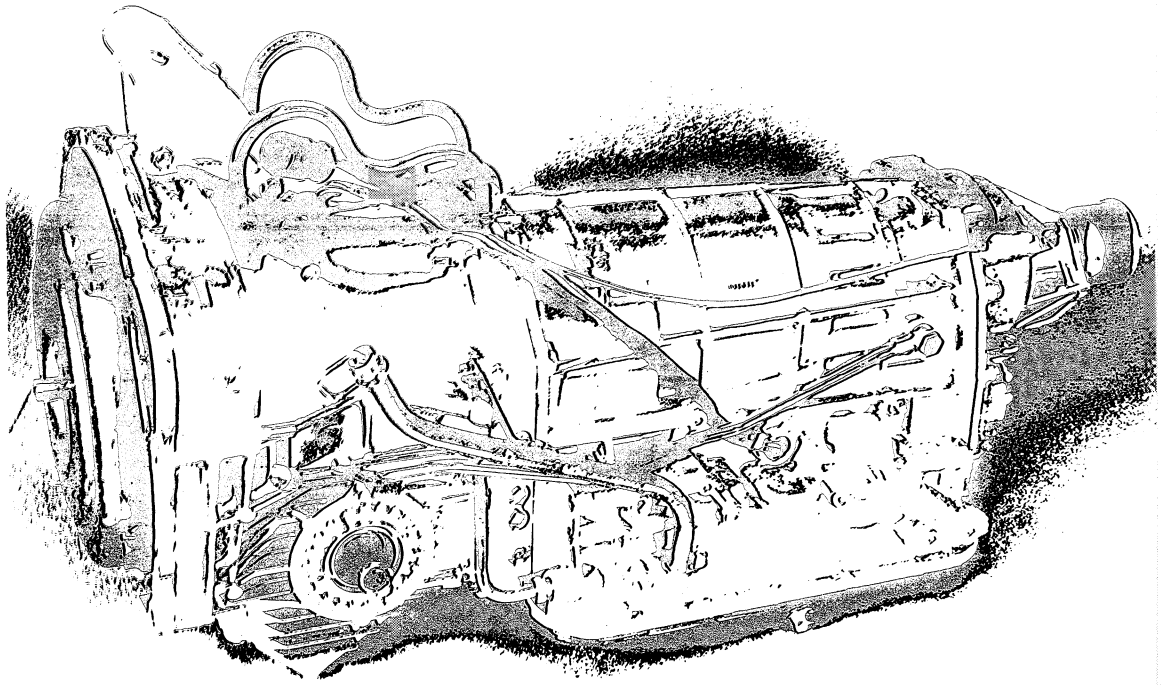
SUBARU®

4EAT TRANSMISSION DIAGNOSIS

Video Reference Booklet



TECHNICAL TRAINING

Subaru of America reserves the right at any time to make changes or modifications to systems, procedures, descriptions, and illustrations contained in this book without necessarily updating this document. Information herein is considered current as of January, 1990.

TABLE OF CONTENTS

FOREWORD

"4EAT Transmission Diagnosis" is intended as a supplement to the 4EAT Transmission module of the Subaru Automatic Transmissions Core Course.

This Video Reference Booklet, or VRB, accompanies the "4EAT Transmission Diagnosis" video tape. It summarizes the information covered in the video tape and, where appropriate, provides additional detail.

We recommend that in addition to using this video tape and VRB, you attend the 4EAT transmission module and use its Technicians Reference Booklet (TRB), as well as Subaru service manuals to help you effectively diagnose 4EAT transmission problems.

SEGMENT 1: INTRODUCTION

OVERVIEW

The video portion of this program illustrates the principles of effective 4EAT transmission diagnosis. It follows technician Bill through a complete troubleshooting procedure. Bruce Elliott, the program narrator, appears at regular intervals to explain what Bill is doing--right or wrong-- and to re-direct Bill whenever he takes a wrong turn.

This Video Reference Booklet summarizes the material covered in the video. In addition, it provides additional detail where appropriate.

THE IMPORTANCE OF DIAGNOSIS

The 4EAT is a thoroughly modern, electronically controlled transmission. It is made up of three distinct but interrelated systems: mechanical, hydraulic, electronic. Each of these systems contains many components. Although the transmission has proved extremely reliable in use, its very complexity means that effective diagnosis of 4EAT problems demands proper technique.

A 4EAT diagnosis must be done one step at a time, in a logical sequence. Skipping any step or jumping to a conclusion will inevitably lead to an incomplete or incorrect diagnosis. Until you have done all of the necessary preliminary work, it is best to leave your tools in the toolbox and stay away from the parts department.

The 4EAT troubleshooting sequence follows the established Subaru six-step method:

1. Verify the symptom
   - Does this problem really exist?
   - Is the problem evident now?
2. Look for related symptoms
   - What else is not working as it should?
3. Isolate the problem
   - Determine what is working right
   - Perform tests to narrow the problem area
   - Is the problem mechanical, hydraulic, or electronic?
   - Which system/component is causing the problem?

4. Identify the cause
   - What is wrong (mechanical failure, electric fault, adjustment out of specification, leak)?
   - What led to the failure (is there an underlying condition?)
5. Repair the problem
   - Fix what is wrong
   - If an underlying condition caused the failure, fix that too
6. Verify the repair
   - Repeat appropriate system checks to make sure everything works

SELECT MONITOR CONSIDERATIONS

The vehicle used in the video is a 1990 Legacy. With one exception, the diagnostic procedures shown in the video can be applied to any vehicle equipped with a 4EAT transmission. The exception is this: in the video, Bill uses a Select Monitor for parts of the diagnosis. As of this writing, the Legacy is the only vehicle for which a Select Monitor 4EAT cartridge is available. Use the following techniques when a Select Monitor cartridge is not available:

- Perform D-checks as specified in the service manual
- Read trouble codes by observing the flashing POWER light on the instrument panel
- Check duty cycles (such as that of the line pressure solenoid) with a voltmeter

Two Legacy Select Monitor cartridges are shown below. You can use either cartridge on U.S. vehicles:

498347500	4EAT (U.S. & European)	Section 3-2 [M2400]
498347501	4EAT (U.S. only)	Section 3-2 [M2400]

SEGMENT 2: REPORTED AND RELATED SYMPTOMS

THE REPORTED SYMPTOM

For Bill's troubleshooting session, the reported symptom is "Vehicle will not move for several seconds after I put it in gear." This is the way a customer might describe what we would call *excessive time lag.*

THE ROAD TEST

With a little prompting from Bruce Elliott, Bill takes the vehicle on a roadtest to verify the reported symptom. Since there is nothing to indicate a roadtest might further damage the transmission, this is an appropriate step. In the process, Bill checks for related symptoms and determines what is working right.

After allowing the engine and transmission to warm to normal operating temperature, Bill verifies that there is some excess time lag shifting from neutral to drive and from neutral to reverse. In addition, he notices a slipping sensation pulling away from a full stop. Aside from the lag and the momentary slipping sensation, the transmission operates properly, upshifting and downshifting without any problems in all of the available gear ranges.

SEGMENT 3: ISOLATING THE PROBLEM

THE TIME LAG TEST

Back at the shop, Bill performs a time lag test. This test determines how much time passes between the shift to drive (or reverse) and the bump that signals the transmission applied. The test results are judged to within a tenth of second, so you need a stop watch that can indicate those units or smaller. Bill uses a watch that indicates to a hundredth of a second.

Naturally, your reaction time has some effect on time lag test results. To even out possible errors, repeat the test at least three times and average the results. To allow oil to drain from the applied clutch (forward or reverse), wait at least one minute between tests.

The performance standards for the time lag test are as follows:

- neutral-drive . . . . . 1.2 seconds or less
- neutral-reverse . . . . . 1.5 seconds or less

In three tries, Bill records an average time lag of 1.8 seconds shifting from neutral to drive. This is significantly longer than the performance standard. The service manual offers a few possible causes for excessive time lag:

- neutral-drive
  - line pressure/volume too low
  - forward clutch worn
  - low (1-2) one-way clutch not operating properly
- neutral-reverse
  - line pressure/volume too low
  - reverse clutch worn
  - low & reverse brake worn

LOGIC AND THE GEARSHIFT MECHANISM OPERATION TABLE

To begin isolating the problem, Bill needs to eliminate some of the suggested possible causes. The gearshifting mechanism operation table in the service manual offers some help. The table shows which bands and clutches are applied for all of the available gear ranges. By comparing his observations during the roadtest (related symptoms and what was working right), Bill should be able to eliminate some possible causes simply by using logic.

			Rev./C	B/B	High/C	FWD/C	OWC (3-4)	OVR/C	Lo / Rev./B	OWC (1-2)
Selector lever operation	P									
	R		○						○	
	N									
	D	1ST				○	○			○
		2ND		○		○	○			
		3RD			○	○	○			
		4TH		○	○	○				
	3	1ST				○	○			○
		2ND		○		○	○			
		3RD			○	○	○	○		
	2	1ST				○	○	○		○
		2ND		○		○	○	○		
		3RD			○	○	○	○		
Switchbutton handling	1	1ST				○	○	○	○	
		2ND		○		○	○	○		
		3RD			○	○	○	○		

Figure 1: Legacy gearshifting mechanism operation table

For example, the table shows that the forward clutch is applied in every gear except reverse. Bill observed that the transmission operated properly once away from a full stop, upshifting and downshifting without any problems. This suggests that the forward clutch is probably not the problem. If something were wrong with the forward clutch, it would show up in every gear except reverse.

Using similar logic, Bill eliminates the reverse clutch as a possible cause. Bill verified excessive time lag for both neutral to drive and neutral to reverse. Since the reverse clutch is not even applied when drive is selected, it is probably not the problem.

Finally, Bill applies the same process to eliminate the low (1-2) one-way clutch. That points to the remaining suggested cause as the most likely problem causing the observed symptoms and the excessive time lag: line pressure/volume too low.

POSSIBLE CAUSES FOR LOW LINE PRESSURE

Determining that low line pressure or volume is the most likely problem is an important step. However, it does not finish the diagnosis. There are a number of things that can cause low line pressure, so Bill must continue to try to isolate the problem.

Bill relies on the service manual and on his knowledge of how the 4EAT works to determine the possible causes for low line pressure or volume:

- electrical
  - line pressure duty solenoid
  - TCU
- mechanical
  - pressure modifier valve seized
  - pressure modifier accumulator leaking internally
  - feedback accumulator leaking internally
  - pressure regulator valve seized
  - oil pump malfunction

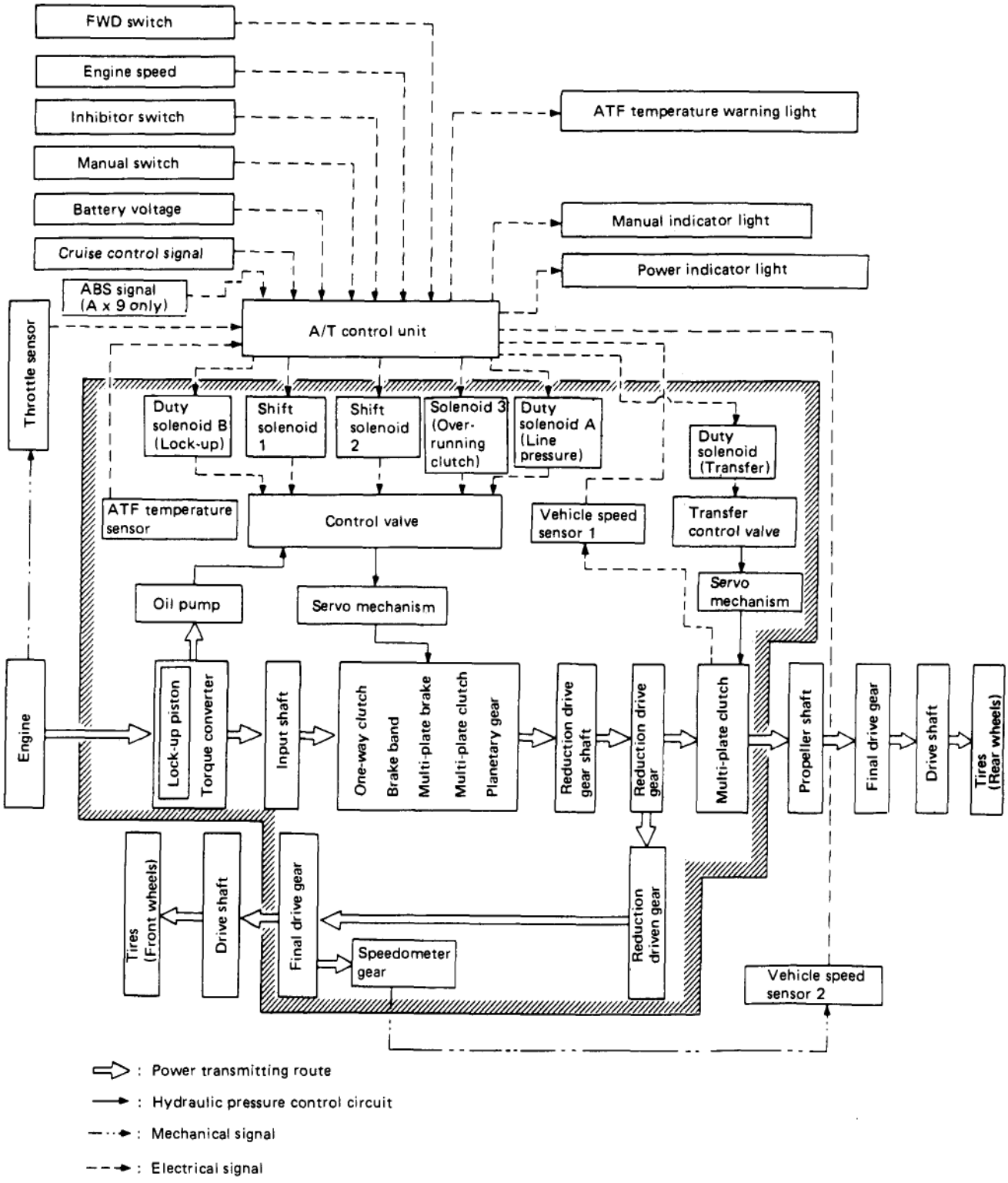


Figure 2: 4EAT control system block diagram

DOING THE EASY CHECKS FIRST

Of the possible causes for low line pressure, the electrical functions are the easiest to check. Before making specific tests, always perform a D-check and determine if any trouble codes are stored in memory. If you are troubleshooting a Legacy 4EAT, you can use a Select Monitor for this step. For all other vehicles, do a standard D-check and observe the flashing POWER light for trouble codes.

Bill finds no problems during the D-check and determines that there are no trouble codes stored. With the preliminary electrical checks done, the next logical step is to check the line pressure solenoid. With the Select Monitor, it is possible to directly observe the control signal sent by the TCU to the solenoid. The signal is displayed as percent duty ratio. To examine this signal without a Select Monitor, connect a voltmeter between the line pressure solenoid positive input and ground. Although you will not be able to determine the actual duty ratio this way, you will be able to tell whether or not some kind of voltage signal is present, and it should change as the throttle is opened.

The performance standard for the line pressure solenoid (checked with Select Monitor mode 11) is as follows:

- throttle fully open 10%
- throttle fully closed . . . . . 100 %

Since the test is performed with the ignition "ON" and the engine not running, you will be able to hear the line pressure solenoid operating when you open the throttle. This is another indication that a TCU control signal is reaching the solenoid.

Proving that a TCU signal reaches the solenoid does not prove that it is actually working properly. For example, the solenoid valve could stick closed or open, or an internal passage could be blocked. With such a malfunction, the solenoid would appear to be working electrically and would probably still make the correct operating noises. However, it would not accomplish its function of regulating pressure according to duty cycle.

CHECKING OIL PUMP CONTROL PRESSURE

Bill knows that it is not convenient to measure the output of the line pressure solenoid directly. There are no test ports provided on the transmission for that pressure. However, there are test ports for a number of other pressures:

- oil pump control pressure
- reverse clutch pressure
- oil pump outlet pressure
- high clutch pressure
- lock-up apply pressure

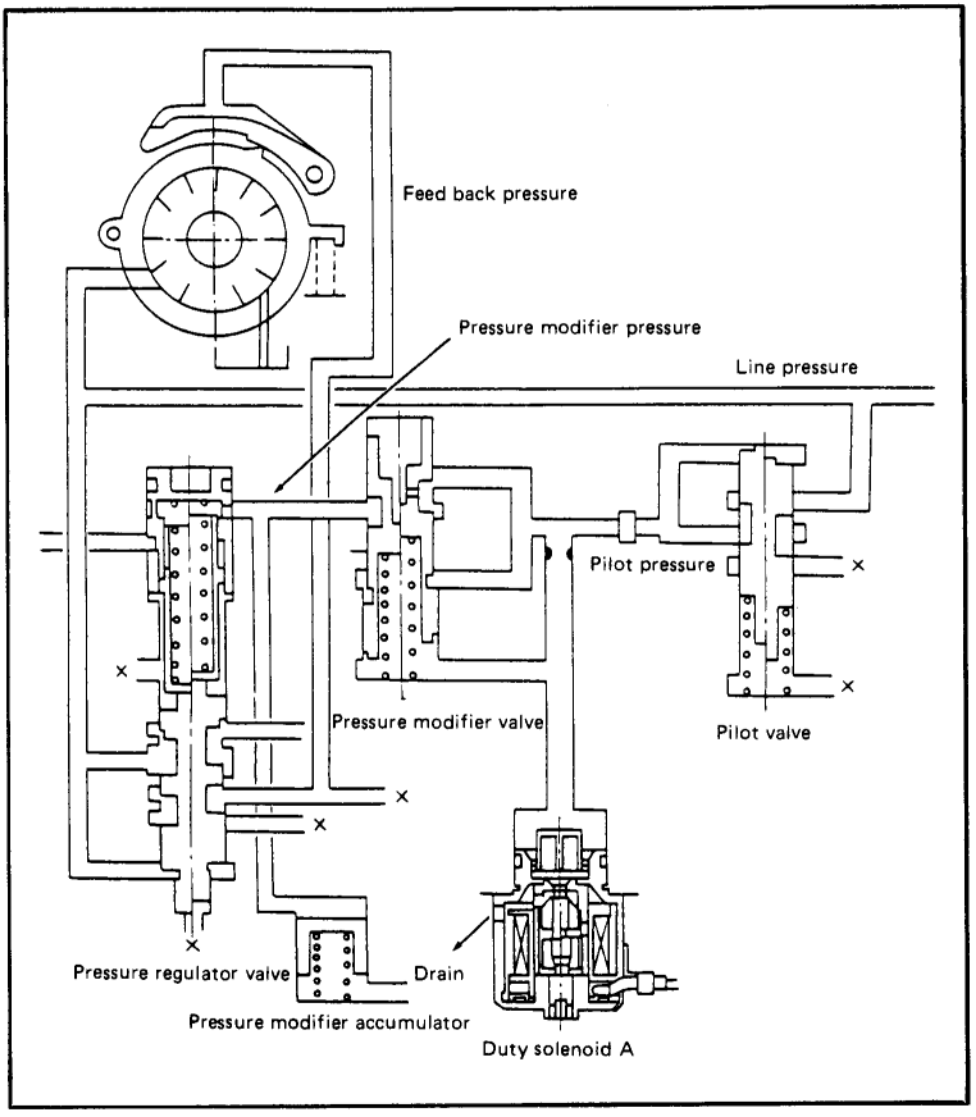


Figure 3: Line pressure control circuit

Bill decides to check oil pump control pressure. Checking the line pressure circuit diagram, he determines that oil pump control pressure is controlled by the following components:

- line pressure solenoid
- pressure modifier valve
- pressure modifier accumulator
- feedback accumulator
- pressure regulator valve

If he finds oil pump control pressure to be okay, he can eliminate all of those components as possible causes for the problem of low line pressure.

Bill connects the pressure gauge to the oil pump control pressure port on the transmission. Since he has the Select Monitor already connected, he decides to monitor line pressure solenoid duty ratio while he checks control pressure. This is not actually necessary, but it is interesting to observe the two change together. If you are troubleshooting without a Select Monitor, it is enough to check oil pump control pressure.

Bill observes that oil pump control pressure is changing as he varies engine rpm. This is the correct system response and proves that the components listed above--including the line pressure solenoid--are working correctly. At this point, Bill has effectively isolated the problem: it is the oil pump. He decides to make one more pressure check to verify his diagnosis.

CHECKING OIL PUMP OUTLET PRESSURE

Having determined that oil pump control pressure is being correctly regulated, Bill decides to verify that the oil pump is the problem. He will do that with a check of oil pump outlet pressure. The service manual refers to this check as a *Line Pressure Test.*

The test calls for two sets of measurements, one made with the engine at idle and another with the engine at stall rpm. Bill observes that outlet pressure is slightly low in Park, but otherwise close to normal with the engine at idle. Checking at stall rpm, Bill observes that outlet pressure does rise, but much too slowly. With everything working properly, outlet pressure should rise immediately to the specified value.

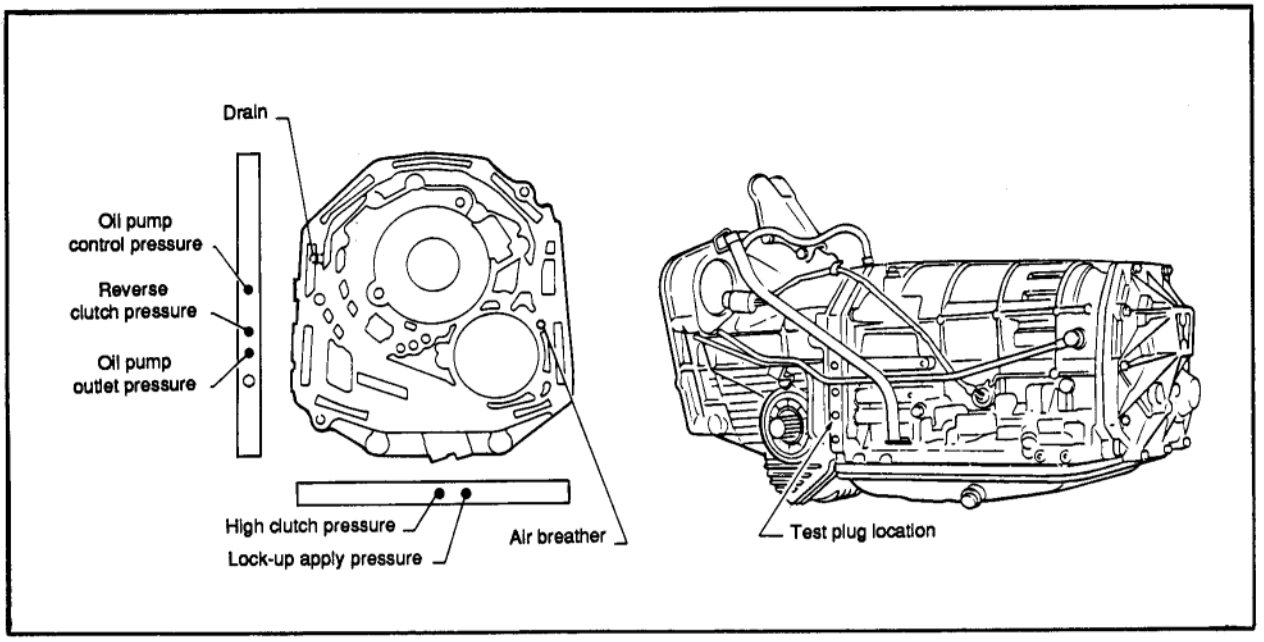


Figure 4: Fluid passage and pressure ports

	Min. line pressure	Max. line pressure
Range	600 — 800 rpm	Stall rpm
P	441 — 569 (4.5 — 5.8, 64 — 82)	—
R	588 — 686 (6.0 — 7.0, 85 — 100)	1,422 — 1,589 (14.5 — 16.2, 206 — 230)
N	441 — 569 (4.5 — 5.8, 64 — 82)	—
D	441 — 569 (4.5 — 5.8, 64 — 82)	1,128 — 1,255 (11.5 — 12.8, 164 — 182)
3	441 — 569 (4.5 — 5.8, 64 — 82)	1,128 — 1,255 (11.5 — 12.8, 164 — 182)
2	441 — 569 (4.5 — 5.8, 64 — 82)	1,128 — 1,255 (11.5 — 12.8, 164 — 182)
1	441 — 569 (4.5 — 5.8, 64 — 82)	1,128 — 1,255 (11.5 — 12.8, 164 — 182)
Accelerator pedal	Full-closed	Fully-open

Figure 5: Line pressure test evaluation standard

SUMMARY AND WRAP-UP

MAKING THE REPAIR

When he disassembled the oil pump, Bill found that the cam ring had been seized. Oil pump control pressure bears on the cam ring, acting against spring tension. If there is insufficient clearance for the cam ring to move, it cannot change oil pump displacement. The result will be that line pressure and volume will not respond to changes in control pressure. Only engine rpm will have an effect, and this will be insufficient for correct operation. In our example, the pump was able to provide correct operation at road speed, but could not provide enough pressure at idle for proper engagement.

When replacing an oil pump cam ring, keep in mind that the deck height of the cam ring cavity must be greater than, not equal to, the thickness of the cam ring itself. If the clearance is equal to the thickness of the cam ring, it will bind as soon as the oil pump is reassembled.

CONCLUSION

To effectively diagnose 4EAT transmission problems, remember the following guidelines:

- Use the six-step troubleshooting method
  - verify the problem
  - determine related symptoms
  - isolate the problem
  - identify the cause
  - repair the problem
  - verify correct operation
- Use all the tools available to you
  - this program (video and VRB)
  - 4EAT module TRB
  - service manuals
  - Select Monitor
  - pressure gauge
- Do the easy steps first
  - preliminary checks for obvious problems
  - look for loose connectors, cut or pinched wires, bad grounds
  - D-check
  - trouble codes
  - Select Monitor
- Keep testing until you are sure you have isolated the cause of the problem

APPENDIX A: 4EAT DATA LIST

The 4EAT Data List is a blank form; use it to record all of the 4EAT data the Select Monitor can read. The performance standards in the Data List are provided as an approximate indication of normal performance. Use them as a guide. Specific vehicles may not duplicate these values precisely, even when they are operating correctly.

Data lists should be filled out at the PDI and every subsequent service activity, and then filed with the vehicle file. When you use data lists in that way, they provide valuable information for troubleshooting. Instead of having to go by general performance standards, you will be able to apply specific, correct readings for the actual vehicle you are testing.

CUSTOMER NAME:	VIN:	LICENSE:
YEAR/MODEL:	ENGINE TYPE/DISPL:	TRANS #:

MODE #	MODE NAME	ABBR	UNITS	VEHICLE STATUS	TEST CONDITION	PERF. STANDARD	DATE ____	DATE ____	DATE ____	DATE ____	DATE ____
00	MODEL YEAR (OF PROM)	YEAR	----	Key ON Engine OFF	---------	4EAT 4WD					
01	BATTERY VOLTAGE	VB	DC VOLTS	Engine running	At idle	≥12 V					
					At 2500RPM	12 - 15V					
02	VEH. SPEED SENSOR #1	VSP1	MPH	Vehicle on lift	25 MPH	Approx. ±10%					
					55 MPH						
04	VEH. SPEED SENSOR #2	VSP2	MPH	Vehicle on lift	25 MPH	Approx. ±10%					
					55 MPH						
06	TACHOMETER	EREV	RPM	Engine running	1,000 RPM	±100 RPM					
					4,000 RPM						
07	ATF TEMPERATURE	ATFT	°C	Key ON Eng. OFF	Eng. COLD	Ambt. ± 10 °C					
					Eng. WARM	70-110 °C					
09	THROTTLE POSITION SENSOR	THV	DC VOLTS	Key ON Eng. OFF	Fully OPEN	Approx. 0.9V					
					Fully CLOSED	Approx. 4.7V					
10	GEAR POSITION	GEAR	----	Testdrive	--------	------					

MODE #	MODE NAME	ABBR	UNITS	VEHICLE STATUS	TEST CONDITION	PERF. STANDARD	DATE ____	DATE ____	DATE ____	DATE ____	DATE ____
11	LINE PRESSURE DUTY	PLDTY	%	Key ON Eng. OFF	Fully OPEN	100%					
					Fully CLOSED	10%					
12	LOCK-UP DUTY	LUDTY	%	Idling	Released	5%					
				Testdrive	Applied	95%					
13	4WD DUTY	4WDTY	%	Key ON Eng. OFF	FWD MODE	95%					
					4WD MODE	25%					
14	ATMOSPHERIC PRESSURE SENSOR	BAROP	mmHg	Key ON Eng. OFF	-------	756-762[1] ± 20%					
A1	MANUAL SWITCH (LED #7)	----	----	Key ON Eng. OFF	LED comes ON with switch ON						
A2	IDLE SWITCH (LED #2)	----	----	Engine running	LED comes ON at idle						
B0	TROUBLE CODES (U&D checks)	----	CODE #'S	Key ON Eng. OFF	Displays all current trouble codes						
B1	TROUBLE CODES (memory)	----	CODE #'S	Key ON Eng. OFF	Displays all stored trouble codes						

NOTE 1: Applies at sealevel only. Calculate appropriate pressure adjustment for your altitude.