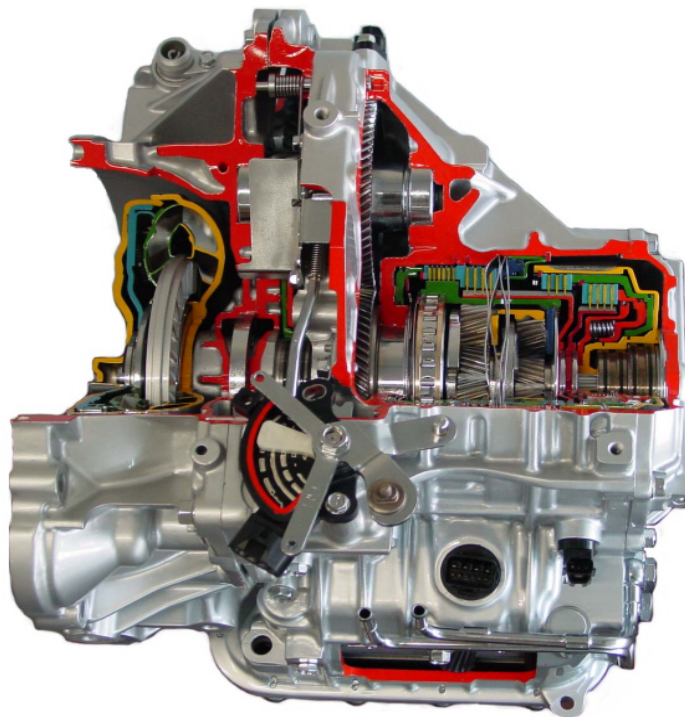


# TRANSAXLE

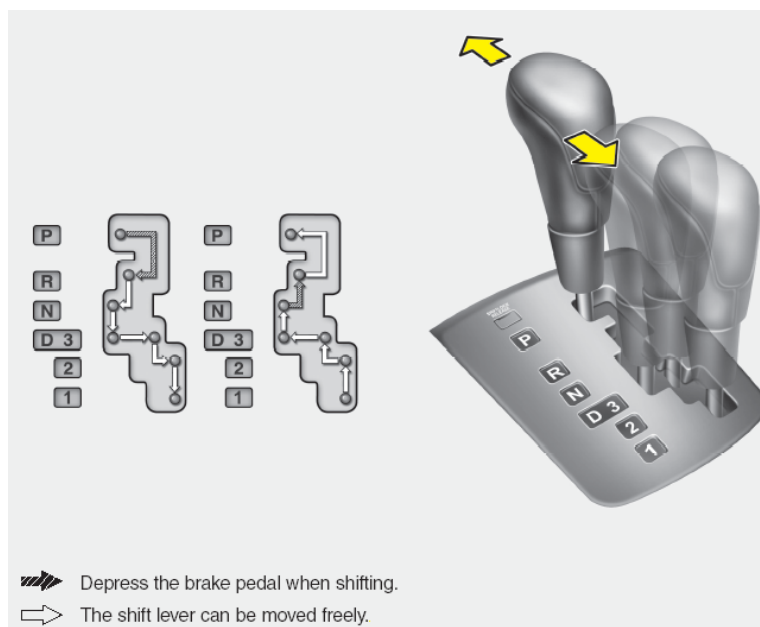


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**Chonan Technical Service Training Center**

**Objectives**

To understand the variation and line-up for ED transaxle.  
To know the system interface and control logic .  
Enable to understand the newly developed technical features.

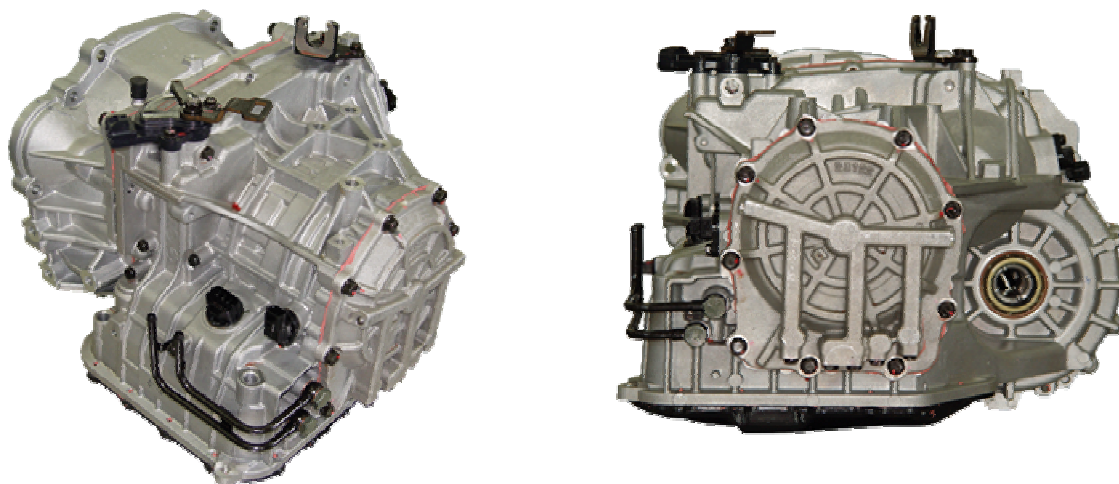
The automatic transaxle for ED is same as one for LD facelift. Just some switch and minor change have been applied. The 3<sup>rd</sup> position switch was added due to the different shift lever (7 positions with step gate type) and the electronic type shift lock control system has been applied in the European market for KMC.



## 1. Introduction

### 1.1 General

ED has New Alpha transmission which is being applied in LD facelift model. Its mechanical structure is nearly same with HIVEC except valve body and the hydraulic circuit and the control logic is a little bit different. In this training manual it will cover main features which are compared to Alpha transaxle (A4AF3) and control logic.



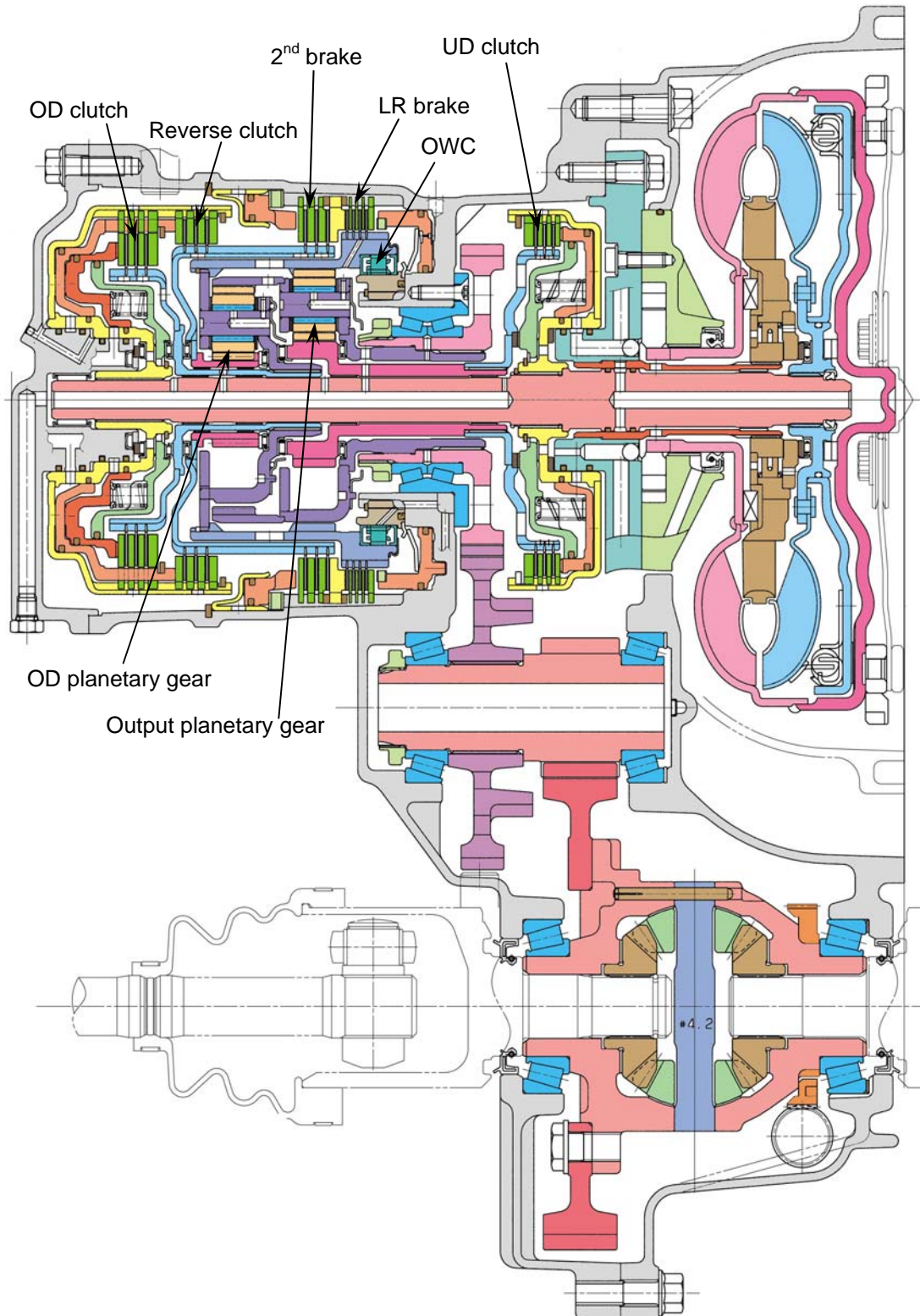
### 1.2 Power train variation

A/T has two models used, these are A4CF1 and A4CF2. However, 1.4L and two diesel models have only manual transaxle as shown in the below table.

Engine				Transaxle		Application		
Model	Volume	Power/Torque (ps/kg-m)		M/T	A/T	5DR	Wagon	3DR
GSL	Gamma	1.4D CVVT	108 / 13.9	M5CF1	-	●	●	●
		1.6D CVVT	121 / 15.6		A4CF1	●	●	●
	Beta	2.0D CVVT	140 / 18.8	M5CF2	A4CF2	●	●	●
DSL	U	1.6 VGT	115 / 26.0	M5CF3	-	●	●	●
	D	2.0 VGT	140 / 31.0	M6GF2	-	●	●	●

### 1.3 Components

Mechanically the structure is similar to Hivac's. PG-A is detected from O/D carrier instead of UD in HIVEC's.



## 1.4 Specification

Following the engine line up has 2 types. Gamma engine and Beta engine are used from PCM.

Items	A4CF1	A4CF2	A4AF3
Engine	Gamma 1.6L	Beta II 2.0L	Alpha II
Max. Torque (kg.m)	15.6	26	14.6
Number of OWC	1	←	←
Number of clutch	3	←	←
Number of brake	2	←	←
Centrifugal balance chamber	3 (UD, OD, REV clutches)		1 (Front clutch)
Accumulator	4 (UD, OD, 2 <sup>nd</sup> , LR)		1 (Rear clutch)
Solenoid valves	6 (PWM – 5, VFS – 1)		6(On/Off-3, PWM-3)
TGS lever	Sports mode		6 with O/D switch
Length (mm)	379		390.5
Weight (kg)	71.9		76
T/Con. Size (DIA.)	236mm		230mm
1st gear ratio	2.919		2.846
2nd gear ratio	1.551		1.581
3rd gear ratio	1.000		1.000
4th gear ratio	0.713		0.685
Reverse gear ratio	2.480		2.176

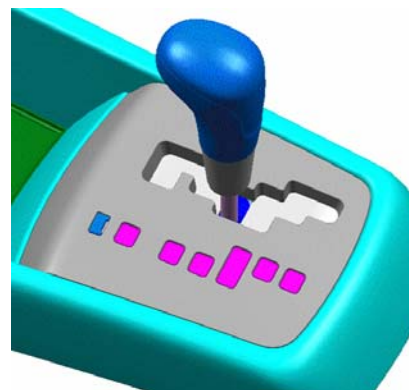
Items		MANUAL				AUTOMATIC	
		M5CF1	M5CF2	M5CF3	M6GF2	A4CF1	A4CF2
		γ 1.4/1.6	β 2.0	U1.6	D2.0	γ 1.6	β 2.0
GEAR RATIO	1ST	3.615	3.308	3.636	3.615	2.919	
	2ND	1.950	1.962	1.962	1.794	1.551	
	3RD	1.370	1.257	1.189	1.542	1	
	4TH	1.031	0.976	0.844	1.176	0.713	
	5TH	0.837	0.778	0.660	0.921	-	
	6TH	-	-	-	0.732	-	
	REV.	3.583	3.583	3.583	3.416	-	
FGR		4.412/4.294	4.188	3.941	4.063/2.955 (For 1,2,R/3~6)	4.619	4.121
CLUTCH		SMF	SMF	SMF	DMF	T/Converter	
T/M oil(ℓ)		1.9	2.0	2.0	1.9	6.8	6.6



## 2. Main Features



A4CFx transmission has a lot of changed items comparing to Alphah T/M. It has

1. Long travel damper clutch torsion spring
2. Flat type torque converter
3. Full line pressure control (VFS)
4. High capacity oil pump which is from alloy material
5. Flexible Printed Circuit (FPC) wiring harness
6. Hall type PG-A and PG-B without VSS
7. Grinding type gears which can reduce NVH.



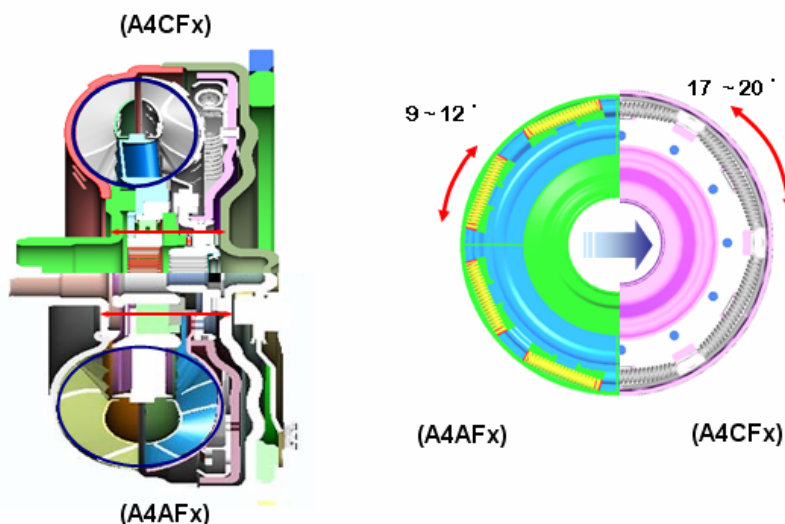
### 2.1 Oil Pump

Oil pump weight is incredibly reduced. Since A4CFx T/M has alloy material used oil pump like Hivex T/M. Also gear type is from Parachoid which increases the output capacity even in low rpm. Total volumetric efficiency is improved from 60% in Alpha to 80% at 1,000 rpm.

Items	A4CFx	A4AF3
Weight	1.9kg	4.7kg
Rotor shape		

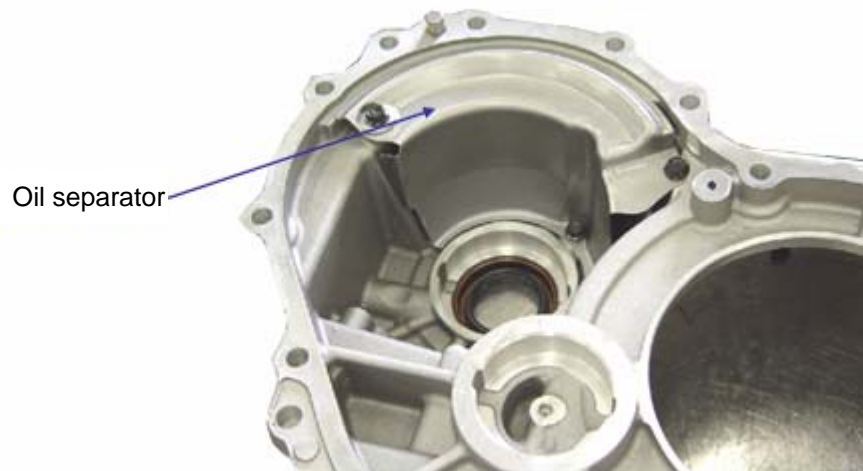
### 2.2 Torque Converter

Torque converter thickness is reduced by 5mm comparing to Alpha T/M. Reducing thickness results in easy installation for different vehicles. Long travel damper clutch is one of the advantages in A4CFx. Using this, more variable damper clutch operation area is extended. Increased damper clutch operation means better efficiency in fuel consumption. Each engine has different T/con. Whenever you replace it, you must use correct one.



## 2.3 Oil Separator

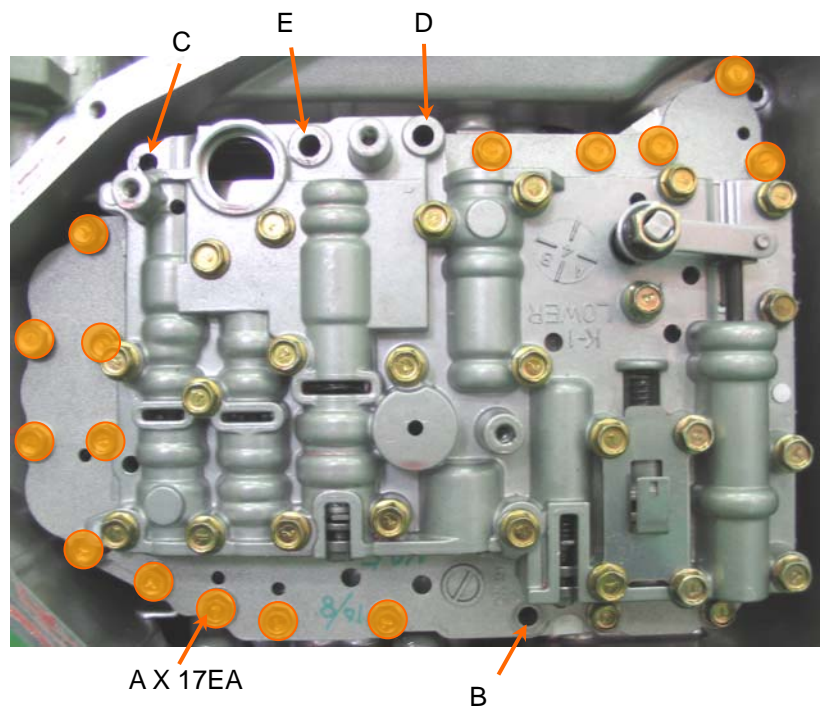
Main function of oil separator is reducing power loss from differential gear which is submerged in T/M oil. Without this differential gear is always inside in T/M oil resulting in friction loss by this. To separate oil and differential gear, this oil separator is used. Only proper T/M oil can be transferred upside from bottom through differential gear.



## 2.4 Valve Body

Valve body is modified from Alpha T/M. When you disassemble valve body, 5 different length bolts are used as shown in the figure.

1. A type (6x30mm) : 17EA
2. B type (6x35mm) : 1EA
3. C type (6x40mm) : 1EA
4. D type (6x55mm) : 1EA
5. E type (6x60mm) : 1EA



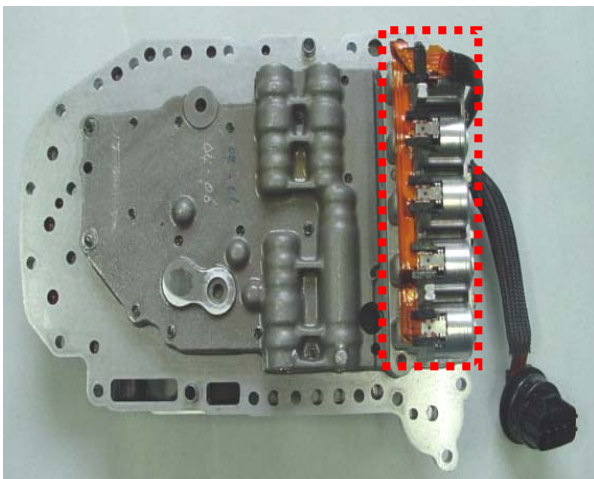
Valve body mounting bolt location

## 2.5 Solenoid Valves

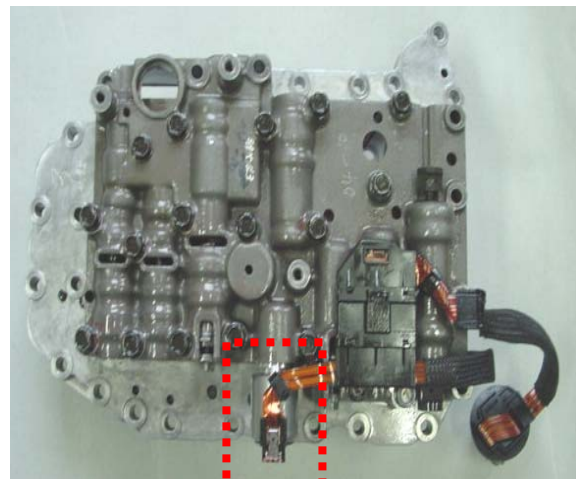
It has 6 solenoid valves.

1. PCSV-A : LR and OD control
2. PCSV-B : 2<sup>nd</sup> and Reverse control
3. PCSV-C : UD Control
4. PCSV-D : DCC Control
5. SCSV(On/Off) : Switching PCSV A from LR to OD Control in pressure
6. VFS Solenoid

Except VFS, other 5 solenoids are interchangeable. These have 3.2 Ohm but VFS has 3.5 Ohm. SCSV (On/Off) is actually controlled with the current controlled pulse – it is not controlled on or off. All solenoid valves are controlled by Current. Maximum control current is limited by 1.2A.



PCSV-C, PCSV-B, PCSV-D,  
SCSV(On/Off), PCSV-A From the Top



VFS

## 2.6 Accumulator

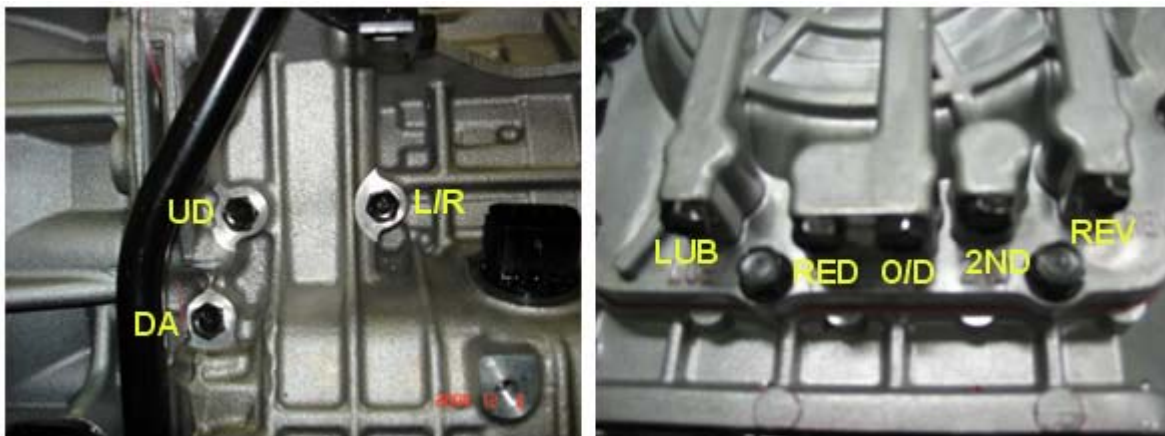
- a: For UD clutch  
→ Two springs with white color
- b: For OD clutch  
→ One spring with yellow color
- c: For 2<sup>nd</sup> brake  
→ Two springs with yellow color
- d: For LR brake  
→ One spring with yellow color





## 2.7 Pressure Checking Port

Each pressure can be measured through pressure checking port. Some measuring port positions are not easy to install pressure gauge because of the main member just below this. For more detail pressure spec, please refer to the relevant workshop manual.



- UD: Under Drive Clutch
- LR: Low and Reverse Brake
- DA: Damper Clutch Apply
- LUB: Lubrication Pressure (Constant 0.2~0.3bar)
- RED: Reducing Pressure (Constant 4.5 bar)
- OD: Over Drive Clutch
- 2<sup>nd</sup>: 2<sup>nd</sup> Brake
- REV: Reverse Clutch

\* The screw diameter and pitch for oil pressure checking port are same as one for HIVEC.

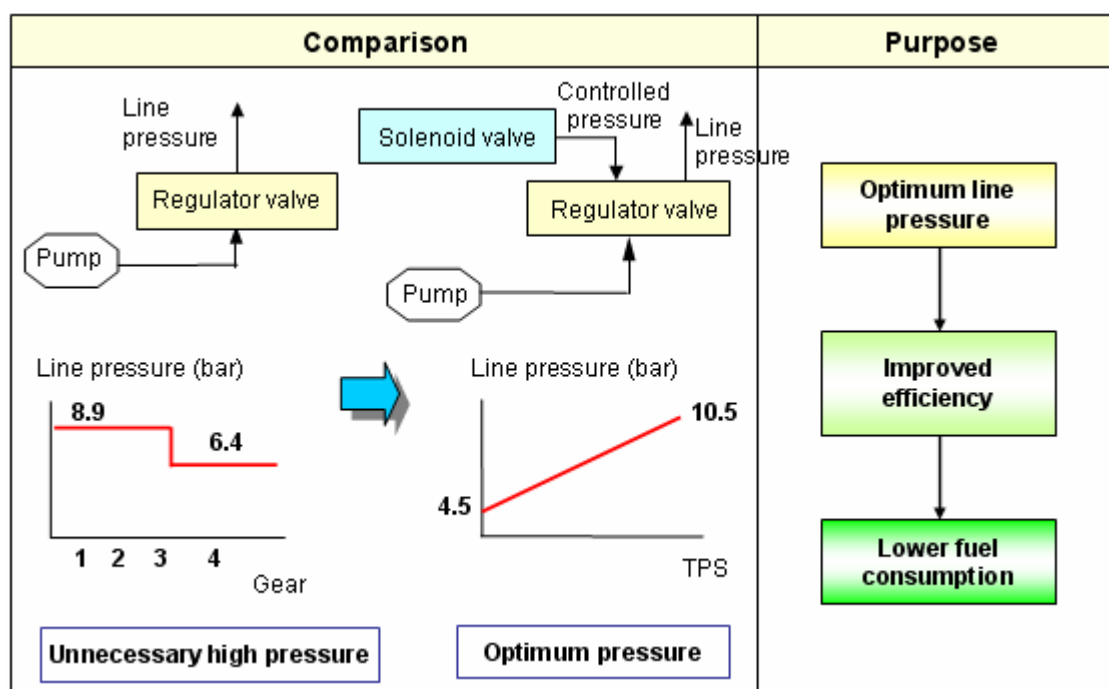
## 2.8 Vehicle speed sensor

Vehicle Speed Sensor which is used for TCM and Cluster speedometer is eliminated. Instead of the conventional vehicle speed sensor, PG-B (Output Speed Sensor) is used. After receiving PG-B signal, PCM (TCM) calculates its vehicle speed and transfers this to cluster with digital waveform. For engine control and body electrical control including auto door lock, front right wheel speed sensor is used for vehicle speed information. However, it differs depending on the vehicle specification and power train option.



## 2.9 VFS (Variable Force Solenoid)

To improve fuel consumption efficiency and reduce unnecessary high pressure, this VFS is added. This system is the same which is already used in MG, VQ and UN. Using this system line pressure can be varied from 4.5 to 10.5 bar. When this system has any failure, line pressure goes to maximum of 10.5 bar resulting in some shifting shock. Control way is similar to VQ Delphi system. Even it has short to ground condition, only VFS doesn't work. It means this condition doesn't lead all solenoid valves off condition. However, in case of 'short to B+' condition, the VFS will operate fully and it may result minimum line pressure. It will cause the severe damage in the clutch disc if you depress the acceleration pedal fully or do the engine stall test in this condition.



## 2.10 Inhibitor Switch

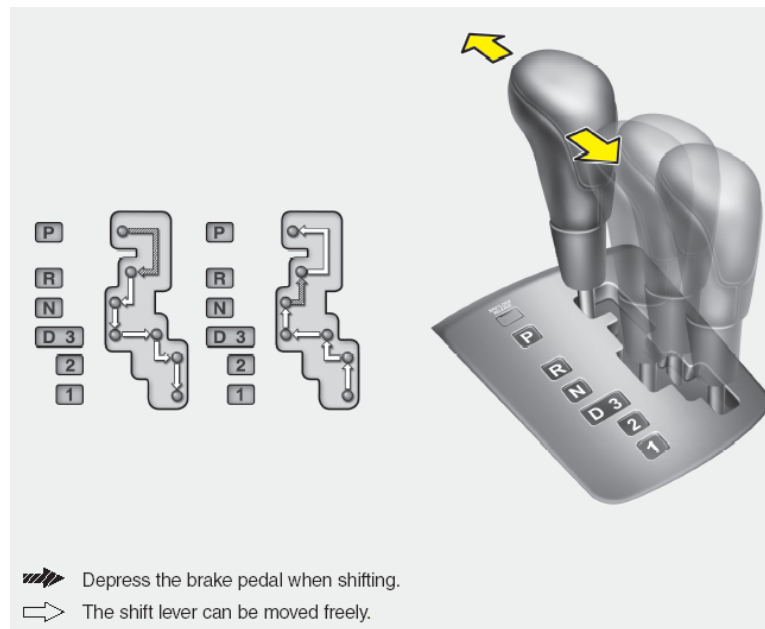
As same as in the case of HIVEC system, the sports mode TGS lever is applied and the inhibitor switch is same as one for HIVEC. For the failsafe of inhibitor switch, the last memory before fault is used to control the shift range by TCM. When the D terminal is open condition, the TCM will control the A/T by N range so the forward driving is not allowed in this condition. When the R terminal is open condition, the TCM will control the A/T by P or N range so the backward driving is not allowed in this condition. This is the difference comparing with the HIVEC. In case of HIVEC, the Reverse clutch hydraulic pressure is supplied from the manual valve and it is done mechanically, however this new alpha A/T has PCSV-B to control 2<sup>nd</sup> brake and Reverse clutch respectively. In this condition, PCSV-B will be ON because TCM control the A/T by N or P. If PCSV-B is ON, no hydraulic pressure is supplied to 2<sup>nd</sup> brake and Reverse clutch and that is the reason why the backward driving

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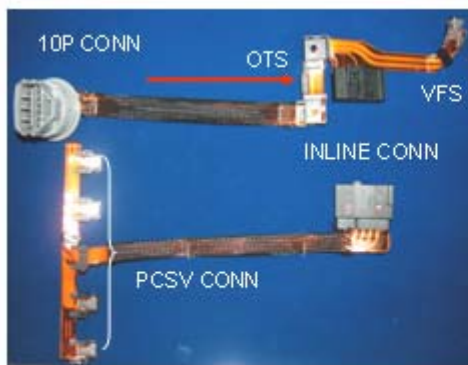
(Straight type – JB)

The 3<sup>rd</sup> position switch which has the same function with O/D off switch is positioned bottom side of shift lever assembly. When shift from D to 3, PCM (TCM) makes shift down from 4<sup>th</sup> to 3<sup>rd</sup> gear.

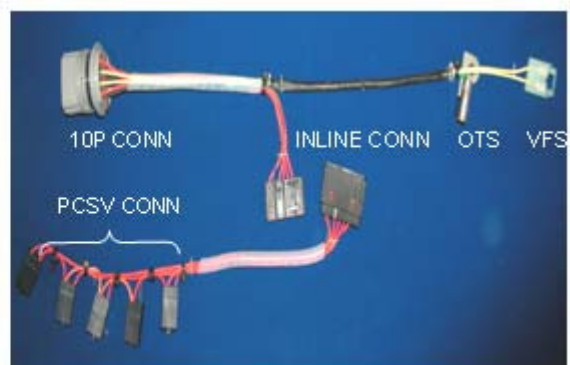


## 2.11 FPC (Flexible Printed Circuit) wiring harness

To increase manufacturing efficiency and save space in solenoid valve, flexible printed circuit type harness is used. It can reduce the weight by 30%.



(F4CFx)



(F4AFx)





### 3. Electronic Control

Input and output components are the same with HIVEC A/T except VSS. In case of on/off solenoid this is the main difference comparing to the one for HIVEC.

#### 3.1 Solenoid valve schedule

LR and OD solenoid is shared together when LR brake is engaged in P, On/Off solenoid is energized to switch its pressure to LR brake.

Items		Solenoid Valve (0%:OFF, 100%:ON)				
Range	Operation	PCSV-A (OD&LR)	PCSV-B (2ND&RVS)	PCSV-C (UD)	PCSV-D (DCCSV)	ON/OFF SOL.
P, N	LR	OFF	ON	ON	OFF	ON
D-1 <sup>st</sup>	UD	*OFF → ON	ON	OFF	OFF	*ON → OFF
D-2 <sup>nd</sup>	UD, 2ND	ON	OFF	OFF	ON	OFF
D-3 <sup>rd</sup>	UD, OD	OFF	ON	OFF	ON	OFF
D-4 <sup>th</sup>	OD, 2ND	OFF	OFF	ON	ON	OFF
R	LR, RVS	OFF	OFF	ON	OFF	ON
S-1 <sup>st</sup>	UD, LR	OFF	ON	OFF	OFF	ON

\* As the front wheel rotates, it is changed depending on the vehicle speed in D range 1<sup>st</sup> gear condition. However, it maintains to engage LR brake in case of Sports mode 1<sup>st</sup> gear.

Next explanation will follow to make you understood the hydraulic control logic.

**PCSV-A:** It concerns of the hydraulic pressure for OD clutch and LR brake. When the oil pressure is required for OD clutch or Low & reverse brake, this solenoid valve must be off. Another solenoid valve (on/off) will decide the oil passage to OD or LR.

**PCSV-B:** It concerns of the hydraulic pressure for 2<sup>nd</sup> brake or Reverse clutch. When the oil pressure is required for 2<sup>nd</sup> brake or Reverse clutch, this solenoid valve must be off. Whenever this solenoid valve is off, it will make the oil passage of reverse clutch opened. If the manual valve 'R' position is selected, the pressure will be applied to the reverse clutch. That is the reason why the reverse clutch is not engaged in 2<sup>nd</sup> and 4<sup>th</sup> gear (PCSV-B off condition)

**PCSV-C:** It is the simplest one among all solenoid valves. It concerns of only for under drive clutch operation. When this solenoid valve is off, UD clutch will be engaged. Not only this PCSV-C but also all solenoid valves in this model are normal high (N/H) type. That is, when the solenoid is energized with the particular current, the relevant element (clutch or brake) is not engaged (normal

condition). It is just like a normal open type solenoid valve.

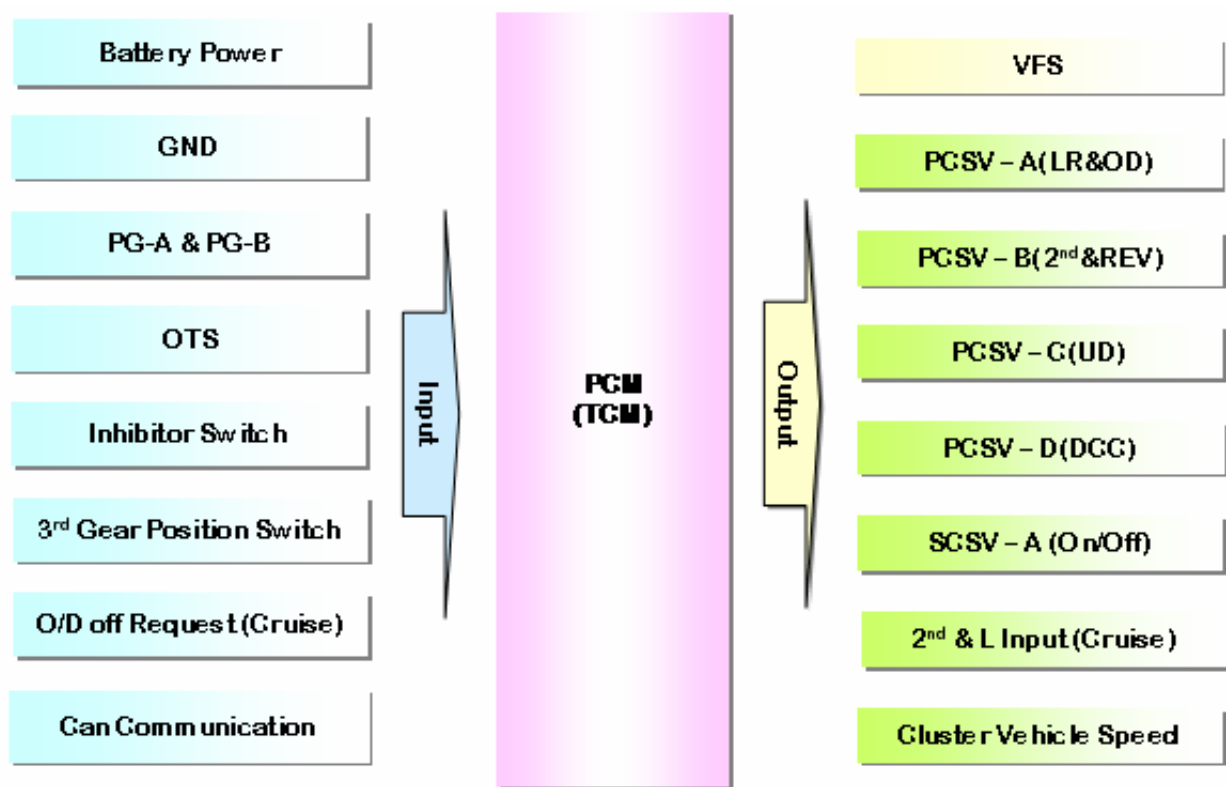
**PCSV-D:** It is only for damper clutch operation as you can see in the table. When this solenoid is off, the damper clutch is released.

**SCSV (On/Off):** As it is mentioned before in this manual, actually it is not controlled by On/Off by TCM as in the case of previous Alpha or Beta automatic transaxle. It shows the duty controlled waveform and the Low & Reverse brake pressure and Over drive clutch pressure is switched depending on the signal of SCSV. When this solenoid valve is off, LR brake pressure is released and the OD clutch pressure is applied. That is the reason why the 3<sup>rd</sup> gear failsafe (mechanically failed 3<sup>rd</sup> gear condition) is possible when the all solenoid valves are off including this solenoid valve.

### 3.2 Inputs and Outputs

O/D off request and 2<sup>nd</sup> and L input are for cruise control only. During driving under 4<sup>th</sup> gear to uphill, shift request is sent from Cruise to PCM(TCM) with O/D off request.

2<sup>nd</sup> and L output is from PCM(TCM) side. When this information is gone to Cruise, Cruise function is executed.



### 3.3 PCM (TCM) location

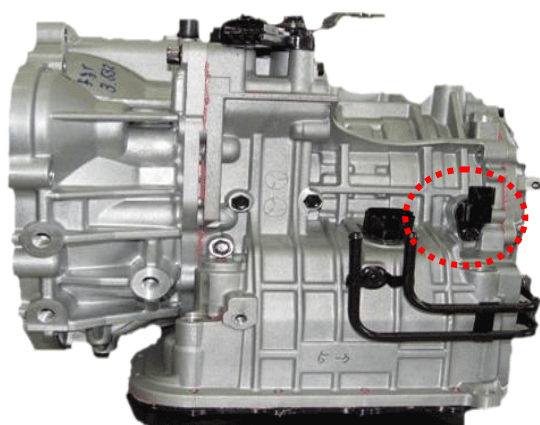
Gamma and Beta's case, PCM type is used and it is installed inside engine room as shown in the below figure.



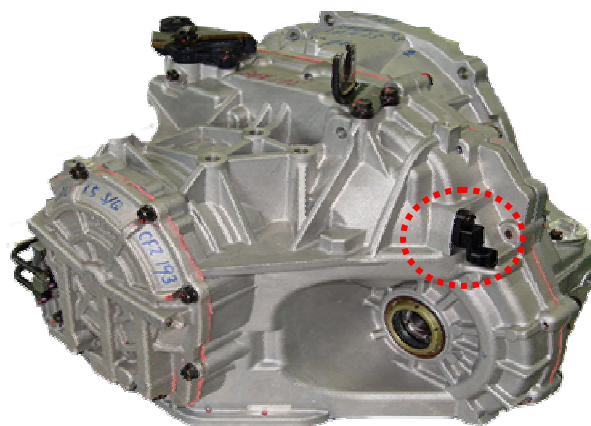
### 3.4 Input and Output Speed Sensor

Input and output speed sensor is from hall IC type which signals with digital waveform. In case of Input speed sensor (PG-A), it detect its signal using OD clutch retainer.

One of important function with these sensors is vehicle speed information. PG-B is used as a main sensor for this signaling.



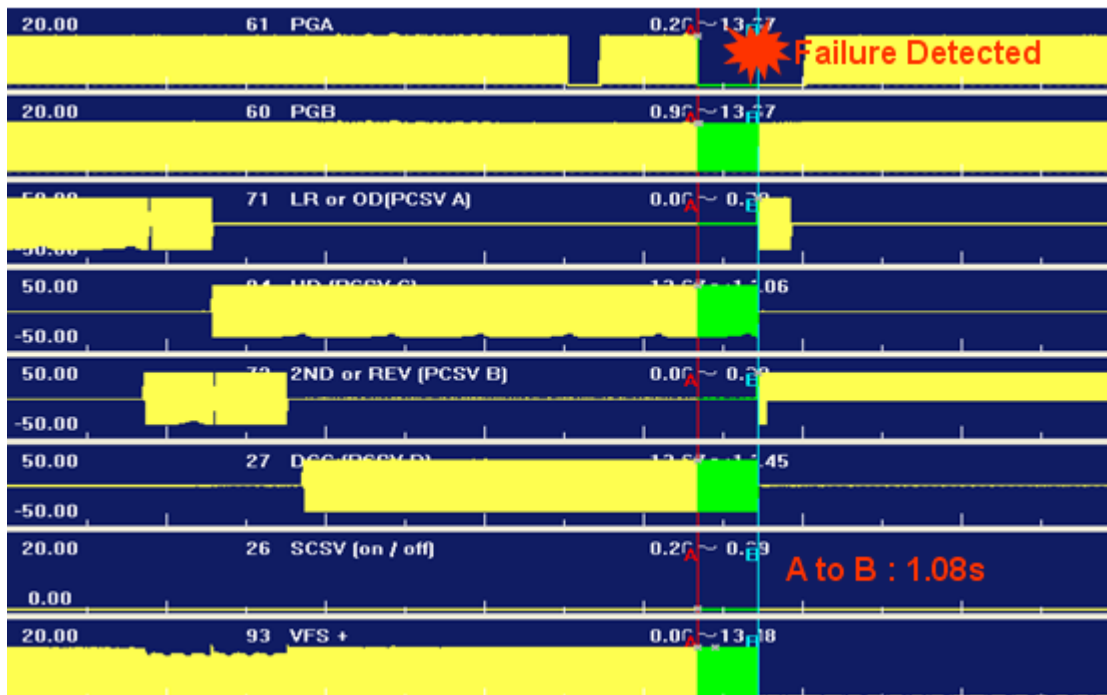
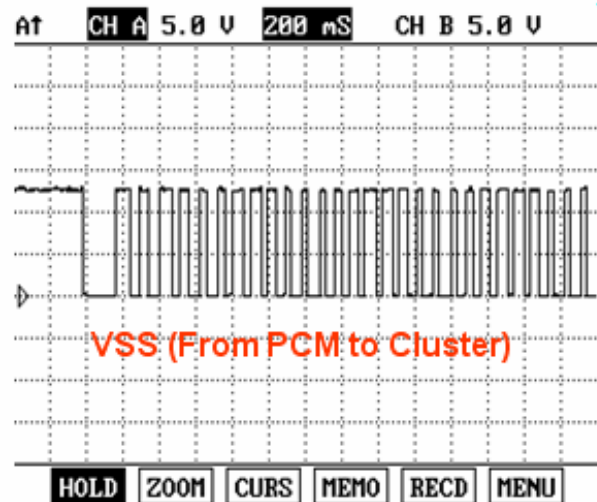
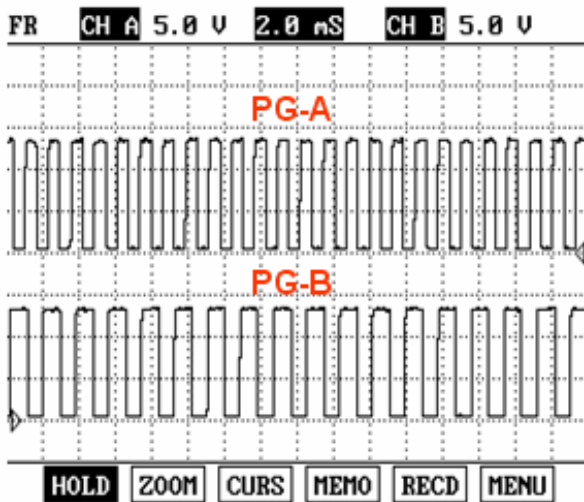
PG-A



PG-B

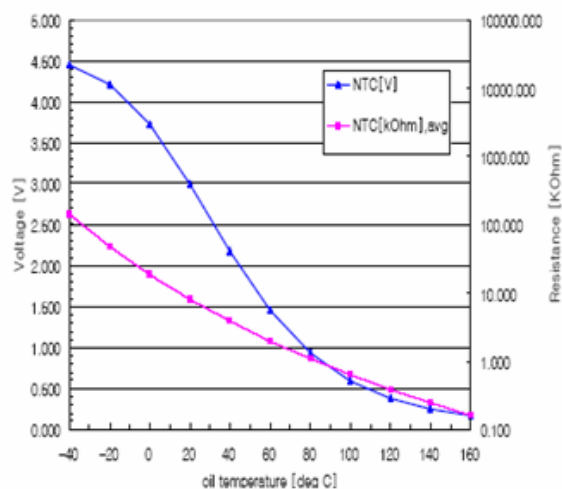
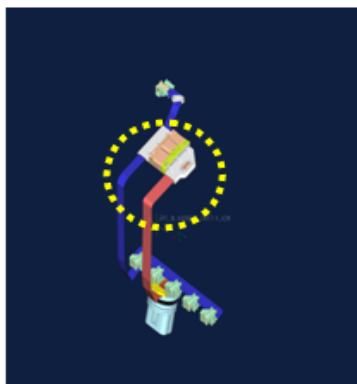
To detect PG-A or PG-B failure, special time and other values conditions are need. Before failure detected above picture, even missing PG-A symptom happens but it doesn't go to limp home. It means to detect this failure more than 1 second missing condition in signal happens then PCM considers this as PG-A failure condition and it goes to limp home. Typical limp home by this is

electrical 3<sup>rd</sup> gear holding but shifting from 3<sup>rd</sup> to 2<sup>nd</sup> is O.K.





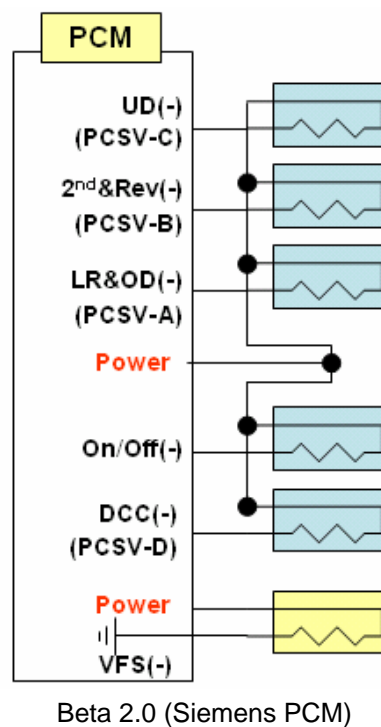
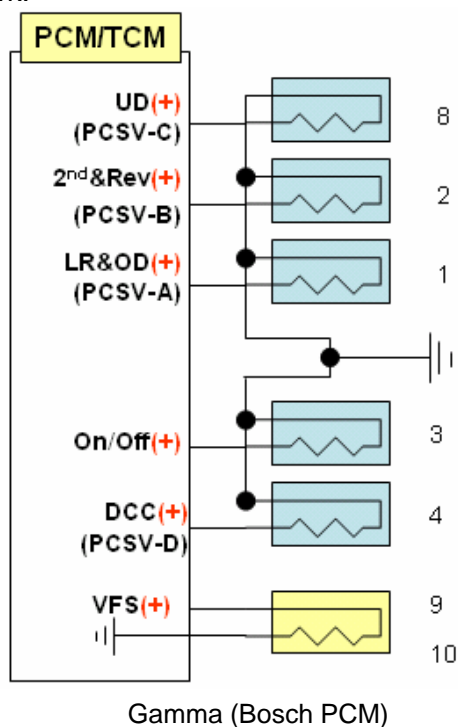
### 3.5 OTS (Oil Temperature Sensor)



When OTS has any failure 80 is fixed in current data. Shifting shock under cold condition can be produced from this.

### 3.6 Solenoid Valve Control

Bosch and Siemens solenoid valve control is different. In case of Bosch, it is controlled by +. It means operating voltage is supplied by PCM (TCM). Oppositely in Siemens, ground control is done except VFS. Both systems adopt positive VFS control. Even VFS has any failure only VFS itself doesn't work.



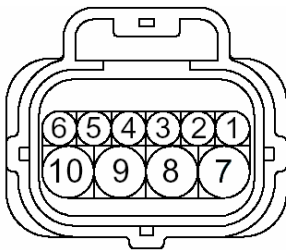


VFS

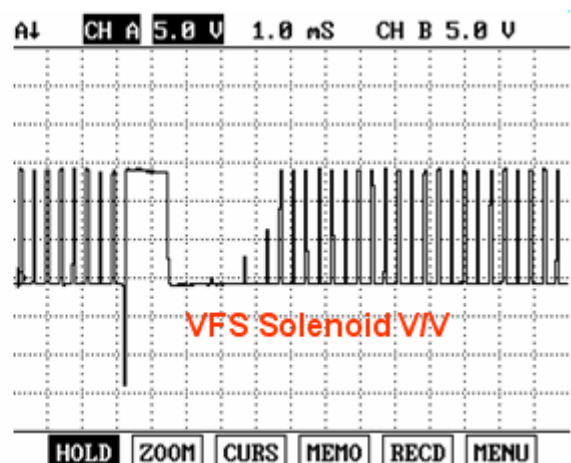
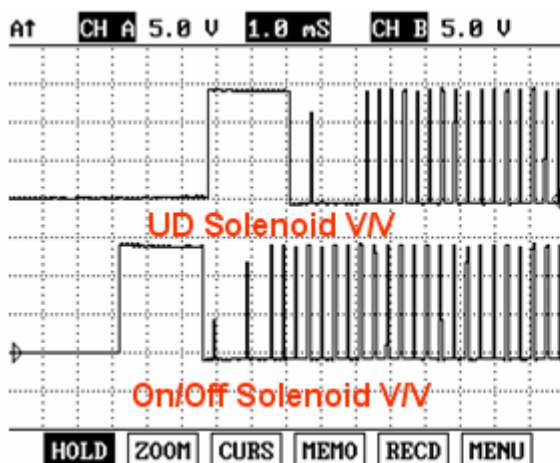


Other Solenoid Valve

### Solenoid valve connector layout



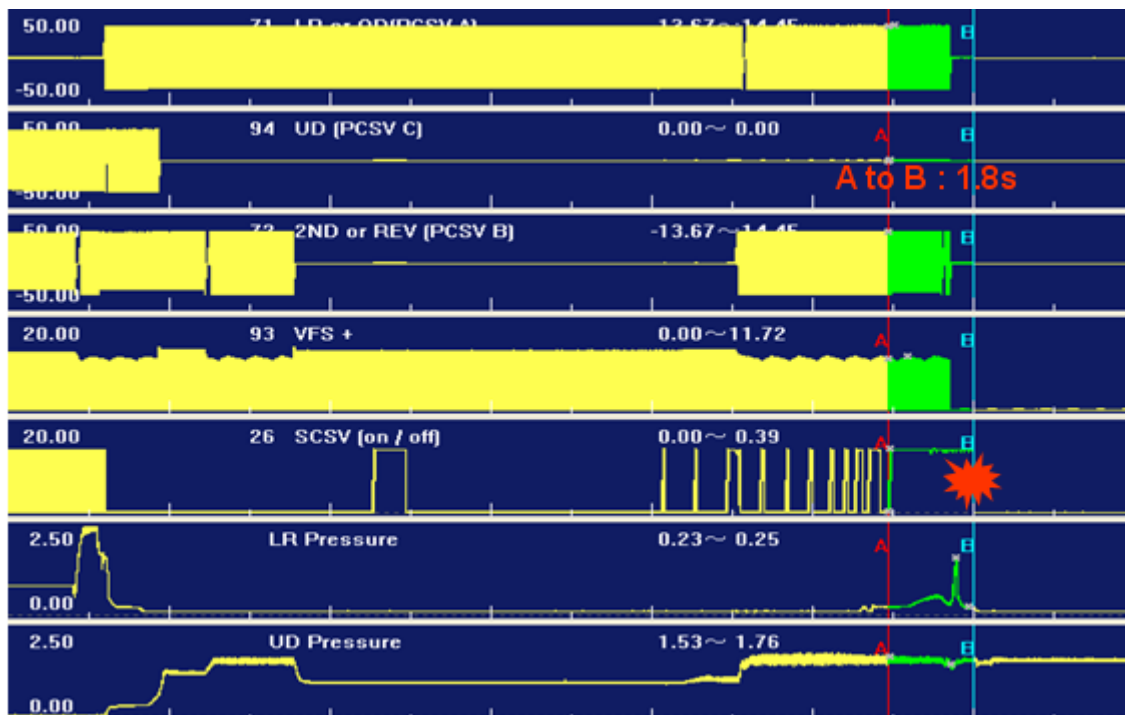
No.	Γ-1.6, U-1.6	B-2.0
1	PCSV-A (OD & LR)	PCSV-A (OD & LR)
2	PCSV-B (2nd & Rev.)	PCSV-B (2nd & Rev.)
3	SCSV (On/Off)	SCSV (On/Off)
4	PCSV-D (Lock up)	PCSV-D (Lock up)
5	OTS (Ground)	OTS (Ground)
6	OTS (Signal)	OTS (Signal)
7	Solenoid valves Ground	Solenoid valves Power
8	PCSV-C (UD)	PCSV-C (UD)
9	VFS	VFS
10	VFS Ground	VFS Power



When solenoid valve has any failure, it goes to immediate 3<sup>rd</sup> gear fix.

In point A, SCSV on/off valve goes to short to GND. Even it does like this before, the duration is not more than 1 second so it doesn't go to limp home. When it goes over more than 1 second, it goes to 3<sup>rd</sup> gear hold and releases all solenoid power. This can be distinguished with PG-A or PG-B failure.

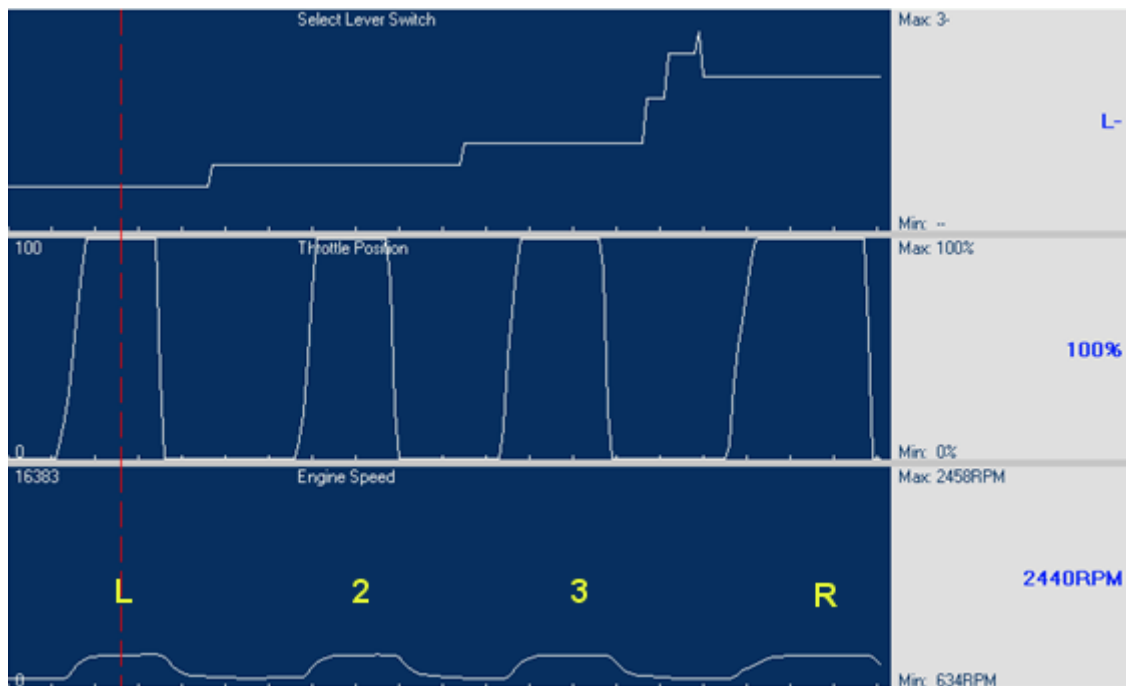
PG-A or PG-B failure's case shifting from 3<sup>rd</sup> to 2<sup>nd</sup> is O.K but solenoid failure doesn't allow any shifting except P & N or R.



### 3.7 Stall Test

One of the effective methods to distinguish is stall test. You can conduct stall test with relevant device. After warming up, depress the TP to maximum so as to check engine rpm under full braking condition. After getting the result, you can compare and estimate whether engine side or T/M side has any failure. For example if you get a high rpm in specified gear range, you can expect that gear engaged solenoid failures. This is indirect way to check T/M problems but quite effective.

Using normal vehicle after warming up, it shows around 2,400 rpm but the reference in workshop manual can be different. For more details feel free to check relevant workshop manual.

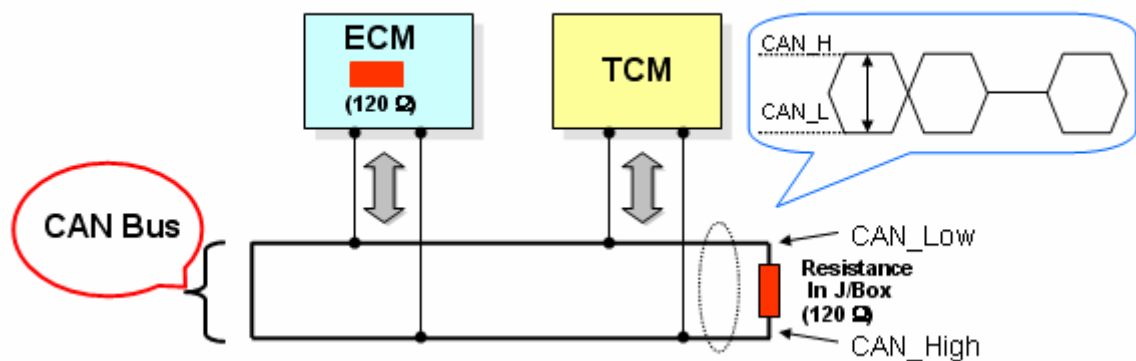


### 3.8 CAN Communication

Both internal and external CAN communication system is used. In case of U 1.6 CRDI, it is used by external CAN communication since ECM and TCM are separated.

Through CAN communication system, these data are interchanging.

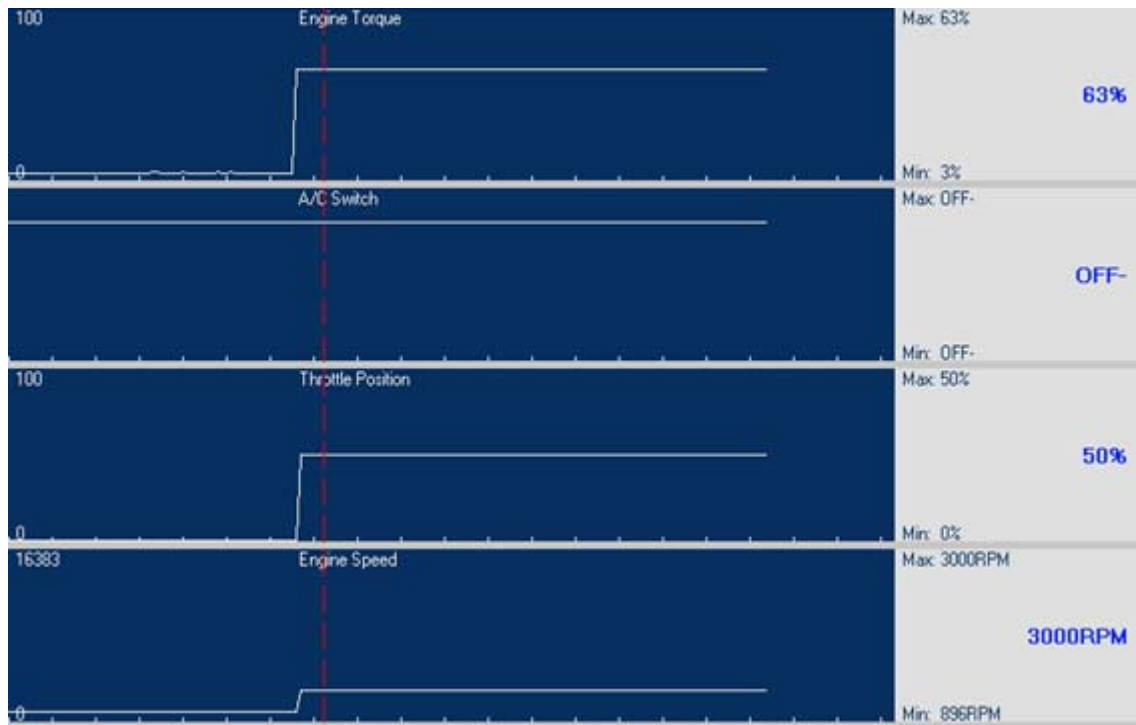
1. Engine rpm
2. Engine torque & torque reduction
3. A/con. On and Off
4. Throttle Position and Engine Coolant Temperature



When CAN system has any failure, it shows can bus off or can time out error. And mentioned data




will be fixed like as follow:



### 3.9 Resetting Auto T/A Values

**Resetting Auto T/A Values**



[ Resetting Auto T/A Values]

This function is for resetting the adaptive values from the used Auto T/A when replacing it.

<Condition>

1. IG. Key On
2. Transaxle Range : P
3. Vehicle Speed : 0 km/h
4. Engine Off

Reset
Cancel

Recent Transmission can have self studying function for better shift quality. Increasing or

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decreasing solenoid valve duty by checking output speed comparing to input speed value is the main factor. Also damping control by each different various is done by this self studying.

Whenever you replace new TM with old PCM(TCM), it is strongly recommended to conduct resetting auto T/A values. Conducting this you can erase all taught value before.

### 3.10 Current Data (P & N)

<input type="checkbox"/> Engine Speed	651	RPM
<input type="checkbox"/> Vehicle Speed Sensor	0	km/h
<input type="checkbox"/> Throttle Position	0	%
<input type="checkbox"/> Input Speed(PG-A)	627	RPM
<input type="checkbox"/> Output Speed(PG-B)	0	RPM
<input type="checkbox"/> DCC Solenoid Duty	0	%
<input type="checkbox"/> Damper Clutch Slip	24	RPM
<input type="checkbox"/> PCSV - A (LR & OD)	0	%
<input type="checkbox"/> PCSV - B (2nd & RVS)	99	%
<input type="checkbox"/> PCSV - C (UD)	99	%
<input type="checkbox"/> SCSV - A (On/Off Solenoid)	ON	-
<input type="checkbox"/> VFS Solenoid	0.0	%
<input type="checkbox"/> Oil Temperature Sensor	73	'C
<input type="checkbox"/> Gear Ratio	0.0	-
<input type="checkbox"/> Shift Position	P,N,R	-
<input type="checkbox"/> Select Lever Switch	P,N	-
<input type="checkbox"/> A/C Switch	OFF	-
<input type="checkbox"/> O/D Off Switch	OFF	-
<input type="checkbox"/> Brake Switch	OFF	-
<input type="checkbox"/> Overdrive OFF Lamp	OFF	-
<input type="checkbox"/> Engine Torque	0	%

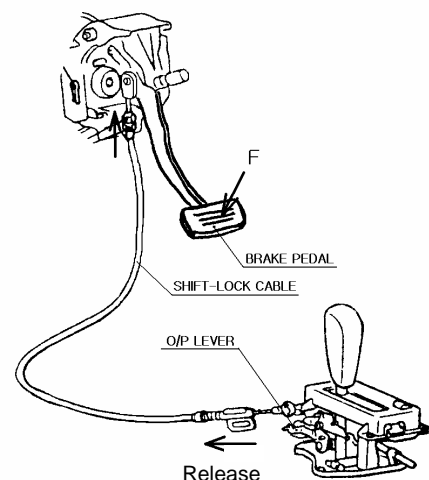
Under P & N range only LR brake is engage. Solenoid 100% means reducing line pressure (No engagement).

### 3.11 Electronic controlled shift lock system

This system has been applied in Kia vehicle for North American or domestic market. It is the first time to adopt in EU market from ED so it will explain this system feature briefly in this manual.

#### 1) Mechanical cable type

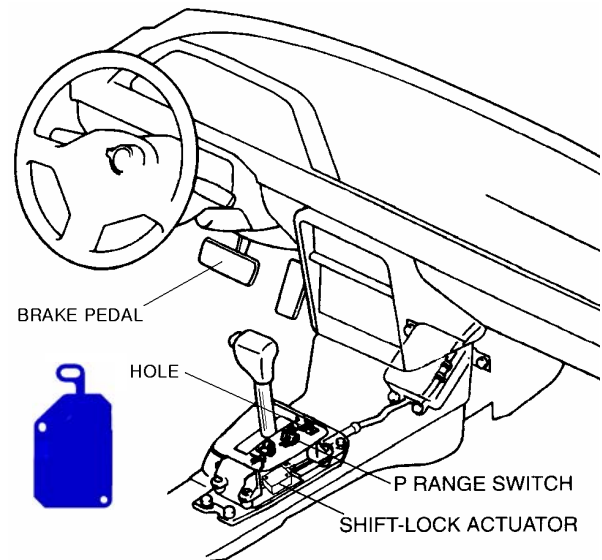
In this system, the independent electronic control module is not required. The operating noise is lower than the electronic system because there is no solenoid valve. This system offers P to R shift lock only, that is N to R shift lock is not supported. Just depressing the foot brake, the lock is released without ignition key ON. This system has been applied in MS, SA, GH, JB (for KMC) and XD, LD, EF, TB, JB (for HMC).



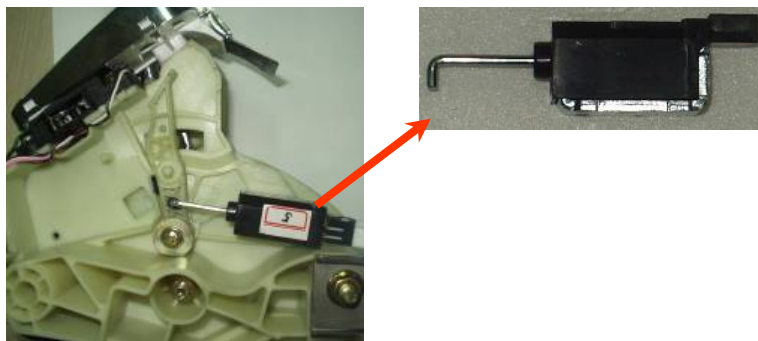
## 2) Actuator (built in control module) type

In this system, the independent electronic control module is not required, it is built in the actuator. The operating noise is higher than other types. This system offers not only P to R shift lock but also N to R shift lock. Depressing the foot brake under the ignition key ON condition to release the actuator.

This system has been applied in GQ,SD,CT,PU,VQ (for KMC).



## 3) Solenoid valve type



In this system, not only P to R shift lock but also 'N shift lock' function is available. (Foot brake ON is required for 'N to R' shift) Generally N to R shift function is added on the vehicle that has the step gate type shift lever because there is no 'push button' in the gate type lever so it is necessary to get the another safety device for R shifting instead of the 'push button'. It has lower operating noise and better layout to install on the vehicle.

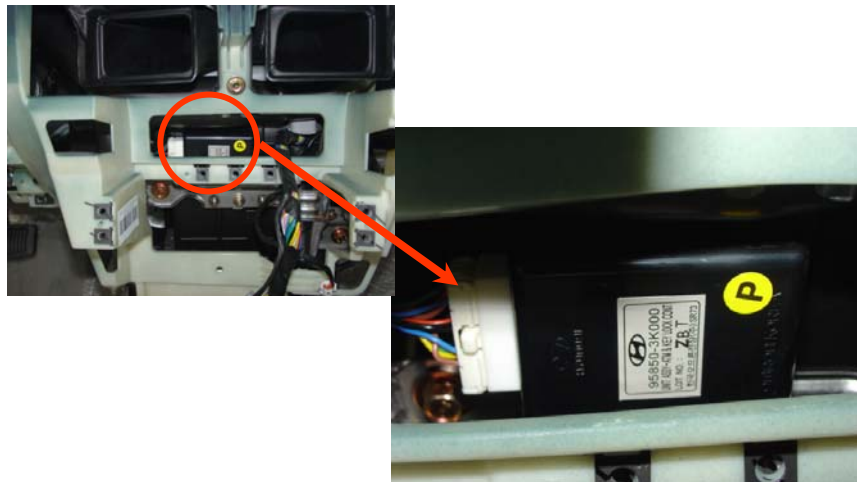
The independent control module is required and it has been applied in EN, EP, ED, NF, TG, LC (for HMC) and MG, VQ, ED (for KMC). Following is the releasing condition of the solenoid valve and it controls the adjustable pedal together in case of some vehicle such as NF, TG, EN (for HMC) and VQ (for KMC).

Releasing condition:

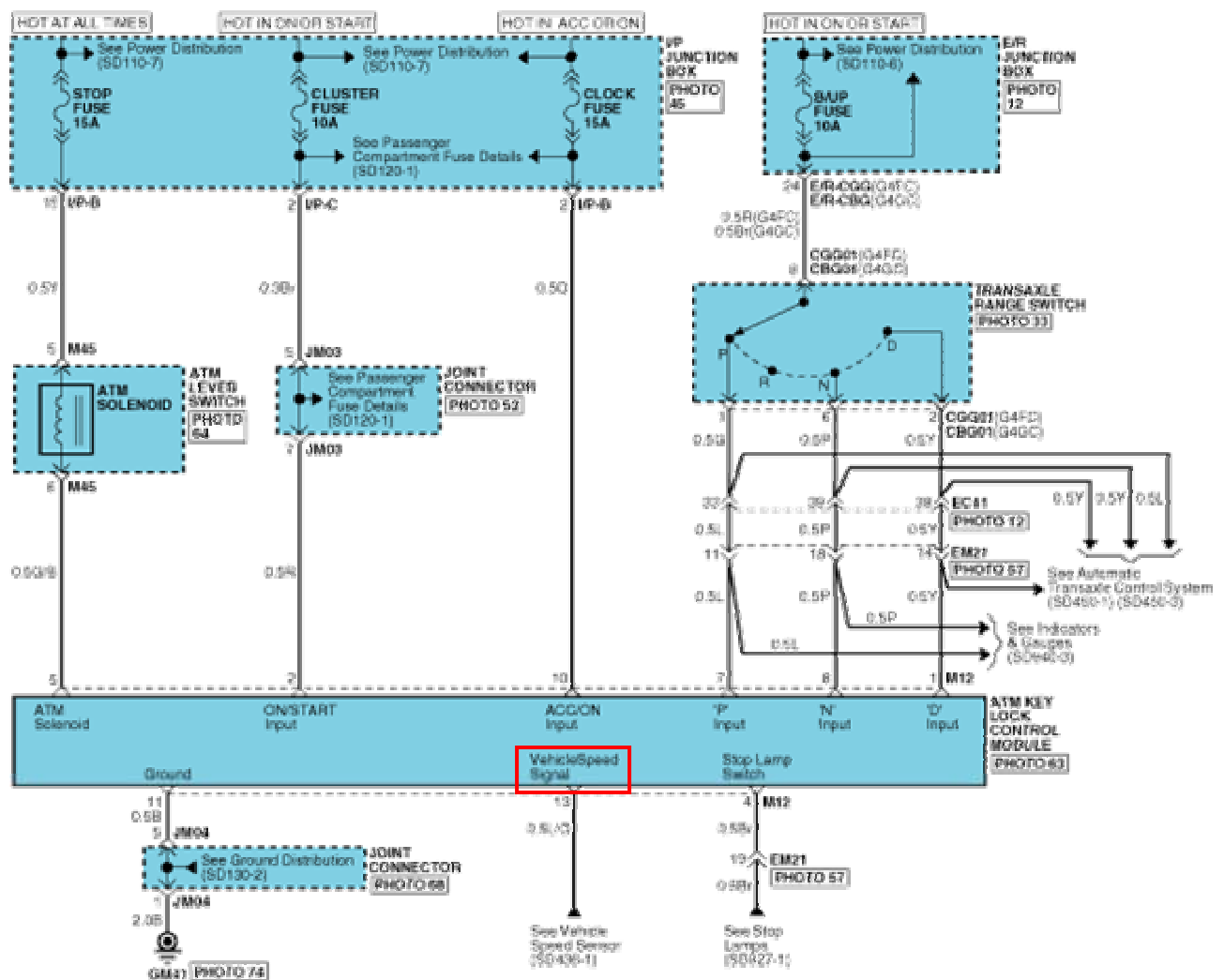
- Ignition key ON
- P, N range
- D range ( $VSS < 7\text{km/h}$ )\*

\* Some vehicle will receive the vehicle speed signal to 'ATM shift lock control module'.

The reason of the input for the vehicle speed sensor is,



ATM & Key lock control







Sometimes, a driver may shift the lever from D to R with very high speed while parking. Basically the shift lock solenoid is not released in D range. But if the driver move the lever from D to R with too much high speed, the 'ATM shift lock control module' may loose the signal of 'N', so that the shift lever cannot move from N to R immediately even though the foot brake pedal is depressed securely. That is why exceptionally the solenoid will be released in advance at D range if the vehicle speed is lower than 7kph (it means that the vehicle is being parked now) for smooth moving form N to R without any stopping and resistance.

Depending on the vehicle model and specification, the 'P' range signal inputs to 'ATM shift lock control module' from the A/T inhibitor switch or independent 'p' position switch located nearby the shift lever.