Automatic Transaxle
(Presentation & Handout)

$$\underline{A} \ \underline{4} \ \underline{A} \ \underline{F} \ \underline{1}$$

①   ②   ③   ④   ⑤
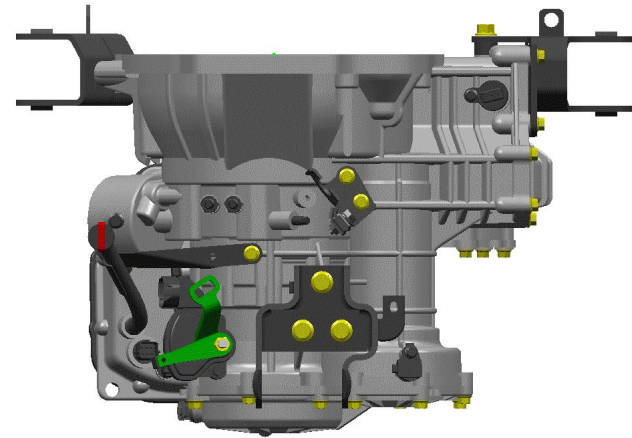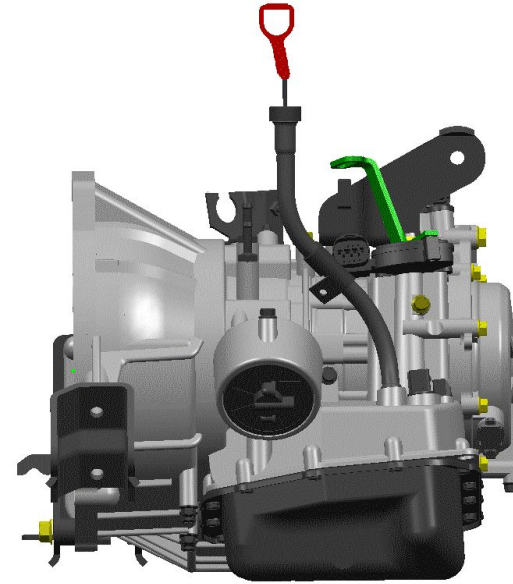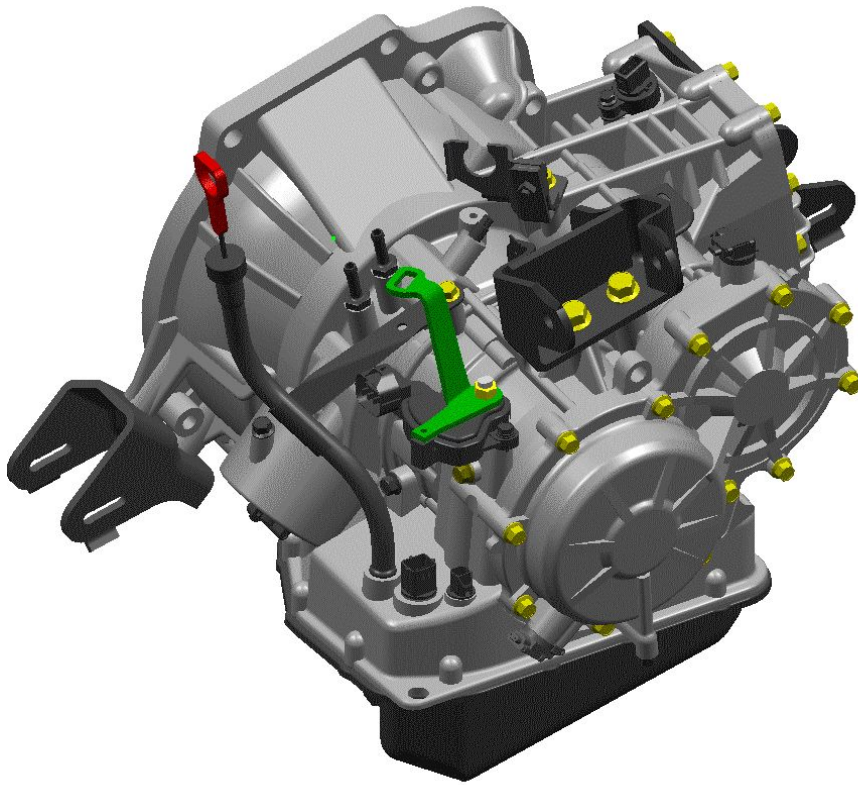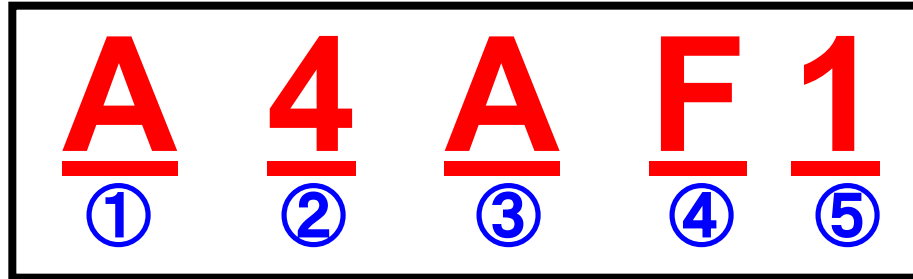
① : Type

  A : Automatic

  M : Manual

② : Speed

  3 : 3rd speed

  4 : 4th speed

  5 : 5th speed

  6 : 6th speed

③ : Project name
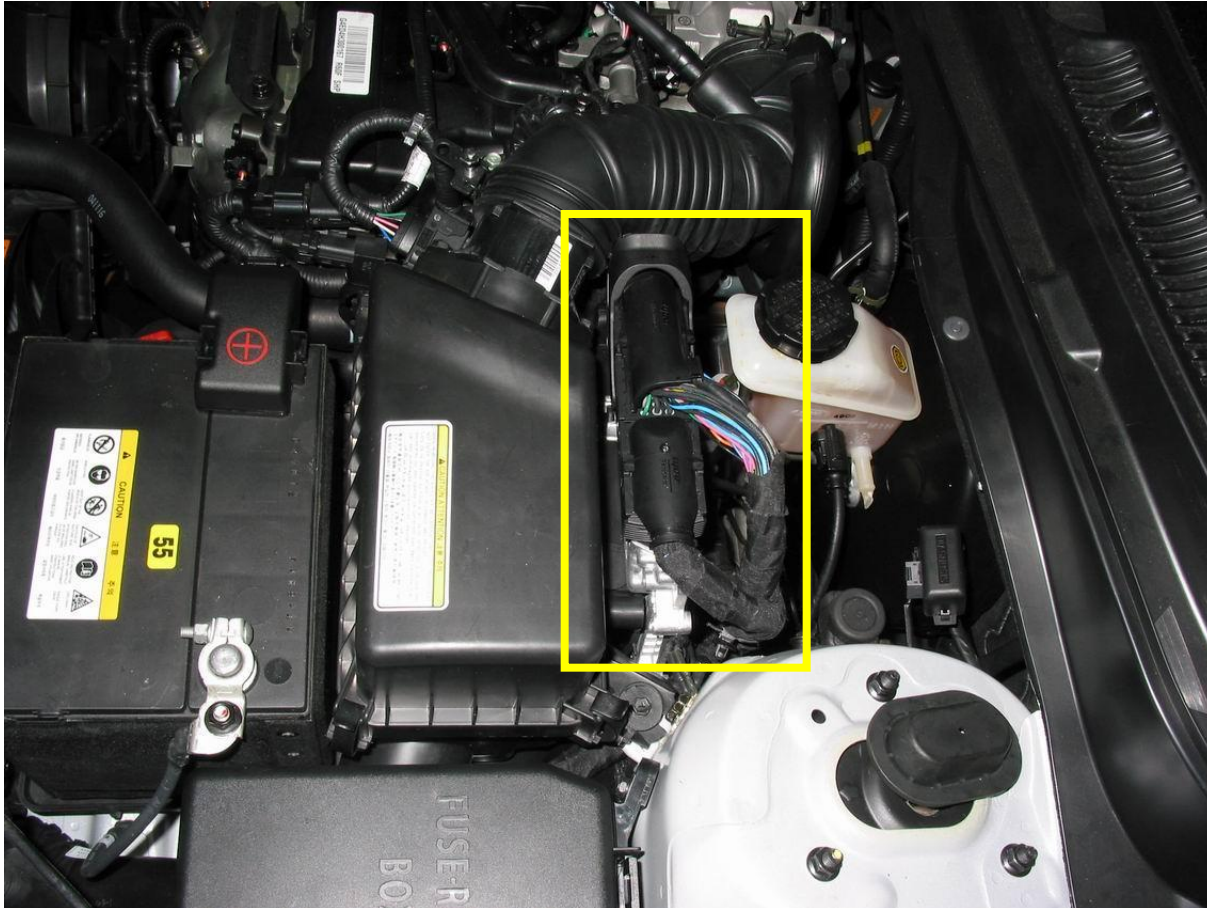
  A : Alpha

  B : Beta

④ : Drive type

  F : Front

  R : RR

  4 : 4WD

⑤ : Development sequence

  1,2,3,…

Item	Model	A4AF3
Control	**Line pressure control**	Applied
	Independent clutch control	Applied
	Skip shift control	Applied (4 ▸2, 3 ▸1)
	Number of solenoid valves	6EA (ON/OFF:3EA PWM:3EA)
Torque converter		3 elements, 2 phases, 1 stage
O/D OFF switch		Applied
Planetary gear		1 Ravinoux type
Friction elements		C:3EA B:2EA OWC:1EA
ATF	**Lubricant**	DIAMOND SP-III, SK SP-III
	Quantity	6.1ℓ
	Replacement period	Normal condition:100,000㎞, Severe condition:40,000㎞
Oil filter		1EA
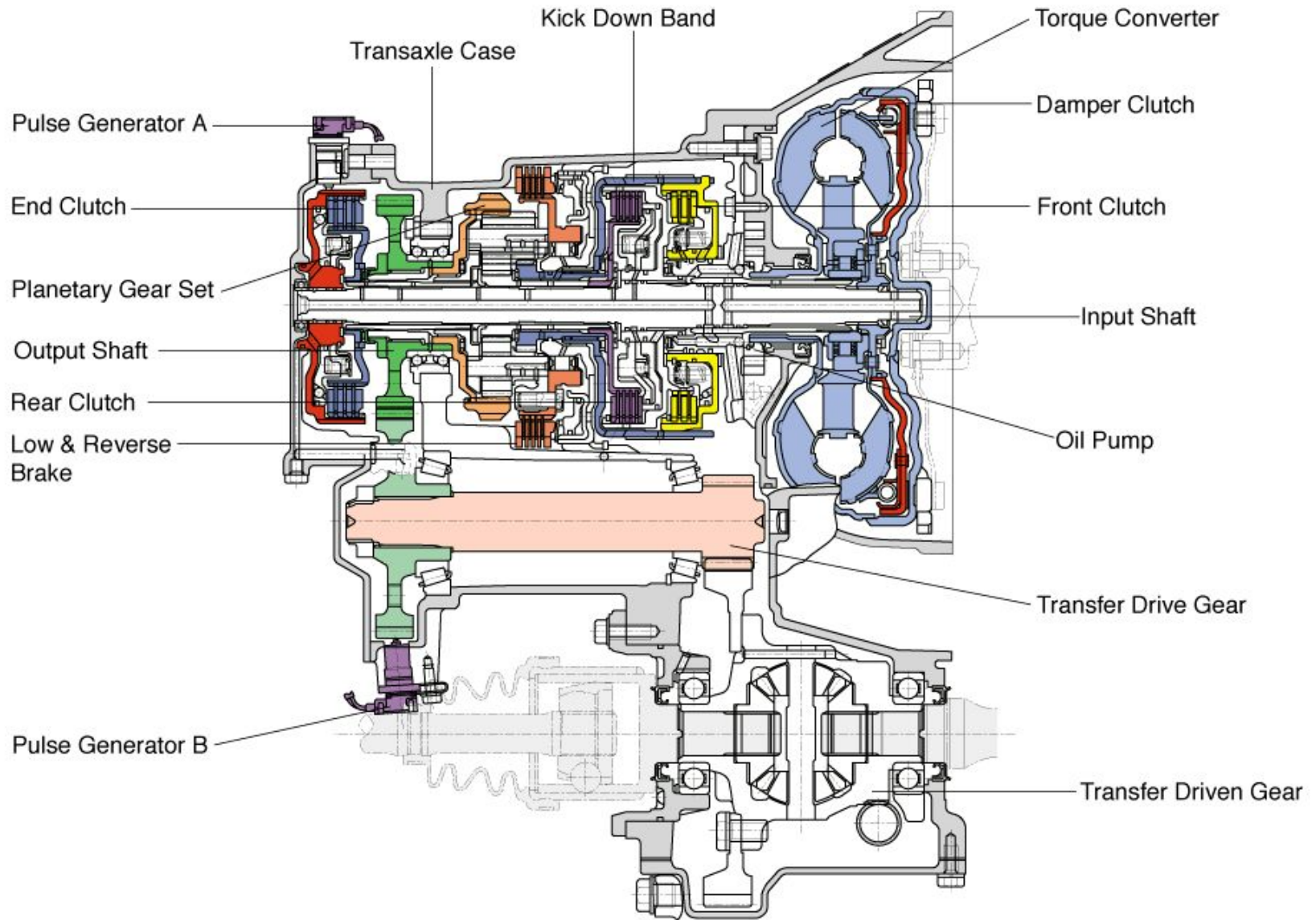
Selector lever position	Gear position	Clutches			Brakes			Solenoid		
		F/C	R/C	E/C	K/D	L&R	OWC	S1	S2	S3
P	Parking							OFF	ON	OFF
R	Reverse	●				●		OFF	ON	OFF
N	Neutral							OFF	ON	OFF
D	1st		●				●	ON	ON	OFF
	2nd		●		●			OFF	ON	OFF
	3rd	●	●	●				OFF	OFF	ON
	4th			●	●			ON	OFF	ON
2	1st		●				●	ON	ON	OFF
	2nd		●		●			OFF	ON	OFF
L	1st		●			●		ON	ON	OFF

Note : ● - Element engaged in each gear position

F/C: Front Clutch   **R/C: Rear Clutch**   **E/C: End Clutch**

K/D: Kickdown Brake   **L&R: Low & Reverse Brake**

OWC: One Way Clutch

Reverse sun gear

Kick-down brake

Ring gear (Annulus gear)

End clutch

Front clutch

Rear clutch

One way clutch

Low & Reverse brake

Long pinion

Short pinion

Forward sun gear

Planetary carrier
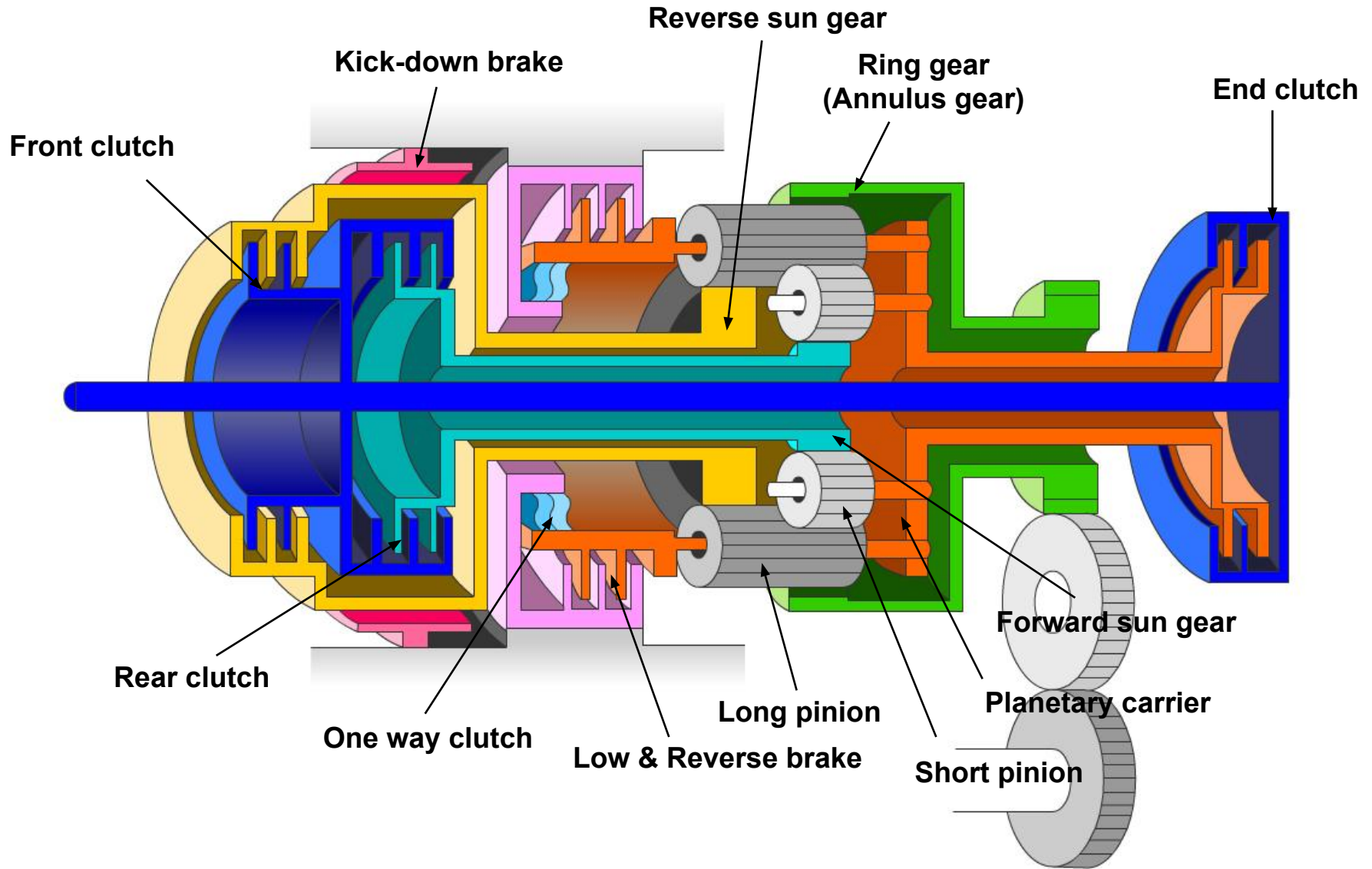
1st Gear ("D" and "2" range)

Operating elements :
* Rear clutch
* One-way clutch

Annulus gear (Ring gear)

Forward sun gear

Transfer drive gear

Idler gear

Transfer driven gear

Rear clutch

One-way clutch
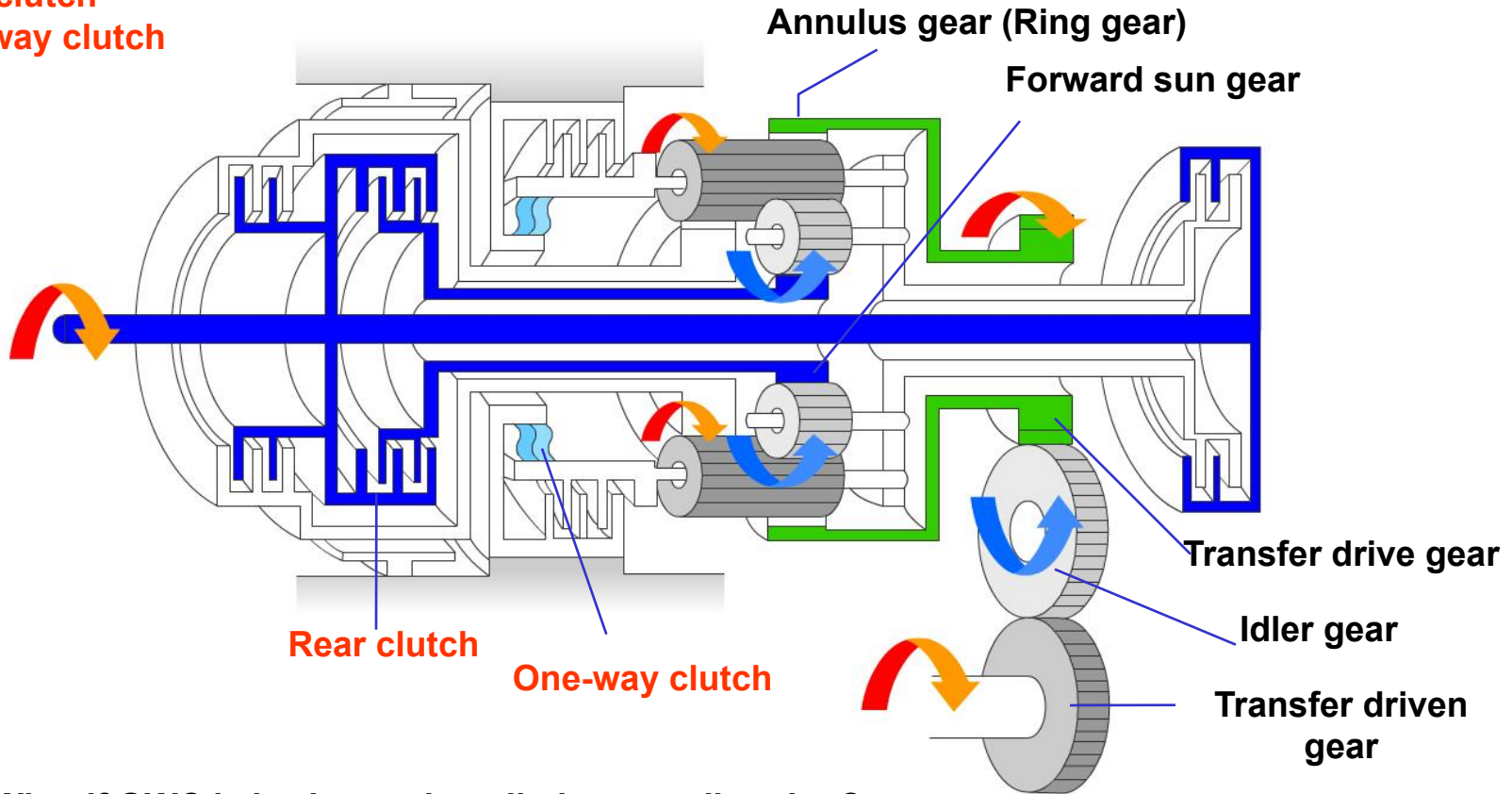
1. **What if OWC is broken or installed wrong direction?**

2. **Is engine brake is available ?**
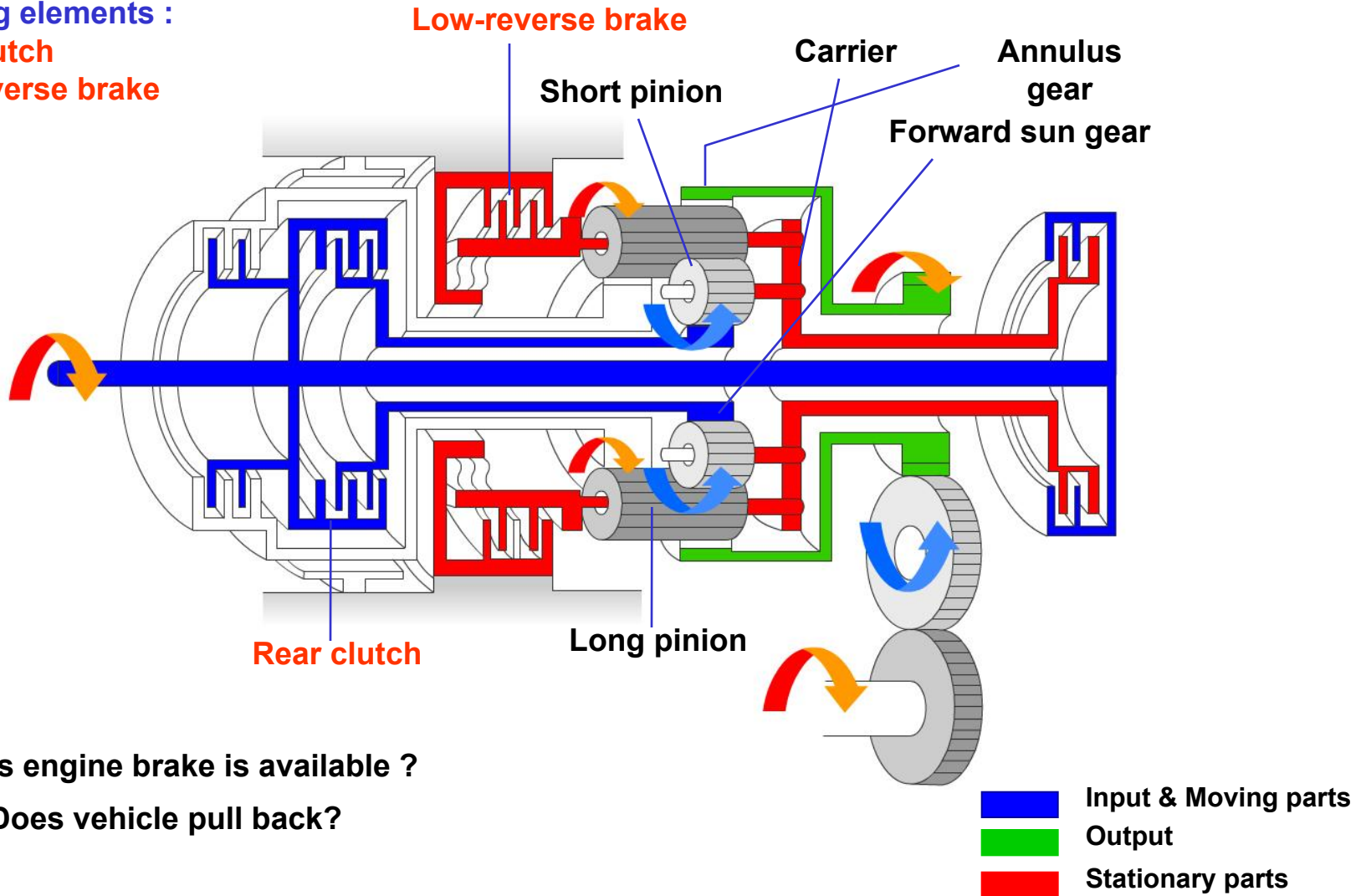
3. **Does vehicle pull back?**

Input & Moving parts

Output

1st Gear ("L" range)

Operating elements :
* Rear clutch
* Low-reverse brake

Low-reverse brake

Carrier

Annulus gear

Short pinion

Forward sun gear

Rear clutch

Long pinion

1. **Is engine brake is available ?**

2. **Does vehicle pull back?**

🟦	**Input & Moving parts**
🟩	**Output**
🟥	**Stationary parts**

2nd Gear ("D" and "2" range)

Operating elements :
* **Rear clutch**
* **Kickdown brake**

Kickdown brake

Annulus gear

Short pinion

Forward sun gear

Rear clutch

Long pinion

1. **Does vehicle pull back?**
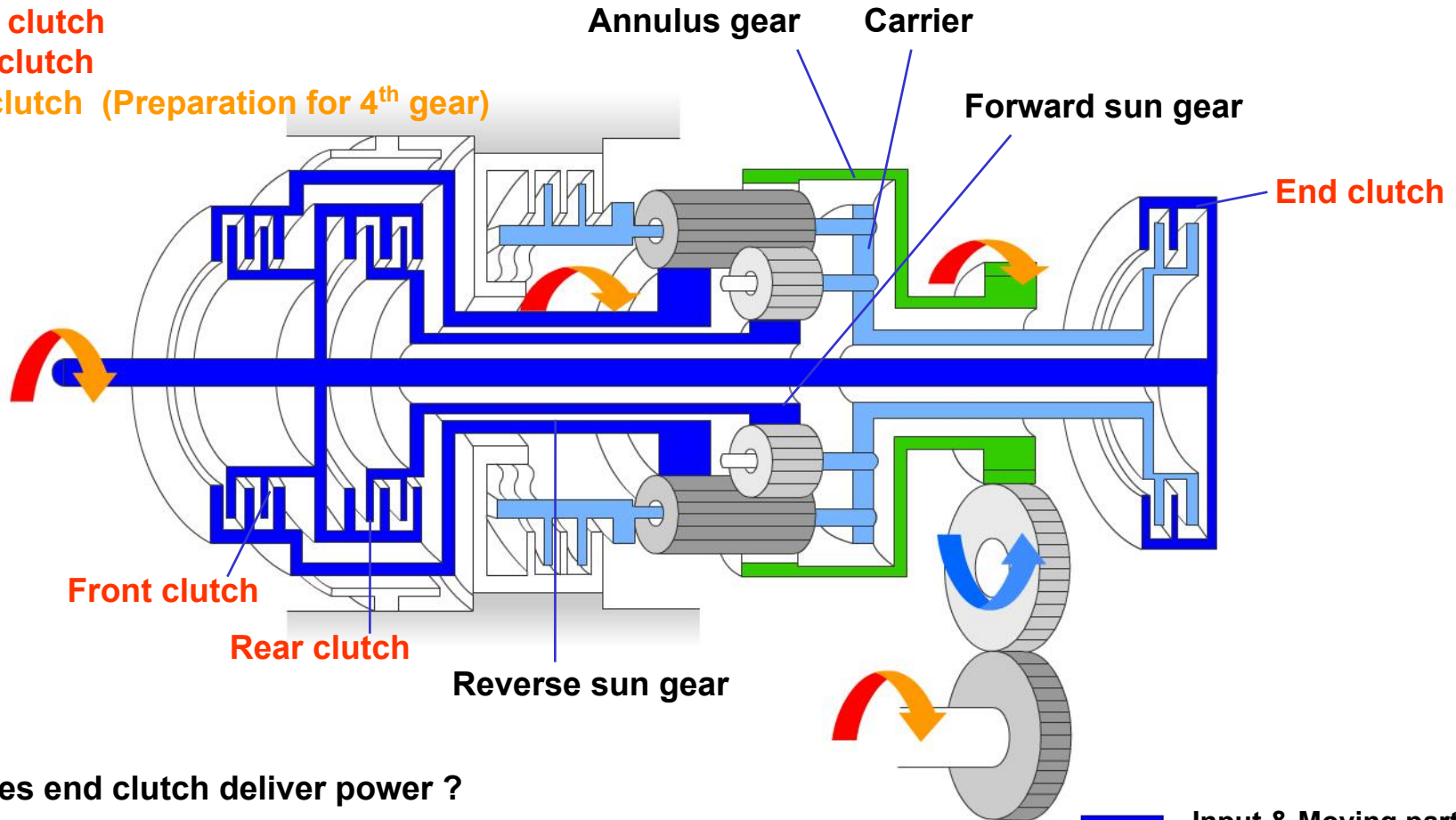
	Input & Moving parts
	Output
	Stationary parts
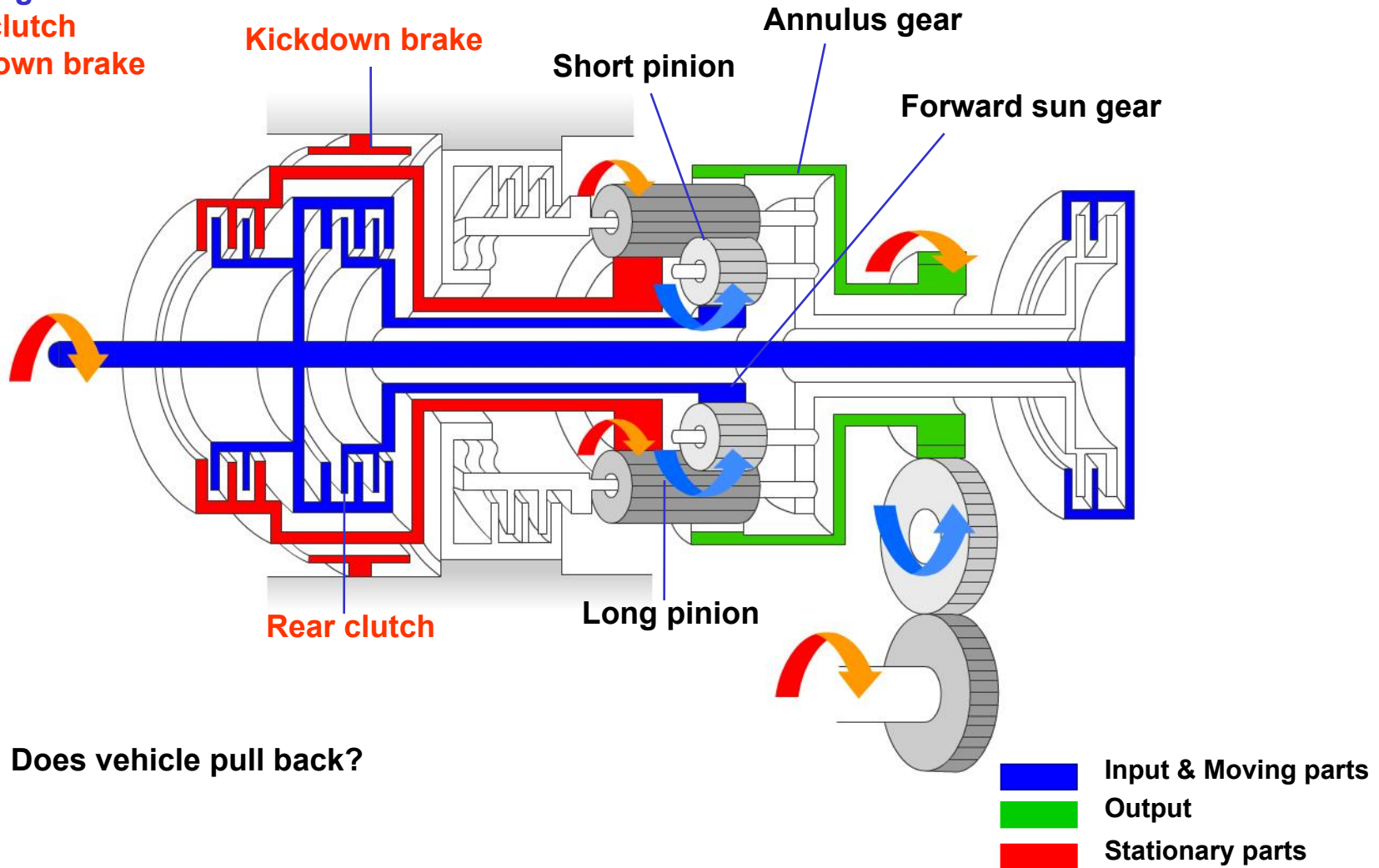
3rd Gear ("D" range)

Operating elements :
* Front clutch
* Rear clutch
* End clutch (Preparation for 4th gear)

Annulus gear   Carrier

Forward sun gear

End clutch

Front clutch

Rear clutch

Reverse sun gear

1. Does end clutch deliver power ?
2. What if end clutch cannot operate? Vehicle can move at 3rd gear?
3. What is the purpose of end clutch engagement at 3rd gear?
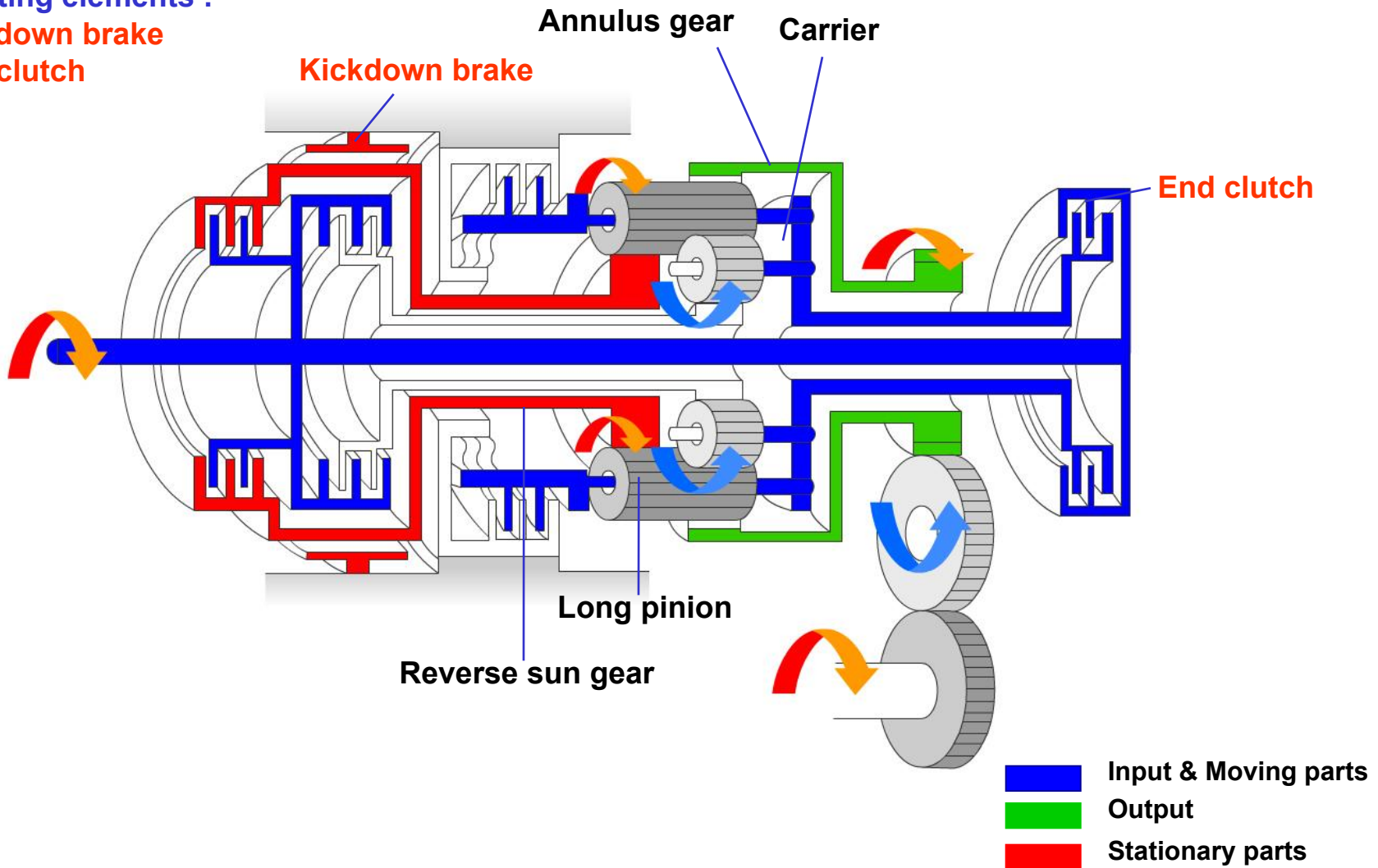
Input & Moving parts
Output
Stationary parts

1. **Does end clutch deliver power ?**

   ☐ **No, end clutch is powered for preparing 4th gear engagement.**

2. **What if end clutch cannot operate? Vehicle can move at 3rd gear?**

   ☐ **Yes, vehicle can have 3rd gear without end clutch engagement.**

3. **What is the purpose of end clutch engagement at 3rd gear?**

   ☐ **End clutch is powered for preparing 4th gear engagement.**

4th Gear ("D" range)

Operating elements :
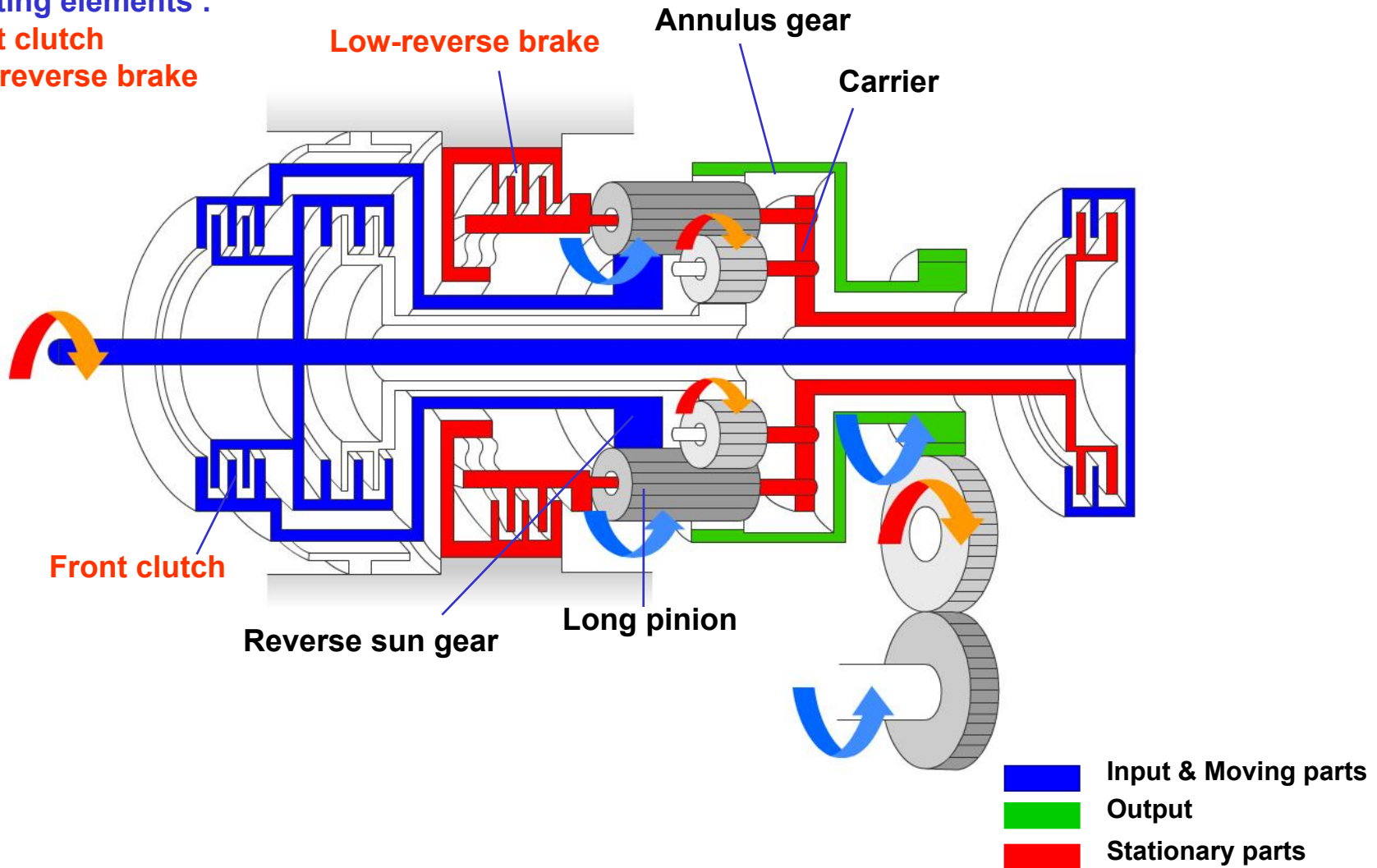*** Kickdown brake**
* End clutch

Kickdown brake

Annulus gear

Carrier

End clutch

Long pinion

Reverse sun gear

Input & Moving parts	(blue)
Output	(green)
Stationary parts	(red)

Reverse range

Operating elements :
* Front clutch
* Low-reverse brake

Low-reverse brake

Annulus gear

Carrier

Front clutch

Reverse sun gear

Long pinion

Input & Moving parts
Output
Stationary parts

Reverse range

Operating elements :
* Front clutch
* Low-reverse brake

Input

Locked

Output

#13   #12   #11   #10   #9   #8   #7   #6   #5   #4   #3   #2   #1
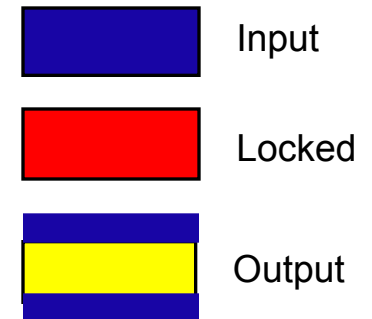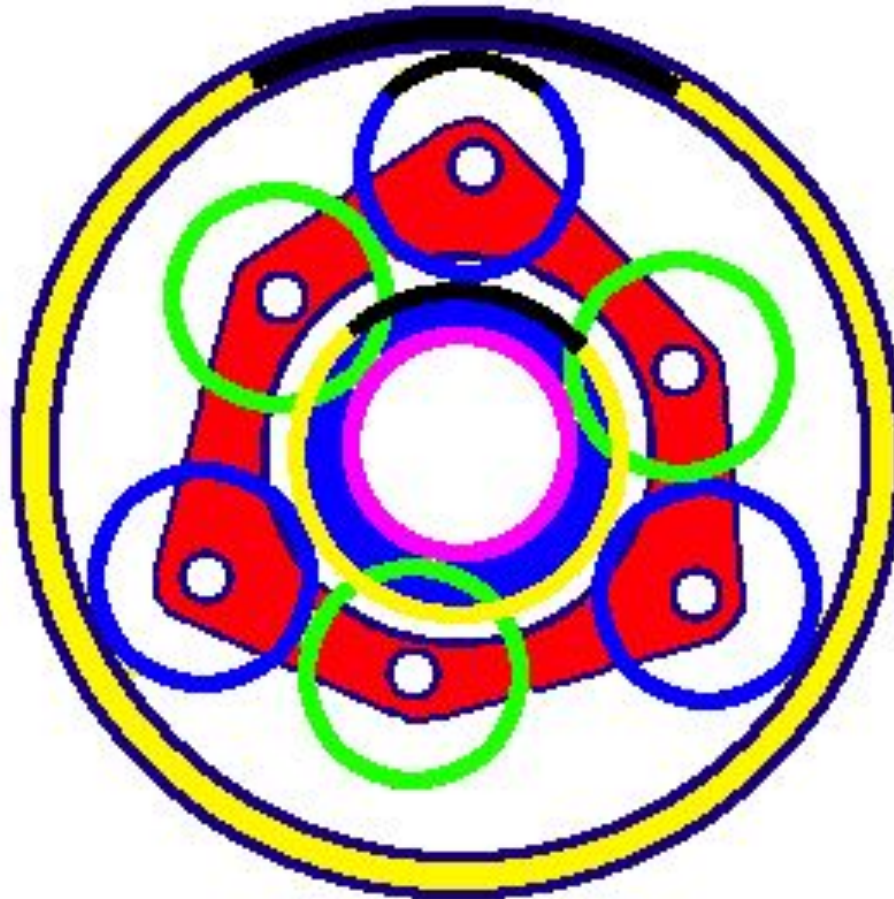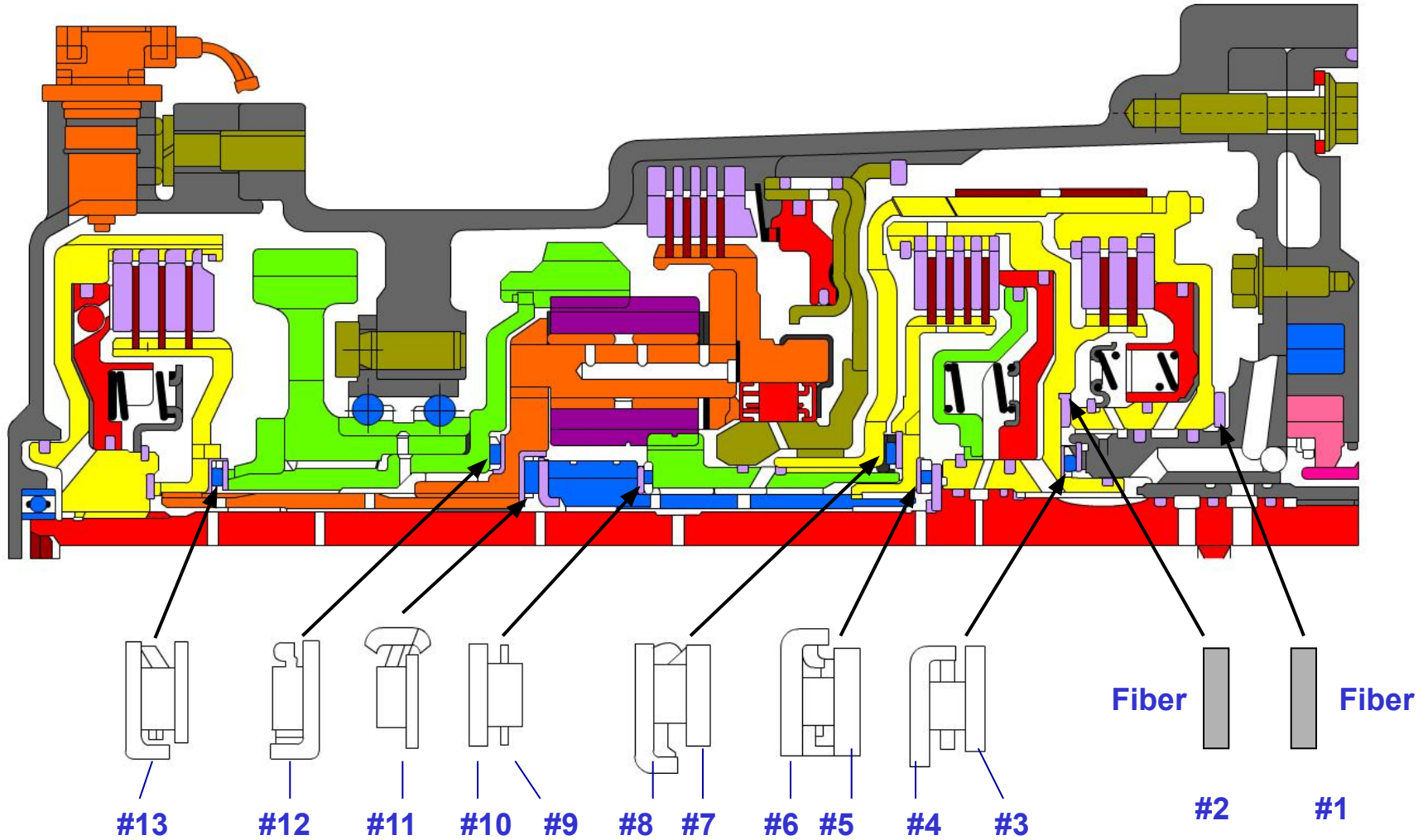
Fiber   Fiber

•Standard value : 0.3 ~ 1.0 mm (0.012~0.040 in.)

□ adjusted by thickness of _____.

also replace _____ located between the oil pump and front clutch.

; Find correct pair of thrust races (metal) and thrust washers (fiber) from following table.

Thrust washer #1 (fiber)	Part Number	Thrust race #3 (metal)	Part Number
Thickness mm (in.)		Thickness mm (in.)	
1.4 (0.055)	45521-36143	1.0 (0.039)	45459-36101
		1.2 (0.047)	45459-36121
1.8 (0.071)	45521-36183	1.4 (0.055)	45459-36141
		1.6 (0.063)	45459-36161
2.2 (0.087)	45521-36223	1.8 (0.071)	45459-36181
		2.0 (0.079)	45459-36201
2.6 (0.102)	45521-36263	2.2 (0.087)	45459-36221
		2.4 (0.095)	45459-36241

1. Application : A4AF3

2. Objectives
  - To measure input shaft endplay
  - To adjust the endply correctly
    by selecting proper race/washer

3. Required materials
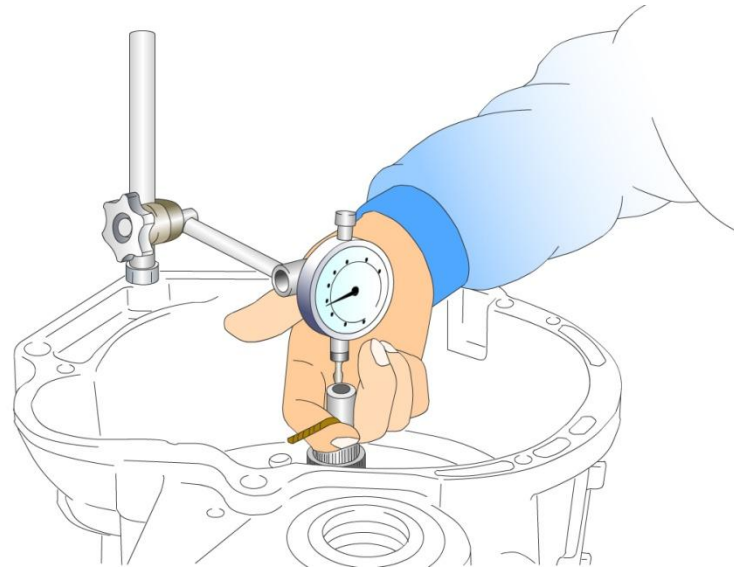 - AT for overhaul
  - Dial gauge

4. Procedure
  - Measure input shaft endplay and
    write it down before overhaul.
  - Overhaul the AT
  - If the endplay is out of spec.,
    select a proper #1 thrust race, #3
    thrust washer when assemly.
  - Measure the input shaft endplay
    after AT assembly.

5. Time to complete : 15 minutes

6. Reference
  : AT 2005 overhaul manual
    (ATMS-EG4DA)

Measure the input shaft endplay and select a proper #3 thrust race and #1 thrust washer.

- Measured endplay : _____ mm

- Standard endplay : _____ mm

1. Application : A4AF3

2. Objectives
 - To measure input shaft endplay
 - To adjust the endply correctly by selecting proper race/washer

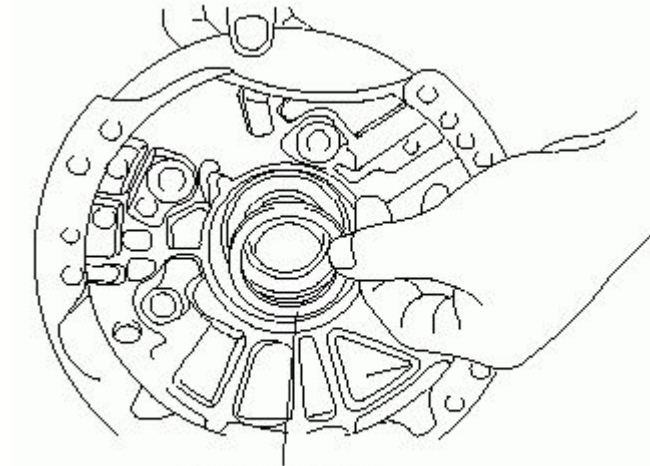3. Required materials
 - AT for overhaul
 - Dial gauge

4. Procedure
 - Measure input shaft endplay and write it down before overhaul.
 - Overhaul the AT
 - If the endplay is out of spec., select a proper #1 thrust race, #3 thrust washer when assemly.
 - Measure the input shaft endplay after AT assembly.

5. Time to complete : 15 minutes

6. Reference
 : AT 2005 overhaul manual (ATMS-EG4DA)

Thrust washer #1

• #3 thrust race selection

☐ Equation :

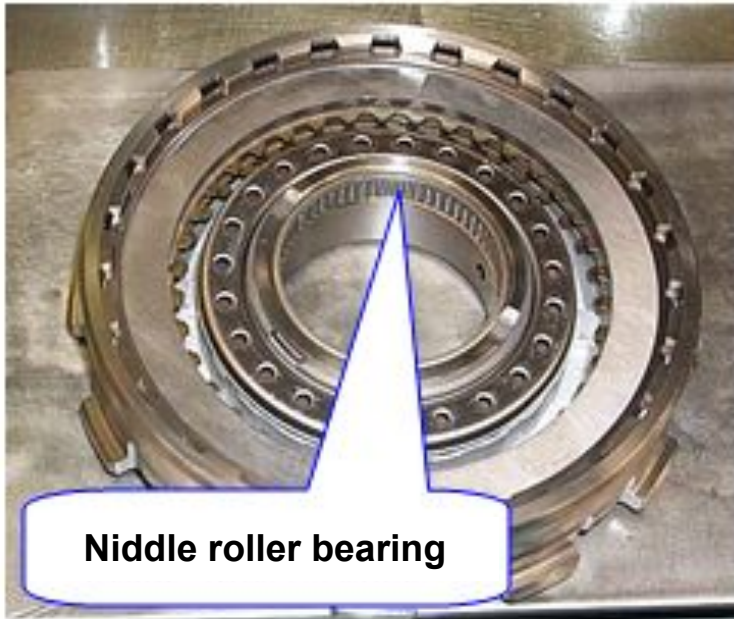(Measurement - Standard endplay) + Thickness of old part

= (_____ mm - _____ mm) + _____ mm

= _____ mm

= _____ t

• #1 thrust washer selection : _____ t

• Measure the input shaft endplay after AT assembly : _____ mm

Niddle roller bearing

- Engaged at D3, R range

- Operates reverse sun gear

- End play : 0.4 ~ 0.6 mm

  (Adjusted by snap ring)

Front clutch pressure
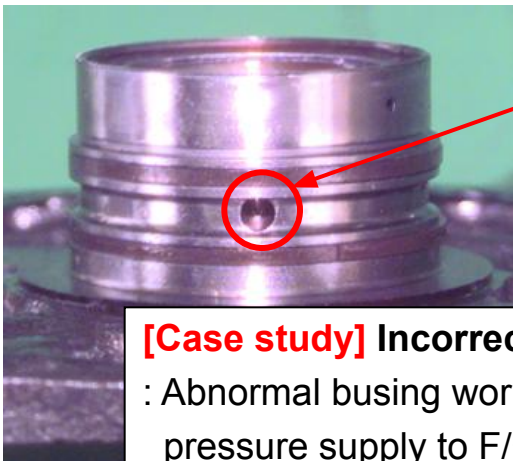
[Case study] Incorrect gear ratio (4th gear)

: Abnormal busing worn-out causes poor oil
  pressure supply to F/C.
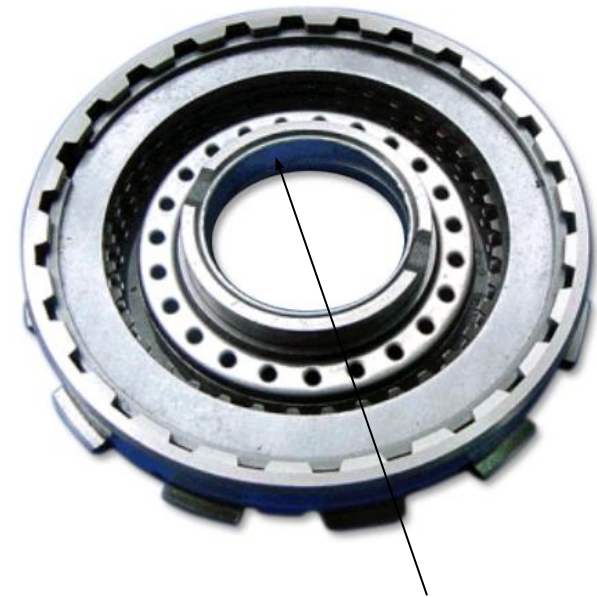
Bushing (for Cerato, before Nov. 07. 2004)

Rear clutch retainer

Input shaft
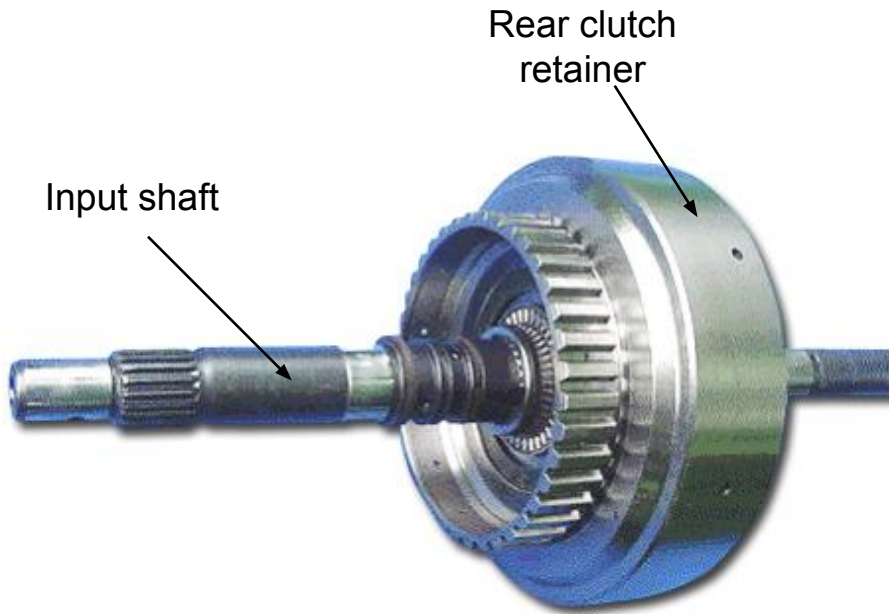
- **Engaged at D1,2,3**

- **Operates forward sun gear**

- **End play : 0.7 ~ 0.9 mm**
  (Adjusted by snap ring)

- **Centrifugal balance chamber applied**

- **4 missing tooth of discs**

Rear clutch pressure

Centrifugal balance chamber

Piston

Piston chamber
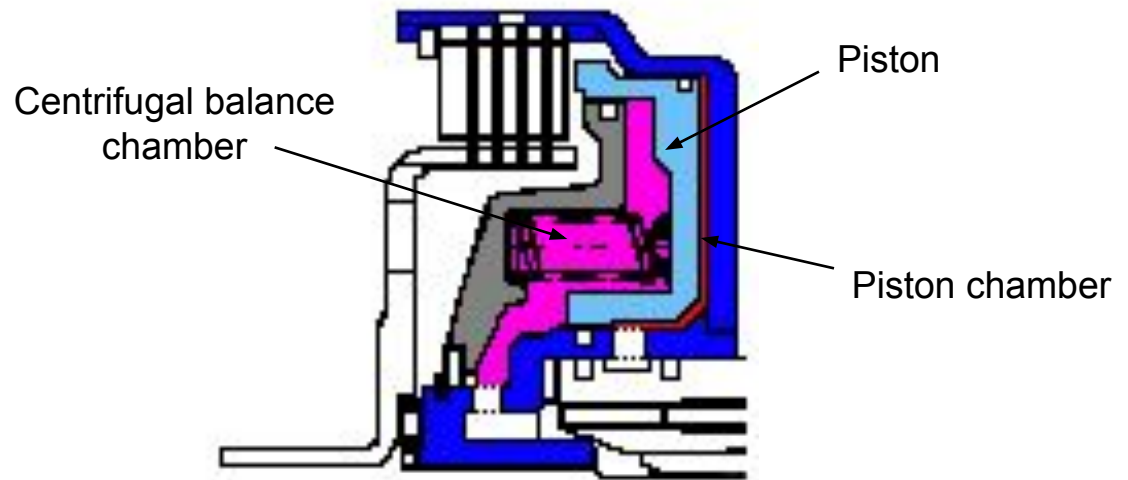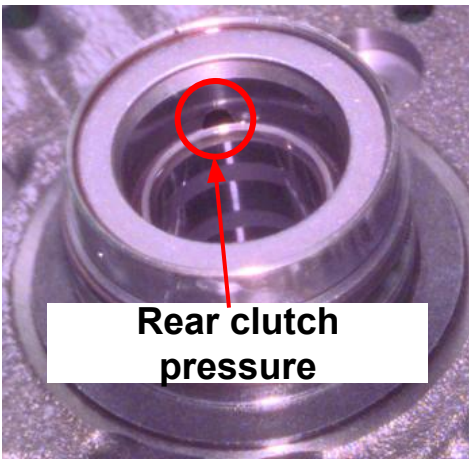
- Engaged at D3,4 (powered only at D4)

- Operates planetary carrier

- End play : 0.4 ~ 0.65 mm

  (Adjusted by snap ring)

Piston rod & piston

Kick-down band

Kick-down drum

- Engaged at D2,4

- hold reverse sun gear
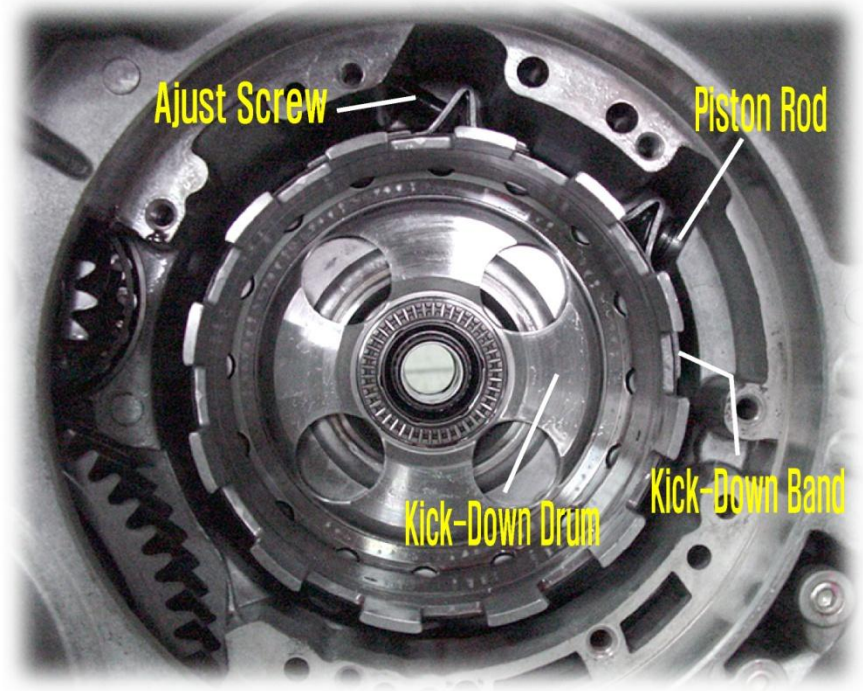
[Installation of the Kickndown Brake]

Kickndown brake servo piston

Servo Release Pressure

K/D switch contact point

Piston rod

Kick-down piston

Servo Apply Pressure
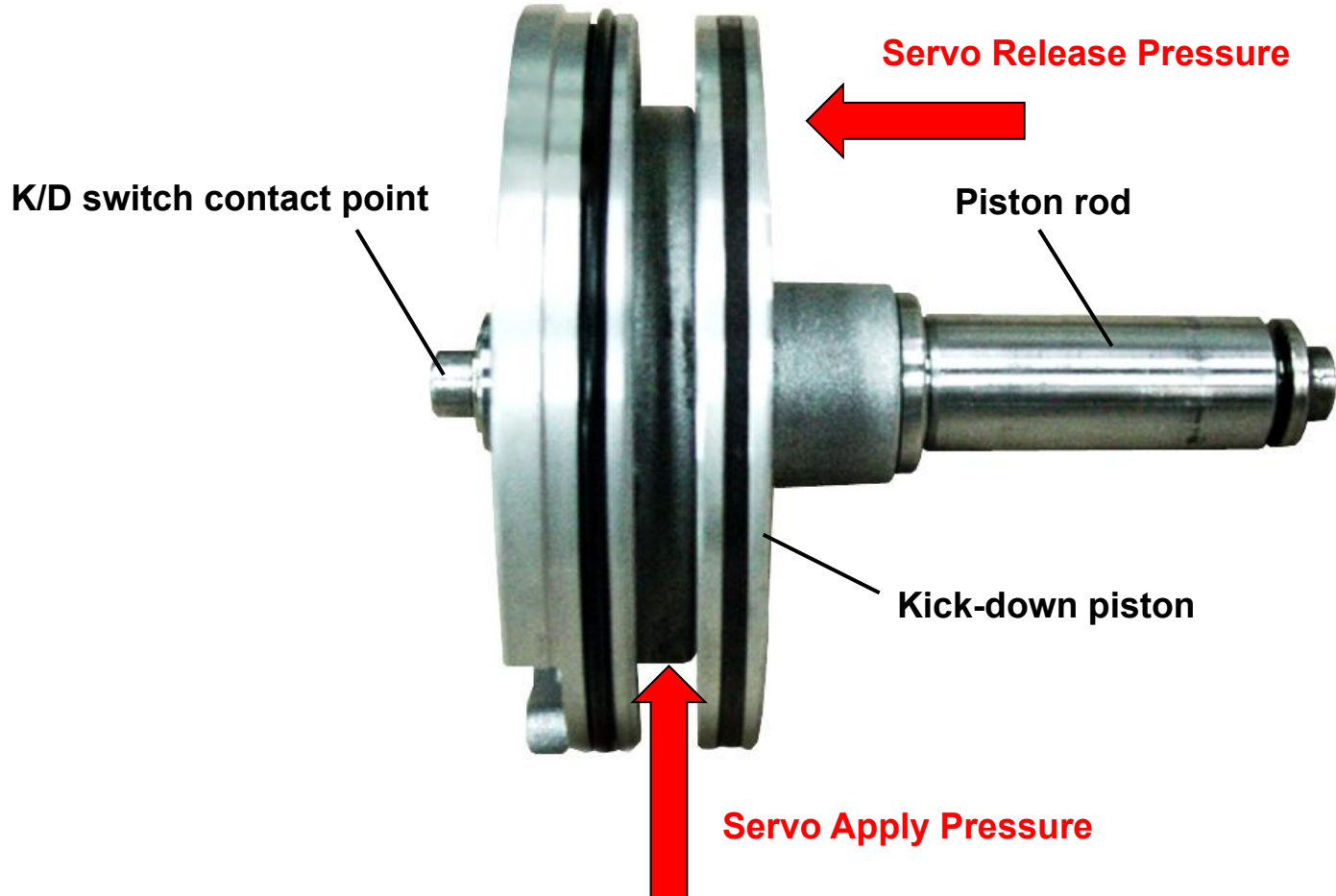
■ **Case Study**

1) **Symptom**

   - **Shift shock at 1st ☐ 2nd gear**

2) **DTC: None**

3) **Cause: Kickdown brake**

☐ **Service Point**

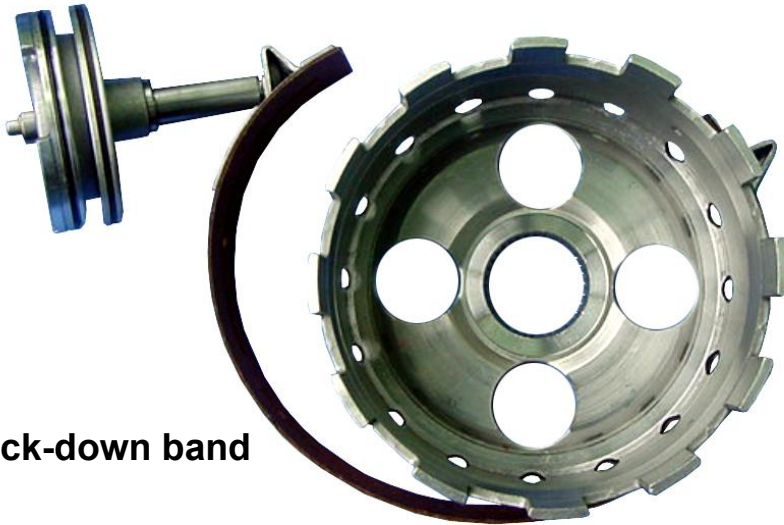| No.	Cause	Symptom	Analysis	Remedy	Remarks
1	Looseness of K/D band	Engine RPM sharply increase (Run-up)	F/C is released prior to K/D band engaged. (1st gear state)	Adjust K/D servo rod	See note
2	Air exhaust plug cap separated	- Shock when shift from 1st to 2nd and from 3rd to 4th gear - 3rd gear hold	K/D piston can't move forward. (K/D band slippage)	Replace air exhaust plug cap	Checking method : repeated shifting from 3rd to 4th or opposite (O/D sw ON-OFF)

* Adjustment procedure

① **Loosen the adjust screw lock nut**
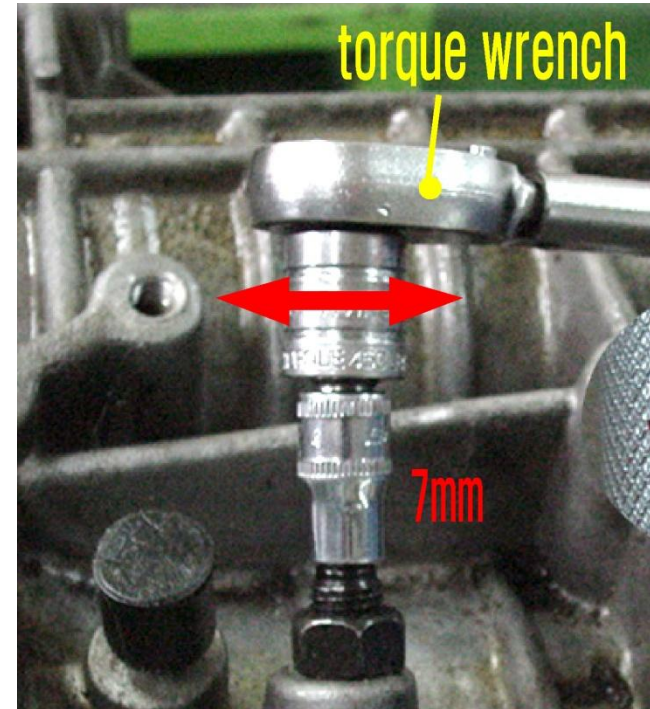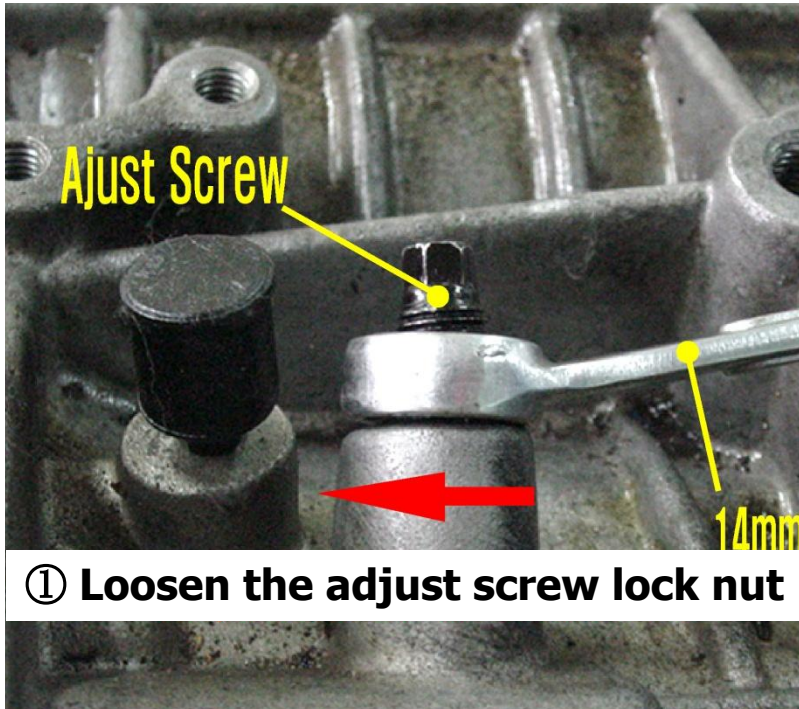
② **Tighten and loosen the adjust screw (2 times, Torque : 5Nm, 50kgcm)**

* Adjustment procedure
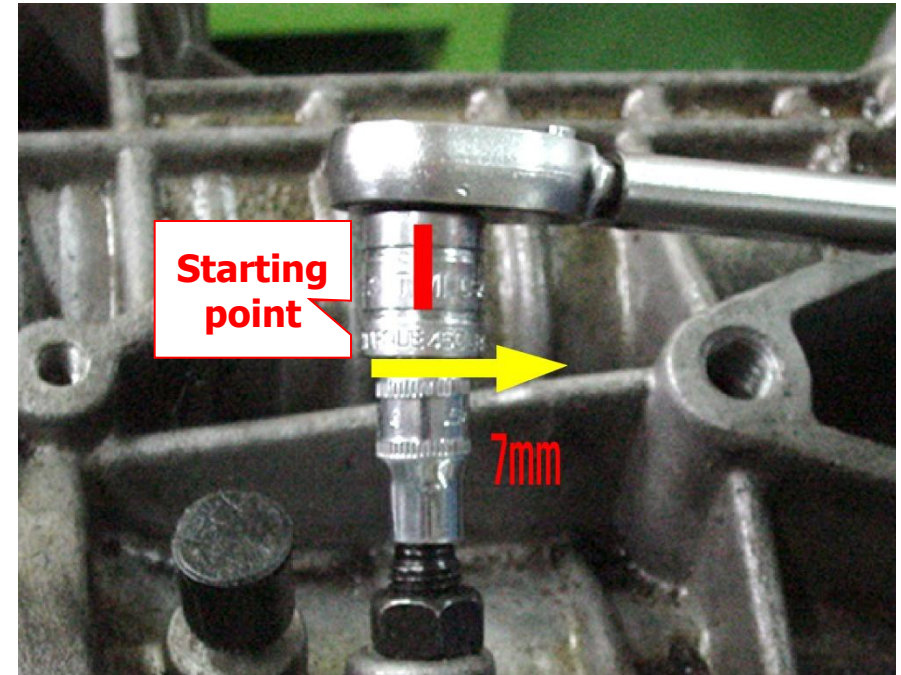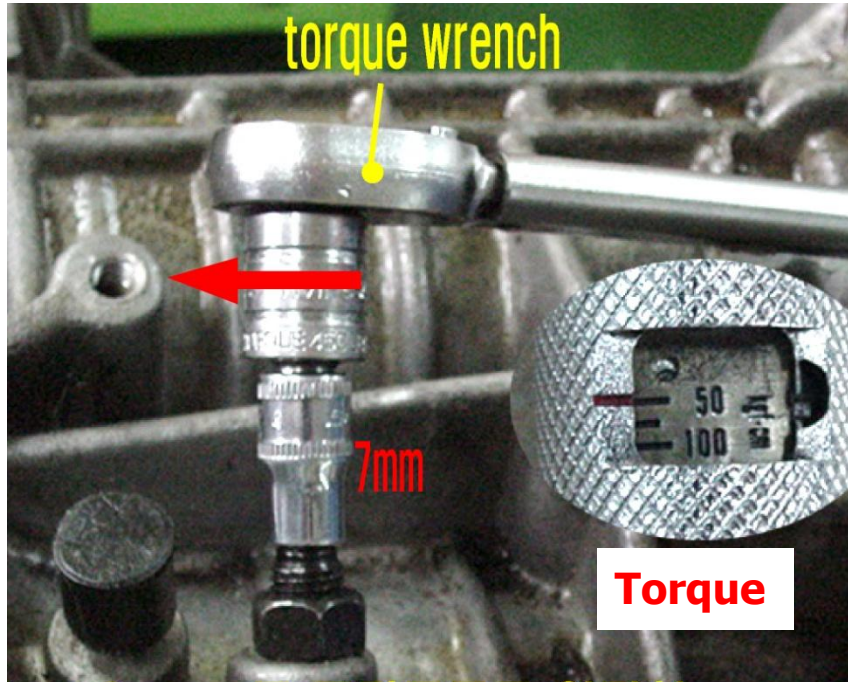
③ **Tighten the adjust screw (Torque : 5Nm, 50kgcm)**

④ **Mark the starting point and release the adjust screw (3 · 1/3 turn)**

* Adjustment procedure
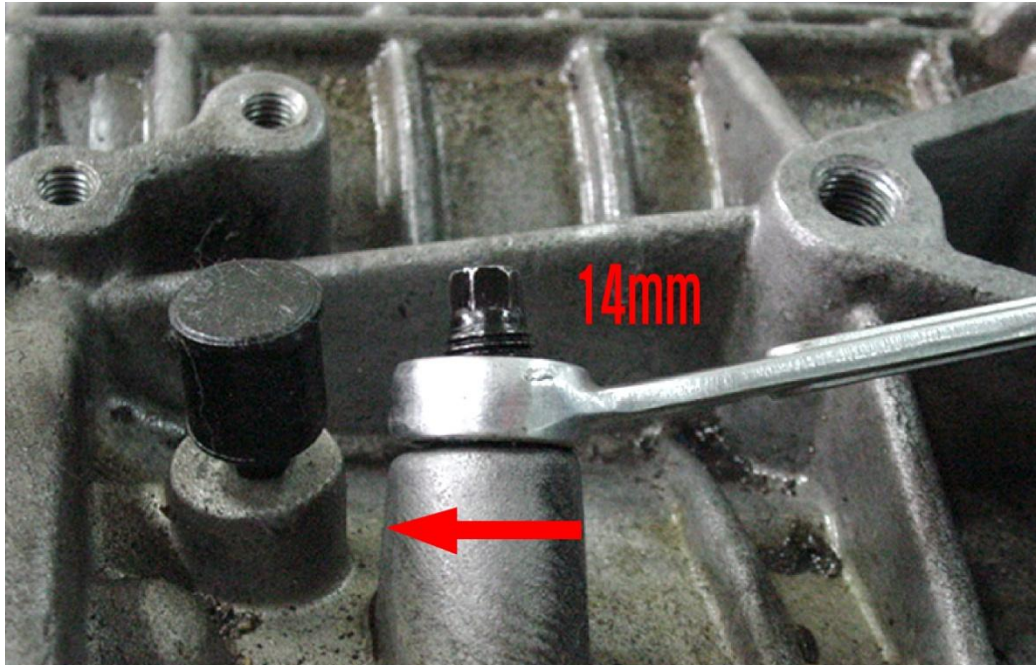
⑤ **Tighten the lock nut. Torque : 20Nm (200kgcm)**

Center support

Wave spring

Hydraulic pressure

LR brake pision
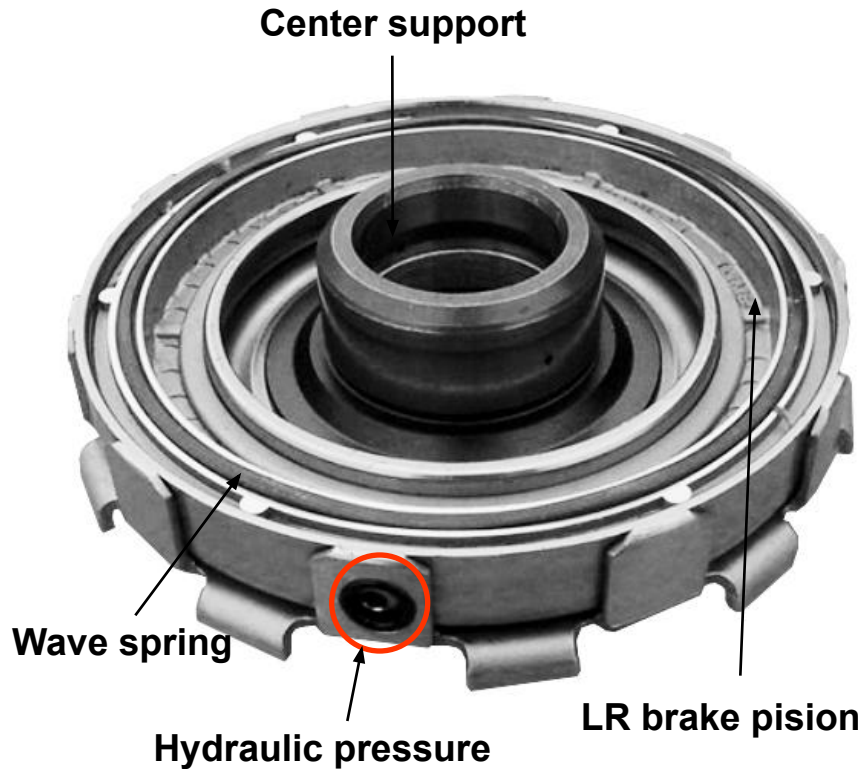
- **Engaged at L, R range**

- **holds planetary carrier**

- **End play : 0.675 ~ 0.987 mm**

  (Adjusted by pressure plate)

[Case study] **R range shift shock □broken wave spring**

Service Point

No.	Cause	Symptom	Analysis	Remedy
1	Pressure plate misselected	Shock generated during "L" or "R" shift - Reverse drive impossible - Stall RPM too high (Clutch slippage)	C1 actuation point (delayed proper endplay) B2 actuation point (delayed:wave spring+proper end play) B2 actuation point moved "N"→"R" shift (C1,B2)　　t(sec)	Select the proper pressure plate

* C1 : Front Clutch
B2 : Low & Reverse Brake

Sprag

Short pinion

Annulus gear

Long pinion

Free

Lock

Inner race
(Center support)

Outer race
(planetary gear carrier)

Forward sun gear
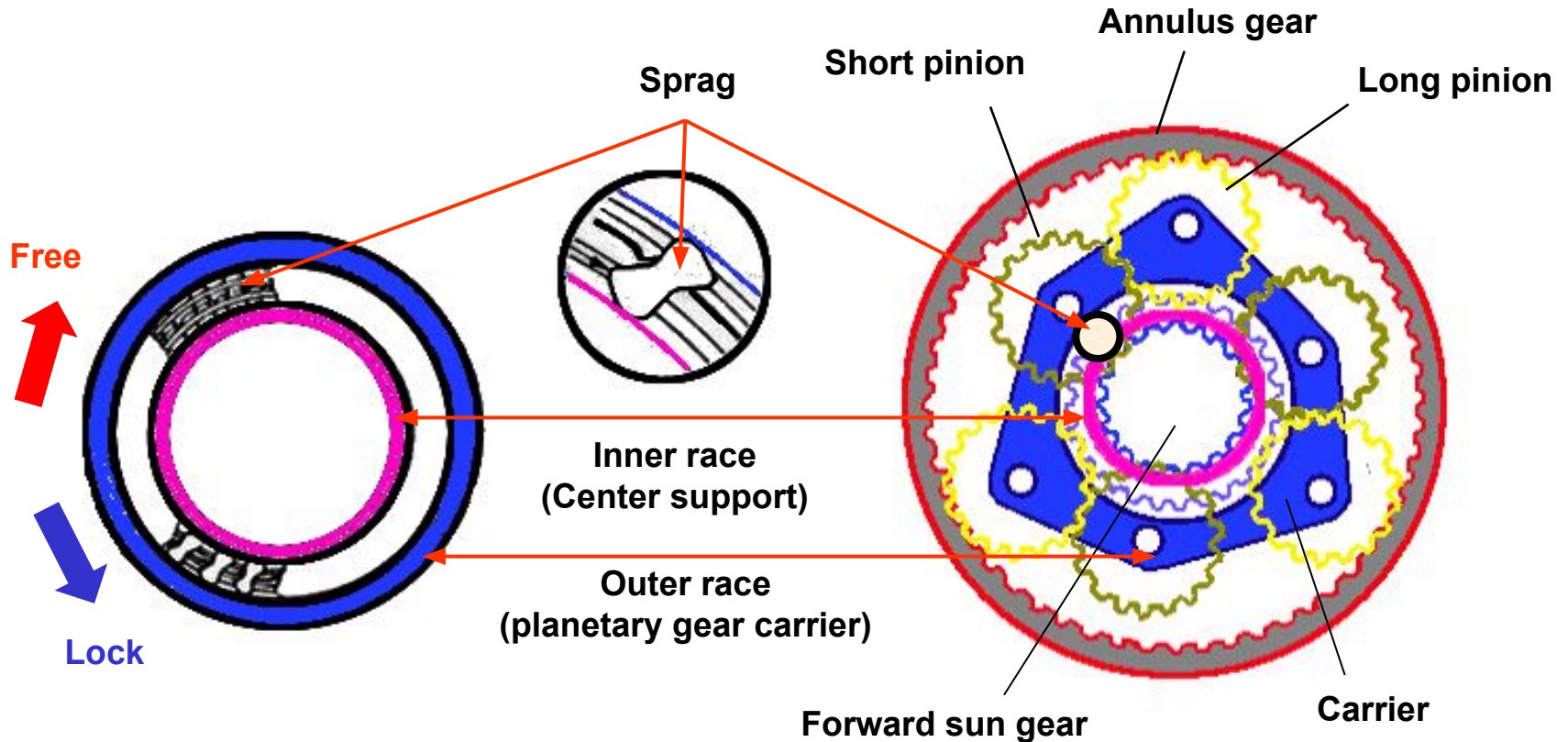
Carrier

Service Point

No.	Cause	Symptom	Analysis	Remedy	Remarks
1	O.W.C wear or damaged	Forward drive impossible	Planetary carrier rotates reverse	Replace O.W.C	Checking method : Drive is possible at "L" range

Reducing pressure

Damper Release

Damper Apply

Rear clutch

Front clutch
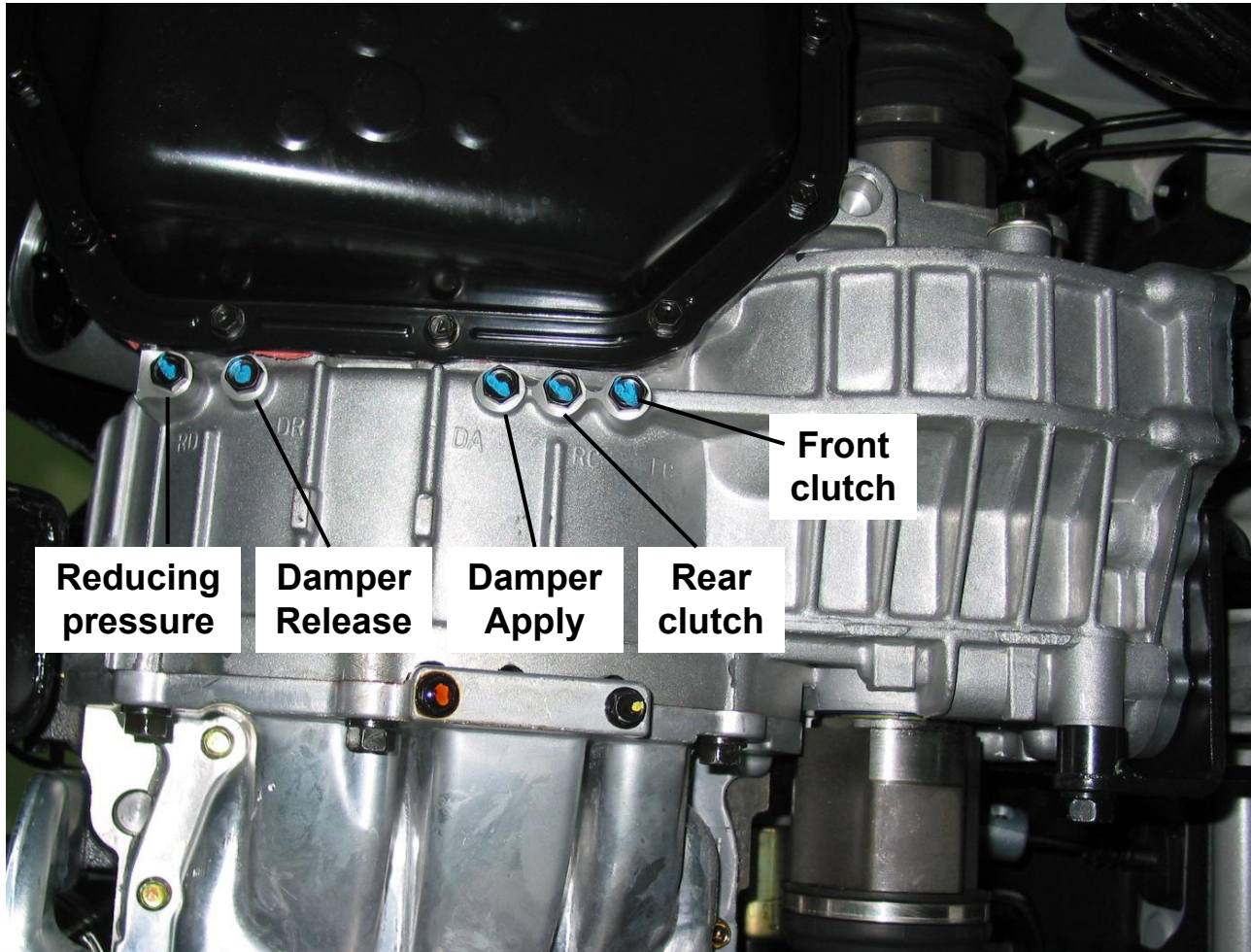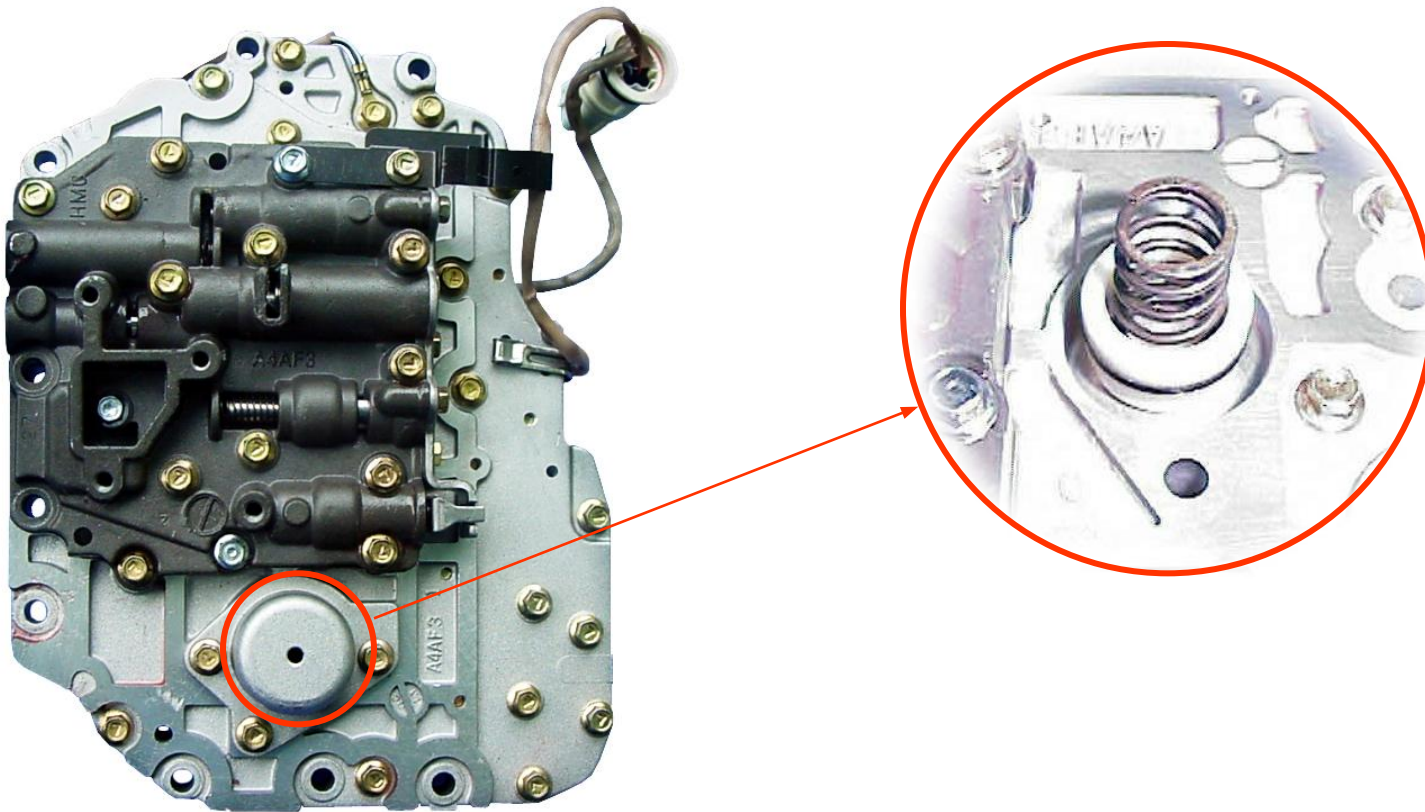
* Function

1) To reduce the shift shock when shifting from N→D, D→N.

2) To prevent R/C slip.

Inputs

- Input speed sensor (PG-A)
- Output speed sensor (PG-B)
- ATF temperature sensor
- Inhibitor switch
- OD OFF switch
- Kick down switch
- Brake switch

PCM

Outputs

- SCSV-A,B,C (ON/OFF)
- PCSV-A,B (PWM)
- DCCSV (PWM)
- OD OFF Lamp
- Dashboard range signal (P,R,N,D & 2,L(PWM))
- MIL (EUR, NA), (ON at 2 D/C)

Input speed sensor
(PG-A)
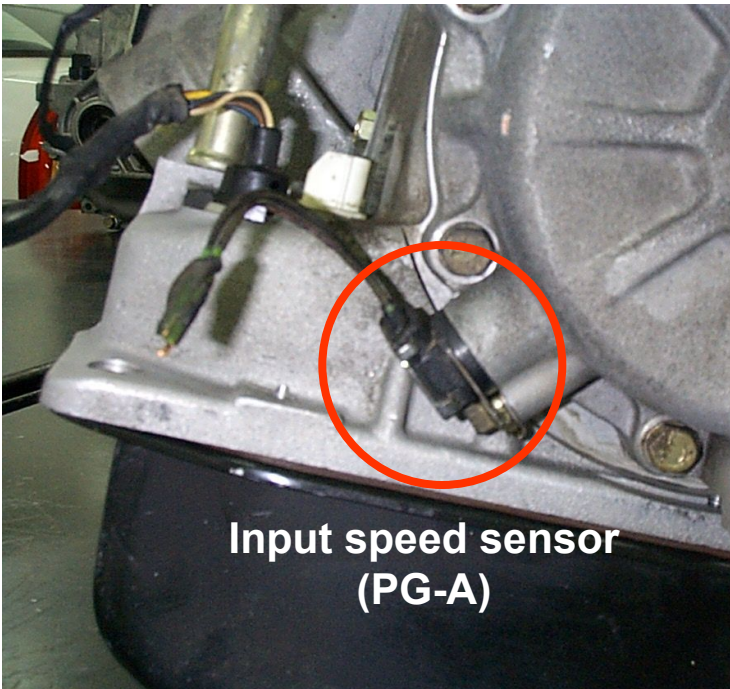
```
        1.2 CURRENT DATA
 ✳ ENGINE SPEED            1694  rpm
 ✳ VEHICLE SPEED SENSOR    60    Km/h
 ✳ THROTTLE P.SENSOR       3.5   %
 ✳ PG-A(INPUT SPEED)       1597  rpm
 ✳ PG-B(OUTPUT SPEED)      2332  rpm
   SHIFT POSITION          4
   TRANSAXLE RANGE SW      D
   O/D SWITCH              ON

  FIX   SCRN   FULL   PART   GRPH   HELP
```

• PG-A detects _____ speed.

• Sensor resistance : 215~275Ω (20˚C)

Output speed sensor (PG-B)
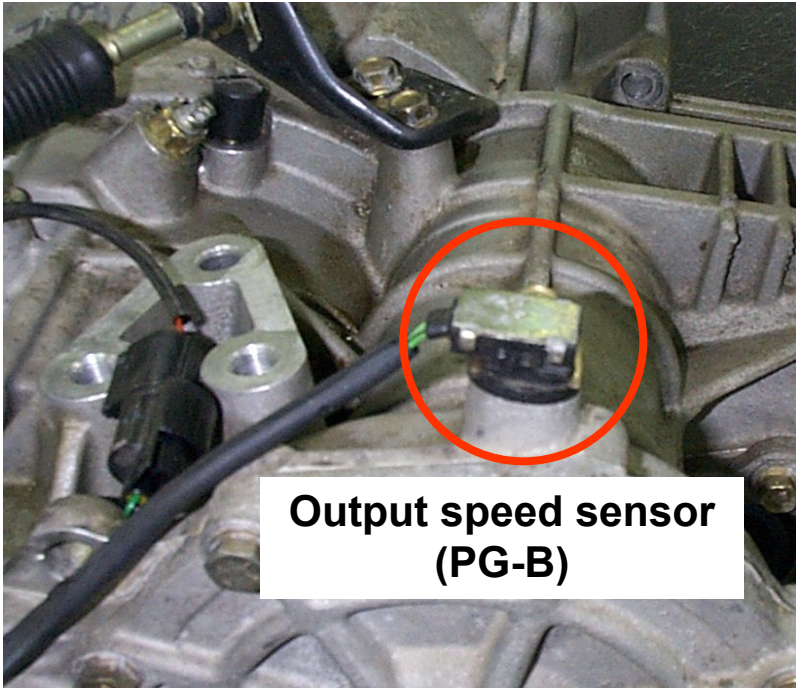

```
        1.2 CURRENT DATA

✳ ENGINE SPEED            1903 rpm
✳ VEHICLE SPEED SENSOR    50    Km/h
✳ THROTTLE P.SENSOR       3.5   %
✳ PG-A(INPUT SPEED)       1902 rpm
✳ PG-B(OUTPUT SPEED)      1903 rpm
  SHIFT POSITION          3
  TRANSAXLE RANGE SW      D
  O/D SWITCH              OFF

 FIX   SCRN   FULL   PART   GRPH   HELP
```

- PG-B detects _____ speed.

- Sensor resistance : 215~275Ω (20˚C)

Input speed sensor

FR   CH A 1.0 V   2.0 mS   CH B 1.0 V

2.5V

2.5V

HOLD   ZOOM   CURS   R-ST   RECD   MENU
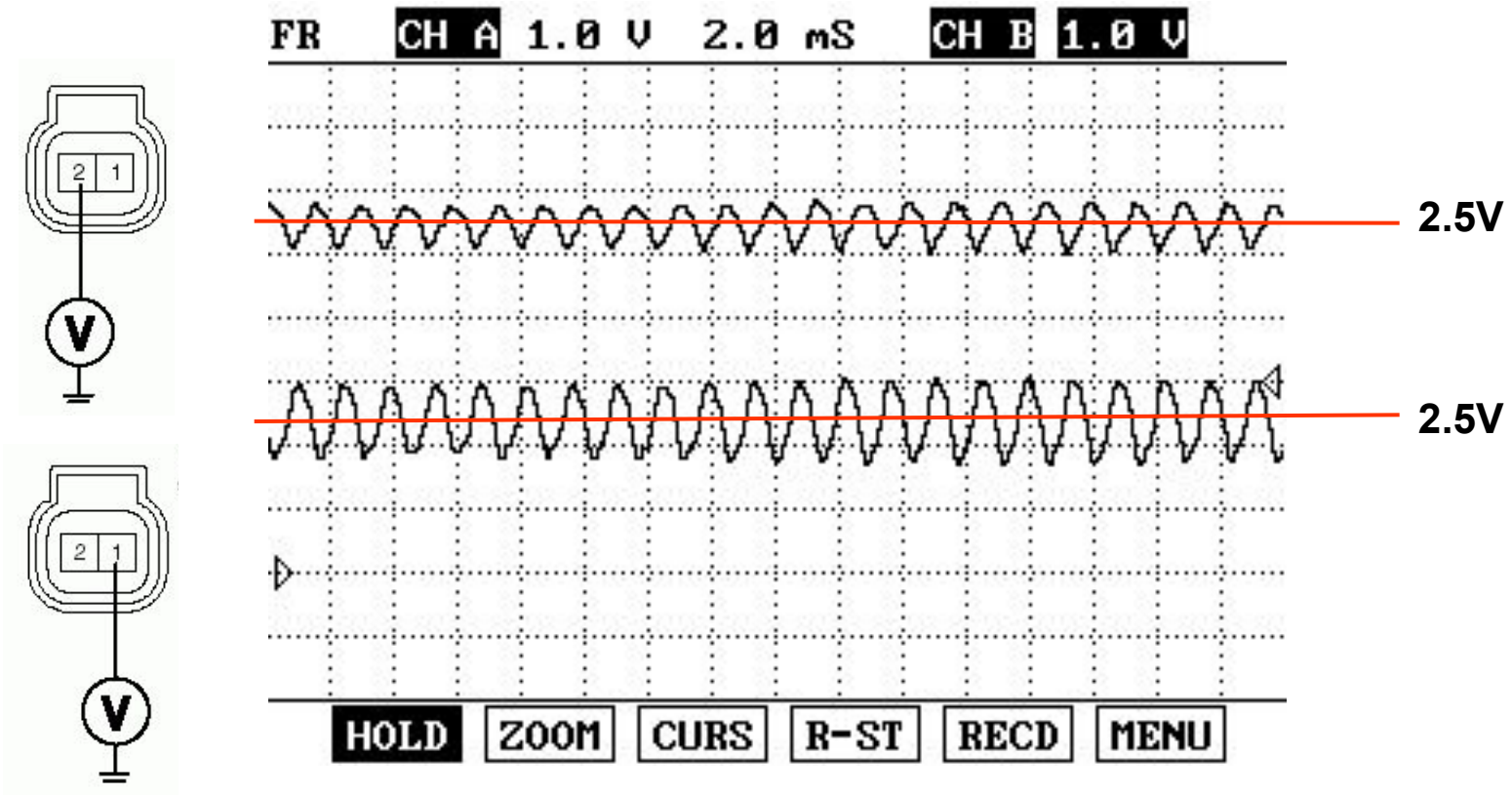
* Output voltage at IG on is 2.5V.

* Rationality

Component System	Fault Code	Description	Malfunction Criteria	Threshold	Filtering Time	MIL On
Input speed sensor	P0716	Rationality high	Input speed	Input speed > 8000[rpm]	1[sec]	2drv. cycle

Test Condition	Battery voltage >=9[V]
Fail safety	D: 3rd gear fix, 2,L: 2nd gear fix, damper open.

* Input speed sensor open

Component System	Fault Code	Description	Malfunction Criteria	Threshold	Filtering Time	MIL On
Input speed sensor	P0717	No Signal	Input speed	Input speed = 0	1[sec]	2drv. cycle

Test Condition	Battery voltage >= 9[V] Inhibitor switch = D, 2, L (No error) Output speed > 1000[rpm] Engine speed > 3000[rpm] (No error) (Only 1st gear)
Fail safety	D: 3rd gear fix, 2,L: 2nd gear fix, damper open.

* Output speed sensor open

Component System	Fault Code	Description	Malfunction Criteria	Threshold	Filtering Time	MIL On
Output speed sensor	P0722	No signal	Output speed	Output speed = 0	6.6[sec] 5.1[sec]	2drv. cycle

Test Condition	Battery voltage >=9V Current gear = 1 and Inhibitor switch : D, 2, L (No error) Brake Off (No Error) Throttle opening > 14.9[%] (No error) and Engine speed > 3500[rpm] (No error) Time Delay : 1.6 sec Filter Time : 5 sec OR Battery voltage >=9V Current gear > 1 and Inhibitor switch : D, 2 (No error) Brake Off (No Error) Input speed > 1500[rpm] (No error) or Engine speed > 3000[rpm] (No error) Time Delay : 100 msec Filter Time : 5 sec
Fail safety	Substitute Output speed (Vehicle speed or input speed signal), D: 3rd gear fix, 2,L: 2nd gear fix, damper open.

* Gear ratio (1st gear speed)

Component System	Fault Code	Description	Malfunction Criteria	Threshold	Filtering Time	MIL On
1 Gear ratio	P0731	Rationality high	Proportionality check between input speed and output speed	Input speed > Synchron speed + 200[rpm]	1.0[sec]	2drv. cycle

Test Condition	Engine speed sensor, OTS, Solenoid, Position lever, Input speed sensor, Output speed sensor, CAN no error Syncron speed is calculated turbine speed The last shift was finished > 2[sec] Oil temperature > -10[ºC] Engine speed > 400[rpm] Inhibitor switch : D, 2, L Input speed > 300[rpm] Output speed > 300[rpm]
Fail safety	Electrical Actuator off (Fixed 3rd gear, damper open)

* Gear ratio (2nd ~ 4th gear speed)

Component System	Fault Code	Description	Malfunction Criteria	Threshold	Filtering Time	MIL On
2, 3, 4 Gear ratio	P0732(2nd) P0733(3rd) P0734(4th)	Rationality low / high	Proportionality check between input speed and output speed	Input speed > Synchron speed ± 200[rpm]	1.0[sec]	2drv. cycle

Test Condition	Engine speed sensor, OTS, Solenoid, Position lever, Input speed sensor, Output speed sensor, CAN no error Syncron speed is calculated turbine speed The last shift was finished > 2[sec] Oil temperature > -10[°C] Engine speed > 400[rpm] Inhibitor switch : 4th(D),3rd(D),2nd(2) Input speed > 300[rpm] Output speed > 600[rpm]
Fail safety	Electrical Actuator off (Fixed 3rd gear, damper open)

Kick-down switch

To TCM

Adjust rod

Kick down servo S/W
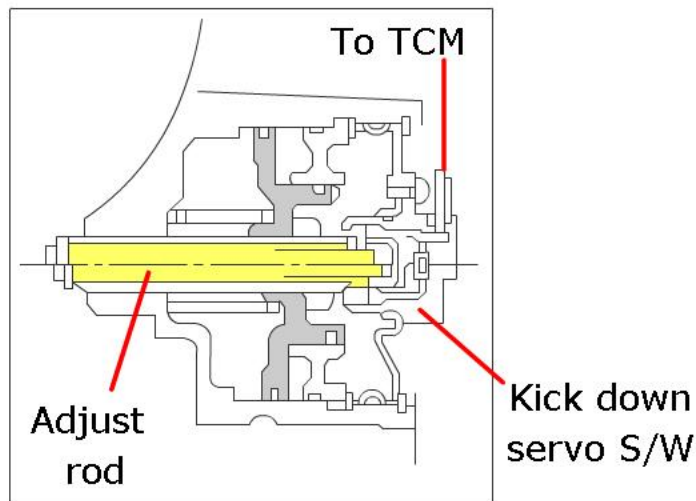
Shift position	K/D switch
1st gear	_____
2nd gear	_____
3rd gear	_____
4th gear	_____

1.2 CURRENT DATA

� ENGINE SPEED	2552	rpm
� PG-A(INPUT SPEED)	0	rpm
� PG-B(OUTPUT SPEED)	2552	rpm
� SHIFT POSITION	3	
K/D SWITCH	ON	
VEHICLE SPEED SENSOR	67	Km/h
THROTTLE P.SENSOR	3.9	%
TCC SOLENOID DUTY	100.0	%

FIX SCRN FULL PART GRPH HELP

1.2 CURRENT DATA

SHIFT POSITION

- 4 -

✱K/D SWITCH

OFF

FIX Z(-) Z(+)
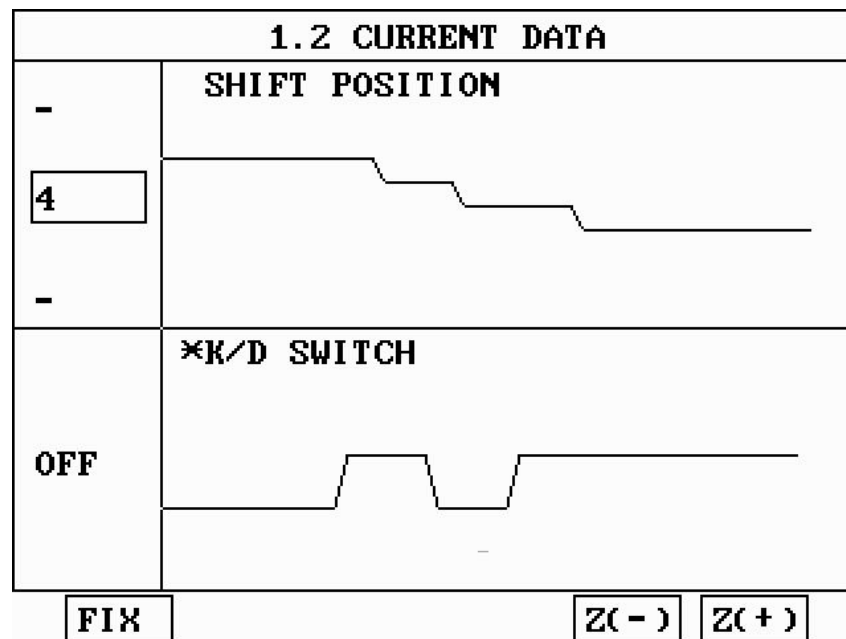
* K/D switch open or short to GND (No MIL)

Failure	Detected Conditions	Failsafe	DTC

No signal
 	
GND Short
	* Output speed > 900 rpm & ATF Temp. > 60℃
	  & Inhibitor S/W ≠ P,R,N & Engine speed > 400 rpm
	
	- S/W OFF continues for 2 seconds or more
	  from 5 seconds after shifting to 1st or 3rd gear
	- S/W ON continues for 2 seconds or more
	  from 5 seconds after shifting to 2nd or 4th gear
		Gear shifting is available	1709

```
1.2 CURRENT DATA

✳ ENGINE SPEED            663   rpm
✳ PG-A(INPUT SPEED)       587   rpm
✳ PG-B(OUTPUT SPEED)      206   rpm
✳ SHIFT POSITION          1
✳ TRANSAXLE RANGE SW      D
✳ K/D SWITCH              OFF
  VEHICLE SPEED SENSOR    5     Km/h
  THROTTLE P.SENSOR       0.0   %

FIX   SCRN   FULL   PART   GRPH   HELP
```

```
1.2 CURRENT DATA

-            SHIFT POSITION

4

-

OFF          ✳K/D SWITCH
                                    ×

FIX                      Z(-)  Z(+)
```

High :12V

Brake applied

Low : 0V

[Brake switch signal]

Purpose

- **Damper cltuch operation (brake applied ☐ damper clutch off)**
- **Output speed sensor failure detection (stall test detection)**

* Rationality check

Component System	Fault Code	Description	Malfunction Criteria	Threshold	Filtering Time	MIL On
Brake switch	P0703	Rationality	Brake input switch	Brake signal : 12V	1[sec]	-

Test Condition	CAN no error Inhibitor switch = D, R Output speed > 600[rpm] (No error) Throttle opening >= 9.8[%] Satisfy time > 30[sec]
Fail safety	Substitute brake signal : Throttle opening > 0 % : Brake off = 0 % : Brake on

Oil temperature sensor
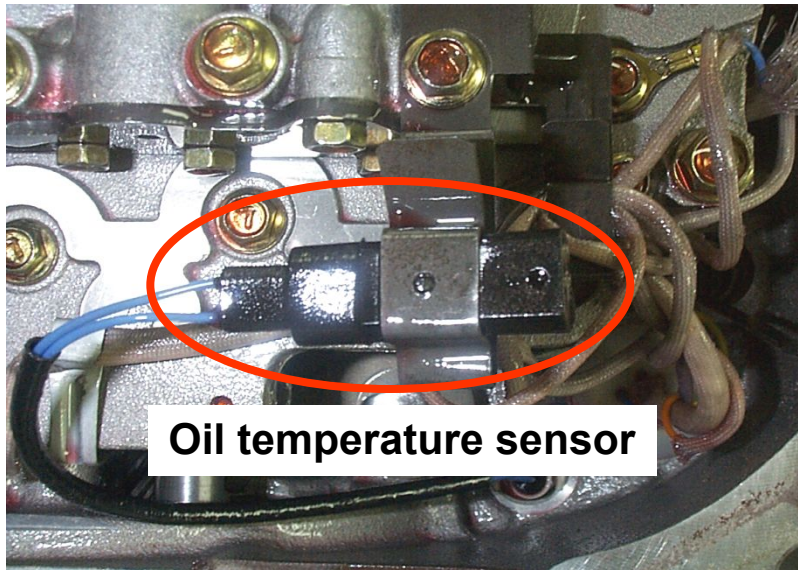
[Valve body]


```
         1.2 CURRENT DATA
  ✳ ENGINE SPEED            1423 rpm
  ✳ THROTTLE P.SENSOR        2.4 %
  ✳ PG-A(INPUT SPEED)       1422 rpm
  ✳ PG-B(OUTPUT SPEED)      2076 rpm
  ✳ TCC SOLENOID DUTY        33.7 %
  ✳ TCC SLIP(AMOUNT)           1  rpm
    FLUID TEMP.SENSOR         54  °C
    SHIFT POSITION             4
  FIX  SCRN  FULL  PART  GRPH  HELP
```

- **Pressure control**

  : PCSV duty changes according to ATF temperature

- **Damper clutch control**

  : damper clutch On/Off control according to ATF temperature

- **High temperature control**

  : performs different shift pattern when ATF temperature is too high (115 ℃)

* Oil temperature sensor

Failure	Detected Conditions	Failsafe	DTC
Rationality	-	*ATF Temp.: 80℃ * Intelligent shift is inhibited	0711
GND Short	- Voltage < 0.1V (over 160℃) for 1 second or more		0712
Open/ Short	* Engine speed ≥ 1000 rpm & Output speed ≥ 500 rpm - Voltage > 4.547V for 160 seconds or more		0713

```
        1.2 CURRENT DATA
✷ PG-A(INPUT SPEED)      5035 rpm
✷ PG-B(OUTPUT SPEED)     5036 rpm
✷ TCC SOLENOID DUTY      0.0  %
✷ PCSV-A DUTY            0.0  %
✷ PCSV-B DUTY            0.0  %
✷ FLUID TEMP.SENSOR      -40  °C
✷ SHIFT POSITION         3
  TCC SLIP(AMOUNT)       29   rpm

  FIX  SCRN  FULL  PART  GRPH  HELP
```

[Oil temperature-circuit open]

```
     1.1 DIAGNOSTIC TROUBLE CODES
P0713 FLUID TEMP.SNSR-OPEN/SHORT




     NUMBER OF DTC  :  1 ITEMS
  PART  ERAS                  HELP
```

[DTC-circuit open]

```
        1.2 CURRENT DATA
✷ PG-A(INPUT SPEED)      2158 rpm
✷ PG-B(OUTPUT SPEED)     3150 rpm
✷ FLUID TEMP.SENSOR      80   °C
✷ SHIFT POSITION         4
  TCC SOLENOID DUTY      36.5 %
  TCC SLIP(AMOUNT)       1    rpm
  PCSV-A DUTY            0.0  %
  PCSV-B DUTY            0.0  %

  FIX  SCRN  FULL  PART  GRPH  HELP
```

[Oil temperature-failsafe]

* Short to GND

Component System	Fault Code	Description	Malfunction Criteria	Threshold	Filtering Time	MIL On
Oil temperature sensor	P0712	Circuit continuity-GND	OTS output voltage	Vots < 0.1[V]	1[sec]	2drv. cycle

Test Condition	Battery voltage >= 9[V]
Fail safety	Oil temperature = 80 degC

* After IG on , OTS short to Battery

Component System	Fault Code	Description	Malfunction Criteria	Threshold	Filtering Time	MIL On
Oil temperature sensor	P0713	Battery short	OTS output voltage	Vots > 4.8[V]	1[sec]	2drv. cycle

Test Condition	Battery voltage >= 9[V]
Fail safety	Oil temperature = 80 degC Oil temperature at IG on >= -38[ºC]

* Before IG on, OTS short to Battery

Component System	Fault Code	Description	Malfunction Criteria	Threshold	Filtering Time	MIL On
Oil temperature sensor	P0713	Battery short	OTS output voltage	Vots > 4.8[V]	1[sec]	2drv. cycle

Test Condition	Battery voltage >= 9[V] Oil temperature at IG on < -38[ºC] Engine speed > 1000[rpm] (No error) Output speed > 500[rpm] Coolant temperature >= 70[ºC] (No error) Accumulated time with above conditions > 160[sec]
Fail safety	Oil temperature = 80 degC

* After IG on, OTS open

Component System	Fault Code	Description	Malfunction Criteria	Threshold	Filtering Time	MIL On
Oil temperature sensor	P0713	Open	OTS output voltage	4.45[V] < Vots < 4.8[V]	1[sec]	2drv. cycle

Test Condition	Battery voltage >= 9[V] Oil temperature at IG on >= -38[ºC]
Fail safety	Oil temperature = 80 degC

* Before IG on, OTS open

Component System	Fault Code	Description	Malfunction Criteria	Threshold	Filtering Time	MIL On
Oil temperature sensor	P0713	Open	OTS output voltage	4.45[V] < Vots < 4.8[V]	1[sec]	2drv. cycle

Test Condition	Battery voltage >= 9[V] Oil temperature at IG on < -38[ºC] Engine speed > 1000[rpm] (No error) Output speed > 500[rpm] Coolant temperature >= 70[ºC] (No error) Accumulated time with above conditions > 160[sec]
Fail safety	Oil temperature = 80 degC

* Rationality(Gradient error)

Component System	Fault Code	Description	Malfunction Criteria	Threshold	Filtering Time	MIL On
Oil temperature sensor	P0711	Rationality (Gradient high)	OTS output voltage	Change of the Vots at 50[ms] > =0.5[V]	1[sec]	2drv. cycle

Test Condition	Input speed or engine speed > 600[rpm] OTS backup value not used at least once 0.1[V] < Vots < 4.547[V] debouncing time to detect gradient error > 1[sec]
Fail safety	Oil temperature = 80 degC

* Rationality(Low Stuck error)

Component System	Fault Code	Description	Malfunction Criteria	Threshold	Filtering Time	MIL On
Oil temperature sensor	P0711	Rationality (Stuck)	Oil temperature	Change of the oil temp. < 3 [ºC]	1[sec]	2drv. cycle

Test Condition	Input speed or engine speed > 600[rpm] OTS backup value not used at least once Output speed > 500[rpm] Engine speed > 1000[rpm] (No error) Throttle angle > 3.5[%] (No error) Output speed no error Oil temperature at cranking < 50 [ºC] Accumulated time of stuck monitoring > 600[sec]
Fail safety	Oil temperature = 80 degC

* Rationality(Cold Stuck error)

Component System	Fault Code	Description	Malfunction Criteria	Threshold	Filtering Time	MIL On
Oil temperature sensor	P0711	Rationality (Stuck)	Oil temperature	Time to reach target Oil Temp. < Filter Time	1[sec]	2drv. cycle

Test Condition	Input speed or engine speed > 600[rpm] OTS backup value not used at least once Oil temperature at cranking < -10[ºC] Target Oil temperature : -10[ºC] (No error) Low stuck no error Inhibitor switch = D, 2, L Accumulated time to reach target oil temperature after cranking
Fail safety	Oil temperature = 80 degC

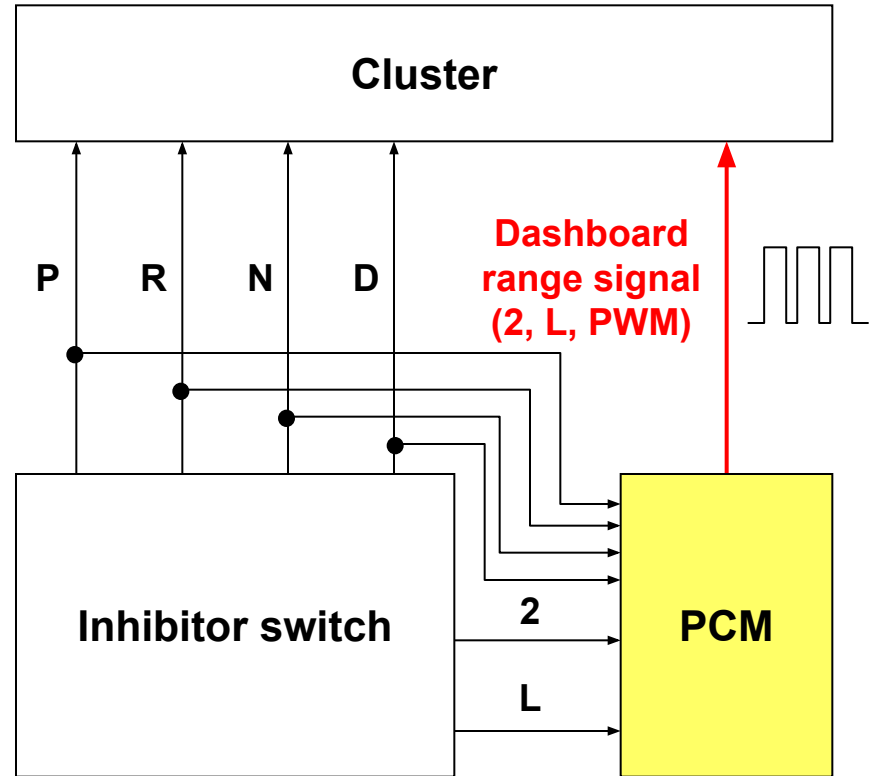| Oil Temp. at Cranking	-40	-30	-20	-10
Filter Time	950	900	650	550

* Rationality(High Stuck error)

Component System	Fault Code	Description	Malfunction Criteria	Threshold	Filtering Time	MIL On
Oil temperature sensor	P0711	Rationality (Stuck)	Oil temperature	CGT – CMO > 10[ºC]	1[sec]	2drv. cycle

Test Condition	Input speed or engine speed > 600[rpm] OTS backup value not used at least once Oil temperature at cranking > 45[ºC] (No error) Coolant temperature > -20[ºC] Cold stuck no error Oil Temp_keyon-CMO_keyon > 10 [ºC] Decrement of the coolant temperature after soaking(ig off) →(CMO_keyoff – CMO_keyon) >= 30[ºC] The variation of coolant temperature after key on > 5[ºC] CGT : Oil temperature , CMO : Coolant temperature
Fail safety	Oil temperature = 80 degC

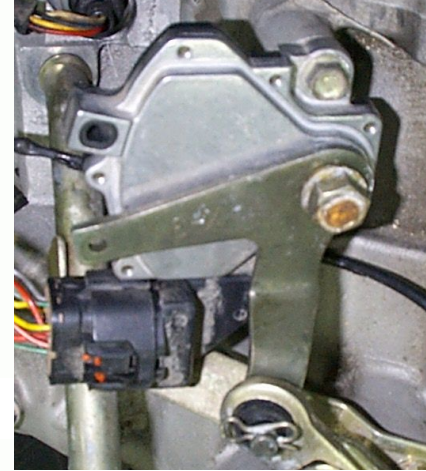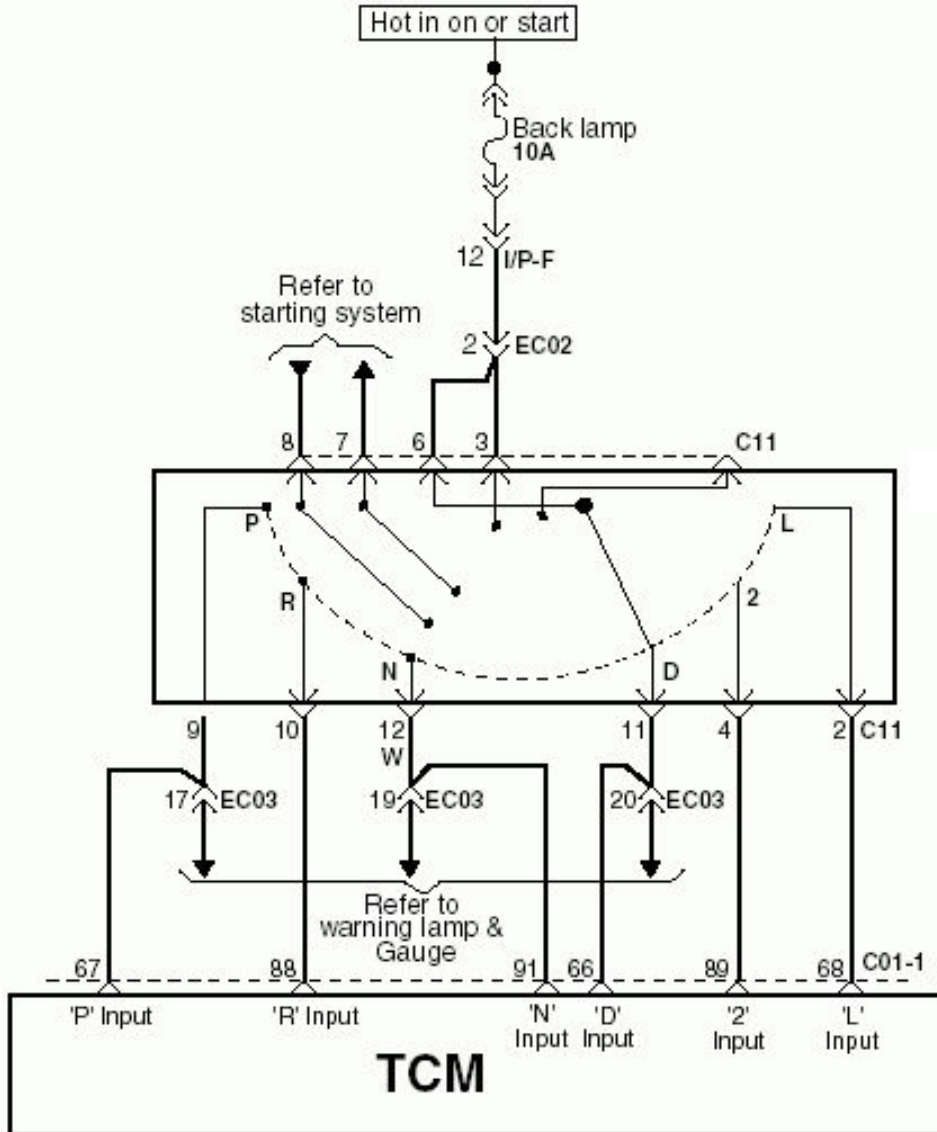[Trip computer display on the clutster]

Cluster

Dashboard range signal (2, L, PWM)

P   R   N   D

Inhibitor switch

2

L

PCM

• Duty at 2 range :   75   %

• Duty at L range :   87   %

* Shift pattern at each range

- D (O/D ON) : 1st ~ 4th
- D (O/D OFF) : 1st ~ 3rd ~ 4th
- 2 : 1st ~ 2nd ~ 3rd t
- L L 1st ~ 2nd

* Rationality(Multiple signal)

Component System	Fault Code	Description	Malfunction Criteria	Threshold	Filtering Time	MIL On
Inhibitor switch	P0708	Rationality	Range switch	Multiple signals are detected	30[sec]	2drv. cycle

Test Condition	Battery voltage >= 9[V]
Fail safety	Substitute position (the last valid value is still store) Fix 3 gear when error occurred at IG Key On.

* Inhibitor switch open

Component System	Fault Code	Description	Malfunction Criteria	Threshold	Filtering Time	MIL On
Inhibitor switch	P0707	Lack of circuit continuity	Range switch	No signal is detected	30[sec]	2drv. cycle

Test Condition	Battery voltage >= 9[V] Engine speed > 500[rpm] (No error)
Fail safety	Substitute position (the last valid value is still store) Fix 3 gear when error occurred at IG Key On.

1. Application : A4AF3

2. Objectives
 - To understand the failsafe function of inhibitor switch

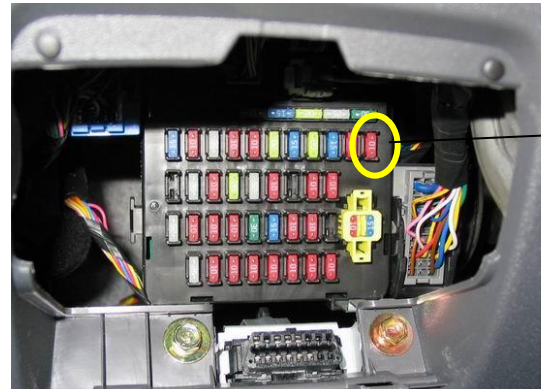3. Required materials
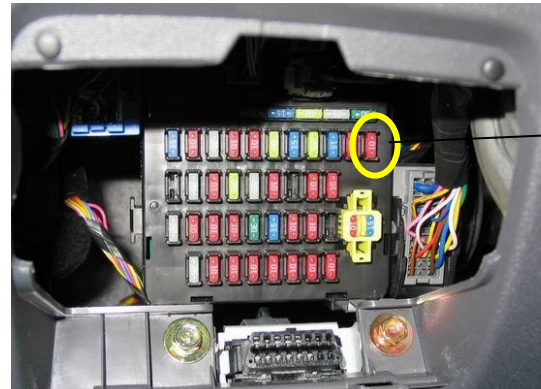 - Vehicle with

4. Procedure
 - Start engine and shift to 'N or P' position.
 - Remove the 10A back-up fuse from the I/P fuse box.
 - Check shift range on the cluster
 - Check the shift position of Hi-scan
 - Check the SCSV-ABC ON/OFF
 - Write down the vehicle movement at R,D,2,L range

5. Time to complete : 5 minutes

6. Reference

1.   Start engine and position shift lever to 'N or P' position

•   Remove the 10A back-up fuse from the I/P fusebox.

Back-up fuse

3.   How is the shift range on the cluster?

4.   Write down SCSV-ABC ON/OFF signal and gear position at D/2/L.

Shift range	SCSV-A	SCSV-B	SCSV-C	Available gear
P/N				
R				
D				
2				
L				

1. Application : A4AF3

2. Objectives
  - To understand the failsafe function of inhibitor switch

3. Required materials
 - Vehicle with

4. Procedure
  - Start engine and shift to 'R' position.
  - Remove the 10A back-up fuse from the I/P fuse box.
  - Check shift range on the cluster
  - Check the shift position of Hi-scan
  - Check the SCSV-ABC ON/OFF
  - Write down the vehicle movement at D,2,L range

5. Time to complete : 5 minutes

6. Reference

1. **Start engine and position shift lever to 'R' position**

- **Remove the 10A back-up fuse from the I/P fusebox.**

Back-up fuse

3. **How is the shift range on the cluster?**

4. **Write down SCSV-ABC ON/OFF signal and gear position at D/2/L.**

Shift range	SCSV-A	SCSV-B	SCSV-C	Available gear
P/N				
R				
D				
2				
L				

1. Application : A4AF3

2. Objectives
  - To understand the failsafe function of inhibitor switch

3. Required materials
 - Vehicle with

4. Procedure
  - Start engine and shift to 'D' position.
  - Remove the 10A back-up fuse from the I/P fuse box.
  - Check shift range on the cluster
  - Check the shift position of Hi-scan
  - Check the SCSV-ABC ON/OFF
  - Write down the vehicle movement at R,2,L range

5. Time to complete : 5 minutes

6. Reference

1.   Start engine and position shift lever to 'D' position

• **Remove the 10A back-up fuse from the I/P fusebox.**
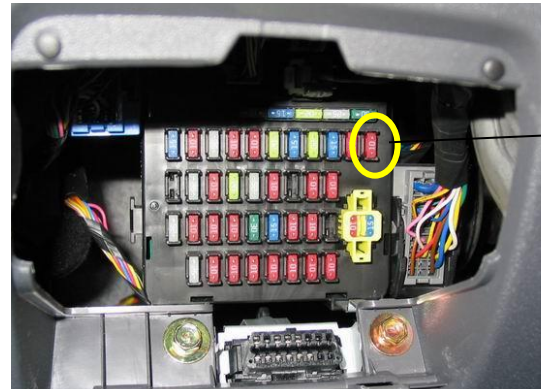
Back-up fuse

3.   How is the shift range on the cluster?

4.   Write down SCSV-ABC ON/OFF signal and gear shifting at R/D/2/L.

Shift range	SCSV-A	SCSV-B	SCSV-C	Available gear
P/N				
R				
D				
2				
L				

1. Application : A4AF3

2. Objectives
  - To understand the failsafe function of inhibitor switch

3. Required materials
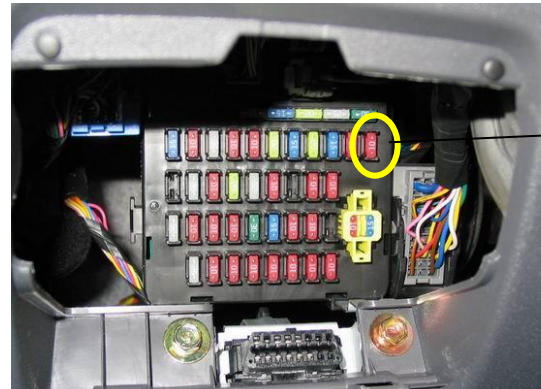 - Vehicle with

4. Procedure
  - Start engine and shift to '2' position.
  - Remove the 10A back-up fuse from the I/P fuse box.
  - Check shift range on the cluster
  - Check the shift position of Hi-scan
  - Check the SCSV-ABC ON/OFF
  - Write down the vehicle movement at R,D, L range

5. Time to complete : 5 minutes

6. Reference

1. **Start engine and position shift lever to '2' position**

• **Remove the 10A back-up fuse from the I/P fusebox.**
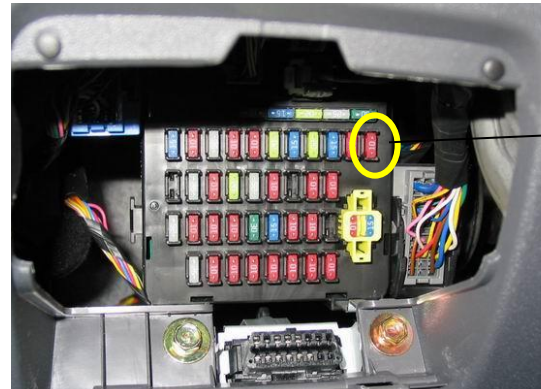
Back-up fuse

3. **How is the shift range on the cluster?**

4. **Write down SCSV-ABC ON/OFF signal and gear shifting at R/D/L.**

Shift range	SCSV-A	SCSV-B	SCSV-C	Available gear
P/N				
R				
D				
2				
L				

1. Application : A4AF3

2. Objectives
  - To understand the failsafe function of inhibitor switch

3. Required materials
  - Vehicle with

4. Procedure
  - Start engine and shift to 'L' position.
  - Remove the 10A back-up fuse from the I/P fuse box.
  - Check shift range on the cluster
  - Check the shift position of Hi-scan
  - Check the SCSV-ABC ON/OFF
  - Write down the vehicle movement at R,D,2 range

5. Time to complete : 5 minutes

6. Reference

1. **Start engine and position shift lever to 'L' position**

• **Remove the 10A back-up fuse from the I/P fusebox.**

Back-up fuse

3. **How is the shift range on the cluster?**

4. **Write down SCSV-ABC ON/OFF signal and gear shifting at R/D/2.**

Shift range	SCSV-A	SCSV-B	SCSV-C	Available gear
P/N				
R				
D				
2				
L				

1. Application : A4AF3

2. Objectives
   - To understand the failsafe function of inhibitor switch

3. Required materials
   - Vehicle with

4. Procedure
   - Remove the 10A back-up fuse from the I/P fuse box.
   - start the engine and change sihft lever one by one
   - Check shift range on the cluster
   - Check the shift position of Hi-scan
   - Check the SCSV-ABC ON/OFF
   - Write down the vehicle movement at R,D,2,L range

5. Time to complete : 5 minutes

6. Reference

1. **Remove the 10A back-up fuse from the I/P fusebox.**

2. **Start engine and change shift lever to each position**
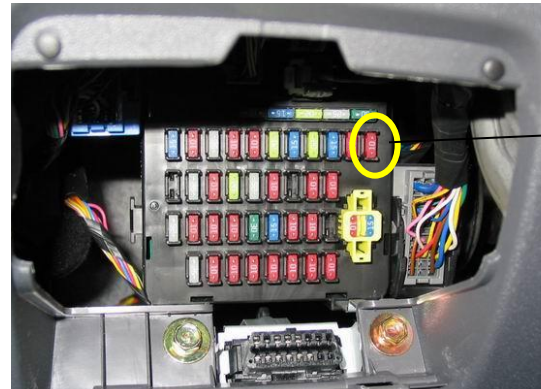
Back-up fuse

3. **How is the shift range on the cluster? Write down SCSV-ABC ON/OFF signal and gear shifting at R/D/2.**

Shift range	SCSV-A	SCSV-B	SCSV-C	Available gear
P/N				
R				
D				
2				
L				

SCSV-B   **SCSV-A**

DCCSV
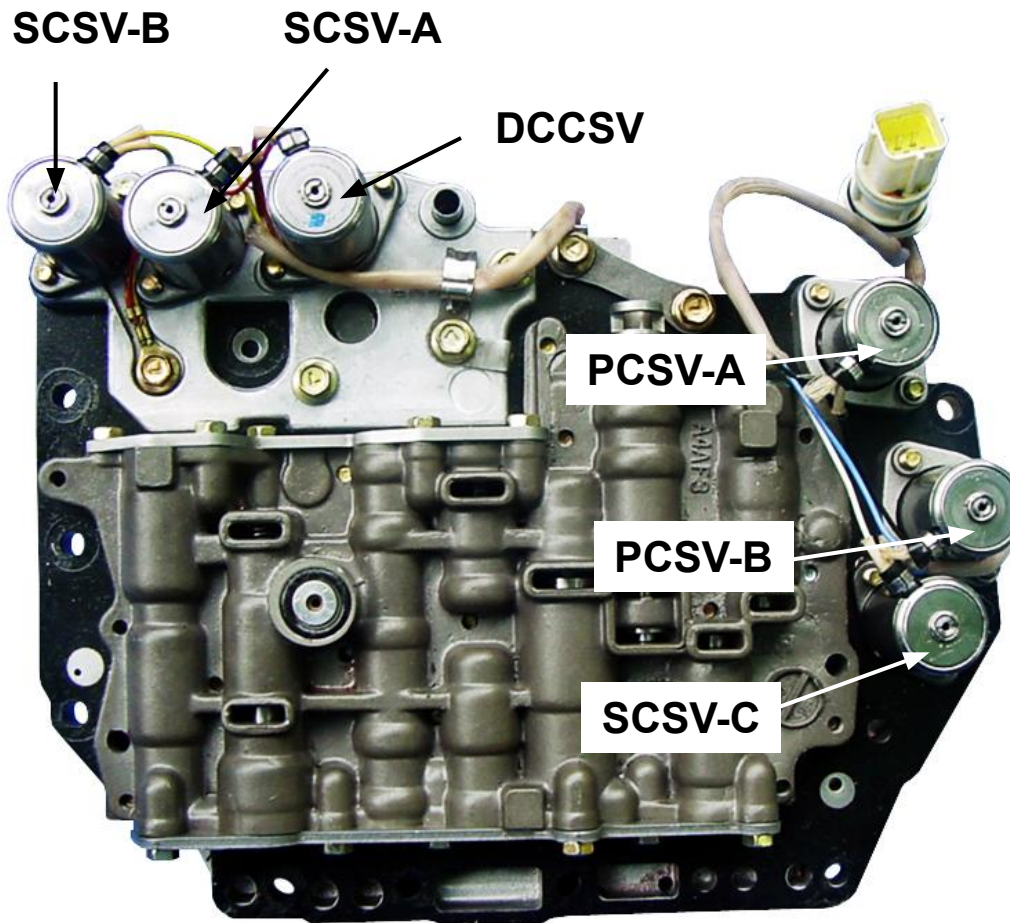
PCSV-A

PCSV-B

SCSV-C

1. Type

- On/Off control
  :

- PWM control (35Hz)
  :

2. Control elements
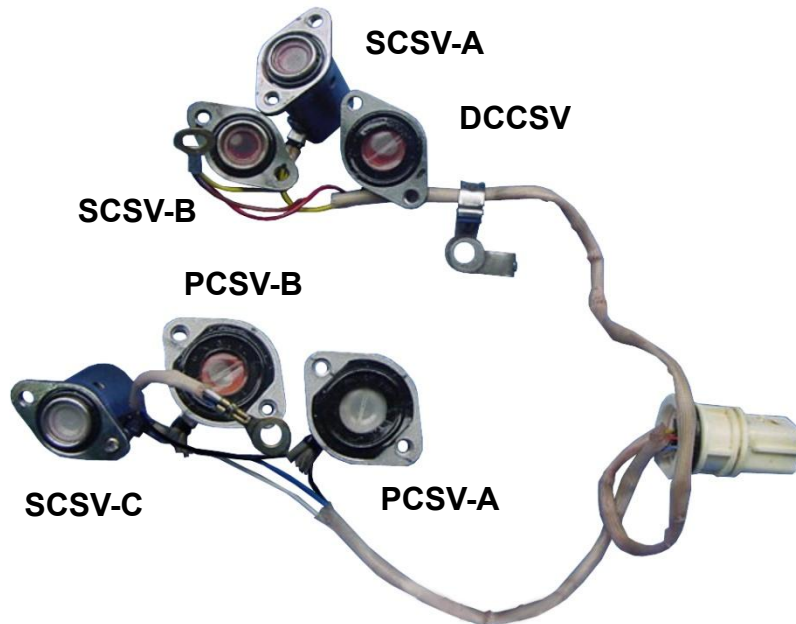
- PCSV-A
  : F/C, E/C, KD/B, LR/B

- PCSV-B : _____

- SCSV-C : _____

- SCSV   : Shift Control Solenoid Valve
- PCSV   : Pressure Control Solenoid Valve
- DCCSV : Damper Clutch Control Solenoid Valve

• **Operation table at D range (SCSV-A,B,C)**

Operation / Position	Shift control solenoid valve		
	A	B	C
1st gear	ON	ON	OFF
2nd gear	OFF	ON	OFF
3rd gear	OFF	OFF	ON
4th gear	ON	OFF	ON

SCSV-A

DCCSV

SCSV-B

PCSV-B

SCSV-C

PCSV-A

• Solenoid resistance

- PCSV: 2.9±0.3Ω

- SCSV: 22.3±1.5Ω

- DCCSV: 3Ω

• **Current data (Damper clutch control solenoid valve)**

1)

```
          1.2 CURRENT DATA
 ✻ ENGINE SPEED         1287 rpm
 ✻ THROTTLE P.SENSOR    2.0  %
 ✻ PG-A(INPUT SPEED)    1286 rpm
 ✻ PG-B(OUTPUT SPEED)   1286 rpm
 ✻ TCC SOLENOID DUTY    37.6 %
 ✻ TCC SLIP(AMOUNT)     1    rpm
   FLUID TEMP.SENSOR    49   °C
   SHIFT POSITION       3
```

2)

```
          1.2 CURRENT DATA
 ✻ ENGINE SPEED         1423 rpm
 ✻ THROTTLE P.SENSOR    2.4  %
 ✻ PG-A(INPUT SPEED)    1422 rpm
 ✻ PG-B(OUTPUT SPEED)   2076 rpm
 ✻ TCC SOLENOID DUTY    33.7 %
 ✻ TCC SLIP(AMOUNT)     1    rpm
   FLUID TEMP.SENSOR    54   °C
   SHIFT POSITION       4
```

3)

```
         1.2 CURRENT DATA
 100.0  ✻TCC SOLENOID DUTY      %

  36.5

   0.0
         SHIFT POSITION
   -

   4          D1  D2
                    D3
                         D4
   -
```
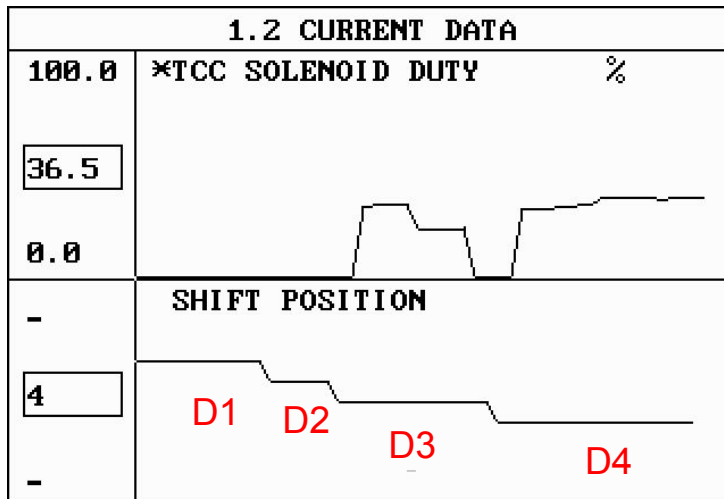
1)   Damper clutch operation at D3

2)   Damper clutch operation at D4

3)   Damper clutch operation at D3
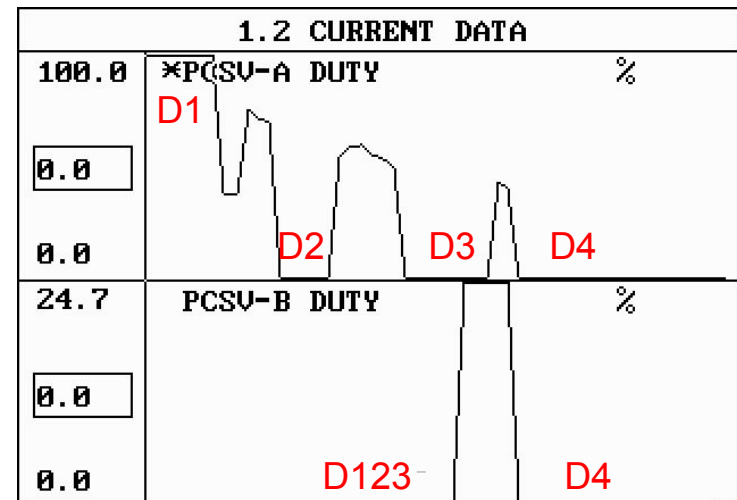
• Current data (Pressure control solenoid valve)

1)

```
        1.2 CURRENT DATA
✖ PCSV-A DUTY          100.0%
✖ PCSV-B DUTY          0.0 %
✖ SHIFT POSITION       1
✖ K/D SWITCH           ON
  ENGINE SPEED         636    rpm
  VEHICLE SPEED SENSOR 0      Km/h
  THROTTLE P.SENSOR    0.0    %
  PG-A(INPUT SPEED)    0      rpm
```
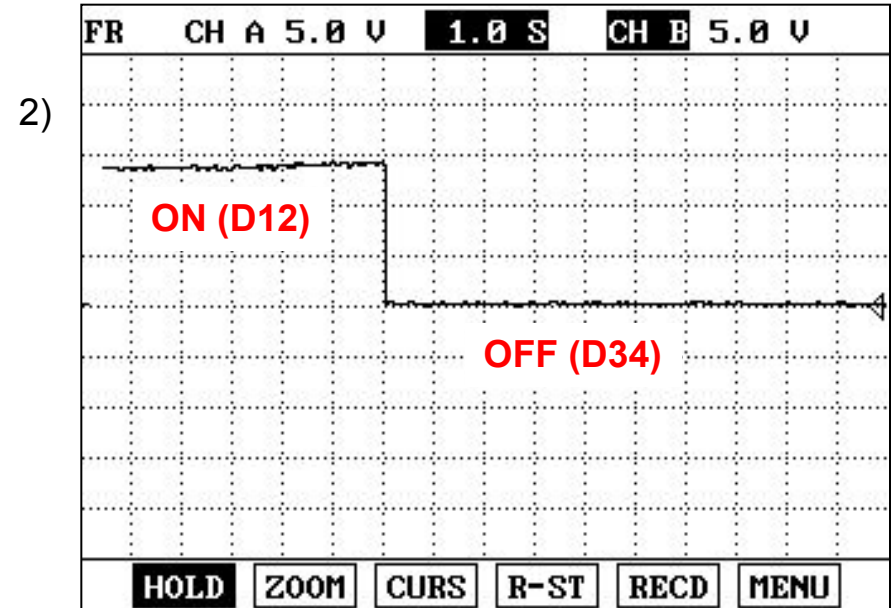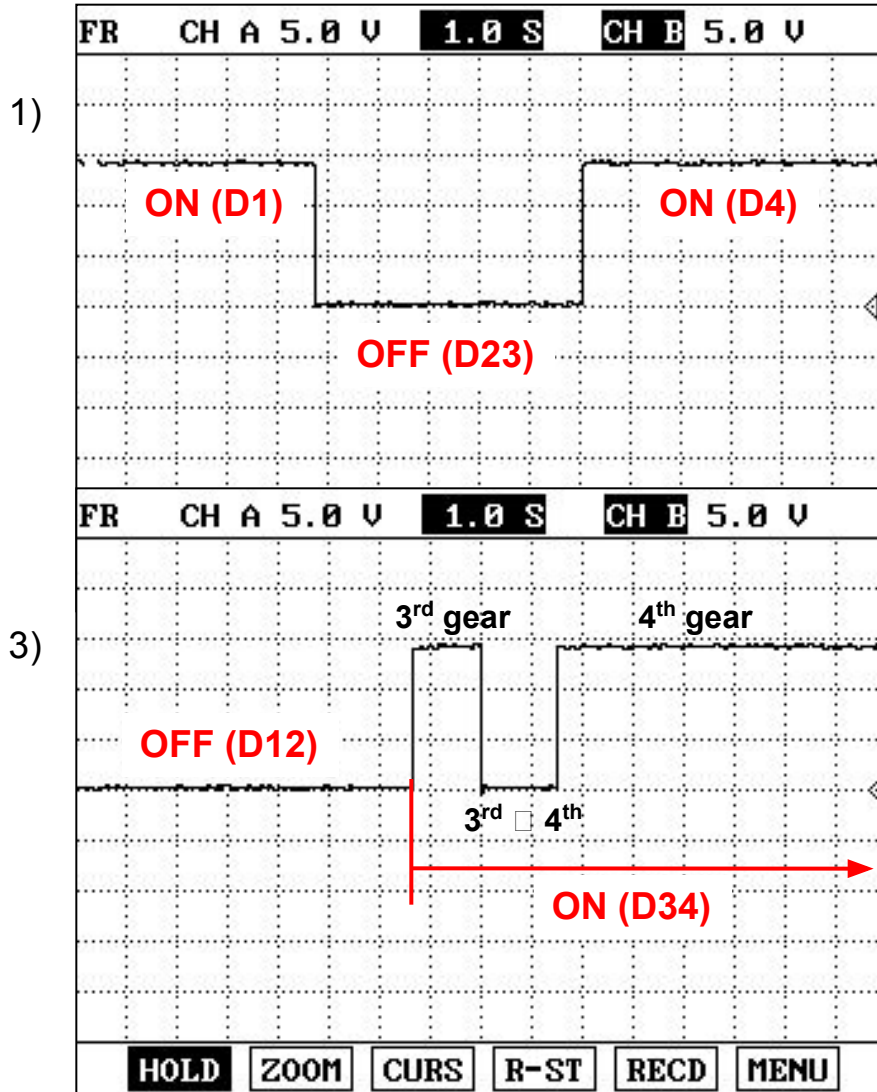
2)

```
        1.2 CURRENT DATA
100.0   ✖PCSV-A DUTY          %
                              D1
100.0
             N-D
0.0

100.0   PCSV-B DUTY           %
             N-D
0.0

0.0                     D1
```
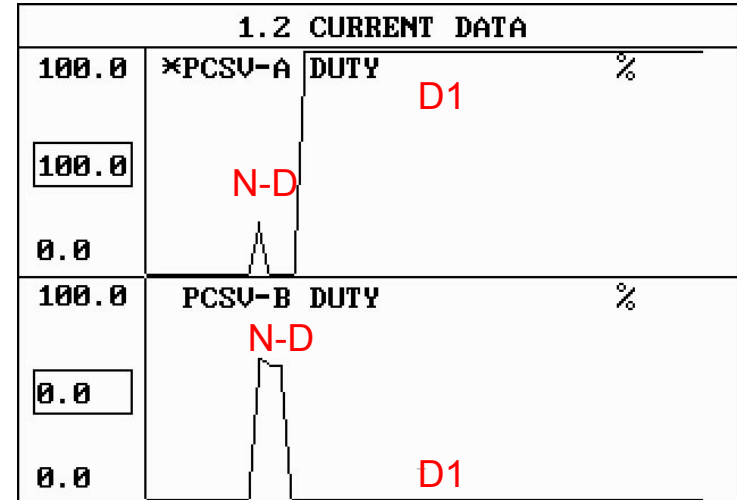
1)   PCSV-A, PCSV-B operation at D1

2)   PCSV-A, PCSV-B operation at N-D

3)   PCSV-A, PCSV-B operation at D range

3)

```
        1.2 CURRENT DATA
100.0   ✖PCSV-A DUTY          %
        D1
0.0
             D2      D3    D4
0.0

24.7    PCSV-B DUTY           %

0.0

0.0         D123           D4
```

• **Current data (Shift control solenoid valve)**

1)

```
FR   CH A 5.0 V   1.0 S   CH B 5.0 V
```
ON (D1)   ON (D4)
OFF (D23)

2)

```
FR   CH A 5.0 V   1.0 S   CH B 5.0 V
```
ON (D12)
OFF (D34)

HOLD ZOOM CURS R-ST RECD MENU

3)

```
FR   CH A 5.0 V   1.0 S   CH B 5.0 V
```
3rd gear   4th gear
OFF (D12)
3rd □ 4th
ON (D34)

HOLD ZOOM CURS R-ST RECD MENU

1) SCSV-A, operation at D range

2) SCSV-B, operation at D range

3) SCSV-C, operation at D range

• **Circuit diagram**


```
CH A: 216.5mV   DT:    9.75mS  FREQ:102.56 Hz
MIN:- 14.1 V   AVE:     1.1 V   MAX:    14.7 V
FREQ:   444.44  Hz      DUTY: 50 %
```

[DCCSV duty signal]

```
AT    CH A 5.0 V   2.0 mS    CH B 0.5 V
```
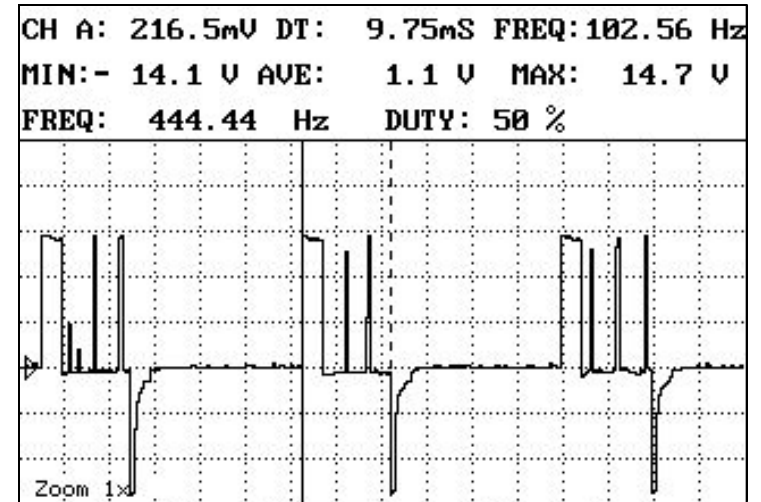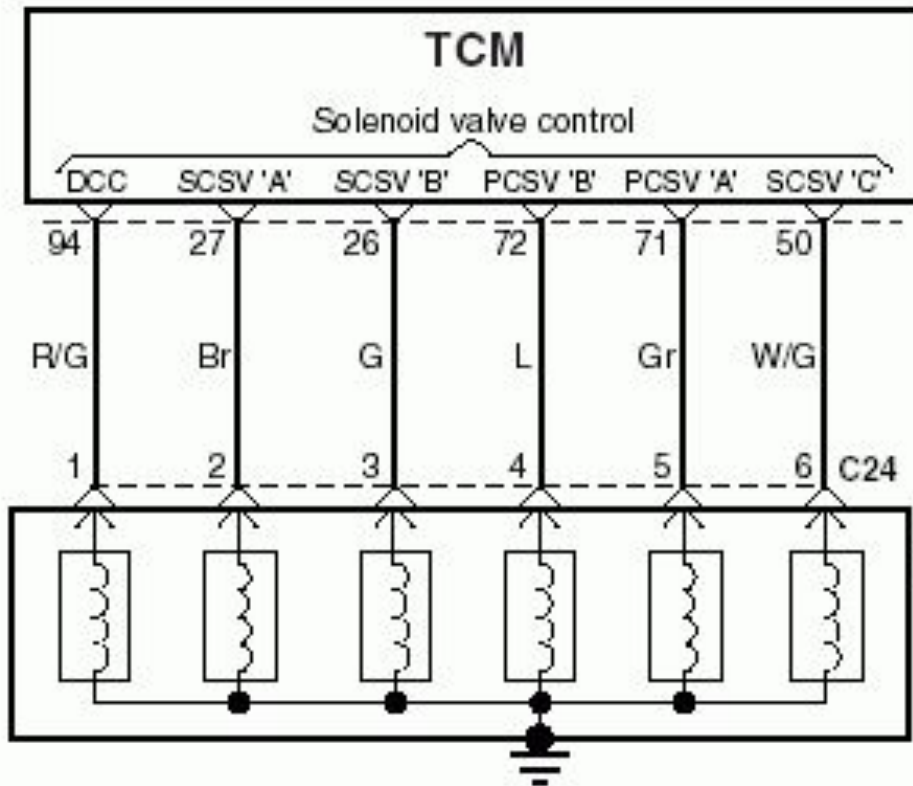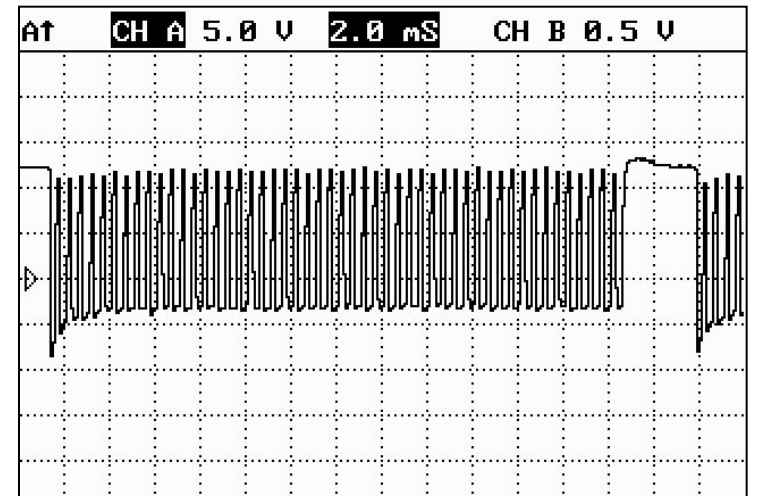
[PCSV-A duty signal-duty 100%]

Failure		Detected Conditions	Failsafe	DTC
PCSV-A PCSV-B	Open/ Short to GND	Circuit open or short for 0.3s or more (Circuit continuity)	3rd gear hold (All solenoids off) Damper clutch inhibited	0745 0775
SCSV-A SCSV-B SCSV-C				0750 0755 0760
DCCSV			Damper clutch inhibited	0743

```
1.1 DIAGNOSTIC TROUBLE CODES

P0775 PCSV-B OPEN/SHORT

P0755 SCSV-B OPEN/SHORT

P0760 SCSV-C OPEN/SHORT




NUMBER OF DTC : 1 ITEMS

PART   ERAS              HELP
```

```
1.2 CURRENT DATA

✱ ENGINE SPEED          643   rpm
✱ PG-A(INPUT SPEED)     503   rpm
✱ PG-B(OUTPUT SPEED)    504   rpm
✱ SHIFT POSITION        3
✱ TRANSAXLE RANGE SW    L
  TCC SOLENOID DUTY     0.0   %
  TCC SLIP(AMOUNT)      153   rpm
  PCSV-A DUTY           0.0   %

FIX  SCRN  FULL  PART  GRPH  HELP
```

[Failsafe: 3rd gear hold at D,2,L]

* Rationality(Closed stuck)

Component System	Fault Code	Description	Malfunction Criteria	Threshold	Filtering Time	MIL On
Damper clutch system	P0742	Closed stuck	Calculated slip	Slip < 5[rpm]	3[sec]	2drv. cycle

Test Condition	* Slip = Engine speed - Input speed Solenoid 3(DCSV) no error No dynamic state Last changed time of shift type > 3[sec] Position lever, Input speed sensor, OTS, Output speed sensor, Engine speed sensor no error Engine speed > 0[rpm] Duty of DCSV = 0[%] Throttle opening > 20[%] Output speed > 1000[rpm] Inhibitor switch = D, 2, L -10[ºC] < Oil temperature < 130[ºC]
Fail safety	Damper open

* Rationality(Open stuck)

Component System	Fault Code	Description	Malfunction Criteria	Threshold	Filtering Time	MIL On
Damper clutch system	P0741	Open stuck	Calculated slip	Slip > 100[rpm]	10[sec]	2drv. cycle

Test Condition	* Slip = Engine speed - Input speed Solenoid 3(DCSV), Input speed sensor, Engine speed sensor no error Input speed > 0[rpm] DCSV duty = 100[%]
fail safety	Damper open

* CAN BUS OFF

```
1.1 DIAGNOSTIC TROUBLE CODES

U0001 CAN BUS OFF


NUMBER OF DTC : 1 ITEMS
HELP  ERAS      INFO      PART
```

Component System	Fault Code	Description	Malfunction Criteria
CAN bus	U0001	Network error	Status of

Test Condition	Battery voltage > 10[V] Input speed > 300[rpm] Ignition On Input speed no error Filtering time > 0.5[sec]

Fail safety	1. If external CAN is Bus off, TCM is switching to internal CAN with ECM.
	2. If external and internal CAN is all error, refer to below.
	  - Engine RPM = 3000 RPM
	  - Indicated Engine Torque = 80%
	  - Vehicle speed = 0 km/h, A/C SW = Off
	  - Engine Temp = 70'C, Throttle angle = 50%
	  - Lamp "Check engine for OBD" = Off
	  - Shift prevention from TCS = Off

- **CAN BUS OFF Error dection**

    1) **CAN-Low short to GND : DTC is not detected**
    CAN communication with Scan tool is normal
    Current data from engine is normal

    2) **CAN-Low short to B+ : Communication error with Hi-scan**
    DTC (U0001) is memorized

    3) **CAN-High short to GND or B+ : Communication error with Hi-scan**
    DTC (U0001) is memorized

- **CAN interface required system (for Hi-scan communication)**
    : Engine, AT, Immobilizer, Code saving

- **K-line communication system (without CAN interface)**
    : ABS, ESP, A/Bag, TPMS

1. Verify complaint

2. Basic inspection

3. Problem symptom confirmation

4. 1) Are there DTC ?
   2) Are current data incorrect ?

No

Yes

5. 1) Does symptom occur intermittently ?
   2) Does the big shock happen ?

No

Yes

6. Electrical problem

7. Electrical

8. Hydraulic problem

9. Mechanical

10. Hydraulic

6. Electrical problem	7. Electrical	8. Hydraulic problem	9. Mechanical	10. Hydraulic

DTC chart, circuit & input sensor inspection	Actuator test	Oil passage or valve body clean and check	Stall test	Hydraulic test

Driving test for flight record

11. Identification of problem

12. Repair

13. Confirmation test

14. END

Symptom		Check point
1	Cannot start engine	- Starting system - Inhibitor switch
2	Cannot move forward	- Verify at D/2/L - ATF level - Line pressure (R/C) - Oil leaking at R/C, L&R - OWC (can move at L range)
3	Cannot move reverse	- ATF level - Oil pressure at F/C, L&R - Oil leaking at F/C, L&R - Defected valve body
4	Cannot move forward/reverse	- Oil pump - Oil pressure at R/C, F/C, L&R
5	Abnormal shock Long time lag at N-D (2s or more)	- Line pressure (R/C) - Defected R/C (disc worn-out, seal rings)

1. **Shift range for stall test : D(1,3), L(1), R**

2. **Preparation**

   - ATF temperature : 80 ~ 90 ℃

   - Fluid level : at 'HOT' mark on the oil level gauge

   - Apply chocks to both rear wheels (or jack up the vehicle)

   - Connect Hi-scan pro and read 'Engine speed'

3. **Stall RPM : 2400 ~ 2800 rpm**

4. **Test result**
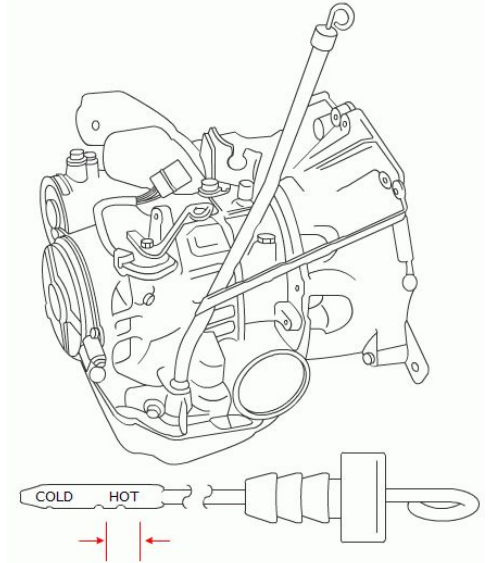
Test result	Shift range		Cause	Remark
Higher than standard value	D	1st gear	- Rear clutch, OWC slip	Check R/C, F/C, LR pressure
		3rd gear	- Front clutch, Rear clutch slip (E/C is not a powered part)	
	L		- Rear clutch, LR brake slip	
	R		- Front clutch, LR brake slip	
Lower than standard value	D/L/R		- Lack of engine power - Torque converter internal faulty	- Check engine - Replace T/C
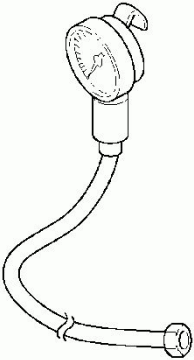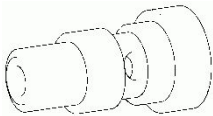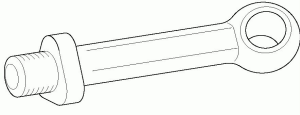
1. **Pressure test range : D/2/L/R**

2. **Preparation**

   - Warm up the engine and ATF temperature : 80 ~ 90 ℃

   - Fluid level : at 'HOT' mark on the oil level gauge

   - Jack up the vehicle

   - Install oil pressure gauge (09452-21500) and gauge adapter (09452-21001,2)
     on each pressure port

   - Read pressure value at idling or stall rpm

3. **Standard value :** Refer to workshop manual

Required SST	
	09452-21002
09452-2150	09452-21001

4. Pressure ports
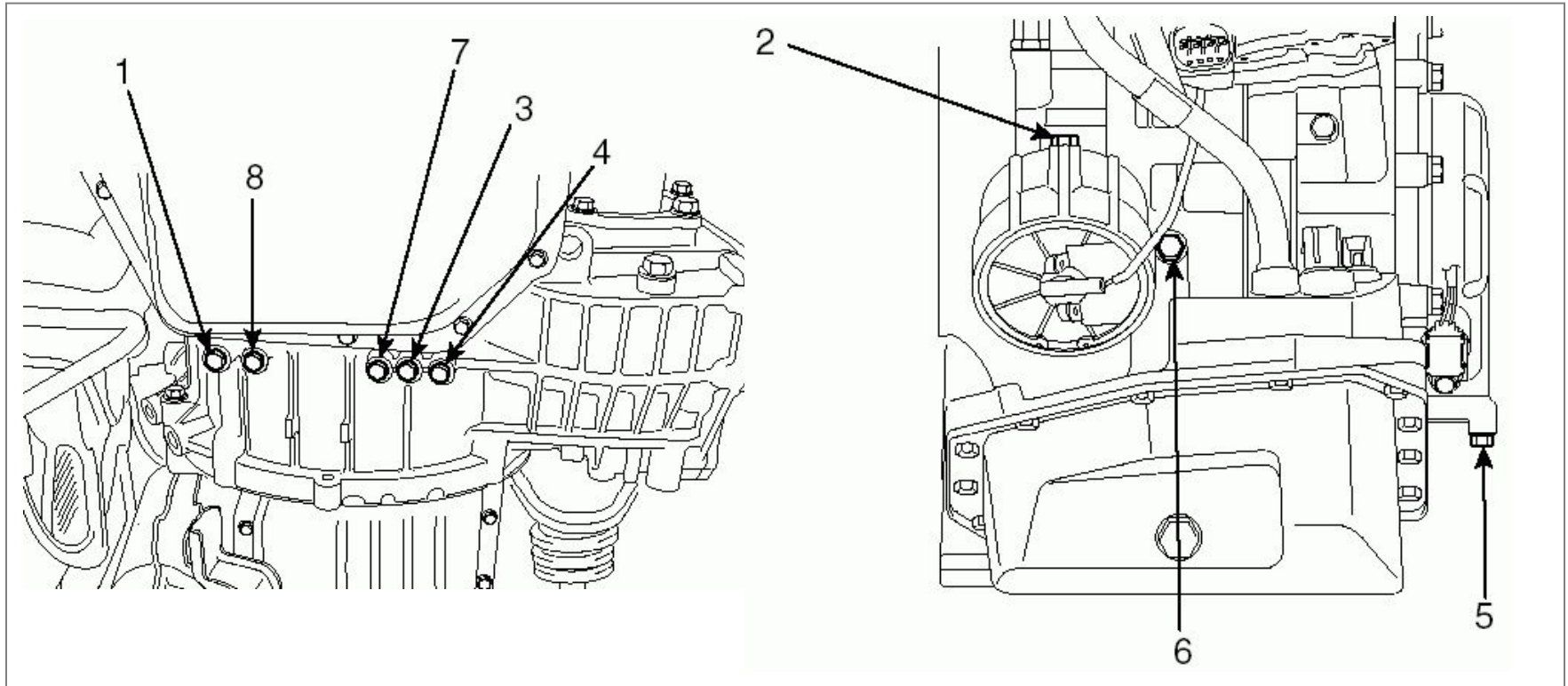
1. Reducing pressure
2. Kickdown wervo pressure
3. Rear clutch pressure
4. Front clutch pressure
5. End clutch pressure
6. Low & reverse brake pressure
7. Damper clutch apply pressure
8. Damper clutch release pressure

5. Diagnosis of test result

Result	Cause
Poor front clutch pressure	- Front clutch piston leaking (D-rings) - Defected front clutch retainer bushing - Defected housing oil seal rings - Defected kickdown servo piston seal ring - Defected valve body
Poor end clutch pressure	- End clutch piston leaking (oil seal, D-ring) - Defected valve body
Poor L&R brake pressure	- Poor O-ring between upper valve body and AT housing - L&R brake piston leaking (O-ring) - Defected valve body
Poor damper clutch pressure	- DCCSV sticking - Oil cooler clogging or leaking - Defected input shaft seal rings - Torque converter internal faulty

AT Tester with adapter cables for AT (F4A**, F4EL-K, AISIN)

Pressure sensor installation with AT Tester

[AT Tester]

[Pressure sensor & adapter]

[Pressure control box]

Pressure sensor installation with AT Tester
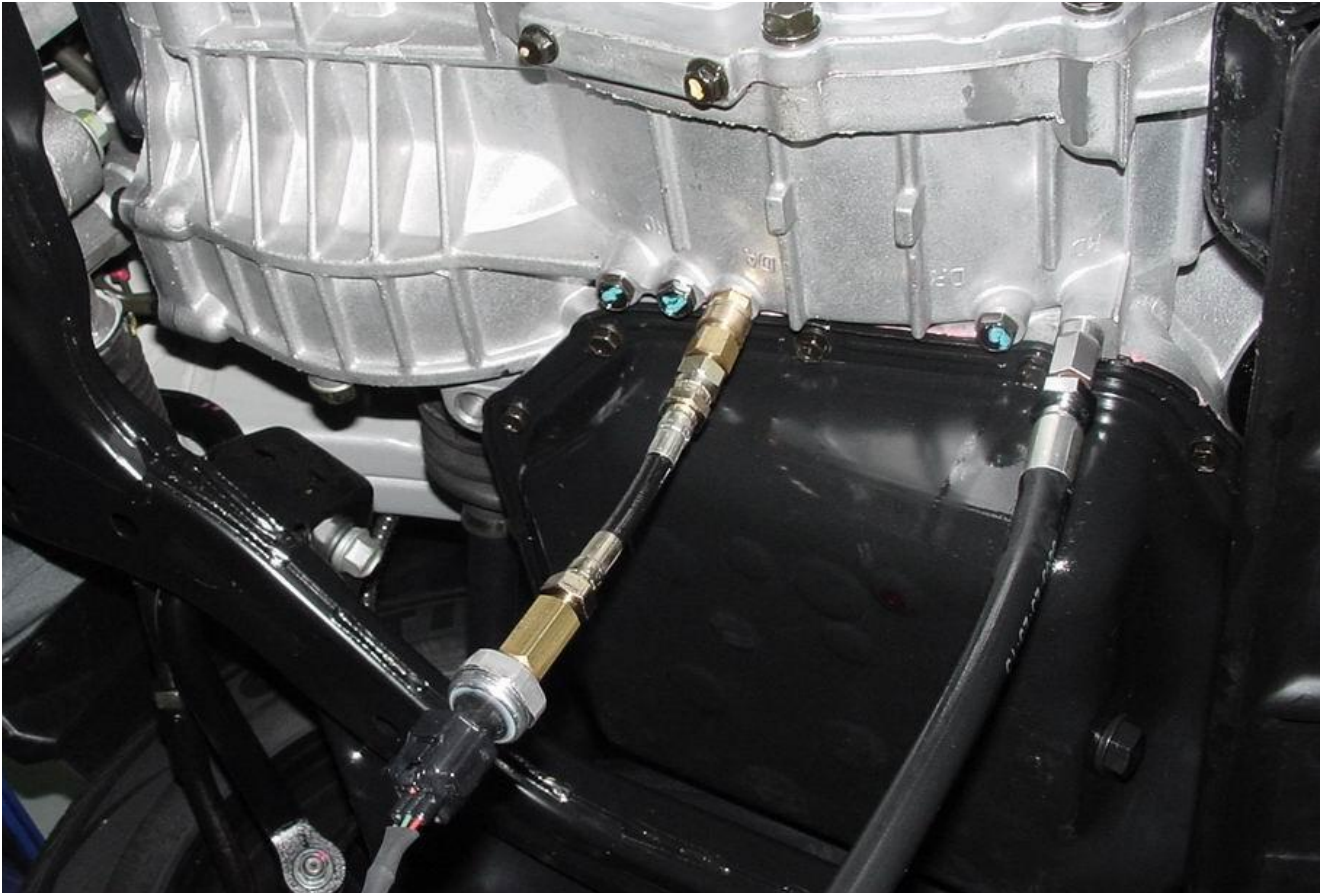
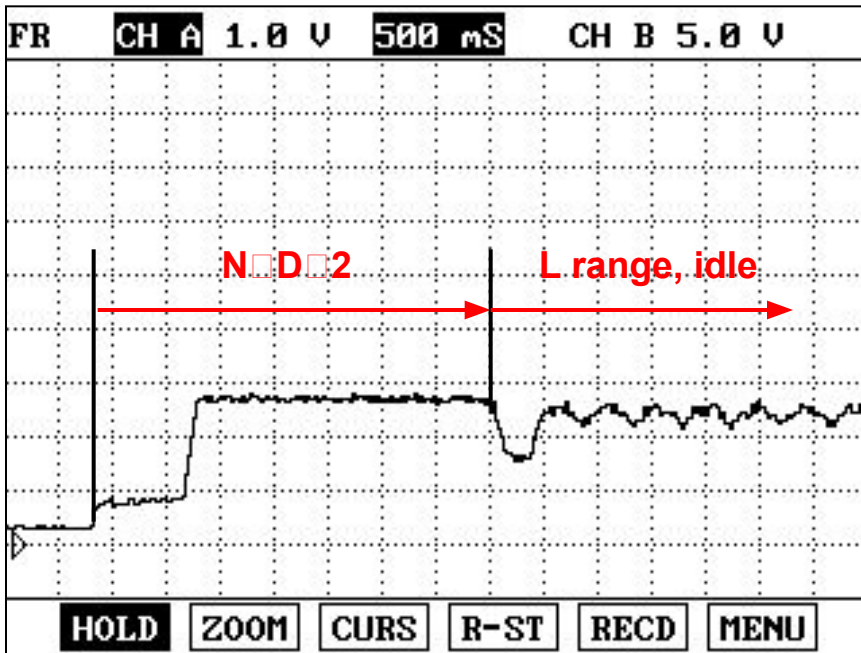## 1) Rear clutch pressure
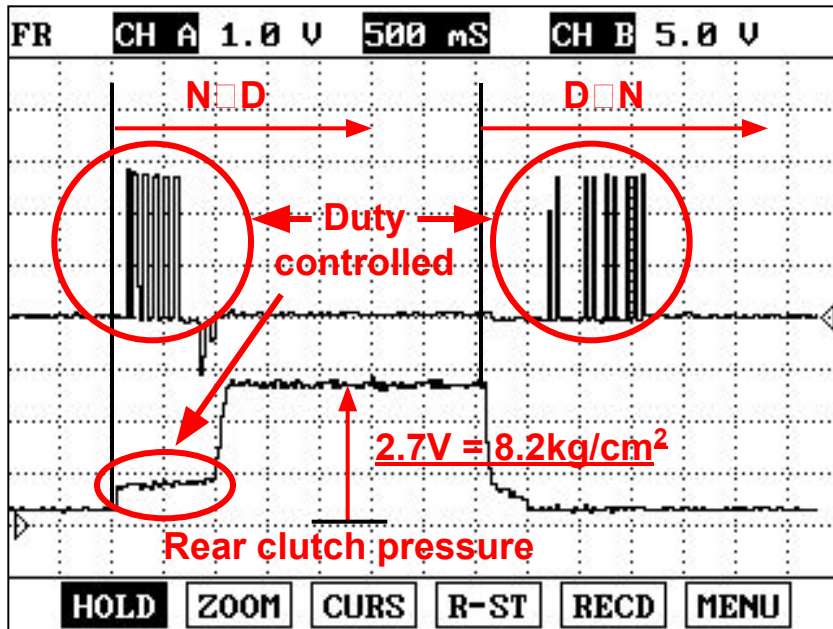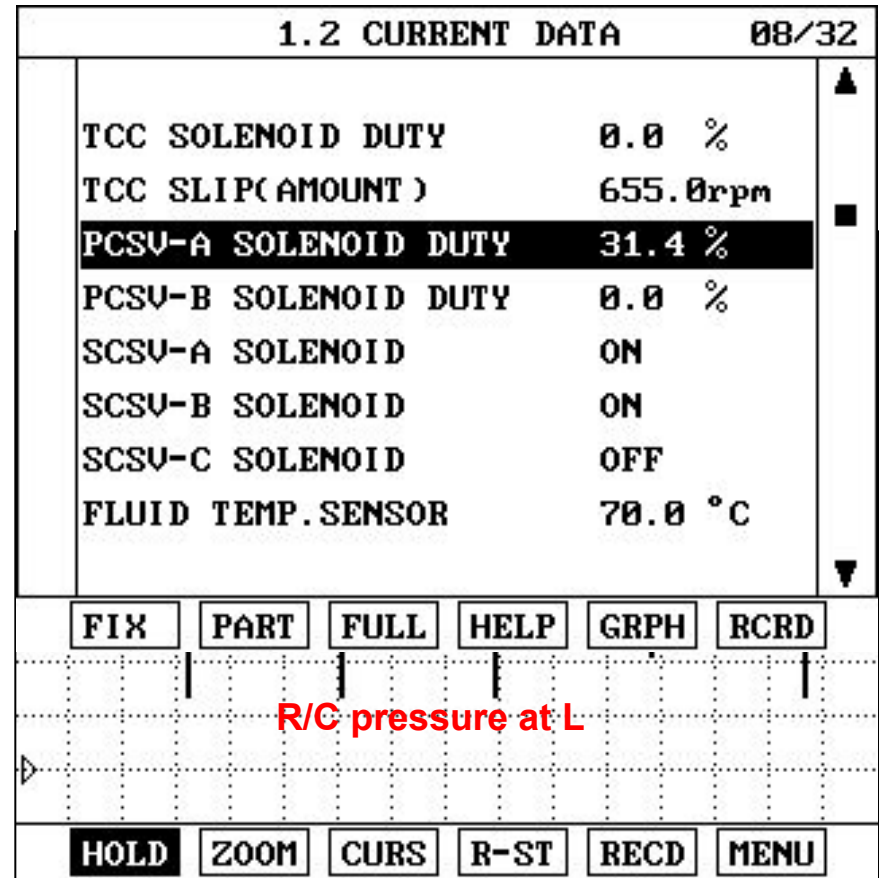

[R/C pressure & PCSV-B operation at N□D□N]
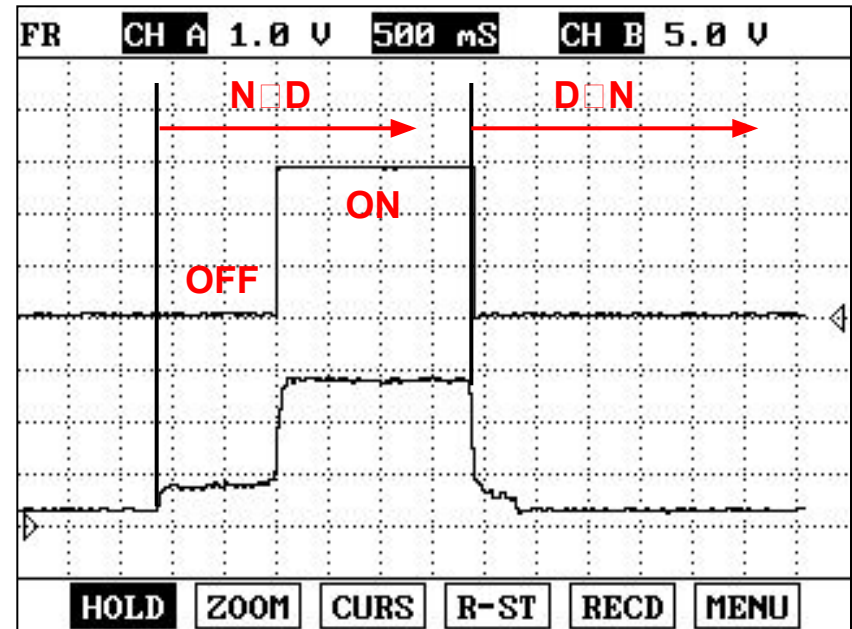
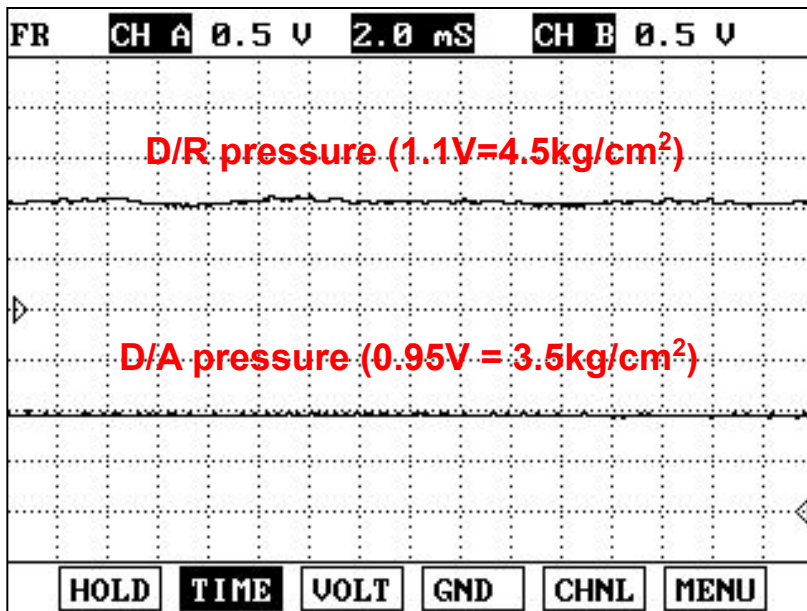[R/C pressure & SCSV-A operation at N□D□N]
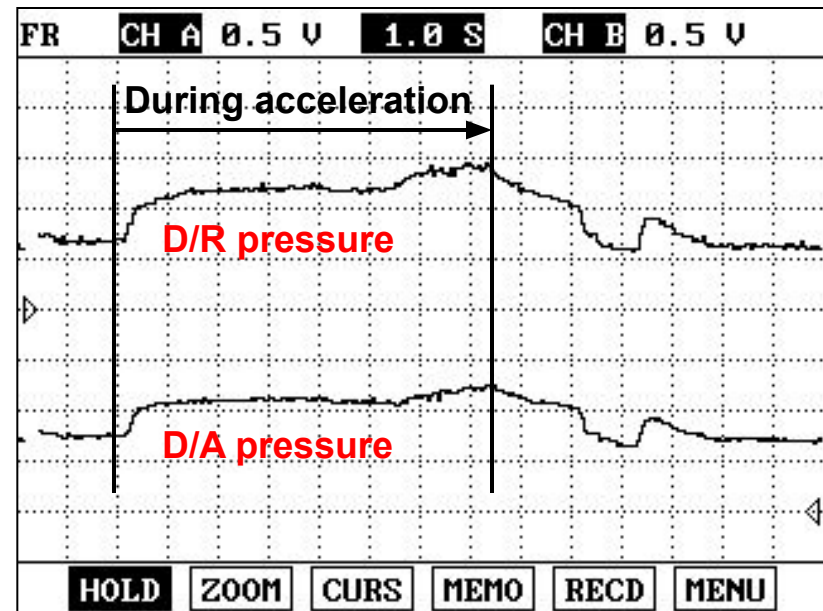
1) Rear clutch pressure

[R/C pressure at N→D→2→L]

[R/C pressure at L]
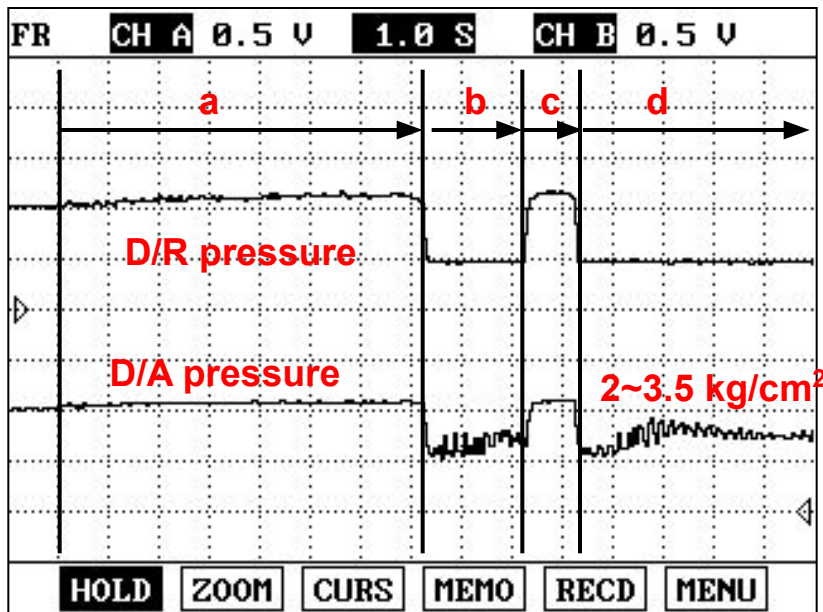
Damper clutch pressure (Waveform from pressure sensor)

FR	CH A 0.5 V	2.0 mS	CH B 0.5 V

D/R pressure (1.1V=4.5kg/cm^2)

D/A pressure (0.95V = 3.5kg/cm^2)

HOLD	TIME	VOLT	GND	CHNL	MENU

[At P,N range]

FR	CH A 0.5 V	1.0 S	CH B 0.5 V

During acceleration

D/R pressure

D/A pressure

HOLD	ZOOM	CURS	MEMO	RECD	MENU

[At R range]

- **D/A: Damper clutch apply**
- **D/R: Damper clutch release**

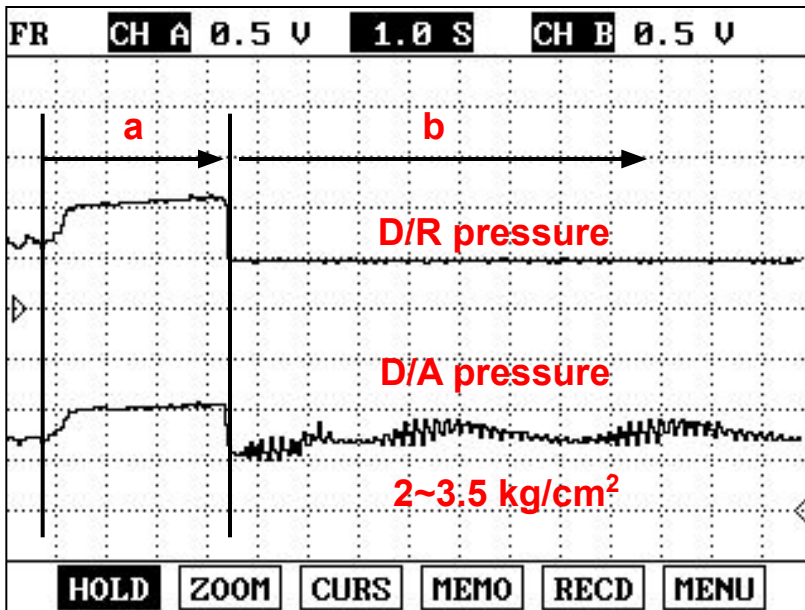**Damper clutch pressure (Waveform from pressure sensor)**
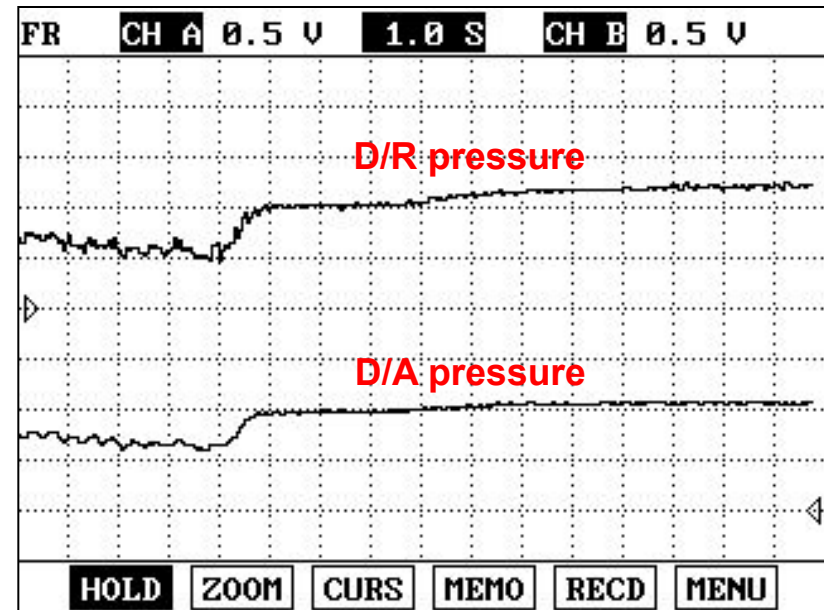

[At D range]
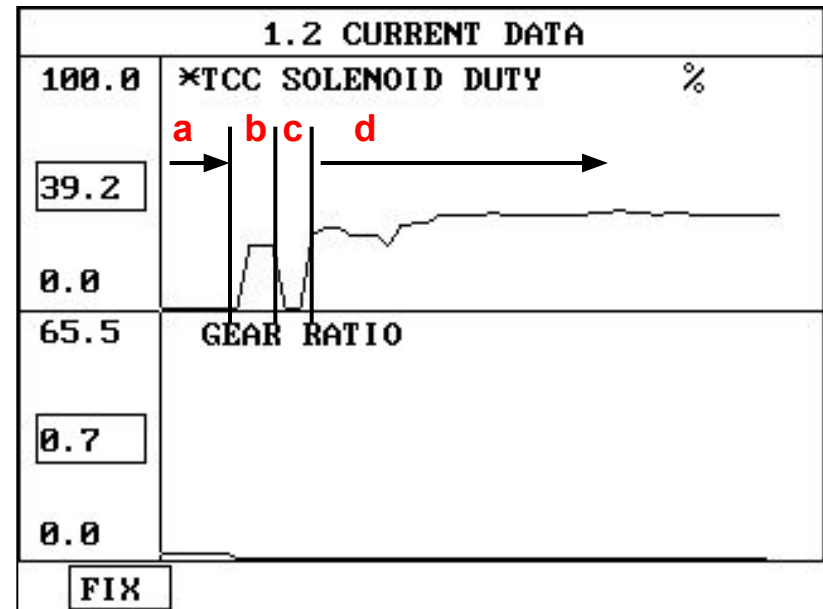
* a : D 1,2,3 gear
b: D 3 gear with damper clutch engaged (lock-up)
c: D3-4 up shift (no lock-up)
d: D4 gear with lock-up

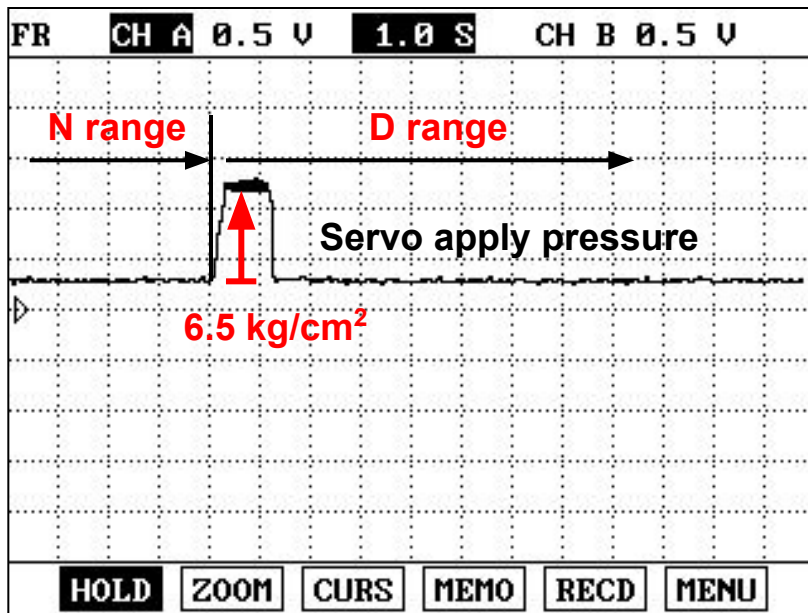**Damper clutch pressure (Waveform from pressure sensor)**
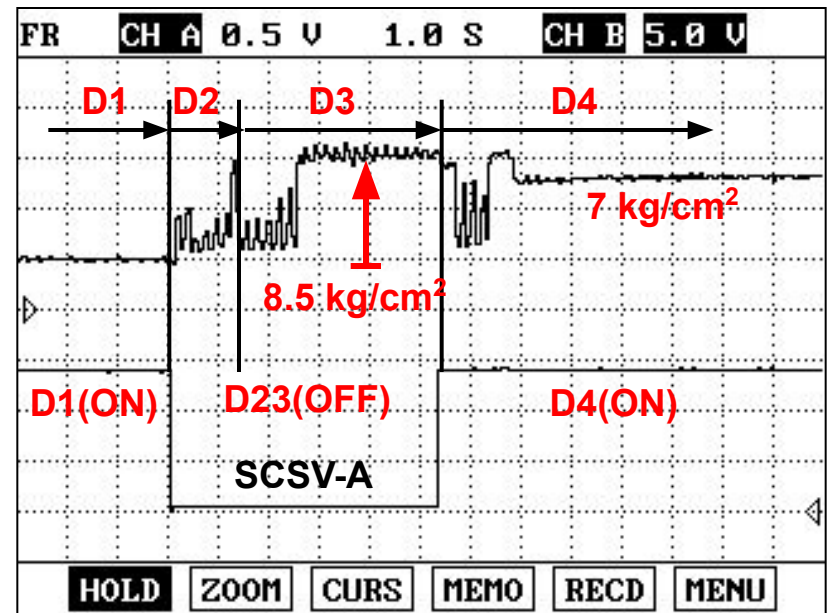

[At 2 range]   [At L range]

* a : 2 range 1,2 gear
  b: 2 range 2 gear with lock-up

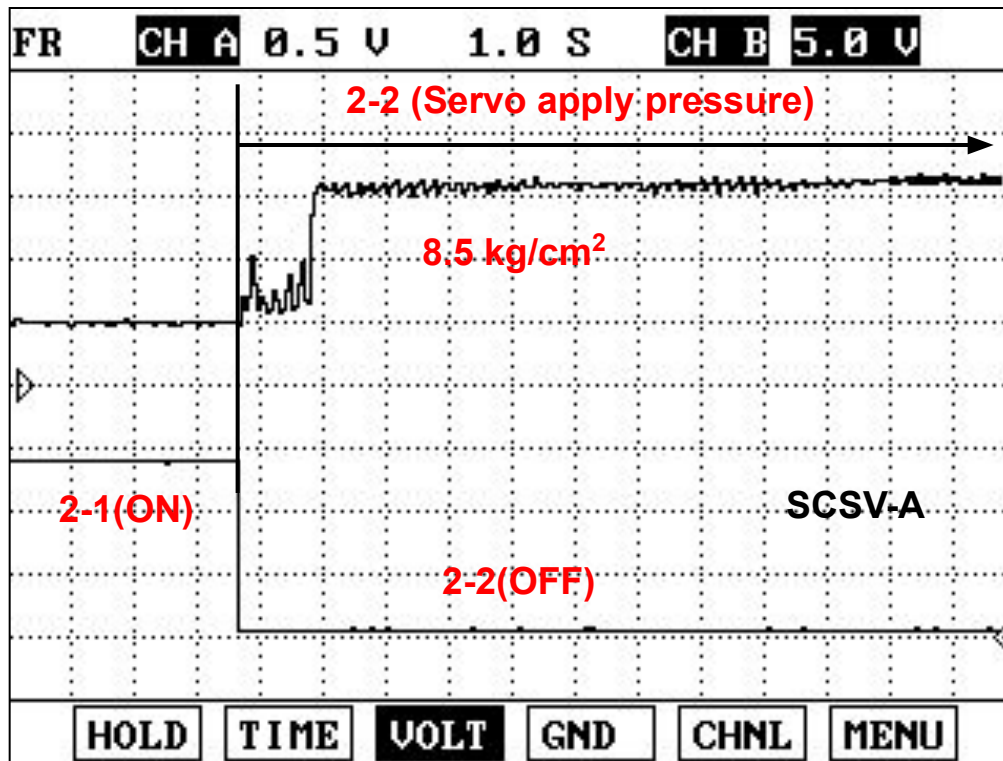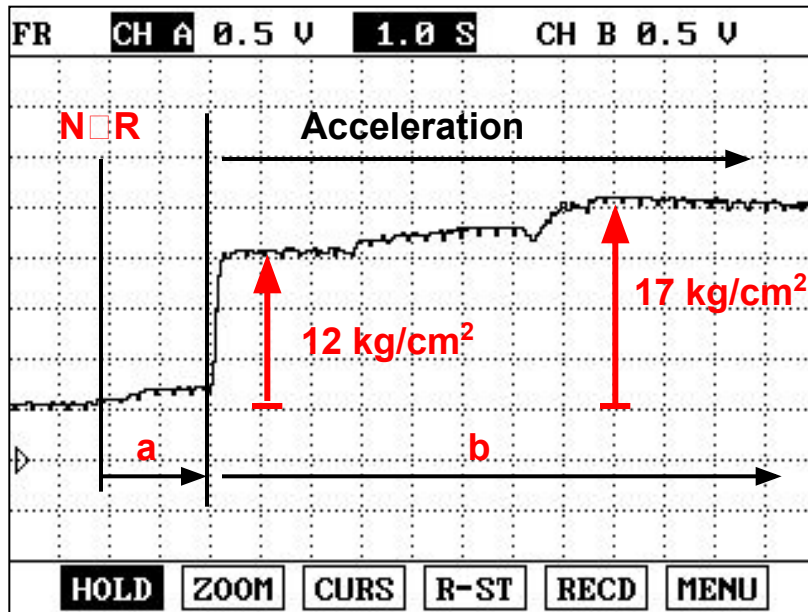**Kick down servo apply pressure (Waveform from pressure sensor)**

FR CH A 0.5 V 1.0 S CH B 0.5 V

N range   D range

Servo apply pressure

6.5 kg/cm^2

HOLD ZOOM CURS MEMO RECD MENU

[At N-D control]

FR CH A 0.5 V 1.0 S CH B 5.0 V

D1 D2 D3 D4

8.5 kg/cm^2

7 kg/cm^2

D1(ON) D23(OFF) D4(ON)

SCSV-A

HOLD ZOOM CURS MEMO RECD MENU

[At D range]

Kick down servo apply pressure (Waveform from pressure sensor)

```
FR    CH A 0.5 V    1.0 S    CH B 5.0 V
```

2-2 (Servo apply pressure)

8.5 kg/cm^2

2-1(ON)

2-2(OFF)

SCSV-A

```
HOLD  TIME  VOLT  GND  CHNL  MENU
```

[At 2 range]

L&R brake pressure (Waveform from pressure sensor)

| FR | CH A 0.5 V | 1.0 S | CH B 0.5 V |

N⎕R Acceleration

12 kg/cm²

17 kg/cm²

a   b

HOLD ZOOM CURS R-ST RECD MENU

[At R range]

| FR | CH A 0.5 V | 1.0 S | CH B 0.5 V |

2 ⎕ L   Acceleration

4~6 kg/cm²

PCSV-A duty control (32%)

HOLD ZOOM CURS R-ST RECD MENU
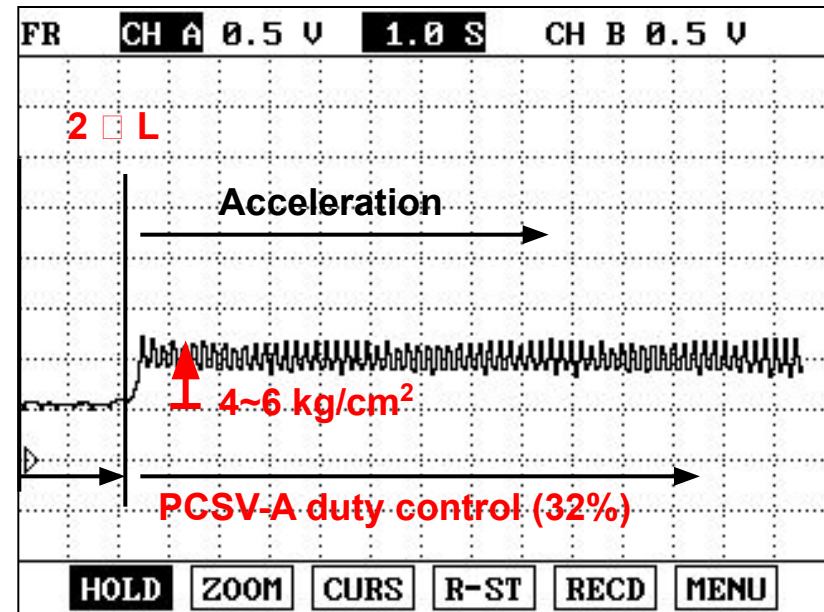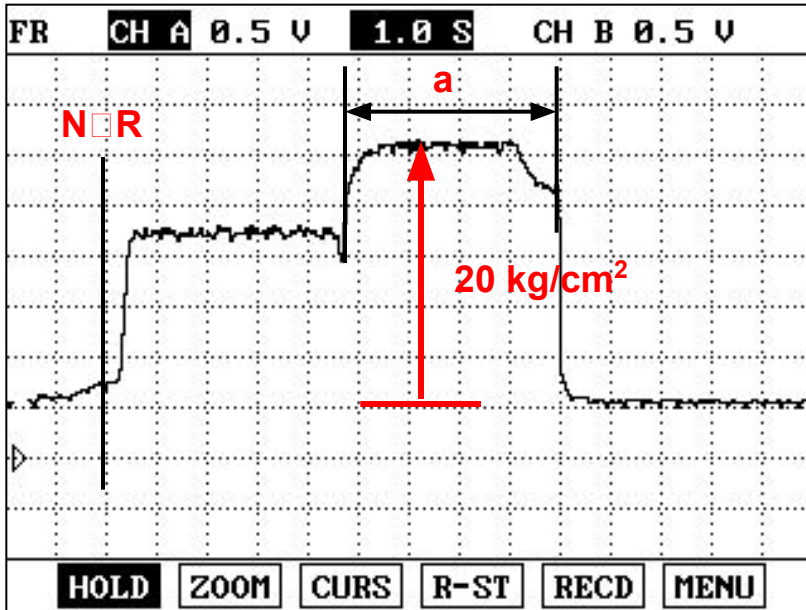
[At L range]

a: PCSV-A duty control

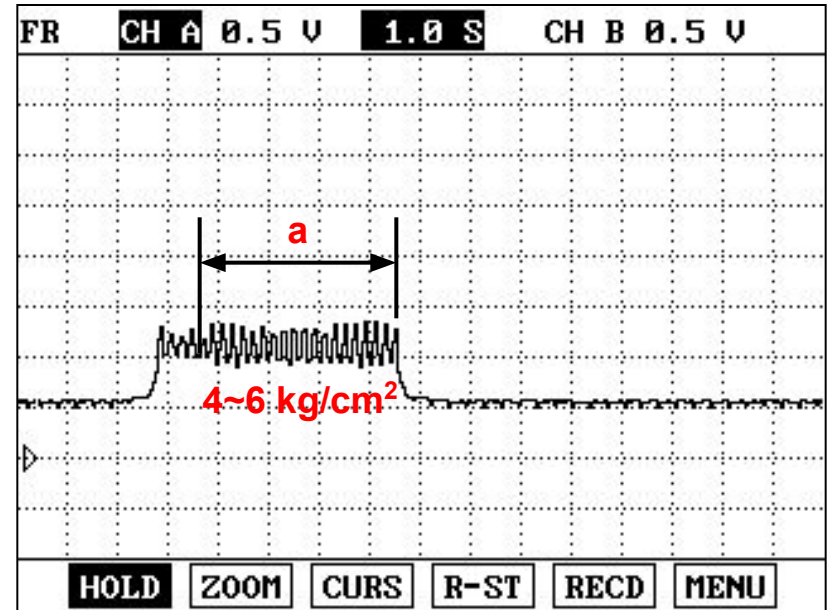**b: PCSV-A duty 0% (accleration)**

L&R brake stall pressure

[R range stall pressure]

[At L range stall pressure]

a: Stall test range