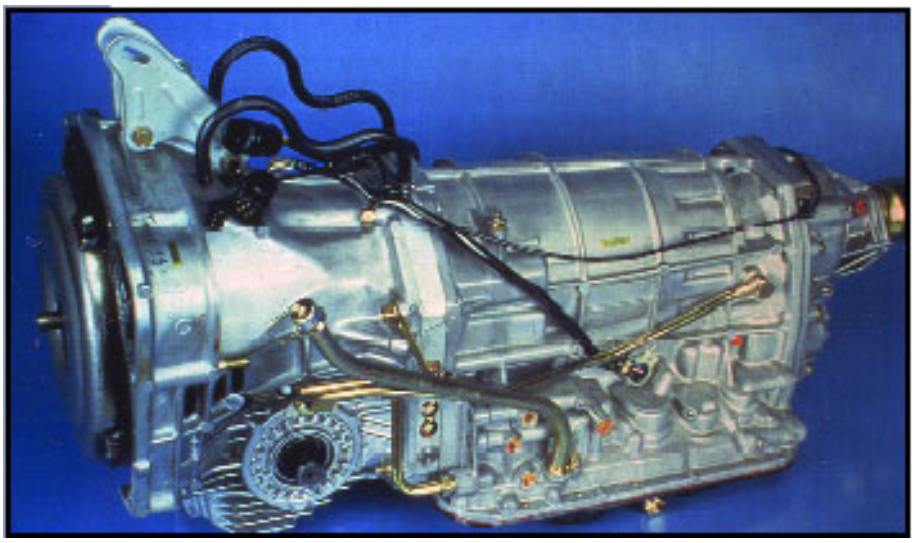
A

GUIDE TO THE

AUTOMATIC TRANSMISSION



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Part 1

Preface

My mechanical skills: I would say I fall into the category of a *parts-changer*, not having near enough skills to be known as a *mechanic*. When my SVX transaxle failed, I could not determine what was at fault or how extensive the necessary repairs would be. As a result, I placed my unit in the hands of a professional. However, curiosity aroused, I began to research troubleshooting and the labor steps involved with a transmission rebuild. The result is this document. I have tried to make it error-free and comprehensive, but honestly do not know what I have omitted, errors I have introduced, or items I failed to adequately represent. Therefore, I ask you to look at this document as I did, a research paper intended to inform the consumer, not to handhold the novice transmission mechanic in a step-by-step repair of the SVX transmission. Also, please note this applies to the US market SVX only. Finally, superscript numbers in parenthesis, i.e., ([1]), refer to additional information, or provide source credit, that can be found in the appendix.

Overview

([1]) The Subaru 4EAT (I have also found literature referring to it as the R4AX-EL) is a four speed electronically-controlled transmission. It features a lock-up torque converter, for which I have seen claims that it will lock up in all forward gears except 1st; although to my knowledge no SVX owner has ever seen it in any other gear than 4th. In P, R, or N, there are no special features. With the selector in D, the transmission shifts through all four forward gears as expected, with the addition of a "power" mode (discussed later in this section). With the selector in 3, the transmission shifts up/down through 1st, 2nd, and 3rd gears. When the selector is in the 2 position, the transmission shifts through 1st and 2nd; however, if necessary, 3rd gear is electronically selected to prevent the engine from over-revving. When in 1st, the tranmission stays in 1st gear, but will upshift to 2nd/3rd when the rpm reachs something just over 6100 in the lower gear to prevent damage to the engine.
The SVX makes use of a "manual" button on the gear selection handle. When the selector is in 3, manual switch *ON*, the transmission will start in 2nd gear and shift to 3rd. When 2 is selected, manual *ON*, the transmission starts and stays in 2nd gear, but will upshift to 3rd gear to prevent damage to the engine. The electronic control system "brain" is hereafter referred to as the Transmission Control Unit (TCU). The TCU monitors, via sensors, various engine and vehicle inputs. It controls the electronic solenoids in the transmission. On all wheel drive (AWD) vehicles, the TCU applies a more aggressive AWD program when the selector is in the 1st position. The electronic control system consists of the TCU, various inputs (sensors), and outputs (lights and solenoids). The TCU is microprocessor based, has a self-diagnostic capability, and long-term memory (stored via the ECU). It also has a failsafe function, which maintains driveability in case of a major electrical component failure. The TCU, based on sensor input, varies the degree of AWD (when equiped) through progressive engagement of a Multi-Plate Transfer (MPT) clutch.

TCU Inputs

- Throttle sensor/idle switch
- Vehicle speed sensor #1
- Vehicle speed sensor #2
- Tachometer signal
- Inhibitor switch
- Cruise control signal
- ATF temperature sensor
- Ignition/battery voltage
- Forced front wheel drive (FWD) mode (on AWD vehicles, obviously)

The throttle sensor/idle switch signal is nominally received from the throttle position sensor (TPS) located on the left side of fuel-injection throttle body. The signal affects: shifting, line pressure and lock-up. The closed throttle input affects the lock-up release mode as well as smooth downshifting into 2nd gear. It also causes a reduction in the pressure. In case of TPS failure, the idle contacts will signal the throttle opening. Line pressure will go to maximum at open throttle, and it will go to minimum at closed throttle.

Vehicle speed sensor #1 is mounted to the transmission and is used to detect vehicle speed and it affects shift points, torque converter lock-up, and line pressure. In FWD transmissions, the speed sensor reads parking gear rotation at the front output shaft. In AWD transmissions, it senses the transfer clutch drum rotation at the rear output shaft.

Vehicle speed sensor #2, in FWD units, is used as a back up for speed sensor #1. In AWD units, it is used as the front output shaft speed sensor.

The system uses a Magnetic Resistance Effect (MRE) speed sensor driven by a conventional speedometer drive gear system in the front differential. The speed sensor generates four pulses per revolution. The Speedometer Driving Unit (SDU), receiving pulses from the MRE sensor, processes the signal sending the information to the TCU. The TCU compares the speed signal from the front output shaft with the signal from the rear output shaft (sensor #1). The speed differential helps the TCU determine the degree of MPT engagement. If a speed sensor fails, the remaining sensor signal will be used, but the MPT is set to minimum engagement.

The tachometer signal affects the shift points at kickdown. The TCU uses the signal to prevent the engine from over-revving.

The inhibitor switch prevents vehicle starting when the gear selector is not in either P or N. Additionally, it provides the signal for the dash display of gear selected. Although the inhibitor switch may fail, the manual valve will still be in the correct position for all selected ranges. However, if it breaks in a position other than P or N there is a high potential for a no-start condition. If the inhibitor breaks during operation, and multiple signals are seen in the forward ranges, the inhibitor switch is ignored and there is no fourth gear.

The cruise control signal tells the TCU of cruise control activation.This allows for a wider operating range in 4^{th} gear unless a large speed differential exists from the set speed in which case the transmission may downshift.

The ATF temperature sensor is located on the lower valve body next to duty solenoid B. When the ATF is cold (less than 50^{o}F), the TCU prevents an upshift into 4^{th} gear. The object is to warm the engine quickly for lower emissions. If the ATF is too hot (my research suggests this temp is in the range of 275-300^{o}F) , the TCU shifts the transmission as if in the POWER mode. This pushes the shift points higher which allows the engine to run faster. As a result, the oil pump then circulates ATF through the oil cooler more quickly to avoid overheating the engine (conversely, I have witnessed transmission damage in some vehicles from a severely overheating engine).

The TCU also monitors system voltage in order to correctly interpret the inputs and alter the control of the outputs. For example, the system is designed for 12-volt operation. When running, however, most vehicles have more than 12 volts available (~14V being typical).

The FWD fuse changes the driving mode from AWD to FWD. The FWD fuse is located in the fuse block near the left front shock tower. It is activated by inserting the spare fuse into the under hood connector. The FWD light on the dash verifies that the vehicle is in FWD.

ABS system inputs turn OFF the over-running clutch when ABS is active and fixes the duty ratio of the MPT to mostly FWD.

TCU Outputs
There are two types of outputs: solenoid controls and light controls. The solenoids control shifting, line pressure, lock-up and AWD. The light controls indicate operating conditions to the driver. They indicate the POWER mode, manually selected 2^{nd} gear, or hot ATF (hot ATF is displayed on AWD vehicles only for some reason).

Solenoid Controls
Shift solenoids #1 and #2 are located on the upper valve body. The TCU induces ON/OFF conditions, which regulate the shifting of the forward gears. When a shift solenoid is ON, it passes pilot pressure to shift valve A and/or shift valve B. The valve(s) will then shift, feeding the appropriate controlling member circuits (high clutch, band, etc.). Pilot pressure in this instance refers to a pressure held at a constant value. When a shift solenoid is OFF, the shift valve moves to its static position due to spring pressure. If shift solenoids #1 or #2 malfunction, the TCU deactivates the other. This results in the "limp home" mode with only 3^{rd} and Reverse gears working.

Shift solenoid #3 is also located on the upper valve body. It is used to control downshifts. It releases the 3-R accumulator pressure during low speed, heavy load situation in order to provide smooth 3-2 downshifts. It also

operates the overrunning clutch in order to provide engine braking during deceleration. It is used to cancel the overrunning clutch momentarily during light throttle 3-2 downshifts, or closed throttle 2-1 downshifts. If shift solenoid #3 malfunctions, the overrunning clutch is always ON and there will be engine braking during deceleration while in D.

Duty Solenoid A is located on the upper valve body. It regulates line pressure with 3 pre-programed routines:

- Basic: Altered with load, vehicle speed and range signal.
- Shifting: Lower line pressure in between shifts to minimize shift shock.
- Start up: With low ATF temperature or a low tachometer signal (cranking speed), it sets line pressure to a minimum.

The dropping resistor (^{2}) is wired in parallel with duty solenoid A, and is used to regulate line pressure. It is located on the inner, left fender wall next to the battery. It takes over line pressure control during the OFF portion of the duty cycle for the duty solenoid so the duty solenoid is never fully OFF. If duty solenoid A fails, line pressure goes to maximum. If the dropping resistor fails, the TCU sets an error code for solenoid A, and below approximately 2,000 RPM, the line pressure is set to maximum (over 2K RPM, the TCU still sends a modulated signal to the solenoid).

Duty Solenoid B is located on the lower valve body next to the ATF temperature sensor. It operates the lock-up clutch in 3 modes: ON, OFF and a gradual ON/OFF control of the lock-up clutch during gear shifting in order to reduce shift shock. If duty solenoid B fails, torque converter lock-up will not occur.

Duty Solenoid C is located in the extension housing. It is also controlled by the TCU. It varies the degree of AWD. If duty solenoid C fails, the AWD control will be set to maximum and the rear wheels will always be powered.

Light Controls

The MANUAL light is activated when the manual button is depressed. The POWER light is activated momentarily whenever the vehicle is started. The TCU, monitoring how quickly the gas pedal is depressed selects the POWER mode. This changes the performance characteristics of the transmission, i.e., it delays upshifts and may downshift if necessary. When selected, the computer turns the POWER light ON. There are a number of predetermined rates for entering POWER mode based on the relationship between vehicle speed and throttle angle. In general, it is easier to activate power mode at lower speeds than at higher speeds. POWER mode increases up and down shift points. It is deactivated by vehicle speed and throttle angle. For example, if speed is equal to or greater than (approximately) 40 MPH with a light throttle deactivation is immediate. If the speed is less than (approximately) 40 MPH a time lag up to 3 seconds will occur before resuming normal shift pattern. An ATF temperature warning light is provided on AWD vehicles. It is activated by the TCU indicating overheated ATF (~300^{o}F). The TCU logic will shift the transaxle as if in the power mode, moving more ATF volume through the cooler. Finally, the dash indication of gear selected is controled by the TCU via the inhibitor switch.

Self Diagnostic System

The 4EAT self-diagnostic system has three modes: a user mode and two dealer modes. The dealer modes are not covered here. In the user mode, the driver is notified through the blinking POWER light on the first start-up after a malfunction occurs. For a more detailed description of the user mode, see the TCU error code section of this document.

Transmission Component Operation

gear		Reverse Clutch	Brake Band	High Clutch	Forward Clutch	One-way Clutch (1-2)	One-Way Clutch (3-4)	Overrunning Clutch	Low & Reverse Band	Sol 1	Sol 2
P										-	-
R		**X**							**X**	-	-
N										-	-
D	1				**X**	**X**[a]	**X**			**X**	**X**
	2		**X**		**X**		**X**			-	**X**
	3			**X**	**X**		**X**			-	-
	4		**X**	**X**	**X**					**X**	-
3	1				**X**	**X**[a]	**X**	**X**	**X**	**X**	**X**
	2		**X**		**X**		**X**	**X**		-	**X**
	3			**X**	**X**		**X**	**X**		-	-
2	1				**X**		**X**	**X**	**X**	**X**	**X**
	2		**X**		**X**		**X**	**X**		-	**X**
	3[b]			**X**	**X**		**X**	**X**		-	-
1	1				**X**		**X**	**X**		**X**	**X**
	2[b]		**X**		**X**		**X**	**X**		-	**X**
	3[b]			**X**	**X**		**X**	**X**		-	-

Notes: an **X** in the table implies that circuit/device is enabled
Superscript **a:** No engine braking exhibited
b: Electronically selected to prevent engine over-revving

For the discussion below, **D-4** means "D" selected on the gear shift and the transmission is operating in 4th gear, **D-3** means "D" selected and operating in 3rd gear, **2-1** means "2" selected and operating in 1st gear, etc.

Operating Principals: Rear Gear Set

The rear sun gear is always powered by the input shaft. The rear planetary carrier always transmits power to the output shaft.

The one way clutch (O.W.C.) 3-4 prevents the rear internal gear from turning counterclockwise. Its inner race is the rear internal gear and its outer race is the forward clutch hub. The overrunning clutch hub is connected, by dogs, to the rear internal gear.

The overrunning clutch provides engine braking during deceleration except in **D-1** and **3-1**. The O.W.C. 3-4 is used in 1st, 2nd, and 3rd gears. The forward clutch is used in all forward gears. The rear internal gear is controlled by the forward clutch through the O.W.C. 3-4. Additionally, the rear internal gear is controlled by the overrunning clutch.

The forward clutch connects the rear internal gear to the front planetary carrier (splined to the forward clutch drum) through the O.W.C. 3-4. The overrunning clutch is also used to connect the rear internal gear to the forward clutch drum and the front planetary carrier. The O.W.C. 1-2 (Sprag) prevents the forward clutch drum from rotating counterclockwise. The Sprag is applied when the transmission is operating in **D-1** or **3-1**.

The Low/Reverse brake is splined to the case. It holds the forward clutch drum in order to keep it from turning when the transmission is in Reverse, and **2-1**.

Operating Principles: Front Gear Set

The high clutch drum (reverse clutch hub) is splined to the input shaft. It supplies power to the reverse clutch and the high clutch. The high clutch hub is splined to the front planetary carrier. When the reverse clutch is applied for reverse gear it powers the front sun gear. When the high clutch is applied in 3rd and 4th gear it powers the front planetary carrier via the high clutch hub.

The front sun gear is dogged to the reverse clutch drum. The front planetary carrier is splined internally to the high clutch hub and it is splined externally to the forward clutch drum.

Band Servo Operation

The band is applied in 2nd and 4th gears by a two stage servo which is controlled by accumulators.

For second gear, the servo is in the 2-Apply mode. Hydraulic pressure from the 2A accumulator pushes the 1-2 piston UPWARD which tightens the band.

For third gear, the servo is in the 3-Release mode. In this case, hydraulic pressure from the 3R accumulator aided by the return spring pushes the 1-2 piston DOWNWARD in order to release the band.

For fourth gear 4-Apply mode, hydraulic pressure from the 4A accumulator pushes the 3-4 piston UPWARD in order to apply the band.

Power Flow

***D-1** or **3-1** Operating Mode*

The input shaft powers the rear sun gear clockwise. When the Forward clutch is applied, the O.W.C. 3-4 outer race (forward clutch hub) is attached to the front carrier. With the O.W.C. 3-4 operating, the rear internal gear can only go clockwise. With the O.W.C. 1-2 operating, the forward clutch drum can only go clockwise. Output power is through the rear carrier. During coast mode, the O.W.C. 3-4 is released and there is no engine braking.

***D-2**, **3-2**, Or **2-2** Operating Mode*

Again, the input shaft powers the rear sun gear clockwise. When the forward clutch is applied, the O.W.C. 3-4 outer race (forward clutch hub) is attached to the front carrier. The band is also applied which holds the front sun gear stationary. Output power is transmitted from the rear carrier (front internal gear). During the coast mode, the O.W.C. 3-4 is released and there is no engine braking.

***D-3**, **3-3** Operating Mode*

The input shaft powers the rear sun gear clockwise. When the forward clutch is applied, the O.W.C. 3-4 outer race (forward clutch hub) is attached to the front carrier. The high clutch is also applied and the front planetary carrier is therefore powered. In this case the planetary gear set is locked up. During the coast mode, the O.W.C. 3-4 releases the rear internal gear and there is no engine braking.

***D-4** Operating Mode*

The input shaft powers the rear sun gear clockwise. When the forward clutch is applied it doesn't affect the power flow. It freewheels through the O.W.C. 3-4. When the high clutch is applied, the front planetary carrier is powered clockwise. Since the band is applied, the front sun gear is held stationary. The output is clockwise through the front internal gear (rear planetary carrier). Engine braking occurs during the coast and deceleration modes. Neither O.W.C. is used.

***2-1** Operating Mode*

The power flow is the same as in the other 1st gears except as follows. The rear internal gear is held by the overrunning clutch instead of by the O.W.C. 3-4. In addition, the forward clutch drum is held by the Low/Reverse brake instead of the O.W.C. 1-2. Engine braking occurs during coast and deceleration due to conditions described above. The overrunning clutch is "ON" and the Low/Reverse brake is "ON."

***Reverse** Operating Mode*

When the reverse clutch is applied the front sun gear is powered. The Low/Reverse brake is also applied, which holds the front planetary carrier stationary. Output power is through the rear carrier.

Lubrication

Service Intervals

You can follow Subaru recommendations for checking fluid levels in the transaxle and differential and changing fluids (see the owner's manual if you're interested). However, unless you have an add-on transmission fluid cooler, I recommend doing a drain & replace of ATF on a 15,000 mile, 15-month interval using a Dexron III rated fluid. Further, I recommend checking the levels, and fluid condition, every month. The cost is so low for differential fluids; I recommend replacement at the 30,000-mile or 30-month interval. I believe Subaru states the add-on transmission filter retrofitted to the 92 model is a "lifetime" component. However, I recommend either periodic changing of this filter or its replacement by an aftermarket "spin-on" filter. The aftermarket solution facilitates (but is not necessary for) the addition of an ATF temperature gauge. To help decide when to change fluids, I recommend the gauge sensor be positioned to measure the temperature coming out of the transmission, before going to the cooler. Knowing what temperature the ATF experiences should affect your fluid replacement interval. At elevated operating temperatures, ATF oxidizes, turns brown and takes on a smell like burnt toast. As heat destroys the fluid's lubricating qualities and friction characteristics, varnish begins to form on internal parts (such as the valve body) which interferes with the operation of the transmission. If the temperature gets above 250^{o}F., rubber seals begin to harden, which leads to leaks and pressure losses. At higher temperatures, the transmission begins to slip, which only aggravates the overheating issue. Eventually the clutches burn out and the transmission needs to be rebuilt. As a rule of thumb, every 20^{o}F increase in operating temperature above 175^{o}F cuts the life of the fluid in half. Assuming an ATF life of 100,000 miles for 175^{o}F, at 195^{o}F fluid life is reduced to 50,000 miles. At 220^{o}F, commonly encountered in transmissions without an add-on cooler, the fluid is good for about 25,000 miles. At 240^{o}F, the fluid won't go much over 10,000 miles. Add another 20 degrees, and life expectancy drops to 5,000 miles. Go to 295/300^{o}F (the temperature reached before the Hot ATF light illuminates), and 1,000 miles may be the maximum you may get before the transmission requires a rebuild.

Checking the Fluid Levels

Transaxle

1) Warm engine to normal operating temperature. Park vehicle on level floor. Engage transaxle in all gear positions.
2) Set transmission selector lever in Park with engine idling. Remove dipstick and clean with lint-free cloth. Replace dipstick, and then pull it out again to check fluid level. Fluid level should be between upper and lower Hot marks on dipstick. Add fluid if necessary. DO NOT overfill.

Differential

Use dipstick marked DIFF OIL on top of differential (right side, rear of engine) to check fluid level. Level should be between "L" and "F" marks. Add fluid if necessary.

OEM Recommended Fluids

Transaxle: Dexron-II ATF (Dexron III is commonly substituted).
Differential: front - 75W-90 API GL-5. rear - 80W-90 GLS. Note: the rear differential is a limited slip unit and may require an additive depending on the fluid used, i.e., use of 75W-90 GL-5

Additional notes on fluid:
Do not overfill because doing so can cause the fluid to become aerated, which adversely affects operation through reduced lubrication and heat carrying capacity. If the dipstick reads low, the transmission is likely leaking. Inspect to determine where the fluid is going. If there are no visible leaks, check the radiator for ATF in the coolant. Although rare, the ATF cooler inside the radiator may be leaking and cross-contaminating the fluids. (For potential sources of external leaks, see the Road Test & External Leak Inspection section of this manual). You should also check the condition of the fluid. Some discoloration and darkening is normal as the fluid ages, but if the ATF is brown or has a burnt smell, it is badly oxidized and needs to be changed. Varnish on the dipstick is another indication of worn out fluid (and excessive heat). Particles in the fluid indicates the presence of internal part failure and is a sign that a rebuilding/overhaul operation will likely be required soon.

Draining & Refilling the Transaxle

Transmission

1) Remove drain plug. If replacing internal filter, remove oil pan. Install NEW gaskets when reassembling. Do not neglect to include a new crush washer on the drain plug. Tighten all bolts to specification.
2) Fill transmission with fluid. Start and warm engine to normal operating temperature. Check fluid level with engine idling. Add fluid as necessary. DO NOT overfill.

Differential

Each differential has its own drain plug. Remove the differential drain plug to drain fluid. Note: on the rear differential, first remove the fill plug to ensure you can replace the fluid before draining it. There has been one occurrence (that I have read) of a front differential dipstick that would not come out of the differential. Although I consider this a rare occurrence, you should ensure the dipstick could be removed before draining the front differential as the dipstick hole also serves as the fill opening.

Fluid Capacities

Transaxle Capacities

Application	Qts. (L)
(AWD)	10.0 (9.5)

Note: This dry fill capacity includes the torque converter & transfer case. Typical drain & fill is ~ 7 qts as some is retained in the cooler/lines and the torque converter (~ 3 qts) which does not have an external drain.

Differential Capacities

Application	Qts. (L)
Front	1.3 (1.2)
Rear	0.85 (0.8)

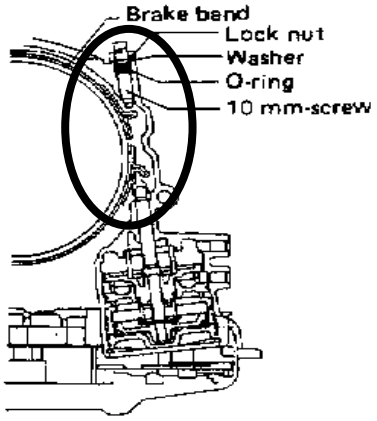
Gear Ratios

1st	2.785
2nd	1.545
3rd	1.000
4th	0.694 *
Reverse	2.272
Differential	3.545

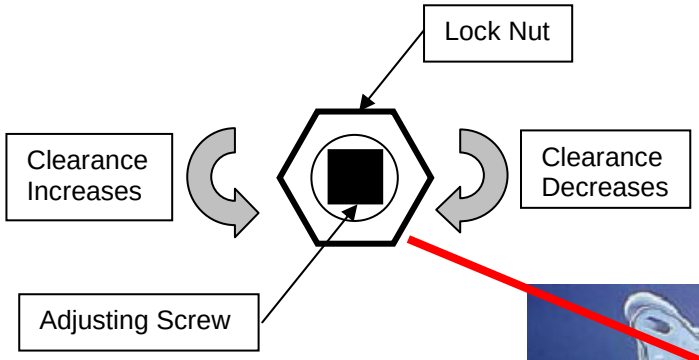
* Note this is a 4-speed transmission, not a 3-speed with overdrive even though the ratios suggest different.

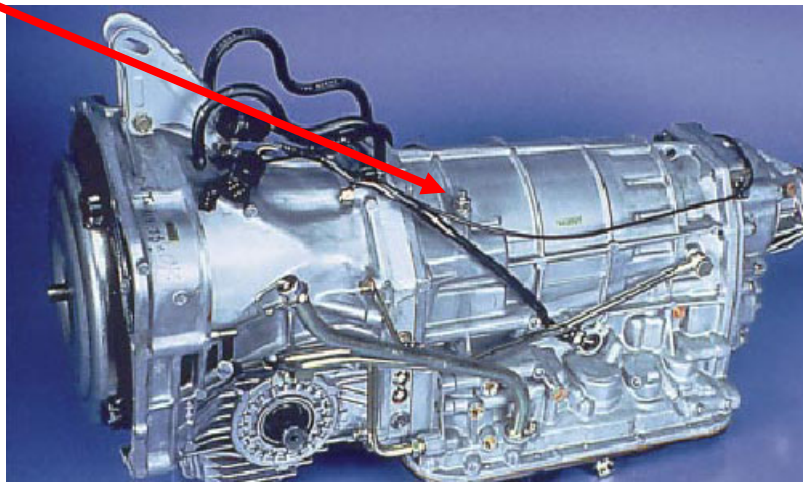
External Adjustments

Band Adjustment



Note: In performing a band adjustment, if you loosen too much (counter-clockwise movement), the band adjustment mechanism can fall off the servo piston *requiring transaxle removal and disassembly*. The figure below is one of looking down on the adjustment mechanism. The lock nut requires a 17mm wrench (boxed-end preferred) and the adjusting screw can be turned with a 7mm open end wrench. Also see ([3]), TPS failure mode.





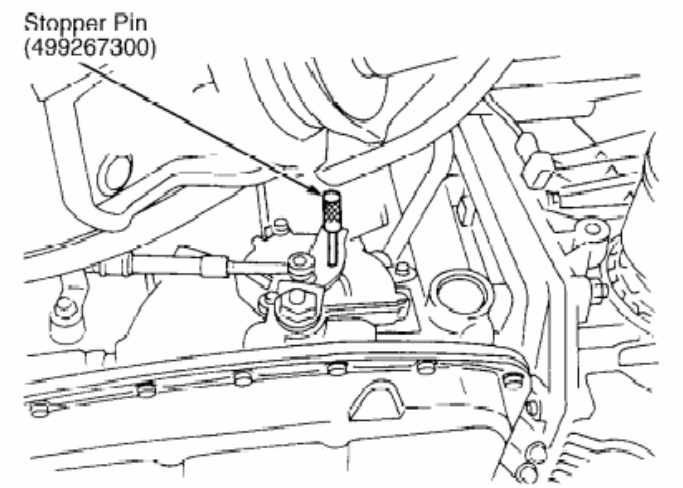
The band adjustment screw is located on front, top, left side of the transmission housing (behind the differential housing and oil pump). For the situation in which up-shifts occur directly from 1st to 3rd gear (too large clearance); or up-shifts from 2nd to 4th gear and/or downshifts from 4th to 2nd (too small clearance) the specified method is to hold the band adjustment screw, and loosen the lock nut. Tighten the adjustment screw (clockwise rotation) to 80 inch-lbs. (9 N.m). Since it's almost impossible to get a torque wrench in there, just snug it up tight with your 7-mm wrench; don't put a lot of muscle on it, which will get you close given the space available. Then back off the adjusting screw off 3 full turns. Hold adjustment screw in position and tighten the lock nut to 18-21 ft-lbs. (24-28 N.m). In the case of engine rpm increasing (flaring) during the 2-3 gearshift (and 2nd and 4th gears still function), or a time lag of over one second occurs during the downshift 3-2, band clearance needs to be decreased (turn clockwise). If the feeling of "braking" occurs during the 2-3 gearshifts, the band clearance needs to be increased (turn counter-clockwise). Adjustments in these circumstances may be made by turning the adjustment screw in 3/4 turn, or less, in the appropriate direction. The specified method is to hold the band adjustment screw, and loosen lock nut. Tighten/loosen adjustment screw (as appropriate). Hold the adjustment screw, and tighten lock nut to 18-21 ft-lbs. (24-28 N.m). .

Kick-Down Switch & Downshift Solenoid

1) With ignition on, press accelerator pedal to stop. A click should be heard just as accelerator bottoms. If adjustment is necessary, loosen adjustment nut and adjust switch position for proper operation. Tighten nut.
2) If kick-down failure occurs infrequently, the solenoid may be malfunctioning because of contamination. Remove and clean inside of solenoid while moving push rod. After cleaning, carefully check solenoid operation. Install with a new O-ring.

Neutral Safety Switch

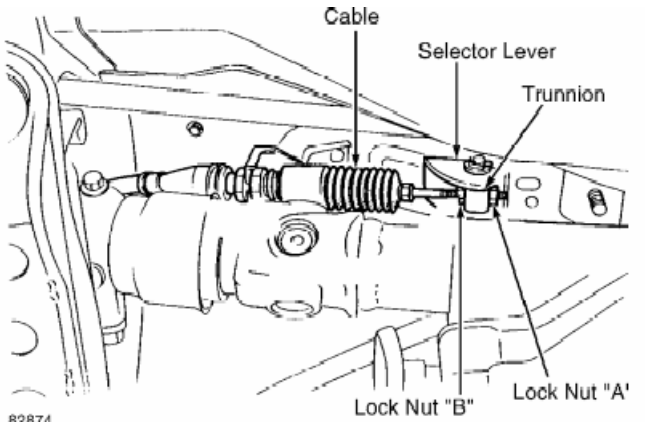
1) Loosen neutral safety (inhibitor) switch mounting screws. Move gear selector lever to Neutral.
2) Insert STOPPER PIN (499267300) as vertically as possible into holes in neutral safety switch lever and switch body. See Figure below. Tighten mounting bolts and recheck adjustment. Note: in the absence of the OEM stopper pin tool, use a suitable rod of size to fit in the holes specified.



Adjusting Neutral Safety Switch

Shift Linkage

1) Adjust shift cable at lower end of selector lever. Set selector lever in Neutral. Loosen lock nuts on both sides of inner cable. See Figure below.
2) Lightly push selector lever away from lock nut "B". Tighten lock nut "A" until it contacts selector lever trunnion. Tighten lock nut "B" to 80-151 INCH lbs. (9-17 N.m).



Adjusting Shift Cables (Typical)

Service Procedures

General Precautions

When disassembling or assembling the automatic transmission, observe the following general precautions.

1) Workshop: Provide a place that is clean and free from dust.
2) Worktable: The size of 36 x 60 inches is adequate, and it is preferred to have its surface is covered with an iron or aluminum plate - that is clean and rust-free.
3) Cleaning of transaxle exterior:
   a. Clean the exterior surface of transmission with steam or suitable degreasing material prior to disassembly; however, note that a covering, i.e., vinyl tape or plastic wrap, should be placed on the air vents, filler pipe, tail shaft, and the opening for torque converter to prevent infiltration of steam, degreaser, dirt, grease into the transmission. The cleaning job should be done away from the place of disassembly/assembly.
   b. Partial cleaning may be sufficient, such as when disassembly is limited to certain parts, e.g., valve body or extension housing (AWD only).
4) Disassembly, assembly and cleaning tips (the order of the tips is not significant):
   a. Inspect the parts during both disassembly (to find problem areas) and assembly (to prevent new problems) in accordance with the appropriate section.
   b. During the job, it is preferred to not use gloves (introduction of dirt/lint issue). Don't clean the parts with rags or paper towels: Use a chamois or other lint-less cloth.
   c. Pay attention to the workshop air supply, especially that used for cleaning/testing. Rid the air of as much moisture and dust as possible. Be careful not to scratch or dent any part while testing with an air gun.
   d. Finish the job from cleaning to completion of assembly as quickly as possible, consistent with good technique, in order to avoid introduction of secondary troubles caused by dust/airborne grit. When you must stop, cover the parts with clean, lint-less cloth to limit dust/dirt entry into the transmission.
   e. Always use new washing/cleaning fluids for cleaning automatic transmission parts.
   f. Although the cleaning may be done by dipping a part into a washing fluid or use of pressurized delivery of washing fluid, dipping is preferred (do not rub with a brush). Assemble (or coat) the parts immediately after cleaning with minimum exposure to the air (to prevent rust). In washing rubber parts, do not leave them into the washing fluid for a long time to prevent deterioration of the rubber.
   g. Apply automatic transmission fluid (ATF), or proper assembly lubricant, on parts immediately prior to assembly, and carefully follow the specified torque values and sequence.
   h. Use a very thin layer of petroleum jelly if it is necessary to hold parts in the position when assembling.
   i. Drain some ATF and differential gear oil into a clean saucer or other suitable container so that the conditions of fluid and oil can be inspected.
   j. Do not support the transmission by axle drive shaft, stator shaft, input shaft or various pipes when moving transmission from one place to another.
   k. Always discard old oil seals and bushings, and install new ones.
   l. Do not reuse old pipes, gaskets, plugs, spring pins, etc. Install new ones.
   m. Be sure to replace parts that are damaged, worn, scratched, discolored, etc.

Preliminary Inspection

Maintenance Precautions: Before jacking up the front of the vehicle for maintenance (with the engine running) or before running the vehicle on a 2-wheel chassis dynamometer, the electronic AWD engagement system must be disengaged by installing the spare fuse (15A) of the fuse box into the FWD connector located under the hood. Failure to do so could result in unexpected movement of vehicle, or damage to the AWD system.

1) Confirm that the engine is functioning correctly. Perform a tune-up if necessary. Check the idling speed.
2) Check that the linkage between the accelerator pedal and the throttle body is functioning properly. Check the full-opened and full-closed throttle positions.
3) See that no fluid is leaking from the ATF cooler circulation piping. See that no fluid is leaking out of the transmission.
4) Check that the electrical circuits of inhibitor switch are functioning properly.
5) Confirm that the manual linkage is operating correctly or that an adjustment has been completed.
6) See that the ATF level and differential oil level are normal.
   ATF temperature. Raise the ATF temperature to 140 to 176°F (60 to 80°C). This temperature may be attained by idling the engine for approximately 30 minutes. The level of ATF varies with fluid temperature, so pay attention to the fluid temperature when checking oil level.
7) Differential Gear Oil Level. Ensure the vehicle is level before taking any fluid measurements. Do not check the oil level, nor add oil to the case, with the front end of the vehicle jacked up; this will result in an incorrect reading of the oil level.

Basic Diagnostic Procedure

Step	Check	Check response: Yes	Check response: No
1 CHECK ATF OIL TEMP WARNING LIGHT.			
Turn the ignition switch to ON.	Does the AT OIL TEMP warning light illuminate?	Go to step **2.**	Repair the AT OIL TEMP warning light circuit or power supply and ground line circuit. Go to step **2.**
2 PERFORM THE INTERNAL DIAGNOSTICS.			
refer to the TCU error code procedure	Is a code displayed?	Record codes found, Go to step **3.**	Go to step **3.**
3 CHECK:			
•Oil leak •Stall speed test •Line pressure test •Transfer clutch pressure test •Time lag test •Road test •Inhibitor switch	Is the unit that might influence AT problem normal	STOP, unit normal	Repair or replace each item

Transmission Control Unit (TCU)

How to Check Transmission Control Unit (TCU) Error Codes

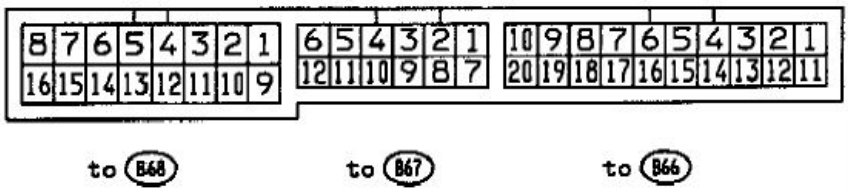
The presence of the "Power" light on the lower dash panel blinking on/off 16 times at half-second intervals immediately after engine start-up indicates the TCU has recorded an error in the electronic system of the transmission. To discover the stored code, one must perform a sequence of steps to get the TCU in its diagnostic mode. Once in the diagnostic mode, the light will blink in a combination of long and/or short blinks, with a long blink = 10, short blink = 1. For example, if you observe 2 long blinks followed by three short blinks, that implies a code of 23. The code will either repeat, or display additional errors stored, until the ignition is turned off. The following method is used to enter the diagnostic mode for existing and previously recorded problems. Clearing the memory of the TCU is not supported, as the code is actually stored in the ECU memory.

To perform the self-diagnosis test for existing problems:
Warm up engine by driving at speeds greater than 12mph.
Stop vehicle and turn ignition switch OFF.
Turn ignition switch ON and make sure POWER indicator lamp comes on.
Turn ignition switch OFF.
Move selector lever to “D” and turn manual switch ON.
Turn ignition switch ON.
Move selector lever to "3" and turn manual switch OFF.
Move selector level to "2" and turn manual switch ON.
Move selector lever to "1" and turn manual switch OFF.
Partially depress accelerator pedal (to turn idle switch off).
Check code as displayed on POWER light. Blinking once every 1/4sec is normal.
To perform the test for previous (stored) problems:
Warm up engine by driving at speeds greater than 12mph.
Stop vehicle and turn ignition switch OFF.
Turn ignition switch ON and make sure POWER indicator lamp comes on.
Turn ignition switch OFF.
Move selector lever to "1" and turn manual switch ON.
Turn ignition switch ON.
Move selector lever to "2" and turn manual switch OFF.
Move selector lever to "3" and turn manual switch ON.
Move selector lever to "D" and turn manual switch OFF.
Partially depress accelerator pedal (to turn idle switch off).
Check code as displayed on POWER light. Blinking once every 1/4sec is normal.

TCU Error Code Table	
Trouble Code	**Item**
11	Duty solenoid A
12	Duty solenoid B
13	Shift solenoid 3
14	Shift solenoid 2
15	Shift solenoid 1
21	ATF temp sensor
22	Atmospheric sensor
23	Engine revolution signal
24	Duty solenoid C
31	Throttle sensor
32	Vehicle speed sensor 1
33	Vehicle speed sensor 2

To troubleshoot TCU error codes found, proceed to TCU: testing and inspection procedures and/or TCU sensor and data table.

TCU Testing and Inspection Procedures



TCU Connector Pin out

Code 11 Duty Solenoid A

1) MEASURE SIGNAL VOLTAGE OUTPUT EMITTED FROM TCU.
   a. Warm up the engine and transmission.
   b. Ignition switch ON (Engine OFF).
   c. Move selector lever to "N".
   d. While opening and closing throttle valve, measure voltage between TCU connector and body.

(Connector) & Terminal(s)	Specified value
(B68) No. 8 - No. 10	1.5 - 3.0 V (Throttle is fully closed.)
	0.5 V, max. (Throttle is fully open.)
(B68) No. 7 - No. 10	5 - 14 V (Throttle is fully closed.)
	0.5 V, max. (Throttle is fully open.)

2) CHECK HARNESSES BETWEEN TCU AND DUTY SOLENOID A AND BETWEEN TCU AND RESISTOR.
   a. Disconnect connector from TCU.
   b. Disconnect connector from transmission.
   c. Disconnect connector from resistor.
   d. Measure resistance between TCU connector and transmission and between TCU connector and body.

(Connector) & Terminal(s)	Specified value
(B68) No. 8 - (B14) No. 7	0 ohm
(B68) No. 8 - Body	1 M-ohm min.

   e. Measure resistance between TCU connector and resistor connector and between TCU connector and body.

(Connector) & Terminal(s)	Specified value
(B68) No. 7 - (F25) No. 1	0 ohm
(B68) No. 7 - Body	1 M-ohm min.

3) CHECK DUTY SOLENOID A's GROUND LINE.
   a. Disconnect connector from transmission.
   b. Measure resistance between transmission connector receptacle (on transmission) and transmission case.

(Connector) & Terminal(s)	Specified value
(T2) No. 4 - Transmission	1 ohm max.

4) CHECK RESISTOR.
   a. Disconnect connector from resistor.
   b. Measure resistance between resistor terminals.
      Specified resistance: 9 - 15 ohm
5) CHECK DUTY SOLENOID A
   a. Disconnect connector from transmission.
   b. Measure resistance between transmission connector receptacle (on transmission) terminals.

(Connector) & Terminal(s)	Specified value
(T2) No. 7 - No. 4	1.5 - 4.5 ohm

Code 13 Shift Solenoid 3

1) MEASURE SIGNAL VOLTAGE OUTPUT EMITTED FROM TCU.
   a. Raise vehicle and support with safety stands. On AWD models, raise all wheels off ground.
   b. Warm up the engine and transmission.
   c. Move selector lever to "D."
   d. Measure signal voltage output emitted from TCU while idling the engine.

(Connector) & Terminal(s)	Specified value
(B68) No. 15 - No. 10	10 - 14 V

2) CHECK HARNESS BETWEEN TCU AND SHIFT SOLENOID 3.
   a. Disconnect connector from TCU.
   b. Disconnect connector from transmission.
   c. Measure resistance between TCU connector and transmission connector, and between TCU connector and body.

(Connector) & Terminal(s)	Specified value
(B68) No. 15 - (B14) No. 1	0 ohm
(B68) No. 15 - Body	1 M-ohm min.
(B68) No. 10 - (B15) No. 4	0 ohm
(B68) No. 10- Body	1 M-ohm min.

3) CHECK SHIFT SOLENOID'S GROUNDING LINE.
   a. Disconnect connector from transmission.
   b. Measure resistance between transmission connector receptacle and transmission case.

(Connector) & Terminal(s)	Specified value
(T2) No. 4 - Transmission	0 ohm

4) CHECK SHIFT SOLENOID.
   a. Disconnect connector from transmission.
   b. Measure resistance between transmission connector receptacle's terminals.

(Connector) & Terminal(s)	Specified value
(T2) No.1 - No.4	20-30 ohm

Code 14 Shift Solenoid 2

1) MEASURE SIGNAL VOLTAGE OUTPUT EMITTED FROM TCU.
   a. Raise vehicle and support with safety stands. On AWD models, raise all wheels off ground.
   b. Warm up the engine and transmission.
   c. Move selector lever to "D."
   d. Measure signal voltage output emitted from TCU while idling the engine.

(Connector) & Terminal(s)	Specified value
(B68) No. 13 - No. 10	10 - 14 V

2) CHECK HARNESS BETWEEN TCU AND SHIFT SOLENOID 2.
   a. Disconnect connector from TCU.
   b. Disconnect connector from transmission.
   c. Measure resistance between TCU connector and transmission connector, and between TCU connector and body.

(Connector) & Terminal(s)	Specified value
(B68) No. 13- (B14) No. 2	0 ohm
(B68) No. 13 - Body	1 M-ohm min.
(B68) No. 10- (B14) No. 4	0 ohm
(B68) No. 10- Body	1 M-ohm min.

3) CHECK SHIFT SOLENOID 2's GROUNDING LINE.
   a. Disconnect connector from transmission.
   b. Measure resistance between transmission connector receptacle and transmission case.

(Connector) & Terminal(s)	Specified value
(T2) No. 4 - Transmission	0 ohm

4) CHECK SHIFT SOLENOID 2.
   a. Disconnect connector from transmission.
   b. Measure resistance between transmission connector receptacle's terminals.

(Connector) & Terminal(s)	Specified value
(T2) No.2 - No.4	20-30 ohm

Code 15 Shift Solenoid 1

1) MEASURE SIGNAL VOLTAGE OUTPUT EMITTED FROM TCU.
   a. Raise vehicle and support with safety stands. On AWD models, raise all wheels off ground.
   b. Warm up the engine and transmission.
   c. Move selector lever to "D."
   d. Measure signal voltage output emitted from TCU while idling the engine.

(Connector) & Terminal(s)	Specified value
(B68) No. 14 - No. 10	10 - 14 V

2) CHECK HARNESS BETWEEN TCU AND SHIFT SOLENOID 1.
   a. Disconnect connector from TCU.
   b. Disconnect connector from transmission.
   c. Measure resistance between TCU connector and transmission connector, and between TCU connector and body.

(Connector) & Terminal(s)	Specified value
(B68) No. 14 - (B14) No. 3	0 ohm
(B68) No. 14 - Body	1 M-ohm min.
(B68) No. 10 - (B14) No. 4	0 ohm
(B68) No. 10 - Body	1 M-ohm min

3) CHECK SHIFT SOLENOID 1's GROUND LINE.
   a. Disconnect connector from transmission.
   b. Measure resistance between transmission connector receptacle and transmission case.

(Connector) & Terminal(s)	Specified value
(T2) No. 4 - Transmission	0 ohm

4) CHECK SHIFT SOLENOID 1.
   a. Disconnect connector from transmission.
   b. Measure resistance between transmission connector receptacle's terminals.

(Connector) & Terminal(s)	Specified value
(T2) No. 3 - No. 4	20 - 30 ohm

Code 21 ATF Temperature Sensor

1) MEASURE SIGNAL VOLTAGE INPUT OF TCU.
   a. Turn ignition switch ON (with engine OFF) and measure signal voltage input of TCU.
   b. Start and warm up the engine. Measure signal voltage input of TCU.

(Connector) & Terminal(s)	Specified value
(B67) No.10 - (B66) No.20	1.4 - 1.7 V [ATF temperature: 20° C (6° F)]
	0.3 - 0.6 V [ATF temperature: 80° C (176° F)]

2) CHECK HARNESS BETWEEN TCU AND ATF TEMPERATURE SENSOR.
   a. Disconnect connector from TCU.
   b. Disconnect connector from transmission.
   c. Measure resistance between TCU connector and transmission connector, and between TCU connector and body.

(Connector) & Terminal(s)	Specified value
(B67) No. 10 - (B14) No. 5	0 ohm
(B67) No. 10 - Body	1 M-ohm min.
(B66) No. 20 - (B14) No. 12	0 ohm

3) CHECK ATF TEMPERATURE SENSOR.
   a. Disconnect connector from transmission.
   b. Measure resistance between transmission connector receptacle's terminals.

(Connector) & Terminal(s)	Specified value
(T2) No. 5 - No. 12	2.3 - 2.7 K-ohm [ATF temperature: 20°C (68°F)

   c. Connect connector to transmission, and warm up the engine to increase ATF temperature.
   d. Stop the engine and disconnect connector from transmission.
   e. Measure resistance between transmission connector receptacle's terminals.

(Connector) & Terminal(s)	Specified value
(T2) No. 5 - No. 12	280 - 360 ohm [ATF temperature: 80°C (176°F)]

Code 23 Engine RPM Signal

Engine RPM Signal Circuit

1) MEASURE SIGNAL VOLTAGE INPUT OF TCU.
   a. Turn ignition switch ON (with engine OFF).
   b. Measure signal voltage input of TCU.

(Connector) & Terminal(s)	Specified value
(B67) No. 5 - Body	10 V, min.

2) CHECK HARNESS BETWEEN TCU AND ECU (MPFI).
   a. Disconnect connector from TCU.
   b. Disconnect connector from ECU.
   c. Measure resistance between TCU connector and ECU connector.

(Connector) & Terminal(s)	Specified value
(B67) No. 5 (B61) No. 16	0 ohm
(B67) No. 5 Body	1 M-ohm, min.

Code 24 Duty Solenoid C

FWD Fuse & Dropping Resistor Location

1) CHECK SIGNAL VOLTAGE OUTPUT EMITTED FROM TCU.
   a. Install spare fuse on FWD connector and set in FWD mode.
   b. Turn ignition switch ON (with engine OFF).
   c. Move selector lever to "D".
   d. Measure voltage output emitted from TCU (with accelerator pedal released).

(Connector) & Terminal(s)	Specified value
(B68) No.3 - No. 10	8-14V

   e. Turn ignition switch OFF.
   f. Remove spare fuse from FWD switch.
   g. Turn ignition switch ON (with engine OFF).
   h. Move selector lever to "D."
   i. Measure voltage output emitted from TCU (with accelerator pedal fully depressed).

(Connector) & Terminal(s)	Specified value
(B68) No. 3 - No. 10	0.5 V (max)

2) CHECK HARNESS BETWEEN TCU AND DUTY SOLENOID C.
   a. Disconnect connector from TCU.
   b. Disconnect connector from transmission.
   c. Measure resistance between TCU connector and transmission connector.

(Connector) & Terminal(s)	Specified value
(B68) No. 3 - (B14) No. 11	0 ohm
(B68) No. 3 - Body	1 M-ohm min.
(B68) No. 10 - (B14) No. 4	0 ohm
(B68) No. 10 - Body	1 M-ohm min.

3) CHECK DUTY SOLENOID C'S GROUND LINE.
   a. Disconnect connector from transmission.
   b. Measure resistance between transmission connector receptacle and transmission case.

(Connector) & Terminal(s)	Specified value
(T2) No. 4 - Transmission	1 ohm max.

4) CHECK DUTY SOLENOID C.
   a. Disconnect connector from transmission.
   b. Measure resistance between transmission connector receptacle's terminals.

(Connector) & Terminal(s)	Specified value
(T2) No. 11 - No.4	9-15 ohm

Code 25 Engine Torque Control Signal

1) MEASURE SIGNAL VOLTAGE OUTPUT OF ECU (MPFI).
   a. Turn ignition switch ON (with engine OFF).
   b. Measure signal voltage output of ECU (MPFI).

(Connector) & Terminal(s)	Specified value
(B59) No. 20 - Body	4 - 5 V

2) MEASURE SIGNAL VOLTAGE INPUT OF TCU.
   a. Disconnect connector from TCU.
   b. Turn ignition switch ON (with engine OFF).

(Connector) & Terminal(s)	Specified value
(B68) No. g - Body	4 - 5 V

Code 31 Throttle Position Sensor

1) MEASURE SIGNAL VOLTAGE INPUT OF TCU.
   a. Turn ignition switch ON (with engine OFF).
   b. Measure signal voltage input emitted from throttle sensor with accelerator pedal fully depressed.

(Connector) & Terminal(s)	Specified value
(B67) No. 8 - Body	0.5 V (Throttle fully closed) 4.5 V (Throttle fully open)

2) CHECK HARNESS/CONNECTOR BETWEEN TCU AND THROTTLE SENSOR.
   a. Disconnect connector from TCU.
   b. Disconnect connector from throttle sensor.
   c. Measure resistance between TCU and throttle sensor connectors.

(Connector) & Terminal(s)	Specified value
(B67) No. 8 - (E11) No.1	0 ohm
(867) No. 8 - Body	1 M-ohm min.

3) CHECK THROTTLE SENSOR.
   a. Disconnect connector from throttle sensor.
   b. Measure resistance between throttle sensor terminals.

(Connector) & Terminal(s)	Specified value
No.1 - No.2	1 K-ohm (Throttle fully closed) 4.3 K-ohm (Throttle fully open)

Code 32 Vehicle Speed Sensor 1

1) MEASURE SIGNAL VOLTAGE INPUT OF TCU.
   a. Raise vehicle and place safety stands. On AWD models, raise all wheels off ground.
   b. Start the engine. Set vehicle in 12 miles/h condition.
   c. Measure signal voltage input of TCU.

(Connector) & Terminal(s)	Specified value
(B67) No.12 - (B66) No.20	1 V, min. (AC signal)

2) CHECK HARNESS/CONNECTOR BETWEEN TCU AND VEHICLE SPEED SENSOR 1.
   a. Disconnect connector from TCU.
   b. Disconnect connector from transmission.
   c. Measure resistance between TCU connector and transmission connector.

(Connector) & Terminal(s)	Specified value
(B67) No. 12 - (B14) No. 16	0 ohm
(B67) No. 12 - Body	1 M-ohm min.
(B66) No. 20 - (B14) No. 9	0 ohm
(B66) No. 20 - Body	1 M-ohm min.

3) CHECK VEHICLE SPEED SENSOR 1.
   a. Disconnect connector from transmission.
   b. Measure resistance between transmission connector receptacle's terminals.

(Connector) & Terminal(s)	Specified value
(T2) No 16 - No. 9	450 - 650 ohm

Code 33 Vehicle Speed Sensor 2

1) MEASURE SIGNAL VOLTAGE INPUT OF TCU.
   a. Turn ignition switch ON (with engine OFF).
   b. Move select lever to "N" and slowly move vehicle by pushing it.
   c. While vehicle is slowly moving, measure signal voltage input of TCU.

(Connector) & Terminal(s)	Specified value
(B66) No. 11 - (B66) No.20	0 or 5V

2) CHECK HARNESS/CONNECTOR BETWEEN TCU AND VEHICLE SPEED SENSOR 2.
   a. Disconnect connector from TCU.
   b. Disconnect connector from vehicle speed sensor 2.
   c. Measure resistance between TCU connector and vehicle speed sensor 2 connector, and vehicle speed sensor 2 connector and body.

(Connector) & Terminal(s)	Specified value
(B66) No. 11 - (B9) No. 1	0 ohm
(B66) No. 11 - Body	1 M-ohm min.
(B9) No.2 - Body/0 ohm	

3) CHECK VOLTAGE OF POWER SUPPLY LINE.
   a. Turn ignition switch ON (with engine OFF).
   b. Measure voltage between vehicle speed sensor 2 connector and body.

(Connector) & Terminal(s)	Specified value
(B9) No. 3 - Body	10V, min.

4) CHECK VEHICLE SPEED SENSOR 2.
   a. Remove vehicle speed sensor 2 from transmission, connect body harness connector (B9) to vehicle speed sensor 2 and turn ignition switch ON.
   b. Rotate vehicle speed sensor 2.
   c. Check that voltage across vehicle speed sensor 2's connector terminals change (from 0 to 5) volts four times per rotation.

(Connector) & Terminal(s)	Specified value
(B9) No. 1 - (B9) No. 2	0 to 5 V

TCU and Sensor Data Table

Content			Connector	Terminal	Conditions	Voltage
Battery supply			B66	14	Ignition switch OFF	10-14
Ignition power supply			B66 B67	1 8	Ignition switch ON (Engine OFF)	10-14
Inhibitor Switch	"P" range switch	Signal (-)	B66	9	"P" range	Less than 1
					Not "P" range	9-13
	"R" range switch	Signal (-)	B66	10	"R" range	Less than 1
					Not "R" range	8-10
	"N" range switch	Signal (-)	B66	8	"N" range	Less than 1
					Not "N" range	9-13
	"D" range switch	Signal (-)	B67	1	"D" range	Less than 1
					Not "D" range	4-7
	"3" range switch	Signal (-)	B67	2	"3" range	Less than 1
					Not "3" range	6-10
	"2" range switch	Signal (-)	B67	3	"2" range	Less than 1
					Not "2" range	6-10
	"1" range switch	Signal (-)	B67	4	"1" range	Less than 1
					Not "1" range	6-10
Manual switch		Signal (-)	B66	6	Manual switch ON	Less than 1
					Manual switch OFF	6-10
Brake switch		Signal (+)	B66	7	Brake pedal pressed	10-14
					Brake pedal released	Less than 0.5
ABS switch		Signal (-)	B66	5	ABS switch on	Less than 1
					ABS switch OFF	6-10

Content		Connector	Terminal	Measuring Conditions	Voltage	Resistance to body (ohm)
TPS	Signal	B67	Throttle closed	0.5	Throttle closed	-
			Throttle full open	4.5	Throttle full open	-
Engine Torque Control signal	Signal	B68	Selector in "N" Throttle closed	4.5-5	Selector in "N" Throttle closed	-
ATF temp sensor	Signal (+)	B67	Temp 68F	3.0-3.5	Temp 68F	2.3K-2.7K
			Temp 176F	1.0-1.3	Temp 176F	280-360
Speed sensor 1	Signal (+)	B67	Speed=0	0	Speed=0	450-600
			Speed > 12mph	>1 (AC)	Speed > 12mph	
Speed sensor 2	Signal (+)	B66	Slowly moved >7 ft	<1 changing to >4	Slowly moved >7 ft	-
Atmospheric sensor	Signal (+)	B67	-	-	-	-
Cruise control	Signal (-)	B66	Cruise ON	<1	Cruise ON	-
			Cruise OFF	6-10	Cruise OFF	
Shift solenoid 1		B68	14	Gear 1 or D	10-14	20-30
				Gear 2 or 3	< 1	
Shift solenoid 2		B68	13	Gear 1 or 2	10-14	20-30
				Gear 3 or 4	< 1	
Shift solenoid 3		B68	15	N (throttle closed)	< 1	20-30
				D (throttle closed)	10-14	
Duty solenoid A w/ Eng OFF		B68	8	Throttle full closed	1.3-3.0	1.5 - 4.5
				Throttle full open	< 0.5	
Dropping resistor w/ Eng OFF		B68	7	Throttle full closed	5-14	9-15
				Throttle full open	< 0.5	
Duty solenoid B		B68	6	At lock-up	8-14	9-15
				Lock-up release	< 0.5	
Duty solenoid C		B68	3	FWD fuse in	8-14	9-15
				No fuse, throttle full-open, 1st gear	< 0.5	
Sensor ground line 1		B67	7	-	0	< 1
Sensor ground line 2		B66	20	-	0	<1
System ground line		B66	1	-	0	<1
Power system ground		B68	10	-	0	<1
FWD switch		B66	2	Fuse removed	10-14	-
			7	Fuse installed	< 1	

Mechanical Tests - System

Physical Symptoms Diagnostic Table

Starter does not rotate when select lever is in “P” or “N” range; and/or starter rotates when select lever is in “R”, “D”, “3” or “2” range.	• Inhibitor switch • Select cable • Select lever • Starter motor and harness
Abnormal noise when select lever is in “P” or “N” range.	• Strainer • Duty solenoid C • Oil pump • Drive plate • ATF level too high or too low
Hissing noise or shudder occurs during start.	• Strainer • ATF level too high or too low
Noise occurs while driving in “D1”.	• Final gear • Planetary gear • Reduction gear • Differential oil level too low
Noise occurs while driving in “D2”	• Final gear • Planetary gear • Reduction gear • Differential oil level too low
Noise occurs while driving in “D3”.	• Final gear • Reduction gear • Differential oil level too high or low
Noise occurs while driving in “D4”.	• Final gear • Low & reverse brake • Planetary gear • Reduction gear
Engine stalls while shifting from one range to another.	• Control valve • Lock-up damper seized • Engine performance • Input shaft
Vehicle moves when select lever is in “N” range.	• Forward clutch
Shock occurs when select lever is moved from “N” to “D” range.	• Control valve • N-D accumulator • ATF deterioration
Excessive time lag occurs when select lever is moved from “N” to “D” range.	• Control valve • Low one-way clutch • Duty solenoid A • Forward clutch
Shock occurs when select lever is moved from “N” to “R” range.	• 4A accumulator • Control valve • ATF deterioration
Excessive time lag occurs when select lever is moved from “N” to “R” range.	• Control valve • Low & reverse brake • Reverse clutch
Vehicle does not move in any shift range (engine stalls).	• Parking brake mechanism • Planetary gear

Vehicle does not move in any shift range (engine revving up).	• Strainer (internal filter) • Duty solenoid A • Control valve • Drive pinion • Hypoid gear • Axle shaft • Differential gear • Oil pump • Input shaft • Output shaft • Planetary gear • Drive plate • ATF level too low
Vehicle does not move in “R” range only (engine revving up).	• Control valve • Low & reverse brake • Reverse clutch
Vehicle does not move in “R” range only (engine stalls).	• Forward clutch • 2-4 brake band
Vehicle does not move in “D”, “3” range only (engine revving up).	• One-way clutch (1-2) • One-way clutch (3-4)
Vehicle does not move in “D”, “3” or “2” range only (engine revving up).	• Forward clutch • Overrunning clutch
Vehicle does not move in “D”, “3” or “2” range only (engine stalls).	• Reverse clutch
Vehicle moves in “R” range only (engine revving up).	• TCU • Control valve • One-way clutch
Acceleration during standing starts is poor (high stall rpm).	• Control valve • Forward clutch • Reverse clutch • ATF level too low
Acceleration during standing starts is poor (low stall rpm).	• Oil pump • Torque converter one-way clutch • Engine performance
Acceleration is poor when select lever is in “D”, “3” or “2” range (normal stall rpm).	• TCU • Control valve • High clutch • 2-4 brake band
Acceleration is poor when select lever is in “R” (normal stall rpm).	• Control valve • High clutch • 2-4 brake band • Overrunning clutch
No shift occurs from 1st to 2nd gear.	• TCU • Rear vehicle speed sensor • Front vehicle speed sensor • Throttle position sensor • Shift solenoid 1 • Control valve • 2-4 brake band & servo
No shift occurs from 2nd to 3rd gear.	• TCU • Control valve • High clutch • Shift solenoid 2

No shift occurs from 3rd to 4th gear.	• TCU • Shift solenoid 1 • ATF temperature sensor • Control valve • 2-4 brake band & servo
Engine brake is not effected when select lever is in “3” range.	• TCU • Throttle position sensor • Control valve
Engine brake is not effected when select lever is in “3” or “2” range.	• Control valve • Forward clutch • Overrunning clutch
Engine brake is not effected when select lever is in “1” range.	• TCU • Control valve • Low & reverse brake
Shift characteristics are erroneous.	• Inhibitor switch • TCU • Front vehicle speed sensor • Rear vehicle speed sensor • Throttle position sensor • Control valve • Ground earth • 2-4 brake band & servo
No lock-up occurs.	• TCU • Throttle position sensor • ATF temperature sensor • Control valve • Lock-up facing • Engine speed signal
No POWER mode	• TCU • Throttle position sensor
Parking brake is not effected. Shift lever cannot be moved or is hard to move from “P” range.	• Select cable • Select lever • Parking mechanism
ATF spurts out.	• ATF level too high
Differential oil spurts out.	• Differential gear oil too high
Differential oil level changes excessively.	• Seal pipe • Double oil seal
Odor is produced from ATF supply pipe.	• High clutch • 2-4 brake band • Low & reverse clutch • Reverse clutch • Lock-up facing • ATF deterioration
Shock occurs from 1st to 2nd gear.	• TCU • Throttle position sensor • 2A accumulator • Control valve • ATF temperature sensor • Duty solenoid A • 2-4 brake band • ATF deterioration • Engine performance

Slipping occurs from 1st to 2nd gear.	• TCU • Throttle position sensor • 2A accumulator • ATF temperature sensor • Duty solenoid A • Control valve • 2-4 brake band & servo
Shock occurs from 2nd to 3rd gear.	• TCU • Throttle position sensor • 3R accumulator • ATF temperature sensor • Duty solenoid A • Control valve • ATF deterioration • Engine performance
Slipping occurs from 2nd to 3rd gear.	• TCU • Throttle position sensor (3) • 2-4 brake band • ATF temperature sensor • Duty solenoid A • Control valve • High clutch • 3R accumulator
Shock occurs from 3rd to 4th gear.	• TCU • Throttle position sensor • 4A accumulator • ATF temperature sensor • Duty solenoid A • Control valve • 2-4 brake band • ATF deterioration • Engine performance • Over running clutch
Slipping occurs from 3rd to 4th gear.	• TCU • Throttle position sensor • 4A accumulator • ATF temperature sensor • Duty solenoid A • Control valve • 2-4 brake band & servo
Shock occurs when select lever is moved from “3” to “2” range.	• TCU • Throttle position sensor • ATF temperature sensor • Over running clutch • Control valve • 2-4 brake band • ATF deterioration
Shock occurs when select lever is moved from “2” to “1” range.	• TCU • Throttle position sensor • ATF temperature sensor • Duty solenoid A • Control valve • Low & reverse clutch • ATF deterioration • Over running clutch

Shock occurs when accelerator pedal is released at medium speeds.	• TCU • Throttle position sensor • ATF temperature sensor • Duty solenoid A • Control valve • Lock-up damper • Engine performance • Over running clutch
Vibration occurs during straight-forward operation.	• TCU • Lock-up duty solenoid • Lock-up facing • Lock-up damper
Vibration occurs during turns (tight corner “braking” phenomenon).	• TCU • Front vehicle speed sensor • Rear vehicle speed sensor • Throttle position sensor • ATF temperature sensor • Transfer clutch • Transfer valve • Duty solenoid C • ATF deterioration • Harness
Front wheel slippage during standing starts.	• TCU • Front vehicle speed sensor • FWD switch • Throttle position sensor • ATF temperature sensor • Control valve • Transfer clutch • Transfer valve • Transfer pipe • Duty solenoid C
Vehicle is not set in FWD mode.	• TCU • FWD switch/fuse • Transfer clutch • Transfer valve • Duty solenoid C
Select lever is hard to move.	• Select cable • Select lever • Detent spring • Manual plate
Select lever is too hard to move (unreasonable resistance).	• Detent spring • Manual plate
Select lever slips out of selection during acceleration or while driving on rough terrain.	• Select cable • Select lever • Detent spring • Manual plate

Road Test

1) D Range Shift Function. Check shifting between 1st, 2nd, 3rd, & 4th while driving on normal city streets.
2) D Range Shift Shock. Check the shock level when shifting up during normal driving.
3) Kick-down Function. Check kick-down for each gear. Also, check the kick-down shock level.
4) Engine Brake Operation:
   - Check the 3rd gear engine brake when shifting between D & 3rd range while driving in 4th gear of D range, 31 to 37 MPH - 50 to 60 km/h.
   - Check the 2nd gear engine brake when shifting between 3 & 2 ranges while driving in the 3 range - 3rd gear 25 to 31 MPH - 40 to 50 km/h.
   - Check the 1st gear engine brake when shifting between 2 & 1 range while driving in the 2 range - 2nd gear 12 to 19 MPH - 20 to 30 km/h.
5) Lock-up Function. Check that engine speed does not change sharply when the accelerator pedal is lightly depressed when driving on flat roads at normal speed in the lock-up range (50+MPH, ATF over 150°F).
6) P Range Operation. Stop the vehicle on an uphill grade of 5% or more and shift to "P" range. Check that the vehicle does not move when the parking brake is released.
7) Unusual Sounds and Vibration. Check for unusual sounds and vibration while driving and during shifting.
8) Climbing Control Function
   - Check that the gear remains in 3rd when going up a grade.
   - Check that the gear remains in 3rd when applying the brakes while going down a grade.
9) Transfer Clutch. Check if the tight corner braking occurs when the vehicle is started with steering wheel held at fully turned position. (AWD model)

External Leak inspection

Oil Leakage Check Points

It is difficult to determine the precise place of an oil leak, since the surrounding area becomes wet with oil/fluid. Leaks can occur due to a defective casting, or at a seal or gasket. Sites to investigate include:

Joints in the case
- Transmission case and oil pump joint
- Converter case and oil pump joint
- Transmission case and rear transmission cover joint (FWD)
- Transmission case and extension case joint (AWD)

Converter housing
- Engine crankshaft oil seal
- Torque converter impeller sleeve oil seal
- ATF cooler pipe connector
- Torque converter

Converter case
- Converter case (Defective casting)
- Axle shaft oil seal
- O-ring on the outside diameter of axle shaft oil seal holder
- O-ring on the differential oil gauge
- Differential oil drain plug
- Speedometer cable mounting portion
- Location of steel balls

Oil pump housing
- Oil pump housing (Defective casting)
- O-ring on the test plugs
- Checking blind plugs
- Differential gear breather
- Automatic transmission case
- Transmission case (Defective casting)
- Mating surface of oil pan
- O-ring on the test plugs
- Checking blind plugs (steel balls)
- Oil supply pipe connector
- ATF cooler pipe connector and gasket
- Oil pan drain plug
- O-ring on the transmission harness holder
- O-ring on the oil pump plugs
- ATF breather
- Shift lever oil seal

Extension case
- Extension case (Defective casting)
- O-ring on the revolution sensor
- Rear drive shaft oil seal
- Checking blind plugs (steel ball)
- O-ring on the test plug

Transmission case

Defective casting - Check whether the leaking oil is ATF or not. ATF is wine red in color, and can be discriminated easily from engine oil and gear oil. Wipe clean the suspect area, using a non-flammable solvent. Run the engine to raise the fluid temperature, and set the selector lever to "D" in order to increase the fluid pressure and assist in detecting a leaking point.

Time Lag Test

If the shift lever is moved while the engine is idling, there should be a certain amount of time lapse between lever movement and you feeling the shock of gear engagement. The test is useful to determine the condition of the forward clutch, reverse clutch, low & reverse brake, forward one-way clutch, and low one-way clutch.

Test Procedures
1) Perform the test after the ATF has reached the operating temperature of 158 to 176^{o}F (70-80^{o}C).
2) Allow a one-minute lapse between tests to ensure the system is stable from one test to the next.
3) Make at least three measurements of each set and average the values
4) Set the parking brake, start the engine, and use the foot brake to avoid movement.
5) Check idling speed (Air-conditioning OFF, in "N" should be ~ 800 RPM
6) Shift from "N" to "D", and using a stopwatch, note time from shift to shock.
7) Repeat test shifting from "N" to "R"

Test Evaluation
1) If the "N" to "D" time is too long
   a. Line pressure may be too low
   b. Forward clutch may be worn
   c. Low one-way clutch may not be operating correctly
2) If the "N" to "R" time is too long
   a. Line pressure may be too low
   b. Reverse clutch may be worn
   c. Low & reverse clutch may be worn

Stall Test

The stall test checks the operation of the clutch and brake band, the operation of the torque converter, and engine performance. It should be conducted to measure the engine stall speeds in “R” and “2” (manual button ON) ranges. The specified value for the tall speed is 2450-2850 RPM. Note: If the stall speed is higher than the specified range, attempt to finish the stall test in as short a time as possible, in order to prevent the automatic transmission from sustaining additional damage.

Testing Routine

1) Ensure the throttle valve opens and closes fully.
2) Levels of fluids, oil, water, ATF, differential are correct
3) Idle the engine until the ATF reaches a temperature of approximately 158 to 176^{o}F (70-80^{o}C).
4) Ensure the tachometer is visible to the person running the test.
5) Chock all wheels and set the parking brake.
6) Move the gear selector linkage to ensure it operates properly, and shift the select lever to the “2” range (Manual button set to ON).
7) While forcibly depressing the foot brake pedal, gradually depress the accelerator pedal until the engine operates at full throttle. Note the maximum RPM reached. Caution, do not operate in this mode for more than 5 seconds - from fully closed to fully open throttle. Failing to follow this caution causes the engine oil and ATF to deteriorate and the clutch and brake band to be damaged.
8) Be sure to cool down the engine/transmission for at least 1 minute after each stall test with the gear select lever set in the “P” or “N” range and with the idle speed lower than 1,200 rpm.
9) If the stall speed in “2” range is higher than specifications, low clutch slipping and 2-4 brake slipping may be occurring. To identify it, conduct the same test as above in “R” range.
10) Repeat the test in the "D" range.

Stall test results interpretation

Stall speed observed	Assessment	Likely cause	Remarks
Higher than specification	Slippage of clutch or brake band	1) low line pressure 2) One-way clutch slippage 3) Forward clutch slippage ("D" and "2" range only) 4) Slippage of low & reverse brake or reverse clutch (in "R" range only)	If engine compression can be used as a brake with 1st gear manually selected during the road test, the reverse clutch is slipping, if not, then low & reverse brake is slipping
Within specification	Control members are in good order		One-way clutch should be checked during the road test
Lower than specification	Throttle not fully opened, engine running poorly, or torque converter one-way clutch is slipping		
Road test supplement	-Poor acceleration to 30 mph -Can not attain 50 mph -Operation faults at all speeds	1) One-way clutch slippage 2) One-way clutch jamming 3) Engine performance poor	For one-way clutch jamming you should observe an abnormal temperature rise in the ATF

Line Pressure Test

General Notes ([1C]):

Using a pressure gauge can seem like a formidable task. These notes will attempt to show how to interpret pressure gauge readings so the tech can find the fix to the problem.

It is best to start pressure tests with mainline pressure. Mainline pressure should be checked in each range: P, R, N, D, 3, 2, and 1. Each range, except Park and Neutral, should be checked under three conditions: Slow idle, fast idle, and wide open throttle. A record should be made of the readings.

If all pressures are within specification at slow idle, then the pump and pressure regulator are functioning properly.

If all pressures are low at slow idle, it indicates a potential problem in the pump, pressure regulator, filter, low fluid, or internal leakage. To help verify where the problem is, check pressures at fast idle. If all the pressures now read normally, it usually indicates a worn pump but the problem could still be internal leaks.
Internal leaks will usually show up in a particular range. For example a forward clutch leak would have normal pressure in Park, Reverse and Neutral but have low pressure in all forward ranges. A direct clutch leak will show a pressure drop when the transmission shifts to third and low pressure in reverse because in most cases, the direct clutch is on in third and reverse.

A restricted filter will usually show up as a gradual pressure drop at higher engine RPM because the filter cannot pass as much fluid as the pump is trying to draw.

A stuck pressure regulator valve will show up as fixed line pressure which means the same pressure all the time. The pressure may vary with engine RPM which means low pressure at slow RPM and higher pressure at higher RPM.

If pressures are high at slow idle it indicates a pressure regulator issue (solenoid A or dropping resistor), or throttle sensor problem. If the transmission has a throttle sensor tap, it will tell you if the throttle pressure circuit is the problem.

Pressures also need to be checked at stall or wide open throttle (WOT). When doing a stall test, always observe safety precautions such as checking for broken mounts or bad brakes. Testing should always be done under operating conditions. See section on stall tests for cautions in testing.

If all pressure at stall are low, then the problem is in the pump or control system.

If all pressures at stall are high, then look at the idle pressures. If the idle pressures are also high then this could be a pressure regulator or throttle system problem. If idle pressures are normal then the problem is in just the throttle system.

The reverse stall test is also a maximum pump output test. If you suspect a weak pump then this test will help find it. Often this will show up as low pressure at reverse stall but all other pressures including idle will be normal.

SVX specific:

This test should be conducted prior to any disassembly. Perform the initial test by connecting the pressure gauge to the “oil pump outlet pressure” test port to determine the overall line pressure (see Fig 3). Should other diagnostics suggest a particular component issue, perform pressure tests at its unique test port (Fig 4, 5, & 6). Note: Fig 5 - transfer case housing, applies for AWD systems only.

NOTES:

- If the clutch or the brake band shows a sign of slippage or shifting sensation is not correct, the line pressure should be checked.
- Excessive shocks during up shifting, or if shifting takes place at a higher point than normal, the cause may be due to the line pressure being too high (rare).
- Slippage, or inability to operate the vehicle, may be due to loss of oil pressure for the operation of the clutch, brake or control valve.
- A one minute cool-down period between heavy load (stall condition) tests are conducted is necessary to prevent damage from ATF and component overheating.

Static tests (vehicle not moving), gear selection as in table below

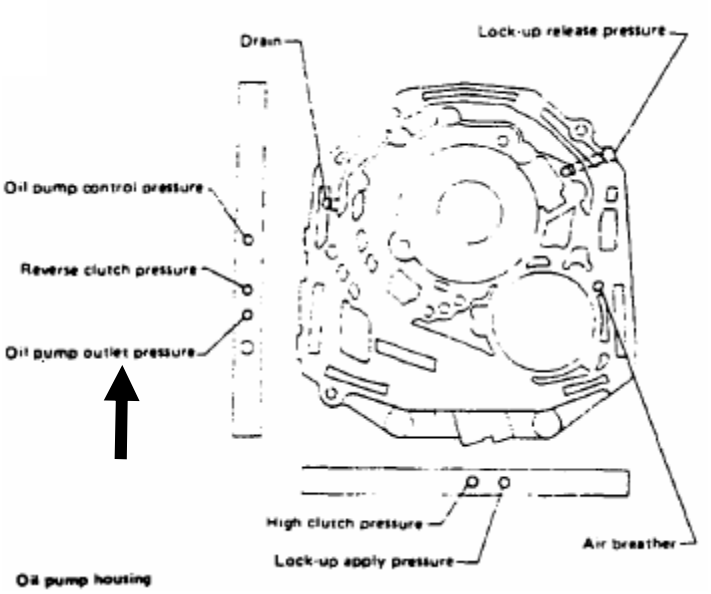
1) Line pressure measurement (under no load - closed throttle - any gear except "R")
   a. Before measuring the line pressure, apply both foot and parking brakes with all wheels chocked.
   b. Maintain the temperature of ATF at approx. 158-176°F (70-80°C) during measurement. (ATF will reach the above temperature after idling the engine for approx. 30 minutes with select lever in “N” or “P”.)
2) Line pressure measurement (under heavy load)
   a. Before measuring the line pressure, apply both foot and parking brakes with all wheels chocked.
   b. Measure the line pressure when select lever is in “R”, “2” with engine under stall conditions.
   c. Measure the line pressure within 5 seconds after shifting the select lever to each position. (If line pressure needs to be measured again, allow the engine to idle, and then stop it to cool down for at least one minute.)
   d. Maintain the temperature of ATF at approx. 158-176°F (70-80°C) during measurement (ATF will reach the above temperature after idling the engine for approx. 30 minutes with the select lever in “N” or “P”.)
3) Temporarily attach the gauge to a suitable place in the driver's compartment, make or remove a blind plug located in front of the toe board and pass the hose of the gauge to engine compartment.
4) Remove the test plug and install the gauge fitting instead.
5) Connect the gauge to the hose.
6) Note values in accordance with throttle position.

Standard line pressure		
Range position	Throttle position	Line pressure PSI *****
2	Full-opened	164 — 189 173--182
R	Full-opened	220 — 249 216--230
Any gear - not "R"	Full-closed	44 — 60 74--83
R	Full-closed	No source 88--91

***** I have found two sets of numbers that contradict each other, do not know which is correct.

Dynamic tests, done while driving the vehicle, requires some experience with what values should be seen with a healthy vehicle for complete and correct evaluation, although the results may be obvious even without such experience. If a person wanted to become really proficient with a pressure gauge they should first put a pressure gauge on a known good working vehicle and leave it there for a week of daily driving and monitoring. Every time they drive the car they should watch the gauge. Once accustomed to normal readings, abnormal readings will stand out like a sore thumb.

If the transfer clutch pressure port is tested and values do not vary between idle and stall speed (from approximately 10psi to 105 respectively), duty solenoid C is likely malfunctioning.



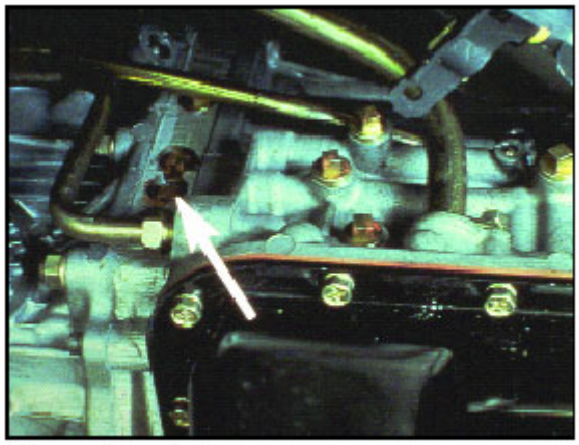


Fig 3 - ATF pump housing

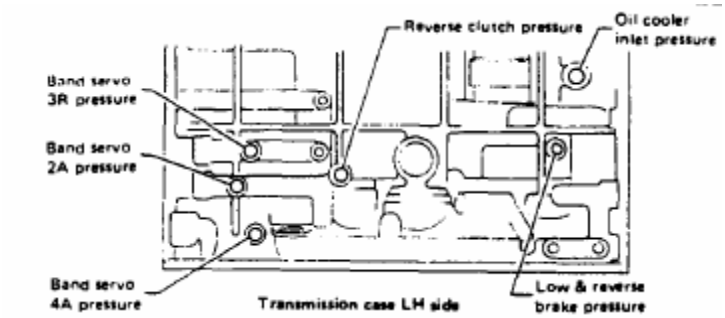


Fig 4: Main Transmission housing - left side view

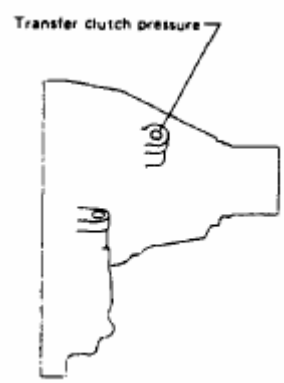


Fig 5: Extension Case housing - left side view

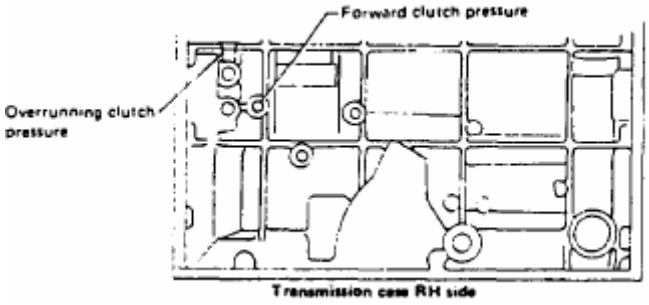


Fig 6: Main Transmission housing - right side view

In Car Serviceable Component Replacement

See the appropriate disassembly/assembly section for drawings, etc.

Internal Filter Replacement

1) Clean the transmission exterior with attention paid to oil pan area
2) Drain ATF
3) Remove oil pan (some ATF will drip), remove & discard gasket
4) Remove the oil cooler pipe, pry it out being careful not to bend or twist the pipe
5) Remove the oil filter (strainer) - 5 bolts
6) Reassemble in reverse order.

Shift Solenoid or Valve Body

1) Clean the transmission exterior with attention paid to oil pan area
2) Drain ATF
3) Remove oil pan (some ATF will drip), remove & discard gasket
4) Disconnect 5 connectors from solenoid
5) If replacing the lock-up solenoid "B", remove three bolts and solenoid. Be careful not to damage the O-ring.
6) Remove the oil cooler pipe (pry out carefully), then oil filter (strainer) - 5 bolts
7) Remove the valve body
8) For shift solenoids 1, 2, & 3, remove 2 bolts and one nut, remove solenoids as a unit
9) For line pressure solenoid "A", remove 1 bolt, 1 nut, remove solenoid
10) For servicing the valve body, see the component section
11) Reassemble in reverse order.

Transfer Solenoid

1) Clean the transmission exterior with attention paid to the tail section of the transmission
2) Remove driveshaft (be ready to catch ATF that drips out)
3) Jack up the transaxle slightly to take weight off rear cross member.
4) Remove speed sensor
5) Remove rear-mounting bolts
6) Remove extension, 11 bolts, disconnect the solenoid connector - use caution as wire harness is not very long
7) Remove & discard gasket
8) Remove solenoid
9) Reassemble in reverse order.

Note: You could also overhaul the transfer clutch assembly in-car. To avoid needless repetition, see the Component Disassembly, Inspection & Reassembly section for details.