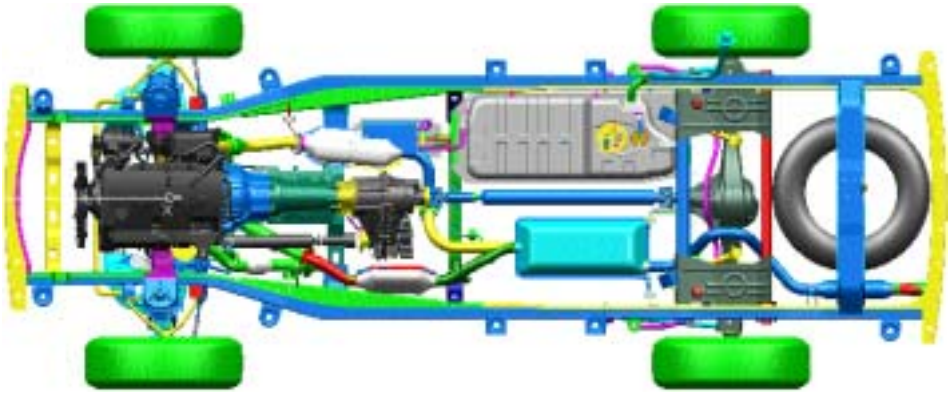
PART TIME 4WD (EST) SYSTEM



EST (Electronic Shift Transfer)

CONTENTS

1. BASIC THEORY OF 4WD

1.1 2WD AND 4WD

Engine power enables a vehicle to get moving and to continue moving. To transfer the engine power into moving force an equal amount of traction is needed.

Traction is the resistance or friction happening between each tire and the ground surface. In 2WD the traction of only two wheels is used. The other two tires have traction as well, but they are just rolling along, in rear wheel drive vehicles they are used to steer the vehicle.

If more torque is applied than there is traction available, the 2 tires will lose its grip and start spinning. So, if in need of more power/torque to move more weight or to go faster more traction is needed. That can be achieved by mounting larger tires with a larger footprint or sending some of the torque to the other two wheels (4WD) and using their traction as well.

So, in 2WD power is divided towards 2 tires and the traction of those two tires has the burden of supporting the engine's power - each powered tire has deal with 50% of the available torque. In 4WD power is divided towards 4 tires. In 4WD the traction at each powered tire has to deal only with 25% of the torque created by engine, transmission, transfer case, and axle. Since each tire in 4WD has to carry a much smaller torque load (25% instead of 50%), it is much less likely for the tires to lose its grip. That is why a 4WD can climb much steeper grades than a 2WD. Because much more torque is needed to move the vehicle up a steep grade, and only when the torque load is spread out over 4 tires instead of 2 tires it is supported by sufficient traction.

All this is true with all 4 tires on the same surface and each wheel loaded down with 25% of the vehicle's weight. The very moment one tire gets onto a surface with less friction (resulting in less traction) than the other wheels - at least one differential will start acting up. The very moment one tire, due to rolling into a small rut for example, gets to carry less than 25% of the vehicle's weight (also resulting in less traction).

The wheel with less traction will receive more than 25% of the torque (power is always following the path of least resistance) the wheel with more traction will get less torque. The opposite wheel will get little or no torque and cannot keep the vehicle moving. 4WD was invented to use the traction of all 4 tires to either move more weight or drive on surfaces with marginal traction, or both.

Differential locks and traction control are invented to counteract the "stupid" differential's intention of wasting torque on wheels with little or no traction. All driven axles have to have a differential to make it possible in turns to send more rpm and more torque to the outside wheel and less rpm and less torque to the inside wheel of a turn.

In general:

- 4WD is helpful to get moving and supports directional stability.
- 4WD is not helpful to go faster.
- 4WD is not helpful to stop the vehicle.

1.2 FULL TIME 4 WHEEL DRIVE VS. ALL WHEEL DRIVE (AWD)

Full time four wheel drive (not part time 4WD) is a system that powers all four wheels at all times. Each tire gets about 25% of the available torque. Driver has a choice of a "4-high" and "4-low".

When "4-low" is selected the wheels receive substantially more (on Terracan of HMC and Sorento of KMC, its 2.48 times more) power than in "4-high", at the same time the vehicle moves at substantially slower speeds (2.48 times slower).

The low setting is an advantage for drivers who need to tow and maneuver a heavy trailer etc and for drivers who at one point or another may want to negotiate difficult off-road terrain.

All wheel drive is a system that powers all four wheels of a vehicle at all times as well. Difference to full time 4WD is that "4-low" is not available. Due to the lack of "low range" AWD vehicle are much less capable than 4WD vehicles.

1) All Wheel Drive (AWD)

- Only mode is 4WD full time, - No 2WD available, - No 4WD "low" available,
- Center differential locks automatically (Torsen diff, viscous coupling),
- Almost useless beyond pavement, - No transfer case

2) Full Time 4WD

- Main mode is 4WD. 4WD is used full time.
- No 2WD mode available.
- All four wheels are powered at all times. Operates well on dry pavement due to a center differential or equivalent device (viscous coupling, planetary gears).
- Part Time 4WD does not have a center differential. A center differential is essential for on-road use but can be detrimental for off-pavement use. When leaving pavement the center differential needs to be disabled (locked). It either locks automatically or it has to be locked (disabled) manually.
- Normal setting for on-road use and light duty off-road use is 4WD "high"
- For more torque 4WD "low", also called low range, is available. Low range substantially provides more torque to the wheels and allows slower speeds than in high range. 4 low does not provide more traction. It only provides more torque.

3) Part Time 4 Wheel Drive

- Main mode is 2 wheel drive for everyday pavement use. Only rear wheels are powered. (In some cases front wheels are powered instead)
- When needed (usually beyond pavement) 4WD can be engaged. (4WD is used part time)
- When 4WD is engaged front wheels are powered as well.
- There are two different settings for 4WD "high" and "low"
- 4WD "high", called high range, cannot be used on dry pavement with a "part time " system.
- For extreme situations 4WD "low" is available, it cannot be used on dry pavement either. 4WD "low", also called low range does not provide more traction. However, it provides two to three times more torque at about half or a third of the speeds in high range.

1.3 ADVANTAGES AND DISADVANTAGES OF 4WD

1) **Traction and Grip :**
   Apparently, 4-wheel drive brings traction and grip to higher level because the tractive effort is shared by 4 wheels instead of two. This enable higher cornering limit, especially in rough roads and wet condition. Since it was introduced in 1980 to rally cars, 4WD proved its superiority in this aspect.

2) **Weight penalty and power loss :**
   Because the driving mechanism of the additional wheels has frictional loss, 4WD consumes a little bit more power than 2WD cars. Anyway, this is still a fraction compare with the increased weight. Most 4WD systems weigh 50kg-100kg more than a 2WD system, thus deteriorate acceleration as well as fuel consumption.

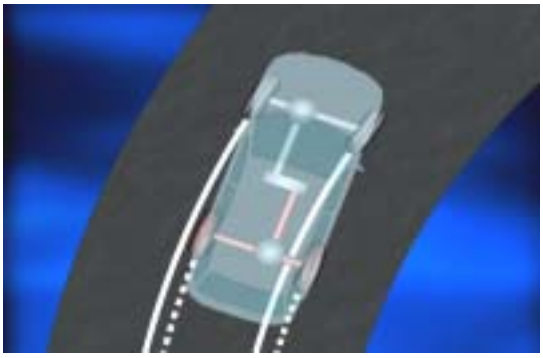
3) **Steering tendency :**
   As mentioned in our study of handling, in theory, permanent 4WD cars generate neutral steering tendency, thanks to the tractive force sharing by all 4 wheels. However, in reality this become much more complicated. Steering tendency can also be corrected by weight distribution, the adjustment of camber and castor, the choice of different size tires in front and rear etc. Moreover, it is widely agreed that a slight oversteering, if could be accurately controlled by throttle and steering, is even more satisfying than neutral steering. In contrast, most 50:50 permanent 4WD cars can hardly enable oversteering, unless in really slippery surface.

4) **Steering feel :**
   Depends on tuning, some 4WD cars deliver less steering feel, since the presence of torque in the front wheels may generate slightly torque steer. However, most modern 4WD cars overcame this problem.

1.4 BASIC LAYOUT OF 4WD

A modern 4-wheel drive system must has 3 differentials - one in the front axle to distribute torque between the left and right front wheels, one in the rear axle again responsible for torque distribution, the third one, calls Center Differential, distributes torque between front and rear axles.

We all know the objective of differential. During cornering, the outside wheels have to travel faster than the inside wheels, therefore we need a differential to distribute different torque to the wheels. For a 4WD car, we in addition need the Center Differential because the front wheels have to travel faster than the rear wheels. The following diagram illustrates this:



If without the center differential, the non-conformance of front and rear wheel speed will lead to tire slip as well as energy losses, tire roar, wear of tires etc. Therefore center differential is a must for modern cars.

1.5 LSD OF 4WD

However, just the 3-differential layout alone cannot cope with the basic requirement for 4WD - provides superior grip in the worst roads. In real world driving, for instance, when pushing the car over its limit in corner, or running on slippery surface, tire slip is inevitable. When a wheel loses traction, a normal differential will transfer nearly all the driving torque to that wheel. As a result, the spinning wheel will spin even wilder, but the wheel that having traction will never share driving torque, therefore the car will be difficult to get out of the trouble. This problem occurs in all kinds of car, no matter 2-wheel drive or 4WD, but it is relatively more important to 4WD because 4WD cars are designed to run in worse roads or cornering harder.

Therefore 4WD cars (or even many latest 2WD sports cars) need Limited Slip Differential (LSD). A LSD lock up both drive shafts whenever tire slip occurs, thus helps the car get out of trouble quickly. The result is enhanced stability and even higher cornering limit.

In fact, LSD is the core of 4WD technology. There are several types of LSD: Torsion LSD, Viscous Coupling LSD, VC differential lock and Active LSD. They have different effectiveness, characteristic and cost so that car makers choose them according to their needs.

Regarding 4WD vehicle such as Santa-Fe(for rear diff.) of Hyundai motors and Sportage, Sorento of Kia motors, Carbon Disc LSD is adapted for the rear as an option.

2. SORENTO 4WD SYSTEM

2.1 4WD SPECIFICATION

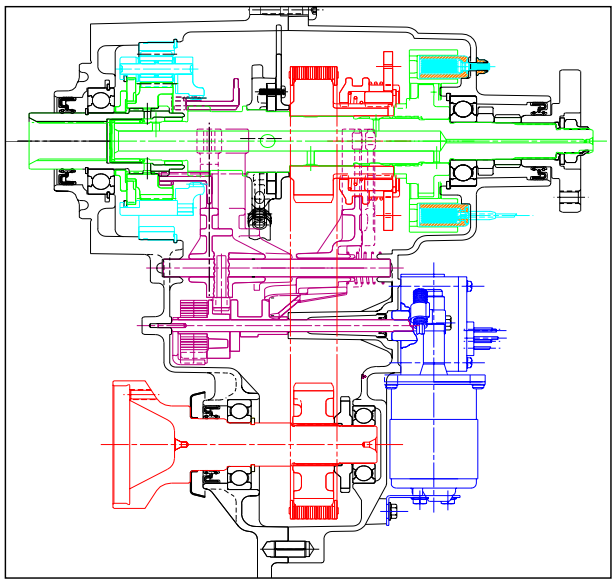
EST: Electrical Shift Transfer is standard on all models and trims for part-time 4WD, allowing drivers to “shift on the fly” between two- and four-wheel-drive modes at speeds up to 80 km/h.

ATT: Active Torque Transfer (or “Torque-on-Demand”) electronically transfers power and torque from the rear to the front as required, enhancing off-road traction, handling agility and steering precision.

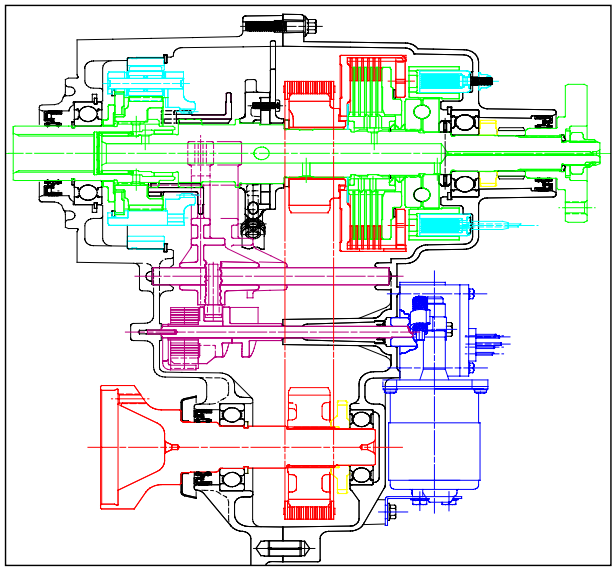
[Comparison between the Part Time 4WD and the Full Time 4WD]

Items	Parts time	Full time
Engine	DSL : 2.5 GSL 2.4, 3.5	
Type	Electronic shift transfer	Active torque transfer
Model	BWA 44-24 ESOF	BWA 44-24 TOD
FRT axle connection	FRRD	No FRRD (Full time connection)
Weight (Kg), Length(mm)	35, 351	37.3, 351
Gear ratio (HIGH)	1 : 1	
Gear ratio (LOW)	2.48 : 1	
FRT driving type	Chain	
Lubricant	DEXRON III	
Lub. Quantity (L)	1.42	
FRRD motor	○	X
Front speed sensor	X	Hall IC effect type
Rear speed sensor	Pulse generator	Hall IC effect type
Vehicle speed sensor	Hall IC effect type	Hall IC effect type

2.2 SYSTEM CONSTRUCTION (EST, TOD) & OPERATING CONDITION



[EST]



[TOD]

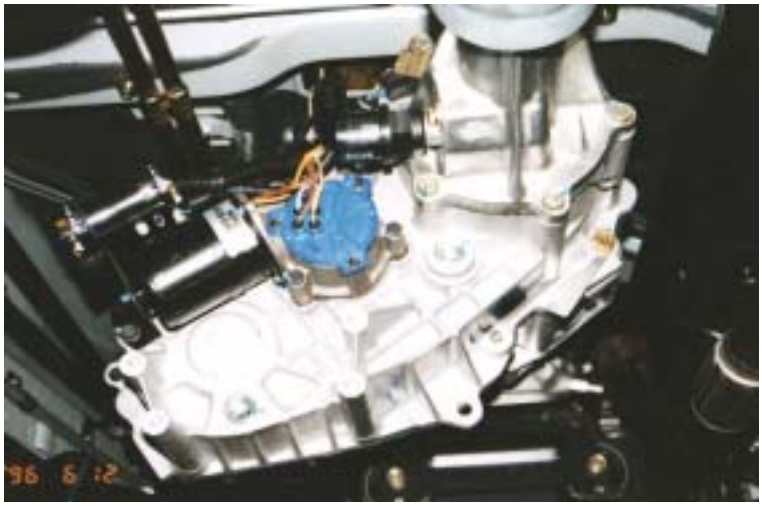
Drive type	Drive item	Drive mode	Drive status	Useful condition
Electric Shift Transfer (EST type)	Drive mode	2H	2WD, Rear wheel drive	Use on the roadway.
		4H	4WD HIGH	* Use on the off-road or snowy and rainy road having slippery road surface. * When turning on the roadway at low speed, vibration and noise happens by tight corner braking.
		4L	4WD LOW	Use in the condition which driving force is required like escaping from rough way and towing.
	Transfer	2H ↔ 4H	2WD ↔ 4WD	Possible to transfer 2WD into 4WD and vice versa at 80kph or below during driving.
		4H ↔ 4WD(L)	4WD(H) ↔ 4WD(L)	* Necessary to stop the vehicle for transfer - M/T vehicle : Transfer after pressing the clutch pedal. - A/T vehicle: Transfer after positioning the A/T lever to “N”. * All vehicles with 4L mode should stop the vehicle for transfer.
Active Torque Transfer (ATT type)	Drive mode	AUTO	2WD ↔ 4WD	* Use on the various road surfaces including roadway, off-road, or snowy and rainy road surface. * Using multiple clutch, control the revolution difference between front and rear wheels electronically. So this mode can correspond to the various road surfaces by controlling the ATT unit automatically.
		LOW	4WD LOW	Refer to 4L of part time.
	Transfer	AUTO ↔ LOW	4WD(H) ↔ 4WD(L)	* Necessary to stop the vehicle for transfer M/T vehicle: Transfer after pressing the clutch pedal. A/T vehicle: Transfer after positioning the A/T lever to “N”. * All vehicles with 4L mode should stop the vehicle for transfer.

3. EST (ELECTRONIC SHIFT TRANSFER)

3.1 INTRODUCTION

EST system is a kind of part time 4wheel drive system and its full name is 'Electronic shift transfer'. Instead of the free wheel hub type adapted by Sportage, FRRD (Free Running Differential) type of SOTF(Shift on the fly) system is employed.
When a vehicle runs with 2WD mode, front axle will rotates idly due to the vehicle speed. Driving chain inside transfer rotates along with the front wheel revolution making a noise and vibration through the propeller shaft. To prevent this, a device, FRRD system is required to cut the connection between the front wheel and the transfer.

When 4WD mode is selected by driver, FRRD air pump motor operates and a dog clutch in FRRD is engaged to pinion shaft making a front wheels drive. Therefore the front propeller shaft and the front drive shaft is coupled rotating together. Oppositely, if 2WD is selected by a driver, the dog clutch in a FRRD is disengaged resulting in disconnection between the front propeller shaft and the front drive shaft.



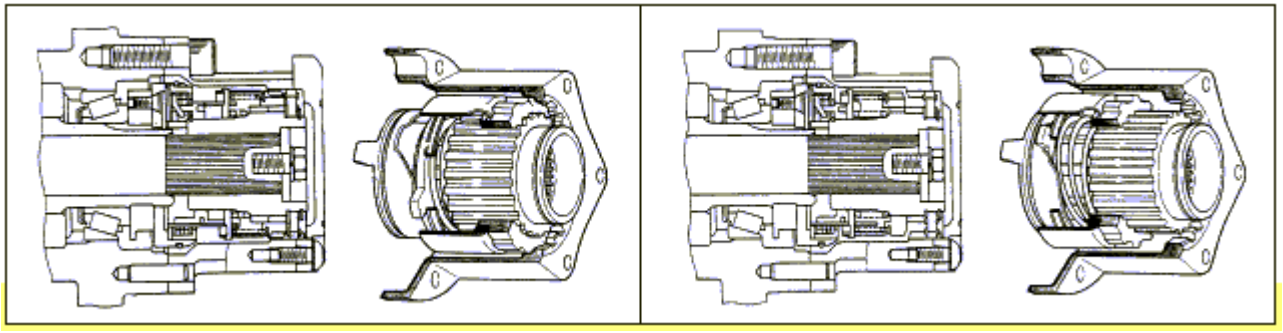
[EST Transfer Case]

3.2 KINDS OF SOTF SYSTEM IN PART TIME 4WD

1) CAM type auto free wheel hub

- Application vehicle : HMC Galloper

- For 2WD from 4WD, vehicle should be moved backward 1 or 2 meters approximately.

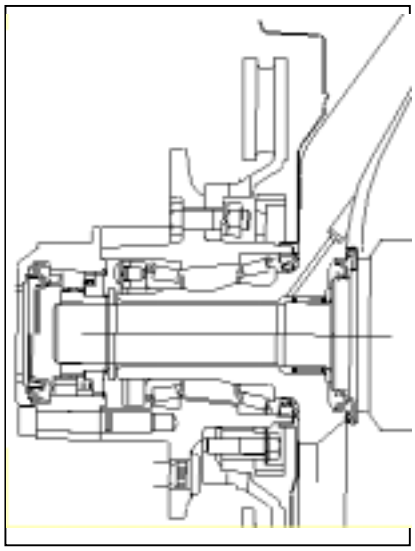


2) Vacuum type free wheel hub

- Application vehicles : HMC H-1, KMC Sportage

- SOTF is activated in condition of 40km/h or less.

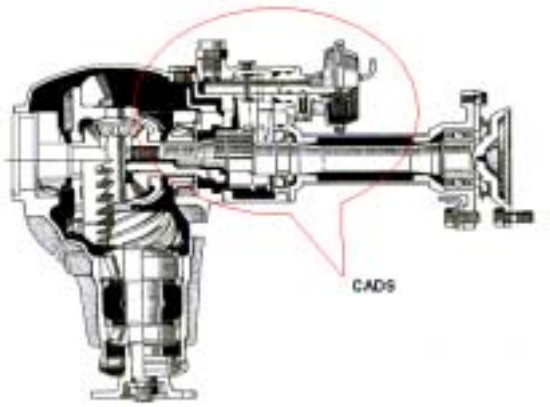
- In respect of durability, it is difficult to prevent the air leakage on the wheel end side.

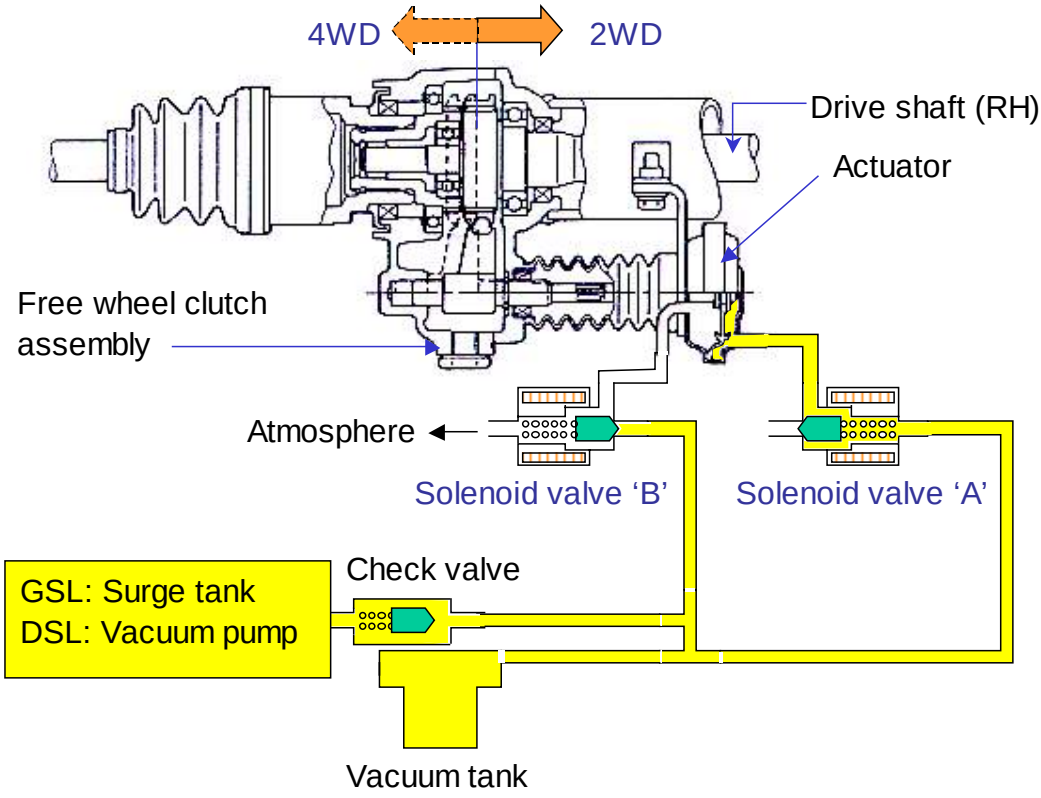


3) CADS (Center axle disconnect system) type

- Application vehicles : HMC Terracan, MMC Pajero, Challenger, Big horn, Surf

- SOTF is activated at 80km/h or less.





When 2WD is selected by driver, the shift fork of the CADS moves by the pressure difference of each side of the diaphragm inside actuator. It results disconnection between axle shaft and differential shaft. Oppositely, if 4WD is selected by driver, the axle shaft and differential shaft is connected so as to be driven by 4WD.

4) FRRD (FRee Running Differential) : refer to the following chapter.

3.3 FRRD(FREE RUNNING DIFFERENTIAL)

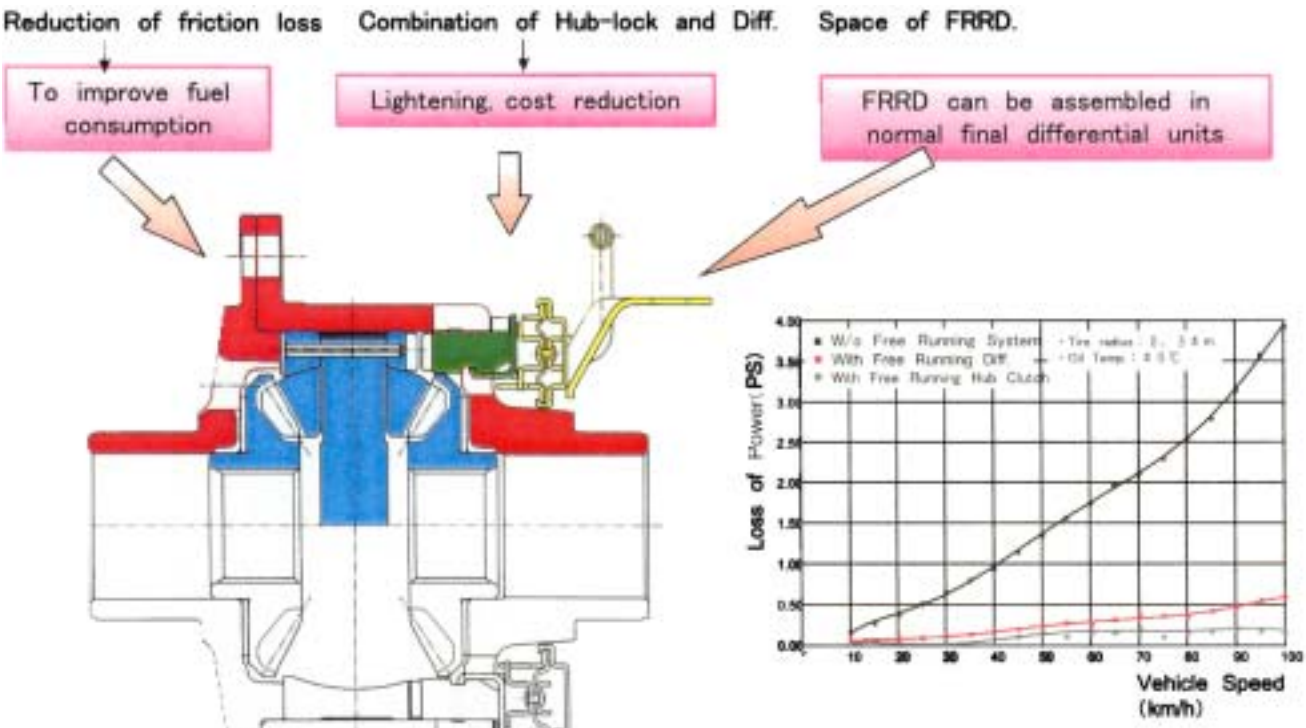
SOTF(Shift On The Fly) system for Sorento is a FRRD type. Sportage, previous KIA 4WD model, has incorporated two types of SOTF system one is a CAM type auto free wheel hub system used till 1999 model, the other type is a Vacuum type free wheel hub system.
A vacuum type has made better performance than a CAM type. But it still has a problem like an air leaking in a hub which is exposed all the time.

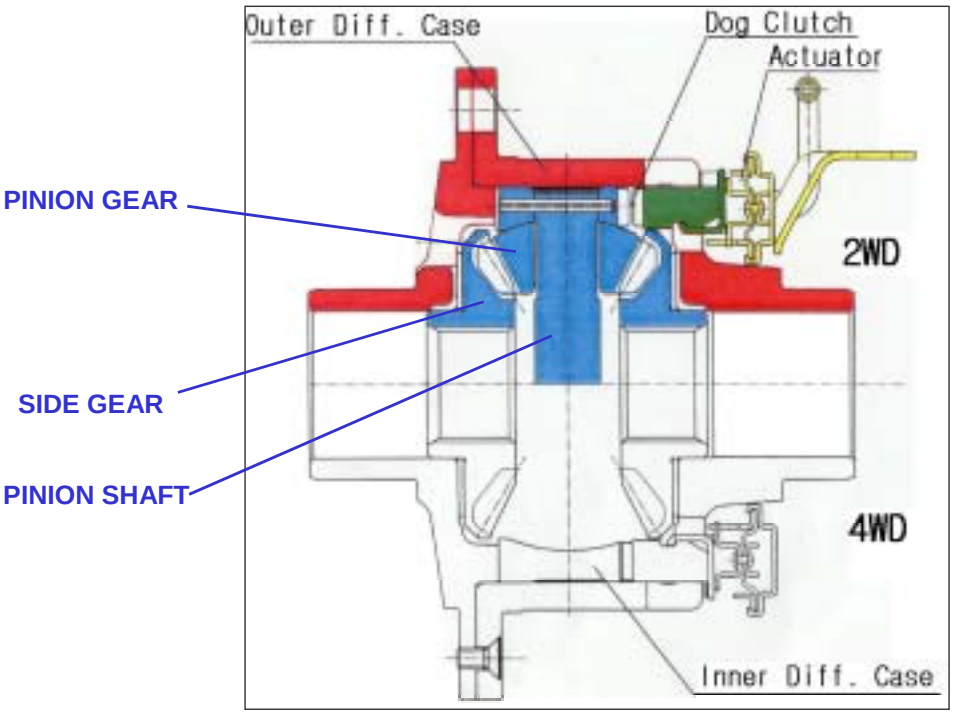
FRRD is installed in the front axle. A driver selects 4WD mode, air pump motor is energized and a dog clutch is engaged connecting a front propeller shaft and a front drive shaft. If a drive selects 2WD mode on driving, the dog clutch is disengaged disconnecting the drive force to a drive shaft.

[FRRD case]

[FRRD outer case]

[ADVANTAGES OF FRRD]

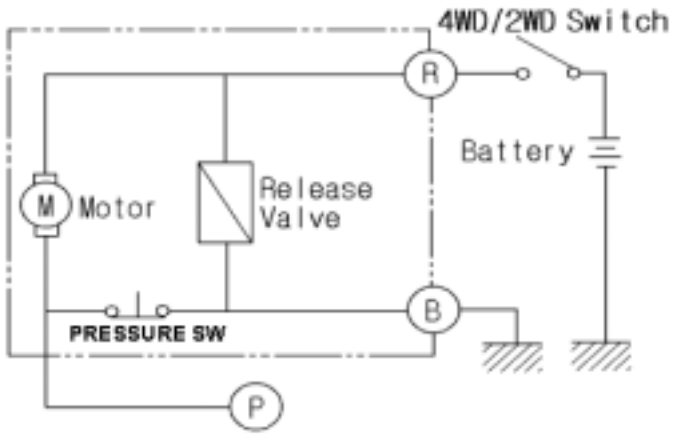




[FRRD section]

[FRRD VACUUM PUMP MOTOR]

[FRRD air pump motor]



[FRRD air pump motor circuit]

[FRRD OPERATION]

① When driver selects 4H mode, power supplies to an air pump motor.

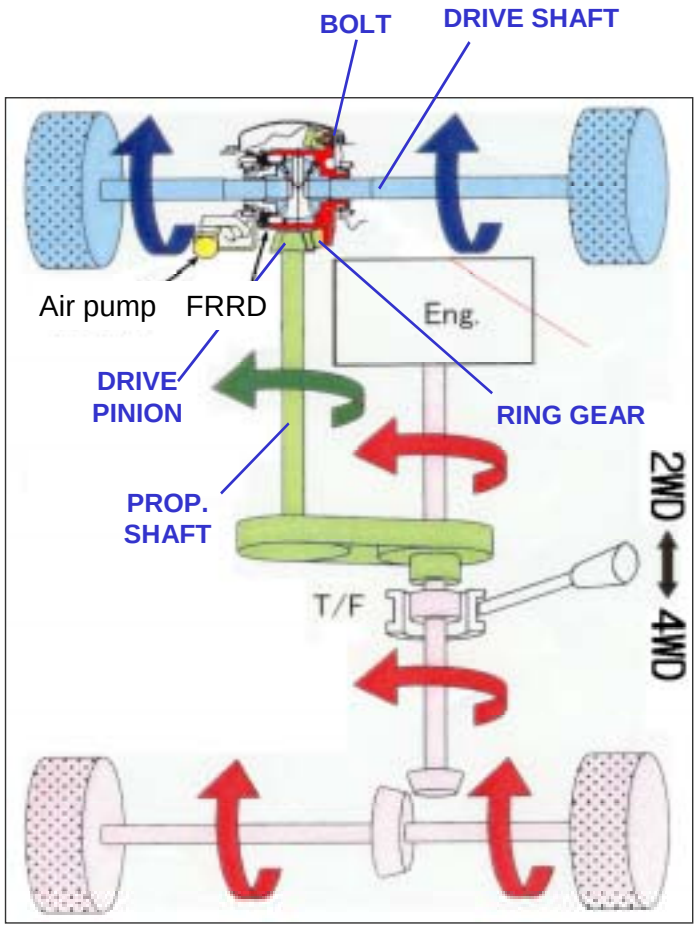
② At the moment, front propeller shaft begins to rotate and the speed difference between the inner case and the outer case is almost same.

③ Air pressure is charged inside the air pump.

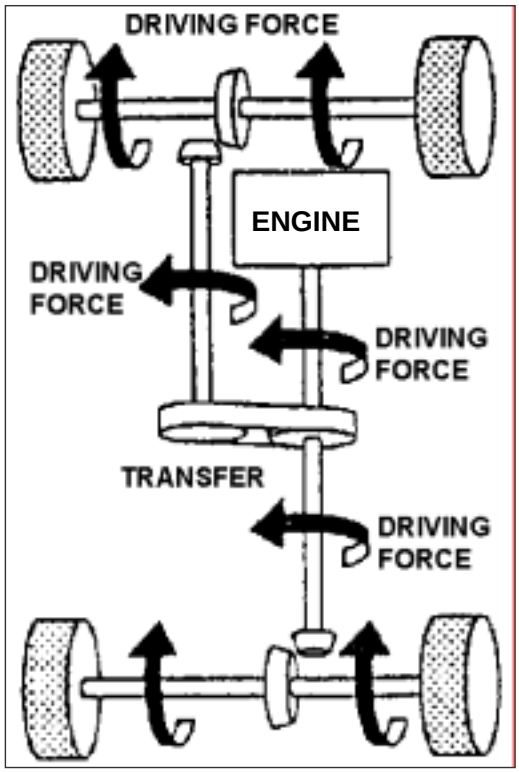
④ The pressure pushes a cam ring and a dog clutch and the inner case are coupled together making a 4WD mode.

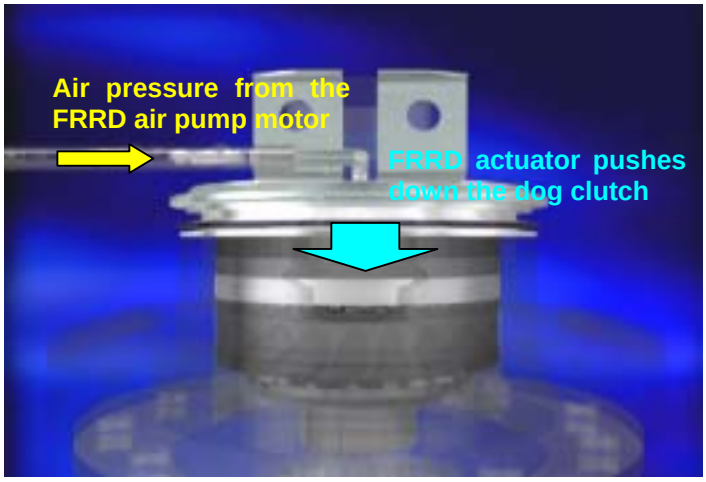
⑤ If the driver selects a 2H mode, drive force is cut off inside a transfer and the power of the air pump is off.

⑥ Cam ring returns by a return spring, connection with the inner case is off to a 2WD mode.



[FRRD OPERATION - 4WD]

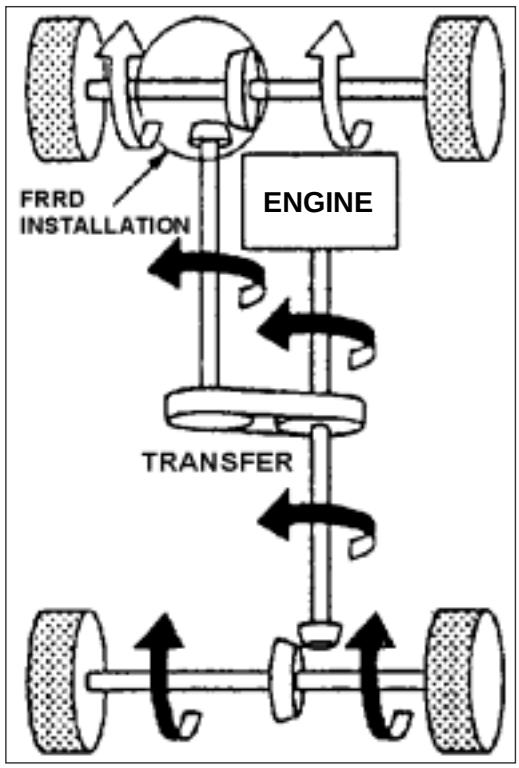


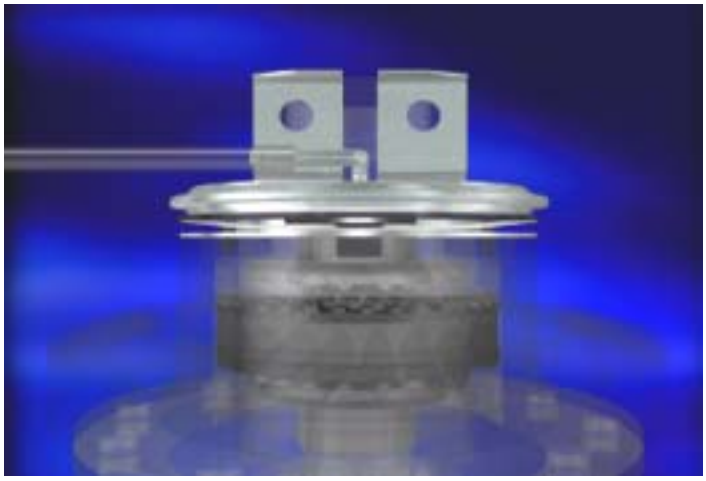


[FRRD operation at 4H or 4L mode]

Air pressure from the FRRD air pump motor pushes down the dog clutch inside FRRD making the differential pinion shaft be coupled with the differential housing.

[FRRD OPERATION - 2WD]

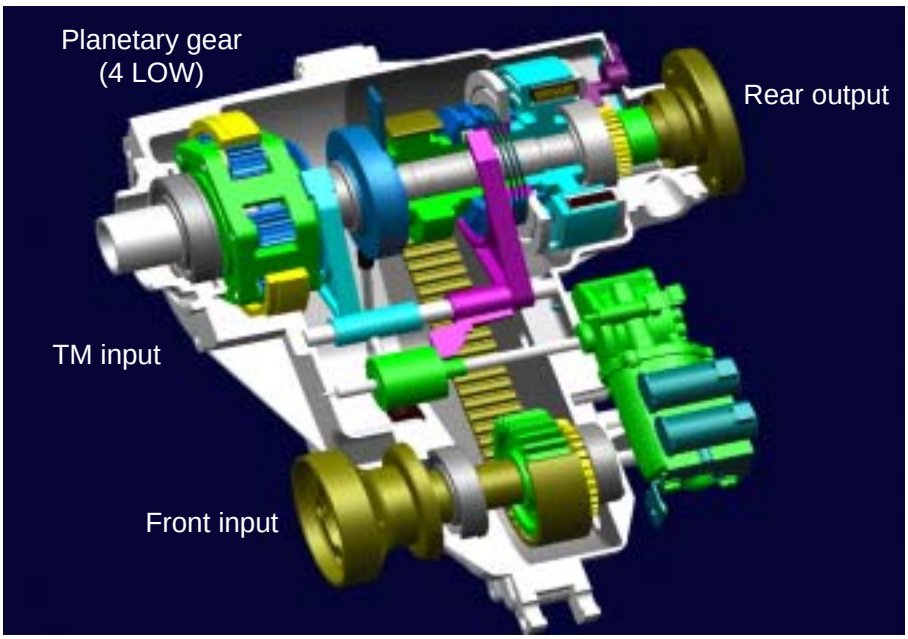




[FRRD operation at 2H]

The FRRD air pump motor does not operate and the differential pinion shaft rotates freely. Therefore the mechanical connection between the front wheels and the transfer case is cut off.

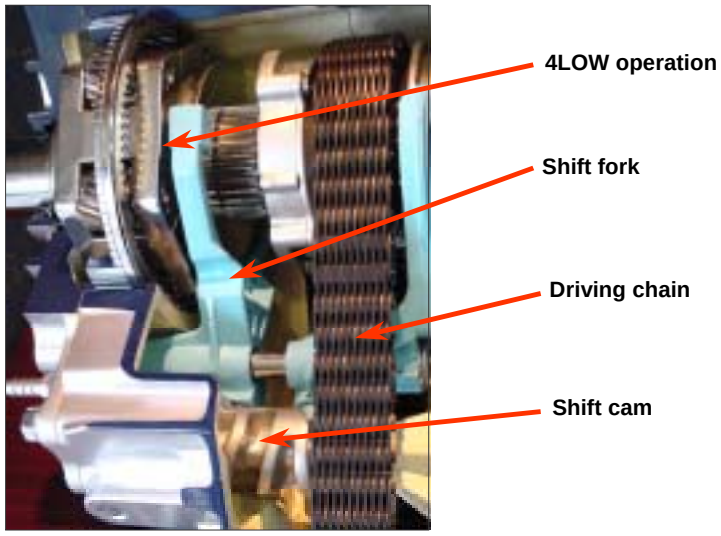
3.4 COMPONENTS

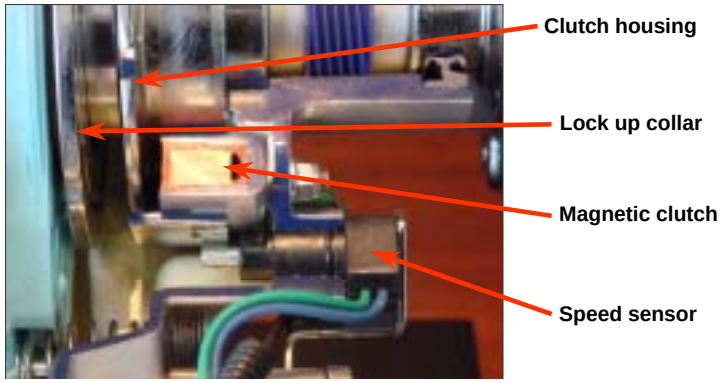


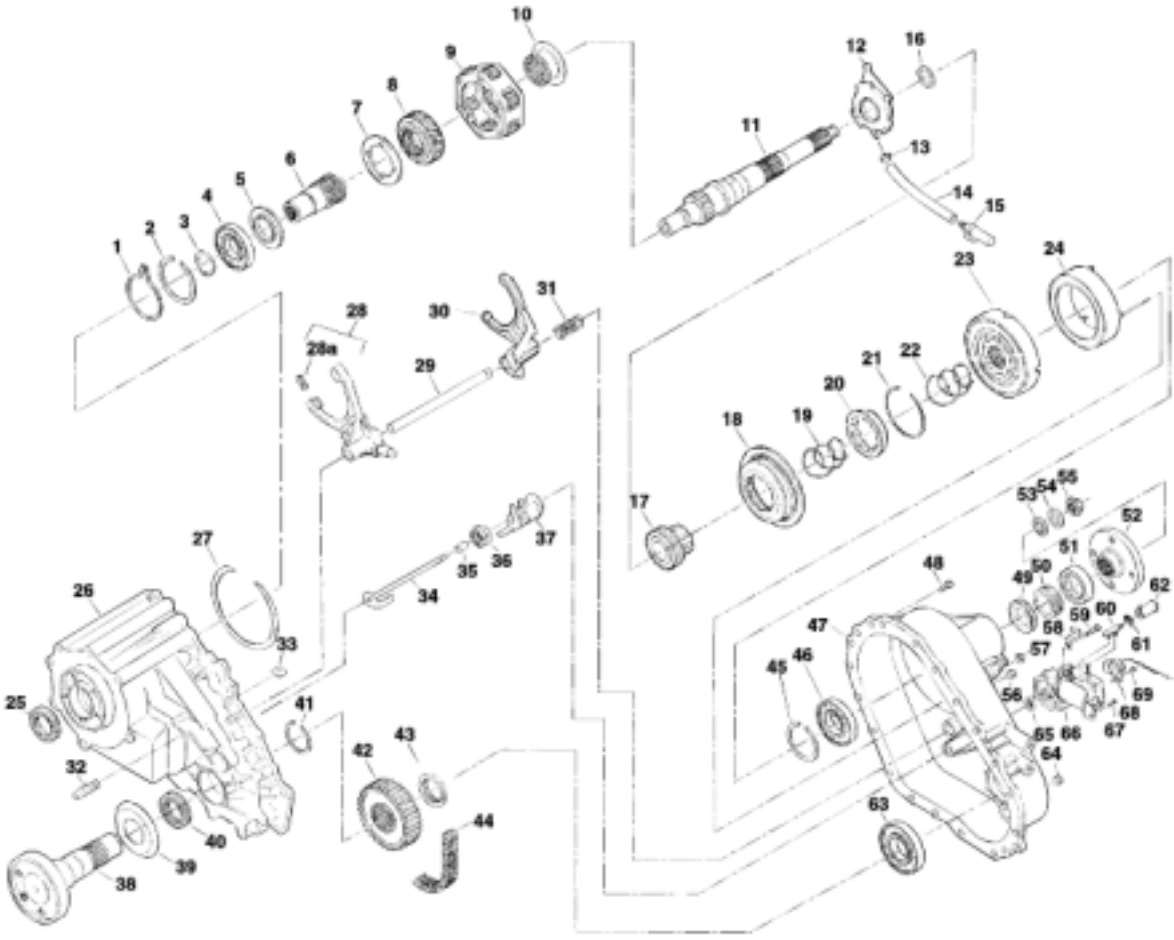
EST case and TOD case looks almost same. But inside it, EST and TOD has some different part for a part time or a full time mechanism.

In case of EST, a lock-up fork and a lock-up collar is added for a part time mechanism. And EST only has a rear output speed sensor differently from a TOD transfer case which has a front output speed sensor as well.

A 4 low mode transfer part which has a planetary gear set to make an output gear ratio of 2.48:1 is the same as that of TOD.

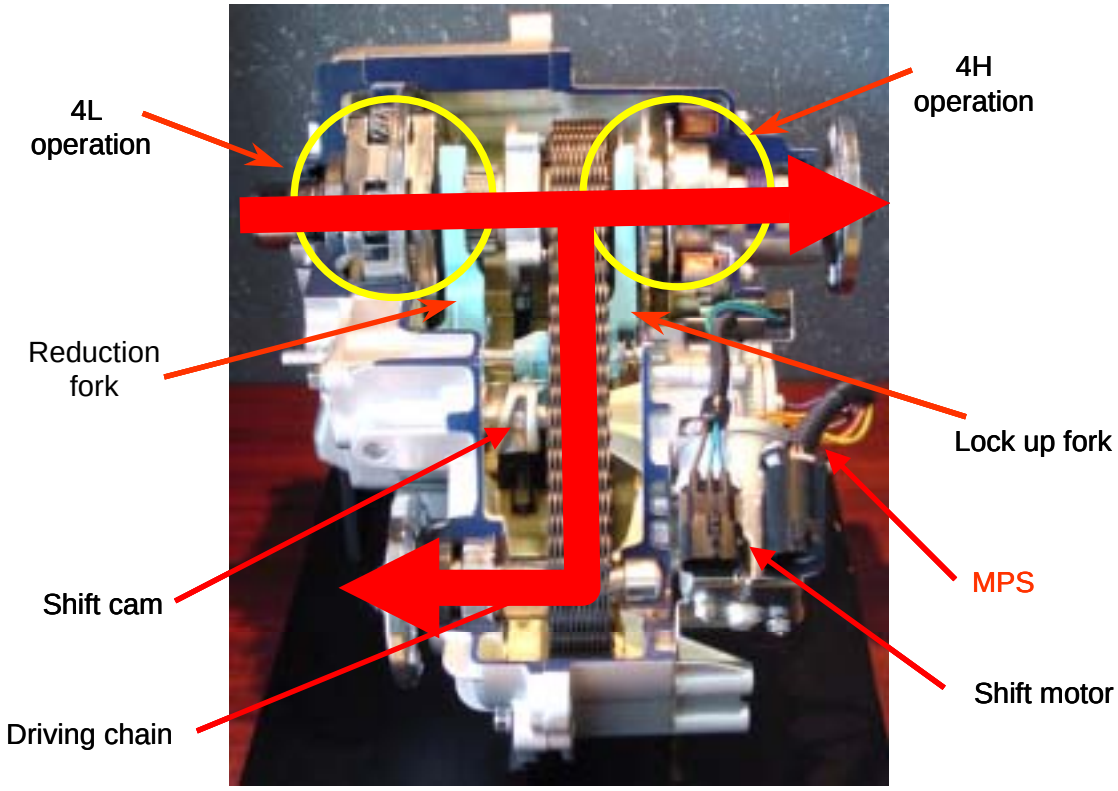






1. Snap ring
2. Snap ring
3. Snap ring
4. Bearing
5. Hub
6. Input shaft
7. Thrust plate
8. Sun gear
9. Carrier
10. Reduction hub
11. Main shaft
12. Rotor pump
13. Hose clamp
14. Hose
15. Filter
16. Thrust washer
17. Upper sprocket
18. Lock-up collar
19. Sleeve return spring
20. Lock-up hub
21. Snap ring
22. Spring
23. Clutch housing
24. Electric coil
25. Oil seal
26. Transfer case
27. Retaining ring
28. Shift fork
28a. Shift fork pad
29. Shift rail
30. Lock-up fork
31. Return spring
32. Breather
33. Magnet
34. Shift shaft
35. Spacer
36. Torsion spring
37. Shift cam
38. Output shaft
39. Dust defector
40. Oil seal
41. Snap ring
42. Lower sprocket
43. Spacer
44. Chain
45. Retaining ring
46. Bearing
47. Cover
48. Nut
49. Tone wheel
50. Speedo gear
51. Oil seal
52. Companion flange
53. Oil seal
54. Washer
55. Nut
56. Pipe plug
57. Nut
58. 'J' clip
59. Bolt
60. Clip
61. Connector lock
62. Connector
63. Bearing
64. Plug
65. Oil seal
66. Electric motor
67. Bolt
68. Speed sensor
69. Bolt

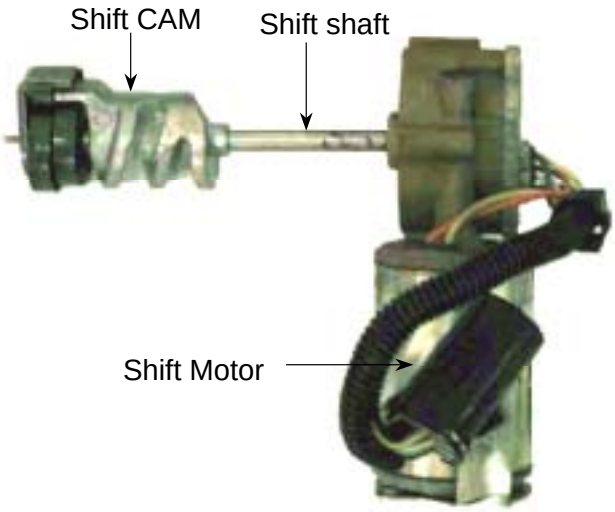
3.5 POWER FLOW



LOCK-UP SHIFT FORK

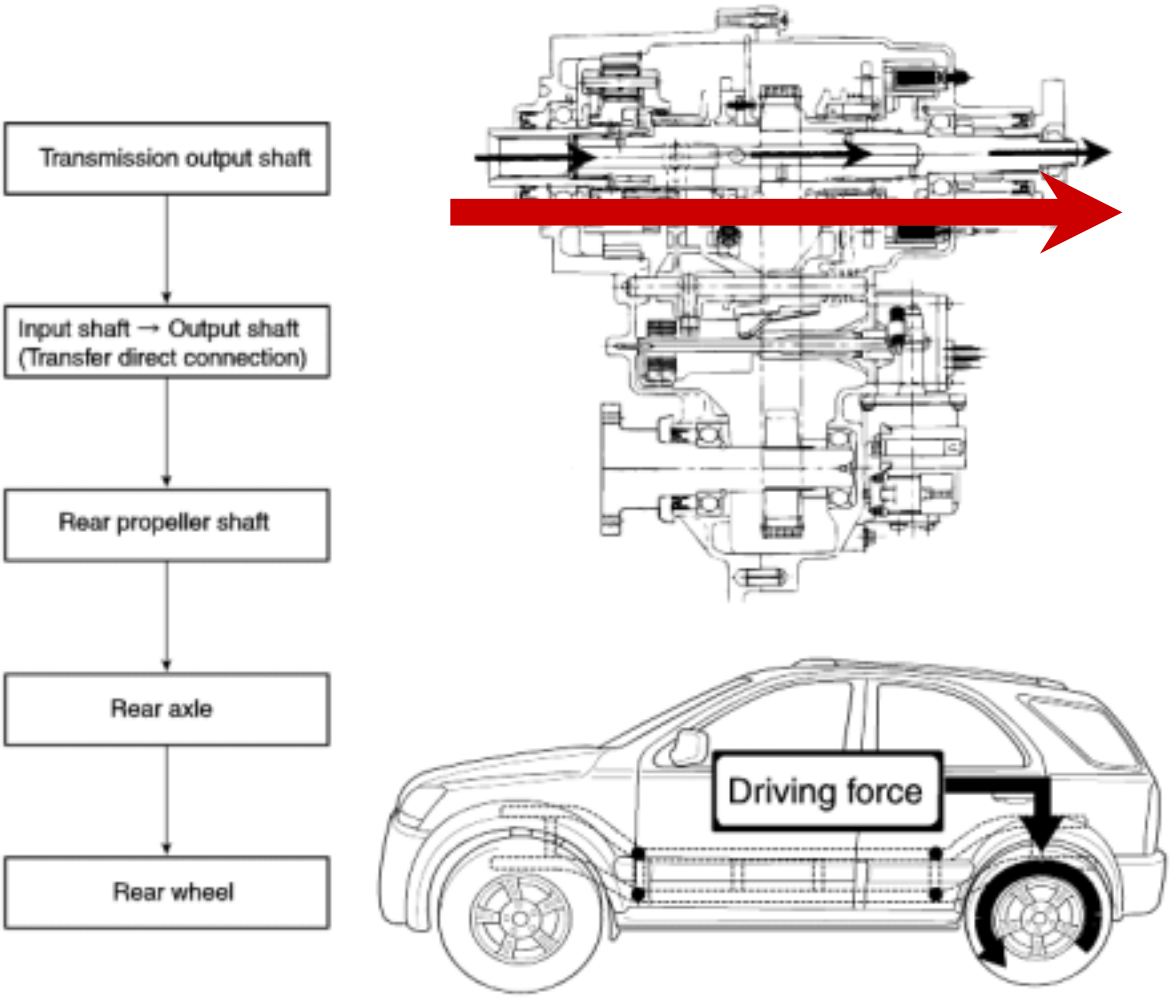
Comparing with the TOD transfer, EST has one more shift fork for engaging 2WD and 4WD. That is a 'Lock up shift fork'.

	EST	TOD
Reduction shift fork	Yes	Yes
Lock up shift fork	Yes	No

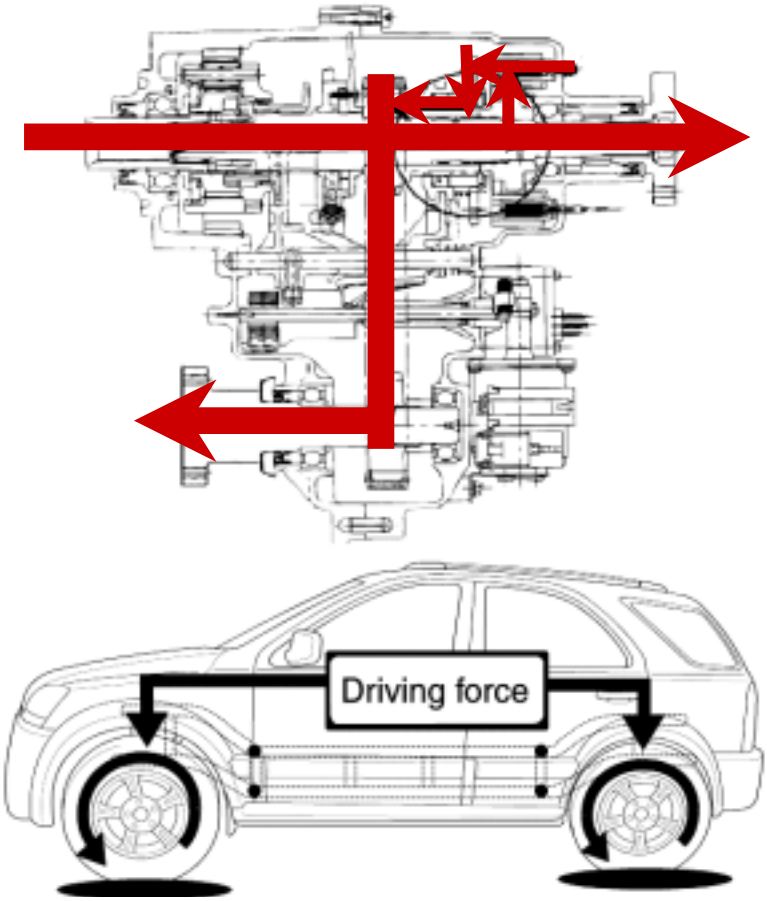


1) POWER FLOW: 2H Mode (Rear Wheel Drive)

At 2H mode, driving force coming from a transmission output shaft directly delivered to the rear output shaft. A shift motor does not operate making a lock-up shift fork remain still. However, driving chain that transfers the rear output speed to the front output shaft can rotate because of the front wheel rotation while driving. The front wheel rotation is transferred into the transfer case rotating a drive chain. To prevent this, front drive shaft and front propeller shaft connected with a transfer case should be disconnected at 2H mode. FRRD(FRee Running Differential) is a kind of center axle disconnect system for that purpose.



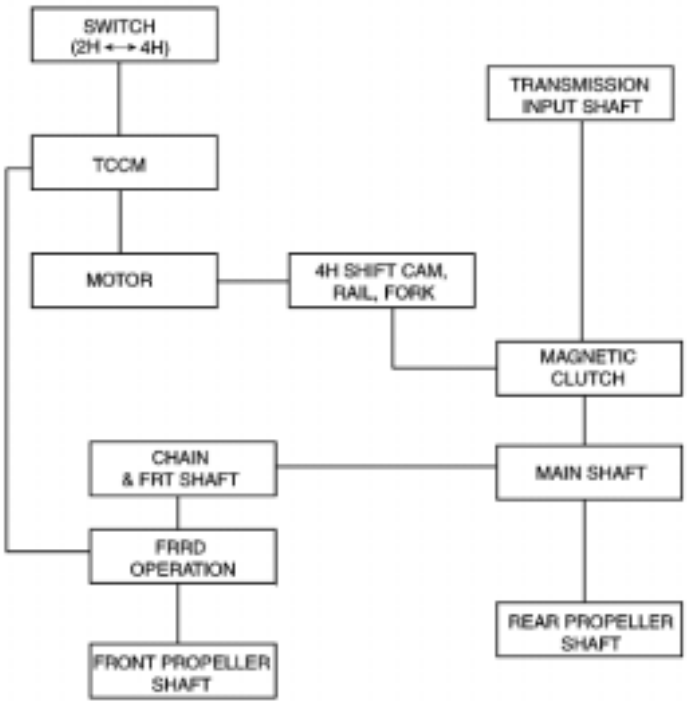
2) POWER FLOW: 4H Mode



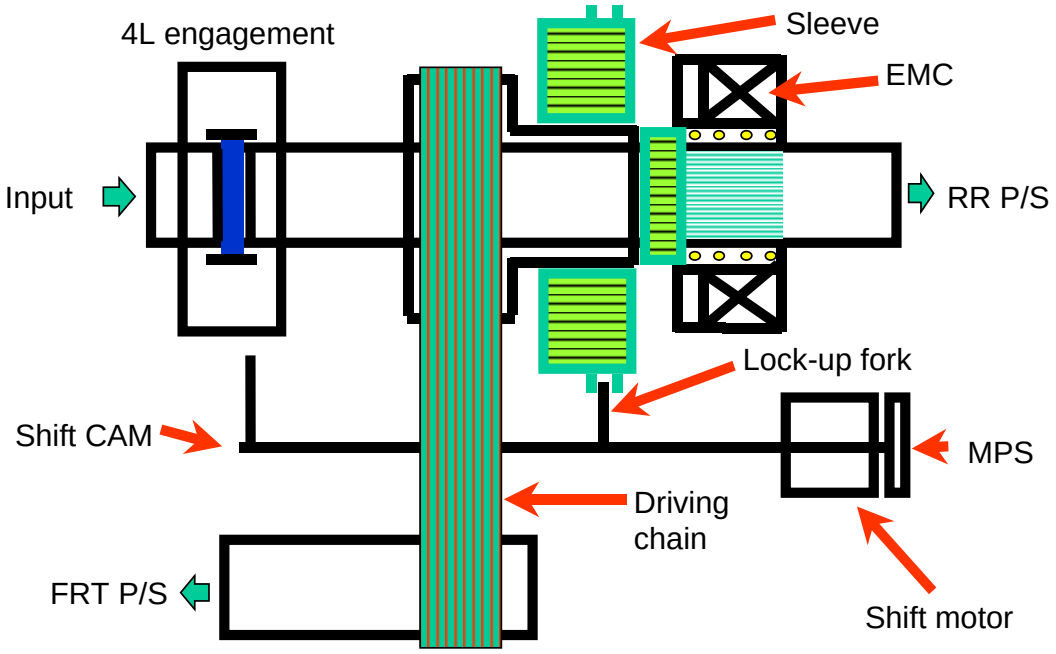
At 4H mode, TCCM(Transfer Case Control Module) sends a signal to the shift motor to rotate. Shift motor rotation slides up a lock-up shift fork which is connected a lock-up shift collar.

The Shift collar is engaged an upper sprocket that drives a drive chain delivering a drive force to the front shaft as soon as a magnetic clutch is on.

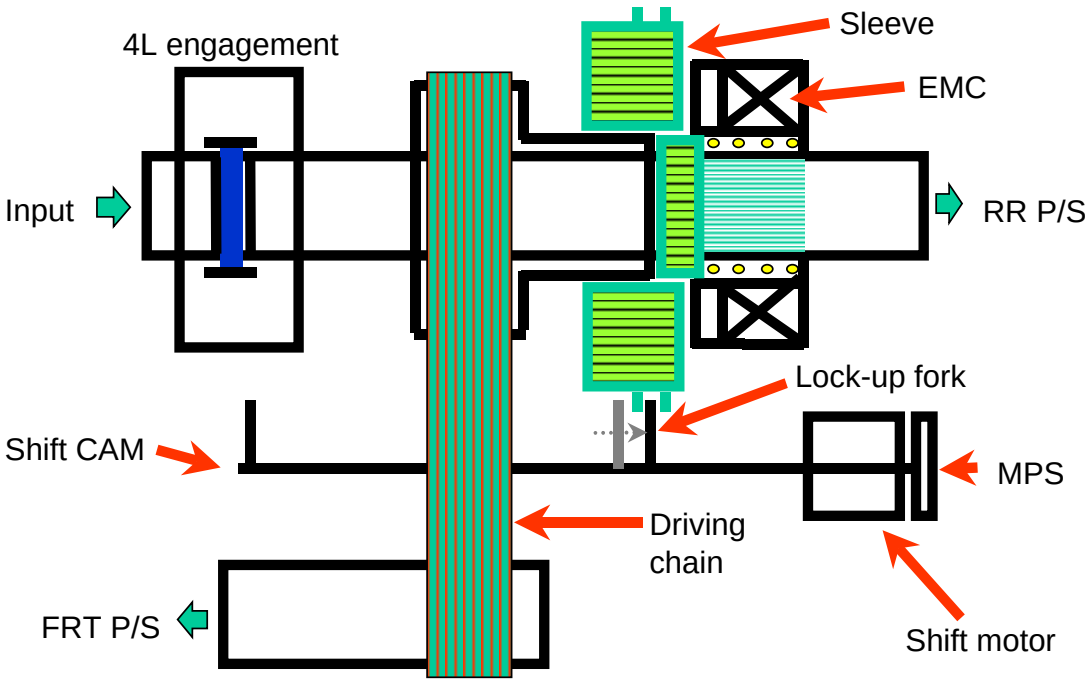
At the moment, TCCM also send a signal to the FRRD air pump motor in order to connect a center axle.



*** 2WD engagement**



*** 4WD engagement**



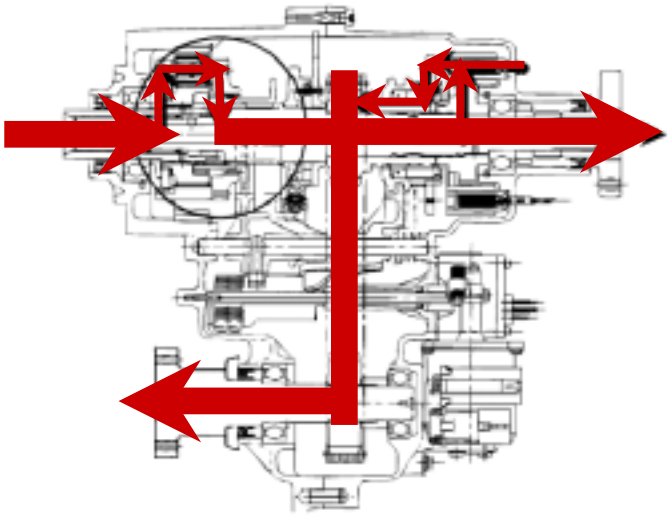
3) POWER FLOW: 4L Mode

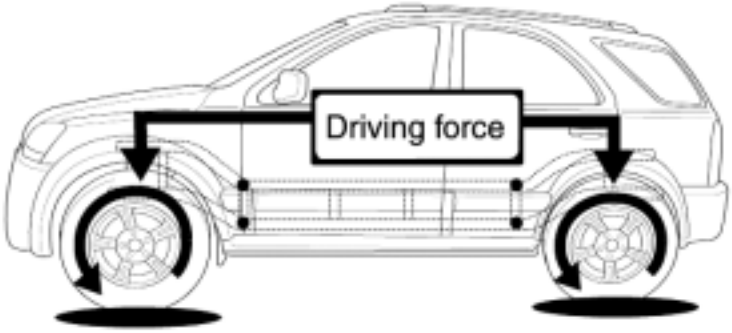
At 4L mode, TCCM (Transfer Case Control Module) sends a signal to the shift motor to rotate. Shift fork as well as a lock-up shift fork which is connected a lock-up shift collar slides up by shift motor rotation.

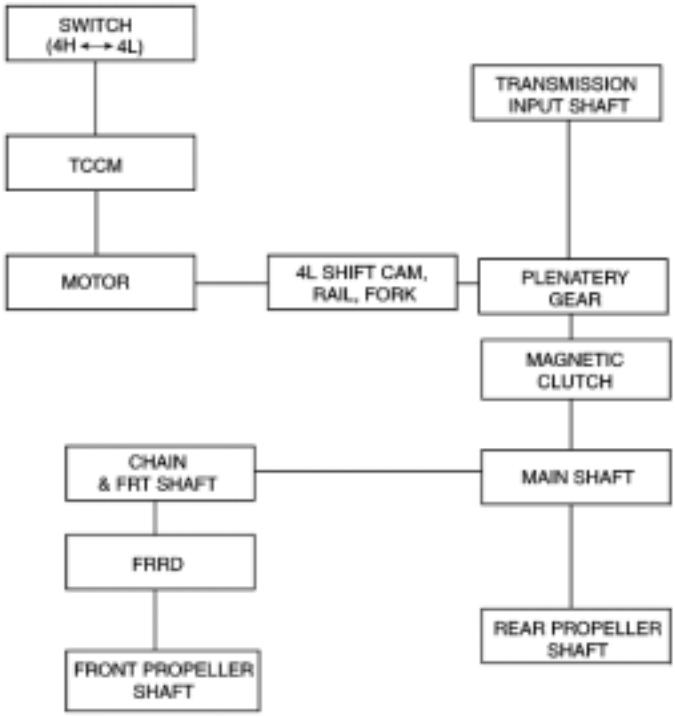
A reduction hub slide outward along the shift fork and a planetary gear is engaged making a lower speed. The output gear ratio is 2.48:1 and the vehicle can get more driving torque than it is in a 4H mode.

A lock-up shift collar slide outward along the lock-up shift fork and it is engaged with an upper sprocket that drives a drive chain delivering a drive force to the front shaft as soon as a magnetic clutch is on.

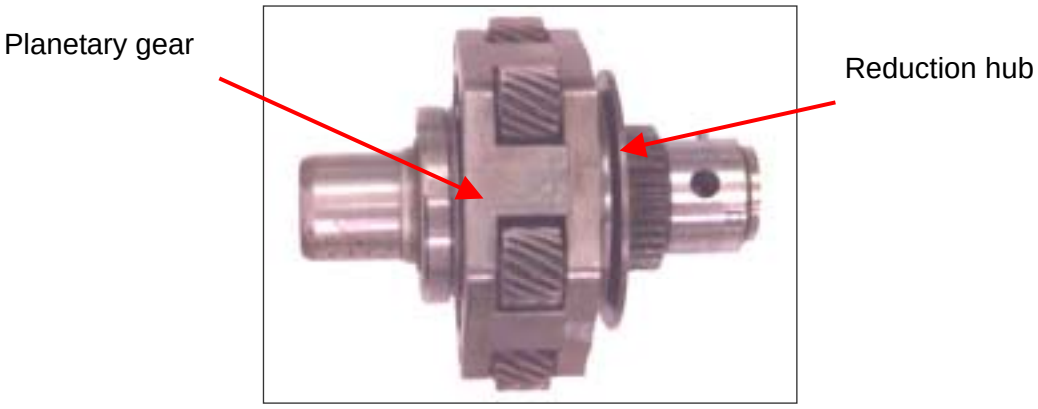
At the moment, TCCM also send a signal to the FRRD air pump motor in order to connect a center axle connection. If a 4L mode is selected from a 4H mode, then the FRRD air pump motor keeps ON and center axle connection remains engaged.



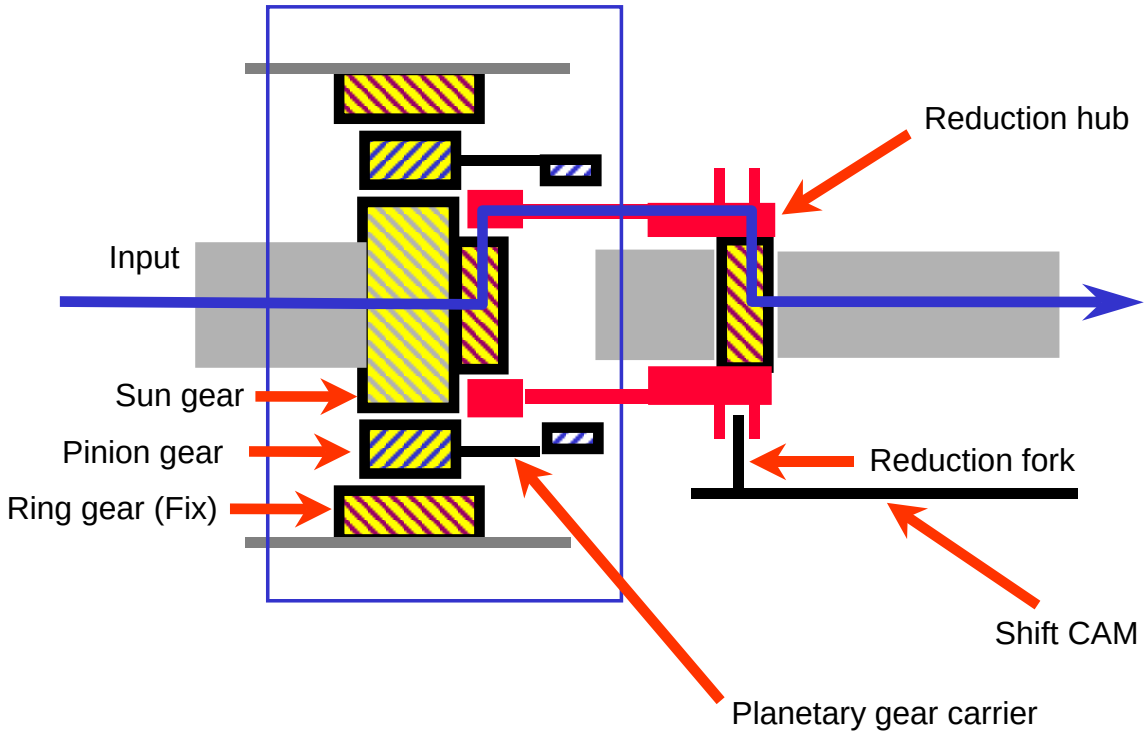




*** Planetary gear engagement (1:1 connection – 2H, 4H)**

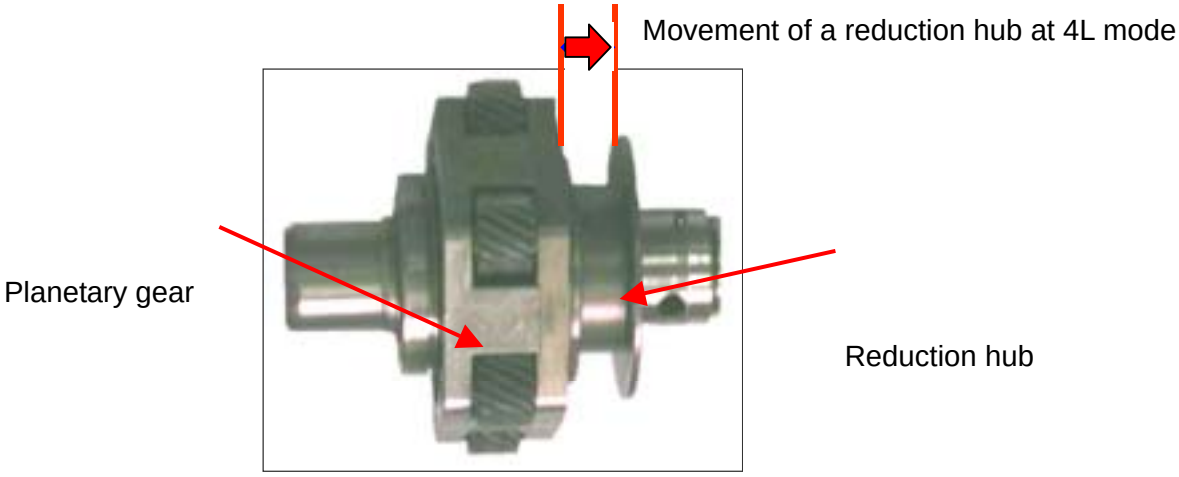


[1:1 connection (2H, 4H)]

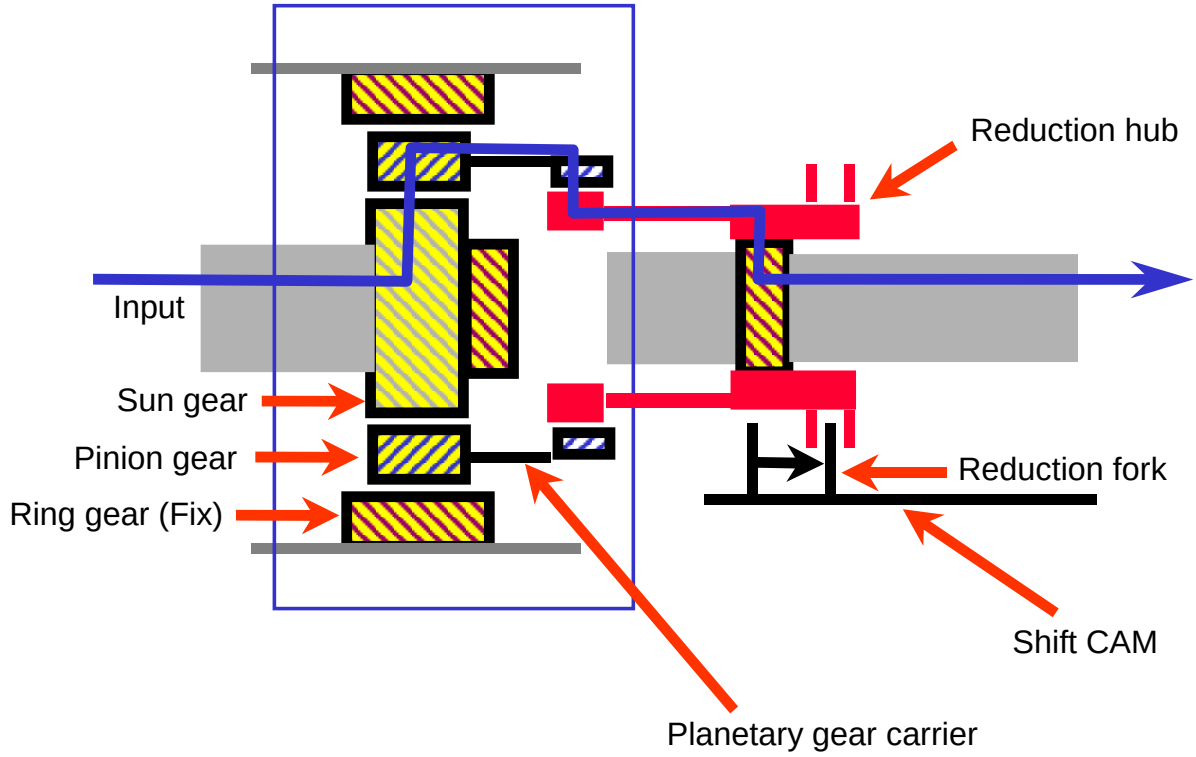


TM output comes into the input shaft of the transfer. At 2H or 4H mode, the planetary gear is not involved because the reduction hub, when it moves inward the planetary gear, is not connected with a planetary pinion gear carrier. Therefore input shaft is directly coupled with the rear output shaft allowing the same revolution speed of the both shafts.

*** Planetary gear engagement (4L mode)**



[4-Low mode → gear ratio 2.48:1]



TM output comes into the input shaft of the transfer. At 4L mode, the planetary gear is involved because the reduction hub, when it moves outward the planetary gear, is connected with a planetary pinion gear carrier. Therefore input shaft is coupled with the planetary gear and then is delivered to the rear output shaft allowing 2:48:1 revolution speed difference between the input shaft speed and the rear output shaft speed.

3.6 COMPONENTS

1) Mode selection switch

- 2H mode: Rear wheel drive mode

- 4H mode: Transferring from 2WD to 4WD can be achieved even while vehicle driving. (SOTF: Shift On The Fly). At this time, the vehicle speed should not be over than 80km/h. If the shift is successfully finished, the 4WD High lamp will be turned on.

- 4L mode: The vehicle should be stopped (3km/h or less). At the moment a shift lever should be positioned “N” position(A/T) or a “Clutch” pedal should be ON before selecting a 4L mode.

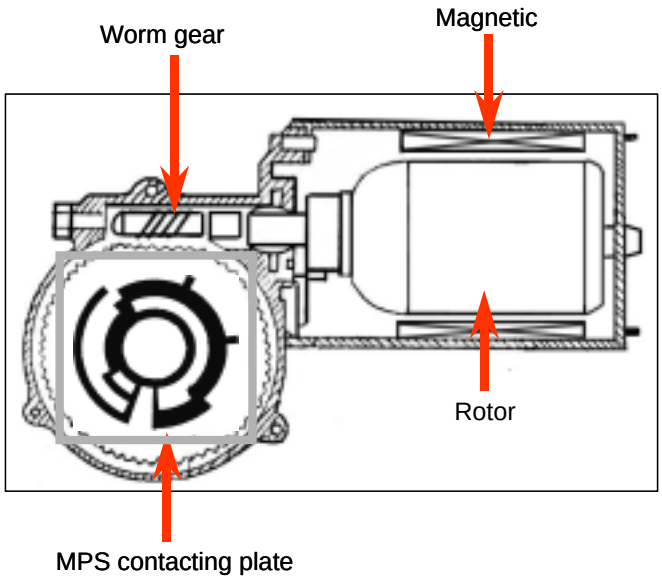
After a mode change is successfully finished, the 4L lamp will be turned on.

2) Shift motor & Motor position sensor

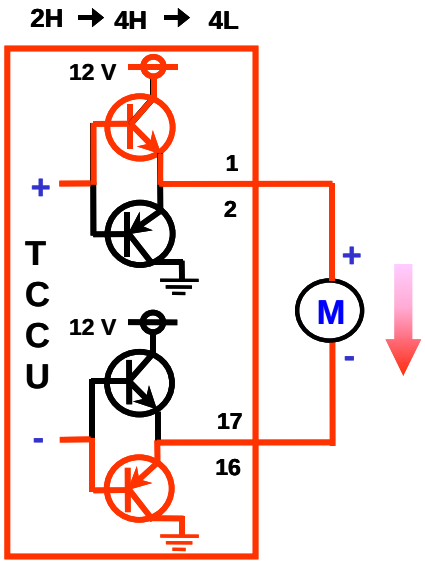
When a driver selects a driving mode, a mode signal comes to a TCCM. Then the TCCM operates a shift motor.

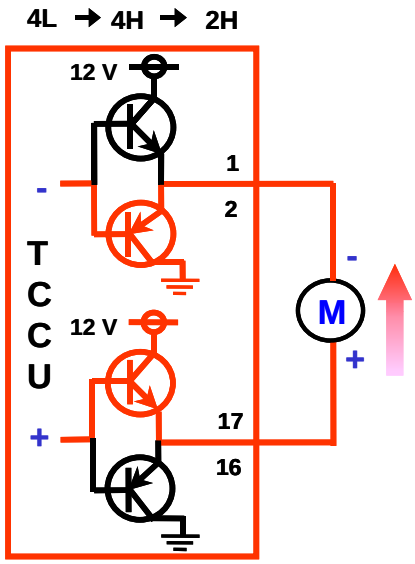
There is a MPS(Motor Position Sensor) inside the motor contacting a position plate which sends a motor position signal to the TCCM. TCCM can get a feedback of a driving mode position.

If the MPS sends to the TCCM different position signals from a mode switch position, a relevant failure code is memorized.

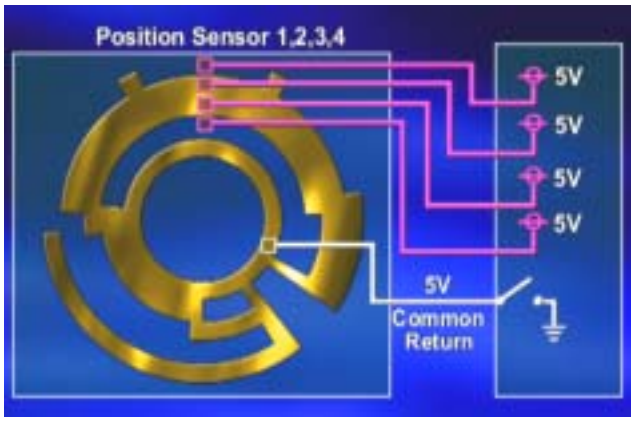


[Shift motor operation while shifting]

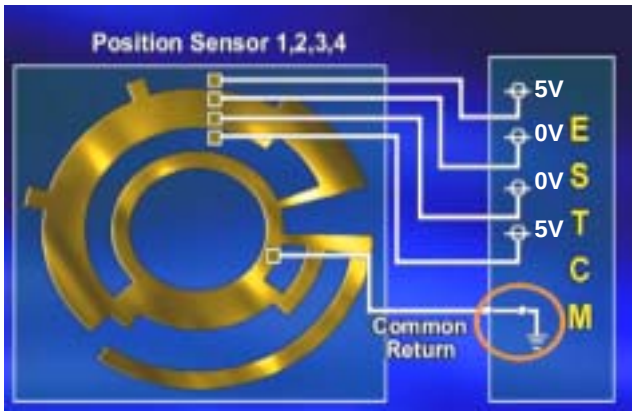




*** Motor position sensor**

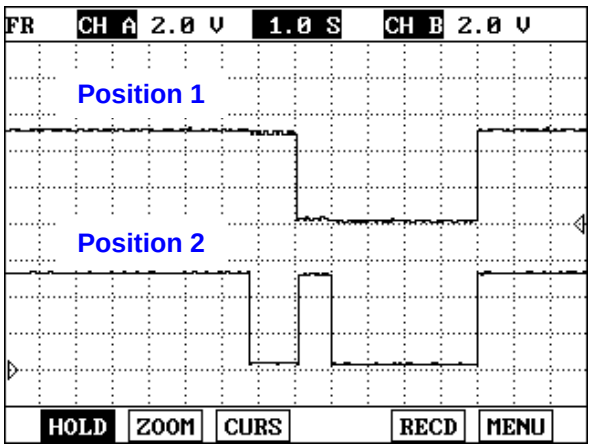


[Sensor output voltage at 2H/4H/4L mode]
The common return terminal is off-grounded. The output voltage of position sensor 1,2,3,4 keeps 5 volts.

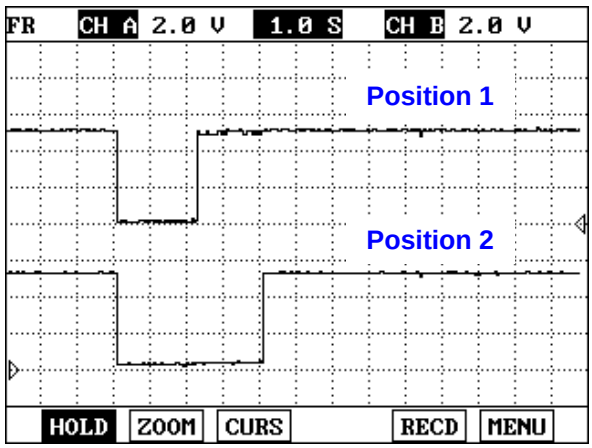


[Sensor output voltage while being shifted]
The common return terminal is grounded for 7 seconds. The output voltage of sensor which contacts the steel plate drops 0 volts.

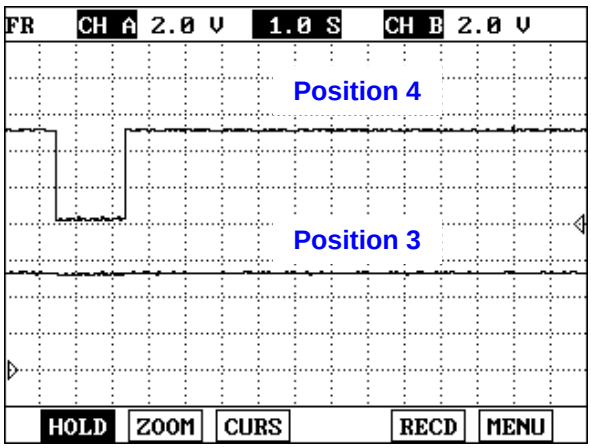
MPS output signal (2H→ 4H)



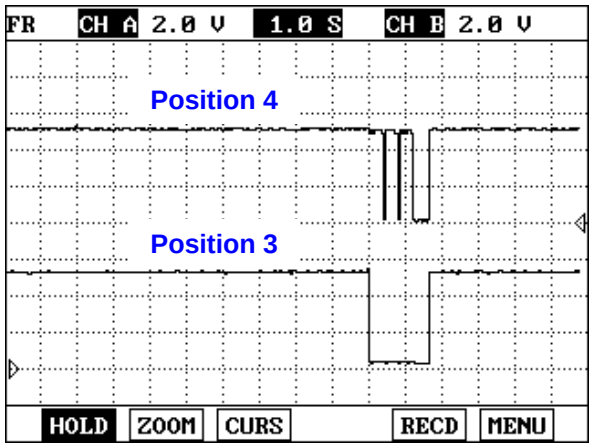
MPS output signal (4H→ 4L)



MPS output signal (2H→ 4H)

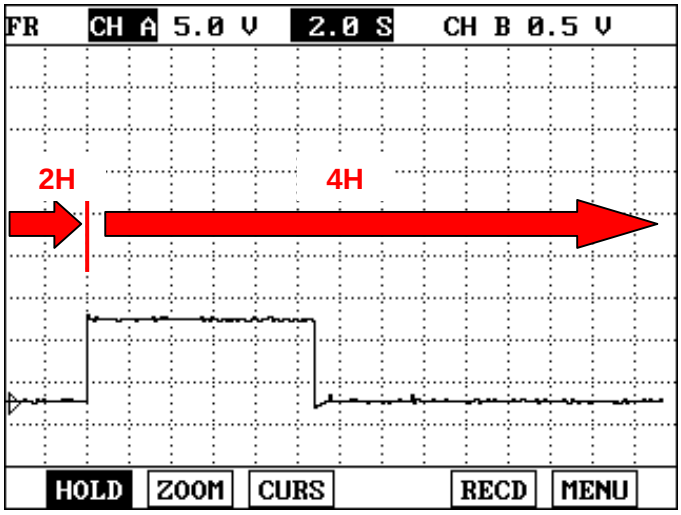


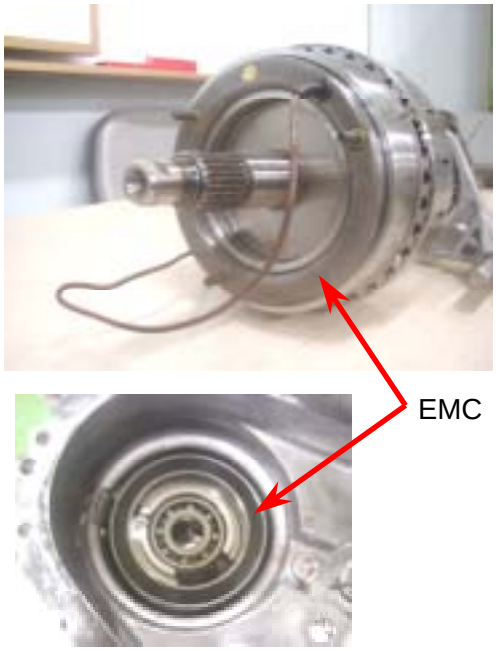
MPS output signal (4H→ 4L)



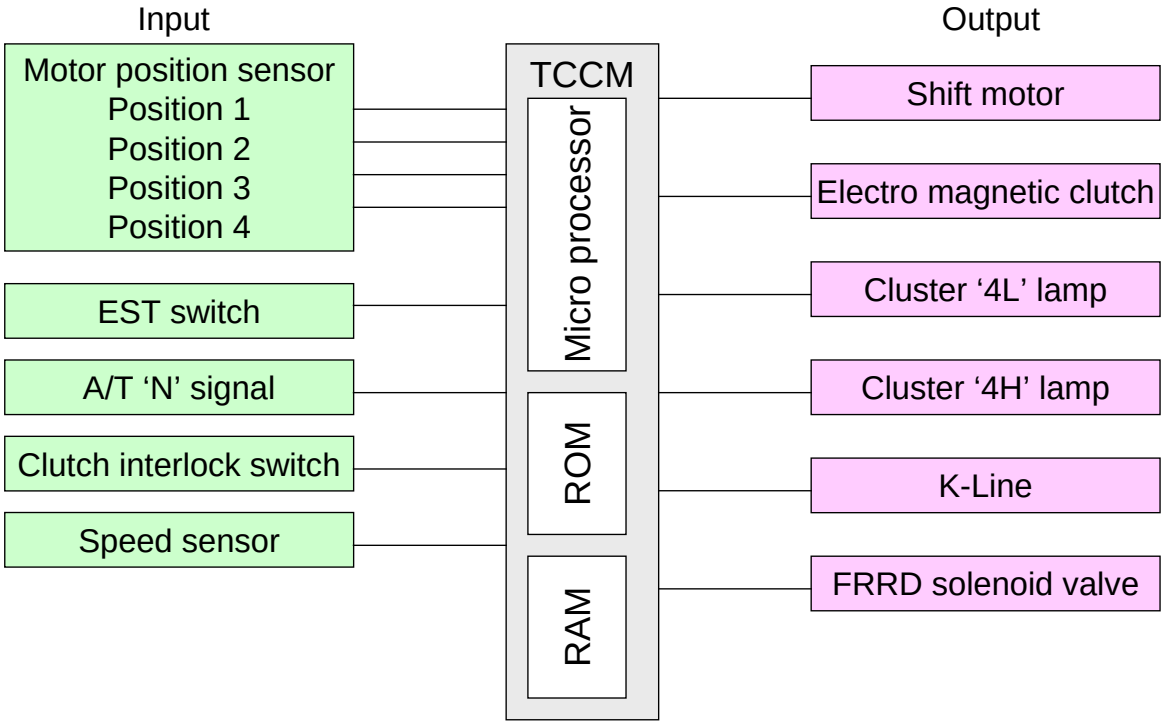
3) EMC(Electronic Magnetic Clutch) signal

EMC is energized to pull the lock-up shift fork to make 4H mode.



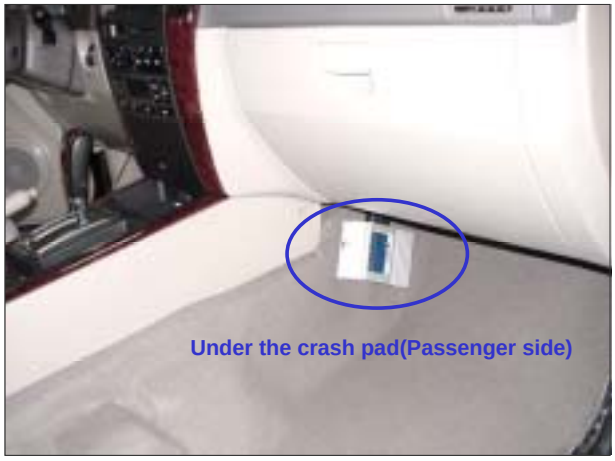


3.7 INPUT AND OUTPUT



3.8 DIAGNOSIS

1) TCCM & DLC location



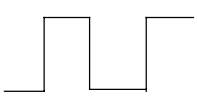
2) DTC

There is no P-code for EST system. DTC is supported with binary code. The binary fault code shall be displayed if a corresponding input or output part is failed.

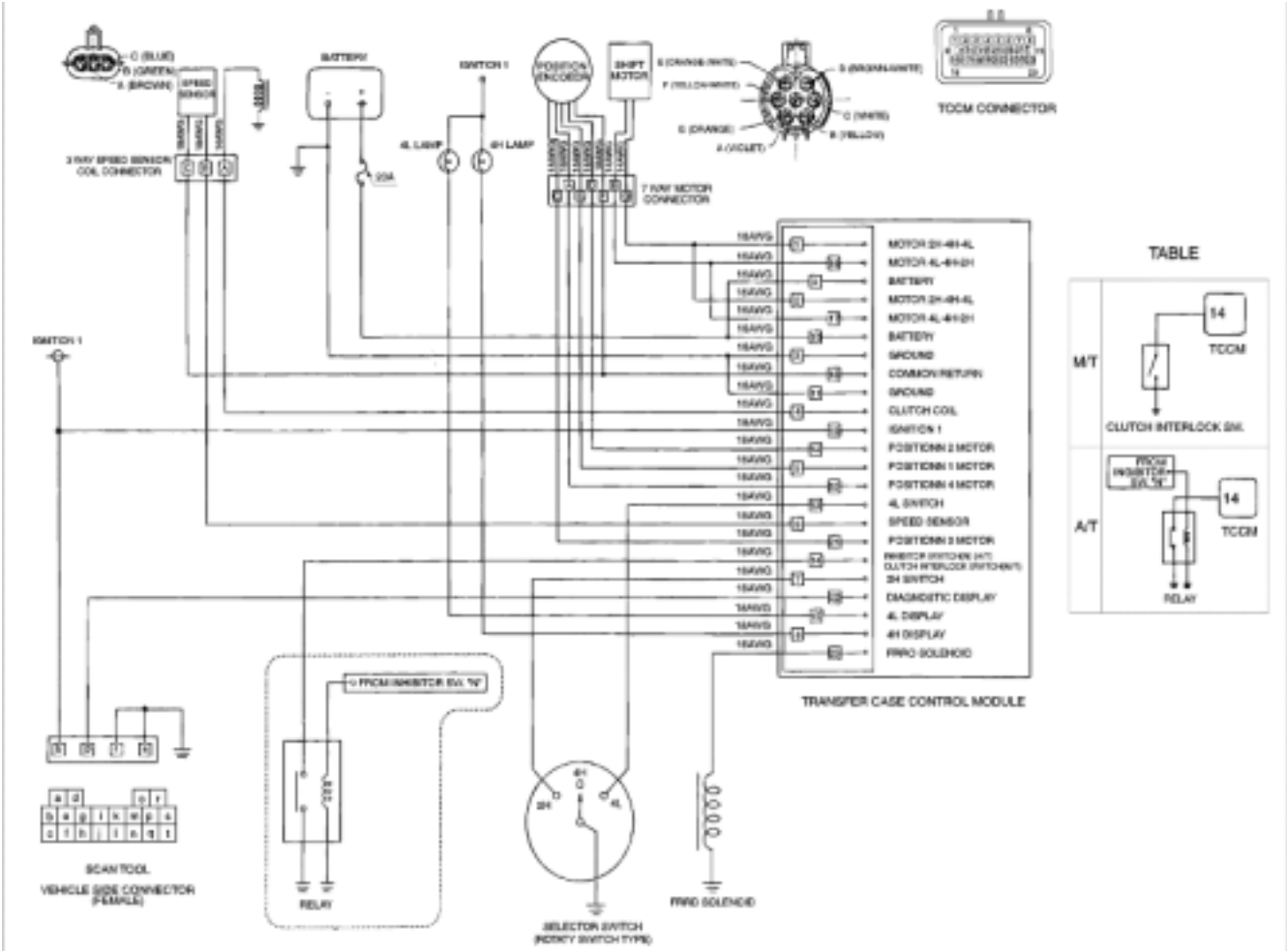
Decimal	Binary	Fault
1	001	TCCM (Transfer case control module)
2	010	Shift motor
3	011	EMC (Electro magnetic clutch)
4	100	Speed sensor
5	101	FRRD air pump motor
6	110	2H-4H-4L switch
7	111	MPS (Motor position sensor)

3) EST standard input and output value in TCCM

No		Items	Condition	Signal		Remarks
				Type	Level	
1	A1	MOTOR OUTPUT (2H-4H-4L)	IDLE("N")	DC	Vbatt	* Current : INRUSH(+) : 4.64A INRUSH(-) : 4.4A Operation : 0.6A
				↑	0V	
2	A2	MOTOR OUTPUT (2H-4H-4L)	IDLE("N")	DC	Vbatt	
				↑	0V	
3	A3	GND				
4	A4	CLUTCH COIL	IDLE (2H →4H →4L)	DC	Vbatt	* Current : 4.28A
				↑	0V	
5	A5	POSITION 1 MTR	IDLE (P/R/N/D/2/L)	2H 2H →4H 4H →4L	CODE : 1010 CODE : 0011 CODE : 1100 LOGIC HI(1) : 5V LOGIC LO(0) : 0.5V or less	* MTR POS. CODE : 1/2/3/4 = XXXX (1 = 5V dc) (0 ≤0.5V dc)
6	A6	SPEED SNSR	IDLE	PULSE	 135Hz at 60KPH	* VSS of 60KPH : HI : 16.4V LO : -6.4V
7	A7	2H SW	SW OFF	DC	4.5 5.5V	
			SW ON	↑	0.5V or less	
8	A8	4H DISPLAY	SW OFF	DC	Vbatt	
			SW ON	↑	0.5V or less	
9	A9	BATT	IGN OFF	DC	Vbatt	
			IGN ON	↑	Vbatt	
10	A10	BATT	IGN OFF	DC	Vbatt	
			IGN ON	↑	Vbatt	
11	A11	GND				
12	A12	POSITION 2 MTR	IDLE (P/R/N/D/2/L)	2H 2H →4H 4H →4L	CODE : 1010 CODE : 0011 CODE : 1100 LOGIC HI(1) : 5V LOGIC LO(0) : 0.5V or less	* MTR POS. CODE : 1/2/3/4 = XXXX (1 = 5V dc) (0 ≤0.5V dc)

No		Items	Condition	Signal		Remarks
				Type	Level	
13	A13	4L SW	SW OFF	DC	4.5 5.5V	
			SW ON	↑	0.5V or less	
14	A14	INHIBITOR SW(AT	N	DC	0V	
		CLUTCH INTERLC	P/R/D/2/L	↑	5V	
		SW(MT)				
15	A15	4L DISPLAY	IDLE("N")	DC	Vbatt	
				↑	0V	
16	A16	MOTOR OUTPUT	IDLE("N")	DC	Vbatt	
		(4L-4H-2H)		↑	0V	
17	A17	MOTOR OUTPUT	IDLE("N")	DC	Vbatt	
		(4L-4H-2H)		↑	0V	
18	A18	COMMON RETUR	IGN OFF	DC	0.9V or less	
			IGN ON	↑	4.75 5.25V	
19	A19	IGN 1	IGN OFF	DC	0V	
			IGN ON	↑	Vbatt	
20	A20	POSITION 4 MTR	IDLE (P/R/N/D/2/L)	2H 2H →4H 4H →4L	CODE : 1010 CODE : 0011 CODE : 1100 LOGIC HI(1) : 5V LOGIC LO(0) : 0.5V or less	* MTR POS. CODE : 1/2/3/4 = XXXX (1 = 5V dc) (0 ≤0.5V dc)
21	A21	POSITION 3 MTR	IDLE (P/R/N/D/2/L)	2H 2H →4H 4H →4L	CODE : 1010 CODE : 0011 CODE : 1100 LOGIC HI(1) : 5V LOGIC LO(0) : 0.5V or less	* MTR POS. CODE : 1/2/3/4 = XXXX (1 = 5V dc) (0 ≤0.5V dc)
22	A22	DIA. DISPLAY	In comm.	PULSE	 4V or more 0 0.9V	
23	A23	C.A.D.S	IDLE	OFF	Vbatt	
			(2H →4H)	ON	0.5V or less	

4) Wiring diagram



4. TRANSFER OVERHAUL

4.1 DISASSEMBLY

* Prepare an EST unit on a table with proper tools.

1. Before overhaul, remove an EMC coil wire carefully from the connector.

* After removing the pin, correct the stopper of the pin using a driver.

2. Remove the shift motor assembly.

* After removing the shift motor assembly.

3. Remove the vehicle speed sensor.

4. Remove the lock nut.

5. Remove the companion flange and the oil seal.

6. Remove the rear speed sensor.

7. Remove the cover bolts.

8. Remove the EMC coil nuts.

* Check the rubber bush and extension housing.

9. Remove the oil seal.

* After removing the oil seal.

10. Remove the speedo gear.

11. Remove the tone wheel.

12. Remove the case upper cover.

13. Remove the EMC coil and the coil housing.

* EMC coil and housing

* EMC housing (bottom)

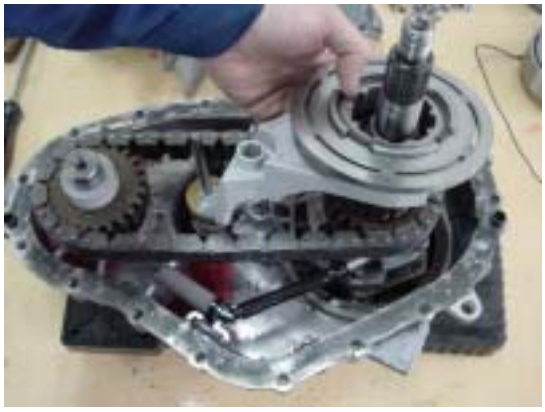
* EMC coil

14. Remove the 4H mode return spring.

15. Check the proper function of the lock-up assembly by pressing the lock-up hub.

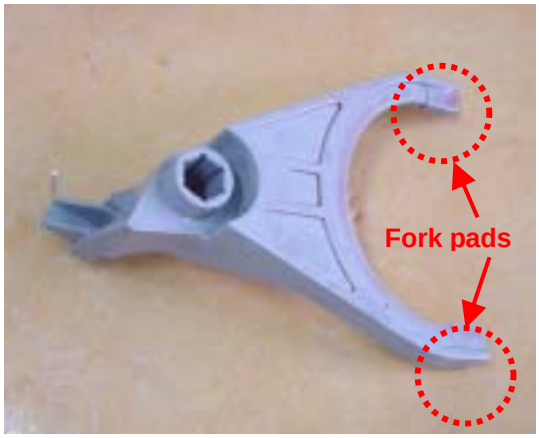
* Examine the wear on the face.

16. Remove the lock-up assembly and the shift-fork together.



* Lock-up assembly and the shift-fork

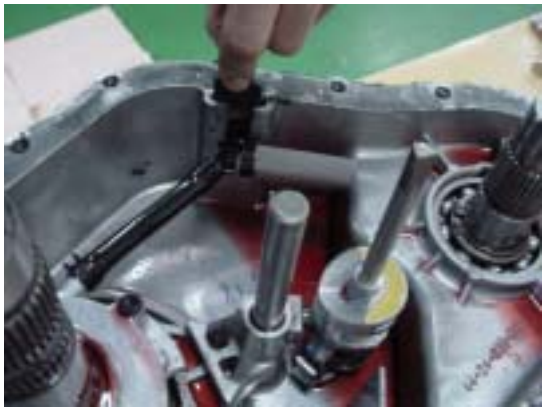
17. Inspect the 4H shift-fork and wear of fork pads.



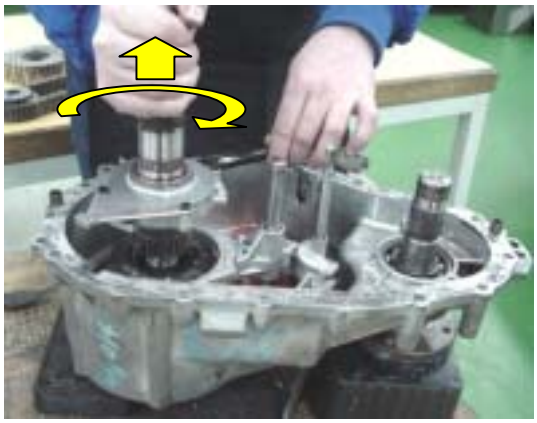
* After removing the lock-up assembly and the shift-fork

18. Remove the chain and sprocket together

19. Remove the magnet before removing the pump from the output shaft.



20. Rotate the output shaft to rotate inner pump gear and remove the pump assembly and the shaft together.



21. Remove the spacer.

22. Lift pump of the shaft.

* Pump assembly is not a serviceable item and should be replaced as an assembly.

23. Inspection of the upper output shaft.

* Check the spline teeth for brakes, chipping, crack.

* Check journals for excessive wear or discoloration.

* After removing the output shaft

24. Remove the shift rail.

25. Remove a shift cam.

26. Remove a reduction fork.

* Inspect the reduction fork. Check the fork pad for wear or discoloration from heat.

27. Remove a reduction hub.

* Check the reduction hub teeth for wear, brakes, chipping, crack.

* Snap ring

28. Ply open the snap ring and pull out the planetary carrier assembly from the cover.

* After removal

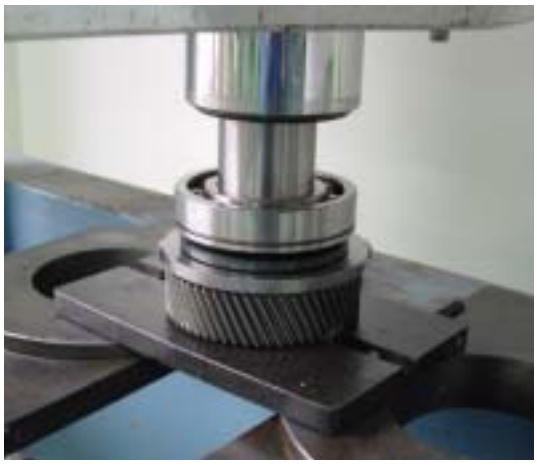
* Planetary carrier assembly

29. Remove a snap ring.

30. Remove a snap ring.

31. Remove the input gear assembly from the carrier assembly.

32. Disassemble the input gear assembly using a press.

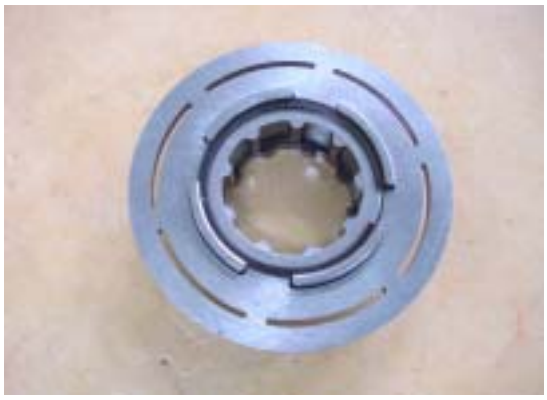


* Input shaft assembly

* Shift cam assembly

33. Disassemble shift cam assembly

* 4H lock-up assembly



34. Disassemble the 4H lock-up assembly by removing a snap ring between the cowl and lock-up hub

* 4H lock-up assembly

4.2 DISASSEMBLY

1. Reassemble the sun gear to the input gear.

   And install new input bearing snap ring.

After installation

2. Install the input assembly into the carrier assembly and then install the snap ring.

3. Insert the shift cam assembly.

4. Place the reduction hub and the shift fork together into the carrier.

* After installation

5. Slide the pump onto the shaft and align the drive pin on the slot in the pump.

6. Insert the output shaft into the input and reduction hub.

7. Insert the magnet into the case.

8. Install a spacer over the shaft onto the pump.

* Location of the spacer.

9. Place the chain and sprocket on the shaft.

* After installation

10. Locate blue chain link which is always on the top side of chain facing up.

11. Place the lock-up assembly and 4H shift fork on the sprocket aligning the lock-up collar teeth with the sprocket teeth.

* After installation

12. Place the coil housing on the shaft.

13. Install the shift fork return spring.

14. Insert the coil in the case.

15. Install the EMC coil nuts.

16. Install cover bolts.

17. Install the speed sensor.

18. Insert the coil pin to the connector.

19. Apply sealant to the shift motor seat on the case.

20. Install the shift motor on the case.

21. Attach wire retainer to the connector.

* After installation