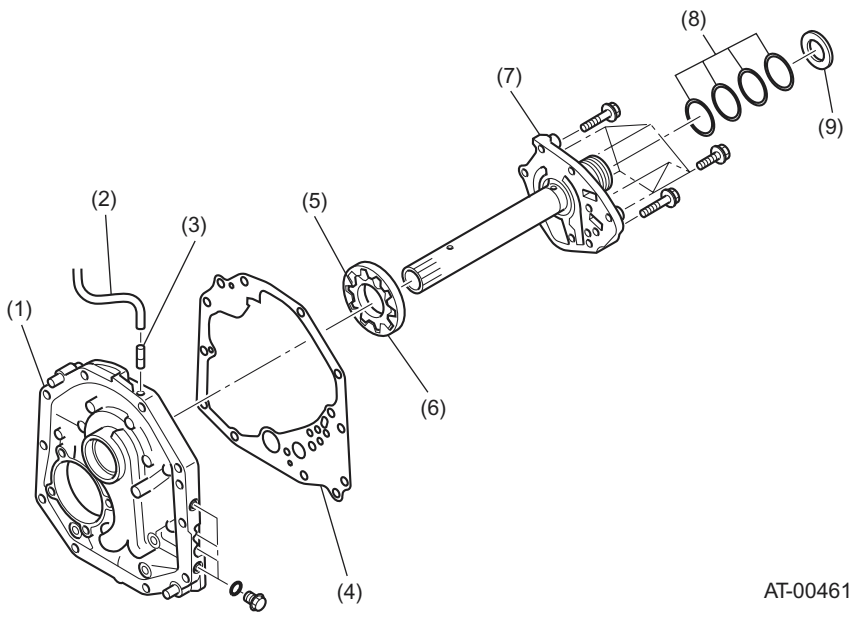
AUTOMATIC TRANSMISSION

1. Oil Pump

A: 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.

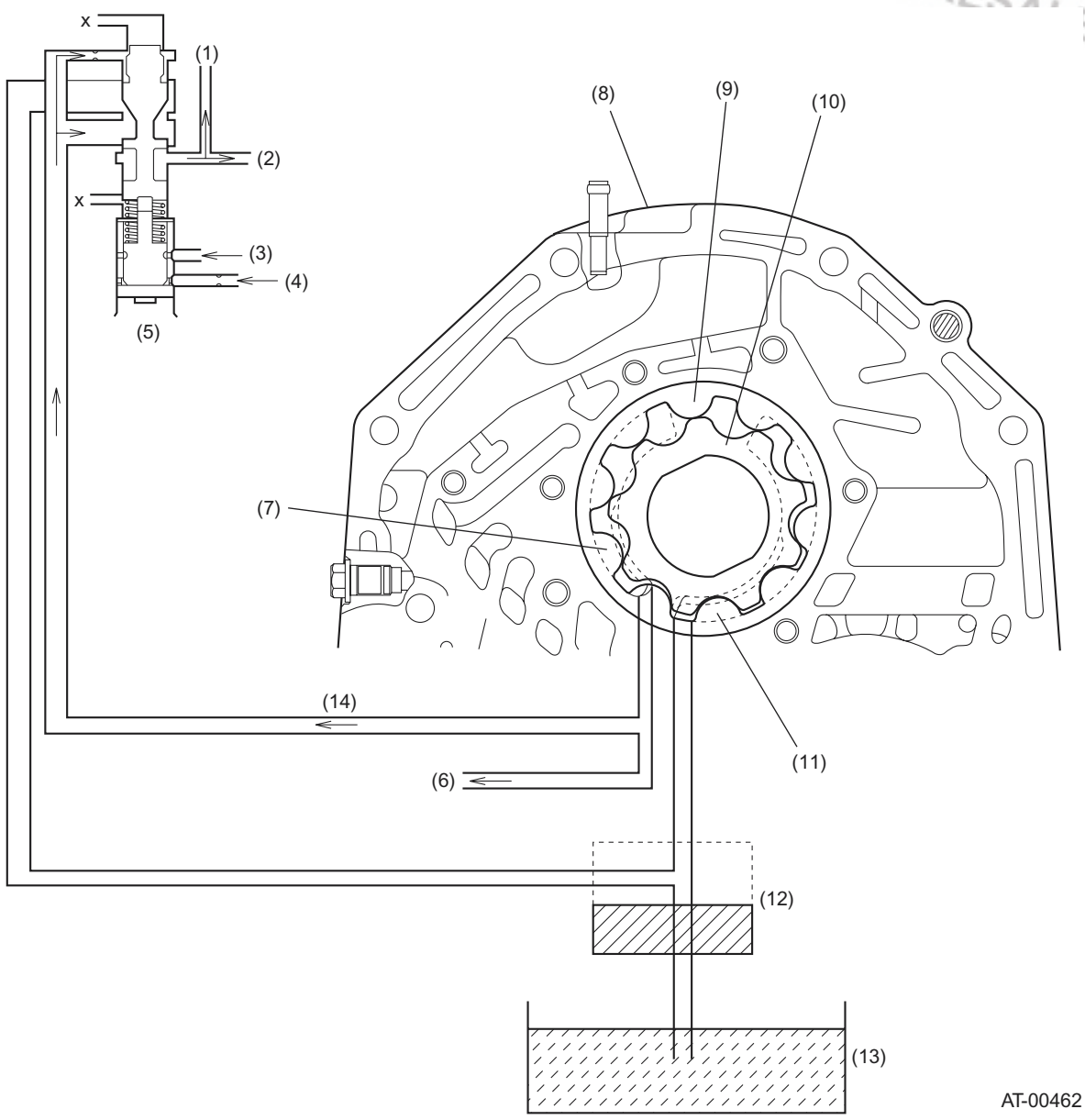


AT-00461

(1) Oil pump housing
(2) Hose
(3) Nipple
(4) Gasket
(5) Inner rotor
(6) Outer rotor
(7) Oil pump cover
(8) Seal ring
(9) Thrust bearing

B: FUNCTION

- The pump draws automatic transmission fluid (ATF) from the oil pan through the oil strainer located under the hydraulic 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 discharged 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 pressure regulator valve in 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, directly and after passing through the regulator valve, 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.

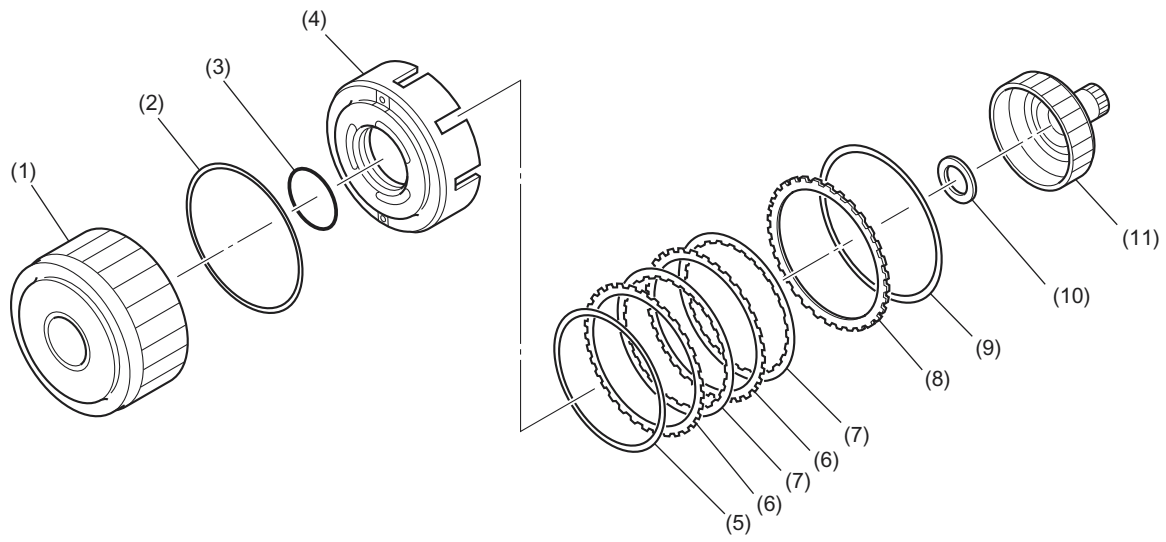


AT-00462

(1) To torque converter regulator valve
(2) To manual valve
(3) From reverse clutch
(4) From pressure modifier valve
(5) Pressure regulator valve
(6) To manual valve
(7) Delivery port
(8) Oil pump housing
(9) Outer rotor
(10) Inner rotor
(11) Suction port
(12) Oil strainer
(13) Oil pan
(14) Line pressure

2. Reverse Clutch

A: CONSTRUCTION



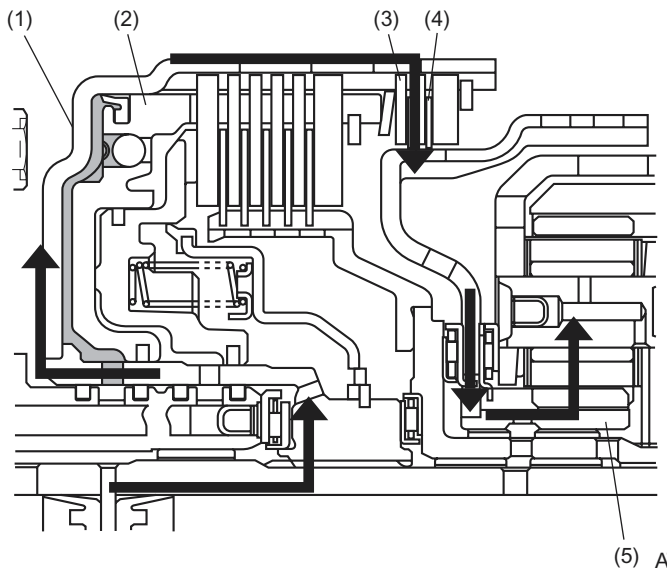
AT-00463

(1) High clutch drum
(2) Lip seal
(3) D-ring
(4) Reverse clutch piston
(5) Dish plate
(6) Driven plate
(7) Drive plate
(8) Retaining plate
(9) Snap ring
(10) Thrust needle bearing
(11) High clutch hub

B: FUNCTION

1. 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.

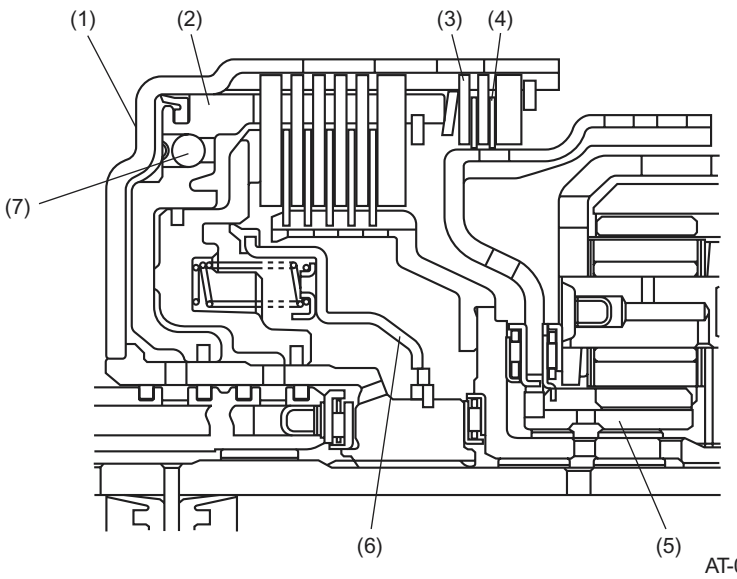


(1) High clutch drum
(2) Reverse clutch piston
(3) Driven plate
(4) Drive plate
(5) Front sun gear

2. WHEN REVERSE IS NOT SELECTED

When the selector lever is in any position other than the reverse, no pressure is applied to the reverse clutch piston. Hence the drive and driven plates are separated from each other, transmitting no power to any element beyond them.

A check ball is built into the clutch piston. This check ball has a function of releasing the pressure which may build up in the fluid remaining behind the piston by centrifugal force generated by the idly rotating high clutch drum, thereby avoiding a half-engaged state of the clutch.

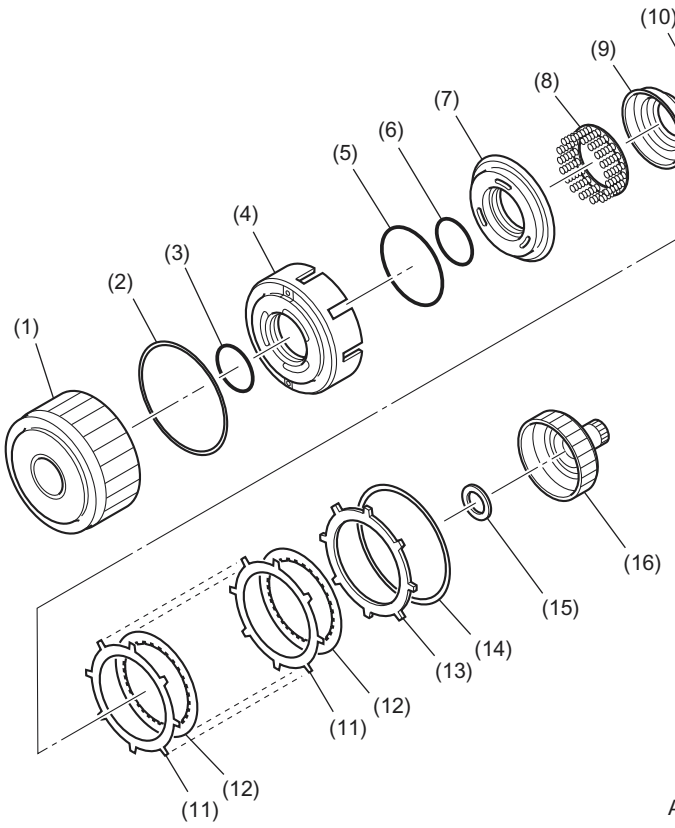


(1) High clutch drum
(2) Reverse clutch piston
(3) Driven plate
(4) Drive plate
(5) Front sun gear
(6) Cover
(7) Check ball

3. 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 to 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.

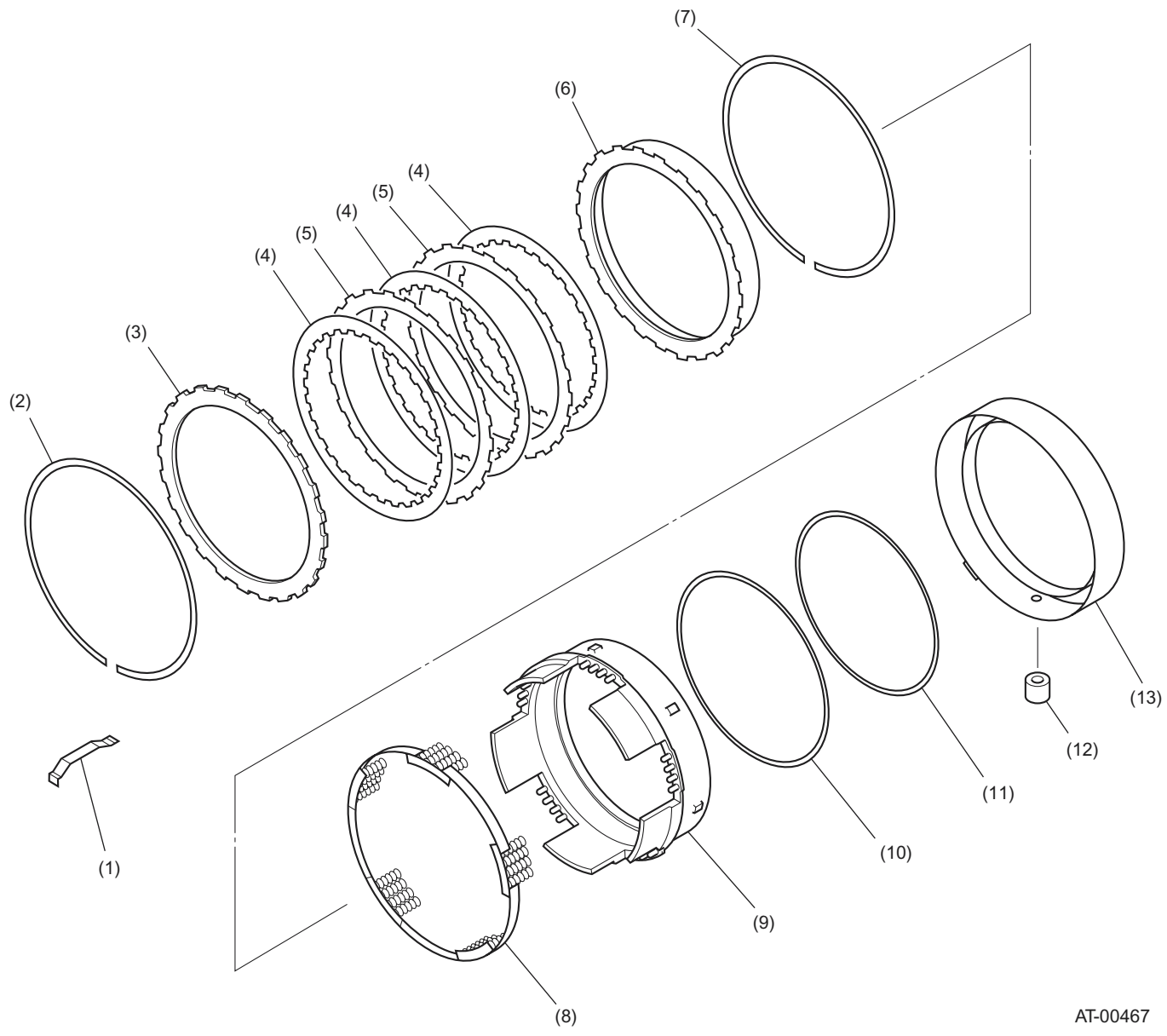


(1) High clutch drum
(2) Lip seal
(3) D-ring
(4) Reverse clutch piston
(5) D-ring (outer)
(6) D-ring (inner)
(7) High clutch piston
(8) Return spring
(9) Cover
(10) Snap ring
(11) Driven plate
(12) Drive plate
(13) Retaining plate
(14) Snap ring
(15) Thrust needle bearing
(16) High clutch hub

4. 2-4 Brake

A: CONSTRUCTION

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

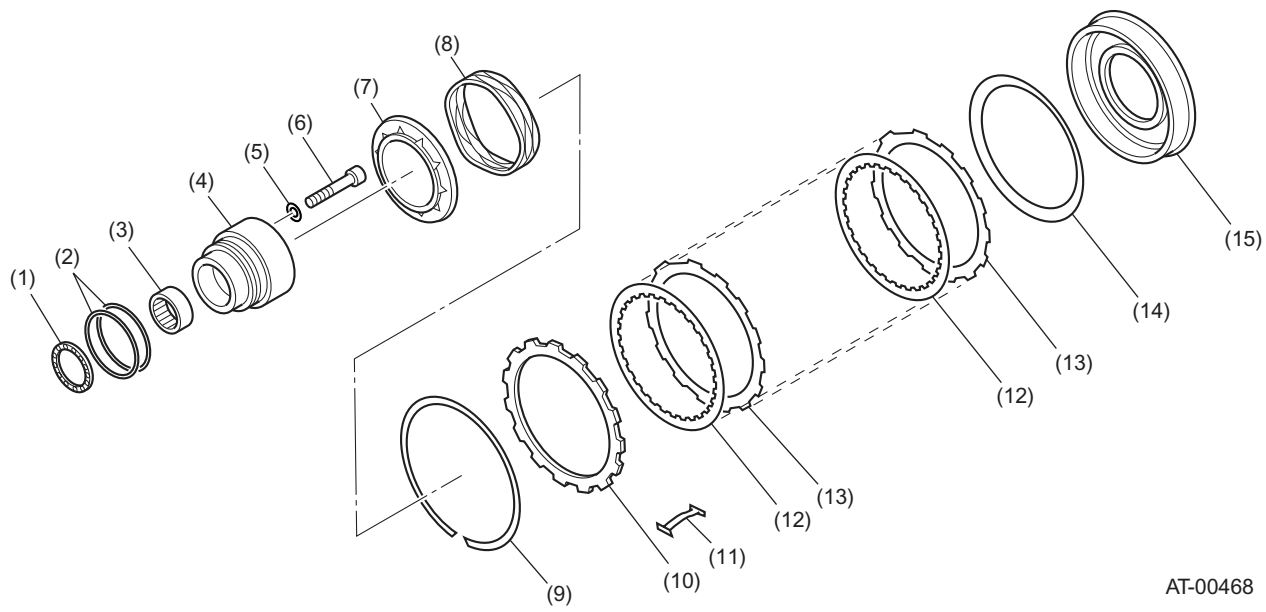


(1) Leaf spring
(2) Snap ring
(3) Retaining plate
(4) Drive plate
(5) Driven plate
(6) Pressure rear plate
(7) Snap ring
(8) Return spring
(9) 2-4 brake piston
(10) D-ring
(11) D-ring
(12) 2-4 brake piston seal
(13) 2-4 brake piston retainer

5. Low & Reverse Brake

A: CONSTRUCTION

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



(1) Thrust bearing
(2) Seal ring
(3) Needle bearing
(4) One-way clutch inner race
(5) Washer
(6) Bolt
(7) Spring retainer
(8) Return spring
(9) Snap ring
(10) Retaining plate
(11) Leaf spring
(12) Drive plate
(13) Driven plate
(14) Dish plate
(15) Low & reverse brake piston

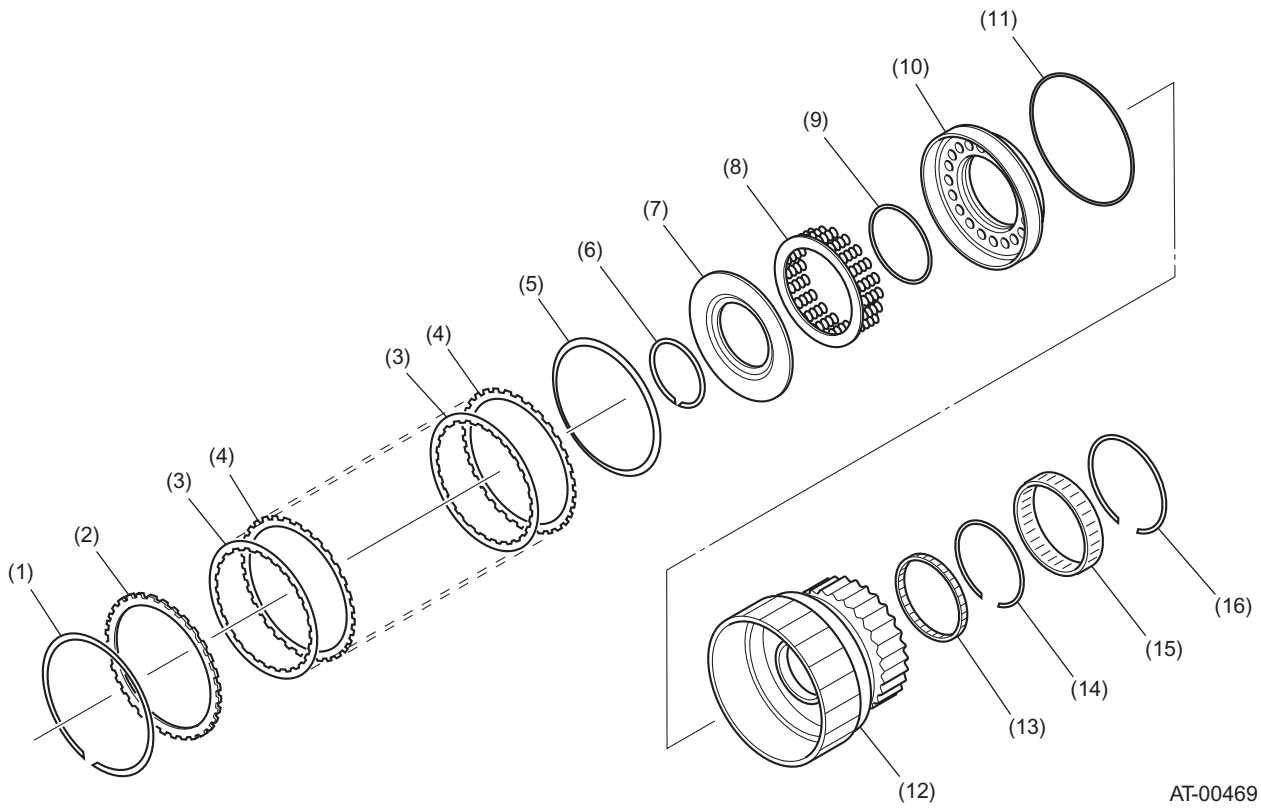
B: FUNCTION

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 drum to lock.

6. Low Clutch

A: CONSTRUCTION

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.
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.

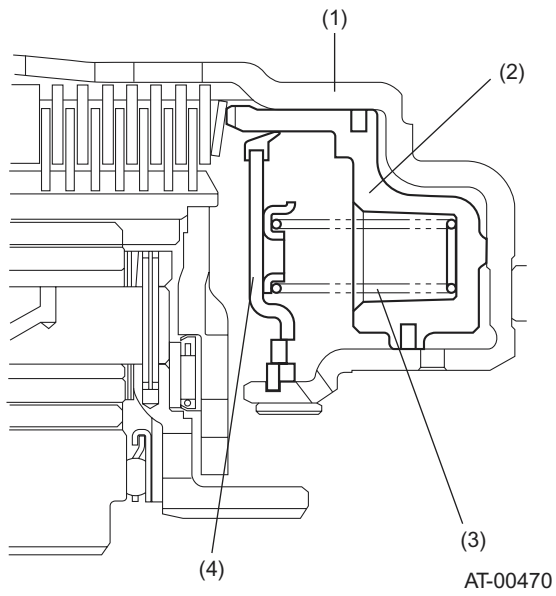


(1) Snap ring
(2) Retaining plate
(3) Drive plate
(4) Driven plate
(5) Dish plate
(6) Snap ring
(7) Cover
(8) Return spring
(9) D-ring
(10) Low clutch piston
(11) D-ring
(12) Low clutch drum
(13) Needle bearing
(14) Snap ring
(15) One-way clutch
(16) Snap ring

B: FUNCTION

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 piston, thus preventing incomplete disengagement of the 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.

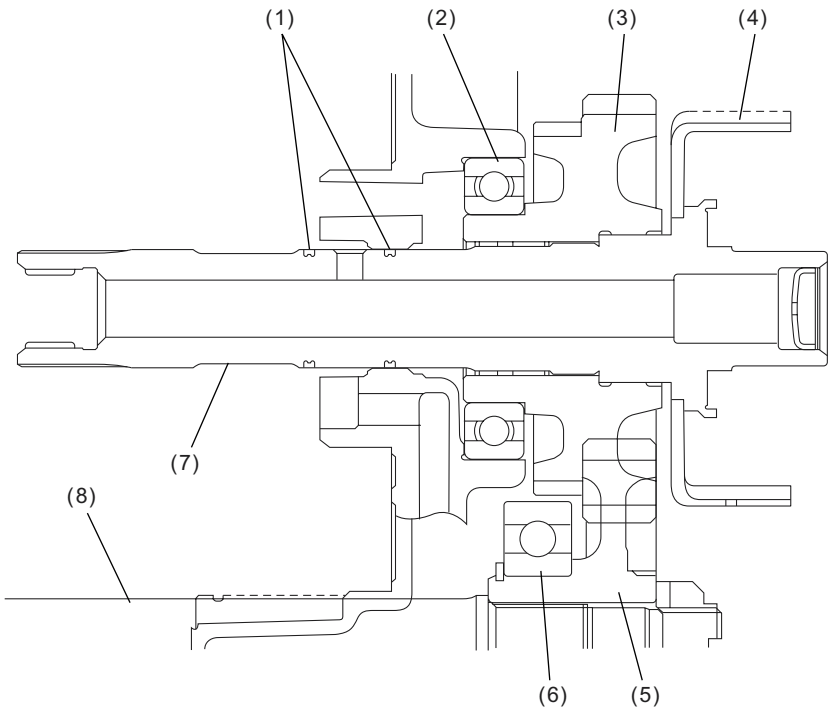


(1) Low clutch drum
(2) Low clutch piston
(3) Return spring
(4) Cover

7. Reduction Gears

A: MPT MODELS

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.

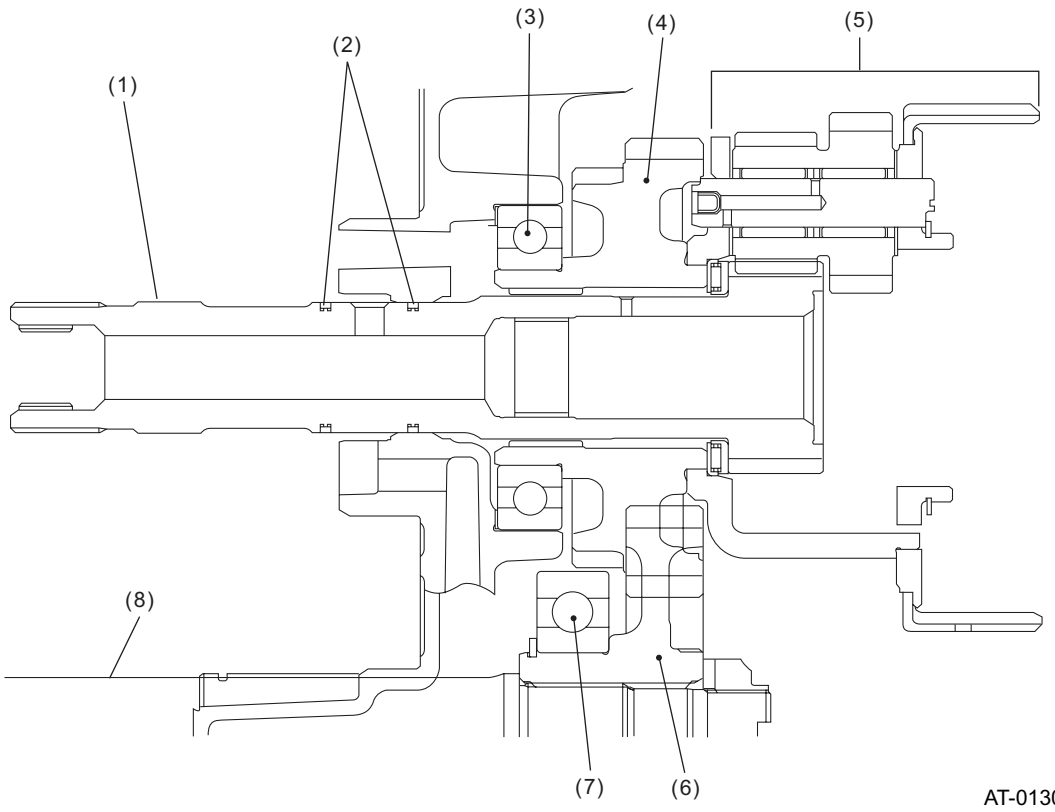


AT-01015

(1) Seal ring
(2) Ball bearing
(3) Reduction drive gear
(4) Transfer clutch hub
(5) Reduction driven gear
(6) Ball bearing
(7) Reduction drive shaft
(8) Drive pinion shaft

B: VTD MODELS

Engine power is transmitted from the rear planetary carrier to the intermediate shaft and the center differential assembly. The input force to the center differential is transmitted from the front sun gear, which is integrated with the intermediate shaft. The center differential front wheel side output is transmitted from the center differential carrier, which is integrated with the reduction drive gear. The rear wheel side output is transmitted from the rear sun gear in the center differential, which is integrated with the rear drive shaft. Power transmission to the front wheels is then transmitted to the final gear through the reduction driven gear and drive pinion. Power to the rear wheels is transmitted sequentially from the rear drive shaft to the propeller shaft, rear differential and rear wheel.



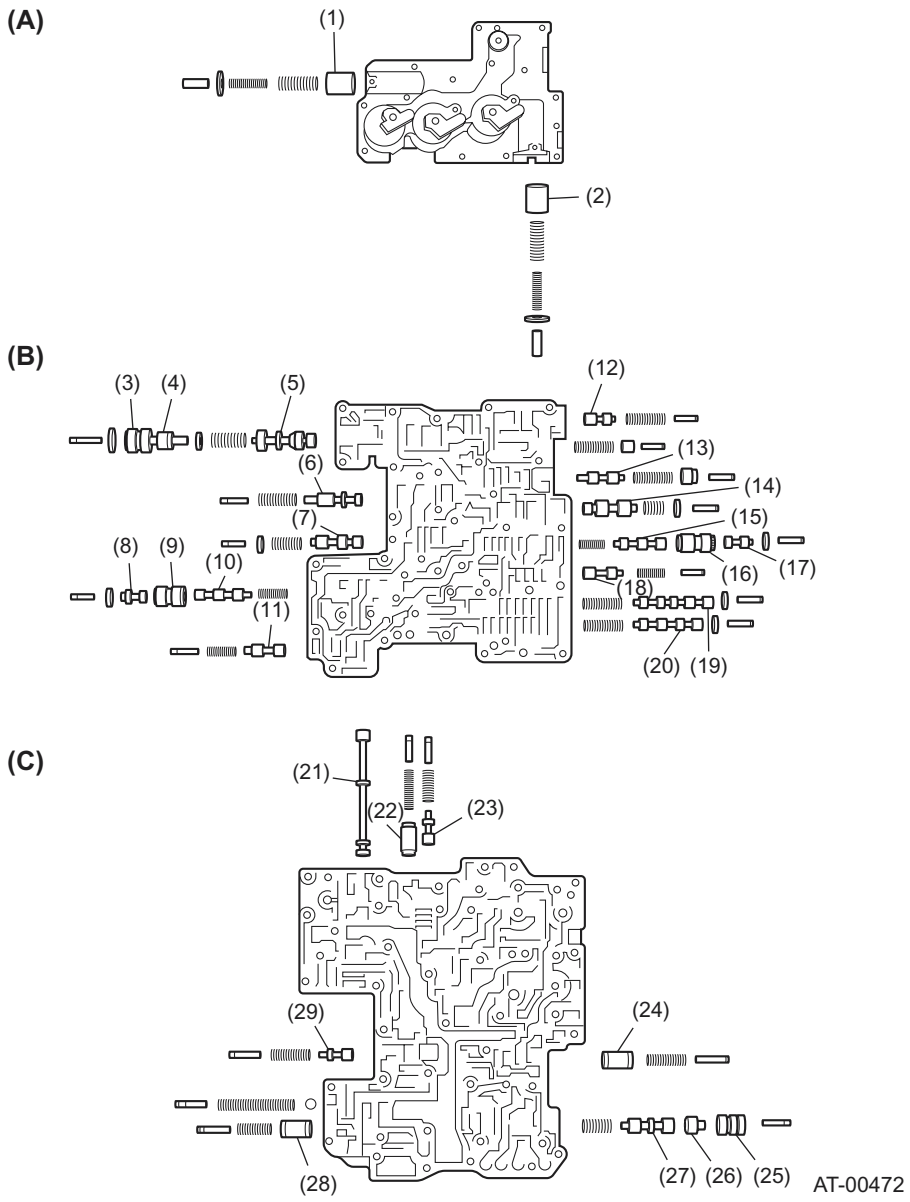
AT-01308

(1) Intermediate shaft
(2) Seal ring
(3) Ball bearing
(4) Reduction drive gear
(5) Center differential assembly
(6) Reduction driven gear
(7) Ball bearing
(8) Drive pinion shaft

8. Hydraulic Control Valve

The hydraulic control system of the automatic transmission consists of an oil pump, valve bodies containing valves, clutches, fluid passages and pipes. The operation of the system is initiated by driver's manual inputs and electric inputs from the TCM.

A: CONSTRUCTION

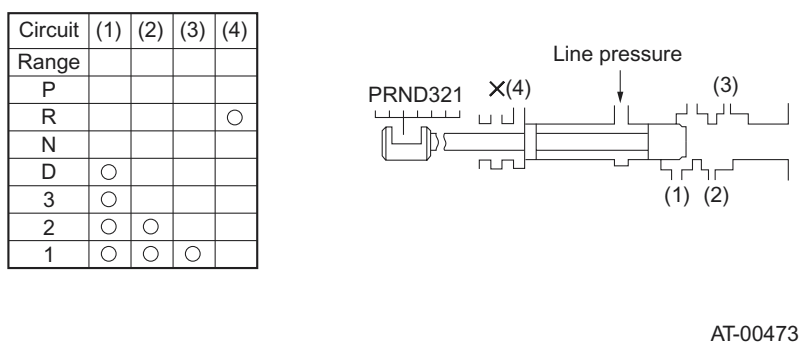


HYDRAULIC CONTROL VALVE

(1) High clutch accumulator piston B
(2) 2-4 brake accumulator piston B
(3) Pressure regulator sleeve
(4) Pressure regulator plug
(5) Pressure regulator valve
(6) Reverse inhibitor valve
(7) Accumulator control valve B
(8) 2-4 brake timing plug A
(9) 2-4 brake timing sleeve A
(10) 2-4 brake timing valve A
(11) 2-4 brake timing valve B
(12) Torque converter regulator valve
(13) Pressure modifier valve
(14) Accumulator control valve A
(15) Low clutch timing valve A
(16) Low clutch timing sleeve A
(17) Low clutch timing plug A
(18) Low clutch timing valve B
(19) Shift valve B
(20) Shift valve A
(21) Manual valve
(22) Throttle accumulator piston B
(23) 1st reducing valve
(24) Throttle accumulator piston A
(25) Lockup control sleeve
(26) Lockup control plug
(27) Lockup control valve
(28) Modifier accumulator piston
(29) Pilot valve

(A) Upper valve body
(B) Middle valve body
(C) Lower valve body

B: FUNCTION

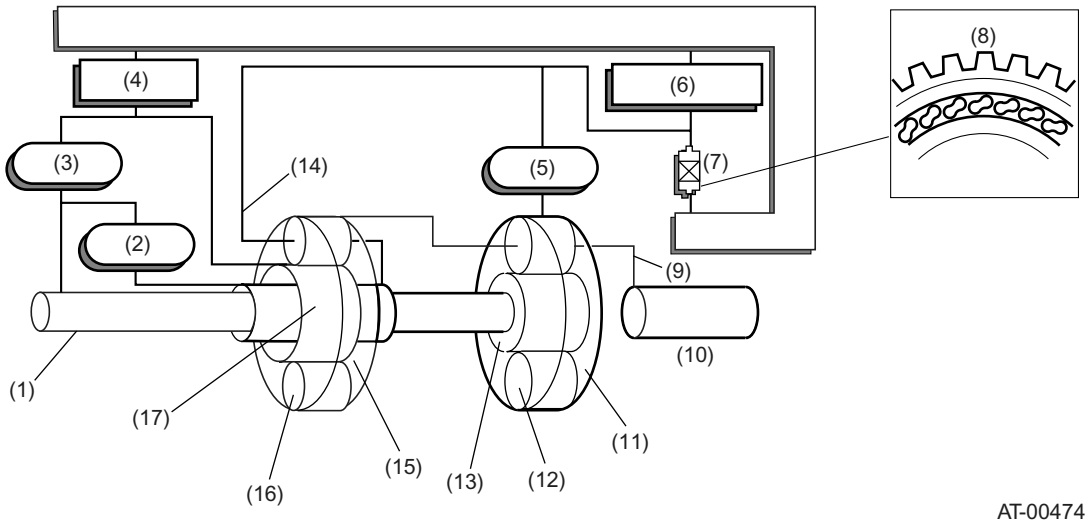
Name	Function
Pressure regulator valve	Regulates the pressure of ATF delivered from the oil pump to an optimum level (line pressure) corresponding to vehicle running conditions.
Pressure modifier valve	Adjusts the pressure modifier output pressure depending on the driving condition to keep the line pressure 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.  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, lockup pressure, and shifting and transfer clutch/brake pressures.
Torque converter clutch regulator valve	Prevents excessive rise of torque converter clutch pressure.
Lockup control valve	Engages or disengages the lockup clutch. Also regulates the lockup clutch engaging pressure to prevent lockup 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 back-pressure 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.
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.

Name	Function
Accumulator control valve A	Regulates the accumulator control A pressure (low clutch accumulator A back-pressure, 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.

9. Gear Train

A: CONSTRUCTION

The gear train consists of two sets of planetary gears, three sets of multi-plate clutches, two sets of multi-plate brakes and one set of one-way clutch.



AT-00474

(1) Input shaft
(2) High clutch (operates in 3rd and 4th speeds)
(3) Reverse clutch (operates while moving in reverse)
(4) 2-4 brake
(5) Low clutch
(6) Low & reverse brake
(7) One-way clutch
(8) Free/locked
(9) Rear planetary carrier
(10) MPT models: reduction drive shaft
VTD Models: intermediate shaft
(11) Rear internal gear
(12) Rear pinion gear
(13) Rear sun gear
(14) Front planetary carrier
(15) Front internal gear
(16) Front pinion gear
(17) Front sun gear

B: OPERATION

1. OPERATION TABLE

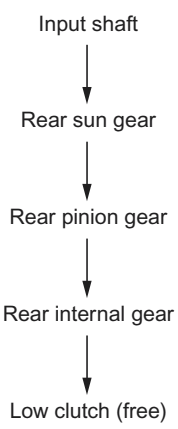
Selector lever operation			Reverse clutch	2-4 brake	High clutch	Low clutch	Low & reverse brake	One-way clutch
P								
R			○				○	
N								
D	1ST					○		○
	2ND			○		○		
	3RD				○	○		
	4TH			○	○			
3	1ST					○		○
	2ND			○		○		
	3RD				○	○		
	4TH			○	○			
2	1ST							
	2ND			○		○		
	3RD				○	○		
	4TH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

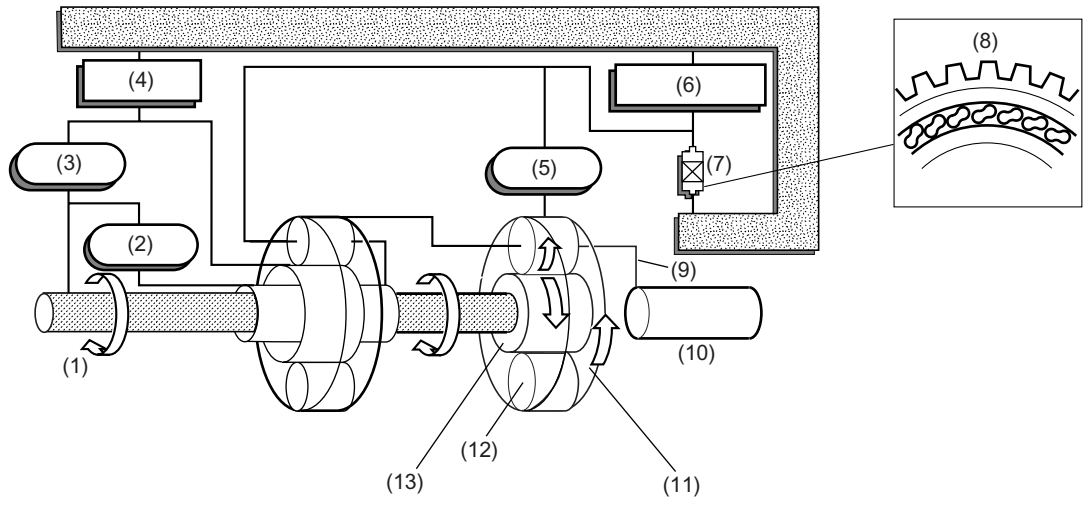
AT-00868

2. N RANGE

Since the rear sun gear and the high clutch drum are in mesh with the input shaft, they rotate together with the input shaft.
The high clutch drum does not transmit the torque to the planetary unit since the reverse clutch and the high clutch are not engaged.
The torque of the rear sun gear is transmitted to the rear internal gear through the pinion gear.
However, the torque of the rear sun gear is not transmitted to the rear planetary carrier since the low clutch is disengaged and, therefore, the rear internal gear is freewheeling.
As a result, the torque of the input shaft is not transmitted to the reduction drive shaft*.

*: MPT models only. VTD models are equipped with an intermediate shaft.

Operating condition of components	Power flow (in acceleration)
All clutches and brakes : disengaged	



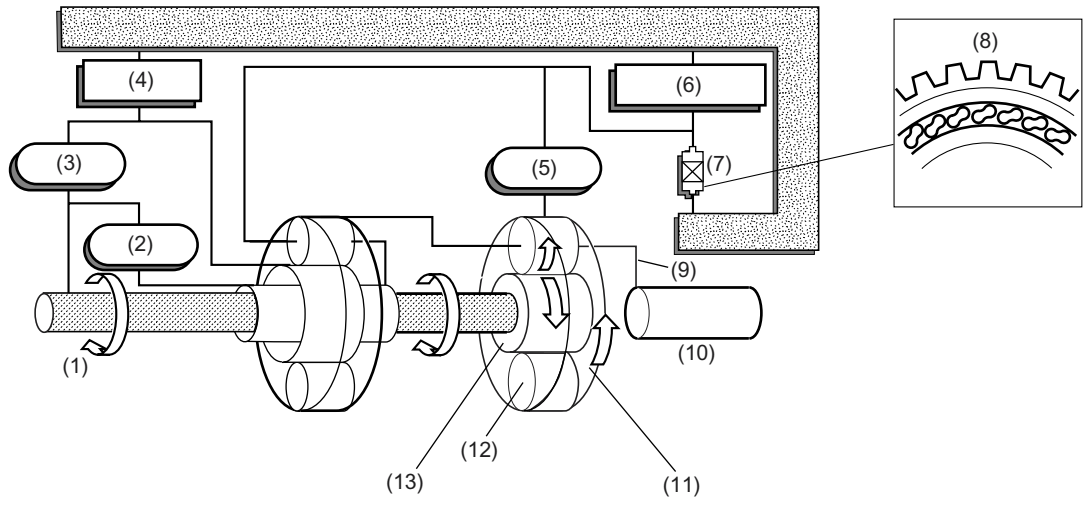
AT-00477

(1) Input shaft
(2) High clutch
(3) Reverse clutch
(4) 2-4 brake
(5) Low clutch
(6) Low & reverse brake
(7) One-way clutch
(8) No effect
(9) Rear planetary carrier
(10) MPT models: reduction drive shaft
VTD Models: intermediate shaft
(11) Rear internal gear
(12) Rear pinion gear
(13) Rear sun gear
(14) Input
(15) Output
(16) Lock
(17) Planetary gear components involved in power transmission

3. P RANGE

All the clutches and brakes are free, just as in the N range. The parking pawl engages with the parking gear which forms an integral part of the reduction drive gear, preventing the gear from rotating.

Operating condition of components	Power flow (in acceleration)
All clutches and brakes : disengaged	Input shaft ↓ Rear sun gear ↓ Rear pinion gear ↓ Rear internal gear ↓ Low clutch (free) AT-00476



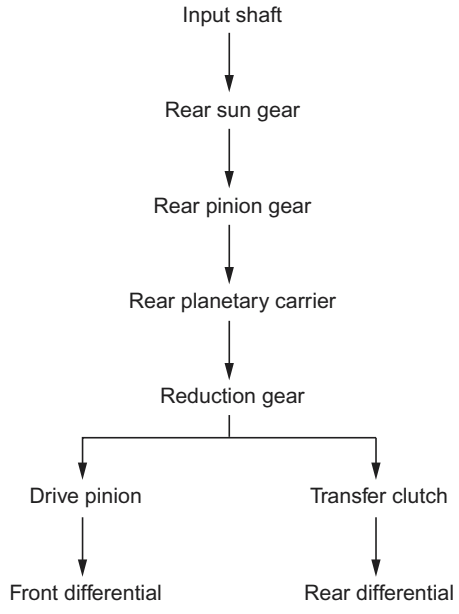
AT-00477

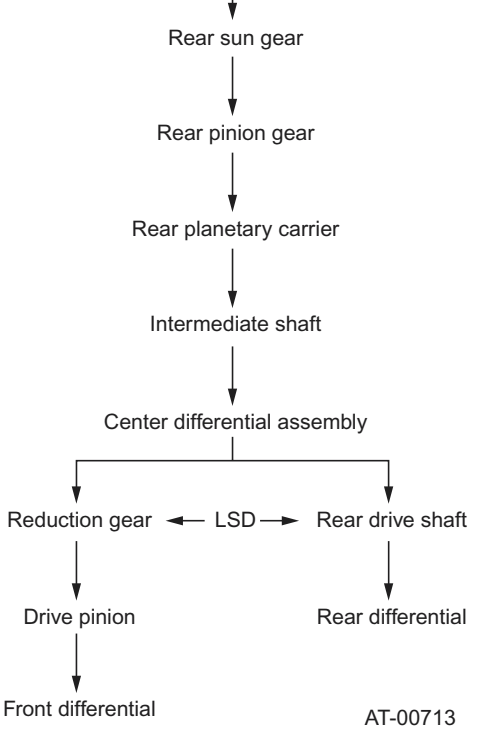
(1) Input shaft
(2) High clutch
(3) Reverse clutch
(4) 2-4 brake
(5) Low clutch
(6) Low & reverse brake
(7) One-way clutch
(8) No effect
(9) Rear planetary carrier
(10) MPT models: reduction drive shaft
VTD Models: intermediate shaft
(11) Rear internal gear
(12) Rear pinion gear
(13) Rear sun gear
(14) Input
(15) Output
(16) Lock
(17) Planetary gear components involved in power transmission

4. 1ST SPEED GEAR OF D OR 3 RANGE (D_1, 3_1)

When the 1st gear is selected in the D or 3 range, only the low clutch is engaged. In this state, the rear internal gear attempts to rotate counterclockwise but it is impossible by the action of the one-way clutch which locks the internal gear to the transmission case. As a result, rotation of the rear sun gear causes the pinion gears to rotate around the sun gear. This causes the planetary carrier to rotate. In this way, rotation of the input shaft is transmitted to the reduction drive shaft* after being subjected to speed reduction by the planetary gear train.
On the other hand, the rear internal gear rotates clockwise if the reverse driving force is applied to it by the reduction drive shaft* during coasting. This clockwise rotation of the internal gear causes the one-way clutch to freewheel. Since the power path between the reduction drive shaft* and the input shaft is lost as a result, no engine braking effect is available.

*: MPT models only. VTD models are equipped with an intermediate shaft.

<table>
<tr><th colspan="2">Operating condition of components</th></tr>
<tr><td colspan="2">Low clutch : engaged
One-way clutch : locked</td></tr>
<tr><th colspan="2">Power flow (in acceleration)</th></tr>
<tr><td>MPT models
 

AT-00480</td><td>VTD models
 

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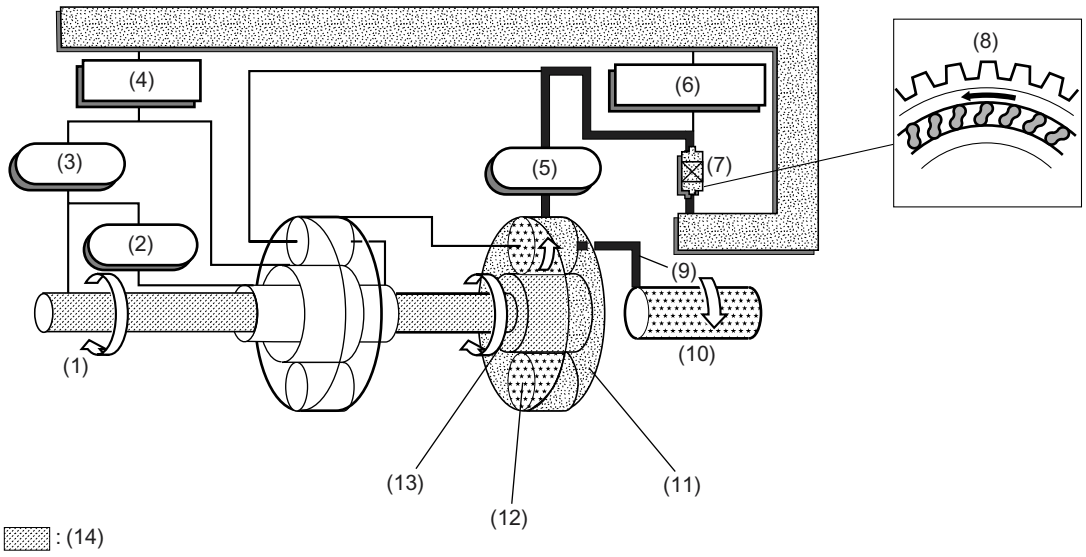


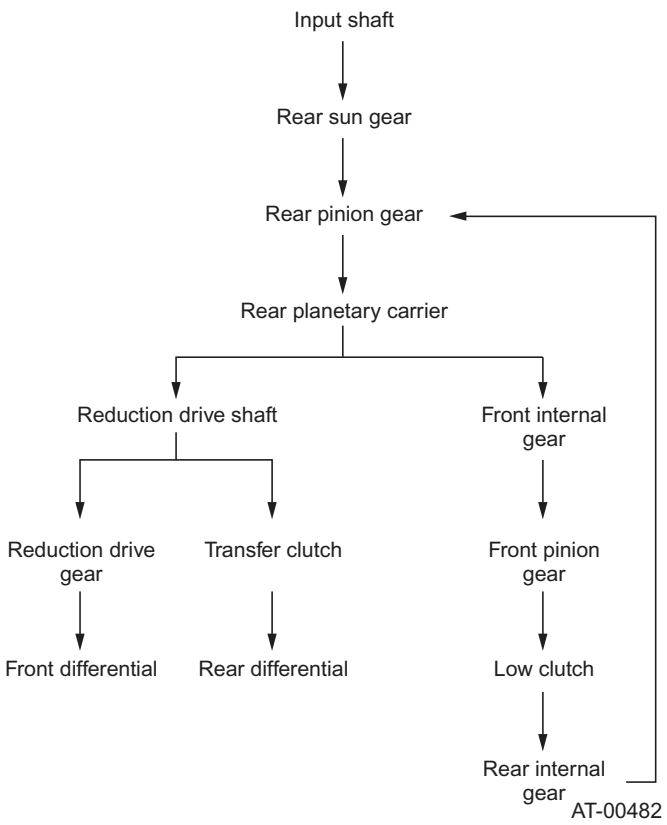
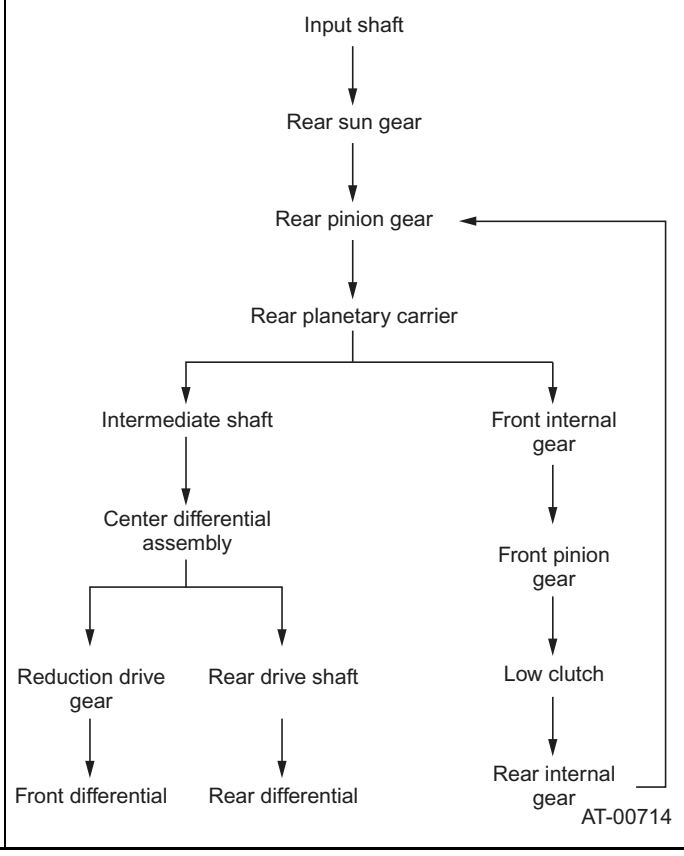
AT-00481

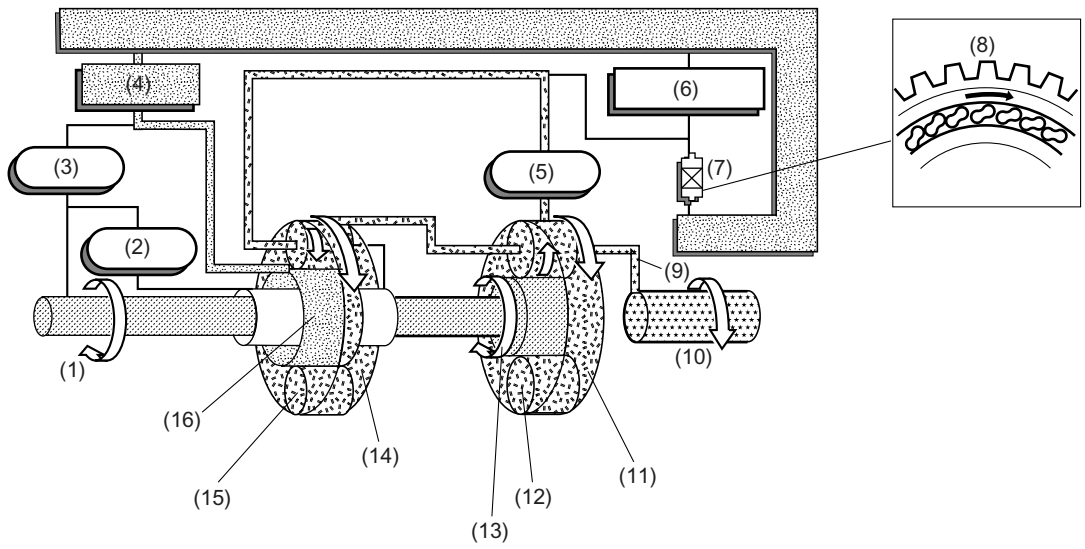
(1) Input shaft
(2) High clutch
(3) Reverse clutch
(4) 2-4 brake
(5) Low clutch
(6) Low & reverse brake
(7) One-way clutch
(8) Locked
(9) Rear planetary carrier
(10) MPT models: reduction drive shaft
VTD Models: intermediate shaft
(11) Rear internal gear
(12) Rear pinion gear
(13) Rear sun gear
(14) Input
(15) Output
(16) Locked
(17) Planetary gear components involved in power transmission

5. 2ND SPEED GEAR IN D, 3, 2 RANGE (D_2, 3_2, 2_2)

When the 2nd gear is selected in D, 3, or 2 range, the 2-4 brake and the low clutch are engaged. The front sun gear is now locked to the transmission case due to engagement of the 2-4 brake. In this state, the torque of the rear sun gear is transmitted to the rear internal gear through the path of the front internal gear, front pinion gears, low clutch drum and low clutch. At this time, the one-way clutch is freewheeling since the low clutch drum is rotating clockwise.
In this power flow configuration, the rear pinion gears are rotated by the rear internal gear at a speed faster than that available from the configuration for the 1st gear, so the rotation speed of the reduction drive shaft* is higher than that of the 1st gear.
Since the drive power is transmitted without passing through the one-way clutch in the 2nd gear, the backward driving force from the wheels is transmitted through the reduction drive shaft* to the input shaft; this makes the engine braking effect available.

*: MPT models only. VTD models are equipped with an intermediate shaft.

Operating condition of components	
Low clutch : engaged 2-4 brake : engaged	
Power flow (in acceleration)	
MPT models	VTD models
	



: (17)
: (18)
: (19)
: (20)

AT-00483

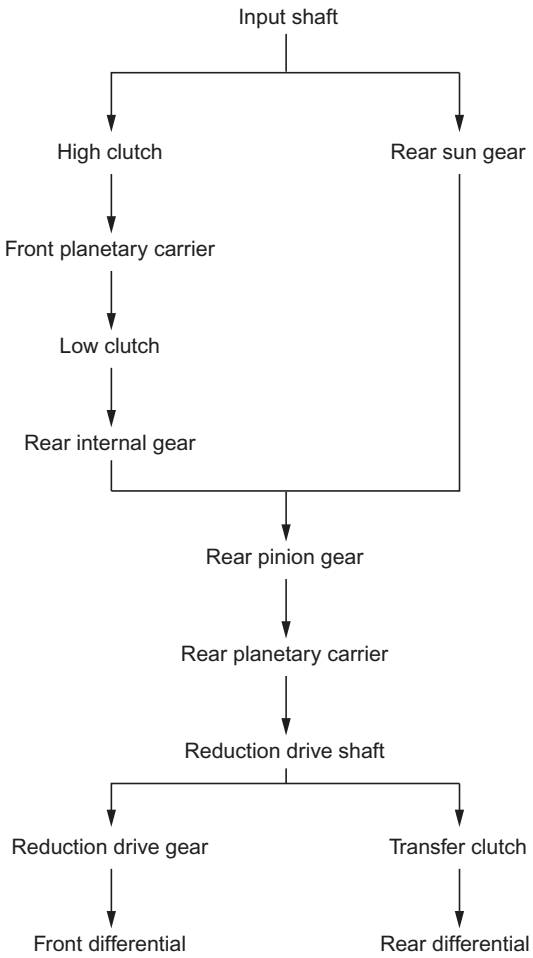
(1) Input shaft
(2) High clutch
(3) Reverse clutch
(4) 2-4 brake
(5) Low clutch
(6) Low & reverse clutch
(7) One-way clutch
(8) Free
(9) Rear planetary carrier
(10) MPT models: reduction drive shaft
VTD Models: intermediate shaft
(11) Rear internal gear
(12) Rear pinion gear
(13) Rear sun gear
(14) Front internal gear
(15) Front pinion gear
(16) Front sun gear
(17) Input
(18) Output
(19) Locked
(20) Planetary gear components involved in power transmission

6. 3RD SPEED GEAR IN D OR 3 RANGE (D_3, 3_3)

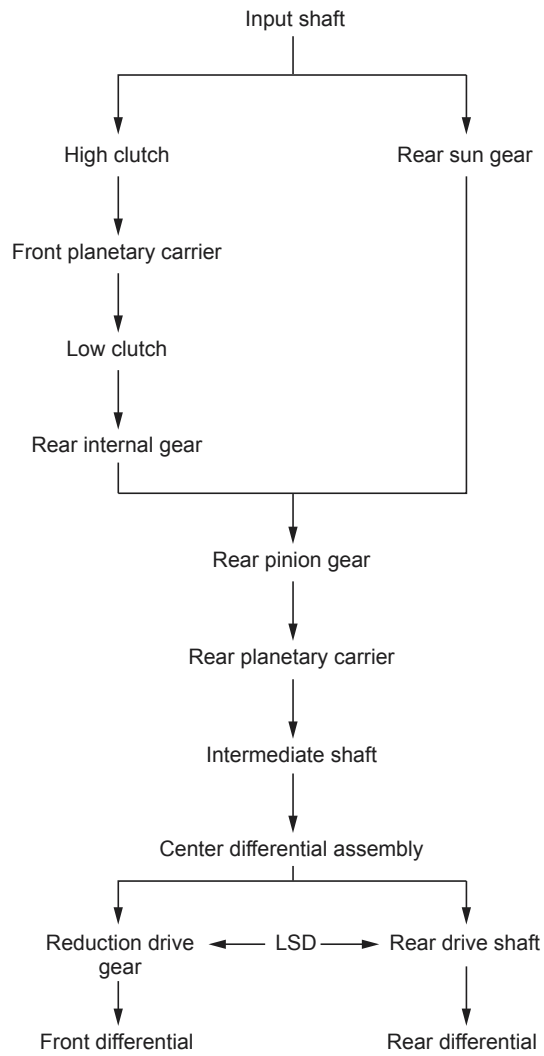
When the 3rd gear is selected in the D or 3 range, the low clutch and the high clutch are engaged. The engaged high clutch rotates through its drum the front planetary carrier, and rotation of the carrier is transmitted to the rear internal gear through the engaged low clutch. In this power flow configuration, the rear sun gear and the rear internal gear rotate at the same speed since the rear pinion gears are solid on their axes and the whole planetary gear train rotates as a unit at the same speed as its sun gear. As a result, the input shaft and the reduction drive shaft* rotate at the same speed. In the 3rd gear, the one-way clutch is freewheeling because the low clutch is rotating clockwise. Since the drive power is transmitted without passing through the one-way clutch, the backward driving force from the wheels is transmitted through the reduction drive shaft* to the input shaft; this makes the engine braking effect available.

*: MPT models only. VTD models are equipped with an intermediate shaft.

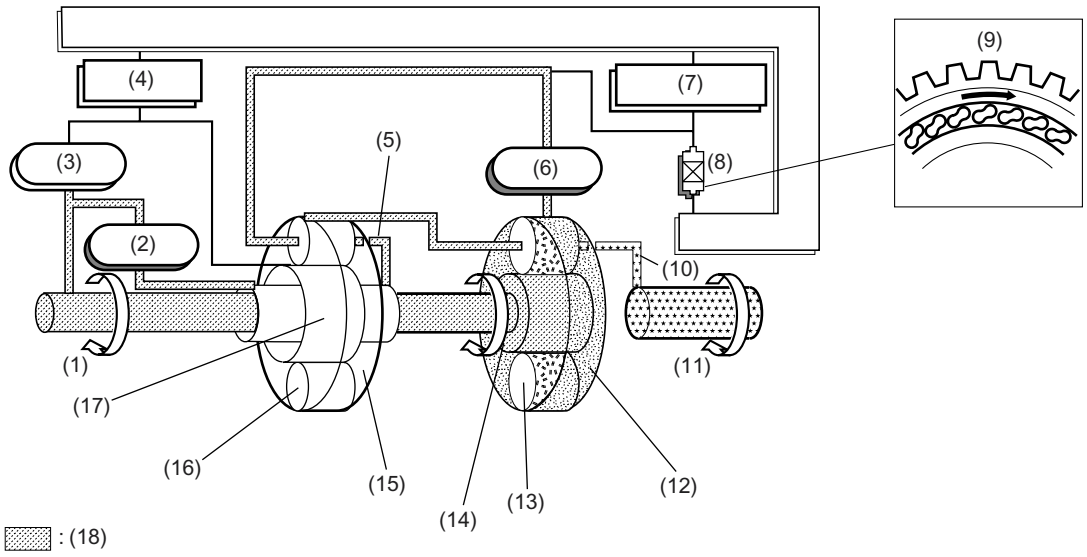
Operating condition of components	
High clutch : engaged Low clutch : engaged	
Power flow (in acceleration)	
MPT models	VTD models



AT-00484



AT-00715



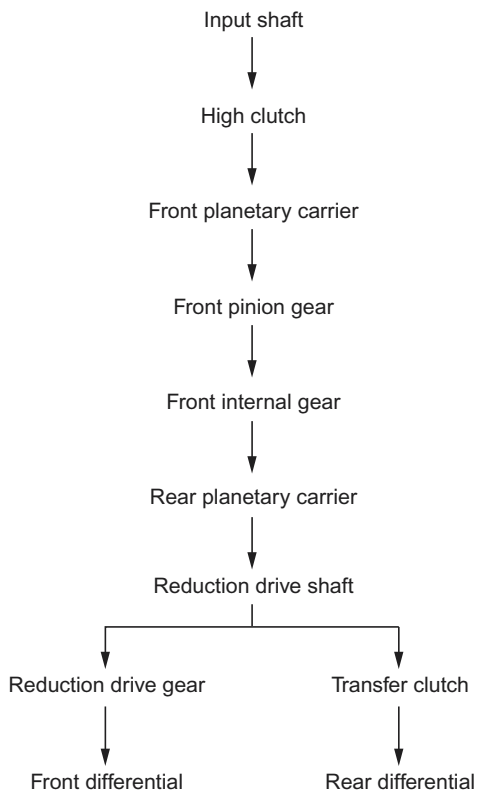
AT-00485

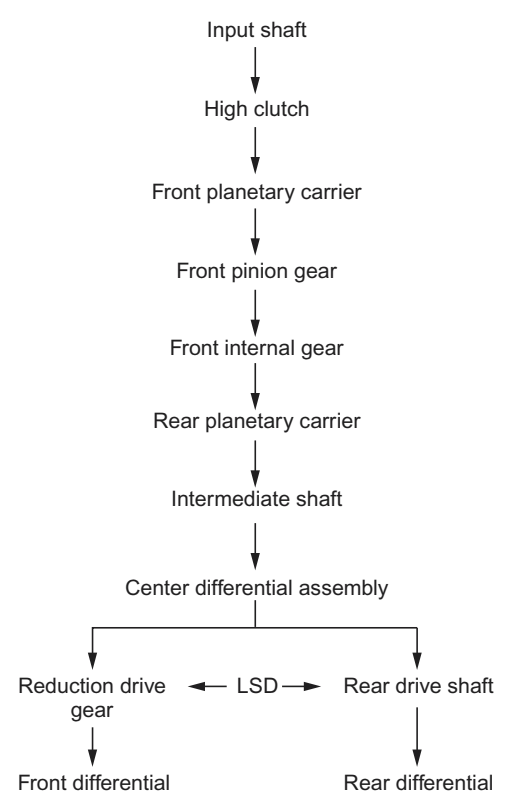
(1) Input shaft
(2) High clutch
(3) Reverse clutch
(4) 2-4 brake
(5) Front planetary carrier
(6) Low clutch
(7) Low & reverse brake
(8) One-way clutch
(9) Free
(10) Rear planetary carrier
(11) MPT models: reduction drive shaft
VTD Models: intermediate shaft
(12) Rear internal gear
(13) Rear pinion gear
(14) Rear sun gear
(15) Front internal gear
(16) Front pinion gear
(17) Front sun gear
(18) Input
(19) Output
(20) Locked
(21) Planetary gear components involved in power transmission

7. 4TH SPEED GEAR IN D RANGE (D_4)

When the 4th gear is selected in the D range, the high clutch and the 2-4 brake are engaged. The engaged high clutch causes the front planetary carrier to rotate, whereas the engaged 2-4 brake causes the front sun gear to be locked to the transmission case.
The front planetary carrier rotates at the same speed as the input shaft. The rotation of the front planetary carrier causes the front pinion gears to revolve around the stationary front sun gear, which causes the front internal gear to rotate faster than the input shaft.
As a result, the reduction drive shaft* is driven at a higher speed than the input shaft.
In the 4th gear, the one-way clutch is freewheeling because the low clutch is rotating clockwise. Since the drive power is transmitted without passing through the one-way clutch, the backward driving force from the wheels is transmitted through the reduction drive shaft* to the input shaft; this makes the engine braking effect available.

*: MPT models only. VTD models are equipped with an intermediate shaft.

<table>
<tr><td colspan="2">Operating condition of components</td></tr>
<tr><td colspan="2">2-4 brake : engaged
High clutch : engaged</td></tr>
<tr><td colspan="2">Power flow (in acceleration)</td></tr>
<tr><td>MPT models
 

AT-00486</td><td>VTD models
 

AT-00716</td></tr>
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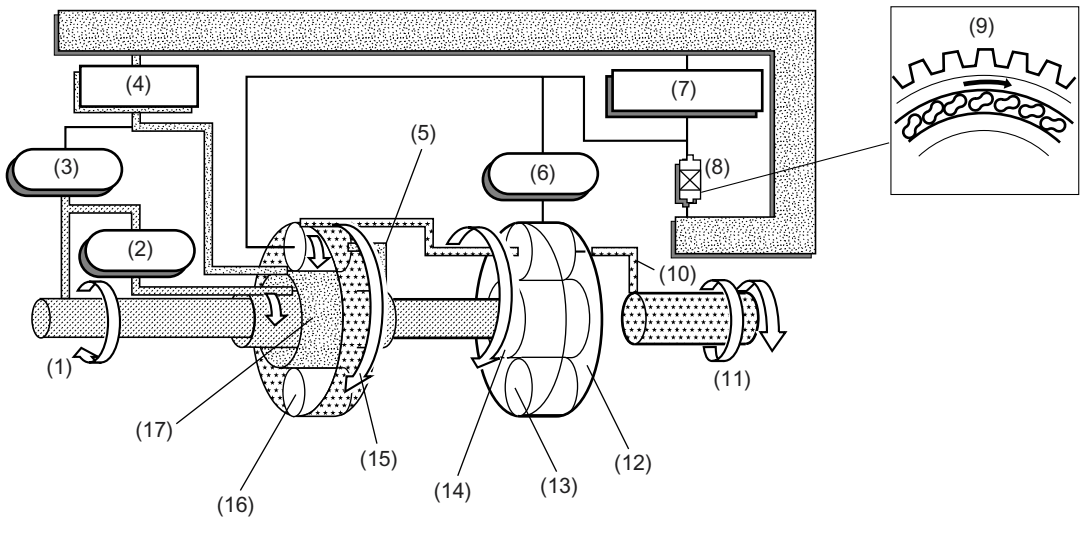


: (18)
: (19)
: (20)
: (21)

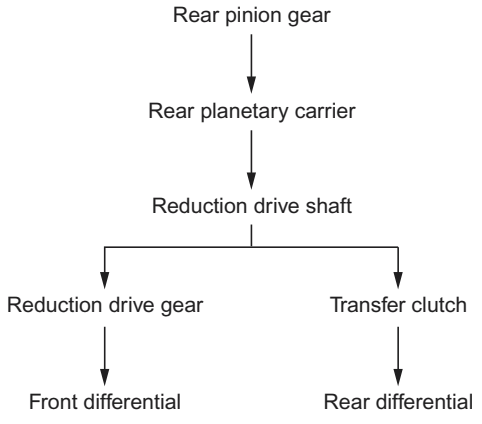
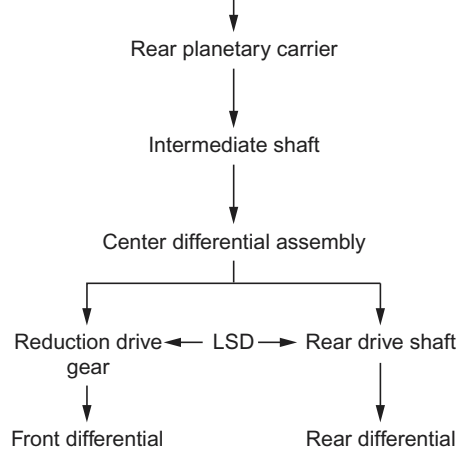
AT-00487

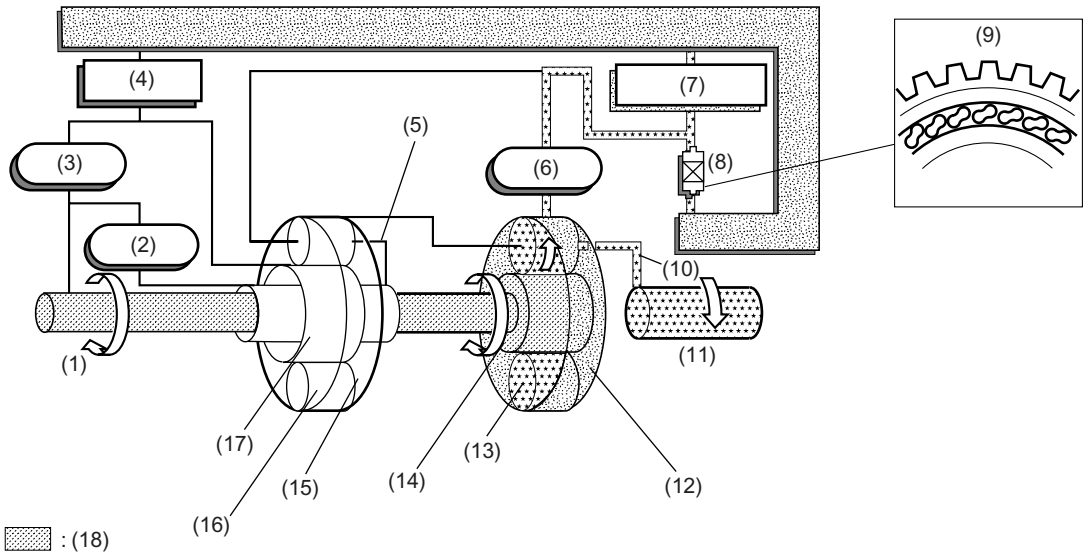
(1) Input shaft
(2) High clutch
(3) Reverse clutch
(4) 2-4 brake
(5) Front planetary carrier
(6) Low clutch
(7) Low & reverse brake
(8) One-way clutch
(9) Free
(10) Rear planetary carrier
(11) MPT models: reduction drive shaft
VTD Models: intermediate shaft
(12) Rear internal gear
(13) Rear pinion gear
(14) Rear sun gear
(15) Front internal gear
(16) Front pinion gear
(17) Front sun gear
(18) Input
(19) Output
(20) Locked
(21) Planetary gear components involved in power transmission

8. 1ST SPEED GEAR IN 1 RANGE (1_1)

When the 1st gear is selected in the 1 range, both the low clutch and the low & reverse brake are engaged. Although the power flow configuration is the same as that with the 1st gear in the D or 3 range, the one-way clutch produces no freewheeling effect because the low & reverse brake is locking the rear internal gear always to the transmission case.
During coasting, therefore, the backward driving force from the wheels is transmitted through the reduction drive gear* to the input shaft. This means, unlike the 1st gear in D or 3 range, that the engine braking effect is available in this range.

*: MPT models only. VTD models are equipped with an intermediate shaft.

Operating condition of components	
Low clutch : engaged Low & reverse brake : engaged One-way clutch : no effect	
Power flow (in acceleration)	
MPT models	VTD models
	
AT-00488	AT-00717



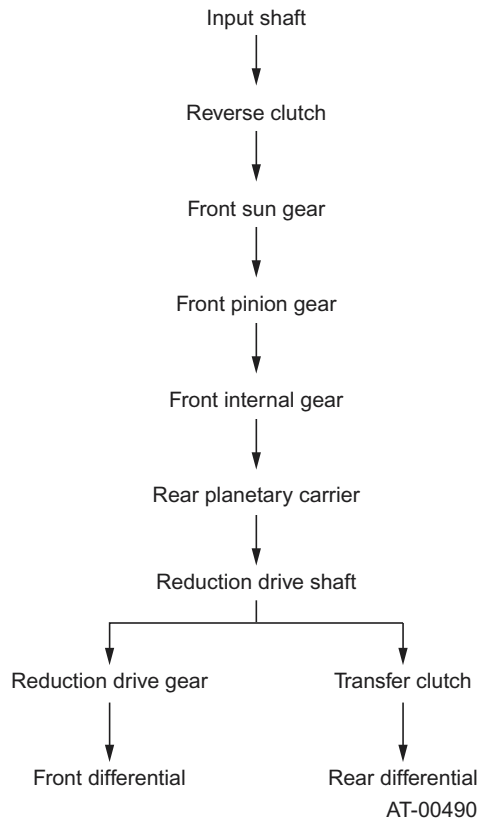
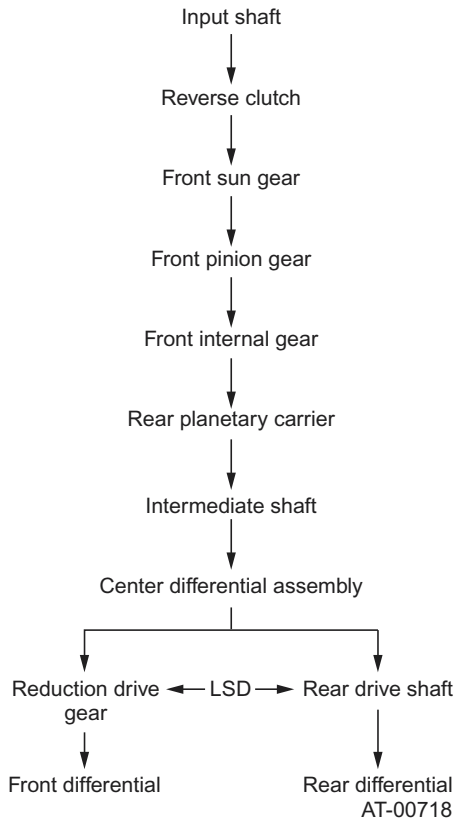
AT-00489

(1) Input shaft
(2) High clutch
(3) Reverse clutch
(4) 2-4 brake
(5) Front planetary carrier
(6) Low clutch
(7) Low & reverse brake
(8) One-way clutch
(9) no effect
(10) Rear planetary carrier
(11) MPT models: reduction drive shaft
VTD Models: intermediate shaft
(12) Rear internal gear
(13) Rear pinion gear
(14) Rear sun gear
(15) Front internal gear
(16) Front pinion gear
(17) Front sun gear
(18) Input
(19) Output
(20) Locked
(21) Planetary gear components involved in power transmission

9. R RANGE

When the selector lever is placed in the R position, the reverse clutch and the low & reverse brake are engaged. The reverse clutch allows the input shaft torque to be transmitted to the front sun gear, while the low & reverse brake allows the low clutch drum to be interlocked with the transmission case.
The rotation of the front sun gear causes the front pinion gear to rotate in the opposite direction and therefore the front internal gear rotates in the same direction.
At this time, the rotation speed transmitted to the front internal gear is reduced through gearing between the front sun gear and the front pinion gears.
The one-way clutch produces no freewheeling effect because the low & reverse brake is in engagement.
In this range, since the power transmission is made without passing through the one-way clutch, the driving force from the wheels is transmitted through the reduction drive shaft* to the input shaft; this makes the engine braking effect available.

*: MPT models only. VTD models are equipped with an intermediate shaft.

<table>
<tr><td colspan="2">Operating condition of components</td></tr>
<tr><td colspan="2">Reverse clutch : engaged
Low & reverse brake : engaged</td></tr>
<tr><td colspan="2">Power flow (in acceleration)</td></tr>
<tr><td>MPT models
 
</td><td>VTD models
 
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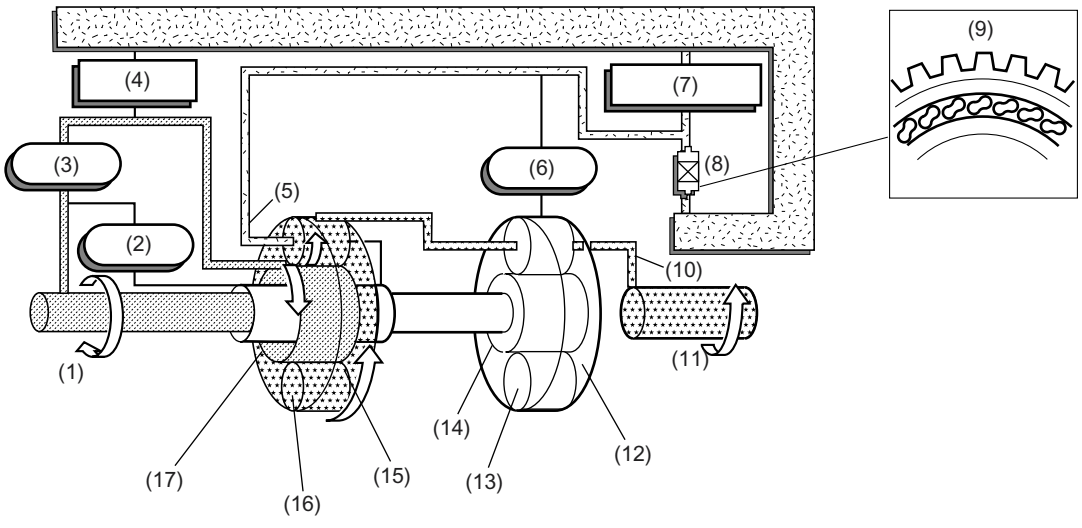


: (18)
: (19)
: (20)
: (21)

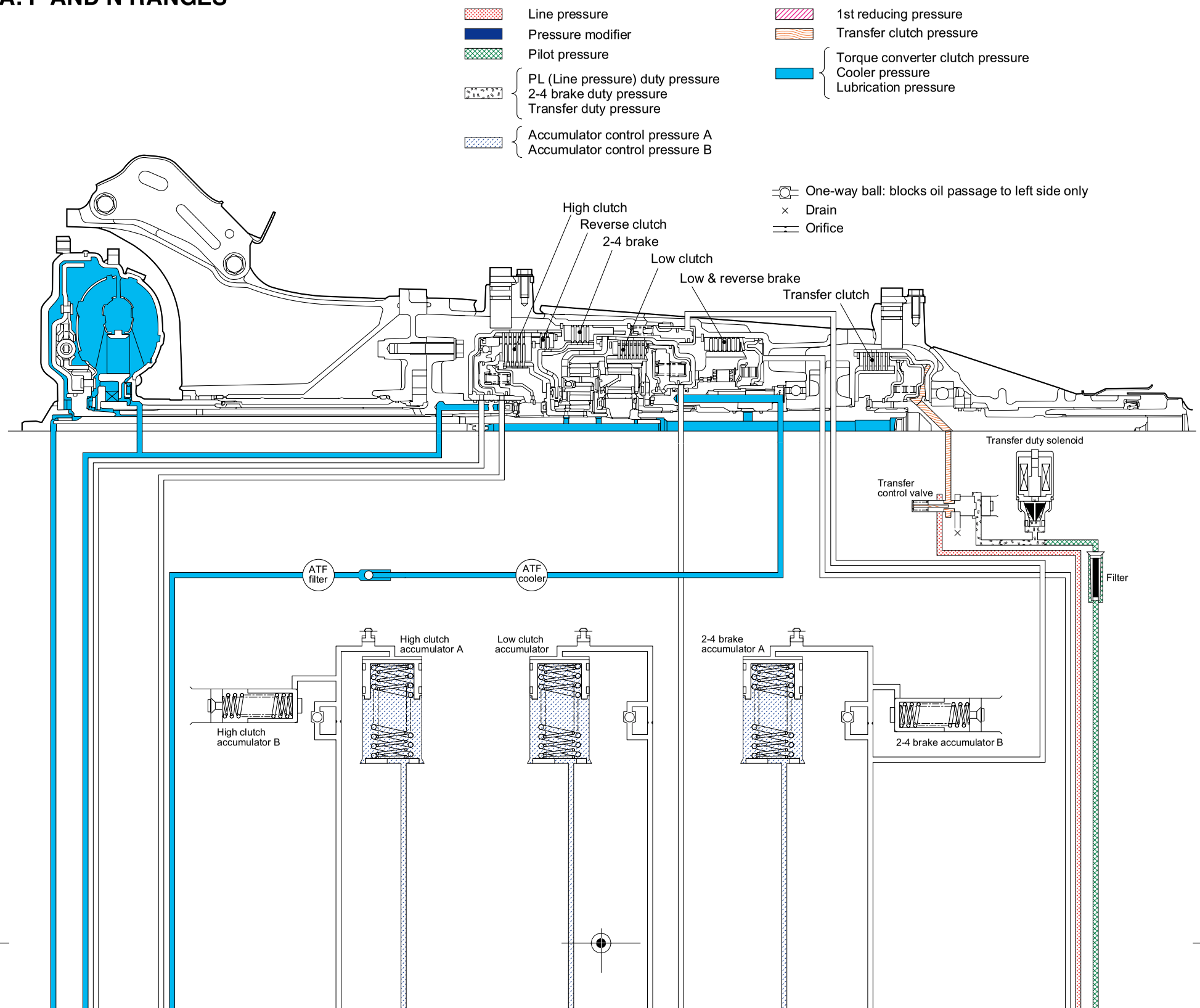
AT-00491

(1) Input shaft
(2) High clutch
(3) Reverse clutch
(4) 2-4 brake
(5) Front planetary carrier
(6) Low clutch
(7) Low & reverse brake
(8) One-way clutch
(9) no effect
(10) Rear planetary carrier
(11) MPT models: reduction drive shaft
VTD Models: intermediate shaft
(12) Rear internal gear
(13) Rear pinion gear
(14) Rear sun gear
(15) Front internal gear
(16) Front pinion gear
(17) Front sun gear
(18) Input
(19) Output
(20) Locked
(21) Planetary gear components involved in power transmission

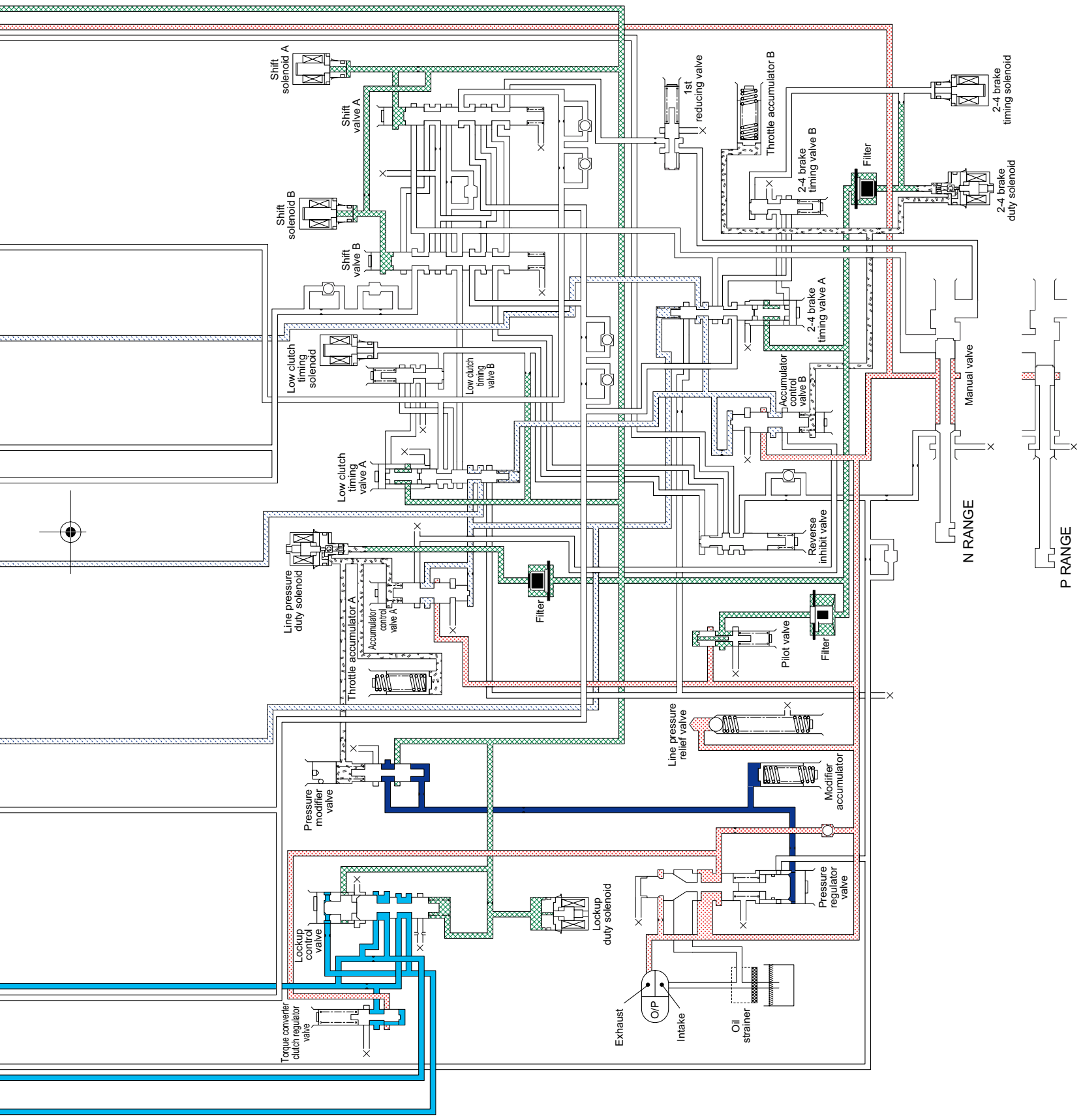
MEMO

10.Schematic Drawings

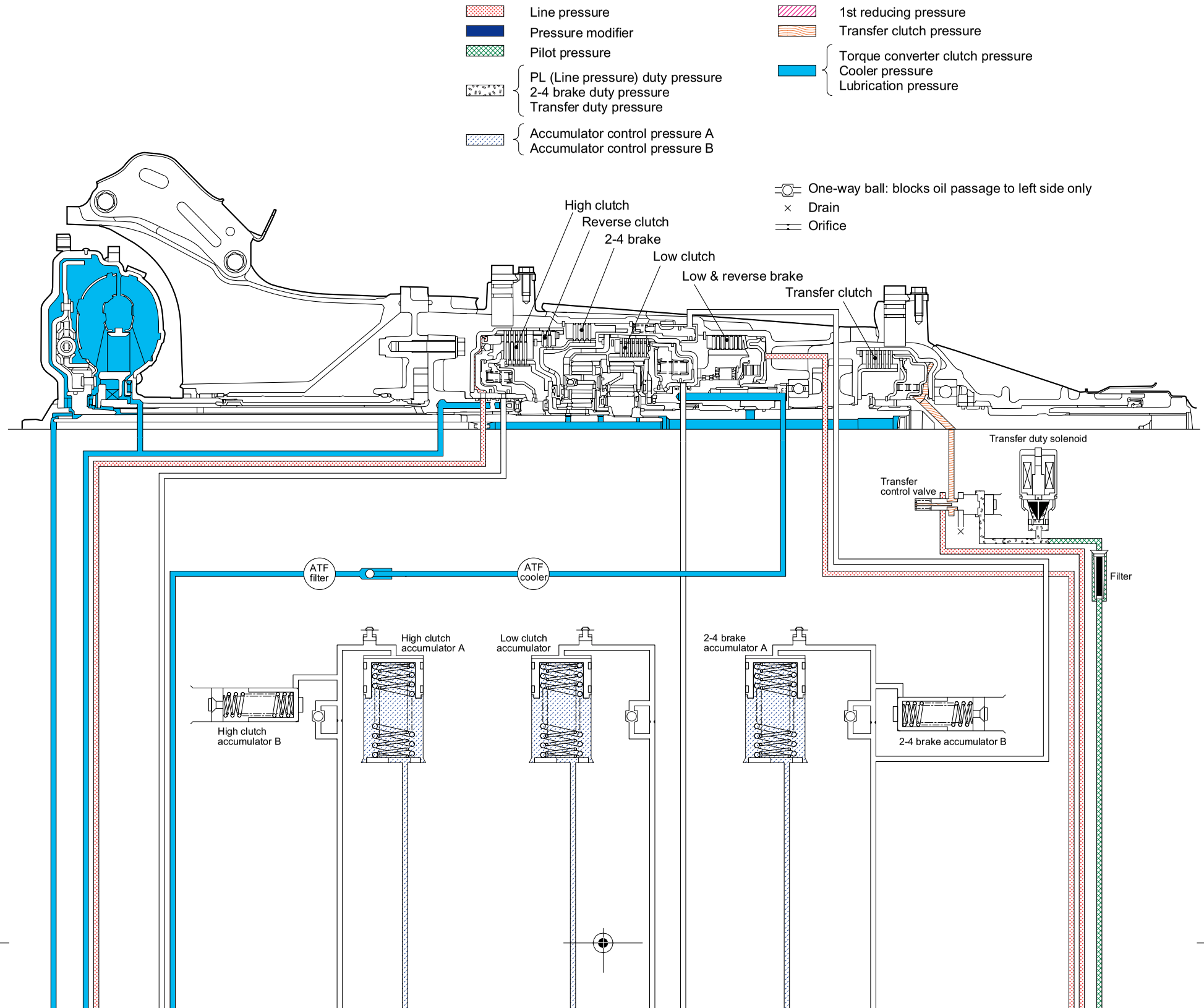
A: P AND N RANGES



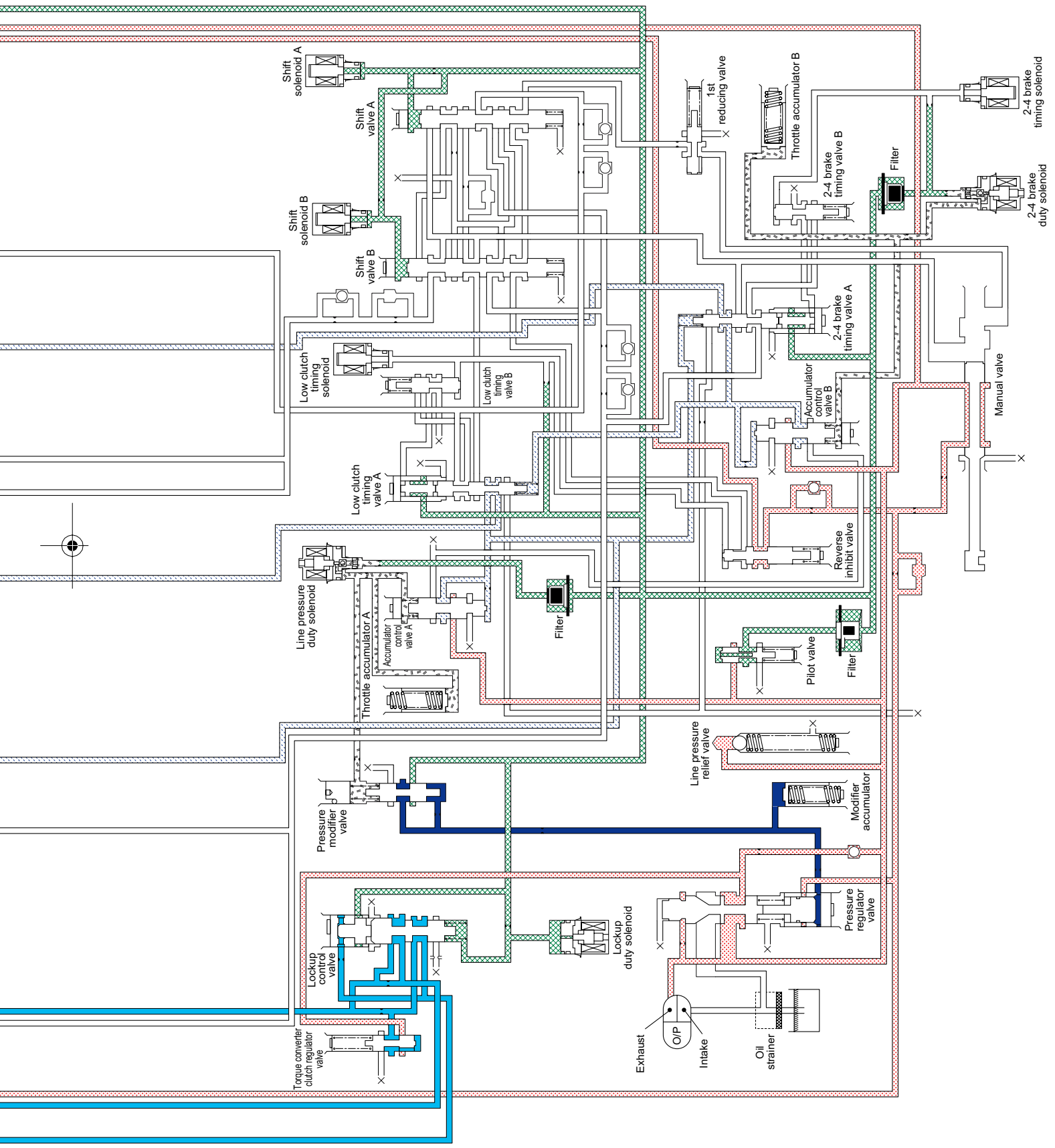
AT-01259


Shift solenoid A
Shift valve A
Shift solenoid B
Shift valve B
Low clutch timing solenoid
Low clutch timing valve B
Low clutch timing valve A
Line pressure duty solenoid
Throttle accumulator A
Accumulator control valve A
Filter
1st reducing valve
Throttle accumulator B
2-4 brake timing valve B
Filter
2-4 brake timing solenoid
2-4 brake duty solenoid
2-4 brake timing valve A
Accumulator control valve B
Manual valve
N RANGE
P RANGE
Reverse inhibit valve
Pilot valve
Filter
Line pressure relief valve
Modifier accumulator
Pressure modifier valve
Lockup control valve
Lockup duty solenoid
Pressure regulator valve
Torque converter clutch regulator valve
Exhaust
O/P
Intake
Oil strainer

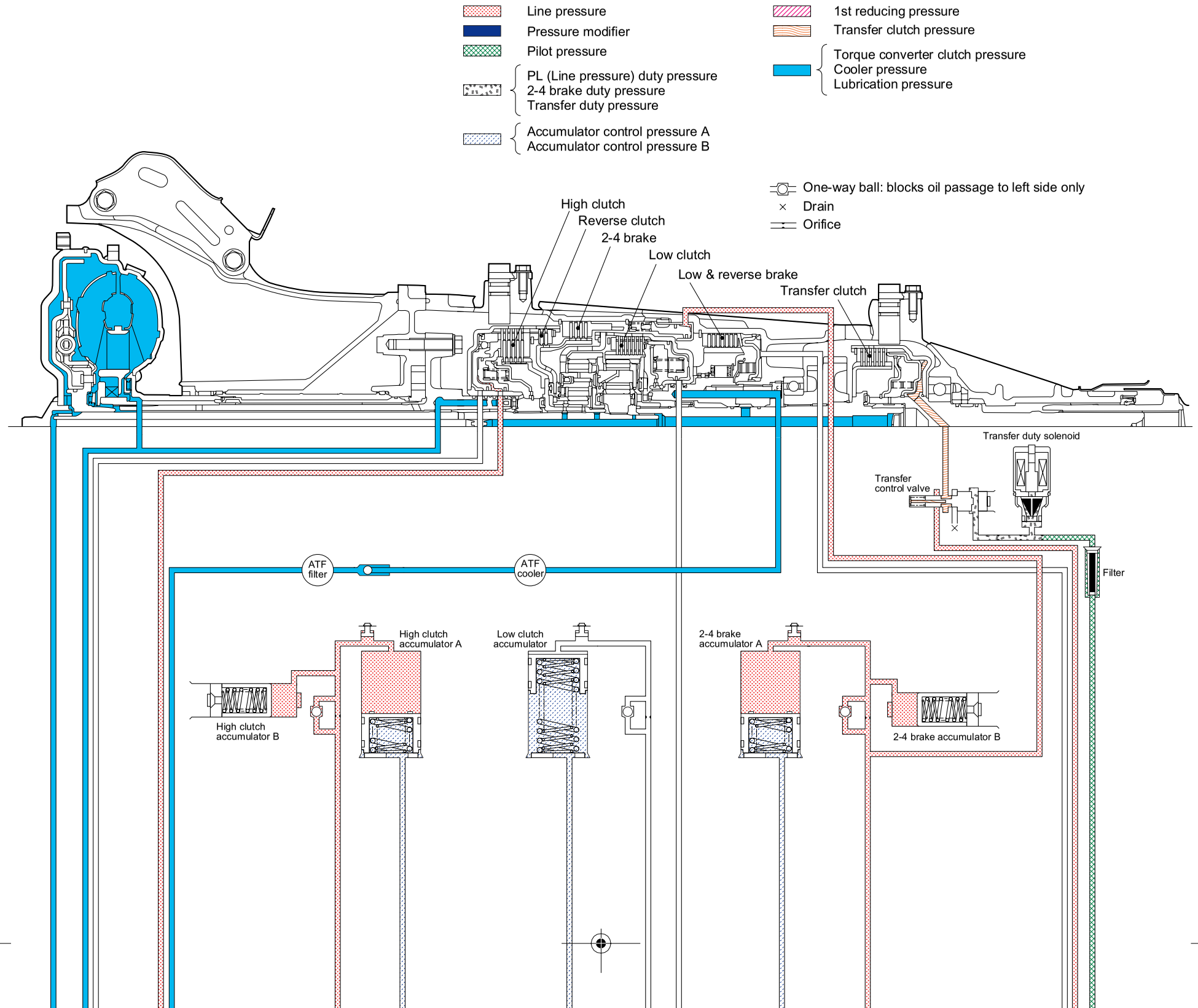
B: R RANGE



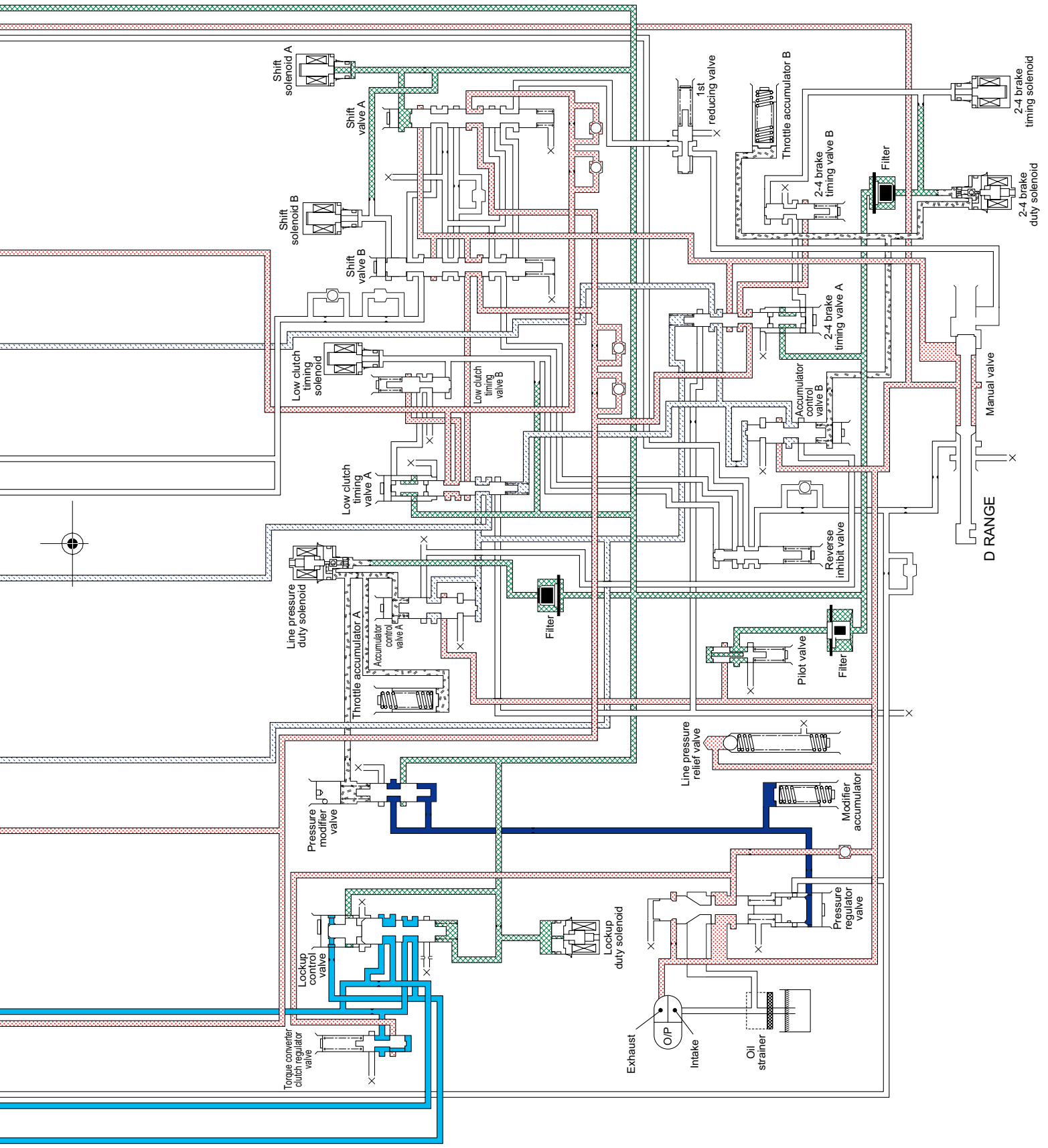
AT-01260



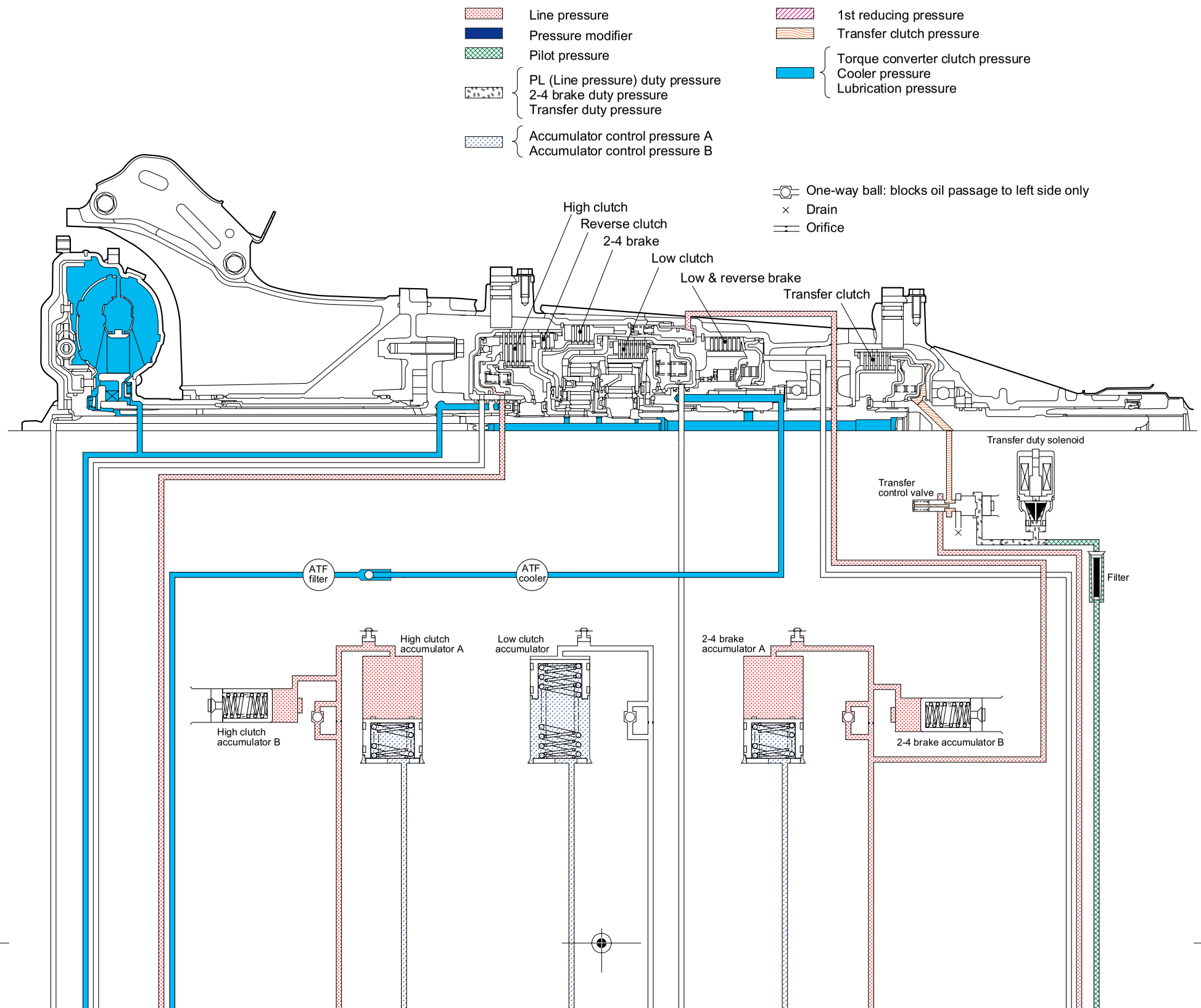
C: 4TH SPEED GEAR IN D RANGE (LOCKUP OFF)



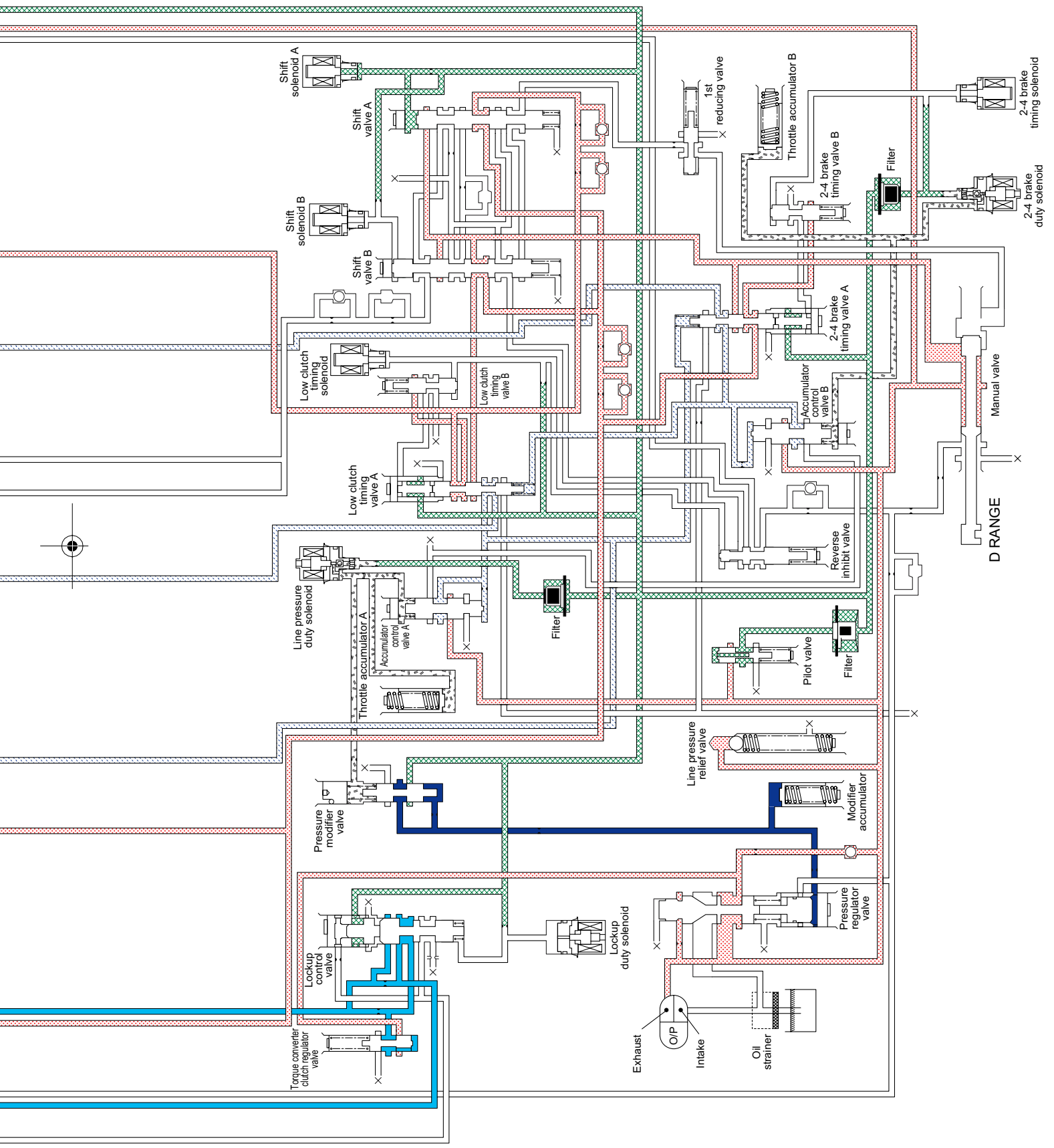
AT-01261


Shift solenoid A
Shift valve A
Shift solenoid B
Shift valve B
Low clutch timing solenoid
Low clutch timing valve B
Low clutch timing valve A
Line pressure duty solenoid
Throttle accumulator A
Accumulator control valve A
Filter
1st reducing valve
Throttle accumulator B
2-4 brake timing valve B
Filter
2-4 brake timing solenoid
2-4 brake duty solenoid
2-4 brake timing valve A
Accumulator control valve B
Manual valve
Reverse inhibit valve
D RANGE
Pilot valve
Filter
Line pressure relief valve
Modifier accumulator
Pressure modifier valve
Lockup control valve
Lockup duty solenoid
Pressure regulator valve
Torque converter clutch regulator valve
Exhaust
O/P
Intake
Oil strainer

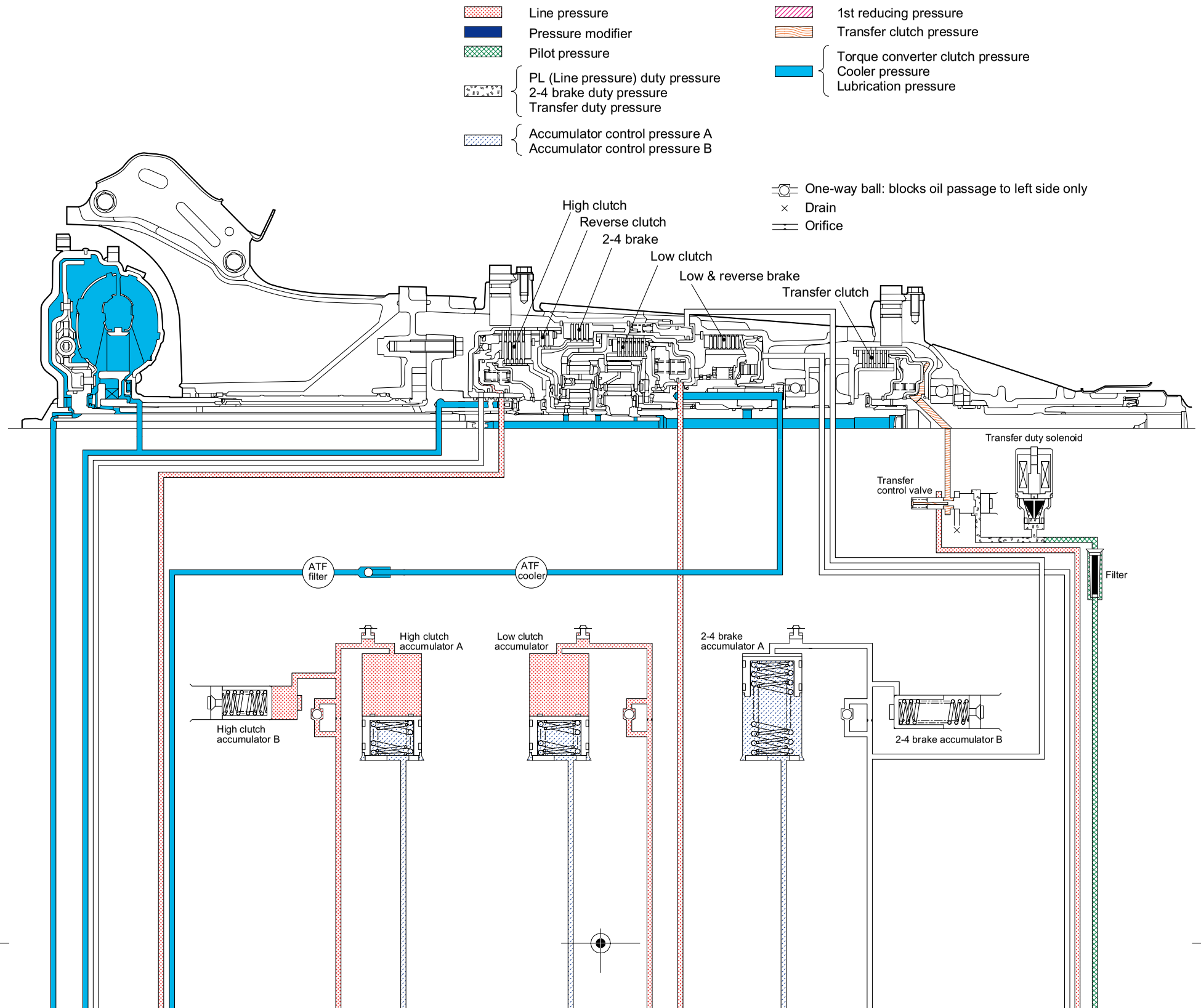
D: 4TH SPEED GEAR IN D RANGE (LOCKUP ON)



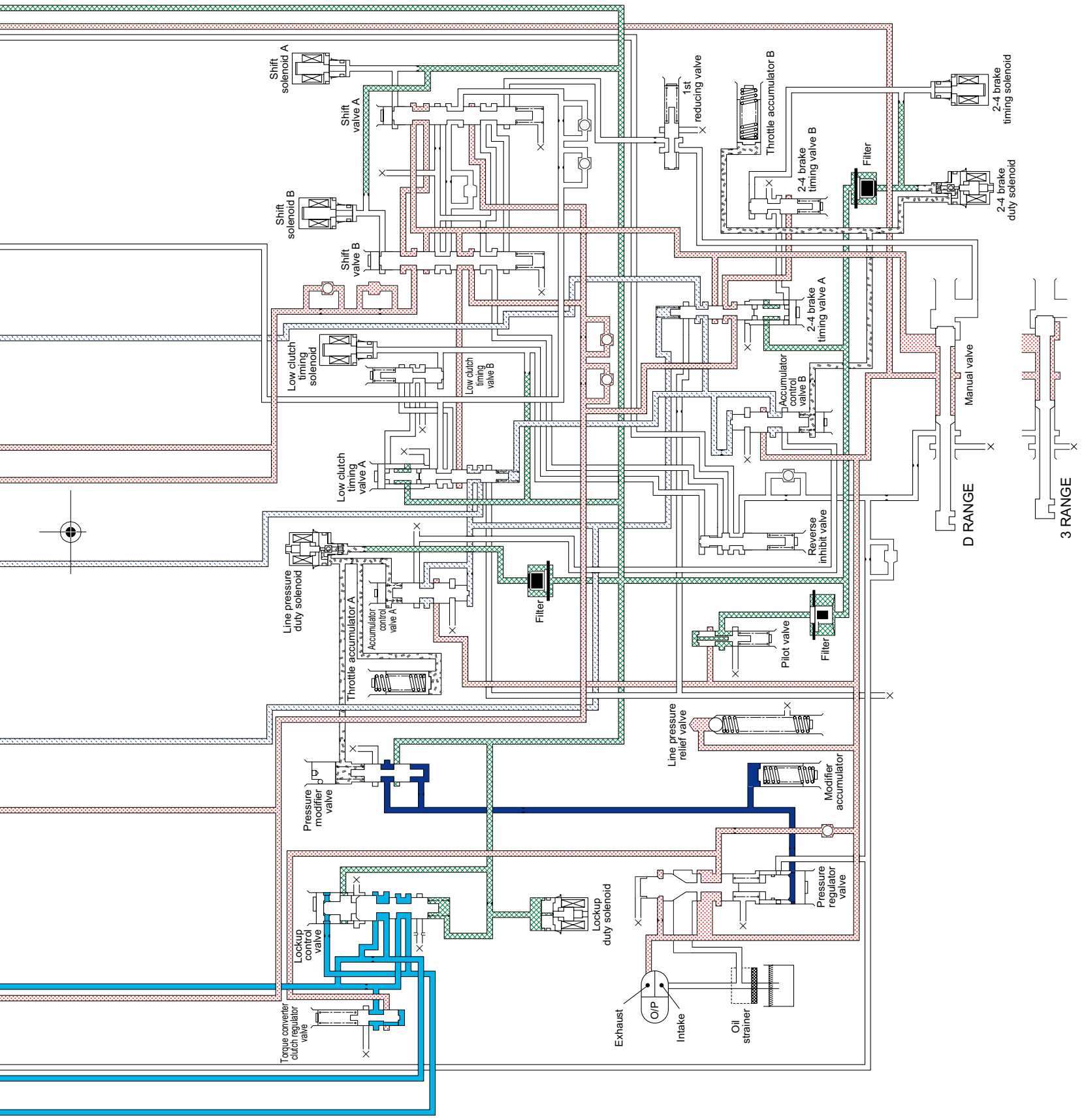
AT-01262


Shift solenoid A
Shift valve A
Shift solenoid B
Shift valve B
Low clutch timing solenoid
Low clutch timing valve B
Low clutch timing valve A
Line pressure duty solenoid
Throttle accumulator A
Accumulator control valve A
Filter
Pressure modifier valve
Lockup control valve
Torque converter clutch regulator valve
Lockup duty solenoid
Exhaust
O/P
Intake
Oil strainer
Pressure regulator valve
Modifier accumulator
Line pressure relief valve
Pilot valve
Filter
Reverse inhibit valve
Accumulator control valve B
2-4 brake timing valve A
Manual valve
D RANGE
2-4 brake timing valve B
Throttle accumulator B
1st reducing valve
Filter
2-4 brake timing solenoid
2-4 brake duty solenoid

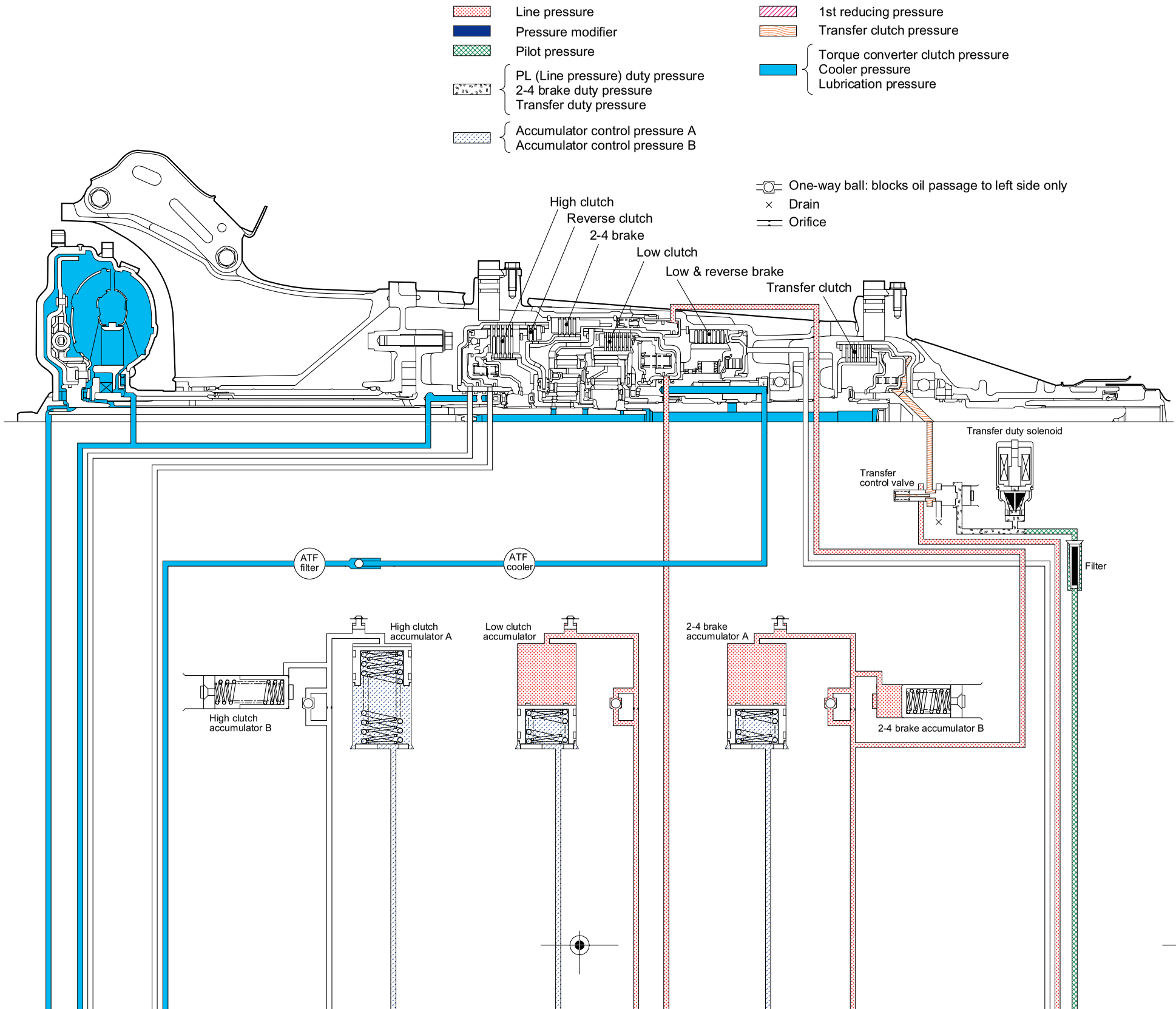
E: 3RD SPEED GEAR IN D AND 3 RANGES

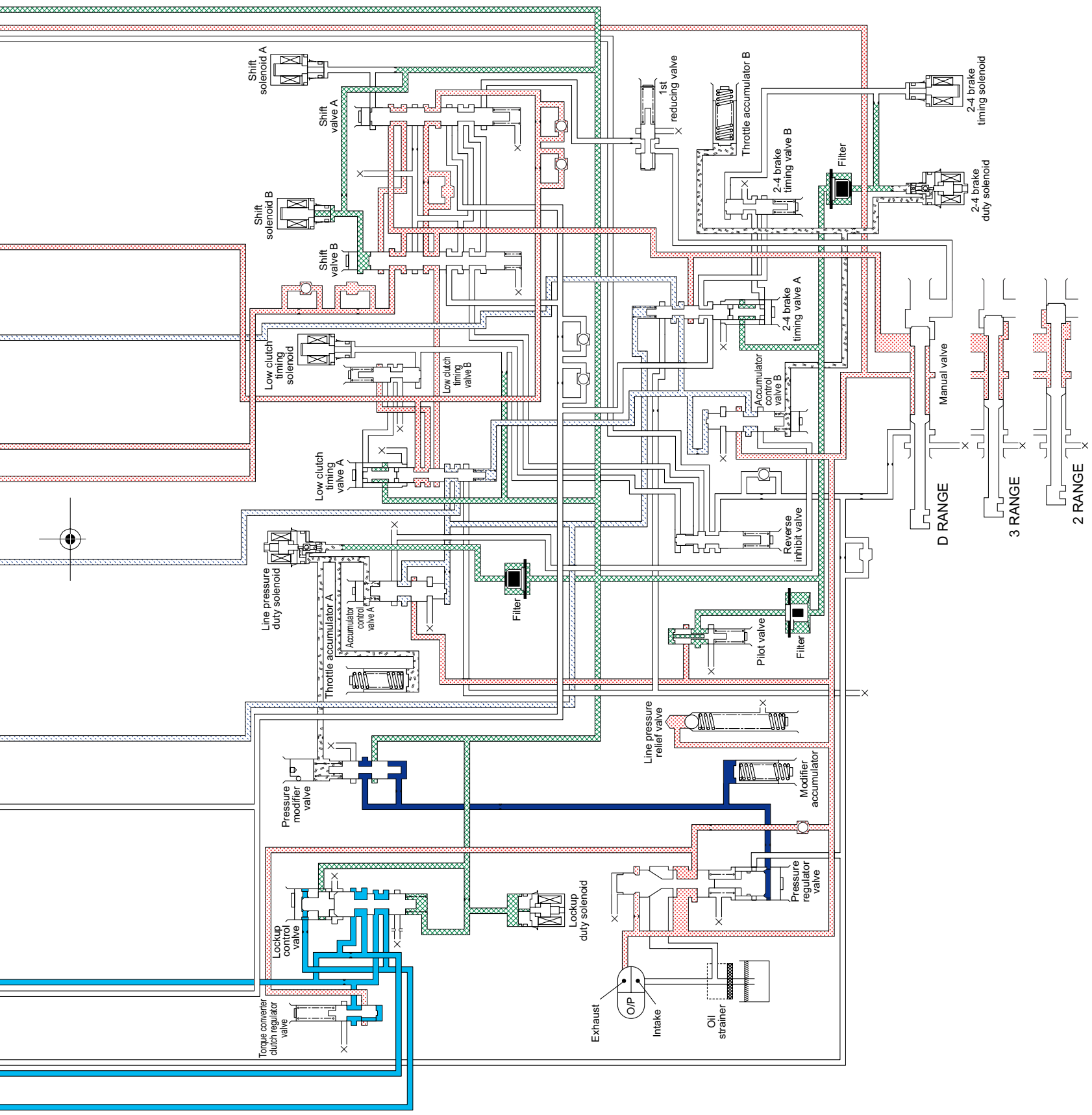


AT-01263

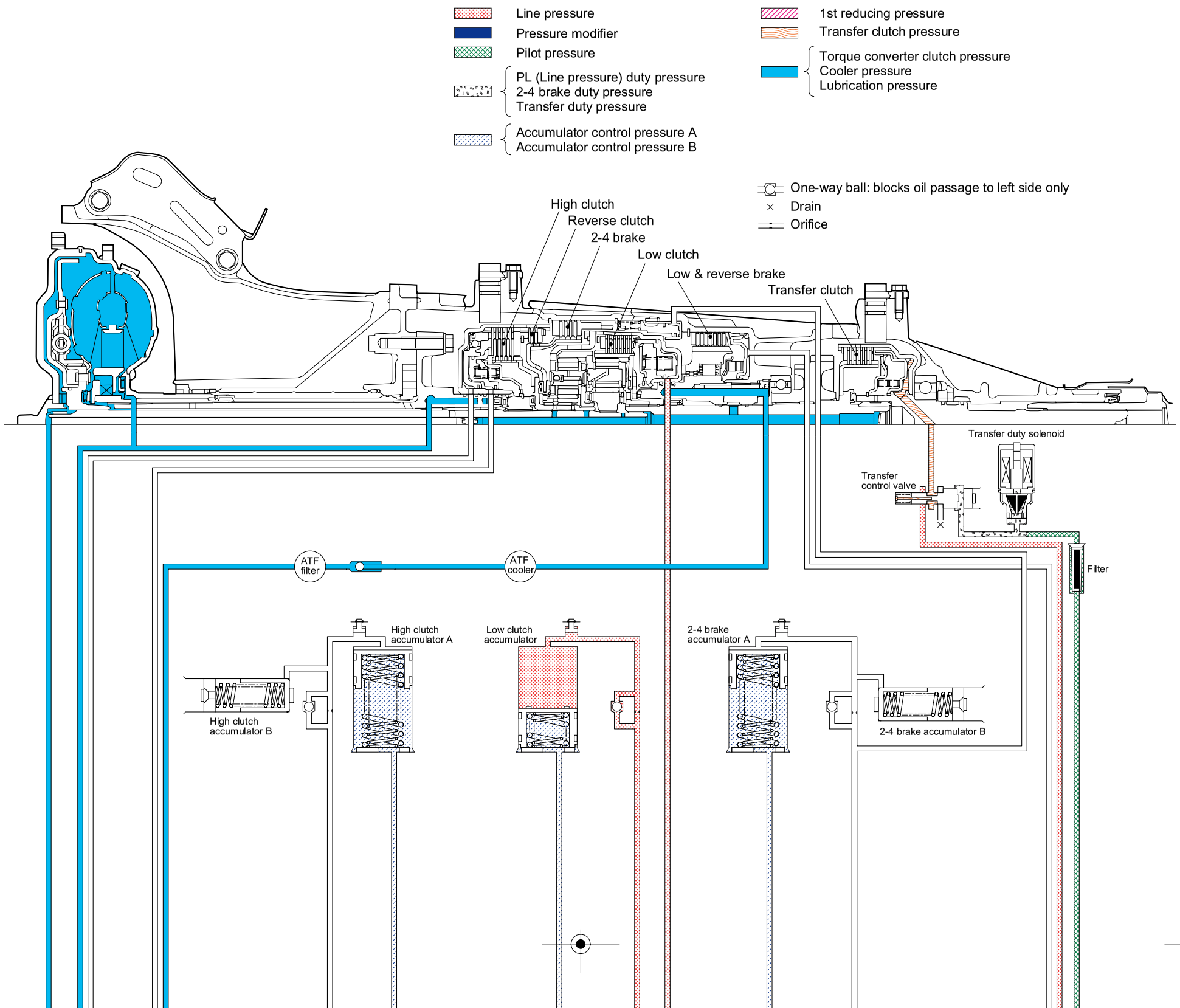

Shift solenoid A
Shift valve A
Shift solenoid B
Shift valve B
Low clutch timing solenoid
Low clutch timing valve B
Low clutch timing valve A
Line pressure duty solenoid
Throttle accumulator A
Accumulator control valve A
Filter
1st reducing valve
Throttle accumulator B
2-4 brake timing valve B
Filter
2-4 brake timing solenoid
2-4 brake duty solenoid
2-4 brake timing valve A
Accumulator control valve B
Manual valve
D RANGE
3 RANGE
Reverse inhibit valve
Pilot valve
Filter
Line pressure relief valve
Modifer accumulator
Pressure modifier valve
Lockup control valve
Lockup duty solenoid
Pressure regulator valve
Torque converter clutch regulator valve
Exhaust
O/P
Intake
Oil strainer

F: 2ND SPEED GEAR IN D, 3 AND 2 RANGES

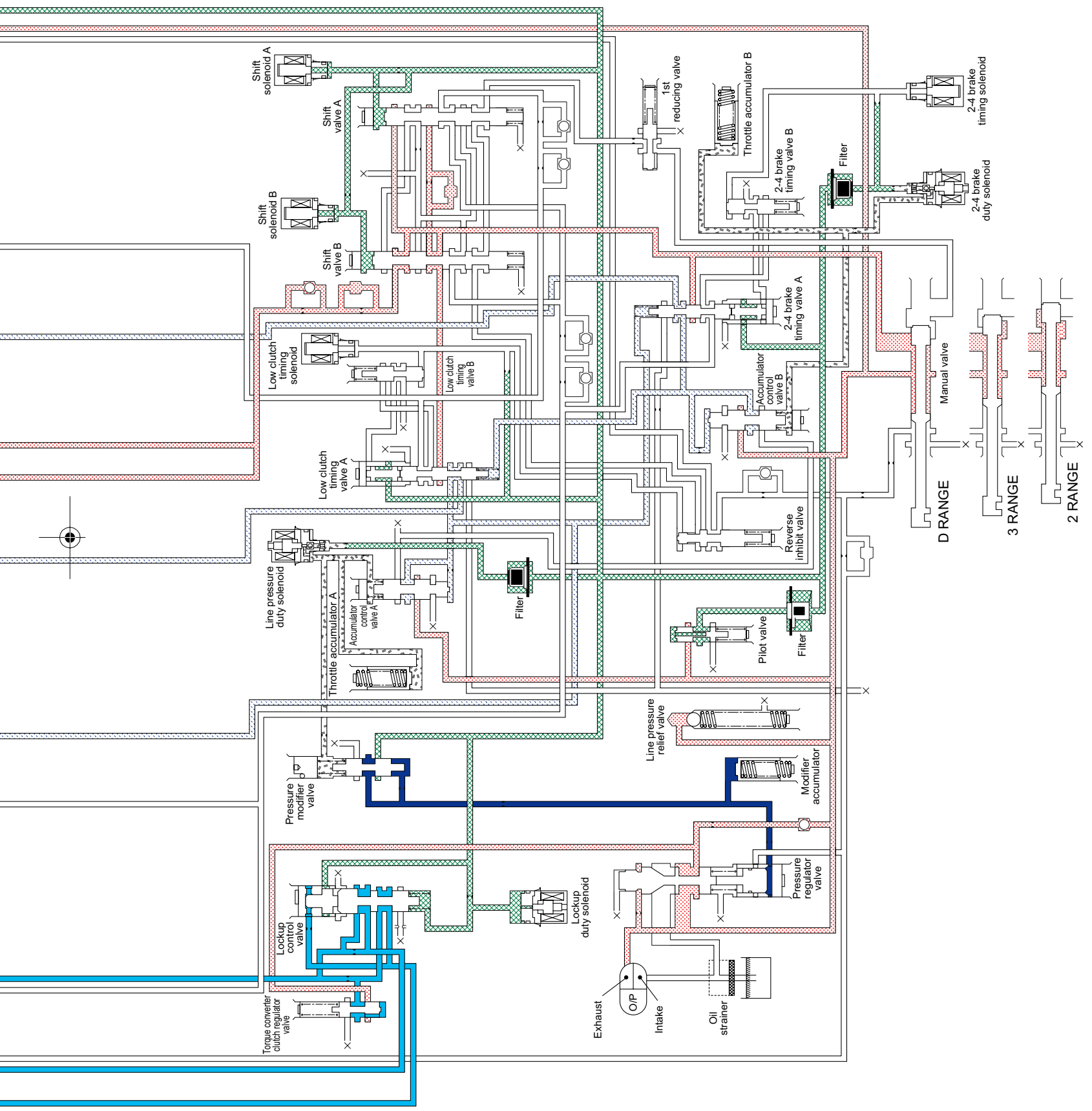



AT-01264
Shift solenoid A
Shift valve A
Shift solenoid B
Shift valve B
Low clutch timing solenoid
Low clutch timing valve B
Low clutch timing valve A
Line pressure duty solenoid
Throttle accumulator A
Accumulator control valve A
Filter
1st reducing valve
Throttle accumulator B
2-4 brake timing valve B
Filter
2-4 brake timing solenoid
2-4 brake duty solenoid
2-4 brake timing valve A
Accumulator control valve B
Manual valve
D RANGE
3 RANGE
2 RANGE
Reverse inhibit valve
Pilot valve
Filter
Line pressure relief valve
Modifier accumulator
Pressure modifier valve
Lockup control valve
Lockup duty solenoid
Pressure regulator valve
Torque converter clutch regulator valve
Exhaust
O/P
Intake
Oil strainer

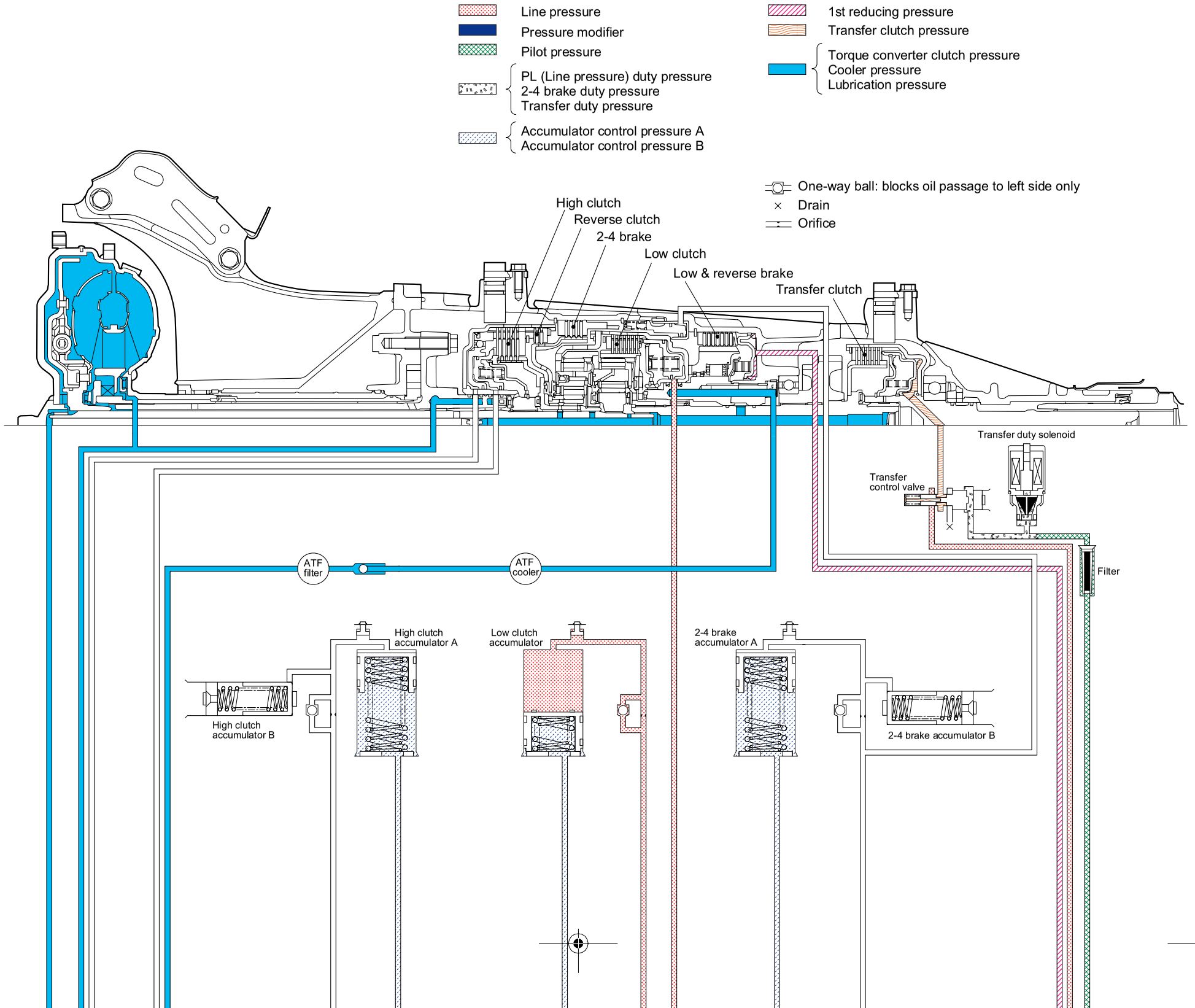
G: 1ST GEAR IN D, 3, AND 2 RANGES

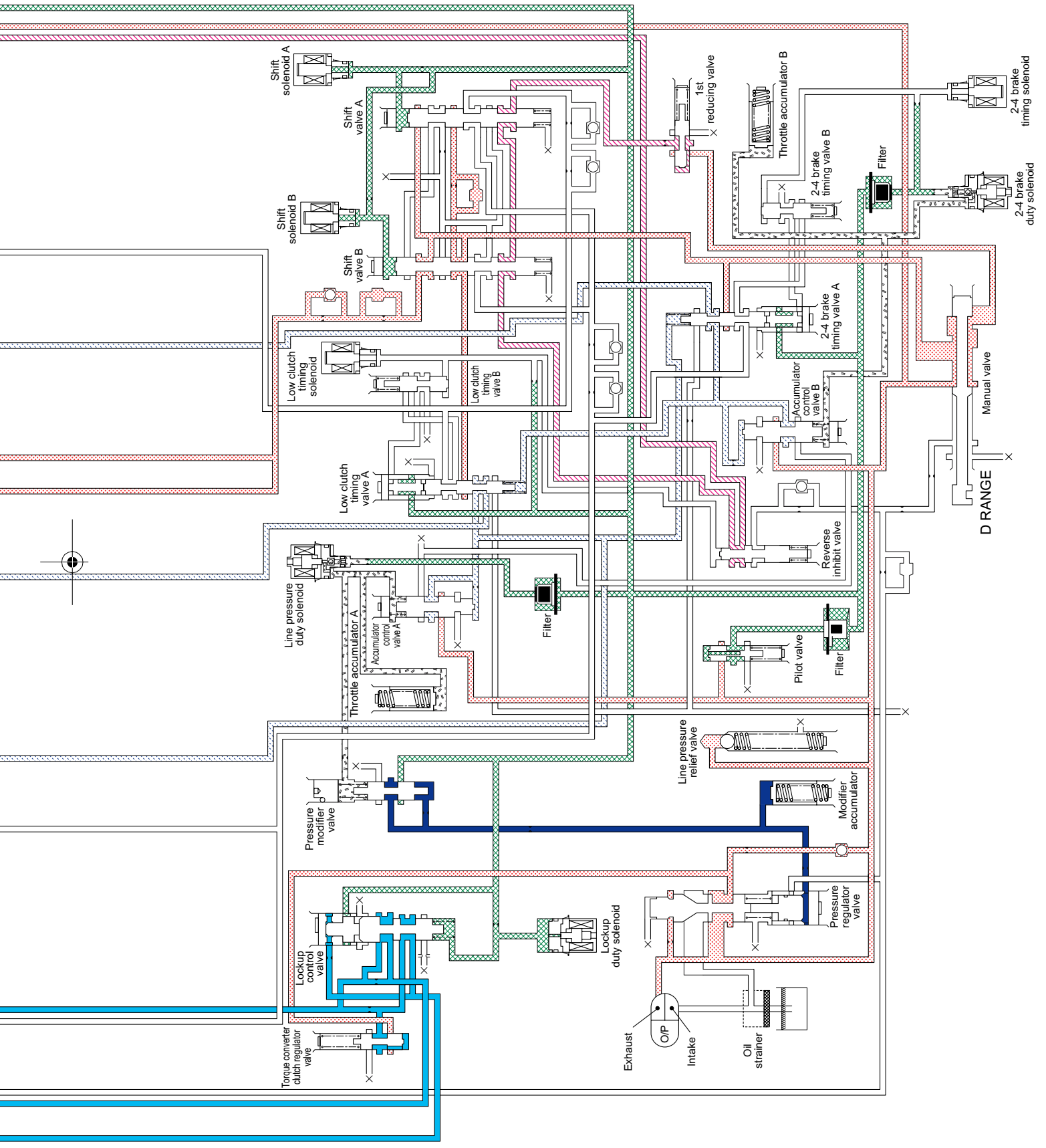


AT-01265


Shift solenoid A
Shift valve A
Shift solenoid B
Shift valve B
Low clutch timing solenoid
Low clutch timing valve B
Low clutch timing valve A
Line pressure duty solenoid
Throttle accumulator A
Accumulator control valve A
Filter
1st reducing valve
Throttle accumulator B
2-4 brake timing valve B
Filter
2-4 brake timing solenoid
2-4 brake duty solenoid
2-4 brake timing valve A
Accumulator control valve B
Manual valve
D RANGE
3 RANGE
2 RANGE
Reverse inhibit valve
Pilot valve
Filter
Line pressure relief valve
Modifier accumulator
Pressure modifier valve
Lockup control valve
Lockup duty solenoid
Pressure regulator valve
Torque converter clutch regulator valve
Exhaust
O/P
Intake
Oil strainer

H: 1ST SPEED GEAR IN 1 RANGE




Shift solenoid A
Shift valve A
Shift solenoid B
Shift valve B
Low clutch timing solenoid
Low clutch timing valve B
Low clutch timing valve A
Line pressure duty solenoid
Throttle accumulator A
Accumulator control valve A
Filter
1st reducing valve
Throttle accumulator B
2-4 brake timing valve B
Filter
2-4 brake timing solenoid
2-4 brake duty solenoid
2-4 brake timing valve A
Accumulator control valve B
Manual valve
D RANGE
Reverse inhibit valve
Pilot valve
Filter
Line pressure relief valve
Modifier accumulator
Pressure modifier valve
Lockup control valve
Lockup duty solenoid
Pressure regulator valve
Torque converter clutch regulator valve
Exhaust
O/P
Intake
Oil strainer

AT-01266

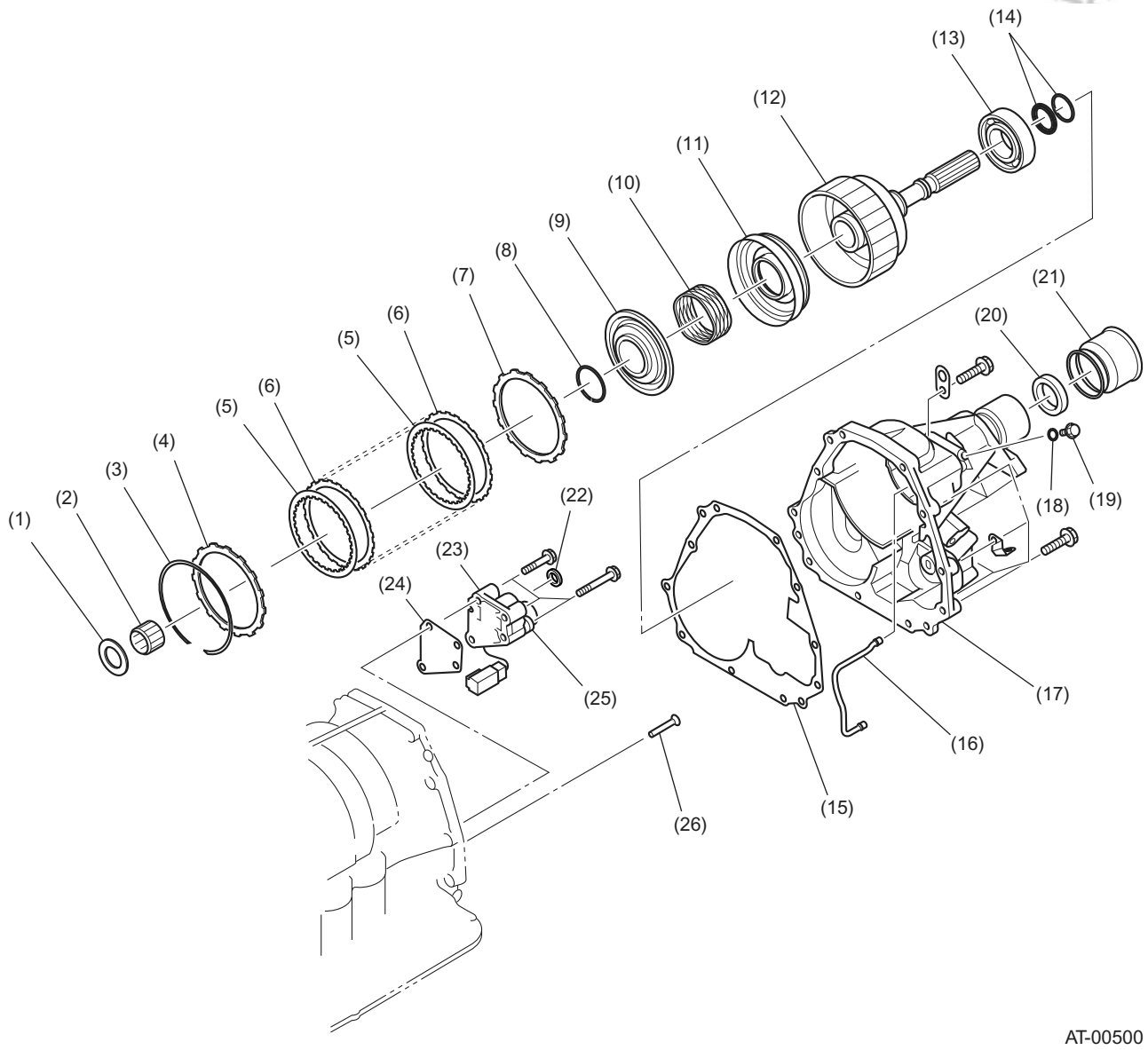
11.AWD Transfer System

A: MPT MODELS

1. GENERAL

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.



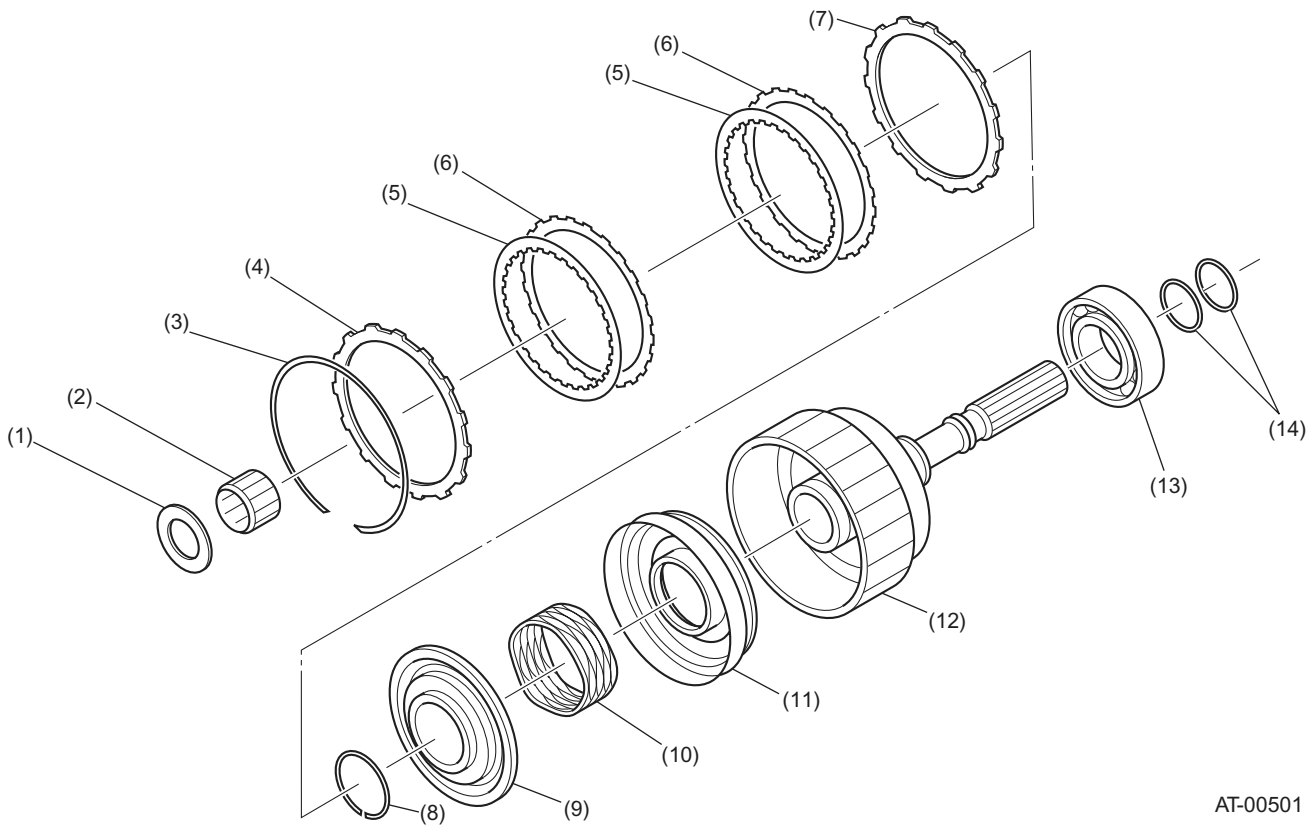
AT-00500

(1) Thrust bearing
(2) Needle bearing
(3) Snap ring
(4) Pressure plate
(5) Drive plate
(6) Driven plate
(7) Pressure plate
(8) Snap ring
(9) Transfer piston seal
(10) Return spring
(11) Transfer clutch piston
(12) Rear drive shaft
(13) Ball bearing
(14) Seal ring
(15) Gasket
(16) Transfer clutch pipe
(17) Extension case
(18) O-ring
(19) Plug
(20) Oil seal
(21) Dust cover
(22) Transfer clutch seal
(23) Transfer control valve
(24) Transfer valve plate
(25) Transfer duty solenoid
(26) Inlet filter

2. CONSTRUCTION

● 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.



(1) Thrust bearing
(2) Needle bearing
(3) Snap ring
(4) Pressure plate
(5) Drive plate
(6) Driven plate
(7) Pressure plate
(8) Snap ring
(9) Transfer piston seal
(10) Return spring
(11) Transfer clutch piston
(12) Rear drive shaft
(13) Ball bearing
(14) Seal ring

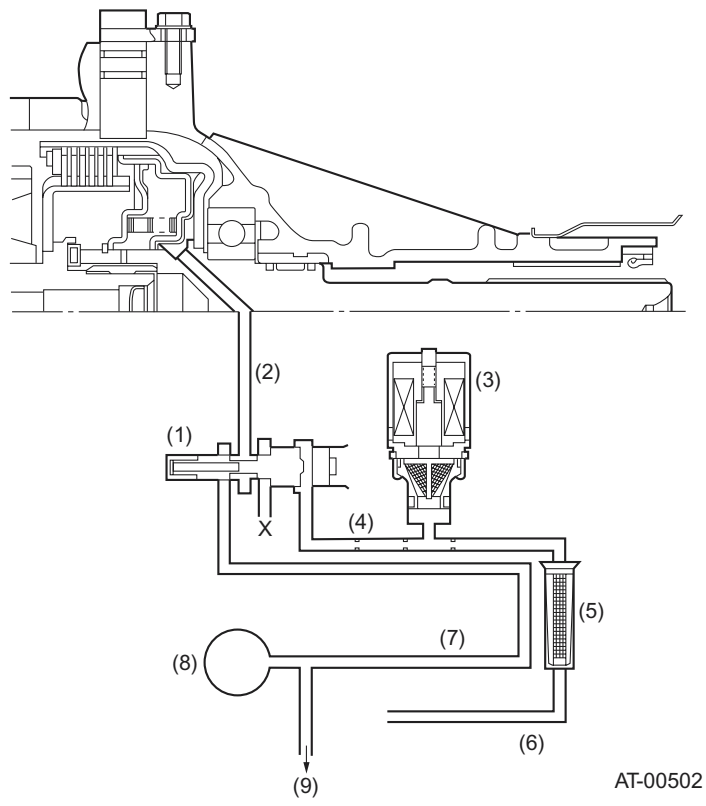
● Transfer hydraulic pressure control unit

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.

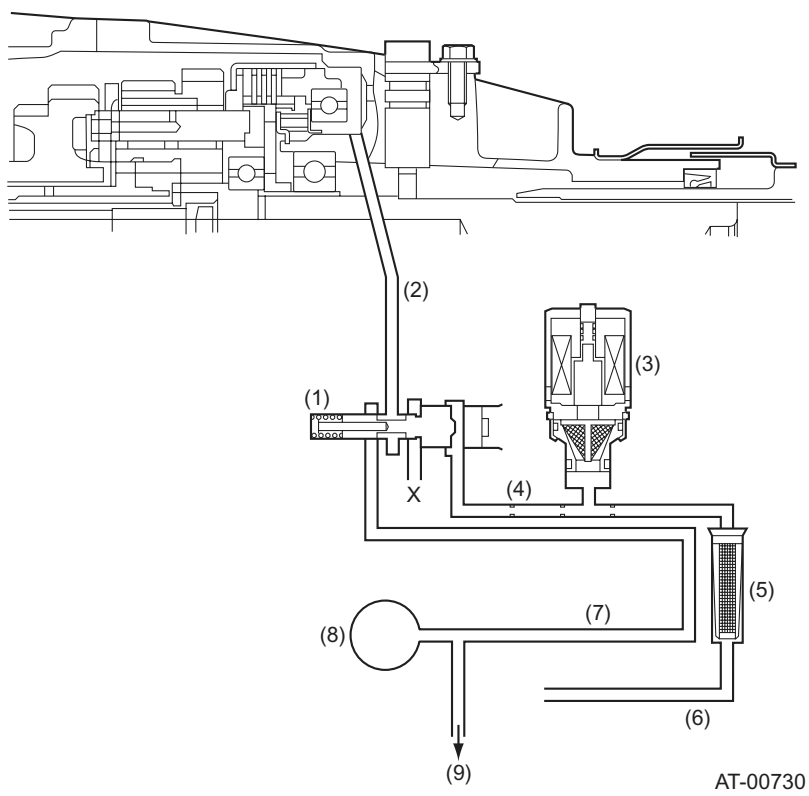


(1) Transfer control valve
(2) Transfer clutch pressure
(3) Transfer duty solenoid
(4) Transfer pressure
(5) Filter
(6) Pilot pressure
(7) Line pressure
(8) Oil pump
(9) Transmission hydraulic control valve assembly

B: VTD MODELS

1. GENERAL

Used in the transfer of the VTD models is the SUBARU drive power distribution system which combines a compound planetary gear type center differential installed in the transfer case behind the transmission and a hydraulically operated multi-plate differential action limiting device (LSD) located between the output components of the center differential. Differential action limiting control is performed by the TCM according to driving and road surface conditions. This system allows combining stability provided by the AWD design with good operability.
The input torque is transmitted to the 1st sun gear of the center differential through the intermediate shaft. From the 1st sun gear, the torque is transmitted through the 1st pinion to the output carrier in the front wheel output components, and through the 2nd pinion to the 2nd sun gear in the rear wheel output components.
The center differential performs the differential functions of absorbing the speed difference between the front and rear wheels and also distributes drive forces to the front and rear wheels at a predetermined ratio. In normal conditions (when there is almost no difference in the speed between the front and rear wheels), the drive force distribution ratio is 45.5 % to the front wheels and 54.5 % to the rear wheels. The hydraulic multi-plate clutch connected in parallel with the center differential between the carrier and 2nd sun gear functions as a differential action limiting device (LSD) and also as a device that controls torque distribution according to driving conditions.
The differential action limiting control is based on the parameters that include the throttle angle, engine speed, vehicle speed, and speed ratio of front and rear wheels. The LSD clutch piston is operated by the fluid whose pressure is adjusted by the duty solenoid and the transfer control valve in the transfer case. According to the pressure applied to the piston, the torque distribution ratio changes from the ratio set for the center differential to the direct AWD ratio.
The speed of the front and rear wheels determine the basic signals for the differential action limiting control. The rear wheel speed is detected by sensor installed above the rear drive shaft and the front wheel speed is detected by the sensor on the parking gear above the reduction drive shaft gear.



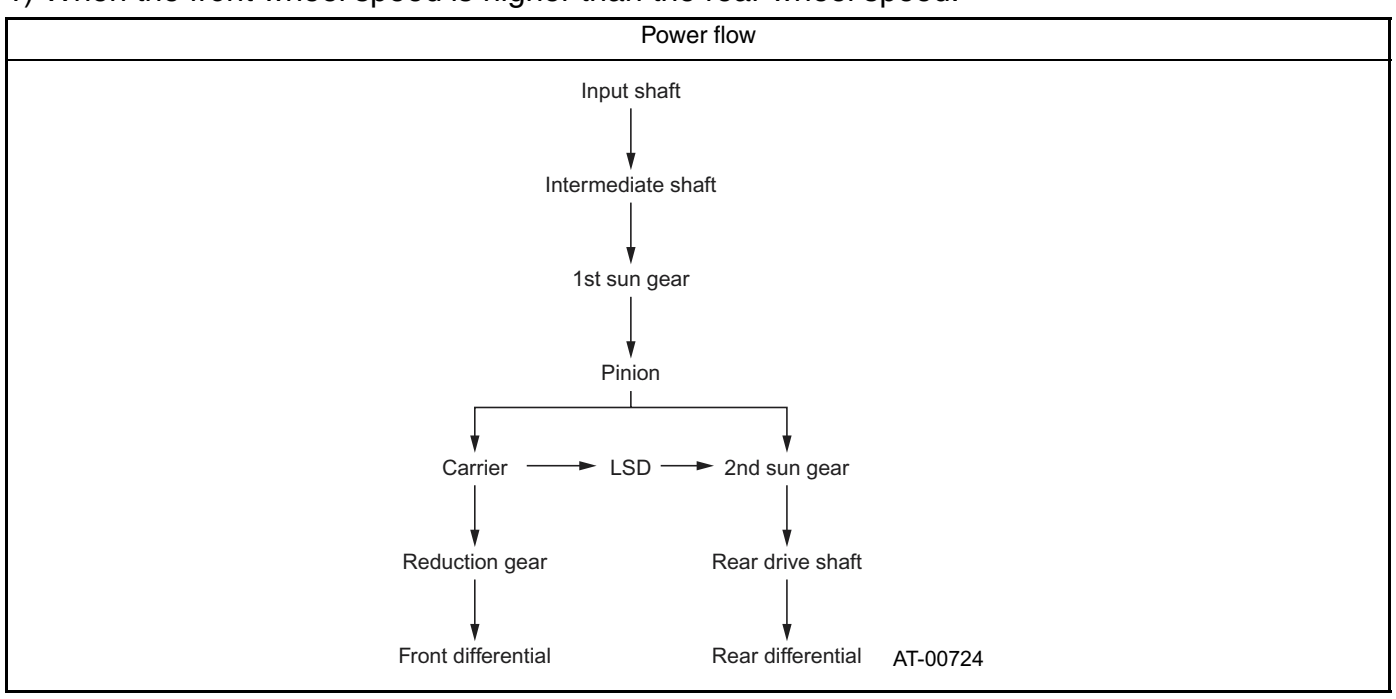
AT-00730

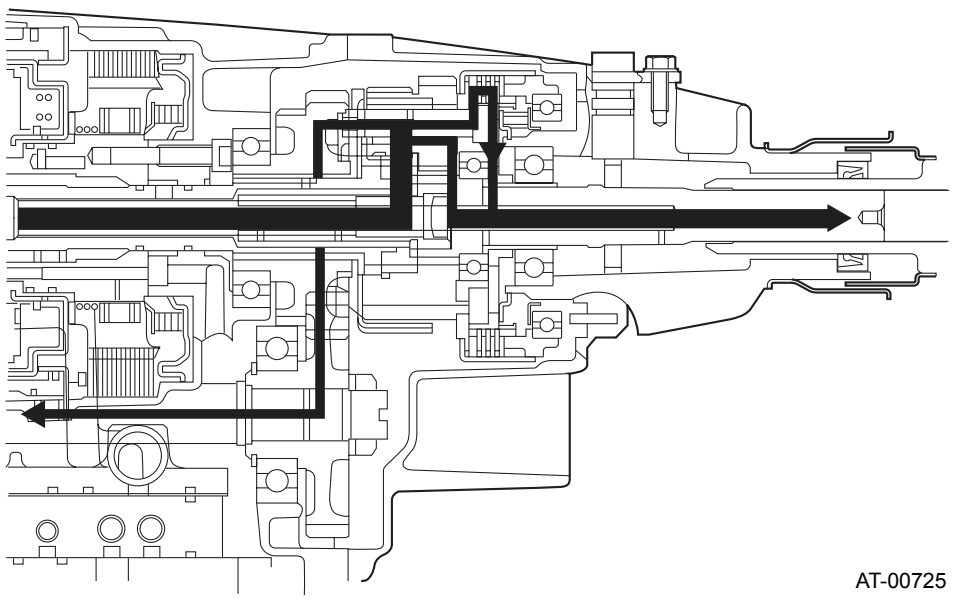
(1) Transfer control valve
(2) Transfer clutch pressure
(3) Transfer duty solenoid
(4) Transfer pressure
(5) Filter
(6) Pilot pressure
(7) Line pressure
(8) Oil pump
(9) Transmission hydraulic control valve assembly

2. VARIABLE TORQUE DISTRIBUTION CENTER DIFFERENTIAL

The front-rear torque distribution ratio is basically determined by the gear tooth ratio of center differential's compound planetary gears and varied by changing the degree of engagement of the hydraulically operated multi-plate clutch that connects the center differential output elements according to driving conditions and road surface conditions.

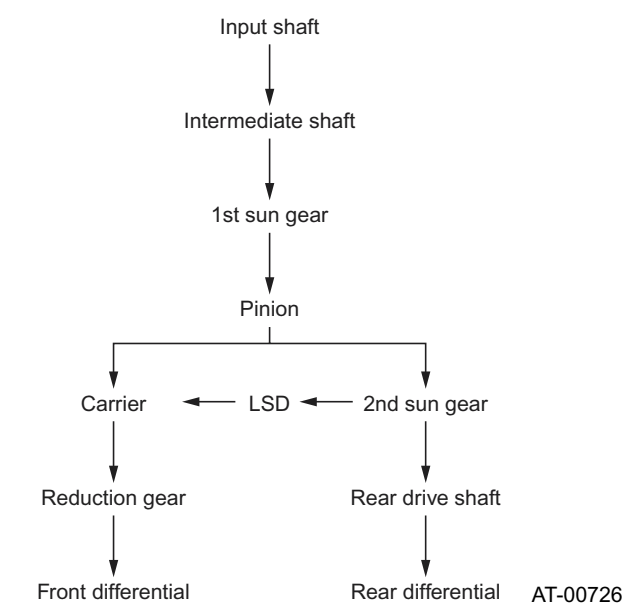
1) When the front wheel speed is higher than the rear wheel speed:



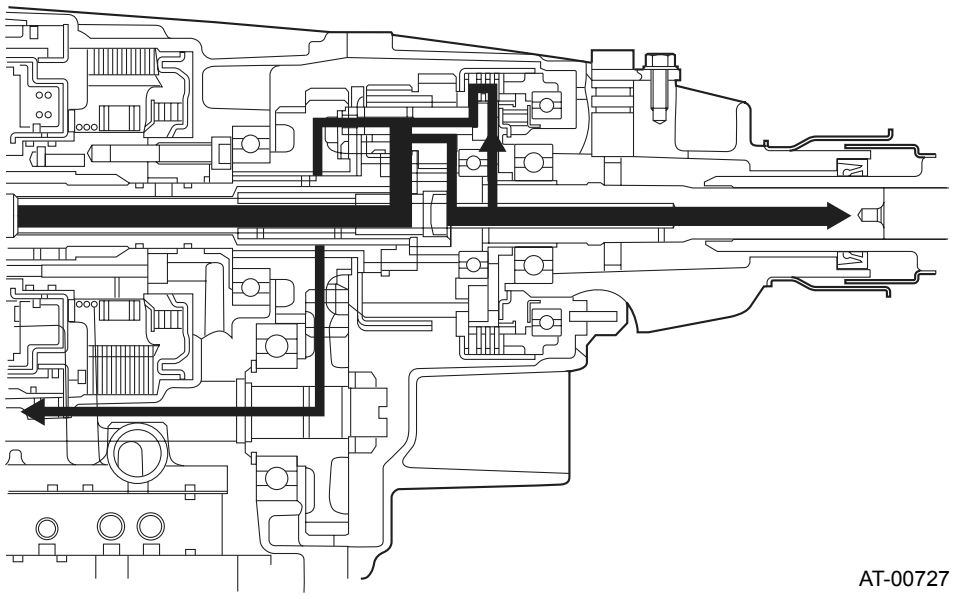


2) When the rear wheel speed is higher than the front wheel speed:

Power flow



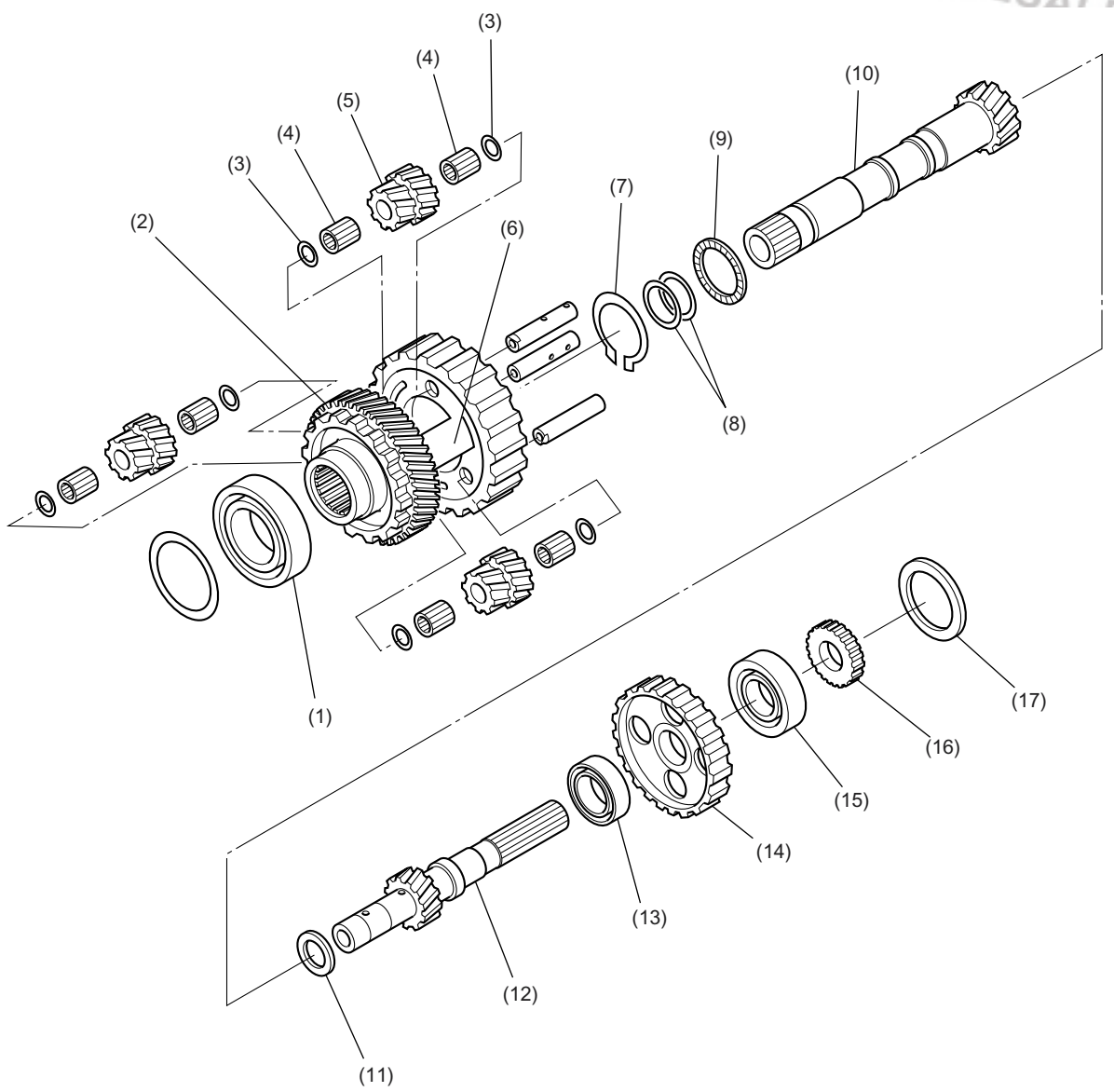
AT-00726



AT-00727

3. CENTER DIFFERENTIAL ASSEMBLY

The center differential is a compound planetary gear set without internally-toothed gears. The input torque from the automatic transmission is transmitted to the input element of the center differential (1st sun gear). The front wheel output elements of the center differential are connected to the carrier and the rear wheel output elements are connected to the 2nd sun gear.
The compound planetary gears uses helical gears for quiet operation and strength. The three pinions are arranged to ensure the best motion balance during operation.

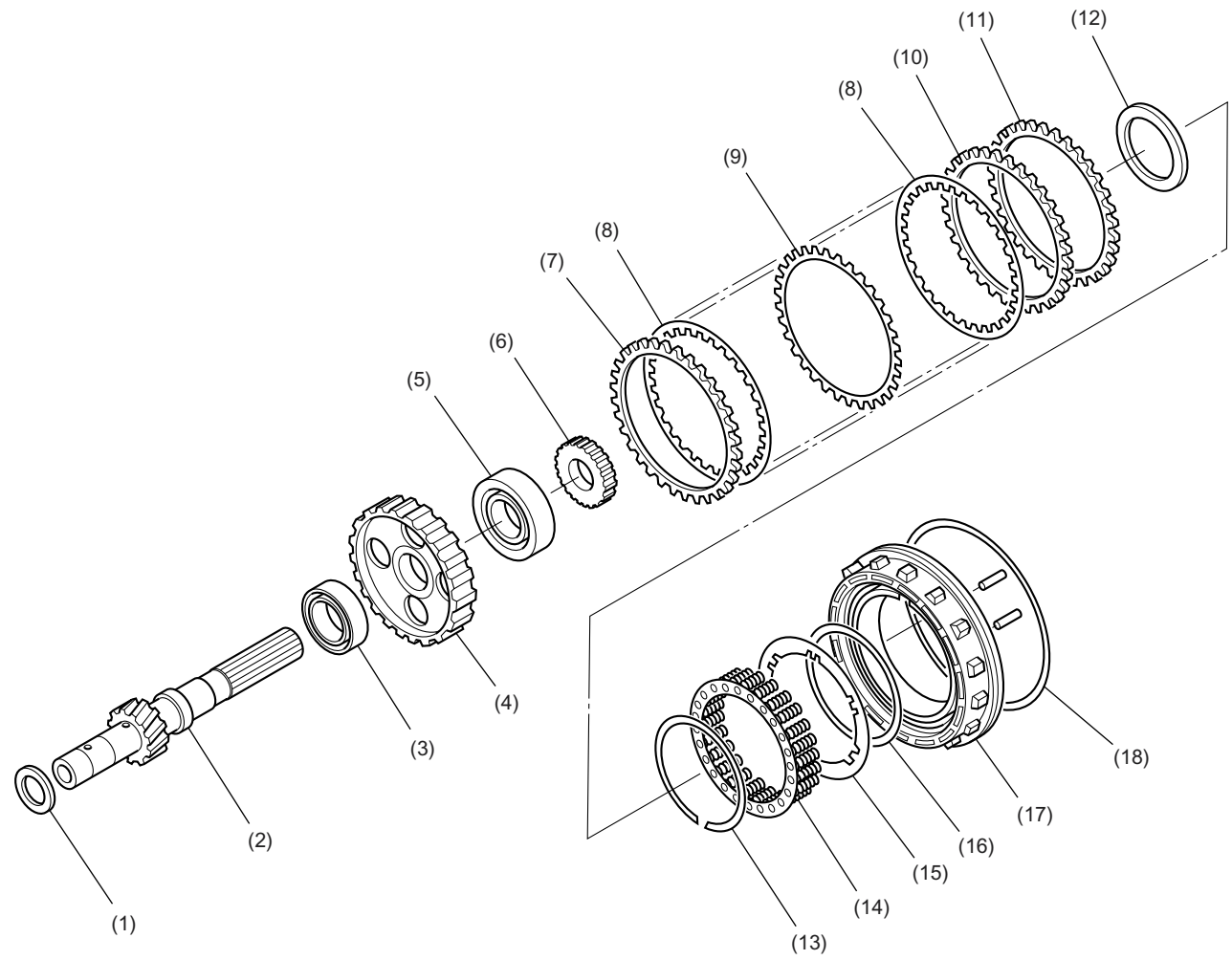


AT-00728

(1) Ball bearing
(2) Reduction drive gear
(3) Washer
(4) Needle bearing
(5) Pinion gear
(6) Carrier
(7) Snap ring
(8) Seal ring
(9) Thrust needle bearing
(10) Intermediate shaft
(11) Thrust washer
(12) Rear drive shaft
(13) Ball bearing
(14) Multi-plate clutch hub
(15) Ball bearing
(16) Revolution gear
(17) Rear drive shaft shim

4. MULTI-PLATE CLUTCH (LSD)

The transfer's differential action limiting device (LSD) consists of a multi-plate clutch and a transfer hydraulic pressure control unit incorporating a transfer duty solenoid.
The transfer duty solenoid is an electromagnetic valve which is controlled by the TCM using various duty ratios stored in its memory as explained in "1. General".
The rear drive shaft has drilled oil passages for lubrication of multi-plate clutch and extension bushing and ball bearing in it.

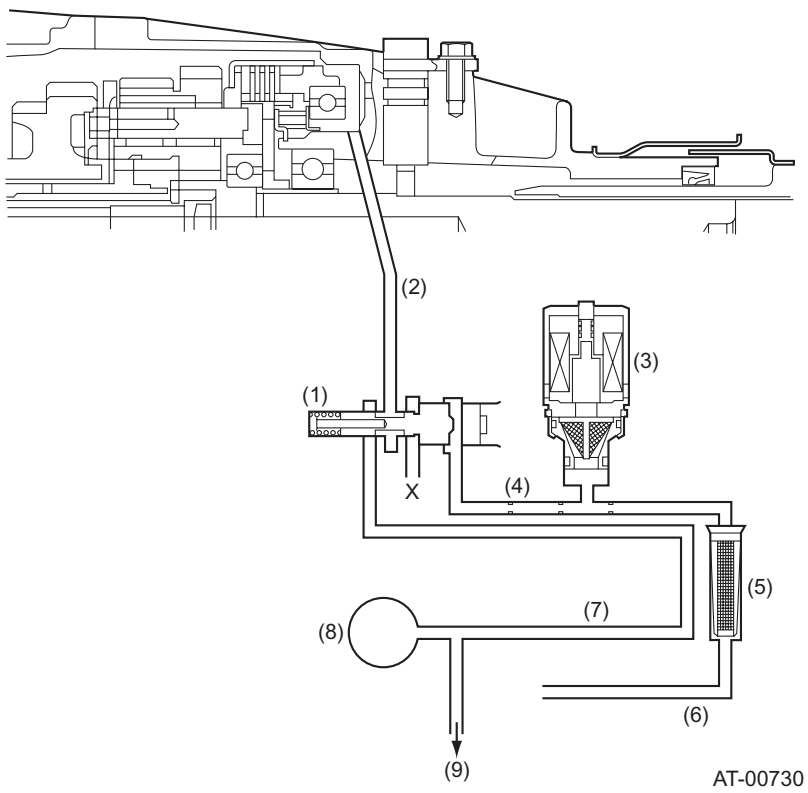


AT-00729

(1) Thrust washer
(2) Rear drive shaft
(3) Ball bearing
(4) Multi-plate clutch hub
(5) Ball bearing
(6) Revolution gear
(7) Driven plate (thicker)
(8) Drive plate
(9) Driven plate (thinner)
(10) Driven plate (thicker)
(11) Adjust plate
(12) Rear drive shaft shim
(13) Snap ring
(14) Spring retainer
(15) Plate
(16) O-ring
(17) Multi-plate clutch piston
(18) D-ring

5. 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 control valve depending on the signals from the TCM. The transfer control 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.



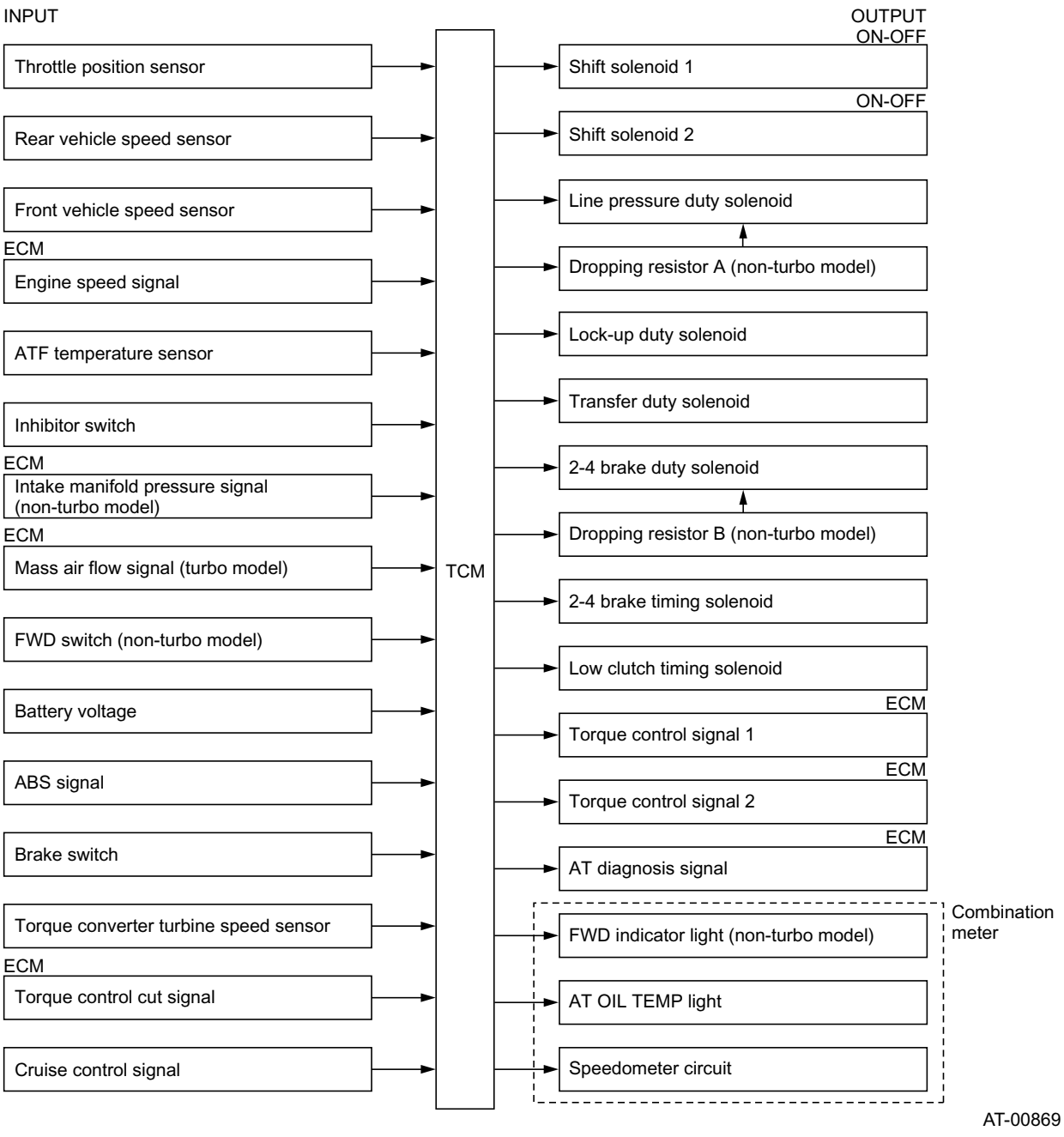
AT-00730

(1) Transfer control valve
(2) Transfer clutch pressure
(3) Transfer duty solenoid
(4) Transfer pressure
(5) Filter
(6) Pilot pressure
(7) Line pressure
(8) Oil pump
(9) Transmission hydraulic control valve assembly

12.Electrohydraulic Control System

A: DESCRIPTION

The electrohydraulic control system for the transmission and transfer consists of various sensors and switches, a transmission control module (TCM) and the hydraulic controlling units including solenoid valves. The system controls the automatic transmission operation, including gear shifting, lockup clutch operation, line pressure, automatic control pattern selection (Base and Power), and gear-shift timing. It also controls the operation of the transfer clutch. The TCM determines vehicle operating conditions from various input signals and controls a total of eight solenoids (shift solenoids 1 and 2, low clutch timing solenoid, 2-4 brake timing solenoid, line pressure duty solenoid, lockup duty solenoid, transfer duty solenoid and 2-4 brake duty solenoid) by sending appropriate signals to them.



B: INPUT SIGNALS

Signal name	Major function
Throttle position sensor	Indicates the throttle valve position. This signal is used to determine shift point, line pressure, and lockup engaging vehicle speed, which vary with engine load.
Front vehicle speed sensor (located on transmission case)	Indicates the vehicle speed. This signal is used for control of gear shifting, lockup engaging, line pressure, and transfer clutch operation.
Rear vehicle speed sensor (located on extension case)	Used to control transfer clutch, and also as backup signal in case of failure of front vehicle speed sensor.
Engine speed signal	Indicates the engine speed. This signal is used for control of lockup clutch to ensure smooth engagement.
Inhibitor switch	Used to determine gears and line pressures in each of ranges P, R, N, D, 3, 2 and 1.
ATF temperature sensor	Indicates the ATF temperature. This signal is used for inhibition of lockup, release of OD and determination of ATF temperature.
FWD switch (SOHC models)	Used for changing the mode from AWD to FWD. Also used for adapting the vehicle to FWD tester roller. Changeover from AWD to FWD can be made by inserting a fuse into the fuse holder.
ABS signal	Used when ABS is operating to optimize ABS control. In this control, transfer clutch torque load capacity is adjusted to eliminate the influence of engine braking and reduce the degree of coupling between front and rear wheels.
Cruise control signal	Indicates operation of cruise control system. It is used to expand 4th operating range.
Torque converter turbine speed sensor	Tells the rotation speed of the input shaft. The proportion of this speed to the vehicle speed determines whether shifting should be made or not.
Torque control cut signal	Sent from engine control module (ECM) to TCM to temporarily inhibit the torque control when starting off with low coolant temperature.
Intake manifold pressure signal (SOHC models)	Used to determine line pressure of gear shifting.
Mass air flow signal (DOHC turbo models)	Used to determine line pressure of gear shifting.
Brake switch	If this signal is issued during downhill driving, TCM makes downshift control, causing the vehicle speed to be reduced.

C: OUTPUT SIGNALS

Signal name	Function
Shift solenoid 1 and 2	Each of these signals controls gear speed by turning the corresponding solenoid ON/OFF. Activating timing is controlled for each solenoid to reduce shift shock.
Line pressure duty solenoid	Regulates the line pressure according to driving conditions.
Lockup duty solenoid	Regulates the hydraulic pressure of the lockup clutch to operate it in three modes (open, smooth and lockup).
Transfer duty solenoid	Regulates the hydraulic pressure of the transfer clutch to control the driving force to the rear drive shaft.
AT OIL TEMP light	Causes the light to illuminate when ATF becomes excessively hot (exceeds a set temperature level). This light is also used to display diagnostic trouble codes for the on-board diagnosis function.
2-4 brake duty solenoid	Regulates 2-4 brake operating pressure to reduce shifting shocks.
2-4 brake timing solenoid	Switches on or off the pressure acting on 2-4 brake timing valve B to control the release timing of the 2-4 brake.
Low-clutch timing solenoid	Switches on or off the pressure acting on the low clutch timing valve B to control the release timing of the low clutch. Also switches on or off the pressure acting on the reverse inhibit valve to control the reverse inhibit function.
Torque control signal 1	Reduces engine torque during range selection and gear change.
Torque control signal 2	Reduces engine torque during range selection and gear change.

D: CONTROL ITEMS

1. MPT MODELS

Control items			Description of control
Transmission control	Shifting control	Base shift control • Base pattern • Power pattern	Upshifting and downshifting are set for each range, gear and pattern according to throttle position and vehicle speed.
		ABS-in-operation control	Gear speed is determined according to vehicle speed when ABS signal and brake signal is input.
		ATF low temperature control	Shifting into 4th gear is prevented when ATF temperature is below the preset value.
	Automatic pattern select control	Power pattern control	Power pattern is selected when throttle opening is changed at a speed exceeding the preset value.
		Base pattern control	When throttle opening is changed at a speed less than the preset value, Base pattern is resumed.
	Lockup control	Base lockup control	Lockup ON is set for D-range 4th gear; ON/OFF is set for all gears (except D-range 4th) and patterns. Lockup control is performed according to throttle position and vehicle speed. (Basically lockup is OFF during gear shifting.)
		Smooth control	Smooth lockup is performed when lockup is switched on.
	Line-pressure control	Ordinary control	Line pressure is regulated according to throttle position, vehicle speed and range signals.
		Shifting control	Line pressure is regulated when shifting to lessen shifting shock.
		Starting control	Line pressure is lowered to a minimum so as to reduce engine cranking load.
	Shift timing control	Gear speed control	ON/OFF timing for shift solenoid is controlled.
		Lockup control	When shifting, the lockup clutch is temporarily released.
		Line-pressure control	When shifting, line pressure is controlled to the optimum level so as to reduce shifting shock.
AWD transfer clutch control	Ordinary transfer control		Transfer clutch pressure is regulated according to the throttle valve angle and vehicle speed.
	1 range control		Transfer clutch pressure is increased.
	Slip control		Immediately after detecting a slip, transfer clutch pressure is controlled to the same pressure as 1 range. (This control is canceled if V ≥ 60 km/h (37 MPH), or when throttle valve is closed fully.)
	Turning control		Transfer clutch pressure is reduced after detecting a turn.
	ABS-in-operation control		Transfer clutch pressure is adjusted to a set level immediately after reception of ABS signal.

2. VTD MODELS

Control items			Description of control
Transmission control	Shifting control	Base shift control • Base pattern • Power pattern	Upshifting and downshifting are set for each range, gear and pattern according to throttle position and vehicle speed.
		ABS-in-operation control	Gear speed is determined according to vehicle speed when ABS signal and brake signal is input.
		ATF low temperature control	Shifting into 4th gear is prevented when ATF temperature is below the preset value.
	Automatic pattern select control	Power pattern control	Power pattern is selected when throttle opening is changed at a speed exceeding the preset value.
		Base pattern control	When throttle opening is changed at a speed less than the preset value, Base pattern is resumed.
	Lockup control	Base lockup control	Lockup ON is set for D-range 4th gear; ON/OFF is set for all gears (except D-range 4th) and patterns. Lockup control is performed according to throttle position and vehicle speed. (Basically lockup is OFF during gear shifting.)
		Smooth control	Smooth lockup is performed when lockup is switched on.
	Line-pressure control	Ordinary control	Line pressure is regulated according to throttle position, vehicle speed and range signals.
		Shifting control	Line pressure is regulated when shifting to lessen shifting shock.
		Starting control	Line pressure is lowered to a minimum so as to reduce engine cranking load.
	Shift timing control	Gear speed control	ON/OFF timing for shift solenoid is controlled.
		Lockup control	When shifting, the lockup clutch is temporarily released.
		Line-pressure control	When shifting, line pressure is controlled to the optimum level so as to reduce shifting shock.
AWD multi-plate clutch (LSD) control	Ordinary transfer control		Multi-plate clutch (LSD) pressure is regulated according to the torque input to the transfer and the driving condition.
	Start control		When starting, the LSD pressure is adjusted proportionately to the throttle value angle.
	Turning control		When the front and rear wheel speed ratio is less than the set value for a vehicle speed, the LSD pressure is decreased.
	Slip control		When a front or rear wheel starts slipping, the LSD pressure is decreased.
	ABS-in-operation control		The LSD pressure is adjusted to the set level immediately after reception of ABS signal.
	Base brake control		When the brake switch is ON and throttle valve is fully closed, the LSD pressure is lowered.
	1 range control		The LSD pressure is increased to improve driveability.

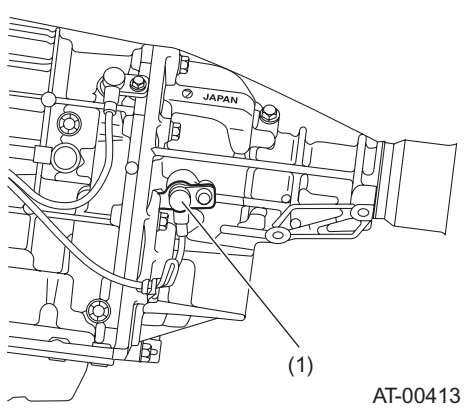
E: THROTTLE POSITION SENSOR

The throttle position sensor provides electrical signals corresponding to throttle valve positions. The throttle valve angular position and accelerator depressing speed are detected by this throttle position sensor.

F: REAR VEHICLE SPEED SENSOR

1. MPT MODELS

This vehicle speed sensor (output shaft speed sensor) is externally mounted on the extension case. It detects the rear wheel speed in terms of the peripheral speed of the transfer clutch drum and sends sine wave signals (30 pulses per rotation) to the TCM.

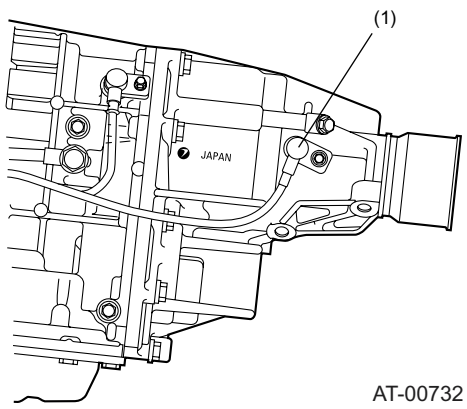


AT-00413

(1) Rear vehicle speed sensor

2. VTD MODELS

This vehicle speed sensor (output shaft speed sensor) is externally mounted on the extension case. It detects the rear wheel speed in terms of the peripheral speed of the rear drive shaft and sends sine wave signals (22 pulses per rotation) to the TCM.



AT-00732

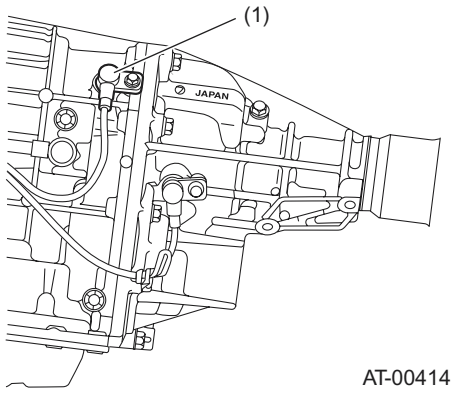
(1) Rear vehicle speed sensor

G: FRONT VEHICLE SPEED SENSOR

This vehicle speed sensor (output shaft speed sensor) is externally mounted on the transmission case. It detects the front wheel speed and sends sine wave signals (16 pulses per rotation) to the TCM.

The TCM converts the signals into pulse signals and outputs them to both the engine control module (ECM) and the combination meter.

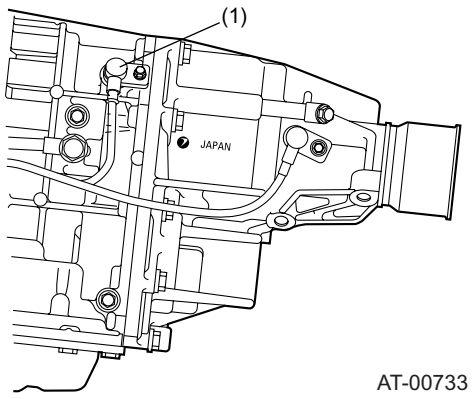
- MPT models



AT-00414

(1) Front vehicle speed sensor

- VTD models

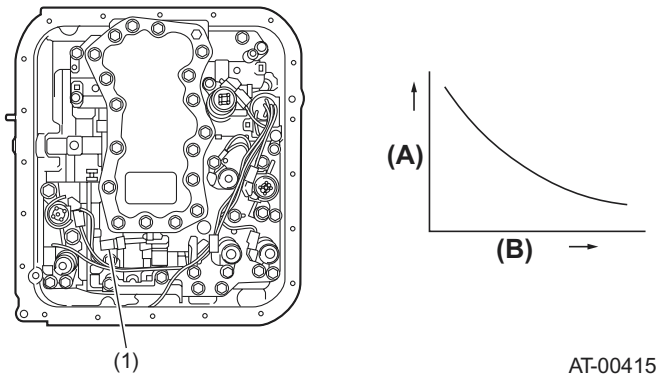


AT-00733

(1) Front vehicle speed sensor

H: ATF TEMPERATURE SENSOR

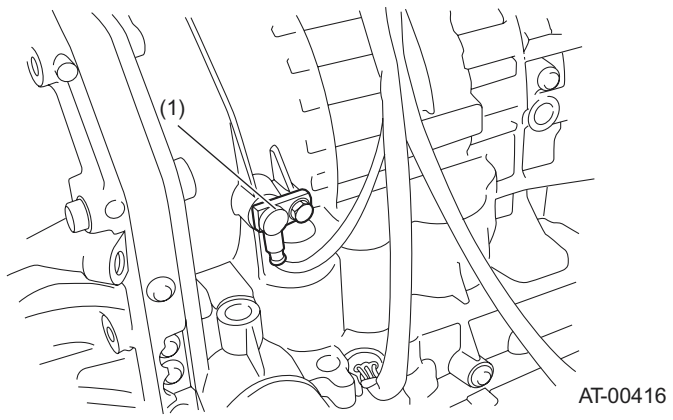
This sensor is integrated with the transmission harness and is mounted on the hydraulic control valve body of the transmission. It detects the temperature of ATF and outputs it as an electrical resistance signal. The output characteristics of the sensor are shown below.



(1) ATF temperature sensor **(A)** Resistance **(B)** Temperature

I: TORQUE CONVERTER TURBINE SPEED SENSOR

The torque converter turbine speed sensor (output shaft speed sensor) is externally mounted on the transmission case.
The sensor detects the torque converter turbine speed in terms of the rotation speed of the periphery of the high clutch drum coupled to the input shaft, and sends sine wave signals (32 pulses per rotation) to the TCM. The TCM calculates the proportion of the input shaft speed to the vehicle speed and determines whether the shifting is to be made or not.



(1) Torque converter turbine speed sensor

J: INHIBITOR SWITCH

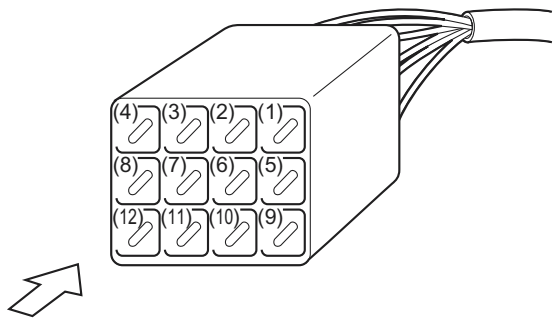
The inhibitor switch assures safety when starting the engine. This switch is mounted on the right side of the transmission case, and is operated by the selector lever.

When the selector lever is set to P or N, the electrical circuit in the inhibitor switch is closed and the starter circuit is completed for cranking the engine.

When the selector lever is in the R, D, 3, 2 or 1 range, the electrical circuit in the inhibitor switch is open. Hence engine cranking is disabled. In the R range, the backup light circuit is completed in the switch, and the backup lights come on.

In addition to the above function, the inhibitor switch incorporates a circuit for detecting the selected range position and sending the range signal to the TCM.

Inhibitor switch side connector

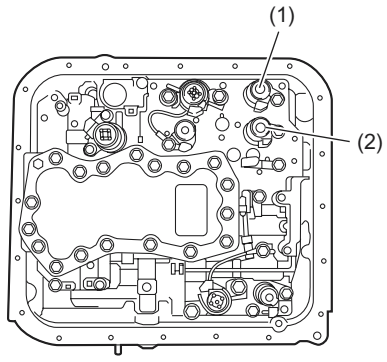


AT-00417

Range position	Pin No.
P	(4) — (3) (12) — (11)
R	(4) — (2) (10) — (9)
N	(4) —(1) (12) — (11)
D	(4) — (8)
3	(4) — (7)
2	(4) — (6)
1	(4) — (5)

K: SHIFT SOLENOIDS 1 AND 2

These solenoids are mounted on the transmission hydraulic control valve body. They are turned ON or OFF according to signals from the TCM. The gear positions are changed according to the ON and OFF condition of these solenoids.

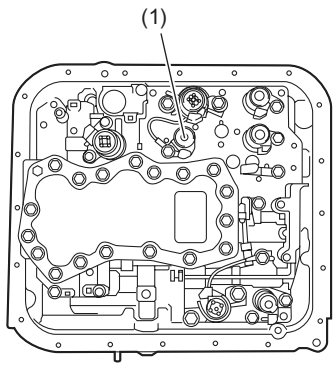


AT-00418

(1) Shift solenoid 2
(2) Shift solenoid 1

L: LOW-CLUTCH TIMING SOLENOID

This solenoid is mounted on the transmission hydraulic control valve body. It is turned ON or OFF according to signals from the TCM. It then controls the low clutch timing valve B and reverse inhibitor valve.

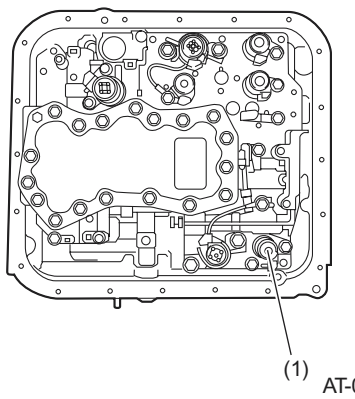


AT-00419

(1) Low-clutch timing solenoid

M: 2-4 BRAKE TIMING SOLENOID

This solenoid is mounted on the transmission hydraulic control valve body. It is turned ON or OFF according to signals from the TCM. It then controls the 2-4 brake timing valve B to decrease the change gear shock.

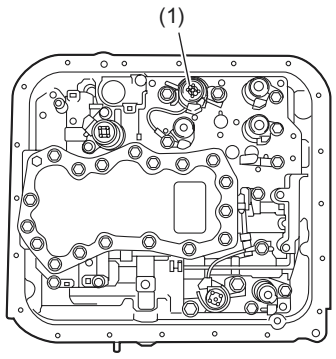


AT-00420

(1) 2-4 brake timing solenoid

N: LINE PRESSURE DUTY SOLENOID

This solenoid is mounted on the transmission hydraulic control valve body. Its duty ratio is controlled by signals from the TCM. This solenoid then controls the pressure modifier valve and accumulator control valve A to adjust the line pressure to an optimum pressure level suitable for operating conditions.

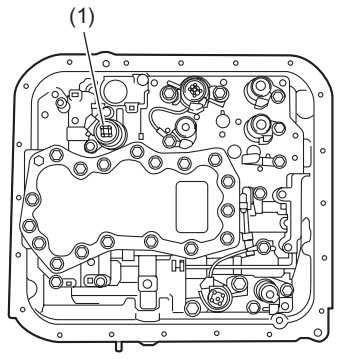


AT-00421

(1) Line pressure duty solenoid

O: LOCKUP DUTY SOLENOID

This solenoid is mounted on the transmission hydraulic control valve body. Its duty ratio is controlled by signals from the TCM. It then controls the lockup control valve to provide smooth engagement and disengagement of the lockup clutch.

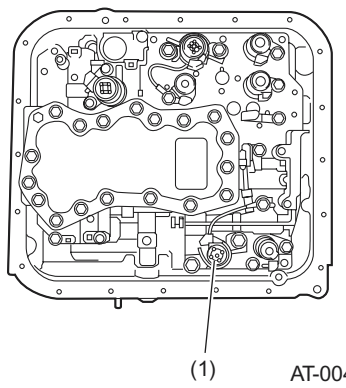


AT-00422

(1) Lockup duty solenoid

P: 2-4 BRAKE DUTY SOLENOID

This solenoid is mounted on the transmission hydraulic control valve body. Its duty ratio is controlled by signals from the TCM. It modulates the 2-4 brake pressure when the 2-4 brake is operated, reducing shifting shocks.



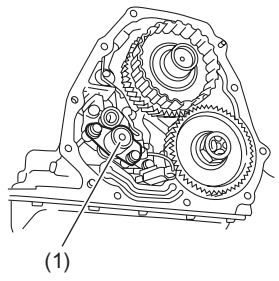
AT-00423

(1) 2-4 brake duty solenoid

Q: TRANSFER DUTY SOLENOID

This solenoid is mounted on the transfer hydraulic pressure control unit on the rear end of transmission case. Its duty ratio is controlled by signals from the TCM. It then controls the transfer clutch/ control valve to control the pressure applied to the transfer clutch.

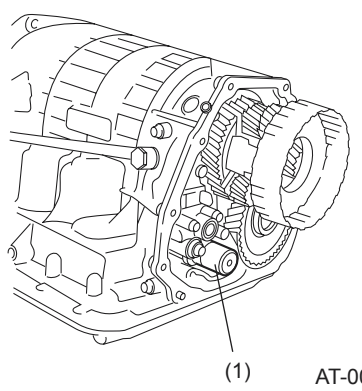
- MPT models



AT-00424

(1) Transfer duty solenoid

- VTD models



AT-00734

(1) Transfer duty solenoid

13.Transmission Control Module (TCM)

The TCM receives various sensor signals and determines the running conditions of the vehicle. It then sends control signals to each solenoid according to the preset gearshift characteristic data, lockup operation data, and transfer clutch torque data (duty ratios).

A: CONTROL SYSTEM

1. MPT MODELS

Control items		Input signals
Shifting control	Ordinary shift control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Engine speed rpm Inhibitor switch
	ABS-in-operation control	ABS signal Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Brake switch
	Hydraulic oil temperature control	ATF temperature sensor
	Reverse inhibition control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Inhibitor switch
	Shift pattern (Base/Power) select control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Inhibitor switch
	Hold control	Inhibitor switch
	Grade control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Brake switch Inhibitor switch Engine speed Intake manifold pressure
Lockup control	Ordinary lockup control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Engine speed Inhibitor switch
	Smooth control	Throttle position sensor
	Hydraulic oil temperature control	ATF temperature sensor

Control items		Input signals
Oil pressure control	Ordinary pressure control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Engine speed Inhibitor switch ATF temperature sensor
	Shifting control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Engine speed Torque converter turbine speed sensor Inhibitor switch ATF temperature sensor
	Starting control	Engine speed ATF temperature sensor Inhibitor switch
	Learning control	Shift solenoid 1 Shift solenoid 2 Rear vehicle speed sensor Front vehicle speed sensor Throttle position sensor Torque converter turbine speed sensor ATF temperature sensor
AWD transfer clutch control	Ordinary transfer control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Inhibitor switch ATF temperature sensor FWD switch
	1 range control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Inhibitor switch
	Slip detection control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor
	Steering control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor
	ABS-in-operation control	ABS signal Rear vehicle speed sensor Front vehicle speed sensor Brake switch

2. VTD MODELS

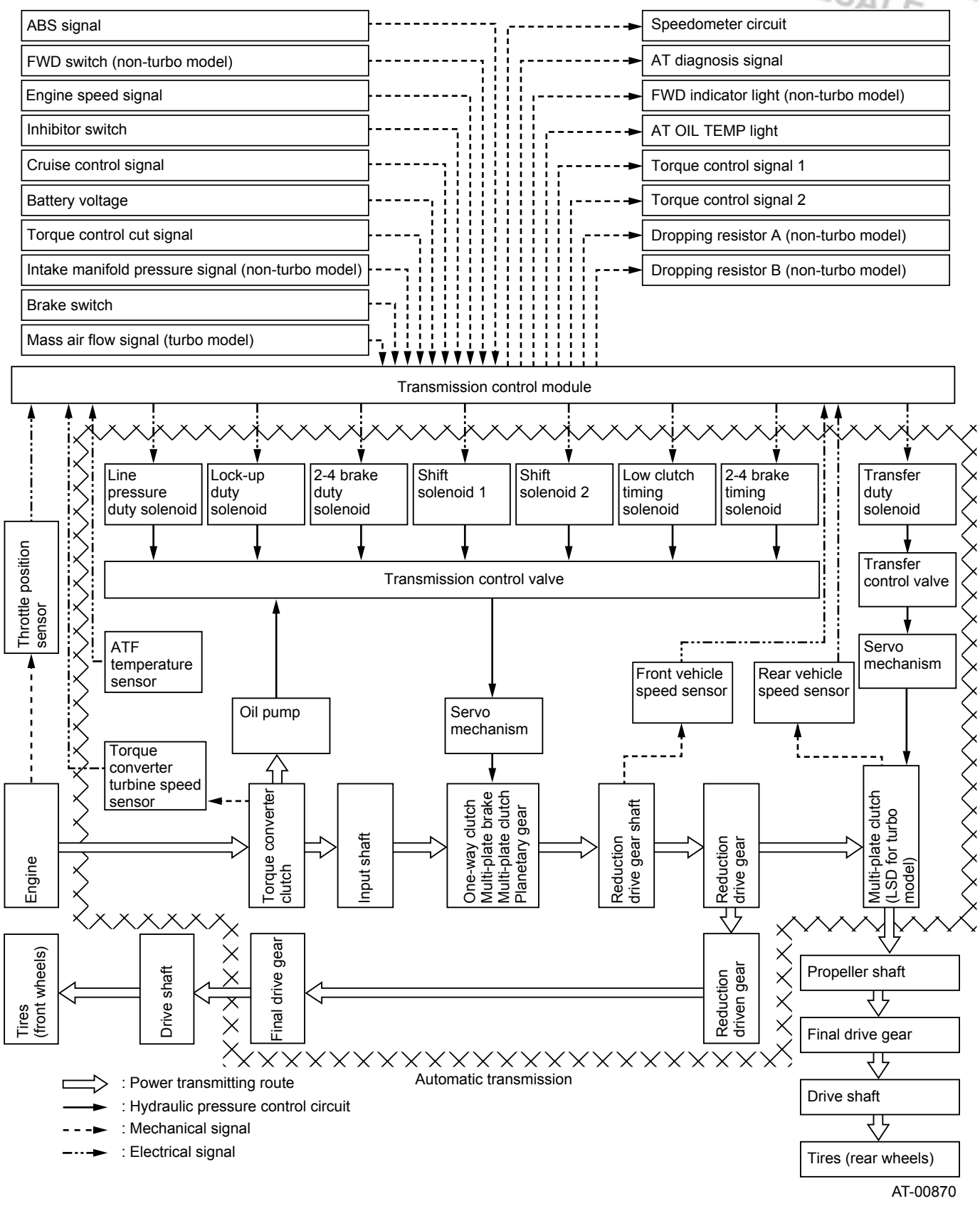
Control items		Input signals
Shifting control	Ordinary shift control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Engine speed Inhibitor switch
	ABS-in-operation control	ABS signal Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Brake switch
	Hydraulic oil temperature control	ATF temperature sensor
	Reverse inhibition control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Inhibitor switch
	Shift pattern (Base/Power) select control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Inhibitor switch
	Grade control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Brake switch Inhibitor switch Engine speed Mass air flow
Lockup control	Ordinary lockup control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Engine speed Inhibitor switch
	Smooth control	Throttle position sensor
	Hydraulic oil temperature control	ATF temperature sensor

Control items		Input signals
Oil pressure control	Ordinary pressure control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Engine speed Inhibitor switch ATF temperature sensor
	Shifting control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Engine speed Torque converter turbine speed sensor Inhibitor switch ATF temperature sensor
	Starting control	Engine speed ATF temperature sensor Inhibitor switch
	Learning control	Shift solenoid 1 Shift solenoid 2 Rear vehicle speed sensor Front vehicle speed sensor Throttle position sensor Torque converter turbine speed sensor ATF temperature sensor
AWD multi-plate clutch (LSD) control	Ordinary transfer control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Inhibitor switch ATF temperature sensor
	1 range control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Inhibitor switch
	Slip detection control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor
	Steering control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor
	ABS-in-operation control	ABS signal Rear vehicle speed sensor Front vehicle speed sensor Brake switch
	Base brake control	Throttle position sensor Front vehicle speed sensor Brake switch

B: SCHEMATIC DIAGRAMS

1. SOHC MODELS

TRANSMISSION CONTROL MODULE (TCM)



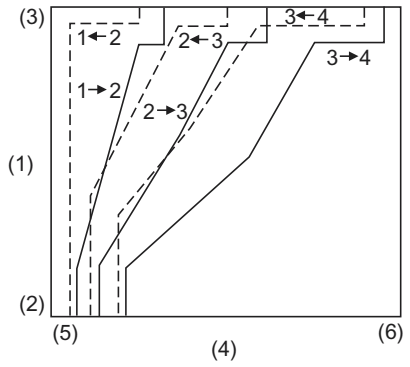
AT-00870

C: SHIFTING CONTROL

The TCM performs gear shifting control according to driving conditions by using the shift point characteristic data stored in its memory. Appropriate solenoids are operated at the proper timing corresponding to the shift pattern, throttle position, and vehicle speed for smooth shifting.

NOTE:
When the ATF temperature is below approximately 10 °C (50 °F), the gear cannot be shifted to the 4th speed.

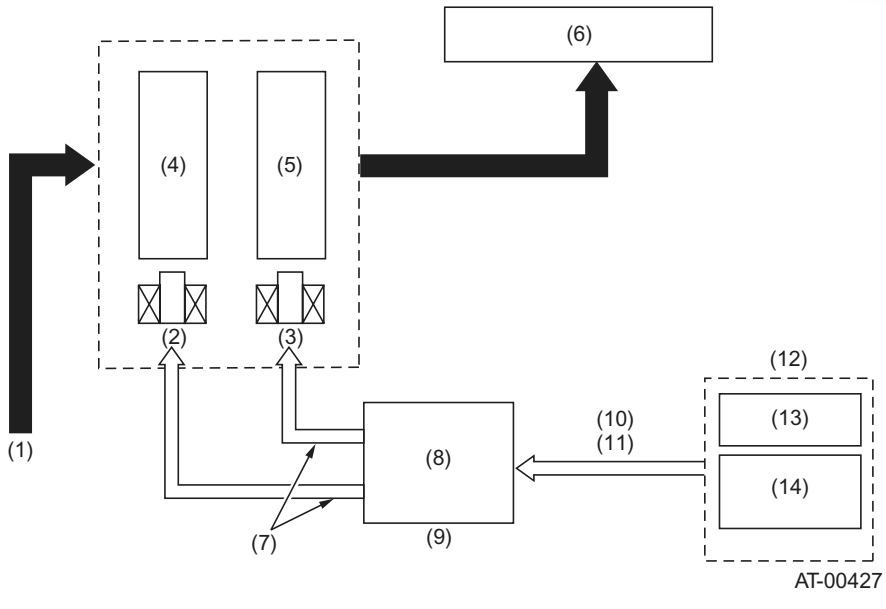
	Solenoid 1	Solenoid 2
1st speed	ON	ON
2nd speed	OFF	ON
3rd speed	OFF	OFF
4th speed	ON	OFF



AT-00426

(1) Throttle opening
(2) Small
(3) Large
(4) Vehicle speed
(5) Low
(6) High

- The TCM activates both solenoids 1 and 2 in response to throttle and vehicle speed signals.
- Shift valves move in response to operation of the solenoids, supplying or interrupting the line pressure to each clutch.
- A shift to each gear takes place according to ON-OFF operation of both the solenoids as indicated in the table above.



(1) ATF
(2) Solenoid 1
(3) Solenoid 2
(4) Shift valve A
(5) Shift valve B
(6) Shift clutch
(7) Shift command signal
(8) TCM
(9) Determination of optimum gear position (including selection of shift pattern)
(10) Throttle opening
(11) Vehicle speed
(12) Sensor
(13) Vehicle speed sensor
(14) Throttle position sensor

D: LOCKUP CONTROL

● The TCM has pre-programmed lockup clutch engagement and disengagement conditions for each gear and shift pattern. The engagement and disengagement conditions are defined in terms of the throttle valve position and vehicle speed.

● The TCM controls the operation of the lockup clutch by means of the duty solenoid which in turn controls the lockup control valve as described below:

1. NON-LOCKUP OPERATION

The duty solenoid allows the pilot pressure (supplied from the pilot valve) to be applied to the “disengaging” end of the lockup control valve spool.The lockup control valve then opens the clutch disengaging circuit port to allow the lockup operating pressure (torque converter clutch regular pressure) to build up in the circuit. On the other hand, the valve opens the clutch engaging circuit’s port and allows the fluid in the circuit to flow to the ATF cooler, thus lowering the pressure in the circuit. As a result, the lockup clutch is disengaged due to difference in pressure between both circuits.

This operation is performed for all the speed gears except the 4th gear of the D range.

2. LOCKUP OPERATION

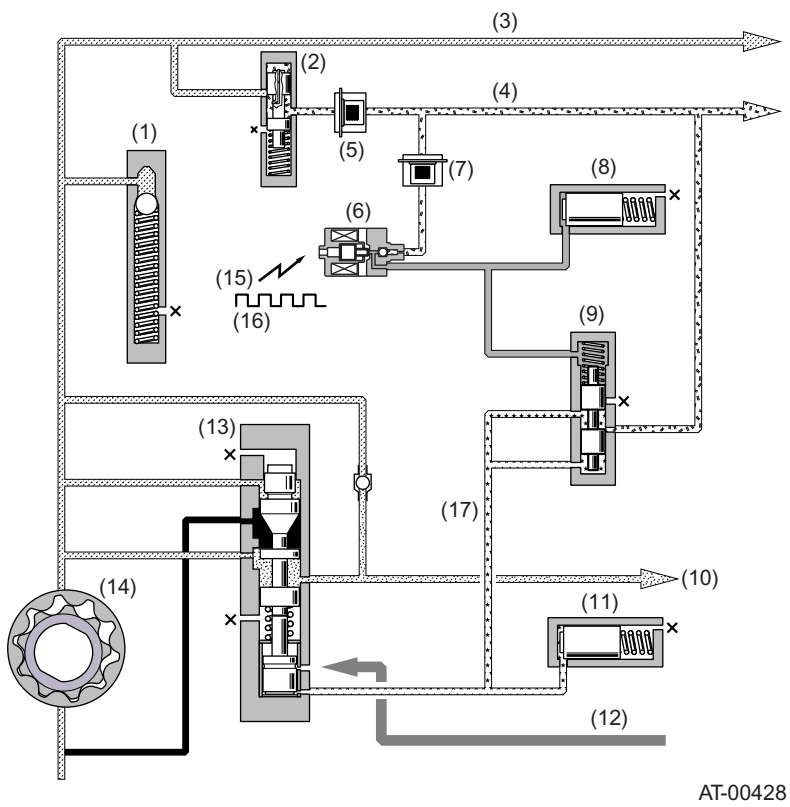
The duty solenoid allows the pilot pressure to be applied to the “engaging” end of the lockup control valve spool.The lockup control valve then opens the clutch engaging circuit’s port that communicates to the torque converter’s impeller chamber, allowing high pressure fluid to flow to the lockup clutch. The clutch then engages.

● The TCM controls the current to the duty solenoid by gradually changing the current. As a result, the lockup control valve also moves gradually, so the clutch engagement pressure increases smoothly. This causes the lockup clutch to become initially in a half-engaged state and then in a fully engaged state, thus preventing shock during engagement.

This operation is performed for all the speed gears.

E: LINE-PRESSURE CONTROL

- The oil pump delivery pressure (line pressure) is regulated to a constant pressure by the pilot valve. This pressure is used as the pilot pressure for controlling spool valves.
- The pilot pressure applied to the pressure modifier valve is modulated into pressure modifier pressure at the line pressure duty solenoid by activating the pressure modifier valve.
- The pressure modifier valve is an auxiliary valve for the pressure regulator valve, and it creates a signal pressure (pressure modifier pressure). The pressure modifier pressure is used to regulate the line pressure to a level optimum for a particular driving condition.
- This pressure modifier pressure is applied to the pressure regulator valve which controls the oil pump delivery pressure.
- The pressure modifier pressure from the pressure modifier valve is cushioned by the pressure modifier accumulator to remove pulsation of the pressure.



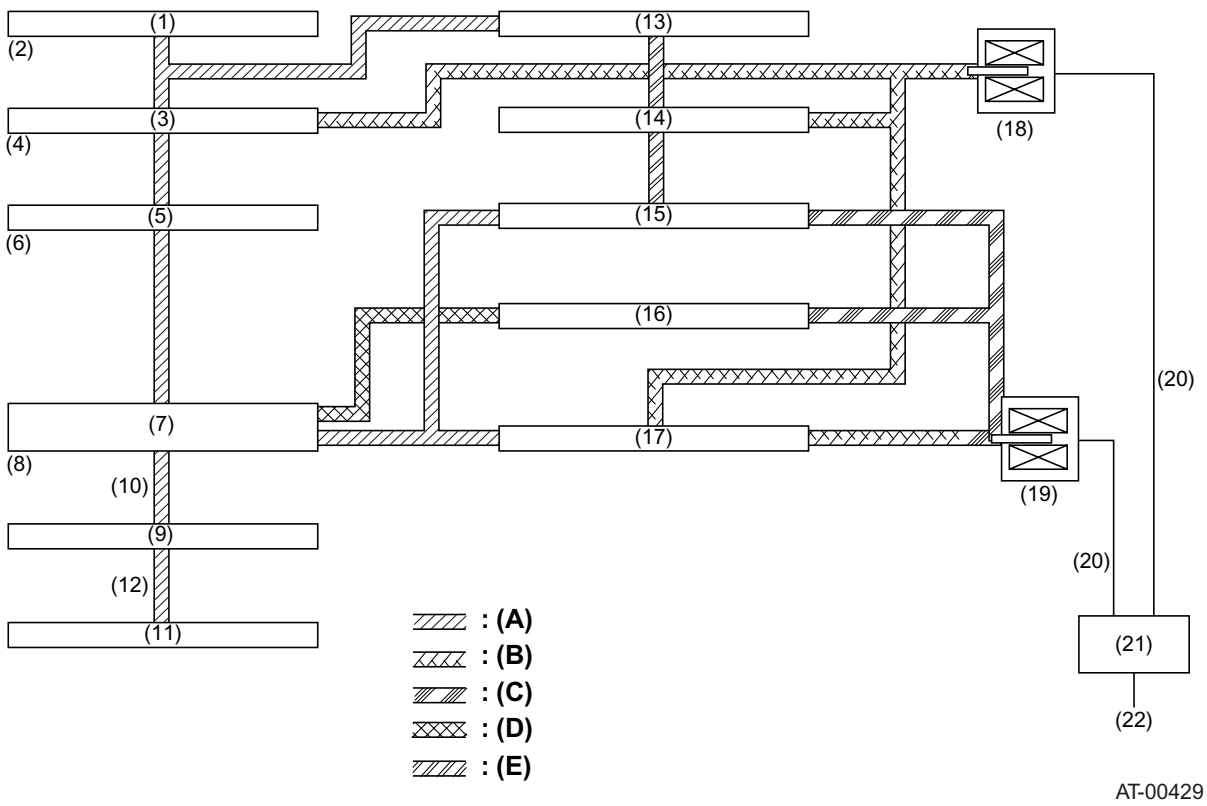
AT-00428

(1) Relief valve
(2) Pilot valve
(3) Line pressure
(4) Pilot pressure
(5) Filter
(6) Line pressure duty solenoid
(7) Filter
(8) Accumulator
(9) Pressure modifier valve
(10) To ATF cooler circuit
(11) Pressure modifier accumulator
(12) From R range pressure circuit
(13) Pressure regulator valve
(14) Oil pump
(15) ON
(16) OFF
(17) Pressure modifier pressure

F: LINE-PRESSURE CONTROL DURING SHIFTING

The line pressure which engages shift clutches to create 1st to 4th speeds is controlled by the TCM to meet varying operating conditions.

During gear shifting, the TCM decreases the line pressure to a level that matches the selected gear in order to minimize shifting shock loads.



(1) Shift clutch
(2) Transient oil pressure to operate clutches
(3) Shift valve
(4) Shift select valve
(5) Manual valve
(6) Manual shift valve operated through selector lever
(7) Pressure regulator valve
(8) Line pressure optimally regulated for clutch operation
(9) Oil pump
(10) Line pressure built up by oil pump
(11) Oil pan
(12) Suction
(13) Low clutch accumulator
(14) Low clutch timing valve A
(15) Accumulator control valve A
(16) Pressure modifier valve
(17) Pilot valve
(18) Shift solenoids 1 and 2
(19) Line pressure duty solenoid
(20) Output signals
(21) TCM
(22) Throttle position, accelerator pedal depressing speed, etc.

(A) Line pressure
(B) Pilot pressure
(C) Line pressure duty pressure
(D) Modifier pressure
(E) Accumulator control

During gear shifting, the TCM controls the line pressure as follows:

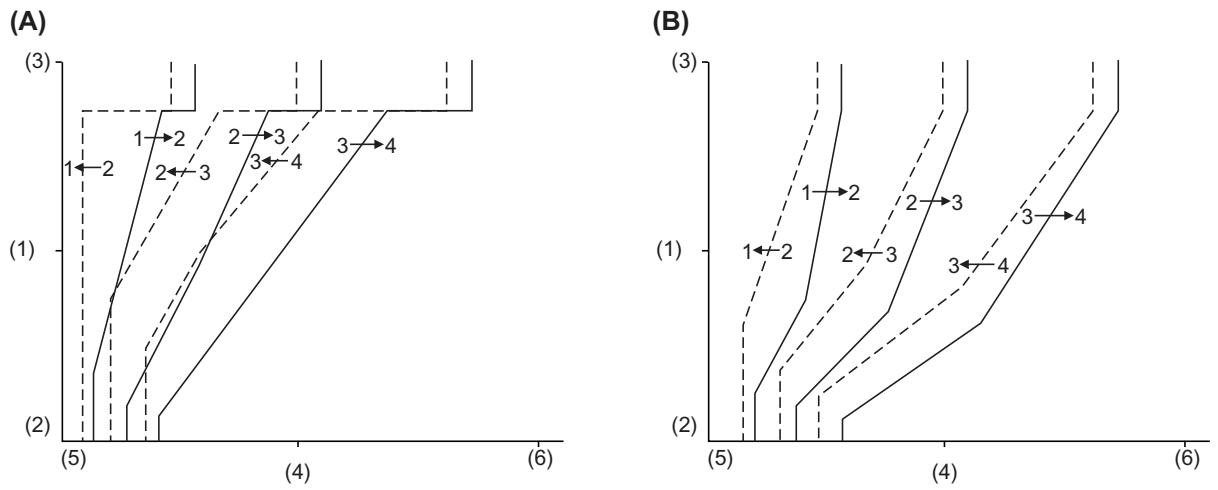
- The TCM receives signals such as throttle position signal and accelerator pedal speed signal. Based on these input signals, it issues a control signal to the line pressure duty solenoid.
- The pressure from the line pressure duty solenoid (line pressure duty pressure) is converted by the pressure modifier valve into a modifier pressure, and the modifier pressure is applied to the pressure regulator valve.
- The pressure regulator valve adjusts the oil-pump-generated line pressure according to the modifier pressure to make the line pressure matched to the driving condition.

G: SHIFT PATTERN SELECTION CONTROL

The TCM changes its gear shift control pattern automatically between the Base pattern suitable for ordinary economy driving and the Power pattern suitable for climbing uphill or rapid acceleration.

In the Power pattern, the downshift point and upshift point are set higher than those of the Base pattern.

Selector lever position	Changeover from Base to Power pattern
D and 3 ranges	Performed automatically according to accelerator pedal depression speed.



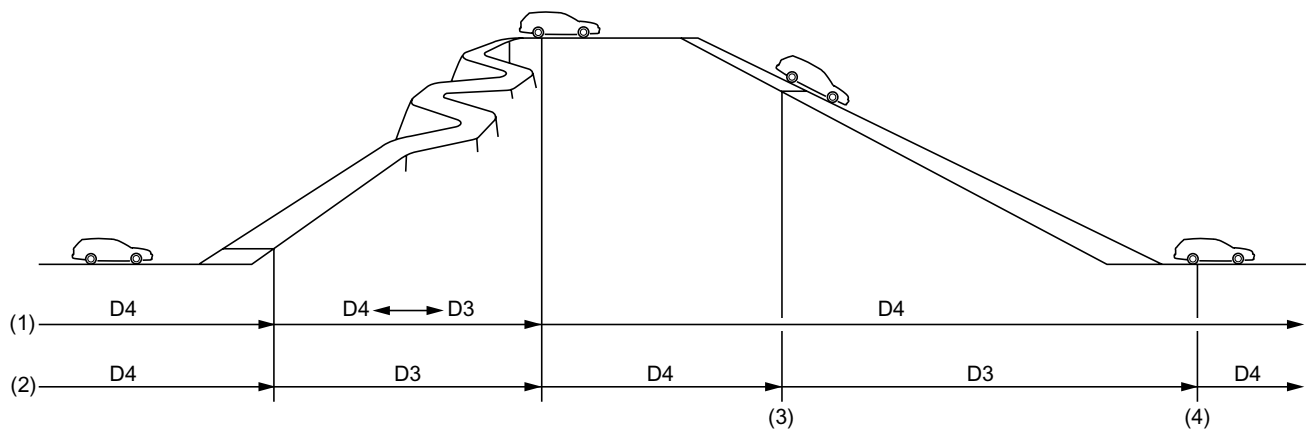
AT-00430

(A) D range (Base pattern)
(1) Throttle opening
(2) Small
(3) Large

(B) D range (Power pattern)
(4) Vehicle speed
(5) Low
(6) High

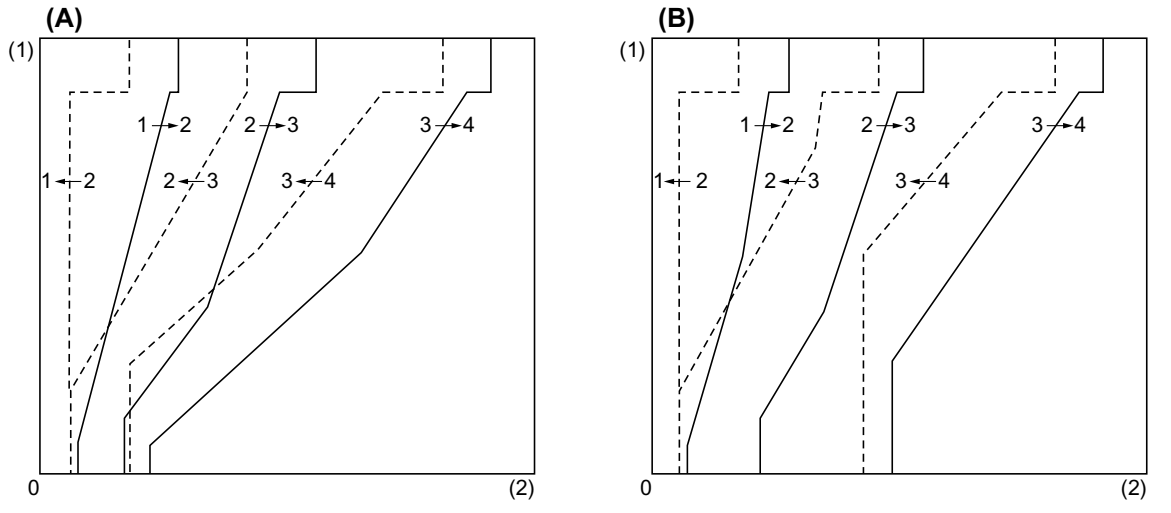
H: GRADE CONTROL

While the vehicle is driving up a hill, the gear is fixed to the 3rd to avoid repeated gear shift between the 3rd and 4th gears.
When the vehicle is descending a steep slope at a speed of approximately 80 km/h (50 MPH), a 4th to 3rd downshift occurs automatically when the brake pedal is depressed. This gearshift control is cancelled when the accelerator pedal is depressed.
The TCM performs these controls based mainly on the throttle opening, engine speed and vehicle speed.



AT-00431

(1) Without grade control
(2) With grade control
(3) Brake pedal ON
(4) Re-acceleration



AT-00432

(A) D range (Base pattern)
(1) Throttle opening

(B) D range (grade control pattern)
(2) Vehicle speed

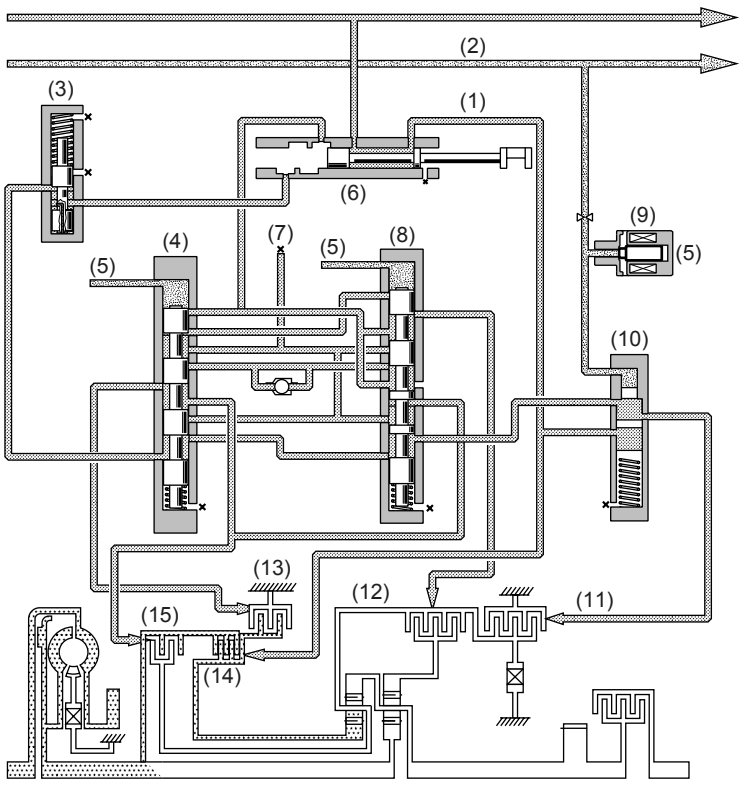
I: LEARNING CONTROL

The TCM has a learning control function with which it can adapt gear shift timing optimally to the current vehicle conditions by updating correction factors in the memory.
For this reason, gear shift shock may become larger after the power supply is interrupted (disconnection of battery, flat battery, etc.) or immediately after the ATF is replaced.
Larger gear shift shock after power supply interruption occurs because the correction data is reset to those for the new vehicle condition.
The TCM starts learning function again as soon as the power supply is restored. After driving for a while, therefore, the transmission will become able to make gear shifts at the optimum timing. Larger shift shock immediately after ATF change is caused by change in friction characteristics of the transmission internal parts. Also in this case, the transmission recovers shock-less gear shifting after driving for a while.

J: REVERSE INHIBITION CONTROL

This control prevents the transmission from shifting into the reverse gear when the select lever is accidentally placed in the R position, thus protecting the components such as reverse clutch from being damaged.

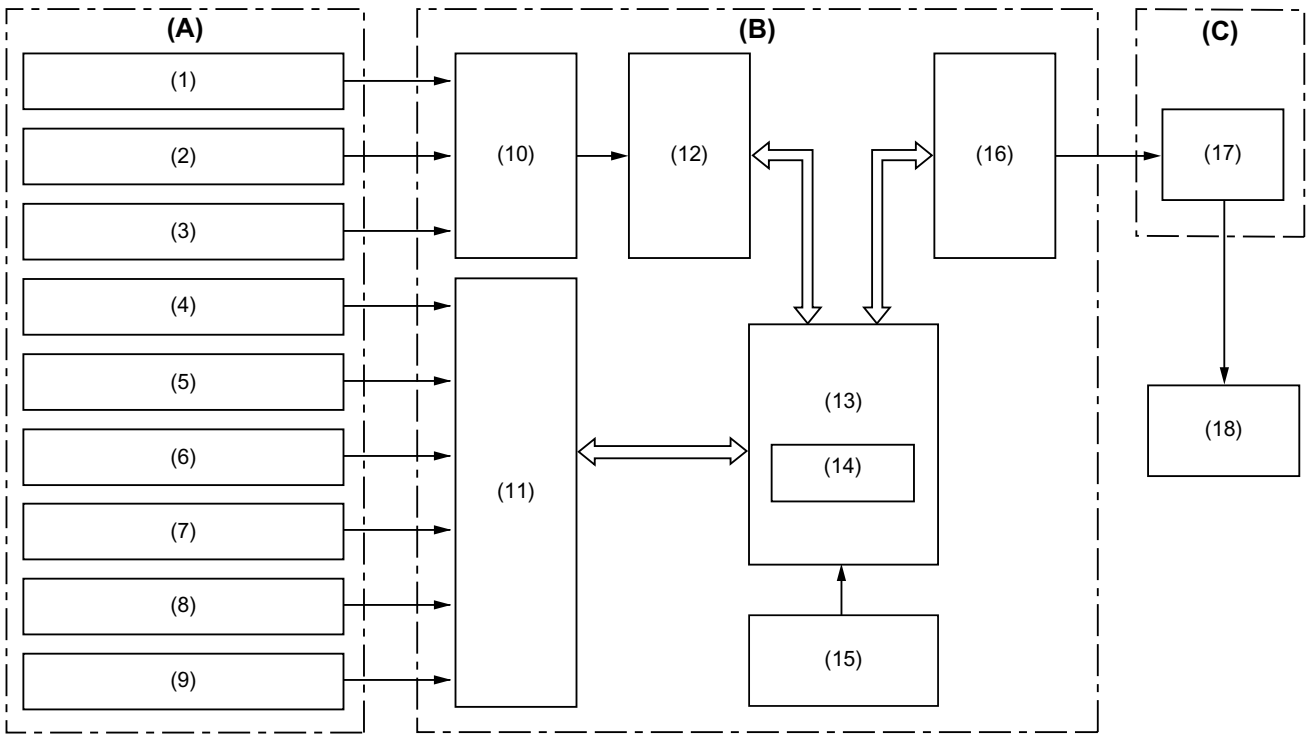
If the selector lever is moved to the R position during driving at a speed faster than the predetermined speed, the low clutch timing solenoid is energized. Then, the pilot pressure is supplied to the reverse inhibitor valve. This causes the reverse inhibitor valve to move downward, closing the low & reverse brake port.
In this condition, the low & reverse brake does not engage since the ATF flowing from the manual valve is blocked by the reverse inhibitor valve.
As a result, the transmission is put into the neutral state, and the shifting into the reverse gear is inhibited.



AT-00433

(1) Line pressure
(2) Pilot pressure
(3) 1st reducing valve
(4) Shift valve A
(5) ON
(6) Manual valve (P range)
(7) Drain
(8) Shift valve B
(9) Low-clutch timing solenoid
(10) Reverse inhibitor valve
(11) Low & reverse brake (released)
(12) Low clutch
(13) 2-4 brake
(14) Reverse clutch
(15) High clutch

K: AWD TRANSFER CLUTCH CONTROL (MPT MODELS)



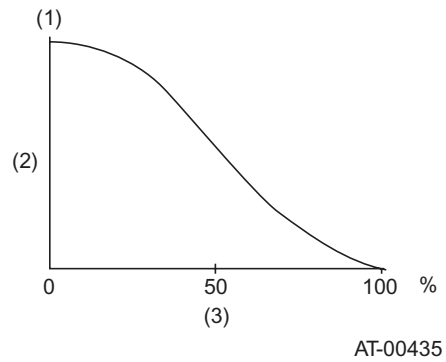
AT-00434

(A) Sensor
(1) Battery voltage
(2) Throttle position sensor
(3) ATF temperature sensor
(4) Rear vehicle speed sensor (rear wheel rpm)
(5) Front vehicle speed sensor (front wheel rpm)
(6) Inhibitor switch

(B) TCM
(7) FWD switch
(8) Brake switch
(9) ABS signal
(10) Input interface circuit
(11) Input interface circuit
(12) A/D converter

(C) Actuator
(13) CPU
(14) Memory
(15) Constant voltage power source
(16) Output interface circuit
(17) Transfer duty solenoid
(18) Transfer clutch

1. BASIC CONTROL

Type of control	Regulates transfer clutch pressure in response to throttle position and vehicle speed.
Gear position	1st thru 4th and reverse
Remarks	 AT-00435 (1) Ordinary control (2) Transfer clutch capacity (3) Duty-ratio

2. 1 RANGE CONTROL

Type of control	Increases transfer clutch pressure above basic control pressure
Gear position	1st speed
Remarks	—

3. SLIP CONTROL

Type of control	Increases transfer clutch pressure to the same level as in the 1 range immediately after a slip is detected.
Gear position	1st thru 4th and reverse
Remarks	Release: The transfer clutch pressure is lowered when a turn under turning control is detected while running faster than the set vehicle speed with fully closed throttle.

4. TURNING CONTROL

Type of control	Decreases transfer clutch pressure upon detection of a turn.
Gear position	1st thru 4th and reverse
Remarks	—

5. ABS CONTROL

Type of control	Regulates to the specified transfer clutch pressure quickly when the ABS signal is input.
Gear position	1st thru 4th and reverse
Remarks	—

6. P AND N RANGE CONTROL

Type of control	Regulates to the specified transfer clutch pressure immediately after a P or N range signal is input.
Gear position	P and N
Remarks	—

L: AWD CENTER DIFFERENTIAL CONTROL (VTD MODELS)

1. CONTROL DESCRIPTION

The TCM controls the engagement of the center differential's multi-plate clutch (LSD) using maps that are pre-programmed based on the throttle opening and torque converter turbine speed. It selects a map according to driving conditions and use it as the control basis.

2. FLOW CONTROL

The torque input to the multi-plate clutch is calculated according to various factors such as intake manifold pressure, torque converter turbine speed and selected speed gear. Based on the calculation result, the basic coupling force of the clutch is determined.

3. START CONTROL

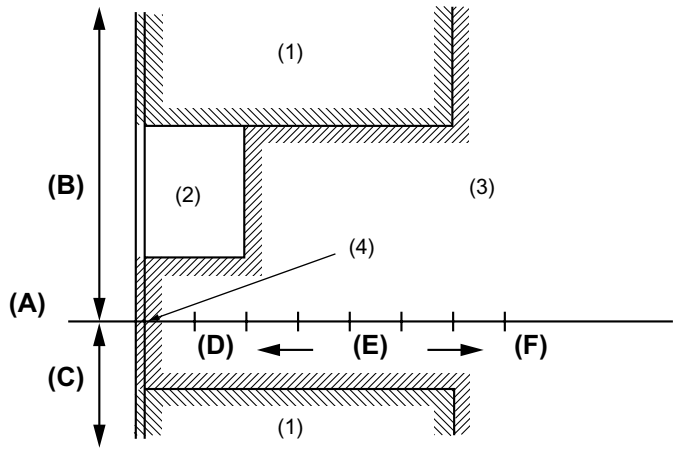
When the vehicle speed is 0 km/h (0 MPH), the TCM makes control to generate differential action limiting torque that is proportional to the throttle angle.
This enables the vehicle to start smoothly without swerving even on a slippery road.

4. TURNING CONTROL

The TCM makes a correction such that the engaging force of the multi-plate clutch is reduced as the steering angle increases.
This function is performed to improves turning performance at certain vehicle speed range.

5. SLIP CONTROL

When front or rear wheels start slipping with the vehicle running slower than the predetermined speed, the TCM makes control to increase the differential action limiting torque.
This function maintains traction and improves driving stability.



AT-00737

(A) Front and rear wheel speed ratio
(B) Front wheel slip
(C) Rear wheel slip
(D) Low
(E) Vehicle speed
(F) High

(1) Slip control
(2) Turning control
(3) Flow control
(4) Start control

6. ABS CONTROL

When the TCM receives an ABS operation signal from the ABS unit, it adjusts the differential action limiting torque to the predetermined level and selects the gear appropriate for the vehicle speed in which the one-way clutch freewheels.
This function improves ABS control.

7. BASE BRAKE CONTROL

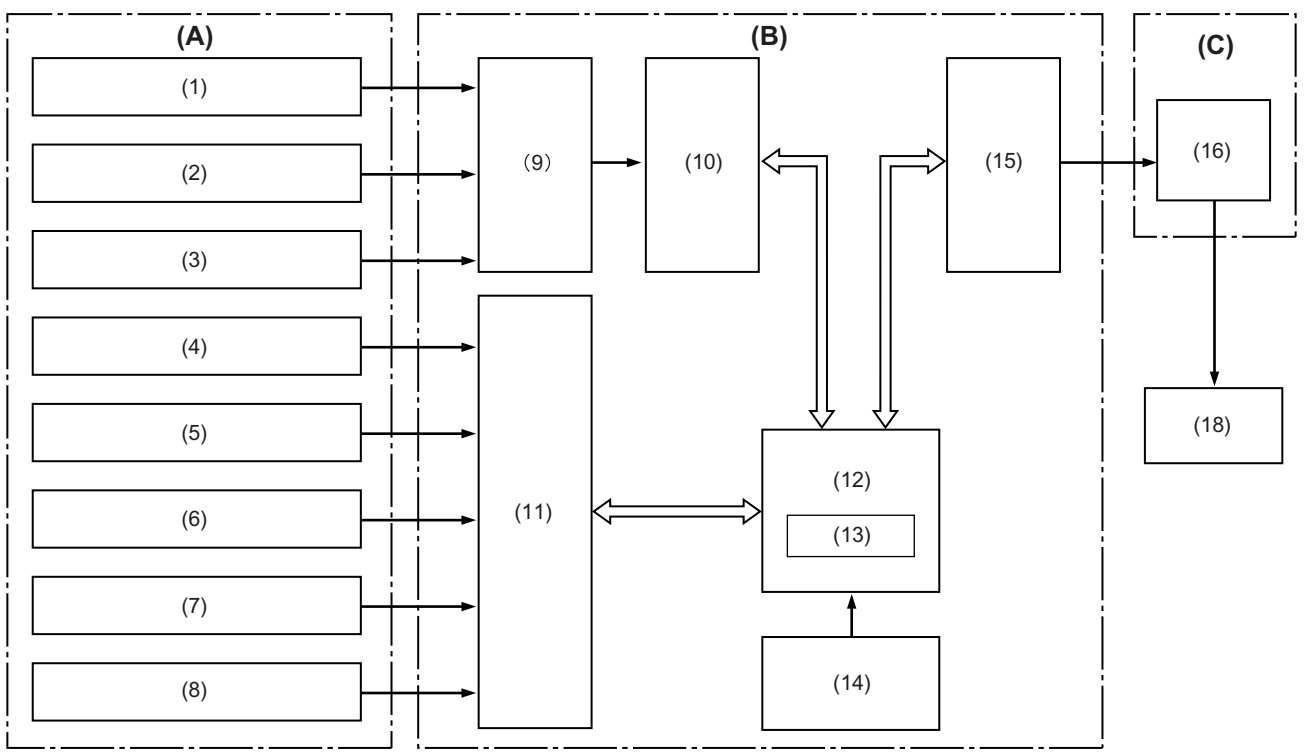
When the brake switch is ON and the throttle valve is fully closed, the TCM makes control to decrease the differential action limiting torque. The ABS control has priority over this control.
This function improves stability during braking.

8. 1 RANGE CONTROL

When the 1 range is selected, the TCM makes control to increase the differential action limiting torque.
This function improves driving performance and traction.

9. CONTROL SYSTEM

The TCM constantly monitors the driving conditions of the vehicle using the eight input signals. Based on the conditions it has determined, the TCM adjusts the duty ratio of current to the transfer duty solenoid thus changing the engagement of the multi-plate clutch. The input signals are used also for automatic transmission control.



AT-01250

(A) Sensor
(1) Power supply
(2) Throttle sensor
(3) ATF temperature sensor
(4) Rear vehicle speed sensor (rear wheel rpm)
(5) Front vehicle speed sensor (front wheel rpm)
(6) Inhibitor switch
(7) Brake switch
(8) ABS signal

(B) TCM
(9) Input interface circuit
(10) A/D converter
(11) CPU
(12) Memory
(13) Constant voltage power source
(15) Output interface circuit

(C) Actuator
(16) Transfer duty solenoid
(17) Multi-plate clutch (LSD)

M: TRANSFER CONTROL

1. MPT MODELS

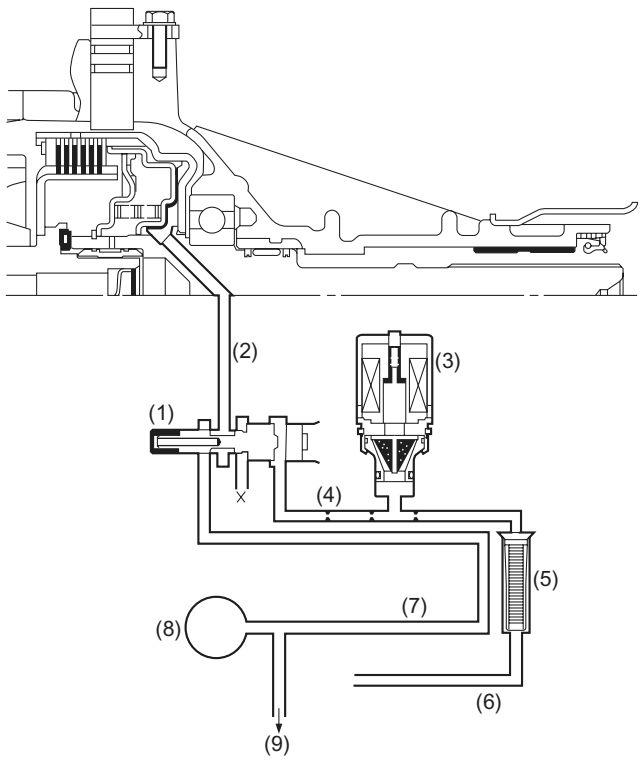
The transfer hydraulic pressure control unit includes a valve body attached to the side of the extension case through a gasket and separator plate.

The pressurized fluids for the transfer hydraulic pressure control (line pressure and pilot pressure) are supplied from the oil pump by way of the passages formed in the transmission case and then the passages in the extension case that lead to the hydraulic circuit in the transfer valve body.

The line pressure is regulated by the transfer control valve whose opening is controlled by the transfer pressure created by the transfer duty solenoid.

- The transfer duty solenoid is controlled by the TCM. The TCM changes the solenoid controlling duty ratio according to driving conditions.
- The transfer duty solenoid creates the transfer pressure from the pilot pressure. The transfer pressure is applied to the transfer control valve and adjusts the valve's opening.
- The line pressure directly led to the transfer control valve, on the other hand, is regulated by the transfer control valve and becomes the transfer clutch pressure.
- The transfer clutch pressure is applied to the transfer clutch and engages the clutch to a controlled degree.

In this way, the degree of transfer clutch engagement is varied so that optimum torque is distributed to the rear wheels according to vehicle driving conditions.



AT-00436

(1) Transfer control valve
(2) Transfer clutch pressure
(3) Transfer duty solenoid
(4) Transfer pressure
(5) Filter
(6) Pilot pressure
(7) Line pressure
(8) Oil pump
(9) Control valve

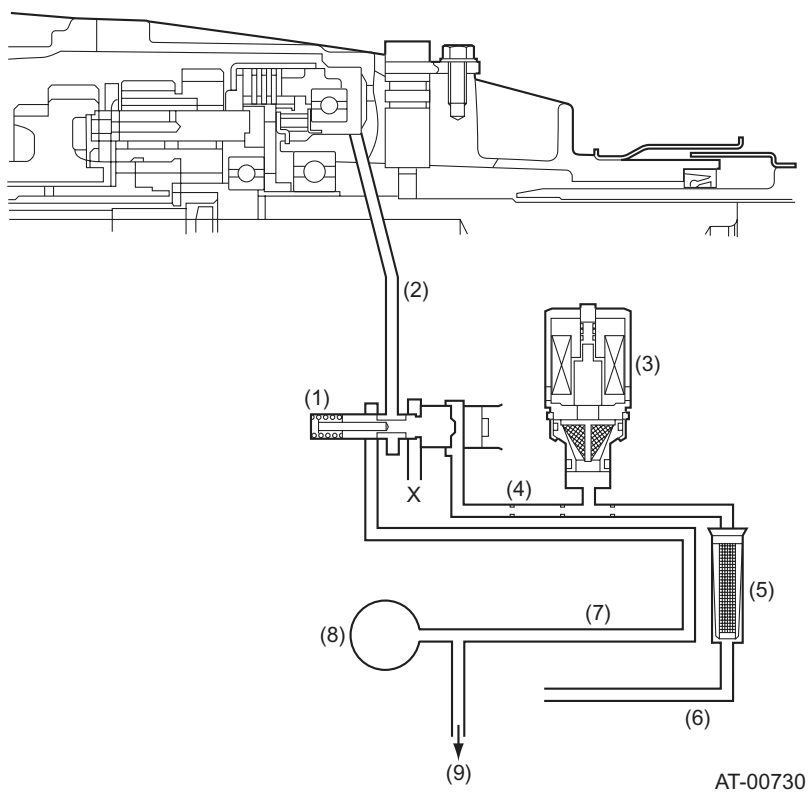
2. VTD MODELS

The drive power distribution system includes a valve body attached to the side of the extension case through a gasket and separator plate.
The pressurized fluids for the drive power distribution system (line pressure and pilot pressure) are supplied from the oil pump by way of the passages formed in the transmission case and then the passages in the extension case that lead to the hydraulic circuit in the transfer valve body.

The line pressure is regulated by the transfer control valve whose opening is controlled by the transfer pressure created by the transfer duty solenoid.

- The pilot pressure created by passing through the pilot valve in the transmission's hydraulic control assembly is further regulated into the transfer pressure by the transfer duty solenoid.
- The transfer duty solenoid is controlled by the TCM. The TCM changes the solenoid controlling duty ratio according to driving conditions.
- The transfer pressure thus created is applied to the transfer control valve and adjusts the valve's opening.
- The line pressure directly led to the transfer control valve, on the other hand, is regulated by the transfer control valve and becomes the transfer clutch pressure.
- The transfer clutch pressure is applied to the multi-plate clutch (LSD) and engages the clutch to a controlled degree.

In this way, the degree of multi-plate clutch engagement is varied so that optimum torque is distributed to the rear wheels.



(1) Transfer control valve
(2) Transfer clutch pressure
(3) Transfer duty solenoid
(4) Transfer pressure
(5) Filter
(6) Pilot pressure
(7) Line pressure
(8) Oil pump
(9) Control valve

14.On-board Diagnostics System

A: FUNCTION

The on-board diagnostics system detects and stores in the form of a code a fault that has occurred in any of the following input and output signal systems.

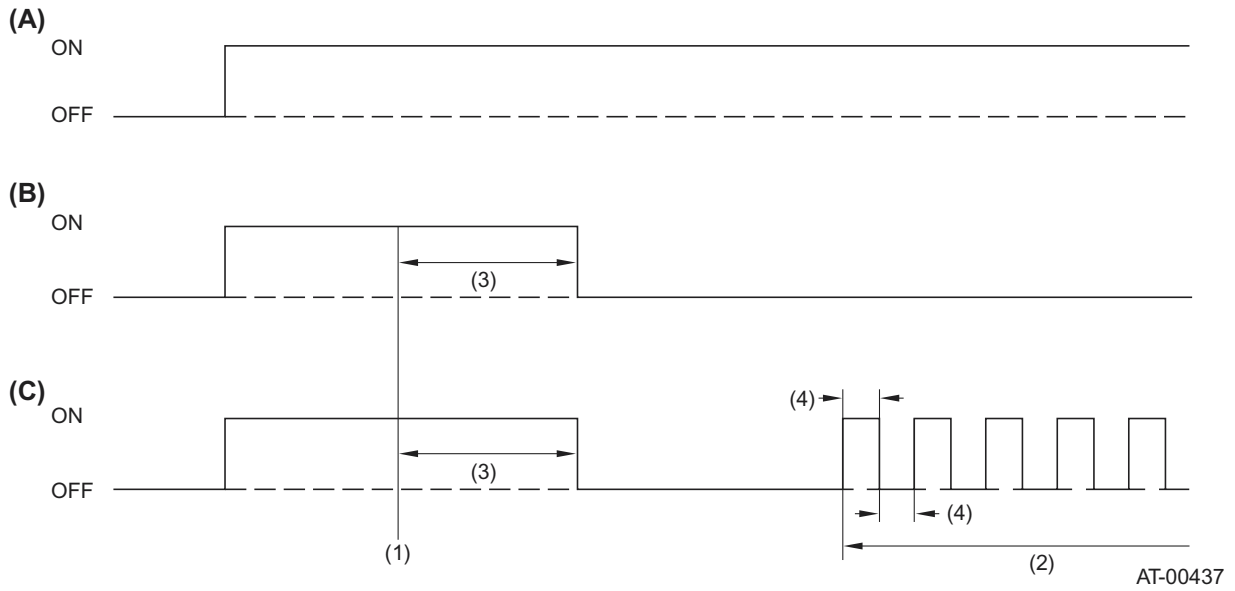
Rear vehicle speed sensor	Transfer duty solenoid	Low-clutch timing solenoid
Front vehicle speed sensor	ATF temperature sensor	Torque converter turbine speed sensor
Throttle position sensor	Engine speed signal circuit	—
Shift solenoid 1	Line pressure duty solenoid	—
Shift solenoid 2	AT load signal circuit	—
2-4 brake timing solenoid	Torque control signal circuit	—
Lockup duty solenoid	2-4 brake duty solenoid	—

If a fault has been detected, the system tells the fault by causing the AT OIL TEMP warning light to operate as follows:

- Repeated flashing at 4 Hz frequency ...Errors such as battery trouble
- Repeated flashing at 2 Hz frequency ...No faults in the system
- Flashing at different intervals and frequencies ...Diagnostic trouble codes of corresponding faults
- Continued illumination of light ...Fault in inhibitor switch, idle switch, or wiring

B: OPERATION OF AT OIL TEMP WARNING LIGHT

On starting the engine, the AT OIL TEMP warning light illuminates and then goes out as shown in the Normal diagram below. If any problem exists, the light continues flashing as shown in the Abnormal diagram below.



(A) Ignition switch ON (engine OFF)
(B) Normal
(C) Abnormal

(1) Engine cranking
(2) Blink
(3) 2 seconds
(4) 0.3 seconds

15.Fail-safe Function

The fail-safe control function ensures minimum level of driveability even if a fault should occur in the vehicle speed sensors, throttle position sensor, inhibitor switch, or any of the solenoids.

- Front and rear vehicle speed sensors

A dual speed-sensing system is used. The speed signal is taken from the transmission (by the output shaft speed sensor). Even if one sensor system fails, the vehicle can be controlled normally with the other normally operating sensor system.

If both the front and rear vehicle speed sensors become faulty, the vehicle is made to operate only in the 3rd speed.

- Throttle position sensor

If the throttle position sensor becomes faulty, control will be maintained by assuming that the throttle opening is at a certain angle.

- Inhibitor switch

If the TCM receives different signals simultaneously from a faulty inhibitor switch, it selects a range in the following priority:

D > N (P) > R > 3 > 2 > 1 >

- Shift solenoid 1 and 2

If a fault occurs in either of solenoids 1 and 2, both the solenoids are de-energized, and the gear is held in the 3rd. If both the solenoids should fail, the TCM invariably selects and keeps the 3rd gear.

- Line pressure duty solenoid

If the line pressure duty solenoid fails, the solenoid is de-energized and the line pressure is raised to the maximum to enable the vehicle to operate.

- Lockup duty solenoid

If the lockup duty solenoid fails, the solenoid is de-energized and the lockup clutch is disengaged.

- Transfer duty solenoid

When the transfer duty solenoid becomes faulty, it is de-energized. This causes maximum oil pressure to be applied to the transfer clutch so that the power is always transmitted to the rear axle (direct-coupled AWD condition).

- 2-4 brake duty solenoid

If a fault occurs in the 2-4 brake duty solenoid, the solenoid is de-energized and the usable gears are limited to the 1st and 3rd.

- Low-clutch timing solenoid

If a fault occurs in the low clutch timing solenoid, the solenoid is de-energized and the usable gears are limited to the 1st and 3rd.

- 2-4 brake timing solenoid

If a fault occurs in the 2-4 brake timing solenoid, the solenoid is de-energized and the usable gears are limited to the 1st and 3rd.

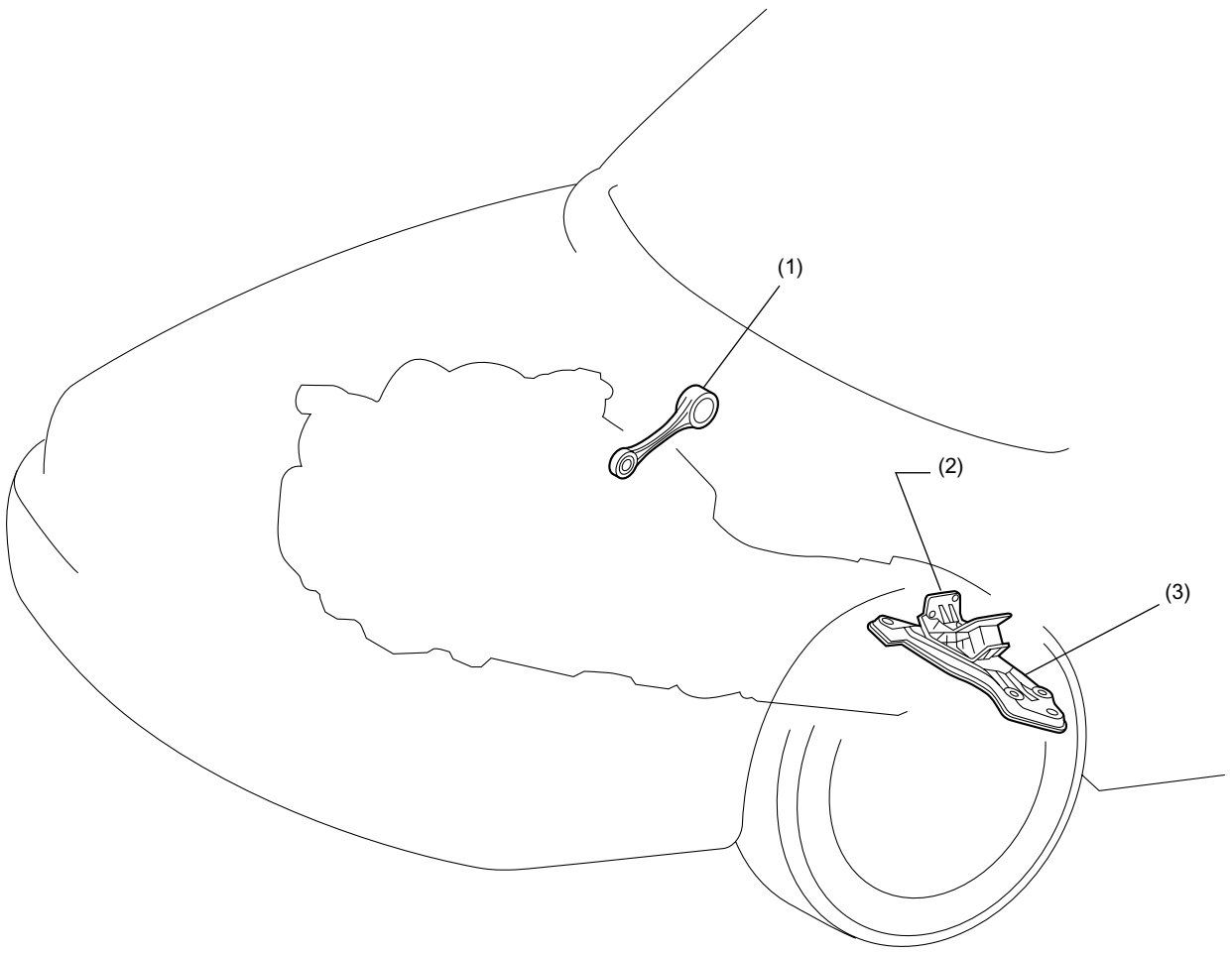
- Torque converter turbine speed sensor

If a fault occurs in the torque converter turbine speed sensor, the usable gears are limited to the 3rd.

16.Transmission Mounting

A: GENERAL

The transmission mounting consists of a pitching stopper, cushion rubber, and a cross member. In addition to support the transmission, these components absorb noise and vibration caused by the transmission.



AT-00438

(1) Pitching stopper
(2) Cushion rubber
(3) Cross member

MEMO