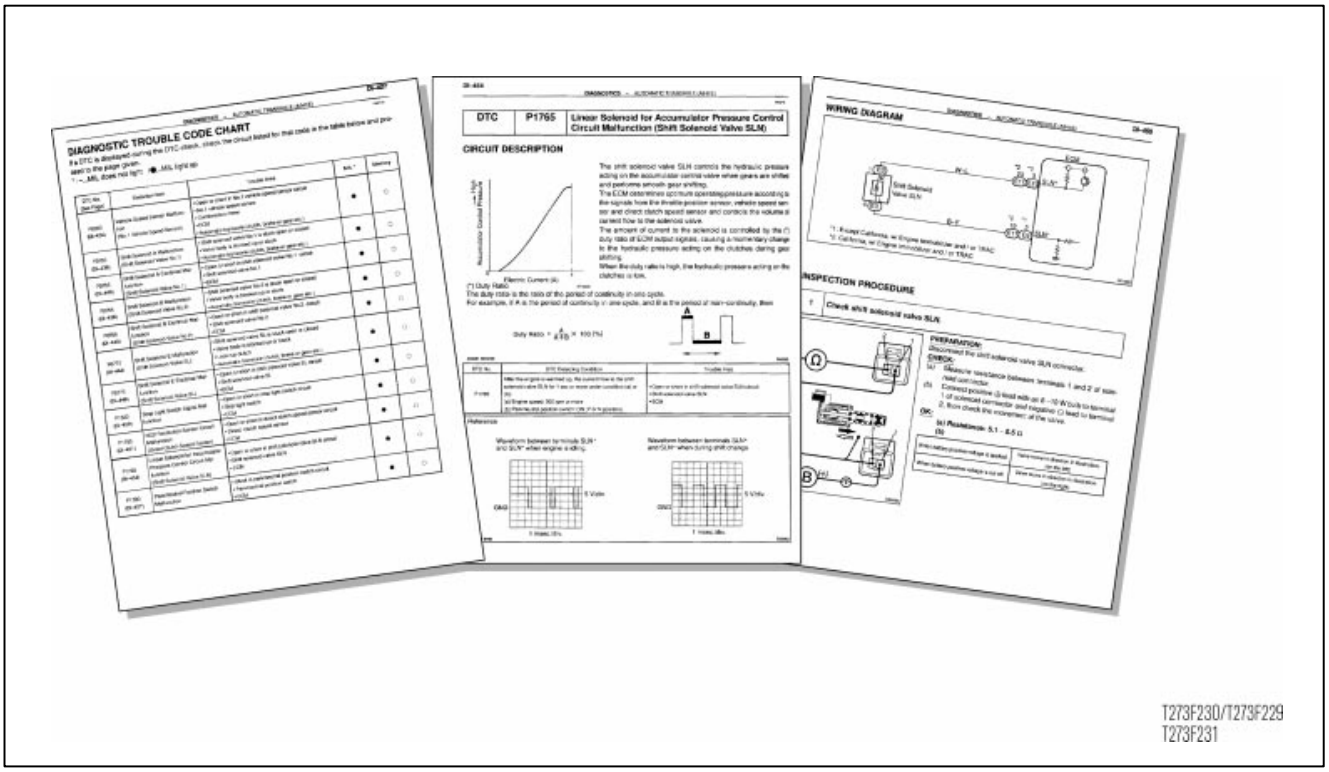
Section 5

Diagnostic Procedures



Lesson Objectives

1. Perform all preliminary checks prior to test driving.
2. Relate the importance that verifying the customer concern plays in diagnosis.
3. Explain the types of fluid contaminants.
4. Explain holding device diagnosis based on a time lag test.
5. Perform a thorough test drive for transmission diagnosis.
6. Perform a manual shift test of an ECT transmission vehicle.
7. Access diagnostic codes using the diagnostic tester or flashing O/D OFF Light in earlier models.
8. Check line pressure at idle and stall speed.
9. Monitor line pressure during automatic and manual upshift operation.
10. Explain Repair Manual features which assist in diagnosis.

Notes

Diagnostic Procedures

Diagnosis of an automatic transmission requires a logical step by step procedure that establishes the cause of the problem. The procedure must eliminate as many causes as possible before the transmission is removed. To accomplish this, it is as important to determine what is working, as it is to determine what is not working. Time spent in diagnosis will help isolate the problem to one of the following:

- engine driveability
- internal mechanical or friction disc failure
- hydraulic logic control
- electronic system failure

Many diagnostic clues are no longer available once the transmission is removed and spread out on a bench. Once diagnosis has narrowed the cause, determine whether the repair can be done with the transmission in the vehicle or if it needs to be removed. Additionally, will it be cost effective to repair the transmission or replace it with a re-manufactured unit?

Diagnostic Sequence of Events

Diagnosis of automatic transmission complaints should follow a systematic sequence of events which resolves the customer's concern.

1. **Verify the Customer Complaint**
   Is there enough information?
2. **Fluid Checks.**
   Ensure the proper level and condition of the fluid.
3. **Time Lag Test**
   Verify clutch engagement for first gear and reverse.
4. **Test Drive**
   Duplicate the condition to experience the customer's concern.
5. **Road Test**
   Thorough evaluation of the transmission operation.
6. **Diagnostic Trouble Codes**
   The ECM monitors the sensors and solenoids and sets a trouble code in memory.
7. **Preliminary Checks and Adjustments**
   Verifies communication between the engine and transmission.
8. **Manual Shift Test**
   Disconnect shift solenoid and verify transmission manual operation.
9. **Diagnostic Tester Usage**
   Analyzing the test drive results.

Verify the Customer Complaint

Verifying the customer complaint is the single most important step in diagnosis. The technician needs to experience the condition and be able to duplicate it to accurately diagnose it. It is impossible to repair a complaint that cannot be verified or repair a condition that is a normal characteristic of the vehicle's transmission. To repair a problem found during diagnosis without ensuring that it fits the customer concern, runs the risk of failing to meet the customer's expectation.

Customer Interview Sheet

Communication between the customer and the technician is essential to verifying the complaint. The technician is frequently isolated from the customer and receives his information third-hand from the Service Writer. To bridge this gap, a customer interview sheet is strongly recommended to ensure the technician has as much information as possible to begin his diagnostic effort. The more details that are available, the more likely the condition can be found quickly. A sample Customer Interview Sheet can be found in Appendix E.

If the complaint cannot be verified, it may be necessary to speak with the customer and have him/her accompany you on the test drive to identify their concern.

Customer and Vehicle Data

The customer and vehicle data are for administrative purposes for tracking the customer or vehicle. Additionally, it's important to determine if the person bringing the vehicle for service is the primary operator who has first-hand knowledge of the complaint.

Automatic Transmission Data

Ask the customer to identify the symptom(s) by checking the appropriate box as well as any subsequent boxes that clarify the selection. Next, identify whether the condition occurs constantly or intermittently.

Three questions should be answered before you begin your diagnostic procedure to ensure a proper repair the first time.

1. What is the specific complaint or *concern*?
   Details of what the customer sees, feels, and hears as abnormal.
2. Under what conditions does the complaint occur?
   Cold or hot operation, occurs always, intermittently or first engagement after sitting overnight.
3. What is the vehicle's recent service history?
   All service both mechanical and body/paint.

Preliminary Fluid Checks

A preliminary fluid check ensures the transmission has sufficient fluid and indicates the condition of the fluid prior to the test drive. There is no need to top off the fluid unless it is extremely low and could cause further damage. Do not attempt to make any adjustments or repairs prior to the test drive as this may mask the symptoms. Be sure to make notes of your findings on the RO for future reference.

Fluid Level

The fluid level should be inspected when the fluid has been warmed up to normal operating temperature, approximately 158°F to 176°F. As a rule of thumb, if the graduated end of the dipstick is too hot to hold, the fluid is hot enough. Proper fluid level is in the hot range between hot maximum and hot minimum. Check the fluid level yourself and don't assume that someone else has done it properly.

NOTE

The cool range found on the dipstick should be used as a reference only when the transmission is cold, to ensure adequate lubrication while the fluid is brought up to temperature. The correct fluid level can only be determined when the fluid is hot.

Fluid Level Check

The fluid is at the proper level if in the hot range between hot maximum and hot minimum.

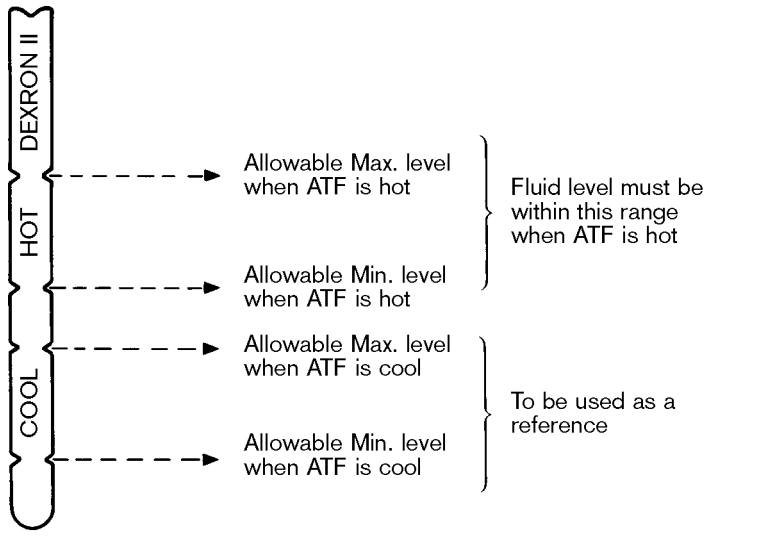


Fig. 5-01
T273F213

Proper fluid levels ensure proper operation of the holding devices, the torque converter and lubrication of the automatic transmission. A low fluid level causes delayed engagement in both drive and reverse and slipping when upshifting. Slipping causes overheating and rapid wear of clutches and bands. Additionally, fluid may migrate away from the oil pickup under heavy deceleration, resulting in a lack of oil volume required to disengage the lockup converter clutch.

Aeration occurs when fluid level is too low or too high. With low fluid level the oil pump draws air, causing it to mix with the fluid. If fluid level is high, the planetary gears and other rotating components agitate the fluid, aerating it and causing similar symptoms.

The aerated fluid combined with overheating due to slippage, causes the fluid to oxidize and varnish builds up on components. Varnish interferes with normal valve, clutch and accumulator operation. Additionally, aerated fluid will rise in the case and leak from the breather plug at the top of the transmission housing or through the dipstick tube.

If the level appears to be correct, check for an air leak on the suction side of the pump. Check the filter installation, paying particular attention to the gasket or O-ring.

Differential Fluid Level

In addition to the transaxle fluid level, some transaxles require a separate check of the differential fluid level. The fluid is separated from the main body of the transaxle by a pair of seals on the drive pinion. Fluid level is checked by removing the filler plug. Fluid should be level with the filler plug hole. This chamber is drained and filled separately from the transaxle. Although some transaxles are open to the differential, be sure to check the differential for proper level when refilling the transaxle.

Differential Fluid Level Check

Some transaxles require a separate check of the differential fluid level.

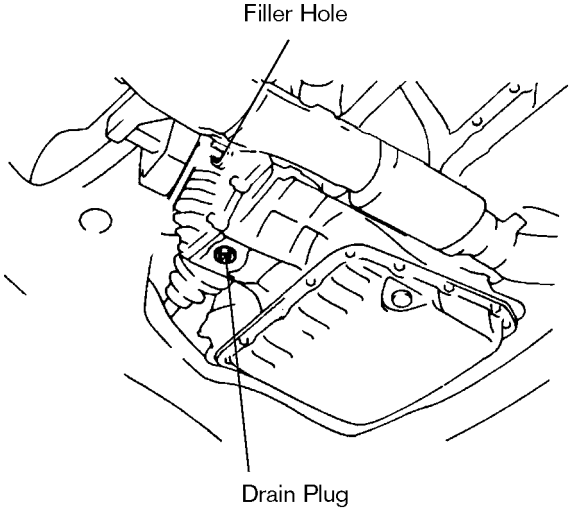


Fig. 5-02
T273F214

Fluid Condition

Two indicators of fluid condition have been color and smell, but these can no longer be relied upon for definitive diagnosis. Since the removal of asbestos from friction material and the added resin content, the chemical formulations of new fluids and resin have contributed to the smell and color changes in current fluids. A dark clear brown or dark clear red fluid color does not by itself indicate a failed unit even if it smells burned.

To get a better indication of fluid condition, place a sample of the fluid on a white paper towel.

Analyzing Fluid Condition

Place a sample of the fluid on a white paper towel for closer analysis of fluid condition.

Fig. 5-03
T273F215

If any of the conditions listed below are found in the fluid sample, the transmission should be rebuilt or replaced with a re-manufactured unit:

- residue or flaky particles of metal or friction material.
- heavily varnished fluid which is tacky and no longer clear.
- milky appearing fluid caused by engine coolant entering the transmission. The coolant may cause the friction facing to loosen from the clutch plates and torque converter clutch

If you're just not sure about the fluid condition and residue on the dipstick, the transmission pan can be removed after the test drive to evaluate the residue content. Residue can be particles of steel, bronze, plastic or friction material reflecting damage to bushings, thrust washers, clutch plates or other parts. Some residue at the bottom of the pan is not uncommon. You will find two or more magnets positioned in the pan to attract metal particles, trapping them from suspension in the fluid and being transported through the transmission. They are usually covered with some metal shavings.

Remove Pan to Inspect Residue

Residue can be particles of steel, bronze, plastic or friction material reflecting damage to bushings, thrust washers, clutch plates or other parts.

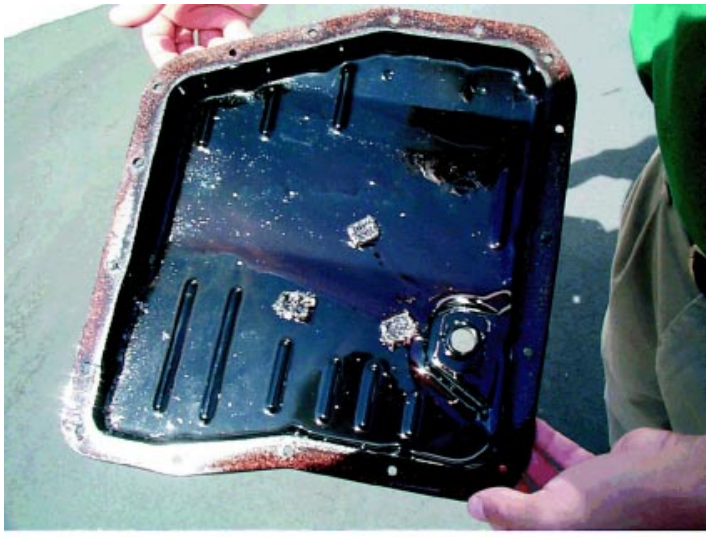


Fig. 5-04
T273F216

When the fluid is clean and residue is minimal, chances are the problem will not be resolved by removing the transaxle and overhauling it or replacing it with a re-manufactured unit. The problem is likely to be outside the transmission.

Time Lag Test

The time lag test is the measurement of time from the movement of the shift lever from neutral to drive or reverse, until the engagement shock of the holding devices is felt. This is useful to determine the integrity of the hydraulic line pressure, the *overdrive direct clutch* (C0), *forward clutch* (C1) and the *first and reverse brake* (B3). Low line pressure or worn clutch seals can cause engagement shock to be delayed.

- The transmission fluid should be at normal operating temperature before conducting the test.
- Apply the parking brake
- Start the engine and check idle speed
- Using a stop watch, make three measurements of the lag time in drive and reverse.
- Allow one minute between tests to allow fluid to exhaust from the holding devices.
- Use the average time to compare against the specifications

The chart below lists several transmissions and the holding devices applied in “drive first gear” and “reverse.” For example, an A-540E’s proper lag time is 1.2 seconds from neutral to drive and 1.5 seconds from neutral to reverse. If the average lag time to drive is longer than 1.2 seconds, one or more of the following may be worn: *forward clutch* (C1), *No. 2 one-way clutch* (F2), or *overdrive one-way clutch* (F0) and *overdrive direct clutch* (C0). Low line pressure may cause late engagement in both drive and reverse.

Time Lag Test

Holding devices engaged in drive and reverse differ depending on the transmission application.

Transmission	Lag Time	Neutral to Drive	Neutral to Reverse
A-130	D=1.2 R=1.5	C1, F2	C2, B3
A-140/A-540	D=1.2 R=1.5	C1, F2, F0	C2, C0, B3
A-340/A-4#	D=1.2 R=1.5	C1, F2, F0	C2, B3, F0
A-240	D=0.7 R=1.2	C1, F2, F3, B4	C2, B3, B4
U-140/U-240	D=1.2 R=1.5	C1, B3, F1, F2	C2, B2, B3
U-340	D=1.2 R=1.5	C1, F2	C2, B3

Fig. 5-05
T273F038

Test Drive

The test drive is important for two reasons. It provides an opportunity to experience the transmission operational characteristics first hand and ultimately allows for the confirmation of your repairs. Your primary purpose should be to duplicate the customers concern.

If the concern cannot be verified during your diagnosis, more information is needed and therefore it is necessary to speak with the customer.

It may be necessary for the customer to accompany you on the test drive to identify the concern.

Road Test

The engine and transmission should be at normal operating temperature. While in neutral position with the engine running, the vehicle should not move either forward or rearward. If the vehicle does move or creep, note the condition and be sure to check the manual linkage adjustment.

During your road test, operate the transmission through each selector range as well as forced and manual downshifts. Check for engine flare or clutch slipping, engagement quality, noise and vibration. Note your findings on the Repair Order, or a copy of the Road Test Procedure Worksheet for each gear position.

D-Range

From a standstill, move the gear selector into D-range. Accelerate the vehicle at 1/4 and 1/2 throttle opening and note each upshift. All upshifts should occur regardless of the throttle opening. However, upshifts will vary at different throttle openings. For example, on a level surface the upshift from 2nd to 3rd will occur at a higher speed at half throttle than at quarter throttle.

While in 4th gear, moderately apply the throttle to test the 4-3 downshift. Note the result and repeat the last step at full throttle. At full throttle, depending on vehicle speed, the transmission may downshift to third or second gear.

2-Range

From a standstill, move the gear selector into 2-range. Accelerate the vehicle at 1/4 and 1/2 throttle opening. The transmission should shift from 1st to 2nd and hold in 2nd gear. This manual 2nd position should provide engine braking on deceleration

L-Range

With the gear selector in the L-range, the transmission should not upshift to 2nd and should have engine braking on deceleration.

R-Range Bring the vehicle to a complete stop and place the gear selector in R-range. Accelerate at part throttle and again at full throttle for a short distance to check the operation.

CAUTION When test driving a vehicle under heavy acceleration, particularly in reverse, be sure to exercise extreme caution. Be aware of vehicles, traffic and pedestrians in the area.

Manual Downshift Press the O/D OFF button on the gear selector and check for a downshift to 3rd gear. At 35 mph or less, move the gear selector from the D position to the 2 position and check for a downshift to 2nd gear. At 25 mph or less, move the gear selector from the 2 position to the L position and check for a downshift to first gear.

On-Board Diagnostic Codes

On-board diagnostics (OBD) have been available on Toyota electronic control transmissions since the mid-eighties. The ECM monitors input and output circuits and compares them to known parameters. When a circuit operates outside these parameters, trouble codes are set, maintained in the ECM memory and the O/D OFF light is illuminated.

In generation two on-board diagnostics (OBD II), not only does the ECM monitor input and output circuits, but it is also capable of determining slippage and shift timing. The ECM causes the overdrive OFF lamp or MIL to illuminate in the event there is a fault either in the engine or trans-mission. The diagnostic codes provide direction to the person diagnosing a customer's concern; be sure to make a note of all codes and freeze data stored in memory.

Diagnostic Tester Toyota's Diagnostic Tester can be connected to OBD II models equipped with a DLC2 or DLC3 connector located under the instrument panel. All stored trouble codes can be read directly from the tester's screen.

Checking Diagnostic Codes With the Diagnostic Tool

All stored trouble codes can be read directly from the tester's screen.

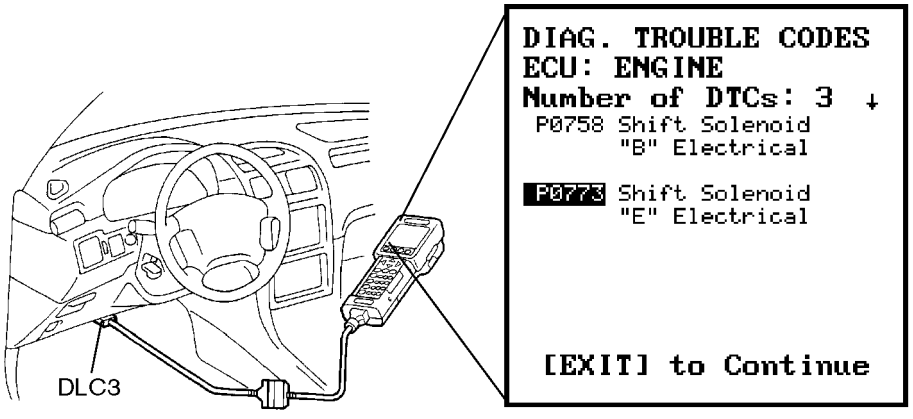


Fig. 5-06
T273F127/T273F217

Some Toyota models in 1994 and 1995, such as the Previa, LandCruiser and Supra, had diagnostic tester capability via the DLC1 connector located in the engine compartment. Common to these models is a TE2 terminal located in the DLC1 connector which allows the scan tool to display codes.

Flashing O/D OFF Light

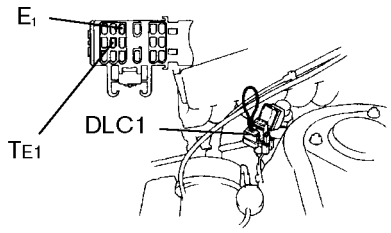
To retrieve codes on earlier models:

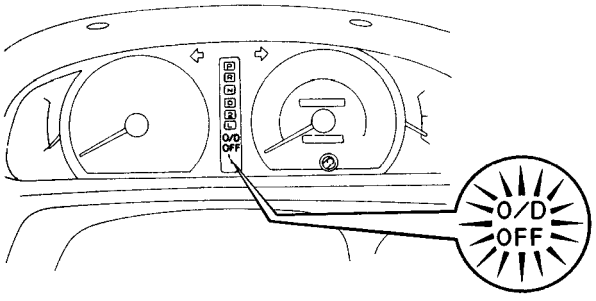
- Turn the ignition switch to the ON position.
- Place O/D switch in the ON position.
- Jumper connectors TE1 and E1 of the DLC1 or DLC2 connector.

Identify the diagnostic code by observing the overdrive OFF indicator light on the instrument panel. Consult the applicable repair manual to determine the procedure appropriate for the vehicle.

Checking Diagnostic Codes with Flashing Lights

Jumper connectors TE1 and E1 of the DLC1 or DLC2 connector and observe the flashing indicator light to determine the diagnostic code.





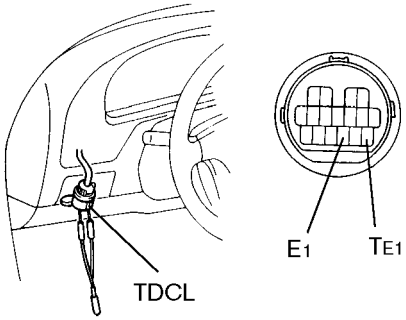


Fig. 5-07
T273F218/T273F219
T273F220

The overdrive OFF light will flash a normal code if the ECM has not detected a malfunction and a two digit code if a malfunction is detected. A normal code flashes twice every second. A malfunction code will flash one time per second with a one and a half second pause between digits. If two or more codes are stored, there will be a two and half second pause between codes. The string of codes will repeat after a four and a half second pause. The codes will always start with the smaller number and end with the larger number.

Trouble code charts can be found in Appendix C in the back of this handbook as well as the vehicle Repair Manual.

Diagnostic Codes

A normal code is output when there is no fault found. If more than one fault is detected, each code is displayed.

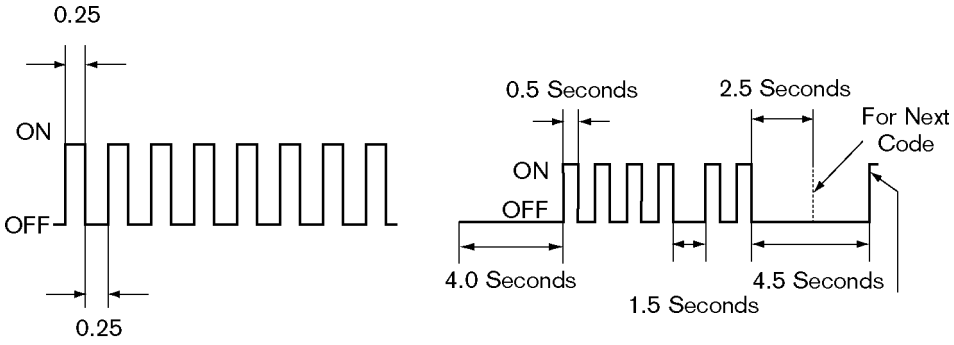


Fig. 5-08
T273F221/T273F222

Code Setting Parameters

Each component monitored by the ECM has its own parameters by which it is evaluated. Any time a code is set for a component, the electrical circuit from the component to the ECM is suspect as well. Some components and faults set a code immediately while others require a two trip detection logic. The two trip logic prevents the MIL light from illuminating and a code being set, until the problem has duplicated itself a second time with a key off cycle in between.

Preliminary Checks and Adjustments

The transmission receives mechanical input from the engine throttle and the gear selector. To optimize transmission operation, these mechanical linkages should be inspected and adjusted as needed.

Throttle Cable

The throttle cable connects the throttle linkage and the transmission throttle valve. As the throttle opens, greater torque is produced by the engine and the transmission may also downshift to a lower gear. Line pressure increases to provide greater holding force to prevent the hydraulic holding devices from slipping. When the throttle is opened, the cable transfers this motion to the base of the throttle valve and increases throttle pressure. This increase in throttle pressure causes the primary regulator valve to increase line pressure.

Throttle Cable Adjustment

With the throttle fully open, check the throttle cable stopper at the boot end and ensure that there is no more than one millimeter between the end of the stopper and the end of the boot.

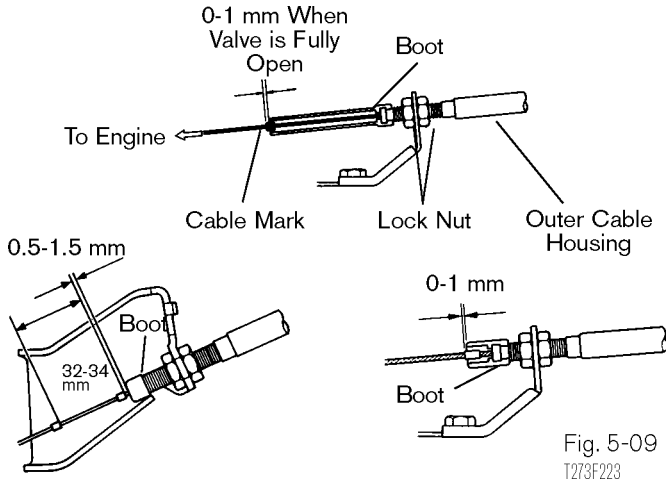


Fig. 5-09
T273F223

Inspection and Adjustment

To inspect the throttle cable adjustment, the engine should be off. Verify the procedure in the repair manual, as early model adjustment was done with the throttle wide open, later models are set with the throttle fully closed.

- With the accelerator fully depressed, ensure the throttle opens fully. Check for obstruction below the accelerator and adjust the accelerator control cable as needed.
- Check the throttle cable stopper at the boot end and ensure that there is no more than one millimeter between the end of the stopper and the end of the boot.

To adjust the throttle cable:

- Loosen the locking nuts on the cable housing.
- Verify with the repair manual whether the throttle is closed or open during the procedure.
- Reposition the cable housing and boot as needed until the specification is reached.

When a new cable is installed, the stopper must be positioned and clamped into place on the cable.

- Pull the inner cable lightly until a slight resistance is felt.
- Position the end of the stopper at a measurement of 0.8 to 1.5 mm from the end of the outer cable housing.
- Clamp the stopper in place on the cable.

When the throttle cable is misadjusted, it will affect line pressure and shift quality in both ECT and non-ECT transmissions. Shift timing will be affected in non-ECT transmissions only.

Shift Cable

The shift cable connects the shift selector to the transmission control shaft lever which moves the manual valve in the valve body. If out of adjustment, the manual valve may send fluid to multiple circuits resulting in loss of pressure and slipping holding devices. It may also cause the vehicle to creep forward or rearward with the selector in neutral position.

Inspection and Adjustment

This inspection is done from the passenger compartment with the engine off. Move the gear selector through each gear selection range noting the detent of the control shaft as it moves the manual valve. As the detent is felt, the position of the gear selector indicator should line up properly. Observe the gear selector indicator to ensure that only one indicator light is illuminated at one time. If more than one is lit, the ECM may sense a 2 or low position rather than a D position.

Adjust the shift cable if the indicator does not line up properly.

- Loosen the swivel nut on the shift linkage.
- Push the manual lever at the transmission fully toward the torque converter end of the transmission.
- Pull the lever back two notches from Park through Reverse to the Neutral position.
- Set the selector lever to the Neutral position and tighten the swivel nut while holding the lever lightly toward the reverse position.

Shift Cable Adjustment

Set the selector lever to the Neutral position and tighten the swivel nut while holding the lever lightly toward the reverse position.

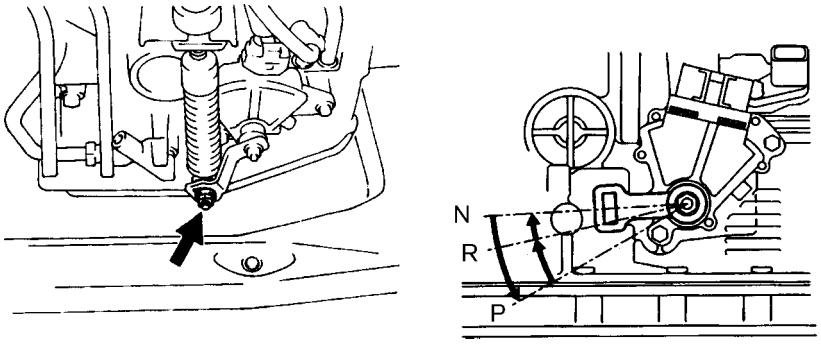


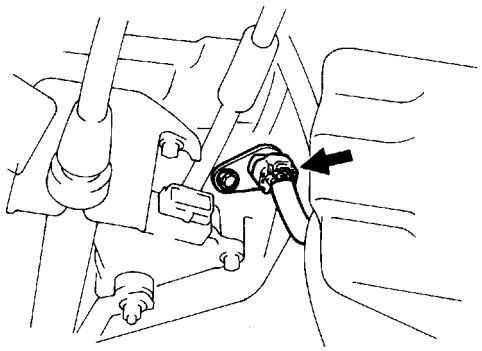
Fig. 5-10
T273F224/T273F225

Manual Shift Test

The manual shift test is used to determine if the cause of the malfunction is electrical or hydraulic. The electrical connector for the solenoid is disconnected at the transmission, disabling the shift solenoids. The transmission is shifted by moving the gear selector to Manual Low to start the vehicle moving. The first upshift occurs when the gear selector is moved to Manual Second. The transmission should shift into third or overdrive gear depending on the transmission model. An A-140, A-240 and A-340 series transmission will shift into third gear in Manual Two position, whereas an A-540 will shift into overdrive. The A-140, A-240 and A-340 will shift into overdrive when the gear selector is moved to the Drive position.

Manual Shift Test

Disconnect the solenoid connector at the transmission and manually upshift the transmission.



Shift Selector Position	A-140, A-240, A-340	U-240, A-540	U-140, U-340
R	Reverse	Reverse	Reverse
D	Overdrive	Overdrive	Third
2	Third	Overdrive	Third
1	First	First	Third

Fig. 5-11
T273F226/T273F128

If the transmission upshifts as described, the problem is likely to be found in the electrical system. To narrow the electrical troubleshooting, two tools are available. The Diagnostic Tool Set for OBD II vehicles and the ECT Analyzer for earlier models. The Diagnostic Tool Set connects to the DLC3 connector and is used to control the upshifts under 30 mph. The ECT Analyzer connects at the transmission solenoid connector and controls upshifts.

If the transmission does not upshift as described, the problem is likely to be found in the hydraulic system.

Stall Testing

The stall test is used to determine the condition of:

- the engine state of tune.
- specific holding devices in the transmission.
- the torque converter.

The stall condition occurs when the engine driven impeller rotates, but the turbine connected to the transmission input shaft and drive train does not. The torque converter stall speed occurs when the engine is unable to drive the impeller at a higher rpm due to the resistance of fluid flow to the turbine.

Before stall testing a torque converter, consider the customer complaint and your road test symptoms. The symptoms regarding poor top-end performance or poor acceleration may already point to the torque converter as the problem. A road test of the vehicle's acceleration and forced downshift will indicate a slipping stator if acceleration is poor. Poor top-end performance will indicate a stator which does not freewheel. Stall speed and line pressure at stall are required information on the Reman Core Information/Credit Request form.

In preparing the vehicle for a stall test:

- consider safety when staging the vehicle so it is not headed toward walls, other vehicles and pedestrians.
- the engine and transmission should be at operating temperature and at the proper level.
- attach a tachometer to the engine.
- the full weight of the vehicle should rest on the wheels.
- place chocks at the front and rear wheels.
- set the parking brake and apply the foot brakes with your left foot.

Stall testing should be checked in drive and reverse by moving the accelerator to wide open throttle and read the maximum engine rpm.

When engine rpm falls within specifications during a stall test, it verifies the following items:

- The one-way clutch in the torque converter stator is holding.
- Holding devices (clutches, brakes, and one-way clutches) used in first and reverse gears are holding properly.
- The transmission oil pressure is adequate.
- Engine is in a proper state of tune.

When engine rpm falls below specification, it may be due to poor engine state-of-tune or an engine control timing change for torque control. Monitor the engine timing advance with the Diagnostic Tester while re-checking the stall speed. If stall speed is several hundred rpm under specification, and the ignition timing is retarded, the torque converter is not likely to be faulty.

If stall speed exceeds the specification limit or unusual noises are heard, release the accelerator immediately to avoid further damage to the transmission.

When a torque converter is determined faulty, be sure to closely inspect the splines of the stator support attached to the oil pump. If the splines are worn, it will also cause the new stator to slip.

CAUTION

Do not stall the converter for more than five seconds as extreme heat is generated as the fluid is sheared in the torque converter. Allow at least one minute at idle speed for the fluid to cool before retesting or turning off the engine.

Line Pressure Testing

Line pressure is produced and maintained by a number of components in the hydraulic control system. Based on the hydraulic pressure created in the oil pump, the hydraulic control system governs the pressure acting on the torque converter clutch, the hydraulic clutches and brakes, and the accumulators. The hydraulic control system components are the pressure regulator valve, the throttle valve (based on throttle position), and the governor valve (non-ECT) (based on vehicle speed).

Pressure readings are taken at idle, during engine stall speed, and also during normal transmission operation.

- Pressure taken when the pump is turning at its slowest speed provides information on the integrity of the hydraulic control system. If the pump is worn, pressure regulator improperly adjusted, or a leak in the system could cause low line pressure.
- Pressure taken during engine stall speed are the maximum system pressure.
- Observing line pressure during normal vehicle operation provides information regarding engine load and vehicle speed as well as pinpointing leakage in a clutch or brake hydraulic circuit.

Because the pump is located above the level of fluid, fluid must be drawn from the oil pan through the filter and passages of the valve body. Any open point between the pump and pickup screen will draw in air and reduce system pressure.

Line Pressure Testing

The hydraulic control system governs the pressure acting on the torque converter clutch, the hydraulic clutches and brakes, and the accumulators.

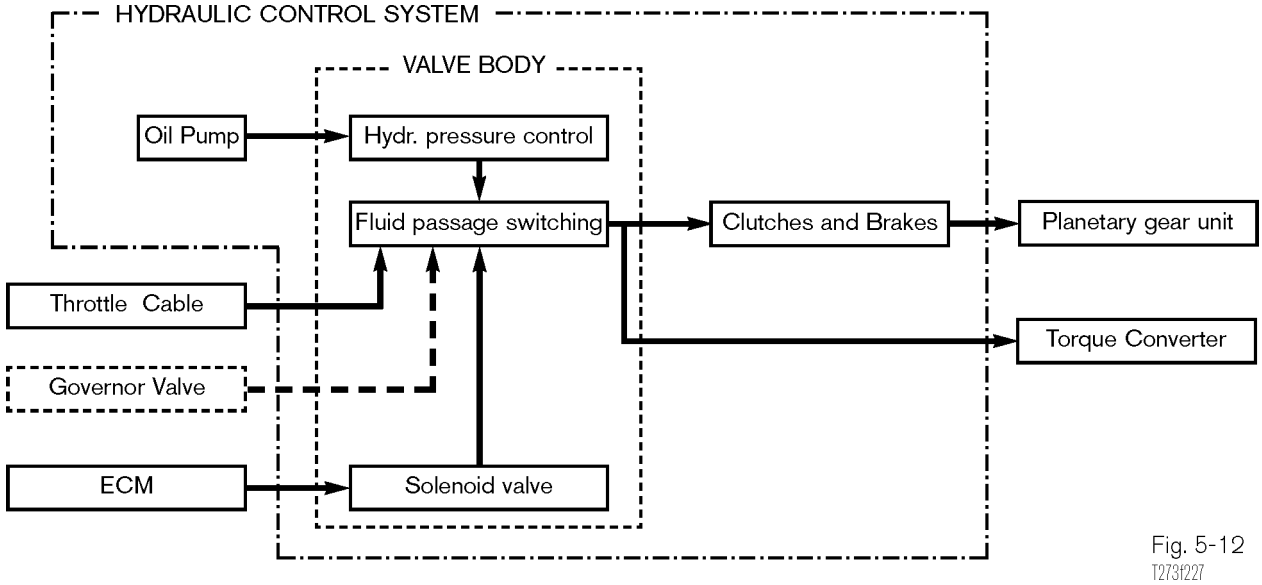


Fig. 5-12
T273f227

Preparation

Prepare the vehicle for pressure testing by installing the high pressure gauge (0 to 300 psi) to the transmission. Refer to the vehicle's repair manual for the test port location. When measuring line pressure at stall speed in the shop, be sure to chock all four wheels as a safety precaution.

Before checking line pressure at engine stall speed, test the line pressure at roughly 2400 rpm, while pulling the throttle cable, check for an increase in line pressure. When adequate line pressure is available and line pressure increases considerably when the throttle cable is pulled, it is safe to perform the stall test and reduce the possibility of additional damage to the transmission. The line pressure measurement at engine stall speed must appear on the Reman Transmission Core request form.

- Route the hose away from hot surfaces such as exhaust pipes and mufflers and place the gauge where it can be observed by the driver.
- Transmission fluid should be at the proper level and at operating temperature.
- Engine should be in a proper state of tune and idling within specifications.
- Move the gear selector to Drive and Reverse recording line pressure in each position.
- Stall test the transmission in Drive and Reverse and record the pressure in each position.

Line Pressure Chart

The chart identifies possible causes based on the pressure test findings.

Problem	Possible Cause
If the measured values at all positions are higher.	• Throttle cable out of adjustment • Throttle valve defective • Regulator valve defective
If the measured values at all positions are lower.	• Throttle cable out of adjustment • Throttle valve defective • Regulator valve defective • Oil pump defective • O/D Direct clutch defective
If pressure is low in the D position only.	• D position circuit fluid leakage • Forward clutch defective
If pressure is low in the R Position.	• R position circuit fluid leakage • Direct clutch defective • 1st and reverse brake defective

Fig. 5-13

Compare your readings with the repair manual line pressure specifications at idle and at stall in both Drive and Reverse. Compare your results with the chart above to determine the possible cause.

Advanced Diagnosis

Line pressure can also be observed to monitor each hydraulic clutch in succession as the transmission upshifts. The colored blocks in the chart below identify the clutch or brake added to the series of holding devices to provide the up-shift. A different hydraulic clutch/brake is applied for each upshift and therefore its integrity can be monitored with a pressure gauge.

For example, in A-series transmissions, C0 is applied in all gears except overdrive. When the gear selector is placed in drive, C1 is applied and remains applied in all forward gears. When B2 is applied, an upshift to second gear occurs. If pressure is normal in first and second gear, but drops in third and the engine speed does not drop (transmission remains in 2nd), it would indicate a leak in the circuit to the *direct clutch* (C2).

- Move the gear selector to Park or Neutral to check the pump circuit and the overdrive direct clutch (C0)
  - If line pressure is low - the pump or C0 could be bad.
  - If pressure comes up when shifting into overdrive, chances are, C0 is bad.
- Move the gear selector to Drive introduces the *forward clutch* (C1) and the transmission is in first gear.
  - If pressure drops, there is likely to be a leak in the seal to C1 or the hydraulic circuit to C1.
  - An upshift to second gear would bring on the *2nd brake* (B2). A drop in pressure would indicate a leak in B2 or its hydraulic circuit.
  - An upshift to third gear would bring on the *direct clutch* (C2). A drop in pressure would indicate a leak in C2 or its hydraulic circuit.
  - An upshift to fourth gear would bring on the *overdrive brake* (B0) and release C0. A drop in pressure would indicate a leak in B0 or it's hydraulic circuit.

Clutch Application Chart

The chart identifies the clutch/brake applied for each upshift gear position based on the pressure test findings.

Shift Lever Position	Gear Position	C0	C1	C2	B0	B1	B2	B3	F0	F1	F2
P	Park	■									
R	Reverse	■		■				■			
N	Neutral	■									
D	1st	■	■						■		■
	2nd	■	■				■		■	■	
	3rd	■	■	■			■		■		
	O/D		■	■	■		■				
2	1st	■	■						■		■
	2nd	■	■			■	■		■	■	
	3rd*	■	■	■			■		■		
L	1st	■	■					■	■		■
	2nd**	■	■			■	■		■	■	

* Does Not Apply to A-140L ** Downshift only - no upshift

■ Indicates the applied holding device.

■ Indicates the single clutch/brake applied to provide the gear change for automatic upshift.

■ Holding device applied but not functional.

Fig. 5-14
T273F514

- Move the gear selector to 2 Range introduces the *second coast brake* (B1) when the transmission shifts into second gear.
  - If pressure drops but did not drop in automatic upshift to second in drive, there is likely to be a leak in the seal of B1 or the hydraulic circuit to B1.
- Move the gear selector to L Range introduces the *first and reverse brake* (B3) when the transmission shifts into first gear.
  - If pressure is lower, there is likely to be a leak in the seal of B3 or the hydraulic circuit to B3.

Monitoring line pressure during a test drive will provide valuable information when a fault is detected in the transmissions operation. In our previous example, slippage occurred in the *direct clutch* (C2). If system pressure did not drop when shifting into third gear, you can save time by eliminating pressure as a cause of the slippage. Instead, you could look at proper number of plates and discs or component assembly as the potential cause of the slipping clutch.

Repair Manual Troubleshooting

Retrieving diagnostic codes is just the beginning of troubleshooting. It identifies the component and its related circuit and requires isolating the problem to the component or wiring level.

To find the appropriate repair manual diagnostic procedure to follow:

- Refer to the first column of the repair manual Diagnostic Trouble Code Chart.
- Just below the trouble code, a page reference is given directing attention to the “trouble code circuit or system description” and “inspection procedure.”
- The description provides information regarding the circuit operation as well as code setting parameters.
- Following the inspection procedure will lead to a diagnosis of the circuit as well as the sensor or component.

Repair Manual Troubleshooting

The Trouble Code Chart provides the page reference to the system or circuit inspection.

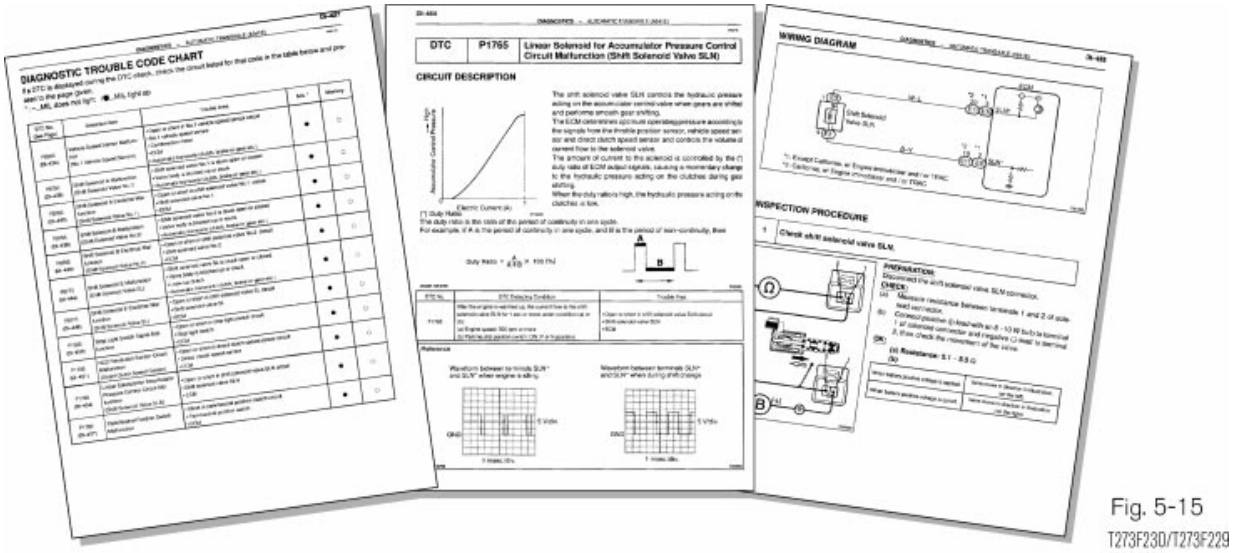


Fig. 5-15
T273F23D/T273F229
T273F231

Symptom Chart Diagnosis

When a normal code is displayed, but you have been able to confirm a legitimate customer's complaint using the repair manual Symptom Charts will direct you toward a specific component or test procedure. The charts are based on whether the transmission is in the vehicle or on the bench. The symptom tables are divided into three chapters:

- Chapter 1: Electronic Circuit Matrix Chart
- Chapter 2: On-vehicle Repair Matrix Chart
- Chapter 3: Off-vehicle Repair Matrix Chart

Electronic Circuit Matrix Chart

When the ECM is suspected as a fault, the electronic circuit matrix chart refers you to a specific page in the Introduction (IN) section of the repair manual. This section guides you through the process of checking for opens, short circuits and grounds on harnesses. The chart may also provide a page reference for a component if it relates to the symptom.

NOTE Before getting too deeply involved in harnesses and connectors be sure to utilize the diagnostic tester or ECT analyzer to verify the operation of sensors and actuators.

Electronic Circuit Matrix Chart

The chart refers you to the Introduction (IN) section of the repair manual with a page reference.

Symptom	Suspect Area	See page
No up-shift (1st→2nd)	ECM	IN-30
No up-shift (1st→3rd)	ECM	IN-30
No up-shift (3rd→O/D)	1. O/D main switch circuit 2. O/D cancel signal circuit 3. ECM	DI-465 DI-462 IN-30
No downshift (O/D→3rd)	ECM	IN-30
No downshift (3rd→2nd)	ECM	IN-30
No downshift (2nd→1st)	ECM	IN-30
No lock-up or No lock up off	ECM	IN-30
Shift point too high or too low	ECM	IN-30
Up-shift to 2nd while in L position	ECM	IN-30
Up-shift to 3rd while in L position	ECM	IN-30
Up-shift to O/D from 3rd	1. O/D main switch circuit 2. ECM	DI-465 IN-30
Up-shift to O/D from 3rd while engine is cold	ECM	IN-30

Fig. 5-16
T273F131

On-Vehicle Repair Matrix Chart

The On-Vehicle repair chart identifies components in the transmission that can contribute to the specific symptom. These components can be accessed without removing the transmission. The repair manual reference indicated by the star, can be found at the top of the chart. (for example: A-540E AUTOMATIC TRANSAXLE Repair Manual Pub. No. RM530U) The overhaul repair manual for automatic transmissions is a separate silver and black publication for each transmission model.

On-Vehicle Repair Matrix Chart

The chart refers you to a separate transmission repair manual and identifies the components which contribute to the symptom.

Symptom	Suspect Area	See page
Vehicle does not move in any forward position and reverse position	1. Manual Valve 2. Throttle Valve 3. Primary regulator valve 4. Off-vehicle repair matrix chart	* * * DI-431
Vehicle does not move in R position	1. Off-vehicle repair matrix chart	DI-431
No up-shift (1st→2nd)	1. 1-2 shift valve 2. Off-vehicle repair matrix chart	* DI-431
No up-shift (2nd→3rd)	1. 2-3 shift valve 2. Off-vehicle repair matrix chart	* DI-431
No up-shift (3rd→O/D)	1. 3-4 shift valve 2. Off-vehicle repair matrix chart	* DI-431
No downshift (O/D →3rd)	1. 3-4 shift valve	*
No downshift (3rd →2nd)	1. 2-3 shift valve	*
No downshift (2nd →1st)	1. 1-2 shift valve	*
No lock-up or No lock-up off	1. Lock-up relay valve 2. Off-vehicle repair matrix chart	* DI-431

*Refer to the *Overhaul Repair Manual.*

Fig. 5-17
T273F132

Off-Vehicle Repair Matrix Chart

The Off-Vehicle repair chart identifies components in the transmission that can contribute to the specific symptom. With the exception of the torque converter, these components require removal of the transmission and disassembly. Removal of the pan may be the determining factor whether to go with a reman unit or overhaul. With minimal debris in the pan and an accurate diagnosis, overhaul can come in under the cost of a reman.

Off-Vehicle Repair Matrix Chart

The chart refers you to internal components which may have failed based on the symptom.

Symptom	Suspect Area	See page
Vehicle does not move in any forward position and reverse position	1. Front and rear planetary gear	*
	2. O/D planetary gear	*
	3. O/D One-way clutch (F0)	*
	4. O/D Direct clutch (C0)	*
	5. Forward clutch (C1)	*
	6. O/D Brake (B0)	*
Vehicle does not move in R position	1. Front and rear planetary gear unit	*
	2. Direct clutch (C2)	*
	3. O/D Direct clutch (C0)	*
	4. 1st and reverse brake (B3)	*
No up-shift (1st→2nd)	1. No. 1 one-way clutch (F1)	*
	2. 2nd brake (B2)	*
No up-shift (2nd→3rd)	Direct clutch (C2)	*
No up-shift (3rd→O/D)	O/D Brake (B0)	*
No lock-up or No lock-up off	Torque converter	*
Harsh engagement (N→D)	1. Forward clutch (C1)	*
	2. O/D one-way clutch (F0)	*
	3. No. 2 one-way clutch (F2)	*

Fig. 5-18
T273F133

Analyzing Test Drive Results

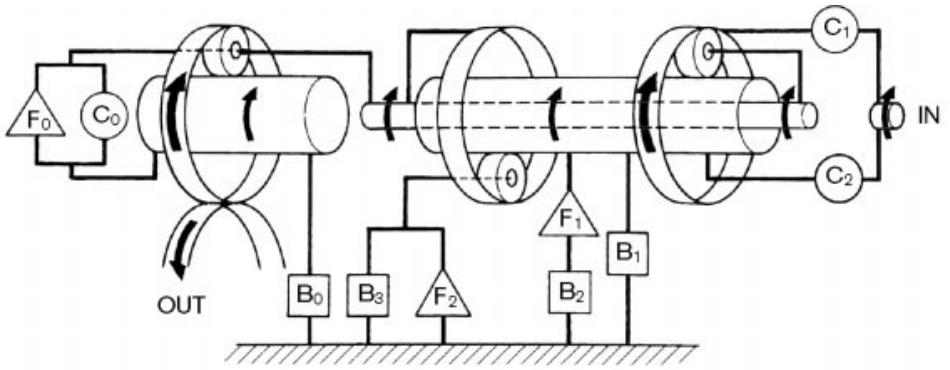
At the conclusion of a thorough test drive, you have most of the information necessary to make an accurate diagnosis. You will need to know which holding devices are necessary for each gear. The clutch application chart will provide this information and the gear train model will provide a visual reference for each holding device and its relationship to the drive components.

Clutch Application Chart

The chart used in the diagnostic examples on the next few pages are based on the A-140 and A-540 transaxle. This same chart can apply to rear wheel drive transmissions (A-43, A-45, A-340). The primary difference is the *overdrive one-way clutch* (F0) which locks in both forward and reverse in the rear wheel drive transmissions, but does not lock in reverse in the front drive transaxles.

Clutch Application Chart and Gear Train Model

The clutch application chart provides a ready reference of each holding device for each gear position and the gear train model provides a visual reference.



Shift Lever Position	Gear Position	C0	C1	C2	B0	B1	B2	B3	F0	F1	F2
P	Park	■									
R	Reverse	■		■				■			
N	Neutral	■									
D	1st	■	■						■		■
	2nd	■	■				■		■	■	
	3rd	■	■	■			⊠		■		
	O/D		■	■	■		⊠				
2	1st	■	■						■		■
	2nd	■	■			■	■		■	■	
	3rd*	■	■	■			⊠		■		
L	1st	■	■					■	■		■
	2nd**	■	■			■	■		■	■	

* Does Not Apply to A-140L ** Downshift only - no upshift

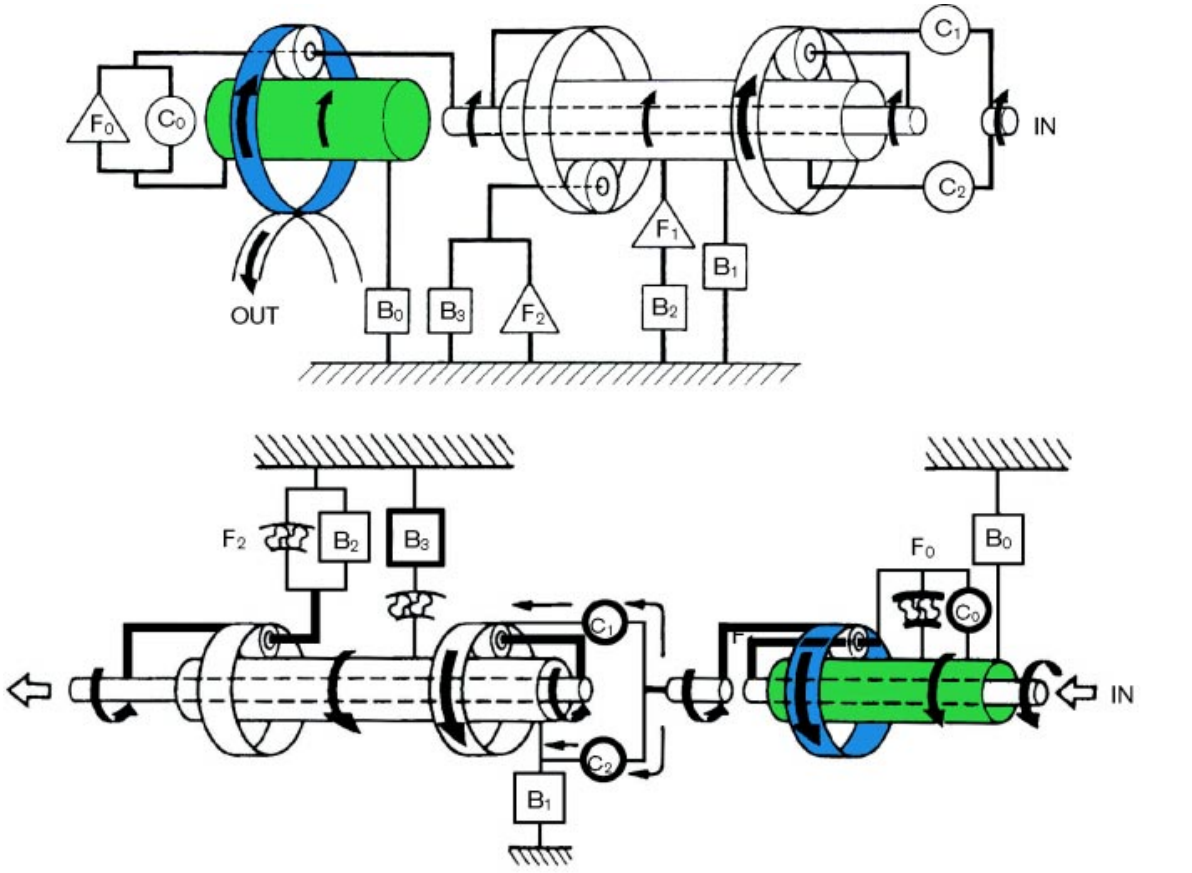
Fig. 5-19
T273F235/T273F236

The *overdrive direct clutch* (C0) is applied in all gears and shift positions except overdrive. It is a parallel holding device to the overdrive one-way clutch (F0). In a rear wheel drive transmission the overdrive unit is positioned before the planetary gear set and both are holding. In a front drive transaxle, however, the overdrive unit is located after the planetary gear set and the overdrive one-way clutch freewheels in reverse as the intermediate shaft rotates counterclockwise. That's why if the C0 is bad, it slips in reverse and there is no engine braking in third, second or low, but forward gears work because the F0 holds.

The *forward clutch* (C1) is applied in all forward gears and shift positions. If all forward gears slip but reverse holds, C1 is the likely cause.

Transmission Power Flow Models

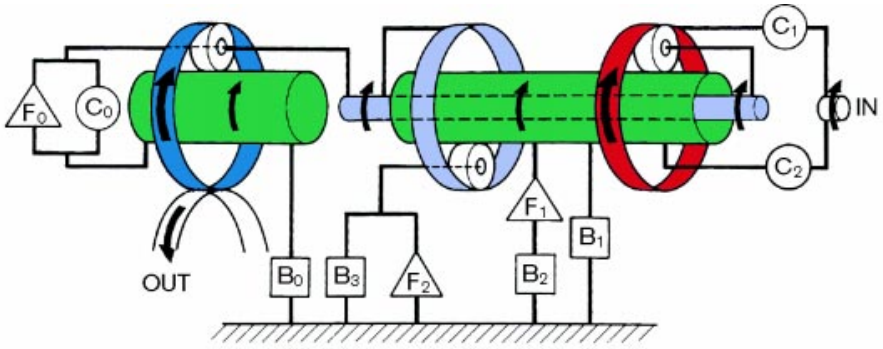
In a rear wheel drive transmission the overdrive unit is located before the planetary gear set. In a front drive transaxle, however, the overdrive unit is located after the planetary gear set.



D-Range Move the gear selector into D-range, the *forward clutch* (C1) is applied and the *No. 2 one-way clutch* (F2) locks; engagement should be felt. If there is delayed engagement, or slippage, the forward clutch may be the cause. To determine if slippage is caused by C1 or F2, move the gear selector to L-range. In L-range the *1st and reverse* (B3) is a parallel holding device with F2. If slippage stops, then F2 is the cause. If slippage still occurs, C1 is the cause.

D-Range Power Flow

As the upshift to second occurs, B2 applies and remains applied when the upshift to third and O/D occurs. Likewise, when third upshift occurs C2 applies and remains applied when the upshift to O/D occurs.



Shift Lever Position	Gear Position	C0	C1	C2	B0	B1	B2	B3	F0	F1	F2
N	Neutral	■									
D	1st	■	■						■		■
	2nd	■	■				■		■	■	
	3rd	■	■	■			⊠		■		
	O/D		■	■	■		⊠				
2	1st	■	■						■		■
L	1st	■	■					■	■		■

Fig. 5-21
T273F239/T273F240

Second Gear Upshift When the upshift to second gear occurs, the *2nd brake* (B2) applies which locks *No. 1 one-way clutch* (F1). These two apply in series to hold the planetary sun gear. F1 freewheels on deceleration and allows the vehicle to coast. If slippage occurs when upshifting to second gear, either the engine speed drops slowly as the clutch engages or the transmission remains in first gear and engine speed remains the same. In either event, B2 or F1 is the likely cause.

Third Gear Upshift When third gear upshift occurs, the *direct clutch* (C2) applies providing a direct drive through the Simpson planetary gear set. As C2 is applied, *No.1 one-way clutch* (F1) freewheels as the sun gear turns clockwise. Although B2 remains applied, it has no affect on 3rd and 4th gears because F1 freewheels. If slippage occurs, engine speed will drop slowly as the clutch applies. As slippage becomes more severe, engine speed will not change as the transmission remains in second gear. C2 is the likely cause.

Fourth Gear Upshift

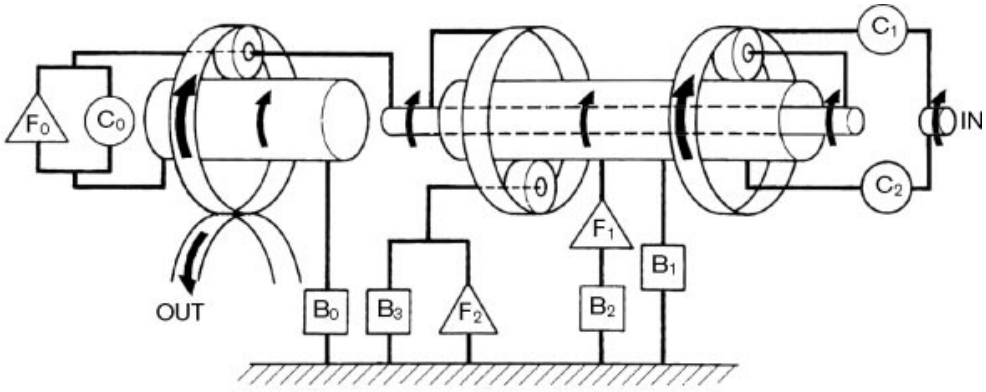
When fourth gear upshift occurs, the *overdrive brake* (B0) applies and *overdrive direct clutch* (C0) releases with the same movement of the 3-4 shift valve. The *overdrive one-way clutch* (F0) freewheels. If slippage occurs, engine speed will drop slowly as the clutch applies. As slippage becomes more severe, engine speed will not change as the transmission remains in third gear. Although C0 is released, F0 holds on acceleration. However, engine rpm will fall to idle speed as F0 freewheels when the accelerator is released and the vehicle decelerates. B0 is the likely cause.

2-Range

Move the gear selector into 2-range, the *forward clutch* (C1) is applied and the *No. 2 one-way clutch* (F2) locks just like D-range; engagement should be felt. When 2nd gear upshift occurs, the *2nd coast brake* (B1) applies in parallel with *2nd brake* (B2) and *No. 1 one-way clutch* (F1). The *2nd coast brake* holds the sun gear from turning either way and therefore prevents the transmission from freewheeling on deceleration. This position uses the engine to slow the vehicle while decelerating and provides additional holding force on the planetary sun gear.

2-Range

The 2nd coast brake (B1) applies in parallel with 2nd brake (B2) and No 1 one way clutch (F1) to hold the sun gear.



Shift Lever Position	Gear Position	C0	C1	C2	B0	B1	B2	B3	F0	F1	F2
N	Neutral	■									
2	1st	■	■						■		■
	2nd	■	■			■	■		■	■	
L	1st	■	■					■	■		■

Fig. 5-22
T273F235/T273F242

L-Range Move the gear selector into the L-range, the *1st and reverse brake* (B3) and the *No. 2 one-way clutch* work in parallel to hold the rear planetary carrier. Engagement should be felt. This position uses the engine to slow the vehicle while decelerating and provides additional holding force on the planetary carrier.

Slippage in any one of the previous scenarios or abnormal noise may be sufficient to warrant an overhaul or replacement of the transmission. However, if the findings were power related or shift timing either too early or late, or harsh shifting will require further testing.

The following will require further testing:

- Early shift timing.
- Late shift timing.
- Harsh shifting.
- Erratic shifting.

Notes