SUBARU

QUALITY DRIVEN® SERVICE

CERTIFIED SUBARU TECHNICIAN

Technicians Reference Booklet

4EAT Phase 2

Module 304

AUTOMOTIVE Youth Educational Systems YES

September 2006

MSA5P0141C

Technical Training

Subaru of America, Inc. 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 contained herein is considered current as of September 2006.

This book is revised with material from New Model Updates 912 to 916.

Table of Contents

Introduction

The 4EAT Phase 2 (introduced on 1999 Model Year vehicles) provides the same type of electronic control used by prior model year vehicles and shares many of the same diagnostic procedures, however there have been internal and external changes that require this 4EAT to be viewed as an entirely new automatic transmission. Additionally, beginning with the 2001 model year, an enhancement to the all wheel drive transfer section was introduced. This enhancement, Variable Torque Distribution (VTD), is covered in this reference booklet.

Left Side

Right Side

The use of an external canister type oil filter has been adopted which requires no scheduled maintenance.

Three speed sensors are now located on the outside surface of the transmission case reading rotational speeds of internal components improving transmission characteristics.

Internally the Brake Band and Servo Mechanism have been deleted and in its place an additional clutch pack is used as a holding member for second and fourth gear. Also the remaining clutch assemblies and the valve body have been redesigned requiring new disassembly and assembly procedures.

Selector lever operation		Reverse clutch	2-4 brake	High clutch	Low clutch	Low reverse brake	One-way clutch
P							
R		○				○	
N							
D	1ST				○		○
	2ND		○		○		
	3RD			○	○		
	4TH		○	○			
3	1ST				○		○
	2ND		○		○		
	3RD			○	○		
	4TH		○	○			
2	1ST						
	2ND		○		○		
	3RD			○	○		
	4TH		○	○			
1	1ST				○	○	○
	2ND		○		○		
	3RD			○	○		
	4TH		○	○			

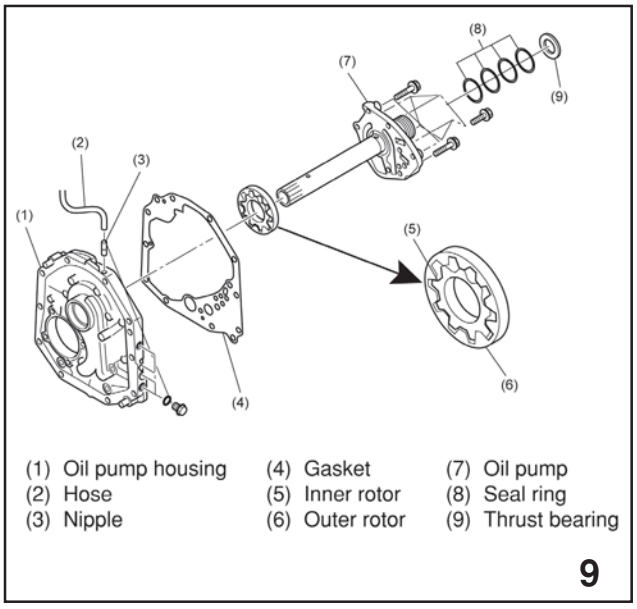
AT-00475

7

Gear Train Operation Table

Construction

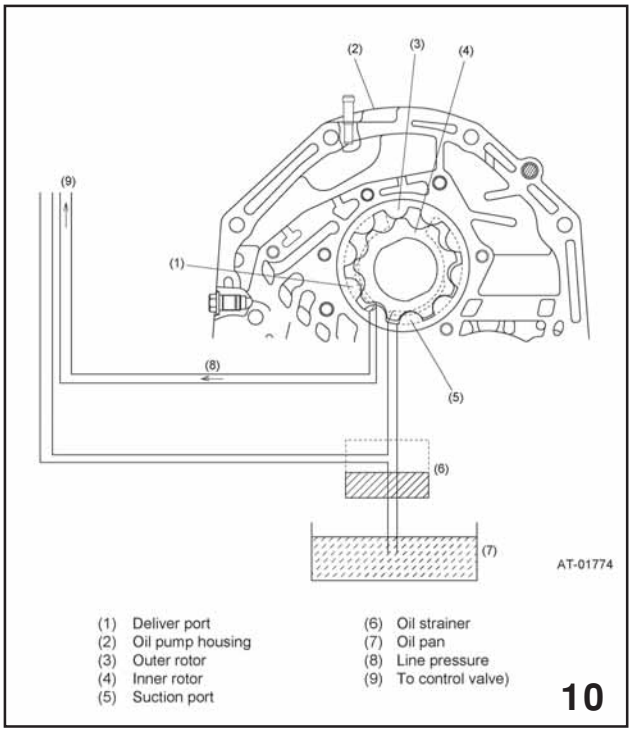
The pump consists of a parachoid rotor pair, a housing and a cover. The inner rotor has nine teeth and the outer rotor has ten teeth.



Oil Pump Construction

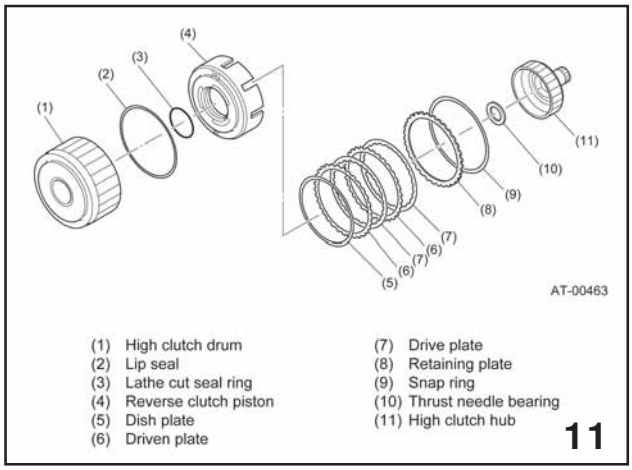
Function

- The pump draws automatic transmission fluid (ATF) from the oil pan through the oil strainer located under the control valve assembly. The ATF then flows through a passage in the transmission case, and after passing through the oil pump housing and oil pump cover, it enters the suction port.
- As the inner rotor rotates, the outer rotor also rotates. This motion causes the ATF to be sucked up through the suction port and discharged from the discharge port.
- The discharged ATF flows through a passage in the oil pump cover and then a passage in the oil pump housing. It then goes through a passage in the transmission case to the control valve assembly, from which the ATF is directed to various clutches, brakes, and torque converter lockup clutch for acting as hydraulic fluid and lubricating oil. Part of the ATF also flows to the manual valve, from where it is distributed to the circuit corresponding to the range selected by the selector lever.
- As engine speed increases, the delivery rate of the oil pump also increases.



Torque Converter

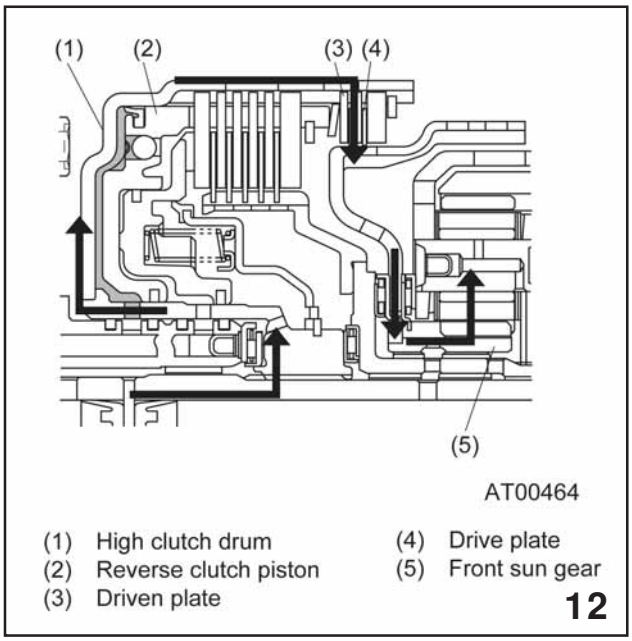
Reverse Clutch



Reverse Clutch Construction

When reverse is selected

Hydraulic pressure from the hydraulic control valve is applied to the reverse clutch piston when a shift is made into the reverse. The drive and driven plates are pressed together by this pressure, so that the engine torque from the high clutch drum is transmitted to the front sun gear through the 2-4 brake hub.



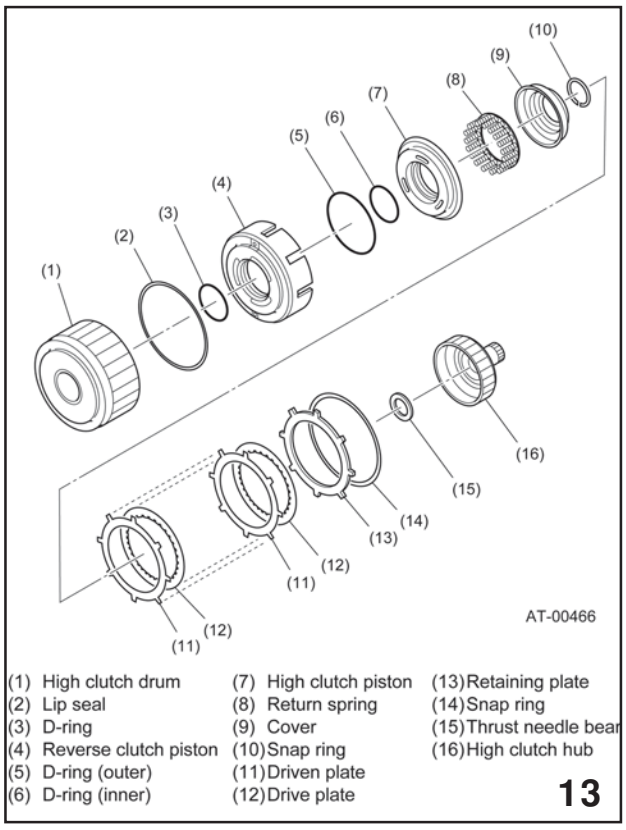
Hydraulic Pressure in Reverse

High Clutch

When the 3rd or 4th gear is selected, hydraulic pressures are applied to the high clutch from the shift valve and pressure regulator valve. The clutch's drive and driven plates are pressed together, thus transmitting the engine power from the input shaft tot the front planetary carrier through the high clutch hub.

A cover is placed inside the piston, and the space between the piston and the cover is filled with ATF. When the high clutch is not in engagement, the centrifugal force generated in the ATF inside the cover cancels out the centrifugal force generated in the ATF remaining behind the high clutch piston, thus preventing incomplete disengagement of the clutch.

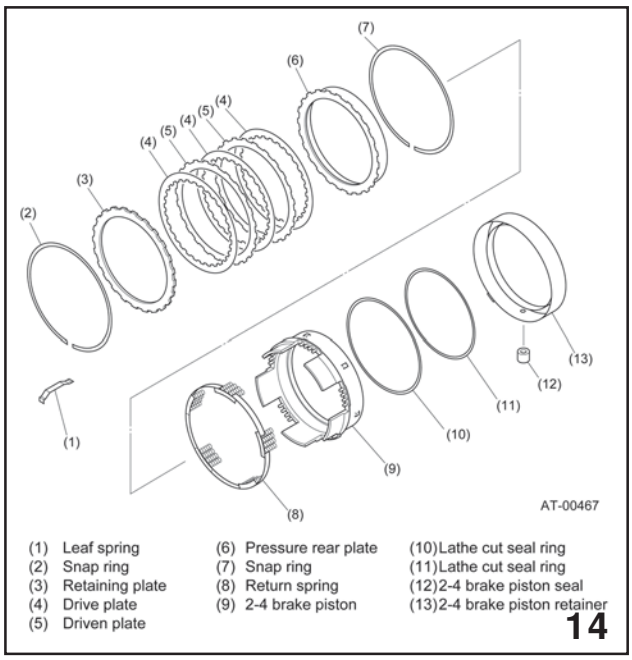
When the high clutch is engaged, the pressure pushing the clutch piston is much larger than the counteracting force of the ATF in the cover, so the clutch remains engaged.



High Clutch Construction

2-4 Brake

The 2-4 brake consists of a 2-4 brake piston, a return spring, a pressure plate, drive plates and driven plates.

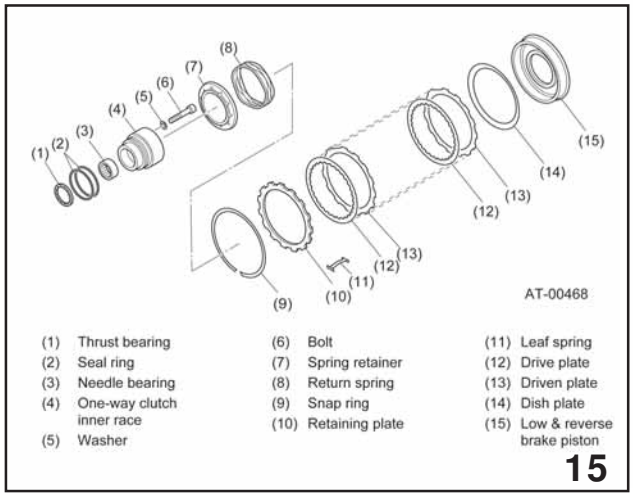


2-4 Brake Components

This brake is engaged by the hydraulic pressure from the transmission control valve and locks the front sun gear when the 2nd gear is selected in the D, 3 or 2 range, or when the 4th gear is selected in the D range.

Low & Reverse Brake

The low & reverse brake consists of a piston, a dish plate, drive plates, driven plates, a retaining plate and a snap ring that are placed in a housing formed in the transmission case.

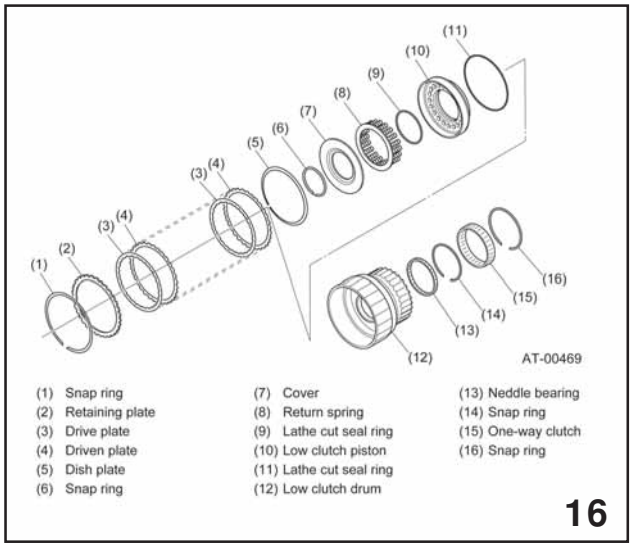


Low & Reverse Brake Components

When the 1st gear is selected in the 1 range or the reverse is selected, the pressure from the pressure regulator valve is applied to the low & reverse brake piston. The piston then presses the drive and driven plates together and causes the low clutch to lock.

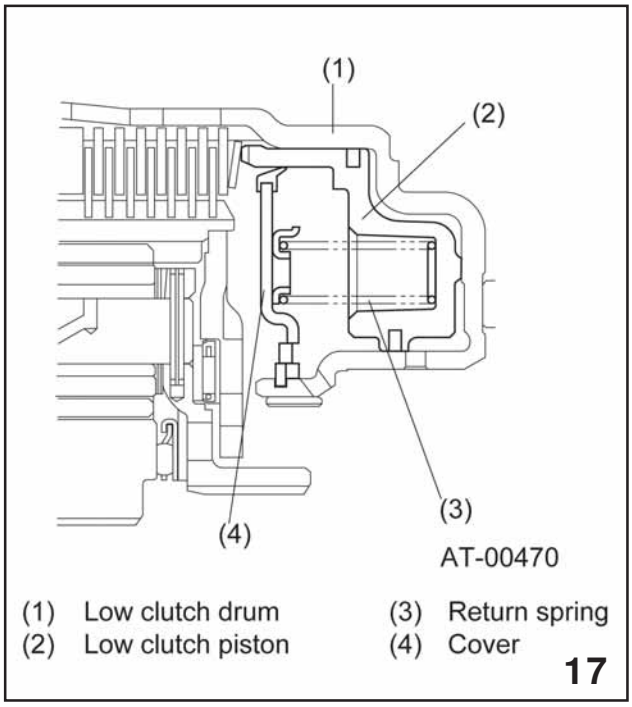
Low Clutch

The low clutch consists of a drum, a piston, return springs, a cover, drive plates, driven plates, a one-way clutch, and other sealing and retaining elements.



Low Clutch Components

The low clutch drum is made of a press-formed metal sheet. The drum's outer race and sleeve are welded together to the drum by an electron beam welding technique.



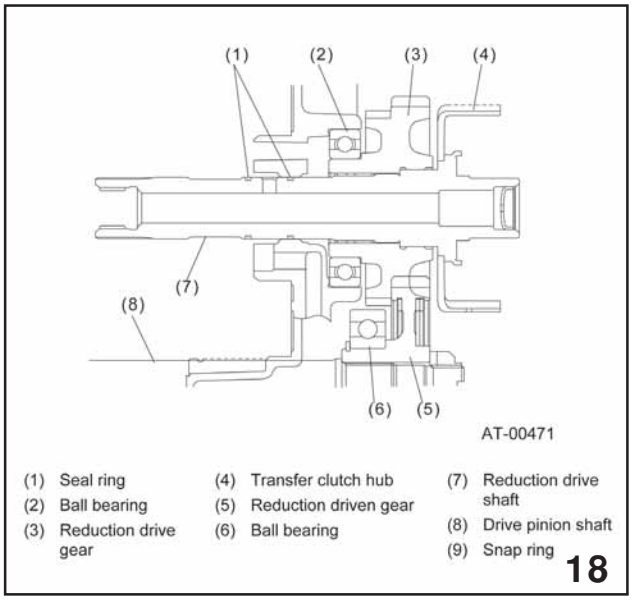
Low Clutch D-Range

The low clutch operates in the D range (1st, 2nd, and 3rd gears), 3 range (1st, 2nd, and 3rd gears), 2 range (2nd and 3rd gears), and 1 range (1st, 2nd, and 3rd gears).

This clutch engages when the hydraulic pressure from the transmission control valve is applied to its piston, transmitting the power to the reduction drive shaft.

A cover is placed inside the piston, and the space between the piston and the cover is filled with ATF. When the low clutch is not in engagement, the centrifugal force generated in the ATF inside the cover cancels out the centrifugal force generated in the ATF remaining behind the low clutch When the low clutch is engaged, the pressure pushing the clutch piston is much larger than the counteracting force of the ATF in the cover, so the clutch remains engaged.

Reduction Gears



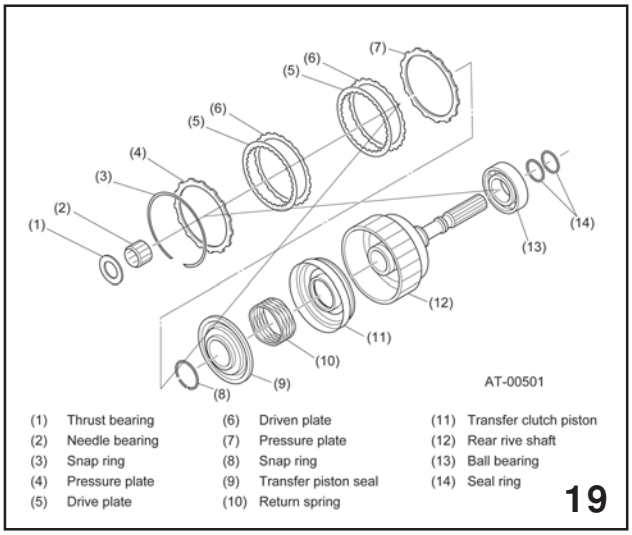
Reduction Gear

Engine torque is transmitted from the rear planetary carrier to the reduction drive shaft and the reduction drive gear. The torque is then transmitted to the front final gears through the reduction driven gear and drive pinion. The torque is also transmitted to the rear wheels from the transfer clutch hub (welded to the side of the reduction drive gear) through the transfer clutch and the following path: rear drive shaft ➔ propeller shaft ➔ rear differential.

AWD System

Transfer Clutch

The transfer clutch drum and rear drive shaft are joined to each other by welding. The rear drive shaft has drilled oil passages for transfer clutch control and also for lubrication of extension bushing and ball bearing in it.

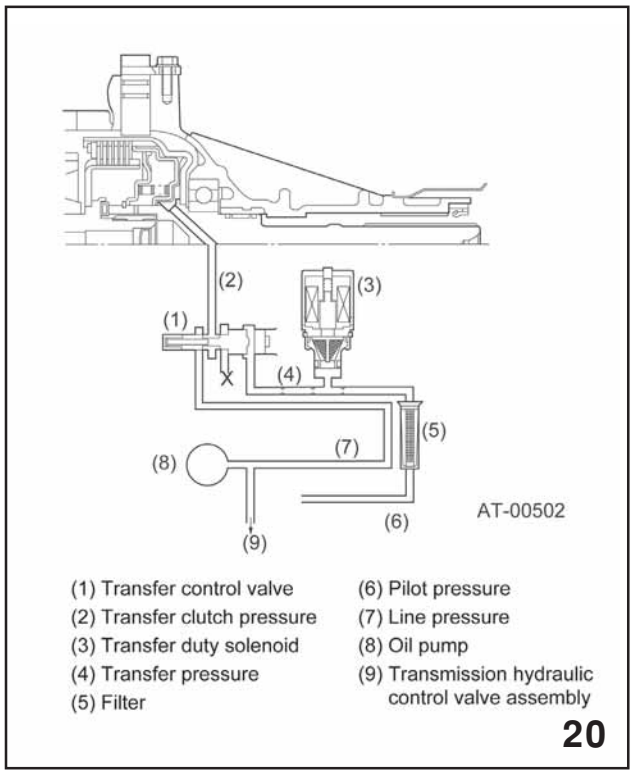


Transfer Clutch Components

This all-wheel-drive (AWD) transfer system uses an electronically controlled multi-plate type transfer clutch. The clutch is controlled by the TCM through the transfer hydraulic pressure control unit which consists of a duty-cycle-controlled solenoid valve and is located at the rear of the automatic transmission section together with the vehicle speed sensor.

The TCM has in its memory a set of duty ratio data, each defining at what ratio the transfer clutch should transmit the torque for a particular driving condition. Based on the driving condition information it receives from the corresponding sensors (vehicle speed, throttle opening, gear range, slip of wheels, etc.), the TCM selects an appropriate duty ratio from the memory and uses it to control the solenoid valve. The solenoid valve then regulates the pilot pressure of the transfer control valve which creates the pressure to the clutch from the line pressure. The clutch is engaged to a degree determined by the transfer clutch pressure thus created. Through this process, the torque from the engine is distributed to the rear wheels optimally according to driving conditions.

Transfer Hydraulic Pressure Control Unit



Transfer Hydraulic Pressure Control Unit

The transfer hydraulic pressure control unit is bolted at the rear end of transmission case through the transfer valve plate.

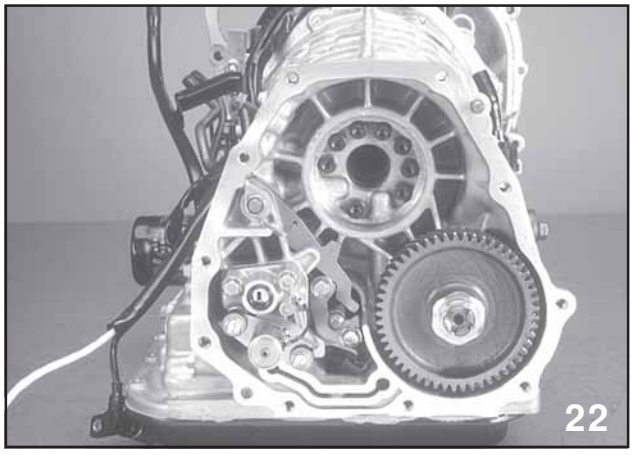
The hydraulic pressures used for the transfer hydraulic pressure control unit (line pressure and pilot pressure) are supplied from the transmission's hydraulic control valve assembly through the passages formed in the transmission case.

The transfer duty solenoid adjusts the pilot pressure of the transfer clutch valve depending on the signals from the TCM. The transfer clutch valve in turn modulates the line pressure into the transfer clutch pressure before it is applied to the clutch piston.

The transfer clutch pressure adjusted in this way engages the clutch to different degrees according to driving conditions so that the optimum torque is distributed to the rear wheels.

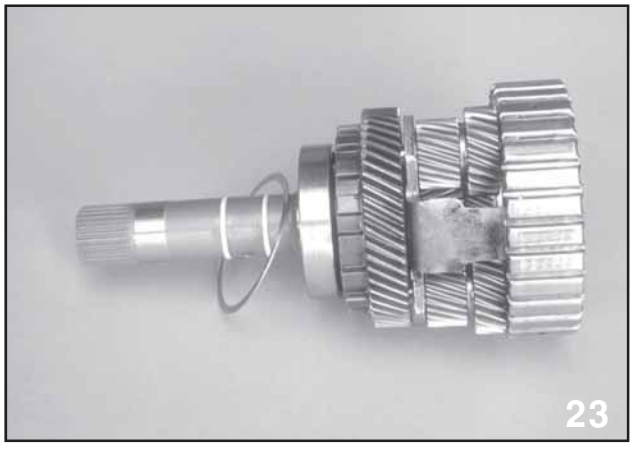
Variable Torque Distribution (VTD)

Variable Torque Distribution (VTD) is an addition to the current 4EAT transfer section. VTD is designed to smoothly transfer and divide the power from the engine to the wheels. This new system for North America is equipped on all Subaru vehicles with Vehicle Dynamic Control (VDC).



Extension Case Area

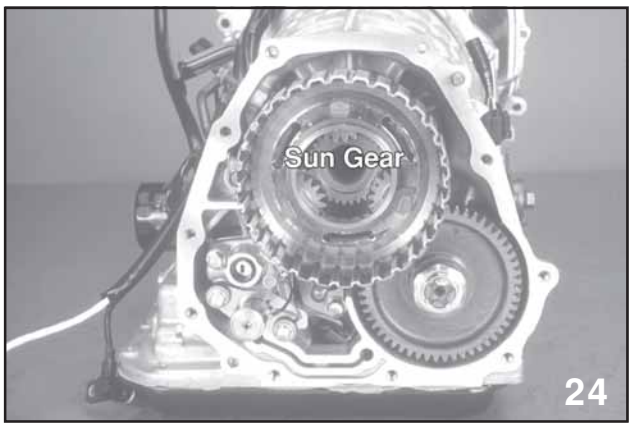
The view of the extension case area is similar to the current 4EAT Phase 2. The difference is the Reduction Drive Assembly.



Sun Gear

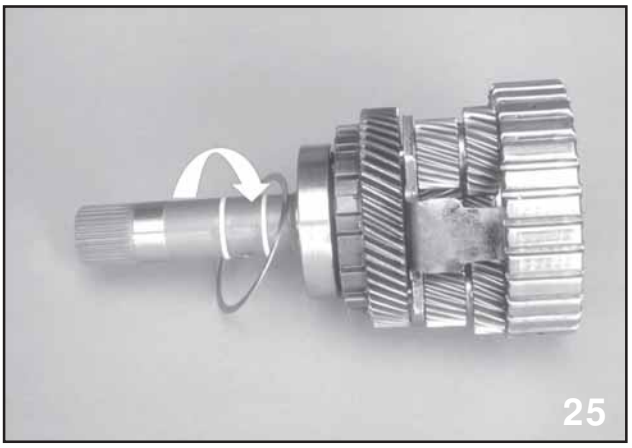
An Intermediate Shaft is splined to the Rear Internal Gear, carrying power to a Sun Gear.

The Sun Gear is made onto the end of the Intermediate Shaft. The rotating Sun Gear delivers power to a set of Pinion Gears.



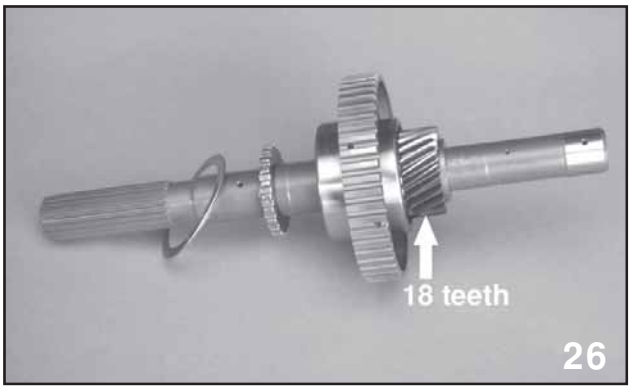
Extension Case Area with Sun Gear Showing

The Pinion Gears are two gears made together. The smaller gear and larger gear have the same number of teeth. The Intermediate Sun Gear drives the smaller Pinion Gear and the larger Pinion Gear.



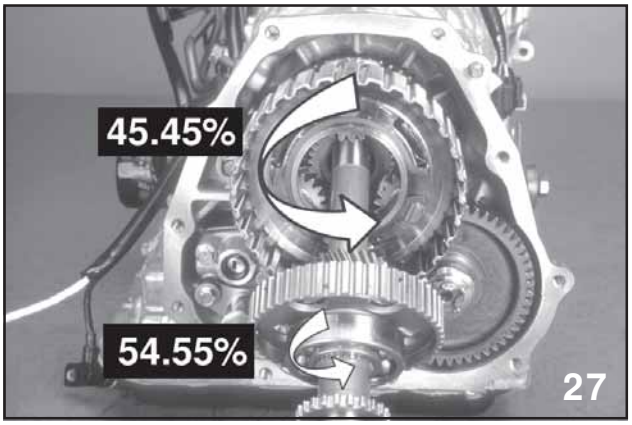
Sun Gear Showing Rotating Direction

The Pinion Gear is secured to the carrier and delivers power to it. The carrier will now rotate, driving the Reduction Drive Gear. This supplies power to the front wheels. At the same time, the larger Pinion Gear is driving the Rear Drive Shaft.



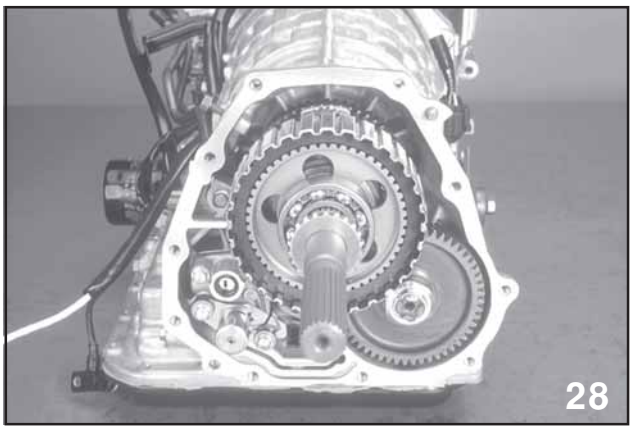
Sun Gear showing 18 teeth

A Sun Gear made on to the end of the Rear Drive Shaft receives the power and transfers the power to the shaft. The final drive shaft is splined to the Rear Drive Shaft. This carries power to the rear differential.



Power Split

Assuming the friction of the front and rear tires is the same, the power is split 54.55% to the rear and 45.45% to the front.



Transfer Clutch

The Front Wheels load the reduction drive and driven gears.

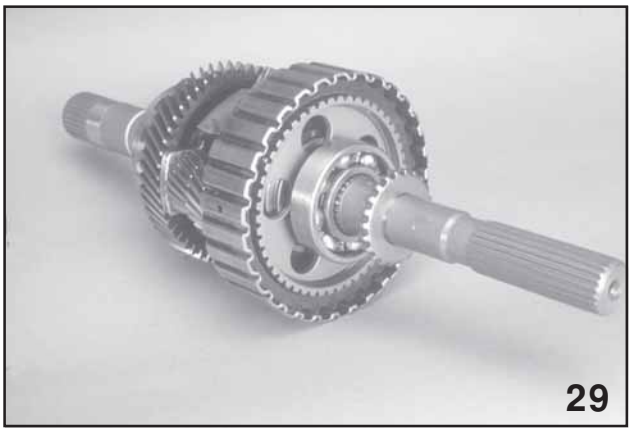
The Rear Wheels load the Rear Drive Shaft and Pinion Gears.

Driving the vehicle results in the Pinion Gears rotating and advancing around the Intermediate Sun Gear.

The Intermediate Sun Gear has 33 teeth; the Small Pinion has 21 teeth.

The Rear Drive Shaft Sun Gear has 18 teeth; Large Pinion has 21 teeth.

You can calculate the power split by dividing 18 by 33 for the Rear Wheels. The remaining power drives the Front Wheels.



Transfer Planetary

The TCM adjusts the duty ratio of the MPT clutch to maintain the optimum transfer of power.

A large speed difference in the rear to the front wheels results in the MPT clutch locking the Rear Drive Shaft to the carrier.

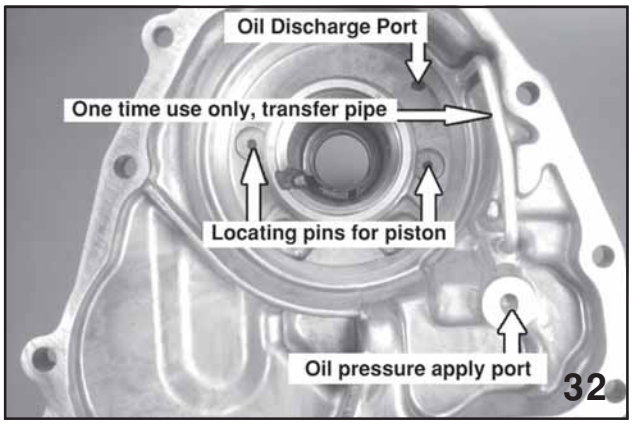
Power is then split 50% to the front and 50% to the rear.

Piston Clutch Side

The piston for the MPT Clutch is machined to spline with the MPT Drum. The piston will rotate with the drum.

Piston Case Side

The backside of the piston is made with two locating pins. This prevents the backside of the piston from rotating.



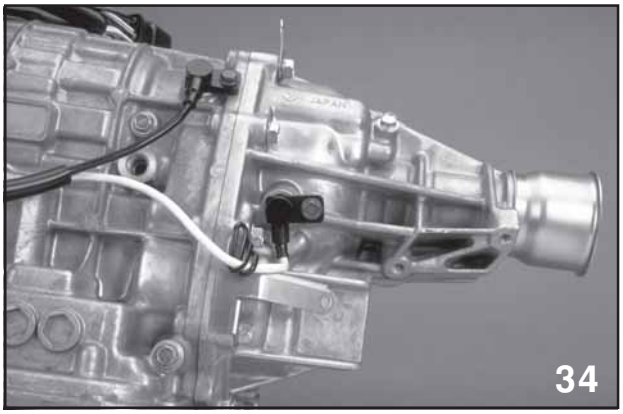
Pressure Ports

Pressure port locations.

NOTE: OIL PRESSURE TRANSFER PIPE IS ONETIME USE ONLY.

Disassembly

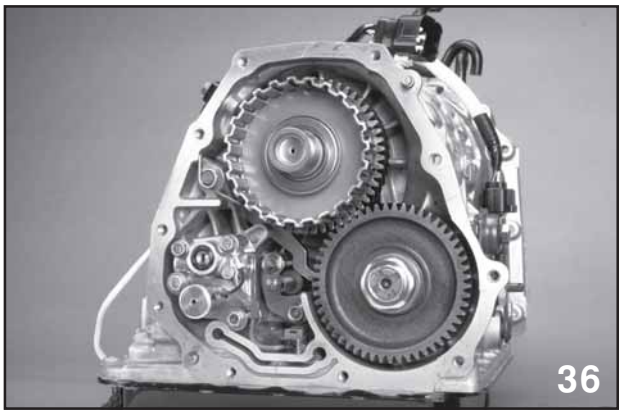
Before beginning the disassembly process, label the speed sensors so that they are not incorrectly installed during reassembly.



Extension Housing

Remove vehicle Speed Sensor 1 from the extension case. Followed by the bolts that secure the extension case to the rear of the transmission.

Transfer Clutch



Reduction Gears

Set the select lever to the park position to engage the Parking Pawl to the front of the reduction drive gear.

Hammer and Punch

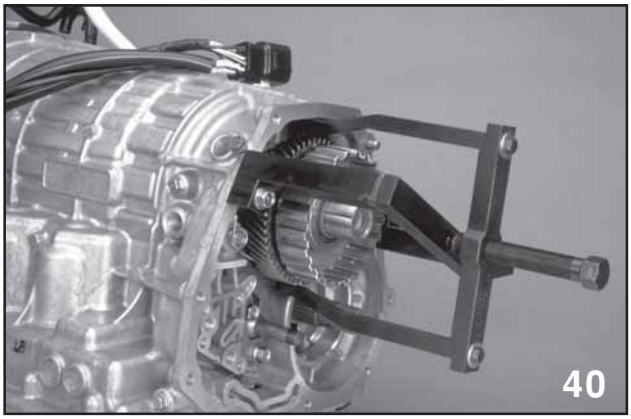
Straighten the peen mark of the locknut. (This locknut is designed to be used only once.) Remove the locknut and washer.

Clean the threaded portion of the backside of the Reduction Driven Gear and install the special tool puller. (499737000 and 899524100)

Tool Usage

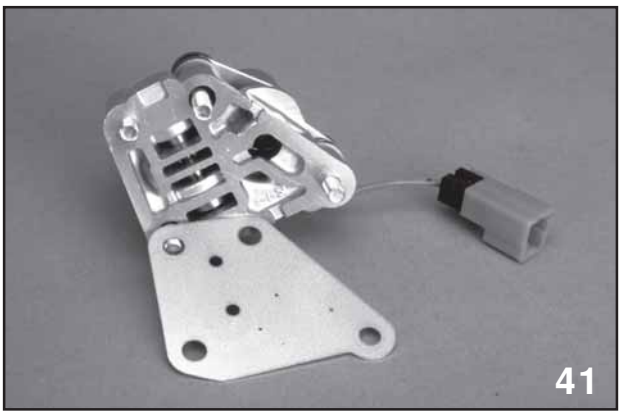
Gear on Bench

Turn the puller until the Reduction Driven Gear has cleared the Pinion shaft.



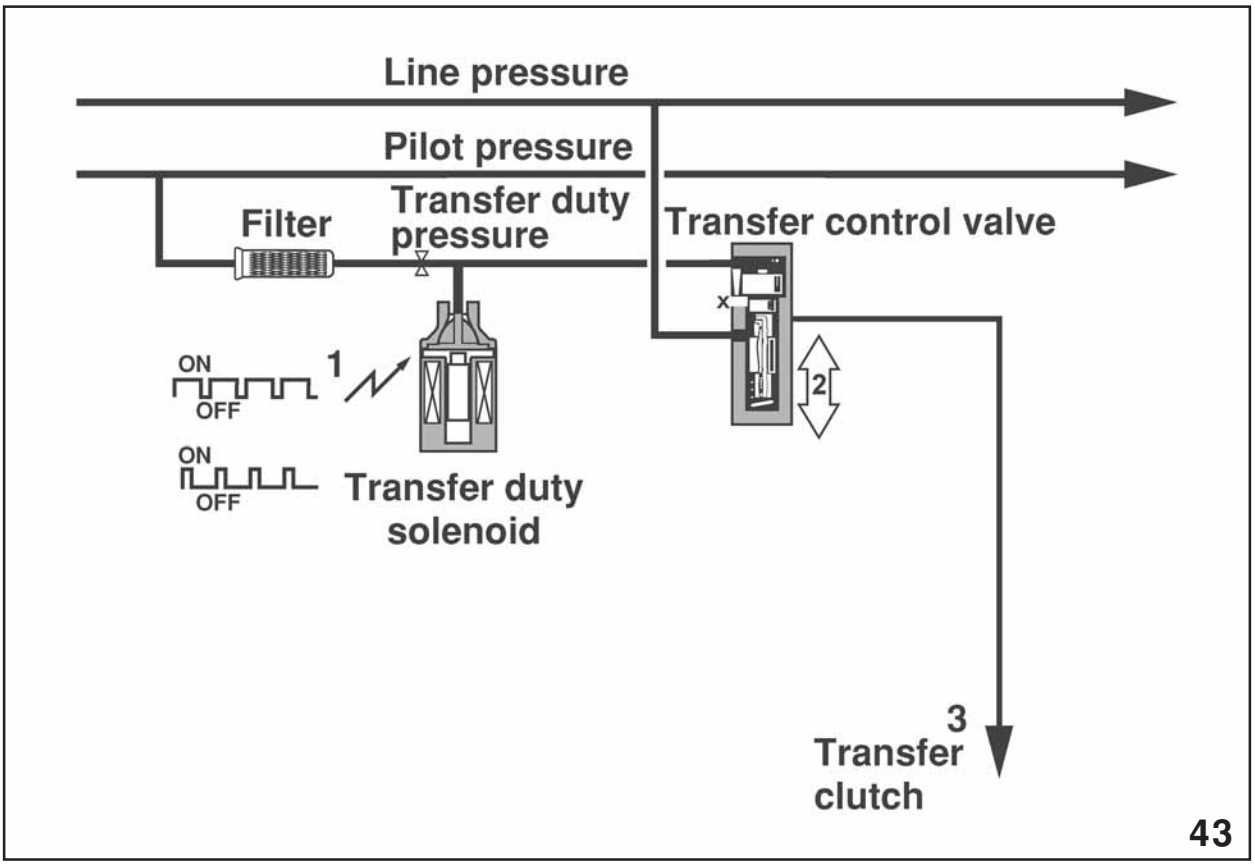
Tool Usage

Install the reduction drive gear puller to the rear of the transmission as shown and slowly remove the drive gear assembly. (499737100 and 899524100)



Solenoid

Filter



Transfer Duty

The Transfer Duty Solenoid controls the amount of pilot pressure supplied to the backside of the Transfer Control Valve Piston. If the duty ratio signal from the Transmission Control Unit (TCU) is small the Transfer Duty Solenoid stays off more than it is on and drains less of the pilot pressure. This will result in an upward movement of the control valve increasing the amount of line pressure to the Transfer Clutch. An increase in the duty ratio turns the solenoid on more than it is off and drains more of the pilot pressure. The Transfer Control Valve moves downward restricting the amount of line pressure to the Transfer Clutch.

Oil Pan

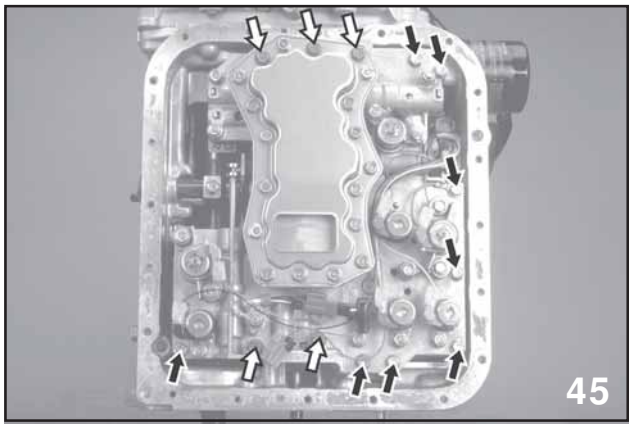
The next step in the disassembly process is to remove the Oil Pan. Position the transmission on the worktable with the Oil Pan facing upward and held in position with wooden blocks.

Remove the Oil Pan Bolts. Use a putty knife or similar tool with a hammer and carefully separate the pan from the transmission. Do not score or scratch the mating surface.

4EAT Phase 2 Disassembly Continued

Carefully disconnect and remove the wiring harness.

Remove the control valve body. There are 8 short bolts marked with an (8) and 5 long bolts marked with (7B).



Valve Body with Artwork

Valve Body Removed

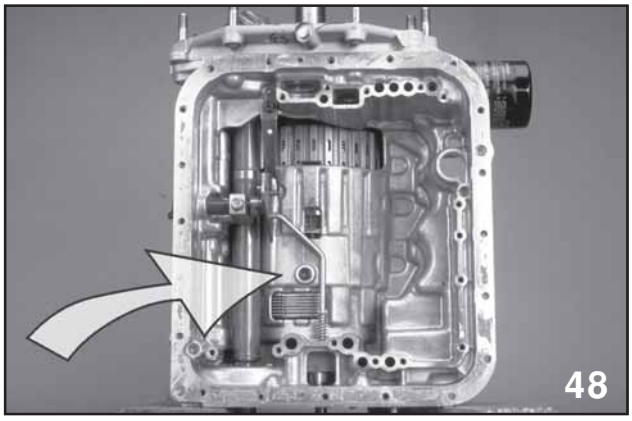
Carefully disconnect all solenoids. Observe the color of the connectors and the color of the wire that connects to them.

Solenoid	Color	Failsafe
2-4 Brake	Red	1st and 3rd
2-4 Brake Timing	Black	1st and 3rd
Shift A	Green	3rd
Shift B	Yellow	3rd
PL	Red	1st and 3rd Line press set at maximum
Low Clutch Timing	Gray	1st and 3rd
Lock Up	Blue	no lock up

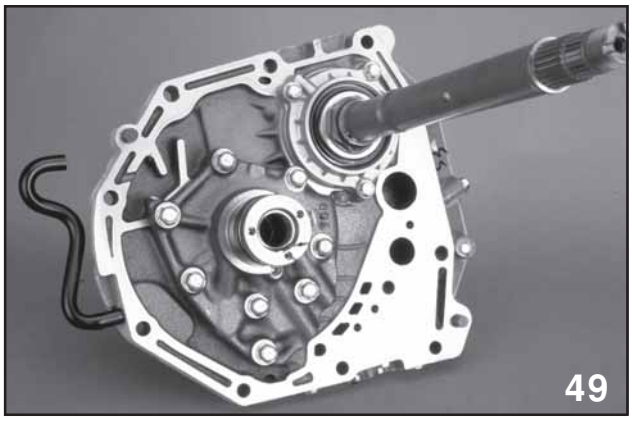
47

Solenoid Color Chart

Reposition the transmission to vertical using the wooden blocks to stabilize the case. Remove the bolts and nuts that secure the pump assembly to the transmission case. Remove Seal Pipe.



Seal Pipe Removal

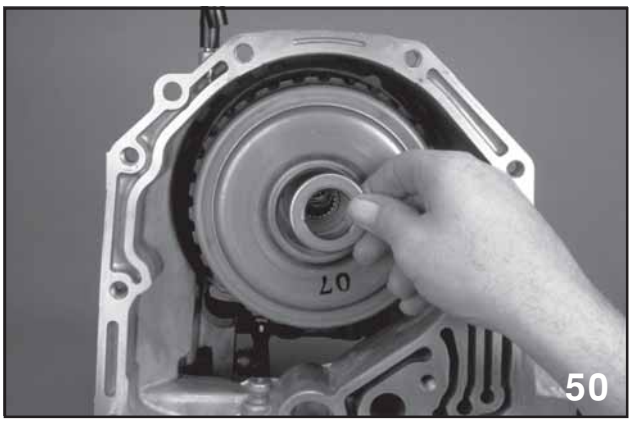


Oil Pump

Use the stator support as a handle and remove the pump assembly and gasket.

CAUTION: THE THRUST NEEDLE BEARING MAY STICK TO THE PUMP. ENSURE IT IS SET ASIDE AS IT MAY BE USED DURING REASSEMBLE IF THE TOTAL END PLAY REQUIRES THE THICKNESS OF THE NEEDLE BEARING TO BE THE SAME AS THE ORIGINAL.

Remove the High Clutch Drum, Thrust Needle Bearing and the High Clutch Hub.

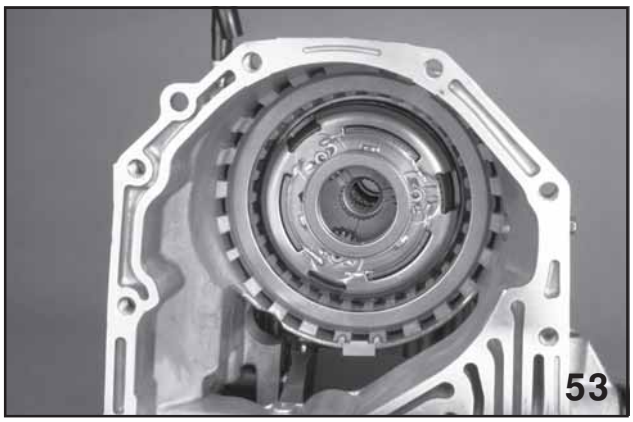


High Clutch

Hub

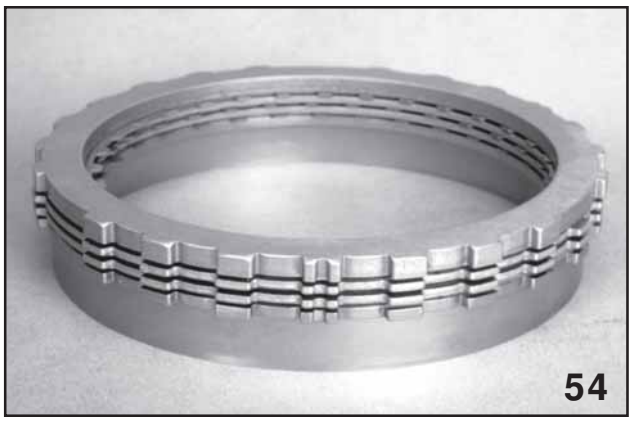
Remove the Thrust Needle Bearing and the front Sun Gear.

Front Sun Gear



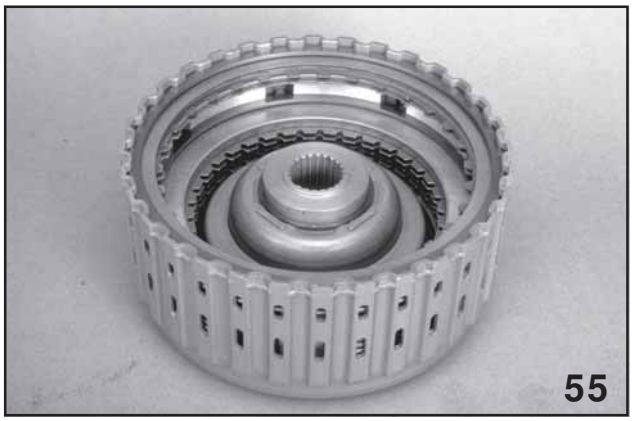
Leaf Spring

Remove the Snap Ring and the drive and driven plates of the 2-4 brake clutch with pressure plate.



2-4 Clutches

NOTE: WHEN INSTALLING THE 2-4 BRAKE CLUTCH, LINE UP THE GROOVES TO ENSURE PROPER LEAF SPRING POSITIONING.



High Clutch

High Clutch Drum and Front Sun Gear

The High Clutch Drum houses the high and reverse clutch. The high clutch is applied in all 3rd and 4th gear ranges. The Reverse clutch is applied in the reverse range only. Position the high clutch with the open end facing upward. The lower positioned clutch assembly is the high clutch. The wide end of the High Clutch Hub engages with these drive and driven plates while the smaller end of the High Clutch Hub engages with the Front Planetary Carrier.

The reverse clutch plates engage with the top section of the front Sun Gear. The lower section of the front Sun Gear engages with the 2-4 brake clutch. Any time the 2-4 brake clutch is applied the front Sun Gear assembly is fixed to the case of the transmission and cannot rotate.

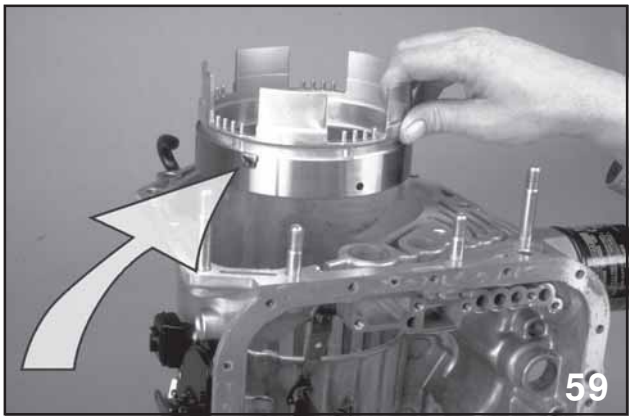
The High Clutch Drum itself is splined to the turbine shaft. When the high clutch is applied the power from the drum is transferred to the rear Sun Gear via the High Clutch Hub and turns the rear planetary carrier.

Remove the Upper Leaf Spring. This device reduces chatter and vibration. Carefully observe its location.

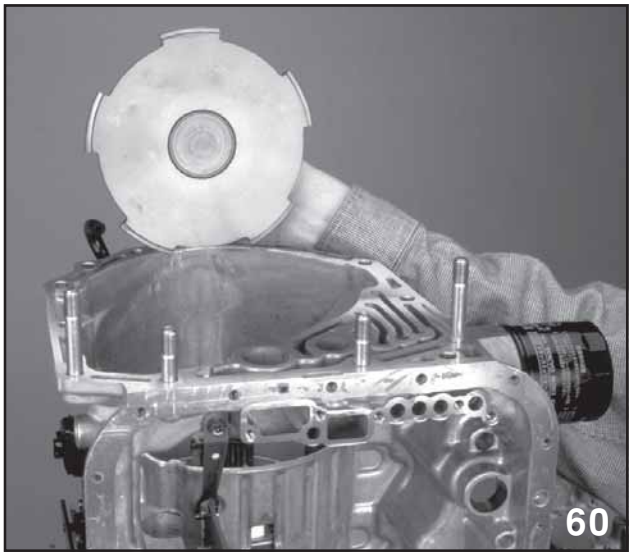
Leaf Spring

Planetary

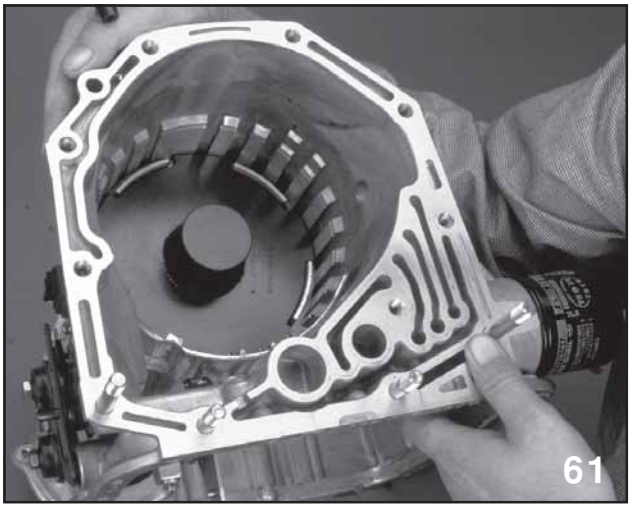
Remove the planetary assemble as a unit. Followed by the Snap Ring and Spring Retainer of the 2-4 Brake Piston. Observe the location of the 2-4 locating lug of the 2-4 Brake Piston so that it is properly positioned during reassembly.



2-4 Brake Piston



Tool Usage



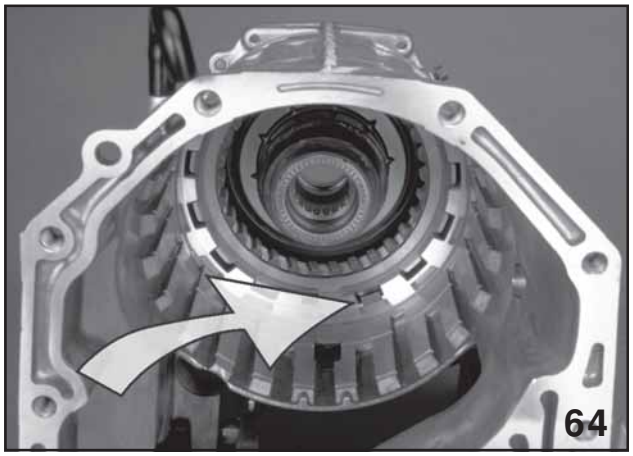
Tool Usage

During reassembly, the installation of the Snap Ring of the 2-4 brake Spring Retainer requires the use of a special tool. Carefully position the Snap Ring over the retainer and place the special tool on top of the Snap Ring. Apply steady, firm pressure until you hear the Snap Ring fully seat. Remove the tool and check that the Snap Ring is fully seated.

Using both hands, remove the 2-4 Brake Piston. It may be necessary to provide a wobbling motion to expedite its removal. The piston retainer may come out with the piston. If it does not, remove it at this time.

2-4 Brake Piston

Spring Retainer



Leaf Spring

Remove the Lower Leaf Spring followed by the Snap Ring and Low and Reverse Brake Clutch. Observe the orientation of the Dish Plate so it is properly positioned during reassemble.

Valve Body with Seal Pipe

The Seal Pipe carries pressure from the valve body to the 2-4 Brake Clutch Piston Retainer.

One-Way Clutch Inner Race

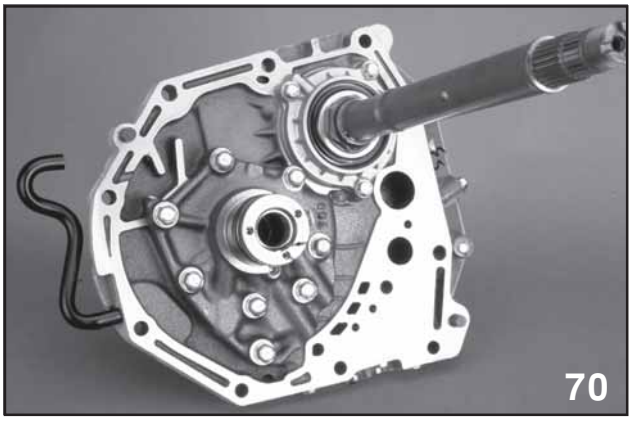
One-Way Clutch Outside Bolts

Remove the Thrust Needle Bearing from the machined surface of the one way clutch inner race. Reposition the transmission case horizontally and remove the bolts that secure the one way inner race to the transmission case. Carefully remove the inner race from the transmission.

Wave Washer

Piston and Seal

Also remove the Spring Retainer, Wave Washer and the Low and Reverse Brake Piston.



Oil Pump

Oil Pump Inner

Servicing the Oil Pump

Remove the seven bolts from the Oil Pump Cover. Lift the cover off and inspect the inner and outer rotor for damage. Check for wear, seizing, and deformation of parts and clogged or dirty oil passages.
Measure the clearance between the inner and outer rotor.

Standard value 0.02-0.15 mm

Measure the side clearance of the inner and outer rotor.

Standard value 0.02-0.04 mm

If the side clearance is beyond specifications replace the rotors as a set. Choose the thickness of the set that will place the side clearance within specifications.

Parts number	Thickness
15008AA060	11.37-11.38
15008AA070	11.38-11.39
15008AA080	11.39-11.40

Line the dowel pins of the oil pump housing with the alignment holes of oil pump cover and set the cover into place. Torque the bolts to the proper specifications.

CAUTION: THE COVER MUST SIT FLUSH ON THE PUMP BEFORE IT IS TIGHTENED. FAILURE TO DO THIS WILL RESULT IN A CRACKED PUMP AND OR COVER.

NOTE: WHEN INSTALLING NEW FRICTION PLATES SOAK THEM IN AUTOMATIC TRANSMISSION FLUID FOR AT LEAST 2 HOURS BEFORE INSTALLATION.

High Clutch

Tool Usage

Servicing the High and Reverse Clutch

Remove the Snap Ring from the open end of the High Clutch Drum.

Caution: the Retaining Plate of the High Clutch is directional. Observe how it is positioned so it is properly placed during reassemble.

Caution: the Dish Plate is directional. Observe how it is positioned so it is properly placed during reassemble. Remove the drive and driven plates.

Remove the Snap Ring and the Drive and Driven Plates of the Reverse Clutch.

Position the High Clutch Drum with the open-end facing upward on suitable press plates. Carefully position the compressor and seat against the High Clutch Spring Retainer. Apply slow steady pressure until there is enough room to remove the Snap Ring. Slowly release the pressure ensuring the Spring Retainer does not move to one side partially engaging with the Snap Ring groove.

Remove the Spring Retainer, spring, High Clutch Piston and Reverse Clutch Piston.

Reassemble parts in reverse order of disassembly. Check the operation of the high and reverse clutch by applying air pressure to the their pressure ports.

Check for proper clearance between the Snap Ring and Retaining Plate of each clutch assembly.

If the clearance is beyond specifications replace the Retaining Plate with one that will provide the proper clearance.

Retaining Plate		Retaining Plate	
High Clutch	Thickness	Reverse Clutch	Thickness
31567AA710	4.7	31567AA750	3.8
31567AA720	4.8	31567AA760	4.0
31567AA740	5.0	31567AA780	4.4
31567AA730	4.9	31567AA770	4.2
31567AA670	5.1	31567AA790	4.6
31567AA680	5.2	31567AA800	4.8
31567AA690	5.3	31567AA810	5.0
31567AA700	5.4	31567AA820	5.2

Servicing the Planetary Gear Assembly and Low Clutch

Position the planetary gear assembly with the open end upward. Remove the Snap Ring.

CAUTION: THERE ARE 2 THRUST NEEDLE BEARINGS AND THRUST WASHERS USED IN THIS ASSEMBLE. THEY MAY STICK TO COMPONENTS WHEN THEY ARE REMOVED. USE EXTREME CARE WHEN HANDLING.

Remove the Front Planetary Carrier, Thrust Needle Bearing and rear Sun Gear.

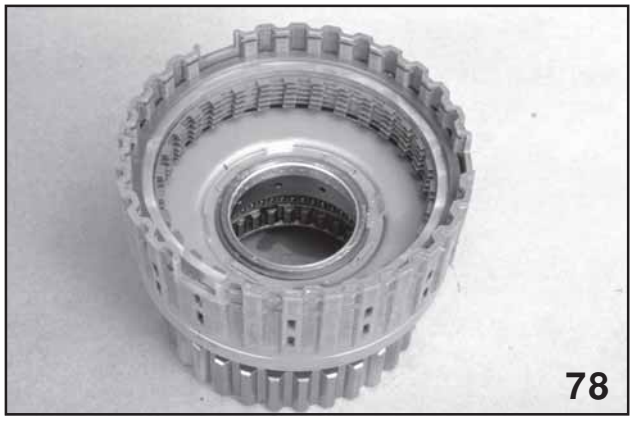
NOTE: ALL BEARINGS, WASHERS, AND GEARS ARE DIRECTIONAL.

Planetary

Front Planetary and Rear Sun Gear

Remove the Rear Planetary Carrier, Thrust Washer, and Thrust Needle Bearing. Remove the Rear internal gear and Thrust Washer.

Rear Planetary

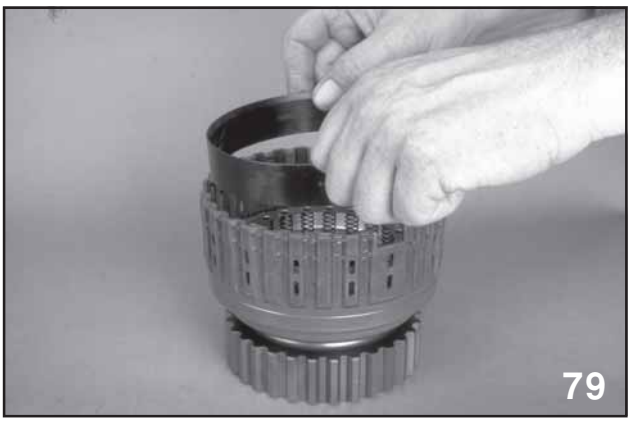


Low Clutch

Remove the Snap Ring and Retaining Plate. Next remove Drive and Driven Plates. **Caution: The Retaining Plate of the Low Clutch is directional**. Observe how it is positioned so it is properly placed during reassemble.

Position the Low Clutch Drum with the open-end facing upward on suitable press plates. Carefully position the compressor and seat against the Low Clutch Spring Retainer. Apply slow steady pressure until there is enough room to remove the Snap Ring. Slowly release the pressure ensuring the Spring Retainer does not move to one side partially engaging with the Snap Ring groove.

Remove the Spring Retainer, Spring, and Low Clutch piston.



Tool Usage

Tool Usage

Reassemble parts in reverse order of disassembly. Use the Low Clutch Spring Retainer guide to help center and maintain the position of the retainer. This prevents the guide from catching on the Snap Ring groove. Check for proper clearance between the Snap Ring and Retaining Plate.

If the clearance is beyond specifications replace the Retaining Plate with one that will provide the proper clearance.

Available Retaining Plates

Part Number	**Thickness**
31567AA830	3.8
31567AA840	4.0
31567AA850	4.2
31567AA860	4.4
31567AA870	4.6

Check the operation of the Low Clutch by placing the one way clutch inner race into the bottom of the Low Clutch Drum and applying air pressure to the pressure port.

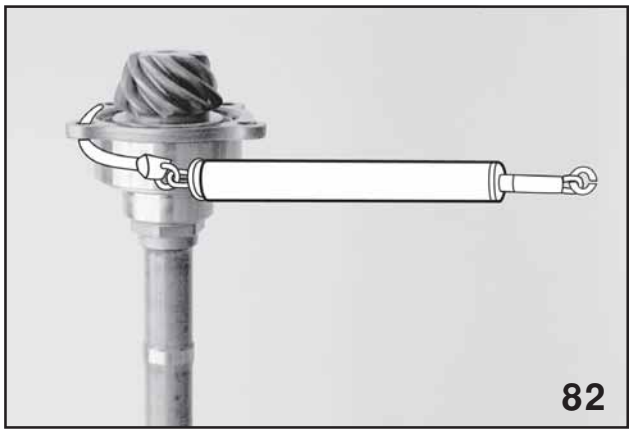
CAUTION: DO NOT PLACE HANDS INSIDE DRUM WHEN AIR CHECKING.

Check the operation of the One Way Clutch at this time. It should **not** allow the Low Clutch Drum to rotate counter clockwise. The Low Clutch is applied in all forward gears except 4th. When applied the Low Clutch locks the rear internal gear to the Low Clutch Drum.

In 1st gear this action initially turns the Low Clutch Drum counterclockwise. However, the One Way Clutch catches the drum and prevents it from turning. The rear internal gear locked to Low Clutch Drum via the Low Clutch now makes the planetary pinions revolve around the rear Sun Gear. This turns the rear planetary carrier, which is connected, to the reduction drive gear assembly.

Pinion Shaft and Differential

Drive Pinion

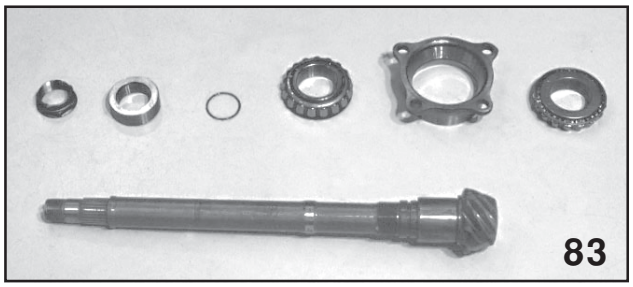


Checking Starting Torque

Prior to disassembling the pinion shaft, verify proper starting torque of the bearings.

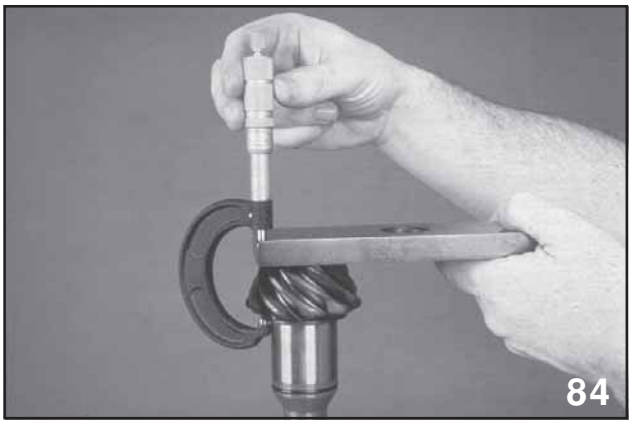
IF THE REPAIR IS FOR OTHER THAN A RING AND PINION LUBRICATION FAILURE THIS SHOULD BE DONE FIRST. SO A NEW BEARING CAN BE ORDERED PRIOR TO REASSEMBLY IF OUT OF SPECIFICATIONS. IF THERE IS A RING AND PINION LUBRICATION FAILURE, YOU WILL MORE THAN LIKELY NEED A NEW BEARING.

IF THE BEARING IS OUT OF SPECIFICATIONS, NEW ROLLER BEARINGS ARE REQUIRED. DO NOT OVERTIGHTEN THE LOCK NOT TO COMPENSATE.



Drive Pinion Assembly

Disassemble the drive pinion shaft and examine the components for gouges, cuts, damage, etc.



Measuring "A"

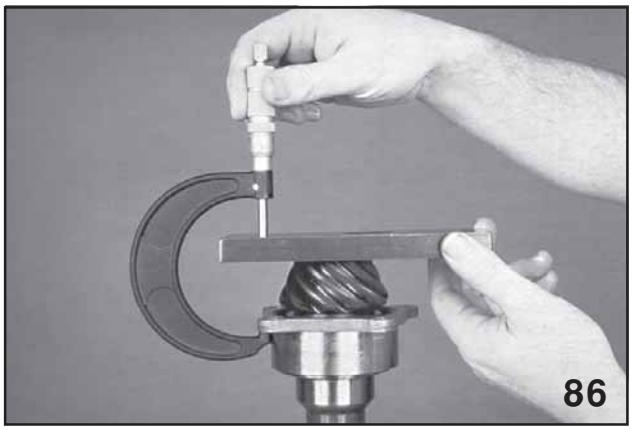
Next, determine the pinion depth. A two step process is used to determine the number of shims and the thickness of the shims.

First, measure the thickness of the pinion gear and record this as measurement “A”.

NOTE: DIMENSION “A” INCLUDES THE THICKNESS OF THE TOOL.

Use of Special Tools

Then install the flange assembly with bearings using a new O-ring and carefully install the collar and washer with a new nut. Make sure the bearings are lubricated and then torque the nut to specifications. Use special tools **#499787100** Wrench and **#498937100** Holder. Be sure to stake the new lock nut in place.



Measuring "B"

For the second step of the pinion depth measurement, the combined thickness of the flange and pinion must be determined. Record this as measurement “B”.

Perform the following calculation in order to determine the shim thickness (t) in millimeters.

FORMULA: t = 6.50 ± 0.0125 - (B - A)

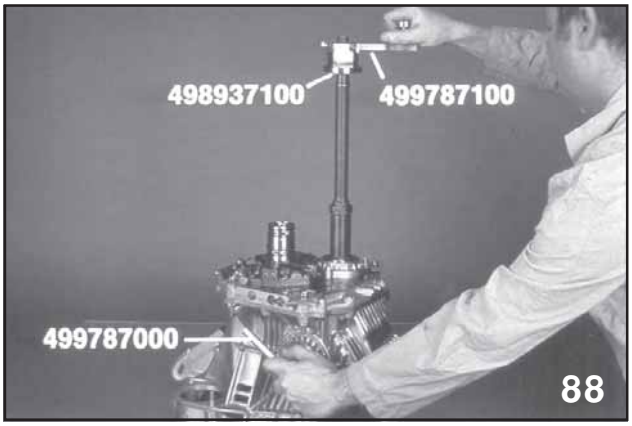
- t = Thickness of drive pinion shim(s)
- 6.50 ± 0.0125 = Ideal distance of pinion protrusion from oil pump housing
- B = Thickness of pinion and flange
- A = Thickness of pinion **87**

Pinion Depth Formula

Finally, mount the pinion to the housing using the selected shim(s). See Service information on STIS.

Install the differential carrier into the torque converter case. Insert the stub axle shafts using new snap rings and check axle shaft end play. Wrap the stub axles with vinyl tape and install the carrier bearing retainers. Screw in the right retainer further tan the left retainer. This prevents potential damage to the ring and pinion. Install the pinion shaft into the oil pump housing with the shims you have just calculated for your pinion depth. Using four bolts install the oil pump housing onto the torque converter case. Take extra precaution to protect the sealing surface from bolt damage by temporarily installing gasket material under the bolt heads.

NOTE: THE LIP SEAL RETAINER CAN BE INSTALLED BEFORE OR AFTER PREFORMING THE BACKLASH ADJUSTMENT. CHECK THE ORIENTATION OF THE LIP SEALS AND USE THE SPECIAL TOOL #4992457300 TO INSTALL IT AT THE CORRECT DEPTH.



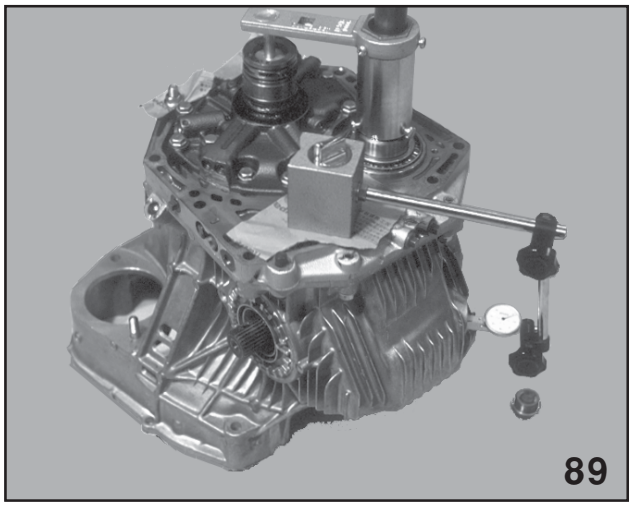
Zero State

Next, rotate the pinion several times using the following special tools:

- **#499787100** Wrench
- **#498937100** Holder

In order to set the pre-load, the “zero” state must be established first. Tighten the LH retainer and loosen the RH retainer until contact is felt while rotating the shaft. Repeat this process several times to confirm the point at which the contact is felt. This is the “zero” state.

After the “zero” state is established, back off the LH retainer 3 notches and secure it with the locking tab. Then back off the RH retainer and retighten until it stops. Repeat this procedure several times. Tighten the RH retainer 1 3/4 notches further. This sets the pre-load. Finally, secure the retainer with its locking tab.



Checking Backlash

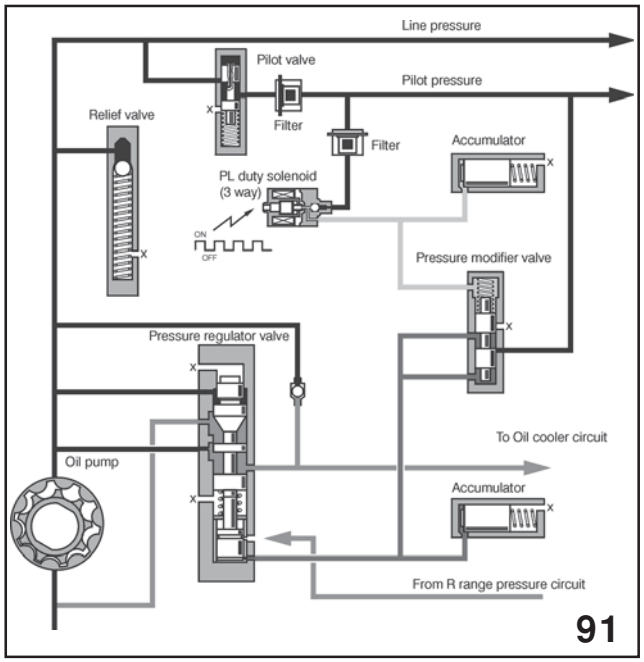
In order to check the backlash; mount a dial indicator securely so that it extends through the drain hole. Then lock the pinion shaft using the special tool #499787100 (Wrench), and check the backlash.

In order to change the backlash; rotate the retainers an equal amount in opposite directions. This maintains the proper pre-load. In order to increase backlash, loosen the LH retainer and tighten the RH retainer. In order to decrease backlash, tighten the LH retainer and loosen the RH retainer. One notch of the retainer equals 0.002 in. or (0.05mm).

Finally, mark the position of the retainers, and remove them so they can be reinstalled with their O-rings. Also reinstall and secure the lock-plates.

Hydraulic Control

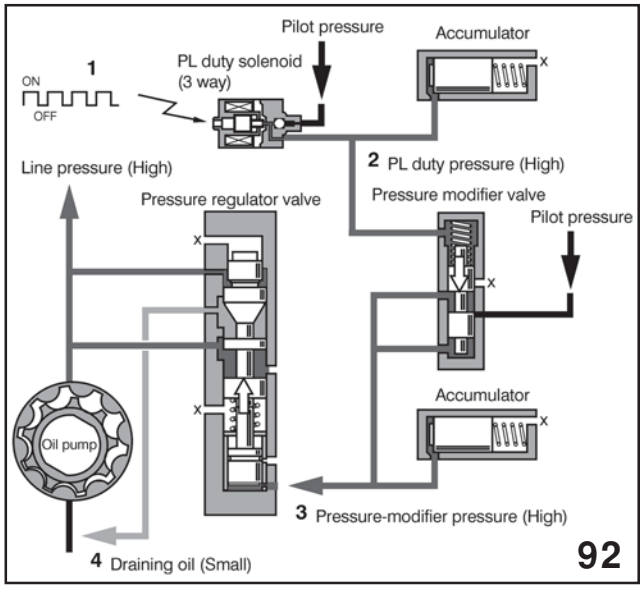
Line Pressure



Artwork Line Pressure

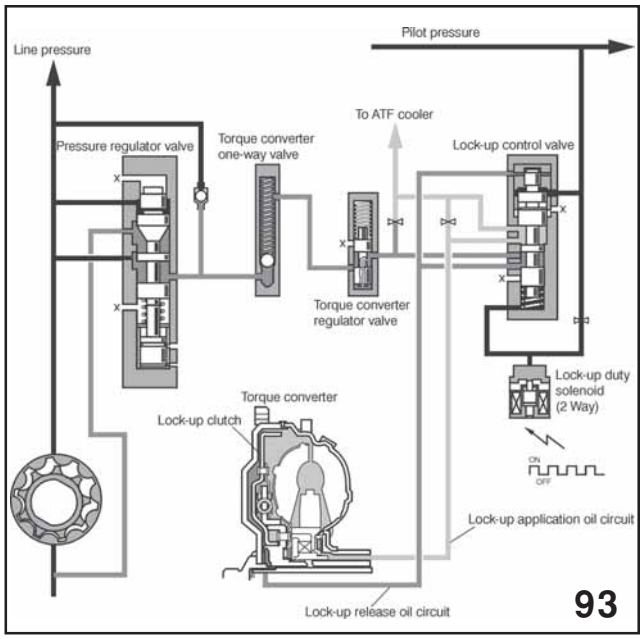
Line pressure provides the force necessary to engage driving and holding members as well as lubricate and cool the transmission. Adjusting the line pressure to various levels reduces the amount of load placed on the engine and minimizes wear on the transmission.

Line pressure is adjusted using data that indicates throttle opening, vehicle speed, and other input signals. Control of the pressure during low load conditions results in a duty ratio, or on verses off time that is large. This duty ratio results in the PL Duty Solenoid staying on more than it is off. Pilot pressure is drained away from the Pressure Modifier Valve. Resulting circuit action lowers the pressure in the lower side of the Pressure Regulator Valve allowing line pressure in the upper side of the valve to push the valve down increasing the amount of pressure drained from the line pressure circuit.



Artwork Line Pressure (Detail)

Control during high load conditions results in a low duty ratio increasing the pressure to the pressure modifier valve. This will result in an increase in pressure to the bottom of the pressure regulator valve creating an upward movement of the pressure regulator valve. Reducing the amount of line pressure drained. The amount of line pressure throughout the transmission will then increase.



Artwork Lock-Up Engagement

Lock up control engages the Lock Up Clutch inside the Torque Converter when traveling in 4th gear under uniform conditions, transmitting engine power directly to the Input Shaft.

Lock up Engagement

1. The TCM increases the duty ratio and the oil drainage rate increases in proportion to the duty ratio.
2. The lock up control valve is pushed down, connecting the torque converter regulator valve port and the lock up application port.
3. Oil pressure from the Torque Converter Regulator Valve is conducted through the application port to the torque converter and the Torque Converter Clutch. The lock up release port ATF is drained through the lockup control valve at this time.
4. The lock up clutch is engaged by the oil pressure from the lock up application port. After the clutch is engaged, the TCM lock up duty solenoid ratio is fixed in the on position.

Lock up Release

1. The Duty Ratio of the Lock up solenoid is adjusted to 5%. Drainage of the duty solenoid oil is stopped and the lock up duty pressure rises.
2. The lock up control valve spool is pushed up, connecting the torque converter regulator valve port and the torque converter release port.
3. Oil pressure from the Torque Converter Regulator Valve is conducted through the release port to the Torque Converter Clutch and the Torque Converter Application Circuit.
4. The Clutch Plate moves away from the Torque Converter Case and the Lock up Clutch is released.

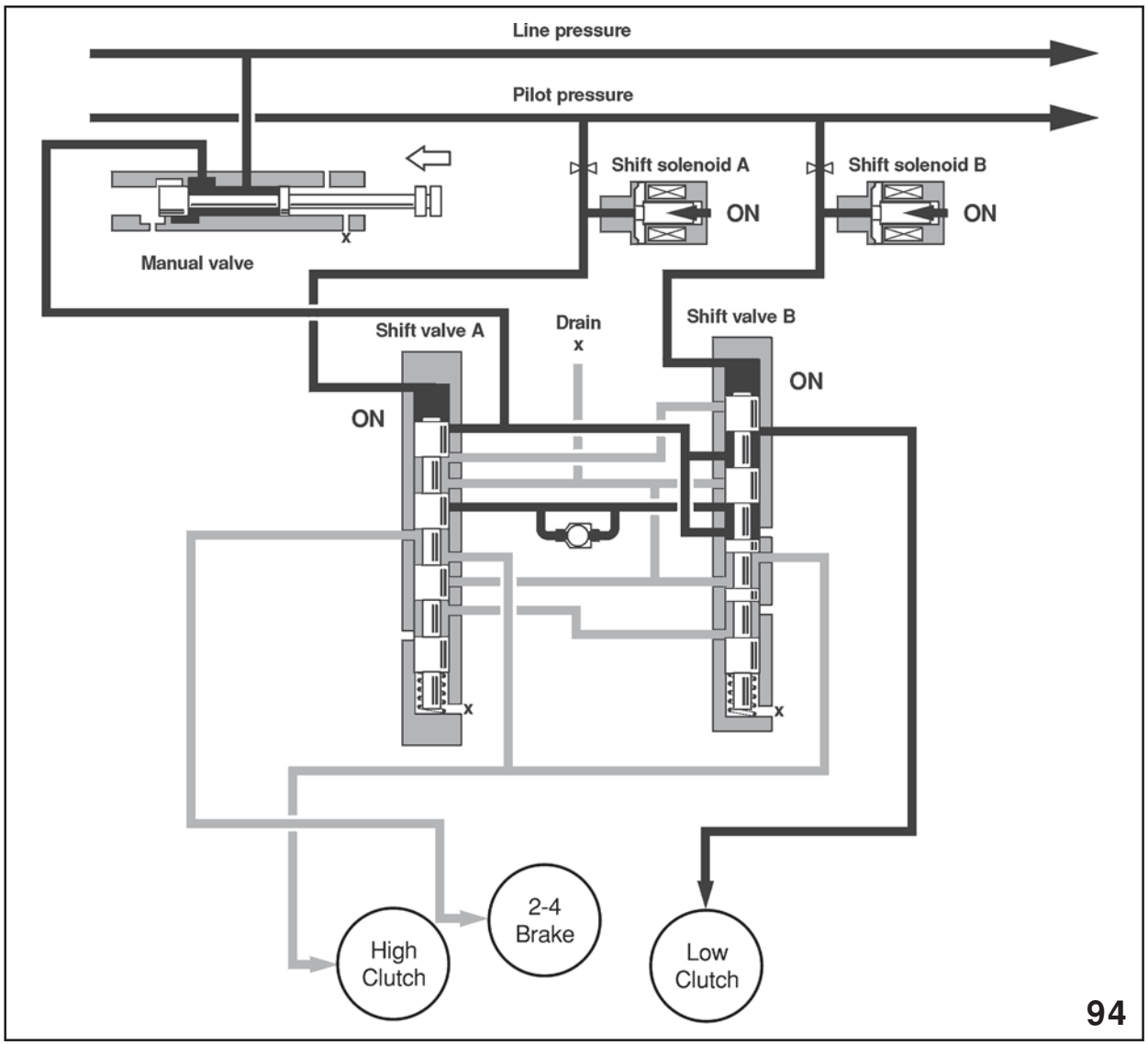
Gear Shift Control

The shift control operates the engagement and release of the Low Clutch, 2-4 Brake, and the High Clutch. TCM output signals control Shift Solenoid A and Shift Solenoid B based on input from vehicle speed and throttle opening.

The solenoids in turn supply or remove pilot pressure from Shift Valve A and Shift Valve B. The positioning of the shift valves route line pressure to the correct clutch and or brake assemblies.

1st gear

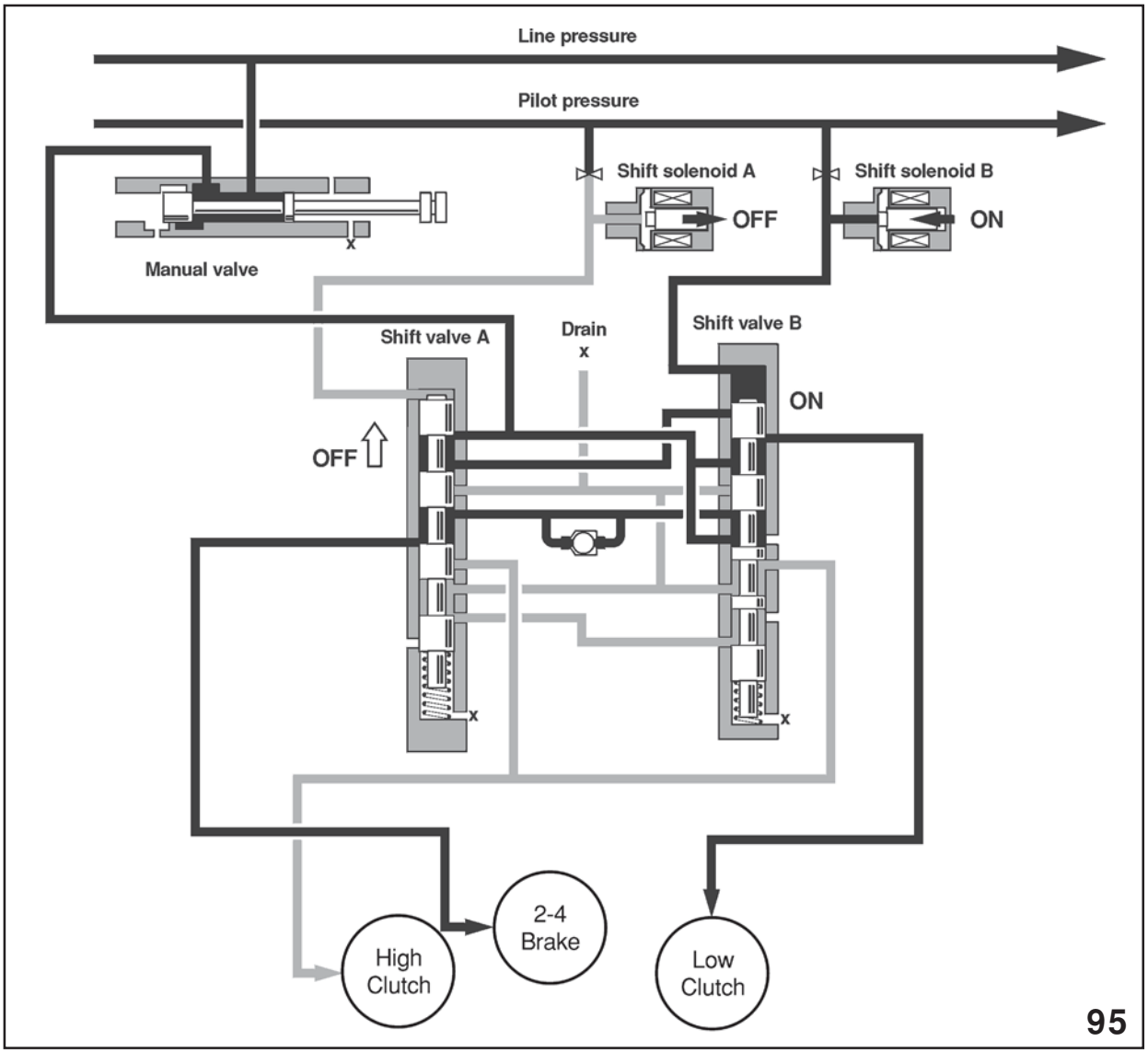
When the selector lever is placed in the D range the manual valve opens the port to the shift valves A and B supplying Line pressure. Shift solenoids A and B are turned on by the TCM and pilot pressure is applied to the top of both Shift Valves. The Shift valves move to the bottom of their bores providing a route for line pressure to the Low Clutch.



Artwork 1st Gear

2nd Gear

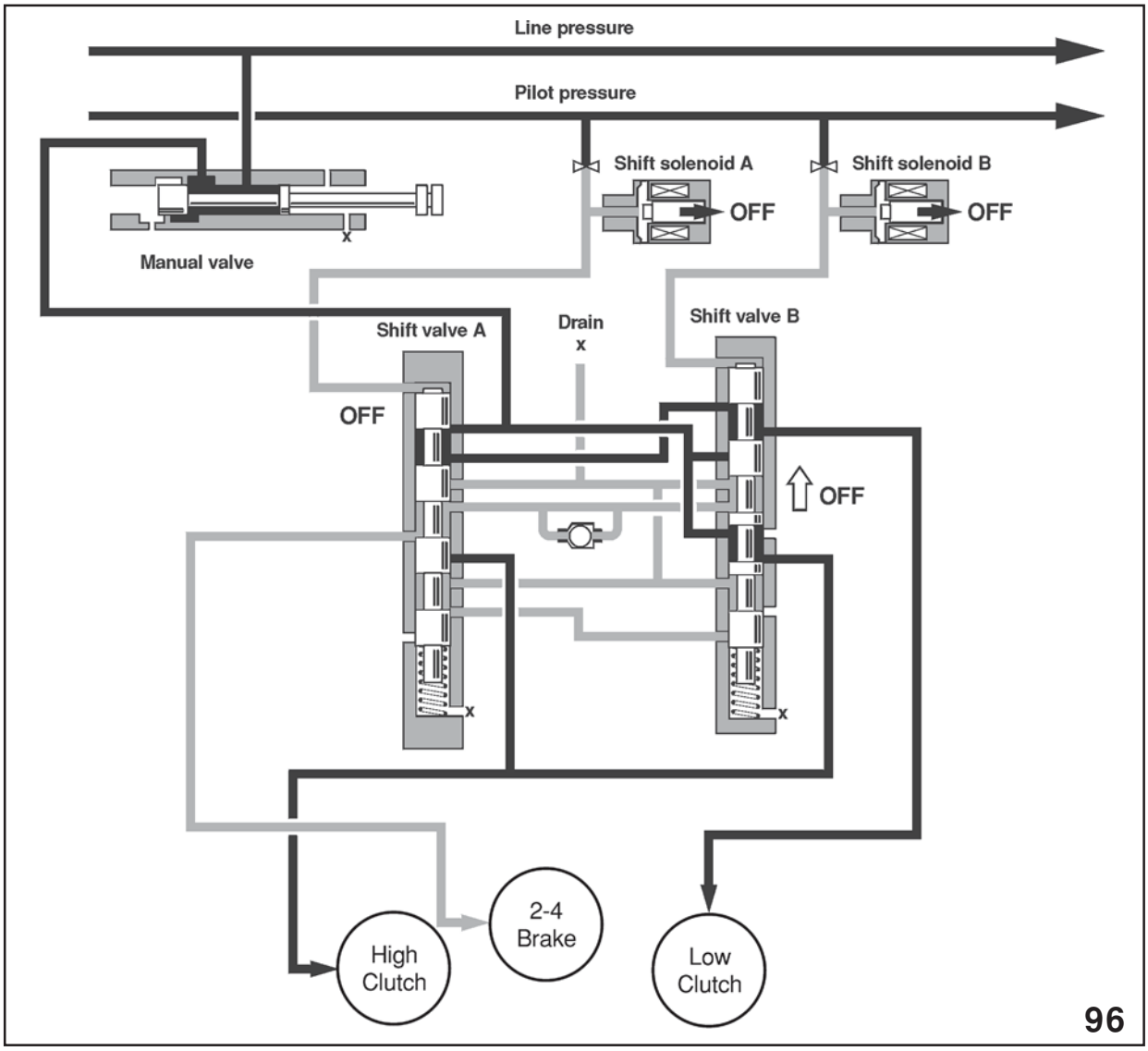
TCM output turns shift solenoid A off and shift solenoid B on. Shift valve A moves upward and opens the 2-4-Brake port. The Low Clutch and 2-4 brake are now applied.



Artwork 2nd Gear

3rd Gear

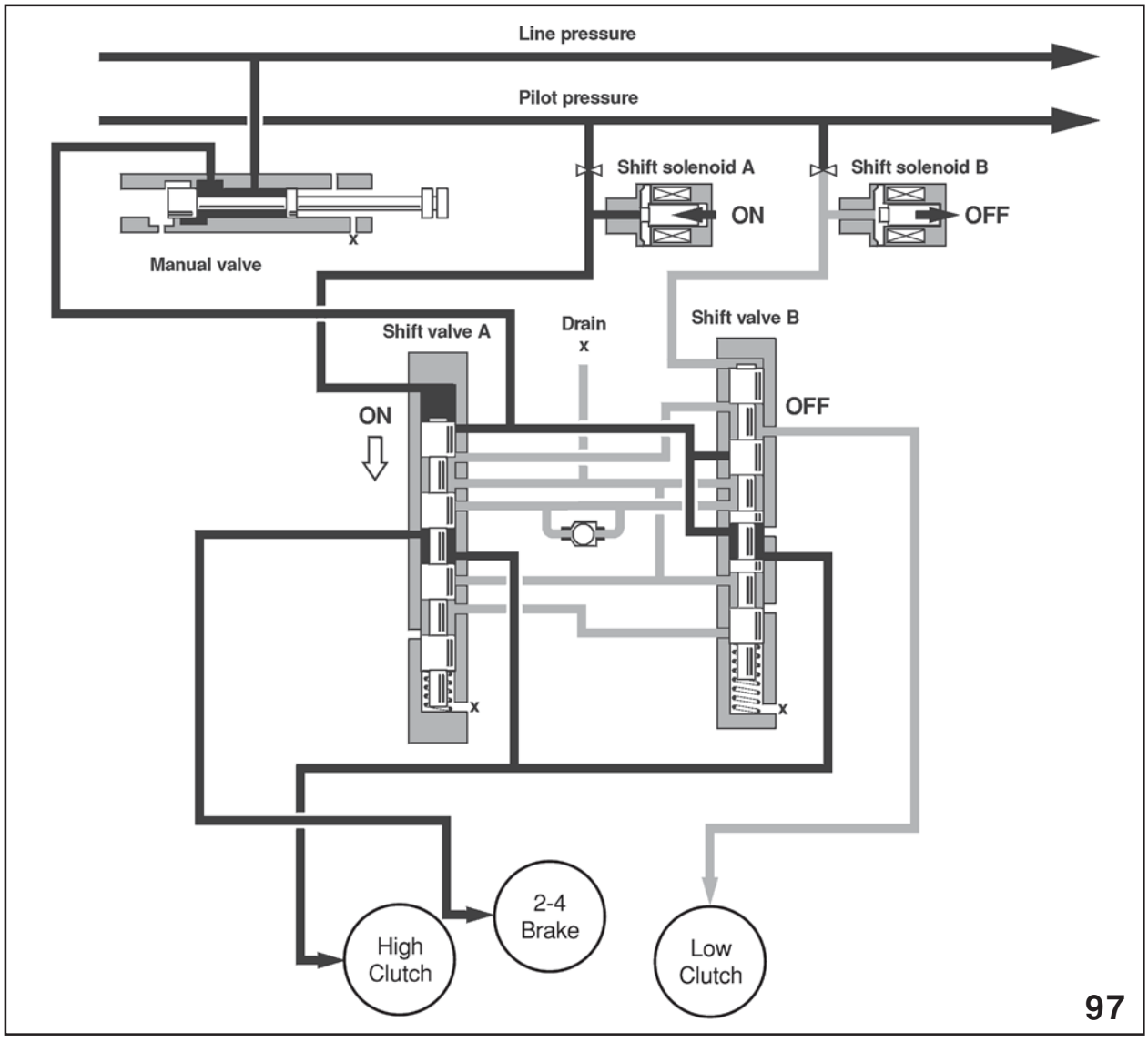
Both solenoids are turned off allowing the pilot pressure supplied to the shift valve to drain. The shift valves move upward allowing line pressure to the Low Clutch and the High Clutch.



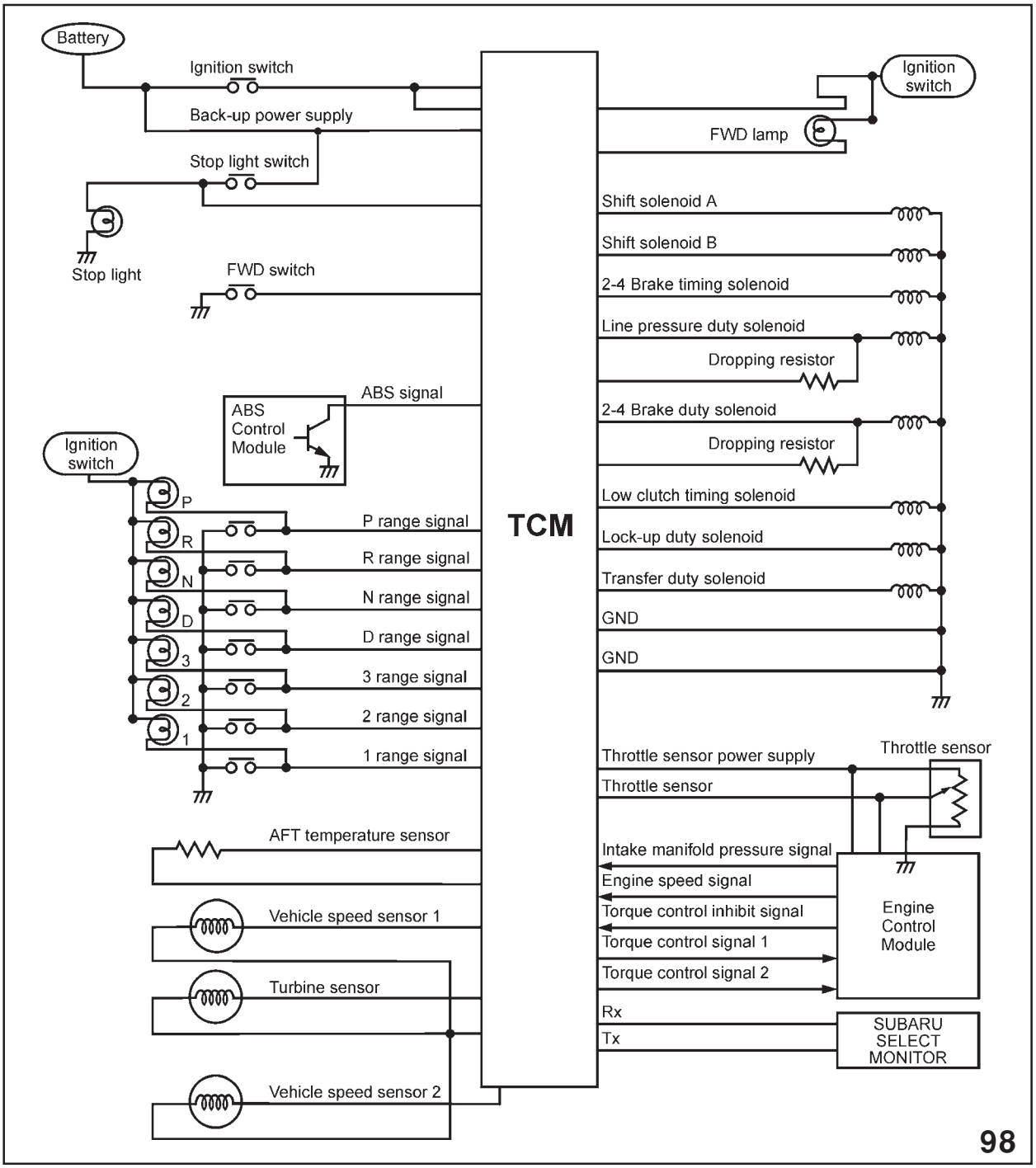
Artwork 3rd Gear

4th Gear

The TCM turns shift solenoid A on and B off. Pilot pressure is supplied to the top of shift valve A which results in the valve moving downward closing the passage for the Low Clutch and opening the passage for the 2-4 brake. The High Clutch and 2-4 brake is now applied.



Artwork 4th Gear



Input / Output Chart

TCM Control

Normal Shifting

The logic for all gear ranges is stored in the TCM memory and is mainly influenced by the throttle opening and vehicle speed. Monitoring of these signals enables the TCM to turn on or off the shift solenoids enabling up and down shifting.

Slope Control

This control regulates shifting up from 3rd to 4th gear when traveling uphill and forcefully downshifts from the 4th to 3rd gear when traveling downhill.

The TCM determines the driving force of the traveling vehicle from input of the speed sensor signals, throttle signal, turbine sensor signal, etc.. and forcefully maintains 3rd gear.

Control at Low Temperature

To prevent shift shock, shifting up to D range 4th gear is not performed when the ATF temperature is below approximately 12 degrees C.

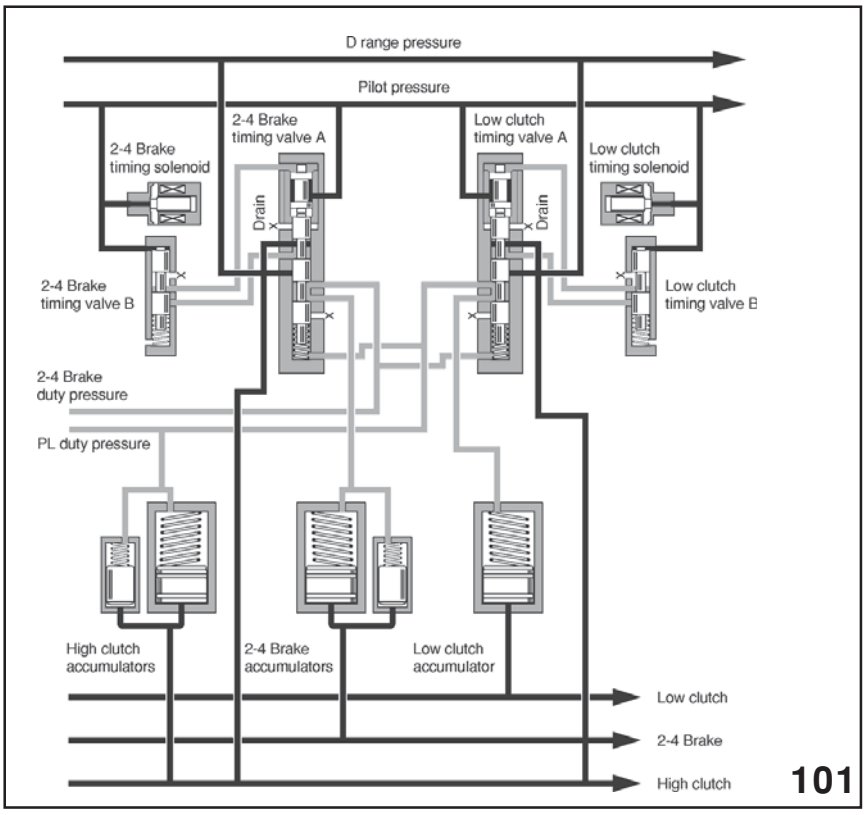
Control During ABS Operation

During ABS operation the TCM forces the transmission to 3rd gear. This allows the ABS control to exhibit its maximum effect.

Engine Over Speed Prevention Control

Engine over speed is controlled by a fuel cut.

Timing Control



Artwork 2-4 Brake Timing

Timing control is designed to prevent shift shock and engine racing. Two types of timing control are used with the new eat. 2-4 brake timing and Low Clutch Timing.

2-4 brake timing is utilized during the upshift from 2nd to 3rd gear. This control temporarily engages both the 2-4 brake and the high clutch, preventing shift shock and engine racing when upshifting from 3rd to 4th gear.

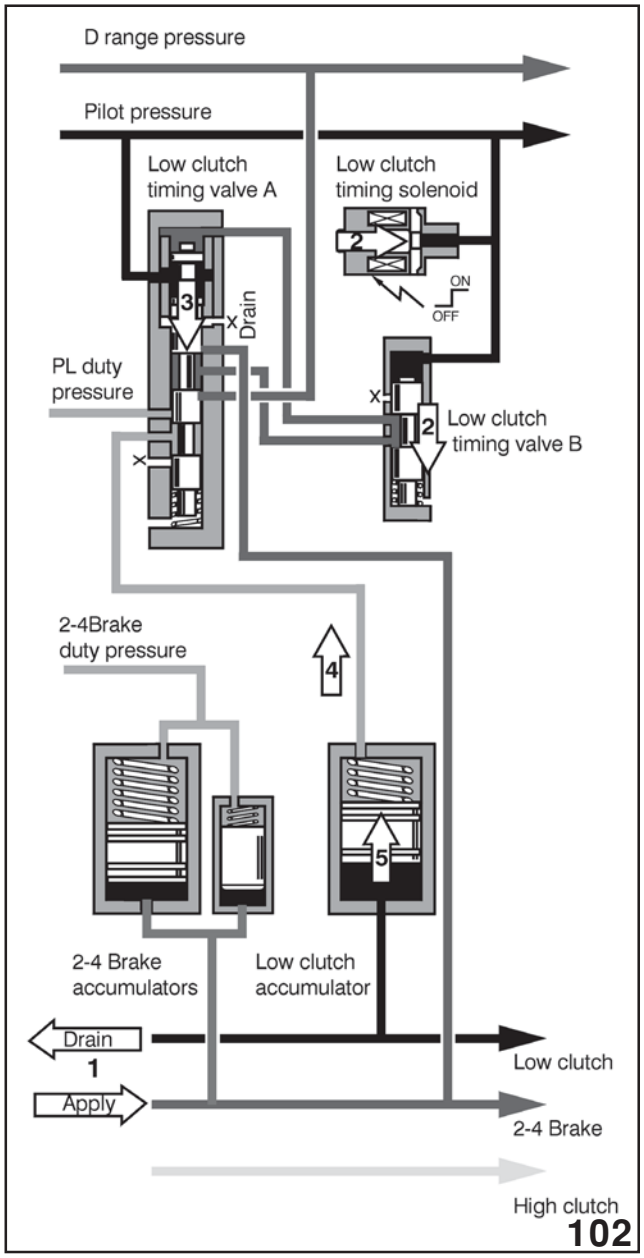
When the TCM turns the 2-4 brake timing solenoid on the 2-4 brake-timing valve A is acted upon by the high clutch pressure.

The 2-4-Brake Timing Valve Spool is pushed down as the high clutch pressure overcomes the set pressure.

The movement of the spool valve changes the draining characteristics of the 2-4 brake accumulators. The faster the back pressure of the accumulators drain the faster the release of the 2-4-Brake Clutch.

Low Clutch Timing

Low Clutch Timing Control is designed to prevent shift shock and engine racing when the transmission is upshifting from 3rd to 4th gear.
During the upshift to 4th gear the 2-4-Brake clutch and the Low Clutch are temporarily engaged together. At the same time the Low Clutch Timing Solenoid is activated controlling the pilot pressure applied to top side of the Low Clutch Timing valve B.



Artwork Low Clutch Timing

The movement of the Low Clutch Timing valve B spool regulates the 2-4 brake apply pressure to the top of Low Clutch Timing valve A. When this pressure overcomes the set pressure the spool valve moves down, changing the draining characteristics of the Low Clutch accumulator back pressure. The faster the back pressure of the accumulator drains the faster the low clutch fully disengages.

Control performed by the PL Duty Solenoid and the 2-4 Brake Duty Solenoid

The line pressure duty solenoid and the 2-4 brake duty solenoid are adjusted to set values determined from preexisting conditions of the vehicle just before an up shift or down shift occurs. This set value is lower than the applied value and is designed to prevent shift shock and improve shifting characteristics.
The drop in both duty pressures cause the accumulator control valve A and B spool valves to move up, and the low clutch and 2-4 brake accumulator back pressures to be reduced.
This allows the accumulators to absorb a larger shock when the clutches are applied.
The turbine sensor detection signal inputted to the TCM influences the rate in which the duty ratios are increased.

Down shifting from 4th to 3rd

The line pressure and 2-4 brake duty solenoid are adjusted to a lower set value just before the actual downshift.
This drops the back pressure in the high and 2-4 brake accumulators. The lowered back pressure allows the applied pressures to be lower, creating a slipping condition of the high and 2-4 brake. Higher engine speeds will then be obtained, generating a higher driving force to the rear internal gear.
The TCM gradually increases the duty ratios eliminating the slip.

Engine Torque Control

Engine torque control is performed by the engine control module which lowers the engine torque by retarding the engine ignition timing and cutting the fuel supply, reducing shift shock.
While shifting is in progress, the TCM detects the brake and clutch engagement \ release conditions by comparing the turbine sensor signal and the speed sensor signals. The TCM outputs a signal to the ECM to reduce the torque when set conditions are reached.

Learning Control

Learning control is utilized to prevent shift shock that is created because of clutch and brake wear.
The TCM always detects the turbine sensor signal after starting shift control. It measures the time from when this signal changes until the clutch or brake starts to engage and the time from that point until the clutch or brake fully engages.
The TCM compares these times and their respective target values and determines the clutch or brake status. Based on the results, it decides the operating characteristics of the line pressure control solenoid and the 2-4 brake duty solenoid. By controlling the line pressure control solenoid and the 2-4-Brake solenoid based on these operating characteristics, increased shift shock due to change with passage of time can be prevented.

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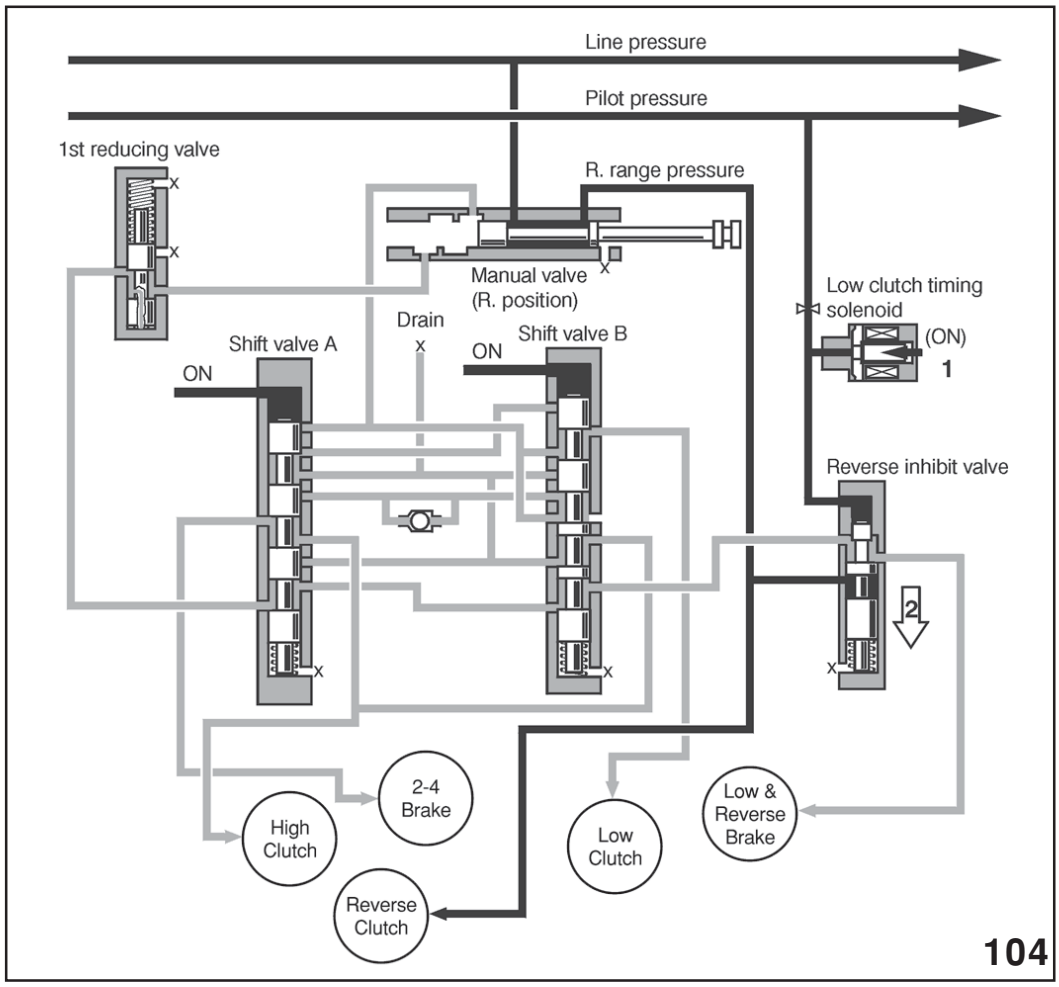
Reverse Inhibit Control

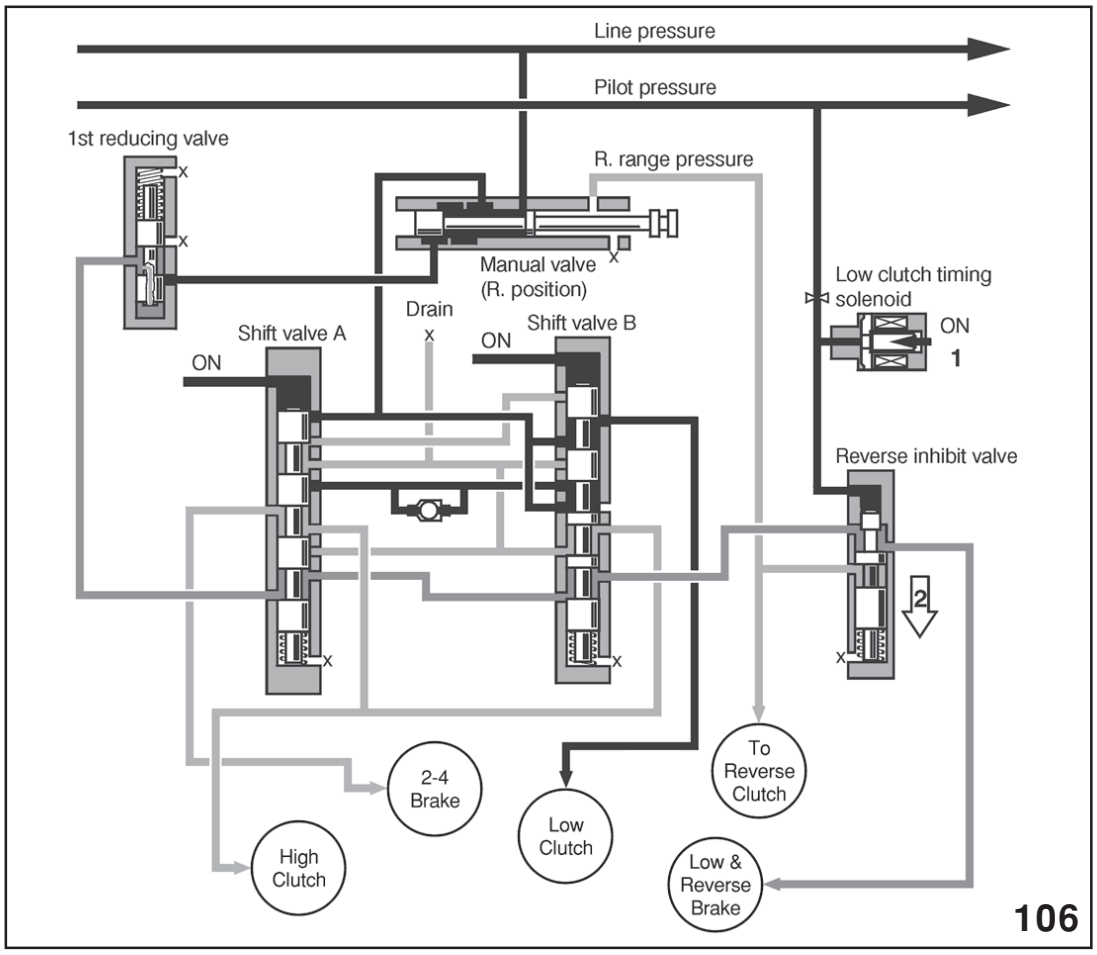
Designed to prevent the accidental shift into reverse gear . This feature is only active above 10km/h (6 m.p.h.). The Low Clutch Timing solenoid is turned on allowing pilot pressure to build up on the top side of the Reverse Inhibit valve. The valve spool is then pushed down blocking the passageway to the low and reverse brake.



Artwork Reverse Inhibit Control

Engine Brake Control

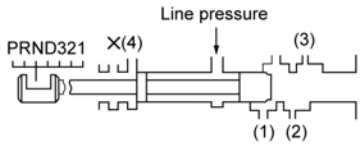
Engine brake operation will occur in the 1 range 1st gear. The TCM turns the Low Clutch Timing Solenoid on and supplies pilot pressure to the reverse inhibit valve. The pilot pressure causes the reverse inhibit valve spool to move downward, opening the port to the low and reverse brake. Pressure from the 1st reducing valve engages the low and reverse brake. The Low Clutch Drum is then fixed to the transmission case and the rotation of the wheels is transmitted to the engine side, operating the engine brake effect.



Artwork Engine Brake Control

The Low Clutch Timing solenoid is turned on allowing pilot pressure to build up on the top side of the Reverse Inhibit valve. The valve spool is then pushed down blocking the passageway to the low and reverse brake.

Hydraulic Control Valve

Name	Function
Pressure regulator valve	Regulates the pressure of ATF delivered from the oil pump to an optimum level (line pressure) corresponding to vehicle running conditions.
Pressure modifier valve	Adjusts the pressure modifier output pressure depending on the driving condition to keep the line pressure at the optimum level.
Pressure modifier accumulator piston	Cushions the pressure modifier valve output pressure to remove pulsation in line pressure.
Line pressure relief valve	Prevents excessive rise of the line pressure.
Manual valve	Allows the line pressure to the circuit corresponding to the selected range. Circuit / Range: P, R ○(4), N, D ○(1), 3 ○(1), 2 ○(1) ○(2), 1 ○(1) ○(2) ○(3)  AT-00473 When the valve is placed in the position allowing the line pressure to go nowhere, the pressure is released.
Pilot valve	Reduces the line pressure to create a constant pressure (pilot pressure) for use in controlling the line pressure, lock-up pressure, and shifting and transfer clutch/ brake pressures.
Torque converter clutch regulator valve	Prevents excessive rise of torque converter clutch pressure.
Lock-up control valve	Engages or disengages the lock-up clutch. Also regulates the lock-up clutch engaging pressure to prevent lock-up shocks.
Shift valve A	Simultaneously changes three different ATF passages using shift solenoid 1 output pressure which varies according to such operating condition factors as vehicle speed and throttle position. In combination with shift valve B, this valve creates 1st, 2nd, 3rd, and 4th speeds.
Shift valve B	Simultaneously changes three different ATF passages using shift solenoid 2 output pressure which varies according to such operating condition factors as vehicle speed and throttle position. In combination with shift valve A, this valve creates 1st, 2nd, 3rd, and 4th speeds.
Low clutch timing valve A	Switches the ATF passages when the 2-4 brake pressure rises to a certain level during 3rd-to-4th upshifting in order to drain the low clutch accumulator back-pressure and to release the low clutch. This ensures smoother shifting.
Low clutch timing valve B	Returns the low clutch timing valve A to the original position after 3rd-to-4th upshifting.
2-4 brake timing valve A	Switches the ATF passages when the high clutch pressure rises to a certain level during 2nd-to-3rd upshifting in order to drain the 2-4 brake accumulator A - and to release the 2-4 brake. This ensures smoother shifting.
2-4 brake timing valve B	Returns the 2-4 brake timing valve A to the original position after 2nd-to-3rd upshifting
Reverse inhibitor valve	Allows the ATF in the low & reverse brake circuit to drain during forward driving at a speed higher than the predetermined value, preventing shifting into the reverse even when R range is selected.

108

Hydraulic Control Valve Chart

Name	Function
1st reducing valve	Reduces the low-reverse brake pressure so as to reduce engine braking shock when changing from the 2nd to the 1st in the 2 range.
Accumulator control valve A	Regulates the accumulator control A pressure (low clutch accumulator A backpressure, high clutch accumulator A back-pressure, 2-4 brake timing control signal pressure) depending upon driving conditions.
Accumulator control valve B	Regulates the accumulator control B pressure (2-4 brake accumulator A back-pressure, low clutch timing control signal pressure) depending upon driving conditions.
Low clutch accumulator	Modulates the low clutch pressure gradually to damp shifting shocks when the low clutch is engaged and disengaged.
2-4 brake accumulator A	Modulates the 2-4 brake clutch pressure gradually to damp shifting shocks when the 2-4 brake clutch is engaged and disengaged.
2-4 brake accumulator B	Slows down the 2-4 brake clutch pressure increase rate during 3rd-to-4th upshifting to prevent timing variation which may occur when the low clutch timing valve A is switched (to damp shifting shocks).
High clutch accumulator A	Modulates the high clutch pressure gradually to damp shifting shocks when the high clutch is engaged and disengaged.
High clutch accumulator B	Slows down the high clutch pressure increase rate during 2nd-to-3rd upshifting to prevent timing variation which may occur when the 2-4 brake clutch timing valve A is switched (to damp shifting shocks).
Throttle accumulator A	Cushions the output pressure of the line pressure duty solenoid valve to remove pulsation.
Throttle accumulator B	Cushions the output pressure of the 2-4 brake duty solenoid valve to remove pulsation.

109

Hydraulic Control Valve Chart (continued)

Direct Control 4-EAT

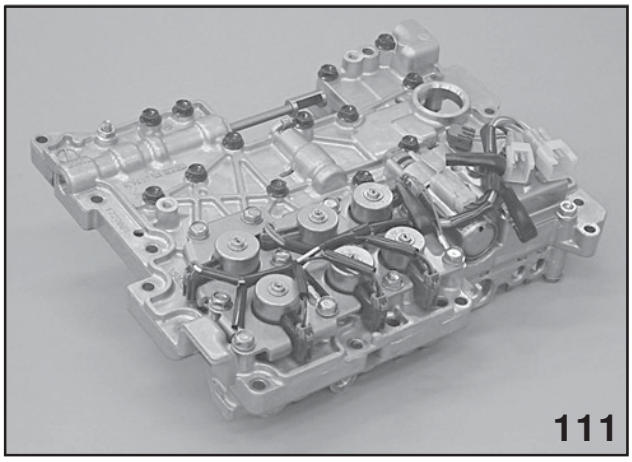
Outline

The Direct control 4EAT has been introduced to further improve the control and feel of forward gear shifting. This new design focuses only on the controlling elements of the transmission. The internal construction of the 4EAT remains the same as the previous model year. There are no accumulators in the new design. Their functions have been replaced with more precise control of the solenoid valves.

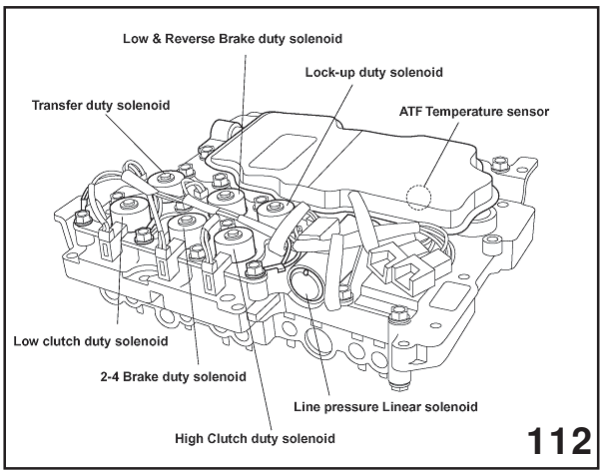
The following is brief explanation of construction and features on the new transmission.

- Accuracy of the hydraulic control is improved by the employment of a new hydraulic valve body assembly.
- The transfer control valve located at the rear end of transmission is relocated inside of hydraulic valve body assembly.
- A hall element sensor is used for the rear wheel speed sensor in order to improve detecting accuracy.

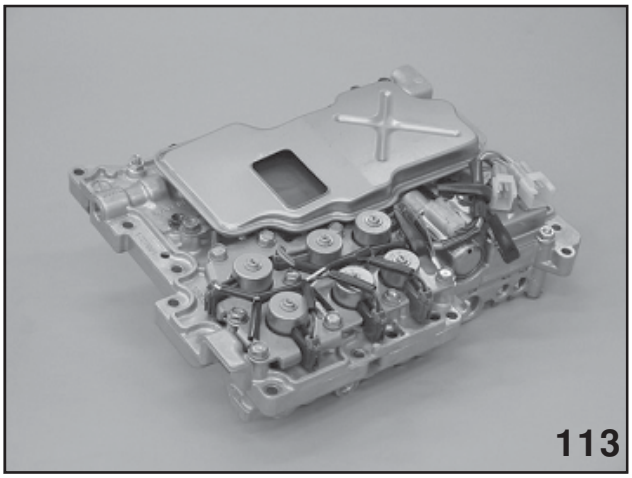
* **Reverse inhibit control method is changed to select lever locking method from hydraulic control method in the reverse inhibit circuit.**



Valve Body



Valve Body Artwork



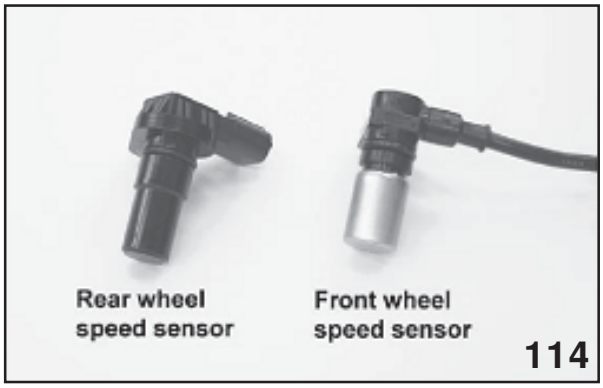
Valve Body Sensor Screen on

Control Valve Assembly

The new valve body assembly consists of a two-piece structure compared to the previous three-piece structure. It has seven solenoid valves and one ATF temperature sensor.

NOTE: VALVE BODY AND SOLENOIDS ARE NOT SERVICEABLE.

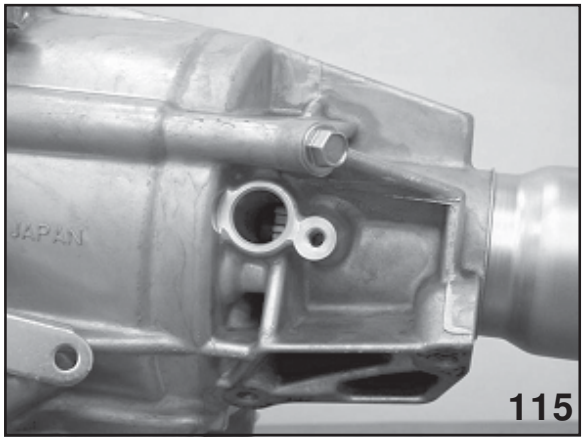
Rear wheel speed sensor



Speed Sensor

A Hall element sensor is used for rear wheel speed sensor. The Shape of the extension case where the sensor is installed has been modified according to the sensor change.

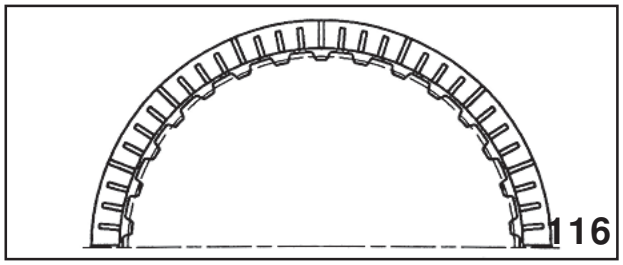
Transmission case



Speed Sensor Mount

The Transfer control valve located at the rear end of transmission has been relocated inside of valve body assembly. According to this modification, the contour of the rear end of transmission case is changed.

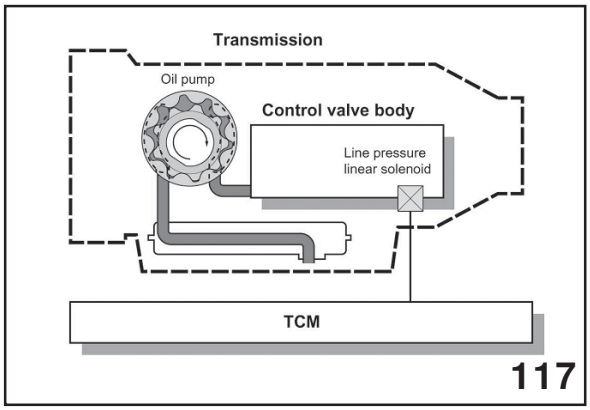
Clutch plate face



Artwork Clutch Plate

Loss-reduction type clutch plates are used to improve clutch release. They are incorporated into 2-4 brake, reverse clutch and low clutch.

Line pressure control



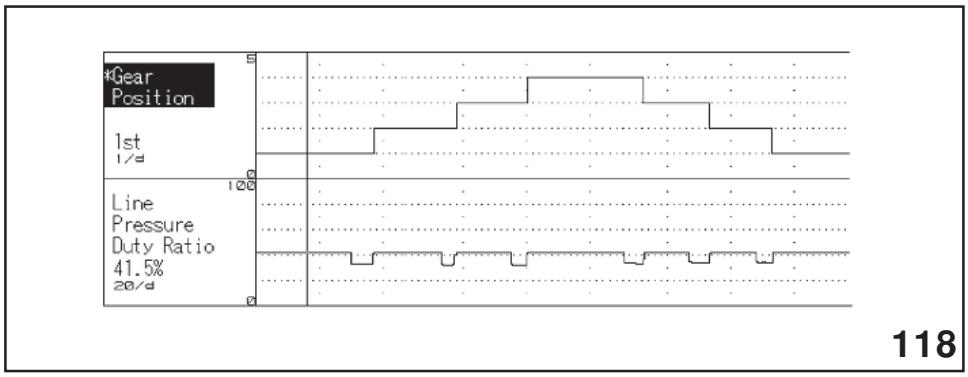
Artwork Line Pressure

The TCM judges driving condition of the vehicle from signals such as throttle opening angle, vehicle speed, gear position and so on, and controls the line pressure linear solenoid so as to become optimum line pressure at that time. The linear solenoid driving signal sent from TCM is 300Hz duty signal. The TCM performs the following line pressure control.

Normal control

Line pressure is controlled according to the throttle opening angle, vehicle speed, and select lever position.

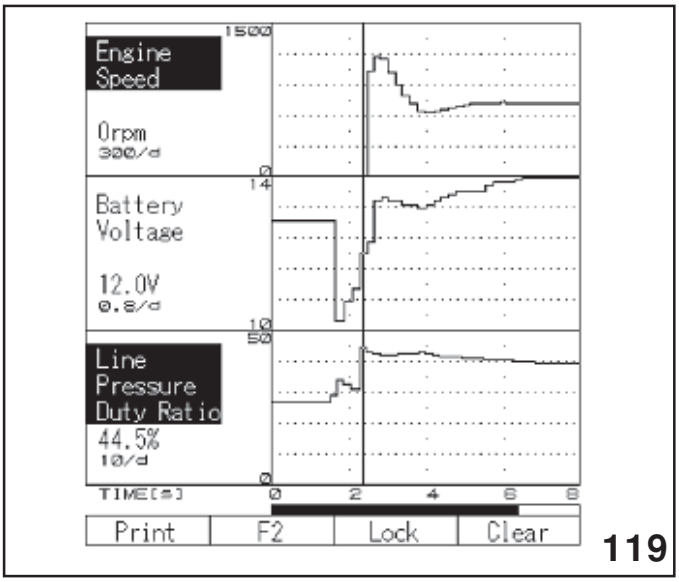
Line Pressure Control at Gear shifting



NSM Graph

Line pressure is controlled in order to reduce shift shock at gear shifting.

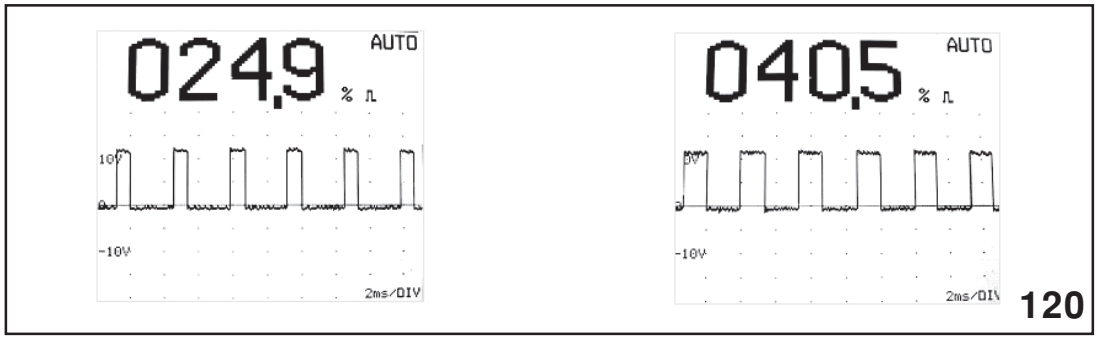
Engine start control



NSM Graph

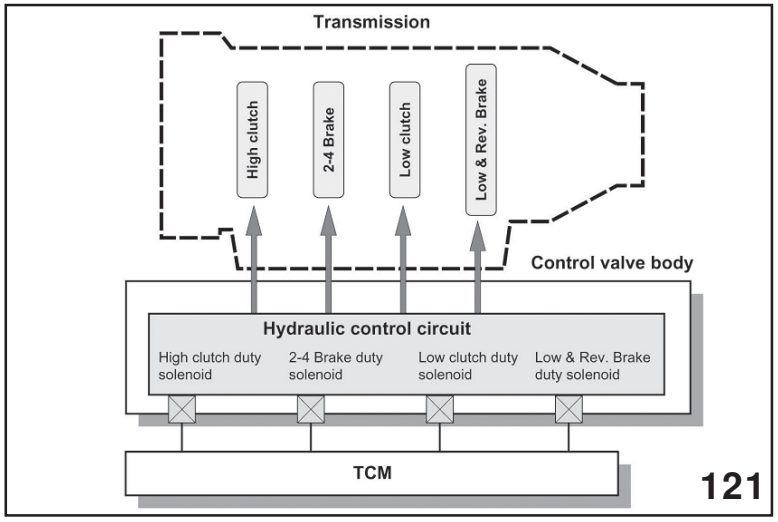
Line pressure is fixed at the minimum pressure for reducing starter motor loads at the engine starting.

Linear solenoid driving signal of TCM



Waveform for Linear Solenoid

Gear shift control



Artwork 4 Solenoid

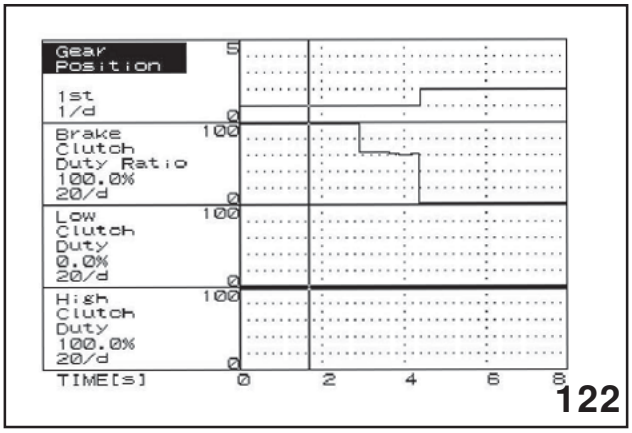
The manual valve and 4 duty solenoid valves, H/C, L/C, 2-4B, and Low & Rev. Brake are involved to carry out gear-shifting.
These solenoid valves control engagement and disengagement of Low clutch, 2-4 Brake, High clutch, and Low & Rev. Brake that are gear-shifting members assembled inside of the transmission, and 1st through 4th gear-shifting is carried out.
Also, these solenoid valves work under a duty control signal and adjust oil pressure variation smoothly when gear-shifting. The accumulators used for previous 4EAT are discontinued by this modification.

NOTE: THE REVERSE SHIFT DOES NOT USE ANY SOLENOID VALVE. OIL PRESSURE FROM THE MANUAL VALVE ENGAGES BOTH REVERSE CLUTCH AND LOW & REV. BRAKE FOR REVERSE SHIFT.

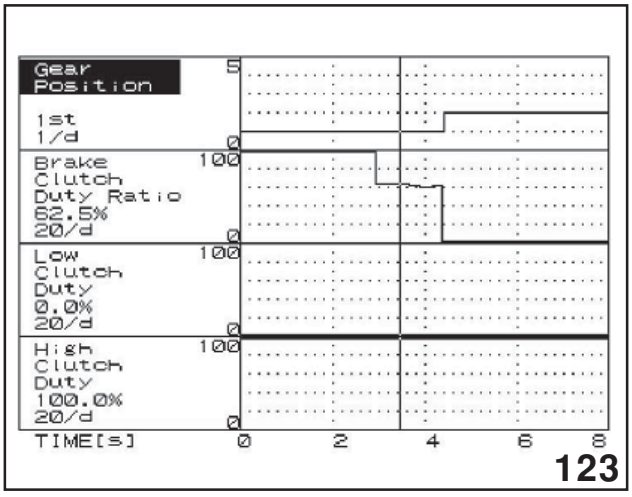
TCM performs the following hydraulic control

Basic control

Gear shifting is carried out according to the gearshift map in response to throttle opening angle signal and vehicle speed signal.

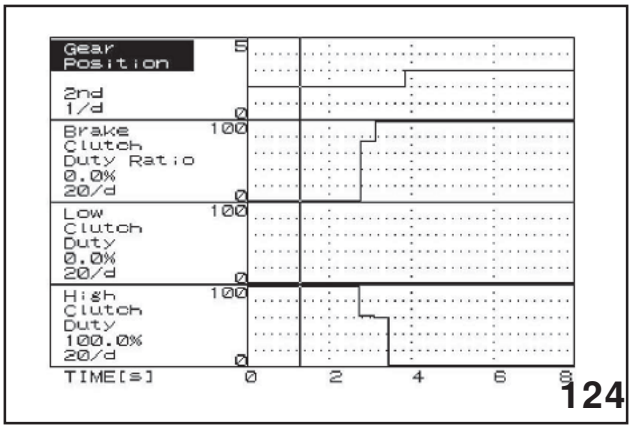


NSM Graph 1st Gear

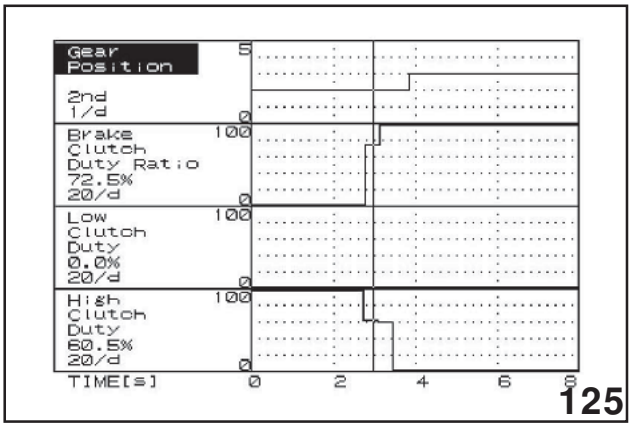


NSM Graph Shift to 2nd

Condition of solenoid valve during gear shifting from 1st to 2nd

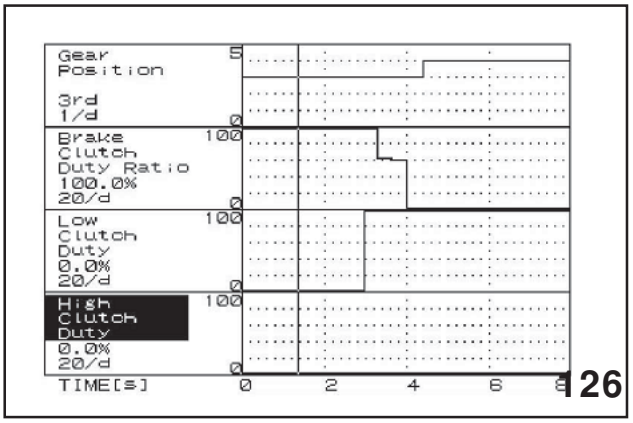


NSM Graph 2nd Gear

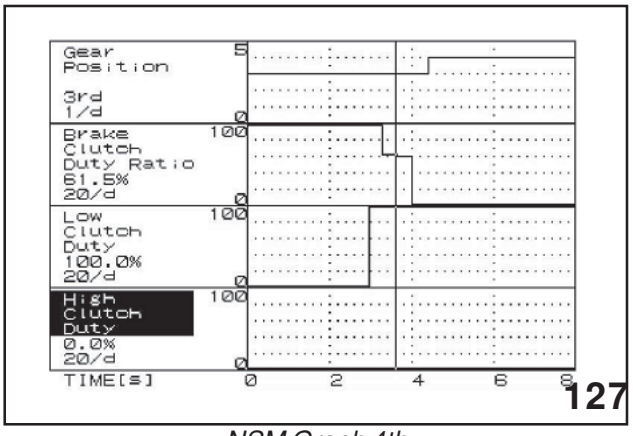


NSM Graph Shift to 3rd Gear

Condition of solenoid valve during gear shifting from 2nd to 3rd



NSM Graph 3rd



NSM Graph 4th

Condition of solenoid valve during gear shifting from 3rd to 4th

ABS in-operation control

When TCM receives ABS operating signal and brake switch ON signal, TCM fixes, in response to the vehicle speed, transmission gear to the one so as to the ABS system can work maximum effect.

Low temperature ATF control

TCM does not allow shifting to the 4th gear when ATF temperature is lower than the predetermined temperature. (about - 10° C and lower)

Hold mode control

TCM performs starting control from 2nd gear when select lever is in the 2nd range.

Engine torque control during gearshift

Control that makes engaging and disengaging of clutch and brake smoothly is carried out with reducing engine torque temporary for a gear shifting.

TCM transmits cooperate control signal to ECM at the start of gear shifting. ECM makes engine torque reduced temporary according to the received signal.

Uphill and down hill control

TCM fixes the gear position to 3rd speed during uphill driving in order to avoid frequent gear shifting between 3rd speed and 4th speed. Also, TCM shifts the gear down to 3rd speed when brake switch is ON during downhill driving at about 80 km/h.

Learning control

Shift shock is apt to occur when a transmission becomes old by reason of a change on standing and/or wear of clutch plates and brake plates, deterioration of ATF and so on.
Learning control reduces shift shock caused by a change of standing.

TCM measures a gear shifting motion time based on the signals from turbine speed sensor, rear wheel speed sensor, engine revolution, ATF temperature and throttle opening* during gear shifting of transmission, and is comparing it with criterion time memorized in the memory. Stable gearshift feeling can be maintained for a long time with adjusting an oil pressure added to the clutches and brakes based on the comparison result.

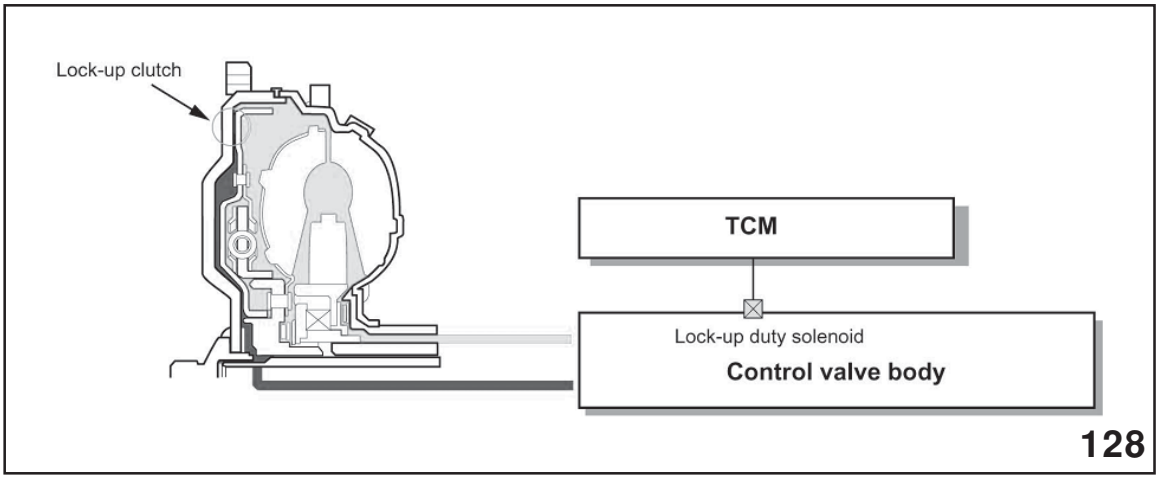
* Engine revolution signal and throttle opening signals are sending by ECM.

Lock-up clutch control

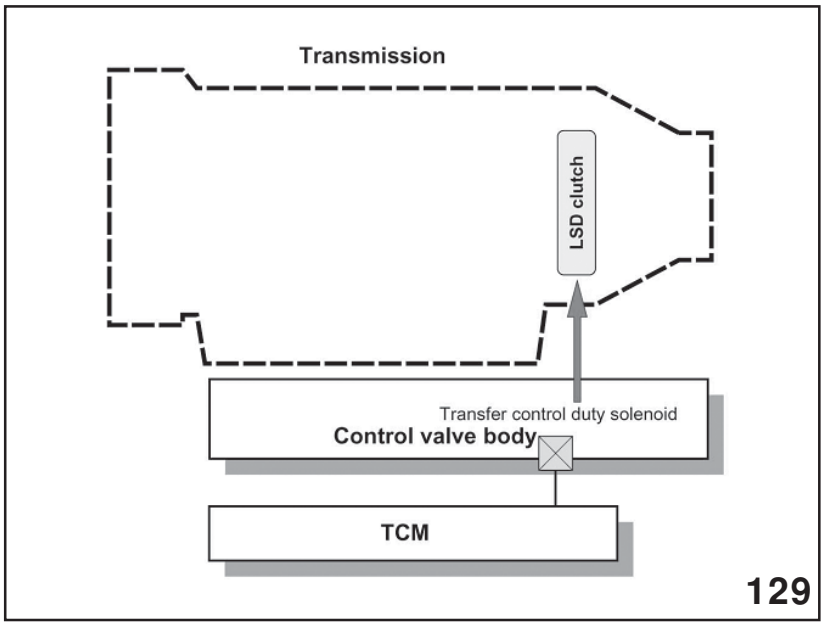
Lock-up control operates beyond a certain vehicle speed with 4th gear driving. TCM is carrying out smooth lock-up control in order to reduce engaging and disengaging shocks of lock-up clutch.

Smooth lock-up control

When vehicle-driving conditions meet the term of lock-up engagement, TCM increases duty ratio of lock-up duty solenoid driving signal gradually, and has lock-up clutch engaged slowly. This process prevents a shock of lock-up clutch engagement.



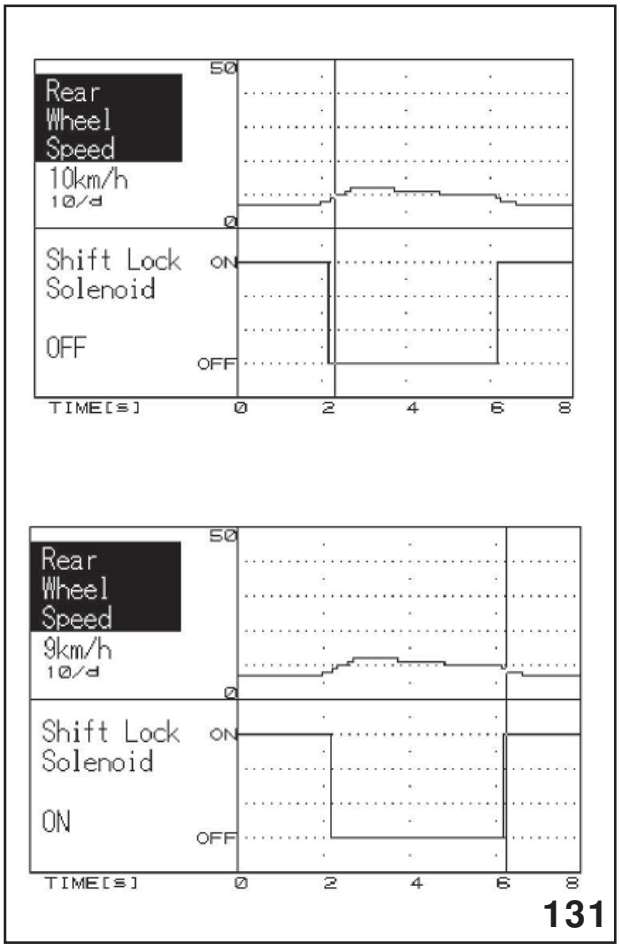
Lock-up Clutch Control



Transfer Clutch Control

Transfer control valve and duty solenoid mounted at the rear end of transmission case of the previous 4-EAT are assembled in the hydraulic control valve assembly in the Direct control 4-EAT.

Reverse Shifting Control



NSM Graph

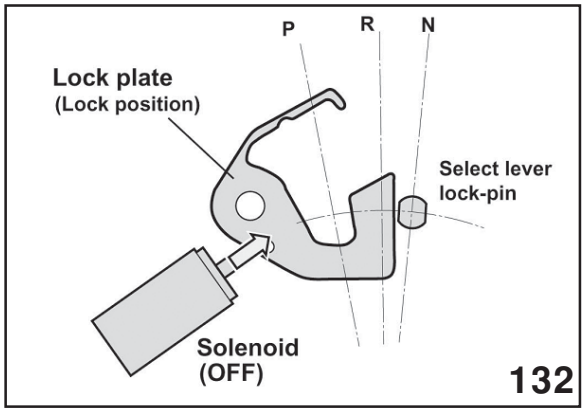
This control works to block gear shifting into R range with select lever at and over a certain vehicle speed during forward driving.

Reverse inhibit control system of previous 4-EAT has the structure that hydraulic circuit in the hydraulic control valve assembly works to prevent gearshift into the reverse position when a driver tries to shift into R range beyond a certain forward driving speed.

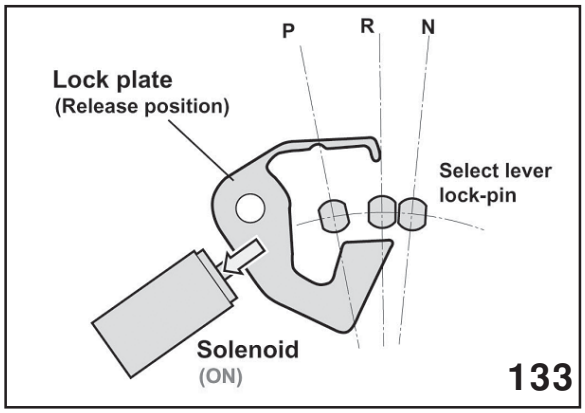
On the direct 4-EAT system, the system is modified to prevent the movement of select lever to R range beyond a certain forward driving speed.

Prevention of the select lever movement to R range is carried out with lock plate assembled at the bottom of the select lever. Since shift lock solenoid is OFF when a vehicle speed is beyond about 10 km/h in forward direction, lock plate moves to lock position, and select lever movement to R range from D range is blocked.

NOTE: WHEN IGNITION SWITCH IS OFF WITH THE RANGE OTHER THAN P, SHIFT LOCK SOLENOID IS TURNED ON BY TCM FOR ABOUT 30 SECONDS AND SELECT LEVER MOVEMENT TO P BECOMES POSSIBLE.



Shift Lock Solenoid Artwork Off



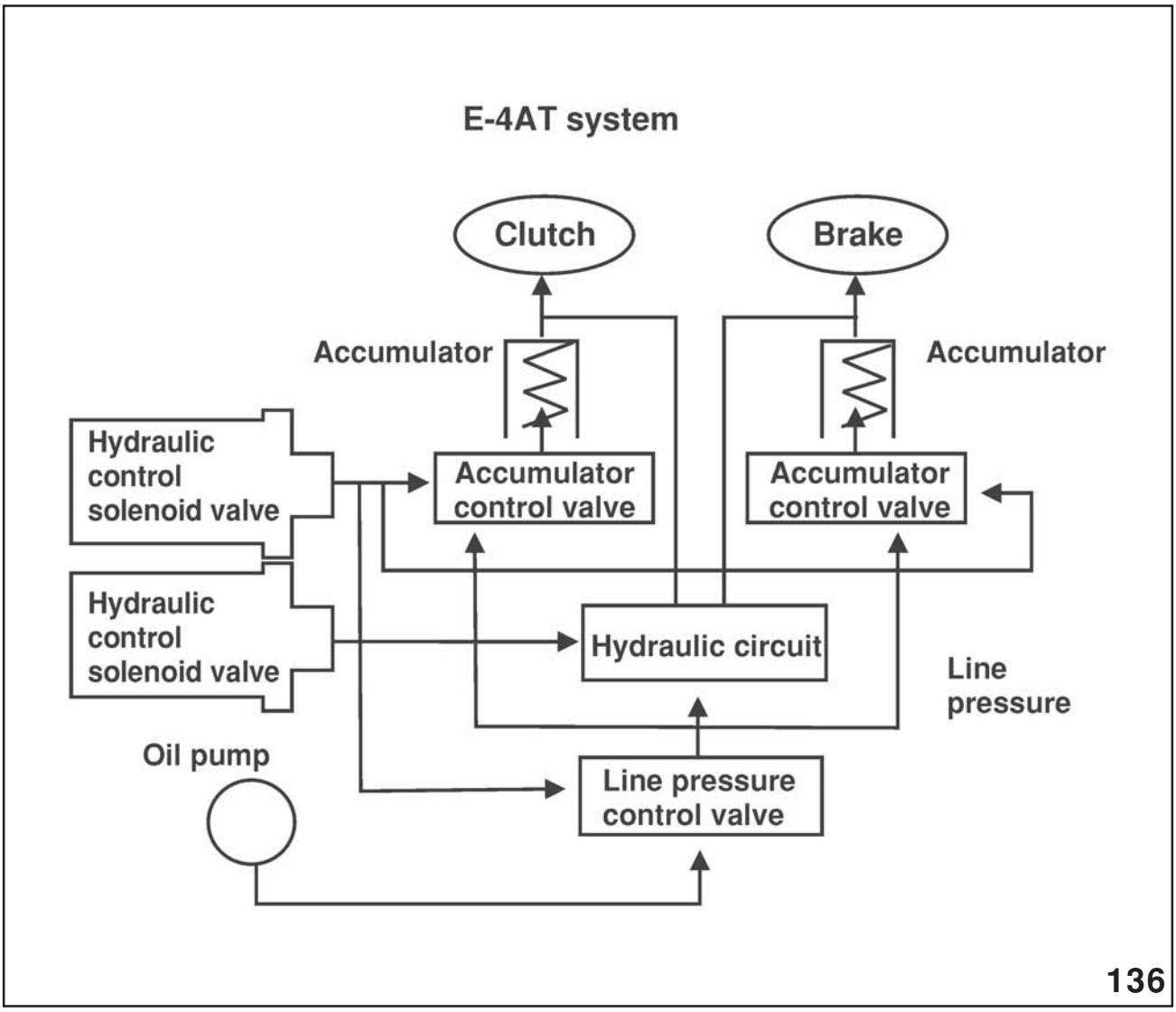
Shift Lock Solenoid Artwork On
Failsafe function

Failsafe Function

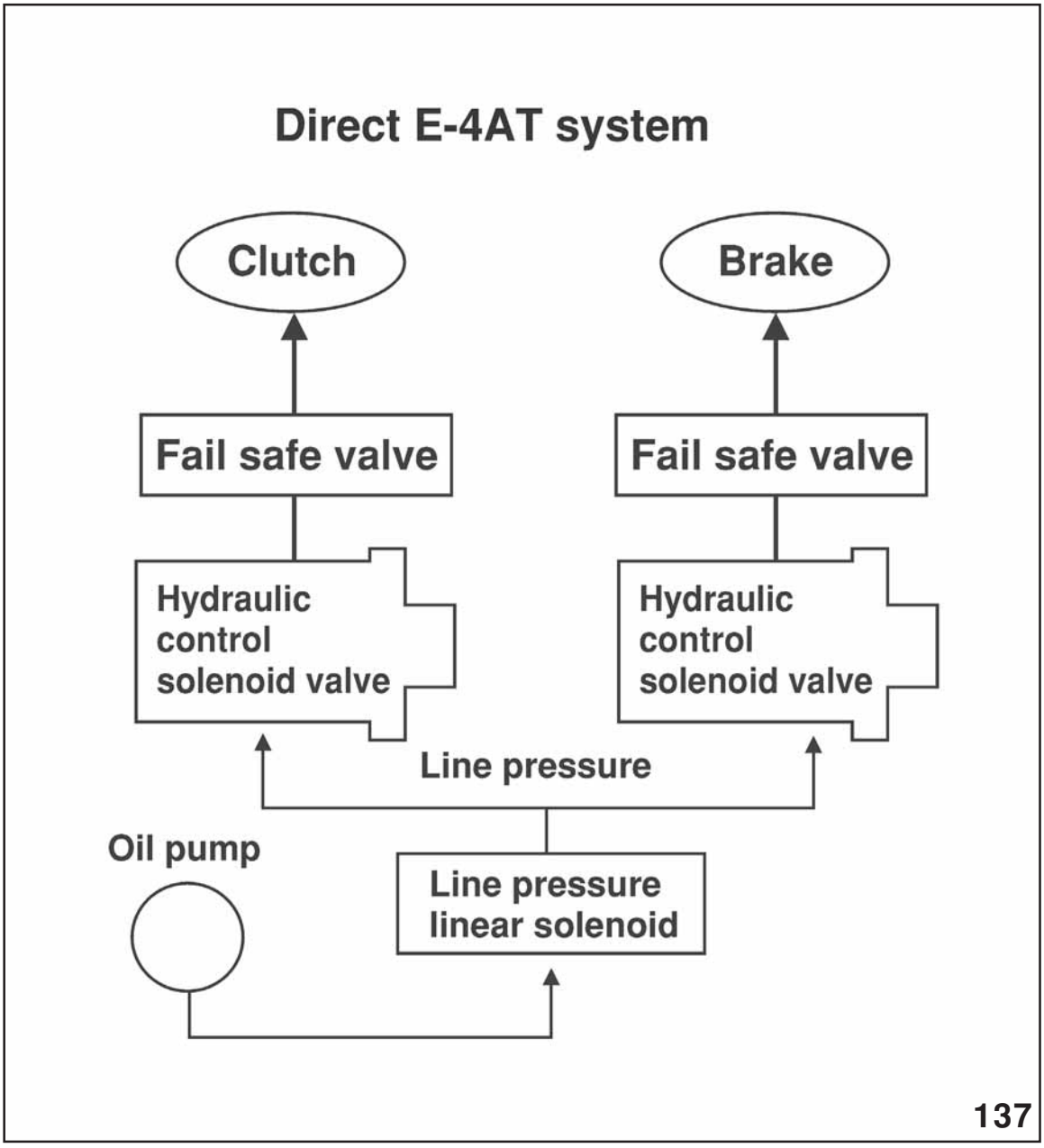
Speed Sensor	When TCM detects a failure in a circuit (open or short?). Front wheel sensor supports rear wheel sensor. (Turbine speed sensor supports from wheel speed sensor further.) Impossible case of support: Transmission gear position is fixed to 3rd speed.
Turbine speed sensor	When TCM detects a failure in a circuit (open or short?). Vehicle speed sensor supports Turbine Sensor.
Throttle position sensor	When TCM detects a failure by the communication with ECM (open or short?). The certain fixed value is used for the control.
Inhibitor switch	Multiple signals from inhibitor switch input into TCM simultaneously, selects shift range by the following order of priority. D.3.2.1.N.P
Line pressure linear solenoid	When TCM detects open or short in a circuit, TCM makes the solenoid OFF. In result, lock-up mechanism is fixed to disengaged condition.
Lock-up duty solenoid	When TCM detects open or short in a circuit, TCM makes the solenoid OFF. In results, lock-up mechanism is fixed to disengaged condition.
Transfer duty solenoid	When TCM detects open or short in a circuit, TCM makes the solenoid OFF. In results, lock-up mechanism is fixed at 0 and transfer becomes FWD.
2-4 Brake duty solenoid	When TCM detects open in a circuit, TCM fix the gear at 2nd position. When TCM detects battery short in a circuit, TCM fix the gear at 3rd position.
Low clutch duty solenoid	When TCM detects open in a circuit, TCM fix the gear at 3rd position. When TCM detects battery short in a circuit, TCM fix the gear at 4th position.
High clutch duty solenoid	When TCM detects open in a circuit, TCM fix the gear at 3rd position. When TCM detects battery short in a circuit, TCM fix the gear at 2nd position.
Low & Reverse duty solenoid	When TCM detects open in a circuit, TCM fix the gear at 1 range 1st position. When TCM detects battery short in a circuit, TCM shift the gear as usual (1st-4th), but 1 range-1st is not available

135

Failsafe Function Chart


E-4AT system
Clutch
Brake
Accumulator
Accumulator
Hydraulic control solenoid valve
Accumulator control valve
Accumulator control valve
Hydraulic control solenoid valve
Hydraulic circuit
Line pressure
Oil pump
Line pressure control valve
136

E-AT System



Direct E-4at System

Air Bleeding of Control Valve

Whenever the valve body of a Direct 4EAT is removed or transmission fluid drained from the sump, the air must be bled from the valve body. You can accomplish this with the help of the NSM or Select monitor III. You will need to follow the specific procedure in the appropriate service manual for the year and model Subaru you are servicing. Make sure the transmission fluid is less than 140 degrees F. before performing the air bleed procedure.

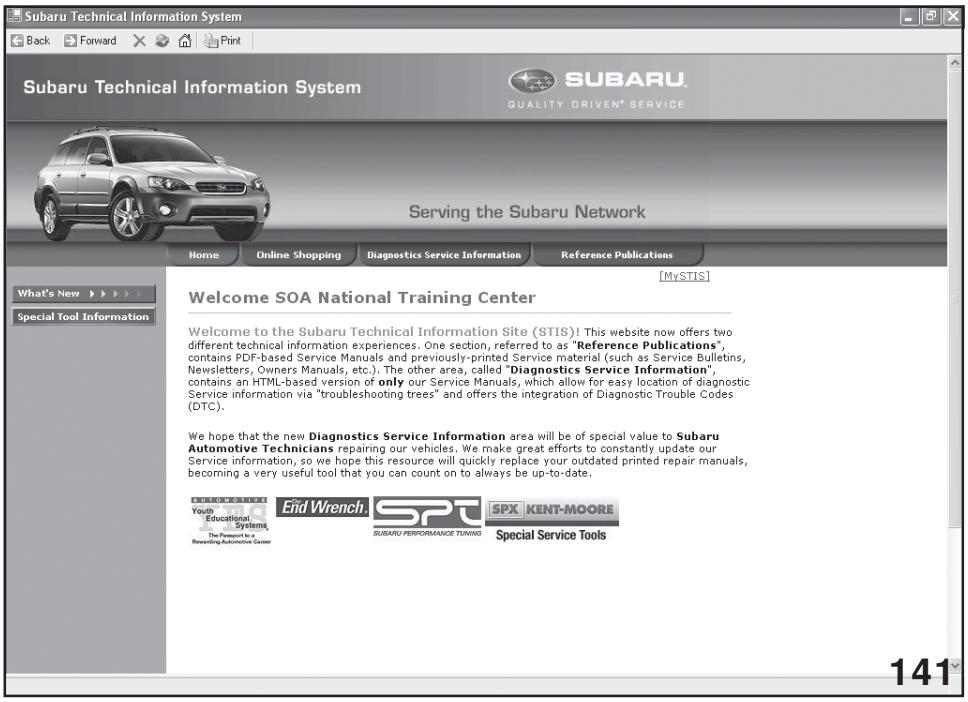
Advanced Learning Control

The learning control procedure allows the transmission control module to learn the fill rates of the clutch packs so that smooth shifting will occur within a few miles of driving. The learning control procedure must be performed when the following components have been replaced.

- TCM
- Transmission
- Valve body
- Any electrical components related to the Direct 4-EAT

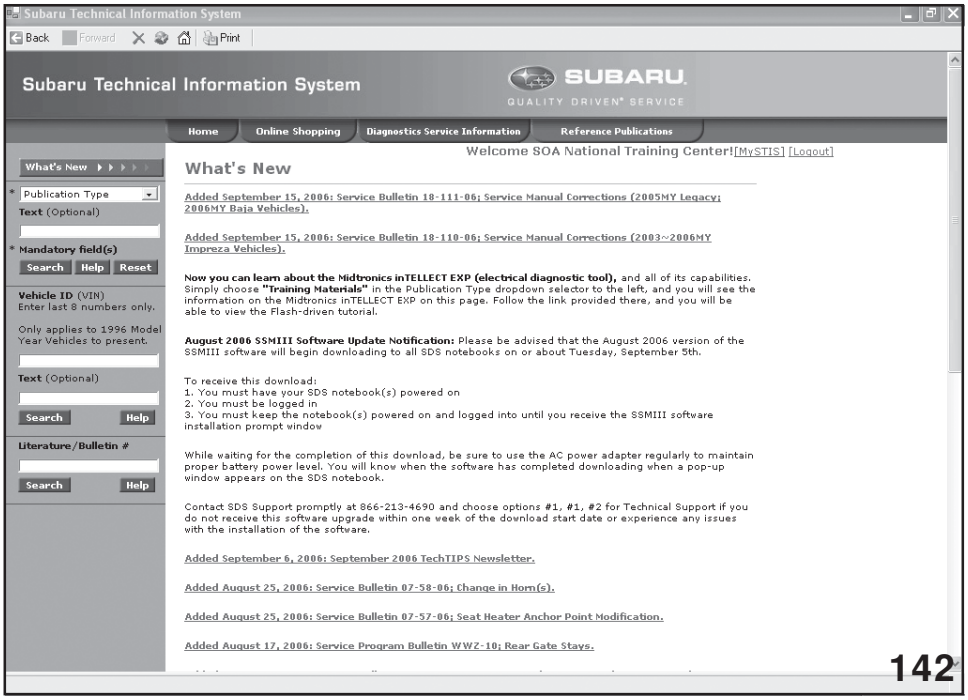
Before performing the procedure, make sure there are no codes stored in the TCM and perform a Clear Memories 2 procedure. The temperature of the transmission fluid must be between 140 and 194 degrees F. You will need to follow the specific procedure in the appropriate service manual for the year and model Subaru you are servicing. Test drive the vehicle to verify the transmission shifts smoothly when finished.

Diagnostics



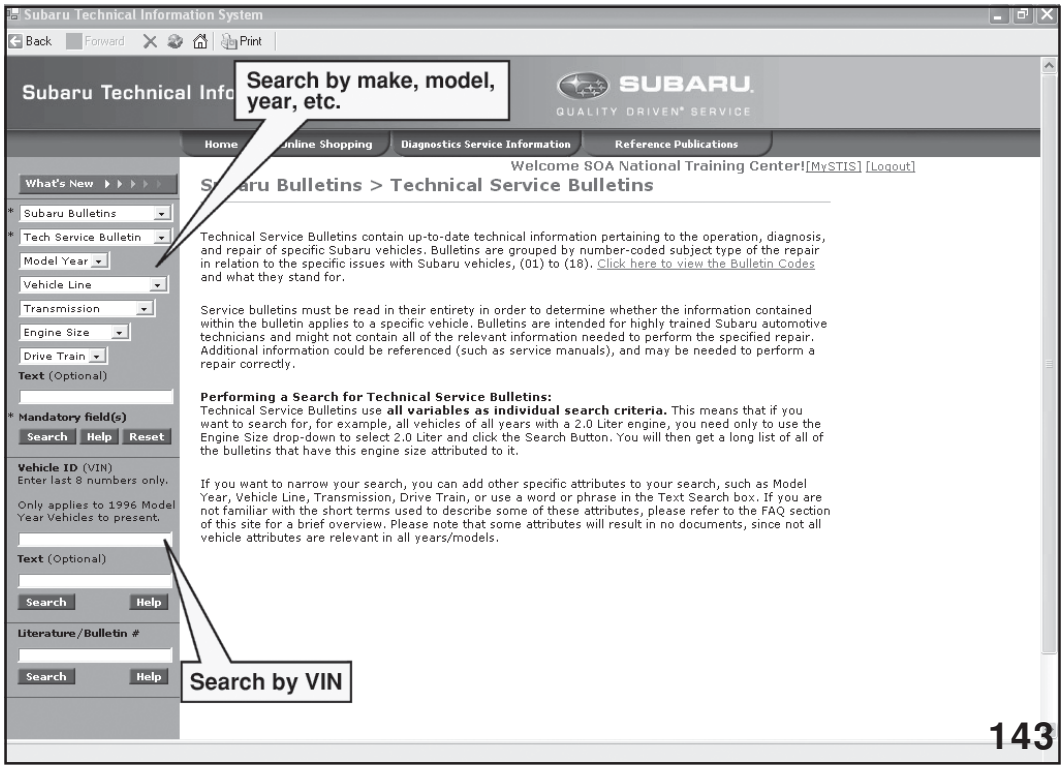
STIS Home Page

Subaru technicians should be familiar with the Subaru Technical Information System. (STIS) The STIS site can provide the most up to date technical information on Subaru vehicles.



What's New Tab

By clicking on the “What’s New” tab you will be kept up to date on the most recent technical releases.



Search for Bulletins

You can search for bulletins by make, model, and year of vehicle. You can also search by entering the last eight characters of the VIN on 1996 vehicles or newer.

Diagnostics begin with a complete description of how and when the problem occurs. You can use the attached sheet which is from the Subaru Service Manual as a tool to get the required information from the customer.

Customer s name			
Date of purchase			
Date of repair			
Transmission model	Transmission		V.I.N.
Odometer reading	km (miles)		
Frequency	❑ Continuous ❑ Intermittent (times a day)		
Weather	❑ Fine ❑ Cloudy ❑ Rainy ❑ Snowy ❑ Others ( )		
Place	❑ Highland ❑ Suburbs ❑ Inner city ❑ Uphill ❑ Rough road ❑ Others ( )		
Ambient air temperature	❑ Hot ❑ Warm ❑ Cool ❑ Cold		
Vehicle speed	km/h (MPH)		
AT warning light (ATF temperature warning light)	❑ Blinks continuously	❑ Does not blink	
Select lever position	❑ P ❑ R ❑ N ❑ D ❑ SPORT mode		
Driving condition	❑ Not affected ❑ At racing ❑ While decelerating	❑ At starting ❑ While accelerating ❑ While turning (❑ RH/❑ LH)	❑ While idling ❑ While cruising
SPORT mode	❑ ON ❑ OFF		
Symptom	❑ No up-shift		
	❑ No down-shift		
	❑ No kick down		
	❑ Vehicle does not move (❑ Any position ❑ Particular position)		
	❑ Lock-up malfunction		
	❑ Noise or vibration		
	❑ Shift shock or slip		
	❑ Select lever does not move		
	❑ Others ( )		

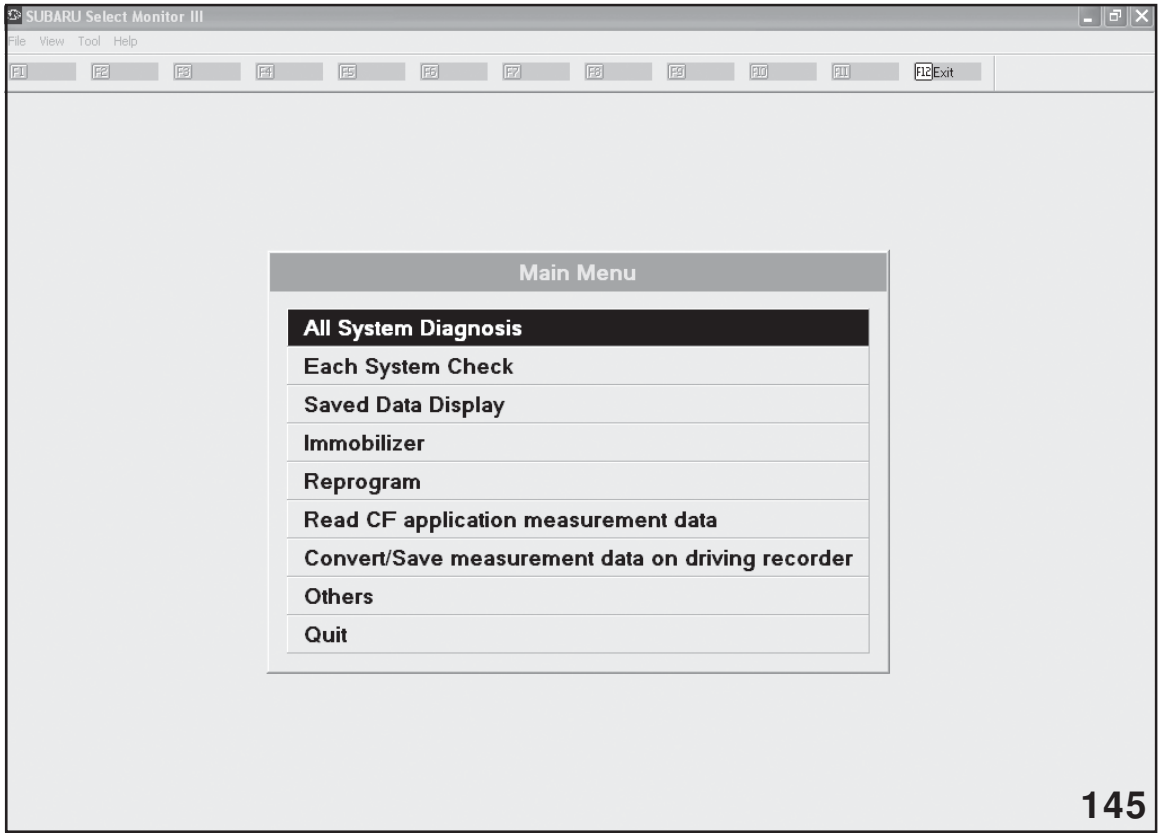
144

Customer Concern Form

A road test is essential in an attempt to reproduce the customer concern. Before a road test is conducted, a thorough visual inspection should be performed. This includes checking fluid levels, checking for physical damage, (ex. Transmission oil pan that has been crushed which could damage a solenoid) and checking electrical connections. Note any items requiring attention on the back of the service order.

Connect your Subaru Diagnostic System to the vehicle and the SM III diagnostic software to record the transmission PID's during the road test. This information can be analyzed for irregular readings once you return to the shop. Checking for trouble codes can be accomplished at this time.

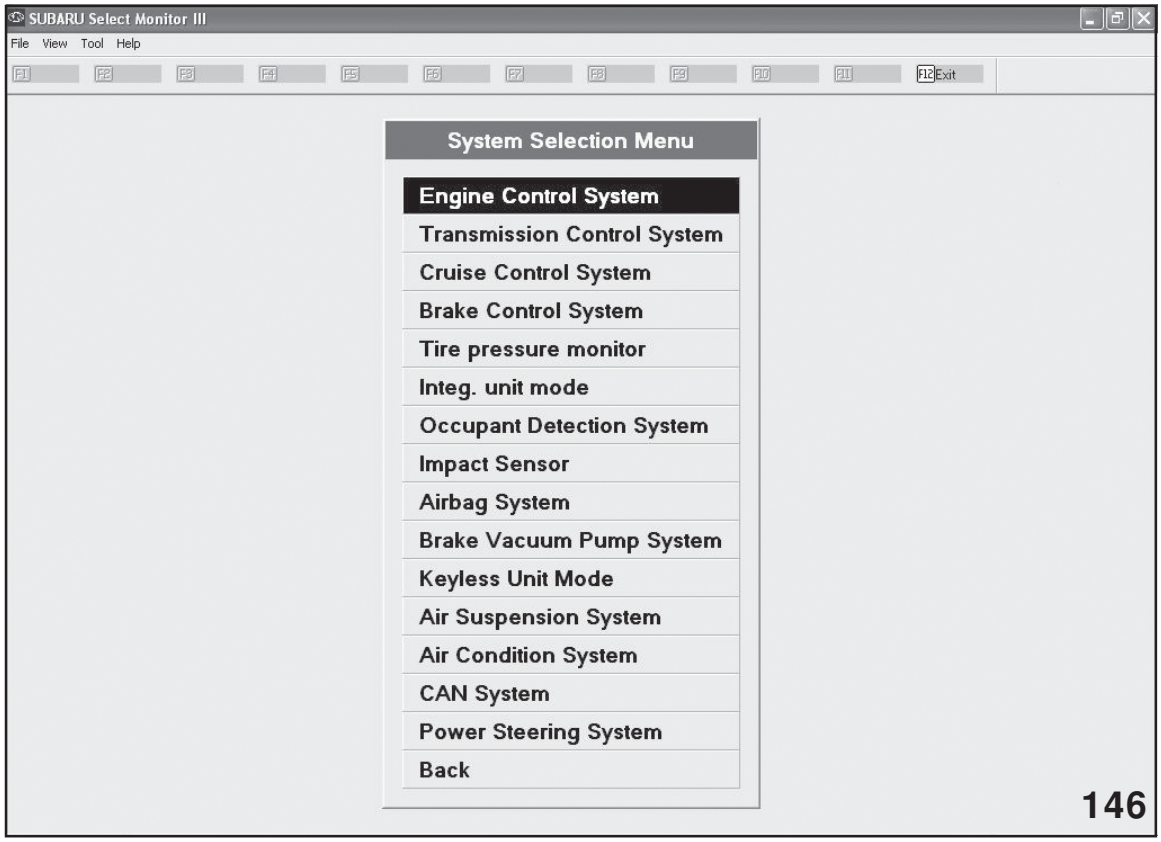
Main Menu



SMIII Main Menu

Select "Each System Check"

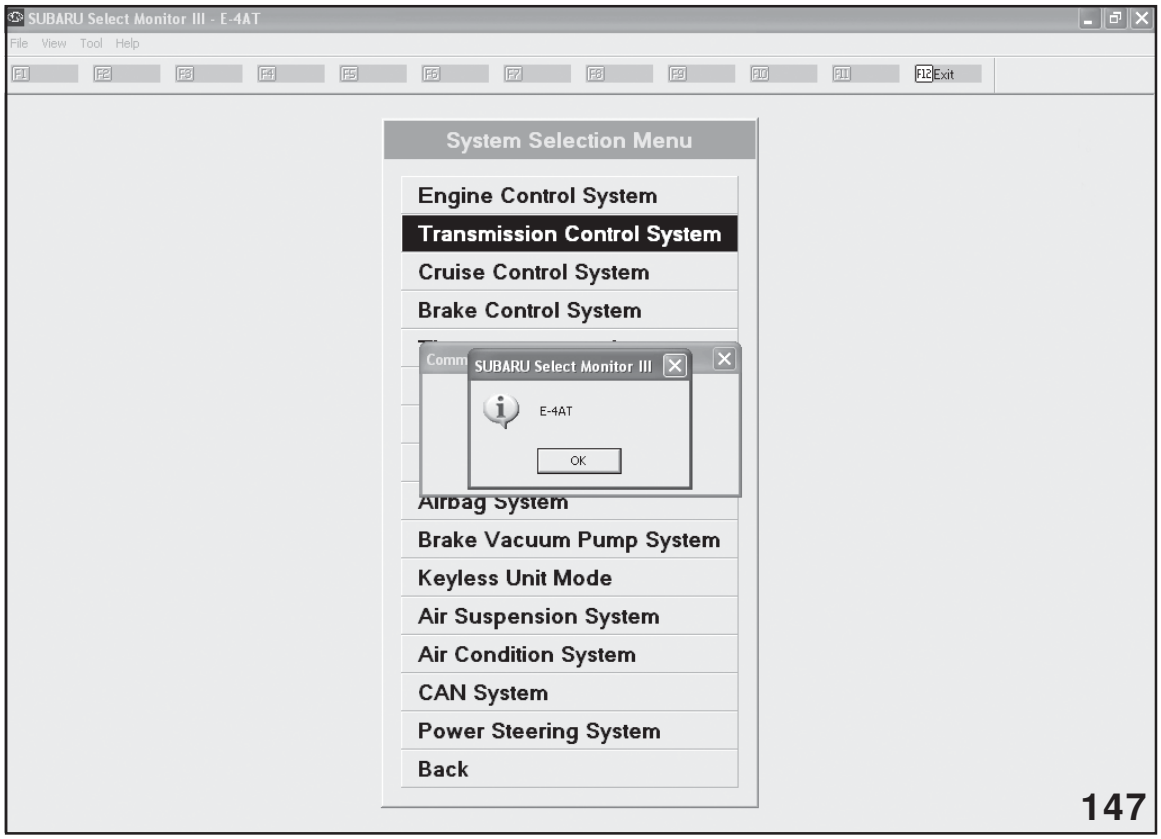
System Selction Menu



System Selection Menu

Select "Transmission Control System"

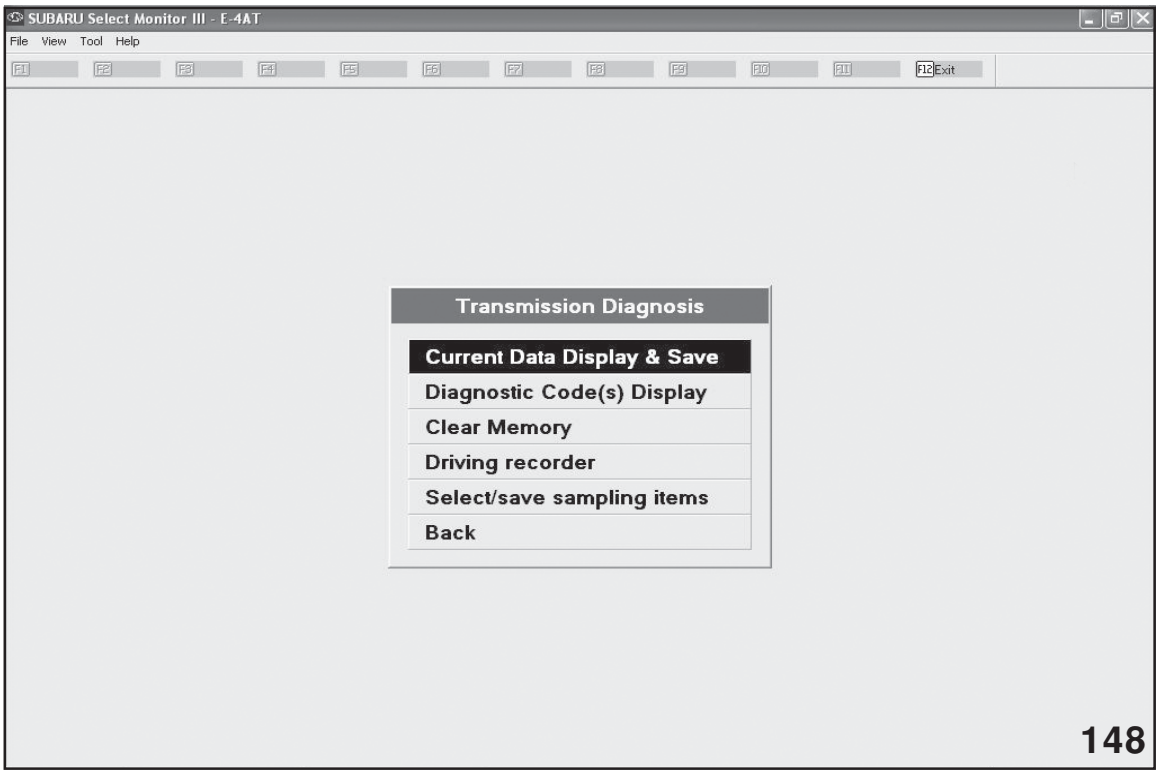
Communication with Transmission takes place.



Transmission type

Select “OK”

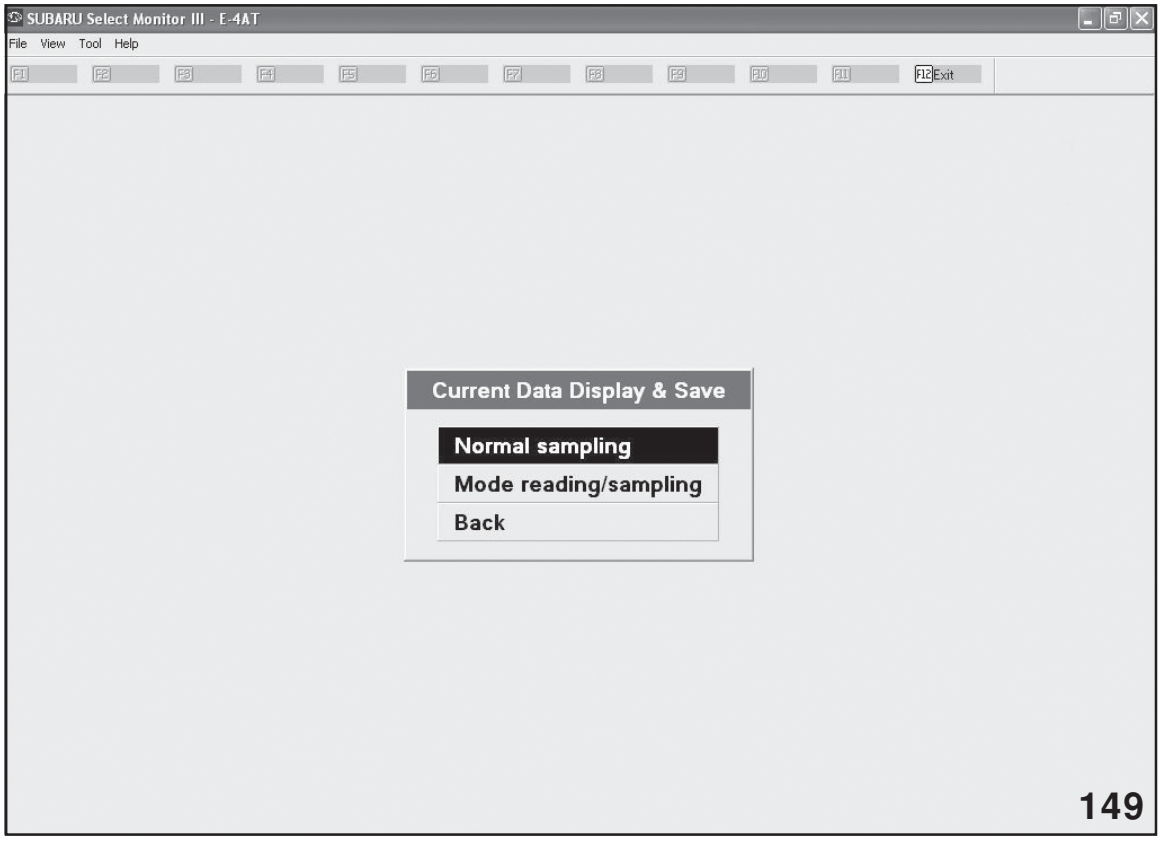
Transmission Diagnosis Screen



Transmission Diagnosis Screen

Select “Current Data Display & Save”

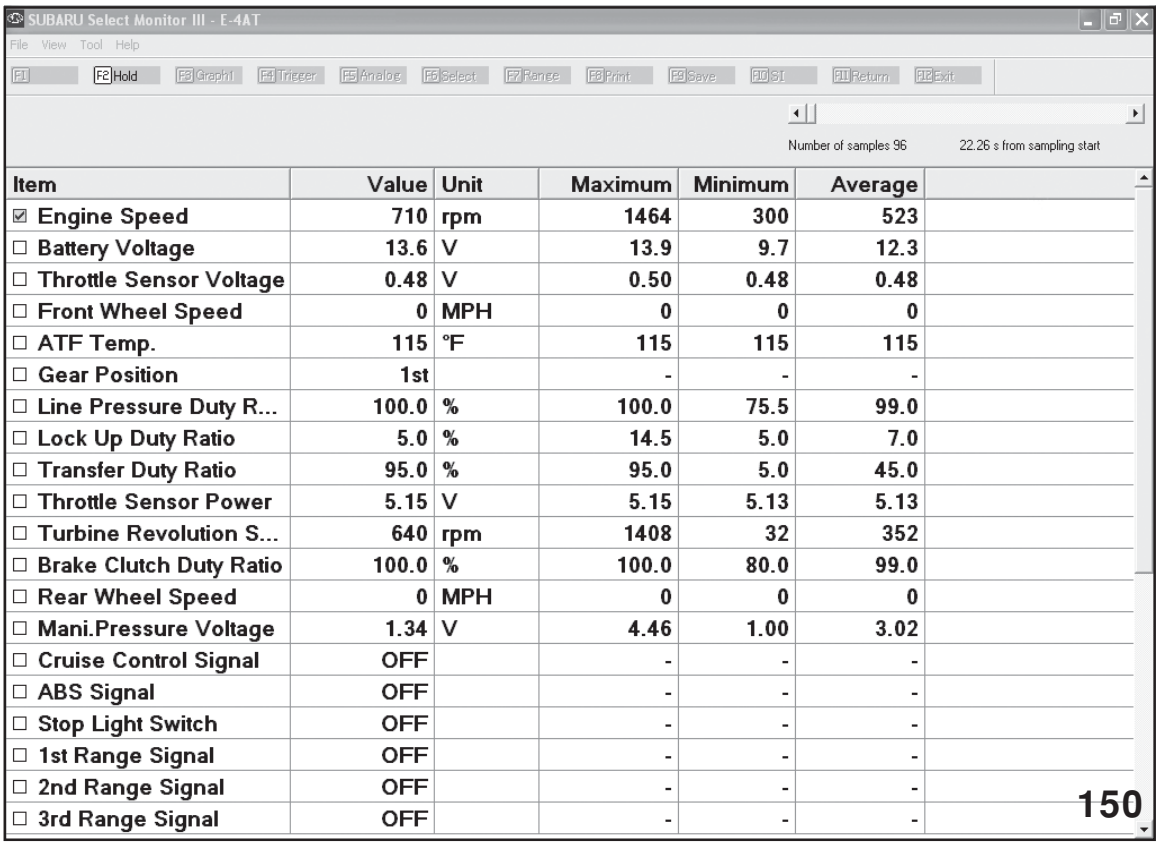
Current Data Display & Save Screen



Current Data Display & Save Screen

Select “Normal Sampling”

You are now in “Snapshot View”

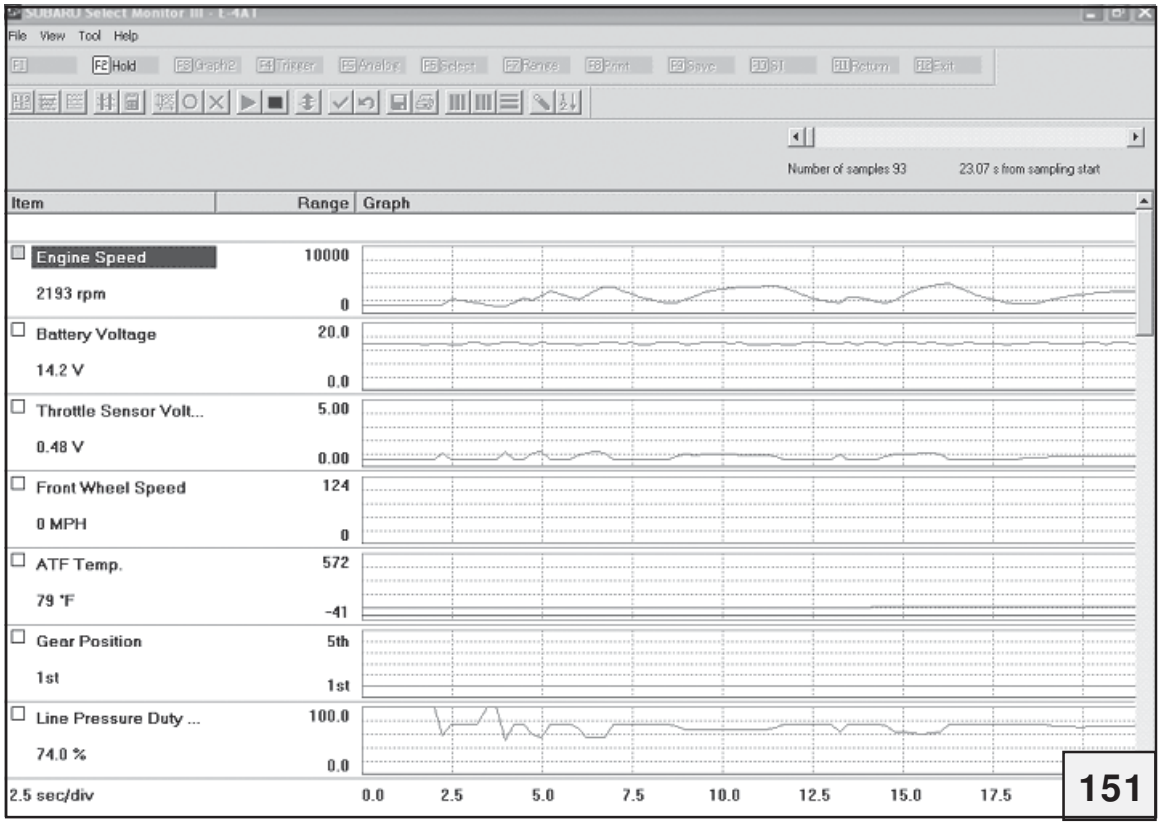


Item	Value	Unit	Maximum	Minimum	Average
☑ Engine Speed	710	rpm	1464	300	523
☐ Battery Voltage	13.6	V	13.9	9.7	12.3
☐ Throttle Sensor Voltage	0.48	V	0.50	0.48	0.48
☐ Front Wheel Speed	0	MPH	0	0	0
☐ ATF Temp.	115	°F	115	115	115
☐ Gear Position	1st		-	-	-
☐ Line Pressure Duty R...	100.0	%	100.0	75.5	99.0
☐ Lock Up Duty Ratio	5.0	%	14.5	5.0	7.0
☐ Transfer Duty Ratio	95.0	%	95.0	5.0	45.0
☐ Throttle Sensor Power	5.15	V	5.15	5.13	5.13
☐ Turbine Revolution S...	640	rpm	1408	32	352
☐ Brake Clutch Duty Ratio	100.0	%	100.0	80.0	99.0
☐ Rear Wheel Speed	0	MPH	0	0	0
☐ Mani.Pressure Voltage	1.34	V	4.46	1.00	3.02
☐ Cruise Control Signal	OFF		-	-	-
☐ ABS Signal	OFF		-	-	-
☐ Stop Light Switch	OFF		-	-	-
☐ 1st Range Signal	OFF		-	-	-
☐ 2nd Range Signal	OFF		-	-	-
☐ 3rd Range Signal	OFF		-	-	-

150

Samples of Data

Above are examples of some of the data that can be analyzed with the CF-18.

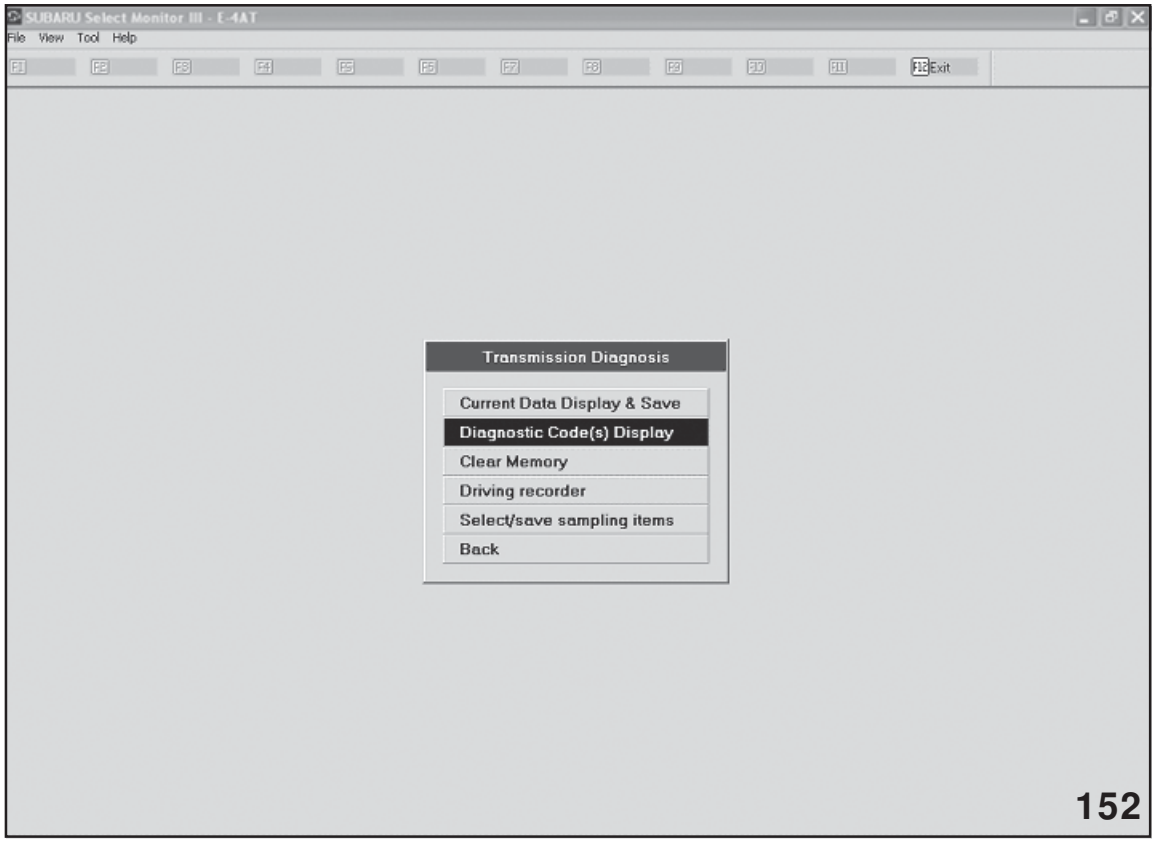


Graph View

Parameter ID's are now being shown in "Graph View"

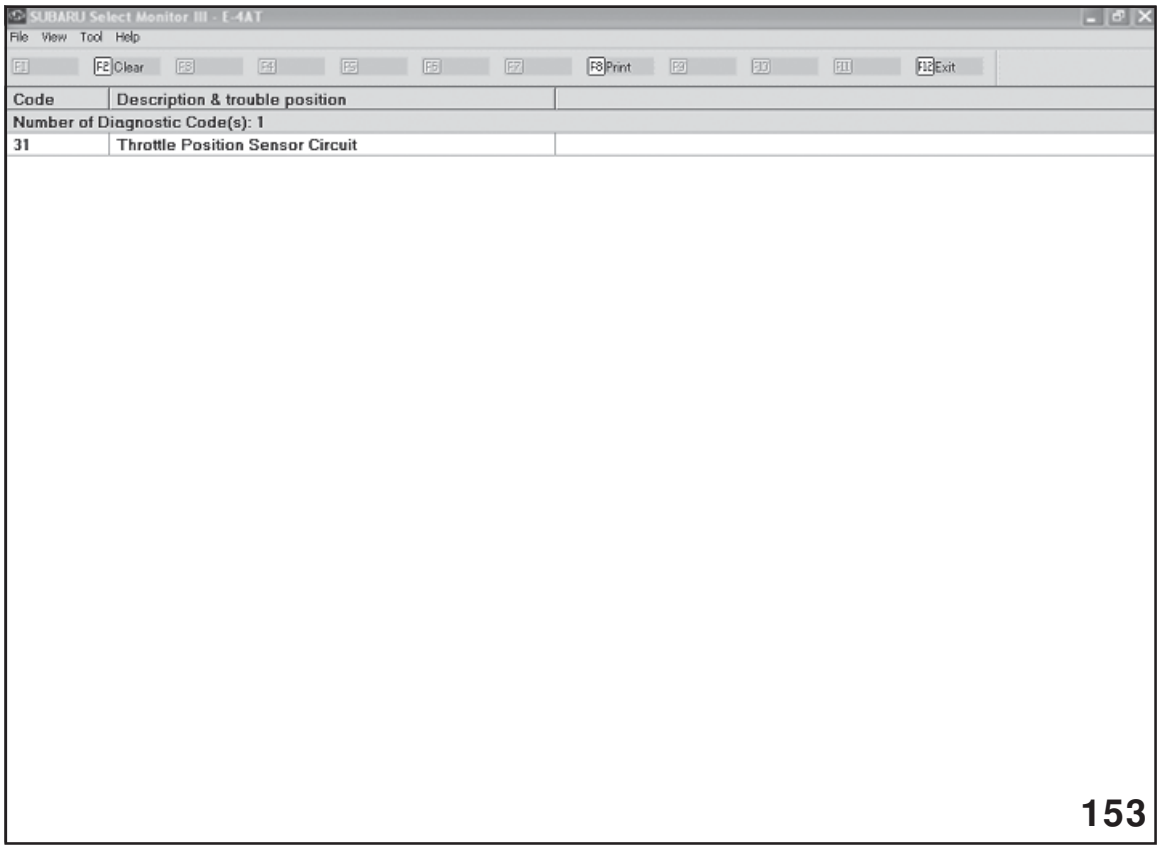
Trouble codes also can be accessed with the CF-18 and SMIII software.

Transmission Diagnosis Screen



Transmission Diagnosis Screen

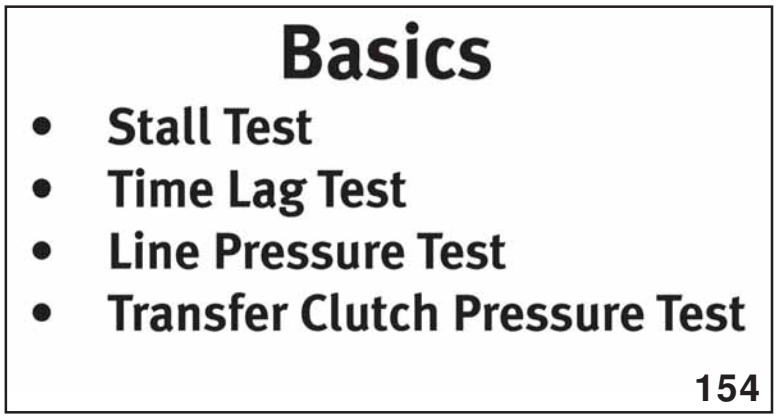
Select **"Diagnostic Code Display"**



The Subaru Diagnostic System contains other powerful tools that in the hands of a skilled technician can make diagnosis of transmission concerns faster and easier.

There are in-vehicle tests that can be performed to pinpoint transmission concerns. It is important to do as much diagnostic work as you can while the transmission is in the vehicle. Once the transmission is removed from the vehicle, testing is limited.

Basics



Stall Test:

The stall test is of extreme importance in diagnosing the condition of the automatic transmission and the engine. It should be conducted to measure the engine stall speed in Reverse range and 2nd range. The purpose of the stall test is to check the operation of the automatic transmission clutch packs, check operation of the torque converter, and check engine performance. Refer to the on line service manual for specifications and procedures for your specific vehicle.

Time Lag Test:

The time lag test measures the time it takes from when you shift into D range or R range and when you feel the shift shock of the transmission going into gear. Excessive times may indicate low line pressures, worn clutches, or internal hydraulic leaks. Refer to the on line service manual for specifications and procedures for your specific vehicle.

Line Pressure Test:

If a clutch or brake shows signs of slippage or excessive shift shock, line pressure measurements should be checked. Normally, line pressure is checked in R and 2 range under full throttle conditions and D range at closed throttle. Abnormal pressures may indicate internal hydraulic leaks, sticky valve body components, or incorrect sensor inputs to the TCM. Refer to the on line service manual for specifications and procedures for your specific vehicle.

Transfer Clutch Pressure Test:

Pressure tests of the transfer clutch can help diagnose “tight-corner braking phenomena” when the steering wheel is fully turned and the vehicle is traveling at low speed. If no trouble code for Duty solenoid C is stored and the solenoid is operating properly, the tight-corner braking may be caused by a sticky transfer control valve or mechanical problems with the transfer clutch.

Self Diagnostic System

The TCM detects trouble in the detection signals from the sensors and the signal's out put to the actuators. This function is referred to as the self-diagnosis function. When either signal is faulty, the TCM indicates trouble to the driver by flashing ATF or Sport lamp in the combination Meter. A trouble code will be stored in the memory of the TCM. Trouble codes can be accessed with the CF-18 and SM-III application.

The TCM detects trouble in the detection signals from the sensors and the signals output to the actuators. This function is referred to as the self-diagnosis function. When either signal is faulty, the TCM indicates system trouble by flashing the ATF or Sport lamp in the combination meter.

Below is a basic list of trouble codes. The list can change as new codes are added or old ones deleted.

CODE	ITEM	DIAGNOSIS	TROUBLE
11	Line pressure duty solenoid	Short or Disconnection in solenoid driving circuit	More severe shifting shock and faulty shifting
12	Lockup duty solenoid	Short or disconnection in solenoid driving circuit	Fails to lock up (after warm-up)
13	2-4 brake timing solenoid	Short or disconnection in solenoid driving circuit	Faulty shifting
14	Shift solenoid B	Short or disconnection in solenoid driving circuit	Fails to shift
15	Shift solenoid A	Short or disconnection in solenoid driving circuit	Fails to shift
16	2-4 brake duty solenoid	Short or disconnection in solenoid driving circuit	Faulty shifting
21	ATF temperature sensor	Short or disconnection in input circuit	Faulty shifting when cold
22	Pressure sensor	Short or disconnection in input circuit	More severe shifting shock
23	Engine speed signal	No signal input above 10km/h	Fails to lock up (after warm-up)
24	Transfer (AWD duty solenoid	Short or disconnection in solenoid driving circuit	Excessive tight corner braking phenomena
25	Engine torque control signal	Short or disconnection in engine torque control signal circuit	More severe shifting shock
31	Throttle sensor	Short or disconnection in input circuit	Faulty shifting and excessive shifting shock
32	Vehicle speed sensor 1	No signal input to speed sensor 1 above 20km/h	Speed sensor 1 malfunctions: more severe shifting shock
33	Vehicle speed sensor 2	No signal input to speed Sensor 2 above 20km/h	One or the other malfunctions: excessive tight corner braking phenomena Both malfunction: fails to shift
34	Turbine sensor	No signal input in ranges other than N range (vehicle speed sensors 1 and 2 are operating normally) while vehicle is traveling	More severe shifting shock
36	Low clutch timing solenoid	Short or disconnection in solenoid driving circuit	Faulty shifting

156

Self Diagnostic System Chart

Failsafe Function

Failsafe function is a TCM controlled function that enables the vehicle to be driven in the event of malfunction of the vehicle speed sensors, throttle sensor, inhibitor switch, or the various solenoids. In the event of trouble the TCM executes the following control.

Item	Failsafe Function
Line pressure duty solenoid	TCM turns the solenoid off and sets the transmission so only 1st and 3rd are available . The line pressure is also set to maximum.
Lockup duty solenoid	TCM turns the solenoid off and torque converter lock up does not occur.
2-4 brake timing solenoid	TCM turns the solenoid off and sets the transmission so only 1st and 3rd are available.
Shift solenoid B	When either solenoid malfunctions the TCM turns both solenoids off and sets the transmission to 3rd gear.
Shift solenoid A	When either solenoid malfunctions the TCM turns both solenoids off and sets the transmission to 3rd gear.
2-4 brake duty solenoid	TCM turns the solenoid off and sets the transmission so only 1st and 3rd are available
Transfer (AWD duty solenoid	TCM turns the solenoid off and adjusts the transfer clutch pressure to maximum.
Throttle sensor	TCM assumes the throttle opening of 3/8 open and continues at that level.
Vehicle speed sensor 1	Vehicle speed sensor 2
Vehicle speed sensor 2	Vehicle speed sensor 1 (If both sensors malfunction then the TCM sets the transmission to 3rd gear.)
Low Clutch Timing Solenoid	TCM turns the solenoid off and sets the transmission so only 1st and 3rd are available

158

Failsafe Function Chart

NOTE: IF THE VEHICLE IS EQUIPPED WITH THE SPORT SHIFT FUNCTION, IT WILL NOT OPERATE WITH THE TRANSMISSION IN FAILSAFE.

Slide Sequence

Slide No.	Description	Page No.
1	Title Slide (4EAT Phase 2)	
2	Created By	
3	Teaching Aids	
4	Title Slide (Introduction)	8
5	Left Side	8
6	Right Side	8
7	Gear Train Operation Table	8
8	Title Slide (Construction)	9
9	Oil Pump Construction	9
10	Torque Converter	9
11	Reverse Clutch Construction	10
12	Hydraulic Pressure in Reverse	10
13	High clutch Construction	10
14	2-4 Brake Components	11
15	Low & Reverse Brake Components	11
16	Low Clutch Components	12
17	Low Clutch D-Range	12
18	Reduction Gear	13
19	Transfer Clutch Components	13
20	Transfer Hydraulic Pressure Control Unit	14
21	Title Slide (Variable Torque Distribution (VTD))	14
22	Extension Case Area	14
23	Sun Gear	14
24	Extension Case Area with Sun Gear Showing	15
25	Sun Gear Showing Rotating Direction	15
26	Sun Gear showing 18 teeth	15
27	Power Split	15
28	Transfer Clutch	16
29	Transfer Planetary	16
30	Piston Clutch Side	16
31	Piston Case Side	17
32	Pressure Ports	17
33	Title Slide (Disassembly)	17
34	Extension Housing	17
35	Transfer Clutch	17
36	Reduction Gears	18
37	Hammer and Punch	18
38	Tool Usage	18
39	Gear on Bench	18
40	Tool Usage	18
41	Solenoid	19
42	Filter	19
43	Transfer Duty	19
44	Oil Pan	20
45	Valve Body with Artwork	20
46	Valve Body Removed	20
47	Solenoid Color Chart	20
48	Seal Pipe Removal	21
49	Oil Pump	21
50	High Clutch	21
40	Tool Usage	18

Slide Sequence

Slide Sequence

Slide Sequence

Service Bulletins

No.	Date	Title	Subject
16-48-91	05-15-91	4EAT Slow Engagement	
16-49-91	12-31-91	4EAT FWD and 4WD Brake Band Adjustment on Car Servicing	
16-51-92R	03-15-92	4EATATF Auxiliary Filter Installation	
16-52-92	04-14-92	Reduction Gear and Transfer GearPhase Matching	
16-53-92	07-09-92	Identification of Correct 4EAT Cooler Hose Routing	
16-54-92	11-27-92	Gear Reduction DrivenShaft Replacement	
16-55-93	05-03-93	Infromation and Installation Tips	
16-56-93	05-12-93	4EAT ATF Auxiliary /filter Kit and Hose Installation	
16-57-3	05-12-93	4EAT Cooler Hose Kit Installation (Without Filter Kit)	
16-58-94	03-	4EAT Modifications	
16-59-94		Prevention of Repeat Planetary Gear Failure	
16-60-94		Installation of Speedometer Cable Adaptor	
16-61-94	06-01	4EAT Modifications Updated Information	
16-62-97	05-16-97	Transfer Clutch Binding And/Or Bucking On Turns	
16-63-99R	08-05-00	4EAT Remanufactured Transaxle Program	
16-64-99	09-15-99	Revised Transfer Clutch Assembly Replacement	
16-65-99	03-	TCM Trouble Code 38	
16-65-99R	04-03-00	TCM Trouble Code 38 (Revised)	
16-66-02	03-15-03	TCU Code 45 and AWD Harsh Engagement	

Tech TIPS

Date	Subject
12/93	Duty Solenoid "C" Swapping for Test Purposes
03/95	ECVT Loss of Line Pressure
05/95	95MY 4EAT Vehicle Noise
09/95	1995 Subaru Legacy/Impreza Shift Lock Diagnosis
09/95	4EAT Low or Erratic Line Pressure
10/95	Repeat ECVT ECU Failures
11/95	Correct Axle ratios
12/95	Over-Cautious November Update "Correct Axle Ratios" Information
04/96	Change in Configuration of 4EAT Pinion Shaft
05/96	4EAT Delayed Engagement into Drive when Warm
07/96	4EAT AWD Extension Case Roller Bearing Removal
07/96	4EAT Systems Diagnosis
08/96	4EAT Transmission Binding Removal
11/96	4EAT Cold Weather Operation
04/97	4EAT Speed Sensors
08/97	Vehicle Engine RPM Goes to Zero when coming to a Stop
11/97	1998 Subaru Impreza FWD Fuse Holder
01/98	Rear Axle Binding on Turns- (One more Time)
09/98	1999 2.2L 4EAT Subaru Legacy Model Harsh Down Shifting
10/98	4EAT Transmission Operation
04/99	Transmission Repairs or Replacements
09/99	Transmission Control Units (TCM) Part Numbers
02/00	1999MY and Later (Second Generation 4EAT) Trouble Codes
11/01	4EAT Torque Bind
03-04/02	Phase 2 4EAT (1999 to Present) Repairs
08/02	4EAT Remanufactured Transaxle Program - a reminder
09-10/02	Remanufactured Transmission Paperwork Packets
11/02	2003MY 4EAT Differential Drain Plug
01-02/03	2003MY Legacy 2.5GT Sport Shifter Cold Weather Operation
04/03	Slope Control Change for 2003-2004 Vehicles
09-03	2004 Direct AT (4EAT) Control Valve Body Assembly Collection (2004 Baja Turbo and Forester Turbo)
10-03	Remanufactured Transmission Installations
11-03	Phase II 4EAT Stud Leak Repair
03/04	Procedures for Handling Returns/claims-Reman. Trans
05/04	Phase 2 4EAT transmission Characteristics-A Reminder
08/04	2005MY Legacy/Outback AT models Ring Indicator Removal
08/04	Transmission Information Worksheet

10/04	2005MY Legacy/Outback AT models Ring Indicator Removal-Revised
12/04	Inspection and Correction Methods of Connector T4/B11
01/05	T.S.B. # 16-67-04
03/05	Remanufactured Automatic Transmission core Fluid Draining Process
04/05	WWV-06 Campaign
05/06	Phase 2 4EAT Transmission Characteristics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