" and "▼" (upshift and downshift arrows) buttons at the same time on the pushbutton shifter.

NOTE

If a "DO NOT SHIFT" condition is present at this time, the lever should be in the same position as it was at the time of code detection. If not, this shifter tone will sound continuously.

NOTE

If an Oil Level Sensor (OLS) is present, the oil level will be displayed first. Diagnostic code display is achieved by depressing the UPSHIFT and DOWNSHIFT arrows or display MODE button a second time.

2. Read the first code in the first of five code positions on the digital display of the shifter. For example, we will read code 25 11 in the first position. The display will change every two seconds as follows:
 - a. Code list position --"d1";
 - b. Main code --"25";
 - c. Sub code --"11"; and
 - d. Display will repeat cycle of a., b. and c, above.
3. Press the "MODE" button momentarily to view the second position (d2) in the same way as 2. above.
4. To view the third, fourth and fifth positions (d3, d4 and d5), momentarily press the "MODE" button as explained above.
5. Pressing the "MODE" button momentarily after the fifth position is displayed will cause the sequence of code positions to start over with the first position.
6. Any code that is active will be indicated by the "MODE ON" indicator (Active Indicator) being turned on while in that code position (while in the normal operation).
7. Any code position in the list which does not have a diagnostic code logged will display "- -" for both the main and sub code displays. All positions after a code codes.

10.1.5 Clearing Codes

1. Clearing of the active indicator is automatically done at ECU power down on all but code 69 34.
2. Some codes will clear the active indicator automatically when the condition causing the code is no longer detected by the ECU (see Diagnostic Code List and Description, page 7 - 22).
3. Manual clearing is possible while in the diagnostic display mode and after the condition causing the code is corrected (output speed must be zero).

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- a. To clear all active indicators, hold the "MODE" button down continuously for 3 seconds until the shifter tone sounds for 0.5 seconds.
- b. Release the "MODE" button to return to normal operating mode. If the condition causing the code was not active at the time, the active indicator will turn off.



If clearing a code while locked in a Forward or Reverse position (fail-to-range), the transmission will still be in Drive or Reverse when the clearing procedure is completed. Neutral must be selected manually.

Exiting the Diagnostic Display Mode

The diagnostic display mode can be exited by any of the following procedures:

1. Press the "▲" and "▼" (upshift and downshift) buttons at the same time on the pushbutton shifter.
2. Press any range button, "D", "N" or "R", on the pushbutton shifter (the shift will be commanded if it is not inhibited by an active code).
3. Do nothing and wait until the calibrated time (approximately 10 minutes) has passed and the system automatically returns to the normal operating mode.
4. Turn off power to the ECU (turn off the vehicle at the ignition switch).
5. After the clearing of a code, the active indicator procedure described above has been performed.

Clearing Records from the Code List in Memory

If the requirements for Manual Clearing the Active Indicator have been satisfied, and the "MODE" button is held down continuously for ten seconds while in the display mode until a tone sounds, then all diagnostic records in the code list that are not active will be cleared and the remaining records will be moved up in the code list.

Abbreviations found in the Code Chart

The following responses are used throughout the following chart to command safe operation when diagnostic codes are set.

1. **DNS (Do Not Shift) Response**
 - a. Turn off lockup clutch and inhibit lockup operation.
 - b. Inhibit all shifts.
 - c. Turn on the *DO NOT SHIFT* light.
 - d. Pulse the tone generator for 8 seconds when the condition is first detected.
 - e. Blank the select digit in the display.
 - f. Ignore any range selection inputs and disable the button feedback tone for the pushbutton shifter.
2. **SOL OFF (Solenoid Off) Response**

All solenoids are commanded off (turning solenoids "A" and "B" off electrically causes them to be on hydraulically).
3. **RPR (Return to Previous Range) Response**

When the ratio or C3 pressure switch tests associated with a shift are not passed, the ECU commands the same range as commanded at the beginning of the shift.
4. **NNC (Neutral No Clutches) Response**

When certain ratio or C3 pressure switch tests are not passed, the ECU commands a neutral condition with no clutches applied.

Diagnostic code list and description

MAIN CODE	SUB CODE	DESCRIPTION	DO NOT SHIFT LIGHT	INHIBITED OPERATION DESCRIPTION
12	12	Oil level, low	No	No upshift above a calibration range
12	23	Oil level, high	No	No upshift above a calibration range
13	12	ECU input voltage, low	Yes	DNS, SOL OFF (Hydraulic default)
13	13	ECU input voltage, medium low	No	None: Shift adaptive feature will not function.
13	23	ECU input voltage, high	Yes	DNS, SOL OFF (Hydraulic default)
14	12	Oil level sensor, low	No	None
14	23	Oil level sensor, high	No	None
21	12	Throttle position sensor, low	No	Use Throttle default value
21	23	Throttle position sensor, high	No	Use Throttle default value
22	14	Engine speed sensor reasonableness test	No	Use default engine speed
22	15	Turbine speed sensor reasonableness test	Yes	DNS, Lock in current range
22	16	Output speed sensor reasonableness or rapid decel test	Yes	DNS, Lock in current range
23	12	Primary Shifter or RSI Link Fault	No	Hold in last valid direction
23	13	Primary Shifter Mode Function Fault	No	Mode change not permitted
23	14	Secondary Shifter or RSI Link Fault	No	Hold in last valid direction
23	15	Secondary Shifter Mode Function Fault	No	Mode change not permitted
24	12	Sump oil temperature, cold	Yes	DNS
24	23	Sump oil temperature, hot	No	No upshifts above a calibration range
25	00	Output speed reasonableness test, detected at 0 speed, (L)	Yes	DNS, Lock in current range (L)
25	11	Output speed reasonableness test, detected at 0 speed, (1st)	Yes	DNS, Lock in current range (1st)
25	22	Output speed reasonableness test, detected at 0 speed 2nd	Yes	DNS, Lock in current range (2nd)
25	33	Output speed reasonableness test, detected at 0 speed, 3rd	Yes	DNS, Lock in current range (3rd)

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MAIN CODE	SUB CODE	DESCRIPTION	DO NOT SHIFT LIGHT	INHIBITED OPERATION DESCRIPTION
25	44	Output speed reasonableness test, detected at 0 speed, 4th	Yes	DNS, Lock in current range (4th)
25	55	Output speed reasonableness test, detected at 0 speed, 5th	Yes	DNS, Lock in current range (5th)
25	66	Output speed reasonableness test, detected at 0 speed, 6th	Yes	DNS, Lock in current range (6th)
25	77	Output speed reasonableness test, detected at 0 speed, R	Yes	DNS, Lock in current range (R)
32	00	C3 pressure switch open, L range	Yes	DNS, Lock in current range (L)
32	33	C3 pressure switch open, 3rd range	Yes	DNS, Lock in current range (3rd)
32	55	C3 pressure switch open, 5th range	Yes	DNS, Lock in current range (5th)
32	77	C3 pressure switch open, R range	Yes	DNS, Lock in current range (R)
33	12	Sump oil temperature sensor, low	No	Use default value of 200° F (93° C)
33	23	Sump oil temperature sensor, high	No	Use default value of 200° F (93° C)
34	12	EEPROM, factory cal. compatibility number wrong	Yes	DNS, SOL OFF (Hydraulic default)
34	13	EEPROM, factory calibration block checksum	Yes	DNS, SOL OFF (Hydraulic default)
34	14	EEPROM, Power Off Block checksum	Yes	Use previous location, or factory calibration and reset adaptive
34	15	EEPROM, Diagnostic Queue Block Checksum	Yes	Use previous location, or clear diagnostic queue
34	16	EEPROM, Real Time Block Checksum	Yes	DNS, SOL OFF (Hydraulic default)
35	00	Power interruption (Code set after power restored)	No	NONE (Hydraulic default during interruption)
35	16	Real Time EEPROM Write Interruption	Yes	DNS, SOL OFF (Hydraulic default)
36	00	Hardware/Software not compatible	Yes	DNS, SOL OFF (Hydraulic default)
41	12	Open or short to ground, A solenoid circuit	Yes	DNS, SOL OFF (Hydraulic default)

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MAIN CODE	SUB CODE	DESCRIPTION	DO NOT SHIFT LIGHT	INHIBITED OPERATION DESCRIPTION
41	13	Open or short to ground, B solenoid circuit	Yes	DNS, SOL OFF (Hydraulic default)
41	14	Open or short to ground, C solenoid circuit	Yes	DNS, SOL OFF (Hydraulic default)
41	15	Open or short to ground, D solenoid circuit	Yes	DNS, SOL OFF (Hydraulic default)
41	16	Open or short to ground, E solenoid circuit	Yes	DNS, SOL OFF (Hydraulic default)
41	21	Open or short to ground, F solenoid circuit	No	Lock-up inhibited
41	22	Open or short to ground, G solenoid circuit	Yes	DNS, SOL OFF (Hydraulic default)
41	23	Open or short to ground, H solenoid circuit	No	Retarder allowed, differential lock inhibited
41	24	Open or short to ground, J solenoid circuit	No	Low and 1st inhibited
41	25	Open or short to ground, K solenoid circuit	No	K solenoid operation inhibited
41	26	Open or short to ground, N solenoid circuit	No	Low and 1st inhibited
42	12	Short to battery, A solenoid circuit	Yes	DNS, Lock in a range
42	13	Short to battery, B solenoid circuit	Yes	DNS, Lock in a range
42	14	Short to battery, C solenoid circuit	Yes	DNS, Lock in a range
42	15	Short to battery, D solenoid circuit	Yes	DNS, Lock in a range
42	16	Short to battery, E solenoid circuit	Yes	DNS, Lock in a range
42	21	Short to battery, F solenoid circuit	No	Lock-up inhibited
42	22	Short to battery, G solenoid circuit	Yes	DNS, Lock in a range
42	23	Short to battery, H solenoid circuit	No	Retarder allowed, differential lock inhibited
42	24	Short to battery, J solenoid circuit	No	Low and 1st inhibited

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MAIN CODE	SUB CODE	DESCRIPTION	DO NOT SHIFT LIGHT	INHIBITED OPERATION DESCRIPTION
42	25	Short to battery, K solenoid circuit	No	K solenoid operation inhibited
42	26	Short to battery, N solenoid circuit	No	Low and 1st inhibited
43	21	Low side driver, F solenoid circuit	No	Lock-up inhibited
43	25	Low side driver, K solenoid circuit	No	K solenoid operation inhibited
43	26	Low side driver, N solenoid circuit	No	Low and 1st inhibited
44	12	Short to ground, A solenoid circuit	Yes	DNS, SOL OFF (Hydraulic default)
44	13	Short to ground, B solenoid circuit	Yes	DNS, SOL OFF (Hydraulic default)
44	14	Short to ground, C solenoid circuit	Yes	DNS, SOL OFF (Hydraulic default)
44	15	Short to ground, D solenoid circuit	Yes	DNS, SOL OFF (Hydraulic default)
44	16	Short to ground, E solenoid circuit	Yes	DNS, SOL OFF (Hydraulic default)
44	21	Short to ground, F solenoid circuit	No	Lock-up inhibited
44	22	Short to ground, G solenoid circuit	Yes	DNS, SOL OFF (Hydraulic default)
44	23	Short to ground, H solenoid circuit	No	Retarder allowed. differential lock inhibited
44	24	Short to ground, J solenoid circuit	No	Low and 1st inhibited
44	25	Short to ground, K solenoid circuit	No	K solenoid operation inhibited
44	26	Short to ground, N solenoid circuit	No	Low and 1st inhibited
45	12	Open circuit, A solenoid circuit	Yes	DNS, SOL OFF (Hydraulic default)
45	13	Open circuit, B solenoid circuit	Yes	DNS, SOL OFF (Hydraulic default)
45	14	Open circuit, C solenoid circuit	Yes	DNS, SOL OFF (Hydraulic default)

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MAIN CODE	SUB CODE	DESCRIPTION	DO NOT SHIFT LIGHT	INHIBITED OPERATION DESCRIPTION
45	15	Open circuit, D solenoid circuit	Yes	DNS, SOL OFF (Hydraulic default)
45	16	Open circuit, E solenoid circuit	Yes	DNS, SOL OFF (Hydraulic default)
45	21	Open circuit, F solenoid circuit	No	Lock-up inhibited
45	22	Open circuit, G solenoid circuit	Yes	DNS, SOL OFF (Hydraulic default)
45	23	Open circuit, H solenoid circuit	No	Retarder allowed differential lock inhibited
45	24	Open circuit, J solenoid circuit	No	Low and 1st inhibited
45	25	Open circuit, K solenoid circuit	No	K solenoid operation inhibited
45	26	Open circuit, N solenoid circuit	No	Low and 1st inhibited
51	10	Offgoing ratio test (during shift), 1 to L	Yes	Low and 1st inhibited
51	12	Offgoing ratio test (during shift), 1 to 2	Yes	DNS, RPR
51	21	Offgoing ratio test (during shift), 2 to 1	Yes	DNS, RPR
51	23	Offgoing ratio test (during shift), 2 to 3	Yes	DNS, RPR
51	43	Offgoing ratio test (during shift), 4 to 3	Yes	DNS, RPR
51	45	Offgoing ratio test (during shift), 4 to 5	Yes	DNS, RPR
51	65	Offgoing ratio test (during shift), 6 to 5	Yes	DNS, RPR
52	01	Offgoing C3PS test (during shift), L to 1	Yes	DNS, RPR
52	08	Offgoing C3PS test (during shift), L to N1	Yes	DNS, NNC
52	32	Offgoing C3PS test (during shift), 3 to 2	Yes	DNS, RPR

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MAIN CODE	SUB CODE	DESCRIPTION	DO NOT SHIFT LIGHT	INHIBITED OPERATION DESCRIPTION
52	34	Offgoing C3PS test (during shift), 3 to 4	Yes	DNS, RPR
52	54	Offgoing C3PS test (during shift), 5 to 4	Yes	DNS, RPR
52	56	Offgoing C3PS test (during shift), 5 to 6	Yes	DNS, RPR
52	71	Offgoing C3PS test (during shift), R to 1	Yes	DNS, NNC
52	72	Offgoing C3PS test (during shift), R to 2	Yes	DNS, NNC
52	78	Offgoing C3PS test (during shift), R to N1	Yes	DNS, NNC
52	79	Offgoing C3PS test (during shift), R to 2 (R to NNC to 2)	Yes	DNS, NNC
52	99	Offgoing C3PS test (during shift), N3 to N2	Yes	DNS, RPR
53	08	Offgoing speed test (during shift), L to N1	Yes	DNS, NNC
53	18	Offgoing speed test (during shift), 1 to N1	Yes	DNS, NNC
53	28	Offgoing speed test (during shift), 2 to N1	Yes	DNS, NNC
53	29	Offgoing speed test (during shift), 2 to N2	Yes	DNS, RPR
53	38	Offgoing speed test (during shift), 3 to N1	Yes	DNS, NNC
53	39	Offgoing speed test (during shift), 3 to N3	Yes	DNS, RPR
53	48	Offgoing speed test (during shift), 4 to N1	Yes	DNS, NNC
53	49	Offgoing speed test (during shift), 4 to N3	Yes	DNS, RPR
53	58	Offgoing speed test (during shift), 5 to N1	Yes	DNS, NNC
53	59	Offgoing speed test (during shift), 5 to N3	Yes	DNS, RPR

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MAIN CODE	SUB CODE	DESCRIPTION	DO NOT SHIFT LIGHT	INHIBITED OPERATION DESCRIPTION
53	68	Offgoing speed test (during shift), 6 to N1	Yes	DNS, NNC
53	69	Offgoing speed test (during shift), 6 to N4	Yes	DNS, RPR
53	78	Offgoing speed test (during shift), R to N1	Yes	DNS, NNC
53	99	Offgoing speed test (during shift), N2 to N3 or N3 to N2	Yes	DNS, RPR
54	01	Oncoming ratio test (after shift), L to 1	Yes	DNS, RPR
54	07	Oncoming ratio test (after shift), L to R	Yes	DNS, NNC
54	10	Oncoming ratio test (after shift), 1 to L	Yes	DNS, RPR
54	12	Oncoming ratio test (after shift), 1 to 2	Yes	DNS, RPR
54	17	Oncoming ratio test (after shift), 1 to R	Yes	DNS, NNC
54	21	Oncoming ratio test (after shift), 2 to 1	Yes	DNS, RPR
54	23	Oncoming ratio test (after shift), 2 to 3	Yes	DNS, RPR
54	27	Oncoming ratio test (after shift), 2 to R	Yes	DNS, NNC
54	32	Oncoming ratio test (after shift), 3 to 2	Yes	DNS, RPR
54	34	Oncoming ratio test (after shift), 3 to 4	Yes	DNS, RPR
54	43	Oncoming ratio test (after shift), 4 to 3	Yes	DNS, RPR
54	45	Oncoming ratio test (after shift), 4 to 5	Yes	DNS, RPR or SOL OFF (Hydraulic default)
54	54	Oncoming ratio test (after shift), 5 to 4	Yes	DNS,RPR
54	56	Oncoming ratio test (after shift), 5 to 6	Yes	DNS,RPR

Section 07: TRANSMISSION

MAIN CODE	SUB CODE	DESCRIPTION	DO NOT SHIFT LIGHT	INHIBITED OPERATION DESCRIPTION
54	65	Oncoming ratio test (after shift), 6 to 5	Yes	DNS,RPR
54	70	Oncoming ratio test (after shift), R to L	Yes	DNS,NNC
54	71	Oncoming ratio test (after shift), R to 1	Yes	DNS,NNC
54	72	Oncoming ratio test (after shift), R to 2	Yes	DNS,NNC
54	80	Oncoming ratio test (after shift), N1 to L	Yes	DNS,RPR
54	81	Oncoming ratio test (after shift), N1 to 1	Yes	DNS,RPR
54	82	Oncoming ratio test (after shift), N1 to 2	Yes	DNS,RPR
54	83	Oncoming ratio test (after shift), N1 to 3	Yes	DNS,RPR
54	85	Oncoming ratio test (after shift), N1 to 5	Yes	DNS,RPR
54	86	Oncoming ratio test (after shift), N1 to 6	Yes	DNS, RPR
54	92	Oncoming ratio test (after shift), R to 2 (R to NNC to 2)	Yes	DNS, NNC
54	92	Oncoming ratio test (after shift), N1 to 2 (N1 to NNC to 2)	Yes	DNS, RPR
54	92	Oncoming ratio test (after shift), N2 to 2	Yes	DNS, RPR
54	93	Oncoming ratio test (after shift), N3 to 3	Yes	DNS, RPR
54	95	Oncoming ratio test (after shift), N3 to 5	Yes	DNS, RPR
54	96	Oncoming ratio test (after shift), N4 to 6	Yes	DNS, RPR
54	97	Oncoming ratio test (after shift), 2 to R (2 to NNC to R)	Yes	DNS, NNC
55	17	Oncoming C3PS test (after shift), 1 to R	Yes	DNS, NNC

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MAIN CODE	SUB CODE	DESCRIPTION	DO NOT SHIFT LIGHT	INHIBITED OPERATION DESCRIPTION
55	27	Oncoming C3PS test (after shift), 2 to R	Yes	DNS, NNC
55	80	Oncoming C3PS test (after shift), N1 to L	Yes	DNS, RPR
55	87	Oncoming C3PS test (after shift), N1 to R	Yes	DNS, RPR
55	97	Oncoming C3PS test (after shift), 2 to R or NVL to R (2 to NNC to R)	Yes	DNS, NNC
56	00	Range verification test, L	Yes	DNS, 1st, Low, or SOL OFF (Low)
56	11	Range verification test, 1st	Yes	DNS, 6th
56	22	Range verification test, 2nd	Yes	DNS, 6th or 5th
56	33	Range verification test, 3rd	Yes	DNS, 5th or SOL
56	44	Range verification test, 4th	Yes	DNS, 3rd or 5th
56	55	Range verification test, 5th	Yes	DNS, SOL OFF (5th) or 3rd
56	66	Range verification test, 6th	Yes	DNS, 5th, 3rd, or SOL OFF (3rd)
56	77	Range verification test, R	Yes	DNS, N2 or N3
57	11	Range verification C3PS test, 1st	Yes	DNS, SOL OFF (3rd)
57	22	Range verification C3PS test, 2nd	Yes	DNS, 3rd
57	44	Range verification C3PS test, 4th	Yes	DNS, 5th or SOL OFF (3rd)
57	66	Range verification C3PS test, 6th	Yes	SOL OFF (5th), DNS
57	88	Range verification C3PS test, N1	Yes	DNS, N3
57	99	Range verification C3PS test, N2 or N4	Yes	DNS, N3
61	00	Retarder oil temperature, hot	No	None
62	12	Retarder oil temperature sensor, low	No	None
62	23	Retarder oil temperature sensor, high	No	None
63	00	Special function input	No	Depends on special function
64	12	Retarder modulation request sensor, low	No	Retarder operation inhibited
64	23	Retarder modulation request sensor, high	No	Retarder operation inhibited

Section 07: TRANSMISSION

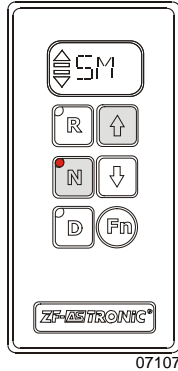
MAIN CODE	SUB CODE	DESCRIPTION	DO NOT SHIFT LIGHT	INHIBITED OPERATION DESCRIPTION
65	00	Engine rating too high	Yes	DNS
66	00	Serial communications interface fault	No	Use default throttle values
69	12	ECU, A solenoid driver open	Yes	DNS, SOL OFF (hydraulic default)
69	13	ECU, B solenoid driver open	Yes	DNS, SOL OFF (hydraulic default)
69	14	ECU, C solenoid driver open	Yes	DNS, SOL OFF (hydraulic default)
69	15	ECU, D solenoid driver open	Yes	DNS, SOL OFF (hydraulic default)
69	16	ECU, E solenoid driver open	Yes	DNS, SOL OFF (hydraulic default)
69	21	ECU, F solenoid driver open	No	Lock-up inhibited
69	22	ECU, G solenoid driver open	Yes	DNS, SOL OFF (Hydraulic default)
69	23	ECU, H solenoid driver open	No	Retarder allowed, differential lock inhibited
69	24	ECU, J solenoid driver open	No	Low and 1 st inhibited
69	25	ECU, K solenoid driver open	No	K solenoid operation inhibited
69	26	ECU, N solenoid driver open	No	Low and 1st inhibited
69	32	ECU, SPI communications link fault	No	Hold in last valid direction
69	33	ECU, Central Operating Processor (COP) time-out	Yes	Reset ECU, Shutdown ECU on 2nd occurrence (power loss: hydraulic defaults)
69	34	ECU, EEPROM write time-out	Yes	DNS, SOL OFF (Hydraulic default)
69	35	ECU, EEPROM checksum	Yes	Induce COP time-out (reset ECU)
69	36	ECU, RAM self test	Yes	Induce COP time-out (reset ECU)
69	41	ECU, I/O ASIC addressing test	Yes	Induce COP time-out (reset ECU)
0	35	Software, minor loop overrun	Yes	Induce COP time-out (reset ECU)

Section 07: TRANSMISSION

MAIN CODE	SUB CODE	DESCRIPTION	DO NOT SHIFT LIGHT	INHIBITED OPERATION DESCRIPTION
70	35	Software, illegal write to access \$0000	Yes	Induce COP time-out (reset ECU)
70	35	Software, major loop overrun	Yes	Induce COP time-out (reset ECU)

11. ZF-ASTRONIC TRANSMISSION SYSTEM FAULTS AND ERROR MESSAGES

11.1 SYSTEM FAULTS (ERROR MESSAGES)



If the “SM” symbol appears in the display, a system error has occurred.

- Stop the vehicle
- Vehicle may no longer be driven

Error messages and the reactions resulting from these errors can be deleted with the vehicle at a standstill and the “Ignition OFF”. (Wait until the display goes out). If the display does not go out once the ignition has been turned “OFF”, set the battery master switch to the **OFF** position. Switch the ignition back on. If the error message is still in place, the transmission has to be repaired. The transmission is inoperative. The vehicle will have to be taken to a service point. The error number(s) must be specified when the service point is contacted.

ERROR CODES

Remark to titles in table:

ZF fault number: defined by ZF.

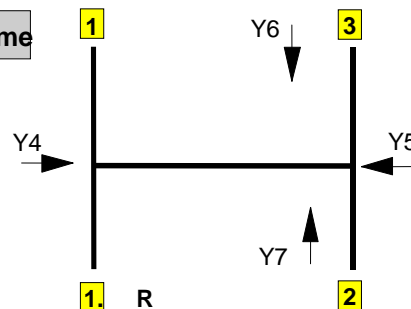
Display SM-Symbol : (0=NO, 1=YES) Display shows “SM”(severe failure)

Warning lamp : (0=NO, 1=YES) Telltale panel warning lamp “check trans”(less severe failure)

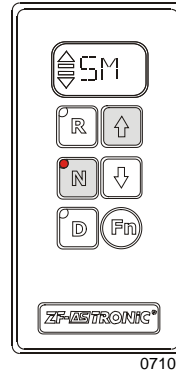
Shift schemes of transmissions:

- Y2 Splitter K2
- Y3 Splitter K1
- Y8 Range (GP) low
- Y9 Range (GP)

10/12-Gear Scheme

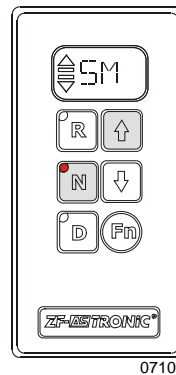


Calling up error numbers



- Switch on ignition
- Depress “N” key
- Hold down “↑” key
- * One or more error numbers appear on the display. These correspond to the errors presently active in the system.

Calling up error numbers from the error memory:



- Switch on ignition
- Press “N” key and at the same time depress the foot-operated brake
- Hold down the foot-operated brake and depress and hold down “↑” key
- * The errors stored in the transmission ECU are shown on the display one after another.

ON MESSAGES CENTER DISPLAY (MCD) SAE-J1587 Codes	ON SHIFT SELECTOR DISPLAY	ISO CODES WITH TESTMAN TOOL	DESCRIPTION
8, 7	8	161	Easy Start, Brake doesn't open completely
8, 14	8	162	Easy Start, Not Available
20,6	14	22	Short circuit to ground at output ACC (wakeup control signal for ZMTEC, keep alive signal for voltage doubler, and power signal for speed sensor #2)
20,5	14	54	Interruption at output ACC (wakeup control signal for ZMTEC, keep alive signal for voltage doubler, and power signal for speed sensor #2)
20,3	14	86	Short circuit to positive at output ACC (wakeup control signal for ZMTEC, keep alive signal for voltage doubler, and power signal for speed sensor #2)
21,2	15	127	Error on ECU temperature sensor signal
21,0	15	193	ECU temperature too high
31,3	1F	137	No range change group (GP) sensor signal (Short circuit to positive)
31,6	1F	138	No range change group (GP) sensor signal (Short circuit to ground)
31,5	1F	139	No range change group (GP) sensor signal (Interruption)
31,13	1F	140	Self adjustment error of range change group sensor in position fast
31,7	1F	159	Range-change group sensor signal leaves engaged position during driving
32,3	20	141	No splitter group (GV) sensor signal (Short circuit to positive)
32,6	20	142	No splitter group (GV) sensor signal (Short circuit to ground)
32,5	20	143	No splitter group (GV) sensor signal (Interruption)
32,13	20	144	Splitter group (GV) sensor self adjustment error
32,7	20	160	Splitter sensor signal leaves engaged position during driving
33,14	21	107	Stabilised voltage supply at output AU (clutch sensor supply) too high or too low
33,13	21	117	Error in clutch self-adjustment process
33,2	21	124	Error on clutch travel signal
34,7	22	120	Mechanical failure of small clutch disengagement valve
34,7	22	121	Mechanical failure of large clutch disengagement valve
34,7	22	122	Mechanical failure of small clutch engagement valve
34,7	22	123	Mechanical failure of large clutch engagement valve
34,6	22	18	Short circuit to ground at output stage to small disengagement clutch valve
34,6	22	19	Short circuit to ground at output stage to small engagement clutch valve
34,6	22	20	Short circuit to ground at output stage to large disengagement clutch valve
34,6	22	21	Short circuit to ground at output stage to large engagement clutch valve
34,5	22	50	Interruption at output stage to small disengagement clutch valve
34,5	22	51	Interruption at output stage to small engagement clutch valve

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ON MESSAGES CENTER DISPLAY (MCD) SAE-J1587 Codes	ON SHIFT SELECTOR DISPLAY	ISO CODES WITH TESTMAN TOOL	DESCRIPTION
34,5	22	52	Interruption at output stage to large disengagement clutch valve
34,5	22	53	Interruption at output stage to large engagement clutch valve
34,3	22	82	Short circuit to positive at output stage to small disengagement clutch valve
34,3	22	83	Short circuit to positive at output stage to small engagement clutch valve
34,3	22	84	Short circuit to positive at output stage to large disengagement clutch valve
34,3	22	85	Short circuit to positive at output stage to large engagement clutch valve
35,5	23	41	Interruption at output stage to Y9 (Valve Range)
35,3	23	73	Short circuit to positive at output stage to Y9 (Valve range)
35,6	23	9	Short circuit to ground at output stage to Y9 (Valve Range)
36,5	24	40	Interruption at output stage to Y8 (Valve Range)
36,3	24	72	Short circuit to positive at output stage to Y8 (Valve range)
36,6	24	8	Short circuit to ground at output stage to Y8 (Valve Range)
37,6	25	2	Short circuit to ground at output stage to Y2 (Valve Splitter)
37,5	25	34	Interruption at output stage to Y2 (Valve Splitter)
37,3	25	66	Short circuit to positive at output stage to Y2 (Valve Splitter)
38,6	26	3	Short circuit to ground at output stage to Y3 (Valve Splitter)
38,5	26	35	Interruption at output stage to Y3 (Valve Splitter)
38,3	26	67	Short circuit to positive at output stage to Y3 (Valve Splitter)
39,5	27	36	Interruption at output stage to Y4 (Valve Select)
39,6	27	4	Short circuit to ground at output stage to Y4 (Valve Select)
39,3	27	68	Short circuit to positive at output stage to Y4 (Valve Select)
40,5	28	38	Interruption at output stage to Y6 (Valve Shift)
40,6	28	6	Short circuit to ground at output stage to Y6 (Valve Shift)
40,3	28	70	Short circuit to positive at output stage to Y6 (Valve Shift)
43,2	2B	175	Error on "Ignition lock" signal (terminal 15)
48,3	30	129	No shift sensor signal (Short circuit to positive)
48,6	30	130	No shift sensor signal (Short circuit to ground)
48,5	30	131	No shift sensor signal (Interruption)
48,13	30	132	Self adjustment error of shift sensor
48,7	30	157	Selector sensor signal leaves position during driving
48,7	30	158	Engage sensor signal leaves engaged position during driving
50,5	32	37	Interruption at output stage to Y5 (Valve Select)

ON MESSAGES CENTER DISPLAY (MCD) SAE-J1587 Codes	ON SHIFT SELECTOR DISPLAY	ISO CODES WITH TESTMAN TOOL	DESCRIPTION
50,6	32	5	Short circuit to ground at output stage to Y5 (Valve Select)
50,3	32	69	Short circuit to positive at output stage to Y5 (Valve Select)
51,5	33	39	Interruption at output stage to Y7 (Valve Shift)
51,6	33	7	Short circuit to ground at output stage to Y7 (Valve Shift)
51,3	33	71	Short circuit to positive at output stage to Y7 (Valve Shift)
54,6	36	17	Short circuit to ground at output stage to Y1 (inertia brake valve)
54,5	36	49	Interruption at output stage to Y1 (inertia brake valve)
54,3	36	81	Short circuit to positive at output stage to Y1 (inertia brake valve)
55,7	37	114	Clutch engaged unintentionally at standstill, gear engaged
55,7	37	118	Clutch does not disengage
55,7	37	119	Clutch does not engage / does not transmit engine torque
56,7	38	145	Range change group (GP) disengagement error
56,7	38	146	Changeover error during range change group (GP) shifting
56,7	38	147	Range change group (GP) does not engage
57,2	39	108	Error in shift lever
57,14	39	110	ZF CAN timeout (can also means shift lever error through ZMP06400.hex)
58,7	3A	154	Main transmission gear does not disengage
58,7	3A	155	Main transmission gear does not engage
58,7	3A	156	Wrong gear shifting
59,7	3B	151	Selector cylinder does not disengage
59,7	3B	152	Change over error during gate selection procedure
59,7	3B	153	Selector cylinder does not engage
60,3	3C	133	No gate select sensor signal (Short circuit to positive)
60,6	3C	134	No gate select sensor signal (Short circuit to ground)
60,5	3C	135	No gate select sensor signal (Interruption)
60,13	3C	136	Gate select sensor self adjustment error
61,7	3D	148	Splitter (GV) does not disengage
61,7	3D	149	Change over error during splitter shifting
61,7	3D	150	Splitter (GV) does not engage
63,14	3F	100	Error on output speed signal 2
106,0	6A	125	Error on pressure reduction valve
106,14	6A	126	Error on pressure sensor signal

Section 07: TRANSMISSION

ON MESSAGES CENTER DISPLAY (MCD) SAE-J1587 Codes	ON SHIFT SELECTOR DISPLAY	ISO CODES WITH TESTMAN TOOL	DESCRIPTION
150,14	96	59	Acknowledge fault of PTO 1
150,14	96	60	Acknowledge fault of PTO 2
150,7	96	61	Disengagement fault of PTO 1
150,7	96	62	Disengagement fault of PTO 2
150,7	96	63	Engagement fault of PTO1
150,7	96	64	Engagement fault of PTO2
151,14	97	102	Plausibility error between transmission input speed and output speed
152,6	98	10	Short circuit to ground at output stage to Y10 (Main valve)
152,5	98	42	Interruption at output stage to Y10 (Main valve)
152,3	98	74	Short circuit to positive at output stage to Y10 (Main valve)
153,14	99	-	Error on ISO 14320 communications line
154,14	9A	101	Error on both output speed signals
161,14	A1	98	Error on transmission input speed signal
177,2	B1	128	Error on oil temperature sensor signal
191,14	BF	194	Both sources of vehicle speed are faulty
191,14	BF	99	Error on output speed signal 1
230,14	E6	166	Permanent idle signal
230,14	E6	168	No idle signal or error on "idle signal switch" signal (EEC2)
230,14	E7	103	Error on "Wheel-based vehicle speed" signal (CCV
231,7	E7	163	Engine does not react on torque intervention
231,14	E7	164	Error on "Drivers demand engine percent torque" (EEC1)
231,14	E7	165	Error on "Accelerator pedal position" (EEC2)
231,14	E7	167	Error on "Percent load at current speed" signal (EEC2)
231,14	E7	171	Error on "Actual engine percent torque" signal (EEC1)
231,14	E7	172	Permanent engine brake request signal
231,14	E7	173	Error on "Brake switch" signal (CCVS)
231,14	E7	177	System-CAN Busoff error
231,11	E7	178	CAN error frames
231,11	E7	179	CAN queue overrun
231,14	E7	180	CAN EEC1 timeout
231,14	E7	181	CAN EEC2 timeout
231,14	E7	182	CAN CCVS timeout

ON MESSAGES CENTER DISPLAY (MCD) SAE-J1587 Codes	ON SHIFT SELECTOR DISPLAY	ISO CODES WITH TESTMAN TOOL	DESCRIPTION
231,14	E7	183	CAN ERC1_ER timeout
231,14	E7	197	Error on "Front axle speed" (WSI)
231,14	E7	198	Error on "Relative wheel speeds" (WSI)
231,14	E7	199	CAN WSI timeout
231,14	E7	26	CAN engine configuration timeout
231,14	E7	27	Error on "engine configuration message" (engine configuration)
231,14	E7	31	Error on "Actual engine retarder - percent torque" signal (ERC1_ER)
231,14	E7	32	Error on "Engine retarder configuration message" (Engine retarder configuration)
231,14	E7	33	CAN "Engine retarder configuration" timeout
231,14	E7	91	CAN EBC1 timeout
231,14	E7	92	Error on "ABS active" signal (EBC1)
231,14	E7	93	Error on "ASR engine control active" signal (EBC1)
231,14	E7	94	Error on "ASR brake control active" signal (EBC1)
231,14	E7	95	Error on "Cruise control active" signal (CCVS)
231,14	E7	96	Error on "Cruise control set speed" (CCVS)
231,14	E7	97	Error on "Engine speed" signal (EEC1)
-	EE	-	Communication error between GS3 and ZMTEC on display line
248,6	F8	25	Short circuit to ground at output SD to display
248,3	F8	89	Short circuit to positive at output SD to display

12. SPECIFICATIONS

ALLISON AUTOMATIC TRANSMISSION WITH OR WITHOUT RETARDER

XL2 Buses

Gross input power (maximum).....500 HP (373 kW)
Gross input torque (maximum) 1525 Lbf-ft- (2068 Nm)
Rated input speed (minimum-maximum) 1600-2300 rpm

XL2 MTH

Gross input power (maximum).....525 HP (392 kW)
Gross input torque (maximum) 1650 Lbf-ft (2237 Nm)
Rated input speed (minimum-maximum) 1600-2300 rpm

Mounting:

Engine..... SAE #1 flywheel housing, flex disk drive

Torque converter:

Type One stage, three element, polyphase
Stall torque ratio..... TC 551-1.8
Lockup clutch with torsional damper Integral/standard

Gearing:

Type Patented, constant mesh, helical, planetary

Ratio:

First 3.51:1
Second..... 1.91:1
Third..... 1.43:1
Fourth..... 1.00:1
Fifth 0.74:1
Sixth 0.64:1
Reverse..... 4.80:1

Ratio coverage:

6 speed 5.48:1

*** Gear ratios do not include torque converter multiplication.**

Oil System:

Oil type..... TRANSYND, DEXRON III/VI
Capacity (excluding external circuits)..... Initial fill 47 US qts (45 liters)
Oil change..... 24 US qts (23 liters)
Oil change (with retarder) 27.6 US qts (26 liters)

Oil Filters:

Make Allison Transmission
Type Disposable cartridge
Supplier number 29503829
Prévost number 57-1687