

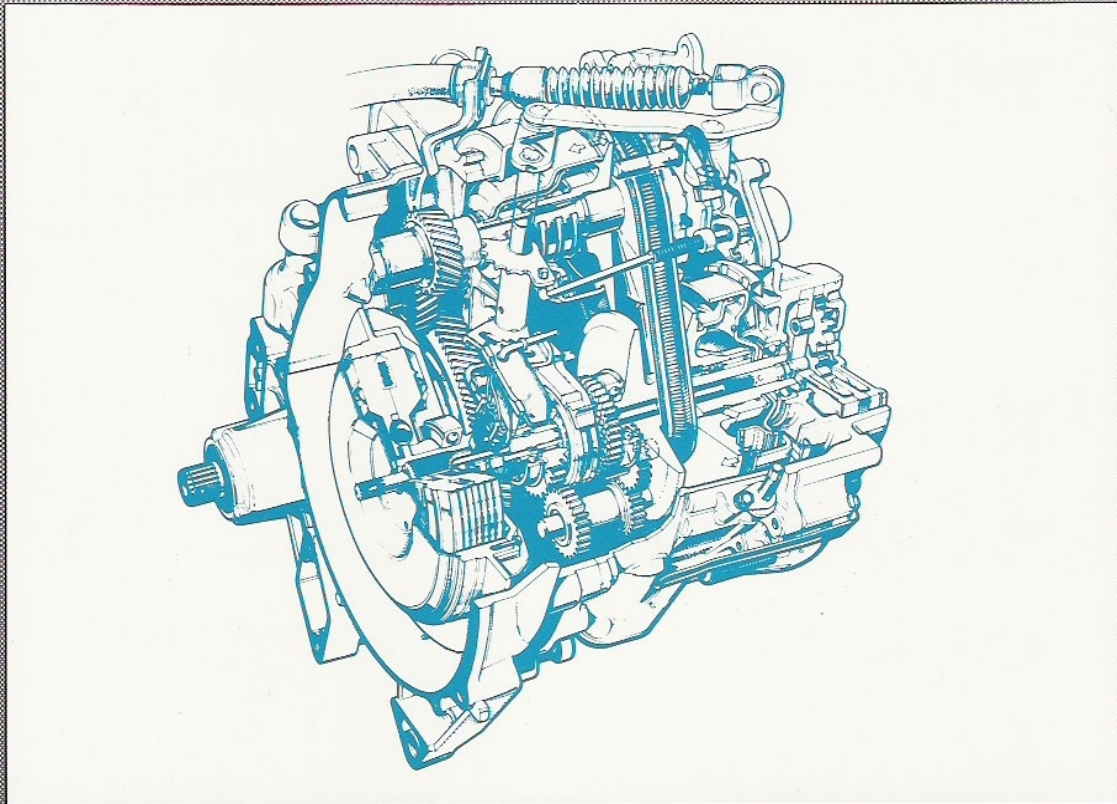
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**SUBARU®**

# **ECVT TRANSMISSION DIAGNOSIS**

**Video Reference Booklet**



**TECHNICAL TRAINING**



**ECVT  
TRANSMISSION  
DIAGNOSIS**

**Video Reference Booklet**

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**TECHNICAL TRAINING**



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## **FOREWORD**

This Video Reference Booklet, or VRB, accompanies the "ECVT 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 first attend the Subaru Courses relating to the ECVT and use the Technicians Reference Booklet (TRB).

Always refer to the applicable model year Subaru Service Manual and the latest Service Bulletins for detailed service procedures and specifications when performing service work.



## **INTRODUCTION**

The ECVT is an Electronic Continuously Variable Transmission. It's an advanced design, lightweight, automatic overdrive transmission without traditional forward gears. Due to its stepless infinite ratio changes, it is much smoother than a conventional automatic transmission.

The ECVT provides the convenience of an automatic with fewer moving parts and the efficiency of a manual transmission. It does this without a torque converter. Instead, it uses an electromagnetic clutch, a pair of adjustable pulleys and a steel belt to deliver the engine power to the drive wheels.

Continuously Variable Transmissions have been used in the past for automotive, industrial and recreational vehicle applications. Their previous short-coming was the use of a rubber belt which needed frequent replacement. This increased the operating cost and reduced their dependability.

Subaru, on the other hand, uses an advanced flexible multi-segment Van Doorne steel belt designed to last the life of the vehicle. Because this belt operates wet, it's a more durable design providing for cooler operation with less noise.

The net effect is the ability to apply an automatic type transmission to a small displacement vehicle and achieve performance and fuel economy comparable to a manual transmission.

## **OVERVIEW**

The focus of this video is to establish a basic understanding of normal ECVT operating characteristics. In addition, it covers adjustment procedures which require special attention. The test vehicle used in this video was a 1990 4WD ECVT Justy. We purposely did not cover detailed diagnostic information because this information is found in Section 3-2 of the Justy Service Manual.

Acceleration runs were for demonstration purposes only. They do not constitute actual performance criteria.

If you drive a normally operating ECVT, and follow the performance road tests demonstrated in this video, you should get an idea of how the transmission is supposed to work.

Generally speaking, shift change characteristic problems will be apparent quickly and manifest themselves in the form of sluggish acceleration or RPM that constantly appears to be too high. Refer to your Service Manual for exact specifications and troubleshooting procedures.



## OPERATING CHARACTERISTICS

The ECVT consists of three integrated systems which control the transmission: Electronic, Hydraulic, and Mechanical.

The electromagnetic clutch replaces the torque converter found on conventional automatics. It couples and uncouples the transmission with the engine. It relies on sensor inputs to the Clutch Control Unit (CCU) in order to operate.

There are also two pulleys which vary in diameter. They work in conjunction with a steel belt and a simplified conventional hydraulic valve body to provide continuously variable ratios.

Finally, there is a mechanical gearset with a synchronizer for switching between forward and reverse.

In the "D" position, a synchronizer assembly engages the input shaft directly to the primary pulley. Power flow is then transmitted through stepless "shifts" over the entire ratio range. This is similar to "D" in a conventional automatic transmission.

"Ds" can be selected "on-the-fly" at any speed without damaging the transmission. This is because you're not moving the synchronized mechanical gearset. You're only modifying ratios hydraulically.

In the "Ds" position, the ratio changes are modified from the lower ratio through approximately mid ratio at light to medium throttle. However, it does not limit ratio changes toward overdrive. This position is similar to downshifting a conventional automatic transmission. It allows engine braking for descending steep grades. In sporty driving situations, it holds the engine RPM in its maximum torque range.

Inside the transmission in "Ds", hydraulic control pressure is bled "OFF" by the Engine Brake Valve. This modulates the control spring tension of the Shift Control Valve.

There are no special features in "P" or "N". When "Reverse" is selected, however, the synchronizer assembly engages the reverse transfer gears to the primary pulley.

### Summary

- Gear Ratio Changes
  - Effected mechanically and hydraulically, NOT electronically
- Clutch Operation
  - Electronic control system
  - No effect on ratio changes



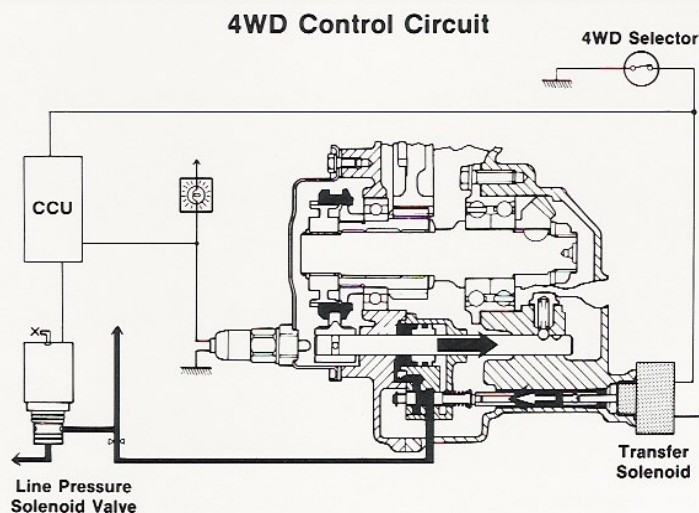
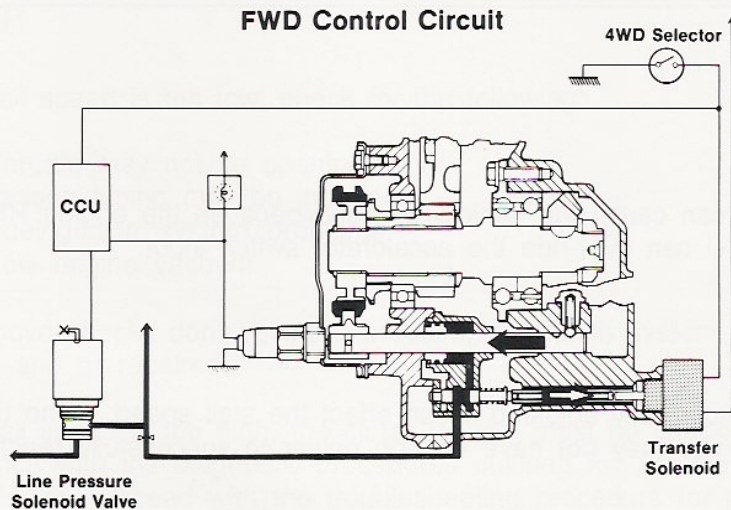
## 4WD OPERATION

Four Wheel Drive is controlled by an electro-hydraulic solenoid known as the Transfer Solenoid. It is mounted on the transfer case.

In order to shift into 4WD while moving, depress the 4WD switch and momentarily lift your foot off the accelerator. This will activate the Line Pressure Control solenoid.

Remember that a shift can't occur while torque is applied to the drive train. This prevents damage to the 4WD components. Hydraulic pressure supplied by the line pressure solenoid is used to shift in or out of 4WD.

Whenever the line pressure solenoid is activated, it reduces line pressure during light throttle or idle conditions. At this time the line pressure solenoid also supplies hydraulic pressure to the 4WD transfer mechanism.






## DIAGNOSTIC PROCEDURES

Before performing any adjustments, it is assumed that the vehicle has been road tested and it has been determined that there is a problem. Detailed diagnostic information is found in Section 3-2 of the Justy Service Manual.

It should also be pointed out that skills used to work on a conventional three speed automatic transmission can be applied to the hydraulics in the ECVT, since it incorporates a conventional style hydraulic pump and a very simple valve body. This applies, for example, to pressure tests and stall speed tests.

As a rule of thumb, always perform the simple checks first, such as the engine idle speed, ignition timing and ATF level. Also, make sure that the connectors are tight and that there aren't any oil leaks. At any step where you make an adjustment or repair check to see if this solves the problem.

 **TIP****Idle Speed:**

High idle speed can cause the vehicle to creep because the engine RPM signal to the CCU can over-ride the accelerator switch input.

**Ignition Timing:**

If the timing is incorrectly adjusted it can effect the stall speed. If the timing is retarded, the engine may not have enough power to successfully reach stall speed.




## ADJUSTMENTS

### Stall Speed

This test is used to isolate a slipping clutch, a slipping belt, or poor engine performance.

The stall speed test is performed at engine operating temperature with the wheels blocked and the emergency brake set. This test is performed for no more than 5 seconds at a time in the same manner as on conventional automatics.

After completing the stall test, place the transmission in "Neutral" at fast idle for a few minutes to cool down the clutch. If the stall speed is out of specification, refer to the appropriate Service Manual and follow the prescribed troubleshooting procedures.

 **TIP**

If the stall speed is too low, check for the following:

1. Throttle may not be opening fully
2. Ignition timing may be incorrect
3. Fuel/Ignition system problems
4. Low engine vacuum

If the above checks don't reveal a problem, the clutch system must be checked and or repaired.

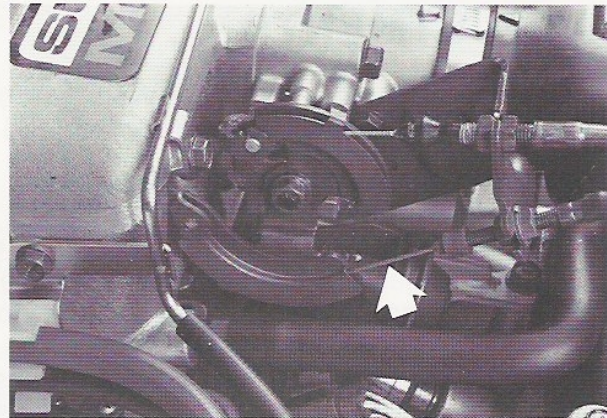
If the stall speed is too high, the clutch system must be checked first in accordance with the diagnostic procedures outlined for Trouble Code 34. If no fault is found, proceed with the troubleshooting procedure for a slipping belt.



**Transmission Control Cable**

The transmission control cable is the bottom cable that connects the throttle linkage to the transmission valve body.

With the engine off and the accelerator floored by a helper, make sure the throttle valve is fully open. If not, adjust the throttle cable on top of the bellcrank until it is fully open.



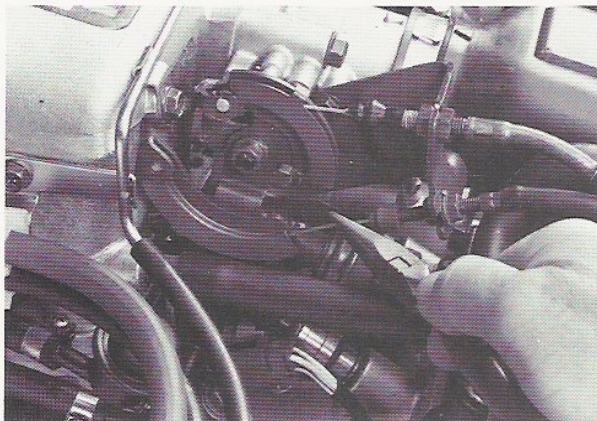
*Transmission Control Cable*

 **TIP**

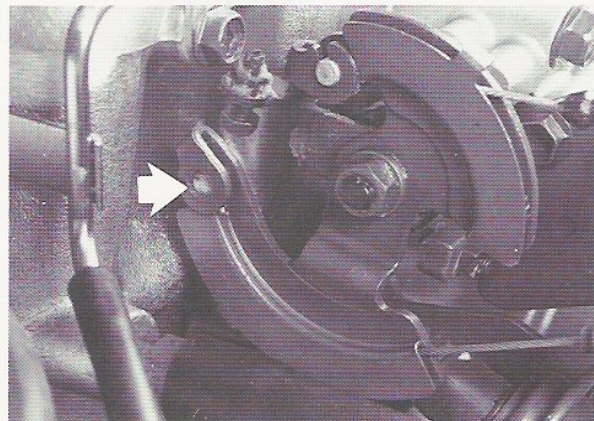
If the throttle cable is too loose, it can effect the stall speed and limit the transmission control cable travel. The transmission will not go to its lowest possible ratio during acceleration because the engine is not getting full throttle.

If the cable is too tight, it may hold the throttle open causing a higher idle than normal. This can also cause the vehicle to creep.

Use a pair of needle nose pliers so as not to damage the cable and carefully move the shift control cable in and out and check for the proper free play.



*Transmission Control Cable Free Play*



*Transmission Control Cable End-Lug*



When properly adjusted, there should be just enough free play to see the cable end-lug move slightly in the bellcrank.

The Service Manual gives specified measurements that are difficult to measure. You can approximate the measurement by observing the movement of the end-lug which is approximately equal to the specifications.

**NOTE: WHEN PULLING ON THE CABLE WITH PLIERS, THE CABLE SHOULD NOT BECOME SLACK IN THE BELLCRANK.**

**TIP**

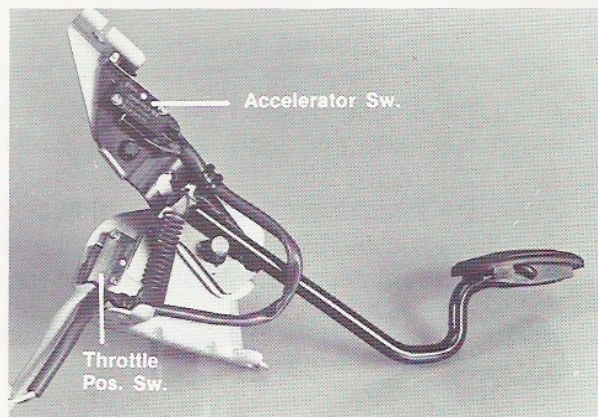
If the transmission control cable is too loose, the vehicle may feel sluggish because the gear ratios are not being held in the lowest possible ratio during acceleration. This will be most evident in the tachometer readings at full throttle at approximately 15 - 20 MPH.

If the transmission control cable is too tight it will tend to hold the transmission in its lower ratios. In this case there would be higher than normal tachometer readings throughout all driving conditions. This can also limit full throttle opening.

### Accelerator Pedal Switches

There are two accelerator pedal switches in the ECVT control system, an Accelerator Switch and a Throttle Position Switch. Since each of these switches is normally closed, there should be continuity until you depress the pedal.

As you depress the pedal, measure the pedal travel until there is no continuity. Perform this procedure for each switch.



**Accelerator Pedal Switches**



If the accelerator switch is out of adjustment, loosen the two screws on the accelerator switch and move the switch until it opens at the dimension specified in the Service Manual.

For the throttle position switch, loosen the single screw and adjust the cam until the pedal travel is within the specifications listed in the Service Manual.

 **TIP****Accelerator Switch:**

If the accelerator switch is stuck or held open (No Current), the vehicle will creep immediately when the transmission is placed in gear. It will also be difficult to shift out of gear and when shifting through "NEUTRAL" it may possibly be accompanied by a grinding noise. In this situation the CCU does not recognize a problem. Therefore, the Check Light will not illuminate and no code is stored in memory. However it can be easily checked with the Select Monitor by using Mode FA1 and observing LED #9.

If the accelerator switch is stuck closed, the engine RPM signal to the CCU will over-ride the accelerator switch input at about 1000 RPM. Clutch engagement will occur in a normal manner and it will trip the "CLUTCH TEMP" or "CHECK ECVT" light and store a Trouble Code in the CCU memory when the throttle position switch is activated.

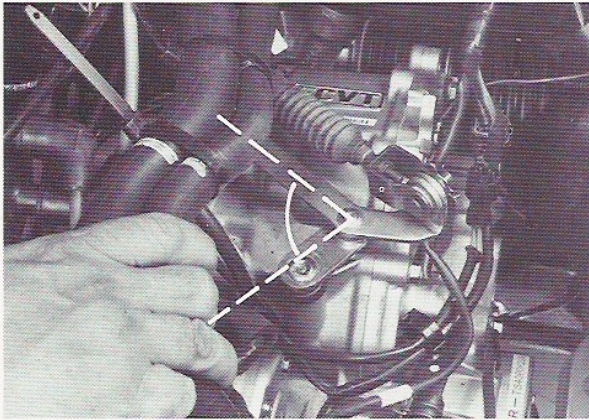
 **TIP****Throttle Position Switch:**

If the throttle position switch is stuck in the open position, it will simply trip the check lamp and store a Trouble Code.

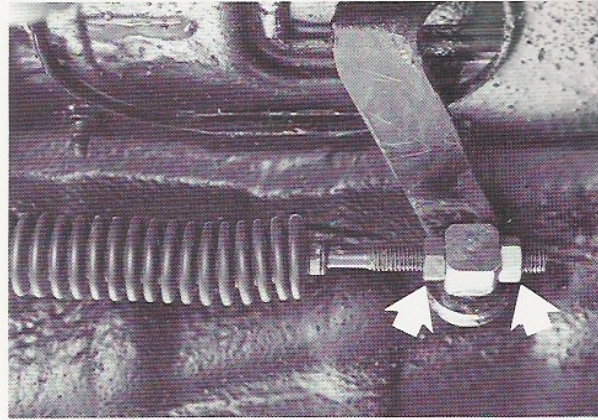
If the throttle position switch is stuck in the closed position, the CCU will not pick up a fault or display a Check Light. This switch can also be checked with the Select Monitor by using Mode FA1 and observing LED #8.



## Transmission Shift Linkage



*Shift Linkage at 90 Degrees*



*Shifter Arm Adjusting Nuts*

First, place the shifter in "Neutral" and verify that this linkage on top of the transmission forms a 90 degree angle.

Then without touching the push button, lightly push the shift lever from "Neutral" toward "Reverse" and at the same time observe the shifter free play. Also perform the same procedure between "D" and "Ds". Both free-play measurements should be approximately the same.

If the free-play is not the same, place the shifter in "Neutral" and raise the vehicle. Then loosen the two adjusting nuts on the bottom of the shifter arm. Gently tighten the inner (front) nut until it just touches the end of the shifter rod. Secure the rod in place by tightening the outer (rear) nut.

Finally, re-check the free-play from "Neutral" to "Reverse" and from "D" to "Ds" as you did earlier.

### **TIP**

If the shift cable is misadjusted it may not stay in the selected gear or "Park" may not function properly. This can cause possible damage to the synchronizer assembly or to the parking pawl.

**NOTE: ANY TIME THAT THE SHIFT CONTROL CABLE IS ADJUSTED, THE INHIBITOR SWITCH ADJUSTMENT MUST ALSO BE CHECKED.**



## Inhibitor Switch



*Aligning Inhibitor Switch*

The inhibitor switch can be readjusted rather simply with a 5/64" drill bit marked off to a depth of 7/16ths of an inch. We suggest a 5/64" drill bit because it is more readily available than the 0.08" rod specified in the Service Manual.

After removing the cover, place the shifter in the "Neutral" position and loosen the two inhibitor switch attaching bolts. With the shifter in "Neutral", slide the switch back and forth, until the drill bit slides through the alignment hole to a depth of 7/16ths of an inch.

With the drill still inserted, put slight pressure on the shifter toward "Park" and tighten the bolts.

### **TIP**

If the inhibitor switch is misadjusted in relation to the shift control cable, improper clutch engagement or disengagement may occur.

#### **Example:**

If the transmission is placed in gear there may be no clutch engagement due to the fact that there is an incorrect signal being sent from the inhibitor switch to the Clutch Control Unit.

#### **Example:**

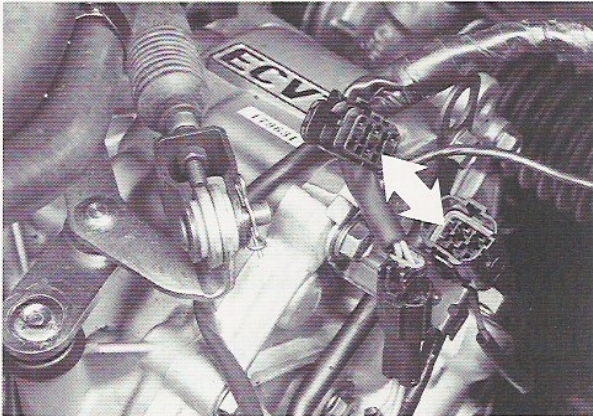
When the transmission is placed in gear, the vehicle may operate in a normal manner. However, the clutch may disengage if the transmission shift lever moves due to a rough road surface or if it is touched lightly (hand is rested on the shifter).

#### **Example:**

If the CCU receives a signal from the inhibitor switch indicating that the vehicle is in gear while it is actually in the "NEUTRAL" position, the clutch will engage. Attempts to shift into gear will be difficult with a possible gear grind. This can also cause possible damage to the synchronizer assembly.



## LINE PRESSURE TEST



*Line Pressure Control Solenoid Connector*

If an abnormality is noted during the road test or the Stall Speed Test, a line pressure test should be performed.

First, remove the cover plug and install the pressure gauge specified in the Service Manual. Note that this is a Subaru special Service tool. Then disconnect the electrical plug connector for the line pressure control solenoid valve. (4WD shown in photo.)

Finally, with the engine idling in "Neutral", observe the pressure readings and compare them with the specifications and trouble shooting procedures outlined in the Service Manual.

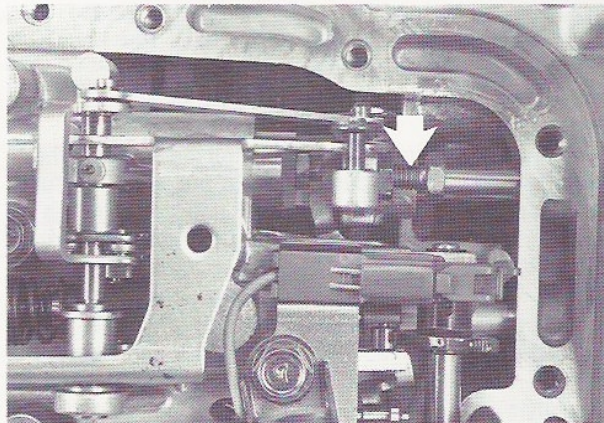
**NOTE: IF THE LINE PRESSURE CONTROL SOLENOID CONNECTOR IS NOT DISCONNECTED THE PRESSURE TEST WILL SHOW ABNORMALLY LOW LINE PRESSURE READINGS.**

Line pressure is adjustable as defined in the 1990 Justy Service Manual, Section 3 - 2, pg. 128. For other model years consult the appropriate Service Manual.

**NOTE: THE LINE PRESSURE SPECIFICATIONS IN THE SERVICE MANUAL ARE "MINIMUM" READINGS. MODERATELY HIGHER LINE PRESSURE IS ACCEPTABLE.**

Note that:

- The engine must be warmed up.
- Adjustment procedures require the removal of the oil pan.
- The adjusting bolt is located on the end of the pressure regulator guide.



*Line Pressure Adjusting Bolt*



## RATIO CHART

If there is a suspected problem with shift ratio changes, data can be gathered for filling out a ratio change characteristics chart which can be used as a diagnostic aid. A blank ratio chart is provided in the Appendix at the end of this book. Although the Service Manual indicates that this information can be gathered on a road test, it could be difficult or hazardous if performed on busy roadways. For this reason, we recommend gathering this information in the shop.

In the case of a suspected problem, it would be helpful to compare a specific vehicle ratio chart to the chart found in the supplement to the 1990 Justy Service Manual.

For safety, place the vehicle on a lift and raise it slightly so that all four wheels are off the ground. Then remove the front hub caps. Since the front wheels will be turning at high speeds, this prevents the possibility of having a hub cap flying off accidentally.

After the vehicle reaches operating temperature, you can gather information regarding tachometer and speedometer readings for this performance chart by performing the following tests.

**NOTE: THESE PROCEDURES MAY VARY FROM THOSE FOUND IN THE SERVICE MANUAL.**

### Test 1.

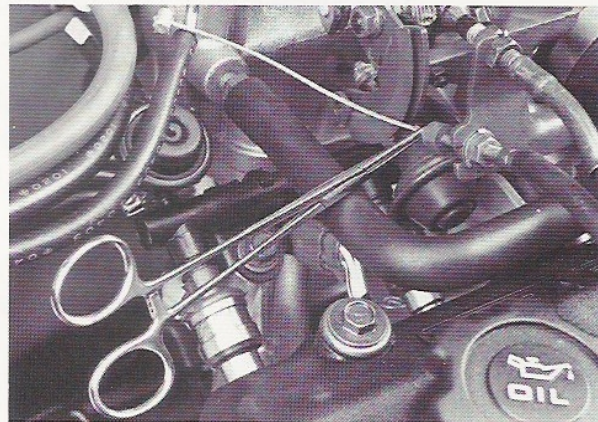
Place the transmission in "D" Range and depress the accelerator. Hold the accelerator until the speedometer reaches 100 MPH and then release the throttle. Jot down the tachometer and speedometer readings in 10 Mile Per Hour increments as the speed decreases from 100 to 10 Miles Per Hour. (This may require several applications.)

### Test 2.

Place the transmission in "Ds" Range and depress the accelerator. Hold the accelerator until the speedometer reaches 100 MPH and then release the throttle. Jot down the tachometer and speedometer readings in 10 Mile Per Hour increments as the speed decreases from 100 to 10 Miles Per Hour. (This may require several applications.)

### Test 3.

Disconnect the transmission control cable from the throttle body. Then pull the cable out until it is fully extended (all the way out). Lock the cable in this position with a hemostat or other suitable method so as not to damage the cable (see photo). Next, place the transmission in "D" Range and depress the accelerator. Hold the accelerator until the speedometer reaches 100 MPH and then release the throttle. Jot down the tachometer and speedometer readings in 10 Mile Per Hour increments as the speed decreases from 100 to 10 Miles Per Hour. (This may require several applications.)



*Hemostat Holding Throttle Cable*

### Test 4.

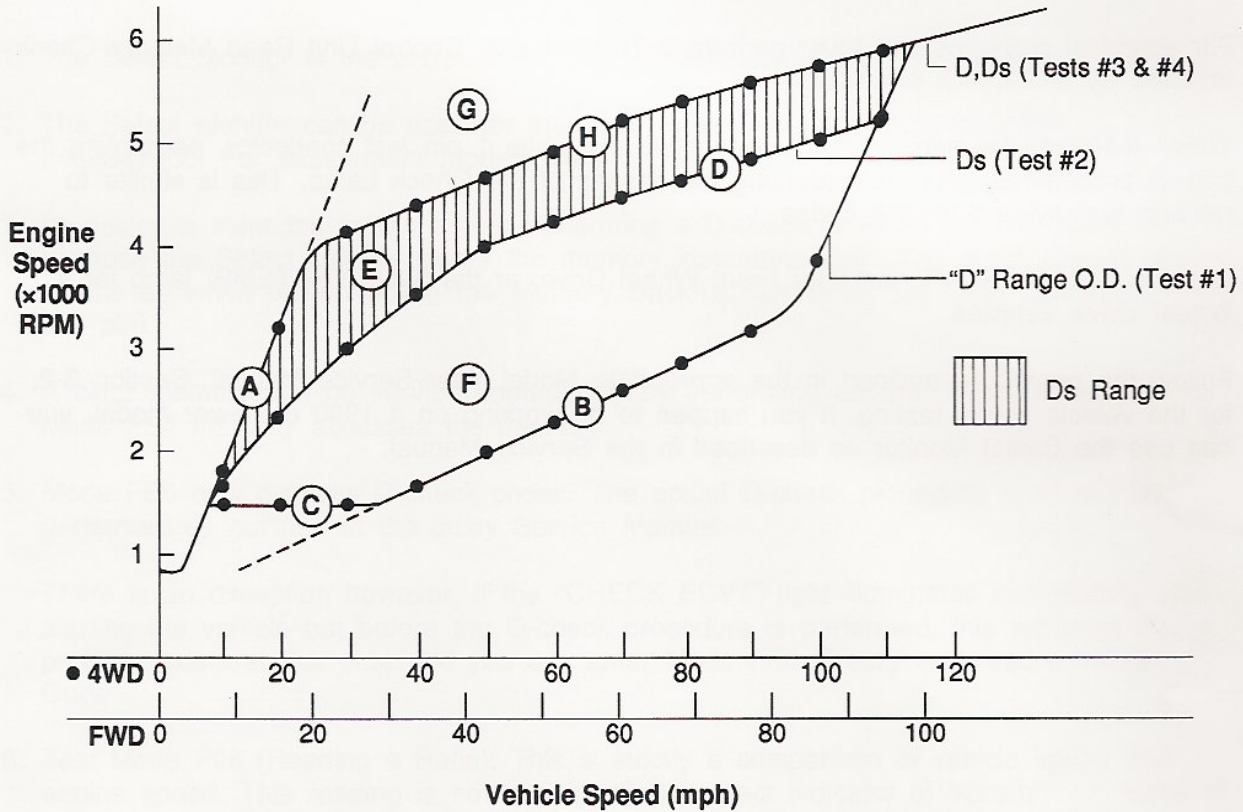
This test is identical to Test 3, except that it is performed with the transmission in the "Ds" Range.

Compare all the test results with the following chart. If test results vary significantly, follow the Diagnostic Procedures found in the appropriate year Justy Service Manual.

**NOTE: TRANSFER THE TACHOMETER AND SPEEDOMETER READINGS FROM THESE TESTS INTO DOTS ON THE BLANK RATIO CHART, THEN CONNECT THE DOTS TO FORM LINES.**



SAMPLE RATIO CHART



	Symptom	Section in the diagram
1.	Vehicle speed does not increase, but engine speed increases. (Vehicle remains in low range).	Line A
2.	Engine speed does not increase at all or very slowly, although the accelerator pedal is being depressed. (Transmission remains in OD position).	Line B
3.	The engine brake is suddenly activated while driving in D range (engine speed increases). (Corresponds to Ds range).	B ) C ) → D
4.	The engine brake is too effective in D range (engine speed too high).	Section E
5.	Engine brake does not work in Ds range (engine speed does not increase). (It works normally in D range).	Section F, or lines B and C
6.	The gear change line is too high in relation to the accelerator pedal position.	The line will reach section G if the accelerator pedal is fully depressed.
7.	The gear change line is too low in relation to the accelerator pedal position.	The line will not reach line H even if the accelerator pedal is fully depressed.



## **ELECTRICAL DIAGNOSIS**

For electrical problems you must perform a Transmission Control Unit Read Memory Check followed by a D-check procedure.

These tests can be performed by connecting the white 1 pin test connector, performing the correct procedures, and then counting the flashes of the Check Lamp. This is similar to reading fuel system trouble codes.

Use the "CHECK ECVT" lamp for Front Wheel Drive, or the "CLUTCH TEMP" lamp for 4 Wheel Drive vehicles.

Follow the procedure outlined in the appropriate Model Year Service Manual, Section 3-2, for the vehicle you're testing. If you happen to be working on a 1990 or newer model, you can use the Select Monitor as described in the Service Manual.



## SELECT MONITOR CLARIFICATIONS

1. The Select Monitor is the preferred method for diagnosing the ECVT electrical system.
2. The Select Monitor can be used for the 1990 Justy ECVT by using cartridge #498347800. For subsequent models, refer to the Service Manual.
3. Its easier to clear the memory after performing a D-check or Read Memory check because the Select Monitor clears the memory instantaneously. You don't have to wait a minute as when disconnecting the Memory Back-Up connector (normally connected white two pin).
4. A clear memory can be verified immediately by performing another Read Memory check. Mode FB1 instantly accesses the memory.
5. Mode FB0 only displays D-check codes. The actual D-check procedure must still be performed as outlined in the Justy Service Manual.

There is an exception however, if the "CHECK ECVT" light illuminates immediately after starting the vehicle but before the D-check procedure is performed, this indicates that a problem exists at that time and you can enter Mode FB0 directly and read a Trouble Code.

6. Test Mode F06 (Reading a Ratio): This is strictly a comparison of vehicle speed and engine speed. This reading is not necessarily an exact indicator of transmission ratios at that particular moment. It is only accurate between 32-39 MPH as specified in the Service Manual. This reading can be used however, as an **indicator** of improper shifting characteristics.

**NOTE: A READING OF 2.50 IN "PARK" OR "NEUTRAL" IS NORMAL.**

7. When using the 1990 Justy Supplement, pages 18 and 73 should be cross-referenced. Specific functions are described on pages 18-20, while Select Monitor Diagnostic Procedures are found on pages 73-78.

### Time Saver

Use the Select Monitor FA Modes as a quick way to check switch inputs. By observing the LED's, a technician can quickly check to see if the Clutch Control Unit is receiving all its proper switch inputs.



## **CONCLUSION**

This program covered normal ECVT operating characteristics based on its three simple integrated systems: Electronic, Hydraulic, and Mechanical. It also covered trouble shooting and service adjustments. Tips were also provided where appropriate as additional trouble shooting aids.

Even though the Justy ECVT may operate a little differently than conventional automatics, its just as easy, if not easier to troubleshoot. In fact, many customer complaints turn out not to be problems at all. Remember, it's up to you to know your product. And if you know your product, repairs will be quicker, and your customers will enjoy many shiftless trouble-free miles.

**NOTE: THE APPROPRIATE MODEL YEAR SERVICE MANUAL SHOULD ALWAYS BE USED WHEN REFERRING TO SPECIFICATIONS AND TROUBLE SHOOTING PROCEDURES.**



**SERVICE BULLETINS**

#16-32-89:

APPLICABILITY: 1989 ECVT JUSTY  
SUBJECT: ELECTROMAGNETIC CLUTCH RATTLE NOISE

#16-33-89

APPLICABILITY: 1989 JUSTY VEHICLES EQUIPPED WITH ECVT  
SUBJECT: VALVE BODY DISASSEMBLY AND ASSEMBLY

#16-34-89

APPLICABILITY: JUSTY WITH ECVT TRANSMISSION  
SUBJECT: ALTERNATE ECVT ADJUSTMENT FORMULA AND PROCEDURE

#16-38-90:

APPLICABILITY: 89MY JUSTY ECVT  
SUBJECT: INTERMITTENT ECVT CHECK LAMP ILLUMINATION, TROUBLE CODE 21

#16-41-90

APPLICABILITY: ALL 1989 JUSTY ECVT MODELS  
SUBJECT: TROUBLE CODE 25 IN ECVT CONTROL UNIT



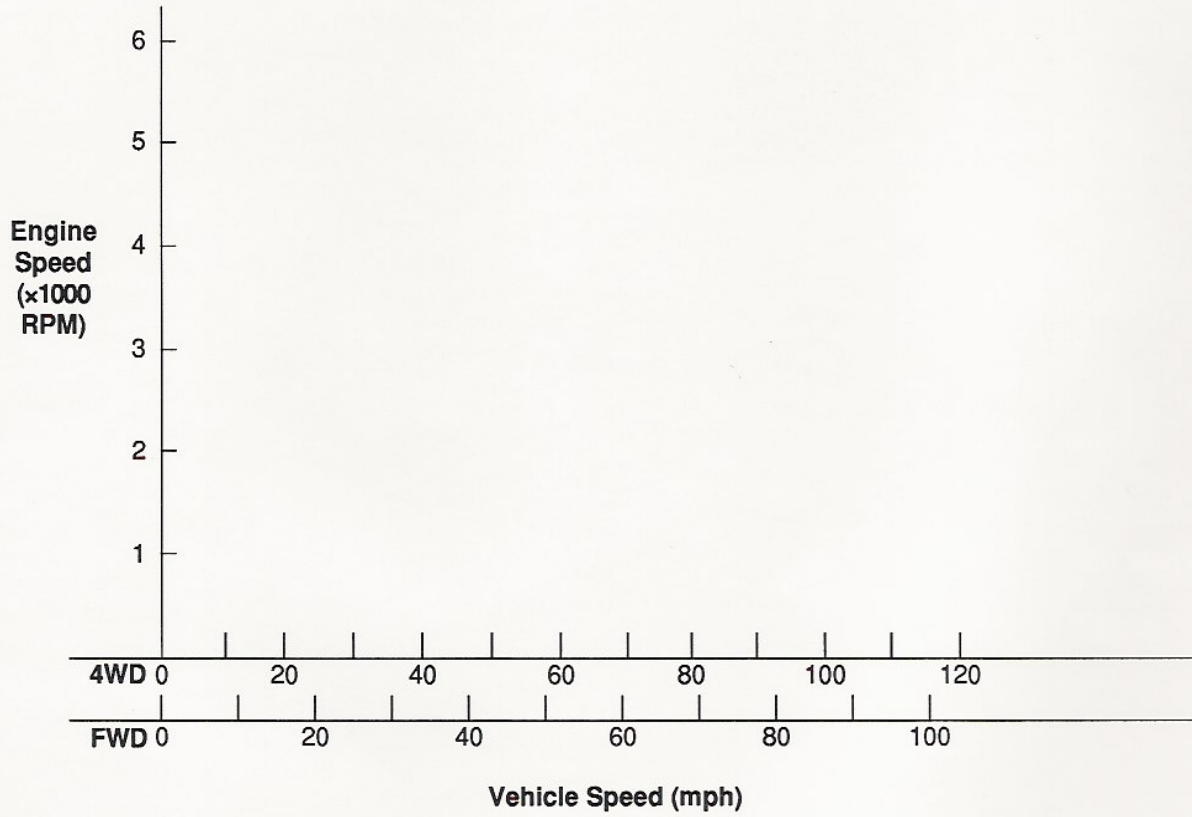
**RECOMMENDED TOOL LIST**

Select Monitor Kit #498307500  
Select Monitor Cartridge #498347800  
Service Manual  
Service Manual Supplement  
Continuity Meter  
Digital VOM (With continuity feature if possible)  
Pressure Gauge #498575400  
Pressure Gauge Adapter #498895400  
Ignition Scope  
Terminal Repair Kit  
Crimping Pliers  
Induction Type Hand Held Tachometer (digital or analog)  
Drill Bit: 5/64 inches  
Timing Light (Induction Type)  
Vacuum Gauge  
Metal Scale (Ruler)  
Miscellaneous Hand Tools



APPENDIX

RATIO CHART



NOTES



**SUBARU**<sup>®</sup>