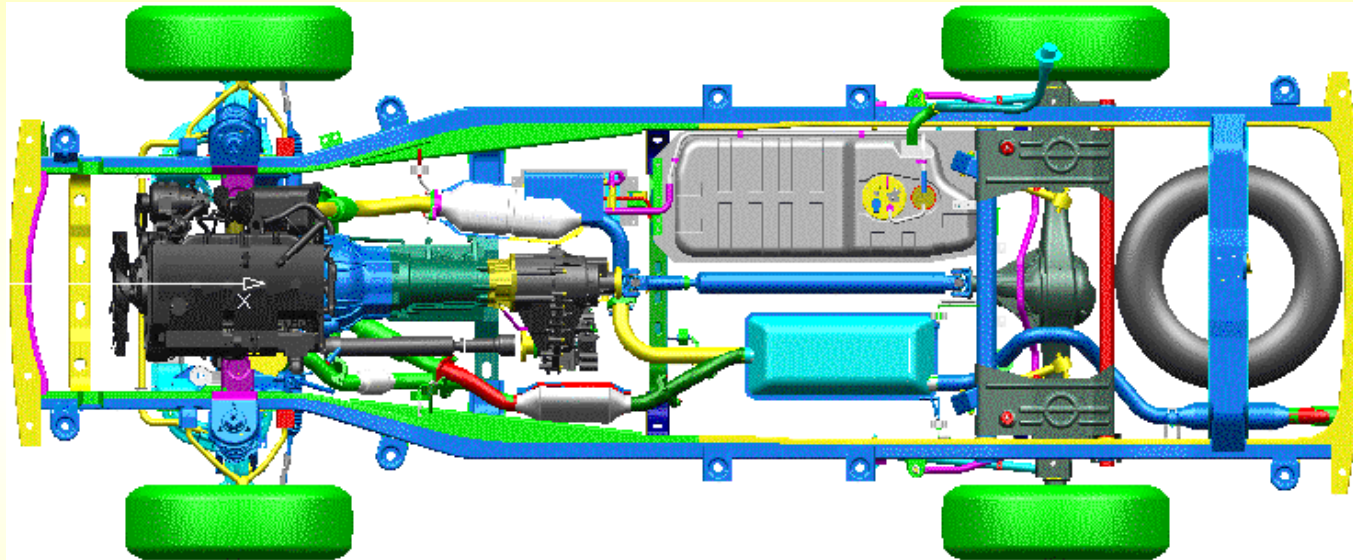


BL 4WD SYSTEM



- EST (Electronic Shift Transfer)
- TOD (Torque On Demand)


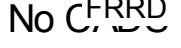



BL 4WD SYSTEM

What EST & ATT is

- **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.

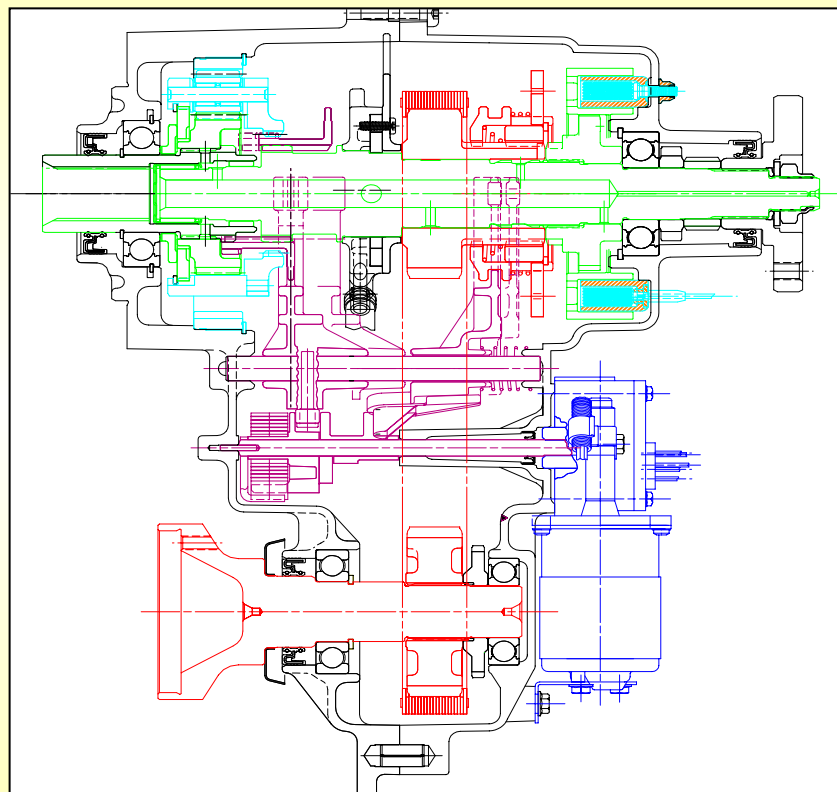
BL 4WD SYSTEM

Specifications

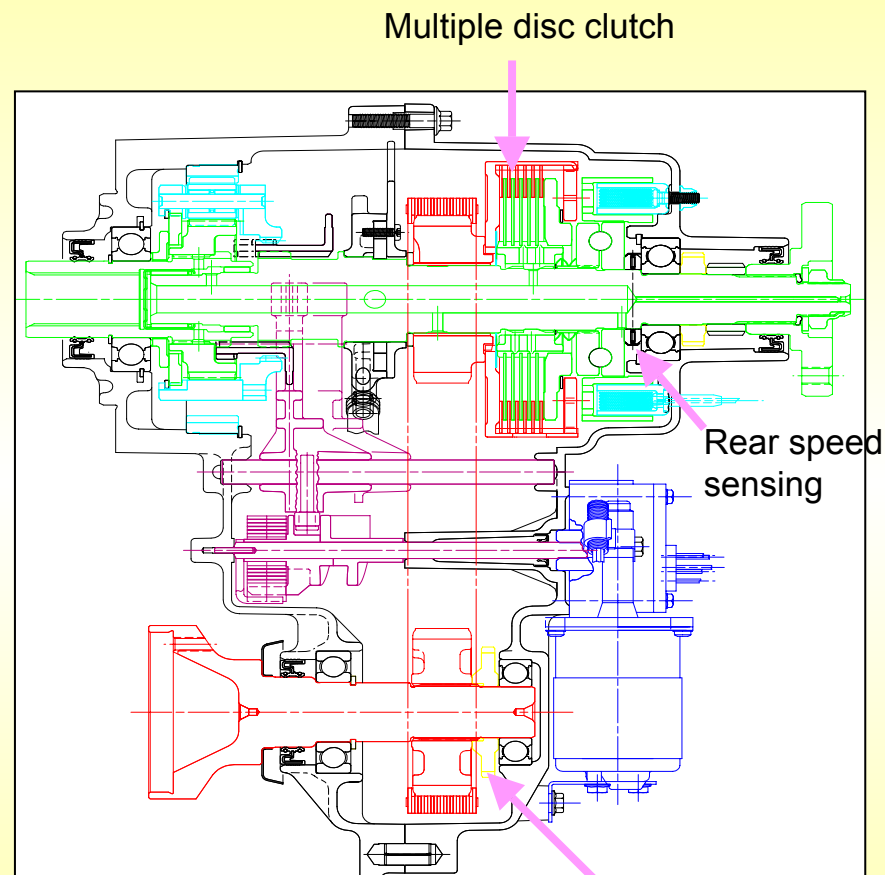
Items	Parts time	Full time
Engine	DSL 2.5, 2.9 ^{GSL 2.4, 3.5}	
Type	Electronic shift transfer	Active torque transfer
Model	BWA 44-24 ESOF	BWA 44-24 TOD
FRT axle connection		No  (Full time connection)
Weight (Kg), Length(mm)	35, 351	37.3, 351
Gear ratio (HIGH)	1 : 1	
Gear ratio (LOW)	2.48 : 1	
FRT driving type	Chain	
Lubricant	DEXRON III (Permanent use : No replacement)	
Lub. Quantity (L)	1.42	
CAD  motor valve	○	×
Front speed sensor	×	Hall IC effect type
Rear speed sensor	Pulse generator 	Hall IC effect type
Vehicle speed sensor	Hall IC effect type 	Hall IC effect type

BL 4WD SYSTEM

EST & TOD



**Electronic Shift
Transfer**



**Torque On
Demand**

Multiple disc clutch

Rear speed sensing

Front speed sensing

BL 4WD SYSTEM

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	<ul style="list-style-type: none"> * 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)	<ul style="list-style-type: none"> * 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	<ul style="list-style-type: none"> * 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. <p>So this mode can correspond to the various road surfaces by controlling the ATT unit automatically.</p>
		LOW	4WD LOW	Refer to 4L of part time.
	Transfer	AUTO ↔ LOW	4WD(H) ↔ 4WD(L)	<ul style="list-style-type: none"> * 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.

BL 4WD SYSTEM

Contents

Part time 4WD system (EST)

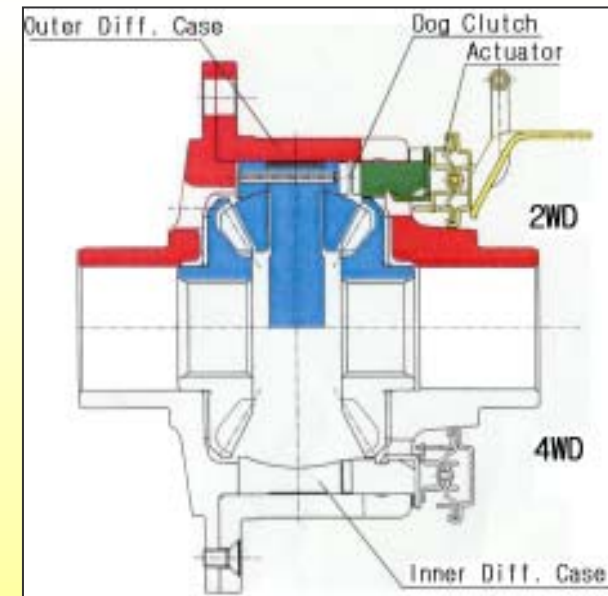
- Introduction
- SOTF (Shift On The Fly)
- FRRD (Free Running Differential)
- System block diagram
- DTC
- Electrical wiring diagram

EST

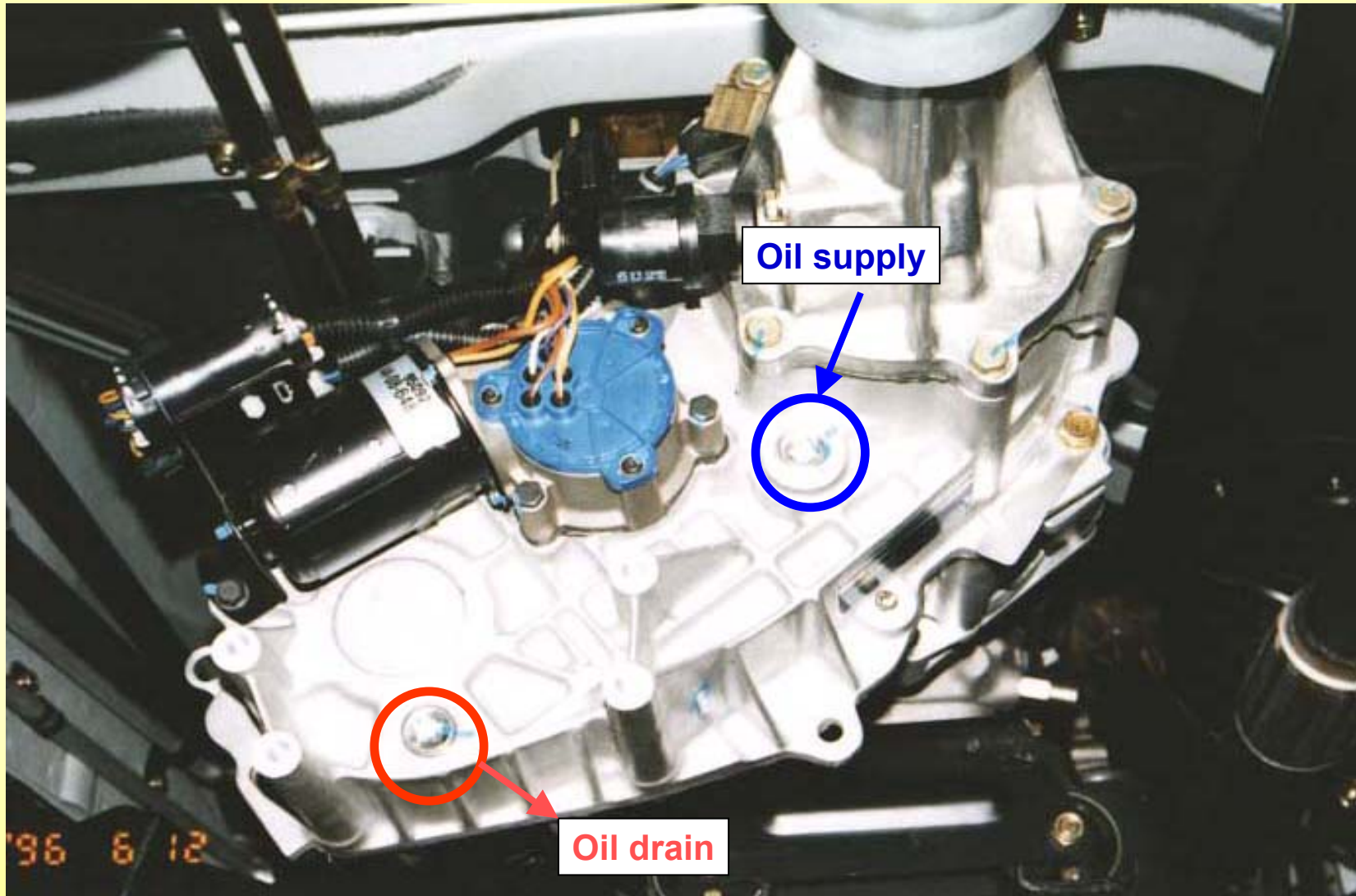
Introduction

EST system is a kind of part time 4wheel drive system and its full name is 'Electronic shift transfer. Instead of previous free wheel hub, FRRD(FRee Running Differential) was adopted and this one is for SOTF(shift on the fly) while vehicle driving. When the vehicle runs with 2WD again, the front axle will be rotated idly due to the vehicle speed and this makes the noise and vibration on the propeller shaft and ring gear set. Therefore FRRD will prevent this phenomena to get a driving stability, efficiency and improved NVH.

When 4WD is selected by driver, a 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

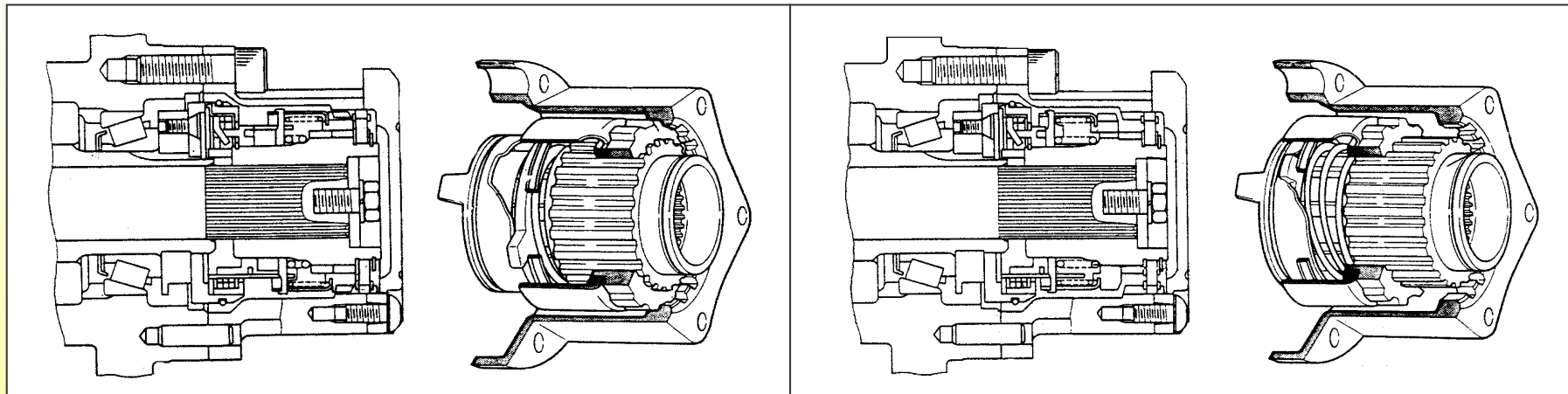


EST

The kinds of SOTF system in part time 4WD

1) CAM type auto free wheel hub

- Application vehicle : HMC Galloper
- For 2WD driving from 4WD, vehicle should be moved backward from 1 to 2 meters approximately.



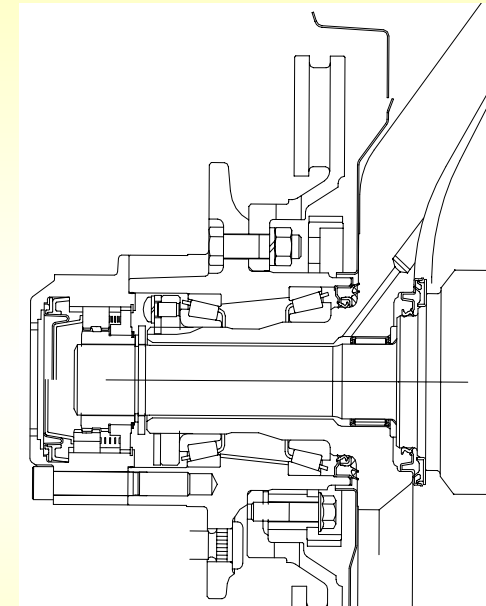
[Engaged]

[Disengaged]

The kinds of SOTF system in part time 4WD

2) Vacuum type free wheel hub

- Application vehicles : 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

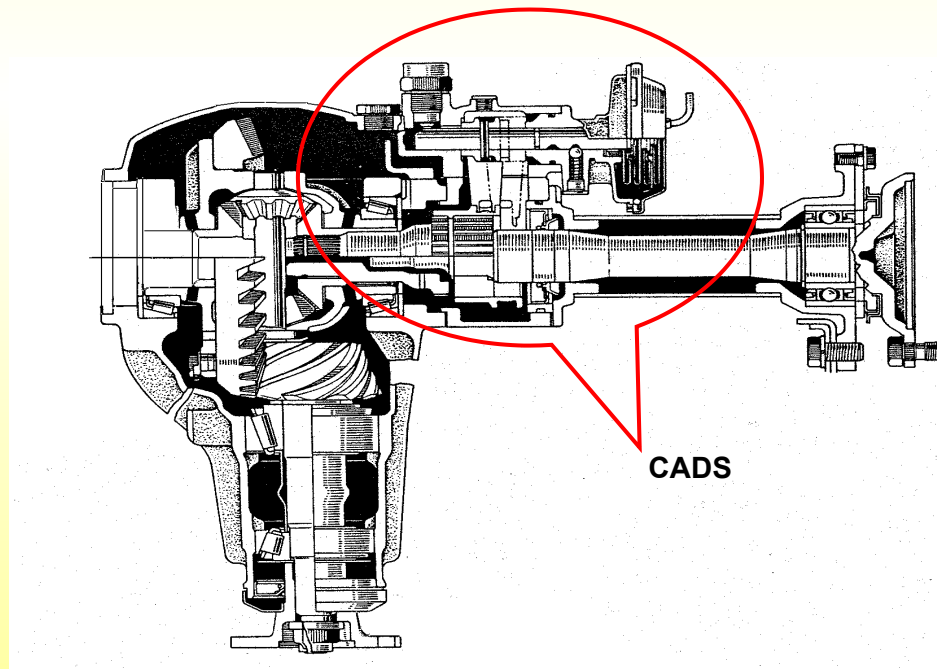


EST

The kinds of SOTF system in part time 4WD

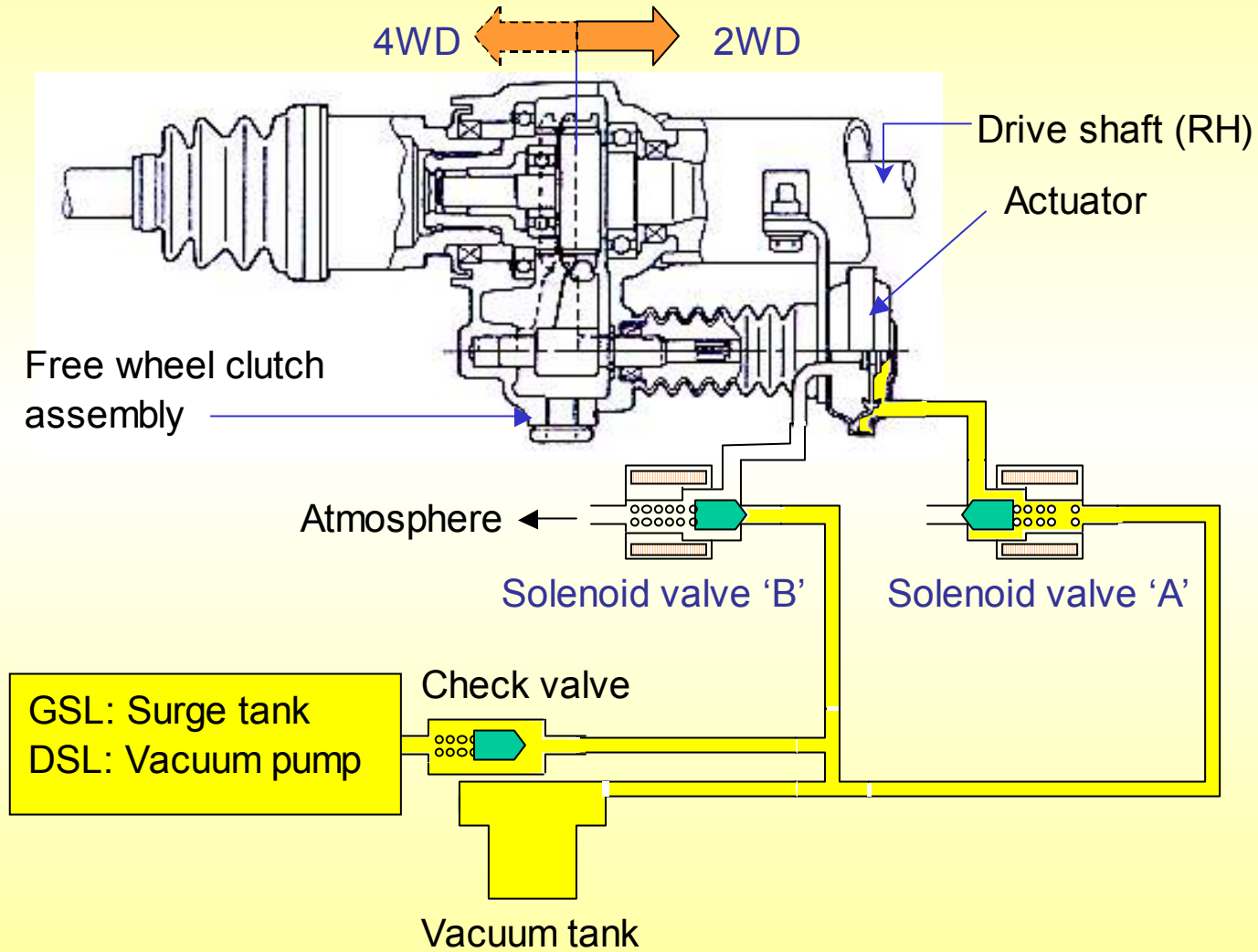
3) CADS (Center axle disconnect system) type

- Application vehicles: HMC Terracan, MMC Pajero, Challenger, Big horn, Surf
- SOTF is activated at 80km/h or less.



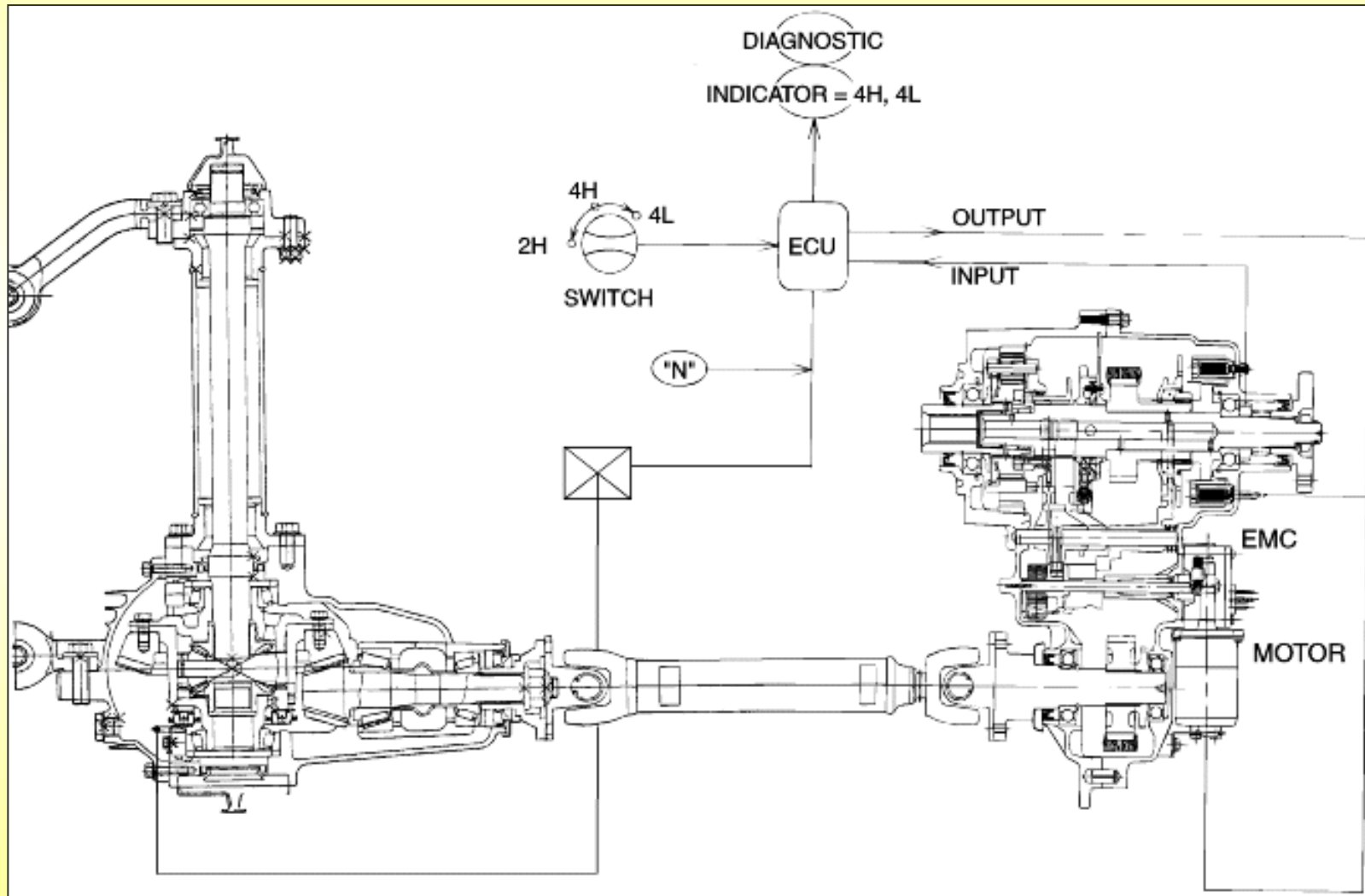
EST

CADS



EST

FRRD (Free Running Differential)



EST

FRRD (Free Running Differential)



EST

Reduction of friction loss

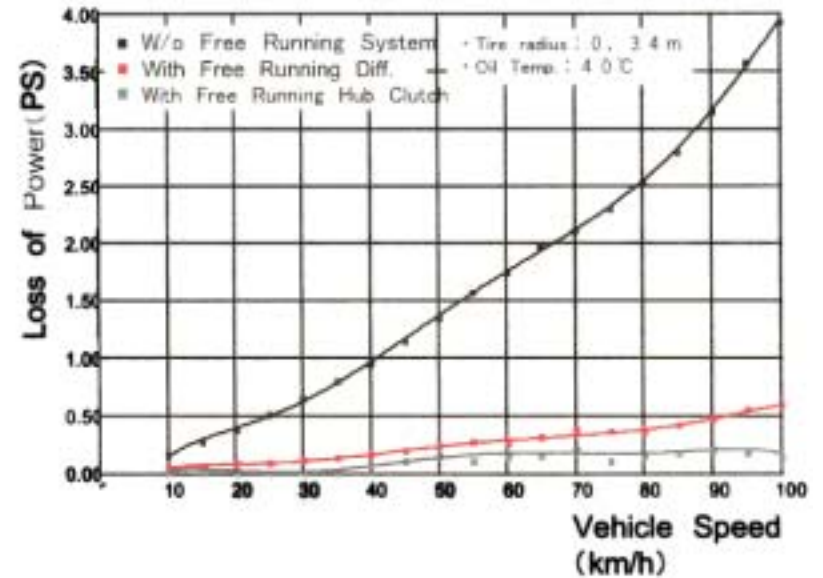
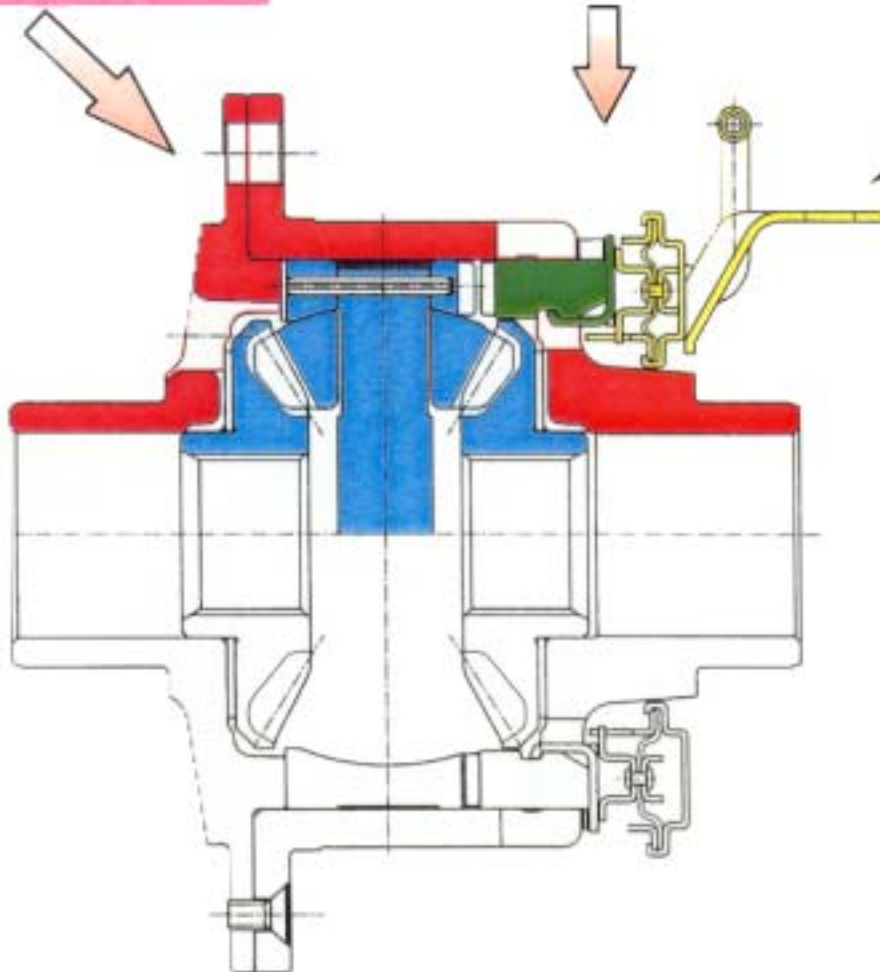
Combination of Hub-lock and Diff.

Space of FRRD.

To improve fuel consumption

Lightening, cost reduction

FRRD can be assembled in normal final differential units

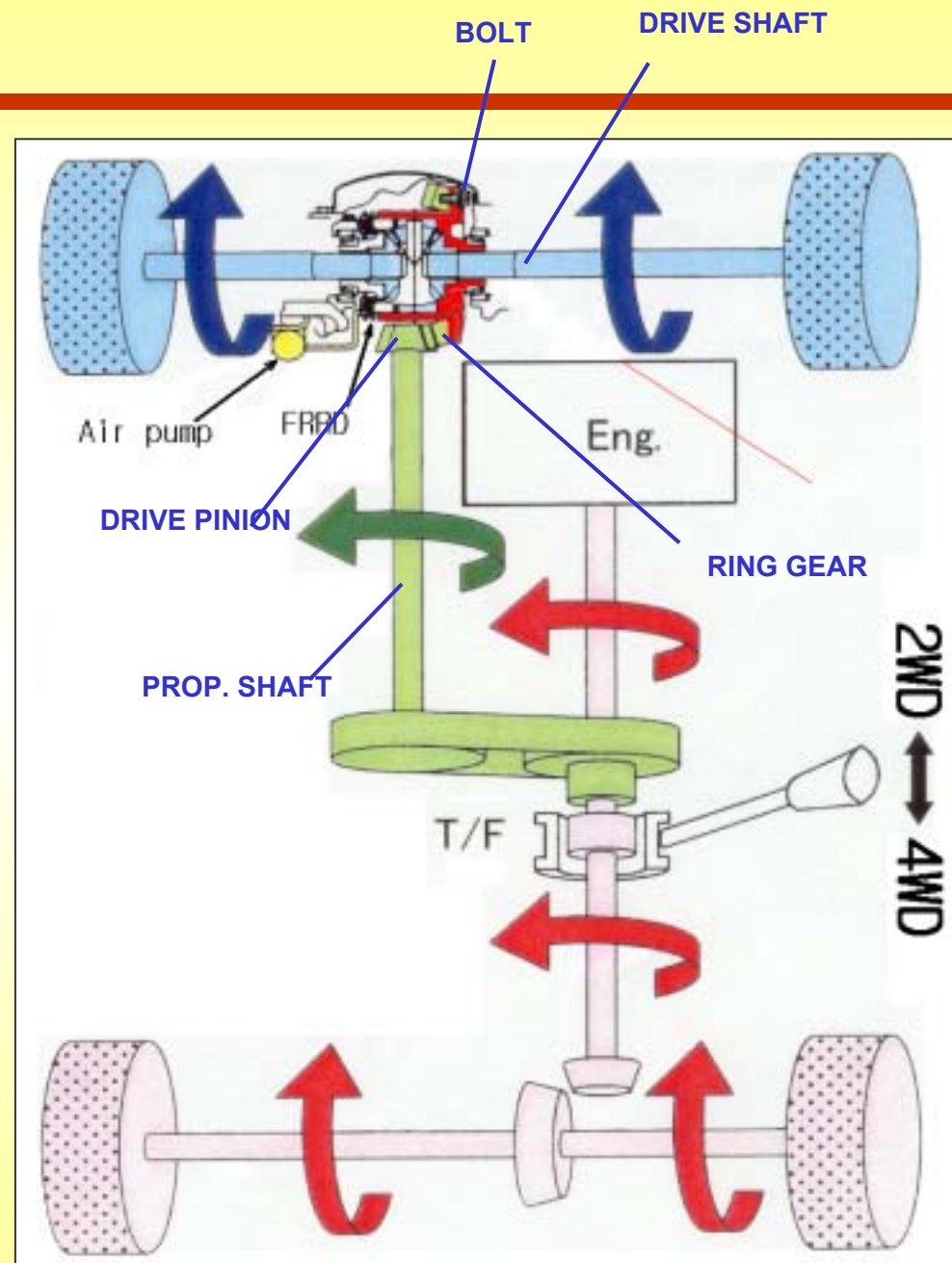


EST

FRRD (Free Running Differential)

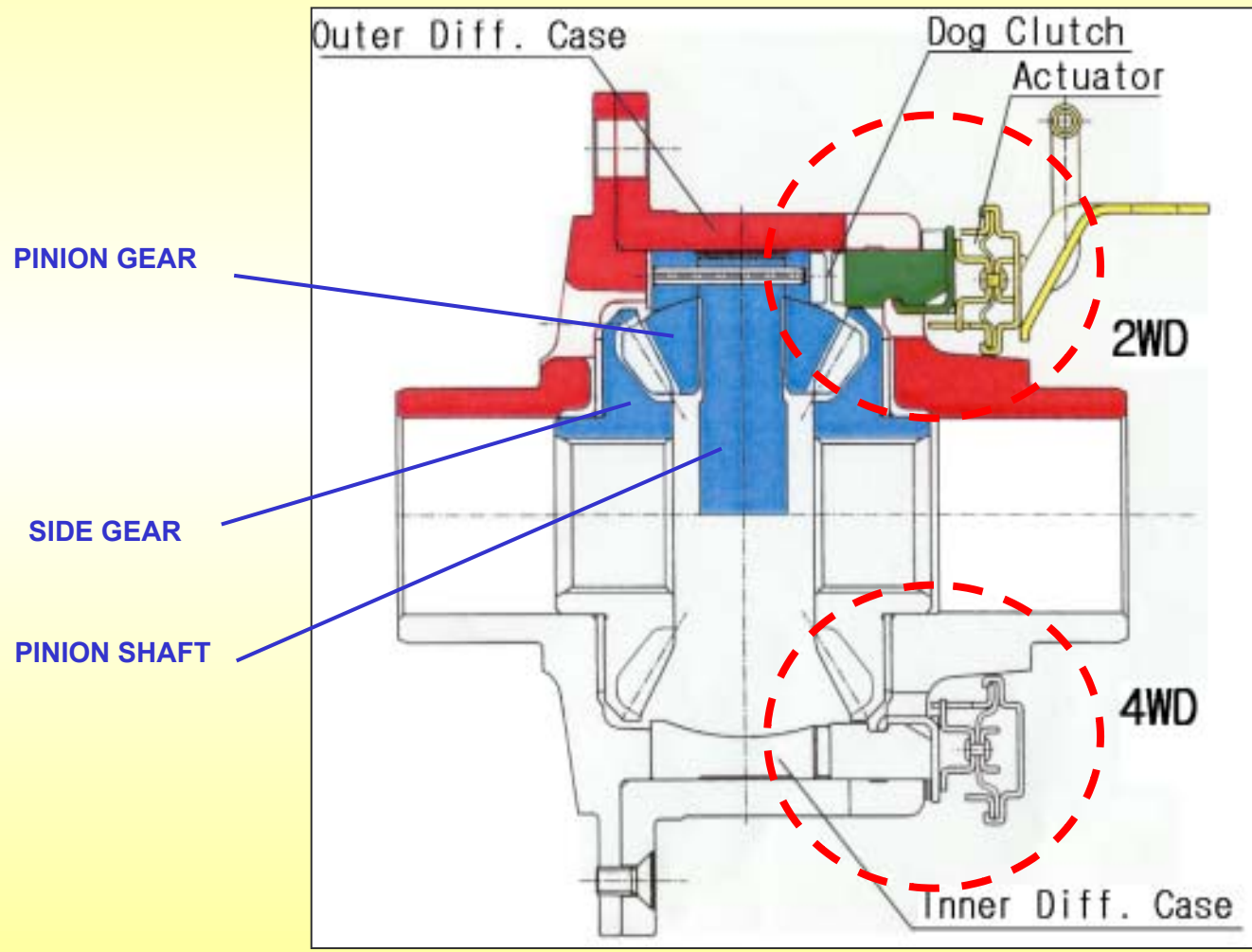


FRRD AIR PUMP CIRCUIT



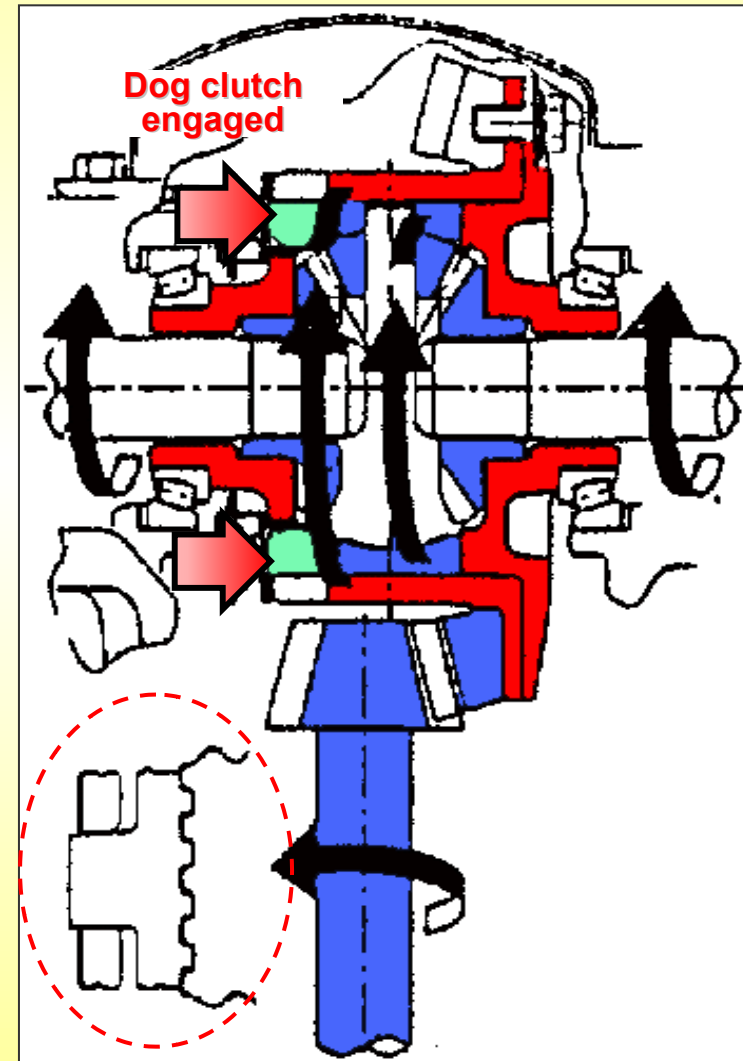
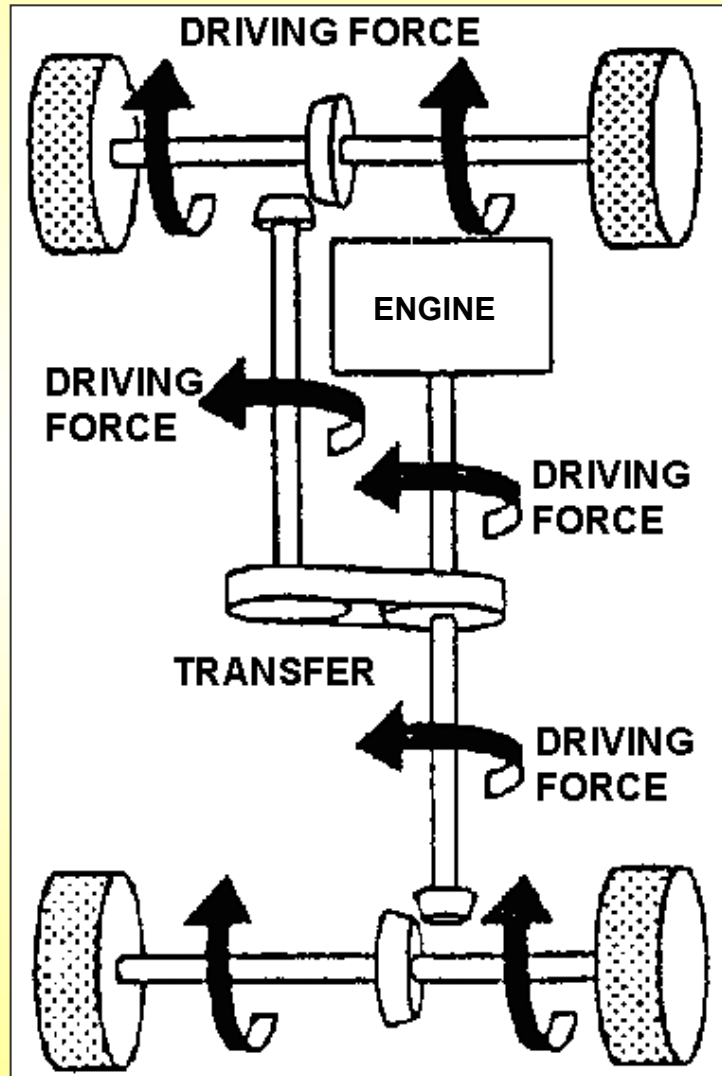
EST

FRRD (Free Running Differential)



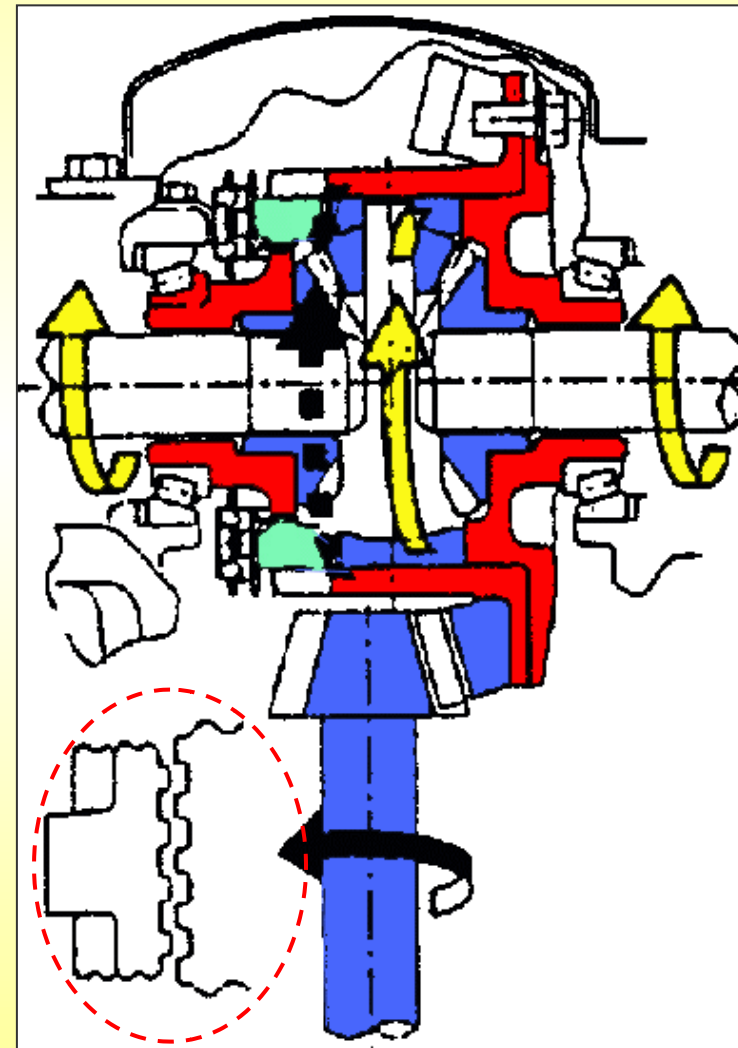
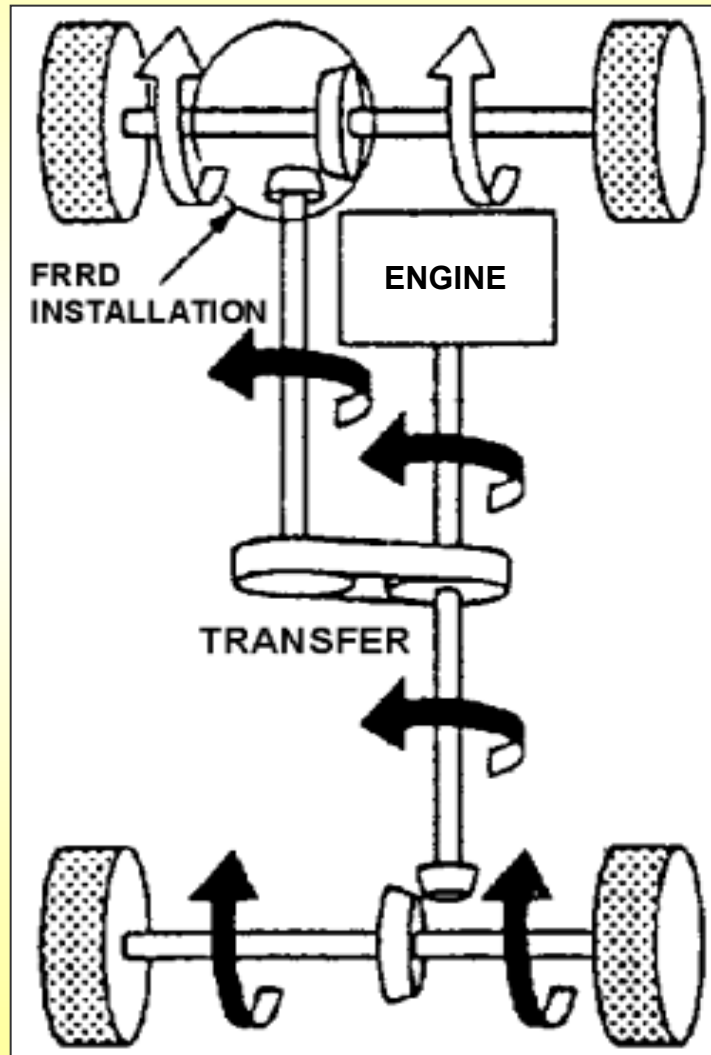
EST

FRRD operation (4WD mode)



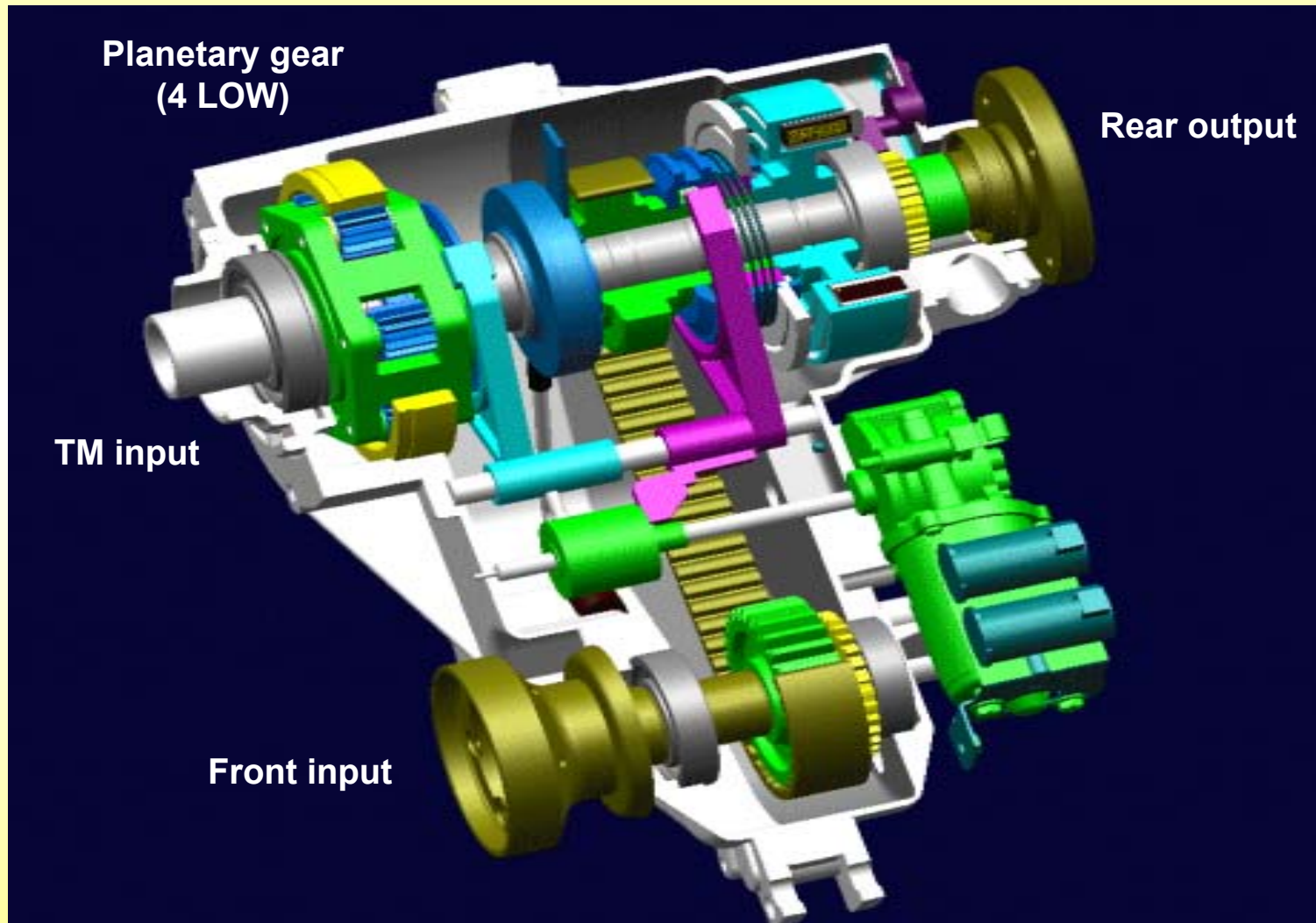
EST

FRRD operation (2WD mode)



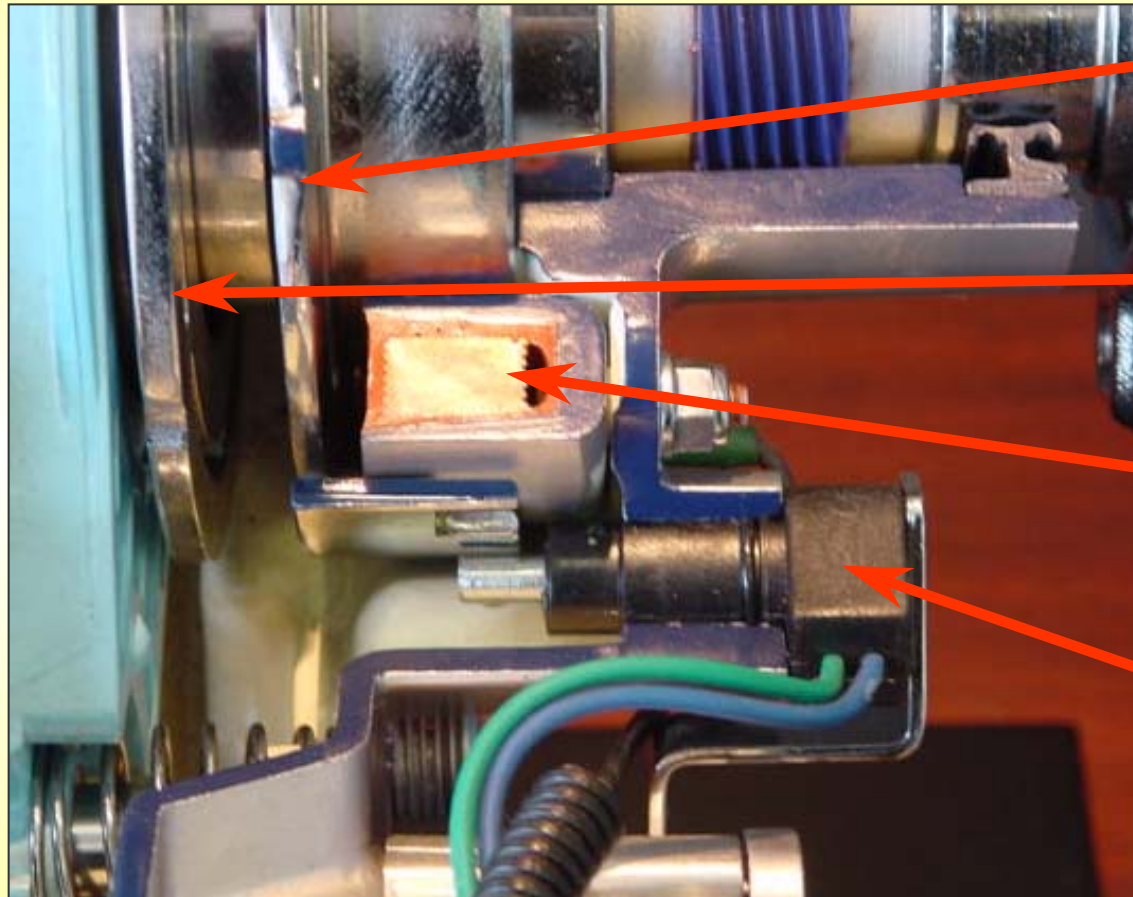
EST

Components



EST

Components



Clutch housing

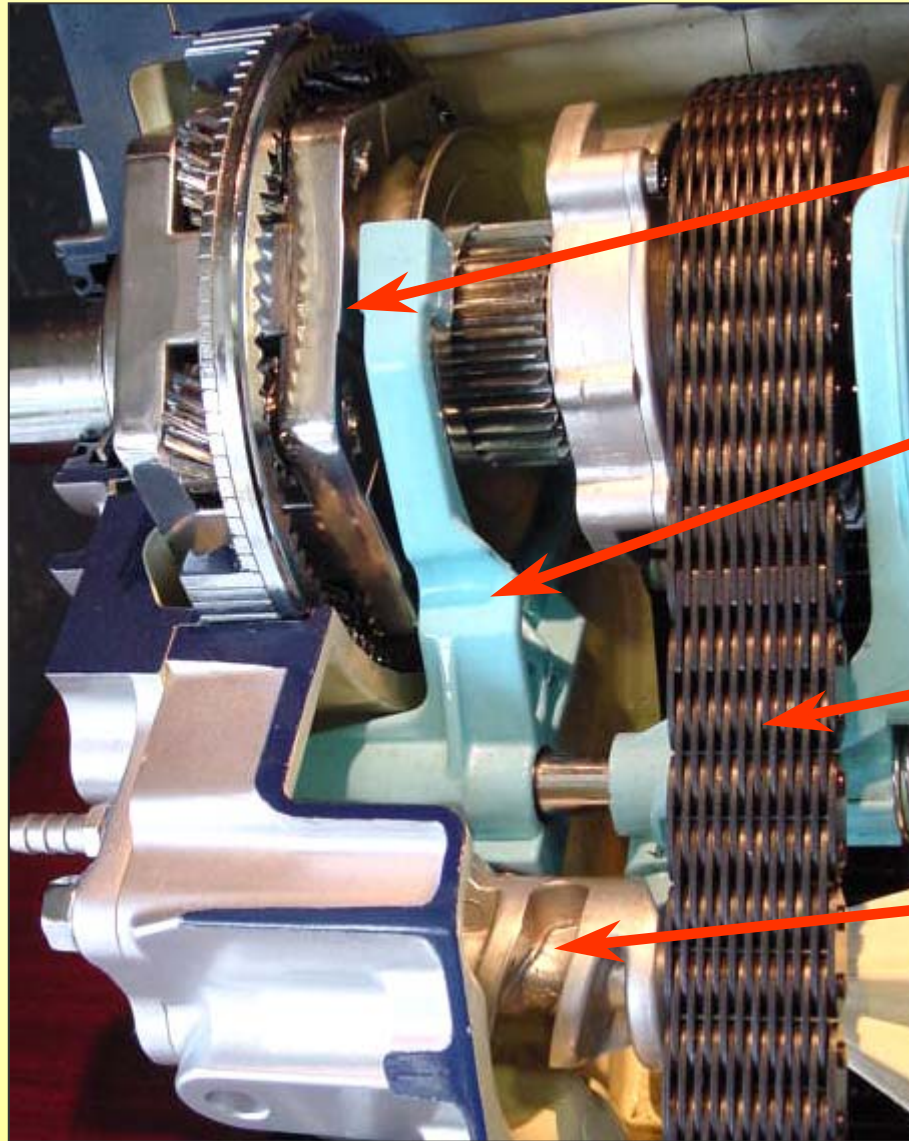
Lock up collar

Magnetic clutch

Speed sensor

EST

Components



4LOW operation

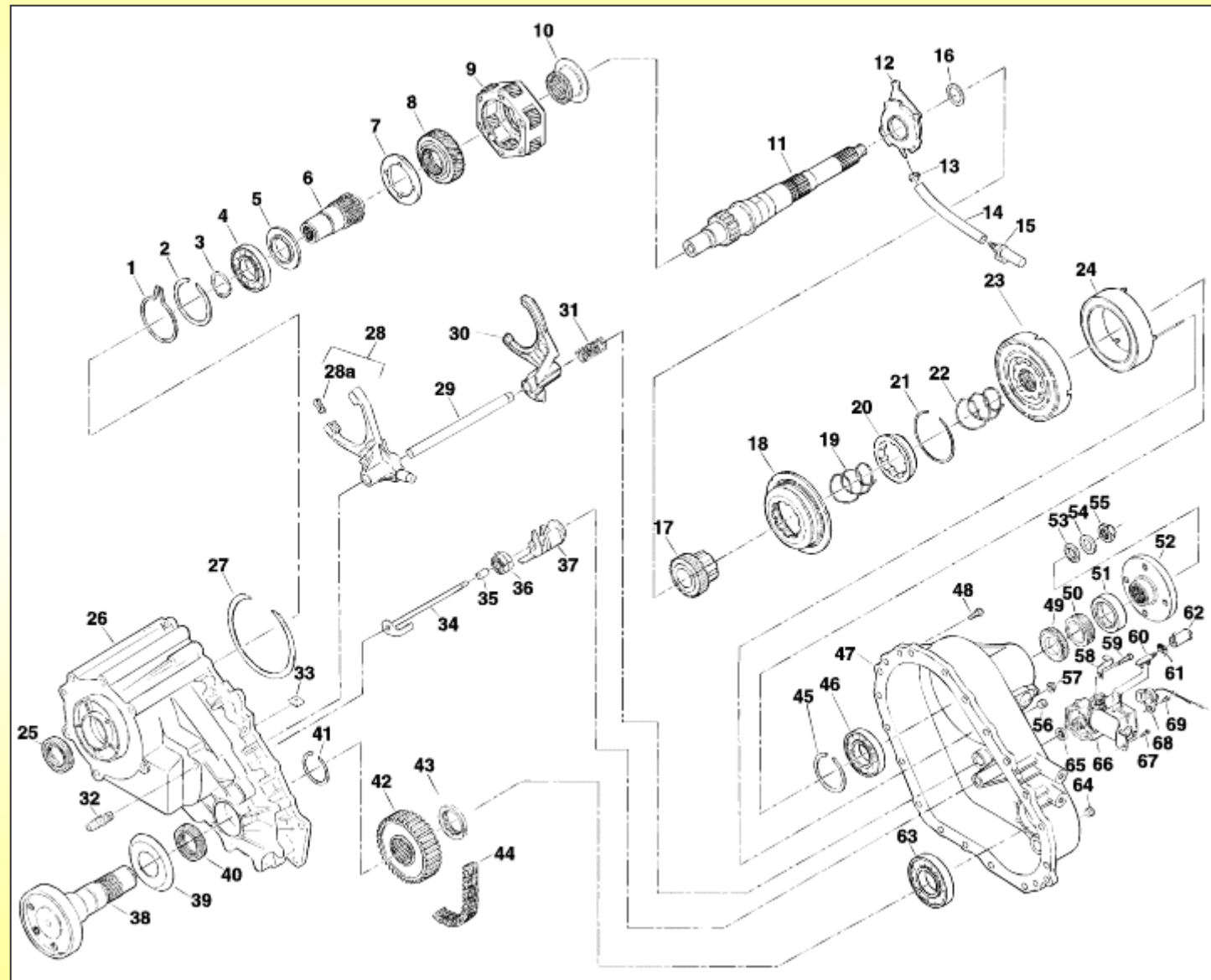
Shift fork

Driving chain

Shift cam

EST

Components



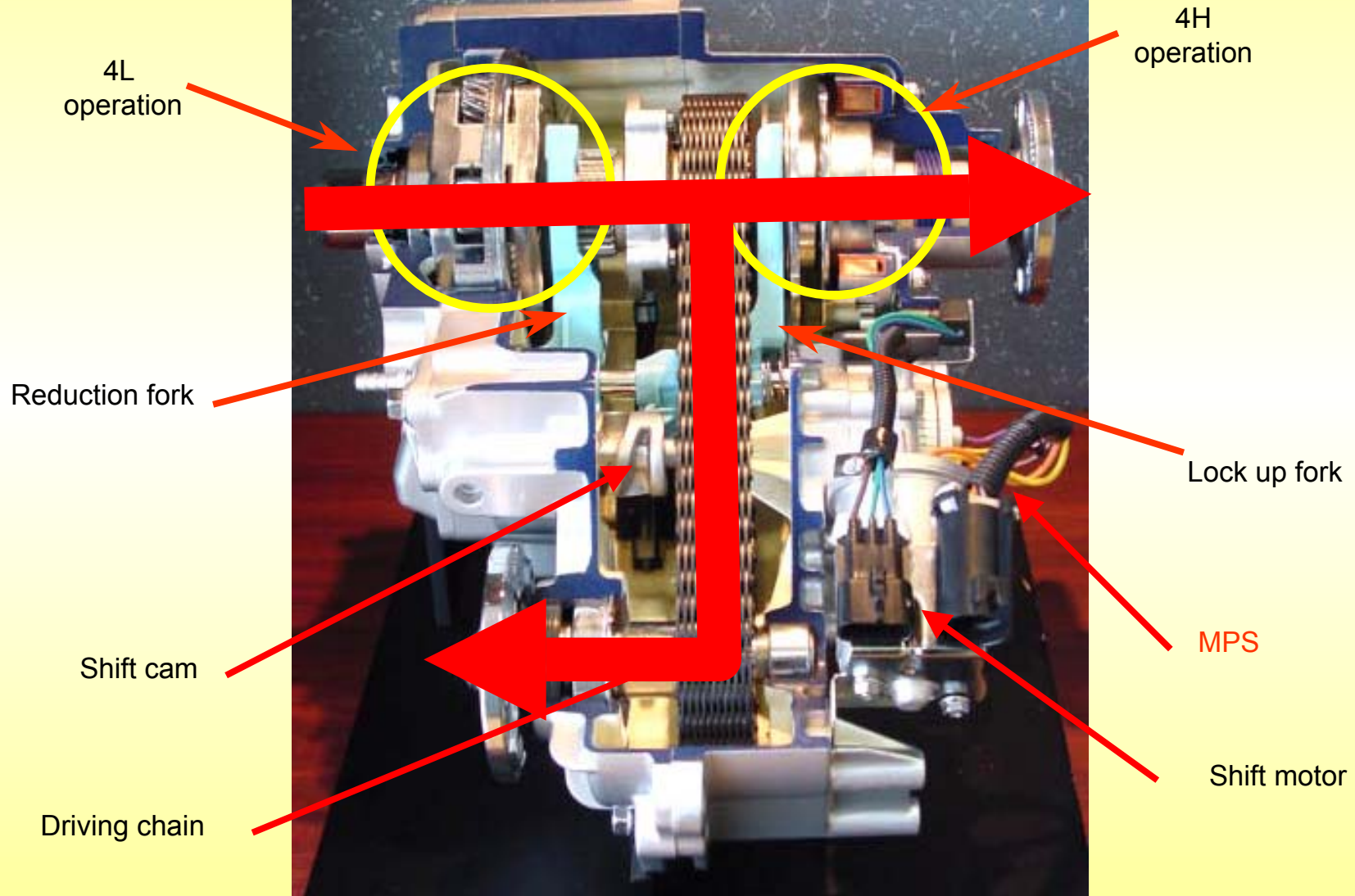
EST

Components

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

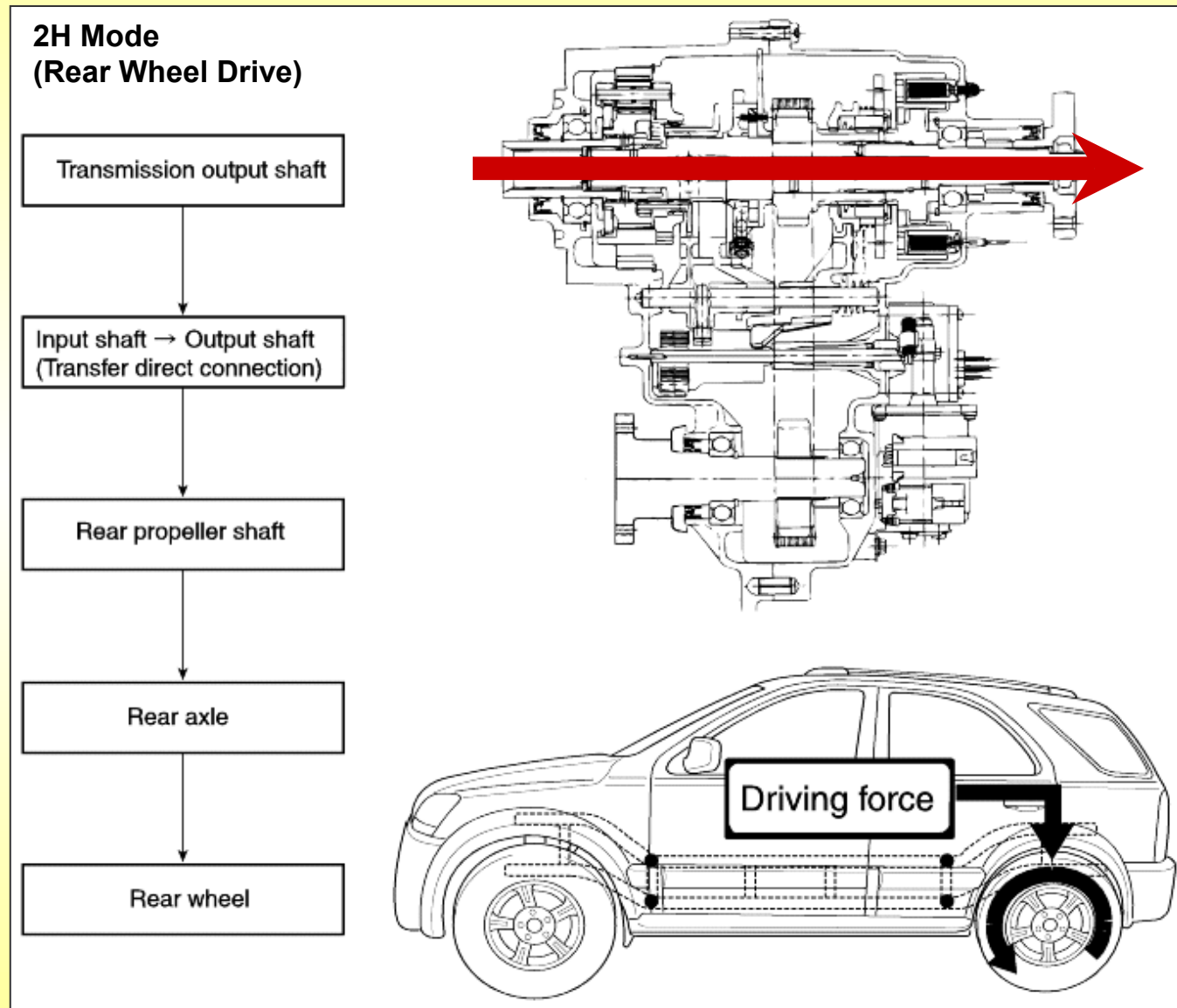
EST

Power Flow



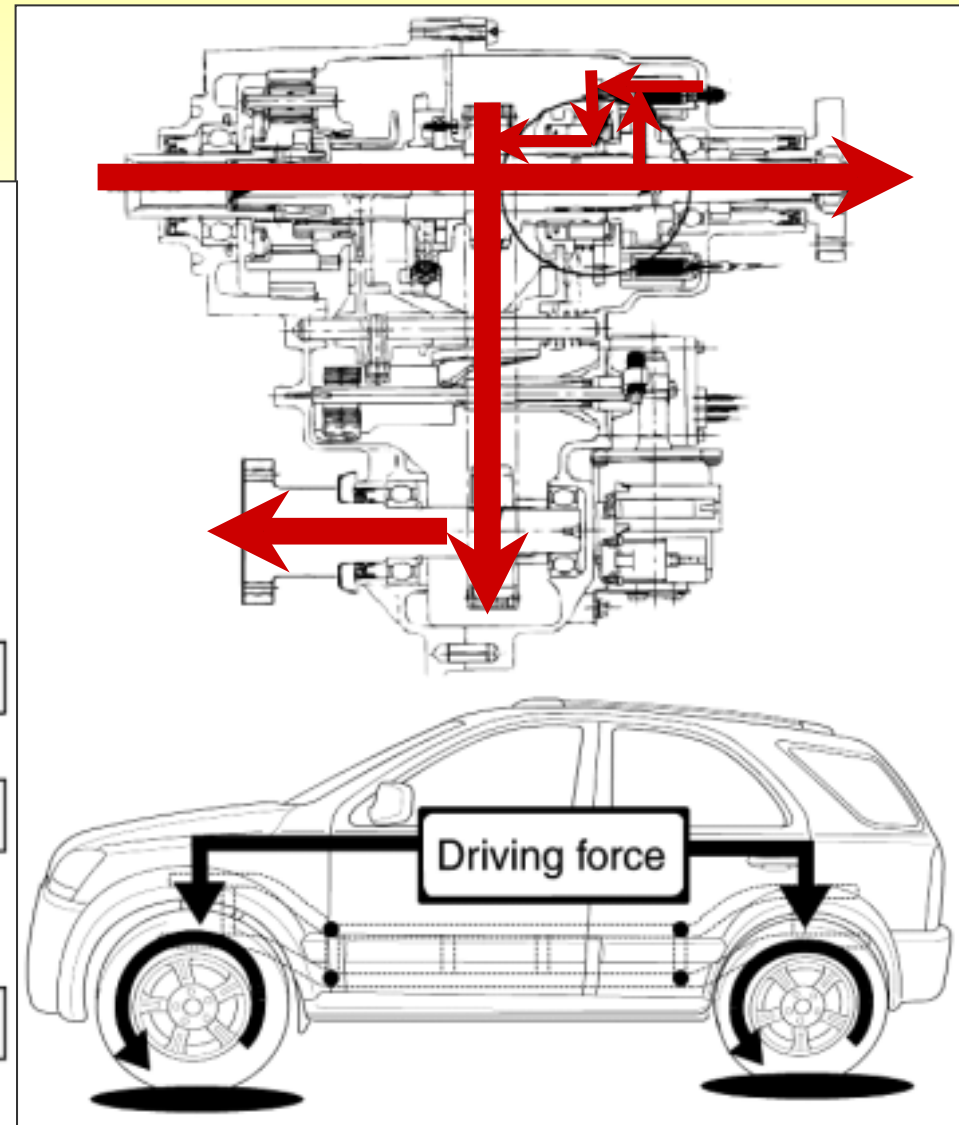
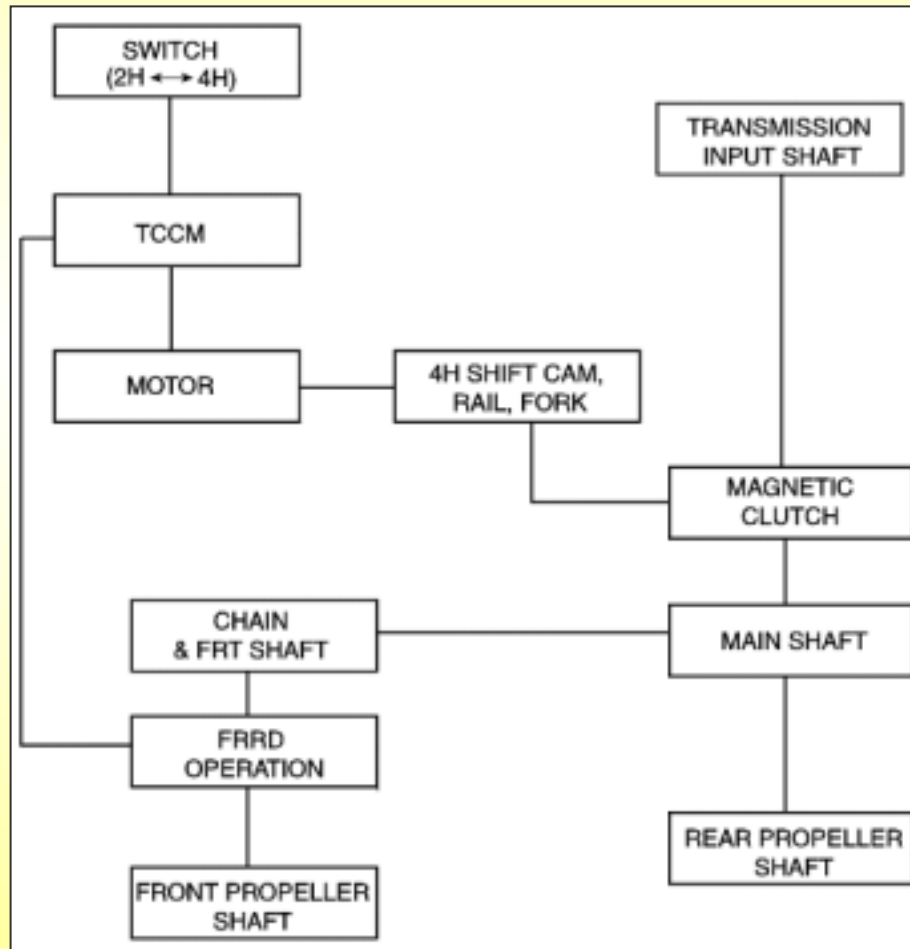
EST

Power Flow



EST

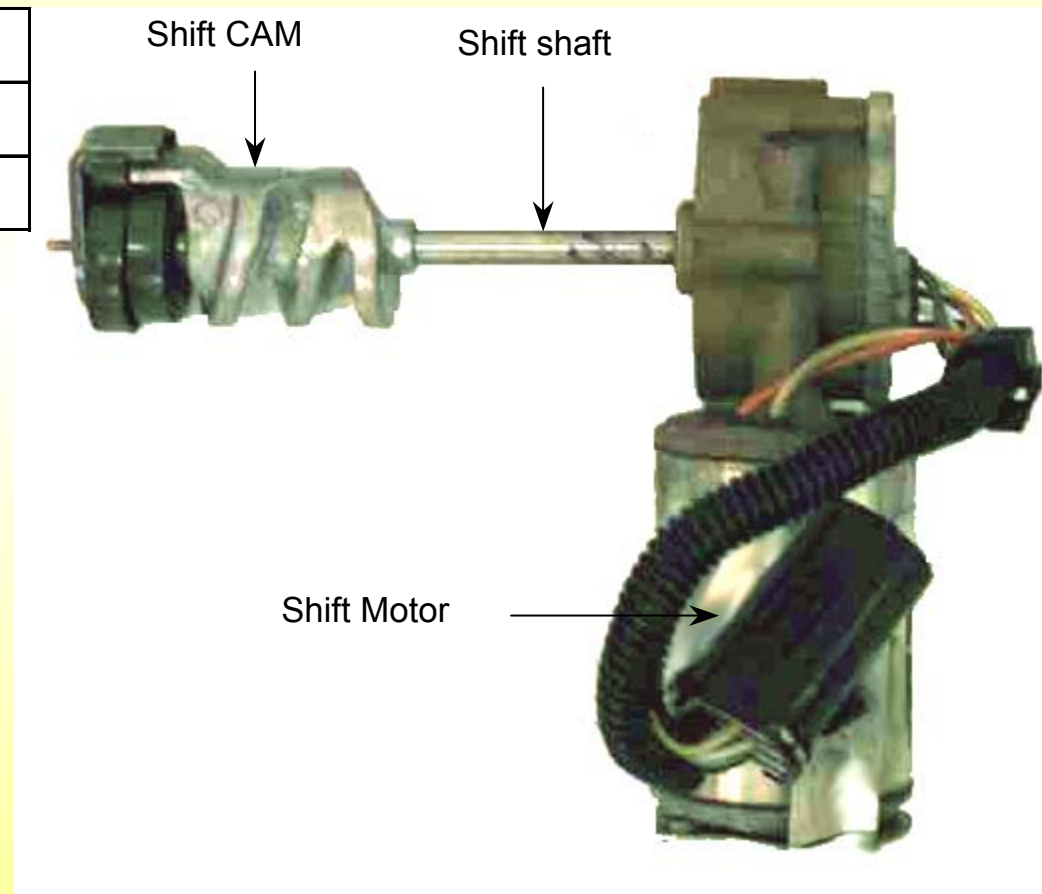
Power Flow (4H Mode)



EST

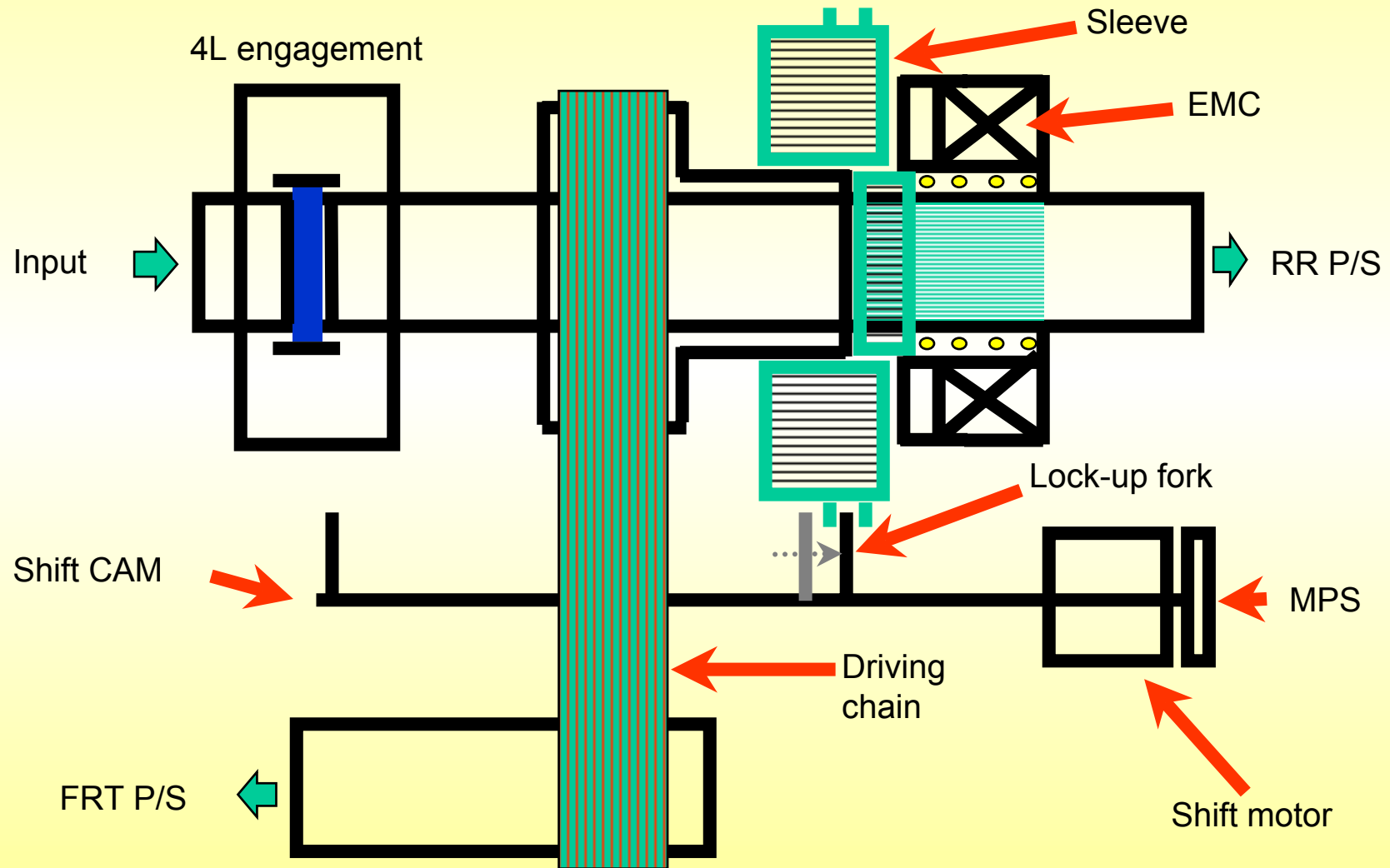
Comparing with the TOD transfer, EST has one more shift fork for engaging 2WD and 4WD. That is a 'Lock up shift fork'.

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



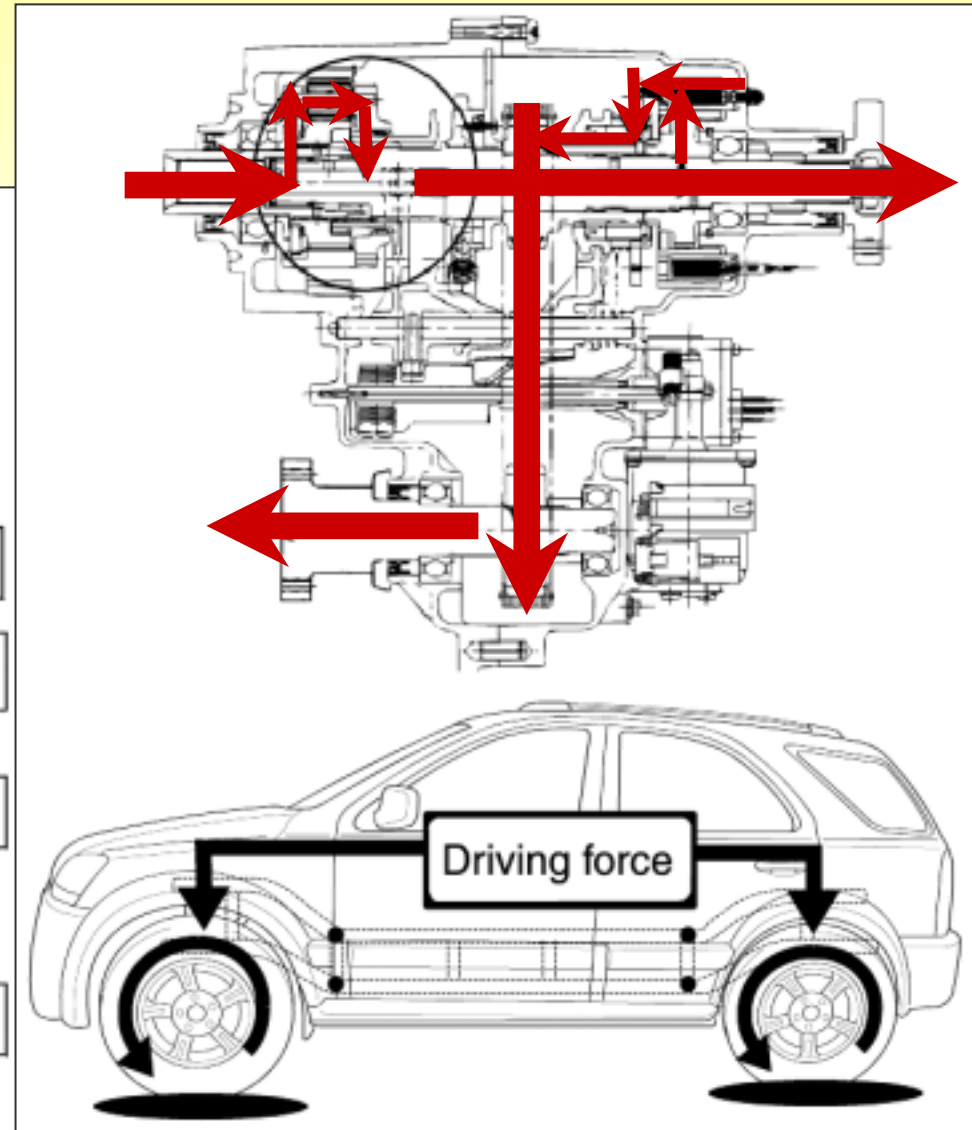
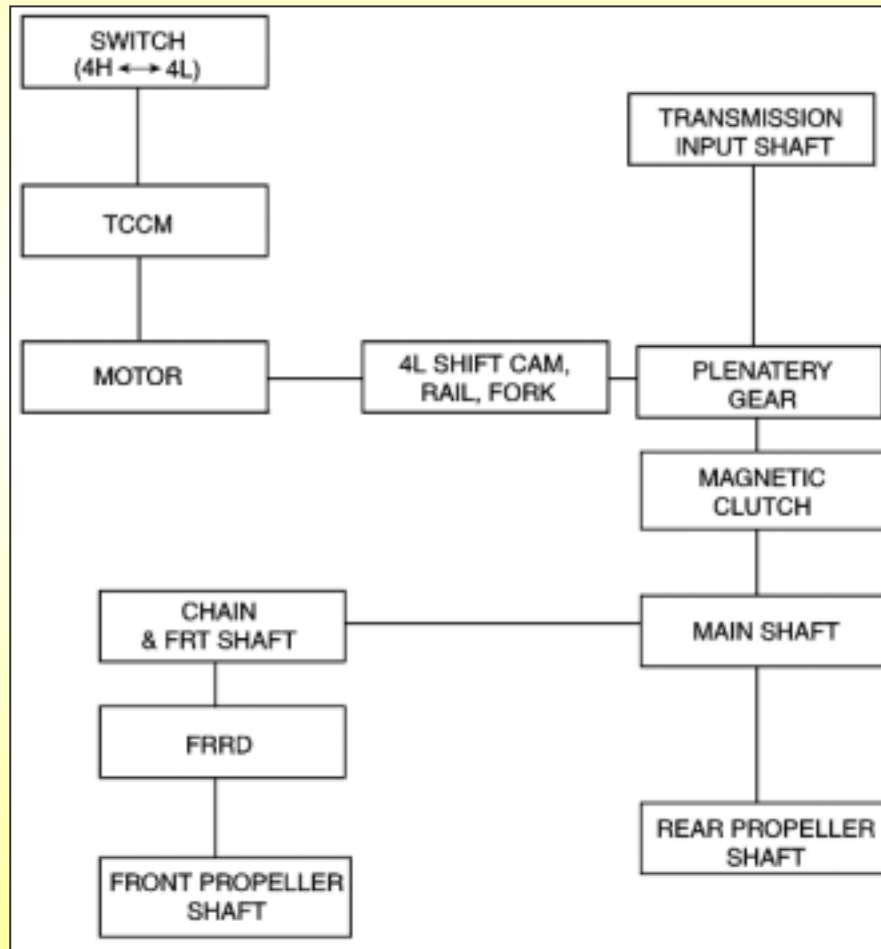
EST

4WD engagement



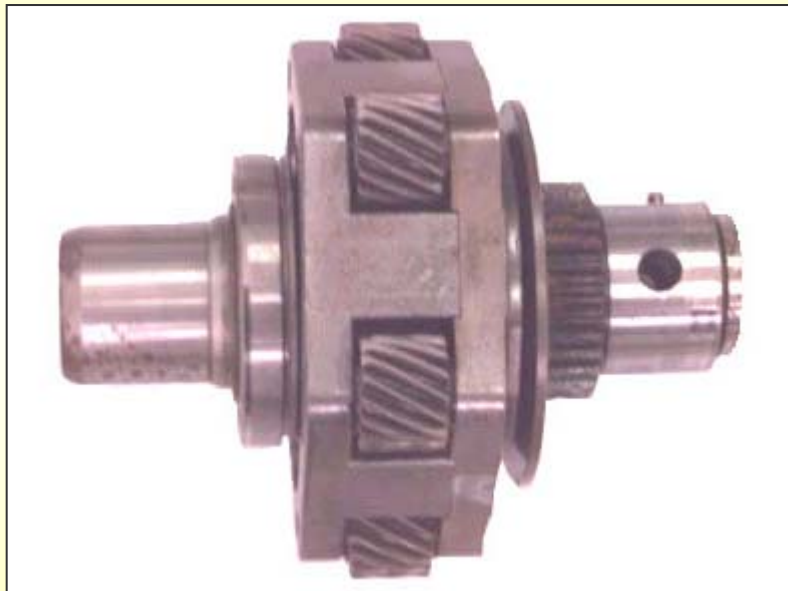
EST

Power Flow (4L Mode)

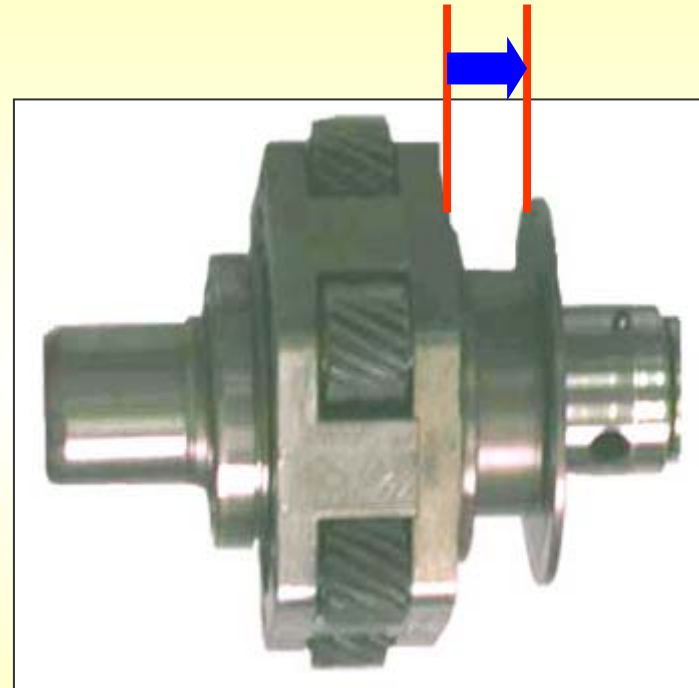


EST

1:1 connection (2H, 4H)



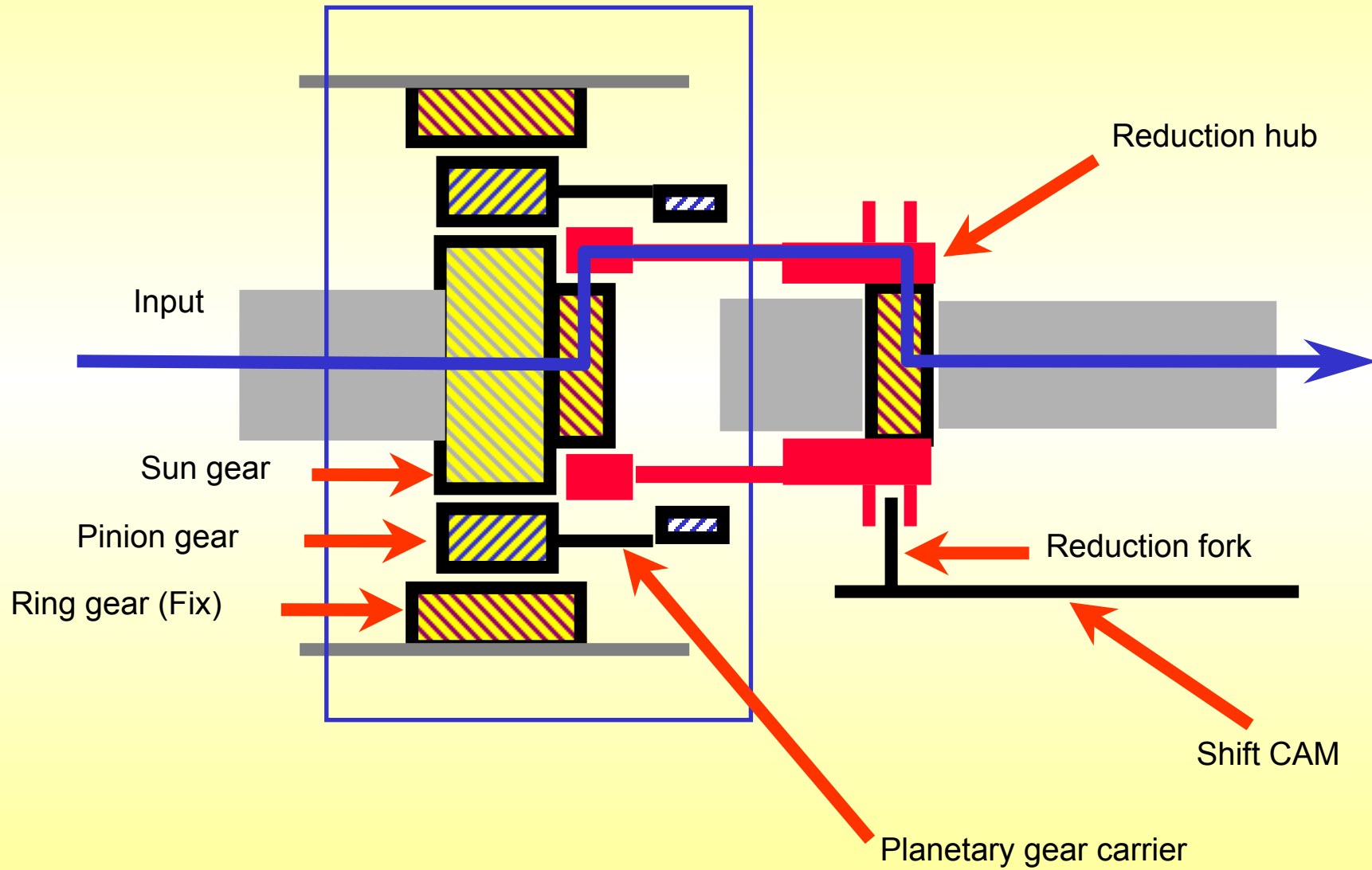
[1:1 connection (2H, 4H)]



[4-Low mode]

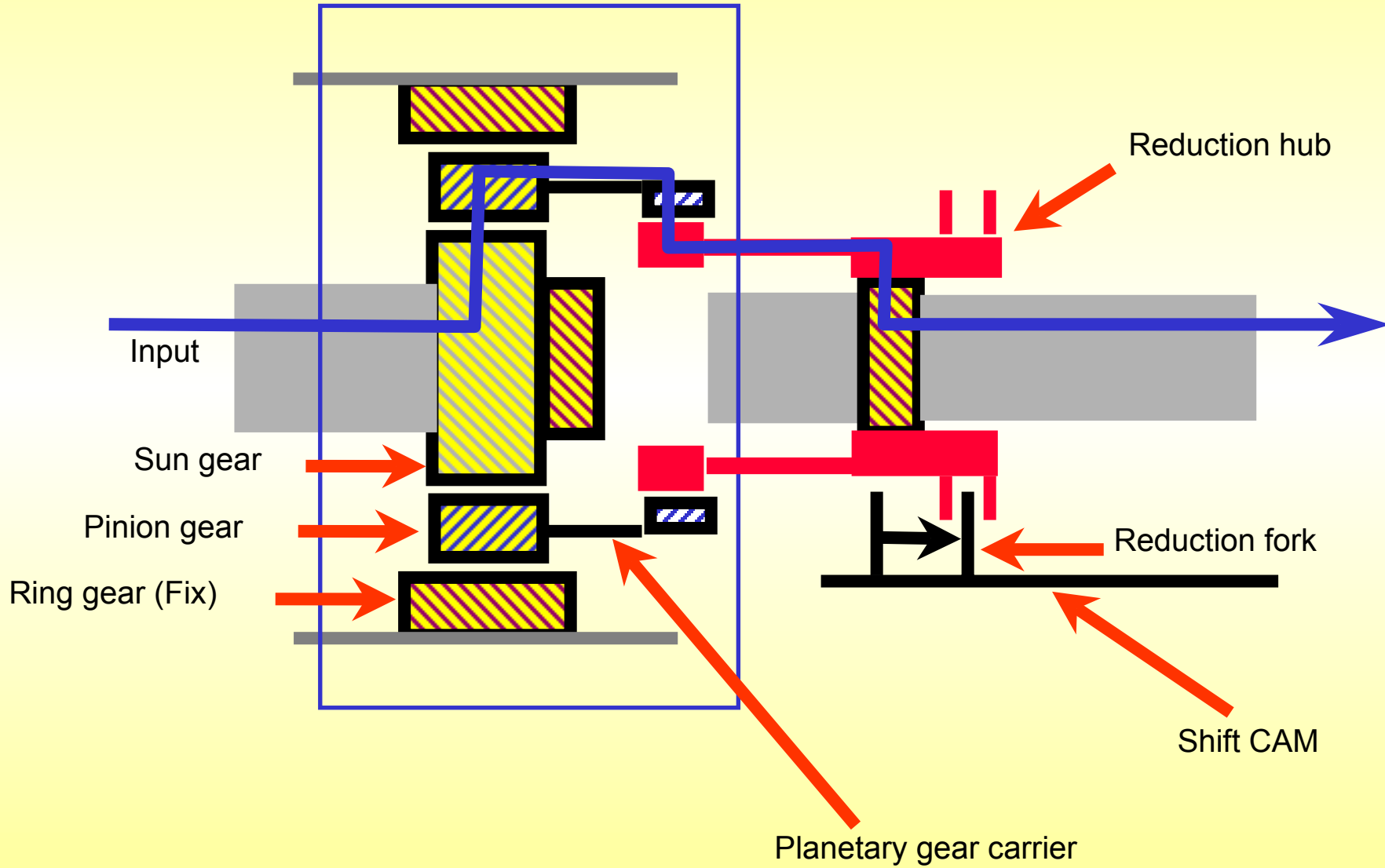
EST

1:1 connection (2H, 4H)



EST

4LOW mode



EST

Components – 2H/4H/4L switch

1) 2H mode: Rear wheel drive

2) 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.

3) 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 “Clutch interlock switch” should be On before selecting a 4L mode. After a mode change is successfully finished, the 4L lamp will be turned on.

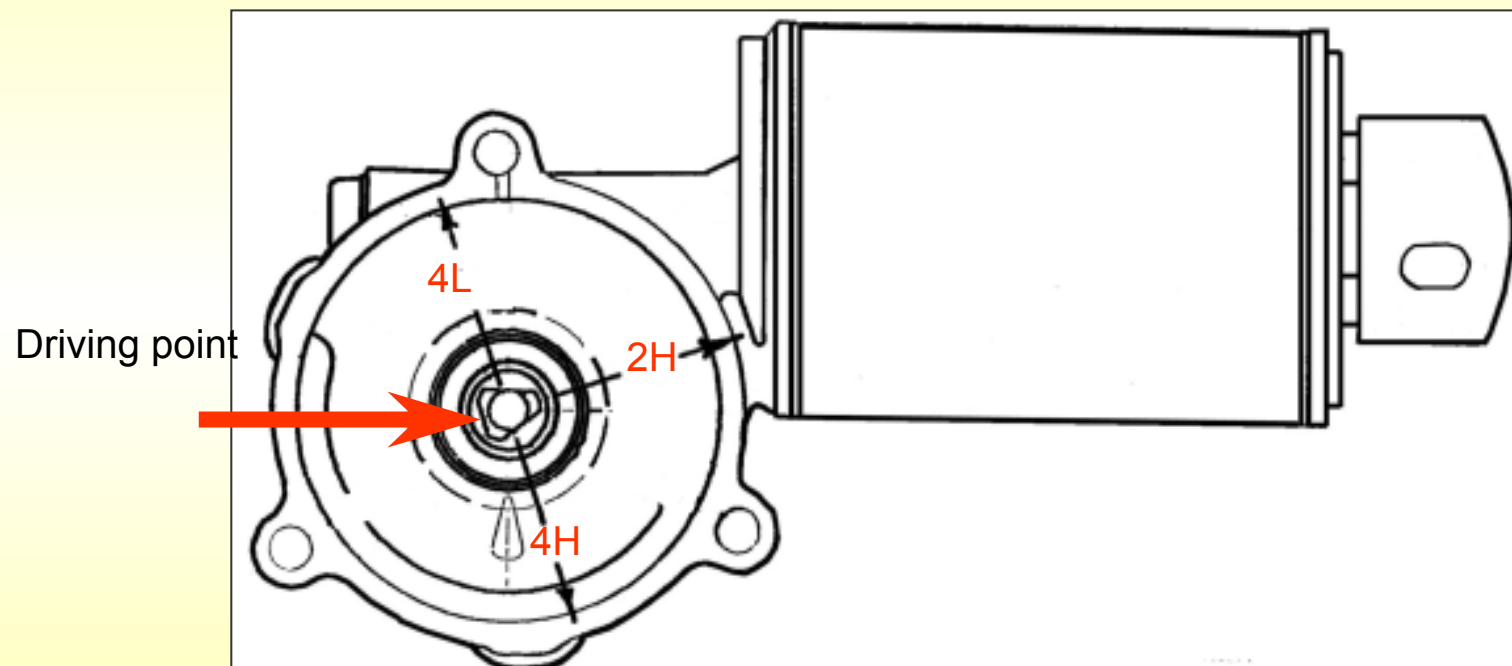


EST

SHIFT MOTOR



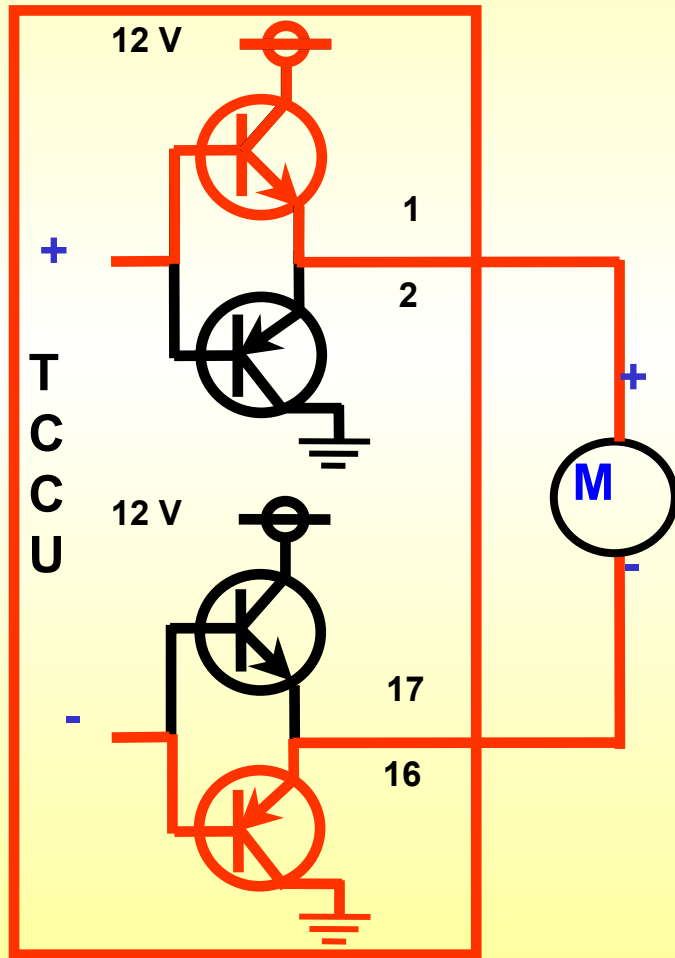
SHIFT MOTOR



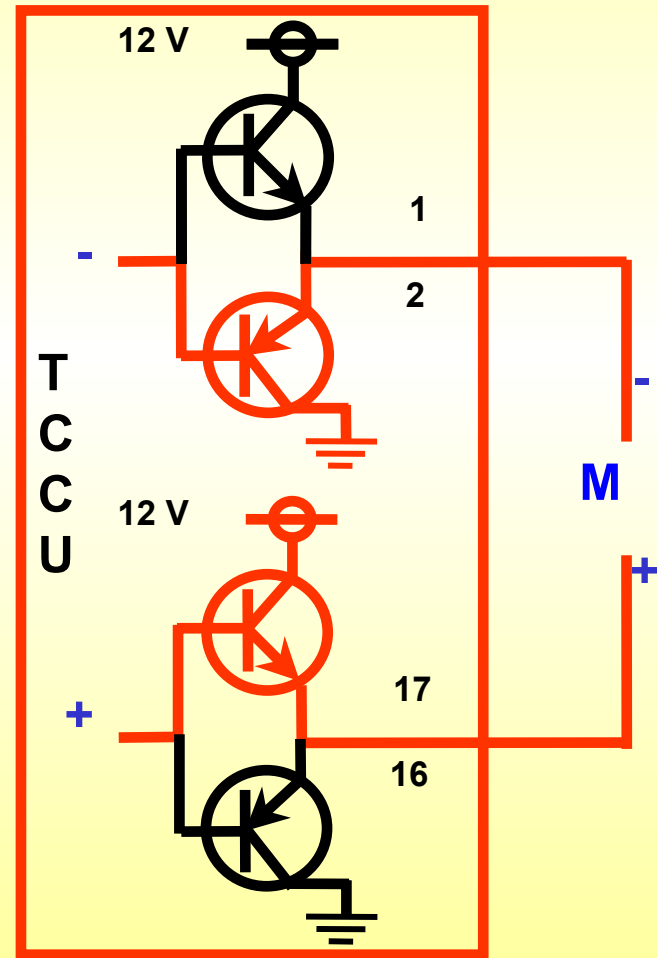
EST

SHIFT MOTOR

2H → 4H → 4L

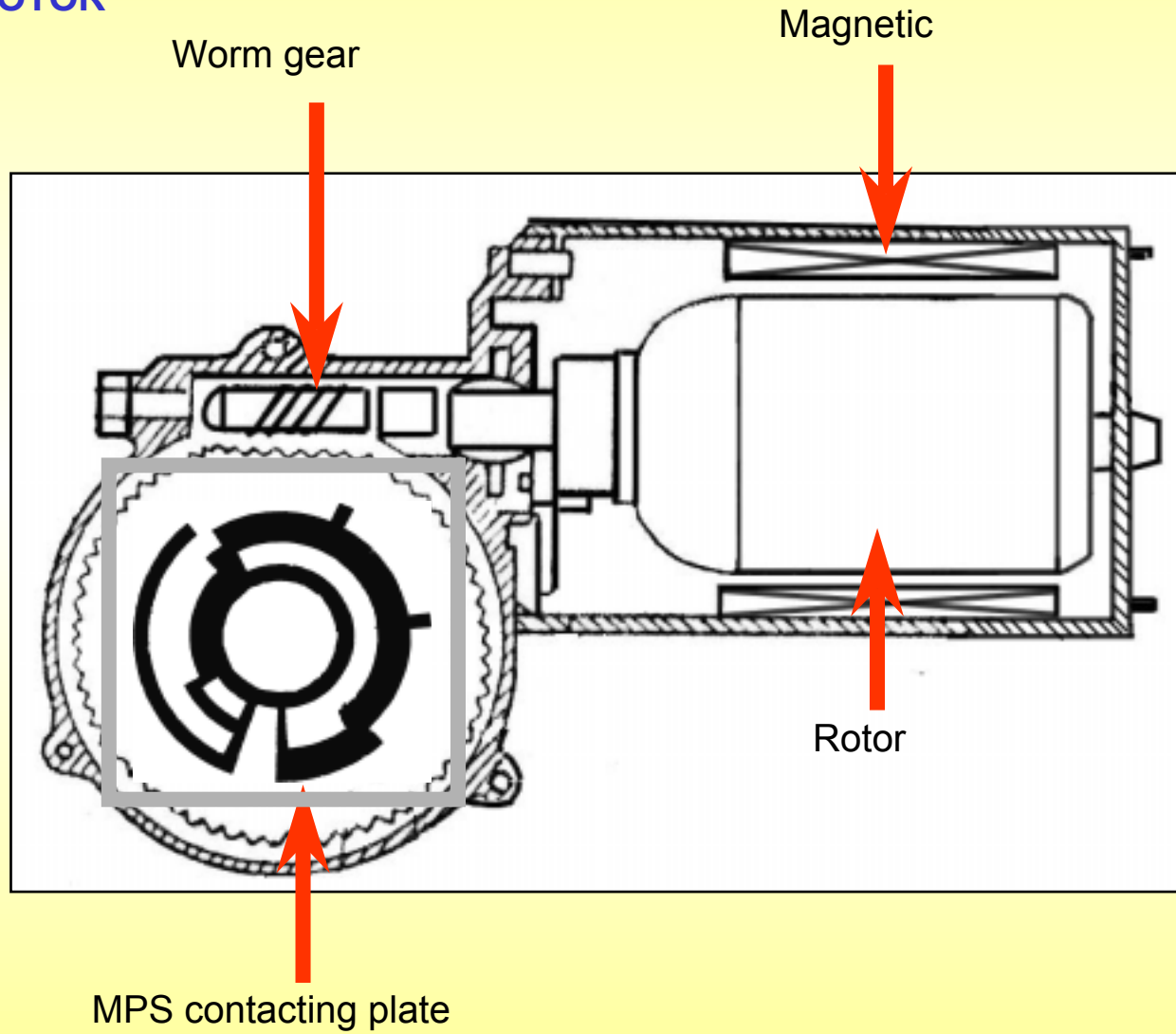


4L → 4H → 2H



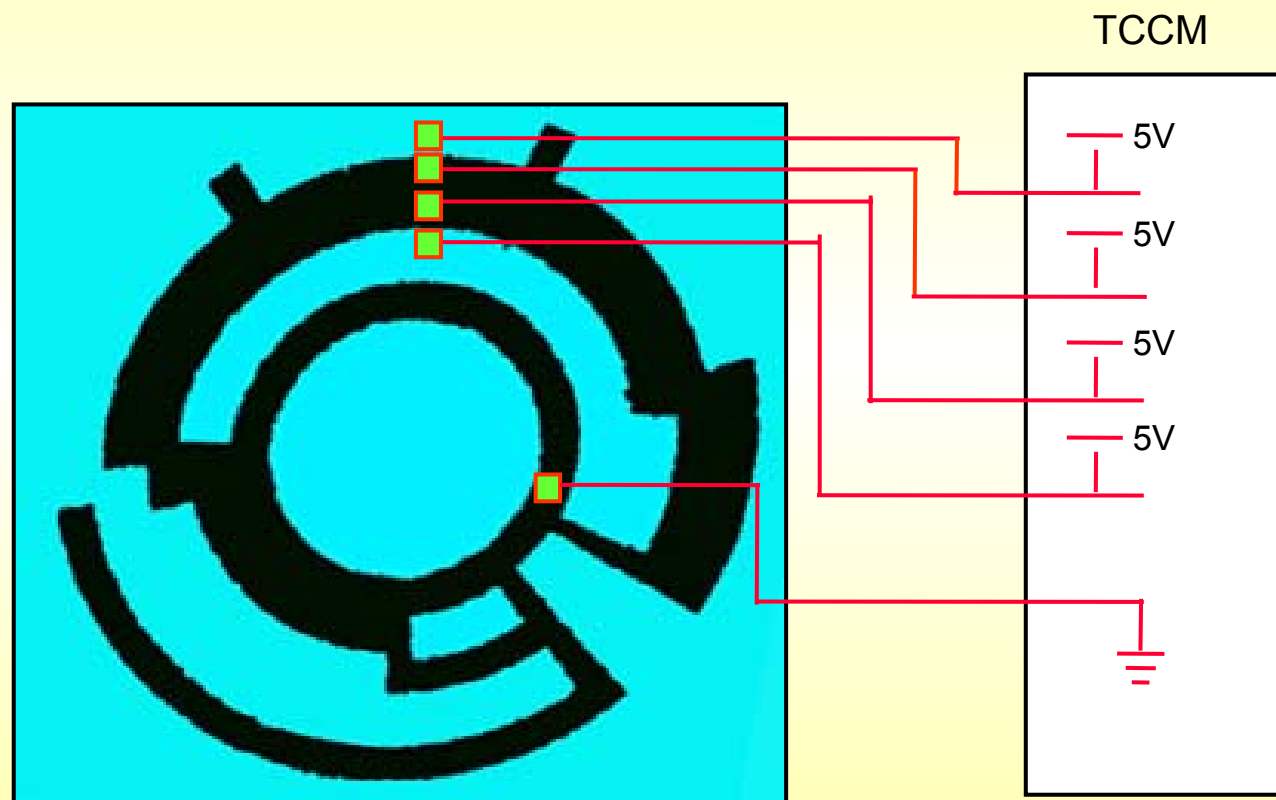
EST

SHIFT MOTOR



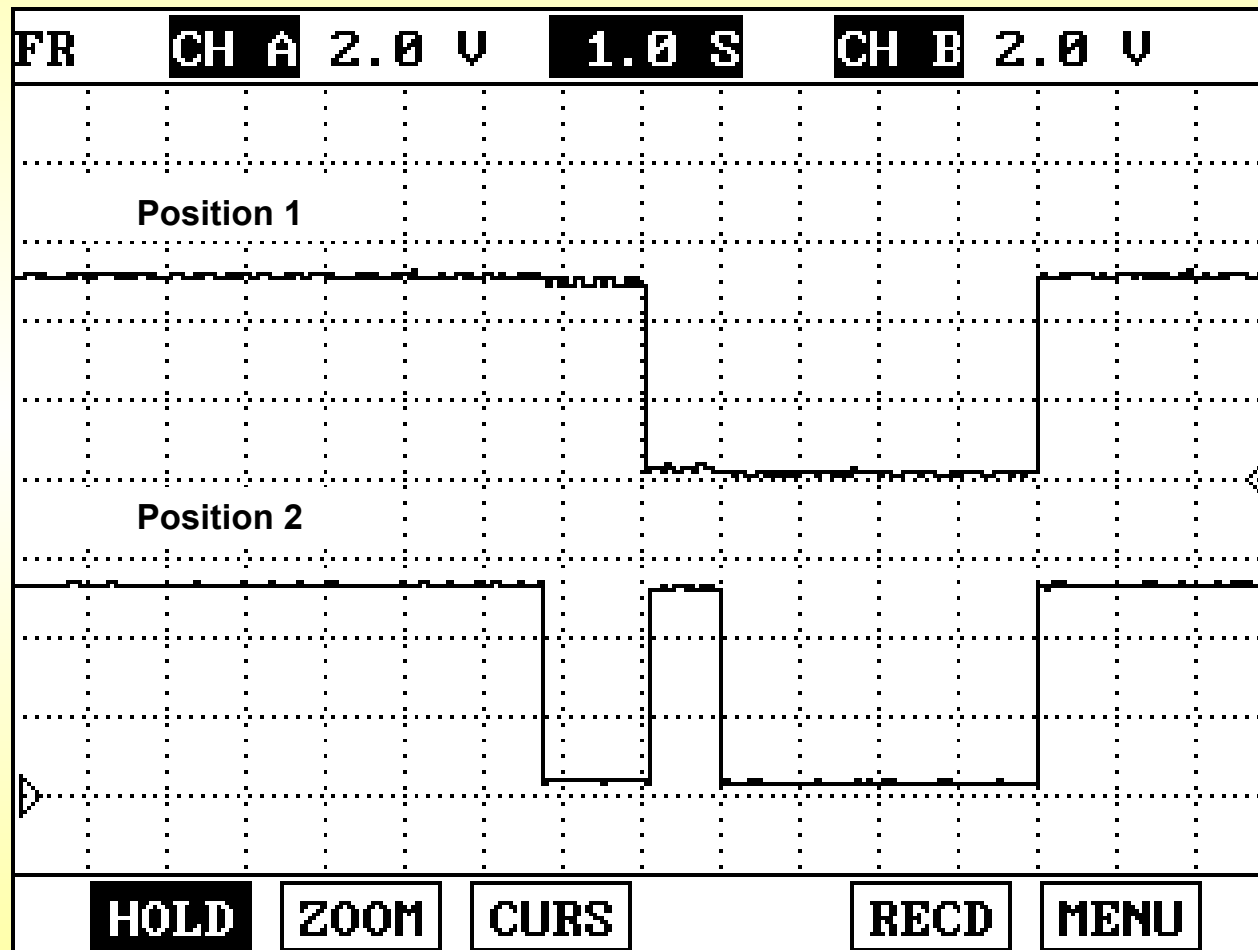
EST

MPS contacting points



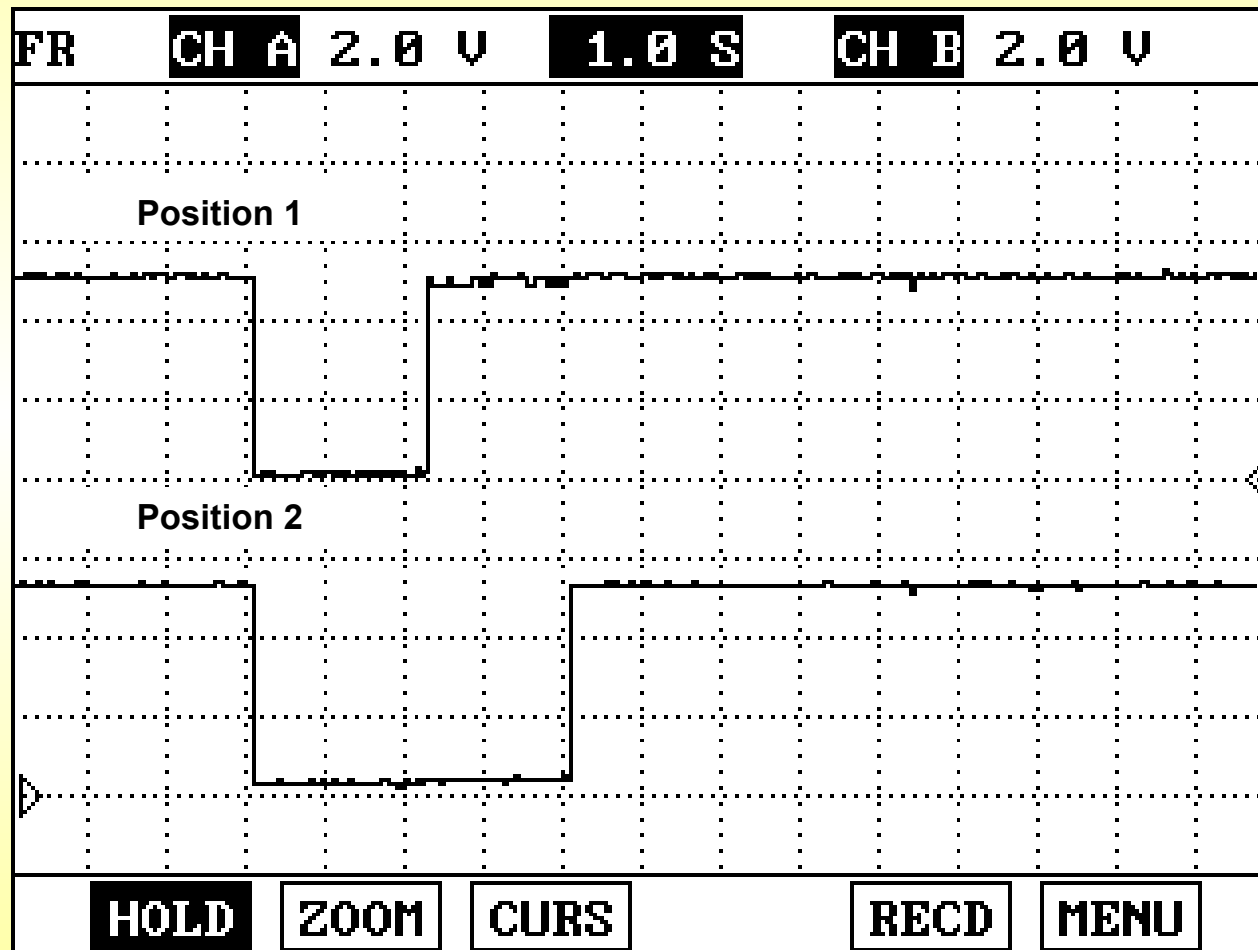
EST

MPS signals (2H → 4H)



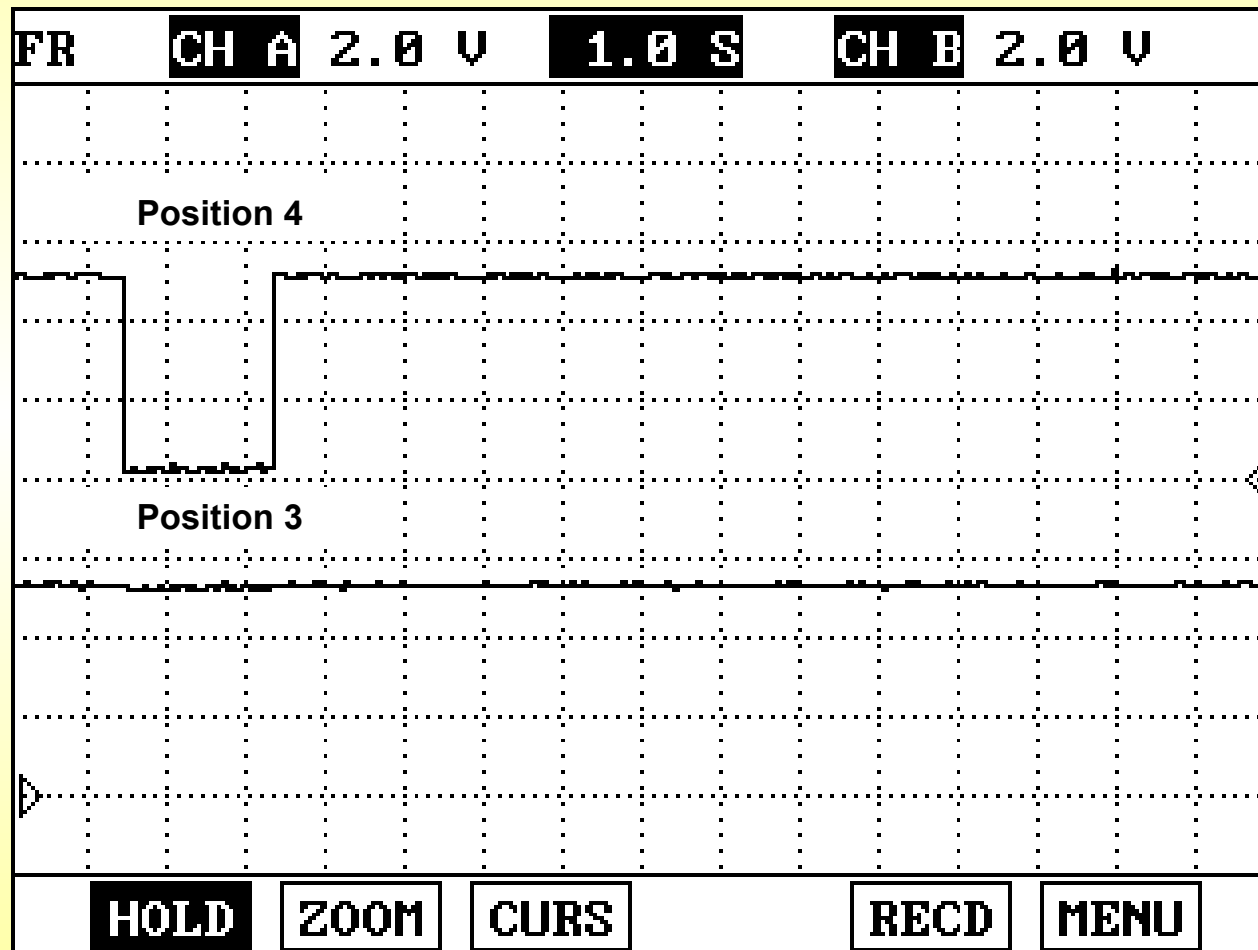
EST

MPS signals (4H → 4L)



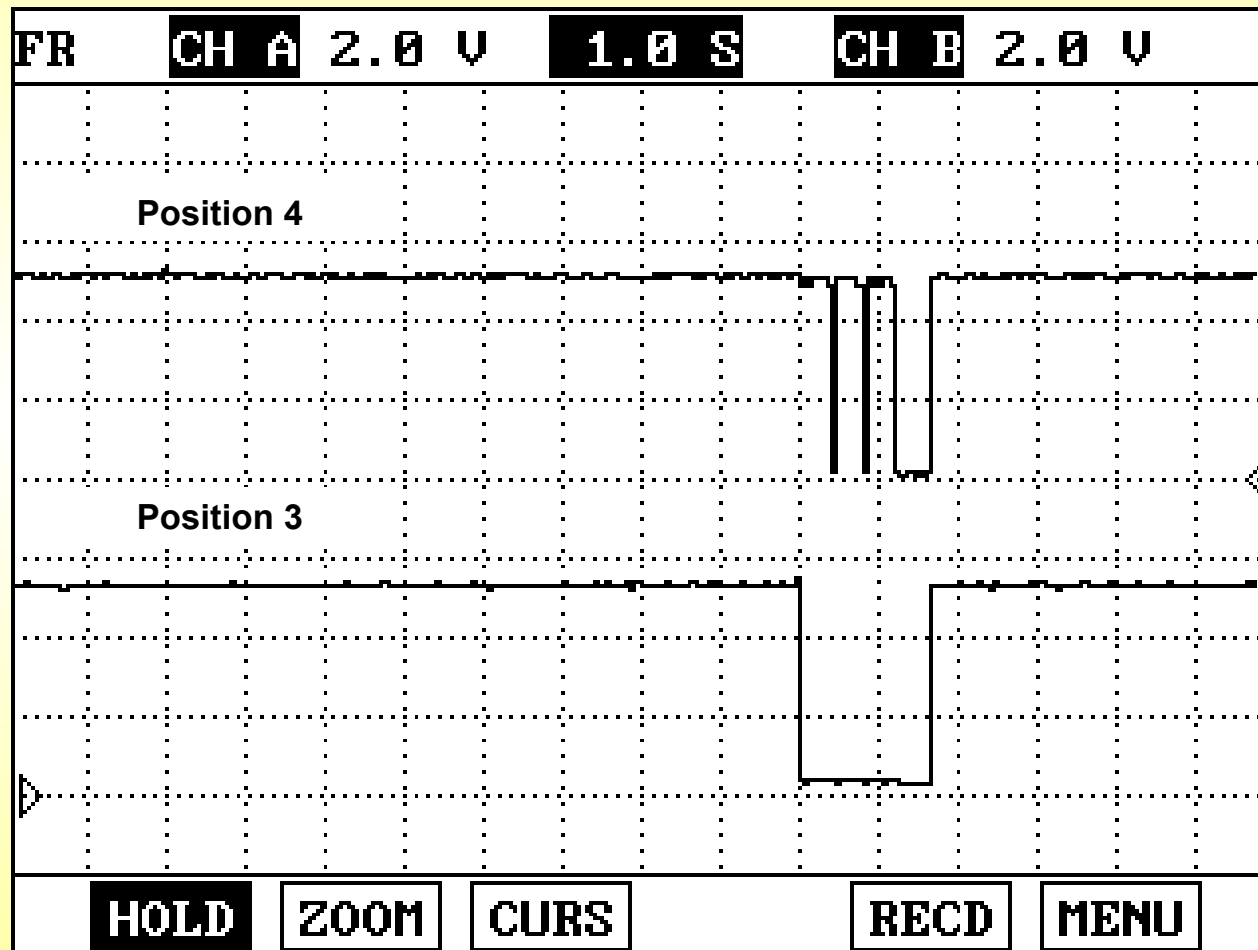
EST

MPS signals (2H → 4H)



EST

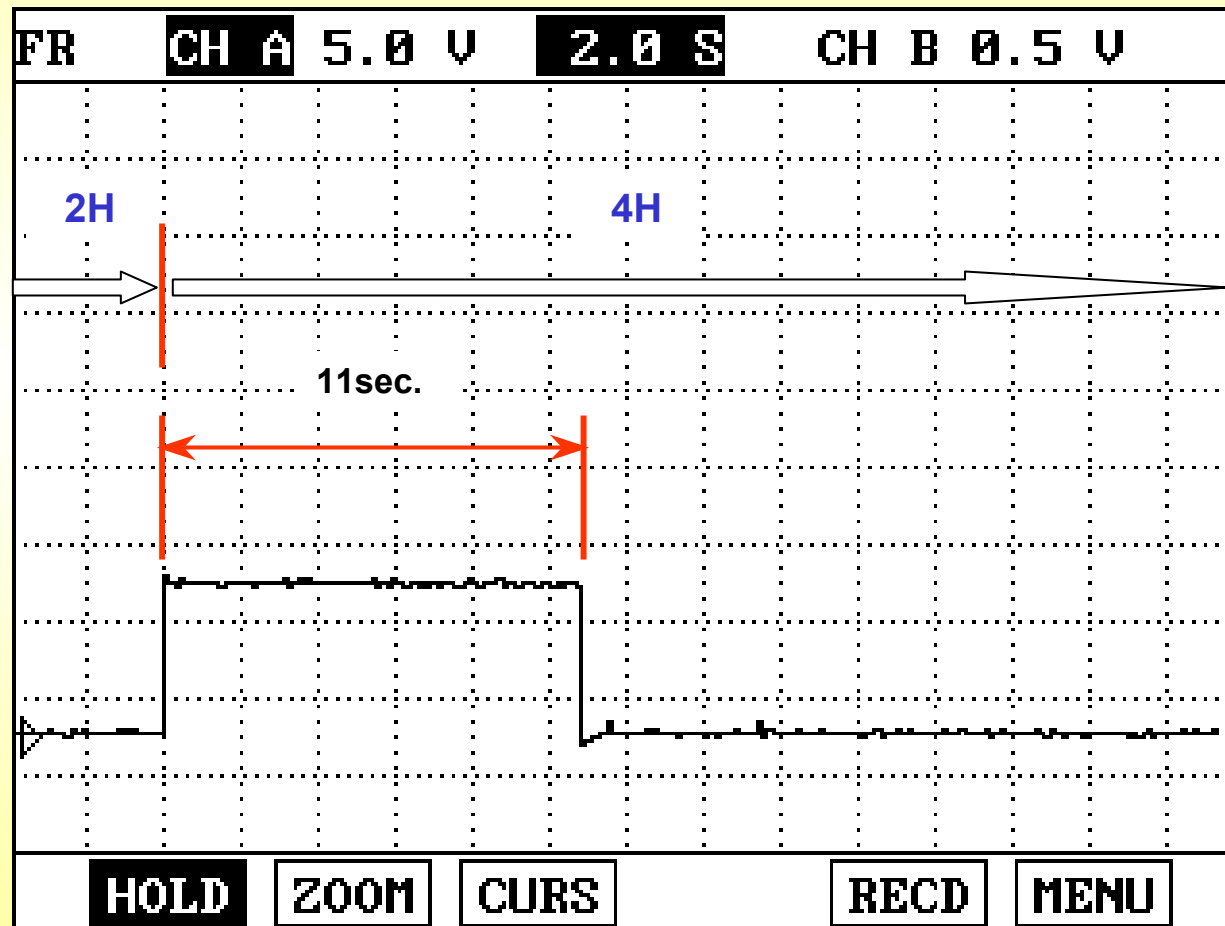
MPS signals (4H → 4L)



EST

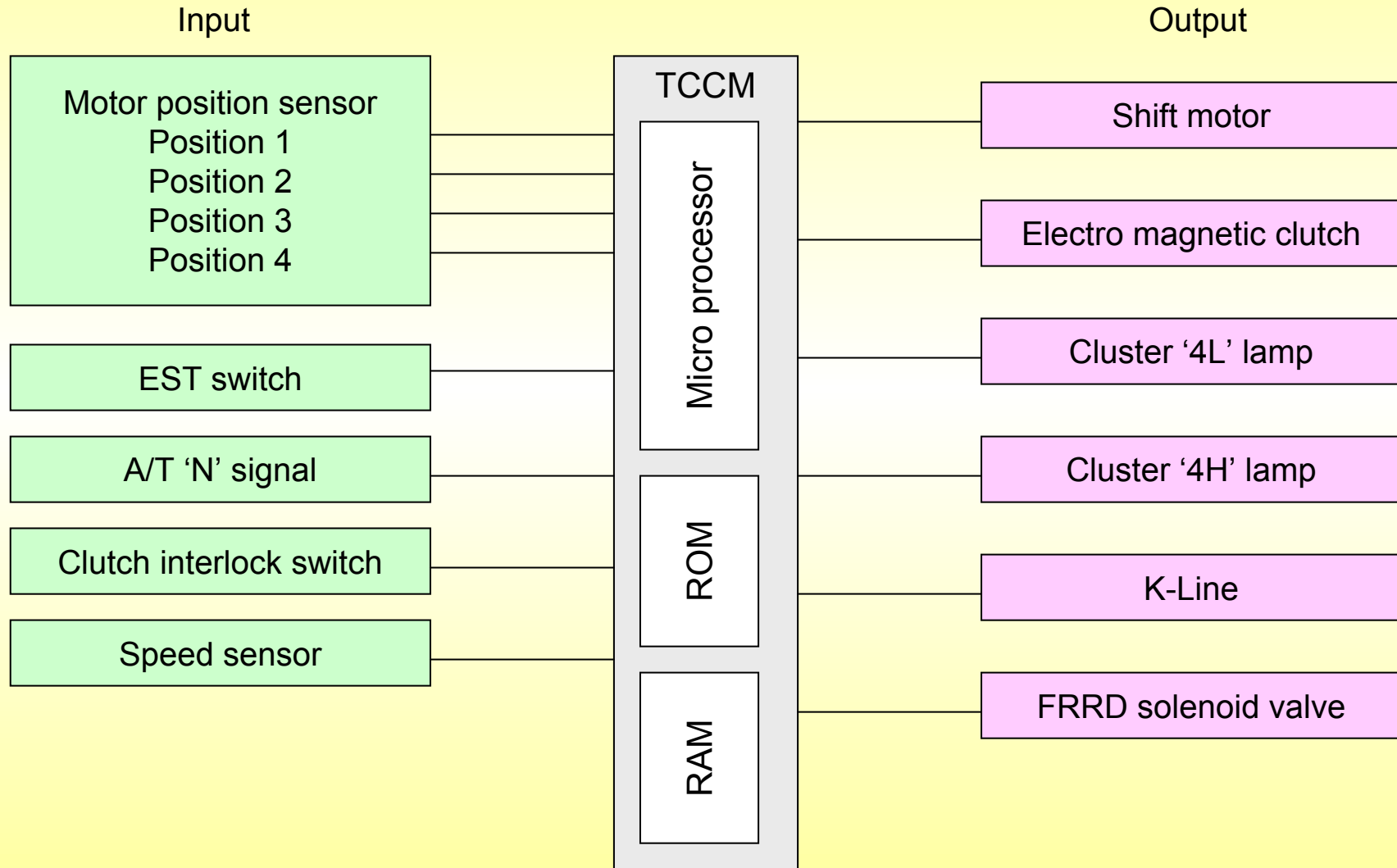
EMC signal (2H → 4H)

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



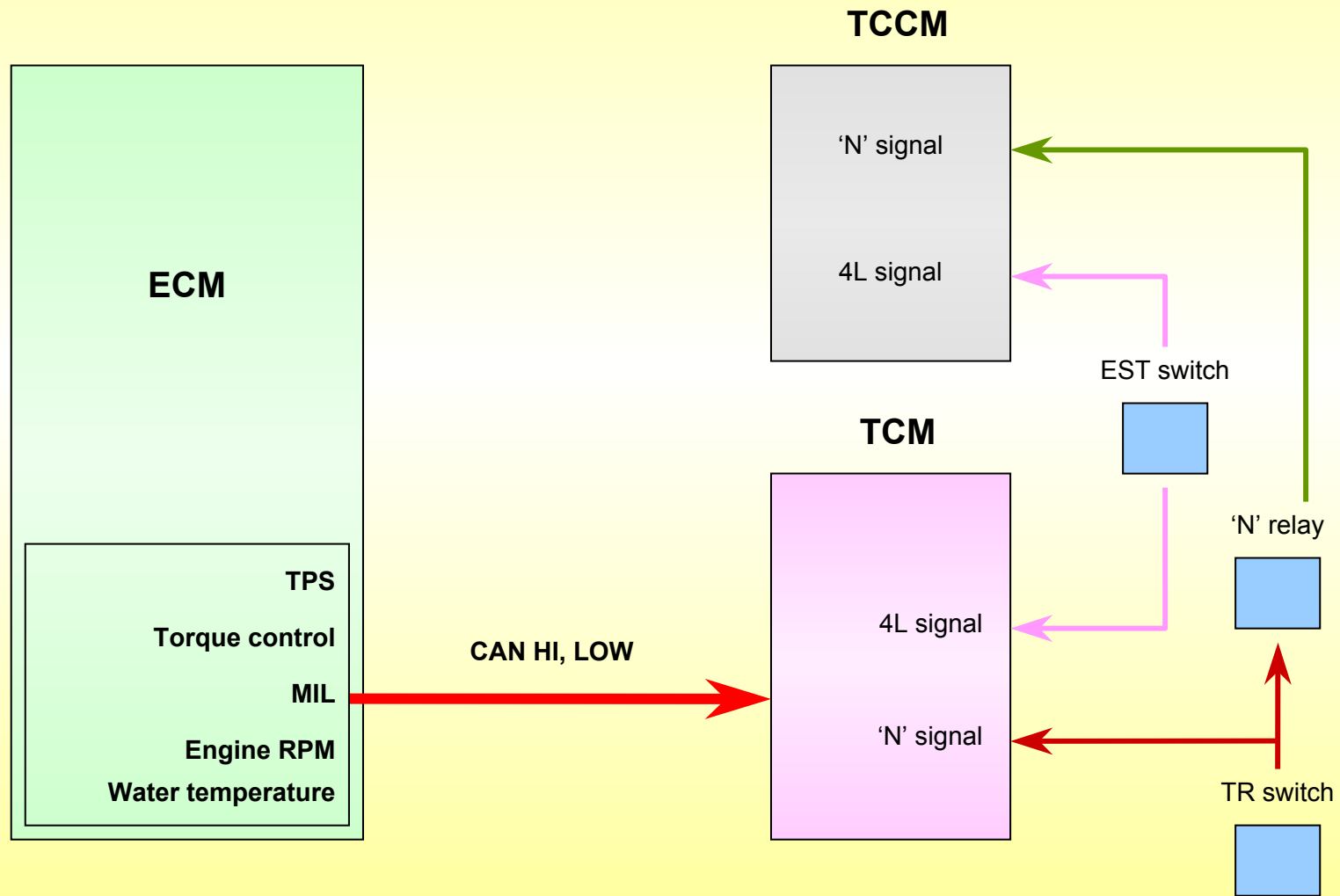
EST

System block diagram



EST

Pin to pin communication



EST

TCCM location



Under the crash pad(Passenger side)

EST

Data Link Connector



EST

DTC

There is no P-code for EST system. DTC is supported with binary code. The digital code for a fault shall be displayed most significant bit first with a total of three (3) bits.

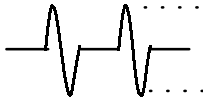
Decimal	Binary	Fault
1	001	TCCM (Transfer case control module)
2	010	Shift motor
3	011	EMC (Electro magnetic clutch)
4	100	Speed sensor
5	101	FRRD air pump motor
6	110	2H-4H-4L switch
7	111	MPS (Motor position sensor)

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	* Current : 4.28A
				↑	0V	
3	A3	GND				
4	A4	CLUTCH COIL	IDLE (2H → 4H → 4L)	DC	Vbatt	* Current : 4.28A
				↑	0V	
5	A5	POSITION 1 MTR (P/R/N/D/2/L)	IDLE	2H	CODE : 1010	* MTR POS. CODE : 1/2/3/4 = XXXX (1 = 5V dc) (0 ≤ 0.5V dc)
				2H → 4H	CODE : 0011	
				4H → 4L	CODE : 1100	
					LOGIC HI(1) : 5V LOGIC LO(0) : 0.5V or less	

EST

Standard Input and Output value in TCCM

No	Items	Condition	Signal		Remarks	
			Type	Level		
6	A6	SPEED SNSR	IDLE	PULSE	 <p>135Hz at 60KPH</p>	* 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				

Standard Input and Output value in TCCM

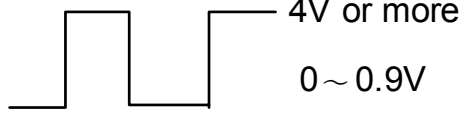
No	Items	Condition	Signal		Remarks	
			Type	Level		
12	A12	POSITION 2 MTR (P/R/N/D/2/L)	IDLE 2H → 4H 4H → 4L	2H 2H → 4H 4H → 4L	CODE : 1010 CODE : 0011 CODE : 1100 LOGIC HI(1) : 5V LOGIC LO(0) : 0.5V or less	* MTR POS. CODE : 1/2/3/4 = XXXX (1 = 5V dc) (0 ≤ 0.5V dc)
13	A13	4L SW	SW OFF	DC	4.5 ~ 5.5V	
			SW ON	↑	0.5V or less	
14	A14	INHIBITOR SW(AT) CLUTCH INTERLOCK SW(MT)	N P/R/D/2/L	DC ↑	0V Vbatt	
15	A15	4L DISPLAY	IDLE("N")	DC ↑	Vbatt 0V	
16	A16	MOTOR OUTPUT (4L-4H-2H)	IDLE("N")	DC ↑	Vbatt 0V	

Standard Input and Output value in TCCM

No	Items	Condition	Signal		Remarks	
			Type	Level		
17	A17	MOTOR OUTPUT (4L-4H-2H)	IDLE("N")	DC	Vbatt	
				↑	0V	
18	A18	COMMON RETURN	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)

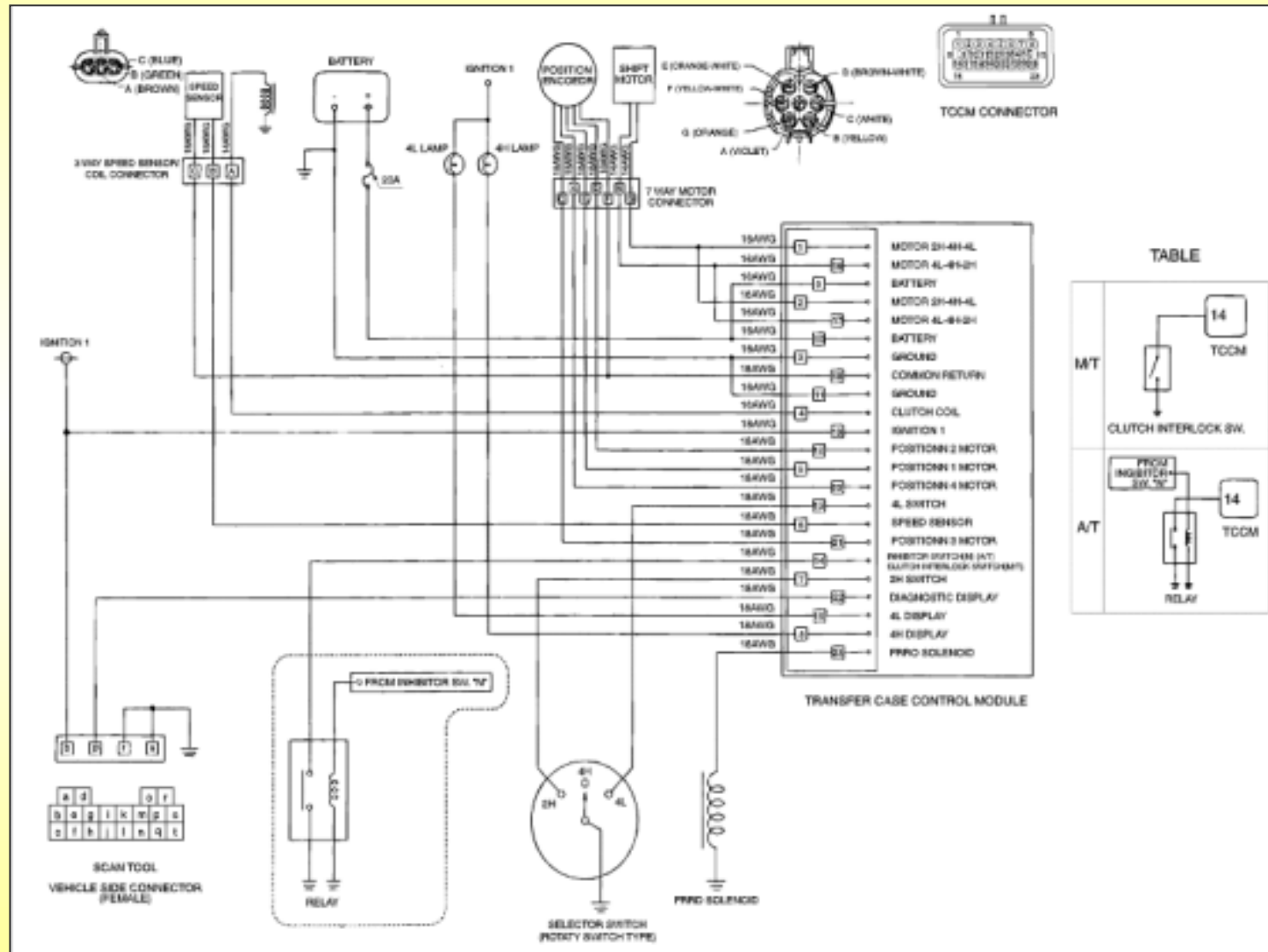
EST

Standard Input and Output value in TCCM

No	Items	Condition	Signal		Remarks	
			Type	Level		
21	A21	POSITION 3 MTR (P/R/N/D/2/L)	IDLE	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		
23	A23	C FRRD SOLENOID (2H → 4H)	IDLE	OFF		
				ON	' or less	

EST

EST electrical wiring diagram



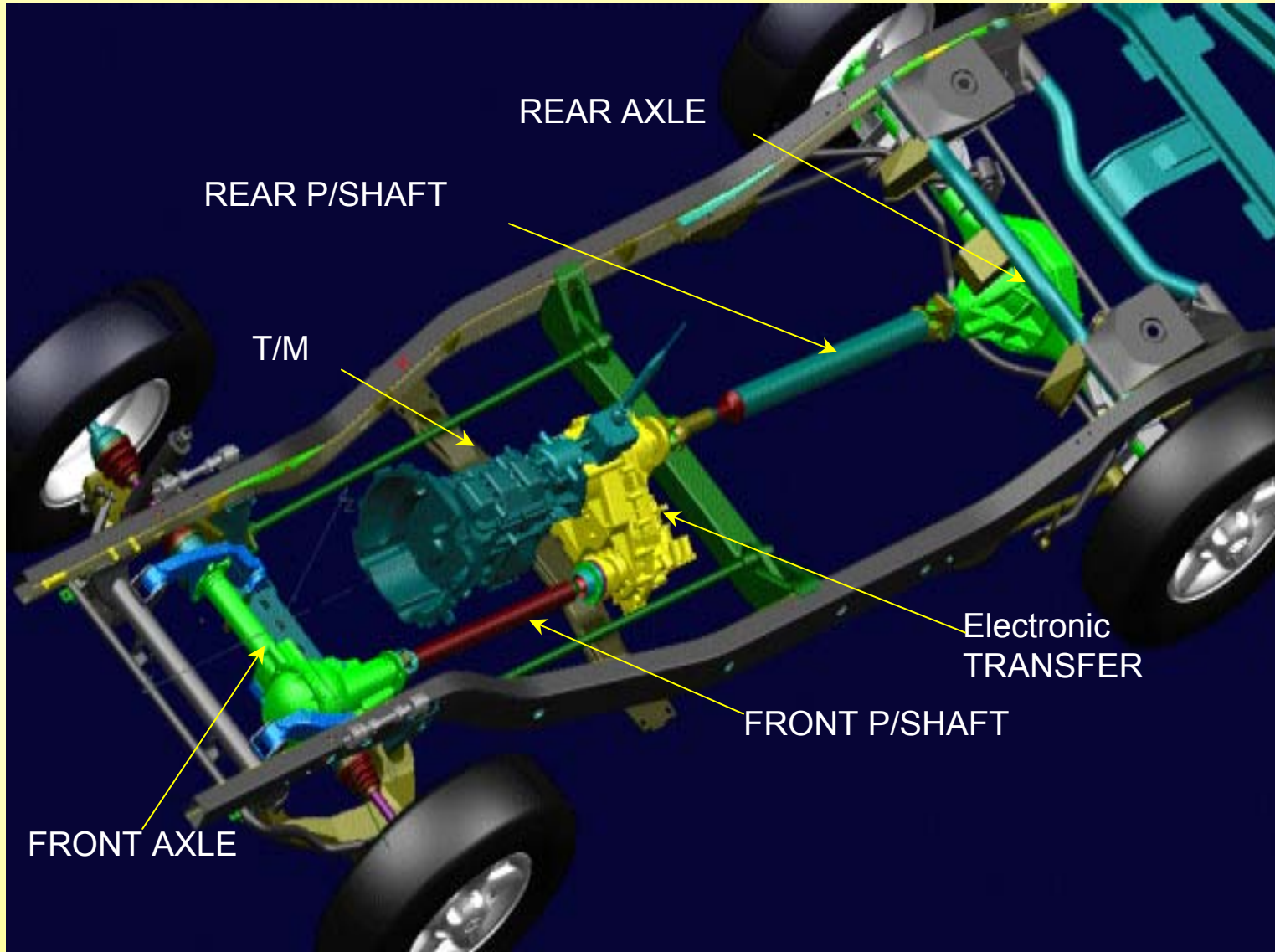
BL 4WD SYSTEM

Contents

Full time 4WD system (TOD or ATT)

- Introduction
- Structure
- Components
- Selecting mode

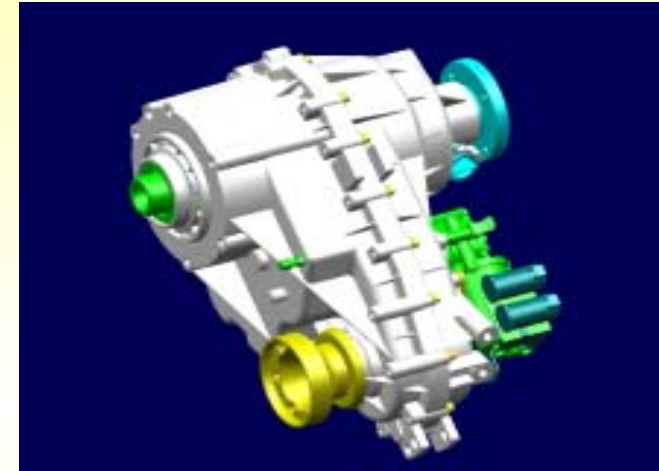
TOD



TOD

Introduction

TOD system is a kind of full time 4wheel drive system and its full name is 'Torque on demand'. This is a trademark of Borg Warner in USA. The optimum engine torque distribution ratio between front and rear is controlled by TOD transfer case. This transfer case is controlled and operated by independent control module, that is, TCCM (Transfer case control module) and it is located under the crash pad on passenger side.



The torque transmission ratio to front and rear side is not fixed and it is changed and controlled continuously depends on the road and vehicle driving condition. Basically the torque split ratio will be 0:100 (that is 'FR' situation) on road driving with low and medium vehicle speed. If there is any amount of slip on the rear wheel, the optimum amount of torque will be distributed to front wheel to get a stable driving performance.

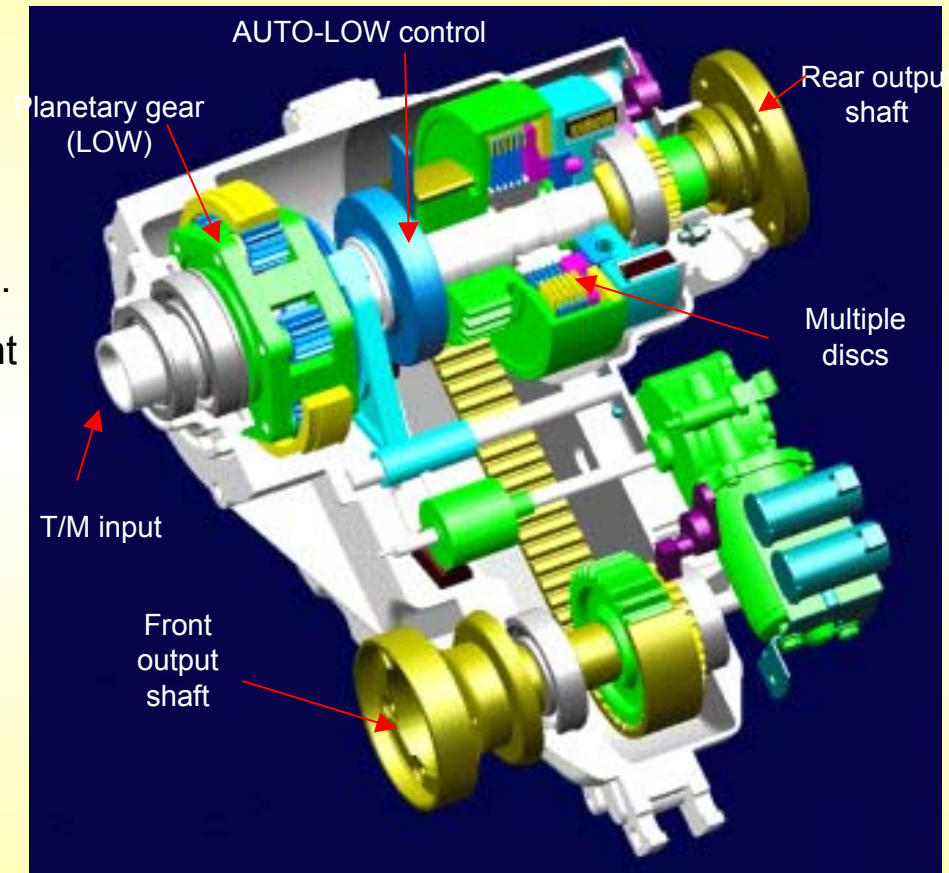
The range of torque split ratio is from 0:100 to 50:50. It means the maximum torque amount of front wheel cannot be higher than rear wheel in any kind of road or vehicle condition.

TOD

Introduction

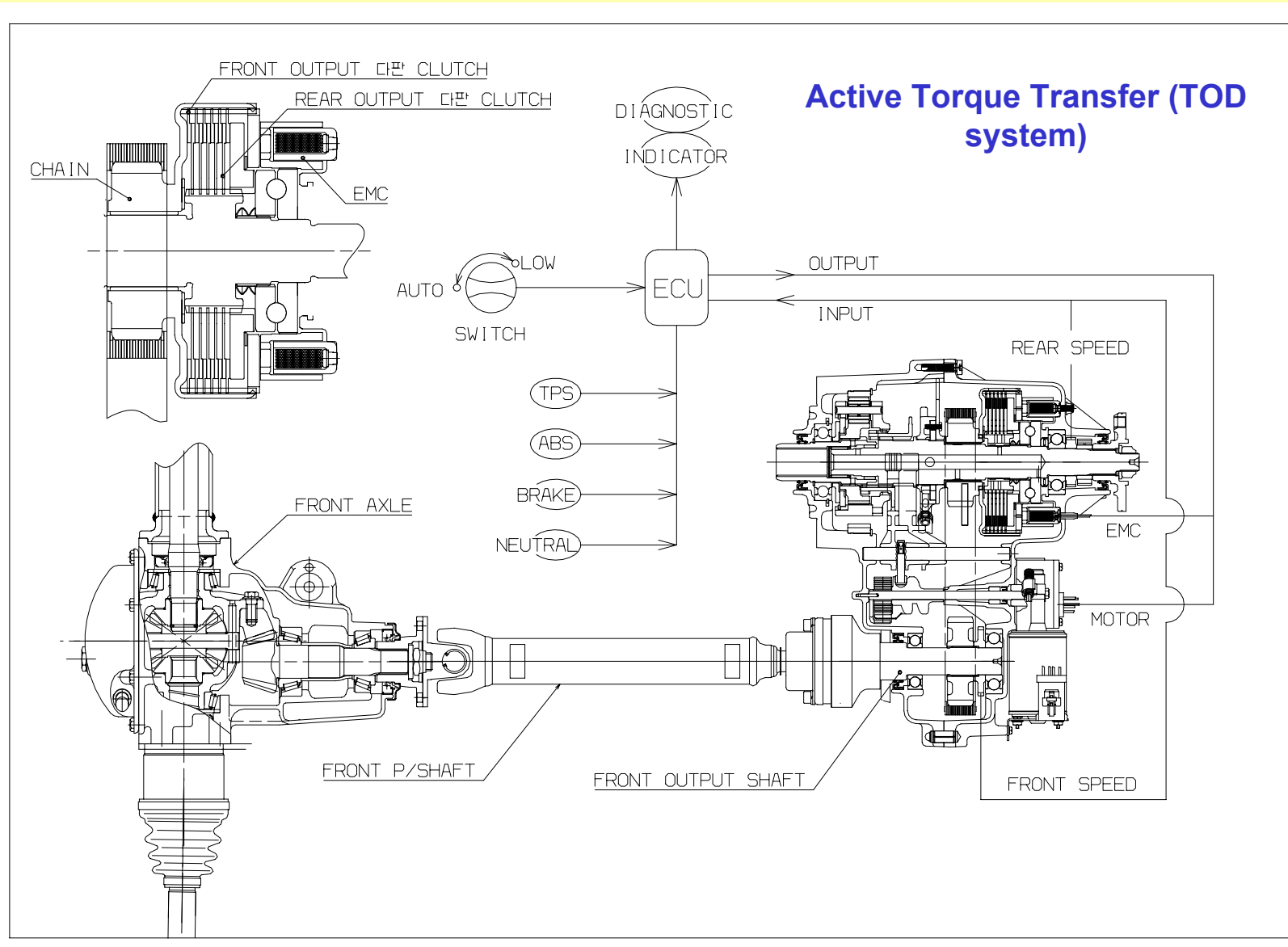
According to the speed signal of front and rear wheel from each sensor, the engine torque information from engine ECM, EMC (Electro magnetic clutch) will be activated and it will result the change of depressing force to the multiple disc clutch. If the force is high, more engine torque will be transmitted to front wheel.

Oppositely, if it becomes low, the torque to front side also will be decreased. It means the slip inside of multiple disc clutch will be increased also. Therefore the oil pump for lubrication of clutch is installed and very important for the overall system durability.



TOD or ATT (Active torque transfer)

TOD



TOD

Merits and Characteristics

- 1) The fuel consumption is improved while driving in 4WD due to the optimum and proper engine torque distribution between front and rear wheel.
- 2) The maximum adhering force of tire into road can be acquired due to the electronic control depends on the road condition.
- 3) Light weight comparing with another kind of systems.
- 4) Simple internal structure.
- 5) Driving performance and steering stability on the off-road and on-road is very excellent.
- 6) It is easy to handle and control due to the electronic control system.
- 7) The efficiency of ABS operation is improved due to the easy system configuration with ABS system.
- 8) The center differential 'free' and 'locking' is controlled by TCCM so the center differential is not necessary and a tight corner braking development can be prevented.

TOD

Selecting Mode

- Auto mode

In Auto mode, TOD system controls the clutch mechanism by detecting the rotating speed of front and rear propeller shaft. If its difference is out of mapping data, the EMC is activated and the engine torque is transmitted to front wheel.

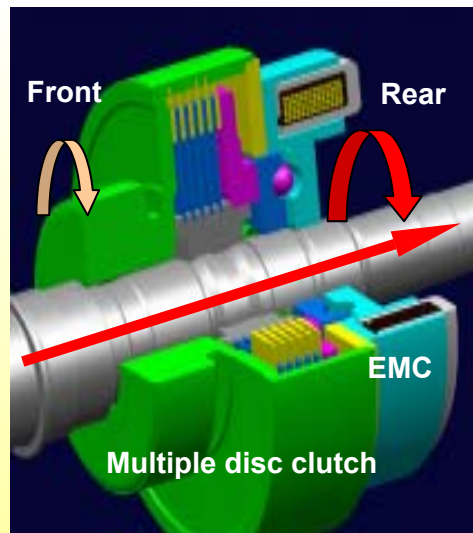
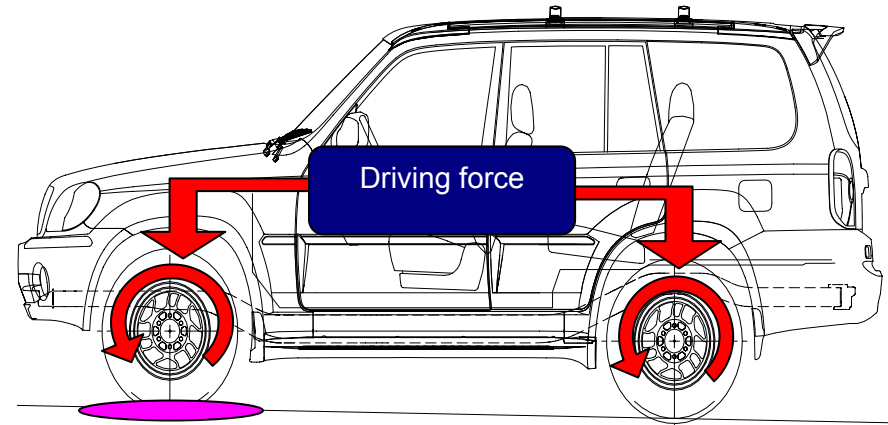
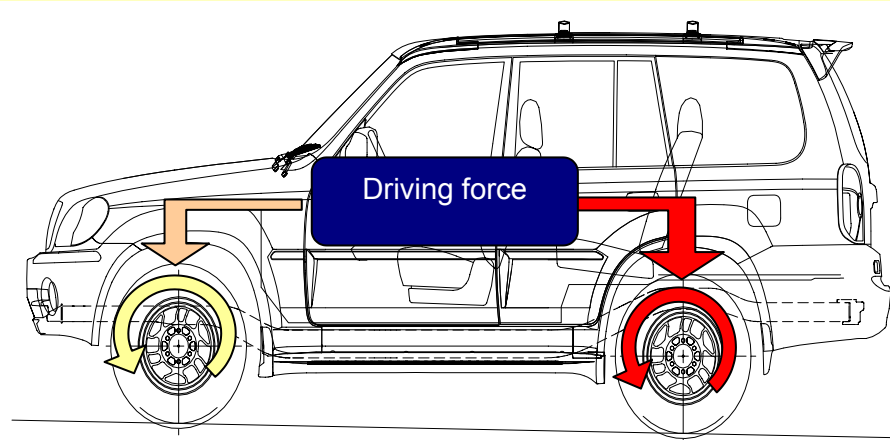
In this time, the gear ratio becomes 1:1 because the output shaft is connected to input shaft through not planetary carrier but sun gear.

- Low mode

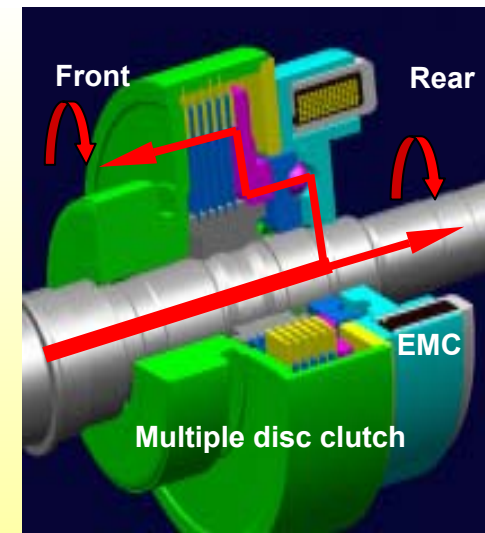
In Low mode, the driving system for vehicle becomes 4wheel drive low speed. To transmit maximum engine torque to front wheel, the multiple disc clutch with EMC (Electro magnetic clutch) will be "Lock" and the shift motor is activated toward 'LOW' position. Through the cam mechanism, the output shaft is connected to carrier of planetary gear set. At this time, the gear ratio is changed from 1:1 to 2.48:1.

TOD

Selecting Mode



AUTO mode



LOW mode

TOD

Selecting Mode

- Shifting from 'Auto mode' to 'Low mode'

To select 'Low mode' from 'Auto mode' driving, the vehicle should be stopped.

→The rotating speed of front and rear speed sensor should be 87rpm
(2,580pulses per minute) or less.

* A/T vehicle : Move the shift lever to 'N' position for 2 seconds or more and select
'Low mode' switch.

* M/T vehicle : Depress the clutch pedal and select 'Low mode' switch.

If above conditions are not satisfied, the shifting from 'Auto mode' to 'Low mode' will be stopped (shift 'default mode' by TCCM) and the 'Low' lamp on the cluster will be blink.

If the shift from 'Auto mode' to 'Low mode' is successfully performed, the blinking of 'Low' lamp will be stopped and the lamp will be turned on continuously.

TOD

Torque distribution depends on the driving condition

No.	Items	Condition	Torque distribution	Decision by
1	Fast start	When vehicle starts abruptly to get a enough driving power	50:50	TPS Vehicle speed DIFF.(FRT-RR speed)
2	Normal driving	When vehicle drives at straight road for stable driving and fuel consumption	0:100 ~ 30:70	↑
3	Acceleration	When vehicle catch up with another vehicle to get more power and stable driving	30:70 ~ 50:50	↑
4	Normal steering	When vehicle steers for stable steering performance	20:80 ~ 30:70	↑
5	Driving and steering at slippery road	When vehicle drives or steers at slippery road to minimize wheel slip and get a stability	30:70 ~ 40:60	↑

TOD

Torque distribution depends on the driving condition

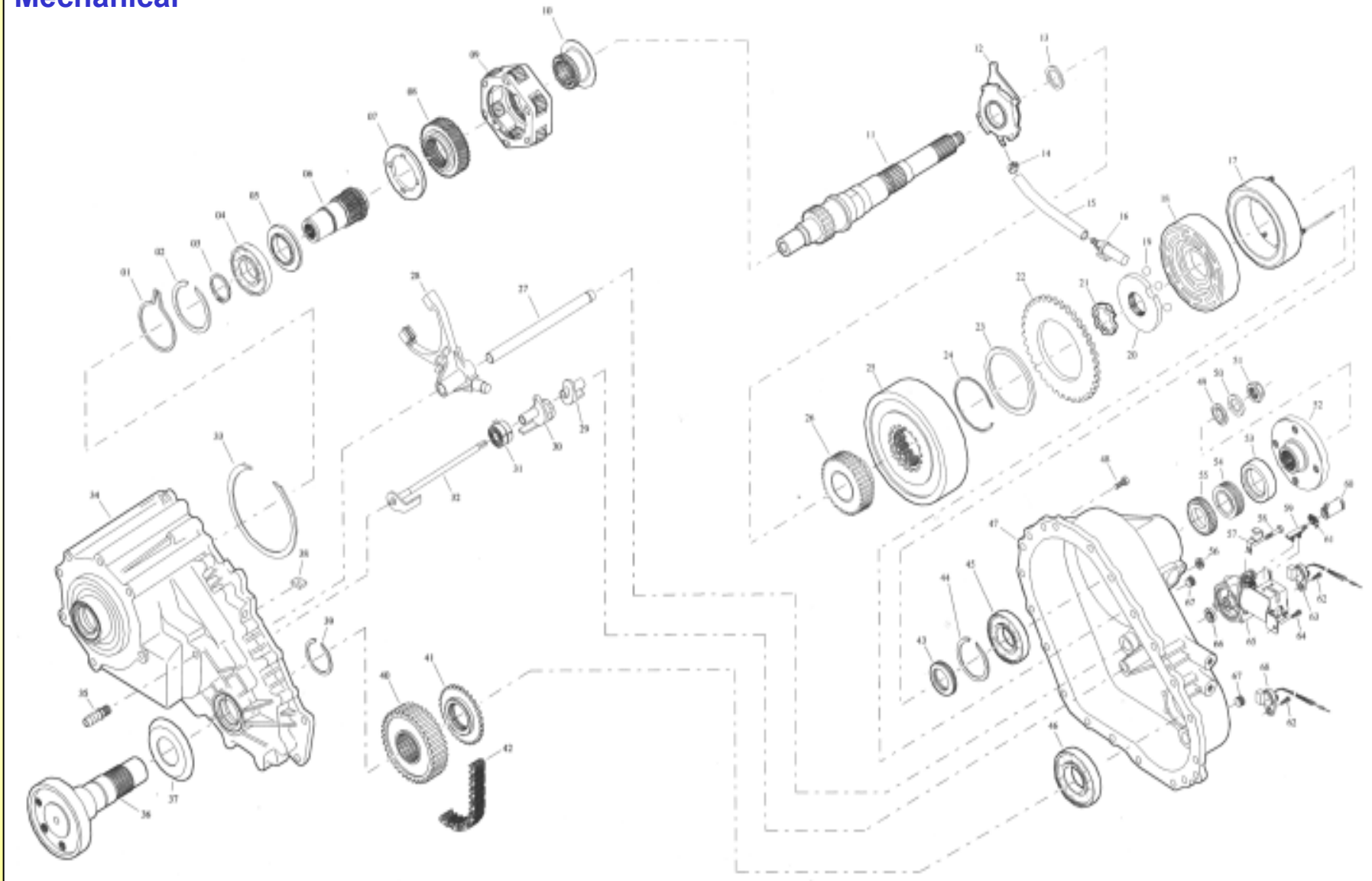
No.	Items	Condition	Torque distribution	Decision by
6	Parking control	When vehicle steers and starts in vehicle stopping condition	5:95 ~ 20:80	↑
7	Braking control	When vehicle stops for stable braking and reduce a braking distance	0:100 ~ 10:90	Vehicle speed DIFF.(FRT-RR speed)
8	ABS control	When ABS is operated to get a stable braking performance	30:70	ABS operation signal DIFF.(FRT-RR speed)
9	Off-road, Steep slope road	To get a enough driving power	50:50	LOW signal Vehicle speed
10	Fail-safe	1. AUTO mode	0:100	
		2. LOW mode	50:50	

※ DIFF. (FRT-RR speed) :

The difference of rotating speed between front and rear propeller shaft.

TOD

Mechanical

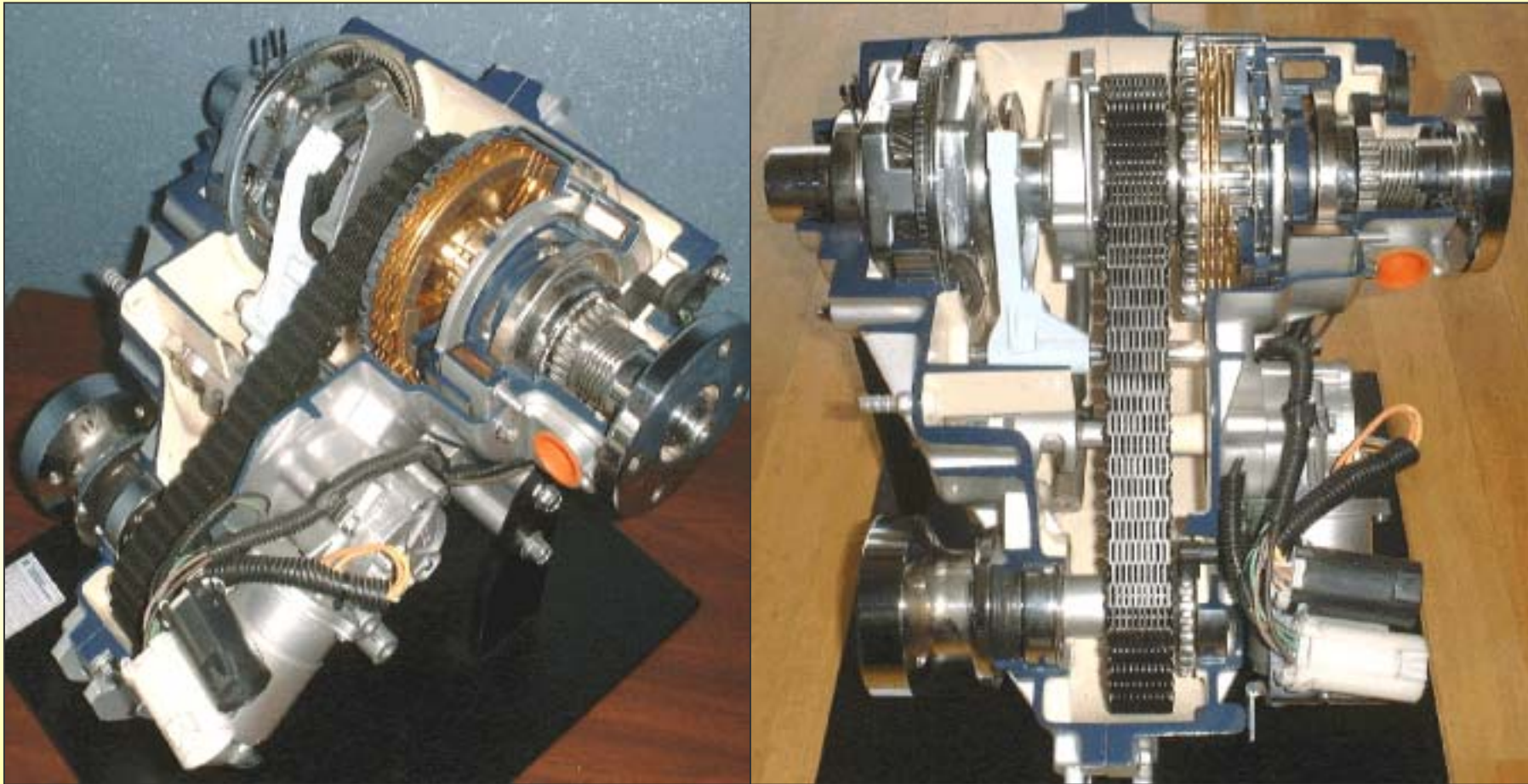


TOD

NO	PART NAME	NO	PART NAME
1	RING-SNAP	36	SHAFT-OUTPUT
2	RING-SNAP	37	DEFLECTOR-DUST
3	RING-SNAP	38	MAGNET
4	BEARING	39	RING-SNAP
5	HUB-CIRCLULA	40	SPROCKET-LOWER
6	SHAFT ASSY- INPUT	41	TOE WHEEL-LOWER
7	PLATE-THRUST	42	CHAIN
8	GEAR-SUN	43	ASSY-BEARING THRUST
9	ASSY-CARRIER	44	RING-RETAINING
10	HUB-REDUCTION	45	BEARING
11	SHAFT-MAIN	46	BEARING
12	ASSY-GEROTOR PUMP	47	COVER
13	WASHER-THRUST	48	BOLT-METRIC
14	CLAMP-HOSE	49	SEAL-OIL
15	HOSE	50	WASHER
16	FILTER	51	NUT-METRIC
17	COIL ASSY-ELECTRIC	52	FLANGE-COMPANION
18	HOUSING ASSY-CAM COIL	53	SEAL-OIL
19	BALL	54	GEAR-SPEEDO
20	CAM APPLY	55	TOE WHEEL-UPPER
21	SPRING-WAVE	56	NUT-METRIC
22	ARMATURE	57	CLIP-J
23	WASHER-INSULATOR	58	BOLT-HEX HEAD
24	RING-RETAINING	59	CLIP
25	ASSY-CLUTCH PACK	60	CONNECTOR
26	SPROCKET ASY-DRIVE	61	LOCK-CONNECTOR
27	RAIL-SHIFT	62	BOLT-HEX HEAD
28	FORK ASSY-SHIFT	63	SENSOR-SPEED,UPPER
29	CAM-ELECTRIC SHIFT	64	CAP SCREW-HEX HEAD
30	CAM-ELECTRIC SHIFT	65	MOTOR ASSY-ELECTRIC
31	SPRING-TORSION	66	SEAL-OIL
32	SHAFT-SHIFT	67	PLUG-PIPE
33	RING-RETAINING	68	SPEED SENSOR-LOWER
34	CASE ASSY-TRANSFER		
35	BARB-BREATHER		

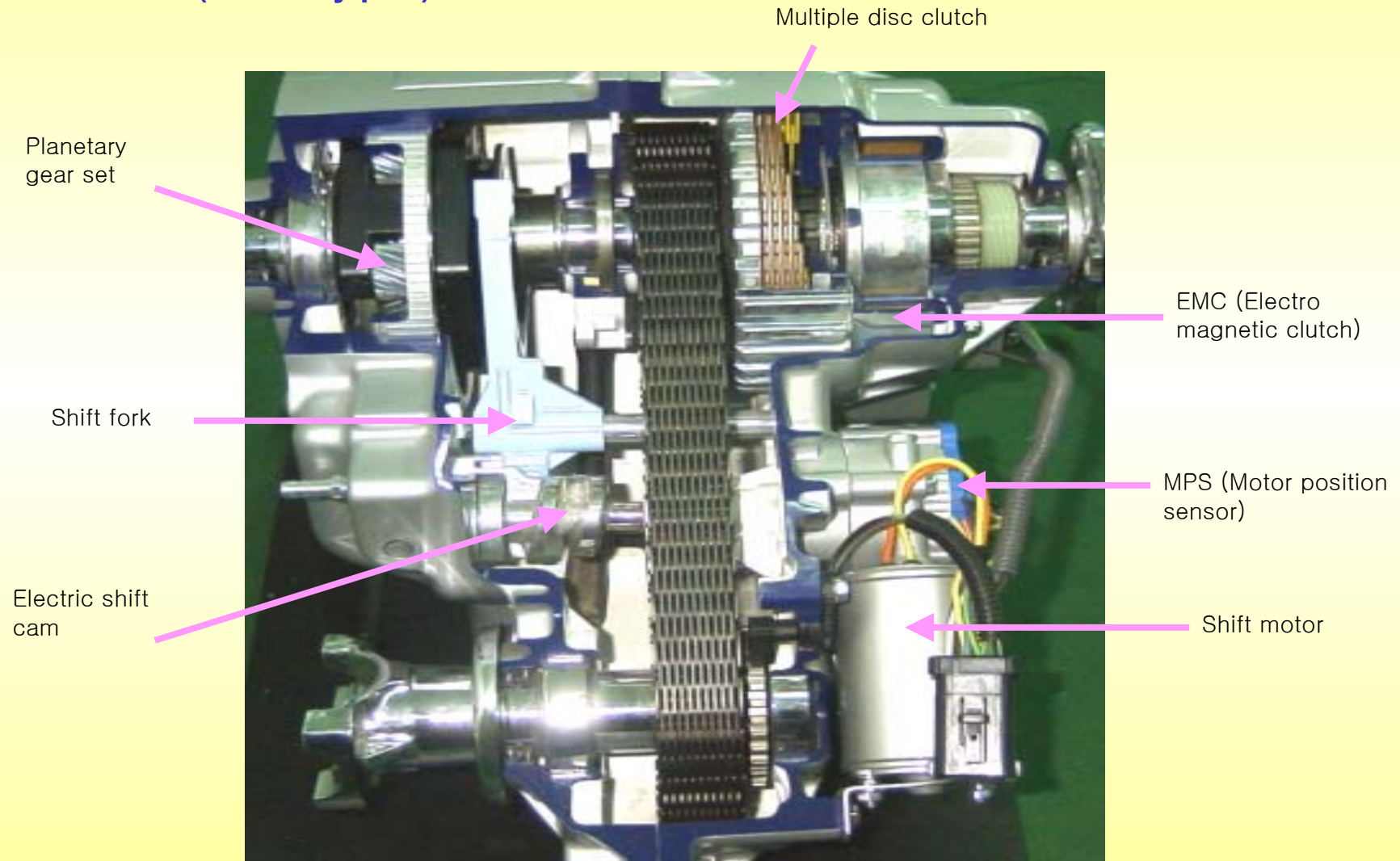
TOD

Construction (Cut-away part)



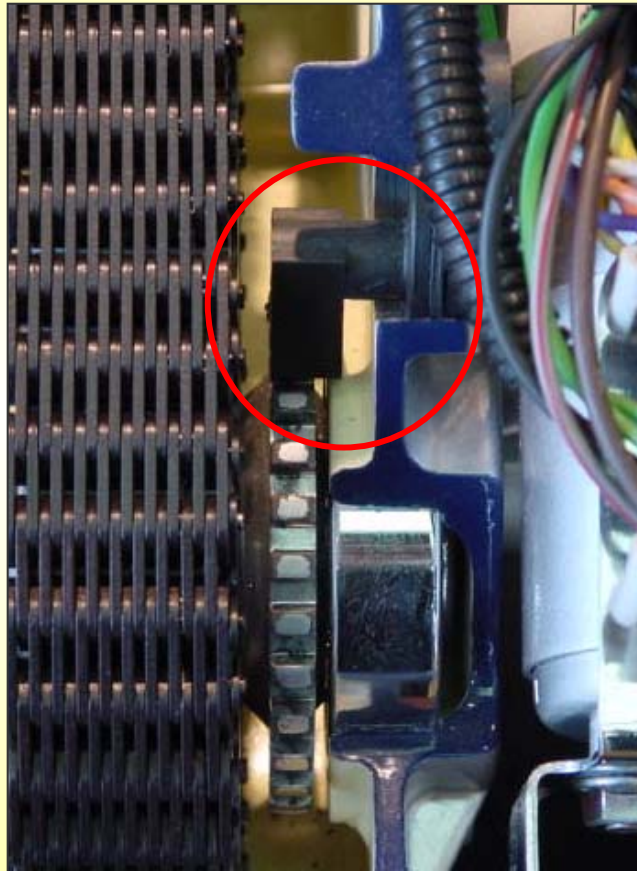
TOD

Construction (Cut-away part)

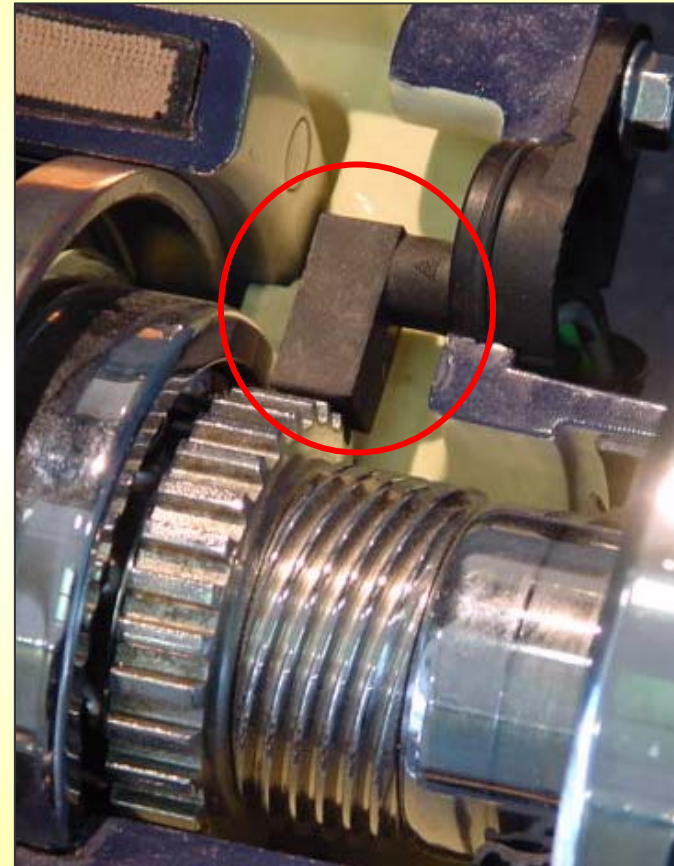


TOD

Speed sensors



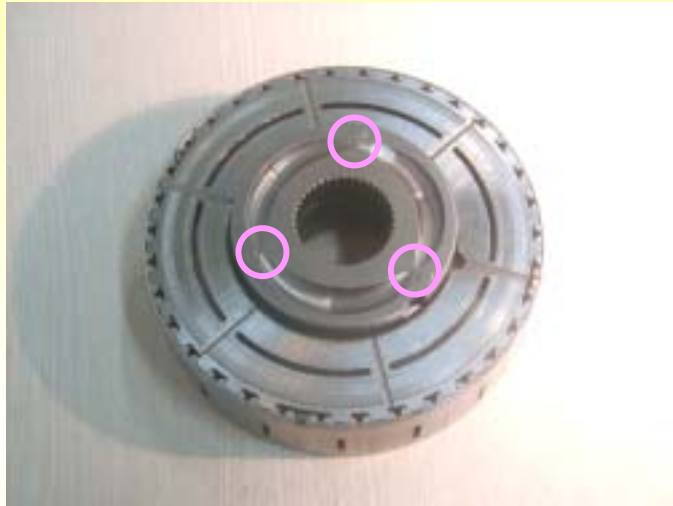
[Front Speed Sensor]



[Rear Speed Sensor]

TOD

Components – Multiple disc clutch



3 steel balls (Ball ramp mechanism) were installed to be controlled by EMC.

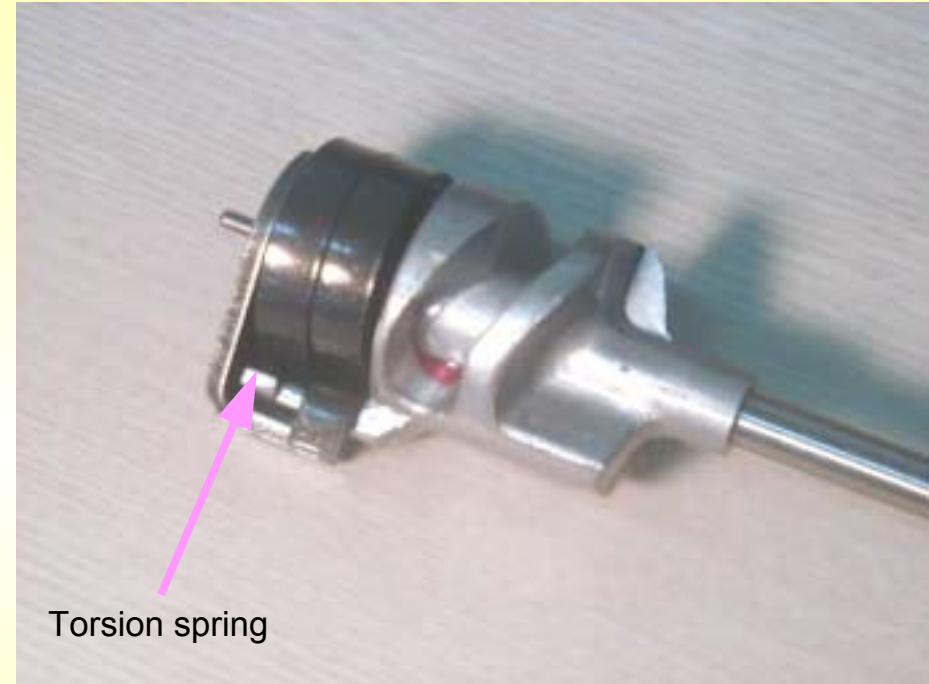
Ball ramp is for changing the rotational movement into reciprocating movement to compress the clutch.



11 clutch discs were installed.

TOD

Components – Shift CAM



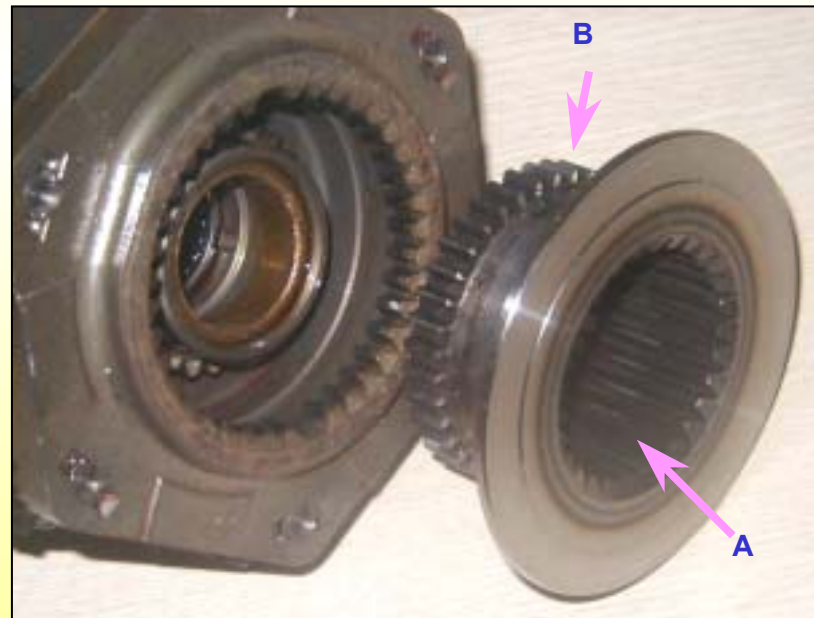
TOD

Components – Planetary gear set

Planetary gear set



To make 4LOW gear ratio (2.480), the planetary gear set was installed and controlled by electronic shift fork. The connecting point 'A' and 'B' is shifted depends on the moving direction of shift fork.

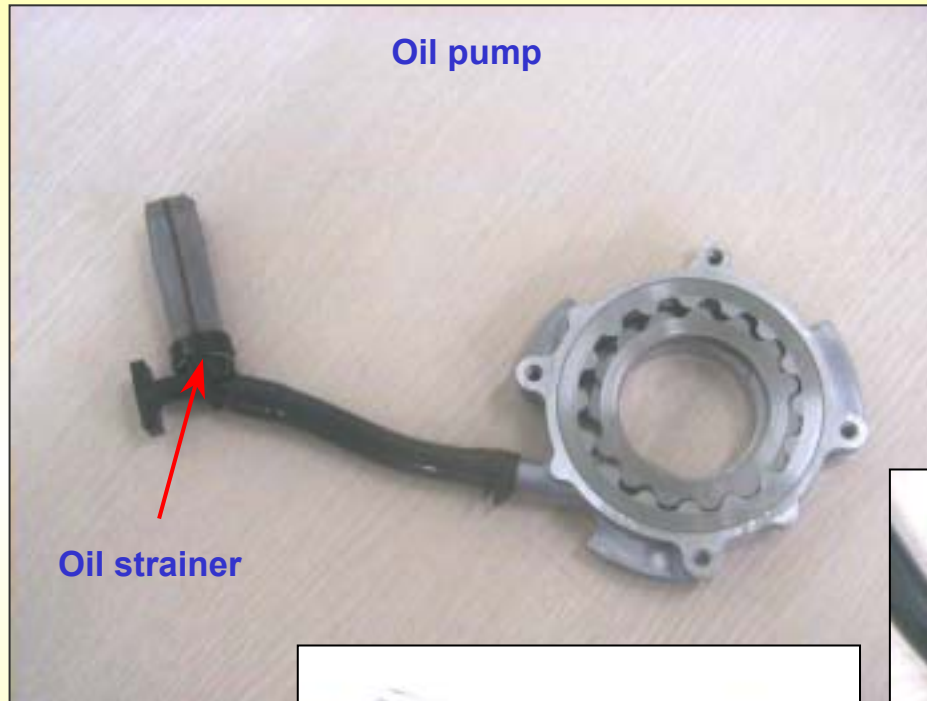


In case of point 'A' connection : Planetary sun gear -> 1:1

In case of point 'B' connection : Planetary carrier -> 1:2.48 (4LOW)

TOD

Components – Oil pump

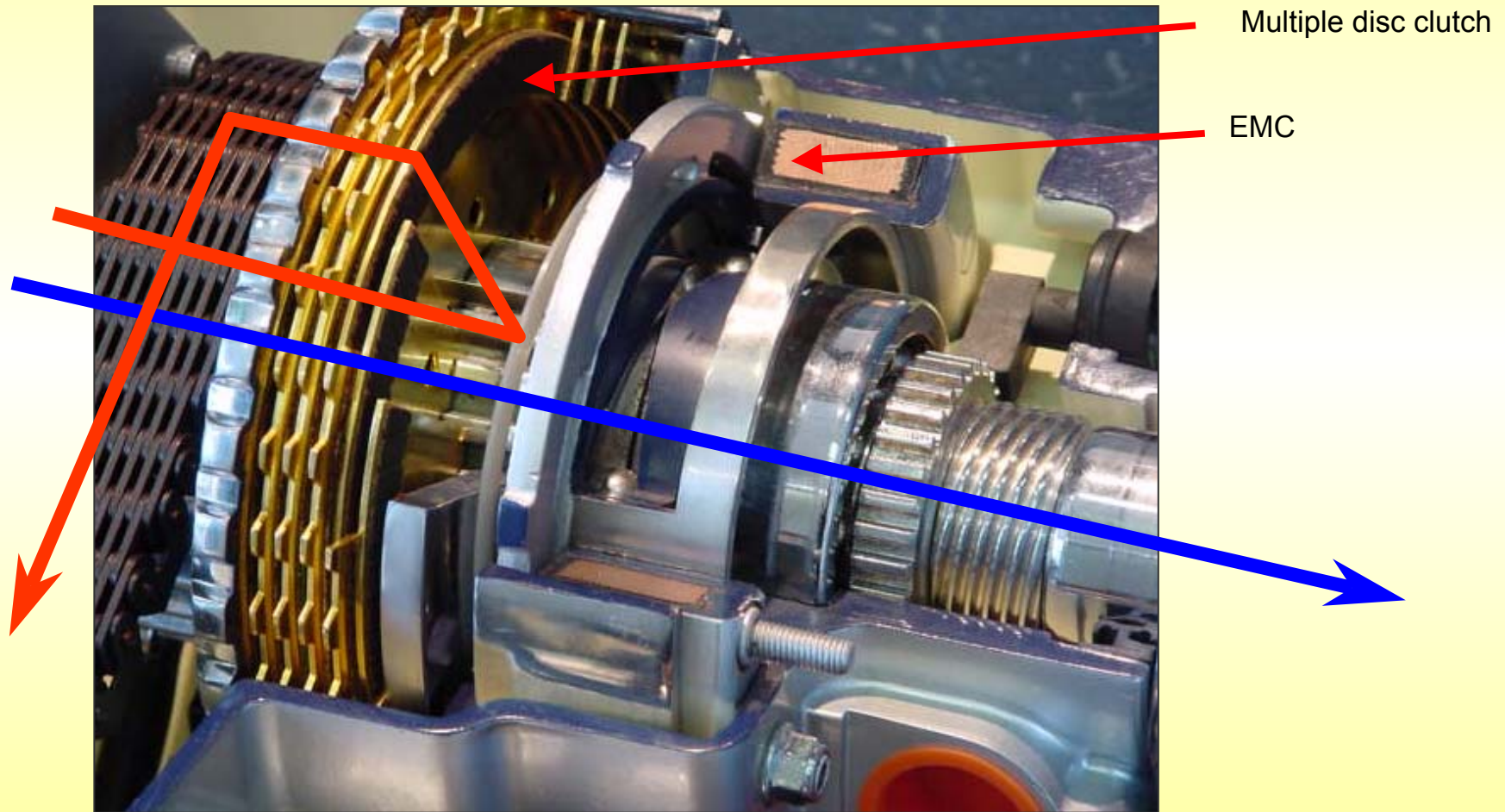


The oil pump for lubrication of multiple disc clutch as well as other parts in the transfer case while vehicle driving was installed.



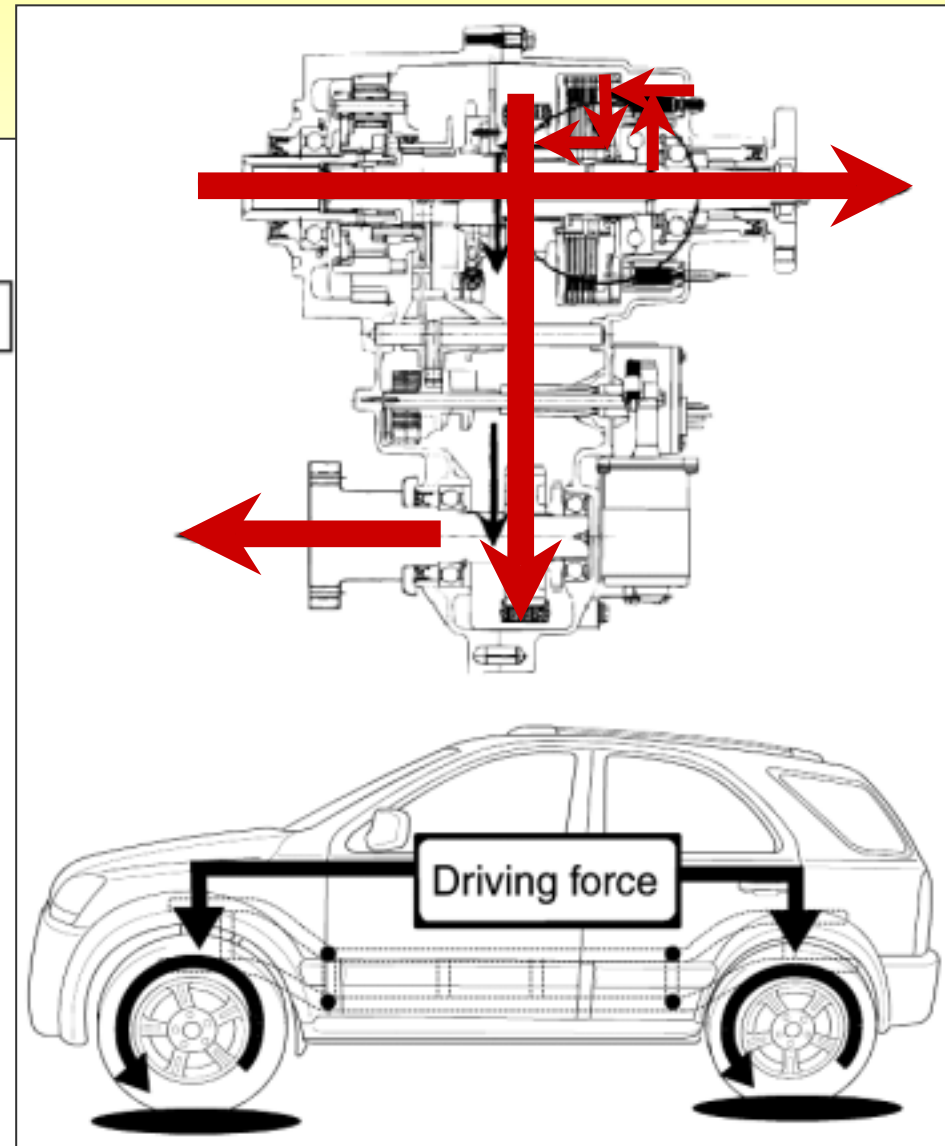
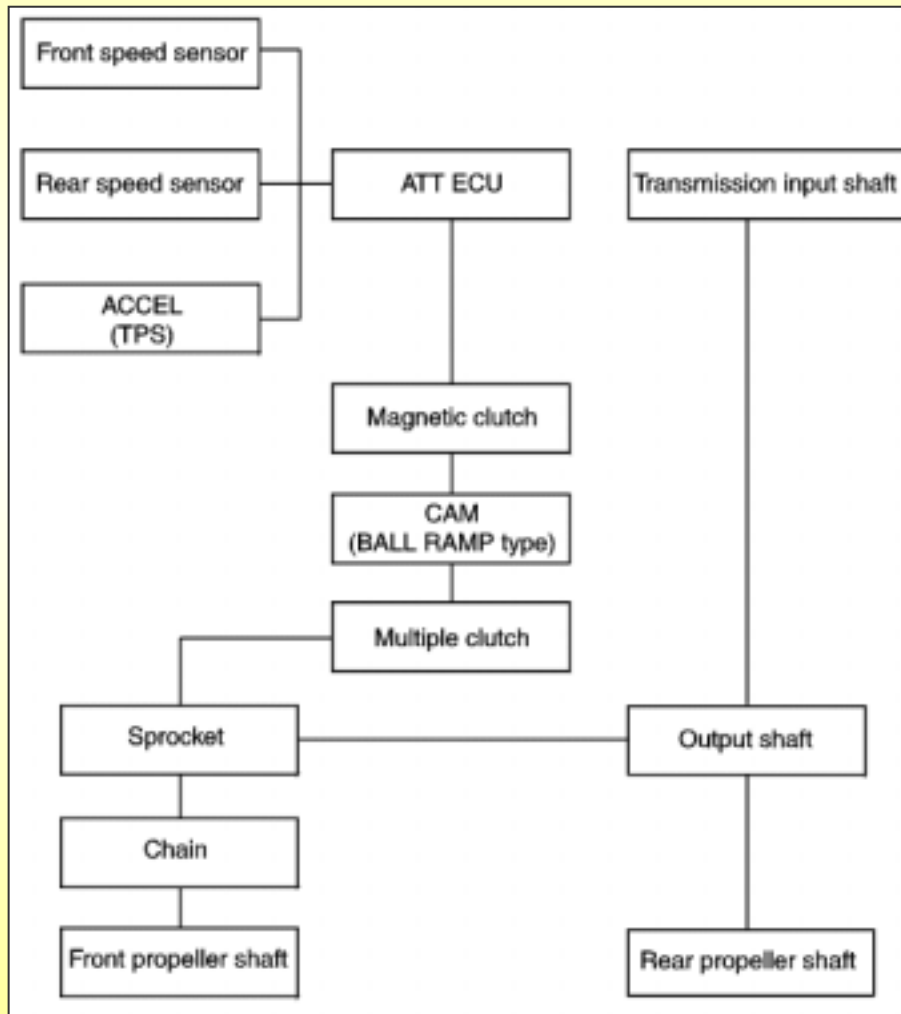
TOD

Power Flow



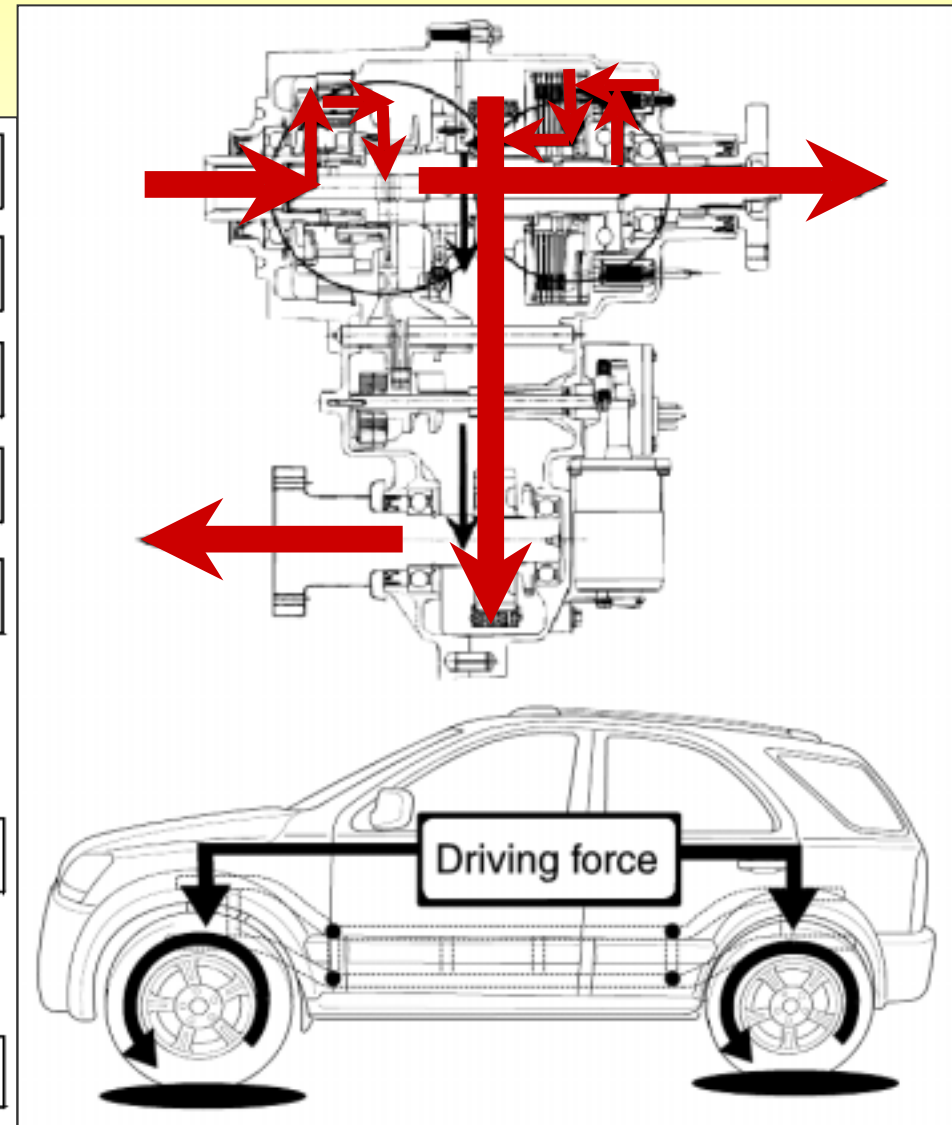
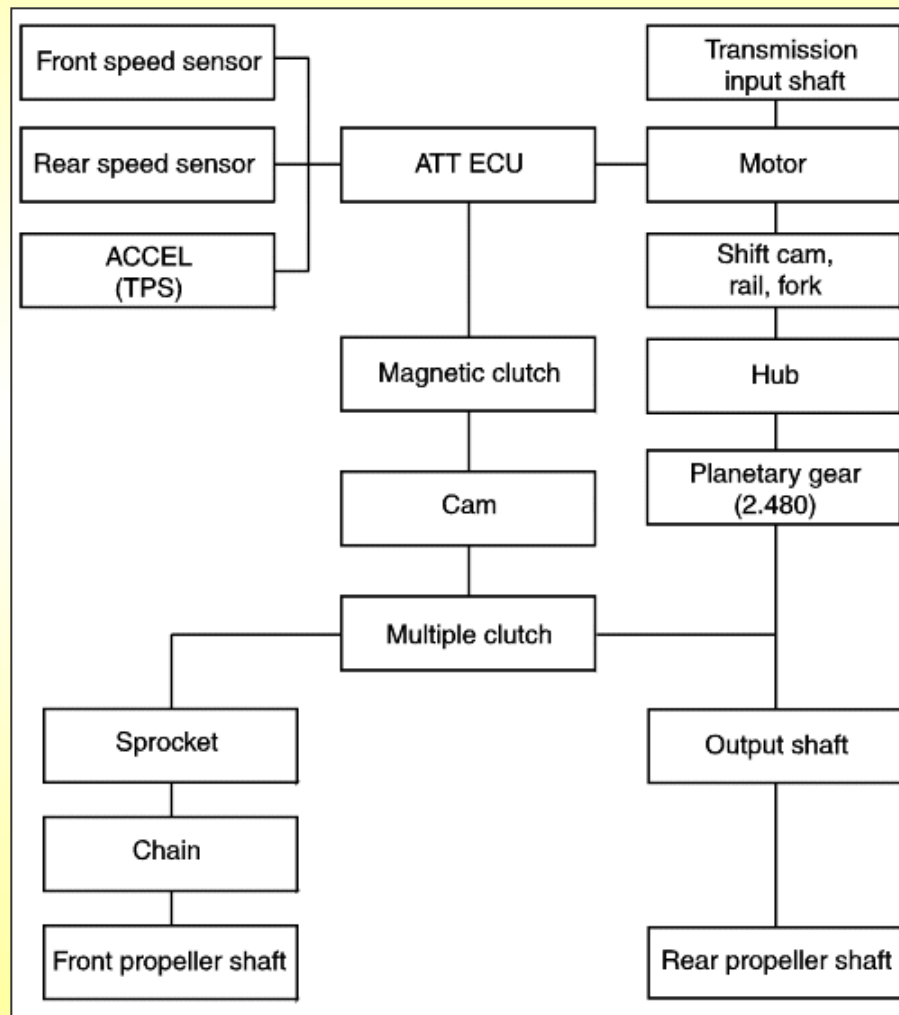
TOD

Power Flow (AUTO Mode)



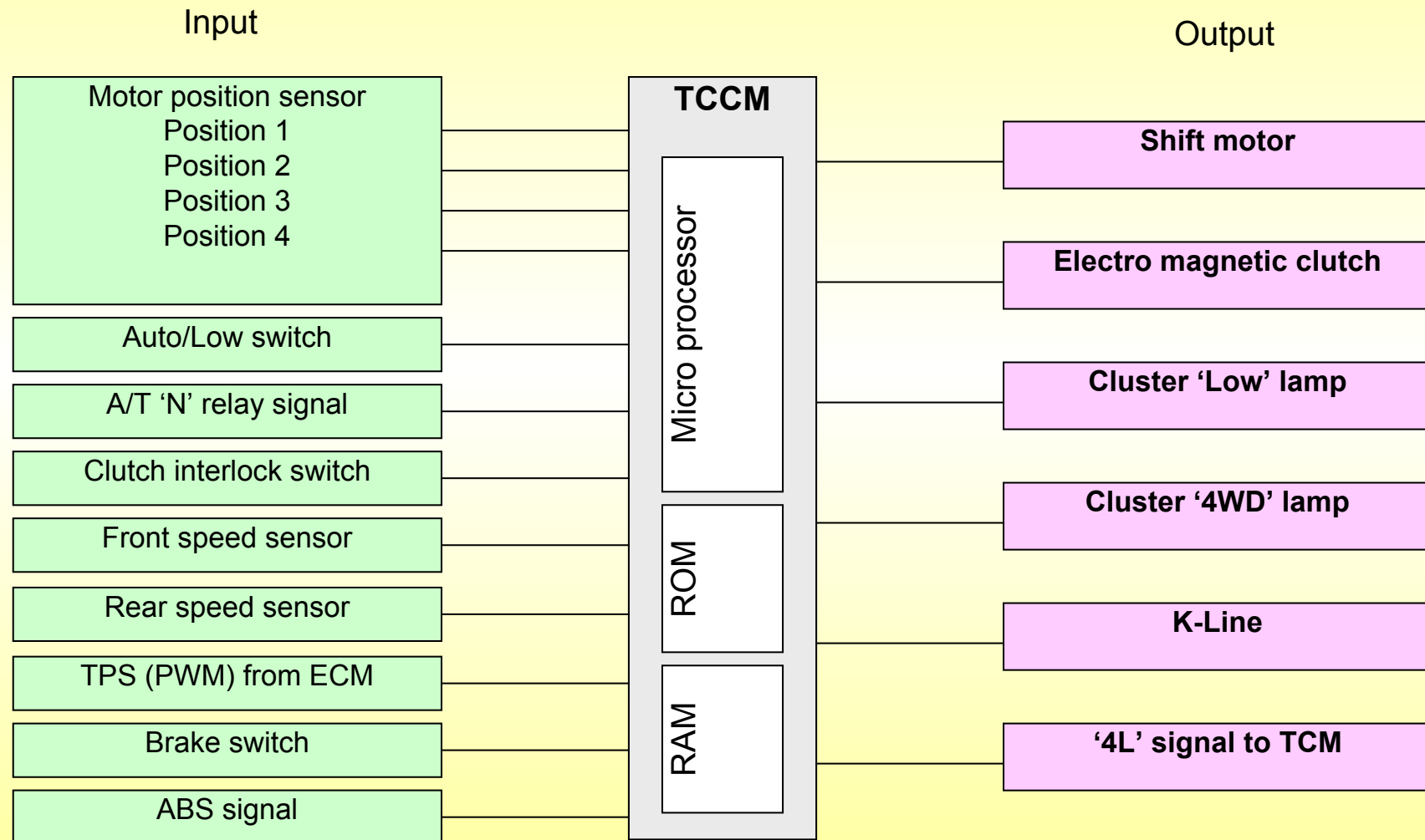
TOD

Power Flow (LOW Mode)



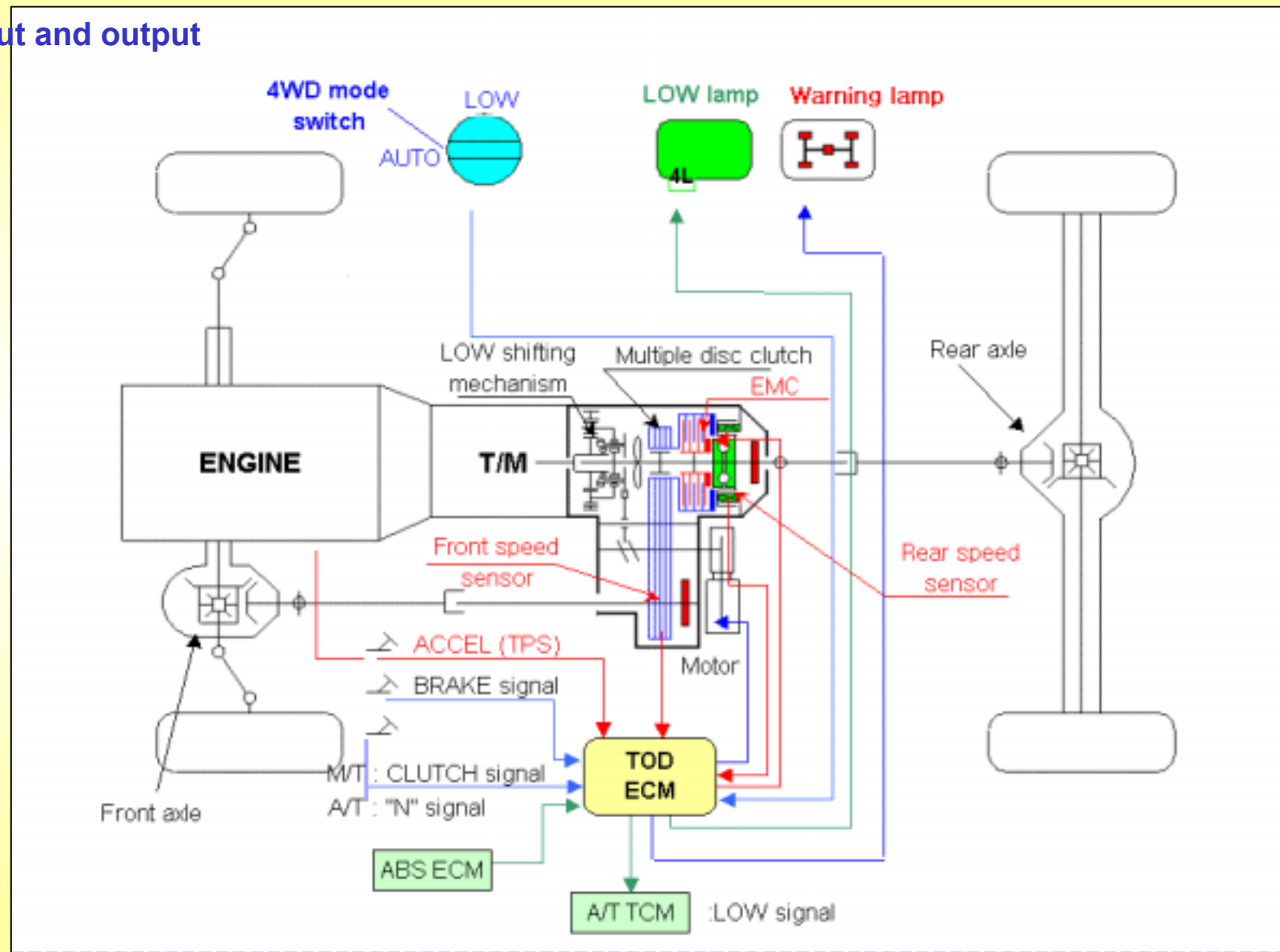
TOD

Input and output



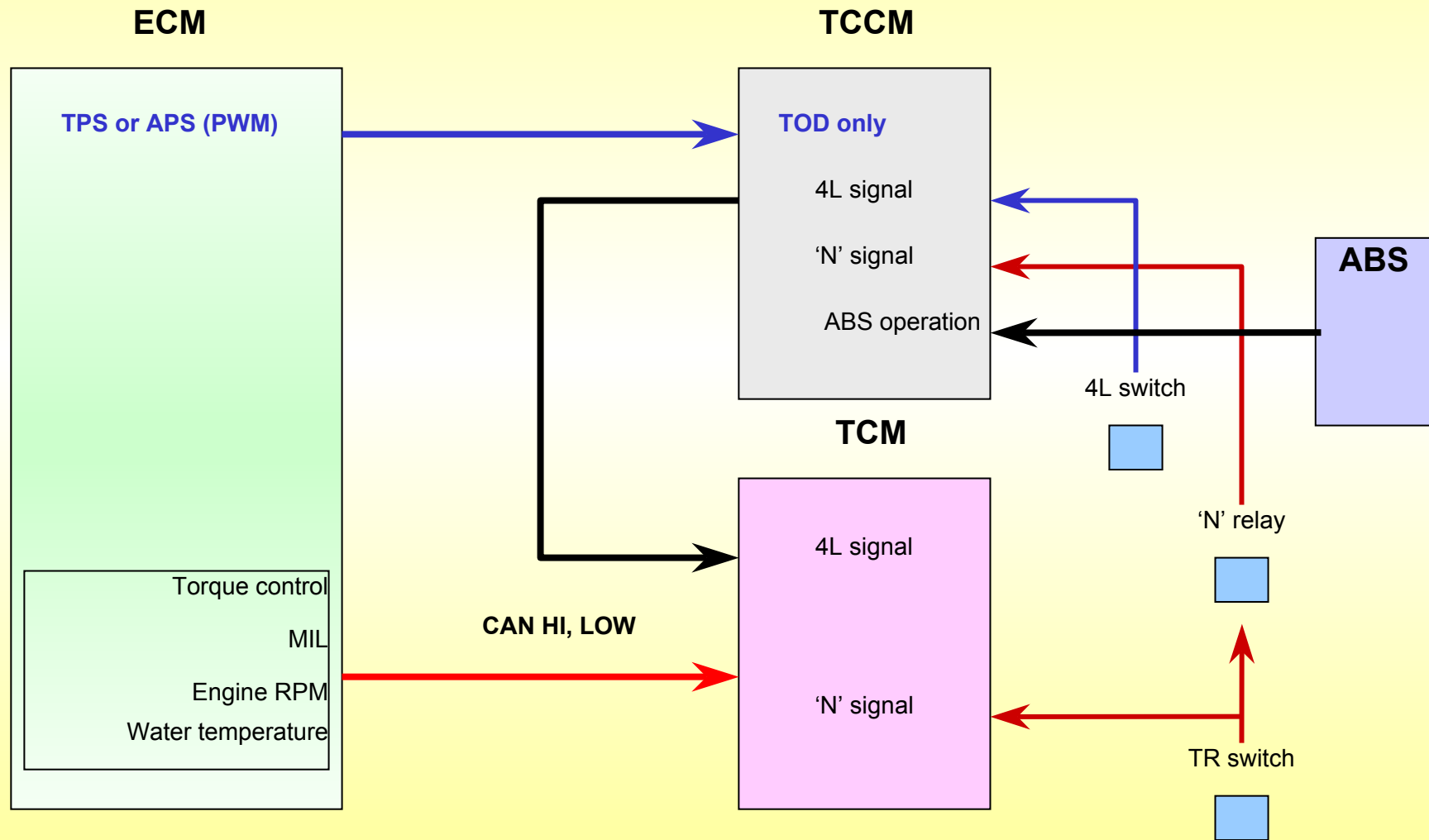
TOD

Input and output



TOD

Pin to pin communication



TOD

Components – EMC (Electronic magnetic clutch)



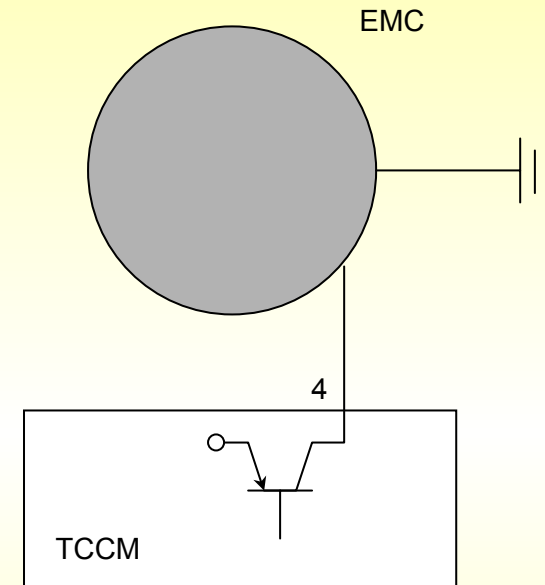
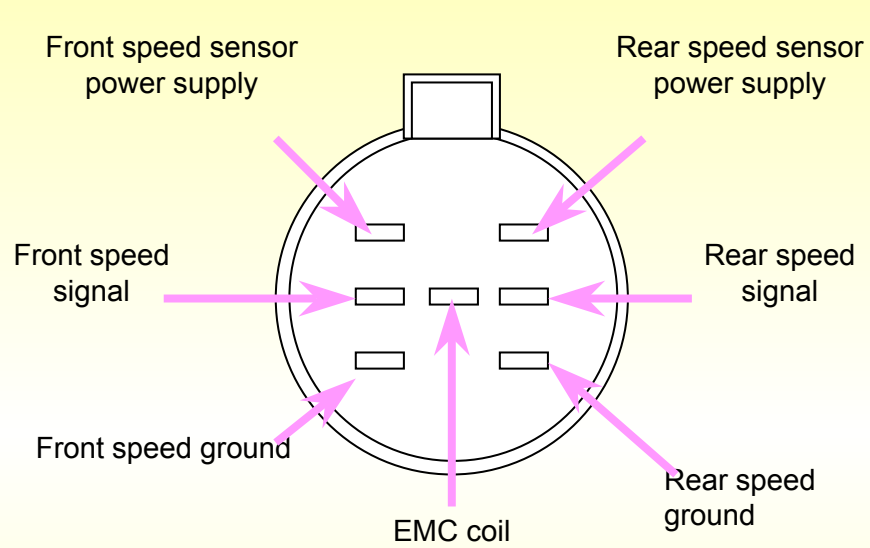
EMC

Multiple disc clutch

If EMC is energized, the multiple disc clutch is engaged so the torque is transmitted to front wheel. Depends on EMC duty ratio, the amount of transmitted torque to front side is changed.

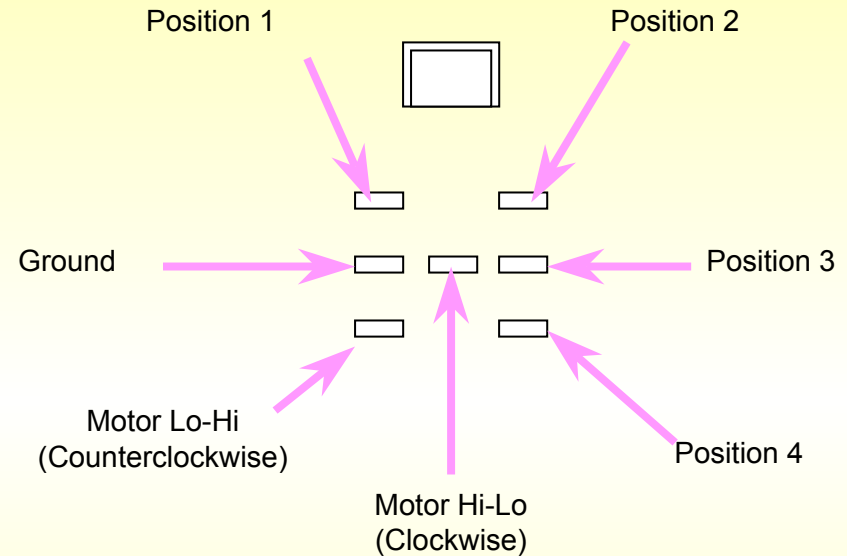
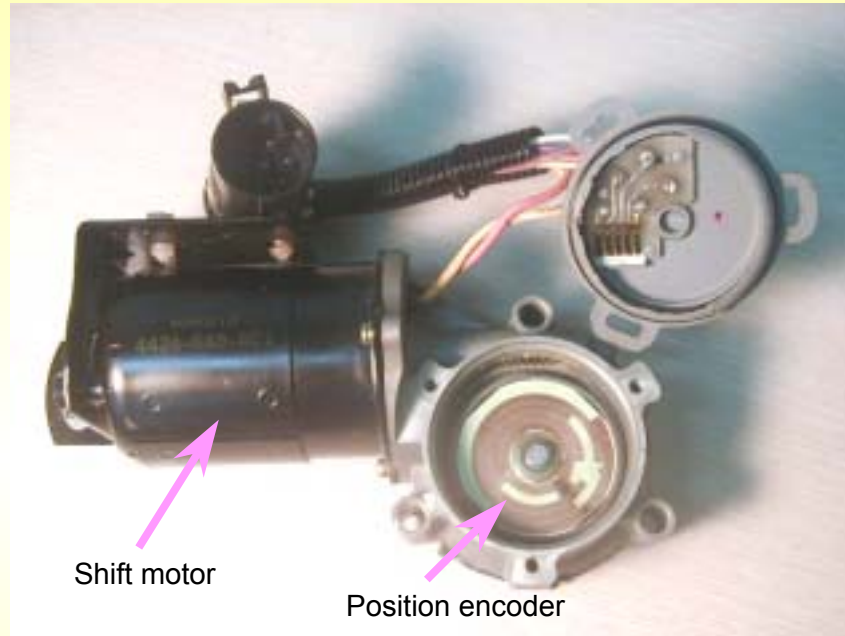
TOD

Components – EMC (Electro magnetic clutch)



TOD

Components – Shift motor & Motor position sensor



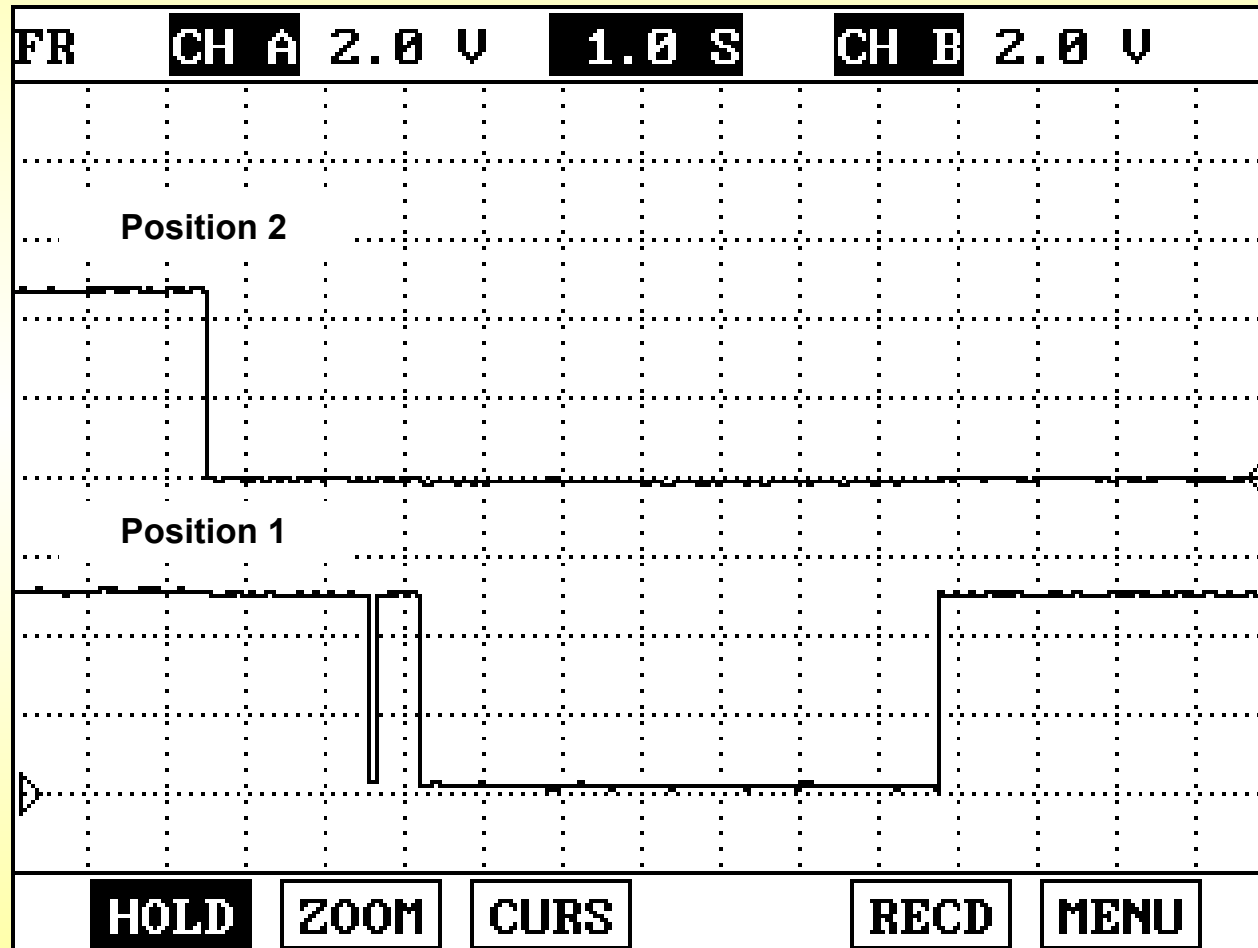
This shift motor is DC motor and controlled by TCCM. Its function is to shift into 4LOW for higher gear ratio. If shift motor is overhauled, the MPS signal is changed and cannot be reused. Therefore shift motor should not be overhauled.

Coil resistance value : $0.78 \pm 0.078\Omega$

* The shift motor for TOD cannot be replaced with one for EST.

TOD

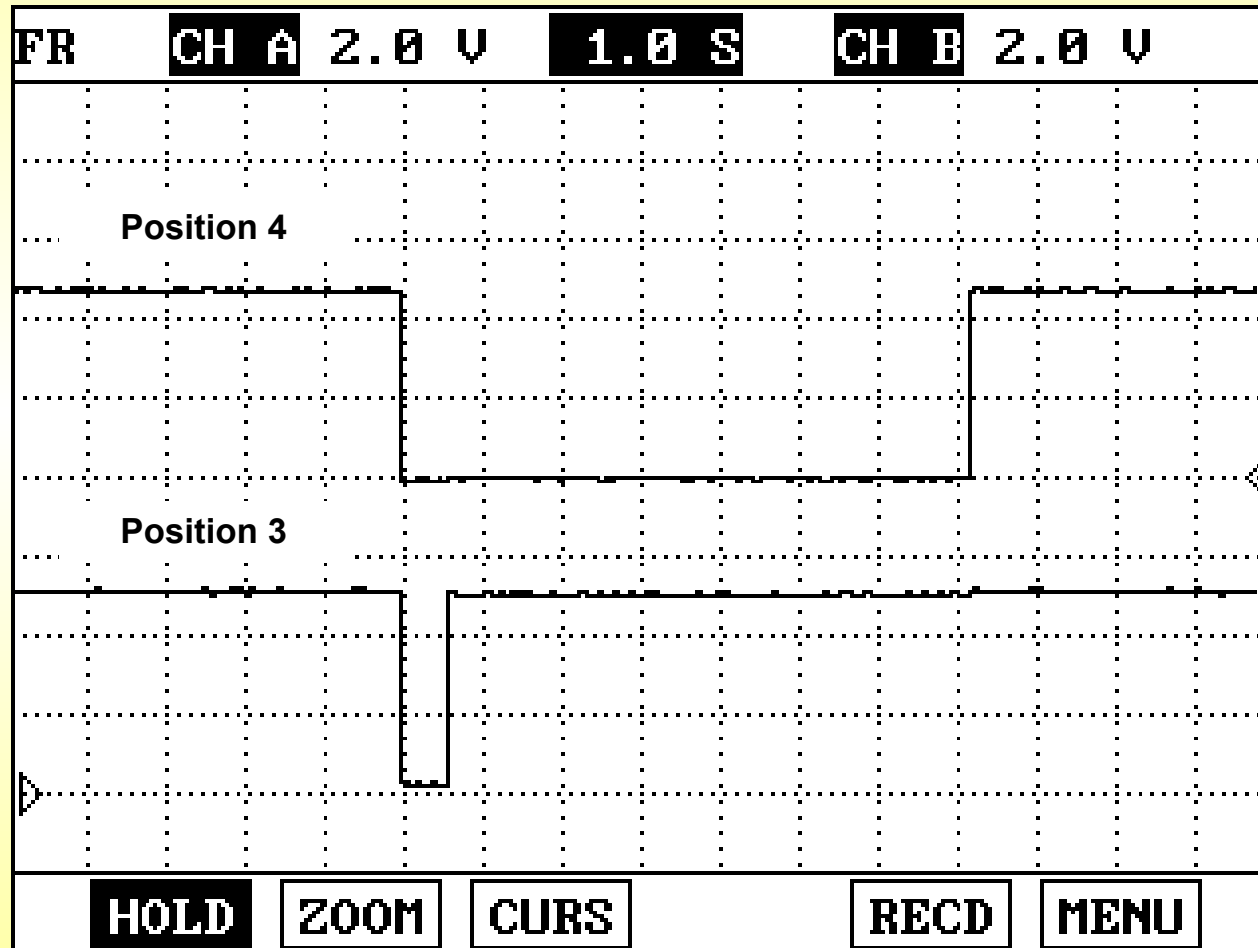
MPS signals (AUTO → LOW)



3.5 GSL with TOD

TOD

MPS signals (AUTO → LOW)



3.5 GSL with TOD

TOD

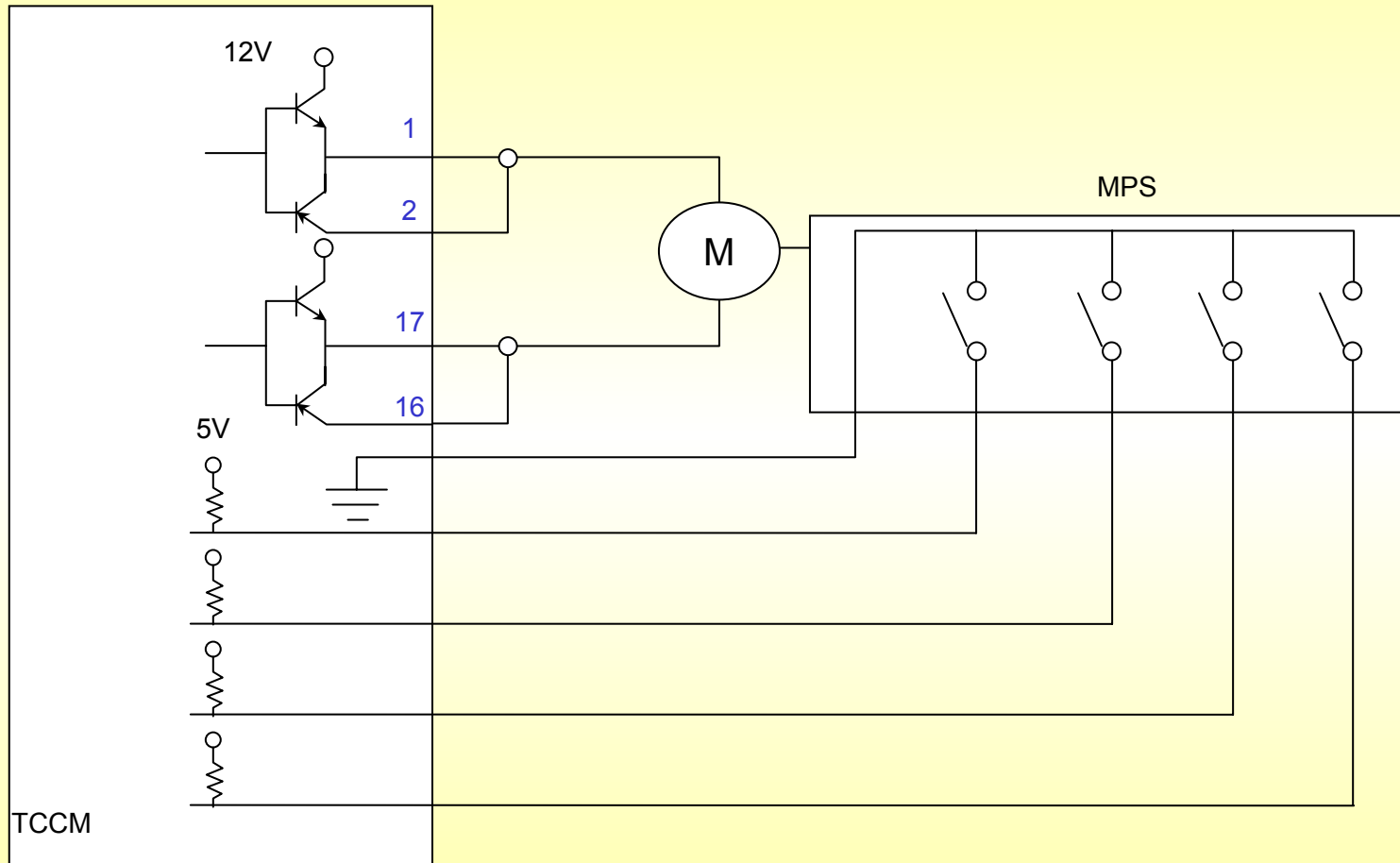
Components – Shift motor & Motor position sensor

Output signal is changed depends on the shift motor position. There are 9 valid codes for the position to be detected by TCCM.

Motor position	Position 1	Position 2	Position 3	Position 4	Reamrks
Left stop	OFF	OFF	OFF	ON	ON : 0.8V or less OFF : 4.5V or more
Left of high	OFF	ON	OFF	ON	
High	ON	ON	OFF	ON	
Right of high	ON	ON	ON	ON	
Zone 1	OFF	OFF	OFF	OFF	
Neutral	OFF	ON	ON	OFF	
Zone 2	ON	ON	ON	OFF	
Low	ON	OFF	ON	OFF	
Right stop	ON	OFF	ON	ON	

TOD

Components – Shift motor & Motor position sensor



Clockwise rotation (Hi → Lo) : Terminal 1,2 is B+ (12V), terminal 16,17 is earth.

Counterclockwise (Lo → Hi) : Terminal 1,2 is earth, terminal 16,17 is B+ (12V).

TOD

Components – Front & Rear speed sensor



Sensing tone wheel for front speed (teeth = 30EA)



Hall effect type speed sensor



Sensing tone wheel for rear speed (teeth = 30EA)

Location : The end of rear propeller shaft

TOD

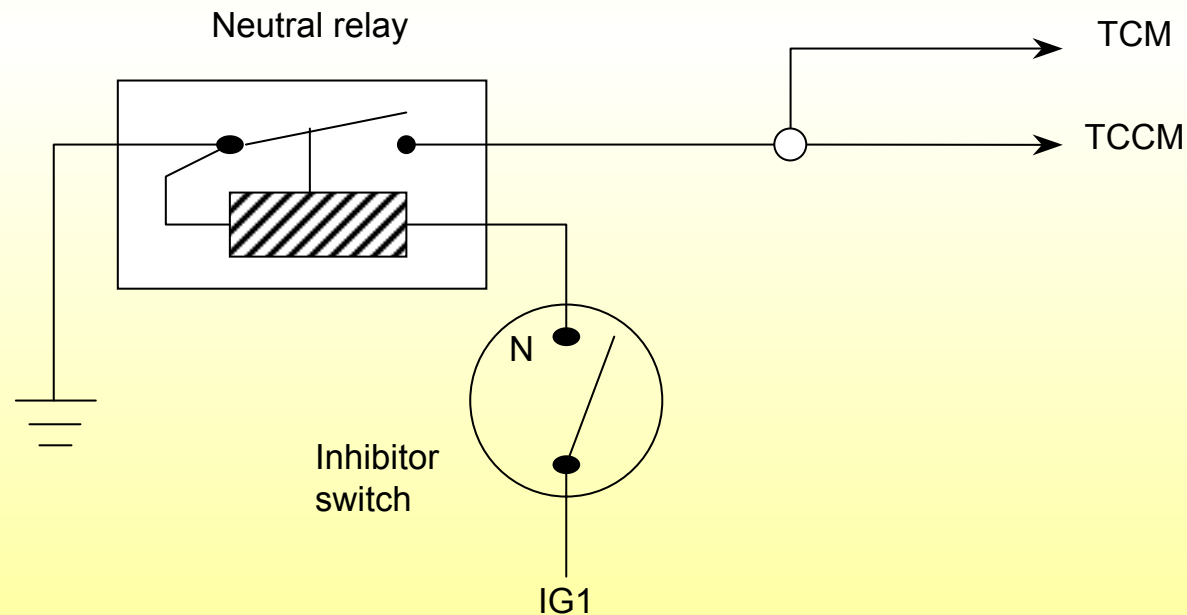
Components - Indicator

Condition	AT LEVER	TOD SW mode	INDICATOR		Description
			4LOW	W/Lamp	
IGN ON or IDLE	P/R/D/2/1	AUTO	ON (3sec)	ON (3sec)	ON (3sec) --> OFF at IG. ON
		AUTO→4LOW	Blinking	OFF	'AUTO mode' holding
		4LOW→AUTO	OFF	OFF	'AUTO mode' holding
	N	AUTO	ON (3sec)	ON (3sec)	ON (3sec) --> OFF at IG. ON
		AUTO→4LOW	7 times blinking --> ON	OFF	4LOW indicator : 6 times blinking --> Shift motor ON --> 1 time blinking --> ON
		4LOW→AUTO	7 times blinking --> OFF	OFF	4LOW indicator : 6 times blinking --> Shift motor ON --> 1 time blinking --> OFF

TOD

Components – A/T neutral relay (EST / TOD)

In case of automatic transaxle vehicle, there is a A/T neutral relay to detect the condition that shifts from 'Auto mode' to 'Low mode' (TOD) or '4H' to '4L' mode (EST). Due to the characteristics of TCCM, the 'N' signal (battery 12voltage) from inhibitor switch cannot be switched directly. That's why neutral relay was installed. In case of manual transaxle, the clutch lock switch was installed instead of A/T neutral relay so as to prevent the '4LOW' engagement during vehicle driving.



TOD

Warning lamp

Items	Condition	BL		
		INDICATOR		Description
		4LOW	W/Lamp	
TPS	OPEN OR SHORT(GND)	OFF	OFF	<ol style="list-style-type: none"> 1. No warning lamp blink or ON. 2. AUTO ↔ 4LOW shift is possible
SHIFT MOTOR	OPEN	OFF	Blink	<ol style="list-style-type: none"> 1. Warning lamp blinks after 1 sec. since the fault is occurred. 2. Fail at the 'AUTO mode' <ul style="list-style-type: none"> : AUTO mode holding : '4LOW' lamp blinks if '4L' is selected 3. Fail at the '4LOW mode' <ul style="list-style-type: none"> : 4L mode holding : '4L OW lamp blinks if 'AUTO' is selected 4. Even though the fault is repaired, shift prevention is still existed. If IG. ON again, system is operated normally.

TOD

Warning lamp

Items	Condition	BL		
		INDICATOR		Description
		4LOW	W/Lamp	
SHIFT MOTOR POSITION SENSOR (1), (2), (3), (4), (5)	OPEN Short to battery	OFF	Blink	1. Warning lamp blinks after 1 sec. since the fault is occurred. 2. Fail at the 'AUTO mode' : AUTO mode holding : '4LOW' lamp blinks if '4L' is selected
	SHORT(GND)			3. Fail at the '4LOW mode' : 4L mode holding : '4L OW lamp blinks if 'AUTO' is selected 4. Even though the fault is repaired, shift prevention is still existed. If IG. ON again, system is operated normally.

TOD

Warning lamp

Items	Condition	BL		
		INDICATOR		Description
		4LOW	W/Lamp	
FRT SPEED SENSOR	OPEN	OFF	OFF	<ol style="list-style-type: none"> 1. Warning lamp blinks after 0.5 sec. since the fault is occurred. 2. Fail at the 'AUTO mode' <ul style="list-style-type: none"> : AUTO mode holding : '4LOW' lamp blinks if '4L' is selected 3. Fail at the '4LOW mode' <ul style="list-style-type: none"> : 4L mode holding : '4L OW lamp blinks if 'AUTO' is selected
RR SPEED SENSOR	OPEN	OFF	OFF	<ol style="list-style-type: none"> 4. Even though the fault is repaired, shift prevention is still existed. <p>If IG. ON again, system is operated normally.</p>

TOD

Warning lamp

Items	Condition	BL		
		INDICATOR		Description
		4LOW	W/Lamp	
EMC (ELECTRO- MAGNETIC CLUTCH)	OPEN	OFF	Blink	<ol style="list-style-type: none"> 1. Warning lamp blinks after 0.8 sec. since the fault is occurred. 2. Fail at the 'AUTO mode' : AUTO mode holding : '4LOW' lamp blinks if '4L' is selected 3. Fail at the '4LOW mode' : 4L mode holding : '4L OW lamp blinks if 'AUTO' is selected
	SHORT(GND)	OFF	Blink	<ol style="list-style-type: none"> 4. Even though the fault is repaired, shift prevention is still existed. If IG. ON again, system is operated normally.

TOD

DTC List

DTC	Content
P1725	TOD CONTROL MODULE(CHECKSUM) ERROR
P1726	THROTTLE POSITION INPUT - LOSS OF SIGNAL
P1727	THROTTLE POSITION INPUT - OUT OF RANGE
P1728	EMC - OPEN/SHORT TO BATTERY
P1729	EMC - SHORT TO GROUND
P1730	FRONT SPEED SENSOR - LOW INPUT
P1731	FRONT SPEED SENSOR - HIGH INPUT
P1732	REAR SPEED SPEED SENSOR - LOW INPUT
P1733	REAR SPEED SPEED SENSOR - HIGH INPUT
P1734	SPEED SENSOR REFERENCE - LOW INPUT
P1735	SPEED SENSOR REFERENCE - HIGH INPUT
P1736	SHIFT MOTOR - OPEN
P1737	SHIFT MOTOR - OPEN/SHORT TO GROUND
P1738	SHIFT SYSTEM TIMEOUT
P1739	GENERAL POSITION ENCODER FAULT
P1740	POSITION 1 - SHORT TO GROUND
P1741	POSITION 2 - SHORT TO GROUND
P1742	POSITION 3 - SHORT TO GROUND
P1743	POSITION 4 - SHORT TO GROUND

TOD

DTC & Fail-safe

No.	Description	P-code	Failure effect	Fail-safe	W/Lamp
1	EEPROM checksum fault	P1725	TOD	Default calibration data	-
2	TPS loss of signal	P1726	TOD (TPS Idle)	TOD Determined by wheel slip only	OFF
3	TPS out of range	P1727	TOD (TPS Idle)	TOD Determined by wheel slip only	OFF
4	EMC open/shorted to battery	P1728	TOD Halted (2WD)	None	Blink
5	EMC shorted to ground	P1729	TOD Halted (2WD)	None	Blink
6	Front speed sensor voltage Low	P1730	TOD	4H mode fail, Rear speed sensor, EMC Touch off level fixing. 4L Mode fail, EMC Maximum level fixing.	OFF
7	Front speed sensor voltage High	P1731	TOD		OFF

TOD

DTC & Fail-safe

No.	Description	P-code	Failure effect	Fail-safe	W/Lamp
8	Rear speed sensor voltage Low	P1732	TOD	4H mode fail, Front speed sensor, EMC Touch off level fixing. 4L Mode fail, EMC Maximum level fixing.	OFF
9	Rear Speed sensor voltage High	P1733	TOD		OFF
10	Vehicle speed sensor reference Voltage Low	P1734	TOD	4H mode fail, Zero speed sensor, EMC Touch off level fixing. 4L Mode fail, EMC Maximum level fixing.	OFF
11	Vehicle speed sensor reference Voltage High	P1735	TOD		OFF
12	Shift motor open/shorted to Battery	P1736	Electric motor shifting(4H-4L-4H)	No Shifts	Blink
13	Shift motor open/shorted to Ground	P1737	Electric motor shifting(4H-4L-4H)	No Shifts	Blink

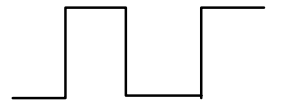
TOD

DTC & Fail-safe

No.	Description	P-code	Failure effect	Fail-safe	W/Lamp
14	Shift system timeout	P1738	Electric motor shifting(4H-4L-4H)	No Shifts	Blink
15	General position encoder Fault	P1739	Electric motor shifting(4H-4L-4H)	No Shifts	OFF
16	Position 1 shorted to Ground	P1740	Electric motor shifting(4H-4L-4H)	No Shifts	OFF
17	Position 2 shorted to Ground		Electric motor shifting(4H-4L-4H)	No Shifts	
18	Position 3 shorted to Ground		Electric motor shifting(4H-4L-4H)	No Shifts	
19	Position 4 shorted to Ground		Electric motor shifting(4H-4L-4H)	No Shifts	

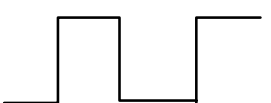
TOD

Standard Input and Output value in TCCM (2.5 TCI – TOD)

No	Items	Condition	Signal		Remarks	
			Type	Level		
1	A1	MOTOR OUTPUT (HI-LOW)	IDLE("N"단)	DC	Vbatt	
				↑	0V	
2	A2	MOTOR OUTPUT (LOW-HI)	IDLE("N"단)	DC	Vbatt	
				↑	0V	
3	A3	EMC	Vehicle driving	PULSE (PWM)	 Vbatt 0V FREQ. : 50Hz DUTY(-) : 0 ~ 88%	* 4LOW DUTY(-): 88.72%
4	A4	BATT	IGN OFF	DC	Vbatt	
			IGN ON	↑	Vbatt	
5	A5	IGN 1	IGN OFF	DC	0V	
			IGN ON	↑	Vbatt	
6	B1	ENCODER GND				
7	B2	DIAGNOSTIC	LAMP OFF	DC	Vbatt	
		DISPLAY	LAMP ON	↑	0.5V or less	

TOD

Standard Input and Output value in TCCM (2.5 TCI – TOD)

No	Items	Condition	Signal		Remarks	
			Type	Level		
8	B3	TPS(PWM)	ACCEL C.T & W.O.T	PWM	HI : 4V MIN LO : 0.9V MAX FREQ. : 100Hz DUTY(-) : C.T - 10% W.O.T - 83%	
9	B4	AUTO/LOW SW	IDLE (A/T LEVER "N")	AUTO LOW	4V or more 0.9V or less (AUTO mode : 4V or more)	
10	B5	SHIFT MOTOR POSITION 2	IDLE (A/T LEVER "N")	→ AUTO → LOW	CODE : 0010 → 0000 CODE : 0101 → 0000 LOGIC HI(1) : 4.5V or more LOGIC LO(0) : 0.5V or less	* MTR POS. CODE: 1/2/3/4 = XXXX
11	B6	FRT SPEED SNSR	Vehicle driving	PULSE	 4V or more 0~0.9V 30PULSE/PROPSHAFT REV. DUTY(-) : 50%	* VSS 60KPH : 985Hz

TOD

Standard Input and Output value in TCCM (2.5 TCI – TOD)

No	Items	Condition	Signal		Remarks	
			Type	Level		
12	B7	N.A				
13	B8	SPEED SNSR GND				
14	A6	MOTOR OUTPUT (HI-LOW)	IDLE("N")	DC	Vbatt	
				↑	0V	
15	A7	MOTOR OUTPUT (LOW-HI)	IDLE("N")	DC	Vbatt	
				↑	0V	
16	A8	SPEED REFERENCE	IGN OFF	DC	0.9V or less	
			IGN ON	↑	4.75 ~ 5.25V	
17	A9	GND FOR ECU				
18	A10	GND FOR ECU				
19	A11	BATT	IGN OFF	DC	Vbatt	
			IGN ON	↑	Vbatt	
20	A12	K-LINE	In comm. (10.4Kbps)	PULSE	LOGIC "0" : Vbatt 20% or less LOGIC "1" : Vbatt 80% or more	

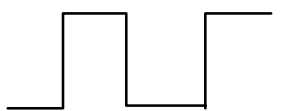
TOD

Standard Input and Output value in TCCM (2.5 TCI – TOD)

No	Items	Condition	Signal		Remarks	
			Type	Level		
21	B9	4LOW DISPLAY	SW OFF	DC	Vbatt	* IGN ON : Turned on for 3sec.
			SW ON	↑	0.5V or less	
22	B10	N.A				
23	B11	N.A				
24	B12	TRANS. NEUTRAL	N	DC	0.9V or less	
			P/R/D/2/L	↑	4.5 ~ 5.5V	
25	B13	ABS INPUT	ABS OFF	DC	4.5 ~ 5.5V	
			ABS ON	↑	0.9V or less	
26	B14	BRAKE SW	SW OFF	DC	0.9V or less	
			SW ON	↑	Vbatt	
27	B15	SHIFT MOTOR POSITION 1	IDLE (A/T LEVER "N")	→ AUTO → LOW	CODE : 0010 → 0000 CODE : 0101 → 0000 LOGIC HI(1) : 4.5V or more LOGIC LO(0) : 0.5V or less	* MTR POS. CODE: 1/2/3/4 = XXXX

TOD

Standard Input and Output value in TCCM (2.5 TCI – TOD)

No	Items	Condition	Signal		Remarks	
			Type	Level		
28	B16	SHIFT MOTOR POSITION 3	IDLE (A/T LEVER "N")	→ AUTO → LOW	CODE : 0010 → 0000 CODE : 0101 → 0000 LOGIC HI(1) : 4.5V or more LOGIC LO(0) : 0.5V or less	* MTR POS. CODE: 1/2/3/4 = XXXX
29	B17	RR SPEED SNSR	Vehicle driving	PULSE	 4V or more 0~0.9V 30PULSE/PROPSHAFT REV. DUTY(-) : 50%	* VSS 60KPH : 966Hz
30	B18	SHIFT MOTOR POSITION 3	IDLE (A/T LEVER "N")	→ AUTO → LOW	CODE : 0010 → 0000 CODE : 0101 → 0000 LOGIC HI(1) : 4.5V or more LOGIC LO(0) : 0.5V or less	* MTR POS. CODE: 1/2/3/4 = XXXX

TOD

Wiring Diagram

