GENERAL

4110-01

GENERAL INFORMATION

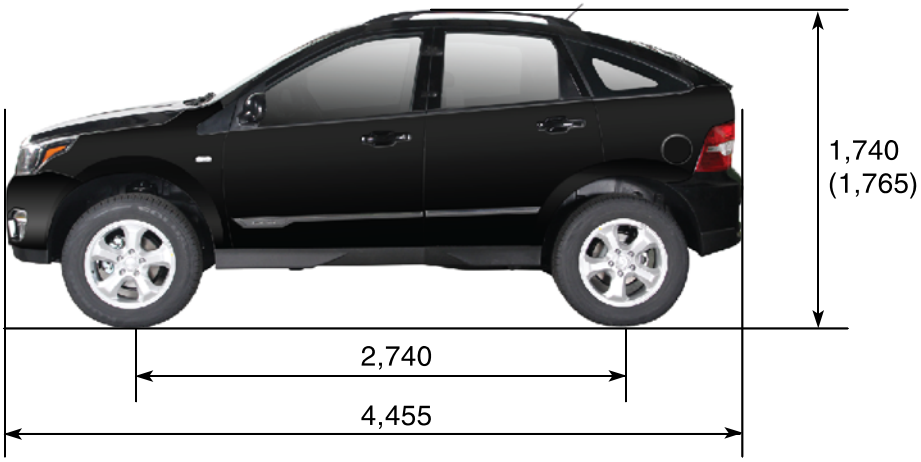
1. DIMENSIONS

Unit: mm

Top view



Side view



Front view



Rear view



Modification basis	
Application basis	
Affected VIN	

2. SPECIFICATIONS

* ( ) Optional, [ ] 2WD

Descriptions			D20DTR	G23D
General	Overall length (mm)		4,455	←
	Overall width (mm)		1,880 (1,920)	←
	Overall height (mm)		1,740 (1,765)	←
	Gross vehicle weight (kg)	A/T	2,520	←
		M/T	2,520	←
	Curb vehicle weight (kg)	A/T	1,949 [1,837]	1,936 [1,826]
		M/T	1,925 [1,813]	1,909 [1,800]
	Fuel		Diesel	Gasoline
	Fuel tank capacity (ℓ)		75	←
	Min. turning radius (m)		5.6	←
Engine	Numbers of cylinders/Compression ratio		4 / 16.5:1	4 / 10.4:1
	Total displacement (cc)		1,998	2,295
	Camshaft arrangement		DOHC	←
	Max. power		153 ps / 3,400 ~ 4,000 rpm	150 ps / 5,500 rpm
	Max. torque		360 Nm / 1,500 ~ 2,800 rpm	214 Nm / 3,500 ~ 4,600 rpm
	Idle speed		750 ± 20 rpm	750 ± 50 rpm
	Cooling system		Water- cooled / forced circulation	←
	Coolant capacity (ℓ)		8.5	10.5 ~ 11.0
	Lubrication type		Gear pump, forced circulation	←
	Max. oil capacity (ℓ) (when shipping)		6.0	7.9
	Turbocharger and cooling type		Turbocharger, air-cooled	–
Manual Transmission	Operating type		Semi-Remote control, floor change type	←
	Gear ratio	1st	4.489	4.315
		2nd	2.337	2.475
		3rd	1.350	1.536
		4th	1.000	1.000
		5th	0.784	0.807
		6th	0.679	–
		Reverse	4.253	3.919

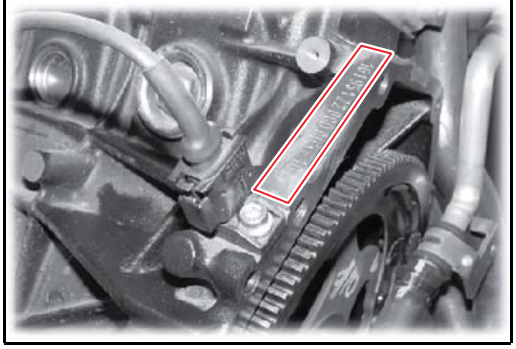
Modification basis	
Application basis	
Affected VIN	

* ( ) Optional, [ ] 2WD

Descriptions			D20DTR	G23D
Automatic Transmission	Model		Electronic, 6-speed	–
	Operating type		Floor change type	–
	Gear ratio	1st	3.595	3.536
		2nd	2.186	2.143
		3rd	1.405	1.478
		4th	1.000	1.156
		5th	0.831	0.866
		6th	–	0.677
		Reverse 1st	3.167	3.094
		Reverse 2nd	1.926	–
Transfer Case	Model		2WD, Part-time	←
	Type		Planetary gear type	←
	Gear ratio	High (4H)	1.000 : 1	←
		Low (4L)	2.483 : 1	←
Clutch (M/T)	Operating type		Hydraulic type	←
	Disc type		Dry single diaphragm type	←
Power Steering	Type		Rack and pinion	←
	Steering angle	Inner	36.2°	←
		Outer	32.4°	←
Front Axle	Drive shaft type		Ball joint type	←
	Axle housing type		Build-up type	←
Rear Axle	Drive shaft type	Solid axle suspension	Semi-floating type	←
	Axle housing type		Build-up type	←
Brake	Master cylinder type		Tandem type	←
	Booster type		Vacuum assisted booster type	←
	Brake type	Front wheels	Disc type	←
		Rear wheels	Drum & DISC	←
	Parking brake		Cable type (internal expansion)	←
Suspension	Front suspension		Wishbone + coil spring	←
	Rear suspension	Solid axle suspension	5-link + coil spring	←
Air Conditioner	Refrigerant (capacity)		R-134a (650 ± 30g)	←
Electrical	Battery type / Capacity (V-AH)		MF / 12 - 90	←
	Starter capacity (V-kW)		12 - 2.2	12 - 1.2
	Alternator capacity (V-A)		12 - 120	12 - 115

3. VEHICLE IDENTIFICATION

Engine Number (G23D)

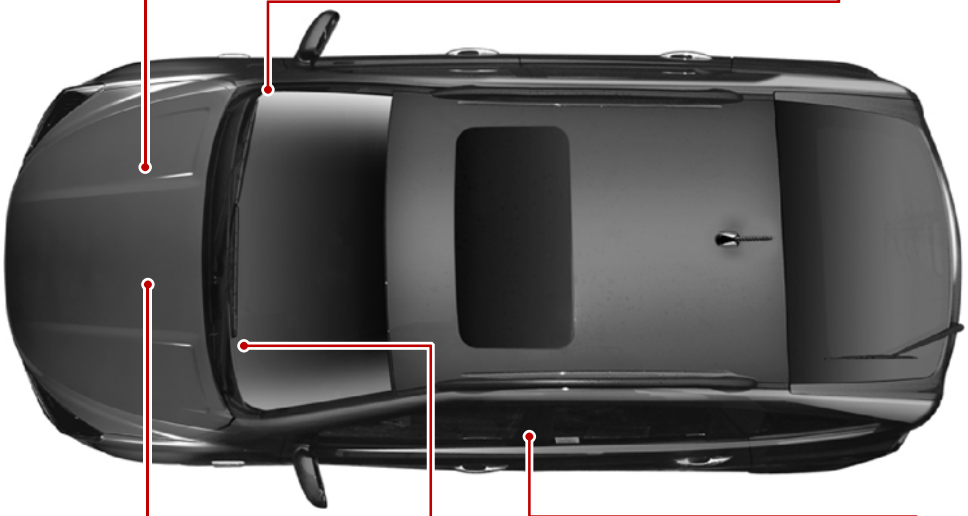


The engine number is stamped on the upper rear left-hand side of the cylinder block.

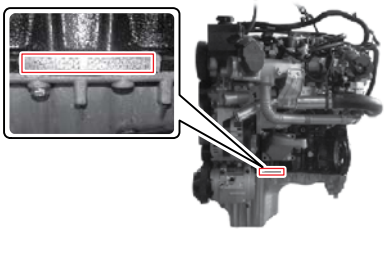
Chassis Number



The chassis number is stamped on the frame behind the front right tire.



Engine Number (D20DTR)



The engine number is stamped on the lower area of cylinder block behind the Intake manifold.

Vin Label



Certification Label



The certification label is located on the driver's door sill.

Modification basis	
Application basis	
Affected VIN	

4. MAINTENANCE INTERVAL

1) Diesel Engine - EU

* Use only approved Ssangyong genuine parts.

Maintenance service and record retention are the owner's responsibility. You should retain evidence that proper maintenance has been performed on your vehicle in accordance with the scheduled maintenance service chart.

* EU Countries: Only countries that belong to EU. (It does not apply to all countries in EU.)

MAINTENANCE INTERVAL / MAINTENANCE ITEM	Kilometers (miles) or time in months, whichever comes first							
	x1000 km	20	40	60	80	100	120	140	160
	x1000 miles	12.5	25	37.5	50	62.5	75	87.5	100
	Months	12	24	36	48	60	72	84	96
ENGINE CONTROL SYSTEM									
Drive belt		I	I	I	I	I	I	I	I
* Engine oil & filter *1 (1)* (3)* (4)*		R	R	R	R	R	R	R	R
		Shorten the service interval under severe conditions							
Cooling system hose & connections		I	I	I	I	I	I	I	I
Engine coolant (3)* (4)		Change every 200000 km or 5 years. And, inspect and replenish if necessary.							
Fuel filter (1)*		I	R	I	R	I	R	I	R
		Drain the water from fuel filter: whenever replacing the engine oil							
Fuel line & connections		I	I	I	I	I	I	I	I
Air cleaner (2)*		R	R	R	R	R	R	R	R
		Shorten the service interval under severe conditions							

Chart Symbols:

I - Inspect these items and their related parts. If necessary, correct, clean, replenish, adjust or replace.
*1 Check the engine oil level and leak every 3000 km (2000 miles) or before starting a long trip.

R- Replace or change.

(1)* If vehicle is operated under severe condition:
Shorten the service interval.
- Frequent stop-and-go traffic, extended idling, short driving distance below 6 km, driving distance below 16 km when the outside temperature remains below freezing
- Driving in a hilly or mountainous terrain, sandy, or dusty area
- High load driving such as trailer towing
- Taxi, patrol service or delivery service (extended idling and excessive driving with low speed)

(2)* If vehicle is operated under severe condition, driving in dusty condition or sandy condition, pollutant area or off-road driving, frequently inspect the air cleaner, if necessary, change the air cleaner.

(3)* More frequent maintenance is required if under dusty driving condition.

(4)* Refer to "Recommended fluids, coolant and lubricants".

* EU Countries: Only countries that belong to EU. (It does not apply to all countries in EU.)

MAINTENANCE INTERVAL / MAINTENANCE ITEM		Kilometers (miles) or time in months, whichever comes first							
	x1000 km	20	40	60	80	100	120	140	160
	x1000 miles	12.5	25	37.5	50	62.5	75	87.5	100
	Months	12	24	36	48	60	72	84	96
CHASSIS AND BODY									
Exhaust pipes & mountings		I	I	I	I	I	I	I	I
Brake / Clutch fluid (3)*		Change every 2 years (inspect frequently)							
Parking brake / Brake pads (Front & Rear) (4)*		I	I	I	I	I	I	I	I
Brake line & connections (including booster)		I	I	I	I	I	I	I	I
Manual transmission oil (5)*				I			I		
Clutch & brake pedal free play		I	I	I	I	I	I	I	I
Transfer case fluid (3)*		I	I	R	I	I	R	I	I
Axle oil	Front	I	R	I	R	I	R	I	R
	Rear	I	R	I	R	I	R	I	R
Automatic transmission fluid (6)*		I	I	I	I	I	I	I	I
		Change every 60000 km under severe condition							
Chassis & underbody bolts & nuts tight / Secure (6)*		Check frequently and adjust or replace if necessary							
Tire condition & inflation pressure		Check frequently and adjust or replace if necessary							
Wheel alignment (7)*		Inspect when abnormal condition is noted							
Steering wheel & linkage		I	I	I	I	I	I	I	I

Chart Symbols:

I - Inspect these items and their related parts. If necessary, correct, clean, replenish, adjust or replace.

R- Replace or change.

(3)* Refer to “Recommended fluids and lubricants”.

(4)* More frequent maintenance is required if the vehicle is operated under any of the following conditions:
- In heavy city traffic where the outside temperature regularly reaches 32°C (90°F) or higher, or
- In hilly or moutainous terrain, or
- When doing frequent trailer towing, or
- Uses such as found in taxi, police or delivery service.

(5)* Inspect and replenish every 60000 km (or 3 years)
Normal driving condition: Fill for Life
(Severe driving condition: Change every 120000 km)

(6)* If vehicle is operated under severe condition: Shorten the service interval.
- Towing a trailer or off-road driving (Inspect the leak of fluid at any time, occasionlly)
- Taxi, patrol service or delivery service (extended idling and excessive driving with low speed)
- Frequent stop-and-go traffic, extended idling, short driving distance
- Driving in a hilly or mountainous terrain, sandy, or dusty area
- Driving frequently at high speed over 170 km/hour
- Driving frequently in area where heavy traffic under the ambient temperature above 32°C

(7)* If necessary, rotate and balance wheels.

Modification basis	
Application basis	
Affected VIN	

* EU Countries: Only countries that belong to EU. (It does not apply to all countries in EU.)

MAINTENANCE INTERVAL / MAINTENANCE ITEM	Kilometers (miles) or time in months, whichever comes first							
	x1000 km	20	40	60	80	100	120	140	160
	x1000 miles	12.5	25	37.5	50	62.5	75	87.5	100
	Months	12	24	36	48	60	72	84	96
CHASSIS AND BODY									
Power steering fluid & lines (3)*		I	I	I	I	I	I	I	I
Drive shaft boots (8)*		I	I	I	I	I	I	I	I
Seat belts, buckles & anchors		I	I	I	I	I	I	I	I
Lubricate locks, hinges & bonnet latch		Check frequently and adjust or replace if necessary							
Wheel bearing grease		I	I	I	I	I	I	I	I
Propeller shaft grease - Front / Rear (9)*		I	I	I	I	I	I	I	I
Air conditioner filter (10)*		R	R	R	R	R	R	R	R
		Shorten the service interval under severe conditions							

Chart Symbols:

I - Inspect these items and their related parts. If necessary, correct, clean, replenish, adjust or replace.

R- Replace or change.

(3)* Refer to “Recommended fluids and lubricants”.

(8)* After completion of off-road operation, the drive shaft boots should be inspected.

(9)* Inspect propeller shaft grease every 5000 km or 3 months if the vehicle is mainly driven under severe condition.

- In off-road or dusty road, or
- In heavy city traffic where the outside temperature regularly reaches 32°C (90°F) or higher, or
- In hilly or moutainous terrain.

(10)* Severe Conditions in Air Conditioner Filter

- Pollutant area or off-road driving, extended air conditioner or heater operation

2) Diesel Engine - GENERAL

* Use only approved Ssangyong genuine parts.

Maintenance service and record retention are the owner's responsibility. You should retain evidence that proper maintenance has been performed on your vehicle in accordance with the scheduled maintenance service chart.

MAINTENANCE INTERVAL / MAINTENANCE ITEM	Kilometers (miles) or time in months, whichever comes first								
	x1000 km	15	30	45	60	75	90	105	120
	x1000 miles	10	20	30	40	50	60	70	80
	Months	12	24	36	48	60	72	84	96

ENGINE CONTROL SYSTEM

Drive belt	I	I	I	I	I	I	I	I
* Engine oil & filter *1 (1)* (3)* (4)*	R	R	R	R	R	R	R	R
	Shorten the service interval under severe conditions							
Cooling system hose & connections	I	I	I	I	I	I	I	I
Engine coolant (3)* (4)	Change every 200000 km or 5 years. And, inspect and replenish if necessary.							
Fuel filter (1)*	I	I	R	I	I	R	I	I
	Drain the water from fuel filter: whenever replacing the engine oil							
Fuel line & connections	I	I	I	I	I	I	I	I
Air cleaner (2)*	R	R	R	R	R	R	R	R
	Clean every 7500 km, Shorten the service interval under severe conditions							

Chart Symbols:

I - Inspect these items and their related parts. If necessary, correct, clean, replenish, adjust or replace.
*1 Check the engine oil level and leak every 3000 km (2000 miles) or before starting a long trip.

R- Replace or change.

(1)* If vehicle is operated under severe condition:
Shorten the service interval.
- Frequent stop-and-go traffic, extended idling, short driving distance below 6 km, driving distance below 16 km when the outside temperature remains below freezing
- Driving in a hilly or mountainous terrain, sandy, or dusty area
- High load driving such as trailer towing
- Taxi, patrol service or delivery service (extended idling and excessive driving with low speed)

(2)* If vehicle is operated under severe condition, driving in dusty condition or sandy condition, pollutant area or off-road driving, frequently inspect the air cleaner, if necessary, change the air cleaner.

(3)* More frequent maintenance is required if under dusty driving condition.

(4)* Refer to "Recommended fluids, coolant and lubricants".

Modification basis	
Application basis	
Affected VIN	

MAINTENANCE INTERVAL / MAINTENANCE ITEM		Kilometers (miles) or time in months, whichever comes first							
	x1000 km	15	30	45	60	75	90	105	120
	x1000 miles	10	20	30	40	50	60	70	80
	Months	12	24	36	48	60	72	84	96

CHASSIS AND BODY

Exhaust pipes & mountings		I	I	I	I	I	I	I	I
Brake / Clutch fluid (3)*		Change every 2 years (inspect frequently)							
Parking brake / Brake pads (Front & Rear) (4)*		I	I	I	I	I	I	I	I
Brake line & connections (including booster)		I	I	I	I	I	I	I	I
Manual transmission oil (5)*					I				I
Clutch & brake pedal free play		I	I	I	I	I	I	I	I
Transfer case fluid (3)*		I	I	I	R	I	I	I	R
Axle oil	Front	I	R	I	R	I	R	I	R
	Rear	I	R	I	R	I	R	I	R
Automatic transmission fluid (6)*		Inspect every 15000 km or 12 month (But change every 60000 km under severe condition)							
Chassis & underbody bolts & nuts tight / Secure (6)*		Check frequently and adjust or replace if necessary							
Tire condition & inflation pressure		Check frequently and adjust or replace if necessary							
Wheel alignment (7)*		Inspect when abnormal condition is noted							
Steering wheel & linkage		I	I	I	I	I	I	I	I

Chart Symbols:

I - Inspect these items and their related parts. If necessary, correct, clean, replenish, adjust or replace.

R- Replace or change.

(3)* Refer to “Recommended fluids and lubricants”.

(4)* More frequent maintenance is required if the vehicle is operated under any of the following conditions:
- In heavy city traffic where the outside temperature regularly reaches 32°C (90°F) or higher, or
- In hilly or moutainous terrain, or
- When doing frequent trailer towing, or
- Uses such as found in taxi, police or delivery service.

(5)* Inspect and replenish every 60000 km (or 3 years)
Normal driving condition: Fill for Life
(Severe driving condition: Change every 120000 km)

(6)* If vehicle is operated under severe condition: Shorten the service interval.
- Towing a trailer or off-road driving (Inspect the leak of fluid at any time, occasionlly)
- Taxi, patrol service or delivery service (extended idling and excessive driving with low speed)
- Frequent stop-and-go traffic, extended idling, short driving distance
- Driving in a hilly or mountainous terrain, sandy, or dusty area
- Driving frequently at high speed over 170 km/hour
- Driving frequently in area where heavy traffic under the ambient temperature above 32°C

(7)* If necessary, rotate and balance wheels.

MAINTENANCE INTERVAL / MAINTENANCE ITEM	Kilometers (miles) or time in months, whichever comes first							
	x1000 km	15	30	45	60	75	90	105	120
	x1000 miles	10	20	30	40	50	60	70	80
	Months	12	24	36	48	60	72	84	96
CHASSIS AND BODY									
Power steering fluid & lines (3)*		I	I	I	I	I	I	I	I
Drive shaft boots (8)*		I	I	I	I	I	I	I	I
Seat belts, buckles & anchors		I	I	I	I	I	I	I	I
Lubricate locks, hinges & bonnet latch		Check frequently and adjust or replace if necessary							
Wheel bearing grease		I	I	I	I	I	I	I	I
Propeller shaft grease - Front / Rear (9)*		I	I	I	I	I	I	I	I
Air conditioner filter (10)*		R	R	R	R	R	R	R	R
		Shorten the service interval under severe conditions							

Chart Symbols:

I - Inspect these items and their related parts. If necessary, correct, clean, replenish, adjust or replace.

R- Replace or change.

(3)* Refer to “Recommended fluids and lubricants”.

(8)* After completion of off-road operation, the drive shaft boots should be inspected.

(9)* Inspect propeller shaft grease every 5000 km or 3 months if the vehicle is mainly driven under severe condition.

- In off-road or dusty road, or
- In heavy city traffic where the outside temperature regularly reaches 32°C (90°F) or higher, or
- In hilly or moutainous terrain.

(10)* Severe Conditions in Air Conditioner Filter

- Pollutant area or off-road driving, extended air conditioner or heater operation

Modification basis	
Application basis	
Affected VIN	

3) Gasoline Engine

* Use only approved Ssangyong genuine parts.

Maintenance service and record retention are the owner's responsibility. You should retain evidence that proper maintenance has been performed on your vehicle in accordance with the scheduled maintenance service chart.

* EU Countries: Only countries that belong to EU. (It does not apply to all countries in EU.)

MAINTENANCE INTERVAL / MAINTENANCE ITEM	Kilometers (miles) or time in months, whichever comes first								
	x1000 km	10	20	30	40	50	60	70	80
	x1000 miles	6	12	18	24	30	36	42	48
	Months	12	24	36	48	60	72	84	96
ENGINE CONTROL SYSTEM									
Drive belt		I	I	I	I	I	I	I	I
Engine oil & engine oil filter (1)* (3)*		R**	R	R	R	R	R	R	R
Cooling system hose & connections		I	I	I	I	I	I	I	I
Engine coolant (3)*		Change every 200,000 km or 5 years. And, inspect replenish if necessary.							
Fuel filter (2)*		Replace every 100,000 km (if using poor quality of fuel, replace every 30,000 km)							
Fuel line & connections		I	I	I	I	I	I	I	I
Air cleaner (2)*		R	R	R	R	R	R	R	R
		Shorten the service interval under severe conditions							
Ignition timing		I	I	I	I	I	I	I	I
Spark plugs (G23D)		-	-	R	-	-	R	-	-
Charcoal canister & vapor lines		-	-	I	-	-	I	-	-

Chart Symbols:

I - Inspect these items and their related parts. If necessary, correct, clean, replenish, adjust or replace.

R- Replace or change.

**- In order to secure engine long life and effective break-in, first oil (factory filled) would be recommended to drain with in 10,000 km.

(1)* If vehicle is operated under severe condition:
Shorten the service interval.
- Frequent stop-and-go traffic, extended idling, short driving distance below 6 km, driving distance below 16 km when the outside temperature remains below freezing
- Driving in a hilly or mountainous terrain, sandy, or dusty area
- High load driving such as trailer towing
- Taxi, patrol service or delivery service (extended idling and excessive driving with low speed)

(2)* If vehicle is operated under severe condition, pollutant area or off-road driving, driving in dusty condition or sandy condition, frequently inspect the air cleaner, if necessary, change the air cleaner.

(3)* Refer to "Recommended fluids and lubricants".

* EU Countries: Only countries that belong to EU. (It does not apply to all countries in EU.)

MAINTENANCE INTERVAL / MAINTENANCE ITEM	Kilometers (miles) or time in months, whichever comes first								
	x1000 km	10	20	30	40	50	60	70	80
	x1000 miles	6	12	18	24	30	36	42	48
	Months	12	24	36	48	60	72	84	96

CHASSIS AND BODY

Exhaust pipes & mountings		I	I	I	I	I	I	I	I
Brake / Clutch fluid (3)*		Change every 2 years (inspect frequently)							
Parking brake / Brake pads (Front & Rear) (4)*		I	I	I	I	I	I	I	I
Brake line & connections (including booster)		I	I	I	I	I	I	I	I
Manual transmission oil (5)*							I		
Clutch & brake pedal free play		I	I	I	I	I	I	I	I
Transfer case fluid (3)*		I	I	I	I	I	R	I	I
Axle oil	Front	I	I	R	I	I	R	I	I
	Rear	I	I	R	I	I	R	I	I
Automatic transmission fluid (6)*		Inspect every 10000 km or 12 month (But change every 60000 km under severe condition)							
Chassis & underbody bolts & nuts tight / Secure (6)*		Check frequently and adjust or replace if necessary							
Tire condition & inflation pressure		Check frequently and adjust or replace if necessary							
Wheel alignment (7)*		Inspect when abnormal condition is noted							
Steering wheel & linkage		I	I	I	I	I	I	I	I

Chart Symbols:

I - Inspect these items and their related parts. If necessary, correct, clean, replenish, adjust or replace.

R- Replace or change.

(3)* Refer to “Recommended fluids and lubricants”.

(4)* More frequent maintenance is required if the vehicle is operated under any of the following conditions:
- In heavy city traffic where the outside temperature regularly reaches 32°C (90°F) or higher, or
- In hilly or moutainous terrain, or
- When doing frequent trailer towing, or
- Uses such as found in taxi, police or delivery service.

(5)* Inspect and replenish every 60000 km (or 3 years)
Normal driving condition: Fill for Life
(Severe driving condition: Change every 120000 km)

(6)* If vehicle is operated under severe condition: Shorten the service interval.
- Towing a trailer or off-road driving (Inspect the leak of fluid at any time, occasionlly)
- Taxi, patrol service or delivery service (extended idling and excessive driving with low speed)
- Frequent stop-and-go traffic, extended idling, short driving distance
- Driving in a hilly or mountainous terrain, sandy, or dusty area
- Driving frequently at high speed over 170 km/hour
- Driving frequently in area where heavy traffic under the ambient temperature above 32°C

(7)* If necessary, rotate and balance wheels.

Modification basis	
Application basis	
Affected VIN	

* EU Countries: Only countries that belong to EU. (It does not apply to all countries in EU.)

MAINTENANCE INTERVAL / MAINTENANCE ITEM	Kilometers (miles) or time in months, whichever comes first								
	x1000 km	10	20	30	40	50	60	70	80
	x1000 miles	6	12	18	24	30	36	42	48
	Months	12	24	36	48	60	72	84	96
CHASSIS AND BODY									
Power steering fluid & lines (3)*		I	I	I	I	I	I	I	I
Drive shaft boots (8)*		I	I	I	I	I	I	I	I
Seat belts, buckles & anchors		I	I	I	I	I	I	I	I
Lubricate locks, hinges & bonnet latch		Check frequently and adjust or replace if necessary							
Wheel bearing grease		I	I	I	I	I	I	I	I
Propeller shaft grease - Front / Rear (9)*		I	I	I	I	I	I	I	I
Air conditioner filter (10)*		R	R	R	R	R	R	R	R
		Shorten the service interval under severe conditions							

Chart Symbols:

I - Inspect these items and their related parts. If necessary, correct, clean, replenish, adjust or replace.

R- Replace or change.

(3)* Refer to “Recommended fluids and lubricants”.

(8)* After completion of off-road operation, the drive shaft boots should be inspected.

(9)* Inspect propeller shaft grease every 5000 km or 3 months if the vehicle is mainly driven under severe condition.

- In off-road or dusty road, or
- In heavy city traffic where the outside temperature regularly reaches 32°C (90°F) or higher, or
- In hilly or moutainous terrain.

(10)*Severe Conditions in Air Conditioner Filter

- Pollutant area or off-road driving, extended air conditioner or heater operation

5. RECOMMENDED FLUIDS AND LUBRICANTS

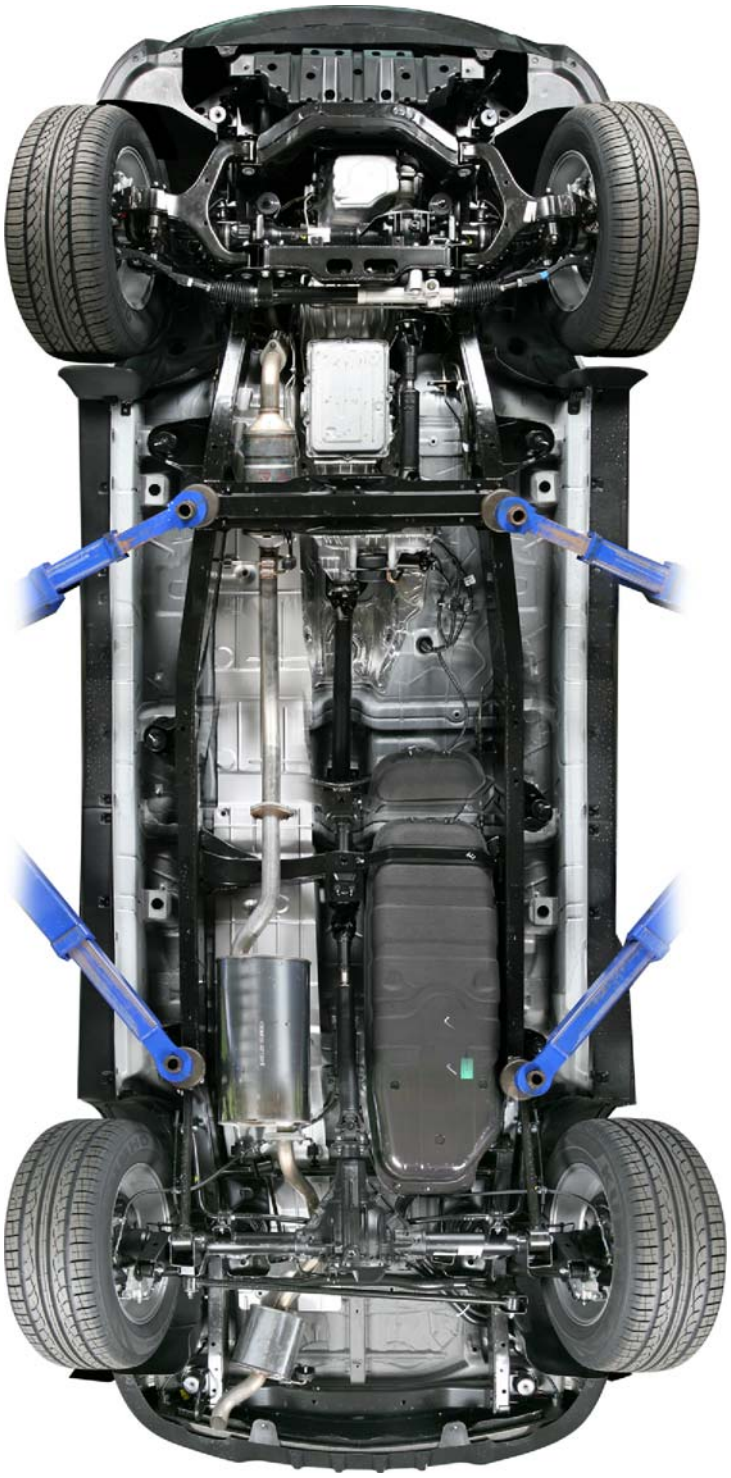
Descriptions			Capacity	Specifications
Engine Oil		D20DTR	≒ 6.0ℓ	Quality class: Ssangyong genuine engine oil (Approved by MB Sheet 229.51, SAE 5W/30)
		G23D	≒ 7.5ℓ	Quality class: Ssangyong genuine engine oil (Approved by MB Sheet 229.1 or 229.3 or 229.31)
Engine Coolant		D20DTR	≒ 8.5ℓ	Ssangyong genuine coolant Anti-Freeze SYC-1025, Anti-Freeze:Water = 50:50 ORGANIC ACID TYPE, COLOR:BLUE
		G23D	10.5~11.0ℓ	
Automatic Transmission Fluid		6 A/T	≒ 9.5ℓ	Ssangyong genuine oil (FUCHS ATF 3292)
		5 A/T	≒ 8.0ℓ	Ssangyong genuine oil (Shell ATF 134 or Fuchs ATF 134)
Manual Transmission Fluid	6-speed		≒ 2.2ℓ	Ssangyong genuine oil (HD MTF 75W/85 (SHELL) or HK MTF 75W/85(SK))
	5-speed	2WD	≒ 3.4ℓ	Ssangyong genuine oil (ATF DEXRON II)
		4WD	≒ 3.6ℓ	
Transfer Case Fluid			≒ 1.4ℓ	Ssangyong genuine oil (ATF DEXRON III)
Axle Oil		Front	≒ 1.4ℓ	Ssangyong genuine oil (SAE 80W/90, API GL-5)
		Rear	≒ 2.0ℓ	Ssangyong genuine oil (SAE 80W/90, API GL-5)
Brake / Clutch Fluid			As required	Ssangyong genuine oil (DOT4)
Power Steering Fluid			≒ 1.0ℓ	Ssangyong genuine oil (S-PSF-3) *TOTAL FLUIDE DA(Extreme cold condition only)

CAUTION

- Use only Ssangyong recommended fluids and lubricants.
- Do not mix any different types or brands of oils or fluids. This may cause damages.
- Keep the specified levels when adding or replacing the fluids.

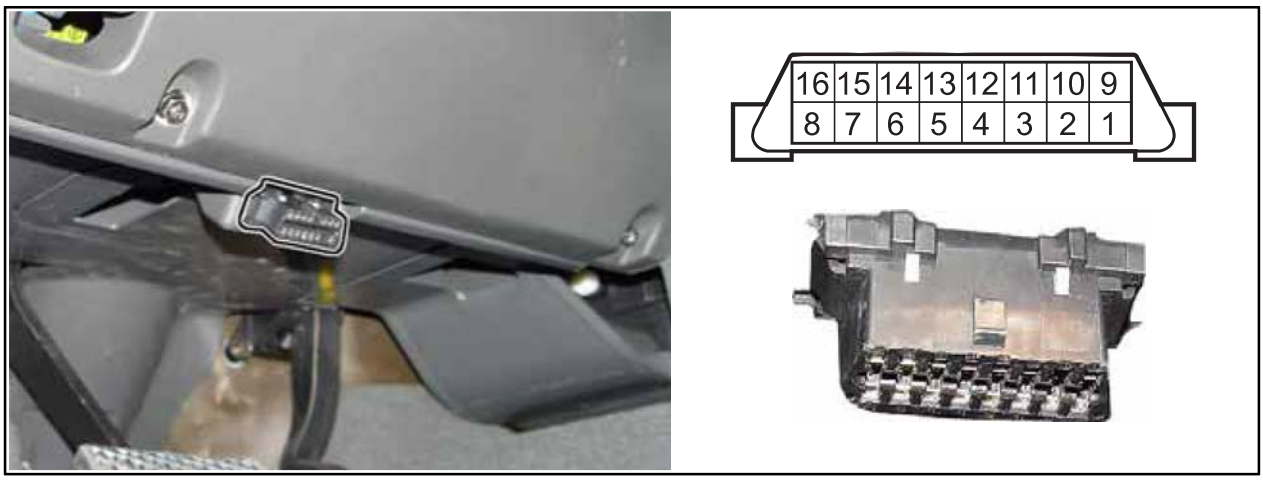
Modification basis	
Application basis	
Affected VIN	

6. JACK-UP POINTS



7. PIN ARRANGEMENT OF DIAGNOSTIC CONNECTOR

It is installed under the instrument panel and consists of 16 pins



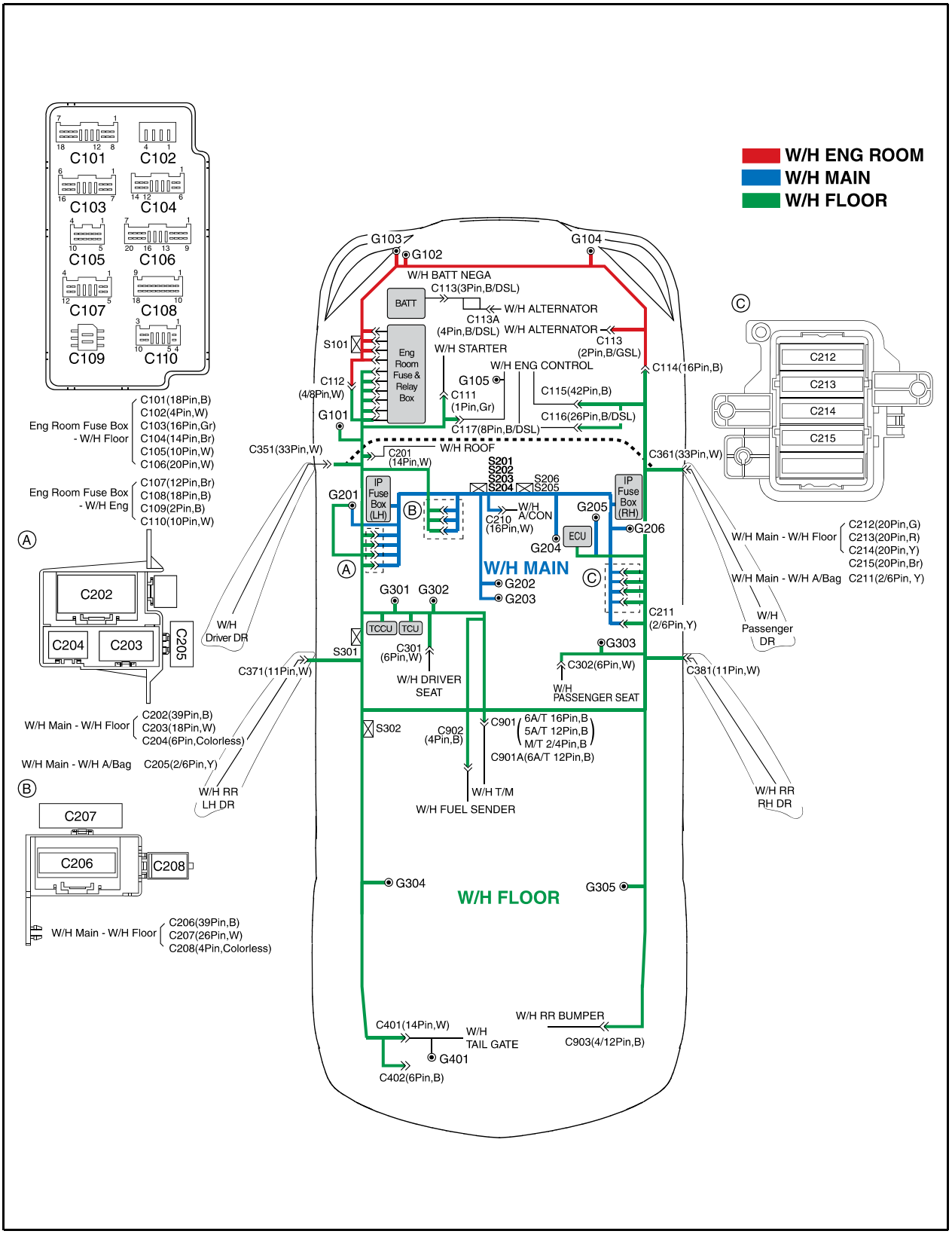
1) Functions of Terminal

Pin no. 1	-
Pin no. 2	-
Pin no. 3	STICS "C1"
Pin no. 4	Ground
Pin no. 5	Signal ground
Pin no. 6	CAN - HIGH
Pin no. 7	Engine ECU
Pin no. 8	ABS/ESP UNIT "2"
Pin no. 9	AIR BAG UNIT "9"
Pin no. 10	-
Pin no. 11	TCU "B12" (6-AT) "A18" (5-AT)
Pin no. 12	-
Pin no. 13	TCCU "21"
Pin no. 14	CAN - LOW
Pin no. 15	STICS "B21"
Pin no. 16	Battery +

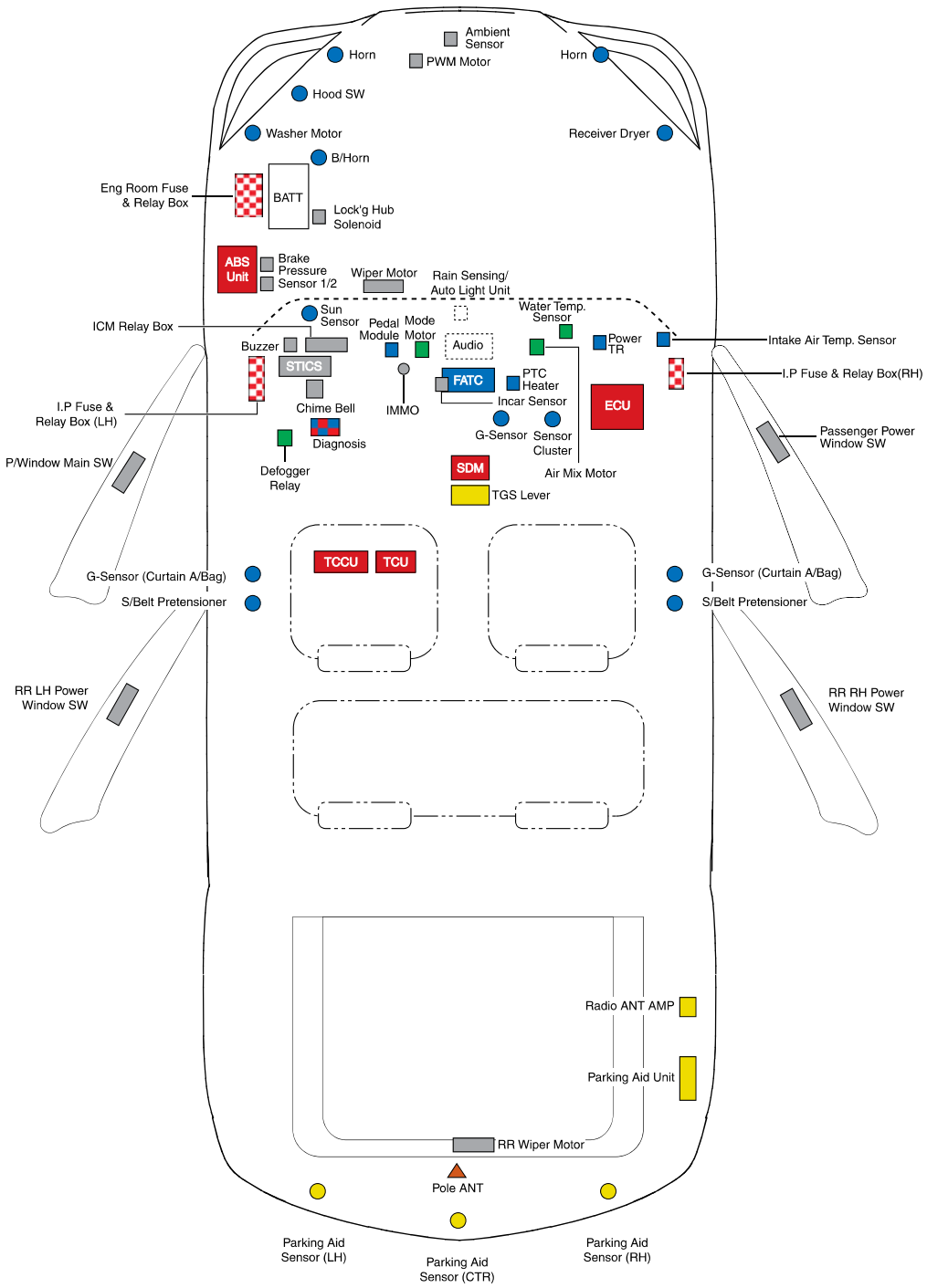
Modification basis	
Application basis	
Affected VIN	

8. ELECTRIC COMPONENTS AND LAYOUT

1) Wiring Harness Arrangement



2) Components Locator

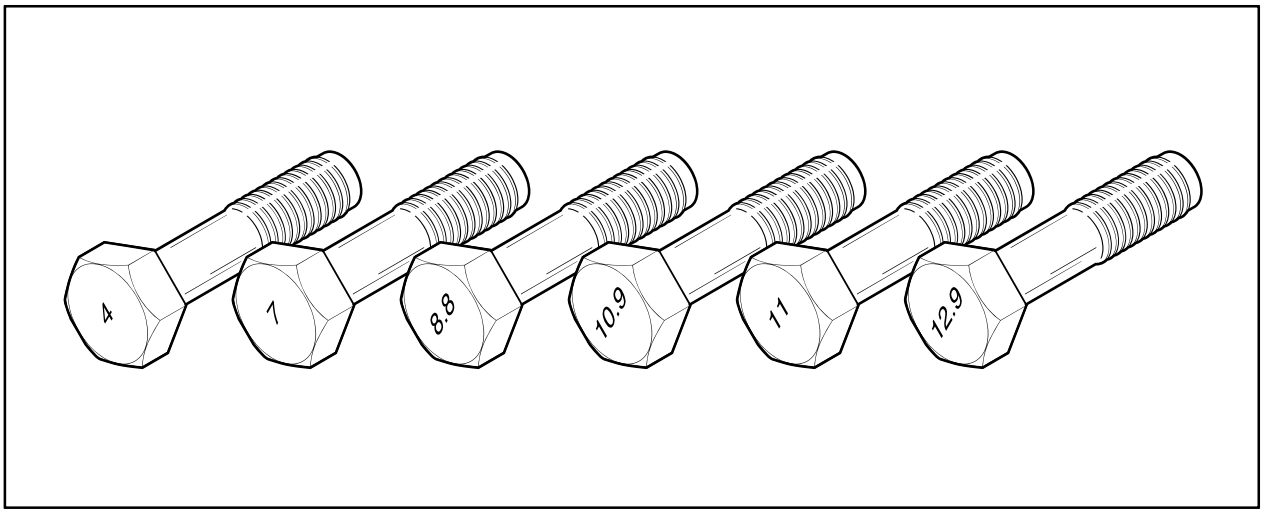


Modification basis	
Application basis	
Affected VIN	

9. STANDARD BOLTS SPECIFICATIONS

Bolt*	Torque (Nm / lb-in)					
	Standard			Limit		
	4T	7T	9T	4T	7T	9T
M3 ×0.5	0.5 Nm (4.5 lb-in)	0.9 Nm (8 lb-in)	1.3 Nm (12 lb-in)	0.7 Nm (6.3 lb-in)	1.2 Nm (11 lb-in)	17 Nm (15 lb-in)
M4 ×0.7	1.2 Nm (11 lb-in)	2.0 Nm (18 lb-in)	3.0 Nm (27 lb-in)	1.6 Nm (14 lb-in)	2.6 Nm (23 lb-in)	4.0 Nm (36 lb-in)
M5 ×0.8	2.4 Nm (22 lb-in)	4.0 Nm (36 lb-in)	5.6 Nm (50 lb-in)	3.1 Nm (28 lb-in)	5.2 Nm (47 lb-in)	7.6 Nm (68 lb-in)
M6 ×1.0	4.0 Nm (36 lb-in)	6.7 Nm (60 lb-in)	9.7 Nm (87 lb-in)	5.4 Nm (49 lb-in)	9.0 Nm (81 lb-in)	12.7 Nm (114 lb-in)
M8 ×1.25	8.6 Nm (77 lb-in)	15.7 Nm (12 lb-in)	22.5 Nm (17 lb-in)	12.7 Nm (9 lb-in)	20.6 Nm (15.2 lb-in)	30.4 Nm (22 lb-in)
M10 ×1.25	18.6 Nm (14 lb-in)	32.3 Nm (24 lb-in)	46.0 Nm (34 lb-in)	25.5 Nm (19 lb-in)	42.1 Nm (31 lb-in)	60.8 Nm (31 lb-in)
M10 ×1.5	18.6 Nm (14 lb-in)	30.4 Nm (22 lb-in)	44.1 Nm (33 lb-in)	24.5 Nm (18 lb-in)	41.2 Nm (30 lb-in)	58.8 Nm (44 lb-in)
M12 ×1.25	34.3 Nm (25 lb-in)	56.8 Nm (42 lb-in)	82.3 Nm (61 lb-in)	45.0 Nm (33 lb-in)	75.5 Nm (56 lb-in)	107.8 Nm (80 lb-in)
M12 ×1.75	32.3 Nm (24 lb-in)	53.9 Nm (40 lb-in)	77.4 Nm (57 lb-in)	43.1 Nm (32 lb-in)	71.5 Nm (53 lb-in)	98.0 Nm (73 lb-in)
M14 ×1.5	54.0 Nm (40 lb-in)	89.2 Nm (66 lb-in)	127.4 Nm (94 lb-in)	71.6 Nm (53 lb-in)	117.6 Nm (87 lb-in)	166.6 Nm (123 lb-in)
M16 ×1.5	81.3 Nm (60 lb-in)	107.8 Nm (80 lb-in)	196.0 Nm (145 lb-in)	107.8 Nm (80 lb-in)	186.2 Nm (138 lb-in)	264.6 Nm (196 lb-in)
M18 ×1.5	117.6 Nm (87 lb-in)	196.0 Nm (145 lb-in)	284.2 Nm (210 lb-in)	156.8 Nm (116 lb-in)	264.6 Nm (196 lb-in)	372.4 Nm (276 lb-in)
M20 ×1.5	166.6Nm (123 lb-in)	274.4 Nm (203 lb-in)	392.0 Nm (290 lb-in)	215.6 Nm (160 lb-in)	362.6 Nm (268 lb-in)	519.4 Nm (384 lb-in)
M22 ×0.5	225.4Nm (167 lb-in)	372.4 Nm (276 lb-in)	529.2 Nm (392 lb-in)	294.0 Nm (218 lb-in)	490.0 Nm (362 lb-in)	705.6 Nm (522 lb-in)
M24 ×1.5	284.2 Nm (210 lb-in)	480.2 Nm (355 lb-in)	686.0 Nm (508 lb-in)	382.2 Nm (283 lb-in)	637.0 Nm (471 lb-in)	921.2 Nm (682 lb-in)
M24 ×2.0	274.4 Nm (203 lb-in)	460.6 Nm (341 lb-in)	666.4 Nm (493 lb-in)	372.4 Nm (276 lb-in)	617.4 Nm (457 lb-in)	891.8 Nm (660 lb-in)

*Diameter X pitch in millimeters



1. Metric bolt strength is embossed on the head of each bolt. The strength of bolt can be classified as 4T, 7T, 8.8T, 10.9T, 11T and 12.9T in general.
2. Observe standard tightening torque during bolt tightening works and can adjust torque to be proper within 15 % if necessary. Try not to over max.
   allowable tightening torque if not required to do so.
3. Determine extra proper tightening torque if tightens with washer or packing.
4. If tightens bolts on the below materials, be sure to determine the proper torque.
   1) Aluminum alloy: Tighten to 80 % of above torque table.
   2) Plastics: Tighten to 20 % of above torque table.

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. GLOSSARY

A	
Abbreviation	**Description**
ABD	Automatic Brake Differential
ABS	Antilock Braking System(미끄럼방지 제동장치)
AC	Alternating Current(교류)
ACIS	Acoustic Control Induction System(가변흡기장치)
ACS	Auto Cruise System(정속주행장치)
ACTR	Actuator
ALT	Alternator
APS	Adjustable Pedal System
AQGS	Advanced Quick Starting System
AQS	Air Quality System
ARP	Anti Roller Protect
ASSY	Assembly(아셈블리)
ATF	Automatic Transmission Fluid(자동변속기용 작동유)
ATS	Air Temperature Sensor(흡입공기 온도 센서)
AV	Audio Visual
AVN	Audio Visual & Navigation
AWD	All Wheel Drive

B	
Abbreviation	**Description**
BCM	Body Control Module

C	
Abbreviation	**Description**
CAB	Curtain A/Bag
CAN	Controller Area Network
CDM	Central Display Module
CDP	Compact Disc Play
CDPF	Catalyzed Diesel Particulate Filter
CVW	Complete Vehicle Kerb Weight

D	
Abbreviation	**Description**
D/S	Door Side
DAB	Driver A/Bag
DC	Damper Clutch
DDM	Driver Door Module
DECEL	Deceleration
DMF	Dual Mass Flywheel
DOC	Diesel Oxygen Catalyst
DPF	Diesel Particulate Filter
DR	Door
DRL	Daytime Running Light
DSL	Diesel
DSM	Driver Seat Module
DTC	Diagnostic Trouble Code

E	
Abbreviation	**Description**
EAS	Electronic Air Suspension
EBD	Electronic Brake Force Distribution
EBS	Electronic Brake System
EBS	Electronic Battery System
ECM	Electronic Chromic Mirror
ECS	Electronic Controlled Suspension(전자제어식 현가장치)
ECU	Engine Control Unit
ECU	Engine Control Unit
EGR	Exhaust Gas Recirculation(배기가스 재순환 시스템)
EPB	Electric Parking Brake
EPS	Electronic Power Steering
ESCL	Electronic Steering Column Lock
ESP	Electronic Stabilizer Program
ESPS	Electronic Steering Power Steering
ESS	Engine Speed Sensor(엔진회전수 검지기)
EV	Electric Vehicle(전기자동차)

F	
Abbreviation	**Description**
FAM	Front Area Module
FATC	Full Auto Temperature Control
FFH	Fuel Fired Heater
FIS	Front Impact Sensor
FRT	Front(앞쪽)

G	
Abbreviation	**Description**
GPS	Global Positioning System
GSL	Gasoline
GVW	Gross Vehicle Weight(차량총중량)
GWM	Gate Way Module

H	
Abbreviation	**Description**
H/LAMP	Head Lamp
HAS	Hill Start Assist
HBA	Hydraulic Brake Assist
HDL	Handle(핸들)
HECU	Hydraulic Electro Control Unit
HFM	Hot Film Air Flow Meter(공기량 측정센서)
HID	High Intensity Discharge
HSC	Height Sensor Calibration
HVAC	Heating, Ventilation and Air Conditioning System

I	
Abbreviation	**Description**
I/P	Instrument Panel
I/PULY	Idler Pulley
I/S	Inside(내측)
ICM	Integrated Circuit Module
IGN	Ignition
INR	Inner
IOP	Integrated Oil Pan
IPS	Intelligent Power Switch
IRDA	Independent Rear Drive Axle
IRS	Independent Rear Suspension(후륜 독립현가)

Modification basis	
Application basis	
Affected VIN	

K	
Abbreviation	**Description**
KAB	Knee A/Bag
KPH	Kilo Per Hour(시간당 주행거리)

L	
Abbreviation	**Description**
L/SPRG	Leaf Spring
LDWS	Lane Departure Waring System
LF	Low Frequnecy
LH	Left Hand
LHD	Left Hand Drive
LIN	Local Interconnect Network
LP	Line Pressure
LR	Low Reverse
LSD	Limited Slip Differential(차동 제한장치)

M	
Abbreviation	**Description**
MFM	Multi Function Module
MTG	Mounting(마운팅)

O	
Abbreviation	**Description**
OBD	On Board Diagnostic System
OD	Over Drive
OTR	Outer(외측)

P	
Abbreviation	**Description**
P/SEAT	Passenger Seat
P/SHF	Propeller Shaft
P/STRG	Power Steering
P/T	Power Train
P/TIME	Part Time
PAB	Passenger A/Bag
PAS	Parking Aid System
PASE	Passive Entry and Start
PASEM	Passive Start and Entry Start System
PCB	Passenger Air Bag
PCM	Power Control Module
PCSV	Purge Control Solenoid Valve
PDM	Passenger Door Module
PG-A	Input Speed Sensor
PG-B	Output Speed Sensor
PLCD	Permanent Magnetic Linear Contactless Displacement
PSM	Passenger Seat Module
PTC	Positive Temperature Coefficient
PWM	Pulse Width Modulation

Modification basis	
Application basis	
Affected VIN	

R	
Abbreviation	**Description**
RAM	Rear Area Module
RASM	Rear Audio Switch Module
RDM	Rear Door Module
RDS	Radio Data System
REKES	Remote Keyless Entry System
RH	Right Hand(우측)
RPM	Revolution Per Minute(1분당 회전수)
RR	Rear(뒤쪽)
RSM	Rear Seat Module
RV	Recreation Vehicle(레크레이션용 차)

S	
Abbreviation	**Description**
SAB	Side Air Bag
SAS	Secondary Air Supply(2차 공기 공급장치)
SBR	Seat Belt Reminder
SCU	Sunroof Control Unit
SDM	Sensing & Diagnostic Module
SIG	Signal
SIS	Side Impact Sensor
SKM	Smart Key Module
SNR	Sensor
SOC	State of Charge
SRS	Supplemental Restraint System
SSPS	Speed Sensing Power Steering(속도감응형 파워핸들)
SST	Special Service Tool(정비용 특수공구)
STICS	Super Time & Alarm Integrated Control System(다기능 시간제어 전자경보장치)
STPS	Seat Track Position Sensor
SVC	Super Vision Cluster

T	
Abbreviation	**Description**
T/A	Trans Axle
T/C	Transfer Case
T/GATE	Tail Gate
T/LAMP	Tail Lamp
T/M	Transmission
TCS	Traction Control System(구동력 자동제어시스템)
TCU	Transmission Control Unit(변속기 제어센서)
TGS	Transmission Gear Shift(변속기 레버)
TOD	Torque on Demand
TPIS	Transmission Position Indicator Switch
TPMS	Tire Pressure Monitoring System
TPS	Throttle Position Sensor

U	
Abbreviation	**Description**
UD	Under Drive
UPR	Upper(아래쪽)

V	
Abbreviation	**Description**
VAPS	Vehicle Air Purifier System
VC	Variant Coding
VEMS	Vehicle Energy Management System
VFS	Variable Force Solenoid
VGT	Variable Geometry Turbocharger
VIN	Vehicle Identification Number(차대 각자번호)
VOL	Volume
VSM	Voltage Stabilizer Module
VSS	Vehicle Speed Sensor

Modification basis	
Application basis	
Affected VIN	

ENGINE GENERAL

0000-00

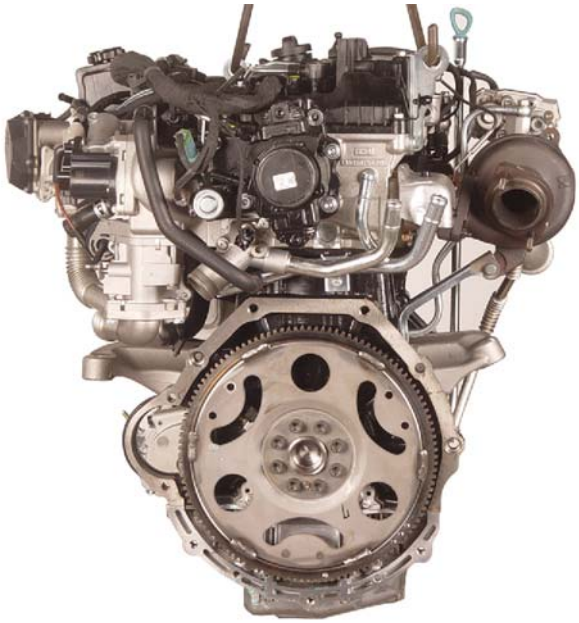
GENERAL INFORMATION

1. ENGINE LAYOUT

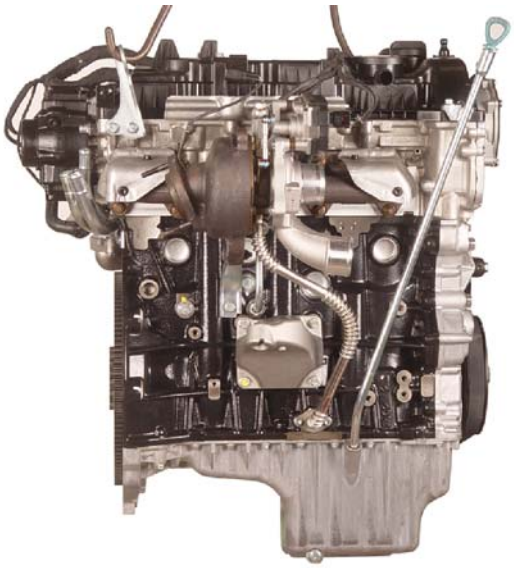
Front view



Rear view



Right view



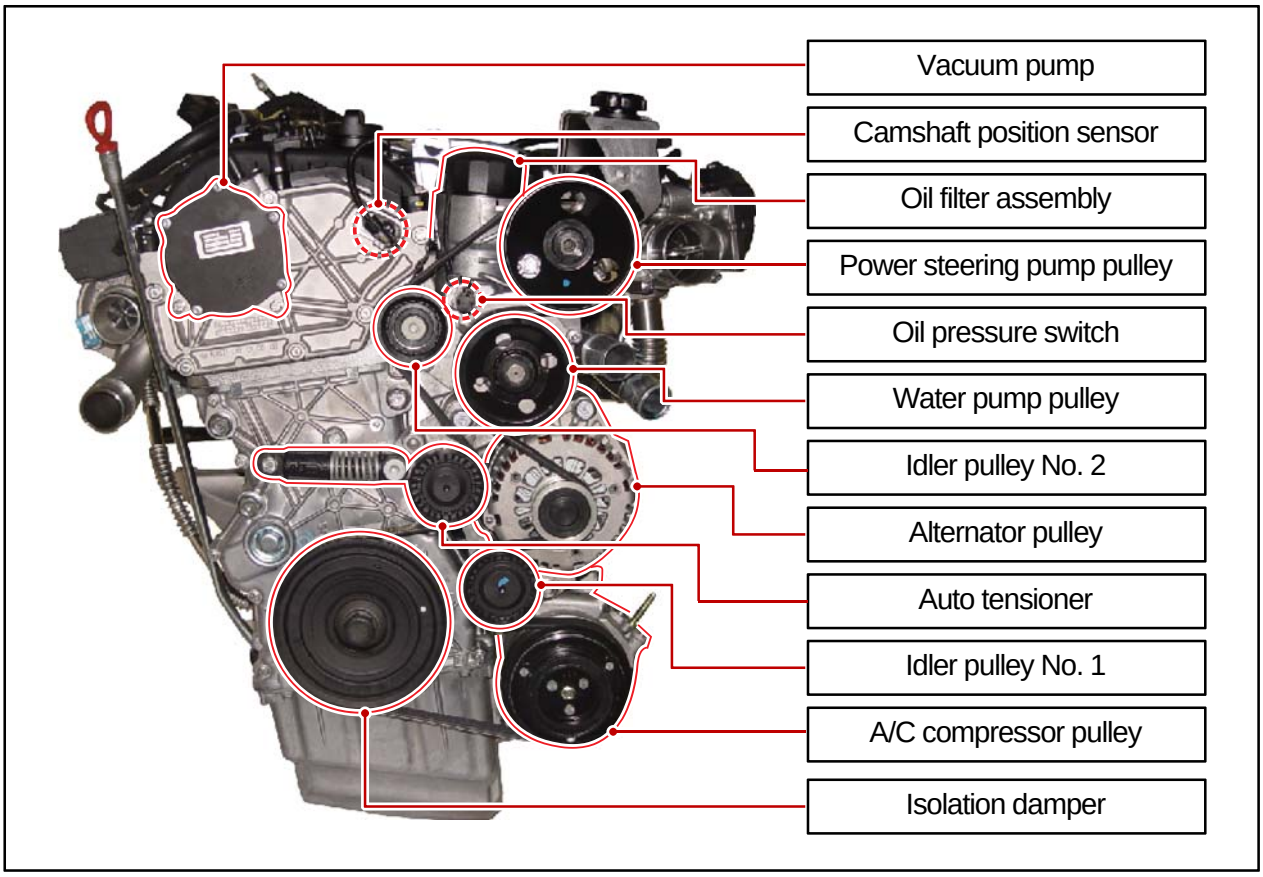
Left view



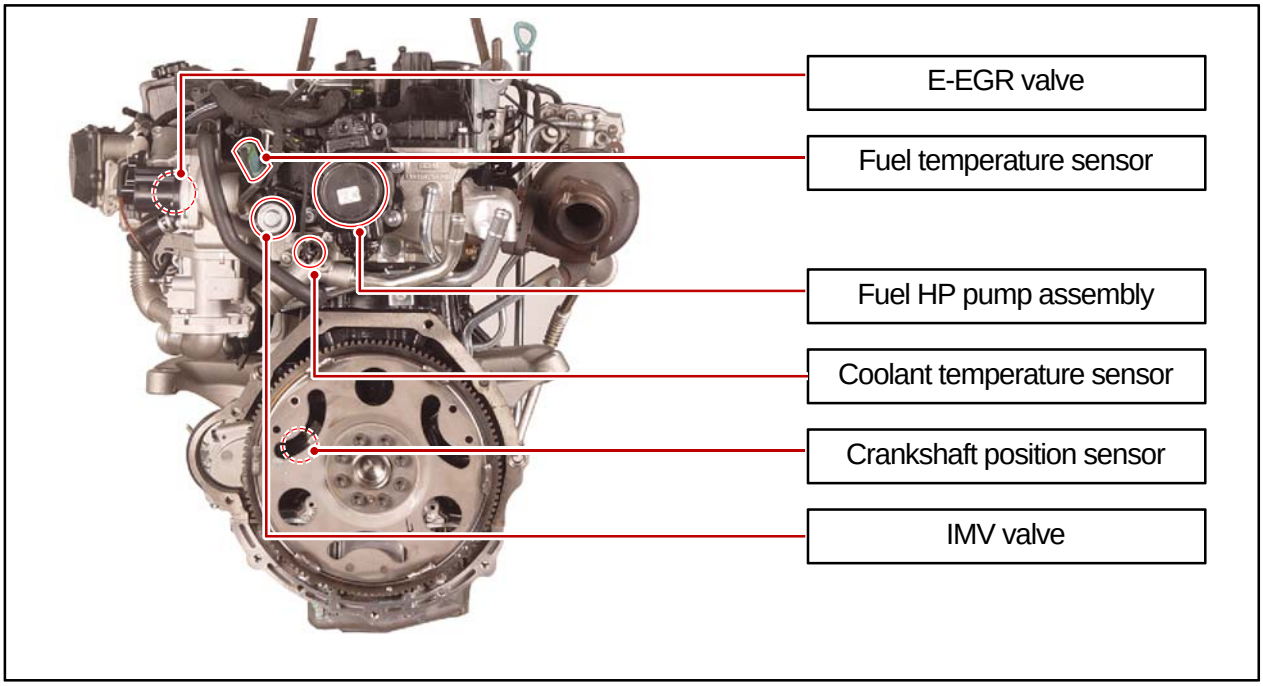
Modification basis	
Application basis	
Affected VIN	

2. MAJOR COMPONENTS

▶ **Front view**

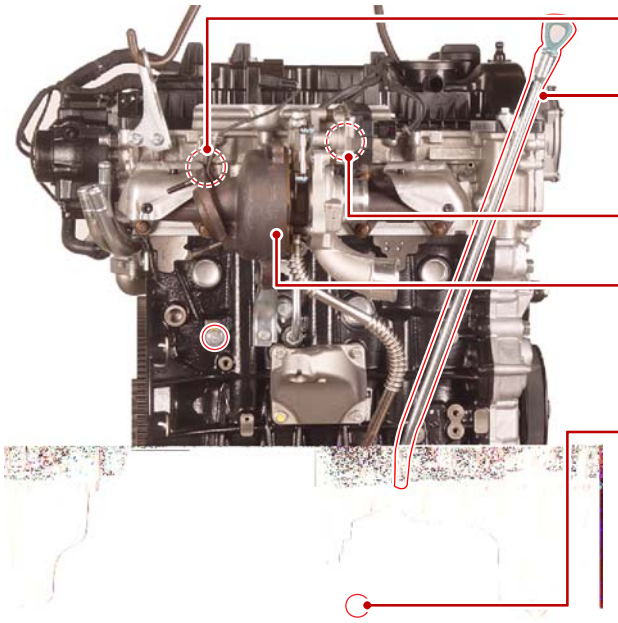


▶ **Rear view**

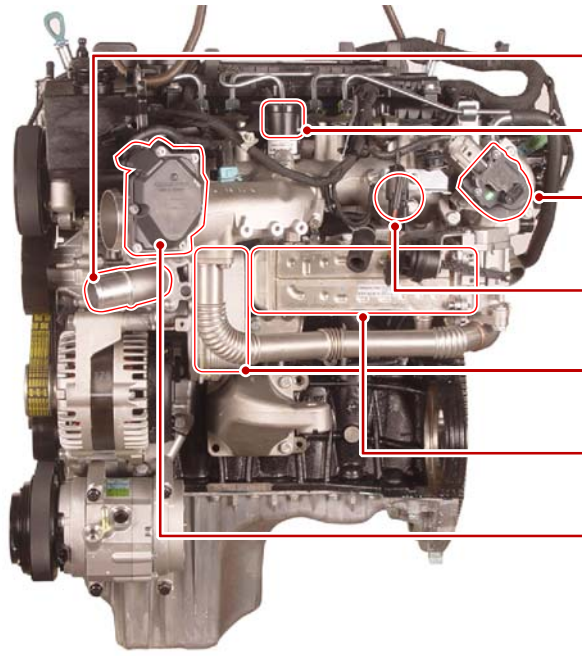


Modification basis	
Application basis	
Affected VIN	

▶ Right view

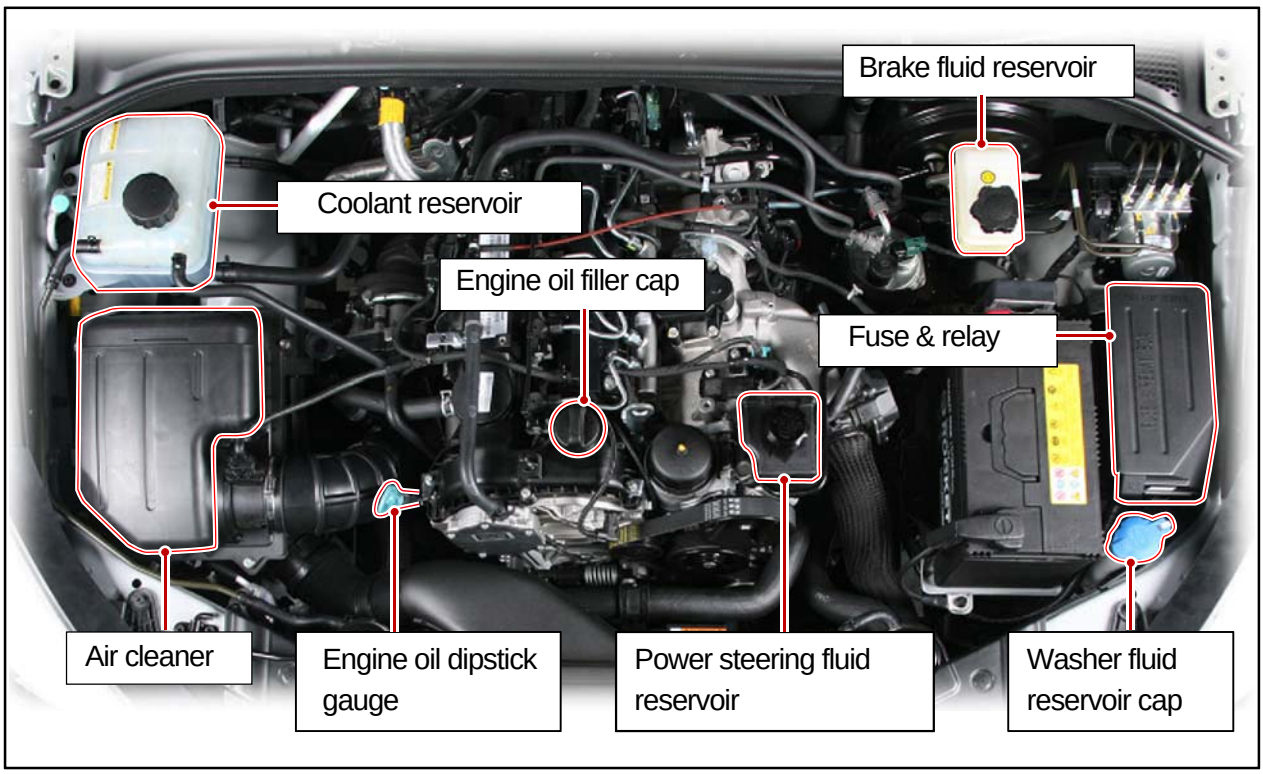


▶ Left view



Modification basis	
Application basis	
Affected VIN	

3. ENGINE COMPARTMENT LAYOUT



CAUTION

- Do not work on the engine compartment while the engine, radiator, exhaust manifold, muffler or catalytic converter is hot. Always turn the engine off and allow it to cool before starting the maintenance.
- Regularly check the engine oil level and add Ssangyong genuine engine oil if necessary.
- Clean the dipstick with clean cloth so that any foreign materials cannot get into the engine.

WARNING

Operating vehicle with insuffi cient amount of oil can damage the engine. Make sure the engine oil level is correct and add oil if necessary.

Modification basis	
Application basis	
Affected VIN	

1) Service Interval

Description	Daily inspection	Weekly inspection	Service interval	
Engine oil & oil filter	Inspection	-	EU	Change every 20,000 km or 12 months (The service interval should be shortened under severe conditions)
			General	Change every 15,000 km or 12 months (The service interval should be shortened under severe conditions)
Coolant	Inspection	-	Change every 200,000 km or 5 years	
Air cleaner element	-	Inspection	EU	Change every 20,000 km (The service interval should be shortened under severe conditions)
			General	Clean every 7,500 km, change every 15,000 km (The service interval should be shortened under severe conditions)
Fuel filter	-	-	EU	Change every 40,000 km (Draining water from fuel filter: whenever replacing the engine oil)
			General	Change every 45,000 km (Draining water from fuel filter: whenever replacing the engine oil)

2) Specification and Capacity

Engine oil	Specification	Quality class: Ssangyong genuine engine oil (Approved by MB Sheet 229.51, SAE 5W/30)
	Capacity	approx. 6.0 litter
Engine coolant	Specification	Ssangyong genuine coolant Anti-Freeze SYC-1025
	Capacity	approx. 8.5 litter

Severe condition

- Frequent stop-and-go traffic, extended idling, short driving distance below 6 km, driving distance below 16 km when the outside temperature remains below freezing
- Driving in a hilly or mountainous terrain, sandy, or dusty area
- High load driving such as trailer towing
- Taxi, patrol service or delivery service (extended idling and excessive driving with low speed)

4. CAUTION WHEN SERVICING THE ENGINE

1) Cleaness

Engine has a lot of precisely machined (grinding, polishing, lapping) surfaces. Thus, there should be great cautions for cleaness when servicing the engine components. Apply the engine oil on the sliding surfaces when assemblying the components. Every component should be disassembled and reassembled in accordance with the correct sequences. Before servicing the engine, the negative cable should be diconnected from the battery. Otherwise, some electric or electronic components could be damaged.

2) Servicing

CAUTION

- Before service work, be sure to disconnect battery negative (-) terminal to prevent damages by bad wire and short.
- To prevent the foreign material from getting into engine cylinder, cover the inlet of air cleaner if the air cleaner has been removed

(1) Lifting up the vehicle

- Always keep the safety precautions.
- To prevent the vehicle from rolling down, put the chocks under the tires (when using a 4-post lift). Make sure to support the correct lifting points (when using a 2-post lift)
-

(2) Exhaust system

- Wear the safety glove when removing the exhaust pipe.
- Make sure that the exhaust pipe is cooled before removing it.

Modification basis	
Application basis	
Affected VIN	

(3) Cautions before service

Scalding hot coolant and steam could be blown out under pressure, which could cause serious injury. Never remove the coolant reservoir cap when the engine and radiator are hot.

(4) Lubrication system

- Prolonged exposure to the engine oil make cause a skin cancer or an irritation.
- Used engine cotains the hazardous material that may cause the skin cancer. Do not allow the used engine to make contact with your skin.
- Make sure to wear the protection gloves and goggle when handling the engine oil. If contact happens, rinse affected areas immediately with plenty of water. Do not wash it with gasoline or solvent. If irritation persists, consult a doctor.
  Improperly disposed engine oil can pollute the environment. Dispose used engine oil in accordance with local environmental regulations.

(5) Tightening the fastener

- Clean the mating surfaces before tightening.
- Place the marks with paint to tighten by angle if the angle wrench is not available.

3) Fuel and Oil System

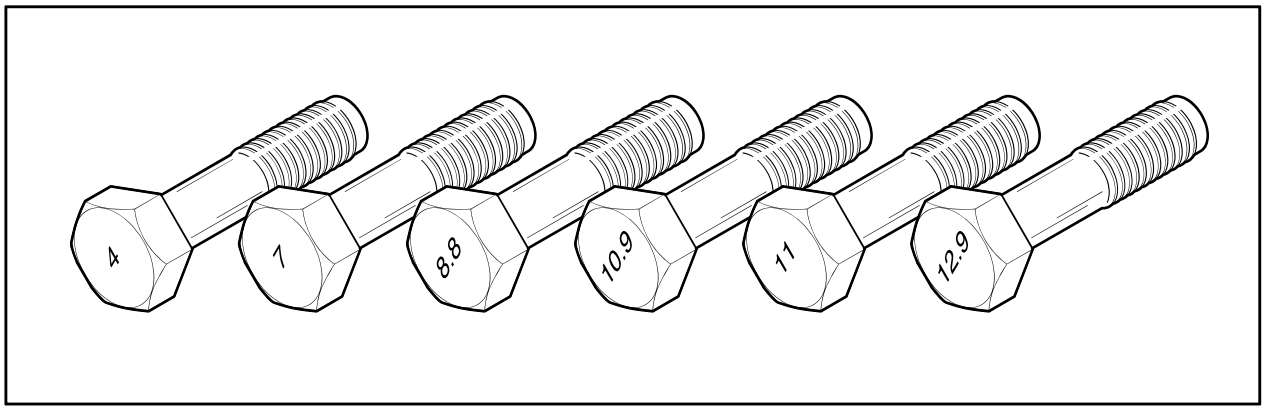
- If work on the fluid system such as fuel and oil, working area should be well ventilated and smoking should be prohibited.
- Gasket or seal on the fuel/lubrication system should be replaced with new ones and bolts and nuts should be tightened as specified.

NOTE

1. If fine dust or foreign material enters into DI engine's fuel system, there can be serious damages between HP pump and injectors. So, be sure to cover removed fuel system components with cap and protect removed parts not to be contaminated with dirt. (Refer to cleanness in this manual while working on DI engine fuel system)
2. When working on the fuel line between priming pump and injector (including return line), always plug the openings with caps to prevent foreign materials or dust from entering to the openings and connections.
3. The HP fuel supply pipe (HP pump to fuel rail) and HP fuel pipe (Fuel rail to injector) should be replaced with new ones when removed.

5. STANDARD BOLTS SPECIFICATIONS

Bolt	Pitch	Tightening torque(kgf.cm)					
		Standard			Limit		
		4T	7T	9T	4T	7T	9T
M3	0.5	5	9	13	7	12	17
M4	0.7	12	20	30	16	27	40
M5	0.8	24	40	57	32	53	77
M6	1.0	41	68	99	55	91	130
M8	1.25	88	160	230	130	210	310
M10	1.25	190	330	470	260	430	620
	1.5	190	310	450	250	420	600
M12	1.25	350	580	840	460	770	1,100
	1.75	330	550	790	440	730	1,000
M14	1.5	550	910	1,300	730	1,200	1,900
M16	1.5	830	1,100	2,000	1,100	1,900	2,700
M18	1.5	1,200	2,000	2,900	1,600	2,700	3,800
M20	1.5	1,700	2,800	4,000	2,200	3,700	5,300
M22	1.5	2,300	3,800	5,400	3,000	5,000	7,200
M24	1.5	2,900	4,900	7,000	3,900	6,500	9,400
	2.0	2,800	4,700	6,800	3,800	6,300	9,100



1) Metric bolt strength is embossed on the head of each bolt. The strength of bolt can be classified as 4T, 7T, 8.8T, 10.9T, 11T and 12.9T in general.
2) Observe standard tightening torque during bolt tightening works and can adjust torque to be proper within 15 % if necessary. Try not to over max. allowable tightening torque if not required to do so. Determine extra proper tightening torque if tightens with washer or packing.
3) If tightens bolts on the below materials, be sure to determine the proper torque.
4)

- Aluminum alloy: Tighten to 80 % of above torque table.
- Plastics: Tighten to 20 % of above torque table.

Modification basis	
Application basis	
Affected VIN	

6. TIGHTENING TORQUE

Name	Size	Numbers of fastener	Tightening torque (Nm)	Note (total tightening torque)
Main bearing cap	M12×82	10	55±5Nm, 180°	Not-reusable
Connecting rod cap	M9×52	8	40±5Nm, 90°+10°	50 ~80Nm
Crankshaft rear seal	M6×20	6	10±1Nm	-
Oil pump	M8×35	3	25±2.5Nm	-
Drive plate	M10×22	8	45±5Nm, 90°+10°	Not-reusable
Isolation damper center bolt	M18×50	1	200±20Nm, 180°+20°	660~720 Nm Not-reusable
Oil pan	M6×20	18	10±1Nm	-
	M6×35	2	10±1Nm	-
	M6×85	2	10±1Nm	-
	M6×120	2	10±1Nm	-
	M8×40	2	25±2.5Nm	-
Mounting nut for high pressure pump	M14×1.5-8-1	1	65±5Nm	-
Mounting bolt for high pressure pump	M8×30	3	25±2.5Nm	-
Cylinder head	M13×150	12	85Nm 270°±10°	-
Camshaft cap	M6×30	16	10±1Nm	-
	M8×60	4	25±2.5Nm	-
Exhaust stud bolt		10	15±1.5Nm	-
Exhaust sprocket	M11×40	1	30±3Nm	-
Chain tensioner screw plug	M38×1.5	1	25±2.5Nm	-
Coolant temperature sensor		1	20±2.0Nm	-
Belt auto tensioner	M8×30(LOW)	1	25±2.5Nm	-
	M10×75(Upper)	1	55±5.5Nm	-
Water pump	M6×50	7	10±1.0Nm	-

Name	Size	Numbers of fastener	Tightening torque (Nm)	Note (total tightening torque)
Hot water inlet pipe	M6×12	2	10±1Nm	-
Alternator	M10×90	1	(LO) 25±2.5Nm	-
	M10×116	1	(HI) 46±4.6Nm	-
Air conditioner compressor	M8×85	4	25~2.5Nm	-
Air conditioner bracket	M6×25	4	10±1Nm	-
Intake manifold	M8×35	2	25±2.5Nm	-
	M8×110	6	25±2.5Nm	-
Oil filter module	M8×40	6	25±2.5Nm	-
	M8×20	1	25±2.5Nm	-
	M8×140	2	25±2.5Nm	-
Knock sensor	M8×28	2	20±5Nm	-
Camshaft position sensor	M8×14	1	10~14Nm	-
T-MAP pressure sensor	M6×20	1	10±1Nm	-
Exhaust manifold	M8	10	40±4Nm	-
Turbocharger	M8	3	25±2.5Nm	-
T/C support bolt	M8	1	25±2.5Nm	-
T/C oil supply pipe	M6(to block)	1	10±1.0Nm	-
	M6 (to turbocharger)	1	17±2.0Nm	-
T/C oil return pipe	M6×16(to block)	2	10±1Nm	-
	M6×16 (to turbocharger)	2	10±1Nm	-
EGR valve	M8×22	3	25±2.5Nm	-
EGR pipe bolt (to exhaust manifold)	M8×16	2	10±1Nm	-
EGR pipe bolt (to EGR cooler)	M8×16	2	25±2.5Nm	-

Modification basis	
Application basis	
Affected VIN	

Name	Size	Numbers of fastener	Tightening torque (Nm)	Note (total tightening torque)
Idler pulley/tensioner pulley		1	45±4.5Nm	-
Glow plug	M5	4	20±2Nm	-
Vacuum pump	M8×25	3	10±1Nm	-
Timing gear case cover	M6×40	7	10±1Nm	-
	M6×45	1	10±1Nm	-
	M6×50	3	10±1Nm	-
Cylinder head cover	M6×35	21	10±1Nm	-
Oil dipstick gauge cover	M6×16	1	10±1Nm	-
Oil filter cap		1	25±2.5Nm	-
Fuel rail	M8×25	2	25±2.5Nm	-
Injector clamp bolt	M6×44	2	9±1.0Nm 130°±10°	-
High pressure pipe (between high pressure pump and fuel rail assembly)	M17	1	30±3Nm	-
High pressure pipe (between fuel rail assembly and injector)	M17	4	30±3Nm	-
Crankshaft position sensor	M5×14	1	8±0.4Nm	-
Main wiring	M6×16	5	10±1Nm	-
Intake duct	M8×25	3	25±2.5Nm	-
Power steering pump	M8×100	3	25±2.5Nm	-
Cylinder head front cover	M6×10	5	10±1Nm	-

7. CODING AND INITIALIZATION

1) Engine Variant Coding

Unit	Selection	Description	Remarks
PTC auxilary heater	NO	For PTC auxilary heater equipped vehicle, select "YES".	-
	YES		YES
Glow plug	Relay (K-line)	Select "AQGS".	-
	AQGS (CAN)		AQGS (CAN)
Transmission	6-speed M/T	Select the appropriate system.	Select
	5-speed A/T (DC 5 AT)		Select
	6-speed A/T (DSI 6 AT)		Select
Pressure sensor for A/C refrigerant	NO	Select the appropriate system.	-
	Type		Pressure sensor for A/C refrigerant
Immobilizer	NO	Select "YES" if the vehicle has immobilizer.	-
	YES		YES
Vehicle speed input type	CAN	Select "CAN" if the vehicle has ABS or ESP	CAN
	WIRE		-
Fan	2 relays	Select "PWM".	-
	PWM fan		PWM fan
Auto cruise	NO	Select "YES" if the vehicle has cruise contro.	-
	YES		YES
G-sensor	NO	2WD ABS & Non-ABS: NO 4WD ABS & ESP: YES	Select
	YES		Select

Modification basis	
Application basis	
Affected VIN	

D20DTR ENGINE ASSEMBLY

0000-00

GENERAL INFORMATION

1. SPECIFICATION

Unit	Description		Specification	Remark
Cylinder head	Height		131.9 to 132.1 mm	-
	Flatness		below 0.1 mm	-
	Valve protrusion	Intake valve	0.6 to 1.0 mm	-
		Exhaust valve	0.6 to 1.0 mm	-
	Flatness on manifold side	Intake manifold	0.08 mm	-
		Exhaust manifold	0.08 mm	-
Connecting rod	End play		0.05 to 0.31 mm	-
Camshaft	Axial end play	Intake	0.1 to 0.35 mm	-
		Exhaust	0.1 to 0.35 mm	-
Crank shaft	End play		0.1 to 0.266 mm	-
Camshaft position sensor	Distance between Camshaft position sensor and sprocket		0.20 to 1.80 mm	-
Valve	Clearance between valve and piston	Intake	1.12 mm	-
		Exhaust	1.09 mm	-
	Valve recess	Intake	0.6 to 1.0 mm	-
		Exhaust	0.6 to 1.0 mm	-
Cylinder block	Piston protrusion		0.475 to 0.745 mm	-
Piston ring	TOP ring end gap		0.20 to 0.40 mm	-
	2nd ring end gap		0.35 to 0.50 mm	-
	3rd ring end gap		0.2 to 0.40 mm	-
	Offset		0.3 mm	-
Head gasket	Piston protrusion	0.475 to 0.540	1.2t	-
		0.541 to 0.649	1.3t	-
		0.650 to 0.745	1.4t	-

2. TIGHTENING TORQUE

Component	Size	Bolt Quantity	Specified torque (Nm)	Remark (Total torque)
Main bearing cap	M12×82	10	55±5Nm, 180°	Not re-usable
Connecting rod cap	M9×52	8	40±5Nm, 90°+10°	50 to 80 Nm
Rear cover	M6×20	6	10 ± 1 Nm	-
Oil pump	M8×35SOC	3	25 ± 2.5 Nm	-
Flywheel	M10×22	8	45 ± 5 Nm, 90°+10°	60 to 100 Nm
Crankshaft center bolt	M20×85	1	200 ± 20 Nm, 180°+20°	660 to 720 Nm Not re-usable
Oil pan	M6×20	18	10 ± 1 Nm	-
	M6×35	2	10 ± 1 Nm	-
	M6×85	2	10 ± 1 Nm	-
	M6×120	2	10 ± 1 Nm	-
	M8×40	2	25 ± 2.5 Nm	-
HP pump main nut	M14×1.5-8-1	1	65 ± 5 Nm	-
HP pump bolt	M8×55	3	25 ± 2.5 Nm	-
Cylinder head	M13×150	12	85Nm 270°±10°	-
Camshaft cap	M6×30	16	10 ± 1 Nm	-
	M8×60	4	25 ± 2.5 Nm	-
Exhaust stud bolt		10	15±1.5Nm	-
Exhaust sprocket bolt	M11×40	1	30 ± 3 Nm	-
Chain tensioner screw bolt	M38×1.5	1	25±2.5Nm	-
Coolant temperature sensor		1	20±2.0Nm	-
Auto tensioner	M8×30(LOW)	1	25±2.5Nm	-
	M10×75(Upper)	1	55±5.5Nm	-
Coolant pump	M6×50	1	10±1.0Nm	-

Modification basis	
Application basis	
Affected VIN	

Component	Size	Bolt Quantity	Specified torque (Nm)	Remark (Total torque)
Hot water inlet pipe	M6×16	2	10±1Nm	-
Alternator	M10×90	1	25±2.5Nm	-
	M10×116	1	46±4.6Nm	-
A/C bracket	M8×25	4	7.8~11.8Nm	-
A/C sub bracket	M6×25	4	10±1Nm	-
Intake manifold	M8×35	2	25±2.5Nm	-
	M8×110	6	25±2.5Nm	-
Oil filter module	M8×40	6	25±2.5Nm	-
	M8×20	1	25±2.5Nm	-
	M8×140	2	25±2.5Nm	-
Knock sensor	M8×28	2	20±5Nm	-
Cam position sensor	M8×14	1	10~14Nm	-
Booster pressure sensor	M6×20	2	10±1Nm	-
Exhaust manifold	M8	10	40±4Nm	-
Turbocharger	M8	3	25±2.5Nm	-
Support bolt		1	25±2.5Nm	-
Support nut	M8	1	25±2.5Nm	-
T/C oil supply pipe	M6(block side)	1	10±1.0Nm	-
	M6(turbo side)	1	17±2.0Nm	-
T/C oil return pipe	M6×16(turbo side)	2	10±1Nm	-
	M6×16(block side)	2	10±1Nm	-
EGR valve	M8×22	2	25±2.5Nm	-
EGR pipe bolt (Intake side)	M8×16	2	25±2.5Nm	-
EGR pipe bolt (EGR cooler side)	M8×16	2	25±2.5Nm	-
EGR combination bolt	M6×16	4	10±1Nm	-
	M8×16	16	25±2.5Nm	-
Idle pulley/Tensioner pulley		1	45±4.5Nm	-

Component	Size	Bolt Quantity	Specified torque (Nm)	Remark (Total torque)
Glow plug	M5	4	20±2Nm	-
Vacuum pump	M8×25	3	10±1Nm	-
Timing gear case cover	M12×55	3	85±8.5Nm	-
	M6×25	7	10±1Nm	-
	M6×45	1	10±1Nm	-
	M6×50	3	10±1Nm	-
Cylinder head cover	M6×35	21	10±1Nm	-
Oil gauge tube	M6×16	1	10±1Nm	-
Oil filter cap		1	25±2.5Nm	-
Fuel rail	M8×35SOC	2	25±2.5Nm	-
Injector clamp bolt	M6×60	2	10±1Nm, 120°+10°	-
High pressure pipe (between HP pump and fuel rail)	M17	1	30±3Nm	-
High pressure pipe (between fuel rail and injector)	M17	4	30±3Nm	-
Crank position sensor	M5×14	1	8±0.4Nm	-
Main wiring	M6×16	5	10±1Nm	-
Intake duct	M8x25	4	25±2.5Nm	-
Power steering pump	M8×100	3	25±2.5Nm	-
Cylinder head front cover	M6×10	5	10±1Nm	-
Ladder frame	M8×16	5	30±3Nm	-
Oil pump	M8×35	3	25±2.5Nm	-

Modification basis	
Application basis	
Affected VIN	

3. CHECK AND INSPECTION

1) Cylinder

(1) Compression pressure test

▶ **Specified value**

Compression ratio		16.5 : 1
Test condition		at normal operating temperature (80°C)
Compression pressure	**Standard**	32 bar
	Minimum	18 bar
Differential limit between cylinders		Maximum 3 bar

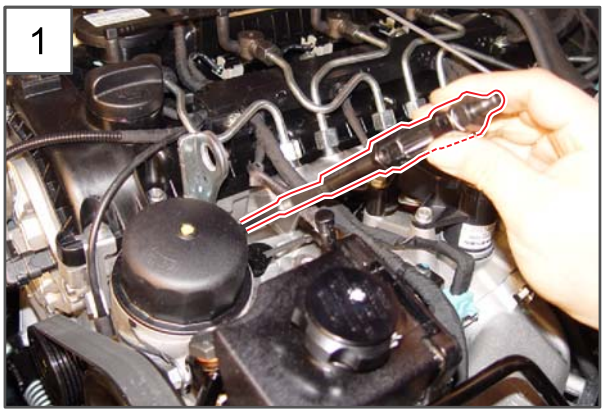
The compression pressure test is to check the conditions of internal components (piston, piston ring, intake and exhaust vale, cylinder head gasket). This test provides current engine operating status.

CAUTION

- Before cranking the engine, make sure that the test wiring, tools and persons are keeping away from moving components of engine (e.g., belt and cooling fan).
- Park the vehicle on the level ground and apply the parking brake.
- Do not allow anybody to be in front of the vehicle.

▶ **Measurement**

- Warm the engine up to normal operating temperature (80°C).
- Disconnect the fuel rail pressure sensor connector to cut off the fuel injection.
- Remove the air cleaner duct and glow plugs.



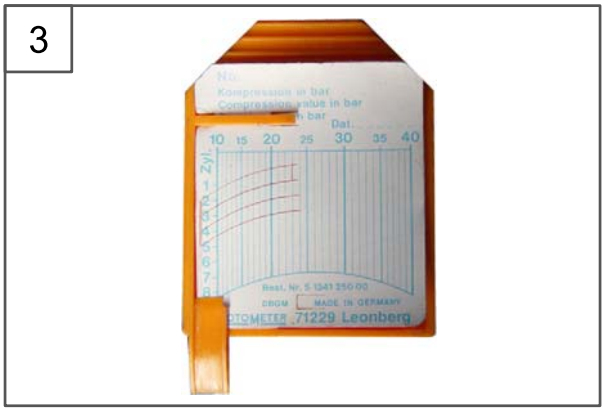
1. Place the diagram sheet to compression pressure tester and install it into the plug hole.

2



2. Crank the engine for approx. 10 seconds by using the start motor.

3



3. Record the test result and measure the compression pressure of other cylinders with same manner.

4. If the measured value is out of specified value, perform the cylinder pressure leakage test.

(2) Cylinder pressure leakage test

▶ **Specified value**

Test condition: normal engine operating temperature (80°C)	**Specified value**
Whole engine	below 25%
at valve and cylinder head gasket	below 10%
at piston ring	below 20%

If the measured value of the compression pressure test is not within the specifications, perform the cylinder pressure leakage test.

CAUTION

- Perform this test in the sequence of firing order.
- Do not test the cylinder pressure leakage with wet type test procedure. (do not inject the engine oil into the combustion chamber)

Modification basis	
Application basis	
Affected VIN	

(3) Piston protrusion check



Position the piston at TDC and measure the piston protrusion from crank case mating surface.

Specified value	0.475 to 0.745 mm

CAUTION

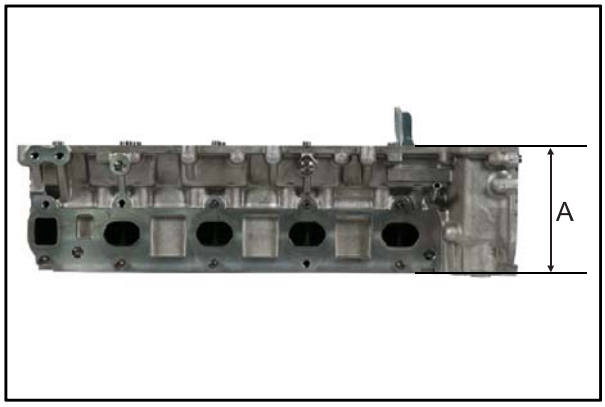
- Measure it at both ends of crankshaft.

2) Cylinder Head

(1) Cylinder head mating surface check

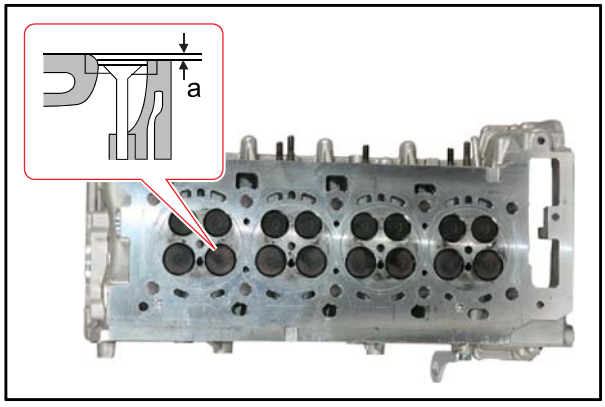
▶ **Specified value**

Total height "A"		131.9 to 132.1 mm
Minimum height after machining		131.9 mm
Flatness	**Longitudinal direction**	0.1 / 150
	Transverse direction	0.15
Parallel deviation of cylinder head		below 0.1 mm
Peak-to valley of surface		Rmax 7 Rz 6.3
valve recess "a"	**Intake valve**	0.6 to 1.0 mm
	Exhaust valve	0.6 to 1.0 mm



1. Measure the cylinder head height "A".

CAUTION
- If the height is less than the limit, the cylinder head must be replaced.



2. Insert the valves into the valve guides and measure the recesses.

Valve recess "a	0.6 to 1.0 mm

CAUTION
- If the measured value is out of the specified range, machine the valve seat as much as necessary until the specified value is achieved.

(2) Cylinder head pressure Leak test

Immerse the cylinder head with the pressure plate into warm water (approx. 60°C) and pressurize with compressed air to 2 bar.

Modification basis	
Application basis	
Affected VIN	

4. GUIDELINES ON ENGINE SERVICE

To prevent personal injuries and vehicle damages that can be caused by mistakes during engine and unit inspection/repair and to secure optimum engine performance and safety after service works, basic cautions and service work guidelines that can be easily forgotten during engine service works are described in.

▶ **Cautions before service works**

- For safe and correct works, you must observe the working procedures and instructions in this manual. And, use the designated tools as follow:
  Engine stand / Heavy duty engine jack
- To prevent the engine from starting abruptly, do not allow anybody to get in the vehicle while servicing in engine compartment.
- Before work on engine and each electrical equipment, be sure to disconnect battery negative (-) terminal.
- Before service works, be sure to prepare the works by cleaning and aligning work areas.
- Do not allow the foreign material get into the fuel injection system.
- When removing the engine, use only the safety hook on engine and engine hanger. Do not support the bottom of oil pan with a jack.

▶ **Engine and accessories**

- Completely drain the engine oil, coolant and fuel from engine before removal.
- Before disassembling/assembling the engine components, carefully read the working procedures in this manual.
- Make sure to keep the specified tightening torques during installation.
- Clean and properly lubricate the parts before reassembly.
- Carefully check that there are not any interference while servicing.

▶ **Fuel and lubrication system**

- Do not allow the fluid and engine oil to make contact with the body paintwork and hoses.
- If work on the fluid system such as fuel and oil, working area should be well ventilated and smoking should be prohibited.
- Gasket or seal on the fuel/lubrication system should be replaced with new ones and bolts and nuts should be tightened as specified.
- After removal/installation works, be sure to check whether there is leak on the connecting section.

If fine dust or foreign material enters into DI engine's fuel system, there can be serious damages in HP pump and injectors. Thus, be sure to plug the inlets of removed fuel line components with cap and protect removed parts not to be contaminated with dirt. (Refer to cleanness in this manual while working on DI engine fuel system)

▶ **Electrical equipment**

Electric devices should be handled more carefully.
Currently, the engine has a lot of electric devices. there could be poor engine performance, incomplete combustion and other abnormal symptoms due to short circuit or poor contact.

- Before work on engine and each electrical equipment, be sure to disconnect battery negative (-) terminal.
- When replacing the electric device, use only genuine part and check the conditions of connections and grounds. Loosened connection or ground make cause a fire and personal injury.

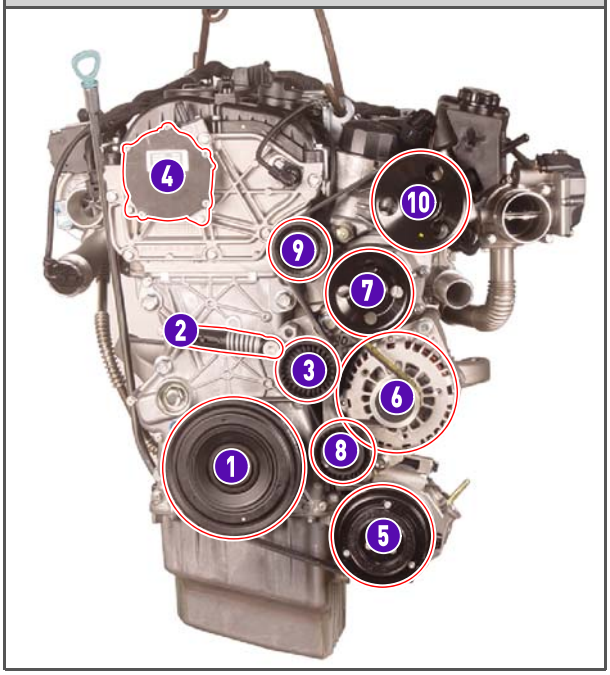
Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. BELT LAYOUT

It is single drive type and uses FEAD (Front End Accessories Drive) design to make a compact layout.

▶ **Components**

D20DTR Engine


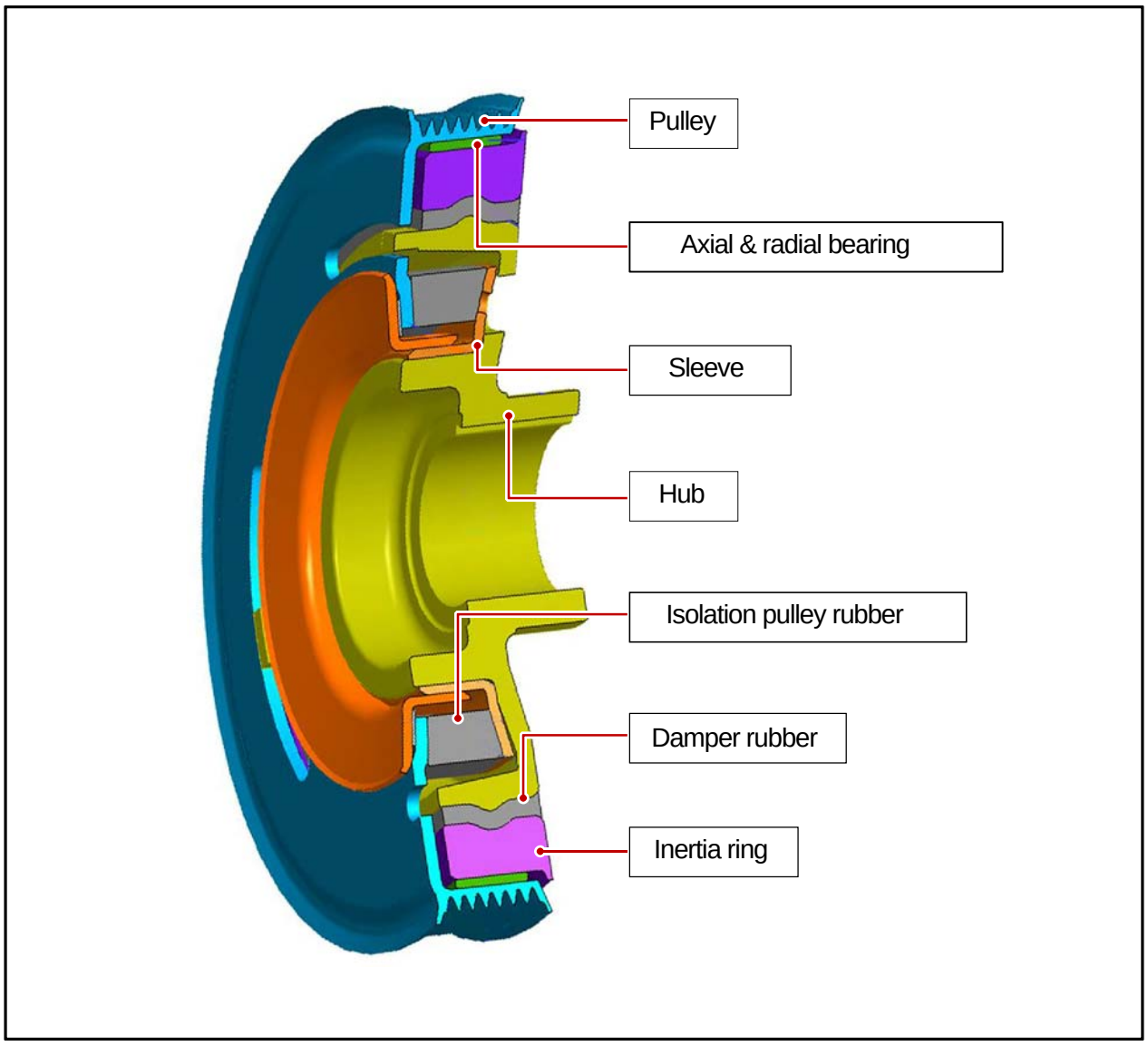
	HPS (Hydraulic Power Steering)
1	Crankshaft pulley (DDU)
2	Auto tensioner
3	Tensioner pulley
4	Vacuum pump
5	A/C compressor pulley
6	Alternator pulley
7	Water pump pulley
8	Idle pulley #1
9	Idle pulley #2
10	Power steering pump pulley

1) Crankshaft Pulley (Isolation Damper)

(1) Overview

The strut type tensioner automatically adjusts the belt tension to provide the reliability and durability for the system. And, the belt tension is decreased to minimize the friction loss and improve the belt operating noise.

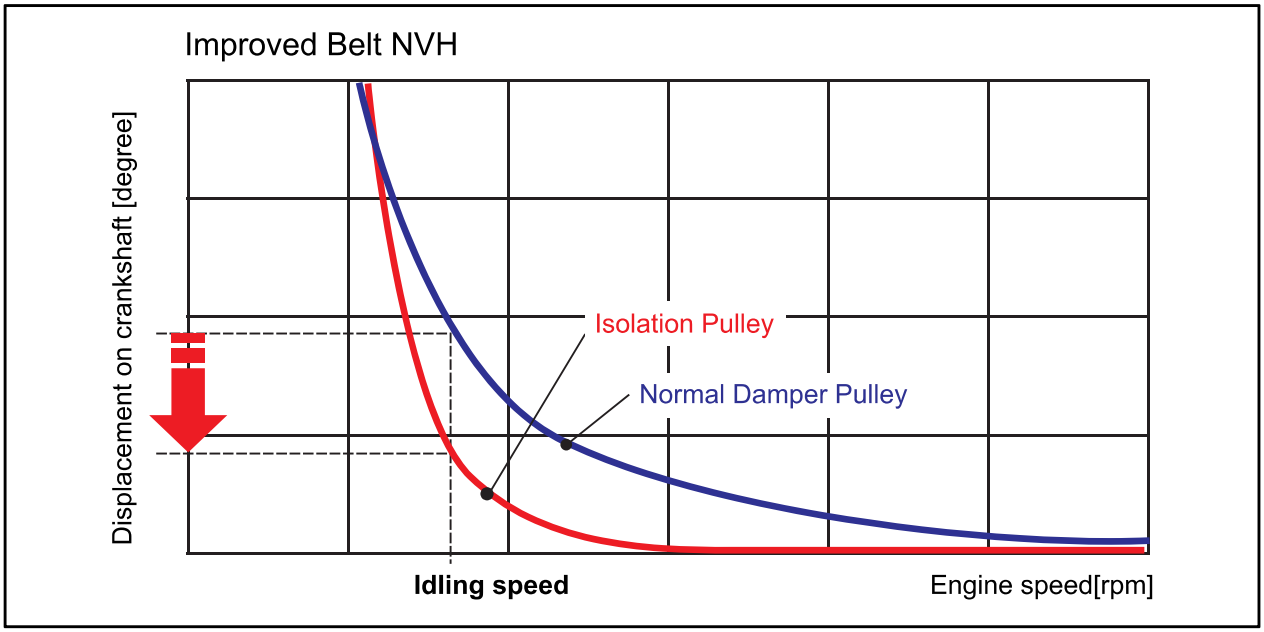
(2) Sectional drawing



Modification basis	
Application basis	
Affected VIN	

(3) Features

1. Rubber damper: Decrease crankshaft torsion
2. Improve belt NHV: Reduce unbalance speed to crankshaft due to irregular combustion
3. Minimize noise: Anti-vibration from crankshaft and belt
4. Post bonded type rubber damper: Improve durability of rubber damper

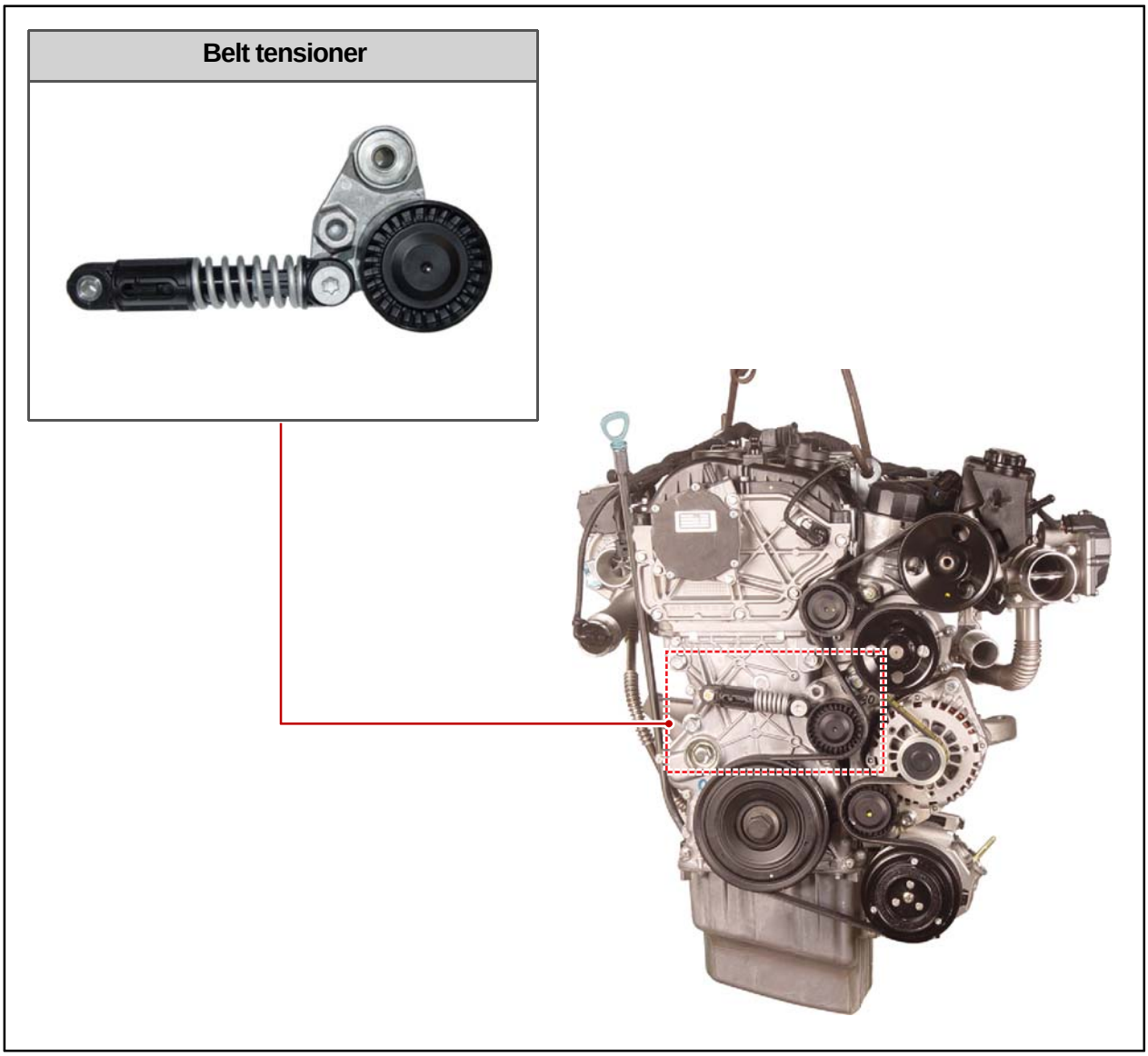


2) Belt Tensioner

(1) Overview

The torque deviation from crankshaft affects the components in belt drive system and the belt movement. The auto tensioner system is to adjust this deviation automatically.
In D20DTR engine, one of the mechanical tensioner, pivot damped tensioner is used to keep the damping force, system reliability and durability. The single belt drive system needs to use the automatic belt tensioning device to transfer the power to pulleys effectively. To get this, the tensioner uses the spring and damping unit.

(2) Location



Modification basis	
Application basis	
Affected VIN	

2. VACUUM PUMP

Vacuum pump generates the vacuum pressure and supplies it to EGR cooler bypass solenoid. This pump is single vane type and displacement is 210 cc/rev. The lubrication oil is supplied through the hole in hollow shaft.

▶ Components

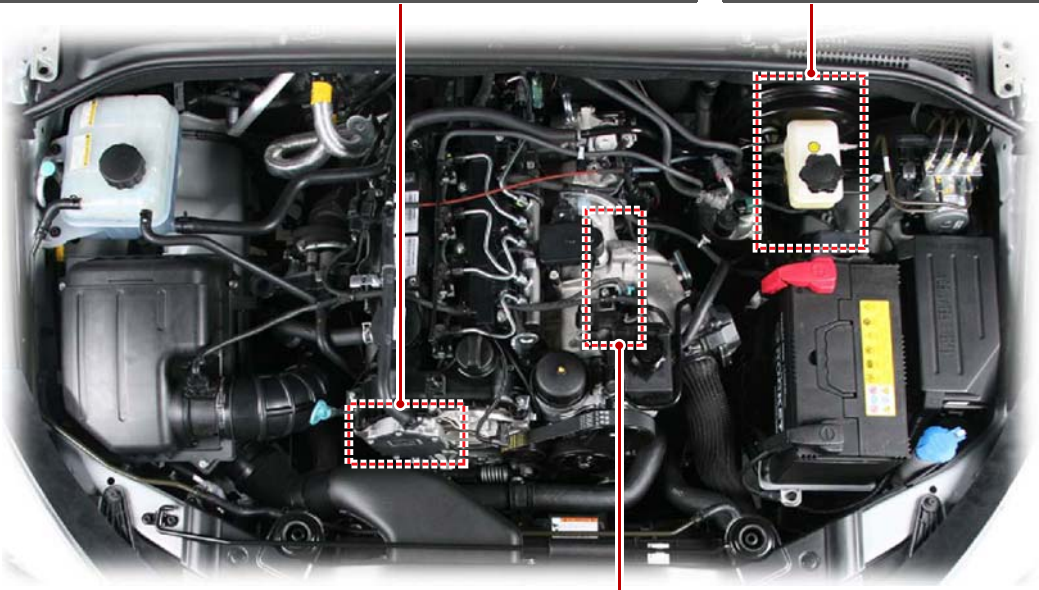
Vacuum pump



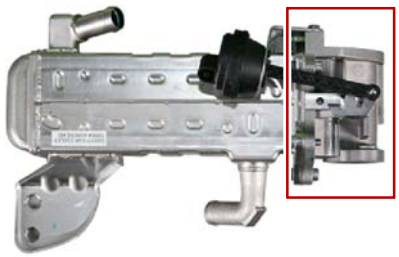
Pump capacity: 210 cc/rev
Camshaft speed: 375 to 3,000 rpm
Lubrication temperature: -40 to 155°C
Oil: 5W30
Drive type: Driven by exhaust Camshaft sprocket

Brake booster and naster cylinder



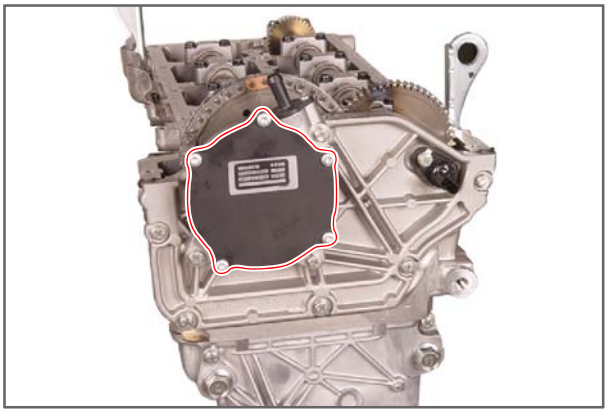


EGR cooler bypass valve



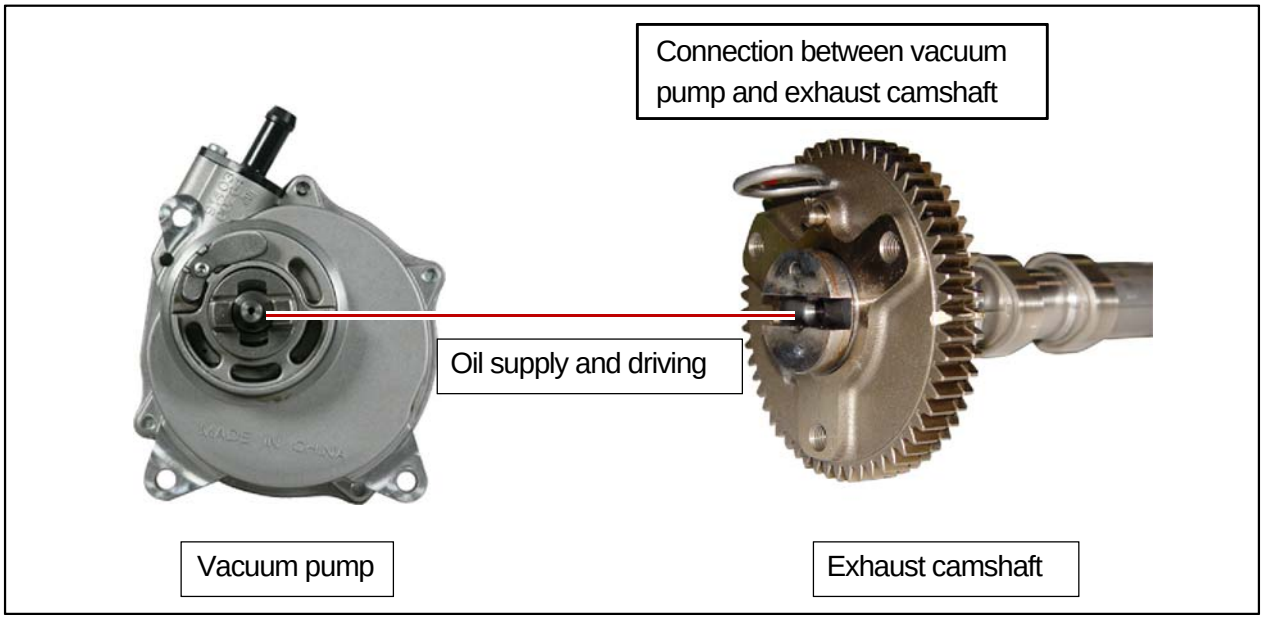
This valve is controlled by ECU. When the engine is cooled, the exhaust gas goes to combustion chamber without passing through EGR cooler because the valve is closed by vacuum pressure.

1) Location



2) Operation

The vacuum pump is engaged to the exhaust camshaft.



Modification basis	
Application basis	
Affected VIN	

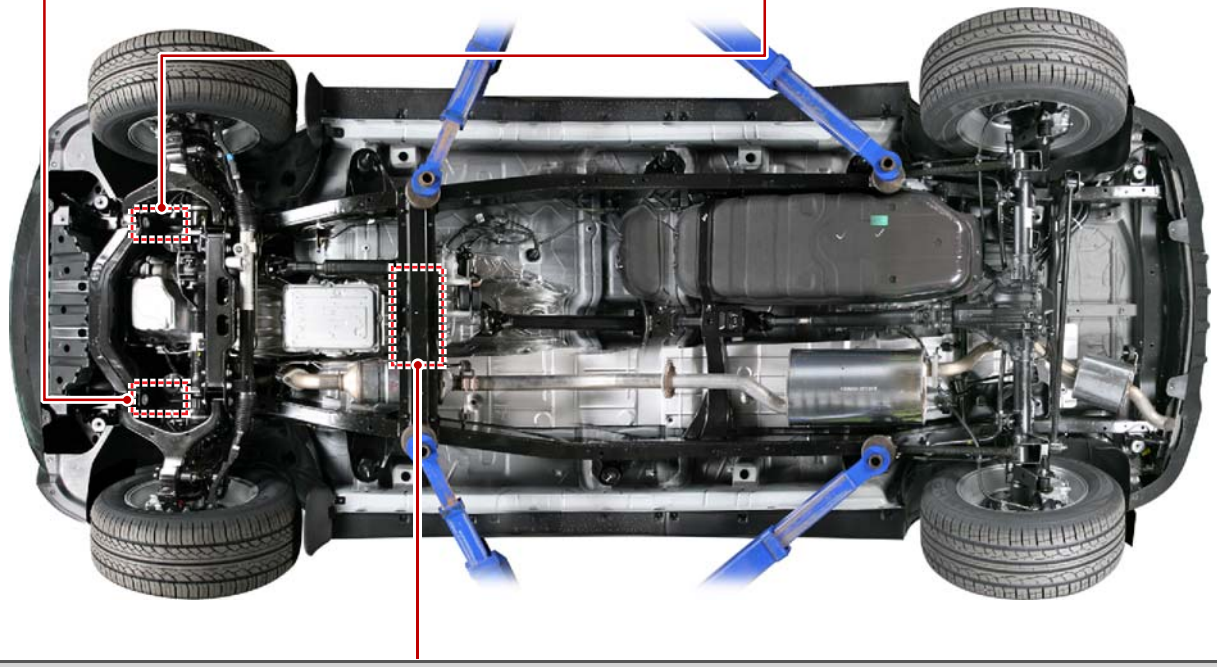
3. ENGINE MOUNTING

D20DTR engine uses 3-point mounting type that supports the engine and transmission simultaneously.

▶ **Components**

Front mounting insulator (Right side)	
Location	**Insulator**
	

Front mounting insulator (Left side)	
Location	**Insulator**
	



Rear mounting insulator			
2WD		**4WD**	
A/T	**M/T**	**A/T**	**M/T**
			

1) Functions

Appearance	Type and function
Front mounting insulator (Right side) 	Type: Rubber mounting Function: Supports the torque reaction
Front mounting insulator (Left side) 	Type: Rubber mounting Function: Supports the torque reaction
Rear mounting insulato 	Type: Rubber mounting Function: Supports the powertrain rod

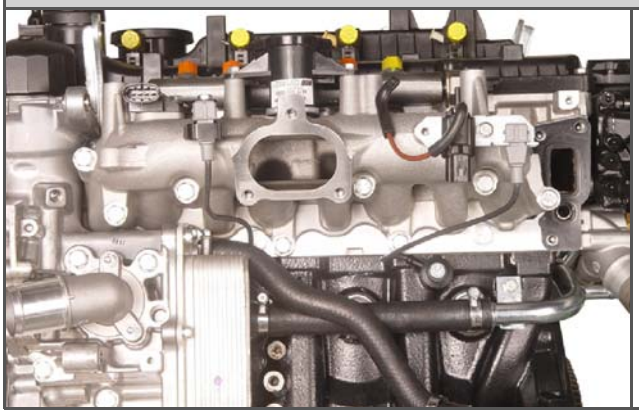
Modification basis	
Application basis	
Affected VIN	

4. INTAKE/EXHAUST MANIFOLD

1) Intake Manifold

Intake manifold is installed on the cylinder head with 8 bolts. The variable swirl valve is introduced to improve the EGR gas mixture and turbulence in combustion chamber and to decrease the exhaust gas.

▶ **Components**

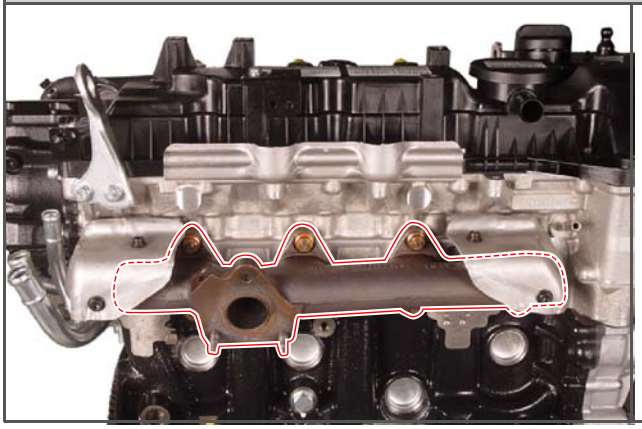
Intake manifold	
	

* For detailes, refer to Chapter "Intake System".

2) Exhaust Manifold

Exhaust manifold is installed on the cylinder head with 10 stud bolts and nuts. EGR port is integrated in cylinder head.

▶ **Components**

Exhaust manifold	
	

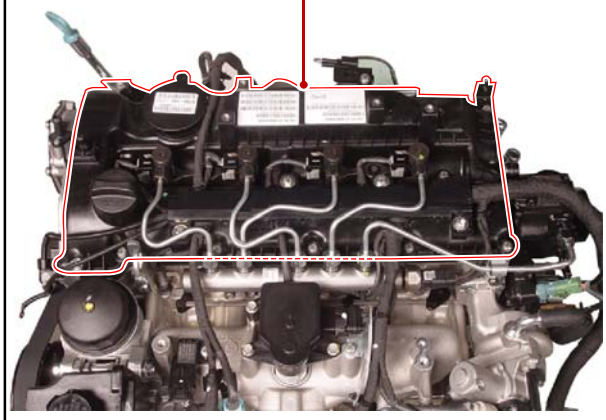
* For detailes, refer to Chapter "Exhaust System".

5. CYLINDER HEAD COVER AND OIL SEPARATOR

1) Cylinder Head Cover

The cylinder head cover is made by high strength plastic to reduce the weight. The multi twist type oil separator improves the oil consumption.

▶ **Components**



Front view



Rear view



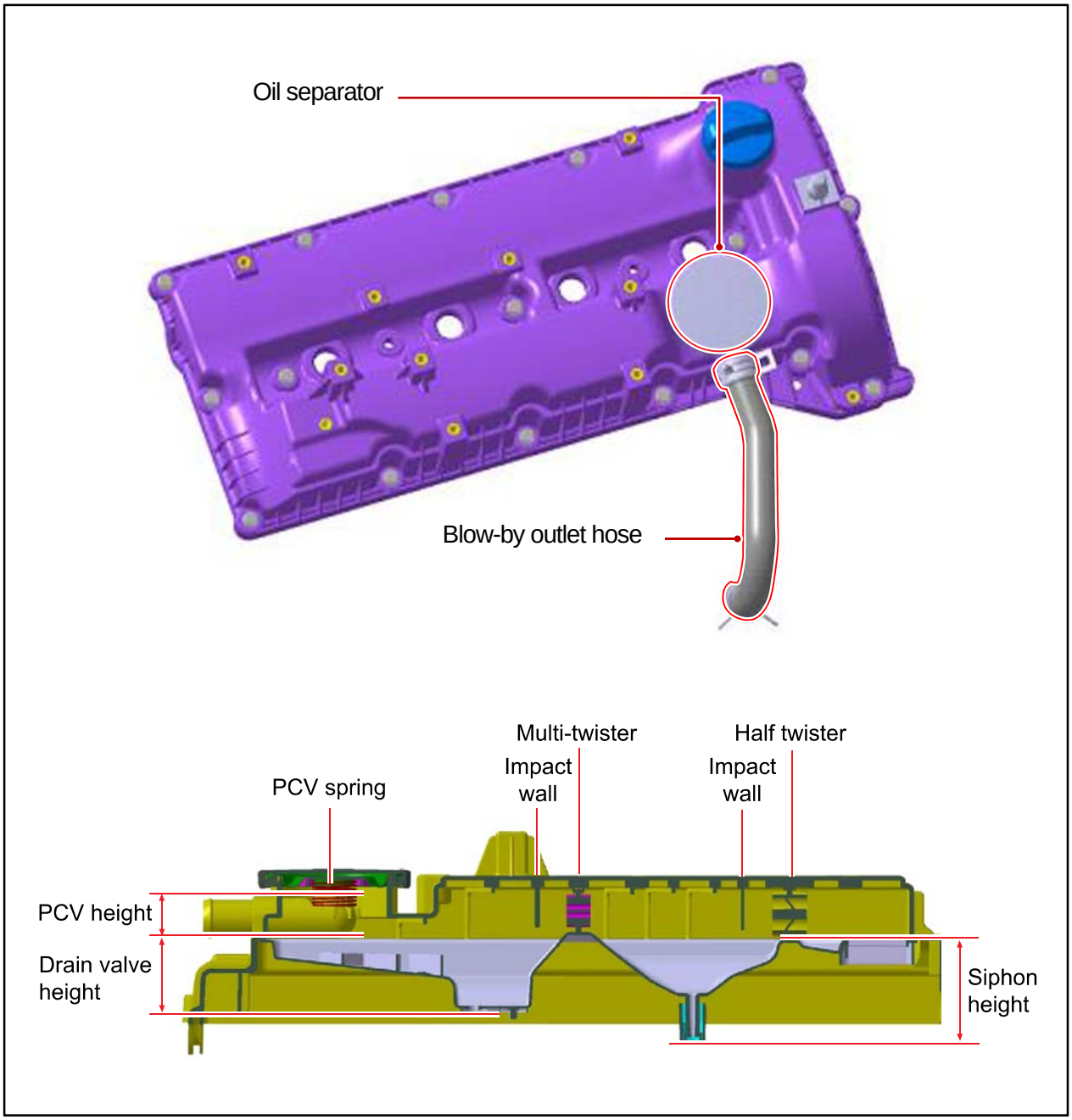
Modification basis	
Application basis	
Affected VIN	

2) Oil Separator

(1) Overview

Oil separator separates the particle in blow-by gas to minimize the engine oil consumption and reduces the inflow oil from intake system into the combustion chamber. The separated oil returns to oil pan through cylinder head.

(2) Layout



6. CYLINDER HEAD

Cylinder head contains cam position sensor, vacuum pump, intake manifold, exhaust manifold and valve assembly. Vacuum pump and the high pressure (HP) pump are driven by Camshaft and valves are install in vertical direction. This enables the compact layout in cylinder head assembly.

▶ **Components**

Finger follower & HLA

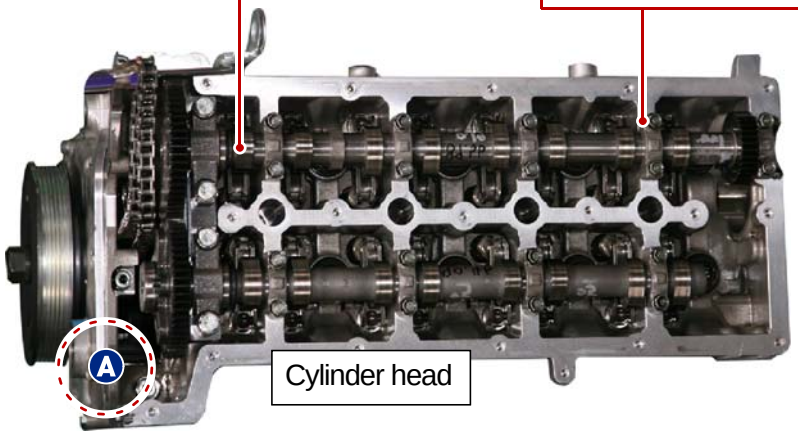


Intake/exhaust Camshafts



Camshaft sprocket





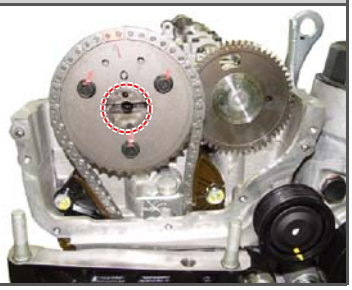
Camshaft position sensor



HP pump drive gear



Vacuum pump drive



Cylinder head gasket



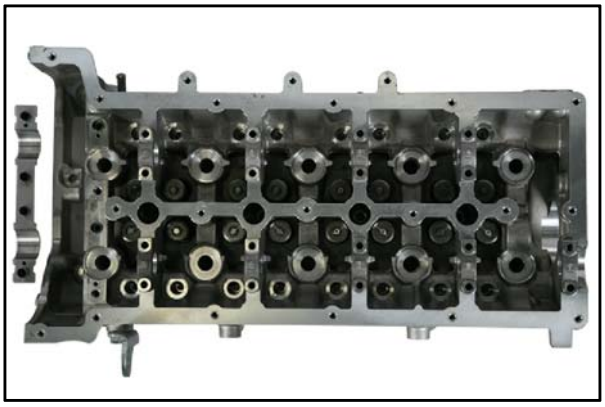
Modification basis	
Application basis	
Affected VIN	

1) Cylinder Head

(1) Overview

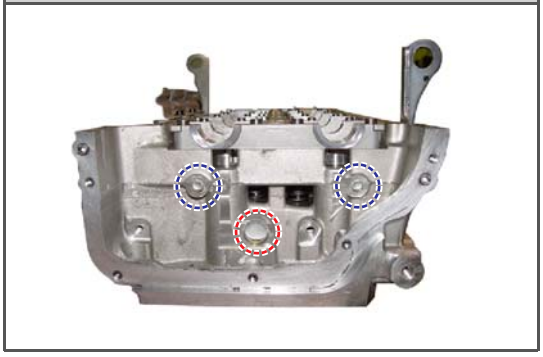
The cylinder is made by gravity casting and the water jacket is integrated type.
The cylinder oil passage is drilled and sealed by cap.
The Camshaft bearing cap is also made by casting and installed on the cylinder head.

(2) Features

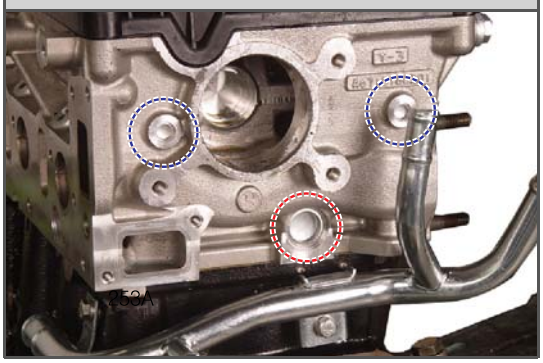


Location of Expansion Plugs

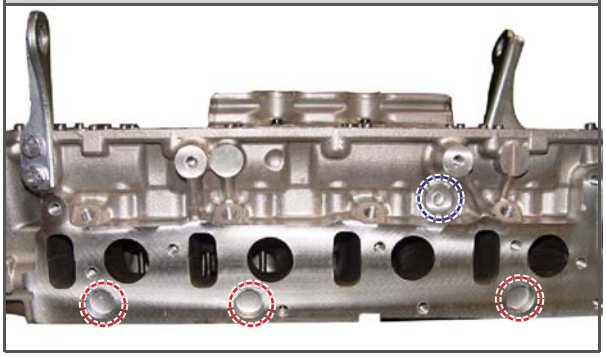
Front



Rear

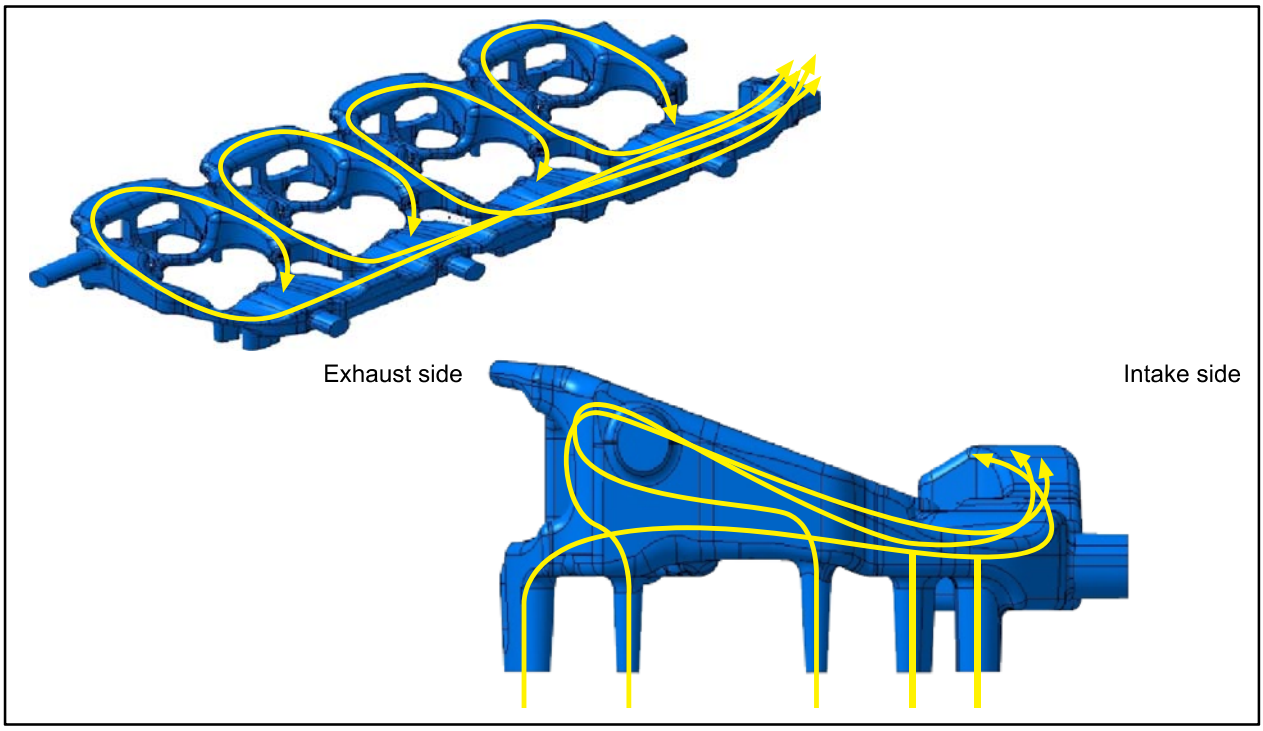


Intake side



Coolant expansion plug (M21)
Oil gallery expansion plug (M10)

▶ **Closed flow type water jacket (improving cooling performance)**



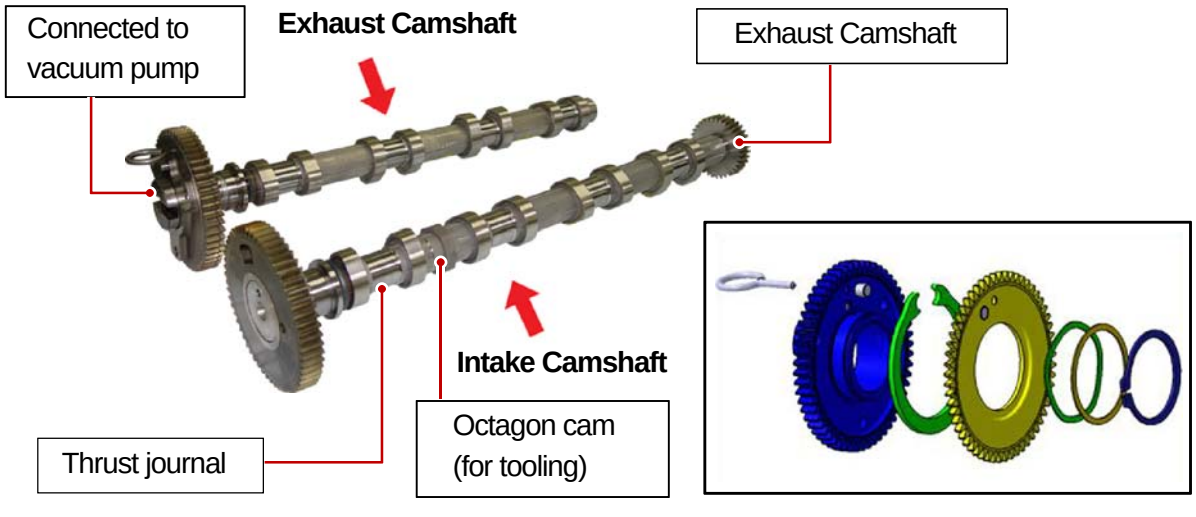
2) Camshaft

(1) Overview

Hollow type camshaft contains cam, octagon cam, HP pump gear and intake/exhaust gears. Camshaft operates the intake/exhaust valves, vacuum pump and HP pump, and transfers the engine oil to vacuum pump through the internal oil passage.

(2) Location

Intake/Exhaust Camshafts



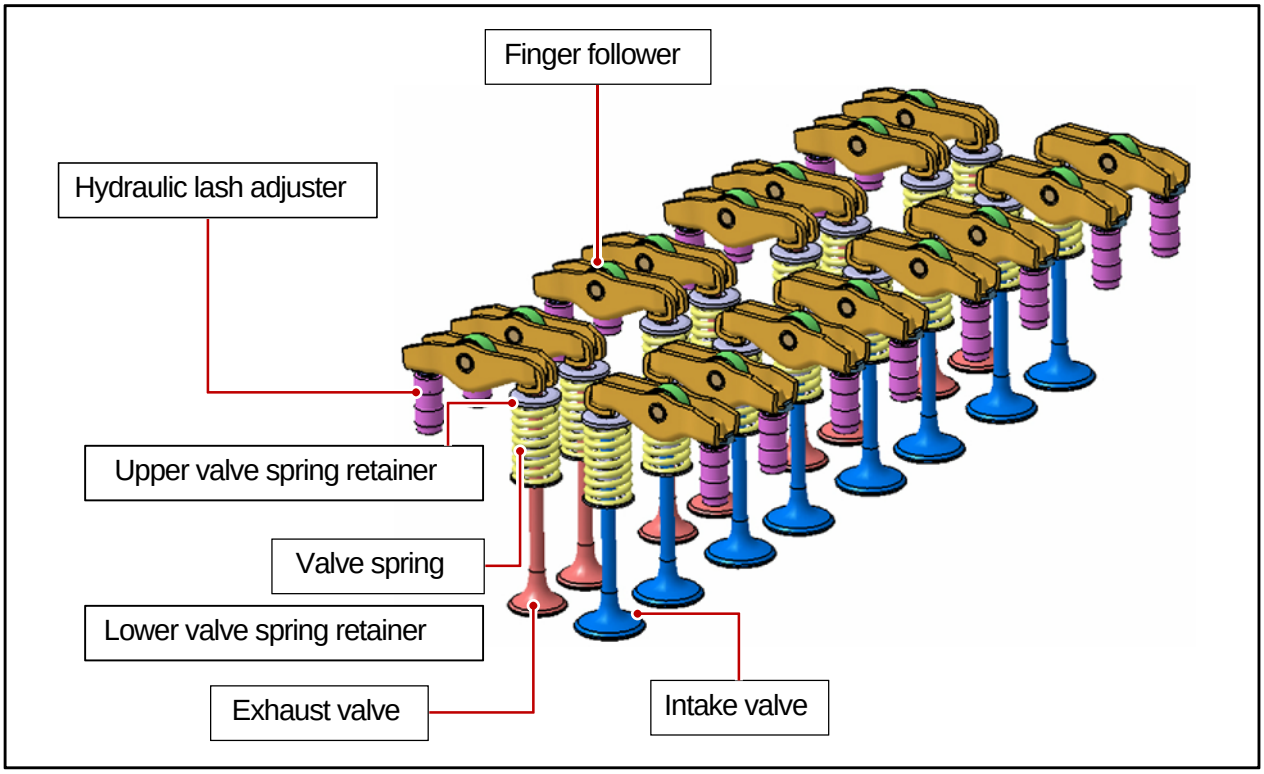
Modification basis	
Application basis	
Affected VIN	

3) Valve Assembly (Installed in Cylinder Head)

(1) Features

1. Automatic valve clearance adjuster by hydraulic pressure (Maintenance Free) - Hydraulic lash
2. Optimized adjustment of valve clearance reduces the valve noise.
3. Roller type finger follower reduces the friction loss.
4. Vertical installation.
5. Simple and compact design reduces the moving operation (improving valve following and fuel consumption at high speed)

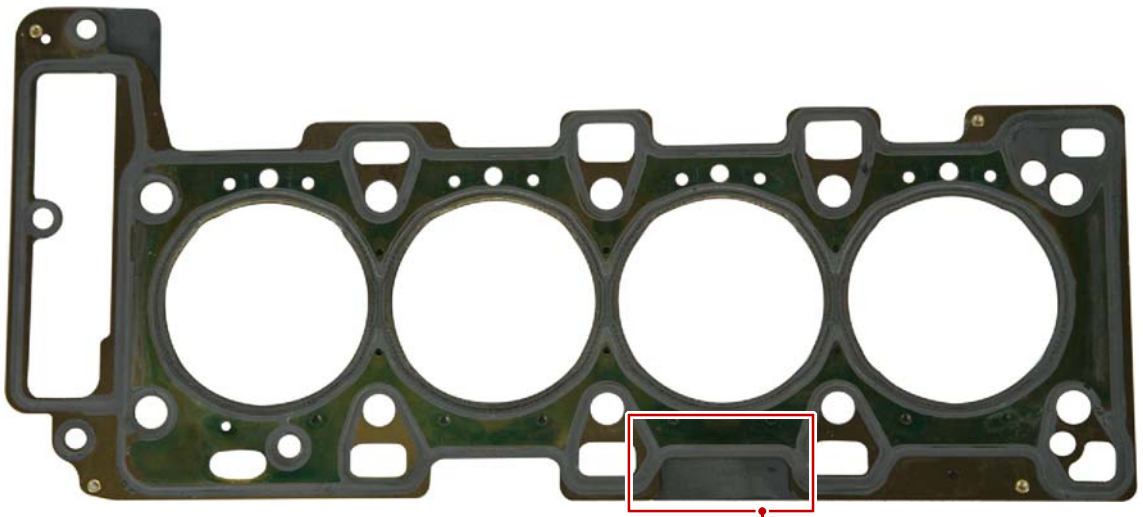
(2) Arrangement



4) Cylinder Head Gasket

(1) Features

1. Sealing the cylinder gas pressure - Peak pressure: 190 bar
2. Minimizing the distortion of engine structure (cylinder head, block): profile stopper, backland stopper
   Material: MLS (Multi Layer Steel), Gasket (3 layers)
3. Thickness of gasket: 3 types (1.2 /1.3 /1.4 mm)
4.



Thickness marking	
	Ex: 1.3t

(2) Thickness of cylinder head gasket

There are three types of gasket to managing the compression ratio.

▶ **Piston protrusion**

Piston protrusion	Thickness
0.475 to 0.540 mm	1.2t
0.541 to 0.649 mm	1.3t
0.650 to 0.745 mm	1.4t

Modification basis	
Application basis	
Affected VIN	

7. CHAIN AND GEAR DRIVE SYSTEM

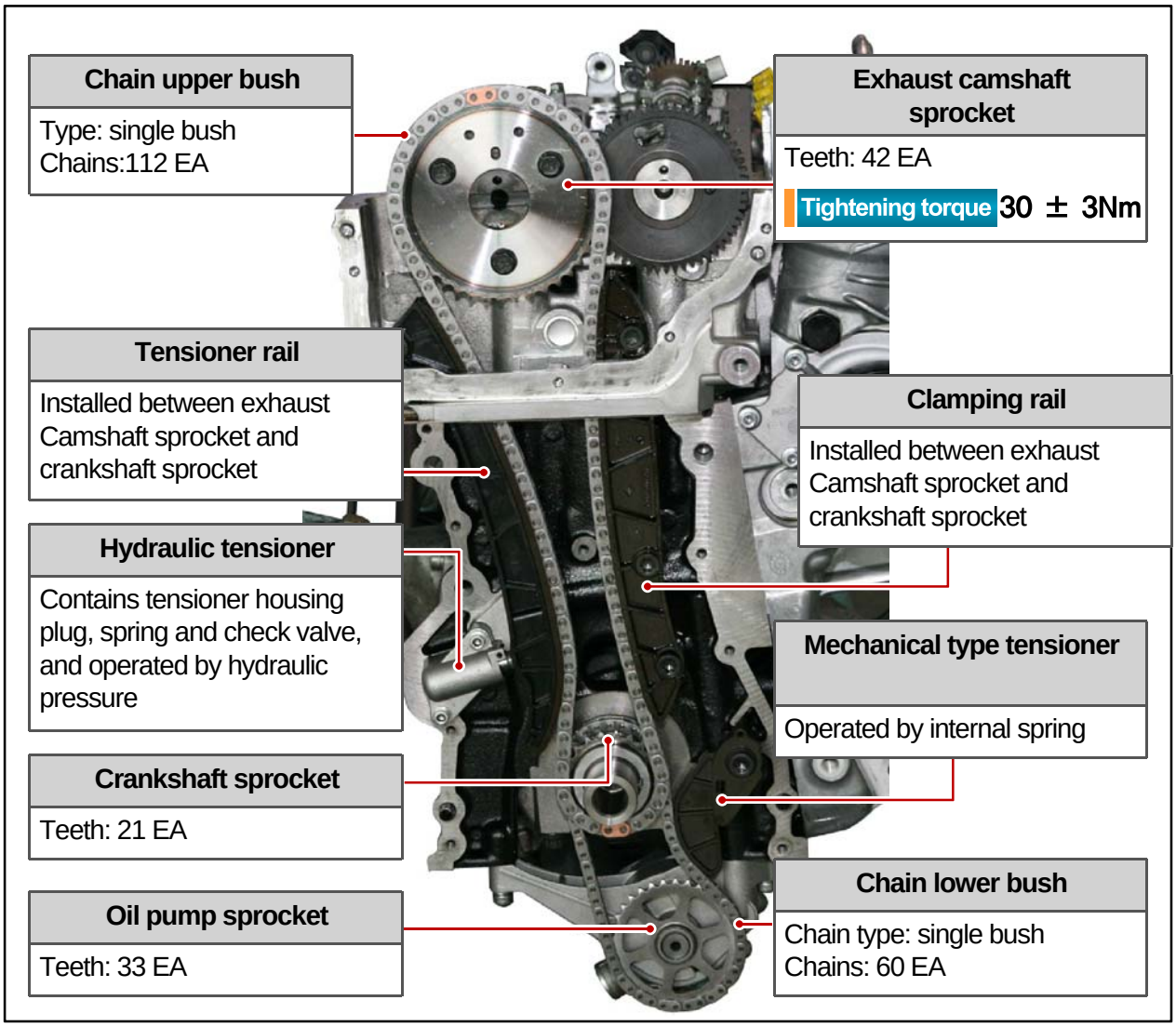
D20DTR engine uses single stage chain drive system. Timing chain drives the exhaust side and gear drive the intake side. Timing chain is single bush type. Upper chain drives HP pump connected to intake Camshaft by driving exhaust cam shift sprocke, and lower chain drives oil pump to lubricate the engine.

1) Chain Drive

(1) Overview

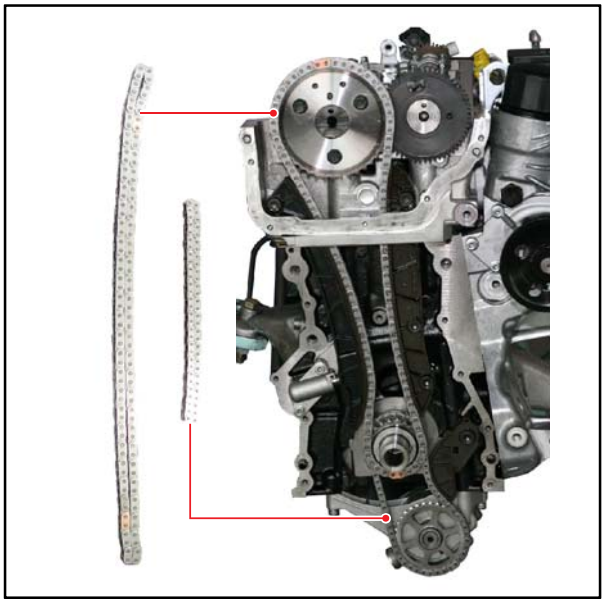
The drive chain is single chain drive system with simple design and variable performance, and it utilizes the hydraulic tensioner to reduce the wave impact generated by the chain. This chain is light weight and has high durability through single bush chain. Shoulder bolts are used for better NHV.

(2) Layout



2) Timing Chain and Gear

(1) Timing chain



- Simple layout: optimized timing, enhanced NVH
- Single stage layout: minimized chain load

Chain upper bush
- Single bush type (112 EA)

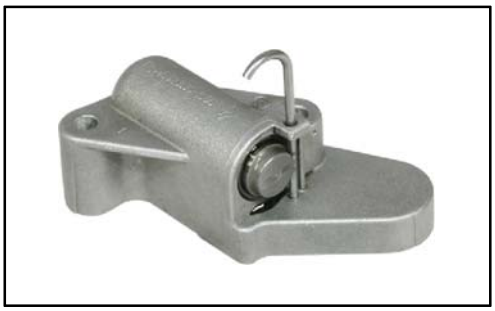
Chain lower bush
- Single bush type (60 EA)

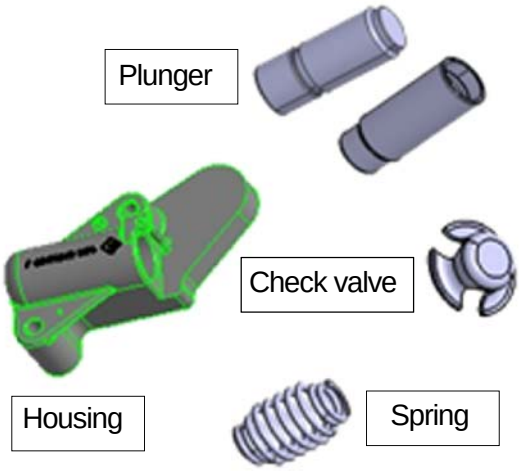
(2) Tensioner

Tensioner adjusts the chain tension to keep it tight during engine running. This reduces the wear in guide rail and spoke.

▶ **Hydraulic tensioner assembly**

1. Operating principle
   - Use the spring tension in tensioner and hydraulic pressure
2. Tensioner type
   - Compensation and impact absorbing
3. Static and dynamic force
   - Spring + Hydraulic pressure





Modification basis	
Application basis	
Affected VIN	

(3) Mechanical Tensioner Assembly



Operating principle
- Use only spring tension

Tensioner type
- Compensation and impact absorbing

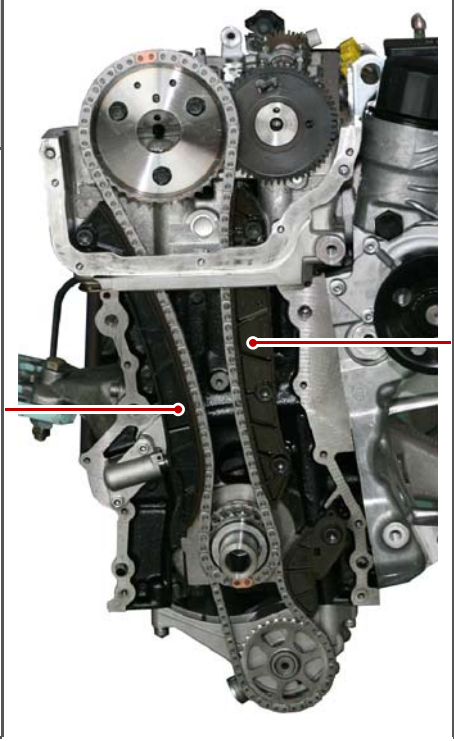
Static and dynamic force
- Spring

(4) Guide rail

The guide rail is used for optimizing the movement of chain drive system. And it also prevents the chain from contacting each other when the chain is loose, and reduces the chain wear.
The guide rail is made of plastic, nylon, Teflon, etc. The guide rail is specially required when the distance between two spokes is too great. It pushes the chain with constant force so that the chain can work smoothly. The guide rail is fitted by pins.

Tensioner guide rail
Installed between exhaust Camshaft sprocket and crankshaft sprocket



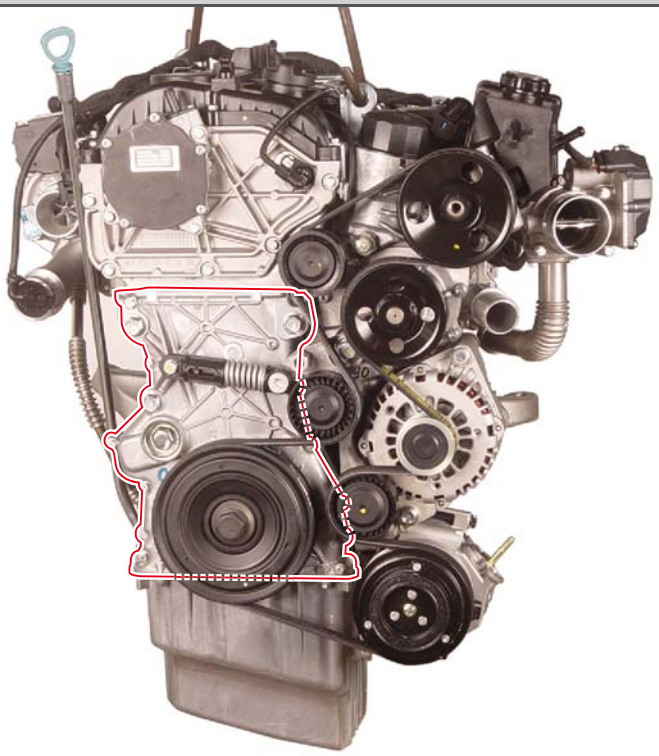


Clamping guide rail
Installed between exhaust Camshaft sprocket and crankshaft sprocket



(5) Timing gear case cover

Timing gear case cover (TGCC)



Timing gear case cover



Oil seal



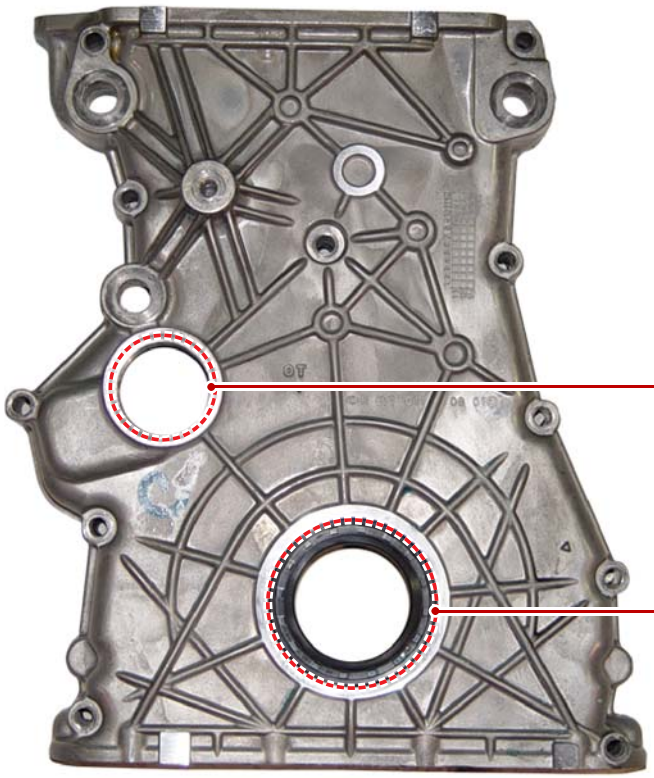
Screw plug



Modification basis	
Application basis	
Affected VIN	

▶ **Features**

- Major function: Protecting the chain drive system, minor function: Shielding the chain noise.
- Install crankshaft front seal and screw plug on the timing gear case cover.



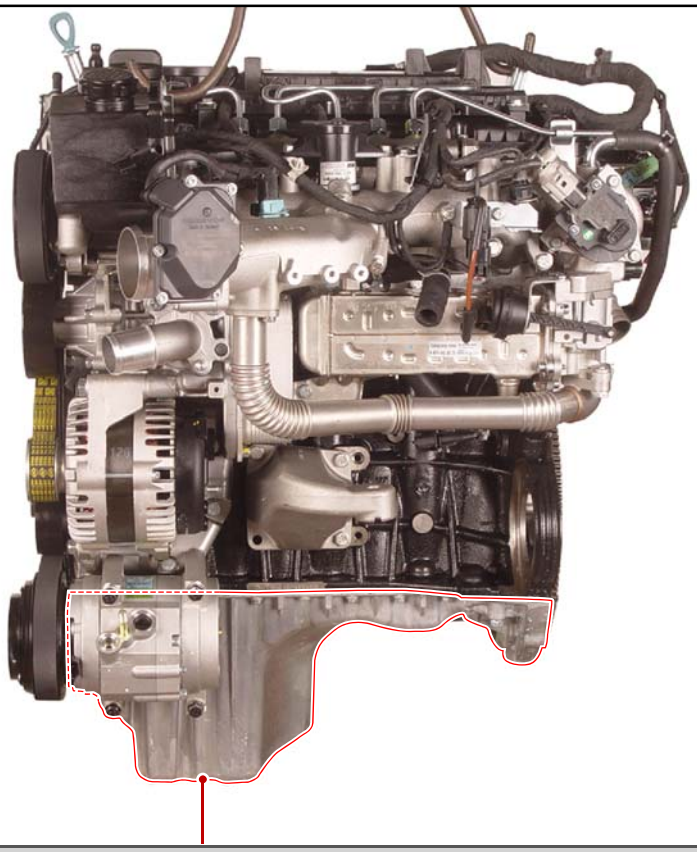
CAUTION

- Do not touch the inner lip of crankshaft front seal.
- Be careful not to damage the screw thread when removing the lock pin to release the chain tensioner.
- Be careful not to damage the O-ring when installing the screw plug.

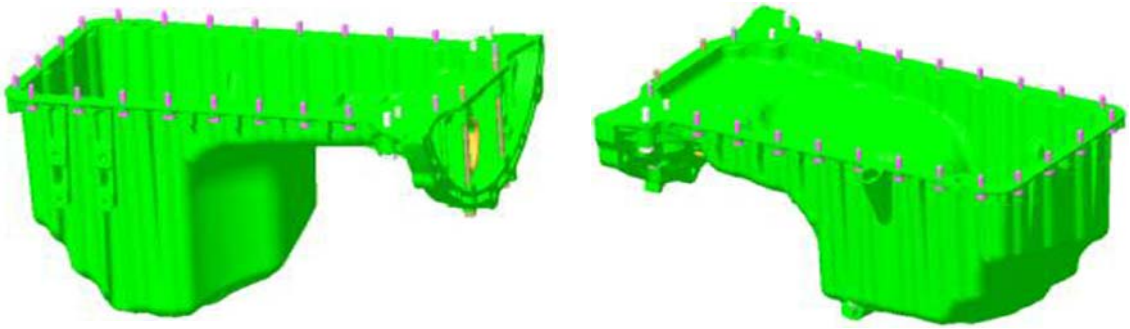
8. OIL PAN

The oil pan in D20DTR engine improves the NVH. Especially, the oil draining is much easier than before.

▶ **Components**



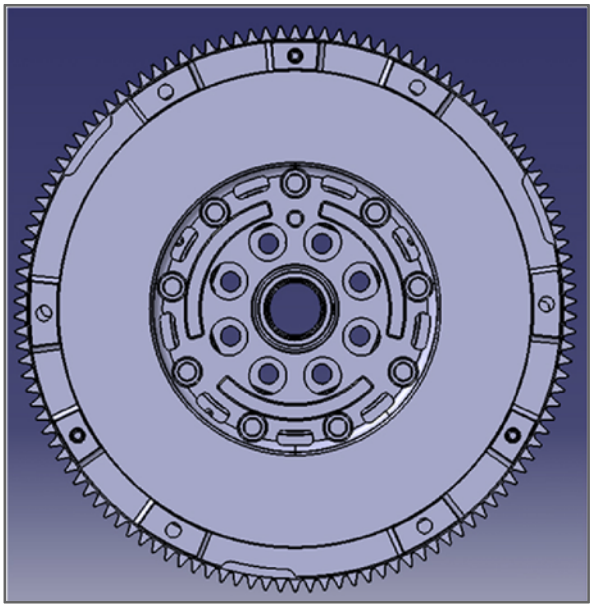
Oil pan sassembly



Modification basis	
Application basis	
Affected VIN	

9. DUAL MASS FLYWHEEL (DMF) & DRIVE PLATE

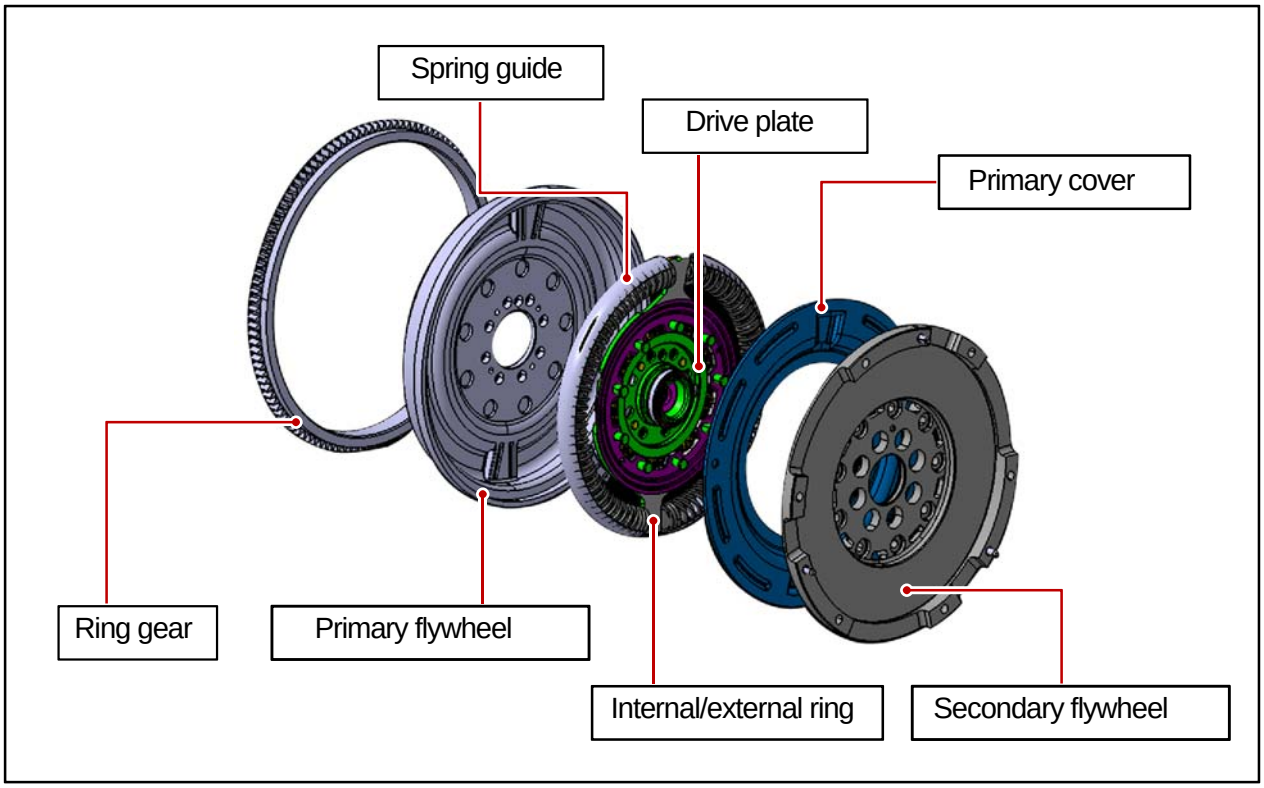
1) Overview



Flywheel is installed on crankshaft. When starting the engine, this functions as follows:

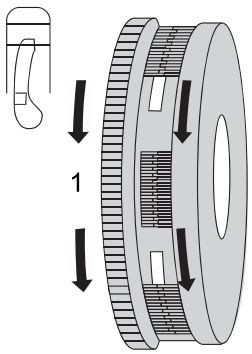
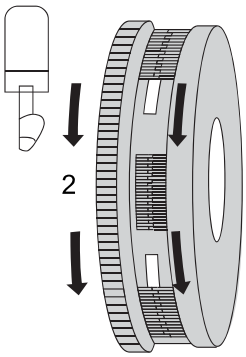
- Reducing the irregular speed of crankshaft due to unbalanced combustion -> Improving the power train NVH, Improving the driving performance
- Reducing the clutch noise by using ball bearing
- Improving the durability of DMF by using strong arch spring

2) Layout

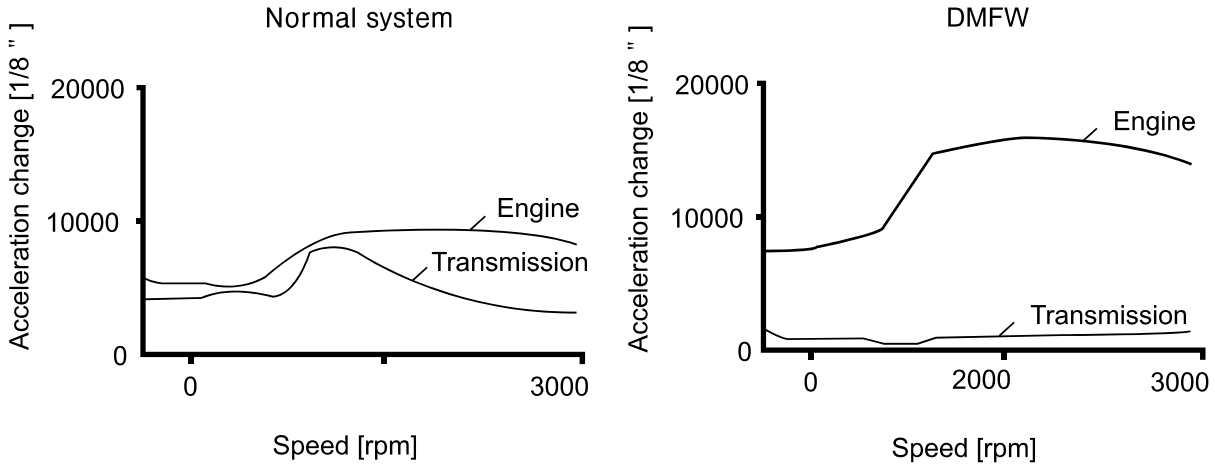


3) Operation

- Compensating the irregular operation of engine: The secondary flywheel operates almost evenly so does not cause gear noises
- The mass of the primary flywheel is less than conventional flywheel so the engine irregularity increases more (less pulsation absorbing effect).
- Transaxle protection function: Reduces the torsional vibration to powertrain (transaxle) by reducing the irregularity of engine.

Compression stroke	Combustion stroke
	
Small changes from engine (k): Damper increases the torque changes to clutch	**Large changes from engine (j):** Damper decreases the torque changes to transaxle by absorbing the impact

Torque change curve of engine and drive shaft



Modification basis	
Application basis	
Affected VIN	

4) Features

- Reduced vibration noise from the powertrain by blocking the torsional vibrations
- Enhanced vehicle silence and riding comforts: reduced engine torque fluctuation
- Reduced shifting shocks
- Smooth acceleration and deceleration

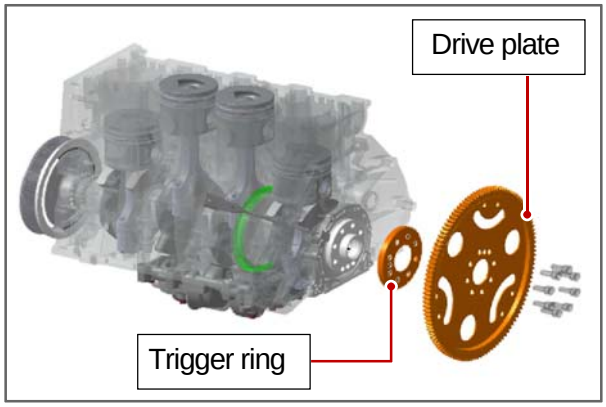
5) Advantages

- Improved torque response by using 3-stage type spring: Strengthens the torque response in all ranges (low, medium, and high speed) by applying respective spring constant at each range.
  Stable revolution of the primary and secondary wheel by using planetary gear: Works as auxiliary
- damper against spring changes
  Less heat generation due to no direct friction against spring surface: Plastic material is covered on
- the spring outer surface
  Increased durability by using plastic bushing (extends the lifetime of grease)
-

6) Drive Plate

Drive plate receives the power from the start motor when starting the engine. With this, the drive plate initially drives the power train system. And, it is connected to the torque converter to transfer the engine torque to the power train system.

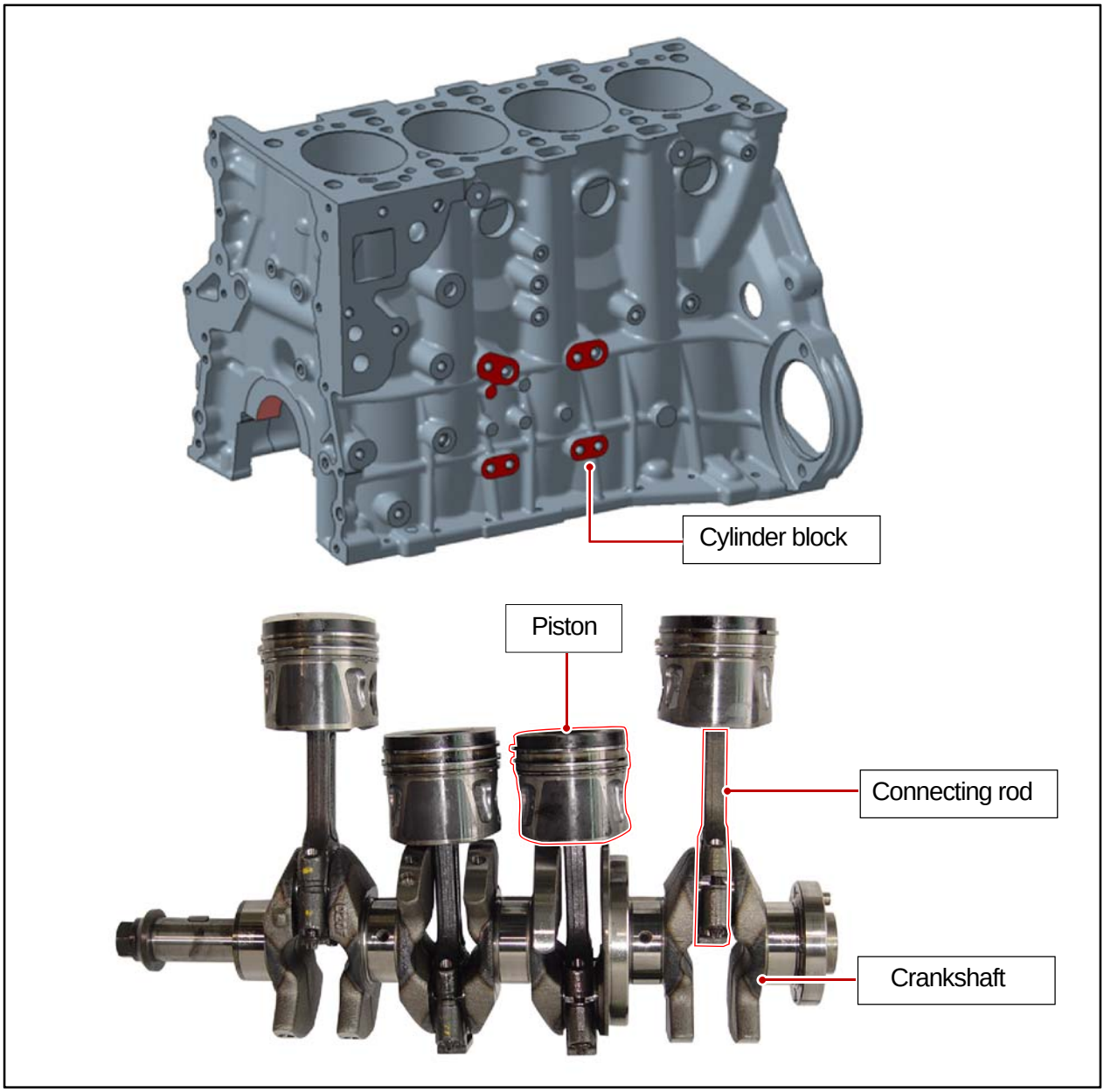
▶ **Components**



10. PISTON/CRANKSHAFT/CYLINDER BLOCK

The crankshaft and the cylinder block convert the compression pressure to the rotating energy.

▶ **Components**



Modification basis	
Application basis	
Affected VIN	

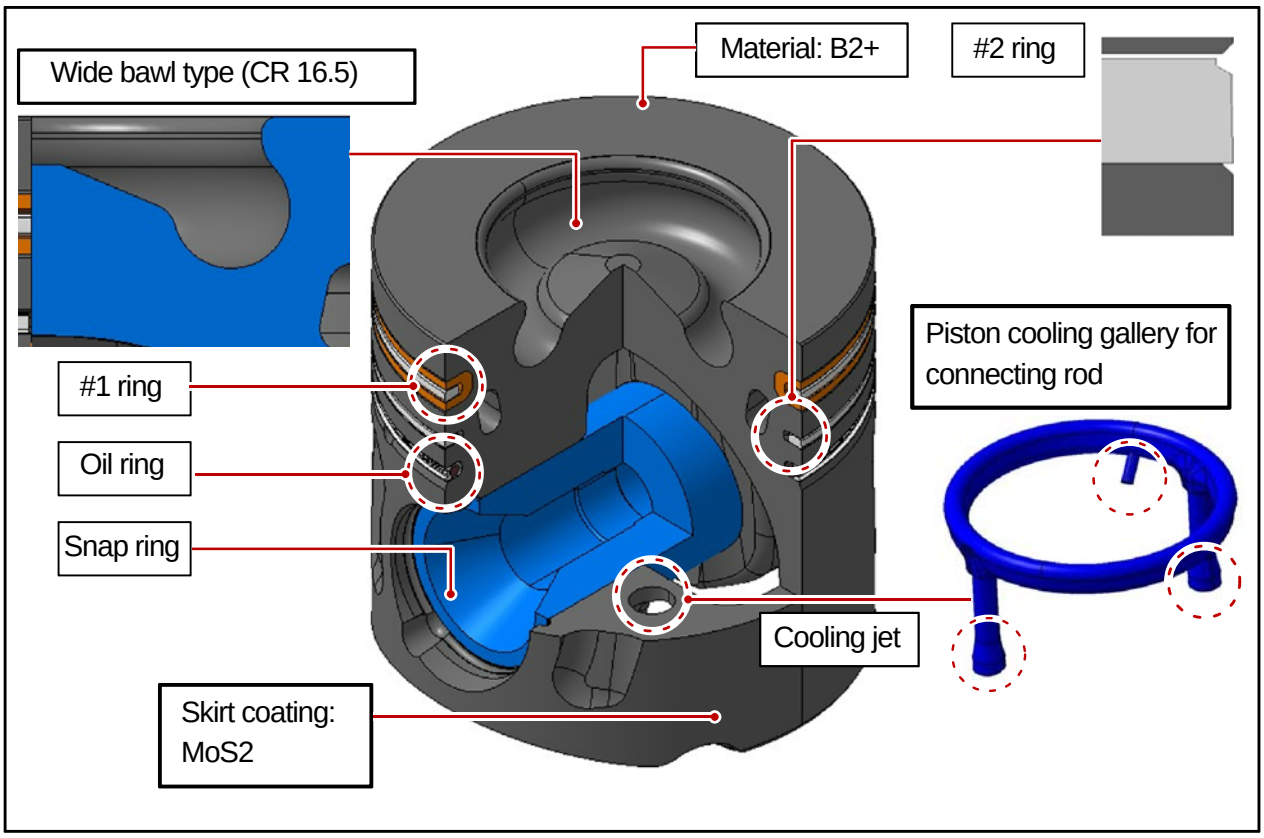
1) Piston

(1) Overview



Piston assembly contains piston, #1 ring, #2 ring, oil ring, piston pin and snap ring. The expansion energy from engine is transferred to the crankshaft through connecting rod to convert the linear movement to rotating energy.

(2) Layout



(3) Functions

Piston transfers the combustion energy from engine to connecting rod. Especially in the direct injection engine such as D20DTF, it provides the combustion space and largely effects to the engine performance and exhaust gas.

▶ **Piston ring**

- #1 ring (Top ring) : Prevents the high pressurized combustion gas from leaking into crank chamber, and prevents the engine oil getting into combustion chamber.
- #2 ring: Scrapes the engine oil on the cylinder bore, and prevents the leaked combustion gas from #1 ring from leaking into the crank chamber.
- Oil ring: Scrapes the engine oil on the cylinder bore.

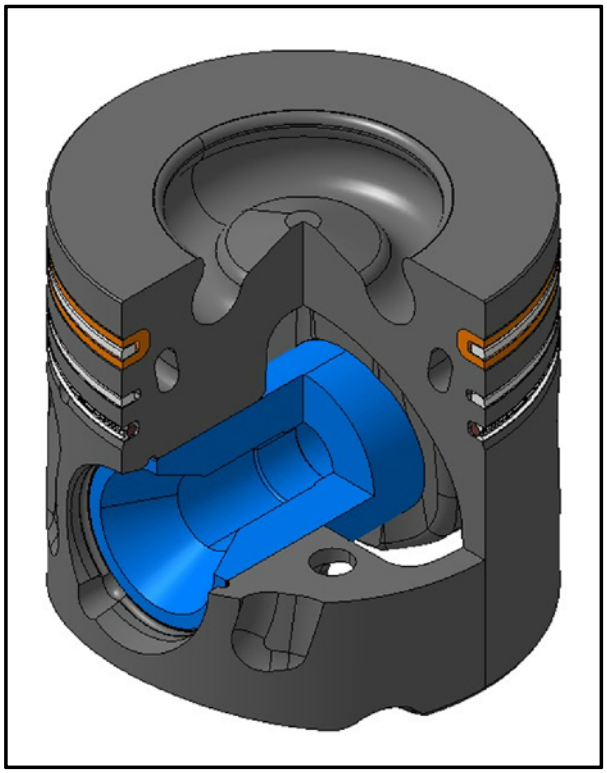
▶ **Piston pin**

- Connects the piston the connecting rod, and transfers the linear movement of piston to connecting rod to convert it to rotating energy

▶ **Snap pin**

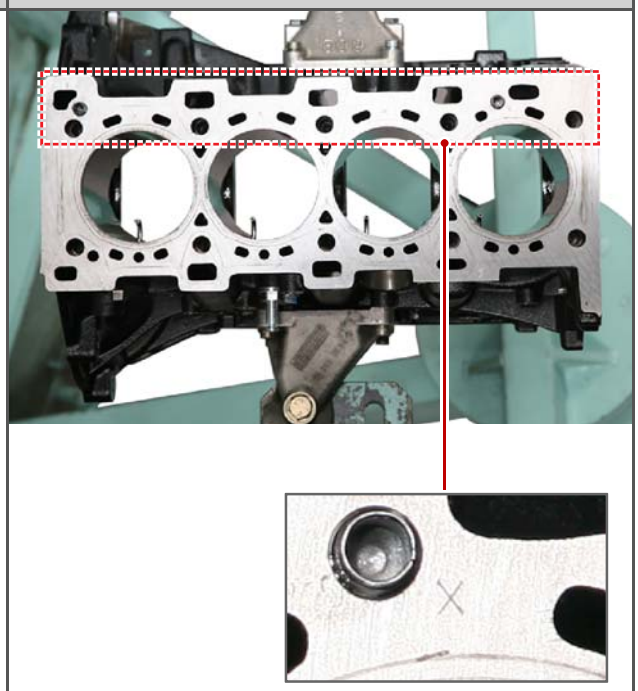
- Locks the piston pin.

(4) Assembling the piston



1. Install the piston rings with the "Y" mark on the ring facing upwards.
2. Position the end gap of #1 ring at 180˚ away from the end gap of #1 ring.
3. Position the end gap of oil ring at 180˚ away from the end gap of coil spring, and position the end gap of oil ring at 90˚ away from the end gap of #2 ring.

Modification basis	
Application basis	
Affected VIN	

Selecting piston oversize	
Top of piston	Top of cylinder block
	

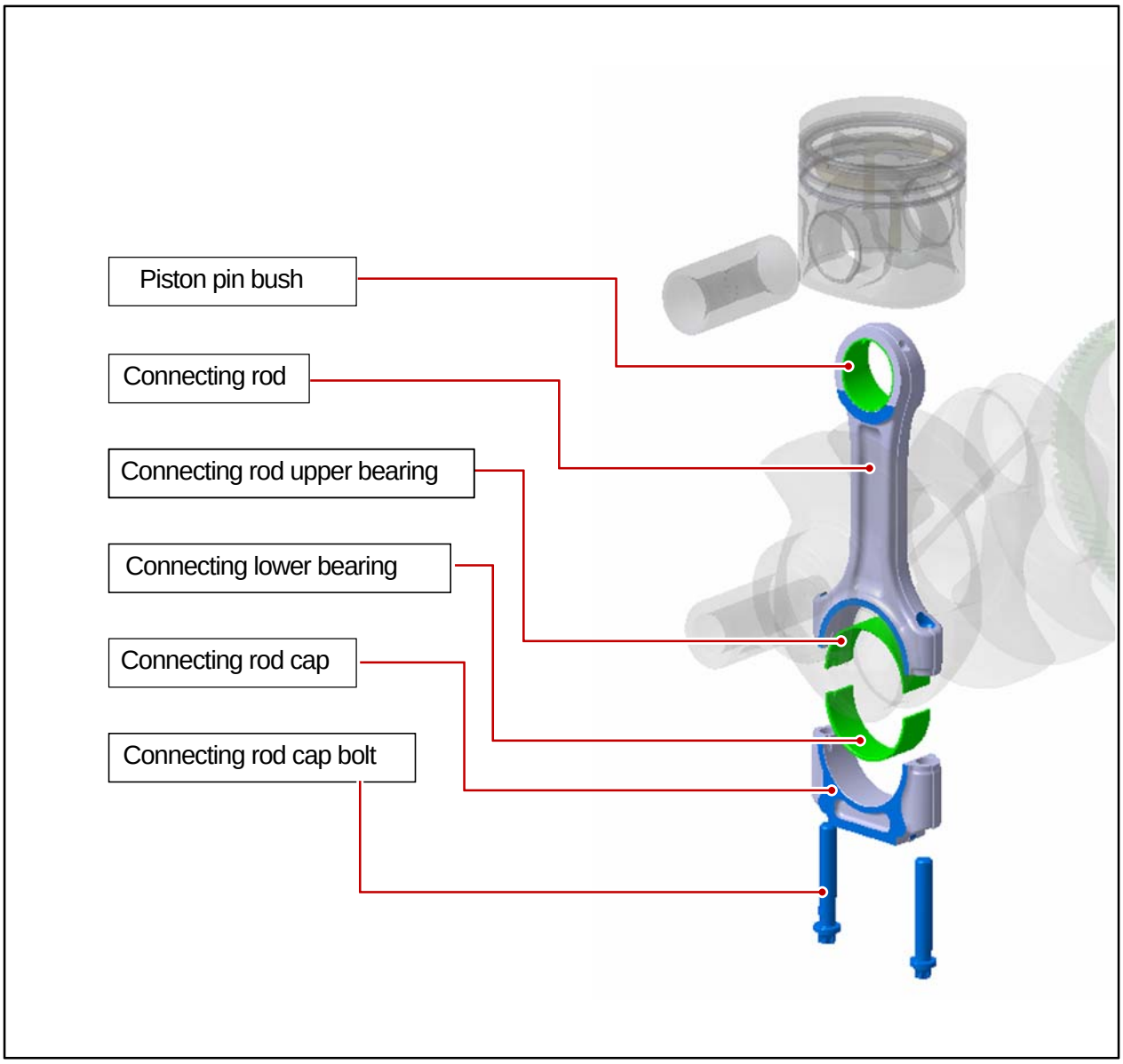
Engine	Piston		Cylinder bore
	Part NO	Marking NO.	-
D20DTF	671 030 06 17	-	-
	671 037 07 01	A	A
	671 037 08 01	X	X
	671 037 09 01	B	B
	671 037 10 01	+5	-
	671 037 11 01	+10	-

2) Connecting Rod

(1) Overview

Connecting rod converts the reciprocating movement of piston to the rotating movement of crankshaft. The big end is connected to connecting rod bearing and the crank pin journal, and the small end is connected to the piston pin.

(2) Components



Modification basis	
Application basis	
Affected VIN	

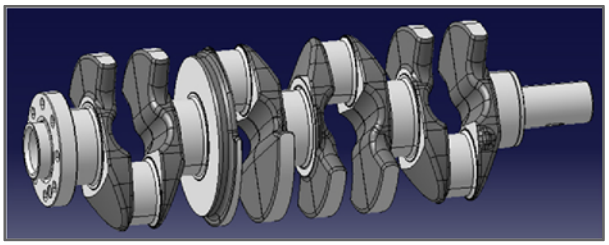
(3) Selection of crankshaft pin journal bearing

- The connecting rod bearing contains 3 sets of 3 grades in upper and lower sections.
- Three sets in the table below have nearly same oil clearance (0.015~0.063 mm) of bearing.
- Identification: Coloe mark on bearing side surface

No	Connecting rod/ Bore diameter in big end	Upper bearing		Lower bearing		Journal diameter of crank pin	Oil clearance of bearing
		Grade	Bearing thickness	Grade	Bearing thickness		
1	54.600	R	1.804	B	1.812	50.935	0.017
			1.808		1.815		0.063
2		Y	1.808	Y	1.809		0.016
	54.614		1.812		1.812	50.960	0.062
3		B	1.812	R	1.806		0.015
			1.816		1.809		0.061
Oil clearance of connecting rod bearing						Min.	0.015
						Max.	0.063

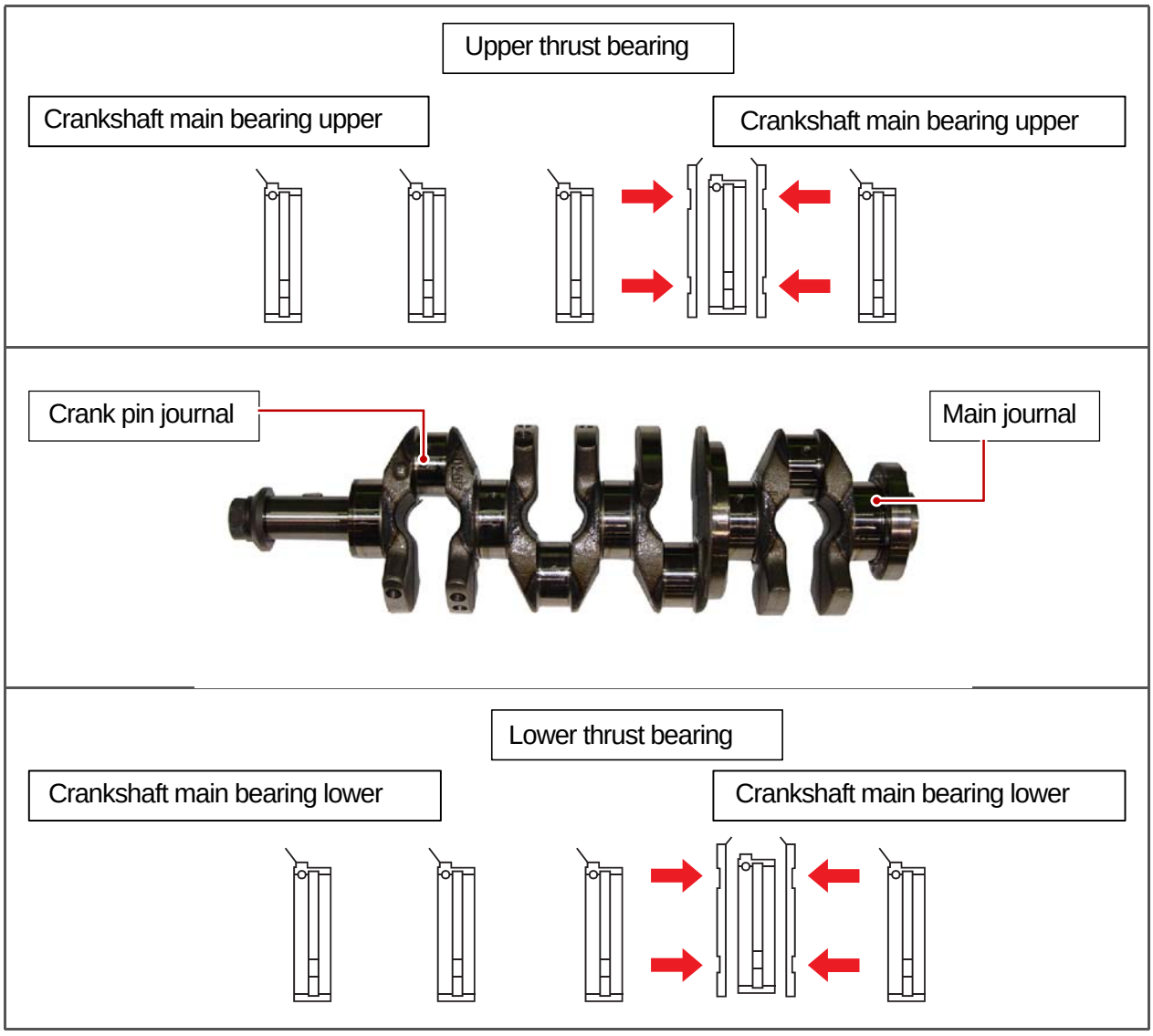
3) Crankshaft

(1) Overview



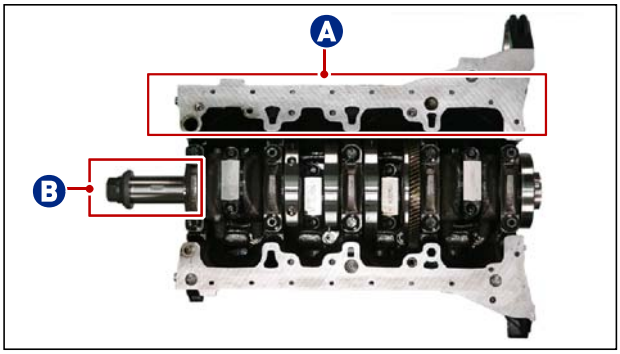
Crankshaft is installed on the cylinder block.

(2) Arrangement

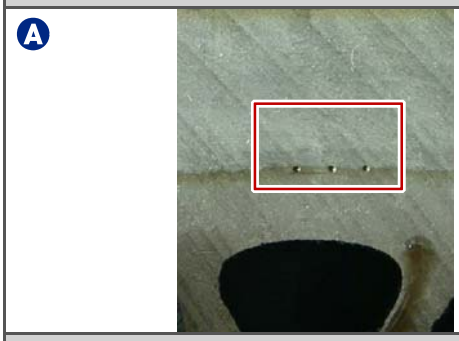


Modification basis	
Application basis	
Affected VIN	

(3) Selection of crankshaft main bearing



Bottom of cylinder block

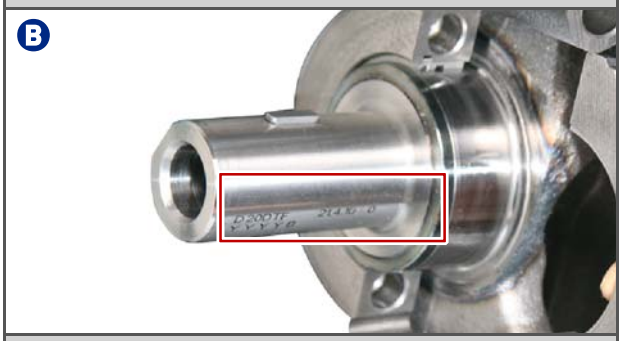


Selection of upper main bearing



Selection of bearing according to pin punch & color		
Mark	Color	Thickness of main bearing
*	Blue	66.500~66.506
**	Yellow	66.506~66.513
***	Red	66.513~66.519

Mating surface of crankshaft sprocket



Selection of lower main bearing

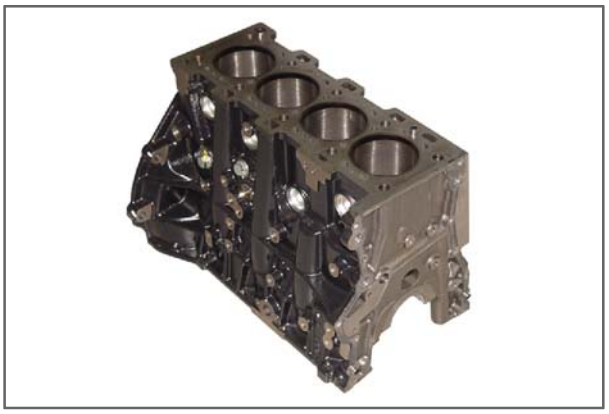


Engine name	D	2	0	D	T	F
Main journal bearing	Y	Y	Y	Y	B	
	1	2	3	4	5	

Mark	Color	Thickness of main bearing (mm)
V	Violet	2.25 +0.030 +0.025
W	White	2.25 +0.025 +0.020
R	Red	2.25 +0.020 +0.015
Y	Yellow	2.25 +0.015 +0.010
B	Blue	2.25 +0.010 +0.005

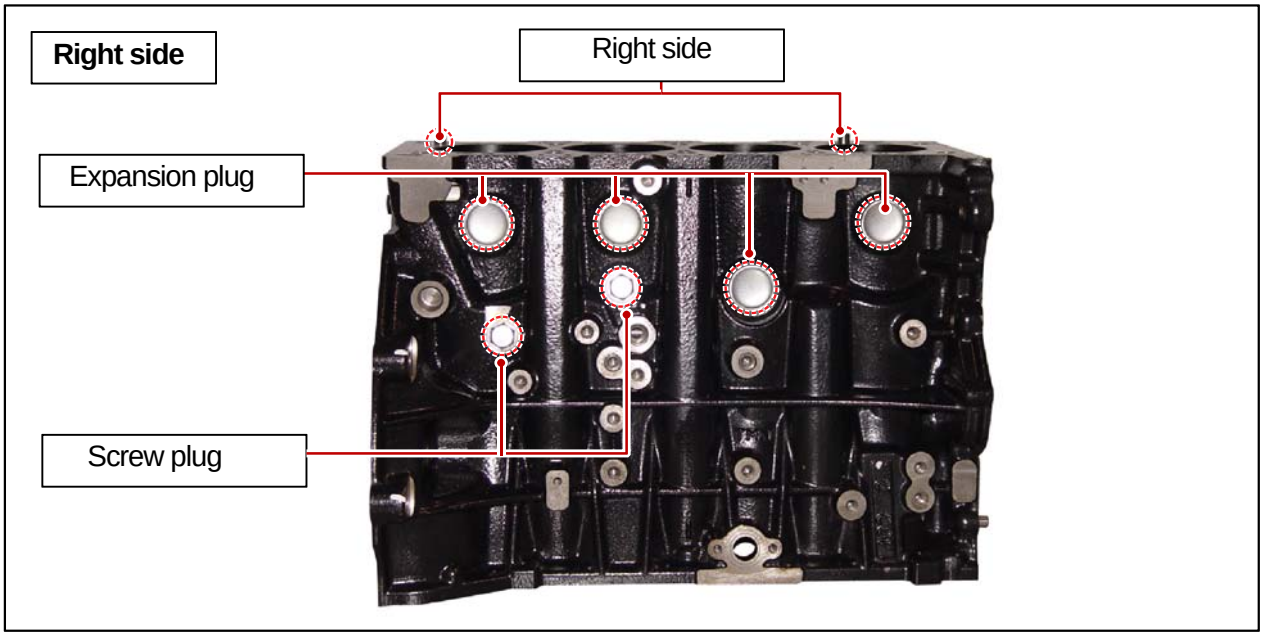
4) Cylinder Block

(1) Overview

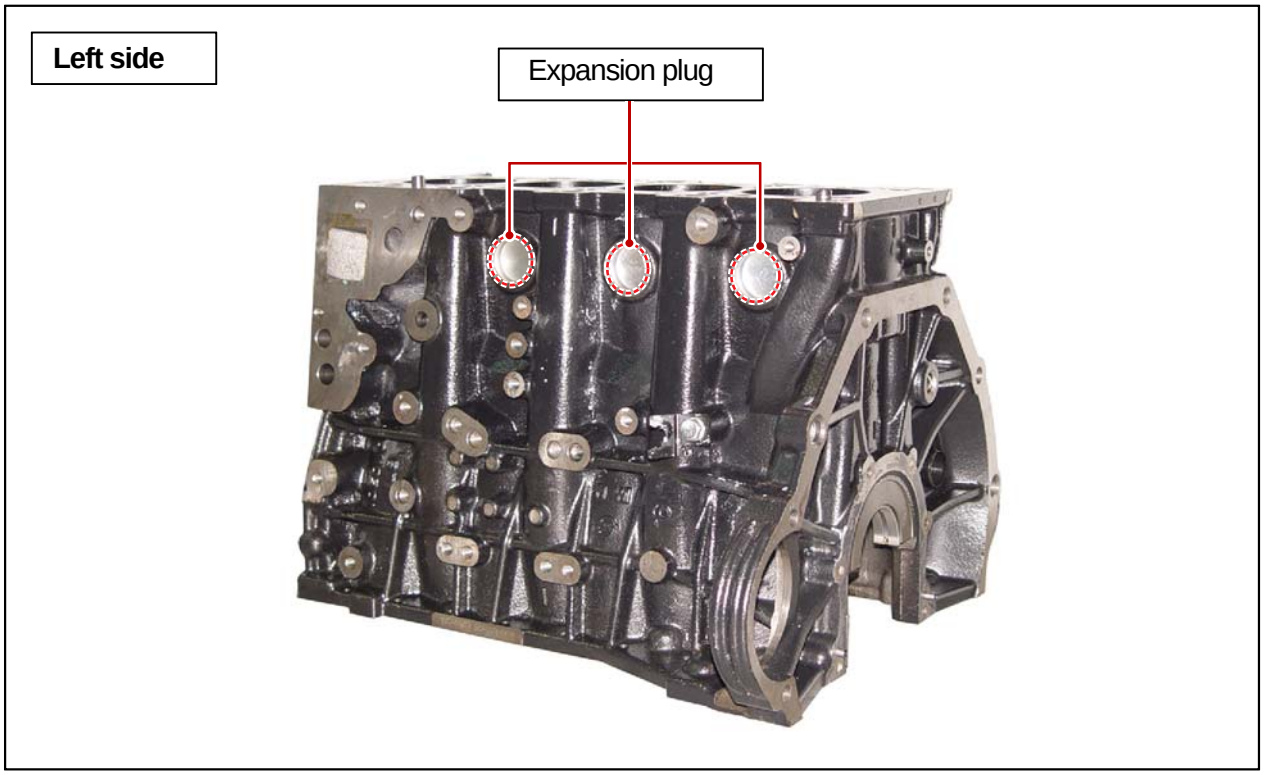


The major dimensions in D20DTR are similar to D20DTR engine. It has two mounting bosses for knock sensor and meets the requirements for EURO5 regulation.

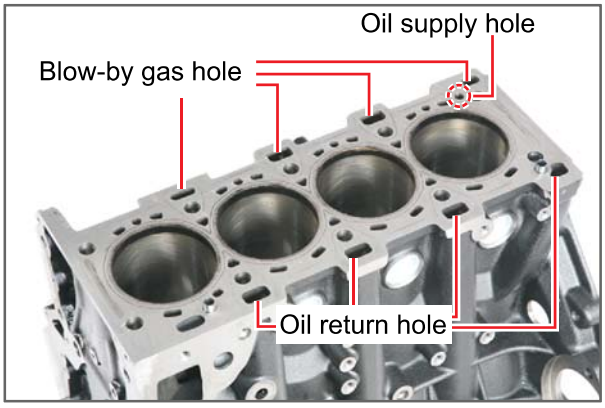
(2) Layout



Modification basis	
Application basis	
Affected VIN	



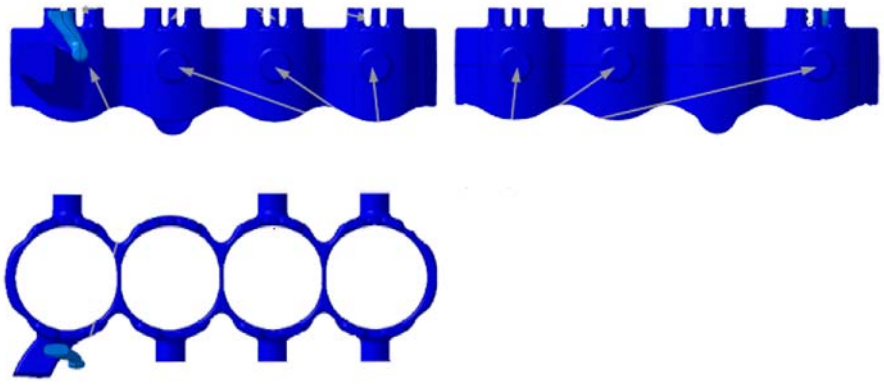
(3) Features



For simple manufacturing, the crankcase blow-by gas passage and the oil return hole are made by casting on the cylinder block.

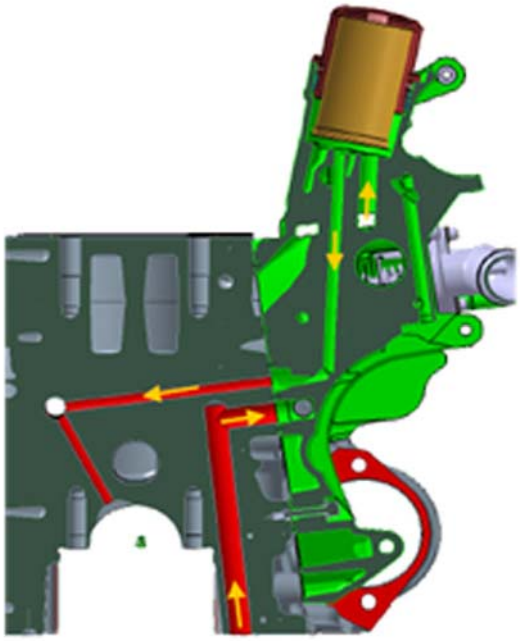
The bottom side of water jacket is desgined as sine wave to strengthen the structure of crankcase. The main flow of coolant starts from outlet port of water pump and goes along the longitudinal direction of engine. The coolant passage from cylinder head to inlet port of water pump is integrated in cylinder head.

Water jacket core



The engine oil from oil pump is supplied to the main oil gallery through oil channel, oil filter module and cross bore in cylinder block without using external pipes. This oil is supplied to main bearing, cylinder head and MBU. And, it is sprayed to the chain through the chain tensioner connected to cross bore.

Crankcase cross bore for oil supply



Modification basis	
Application basis	
Affected VIN	

FUEL SYSTEM 2210-01

GENERAL INFORMATION

1. SPECIFICATION

Description			Specification
Fuel			Diesel
Fuel filter	Type		Fuel heater + priming pump + water separator integrated type
	Filter type		Changeable filter element type
	Change interval	EU	every 40,000 km
		GEN	every 45,000 km
	Water separation interval	EU	every 20,000 km
		GEN	every 15,000 km
	Water accumulating capacity		200 cc
	Heater capacity		250W 13.5V
Injector	System pressure		1800 bar
High pressure fuel pump	Type		Eccentric cam/Plunger type
	Operating type		Gear driven type
	Normal operating temperature		−40 ~ 125°C
	Operating pressure		1800 bar
	Operating temperature		−30 ~ 120°C
Low pressure fuel pump	Type		Vane type
	Gear ratio (pump/engine)		0.5 : 1
	Pressure		6 bar
Fuel tank	Capacity		75 L
	Material		Steel
	Fuel sender		Single sender type

2. MAINTENANCE AND INSPECTION

1) Maintenance Procedures for DI Engine Fuel System

1. Always keep the workshop and lift clean (especially, from dust).
2. Always keep the tools clean (from oil or foreign materials).
3. Wear a clean vinyl apron to prevent the fuzz, dust and foreign materials from getting into fuel system. Wash your hands and do not wear working gloves.

NOTE

Follow the below procedures before starting service works for fuel system.

Carefully listen the symptoms and problems from customer.

↓

Visually check the leaks and vehicle appearance on the wiring harnesses and connectors in engine compartment.

↓

Perform the diagnosis proceee with SCAN tool

↓

Locate the fault. If the cause is from fuel system (from priming pump to injector, including return line), follow the step 1 through step 4 above.

↓

4. If the problem is from HP pump, fuel supply line or injector, prepare the clean special tools and sealing caps to perform the diagnosis for DI engine fuel system in this manual. At this point, thoroughly clean the related area in engine compartment.

CAUTION

Clean the engine compartment before starting service works.

Tool kit for high pressure line	Took kit for low pressure line
	

Modification basis	
Application basis	
Affected VIN	

5. Follow the job procedures. If you find a defective component, replace it with new one.

Disconnect the negative battery cable.

Use special tools and torque wrench to perform the correct works.

Once disconnected, the fuel pipes between HP pump and fuel rail and between fuel rail and each injector should be replaced with new ones. The pipes should be tightened tospecified tightening torques during installation. Over or under torques out of specified range may cause damages and leaks at connections. Once installed, the pipes have been deformed according to the force during installation, therefore they are not reusable. The copper washer on injector should be replaced with new one. The injector holder bolt should be tightened to specified tightening torque as well. If not, the injection point may be deviated from correct position, and it may cause engine disorder.

Plug the disconnected parts with sealing caps, and remove the caps immediately before replacing the components.

6. Plug the removed components with clean and undamaged sealing caps and store it into the box to keep the conditions when it was installed.

Fuel filter assembly



7. To supply the fuel to transfer line of HP pump press the priming pump until it becomes hard.

Priming pump cap



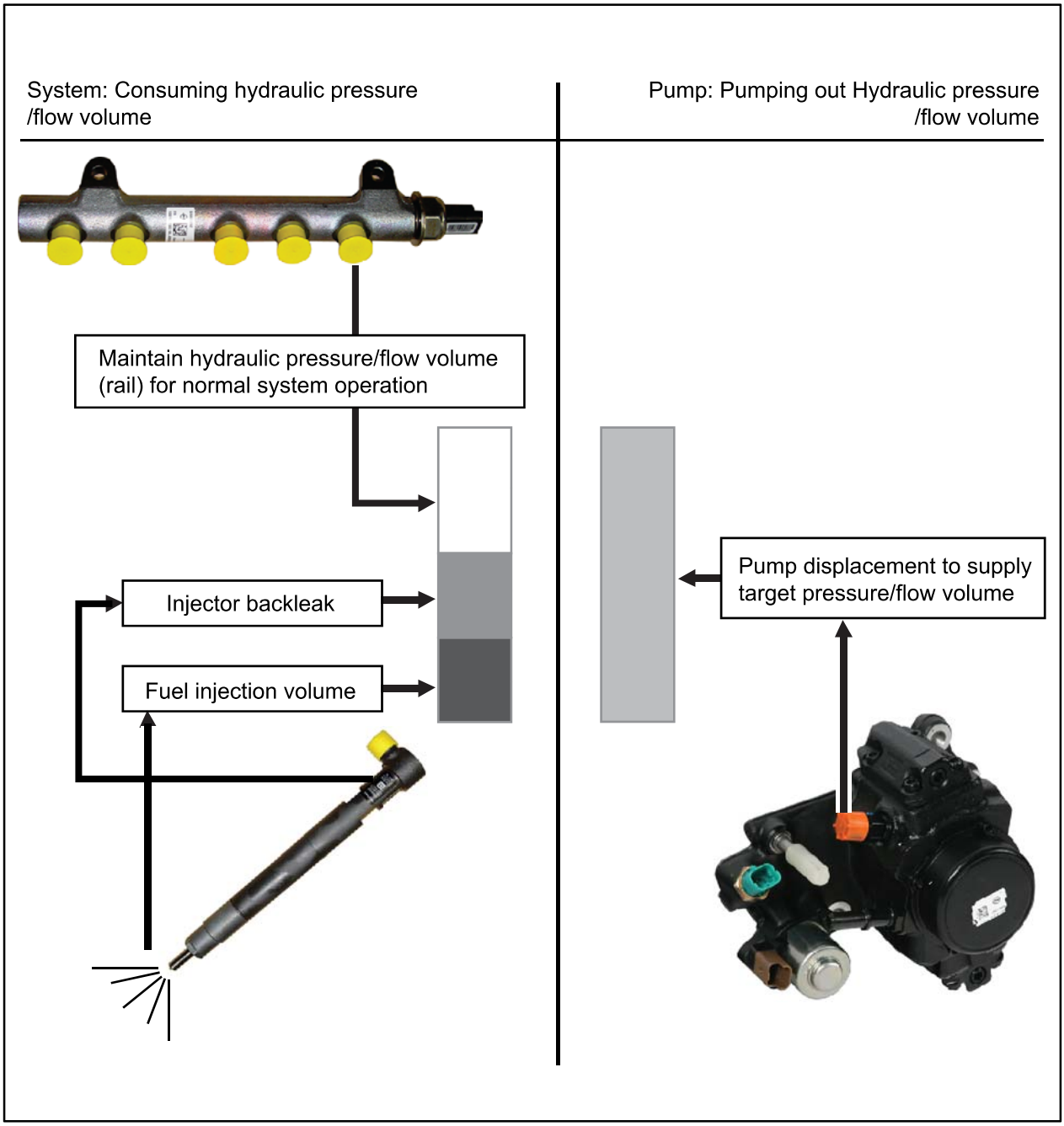
8. Check the installed components again and connect the negative battery cable. Start the engine and check the operating status.
9. With Scan Tool, check if there are current faults and erase the history faults.

2) Diagnostic Test for Engine Fuel System

(1) Overview

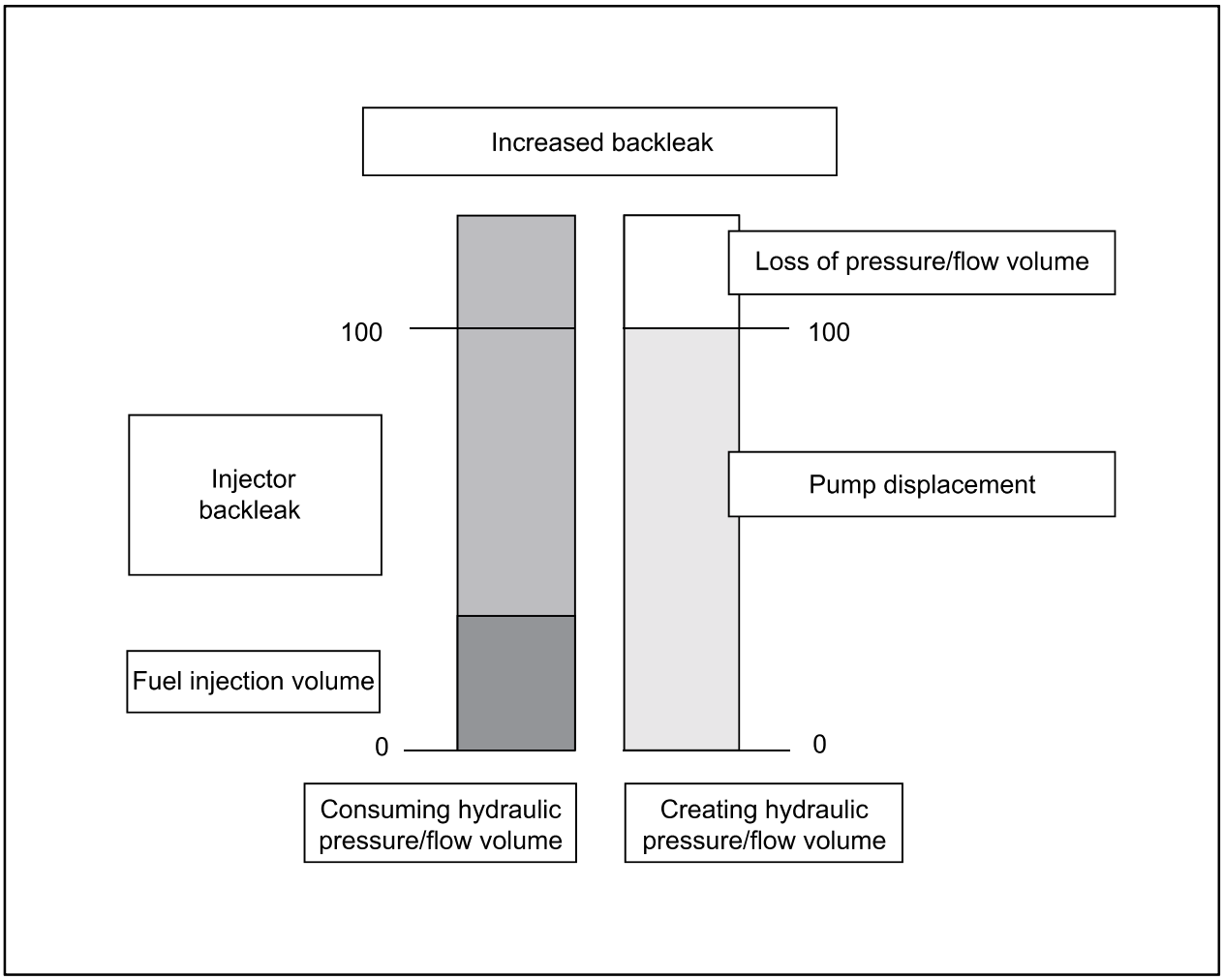
If a DTC is displayed on the diagnostic device, check the low pressure- and high pressure fuel systems before removing the components.
To run the system properly, the electric system must be intact but for the DI engine, the fuel pressure should be measured also when there is a malfunction even after the diagnostic test with a diagnostic device.

(2) Hydraulic system



Modification basis	
Application basis	
Affected VIN	

(3) Excessive backleak of injector



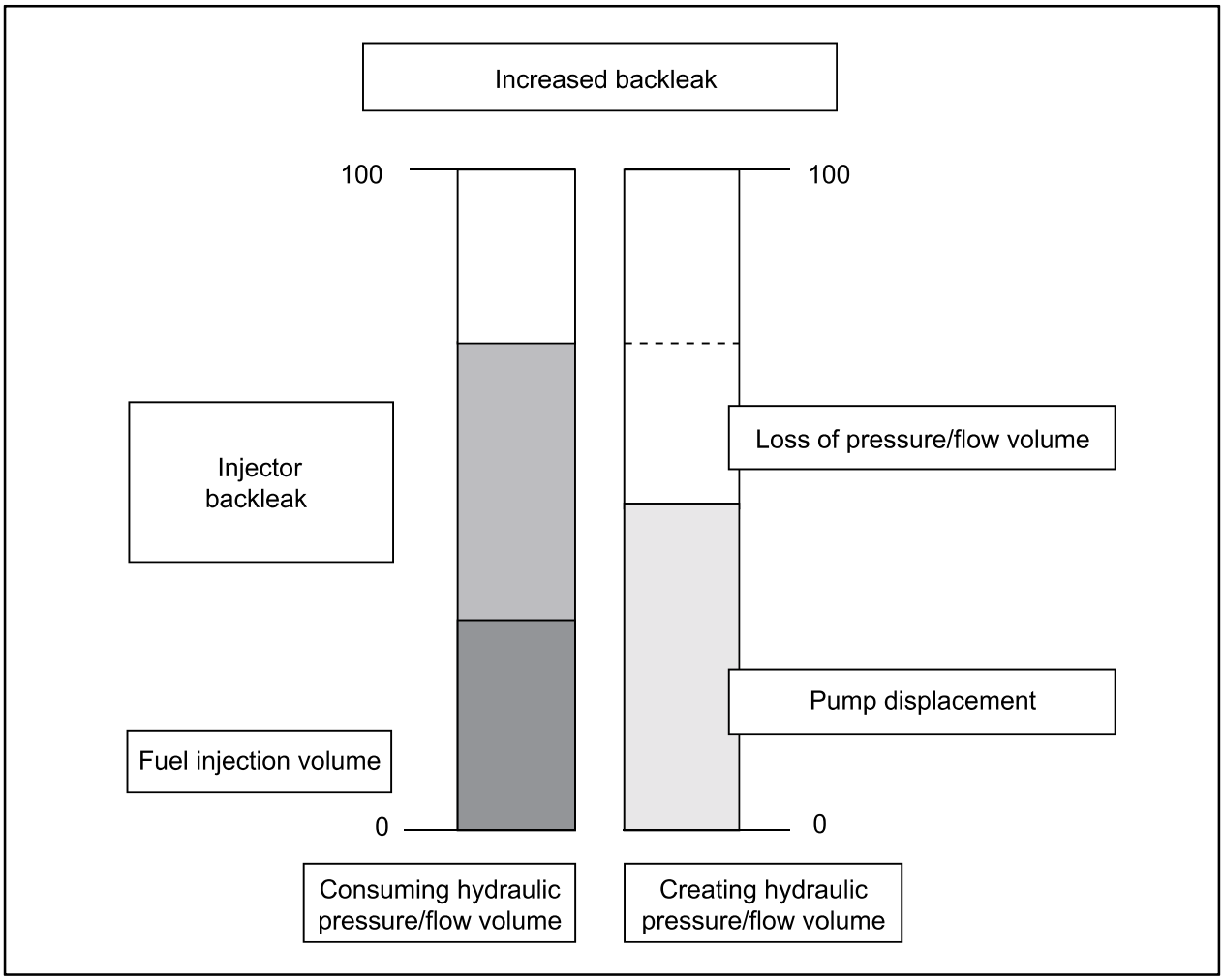
▶ **Excessive injector backleak**

Occurs when the injector control valve is not sealed due to the entry of the foreign materials.

▶ **Example:**

- Entry of foreign materials
- Burned out and worn HP pump
- Mechanical damage inside the injector

(4) Loss of pump pressure/flow



▶ **Loss of HP pump pressure/flow**

Faulty fuel supply line, or damaged or worn pump causes the lack of flow pressure and flow volume

▶ **Example:**

- Air in fuel supply line
- Excessive load on fuel supply line (←400 mBar)
- Burned out and mechanical worn pump
- High temperature of fuel supply (> 85℃)

Modification basis	
Application basis	
Affected VIN	

3) DI Engine Fuel System Pressure Test

(1) Test device (Tool kit)

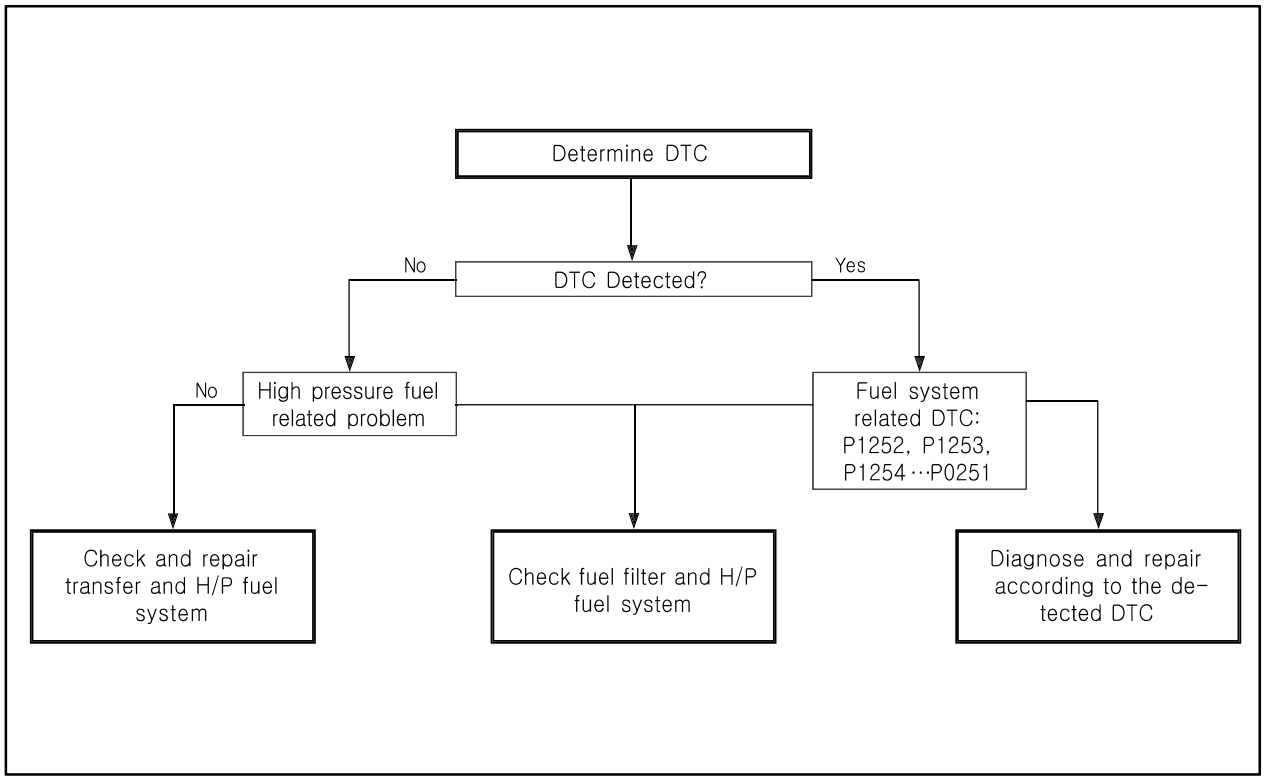
Device for high pressure

Device for low pressure


(2) Pre-check

- Check-tighten fuel supply line
- Check fuel level in fuel tank
- Check air in fuel supply line (bubble in fuel supply line or fuel)
- Check fuel supply line for leaks (low pressure and high pressure)
- Check that specified fuel is used
- Check fuel filter for contamination

(3) DI Engine Fuel System Check Procedure

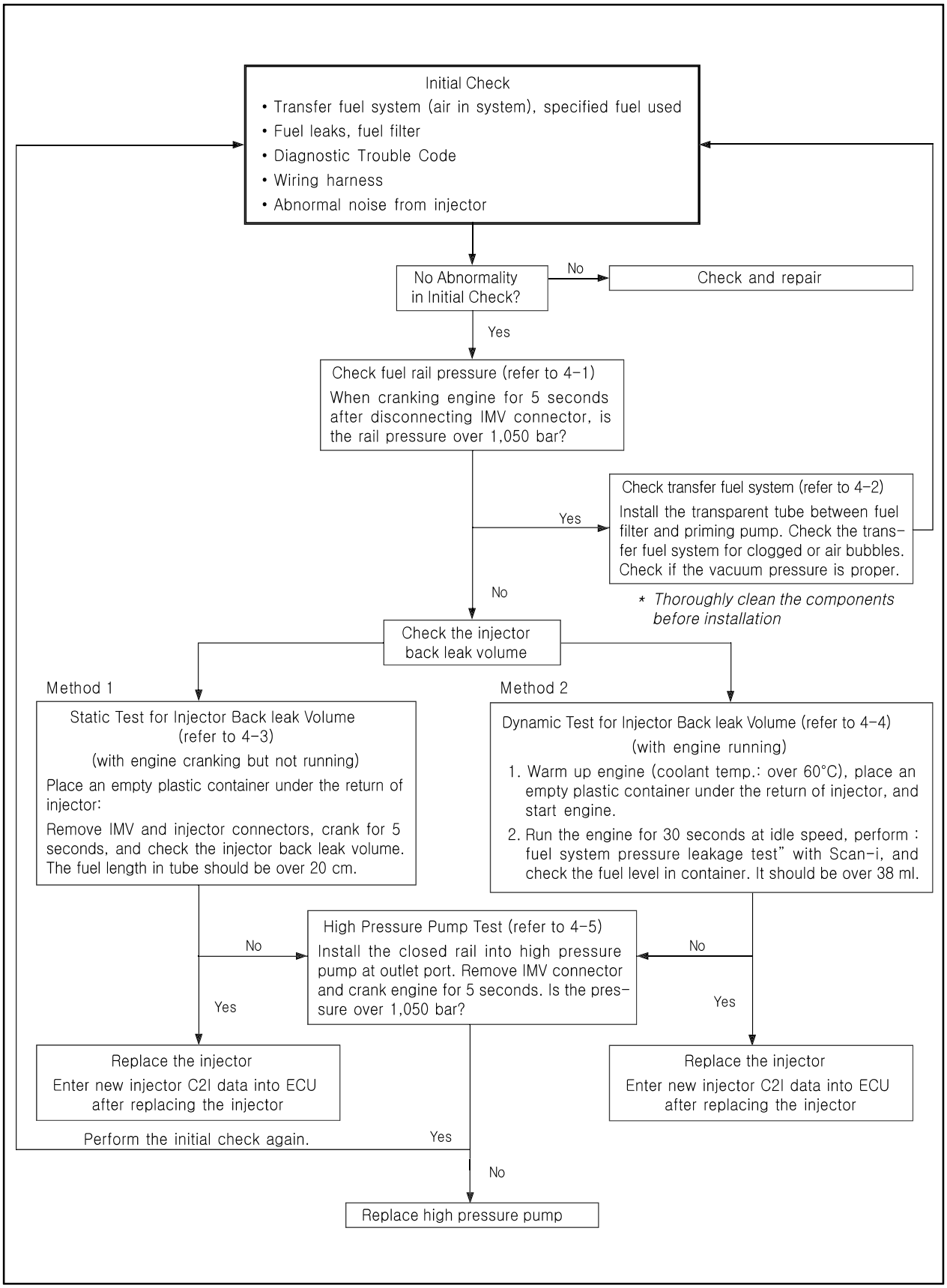


CAUTION

If several DTCs are output simultaneously, check the electric wiring for open or short circuit.
Check the low pressure fuel system and fuel filter and confirm that there are no abnormalities. Carry out the high pressure fuel system check.

Modification basis	
Application basis	
Affected VIN	

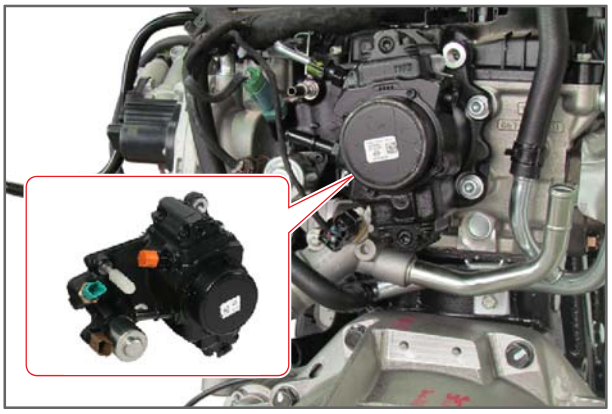
(4) Fuel System Check Procedure



Modification basis	
Application basis	
Affected VIN	

(5) High Pressure System Pressure Test

▶ **Fuel rail pressure test**



1. Disconnect the fuel rail pressure sensor connector and then IMV connector.



2. Connect the pressure tester to the fuel rail pressure sensor connector.



3. Crank the engine 2 times for 5 seconds.
   - Read the highest pressure value displayed on the tester display.
   - If the highest pressure value is 1,050 bar or less, refer to the section "Fuel System Check Process".

Modification basis	
Application basis	
Affected VIN	

▶ How To Use Pressure Tester



1. Press the "TEST" button on the tester to check if the message "TEST?" is displayed. If the button is pressed again at 4 seconds
2. after starting engine cranking, the highest pressure is displayed on the tester.

NOTE

The fuel rail pressure value can be checked using a diagnostic device.

Modification basis	
Application basis	
Affected VIN	

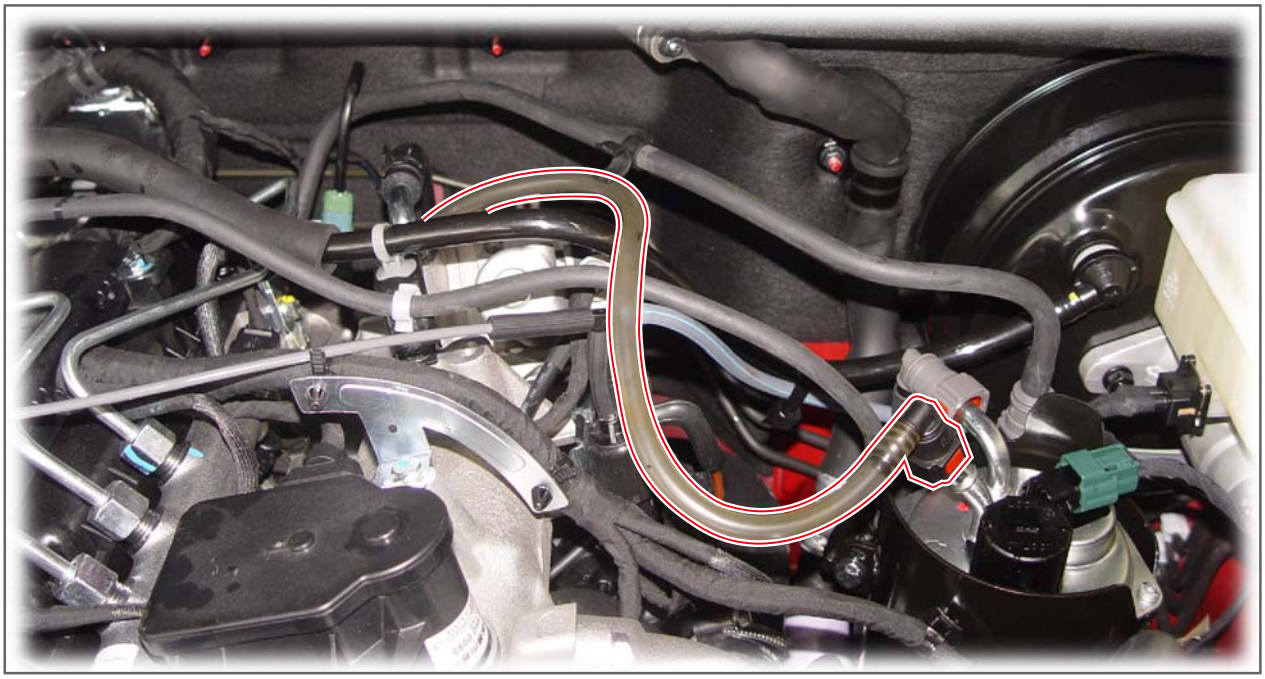
(6) Low Pressure System Pressure Test

▶ **Inspection procedure**



1. All wirings/connectors and fuel lines should be connected and the engine should work properly.
2. Prepare a special tool for low pressure test and clean it thoroughly to prevent foreign materials from entering.

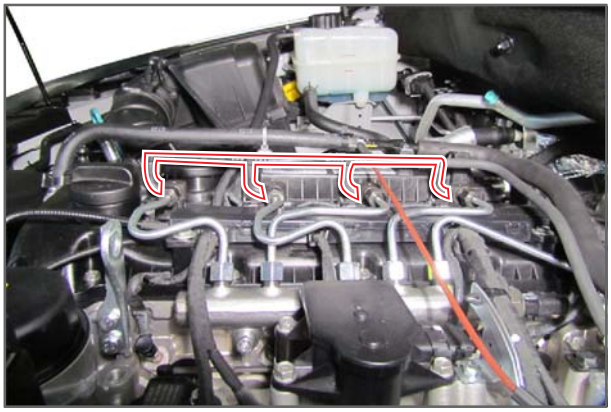
3. Disconnect the key connector for fuel filter connection, and connect both connectors to the fuel filter and hose.



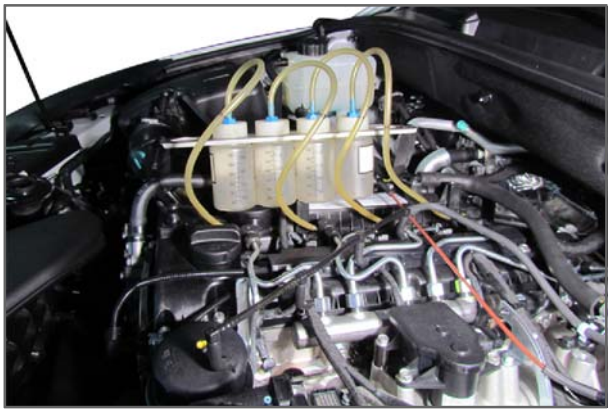
4. Start the engine and check visually for clogged low pressure fuel system, excessive air or air entry. If the fuel flow is not sufficient or air is in the fuel, repair the leak area.
5.

Modification basis	
Application basis	
Affected VIN	

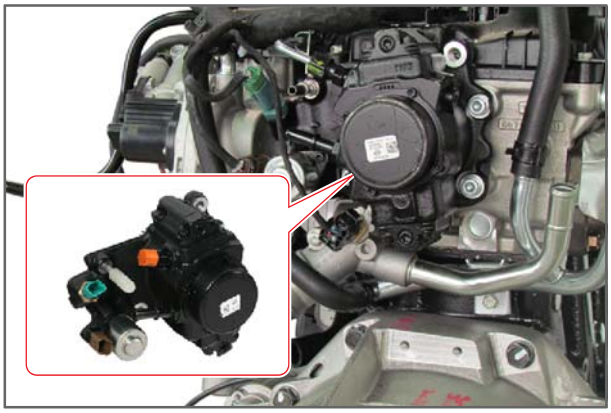
▶ Static test for backleak of injector



1. Disconnect the injector return hose and cover the openings with caps shaped screw (included in the special tool).



2. Connect the hose of the container for measuring backleak to the return nipple of the injector.
   (prevent air entry to the low pressure line)



3. Disconnect the IMV connector of the high pressure pump and then fuel pressure sensor connector.

CAUTION

The connector of the injector can be easily contaminated. Always keep it clean.



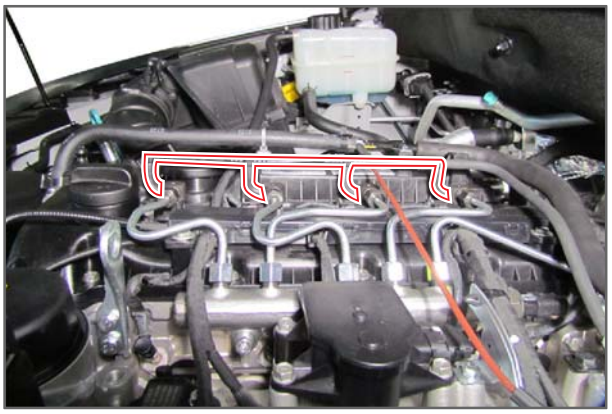
4. Crank the engine 2 times for 5 seconds.
5. Check the time for flow if injector backleak and confirm that it is within the specified range.

Specification	Below 20 sec.

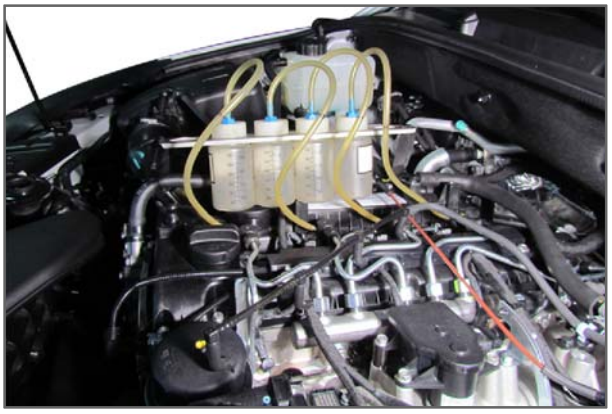
NOTE

If the value is out of the specified range, replace the injector.

▶ Dynamic test for backleak of injector



1. Warm up the engine so that the engine coolant temperature be over 80℃ and star the engine again.
2. Disconnect the injector return hose and cover the openings with caps shaped screw (included in the special tool)..



3. Connect the hose of the container for measuring backleak to the return nipple of the injector.
4. Start the engine again and let the engine idle for 30 seconds.
5. Perform backleak test of fuel system with a diagnostic device after 30 seconds.

This test consists of 4 cycles, and the engine rpm reaches 3,500 rpm for 18 seconds in each cycle.



6. Check the amount of backleak collected into the container and confirm that it is within the specified range.

Specification	38 ml or less

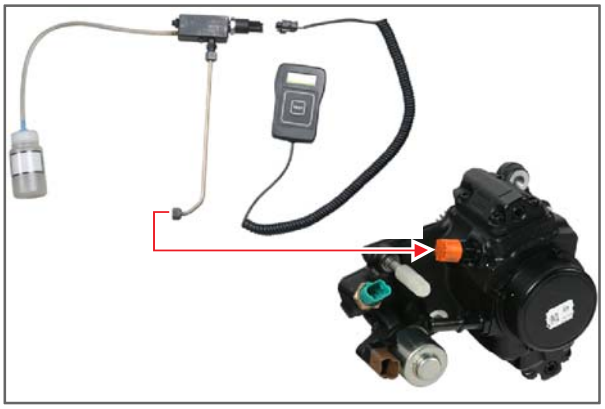


Modification basis	
Application basis	
Affected VIN	

▶ HP pump pressure test



1. Prepare a special tool for high pressure test and clean it thoroughly to prevent foreign materials from entering.



2. Disconnect the high pressure fuel supply pipe on the HP pump and install the close rail in the tool kit.

Tightening torque 30Nm

3. Connect the other end of the close rail to the fuel rail for test.

Tightening torque 30Nm

4. Disconnect the return hose for HP pump and connect the clear hose and connect its the other end to the return port of the fuel rail for test.



5. Connect the digital tester connector to the sensor connector of the fuel rail for test.
6. Crank the engine 2 times for 5 seconds after removing the IMV connector and fuel rail pressure sensor connector.
7. Read the pressure value displayed on the tester display is within the specified

Specification	1,050 bar or more

3. CAUTIONS FOR DI ENGINE

1) Cautions for DI Engine

This chapter describes the cautions for DI engine equipped vehicle. This includes the water separation from engine, warning lights, symptoms when engine malfunctioning, causes and actions.

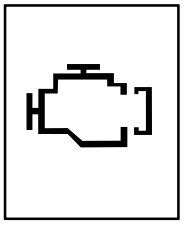
1. DI Engine

Comparatively conventional diesel engines, DI engine controls the fuel injection and timing electrically, delivers high power and reduces less emission..

2. System Safety Mode

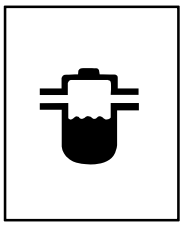
When a severe failure has been occurred in a vehicle, the system safety mode is activated to protect the system. It reduces the driving force, restricts the engine speed (rpm) and stops engine operation. Refer to "Diagnosis" section in this manual.

3. Engine CHECK Warning Lamp



The Engine CHECK warning lamp on the instrument cluster comes on when the fuel or major electronic systems of the engine are not working properly. As a result, the engine's power output may decrease or the engine may stall.

4. Water Separator Warning Lamp



When the water level inside water separator in fuel filter exceeds a certain level (approx. 45 cc), this warning light comes on and buzzer sounds.
Also, the driving force of the vehicle decreases (torque reduction). If these conditions occur, immediately drain the water from fuel filter.

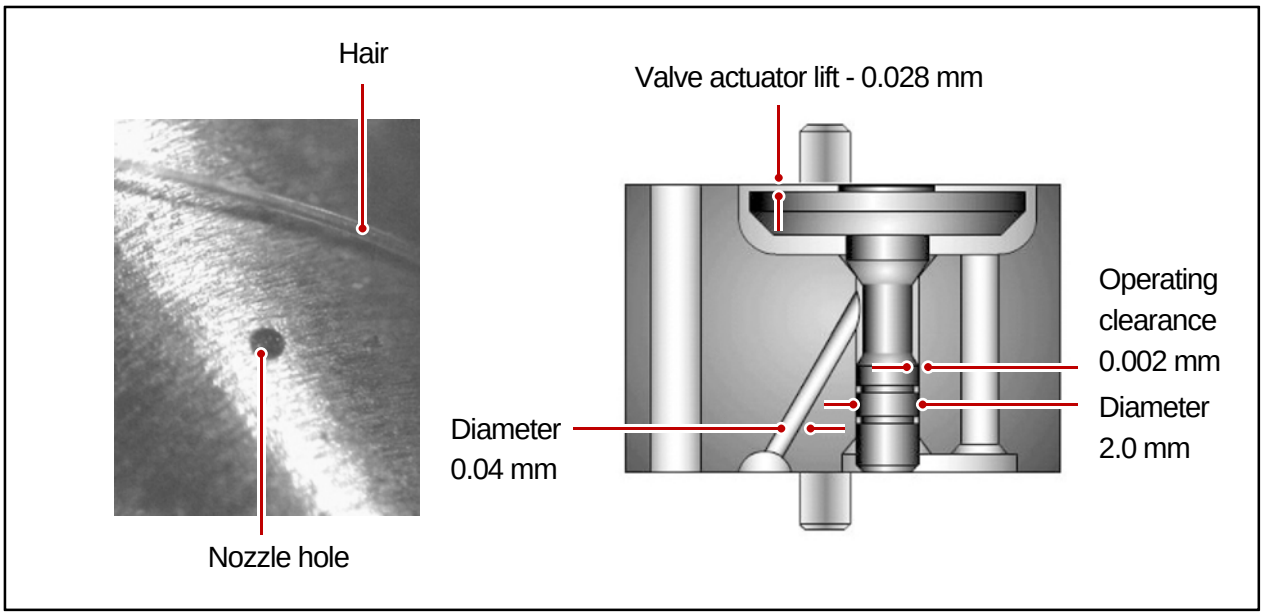
Modification basis	
Application basis	
Affected VIN	

2) Cleanness

(1) Cleanness of DI engine fuel system

▶ Cleanness of DI engine fuel system and service procedures

The fuel system for DI engine consists of transfer (low pressure) line and high pressure line.
Its highest pressure reaches over 1,800 bar.
Some components in injector and HP pump are machined at the micrometer 100 μm of preciseness.
The pressure regulation and injector operation are done by electric source from engine ECU.
Accordingly, if the internal valve is stuck due to foreign materials, injector remains open.
Even in this case, the HP pump still operates to supply high pressurized fuel. This increases the pressure to combustion chamber (over 250 bar) and may cause fatal damage to engine.
You can compare the thickness of injector nozzle hole and hair as shown in below figure (left side). The below figure shows the clearance between internal operating elements.



The core elements of fuel system has very high preciseness that is easily affected by dust or very small foreign material. Therefore, make sure to keep the preliminary works and job procedures in next pages. If not, lots of system problems and claims may arise.

(2) Di engine and its expected problems and remedies can be caused by water in fuel

▶ System supplement against paraffin separation

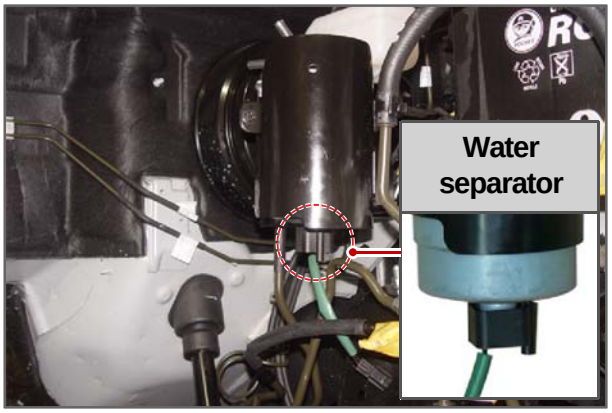
In case of Diesel fuel, paraffin, one of the elements, can be separated from fuel during winter and then can stick on the fuel filter blocking fuel flow and causing difficult starting finally. Oil companies supply summer fuel and winter fuel by differentiating mixing ratio of kerosene and other elements by region and season. However, above phenomenon can be happened if stations have poor facilities or sell improper fuel for the season. In case of DI engine, purity of fuel is very important factor to keep internal preciseness of HP pump and injector.
Accordingly, more dense mesh than conventional fuel filter is used. To prevent fuel filter internal clogging due to paraffin separation, SYMC is using fuel line that high pressure and temperature fuel injected by injector returns through fuel filter to have an effect of built-in heater (see fuel system).

▶ System supplement and remedy against water in fuel

As mentioned above, some gas stations supply fuel with excessive than specified water. In the conventional IDI engine, excessive water in the fuel only causes dropping engine power or engine hunting. However, fuel system in the DI engine consists of precise components so water in the fuel can cause malfunctions of HP pump due to poor lubrication of pump caused by poor coating film during high speed pumping and bacterization (under long period parking). To prevent problems can be caused by excessive water in fuel, water separator is installed inside of fuel filter. When fuel is passing filter, water that has relatively bigger specific gravity is accumulated on the bottom of the filter.

▶ Water drain from water separator

If water in the separator on the fuel filter exceeds a certain level, it will be supplied to HP pump with fuel, so the engine ECU turns on warning lamp on the meter cluster and buzzer if water level is higher than a certain level.
Due to engine layout, a customer cannot easily drain water from fuel filter directly, so if a customer checks in to change engine oil, be sure to perform water drain from fuel filter.



NOTE

To separate the water from the fuel filter, remove the fuel filter assembly first.

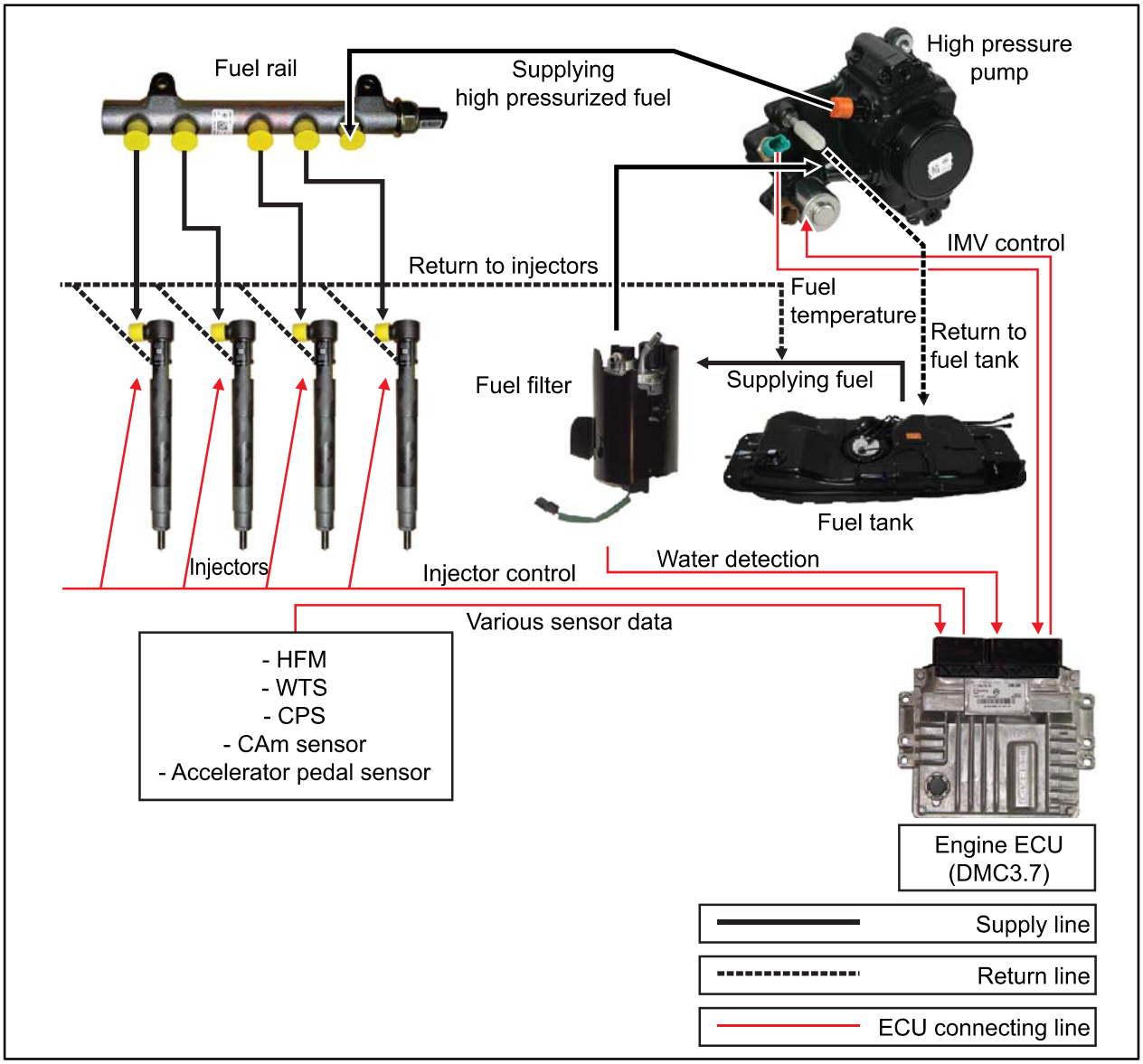
Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

The components in fuel system supply the fuel and generate the high pressure to inject the fuel to each injector. They are controlled by the engine ECU.
The common rail fuel injection system consists of fuel tank, fuel line, low pressure line which supplies low pressure fuel to the low pressure pump (including high pressure pump), common rail which distributes and accumulates the high pressurized fuel from the fuel pump, high pressure line which connected to the injector, and the engine control unit (ECU) which calculates the accelerator pedal position and controls the overall performance of vehicle based on the input signals from various sensors.

1) Fuel Flow Diagram



2. SYSTEM LAYOUT AND OPERATION

1) Layout

NOTE

For sensor and actuator control logic, refer to Chapter "Engine Control".

Engine ECU (D20DTR)

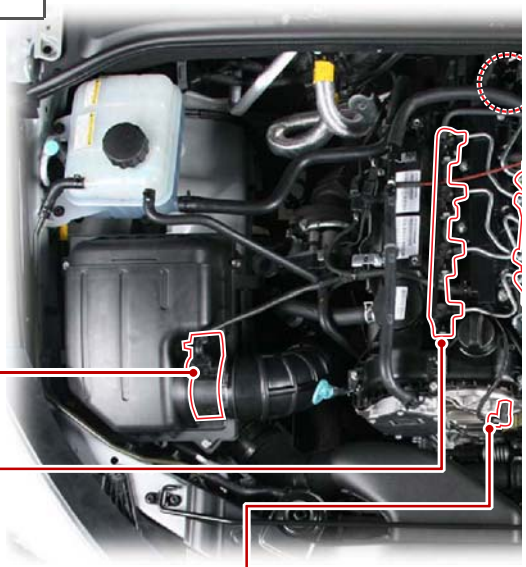


Engine control by various signals

Fuel tank



Fuel metering by sender



HFM sensor



Measuring intake air mass and temperature

Crankshaft position sensor



Measuring engine rpm

Injector (C3I)



Pre-injection, main injection, after-injection by signals from ECU

Camshaft position sensor



Determining injection order

Modification basis	
Application basis	
Affected VIN	

High pressure pump

Plunger type HP pump (1,800 bar)



Vane type LP pump (6 bar)

Generating high pressurized fuel and supplying it according to engine rpm, required volume, required pressure

Accelerator pedal position sensor

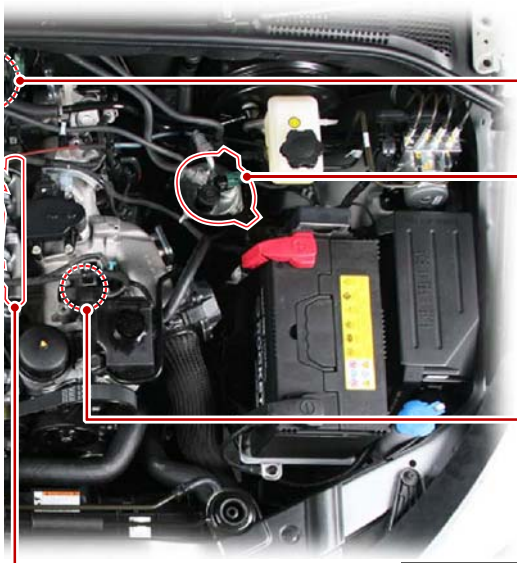


Detecting driver's intention for speed up/down

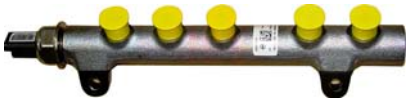
Fuel filter assembly



Supplying clean fuel/fuel heating/water separation by priming pump



Fuel rail assembly



Relieving the pulsation.
Measuring the fuel pressure.
Distributing the fuel to injectors.

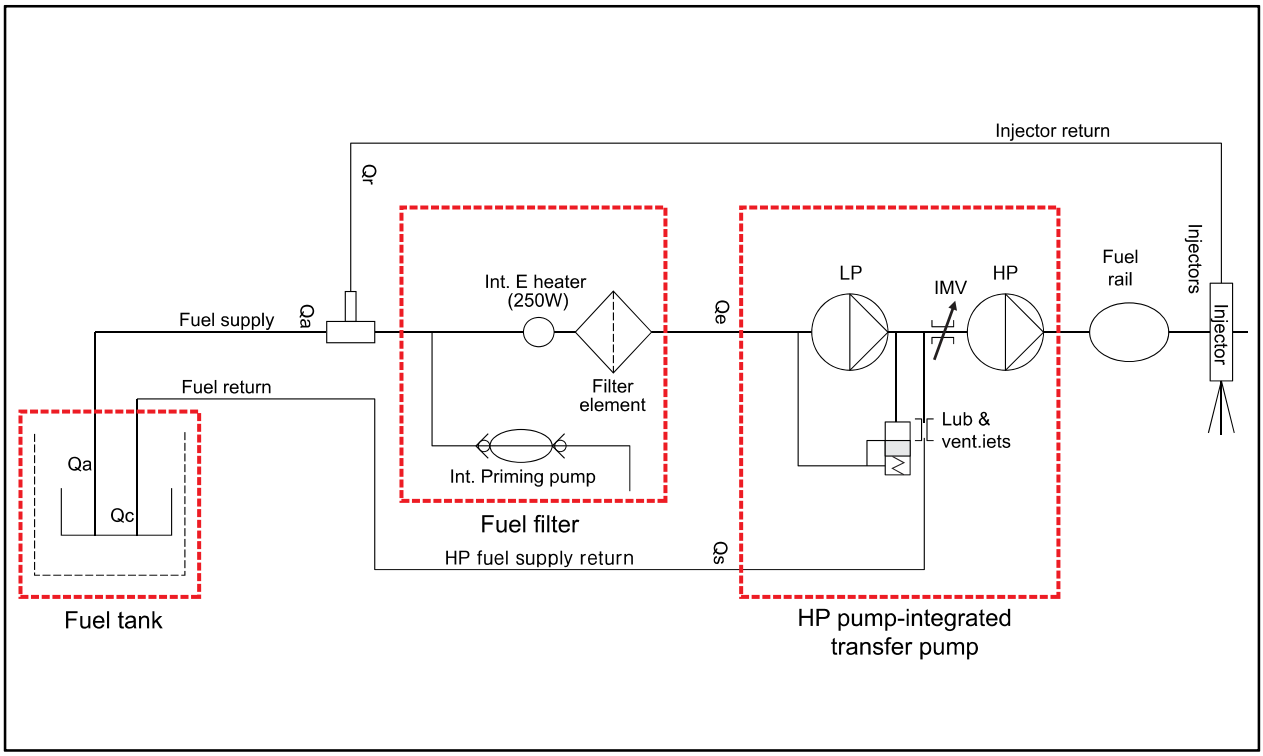
T-MAP sensor



Measuring booster pressure and temperature

Modification basis	
Application basis	
Affected VIN	

2) Fuel System Flow Diagram



The fuel from the fuel tank is supplied to the fuel heater of fuel filter/priming pump and then low pressure generated by the low pressure pump (built into HP pump) is transmitted to the HP pump.
The fuel pressure at the HP pump is controlled by the IMV valve, and the maximum allowed pressure is 1,800 bar. The compressed fuel at the fuel pump is delivered to the rail, and injected by the injectors according to the injection signals. The injection method is the same with the conventional method; Fuel return by backleak which operates the needle valve.
The major difference is that the fuel return line is connected to the fuel filter inlet port, not the HP pump venturi.
The pressure from the high pressure pump is increased to 1,800 bar from 1,600 bar, and the pump is now installed to the cylinder head (cylinder block for previous model). The fuel pressure is generated by the operation of intake camshaft and gears. The specifications for the IMV valve and the fuel temperature sensor are not changed.

Modification basis	
Application basis	
Affected VIN	

3) Input/Output devices

Input		Control	Output	
Main Map		D20DTR ECU		
Crankshaft position sensor 	Engine rpm (Engine load)			
Cam position sensor 	Injection sequence (Engine rpm)		Fuel volume feedback control	 IMV (Inter metering valve)
HFM (Intake air flow) 	Required flow volume Required rail pressure			
Accelerator pedal 	Driver's will for acceleration Requested rail pressure			
Fuel rail pressure sensor 	Measured rail pressure			
Sub Map				
Fuel temperature center 	Fuel temperature measured		Air-fuel ratio control Fuel volume injection volume	 Injector
Coolant temperature 	Compensation by coolant temperature			
T-MAP 	Boost pressure/ temperature (Air volume calibration)			

* Refer to Chapter "Engine Control".

The engine ECU calculates the accelerator pedal based on the input signals from various sensors, and controls the overall operation of the vehicle.
The ECU receives the signals from various sensor through data line, and performs effective air-fuel ratio control based on these signals.
The crankshaft speed (position) sensor measures the engine speed, and the camshaft speed (position) sensor determines the order of injections, and the ECU detects the amount of the accelerator pedal depressed (driver's will) by receiving the electrical signals from the accelerator pedal sensor.
The mass air flow sensor detects the volume of intake air and sends the value to the ECU.
The major function of the ECU is controlling air-fuel ratio to reduce the emission level (EGR valve control) by detecting instantaneous air flow change with the signals from the mass air flow sensor.
Also, the ECU uses the signals from the coolant temperature & air temperature sensors, booster pressure sensor, atmospheric pressure sensor to: a) determine injection starting point and set value for pilot injection, and b) deal with various operations and variable conditions.

Modification basis	
Application basis	
Affected VIN	

INTAKE SYSTEM 1719-00

GENERAL INFORMATION

1. SPECIFICATION

Unit	Description	Specification
Air cleaner element	Filter type	Dry, filter element
	Initial resistance	Max. 300 mmAq
	Service interval	EU; Clean or change every 20,000 km
		GEN: Clean or change every 15,000 km
Air cleaner assembly	Operating temperature	−30 ~ 100°C
Intercooler	Core material	Aluminum
	Core size	614W x 192H x 30T
	Tank material	Plastic (Molding)
	Efficiency	80%

* Shorten the service interval under severe conditions such as driving on a dusty road or offroad.

2. INSPECTION

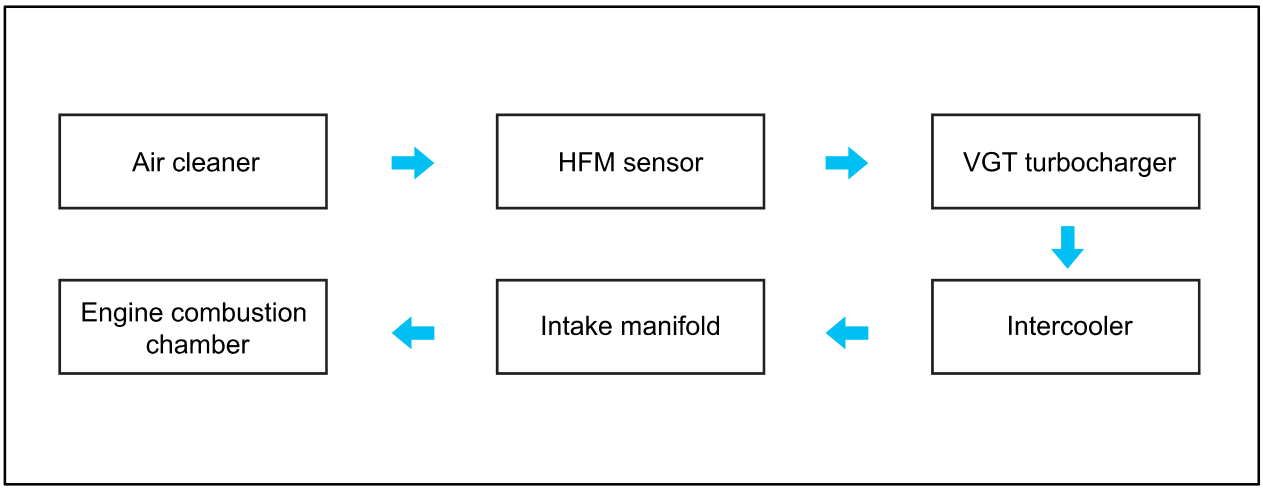
1) Troubleshooting

▶ **When Abnormal Noises are Heard from the Engine Room**

CAUTION

For the vehicle equipped with DI engine, if a learning noise occurs in each range or other noises occur, the major cause of it is a faulty turbocharger assembly. But an interference issue, poor tightness or loose in the intake and exhaust system also can cause those noises. This is mainly because the operator didn't follow the instruction exactly when reconnecting the intake hoses and pipes which were disconnected to check the system or replace the air cleaner. If the intake system is free of any faults, check the EGR and PCV oil separator connected to the intake system.
The figure may be different from the actual engine. Therefore, read thoroughly below before replacing the parts.

2) Abnormal Noise Caused by Poor Tightness of Intake System



When the DI engine is running, the air entered into the engine flows in the sequence as shown above. If high intake pressure is applied to the loose or damaged part, a whistling noise may occur, the intake air volume is measured incorrectly or the engine power is derated.

Modification basis	
Application basis	
Affected VIN	

3) Troubleshooting Sequence

The basic checks for intake system are as follows:

▶ Basic Checks for Intake System

Check if any abnormal noise occurs in each range while the vehicle is driven.

↓

Check if the engine warning lamp is illuminated or any DTC is displayed on the diagnostic device.

↓

Check the hoses for loose connections, or the clamps for deformation.

↓

Check tightness of the air cleaner housing by shaking it.

↓

Check the turbocharger and the intake/exhaust system for interferences in each range.

↓

Check the vacuum system and the hoses connected.

Make sure to replace or clean the air cleaner element periodically. Otherwise, engine will be derated or work abnormally because of low intake air volume.
Unlike the fuel system, which is a closed circuit, the intake system is an open circuit system. Therefore any malfunction may occur due to dust and dirt.
Most of the connections consist of hoses so the system cannot withstand high temperature and pressure. Also it can be deformed or loosened easily because it is a clamp mounting system. Thus, when checking the engine, basic inspections, such as tightened status check and visual inspection for hose, etc., should be carried out in advance.

▶ Other Checks for Intake System

Check the EGR system (vacuum circuit, electrical circuit of modulator, mechanical movements of EGR valve).

↓

Check the PCV oil separator.

If the intake system is free of any faults, check for EGR and PCV oil separator.

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

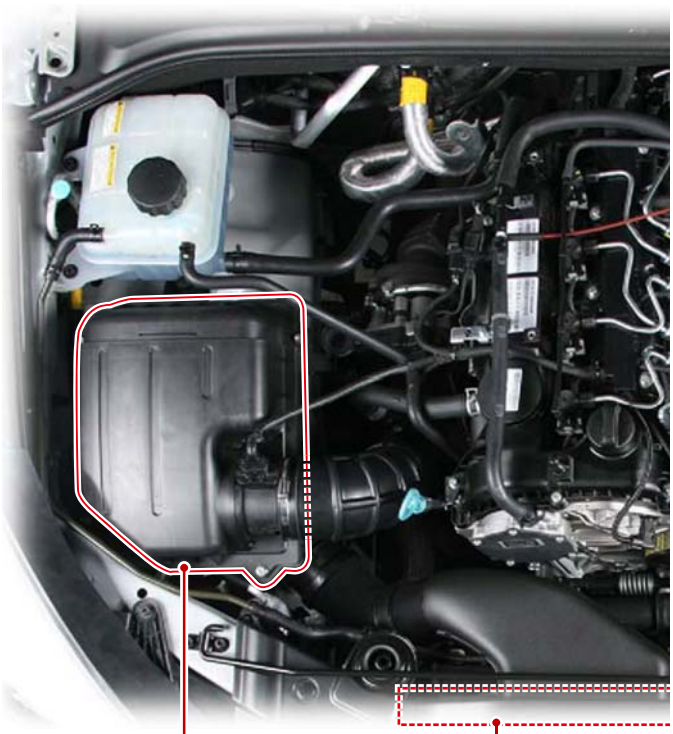
The intake system for D20DTR engine is equipped with a throttle body which includes a flap. This flap is controlled by an electrical signal to cut off the intake air entering to the engine when the ignition switch is turned off. Because of this, the shape of the intake manifold has been changed and improved HFM sensor is newly adopted to control the intake air volume more precisely.

2. COMPONENT

2313-15	HFM sensor



HFM sensor, version 6
*For more information, refer to Chapter "Engine Control".



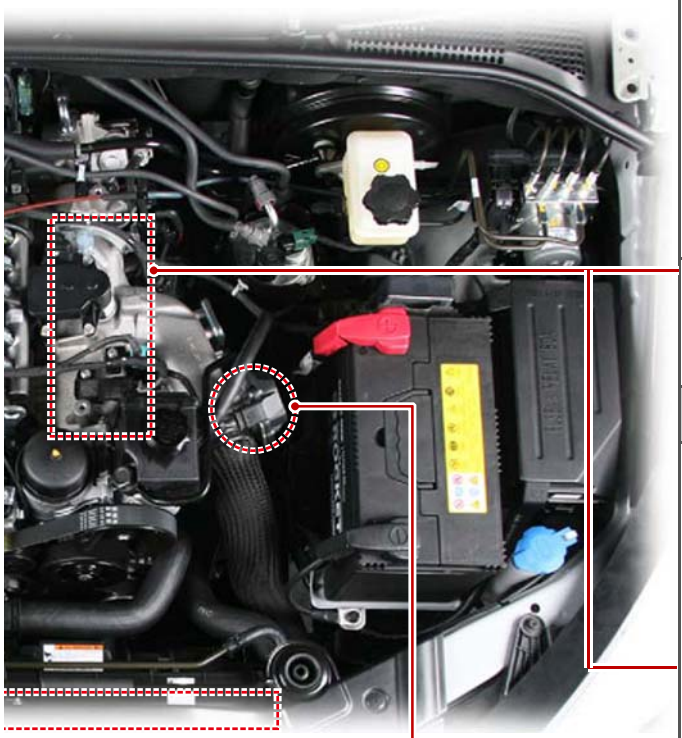
2313-01	Air cleaner assembly



2330-01	Intercooler assembly



Modification basis	
Application basis	
Affected VIN	



1719-02	Swirl control valve



Operating variably in accordance with the engine load and rpm.* For more information, refer to Chapter "Engine Control".

1719-01	Intake manifold



Passage for variable swirl valve and for intake air

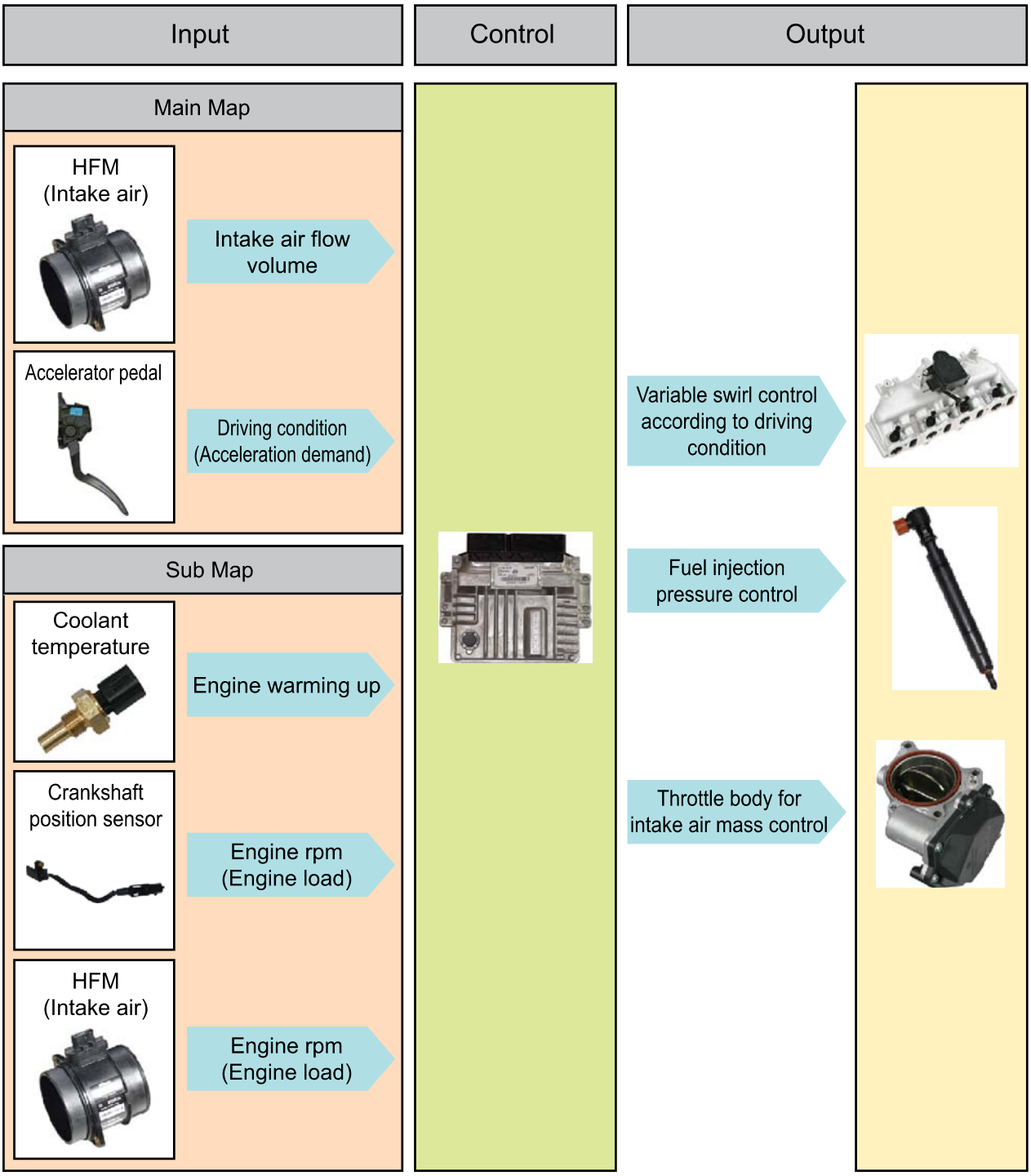
1719-16	Electric throttle body



* For more information, refer to Chapter "Engine Control".

Modification basis	
Application basis	
Affected VIN	

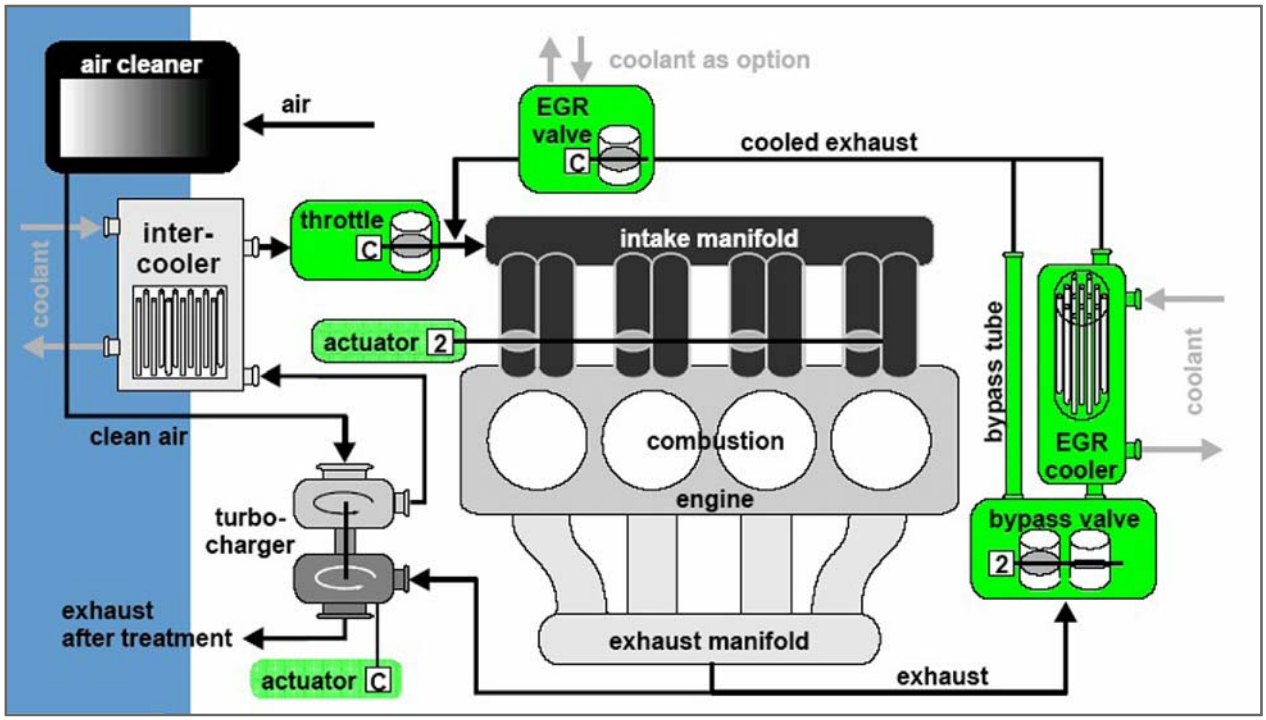
3. INPUT/OUTPUT OF INTAKE SYSTEM



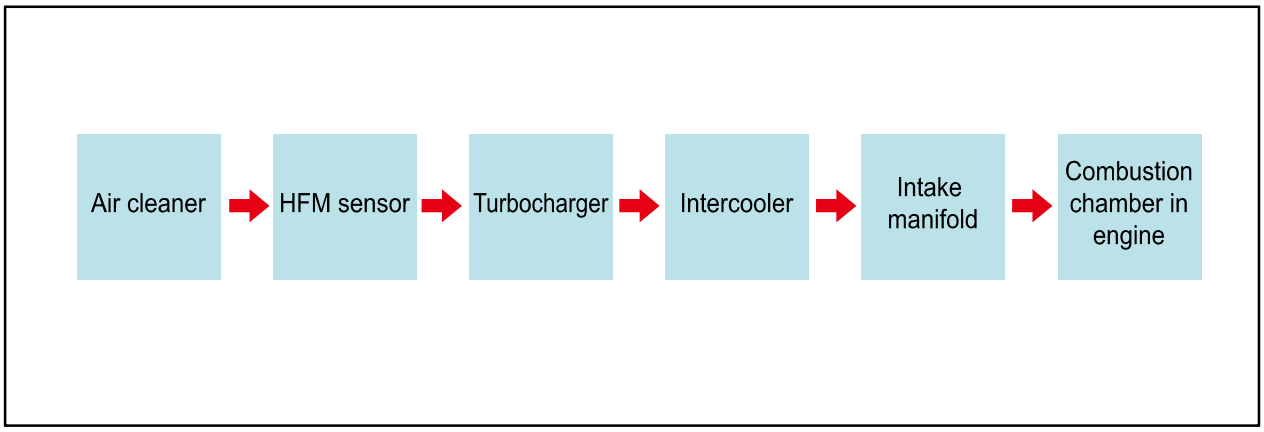
* For more information, refer to Chapter " Engine Control".

Modification basis	
Application basis	
Affected VIN	

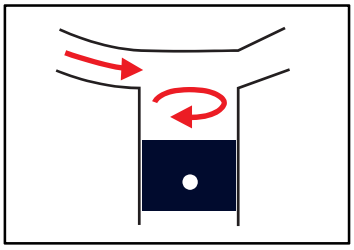
4. OPERATING PROCESS



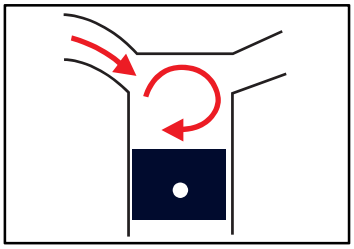
▶ **Work Flow**



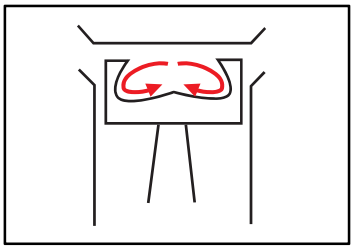
1) Types of swirl



Swirl: One cylinder has two intake air ports, one is set horizontally and the other one is set vertically. Swirl is the horizontal air flows in cylinder due to the horizontal intake air ports.



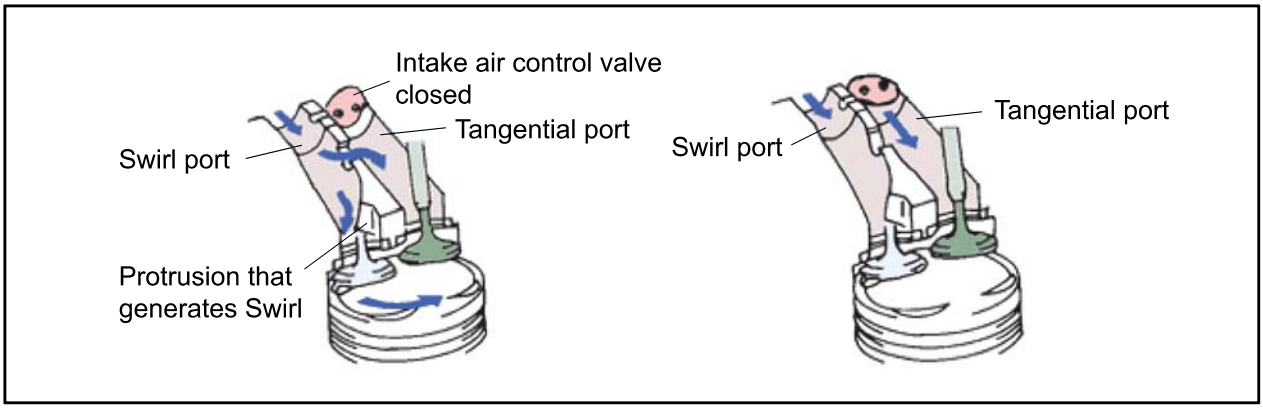
Tumble: Tumble is the vertical air flows in cylinder due to the vertical intake air port



Squish: Squish is the air flows due to the piston head. Normally, this is appears at the final process of compression. In CRDi engine, the piston head creates the bowl type squish.

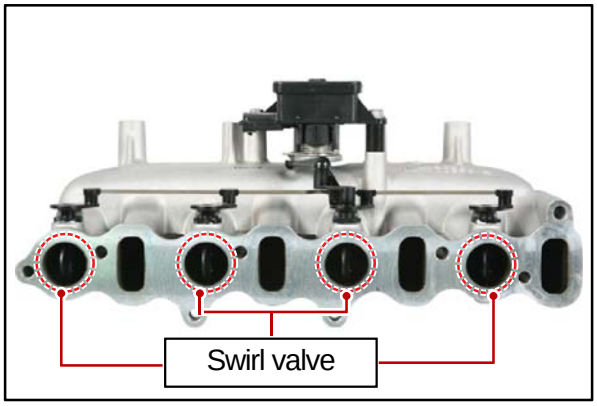
2) Swirl control

In DI type diesel engine, the liquefied fuel is injected into the cylinder directly. If the fuel is evenly distributed in short period, the combustion efficiency could be improved. To get this, there should be good air flow in cylinder. In general, there are two intake ports, swirl port and tangential port, in each cylinder. The swirl port generates the horizontal flow and the tangential port generates the longitudinal flow. In low/mid load range, the tabgential port is closed to increase the horizontal flow. Fast flow decreases the PM during combustion and increases the EGR ratio by better combustion efficiency.

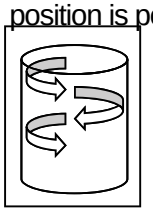


Modification basis	
Application basis	
Affected VIN	

Load	Engine speed	Swirl valve	Amount of swirl	Remarks
Low speed, Low load	below 3,000 rpm	Closed	Heavy	Increased EGR ratio, better air-fuel mixture (reduce exhaust gas)
High speed, High load	over 3,000 rpm	Open	Light	Increase charge efficiency, higher engine power



The variable swirl valve actuator operates when turning the ignition switch ON/OFF position to open/close the swirl valve. In this period, the soot will be removed and the learning for swirl valve position is performed.



NOTE

Swirl: This is the twisted (radial) air flow along the cylinder wall during the intake stroke. This stabilizes the combustion even in lean air-fuel mixture condition.

3) Features

- Swirl and air intake efficiency
  To generate the swirl, the intake port should be serpentine design. This makes the resistance in air flow. The resistance in air flow in engine high speed decreases the intake efficiency. Eventually, the engine power is also decreased, Thus, the swirl operation is deactivated in high speed range to increase the intake efficiency.
- Relationship between swirl and EGR
  To reduce Nox, it is essential to increase EGR ratio. However, if EGR ratio is too high, the PM also could be very higher. And, the exhaust gas should be evenly mixed with newly aspired air. Otherwise, PM and CO are dramatically increased in highly concentrated exhaust gas range and EGR ratio could not be increased beyond a certain limit. If the swirl valve operates in this moment, the limit of EGR ratio will be higher.

4) Relationship between swirl and fuel injection pressure

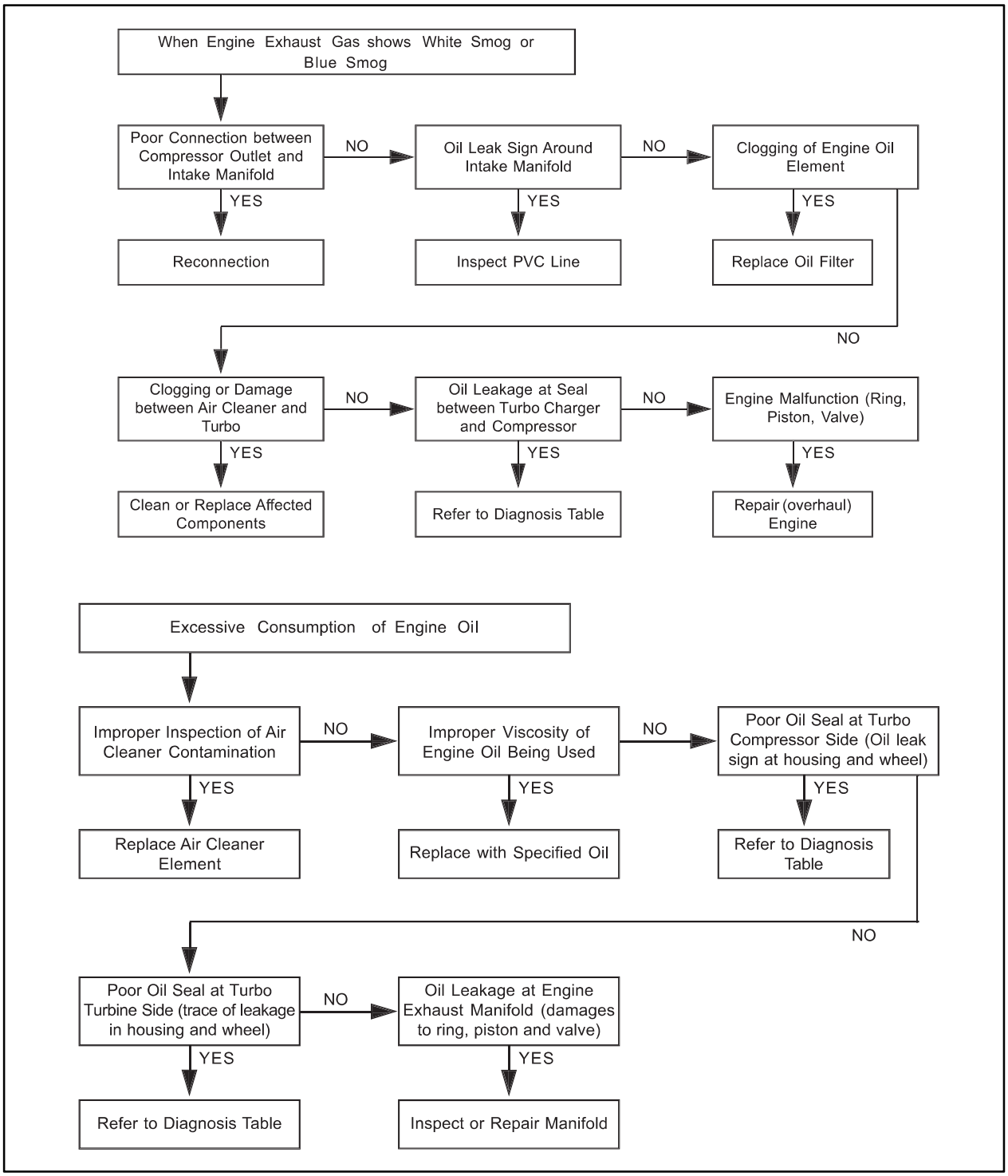
The injector for DI engine uses the multi hole design. For this vehicle, there are 8 holes in injector. If the swirl is too strong, the injection angles might be overlapped and may cause the increased PM and insufficient engine power. Also, if the injection pressure is too high during strong swirl, the injection angles might be overlapped. Therefore, the system may decreases the fuel injection pressure when the swirl is too strong.

ENGINE EXHAUST SYSTEM 1729-01

GENERAL INFORMATION

1. TROUBLESHOOTING

1) Work Flow



Modification basis	
Application basis	
Affected VIN	

2. CAUTIONS

- Do not park the vehicle on flammable materials, such as grass, leaves and carpet.
- Do not touch the catalyst or the exhaust gas ignition system when the engine is running.
- If a misfire occurs in the combustion chamber or the emission of pollutant exceeds the specified level, the catalyst can be damaged.
- When servicing or replacing components of the exhaust system, makes sure that the components are positioned at regular intervals from all other parts of the under body.
- Be careful not to damage the exhaust system when lifting the vehicle from its side.
- All components and body parts of the engine exhaust system should be inspected for crack, damage, air hole, part loss and incorrect mounting location. Also check for any deformation which can result in exhaust gas drawn into the vehicle.
- Make sure that the exhaust pipe is cooled down sufficiently before working on it because it is still hot right after the engine is stopped.
- Wear protective gloves when removing the exhaust pipe.

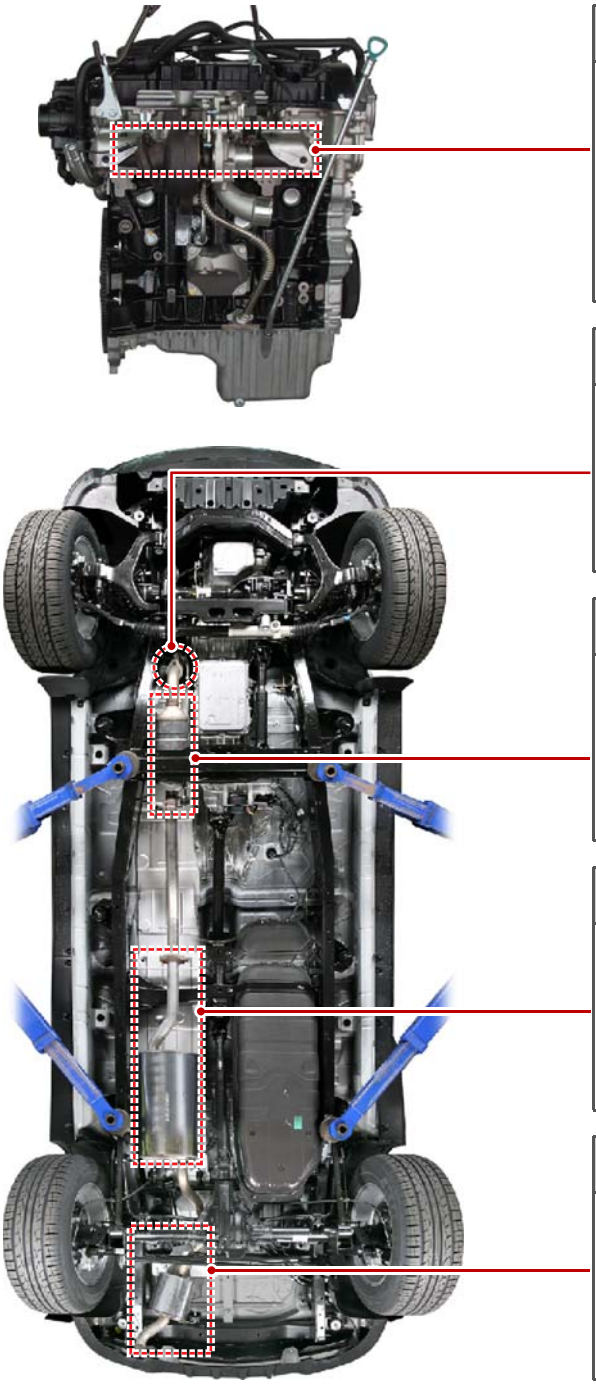
Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

This system purifies the exhaust gas generated by the combustion in the engine to reduce the pollutants and noise during that arise during combustion.

2. LAYOUT



Exhaust manifold assembly



Exhaust front pipe assembly



CDPF assembly



* For more information, refer to Chapter "Engine Control".

Muffler assembly

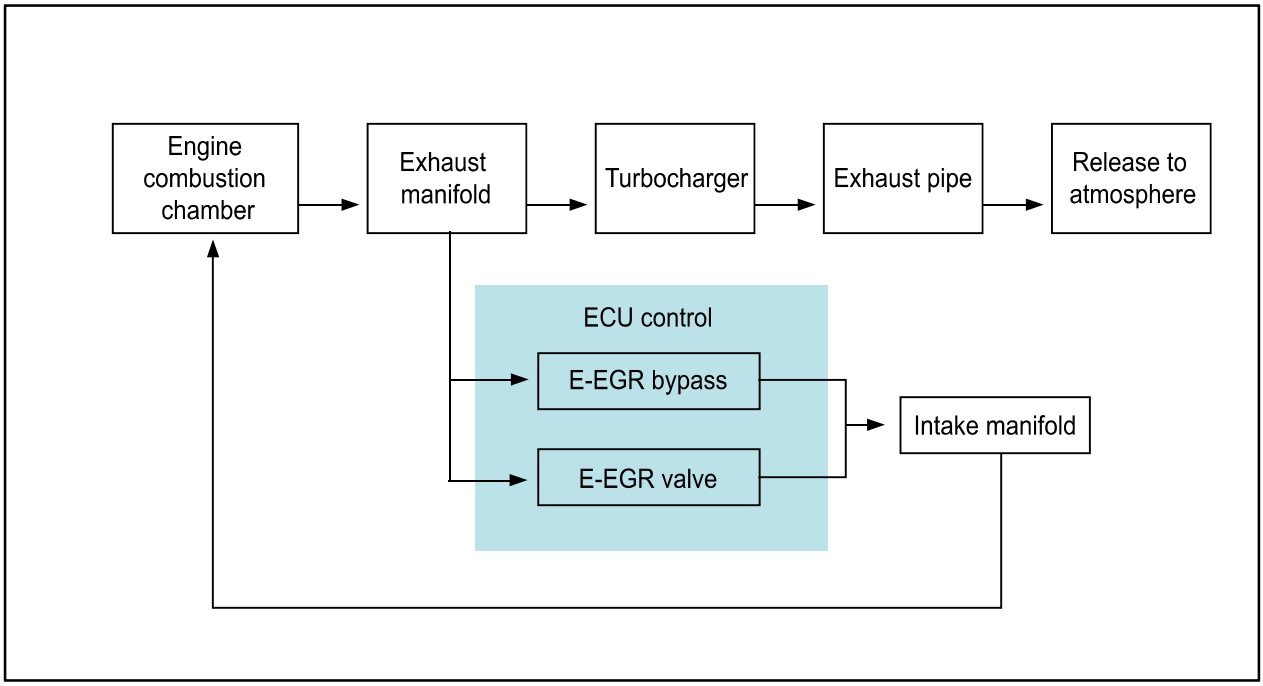


Exhaust tail pipe assembly

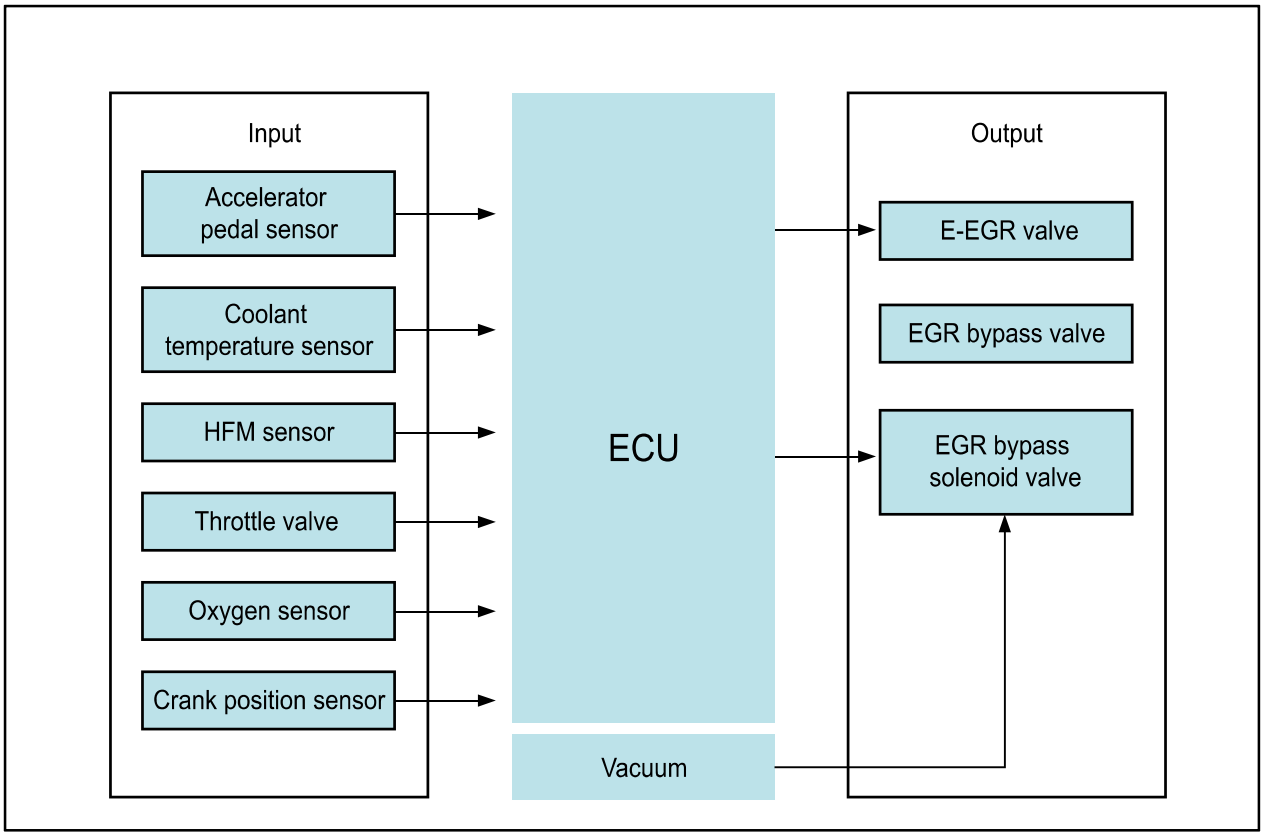


3. OPERATING PROCESS

1) Exhaust Gas Flow



2) Input & Output Devices



Modification basis	
Application basis	
Affected VIN	

TURBOCHARGER 1914-01

GENERAL INFORMATION

1. SPECIFICATION

Unit	Description	Specification
Turbocharger	Max. expansion coefficient	4.0
	Max. turbine speed	226,000rpm
	Max. temperature of turbine housing	790 ℃
	Weight	6.5kg
E-VGT actuator	Operation duty cycle	250Hz

2. INSPECTION

1) Cautions During Driving

The following lists cautions to take during test drive and on the turbocharger vehicle, which must be considered during the operation.

1. It's important not to drastically increase the engine rpm starting the engine. It could make rotation at excessive speed even before the journal bearing is lubricated and when the turbocharger rotates in poor oil supply condition, it could cause damage of bearing seizure within few seconds.
   If the engine is running radically after replacing the engine oil or oil filter brings poor oil supply
2. condition. To avoid this, it's necessary to start off after idling the engine for about 1 minute allowing oil to circulate to the turbocharger after the replacement.
   When the engine is stopped abruptly after driving at high speed, the turbocharger continues to rotate
3. in condition where the oil pressure is at '0'. In such condition, an oil film between the journal bearing and the housing shaft journal section gets broken and this causes abrasion of the journal bearing due to the rapid contact. The repeat of such condition significantly reduces life of the turbocharger. Therefore, the engine should be stopped possibly in the idle condition.

CAUTION

After string for long period of time during winter season or in the low temperature condition where the fluidity of engine oil declines, the engine, before being started, should be cranked to circulate oil and must drive after checking the oil pressure is in normal condition by idling the engine for few minutes.

Modification basis	
Application basis	
Affected VIN	

2) Inspection of Turbocharger

When problem occurs with the turbocharger, it could cause engine power decline, excessive discharge of exhaust gas, outbreak of abnormal noise and excessive consumption of oil.

1. On-board Inspection

- Check the bolts and nuts foe looseness or missing
- Check the intake and exhaust manifold for looseness or damage
- Check the oil supply pipe and drain pipe for damages
- Check the housing for crack and deterioration

2. Inspection of turbine

Remove the exhaust pipe at the opening of the turbine and check, with a lamp, the existence of interference of housing and wheel, oil leakage and contamination (at blade edge) of foreign materials.

- Interference: In case where the oil leak sign exists, even the small traces of interferences on the turbine wheel mean, most of times, that abrasion has occurred on the journal bearing. Must inspect after overhauling the turbocharger.
- Oil Leakage: Followings are the reasons for oil leakage condition
  * Problems in engine: In case where the oil is smeared on inner wall section of the exhaust gas opening.
  * Problems in turbocharger: In case where the oil is smeared on only at the exhaust gas outlet section.

CAUTION

Idling for long period of time can cause oil leakage to the turbine side due to low pressure of exhaust gas and the rotation speed of turbine wheel. Please note this is not a turbocharger problem.

- Oil Drain Pipe Defect
  In case where oil flow from the turbocharger sensor housing to the crank case is not smooth would become the reason for leakage as oil builds up within the center housing. Also, oil thickens (sludge) at high temperature and becomes the indirect reason of wheel hub section. In such case, clogging and damage of the oil drain pipe and the pressure of blow-by gas within the crank case must be inspected.
  Damages due to Foreign Materials
- When the foreign materials get into the system, it could induce inner damage as rotating balance of the turbocharger gets out of alignment.

3) Inspection of Turbine

Thoroughly check the followings.

CAUTION

Must absolutely not operate the turbocharger with the compressor outlet and inlet opened as it could damage the turbocharger or be hazardous during inspection.

- Interference: In case where is trace of interference or smallest damage on the compressor wheel means, most of times, that abrasion has occurred on the journal bearing. Must inspect after the overhaul.
- Oil Leakage: The reason for oil leakage at the compressor section is the air cleaner, clogged by substances such as dust, causes the compressor inlet negative pressure.

  a. Rotating in high speed at no-load for extended period of time can cause oil leakage to the compressor section as oil pressure within the center housing gets higher than pressure within the compressor housing.
  b. Overuse of engine break (especially in low gear) in down hill makes significantly low exhaust gas energy compared to the time where great amount of air is required during idling conditions of the engine. Therefore, amount of air in the compressor inlet increases but the turbocharge pressure is not high, which makes negative

CAUTION

No problem will occur with the turbocharger if above conditions are found in early stage but oil leaked over long period of time will solidify at each section causing to breakout secondary defects.

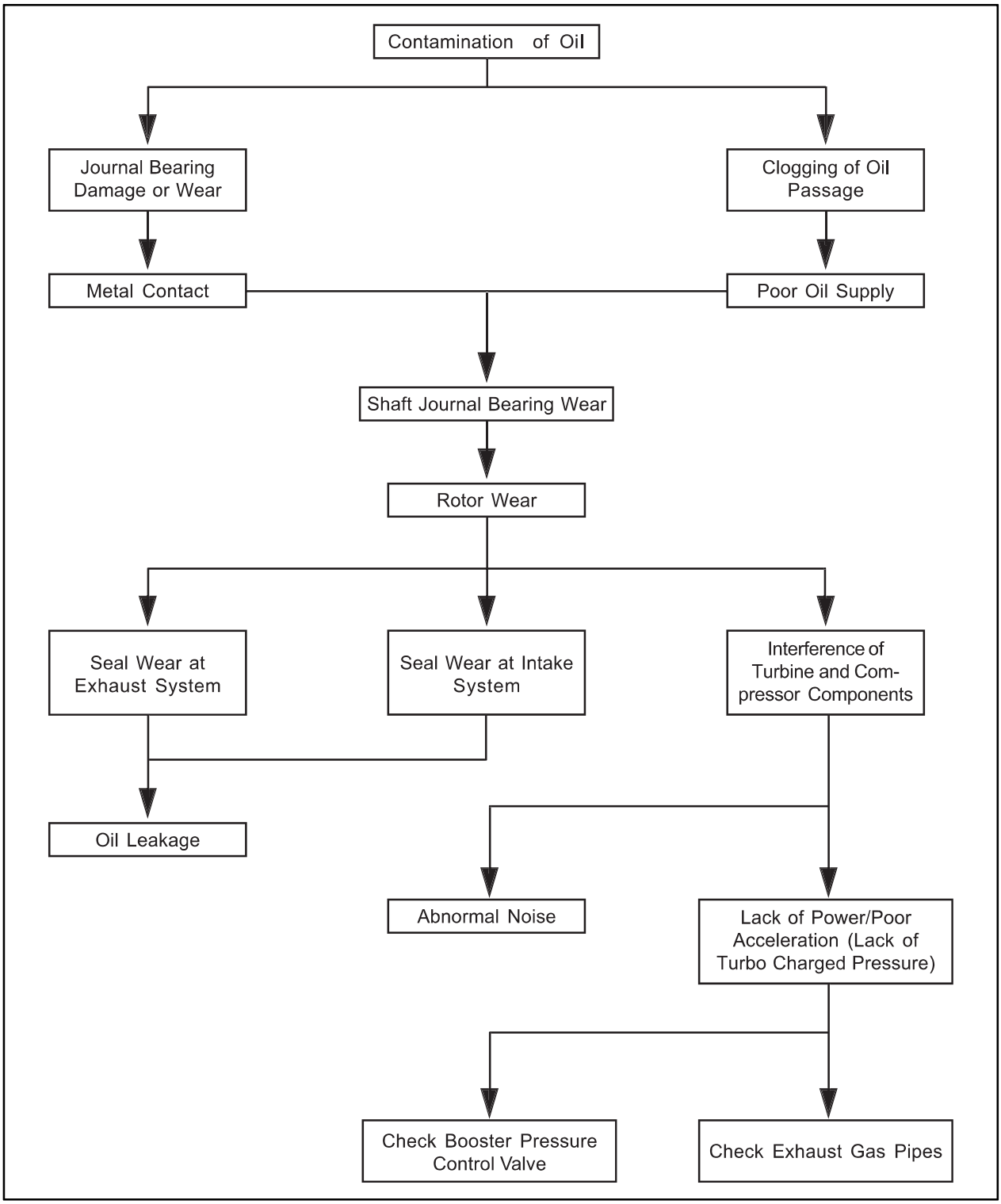
Damages by foreign materials: In case where the compressor wheel is damaged by foreign materials requires having an overhaul. At this time, it's necessary to check whether the foreign materials have contaminated intake/exhaust manifold or inside of engine.

Modification basis	
Application basis	
Affected VIN	

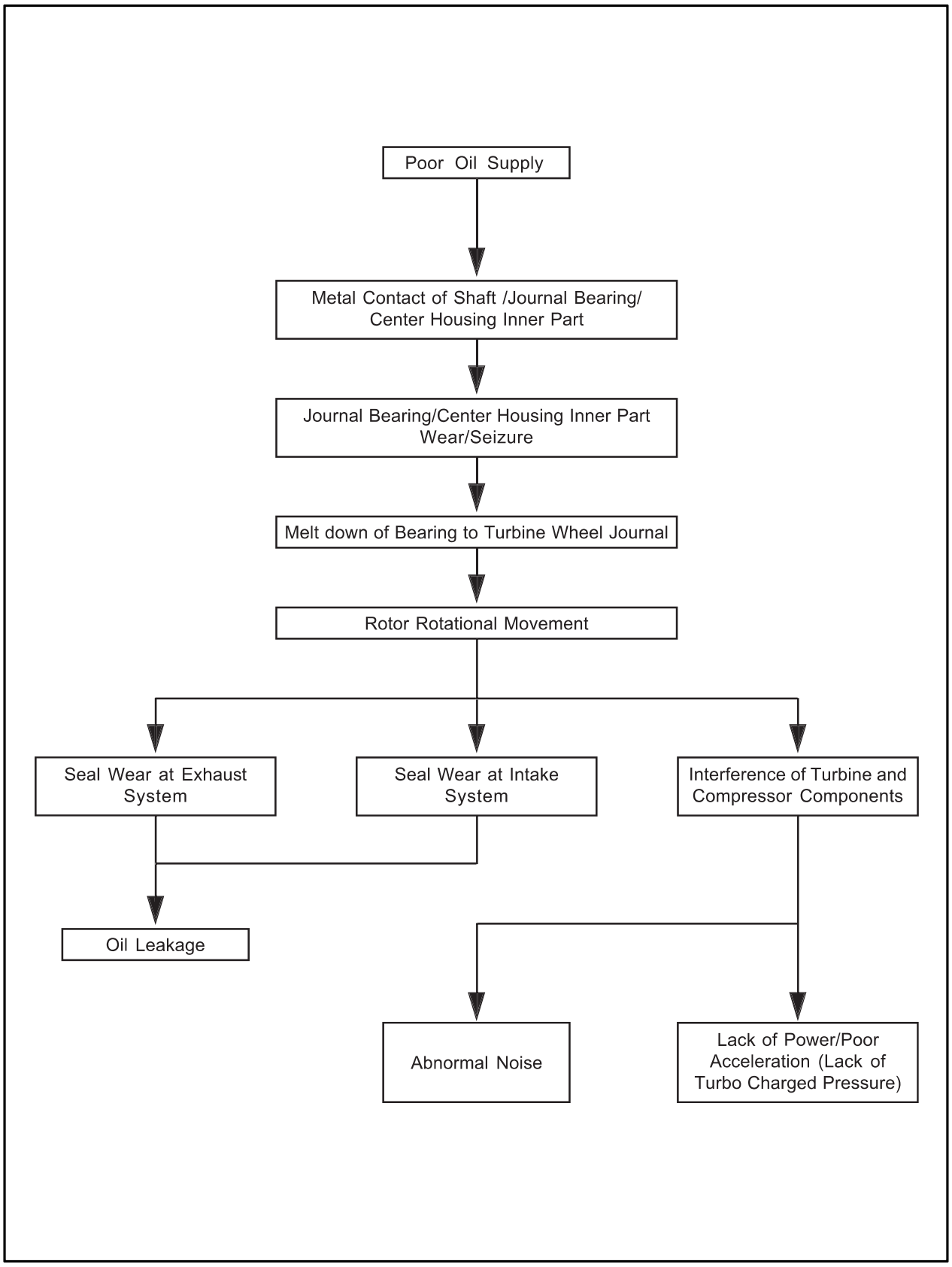
4) Possible Causes of Defect

The following tries to understand the defects that can occur with vehicle installed with the turbocharger and to manage the reasons of such defects.

1. In case where oil pan/oil pipe has been contaminated, oil filter is defected and where adhesive of gaskets has been contaminated into the oil line.

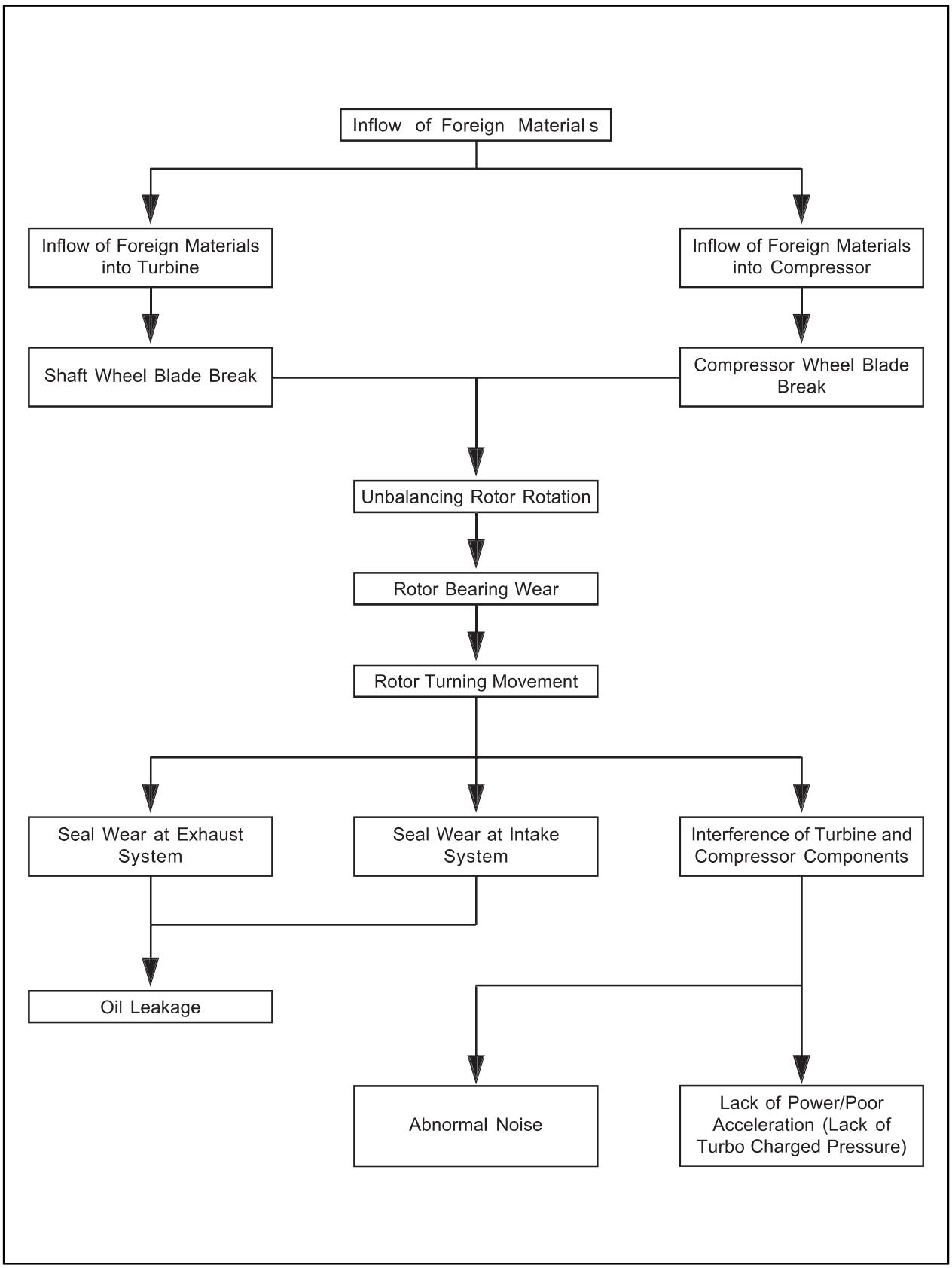


2. Oil Pump Defect: Rapid over-loaded driving after replacing oil filter and oil and clogging of oil line.

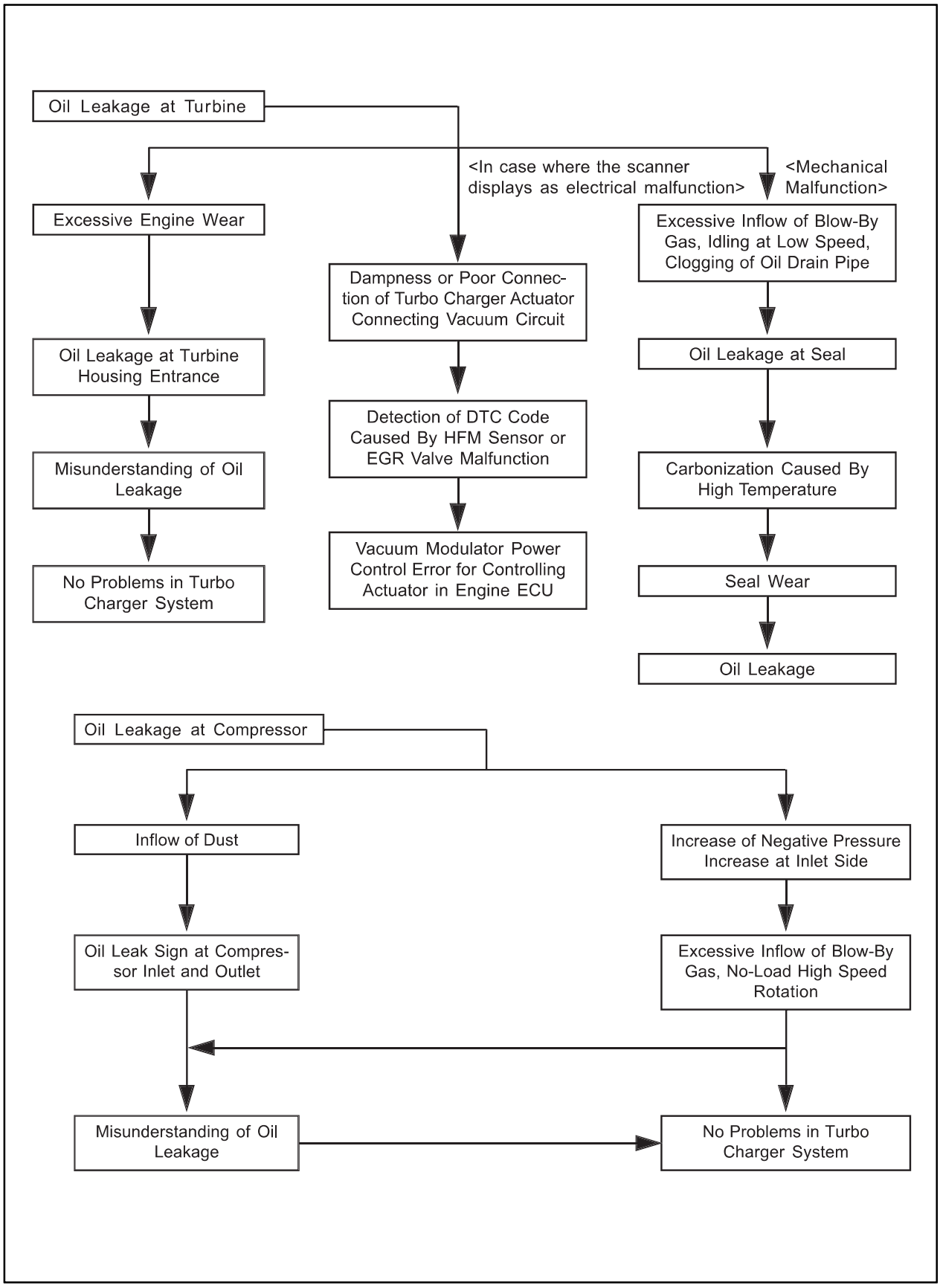


Modification basis	
Application basis	
Affected VIN	

3. Turbine Side: Inflow of foreign materials from engine
   Compressor Side: such as air filter, muffler and nut



4. Defects caused by reasons other than that of the turbocharger.



Modification basis	
Application basis	
Affected VIN	

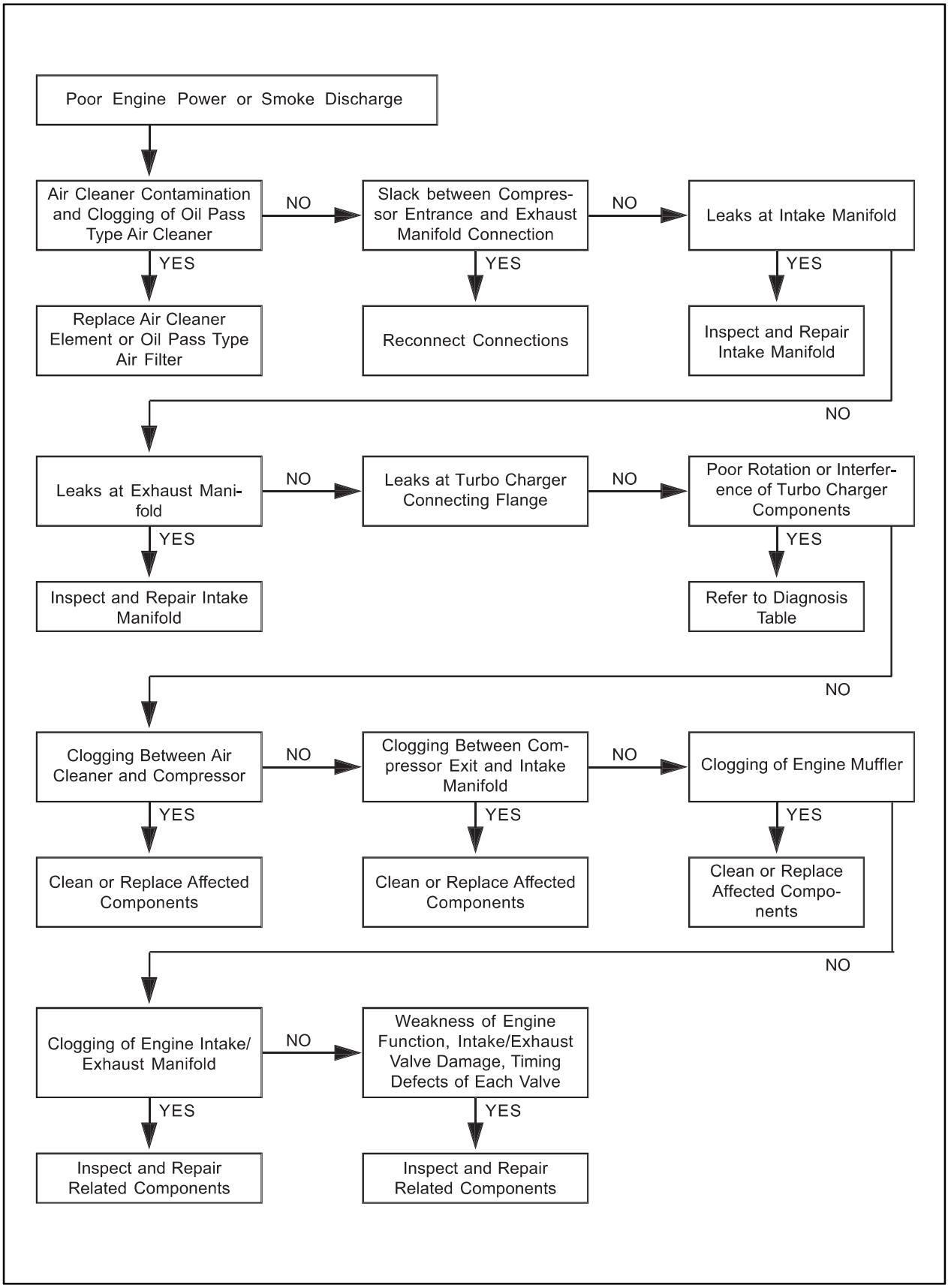
3. TROUBLESHOOTING

The followings are cautions to take in handling defects of turbocharger, which must be fully aware of.

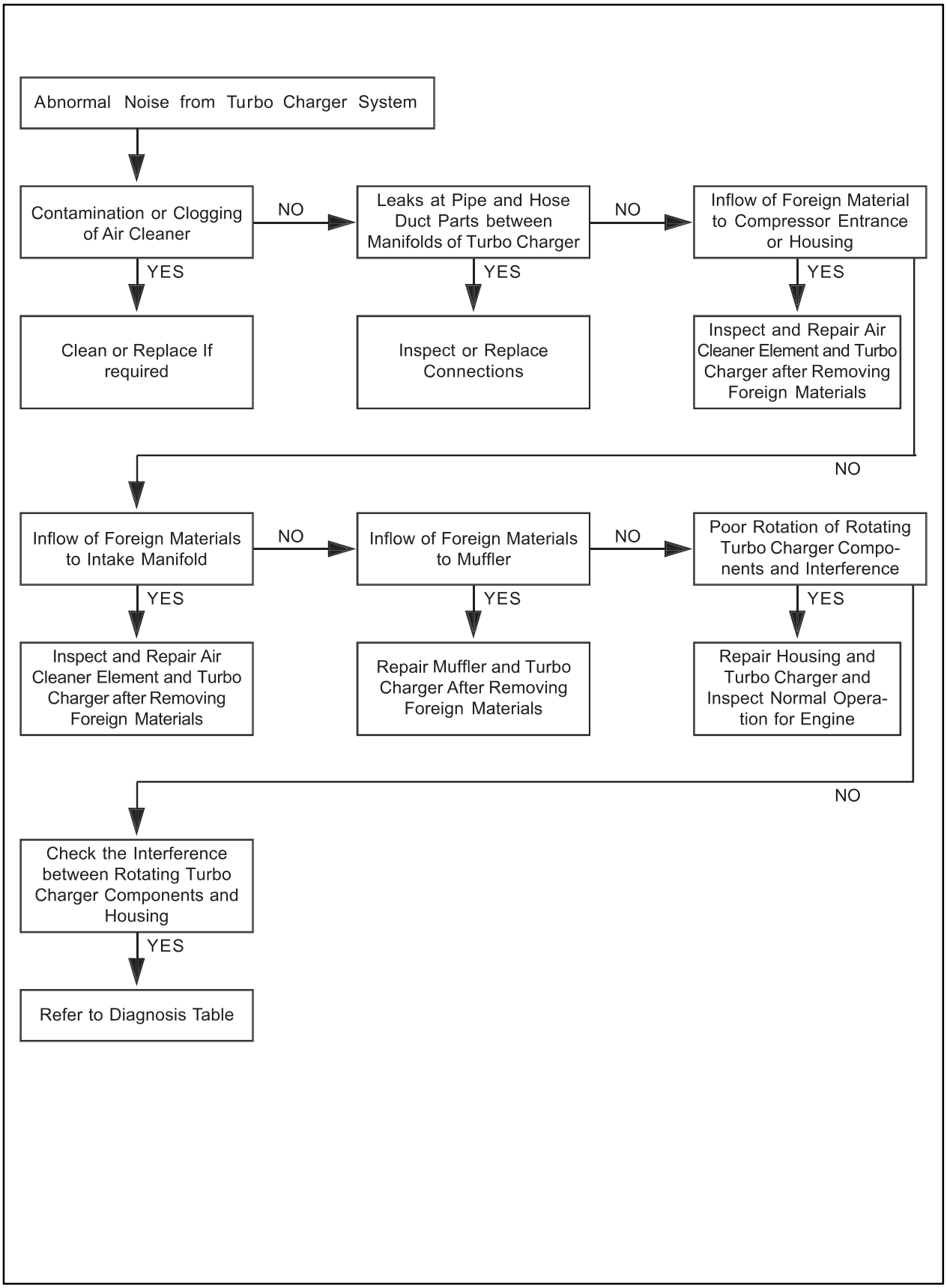
1) Cautions

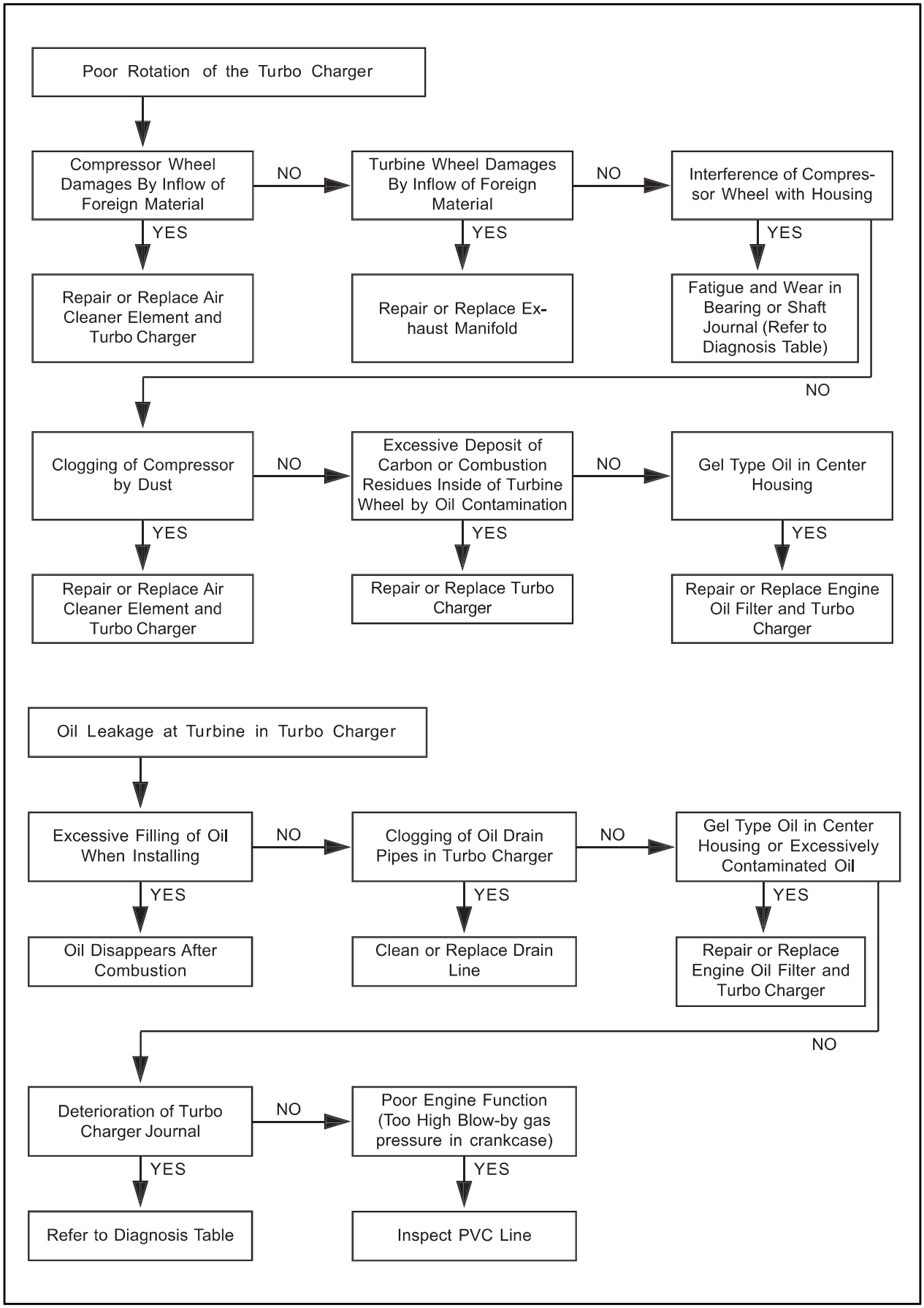
1. After stopping the engine, check whether the bolts on pipe connecting section are loose as well as the connecting condition of vacuum port and modulator, which is connected to the actuator.
2. During idling of the engine, check for leakage in the connecting section of pipe (hoses and pipes, duct connections, after the turbocharger) by applying soap water. The leakage condition in the engine block and turbine housing opening can be determined by the occurrence of abnormal noise of exhaust.
3. By running the engine at idle speed, abnormal vibration and noise can be checked. Immediately stop the engine when abnormal vibration and noise is detected and make thorough inspection whether the turbocharger shaft wheel has any damages as well as checking the condition of connections between pipes.
4. In case where the noise of engine is louder than usual, there is possibility of dampness in the areas related with air cleaner and engine or engine block and turbocharger. And it could affect the smooth supply of engine oil and discharge.
5. Check for damp condition in exhaust gas when there is sign of thermal discoloration or discharge of carbon in connecting area of the duct.
6. When the engine rotates or in case where there is change in noise level, check for clogging of air cleaner or air cleaner duct or if there is any significant amount of dust in the compressor housing.
7. During the inspection of center housing, inspect inside of the housing by removing the oil drain pipe to check for sludge generation and its attachment condition at shaft area or turbine side.
8. Inspect or replace the air cleaner when the compressor wheel is damaged by inflow of foreign materials.
9. Inspect both side of the turbocharger wheel after removing inlet and outlet pipe of the turbocharger.

2) Work Flow for Troubleshooting

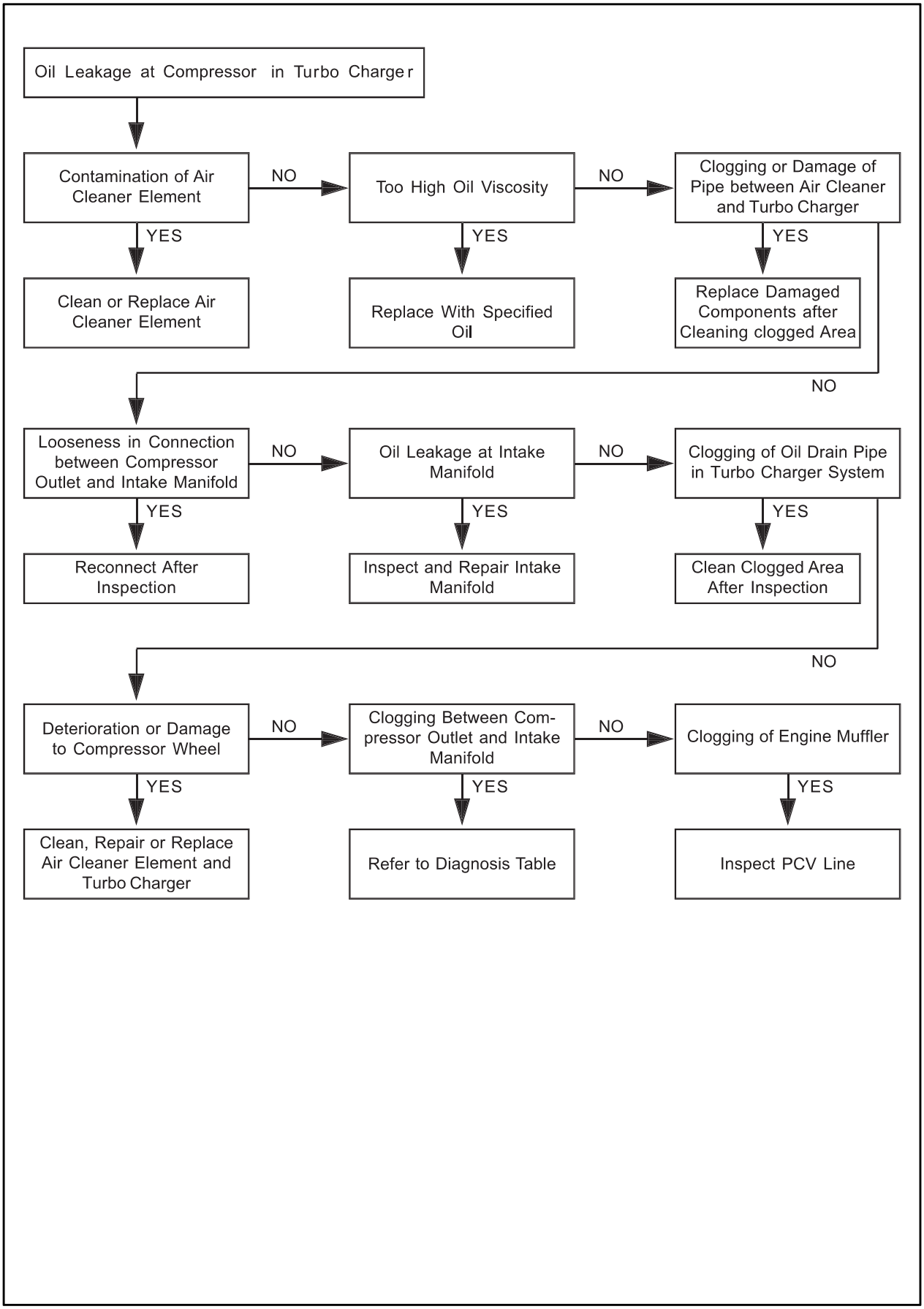


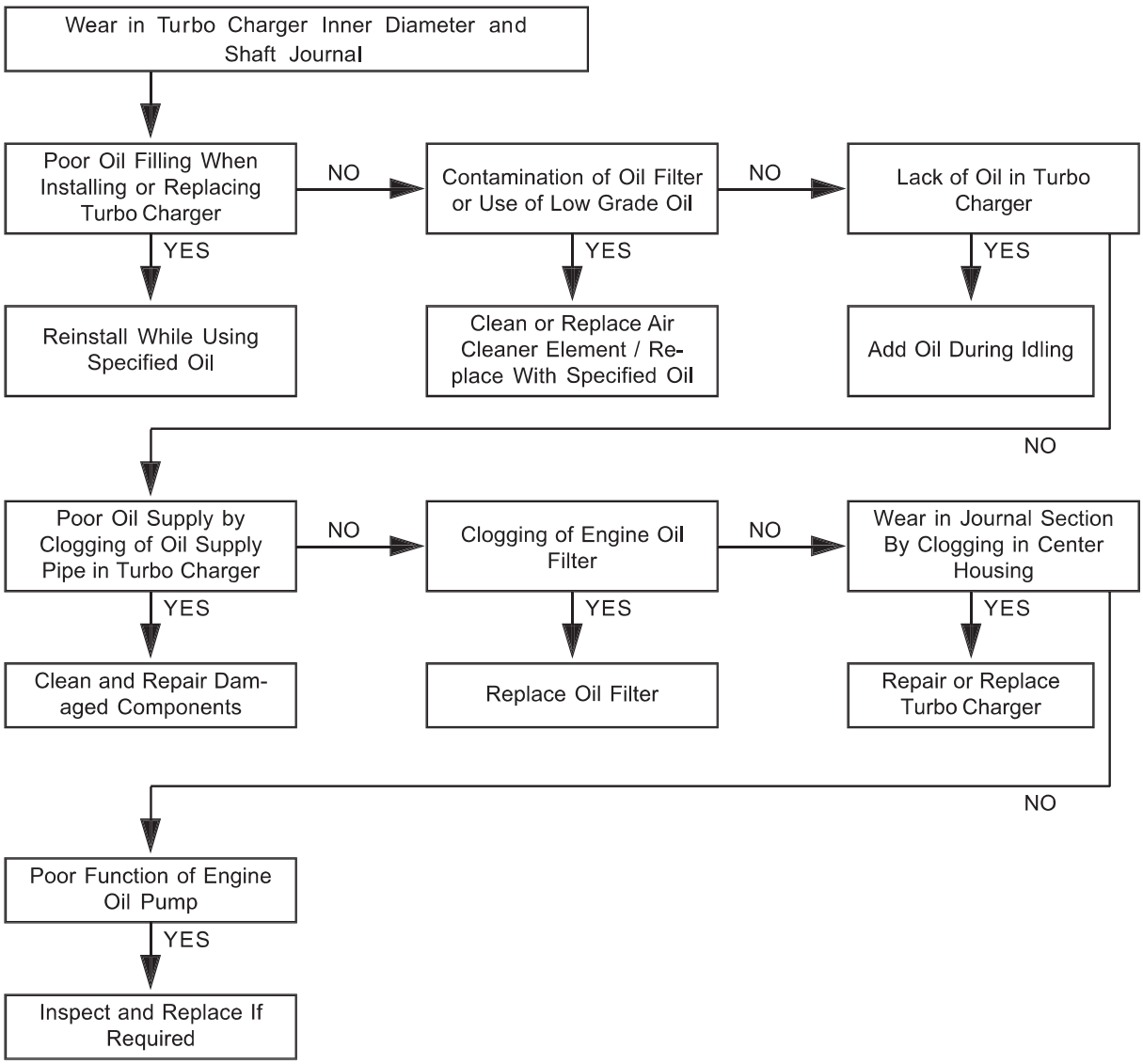
Modification basis	
Application basis	
Affected VIN	


Abnormal Noise from Turbo Charger System
Contamination or Clogging of Air Cleaner
NO
Leaks at Pipe and Hose Duct Parts between Manifolds of Turbo Charger
NO
Inflow of Foreign Material to Compressor Entrance or Housing
YES
YES
YES
Clean or Replace If required
Inspect or Replace Connections
Inspect and Repair Air Cleaner Element and Turbo Charger after Removing Foreign Materials
NO
Inflow of Foreign Materials to Intake Manifold
NO
Inflow of Foreign Materials to Muffler
NO
Poor Rotation of Rotating Turbo Charger Compo-nents and Interference
YES
YES
YES
Inspect and Repair Air Cleaner Element and Turbo Charger after Removing Foreign Materials
Repair Muffler and Turbo Charger After Removing Foreign Materials
Repair Housing and Turbo Charger and Inspect Normal Opera-tion for Engine
NO
Check the Interference between Rotating Turbo Charger Components and Housing
YES
Refer to Diagnosis Table



Modification basis	
Application basis	
Affected VIN	


Oil Leakage at Compressor in Turbo Charger
Contamination of Air Cleaner Element
NO
Too High Oil Viscosity
NO
Clogging or Damage of Pipe between Air Cleaner and Turbo Charger
YES
YES
YES
Clean or Replace Air Cleaner Element
Replace With Specified Oil
Replace Damaged Components after Cleaning clogged Area
NO
Looseness in Connection between Compressor Outlet and Intake Manifold
NO
Oil Leakage at Intake Manifold
NO
Clogging of Oil Drain Pipe in Turbo Charger System
YES
YES
YES
Reconnect After Inspection
Inspect and Repair Intake Manifold
Clean Clogged Area After Inspection
NO
Deterioration or Damage to Compressor Wheel
NO
Clogging Between Compressor Outlet and Intake Manifold
NO
Clogging of Engine Muffler
YES
YES
YES
Clean, Repair or Replace Air Cleaner Element and Turbo Charger
Refer to Diagnosis Table
Inspect PCV Line



▶ For other diagnosis, refer to Diagnosis section.

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. SYSTEM DESCRIPTION OF E-VGT (Electric-Variable Geometry Turbine)

1) Overview

The E-VGT turbocharger has one shaft where at each ends are installed with two turbines having different angles to connect one end of housing to the intake manifold and the other end to the exhaust manifold. As the turbine, at exhaust end, is rotated by exhaust gas pressure the impeller, at intake end, gets rotated to send air around center of the impeller, being circumferentially accelerated by the centrifugal force, into the diffuser. The air, which has been introduced to the diffuser having a passage with big surface, transforms its speed energy into the pressure energy while being supplied to the cylinder improving the volume efficiency. Also, the exhaust efficiency improves as the exhaust turbine rotates. The turbocharger is often referred to as the exhaust turbine turbocharger.

Diffuser: With the meaning of spreading out it is a device that transforms fluid's speed energy into the pressure energy by enlarging the fluid's passage to slow down the flow.
The E-VGT system installed to the D20DTR engine variably controls the passages of the turbine housing to regulate the flow rate of the exhaust gas. The actuator of E-VGT is a DC motor actuator (E-Actuator) which controls more quickly and precisely than the previous vacuum type actuator.

The engine ECU controls the E-Actuator electronically as follows:

- At low speed: Narrows the flow passage for the exhaust gas, resulting in increasing the flow speed of the exhaust gas and running the turbine quickly and powerfully.
- At high speed: Expands the flow passage for the exhaust gas, resulting in increasing the mass flow of the exhaust gas and running the turbine more powerfully.

2) Features

(1) Performance (for EURO V)

1. Enhanced emmission control: By temperature control with CDPF system
   - Target temperature and airflow control

(2) E-VGT Actuator (Electric-Actuator)

1. Optimizes the exhaust gas flow rate by controlling the vanes inside the turbine housing with the E-Actuator.
   - Maximizes the intake air charging efficiency (Approx. 15%)
2. Has a faster response time than the conventional vacuum actuator.
   - Improved low speed torque, high speed power and fuel economy.
   - Improved acceleration performance with rapid response time of vane.



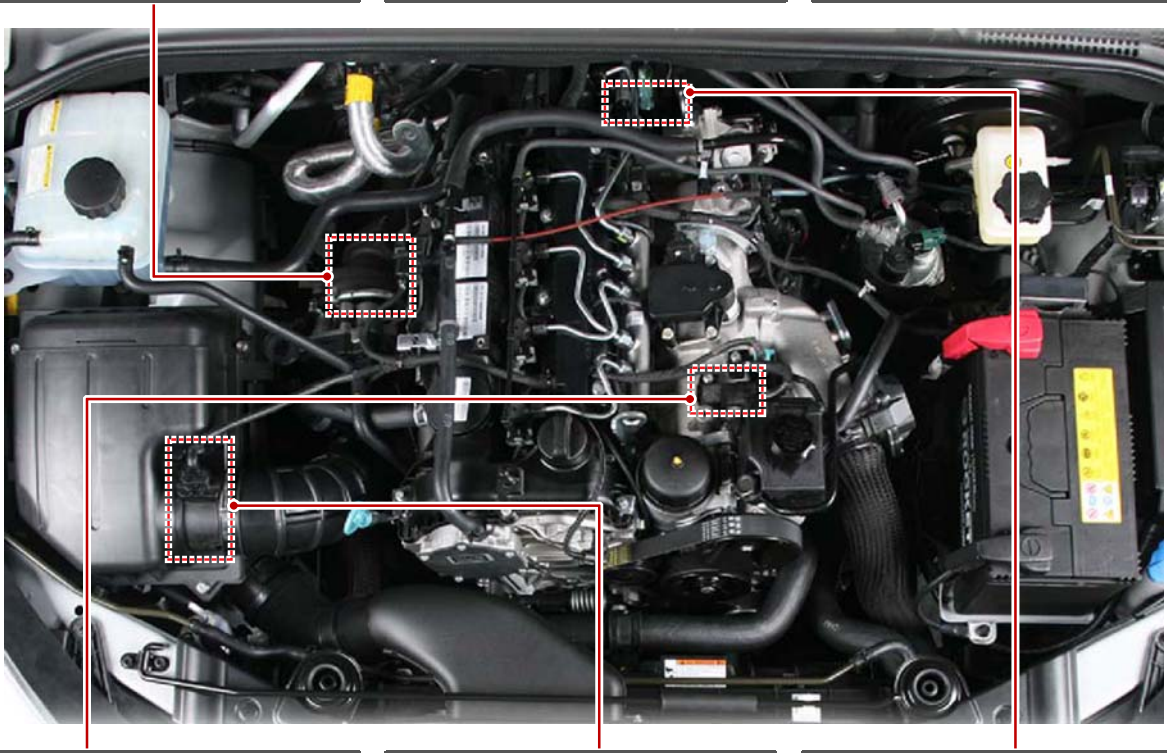
Features	- Folding and unfolding of the vane is controlled electrically - Easy to get low speed air volume Rapid response time - Electric control -
Benefits	- Improved low speed torque and power - Reduced exhaust gas - Improved fuel consumption - Improved acceleration performance

Modification basis	
Application basis	
Affected VIN	

2. COMPONENTS

* For detailed information about the control logic, refer to Chapter "Engine Control".

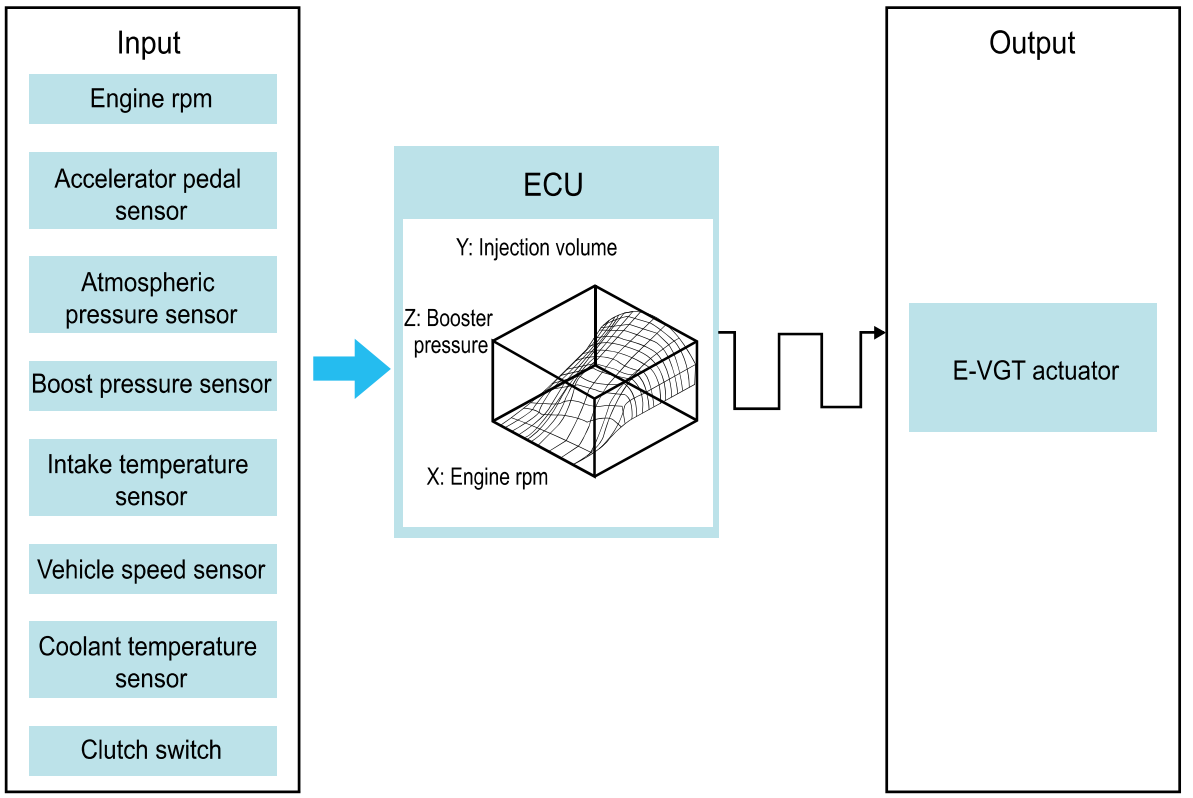
E-VGT turbocharger	Engine ECU (D20DTR)	Accelerator pedal position sensor
	 Atmospheric pressure, RPM signal	 Transfers driver's will to accelerate to ECU
Improves engine power	E-VGT duty control	

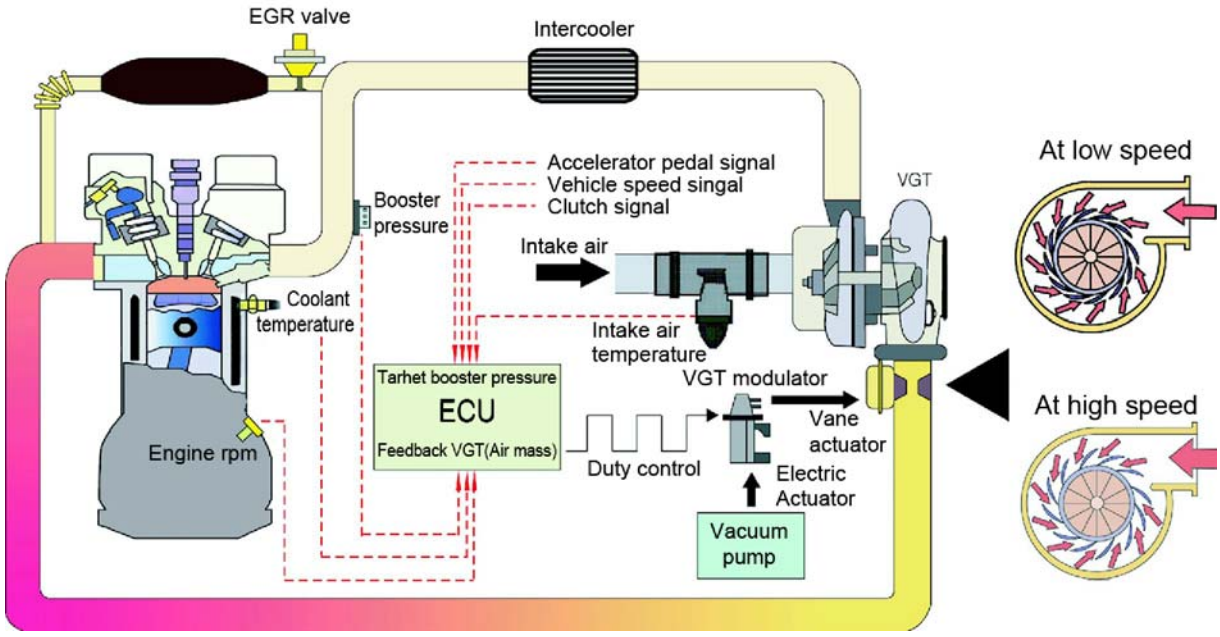


T-MAP sensor	HFM sensor	Coolant temperature sensor
		
Booster pressure and temperature	Improves the engine power	Operates the VGT according to engine warm-up

Modification basis	
Application basis	
Affected VIN	

3. INPUT/OUTPUT DEVICES





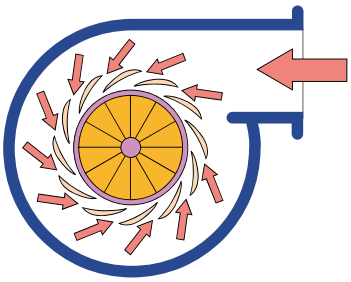
Modification basis	
Application basis	
Affected VIN	

4. OPERATING PRINCIPLES

The E-VGT is designed to get more improved engine power in all ranges by controlling the turbine as follows:

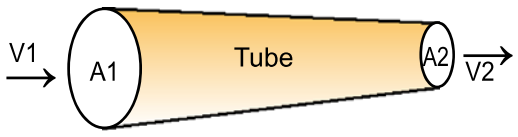
1) How it Works at Low Speed

Normal turbocharger cannot get the turbo effect because the amount of exhaust gas is not enough and the flow speed is slow in a low speed zone, but VGT allows the flow passage of exhaust to narrow, resulting in increasing the flow speed of exhaust gas and running the turbine quickly and powerfully. Therefore, as VGT can intake more air than normal turbocharger, it can give the benefit of the increased output even in a low speed zone.

Control range	Turbocharger driving mechanism	Control method	Effect	Improved performance
At low speed		Narrows the flow passage for the exhaust gas by folding the vanes	The flow rate is increased as the exhaust gas passes the narrow passage → Increased turbine & impeller speed, Increased compressive force	Improved low speed torque

※ **Basic principle at low speed**

At low speed, it utilizes the principle of venturi. For example, when air flows through the venturi tube, the flow speed is faster and the pressure is lower at the point "A". In this case, if the inner diameter of venturi is more narrowed, the flow speed is so much faster (refer to the equation).



V1 x A1 = V2 x A2 = Constant

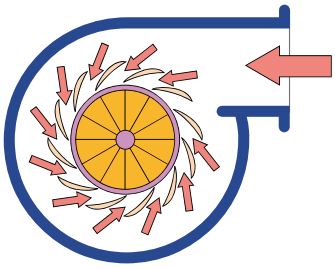
NOTE

Turbocharger lag

The turbocharger is at idle speed when there is no load or it is in the normal driving condition. During this period, the amount of exhaust gas passing through the turbine is not enough to turn the compressor wheel (impeller) fast. Therefore, the intake air is not compressed as needed. Because of this, it takes time for turbocharger to supply the additional power after the accelerator pedal is depressed. This is called "turbocharger lag".

2) How it Works at High Speed

In a high speed zone, the amount of exhaust gas increases and it is accompanied with a great force. Therefore, if the inner diameter of venturi is more widened, the turbine in the turbocharger by the releasing force of abundant exhaust gas can deliver a more increased energy to the compressor. The output will increase in submission to the increase of intake air volume.

Control range	Turbocharger driving mechanism	Control method	Effect	Improved performance
At high speed		Expands the flow passage for the exhaust gas by unfolding the vanes	The flow rate is increased due to the expanded passage→ Increased turbine & impeller speed, Increased compressive force	Improved maximum power

Modification basis	
Application basis	
Affected VIN	

LUBRICATION SYSTEM 1543-00

GENERAL INFORMATION

1. SPECIFICATION

Unit			Specification
Oil pump	Lubrication system		Gear pump, forced circulation
	Type		Inscribed gear
	Capacity		63 L at 4,000 rpm
	Relief pressure		5.8 bar ± 0.3 bar
Oil filter	Type		Full flow/Paper element
Engine oil	Specified oil		SAE 5W30 (approved by MB SHEET 229.51)
	Capacity (L)		Min.: 4.5 L Max.: 6.0 L
	Service interval	EU	Change every 20,000 km or 12 months (The service interval should be shortened under severe conditions)
		General	Change every 15,000 km or 12 months (The service interval should be shortened under severe conditions)
Oil injection nozzle	Type		Piston
	Operating pressure		1.5bar
	Closing pressure		1.0bar
	Oil flow		4 L/min
Oil pressure switch	Permissible pressure		10bar

CAUTION

The engine oil filter element should be changed at the same time with the engine oil.

- Regularly check the engine oil level and add the engine oil if necessary.
- Remember to check the engine oil level and shorten the cycle to replace the engine oil under severe driving conditions.

Severe Driving Condition

- Frequent stop-and-go traffic, extended idling, short driving distance below 6 km, driving distance below 16 km when the outside temperature remains below freezing
- Driving in a hilly or mountainous terrain, sandy, or dusty area
- High load driving such as trailer towing
- Taxi, patrol service or delivery service(extended idling and excessive driving with low speed)

2. MAINTENANCE

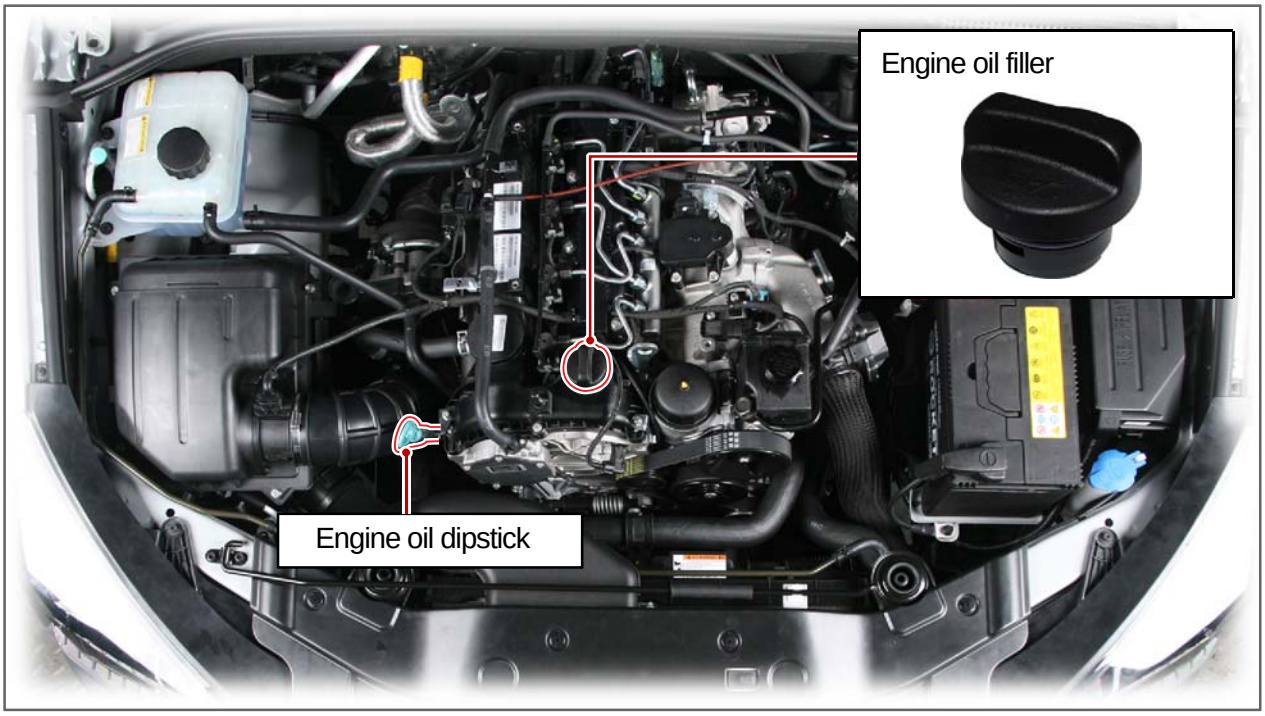
1) Level Check

Park the vehicle on a level ground and apply the parking brake. Stop the engine and wait more than 5 minutes.

- Pull out the dipstick and wipe it with a clean cloth. Reinsert it all the way.
- Pull out it again and check the oil level.
- The oil level should be between the maximum (Max) mark and minimum (Min) mark on the oil dipstick. Oil should be replenished before the level goes below the minimum mark.

WARNING

Operating vehicle with insufficient amount of oil can damage the engine. Make sure the engine oil level is correct and add oil if necessary.



2) Replenishment

If the level gets to the lower point, open the filler cap on top of the cylinder block and add the genuine oil without exceeding the level of the upper mark.
Recheck the oil level after 5 minutes.

CAUTION

- Regularly check the engine oil level and add Ssangyong genuine engine oil if necessary.
- Clean the dipstick with clean cloth so that any foreign materials cannot get into the engine.
- The oil should not go above the upper mark on the dipstick.
- The engine oil may be consumed more if the engine is new.

Modification basis	
Application basis	
Affected VIN	

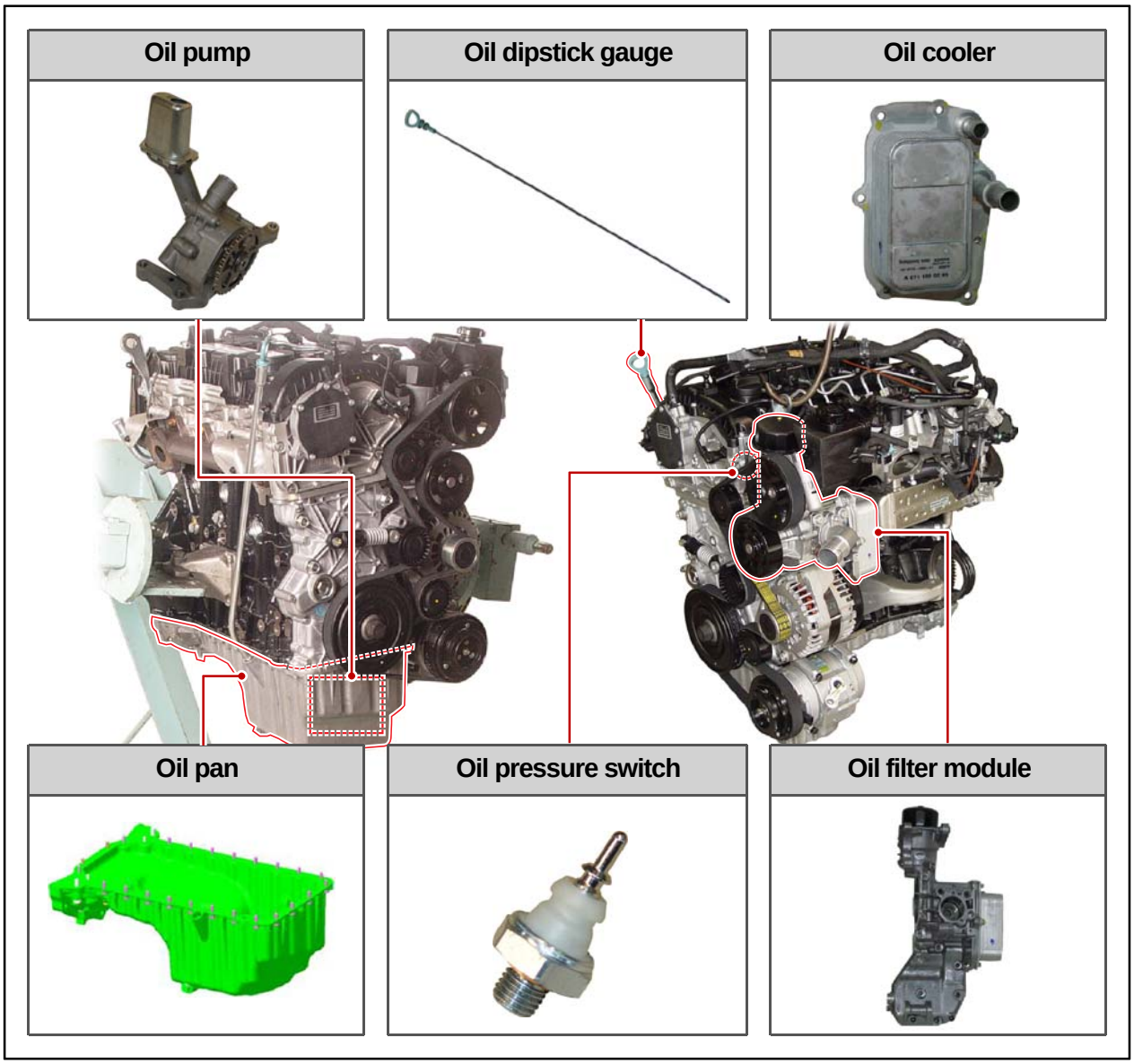
OVERVIEW AND OPERATING PROCESS

1. SYSTEM DESCRIPTION

1) Overview

The lubrication system supplies oil to each lubrication section to prevent friction and wear and to remove heat from the friction part. As the engine runs, frictional heat is generated on each lubrication section. If this condition persists, the bearing can be burned and stuck.
In other words, it creates an oil film on each sliding surface to convert solid friction to liquid friction in order to minimize wear and prevent temperature increasing on the friction part.
For the D20DTF engine with no oil pressure switch, the engine ECU receives the low engine oil level signal from the oil level sensor and communicates with the instrument cluster through the CAN communication to turn on the warning lamp.

2) Components



Modification basis	
Application basis	
Affected VIN	

2. FUNCTIONS OF LUBRICATION

1) Lubrication

It creates a viscous barrier between moving parts that reduces friction, which means less heat and longer life for those parts. As a lubricant, oil must maintain a protective film to prevent metal-to-metal contact. It must be fluid enough to allow easy starting and to circulate quickly through the engine, yet remain thick enough at higher operating temperatures and speeds to provide adequate lubrication.

2) Cooling

Combustion heat and friction energy must be removed from the engine in order to prevent its overheating. Most of heat energy is taken by the engine oil.
Clean oil passages, proper viscosity and low contamination provide sufficient flow rate of the engine oil and effective cooling.

3) Sealing

It helps to seal the space between the pistons and the cylinder walls so that compression is more effective and power is not lost during combustion.

4) Anti-corrosion

As a corrosion inhibitor, oil coats internal engine parts to prevent surface rust on the inside of the engine which can be caused by blow-by products and water formed in combustion. It must also be capable of neutralizing the acids that are formed by combustion blow-by and oil oxidation at high temperatures.

5) Cleaning

The small particles of dirt or other contaminants are suspended in oil and carried away to be filtered out. As a detergent, engine oil must be able to gather and suspend dirt and other contaminants until the oil can leave them as it passes through the filter and returns to the internal engine environment.

Modification basis	
Application basis	
Affected VIN	

COOLING SYSTEM 1520-00

GENERAL INFORMATION

1. SPECIFICATION

Unit	Description	Specification
Cooling system	Type	Water cooling, forced circulation
Coolant	Capacity	approx. 8.5 L
Radiator	Core size	555W x 582.4H x 27T (over 326,250mm2)
	Flow type	Cross flow
	Min. cooling capacity	over 68,000 kcal/h
Antifreeze	Type	SYC1025 (Long life coolant)
	Mixing ratio (water:antifreeze)	50 : 50
Cooling fan module	Type	Electric
	Capacity	Ø472 x 400W x 5B
	Control type	PWM type
Coolant reservoir	Capacity	over 1.5 L
	Circulation	Closed roof type
	Pressure cap	Screw type, 1.4bar
	Vacuum valve	Screw type, 1.4bar
Thermostat	Type	Wax pallet type
	Opening temperature	90˚C
	Fully open temperature	100˚C
	Valve lift	8 mm

2. INSPECTION

Problem	Possible Cause	Action
Coolant level is too low	- Leak from the radiator - Leak from the coolant auxiliary tank - Leak from the heater core	- Change the radiator - Change the coolant auxiliary tank - Change the heater
	- Leak from the coolant hose connections - Damaged coolant hose	- Reconnect the hose or replace the clamp - Change the hose
	- Leak from the water pump gasket - Leak from the water pump internal seal	- Change the gasket - Change the water pump
	- Leak from the water inlet cap - Leak from the thermostat housing	- Change the water inlet cap gasket - Change the thermostat sealing
	- Incorrect tightening torque of the cylinder head bolts - Damaged cylinder head gasket	- Tighten the bolts to the specified torque - Change the cylinder head gasket
Coolant temperature is too high	- Coolant leakage (Coolant level is low) - Improper coolant mixture ratio - Kinked coolant hose	- Add coolant - Check the coolant concentration (Anti-freeze) - Repair or replace the hose
	- Defective thermostat - Defective water pump - Defective radiator - Defective coolant auxiliary tank or tank cap	- Change the thermostat - Change the water pump - Change the radiator - Change the coolant auxiliary tank or tank cap
	- Cracks on the cylinder block or cylinder head - Clogged coolant passages in the cylinder block or cylinder head	- Change cylinder block or cylinder head - Clean the coolant passage
	- Clogged radiator core	- Clean the radiator core
	- Improper operation of cooling fan	- Replace the cooling fan or repair the related circuit
	- Defective temperature sensor or faulty wiring	- Replace the sensor or repair the related wiring
Coolant temperature is too low	- Thermostat is stuck open	- Change the thermostat
	- Improper operation of cooling fan	- Replace the cooling fan or repair the related circuit
	- Defective temperature sensor or faulty wiring	- Replace the sensor or repair the related wiring

Modification basis	
Application basis	
Affected VIN	

1) Coolant Level Check

1. Park the vehicle on level ground and apply the parking brake. Stop the engine and wait until it is cooled down.
2. The coolant level should be between the MAX and MIN mark on the coolant reservoir.
   Check the coolant level. If the level is below the "MIN" mark, immediately add coolant.



CAUTION

- Scalding hot coolant and steam could be blown out under pressure, which could cause serious injury. Never remove the coolant reservoir cap when the engine and radiator are hot.
- Avoid any direct contact of the coolant to the painted body of the vehicle.

2) Leak Test



1. Release the pressure in the system by loosening the pressure cap of the coolant reservoir slightly. Then, remove the pressure cap completely.

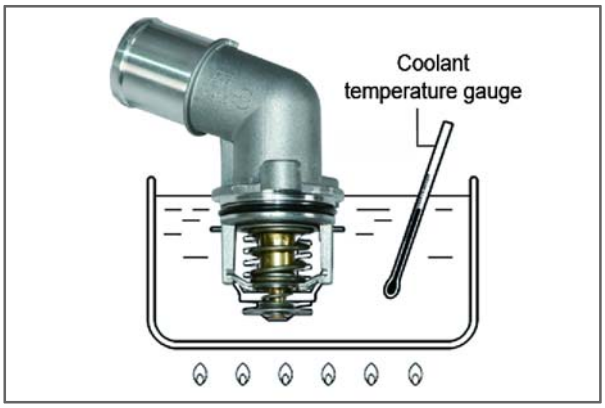
CAUTION

Never open the cap until the coolant temperature becomes under 90℃ to prevent any burn.



2. Add the coolant so that the coolant level is between MAX and MIN mark on the coolant auxiliary tank.
3. Connect the tester to the tank filler and apply pressure (1.4 bar).
4. Check all the coolant hoses, pipes and connections for leaks when the pressure of the tester drops, and replace or tighten, if necessary.

3) Thermostat



Immerse the thermostat into the water. Heat the water and check the valve opening temperature.

Valve opening temperature	90±2℃

Modification basis	
Application basis	
Affected VIN	

3. CAUTIONS

CAUTION

- If 100% of anti-freeze is added, the water pump vane can be damaged and thermal conductivity can be decreased resulting in poor circulation in the cooling system which leads to overheated engine.
- Use of non-recommended coolant could cause damage to the cooling system and overheating of the engine.
- Opening the coolant reservoir cap while the engine is running or hot can cause burns by hot steam or water.
- To open the coolant reservoir cap, wrap the cap with a wet towel or thick cloth after the engine is cooled down sufficiently.
- If cool water is added to the heated engine, the engine or radiator can be deformed.
- The anti-freeze in the coolant can damage the painted surface, so avoid the contact of the coolant to the painted body.
- The anti-freeze and water should be mixed in proper mixture ratio. Never add only water when adding coolant.
- If the anti-freeze content is too low, the coolant can be frozen while the engine can be overheated if anti-freeze content is too high.

OVERVIEW AND OPERATING PROCESS

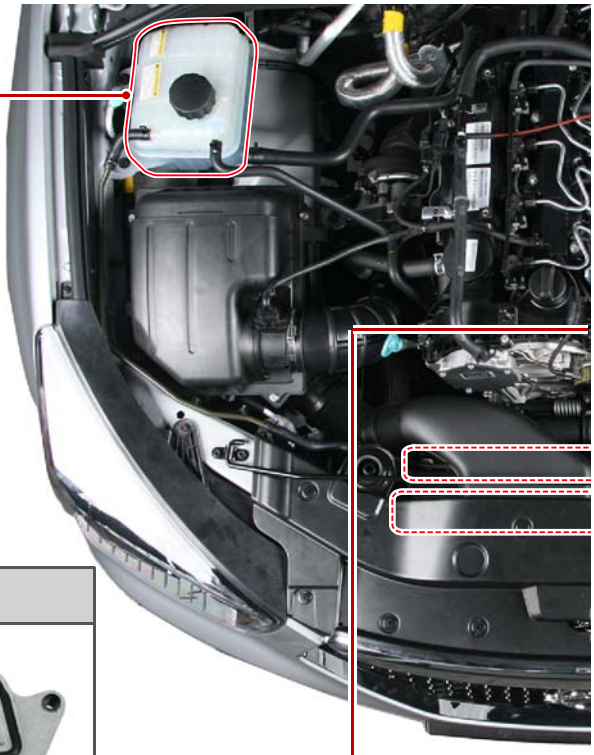
1. SYSTEM DESCRIPTION

1) Overview

Coolant reservoir



Long life coolant is used.



Water pump



Water pump



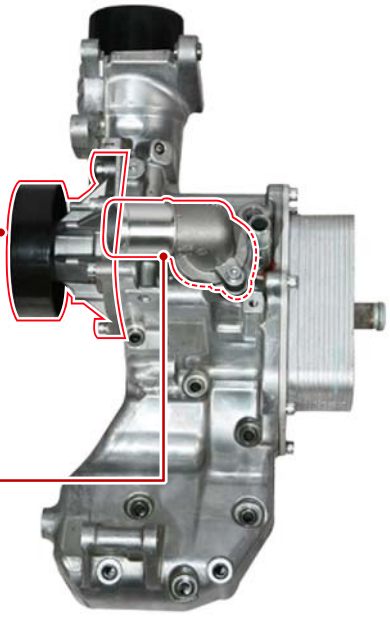
The water pump is driven by the engine drive belt and supplies the coolant to each area of the engine.

Thermostat

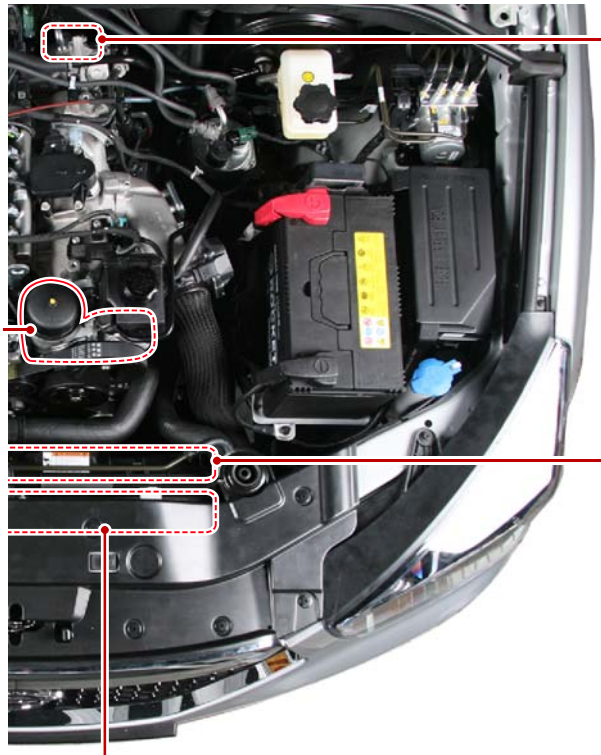


When the engine coolant reaches 90℃, the thermostat starts to open (fully open at 100℃) and lets the coolant flow to the radiator to maintain the engine temperature.

Oil filter module



Modification basis	
Application basis	
Affected VIN	



Coolant temperature sensor



Measures the coolant temperature and sends the result to the engine ECU.

Electric fan



Circulates the fresh air forcibly to exchange heat with the radiator core fin.

Radiator



Releases heat through fins and cools down the hot coolant as the coolant passes through the tube of the radiator core.

Modification basis	
Application basis	
Affected VIN	

CHARGING SYSTEM 1451-01

GENERAL INFORMATION

1. SPECIFICATION

Unit	Description		Specification
Alternator	Crankshaft pulley : Alternator pulley		1 : 2.94
	Normal output (idling/2200 rpm)		70/120 A
	Regulator voltage		14.6 V
	Brush	Length	12.5 mm
		Wear limit	7 mm
Battery	Type		MF
	Capacity		90 AH

2. INSPECTION

1) Alternator Output Test

Item	How to check	DTC set value / Action
Output current	1. Disconnect the cable connected to the B terminal on the alternator. Connect one end of the ammeter to the B terminal and the other end to the cable connected to the B terminal. 2. Measure the maximum output value. (Maintain the engine speed between 2,500 and 3,000 rpm.) (Turn the headlamp and all the electrical switches on.)	- Pass: If the measured current is 45 A or higher. - Fail: If the measured current is less than 45 A. - Check the current of the B terminal.
B terminal current	1. Move the gear selector lever to the neutral position. 2. Maintain the engine speed at 2,500 rpm with the vehicle unloaded. (Turn all the electrical switches off.)	- Open circuit: If the measured current is 5 A or higher.
Rotor coil resistance	1. Disconnect the negative cable from the battery. 2. Remove the B terminal and turn off the ignition switch. 3. Measure the resistance between the L and F terminals with an ohmmeter.	- Pass: If the measured resistance is between 3 and 6 Ω. - Faulty rotor coil or slip ring: If the measured resistance is less than 3 Ω or greater than 6 Ω.
L terminal voltage	1. Connect the B terminal wiring. 2. Measure the voltage with the engine running.	- Specification: 12.5 V to 14.5 V - Faulty IC regulator or field coil: If the measured voltage is 14.5 V or higher.

CAUTION

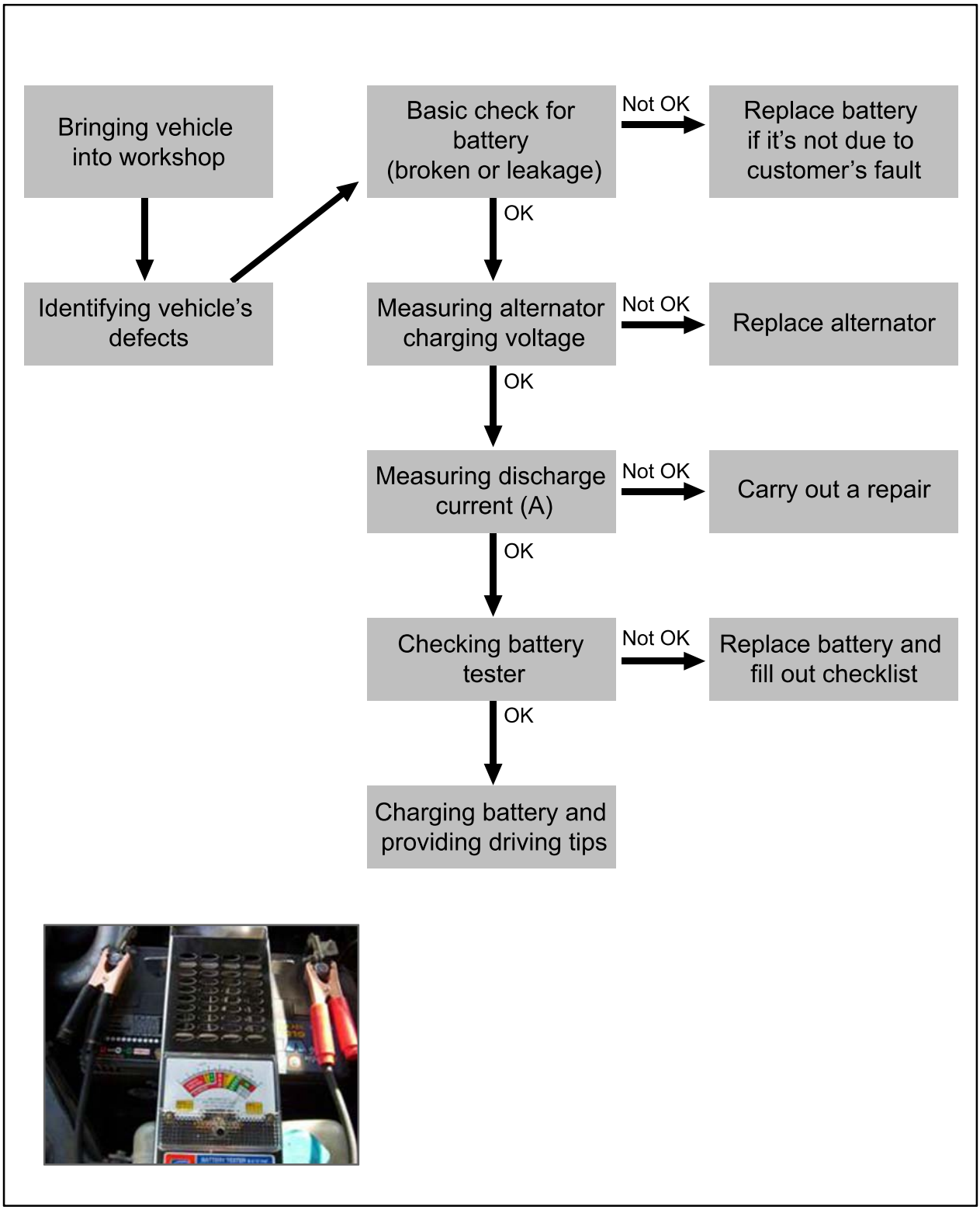
- Disconnect the negative battery cable.
- Connect the negative cable again after connecting the ammeter.

Modification basis	
Application basis	
Affected VIN	

2) Troubleshooting for Alternator

Item	Cause	Action
Overcharged battery	Defective alternator voltage regulator	Replace the alternator
	Defective voltage detection wiring	Repair or replace
	Loose alternator drive belt	Adjust the belt tension or replace
Discharged battery	Poor connection of related circuit or open circuit	Retighten the loose connection or repair open circuit
	Defective alternator voltage regulator	Replace the alternator
	Defective alternator voltage regulator	Replace the alternator
	Terminated battery	Replace the battery
	Defective ground	Repair
Charge warning lamp does not come on when turning on ignition switch with engine stopped	Defective alternator voltage regulator	Replace the alternator
	Open circuit in charge warning lamp, fuse or wiring	Replace or repair the charge warning lamp or fuse
	Defective ignition switch	Replace the ignition switch
	Defective ground of alternator circuit	Repair
Charge warning lamp is not turned off after starting engine	Defective alternator voltage regulator	Replace the alternator
	Corroded or worn battery cable	Repair or replace the battery cable
	Loose alternator drive bel	Replace the batteryAdjust the belt tension or replace the belt
	Defective wiring harness	Repair or replace

3) Checking Battery



Modification basis	
Application basis	
Affected VIN	

(1) Checking

▶ **Using battery tester**

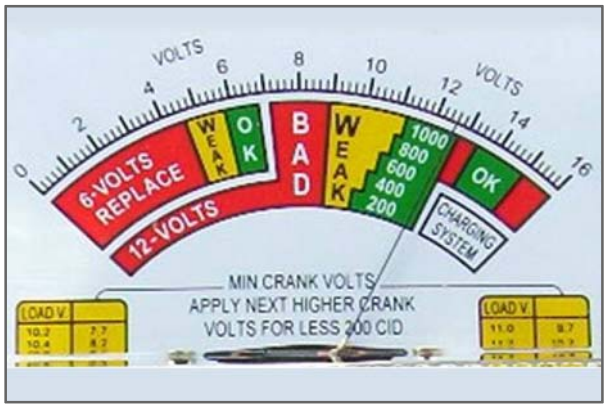
- PASS (11.0 V or more): Explain to the customer that the battery is reusable.
- Need to be charged (9.0 to 11.0 V): Charge the battery with a charger and reinstall it. Explain it to the customer.
- Need to be replaced (9.0 V or more): The battery should be replaced due to overdischarging.

(2) How to use battery tester



▶ **How it works and How to use it**

- Determine battery capacity by fixing current (load capacity) and time and varying voltage. Determine battery capacity based on the
- amount of voltage drop when discharging a fixed load capacity (120 A) for 5 seconds. Connect the tester to the battery and read the display while applying a load for 5 seconds.
-



▶ **How to read display**

- Red area (①): overdischarge or faulty battery
- Yellow area (②): Need to be charged (using a vehicle alternator and a battery charger) Green area (③): Normal
- Red area on the left-hand side of OK (④):
- Impossible to charge with an alternator Green area with OK (⑤): Normally charged
- Red area on the right-hand side of OK (⑥): Overcharged by an alternator태
-

(3) Starting with jumper cable

If the battery is weak or terminated, the battery from another vehicle can be used with jumper cables to start the engine.

▶ Connecting order

1. The positive (+) terminal of the discharged battery
2. The positive (+) terminal of the booster battery
3. The negative (-) terminal of the booster battery
4. Connect one end of the other jumper cable to the body of the discharged vehicle, such as the engine block or a front towing hook.

▶ Starting

1. Prepare a set of jumper cables.
2. Place another vehicle that has the same 12 V of power near to the discharged vehicle.
3. Switch off all electrical accessories for the discharged vehicle.
4. Apply the parking brake and shift the transaxle to the P position (automatic transaxle) or neutral (N) position (manual transaxle).
5. Connect the jumper cables.
6. Try to start the discharged vehicle while accelerating the engine rpm in the booster vehicle.
7. Attempt to start the engine with the discharged battery.
8. After starting the engine, carefully disconnect the jumper cables in the reverse sequence of connection.



Modification basis	
Application basis	
Affected VIN	

(4) Maintenance

If the charge warning lamp ( ) on the instrument cluster comes on while driving, there is a malfunction in the charge system including the battery. Therefore, carrying out the system check is needed.



- Make sure that the battery cables are firmly connected.
- If the terminals are corroded, clean them with a wire brush or sandpapers.
- Always disconnect the battery cables with the ignition key removed. When disconnecting the battery cables with the ignition key turned to ON or ACC position, several electric units can be damaged due to sudden voltage change.
- Check the battery for crack, damage or fluid leaks. Replace it if necessary.
  Wipe out the battery fluid on the battery surface using a rubber glove and a clean cloth wetted with soapy water.

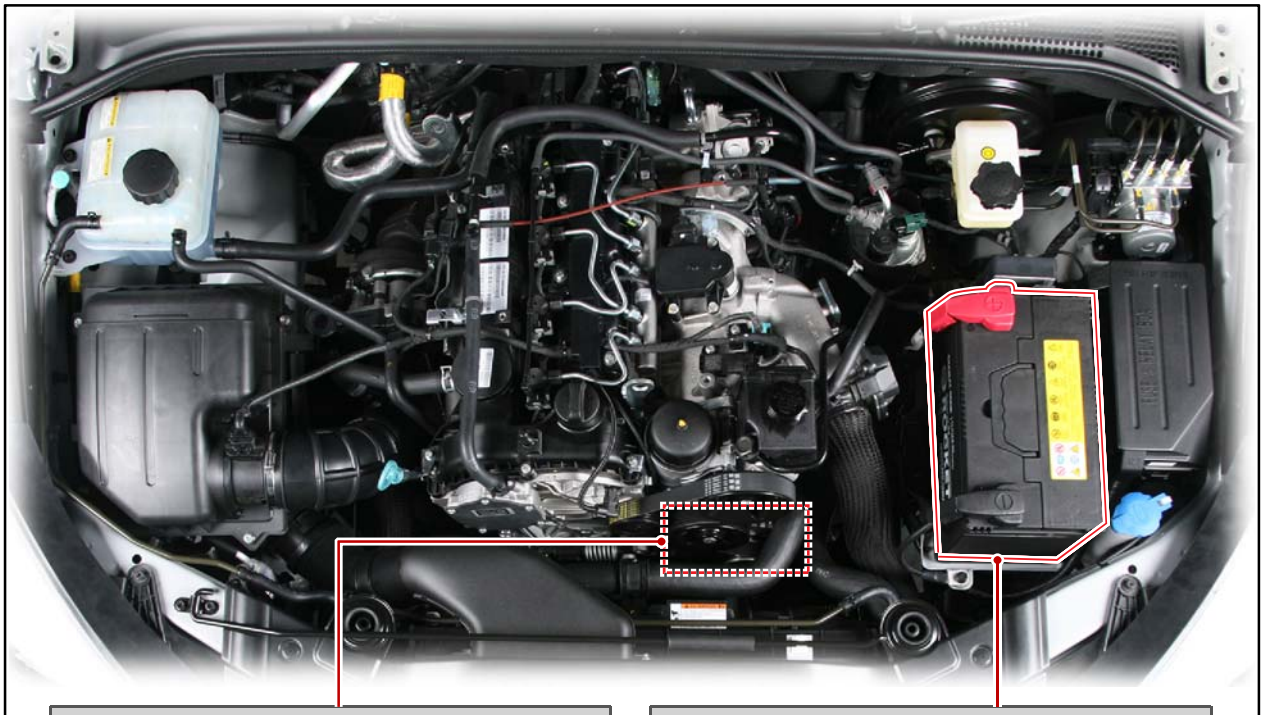
OVERVIEW AND OPERATING PROCESS

1. SYSTEM DESCRIPTION

1) Overview

The charge system is designed to supply electrical energy to the vehicle while driving, and supplies a constant direct current voltage by converting mechanical rotational movement to electrical energy.
The voltage regulator on the back of the alternator controls the generated voltage in all rotating ranges and adjusts the system voltage according to the electric load and ambient temperature change.

2) System Layout (Locations)

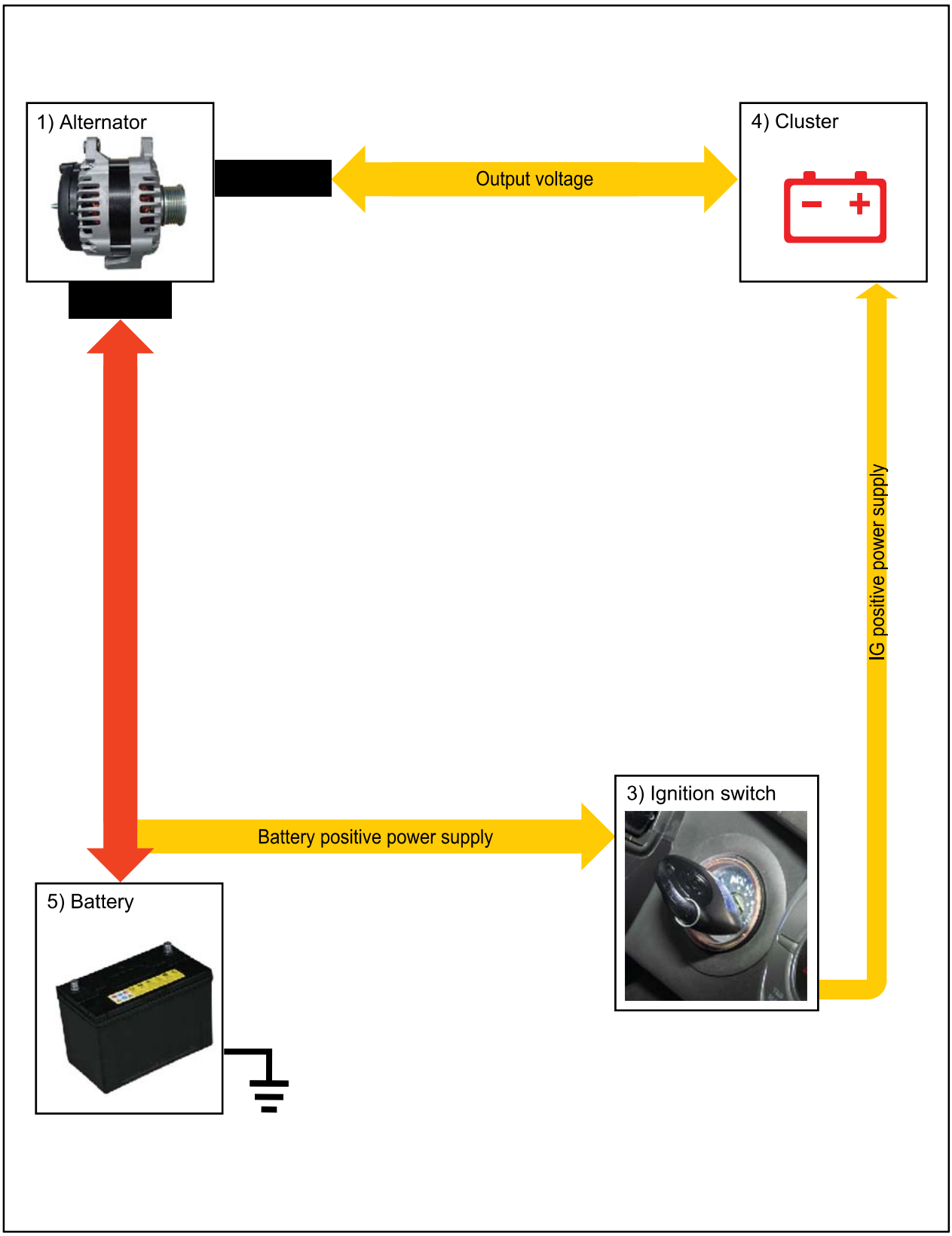


Alternator	Battery
	
The alternator charges the battery and supplies power to each electric unit by converting the mechanical energy to the electrical energy.	It converts the chemical energy to the electrical energy and supplies power to the corresponding electric units when starting the engine.

Modification basis	
Application basis	
Affected VIN	

2. OPERATING PROCESS

1) Charging Flow



Modification basis	
Application basis	
Affected VIN	

2) Charging

The alternator uses a new regulator which has three diodes. It consists of the delta stator, rectifier bridge, slip ring and brush.

▶ **Charging time according to vehicle conditions and environment**

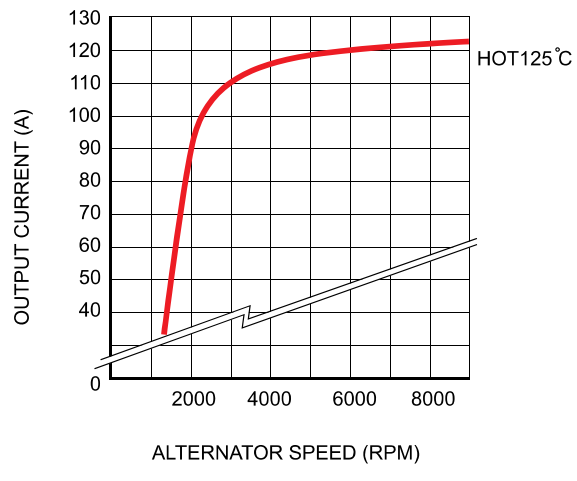


Specification: Charging a fully depleted high-capacity battery takes twice or more as long as charging a fully depleted battery for small vehicles.
Temperature: The lower the temperature is, the longer the time taken to charge the battery. When connecting the battery charger to the cold battery, the amount of current the battery can accept initially is very small. As the battery gets warmer, it can accept more current.

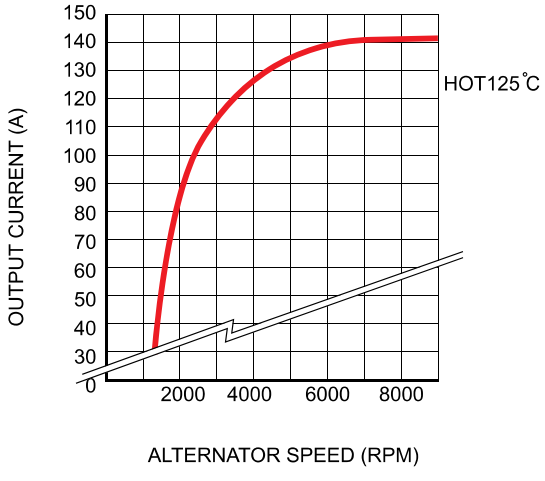
Charging capacity: Charging a battery with a low-capacity charger takes longer time than charging with a high-capacity charger.
Charging status: Charging a fully depleted battery takes twice or more as long as charging a half-depleted battery. Since the electrolyte in a fully depleted battery consists of nearly pure water and conductor, only a very small amount of current can be accepted by the battery initially. The charging current increases as the amount of acids in the electrolyte is increased by the charging current.

3) Output Characteristics

Alternator (120 A)

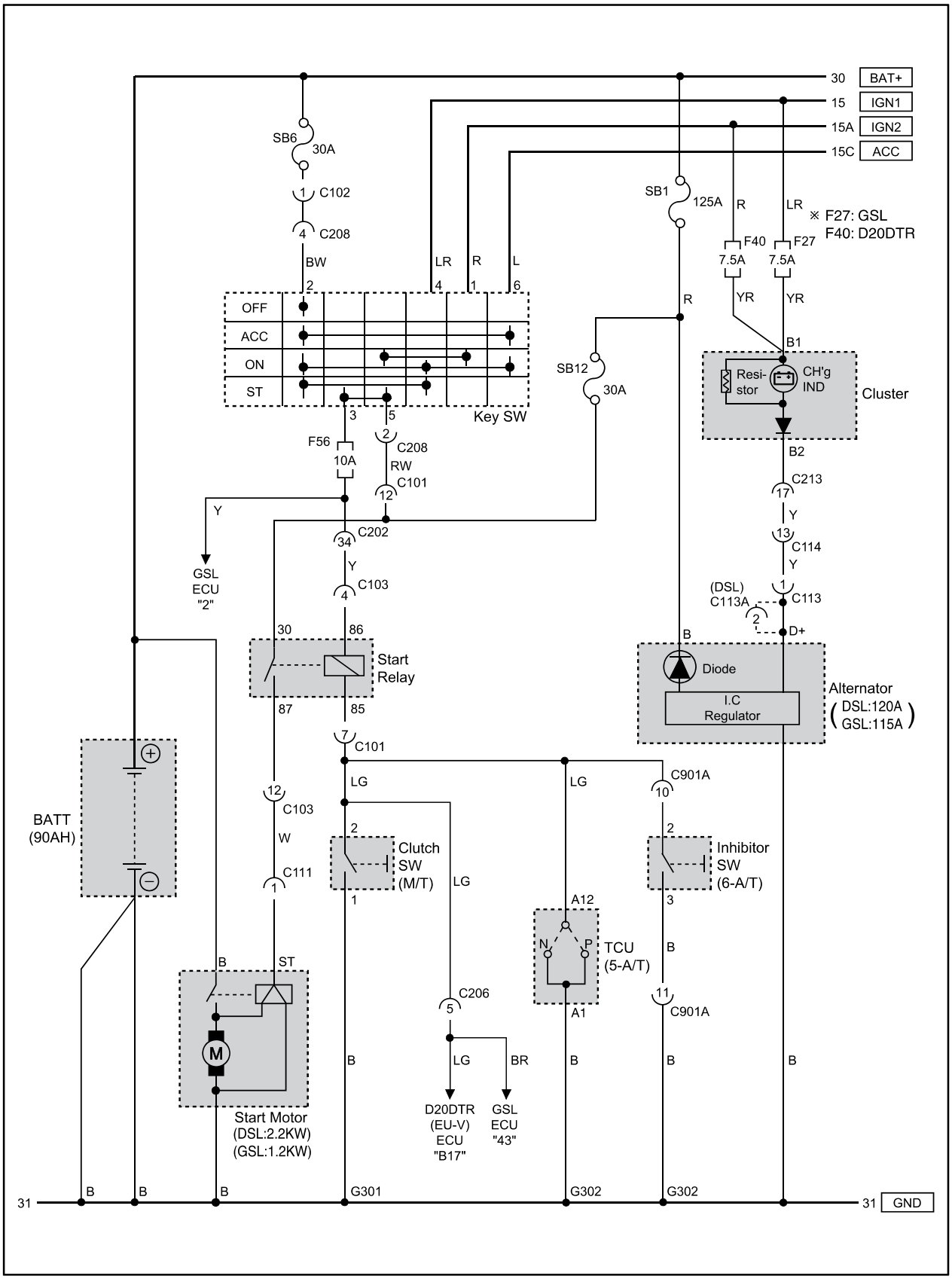


Alternator (140 A)



Modification basis	
Application basis	
Affected VIN	

3. CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	

D20DTR PRE-HEATING

1413-00

GENERAL INFORMATION

1. SPECIFICATION

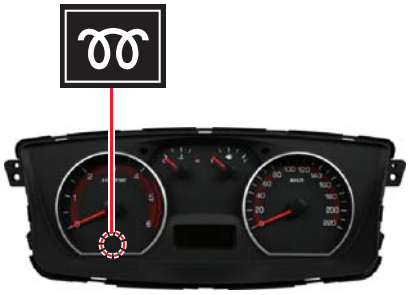
Description		Specification
Glow plug	Rated voltage	12 V
	Maximum temperature	1100°C
	Operating temperature	1080 ~ 1100°C
Glow plug control unit	EMS operating voltage	6 ~ 16 V
	Operating temperature	−40°C ~ 110°C
	Dark current	Max. 1 mA

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

The pre-heating system for D20DTR engine has the glow plug to the cylinder head (combustion chamber), and improves the cold start performance and reduces the emission level.
The pre-heating resistor (air heater) is used to heat the intake air.
This enables the diesel fuel to be ignited in low temperature condition.
The ECU receives the information such as, engine rpm, coolant temperature, engine torque, etc., through CAN communication during pre-heating process; and the pre-heating control unit controls the pre-heating, heating during cranking and post-heating by the PWM control.

Glow indicator



Engine ECU (D20DTR)





Glow plug



Tightening torque 20 ± 2.0Nm

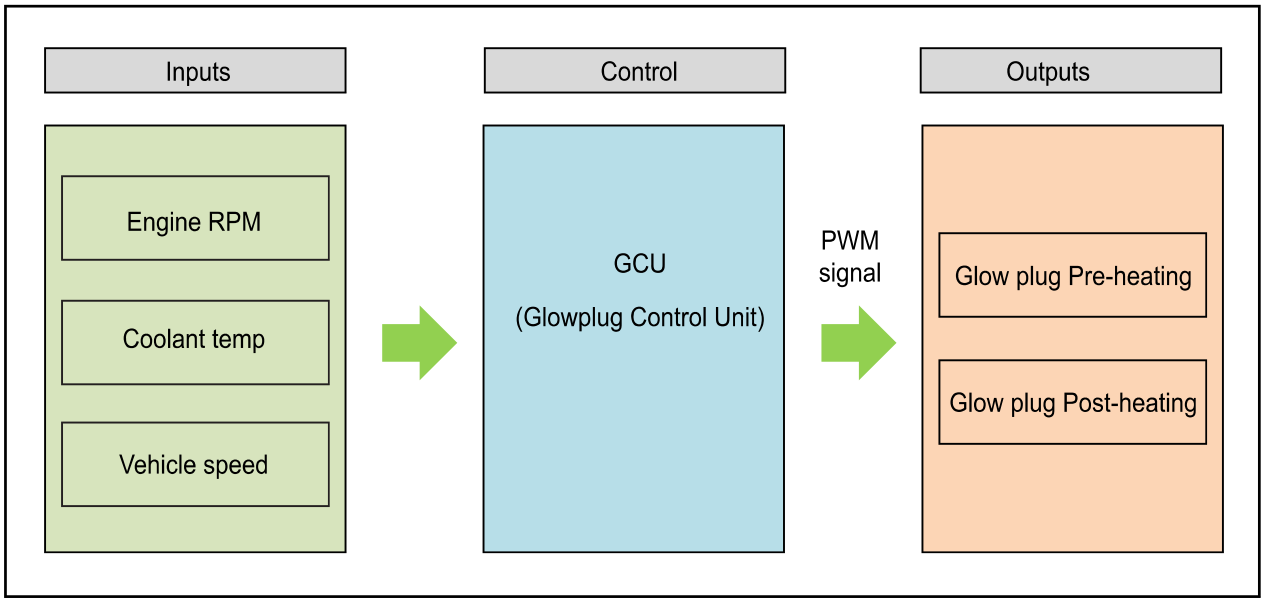
Glow plug control unit (GCU)



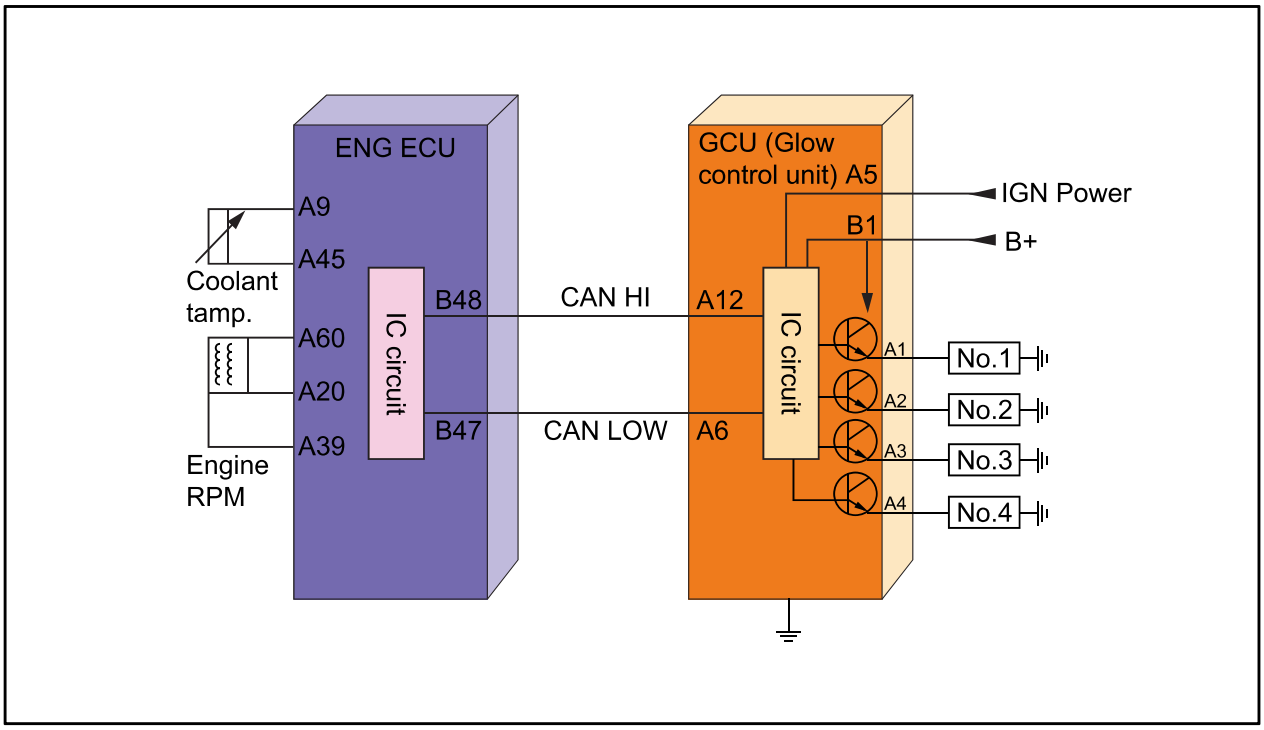
Modification basis	
Application basis	
Affected VIN	

2. SYSTEM OPERATION

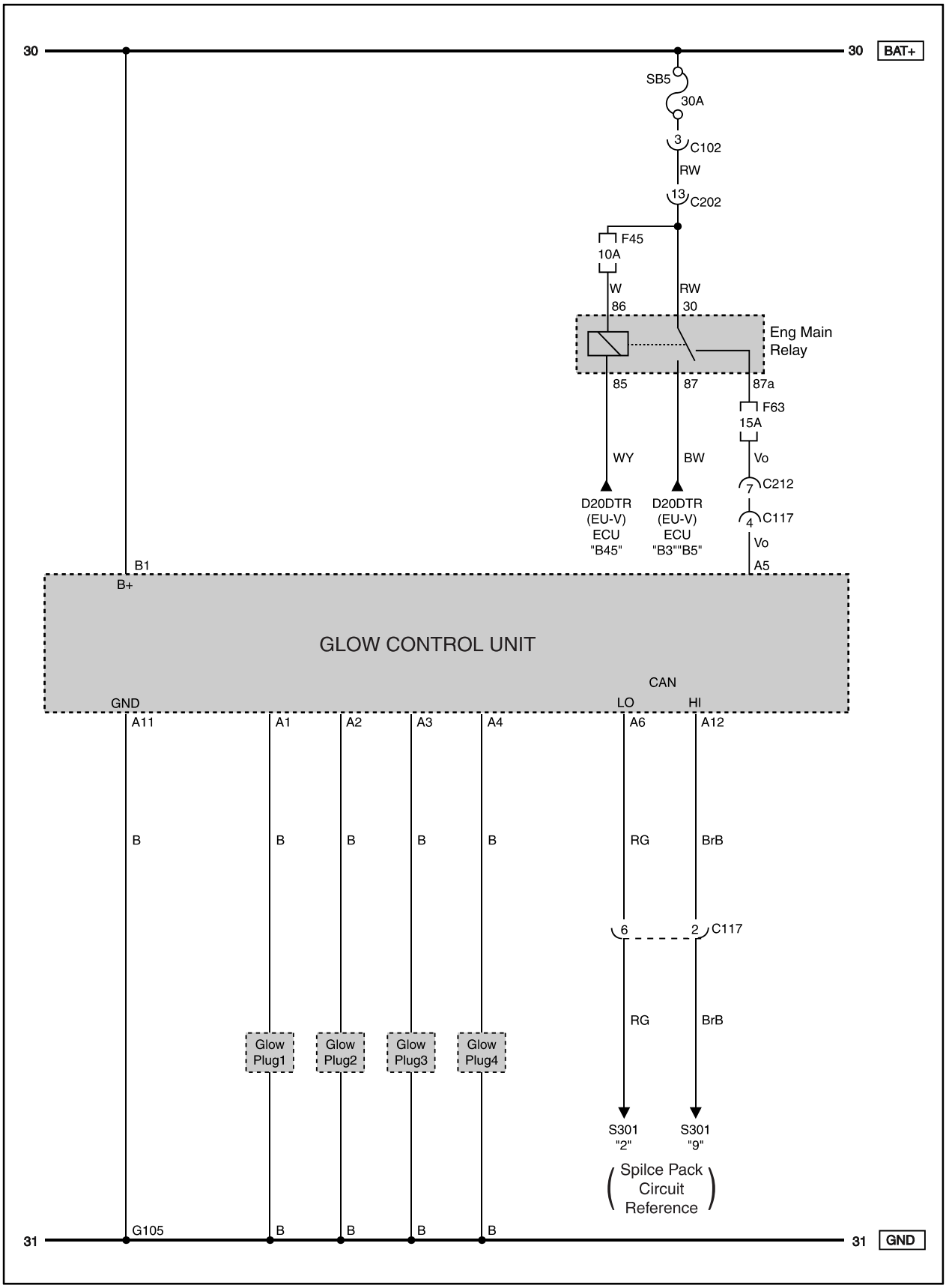
1) Input/Output Diagram of Glow Plug Control Unit



2) System Diagram



3) Circuit Diagram

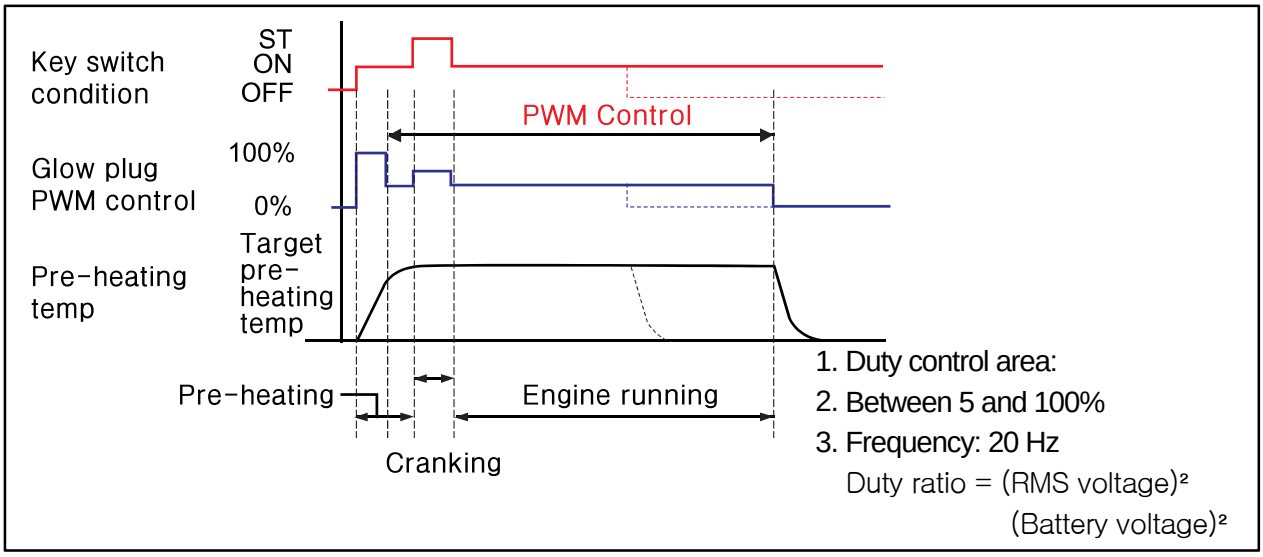


Modification basis	
Application basis	
Affected VIN	

4) Operation

Glow plug is installed in the cylinder head. It enhances the cold starting performance and reduces the exhaust gas during cold starting.

(1) Operation



▶ **Pre-Glow: Step 1**

If normal communication with the ECU is established 2 seconds after the power is supplied to the IGN terminal from the battery, the GCU supplies the battery power to raise the temperature of the glow plug to 1000℃ by the pre-heating request from the engine ECU before starting.

- The time for pre-heating is controlled by the ECU.

Pre-heating	**Coolant temperature**	−30°C	−25°C	−20°C	−10°C	−5°C	0°C	20°C
	Operating time	28 s	25 s	15 s	5 s	2 s	2 s	0 s
	Operating conditions	- IGN: ON - B+: below 15.2 V			**Stop conditions**	- Time-out - IGN: OFF - when engine cranking		

1. If the input power (VB) is 11.5 V or less, the GCU supplies the battery power for arrival time (T1).
   If the input power (VB) is greater than 11.5 V, the GCU supplies the voltage of 11.5 V for arrival time
2. (T1).

NOTE

The time for pre-heating by coolant temperature can vary slightly depending on e.g. other vehicle operation elements.

▶ During cranking: Step 2 and step 3

1. Step 2: If the ECU receives the cranking signal after pre-heating (step 1), the GCU supplies the voltage of 6.8 V for 1 sec to raise the temperature to 1,100℃.
2. Step 3: The GCU supplies the voltage of 5.1 V to keep the temperature at 1,000°C.

* Under fixed temperature: The AQGS unit supplies power for 30 seconds (Step 1 + Step 3) if no cranking signal is received after the step 1.

* At cranking: The step 3 is started after the step 2.

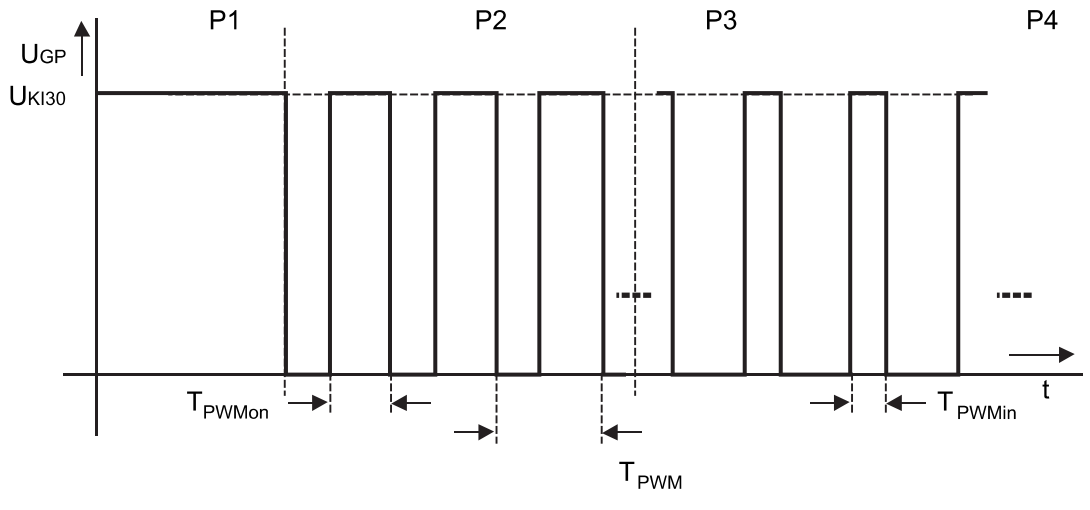
▶ Post-glow: Step 4:

The post-heating is for reducing HC/CO after the engine is started. If the time for post-heating exceeds 180 sec., the GCU unit cuts off the power to each glow plug even if there is pre-heating request from the engine ECU.

Post-heating	**Operating time (approx.)**	−20°C	−10°C	0°C	20°C	80°C
	Operating time (approx.)	100 s	50 s	25 s	10 s	10 s

▶ Emergency glow

If no CAN signal is received for 4 seconds from the engine ECU after the IGN ON signal is input, the GCU performs emergency preheat (Step 3) for 30 seconds.



P1 to P2: Pre glow
P3 to P4: Post glow

Modification basis	
Application basis	
Affected VIN	

STARTING SYSTEM 1461-01

GENERAL INFORMATION

1. SPECIFICATION

Description	Specification
Capacity	12 V, 2.2 kW
Engagement	Meshed type
Rotating direction	Clockwise
Pinion gear manufacturing	Cooled forging
Solenoid operating voltage	Max. 8 V
Weight	2.5 kg
Bracket manufacturing	Aluminum die casting

2. TROUBLESHOOTING

Problem	Possible Cause	Action
Engine will not crank	Low battery voltage	Charge or replace
	Loose, corroded or damaged battery cable	Repair or replace
	Faulty starter or open circuit	
	Faulty ignition switch or blown fuse	Repair or replace
	Poor engine ground	Repair
Engine cranks too slow	Low battery voltage	Charge or replace
	Loose, corroded or damaged battery cable	Repair or replace
	Faulty starter	
Starter does not stop	Faulty starter	
	Faulty ignition switch	Replace
Engine cranks normally, but does not start	Broken pinion gear or faulty starter	Replace the starter
	Broken flywheel ring gear	Replace
	Open circuit	Repair

Modification basis	
Application basis	
Affected VIN	

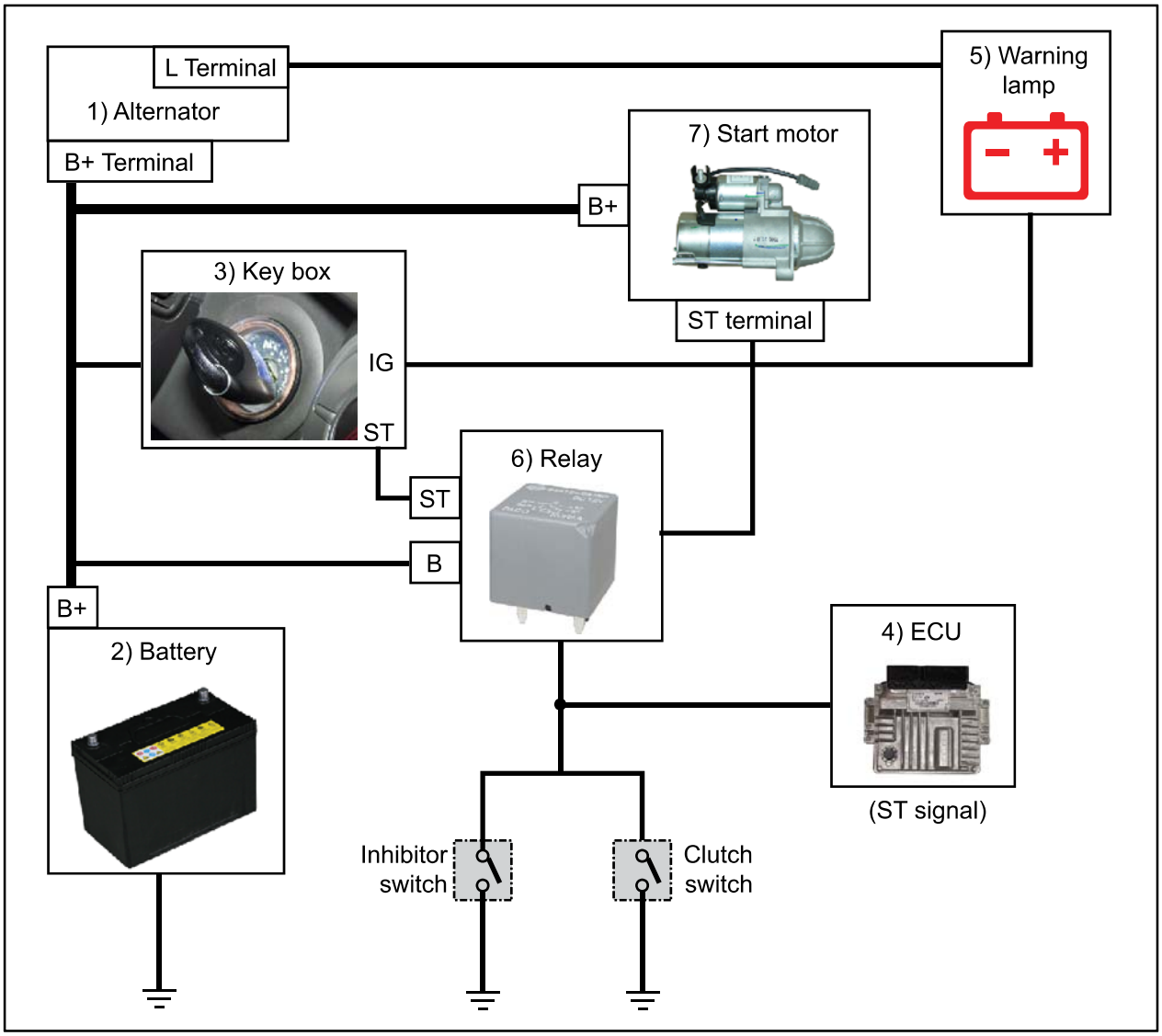
OVERVIEW AND OPERATING PROCESS

1. SYSTEM DESCRIPTION

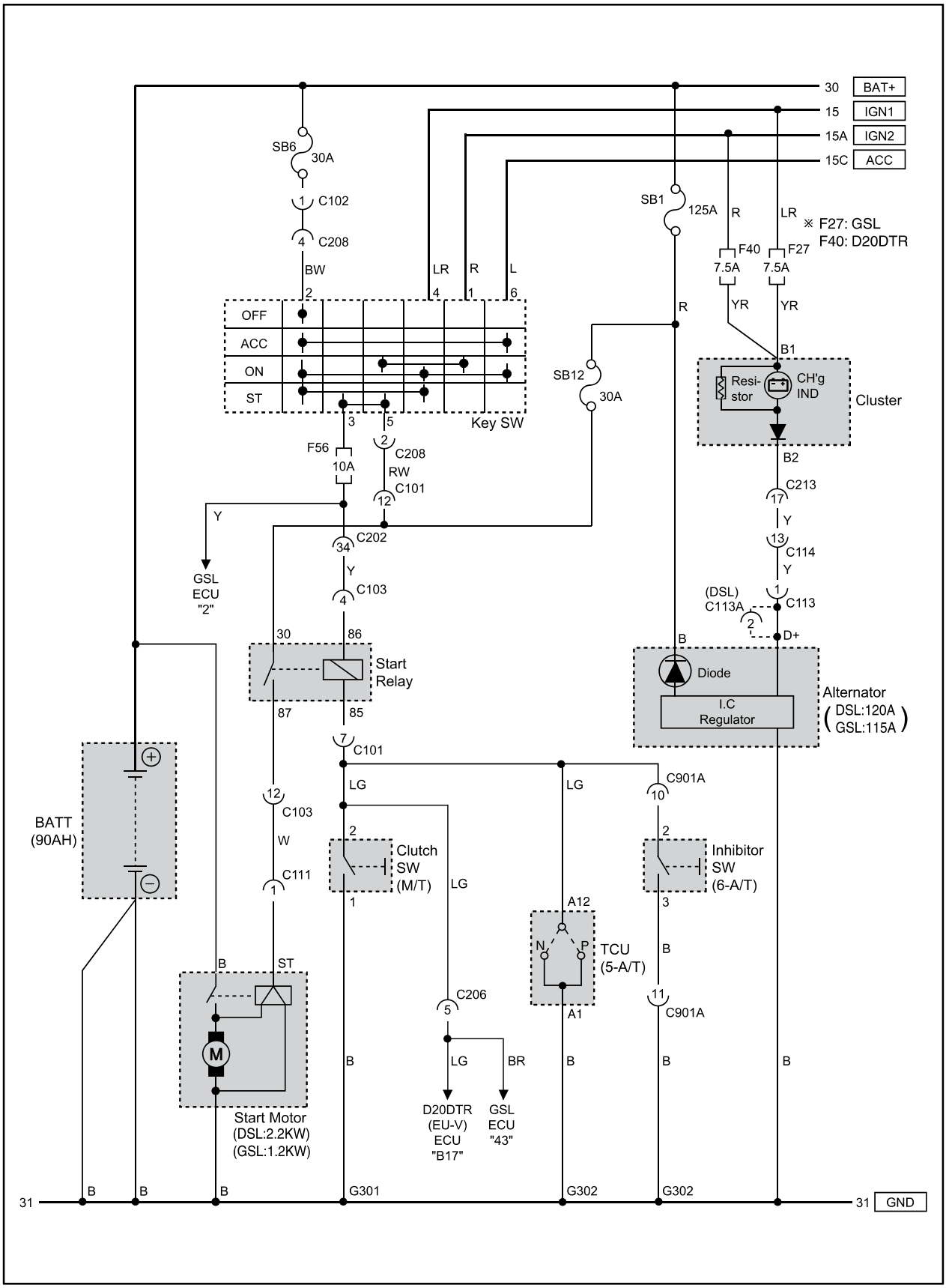
The starter (start motor) starts the engine with rotational power by converting the electric energy to the mechanical energy.
When the engine is cranking, the pinion gear meshes with the ring gear. If the ring gear overruns, the pinion gear clutch overruns to protect the pinion gear.

2. OPERATING PROCESS

1) System Layout



2) Circuit Diagram



Modification basis	
Application basis	
Affected VIN	

CRUISE CONTROL SYSTEM 8510-23

OVERVIEW AND OPERATION PROCESS

1. CRUISE CONTROL SWITCH



The cruise control is an automatic speed control system that maintains a desired driving speed without using the accelerator pedal.
The vehicle speed must be greater than 36 km/h to engage the cruise control. This feature is especially useful for motorway driving.

CAUTION

The cruise control system is a supplementary system, which helps the driver to drive the vehicle at a desired speed without using the accelerator pedal under the traffic condition where the vehicle-to-vehicle distance meets the legal requirement.

1) Traffic Conditions for Using Cruise Control

Use the cruise control system only when the traffic is not jammed, driving on motorways or highways where there is no sudden change in the driving condition due to traffic lights, pedestrian, etc.

WARNING

Improper use of the cruise control could be dangerous.
- Do not use on winding roads.yy
- Do not use in heavy traffic.yy
- Do not use on slippery, wet roads.

This could result in a loss of control, collision, and/or personal injuries.

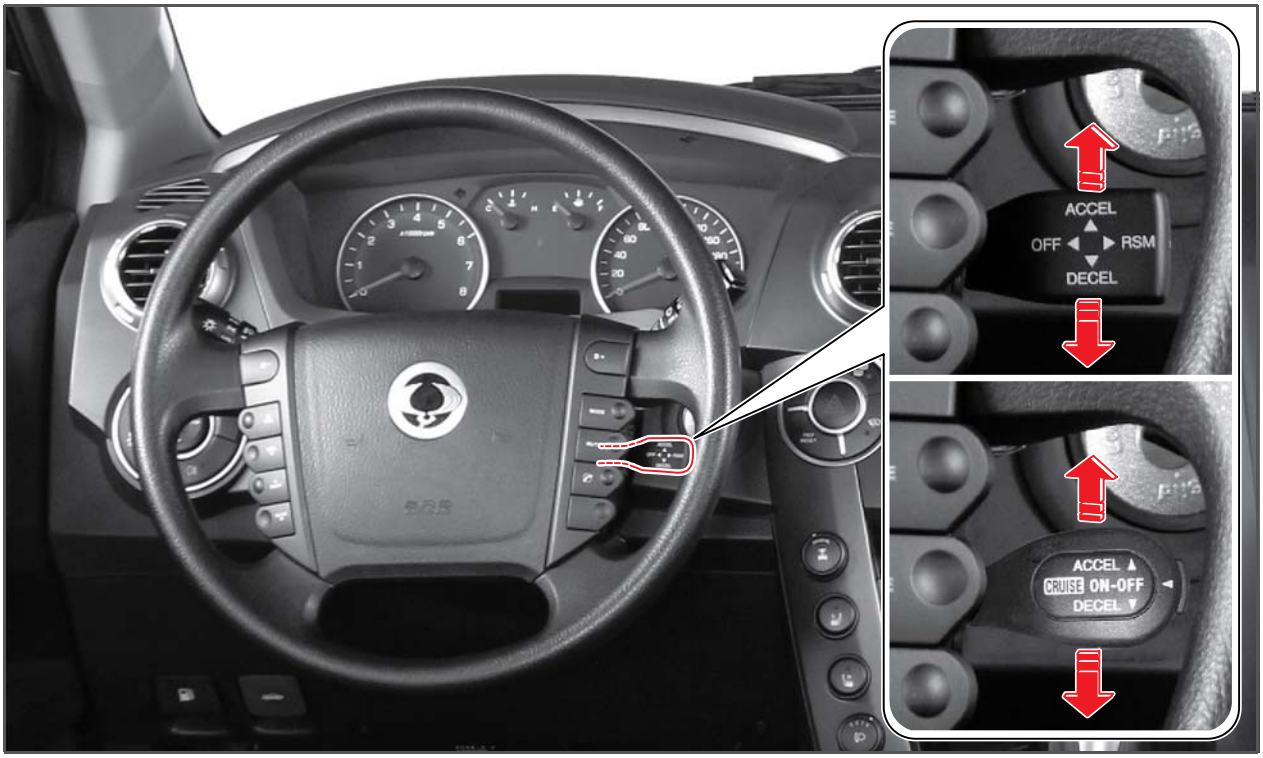
NOTE

The described speed value may vary slightly depending on the road conditions.

Modification basis	
Application basis	
Affected VIN	

2. HOW TO OPERATE CRUISE CONTROL SWITCH

1) Setting a Desired Speed



1. To operate the cruise control, accelerate to the desired speed, which must be more than 36 km/h (23 MPH) and less than 150 km/h (90 MPH).
2. When the desired speed is reached, push up the ACCEL switch of the cruise control lever or push down the DECEL switch for 1 second per one switching and then release the accelerator pedal slowly.
3. Now, the vehicle is cruised by this system with the set speed.
4. And you can set to other vehicle speeds again with above steps after an accelerator pedal intervention during the cruise control running.

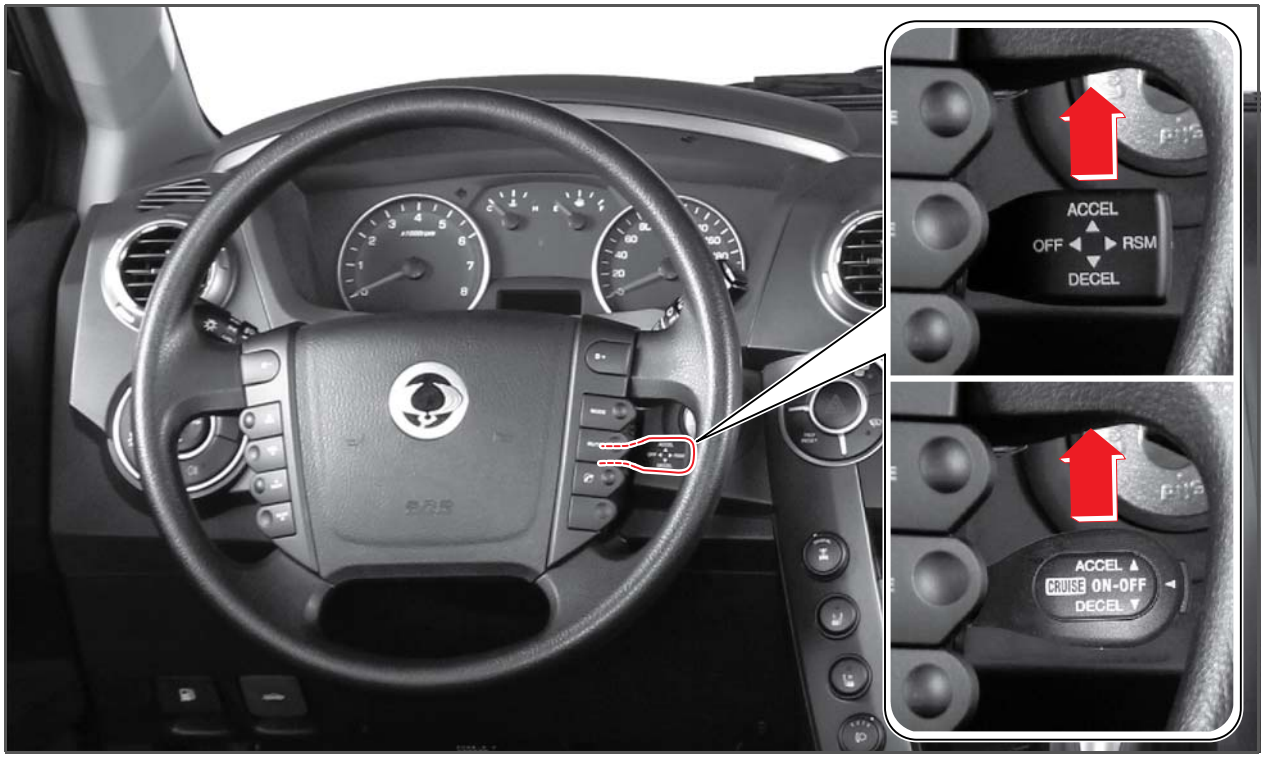
CAUTION

Never use the cruise control system until you get used to it.
Improper use or not fully aware of this function could result in collision and/or personal injuries.

(1) Manual transmission equipped vehicle

The cruise control is only available when the 3rd or higher speed gear is engaged.

2) Accelerating with the Cruise Control System



(1) While the cruise control system is running

1. Push up the ACCEL switch of the cruise control lever and hold it until the desired speed is reached without an accelerator pedal intervention.
2. When the desired speed is reached, release the lever.

(2) While the cruise control system is not running

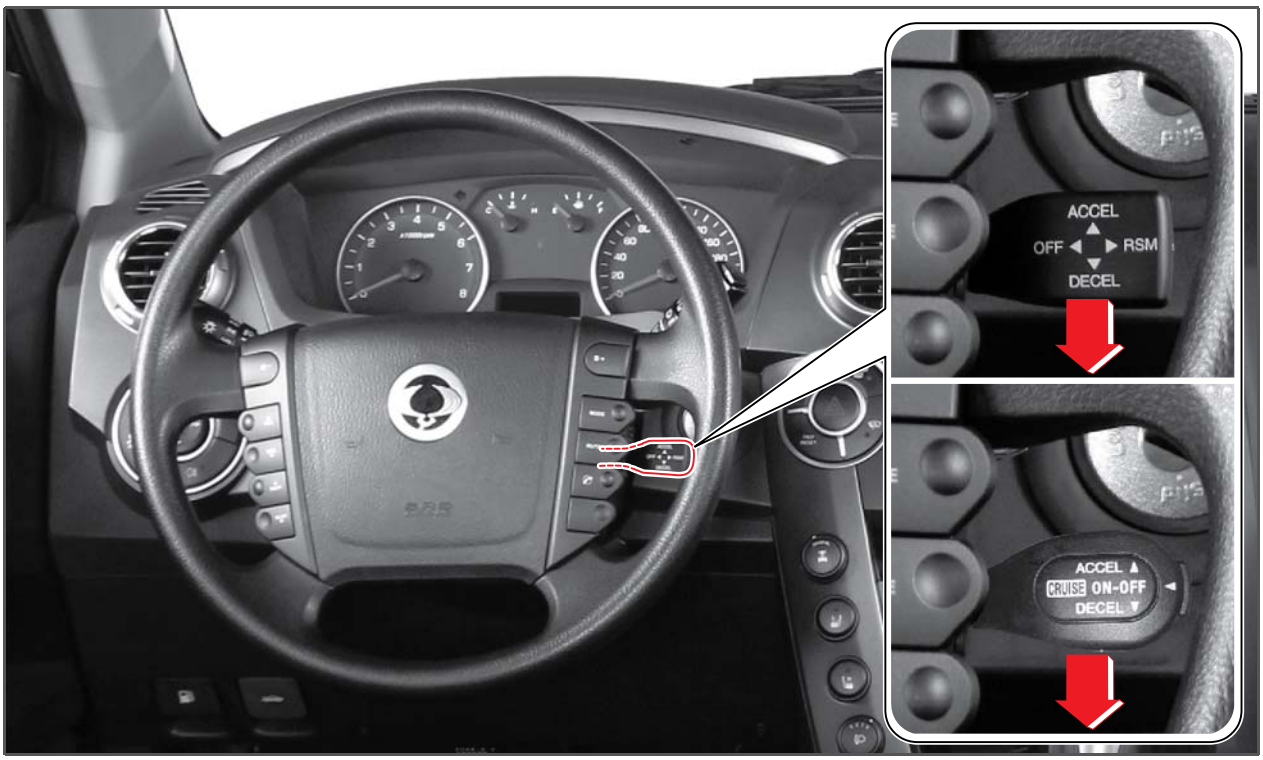
1. Accelerate using the accelerator pedal over 36 km/h.
2. Push up the ACCEL switch of the cruise control lever and hold it.
3. And then release the accelerator pedal slowly.
4. When the desired speed is reached, release the lever.

(3) Tap-up while the cruise control system is running

1. Push up the ACCEL switch of the cruise control lever less than 0.5 second per one switching while the cruise control system is running. This is a tap-up switching.
2. When you operate a tap-up switching, the vehicle is accelerated by 1.3 km/h over the previous set speed.
3. If you want to accelerate to 13 km/h, operate the tap-up switching ten times without accelerating with the cruise control system.

Modification basis	
Application basis	
Affected VIN	

3) Decelerating with the Cruise Control System



(1) While the cruise control system is running

1. Push down the DECEL switch of the cruise control lever and hold it until the desired speed is reached without a brake pedal intervention. But the cruise control system cannot maintain the cruise function at less than 34 km/h.
2. When the desired speed is reached, release the lever.

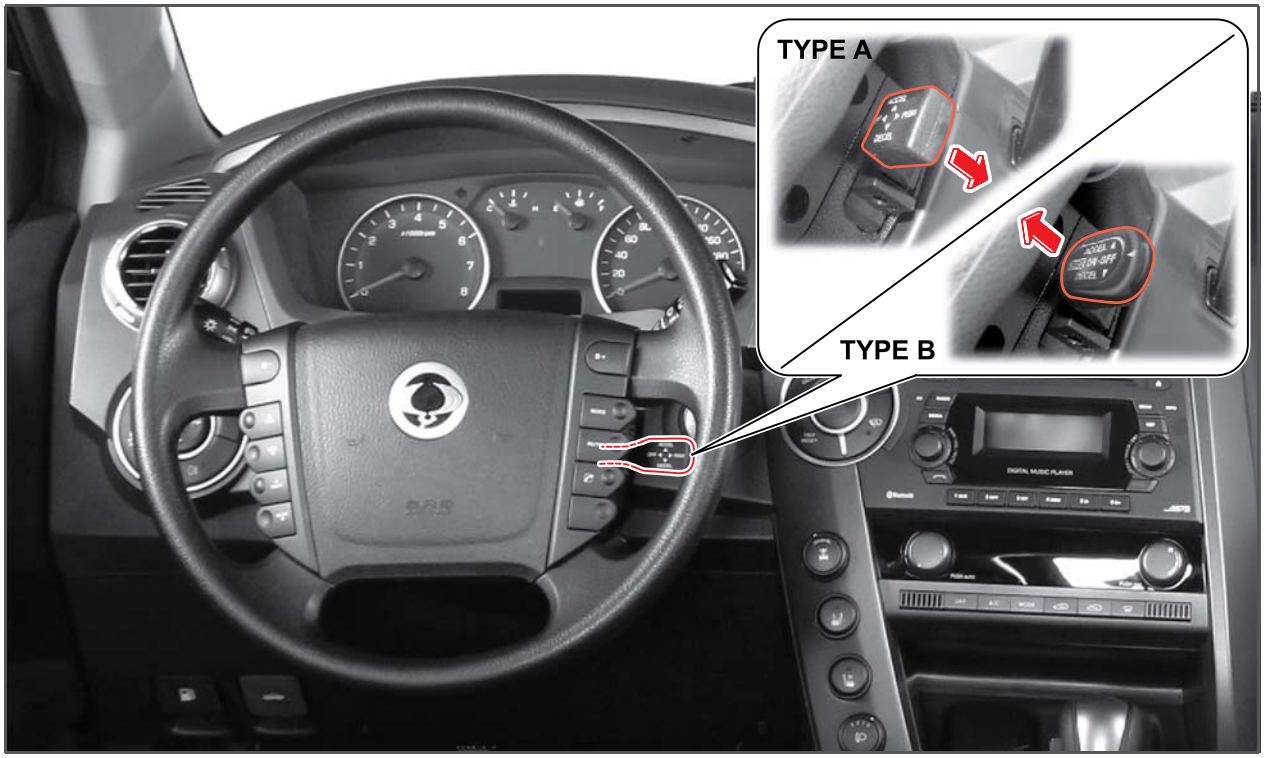
(2) When the cruise control system is not running

1. Push down the DECEL switch of the cruise control lever and hold it.
2. And then release the accelerator pedal slowly.
3. When the desired speed is reached, release the lever. But the cruise control system cannot maintain the cruise function at less than 34 km/h.

(3) Tap-down while the cruise control system is running

1. Push down the DECEL switch of the cruise control lever less than 0.5 second per one switching while the cruise control system is running. This is a tap-down switching.
2. When you operate a tap-down switching, the vehicle is decelerated by 1.0 km/h below the previous set speed.
3. If you want to decelerate to 10 km/h, operate the tap-down switching ten times without the brake pedal intervention.

4) Recovery of Set Speed (RESUME)



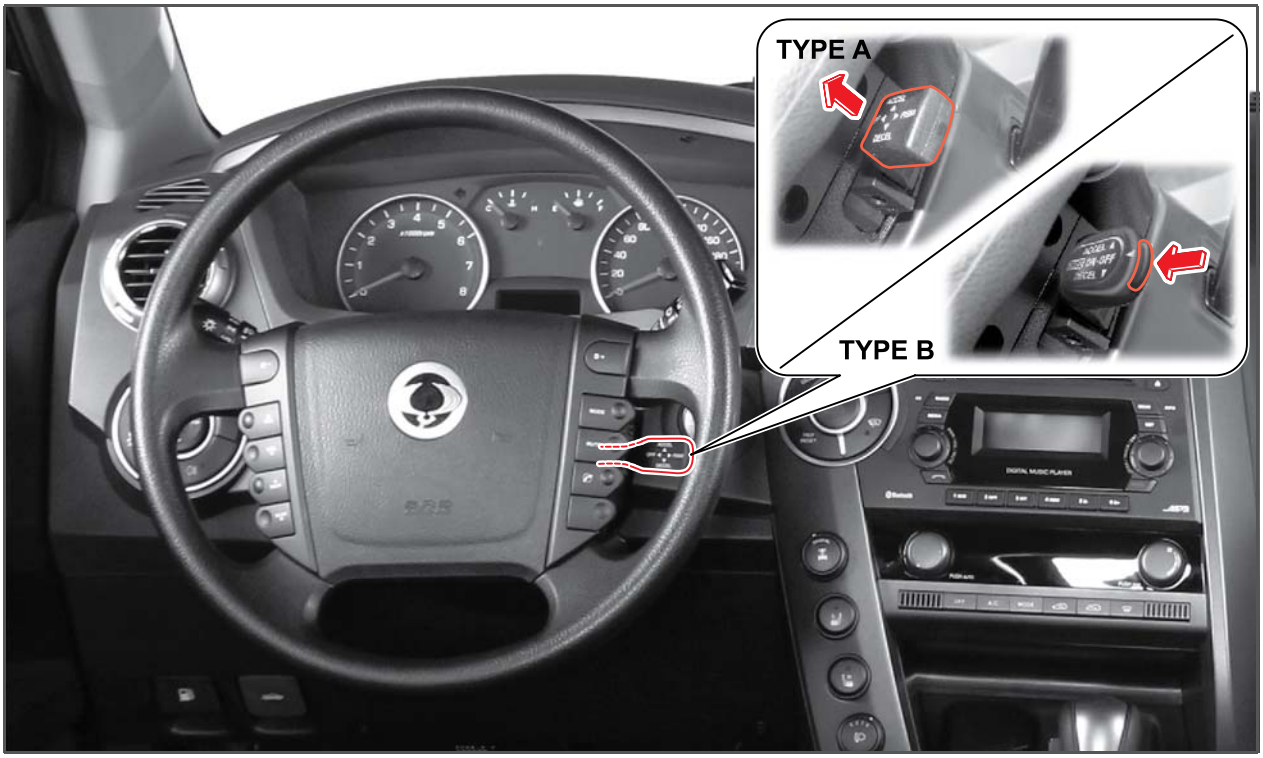
Even if the cruise control is cancelled, the previous set cruise speed can be recovered by pushing (Type A) or pulling (Type B) toward the cruise control lever when the current vehicle speed is over 36 km/h without an acceleration intervention. But if you turn off the ignition switch, the memorized set speed is cleared and you cannot recover the previous set speed.

CAUTION

The resume position should only be used if the driver is fully aware of this speed and wishes to resume this particular speed.

Modification basis	
Application basis	
Affected VIN	

5) Normal Cancellation of the Cruise Control



The cruise control system will be canceled when one or more items of the following conditions are applied;

1. When the brake pedal is depressed.
2. When the cruising speed is downed less than 38 km/h.
3. When the OFF switch is operated by pulling the cruise control lever (Type A) or by pushing the ON-OFF switch of the cruise control lever (Type B).
4. When ESP is activated.
5. When applying the parking brake when driving.
6. When using the clutch in order to shift (M/T only).
   And the cruise control system can be operated again in driving state.

CAUTION

Keep the main cruise control switch in the neutral position when not using the cruise control.

(1) Abnormal Cancellation of the Cruise Control

1. When the rapid deceleration is applied without braking.
2. When the rapid acceleration is applied without acceleration pedal intervention.
3. When the cruise control lever is failed.
4. When the brake switch and the brake light switch input signal are implausible.

And the cruise control system cannot be operated again in driving state. In this case, you should stop the vehicle, and turn off the ignition switch and then turn it on again. After you do that, you can use the cruise control system again. But if the cruise control system isn't recovered, you should contact a Ssangyong Dealer for diagnosis of the cruise control system.

CAUTION

- Abnormal changes of the gear selector lever can damage the yyengine. Do not move the gear shift lever to Neutral while driving at the set speed. Automatic transmission damage may result.
  The speed that has been set may not be maintained on uphill yyor downhill slopes.
- The speed may drop to less than the set speed on a steep uphill yygrade. The accelerator must be
- used if you want to maintain that speed.
  The speed may increase to more than the set speed on a steep yydownhill grade. When the speed
- increases too much, turn off the cruise control.

(2) Using the Cruise Control on Hills

How well the cruise control works on hills depends on the speed, load, and the steepness of the hill. When going up steep hills, you may have to depress the accelerator pedal to maintain your speed. When going downhill, you may have to brake or shift to a lower gear to keep your speed down.
Applying the brake takes you out of the cruise control.

Modification basis	
Application basis	
Affected VIN	

E-EGR SYSTEM

1793-00

GENERAL INFORMATION

1. SPECIFICATION

Item			Specification
E-EGR valve	Motor	EGR response time	50 ms
		Driven by	DC motor
	Valve	EGR gas flow rate	120 kg/h
E-EGR cooler		Cooling capacity	8.3 kW or more
		Cooling fin type	Wavy fin
		Cooler type	U-shaped
E-EGR bypass valve	Solenoid valve	Drivien by	Vacuum (Solenoid valve)

OVERVIEW AND OPERATING PROCESS

1. SYSTEM DESCRIPTION

1) Overview

The EGR (Electric-Exhaust Gas Recirculation) valve reduces the NOx emission level by recirculating some of the exhaust gas to the intake system.
To meet Euro-V regulation, the capacity and response rate of E-EGR valve in D20DTR engine have been greatly improved. The EGR cooler with high capacity reduces the Nox, and the bypass valve reduces the CO and HC due to EGR gas before warming up.
Also, the engine ECU adjusts the E-EGR opening by using the air mass signal through HFM sensor. If the exhaust gas gets into the intake manifold when the EGR valve is open, the amount of fresh air through HFM sensor should be decresed.

▶ **Benefits of E-EGR valve**

- Improved accuracy and response through electric control
- Feedback function (Potentiometer)
- Preventing chattering of EGR valve and improved durability
- Self-cleaning function

Modification basis	
Application basis	
Affected VIN	

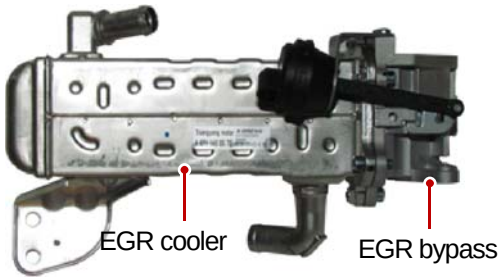
2) Location and Components

HFM sensor



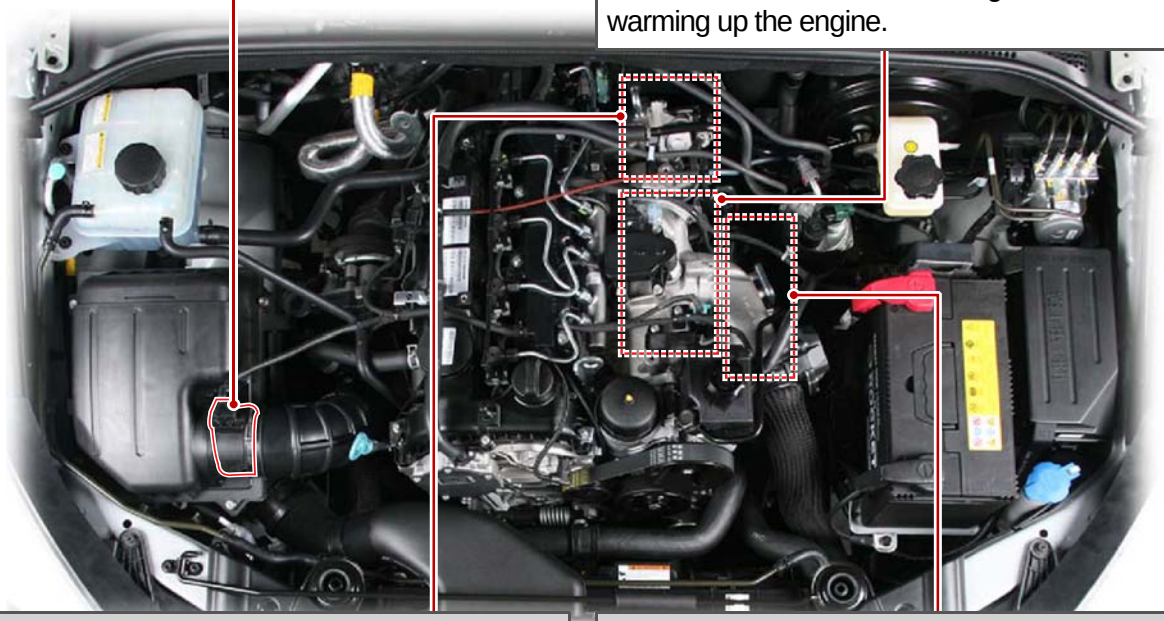
Used as a main map value to control the EGR. The coolant temperature, engine rpm, engine load, intake air temperature (HFM: decreased at 60˚C or more), atmospheric pressure (atmospheric pressure sensor: altitude compensation) are used as auxiliary map values.

E-EGR cooler and bypass valve



See the section "Engine control" for E-EGR valve control logic.

The cooler lowers the high temperature of the exhaust gas and the bypass valve directly supplies the exhaust gas to the intake duct without passing through the EGR cooler to reduce the emission of exhaust gas before warming up the engine.



E-EGR valve



Receives the electric signal from the ECU to control the valve.

EGR pipe

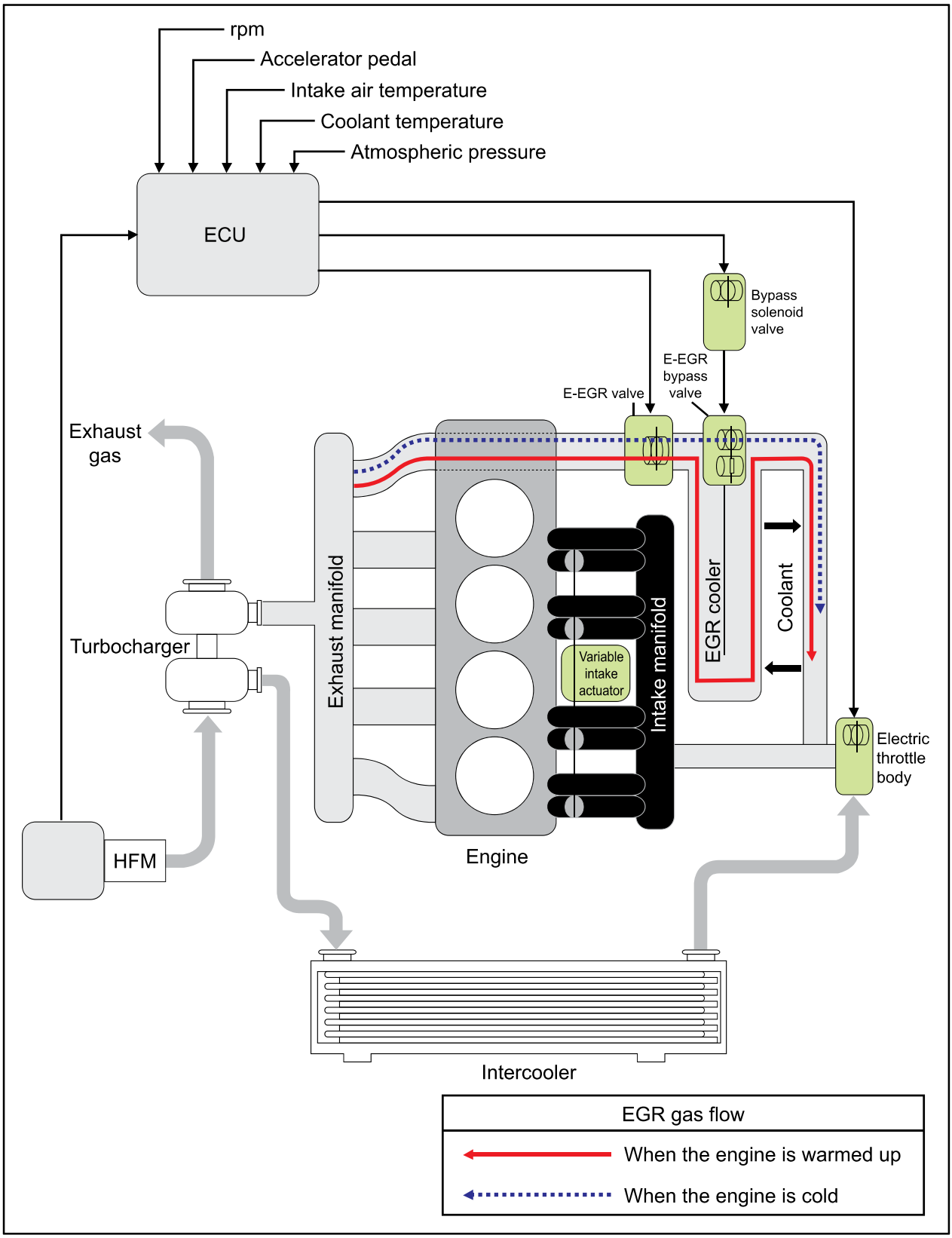


Transports the exhaust gas from the EGR cooler and EGR bypass valve to the intake duct.

* For details, see the section "Engine control".

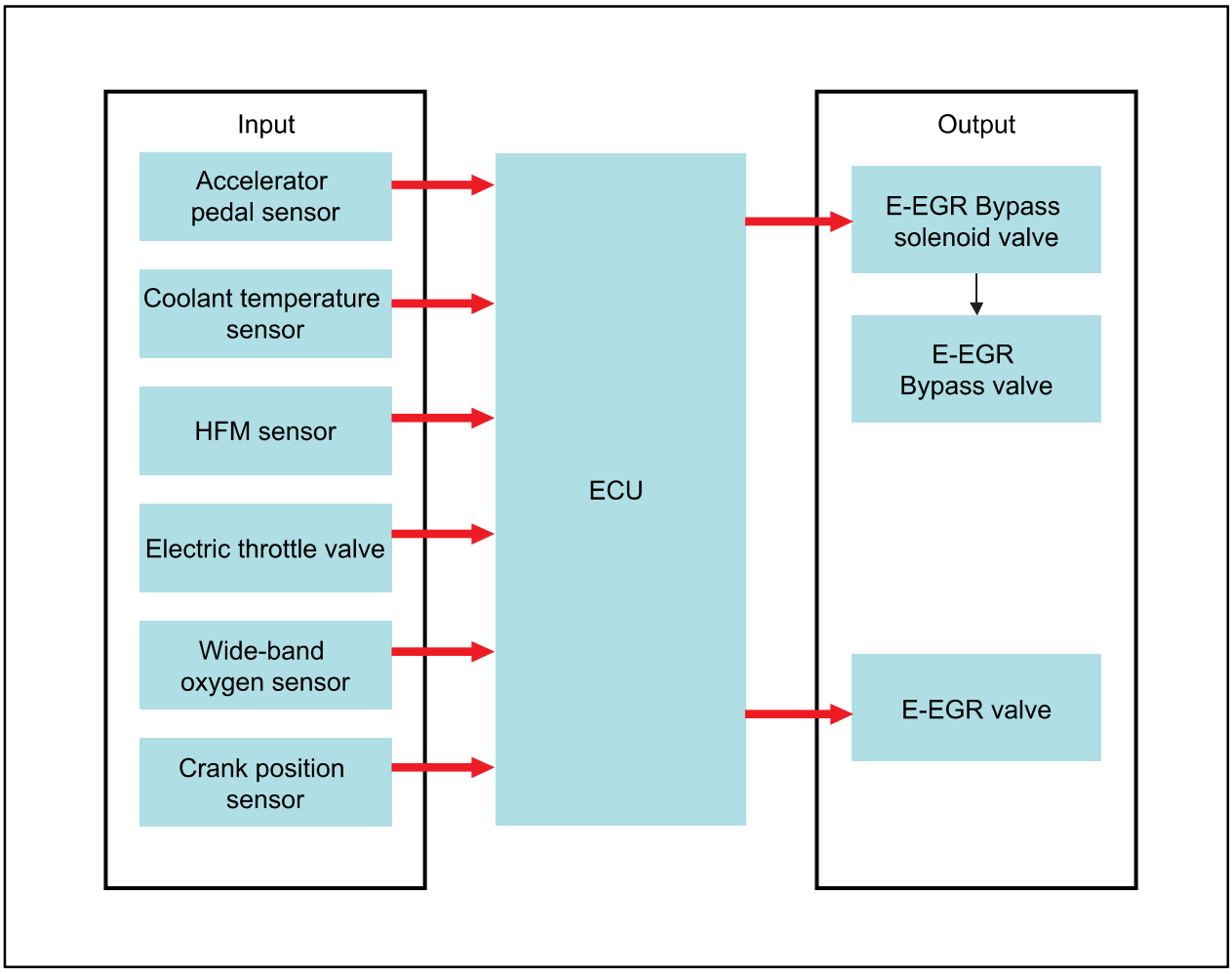
2. OPERATING PROCESS

1) Schematic Diagram



Modification basis	
Application basis	
Affected VIN	

2) Input/Output Devices



3) Control Logic

The EGR system controls the EGR amount based on the map values shown below:

※ Main map value: Intake air volume

※ Auxiliary map value:

- Compensation by the coolant temperature
- Compensation by the atmospheric pressure: Altitude compensation
- Compensation by the boost pressure deviation (the difference between the requested value and the measured value of boost pressure)
- Compensation by the engine load: During sudden acceleration
- Compensation by the intake air temperature

The engine ECU calculates the EGR amount by adding main map value (intake air volume) and auxiliary map value and directly drives the solenoid valve in the E-EGR to regulate the opening extent of the EGR valve and sends the feedback to the potentiometer.

(1) Operating conditions

- Intake air temperature: between −10 and 50℃
- Atmospheric pressure: 0.92 bar or more
- Engine coolant temperature: between 0 and 100°C
- When there is no fault code related to EGR

(2) Shut off conditions

- Abrupt acceleration: with engine speed of 2600 rpm or more
- When the engine is idling for more than 1 minute
- Vehicle speed: 100 km/h or more
- Engine torque: 380 Nm or more

Modification basis	
Application basis	
Affected VIN	

Memo

CDPF SYSTEM

2412-02

GENERAL INFORMATION

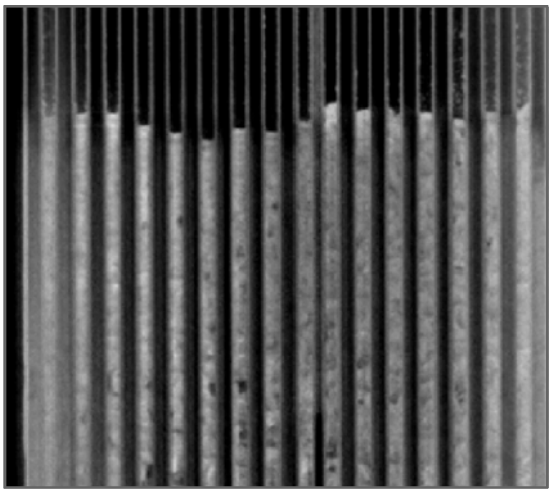
1. SPECIFICATION

Emission Regulation		Euro-V
Front Area		154.06㎠
Size	DOC	158 X 124 X 78L
	DPF	158 X 124 X 254L
CDPF Canister	Shell	SUS430J1L X 1.5t
	End Cone	SUS430J1L X 2.0t (Single)
CDPF	Catalyst Capacity	5.1L
	Material of Filter	SiC

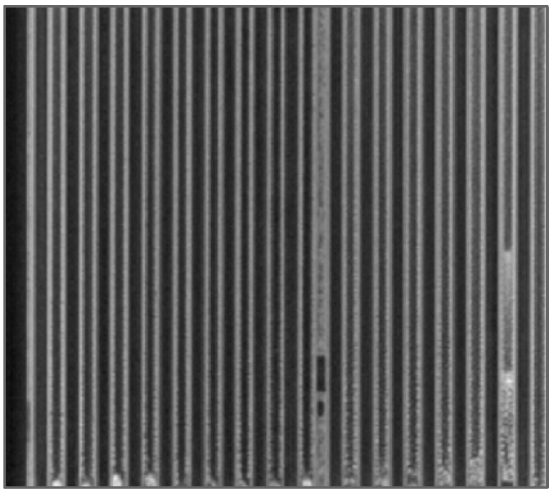
2. CAUTIONS

▶ **Standard pattern of soot accumulation**

(1) Abnormal Soot Accumulation



(2) Normal Soot Combustion



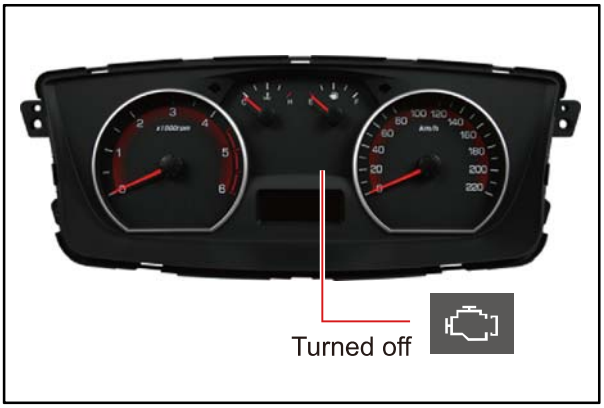
▶ **Cautions to protect the catalyst filter**

- Use the designated fuel only.
- Observe the recommended service intervals of engine oil.
- Check the engine oil level frequently and add if necessary.
- Do not idle the vehicle unnecessarily.
- Do not turn off the engine while the vehicle is running.
- Do not shift the gear selector lever to neutral when going downhill.
- Do not use improper engine oil or fuel additives.
- Do not drive for a long time when the warning lamp is illuminated.
- Make sure no flammable material, such as dry grass or tissue paper, contacts with the catalyst filter while the vehicle is parked.
- For the vehicles used in urban traffic, driving on the expressways for more than 1 hour at least once per week is needed so that the PM inside CDPF isn't collected to one side only.

Modification basis	
Application basis	
Affected VIN	

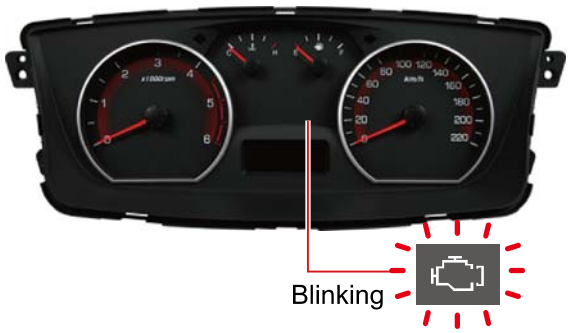
(3) Warning Lamp Related to CDPF

▶ CDPF regeneration process (warning lamp NOT illuminated)



The CDPF system enters the regeneration mode when the driving distance becomes approx. 600 to 1,200 km (may differ by the driving condition and driving style). Then, the engine ECU performs the CDPF regeneration operation. However, the driver is not informed with this operation by any engine warning lamp or vehicle signal, so he/she may not detect this operation. The control logic at the post-injection dur-ing the regeneration process is to increase the fuel injection volume and control the intake air volume (by the throttle body) in order to increase the temperature of the exhaust gas. The driver may not feel any particular difference from the vehicle.

Overload of CDPF (warning lamp blinking)



1. If the CDPF cannot reach the regeneration temperature due to low speed driving or other reason during the regeneration process, the soot is continuously accumulated in the CDPF. When this
2. condition continues and the CDPF is overloaded with soot, the engine warning lamp blinks to inform this situation to the driver.
   In order to solve this problem, drive the vehicle at a speed of approx. 80 km/h for 15 to 20 minutes to perform the CDPF regeneration process.
3. If the engine warning lamp on the instrument cluster blinks, the CDPF is overloaded. In this case, perform the step 2.

Excessive overload of CDPF (warning lamp illuminated)

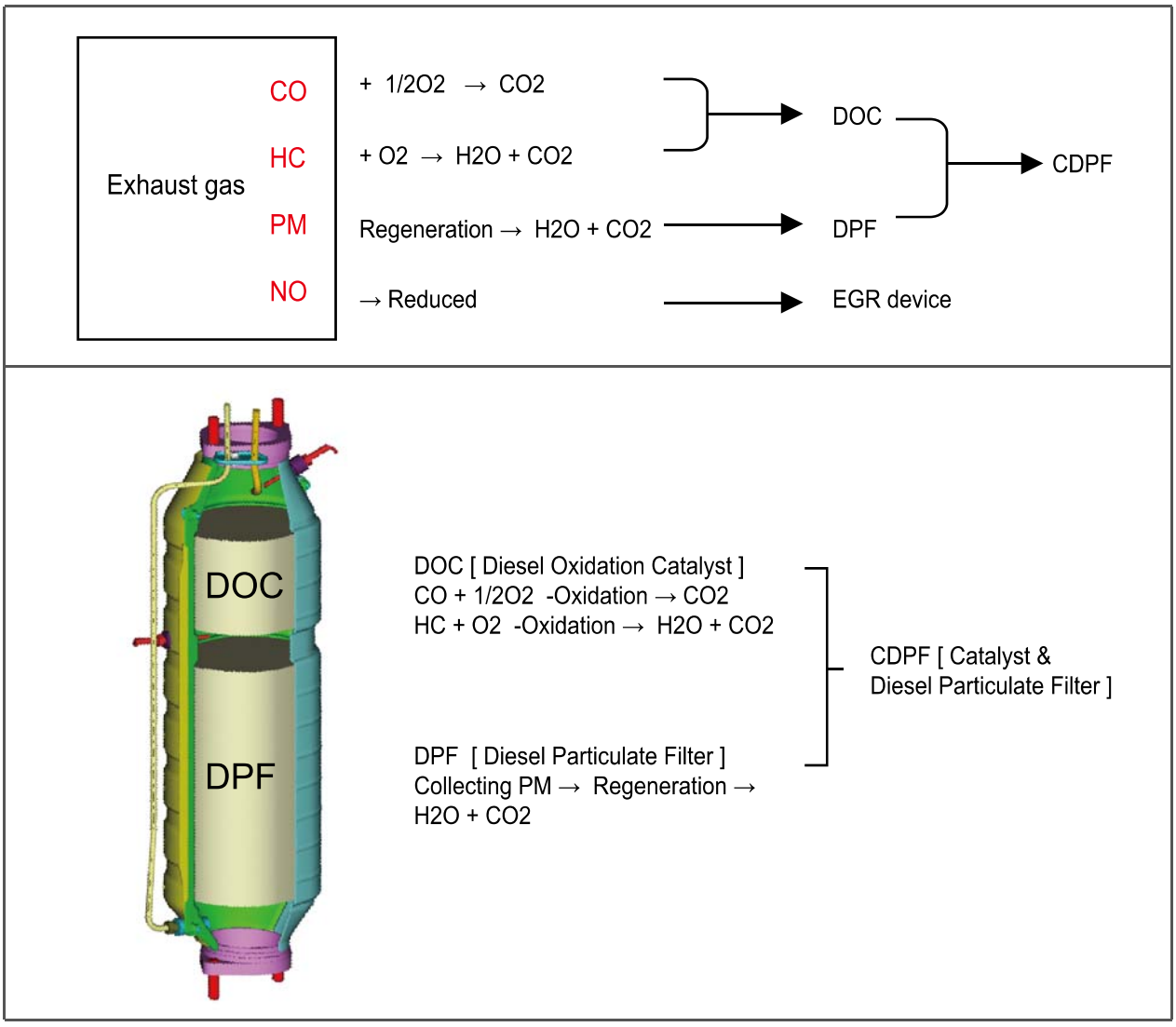
1. If the vehicle is driven at a speed of 5 to 10 km/h for an extended period of time, the soot accumulated in the CDPF cannot be burned as the CDPF cannot reach the regeneration temperature. Then, an excessive amount of soot can be accumulated in the CDPF. 2. This case is much worse than the simple over-load of the CDPF. To inform this to the driver, the engine warning lamp comes on and the engine power is decreased to protect the system. To solve this problem, blow soot between the engine and exhaust system several times and erase 3. the related DTC. Then, check if the same DTC is regenerated again. If so, check the DTC related to the differential pressure sensor.

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

The DOC (Diesel Oxidation Catalyst) generates CO2 and H2O which are harmless through the oxidation process of CO and HC. And the DPF (Diesel Particulate Filter) collects PM (Particle Matter) and is regenerated to reduce the quantity of particulates, HC and CO. But there is a limitation in reducing the emission of exhaust gas for each system, so the CDPF which combines these two system is applied.



2. COMPONENT

Front temperature sensor



Protects the turbocharger.

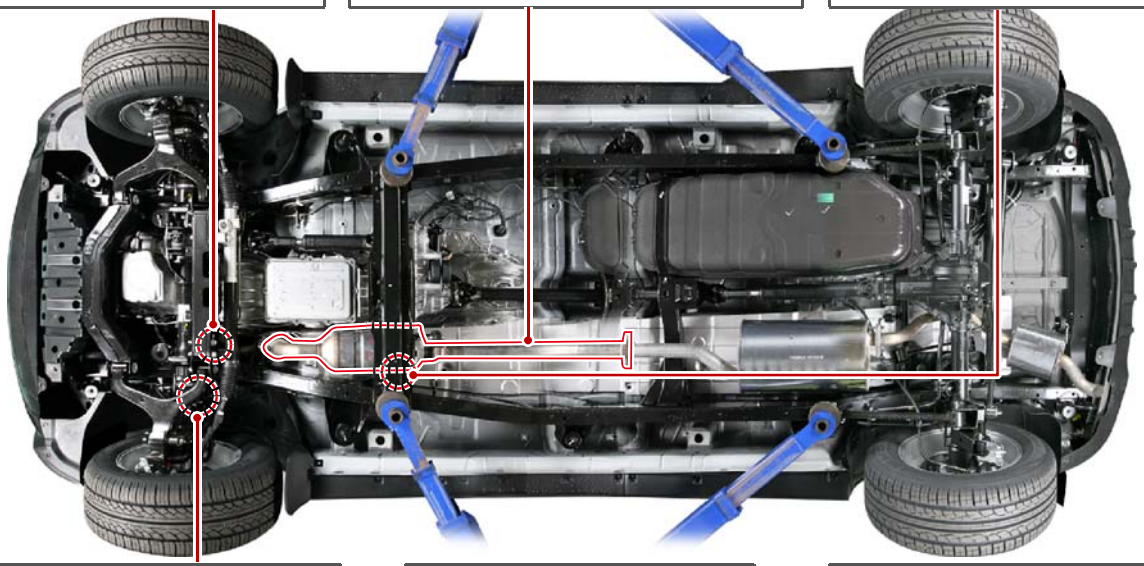
CDPF DOC+DPF



Rear temperature sensor



Measures the temperature of fuel combustion.



Differential pressure sensor



Calculates the amount of PM collected by reading the pressure difference between before and after the CDPF.

Engine ECU DCM 3.7



Post-injection

Throttle valve

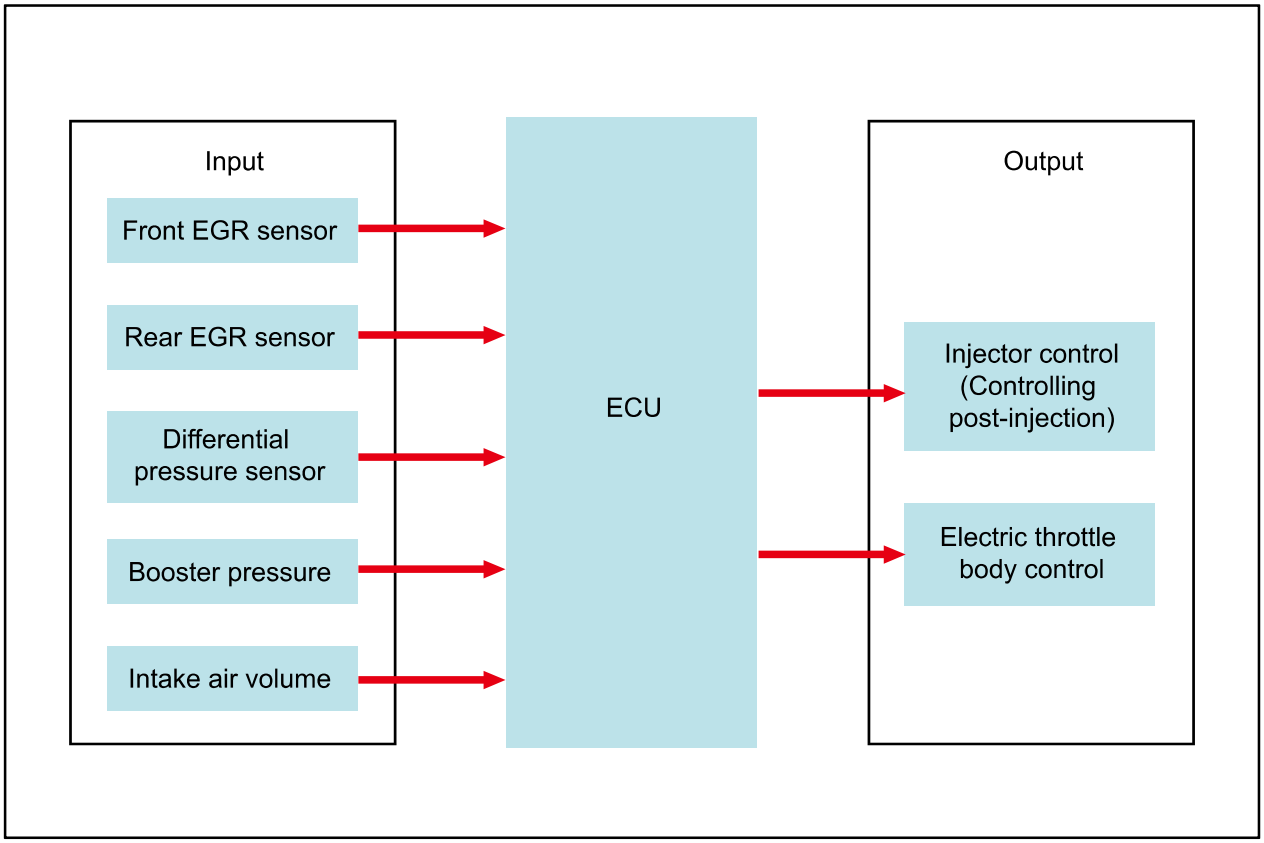


Regulates the rate of air intake.

* For details, refer to section "Engine Control".

Modification basis	
Application basis	
Affected VIN	

3. INPUT/OUTPUT DEVICES



1. Front temperature sensor: This sensor is installed at the inlet of DOC and detects whether the DOC can burn (oxidize) the post-injected fuel or not.
2. Rear temperature sensor: This sensor is installed at the inlet of DPF and monitors that the temperature of the exhaust gas is kept at 600℃.

- If the temperature exceeds 600℃, the life of CDPF can be reduced. So the amount of fuel post-injection is decreased.
- If the temperature drops under 600℃, the rate of regeneration can be decreased. So the amount of fuel post-injection is increased.

3. Differential pressure sensor: This sensor checks the amount of PM collected by calculating the pressure difference between before and after the CDPF.
4. Electric throttle valve: This valve reduces the intake air flow to raise the temperature of the exhaust gas when the CDPF is operating during idling.

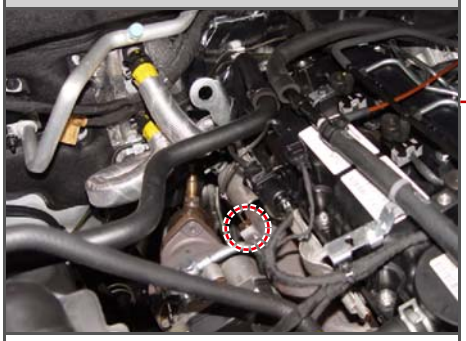
4. POST-INJECTION AND AIR MASS CONTROL

A DPS (Differential Pressure Sensor) measures the pressure difference between before and after the CDPF and detects whether the soot is collected in the CDPF or not. If PM is collected in the CDPF (In this case the pressure difference between before and after the CDPF exceeds the specified value. Normally, the system sends the signal when the driving distance becomes approx. 600 to 1,200 km), the temperature of exhaust gas is increased and the post-injection is started for regeneration. The amount of fuel post-injection is controlled by the exhaust gas temperature measured by the rear temperature sensor. If the temperature is less than 600℃, the amount of post-injection is increased to increase the regeneration temperature. Otherwise, the fuel injection amount is decreased or the fuel is not injected.

When the engine is running with low load, the intake air amount is also controlled as well as fuel injection amount. This function is used to increaser the combustion temperature by increasing the amount of fuel post-injection with the lowest air amount within the specified control logic.

Modification basis	
Application basis	
Affected VIN	

Front temperature sensor



Measures the temperature of exhaust gas.

This sensor is located at the rear side of exhaust manifold and monitors the temperature of combusted gas to prevent the exhaust system from overheating. When the temperature gets higher, this sensor cuts off the fuel delivery and controls the EGR to lower the temperature.

Differential pressure sensor



Measures the difference between inlet and outlet pressures of CDPF.

If the difference is higher than the specified value when collecting the PM, this makes the post injection for forced recycling of PM.

HFM sensor

Intake air mass

Engine ECU (D20DTR)



Measures the excessive amount of PM.

Wide band oxygen sensor

Boost pressure/ temperature

T-MAP sensor

Rear temperature sensor



Measure the outlet temperature of DOC.

This sensor is located at the rear side of DOC and monitors the overheating of CDPF and post injection volume.

Injector (C31)



Controls the post injection.

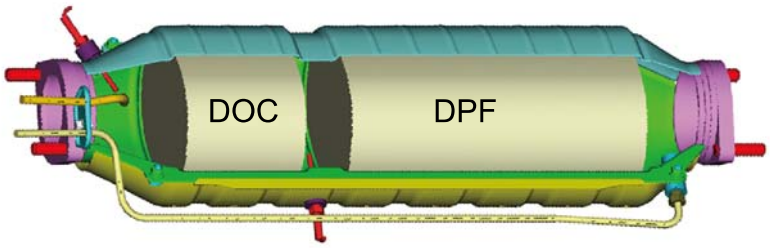
Electric throttle body

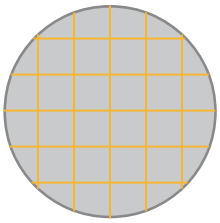


Controls the intake air mass.

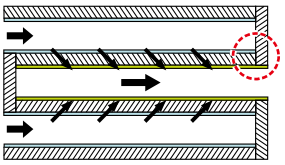
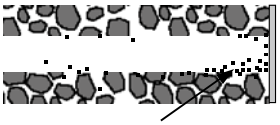
5. OPERATING PROCESS

[Configuration and principle of operation]





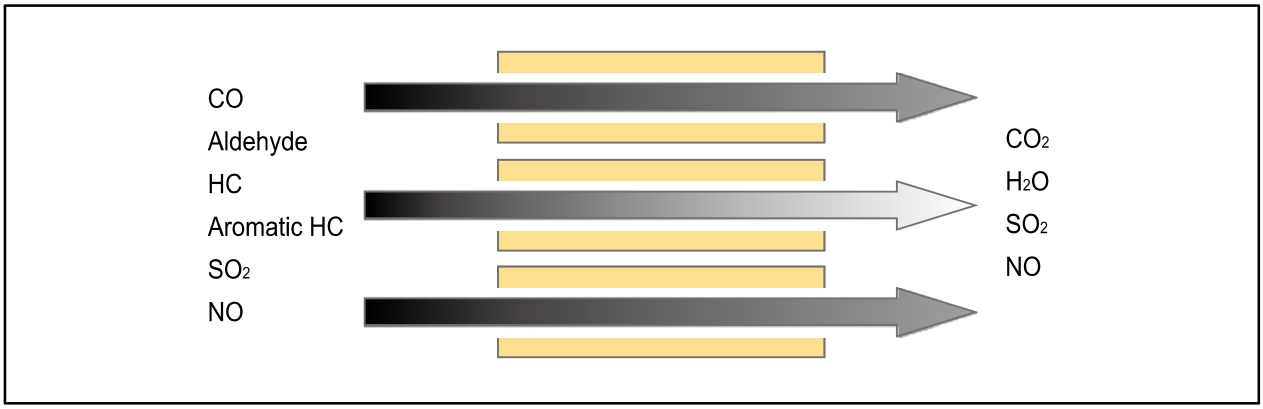
The exhaust gas passed through the exhaust manifold enters into the CDPF assembly (at approx 250℃).

Oxidation (DOC)	Collecting PM → Regeneration
	
When the exhaust gas enters into the CDPF assembly, its CO, HC and PM are reduced by the redox reaction of the DOC. The remaining PM is filtered and collected in CDPF, and the temperature of the exhaust gas is increased to between 450 and 500°C.	The engine ECU detects the amount of PM collected by the information from the temperature sensors and differential pressure sensor. When the soot is accumulated, the engine ECU performs post-injection to increase the exhaust gas temperature and burns the collected PM at approx. 600°C.

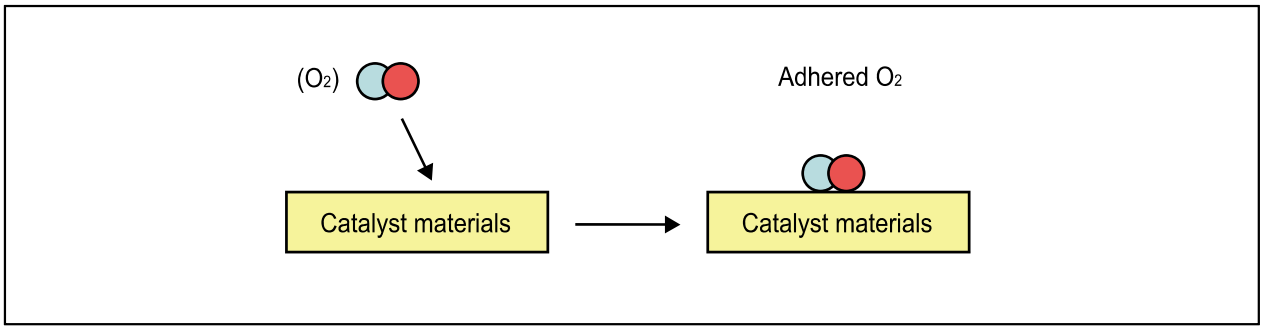
Modification basis	
Application basis	
Affected VIN	

1) Oxidation of DOC

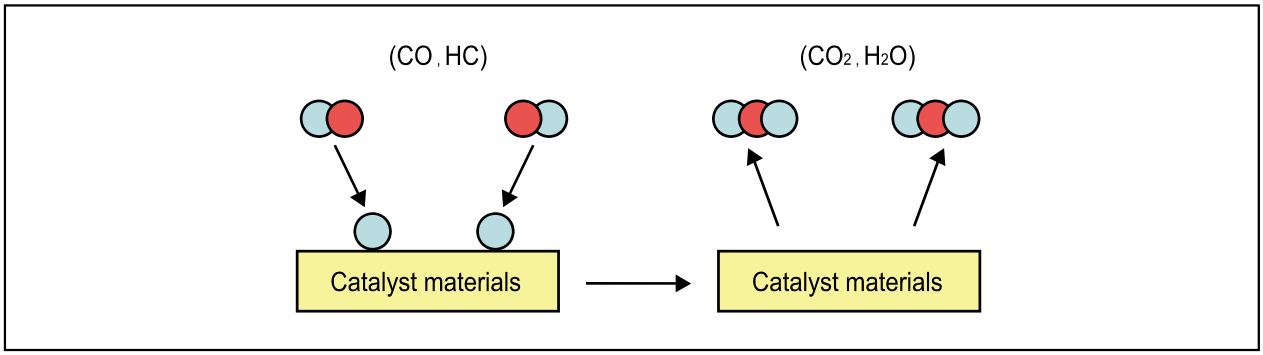
The DOC oxidizes HC and CO of the exhaust gas in the two-way catalytic converter at 180℃ or more, and performs best at the temperature between 400 and 500℃. The front EGT sensor detects whether the DOC can burn (oxidize) the post-injected fuel or not, and sends the signal to the ECU to maintain the DOC operating temperature between 300 and 500℃. The DOC reduces CO and HC of the exhaust gas by redox reaction and also reduces small amount of PM.



1. Oxygen adheres to the catalyst materials: Less than 180℃



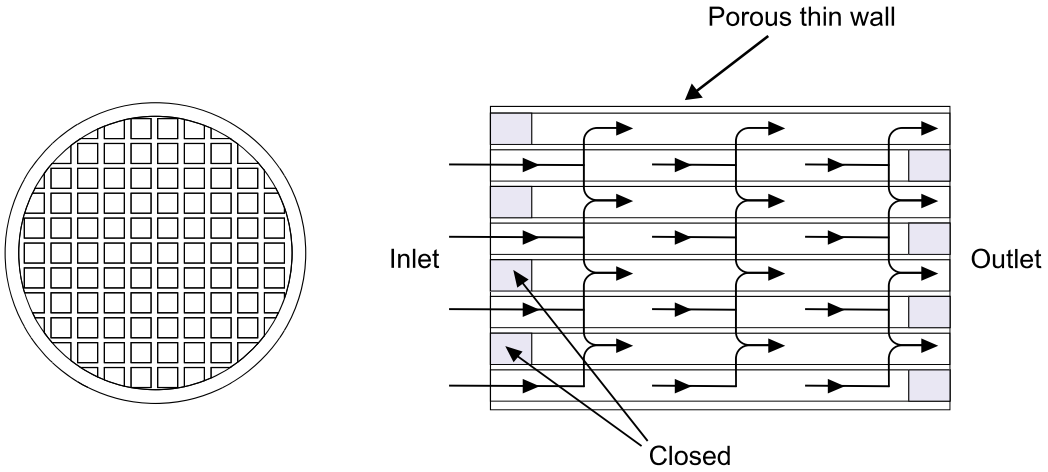
2. CO and HC are oxidized by the catalyst materials: More than 180℃

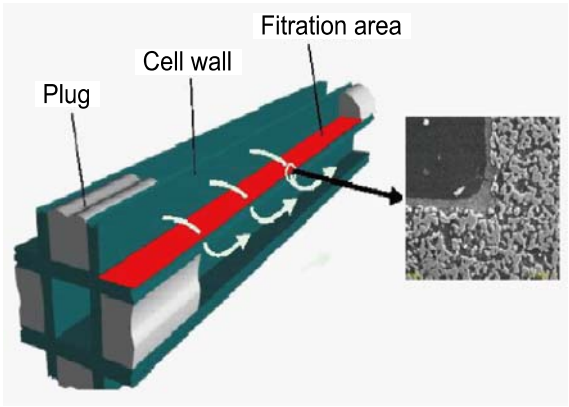


2) Collecting PM of DPF

There is a filter installed in the DPF and the PM filtered by this filter is burned (regeneration) when the temperature of exhaust gas is increased due to post-injection. The filter has a honeycomb-like structure to capture the particulate matter and the inlet and outlet of each channel are closed alternatively. Once the exhaust gas enters to the inlet of a channel, it is released from the outlet of the adjacent channel through the porous wall because of the closed outlet of the first channel, and the PM is collected in the first channel.

[Collecting PM of CDPF]





NOTE

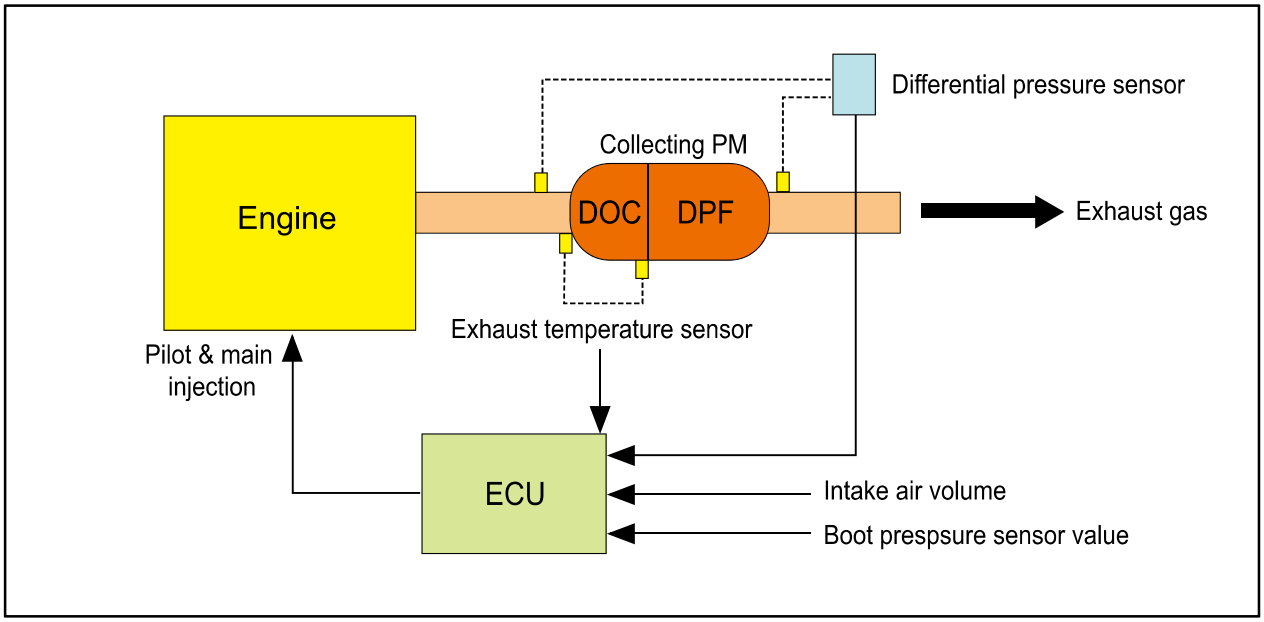
Normally, when the driving distance becomes approx. 600 to 1,200 km, enough amount of soot to be burned is filtered and accumulated in the CDPF. The ECU increases the amount of fuel post-injection to increase the temperature of the exhaust gas up to 600°C, so that the soot is burned. The soot is burned for 15 to 20 minutes (may differ by conditions).

Modification basis	
Application basis	
Affected VIN	

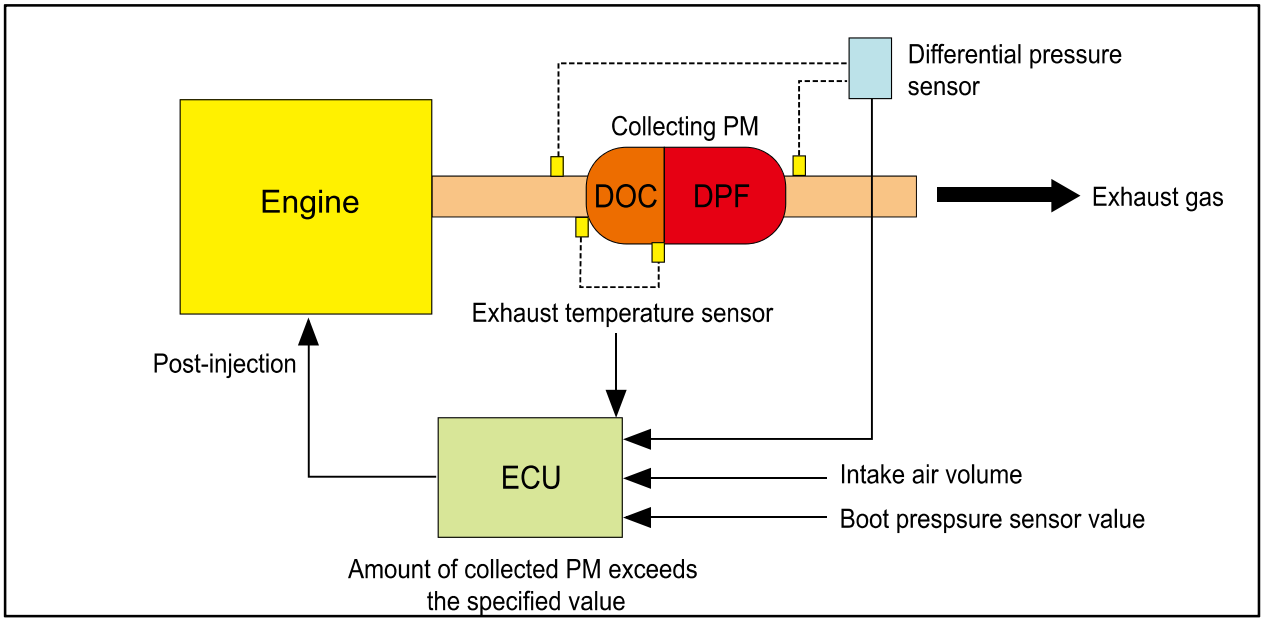
3) PM Regeneration of DPF

The differential pressure sensor installed in the DPF measures the pressure values of inlet and outlet of CDPF. And the amount of the PM collected in the filter is calculated based on the exhaust temperature, intake air mass flow, booster pressure, etc.
The regeneration is started when the amount of the collected PM is 28 g or more.
The ECU commands post-injection to increase the temperature of CDPF to 600℃.

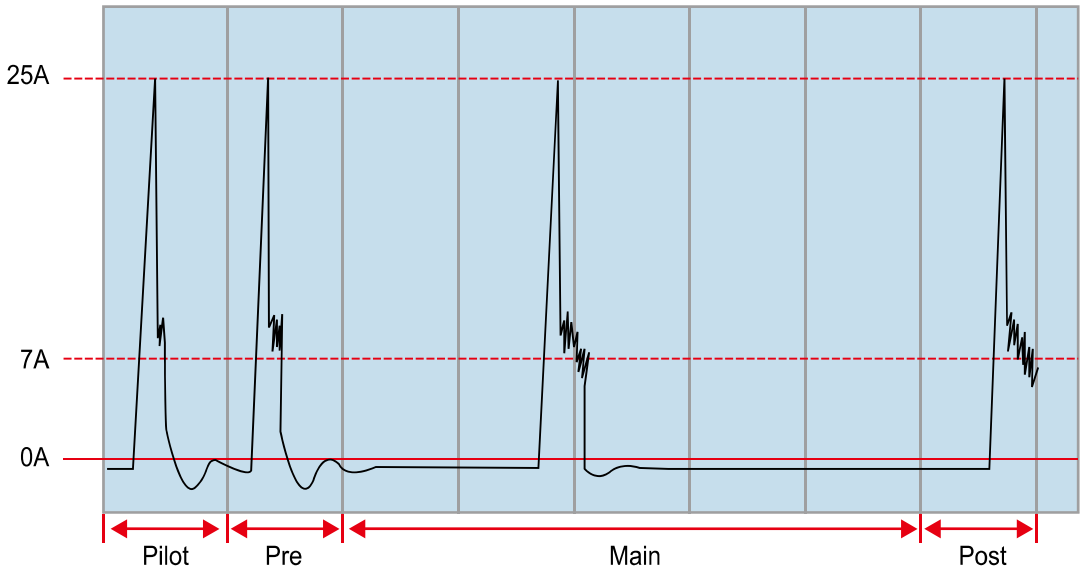
1. When the amount of the collected PM is not enough: The DPF works as a filter.



2. When enough amount of PM is collected: The ECU commands post-injection and increase the exhaust gas temperature to start regeneration.



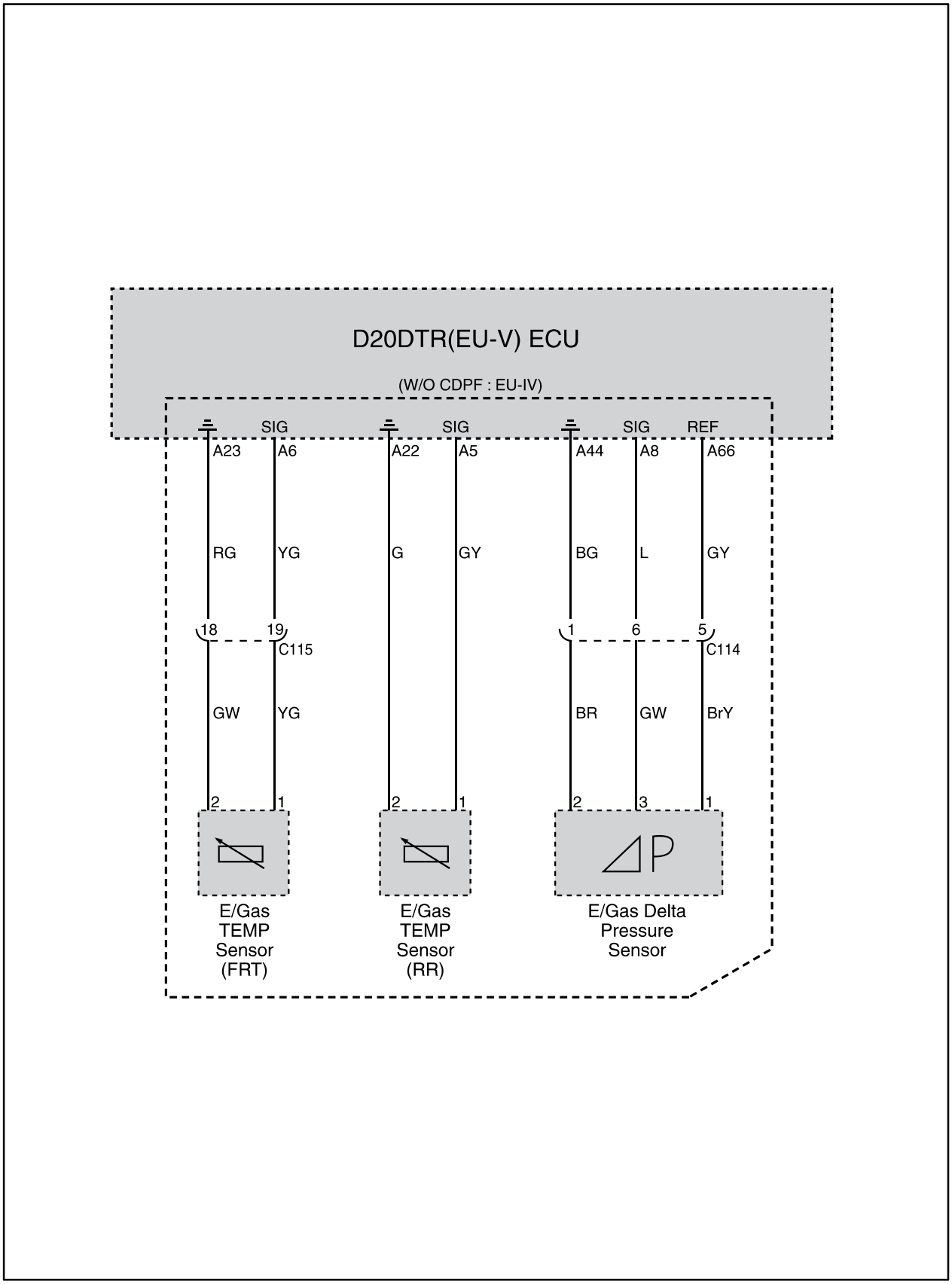
4) Fuel Injection During CDPF Regeneration



Injection	Effect
Pilot injection	Decrease of PM by fuel mixture Decrease of noise from engine combustion
Pre-injection	Decrease of NOx by shortening main injection delay due to flammability Decrease of noise from engine combustion
Main injection	Main power source
Post-injection	Activation of CDPF by increasing exhaust gas temperature and supplying reduction material

Modification basis	
Application basis	
Affected VIN	

6. ELECTRIC CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	

ENGINE CONTROL

0000-00

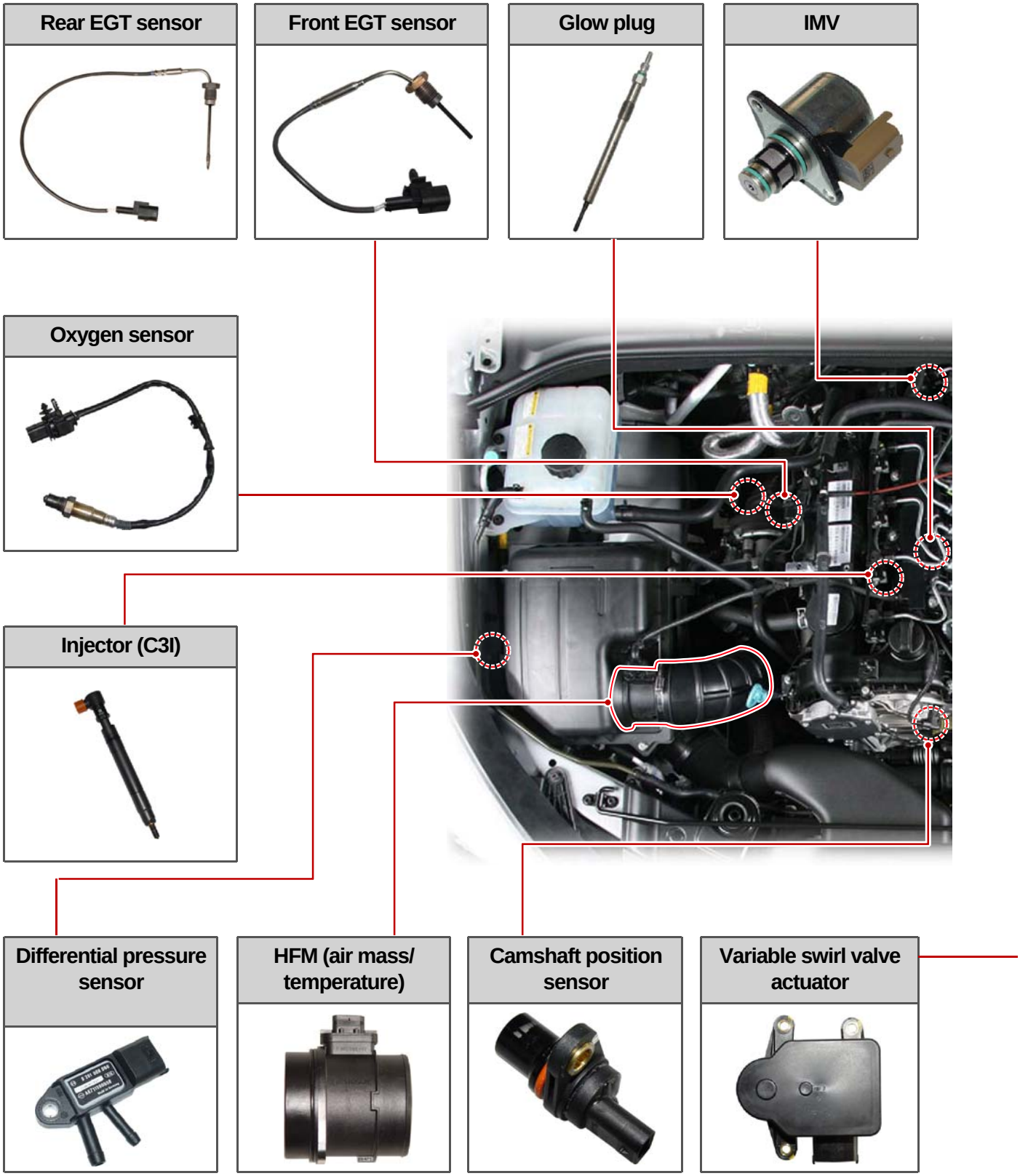
GENERAL INFORMATION

1. ENGINE DATA LIST

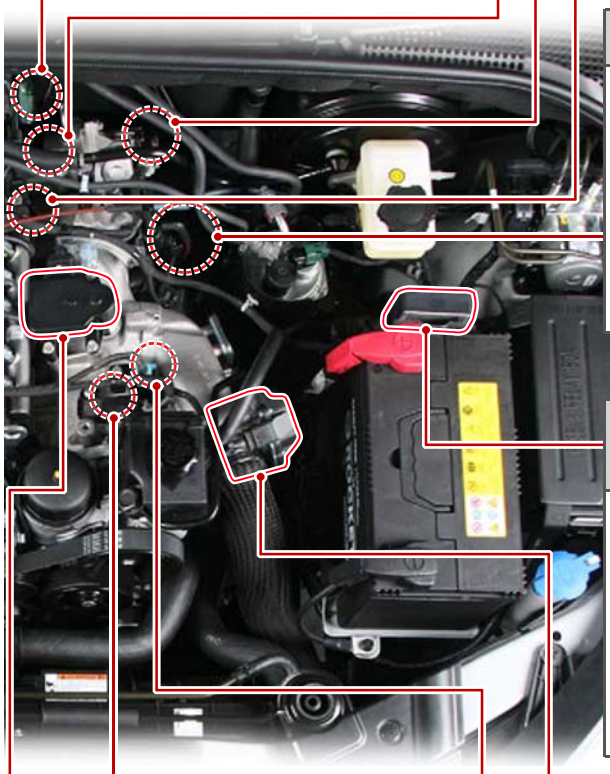
Data	Unit	Value
Coolant temperature	℃	0.436 V (130℃) to 4.896 V (−40℃)
Intake air temperature	℃	−40 to 130℃ (varies by ambient air temperature or engine mode)
Idle speed	rpm	750 ± 20
Engine load	%	18~25%
Mass air flow	kg/h	16 to 25 kg/h
Throttle position angle	°TA	0° (Full Open) to 78° (Close)
Engine torque	Nm	varies by engine conditions
Injection time	ms	3 to 5ms
Battery voltage	V	13.5 V to 14.1 V
Accelerator pedal position 1	V	0.4. to 4.8V
Accelerator pedal position 2	V	0.2 to 2.4 V
Throttle position 1	V	0.3 to 4.6 V
Throttle position 2	V	0.3 to 4.6 V
Oxygen sensor	mV	0 to 5 V
A/C compressor switch	1=ON / 0=OFF	-
Full load	1=ON / 0=OFF	-
Gear selection (A/T)	1=ON / 0=OFF	-
Knocking control	1=ON / 0=OFF	-
Brake switch	1=ON / 0=OFF	-
Cruise control	1=ON / 0=OFF	-

OVERVIEW AND OPERATINF PROCESS

1. MAJOR COMPONENTS



Modification basis	
Application basis	
Affected VIN	



Coolant temperature sensor



Fuel temperature sensor



EGR valve



Fuel rail pressure sensor



E-EGR bypass valve



E-VGT actuator



GCU (Preglow control unit)



Water sensor



T-MAP sensor



Knock sensor (2 ea)



Electric throttle body



D20DTR ECU

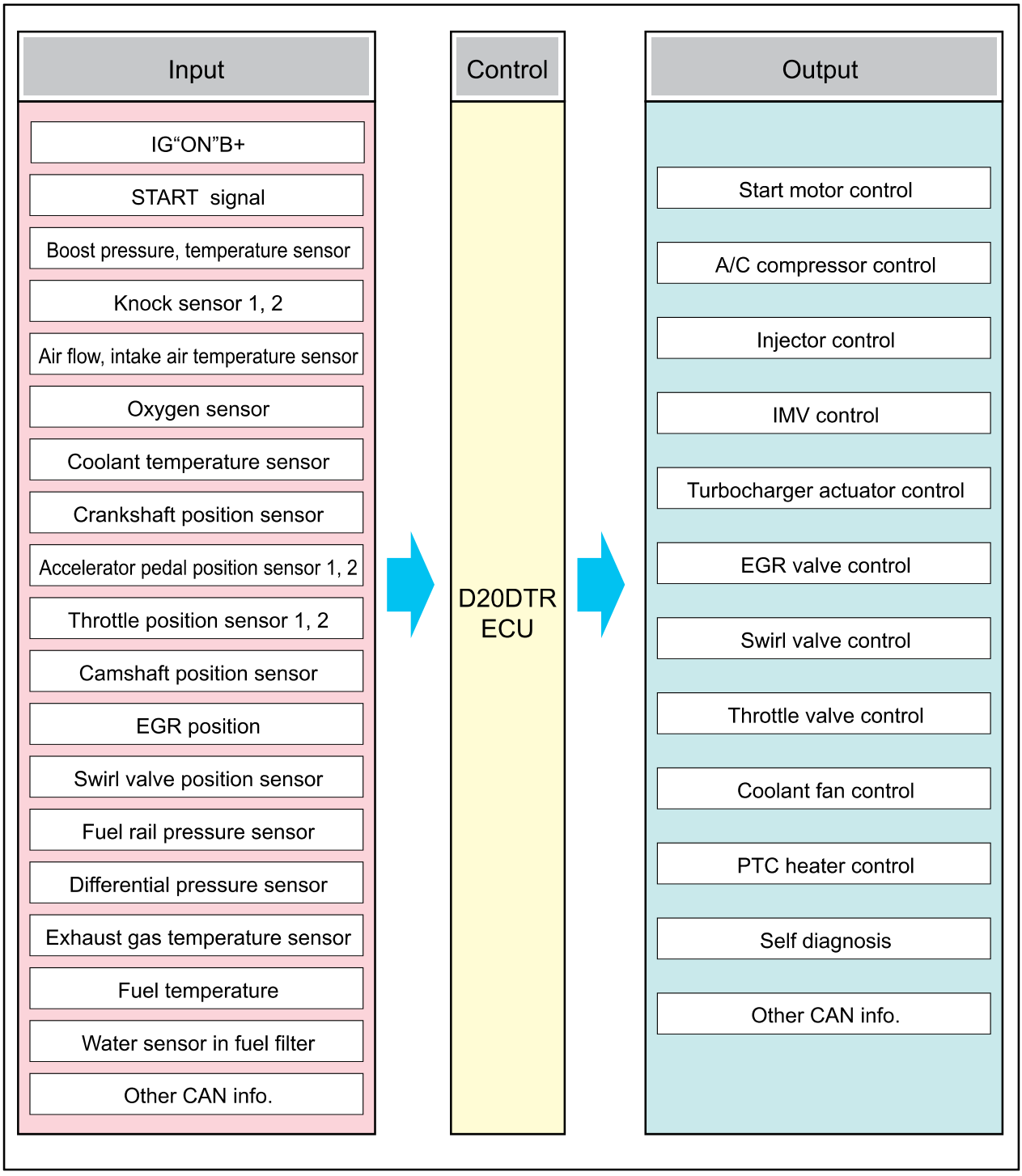


Modification basis	
Application basis	
Affected VIN	

2. SYSTEM OPERATION

1) Input/Output of ECU

(1) ECU Block diagram



Modification basis	
Application basis	
Affected VIN	

(2) Components for ECU Input



-Auto cruise switch
- Rear right wheel speed (without ABS)
- Refrigerant pressure sensor
- Clutch pedal signal
- Blower switch signal
- Brake pedal signal

Crankshaft position sensor	**Accelerator pedal sensor**	**Throttle position sensor**	**Knock sensor**
			
Exhaust gas temperature sensor	**HFM sensor**	**T-MAP sensor**	**Oxygen sensor**
			
Differential pressure sensor	**E-EGR valve position sensor**	**Camshaft position sensor**	**Coolant temperature sensor**
			
Fuel rail pressure sensor	**Swirl valve position sensor**	**Water sensor**	**CAN**
			- ABS & ESP - GCU - Instrument cluster - TCU

(3) Components for ECU Output



E-EGR valve	A/C compressor	Injector	Throttle position sensor
			

E-EGR cooler bypass valve	Variable swirl valve	E-VGT actuator	IMV valve
			

PTC heater	Cooling fan
	

CAN	
- Glow plug unit	- Instrument cluster
- ABS & ESP unit	- TCU
- GCU	- Self diagnosis

Modification basis	
Application basis	
Affected VIN	

2) ECU Control

(1) Function

a. ECU Function

ECU receives and analyzes signals from various sensors and then modifies those signals into permissible voltage levels and analyzes to control respective actuators.
ECU microprocessor calculates injection period and injection timing proper for engine piston speed and crankshaft angle based on input data and stored specific map to control the engine power and emission gas.
Output signal of the ECU microprocessor drives pressure control valve to control the rail pressure and activates injector solenoid valve to control the fuel injection period and injection timing; so controls various actuators in response to engine changes. Auxiliary function of ECU has adopted to reduce emission gas, improve fuel economy and enhance safety, comforts and conveniences. For example, there are EGR, booster pressure control, autocruise (export only) and immobilizer and adopted CAN communication to exchange data among electrical systems (automatic T/M and brake system) in the vehicle fluently. And Scanner can be used to diagnose vehicle status and defectives.
Operating temperature range of ECU is normally −40 to +85°C and protected from factors like oil, water and electromagnetism and there should be no mechanical shocks.
To control the fuel volume precisely under repeated injections, high current should be applied instantly so there is injector drive circuit in the ECU to generate necessary current during injector drive stages. Current control circuit divides current applying time (injection time) into full-in-current-phase and hold-current-phase and then the injectors should work very correctly under every working condition.

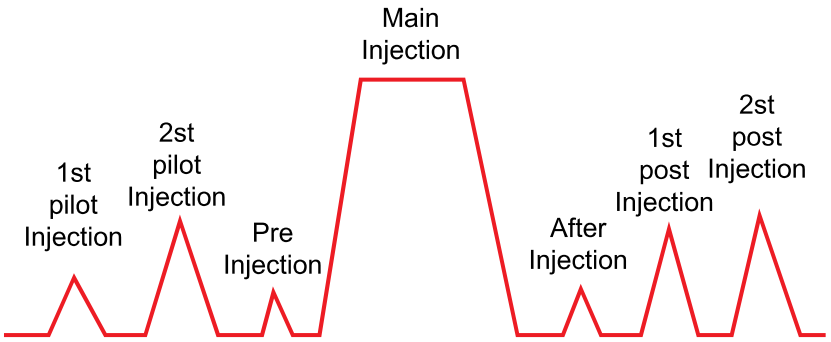
b. Control Function

- Controls by operating stages
  To make optimum combustion under every operating stage, ECU should calculate proper injection volume in each stage by considering various factors.
- Starting injection volume control
  During initial starting, injecting fuel volume will be calculated by function of temperature and engine cranking speed. Starting injection continues from when the ignition switch is turned to ignition position to till the engine reaches to allowable minimum speed.
- Driving mode control
  If the vehicle runs normally, fuel injection volume will be calculated by accelerator pedal travel and engine rpm and the drive map will be used to match the drivers inputs with optimum engine power.

(2) Fuel injection control

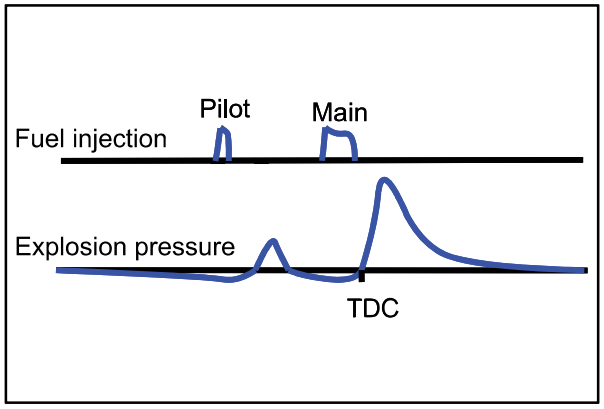
a. Multi injection

Fuel injection process consists of 3 steps: Main Injection, Pilot Injection, Post Injection

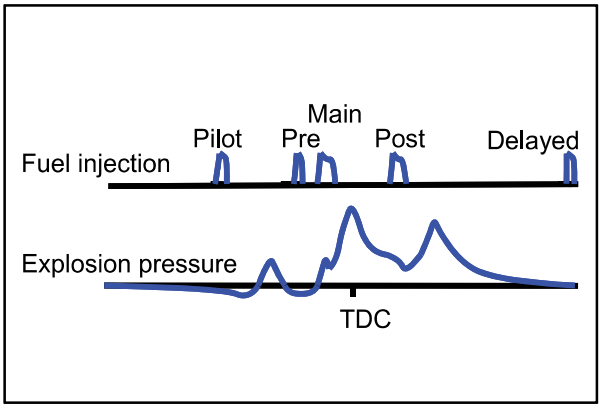


Injection	Function	Main	Produces engine power
Pilot 1	Reduces PM by injecting before main injection.	**After**	PM control
Pilot 2	Reduces NOx and noise by shortening main injection delay due to flammability	**Post 1**	Reduces PM by enabling fuel activation.
Pre	Controls NOx emission level, Combustion noise and Stable idle	**Post 2**	Activates CDPF by increasing exhaust gas temperature and supplying reduction material

▶ **Pilot injection**



▶ **Multi injection**



Modification basis	
Application basis	
Affected VIN	

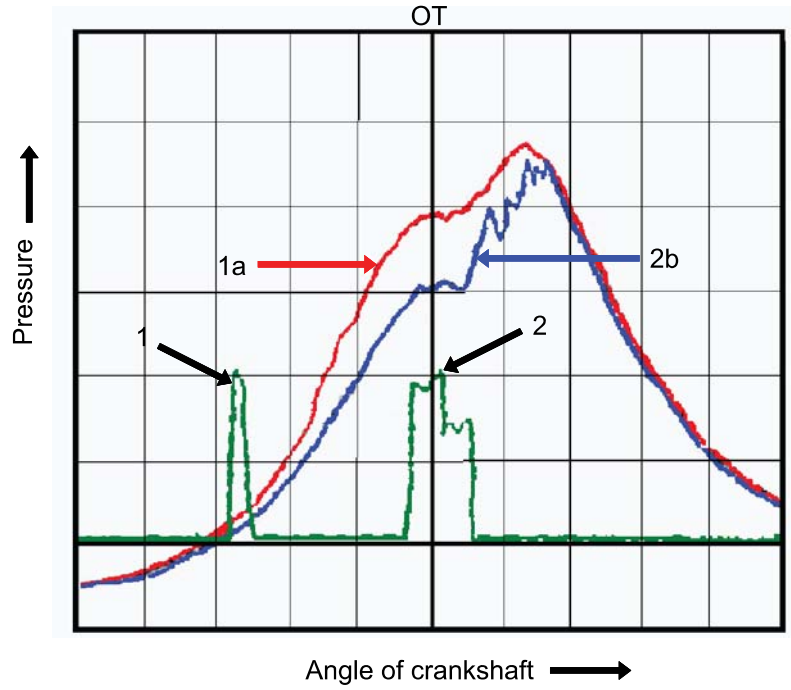
b. Pilot Injection

Injection before main injection. Consists of 1st and 2nd pilot injection, and Pre-injection
Inject a small amount of fuel before main injection to make the combustion smooth. Also, called as preliminary injection or ignition injection. This helps to reduce Nox, engine noise and vibration, and to stabilize the idling.
The injected fuel volume is changed and stopped according to the coolant temperature and intake air volume.

Stop conditions

- Pilot injection is much earlier than main injection due to higher engine rpm
- Too small injection volume (insufficient injection pressure, insufficient fuel injection volume in main injection, engine braking)
- System failure (fuel system, engine control system)

▶ **Combustion pressure characteristic curve for pilot injection**



1. Pilot injection
2. Main injection

1a.Combustion pressure with pilot injection
2b.Combustion pressure without pilot injection

c. Main Injection

The power of the vehicle is determined by the main fuel injection volume.
Main injection calculates the fuel volume based on pilot injection. The calculation uses the value for accelerator pedal position, engine rpm, coolant temperature, intake air temperature, boost pressure, boost temperature and atmospheric pressure etc.

d. Post Injection

Injection after main injection. Consists of After injection, Post 1, Post 2 injection.
Post injection reduces PM and smoke from exhaust gas. No actual output is generated during these injections, instead, fuel is injected to the unburned gas after main injection to enable fuel activation. The PM amount in the emission and smoke can be reduced through these processes.
Only up to 5 types of injections can be performed within 1 cycle. If these 7 injections are all performed, fuel economy and emission performance becomes poor.

Modification basis	
Application basis	
Affected VIN	

(3) Fuel Pressure Control

▶ Fuel Pressure

Fuel pressure is controlled by IMV opening according to the calculated value by ECU.

▶ Pressure in the fuel rail is determined according to engine speed and load on the engine.

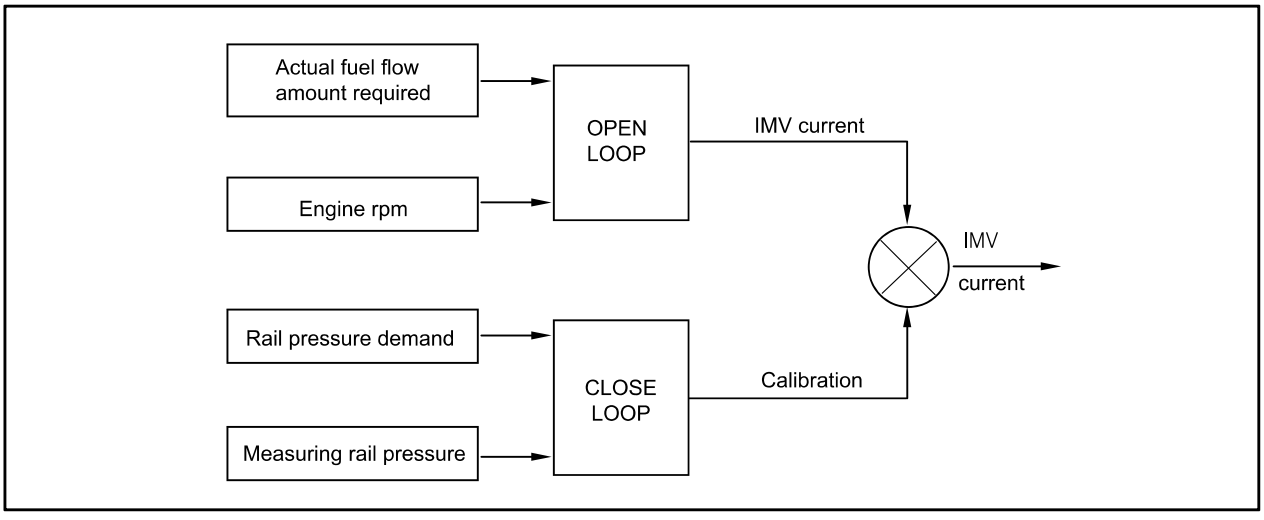
- When engine speed and load are high
  The degree of turbulence is very great and the fuel can be injected at very high pressure in order to optimize combustion.
- When engine speed and load are low
  The degree of turbulence is low. If injection pressure is too high, the nozzle's penetration will be excessive and part of the fuel will be sprayed directly onto the sides of the cylinder, causing incomplete combustion. So there occurs smoke and damages engine durability.

Fuel pressure is corrected according to air temperature, coolant temperature and atmospheric pressure and to take account of the added ignition time caused by cold running or by high altitude driving. A special pressure demand is necessary in order to obtain the additional flow required during starts. This demand is determined according to injected fuel and coolant temperature.

▶ Open loop determines the current which needs to be sent to the actuator in order to obtain the flow demanded by the ECU.

▶ Closed loop will correct the current value depending on the difference between the pressure demand and the pressure measured.

- If the pressure is lower than the demand, current is reduced so that the fuel sent to the high pressure pump is increased.
- If the pressure is higher than the demand, current is increased so that the fuel sent to the high pressure pump is reduced.



(4) Injection Timing Control

▶ **Injection timing is determined by the conditions below.**

1. Coolant temperature
   Hot engine - Retarded to reduce Nox
   Cold engine - Advanced to optimize the combustion
2. Atmospheric pressure
   Advanced according to the altitude
3. Warming up
   Advanced during warming up in cold engine
4. Rail pressure
   Retarded to prevent knocking when the rail pressure is high
5. EEGR ratio
   Advanced to decrease the cylinder temperature when EGR ratio increases

▶ **Pilot injection timing control**

The pilot injection timing is determined as a function of the engine speed and of the total flow.
The elements are:

- A first correction is made according to the air and coolant temperatures. This correction allows the pilot injection timing to be adapted to the operating temperature of the engine.
- A second correction is made according to the atmospheric pressure. This correction is used to adapt the pilot injection timing as a function of the atmospheric pressure and therefore the altitude.

▶ **Main injection timing control**

The pulse necessary for the main injection is determined as a function of the engine speed and of the injected flow.
The elements are:

- A first correction is made according to the air and coolant temperatures.
  This correction makes it possible to adapt the timing to the operating temperature of the engine. When the engine is warm, the timing can be retarded to reduce the combustion temperature and polluting emissions (NOx). When the engine is cold, the timing advance must be sufficient to allow the combustion to begin correctly.
- A second correction is made according to the atmospheric pressure.
  This correction is used to adapt the timing advance as a function of the atmospheric pressure and therefore the altitude.
- A third correction is made according to the coolant temperature and the time which has passed since starting.
  This correction allows the injection timing advance to be increased while the engine is warming up (initial 30 seconds). The purpose of this correction is to reduce the misfiring and instabilities which are liable to occur after a cold start.

Modification basis	
Application basis	
Affected VIN	

- A fourth correction is made according to the pressure error.
  This correction is used to reduce the injection timing advance when the pressure in the rail is higher than the pressure demand.
  A fifth correction is made according to the rate of EGR.
- This correction is used to correct the injection timing advance as a function of the rate of exhaust gas recirculation.

When the EGR rate increases, the injection timing advance must in fact be increased in order to compensate for the fall in termperature in the cylinder.

(5) Fuel Control

A. Main Flow Control

The main flow represents the amount of fuel injected into the cylinder during the main injection. The pilot flow represents the amount of fuel injected during the pilot injection.

The total fuel injected during 1 cycle (main flow + pilot flow) is determined in the following manner.

- When the driver depress the pedal, it is his demand which is taken into account by the system in order to determine the fuel injected.
- When the driver release the pedal, the idle speed controller takes over to determine the minimum fuel which must be injected into the cylinder to prevent the enigne from stalling.

It is therefore the greater of these 2 values which is retained by the system. This value is then compared with the lower flow limit determined by the ESP system.

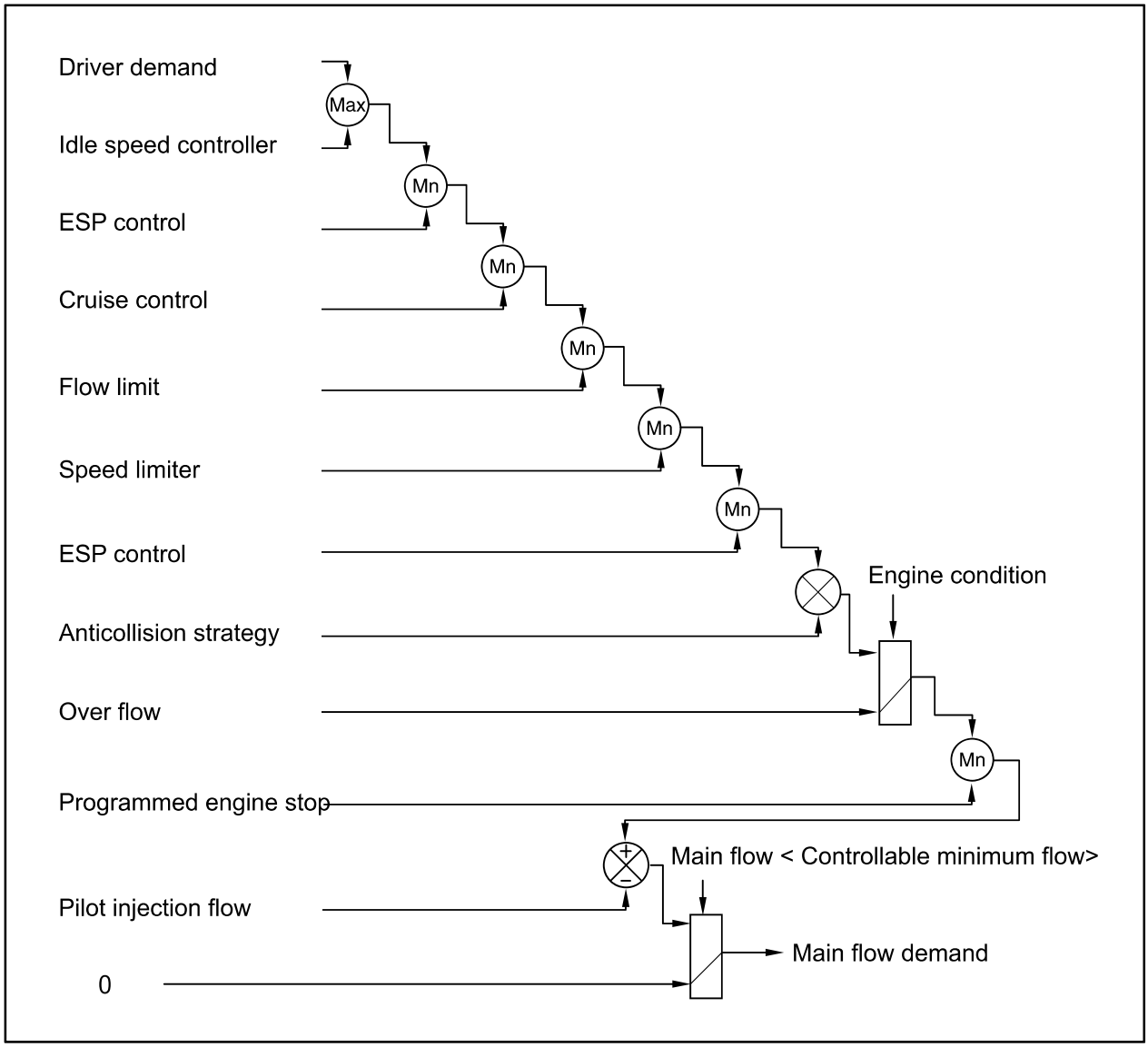
As soon as the injected fuel becomes lower than the flow limit determined by the ESP system, the antagonistic torque (engine brake) transmitted to the drive wheels exceeds the adherence capacity of the vehicle and there is therefore a risk of the drive wheels locking.
The system thus chooses the greater of these 2 values (main flow & pilot flow) in order to prevent any loss of control of the vehicle during a sharp deceleration.

As soon as the injected fuel becomes higher than the fuel limit determined by the ASR trajectory control system, the engine torque transmitted to the wheels exceeds the adhesion capacity of the vehicle and there is a risk of the drive wheels skidding. The system therefore chooses the smaller of the two values in order to avoid any loss of control of the vehicle during accelerations.
The anti-oscillation strategy makes it possible to compensate for fluctuations in engine speed during transient conditions. This strategy leads to a fuel correction which is added to the total fuel of each cylinder.

A switch makes it possible to change over from the supercharge fuel to the total fuel according to the state of the engine.

- Until the stating phase has finished, the system uses the supercharged fuel.
- Once the engine changes to normal operation, the system uses the total fuel.

The main fuel is obtained by subtracting the pilot injection fuel from the total fuel.
A mapping determines the minimum fuel which can control an injector as a function of the rail pressure.
As soon as the main fuel falls below this value, the fuel demand changes to 0 because in any case the injector is not capable of injecting the quantity demand.



B. Driver Demand

The driver demand is the translation of the pedal position into the fuel demand. It is calculated as a function of the pedal position and of the engine speed. The driver demand is filtered in order to limit the hesitations caused by rapid changes of the pedal position. A mapping determines the maximum fuel which can be injected as a function of the driver demand and the rail pressure. Since the flow is proportional to the injection time and to the square root of the injection pressure, it is necessary to limit the flow according to the pressure in order to avoid extending the injection for too long into the engine cycle. The system compares the driver demand with this limit and chooses the smaller of the 2 values. The driver demand is then corrected according to the coolant temperature. This correction is added to the driver demand.

Modification basis	
Application basis	
Affected VIN	

C. Idle Speed Controller

The idle speed controller consists of 2 principal modules:

- The first module determines the required idle speed according to:
  * The operating conditions of the engine (coolant temperature, gear engaged)
  * Any activation of the electrical consumers (power steering, air conditioning, others)
  * The battery voltage
  * The presence of any faults liable to interface with the rail pressure control or the injection control. In this case, increase the idle speed to prevent the engine from stalling.
- The second module is responsible for providing closed loop control of the engine's idle speed by adapting the minimum fuel according to the difference between the required idle speed and the engine speed.

D. Flow Limitation

The flow limitation strategy is based on the following strategies:

- The flow limitation depending on the filling of the engine with air is determined according to the engine speed and the air flow. This limitation allows smoke emissions to be reduced during stabilized running.
- The flow limitation depending on the atmospheric pressure is determined according to the engine speed and the atmospheric pressure. It allows smoke emissions to be reduced when driving at altitude.
- The full load flow curve is determined according to the gear engaged and the engine speed. It allows the maximum torque delivered by the engine to be limited.
- A performance limitation is introduced if faults liable to upset the rail pressure control or the injection control are detected by the system. In this case, and depending on the gravity of the fault, the system activates:

Reduced fuel logic 1: Guarantees 75 % of the performance without limiting the engine speed.
Reduced fuel logic 2: Guarantees 50 % of the performance with the engine speed limited to 3,000 rpm.
Reduce fuel logic 3: Limits the engine speed to 2,000 rpm.

The system chooses the lowest of all values.
A correction depending on the coolant temperature is added to the flow limitation. This correction makes it possible to reduce the mechanical stresses while the engine is warming up.
The correction is determined according to the coolant temperature, the engine speed and the time which has passed since starting.

E. Superchager Flow Demand

The supercharge flow is calculated according to the engine speed and the coolant temperature. A correction depending on the air temperature and the atmospheric pressure is made in order to increase the supercharge flow during cold starts. It is possible to alter the supercharge flow value by adding a flow offset with the aid of the diagnostic tool

F. Pilot Flow Control

The pilot flow represents the amount of fuel injected into the cylinder during the pilot injection. This amount is determined according to the engine speed and the total flow.

- A first correction is made according to the air and water temperature.
  This correction allows the pilot flow to be adapted to the operating temperature of the engine. When the engine is warm, the ignition time decreases because the end-of-compression temperature is higher. The pilot flow can therefore be reduced because there is obviously less combustion noise when the engine is warm.
- A second correction is made according to the atmospheric pressure.

During starting, the pilot flow is determined on the basis of the engine speed and the coolant temperature.

G. Cylinder Balancing Strategy

▶ Balancing of the point to point flows

The pulse of each injector is corrected according to the difference in instantaneous speed measured between 2 successive injectors.

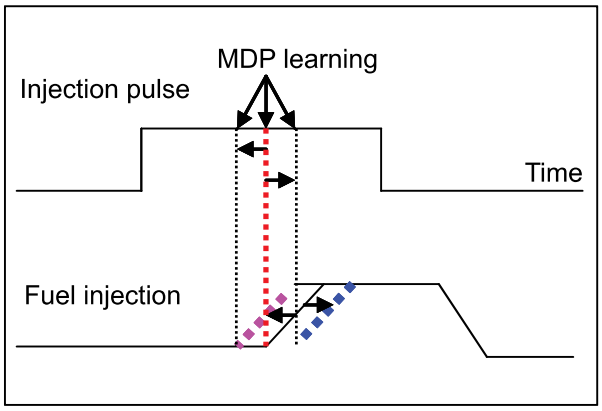
The instantaneous speeds on two successive injections are first calculated.
The difference between these two instantaneous speeds is then calculated.
Finally, the time to be added to the main injection pulse for the different injectors is determined.
For each injector, this time is calculated according to the initial offset of the injector and the instantaneous speed difference.

▶ Detection of an injector which has stuck closed

The cylinder balancing strategy also allows the detection of an injector which has stuck closed. The difference in instantaneous speed between 2 successive injections then exceeds a predefined threshold. In this case, a fault is signaled by the system.

Modification basis	
Application basis	
Affected VIN	

(6) MDP Learning Control



MDP (Minimum Drive Pulse) refers to the minimum power supply pulse for injection which the injector can perform. It is possible to control the fuel volume for each injector accurately through correct learning for the MDP value. The basic process of MDP learning is that the pulse slightly higher than MDP is supplied and then (b) the vibration generated from the cylinder is detected. The knock sensor detects the vibration from the engine after a small volume of fuel is injected. And the time interval between the points of injection and vibration is measured so that MDP can be learned. MDP learning is helpful to prevent engine vibration, high emission and power reduction through performing calibration for the old injectors. During MDP learning, a little vibration and noise can be occur for a while. This is because the fuel pressure is increased instantaneously and the exact injection value is not input, so that the exact engine vibration timing can be detected.

A. MDP Learning

When the pulse value that the injector starts injection is measured, it is called minimum drive pulse (MDP). Through MDP controls, can correct pilot injections effectively. Pilot injection volume is very small, 1 to 2 mm/str, so precise control of the injector can be difficult if it gets old. So there needs MDP learning to control the very small volume precisely through learning according to getting older injectors.

B. Purpose of MDP learning

The system measures the pulse at initial injection to reduce the engine vibration.

- Control the fuel injection volume precisely by MDP learning even for the old injector.
- ECU corrects the pilot injection effectively by MDP control.
- MDP learning is performed by the signal from knock sensor.

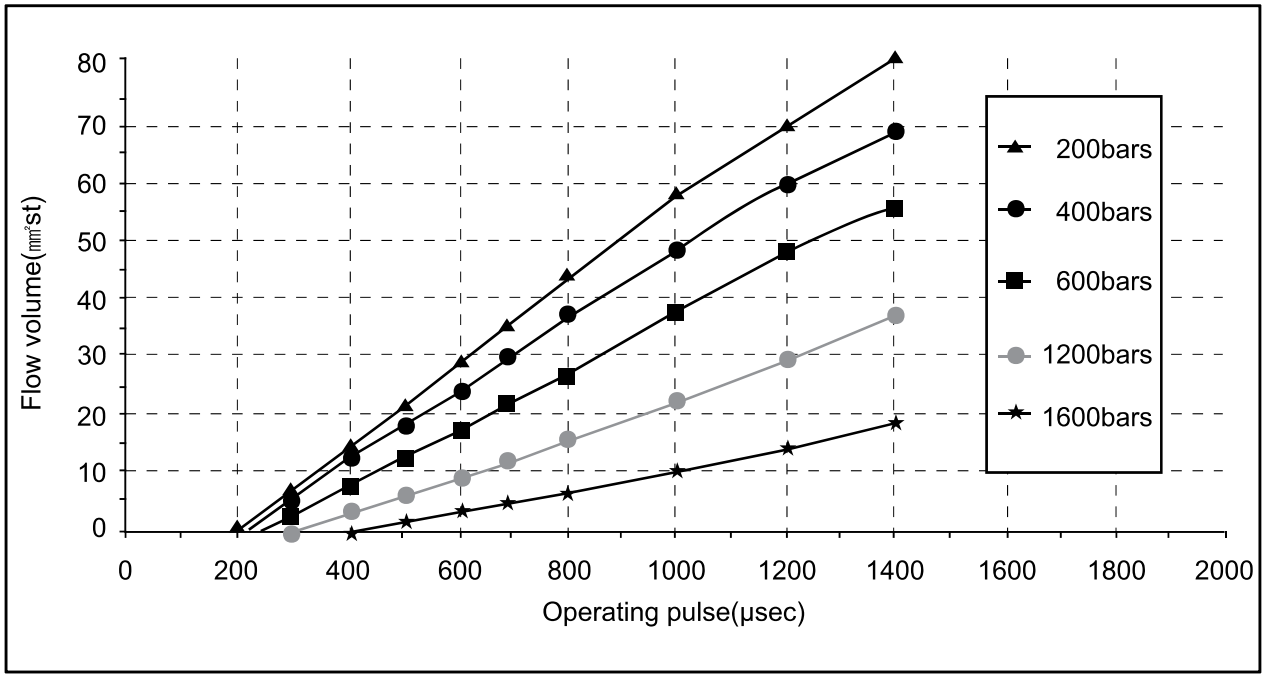
C. Learning Conditions

	Idle MDP learning	Drive MDP learning
Coolant temperature	over 60℃	over 60℃
Vehicle speed	Idling	over 50km/h (over 5 seconds)
Engine rpm		2,000 to 2,500 rpm
Fuel temperature	0 < Fuel temperature < 80℃	
Learning	2 times for each cylinder (every 5 seconds)	2 times for each cylinder (every 5 seconds)

CAUTION

- If MDP learning is not properly performed, engine vibration and injection could be occurred.
- MDP learning should be performed after replacing ECU, reprogramming and replacing injector.

D. Injector characteristic curve for rail pressure



Modification basis	
Application basis	
Affected VIN	

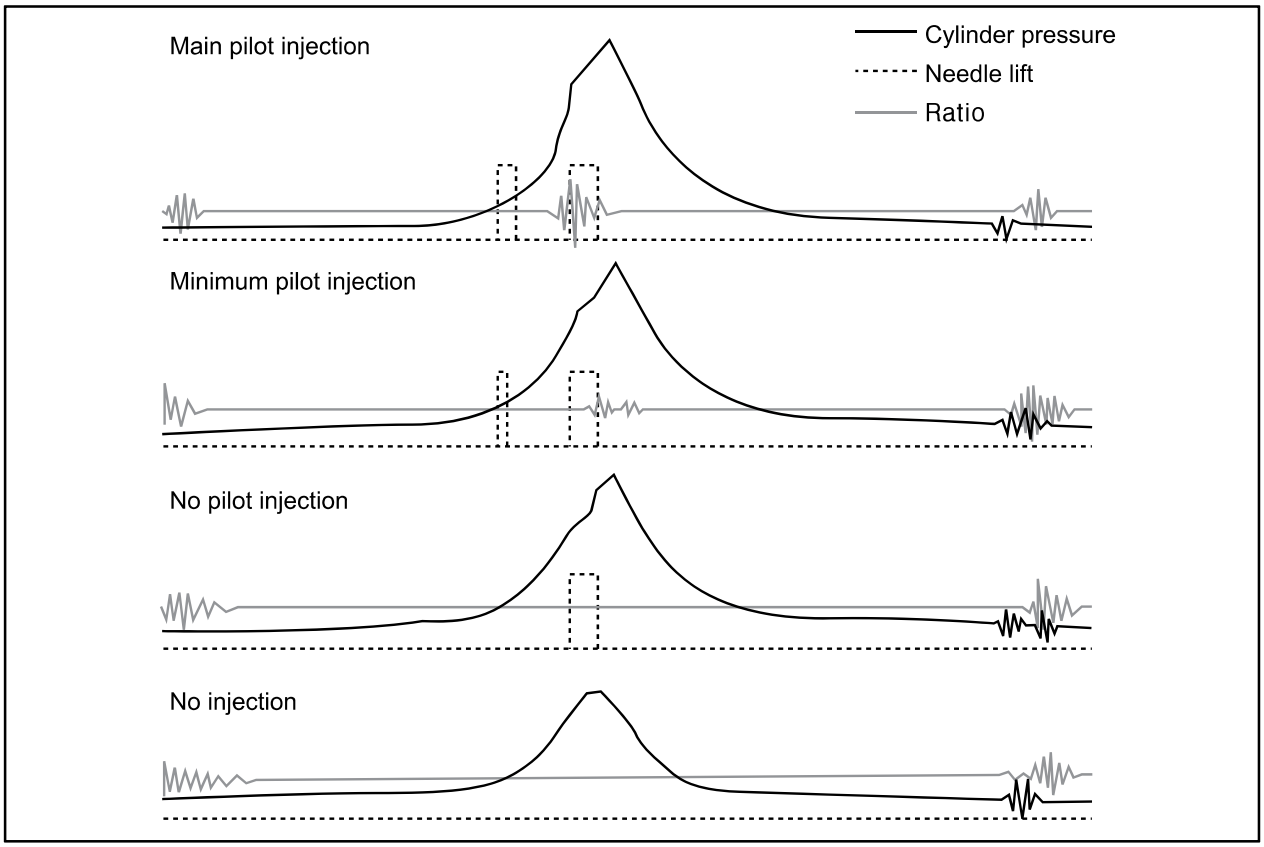
(7) Knocking Control

A. Resetting the pilot injection

The knocking control is used to reset the pilot injection flow in closed loop for each injector. This method allows the correction of any injector deviations over a period of time. The principle of use of the knocking control is based on the detection of the combustion noises.
The sensor is positioned in such a way as to receive the maximum signal for all the cylinders. The raw signals from the knock sensor are processed to obtain a variable which quantifies the intensity of the combustion. This variable, known as the ratio, consists of the ratio between the intensity of the background noise and the combustion noise.

1. A first window is used to establish the background noise level of the knocking control signal for each cylinder. This window must therefore be positioned at a moment when there cannot be any combustion.
2. The second window is used to measure the intensity of the pilot combustion. Its position is such that only the combustion noises produced by the pilot injection are measured . It is therefore placed just before the main injection.

The knock sensor does not allow any evaluation of the quantity injected. However, the pulse value will be measured when the injector starts injection and this pulse value is called the MDP (Minimum Drive Pulse). On the basis of this information, it is possible to efficiently correct the pilot flows. The pilot injection resetting principle therefore consists of determining the MDP, in other words the pulse corresponding to the start of the increase in value of the ratio (increase of vibration due to fuel combustion).



This is done periodically under certain operating conditions. When the resetting is finished, the new minimum pulse value replaces the value obtained during the previous resetting. The first MDP value is provided by the C3I. Each resetting then allows the closed loop of the MDP to be updated according to the deviation of the injector.

B. Detection of leaks in the cylinders

The accelerometer is also used to detect any injector which may have stuck open. The detection principle is based on monitoring the ratio. If there is a leak in the cylinder, the accumulated fuel self-ignites as soon as the temperature and pressure conditions are favorable (high engine speed, high load and small leak).
This combustion is set off at about 20 degrees before TDC and before main injection.
The ratio therefore increases considerably in the detection window. It is this increase which allows the leaks to be detected. The threshold beyond which a fault is signaled is a percentage of the maximum possible value of the ratio.
Because of the severity of the recovery process (engine shut-down), the etection must be extremely robust.
An increase in the ratio can be the consequence of various causes:

- Pilot injection too much
- Main combustion offset
- Fuel leak in the cylinder

If the ratio becomes too high, the strategy initially restricts the pilot injection flow and retards the main injection. If the ratio remains high despite these interventions, this shows that a real leak is present, a fault is signaled and the engine is shut down.

C. Detection of an accelerometer fault

This strategy permits the detection of a fault in the sensor or in the wiring loom connecting the sensor to the ECU.
It is based on detection of the combustion. When the engine is idling, the detection window is set too low for the combustion caused by the main injection. If the ratio increases, this shows that the knock sensor is working properly, but otherwise a fault is signaled to indicate a sensor failure. The recovery modes associated with this fault consist of inhibition of the pilot injection and discharge through the injectors.

Modification basis	
Application basis	
Affected VIN	

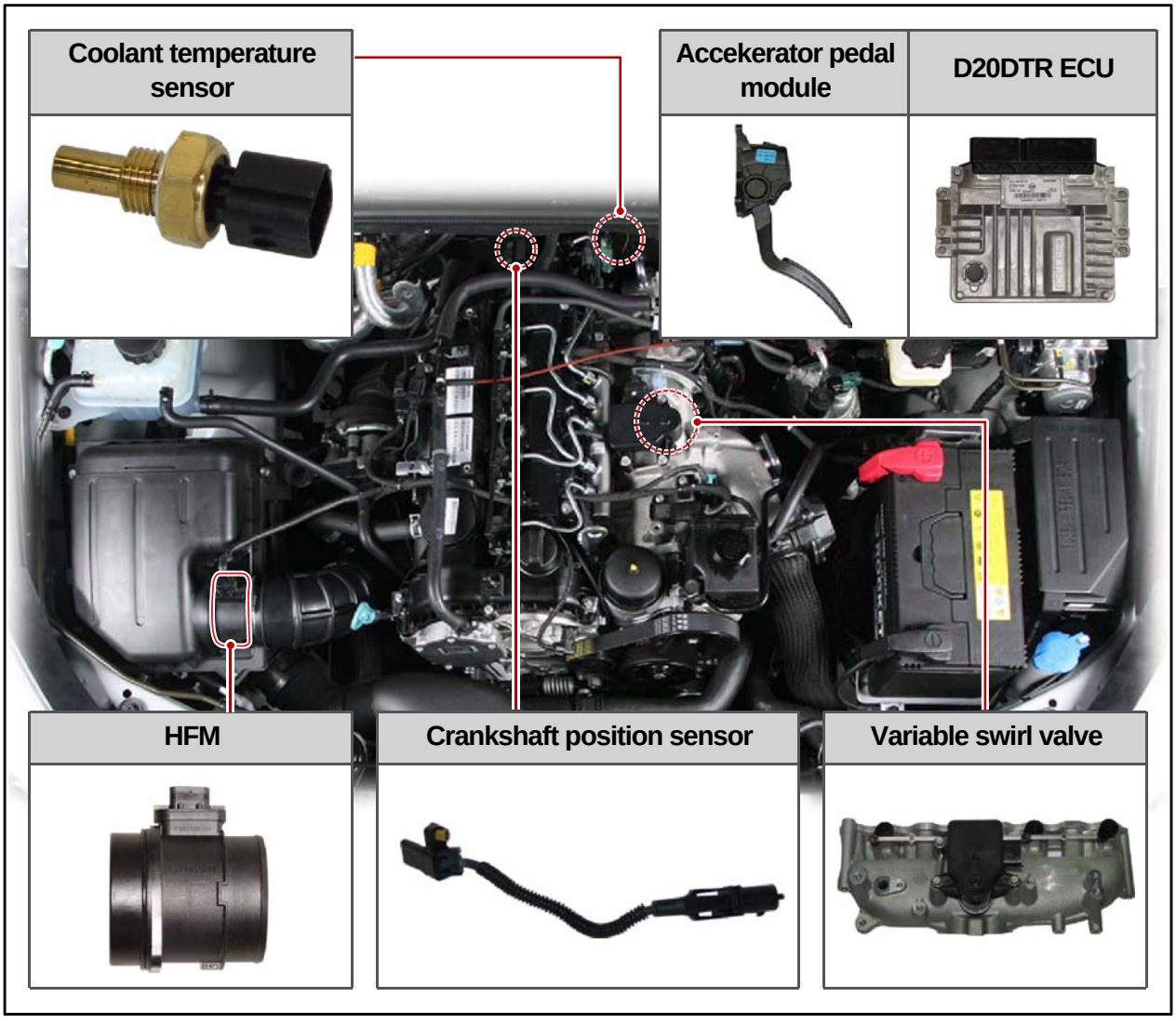
(8) Swirl control

A. Overview

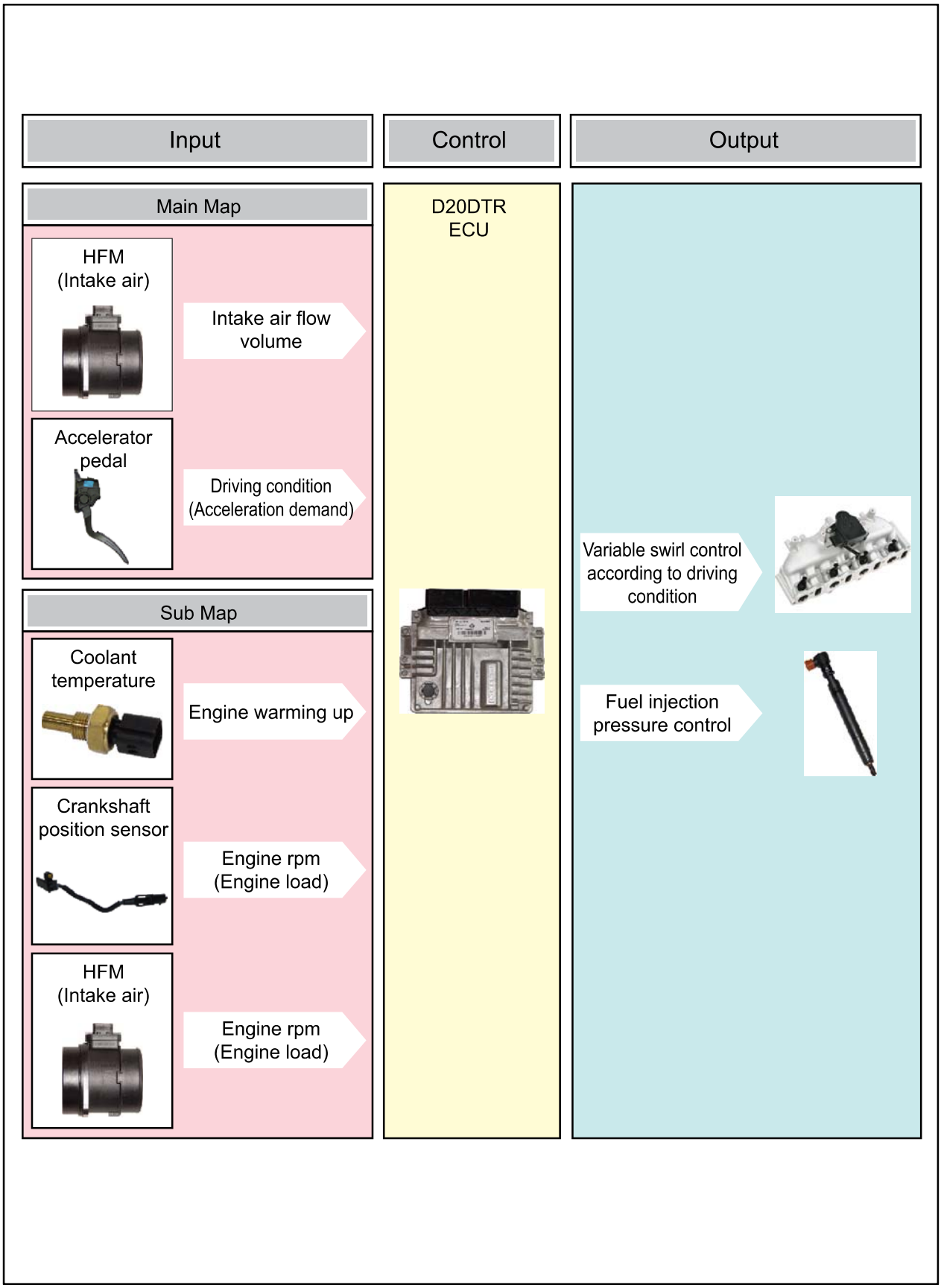
▶ Variable swirl valve

The strong swirl caused by intake air is important element for anti-locking function in diesel engine. The swirl control valve partially closes the intake port to generate the swirl according to the engine conditions. When the engine load is in low or medium range, the swirl could not be generated because the air flow is slow. To generate strong swirl, there are two passages in intake manifold, and one of them has the valve to open and close the passage. When the valve closes the passage, the air flow through the another passage will be faster, and the strong swirl will be generated by the internal structure of the passage. This swirl makes the better mixture of air and fuel, eventually the combustion efficiency in combustion chamber could be improved. This provides the enhanced fuel consumption, power and EGR ratio.

▶ Components

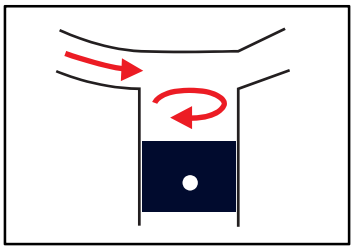


B. Input/Output for variable swirl valve

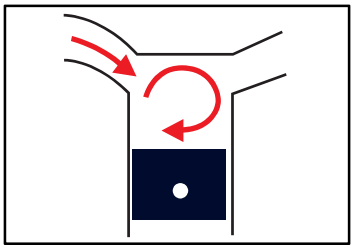


Modification basis	
Application basis	
Affected VIN	

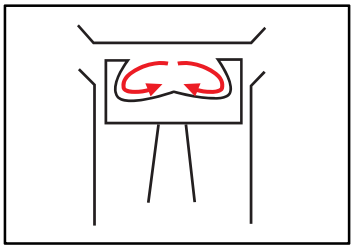
C. Types of swirl



Swirl: One cylinder has two intake air ports, one is set horizontally and the other one is set vertically. Swirl is the horizontal air flows in cylinder due to the horizontal intake air ports.



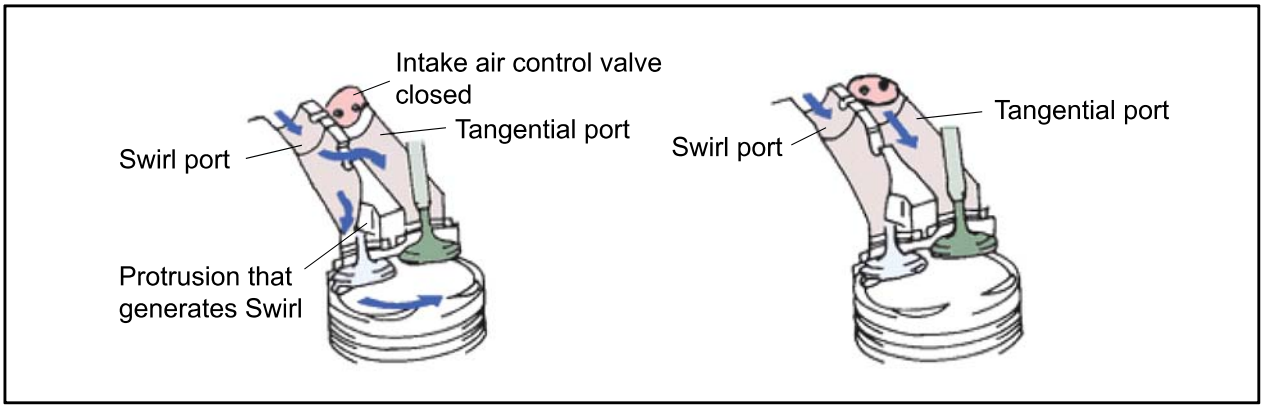
Tumble: Tumble is the vertical air flows in cylinder due to the vertical intake air port



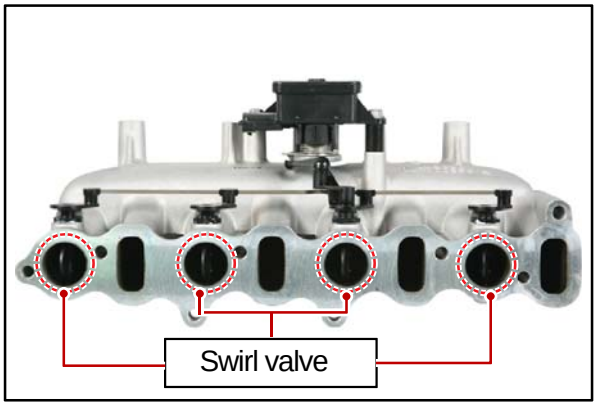
Tumble: Tumble is the vertical air flows in cylinder due to the vertical intake air port

D. Swirl control

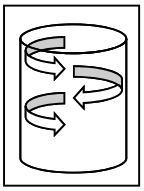
In DI type diesel engine, the liquefied fuel is injected into the cylinder directly. If the fuel is evenly distributed in short period, the combustion efficiency could be improved. To get this, there should be good air flow in cylinder. In general, there are two intake ports, swirl port and tangential port, in each cylinder. The swirl port generates the horizontal flow and the tangential port generates the longitudinal flow. In low/mid load range, the tabgential port is closed to increase the horizontal flow. Fast flow decreases the PM during combustion and increases the EGR ratio by better combustion efficiency.



Load	Engine speed	Swirl valve	Amount of swirl	Remarks
Low speed, Low load	below 3,000 rpm	Closed	Heavy	Increased EGR ratio, better air-fuel mixture (reduce exhaust gas)
High speed, High load	over 3,000 rpm	Open	Light	Increase charge efficiency, higher engine power



The variable swirl valve actuator operates when turning the ignition switch ON/OFF position to open/close the swirl valve. In this period, the soot will be removed and the learning for swirl valve position is performed.



NOTE

Swirl: This is the twisted (radial) air flow along the cylinder wall during the intake stroke. This stabilizes the combustion even in lean air-fuel mixture condition.

E. Features

- Swirl and air intake efficiency
  To generate the swirl, the intake port should be serpentine design. This makes the resistance in air flow. The resistance in air flow in engine high speed decreases the intake efficiency. Eventually, the engine power is also decreased, Thus, the swirl operation is deactivated in high speed range to increase the intake efficiency.
- Relationship between swirl and EGR
  To reduce Nox, it is essential to increase EGR ratio. However, if EGR ratio is too high, the PM also could be very higher. And, the exhaust gas should be evenly mixed with newly aspired air. Otherwise, PM and CO are dramatically increased in highly concentrated exhaust gas range and EGR ratio could not be increased beyond a certain limit. If the swirl valve operates in this moment, the limit of EGR ratio will be higher.

F. Relationship between swirl and fuel injection pressure

The injector for DI engine uses the multi hole design. For this vehicle, there are 8 holes in injector. If the swirl is too strong, the injection angles might be overlapped and may cause the increased PM and insufficient engine power. Also, if the injection pressure is too high during strong swirl, the injection angles might be overlapped. Therefore, the system may decreases the fuel injection pressure when the swirl is too strong.

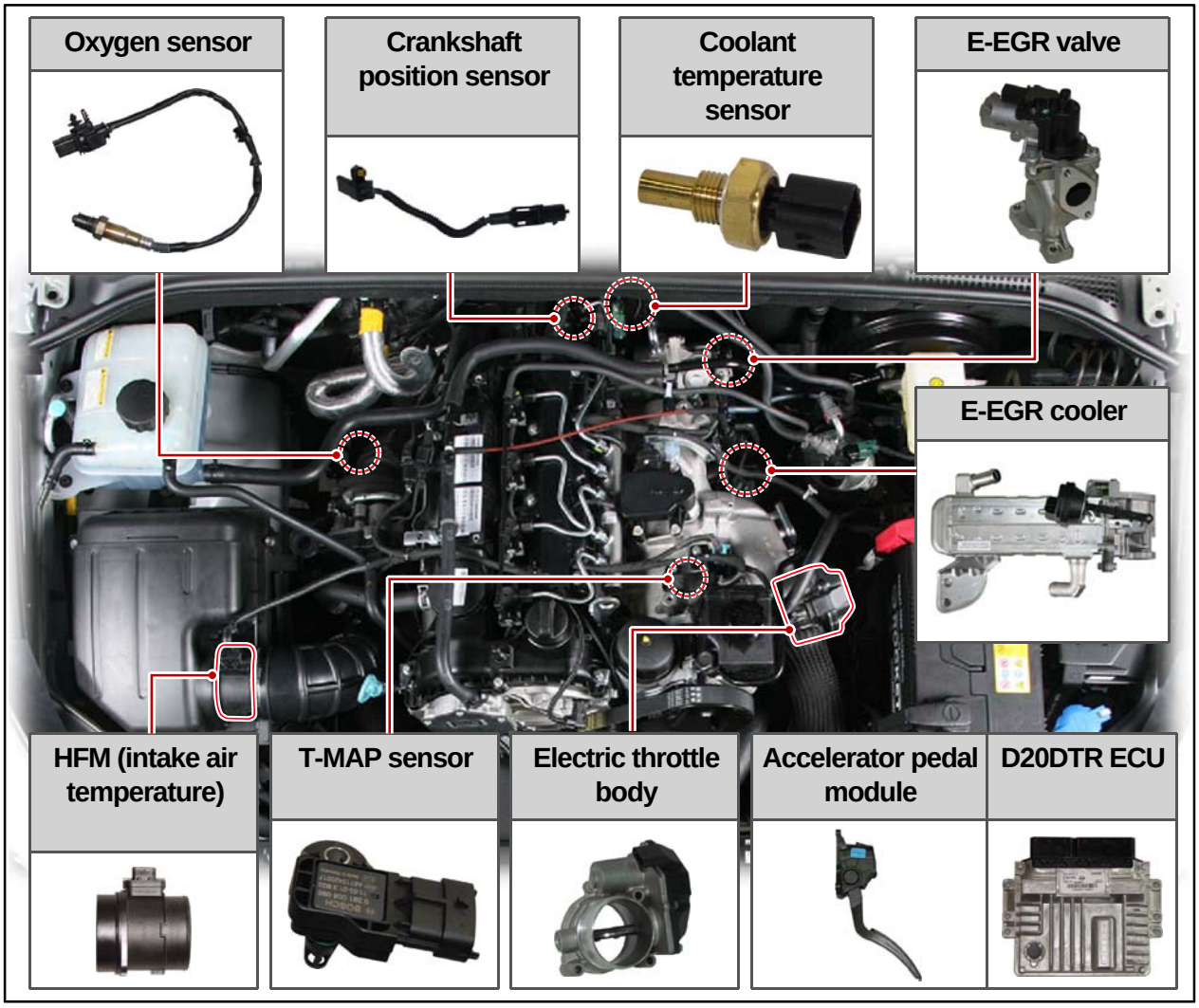
Modification basis	
Application basis	
Affected VIN	

(9) EGR control

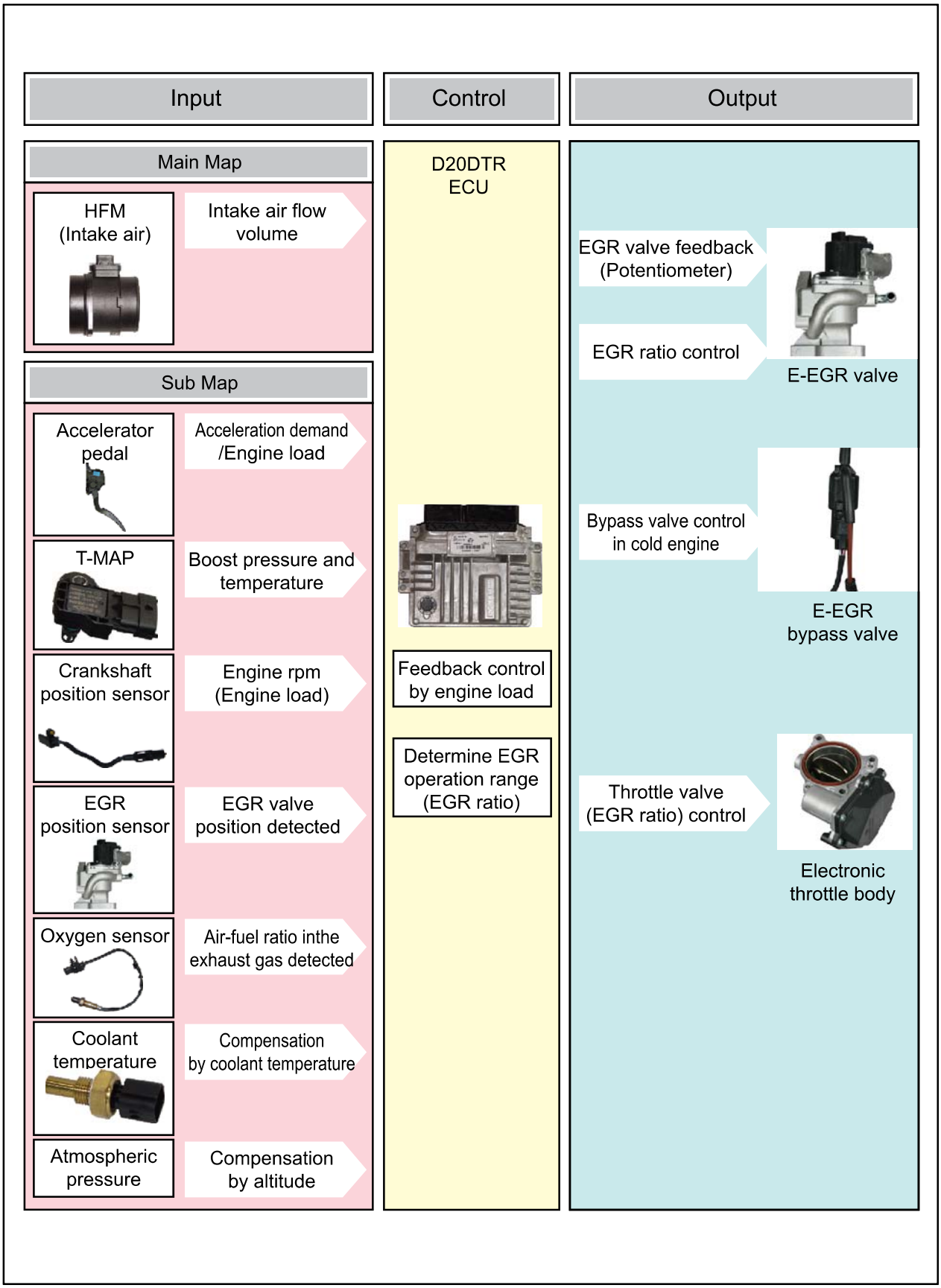
A. Overview

The EGR (Electric-Exhaust Gas Recirculation) valve reduces the NOx emission level by recirculating some of the exhaust gas to the intake system.
To meet Euro-V regulation, the capacity and response rate of E-EGR valve in D20DTR engine have been greatly improved. The EGR cooler with high capacity reduces the Nox, and the bypass valve reduces the CO and HC due to EGR gas before warming up.
Also, the engine ECU adjusts the E-EGR opening by using the air mass signal through HFM sensor. If the exhaust gas gets into the intake manifold when the EGR valve is open, the amount of fresh air through HFM sensor should be decresed.

B. Components



C. Input/Output of E-EGR system

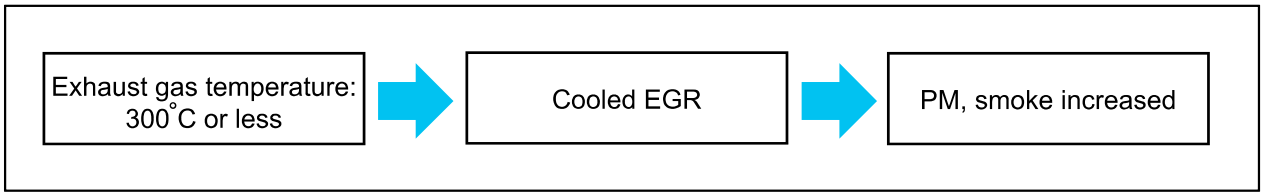


Modification basis	
Application basis	
Affected VIN	

D. Bypass control for EGR cooler

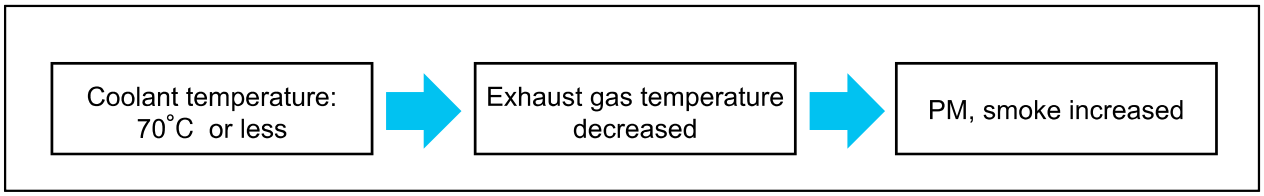
▶ Cooler temperature

When the coolant temperature is below 70℃, the exhaust gas is bypassed the EGR cooler.



▶ Exhaust gas temperature

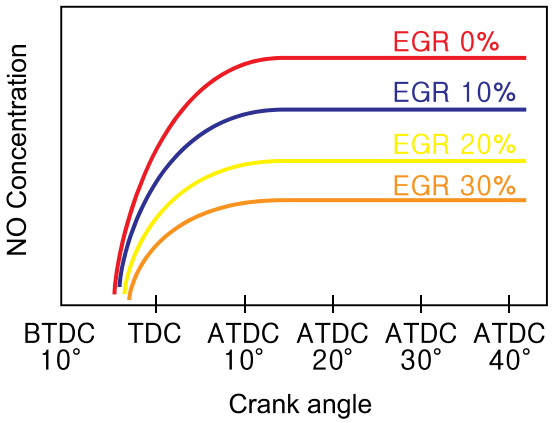
When the exhaust gas temperature is below 300℃, the exhaust gas is bypassed the EGR cooler. Otherwise, PM could be increased due to too low exhaust gas temperature.



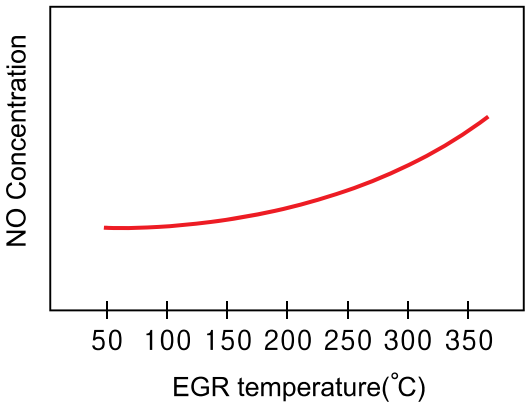
E. Control elements for EGR system

- Accelerator pedal (engine load) - Indicates the driver's intention and engine load. If the load goes up, the EGR ratio is decreased.
- T-MAP (boost pressure map stored in ECU) - Compensates the difference in boost pressure by adjusting EGR ratio.
- Engine rpm - Used as the signal for determining EGR operating range.
- Coolant temperature - When the coolant temperature is low, NOx is decreased but PM could be increased. So, to reduce PM, decrease EGR ratio when the coolant temperature is low.
  Intake air mass and temperature - HFM sensor measures the intake air mass to calculate the actual EGR volume. If the air mass is larger than programmed value in map, EGR ratio will be higher.
  EGR position sensor - Detects the actual opening angle of EGR valve and performs feedback
- function according to PWM control by ECU.
  Wide band oxygen sensor - Detects the oxygen volume in exhaust gas to check if the EGR ratio is
- proper.
  Electronic throttle body - Keeps EGR ratio to optimized level by controlling the throttle body in EGR
- operating range (decreasing pressure in intake manifold).

F. Features



As EGR ratio goes up, smoke volume will be higher. But, this lowers the combustion chamber temperature and accordingly the concentration of NOx is decreased. The point with highest NOx is immediately after TDC.



As EGR temperature goes up, the concentration of NOx will be higher. Thus, it is necessary to cool down the exhaust gas. However, during engine cooled, it may cause large amount of PM. To prevent this, the exhaust gas is bypassed the EGR cooler.

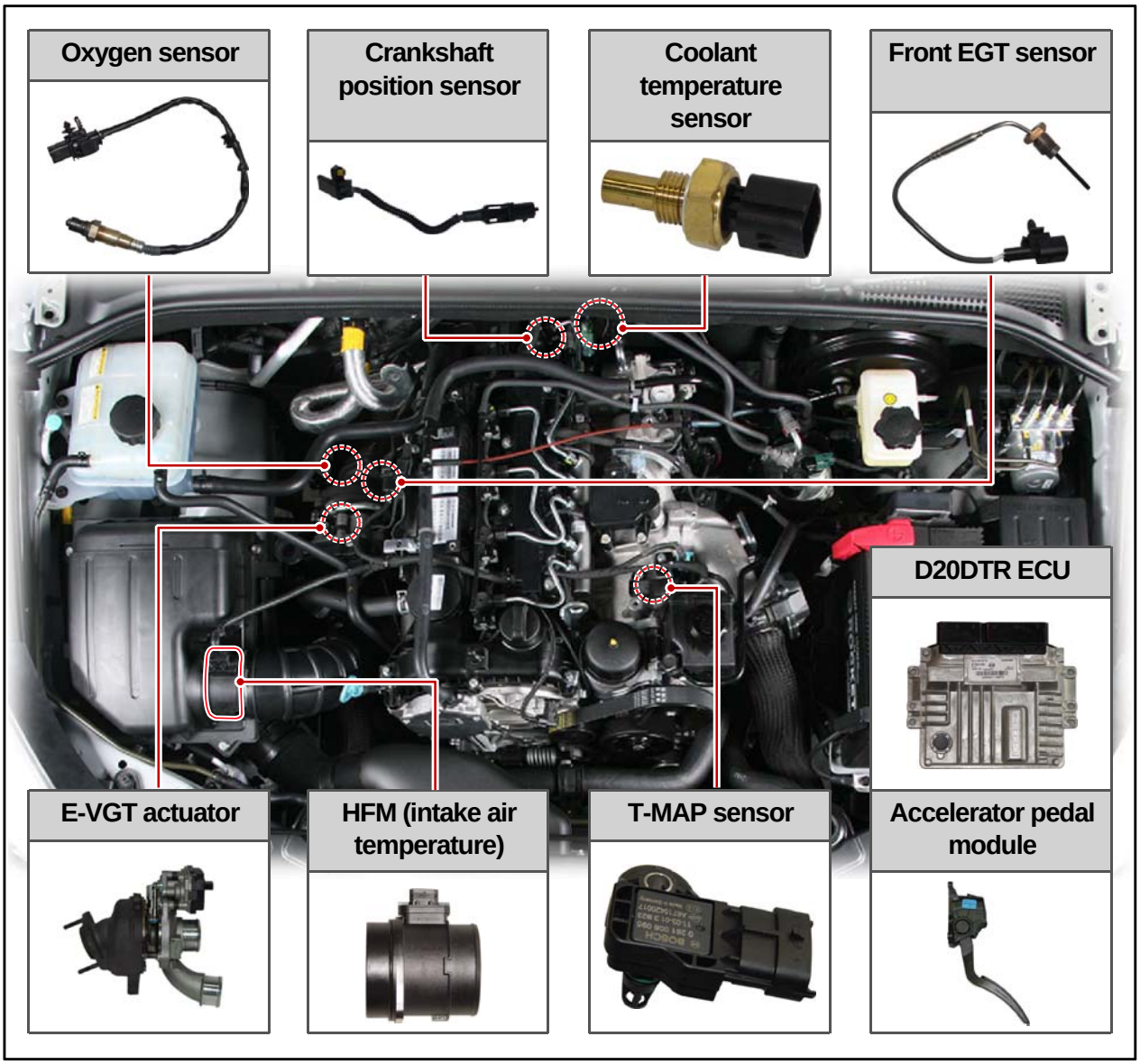
Modification basis	
Application basis	
Affected VIN	

(10) E-VGT control

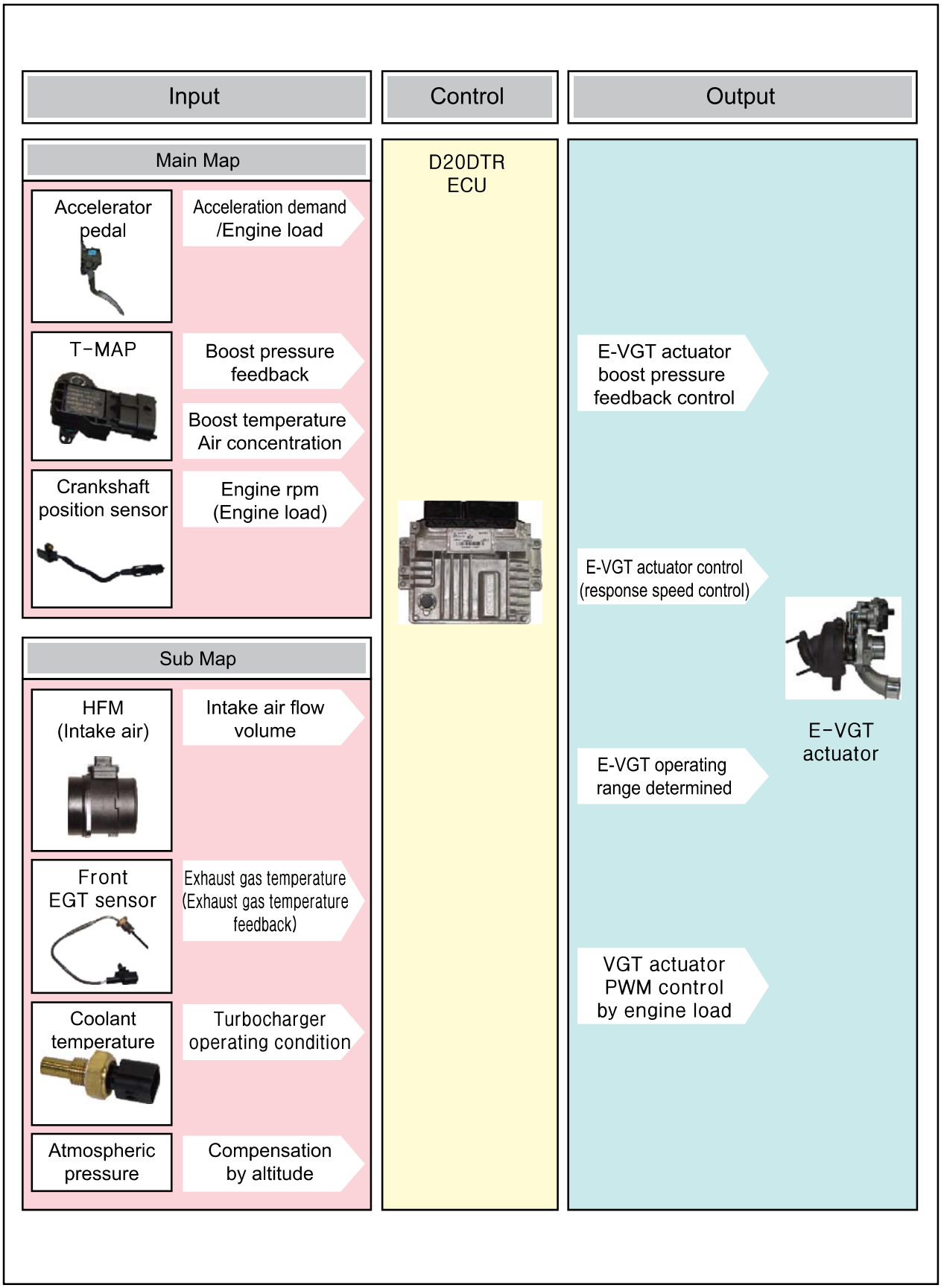
A. Overview

E-VGT (Electric-Variable Geometry Turbine) turbocharger system in D20DTF engine uses the venturi effect that controls the flow rate of exhaust gas by adjusting the passage in turbine housing. The newly adopted DC motor actuator (E-actuator) controls the E-VGT system more precisely and faster. To get the high operating power from turbine, the ECU reduces the exhaust gas passage In low speed range and increases it in high speed range.

B. Components



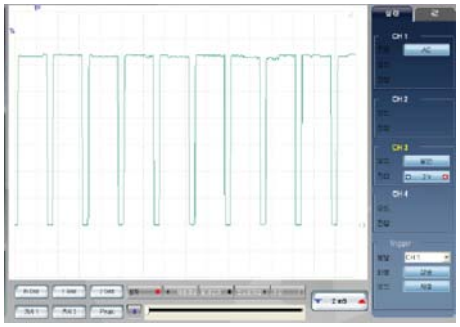
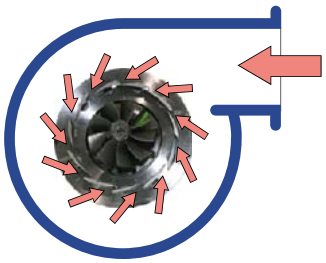
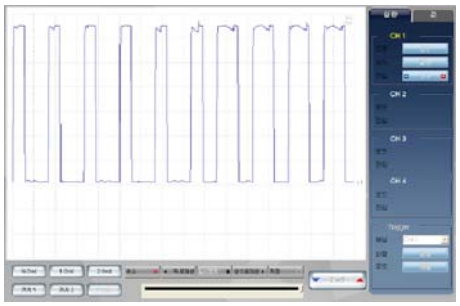
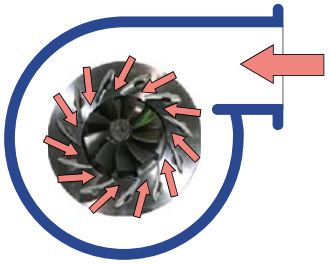
C. Input/Output for E-VGT system



Modification basis	
Application basis	
Affected VIN	

D. E-VGT system control

Turbocharger system operates the E-VGT actuator according to the signals for engine epm, accelerator pedal position, atmospheric pressure, T-MAP, coolant temperature and intake air temperature.
Turbocharger actuator is performed PWM control by ECU.
In general, the boost pressure feedbacks the turbocharger operation and the boost temperature is used for calculating the precise density.
E-VGT provides higher engine power with faster reaction speed compared to conventional VGT.

	Operating wave	Vane	Control
Low speed range			In low speed range: retract the vane to increase boost pressure. The vane has low (-) duty, and the unison ring moves to retract the vane in weak PWM signal.
High speed range			The unison ring moves to extend the vane in strong PWM signal. Maximum pressure is 3 bar and the system controls it according to the input signals.

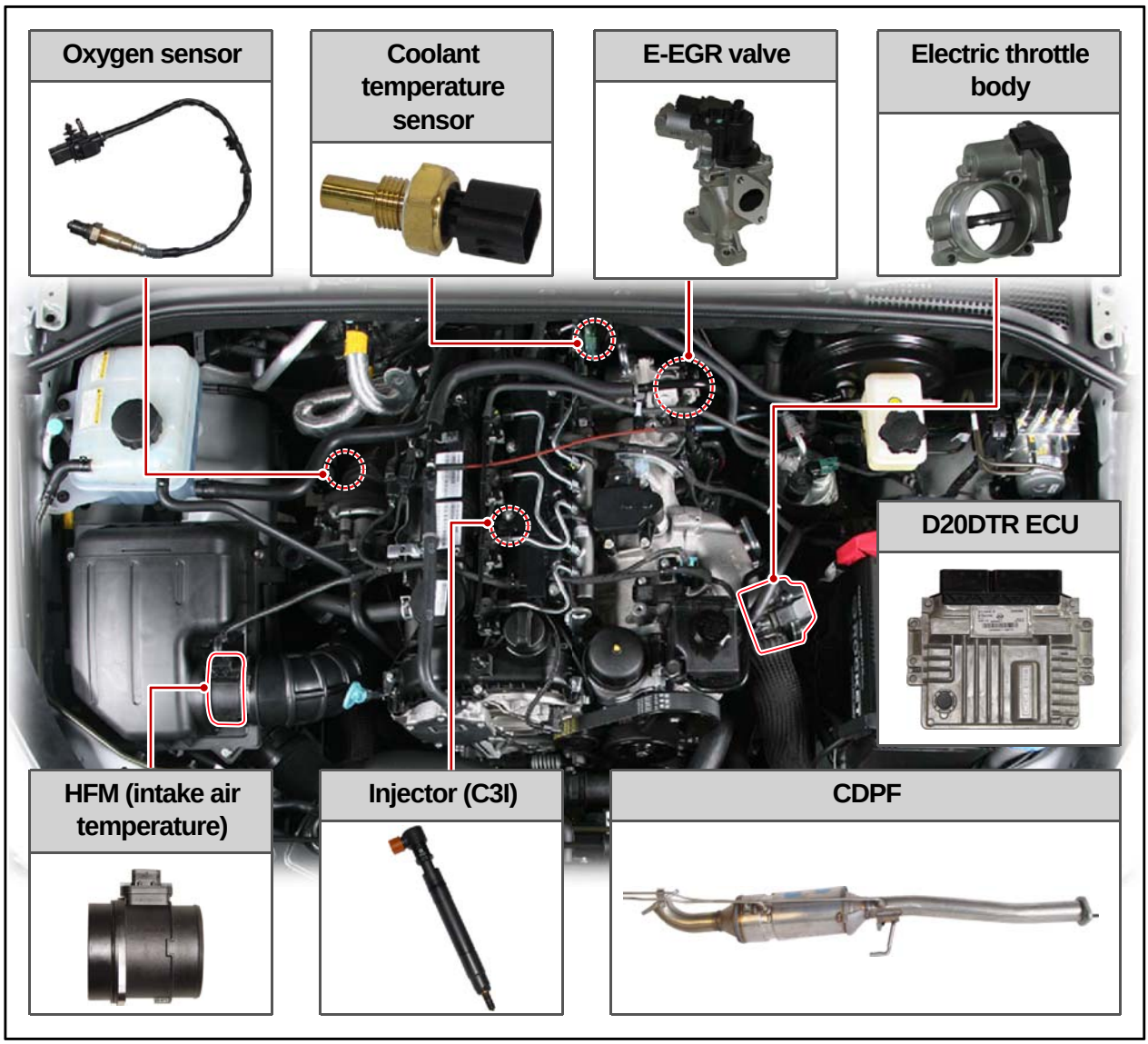
(11) Wide band oxygen sensor control

A. Overview

For diesel engine, combustion is not performed at the optimum (theoretically correct) air-fuel ratio and the oxygen concentration is thin in most cases. So the wide-band oxygen sensor is used for this kind of engine, and this sensor is a little different from the one that used for gasoline engine. The combustion in diesel engine is controlled by fuel injection volume. Therefore, the wide band oxygen sensor should be used in diesel engine. This sensor measures the air-fuel ratio in very wide range, and is also called full range oxygen sensor.

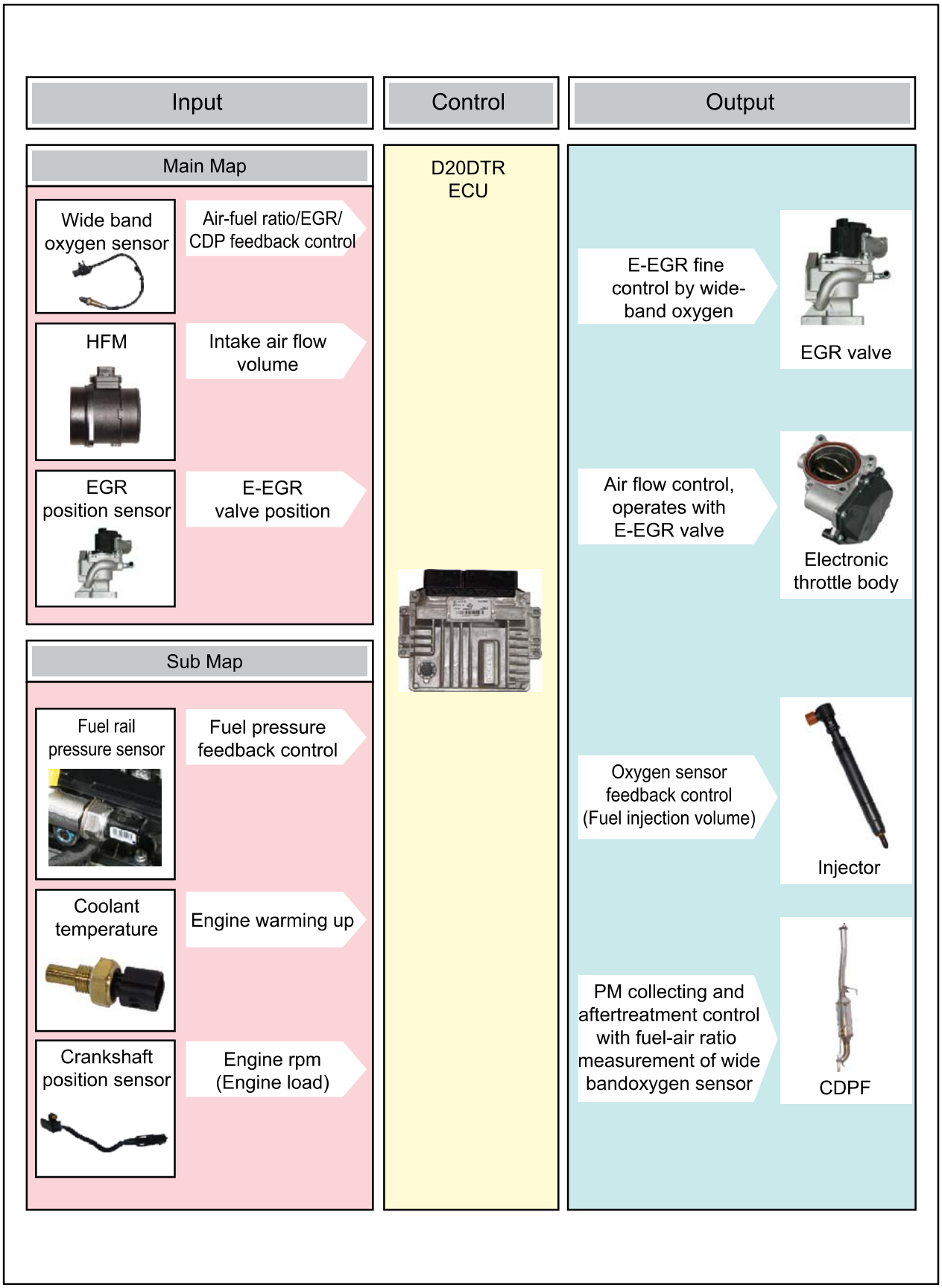
- The wide band oxygen sensor measures the oxygen density in exhaust gas and sends it to ECU to control the EGR more precisely.

B. Components



Modification basis	
Application basis	
Affected VIN	

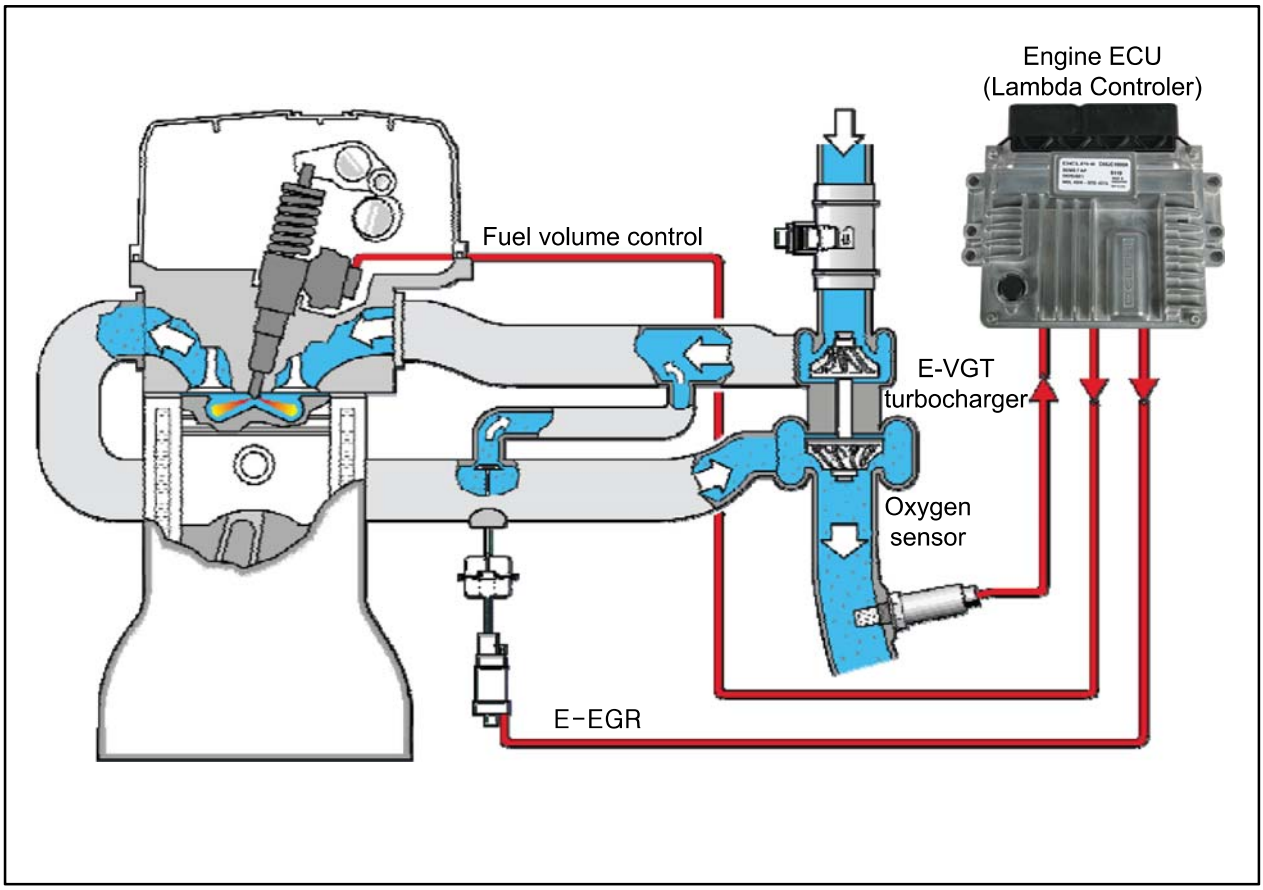
C. Input/Output for oxygen sensor



Modification basis	
Application basis	
Affected VIN	

D. Oxygen sensor control

The wide band oxygen sensor uses ZnO2. It produces the voltage by movement of oxygen ions when there is oxygen concentration difference between exhaust gas and atmosphere.
If a certain voltage is applied to the sensor, the movement of oxygen ions occurs regardless of the oxygen density. The current generated through this flow of ions, is called pumping current (IP), and the oxygen sensor measures this value.



Modification basis	
Application basis	
Affected VIN	

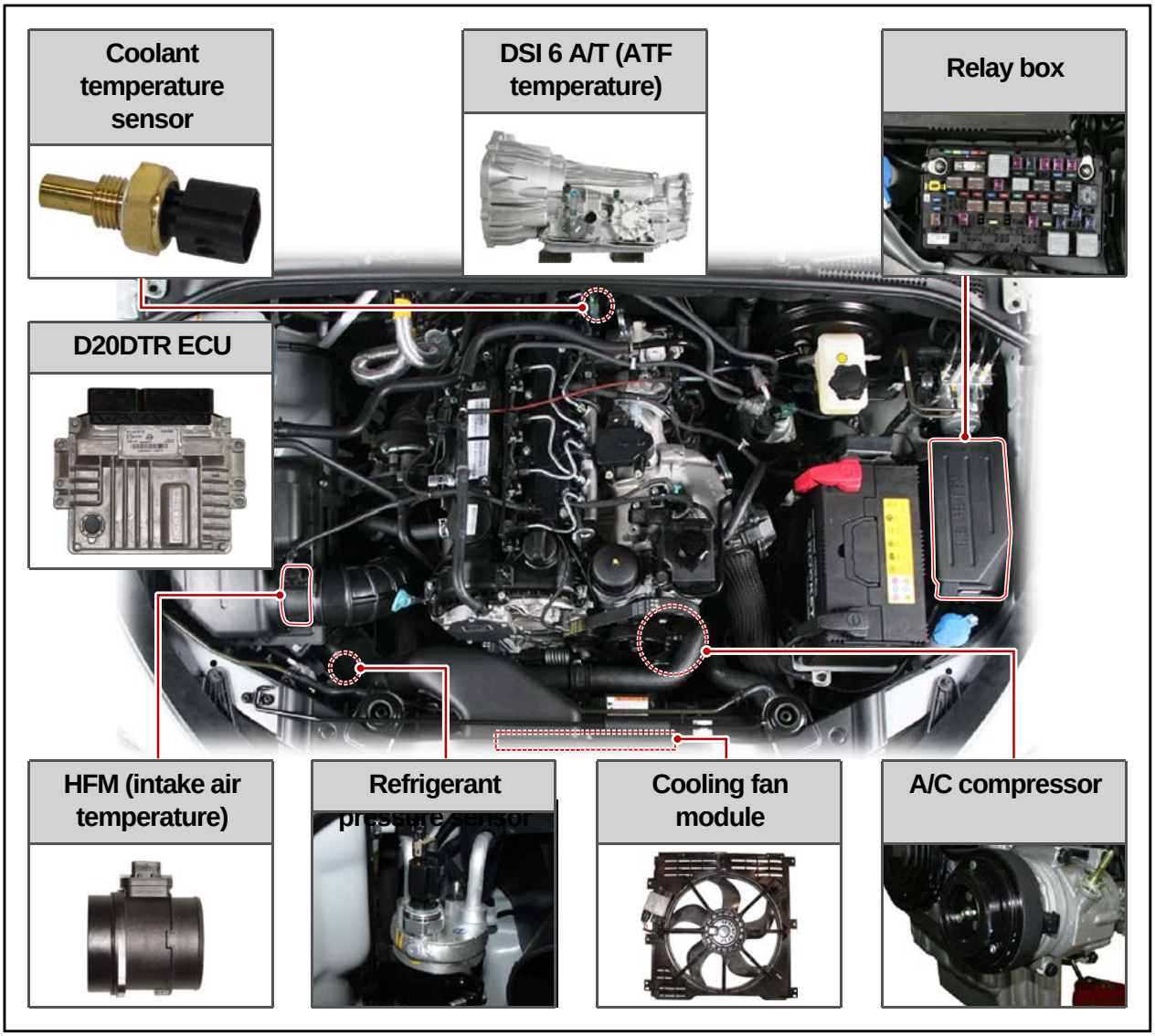
(12) Cooling fan control

A. Overview of cooling fan and A/C compressor

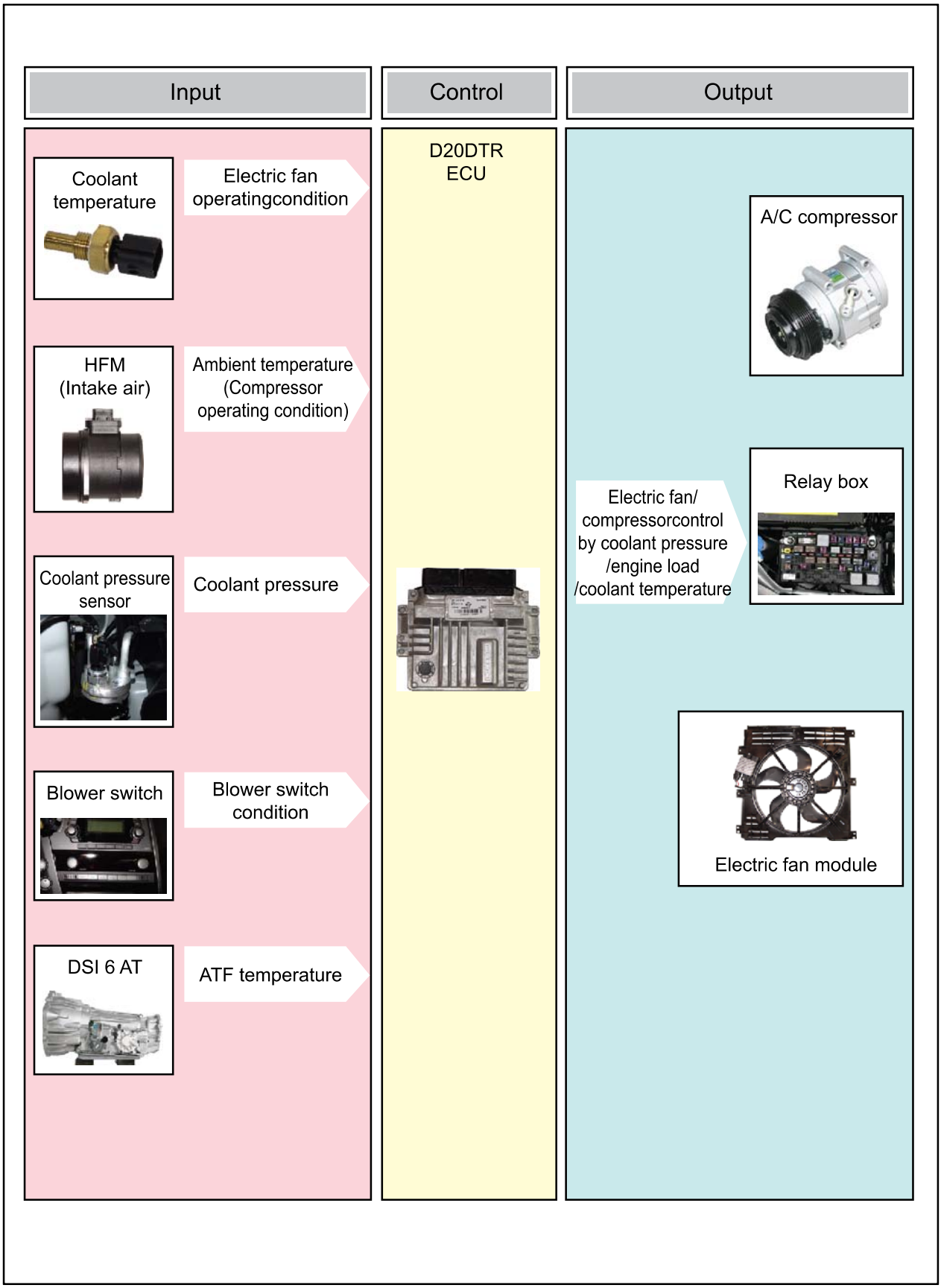
The cooling system maintains the engine temperature at an efficient level during all engine operating conditions. The water pump draws the coolant from the radiator. The coolant then circulates through water jackets in the engine block, the intake manifold, and the cylinder head. When the coolant reaches the operating temperature of the thermostat, the thermostat opens. The coolant then goes back to the radiator where it cools. The heat from automatic transmission is also cooled down through the radiator by circulating the oil through the oil pump. ECU controls the electric cooling fans with three cooling fan relays to improve the engine torque and air conditioning performance.

reference For detailed information, refer to Chapter "Air Conditioning System".

B. Components



C. Input/Output for cooling fan and A/C compressor



Modification basis	
Application basis	
Affected VIN	

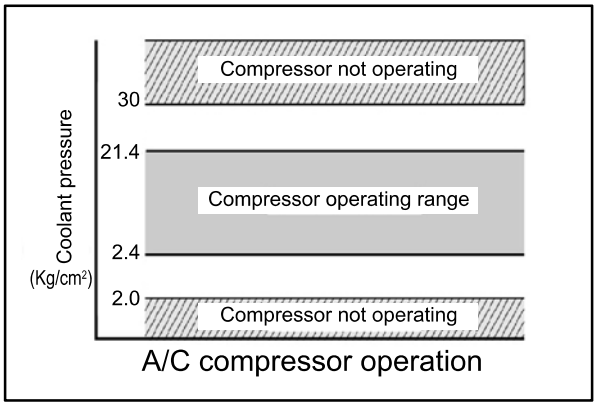
D. Cooling fan and A/C compressor control

▶ Conditions for cooling fan

The cooling fan module controls the cooling fan relay, high speed relay and low speed relay. The cooling fan is controlled by the series and parallel circuits.

A/C switch	Cooling fan	Coolant temperature	Refrigerant pressure	A/C compressor
OFF	OFF	Coolant temp. < 90℃	-	
	LO	90℃ ≤ Coolant temp. < 105℃	-	
	HI	105℃ ≤ Coolant temp.	-	
ON	LO	Coolant temp. < 105℃	Refrigerant pressure < 18 bar	ON
	HI		18 bar ≤ Refrigerant pressure	
	HI	105℃ ≤ Coolant temp. < 115℃	-	
	HI	115℃ ≤ Coolant temp.	-	OFF (cut)

▶ A/C compressor OFF conditions



A/C compressor operation

- Coolant temperature: below −20℃ or over 115℃
- Approx. 4 seconds after starting the engine
- Engine rpm: below 650 rpm or over 4500 rpm
- When abrupt acceleration
- Refrigerant pressure:
  * OFF below 2.0 kg/㎠, then ON over 2.4 kg/㎠
  * OFF over 30 kg/㎠, then ON below 21.4 kg/㎠

▶ Output voltage according to refrigerant pressure

The output voltage from refrigerant pressure sensor is 1.7 V to 3.5 V when the refrigerant pressure is 10 to 24 kgf/㎠ with A/C "ON".

▶ Cooling fan controls according to ATF

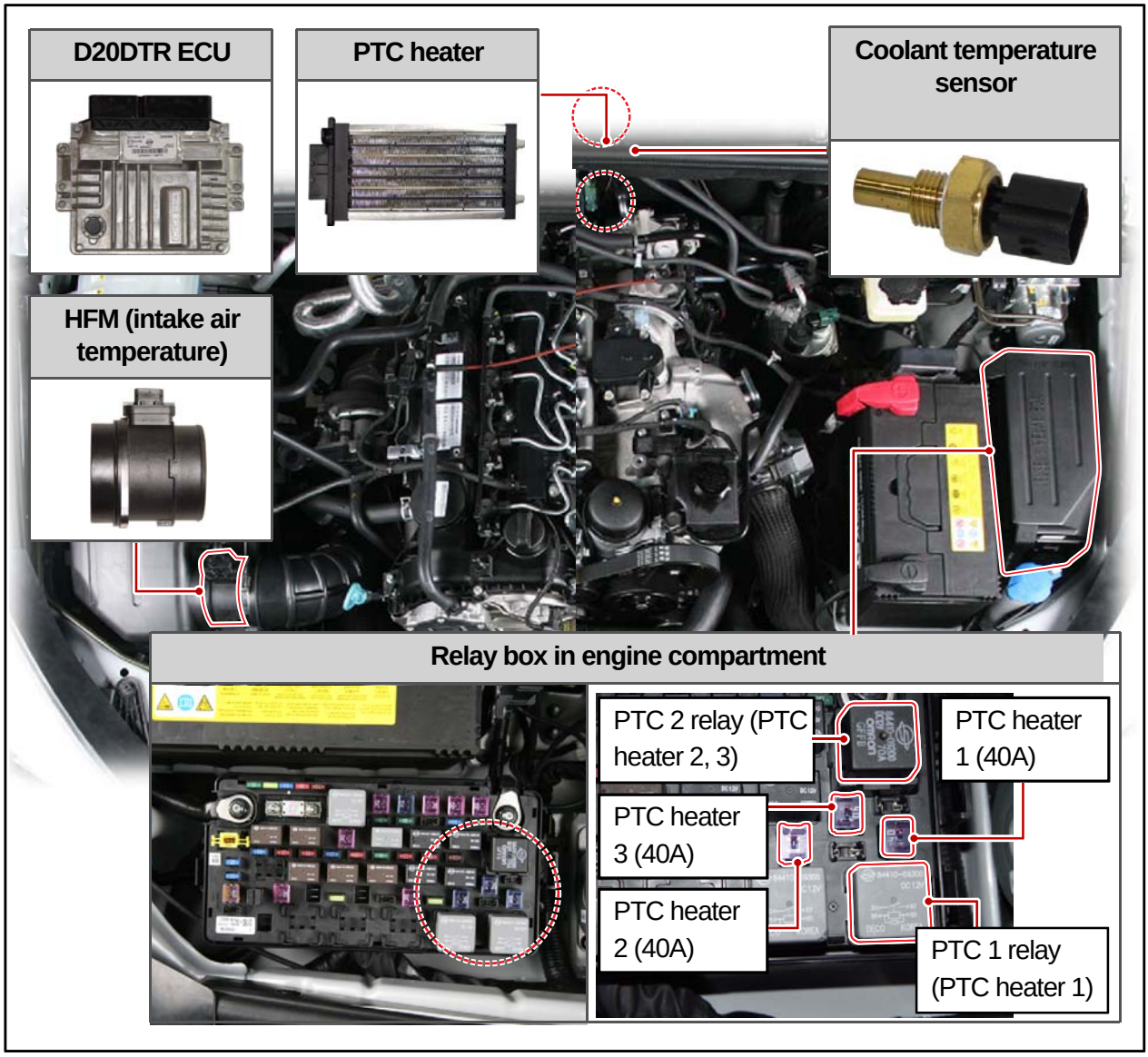
ATF temperature	Fan condition	Remark
Over 110˚C	High speed	-

(13) PTC heater control

A. Overview

The supplementary electrical heater is installed in DI engine equipped vehicle as a basic equipment. The PTC system is operated according to two temperature values measured at the coolant temperature sensor and HFM sensor. This device is mounted in the heater air outlet and increase the temperature of air to the passenger compartment. Because PTC system is heated by electrical power, high capacity alternator is required. PTC does not operate during engine cranking, while the battery voltage is lower than 11 V or during preheating process of glow plugs.

B. Components

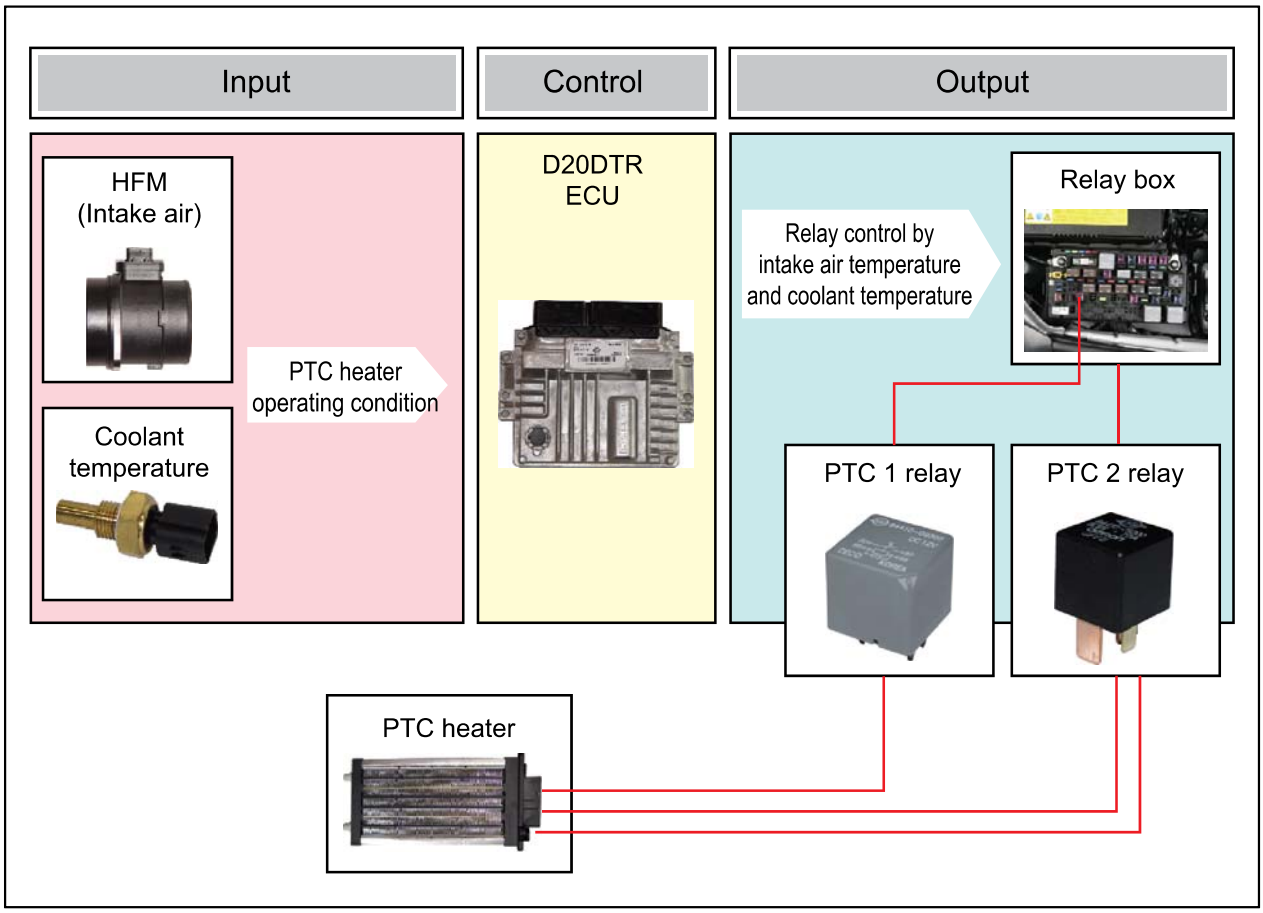


Modification basis	
Application basis	
Affected VIN	

C. Operation process

The ceramic PTC has a feature that the resistance goes up very high at a certain temperature. There are three circuits in PTC heater. Only one circuit is connected when PTC1 relay is ON, and two circuits are connected when PTC2 relay is ON.

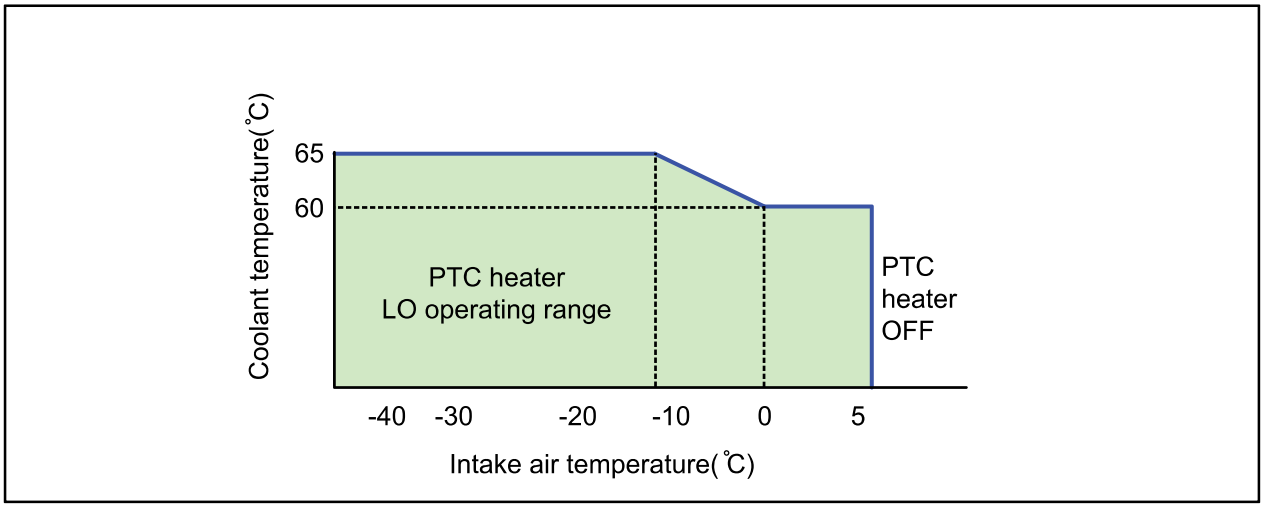
Operation process: reaches at a certain temperature→high resistance→low current→less heat radiation→temperature down→high resistance→high current→temperature up



D. Control conditions

Operation	Operating condition	PTC Heater
HI (PTC2)	- Coolant temperature < 15℃	PTC HI ON
LO (PTC1)	- Coolant temperature 15℃ ≤ 65℃, intake air temperature ≤ −10℃ - Coolant temperature 15℃ < 65 to 60℃, intake air temperature <−10℃ to 0℃ - Coolant temperature 15℃ ≤ 60℃, intake air temperature ≤ 0℃ to 5℃	PTC LO ON
Stop	- A/C blower switch OFF - Defective ambient air temperature sensor (including open or short circuit) - Engine cranking - Low battery voltage (below 11V) - During pre-glow process (glow indicator ON)	

▶ **Operation diagram for PTC heater LO (step 2)**



Modification basis	
Application basis	
Affected VIN	

(14) Immobilizer control

A. Overview

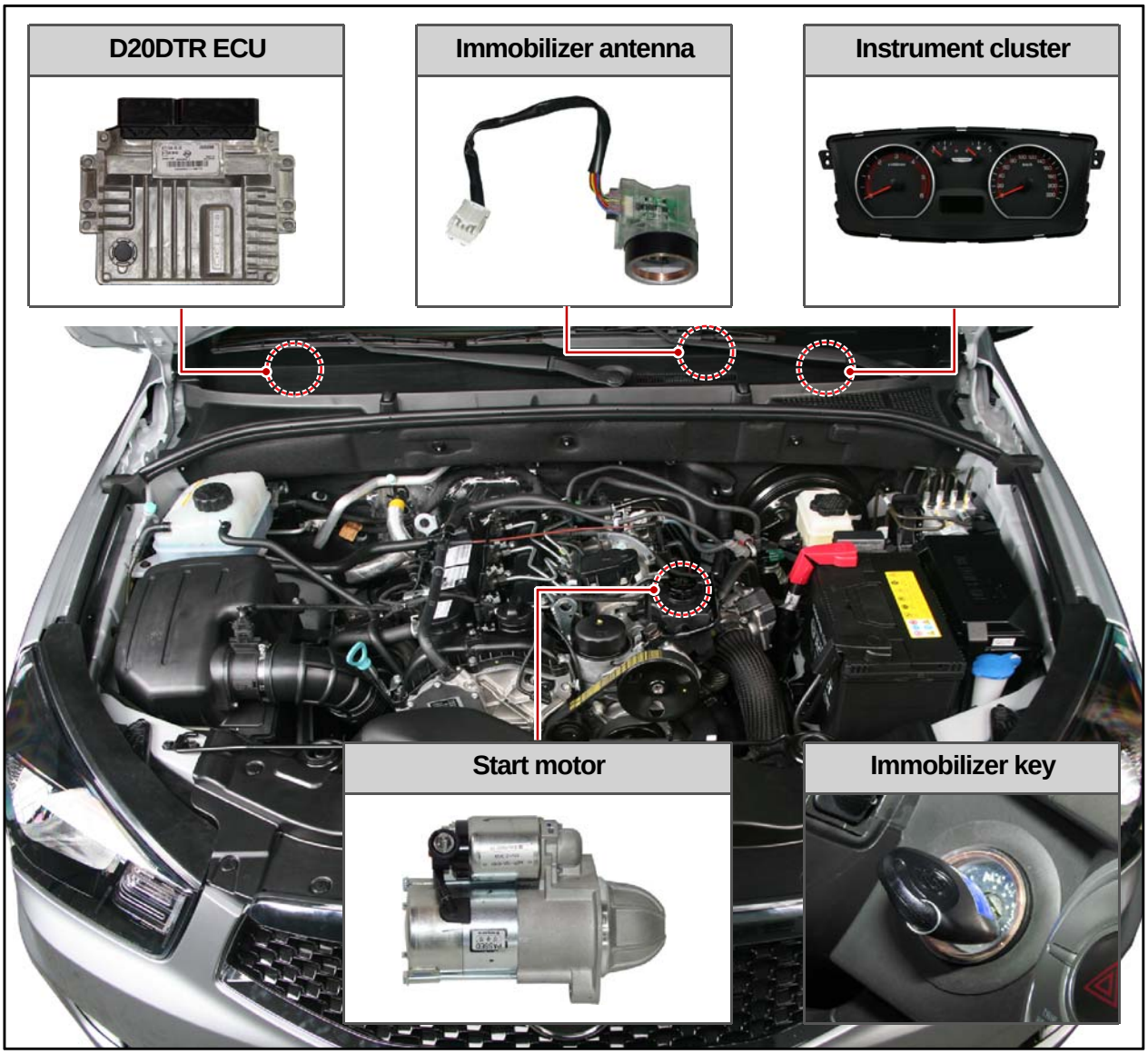
The Immobilizer System provides an additional theft deterrent to the vehicle in which it is installed and prevents it from being started by unauthorized persons. The transponder integrated in the key and the engine control unit have the same code. When the ignition key with the integrated transponder is turned to the ON position, the ECU (Engine Control Unit) checks the crypto code of the key and, if correct, allows the vehicle to start the engine.

NOTE

For details, refer to Chapter "Immobilizer".

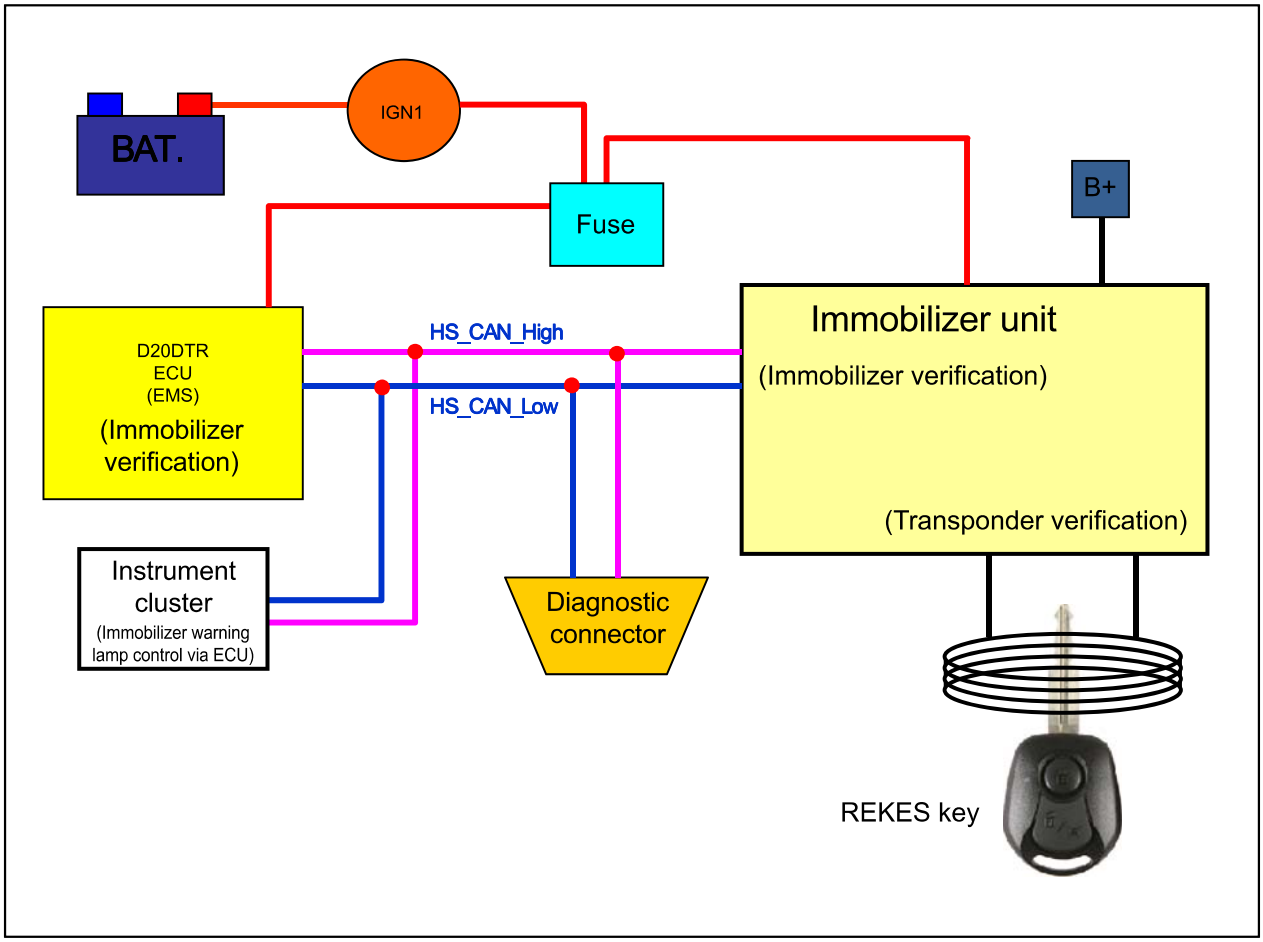
B. Components

▶ **Basic components (ignition key system)**



▶ Key approval process

When turning the ignition switch to ON position, the power is supplied to BCM and ECU. ECU communicate with the immobilizer key to check if it is valid crypto code. If it is valid, ECU start to control the engine when turning the ignition switch to START position. The system has 10 seconds of valid time-out period. If the engine does not start in this period, the key approval process should be done again.



Modification basis	
Application basis	
Affected VIN	

(15) CDPF control

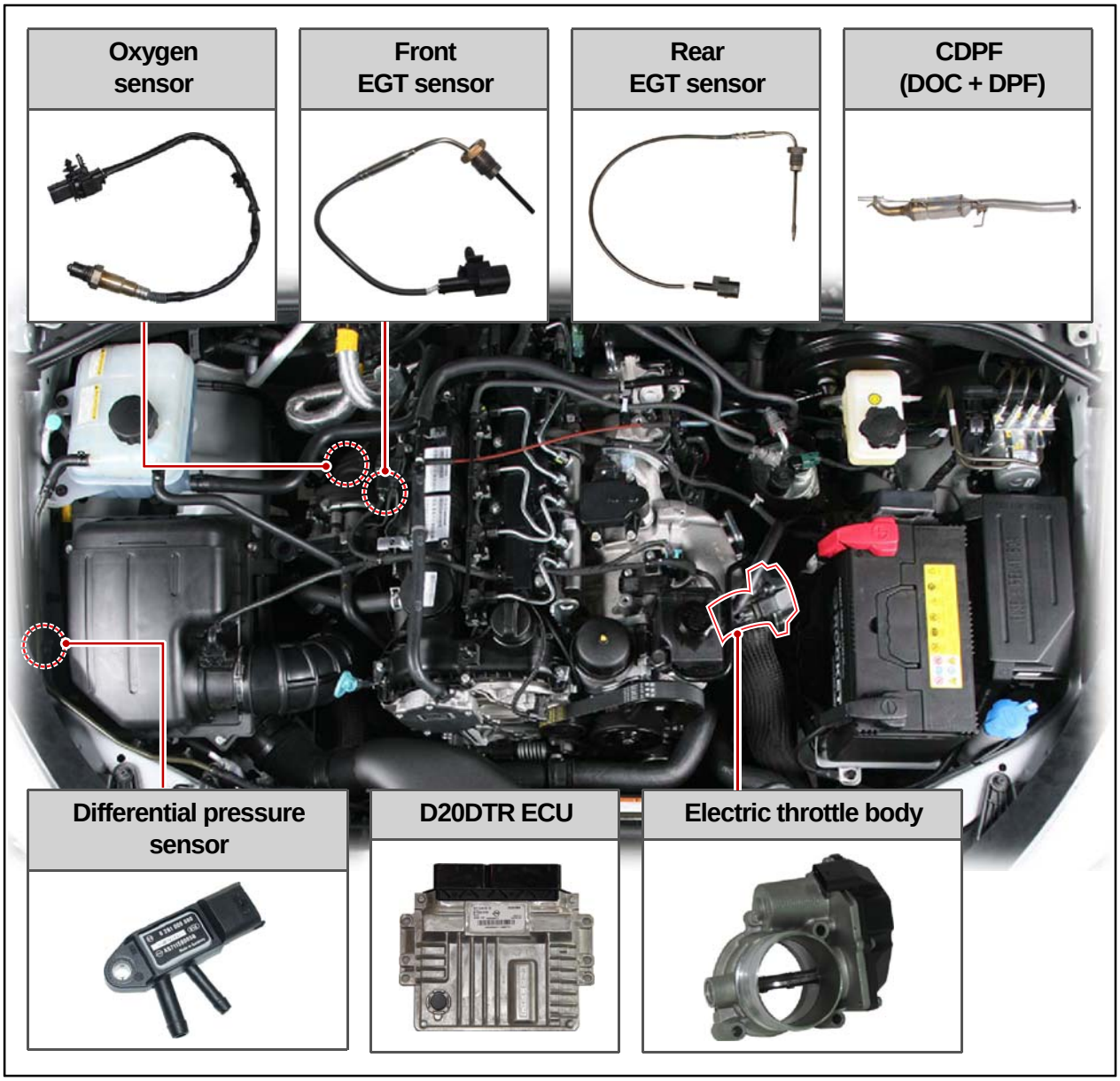
A. Overview

As the solution for environmental regulations and PM Particle Material) of diesel engine, the low emission vehicle is getting popular. This vehicle is equipped with an extra filter to collect the soot and burn it again so that the amount of PM in the exhaust gas passed through the DOC (Diesel Oxidation Catalyst) is reduced. The CDPF (Catalyst & Diesel Particulate Filter) is an integrated filter including DOC (Diesel Oxidation Catalyst) and DPF (Diesel Particulate Filter).

NOTE

For details, refer to Chapter "CDPF".

B. Components



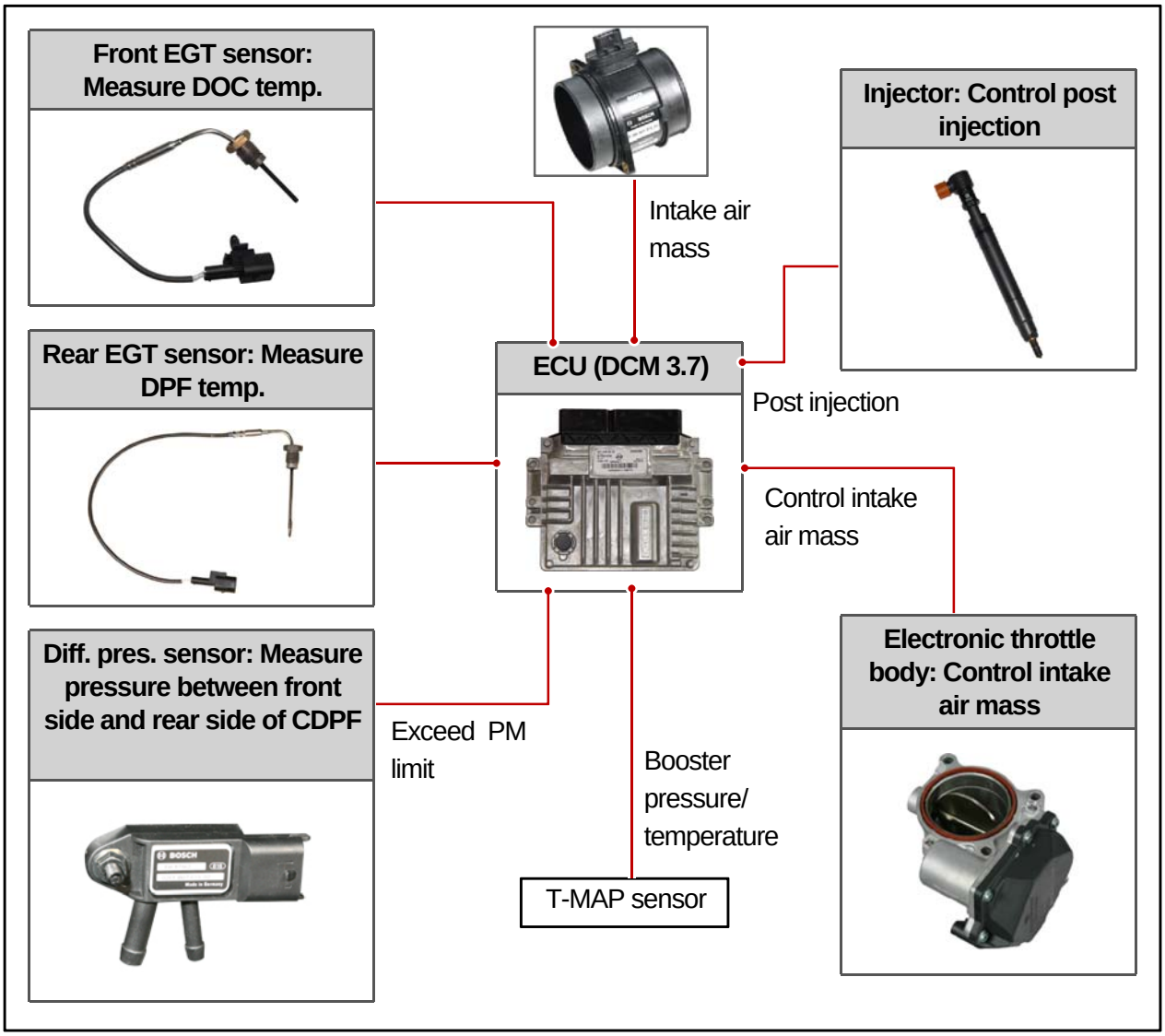
C. Input/Output for CDPF control

Input	Control	Output
Differential pressure sensor  → Pressure difference between before and after CDPF detected	D20DTR ECU 	Injection volume control (Post-injection control) → Injector 
Wide band oxygen sensor  → Air-fuel ratio during EGR/CDPF operation (feedback control)		
Front EGT  → Combustion temperature value of engine (Preventing High temperature combustion)		Air intake ratio control → Electronic throttle body 
Rear EGT sensor  → CDPF temperature value (Protecting CDPF)		
HFM (Intake air temperature)  → Intake air flow volume		CO/HC->CO_2/H_2O PMCollecting ->Combustion → CDPF 

Modification basis	
Application basis	
Affected VIN	

D. Operation process

When the differential pressure sensor detects the pressure difference between the front and the rear side of CDPF, the sensor sends signal indicating the soot is accumulated and the post injection is performed to raise the temperature of exhaust gas. The amount of fuel injected is determined according to the temperature of exhaust gas detected by the rear temperature sensor. If the temperature is below 600°C, the amount of fuel injected is increased to raise the temperature. If the temperature is over 600°C, the amount of fuel injected is decreased or not controlled. When the engine is running in low load range, the amount of post injection and the amount of intake air are controlled. It is to raise the temperature by increasing the amount of fuel while decreasing the amount of intake air.



E. Cautions

- Use only specified Engine Oil (approved by MB Sheet 229.51) for CDPF.

▶ Use only specified engine oil (Low Ash Oil)

- The vehicle equipped with CDPF should use specific engine oil to improve the engine performance and fuel economy, and ensure the service life of CDPF.

▶ Issue with normal engine oil

- Sulfur, one of the contents of engine oil is burned and generates soot that is not regenerated by the DPF. This remains on the filter as ashes and keeps accumulating. Eventually, this ashes will block the filter.

▶ Benefit for specified engine oil

- Minimized the sulfur content of engine oil which reduces the service life.
- Improved fuel economy and emission level of CO2 with high performance and low viscosity.
- Increased service life of engine oil with high resistance to temperature.

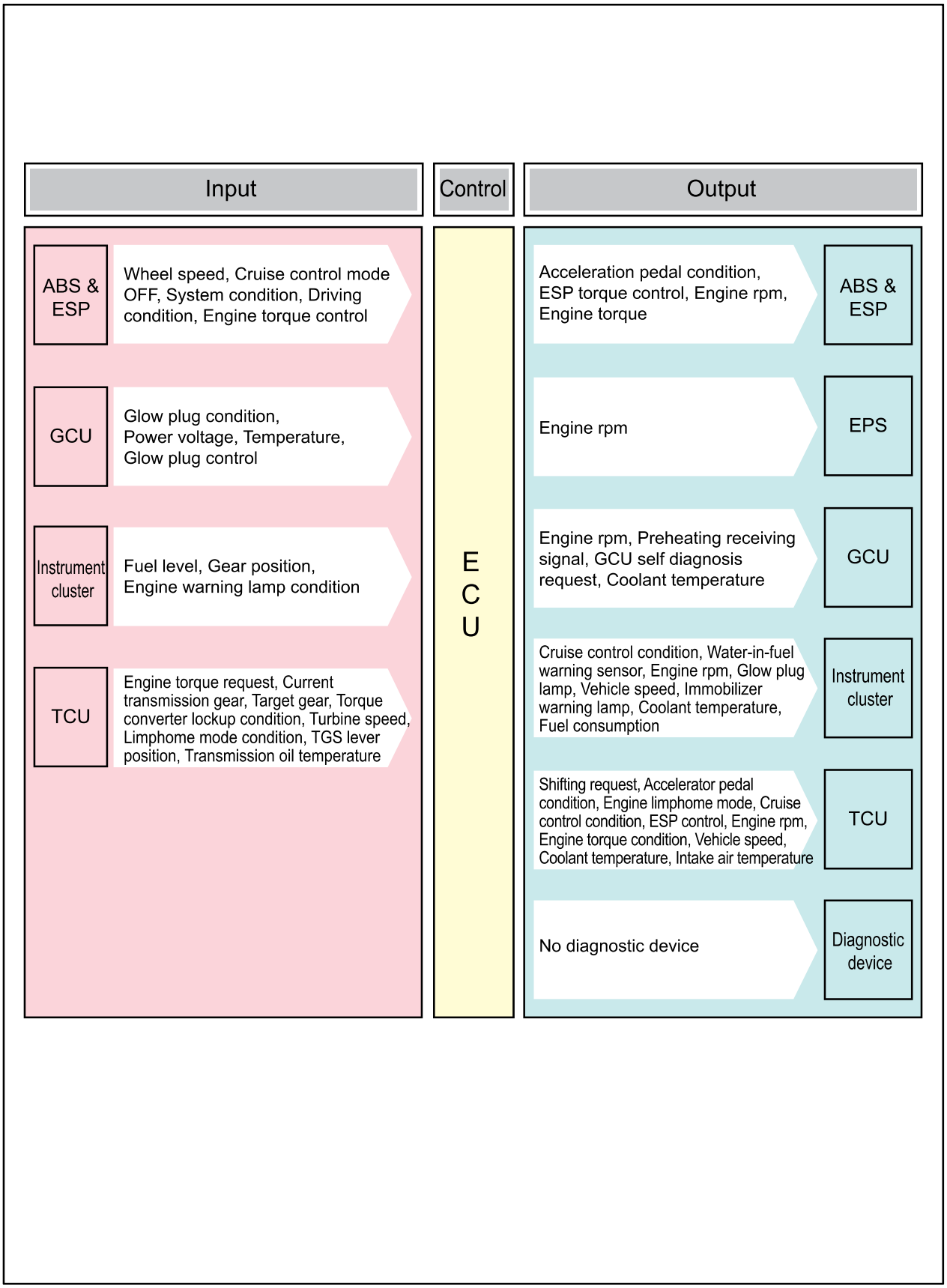
▶ Problems when using unspecified engine oil

- The service life of filter may be reduced by 30% or more by the ashes accumulated on the filter.
  The fuel economy may be reduced because of engine rolling resistance, frequent regeneration of
- DPF.

* These problems are also caused by oil with high sulfur content, such as tax exemption oil and heating oil, etc.

Modification basis	
Application basis	
Affected VIN	

3) Input/Output for CAN communication



ENGINE ASSEMBLY 1113-01

GENERAL

1. DESCRIPTION AND OPERATION

1) Cleanliness and Care

An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in the ten-thousanths of an inch.

When any internal engine parts are serviced, care and cleanliness are important.

A liberal coating of enigne oil should be applied to friction areas during assembly, to protect and lubricate the surfaces on initial operation. Proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure.

This is considered standard shop practice even if not specifically stated.

Whenever valve train components are removed for service, they should be kept in order. They should be installed in the same locations, and with the same mating surfaces, as when they were removed.

Battery cables should be disconnected before any major work is performed on the engine. Failure to disconnect cables may result in damage to wire harness or other electrical parts.

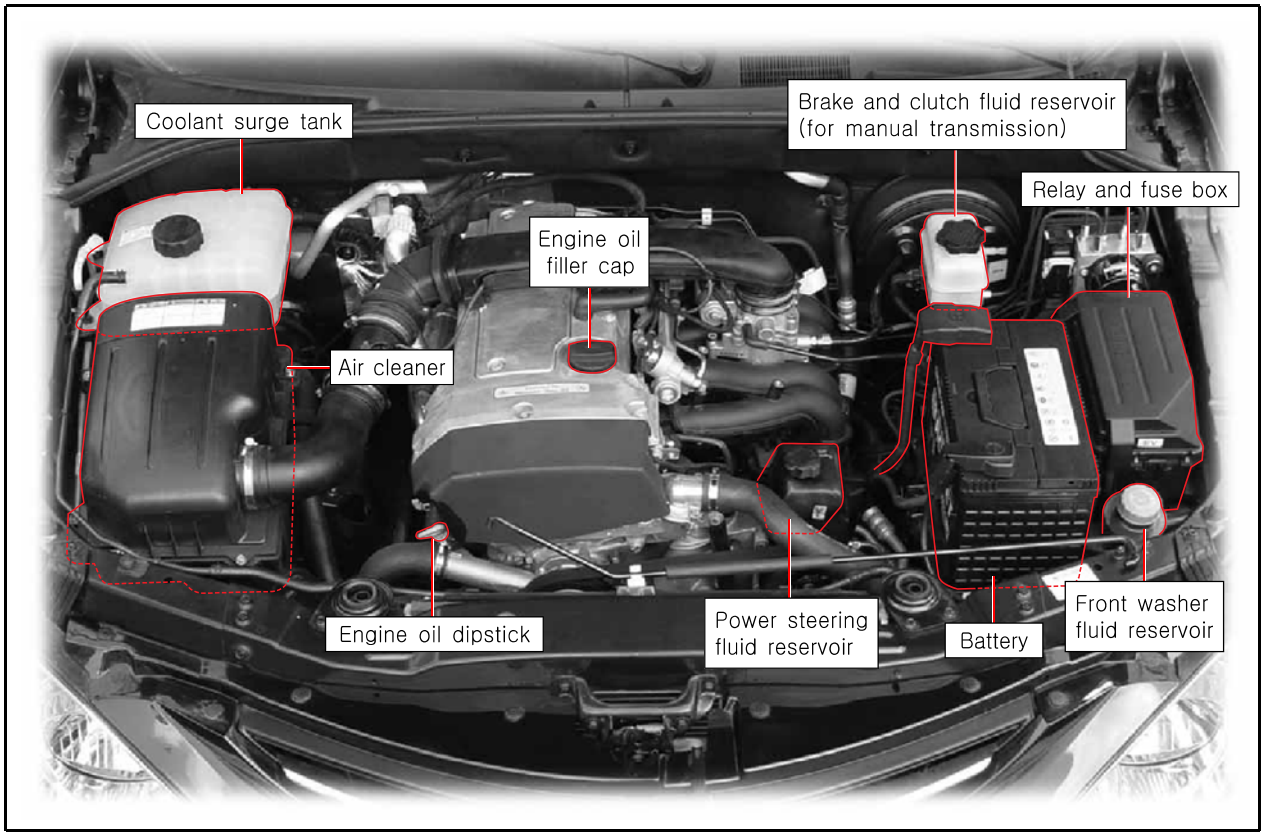
2) On-engine Service

CAUTION

- Disconnect the negative battery cable before removing or installing any electrical unit, or when a tool or equipment could easily come in contact with exposed electrical terminals.
  Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

CAUTION

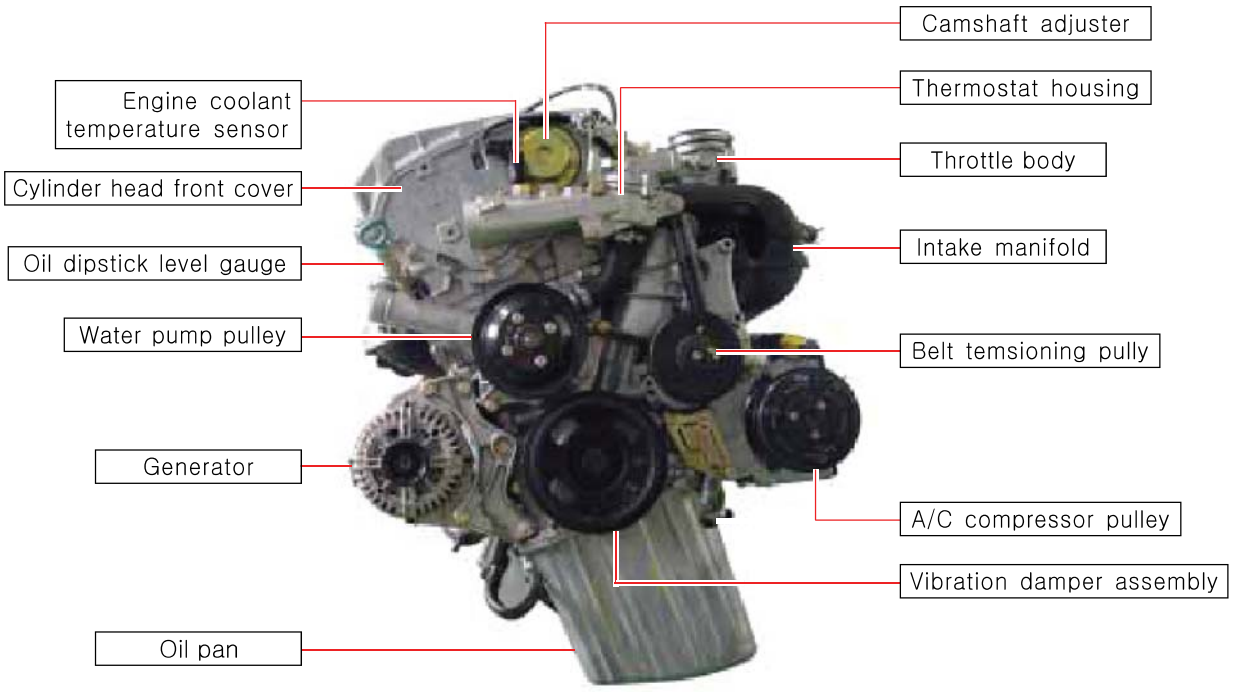
- Any time the air cleaner is removed, the intake opening should be covered. This will protect against accidental entrance of foreign material, which could follow the intake passage into the cylinder and cause extensive damage when the engine is started.



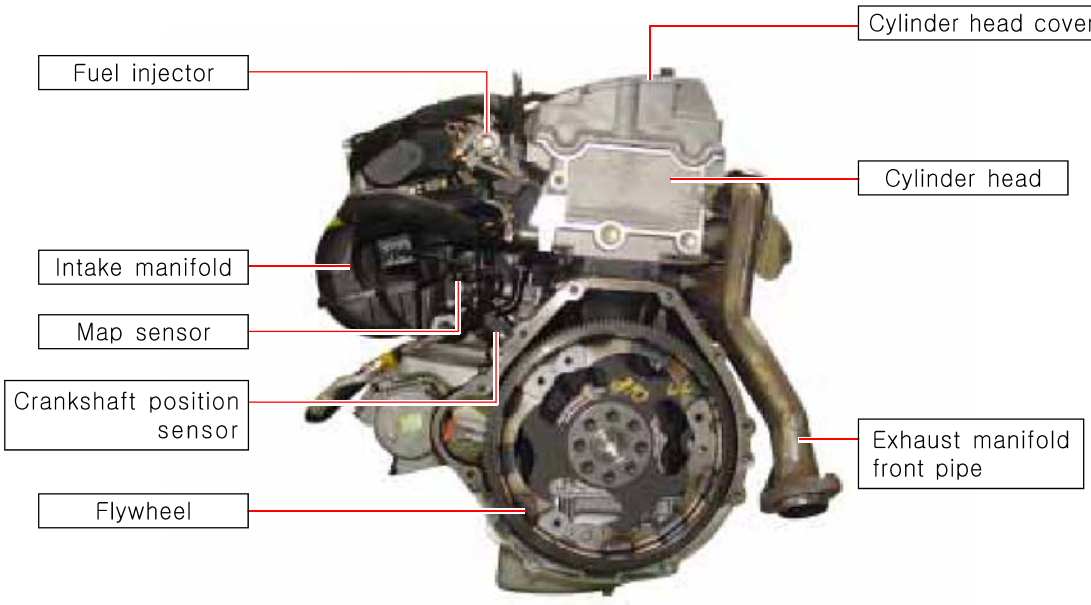
Modification basis	
Application basis	
Affected VIN	

2. G23D ENGINE ASSEMBLY

Front View

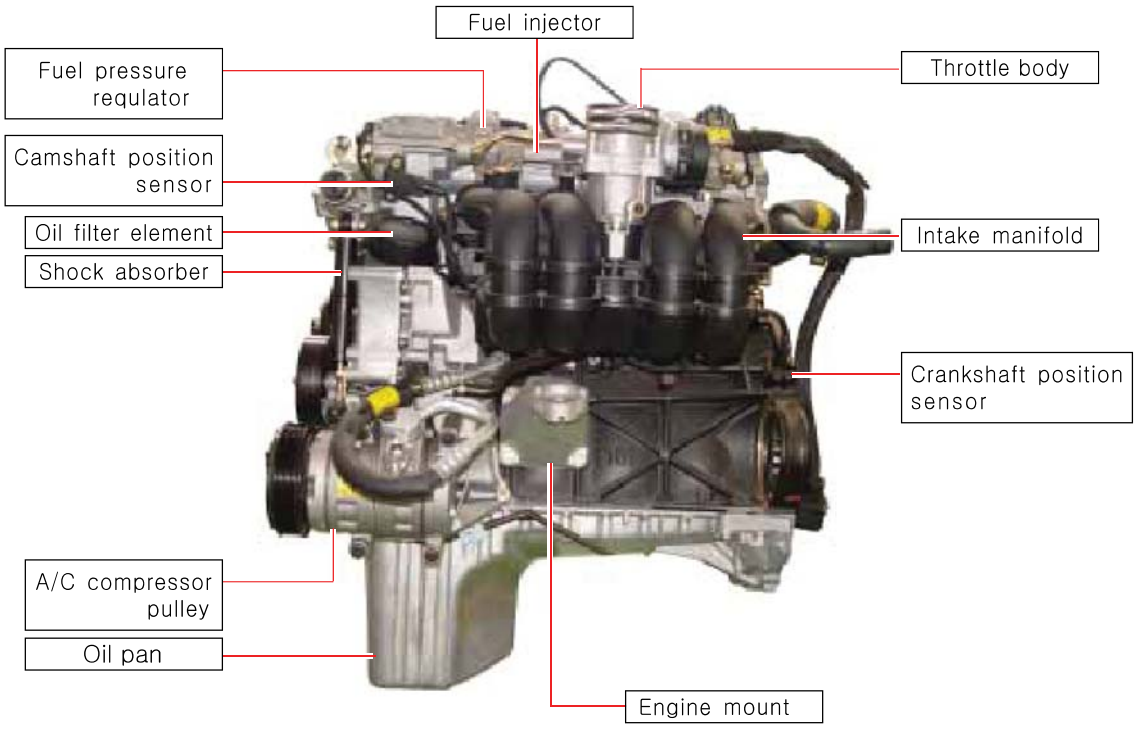


Rear View

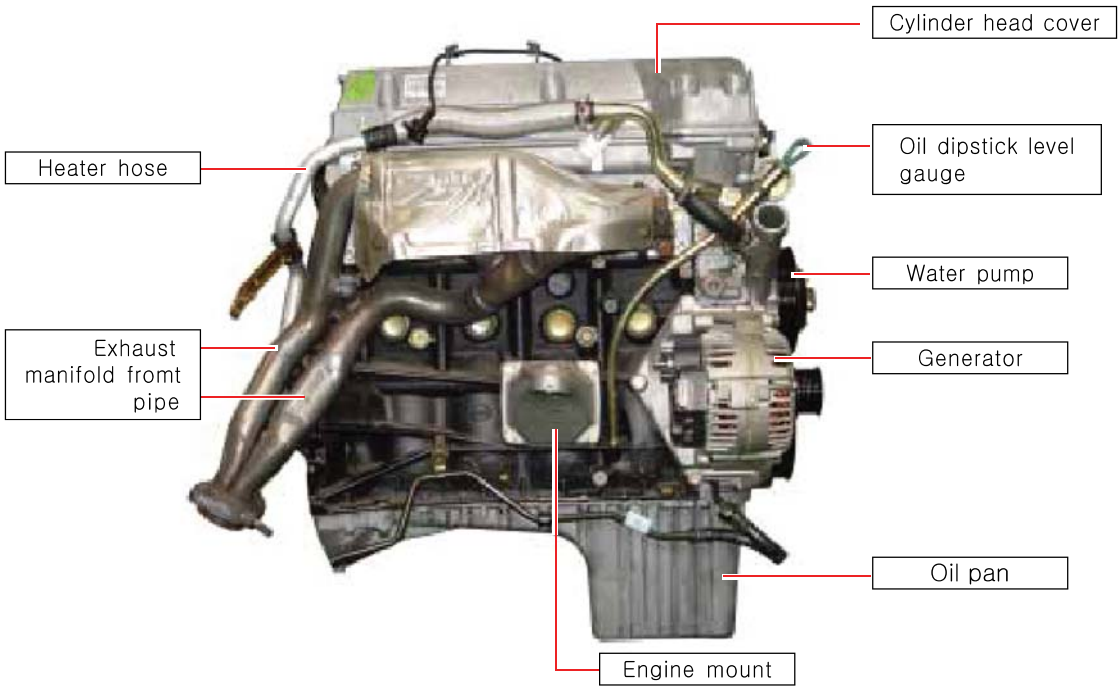


Modification basis	
Application basis	
Affected VIN	

LH Side View



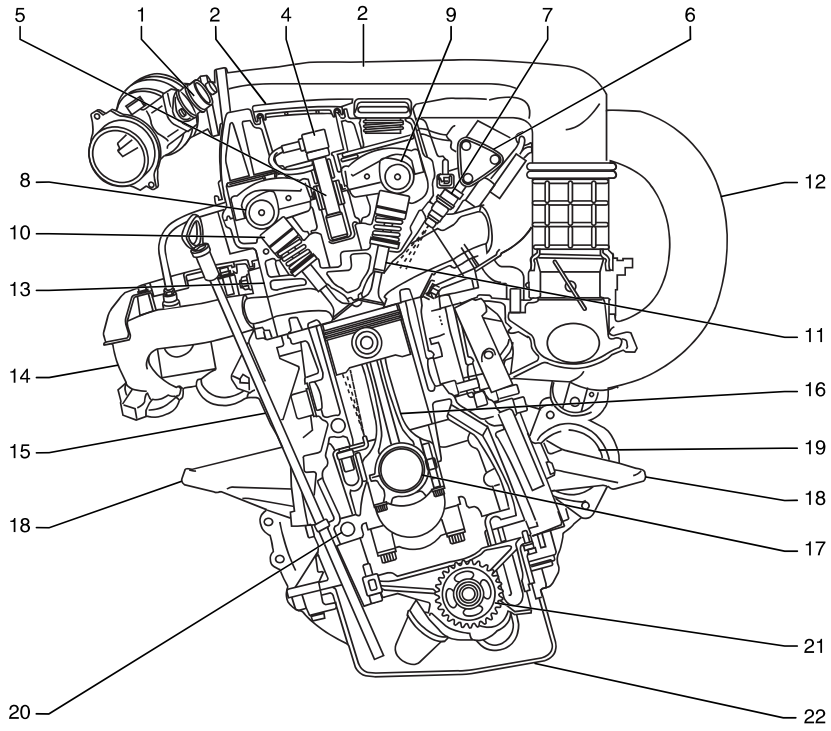
RH Side View



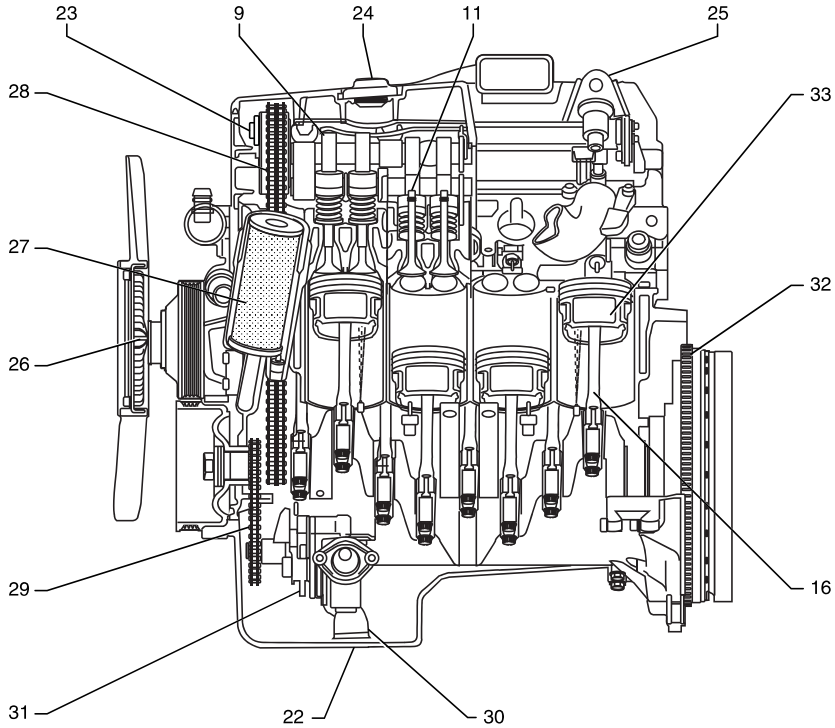
Modification basis	
Application basis	
Affected VIN	

3. G23D ENGINE STRUCTURE

Front View



Side View



Modification basis	
Application basis	
Affected VIN	

▶ **Front View**

NO.	FUNCTION	NO.	FUNCTION
1	HFM Sensor	12	Intake Manifold
2	Intake Air Duct	13	Cylinder Head
3	Cylinder Head Cover	14	Exhaust Manifold
4	Ignition Coi	15	Dipstick Guide Tube and Gauge
5	Spark Plug Connector	16	Connecting Rod
6	Fuel Distributor	17	Crankshaft
7	Injector	18	Engine Mounting Bracket
8	Exhaust Camshaft	19	Starter
9	Intake Camshaft	20	Crankcase
10	Valve Tappet	21	Oil Pump Sprocket
11	Intake Valve	22	Oil Pan

▶ **Side View**

NO.	FUNCTION	NO.	FUNCTION
23	Camshaft Adjuster	29	Oil Pump Drive Chain
24	Oil Filler Cap	30	Oil Strainer
25	Engine Hanger Bracket	31	Oil Pump
26	Cooling Fan and Viscous Clutch	32	Ring Gear and Flywheel of Drive Plate
27	Oil Filter	33	Piston
28	Timing Chain		

Modification basis	
Application basis	
Affected VIN	

4. DIAGNOSTIC INFORMATION AND PROCEDURE

1) Oil Leak Diagnosis

Most fluid oil leaks are easily located and repaired by visually finding the leak and replacing or repairing the necessary parts. On some occasions a fluid leak may be difficult to locate or repair. The following procedures may help you in locating and repairing most leaks.

▶ **Finding the Leak**

- Identify the fluid. Determine whether it is engine oil, automatic transmission fluid, power steering fluid, etc.
- Identify where the fluid is leaking from.
  · After running the vehicle at normal operating temperature, park the vehicle over a large sheet of paper.
  · Wait a few minutes.
  · You should be able to find the approximate location of the leak by the drippings on the paper.

- Visually check around the suspected component.
  Check around all the gasket mating surfaces for leaks. A mirror is useful for finding leaks in areas that are hard to reach.
- If the leak still cannot be found, it may be necessary to clean the suspected area with a degreaser, steam or spray solvent.
  · Clean the area well.
  · Dry the area.
  · Operate the vehicle for several miles at normal operating temperature and varying speeds. After operating the vehicle, visually check the suspected component.
  · If you still cannot locate the leak, try using the powder or black light and dye method.
  ·

▶ **Powder Method**

- Clean the suspected area.
- Apply an aerosol-type powder (such as foot powder) to the suspected area.
- Operate the vehicle under normal operating conditoins.
- Visually inspect the suspected component. You should be able to trace the leak path over the white powder surface to the source.

▶ Black Light and Dye Method

A dye and light kit is available for finding leaks, Refer to the manufacturer's directions when using the kit.

- Pour the specified amount of dye into the engine oil fill tube.
- Operate the vehicle normal operating conditions as directed in the kit.
- Direct the light toward the suspected area. The dyed fluid will appear as a yellow path leading to the source.

▶ Repairing the Leak

Once the origin of the leak has been pinpointed and traced back to its source, the cause of the leak must be determined in order for it to be repaired properly.

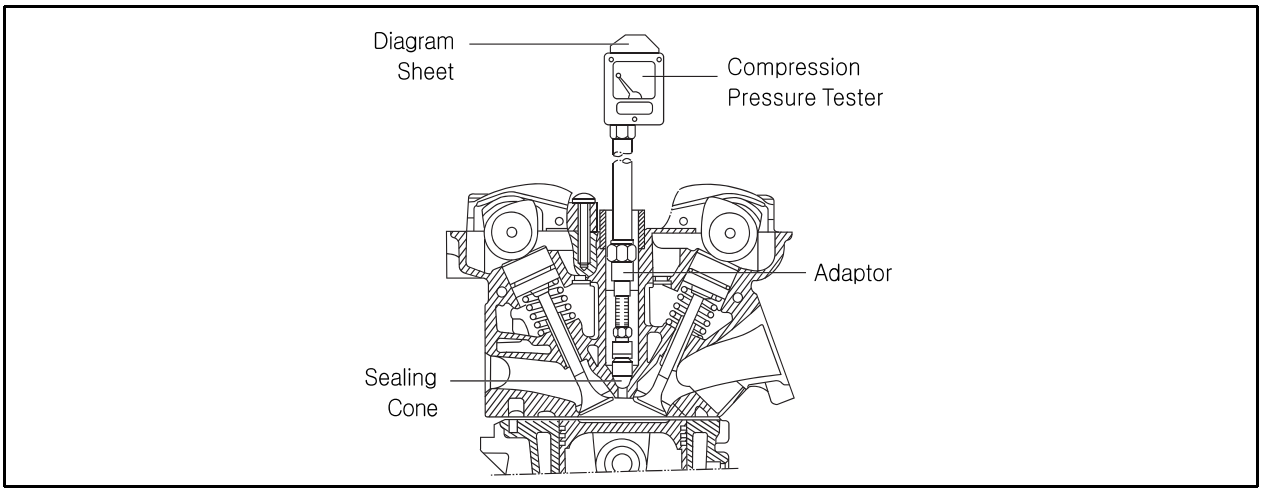
If a gasket is replaced, but the sealing flange is bent, the new gasket will not repair the leak. The bent flange must be repaired also. Before attempting to repair a leak, check for the following conditions and correct them as they may cause a leak.

▶ Gaskets

- The fluid level/pressure is too high.
- The crankcase ventilation system is malfunctioning.
- The seal bore is damaged (scratched, burred or nicked).
- The seal is damaged or worn.
- Improper installation is evident.
- There are cracks in the components.
- The shaft surface is scratched, nicked or damaged.
- A loose or worn bearing is causing excess seal wear.

Modification basis	
Application basis	
Affected VIN	

2) Compression Pressure Test



▶ Standard Service Data

Application	G23D Engine
Compression Ratio	10.4 : 1
Normal Engine Temperature	←
Normal Compression Pressure	Min. 11 bar, Max. 15 bar
Permissible Pressure Difference Between Individual C ylinders	←

CAUTION

- A9912 0012B (001 589 76 21 00) Compression Pressure Tester

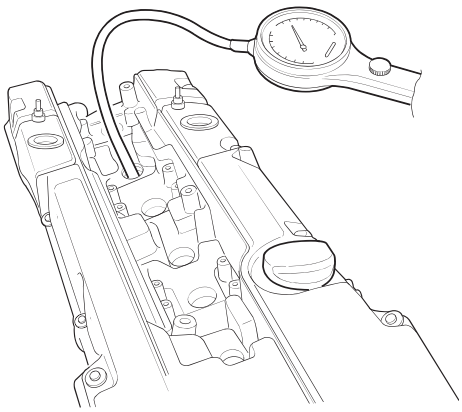
▶ Measuring Procedure

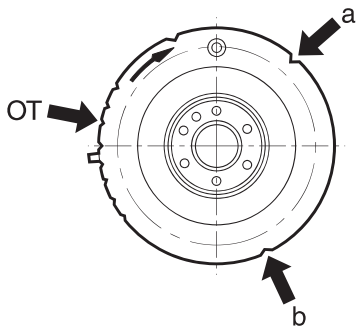
- Warm the engine up to normal operating temperature.
- Remove the spark plugs using the spark plug wrench.
- Place the diagram sheet to compression pressure tester A9912 0012B (001 589 76 21 00).
  Connect the adaptor to compression pressure tester A9912 0012B (001 589 76 21 00) and
- install it into the spark plug hole.
  Crank the engine approx. eight revolutions by using the start motor.
- Compare the measurements of compression pressure tester A9912 0012B (001 589 76 21 00)
- with the specifications.
  Measure the compression pressure of the other cylinders in the same way.
- If measured value is not within the specifications, perform the cylinder pressure leakage test.
-

CAUTION

- Discharge the combustion residues in the cylinders before testing the compression pressure.
  Apply the parking brake before cranking the engine.
-

3) Cylinder Pressure LeakageTest





▶ **Permissible Pressure Leakage**

At Whole Engine	Max. 25 %
At Valve and Cylinder Head Gasket	Max. 10 %
At Piston and Piston Ring	Max. 20 %

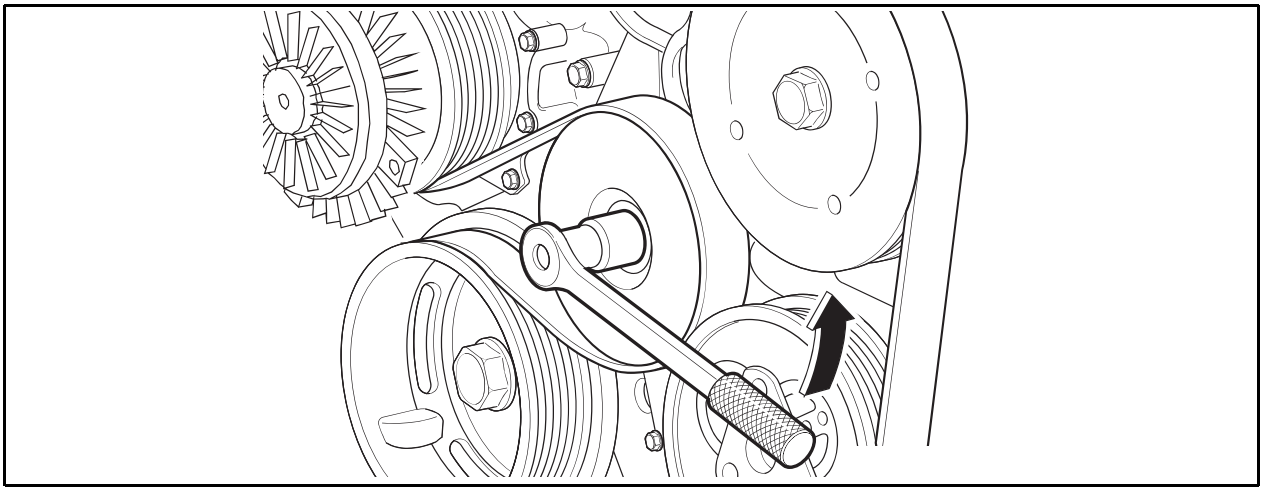
▶ **Cylinder Number**

OT (TDC)	1, 4
UT (BDC 180 °)	2, 3

▶ **Cylinder Number**

Cylinder Pressure Leakage Tester	Bosch, EFAW210A Sun, CLT 228

Modification basis	
Application basis	
Affected VIN	



▶ **Leakage Test**

- Warm the engine up to normal operating temperature.
- Disconnect the negative battery cable.
- Remove the spark plugs.
- Check the coolant level by opening the coolant reservoir cap and replenish if insufficient.
- Open the engine oil filler cap.
- Connect the tester to air pressure line and adjust the scale of tester.
- Install the connecting hose to spark plug hole.
- Position the piston of No.1 cylinder at TDC by rotating the crankshaft.
- Connect the connecting hose to tester and measure the leakage volume after blowing up 5 bar of compressed air.

CAUTION

- Measure the leakage volume in the completely opening condition of throttle valve by pulling the acceleration cable.

- Perform the pressure test according to the firing order.

CAUTION

- Firing Order: 1 - 3 - 4 - 2

- Compare the leakage pressure with the specifications.

5. GENERAL DIAGNOSIS

Condition		Probable Cause	Correction
Hard starting (With normal cranking)	Malfunction of immobilizer system	• Faulty immoblilzer system	• Check (Antenna, Immobilizer transponder) • Replace (Antenna, Immobilizer transponder)
	Malfunction of ignition system	• Faulty fuse	• Replace the fuse.
		• Faulty spark plug.	• Clean, adjust the plug gap or replace.
		• Electric leakage at the high tension cable.	• Replace the cable.
		• Poor connection of the high tension cable or lead wires.	• Replace the cable or wires.
		• Faulty ignition coil.	• Replace the ignition coil.
	Malfunction of fuel system	• Empty of fuel in the fuel tank.	• Feed the fuel.
		• Dirty or clogged fuel filter.	• Replace the filter.
		• Clogged fuel pipe.	• Clean the fuel pipe.
		• Malfunction of the fuel pump.	• Replace the fuel pump.
		• Malfunction of the fuel injector.	• Replace the injector.
		• The foreign material in the fuel tank.	• Clean the fuel tank.
	Decline of compression pressure	• Poor tightening spark plug.	• Tighten to the specified torque. Compression
		• Cracked cylinder head gasket.	• Replace the gasket.
		• Inadequate the valve clearance.	• Adjust the clearance.
		• Leakage of the valve clearance.	• Repair the valve.
		• Interference of the valve stem.	• Replace the valve or the valve guide.
		• Low elasticity or damage of the valve spring.	• Replace the valve spring.
		• Abnormal interference of pistons and cylinders.	• Replace the piston ring.
		• Excessive wear of pistons, rings, or cylinders.	• Replace the ring or the piston and boring or replace the cylinder.
	Others	• Broken timing belt.	• Replace the belt.
		• Loosening, damage or leakage of the vacuum hose.	• Connect the hose correctly or replace it.
		• Leakage of intake system.	• Replace intake system.
Lack of engine power	Decline of compression pressure	• Refer to above in this page.	• Refer to above in this page.
	Malfunction of ignition system	• Faulty spark plug.	• Adjust or replace the spark plug.
		• Electric leakage or poor connection of the high tension cable.	• Connect the cable correctly or replace it.

Modification basis	
Application basis	
Affected VIN	

▶ General Diagnosis (Cont'd)

Condition		Probable Cause	Correction
Lack of engine power	Malfunction of fuel system	• Clogged fuel pipe.	• Clean the pipe.
		• Clogged or contaminated fuel filter.	• Replace the filter.
	Others	• Clogged exhaust system.	• Check and repair the system.
		• Clogged or contaminated air cleaner element.	• Clean or replace the air cleaner element.
		• Leak of the intake manifold gasket.	• Replace the gasket.
		• Dragging brakes.	• Repair or replace the brakes.
Rough engine idling	Malfunction of fuel system	• Clogged fuel pipe.	• Clean the pipe.
		• Clogged or contaminated fuel filter.	• Replace the filter.
		• Malfunction of the fuel pressure regulator.	• Replace the regulator.
	Malfunction of ignition system	• Malfunction of the spark plug.	• Adjust or replace the spark plug.
		• Electric leakage or poor connection of the high tension cable.	• Connect the cable correctly or replace it.
		• Malfunction of the ignition coil.	• Replace the ignition coil.
	Others	• Clogged or contaminated air cleaner element.	• Clean or replace the air cleaner element.
		• Leak of the intake manifold gasket.	• Replace the gasket.
		• Poor connection or damage or leakage of the vacuum hose.	• Connect the hose correctly or replace it.
Engine hesitate (Upon pressing accelerating pedal, the engine makes delayed response This situation is remarkable when cruising or starting.)	Malfunction of ignition system	• Poor spark plug or Poor adjustment of the plug gap.	• Replace the plug or adjust the gap.
		• Electric leakage or poor connection of the high tension cable.	• Connect the cable correctly or replace it.
	Others	• Malfunction of the air cleaner system.	• Clean or replace the air cleaner system.
		• Leak of the intake manifold gasket.	• Replace the gasket.

▶ General Diagnosis (Cont'd)

Condition		Probable Cause	Correction
Engine surging (Engine power makes fluctuation in a fixed speed and speed changes without operating the accelerating pedal.)	Malfunction of fuel system	• Clogged fuel pipe.	• Clean the pipe.
		• Clogged or contaminated fuel filter.	• Replace the filter.
		• Malfunction of the fuel pressure regulator.	• Replace the fuel pressure regulator.
	Malfunction of ignition system	• Malfunction of the spark plug.	• Adjust or replace the spark plug.
		• Electric leakage or poor connection of the high tension cable.	• Connect the cable correctly or replace it.
		• Poor ignition timing.	• Adjust the ignition timing.
	Others	• Leak of the intake manifold gasket.	• Clean or replace the gasket.
		• Leakage of the vacuum hose.	• Connect the hose correctly or replace it.
Excessive detonation (According to the opening range of Malfunction of metallic is made with abnormal explosion)	Malfunction of fuel system	• Abnormal spark plug.	• Replace the spark plug.
		• Electric leakage or poor connection of the high tension cable.	• Connect the cable correctly or replace it.
	Malfunction of ignition system	• Clogged or contaminated fuel filter and fuel pipe.	• Clean or replace the fuel filter and the fuel pipe.
	Others	• Leak of the intake manifold gasket.	• Replace the gasket.
		• Excessive carbon deposit due to abnormal combustion.	• Remove the carbon.
Overheat	Malfunction of cooling system	• Lack of coolant.	• Refill coolant.
		• Malfunction of the thermostat.	• Replace the thermostat.
		• Malfunction of the cooling fan.	• Check or replace the cooling fan.
		• Poor water pump performance.	• Replace the pump.
		• Clogged or leaky radiator.	• Clean, repair or replace the radiator.
	Malfunction of lubrication system	• Poor engine oil.	• Replace engine oil with the specified one.
		• Blocking oil filter or strainer.	• Clean or repair the oil filter or the strainer.
		• Lack of engine oil.	• Refill oil.
		• Poor oil pump performance.	• Replace or repair the pump.
	Other	• Leakage of oil	• Repair.
		• Damaged cylinder head gasket.	• Replace the gasket.

Modification basis	
Application basis	
Affected VIN	

▶ General Diagnosis (Cont'd)

Condition		Probable Cause	Correction
Poor fuel consumption	Malfunction of fuel system	• Leakage of the fuel tank or the fuel pipe.	• Repair or replace the fuel tank or the fuel pipe
	Malfunction of ignition system	• Abnormal spark plug (Excessive carbon deposit, inadequate gap, burnt electrode).	• Replace the plug.
		• Electric leakage or poor connection of the high tension cable.	• Connect the cable normally or replace it.
	Malfunction of cooling system	• Malfunction of the thermostat.	• Repair the thermostat.
	Others	• Improperly installed valve.	• Repair or replace the valve.
		• Low pressure of tires.	• Adjust the pressure of tires.
Excessive consumption of engine oil	Leakage of engine oil	• Loosened oil drain plug.	• Tighten the plug.
		• Loosened oil pan bolt.	• Tighten the bolt. Engine Oil
		• Loosened oil filter.	• Tighten the filter.
		• Loosened oil pressure switch.	• Tighten the switch.
		• Leakage of camshaft front oil seal.	• Replace the seal.
		• Leakage of crankshaft front oil seal.	• Replace the seal.
		• Leakage at the cylinder head cover gasket.	• Replace the gasket.
		• Damage of the cylinder head gasket.	• Replace the gasket.
	Oil mixing in combustion chamber	• Stuck piston ring.	• Remove carbon and replace the ring.
		• Worn piston or cylinder.	• Replace the piston or the cylinder.
		• Worn piston ring or ring groove.	• Replace the piston or ring.
		• Inadequate position of the piston ring cutting part.	• Adjust the position.
		• Abrasion or damage of the valve system.	• Replace the valve system.
Low oil pressure	Malfunction of lubrication system	• Inadequate oil viscosity.	• Replace with the specified one.
		• Loosening of the oil pressure switch.	• Tighten the switch.
		• Lack of engine oil.	• Refill oil.
		• Blocking oil strainer.	• Clean the strainer.
		• Lowered function of the oil pump.	• Replace the pump.
		• Abrasion or damage of the oil pump relief valve.	• Replace the valve.

▶ General Diagnosis (Cont'd)

Condition		Probable Cause	Correction
Engine noise	Valve noise	• Inadequate valve clearance	• Adjust the valve clearance.
		• Abrasion of valve stem or guide.	• Replace the valve stem or the guide.
		• Weak valve spring.	• Replace the spring.
	Piston, ring, cylinder noise	• Abrasion of the piston, the ring or the cylinder.	• Boring the cylinder or replace the piston, the ring or the cylinder.
	Connecting rod noise	• Abrasion of the connecting rod bearing.	• Replace the bearing.
		• Loosened the connecting rod nut.	• Tighten to the specified torque
	Crankshaft noise	• Abrasion of the crankshaft bearing.	• Replace the bearing.
		• Abrasion of the crankshaft journal.	• Grind or replace the crankshaft journal.
		• Loosened bearing cap bolt.	• Tighten to the specified torque.
		• Excessive clearance of the crankshaft thrust bearing.	• Adjust or replace.

Modification basis	
Application basis	
Affected VIN	

6. SPECIFICATIONS

1) Engine Specifications

Application			G23D Engine	Remarks
Engine Model			M161.970	
Displacement			2295 cc	
Cylinder (Bore x Stroke)			90.9 x 88.4 mm	
Fuel Injection / Ignition System			MSE 3.53D	
Compression Ratio			10.0 : 1	
Number of Cylinders			4	
Camshaft Valve Arrangement			DOHC	
Camshaft Drive Type			Chain-Driven	
Max. Output			150 ps / 5500 rpm	
Max. Torque			214 Nm / 3,500 ~ 4,000 rpm	
Firing Order			1 - 3 - 4 - 2	
Ignition Type			Distributor less double ignition	
Ignition Timing			BTDC 6° ± 2°	
Valve Timing	Intake	Open/Close	ATDC 13.15° / ABDC 13.57°	
	Exhaust	Open/Close	BBDC 16.58° / BTDC 17.05°	
Valve Clearance Adjustment			←	
Idle Speed			750 ± 50 rpm	
Fuel Injection Pressure			3.2 - 4.2 kg/cm²	
Oil Capacity			7.9 ℓ	
Lubrication Type			Forced by gear pump	
Oil Filter Type			Full flow with paper filter	
Fuel			Unleaded gasoline	

MSE : Engine Control Module

3.53D : 4 Cylinder Version

2) Fastener Tightening Specifications

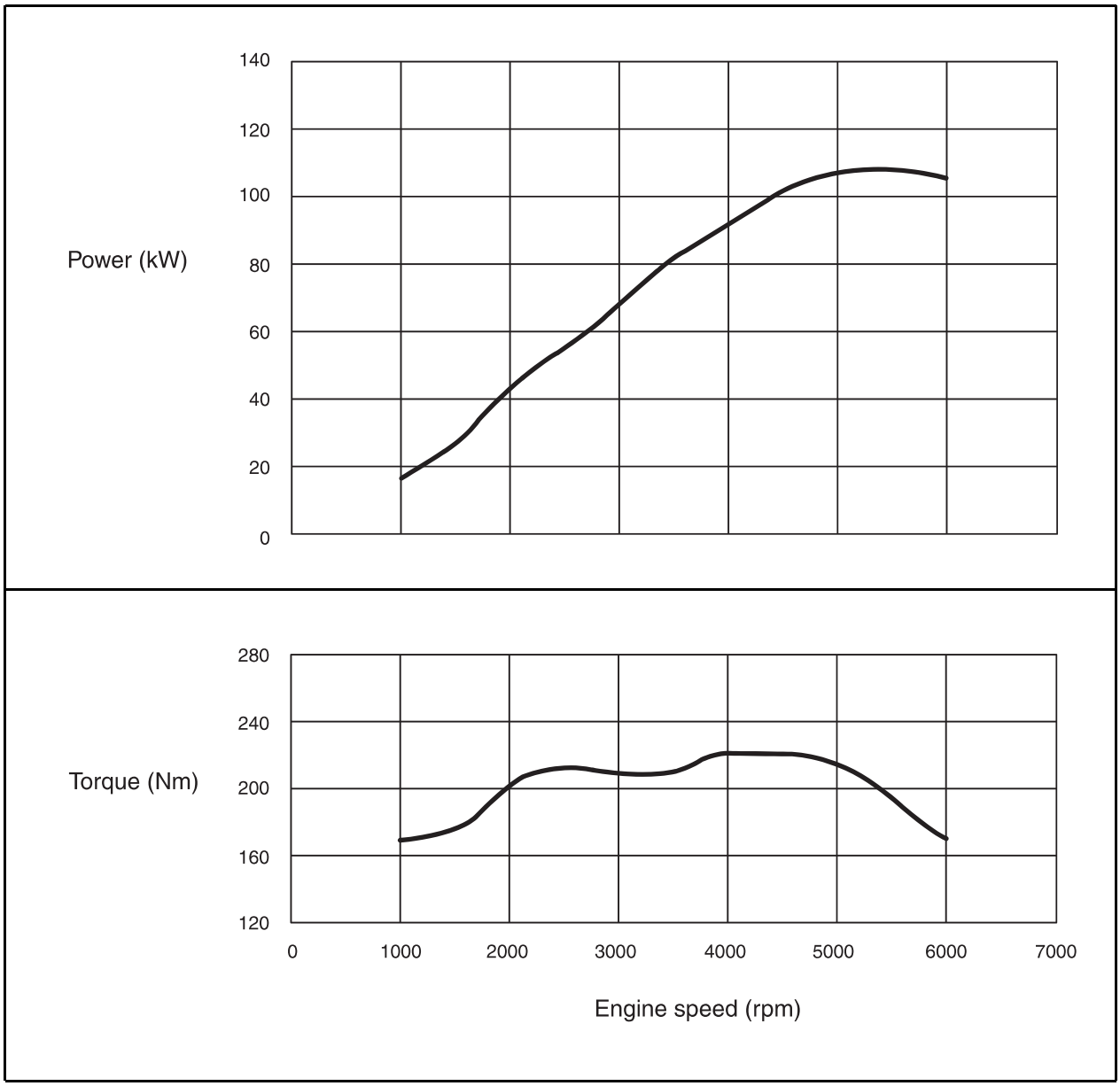
Application		N•m	Lb-Ft	Lb-In
Fuel Feed and Return Line		21 ~ 25	15 ~ 18	-
Exhaust Manifold and Pipe		30	22	-
Engine Mounting Nuts		70	52	-
Generator Carrier Bolts		25	18	-
Tensioning Pulley Bolt		40.5 ~ 49.5	29.9 ~ 36.5	-
Steering Pump Bolts		22.5 ~ 27.5	16.6 ~ 20.3	-
A/C Braket Bolts		22.5 ~ 27.5	16.6 ~ 20.3	-
Intake Air Duct Mounting Nuts		9 ~ 11	-	80 ~ 97
Spark Plug Cover Bolts		9 ~ 11	-	80 ~ 97
Cylinder Head Cover Bolts		9 ~ 11	-	80 ~ 97
Magnetic Assembly Bolt		9 ~ 11	-	80 ~ 97
Cylinder Head Front Cover Bolts	M8	22.5 ~ 27.5	16.6 ~ 20.3	-
	M6	9 ~ 11	-	80 ~ 97
Cylinder Head Bolts		55 +90° +90°	41 +90° +90°	- - 80 ~ 97
Timing Gear Case Cover Bolts		22.5 - 27.5	16.6 ~ 20.3	-
Crankshaft Sealing Rear Cover Mounting Bolts		9 ~ 11	-	-
Vibration Damper Center Bolts		200 + 20 +90° + 10°	148 + 15 +90° + 10°	- -
Flywheel Mounting Bolt		40 +90°	30 +90°	- -
Amarture Bolt in Flywheel		45 + 5	33 + 3.7	-
Camshaft Adjuster Flange Bolts		+90° + 10° 35	+90° + 10° 26	- -
Intake Flange Shaft Bolts		18 ~ 22 60° ± 5°	13 ~ 16 60° ± 5°	- -
Exhaust Camshaft Sprocket Bolts		18 ~ 22 60° ± 5°	13 ~ 16 60° ± 5°	- -
Intake Flange Shaft Bolts		18 ~ 22	13 ~ 16	-
Exhaust Camshaft Sprocket Bolts		60° ± 5°	60° ± 5°	-
Camshaft Bearing Cap Bolts		22.5 ~ 27.5	16.6 ~ 20.3	-
Chain Tensioner Screw Plug		40	30	-
Chain Tension Assembly		72 ~ 88	53 ~ 65	-
Oil Pump Sprocket Bolt		29 ~ 35	21 ~ 26	-
Tensioning Device Bolts		26 ~ 32	19 ~ 24	-
Water Pump Pulley		22.5 ~ 27.5	16.6 ~ 20.3	-
Upper Intake Manifold Bolt		22.5 ~ 27.5	16.6 ~ 20.3	-
Lower Intake Mainfold Bolt		22.5 ~ 27.5	16.6 ~ 20.3	-
Flange Bolt to Exhaust Mainfold		30	22	-

Modification basis	
Application basis	
Affected VIN	

▶ Fastener Tightening Specifications (Cont'd)

Application	N•m	Lb-Ft	Lb-In
Exhaust Mainfold Nut to Stud Bolt	26 ~ 34	19 ~ 25	-
Oil Drain Plug	25	18	-
Oil Filter Cover	25	18	-
Oil Filter Bolt	22.5 ~ 27.5	16.6 ~ 20.3	-
Oil Pump Drive Sprocket Bolt	29 ~ 35	21 ~ 26	-
Oil Pump Mounting Bolt	22.5 ~ 27.5	16.6 ~ 20.3	-
Oil Strainer Bracket Bolt	9 ~ 11	-	80 ~ 97
Oil Pressure Relief Valve Screw Plug	50	37	-
Oil Dipstick Guide Tube Bolt	9 ~ 11	-	80 ~ 97
Oil Gallery Screw Plug	15	11	-
Shock Absorber Bolts	22.5 ~ 27.5	16.6 ~ 20.3	-
Crankshaft Bearing Cap Bolts	55/+90°	41/+90°	-
Torque Converter Mounting Bracket Bolts	42	31	-

2) Performance Curve



Modification basis	
Application basis	
Affected VIN	

Memo

FUEL SYSTEM

2211-06

GENERAL

1. FUEL SYSTEM SPECIFICATION

▶ Use Only Unleaded Fuel Rated at 89 Octane or Higher

Fuel quality and additives contained in fuel have a significant effect on power output, drivability, and life of the engine.

Fuel with too low an octane number can cause engine knock.

Caution: Use of fuel with an octane number lower than 89 may damage engine and exhaust system.

CAUTION

- To prevent accidental use of leaded fuel, the nozzles for leaded fuel are larger, and will not fit the fuel filler neck of your vehicle.

▶ Do Not Use Methanol

Fuels containing methanol (wood alcohol) should not be used in vehicle.

This type of fuel can reduce vehicle performance and damage components of the fuel system.

CAUTION

- Use of methanol may damage the fuel system.

▶ Vehicle Fueling from Drums or Storage Containers

For safety reasons (particularly when using noncommercial fueling systems) fuel containers, pumps and hoses must be properly earthed.

Static electricity build up can occur under certain atmospheric and fuel flow conditions if unearthed hoses, particularly plastic, are fitted to the fuel-dispensing pump.

It is therefore recommended that earthed pumps with integrally earthed hoses be used, and that storage containers be properly earthed during all noncommercial fueling operations.

▶ Temperature VS Resistance

°C	°F	ECT sensor	IAT sensor
		ohms ( )	
Temperature vs Resistance Values (Approximate)			
130	266	88	102
120	248	111.6	127
110	230	143	159
100	212	202	202
90	194	261	261
80	176	340	340
70	158	452	452
60	140	609	609
50	122	835	835
40	113	1166	1166
30	86	1662	1662
20	68	2420	2420
10	50	3604	3604
0	32	5499	5499
-10	14	8609	8609
-20	-4	13850	13850
-30	-22	22960	22960
-40	-40	39260	39260

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATION PROCESS

1. FUEL SYSTEM

The function of the fuel metering system is to deliver the correct amount of fuel to the engine under all operating conditions.
The fuel is delivered to the engine by the individual fuel injectors mounted into the intake manifold near each cylinder.
The main fuel control sensors are the Mass Air Flow (MAF) sensor and the oxygen (O2) sensors.
The MAF sensor monitors the mass flow of the air being drawn into the engine. An electrically heated element is mounted in the intake air stream, where it is cooled by the flow of incoming air. Engine Control Module (ECM) modulates the flow of heating current to maintain the temperature differential between the heated film and the intake air at a constant level. The amount of heating current required to maintain the temperature thus provides an index for the mass air flow. This
concept automatically compensates for variations in air density, as this is one of the factors that determines the amount of warmth that the surrounding air absorbs from the heated element. MAF sensor is located between the air filter and the throttle valve.
Under high fuel demands, the MAF sensor reads a high mass flow condition, such as wide open throttle. The ECM uses this information to enrich the mixture, thus increasing the fuel injector on-time, to provide the correct amount of fuel. When decelerating, the mass flow decreases. This mass flow change is sensed by the MAF sensor and read by the ECM, which then decreases the fuel injector on-time due to the low fuel demand conditions.
The O2 sensors are located in the exhaust pipe before catalytic converter. The O2 sensors indicate to the ECM the amount of oxygen in the exhaust gas, and the ECM changes the air/fuel ratio to the engine by controlling the fuel injectors. The best air/fuel ratio to minimize exhaust emissions is 14.7 to 1, which allows the catalytic converter to operate most efficiently. Because
of the constant measuring and adjusting of the air/fuel ratio, the fuel injection system is called a "closed loop" system.
The ECM uses voltage inputs from several sensors to determine how much fuel to provide to the engine. The fuel is delivered under one of several conditions, called "modes".

1) Starting Mode

When the ignition is turned ON, the ECM turns the fuel pump relay on for 1 second. The fuel pump then builds fuel pressure. The ECM also checks the Engine Coolant Temperature (ECT) sensor and the Throttle Position (TP) sensor and determines the proper air/fuel ratio for starting the engine. This ranges from1.5 to 1 at -36 ℃ (-33 ℉) coolant temperature to 14.7 to 1 at 94 ℃ (201 ℉) coolant temperature. The ECM controls the amountof fuel delivered in the starting mode by changing how long the fuel injector is turned on and off. This is done by "pulsing" the fuel injectors for very short times.

2) Run Mode

The run mode has two conditions called "open loop" and "closed loop".

3) Open Loop

When the engine is first started and it is above 690 rpm, the system goes into "open loop" operation. In "open loop", the ECM ignores the signal from the HO2S and calculates the air/fuel ratio based on inputs from the ECT sensor and the MAF sensor. The ECM stays in "open loop" until the following conditions are met:

- The O2 has a varying voltage output, showing that it is hot enough to operate properly.
- The ECT sensor is above a specified temperature (22.5 ℃).
- A specific amount of time has elapsed after starting the engine.

4) Closed Loop

The specific values for the above conditions vary with different engines and are stored in the Electronically Erasable Programmable Read-Only Memory (EEPROM).
When these conditions are met, the system goes into "closed loop" operation. In "closed loop", the ECM calculates the air/fuel ratio (fuel injector on- time) based on the signals from the O2 sensors. This allows the air/fuel ratio to stay very close to 14.7 to 1.

5) Acceleration Mode

The ECM responds to rapid changes in throttle position and airflow and provides extra fuel.

6) Deceleration Mode

The ECM responds to changes in throttle position and airflow and reduces the amount of fuel. When deceleration is very fast, the ECM can cut off fuel completely for short periods of time.

Modification basis	
Application basis	
Affected VIN	

7) Battery Voltage Correction Mode

When battery voltage is low, the ECM can compensate for a weak spark delivered by the ignition module by using the following methods:

- Increasing the fuel injector pulse width.
- Increasing the idle speed rpm.
- Increasing the ignition dwell time.

8) Fuel Cut-Off Mode

No fuel is delivered by the fuel injectors when the ignition is off. This prevents dieseling or engine runon. Also, the fuel is not delivered if there are no reference pulses received from the CKP sensor. This prevents flooding.

ENGINE INTAKE SYSTEM

0000-00

GENERAL

1. SPECIFICATIONS

(1) Fastener Tightening Specifications

Application	N•m	Lb-Ft	Lb-In
DOC to Muffler Nut	28 - 47	21 - 35	-
Exhaust Manifold to Front Exhaust Pipe Nut	15 - 28	11 - 21	-
Front Exhaust Pipe to DOC Nut	28 - 47	21 - 35	-
Front Exhaust Pipe to Muffler Nut	28 - 47	21 - 35	-
Intake Air Duct Mounting Bolt	22.5 - 27.5	16.6 - 20.3	-
Intake Manifold Mounting Bolt	22.5 - 27.5	16.6 - 20.3	-
Muffler to Tail Exhaust Pipe Nut	28 - 47	21 - 35	-
Resonance Flap Mounting Bolt	9 - 11	-	80 - 97

ENGINE EXHAUST SYSTEM

2420-01

GENERAL

1. SPECIFICATION

(1) Fastener Tightening Specifications

Application	N•m	Lb-Ft	Lb-In
DOC to Muffler Nut	28 - 47	21 - 35	-
Exhaust Manifold to Front Exhaust Pipe Nut	15 - 28	11 - 21	-
Front Exhaust Pipe to DOC Nut	28 - 47	21 - 35	-
Front Exhaust Pipe to Muffler Nut	28 - 47	21 - 35	-
Intake Air Duct Mounting Bolt	22.5 - 27.5	16.6 - 20.3	-
Intake Manifold Mounting Bolt	22.5 - 27.5	16.6 - 20.3	-
Muffler to Tail Exhaust Pipe Nut	28 - 47	21 - 35	-
Resonance Flap Mounting Bolt	9 - 11	-	80 - 97

OVERVIEW AND OPERATION PROCESS

1. DESCRIPTION AND OPERATION

1) Exhaust System

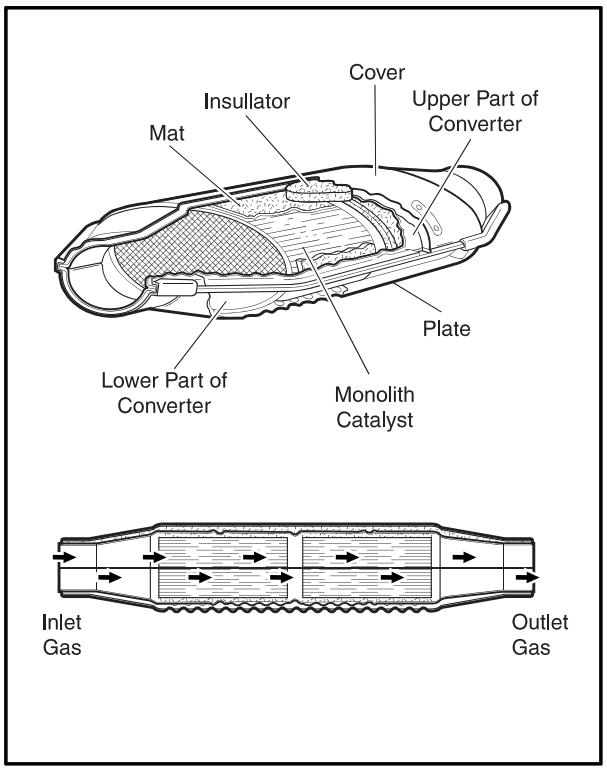
CAUTION

When you are inspecting or replacing exhaust system components, make sure there is adequate clearance from all points on the underbody to avoid possible
overheating of the floor panel and possible damage to the passenger compartment insulation and trim materials.
Check the complete exhaust system and the nearby body areas and trunk lid for broken, damaged, missing or mispositioned parts, open seams, holes, loose connections, or other deterioration which could permit exhaust fumes to seep into the trunk may be an indication of a problem in one of these areas. Any defects should be corrected immediately.

2) Catalytic Converter (Gasoline Engine)

1. When jacking or lifting the vehicle from the body side rails, be certain that the lift pads do not contact the catalytic converter, as this could damage the catalytic converter.
2. Use of anything other than unleaded fuel will damage the catalyst in the catalytic converter.

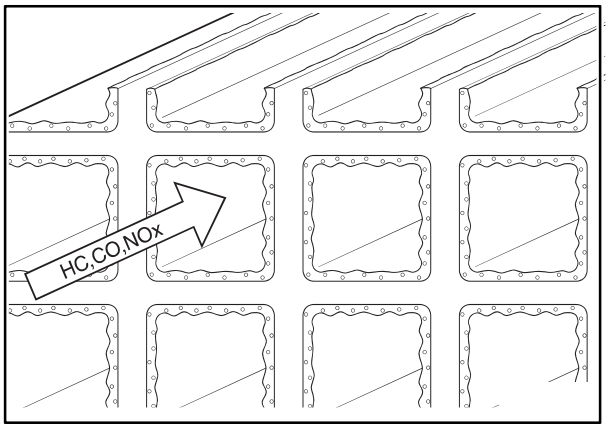
▶ **Catalytic Converter Structure**



The Catalytic converter of monolith type consists of 2 walled metal bodies which is made of Cordierite. The principal element of converter consists of the materials like Alumina or oxidized Serume in order to apply to Ceramic Monolith. Washer coat operates first, and catalytic metal elements (Pt, Pd, Rh) operates to washer coat next.
Monolith type is lighter than other types, easy to manufacture and quickly approaches to proper temperature. Washer coat is used to make a contact surface with exhaust gas bigger by adhering closely to small holes
of inner layer. If a lead compound or phosphorus adheres to the surface and the temperature rises, its surface is decreased. The total area of general monolith converter is about 45, 000~500,000ft3. (10 times of a football field) Generally Alumina (AL2 O3) is used as a raw materialand its 7 phases of gamma, delta, theta have big areas and high stability for the temperature, and nowadays gamma Alumina is used usually.

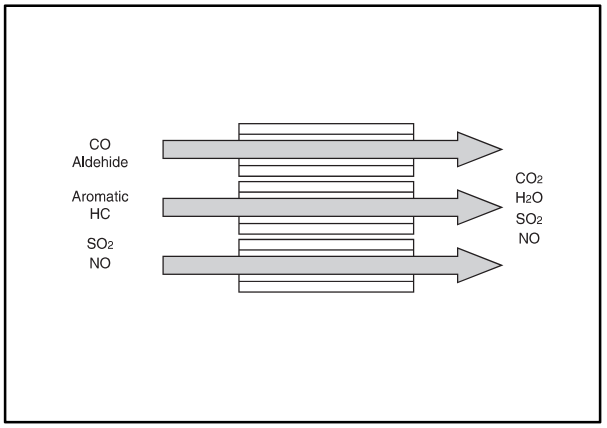
Modification basis	
Application basis	
Affected VIN	

▶ Catalytic Converter and Temperature

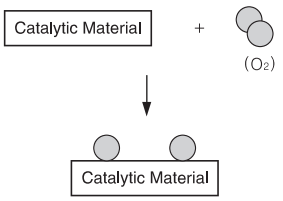
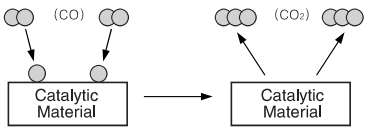
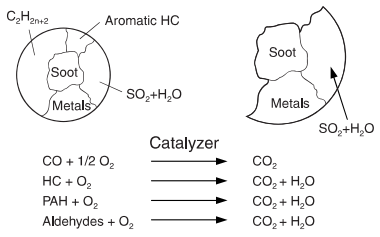


Catalytic converter has the normal function of purification at a range of the temperature.
Because it has a weak point of decreasing of the purification rate in the condition of continuous high temperature, it should keep the temperature range of 400 to 500°C for normal condition.
HC purification rate becomes better according to the increase of temperature in the normal range of temperature. CO purification rate becomes the best near the temperature of 450°C, and NOx does so near the temperature of 400 to 500°C.

▶ Purification of Catalytic Converter



- Adhesion of soluble organic fraction (SOF) below 180°C
- Purification of soluble organic fraction (SOF) over 180°C
  Chemical reaction formula
  SOF(HC)+O2 → CO2+H2O
  2CO+O2 → 2CO2
  2C2H6+7O2 → 4CO2+6H20
- By catalytic action of two primary catalytic converter, oxidation occurs in order to decrease HC and CO.

Oxygen adheres to catalytic material : below 180°C	Catalytic material supplies each CO and HC with O2 for their oxidation : above 180°C	Catalytic material conversion process by DOC
		

Modification basis	
Application basis	
Affected VIN	

▶ **Method for Reduction of NOx**

NOx is generated a great deal in case that combustion temperature and excess air factor are high. EGR valve can decrease NOx (30 to 35% decrease) by making temperature of combustion chamber fall by means of exhaust gas re-circulation.

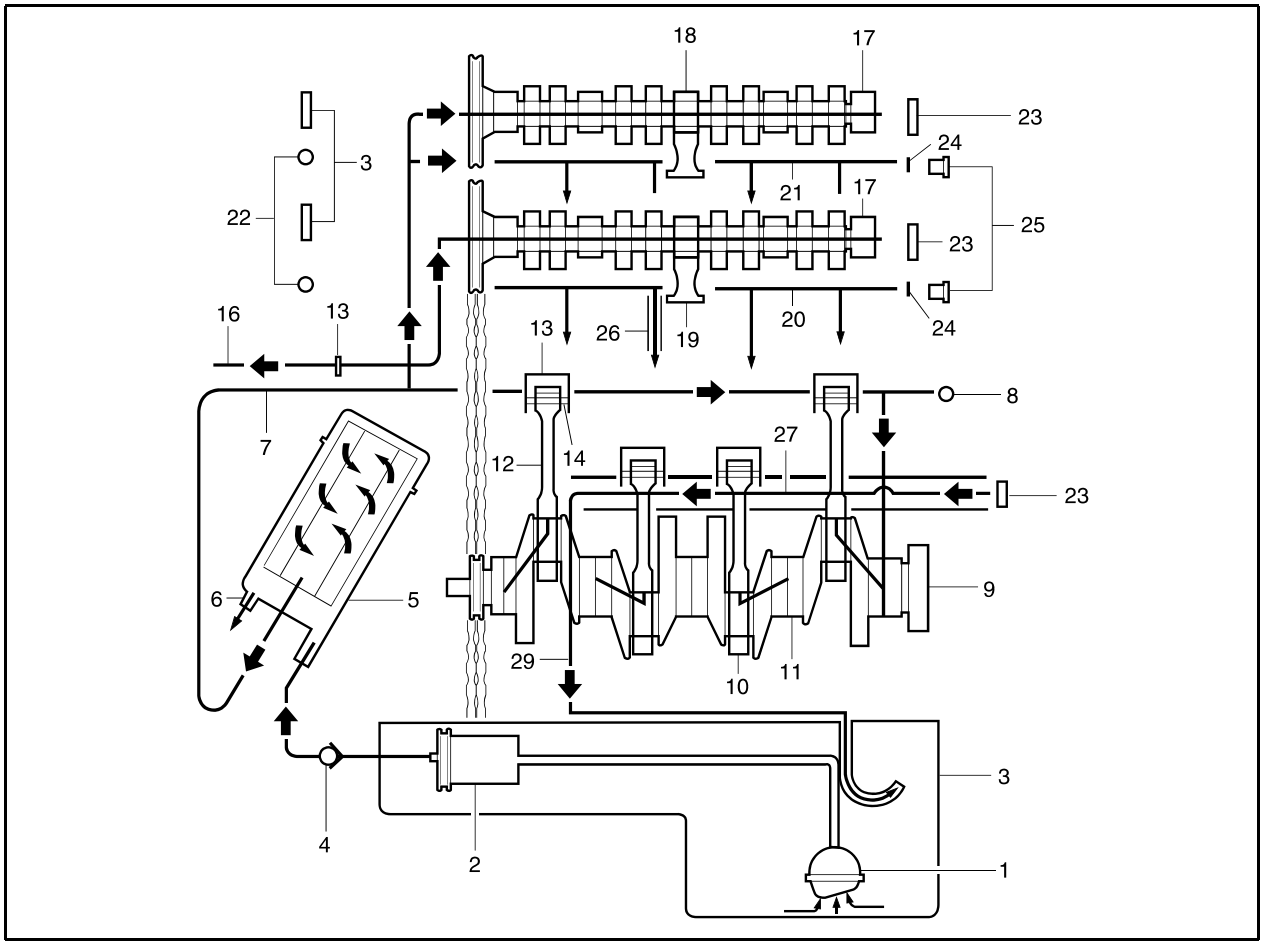
- EGR valve is installed on the diesel engine of Musso, Korando, Istana and Rexton.
  And micro switch is installed together to control EGR valve.
- The setting method of micro switch is identical with the existing one.

Modification basis	
Application basis	
Affected VIN	

LUBRICATION SYSTEM 1531-24

OVERVIEW AND OPERATION PROCESS

1. OIL CIRCULATION



1 Oil Strainer
2 Oil Pump
3 Oil Pan
4 Oil Non-Return Valve
5 Oil Filter
6 Oil Filter Bypass Valve
7 Main Oil Gallery
8 Closing Ball (ϕ 15 mm)
9 Crankshaft
10 Connecting Rod Bearing
11 Crankshaft Bearing
12 Connecting Rod
13 Piston
14 Oil Spray (Piston Crown Area)
15 Non-Return Valve (Crankcase)
16 Oil Supply (To Chain Tensioner)
17 Camshaft
18 Cam Bearing
19 Valve
20 Oil Gallery (Supply Oil to Intake Tappet)
21 Oil Gallery (Supply Oil to Exhaust Tappet)
22 Ball (ϕ 8 mm)
23 Camshaft Plug
24 Seal
25 Screw Plug
26 Oil Return Gallery (Cylinder Head and Crankcase)
27 Oil Return Gallery (Crankcase)
28 End Cover (ϕ 20 mm)
29 Oil Return Pipe

ENGINE COOLING SYSTEM

2110-01

GENERAL

1. GENERAL SPECIFICATIONS

Application		Unit	Gasoline Engine
Cooling System	Type	-	Water Cooling Forced Circulation
Coolant	Capacity	L	11.3
Thermostat	Type	-	Wax Pellet Type
	Initial Opening Temp.	°C (°F)	82 (180)
	Fully Opening Temp.	°C (°F)	95 (203)
	Fully Closing Temp.	°C (°F)	80 (176)
	Stroke	mm	7
Cooling Fan	Type	-	PWM
	Blades	-	5
	Diameter	mm	320
	Low Speed ON Temp.	°C (°F)	95 (203)
	Low Speed OFF Temp.	°C (°F)	90 (194)
	High Speed ON Temp.	°C (°F)	105 (221)
	High Speed OFF Temp.	°C (°F)	100 (212)
	High Speed ON Temp. (By A/C Pressure)	kPa (psi)	269.8 (1860)
Coolaant Reservoir	Pressure Valve Opening Pressure	kPa (psi)	118 - 147 (17.1 - 21.3)
	Vacuum Valve Opening Pressure	kPa (psi)	9.8 (1.4)
Water Pump	Type	-	Turbo Centrifugal
	Impeller Diameter	mm	65
	Impeller Blades	-	8
Radiator	Type	-	Cross-flow
	Core Width	mm	701
	Core Height	mm	372
	Core Thickness	mm	18
Coolant Temperature Gauge	Minimum Radiation Capability	Kcal/h	45,000
	Resistance (at 50 °C (122°F))	Ω	185.2
	Resistance (at 80 °C (176°F))	Ω	47.4
	Resistance (at 105 °C (221°F))	Ω	28.2
Engine Coolant Temperature Sensor	Resistance (at 20 °C (68°F))	K Ω	3.33 - 37.8
	Resistance (at 80 °C (176°F))	K Ω	0.32 - 0.35
Anti-Freeze Agent	Type	-	ALUTEC-P78
	Mixture of Water and Good Quality Ethylene Glycol-Base Anti-Freeze	-	50 : 50

Modification basis	
Application basis	
Affected VIN	

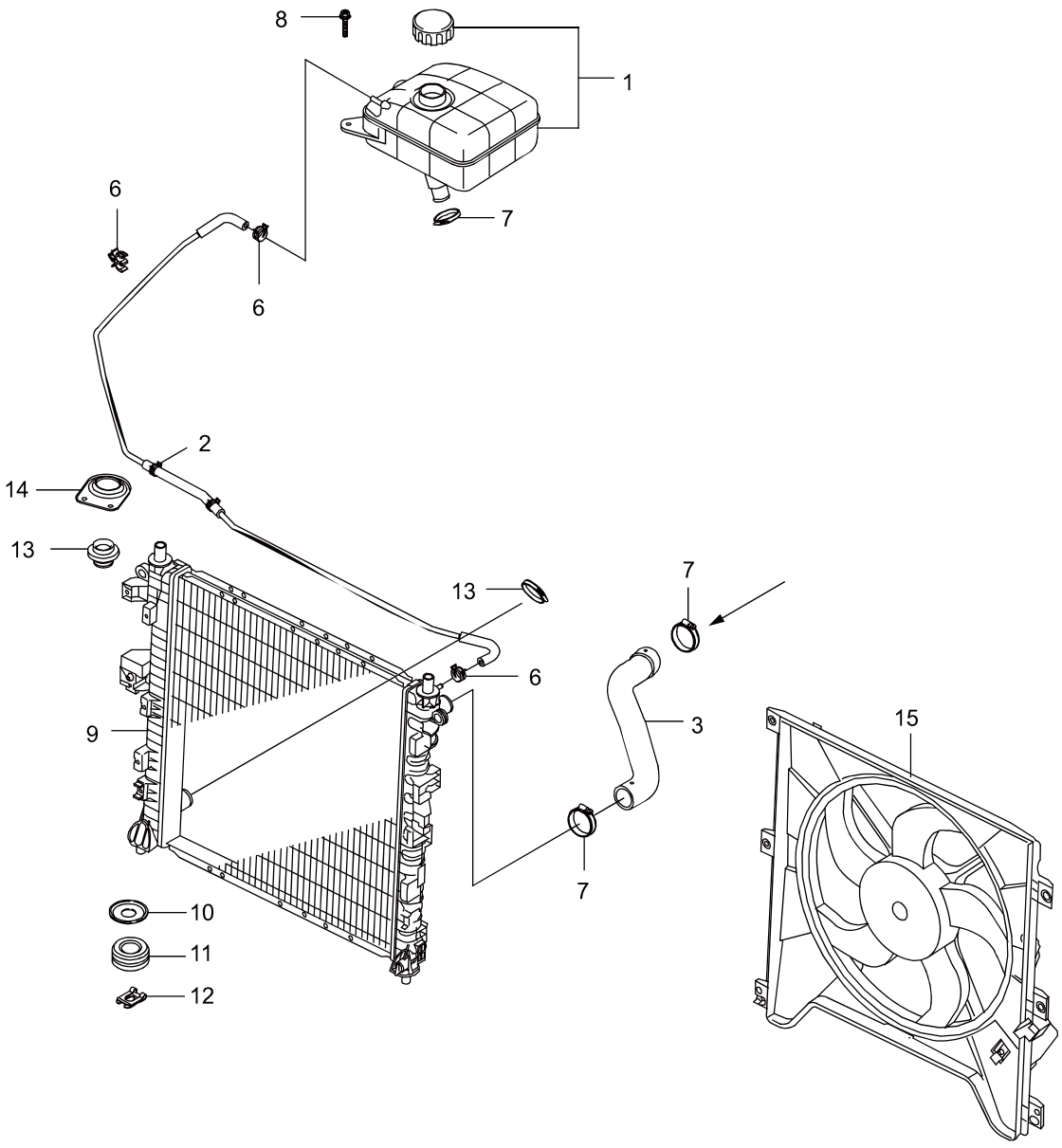
2. FASTENER TIGHTENING SPECIFICATIONS

Application		Nm	Lb-Ft	Lb-In
Automatic Transmission Oil Cooler Pipe		20	15	-
Automatic Transmission Oil Cooler Pipe Mounting Bolt		3 - 7	-	27 - 62
Coolant Drain Plug		30	22	-
Cooling Fan Bolt		9 - 11	-	80 - 97
Cooling Fan Shroud Bolt		3 - 7	-	27 - 62
Oil Cooler Pipe Line Bolt		9 - 11	-	80 - 97
Radiator Mounting Bracket Bolt		3 - 7	-	27 - 62
Tensioning Device Shock Absorber Bolt		22.5 - 27.5	16.6 - 20.3	-
Thermostat Cover Bolt		9 - 11	-	80 - 97
Thermostat Housing Bolt	M6	9 - 11	-	80 - 97
	M8	22.5 - 27.5	16.6 - 20.3	-
Viscous Clutch Mounting Bolt		40.5 - 49.5	29.8 - 36.5	-
Water Pump Housing Bolt	M6	9 - 11	-	80 - 97
	M8	22.5 - 27.5	16.6 - 20.3	-
Water Pump Pulley Bolt		9 - 11	-	80 - 97

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATION PROCESS

1. COMPONENT LOCATOR



1. Reserver Tank
2. Deaeration Tube
3. Inlet Hose
6. Clamp
7. Clamp
8. Bolt (M6, 2 piece)
9. Radiator
10. Lower Radiator Insulator
11. Plate
12. Clip
13. Upper Radiator Insulator
14. Bracket
15. PWM Electric Fan

2. DESCRIPTION AND OPERATION

1) General Description

The cooling system maintains the engine temperature at an efficient level during all engine operating conditions.
When the engine is cold, the cooling system cools the engine slowly or not at all. This slow cooling of the engine allows the engine to warm up quickly.
The cooling system includes a radiator and recovery subsystem, cooling fans, a thermostat and housing, a water pump, and a water pump drive belt. The timing belt drives the water pump.
All components must function properly for the cooling system to operation. The water pump draws the coolant from the radiator. The coolant then circulates through water jackets in the engine block, the intake manifold, and the cylinder head. When the coolant reaches the operating
temperature of the thermostat, the thermostat opens. The coolant then goes back to the radiator where it cools.
This system directs some coolant through the hoses to the heat core. This provides for heating and defrosting.
The coolant reservoir is connected to the radiator to recover the coolant displaced by expansion from the high temperatures. The coolant reservoir maintains the correct coolant level.
The cooling system for this vehicle has no radiator cap or filler neck. The coolant is added to the cooling system through the coolant reservoir.

2) Radiator

This vehicle has a lightweight tube-and-fin aluminum radiator. Plastic tanks are mounted on the upper and the lower sides of the radiator core.
On vehicles equipped with automatic transaxles, the transaxle fluid cooler lines run through the radiator tank.
A radiator drain plug is on this radiator.
To drain the cooling system, open the drain plug.

3) Coolant Reservoir

The coolant reservoir is a transparent plastic reservoir, similar to the windshield washer reservoir.
The coolant reservoir is connected to the radiator by a hose and to the engine cooling system by another hose.
As the vehicle is driven, the engine coolant heats and expands. The portion of the engine coolant displaced by this expansion flows from the radiator and the engine into the coolant reservoir. The air trapped in the radiator and the engine is degassed into the coolant reservoir.
When the engine stops, the engine coolant cools and contracts. The displaced engine coolant is then drawn back into the radiator and the engine. This keeps the radiator filled with the coolant to the desired level at all times and increases the cooling efficiency.
Maintain the coolant level between the MIN and MAX marks on the coolant reservoir when the system is cold.

Modification basis	
Application basis	
Affected VIN	

4) Water Pump

The belt-driven centrifugal water pump consists of an impeller, a drive shaft, and a belt pulley.
The impeller is supported by a completely sealed bearing.
The water pump is serviced as an assembly and, therefore, cannot be disassembled.

5) Thermostat

A wax pellet-type thermostat controls the flow of the engine coolant through the engine cooling system. The thermostat is mounted in the thermostat housing to the front of the cylinder head.
The thermostat stops the flow of the engine coolant from the engine to the radiator to provide faster warm-up, and to regulate the coolant temperature. The thermostat remains closed while the engine coolant is cold, preventing circulation of the engine coolant through the radiator. At this point, the engine coolant is allowed to circulate only throughout the heater core to warm it quickly and evenly.
As the engine warms, the thermostat opens. This allows the engine coolant to flow through the radiator wherethe heat is dissipated. This opening and closing of the thermostat permits enough engine coolant to enter the radiator to keep the engine within proper engine temperature operating limits.
The wax pellet in the thermostat is hermetically sealed in a metal case. The wax element of the thermostat expands when it is heated and contracts when it is cooled.
As the vehicle is driven and the engine warms, the engine coolant temperature increases. When the engine coolant reaches a specified temperature, the wax pellet element in the thermostat expands and exerts pressure against the metal case, forcing the valve open. This allows the engine coolant to flow through the engine cooling system and cool the engine.
As the wax pellet cools, the contraction allows a spring to close the valve.
The thermostat begins to open at 82°C(180 °F) and is fully open at 95°C(203°F). The thermostat closes at 80°C (176°F).

6) Electric Cooling Fan

CAUTION

- Keep hands, tools, and clothing away from the engine cooling fans to help prevent personal injury. This fan is electric and can turn on even when the engine is not running.

CAUTION

- If a fan blade is bent or damaged in any way, no attempt should be made to repair or reuse the damaged part. A bent or damaged fan assembly should always be replaced with a new one to prevent possible injury.

The cooling fans are mounted behind the radiator in the engine compartment. The electric cooling fans increase the flow of air across the radiator fins and across the condenser on air conditioned (A/C)-equipped vehicles.
This helps to speed cooling when the vehicle is at idle or moving at low speeds.
All models have two fans. The main fan is 320 mm (12. 6 inches) in diameter with seven blades to aid the airflow through the radiator and the condenser. An electric motor attached to the radiator support drives the fan.
The auxiliary fan is 320 mm (12.6 inches) in diameter.

▶ **A/C Off or Non-AC Model**

- The cooling fans are actuated by the engine control module (ECM) using a low-speed cooling fan relay, a high-speed cooling fan relay and a cooling fan motor relay.
- The ECM will turn the cooling fans on at low speed when the coolant temperature reaches 95°C(203°F) and at high speed when the coolant temperature reaches 105°C(221°F).
  The ECM will change the cooling fans from high peed to low speed at 100°C(212°F) and
- will turn the cooling fans off at 90°C (194°F).

▶ **A/C On**

- The ECM will turn the cooling fans on at low speed when the A/C system is on. The ECM will change to high speed when the high side A/C pressure reaches 1860 kPa (269.8 psi).
  The cooling fans will return to low speed when the high side A/C pressure reaches 1378 kPa
- (199.8 psi).

7) Engine Coolant Temperature Sensor

The Engine Coolant Temperature (ECT) sensor uses a temperature to control the signal voltage to the Engine Control Module (ECM).

8) Coolant Temperature Gauge

The coolant temperature gauge controls the instrument panel temperature indicator. The coolant temperature gauge is located with ECT sensor.

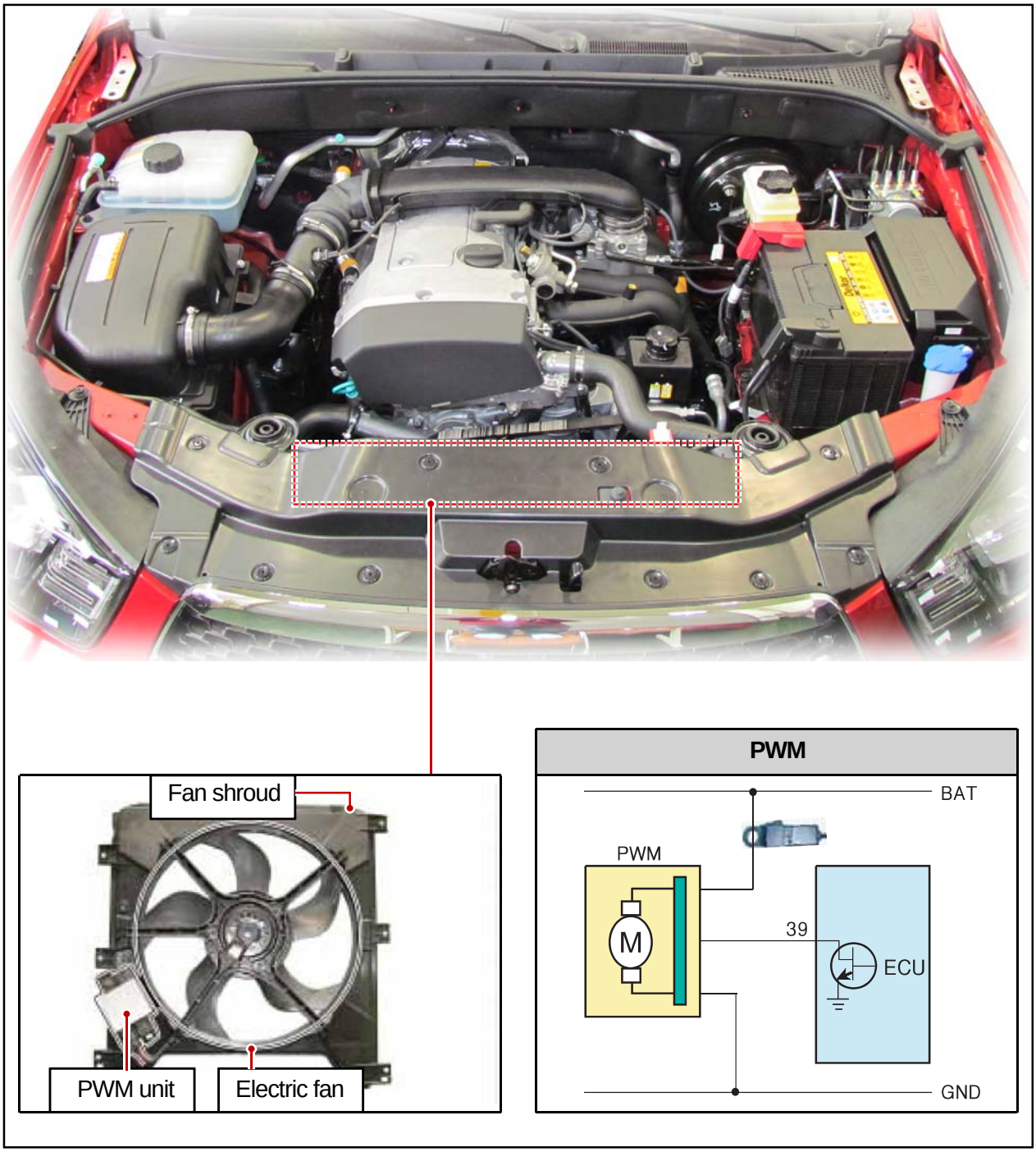
Modification basis	
Application basis	
Affected VIN	

3. PWM (PULSE WIDTH MODULATION) ELECTRIC FAN OPERATION

1) Function

The PWM (Pulse Width Modulation) high capacity electric fan is installed instead of electric condenser fan to enhance the durability and controllability and reduce noise.

2) Mounting Location



3) PWM Electric Fan

(1) Advantages and Disadvantages of the PWM Electric Fan



▶ **Advantages**

- Enhanced A/C performance: at low speed, at idling, driving in city
- Reduction of vibration/noise: fan activated by PWM only when necessary
- Reduction of engine consuming power (V/Fan driving force) by 4 Hp - Cost saving

▶ **Disadvantage**

- Poor engine cooling perfomance at low and high rpm

4) PWM (Pulse Width Modulation) Unit



It controls the time of the output voltage to control the fan motor speed independently.

▶ **Internal functions**

- Motor power shutting-off function when overcurrent is applied
- Adverse voltage prevention function
- Detection function for the motor lock
- Temperature detecting function: The electric fan operates at FULL speed to cool down the PWM unit when the interior temperature of PWM unit is over 120~150°C.
- Communication function when failing: The fail signal is transmitted to the ECU when the PWM unit is malfunctioning.
- Soft start function: The motor speed is gradually increased when the motor is initially operated.

Modification basis	
Application basis	
Affected VIN	

5) Shutting-off Condition of the A/C Compressor

▶ **Coolant temperature**

- When coolant temperature is below 20°C or over 115°C, engine speed is below 650 rpm or over 4500 rpm for 4 seconds after engine starting, abrupt acceleration and A/C refrigerant pressure sensor detecting the followings
- A/C compressor is turned off when the refrigerant pressure is below 2.0 kg/cm2 and then is turned on when the refrigerant pressure is over 2.4 kg/cm2.
- A/C compressor is turned off when the refrigerant pressure is over 30 kg/cm2 and then is turned on when the refrigerant pressure is below 21.4 kg/cm2.

ENGINE ELECTRIC DEVICES

0000-00

GENERAL

1. DIAGNOSTIC INFORMATION AND PROCEDURE

1) Ignition System

Condition	Probable Cause	Correction
No Crank	• Low battery voltage.	• Charging the battery or Replace the battery.
	• Battery cable is loose, corroded, or damaged.	• Repair or Replace the battery cable.
	• Faulty starter motor or starter motor circuit is open.	• Repair or Replace the starter motor/starter motor circuit.
	• Faulty ignition switch.	• Replace the ignition switch.
	• Ground short.	• Repair the ground short.
Crank OK, But Too Slow	• Low battery voltage.	• Charging the battery or Replace the battery.
	• Battery. • Battery cables are loose, corroded, or damaged.	• Repair or Replace the battery cable.
	• Faulty starter motor.	• Repair or Replace the starter motor.
Starter Motor Does Not Stop	• Faulty starter motor.	• Repair or Replace the starter motor.
	• Faulty ignition switch.	• Replace the ignition switch.
Starter Motor Running, But Not Cranking	• Broken the clutch pinion gear or faulty starter motor.	• Replace the starter motor.
	• Broken the flywheel ring gear.	• Replace the flywheel.
	• Connected circuit is open.	• Repair the open circuit.
Battery Discharge	• Loosen the generator drive belt.	• Adjust the belt tension or Replace the belt.
	• The circuit is open or a short.	• Repair the open or a short circuit.
	• Battery run down.	• Replace the battery.
	• Open ground circuit.	• Repair the open ground circuit.
Charging Indicator Lamp Does Not Work When the Ignition Switch ON (Engine Does Not Work)	• Charging indicator lamp is blown or fuse is blown.	• Repair or Replace the charging indicator lamp/fuse.
	• Faulty ignition switch.	• Replace the ignition switch.
	• Generator ground circuit is open or a short.	• Repair the circuit.
Charging Indicator Lamp Does Not Put Out Lights After Starting the Engine	• Battery cable is corroded or damaged.	• Repair or Replace the battery cable.
	• Loosen the generator drive belt.	• Adjust the belt tension or Replace the belt.
	• Faulty wiring harness.	• Repair the wiring harness.
Battery Over Charging	• Generator Voltage Regulator Faulty	• Replace Generator
	• Voltage detecfing wiring faulty	• Repair Wiring

2) Ignition System (Cont'd)

Condition	Probable Cause	Correction
Hard Engine Starting	• Ignition coil faulty	• Replace ignition coil
	• Distributor (including optical sensor) faulty	• Replace distribator (or sensor)
	• Spark plug malfuntion	• Replace spark plug or adjust clearance
	• Ignition timing faulty (spark plug light is normal)	• Resetting valve timing
Unstable Engine Idling	• Spark plug malfunction	• Replace spark plug or adjust clearance
	• Ignition coil faulty	• Replace ignition coil
	• Ignition timing faulty	• Resetting valve timing
Enging Acceralation Malfunction	• Ignition timing faulty	• Resetting valve timing

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATION PROCESS

1. DESCRIPTION AND OPERATION

1) Battey

The sealed battery is standard on all cars. There are no vent plugs in the cover.
The battery is completely sealed, except for two small vent holes in the sides.
These vent holes allow the small amount of gas produced in the battery to escape.
The battery has the following advantages over conventional batteries:

- No water addition for the life of the battery.
- Overcharge protection. If too much voltage is applied to the battery, it will not accept as much current as a conventional battery.
  In a conventional battery, the excess voltage will still try to charge the battery, leading to gassing, which causes liquid loss.
- Not as liable to self-discharge as a conventional battery. This is particularly important when a battery is left standing for long periods of time.
- More power available in a lighter, smaller case.

The battery has three major functions in the electrical system.
First, the battery provides a source of energy for cranking the engine.
Second, the battery acts as a voltage stabilizer for the electrical system. Finally, the battery can, for a limited time, provide energy when the electrical demand exceeds the output of the generator.

2) Ratings

▶ A battery has two ratings: (1) a reserve capacity rating designated at 27°C(80°F), which is the time a fully charged battery will provide 25 amperes of current flow at or above 10.5 volts (2) a cold cranking amp rating determined under testing at -18°C(0°F), which indicates the cranking load capacity.

(1)Reserve Capacity

The reserve capacity (RC) is the maximum length of time it is possible to travel at night with the minimum electrical load and no generator output. Expressed in minutes, the RC rating is the time required for a fully charged battery, at a temperature of 27°C(80°F) and being discharged at a current of 25 amperes, to reach a terminal voltage of 10.5 volts.

(2) Cold Cranking Amperage

The cold cranking amperage test is expressed at a battery temperature of −18°C(0°F).
The current rating is the minimum amperage, which must be maintained by the battery for 30 seconds at the specified temperature, while meeting a minimum voltage requirement of 7.2 volts.
This rating is a measure of cold cranking capacity.
The battery is not designed to last indefinitely. However, with proper care, the battery will provide many years of service. If the battery tests well, but fails to perform satisfactorily in service for no apparent reason, the following factors may point to the cause of the trouble:

- Vehicle accessories are left on overnight.
- Slow average driving speeds are used for short periods.
- The vehicle's electrical load is more than the generator output, particularly with the addition of aftermarket equipment.
- Defects in the charging system, such as electrical shorts, a slipping generator belt, a faulty generator, or a faulty voltage regulator.
- Battery abuse, including failure to keep the battery cable terminals clean and tight or a loose battery hold-down clamp.
- Mechanical problems in the electrical system, such as shorted or pinched wires.

3) Charging Time Required

The time required to charge a battery will vary depending upon the following factors:

▶ Size of Battery - A Completely discharged large heavy-duty battery required more than twice the recharging time as a completely discharged small passenger car battery.

▶ Temperature − A longer time will be needed to charge any battery at −18°C(0°F) than at 27°C(80°F).
When a fast charger is connected to a cold battery, the current accepted by the battery will be very low at first.
The battery will accept a higher current rate as the battery warms.

▶ Charger Capacity - A charger which can supply only 5 amperes will require a much longer charging period than a charger that can supply 30 amperes or more.

▶ State-of-Charge - A completely discharged battery requires more than twice as much charge as a onehalf charged battery.
Because the electrolyte is nearly pure water and a poor conductor in a completely discharged battery, the current accepted by the battery is very low at first. Later, as the charging current causes the electrolyte acid content to increase, the charging current will likewise increase.

Modification basis	
Application basis	
Affected VIN	

4) Charging a Completely Discharged Battery (Off the Vehicle)

Unless this procedure is properly followed, a perfectly good battery may be needlessly replaced.
The following procedure should be used to recharge a completely discharged battery:

1. Measure the voltage at the battery terminals with an accurate voltmeter.
   If the reading is below 10 volts, the charge current will be very low, and it could take some time before the battery accepts the current in excess of a few milliamperes.
   Refer to "Charging Time Required" in this section, which focuses on the factors affecting both the charging time required. Such low current may not be detectable on ammeters available in the field.
   Set the battery charger on the high setting.
2.

CAUTION

Some chargers feature polarity protection circuitry, which prevents charger unless the charger leads are correctly connected to the battery terminals.
A completely discharged battery may not have enough voltage to activate this circuitry, even though the leads are connected properly, making it appear that the battery will not accept charging current.
Therefore, follow the specific charger manufacturer's instruction for by passing or overriding the circuitry so that the charger will turn on and charge a low-voltage battery.

3. Continue to charge the battery until the charge current is measurable. Battery chargers vary in the amount of voltage and current provided. The time required for the battery to accept a measurable charger current at various voltages may be as follows:

Voltage	Hours
16.0 or more	Up to 4 hours
14.0 - 15.9	Up to 8 hours
13.9 or less	Up to 16 hours

- If the charge current is not measurable at the end of the above charging times, the battery should be replaced.
- If the charge current is measurable during the charging time, the battery is good, and charging should be completed in the normal manner.

CAUTION

It is important to remember that a completely discharged battery must be recharged for a sufficient number of ampere hours (AH) to restore the battery to a usable state.

- If the charge current is still not measurable after using the charging time calculated by the above method, the battery should be replaced.

5) Jump Starting Procedure

1. Position the vehicle with the charged battery so that the jumper cables will reach from the charged battery to the battery that requires charging.
2. Turn off the ignition, all the lights, and all the electrical loads in both vehicles.
3. Leave the hazard flasher on if jump starting where there may be other traffic and any other lights needed for the work area.
4. Apply the parking brake firmly in both vehicles.

CAUTION
In order to avoid damaging the vehicle make sure the cables are not on or near pulleys, fans, or other parts that will move when the engine starts.

5. Shift an automatic transmission to PARK.

CAUTION
In order to avoid injury, do not use cables that have loose or missing insulation.

6. Clamp one end of the first jumper cable to the positive terminal on the booster battery. Make sure it does not touch any other metal parts.
7. Clamp the other end of the same cable to the positive terminal on the discharged battery. Never connect the other end to the negative terminal of the discharged battery.

CAUTION
Do not attach the cable directly to the neg-ative terminal of the discharged battery.
Doing so could cause sparks and possible battery explosion.

8. Clamp one end of the second cable to the negative terminal of the booster battery.
9. Make the final connection to a solid engine ground, such as the engine lift bracket at least 450 millimeters (18 inches) from the discharged battery.
10. Start the engine of the vehicle with the good battery.
    Run the engine at a moderate speed for several minutes.
11. Then start the engine of the vehicle with the discharged battery.
12. Remove the jumper cables by reversing the above sequence exactly, removing the negative cable from the vehicle with the discharged battery first.
    While removing each clamp, take care that it does not touch any other metal while the other end remains attached.

Modification basis	
Application basis	
Affected VIN	

6) Alternator

Alternators are equipped with internal regulators.
Unlike three-wire generators, the alternator may be used with only two connections: battery positive and an "D+" terminal to the charge indicator lamp.
As with other charging systems, the charge indicator lamp lights when the ignition switch is turned to RUN, and goes out when the engine is running.
If the charge idicator is on with the engine running, a charging system defect is indicated. This indicator light will glow at full brilliance for several kinds of defects as well as when the system voltage is too high or too low.
The regulator voltage setting varies with temperature and limits the system voltage by controlling rotor field current.
Achieve correct average field current for proper system voltage control by varying the on-off time. At high speeds, the on-time may be 10 percent and the off-time 90 percent.
At low speeds, with high electrical loads, the on-time may be 90 percent and the off-time 10 percent.

7) Charging System

Generators use a new type of regulator that incorporates a diode trio.
A Delta stator, a rectifier bridge, and a rotor with slip rings and brushes are electrically similar to earlier generators.
A conventional pulley and fan are used.
There is no test hole.

8) Starter

Wound field starter motors have pole pieces, arranged around the armature, which are energized by wound field coils.
Enclosed shift lever cranking motors have the shift lever mechanism and the solenoid plunger enclosed in the drive housing, protecting them from exposure to dirt, icy conditions, and splashes.
In the basic circuit, solenoid windings are energized when the switch is closed.
The resulting plunger and shift lever movement causes the pinion to engage the engine flywheel ring gear.
The solenoid main contacts close. Cranking then takes place.
When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened, at which time the return spring causes the pinion to disengage.
To prevent excessive overrun, the switch should be released immediately after the engine starts.

9) Starting System

The engine electrical system includes the battery, the ignition, the starter, the generator, and all the related wiring.

Diagnostic tables will aid in troubleshooting system faults. When a fault is traced to a particular component, refer to that component section of the service manual.

The starting system circuit consists of the battery, the starter motor, the ignition switch, and all the related electrical wiring.

All of these components are connected electrically.

Modification basis	
Application basis	
Affected VIN	

CRUISE CONTROL SYSTEM 8510-23

OVERVIEW AND OPERATION PROCESS

1. CRUISE CONTROL SWITCH



The cruise control is an automatic speed control system that maintains a desired driving speed without using the accelerator pedal.
The vehicle speed must be greater than 36 km/h to engage the cruise control. This feature is especially useful for motorway driving.

CAUTION

The cruise control system is a supplementary system, which helps the driver to drive the vehicle at a desired speed without using the accelerator pedal under the traffic condition where the vehicle-to-vehicle distance meets the legal requirement.

1) Traffic Conditions for Using Cruise Control

Use the cruise control system only when the traffic is not jammed, driving on motorways or highways where there is no sudden change in the driving condition due to traffic lights, pedestrian, etc.

WARNING

Improper use of the cruise control could be dangerous.
- Do not use on winding roads.yy
- Do not use in heavy traffic.yy
- Do not use on slippery, wet roads.

This could result in a loss of control, collision, and/or personal injuries.

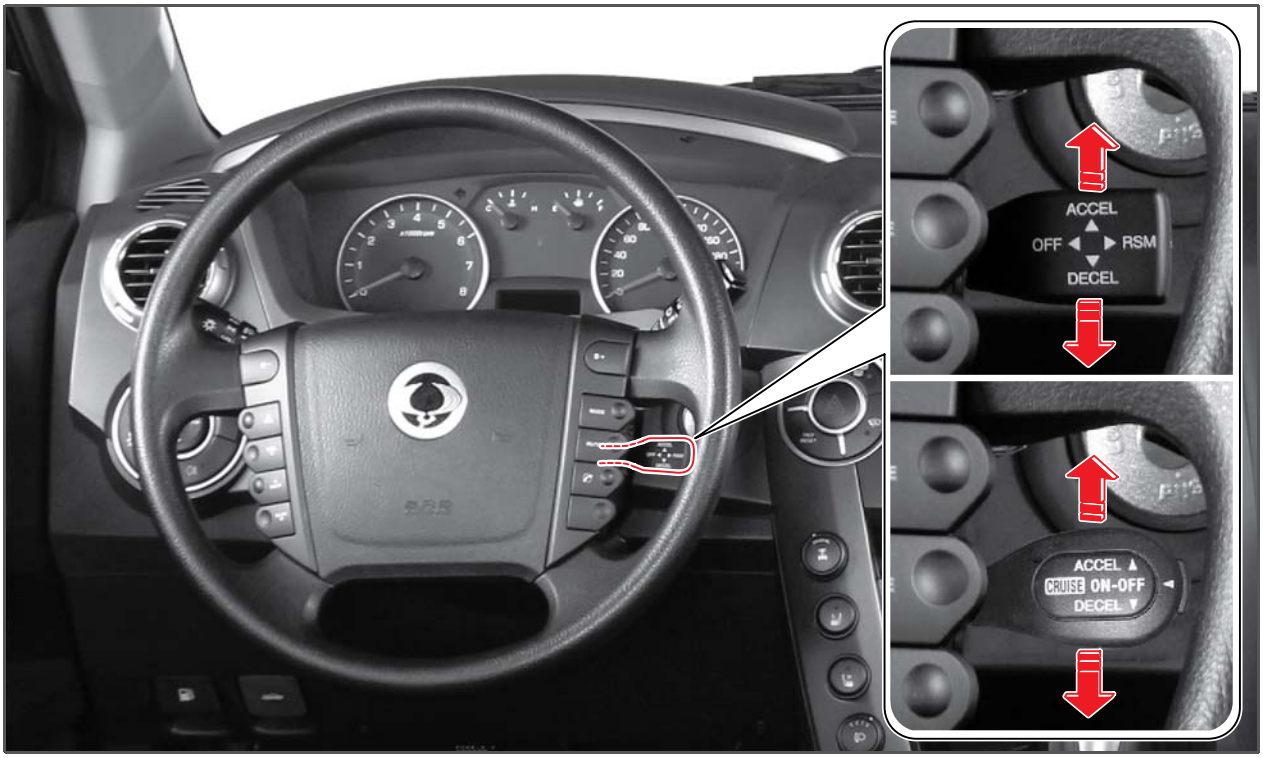
NOTE

The described speed value may vary slightly depending on the road conditions.

Modification basis	
Application basis	
Affected VIN	

2. HOW TO OPERATE CRUISE CONTROL SWITCH

1) Setting a Desired Speed



1. To operate the cruise control, accelerate to the desired speed, which must be more than 36 km/h (23 MPH) and less than 150 km/h (90 MPH).
2. When the desired speed is reached, push up the ACCEL switch of the cruise control lever or push down the DECEL switch for 1 second per one switching and then release the accelerator pedal slowly.
3. Now, the vehicle is cruised by this system with the set speed.
4. And you can set to other vehicle speeds again with above steps after an accelerator pedal intervention during the cruise control running.

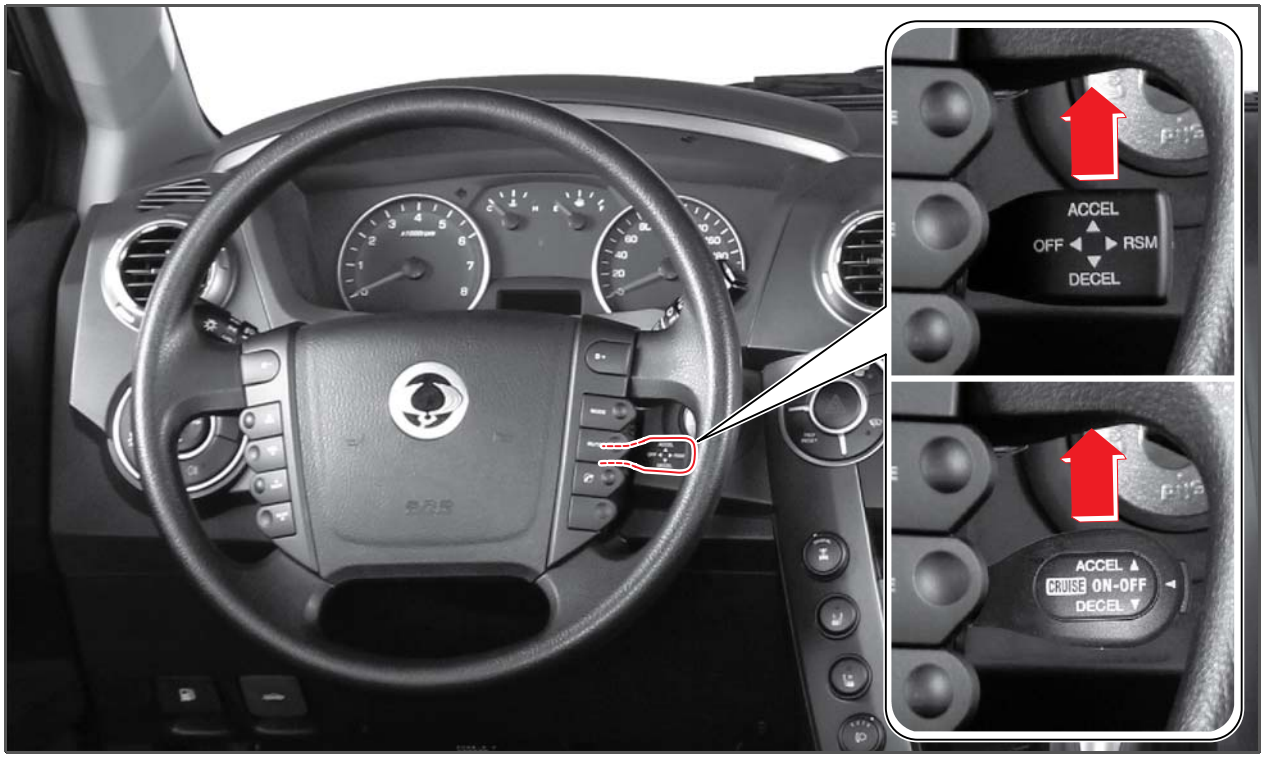
CAUTION

Never use the cruise control system until you get used to it.
Improper use or not fully aware of this function could result in collision and/or personal injuries.

(1) Manual transmission equipped vehicle

The cruise control is only available when the 3rd or higher speed gear is engaged.

2) Accelerating with the Cruise Control System



(1) While the cruise control system is running

1. Push up the ACCEL switch of the cruise control lever and hold it until the desired speed is reached without an accelerator pedal intervention.
2. When the desired speed is reached, release the lever.

(2) While the cruise control system is not running

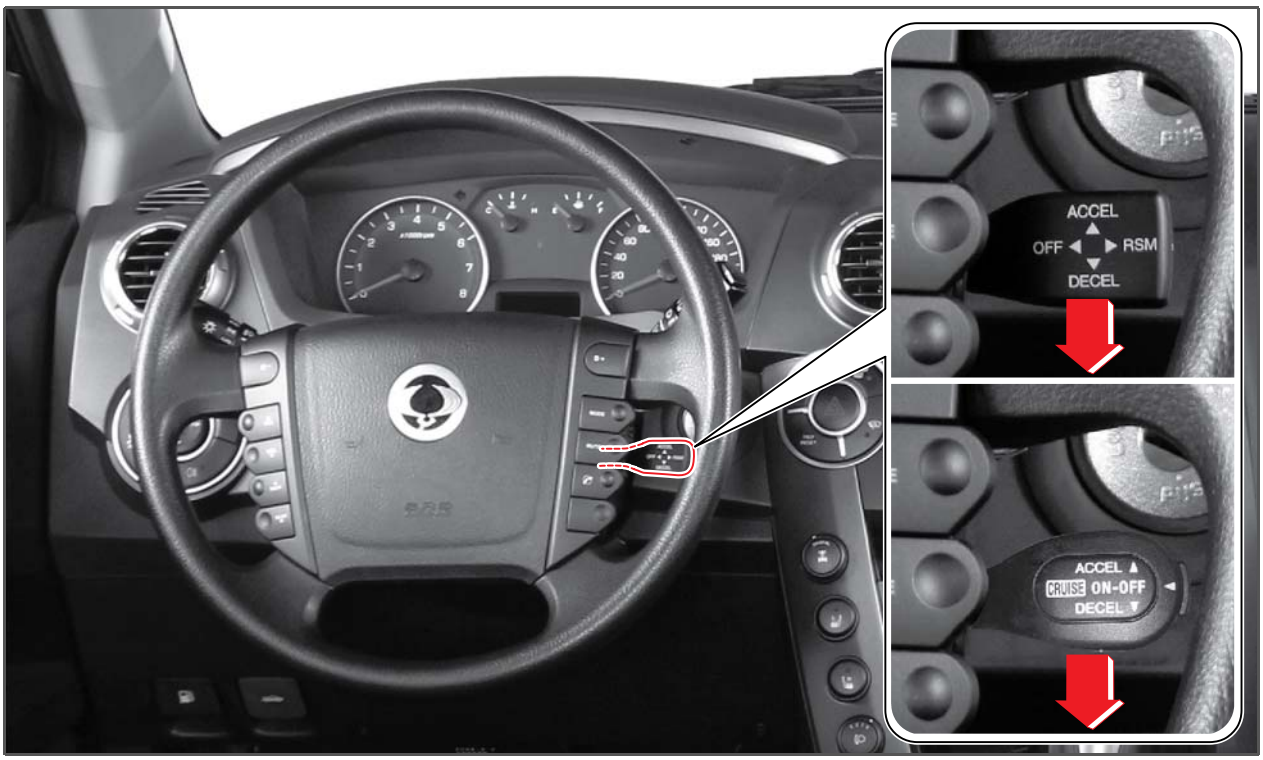
1. Accelerate using the accelerator pedal over 36 km/h.
2. Push up the ACCEL switch of the cruise control lever and hold it.
3. And then release the accelerator pedal slowly.
4. When the desired speed is reached, release the lever.

(3) Tap-up while the cruise control system is running

1. Push up the ACCEL switch of the cruise control lever less than 0.5 second per one switching while the cruise control system is running. This is a tap-up switching.
2. When you operate a tap-up switching, the vehicle is accelerated by 1.3 km/h over the previous set speed.
3. If you want to accelerate to 13 km/h, operate the tap-up switching ten times without accelerating with the cruise control system.

Modification basis	
Application basis	
Affected VIN	

3) Decelerating with the Cruise Control System



(1) While the cruise control system is running

1. Push down the DECEL switch of the cruise control lever and hold it until the desired speed is reached without a brake pedal intervention. But the cruise control system cannot maintain the cruise function at less than 34 km/h.
2. When the desired speed is reached, release the lever.

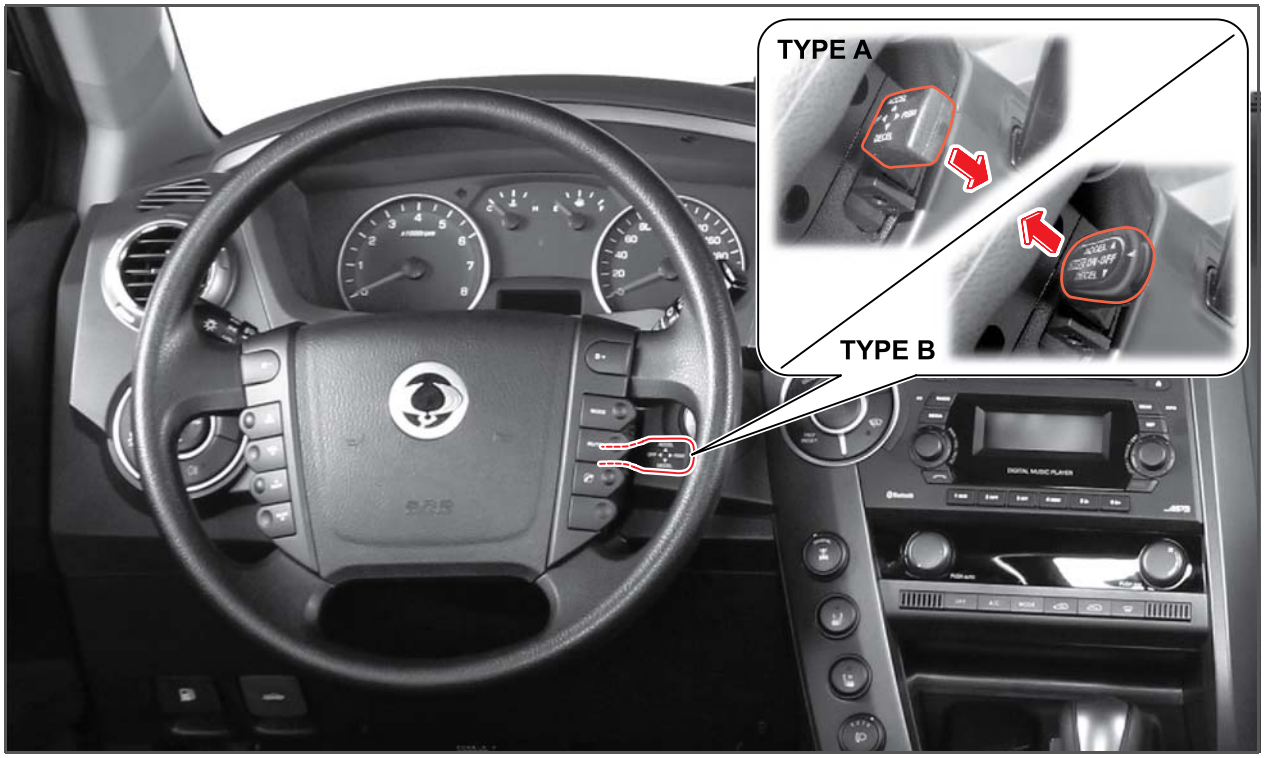
(2) When the cruise control system is not running

1. Push down the DECEL switch of the cruise control lever and hold it.
2. And then release the accelerator pedal slowly.
3. When the desired speed is reached, release the lever. But the cruise control system cannot maintain the cruise function at less than 34 km/h.

(3) Tap-down while the cruise control system is running

1. Push down the DECEL switch of the cruise control lever less than 0.5 second per one switching while the cruise control system is running. This is a tap-down switching.
2. When you operate a tap-down switching, the vehicle is decelerated by 1.0 km/h below the previous set speed.
3. If you want to decelerate to 10 km/h, operate the tap-down switching ten times without the brake pedal intervention.

4) Recovery of Set Speed (RESUME)



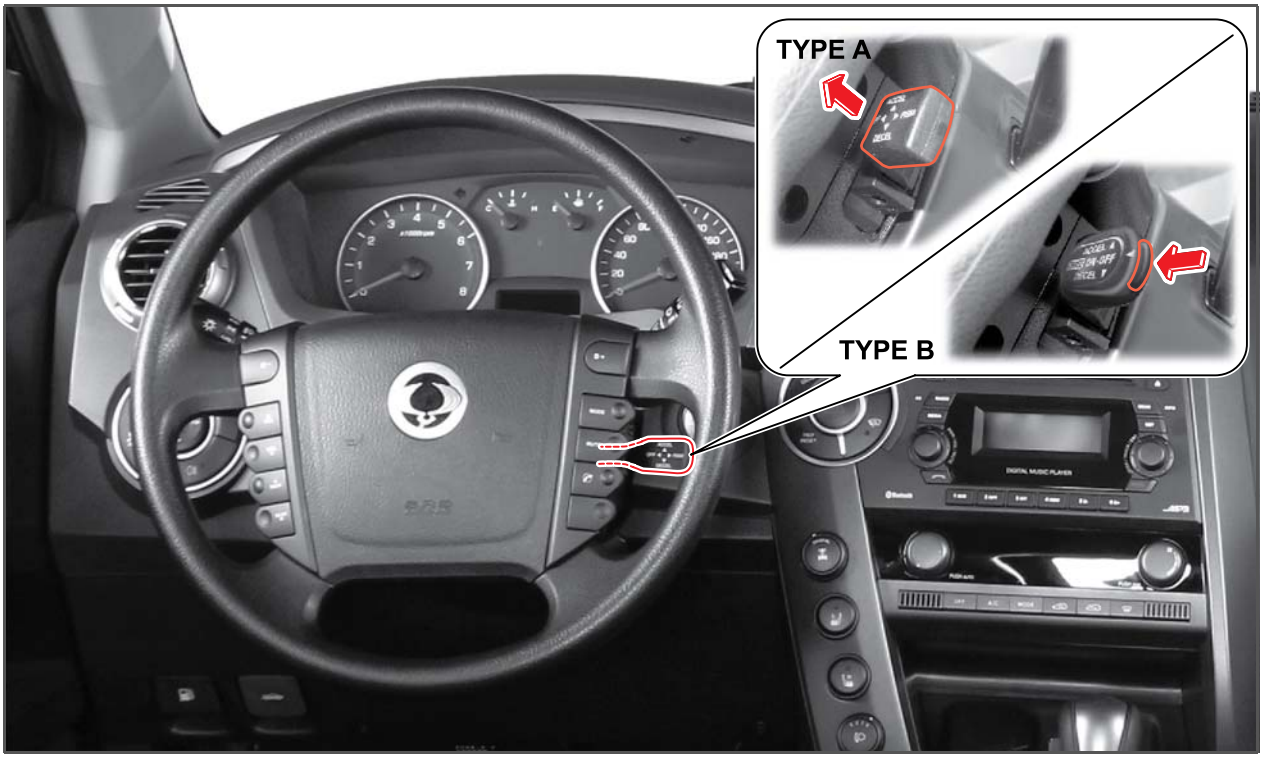
Even if the cruise control is cancelled, the previous set cruise speed can be recovered by pushing (Type A) or pulling (Type B) toward the cruise control lever when the current vehicle speed is over 36 km/h without an acceleration intervention. But if you turn off the ignition switch, the memorized set speed is cleared and you cannot recover the previous set speed.

CAUTION

The resume position should only be used if the driver is fully aware of this speed and wishes to resume this particular speed.

Modification basis	
Application basis	
Affected VIN	

5) Normal Cancellation of the Cruise Control



The cruise control system will be canceled when one or more items of the following conditions are applied;

1. When the brake pedal is depressed.
2. When the cruising speed is downed less than 38 km/h.
3. When the OFF switch is operated by pulling the cruise control lever (Type A) or by pushing the ON-OFF switch of the cruise control lever (Type B).
4. When ESP is activated.
5. When applying the parking brake when driving.
6. When using the clutch in order to shift (M/T only).
   And the cruise control system can be operated again in driving state.

CAUTION

Keep the main cruise control switch in the neutral position when not using the cruise control.

(1) Abnormal Cancellation of the Cruise Control

1. When the rapid deceleration is applied without braking.
2. When the rapid acceleration is applied without acceleration pedal intervention.
3. When the cruise control lever is failed.
4. When the brake switch and the brake light switch input signal are implausible.

And the cruise control system cannot be operated again in driving state. In this case, you should stop the vehicle, and turn off the ignition switch and then turn it on again. After you do that, you can use the cruise control system again. But if the cruise control system isn't recovered, you should contact a Ssangyong Dealer for diagnosis of the cruise control system.

CAUTION

- Abnormal changes of the gear selector lever can damage the yyengine. Do not move the gear shift lever to Neutral while driving at the set speed. Automatic transmission damage may result.
  The speed that has been set may not be maintained on uphill yyor downhill slopes.
- The speed may drop to less than the set speed on a steep uphill yygrade. The accelerator must be
- used if you want to maintain that speed.
  The speed may increase to more than the set speed on a steep yydownhill grade. When the speed
- increases too much, turn off the cruise control.

(2) Using the Cruise Control on Hills

How well the cruise control works on hills depends on the speed, load, and the steepness of the hill. When going up steep hills, you may have to depress the accelerator pedal to maintain your speed. When going downhill, you may have to brake or shift to a lower gear to keep your speed down.
Applying the brake takes you out of the cruise control.

Modification basis	
Application basis	
Affected VIN	

ENGINE CONTROL SYSTEM 1521-01

GENERAL

1. ENGINE DATA DISPLAY TABLE

Parameter	Unit	Value
Engine coolant temp.	℃	greater than 95℃ after warm up
Intake air temp.	℃	-40 ~ 130℃ (varies with ambient temp. or engine mode)
Engine rpm	rpm	700 ± 50 (P/N), 600 ± 50 (D)
Regular rpm	rpm	700 ± 50 (P/N), 600 ± 50 (D)
Engine load	%	18 ~ 25 %
Mass air flow meter	Kg/h	16 ~ 25 Kg/h
Throttle position angle	°TA	0°TA (up to 100°TA at the wide open throttle)
Spark advance	°CA	°CA (6 ~ 9°CA)
Indicated engine torque	Nm	Varies with engine condition
Injection time	ms	3 ~ 5 ms
Battery voltage	V	13.5 ~ 14.1V (engine running)
Front axle speed	Km/h	0 ~ 265 Km/h
Rear axle speed	Km/h	0 ~ 265 Km/h
Accel. Pedal position 1	V	0.4 ~ 4.8 V
Accel. Pedal position 2	V	0.2 ~ 2.4 V
Throttle position 1	V	0.3 ~ 4.6 V
Throttle position 2	V	0.3 ~ 4.6 V
Fuel integrator		0.8 ~ 1.2
Oxygen sensor	mv	100 ~ 900 mv
A/c s/w condition	1=ON/0=OFF	-
Full load state	1=ON/0=OFF	-
Shift gear state (A/T)	1=ON/0=OFF	-
A/c control state	1=ON/0=OFF	-
Clutch switch (M/T)	1=ON/0=OFF	-
Cam actuator state	1=ON/0=OFF	-
Knocking control	1=ON/0=OFF	-
Protect mission	1=ON/0=OFF	-
Purge control valve	1=ON/0=OFF	-
Lambda function	1=ON/0=OFF	-
Catalyst heating	1=ON/0=OFF	-
Overrun fuel cut	1=ON/0=OFF	-
Full fuel cut	1=ON/0=OFF	-
Brake switch	1=ON/0=OFF	-
Cruise control status	1=ON/0=OFF	-

* Condition: Warmed up, idle, P/N or neutral

1) TEMPERATURE VS RESISTANCE

℃	°F	ECT Sensor	IAT Sensor
		ohms (Ω)	
Temperature vs Resistance Values (Approximate)			
130	266	88	102
120	248	111.6	127
110	230	143	159
100	212	202	202
90	194	261	261
80	176	340	340
70	158	452	452
60	140	609	609
50	122	835	835
40	113	1166	1166
30	86	1662	1662
20	68	2420	2420
10	50	3604	3604
0	32	5499	5499
-10	14	8609	8609
-20	-4	13850	13850
-30	-22	22960	22960
-40	-40	39260	39260

2. FASTENER TIGHTENING SPECIFICATIONS

Application	Nm	Lb-Ft	Lb-In
Camshaft position sensor retaining bolts	10	-	89
Canister mounting bolts	6	-	53
Coolant temperature sensor	30	22	-
Crankshaft position sensor retaining bolt	10	-	89
Engine Control Module (ECM) mounting bracket nuts	10	-	89
Fuel filter mounting bracket bolt	6	-	53
Fuel filter lines	28	21	-
Fuel pressure test connector	25	18	-
Fuel rail assembly bolts	25	18	-
Fuel return and supply lines	23	17	-
Fuel tank retaining nuts	38	28	-
Intake air duct mounting bolts	9	-	80
Knock sensor mounting bolt	25	18	-
Oxygen sensor	55	41	-
Pedal position censor mounting bolts and nut	6	-	53
Throttle body bolts	12	-	106

Modification basis	
Application basis	
Affected VIN	

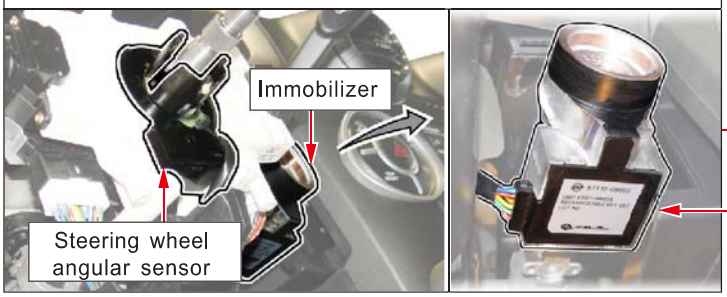
ELECTRIC GENERAL

0000-00

GENERAL

1. LOCATIONS OF INTERIOR UNITS AND SENSORS

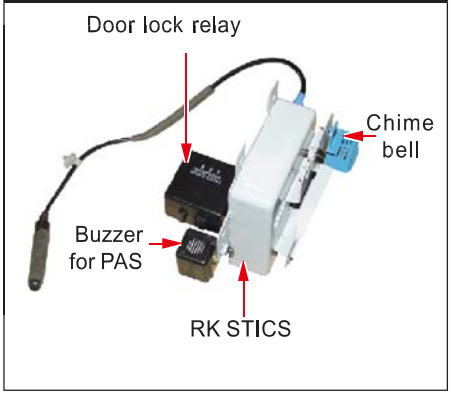
Steering Wheel Angular Sensor / Immobilizer

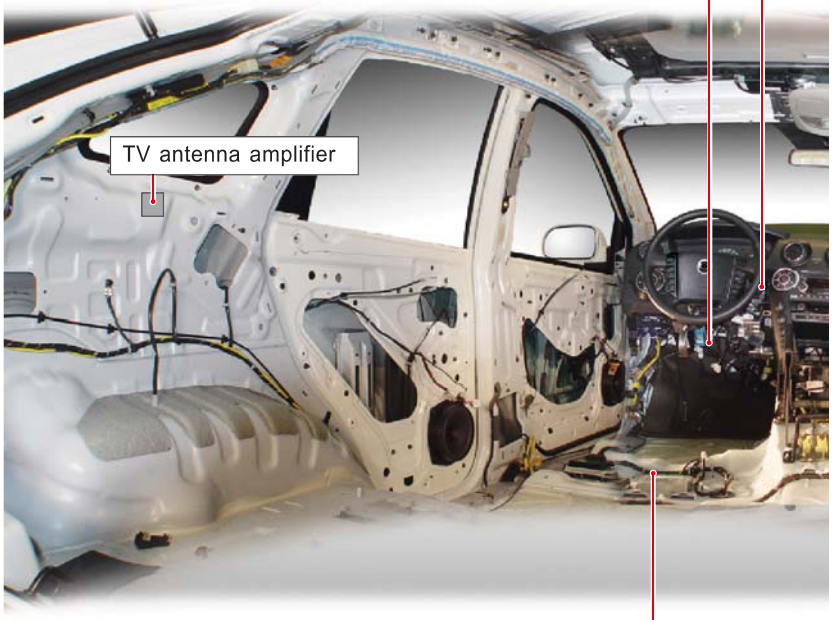


Under Instrument Panel



Door lock relay

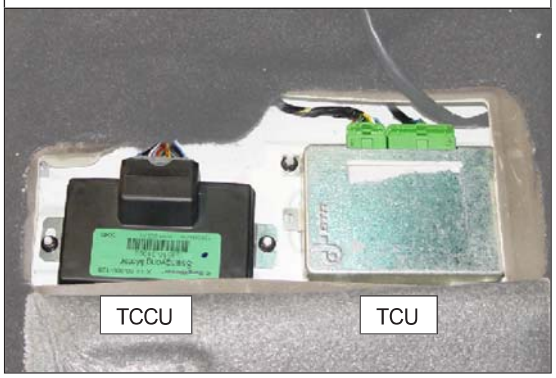




Interior Temperature



TCCU and TCU

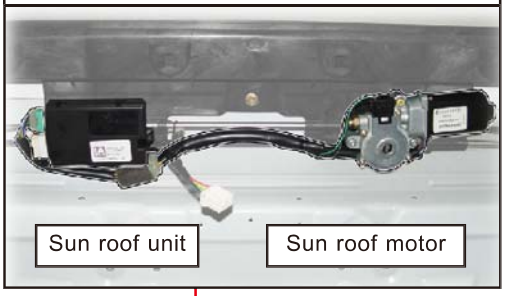


Modification basis	
Application basis	
Affected VIN	

Rain Sensing Unit (Including Auto Lignt) and ECM

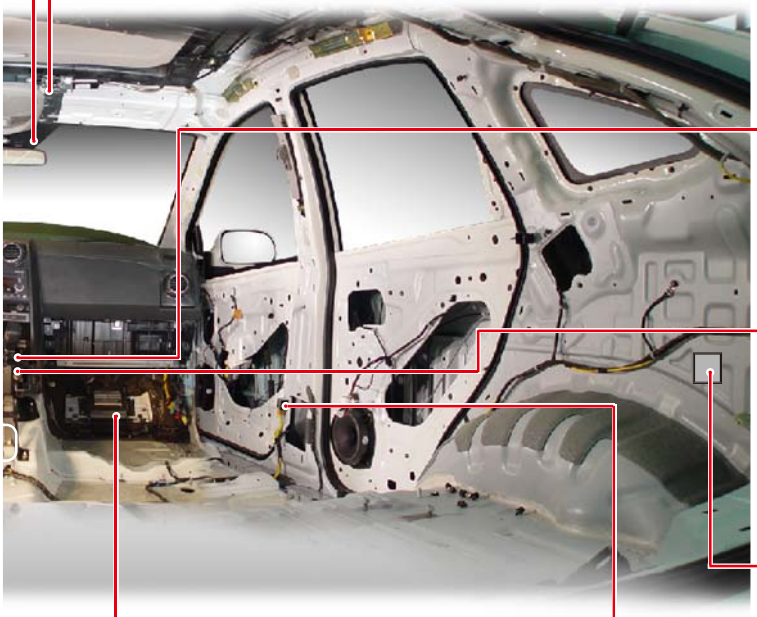


Sun Roof Unit and Moto r



Sensor Cluste r

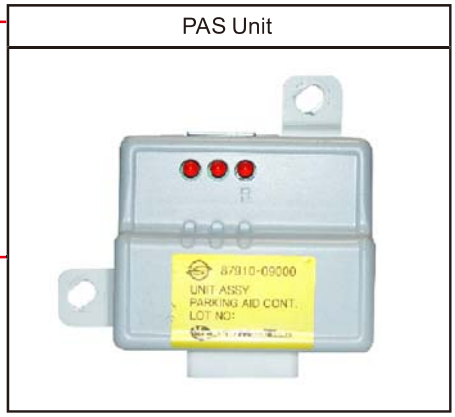




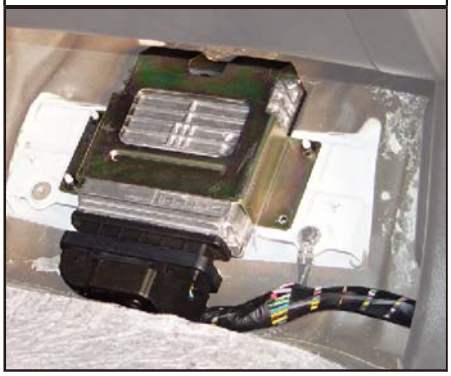
Air Bag ECU



PAS Unit



Engine ECU



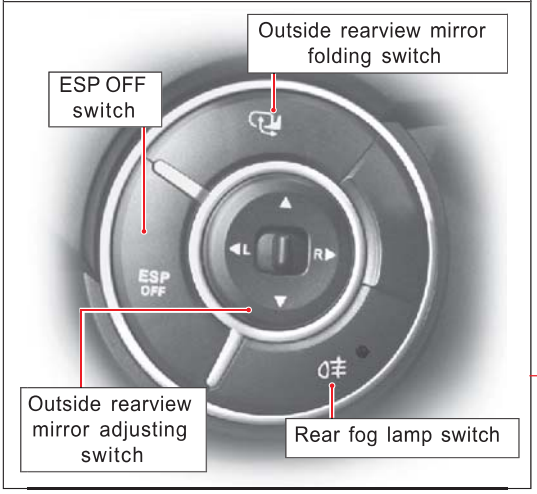
Curtain Air Bag Sensor

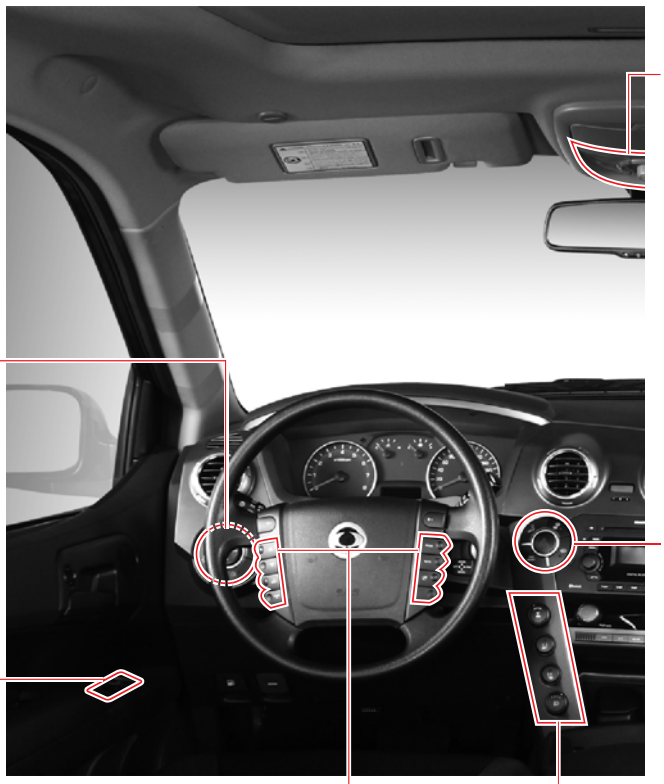


Modification basis	
Application basis	
Affected VIN	

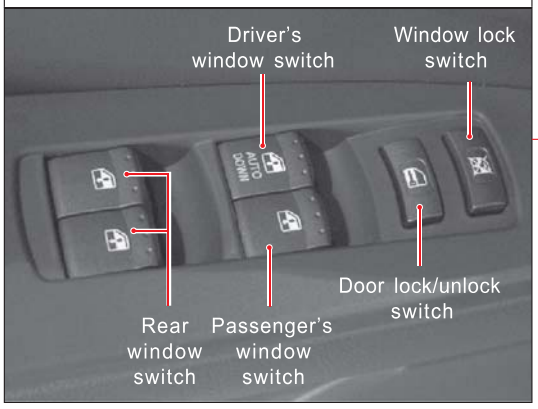
2. LOCATION AND COMPARTMENT OF INTERIOR SWITCHES

Bezel Assembly on Outside Rearview Mirror Adjusting Switch





Driver's Power Window Main Switch



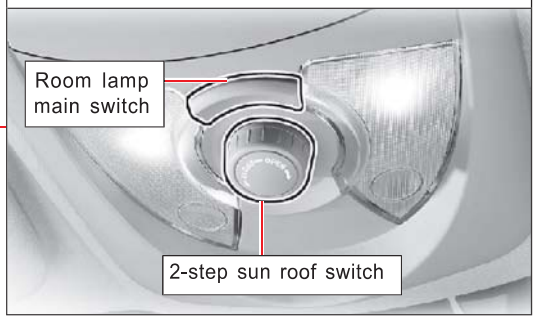
Remote Control Switch on the Steering Wheel



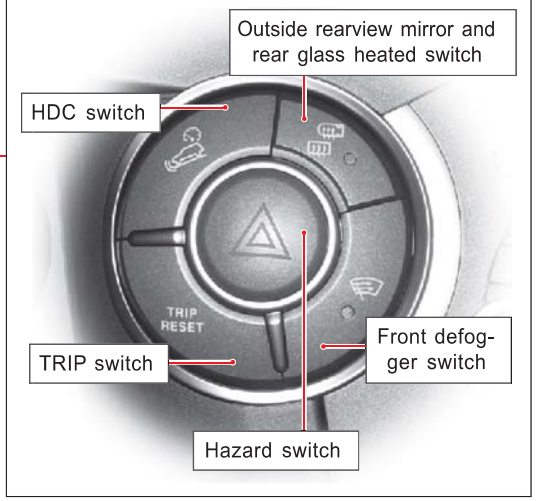
Modification basis	
Application basis	
Affected VIN	



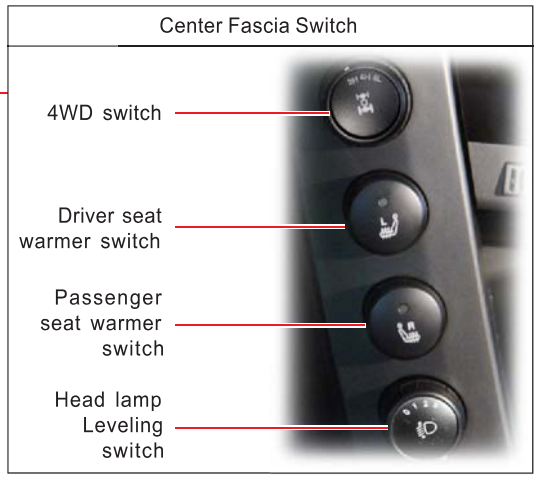
Sun Roof Switch



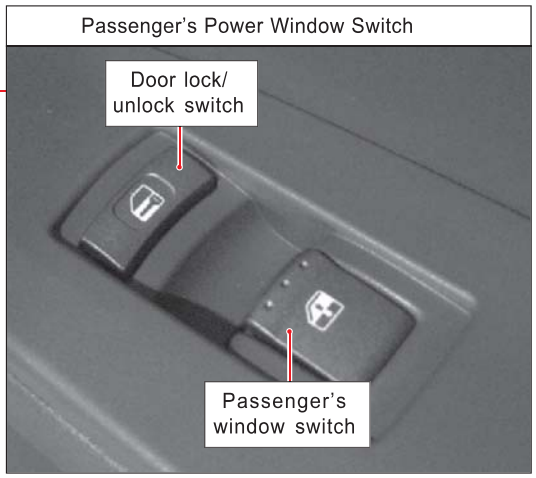
Bezel Assembly on Hazard Switch



Center Fascia Switch



Passenger's Power Window Switch



3. SWITCHES, UNITS AND SENSORS IN ENGINE COMPARTMENT

Receiver drier and horn





Ambient temperature sensor

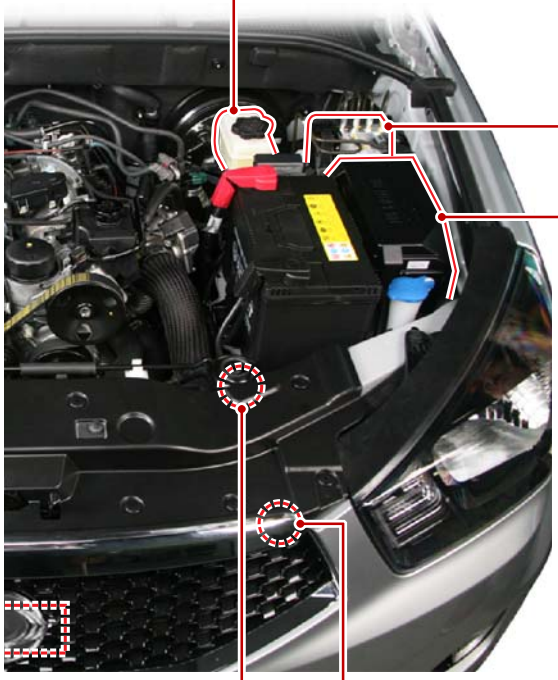


IWE vacuum solenoid valve (4WD)

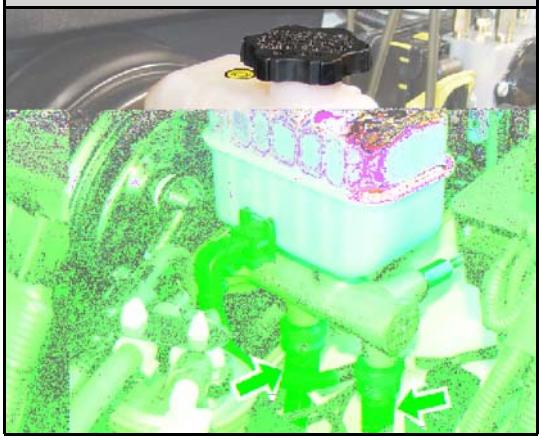


(on battery tray)

Modification basis	
Application basis	
Affected VIN	



ESP pressure sensor / primary, secondary



ESP(ABS) HECU



Theft deterrent horn (under the battery)



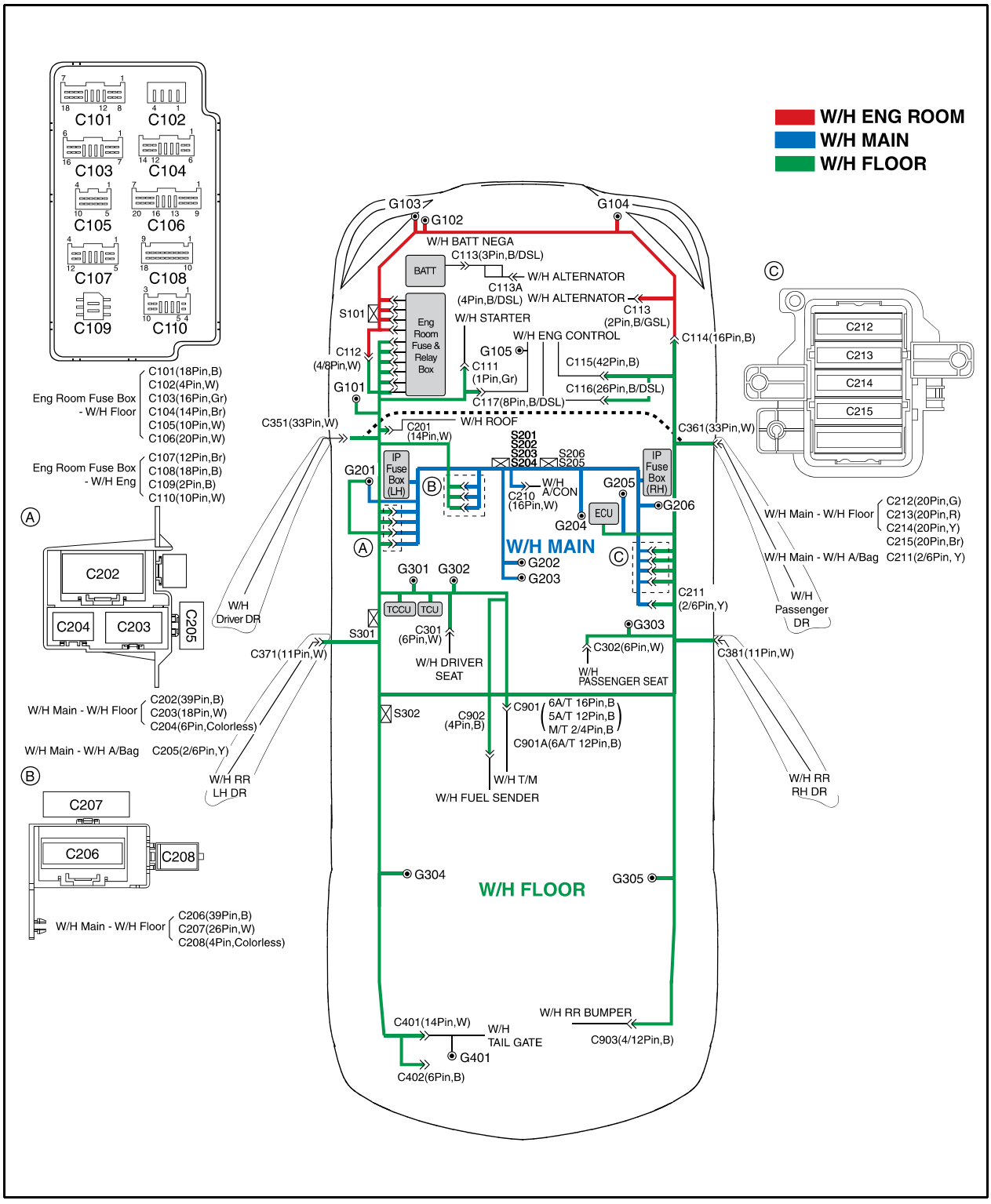
Fuse and relay box



Modification basis	
Application basis	
Affected VIN	

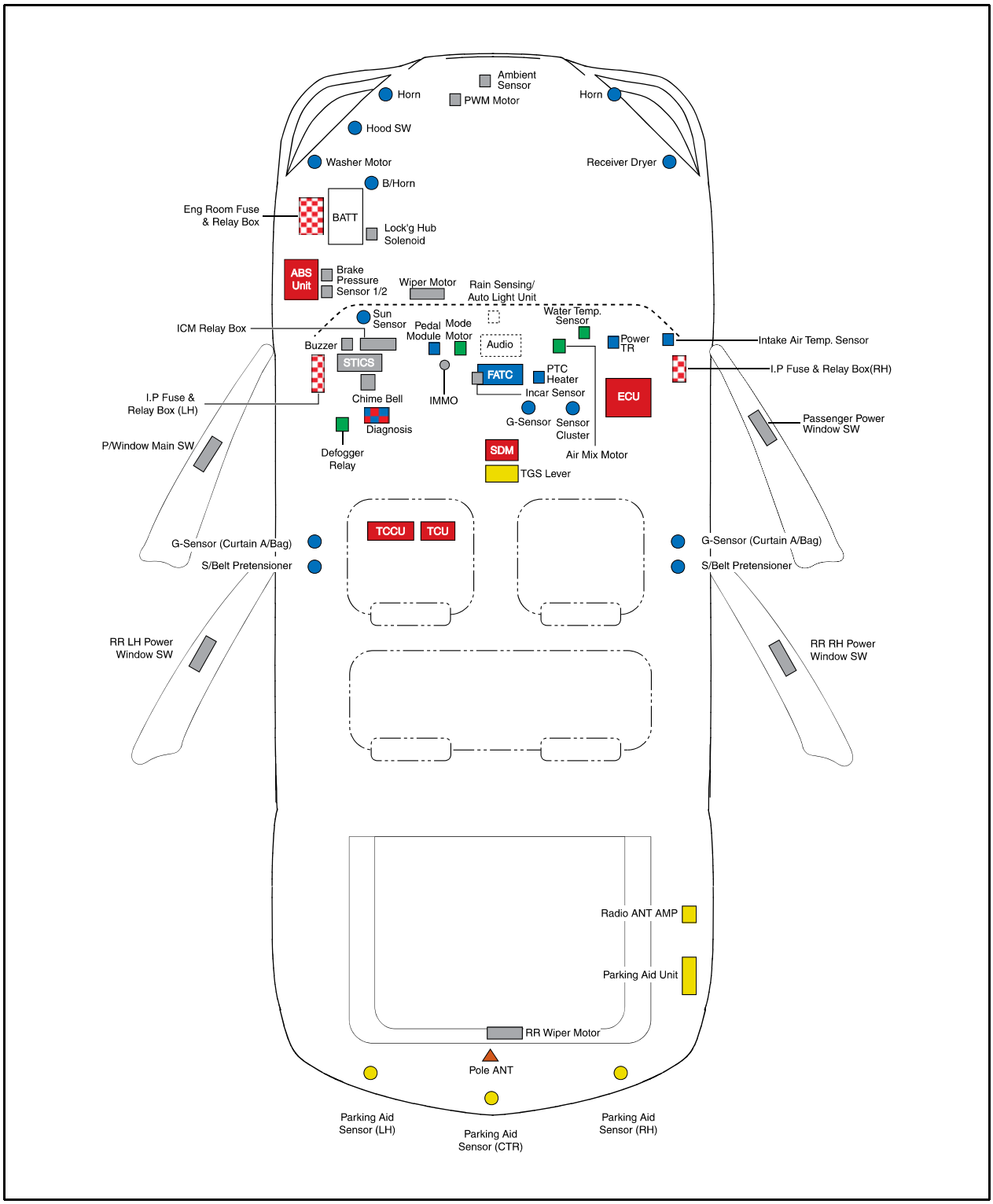
4. ELECTRIC COMPONENTS AND LAYOUT

1) Wiring Harness Arrangement



Modification basis	
Application basis	
Affected VIN	

2) Components Locator



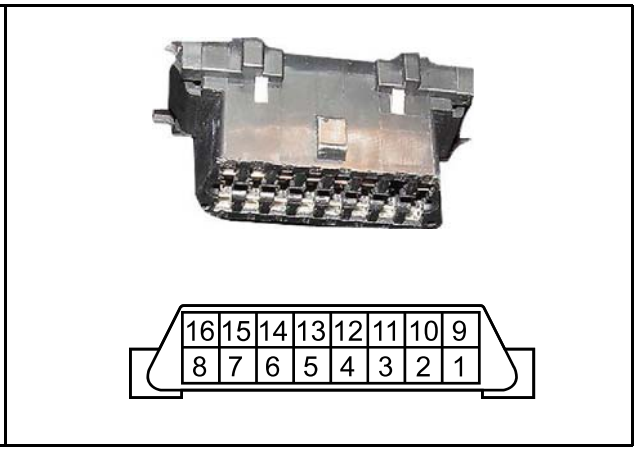
Modification basis	
Application basis	
Affected VIN	

5. DIAGNOSTIC CONNECTOR

1) Pin Arrangement of Diagnostic Connector

It is installed under the instrument panel and consists of 16 pins.
The REKES key coding should be performed with Scan-100.





2) Functions of Terminal

Pin no. 1	-
Pin no. 2	-
Pin no. 3	STICS
Pin no. 4	Ground
Pin no. 5	Signal ground
Pin no. 6	CAN - HIGH
Pin no. 7	Engine ECU
Pin no. 8	ABS / ESP
Pin no. 9	Air bag
Pin no. 10	-
Pin no. 11	TCU
Pin no. 12	-
Pin no. 13	TCCU
Pin no. 14	CAN - LOW
Pin no. 15	STICS "B21"
Pin no. 16	Battery +

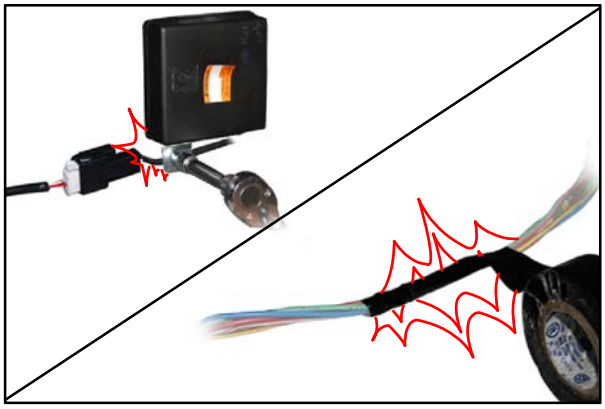
Modification basis	
Application basis	
Affected VIN	

FUSE AND RELAY

8410-00

GENERAL INFORMATION

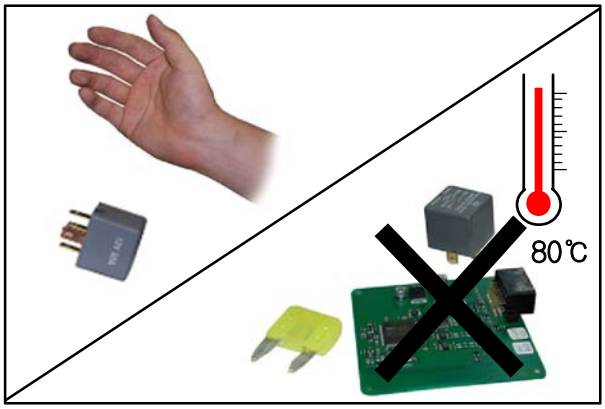
1. CAUTIONS WHEN WORKING ON ELECTRICAL UNITS



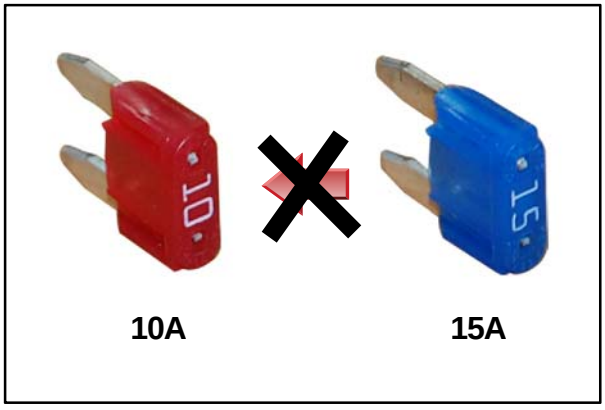
- Disconnect the negative cable from the battery in advance when working on electrical units.

CAUTION

Make sure to turn "OFF" the ignition switch and other lamp switches before disconnecting or connecting the negative battery cable. (Otherwise, semiconductor parts can be damaged.)

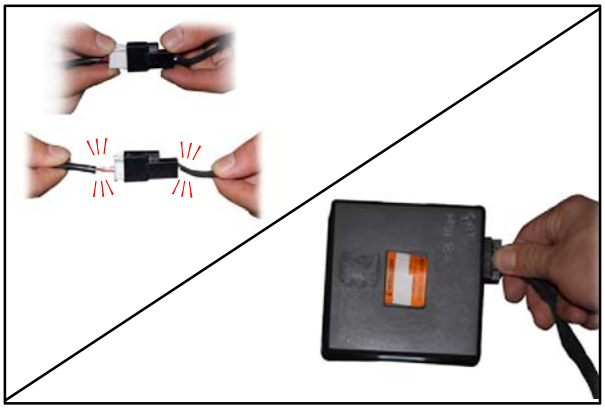


- Do not drop or appy excessive impact to sensors and relays.

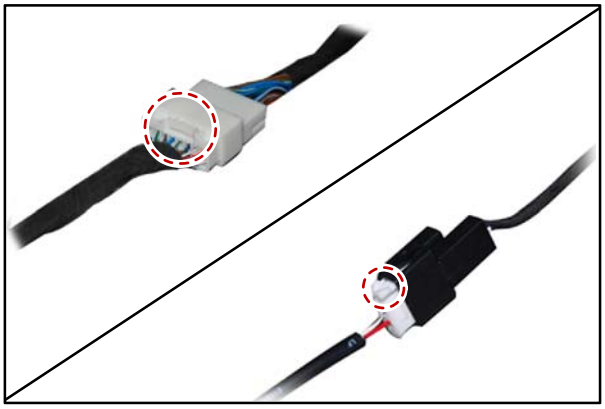


- If a fuse is blown, replace it with a fuse which has the correct amperage rating. If you use a fuse with higher capacity than the specification, the component can be damaged or catch fire.

Modification basis	
Application basis	
Affected VIN	



- Make sure a connector is connected securely. Loose connection results in malfunction.



- When disconnecting a connector equipped with a lock, press it down to the direction in the below figure.



- When checking voltage or continuity of the connector terminal with a circuit tester, connect the tester probe to the terminal at the harness side. For a sealed type connector, connect the probe to the terminal through the hole in the rubber cap of the wiring. Take care not to damage the insulation of the wires. Insert the probe until it contacts the terminal completely.

CAUTION

When inspecting the airbag system, make sure to use a diagnostic device, not a circuit tester.

Modification basis	
Application basis	
Affected VIN	

2. GENERAL INFORMATION

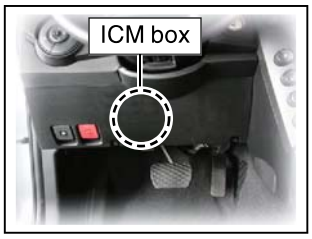
The ICM (Integrated Control Module) box installed to the new Actyon model is integrated with some relays of previous model and is installed to the back of the STICKS.
As the ICM box is newly installed, the following relays are integrated into the ICM box.

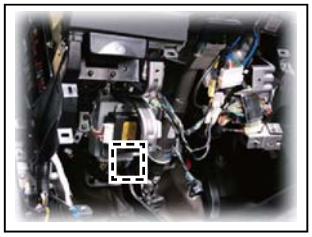
- **Door lock relay (previously installed to STICKS bracket)**
- **Windshield de-icer relay (previously installed next to floor on the driver side)**
- **Turn signal lamp relay (previously installed to passenger side fuse & relay box)**

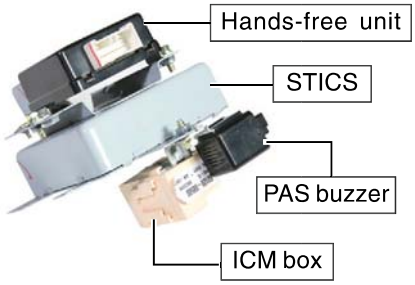
PREVIOUS MODEL

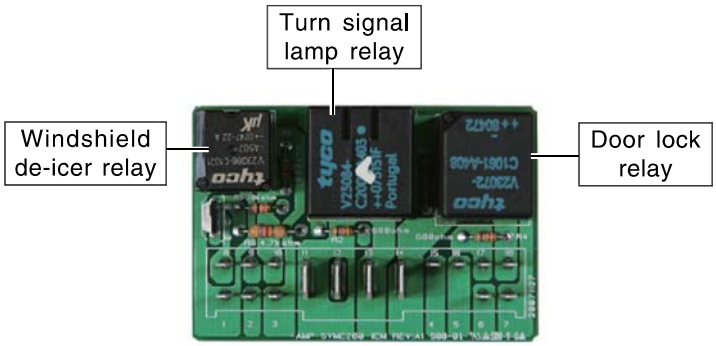


NEW MODEL









Inner view of ICM PCB

* Some relays have been integrated into the ICM box.

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

The ICM (Integrated Control Module) mounted to the back of the STICS is integrated with the door lock relay, windshield de-icer relay and turn signal lamp relay. There are four fuse & relay units.

2. FUSE & RELAY MOUNTING LOCATION

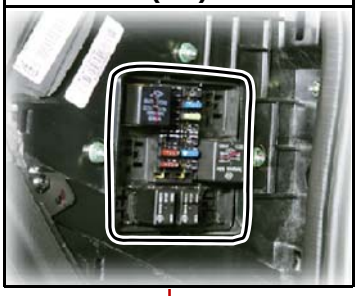
(1) In engine compartment



Fuse & Relay Box InEngine Compartment



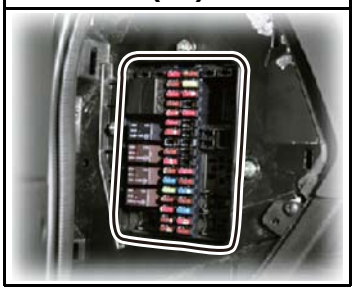
Interior Fuse & Relay Box On The Driver Side (RH)



(2) In vehicle



Interior Fuse & Relay Box On The Driver Side (LH)



Mounting Location of ICM



Modification basis	
Application basis	
Affected VIN	

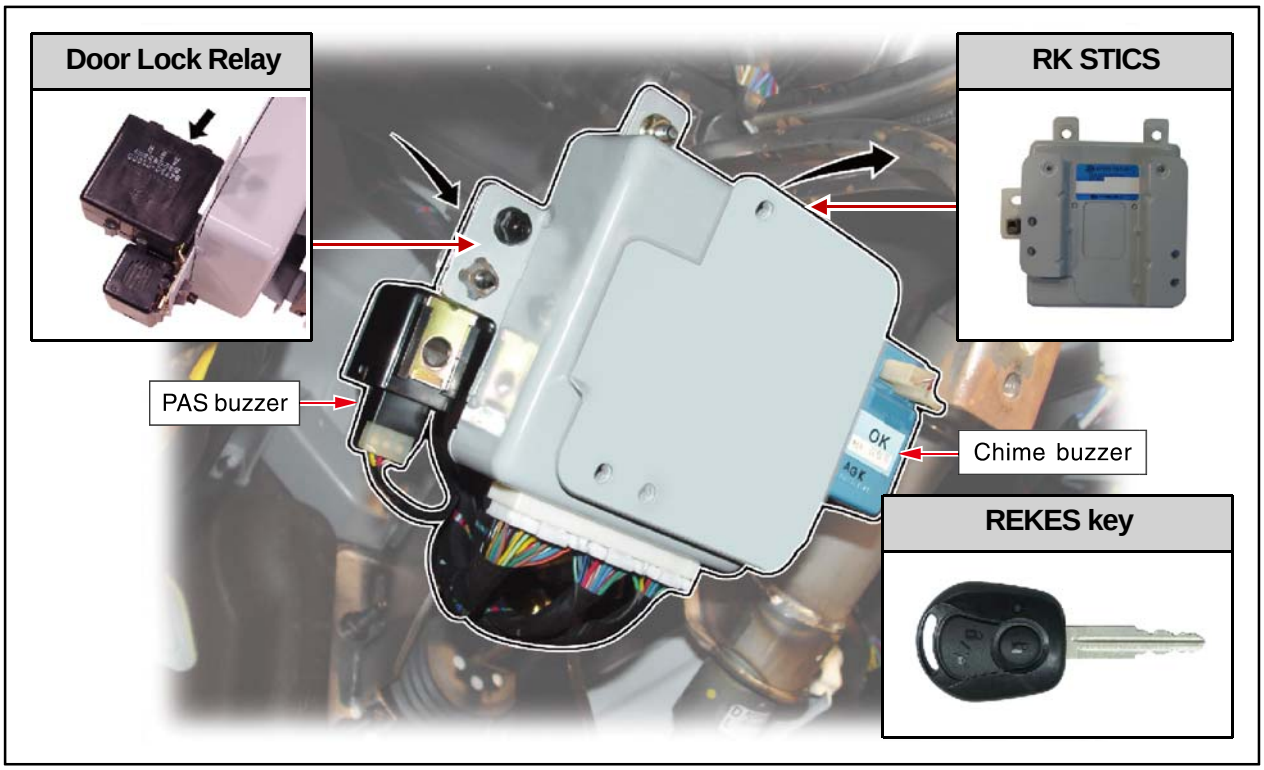
STICS

8710-01

GENERAL

1. OVERVIEW

RKSTICS (REKES + STICS (Super Time & Integrated Control System)), is almost the same as that of ACTYON in terms of its function and role. Due to the removal of tailgate opening switch and rear wiper and washer system, the circuit layout is slightly changed, compared to ACTYON.



Modification basis	
Application basis	
Affected VIN	

2. SPECIFICATIONS

1) Electrical Performance

▶ Electrical Performance

Item	Requirement	Remark
Rated voltage	DC 12.0 V	
Operating voltage	DC 9.0 V ~ 16.0 V	Should operate normally within this range. (9.5 V ~ 16.0 V only for auto hazard lamp function)
Operating temperature	-30°C ~ +80°C	Should operate normally within this range.
Reserved temperature	-40°C ~ +85°C	
Max. operating humidity	95%	
Resistible voltage	24 V	
Insulating resistance	No heat and fire due to the current leaks.	Confined with PCB, waterproof and coating that requires the insulation.
Dark current	below 7.0 mA	When initiating the sleep mode after removing ignition key and locking the doors
Voltage drop	below 1.5 V below 1.8 V	Pin no. 72 and 2, 4, 7, 8, 9, 10, 11, 12, 19, 24, 27, 28, 29, 30, 31, 32, 33, 36, 56, 57, 58, 59, 60, 61, 70, 71 Pin no. 72 and 5, 6, 16, 17, 18, 20, 21, 23, 35, 37, 39, 41, 42, 43, 44, 45, 62, 64, 65, 66, 67, 68, 69

▶ Characteristics of Radio Wave

1. Transmitting frequency: 447.800 ± 0.0125 MHz
2. Channel width: below 12.5 KHz
3. Frequency bandwidth: below 8.5 KHz
4. Modulation method: FSK (Frequency Shift Keying)
5. Receiving distance: Approx. 10 ~ 15 m (In case there are not obstacles around the system)

▶ Rated Load

NO.	Description	Rated Load
1	Chime bell / Buzzer	DC 12V 350 mA (Inductive load)
2	Front Room lamp	DC 12V 16W (Lamp load)
3	Rear Room lamp	DC 12V 8W (Lamp load)
4	Key hole illumination	DC 12V 1.2W (Lamp load)
5	Seat belt warning lamp	DC 12V 1.2W (Lamp load)
6	Parking brake warning lamp	DC 12V 1.2W (Lamp load)
7	Door ajar warning lamp	DC 12V 1.2W (Lamp load)
8	Door lock relay	DC 12V 200 mA (Inductive load)
9	Door unlock relay	DC 12V 200 mA (Inductive load)
10	Horn relay	DC 12V 200 mA (Inductive load)
11	Tail lamp relay	DC 12V 200 mA (Inductive load)
12	Hazard warning relay	DC 12V 200 mA (Inductive load)
13	Power window relay	DC 12V 200 mA (Inductive load)
14	Rear defogger relay	DC 12V 200 mA (Inductive load)
15	Wiper LOW relay	DC 12V 250 mA (Inductive load)
16	Wiper HIGH relay	DC 12V 250 mA (Inductive load)
17	Front washer motor	DC 12V 1.5A
18	Rear washer motor relay	DC 12V 500 mA (Inductive load)
19	Headlamp relay	DC 12V 750 mA (Inductive load)
20	Front defogger relay	DC 12V 200 mA (Inductive load)

▶ Input Signals

Dr: Driver's seat, Ps: Passenger's seat, Fr: Front seat, Rr: Rear seat

NO.	Input Signal Name	Logic Status
1	IGN1	ON = BAT (IGN ON or START)
2	IGN2	ON = BAT (IGN ON)
3	ALT_D	ON = BAT (engine running)
4	Key reminder (door ajar warning switch)	IGN = BAT (Key in)
5	Driver's door switch	OPEN = GND, CLOSE = OPEN
6	Passenger's door switch	OPEN = GND, CLOSE = OPEN
7	Rear door switch	- OPEN (one of rear seats) = GND - CLOSE (all rear seats) = OPEN
8	Tailgate switch	OPEN = GND, CLOSE = OPEN
9	Hood switch	OPEN = GND, CLOSE = OPEN
10	Driver's door lock/unlock switch	LOCK = OPEN, UNLOCK = GND
11	Passenger's door lock/unlock switch	LOCK = OPEN, UNLOCK = GND
12	Rear door lock/unlock switch	- UNLOCK (one of rear seats) = GND - LOCK (all rear seats) = OPEN
13	Tailgate lock/unlock switch	LOCK = OPEN, UNLOCK = GND
14	Rear defogger switch	ON = GND, OFF = OPEN
15	Seat belt switch	Unfastened = GND, Fastened = OPEN
16	Hazard warning flasher selection switch	ON = GND, OFF = OPEN (For export only)
17	Parking brake switch	ON = GND, OFF = OPEN
18	Air bag collision sensor	ON = 200 ms output (LOW), OFF = OPEN
19	Wiper motor (parking) switch	STOP = BAT VOLTAGE, ROTATING = GND
20	Washer switch	ON = BAT, OFF = OPEN
21	Intermittent auto switch	ON = BAT, OFF = OPEN
22	Auto washer switch	ON = BAT, OFF = OPEN
23	Intermittent resistance	0W ~ 51 KW (for intermittent wiper)
24	Speed sensor	ON = GND (PWM), OFF = OPEN
25	IDR (coding)	ON = BAT, OFF = OPEN
26	Front defogger switch	ON = GND, OFF = OPEN
27	Auto hazard switch	ON = GND, OFF = OPEN
28	Central door lock switch	ON = GND, OFF = OPEN
29	Rear washer switch	ON = GND, OFF = OPEN
30	Multifunction auto light switch	ON = GND, OFF = OPEN
31	Indicator lamp switch	ON = BAT/GND, OFF = OPEN (Approx. 5.1 V ~ 9.2 V)
32	Seat adjustment and switch memory unit	ON = GND (PWM), OFF = OPEN
33	Rain sensor	ON = GND (DATA), OFF = BAT
34	Diagnosis (SCAN-100)	ON = GND (DATA), OFF = BAT (KWP2000)
35	Rechargeable key and immobilizer	ON = GND (DATA), OFF = BAT (KWP2000)

Modification basis	
Application basis	
Affected VIN	

▶ Chattering of Input Signals

- Vehicle speed input:
  The vehicle speed is the average value of 4 pulses among 6 pulse inputs regardless of the input for 1.0 second
  after IGI 1 ON. The time indicated in each function does not include the vehicle speed calculating time.
- 20 ms target input:
  Wiper motor A/S (parking) terminal
- 100 ms target input switch
  All switches except wiper motor A/S (parking) terminal

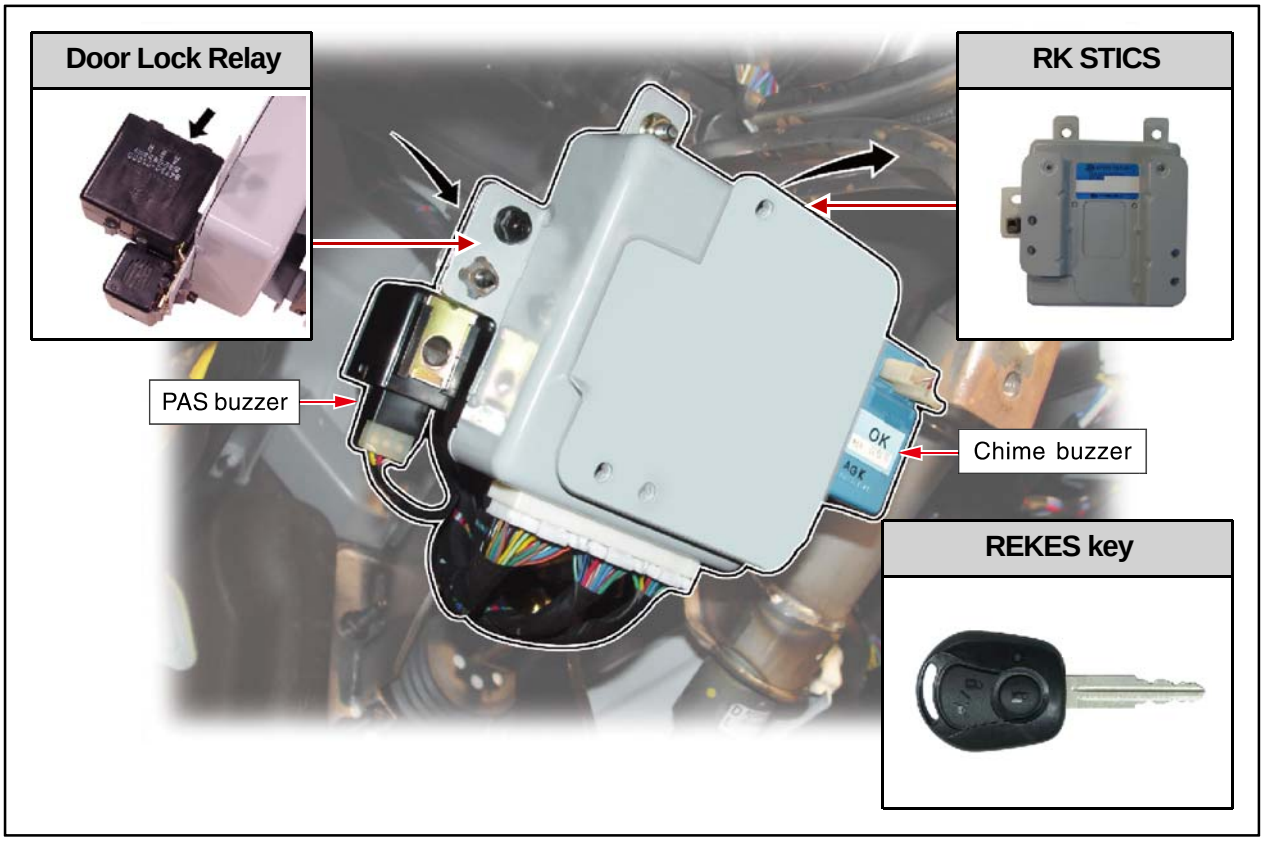
▶ Time Tolerance

- If not indicated, time tolerance will be ± 10%.
  However, if less than 500 ms, time tolerance will be ± 100 ms.
- The time indicated in each function does not include chattering processing time from switch input changing point.

OVERVIEW AND OPERATION PROCESS

1. OVERVIEW

RKSTICS (REKES + STICS (Super Time & Integrated Control System)), is almost the same as that of ACTYON in terms of its function and role. Due to the removal of tailgate opening switch and rear wiper and washer system, the circuit layout is slightly changed, compared to ACTYON.



Modification basis	
Application basis	
Affected VIN	

2. FUNCTIONS AND SPECIFICATIONS

1) Wiper and Washer Operations

Front Automatic Wiping Speed Control Switch

The interval of wiper swings can be adjusted by twisting the control knob upward or downward when the windshield wiper switch is in the AUTO position.

Fast: Fast interval

Slow: Slow interval

Front wiper operation

MIST

When pulling up the lever, the wiper operates once and the wiper lever returns to the "OFF" position.

OFF

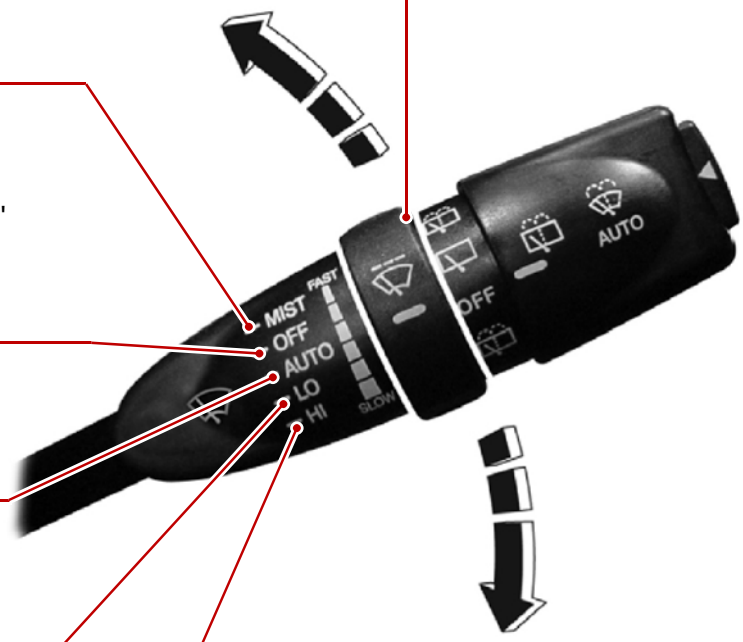
Stop the operation.

AUTO

Operates automatically according to the vehicle speed or the amount of rain.

LO

Continuous wipe, slow operation.



HI

Continuous wipe, fast operation

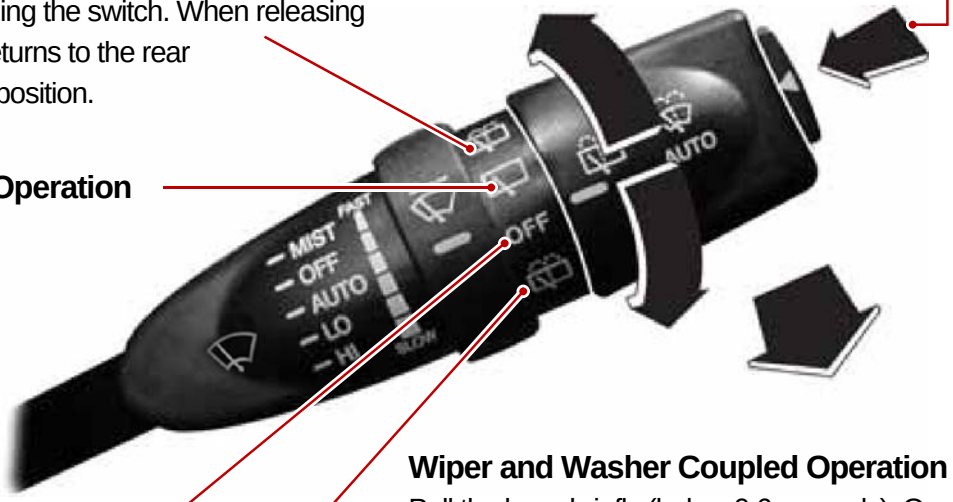
Front Auto Washer and Wiper Switch

When pressing the auto washer switch with the wiper switch "OFF", the washer fluid is sprayed on the windshield and the wiper sweeps off 4 times, after then the washer fluid is sprayed and the wiper sweeps off 3 times again.

Rear Washer and Wiper

The rear washer and the wiper operate only while holding the switch. When releasing the switch, it returns to the rear wiper operate position.

Rear Wiper Operation



Wiper and Washer Coupled Operation

Pull the lever briefly (below 0.6 seconds): One wiping cycle

Pull and hold the lever for more than 0.6 seconds: Three wiping cycles with washer spray

Rear Wiper Stops

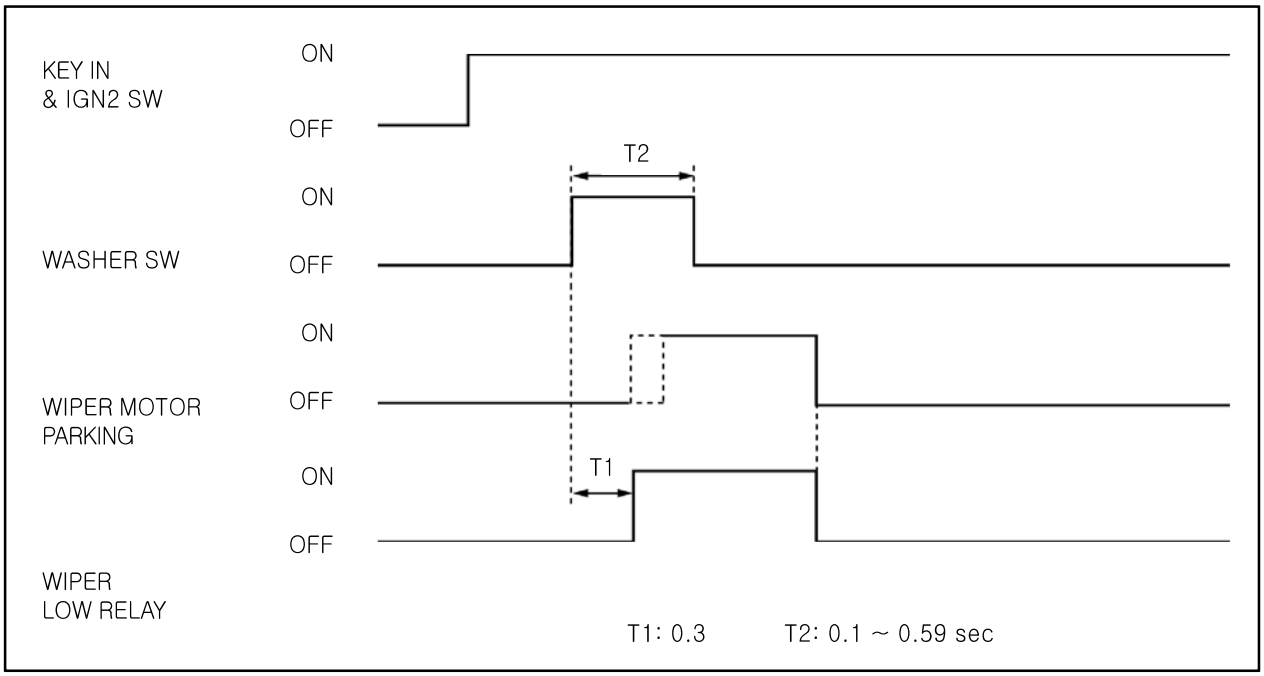
Rear Washer and Wiper

The rear washer and the wiper operate only while holding the switch. When releasing the switch, it returns to "OFF" position.

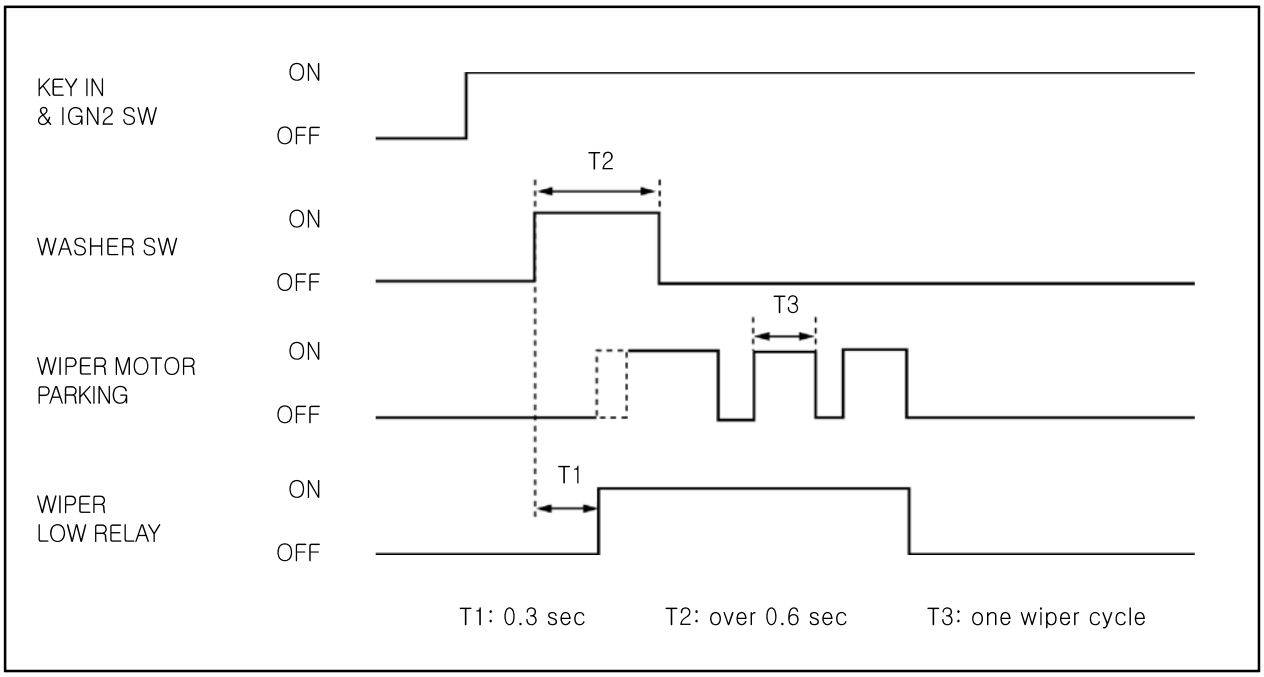
Modification basis	
Application basis	
Affected VIN	

2) Wiper MIST and Front Washer Coupled Wiper

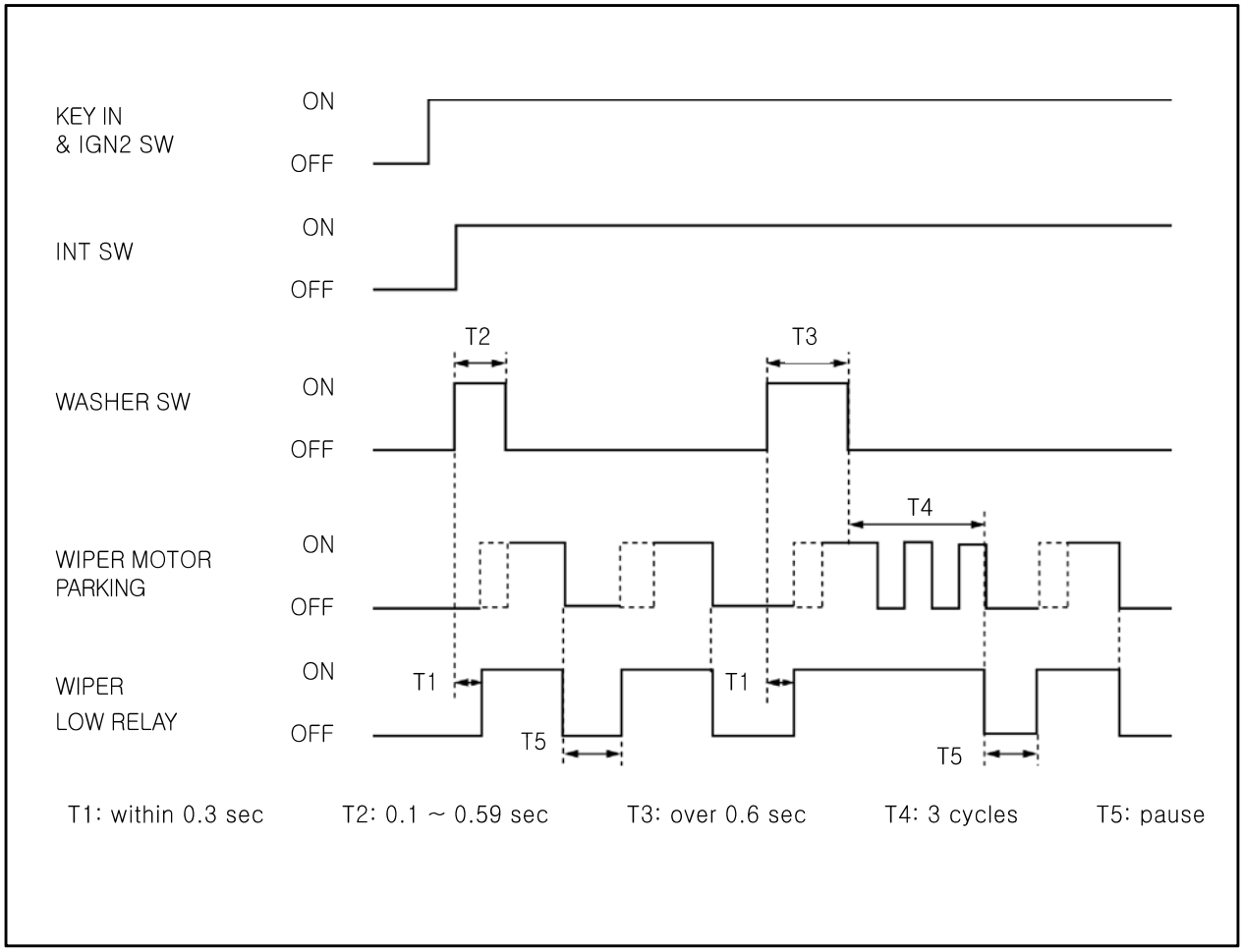
1. The wiper relay is turned on at 0.3 seconds after from the time when the washer switch is turned on for 0.1 to 0.59 seconds (T2) with the ignition switch "ON". If the wiper parking terminal gets off, the wiper relay is turned off.



2. The wiper relay is turned on at 0.3 seconds (T1) after from the time when the washer switch is turned on for more than 0.6 seconds (T2) with the ignition switch "ON". The wiper relay gets on 3 times immediately after turning off the washer switch.



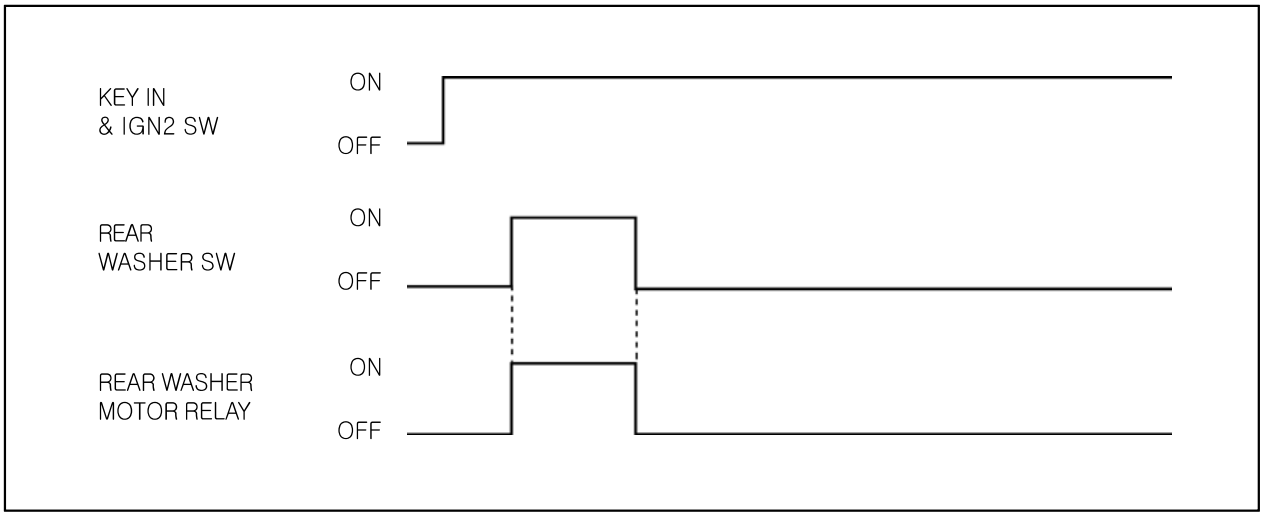
3. When the washer switch is turned on for more than 0.6 seconds during the wiper operation by INT switch, the operation in step (2) is performed. When it is turned on for a certain period of time (0.1 to 0.59 seconds), the operation in step (1) is performed.



Modification basis	
Application basis	
Affected VIN	

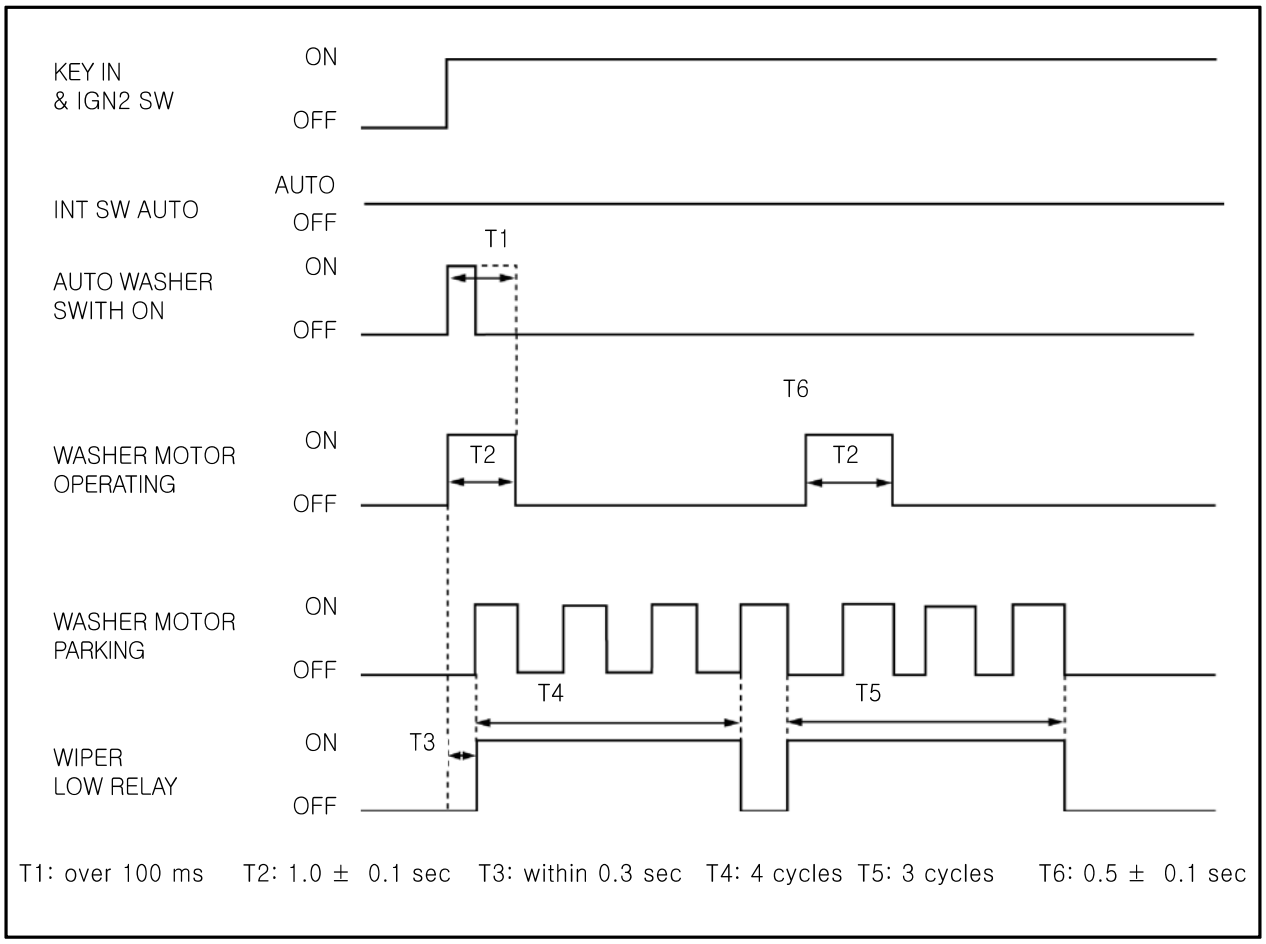
3) Rear Washer Motor Control

1. When the rear washer switch is turned on with the ignition switch "ON", the rear washer motor relay output gets ON from the time when the rear washer switch is turned on. It gets OFF when the rear washer switch is turned off.
2. This control is not available while the front washer switch or the auto washer and wiper (AFW: Advanced Fast Washer) is in operation.



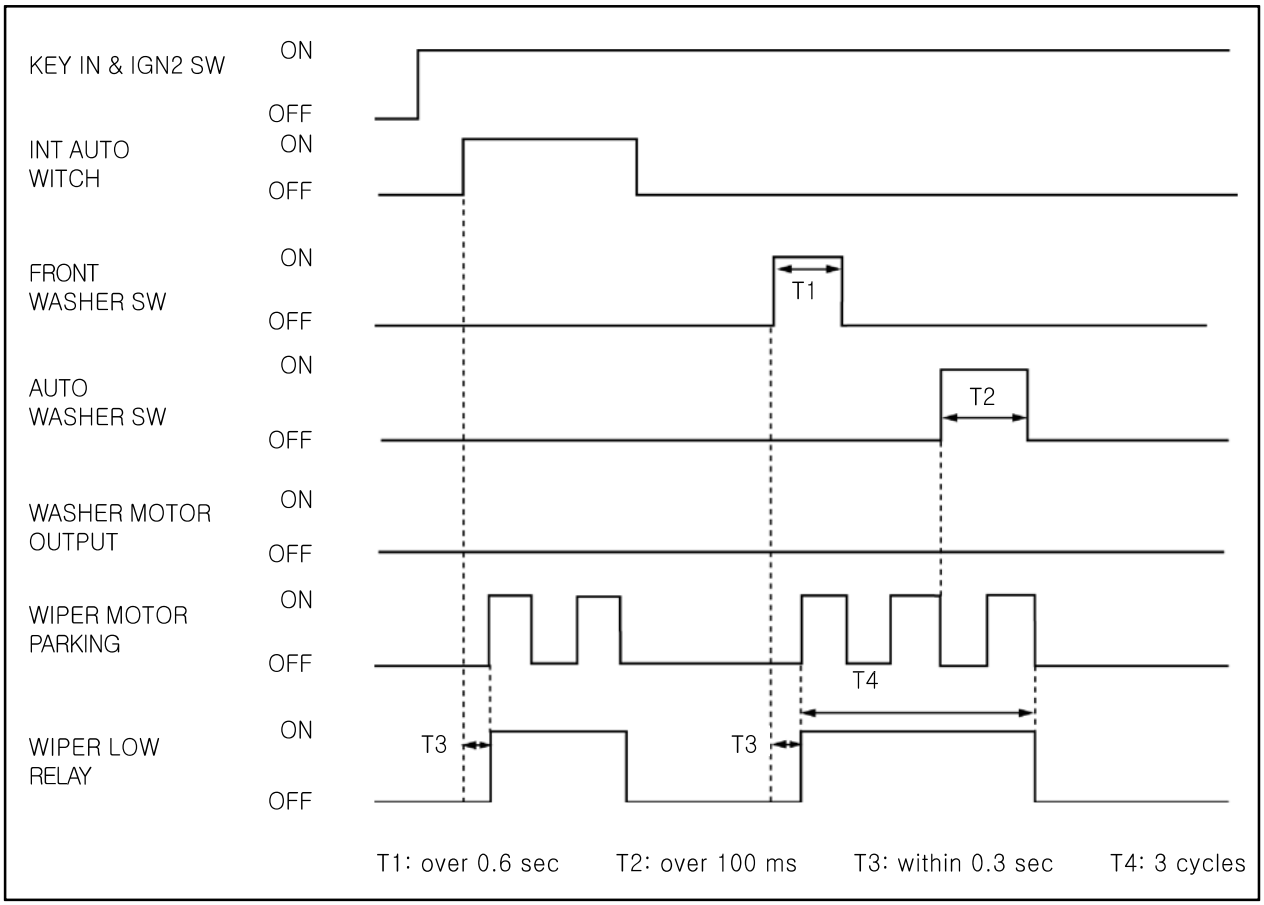
4) Auto Washer and Wiper Switch (AFW)

1. When the auto washer switch is turned on with the ignition switch "ON" and the INT switch "OFF", the washer motor output gets ON for 1 second. If the system recognizes the output signal, the wiper relay output gets ON during 4 cycles and the washer motor output gets ON for 1 second. Then, the wiper relay output gets OFF after 3 cycles.



Modification basis	
Application basis	
Affected VIN	

2. The auto washer switch output is overridden during the washer coupled wiper operation.
3. The auto washer switch input is overridden during the auto washer coupled wiper operation.
4. The auto washer switch input is overridden during the rain sensor coupled wiper or vehicle speed sensitive INT wiper operation.
5. When the auto INT switch input is received during the auto washer operation, the auto washer operation stops and the auto INT operation is activated.



Priorities in Washer Operations

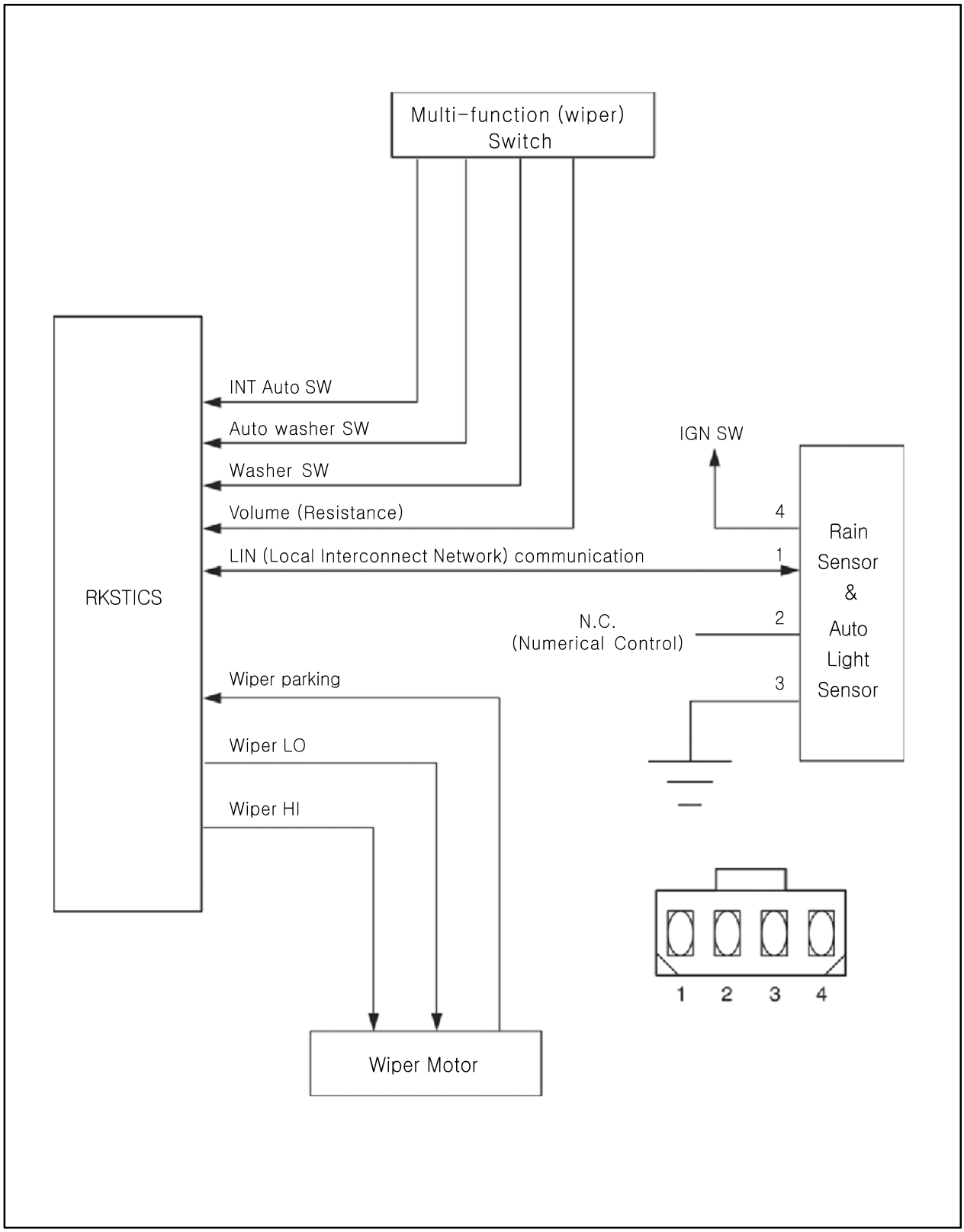
1. he rear washer switch input is overridden during the front washer operation.
2. The rear washer switch input is overridden during the auto washer and wiper (AFW) operation.
   The front washer switch input is overridden during the rear washer operation.
3. The auto washer switch input is overridden during the rear washer operation.
4. The front washer switch input is overridden during the auto washer and wiper (AFW) operation.
5. The auto washer switch input is overridden during the front washer operation.

6.

5) Rain Sensor Coupled Wiper and Auto Light Control

If equipped with RKSTICS rain sensor, it has following operation system.

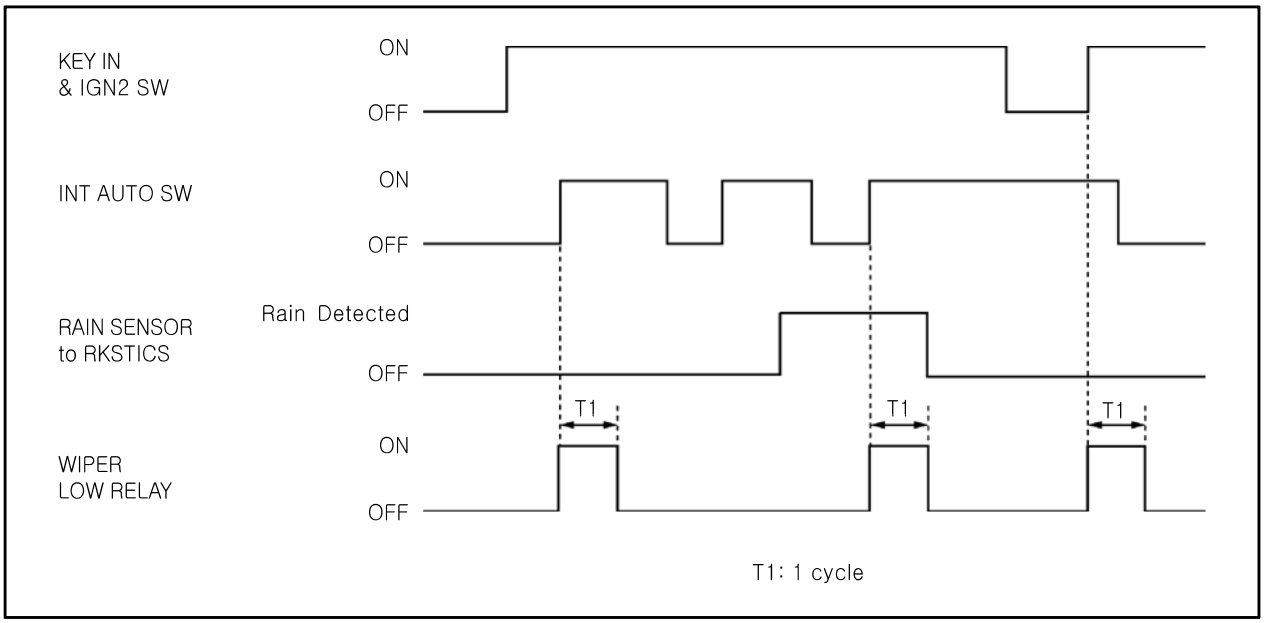
▶ **System layout**



Modification basis	
Application basis	
Affected VIN	

6) INT Switch Auto Position Reminder (Power-Up Reminder Wiper)

1. When turning off and on the auto INT switch, the system drives the wiper motor through LOW relay regardless of communication with rain sensor.
2. The wiper relay (LOW) is turned on and the wiper motor runs one cycle when changing the wiper switch to "AUTO" position from any other positions (while the ignition key is in the "ON" position). When the wiper switch is turned to the "ON" position again from other positions, the system drives the wiper motor through LOW relay one cycle only when the rain sensor detects the "Rain Detected" signal.

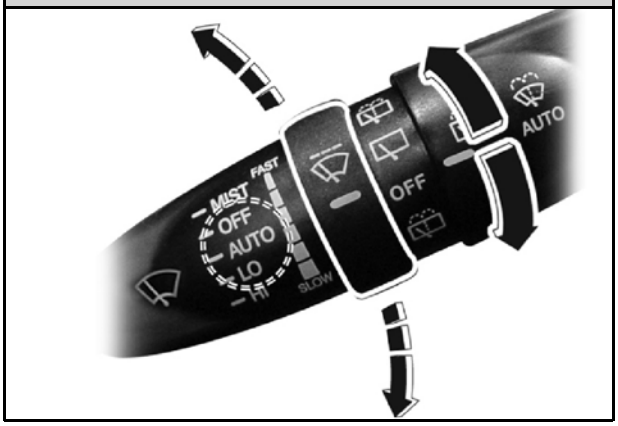


Rain sensing unit (AUTO light integrated type)



A sensor that emits infrared rays through LED and then detects the amount of rain drops by receiving reflected rays against sensing section (rain sensor mounting section on the windshield) with photodiode (auto light sensor integrated type)

Multifunction wiper switch: AUTO and sensitivity control



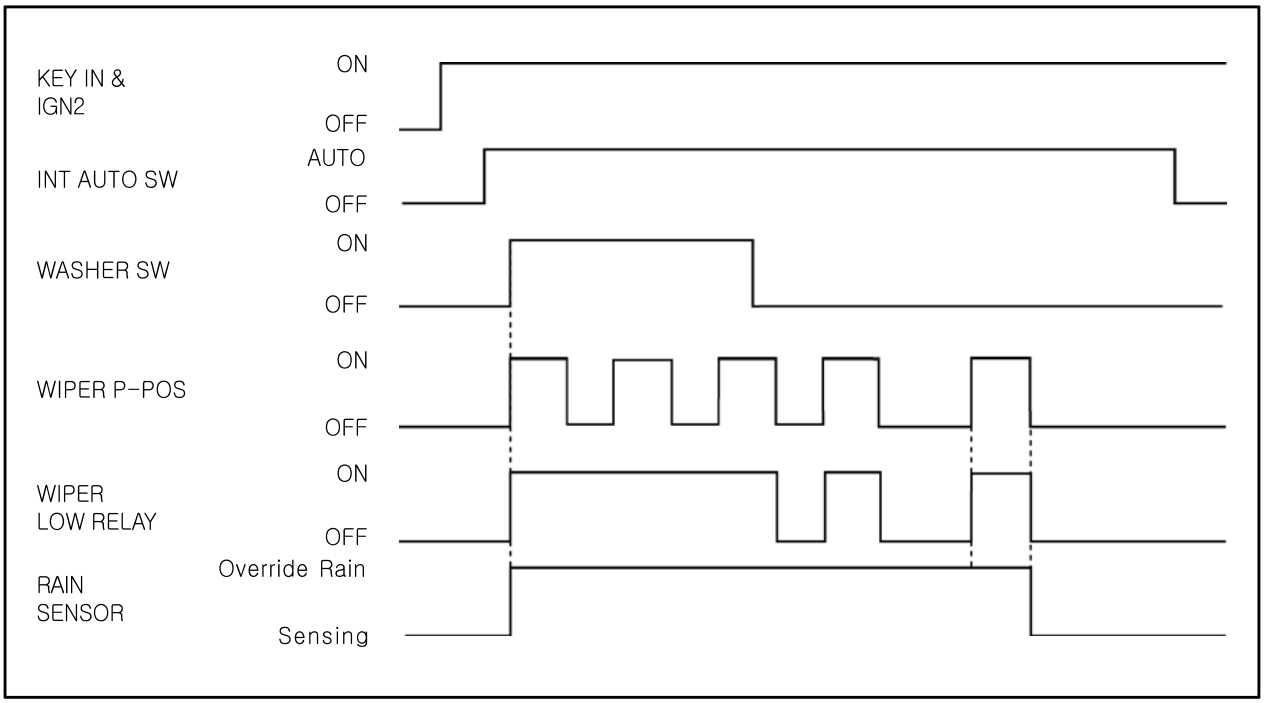
AUTO: Wiper operates automatically by rain sensor

FAST ↔ **SLOW**: Auto delay/Auto speed control. A position that can control sensitivity against rains in the windshield and transmits wiping demand signal accordingly

Modification basis	
Application basis	
Affected VIN	

7) Washer Coupled Wiper in Rain Sensing Mode

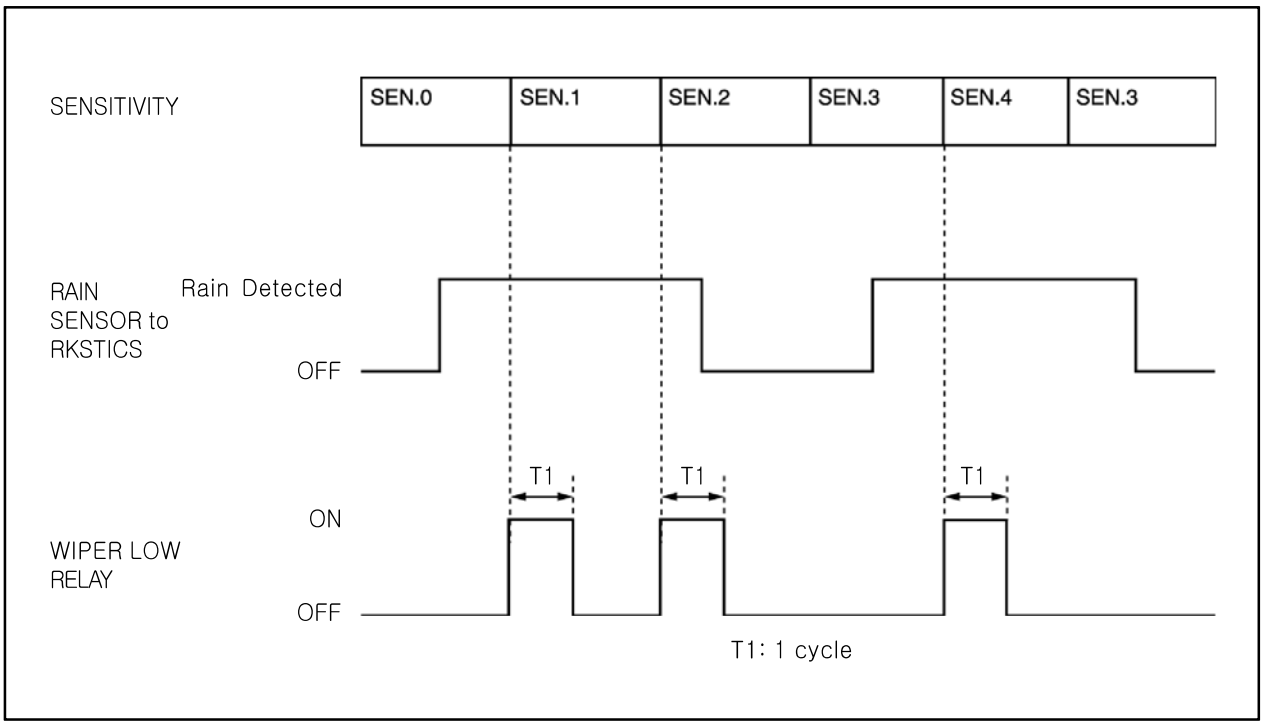
1. The washer coupled wiper is operated when receiving the washer switch input with the ignition switch "ON" and the auto INT switch "ON" in the rain sensing mode. At this moment, the communication with the rain sensor is overridden. However, the washer switch input is overridden during the continuous operation.
2. The operation data is sent to the rain sensor even during the washer coupled wiper's operation.



Modification basis	
Application basis	
Affected VIN	

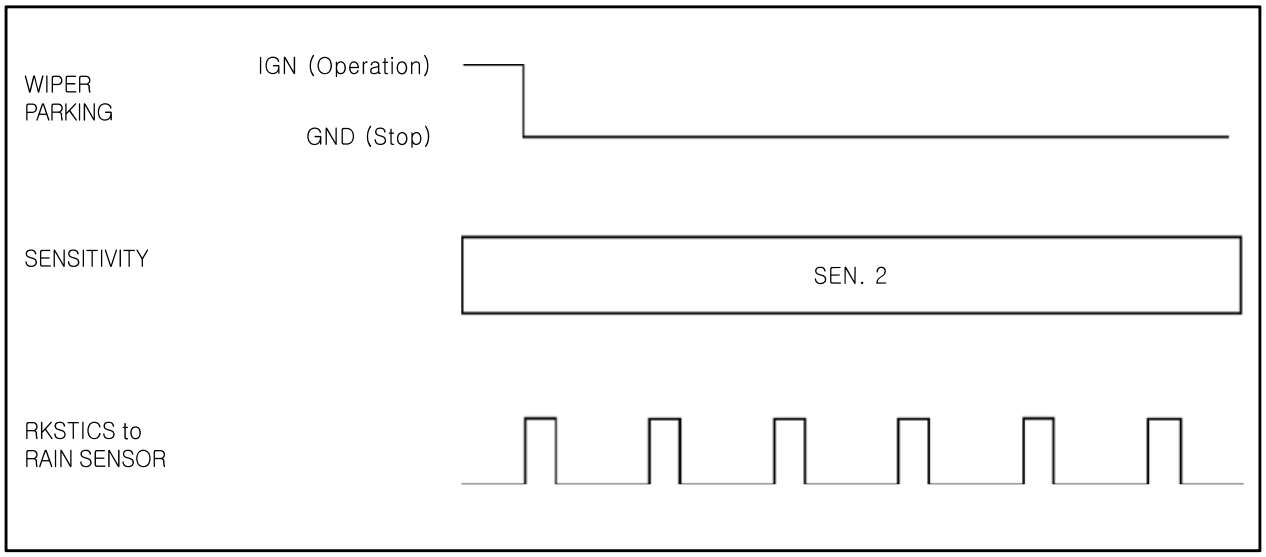
8) Rain Sensing Sensitivity Control

1. The wiper LOW relay is turned on and the wiper motor runs one cycle when the volume sensitivity is increased (while the ignition key is in the "ON" position, the wiper switch is in the "ON" position, and the wiper motor is in "Parked" position). However, the wiper motor can be operated only when the rain sensor detects the "Rain Detected" signal.
   * If the volume sensitivity is changed more than 2 stages within 2 seconds, the wiper motor runs only one cycle.

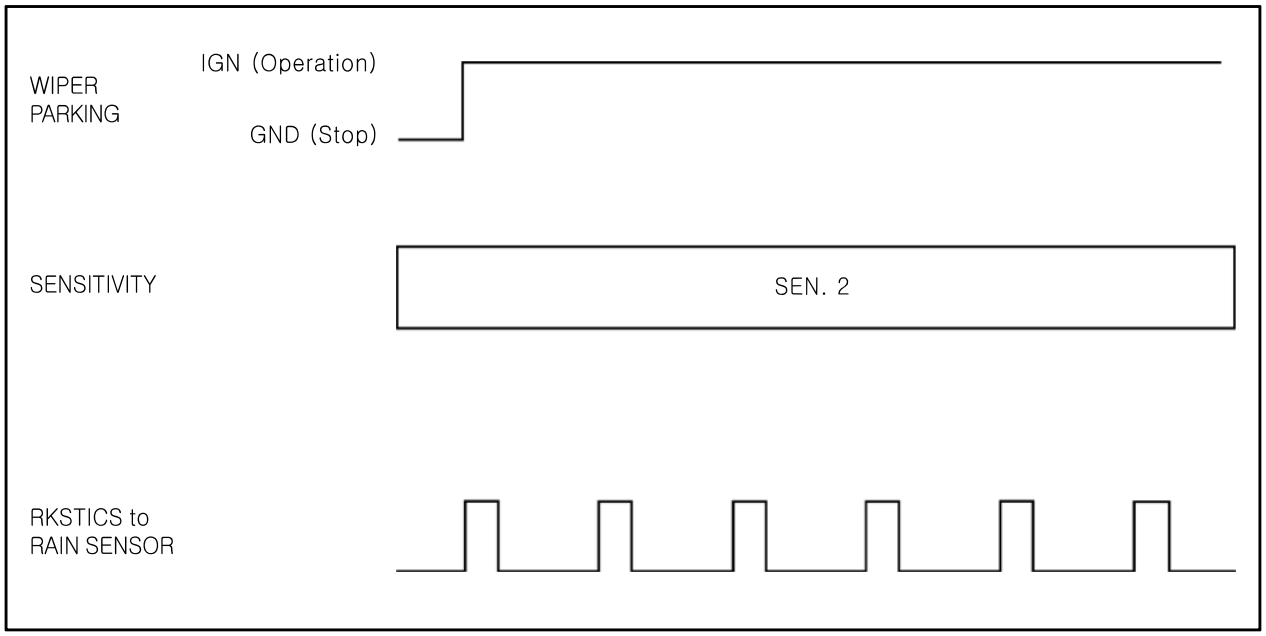


9) When the Wiper Parking Signal is abnormal

1. The wiper system continuously outputs the wiper parking signal when the wiper parking terminal is grounded
   (while the ignition key is in "ON" position and the wiper switch is in "ON" position).
   * The wiper motor runs only when the rain sensor requires the wiper operation.



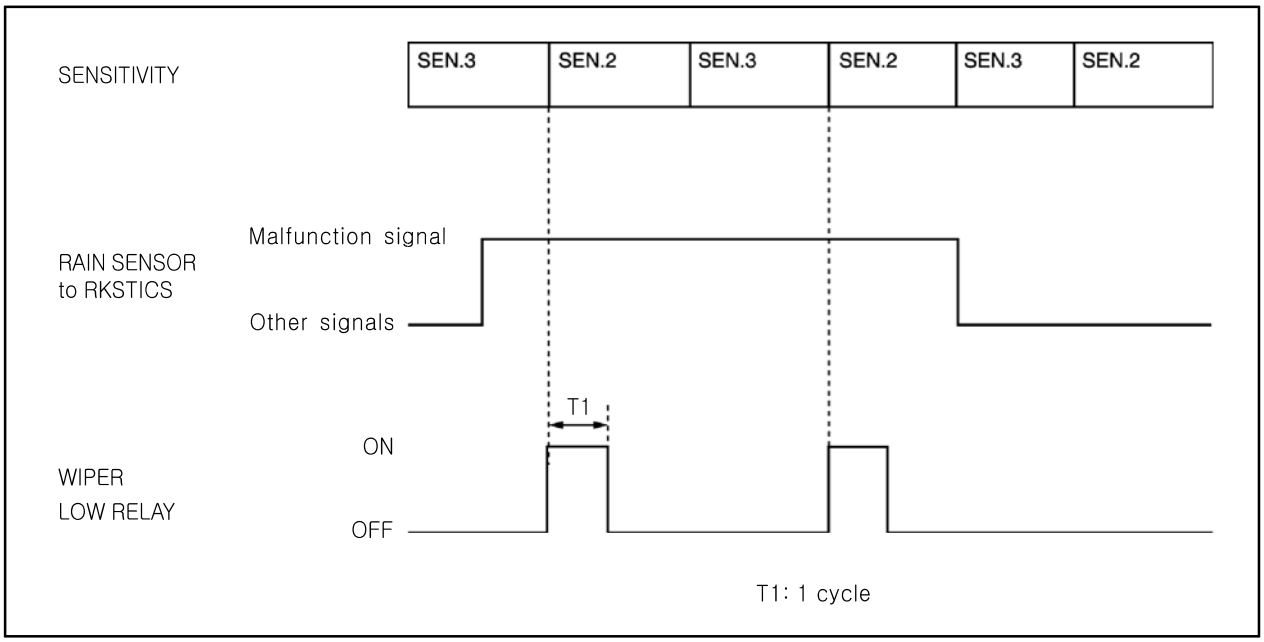
2. When the parking terminal is fixed to IGN, the wiper system outputs the wiper operating signal for 2 seconds, then continuously outputs the wiper parking signal.
   * The wiper motor runs only when the rain sensor requires the wiper operation.



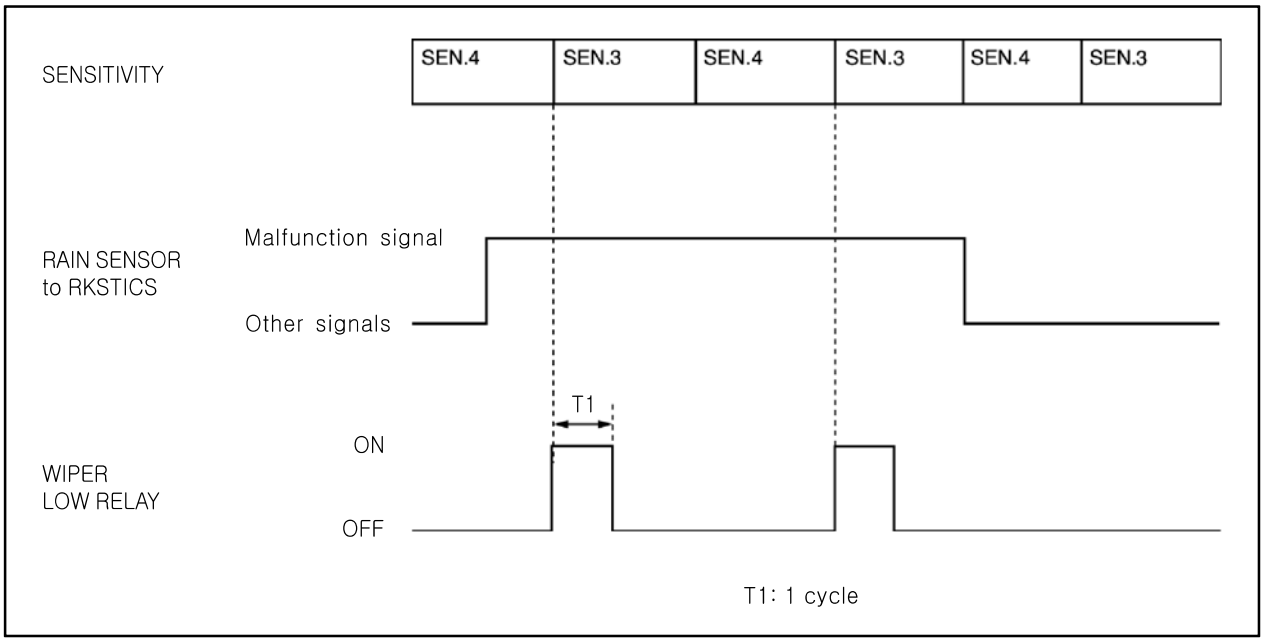
Modification basis	
Application basis	
Affected VIN	

10) Defective Rain Sensor

1. The wiper relay (LOW) is turned on and the wiper motor runs one cycle when the volume sensitivity is changed to 2 from 3 during receiving the malfunction signal from the rain sensor (while the ignition key is in "ON" position and the wiper switch is in "ON" position).



2. The wiper relay (LOW) is turned on and the wiper motor runs one cycle when the volume sensitivity is changed to 3 from 4 during receiving the malfunction signal from the rain sensor (while the ignition key is in "ON" position and the wiper switch is in "ON" position).



(1) Trouble shooting

Symptom 1.	The wiper does not operate one cycle when turning the multifunction wiper switch to the "AUTO" from the "OFF" position or starting the engine while the wiper switch is in the "AUTO" position.

- When starting the engine with the multifunction wiper switch in the "AUTO" position, the wiper operates one cycle to remind a driver that the wiper switch is in the "AUTO" position.
  When the wiper switch is turned to "AUTO" from "OFF", the wiper operates one cycle. It always
- operates one cycle for the initial operation, however, the wiper does not operate afterwards to prevent the wiper blade wear if
  not raining when turning the wiper switch to "AUTO" from "OFF". However, the wiper operates up to 5 minutes after rain stops. If this function does not occur, check No. 8 pin. If the pin is normal, check the wiper relay related
  terminals in the ICM box.

Symptom 2.	It rains but the system does not work in the "AUTO" position.

- Check whether the multifunction wiper switch is in the "AUTO" position.
- Check the power to the sensor. Check the conditions of the pin 3 (Ground) and the pin 4 (IGN). Check the wiper relay for defective.
-

Symptom 3.	The wiper operates 3 or 4 times at high speed abruptly.

- Check whether the variable resistance knob on the multifunction wiper switch is set in "FAST". The "FAST" is the highest stage of the sensitivity and very sensitive to small amount of rain drops. Therefore, change the knob to the low sensitivity.

Symptom 4.	The wiper operates continuously even on the dry glass.

- Check the wiper blade for wear. If the wiper blade cannot wipe the glass uniformly and clearly, this problem could be occurred. In this case, replace the wiper blade with a new one.
  Check whether the variable resistance knob on the multifunction wiper switch is set in "FAST". The
- "FAST" is the highest stage of the ensitivity and very sensitive to small amount of rain drops. Therefore, change the knob to the low sensitivity.

Modification basis	
Application basis	
Affected VIN	

Symptom 5.	The wiper does not operate at high speed even in heavy rain.

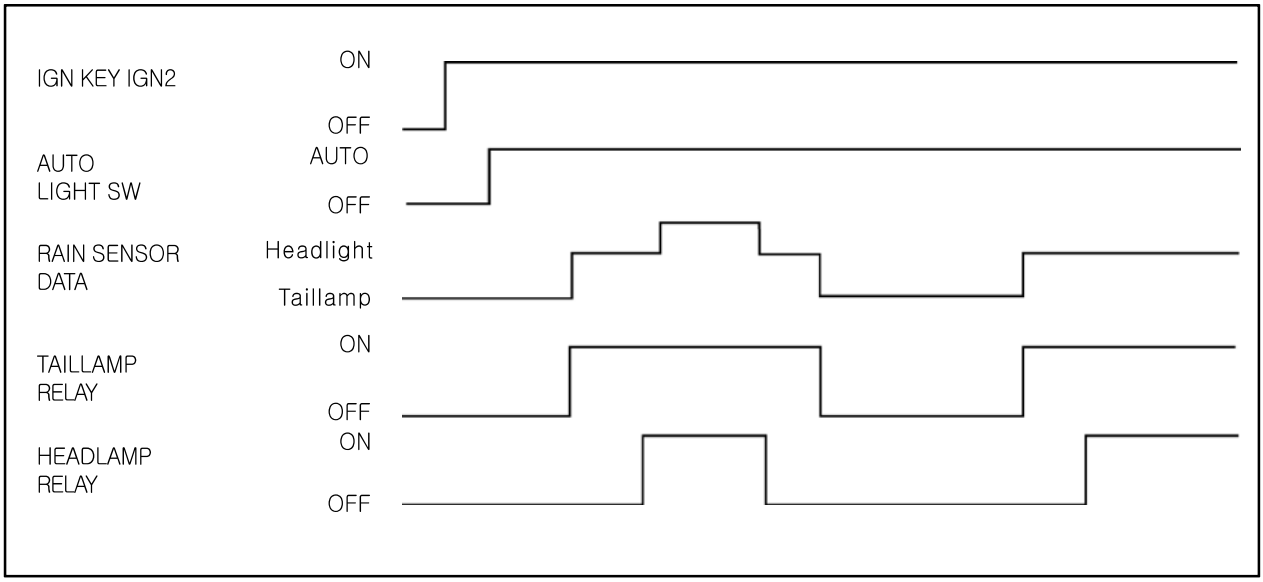
- Check if the wiper operates at high speed when grounding pin 1 and pin 2.

Symptom 6.	The wiper responses are too fast or slow.

- Check whether the variable resistance knob on the wiper switch is set in "FAST" or "SLOW". Notify that the customer can select the sensitivity by selecting the variable resistance value. And, select a proper stage.

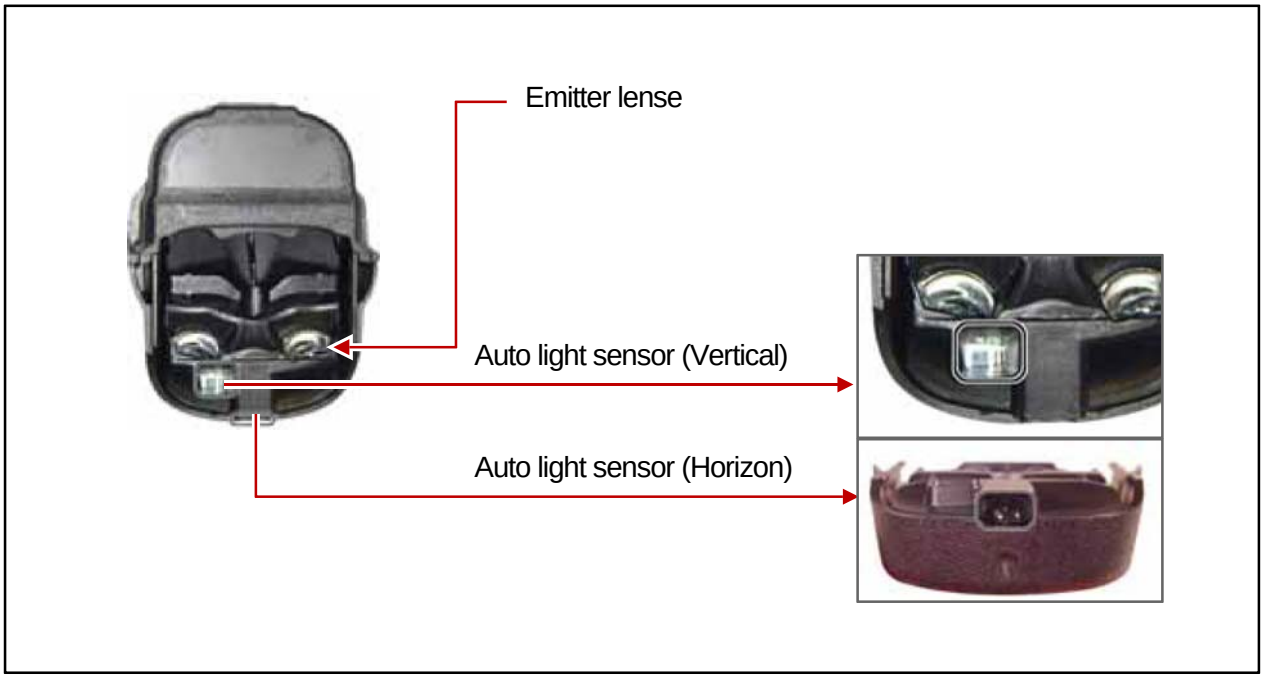
11) Auto Light Control

1. The tail lamps and headlamps can be controlled by the communication with the rain sensor only when the auto light switch is in "AUTO" position with the ignition switch "ON".



2. Rain detected headlamp: If it rains heavy which requires the highest INT speed, the headlamps are turned on automatically.

3. Night detected wiping: When the auto light control turns on the headlamps and the rain sensor detects the rain, the wiper sensitivity is automatically increased by one level. (i.e. the AUTO wiper switch is at the 3rd level, but the wiper operates at the 4th level.)



Modification basis	
Application basis	
Affected VIN	

12) Speed Sensitive INT (Intermittent) Wiper

For RKSTICS without the rain sensor, perform the following operation:

▶ **Controls the wiper intermittent operation by the values from the vehicle speed and the volume.**

- Calculates and converts the Intermittent interval automatically by using the INT VOLUME when the ignition switch is in the "ON" position and the INT switch is in the "ON" position.
  The wipers are operated in vehicle speed sensitive mode when turning the INT switch to the
- "ON" position with the engine running or starting the engine with the INT switch positioned to "ON".
  Intermittent interval (at 0 km/h): 3 ± 0.5 ~ 19 ± 2 seconds
-

▶ **Vehicle speed calculation**

- [Input the vehicle speed]
  It is calculated by the numbers of input pulses for one second.

$$1\ [\text{PULSE/SEC}] = \frac{60\ [\text{km/h}] \times 60\ [\text{sec}]}{637 \times 4\ \text{PULSE}} \fallingdotseq 1.41\ [\text{km/h}]$$

▶ **VOLUME calculation**

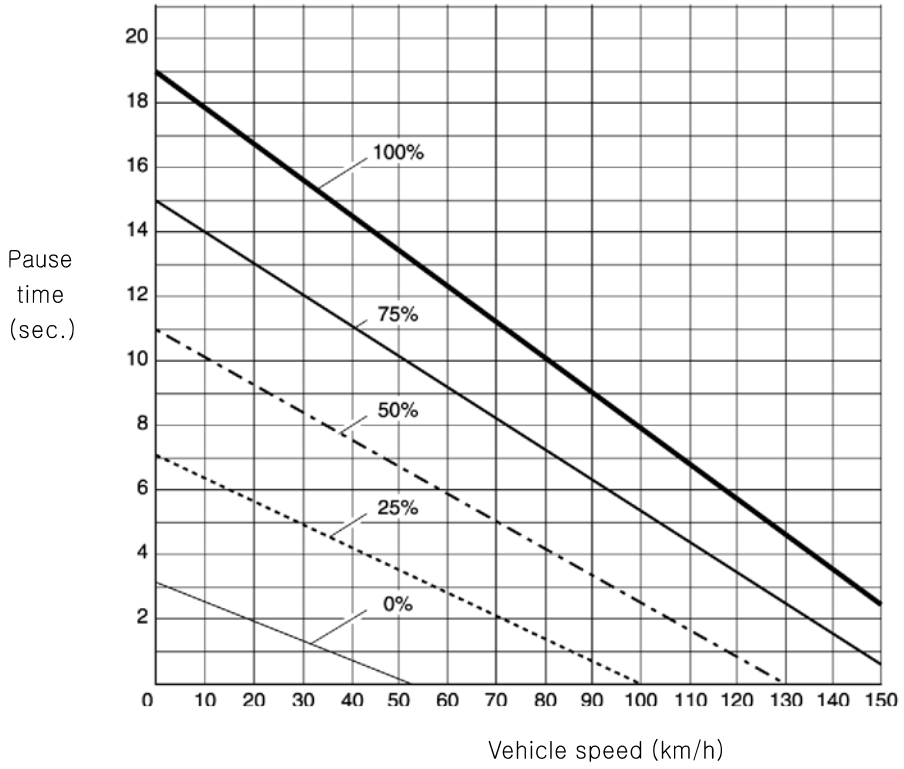
- The pause time of the vehicle speed sensitive INT wiper is calculated by the INT volume (input voltage). Each level has the hysteresis.

▶ **Pause time calculation**

- Pause time: the duration that wipers are stopped at parking position
- Elapsed time: the duration after the wiper motor started to operate from parking position
- The pause time is calculated by the vehicle speed and the VOLUME.
  · If the pause time is below 1.0 second, the wipers operate without pause.
  · If the pause time is over 1.5 seconds, the wipers operate intermittently

Pause time of vehicle speed sensitive INT wiper

Vehicle Speed / Resistance	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
100%	19.00	17.90	16.80	15.70	14.60	13.50	12.40	11.30	10.20	9.10	8.00	6.90	5.80	4.70	3.60	2.50
75%	15.00	14.03	13.06	12.09	11.13	10.16	9.19	8.22	7.26	6.29	5.32	4.35	3.39	2.42	1.45	0.45
50%	11.0	10.16	9.33	8.49	7.66	6.82	5.99	5.15	4.32	3.48	2.65	1.81	0.98	0.14	0.00	0.00
25%	7.00	6.29	5.59	4.89	4.19	3.48	2.78	2.08	1.38	0.67	0.02	0.00	0.00	0.00	0.00	0.00
0%	3.0	2.43	1.86	1.29	0.72	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00



CAUTION

▶ **Speed sensitive INT (intermittent) wiper**

- The wiper relay continues to output for remaining "ON" time even when the INT switch is turned off.
- IGN 2 switch "ON", INT switch "OFF": Resume the intermittent time when turning "ON"
- IGN 2 switch "OFF", INT switch "ON": Resume the intermittent time when turning "ON"

▶ **Controls when the wiper motor parking is defective**

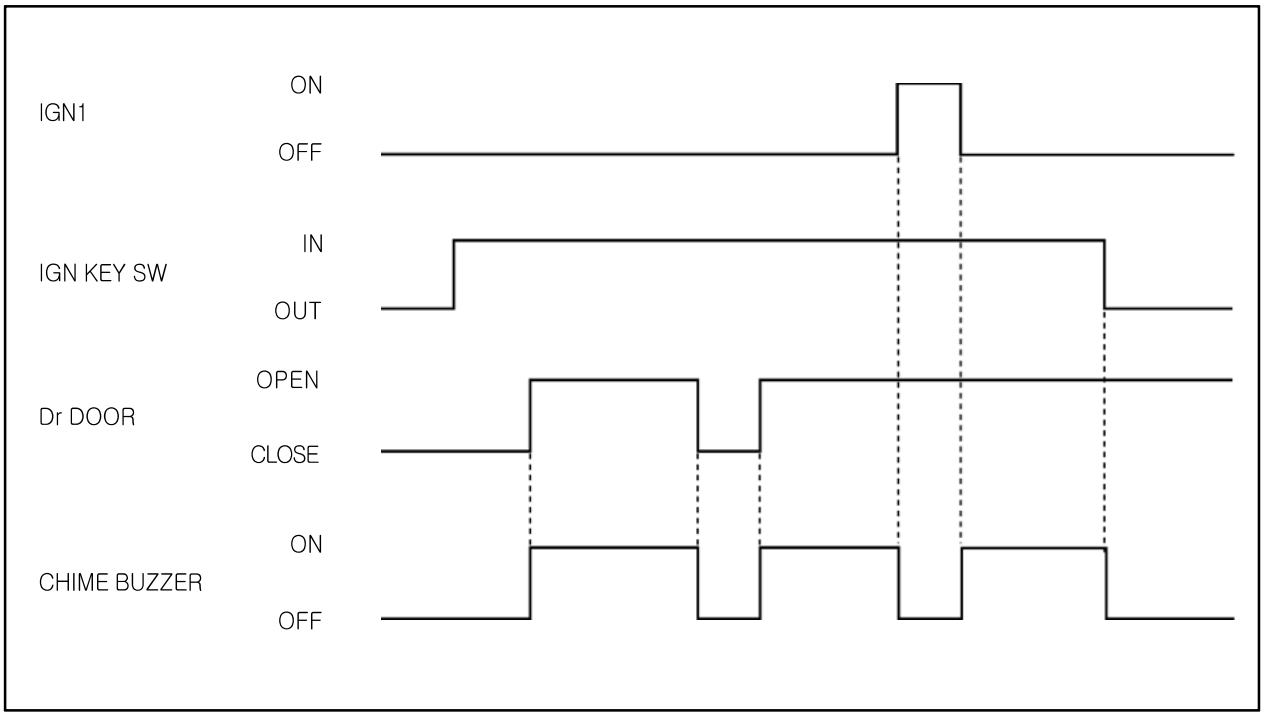
- The wiper relay continues to output when the parking terminal is fixed at the ground or IGN while the wiperrelay is "ON" (INT switch = ON or Washer switch = ON) (The output stops immediately after turning off the switch) (The output stops immediately after turning OFF the switch.)

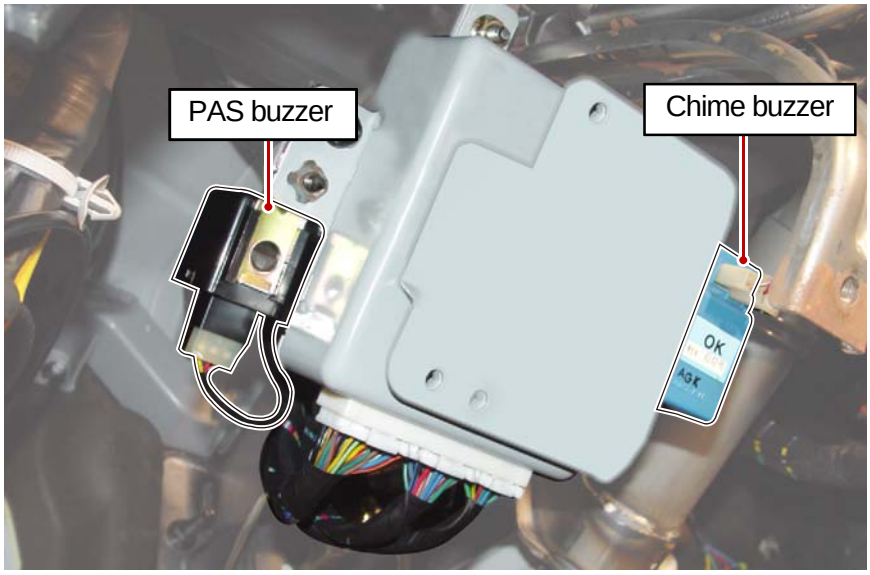
Modification basis	
Application basis	
Affected VIN	

13) Ignition Key Reminder Warning

(The ignition key reminder warning has priority over the "TAILLAMP ON WARNING".)

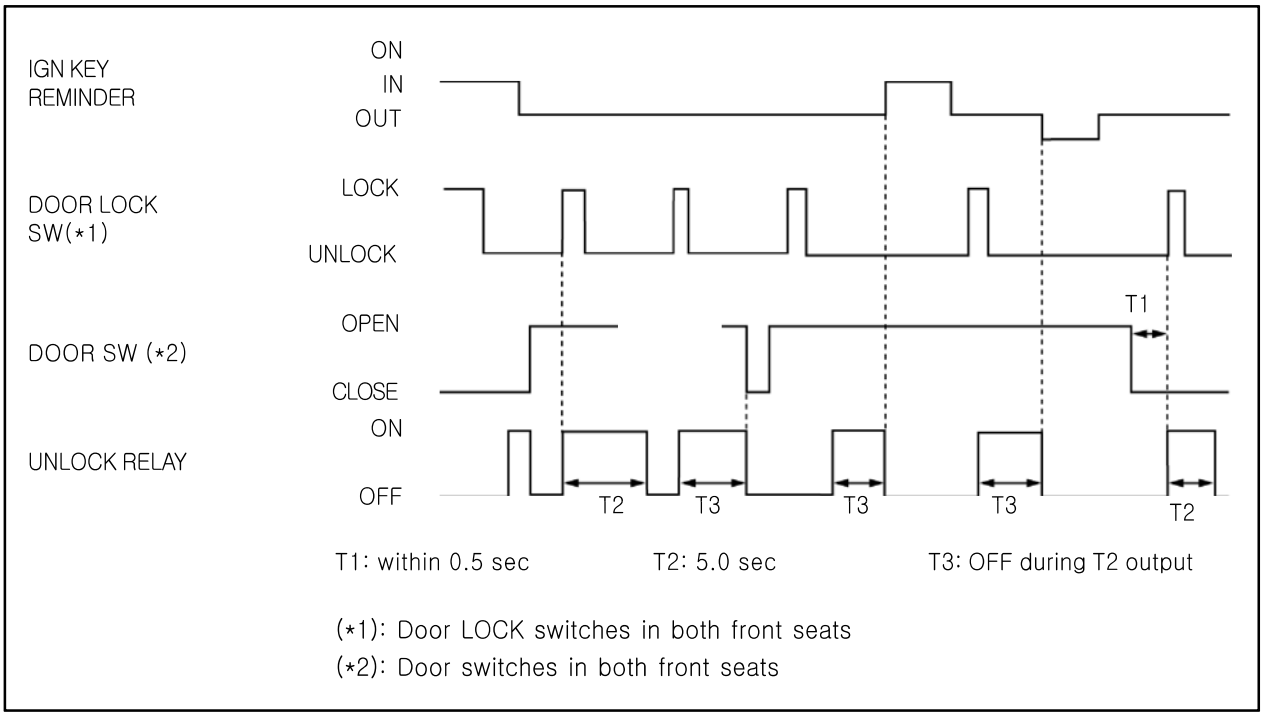
1. The chime buzzer sounds continuously when opening the driver's door while the ignition key is in ignition switch.
2. When removing the ignition key or closing the driver's door during chime buzzer operation, the buzzer stops.
3. This function is not available when the ignition switch is in "ON" position.





▶Ignition Key Reminder

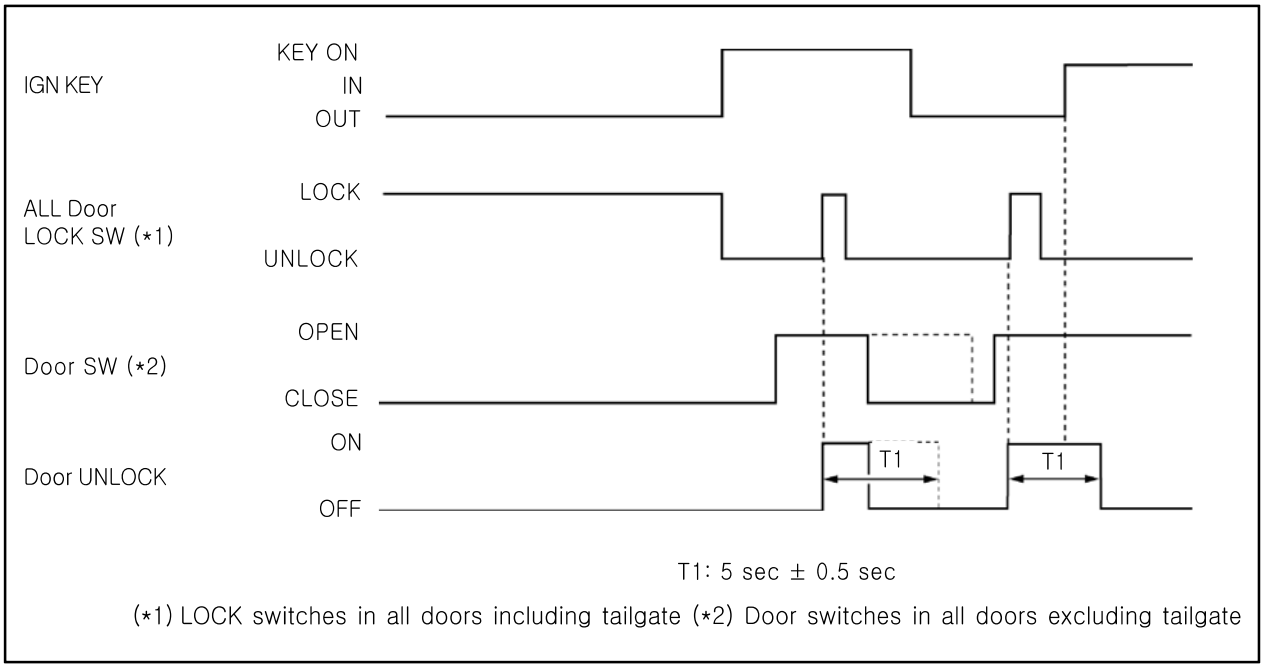
1. The system outputs "UNLOCK" signal for 5 seconds after the driver's door is opened and the door lock switch is changed to "LOCK" (while the ignition key is in ignition switch).
2. The system outputs "UNLOCK" signal for 5 seconds (T2) when the door lock switch is changed to "LOCK" from "UNLOCK" and the driver's door is closed within 0.5 seconds (while the ignition key is in the ignition switch).
3. If the "UNLOCK" conditions are met, the system outputs "UNLOCK" signal unconditionally. However, if the ignition key is removed after the door lock switch is changed from "UNLOCK" to "LOCK", the system does not output "UNLOCK" signal.



Modification basis	
Application basis	
Affected VIN	

14) All Door Lock Prevention Function when a Door is Open

1. All doors, except the tailgate and hood, output "UNLOCK" signal for 5 seconds when the "LOCK" signal is inputted (while the ignition key is removed and one of any doors is open).
2. When the door is closed during the UNLOCK output, the UNLOCK output stops immediately.
3. When the ignition key is inserted during the output, the output continues for approx. 5 seconds. If the ignition switch is in the "ON" position or the ignition switch is removed, the above steps are
4. performed. If the key is in the key cylinder, the ignition key reminder function is activated. This function does not work if the vehicle speed is over 10 km/h.
5.

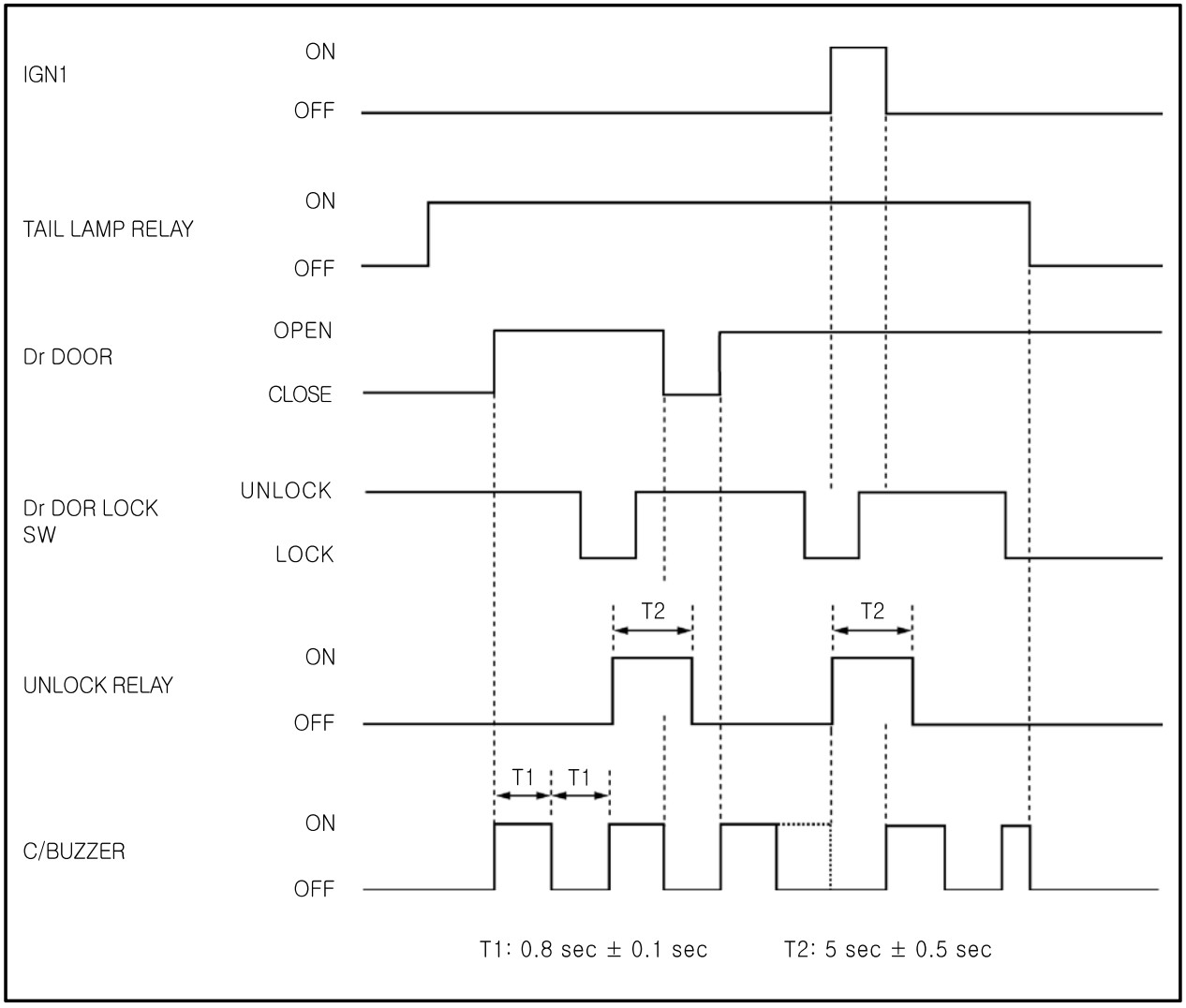


T1: 5 sec ± 0.5 sec

(*1) LOCK switches in all doors including tailgate (*2) Door switches in all doors excluding tailgate

15) Tail Lamp Left on Warning

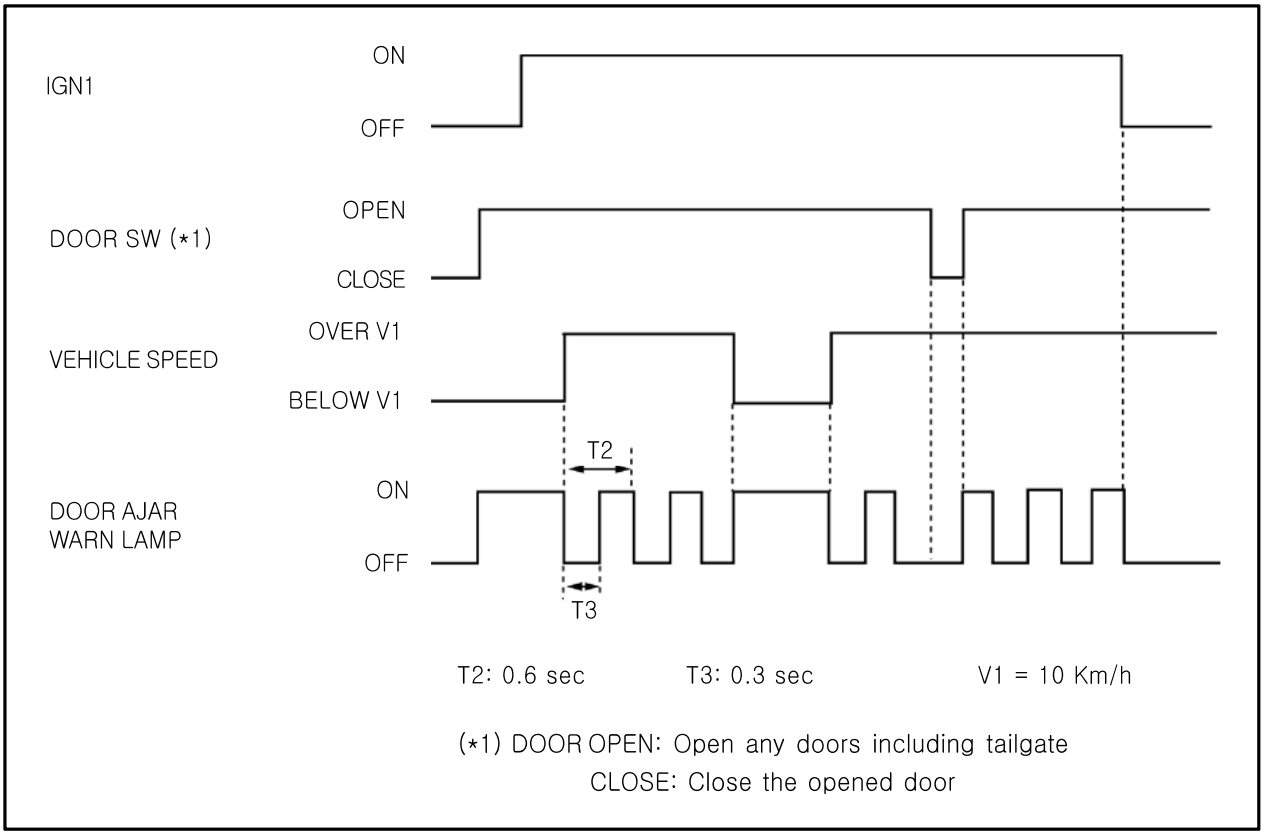
1. The chime buzzer sounds with the interval of 0.8 second when opening the driver's door while the tail lamp is turned on and the ignition key is removed.
2. The chime/buzzer output stops when turning off the tail lamp and closing the driver's door.
3. The system outputs "UNLOCK" signal for 5 seconds when the driver's and passenger's door lock switch is locked (while the tail lamp is turned on and the driver's door is open).
4. This function is not available when the ignition key is in the "ON" position.



Modification basis	
Application basis	
Affected VIN	

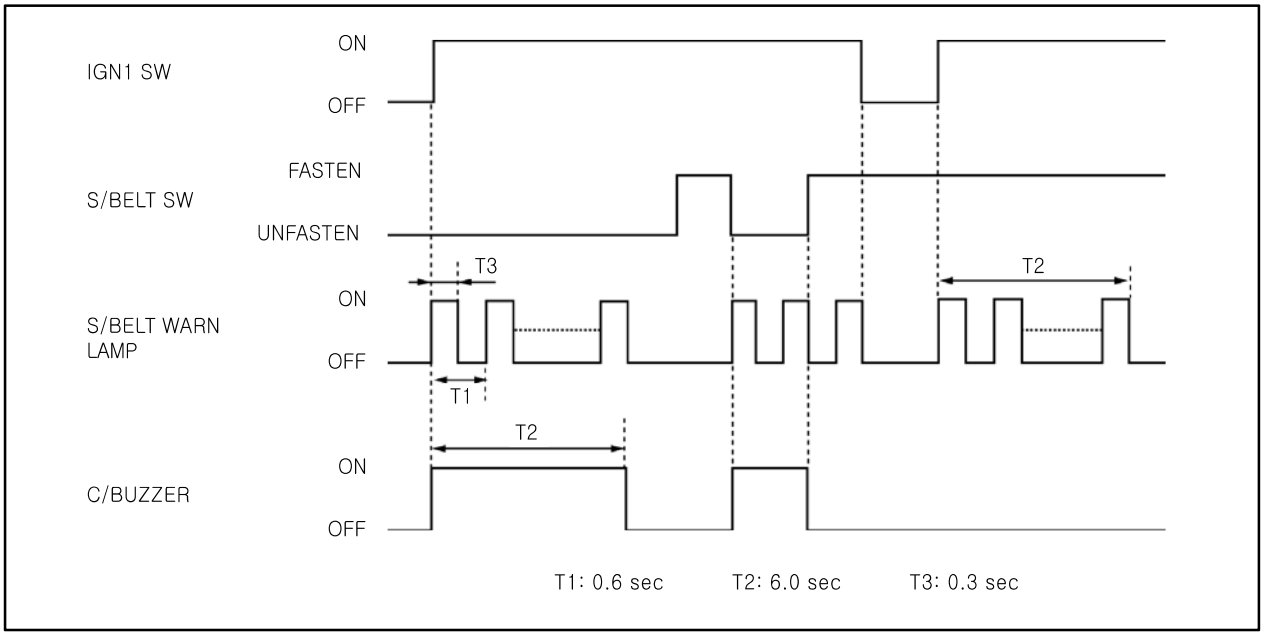
16) Door Ajar Warning

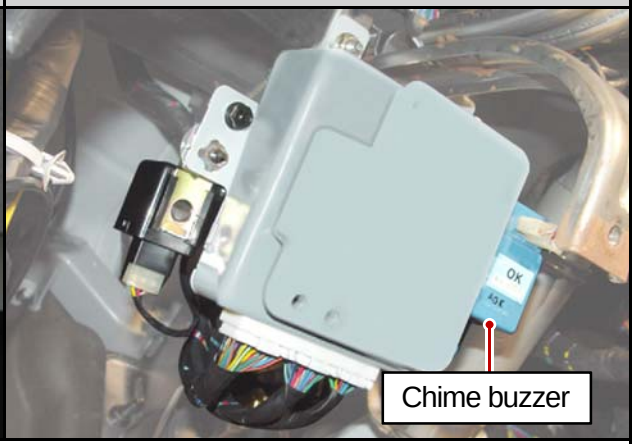
1. The warning light in instrument panel comes on when opening any of doors including tailgate while the vehicle speed is below 10 km/h.
2. The warning light goes off when closing the door under step 1.
3. The warning light blinks when the vehicle speed is over 10 km/h while the warning light is turned on. The warning light blinks when a door is open while the vehicle speed is over 10 km/h.
4. The warning light goes off when closing the door under step 3.
5. The warning light comes on when the vehicle speed goes below 10 km/h under step 3.
6.



17) Seat Belt Warning

1. The seat belt warning light comes on and the chime buzzer sounds for 6 seconds when turning the ignition key to "ON" from "OFF".
2. If the seat belt is fastened before turning the ignition key to the the "ON" position, the warning light in the instrument panel blinks, however, the chime buzzer does not sound.
3. The seat belt warning light goes off and the chime buzzer stops when turning the ignition switch to the "OFF" position.
4. The chime buzzer stops and the seat belt warning light stays on for the specified period of time when fastening the seat belt during the warning operation.
   The seat belt warning light comes on and the chime buzzer sounds for 6 seconds again when unfastening the seat belt during fastening operation while the ignition key is "ON" position.



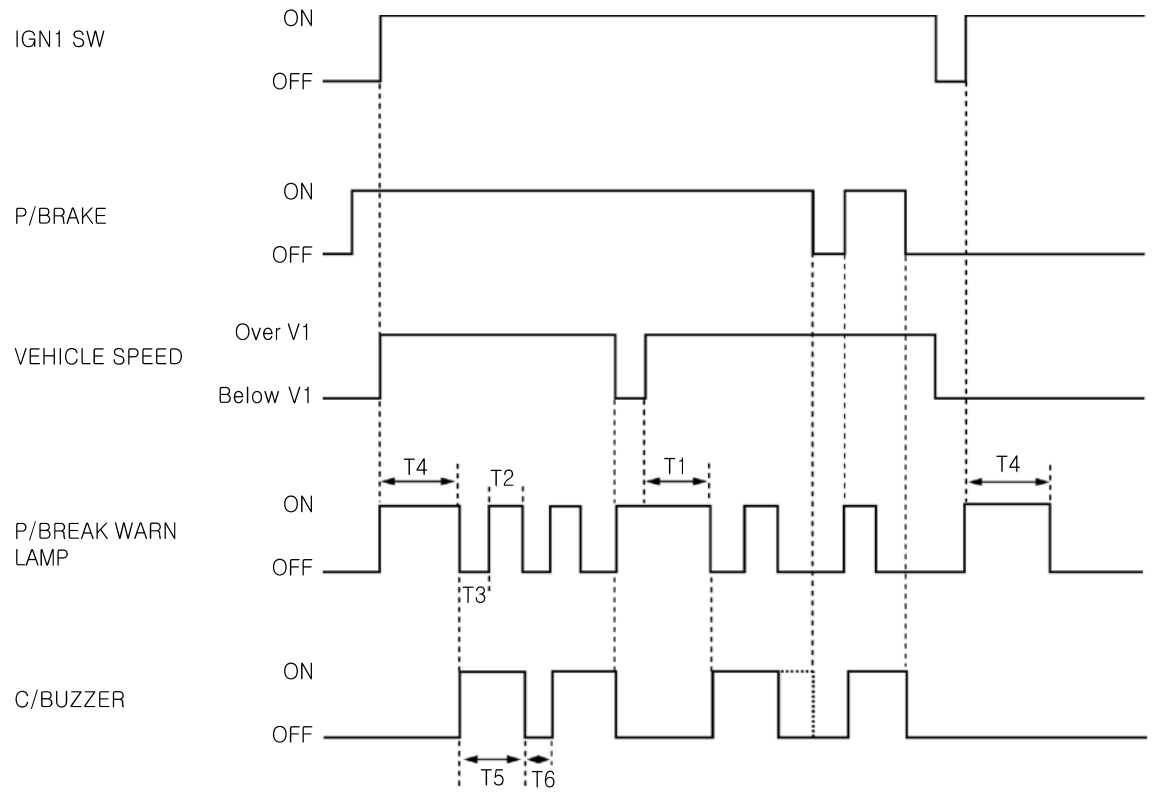
Seat Belt Warning Light	Chime Buzzer
	

The seat belt warning light comes on and the chime buzzer sounds for 6 seconds when turning the ignition key to "ON" from "OFF". After fastening the seat belt, the chime buzzer stops.

Modification basis	
Application basis	
Affected VIN	

18) Parking Brake Warning

1. The parking brake warning light comes on for approx. 4 seconds when turning the ignition key from the "OFF" to the "ON" position regardless of the vehicle speed and the parking brake switch position. After this 4 seconds, the warning lamp comes on, goes off or blinks according to the vehicle speed and the parking brake switch position.
2. The warning light comes on when the parking brake switch is turned on while the vehicle speed is below 10 km/h.
3. The warning light goes off when turning off the parking brake switch under step 2.
4. The warning light blinks and the chime buzzer in the ICM box sounds for 2.85 seconds and stops for 1.5 seconds when the vehicle speed is over 10 km/h for more than 2 seconds while the parking brake switch is turned on.
5. The warning light goes off and the chime buzzer stops when turning off the parking brake switch under step 4.
6. The warning light comes on and the chime buzzer stops when the vehicle speed goes down below 10 km/h under step 4.
7. This function is not available when the ignition key is turned to the "OFF" position.

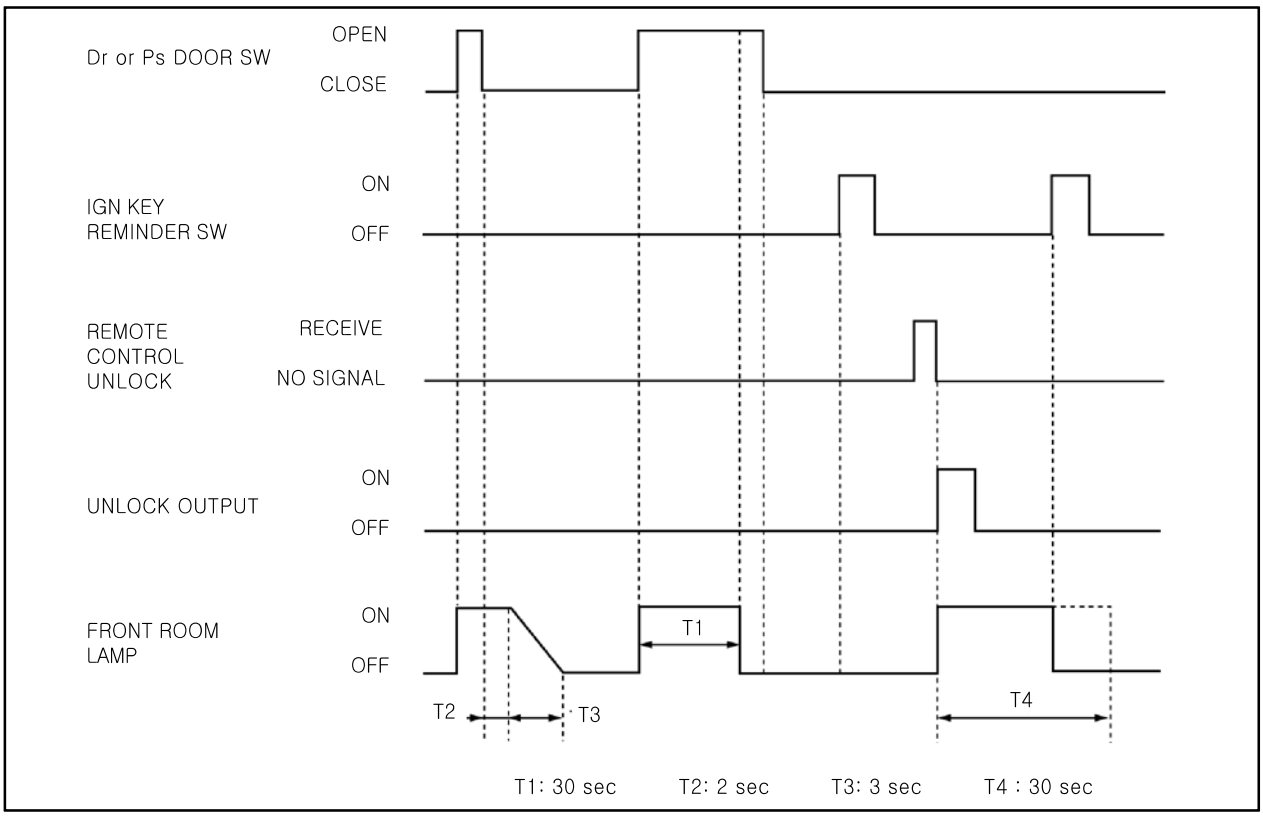


T1: 2.0 sec ± 0.5 sec T2: 0.6 sec T3: 0.3 sec T4: 4.0 sec V1: 10 Km/h T5: 2.5 sec ± 0.1 sec T6: 1.5s ± 0.1 sec

19) Front/Center Room Lamp Control

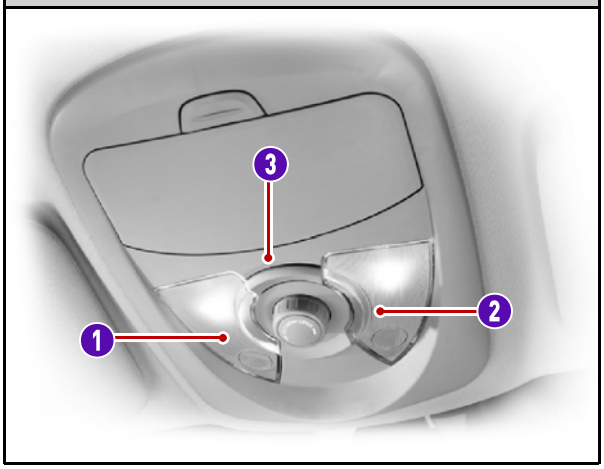
The overhead console lamp (front room lamp) and the center room lamp come on when opening the door while the center room lamp switch is at the coupled operating position and the key reminder switch is "OFF".

1. When the door (Driver's/Passenger's/Rear) is opened, the front and center room lamps come on and automatically go off after 30 seconds.
2. The room lamp stays on for 2 seconds and then dims through 3 seconds when closing the opened doors.
3. The dimming operation must have greater than 32 steps per one second.
4. The room lamp output should stop immediately after turning on the ignition key during the dimming operation.
5. The front room lamp and the center room lamp come on for 30 seconds when receiving the unlock signal from the remote control key while the doors are closed.
6. The front room lamp and the center room lamp output period is extended by 30 seconds when receiving the unlock signal from the remote control key again during output. (The lamp stays on when unlocked by the remote control key.)
7. When a door is opened during its extended period, the lamp stays on. If closed, operates as in step 2.
8. The room lamp output stops immediately after receiving the lock signal from door lock switches while all doors are closed or entering into the anti-theft mode by pushing LOCK button on the remote control key.
9. The luggage room lamp does not have a door coupled operating function. It shoulde be turned on and off by hand.



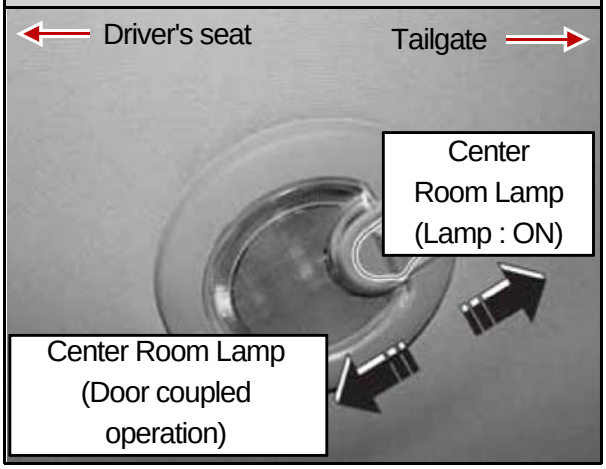
Modification basis	
Application basis	
Affected VIN	

Front Room Lamp: 12V / 8W - 2EA



Front room lamp (driver's or passenger's) is turned on and off when pressing the switch (1 or 2). However, it comes on when a door is opened and goes off when the door is closed. The front and center room lamps come on when pressing the room lamp main switch (3).

Center Room Lamp: 12V / 8W - 1EA



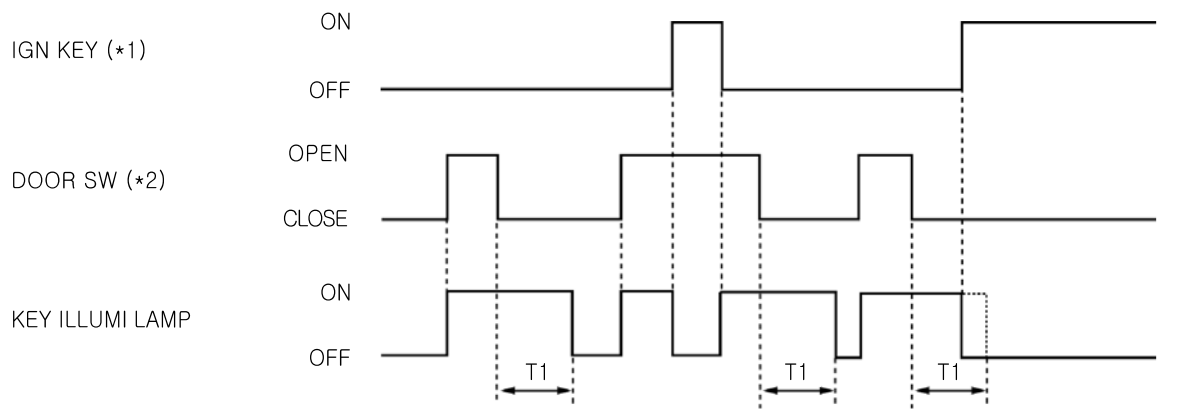
Center Room Lamp

If the switch is at the door coupled position, the center room lamp comes on when a door is opened. The lamp always comes on while the switch is at the other position.



20) Ignition Key Hole Illumination

1. The ignition key hole illumination comes on when opening the driver's door or passenger's door while the ignition key is removed.
2. The ignition key hole illumination stays on for 10 seconds when closing the door after step 1.
3. The output stops when the ignition key is turned to the "ON" position.
4. The output stops when receiving the lock signal from the remote control key (under armed mode).



T1 : 10 sec

(*1) ON : IGN KEY = ON
OFF : IGN KEY = OFF

(*2) OPEN : Driver's or Passenger's door = OPEN
CLOSE : Driver's and Passenger's = CLOSE

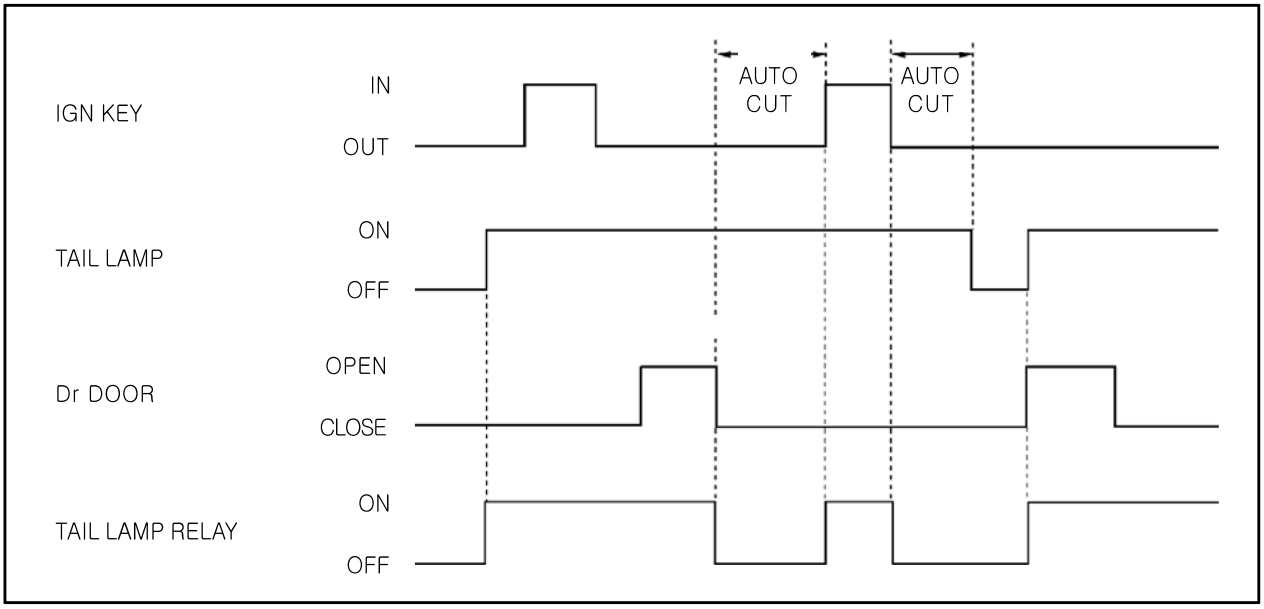
Key cylinder with key hole illumination

For diesel and gasoline engine equipped vehicle	For diesel engine equipped vehicle	For gasoline engine equipped vehicle
		
Without immobilizer →With key hole illumination	With immobilizer →With key hole illumination	With immobilizer →With key hole illumination

Modification basis	
Application basis	
Affected VIN	

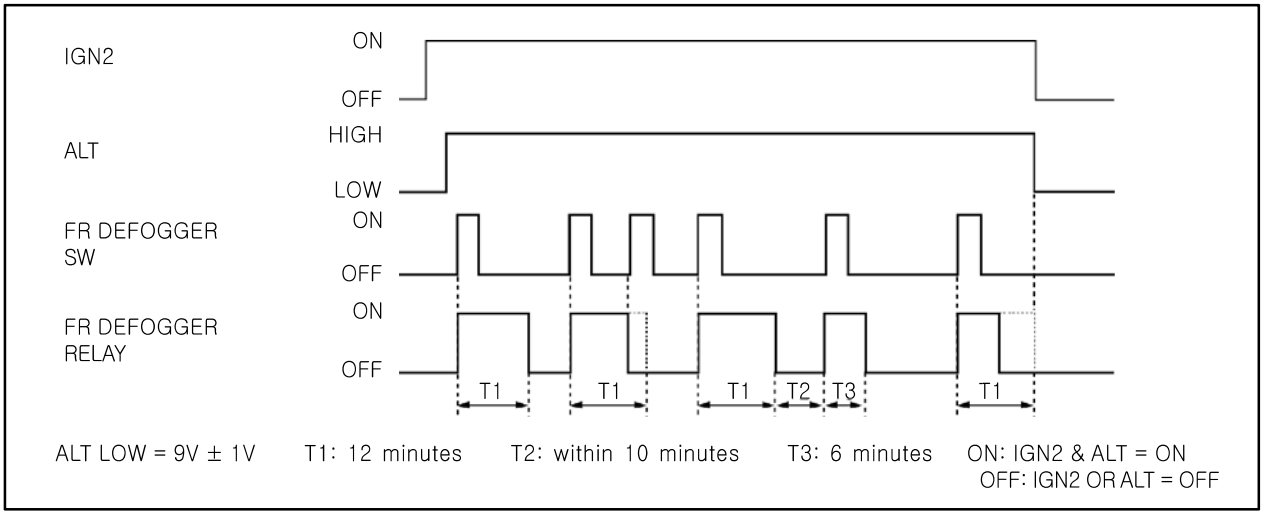
21) Tail Lamp Auto Cut (Battery Saver)

1. The tail lamp is turned on or off according to the operations of the tail lamp switch.
2. The tail lamp relay is turned off (auto cut) when opening and closing the driver's door after removing the ignition key without turning off the tail lamp.
3. The tail lamp relay is turned on when inserting the ignition key into the ignition switch.
4. The tail lamp relay is turned off (auto cut) when opening and closing the driver's door while the ignition key is removed and the tail lamp is turned on.



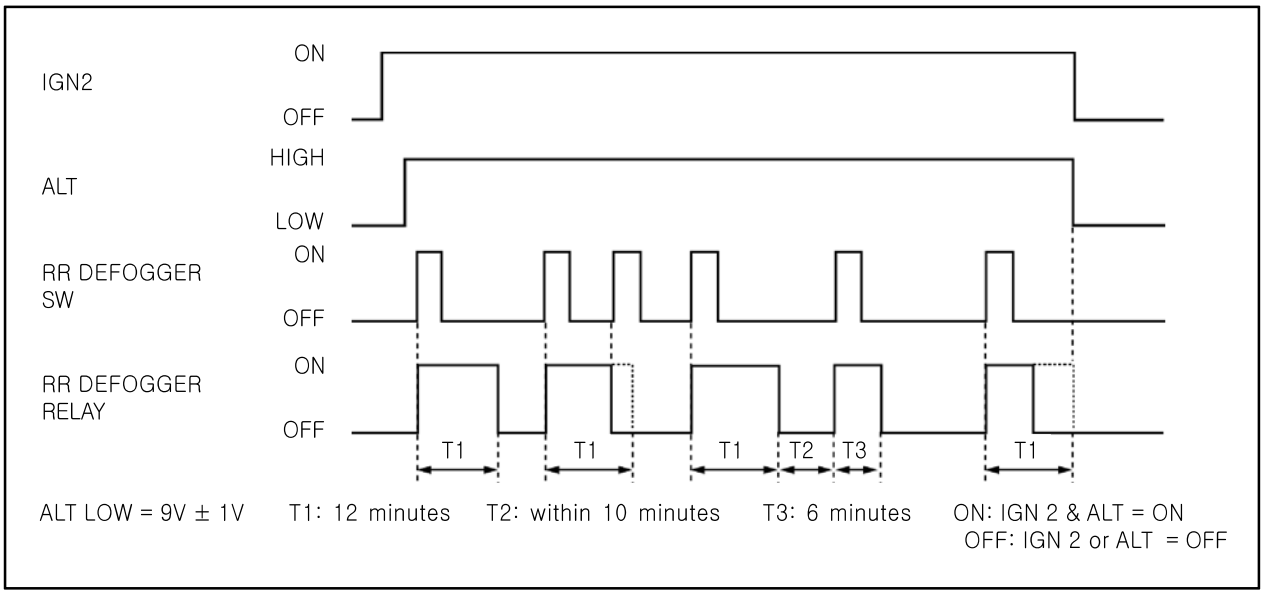
22) Front Defogger Timer

1. The front defogger output is "ON" when turning "ON" the front defogger switch while the ignition switch is "ON" (with engine running).
2. The output stops when turning on the defogger switch again during its operation.
3. The output is "ON" only for 6 minutes when turning "ON" the front defogger switch within 10 minutes after completion of output for 12 minutes. This can be done only once.
4. The output is "OFF" when the ignition switch is "OFF".



23) Rear Defogger Timer

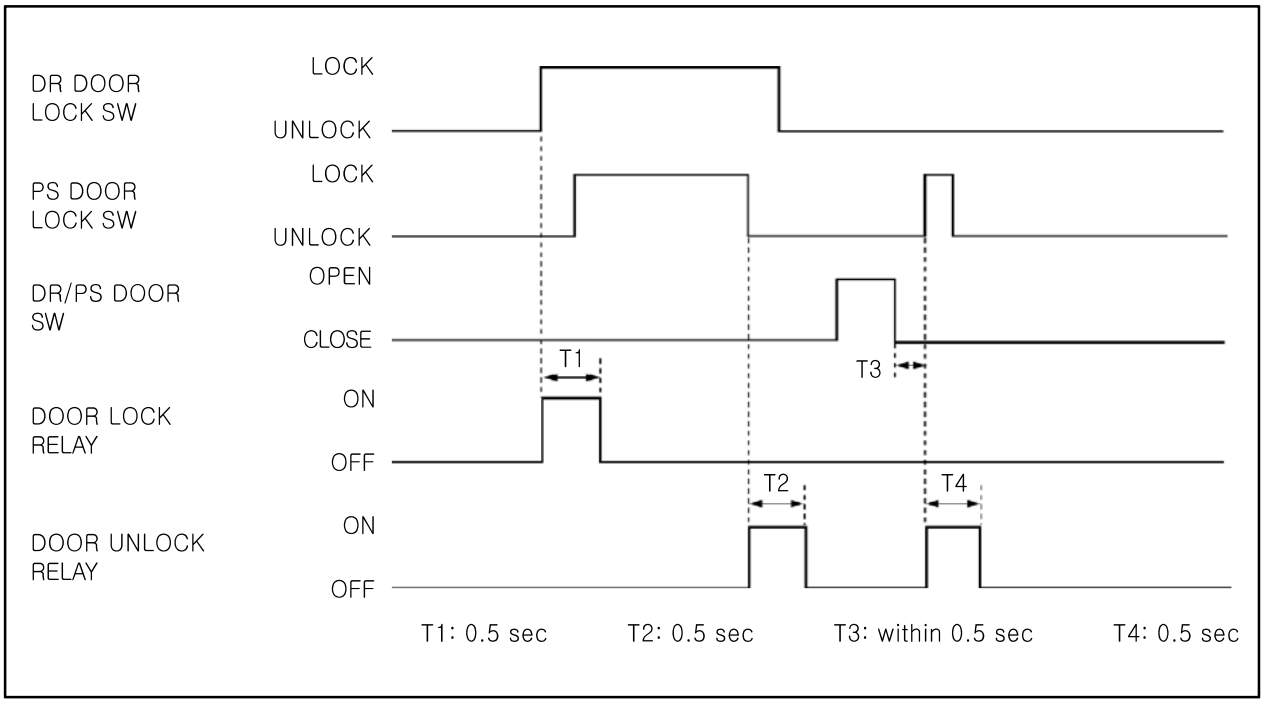
- The rear defogger output is "ON" when turning "ON" the rear defogger switch while the IGN 2 switch is "ON" (with engine running).
- The output is "OFF" when turning "ON" the rear defogger switch again during output.
- The output is "ON" only for 6 minutes when turning "ON" the rear defogger switch within 10 minutes after completion of output for 12 minutes. This can be done only once.
- The output is "OFF" when the IGN 2 switch is "OFF".



Modification basis	
Application basis	
Affected VIN	

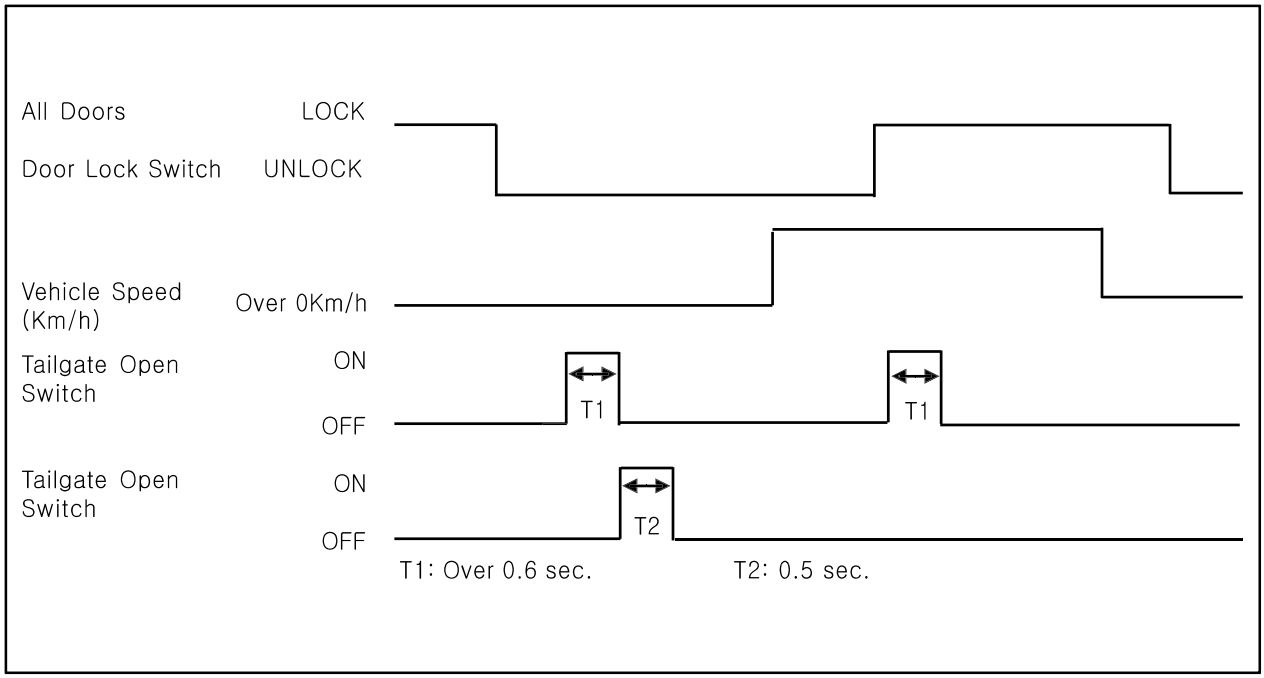
24) Door Lock/Unlock Control by Door Lock Switch

1. The door lock system outputs "LOCK" signal for 0.5 seconds when positioning the driver's or passenger's door lock switch to the lock position.
2. The door lock system outputs "UNLOCK" signal for 0.5 seconds when positioning the driver's or passenger's door lock switch to the unlock position.
3. "LOCK" or "UNLOCK" by the door lock switch is ignored when outputting the "LOCK" or "UNLOCK" signal by other functions.
4. All door lock signals are "UNLOCK" for 0.5 seconds just for once when receiving the "LOCK" signal within 0.5 seconds after closing the driver's or passenger's door while the ignition key is removed.



25) Tailgate Open Control

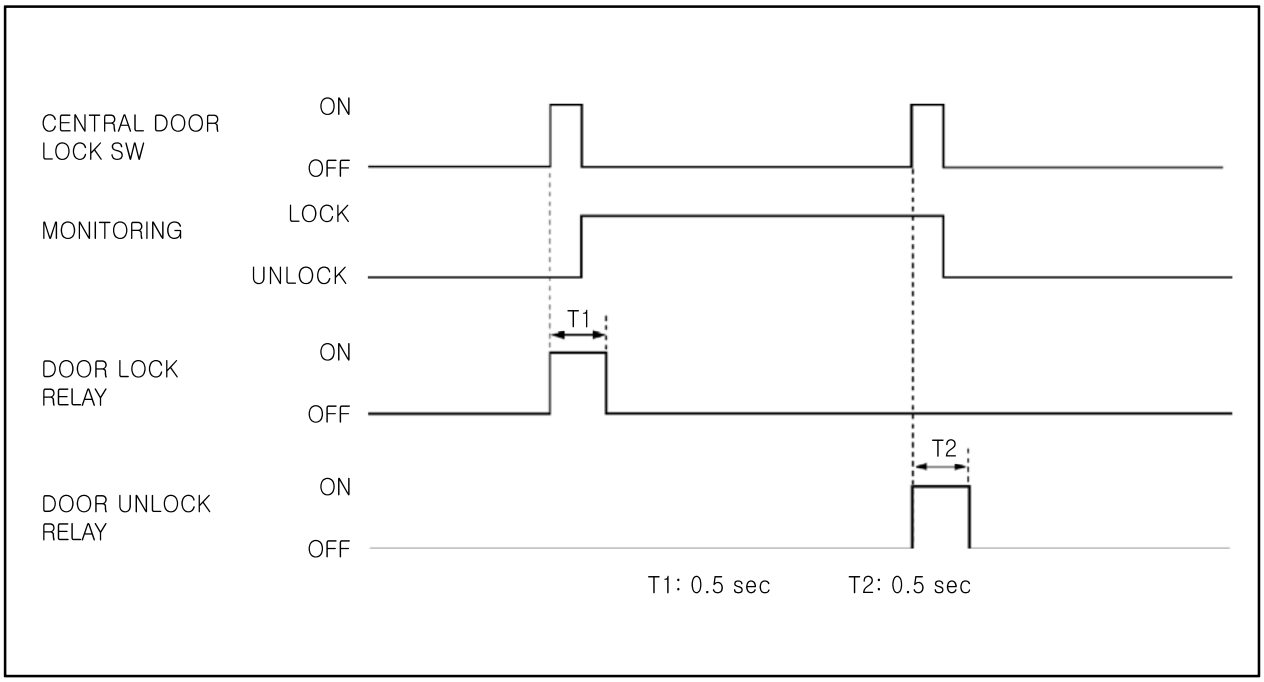
1. When pressing and holding the tailgate open switch for more than 0.6 seconds while LOCK switches in all doors are in UNLOCK position and the vehicle speed is 0 Km/h, STICS operates the tailgate relay for 0.5 seconds to unlock the tailgate.
2. If any LOCK switch is switched to LOCK position or vehicle speed exceeds 3 Km/h while operating the tailgate open relay, the output of the tailgate relay gets OFF.



Modification basis	
Application basis	
Affected VIN	

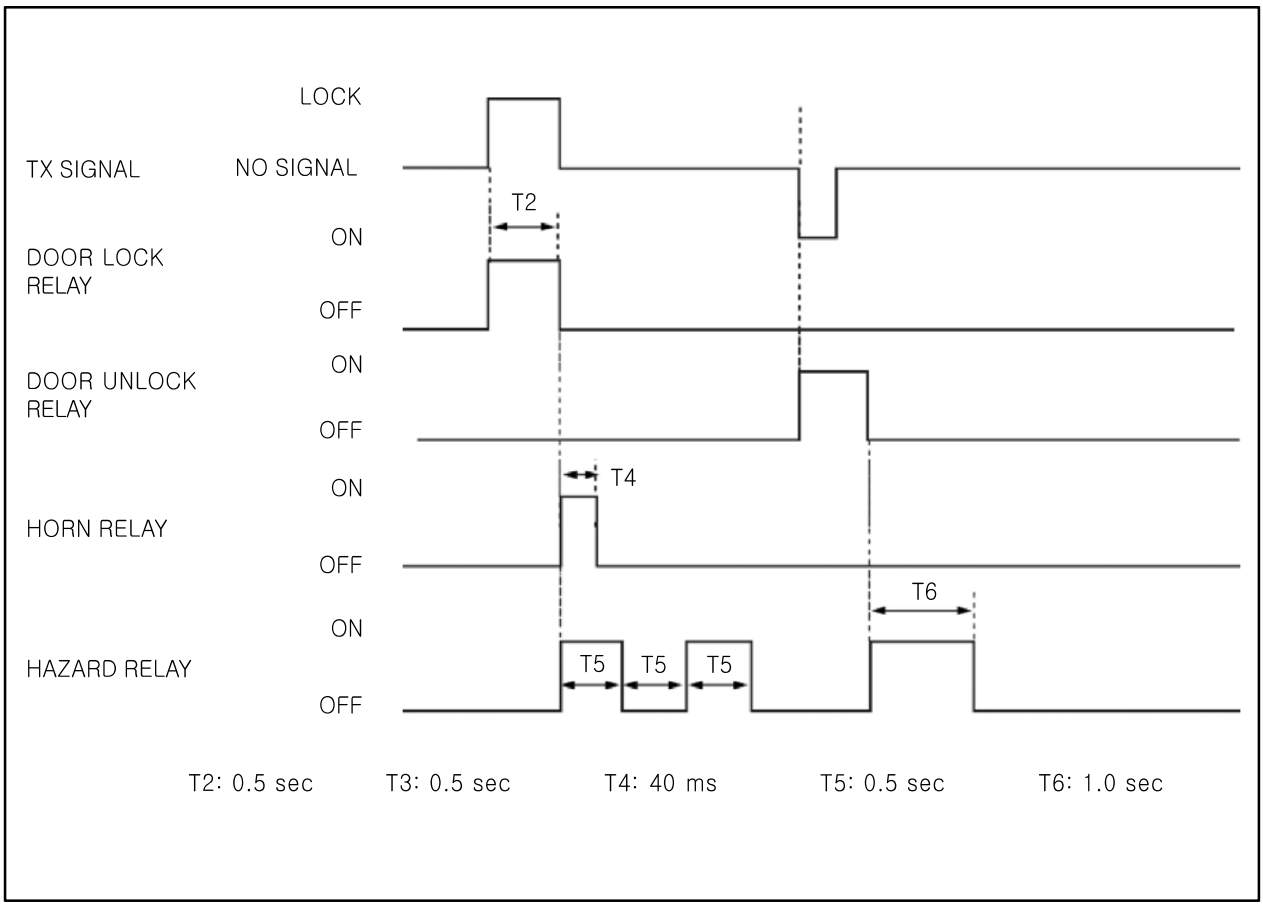
26) Door Lock/Unlock Control by Door Lock Switch

1. The door lock system outputs "LOCK/UNLOCK" signal for 0.5 seconds when operating the central door lock switch. (However, if the door lock switch (front doors) is at LOCK position, the system outputs UNLOCK signal, and vice versa.)
2. The "LOCK" or "UNLOCK" inputs from the central door lock switch in anti-theft mode are ignored.



27) Door LOCK/UNLOCK by Remote Control Key

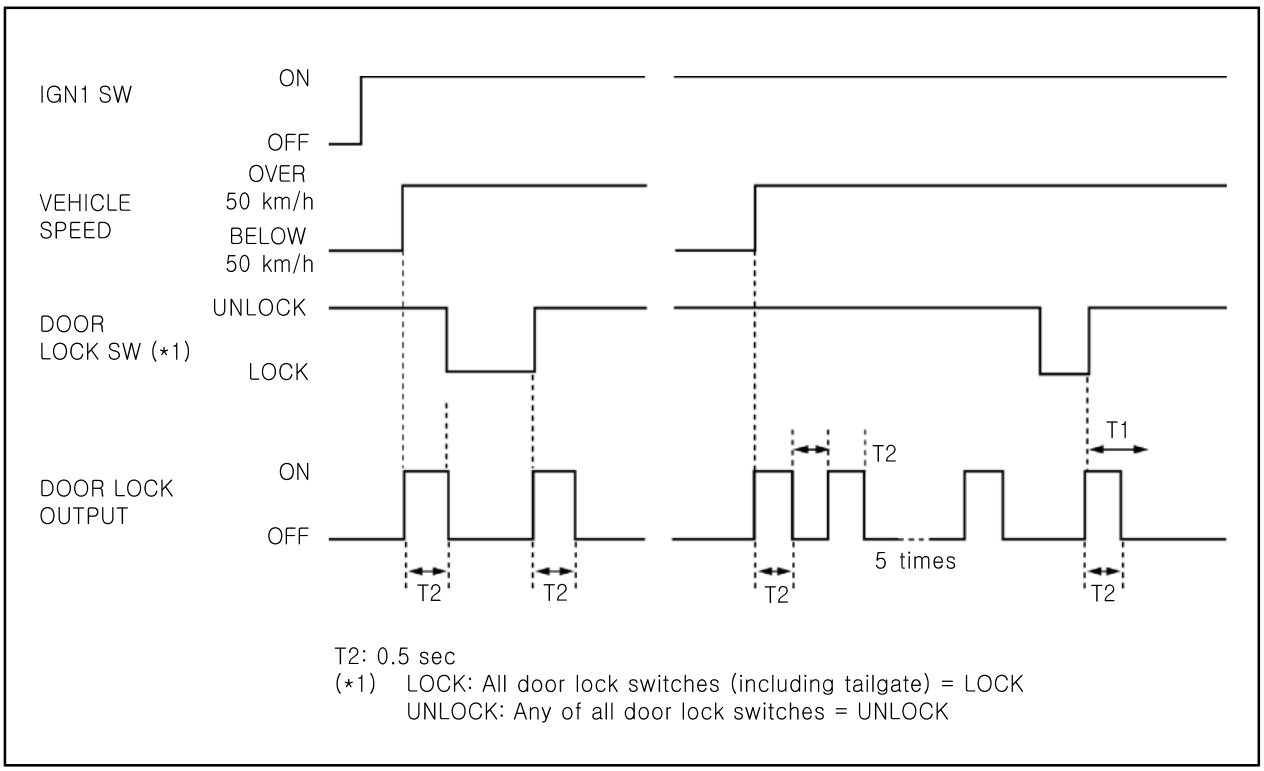
1. The door lock relay output is "ON" for 0.5 seconds when receiving the remote control lock signal.
   The door unlock relay output is "ON" for 0.5 seconds when receiving the remote control unlock signal.
2.



Modification basis	
Application basis	
Affected VIN	

28) Auto Door Lock

1. The door lock system outputs "LOCK" when the vehicle speed maintains over 50 km/h. However, it doesn't output "LOCK" when all doors are locked or failed.
2. If any of doors is unlocked after outputting "LOCK" in step 1, outputs "LOCK" up to 5 times (except step 1) at the interval of one second.
3. If any of doors is unlocked after 5 times of "LOCK" outputs, the door is regarded as "FAIL".
4. If the door that was regarded as fail changes (UNLOCK to LOCK) to unlock, only one "LOCK" output will be done.
5. If any door is regarded as FAIL, the auto door lock function does not work (if it is occurred when the vehicle speed is over 50 km/h, the auto door lock output does not occur even if the vehicle speed falls below 50 km/h and accelerates again to over 50 km/h.). Nonetheless, the central door lock function works properly.
6. When the system receives "UNLOCK" signal from a door switch, it outputs "LOCK" signals 5 times. If additional "LOCK" signal from another door switch is detected during the period, the system outputs five "LOCK" signals 5 times for the door.
7. The door lock system outputs "UNLOCK" automatically if the "LOCK" output conditions are established by this function or the key is cycled (IGN1=OFF) (even when there is no "LOCK" output while the vehicle speed maintains over 50 km/h under lock condition).
   (If the LOCK condition is established with the ignition switch ON, the system outputs UNLOCK signal unconditionally when turning the ignition switch to OFF position.)
   However, when the ignition key is turned to "OFF" position, the lock output conditions will be cancelled.
8. The "FAIL" condition of the door will be erased when the ignition key is turned to "OFF" position.

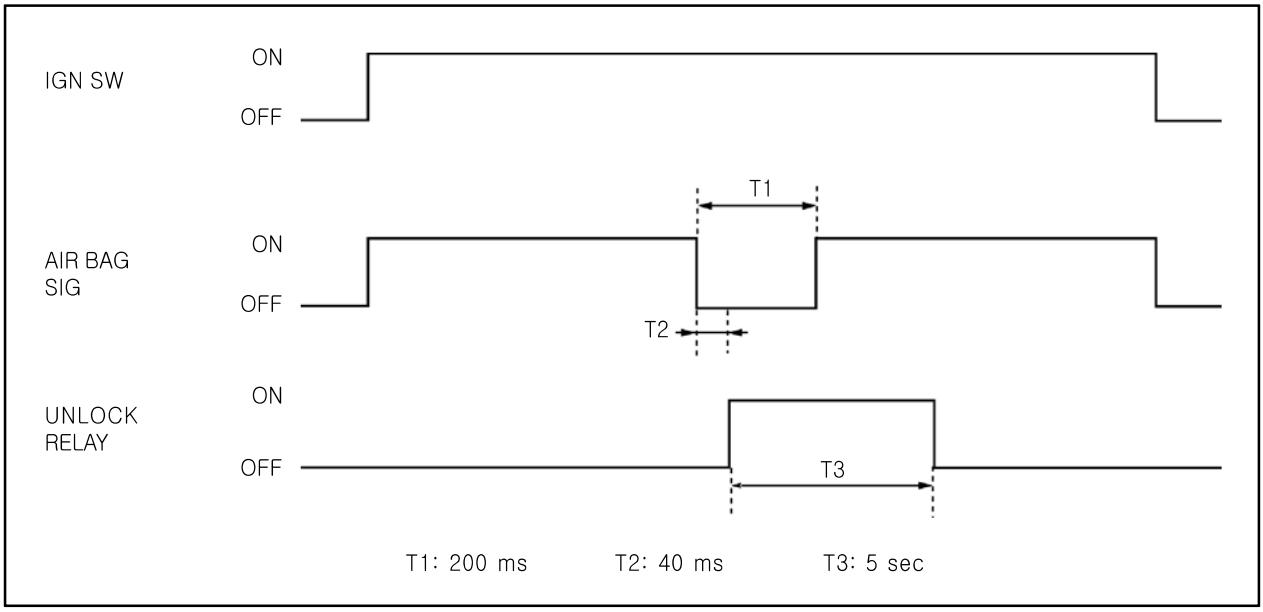


T2: 0.5 sec
(*1) LOCK: All door lock switches (including tailgate) = LOCK
UNLOCK: Any of all door lock switches = UNLOCK

Modification basis	
Application basis	
Affected VIN	

29) Auto Door Unlock (Crash Unlock)

1. The air bag collision signal input cannot be accepted within 7 seconds after turning the ignition key to "ON" position.
2. After this period, the door lock system outputs "UNLOCK" for all doors for 5 seconds from 0.4 seconds after receiving the air bag collision signal.
3. Even though the key is turned to "OFF" position during the output of "UNLOCK", the output continues on for remaining period.
4. The function is erased when turning "OFF" the IGN switch.



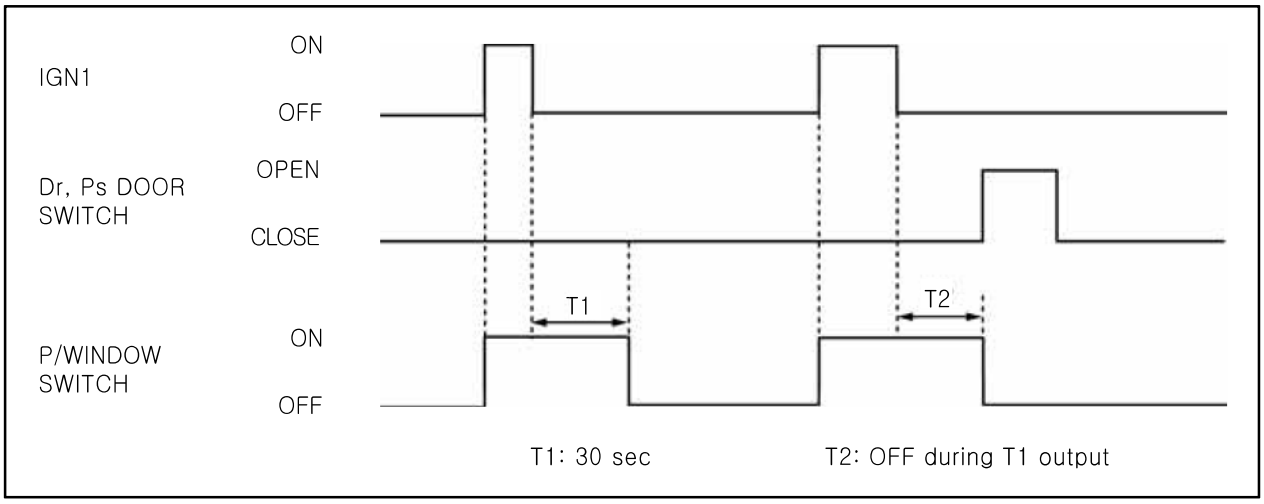
CAUTION

- The "Unlock" control by air bag signal prevails over any "LOCK" or "UNLOCK" control by other functions.
- The "LOCK/UNLOCK" request by other functions will be ignored after/during the output of "UNLOCK" by the air bag.
  However, the door lock is controlled by other functions when the ignition switch is "OFF".
- "LOCK" (or "UNLOCK") output is ignored if "LOCK" (or "UNLOCK") output is required while performing the output of "LOCK" (or "UNLOCK").
- If the door lock system outputs "LOCK" and "UNLOCK" simultaneously, only the "LOCK" output can be activated.

Modification basis	
Application basis	
Affected VIN	

30) Time Lag Power Window Control

1. The power window relay output is "ON" when turning on the ignition switch.
2. The power window relay output is "ON" for 30 seconds when turning off the ignition switch. The power window relay output is "OFF" when opening the driver's door or the passenger's door. The power window relay is turned "OFF" when receiving the remote control key lock signal (armed
3. mode) during its extended operation period of 30 seconds.



31) Definition of Terms

1. DOOR OPEN and DOOR CLOSE
   DOOR OPEN: Any of all door switches (including hood and tailgate) is in "OPEN" position.
   DOOR CLOSE: All door switches (including hood and tailgate) are in "CLOSE" position.

CAUTION
The door lock/unlock operation does not affect the engine hood.

2. DOOR LOCK: Indicates that all door lock switches (including tailgate) are in LOCK positions.
   DOOR UNLOCK: Indicates that any of all door lock switches (including tailgate) is in UNLOCK position.



Engine hood open warning lamp
The warning lamp comes on when the engine hood is open.

32) Description of Theft Deterrent Function

1. Armed mode activation requirements

a. The "LOCK" output is "ON" when the "LOCK" signal is received from transmitter while the ignition key is removed and all doors are closed. The armed mode is activated when the door lock switch is locked (hazard warning flasher blink twice).

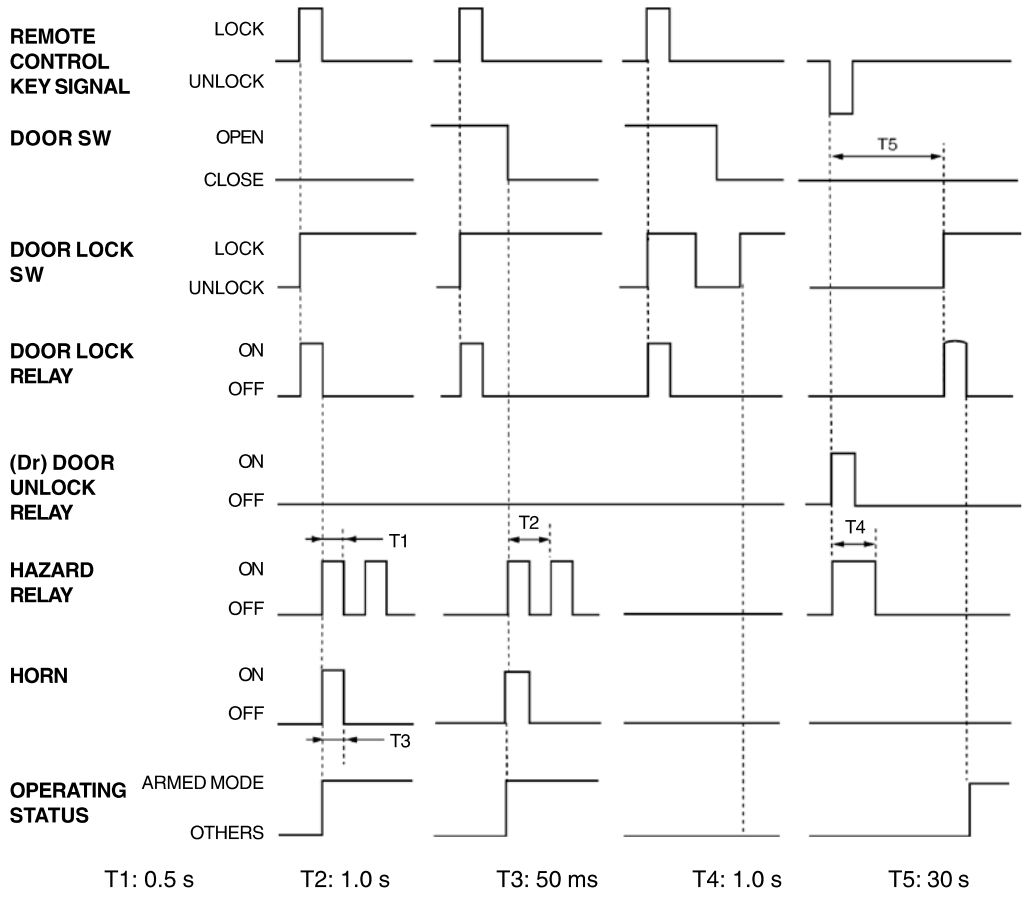
b. The armed mode is still activated and the hazard warning flasher blink twice when the "LOCK" signal is received from the remote control key again in armed mode.

c. When the "LOCK" signal is received from the remote control key while any of doors is not closed, only the "LOCK" output can be done and then activates the armed ready mode (without theft deterrent horn and hazard warning flasher). At this moment, if the ignition key is inserted or the door lock switch is unlocked, it cancels the armed mode and activates the normal mode.

d. When the door is opened or the ignition key is not inserted into ignition switch within 30 seconds after receiving "UNLOCK" signal from the remote control key, it outputs "LOCK" and then activates armed mode (RELOCK operation). Also, at this moment, the system blinks hazard warning flasher twice.

The armed mode will not be activated except above conditions.

e. Ex) The armed mode will not be activated when the door is locked by the ignition key.



* The deck tailgate is not included in the operation conditions of theft deterrent system, because there's no door switch.

Modification basis	
Application basis	
Affected VIN	

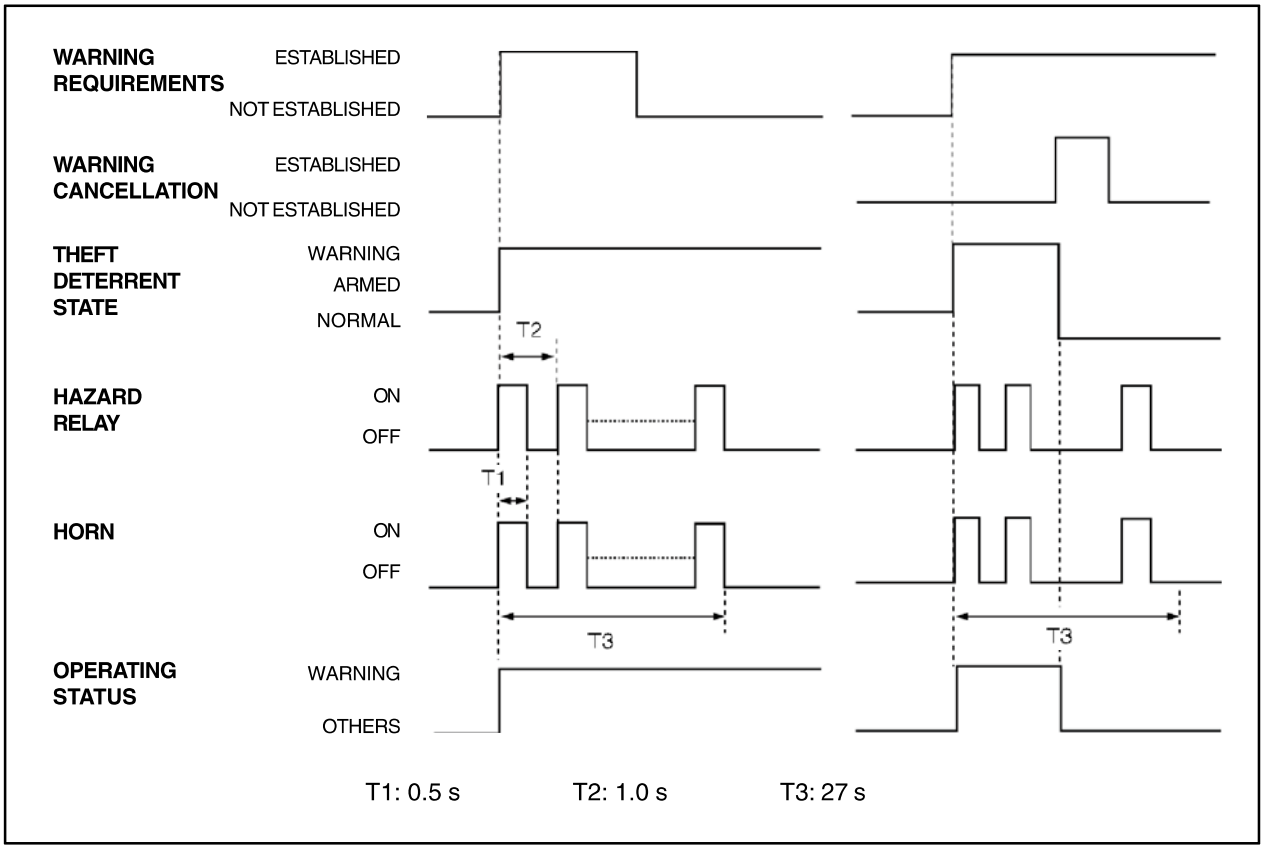
2. Armed mode cancellation requirements
   1) Receiving UNLOCK signal from the remote control key or starting the engine.

3. Warning operation requirements
   1) When opening the door in armed mode
   2) When unlocking the door lock switch in armed mode by other than the remote control key
   3) When closing and then opening the door after completion of warning (27 seconds)

4. Warning operation
   1) The theft deterrent horn and hazard warning flasher output is "ON" for 27 seconds at the interval of 1 second.

5. Warning cancellation requirements
   1) Cancels warning by using any signal from the remote control key (LOCK, UNLOCK, PANIC) during warning operation.
   2) Cancels warning after 27 seconds (remaining time) while the ignition key is turned to "ON" position.
   3) If the ignition switch is turned to ON position when the warning is activated in armed mode, the warning is cancelled immediately and the warning buzzer stops after 27 seconds (remaining time).

6. Operation when warning is cancelled
   1) The theft deterrent horn and hazard warning flasher outputs are "OFF".



8. Operations when removing and installing the battery

Removed \ Installed	Normal	Armed	Warning	Remark
Normal	○			
Armed Ready	○			
Armed		○		
Warning			○	
Warning Completion	○	○	○	
RELOCK Ready	○			

If the system is in armed mode while installing a battery, the horn sounds and the emergency warning lamp blinks (Same operations with warning in armed mode).
RELOCK Operation It the door is not opened or the ignition key is not inserted into the key cylinder within 30 seconds after unlocking the door with remote control key, the system outputs "LOCK" signal and activates the armed mode.

33) Specifications of Remote Control Key

When any of switches on remote control key is pressed, the integrated CPU in remote control key sends the coded control message to the CPU in receiver to control the vehicle.

Switch Functions on Remote Control Key

Function		Switch Operation
Function	Door lock	Briefly press the switch briefly
	Door unlock	Press and hold the door switch
	PANIC	Briefly press the panic button

▶ Door Unlock and Panic Function

Briefly press (below 0.5 sec): Door unlock and theft deterrent mode is deactivated
Press and hold (over 2 sec): Panic function
1. Door unlock (Briefly press)
- If the unlock button on the remote control is pressed, the door will be opened and the theft deterrent mode will be activated. If the door coupled switch of front room lamp is pressed, the lamp will come on for 30 seconds. It will turn off immediately after the lock button of the remote control is pressed.

2. Panic function: activated in the theft deterrent mode
- If you press and hold the door unlock and panic buttons, the buzzer will sound for 27 seconds.
- The function is inactivated if any button of remote control is pressed.

LED flasher
Briefly press: blink once
Press and hold: blink twice



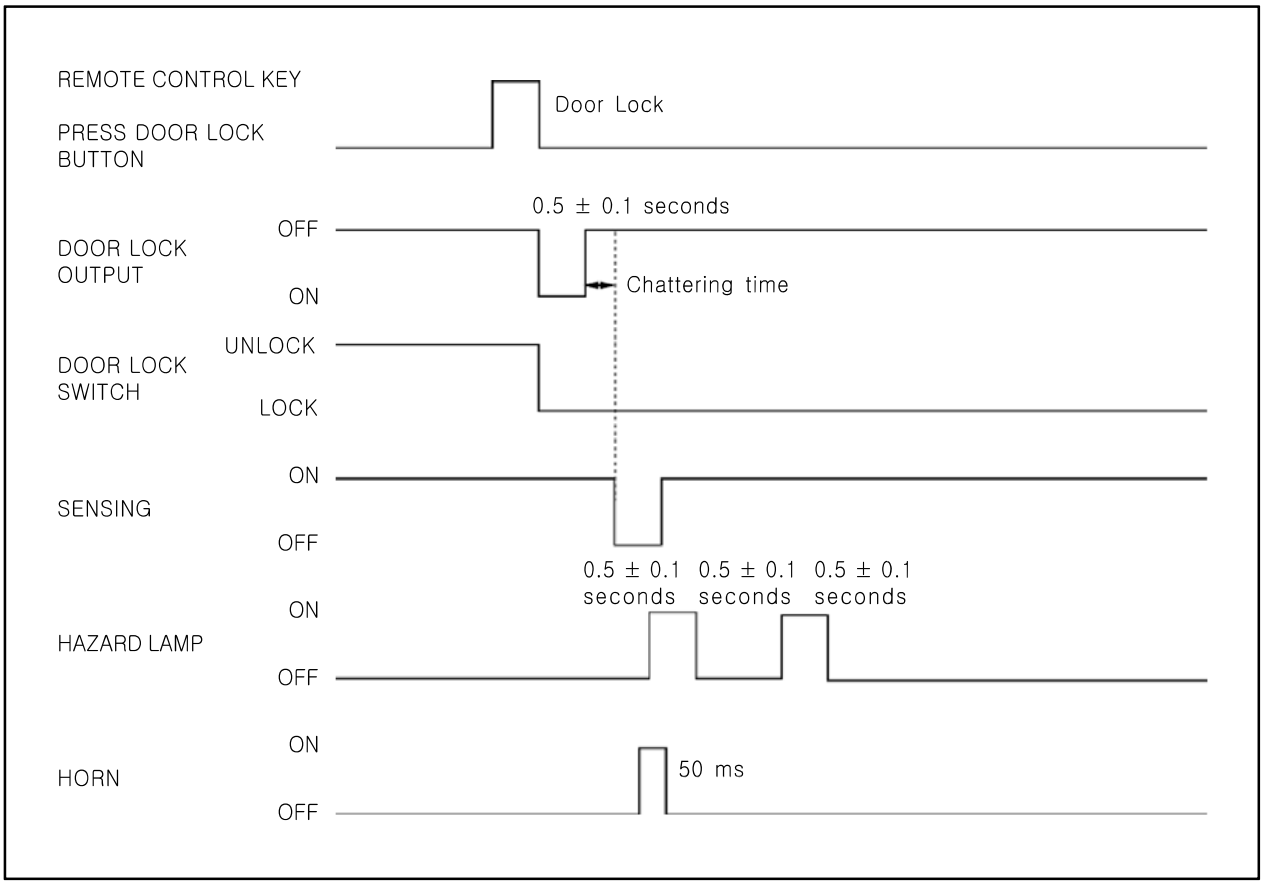
▶ Door Lock Function

Briefly press (below 0.5 sec): Door lock and theft deterrent mode is activated
Door lock (Briefly press)
- If you press this button locks all doors and activates the theft deterrent mode.

Modification basis	
Application basis	
Affected VIN	

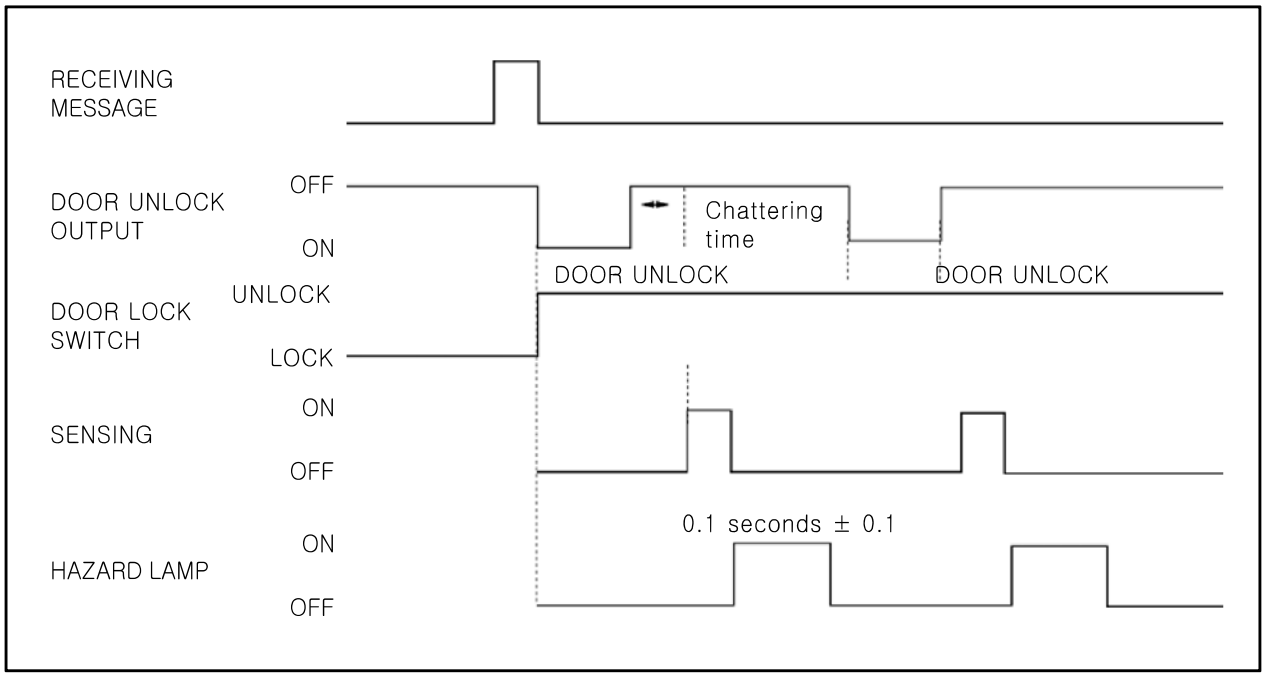
34) Remote Door Lock

1. All doors are locked when briefly pressing the door LOCK switch on remote control key (less than 0.5 seconds).
2. The system outputs LOCK signal immediately after receiving the door lock message from the remote control key. The system activates the theft deterrent mode when all doors are locked while they are fully closed (the hazard warning lamps blink twice.).



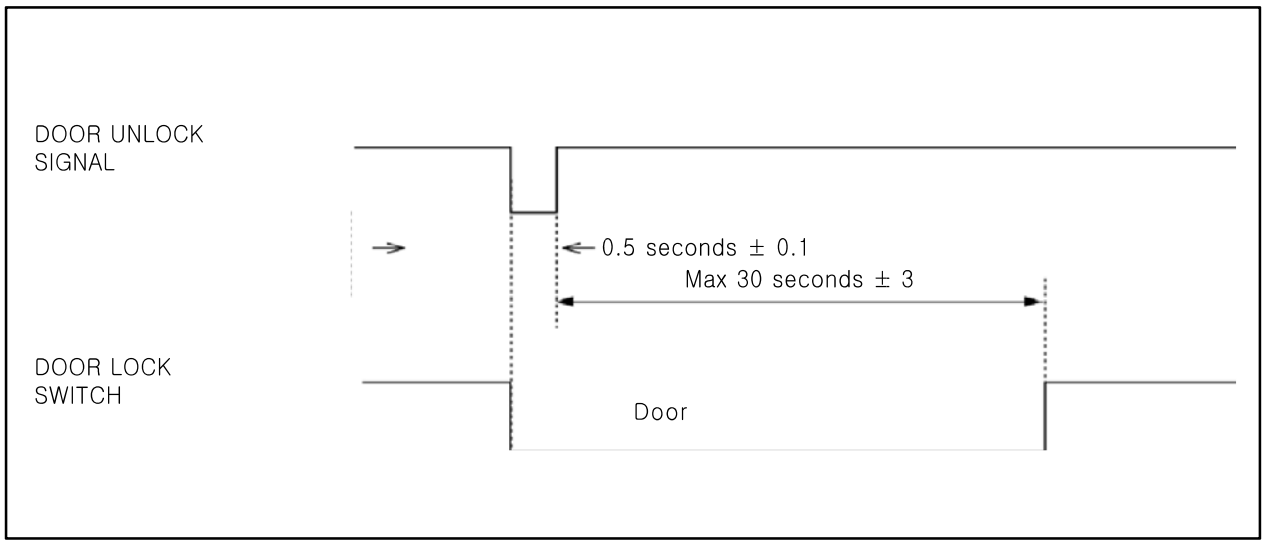
35) Door Unlock

1. The door unlock operates when pressing the door switch on the remote control key for longer than 0.5 seconds.
2. The door unlock relay is "ON" for 0.5 seconds when receiving the door unlock message from the remote control key.
3. The hazard warning lamps blink once only when all the doors unlocked.



36) Auto Door Lock in 30 Seconds after Pressing Door Unlock Button

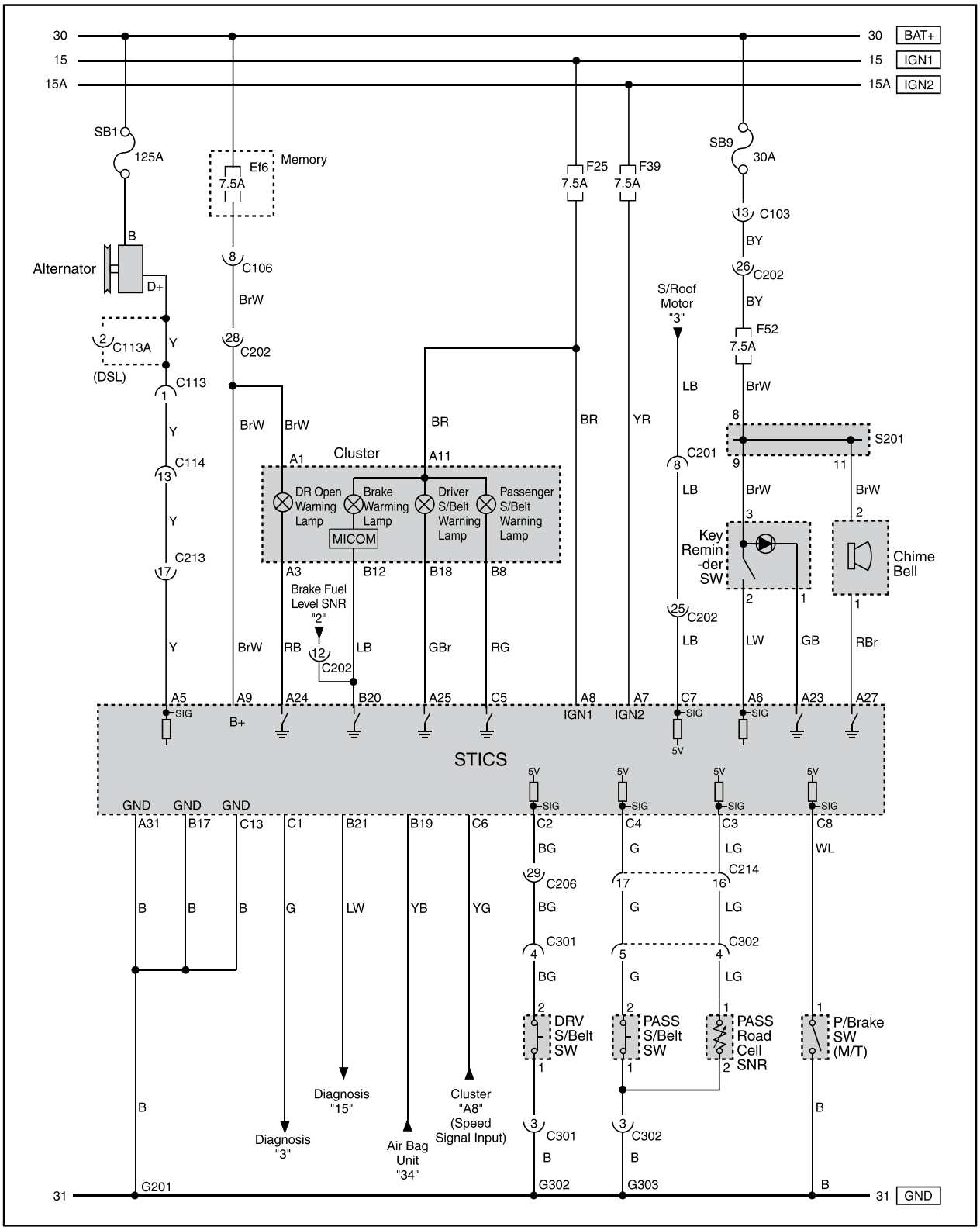
1. If no door is opened for 30 seconds after inputting remote door unlock, the doors are automatically locked and the armed mode of anti-theft system is activated again.



Modification basis	
Application basis	
Affected VIN	

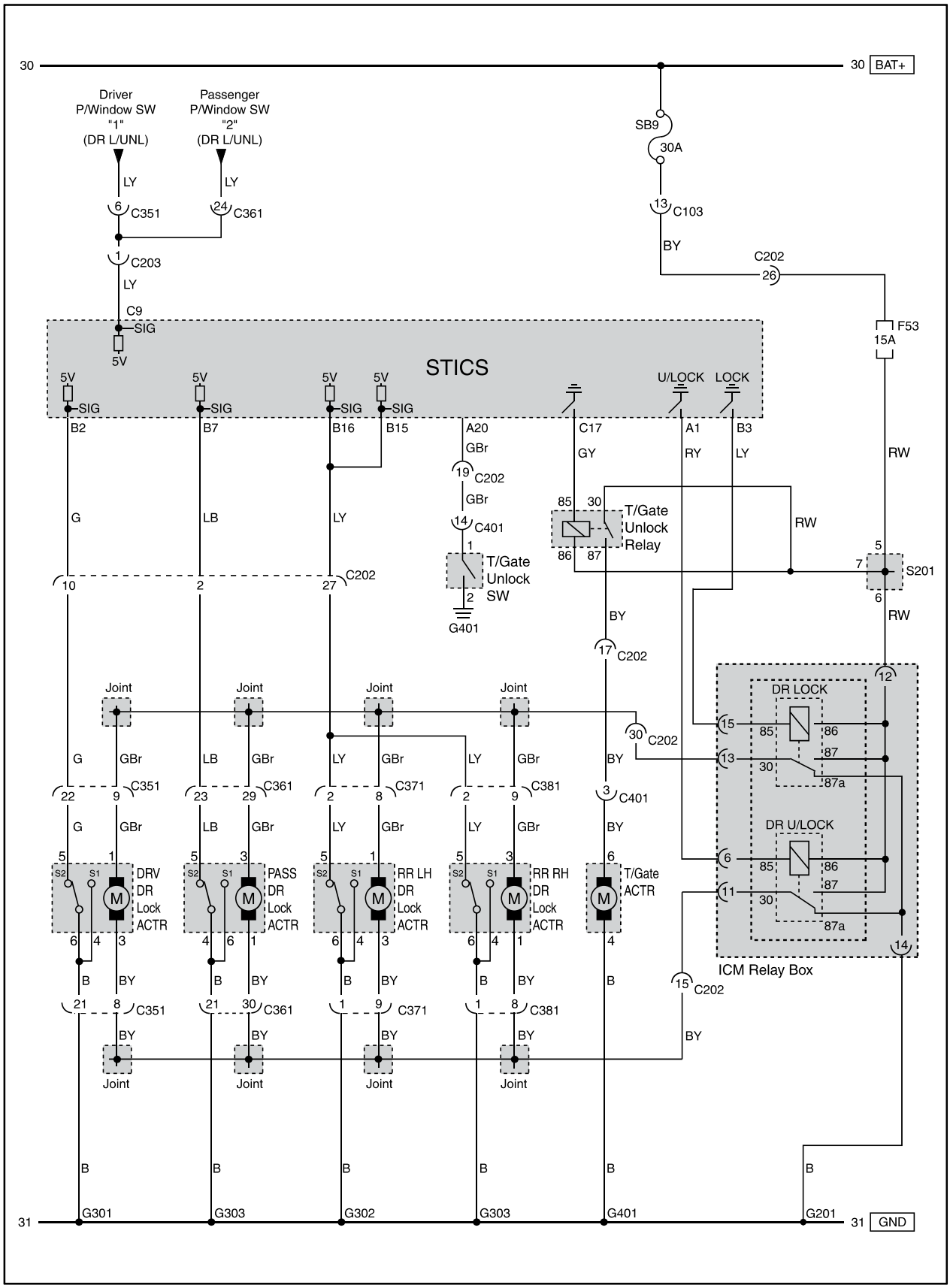
3. CIRCUIT DIAGRAM

1) Power/Ground, Chime Bell, Buzzer Warning Lamp (Brake, Seat Belt, DR Open)



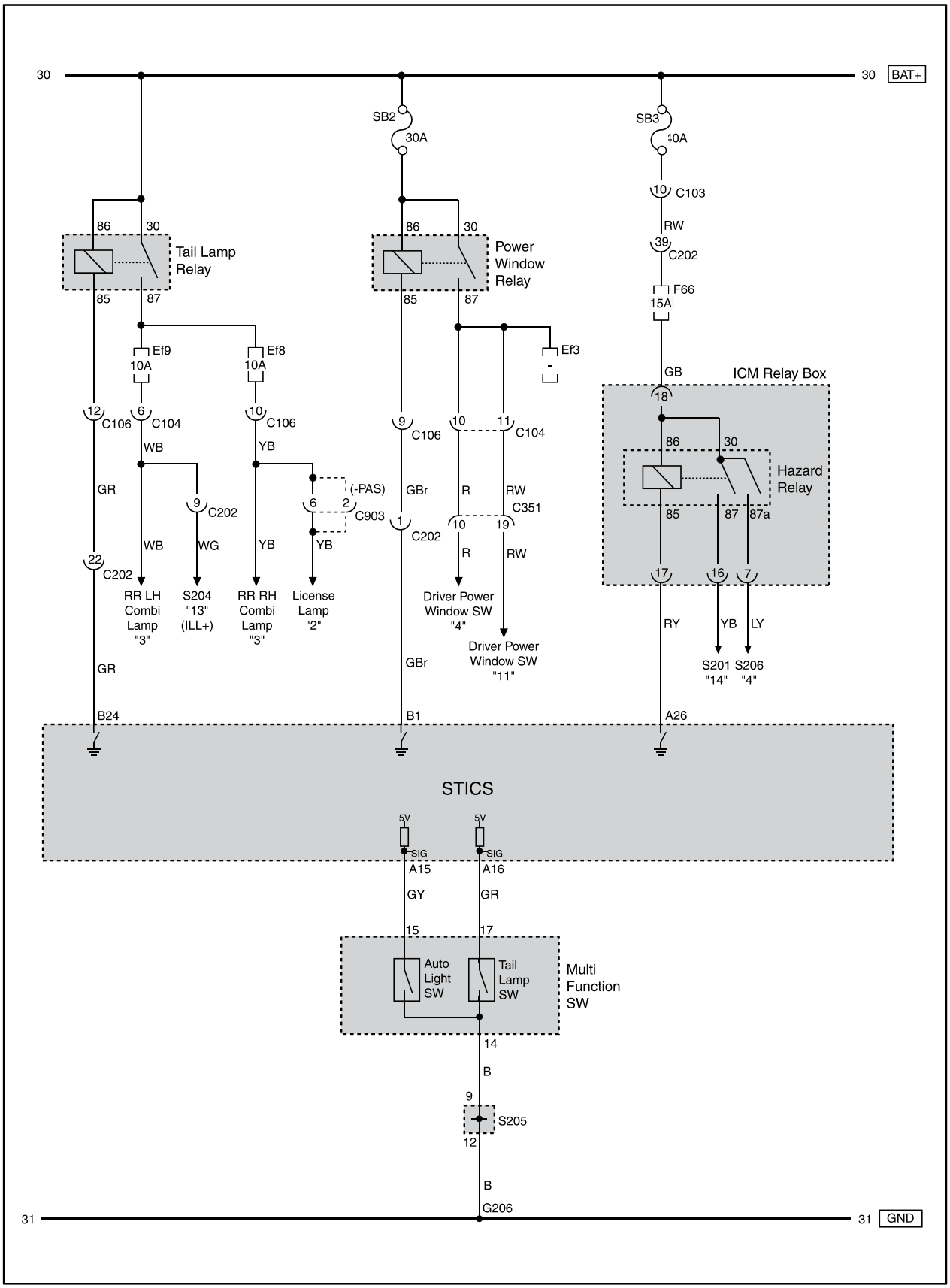
Modification basis	
Application basis	
Affected VIN	

2) Central Door Lock Circuit



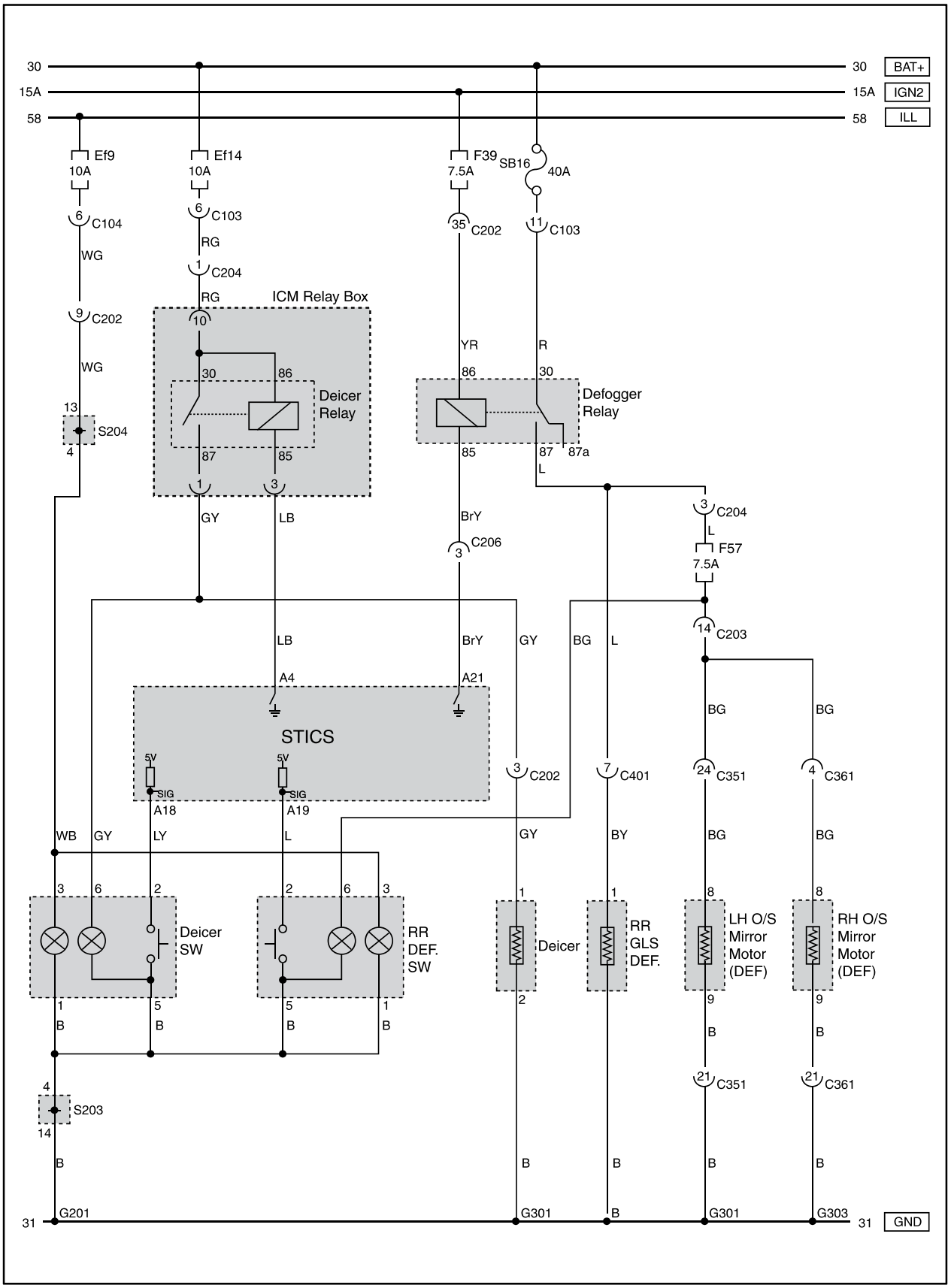
Modification basis	
Application basis	
Affected VIN	

3) Tail Lamp, Hazard, Power Window



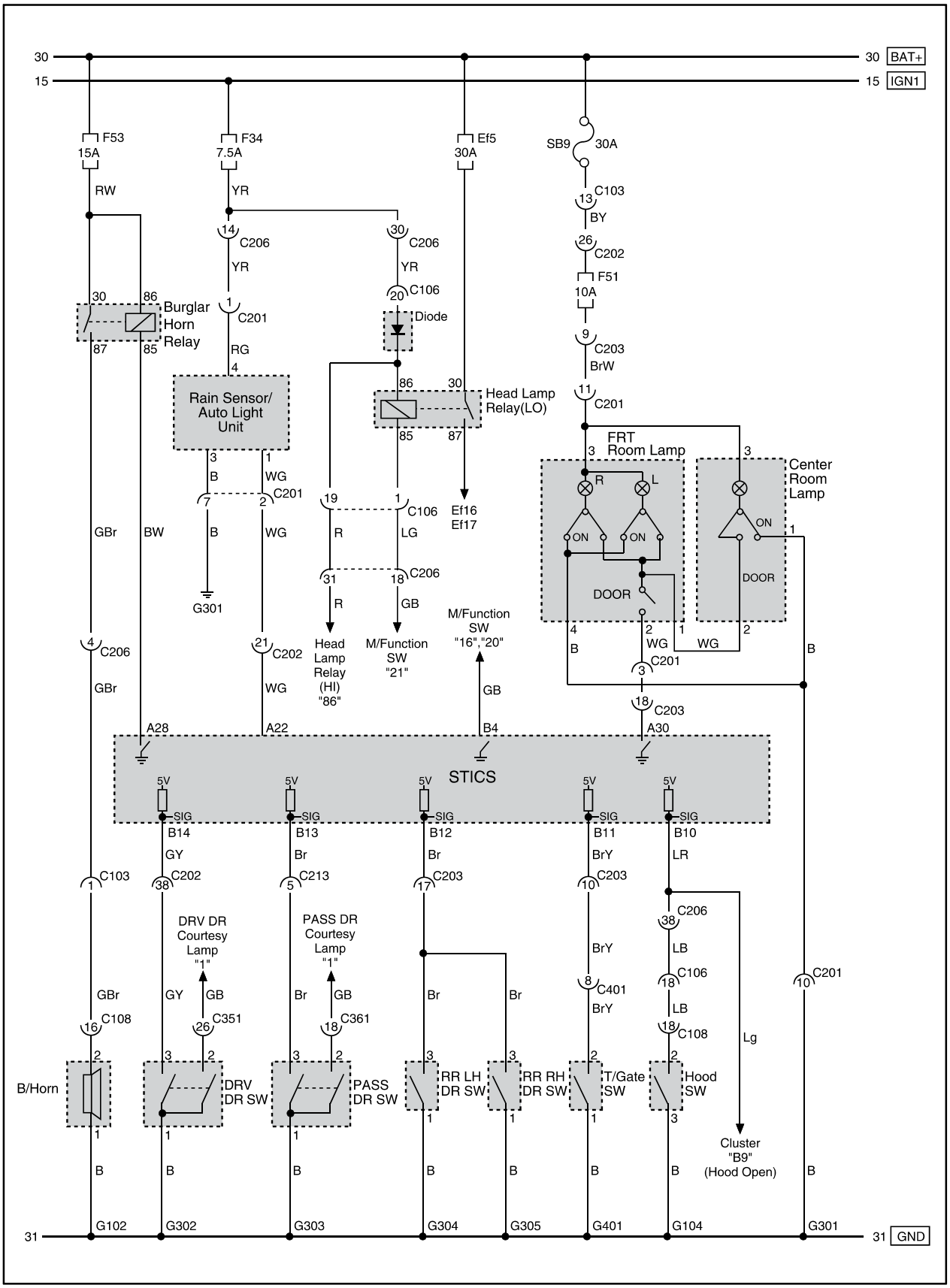
Modification basis	
Application basis	
Affected VIN	

4) Defogger



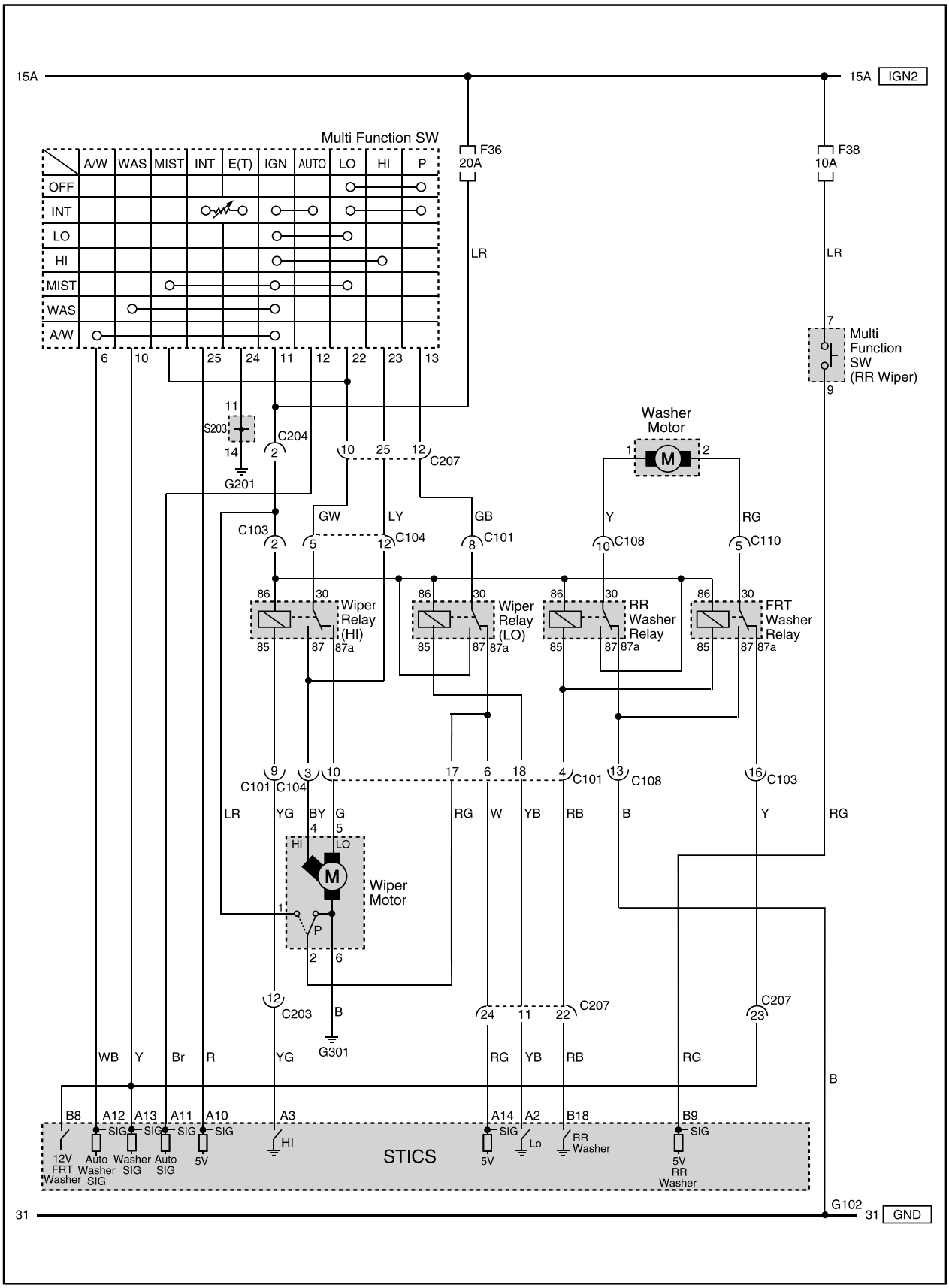
Modification basis	
Application basis	
Affected VIN	

5) Panic, Auto Light / Rain Sensing, Room Lamp



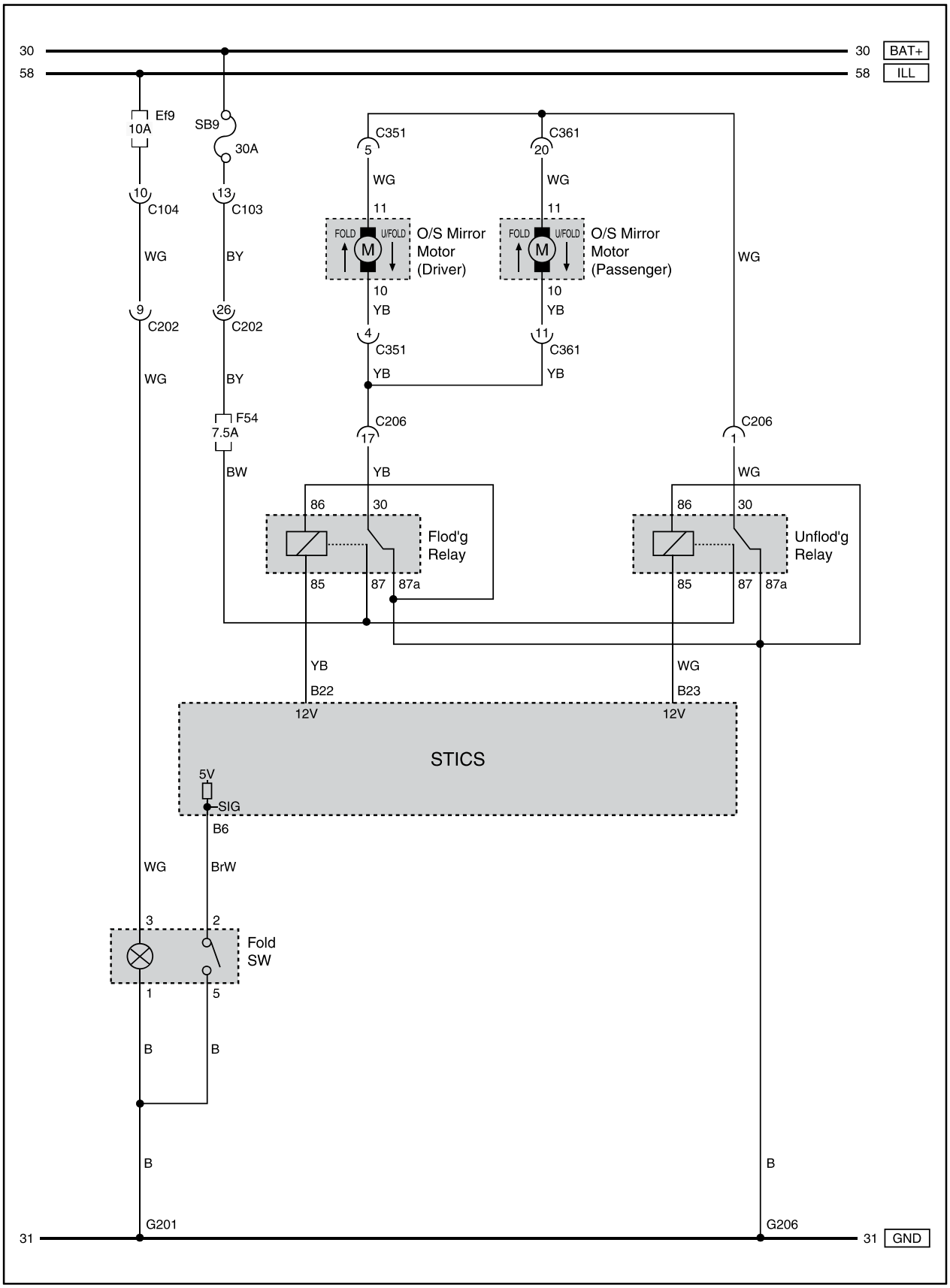
Modification basis	
Application basis	
Affected VIN	

6) FRT Wiper/Washer/ RR Washer



Modification basis	
Application basis	
Affected VIN	

7) Mirror Fold'g/Unfold'g, Fold SW



Modification basis	
Application basis	
Affected VIN	

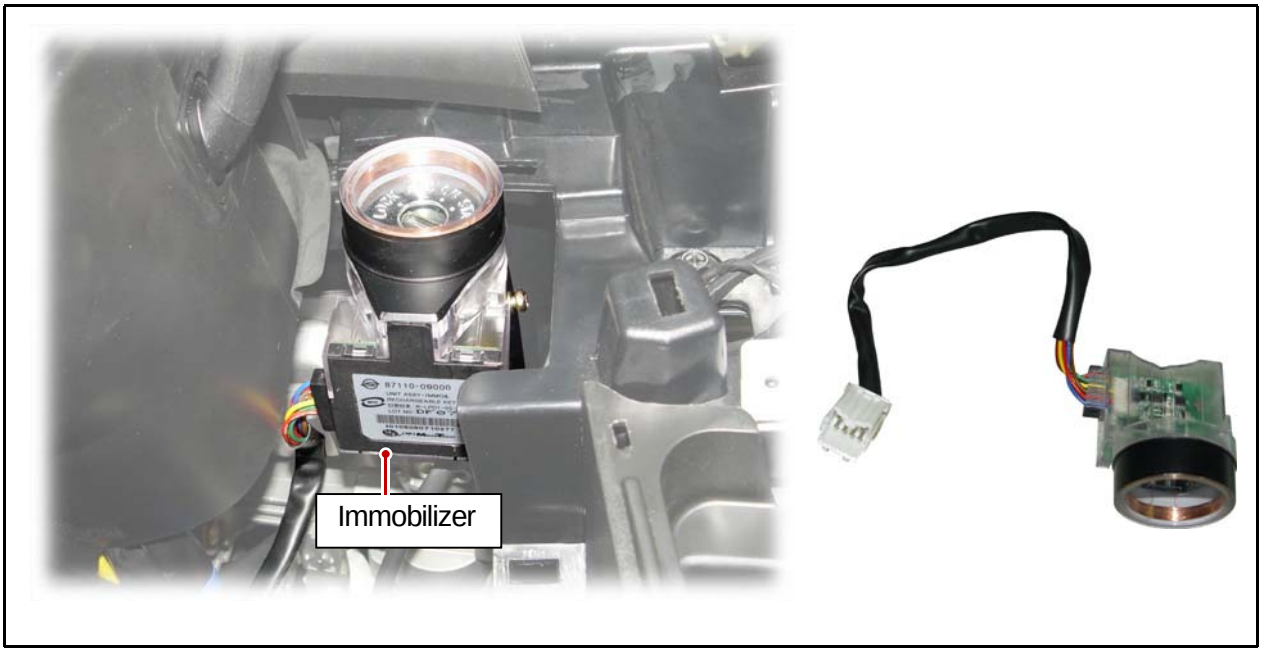
IMMOBILIZER SYSTEM 7010-06

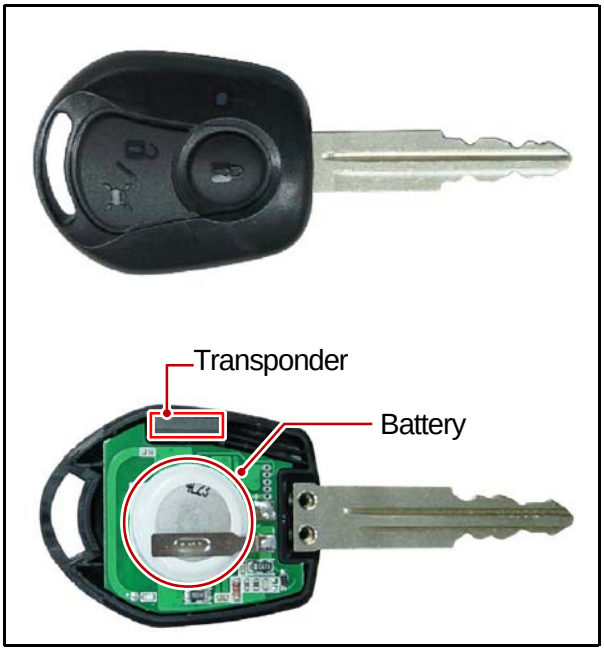
OVERVIEW AND OPERATION PROCESS

1. OVERVIEW

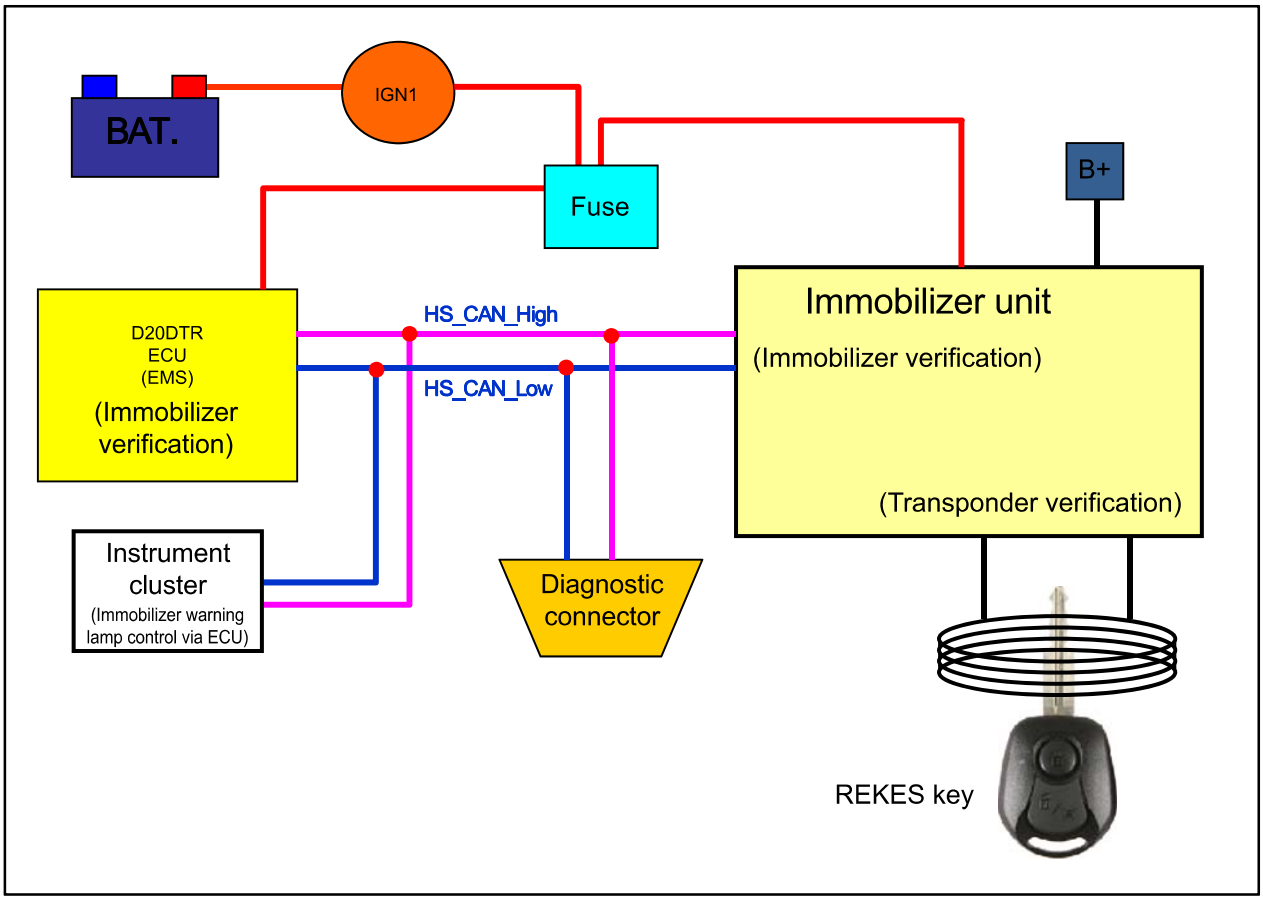
1) What is the Immobilizer System?

The immobilizer system prevents the vehicle theft by allowing only the authorized key to start the engine. The transponder inside the key communicates with the immobilizer installed in the key box, and the system permits the engine to start after confirming the encrypted coding from the engine ECU. Refer to the information that follows for specific functions and their descriptions.





2) System Diagram



The certification for the immobilizer is performed when turning the ignition switch to the "ON" position after the CAN communication between the ECU and immobilizer is established.

Modification basis	
Application basis	
Affected VIN	

2. BASIC FUNCTIONS OF IMMOBILIZER KEY (REKES FUNCTION)

▶ Door Unlock and Panic Function

Briefly press (below 0.5 sec): Door unlock and theft deterrent mode is deactivated

Press and hold (over 2 sec): Panic function

1. Door unlock (Briefly press)
   - If the unlock button on the remote control is pressed, the door will be opened and the theft deterrent mode will be activated. If the door coupled switch of front room lamp is pressed, the lamp will come on for 30 seconds. It will turn off immediately after the lock button of the remote control is pressed.
2. Panic function: activated in the theft deterrent mode
   - If you press and hold the door unlock and panic buttons, the buzzer will sound for 27 seconds.
   - The function is inactivated if any button of remote control is pressed.

LED flasher

Briefly press: blink once

Press and hold: blink twice



▶ Door Lock Function

Briefly press (below 0.5 sec): Door lock and theft deterrent mode is activated

Door lock (Briefly press)

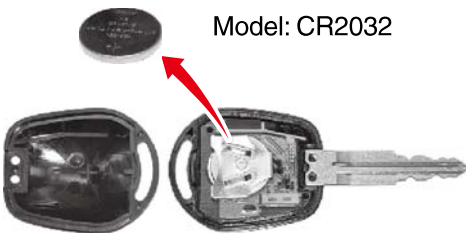
- If you press this button locks all doors and activates the theft deterrent mode.

▶ Battery Replacement

With REKES



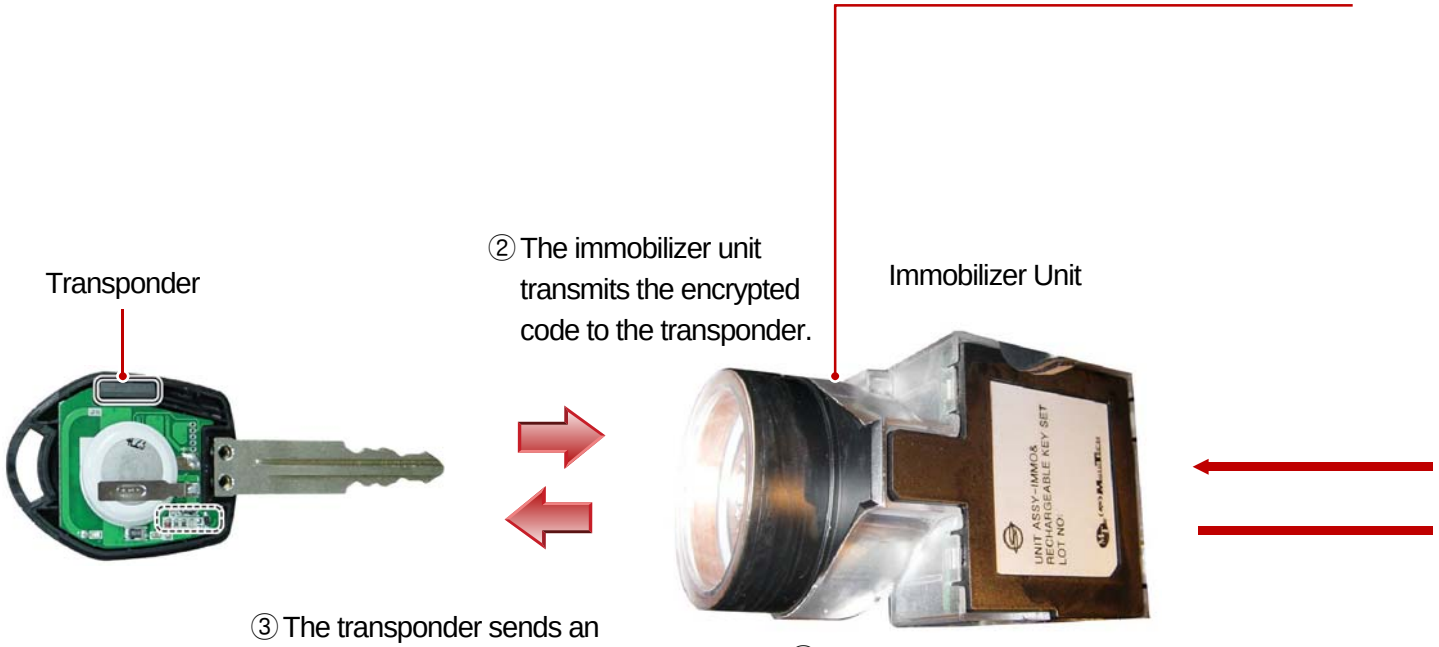
Model	CR 2032 (Rekes key type)
	V 625U (without Rekes)
Amount	One



3. OTHER FUNCTIONS IN SYSTEM

1) Immobilizer Function

The immobilizer system prevents the vehicle theft by allowing only the authorized key to start the engine. The transponder inside the key communicates with the immobilizer installed in the key box, and the system permits the engine to start after confirming the encrypted coding from the engine ECU.



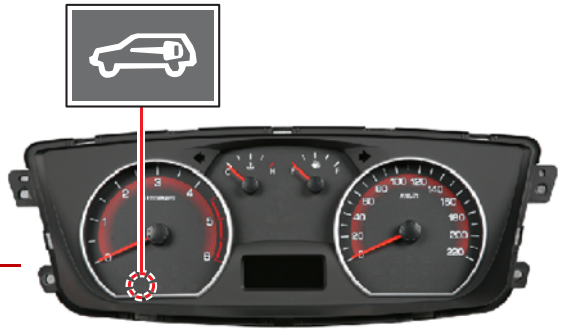
CAUTION

In the following cases, a driver may be unable to start the vehicle with the immobilizer.

- When two or more immobilizer keys come into contact with (each) other(s).
- When the key is close to any device sending or receiving electromagnetic fields or waves.
  When the key is close to any electronic or electric devices such as lightening equipment, security
- keys or security cards.
  When the key is close to a magnetic or metal object or a battery.
-

Modification basis	
Application basis	
Affected VIN	

▶ Immobilizer and Warning Lamp



This indicator comes on when the ignition key is communicating with the engine control unit (during engine starting) and goes out after starting the engine.

Lamp ON: in communication
Blinking twice for one second: immobilizer system failure
Blinking once for two seconds: immobilizer unit is not coded

CAUTION
The immobilizer indicator does not come on if the communication time between immobilizer key and ECU is too short.

① When turning the ignition key to ON position, the ECU transmits the challenge message to the immobilizer unit.
(to verify whether the key is valid)

Engine Control Unit (ECU)

⑥ Only when the two signals are identical, it recognizes the key as the authorized one and transmits the positive message to the ECU.

⑦ The ECU enable the engine to be started.

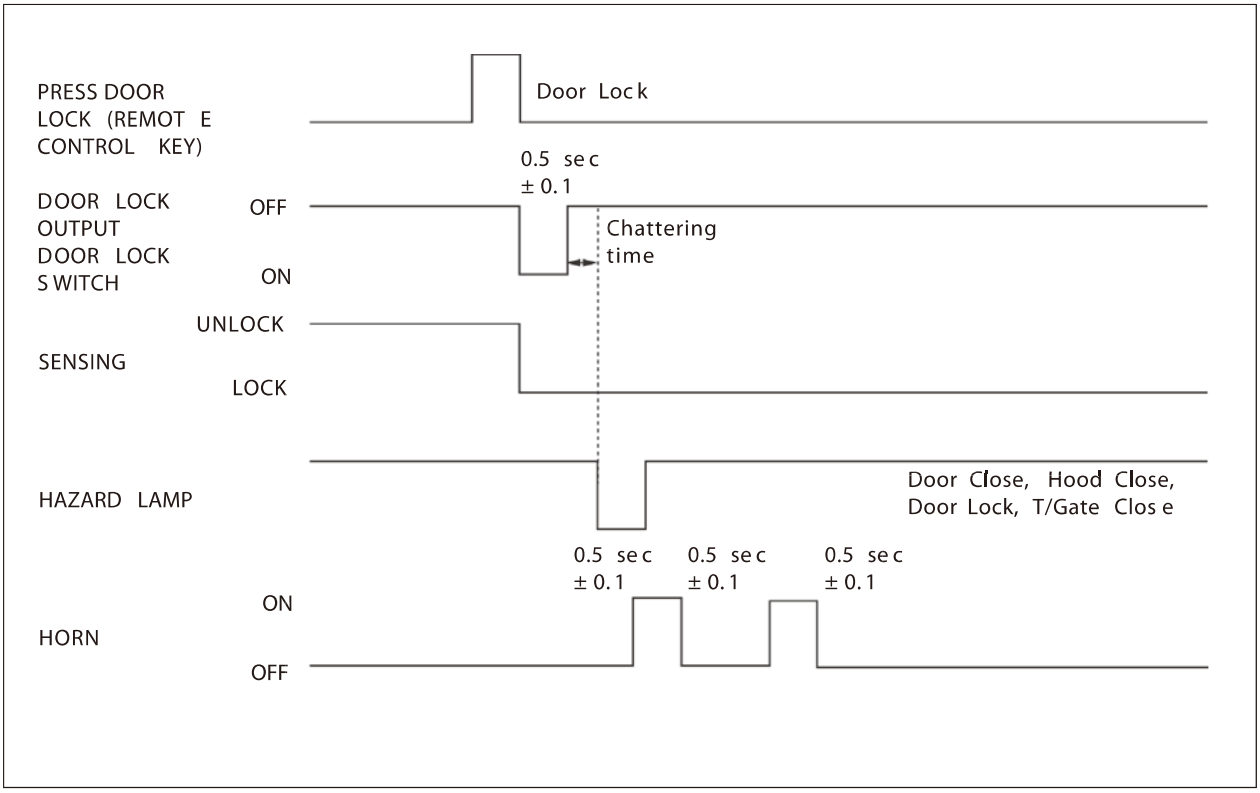
CAUTION
- Do not drop or shock to the transponder in the key as it may be damaged.
- With a damaged transponder, the engine cannot be started.
- When you erase the code or register an extra key, let the owner attend on the site.

CAUTION
- In any case, the immobilizer system can not be removed from the vehicle. If you attempt to remove it and damage the system, starting will be impossible, so never attempt to remove, damage or modify it.
- The remote engine starter cannot be installed on the vehicle equipped with the immobilizer system.

4. REKES OPERATION LOGIC

1) Remote Door Lock

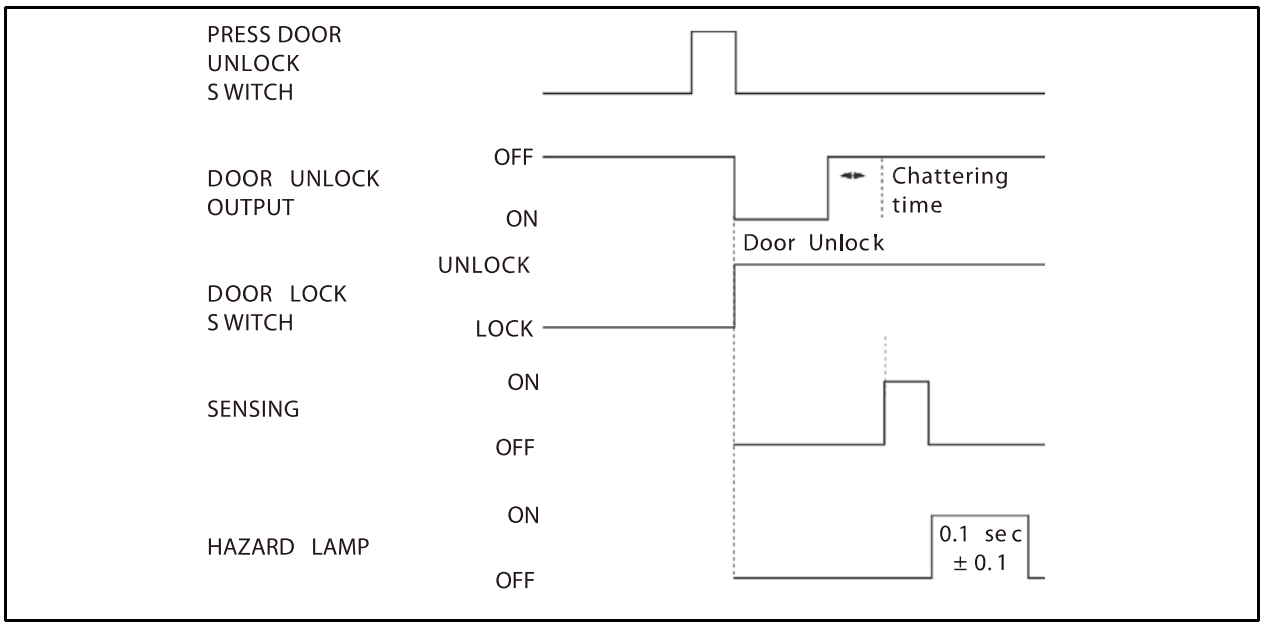
1. When briefly pressing the door lock switch on the remote control key for less than 0.5 seconds, all doors are locked.
2. The system outputs the "LOCK" signal immediately after receiving the door lock message from the remote control key. If the vehicle is locked while all doors including tailgate and engine hood are closed, the theft deterrent mode is activated (hazard warning lamps are blinking twice).



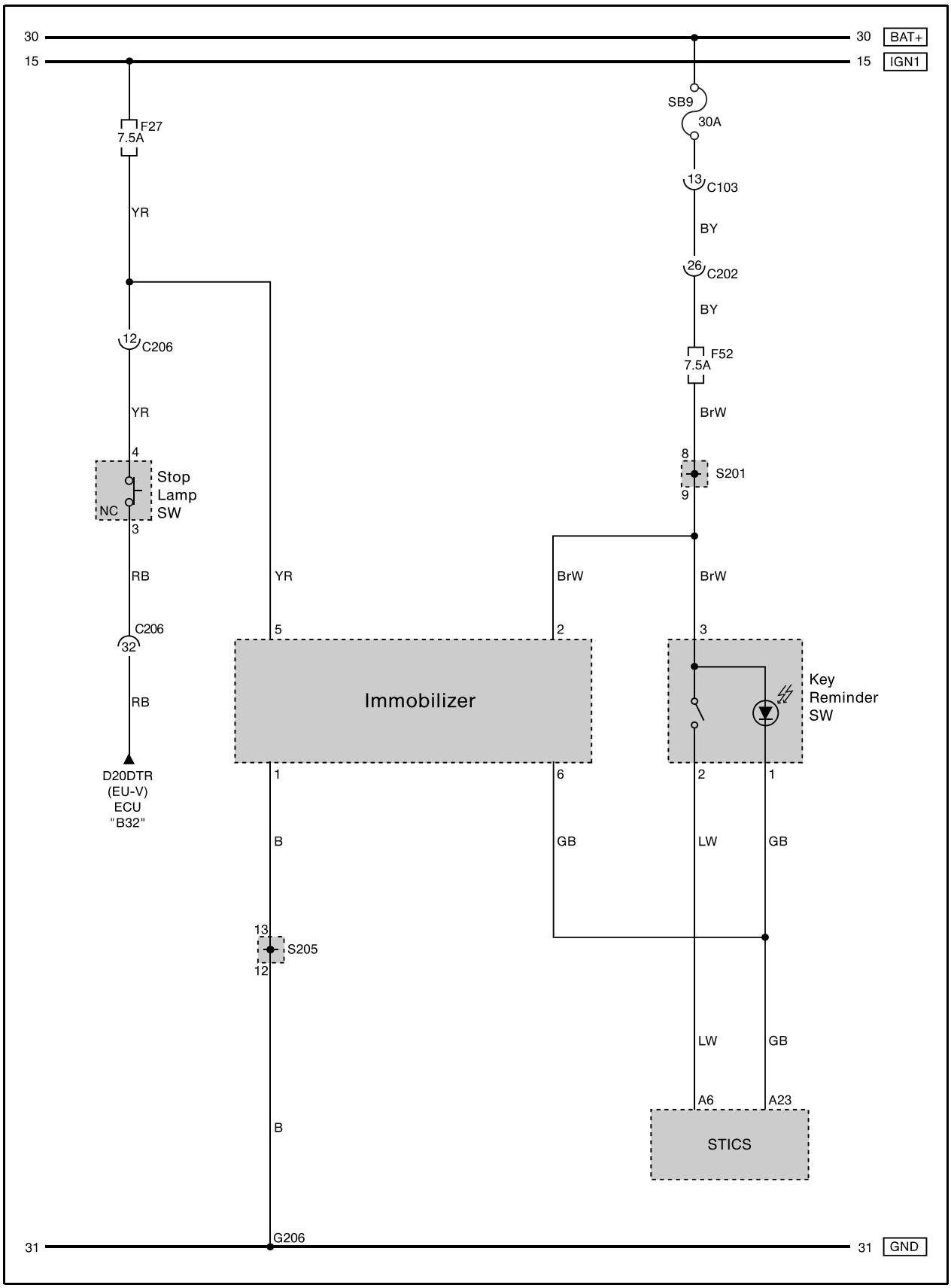
Modification basis	
Application basis	
Affected VIN	

2) Door Unlock

1. When pressing and holding the door unlock switch on the remote control key for more than 0.5 seconds, all doors are unlocked.
2. When receiving the DOOR UNLOCK message from the remote control key, the door unlock relay is turned on for 0.5 seconds.
3. The hazard warning lamps blink once only when the doors are successfully unlocked.



5. CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	

CLUSTER 8010-01

GENERAL

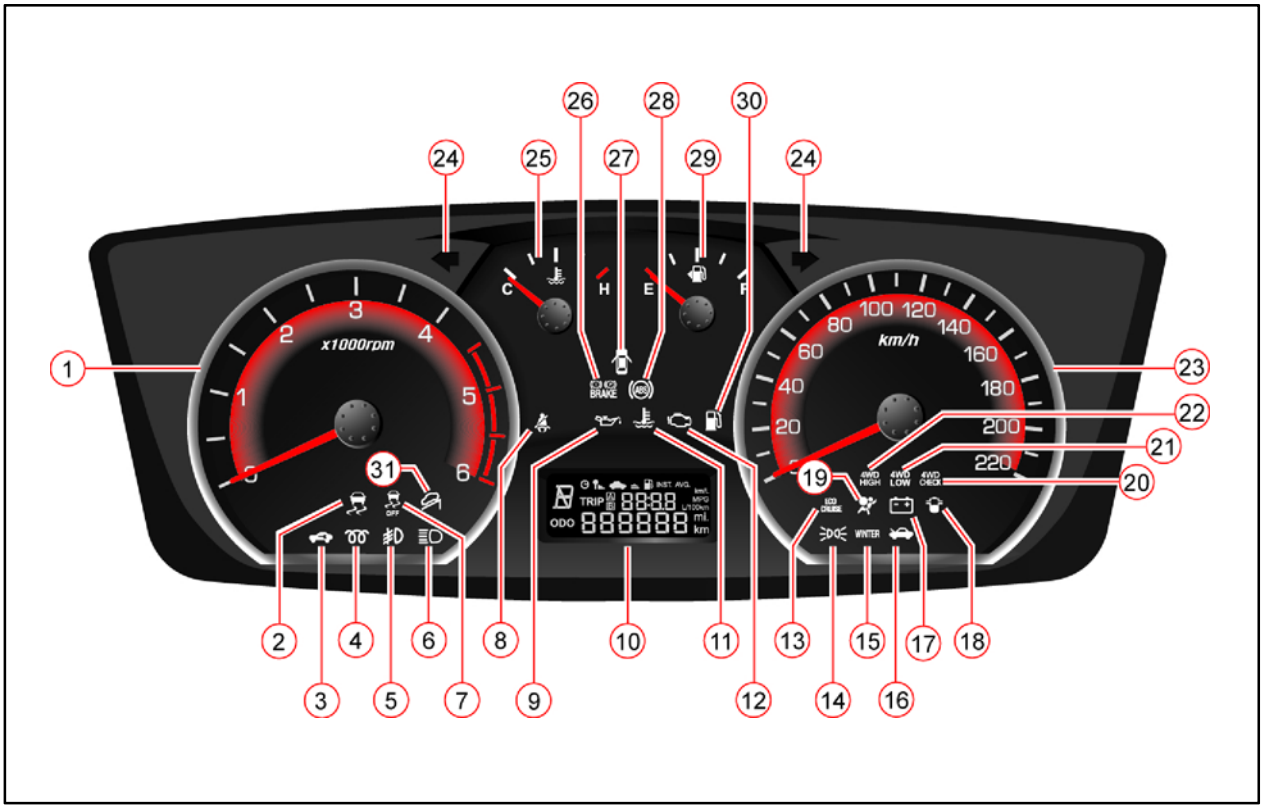
1. SPECIFICATIONS

Item		Specification
Rated voltage		DC 12V
Operating voltage		DC 9 V ~ 16 V
Checking voltage		DC 13.5 V
Operating temperature		−30℃ ~ +80℃
Storage temperature		−40℃ ~ +85℃
Illumination color	Dial	White
	Pointer	Red
	LCD	Red
Gear position display in A/T (Left hand of LCD display)		P, R, N, D, 1, 2, 3, 4, 5 and 6

OVERVIEW AND OPERATING PROCESS

1. DESCRIPTIONS OF INDICATOR DISPLAY

It sends and receives information to/from each unit through CAN communication line. The LCD display and separate ESP ON/OFF indicator are newly added.



1. Tachometer
2. ESP indicator/warning light
3. Immobilizer indicator
4. Glow indicator
5. Front fog light indicator
6. High beam indicator
7. ESP OFF indicator
8. Seat belt reminder
9. Engine oil pressure warning light
10. LCD Display
11. Engine overheat warning light
12. Engine check warning light
13. Auto cruise indicator
14. Light indicator
15. Winter mode indicator
16. Engine hood open warning light
17. Battery charge warning light
18. Water separator warning light
19. Air bag warning light
20. 4WD CHECK warning light
21. 4WD LOW indicator
22. 4WD HIGH indicator
23. Speedometer
24. Turn signal indicator
25. Coolant temperature gauge
26. Brake warning light
27. Door ajar warning light
28. ABS warning light
29. Fuel gauge
30. Low fuel level warning light
31. HDC indicator

Modification basis	
Application basis	
Affected VIN	

▶ System Layout

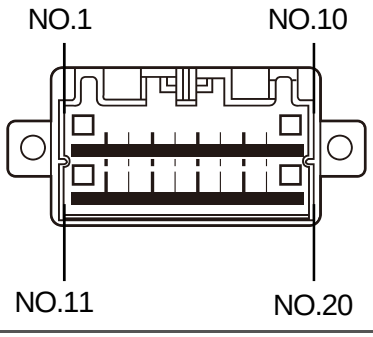
Front view



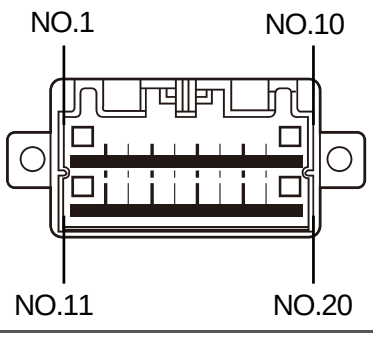
Rear view



A. Main connector (white)



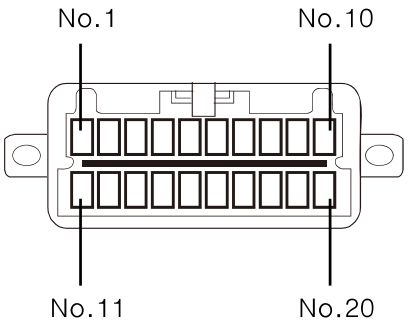
B. Sub connector (gray)



Modification basis	
Application basis	
Affected VIN	

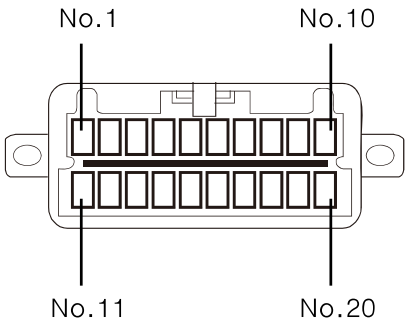
▶ Connector Pin Arrangement

The connector pin sections illustrated below are viewed from the front of the instrument cluster. The arrangement of the pins is the same for both the main connector and the sub connector.



Main connector - 20-pin (white)

1. -
2. Hood open
3. Seat belt - passenger's seat
4. -
5. -
6. Front fog lamp
7. -
8. Engine CHECK warning light
9. Charge
10. IGN 2
11. -
12. Air bag
13. Seat belt - driver's seat
14. High beam (-)
15. Right turn signal lamp (+)
16. High beam (+)
17. Left turn signal lamp (+)
18. Oil pressure
19. Parking brake signal input (STICS)
20. -



Sub connector - 20-pin (gray)

1. -
2. -
3. 4P output
4. Buzzer output
5. Illumination (+)
6. -
7. Check engine (GSL only)
8. Door open
9. -
10. Battery
11. -
12. Fuel input signal
13. TRIP mode/reset switch
14. Manual transmission N (neutral) input
15. Manual transmission R (reverse) input
16. CAN LOW
17. CAN HIGH
18. AGND (fuel -)
19. MICOM ground
20. IGN 1

Modification basis	
Application basis	
Affected VIN	

▶ **Indicators on Instrument Cluster**

No.	Symbol	Item	Bulb Type	Power	Turning ON condition
1		Turn signal lamp-L	LED	Multifunction switch	When activating switch
2		Turn signal lamp-R	LED	Multifunction switch	When activating switch
3		4WD HIGH indicator	LED	IGN	IGN ON/ CAN signal input
4		Winter mode indicator	LED	IGN	IGN ON/ CAN signal input
5		Front fog lamp indicator	LED	Fog lamp relay	When activating switch
6		Cruise control indicator	LED	IGN	IGN ON/ CAN signal input
7		Light illumination indicator	LED	BATT	Tail lamp ON
8		High beam indicator	LED	Headlamp high beam relay	When activating switch
9		ABS warning lamp	LED	IGN	IGN ON/ CAN signal input (ABS, EBD)
10		Glow indicator (DSL only)	LED	IGN	IGN ON/ CAN signal input
11		Immobilizer indicator	LED	IGN	IGN ON/ CAN signal input
12		Low fuel level warnig light	LED	IGN	When analog inputting fuel level

No.	Symbol	Item	Bulb Type	Power	Turning ON condition
13		Engine check warning lamp	LED	IGN	IGN ON/ CAN signal input
14		4WD LOW indicator	LED	IGN	IGN ON/ CAN signal input
15		ESP indicator/ warning light	LED	IGN	IGN ON/ CAN signal input (ESP & buzzer activated)
16		ESP OFF indicator	LED	IGN	IGN ON/ CAN signal input
17		Brake warning light	LED	IGN	IGN ON, CAN signal input (EBD)
18		4WD CHECK indicator	LED	IGN	IGN ON/ CAN signal input
19		Air bag warning lamp	LED	IGN	Signal input
20		Door ajar waning light	LED	BATT	When door opened
21		Charge warning lamp	LED	IGN	Charge system fault
22		Seat belt warning light	LED	IGN	Switch input

Modification basis	
Application basis	
Affected VIN	

No.	Symbol	Item	Bulb Type	Power	Turning ON condition
23		Engine oil pressure warning lamp	LED	IGN	Signal input
24		Water separator warning light (DSL only)	LED	IGN	IGN ON/ CAN signal input
25		Engine coolant overheat warning light	LED	IGN	IGN ON/ CAN signal input
26		Engine hood open warning lamp	LED	IGN	Switch ground
27		EBD warning light	LED	IGN	CAN signal input
28		HDC indicator	LED	IGN	Switch Input

NOTE

There are two colors (green & red) for HDC symbol.

2. CONFIGURATION

1) RPM Gauge



The tachometer indicates engine speed in revolutions per minute. Multiply 1,000 to the current number, then it will be the current number of engine revolutions.

Under the normal engine operating temperature, the proper idling speed is 700 ~ 800 rpm. The red zone (danger rpm range) starts from 4,500 rpm.

1. Connect the tachometer for tune-up test and start the engine.
2. Eliminate the hysteresis by tapping the tachometer.
3. Compare the values on the tester and tachometer and replace the tachometer if the tolerance is excessive.

Description	Specification(VIN=13.5 ± 0.1V, Temperature: 25°C)							GSL
Engine speed(rpm)	750	1000	2000	3000	4000	5000	6000	7000
Tolerance(rpm)	+50	+100	+100	+100	+100	+100	+100(GSL)	+100
	+100	-100	-100	-100	-100	-100	-100(GSL)	+100

Check Method

If the tachometer (engine rpm gauge) pointer vibrates or stops moving at a certain range, or abnormal noises are heard from the tachometer, the tachometer may have a malfunction. If you have reason to suspect that the reading from the tachometer differs from the actual engine speed (rpm), connect a diagnostic device and compare the value on tachometer with the reading from the diagnostic device.

Modification basis	
Application basis	
Affected VIN	

2) Speedometer Gauge



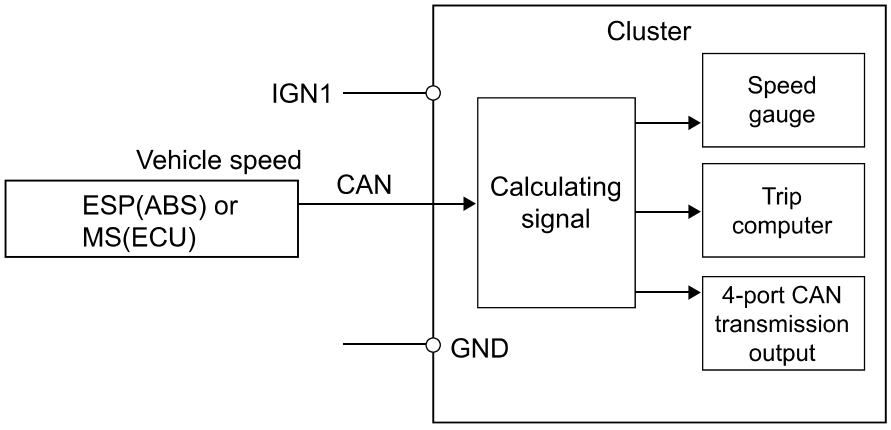
The speedometer indicates the vehicle speed by calculating the signals from the rear left and rear right wheel speed sensors through ABS or ESP unit. (For the vehicle without ABS or ESP, the signals are received from the EMS)

If the speedometer gauge vibrates, stops at a certain range or makes an abnormal noise, there could be defectives in speedometer. **However, these symptoms also could be occured when the tire has uneven wear, different tire inflation pressures or different tire specifications.**

Perform the speedometer test regarding the tolerance as described. However, it is not similar simple work in field due to lack of measuring conditions such as test equipment and preciseness.

1. Check the allowable tolerance of the speedometer and operations of the trip odometer by using a tester.
2. Check if the speedometer pointer is shaking and the abnormal noise sounds.
3. Eliminate the hysteresis by tapping the speedometer.

Description	(VIN = 13.5 ± 0.1V, Temperature: 25°C)										
Standard speed (Km/h)	20	40	(60)	80	100	120	140	(160)	(180)	200	220
Tolerance (Km/h)	+4	+4	+7	+9	+10.5	+12.5	+14.5	+16	+18	+18	-
	0	0	+2.5	+3.5	+4	+6	+7.5	+8.5	+10	+10	-



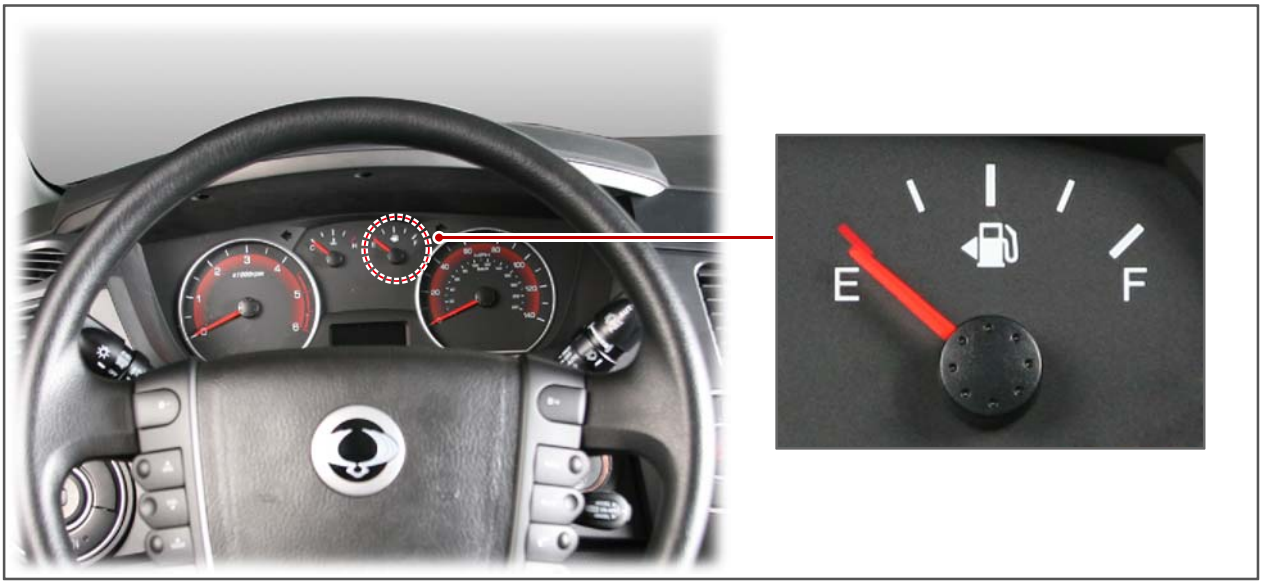
Input/Output Diagram

CAUTION

The allowable tolerance increases when the tires are worn or the tire pressure is out of specified range.

Modification basis	
Application basis	
Affected VIN	

3) Fuel Level Gauge



The fuel level gauge displays the resistance value of the float on the fuel sender in the fuel tank through a pointer. Note that this vehicle doesn't have a service hole for checking the fuel sender connector in the fuel tank.

The fuel sender and its connector can be checked and replaced only when the fuel tank is removed. The power supply and resistance value should be measured at the connector in front of the fuel sender (refer to wiring diagram).

When the power supply and output resistance are normal, the float operation by fuel level may be defective; if so, replace the fuel sender.

Item	Tolerance and resistance value by indicating angle (VIN = 13.5 ± 0.1 V, temperature: 25°C)								
Scale	Full	Full (Gauge)	(3/4)	1/2	(1/4)	LFW		Empty (Gauge)	Empty
						GSL	DSL		
Indicating angle (°)	-	90	67.5	45	22.5	3.0	3.0	0	-
Tolerance (°)	-	+4, 0	-	±5	-	-	-	0, -4	-
Resistance (Ω)	38	43	67	99.5	150	260	268	276.3	283
Fuel (Liter)	75	73	56	39	22	11.5	9.0	5	4

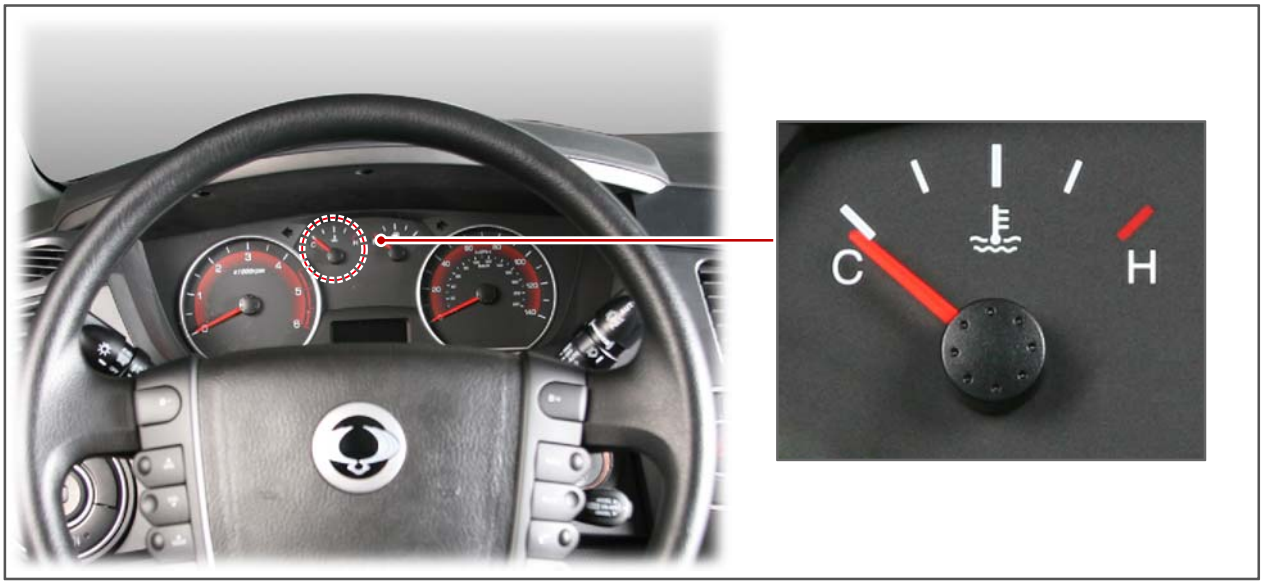
CAUTION

This table shows the tolerance and resistance value changes by fuel level in normal conditions. Therefore, the differences that can be occurred by the road conditions and fuel fluctuations are ignored.

Low fuel warning lamp comes on when:

The fuel level drops to 9 L or less. The lamp goes off if the fuel level reaches 9.5 L or more.

4) Coolant Temperature Gauge



The coolant temperature gauge displays the coolant temperature with a pointer. The angle of pointer that changes by coolant temperature is as shown below.

Item		Tolerance and resistance value by indicating angle				
Coolant temperature	Less than 40°C	DSL 70°C	GSL 80°C	110°C	120°C	Over 125°C
Indicating angle (°)	-	43			90	-
Tolerance	+0°C -4°C	0°C -4°C			-	+4°C +0°C

Measurement of coolant temperature sensor resistance

Measure the resistance between the terminal and the ground with an ohmmeter and replace if the resistance is out of specified range.

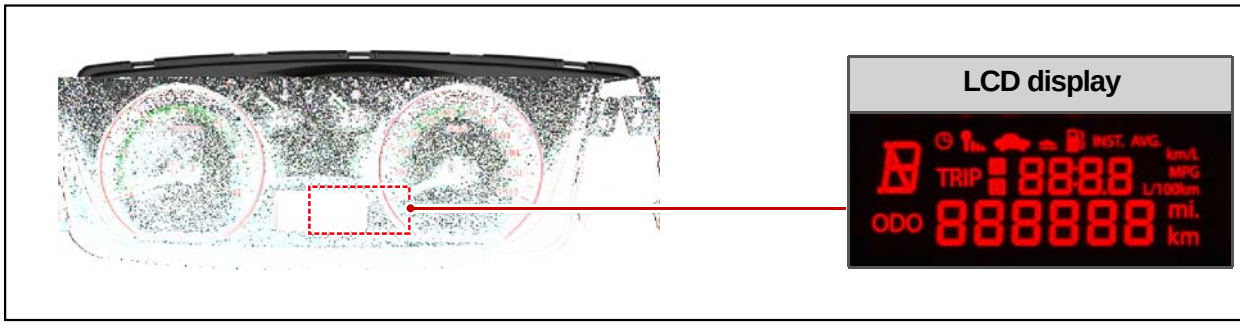
Temperature (ºC)	20	60	80	100	120
Resistance (Ω)	2449Ω ± 5%	589.4kΩ ± 5%	321Ω ± 5%	185.7kΩ ± 5%	112.9kΩ ± 5%
Voltage (V)	3.615	1.910	1.259	0.819	0.536

CAUTION

When the resistance value by coolant temperature is within the specified range, check thermostat, water pump, radiator related coolant circuit for normal operation. Also, check the wiring harnesses and connectors for proper connection.

Modification basis	
Application basis	
Affected VIN	

5) Description for LCD Display



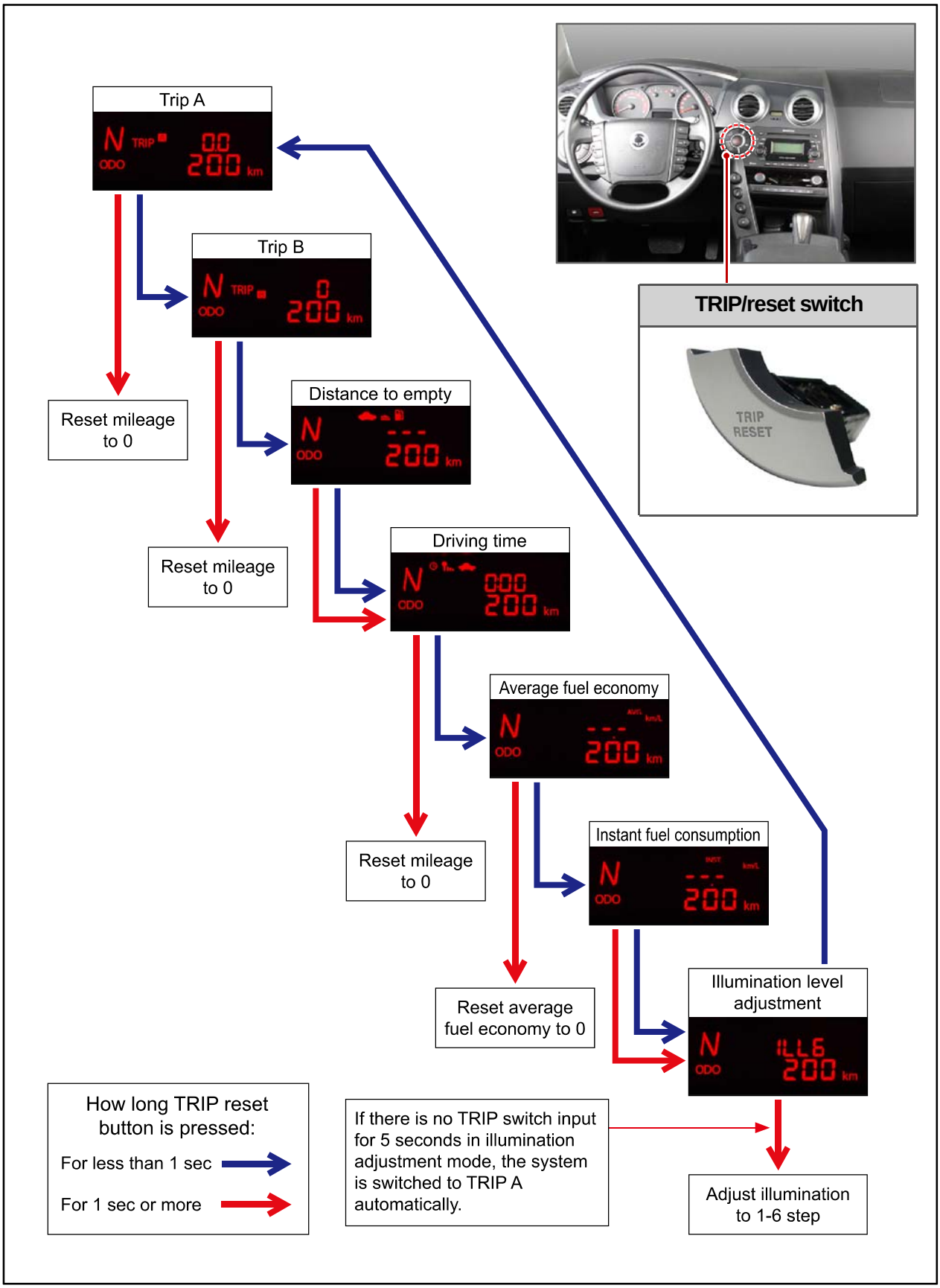
▶ **Mode Description**

Change Order	Mode	LCD Display	Description
1	TRIP A		The maximum distance value that can be displayed is 999.9 km with increments of 0.1 km. The trip meter is reset to 0.0 km when the value reaches above 999.9 km. When measuring a trip distance, reset the distance value in the mode you want to use by pressing the TRIP switch for 1 sec. or more.
2	TRIP B		The maximum distance value that can be displayed is 6,213.09 mi with increments of 0.62mi. The trip meter is reset to 0.0 km when the value reaches above 999.9 km. When measuring a trip distance, reset the distance value in the mode you want to use by pressing the TRIP switch for 1 sec. or more.
3	Distance to empty		The estimated distance that can be traveled is calculated based on the current fuel level. If the DTE is less than 50 km, "---" flashes on the display.
4	Driving time		The driving time from resetting the value (0:00) until now is displayed. The value displayed is accumulated while the engine is running even if the vehicle is not driven. The display range is 00:00 to 99:59. When measuring the driving time, press the TRIP switch for 1 sec. or more to reset the value.
5	Average fuel economy		The average fuel economy from resetting the value (--.-) until now is displayed. The value displayed is accumulated while the engine is running even if the vehicle is not driven. The display range is 0.0 to 99.9 km/h. When measuring the average fuel economy, press the TRIP switch for 1 sec. or more to reset the value. "--.-" is displayed on the screen when resetting. The value is reset automatically whenever the vehicle is fuelled.

Change Order	Mode	LCD Display	Description
6	Instant fuel consumption		The fuel range is calculated based on the distance driven and fuel consumed every 2 seconds. If the vehicle speed is below 10 km/h or the engine rpm is 200 rpm or less, the instant fuel economy is not displayed. The display range is 0.0 to 99.9 km/.
7	Brightness adjustment		The brightness of the illumination can be adjusted in 6 steps by pressing the TRIP switch briefly (less than 1 sec.). The display is changed from ILL1 to ILL6 every time the switch is pressed. If you select one level within the range and press and hold the TRIP switch, the brightness level is memorized. If there is no TRIP switch input for 5 seconds or more, the mode is switched to TRIP A mode automatically. When the battery is reinstalled, the brightness level is reset to level 4.

Modification basis	
Application basis	
Affected VIN	

▶ Shifting Mode

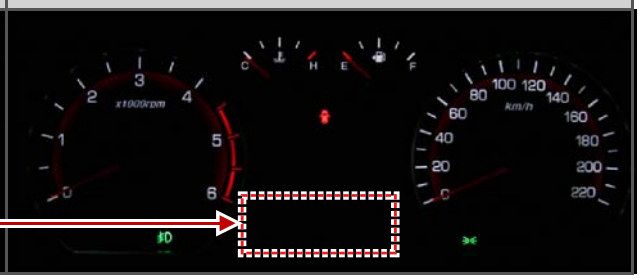


▶ **Brightness of LCD display when turning ON/OFF tail lamp**

Sequence	Level	Tail lamp OFF		Tail lamp ON	
		Display brightness	Brightness ratio	Display brightness	Brightness ratio
1	ILL1		25%		5%
2	ILL2		40%		9% (LCD: 12%)
3	ILL3		55%		13% (LCD: 19%)
4	ILL4		70%		17% (LCD: 26%)
5	ILL5		85%		21% (LCD: 33%)
6	ILL6		100%		25% (LCD: 40%)

▶ **Illumination conditions of LCD display when turning ON/OFF tail lamp**

The illumination for the LCD display comes on when turning on the tail lamp and is adjustable only when the ignition is ON. When turning on the tail lamp switch with the ignition OFF, the tail lamp comes on but the LCD display is not illuminated. Refer to the illustration below.

IGN ON (Comes on regardless of whether the tail lamp switch is turned ON or OFF)	Tail lamp comes on with IGN OFF (Tail lamp comes on but the illumination for LCD display is not turned on)
	

Modification basis	
Application basis	
Affected VIN	

Memo

3. WARNING LIGHTS AND INDICATORS

Seat belt warning lamp

The seat belt warning light comes on and the seat belt warning chime sounds for 6 seconds when the ignition switch is turned to "ON" position unless the driver's seat belt is securely fastened. This reminding operation stops when the driver fastens the seat belt.

Brake warning light

This warning light comes on and warning buzzer sounds when the parking brake is applied and/or the brake fluid level is lower than specified level.

Door ajar warning light

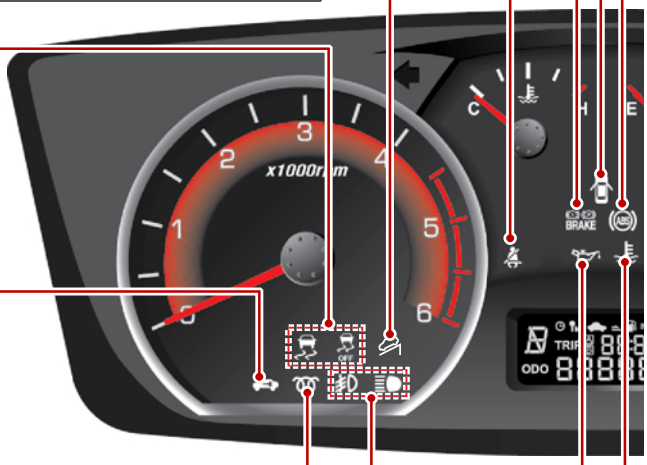
This light comes on when a door or tailgate is either opened or not closed completely.

ESP OFF Indicator

This lamp comes on when pressing the "ESP OFF" switch or the ESP system is defective. When the ESP system is activated, this lamp blinks and a chime sounds.

HDC Indicator

This indicator comes on or blinks according to HDC operations.



Immobilizer Indicator

This indicator comes on when the ignition key is communicating with the engine control unit for approx. 0.5 seconds.

Glow Indicator

When the ignition key is turned ON, this indicator lamp comes on and the combustion chamber is warmed up. In the vehicle equipped with direct injection type engine, this indicator may come on very shortly or may not come on.

Fog Lamp / Headlamp High Beam Indicator

This lamp comes on when the fog lamp or high beam headlamp operates to indicate the operating status.

Engine Oil Pressure Warning Light

This lamp comes on if there is any fault in the engine oil system and goes off when a certain amount of time has elapsed after turning ON the ignition switch.

Engine Coolant Overheat Warning Light

When the coolant temperature is abnormally hot (over 120℃), this warning light blinks and a warning buzzer sounds at 1 Hz. (check cooling system)

Modification basis	
Application basis	
Affected VIN	

ABS Warning Light

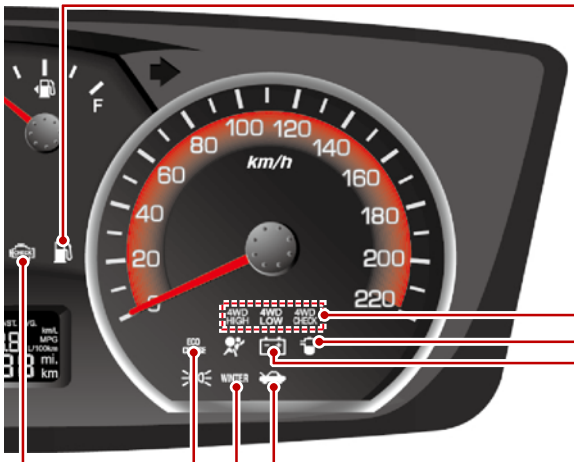
This warning light comes on when the ignition switch is turned to "ON" position and should go out if the system is normal.
The vehicle with ABS performs self-diagnosis. During this diagnosis, brake pedal vibration and noise may be apparent when the driving motors discharges the hydraulic pressure from the internal hydraulic device.

Low Fuel Level Warnig Light

This warning light comes on when the fuel will soon be exhausted. The time it takes turn on, however, varies according to the gradient of the vehicle.

4WD Indicator

- 4WD HIGH Indicator
- The lamp blinks momentarily during the change of driving mode.
- 4WD LOW Indicator
  The lamp blinks momentarily during the change of driving mode.
  4WD CHECK Warning Light
  This indicates that there is something wrong in the transfer case system. (check the system)



Water Separator Warning Light

This lamp comes on to warn the driver of water in the fuel tank which causes the loss of engine power. When a certain amount of water is accumulated, the lamp comes on and a chime sounds.

Charge Warning Light

This warning light comes on when the ignition switch is turned on and go off when the engine is started.
If this light doesn't go off after engine starting, it means there is a malfunction in the system.

Engine Hood Open Warning Light

When the engine hood is open, this light comes on to inform the driver.

Engine CHECK Warning Light

This warning light comes on when the ignition switch is turned to "ON" position and should go out if the system related to engine control is normal.
This comes on when different sensors and devices related to engine control are defective.

Auto Cruise Control Indicator

Operating the cruise control switch turns on the indicator lamp to indicate the cruise control system is activated.

Winter Mode Indicator

Pressing the "W" side of the automatic transmission mode selector switch switches the driving mode to winter mode and turns on the indicator lamp.
Use this mode to drive off smoothly on icy and slippery roads.

(1) Operation of HDC Indicator Controller

This table describes the coming-on and blinking mode of HDC indicator according to the HDC switch operation (ON/OFF). The HDC indicator on the instrument panel has two modes; green (function lamp) and red (warning lamp). The HDC switch is a push & self return type switch ? When you press it once, it starts to operate and when you press it again, it stops the operation.

<table>
<tr><td colspan="3" rowspan="3">HDC Operation Mode</td><td>HDC indicator</td><td>HDC warning lamp</td></tr>
<tr><td>Green</td><td>Red</td></tr>
<tr><td>HDC</td><td>HDC</td></tr>
<tr><td colspan="3">Initial ignition ON (From hence, this signifies operation mode after the engine starts. Even when HDC switch is ON, if the ignition is OFF, HDC operation stops automatically.)</td><td>OFF</td><td>ON</td></tr>
<tr><td rowspan="2">Not available</td><td colspan="2">HDC switch OFF</td><td>OFF</td><td>OFF</td></tr>
<tr><td colspan="2">HDC system error</td><td>OFF</td><td>ON</td></tr>
<tr><td rowspan="2">Stand-by</td><td colspan="2">HDC switch ON</td><td>ON</td><td>OFF</td></tr>
<tr><td colspan="4">The HDC switch is turned ON, but HDC system is in stand-by mode because the operating requirements are not met.</td></tr>
<tr><td rowspan="2">In operation</td><td colspan="2">HDC system is operating.</td><td>Blinking (0.5 seconds of interval)</td><td>OFF</td></tr>
<tr><td colspan="4">The HDC switch is turned ON, and the operating requirements are met. HDC is operating with operating sound.</td></tr>
<tr><td rowspan="3">System overheat</td><td rowspan="2">High brake system temperature (over 350°C)</td><td>HDC stand-by mode</td><td>OFF</td><td>Blinking</td></tr>
<tr><td>HDC is operating</td><td colspan="2">Alternate blinking of green and red lamp (0.5 seconds of interval)</td></tr>
<tr><td colspan="2">Too high brake system temperature (over 450°C)</td><td>OFF</td><td>ON</td></tr>
<tr><td colspan="4">There is no specific temperature sensor in the system, but a programmed logic inside the HECU predicts the temperature based on the operating numbers and conditions of HDC (HDC cannot be operated).</td></tr>
</table>

CAUTION

- Basically, the brake systemapos;s basic functions can work even when there are problems with the HDC system. As given in the table above, the HDC warning lamp comes on when:

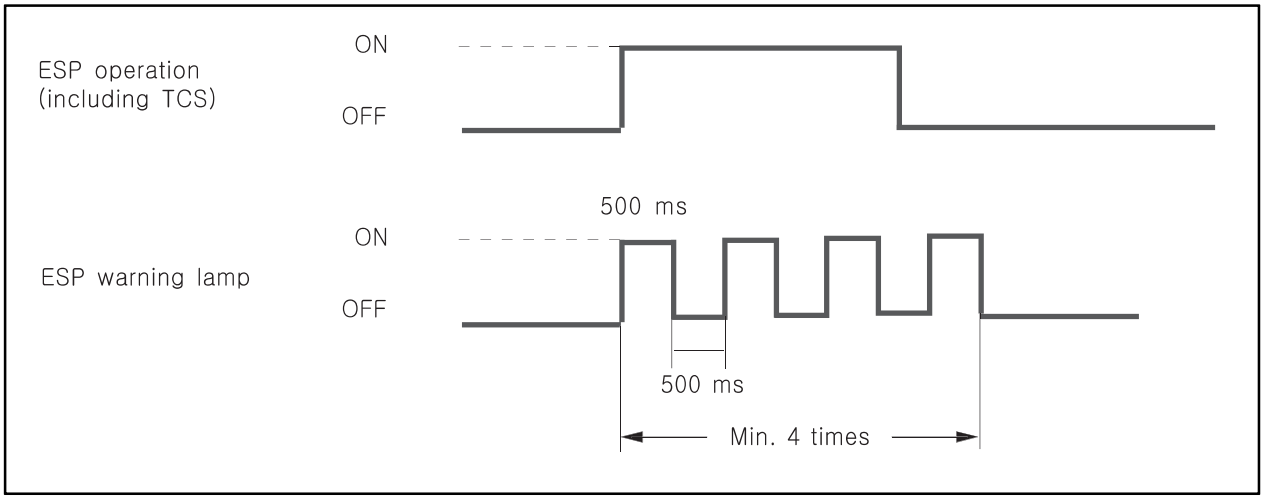
Initial ignition ON
HDC system error occurs
Brake system overheat

Modification basis	
Application basis	
Affected VIN	

(2) ESP Warning Lamp

▶ ESP Warning Lamp Blinking in Control

ESP warning lamp blinks when ESP control is activated. If the activation reaches a certain limitation, a beep sounds to warn the driver. The ESP warning lamp goes off when ESP function is deactivated. Even when the ESP is operated for a very short period of time, the ESP warning lamp blinks minimum of 4 times every 500 milliseconds.



1. When receiving CAN data
LAMP: (200h, 1.5) ESP - INFO - BL: when receiving data, 500 ms on/off
BUZZER: (200h, 1.4) ESP - INFO - BUZZ: when receiving data, 100 ms on/off

▶ ESP System Cancellation Using the ESP OFF Switch

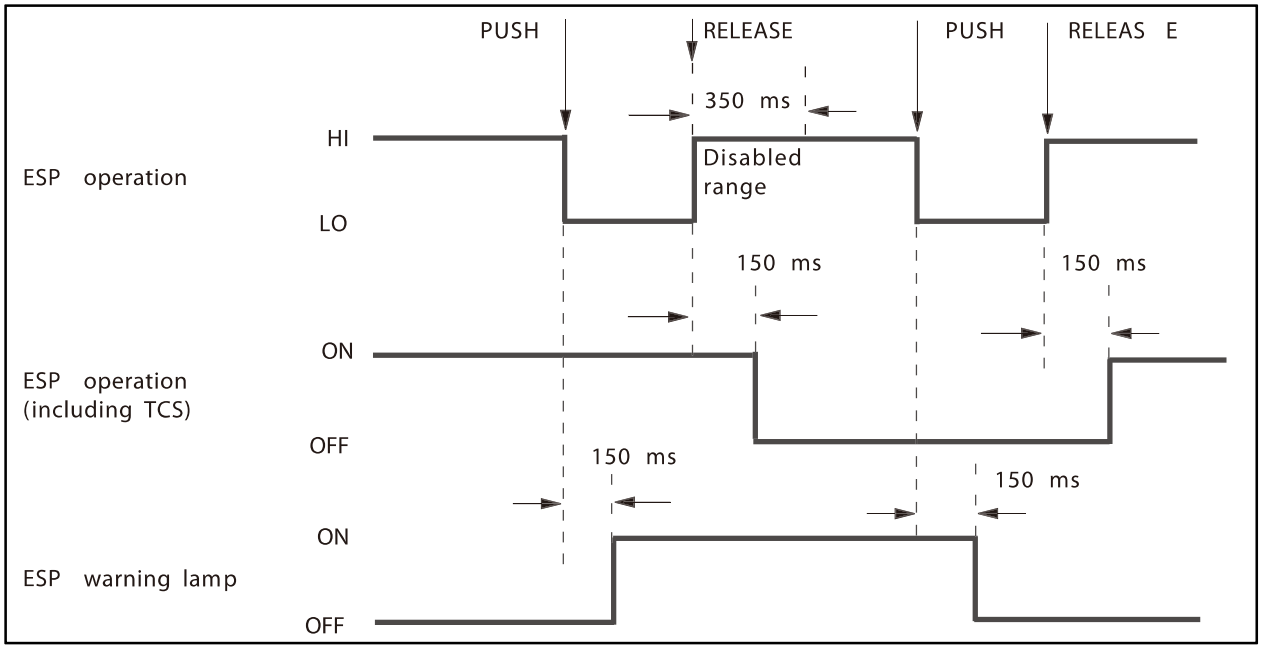
When the ESP switch is pressed (for over approximately 150 ms), the ESP system will be cancelled and the vehicle will be driven regardless of the output values from the corresponding sensors. Then, the ESP warning lamp on the instrument panel comes on.
The detailed operation procedures are as follows:
1. The ESP warning lamp comes on when the ESP OFF switch is pressed for over 150 ms.
2. The switch returns to normal position when the OFF switch is released.
3. The ESP system will be cancelled after approximately 150 ms.
Based on the above procedures, we can see that the ESP system will be cancelled after a certain period (approx.150 ms) from releasing the switch to the original position. The ESP system does not get canceled immediately when the ESP warning lamp is turned on by pressing the ESP OFF switch.
When you turn the ESP system off by pressing the ESP switch for over 150 ms, the TCS system is turned off. And the basic ABS system will operate.

▶ Resuming the ESP System by Using the ESP OFF Switch

The ESP system will be resumed and the ESP warning lamp at the instrument panel goes off when the ESP switch at the center switch panel is pushed (for over approximately 150 ms) while the ESP system is not operating.

The detailed operation procedures are as follows.

1. The ESP warning lamp comes on when the ESP OFF switch is pushed for over 150 ms.
2. The switch returns to normal position when the OFF switch is released.
3. The ESP system will be resumed after approx. 150 ms.



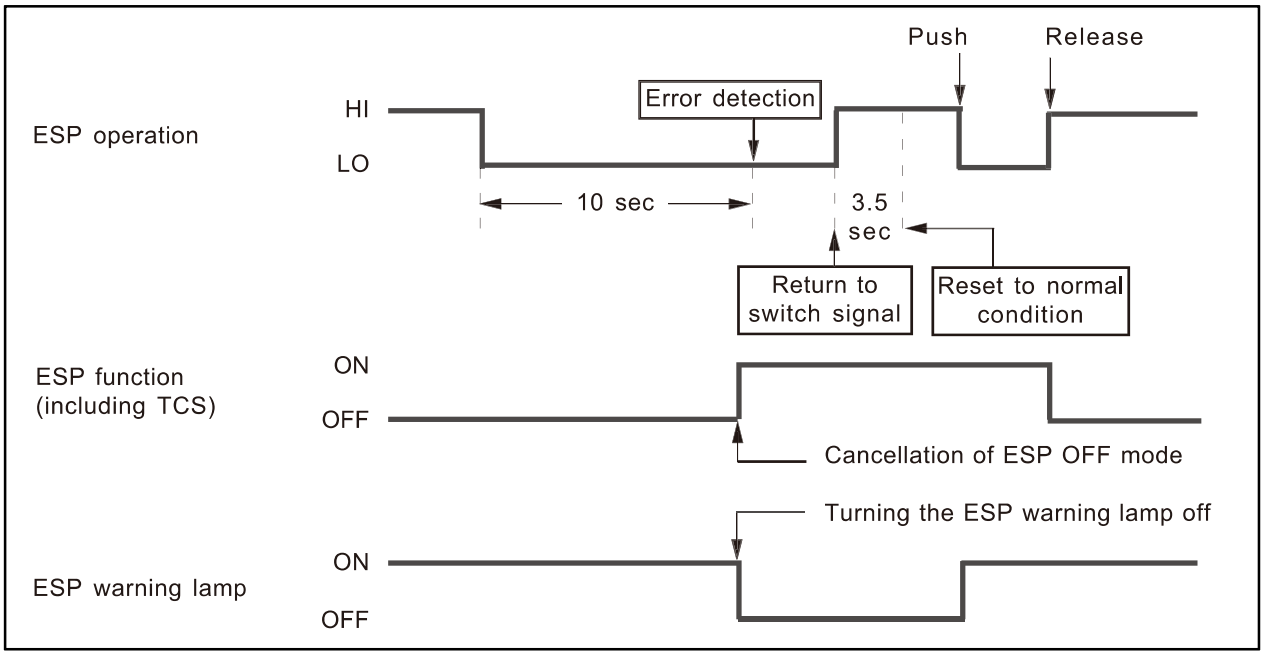
CAUTION

- When turning the ignition switch off while the ESP system is activated, the ESP system will be resumed when ignition switch is turned on again.
- When the vehicle is controlled by ESP system during driving, the ESP OFF switch does not operate.
- The ESP OFF switch operates when it is pushed for over 150 ms. When it is pushed for less than 150 ms, the ESP OFF mode and the ESP warning lamp will not be changed.
- When the ESP OFF switch is pushed within 350 ms of being turned off, the ESP warning lamp and ESP system will not be turned on.

Modification basis	
Application basis	
Affected VIN	

▶ ESP OFF Switch Monitoring

When the ESP unit recognizes that the ESP OFF switch is pushed for over 10 seconds, the ESP unit determines it as a ESP OFF switch malfunction. When the ESP OFF switch is pushed, the ESP system is resumed after 10 seconds. However, the ESP warning lamp comes on when the ESP OFF switch is pushed (for over 150 ms) and then goes out when the ESP system is resumed. When the ESP OFF switch returns to normal position, the ESP unit resets the ESP OFF switch for approx. 3.5 seconds.



▶ ESP Warning Lamp Operation Depending on System Conditions

The table shows ESP warning lamp operations when the ESP system is defective or ESP (including TCS function) is working.

	Warning Lamp		Controls			
	ABS W/L	ESP W/L	ABS	ASR	ABD	Vehicle yaw control
Initial start (for 1.8 sec)	ON	ON	NO	NO	NO	NO
Normal mode	OFF	BLINKS WHEN ESP OPERATION	OK	OK	OK	OK
ESP fault	OFF	ON	OK	NO	NO	NO
ABS fault	ON	ON	NO	NO	NO	NO
System fault	ON	ON	NO	NO	NO	NO
Low batt. voltage	ON	ON	NO	NO	NO	NO
High battery voltage	ON	ON	NO	NO	NO	NO
High brake pad temp	OFF	ON	OK	NO	NO	NO
ESP-OFF mode	OFF	ON	OK	NO	NO	OK Note 1)
Entering diag. mode	ON	ON	NO	NO	NO	NO

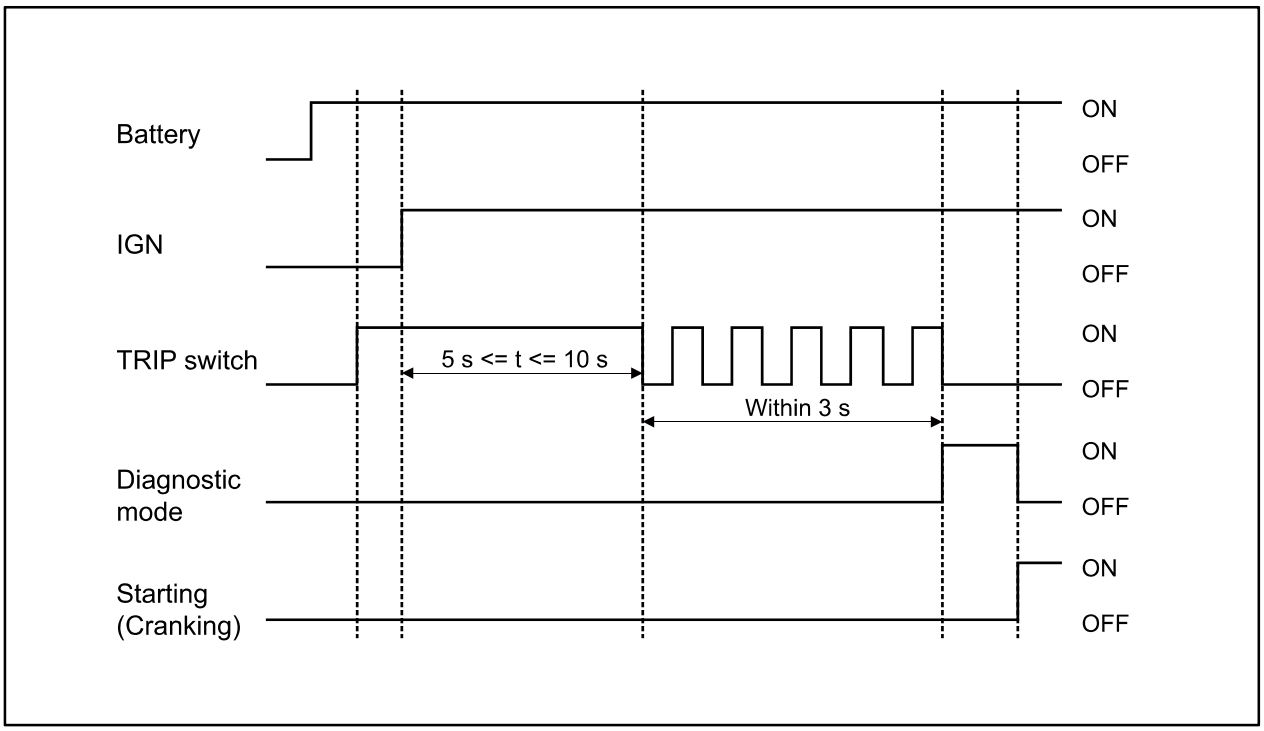
CAUTION

- When the driver presses the brake pedal during the ESP OFF mode, the yaw control is performed to compensate the vehicle stability (posture) during ESP operation.

Modification basis	
Application basis	
Affected VIN	

4. SELF-DIAGNOSIS CHECK

▶ How to enter self-diagnosis mode



1. Turn the ignition ON with the TRIP switch pressed.
2. Press and hold the TRIP switch for 5 to 10 sec. with the ignition ON.
3. Press and hold the TRIP switch for less than 10 sec. and then cycle the switch between ON and OFF 5 times within 3 sec.
4. Confirm that the self-diagnosis mode is activated through the instrument cluster.

▶ Self-diagnosis OFF

If the engine speed increases to 396 rpm or more while the engine is cranking or the ignition key is turned OFF in self-diagnosis mode, the self-diagnosis mode is turned OFF automatically.

▶ Operating process

1. Speed gauge: changes from 0 to 220 km
2. RPM gauge: changes from 0 to 6,000 rpm
3. Fuel gauge: changes from E to F
4. Temperature gauge: changes from C to H
5. Warning/Indicator lamps: All indicator/warning lamps controlled by MICOM are turned ON.
6. Dimming: Illuminates at the highest lighting level.
7. LCD display: All elements are activated.

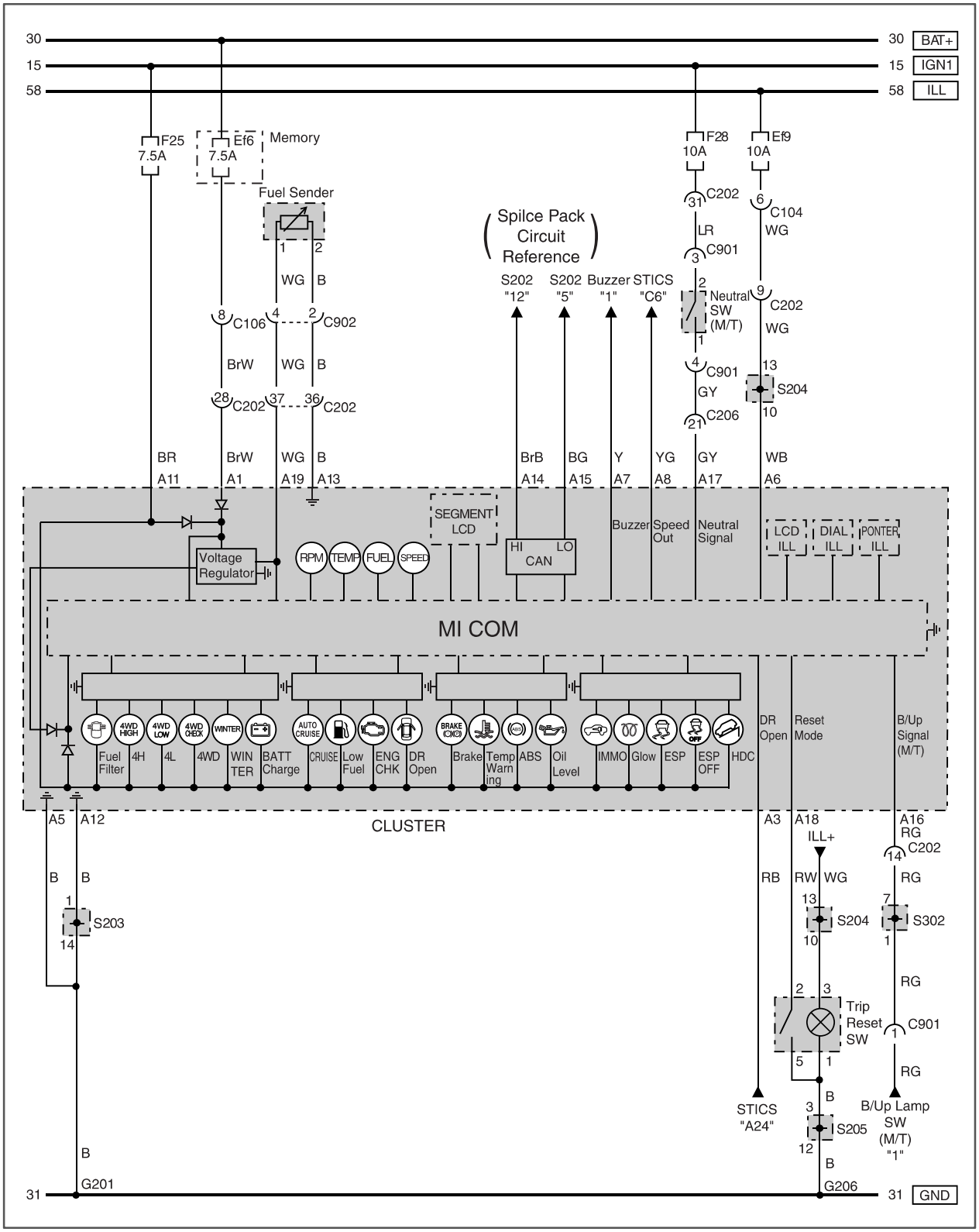
5. BUZZER OUTPUT SPEC

No.	GCC	GCC beside	Buzzer		Priority	Remark
			ON time	OFF time		
RPAS buzzer output	O	O	75ms	650ms	1	650ms delay and then 75ms sound
Over speed warning	O	X	500ms	200ms	2	
ESP buzzer output	O	O	100ms	100ms	3	
Temp buzzer output	O	O	500ms	500ms	4	
Fuel filter	O	O	500ms	500ms	5	WKS_KL= In & NMOT > 400 & IGN ON -> lamp on for 6sec

Modification basis	
Application basis	
Affected VIN	

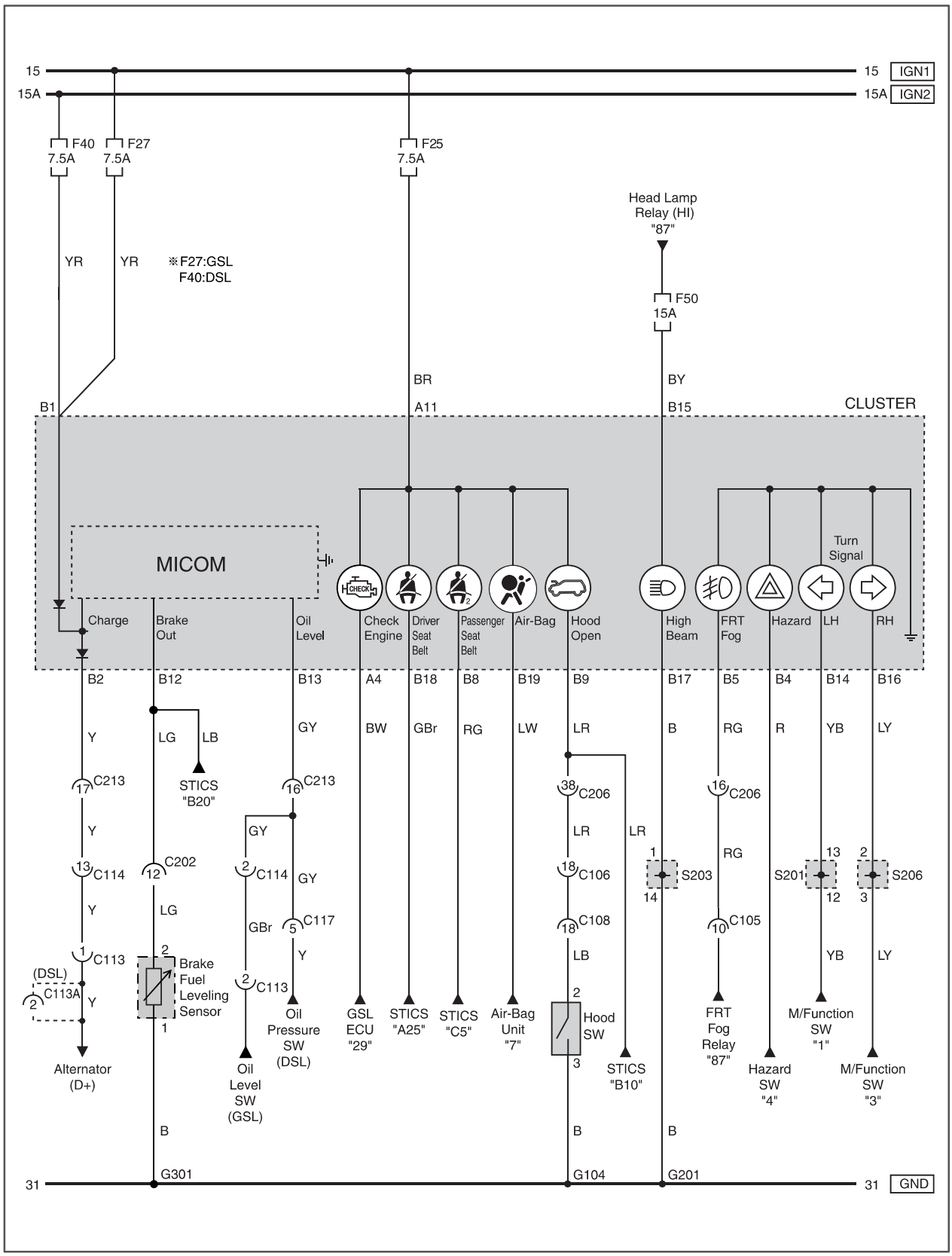
6. CIRCUIT DIAGRAM

1) Gauge (Speed, RPM, Fuel, Temp), Warning Lamp (Fuel, Fuel Filter, ABS, Brake, 4WD)



Modification basis	
Application basis	
Affected VIN	

2) Warning Lamp (BATT Charge, Oil, Hood, Door, ENG Check, Air Bag, Seat Belt), Turn Signal, Fog Lamp, Hazard



Modification basis	
Application basis	
Affected VIN	

LAMP

0000-00

GENERAL

1. SPECIFICATIONS

Description			EU		General	
			Amount	Specification	Amount	Specification
Exterior lamp	Headlamp	High/Low beam	2	H4(60W/ 55W)	2	H4(60W/ 55W)
		Turn signal lamp	2	PY21W	2	PY21W
		Position lamp	2	W5W	2	W5W
	Front fog light		2	H27W	2	H27W
	Day time running light		2	P21W	-	-
	Side repeater			LED		LED
	Rear combina-tion lamp	Stop (tail) lamp	4	P21(5W)	4	P21(5W)
		Turn signal lamp	2	PY21W	2	PY21W
		Back-up lamp	2	W16W	2	W16W
	Rear fog light		2	P21W	-	-
	License plate lamp		2	W5W	2	W5W
Interior lamp	Center room lamp		1	10W	1	10W
	Glove box lamp		1	5W	1	5W
	Front room lamp		2	10W	2	10W
	Door courtesy lamp		2	5W	2	5W
	Luggage lamp		1	10W	1	10W

NOTE

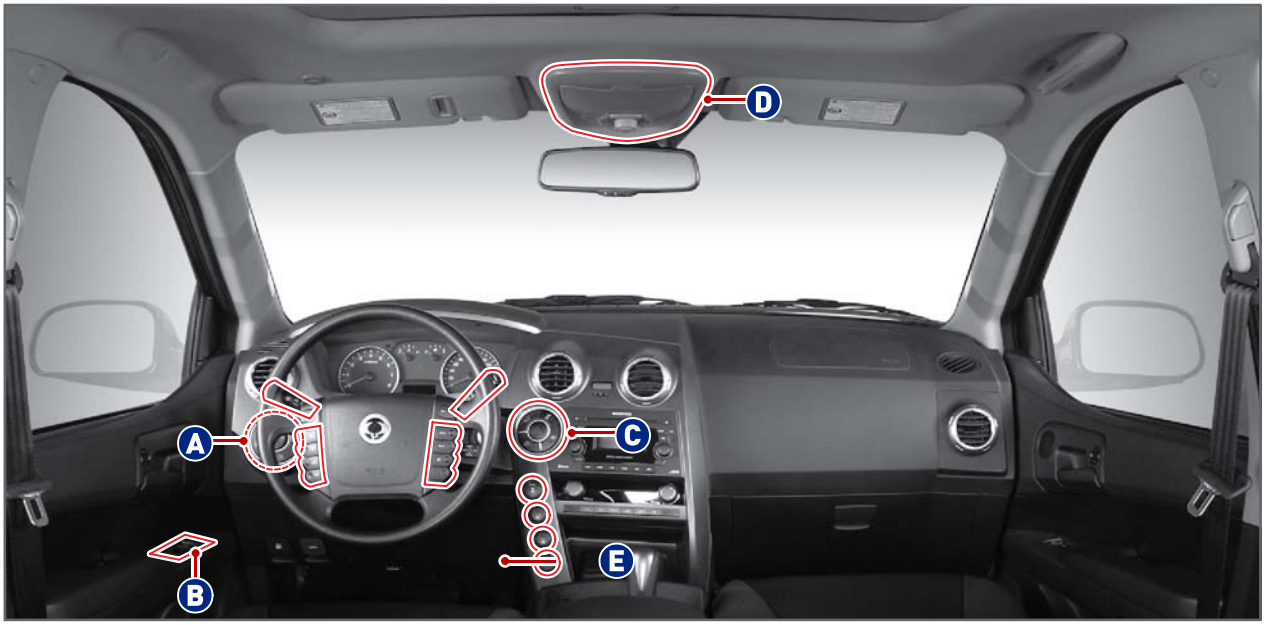
The surface of lamps can get foggy when raining or washing the vehicle. This is normal and is a result of the temperature difference between inner and outer surface of lamp cover. However, if water gets into the lamp, have the system checked at Ssangyong Authorized Service Center.

SWITCH

8510-31

GENERAL

1. SWITCH ARRANGEMENT



A



1 Outside Rearview Mirror Folding Switch
To fold the outside rearview mirrors, press the switch. To unfold the mirrors, press it again.

2 Rear Fog Lamp Switch
The rear fog lamp comes on when the rear fog lamp is turned on only while the front fog lamp is ON.

3 ESP OFF Switch
If you press the ESP OFF switch, the ESP function stops and the indicator lamp in instrument panel comes on. Press this switch again to resume the ESP function. At this time, the indicator lamp goes out.

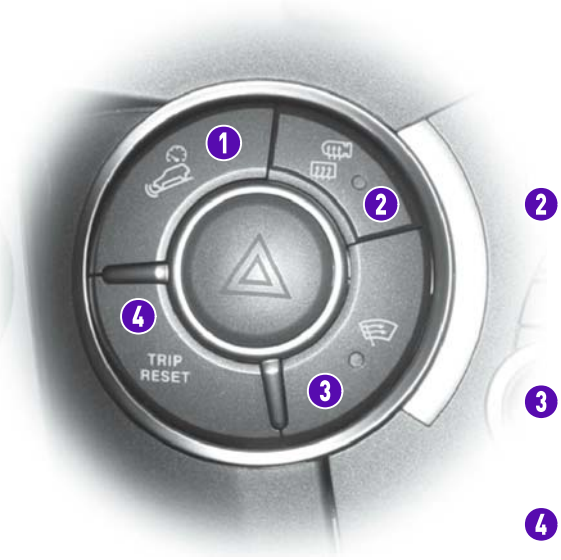
B



Driver's Power Window Switch
Driver can controls all door windows (Open/Close/Lock/Unlock) and doors (Lock/Unlock) with this switch unit.

Modification basis	
Application basis	
Affected VIN	

C



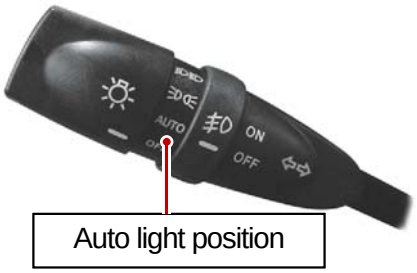
1 HDC Switch
When this button is pressed once, HDC is ready for use. The green HDC indicator comes on the instrument panel. When the button is pressed again, HDC is deactivated and the indicator goes off. (Refer to ABS/ESP section.)

2 Heated Tailgate Glass and Outside Rearview Mirror Glass Switch
Press this switch to turn on the tailgate and outside rearview mirror defogger. It will operate for about 12 minutes.

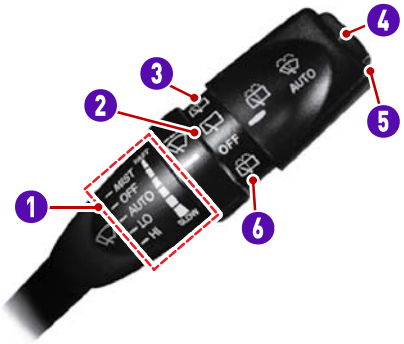
3 Heated Windshield Glass Switch
Press this switch to turn on the heated windshield glass. It will operate for about 12 minutes.

4 TRIP Switch
To choose a desired driving distance display mode, press the switch: Changing sequence: ODO - TRIP A - TRIP B - ODO

Additional Functions of Multifunction Switch



Auto light position



1 Front wiper operation range
(move the wiper lever up/down)

2 Rear wiper operation

3 Washer fluid will be sprayed
onto the rear window glass once during rear wiper operation.

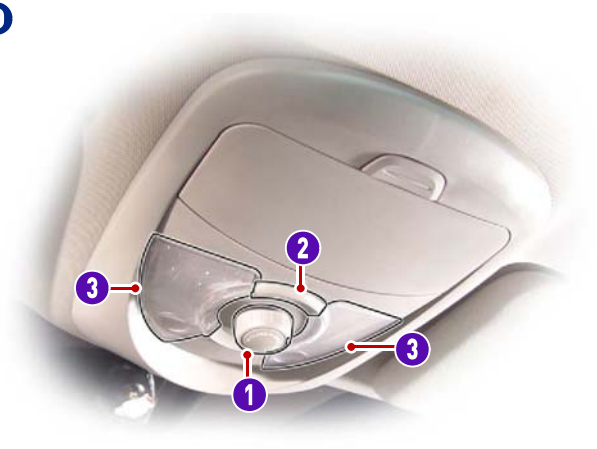
4 Auto Washer Switch
When the front wiper switch is off and this switch is pressed, washer fluid will be sprayed and the wiper will automatically operate 4 times. Then, the fluid will be sprayed again and the wiper will automatically operate 3 times.

5 Front Wiper and Washer Coupled Operation
Pull the lever briefly (below 0.6 seconds): One wiping cycle Pull and hold the lever for more than 0.6 seconds: Three wiping cycles with washer spray

6 Washer fluid will be sprayed onto
the rear window glass and the wiper will also operate once.

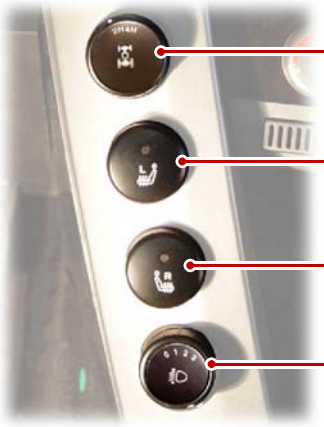
Modification basis	
Application basis	
Affected VIN	

D



1. Sun roof switch
2. Main room lamp switch
3. Front room lamp spot switch

E



- 4WD Control Switch
- Driver's Heated Seat Switch
- Passenger's Heated Seat Switch
- Head Lamp Leveling Switch

Audio Remote Control Switch



- POWE
- MUTE
- MODE
- ▲ VOL
- ▲ SEEK
- VOL ▼
- SEEK ▼
- Bluetooth Switch

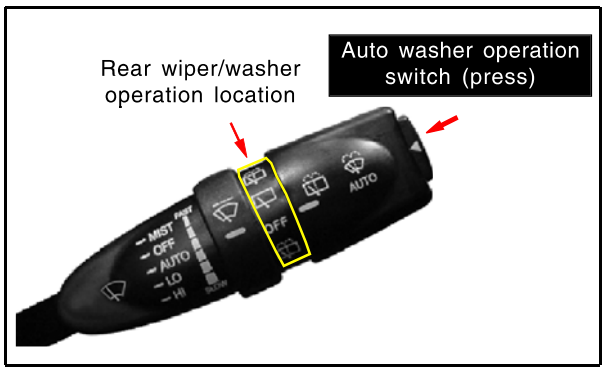
WIPER & WASHER SYSTEM 7810-01

OVERVIEW AND OPERATION PROCESS

1. SYSTEM LAYOUT AND FUNCTION

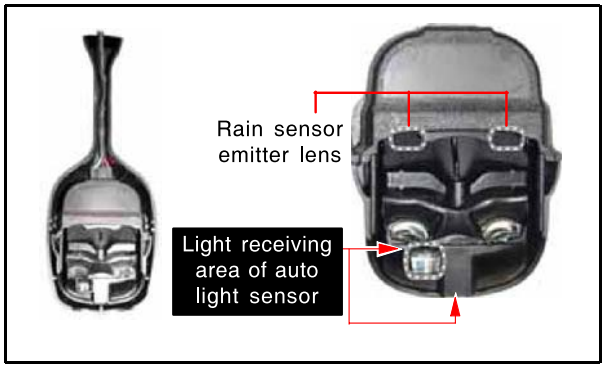
The wiper and washer system are controlled by STICS according to driver's wiper switch operation. And the detection of rain drops by rain sensor is transmitted to STICS as the signal for wiper system control. The characteristics of the wiper and washer system including basic functions of manual wiper are as follows.

1) Wiper Function Coupled Auto Washer



When the front wiper switch is off and this switch is pressed, washer fluid will be sprayed and the wiper will automatically operate 3 times. Then, the fluid will be sprayed again and the wiper will automatically operate 3 times.

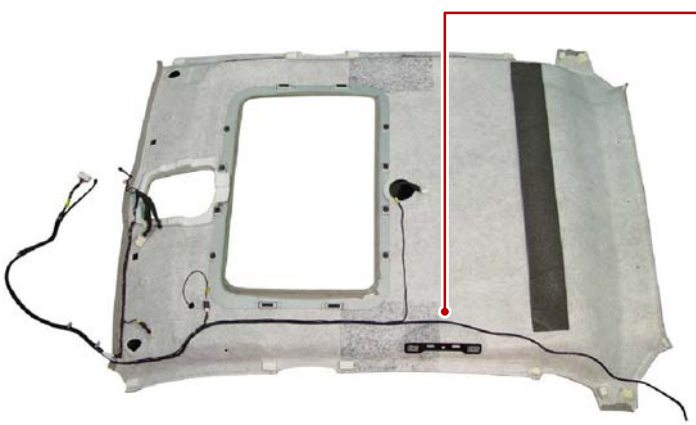
2) Integrated Auto Light Sensor in Rain Sensor Unit



The rain sensor unit is installed on a proper location to detect the rain drops and the illumination intensity. To control the system, the sensed values of rain sensor and auto light sensor are sent to pin no. 63 in STICS unit.

3) Rear Washer Fluid Supply System

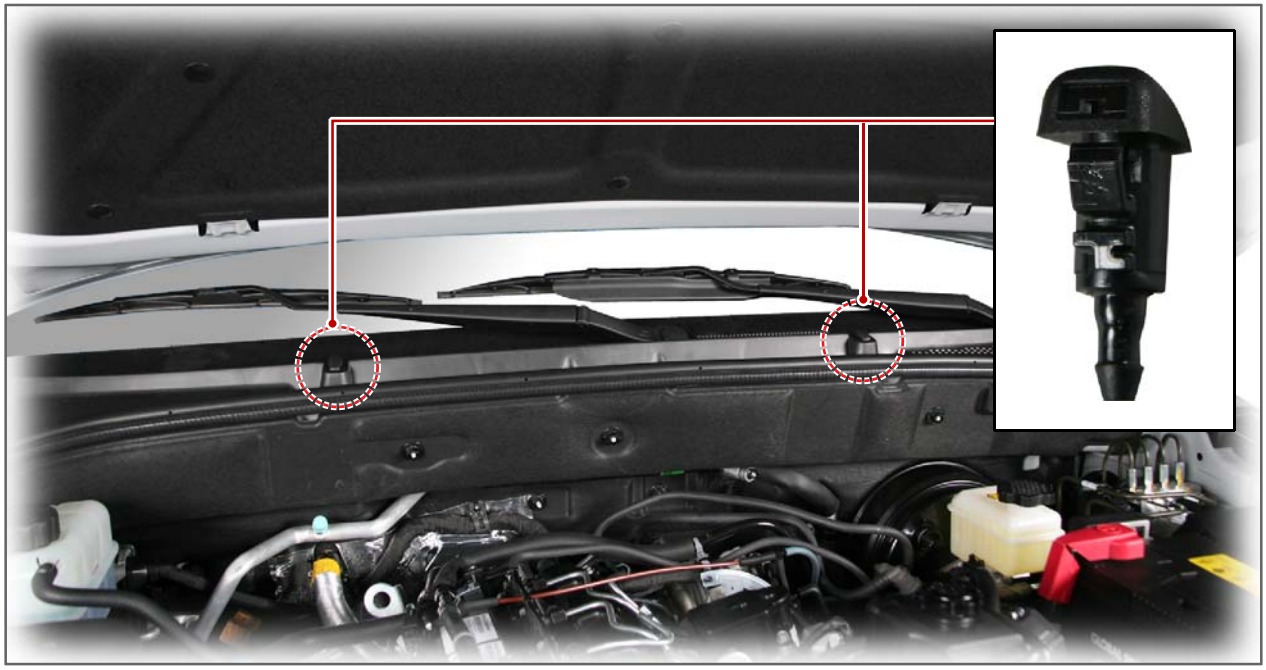
There is no separate washer fluid reservoir for the rear washer system in this vehicle. The rear washer system uses the front washer fluid reservoir. Because of this, the washer hose is supposed to be long between front reservoir tank and rear washer nozzle. To avoid being damaged or interfered while in assembling the vehicle, the rear washer hose is fixed on headlining with silicone.



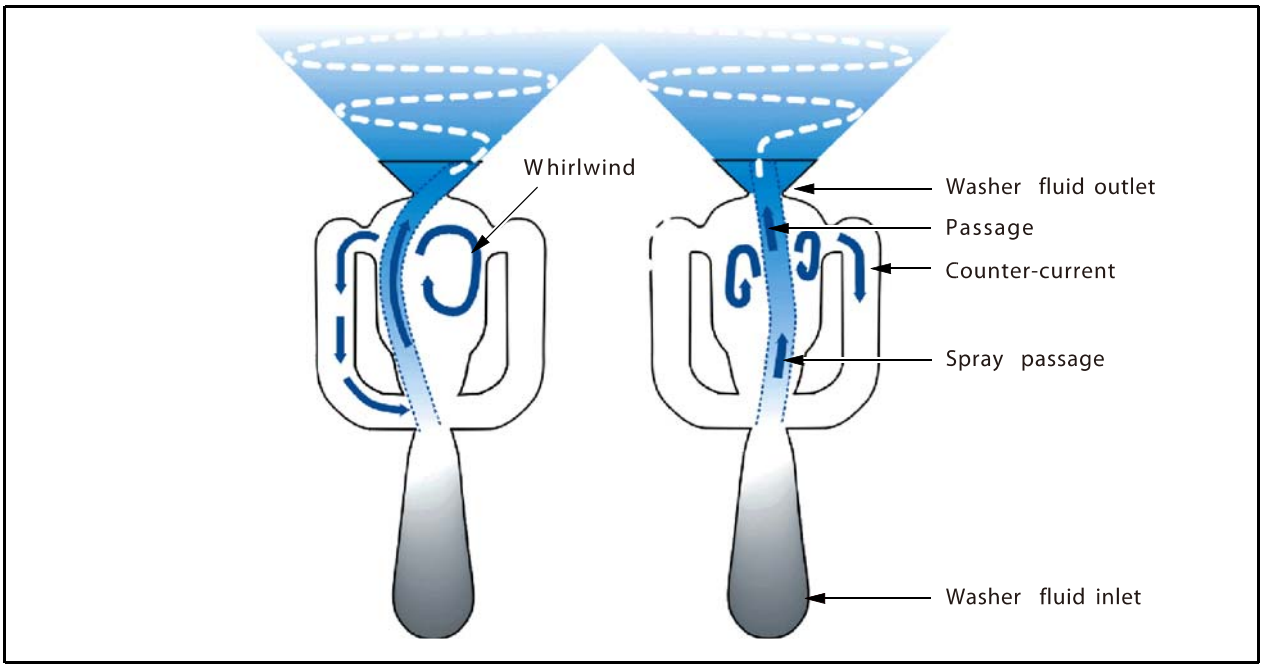
Modification basis	
Application basis	
Affected VIN	

4) Fluidic Washer Nozzle

Fluidic Washer Nozzle is applied to the front washer spray system in this vehicle. The inside of nozzle is designed to utilize the fluidic movement.



This is a shape of the inside of nozzle. It is designed to change the spraying direction continuously according to the spraying time (fan-shape). The figure below shows the changes of spraying direction according to the spraying time.



It is designed to be changed spraying direction using the whirlwind and backflow generated in nozzle.

2. CONFIGURATION (INCLUDING RAIN SENSOR)

Multifunction wiper and washer switch



Auto washer switch

Pressing the switch makes washer fluid to be sprayed for 2 sec. with four wiping, and washer fluid to be sprayed for 1.5 sec. with three wiping, with no delay of time

Rain sensor unit



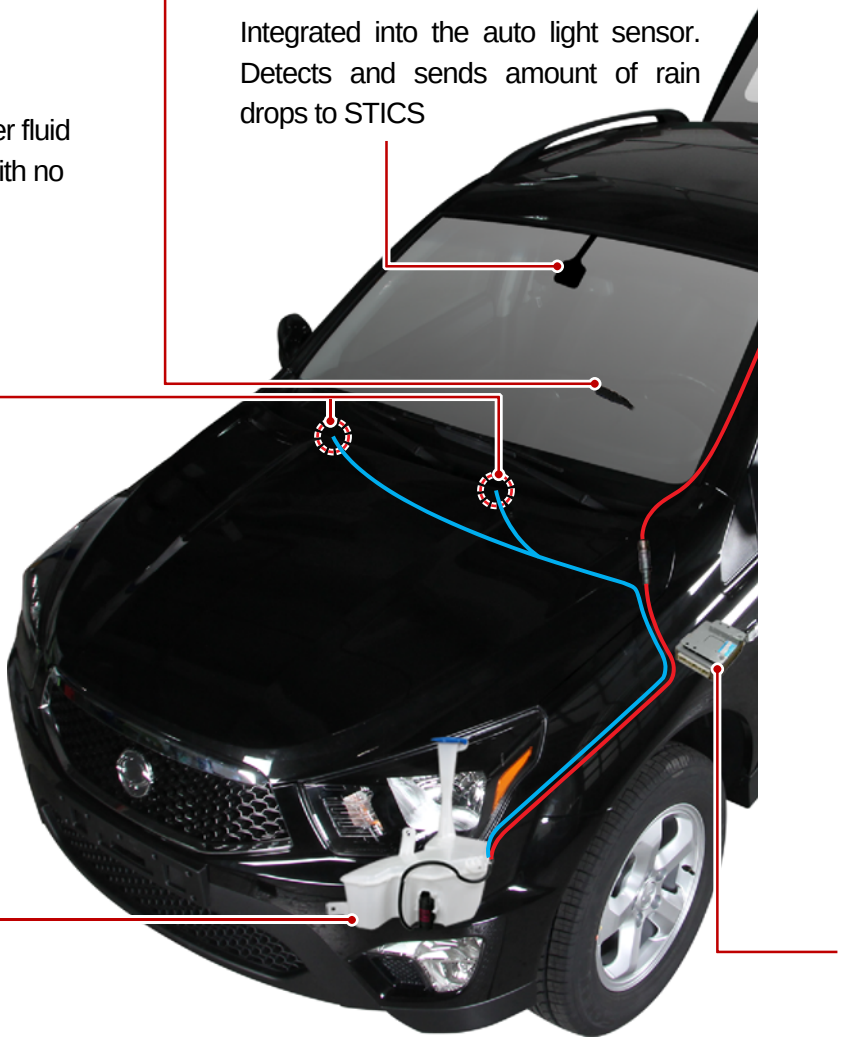
Integrated into the auto light sensor. Detects and sends amount of rain drops to STICS

Front nozzle assembly



Front nozzle

Installed on both sides of the cowl grille assembly (one on each side). Sprays washer fluid in fan-shape to cover the windshield area as much as possible.



Washer reservoir tank assembly



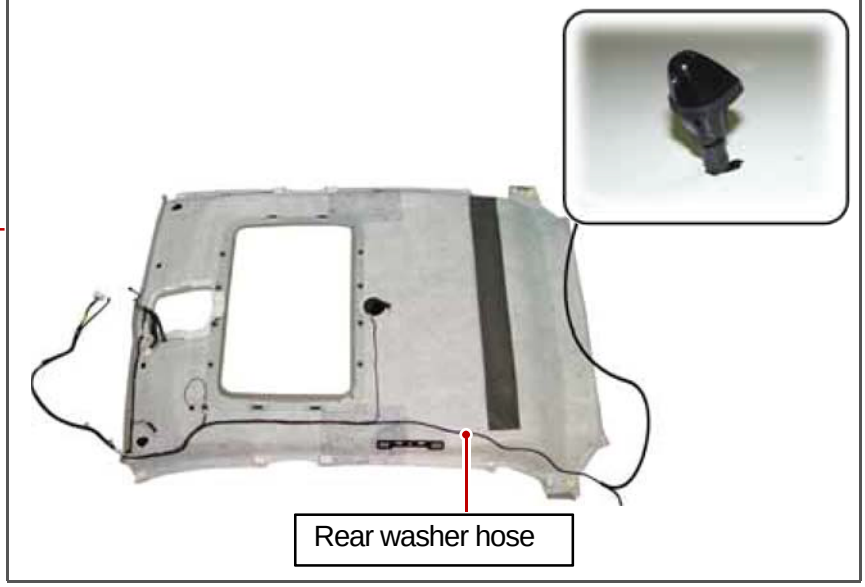
Washer reservoir tank

Tank that supplies washer fluid to front washer system

Modification basis	
Application basis	
Affected VIN	



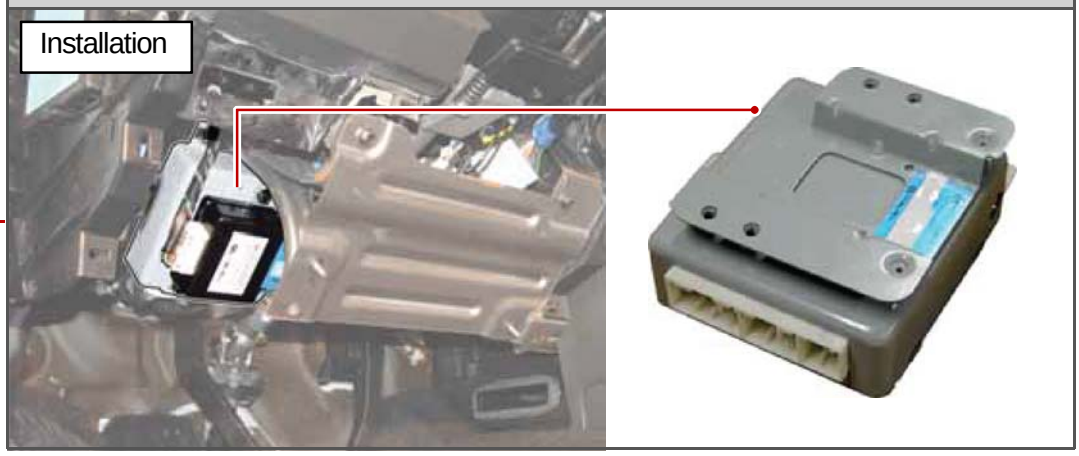
Rear Washer Hose Mounting



Rear washer hose mounting

There is no separate washer fluid reservoir for the rear washer system in this vehicle. The rear washer system uses the front washer fluid reservoir. Because of this, the washer hose is supposed to be long between front reservoir tank and rear washer nozzle. To avoid being damaged or interfered while in assembling the vehicle, the rear washer hose is fixed on headlining with silicone.

STICS



STICS receives the rain sensing data from the rain sensor and controls the wiper and washer systems.

3. WIPER & WASHER RELATED FUNCTION AND SPECIFICATION

1) Wiper and Washer Fluid Switch Operation

MIST
When turning up the switch, the wiper operates once. When releasing the switch, the pointers return back to “OFF” position.

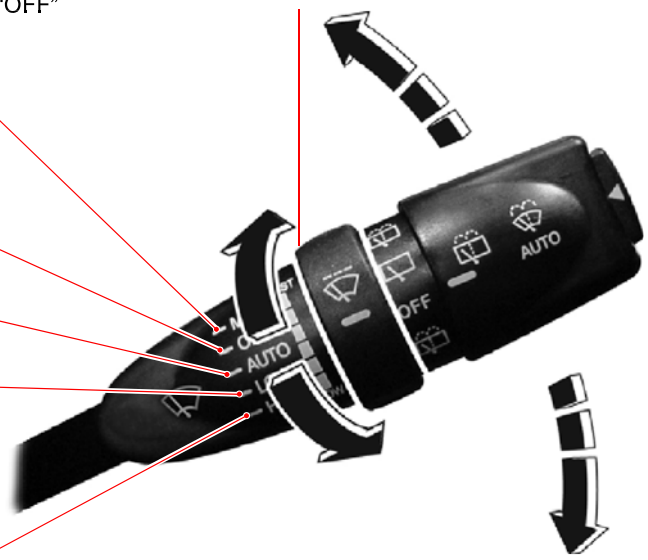
OFF
Wiping stops

AUTO
Wiper speed controls automatically according to the vehicle speed or amount of rain (rain sensing wiper).

LO
Wiping speed gets slower when placing the pointer at the “LO” positon.

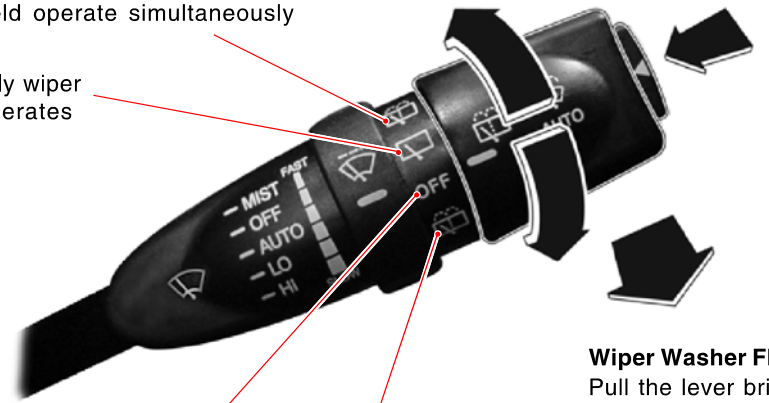
Wiping speed gets faster when placing the pointer at the “HI” positon.
HI

Wiper Speed Control Switch
When turning to FAST, wiping speed gets faster and when turing to SLOW, wiping speed gets slower.



Wiper and washer fluid for rear windshield operate simultaneously

Only wiper operates



Wiping stops

Washer fluid for rear windshield operates once.

Auto Washer Switch
If pressing the switch when the wiper switch turns to the “OFF” position, washer fluid is sprayed once and wiper operates 4 times.
After a while, washer fluid is sprayed one more and the wiper operates 3 times.

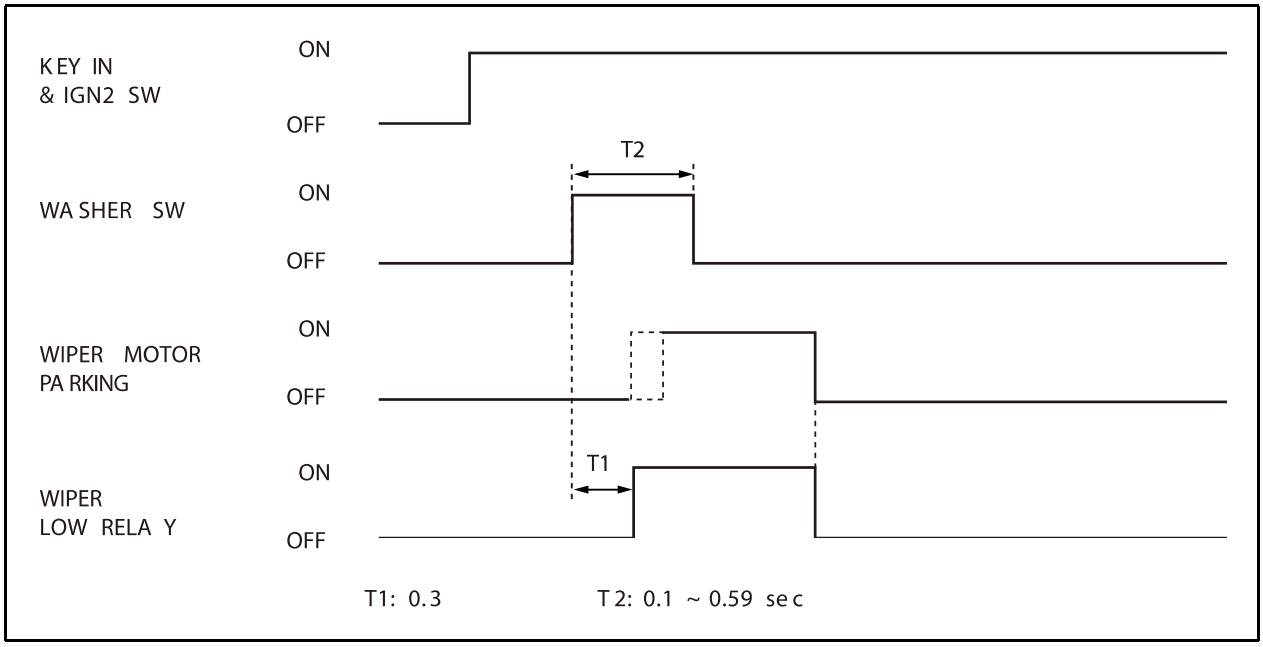
Wiper Washer Fluid Coupled Function
Pull the lever briefly (below 0.6 seconds)
: One wiping cycle with washer spray
Pull and hold the lever for more than 0.6 seconds
: Three wiping cycles with washer spray

Modification basis	
Application basis	
Affected VIN	

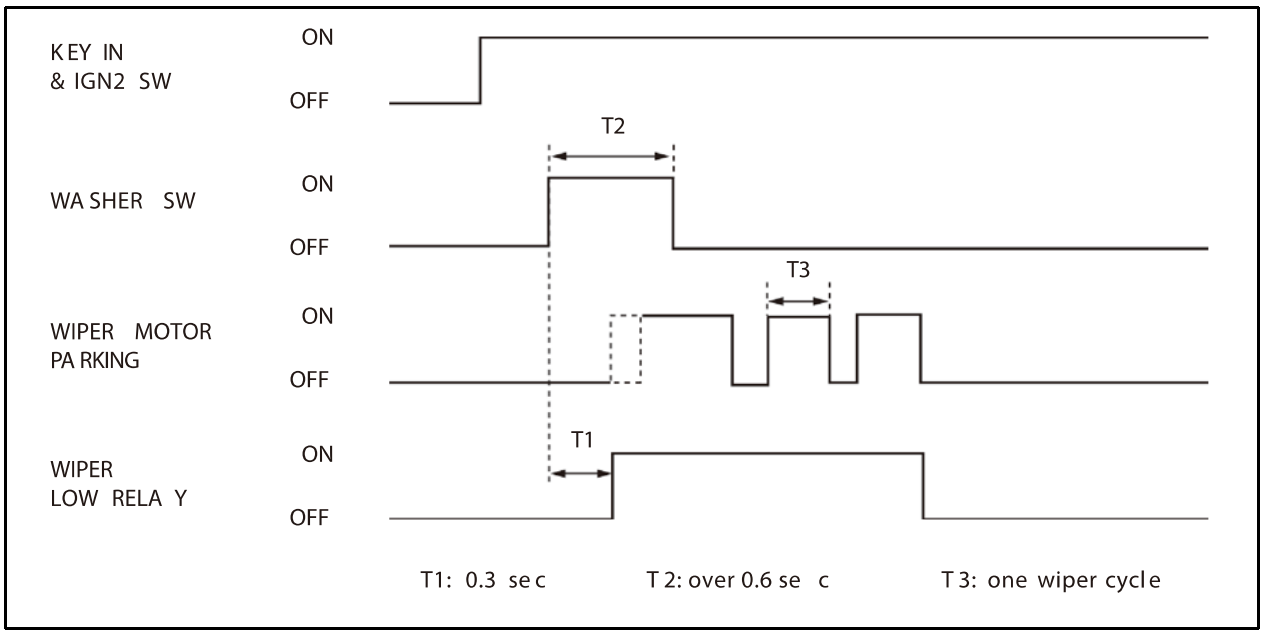
2) STICS Control Logic Related to Wiper and Washer

(1) Wiper MIST and Front Washer Coupled Wiper

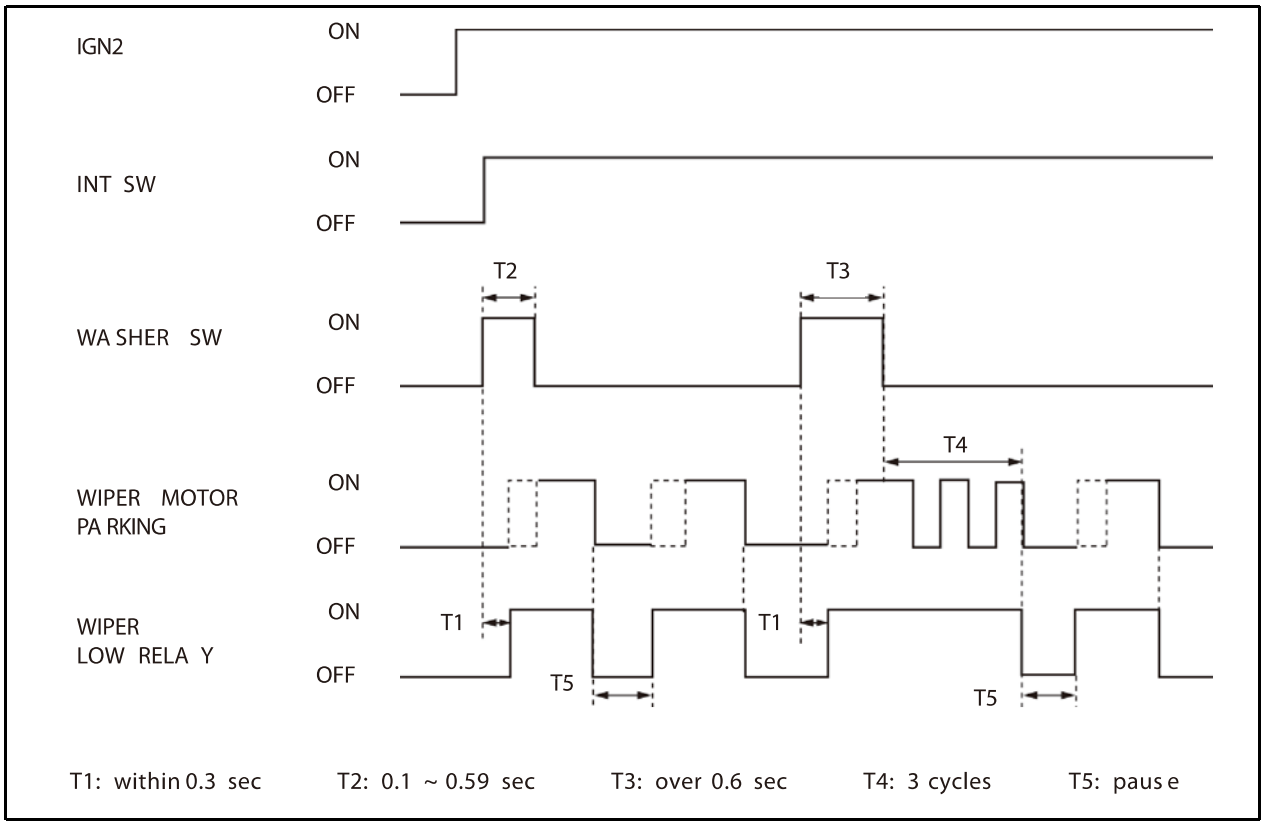
1. The wiper relay is turned on 0.3 seconds after turning "ON" the washer switch for 0.1 ~ 0.59 seconds with the ignition key "ON", and it is turned off when the parking terminal is turned off.



2. The wiper relay is turned on 0.3 seconds after turning "ON" the washer switch over 0.6 seconds with the ignition key "ON", and it is turned on three times immediately after turning off the washer switch.

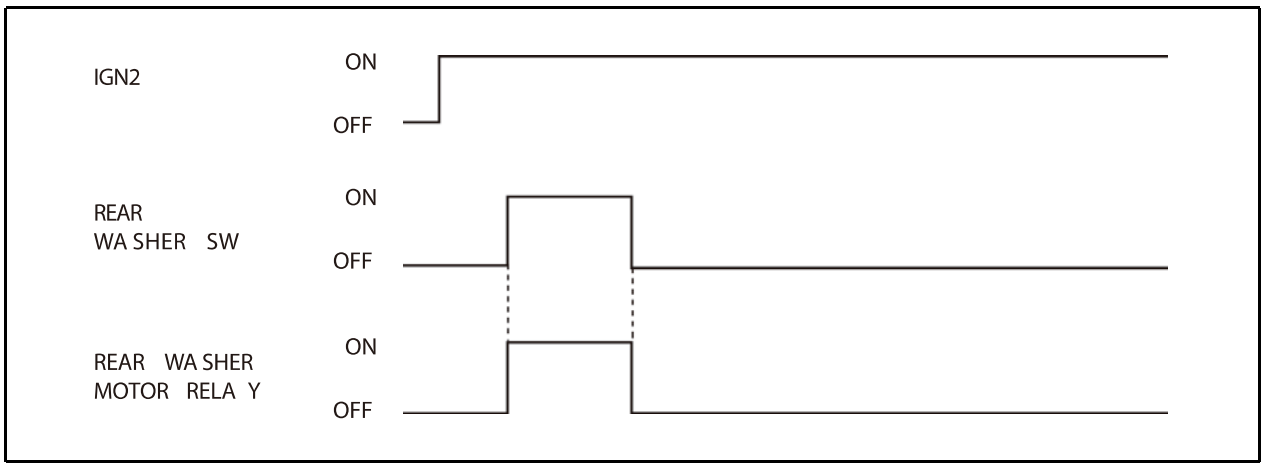


3. When the washer switch is ON for more than 0.6 seconds during the wiper operation by the INT switch, the operation in step (2) is performed. When it is ON for a certain period of time (0.1 to 0.59 seconds), the operation in step (1) is performed.



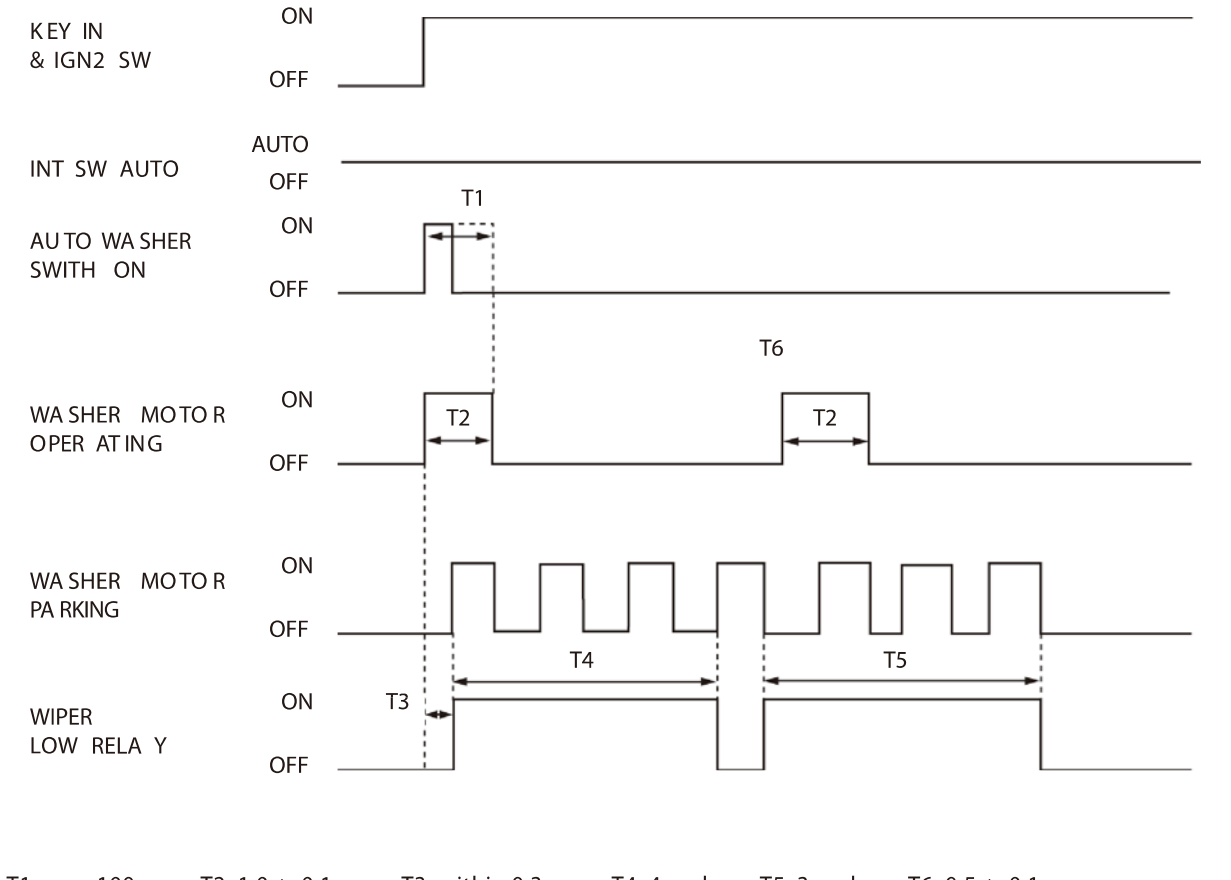
(2) Rear Washer Motor Control

1. When the rear washer switch is turn on with the ignition switch "ON", the rear washer motor relay output is activated from the time when the rear washer switch is turned on, and it is deactivated when the rear washer switch is turned off.
2. It cannot be activated while the front washer switch or the auto washer and wiper (AFW: Advanced Fast Washer) is in operation.



Modification basis	
Application basis	
Affected VIN	

3. The auto washer switch output is overridden during the washer coupled wiper operation.
4. The auto washer switch input is overridden during the auto washer coupled wiper operation.
5. The auto washer switch input is overridden during the rain sensor coupled wiper or vehicle speed sensitive INT wiper operation.
6. When the auto INT switch input is received during the auto washer operation, the auto washer operation stops and the auto INT operation is activated.

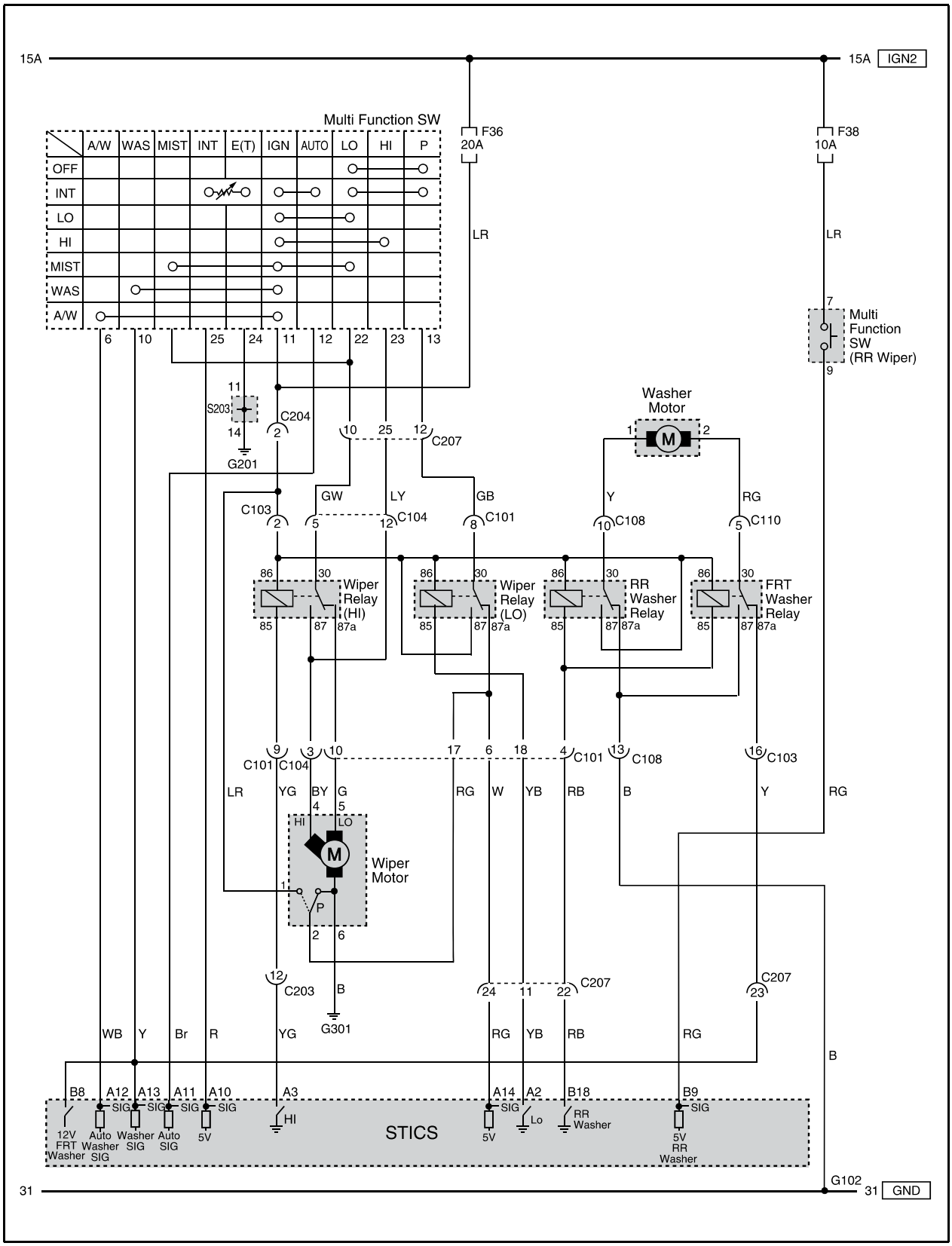


Priorities in Washer Operations

1. The rear washer switch input is overridden during the front washer operation.
2. The rear washer switch input is overridden during the auto washer and wiper (AFW) operation.
   The front washer switch input is overridden during the rear washer operation.
3. The auto washer switch input is overridden during the rear washer operation.
4. The front washer switch input is overridden during the auto washer and wiper (AFW) operation.
5. The auto washer switch input is overridden during the front washer operation.

6.

4. WIPER AND WASHER SYSTEM RELATED CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	

RAIN SENSOR 8610-09

OVERVIEW AND OPERATION PROCESS

1. SYSTEM LAYOUT AND OVERVIEW

The rain sensing wiper unit in this vehicle doesn't control the wiper directly. The rain sensing unit detects the amount of rain drops and sends the operating signal to STICS, and STICS drives the wiper directly.

Rain Sensor Unit (Auto Light Sensor Integrated Type)	Multifunction Wiper Switch: AUTO and Sensitivity Control
	
A sensor that emits infrared rays through LED and then detects the amount of rain drops by receiving reflected rays against sensing section (rain sensor mounting section on the windshield) with photodiode. The auto light sensor is Integrated into the rain sensor (refer to the below picture).	AUTO: Wiper operates automatically by rain sensor FAST <-------> SLOW: Auto delay/Auto speed control. A position that controls sensitivity against rains on the windshield and transmits wiping demand signal accordingly.



Emitter lens

The LED which is located at bottom emits the infrared rays and the lens guides the infrared rays to target point.

Auto light sensor (Vertical)

Auto light sensor (Horizon)



Enlarged auto light sensor section

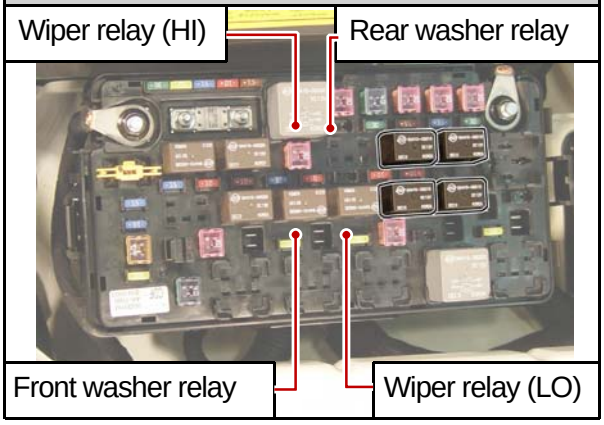
▶ STICS

The rain sensing unit detects the amount of rain drops and sends the operating signal to STICS, and STICS drives the wiper directly. At this moment, STICS determines the wiper operation mode (washer, MIST, AUTO), then sends the information to the rain sensor.

STICS



Engine Compartment Fuse Box



▶ Auto Light Sensor and Rain Sensor Coupled Control

1. Rain detected headlamp: If it rains heavy which requires the intermediate INT speed, the headlamps are turned on automatically.
2. Night detected wiping: When the auto light control turns on the headlamps and the rain sensor detects the rain, the wiper sensitivity is automatically increased by one level. (For example, the AUTO wiper switch is at the 3rd level, but the wiper operates at the 4th level.)

Modification basis	
Application basis	
Affected VIN	

2. RAIN SENSING OPERATION

The rain sensor is installed on the specific heat treated windshield that has minimum 13% of transmittance rate with specified intensity of radiation. It is installed on the glass with a adhesive of Sorepa. It communicates with STICS and makes the wipers to operate automatically under the rain sensing mode (multifunction switch wiper: AUTO mode). The emitting section of the rain sensor unit emits infrared rays against the windshield and then detects the amount of rain drops by receiving reflected rays with photodiode.

The difference compared with the conventional rain sensor is that the auto light sensor is Integrated into the rain sensor. Followings are the components and functions of the rain sensor unit

1) Rain Sensor Unit (Including Cover)



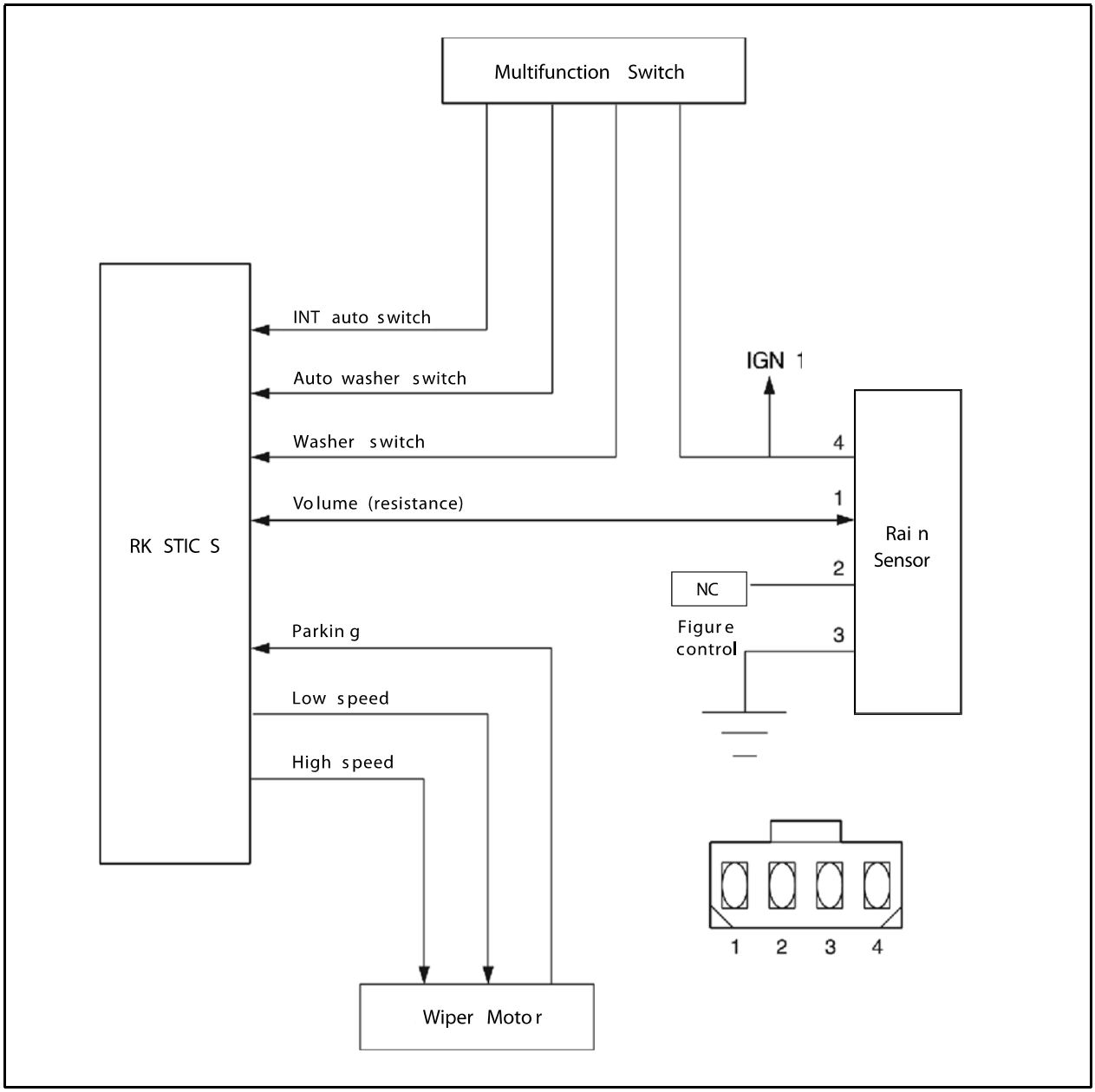
3. RAIN SENSOR RELATED CIRCUIT

The rain sensor has one connector with 4 pins and each pin has following function as shown in the circuit diagram. However, in this vehicle, the terminal No. 1 and No. 2 are for communications between STICS and the rain sensor; the No. 1 terminal sends the detected value from the rain sensor to STICS then the STICS drives wiper motor.

No. 2 terminal sends the wiper and washer operation information such as

washer operation mode,
wiper relay, or
multifunction wiper switch is in AUTO wiper position

to the rain sensor to recognize whether it is actual rain or it is in rain sensing wiper operation mode.

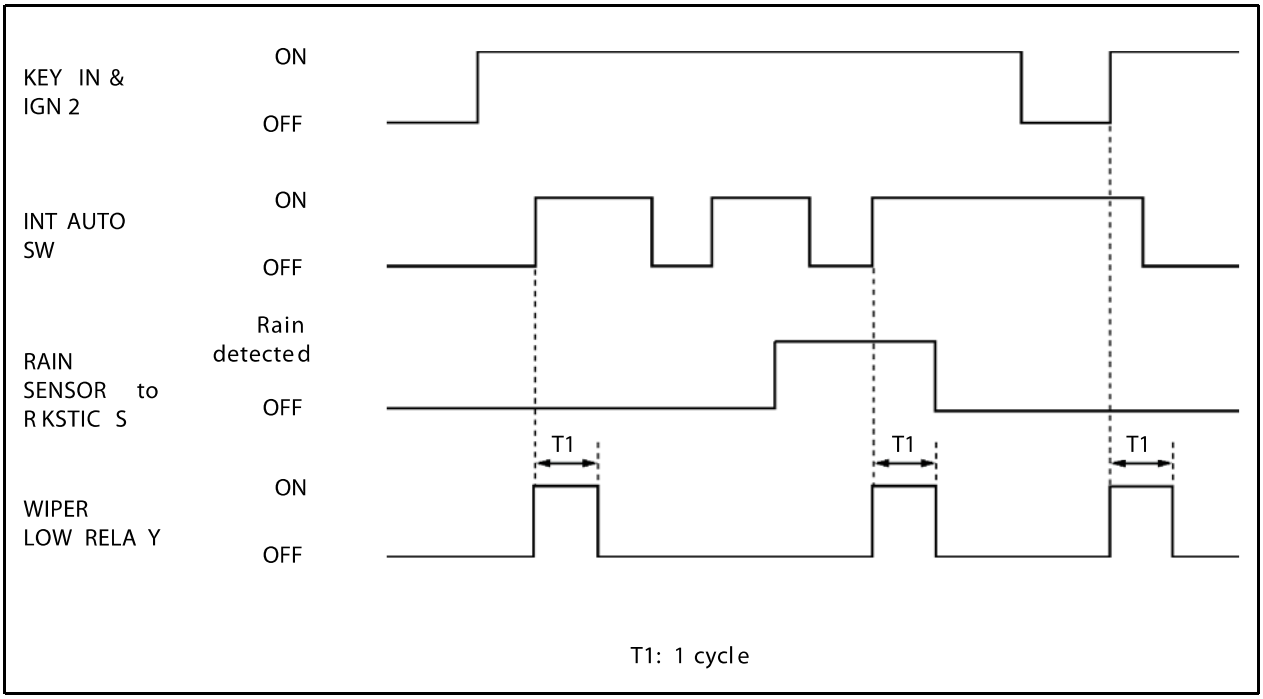


Modification basis	
Application basis	
Affected VIN	

4. FUNCTIONS AND SPECIFICATIONS OF RAIN SENSING WIPER

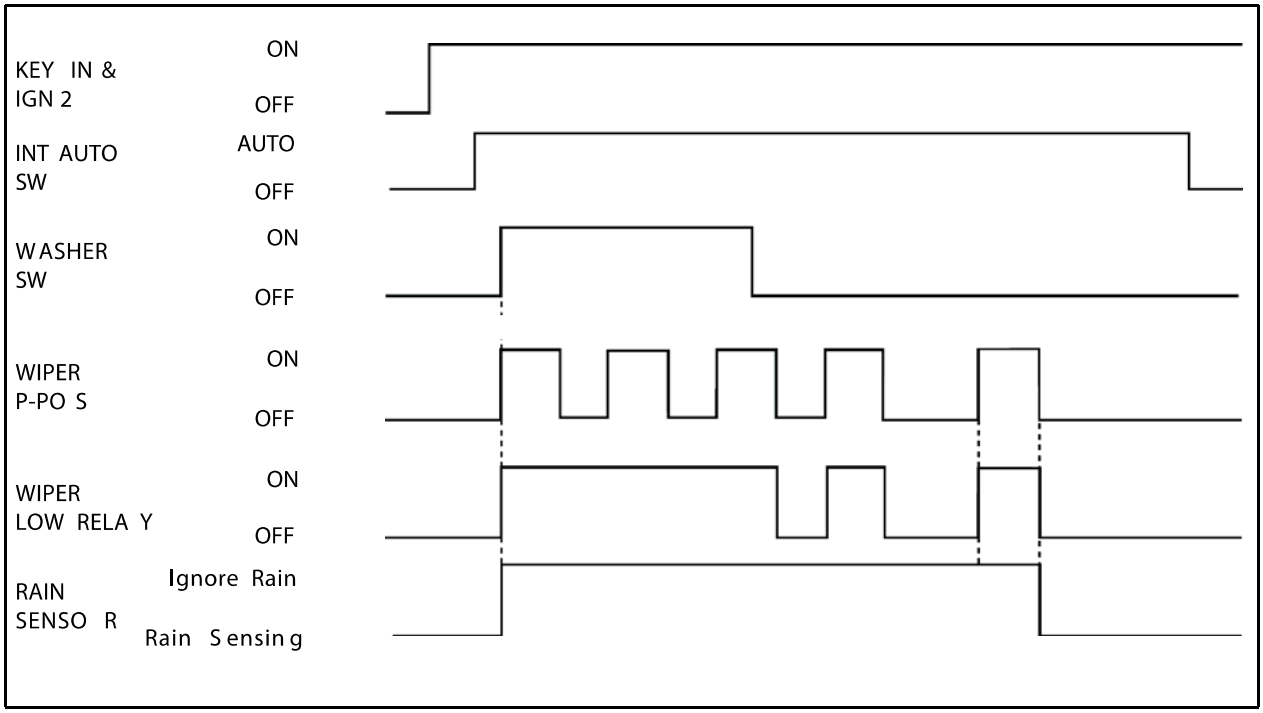
1) Power-up Reminder Wiper

1. When turning off and on the INT auto switch, the system drives the wiper motor for one cycle through LOW relay regardless of communication with rain sensor.
2. The wiper relay (LOW) is turned on and the wiper motor runs one cycle when changing the INT auto switch to "ON" position from "OFF" position for the first tiime(while the ignition key is in "ON" position). When the wiper switch is turned to "ON" position again from "OFF" position, the system drives the wiper motor through LOW relay one cycle only when the rain sensor detects the "Rain Detected" signal.



2) Washer Coupled Wiper in the Rain Sensing Mode

1. The washer coupled wiper is operated when receiving the washer switch input with the ignition switch "ON" and the auto INT switch "ON" in rain sensing mode. At this moment, the communication with the rain sensor is overridden. However, the washer switch input is overridden during continuous operation.
2. The operation data is sent to the rain sensor even during the washer coupled wiper operation.

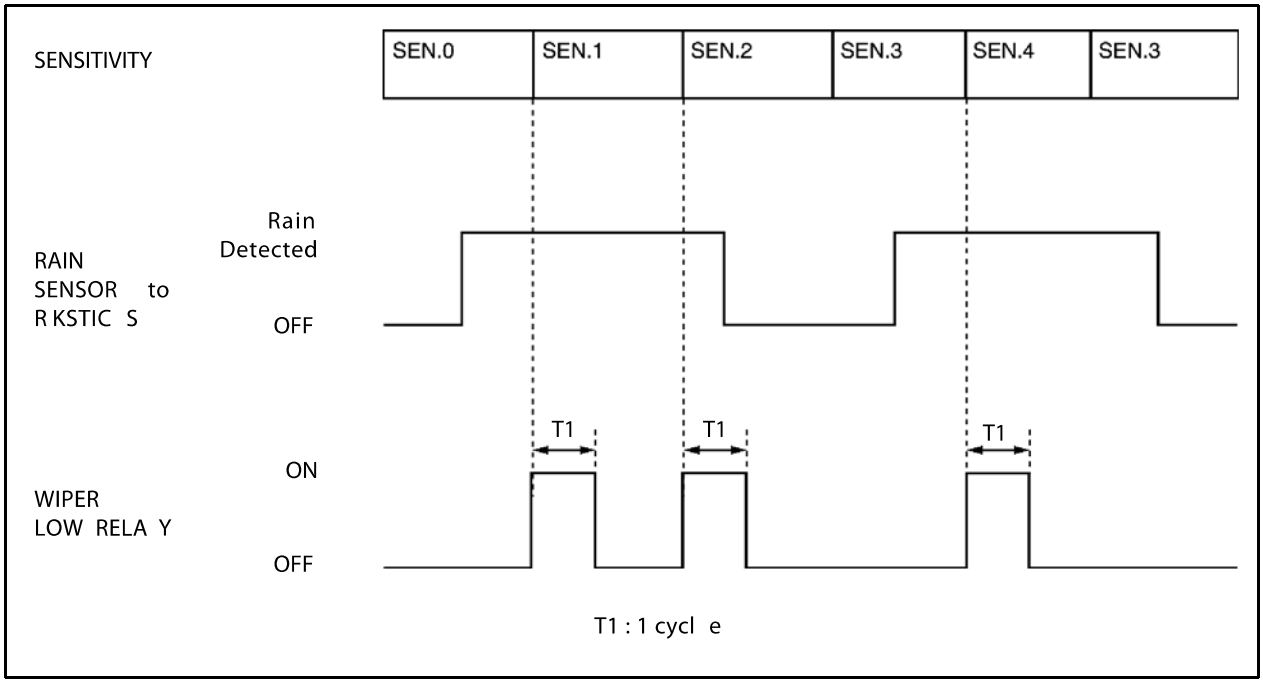


Modification basis	
Application basis	
Affected VIN	

3) Rain Sensing Sensitivity Control

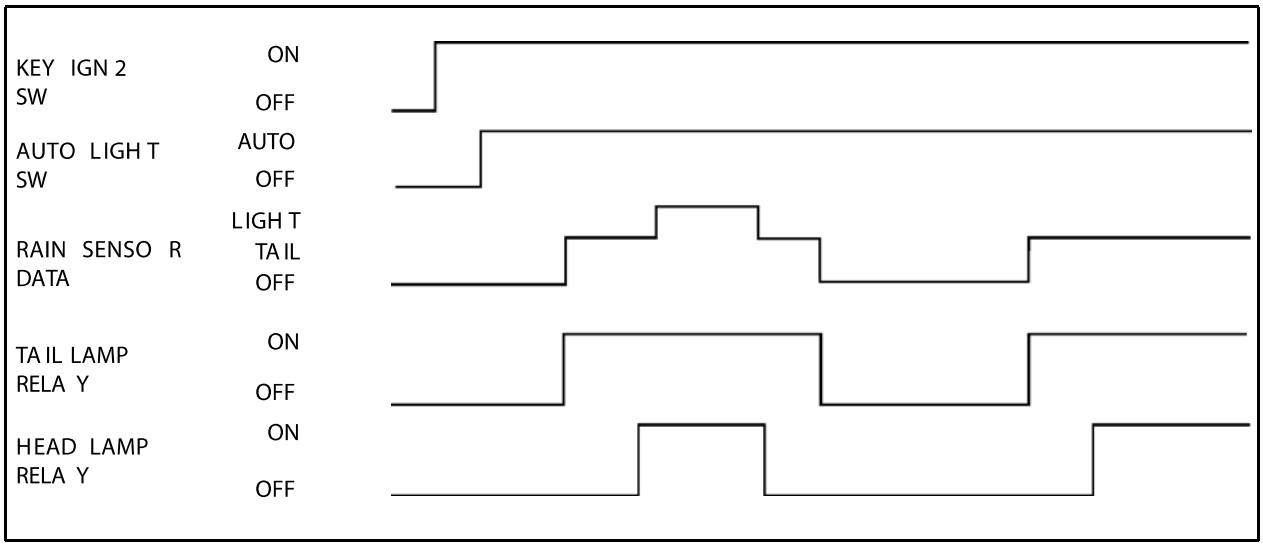
1. The wiper relay (LOW) is turned on and the wiper motor runs one cycle when the volume sensitivity is increased (ex: from 0 to 1) (while the ignition key is in "ON" position, the wiper switch is in "AUTO" position, and the wiper motor is in "Parked" position). However, the wiper motor can be operated only when the rain sensor detects the "Rain Detected" signal.

   ※ If the volume sensitivity is changed more than 1 stage within 2 seconds, the wiper motor runs only one cycle.



4) Auto Light Control

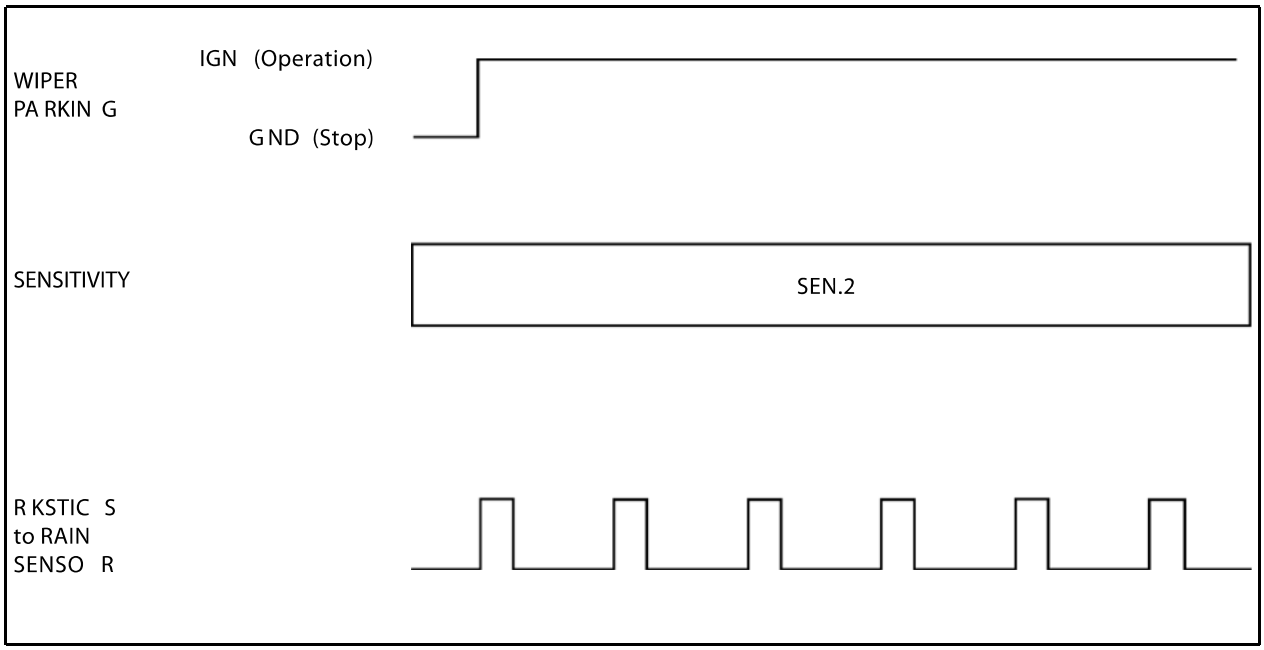
1. Only when the auto light switch is in "AUTO" position, it controls the tail lamp and headlamp by communicating with the rain sensor (while the ignition key is in "ON" position).



5) Wiper Operation When the Wiper Parking Terminal Is Grounded

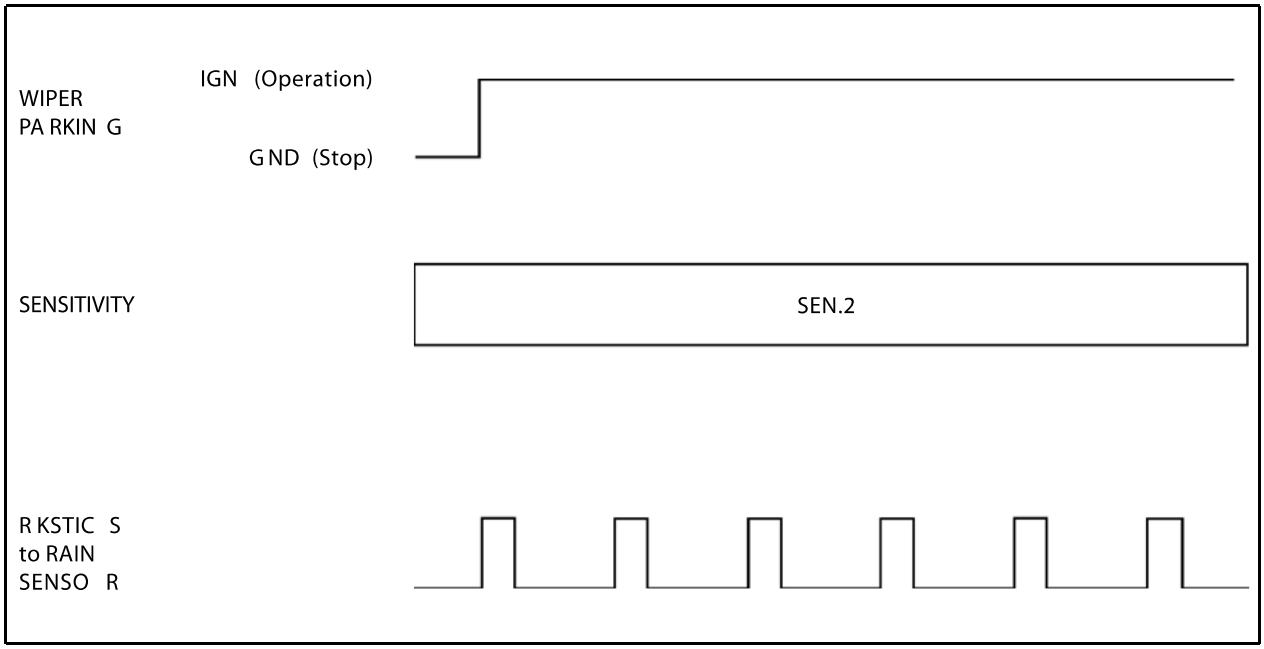
1. The wiper system continuously outputs the parking signal of current sensitivity when the parking terminal is grounded (while the ignition key is in "ON" position and the INT switch is in "ON" position).

※ The wiper motor runs only when the rain sensor requires.



2. When the parking terminal is fixed to IGN, the wiper system outputs the operating signal of current sensitivity for 2 seconds, then continuously outputs the parking signal of current sensitivity (while the ignition key is in "ON" position and the INT switch is in "ON" position).

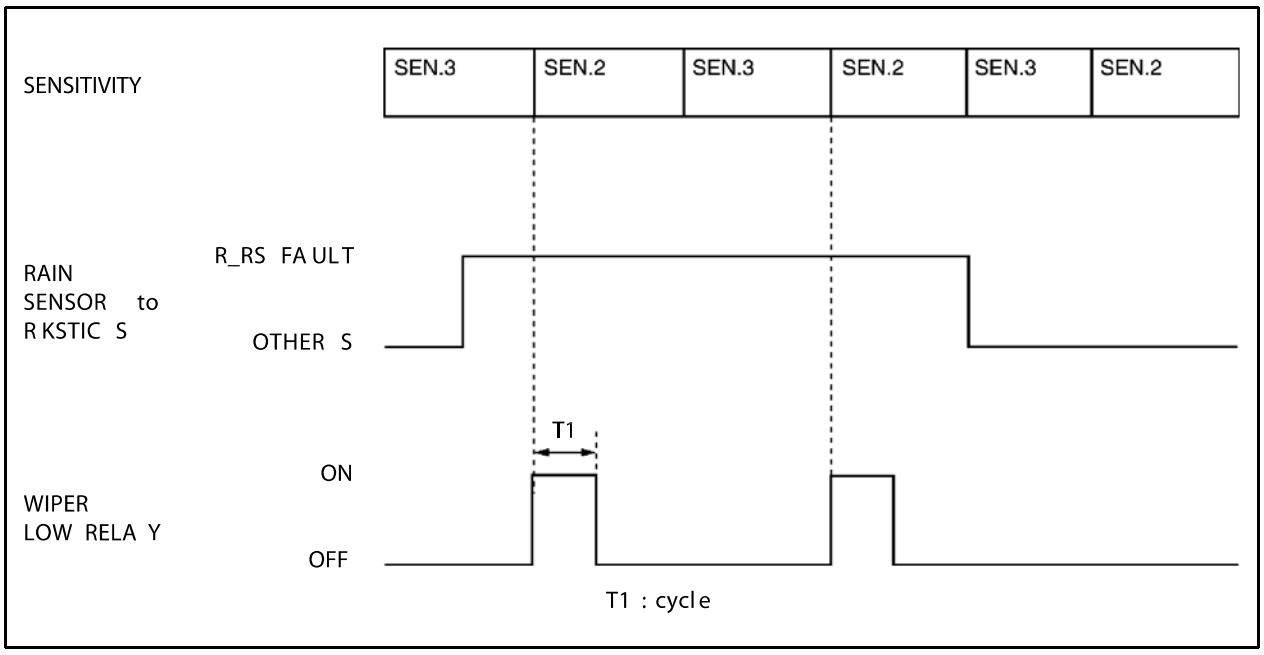
※ The wiper motor runs only when the rain sensor requires.



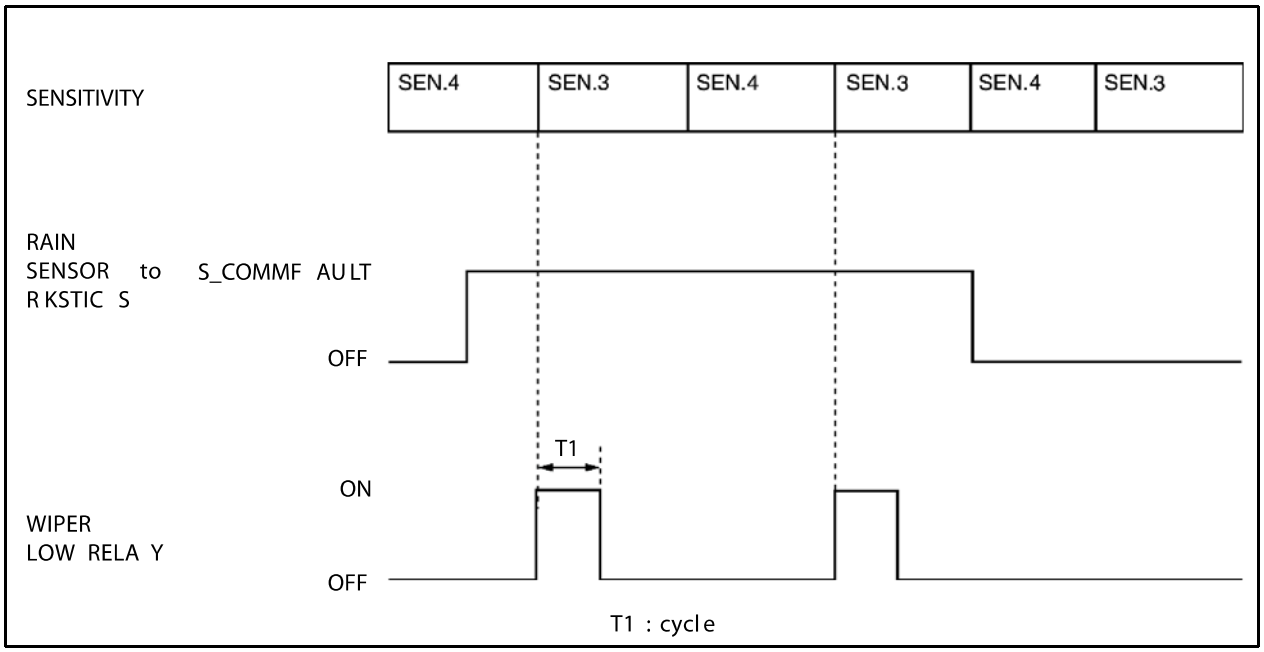
Modification basis	
Application basis	
Affected VIN	

6) Defective Rain Sensor

1. The wiper relay (LOW) is turned on and the wiper motor runs one cycle when the wiper sensitivity is changed to 2 from 3 during receiving the malfunction signal from the rain sensor (while the ignition key is in 'ON' position and the INT switch is in "ON" position).



2. The wiper relay (LO) is turned on and the wiper motor runs one cycle when the wiper sensitivity is changed to 3 from 4 during receiving the malfunction signal from the rain sensor (while the ignition key is in "ON" position and the INT switch is in "ON" position).



5. OPERATION MODE OF RAIN SENSING WIPER SYSTEM

Driver Switch Positions		Operation Mode
MIST (transmits the manual operation mode signal to sensor)		As long as the switch is in MIST position, the wiper motor operates in low speed. The wiper blade returns to parking position if the switch returns to the original position. The rain sensor ignores inputs during parking signal periods.
OFF (transmits the manual operation mode signal to sensor)		The wiper motor rotates in low speed until it returns to parking position. When the system is in manual mode, the sensitivity of sensor will be set to 2 (AUTO 2) internally. By doing so, immediate wiping with proper intervals is possible when a driver sets the system from OFF to AUTO.
AUTO 1 (low sensitivity)	SLOW ▲	Auto delay/auto speed control. Low sensitivity against rains on windshield. When the switch is in AUTO position, the sensor transmits the wiping request signal to STICS.
AUTO 2 (low/med sensitivity)		Auto delay/auto speed control. Low/medium sensitivity against rains on windshield.
AUTO 3 (medium sensitivity)		Auto delay/auto speed control. Medium sensitivity against rains on windshield.
AUTO 4 (med/hi sensitivity)		Auto delay/auto speed control. Medium/high sensitivity against rains on windshield.
AUTO 5 (high sensitivity)	▼ FAST	Auto delay/auto speed control. High sensitivity against rains on windshield.
LOW SPEED (transmits the manual operation mode signal to sensor)		The wiper motor rotates continuously in low speed of approx. 45 rev./minute (in the normal battery voltage). The rain sensor operations are same as in MIST.
HI SPEED (transmits the manual operation mode signal to sensor)		The wiper motor rotates continuously in high speed of approx. 70 rev./minute at (in the normal battery voltage). The rain sensor operations are same as in MIST.

1. Rain detected headlamp: If it rains heavy which requires the highest INT speed, the headlamps are turned on automatically.
2. Night detected wiping: When the auto light control turns on the headlamps and the rain sensor detects the rain, the wiper sensitivity is automatically increased by one level. (i.e. the AUTO wiper switch is at the 3rd level, but the wiper operates at the 4th level.)

Modification basis	
Application basis	
Affected VIN	

PAS

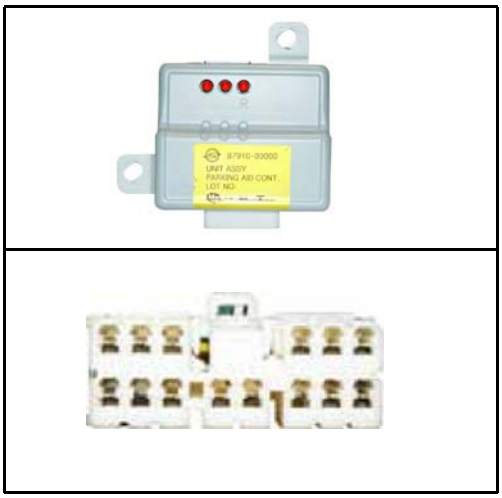
8790-03

GENERAL

1. COMPONENT SPECIFICATIONS

The parking aid system emits the supersonic wave signals from the sensors on the rear bumper with a specific interval and detects the reflected signals from obstacles while the gear selector lever is in "R" position. The alarm interval increases as the obstacle approaches. This supplementary system is to secure the safety distance for parking.

Descriptions		Value	Descriptions		Value
Rated voltage		DC 12 V	Operating temperature		-30°C ~ +80°C
Operating voltage		DC 9 V ~ 16 V	Storage temperature		-40°C ~ +85°C
Current consumption	Unit	Below 100 mA	Relative humidity		95% RH max
	Sensor	Below 20 mA (each)	Weight	Unit	160g ± 10g max
Sensor insulating resistance		Over 5 MW		Sensor	70g ± 10g max



1) Parking Aid Unit

Detecting type: Super sonic wave
Detecting distance: 25 cm ~ 120 cm (distance between sensor and obstacle)



2) Parking Aid Sensor

1. Type: Piezo ceramic element
2. Frequency: 40 KHz ± 2 KHz
3. Detecting range (13.5 V)
   - Horizontal: Min. 20° at 110 ± 5 cm Min. 100° at 50 ± 5 cm
   - Vertical: Min. 20° at 110 ± 5 cm Min. 60° at 50 ± 5 cm

CAUTION

- There is no upper mounting cover and spring in the PAS sensor installed in this vehicle.

2. CAUTIONS ON PARKING AID SYSTEM

CAUTION

- Note that the display does not show everything in the rear area. Always check nobody, especially animals and children, is behind the vehicle when parking or reversing.
- If you can not properly check the vehicle behind, get out of the vehicle and then visually check it.

1. The parking aid system is just a supplemental device to help your parking operation.
2. Always keep the safety precautions.
3. Do not press or shock the sensors by hitting or high-pressure water gun while washing, or the sensors will be damaged.
4. If the system is in normal operating condition, a short beep sounds when the gear selector lever is moved into "R" position with the ignition key "ON".
5. If the system is in abnormal operating condition, a beep sounds for 3 seconds when the gear selector lever is moved into "R" position with the ignition key "ON" or engine running. However, it is also occurred when the obstacle is within 50 cm from the rear bumper.

Modification basis	
Application basis	
Affected VIN	

▶ The parking aid system will not work or improperly work under following cases

1. Certain obstacles that sensors can not detect
   - Wires, ropes, chains.
   - Cotton, sponge, clothes, snow that absorb ultrasonic waves.
   - Obstacles lower than the bumper (ex. drain ditch or mud puddle)

2. Not defective but improperly working
   - When the sensing portion is frozen (operates normally after thawed)
   - When the sensing portion is covered by rain, water drops, snow or mud (operates normally after cleaned)
   - When receiving other ultrasonic signals (metal sound or air braking noises from heavy commercial vehicles)
   - When a high-power radio is turned on

3. Narrowed sensing area
   - When the sensing portion is partially covered by snow or mud (operates normally after cleaned) Surrounding temperature of sensor is too high (approx. over 80°C) or too low (approx.
   - below −30°C)

4. Not defective but may occur improper working
   - When driving on the rough roads, gravel road, hill and grass
   - When the bumper height is changed due to the heavy load
   - When the sensing portion is frozen
   - When the sensing portion is covered by rain, water drops, snow or mud
   - When receiving other ultrasonic signals (metal sound or air braking noises from heavy commercial vehicles)
   - When a high-power radio is turned on
   - When some accessories are attached in detecting ranges

OVERVIEW AND OPERATION PROCESS

1. SYSTEM OVERVIEW

The parking aid device is integrated in the rear bumper and it uses three Piezoelectric elements to measure vertical and horizontal distance to obstacles.
When placing the gear selector lever to "R" position, the designated unit (PAS unit in the rear right quarter panel) activates the parking aid sensors to measure the distance to obstacles.

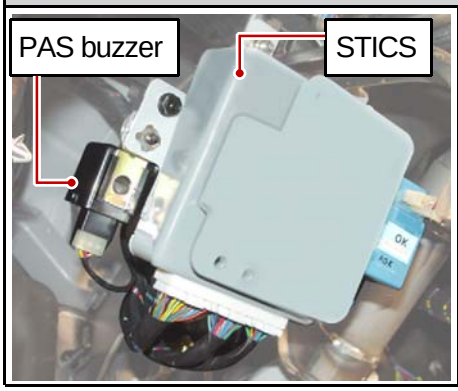
▶ **PAS Related Devices**

Gear Selector Lever (R Position)





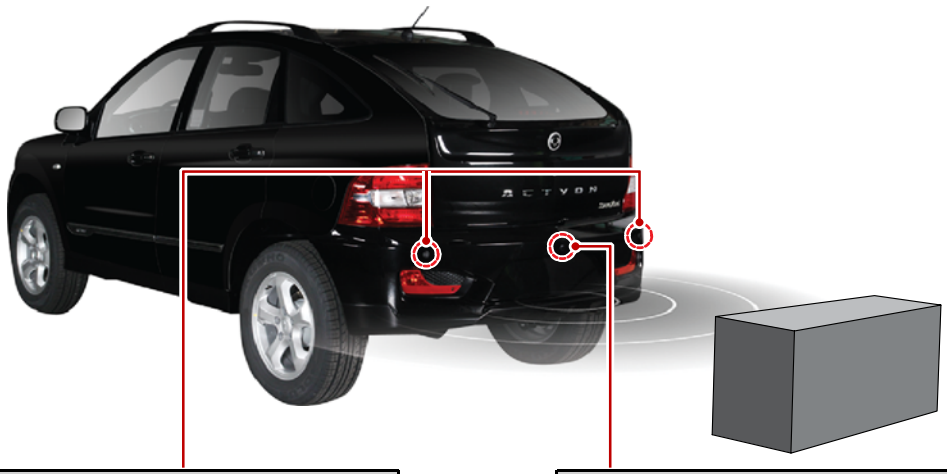
Location of PAS Buzzer Unit



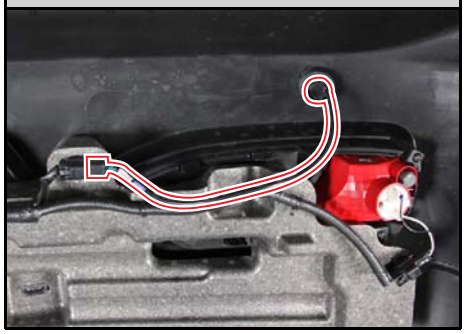


Modification basis	
Application basis	
Affected VIN	

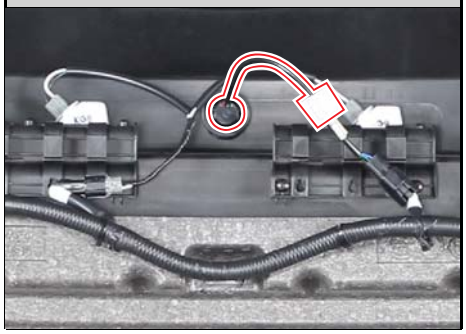
Left/Right/Center Sensor Location



Side Sensor



Center Sensor

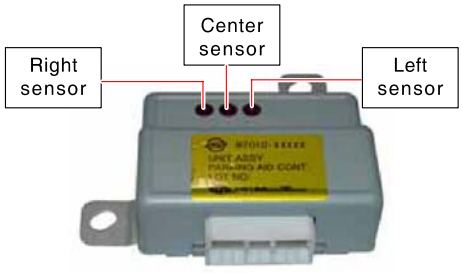




PAS Sensor



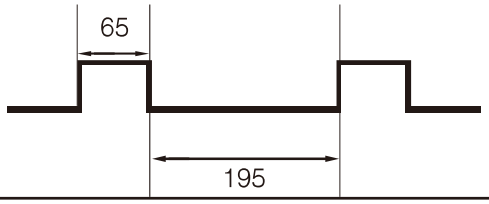
Parking Aid Unit



The PAS unit is installed in the rear right section of the rear quarter panel.

2. ALARM INTERVAL

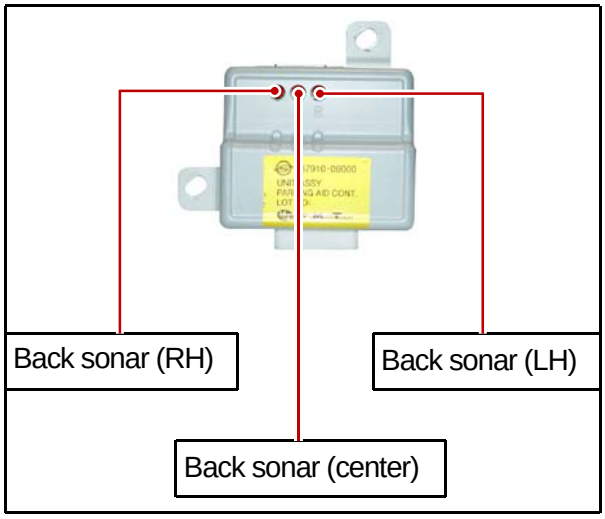
Alarm interval and display changes according to the distance as below:
While reversing, if obstacles are within stage 1, the warning beep sounds with long intervals. If within stage 2, the warning beep sounds with short intervals and if within stage 3, the warning beep sounds continuously.

Stag e	L, C, R Sensor	Interval (msec)	Remark
1	81 ~ 120 cm		"Beep —— "
2	51 ~ 80 cm		"Beep -, Beep -, Beep -"
3	25 ~ 50 cm		"Beep —— "

Modification basis	
Application basis	
Affected VIN	

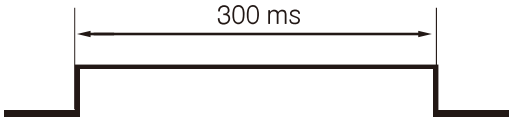
3. TROUBLESHOOTING OF SENSOR

When the power is applied (gear selector lever is in "R" position), the sensor will be diagnosed once. If found any failure due to open circuit to sensor or communication error, warning buzzer sounds for 3 seconds and the data on failed sensor transmits to the instrument panel to light up the corresponding LED. If normal, the warning buzzer sounds only for 65 ms.

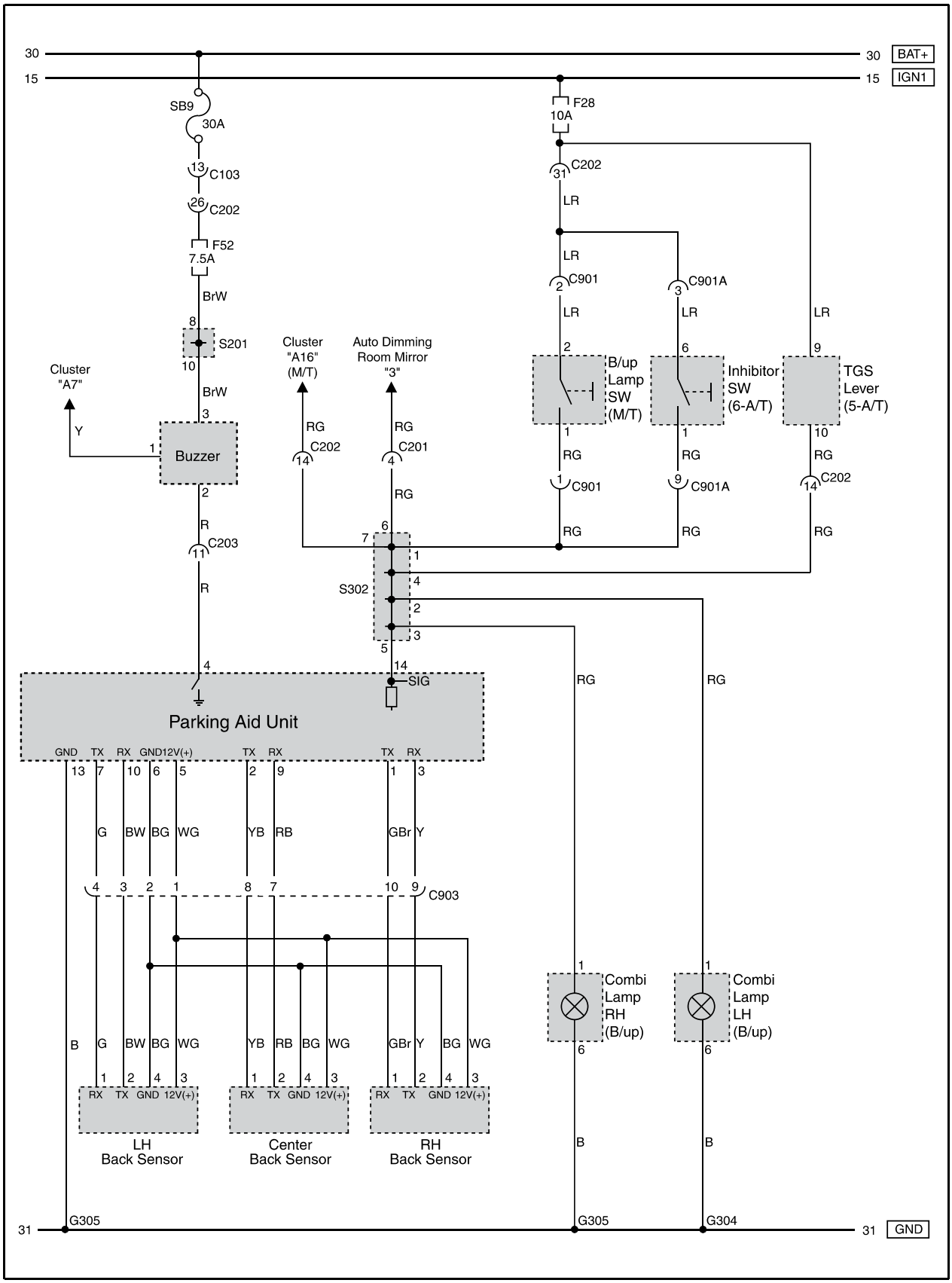


1. Whenever the power is applied, the diagnosis mode is initiated.
2. Sensor failure conditions (conditions for warning beep due to failure)
   - Sensor failure conditions (conditions for warning beep
   - Open in sending circuit
   - Open in receiving circuit
   - Open in power circuit (+, -)

▶ **Warning Beeps**

When failed (also when diagnosing the unit)		
When normal		

4. CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	

MB 5

3650-01

GENERAL INFORMATION

1. SPECIFICATIONS

Item		W5A580(2WD)/W5A400(4WD)
Input torque		450Nm
Diameter(Torque converter)		270mm
Lockup function		Yes
Gear ratios	1st	3.595
	2nd	2.186
	3rd	1.405
	4th	1.000
	5th	0.831
	Reverse: S mode / W mode	3.167/1.926
Driving type		2WD(4WD)
Fluid specification		Shell ATF 134
Fluid capacity		approx. 8ℓ
Selected lever indication	P.R.N.D	Mechanical
	D+/D-	Electrical
Parking lock system		Brake switch(signal) → TGS lever
Reverse lock system		CAN → TGS lever
Selected lever indication	P.R.N.D	Lever position
	1, 2, 3, 4, 5	CAN
Oil temperature sensor	Resistance: R, D	0.5 ~ 2.5kΩ
	Resistance: P, N	20kΩ
TCU		EGS 52
Shift solenoid valve(25℃)	Resistance	3.8 ± 0.2Ω
	Operating distance	0.2mm
	Operating current	1.5 ~ 2A

Modification basis	
Application basis	
Affected VIN	

Item		W5A580(2WD)/W5A400(4WD)	
M/P, S/P solenoid valve(23℃)	Resistance	5.0 ± 0.2Ω	
	Operating distance	0.6mm	
	Operating current	0 ~ 1A	
Lockup solenoid valve(25℃)	Resistance	2.5 ± 0.2Ω	
	Operating distance	0.2mm	
	Operating current	1.5 ~ 2.0A	
	Operating range	3rd to 5th gears	
RPM sensor	Resistance	HALL type	
	Operating voltae	6V	
Start lockout switch	Switch contact	ON(D position)	
	Switch contact	OFF(P, N position)	
Mode switch		W(Winter)	
		S(Standard)	
One-way clutch		F1, F2	
Planetary gear set	Plain planetary gear: 3(number of pinion)	3, 4, 3	4, 4, 4
Disc clutch	Disc: C2*, C2, C3*	Single plate type*	
Disc brake	Disc: B1*, B2, B3	Single plate type*	

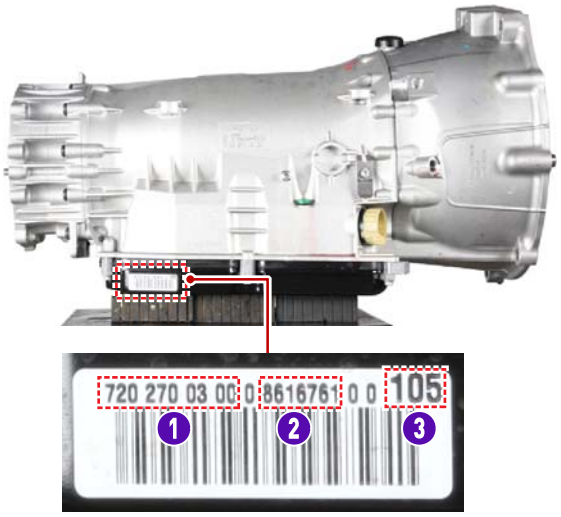
Modification basis	
Application basis	
Affected VIN	

2. TIGHTENING TORQUE

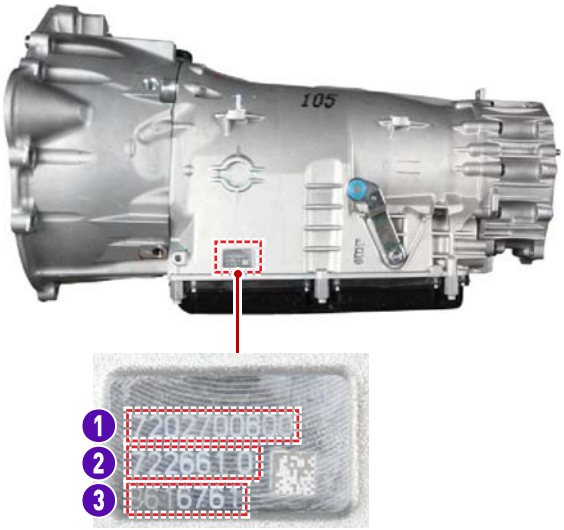
Description	Tightening Torque (Nm)	Remark
Oil drain plug (oil pan)	14	Hexagon, 5 mm
Oil filler pipe (upper)	8 ~ 10	-
Oil filler pipe (lower)	8 ~ 10	-
Oil cooler pipe	30 ~ 38	-
Oil pan	8	T 30
Torque converter housing/oil pump	20	-
Transmission rear mounting bracket (left/right)	36 ~ 44	-
Transmission rear mounting bracket (center)	20	-
Torque converter mounting bolt	42	-
Converter housing/engine	75 ~ 90	-
Converter housing/transmission housing	20	T 45
Valve body	8	T 30
Valve body side cover	4	T 30
Solenoid valve	8	-
12-point collar nut	200	12-point, 30 mm
B2 housing bolt	16	T 45
Selector lever unit mounting bolt	6	-

OVERVIEW AND OPERATION PROCESS

1. OVERVIEW



1. DC A/T Assembly Number (With T/Converter)
2. A/T Serial Number
3. DC A/T Variant Number



1. DC A/T Assembly Number (With T/Converter)
2. Base model AT type
3. A/T Serial Number

▶DC 5-Speed Automatic Transmission

DCAG 5-speed automatic transmission is an electronically controlled 5-speed transmission with a lockup clutch in the torque converter. The ratios for the gears are realized by three planetary gear sets. The 5th gear is designed with a step-up ratio of 0.83 as an overdrive. The selector lever is controlled by electronically and mechanically. The gears are shifted by the corresponding combination of three hydraulically actuated multiple-disc brakes, three hydraulically actuated multiple-disc clutches and two mechanical one-way clutches. This electronically controlled automatic transmission adjusts the operating pressure to provide proper shifting in relation to engine power. This function improves shifting quality significantly. And, the driver can select "S" (Standard) mode or "W" (Winter) mode according to the driving conditions. This automatic transmission provides two gears even during reverse driving. The internal sensors and controls are connected to TCU by cylindrical 13-pin connector.

DCAG 5-speed automatic transmission offers the following advantages:

1. Improved shifting quality
2. More gears
3. Extended working life and reliability
4. Reduced fuel consumption

NOTE

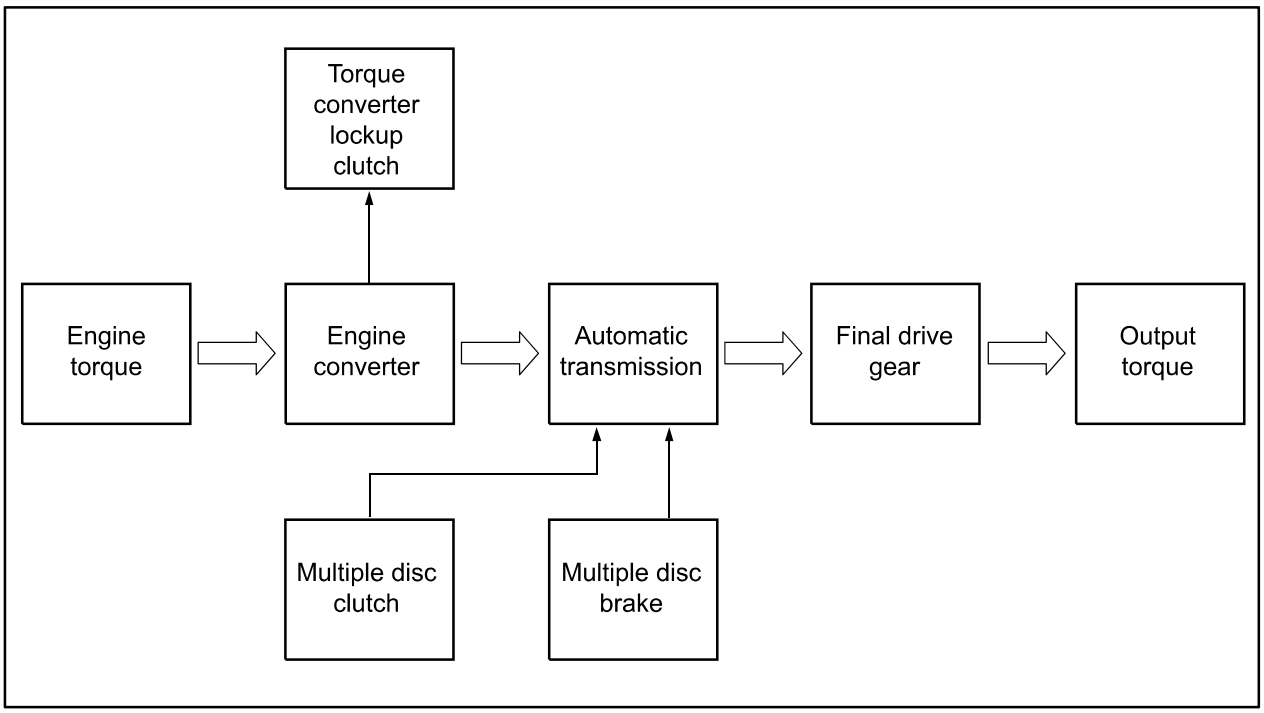
The old version of torque converter is not compatible with new torque converter for MB 5-speed transmission.

Torque converter	P/N
with Damper	A 211 250 19 02
without Damper	A 210 250 07 02

Modification basis	
Application basis	
Affected VIN	

▶Characteristics

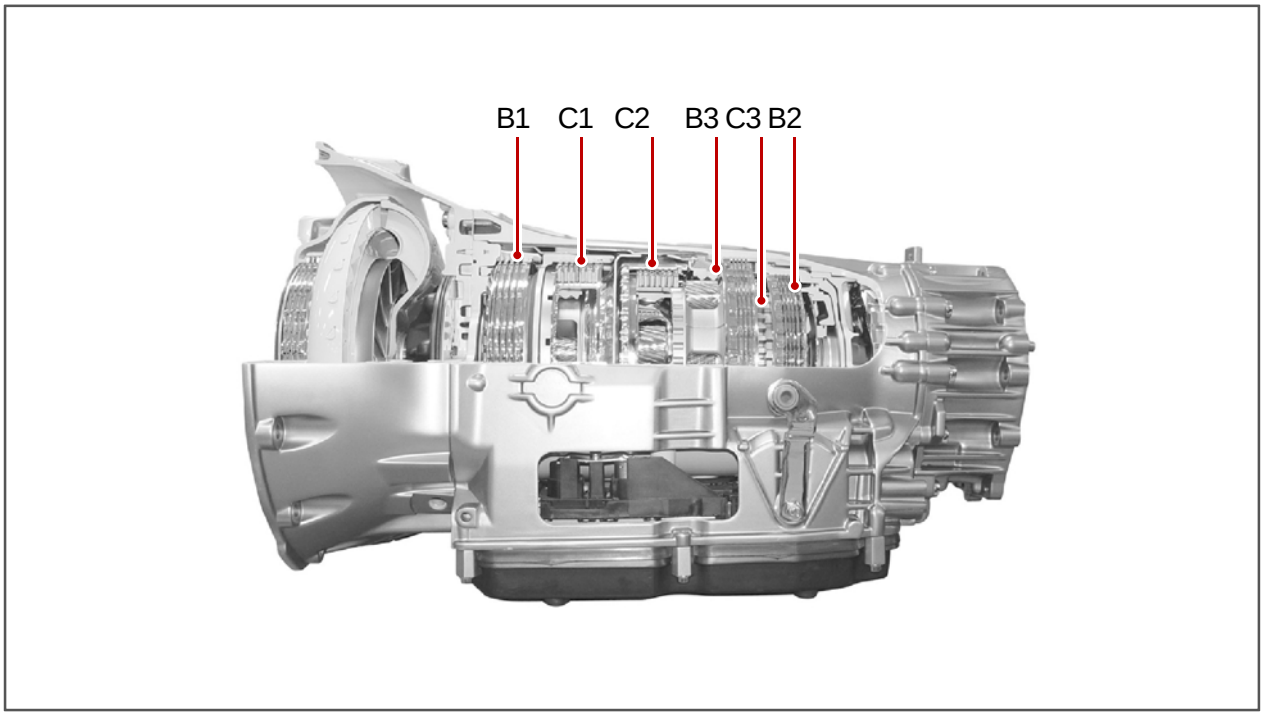
Characteristic	Function and Description	Effect
Slope recognition (down hill, up hill)	Recognize it according to engine RPM and accelerator pedal position	Delay up shift
Engine torque limitation	During 1st gear driving or reverse driving with full throttle condition	Prevent automatic transmission from overheating
Engine torque decrease	Delay of ignition timing to reduce torque at all shifting moments	Improve shift quality
Engine rpm limitation	Limit engine rpm until the gears are fully engaged when shifting from "P" or "N" to "D"	Prevent shift shock
ESP Operation	When the ESP is controlling the engine torque, shifting is not available and vehicle starts off with 2nd gear.	Cannot use kick-down function and shift at maximum rpm
ABS Operation	Not any effect to brake control	
Fast-off function	Does not up shift when accelerator pedal is abruptly released	To get an engine brake effect during cornering
Altitude recognition	As altitude increases (atmospheric pressure reduces) engine torque decreases. Up shift while additionally depressing the accelerator pedal (adjusting shift diagram)	Improves driving performance and increases torque
Oil temperature	If transmission oil temperature is too low, the shifting point gets delayed in full throttle and kick down	Improves driving performance
Hydraulic pressure is produced in emergency driving mode	When starting the engine with cycling the ignition switch ("OFF" and "ON") due to transmission trouble, the selector lever should be placed in "P" position. If starting the engine with selector lever "N" position, the lever should be moved into "P" position. Because, the hydraulic pressure can be produced in selector lever "P" position.	The hydraulic pressure flows with direct operation mode via "R" and "D" valve to operate "R" and "forward 2nd" gear.
Adaptation	Function to optimize the shifting quality.	To exclude play and wear



2. POWER FLOW

1) Power Flow

▶Sectional View



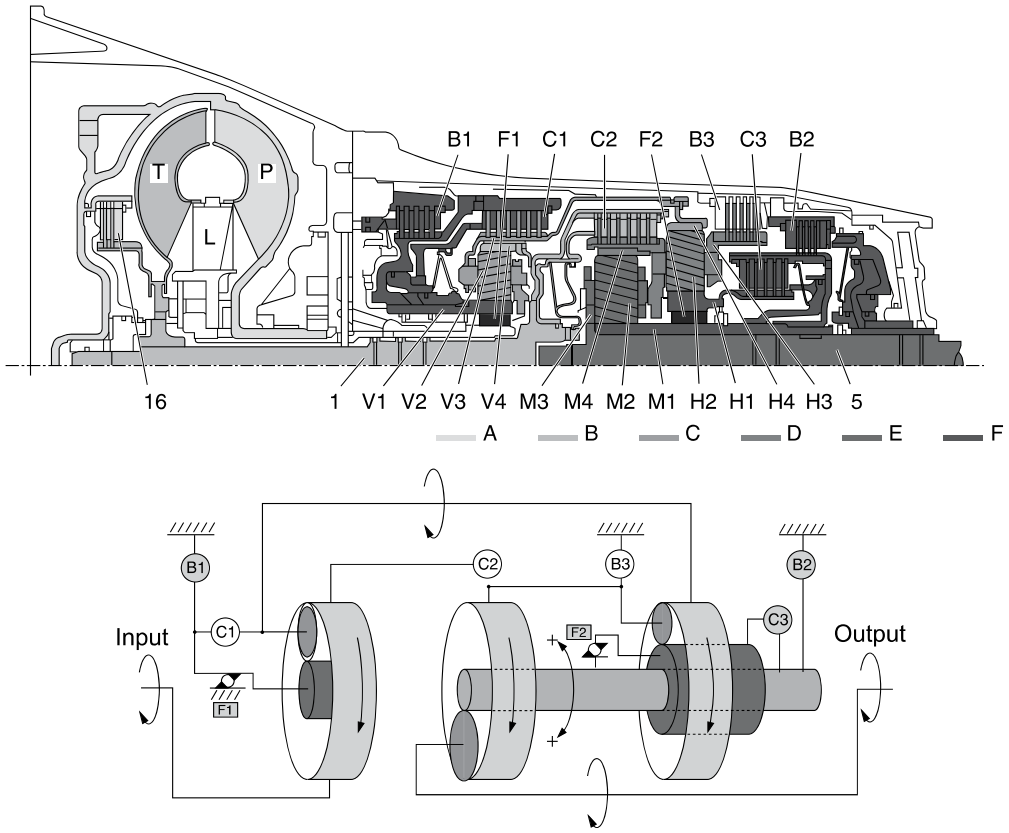
▶Shifting elements

Gear	C1	C2	C3	B1	B2	B3	F1	F2
1			● 3)	● 3)	●		●	●
2	●		● 3)		●			●
3	●	●			●			
4	●	●	●					
5		●	●	● 3)			●	
P/N 1)			●	●				
P/N 2)	●		●					
R 1)			●	● 3)		●	●	
R 2)	●		●			●		

1) Selector program switch: "S" mode
2) Selector program switch: "W" mode
3) Overrun

Modification basis	
Application basis	
Affected VIN	

▶1st Gear (3.932)



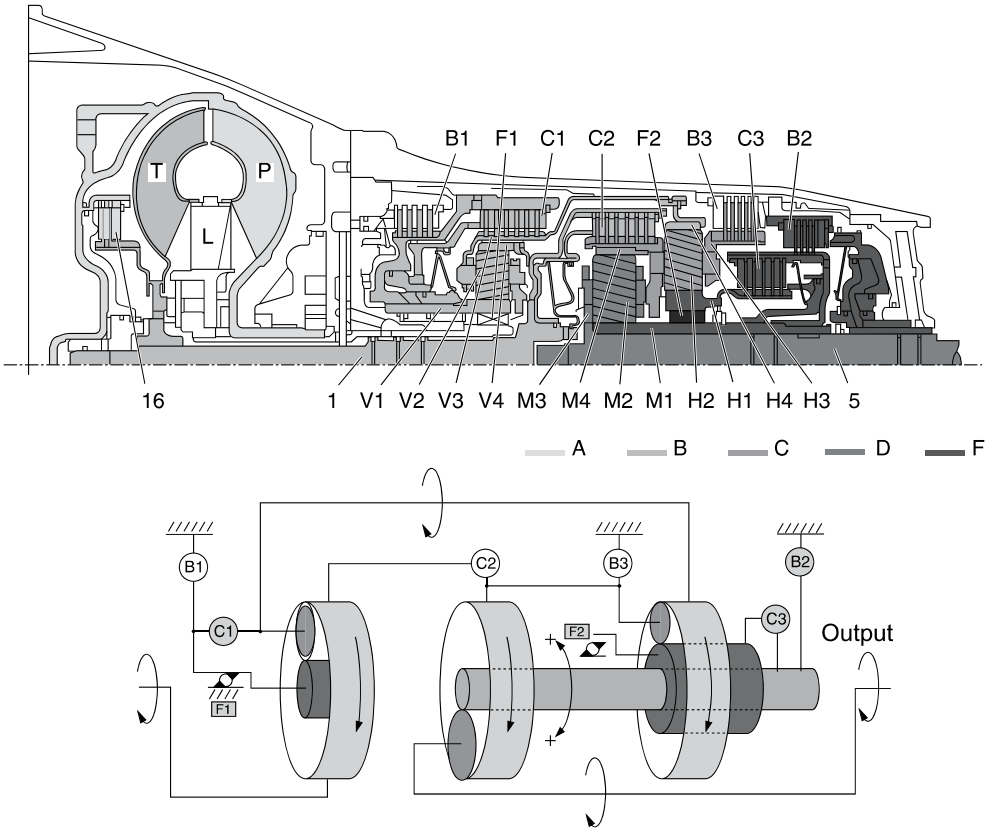
16.Torque converter lockup clutch
A. Engine speed
B. Transmission, input shaft
C. 1st gear ratio
D. 2nd gear ratio
E. 3rd gear ratio
F. Mounting elements
H. Rear planetary gear set
L. Stator
M. Center planetary gear set
P. Impeller
T. Turbine wheel
V. Front planetary gear set

- Input shaft: Clockwise rotation
- Front sun gear: Locked by F1 and B1, Planetary gear carrier: Rotation with reduced speed
- Rear ring gear: Counterclockwise rotation
- Rear sun gear: Locked by F2 and B2, Planetary gear carrier: Clockwise rotation with reduced speed
  Center ring gear: Clockwise rotation
- Center sun gear: Locked by B2, Rotation with reduced speed
- Output shaft: Clockwise rotation
-

3) Overrun

Gear	C1	C2	C3	B1	B2	B3	F1	F2	Lockup clutch
1			●3)	●3)	●		●	●	

▶2nd Gear (2.408)



16.Torque converter lockup clutch
A. Engine speed
B. Transmission, input shaft
C. 1st gear ratio
D. 2nd gear ratio
E. Mounting elements
H. Rear planetary gear set
L. Stator
M. Center planetary gear set
P. Impeller
T. Turbine wheel
V. Front planetary gear set

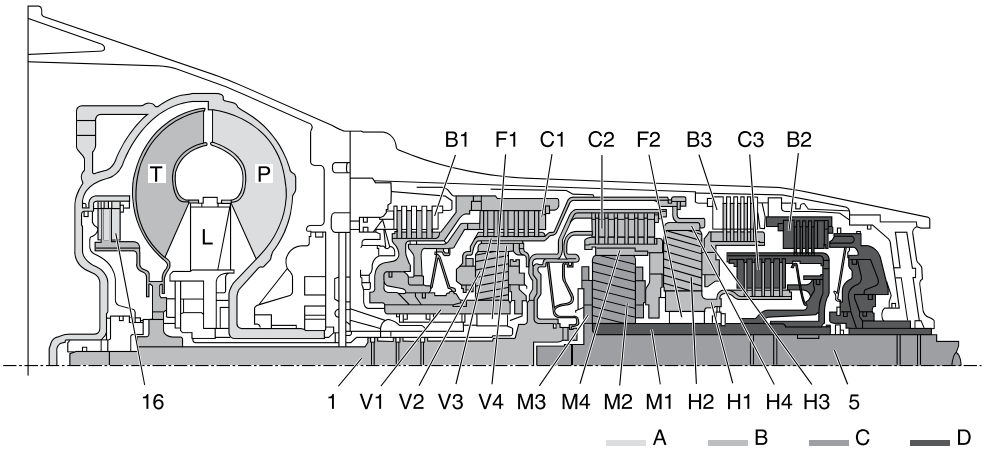
- Input shaft: Clockwise rotation
- Sun gear and planetary gear carrier: Clockwise rotation by C1 activation
- Rear ring gear: Clockwise rotation
- Rear sun gear: Locked by F2 and B2, Planetary gear carrier: Rotation with reduced speed
- Center ring gear: Clockwise rotation
- Sun gear: Locked by B2, Planetary gear carrier: Rotation with reduced speed
- Output shaft: Clockwise rotation

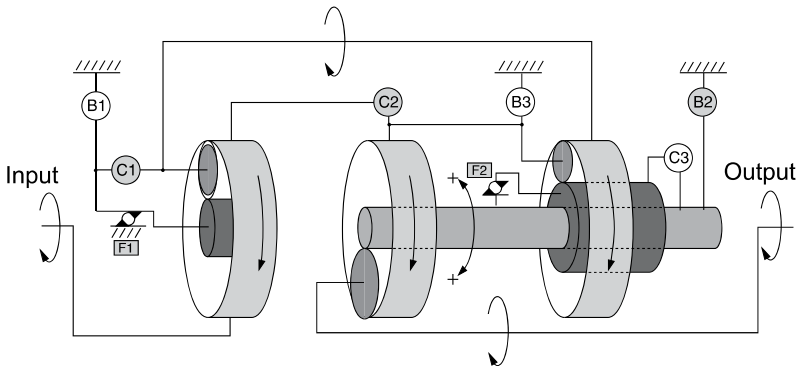
3) Overrun

Gear	C1	C2	C3	B1	B2	B3	F1	F2
2	●		●3)		●			●

Modification basis	
Application basis	
Affected VIN	

▶3rd Gear (1.486)



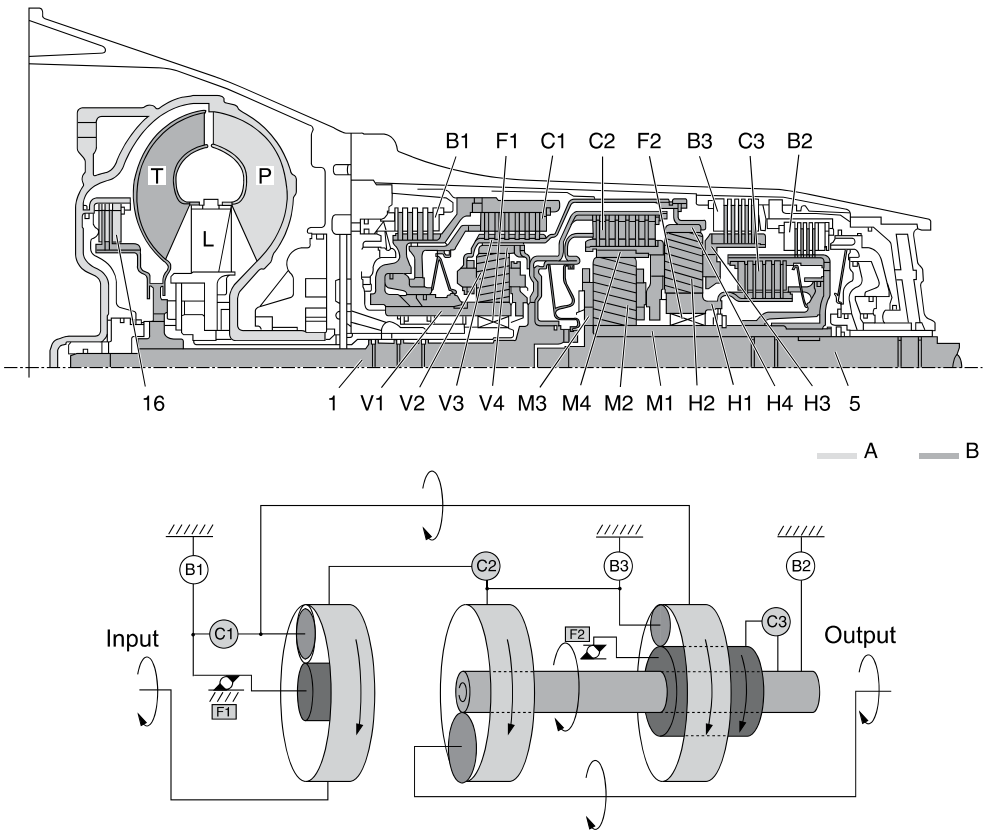


16.Torque converter lockup clutch
A. Engine speed
B. Transmission, input shaft
C. 1st gear ratio
D. Mounting elements
H. Rear planetary gear set
L. Stator
M. Center planetary gear set
P. Impeller
T. Turbine wheel
V. Front planetary gear set

- Input shaft: Clockwise rotation
- Front ring gear: Clockwise rotation
- Center ring gear: Clockwise rotation by clutch 2 activation (direct connection)
- Center sun gear: Locked by B2, Planetary gear carrier: Clockwise rotation with reduced speed
  Output shaft: Clockwise rotation
-

Gear	C1	C2	C3	B1	B2	B3	F1	F2
3	●	●			●			

▶4th Gear (1.000)



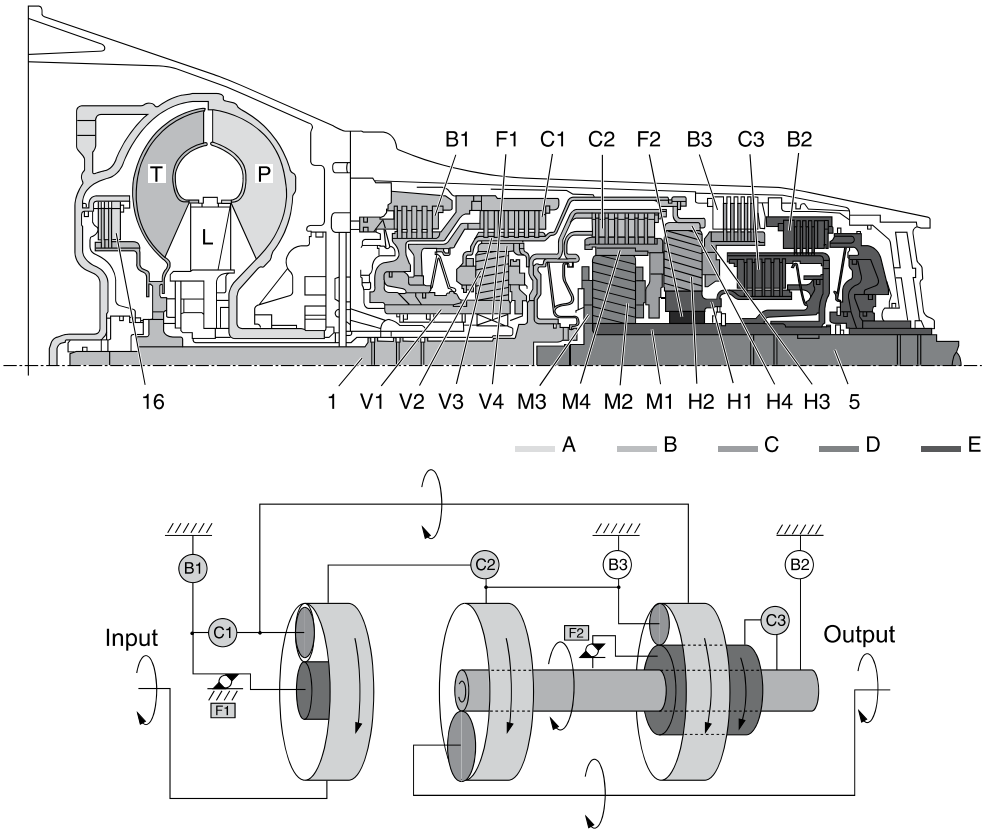
16.Torque converter lockup clutch
Engine speed
A. Planetary gear set
B.
L. Stator
M. Center planetary gear set
Impeller
P.
T. Turbine wheel
V. Front planetary gear set

- Input shaft: Clockwise rotation
- Front ring gear: Clockwise rotation
- Center ring gear and rear planetary gear carrier: Clockwise rotation
- Front sun gear and planetary gear carrier: Clockwise rotation (direct connection)
- Rear ring gear: Clockwise rotation
- Rear sun gear: Rotation by ring gear and planetary gear carrier (direct connection)
- Center ring gear: Clockwise rotation by C3 activation
- Planetary gear carrier: Clockwise rotation by center sun gear and ring gear (direct connection)
  Output shaft: Clockwise rotation
-

Gear	C1	C2	C3	B1	B2	B3	F1	F2
4	●	●	●					

Modification basis	
Application basis	
Affected VIN	

▶5th Gear (0.830)



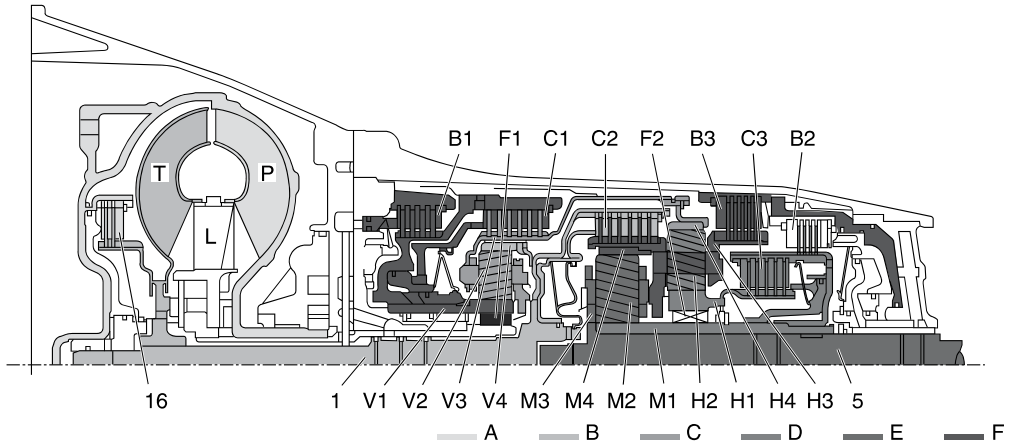
16.Torque converter lockup clutch
Engine speed
A. Transmission, input shaft
B. 1st gear ratio
C.
D. 2nd gear ratio
E. 3rd gear ratio
F. Mounting elements
H. Rear planetary gear set
L. Stator
M. Center planetary gear set
P. Impeller
T. Turbine wheel
V Front planetary gear set

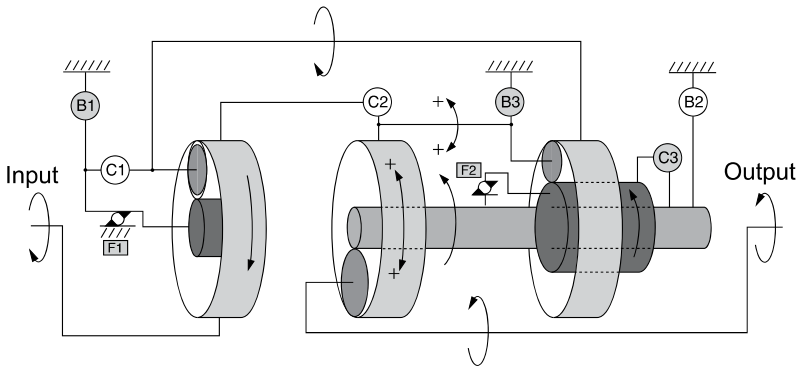
- Input shaft: Clockwise rotation
- Front sun gear: Locked, Planetary gear carrier: Rotation with reduced speed
- Rear planetary gear carrier: Clockwise rotation with reduced speed
- Center ring gear and rear planetary gear carrier: Clockwise rotation by clutch C2 activation
- Rear sun gear: Clockwise rotation because rear planetary gear carrier rotates faster than rear ring gear (increasedspeed)
- Center sun gear: Clockwise rotation with increased speed by C3 activation
- Center planetary gear carrier: Clockwise rotation (increased speed)
- Output shaft: Clockwise rotation (increased speed)

3) Overrun

Gear	C1	C2	C3	B1	B2	B3	F1	F2
5		●	●	●3)			●	

▶Reverse 1st Gear (3.167, "S" Mode)





16.Torque converter lockup clutch
A. Engine speed
B. Transmission, input shaft
C. 1st gear ratio
D. 2nd gear ratio
E. Mounting elements
F. Mounting elements
H. Rear planetary gear set
L. Stator
M. Center planetary gear set
P. Impeller
T. Turbine wheel
V. Front planetary gear set

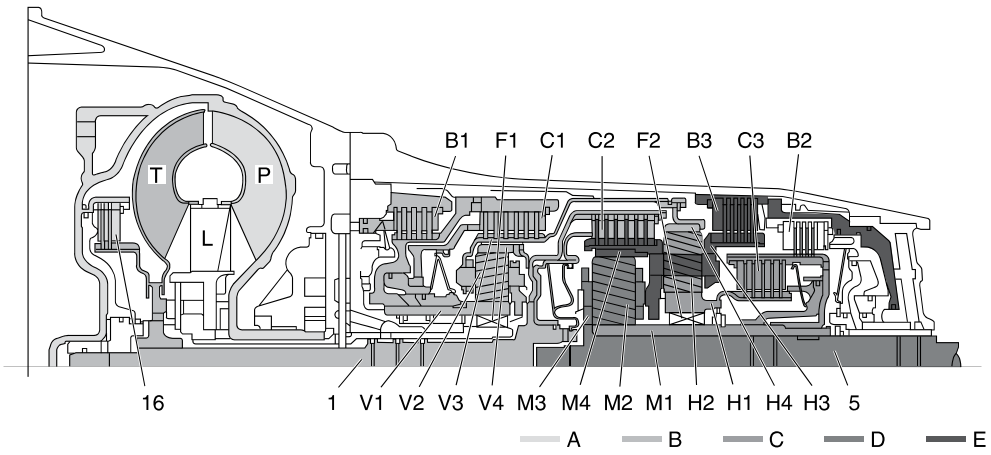
- Input shaft: Clockwise rotation
- Front ring gear: Clockwise rotation
- Front sun gear: Locked by one-way clutch F1
- Front planetary gear carrier: Clockwise rotation (reduced speed)
- Rear planetary gear ring gear: Clockwise rotation
- Rear planetary gear carrier: Locked by B3
- Rear sun gear and center sun gear: Counterclockwise rotation (increased speed)
- Center ring gear: Locked by B3
- Center planetary gear carrier: Counterclockwise rotation (reduced speed)
- Output shaft: Counterclockwise rotation

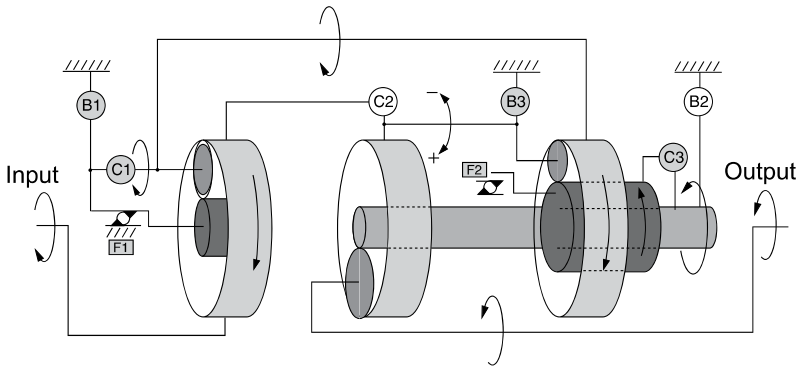
3) Overrun

Gear	C1	C2	C3	B1	B2	B3	F1	F2
R (S)			●	●3)		●	●	

Modification basis	
Application basis	
Affected VIN	

▶Reverse 2nd Gear (1.926, "W" Mode)





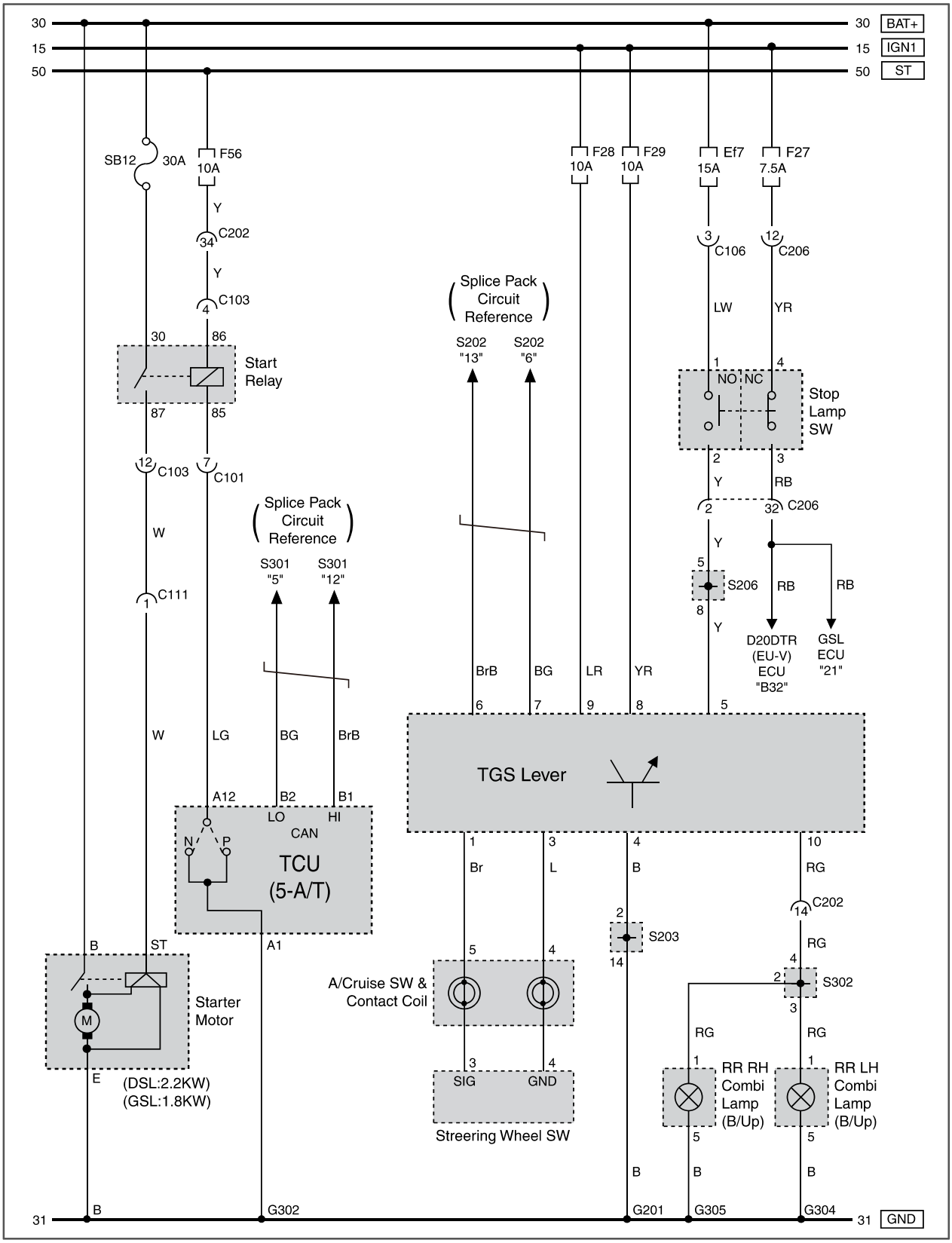
16.Torque converter lockup clutch
A. Engine speed
B. Transmission, input shaft
C. 1st gear ratio
D. 2nd gear ratio
E. Mounting elements
H. Rear planetary gear set
L. Stator
M. Center planetary gear set
P. Impeller
T. Turbine wheel
V. Front planetary gear set

- Input shaft: Clockwise rotation
- Front ring gear: Clockwise rotation
- Front planetary gear carrier: Clockwise rotation by clutch C1 activation (direct connection)
- Rear ring gear: Clockwise rotation
- Rear planetary gear carrier and center ring gear: Locked by brake B3
- Rear sun gear and center sun gear: Counterclockwise rotation (increased speed)
- Center planetary gear carrier: Counterclockwise rotation (reduced speed)
- Output shaft: Counterclockwise rotation

Gear	C1	C2	C3	B1	B2	B3	F1	F2
R (W)	●		●			●		

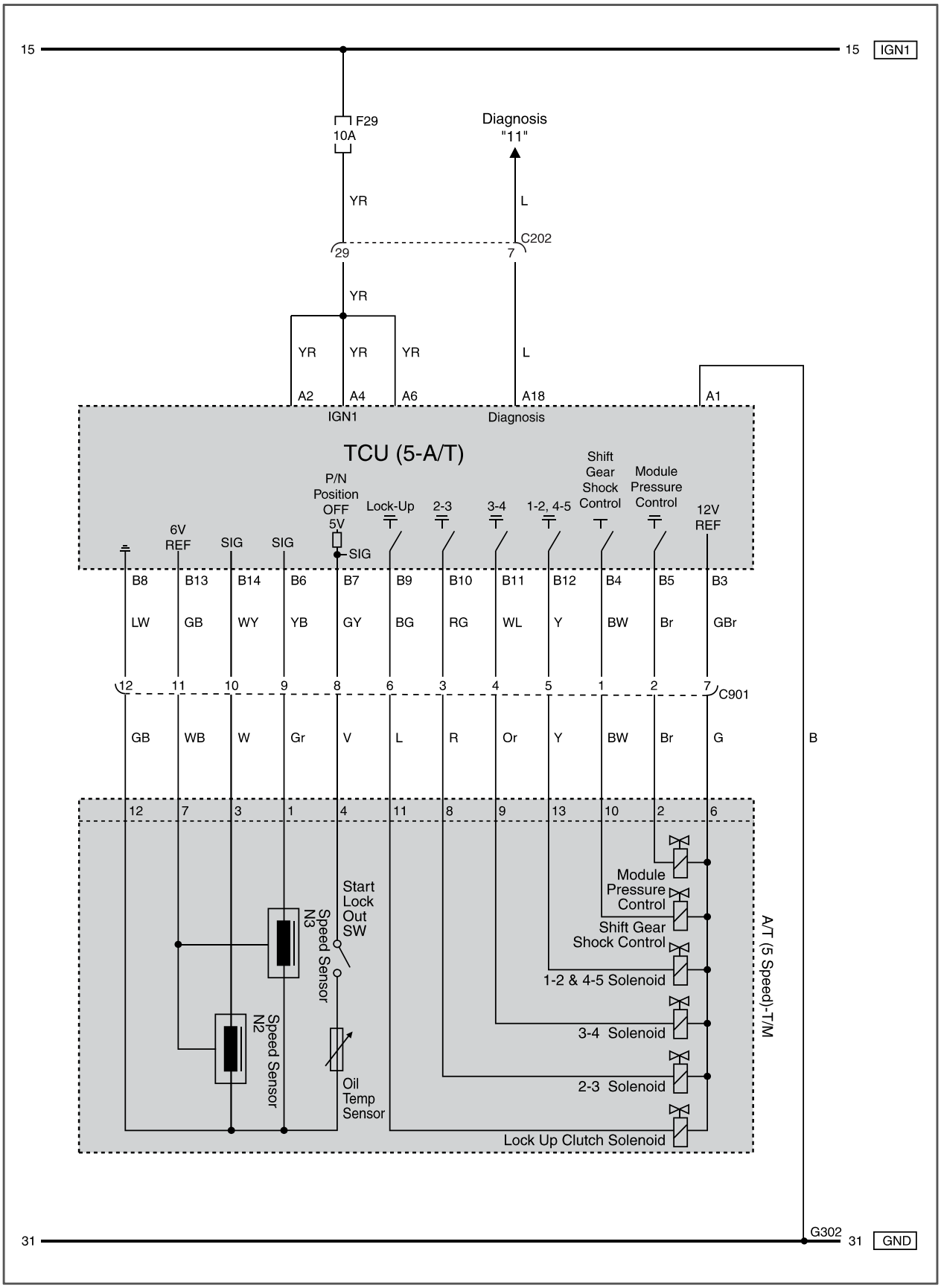
3. CIRCUIT DIAGRAM

▶ Start motor, TGS lever, CAN line



Modification basis	
Application basis	
Affected VIN	

▶Solenoid, Oil temperature sensor, Speed sensor (N2, N3)



Modification basis	
Application basis	
Affected VIN	

DSI 6 A/T

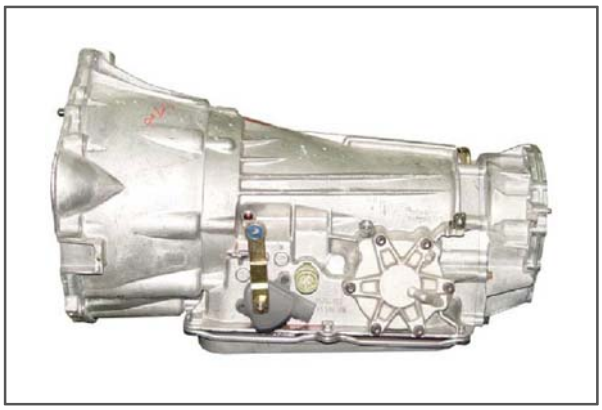
3680-01

GENERAL

1. GENERAL INFORMATION

DSI M78 Automatic Transmission is based on the transmission in the vehicle with D20DT engine for EURO III or EURO IV.
Differences: changed some components (torque converter and torque converter housing, some pinion gears, sun gear), increased torsional damping force.

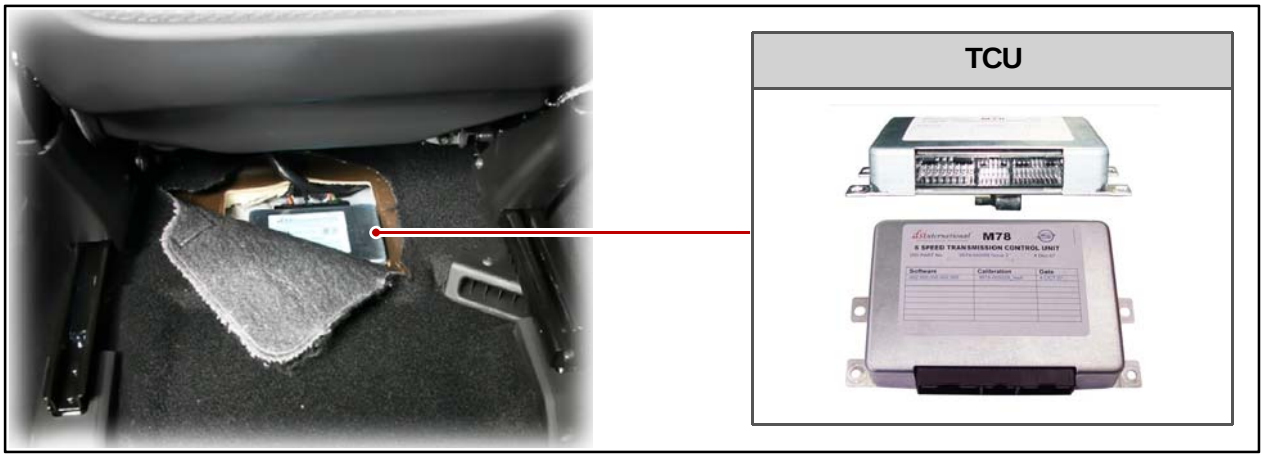
▶ Automatic transaxle (DSI M78)



- Six forward speeds
- One reverse gear
- A toruqe converter with an integral converter lock-up clutch
- Electronic shift and pressure controls
- A single planetary gear-set
- A double planetary gear-set
- Two hydraulically controlled brake bands
- Three multi-plate clutches
- All hydraulic functions are directed by electronic solenoids to control

▶ TCU

TCU is located under the driver's seat and controls the operations of transmission.
TCU receives the ignition voltage and has three connectors (16-pin).
TCU receives input signals from certain transmission-related sensors, gear select lever and inhibitor switch. TCU also uses these signals when determining transmission operating strategy. TCU uses PCAN to communicate with other units. And, TCU communicates with engine ECU, ESP unit, TCCU and instrument cluster through CAN lines to control the gear shifting and to recognize the current gear position.



Modification basis	
Application basis	
Affected VIN	

▶ Tip switch on steering wheel

Driving gear can be adjusted by operating the tip switch after moving the gear select lever in "M" position.

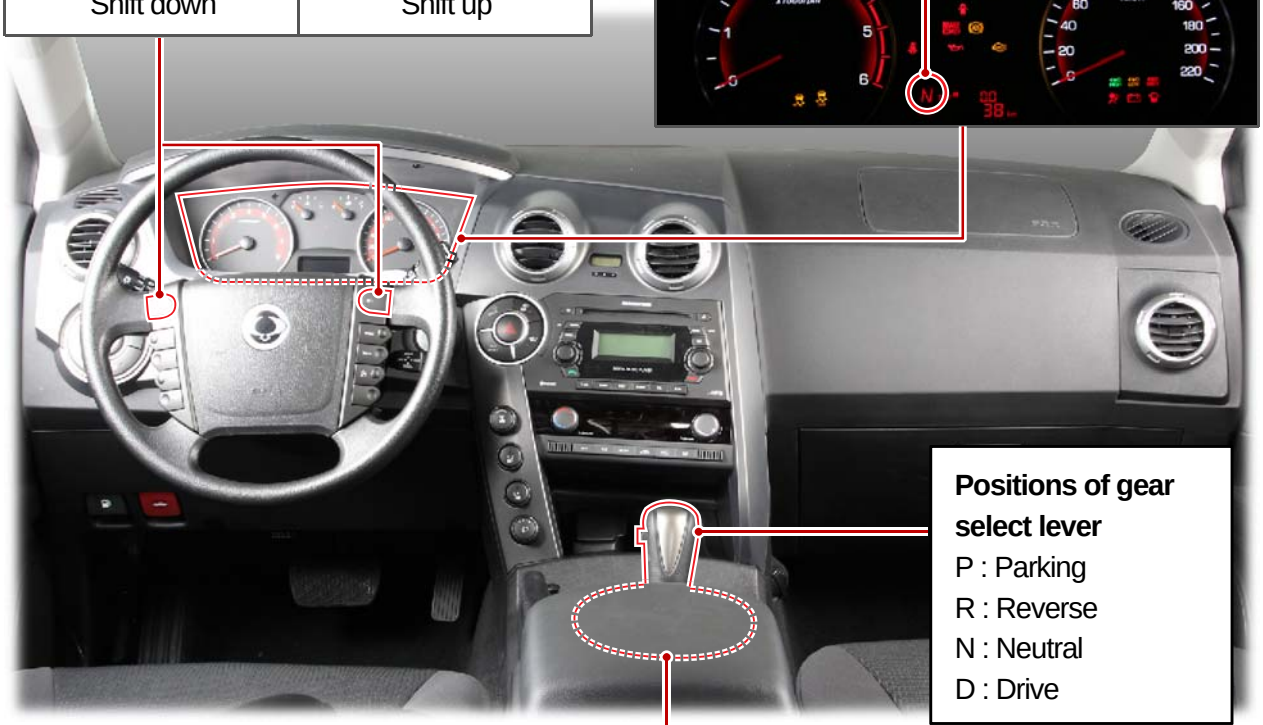


Shift down	Shift up

▶ Gear position display on instrument cluster

This indicator shows the current position of the gear.
In normal mode: P, R, N, D
Gear indication in "M" mode: 1, 2, 3, 4, 5, 6





Positions of gear select lever
P : Parking
R : Reverse
N : Neutral
D : Drive

▶ Gear select lever

Tip Switch in "M" Position (Manual Gear Shift)
The shiftable gear can be adjusted by moving this switch to forward and rearward when the gear select lever is in "M" position.

Mode Switch
W : Winter mode
S : Standard mode (Use the standard mode in normal driving conditions.)

Selection of Manual/ Automatic Shift Function
D : Automatic shift according to the driving condition
M : Manual shift



Shift Lock Release Button Hole when Locked in the "P" Position
If you cannot move the gear select lever from the "P" position, try to move the lever while pushing down here with a sharp object such as a ballpoint pen. For your safety, turn off the engine and depress the brake pedal before the attempt.

Modification basis	
Application basis	
Affected VIN	

2. FEATURES AND SPECIFICATIONS

1) Specifications

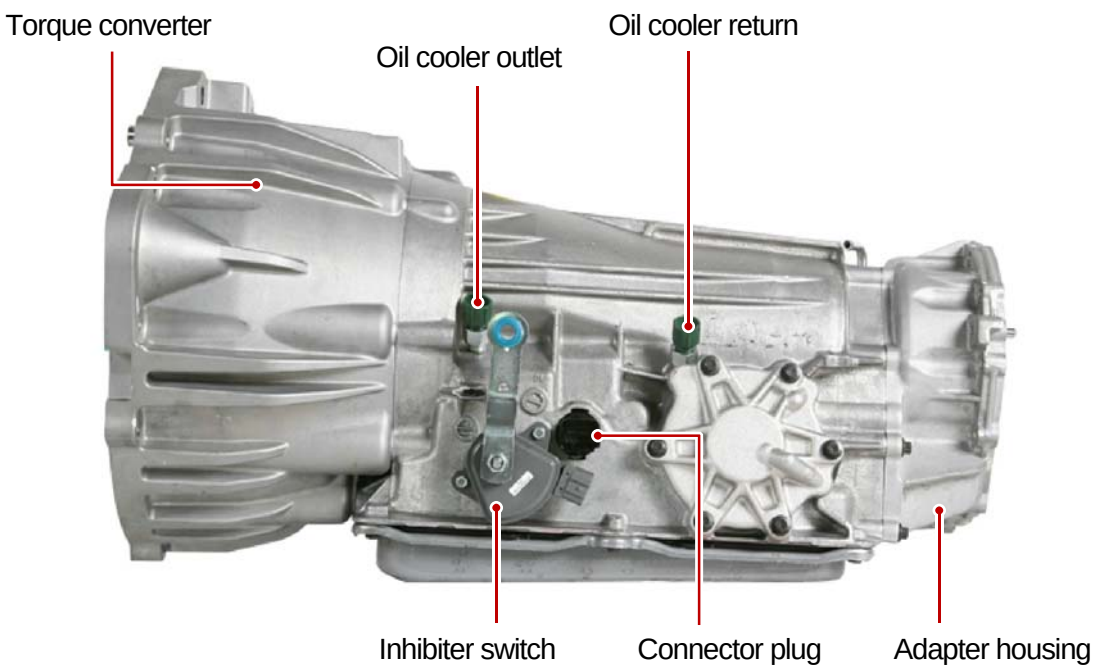
Description		DSI M78 (6-speed)	Remarks
Gear ratio	1st	3.53:1	
	2nd	2.14:1	
	3rd	1.48:1	
	4th	1.16:1	
	5th	0.87:1	
	6th	0.68:1	
	Reverse	3.09:1	
Transmission fluid	Fluid	Fuchs ATF 3292	
	Capacity	Approx. 9.5 L	
	Change interval	Check the fluid at every 10,000 km or 1 year, and change it if necessary.	Under the severe driving conditions, change the fluid at every 60,000 km.
Resistance of oil temperature sensor	-20	430.7 ~ 533.9 kΩ	
	0	146.8 ~ 175.7 kΩ	
	20	56.74 ~ 65.86 kΩ	
	100	3.201 ~ 3.399 kΩ	
Gear position sensor	1	-	
	2	-	
	3	-	
	D	2.686 kΩ ± 8%	
	N	5.036 kΩ ± 8%	
	R	8.953 kΩ ± 8%	
	P	16.786 kΩ ± 8%	

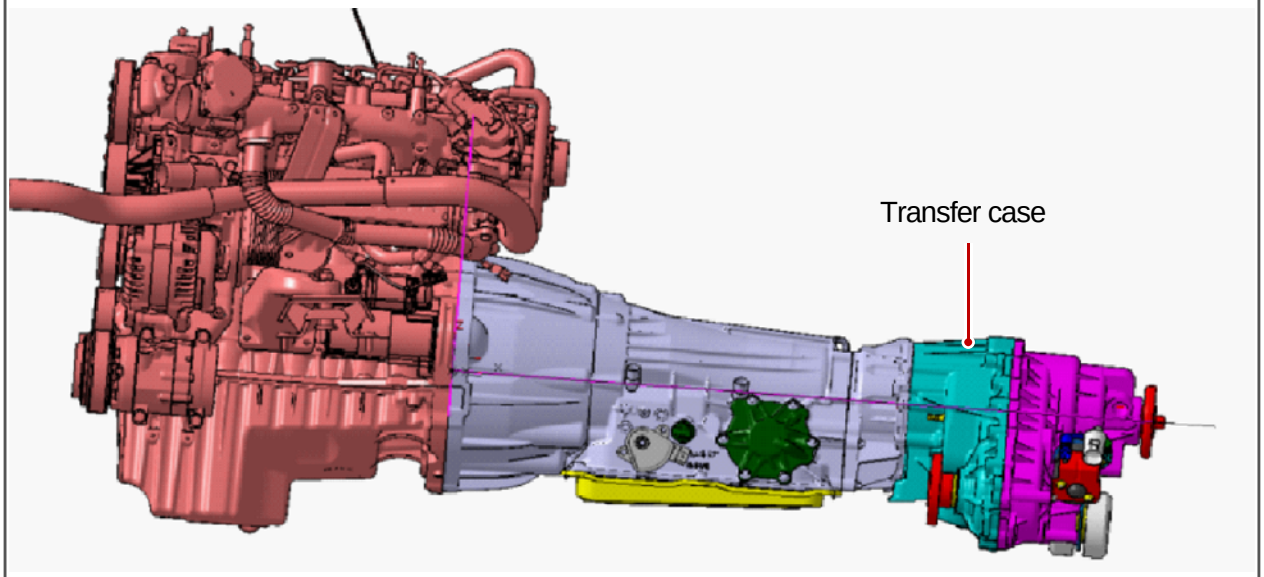
* **Severe driving conditions?**

- Towing a trailer or off-road driving (Inspect the leak of fl uid at any time, occasionlly)
- Taxi, patrol service or delivery service (extended idling and excessive driving with low speed) Frequent stop-and-go traffi c, extended idling,
- short driving distance
- Driving in a hilly or mountainous terrain, sandy, or dusty area
- Driving frequently at high speed over 170 km/hour
- Driving frequently in area where heavy traffi c under the ambient temperature above 32°C

2) Appearance

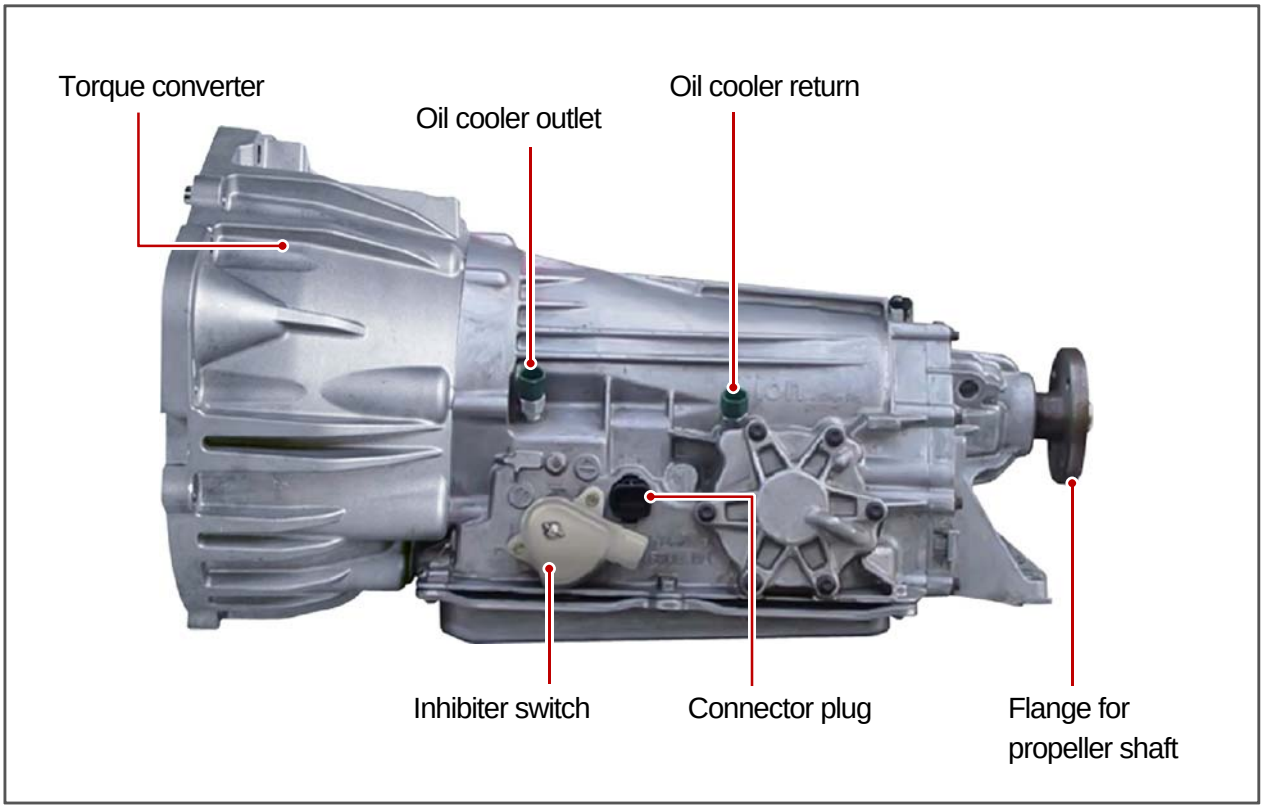
▶ **4WD Automatic Transmission**

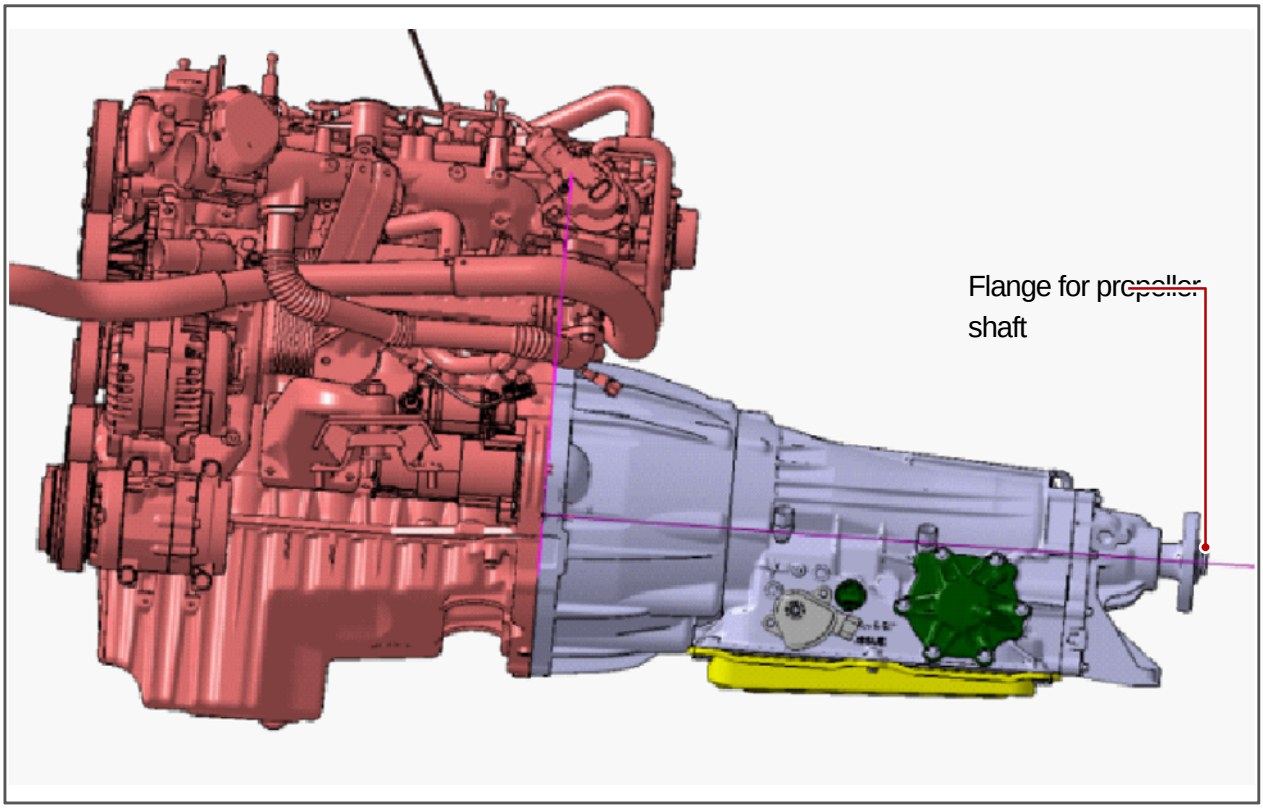




Modification basis	
Application basis	
Affected VIN	

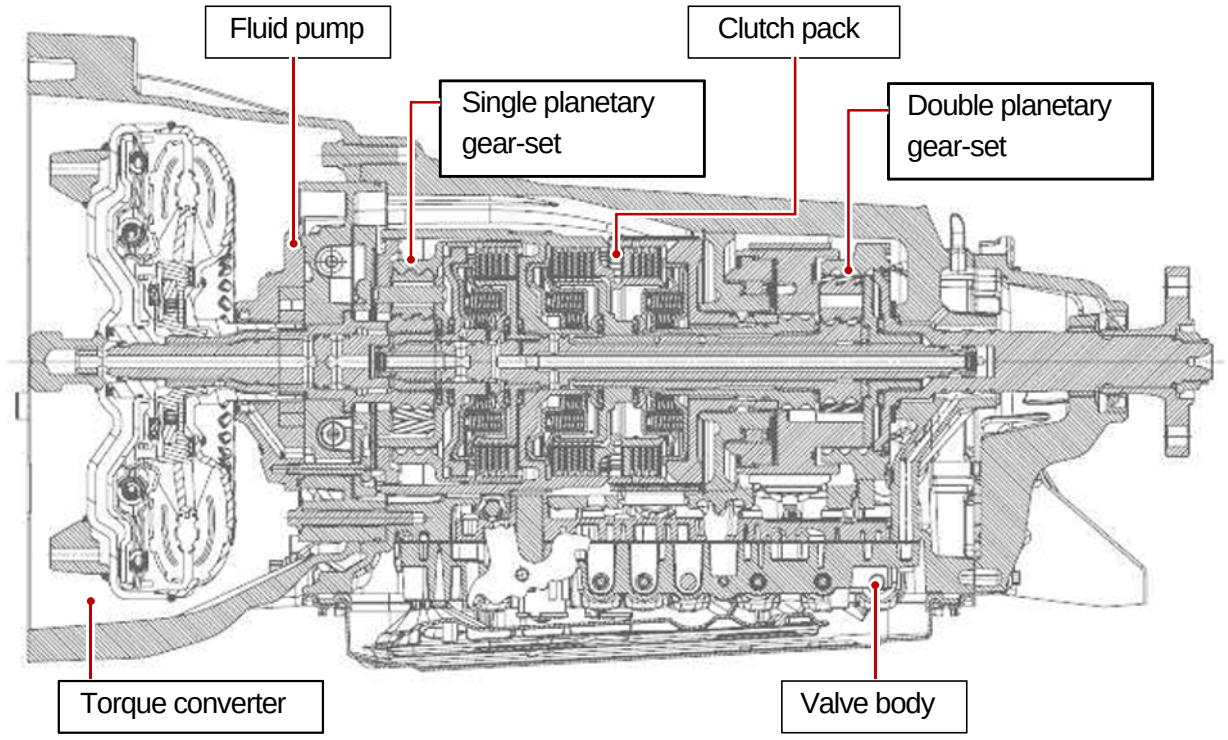
▶ 2WD Automatic Transmission



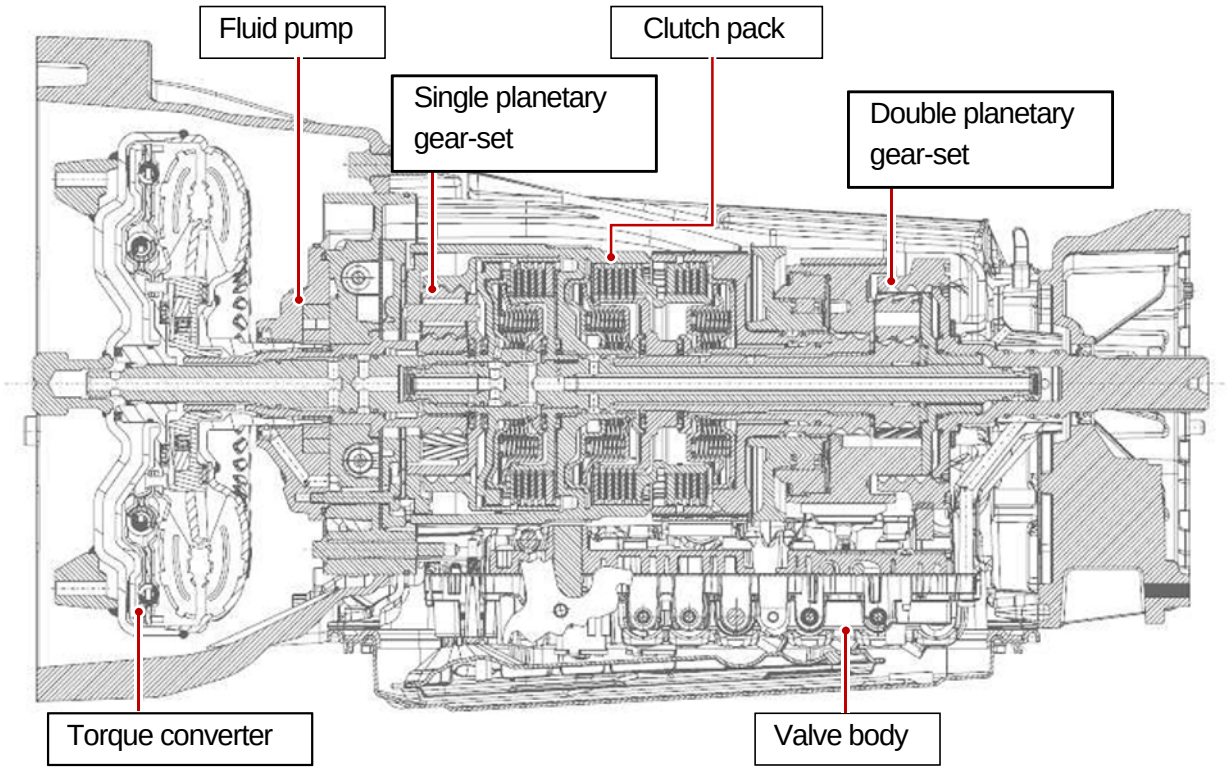


3) Sectional Diagram

4WD



2WD

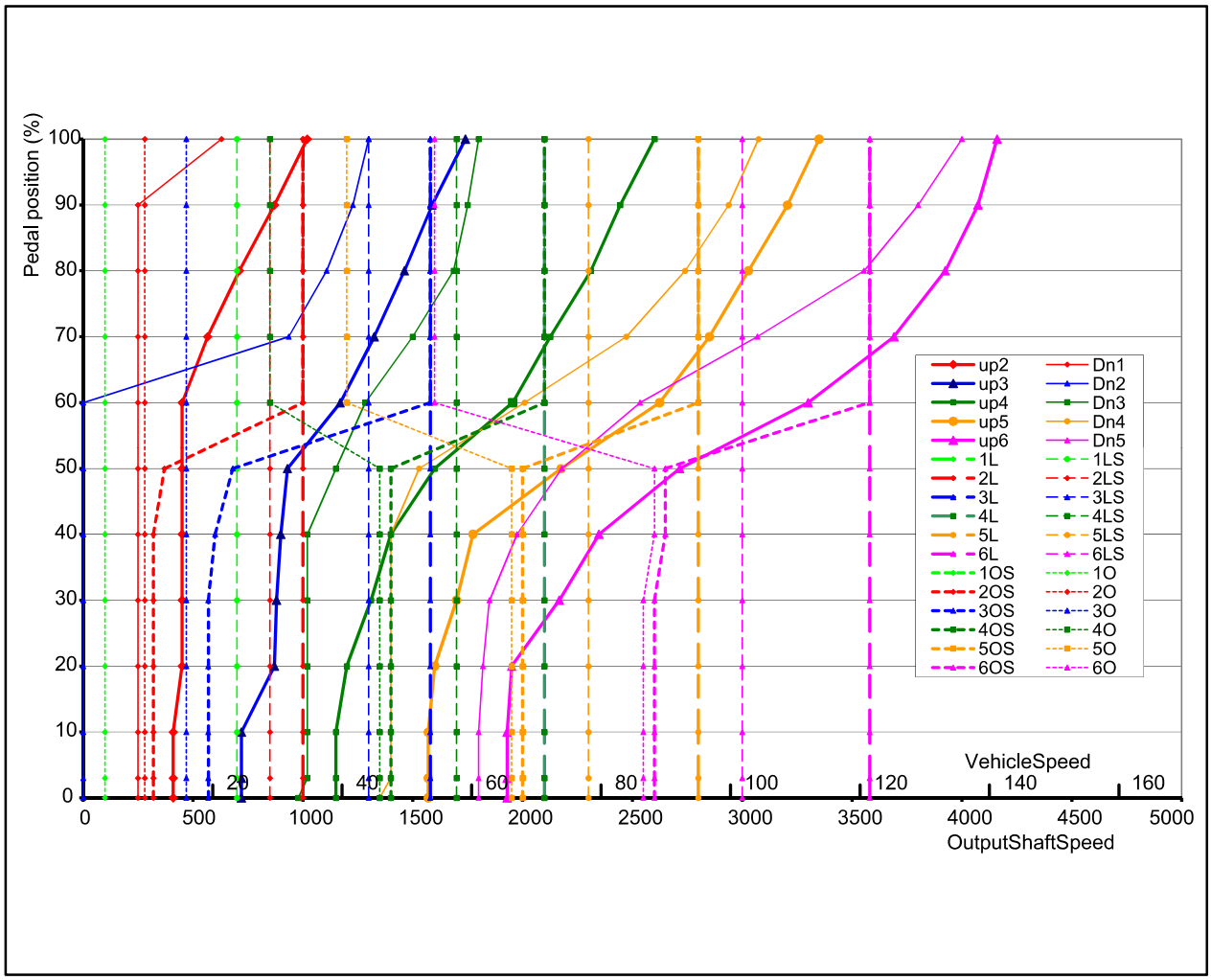


Modification basis	
Application basis	
Affected VIN	

3. TIGHTENING TORQUE

Description	Size x Numbers	Tightening torque
Transfer case housing	M12 x 32	54 ~ 68
Etension housing	M12 x 32	54 ~ 68
Oil pan	M6 x 16	4 ~ 6
Valve body to transmission housing	M6 x 26	8 ~ 13
Valve body to transmission housing	M6 x 45	8 ~ 13
Center support to transmission housing	M10 x 34	20 ~ 27
Output shaft locking nut	M24 x 15	100 ~ 110
Pump cover to oil pump	M8 x 55	24 ~ 27
Pump cover to transmission housing	M8 x 40	24 ~ 34
Pump cover to transmission housing	M8 x 58	24 ~ 34
Upper valve body to lower valve body	M6 x 30	15 ~ 17
Detent spring	M8 x 16	20 ~ 25
Variable bleed solenoid and speed sensor	M4 x 12	2.8 ~ 3.2
Transmission oil level plug		30 ~ 35
Front cooling lines to transmission cooler		25 ~ 35
Rear cooling lines to transmission cooler		25 ~ 35
Drive plate to torque converter		40 ~ 42
Gear select lever to shaft rod		14 ~ 20

4. SHIFT PATTERN DIAGRAM



Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW



The six speed automatic (M78) transmission is available in two variants: four wheel drive and two wheel drive.
The transmission has the following features:

- Six Forward Speeds
- One reverse gear
- A torque converter with an integral converter lock-up clutch
- Electronic shift and pressure controls
- A single planetary gear-set
- A double planetary gear-set
- Two hydraulically controlled brake bands
- Three multi-plate clutches
- All hydraulic functions are directed by electronic solenoids to control:
  - Engagement feel
  - Shift feel
  - Shift scheduling
  - Modulated torque converter clutch applications

The transmission contains fully synthetic automatic transmission fluid (ATF) and is filled for life; therefore it does not require periodic servicing.
Engine power reaches the transmission via a torque converter with integral converter lock-up clutch. The six forward gears and one reverse gear are obtained from a single planetary set, followed by a double planetary set. This type of gear-set arrangement is commonly known as Lepelletier type gear-set.
The automatic transmission is electronically controlled. The control system is comprised of the following elements:

- External transmission control unit (TCU)
- Internal embedded memory module (EMM)
- Input and output speed sensors
- Valve body unit comprised of four on/off solenoid valves and six variable bleed solenoids
- Torque converter

2. FEATURES

1) Features

▶ Early Downshifts with Hard Braking and Skip Shifts

When heavy braking is detected, the transmission downshifts early and skips gears to provide increased engine braking to provide gear selection for tip-in.

▶ Gear Hold on Uphill/Downhill

If the accelerator pedal is released when travelling uphill, upshifts are prevented to reduce busyness on grades. If the accelerator pedal is released when travelling downhill, upshifts are prevented to enhance engine braking.

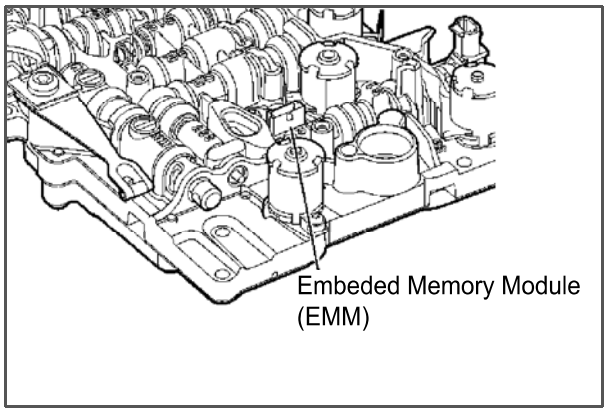
▶ Soft Engagement when Shifting to "D" and "R" Position

A soft engagement feature avoids harsh take up of drive when selecting Drive or Reverse. This is achieved by limiting engine speed and engine torque which results in a rapid, but progressive engagement of either Drive or Reverse when moving from the Park or Neutral positions. There is no drive engagement prevention strategy implemented on the transmission system as there is sufficient engine strategy to protect the system. However, reverse gear engagement is prevented until engine speed is less than 1400 rpm and the accelerator pedal position is less than 12% and vehicle speed is less than 10 km/h.

▶ Converter Clutch Lock-Up In All Gears

The transmission features converter clutch lock-up in all gears. This feature provides improved fuel economy and vehicle performance. It also improves transmission cooling efficiency when towing heavy loads at low speeds, e.g. in city driving or hill terrain.

▶ Embeded Memory Module (EMM)



The embedded memory module (EMM) is matched to the transmission's valve bodies during transmission assembly to ensure refined shift quality. The EMM is integrated into the input speed sensor which is mounted on the valve body in the transmission. The EMM is used to store data such as valve body calibration data and valve body serial number. Upon installation, the TCU will download the data from the EMM and utilise this data in the operation of the transmission.

Modification basis	
Application basis	
Affected VIN	

2) Cooling System

The transmission cooling system ensures rapid warm-up and constant operating temperature resulting in reduced fuel consumption and refined shift quality.
It also includes a cooler by-pass within the hydraulic system to allow sufficient cooling and lubrication to the transmission drivetrain in the event of a blockage in the transmission cooler.

3) Shift Strategy

▶ Gear Shift

Transmission gear change is controlled by the TCU. The TCU receives inputs from various engine and vehicle sensors to select shift schedules and to control the shift feel and torque converter clutch (TCC) operation at each gear change

▶ Coastdown

Coastdown downshifts occur at 0% accelerator pedal when the vehicle is coasting down to a stop. To reduce the shift shock and to improve the shift feeling during downshift, TCU electronically controls the transmission.

▶ Torque Demand

Torque demand downshifts occur (automatically) when the driver demand for torque is greater than the engine can provide at that gear ratio. If applied, the transmission will disengage the TCC to provide added acceleration.

3. MODE DESCRIPTIONS

1) Functions

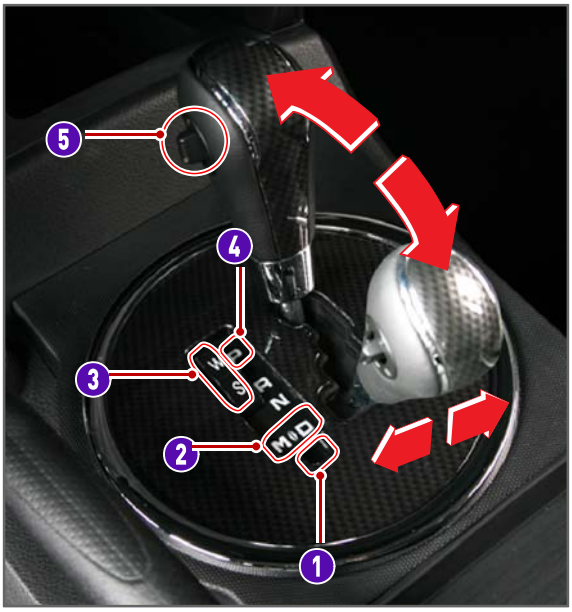
1. **Shift Lock Release Button Hole when Locked in the "P" Position (1)**
   If you cannot move the gear select lever from the "P" position, try to move the lever while pushing down here with a sharp object such as a ballpoint pen. For your safety, turn off the engine and depress the brake pedal before the attempt.

2. Selection of Manual/Automatic Shift Function (M↔D) (2)
   D : Automatic shift according to the driving condition
   M : Manual shift

3. **Mode Switch (3)**
   W : Winter mode (Start off the vehicle in 2nd gear)
   S : Standard mode (Use the standard mode in normal driving conditions.)

4. **Gear Position (4)**
   P : Park
   R : Reverse
   N : Neutral
   D : Drive

5. Tip Switch in "M" Position (Manual Gear Shift) (5)
   The shiftable gear can be adjusted by moving this switch to forward and rearward when the gear select lever is in "M" position.



Modification basis	
Application basis	
Affected VIN	

2) Mode “M” (Manual Shift Mode)

This allows the driver to define the highest possible gear by selecting "+" or "-" on the gear selector when the lever is in the "M" position. When the lever is first moved to the manual "M" position the transmission will select the lowest possible gear.
When maximum engine rpm is reached the transmission will upshift automatically regardless of the driver selected limit. 4WD models with low range will not automatically upshift when low range is selected.

NOTE

Kickdown Function
If you need to accelerate rapidly, depress the accelerator pedal completely to the floor.
Then, a one- or two-lever gear will automatically be engaged. This is called the Kickdown function.

▶ **1st gear position**

- Use on a rugged road, mountain path and steep hill. Engine braking effect on steep hill is available.

▶ **2nd gear position**

- Use on a long and gentle slope. 2-1 automatic kickdown shift is available. Engine braking effect is available.

▶ **3st gear position**

- Use on a long and gentle slope. 3-2 and 2-1 automatic kickdown shift is available. Engine braking effect is available.

▶ **4th gear position**

- Use on a long and gentle slope. 4-3, 4-2 and 4-1 automatic kickdown shift is available.

▶ **5th gear position**

- 5-4 and 5-3 automatic kickdown shift is available.

▶ **6th gear position**

- 6-5 and 6-4 automatic kickdown shift is available.

4. LIMP HOME MODE

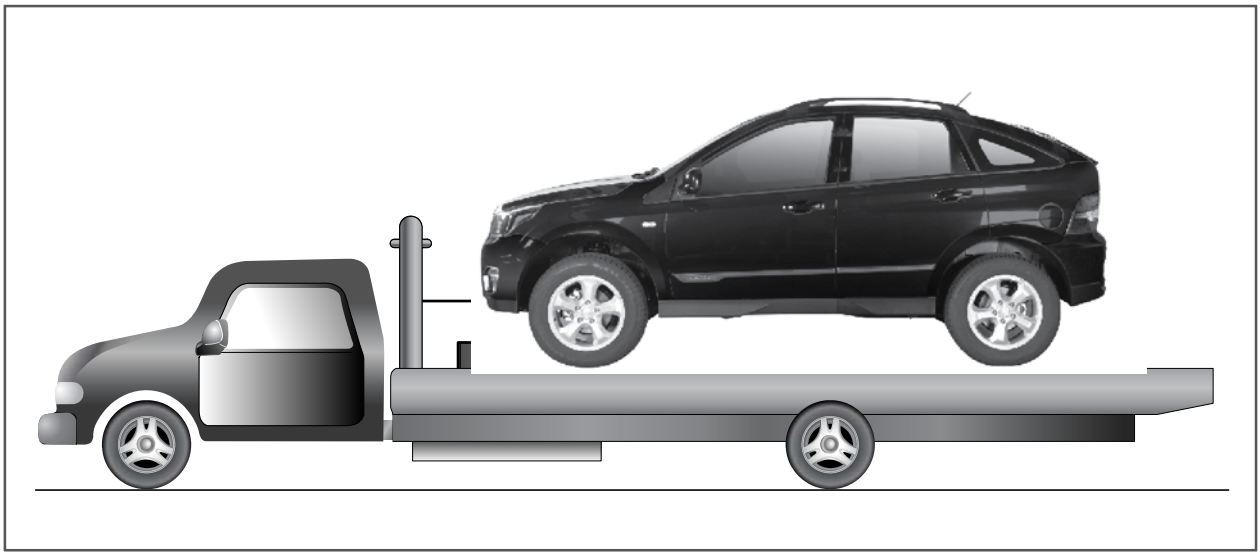
▶ In case of transmission malfunction

1. If a serious fault occurs in the automatic transmission, the TCU enters the limp home mode to secure safe driving and protect the automatic transmission.
2. As power is no longer supplied to the solenoid, the current basic function (P, R, N, D) is maintained and the 4th gear can be maintained only by the operation of the hydraulic system without electrical operation.
3. The ECU communicates with other electric modules with CAN. If a serious fault occurs, the transmission automatically enters the limp home mode for service.
4. The TCU monitors all factors which can affect to the performance of the transmission and diagnose the system according to OBD II regulation.

▶ In case of overheated transmission

1. The TCU enters the limp home mode when the batter voltage drops below 8 V.
2. If the transmission is overheated, the shift pattern is changed to the hot mode to cool the transmission more efficiently.
3. While the transmission is overheated, the selector lever symbol and engine temperature warning lamp on the instrument cluster blink until the transmission is cooled down to the normal operation temperature. If the transmission is excessively overheated, the gear cannot be shifted but remains in the neutral position.

▶ Towing the vehicle with A/T



CAUTION

The best way to transport the vehicle is to load it to a truck and transport it, especially if the vehicle is 4WD.

- If towing the vehicle with the propeller shaft connected, the transmission or oil pump of transfer case may malfunction, resulting in internal damage due to poor lubrication.

Modification basis	
Application basis	
Affected VIN	

5. ELECTRONIC CONTROL SYSTEM

1) Overview

The transmission control unit (TCU) and its input/output networks control the operations of transmission:

- Shift timing
- Line pressure
- Clutch pressure (shift feel)
- Torque converter clutch

In addition, the TCU receives input signals from certain transmission-related sensors and switches. The TCU also uses these signals when determining transmission operating strategy. Using all of these input signals, the TCU can determine when the time and conditions are right for a shift, or when to apply or release the torque converter clutch. It will also determine the pressure needed to optimise shift feel. To accomplish this, the TCU operates six variable bleed control solenoids and four ON/OFF solenoids to control the operations of transmission.

2) Transmission Control Unit (TCU)

The transmission control unit (TCU) is mounted under the driver's seat and controls the operation of the transmission.
TCU processes the analog information from the internal sensors and the digital information through CAN communication lines. TCU monitors all the input and output signals. If there is any failure, TCU changes the system to "Limp Home Mode" and alerts to the driver through the warning lamp on the instrument cluster.

(1) Hard-wired (Analog) Input/Output

▶ **Input/Output Data between TGS Lever and TCU**

- Position and conditions of gear select lever
- Driving moded (Winter or Standard)

▶ **Input/Output Data between Inhibitor and TCU**

- Position of inhibitor switch

▶ **Input/Output Data between Automatic Transmission and TCU**

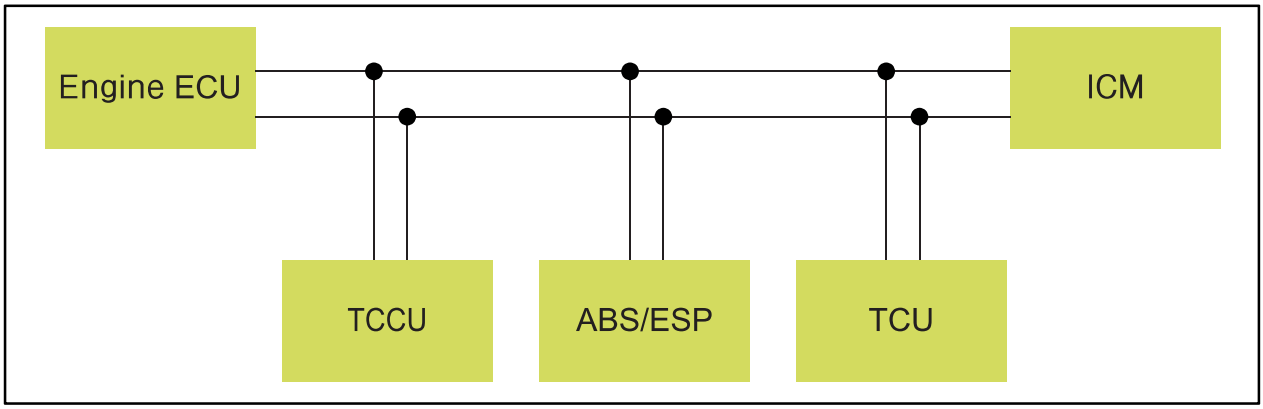
- 6 control signals for variable bleed solenoid
- 4 control signals for ON/OFF solenoid
- Transmission input speed
- Transmission output speed
- Transmission oil temperature
- EMM (Embeded Memory Module)

▶ **Input/Output Data between Self Diagnostic Connector and TCU**

- Various DTC codes and TCU information

(2) CAN Input/Output

TCU receives and sends the data among the units through P-CAN communication.

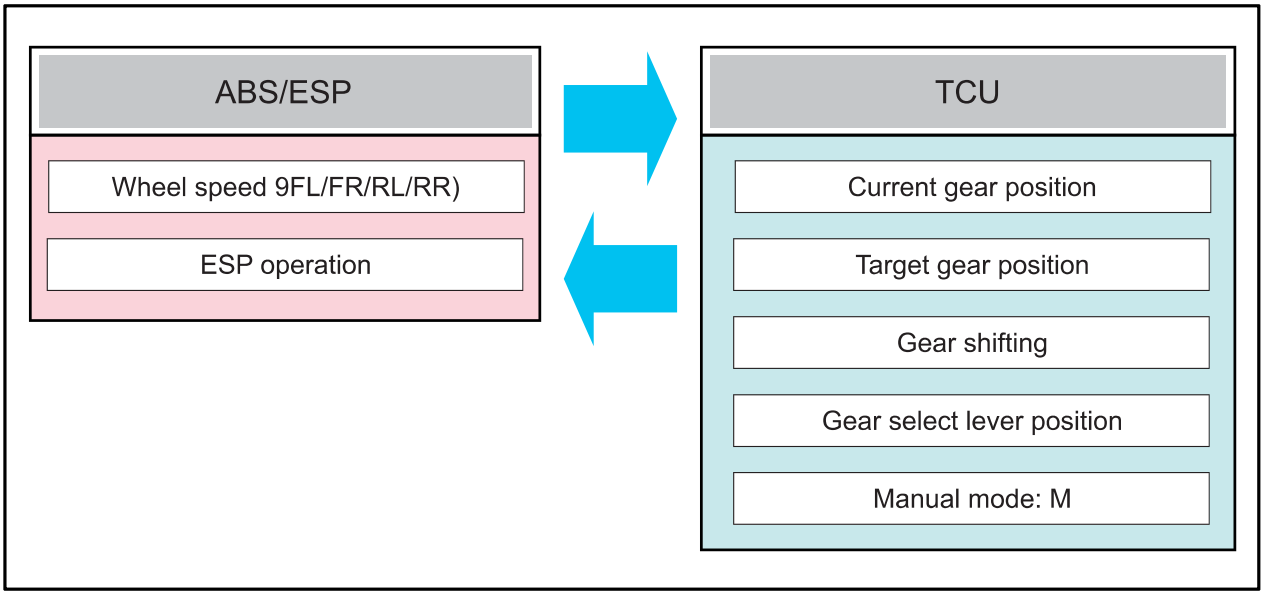


▶ **CAN Input/Output Data between Engine ECU and TCU**

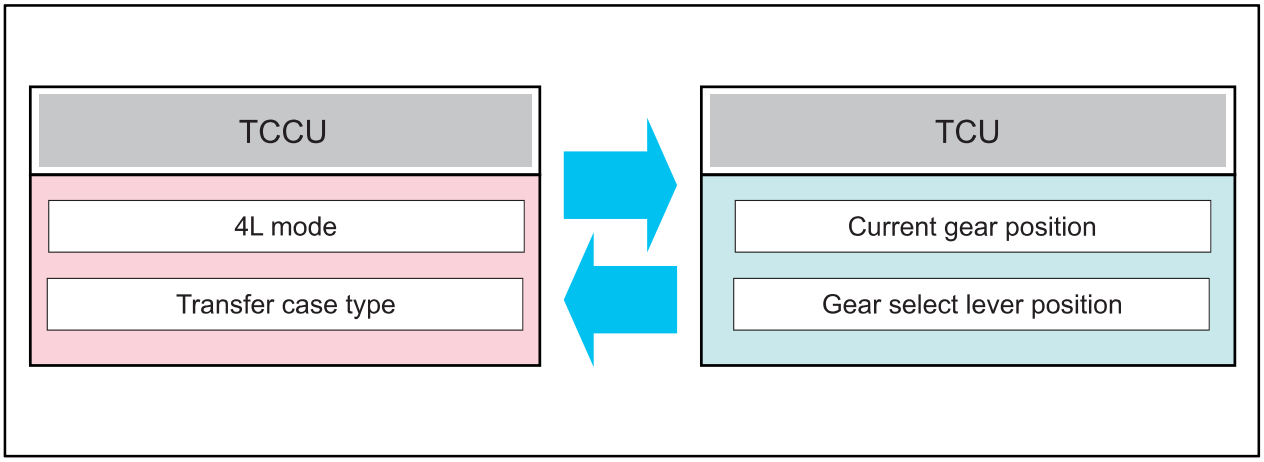
Engine ECU	TCU
Accelerator pedal position	Engine torque (including max/min)
Shift level request	Current gear position
Engine limp home mode	Target gear position
Accelerator pedal sensor error	Torque converter lock up
Cruise control ON	Gear shifting
Requested torque from ESP	Torque request in safety mode
Engine rpm	Engine torque control
Engine torque (including max/min)	Software calibration ID and gear select lever position
Vehicle speed	Failure and error
Stop lamp ON/OFF	Turbine speed of torque converter
Engine coolant temperature	Drive position
Intake air temperature	Driving mode program (Winter or Standatd)
	Transmission oil temperature

Modification basis	
Application basis	
Affected VIN	

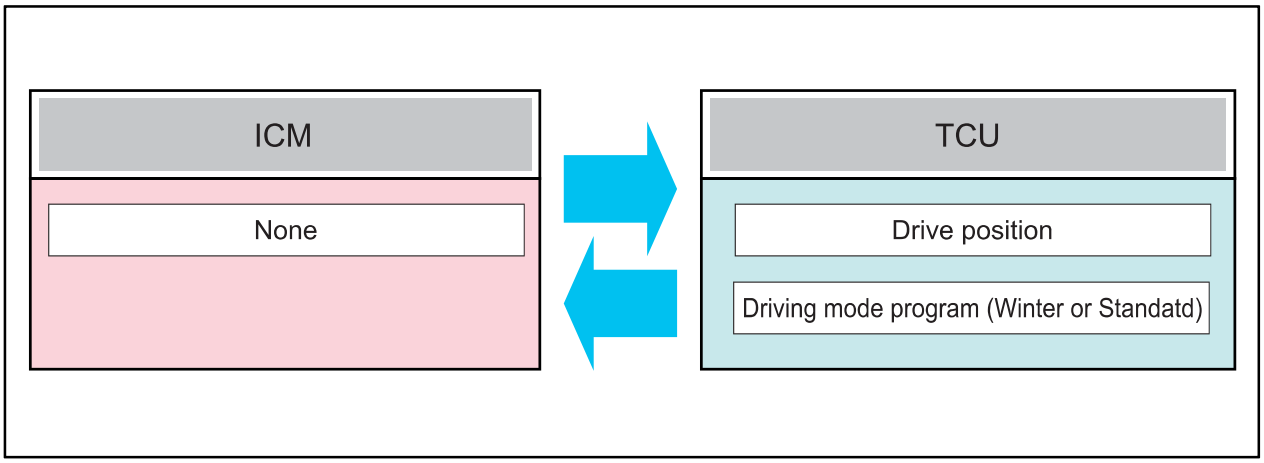
▶ CAN Input/Output Data between ABS/ESP and TCU



▶ CAN Input/Output Data between TCCU and TCU



▶ CAN Input/Output Data between ICM and TCU



3) Transmission Control Monitoring System

TCU monitors all input and output signals to identify possible failures. If a fault is detected, TCU activates the safety mode to keep the driver's safety and the life span of transmission.

▶ Monitoring the Supply Voltage

If the battery voltage is too high or too low, the TCU sets the DTC.

▶ Monitoring the Supply Voltage to Solenoid

TCU monitors the circuits for open or short to ground or supply. The monitoring function evaluates the voltage characteristics while the switch is ON.

▶ Monitoring the Gear Ratio

TCU monitors the gear is engaged properly in the allowed time.

▶ Monitoring the Torque Converter

TCU checks if the torque converter can be locked up properly. If it is failed, TCU releases the torque converter clutch to activate the fail-safe operation.

4) Shift Energy Management

This function involves reducing or increasing the engine output torque during shifting. This reduces the energy which is dissipated in the friction elements of the transmission during up-shift. This is done by reducing the engine torque during the gear ratio change without interrupting the tractive drive.
This function is used for:

- Increasing the life span of transmission by shortening the slipping time
- Improving the shift comfort by reducing the step changes due to gearshift
- Transferring a higher engine power

Real-time control of engine torque is required to maintain the proper shift operations and the durability of transmission. TCU controls the engine torque during the gearshift by synchronizing the operation of transmission clutches.

Modification basis	
Application basis	
Affected VIN	

▶ **Pressure Modulation**

To provide a higher level of shift comfort and durability, the hydraulic pressure in the shift related friction elements of the transmission must be matched accurately to the input torque to transmission. This hydraulic pressure is composed of a hydraulically pre-set basic pressure and a control pressure which is set by one of the variable bleed solenoids.

The transmission input torque can be directly calculated from the following operating parameters:

- engine torque signals
- engine speed or any signal transmitted from ECU through CAN lines
- converter slip

Separate pressure characteristics for each gear change make it possible to adapt precisely to the particular shift operation.

5) Shift Mode Selection by TCU

The driver can select Standard (S) or Winter mode (W) with the mode switch. TCU automatically changes the shift mode according to the transmission oil temperature, uphill or downhill gradient, and altitude to keep the good driving conditions.

▶ **Standard Mode (S)**

Standard Mode is selected when setting the mode switch in Standard (S) position with the gear select lever in "D" and the transmission oil temperature in normal operating range. Proper shift timing provides the optimized fuel economy and good driving conditions.

▶ **Uphii and Downhill Mode**

In this mode, the operating points of torque converter lock-up clutch and the shifting points are adjusted according to the vehicle weight.

▶ **Altitude Mode**

In this mode, the shifting points are automatically adjusted according to the altitude to compensate the engine torque changes due to barometric pressure and temperature.

▶ Winter Mode (W)

When the Winter mode is selected, the second gear is engaged to start off the vehicle easily to prevent wheel spin on slippery surfaces and WINTER mode indicator comes ON. The first gear is not available in this mode.

▶ Low Range Driving Mode

When the vehicle is in 4L driving mode, the transmission uses a different shift mode to optimize the low range driving. Similar to Winter mode, the first gear is not available.

▶ Warm Up Mode

This mode is normally used when the transmission oil temperature is below 20°C.
The torque converter cannot be locked-up below 20°C to provide the warming up process of transmission.

▶ Hot Mode

If the transmission oil temperature is between 110°C and 145°C, the system provides the cooling and reduces the load to the transmission. This is called Hot Mode.

- Above 110°C: PWM fan ON
- Above 130°C: the engine torque is reduced and WINTER indicator is blinking
- Above 145°C: the transmission is held in Neutral (N) gear until the oil temperature falls below 120°C (Final protection)

In Hot Mode, any of shift mode is not available.

▶ Cruise Control

When the cruise control is activated, the engine ECU requests the downshift to increase the engine brake effect.

Modification basis	
Application basis	
Affected VIN	

6. POWER FLOW

Power flows in gears:

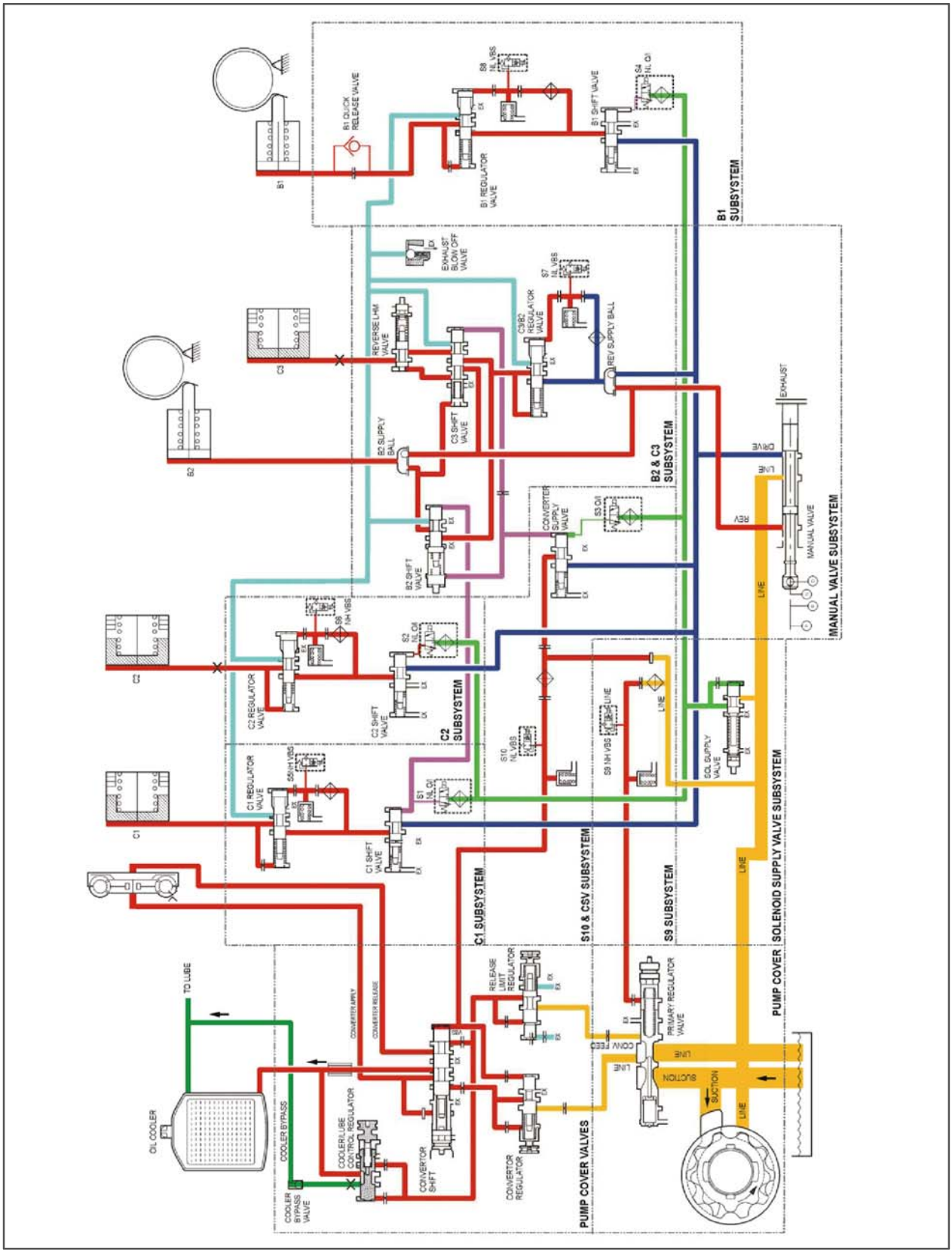
- Power flow - 1st gear (M)
- Power flow - 1st gear (D)
- Power flow - 2nd gear (D)
- Power flow - 2nd gear (D) ? lockup (D)
- Power flow - 3rd gear (D)
- Power flow - 4th gear (D) - 4th gear (D) in Limp home mode
- Power flow - 5th gear (D)
- Power flow - 6th gear (D)

▶ Gear Selection and Engaged Element

Gear	Gear ratio	Engaged element (clutch & band)					
		C1	C2	C3	B1	B2	1-2OWC
M1	3.53		ON			ON	
1st	3.53		ON				ON
2nd	2.14		ON		ON		
3rd	1.48		ON	ON			
4th	1.16	ON	ON				
5th	0.87	ON		ON			
6th	0.68	ON			ON		
Reverse	-3.09			ON		ON	

Gear	ON/OFF solenoid valve				Variable bleed solenoid valve - VBS					
	S1	S2	S3	S4	S5(A)	S6(A)	S7(A)	S8(A)	S9(A)	S10(A)
M1	ON				1	0	1			
1st	ON				1	0			0-1	
2nd	ON			ON	1	0		1	0-1	
3rd	ON		ON		1	0	1		0-1	
4th					0	0			0-1	
5th		ON			0	1	1		0-1	
6th		ON		ON	0	1		1	0-1	
Reverse	ON	ON	ON		1	1	1		0-1	

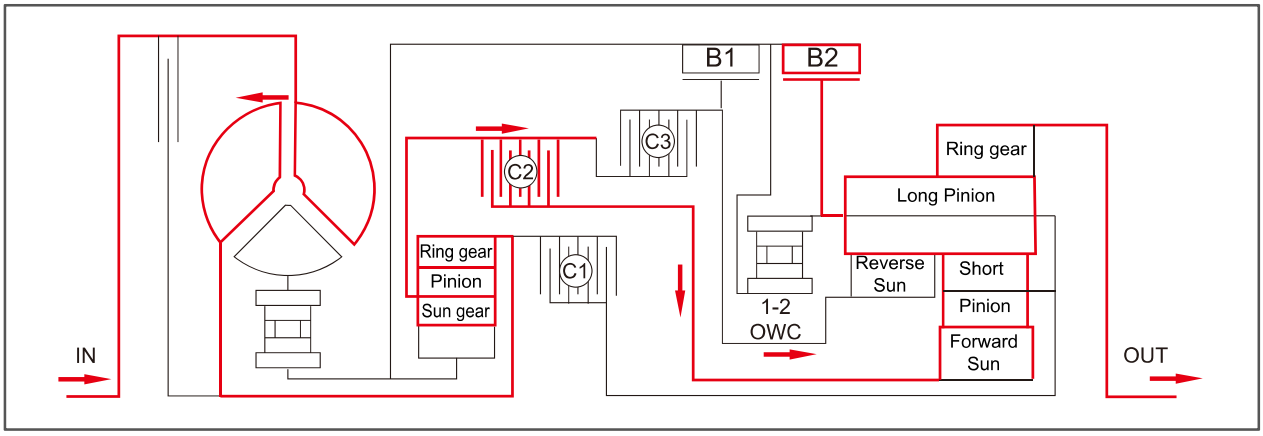
▶ Hydraulic Circuit Diagram



Modification basis	
Application basis	
Affected VIN	

1) Power Flow - Manual (M Position)

▶ Power Flow Diagram



▶ Functioning elements

- C2 applied, FSG (Forward Sun Gear) driven
- B2 applied to hold Rear Planet Carrier stationary
- Provides engine breake effect

CAUTION

Manual 1st gear is not engaged even when moving the manual valve to a certain position. This gear state is obtained electronically by solenoids S1 and S7.

▶ Control

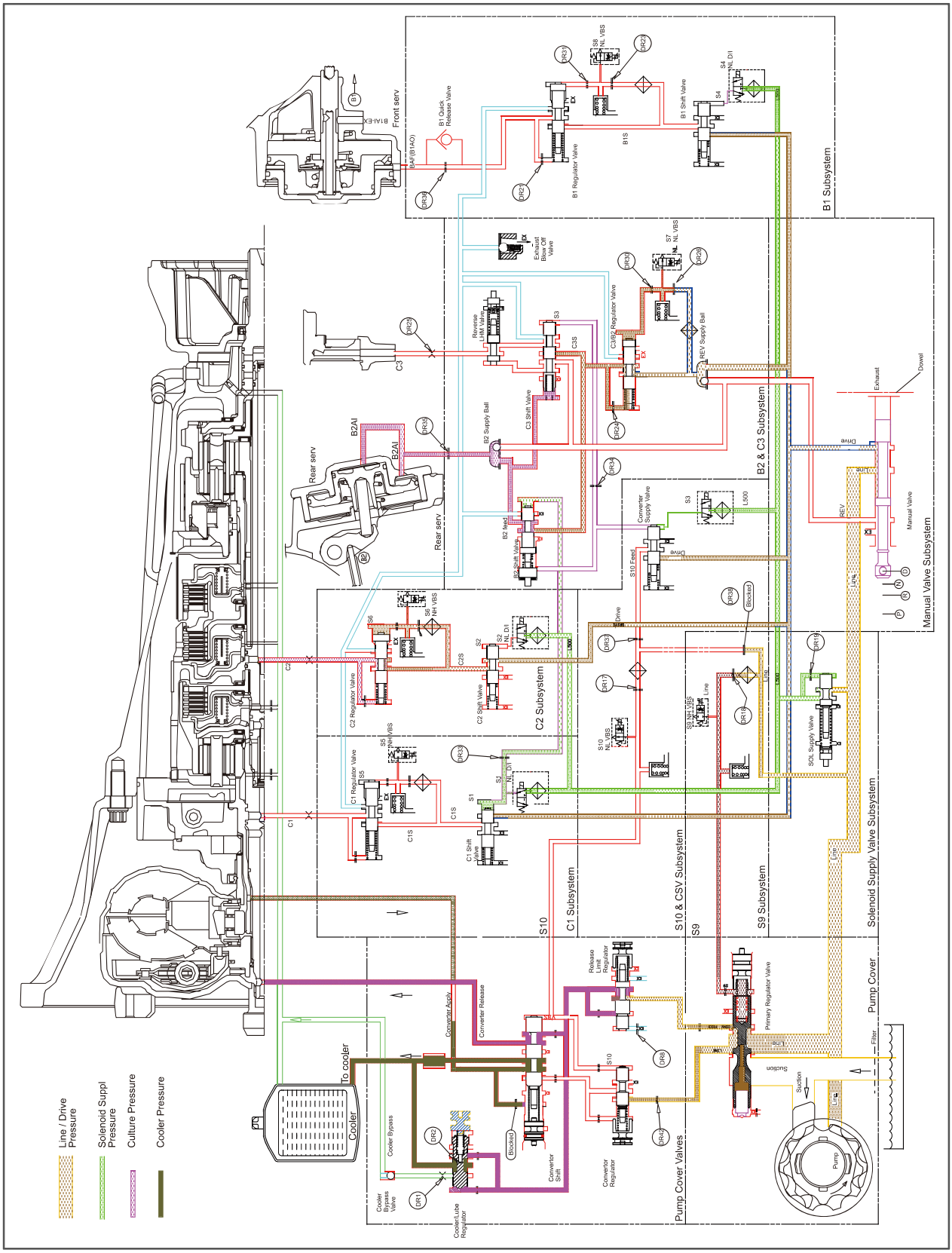
- S1 ON, C1 shift valve moved to the left end, C1 clutch not engaged
- S1 ON, B2 shift valve moved to the left end, B2 band operated (S7 should be ON)
- C2 shift valve open (S2 OFF), C2 clutch engaged by drive oil
- Drive oil (for C2 clutch engagement) is regulated by VBS S6

▶ Connecting Components

Gear ratio	Engaged element									
	C1	C2	C3	B1			B2		OWC	Lock-up clutch
				AO	AI	R	AO	AI		
3.53	ON						ON	ON		

Gear ratio	ON / OFF solenoids				Variable pressure sol. valve-VBS					
	S1	S2	S3	S4	S5(A)	S6(A)	S7(A)	S8(A)	S9(A)	S10(A)
3.53	ON				1	0	1		0-1	

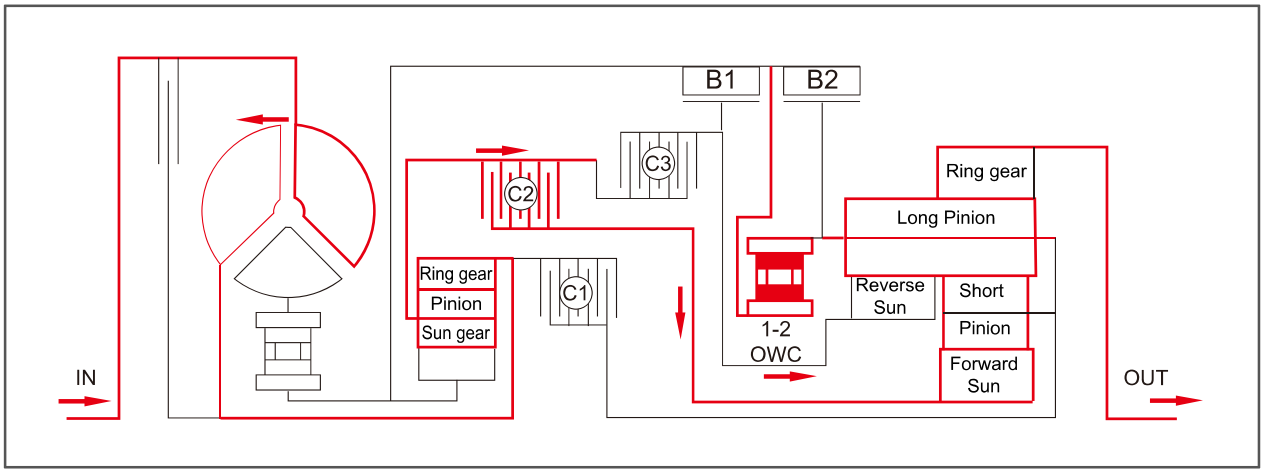
▶ 1st Gear (M) (3.53:1)



Modification basis	
Application basis	
Affected VIN	

2) Power Flow - 1st Gear (D)

▶ Power Flow Diagram



▶ Functioning elements

- C2 applied, FSG (Forward Sun Gear) driven
- 1-2 OWC (One-Way Clutch) operated to hold Rear Planet Carrier stationary

▶ Control

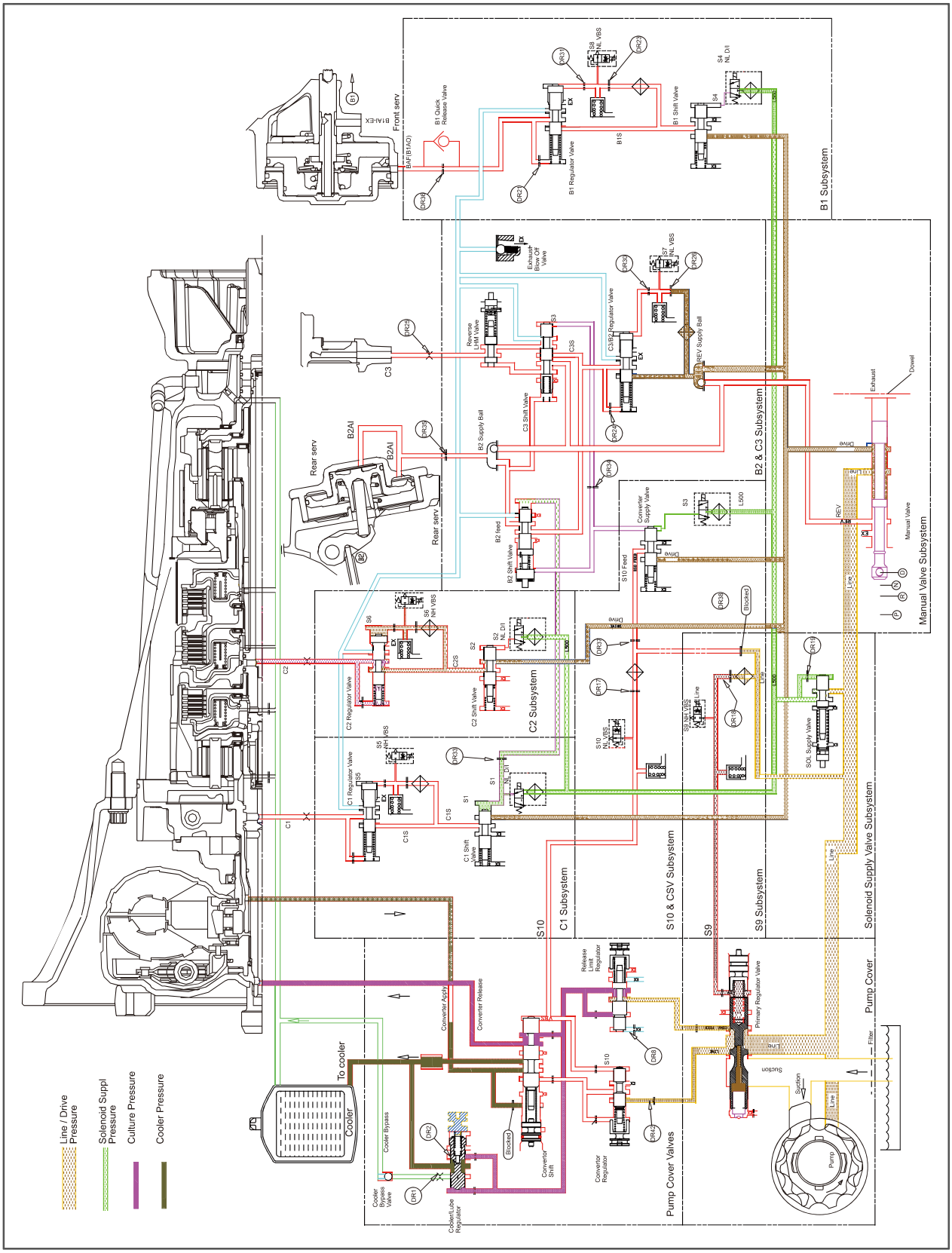
- S1 ON, S2 OFF
- S1 ON, C1 shift valve moved to the left end, C1 clutch not engaged
- C2 shift valve open (S2 OFF), C2 clutch engaged by drive oil
- Drive oil (for C2 clutch engagement) is regulated by VBS S6

▶ Connecting Components

Gear ratio	Engaged element									
	C1	C2	C3	B1			B2		OWC	Lock-up clutch
				AO	AI	R	AO	AI		
3.53		ON							ON	

Gear ratio	ON / OFF solenoids				Variable pressure sol. valve-VBS					
	S1	S2	S3	S4	S5(A)	S6(A)	S7(A)	S8(A)	S9(A)	S10(A)
3.53	ON				1	0			0-1	

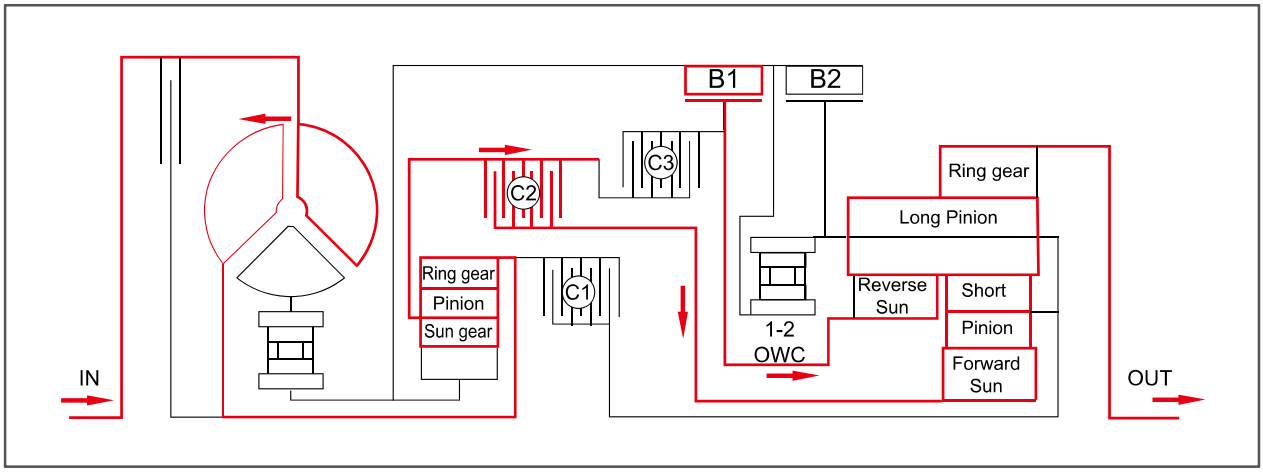
▶ 1st Gear (D) (3.53:1)



Modification basis	
Application basis	
Affected VIN	

3) Power Flow - 2nd Gear (D)

▶ Power Flow Diagram



▶ Functioning elements

- C2 applied, FSG (Forward Sun Gear) driven
- B1 applied to hold Rear Planet Carrier stationary

▶ Control

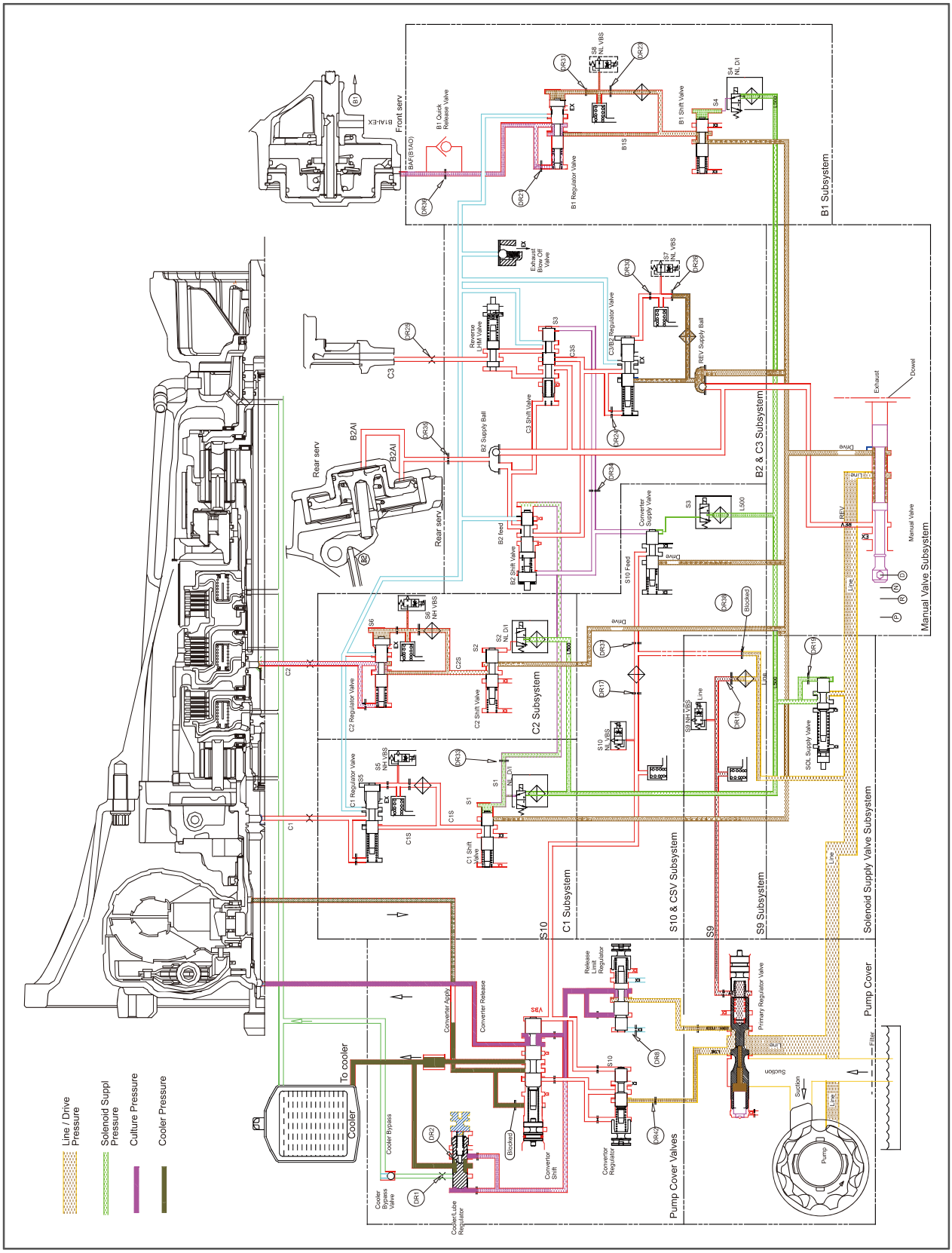
- S1 ON, S4 ON, S2 OFF
- S1 ON, C1 shift valve moved to the left end, C1 clutch not engaged
- C2 shift valve open (S2 OFF), C2 clutch engaged by drive oil
- Drive oil (for C2 clutch engagement) is regulated by VBS S6
- S4 ON, B1 shift valve moved to the left end, B1 band operated
- Drive oil (for B1 band engagement) is regulated by VBS S6

▶ Connecting Components

Gear ratio	Engaged element									
	C1	C2	C3	B1			B2		OWC	Lock-up clutch
				AO	AI	R	AO	AI		
2.14		ON		ON						

Gear ratio	ON / OFF solenoids				Variable pressure sol. valve-VBS					
	S1	S2	S3	S4	S5(A)	S6(A)	S7(A)	S8(A)	S9(A)	S10(A)
2.14	ON			ON	1	0		1	0-1	

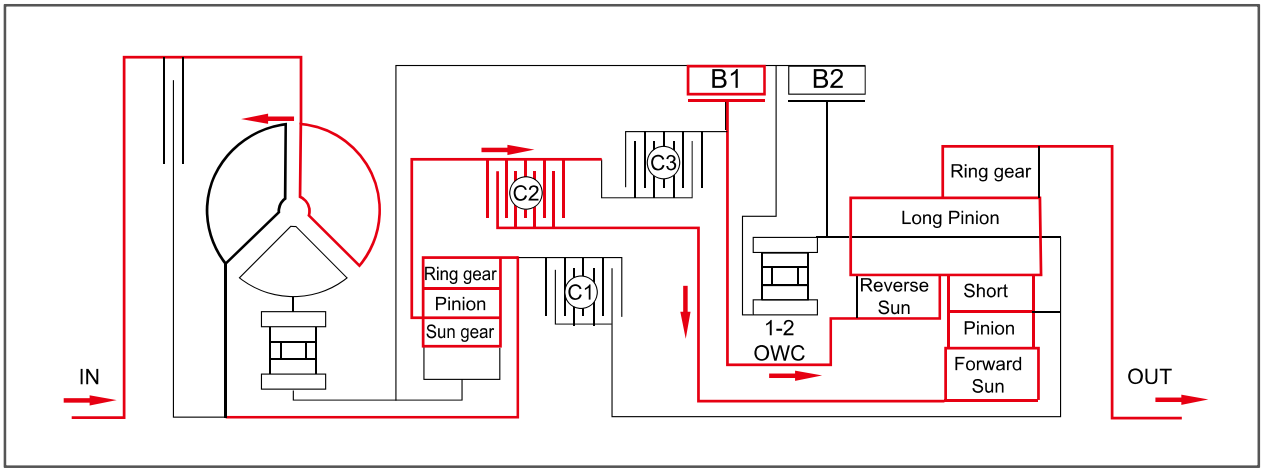
▶ 2nd Gear (D) (2.14:1)



Modification basis	
Application basis	
Affected VIN	

4) Power Flow - 2nd Gear (D) Lock-Up

▶ Power Flow Diagram

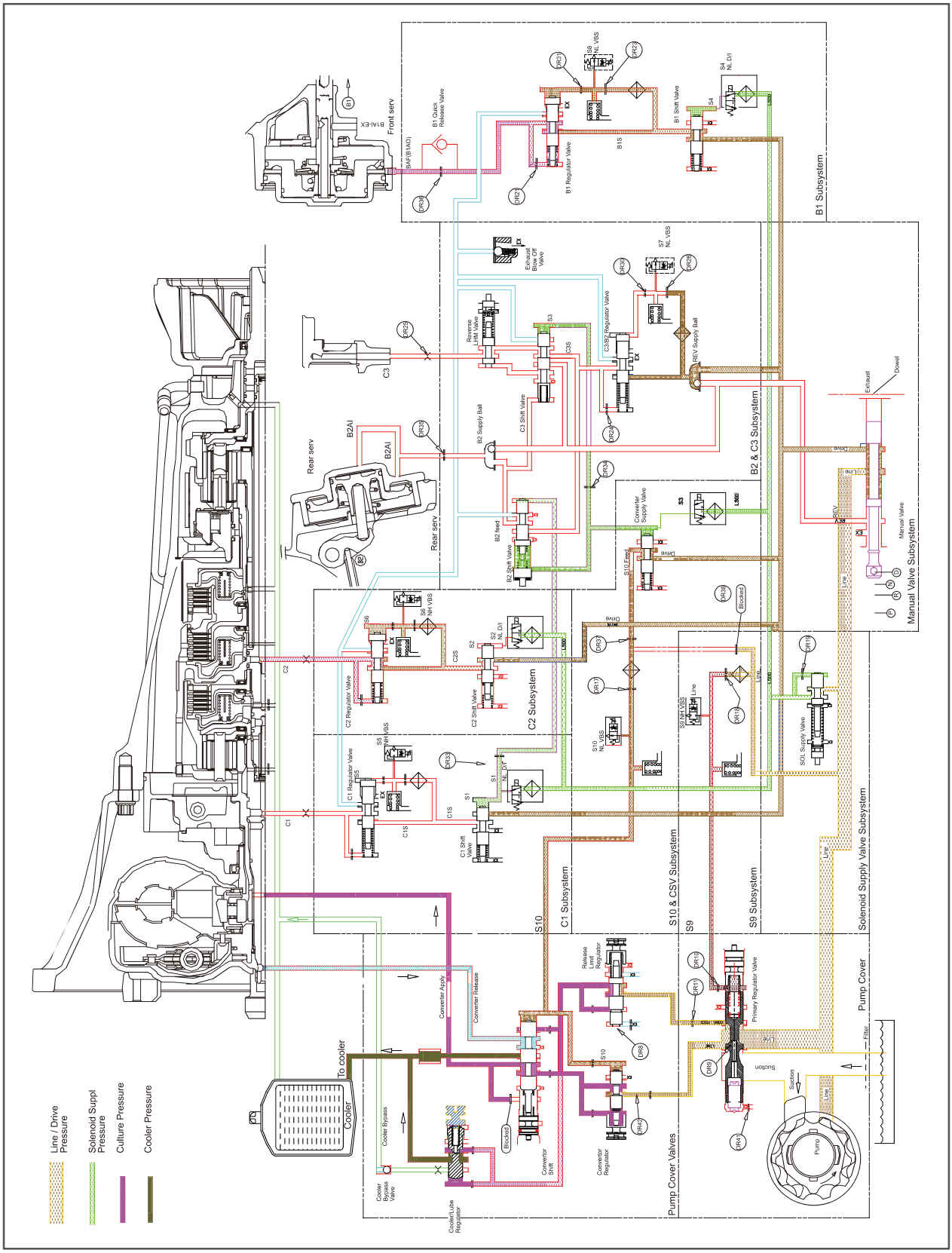


▶ Connecting Components

Gear ratio	Engaged element									
	C1	C2	C3	B1			B2		OWC	Lock-up clutch
				AO	AI	R	AO	AI		
2.14		ON		ON						

Gear ratio	ON / OFF solenoids				Variable pressure sol. valve-VBS					
	S1	S2	S3	S4	S5(A)	S6(A)	S7(A)	S8(A)	S9(A)	S10(A)
2.14	ON		ON	ON	1	0	0	1	0-1	1

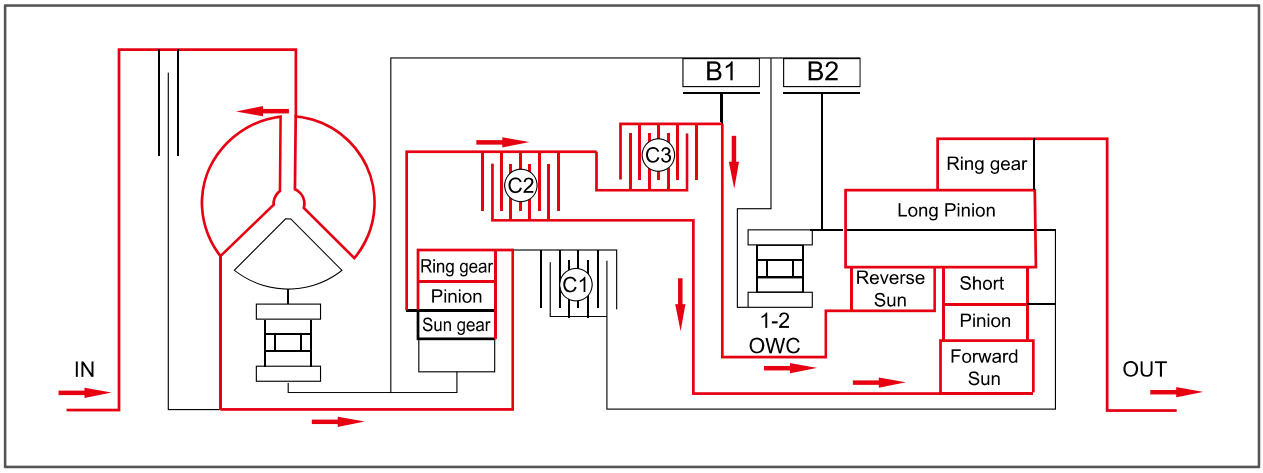
▶ 2nd Gear (D) Lock-Up



Modification basis	
Application basis	
Affected VIN	

5) Power Flow - 3rd Gear (D)

▶ Power Flow Diagram



▶ Functioning elements

- C2 applied, FSG (Forward Sun Gear) driven
- C3 applied, Rear Planet Carrier driven
- Rear Planet Gear Set is locked and its output has the same gear ratio with Front Gear Set.

CAUTION

C3 clutch cannot be engaged if S7 is OFF and the oil pressure is not supplied to C3 regulator valve.

▶ Control

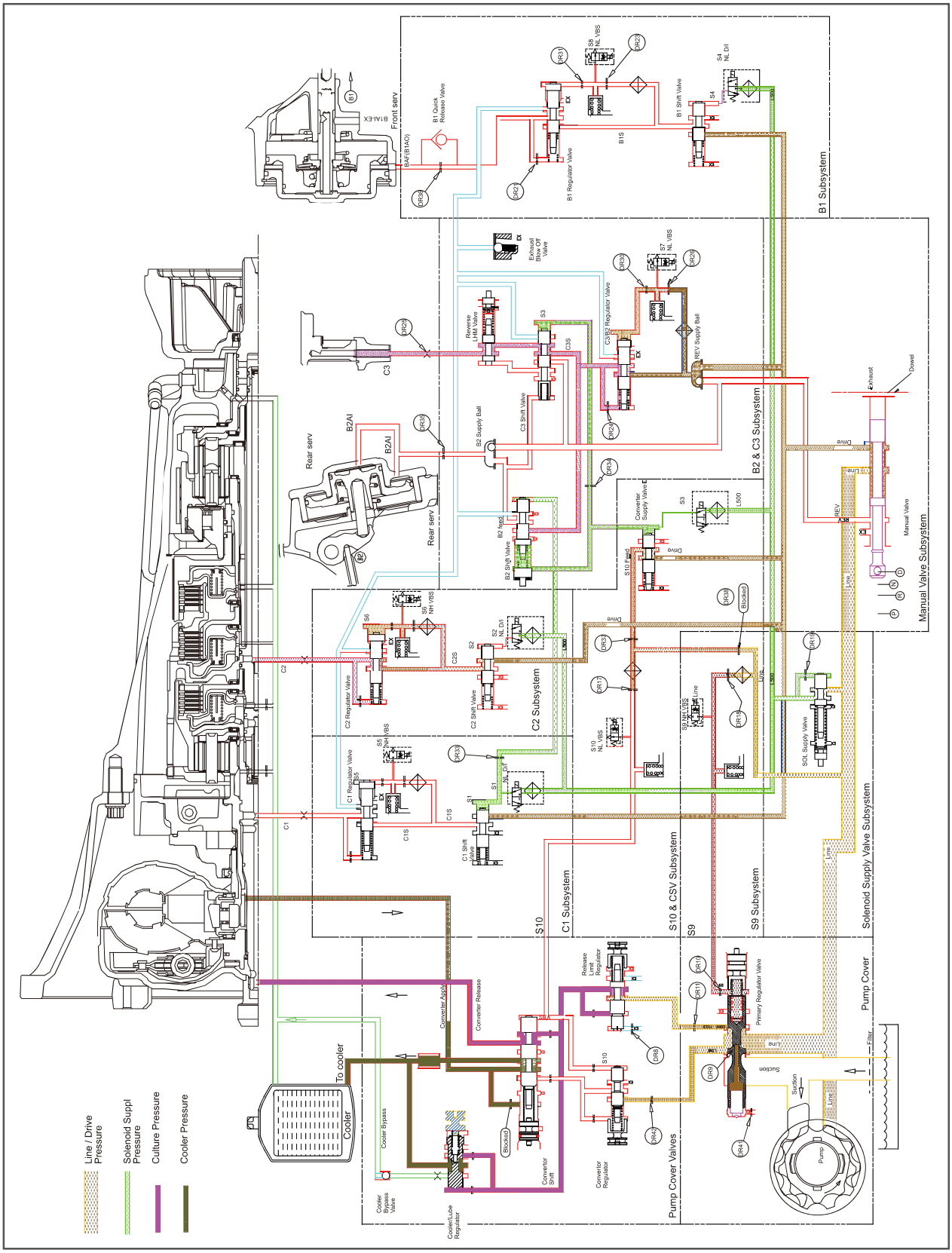
- S1 ON, C1 shift valve moved to the left end, C1 clutch not engaged
- C2 shift valve open (S2 OFF), C2 clutch engaged by drive oil
- S3 and S7 ON, C3 shift valve moved to the left end, C3 clutch engaged

▶ Connecting Components

Gear ratio	Engaged element									
	C1	C2	C3	B1			B2		OWC	Lock-up clutch
				AO	AI	R	AO	AI		
1.48		ON	ON							

Gear ratio	ON / OFF solenoids				Variable pressure sol. valve-VBS					
	S1	S2	S3	S4	S5(A)	S6(A)	S7(A)	S8(A)	S9(A)	S10(A)
1.48	ON		ON		1	0	1		0-1	

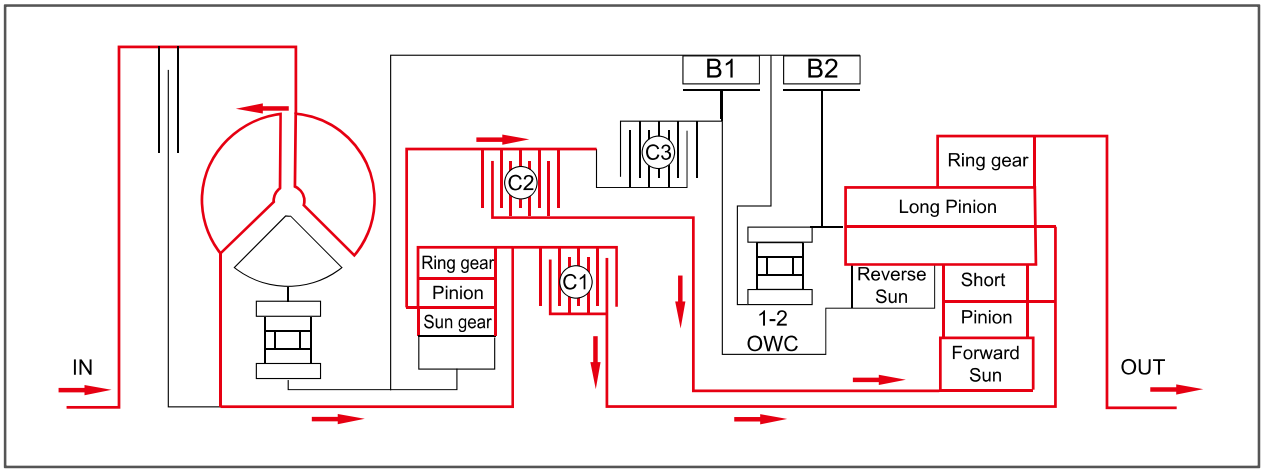
▶ 3rd Gear (D) (1.48:1)



Modification basis	
Application basis	
Affected VIN	

6) Power Flow - 4th Gear (D) & 4th Gear (D) in Limp Home Mode

▶ Power Flow Diagram



▶ Functioning elements

- C2 applied, FSG (Forward Sun Gear) driven
- C1 applied, Rear Planet Carrier driven

CAUTION
4th gear is used as Limp Home Mode.

▶ Control

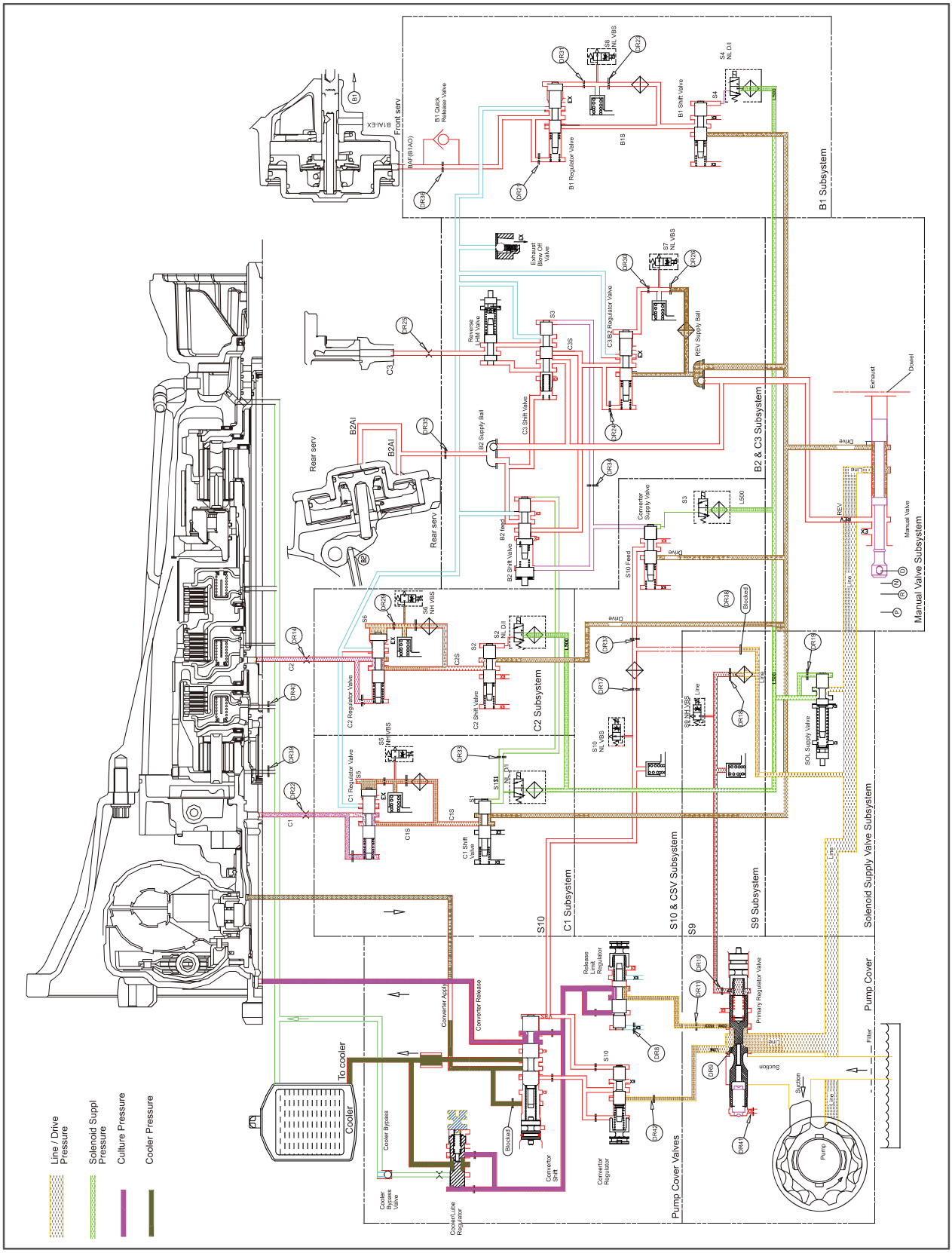
- S1 and S2 ON
- C1 shift valve open (S1 OFF), C1 clutch engaged by drive oil
- C2 shift valve open (S2 OFF), C2 clutch engaged by drive oil
- Drive oil (for C1 and C2 engagement) is regulated by VBS S6 and S6

▶ Connecting Components

Gear ratio	Engaged element									
	C1	C2	C3	B1			B2		OWC	Lock-up clutch
				AO	AI	R	AO	AI		
1.16	ON	ON								

Gear ratio	ON / OFF solenoids				Variable pressure sol. valve-VBS					
	S1	S2	S3	S4	S5(A)	S6(A)	S7(A)	S8(A)	S9(A)	S10(A)
1.16					0	0			0-1	

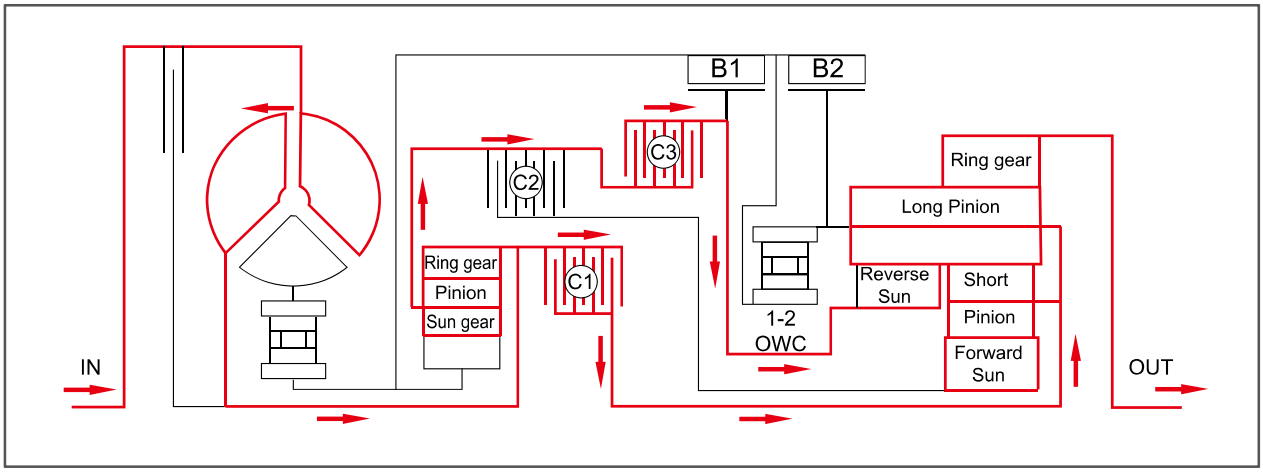
▶ 4th gear (D) & 4th gear (D) in Limp home mode (1.16:1)



Modification basis	
Application basis	
Affected VIN	

7) Power Flow - 5th Gear (D)

▶ Power Flow Diagram



▶ Functioning elements

- C1 applied, Rear Planet Carrier driven
- C3 applied, RSG (Rear Sun Gera) driven

▶ Control

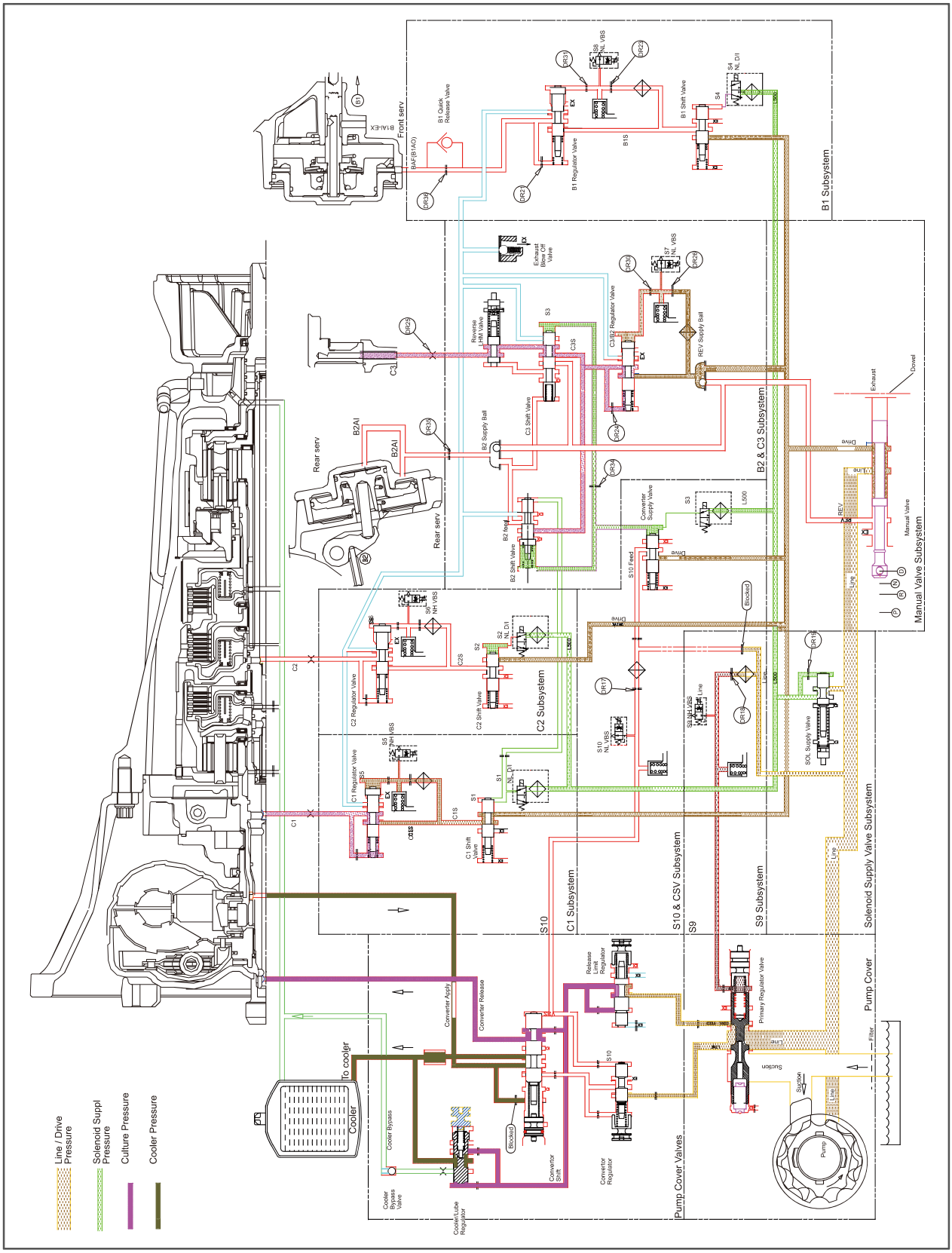
- S1 OFF, S2 and S3 ON
- S2 ON, C2 shift valve moved to the left end, C2 clutch not engaged
- C1 shift valve open (S1 OFF), C1 clutch engaged by drive oil
- S3 and S7 ON, C3 shift valve moved to the left end, C3 clutch engaged

▶ Connecting Components

Gear ratio	Engaged element									
	C1	C2	C3	B1			B2		OWC	Lock-up clutch
				AO	AI	R	AO	AI		
0.87	ON		ON							

Gear ratio	ON / OFF solenoids				Variable pressure sol. valve-VBS					
	S1	S2	S3	S4	S5(A)	S6(A)	S7(A)	S8(A)	S9(A)	S10(A)
0.87		ON	ON		0	1	1		0-1	

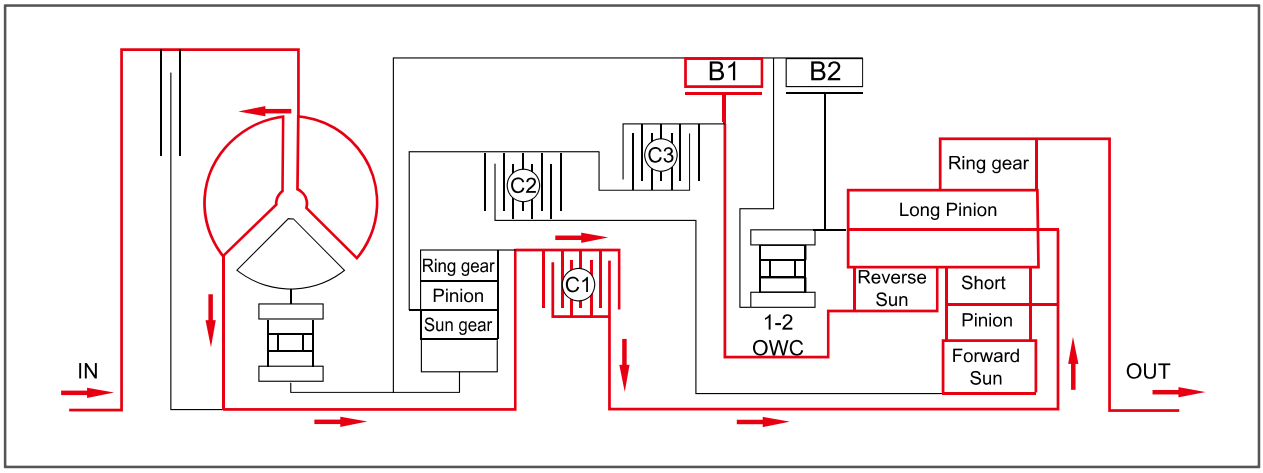
▶ 5th gear (D) (0.87:1)



Modification basis	
Application basis	
Affected VIN	

8) Power flow - 6th gear (D)

▶ Power Flow Diagram



▶ Functioning elements

- C1 applied, Rear Planet Carrier driven
- B1 applied, RSG (Rear Sun Gera) locked

▶ Control

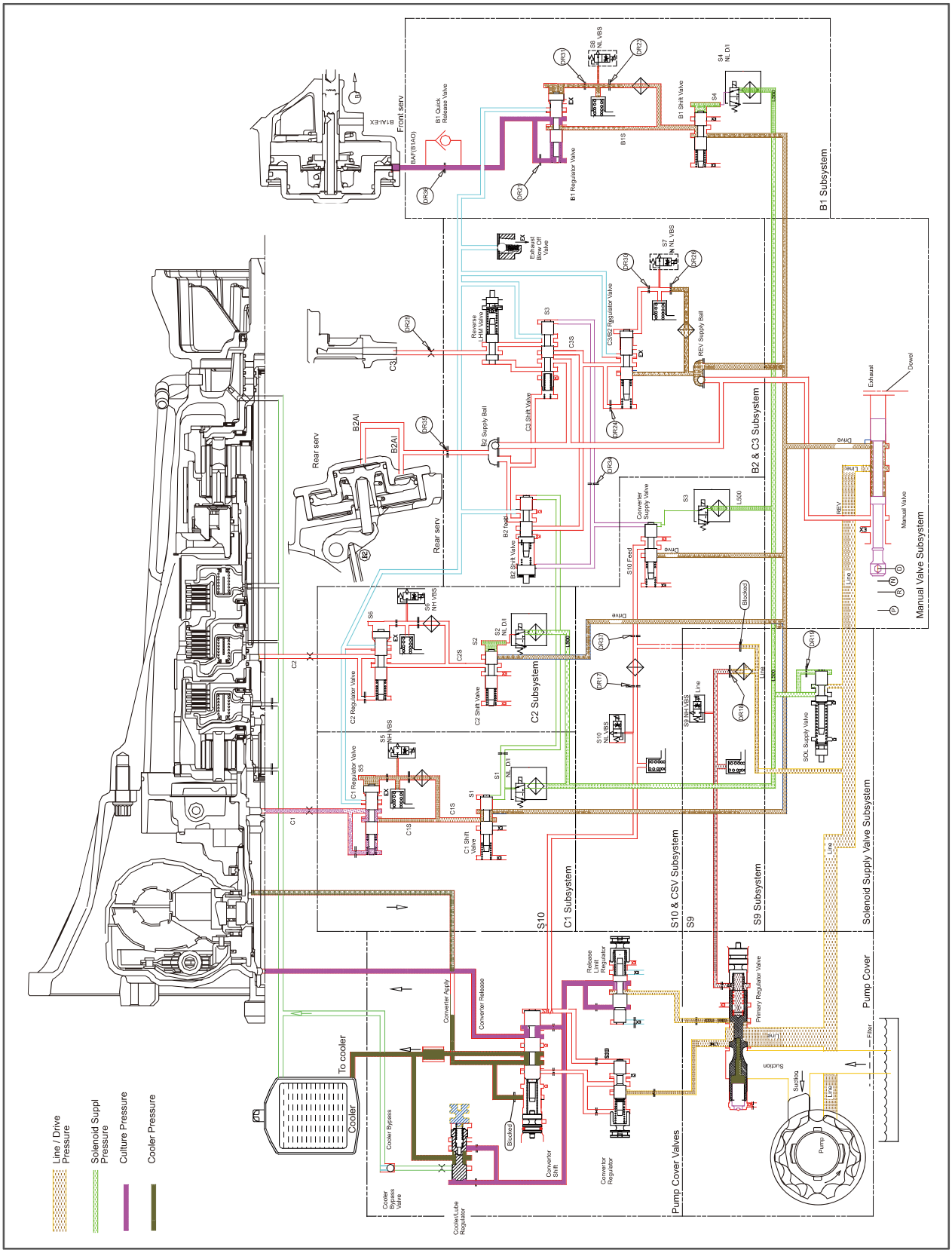
- S1 OFF, S2 and S4 ON
- S3 ON, C2 shift valve moved to the left end, C2 clutch not engaged
- C1 shift valve open (S1 OFF), C1 clutch engaged by drive oil
- S4 ON, B1 shift valve moved to the left end, B1 Band engaged

▶ Connecting Components

Gear ratio	Engaged element									
	C1	C2	C3	B1			B2		OWC	Lock-up clutch
				AO	AI	R	AO	AI		
0.68	ON			ON						

Gear ratio	ON / OFF solenoids				Variable pressure sol. valve-VBS					
	S1	S2	S3	S4	S5(A)	S6(A)	S7(A)	S8(A)	S9(A)	S10(A)
0.68		ON		ON	0	1		1	0-1	

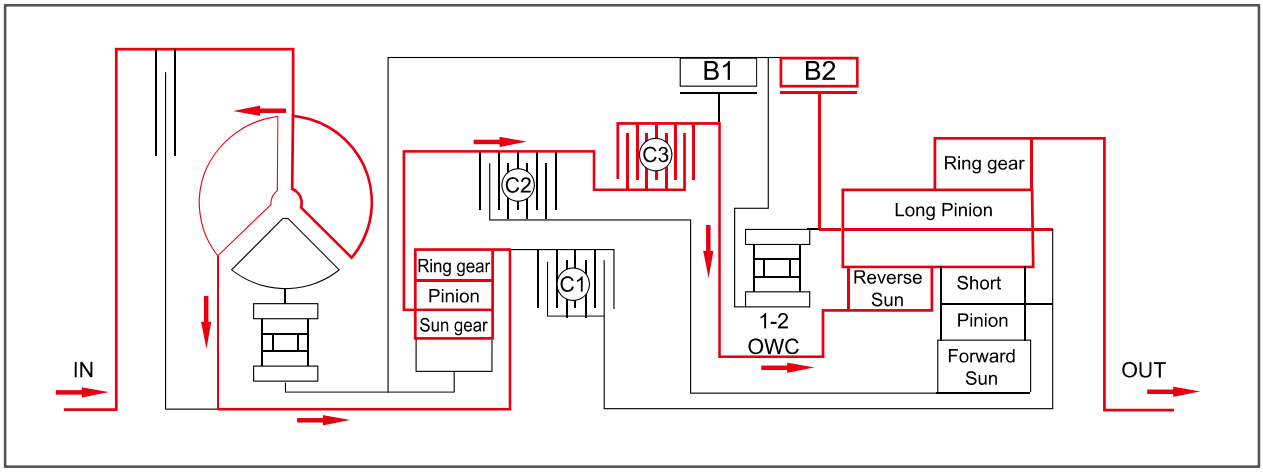
▶ 6th gear (D) (0.68:1)



Modification basis	
Application basis	
Affected VIN	

9) Power flow - Reverse (R)

▶ Power Flow Diagram



▶ Functioning elements

- C3 applied, RSG (Rear Sun Gera) locked
- B2 applied, Rear Planet Carrier locked

▶ Control

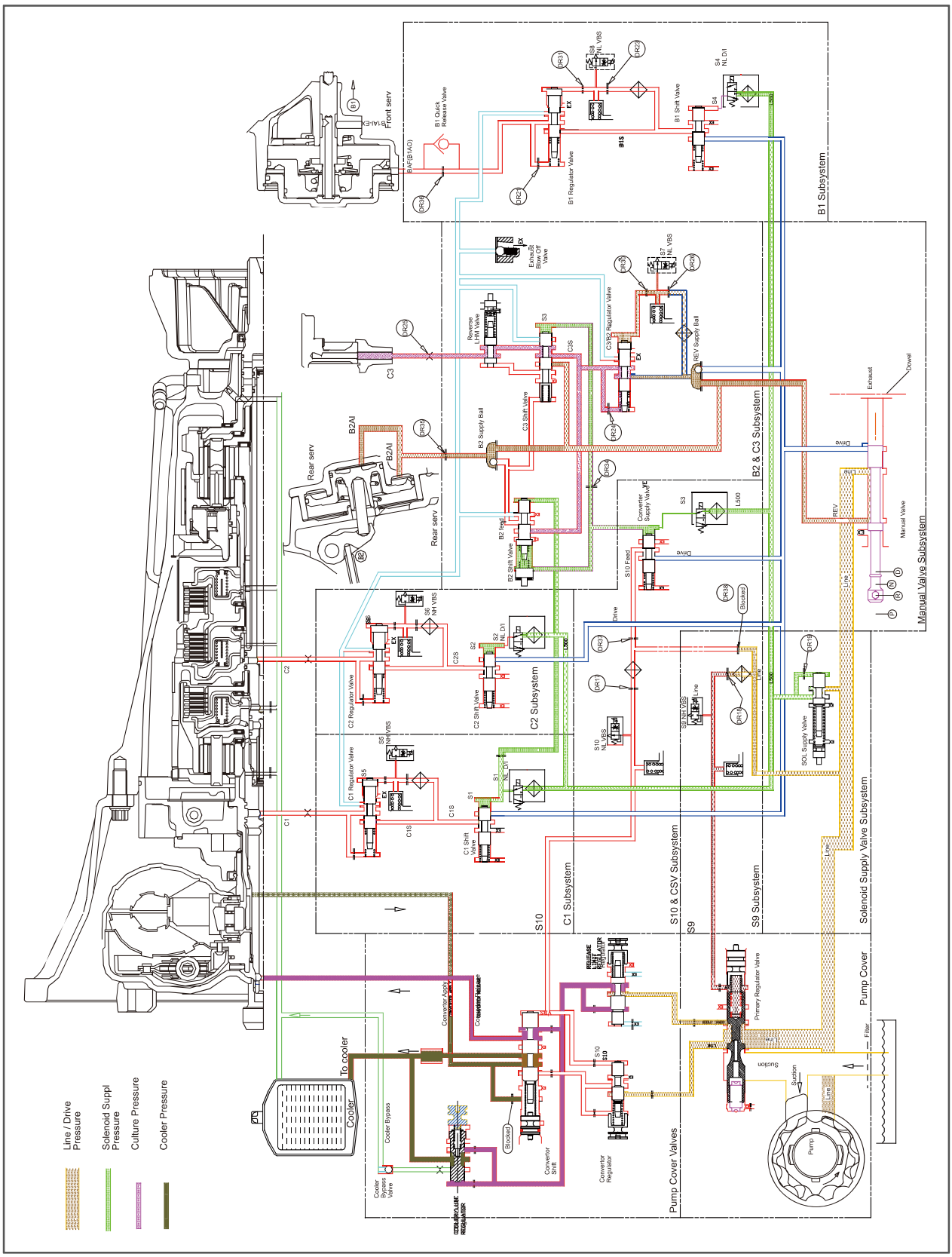
- S1, S2 and S3 ON
- Line pressure applied to B2 Band directly through manual valve
- S3 ON, Pressure to C3 increased or regulated
- S1 and S2 ON, C1 not engaged in any case

▶ Connecting Components

Gear ratio	Engaged element									
	C1	C2	C3	B1			B2		OWC	Lock-up clutch
				AO	AI	R	AO	AI		
3.09			ON				ON	ON		

Gear ratio	ON / OFF solenoids				Variable pressure sol. valve-VBS					
	S1	S2	S3	S4	S5(A)	S6(A)	S7(A)	S8(A)	S9(A)	S10(A)
3.09	ON	ON	ON		1	1	1		0-1	

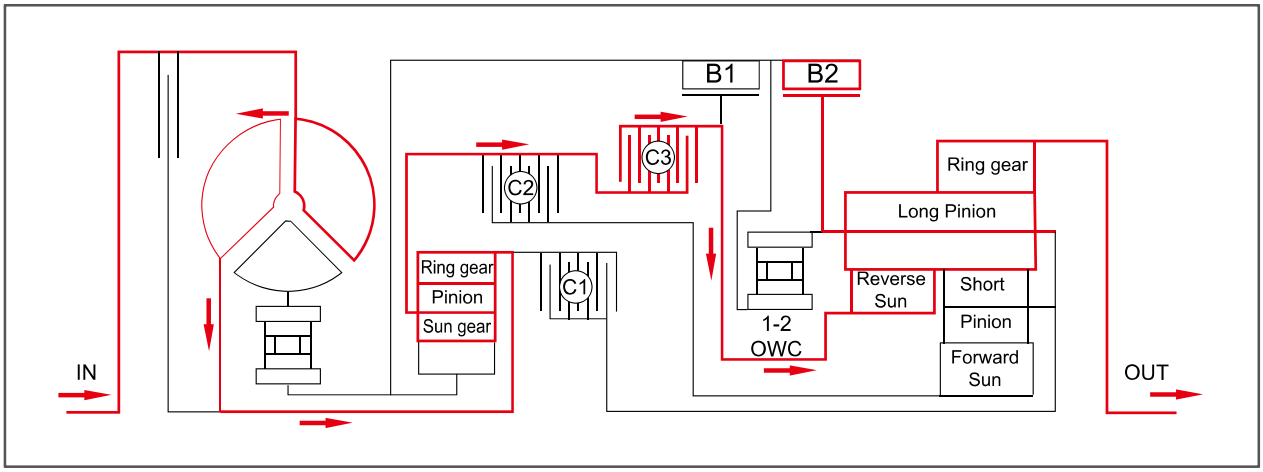
▶ Reverse gear (R) (3.09:1)



Modification basis	
Application basis	
Affected VIN	

10) Power Flow - Reverse (R) Limp Home Mode

▶ Power Flow Diagram

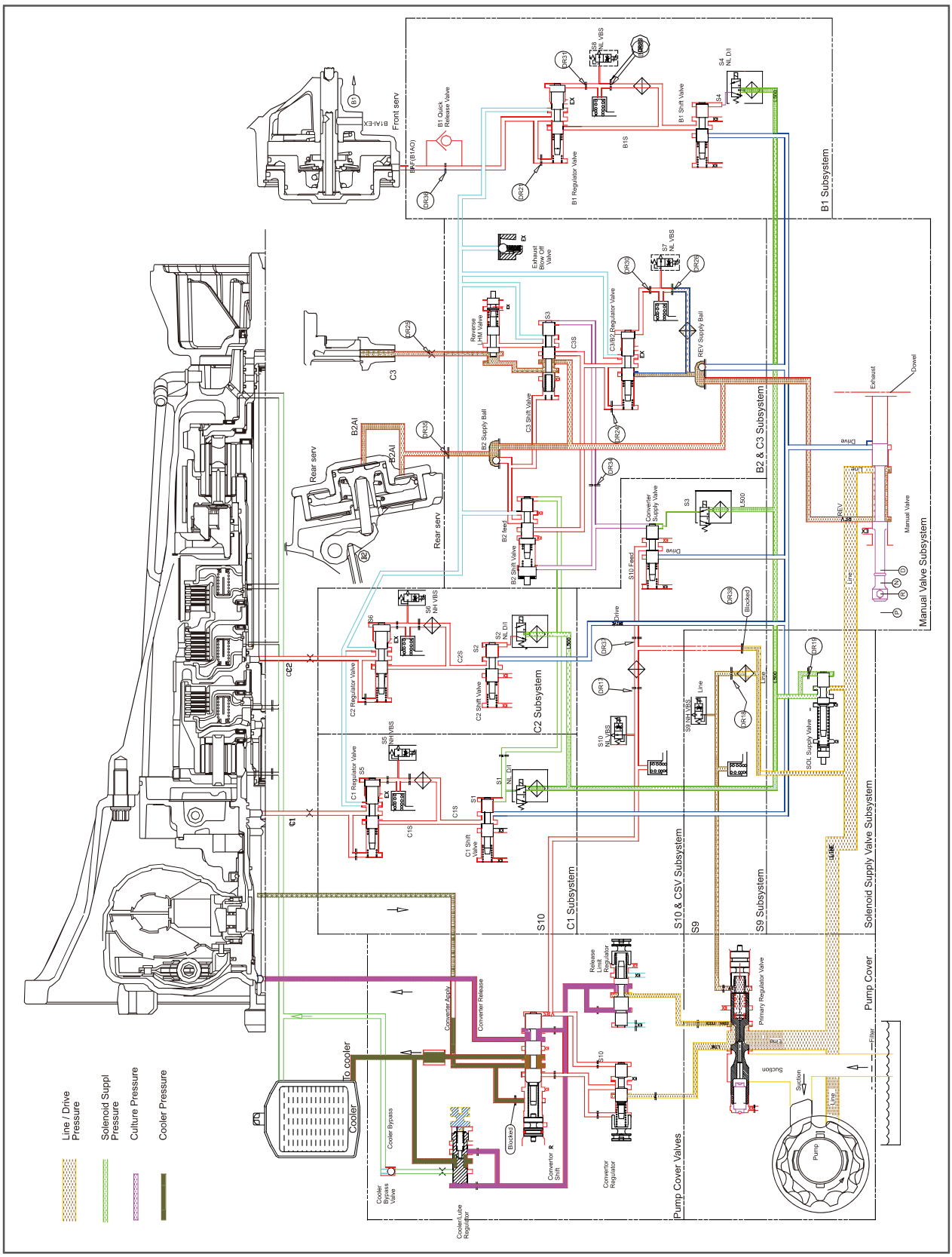


▶ Connecting Components

Gear ratio	Engaged element									
	C1	C2	C3	B1			B2		OWC	Lock-up clutch
				AO	AI	R	AO	AI		
3.09			ON				ON	ON		

Gear ratio	ON / OFF solenoids				Variable pressure sol. valve-VBS					
	S1	S2	S3	S4	S5(A)	S6(A)	S7(A)	S8(A)	S9(A)	S10(A)
3.09					0	0	0	0	0	0

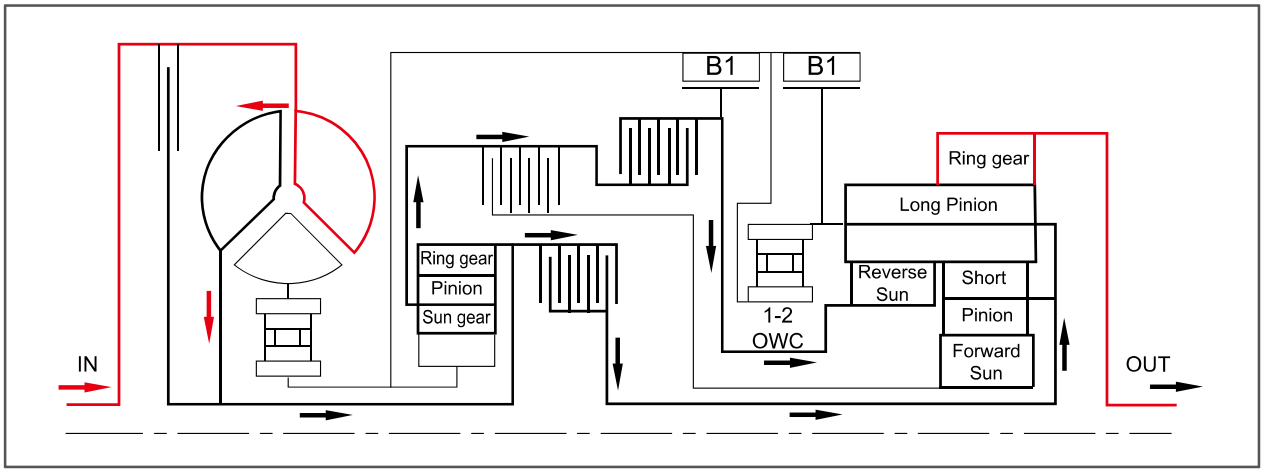
▶ Reverse (R) Limp Home Mode



Modification basis	
Application basis	
Affected VIN	

11) Power flow - Park (P)

▶ Power Flow Diagram

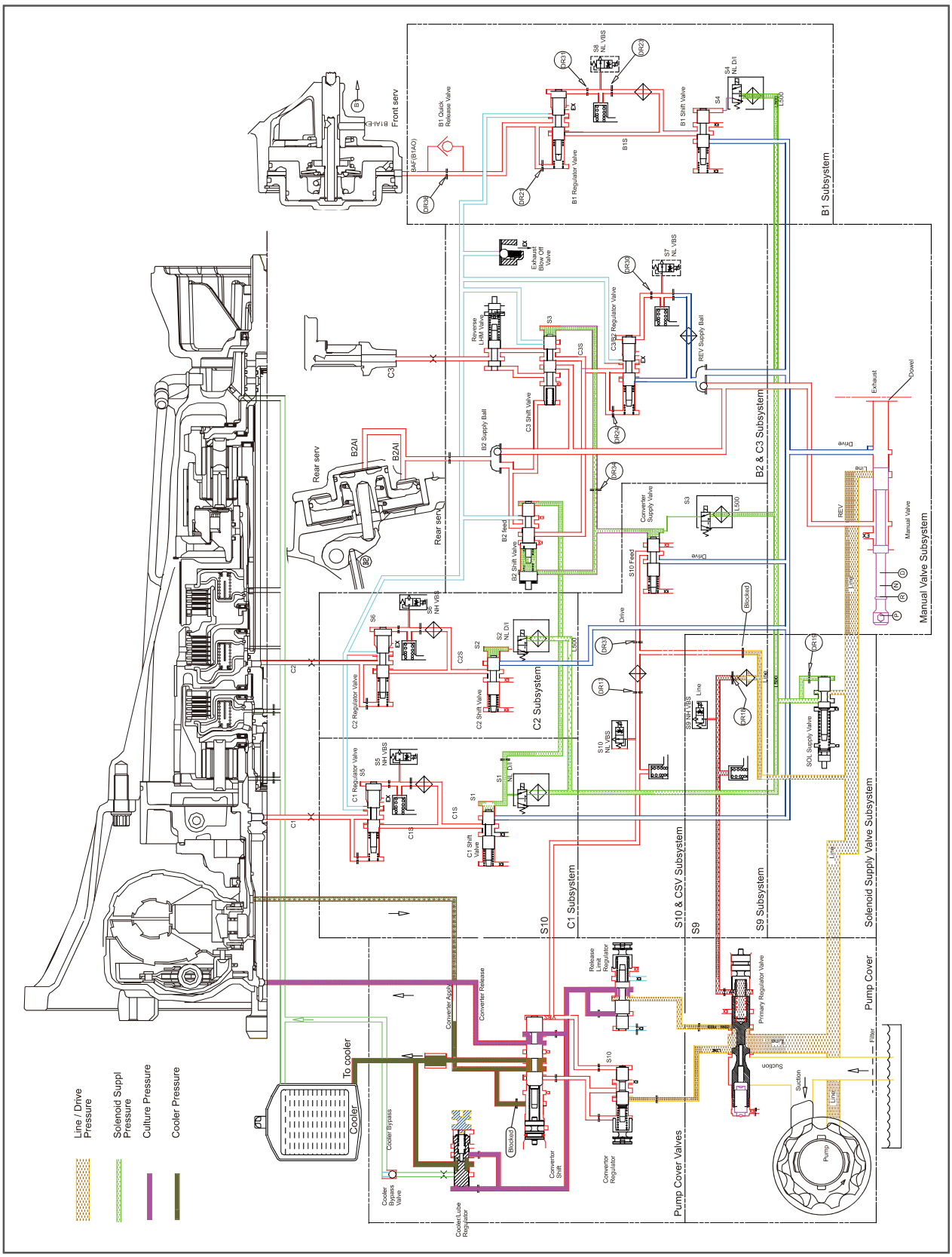


▶ Connecting Components

Gear ratio	Engaged element									
	C1	C2	C3	B1			B2		OWC	Lock-up clutch
				AO	AI	R	AO	AI		
N/A										

Gear ratio	ON / OFF solenoids				Variable pressure sol. valve-VBS					
	S1	S2	S3	S4	S5(A)	S6(A)	S7(A)	S8(A)	S9(A)	S10(A)
N/A	ON	ON	ON							

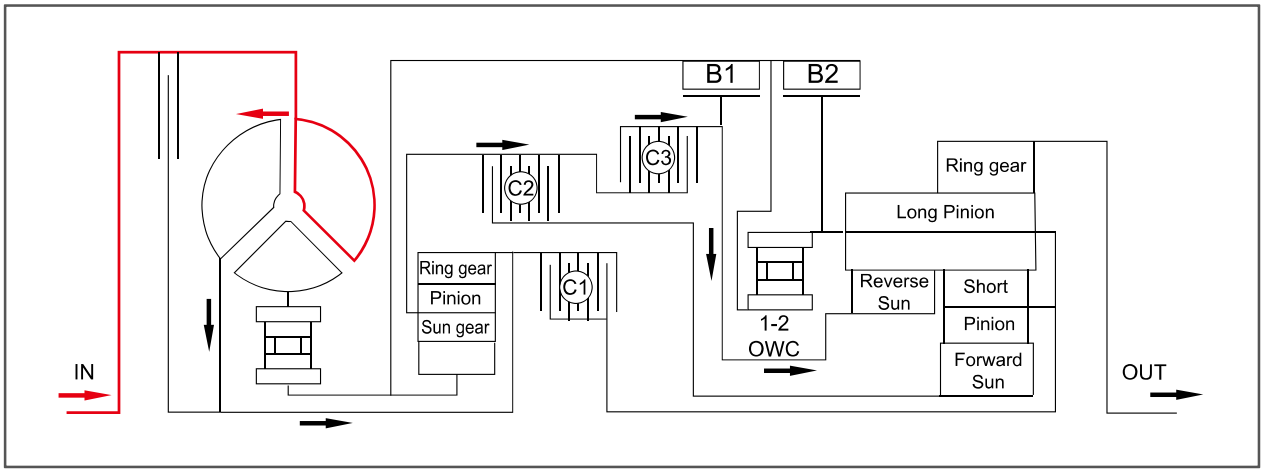
▶ Park



Modification basis	
Application basis	
Affected VIN	

12) Neutral (N)

▶ Power Flow Diagram

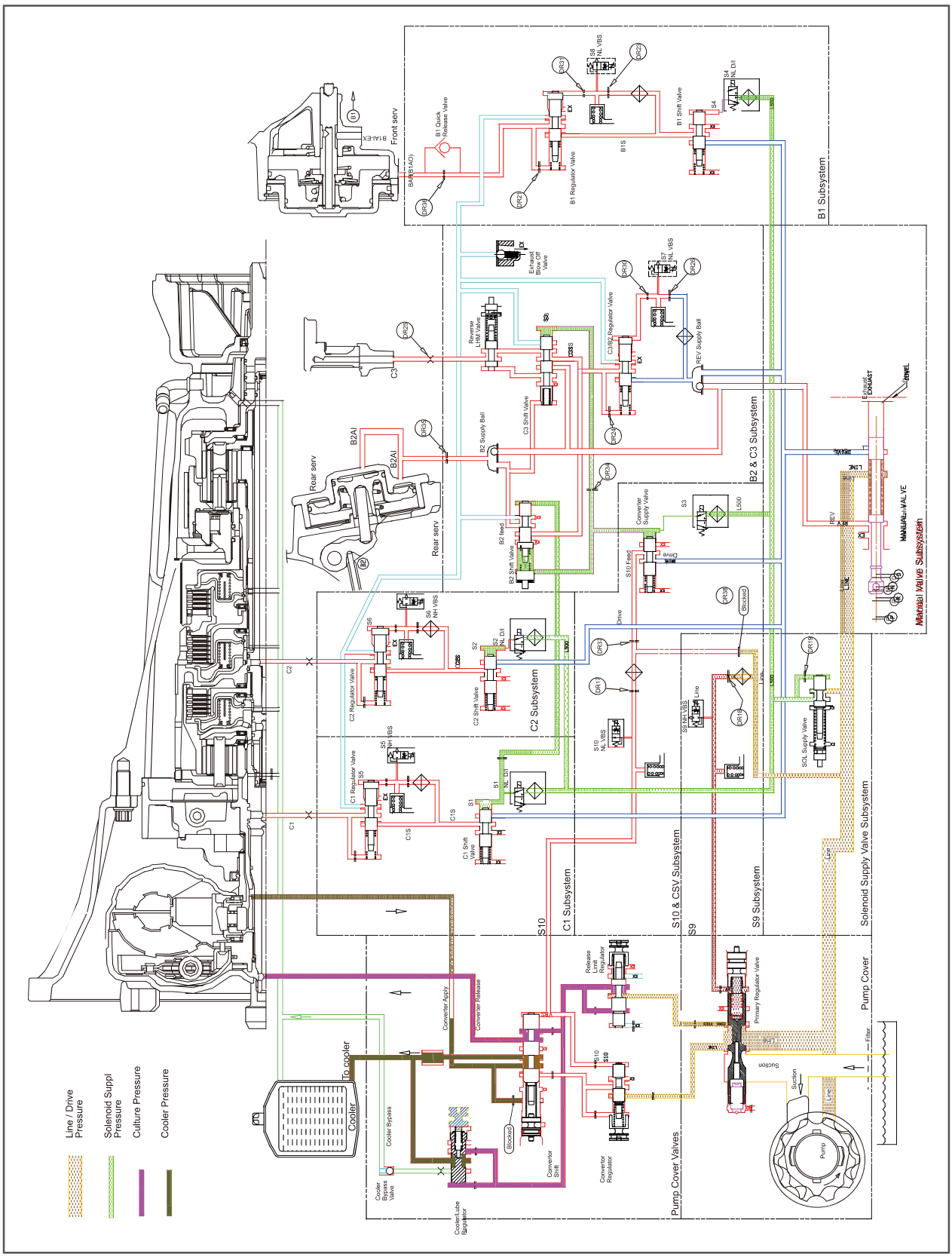


▶ Connecting Components

Gear ratio	Engaged element									
	C1	C2	C3	B1			B2		OWC	Lock-up clutch
				AO	AI	R	AO	AI		
N/A										

Gear ratio	ON / OFF solenoids				Variable pressure sol. valve-VBS					
	S1	S2	S3	S4	S5(A)	S6(A)	S7(A)	S8(A)	S9(A)	S10(A)
N/A	ON	ON	ON						0-1	

▶ Neutral



Modification basis	
Application basis	
Affected VIN	

MANUAL TRANSMISSION (5 M/T) 3170-01

GENERAL

1. OVERVIEW AND CHARACTERISTICS OF MANUAL TRANSMISSION

1) System Components



Inside



Front View





(1) Features

1. All gears use the helical type and high strength materials.

CAUTION
- The helical type gear prevents the axial gear missing and provides less noise.

2. The semi-remote control type gear shift mechanism is used to prevent incorrect shifting.
3. To improve the shifting performance, 3-piece triple cone is used for 1/2 shift.

CAUTION
- TSM54/52 transmission uses the inertia lock type key to make smooth gear engagement and to provide silent gear engagement.

4. The synchronizing devices are installed in 1/2, 3/4, 5/R gears. To prevent the double engagement, the independent interlock devices are installed.
5. The clutch release system is available to use CSC (Concentric Slave Cylinder) or Fork type according to the vehicle model.

Modification basis	
Application basis	
Affected VIN	

2. SPECIFICATIONS AND TIGHTENING TORQUE OF MANUAL TRANSMISSION

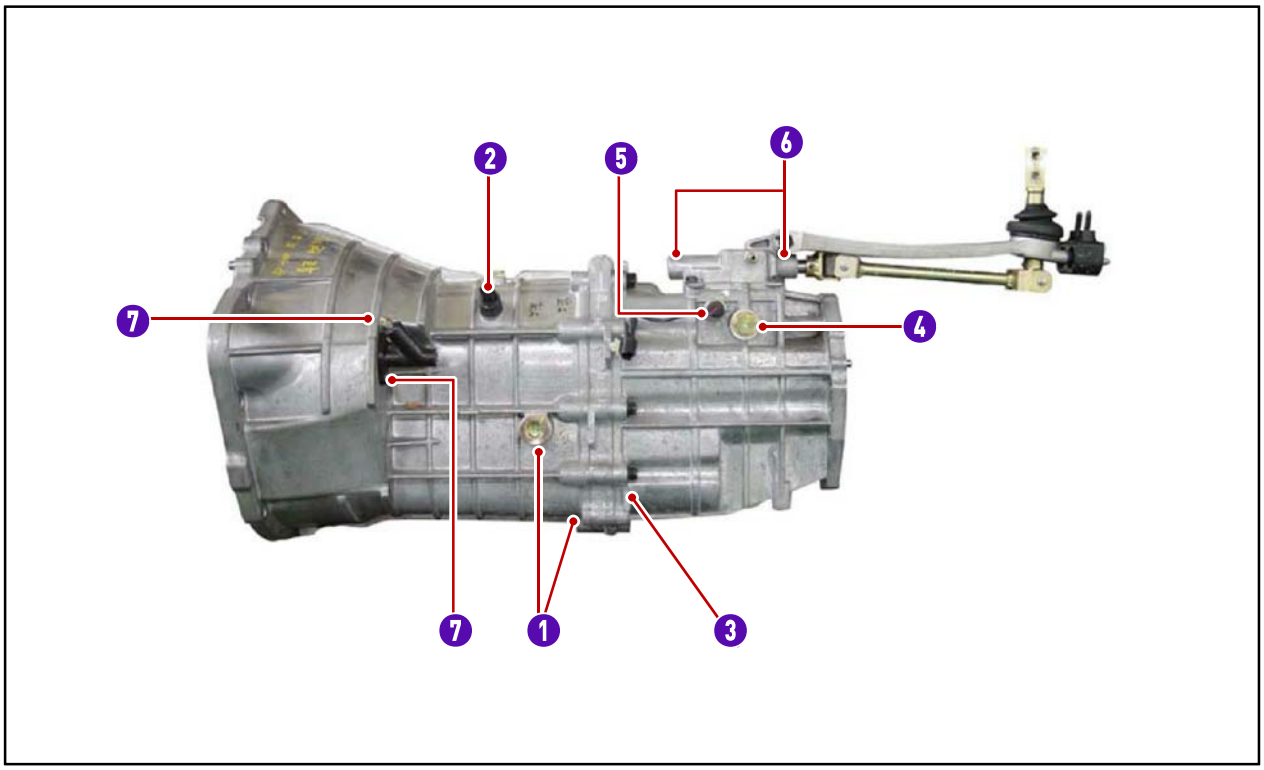
1) Specifications

Description		Specifications (G23D)
Length (mm)		628.3 mm
Distance between shafts (mm)		81 mm
Input torque (kg-m)		34.7 kg-m (340 Nm)
Transmission control type		Semi-remote
Weight (kg) - not including transmission fluid		44 kgm
Gear ratio/Gear teeth (input gear: main gear)	1st gear	4.315
	2nd gear	2.475
	3rd gear	1.536
	4th gear	1.000
	5th gear	0.807
	Reverse gear	3.919
Transmission fluid	Specification	ATF DEXRON II
	Capacity (ℓ)	3.6 / 3.4 ℓ (4WD / 2WD)
	Change interval	Inspect at every 10,000 km, replace at every 60,000 km (add or replace if necessary)

Modification basis	
Application basis	
Affected VIN	

2) Tightening Torque

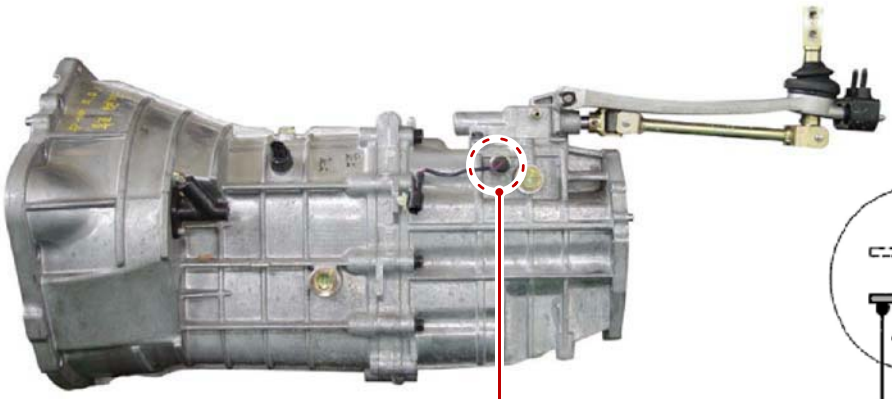
Descriptio n	Tightening Torque
1. Oil drain plug & filler plug	40 ~ 50 Nm
2. Backup lamp switch (24 mm)	30 ~ 40 Nm
3. Extension housing bolt (14 mm)	42 ~ 57 Nm
4. Extension housing spring plug (27 mm)	70 ~ 100 Nm
5. Neutral switch	30 ~ 40 Nm
6. Shift top cover bolt (12 mm)	17 ~ 26 Nm
7. Concentric slave cylinder adapter bolt	10 ~ 16 Nm

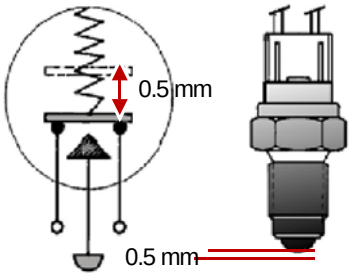


OVERVIEW AND OPERATION PROCESS

1. MANUAL TRANSMISSION SYSTEM

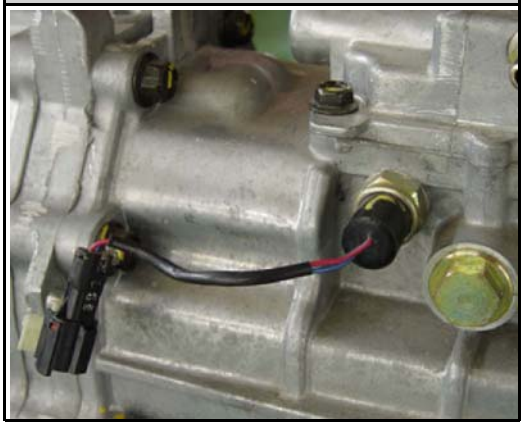
1) Neutral Switch





N (Neutral) Switch

Outside N Switch



Inside N Switch



Modification basis	
Application basis	
Affected VIN	

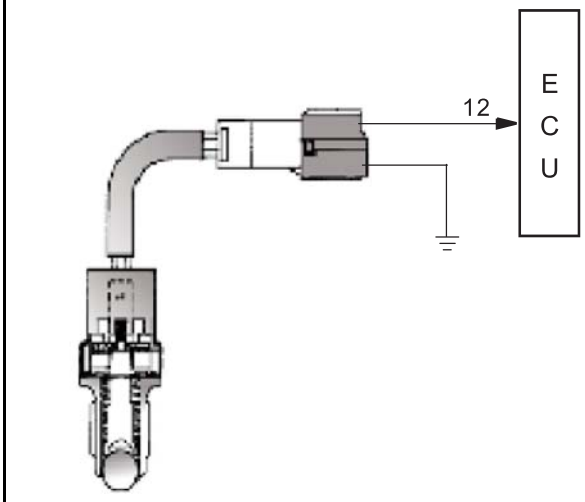
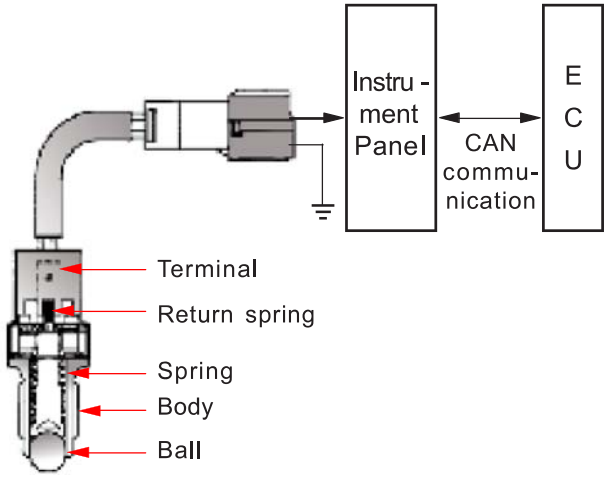
2) Function of N Switch

(1) Aids a smooth start of the vehicle by raising the RPM during the gear shifting when the engine is cold.

When the vehicle is trying to start from the stopped state (vehicle speed below 3 km/h), the N switch determines the shifting timing by using the clutch switch and the N switch. It raises the engine RPM (100 ~ 200 rpm). Operation conditions are as follows.

- The vehicle speed is at the stopped state (Vehicle speed below 3km/h detection).
- While depressing the clutch (Clutch switch detection).
- The gear lever is at a position other than neutral (N switch detection).
- Start the vehicle while depressing the clutch pedal (Clutch switch detection).
- The RPM increases in accordance with the temperature of the engine coolant (Engine coolant temperature sensor detection).
  - · appx. 100 rpm increase
  - · appx. 100 ~ 170 rpm increase
  - · appx. 80°C (normal temperature of the engine coolant): around 200 rpm
- When the gear has been smoothly shifted and the vehicle speed exceeds 3km/h, it returns to the previous operation interval of the engine RPM.

In case of Actyon, the N switch signal is transmitted to the instrument panel, and then the instrument panel transmits it to the engine ECU through the CAN communication.

Vehicle Made After 04.09.15	Actyon
	

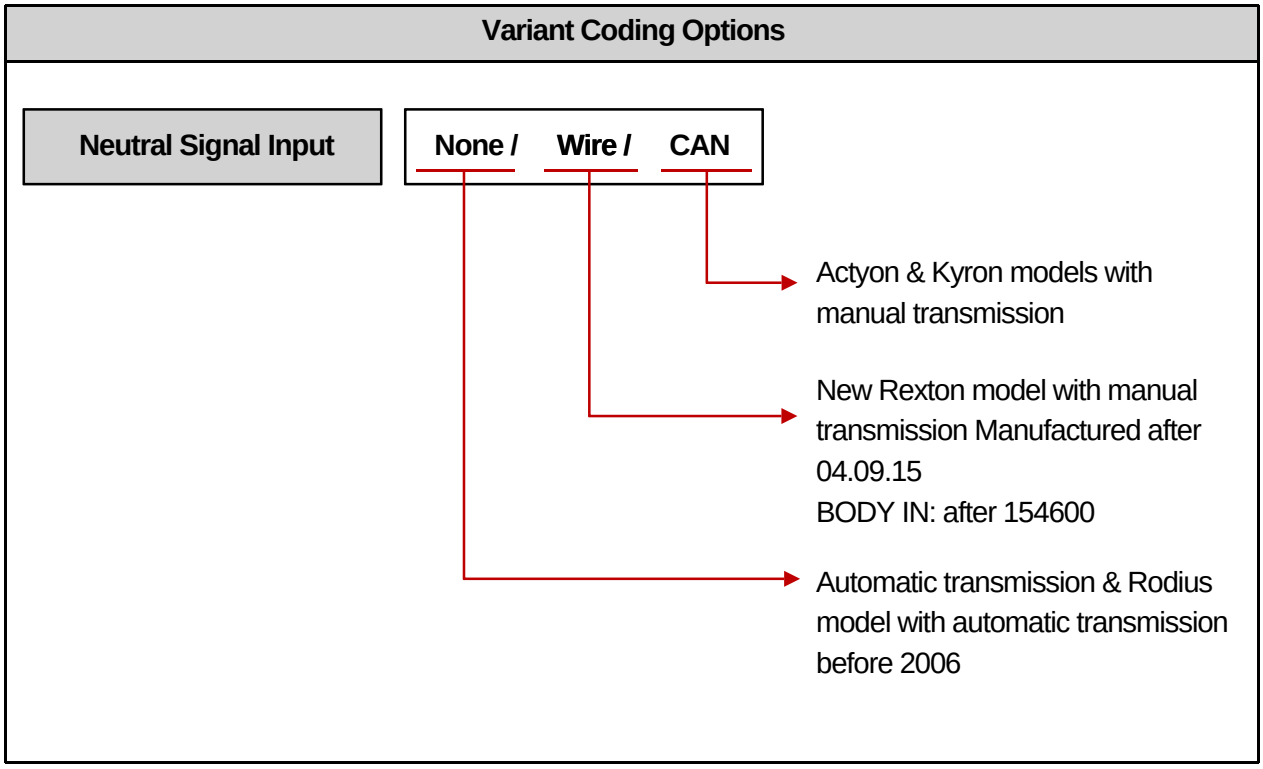
Modification basis	
Application basis	
Affected VIN	

(2) Detects the position of the shifting lever for the HDC operation among ABS/ESP functions.

The HDC function operates only if the M/T shift lever is in forward or reverse position. Please refer to the ABS/ESP section for the specific information related to the HDC.

▶ Variant Coding Related to N Switch

The N switch transmits information to the ECU through the CAN communication while New Rexton is connected to the ECU through wires. Thus, if you set the variant coding in the engine ECU, you must do it differently, and you must set the variant coding differently according to the vehicle category and specification as below.



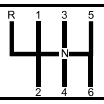
Modification basis	
Application basis	
Affected VIN	

Memo

MANUAL TRANSMISSION (6 M/T) 3170-01

GENERAL INFORMATION

1. SPECIFICATION

Description		Specification
Gear ratio	1st	4.489 : 1
	2nd	2.337 : 1
	3rd	1.350 : 1
	4th	1.000 : 1
	5th	0.784 : 1
	6th	0.679 : 1
	Reverse	4.253 : 1
Synchronizer ring type	1st	T: Triple-cone
	2nd	T: Triple-cone
	3rd	T: Triple-cone
	4th	S: Single-cone
	5th	D: Double-cone
	6th	S: Single-cone
	Reverse	T: Triple-cone
Shifting	Type	Floor change type
	Gear selector lever position	 Reversing: High-force type
Transmission fluid	Type	HD MTF 75W/85 (SHELL) or HK MTF 75W/85(SK)
	Capacity	≒2.2ℓ
	Sercive interval	Inspect and replenish every 60000 km or 3 years (under severe driving conditions, change every 120,000 km)

NOTE What's the severe conditions?

- Towing a trailer or off-road driving (Inspect the leak of fluid at any time, occasionlly)
- Taxi, patrol service or delivery service (extended idling and excessive driving with low speed)
- Frequent stop-and-go traffic, extended idling, short driving distance
- Driving in a hilly or mountainous terrain, sandy, or dusty area
- Driving frequently at high speed over 170 km/hour
- Driving frequently in area where heavy traffic under the ambient temperature above 30°C

2. SPECIAL SERVICE TOOLS

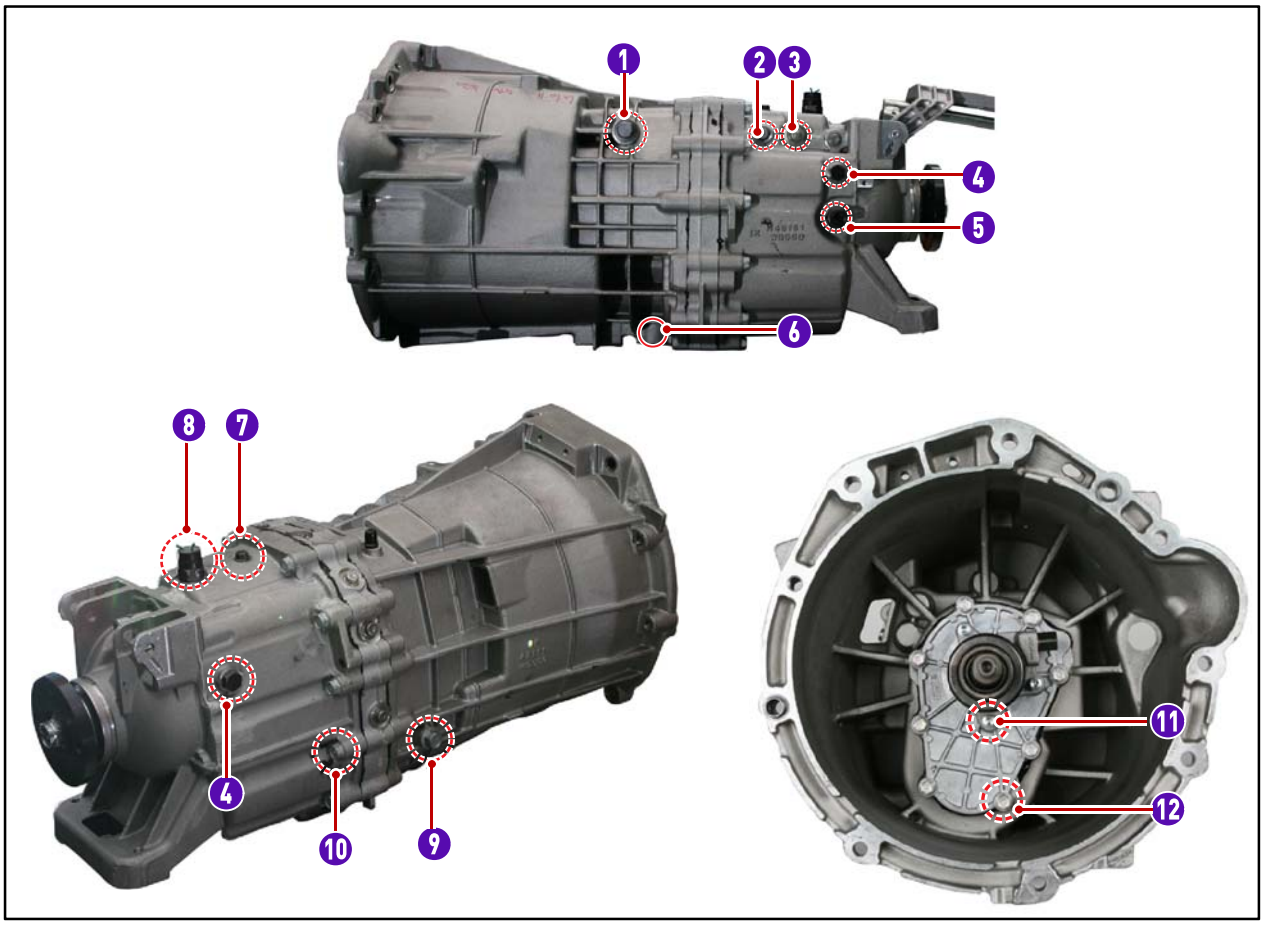
Part No. & Name	Appearance	Description
Part No.: SSM00203-005 **Name**: Main shaft 1st sleeve installer		- Install the main shaft 1st gear sleeve - Install the drive pinion assembly front ball bearing - Install the main shaft double angular ball bearing
Part No.: SSM00203-006 **Name**: Main shaft reverse sleeve installer		- Install the main shaft reverse sleeve and bearing - Install the main drive pinion assembly front ball bearing - Install the main shaft double angular ball bearing - Install the 3rd & 4th synchronizer hub - Install the main shaft 5th gear - Install the main shaft 6th gear
Part No.: SSM00203-002 **Name**: Main shaft 5th sleeve installer		- Install the main shaft 5th gear sleeve - Install the counter shaft 6th gear sleeve - Install the counter shaft reverse gear - Install the main shaft ball bearing
Part No.: SSM00203-003 **Name:** Oil seal installer		Install the extension housing oil seal
Part No.: SSM00203-004 **Name:** Oil seal installer		Install the control shaft oil seal

Modification basis	
Application basis	
Affected VIN	

Part No. & Name	Appearance	Description
Part No.: SSM00203-001 **Name:** **Counter shaft bearing installer**		Install the counter shaft front roller bearing
Part No.: T88310011A-9 **Name:** Bearing support		Support the counter shaft when removing the roller bearing with a puller

* Special service tool Supplier: Tool & Tech

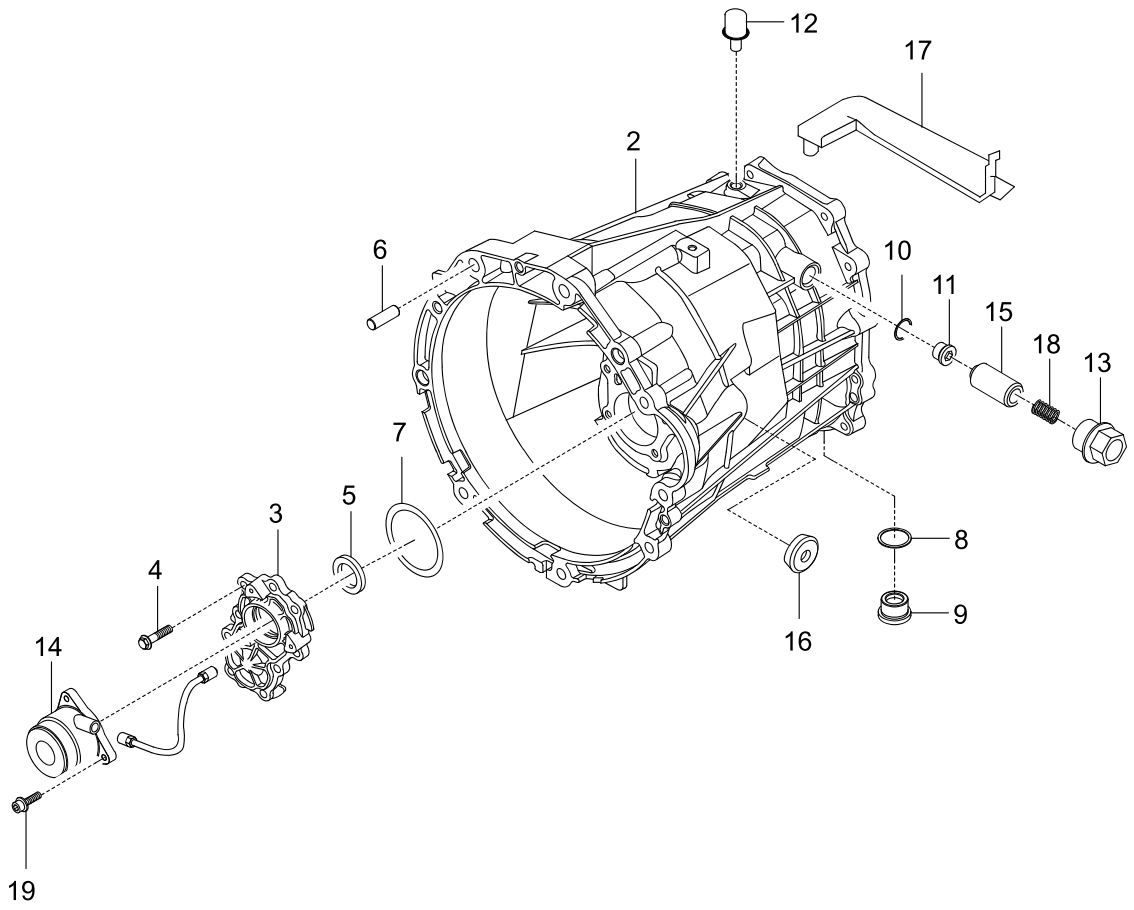
3. TIGHTENING TORQUE



Part name	Tightening torque (Nm)	Numbers	Adhesive
1. Seal bolt (rolling plunger and guide spring)	53.9~67.6	1EA	Loctite
2. Guide bolt	14.7~21.5	1EA	Loctite
3. Pocket ball bearing bolt	29.4~41.1	1EA	Loctite
4. Reverse shift fork retainer bolt	53.9~67.6	2EA	Loctite
5. Backup lamp switch	29.4~34.3	1EA	Loctite
6. Oil drain plug	58.8~78.4	1EA	Loctite
7. Interlock bolt	14.7~21.5	1EA	-
8. Neutral switch	29.4~34.3	1EA	Loctite
9. Oil filler plug	58.8~78.4	1EA	Loctite
10. Extension housing bolt	42.1~53.9	12EA	-
11. Concentric slave cylinder bolt	9.8~15.6	3EA	-
12. Front bearing retainer bolt	19.6~24.5	8EA	Loctite

Modification basis	
Application basis	
Affected VIN	

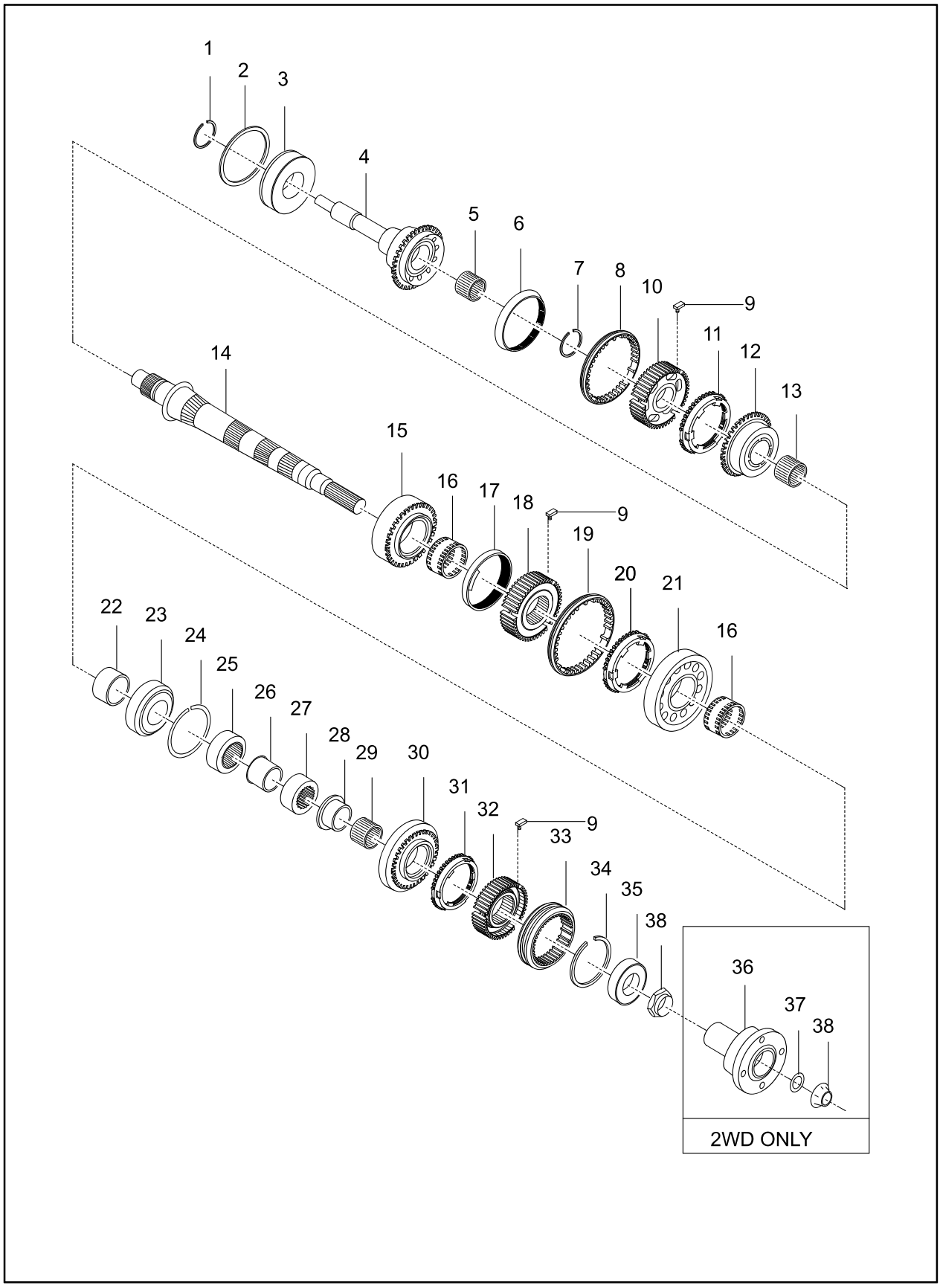
▶ 3163161-00 Housing



2. Case - Transmission
3. Retainer - Bearing
4. Bolt - Seal (19.6 ~ 24.5 Nm)
5. Seal - Oil
6. Bushing
7. Spacer
8. Gasket
9. Plug (58.8 ~ 78.4 Nm)
10. Gasket
11. Plug
12. Breather - Air
13. Pulg - Seal (53.9 ~ 67.6 Nm)
14. Cylinder assembly - Concentric slave
15. Plunger - Rolling
16. Boot
17. Guide - Oil
18. Spring - Guide
19. Bolt - Flange (42.1 ~ 53.9 Nm)

Modification basis	
Application basis	
Affected VIN	

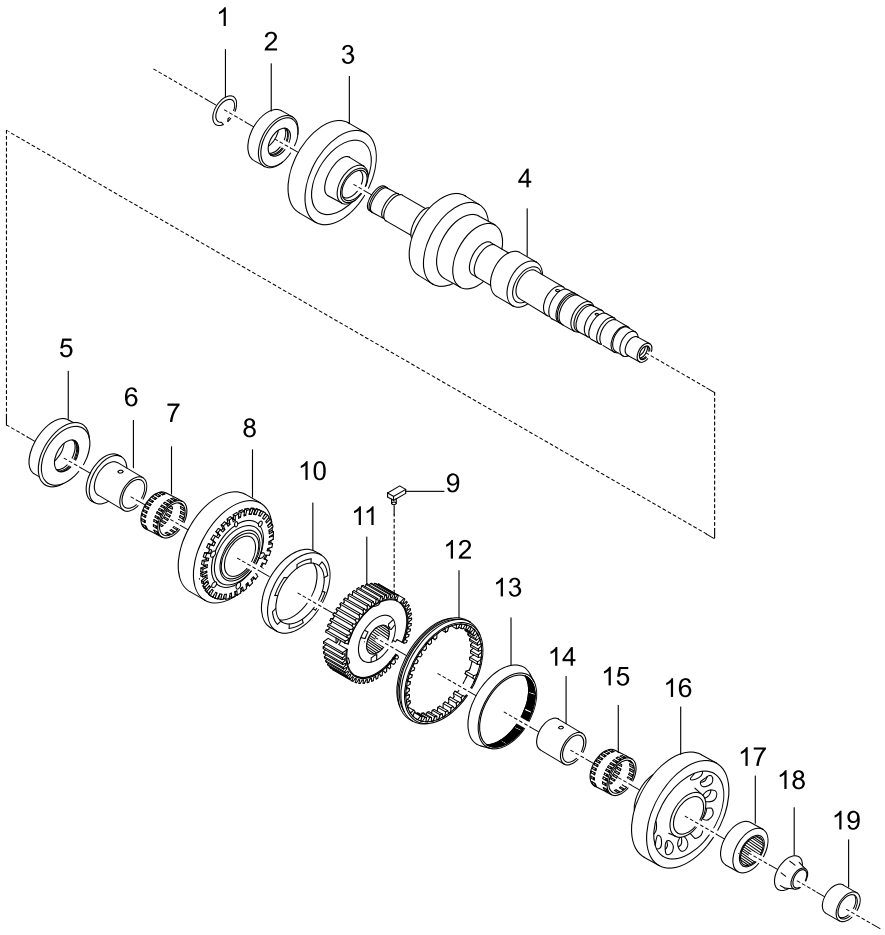
▶ **3162-00 Main shaft**



Modification basis	
Application basis	
Affected VIN	

1. Ring - Snap
2. Ring - Snap
3. Bearing - Ball
4. Pinion assembly - Main drive
5. Bearing - Needle roller
6. Ring - Synchronizer
7. Ring - Snap
8. Sleeeve - Synchronizer
9. Key assembly - Synchronizer
10. Hub - Synchronizer
11. Ring assembly - Triple cone
12. Gear assembly - 3rd speed
13. Bearing - Needle roller
14. Shaft - Main
15. Gear assembly - 2nd speed
16. Bearing - Needle roller
17. Ring assembly - Triple cone
18. Hub - Synchronizer
19. Sleeeve - Synchronizer
20. Ring assembly - Triple cone
21. Gear assembly - 1st speed
22. Sleeve - 1st gear
23. Bearing - Double angular ball
24. Ring - Snap
25. Gear - Main shaft 5th
26. Spacer
27. Gear - Main shaft 6th
28. Sleeve - Reverse gear
29. Bearing - Needle roller
30. Gear assembly - Reverse speed
31. Ring assembly - Triple cone
32. Hub - Synchronizer
33. Sleeeve - Synchronizer
34. Stopper - Synchronizer key
35. Bearing - Ball
36. Flange assembly - Companion
37. O-ring
38. Nut - Locking (4WD: 245.1 ~ 264.7 Nm, 2WD: 117.6 ~ 137.2 Nm)

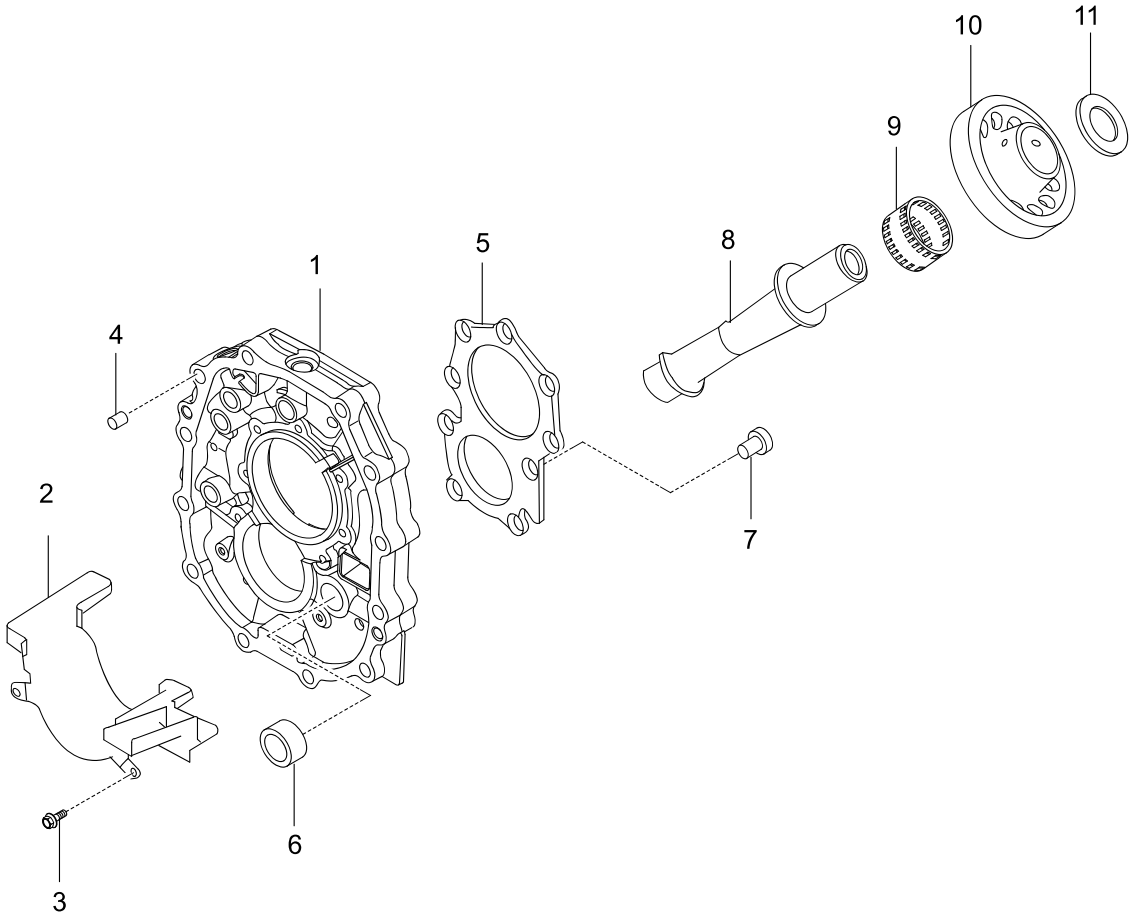
▶ 33163-00 Counter shaft



1. Ring - Snap
2. Bearing - Roller
3. Gear - Counter shaft
4. Gear - Counter shaft cluster
5. Bearing - Roller
6. Sleeve ?- Speed gear
7. Bearing - Needle roller
8. Gear assembly - 5th speed
9. Key assembly - Synchronizer
10. Ring assembly - Triple cone
11. Hub - Synchronizer
12. Sleeeve - Synchronizer
13. Ring - Synchronizer
14. Sleeve - Speed gear
15. Bearing - Needle roller
16. Gear assembly - 6th speed
17. Gear - Counter shaft
18. Nut - Locking (156.9 ~ 186.3 Nm)
19. Bearing - Needle roller

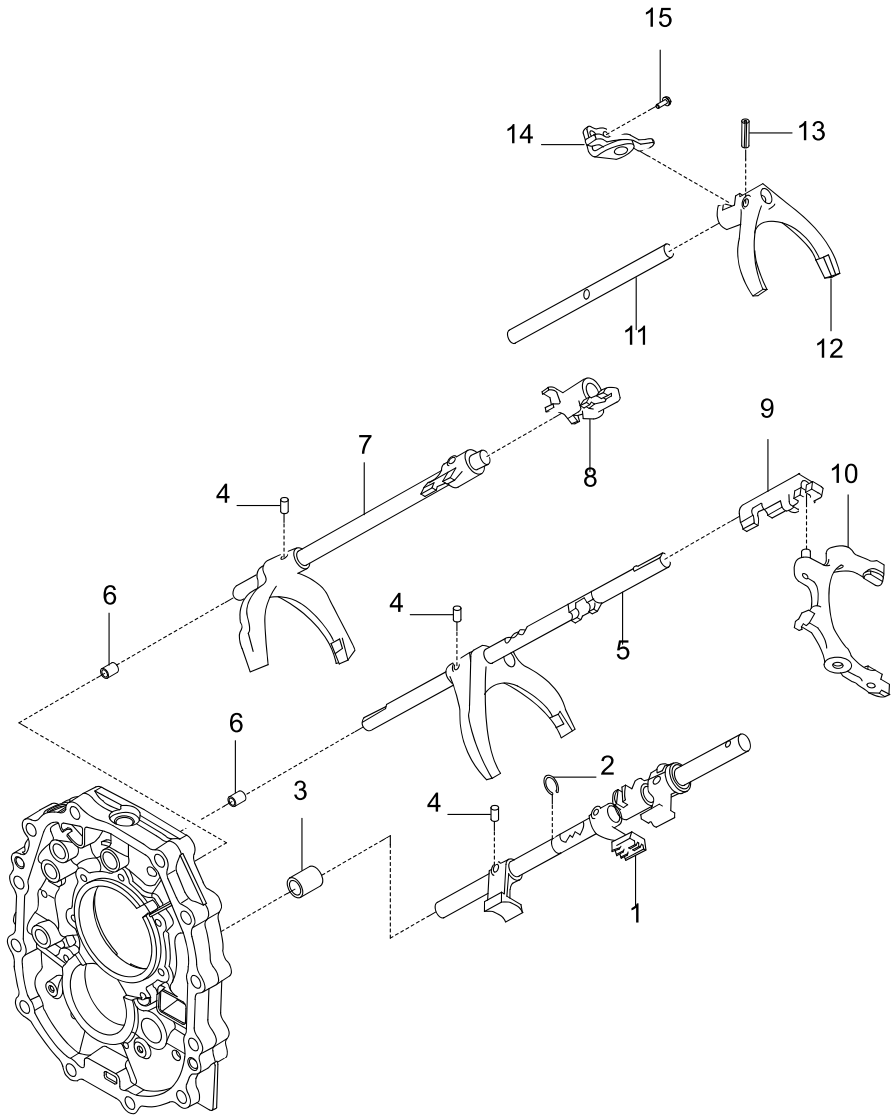
Modification basis	
Application basis	
Affected VIN	

▶ 3164-00 Adapter assembly



1. Plate - Intermediate
2. Guide - Oil
3. Bolt (7.8 ~ 9.8 Nm)
4. Pin - Dowel
5. Retainer - Bearing
6. Magnet
7. Bolt - Seal (19.6 ~ 26.4 Nm)
8. Shaft - Reverse idler gear
9. Bearing - Needle roller
10. Gear - Reverse idler
11. Spacer - Reverse

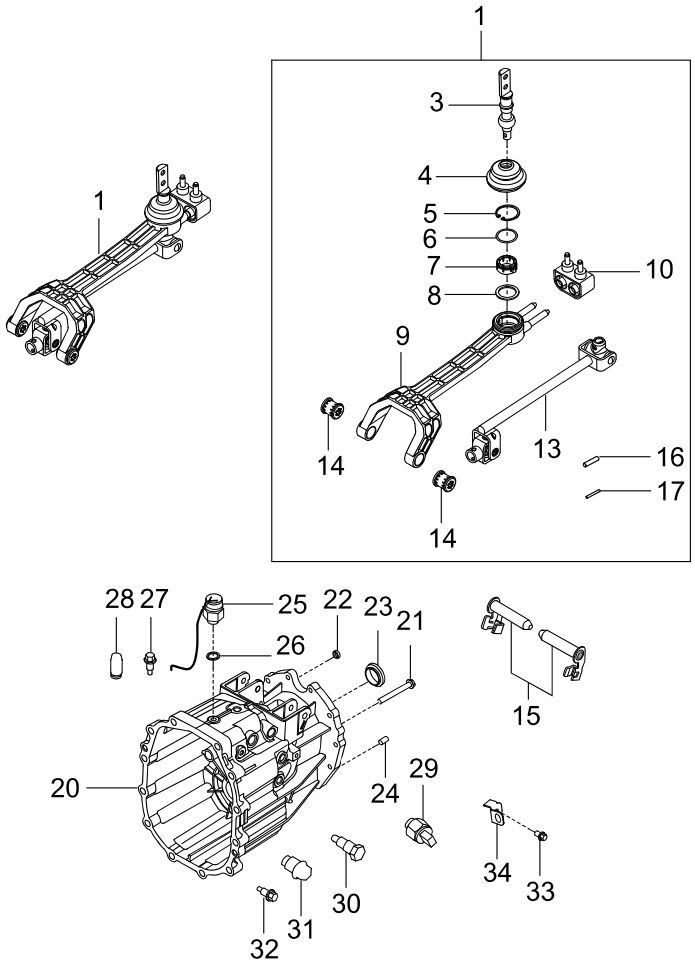
▶ 3165-00 Rail and shift fork



1. Shaft assembly - Control
2. Ring - Retainer
3. Bearing - Retainer ball
4. Pin - Spring
5. Rail sub assembly - Shaft 1st & 2nd
6. Bushing
7. Rail sub assembly - Shaft 3rd & 4th
8. Lug - Shaft 5th & 6th
9. Lug _ Reverse shaft
10. Fork - Reverse shaft
11. Rail - Shaft 5th & 6th
12. Fork - Shaft 5th & 6th
13. Pin - Spring
14. Lever assembly - Shaft 5th & 6th
15. Bolt - Flange (14.7 ~ 21.5 Nm)

Modification basis	
Application basis	
Affected VIN	

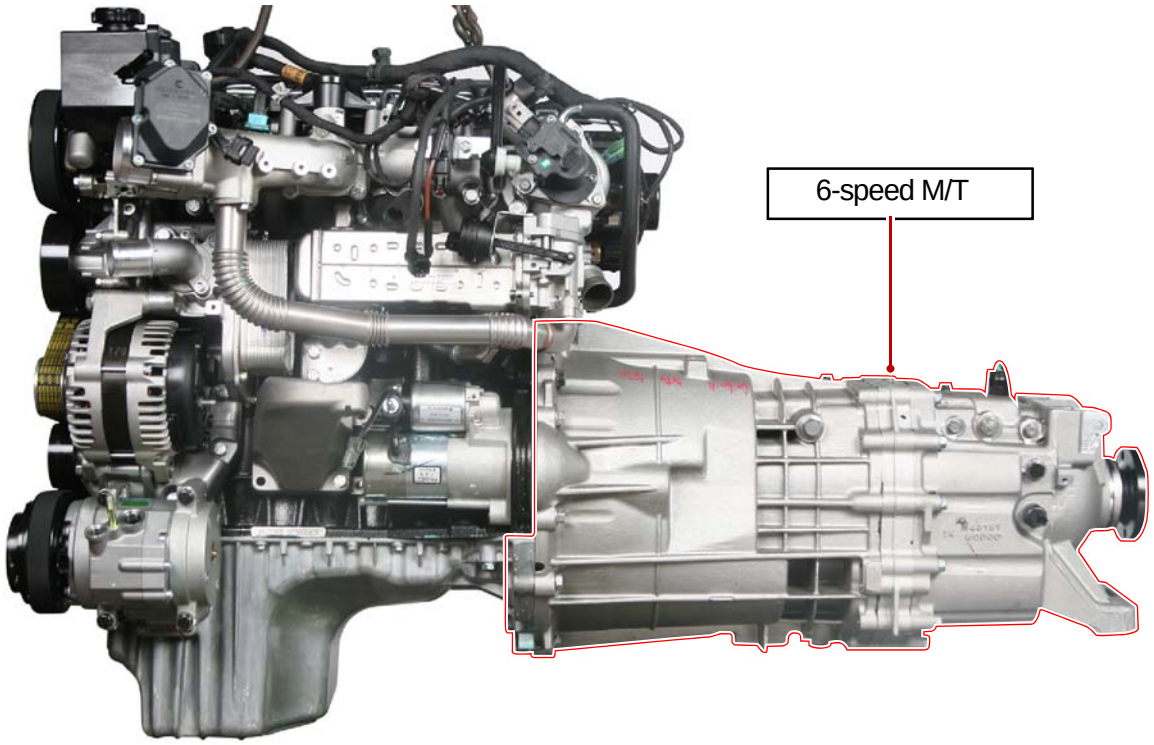
▶ 3166-00 Extension housing



1. Lever assembly - Semi remote
3. Lever - Shift
4. Boot - Rubber
5. Ring - Retainer
6. O-ring
7. Bearing
8. Shim
9. Arm - Control
10. Damper assembly
13. Rod assembly
14. Bushing assembly - TGS mounting
15. Pin - TGS mounting
16. Pin - Spring
17. Pin - Spring
20. Adapter - Case
21. Bolt - Flange (42.1 ~ 53.9 Nm)
22. Seal - Oil
23. Seal - Oil
24. Pin - Dowel
25. Switch - Neutral (29.4 ~ 34.3 Nm)
26. Gasket
27. Bolt - Interlock (14.7 ~ 21.5 Nm)
28. Pin - Detent
29. Switch - Backup lamp (29.4 ~ 34.3 Nm)
30. Bolt - Fork hinge (53.9 ~ 67.6 Nm)
31. Bearing - Poppet ball (29.4 ~ 41.1 Nm)
32. Bolt - Guide (14.7 ~ 21.5 Nm)
33. Bolt (2.9 ~ 4.9 Nm)
34. Bracket - Wiring

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW



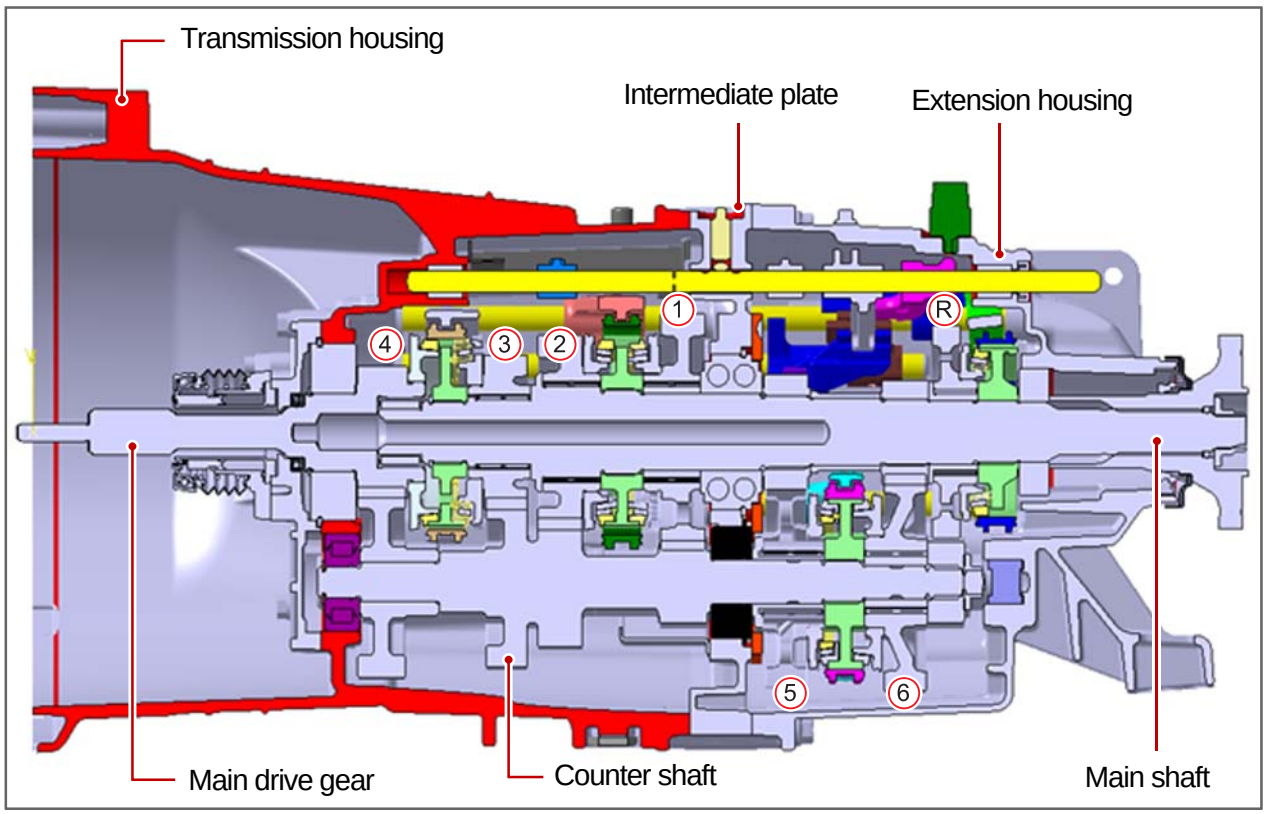
Front view	Sectional view
	

1) Characteristics of Transmission

- Forward and Reverse gears are helical gear.
- The clutch is operated by concentric slave cylinder (CSC).
- To prevent the improper gear shift, semi-remote control system has been introduced.
- To prevent the gears from engaging improperly, the synchronizer mechanisms and independent interlock systems are installed on 1/2 gears, 3/4 gears, 5/6 gears and reverse gear.
  The High-Force system for reverse gear shift has been introduced.
- The synchronizer has three types: Triple (1, 2, 3, R), Double (5), Single (4, 6)
-

Modification basis	
Application basis	
Affected VIN	

2) Sectional Diagram

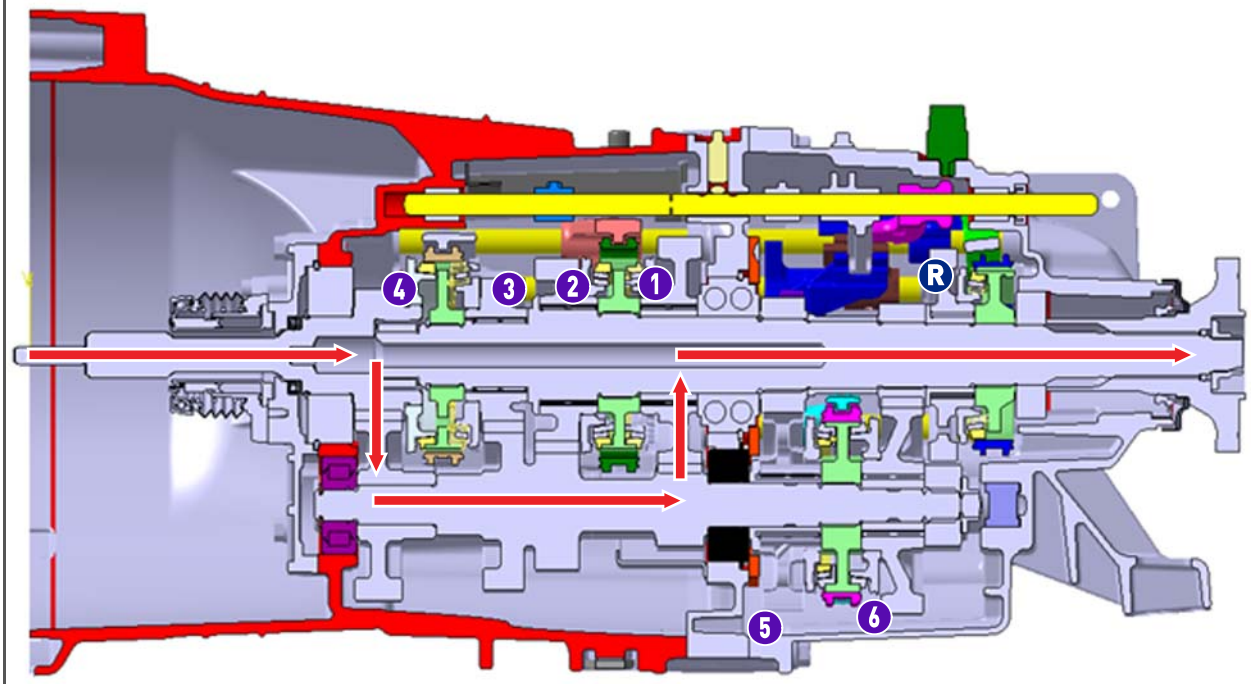


3) Gear Ratio

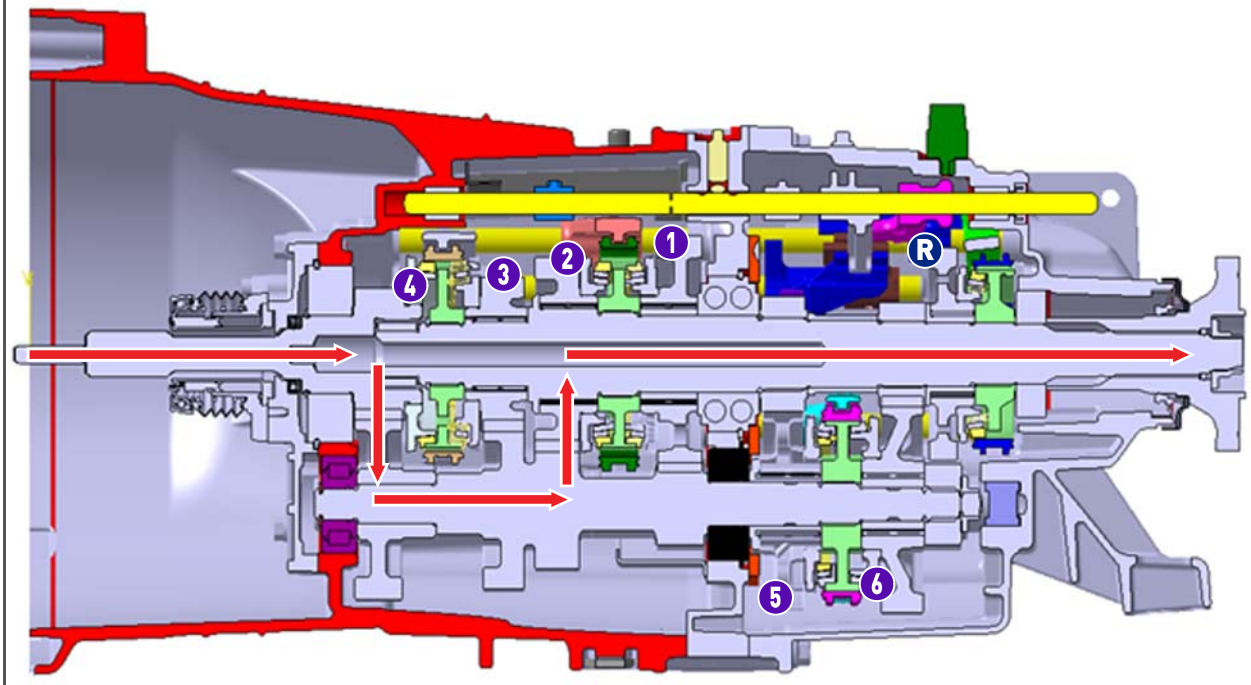
Gear	Teeth		Final gear ratio
	Input	Output	
1st	13	38	4.489
2nd	23	35	2.337
3rd	33	29	1.350
4th	28	43	1.000
5th	47	24	0.784
6th	52	23	0.679
R	13	36	4.253
	Idle: 25		

2. POWER FLOW

1st speed

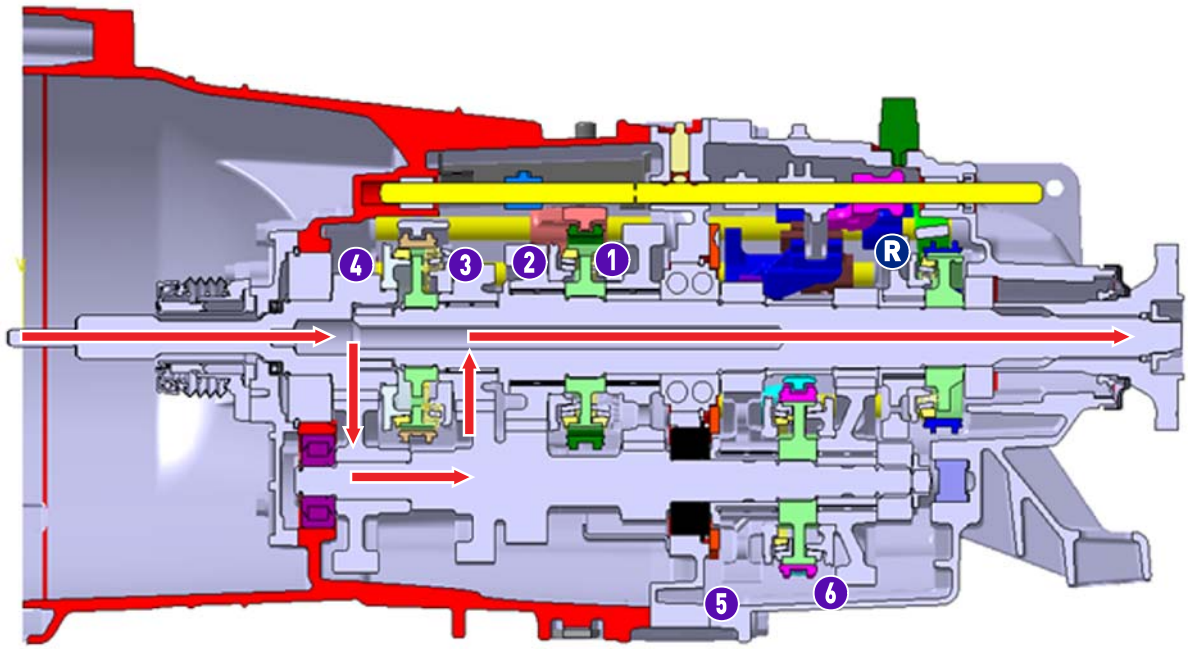


2nd speed

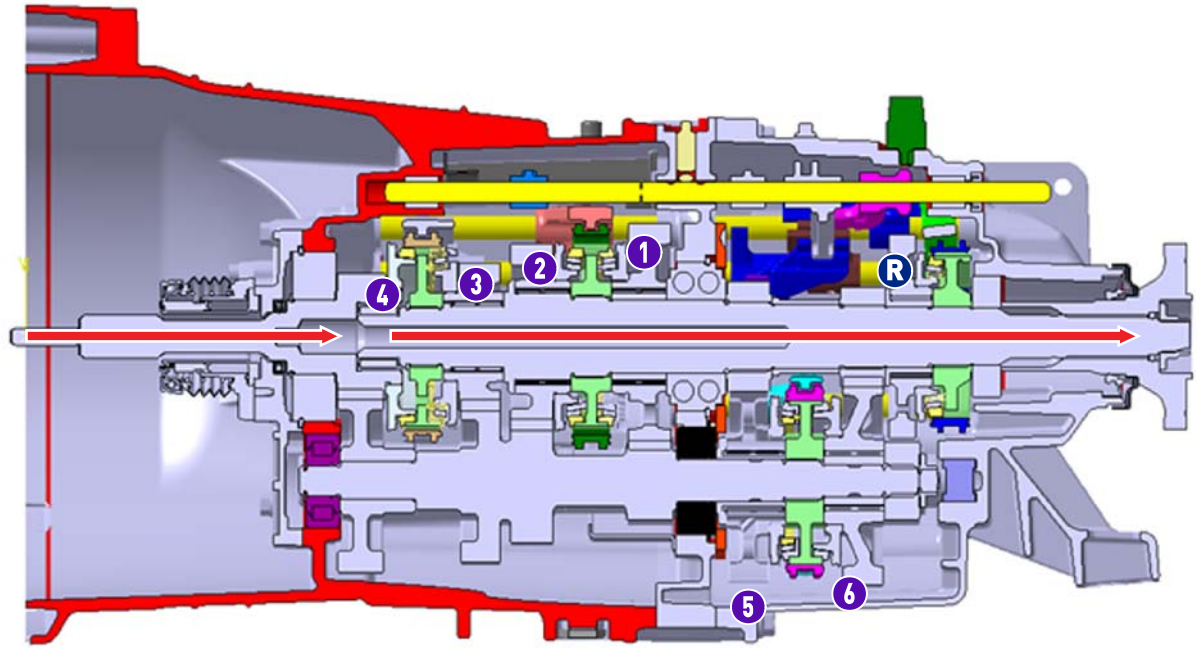


Modification basis	
Application basis	
Affected VIN	

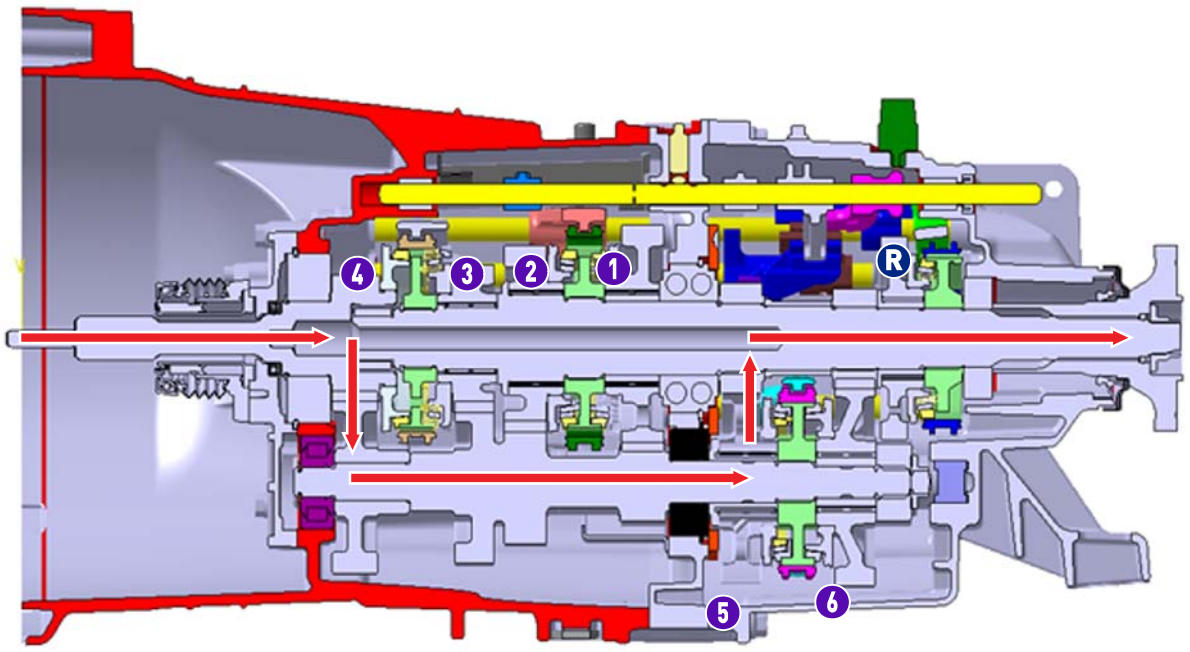
3rd speed



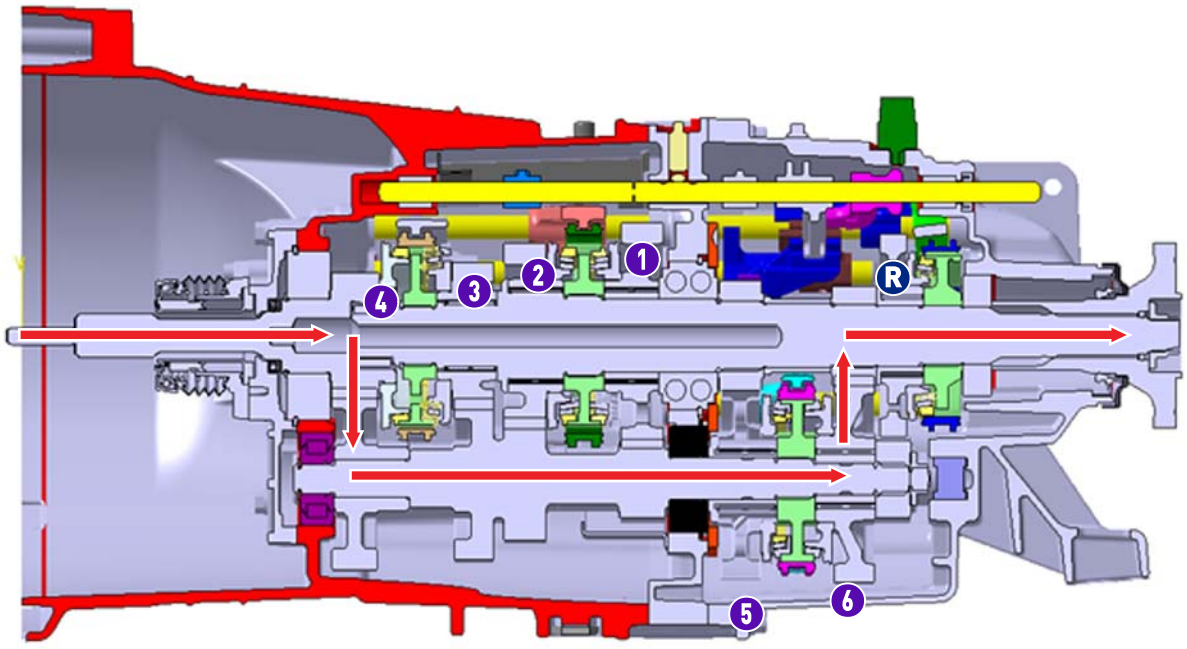
4th speed



5th speed

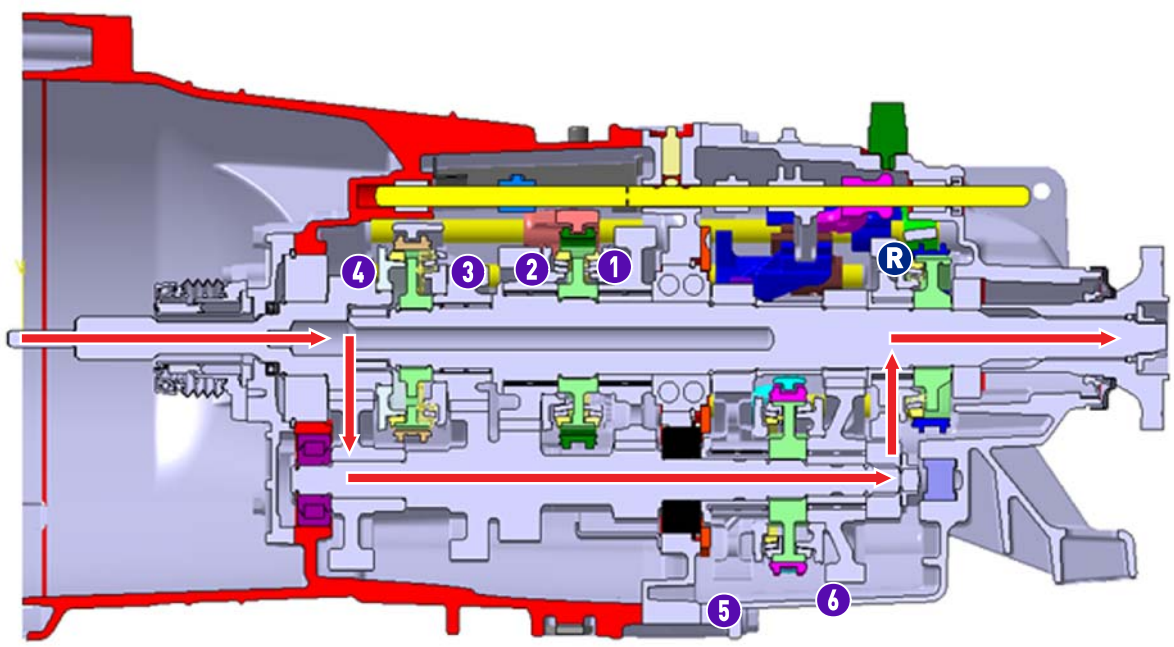


6th speed

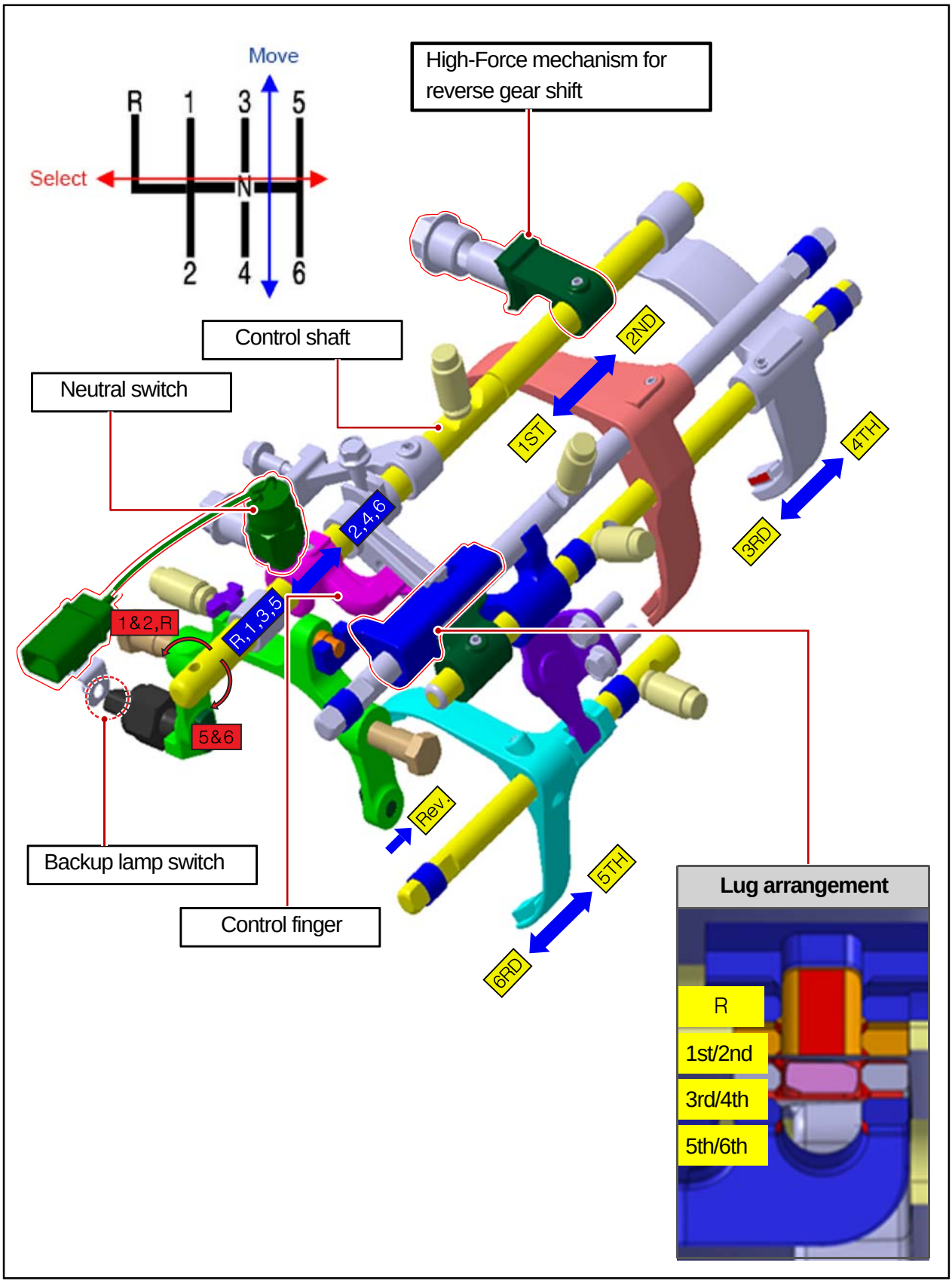


Modification basis	
Application basis	
Affected VIN	

Reverse gear



3. SHIFTING MECHANISM



Modification basis	
Application basis	
Affected VIN	

TGS LEVER 3722-01

OVERVIEW AND OPERATION PROCESS

1. INTRODUCTION

The TGS lever prevents inappropriate or unexpected shifting of gears to increase safety. It also helps the driver safely select a needed gear. The solenoid of the TGS lever has the factory-installed "P" Lock function which allows the driver to shift gears from the ¡°P¡± position only when the brake pedal is depressed.

Because drivers of vehicles without this system can shift gears by only operating the gear selection lever, their safety and convenience are limited. Sometimes, the vehicles' gears can be changed unexpectedly or unintentionally by various factors. Therefore, two tip switches are installed to prevent such changes from happening.

For instance, when a vehicle is running on a severely curved road, the driver must hold the steering wheel with two hands. Shifting gears or using the engine brake while driving on the road will be dangerous. So, one tip switch is installed on the steering wheel. The other tip switch is installed on the knob to prevent unintended gear shifting.

This system is only activated when the TGS lever is engaged in the "M" position. When the lever is pushed to the "D" position, the tip switches will not change gears.

1) Components



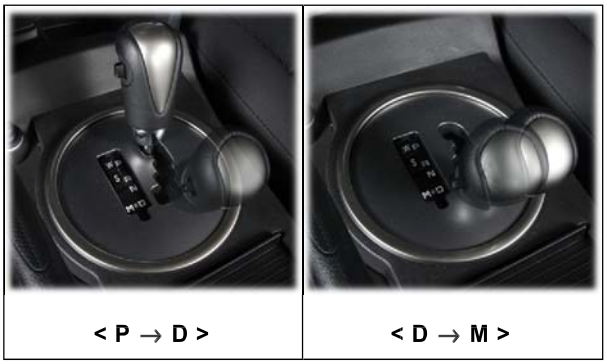
Modification basis	
Application basis	
Affected VIN	

2. FUNCTIONS OF THE SELECTOR LEVER

1) Selector Lever's Positions

(1) P: Parking

The engine can start. The parking pole stops the driving wheels from rolling.
To move the lever from "P" to another position, the brake pedal must be depressed (Parking Lock System).

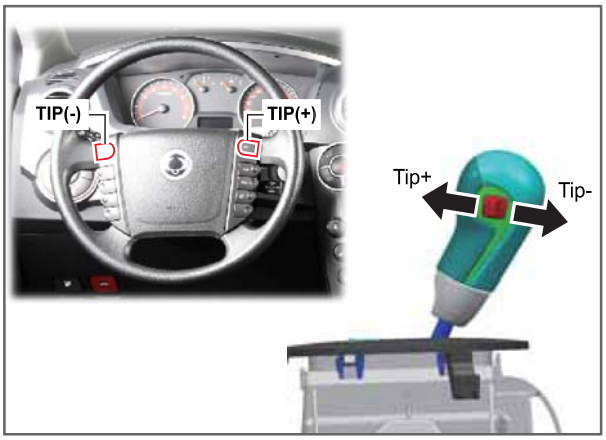


(2) R: Reverse

By switching between the Standard and Winter switches, the reverse speed can be changed. The change should be made before shifting the selector lever to the "P" position.

(3) N: Neutral, Engine Starting or Towing

It is possible to start the engine. This position is also for a brief stop or towing the vehicle. When towing the is vehicle, the towing speed should be 50 km/h or less and the towing distance should not exceed 50 kilometers. It is more recommended to load this vehicle on a flat-bed towing vehicle.



< Only available in the "M" position >

(4) D: 1~6 Gears

This position is for normal driving on paved roads or high speed driving. The gear ratio of the 6th gear is 0.68:1.

(5) M: Manual Mode

This allows the driver to define the highest possible gear by selecting "+" or "-" on the gear selector when the lever is in the "M" position. When the lever is first moved to the manual "M" position the transmission will select the lowest possible gear.
When maximum engine rpm is reached the transmission will upshift automatically regardless of the driver selected limit. 4WD models with low range will not automatically
upshift when low range is selected.

Modification basis	
Application basis	
Affected VIN	

(6) 6: 6 gears (only available in the “M” position)

The 6th gear state will display on the instrument cluster. 6-5, 6-4 automatic kick-down shifts are available. 6th gear has engine braking available.

(7) 5: 5 gears (only available in the “M” position)

The 5th gear state will display on the instrument cluster. 5-4, 5-3 automatic kick-down shifts are available. 5th gear has engine braking available.

(8) 4: 4 gears (only available in the “M” position)

The 4th gear state will display on the instrument cluster. 4-3, 4-2 and 4-1 automatic kick-down shifts are available. 4th gear has engine braking available.

(9) 3: 3 gears (only available in the “M” position)

The 3rd gear state will display on the instrument cluster. 3-2 and 3-1 automatic kick-down shifts are available. 3rd gear has engine braking available.

(10) 2: 2 gears (only available in the “M” position)

The 2nd gear state will display on the instrument cluster. 2-1 automatic kick-down shifts are available. 2nd gear has engine braking available.

(11) 1: 1 gears (only available in the “M” position)

The 1st gear state will display on the instrument cluster. Unlike the normal 1st gear, engine braking will be available in this manual 1st state.

2) Transmission Mode

(1) Activating the Manual Mode (M Mode)

To prevent any wrong shifting down or up in the "D" position, the manual mode can be activated only in the "M" position.
When both tip switches on the steering wheel and the knob send out shifting up or down signals in the M mode to the controller of the selector lever, the controller only accepts the first signal and ignores the second signal.
When the driver briefly touches or continuously pushes one of the up or down shifting tip switch in the M mode, the signal is sent to the TCU. When the driver pushes and holds the switch, the TCU shifts down one or two gears without any jerking. If the driver briefly touches the switch once, the TCU shifts up or down gears one by one.

(2) When switching from D to M

When the selector lever is pushed from the D position to the M mode, the M mode sensor detects this change and sends a signal to the TCU, and the TUC shifts down one or two gears without any jerking. This means the newly engaged gear in the M mode is the one-level lower gear from the D position.
For example, when the selector lever is pushed from the D position to the M mode, the transmission will automatically switch the 3rd gear to the 2nd gear. This basic working algorithm can automatically be adjusted depending on various driving conditions, and the same gear will be used after switching to the M mode. For example, if the vehicle is moving at high speed with the 6th gear in the D position, the same gear will still be used in the M mode to protect the transmission.

(3) When switching from M to D

When the selector lever is pushed to the D position from the M mode, the M position sensor detects the change and sends another signal to the TCU. Then, the TCU enables the transmission to choose from all available gears including the highest one (the D position).

Modification basis	
Application basis	
Affected VIN	

3. MODE SWITCH

1) Function and Usage

The mode switch is installed next to the Selector Lever as shown in the picture. It has the Standard (S) and Winter (W) modes.

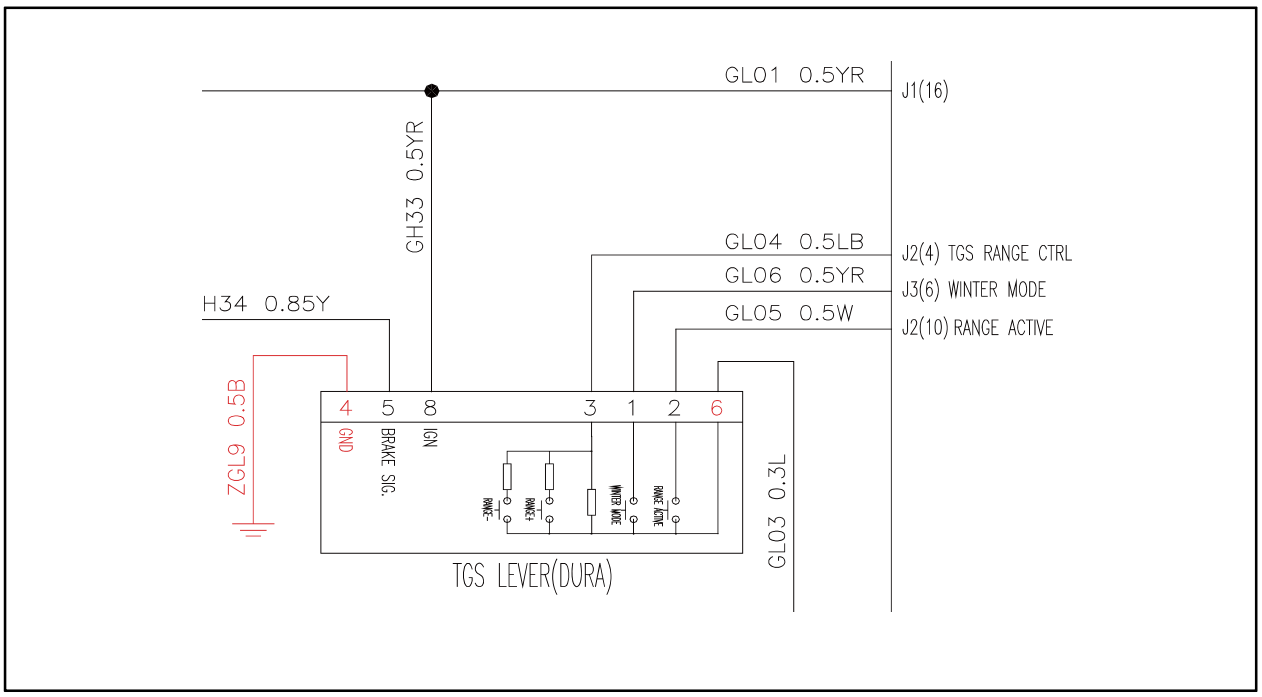


- The S mode is for driving under normal conditions and uses the 1st gear to start off. It also ensures more enjoyable driving by analyzing the driver's driving habits and changing shifting patterns according to the habits. (Degree holding on a hilly road: approximately 11~13. 5% or less)
- When the W mode is selected, the Winter lamp comes on the instrument panel. The mode uses the 2nd gear for the vehicle's smooth driving off. With the Winter mode, 2WD- and AWD-models have fast up-shifts and slow down-shifts to increase gas mileage. When these models use the full throttle, the Winter mode automatically switches to the Standard mode. However, in case of 4WD-models, the Winter mode will stay on even with the full throttle.

In spite of the Winter mode being selected, the transmission will use only the 1st gear to start off under the following condition:

- When the Selector Lever is engaged to the M mode and a tip switch is used to shift down to the 1st gear
- In case of 4WD-models (inapplicable to 2WD- or AWD-models), when the full throttle is attempted at 25 Km/h or slower speed, the Mode switch sends out a control signal from the Selector Lever unit to the TCU through hard wires.

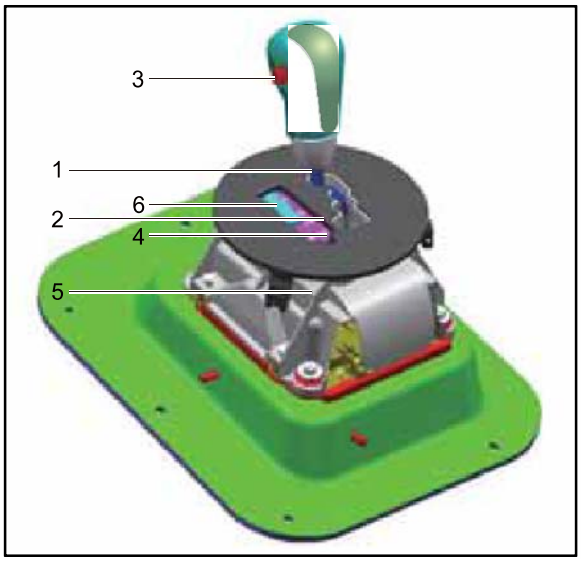
2) Electric Circuit



Modification basis	
Application basis	
Affected VIN	

4. PARKING LOCK SYSTEM

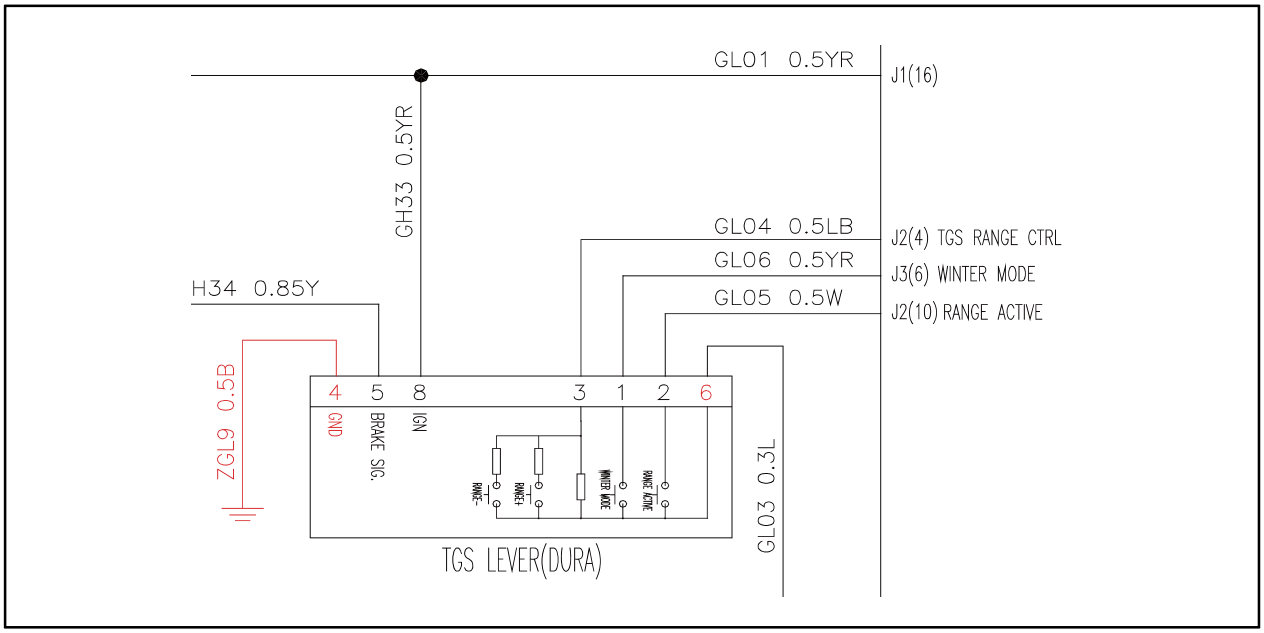
1) Function Description



The parking lock system is built in the selector lever unit as shown in the figure.
The wiring to detect the brake switch is connected to the selector lever unit so that the system detects the brake switch operation signal for allowing shift from the "P" to other positions.
This system is a safety measure to prevent the selector lever from moving unless the brake pedal is depressed.

1. Selector Lever
2. Shift Pattern Display
3. Selector Lever Handle
4. Parking Lock Release Flap
5. Selector Lever Control Unit (Internally Installed)
6. Mode Switch

2) Electric Circuit



Modification basis	
Application basis	
Affected VIN	

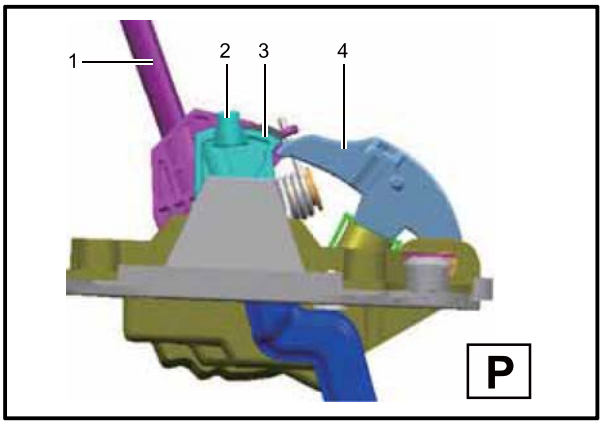
3) Shift Lock Solenoid Function

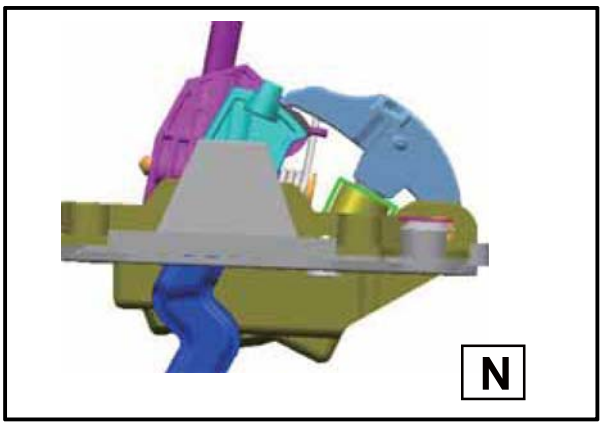
Input				Output	Solenoid	Others
Lever Position	Ignition	Brake	Speed (Km/h)	(Lock Position)		
X	OFF	X	X	1	OFF	
P	ON	OFF	X	1	OFF	P LOCK
P	ON	ON	X	2	ON	
P - R	ON	X	X			The last: utilize useful gear positions
R	ON	X	X	2	OFF	
R - N	ON	X	X			The last: utilize useful gear positions
N	ON	X	X	2	OFF	
N - D	ON	X	X			The last: utilize useful gear positions
D	ON	X	X	2	OFF	

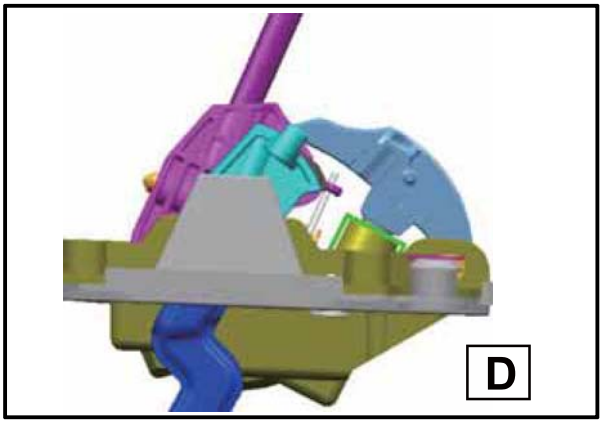
Lock Position	P
1	LOCK
2	UNLOCK

Modification basis	
Application basis	
Affected VIN	

4) Shift Lock Solenoid Function







Unless the ignition switch is turned to "ON" and the brake pedal is pressed, the Selector Lever Unit does not activate the P Locking solenoid and the Selector Lever (1) stays locked. In this situation, the lock lever (4) is engaged to the P Lock position and the Locking Lever Tap (3) holds the Lock Lever (2). Therefore, the Selector Lever cannot be shifted to other positions.

5) Shift Lock Release in P Positions

Although the brake pedal is depressed, if you cannot shift out of "P" with the ignition switch in ON, please apply the following instruction:



1. Apply the parking brake firmly and turn the ignition off.
2. Depress the brake pedal and push down the shift lock release lever with a stick such as a pen. Then, shift the lever to other positions.

CAUTION

Do not push down the shift lock release lever excessively. The internal parts could be damaged.

Modification basis	
Application basis	
Affected VIN	

CLUTCH 3020-01

GENERAL

1. CLUTCH SPECIFICATIONS

Description			Specification
Operating type			Hydraulic
Clutch pedal	Type		Suspended
	Maximum pedal stroke		Diesel engine equipped vehicle: 140 mm
	Pedal free play		5 ~ 10 mm
Clutch disc	Type		Single dry diaphragm
	Dimension of facing		240 × 155 × 4.0 mm
	Facing size/quantity		263 cm^2 / 2
	Thickness of disc		Free: 9.4 ~ 10 mm When loaded: 9.0 ± 0.3 mm
Clutch cover assembly setting force			Min. 720 kg
Clutch master cylinder	Stroke	5MT	30 mm
		6MT	27 mm
	Inner diameter		Φ 17.46 mm
Concentric slave cylinder	Stroke		7.0 mm
	Sectional area		706 mm^2
Clutch fluid			DOT3 or DOT4

2. TIGHTENING TORQUE

Descriptio n	Tightening Torque
Clutch housing bolt (8 locations)	49 ~ 59 Nm
Clutch cover (pressure plate) bolt	21 ~ 27 Nm
Concentric slave cylinder bolt (3 locations)	10 ~ 16 Nm
Concentric slave cylinder flare nut	20 ~ 25 Nm
Adapter flare nut	20 ~ 25 Nm
Clutch oil pipe flange nut	15 ~ 18 Nm
Master cylinder bolt	8 ~ 18 Nm
Fulcrum (clutch pedal bushing) bolt/nut	16 ~ 22 Nm
Clutch pedal bracket mounting bolt	8 ~ 18 Nm
Stopper bolt	16 ~ 22 Nm

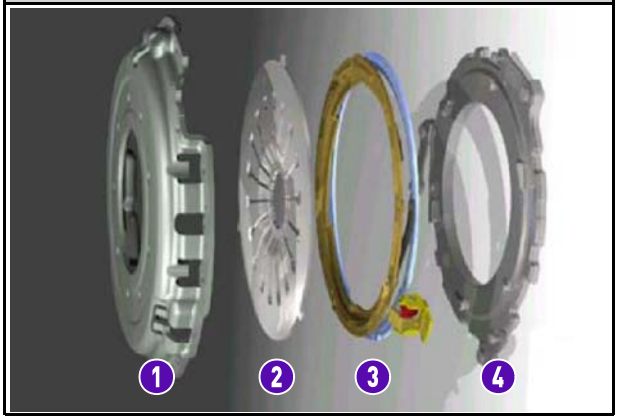
OVERVIEW AND OPERATION PROCESS

1. FUNCTION AND OVERVIEW

1) SAT (Self Adjusting Technology) Clutch System

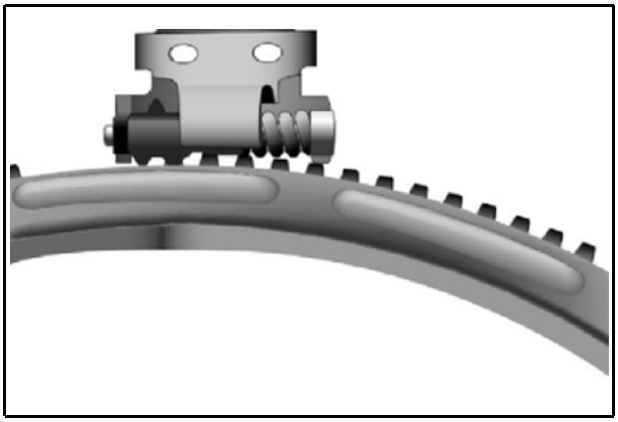
(1) Function

Internal Components of Clutch Cover



SAT is new clutch system which adjusts the clutch freeplay according to the wear of clutch disc.

(2) Operation description



- Diaphragm spring rotates the adjusting equipment as clutch disc is wearing and so, pressure plate is pushed to clutch disc side at the amount of wear.
- Disc wear (Free play) → Diaphragm spring (1) → Adjusting equipment (2, 3) → Pressure plate (4)

Modification basis	
Application basis	
Affected VIN	

2) Overview

▶ Driving Elements

The driving elements consist of two flat surfaces machined to a smooth finish.
One of these is the rear face of the engine flywheel and the other is the clutch pressure plate. The clutch pressure plate is fitted into a clutch steel cover, which is bolted to the flywheel.

▶ Driven Elements

The driven element is the clutch disc with a splined hub which is free to slide lengthwise along the splines of the input shaft.
The driving and driven elements are held in contact by spring pressure. This pressure is exerted by a diaphragm spring in the clutch cover pressure plate assembly.

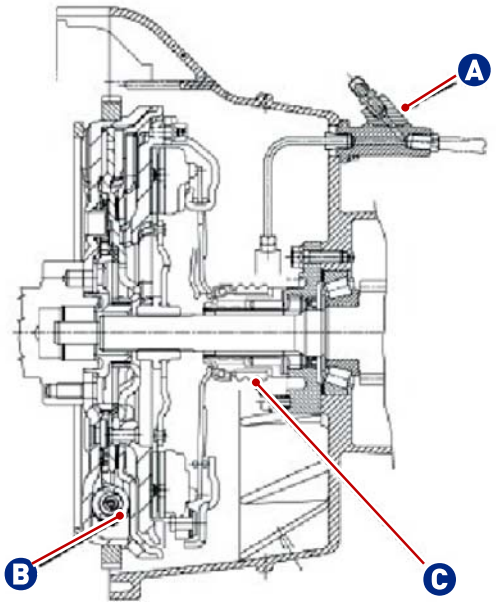
▶ Operating Elements

The clutch "release" system consists of the clutch pedal and clutch release cylinder.
This system directly releases the clutch by using hydraulic pressure while the conventional clutch system releases the clutch by using release lever and release fork. This system provides higher efficiency than conventional clutch system, and its durability is superior.

1) Clutch master cylinder (mounted on clutch pedal)
2) Concentric slave cylinder pipe (mounted inside of transmission)

3) Functions

Components of Clutch Assembly



A Adapter/Pipe Assembly



B Clutch Assembly





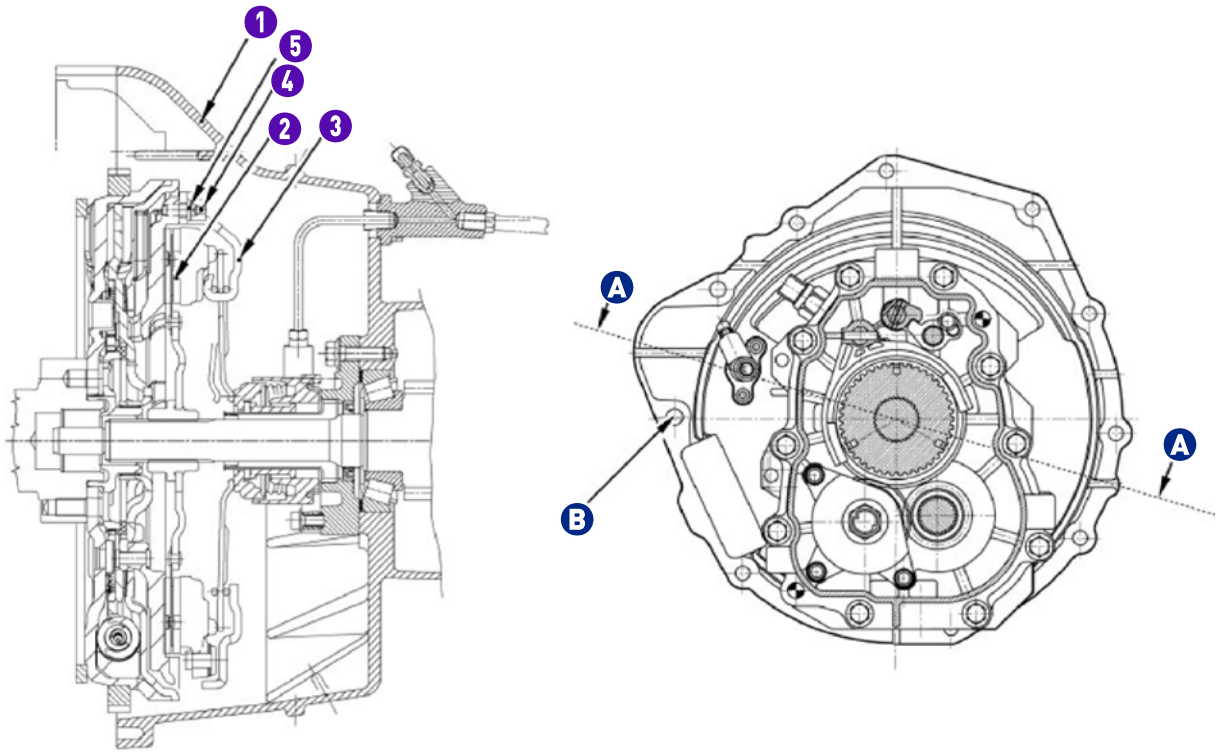
C Concentric Slave Cylinder





Modification basis	
Application basis	
Affected VIN	

Cross Sectional View of Clutch Assembly



1.	Transmission housing	4.	Bolt
2.	Clutch disc assembly	5.	Washer
3.	Clutch disc cover assembly	6.	Bolt

PROPELLER SHAFT 3310-00

GENERAL INFORMATION

1. SPECIFICATION

Description			Specification
Structure			Universal joint with yoke arm and spider
Number of spiders	Front	Part time T/C	Two
	Rear		Three
Runout			Max. 0.3mm
Unbalance			Max. 18 g.cm / 4,500 rpm
Dimension of front propeller shaft (Length x Dia.) (mm)	A/T		552.3*Φ63.5 (Compressed)
	M/T		603.8*Φ63.5 (Compressed)
Dimension of front propeller shaft (Length x Dia.) (mm)	2WD	Front	1136.0*Φ63.5
		Rear	743.*Φ63.5(Compressed)
	4WD(M/T)	Front	785.1*Φ63.5
		Rear	743.*Φ63.5(Compressed)
	4WD(A/T)	Front	836.8*Φ63.5
		Rear	743.*Φ63.5(Compressed)

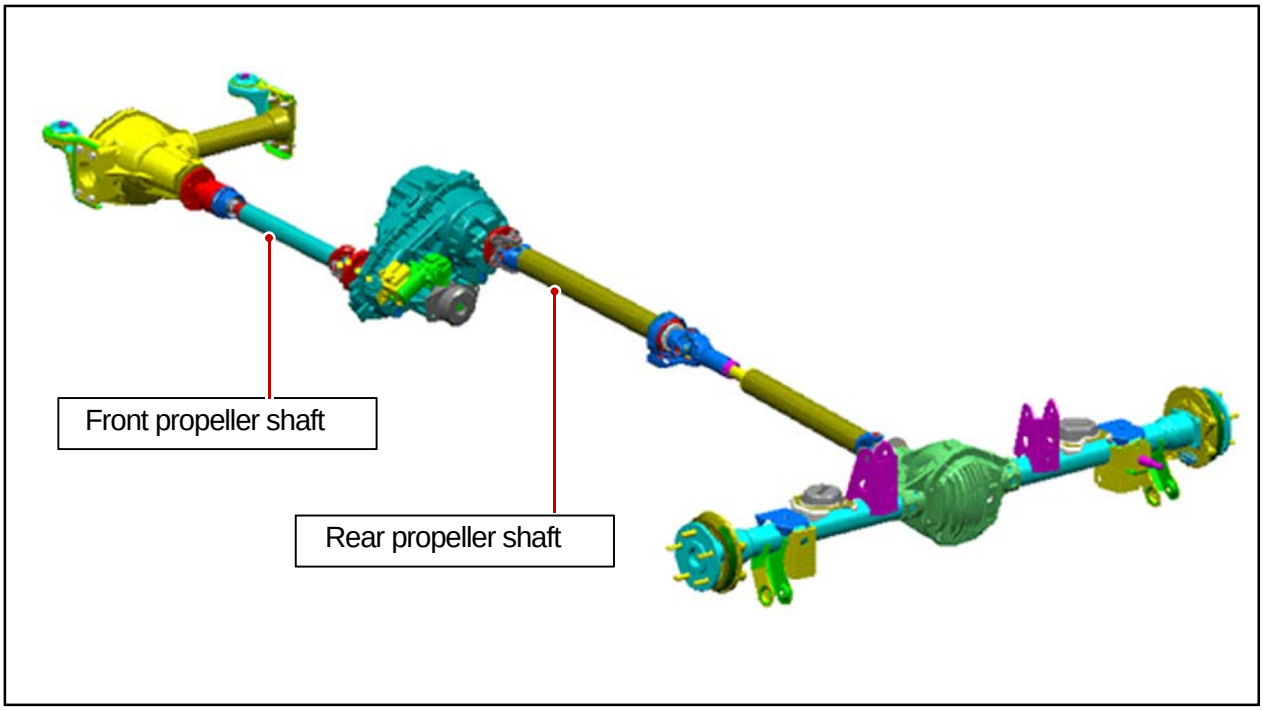
2. TIGHTENING TORQUE

Fastener	Tightening torque
Mounting bolts for front/rear axle	66.7 ~ 73.5Nm
Mounting bolts for T/M and T/C	79.4 ~ 87.2Nm
Mounting bolts for center bearing	78.4 ~93.1Nm

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

The propeller shaft transfers the power through the transmission and transfer case to the front/rear axle differential carrier (final reduction gear).
It is manufactured by a thin rounded steel pipe to have the strong resisting force against the torsion and bending.
Both ends of propeller shaft are connected to the spider and the center of propeller shaft is connected to the spline to accommodate the changes of the height and length.
The rubber bushing that covers the intermediate bearing keeps the balance of rear propeller shaft and absorbs its vibration.



▶ **Function of propeller shaft**

- Transmits driving torque.
- Compensates the angle change (universal joint / CV joint).
- Compensates the axial length change (splines for the slip joint).

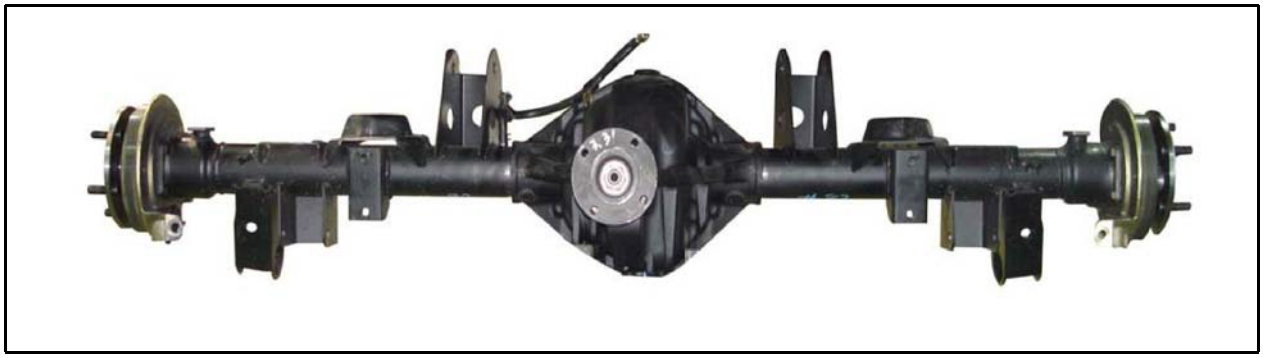
Modification basis	
Application basis	
Affected VIN	

AXLE 4120-01

GENERAL

1. SPECIFICATIONS OF AXLE

1) Front View



2) Rear View



3) Specifications

Description	Specification		
Axle shaft type	Semi-floating type		
Axle housing type	Build-up type		
Differential	Type		Conventional
	Gear type		Hypoid
DSL Eng + A/T, M/T			3.54 / 4.27
GSL Eng + A/T, M/T			4.89 / 4.55
Oil	Capacity	Front	1.4 L
		Rear	2.0 L
	Specification		SAE 80W/90, API GL-5

Modification basis	
Application basis	
Affected VIN	

4) Specifications of Front and Rear Axle

The specification below is for front and rear axles equipped in Actyon, including gear ratio and specific specifications. For details, refer to each section.

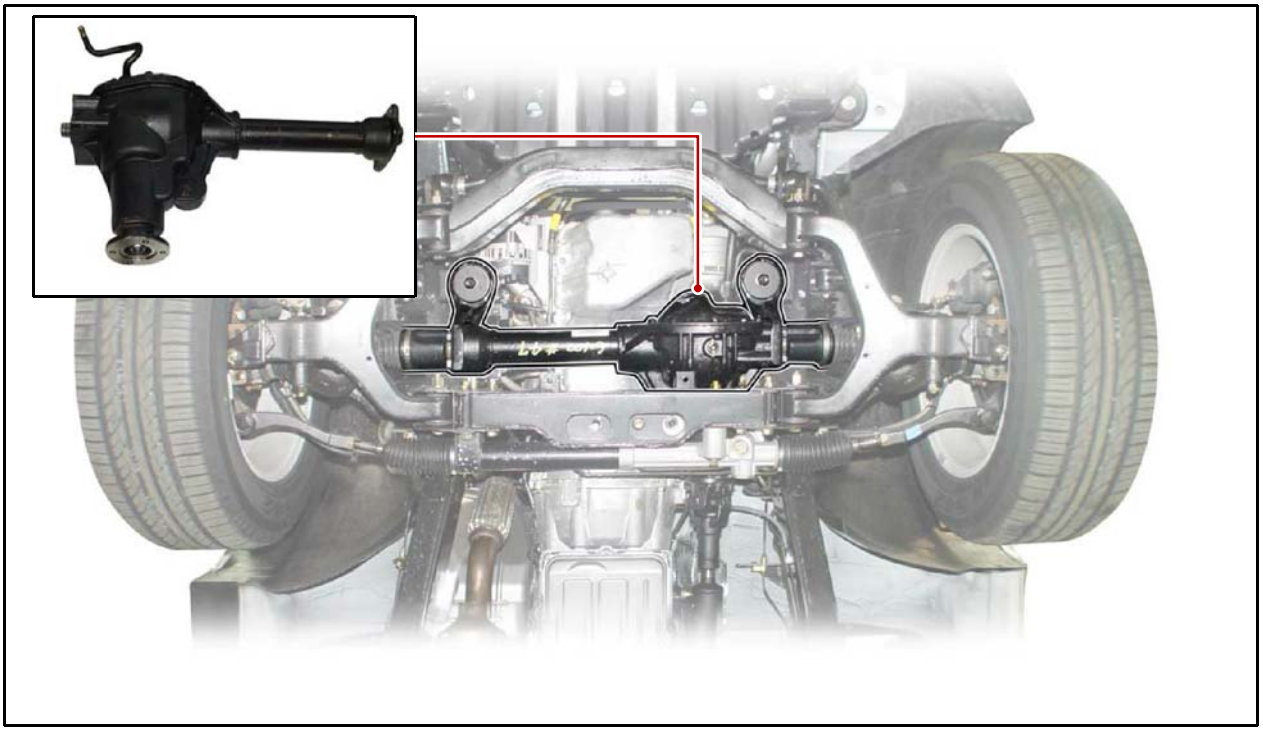
Location		Front axle		Rear axle	
Specification		M/T	A/T	M/T	A/T
Gear ratio		4.55R (5MT) 4.27R (6MT)	3.54R (5AT) 4.89R (6AT)	4.55R (5MT) 4.27R (6MT)	3.54R (5AT) 4.89R (6AT)
Gear	Type	Hypoid	→	←	←
	Size	Φ 182.8 mm	←	Φ 218.4 mm	←
	Offset	28.58 mm (DYMOS) 35 mm	←	38.1 mm	-
Housing		Steel	←	Steel casting (steel, aluminum cover)	←
Oil	Specification	SAE 80W/90 API-GL5	←	SAE 80W/90 API-GL5	←
	Capacity	1.4L	1.4L	2.0L	←
Length		448.0 mm	←	469.0 mm	←
Width		681.9 mm	←	1717.7 mm	←
Weight		45 kg	←	90 kg	←

Modification basis	
Application basis	
Affected VIN	

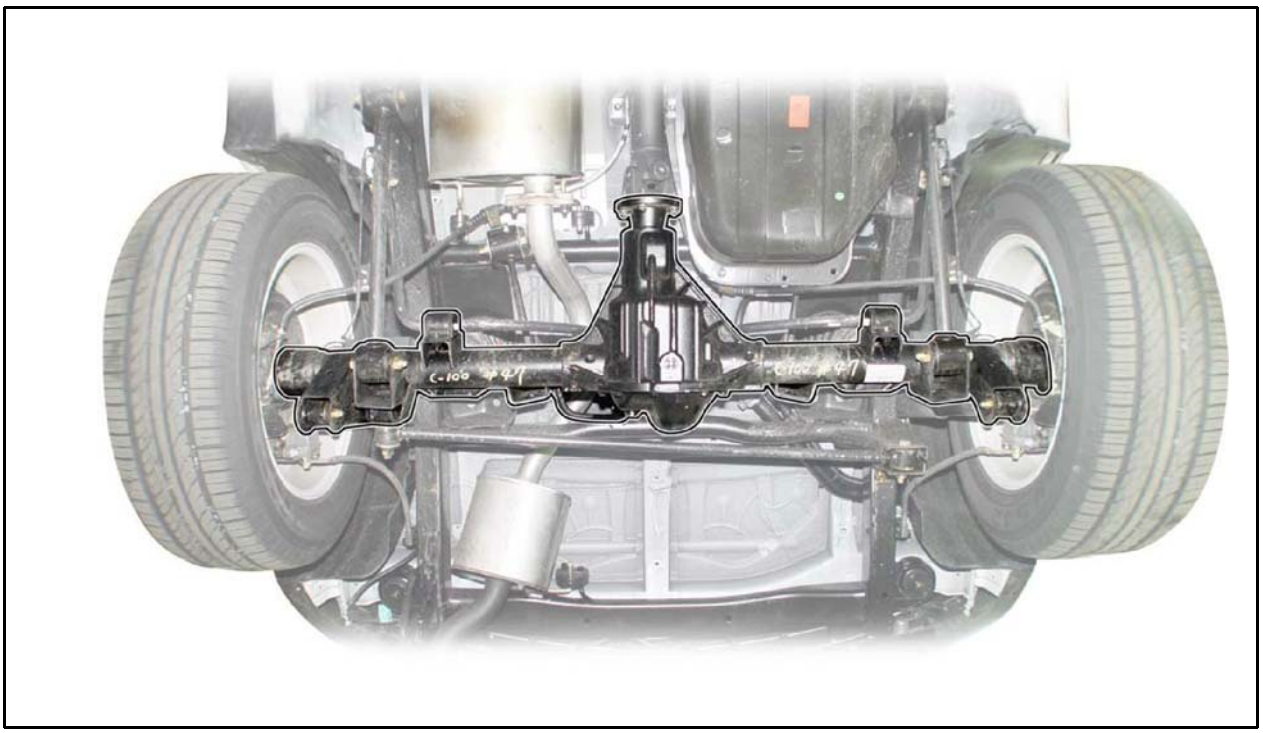
OVERVIEW AND OPERATION PROCESS

1. OVERVIEW OF AXLE

1) Front Axle



2) Rear Axle



TRANSFER CASE 3240-01

GENERAL

1. OVERVIEW

By using the planetary gear sets, two-gears shift type part time transfer case achieves direct connection when selecting 4WD "HIGH" and 2.48 of reduction gear ratio when selecting 4WD "LOW". The silent chain in transfer case transfers the output power to front wheels.
The simple operation of switches on instrument panel allows to shift between "2H" and "4H" easily while driving (for 4L: stop vehicle first). The warning lamp warns the driver when the system is defective.

The 4WD system integrated in ACTYON does not have big difference in comparison to the conventional part time transfer case, but the changes in comparison to the conventional transfer case are as follows:

1. **No additional coding is required when replacing TCCU.**
2. Delete the devices (tone wheel speed sensor, wiring etc.) related to the speed sensor in the transfer case.
   This system receives the speed signals from ABS/ESP HECU or instrument panel (for non-ABS vehicle(Note 1)) through the CAN communication.
3. The new TCCU is available to install on the vehicle with the conventional DI engine part time TCCU.

NOTE

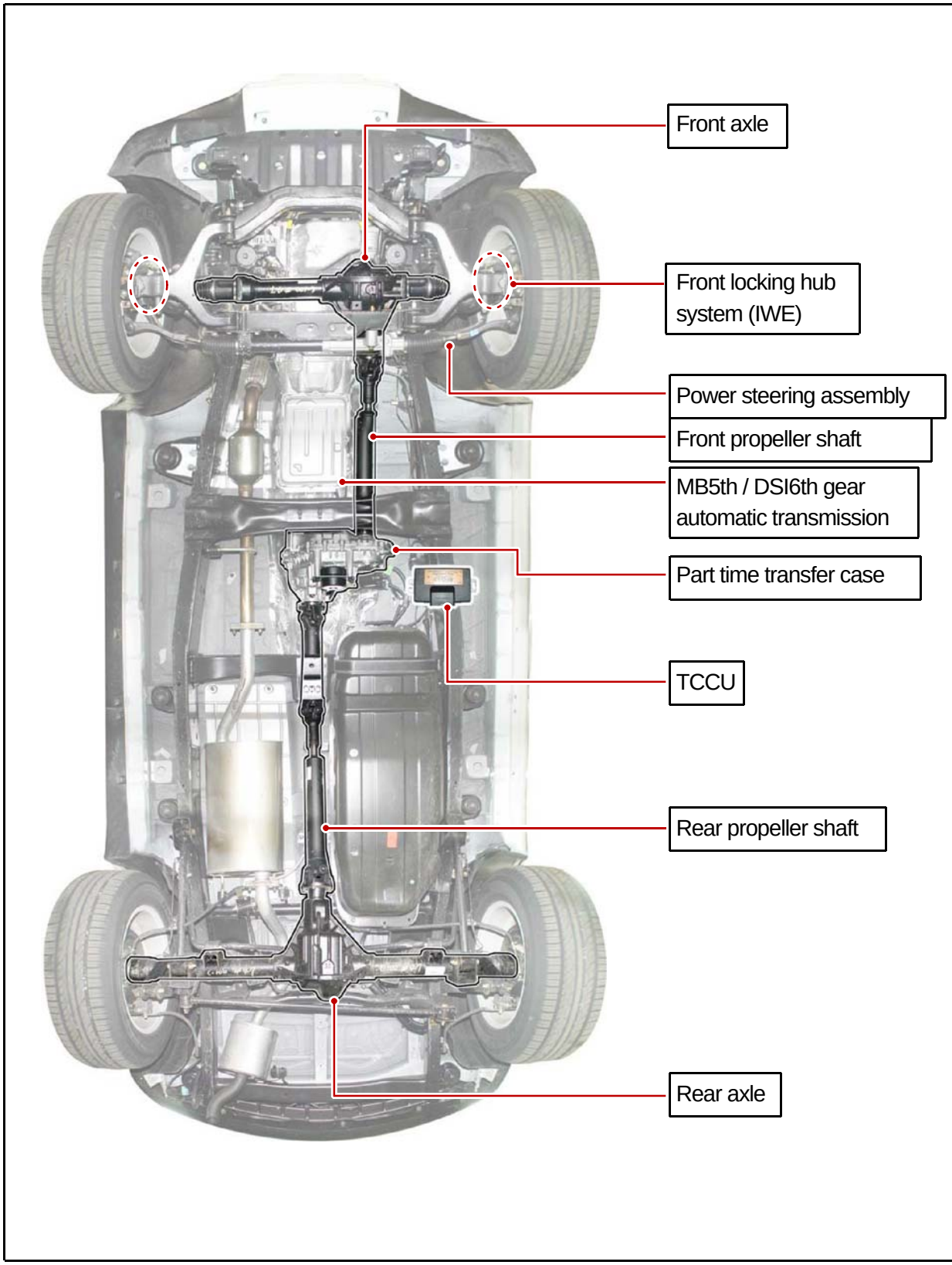
In non-ABS vehicle, the vehicle speed sensor is installed on the rear drive axle. The engine ECU sends the speed signal to the instrument panel, and then the instrument panel provides the information to TCCU and other devices.

2. SPECIFICATIONS

Description		Part Time T/C
Total length		343 mm
Mating surface of front flange		40 mm
Weight		33.9 Kg (without oil)
Oil capacity		1.4 L
Location		Transfer case
Major elements	Housing	Part time
	Tightening bolt	11EA, M8 x 1.25
	Input shaft	A/T: External spline M/T: Internal spline
	Ring gear	Inserted into housing groove
	Sun gear	Separated input shaft and sun gear

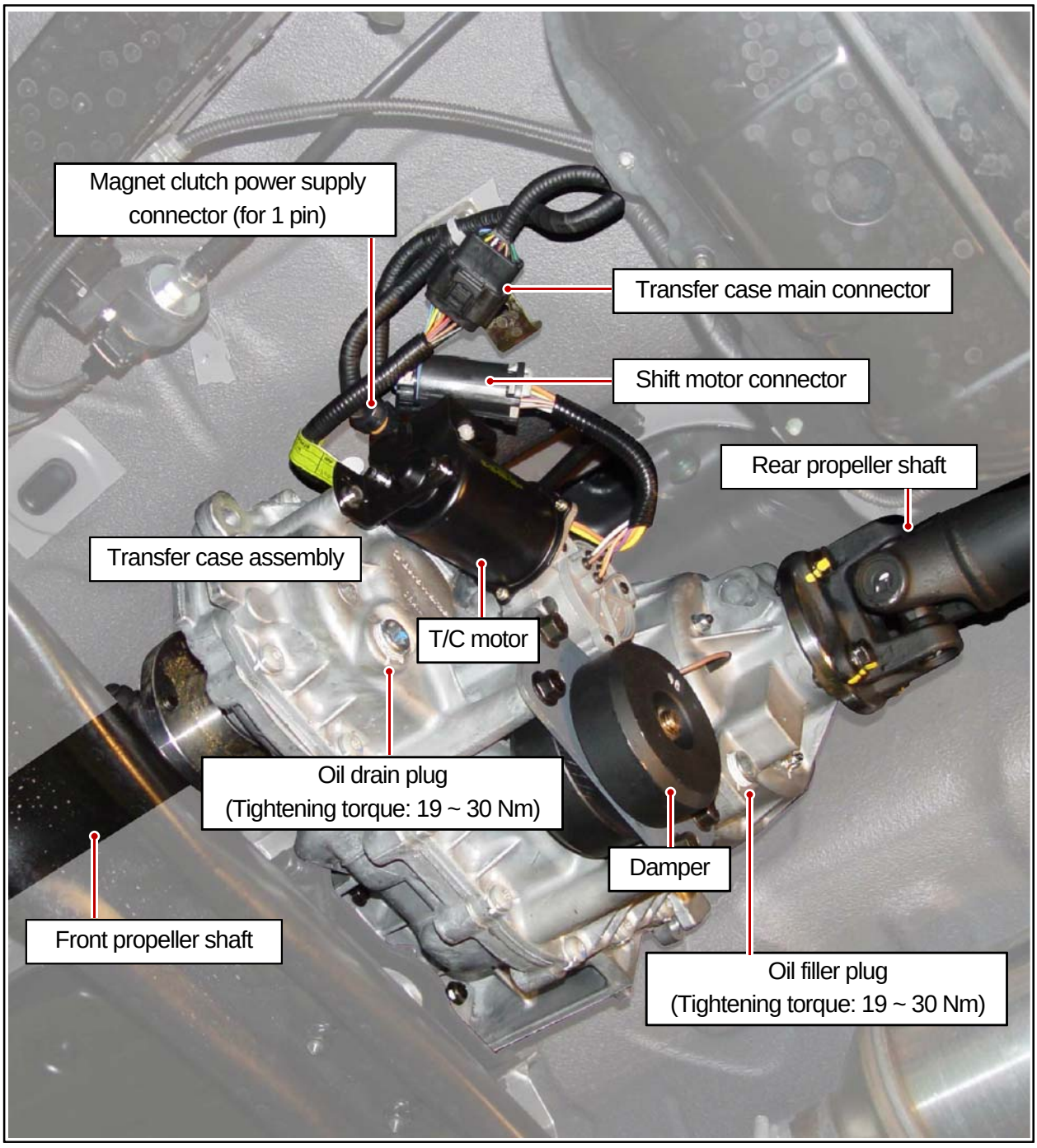
OVERVIEW AND OPERATION PROCESS

1. STRUCTURE



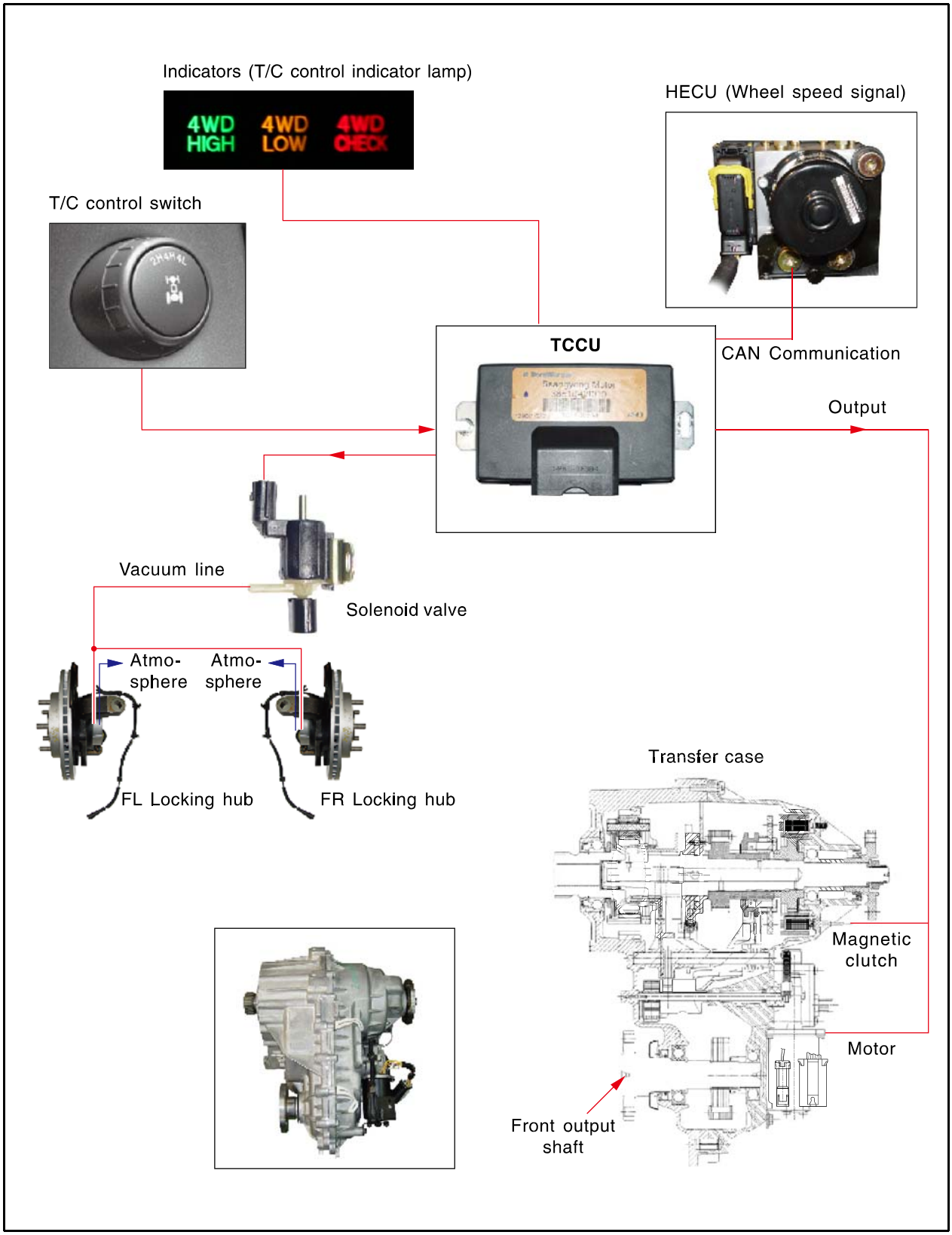
Modification basis	
Application basis	
Affected VIN	

1) Components Location



2. SYSTEM LAYOUT AND OPERATION

1) System Layout

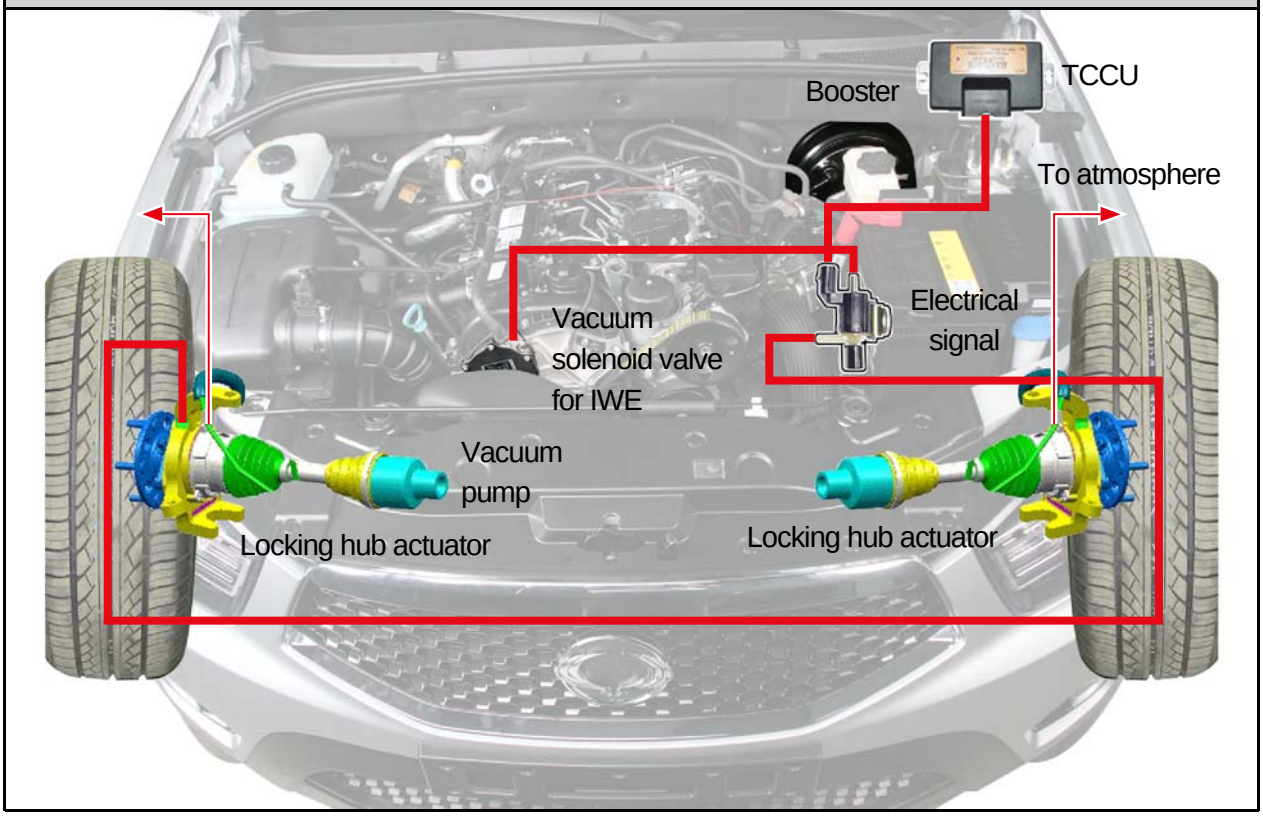


Modification basis	
Application basis	
Affected VIN	

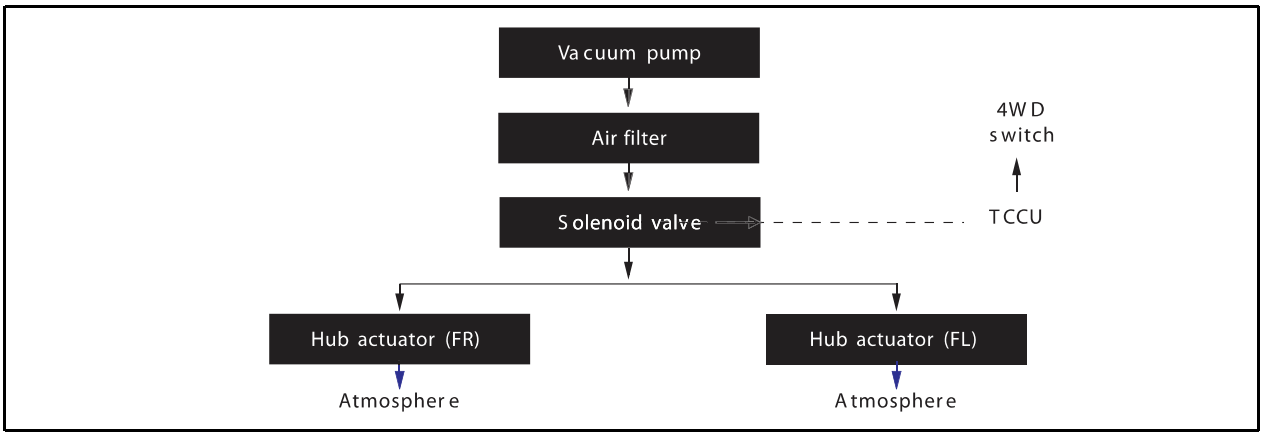
3. LOCKING HUB SYSTEM

The transfer case and the TCCU differ from previous models only in the speed sensor related parts. However, the operaing process of the vacuum locking hub operation system works oppositely from previous models and its components also have changed.
The vacuum locking hub that is applied to Kyron uses the IWE (Integrated Wheel End) system, and in this system, the vacuum is generated only within the hub actuator.
It is structured to transmit power to the front section after the actuator hub is engaged following the release of vacuum from the drive shaft end gear and the hub end gear.

Operating Process



Vacuum generation process in front hub actuator:



Modification basis	
Application basis	
Affected VIN	

1) Vacuum System Related to 4WD



Vacuum operation during 2WD mode

During 2WD mode, the vacuum pressure from vacuum pump is continuously
transmitted to the locking hub system.
This vacuum pressure pulls in the locking hub actuator so that it will not be engaged with the front end hub gear.



In 4WD mode, the TCCU blocks the transferring of vacuum pressure from vacuum pump to locking hub by supplying the power to solenoid valve.

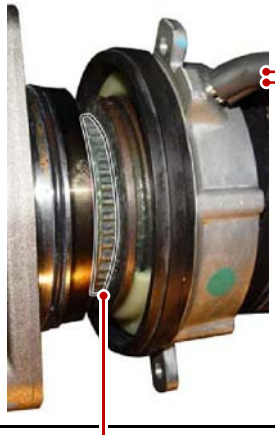
Air filter



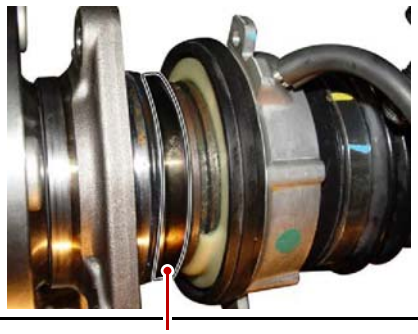
Hub actuator (LH)

Hub actuator (RH)





Atmosphere
(in 4WD mode)



2WD (applying vacuum pressure to hub actuator)
The vacuum pressure pulls in the locking
hub actuator so that it will not be engaged with the front end hub gear.

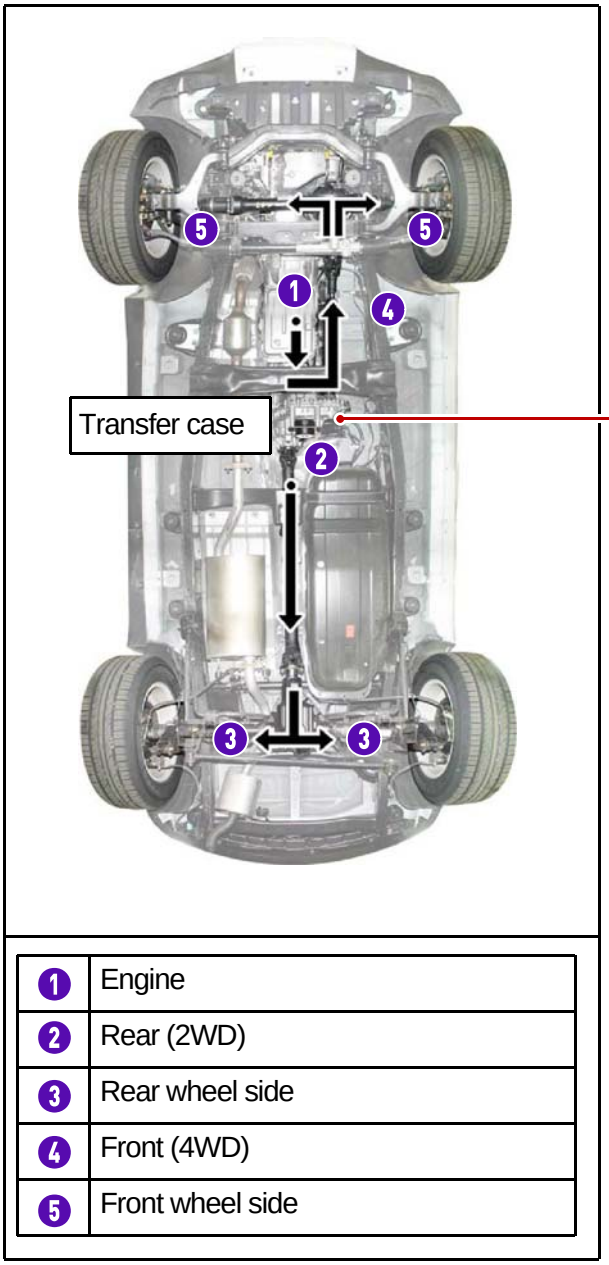
4WD (releasing vacuum pressure from hub actuator)

The vacuum pressure is released from the hub actuator. At this time, the front hub end gear is engaged.

Modification basis	
Application basis	
Affected VIN	

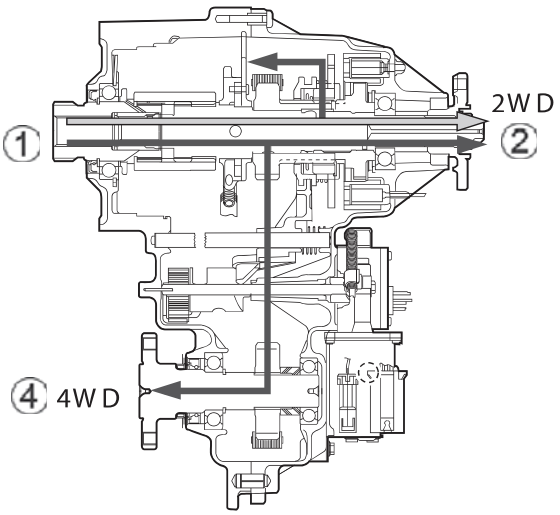
4. POWER FLOW

1) Components of Power Flow

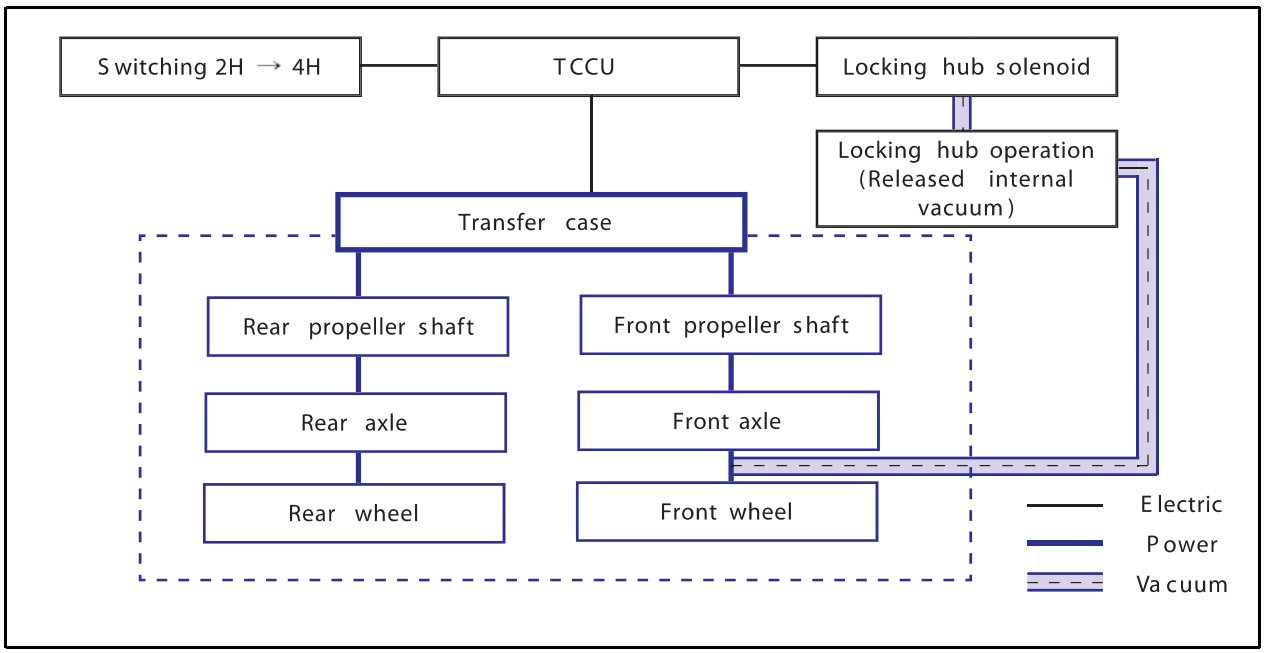


1	Engine
2	Rear (2WD)
3	Rear wheel side
4	Front (4WD)
5	Front wheel side

Part time transfer case

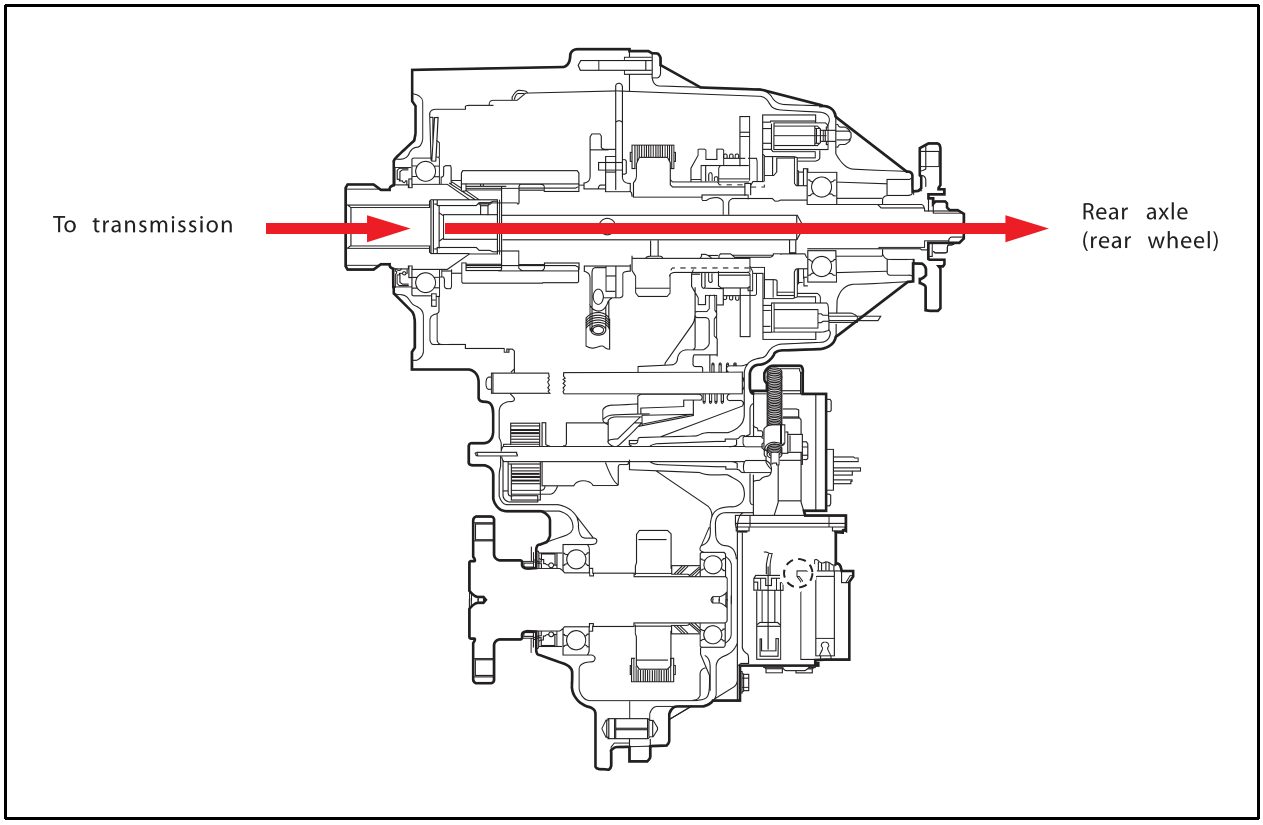


2) Flow Layout

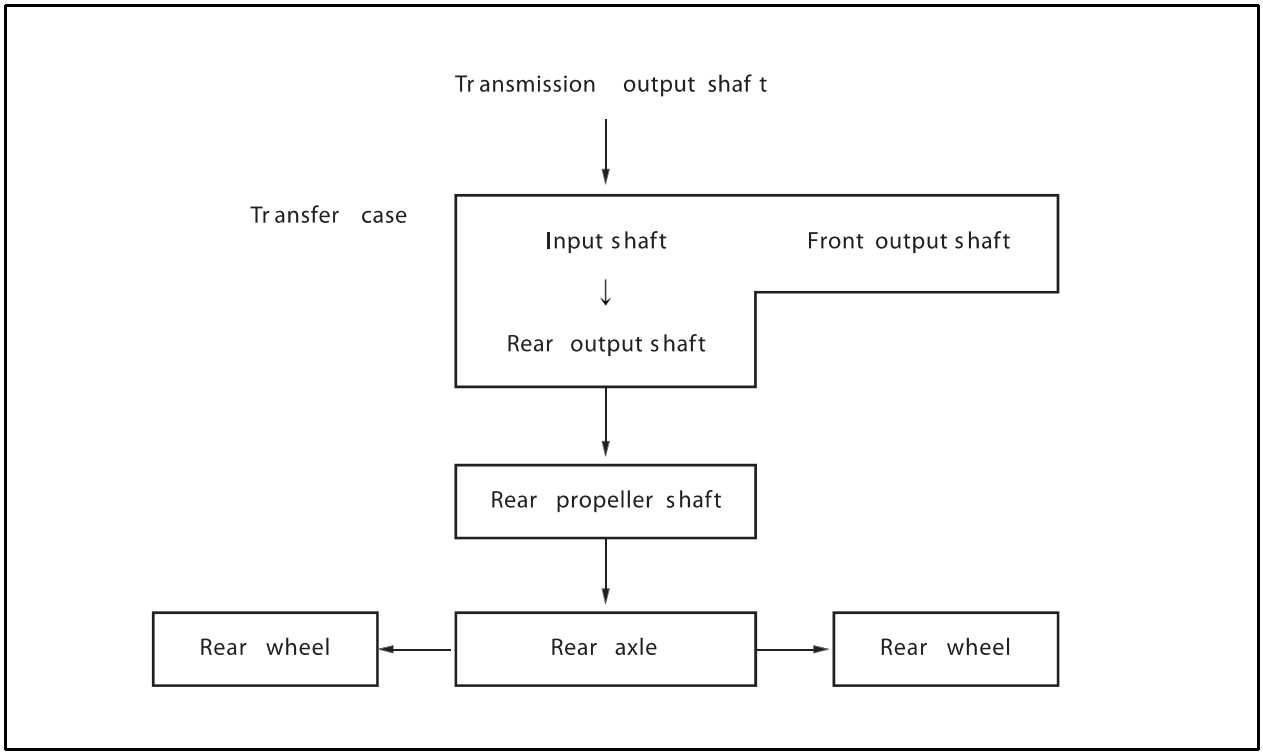


Modification basis	
Application basis	
Affected VIN	

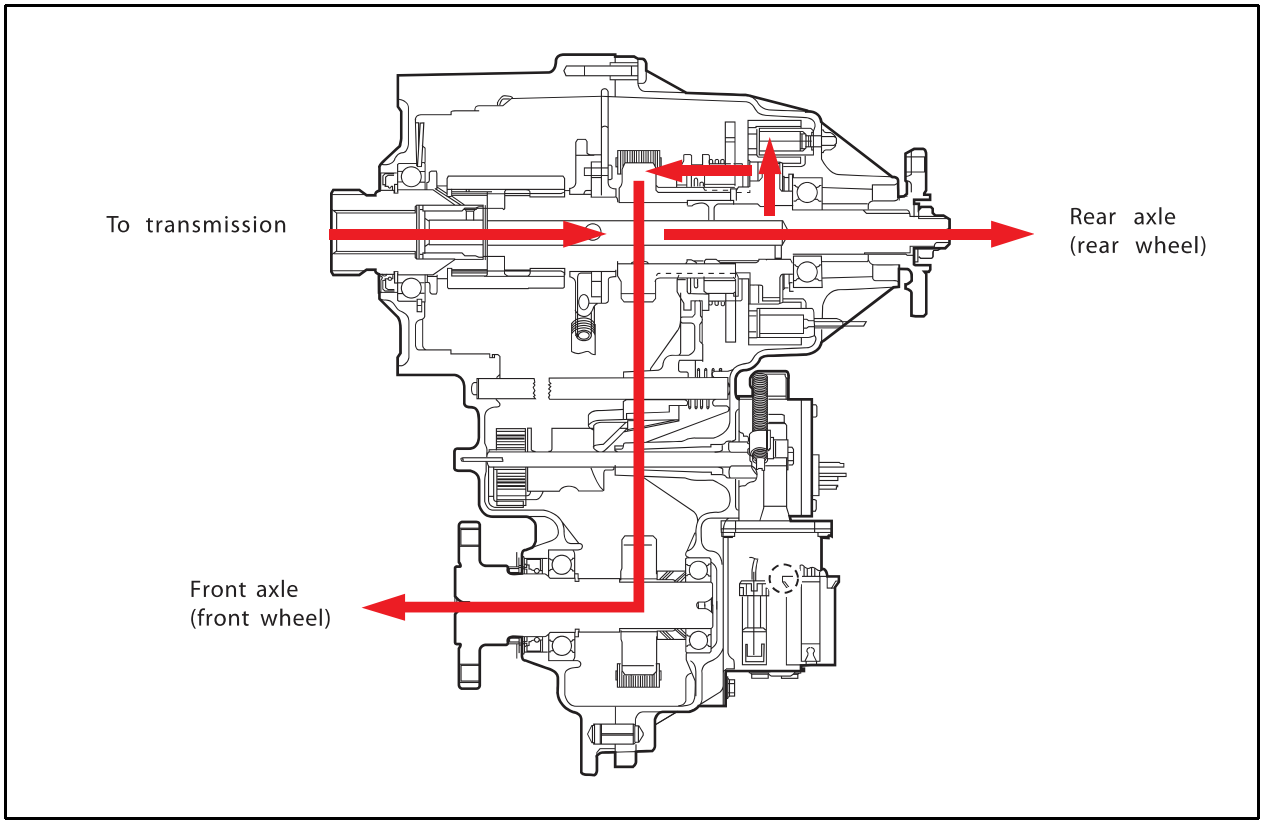
3) 2H Mode (Rear Wheel Drive)



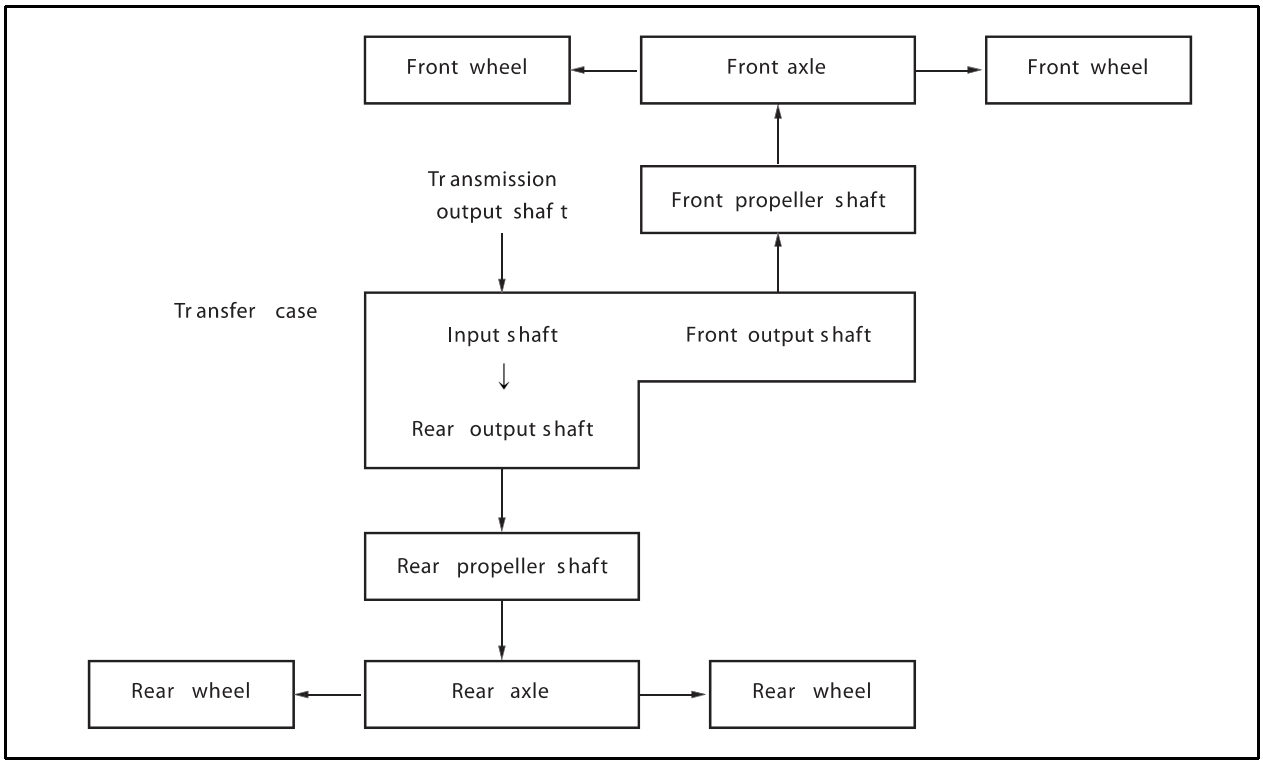
(1) Layout



4) 4H Mode (4 Wheel Drive - High speed)

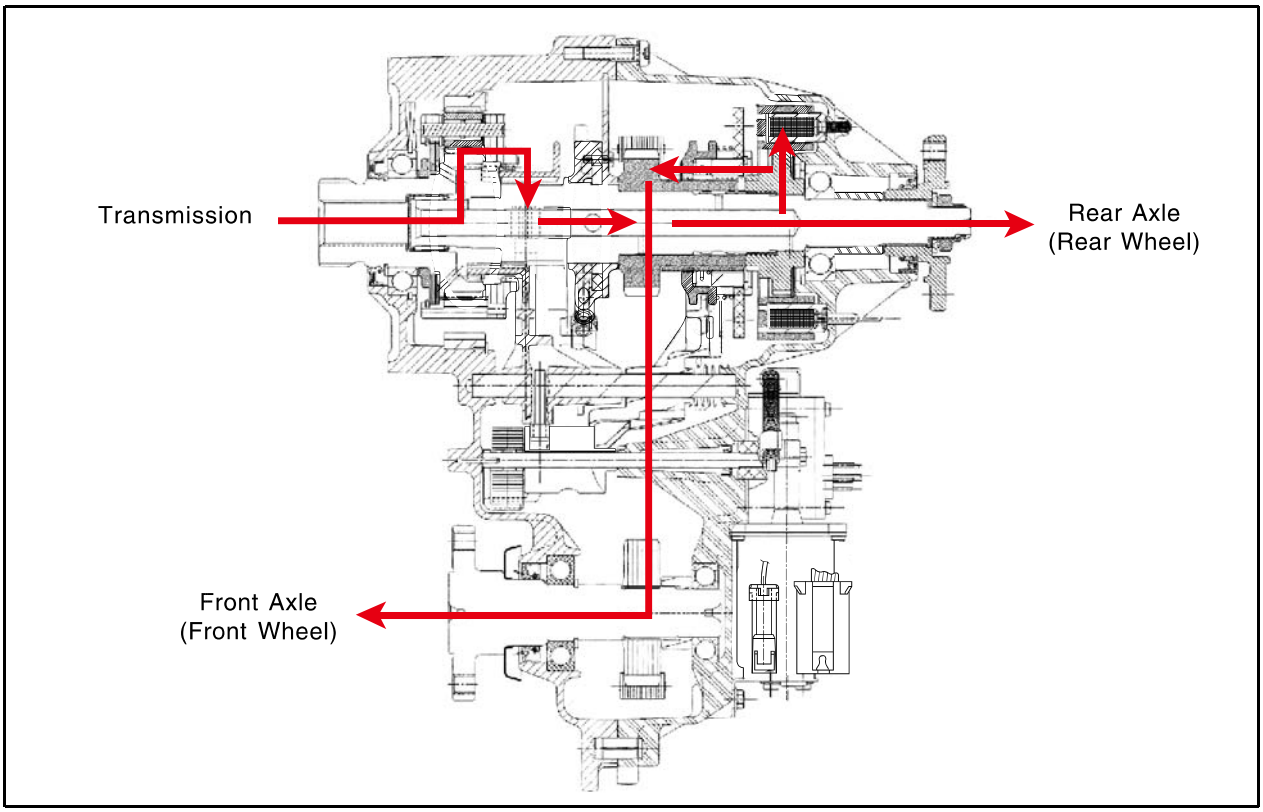


(1) Layout

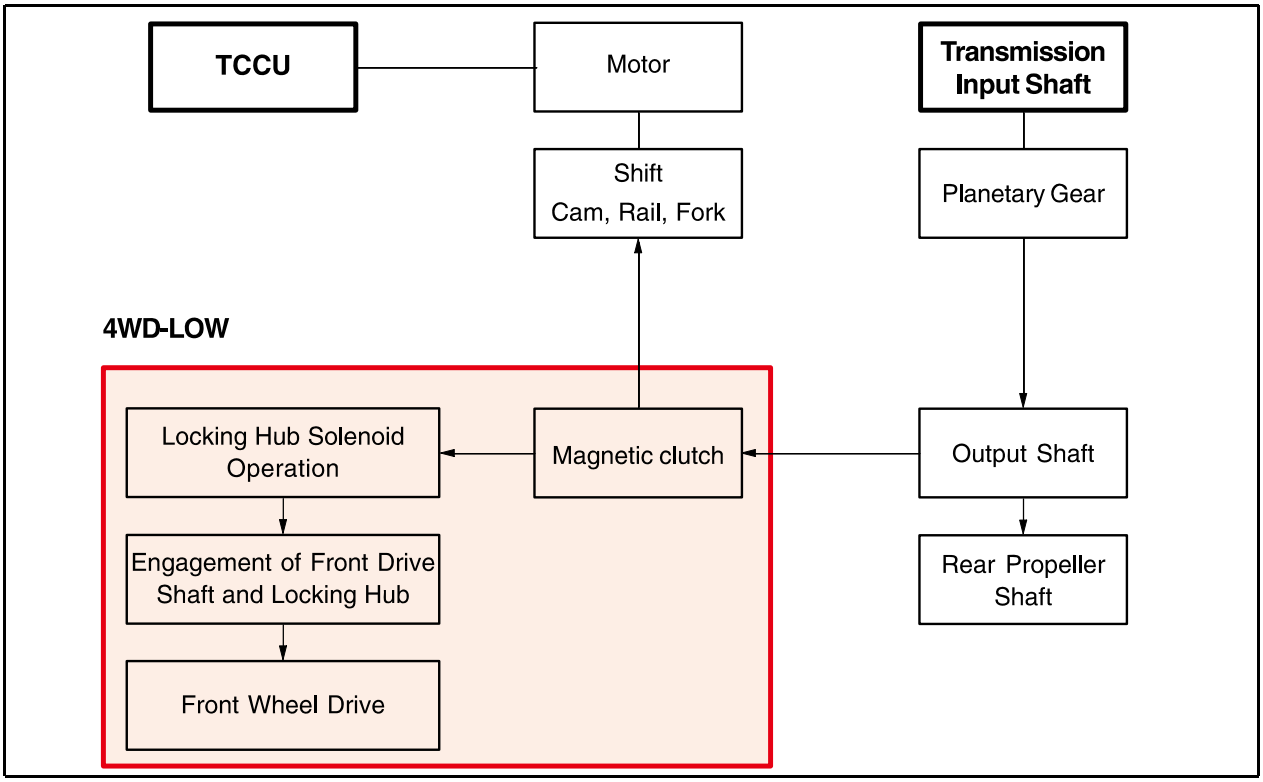


Modification basis	
Application basis	
Affected VIN	

4) 4L Mode (4 Wheel Drive - Low speed)



(1) Layout



SUSPENSION 4510-01

GENERAL

1. SPECIFICATIONS OF SUSPENSION

Description		Specification
Suspension type	Front	Double wishbone
	Rear	5-Link
Spring type		Coil spring
Shock absorber type		Cylindrical double tube (gas type)
Stabilizer type		Torsion bar
Height "H" (When tightening upper arm/lower arm/shock absorber yoke nut)		86.5 ± 5 mm

2. WHEEL ALIGNMENT

Description	Specification	
Toe-in	2 ± 2 mm (0.13 ± 0.13 deg)	
Camber	−0.14 ± 0.25° (LH)	The difference between both ends is should be below 0.5°)
	−0.34 ± 0.25° (RH)	
Caster	4.4 ± 0.4° (LH)	The difference between both ends is should be below 0.5°)
	4.5 ± 0.4° (RH)	

BRAKE SYSTEM 4850-01

GENERAL INFORMATION

1. SPECIFICATION

Unit	Description	Specification
Front brake	Type	Ventilated disc
	Outer diameter of disc	Ø294 mm
	Inner diameter of caliper cylinder	Ø43.0 x 2 mm
	Thickness of disc	28 mm (wear limit: 25.4 mm)
	Area of brake pad	Above 60 cm2
	Pad wear indicator	Mechanical type
Rear brake	Type	Solid disc
	Outer diameter of disc	Ø299 m
	Thickness of disc	10.4 mm (wear limit: 8.5 mm)
	Area of brake pad	Above 28.8 cm2
	Pad wear indicator	Mechanical type
Brake booster	Type	Vacuum assist type
	Size	8” + 9” (Tandem)
Master cylinder	Type	Tandem type(integrated level sensor)
	Inner diameter of cylinder	Ø26.99 mm
Brake pedal	Maximum operating stroke	150 mm
	Pedal ratio	4 : 1
	Free play	3 to 10 mm
Parking brake	Type	Mechanically expanded rear lining
	Operating type	Hand operated type
	Inner diameter of drum	Ø190 mm
Brake oil	Specification	DOT 4
	Capacity	0.7 to 0.8 liters

NOTE

Service Interval: Change the brake oil at every 2 years

DOT?

It is the quality grade of brake fluid established by US Department of Transportation.

2. SYSTEM OVERVIEW

1) Terms and Definition

- CBS: Conventional Brake System
- ABS: Anti-Lock Brake System
- EBD: Electronic brake-Force Distribution
- ESP: Electronic Stability Program
- ABD: Automatic Braking Differential
- ASR: Acceleration Slip Regulation
- AYC: Active Yaw Control (Understeer and Oversteer Control)
- HBA: Hydraulic Brake Assistant
- ARP: Active Rollover Protection
- HSA: Hill Start Assistant
- Brake pad: Brake pad is a component of disk brakes used in automotive and other applications. Brake pad is steel backing plates with friction material bound to the surface that faces the brake disc.
- Brake disc: The brake disc is a device for slowing or stopping the rotation of a wheel while it is in motion.
- Brake caliper: To stop the wheel, friction material in the form of brake pads (mounted on a device called a brake caliper) is forced hydraulically against both sides of the disc. Friction causes the disc and attached wheel to slow or stop.
- Brake master cylinder: The brake master cylinder is a control device that converts non-hydraulic pressure (commonly from a driver's foot) into hydraulic pressure, in order to move other device(s) which are located at the other end of the hydraulic system, such as one or more slave cylinders. As piston(s) move along the bore of the master cylinder, this movement is transferred through the hydraulic fluid, to result in a movement of the slave cylinder(s). The hydraulic pressure created by moving a piston (inside the bore of the master cylinder) toward the slave cylinder(s) compresses the fluid evenly, but by varying the comparative surface-area of the master cylinder and/or each slave cylinder, one will vary the amount of force and displacement applied to each slave cylinder (relative to the amount of force and displacement that was applied to the master cylinder).

2) Functions

<table>
<tr><th>Function</th><th>Vehicle with CBS</th><th>Vehicle with ABS/EBD</th><th>Vehicle with ESP</th></tr>
<tr><td>ABS</td><td rowspan="7">Not applied</td><td>Applied</td><td rowspan="7">Applied</td></tr>
<tr><td>EBD</td><td>Applied</td></tr>
<tr><td>ABD</td><td rowspan="6">Not applied</td></tr>
<tr><td>ASR</td></tr>
<tr><td>AYC</td></tr>
<tr><td>HBA</td></tr>
<tr><td>ARP</td></tr>
</table>

Modification basis	
Application basis	
Affected VIN	

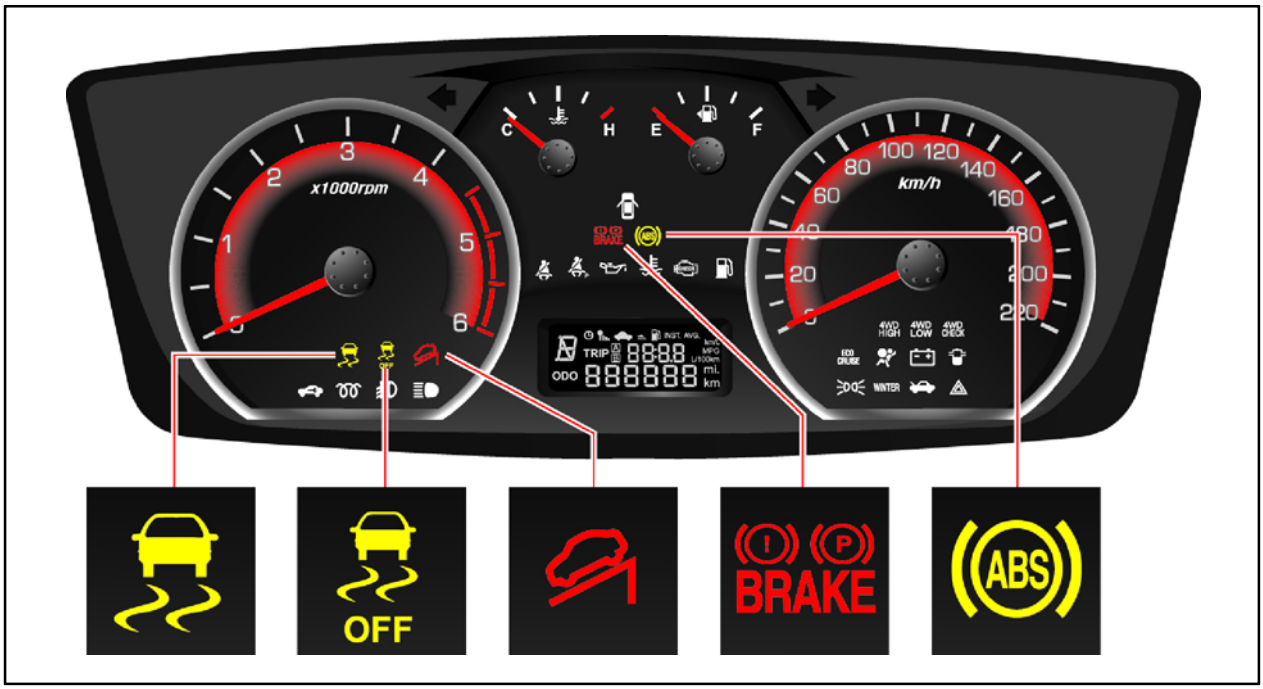
3) Parts Arrangement

Part name	Vehicle with CBS	Vehicle with ABS/EBD	Vehicle with ESP
HECU	Not applied	Applied	Applied
Front wheel speed sensor			
Rear wheel speed sensor			
ABS warning lamp			
EBD indicator			
Longitudinal G sensor		2WD: N/A, 4WD: Applied	Not applied
Sensor cluster (Yaw rate sensor, lateral/longitudinal G sensor)		Not applied	Applied
ESP indicator			
ESP OFF switch and warning lamp			
Steering wheel angle sensor			

4) Components

	ABS		ESP+ARP	
	2WD	4WD	2WD	4WD
Whhel speed sensor	4	4	4	4
Sensor cluster	N/A	N/A	Applied	Applied
G-sensor	N/A	Applied	N/A	N/A
2H G-sensor	-	Operating	-	-
4H G-sensor	-	Operating	-	-
4L G-sensor	-	Operating	-	-
2H sensor cluster	-	-	Operating	Operating
4H sensor cluster	-	-	Operating	Operating
4L sensor cluster	-	-	Operating	Operating

5) Indicators and Warning Lamps for ABS/ESP



Lamp	Indicator/Warning Lamp	Description
EBD warning lamp		ON when EBD function is failed
ABS warning lamp		ON when ABS function is failed
ESP indicator		Blinking when ESP function is operating
ESP OFF indicator		ON when the ESP OFF switch is pressed
ESP warning lamp		ON when ESP function is failed
ESP buzzer		Sound when ESP function is operating
HDC indicator		Red: HDC operating Green: HDC switched ON

Modification basis	
Application basis	
Affected VIN	

3. TROUBLESHOOTING

Problem	Possible Cause	Action
Noise or vehicle vibration when applied	Incorrectly mounted back plate or caliper	Repair
	Loosened bolt of back plate or caliper	Retighten
	Uneven wear of brake disc	Replace
	Brake pad contamination	Clean or replace
	Sticking brake pad on contact surface	Replace
	Wear or hardening of brake pad	Replace
	Excessive clearance between caliper and pad	Repair
	Uneven contact of pad	Repair
	Lack of lubrication in sliding parts	Lubricate
	Improper operation of caliper	Replace
	Dust cover missing	Repair
	Loosened suspension mounting bolt	Retighten
Pulls to one side when braking	Unbalanced tire pressure between left and right	Adjust
	Poor contact of brake pad	Repair
	Oil or grease on brake pad	Replace
	Scratch, uneven wear, distortion of brake disc	Replace
	Improperly installed brake caliper	Repair
	Improper operation of auto adjuster	Repair
	Crack or distortion of brake pad	Replace
Poor braking	Oil leak or contamination	Repair or replace
	Air in brake line	Bleed air
	Improper operation of brake booster	Repair
	Poor contact of brake pad	Repair
	Oil or grease on brake pad	Replace
	Improper operation of auto adjuster	Repair
	Clogged brake line	Repair
	Improper operation of proportioning valve	Repair

Problem	Possible Cause	Action
Increased pedal stroke	Air in brake line	Bleed air
	Oil leak	Repair
	Worn brake pad	Replace
	Excessive clearance between push rod and master cylinder	Adjust
	Worn or damaged piston seal	Replace
Brake dragging	Parking brake is not fully released	Release
	Incorrect adjustment of parking brake	Adjust
	Incorrectly adjusted clearance of parking brake shoe	Adjust
	Faulty brake pedal return spring	Replace
	Incorrectly adjusted free play of brake pedal	Adjust
	Faulty master cylinder	Replace
	Lack of lubrication in sliding parts	Lubricate
	Faulty brake booster (vacuum leak)	Repair
Poor parking brake	Wear, hardening or poor contact of brake pad	Replace
	Oil or water on lining	Repair or replace
	Fixed or broken parking brake cable	Replace
	Excessive stroke of brake lever	Adjust notch
	Faulty auto clearance adjuster	Repair
Increased stroke of parking brake lever	Loosened parking brake cable	Adjust or replace
	Incorrectly adjusted parking brake cable	Adjus
	Defective automatic lining clearance adjuster	Repair or replace
	Worn brake lining	Replace

Problem	Cause	Action
Burning smell around tire	Too frequent braking in high driving speed	Reduce the use of foot brake/use engine brake properly
	Used only foot brake during downhill driving	
	Driving with foot on brake pedal	Get off the foot from pedal
	Foreign materials such as dirt or sand in brake system	Replace: caliper, wheel cylinder, master cylinder, return spring
	Broken return spring in shoe assembly	Replace
	Incorrectly adjusted parking brake cable	Adjust
	Incorrect wheel or wheel cover (generating the heat)	Replace

▶ BRAKE OPERATION AND NOISE

This section describes the noise phenomena occurred possibly in the brake system operation. Distinguish between the information given below and the actual problems and then, inspect the vehicle and take appropriate measures.

- **Noise symptoms and Causes**

Symptom 1. If depressing the brake pedal when the engine is cold, "screeching" sound always occurs and, after driving for a while, the sound disappears..

This usually occurs in the morning. When the temperature goes down, the dew condensation phenomenon sets moisture on the brake disc as the window frost forms. Due to this moisture, the iron within the brake disc and pad oxidizes, forming undetectable micro-rusts on the disc surface. When starting the engine under this condition, noise may sound due to the friction of micro-rusts. When operating the brake several times, the disc temperature goes up and the micro-rusts come off and the noise goes away. Depending on the driving conditions, noise gets louder when slightly depressing the brake pedal and oppositely, noise is smaller when deeply depressing the brake pedal. This is simply a physical phenomenon, called "morning effect" in professional terms, and does not imply any problems with the brake system.

Symptom 2. Slip or screech after the brake pad replacement.

This usually occurs when the bed-in is not made between the disc and the pad's friction material. The bed-in is a state that the brake system normally works and gives no noise out, when, after about 300 km city driving, the contact area of the pad friction material is enlarged and the disk is in complete contact with the pad's friction material. Therefore, for some time after the brake disk/pad replacement, the brake system poorly operates or noise (abnormal sound) occurs due to the partial contact.

Symptom 3. "Groaning" sound occurs in the automatic transmission vehicle when slightly taking the foot off the brake pedal to slowly start after waiting for the signal, or slightly depressing the brake pedal.

This is the noise "Creep groan" that occurs when, in both the automatic and manual transmission, slightly releasing the brake pedal in the neutral gear at downhill roads.
It frequently occurs at the low braking power and low speed, through the following process. When operating the brake system at low speed and low pressure, adhesion and slip repeatedly take place between the brake disk and the friction material, and this makes the braking power inconstant, instantly increasing or decreasing, and gives out the brake noise.
It is also a physical phenomenon and has no relation with the brake performance.

Modification basis	
Application basis	
Affected VIN	

4. AIR BLEEDING

CAUTION

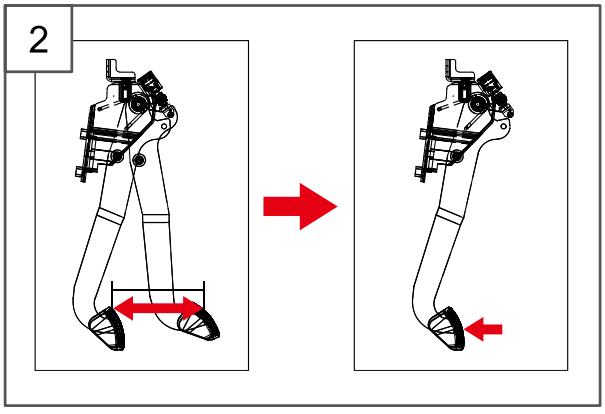
- Never reuse the used brake fluid.
- Use only specifies brake fluid (DOT 4). Add brake fluid between MAX and MIN lines on the reservoir (0.7 to 0.8 liters).
- Be careful not to splash the brake fluid on painted area or body.
- Make sure that any foreign material does not get into brake line.
- Always work with another staff.

1



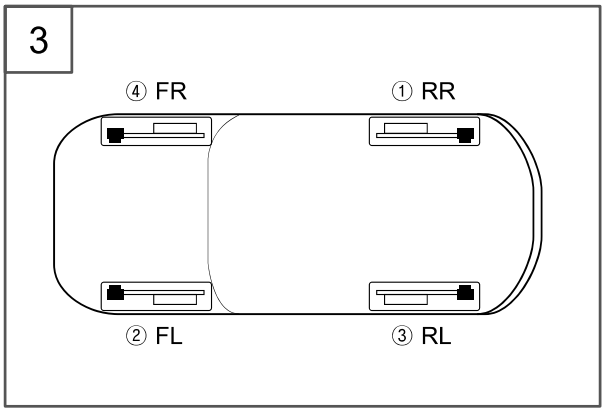
1. Fill up the brake fluid up to "MAX" line on the reservoir.

2



2. Fill the reservoir with brake fluid and pump the brake pedal several times. Then keep it depressed.

3

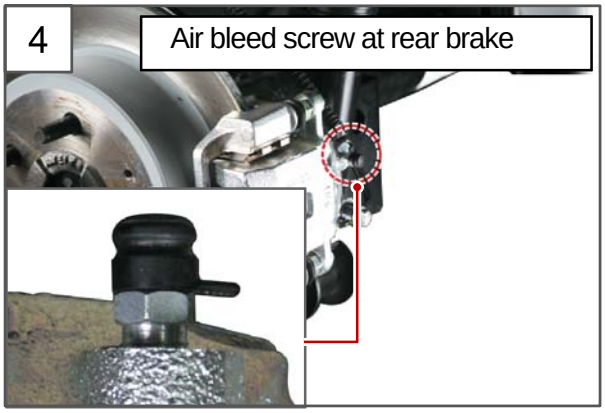


3. Loosen the bleed screw and collect the bleeding brake fluid from the brake line with the order in the figure.

CAUTION

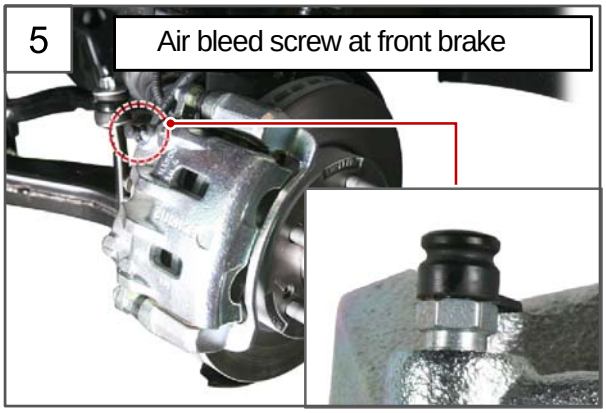
Fill the reservoir with the brake fluid as much as it bleeded, and continue to bleeding operation.

Modification basis	
Application basis	
Affected VIN	



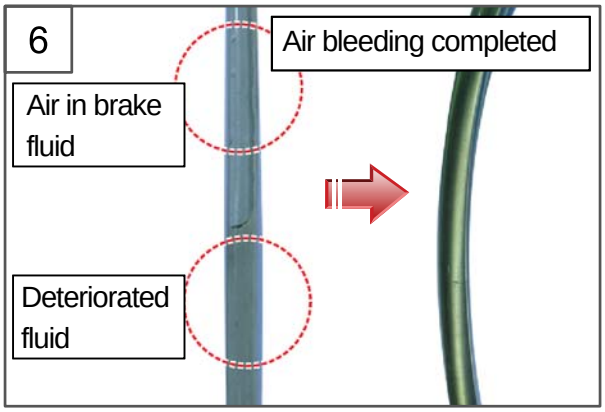
4. Air bleed screw at rear brake

Tightening torque 9.8 ~ 11.2Nm



5. Air bleed screw at front brake

Tightening torque 9.8 ~ 11.2Nm



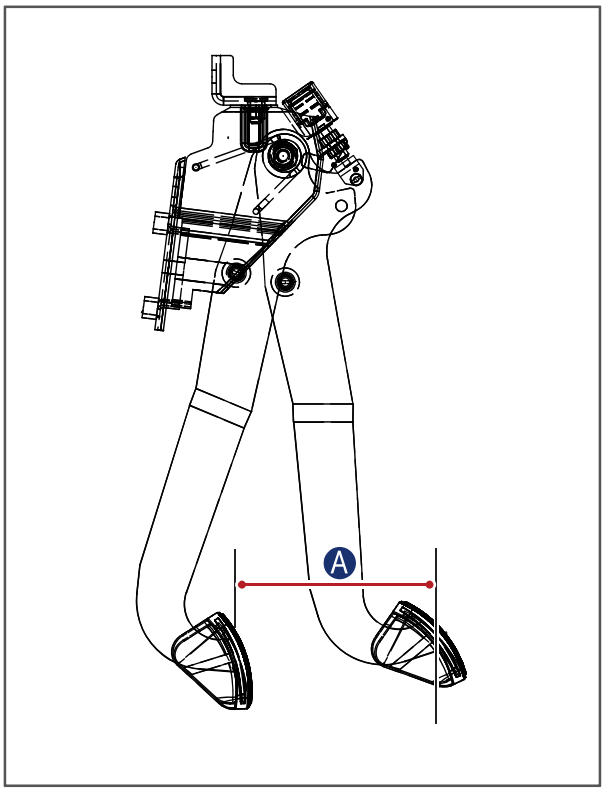
6. Repeat the air bleeding procedures until clear brake fluid comes out of air bleed screw.

7. Check for oil leaks from the brake lines.

Modification basis	
Application basis	
Affected VIN	

5. BRAKE SYSTEM CHECK

▶ **Maximum Stroke of Brake Pedal**



- Check the brake pedal with below procedures:

1. Start the engine.
2. Pump the brake pedal around 3 times.
3. Depress the brake pedal with approx. 30 kg and measure the distance (A) between the upper surface of pedal pad and the lower dash panel.
4. If the measured value is out of the specified value, adjust the length.

Specified value (A)	150mm

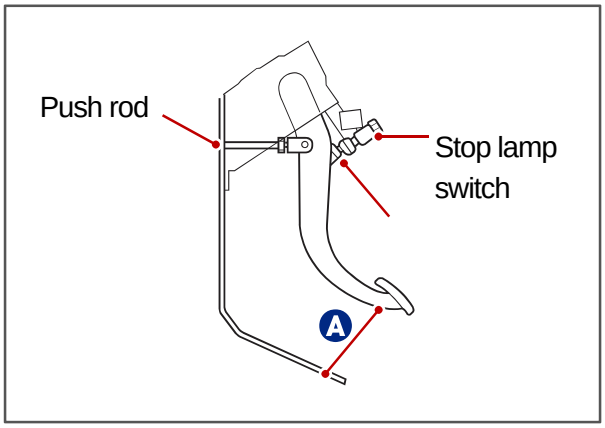
Over the specified value

Cause	Action
Worn brake pad	Replace
Worn brake shoe	Replace
Improper stroke of hand brake	Adjust
Air in brake line	Air bleeding
Oil leak	Repair or replace
Brake booster push rod	Replace or adjust
Improperly adjusted stopper bolt	Adjust

Below the specified value

Cause	Action
Brake booster push rod	Replace or adjust
Air in brake fluid	Replace
Improperly adjusted stopper bolt	Adjust

▶ Pedal Height



- Check the pedal height with below procedures:

1. Start the engine and measure the length (A) between floor mat and pedal.
2. If the measured value is out of the specified value, adjust the length.

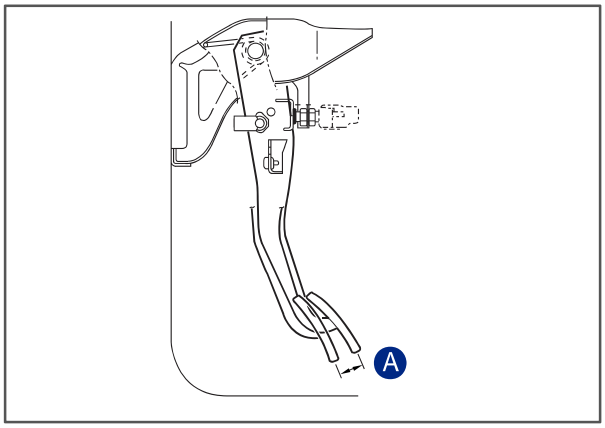
Specified value (B)	155mm

- Adjust the pedal height with below procedures:

1. Disconnect the stop lamp switch connector.
   Unscrew the lock nut and remove the stop
2. lamp switch assembly.
   Loosen the lock nut on the pedal push rod.
3. Turn the pedal push rod to adjust the pedal
4. height.
   Tighten the lock nut.
5. Install the stop lamp switch assembly.
6. Connect the stop lamp switch connector.
7. Check if the stop lamps come on when
8. pressing the brake pedal around 5 mm.
   If the stop lamp dpes not come on, adjust the
9. stop lamp switch assembly again.
   If the stop lamps come on, tighten the lock nut
10. and measure the pedal height again.

Modification basis	
Application basis	
Affected VIN	

▶ Pedal Free Play



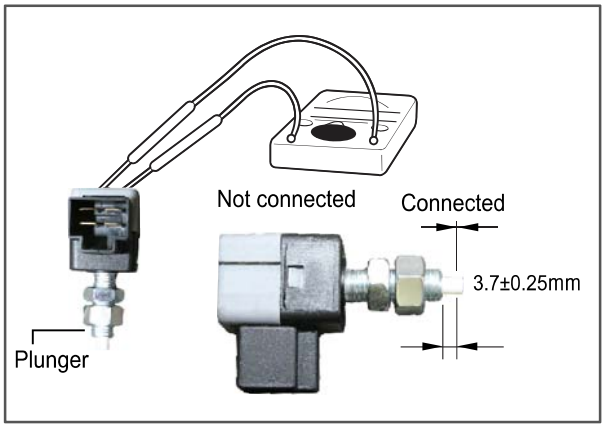
- Check the pedal free play with below procedures:

1. Stop the engine.
2. Depress the brake pedal several times to discharge the vacuum pressure of the brake booster.
3. Depress the brake pedal until you feel the resistance, and measure the movement (A).

Specified value (A)	3 ~ 10mm

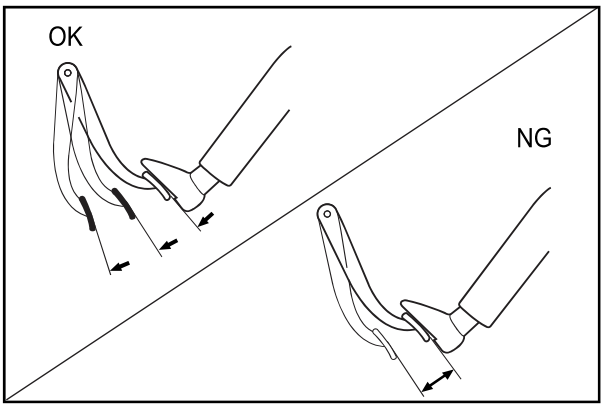
- Below the specified value: Check if the distance between the outer case of stop lamp switch and the brake pedal.
- Over the specified value: It may be caused by bigger clearance between the clevis pin and the brake pedal arm. Replace the components if necessary.

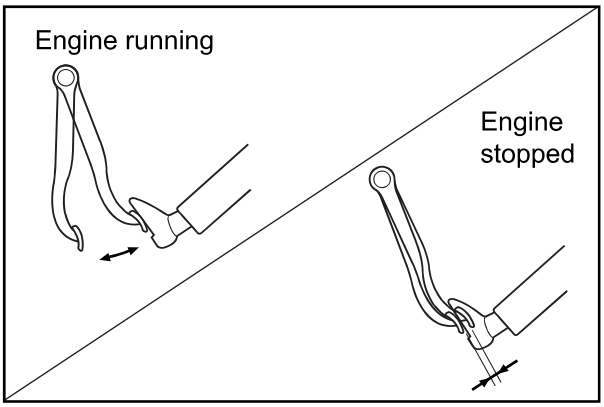
▶ Stop Lamp Switch



- Connect the multimeter to stop lamp switch connector and check if the continuity exists when pushing in the plunger. If the continuity doesn't exist, the stop lamp switch is normal.

▶ Brake Booster





1. Let the engine run for 1 to 2 minutes and stop it. If the brake pedal stroke is shortened as pumping the brake pedal, the system is normal. If not, the system is defective.
2. Depress the brake pedal several times with engine off. If the brake goes down when starting engine with pedal depressed, the system is normal. If not, the system is defective.
3. Depress the brake pedal when the engine is running. If the pedal height is not changed for 30 seconds after stopping the engine, the system is normal. If not, the system is defective.

If the above three checks are OK, the system is normal. If any condition is not met, check the valve, vacuum hose and brake booster.

Modification basis	
Application basis	
Affected VIN	

▶ Brake Fluid

1. Color

   - Ligh gold (New oil) → Brown → Black

2. Service Interval/Type

   - Change: every 2 years, Type: DOT4
     The water in the brake fluid has an adverse effect to the brake system. If the fluid contains around 3% of water, the boiling point of the brake fluid goes down by 25%. It will cause the vapor lock frequently.
     Water content in fluid: around 3% after 18 months, around 7~10% after few years
     The water ib fluid makes the corrosion in the brake lines, deforms and deteriorates the rubber components, brake calipers and pistons.

▶ Brake Fluid Type

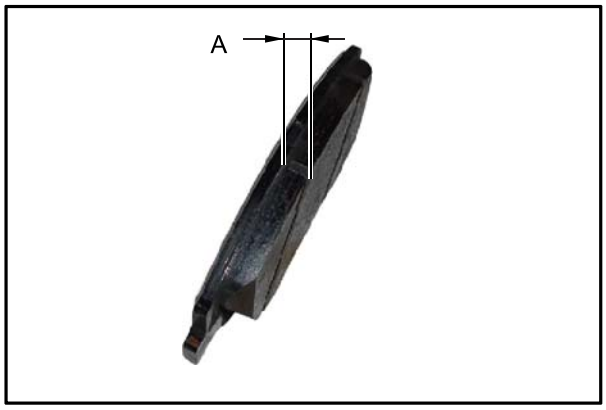
DOT4: Brake fluid for premium vehicle. Lower water absorbing rate AND higher boiling point than DOT3

▶ Brake Fluid Level Check



The brake fluid level should be between "MAX" and "MIN" on the reservoir. If it is below "MIN" mark, check for oil leaks and refill the reservoir with the specified fluid.

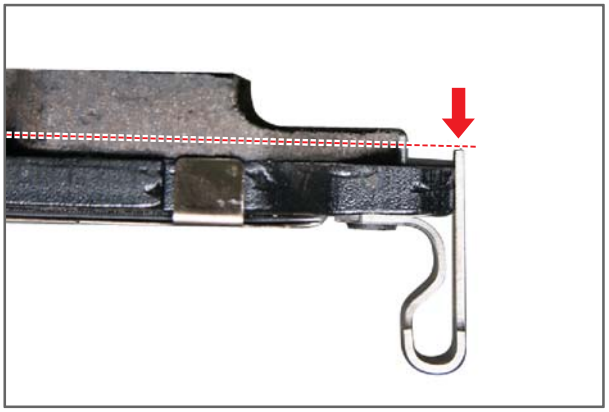
▶ Front Brake



1. Pad Thickness

- Measure the pad thickness and replace it if it is below the wear limit.

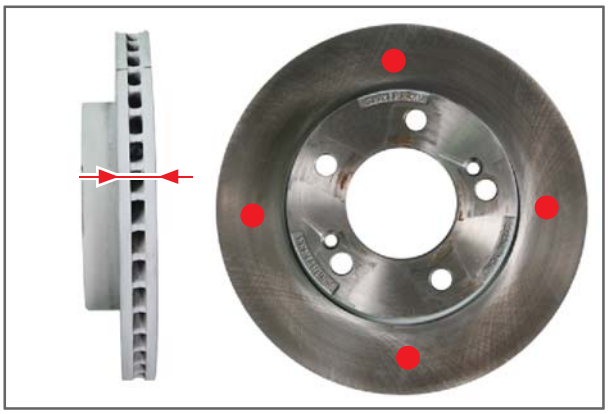
New pad	Wear limit
10.5 mm	2 mm



- Wera limit point

2. Disc Thickness

- Measure the disc thickness at over four points.
- If any of measured points is below the wear limit, replace the brake disc with new one.



New disc	Wear limit
28 mm	25.4 mm

3. Disc Run-Out

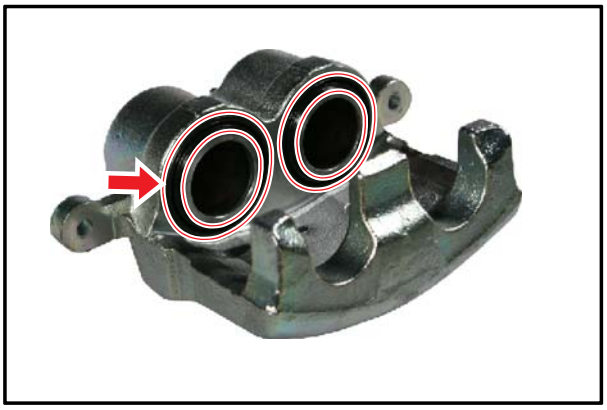
- Install the dial gauge on the side of brake disc and measure the run-out while rotating the brake disc.
- If the measured value exceeds the limit, replace the brake disc with new one. Otherwise, it may cause the pedal vibration and shimmy when braking.



Limit	0.03 mm (before installation)
	0.07 mm (when installed)

Modification basis	
Application basis	
Affected VIN	

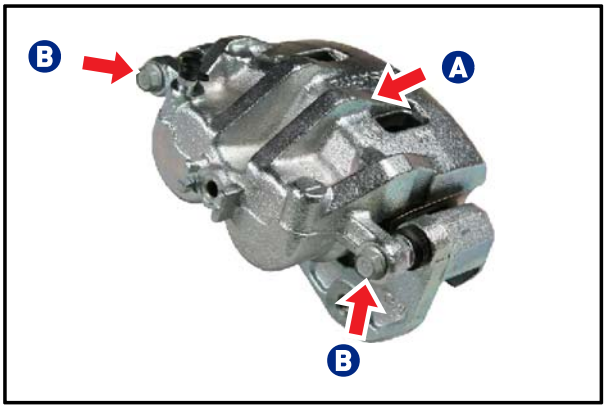
Clean the dissembled components and visually check the followings:



4. Damage and tear on boot



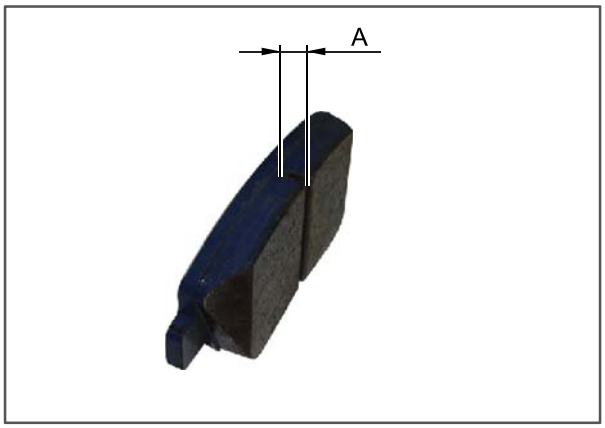
5. Uneven wear and oil contamination



6. Damage, crack and wear on cylinder body (A) and guide pin (B)

7. Wear, rust and damage on the cylinder and piston
8. Scratch and bending on disc plate

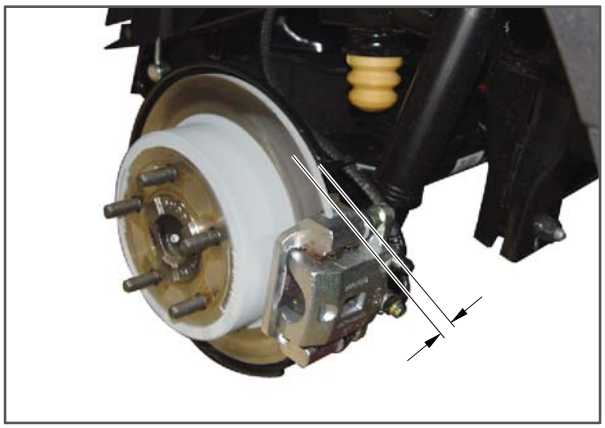
▶ **Rear Brake**



Pad Thickness

1. Remove the front tire.
2. 2. Measure the pad thickness and replace it if it is below the wear limit.

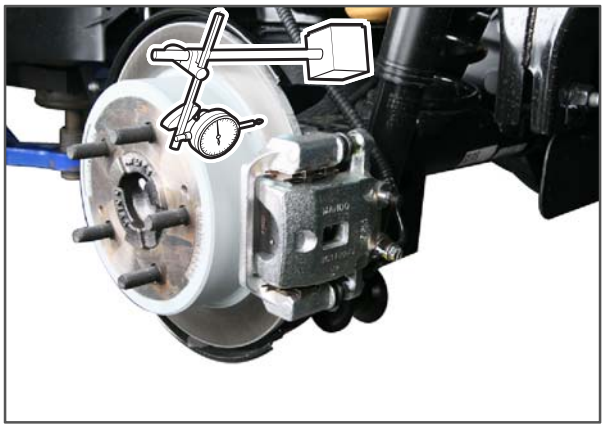
New pad	Wear limit
10 mm	2mm



Disc thickness

1. Measure the disc thickness at over four points.
2. If any of measured points is below the wear limit, replace the brake disc with new one.

New disc	Wear limit
10.4mm	8.5mm



Disc Run-Out

1. Install the dial gauge on the side of brake disc and measure the run-out while rotating the brake disc.
2. If the measured value exceeds the limit, replace the brake disc with new one. Otherwise, it may cause the pedal vibration and shimmy when braking.

Limit	0.03 mm (before installation)
	0.07 mm (when installed)

Modification basis	
Application basis	
Affected VIN	

▶ Parking Brake





Check the brake force with below procedures:

1. Count the number of the clicks (notches) when pulling up the parking brake with 19 kg of force.

Specified notches	5

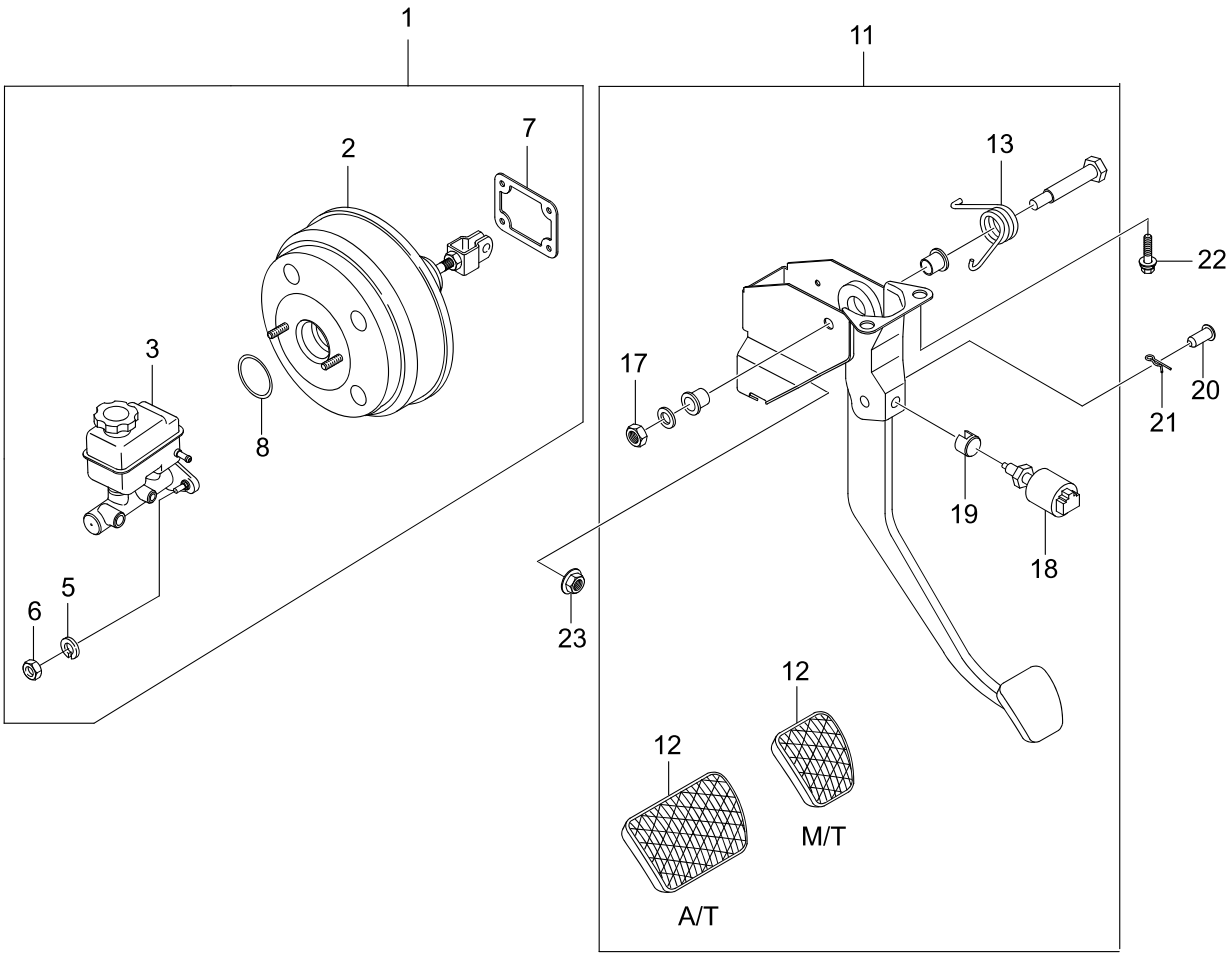
2. If the clicks are over or below the specified value, adjust the clicks to the specified value with the parking brake adjusting nut.
3. Check the parking brake force after adjustment.
4. If the parking brake force is not enough, check the parking brake lever and cable. Replace the components if needed.

CAUTION

Never park the vehicle only with the parking brake on the stiff hill. It may cause roll down of the vehicle due to release of the parking brake. Place the wheel chocks under the wheels.

6. COMPONENTS

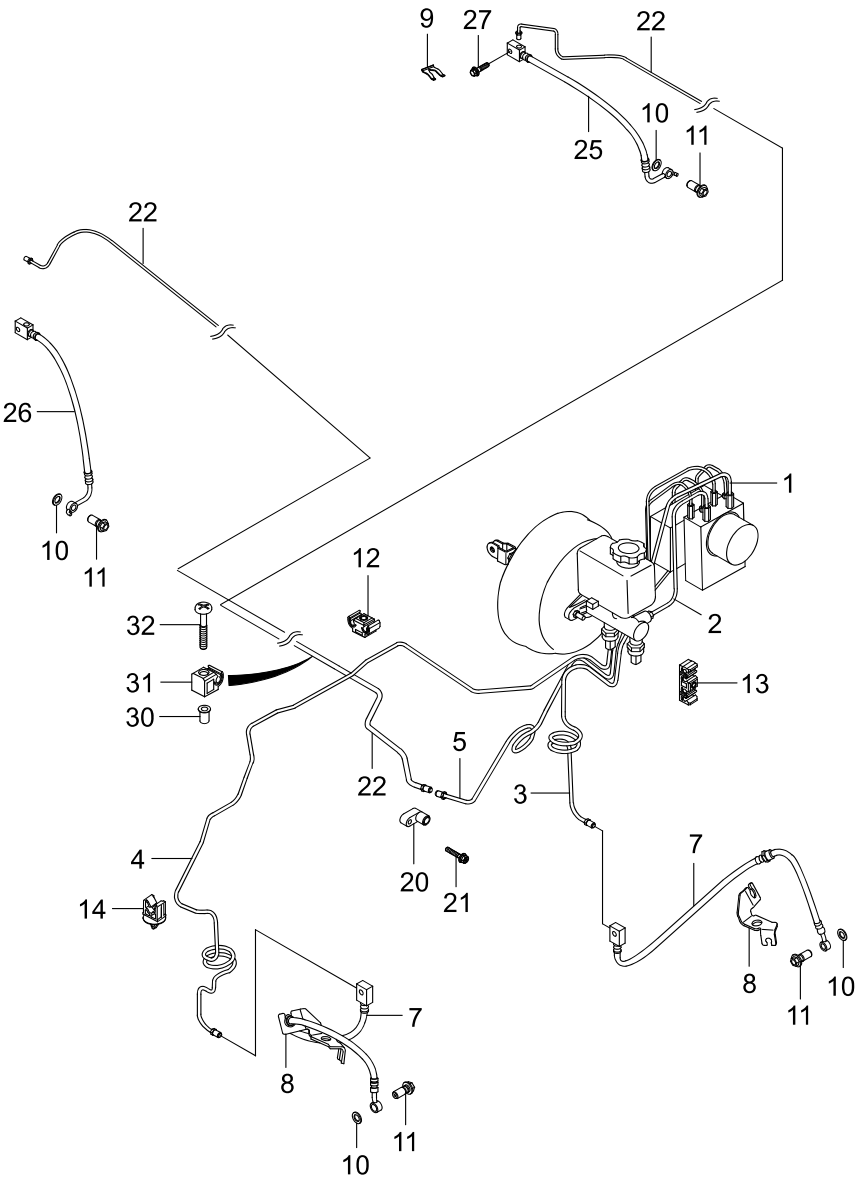
▶ **Brake Pedal, Master Cylinder and Booster**



1. Brake master cylinder assembly
2. Brake booster assembly
3. Brake master cylinder
6. Nut (12.8~16.7 Nm)
7. Booster mounting seal
8. O-ring
11. Brake pedal assembly
12. Brake pedal
13. Brake pedal return spring
17. Nut - Brake pedal
18. Stop lamp switch
19. Stopper
20. Clevis pin
21. Snap pin
22. Bolt - Brake pedal assembly (17.6~21.6 Nm)
23. Nut - Brake booster (17.6~21.6 Nm)

Modification basis	
Application basis	
Affected VIN	

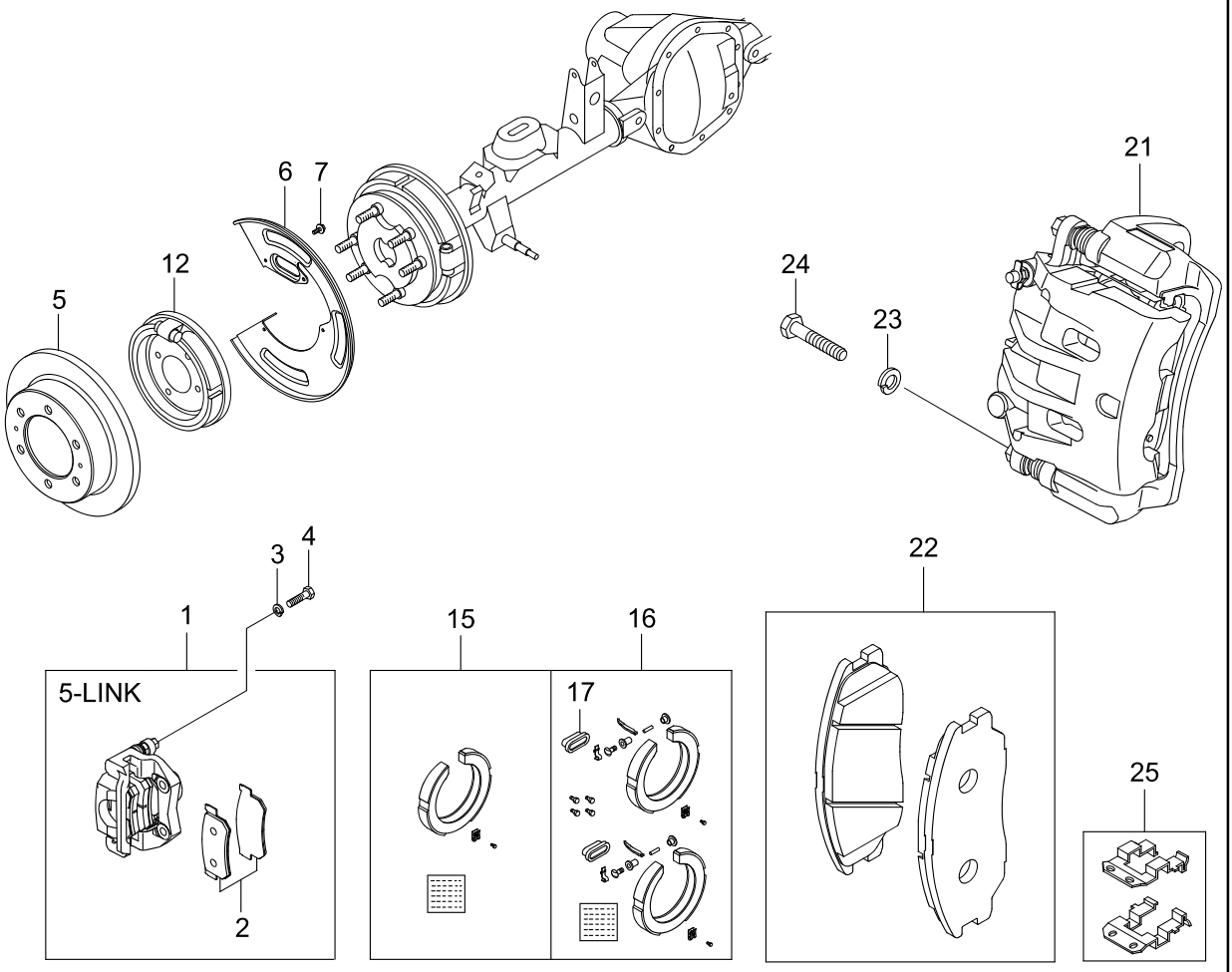
▶ Brake Pipe



1. Master cylinder primary tube assembly
2. Master cylinder secondary tube assembly
3. Front tube assembly
4. Front tube assembly
5. 2-way connector tube assembly
7. Front brake hose assembly
8. Front brake hose mounting holder
9. Flexible hose clip
11. Caliper eye bolt (19.6~29.4 Nm)
12. Brake tube mounting clip
13. Brake tube mounting clip
14. Brake tube mounting holder
20. Brake tube 2-way connector
21. Screw
22. Rear hose 2-way connector
24. 3-way connector hose tube assembly
25. Rear brake hose assembly
26. Rear brake hose assembly
27. Bolt (9.8~11.8 Nm)

Modification basis	
Application basis	
Affected VIN	

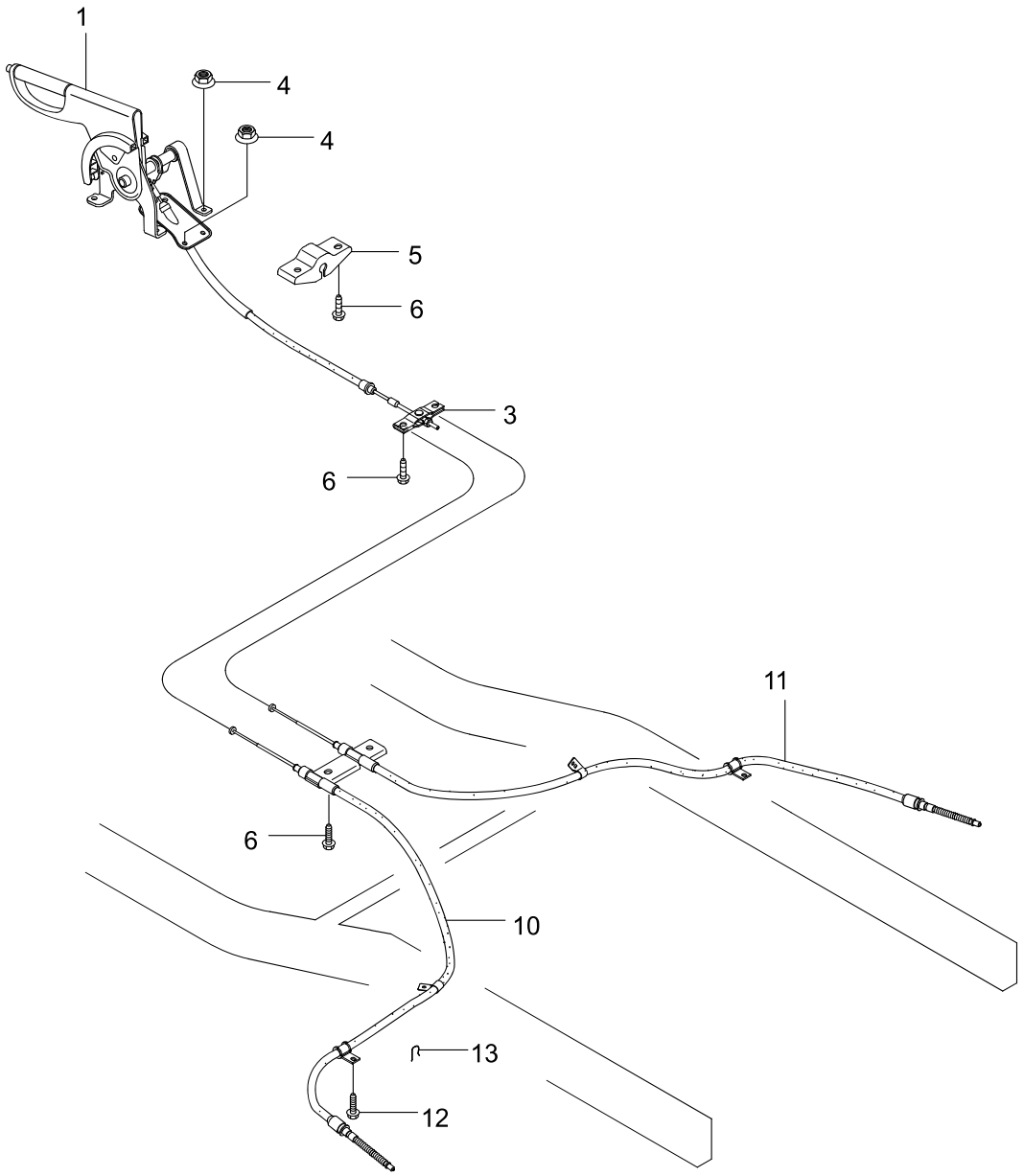
▶ **Front/Rear Brake Assembly**



1. Rear brake caliper assembly
2. Rear brake pad
3. Washer
4. Bolt (52.9~63.7 Nm)
5. Rear brake disc
6. Rear disc brake dust shield
7. Bolt
12. Rear drum brake assembly
15. Parking brake shoe
16. Parking brake repair kit
17. Rear axle shaft grommet
21. Front brake caliper assembly
22. Front brake pad
23. Washer
24. Front caliper mounting bolt (25.5~30.4 Nm)
25. Caliper clip set

Modification basis	
Application basis	
Affected VIN	

▶ Parking Brake



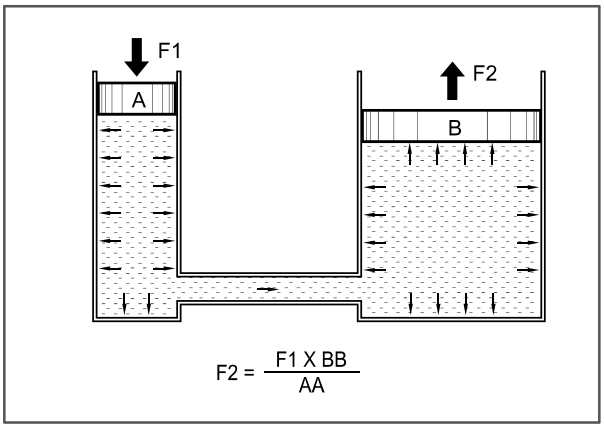
1. Parking brake lever assembly
3. Equalizer
4. Nut (9.8~12.7 Nm)
5. Front brake mounting bracket
6. Bolt
10. Parking brake rear cable assembly
11. Parking brake rear cable assembly
12. Bolt (9.8~12.7 Nm)
13. Parking brake cable retaining ring

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

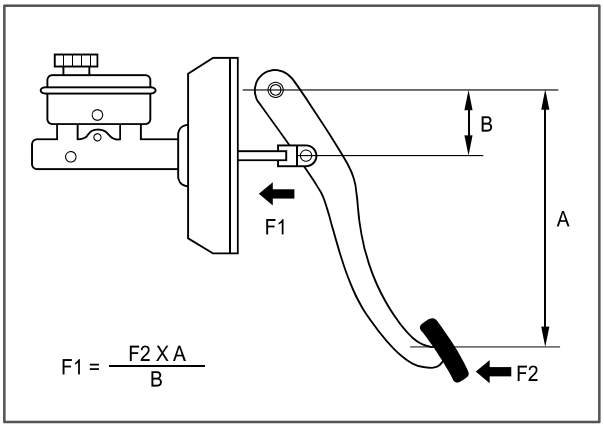
Even though a driver cuts off the power, while driving, the vehicle continues to move due to the law of inertia. Therefore, a braking device is needed to stop the vehicle. The brake system normally uses the frictional discs that converts the kinetic energy to the thermal energy by frictional operation. The brake system consists of the brake disc (front wheel), brake disc or drum (rear wheel), parking brake (mechanical type), master cylinder, booster, pedal and supply lines (pipes and hoses).

▶ Hydraulic Brake



This system uses the leverage effect and Pascal's principle. When depressing the brake pedal, the pedal pressure is increased by booster and is delivered to master cylinder to generate hydraulic pressure. The hydraulic pressure generated by the master cylinder is delivered to the brake caliper through the brake pipes or hoses. This hydraulic pressure pushes the brake calipers, accordingly the caliper pads are contacted to brake disc to generate the braking force.

▶ Brake Pedal



Brake pedal uses the leverage effect to apply bigger force to the brake master cylinder.

Modification basis	
Application basis	
Affected VIN	

▶ Braking distance & stopping distance

Stopping distance = free running distance + braking distance

What is stopping distance?

A certain distance (free running distance + braking distance) is needed from the moment an obstacle appears ahead until you bring your vehicle to a complete stop. This is called as stopping distance.
What is braking distance?
Tire slip occurs until the vehicle stops completely when the the brake is applied.
This slip is what we call a braking distance.

What is free running distance?

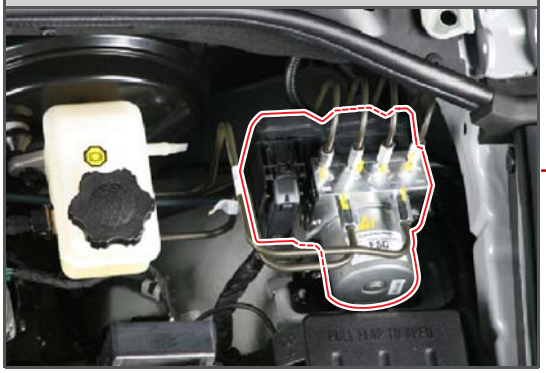
The free running distance is the time from the driver sees the obstacles and begins to prepare for depressing the brake pedal until the moment the brake pedal is depressed.

2. SYSTEM LAYOUT

Master Cylinder and Booster



HECU

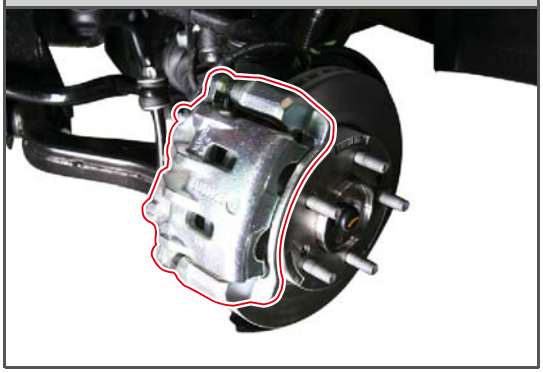




Brake Pedal



Front Brake Assembly



Front Wheel Speed Sensor (4WD)



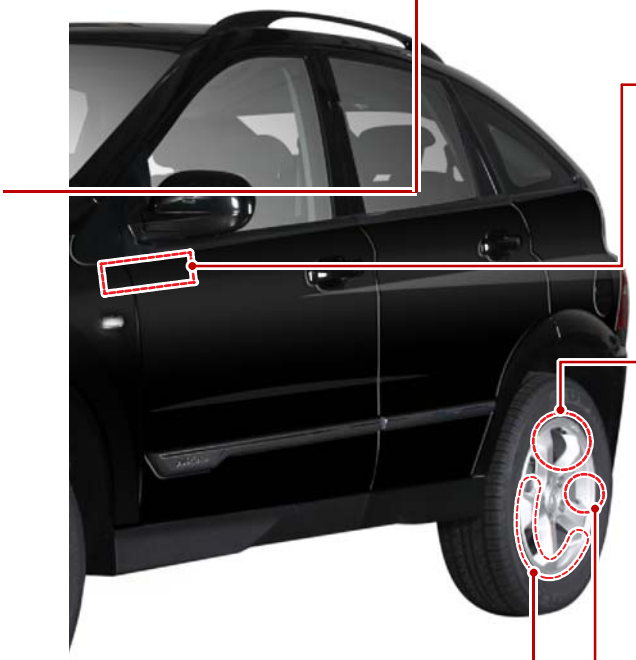
Modification basis	
Application basis	
Affected VIN	

ABS/EBD Indicators

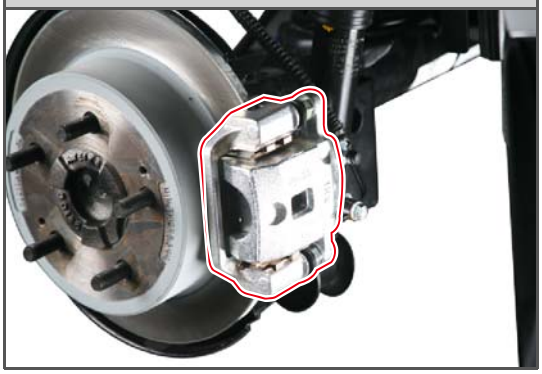


Parking Brake Lever





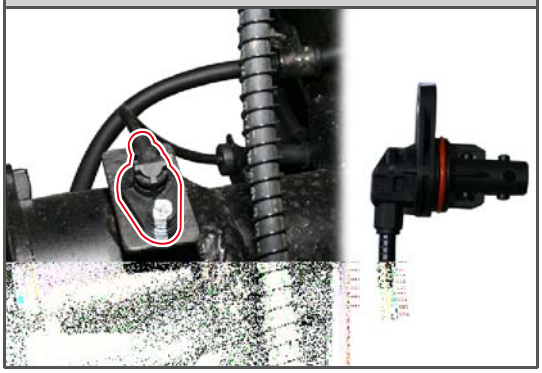
Rear Brake Assembly



Parking Brake



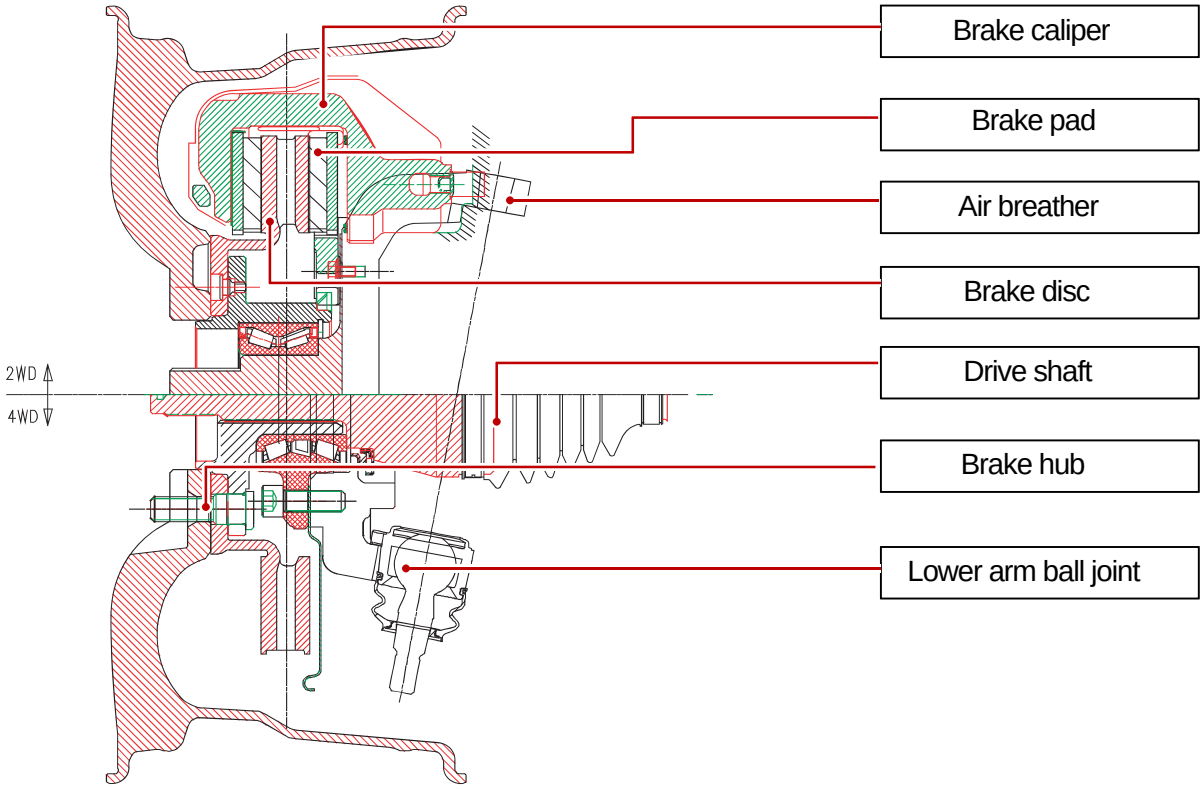
Rear Wheel Speed Sensor (4WD)

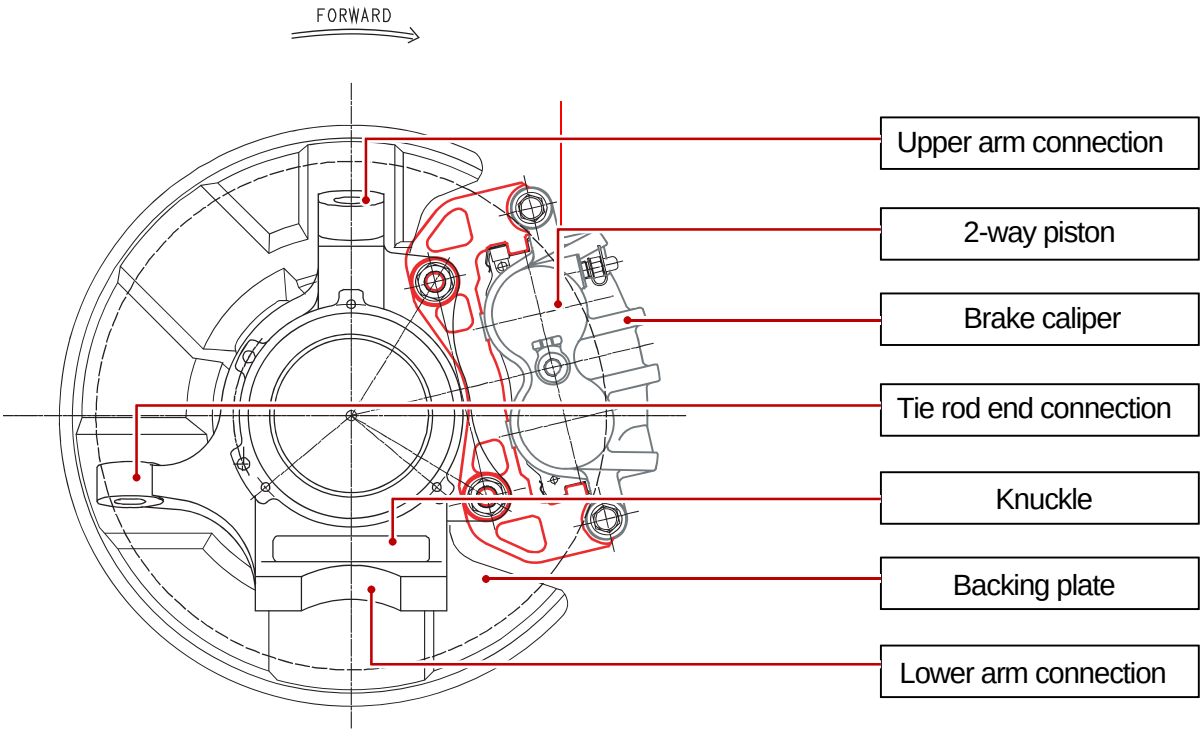


Modification basis	
Application basis	
Affected VIN	

3. PARKING BRAKE

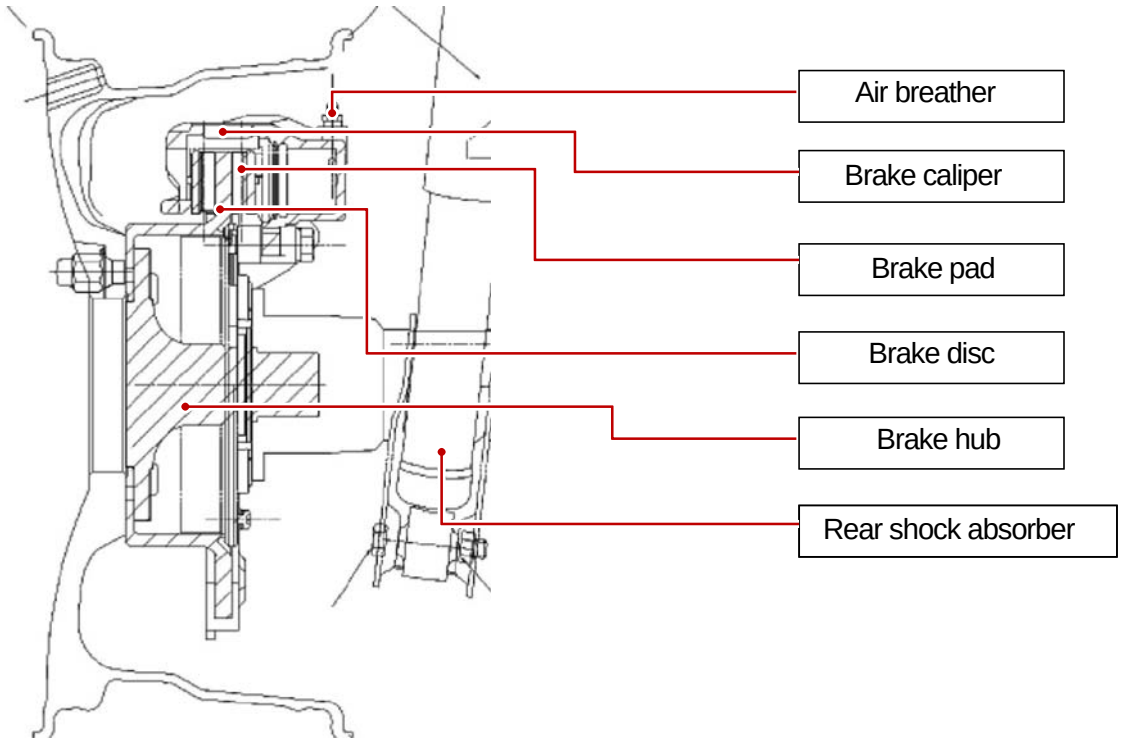
▶ Front Disc Brake

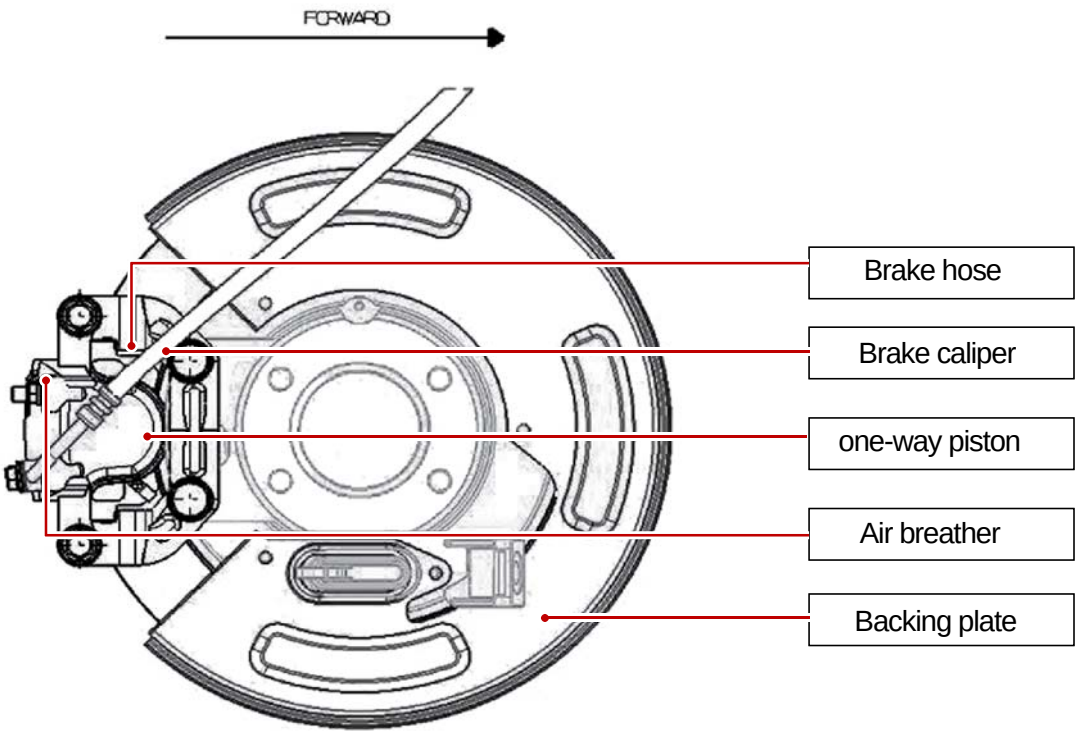




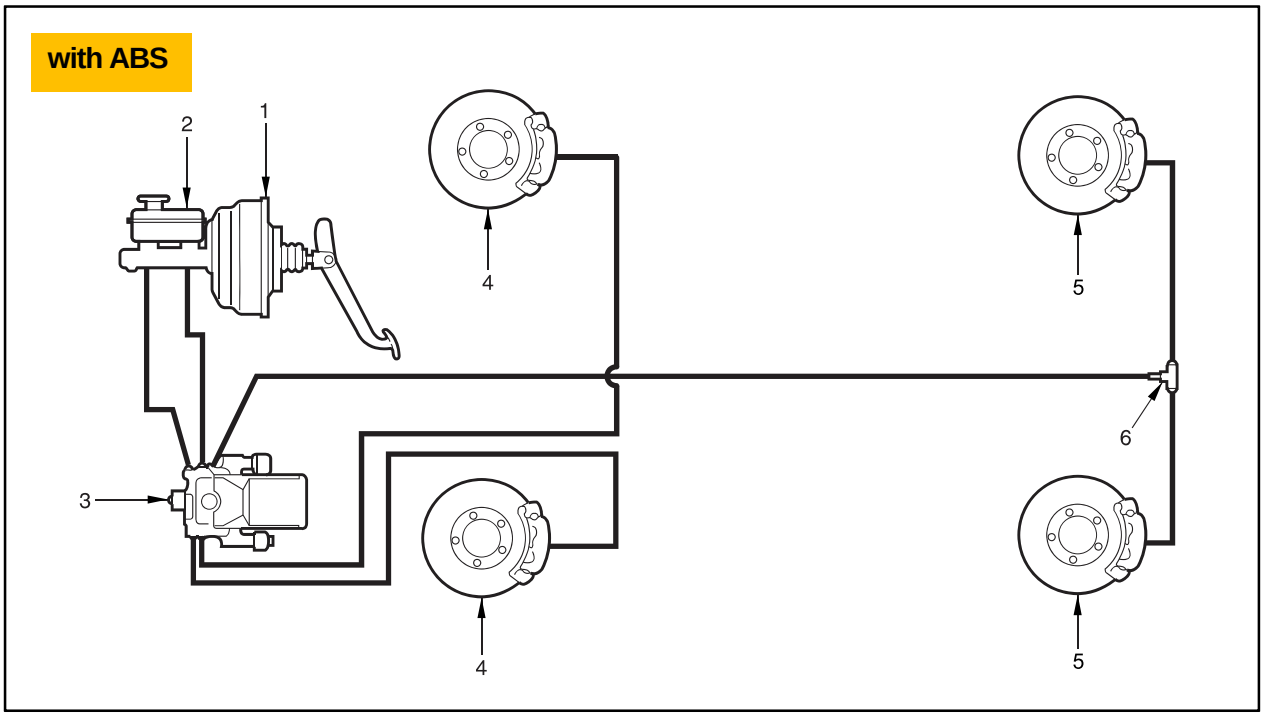
Modification basis	
Application basis	
Affected VIN	

▶ Rear Disc Brake





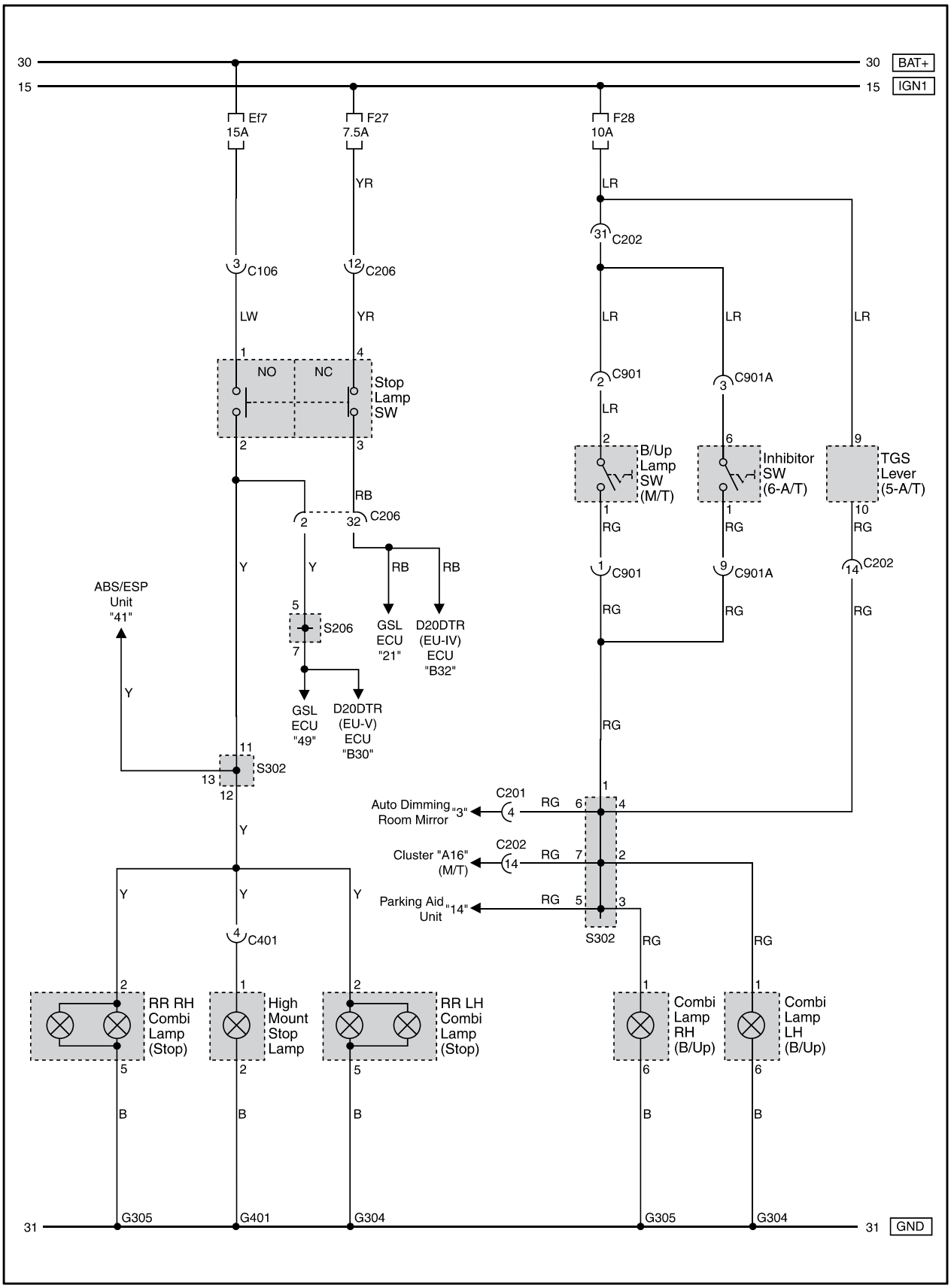
4. HYDRAULIC CIRCUIT



1. Brake booster
2. Brake fluid reservoir and master cylinder
3. HECU (Hydraulic & Electric Control Unit)
4. Front disc brake and caliper
5. Rear disc brake and caliper
6. 3-way connector (ESP ONLY)

Modification basis	
Application basis	
Affected VIN	

5. CIRCUIT DIAGRAM OF STOP LAMP



Modification basis	
Application basis	
Affected VIN	

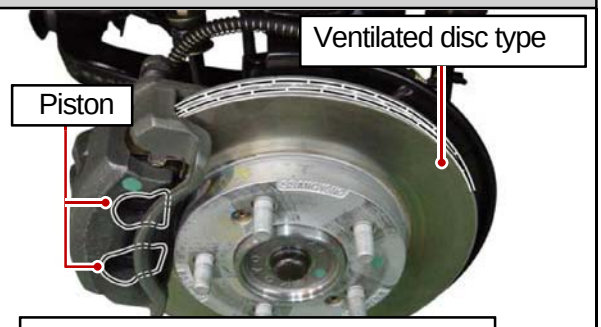
ESP 4892-01

GENERAL

1. SYSTEM GENERAL

1)Front Disc Brake

Front Disc



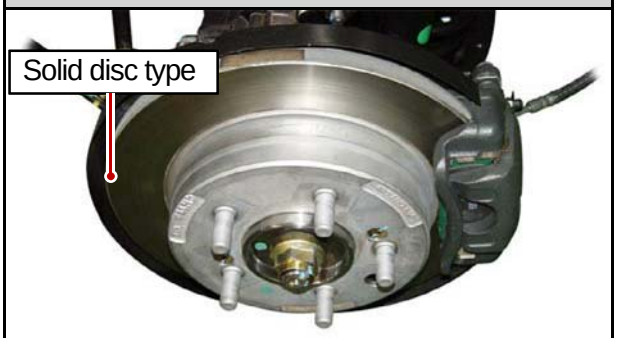
Front Ventilated Disc and Caliper (2 internal Cylinders)

For the front brake system, the ventilated disc type is applied regardless of the ABS/ESP system installation.
Two cylinders are installed in each caliper.

Description	Caliper diameter
Without ABS or ESP	43mm
With ABS or ESP	45mm

2) Rear Disc Brake

Rear Disc



Rear Disc and Caliper (1 Internal Cylinder)

For the rear brake system, it differ between ABS/ESP system equipped vehicle and non-ABS/ESP equipped vehicle.
The drum type brake is installed on non-ABS equipped vehicle while the solid disc (thickness: approx.
10.4 mm) is installed on ABS/ESP equipped vehicle.

Description	Brake type
Without ABS	Drum brake
With ABS or ESP	Solid disc

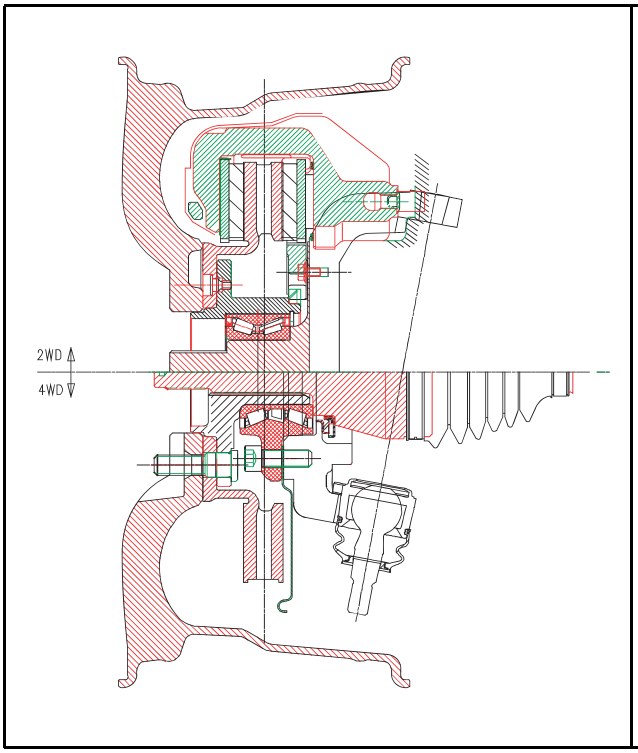
3) Parking Brake

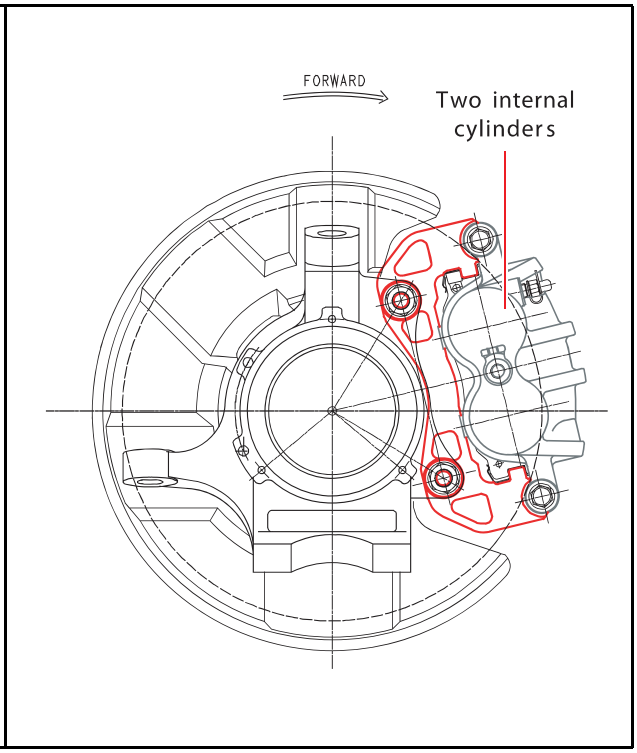


For the parking brake system, the hand operated type parking brake is installed regardless of the models.

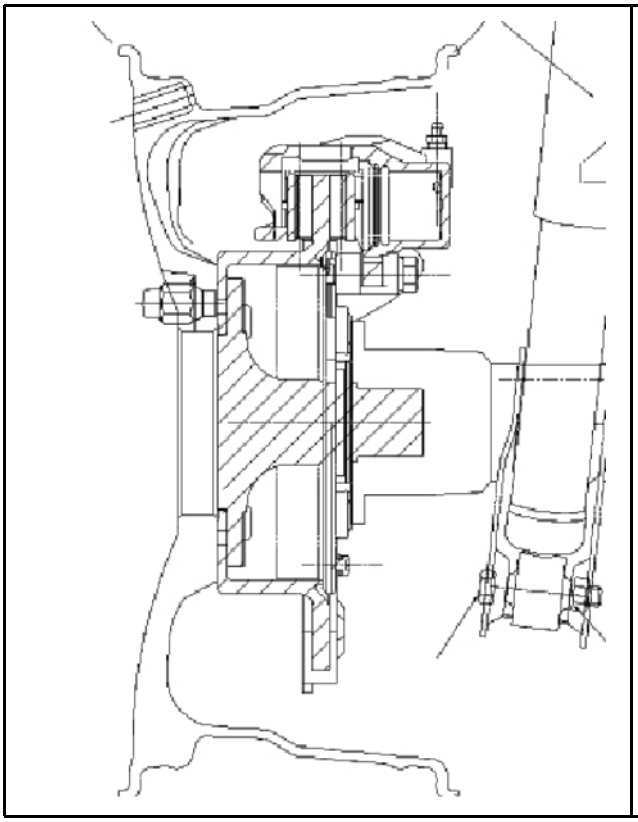
2. SECTIONAL DRAWING

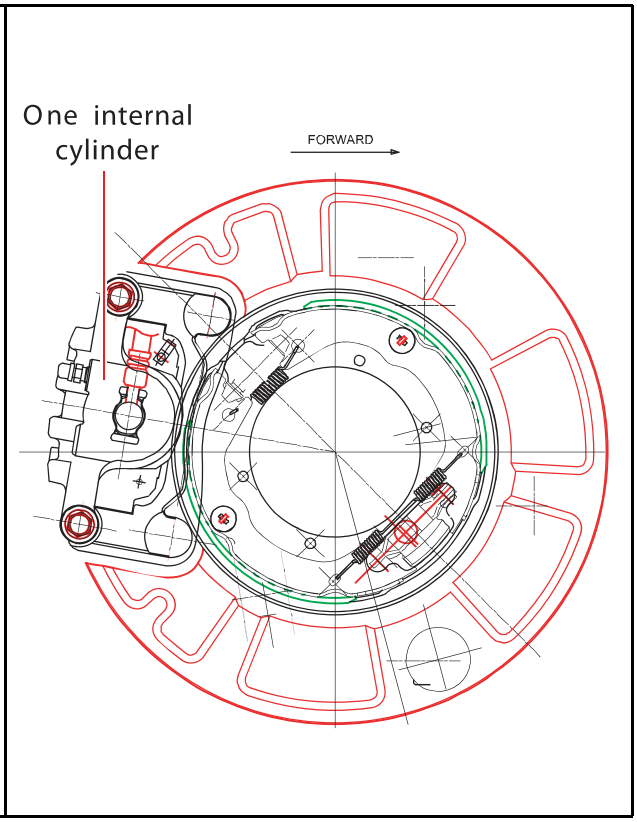
1) Front Disc Brake





2) Rear Disc Brake

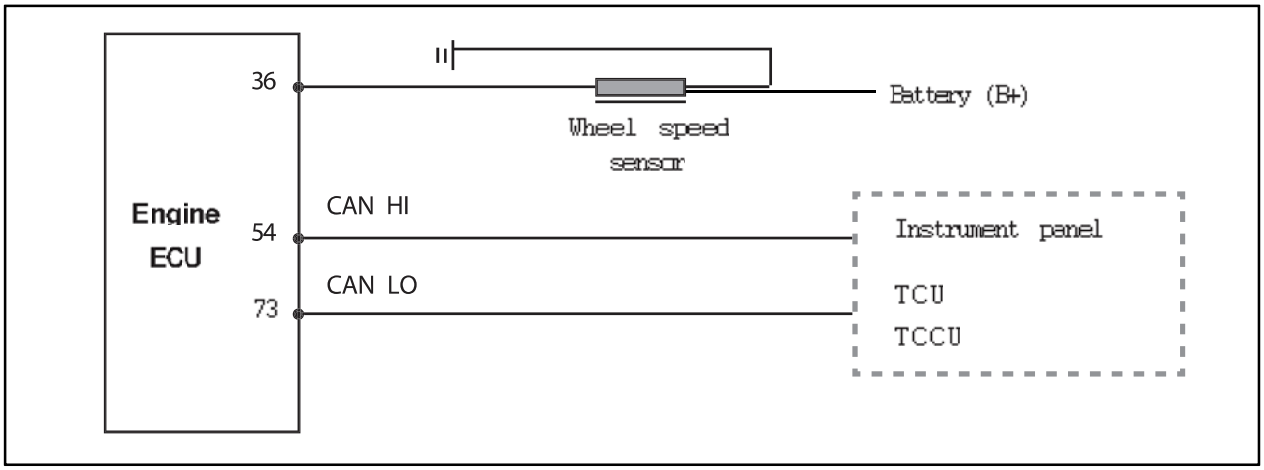




Modification basis	
Application basis	
Affected VIN	

3) Non-ABS Equipped Vehicle - With One Wheel Speed Sensor

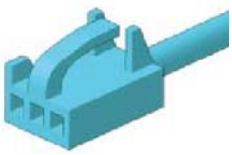
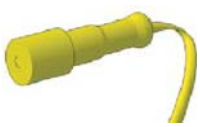
The wheel speed sensor is installed on the rear right wheel regardless of the ABS/ESP installation. This sensor is to signal the vehicle speed to the engine ECU, TCCU, transmission and instrument panel. There is no separate unit to process the wheel speed sensor signal. The wheel speed sensor is connected to the engine ECU (terminal 36), where its signal is processed, and is connected to other related systems through CAN communication.



(1) Location of the wheel speed sensor (rear right wheel)



Location of the Sensor Connector


Connector Appearance	
In vehicle without ABS	In vehicle with ABS/ESP
	

3. SPECIFICATIONS

Description	Item	NON-ABS	ABS/ESP
Brake pedal	Pedal ratio	4.0 : 1	
	Max. operating stroke	150 mm	
	Free play	1 ~ 4 mm	
Brake master cylinder	Type	Tandem type (with level sensor)	
	I.D. of cylinder	ϕ 25.4 mm	
Brake booster	Type	Vacuum assisted type	
	Booster pressure ratio	9 : 1	
Front brake	Type	Ventilated disc type	
	I.D. of caliper cylinder	2 x ϕ 43 mm	2 x ϕ 45 mm
	Brake pad thickness	10.5 mm	
	Brake pad wear limit	2 mm	
	Disc plate thickness	26 mm	
	Disc plate wear limit	24 mm	
	I.D./O.D. of disc plate	ϕ 294 / ϕ 184 mm	
Rear brake	Type	Drum type	Solid disc type
	I.D. of drum	ϕ 254 mm	-
	W x L x T	55 x 243 x 5	-
	I.D. of wheel cylinder	ϕ 23.81 mm	-
	I.D. of caliper cylinder	-	ϕ 42.9 mm
	Brake pad thickness	-	10 mm
	Brake pad wear limit	-	2 mm
	Disc plate thickness	-	10.4 mm
	Disc plate wear limit	-	8.5 mm
	I.D./O.D. of disc plate	-	ϕ 299 / ϕ 220 mm
Parking brake	Type	Cable type (internal expansion)	
	Operation type	Hand Operated	
	I.D. of drum	ϕ 254 mm	ϕ 190 mm
Brake fluid	Capacity	0.7 ~ 0.8	
	Specification	DOT4	

Modification basis	
Application basis	
Affected VIN	

4. BRAKE OPERATION AND NOISE

This section describes the noise phenomena occured possibly in the brake system operation.
Distinguish between the information given below and the actual problems and then, inspect the vehicle and take appropriate measures.

1) Noise Phenomena and Causes

Phenomenon 1. If depressing the brake pedal when the engine is cold, "screeching" sound always occurs and, after driving for a while, the sound disappears.

This usually occurs in the morning. When the temperature goes down, the dew condensation phenomenon sets moisture on the brake disc as the window frost forms.
Due to this moisture, the iron within the brake disc and pad oxidizes, forming undetectable micro-rusts on the disc surface.
When starting the engine under this condition, noise may sound due to the friction of micro-rusts. When operating the brake several times, the disc temperature goes up and the micro-rusts come off and the noise goes away.
Depending on the driving conditions, noise gets louder when
slightly depressing the brake pedal and oppositely, noise is smaller when deeply depressing the brake pedal.
This is simply a physical phenomenon, called "morning effect" in professional terms, and does not imply any problems with the brake system.

Phenomenon 2. Slip or screech after the brake pad replacement.

This usually occurs when the bed-in is not made between the disc and the pad's friction material.
The bed-in is a state that the brake system normally works and gives no noise out, when, after about 300 km city driving, the contact area of the pad friction material is enlarged and the disk is in complete contact with the pad's friction material.
Therefore, for some time after the brake disk/pad replacement, the brake system poorly operates or noise (abnormal sound) occurs due to the partial contact.

Phenomenon 3. "Groaning" sound occurs in the automatic transmission vehicle when slightly taking the foot off the brake pedal to slowly start after waiting for the signal, or slightly depressing the brake pedal.

This is the noise "Creep groan" that occurs when, in both the automatic and manual transmission, slightly releasing the brake pedal in the neutral gear at downhill roads.
It frequently occurs at the low braking power and low speed, through the following process. When operating the brake system at low speed and low pressure, adhesion and slip
repeatedly take place between the brake disk and the friction material, and this makes the braking power inconstant, instantly increasing or decreasing, and gives out the brake noise.
It is also a physical phenomenon and has no relation with the brake performance.

5. ESP SYSTEM RELATED PRECAUTIONS

1. The HDC system is intended for use only on off-roads with a slope level exceeding 10%. Thus, do not use it on public road.
2. Too frequent use of HDC system may weaken the durability of the ESP HECU and related systems. Driver must turn the HDC switch to OFF position when driving on public and level roads.
3. As mentioned previously, when a driver make sharp turns or drive on rough roads, the HDC may suddenly operate for these sudden shocks influencing the G sensor values. When such occurs, the driver may panic because the vehicle speed drops sharply and the driver will experience difficulty in controlling the vehicle.
   During the HDC operation, a loud noise and the vehicle vibration may occur from the HECU and the
4. brake system, but this is a normal condition during the HDC operation.
   The warning lamp flashes and warning beep sounds when the ESP is operating
5. When the ESP operates during vehicle movement, the ESP warning lamp on the instrument panel flashes and beep comes on every 0.1 seconds. The ESP system is only a supplementary device for comfortable driving. When the vehicle exceeds its physical limits, it cannot be controlled. Do not rely on the system. Keep on the safe driving.
   Feeling when ESP is working When the ESP system activates, the feeling can be different depending on vehicle driving conditions.
6. For example, you will feel differently when the ESP system is activated during the ABS is operating with the brakes applied and when the brakes are not applied on a curve.
   If the ESP system operates when the brake is applied, the brake pressure will be increased on the corresponding wheel which already has braking pressure for the ESP controls.
   Noise and vibration that driver feels when ESP system is operating
   The ESP system may transfer noise and vibration to the driver due to the pressure changes caused
7. by the motor and valve operations in a very short period of time. And, keep in mind that the output and vehicle speed could be decreased without rpm increase due to the ASR function that controls the engine power.
   ARP Operation
   During the ARP operation, vehicle safety (rollover prevention) takes the first priority and thus,
8. stronger engine control is in effect. Consequently, the vehicle speed decreases rapidly, so the driver must take caution for the vehicle may drift away from the lane.

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATION PROCESS

1. OVERVIEW OF ESP(ELECTRONIC STABILITY PROGRAM) SYSTEM

The ESP system consists of basic ABS functions, the vehicle position control depending on the driving conditions and the road conditions, the HBA (Hydraulic Brake Assist System) that improves the braking power in an emergency,
and the ARP (Active Rollover Protection) that obstructs the physical tendency to rollover during sharp turns and prevents the vehicle rollover by quickly and firmly controlling the engine output and the brake.

The HDC (Hill Descent Control) is newly introduced function that helps drivers maintain their speed automatically by switch operation when driving slowly on steep hills (over 10°).

ESP HECU



HDC Switch / Indicator

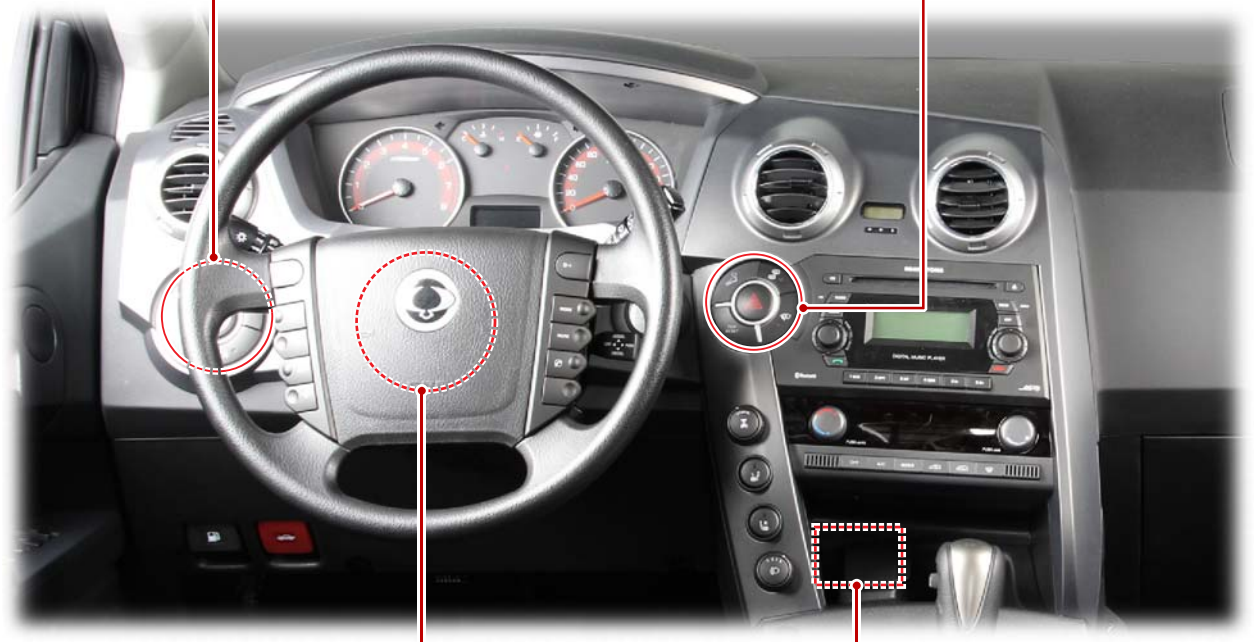


▶ **Functions applied on ESP system are as follows.**

1. ABS (Anti-Lock Brake System)
2. EBD (Electronic Brake-Force Distribution)
3. ABD (Automatic Braking Differential)
4. ASR (Acceleration Slip Regulation)
5. AYC (Active Yaw Control, Understeer Oversteer control)
6. HBA (Hydraulic Brake Assist System)
7. ARP (Active Rollover Protection)
8. HDC (Hill Descent Control)

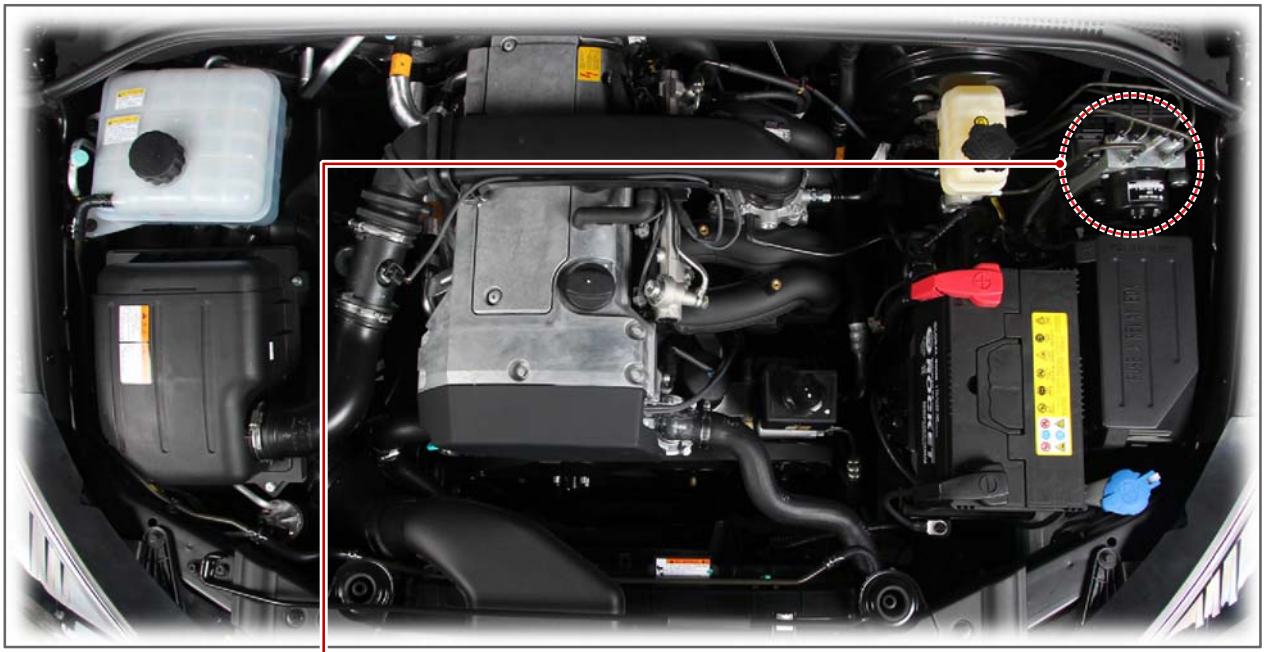
2. COMPONENTS OF ESP

ESP OFF Switch	HDC Switch
	
ESP is deactivated by pressing the switch (ESP warning lamp comes on) ESP is activated by pressing the switch again (ESP warning lamp goes off)	HDC is activated by pressing the switch (Green HDC indicator comes on) HDC is deactivated by pressing the switch again (Green HDC indicator goes off)



Steering Angle Sensor (Steering Wheel)	Sensor cluster Detects
	
Detects the angle of the steering wheel and sends it to HECU.	Detects lateral acceleration, longitudinal acceleration and yaw rate.

Modification basis	
Application basis	
Affected VIN	



HECU



Receives the signals from wheel speed sensor, steering wheel angle sensor, sensor cluster and pressure sensor and perform the vehicle stability control function.

Rear Wheel Speed Sensor (LH/RH)



Wheel Speed Sensor(FOR 4WD)



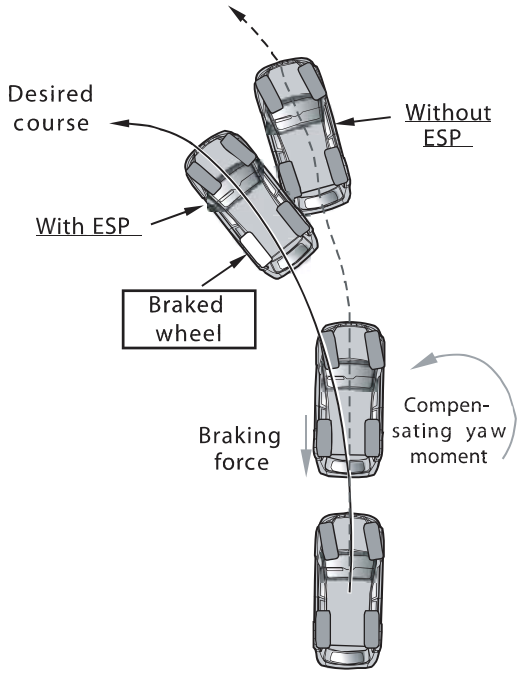
Modification basis	
Application basis	
Affected VIN	

3. PRINCIPLE OF ESP

1) Understeer & Oversteer Control

situations, and stabilizes the vehicle by wheel-individual braking and engine control intervention with no need for actuating the brake.
This system is developed to help the driver avoid the danger of losing the control of the vehicle stability due to under-steering or over-steering during cornering.
The yaw rate sensor, lateral sensor and longitudinal sensor in the sensor cluster and the steering angle sensor under the steering column detect the spin present at any wheels during over-steering, under-steering or cornering.
The ESP ECU controls against over-steering or under-steering during cornering by controlling the vehicle stability using the input values from the sensors and applying the brakes independently to the corresponding wheels.
The system also controls during cornering by detecting the moment right before the spin and automatically limiting the engine output (coupled with the ASR system).

Under Steering

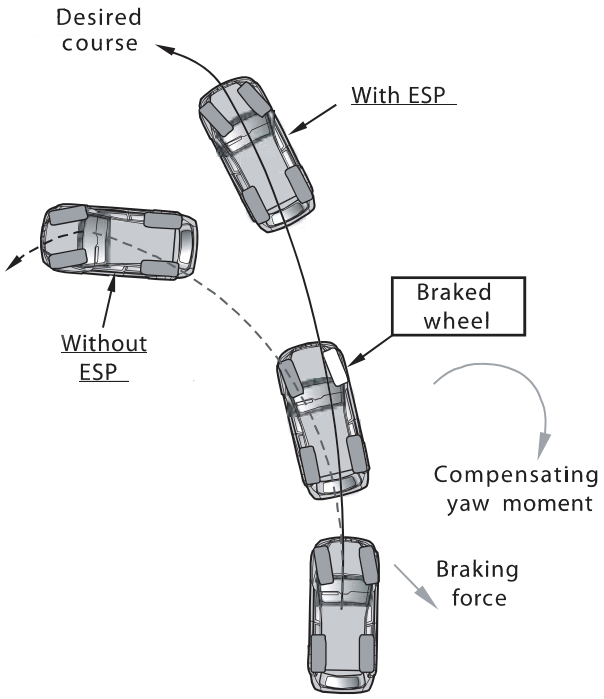


(1) Under steering

Understeering is when the steering wheel is steered to a certain angle during driving and the front tires slip toward the reverse direction of the desired direction.
Generally, vehicles are designed to have under steering.
The vehicle can return back to inside of cornering line when the steering wheel is steered toward the inside even when the vehicle front is slipped outward.
As the centrifugal force increases, the tires can easily lose the traction and the vehicle tends to slip outward when the curve angle gets bigger and the speed increases.

Modification basis	
Application basis	
Affected VIN	

Over steering



(2) Over steering

Oversteering is when the steering wheel is steered to a certain angle during driving and the rear tires slip outward losing traction.

When compared with under steering vehicles, the controlling of the vehicle is difficult during cornering and the vehicle can spin due to rear wheel moment when the rear tires lose traction and the vehicle speed increases.

(3) ESP Controls During Under Steering

The ESP system recognizes the directional angle with the steering wheel angle sensor and senses the slipping route that occurs reversely against the vehicle cornering direction during understeering with the yaw rate sensor and the lateral sensor.
Then the ESP system applies the brake at the rear inner wheel to compensate the yaw moment value.
In this way, the vehicle does not lose its driving direction and the driver can steer the vehicle as driver intends.

(4) ESP Controls During Oversteering

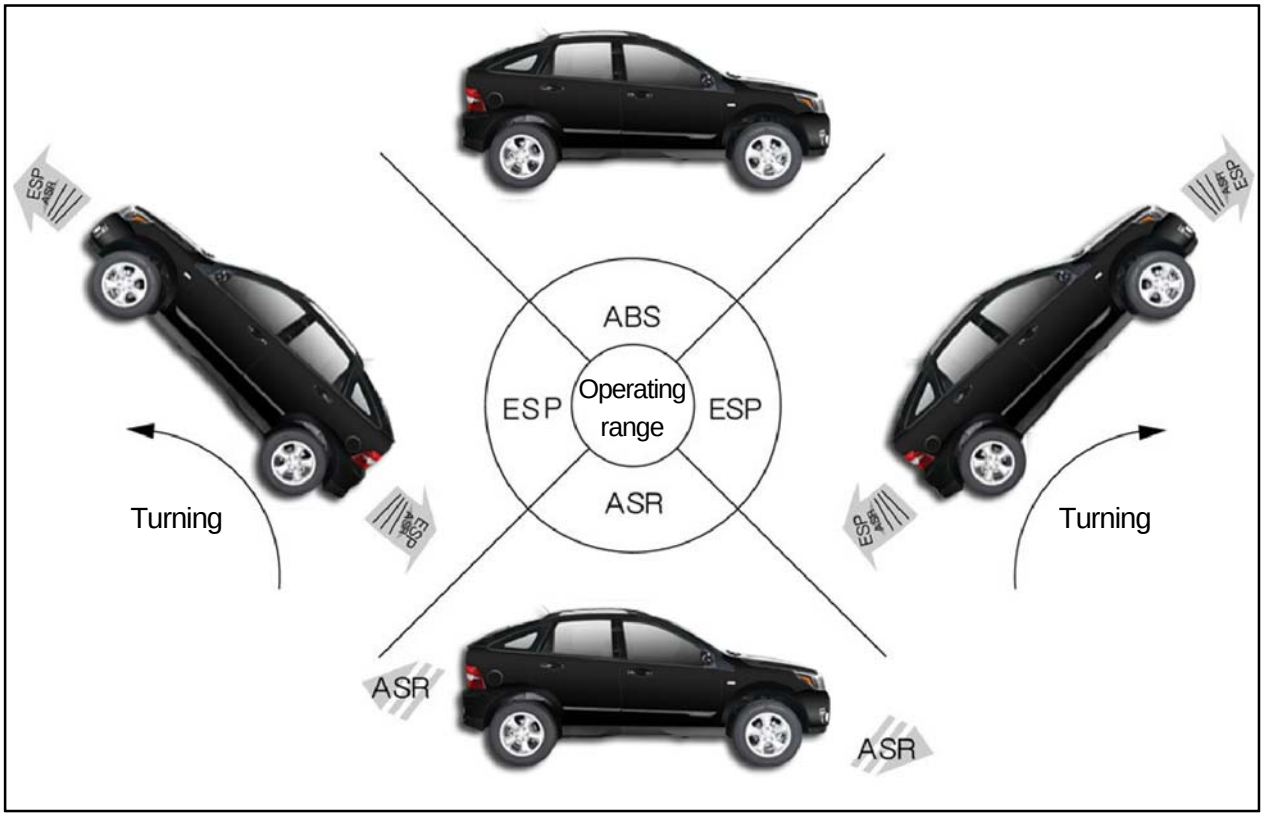
The ESP system recognizes the directional angle with the steering wheel angle sensor and senses the slipping route that occurs towards the vehicle cornering direction during oversteering with the yaw rate sensor and the lateral sensor. Then the ESP system applies the
brake at the front outer wheel to compensate the yaw moment value. In this way, the vehicle does not lose its driving direction and the driver can steer the vehicle as he or she intends.

2) ESP Control

As the single-track vehicle model used for the calculations is only valid for a vehicle moving forward, ESP intervention never takes place during backup.
The ESP system includes the ABS/EBD and ASR systems allowing the system to be able to operate depending to the vehicle driving conditions.
For example, when the brakes are applied during cornering at the speed of 100 km/h, the ABS system will operate at the same time the ASR or ABD systems operate to reduce the power from the slipping wheel. And when yaw rate sensor detects the rate exceeding 4 degree/seconds, the ESP system is activated to apply the brake force to the corresponding wheel to compensate the yaw moment with the vehicle stability control function.
When various systems operate simultaneously under a certain situation, there may be vehicle control problems due to internal malfunction of a system or simultaneous operations.
In order to compensate to this problem, the ESP system sets the priority among systems.
The system operates in the order of TCS (ASR or ABD), ESP and ABS.
The order may be changed depending on the vehicle driving situations and driving conditions.

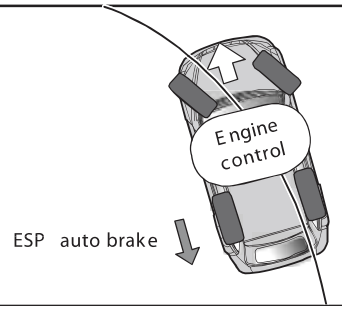
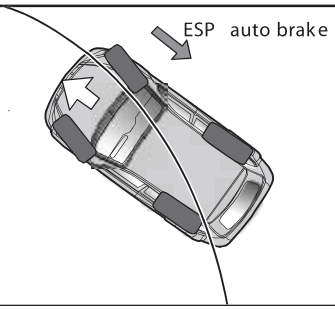
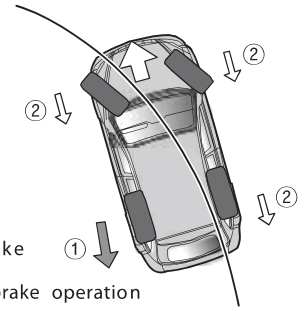
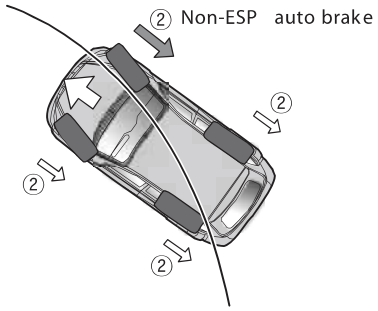
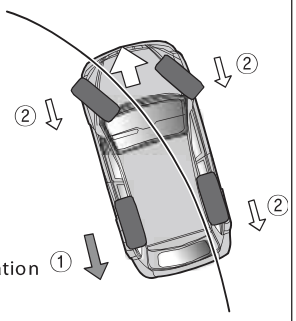
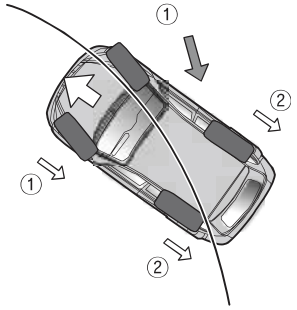
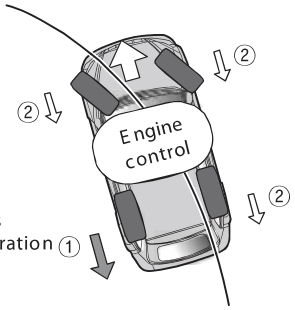
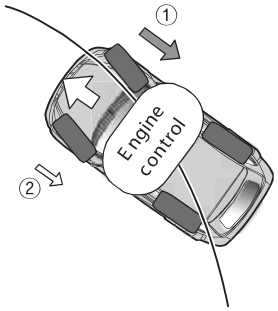
Modification basis	
Application basis	
Affected VIN	

The following figure shows the operating range according to driving conditions.



3) Vehicle Control During Cornering

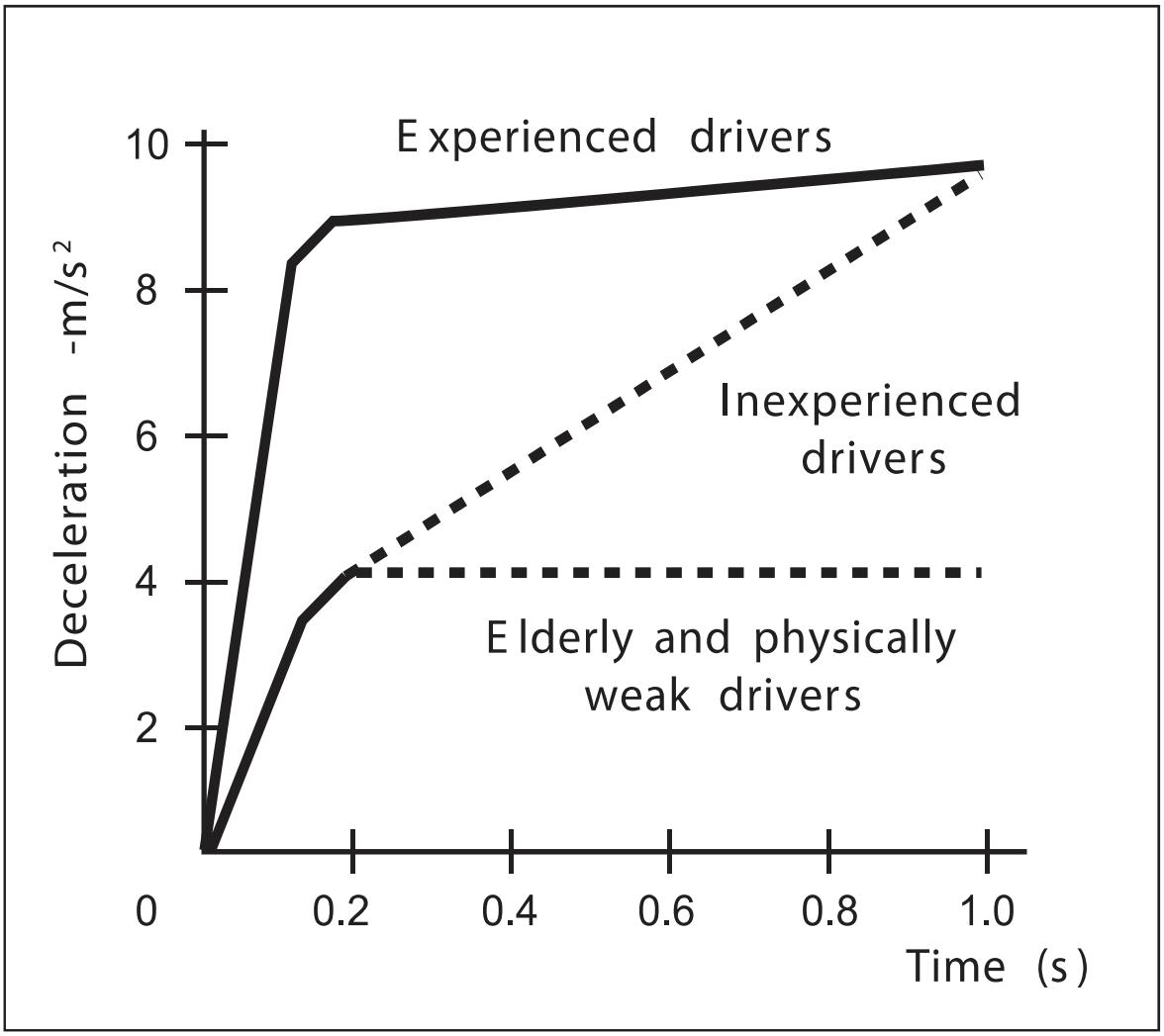
The figure below shows the vehicle controls by ESP system under various situations such as when the brake pedal is pressed (or not pressed) during cornering and when the ABS is operating or when just the conventional brake is operating during braking.
It also includes the vehicle conditions when the TCS that is included in the ESP system is operating.

Operations	Understeering Contro l	Oversteering Contro l
Only ESP operating No braking by driver		
ESP + Conventional brake (ABS not operating)		
ESP + ABS brake		
ESP + TCS (Engine control)		

Modification basis	
Application basis	
Affected VIN	

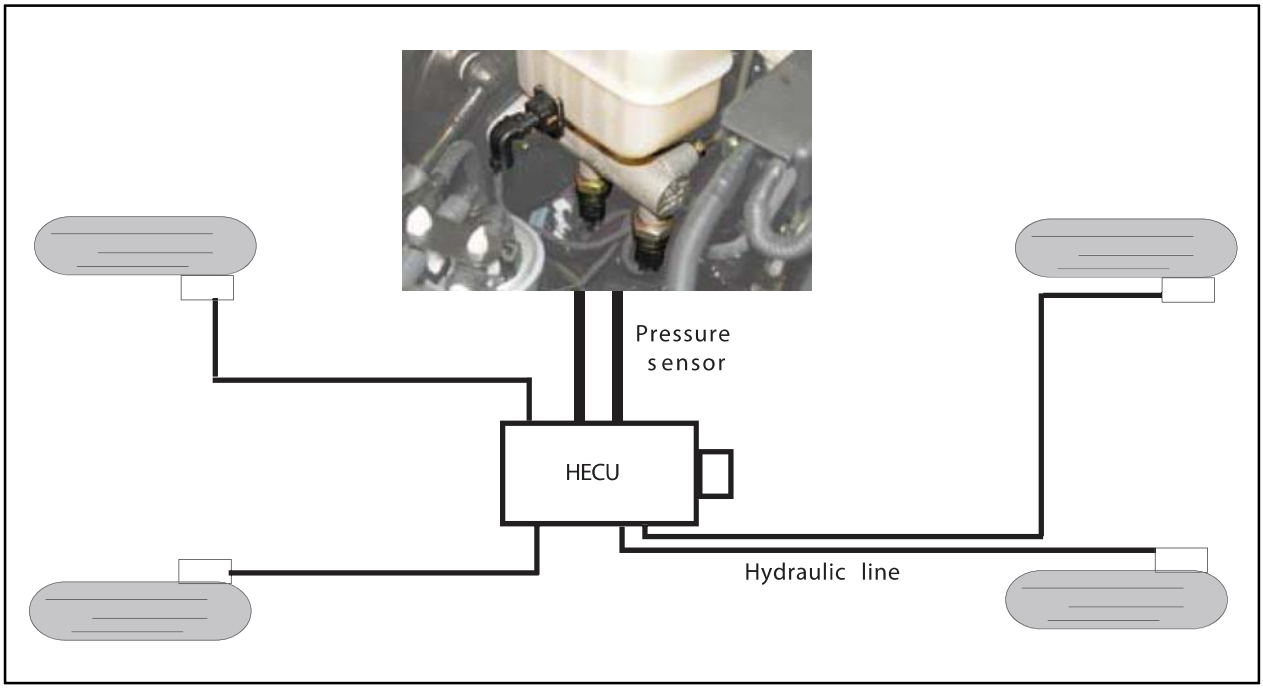
4. PRINCIPLE OF BAS(BRAKE ASSIST SYSTEM)

BAS (Brake Assist System) system helps in an emergency braking situation when the driver applies the brake fast, but not with sufficient pressure, which leads to dangerously long braking distance.
ECU recognizes the attempt at full braking and transmits the signal calling for full brake pressure from the hydraulic booster.



An inexperienced, elderly or physically weak driver may suffer from the accident by not fully pressing the brake pedal when hard braking is required under emergency.
The BAS System increases the braking force under urgent situations to enhance the inputted braking force from the driver.
Based on the fact that some drivers depress the brake pedal too soft even under when hard braking is necessary, the HECU system is a safety supplementary system that builds
high braking force during initial braking according to pressure value of the brake pressure sensor and the pressure changes of the pressure sensor intervals.
When the system is designed to apply high braking force when brake pedal is depressed softly by an elderly or physically weak driver, the vehicle will make abrupt stopping under normal braking situation due to high braking pressure at each wheels.

The brake pressure value and the changed value of the pressure sensor are the conditions in which the BAS system operates.
There are 2 pressure sensors under the master cylinder.
When the ESP ECU system determines that emergency braking is present, the pump operates, the brake fluid in the master cylinder is sent to the pump and the braking pressure is delivered to the wheels via the inlet valves.
If the drive depresses the brake pedal slowly, the pressure change is not high. In this case, only the conventional brake system with booster is activated.



Operating conditions:

1. Pressure: over 20 bar
2. Pressure changes: over 1500 bar/sec
3. Vehicle speed: over 7 Km/h

Modification basis	
Application basis	
Affected VIN	

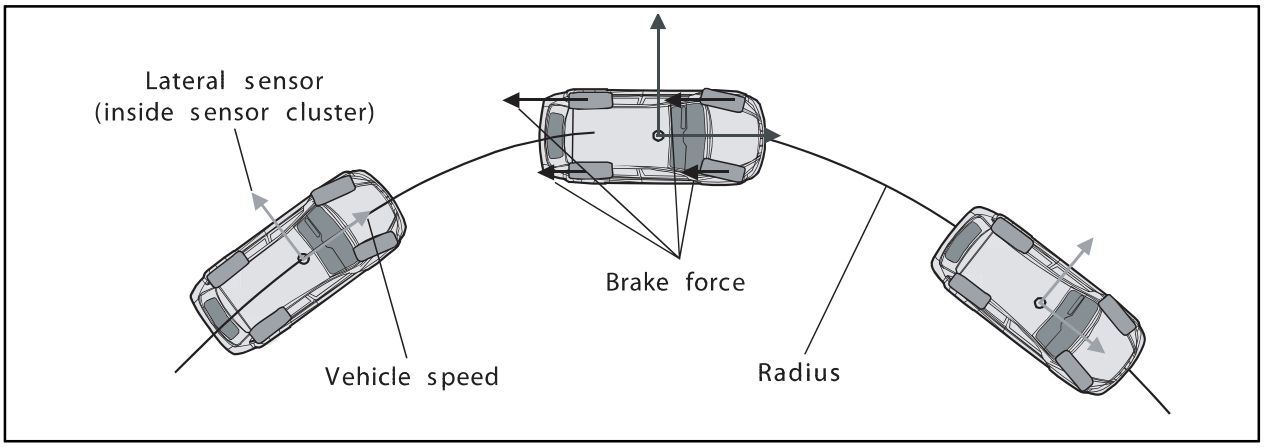
5. PRINCIPLE ARP(ACTIVE ROLL-OVER PROTECTION)

The ARP (Active Roll-over Protection) system is a safety assistant device that minimizes, by controlling brakes and the engine, the physical tendency of the vehicle rollover during sharp lane changes or U-turns.

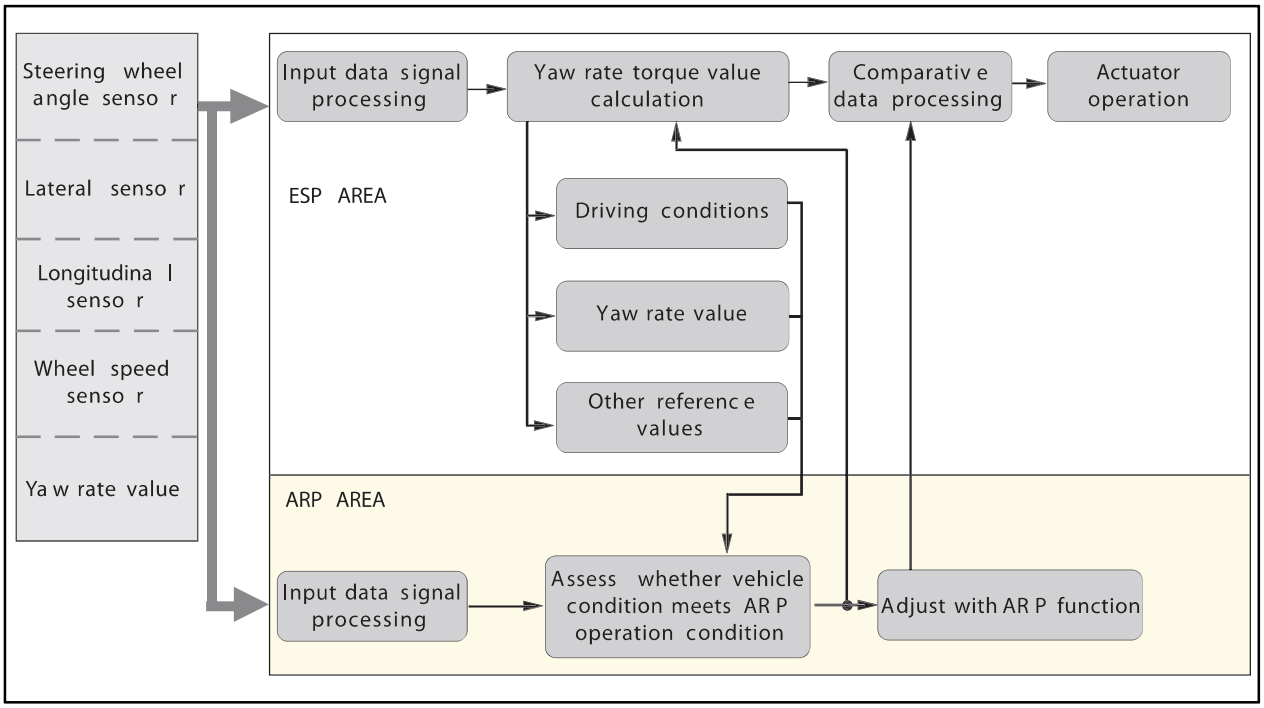
For the system, software is added to the existing ESP system and no additional device or switch is needed.

One must note that the ARP system, just as general assistant devices including the ABS, is only a safety assistant device using the ESP system and its function is useless when the situation overcomes the physical power.

Following picture shows how the ARP compensates the vehicle position by varying each wheel's braking power to overcome the physical tendency of the vehicle rollover during sharp turns.



The vehicle driving condition is controlled by the internally programmed logic according to the input signals from wheel speed sensor, steering angle sensor and lateral sensor.



CAUTION

- During the ARP operation, vehicle safety (rollover prevention) takes the first priority and thus, stronger engine control is in effect. Consequently, the vehicle speed decreases rapidly, so the driver must take caution for the vehicle may drift away from the lane.
- The ARP function is activated when the vehicle is subject to turning over due to sharp cornering even when the ESP function is turned off (however, the ARP function is also deactivated when the ESP function is not operatable due to system malfunction).

Modification basis	
Application basis	
Affected VIN	

6. PRINCIPLE OF HDC(HILL DESCENT CONTROL)

1) System Overview

The HDC system is an automatic descent control device that allows the vehicle to automatically decelerate to about 7 km/h by 0.1G, on steep roads (slope level exceeding 10%) through a separately installed switch operation.
When the vehicle speed reaches below 7 km/h (refer to the information below), the HDC automatically terminates the operation.

When you see a steep downhill ahead, press the HDC switch and the green HDC indicator comes on. When the G sensor within the sensor cluster detects a slope level exceeding 10%, the ESP's HDC function operates.
When this occurs, the green HDC indicator flashes along with a loud operation sound.



HDC Switch



HDC Indicator (Instrument Panel)	Sensor Cluster (G Sensor)
	
When you press the HDC switch, the green HDC indicator comes on, and when the HDC operates, the green HDC indictor flashes at 0.5 second of interval.	The G Sensor within the sensor cluster detects the steepness of driving roads. When the HDC switch is in operation, if the G sensor detects a downhill steepness exceeding 10%, it transmits the HDC operation signal to the ESP HECU.

HDC Red letters

HDC Green letters

CAUTION

The G sensor in sensor cluster measures the actual road steepness. However, it may recognize a sharp turn or rough road as a downhill road with a slope level exceeding 10%, and the HDC may operate.

2) HDC (Hill Descent Control) System Operating Conditions

1. When HDC switch is turned ON **and**
2. Gearshift lever position (Forward/Reverse) **and**

Manual transmission: operates in the 1st gear or reverse gear position (does not operate in neutral position).
Automatic transmission: operates in any position except for P (parking) or N (neutral) positions.

CAUTION

- The vehicles with manual transmission do not have a separate device or switch that detects the 1st gear.
  It only detects the forward/reverse driving direction of the vehicle through backup lamp switch and neutral switch, and cannot solely detect the 1st gear position. The reason why, though the HDC also operates in 2nd gear position, that is because the engine may turn off during the HDC operation process.
  You may face a very dangerous situation if the engine turns off at a steep hill.
- The HDC is the device to improve the engine brake effect during downhill driving on a steep hill.
  For manual transmission equipped vehicle, HDC system should operated only in 1st gear.

3. When not depressing the accelerator pedal or brake pedal. **and**
4. The vehicle speed is above 7 km/h (in Automatic transmission/4H mode). **and**

CAUTION

The vehicle speed given in step (4) varies according to the vehicle driving mode, and the speed ranges by the vehicle driving mode and condition are as follows.

1) Speed available in HDC mode (slope)

Forward driving 2H/4H mode: vehicle speed below 50 km/h (operation slope level: 10%, termination slope level: when it reaches 8%)

Reverse driving 2H/4H mode: vehicle speed below 50 km/h (operation slope level: 8%, termination slope level: when it reaches 5%)

2) HDC target speed in 2H/4H mode

(The HDC target speed is the speed that the HDC is not terminated even after the vehicle speed reaches 7 km/ h, but is converted to the stand-by mode.
When the vehicle speed increases again as a result of the increase of the road steepness, etc., the HDC goes into operation.)

Forward driving: 7 km/h
Reverse driving: 7 km/h (automatic transmission), 8.5 km/h (manual transmission)

Modification basis	
Application basis	
Affected VIN	

5. Vehicle position control function in ESP and HBA function are not in operation: and
The HDC is the device to improve the engine brake effect during downhill driving on a steep hill. If the ESP function is in operation, HDC operation is overridden.

6. Slope level exceeds 10%.
When the slope level exceeds 10%, the HDC operates until the vehicle reaches the speed value given in step (4).

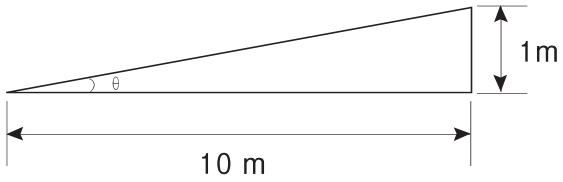
When the slope level is between 10% and 20% during the HDC operation
When depressing the accelerator pedal or brake pedal, HDC system is changed to stand-by mode.
When releasing the pedal, HDC starts its operation again.
Therefore, drivers can control the vehicle speed to a desired level by depressing and releasing the pedal.

When the slope level exceeds 20% during the HDC operation
When depressing the accelerator pedal, HDC system is changed to stand-by mode.
When depressing the brake pedal, HDC continues its operation and the braking power is increased.
In this case, HECU sounds an abnormal noise and brake pedal may be very rigid, but this is a normal condition due to HDC operation.

CAUTION

- **The percentage of the slope level:**
  tan θ X 100 = slope level (%)

ex)



$$\tan\theta \times 100 = \frac{1}{100} \times 100 = 10\ (\%)$$

For example, 10% of slope level indicates that the heigh is 1 m when the transverse length is 10 m.

l 1G = 9.8 m/s²: Acceleration

3) HDC (Hill Descent Control) System Non-Operation Conditions

1. When HDC switch is turned OFF **or**
2. Gearshift lever has passed neutral (N) position. **or**

CAUTION
- Vehicle with manual transmission: Sensing at the neutral switch
- Vehicle with automatic transmission: Sensing at the selector lever unit

3. When the vehicle speed is out of the specified values (under 7 km/h). **or**
4. When the ESP related functions, e.g. vehicle position control, BAS, ARP is activated during HDC operation. **or**

The HDC is the device to improve the engine brake effect during downhill driving on a steep hill. If the ESP function is in operation, HDC operation is overridden

5. When the internal temperature of HDC system goes over 450°C due to long downhill driving on a steep hill with HDC operated. **or**

There is no specific temperature sensor in the system, but a programmed logic inside the HECU predicts the temperature based on the operating times and conditions of HDC.

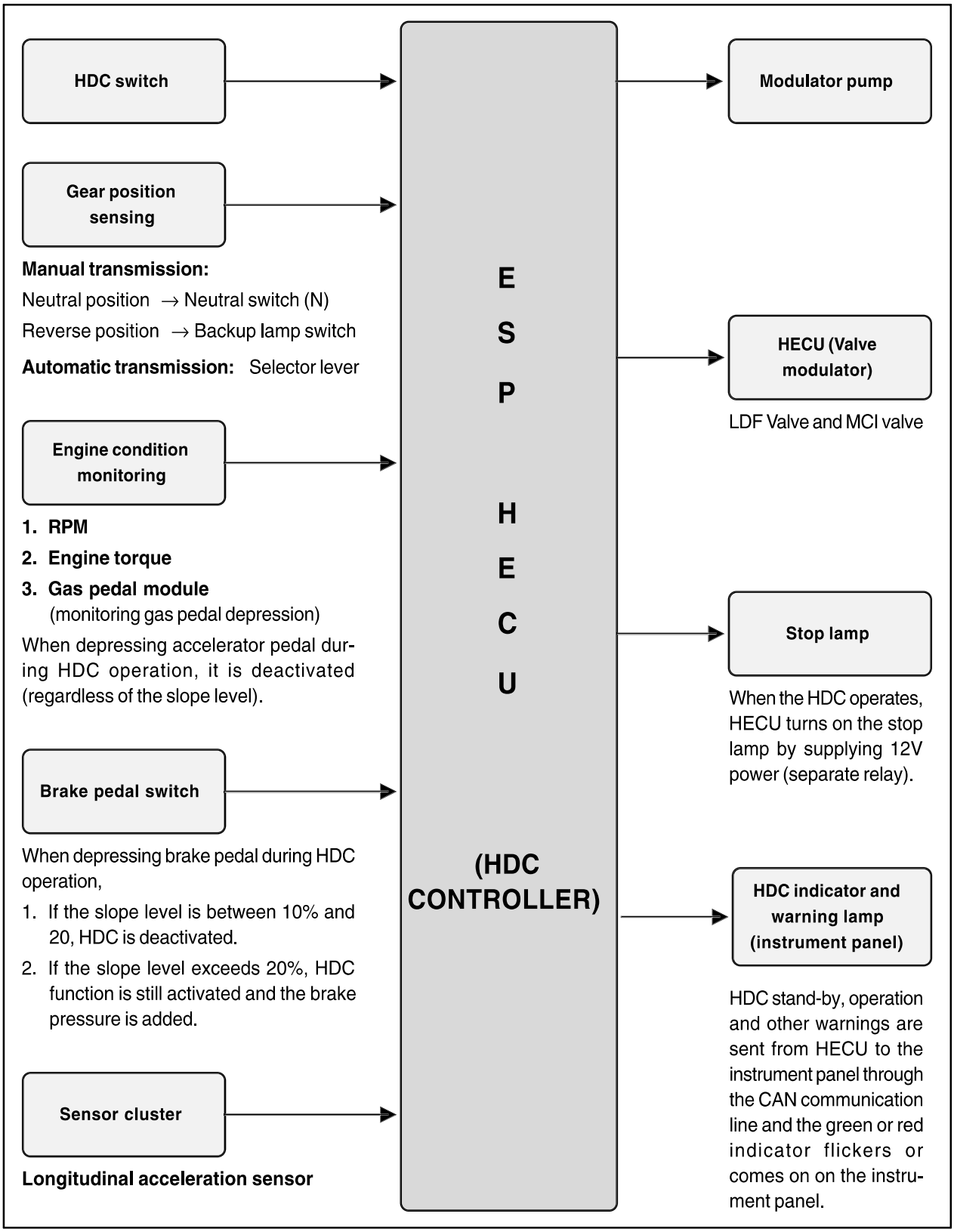
CAUTION
The red HDC warning lamp blinks when the internal temperature goes over 350C. When it reaches 450C, the HDC warning lamp stays on. The HDC can be operated in this range even where the HDC warning lamp blinks.

6. When the slope level is below 10%

Modification basis	
Application basis	
Affected VIN	

4) Input/Output Signals for HDC Operation

The HDC controller operates its function in the HECU inside the ESP unit and receives the following signals to perform the hill descent control function.



Modification basis	
Application basis	
Affected VIN	

5) Operation of HDC Indicator Controller

This table describes the coming-on and blinking mode of HDC indicator according to the HDC switch operation (ON/OFF) and operation conditions.
The HDC indicator on the instrument panel has two modes; green (function lamp) and red (warning lamp).
The HDC switch is a push & self return type switch - when you press it once, it starts to operate and when you press it again, it stops the operation.

<table>
<tr><th colspan="4" rowspan="3">HDC Operation Mode</th><th>HDC Indicator</th><th>HDC Warning Lamp</th></tr>
<tr><th>Green</th><th>Red</th></tr>
<tr><th>HDC</th><th>HDC</th></tr>
<tr><td colspan="4">Initial ignition ON (From hence, this signifies operation mode after the engine starts. Even when HDC switch is ON, if the ignition is OFF, HDC operation stops automatically.)</td><td>OFF</td><td>ON
(goes off after 1.8 seconds)</td></tr>
<tr><td rowspan="2">Not available</td><td colspan="3">HDC switch OFF</td><td>OFF</td><td>OFF</td></tr>
<tr><td colspan="3">HDC system error</td><td>OFF</td><td>ON</td></tr>
<tr><td rowspan="2">Stand-by</td><td colspan="3">HDC switch ON</td><td>ON</td><td>OFF</td></tr>
<tr><td colspan="5">The HDC switch is turned ON, but HDC system is in stand-by mode because the operating requirements are not met.</td></tr>
<tr><td rowspan="2">In operation</td><td colspan="3">HDC system is operating.</td><td>Blinking (0.5 seconds of interval)</td><td>OFF</td></tr>
<tr><td colspan="5">The HDC switch is turned ON, and the operating requirements are met. HDC is operating with operating sound.</td></tr>
<tr><td rowspan="4">System overheat</td><td rowspan="2">High brake system temperature (over 350°C)</td><td>HDC stand-by mode</td><td>OFF</td><td>Blinking</td></tr>
<tr><td>HDC is operating</td><td colspan="2">Alternate blinking of green and red lamp (0.5 seconds of interval)</td></tr>
<tr><td colspan="2">Too high brake system temperature (over 450°C)</td><td>OFF</td><td>ON</td></tr>
<tr><td colspan="4">There is no specific temperature sensor in the system, but a programmed logic inside the HECU predicts the temperature based on the operating numbers and conditions of HDC (HDC cannot be operated).</td></tr>
</table>

CAUTION

Basically, the brake system's basic functions can work even when there are problems with the HDC system.
As given in the table above, the HDC warning lamp comes on when:

- Initial ignition ON
- HDC system error occurs
- Brake system overheat

Modification basis	
Application basis	
Affected VIN	

6) Cautions When Using HDC System

Customers must first acquaint themselves with the HDC operation related information, e.g. operation conditions and non-operation conditions, because they may feel unfamiliar with its function and operation process.
The noise during the HDC operation is very different from that during the ABS/ESP operation. This noise may be irritating and accompany some vibration, because, on steep hills, it attempts to control the physical properties of the vehicle weight with the braking power.

Below is the summary of precautions to remember in HDC operation.

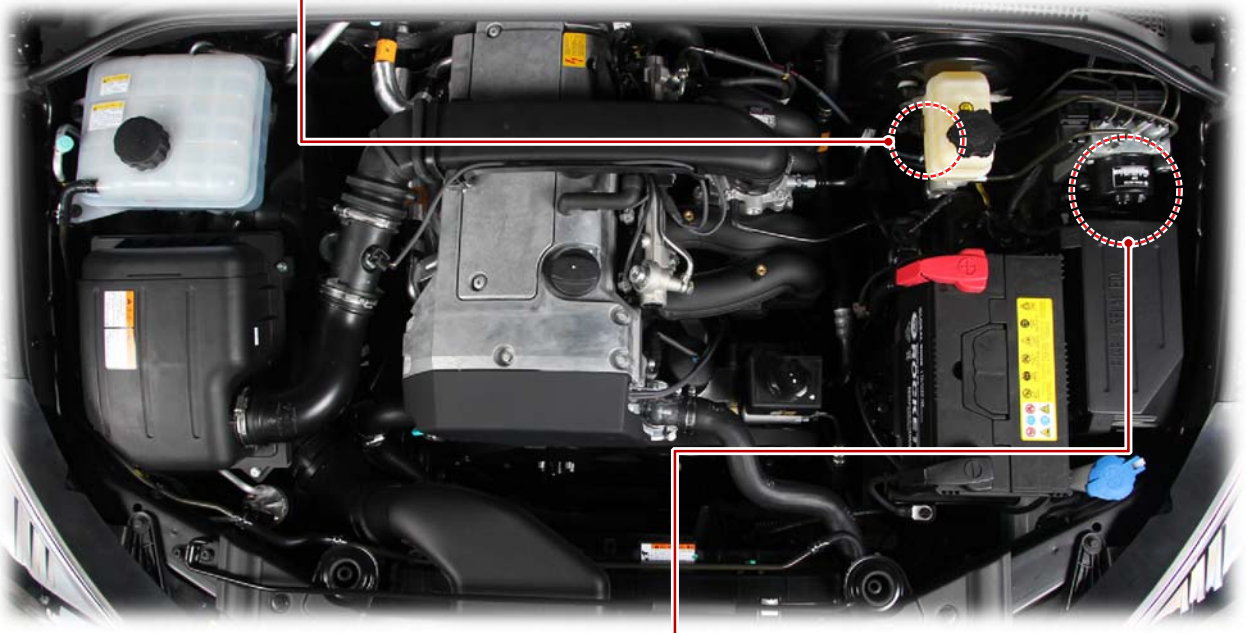
CAUTION

- The HDC system is intended for use only on off-roads with a slope level exceeding 10%. Thus, do not use it on public road.
- Too frequent use of HDC system may weaken the durability of the ESP HECU and related systems.
- Driver must turn the HDC switch to OFF position when driving on public and level roads.
  As mentioned previously, when a driver make sharp turns or drive on rough roads, the HDC may suddenly operate for these sudden shocks influencing the G sensor values.
  When such occurs, the driver may panic because the vehicle speed drops sharply and the driver will experience difficulty in controlling the vehicle.
- During the HDC operation, a loud noise and the vehicle vibration may occur from the HECU and the brake system, but this is a normal condition during the HDC operation.

7) Components and Locations

There are no major changes in the ESP system of ACTYON comparing to the conventional ESP system.
However, the HDC switch and the HDC indicator has been added to the system as the HDC system has been applied.

Master cylinder pressure sensor	Active Wheel Speed Sensor
	



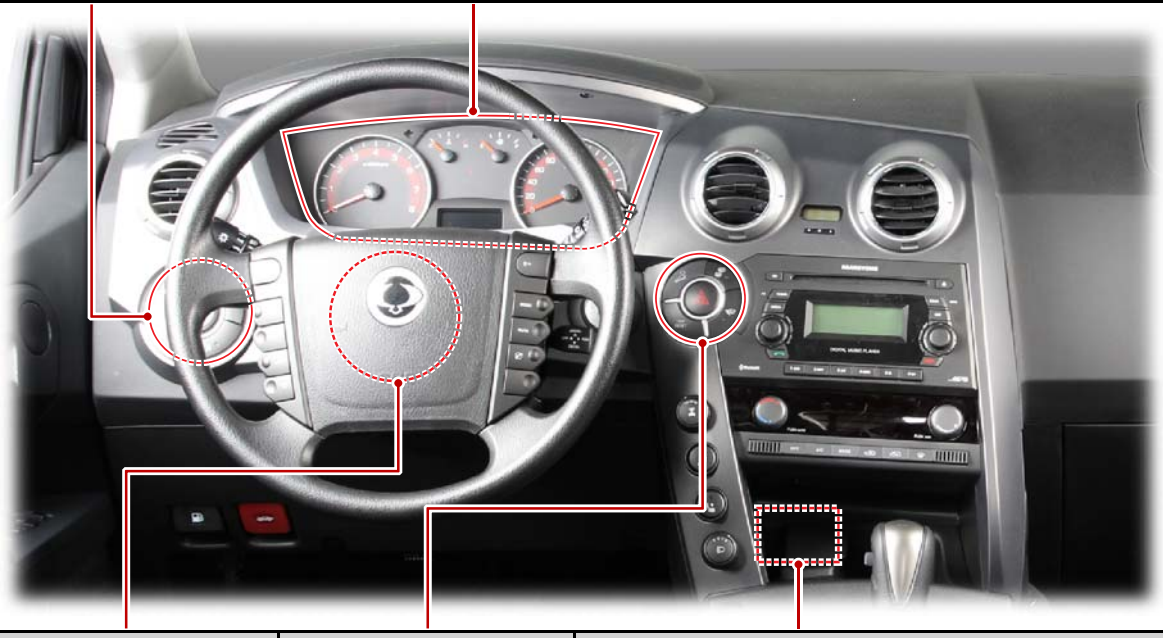
Valve body	Motor pump
	

Modification basis	
Application basis	
Affected VIN	

(1) Comparison with ABS System

No	Name	ESP Component	ABS Component s	Remark
1	HECU	0	0	ESP system contains ESP OFF switch and HDC switch.
2	Pressure sensor	0	N/A	
3	Wheel speed sensor	0	0	
4	S ensor cluste r	0	N/A	
5	Steering wheel angle sensor	0	N/A	

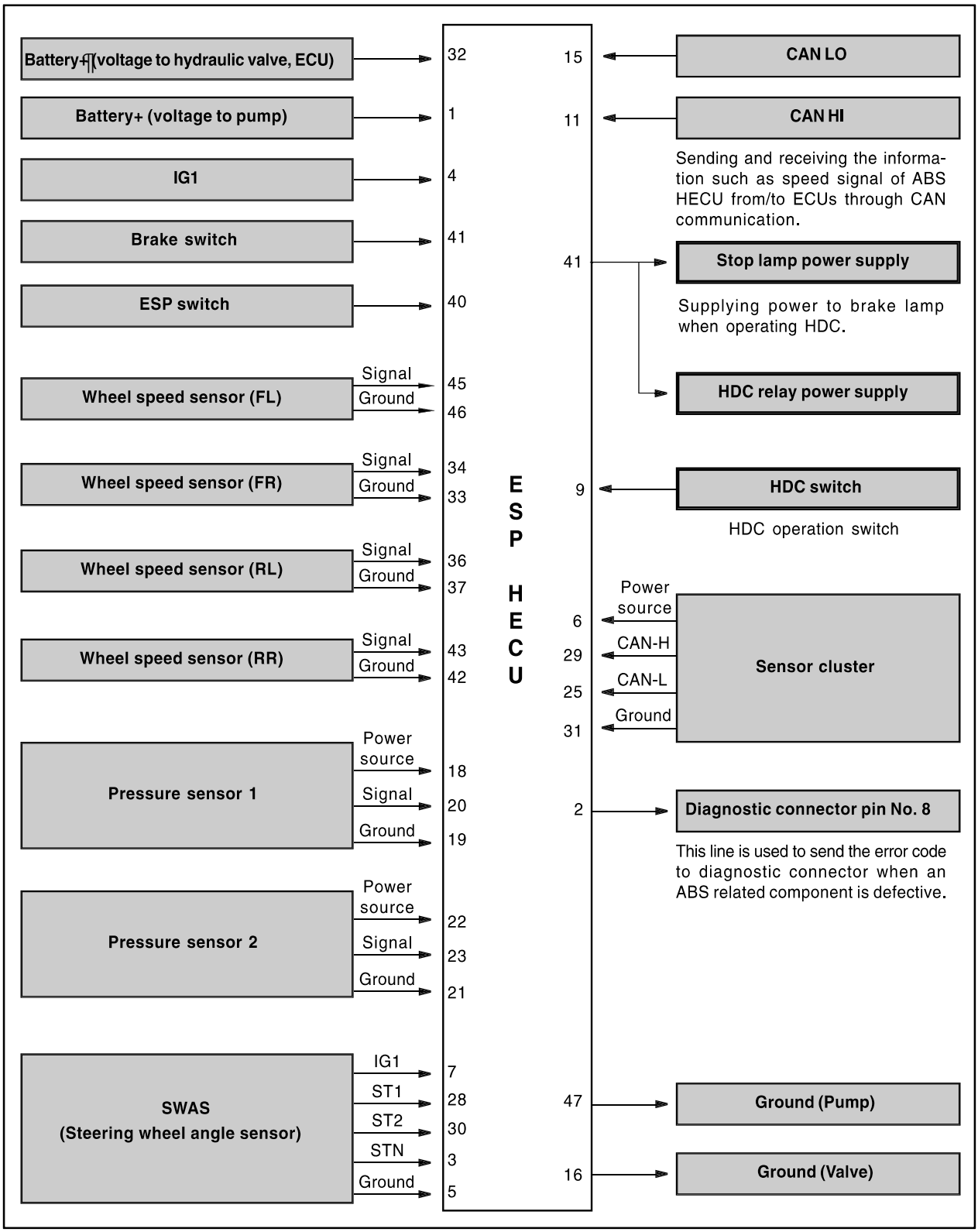
ESP OFF Switch	ABS, ESP, HDC Indicator
	



Steering Wheel Angle Sensor	HDC Switch	Sensor Cluster (Yaw Rate + Lateral Sensor + Longitudinal Sensor)
		

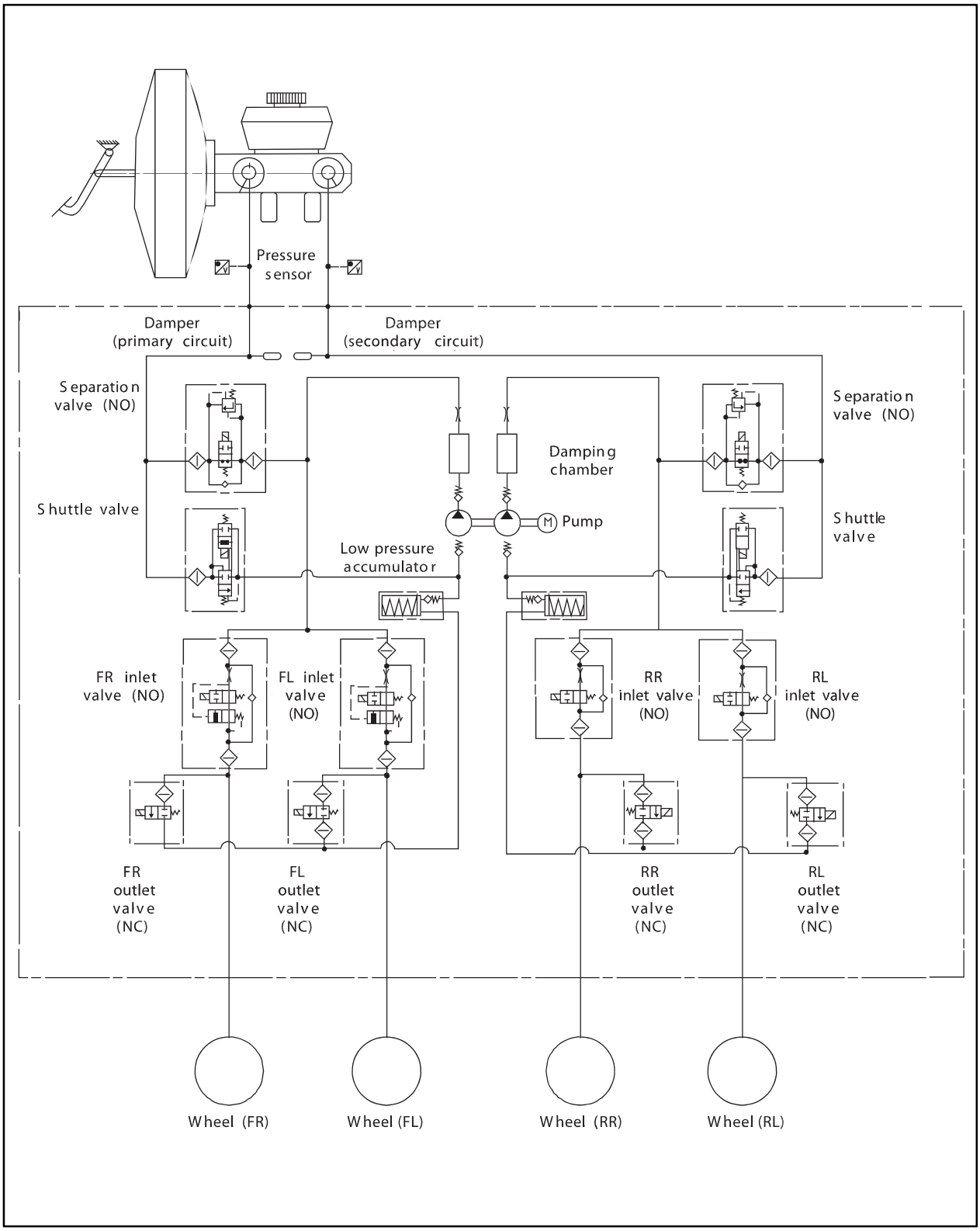
7. INPUT AND OUTPUT DIAGRAM OF ESP SYSTEM

▶ **Input/Output of ESP System**



Modification basis	
Application basis	
Affected VIN	

8. HYDRAULIC CIRCUIT DIAGRAM OF ESP SYSTEM



Modification basis	
Application basis	
Affected VIN	

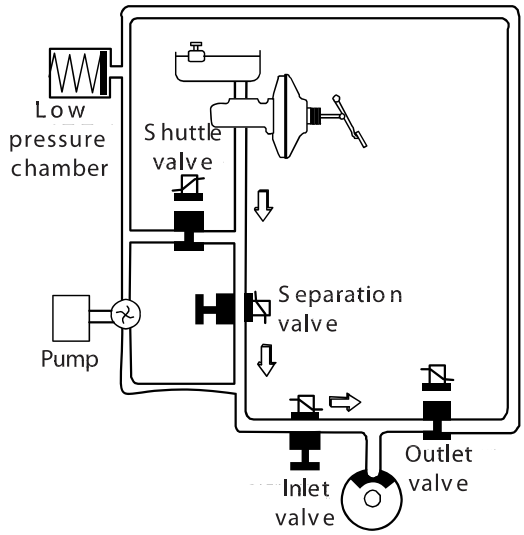
If the vehicle is equipped with ABS, the braking force at each wheel will be controlled with 3-channel 4-sensor method. Also, if the vehicle is equipped with ESP, 4 wheels will be controlled independently with 4-channel method.
(When controlling ABS system only, it will be operated with 3-channel method.) When compared to the vehicle equipped with ABS only, the internal hydraulic circuit has a normally-open separation valve and a shuttle valve in primary circuit and in secondary circuit.
When the vehicle brakes are not applied during engine running or when applying the non-ABS operating brakes, the normally-open separation valve and the inlet valve are open, whereas the normally-closed shuttle valve and the outlet valve are closed.
When the ESP system is operating, the normally-open separation valve will be closed by the solenoid valve operation and the hydraulic circuit will be established by the shuttle valve. Then, the inlet and outlet valves will be closed or open depending on the braking pressure increase, decrease or unchanged conditions.
For details, refer to "Hydraulic Pressure for each ESP Operating Range".

Modification basis	
Application basis	
Affected VIN	

9. HYDRAULIC PRESSURE FOR EACH ESP OPERATING RANGE

ESP Hydraulic unit in idling and normal braking position

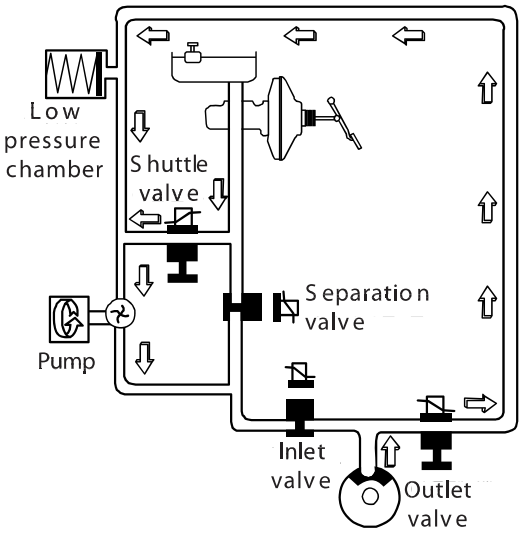
1



In this position, the separation valve and the inlet valve are open (normal open), the electrically operated shuttle valve and the outlet valve are closed.
When the brake is applied under these conditions, the brake fluid will be sent to each wheel via the separation valve and inlet valve.

ESP Hydraulic unit (decreased pressure)

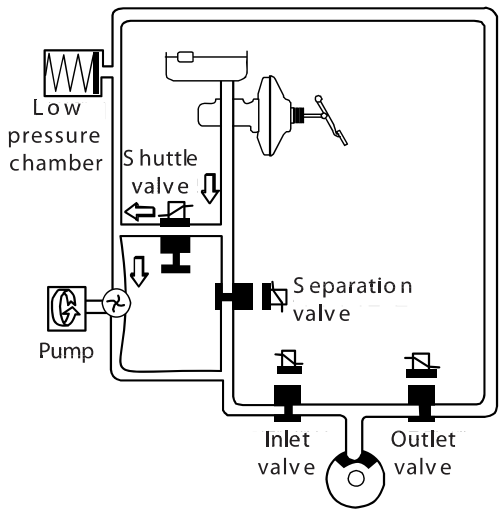
2



The pressure decreases just before the wheel speed drops and the wheels are locked.
The inlet valve closes and the outlet valve opens as in the ABS HECU and the oil is gathered at the low pressure chamber while no additional oil is being supplied.
Then the pump operates to allow fast oil drainage.
The shuttle valve and the separation valve do not operate while decompression.

ESP unit circuit (when the pressure is maintained)

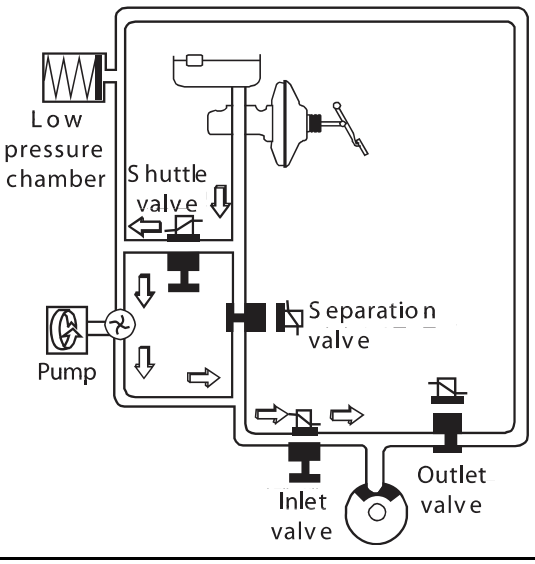
3



The Inlet valve and outlet valve will be closed to maintain the pressure in the hydraulic circuit applied at the wheels.
By closing the valves, the hydraulic pressure at the wheels will not be lost or supplied any more. During ESP operation, the separation valve closes and only the shuttle valve at the pump opens.

ESP unit circuit (when the pressure is increased)

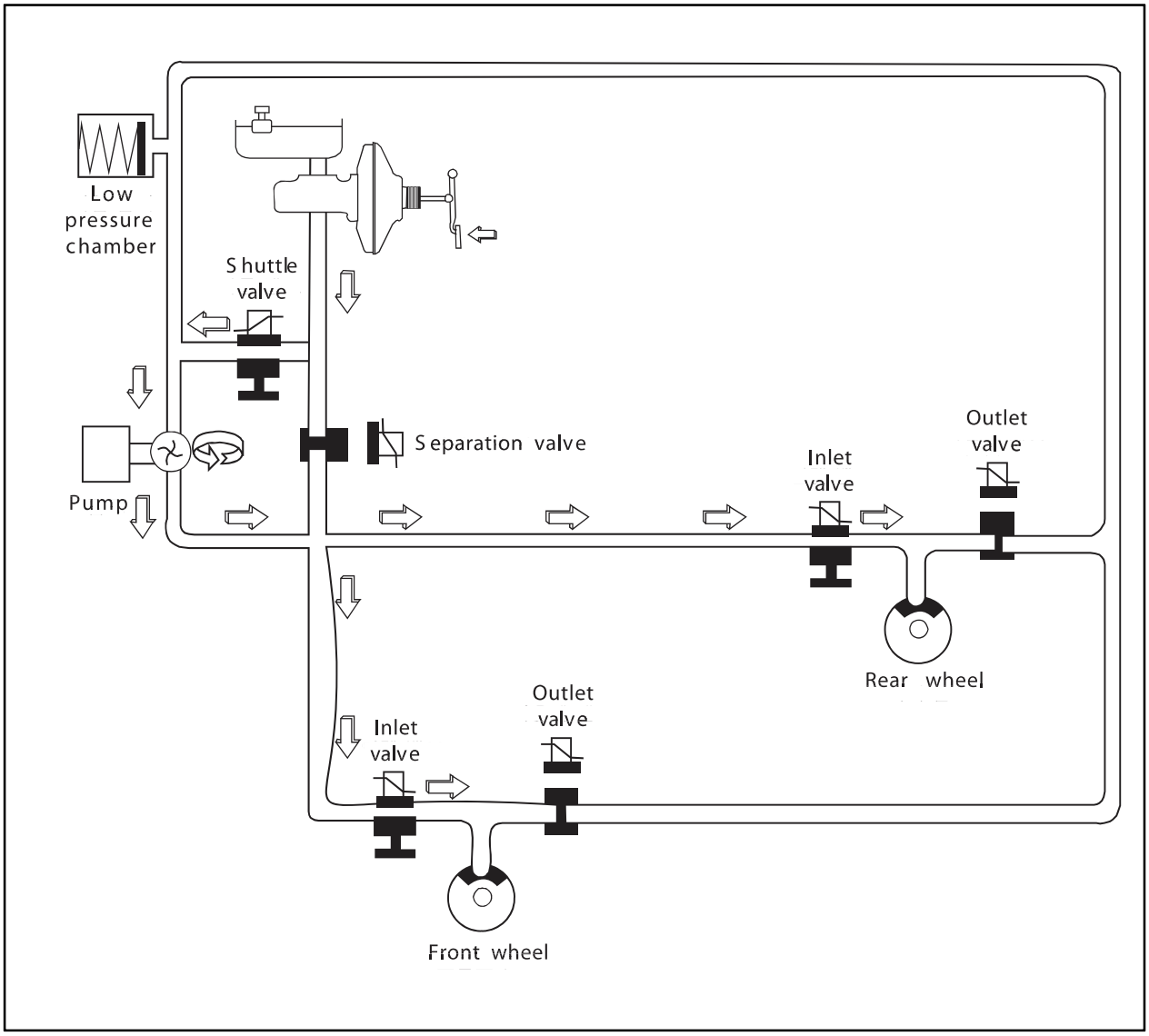
4



The shuttle valve and inlet valve will be open and the separation valve and outlet valve will be closed. Then, the pump is operated.
When ESP operates while the ABS is operating, the pressure will be increased continuously until just before the corresponding wheel gets locked.

Modification basis	
Application basis	
Affected VIN	

10. HYDRAULIC CIRCUIT OF BAS (BRAKE ASSIST SYSTEM)



The above figure shows one front and one rear wheel and the same hydraulic circuit forms as in the ESP operation.

When HECU recognizes that it is an emergency and it is required for hard braking, depending on the pressure value of the brake pressure sensor and pressure changes caused by the pressure sensor timing, it operates the pump immediately to apply the brake pressure at the wheels. Then, the pressure in the pump increases until just before the corresponding wheel gets locked.

The motor still keeps rotating and the outlet valve and the separation valve will stay closed.

When the wheel starts to lock, the BAS function cancels and switches to ABS operation.

11. COMPONENTS OF ABS SYSTEM

The following figure shows the basic system components of the ABS. This system consists of HECU (valve body and ECU integrated type), front wheel speed sensor and rear wheel speed sensor.

HECU (Valve Body and ECU Integrated Type)



Valve body



B: Plunger C: Cam bushing

Motor pump

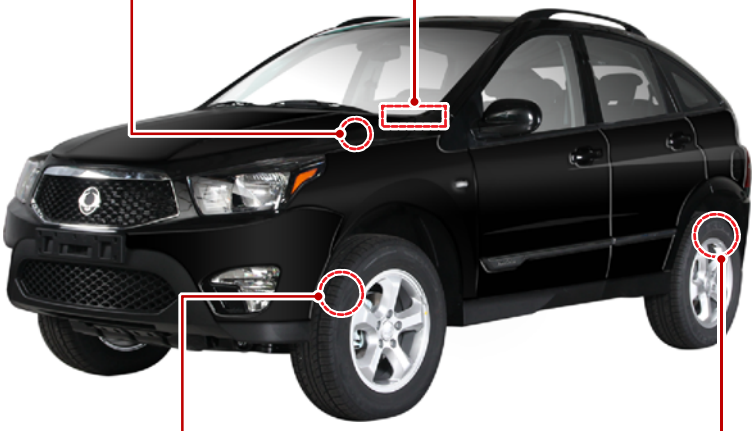


ABS warning lamp





EBD warning lamp
(two indicators come on)



Front Wheel Speed Sensor (for 4WD)

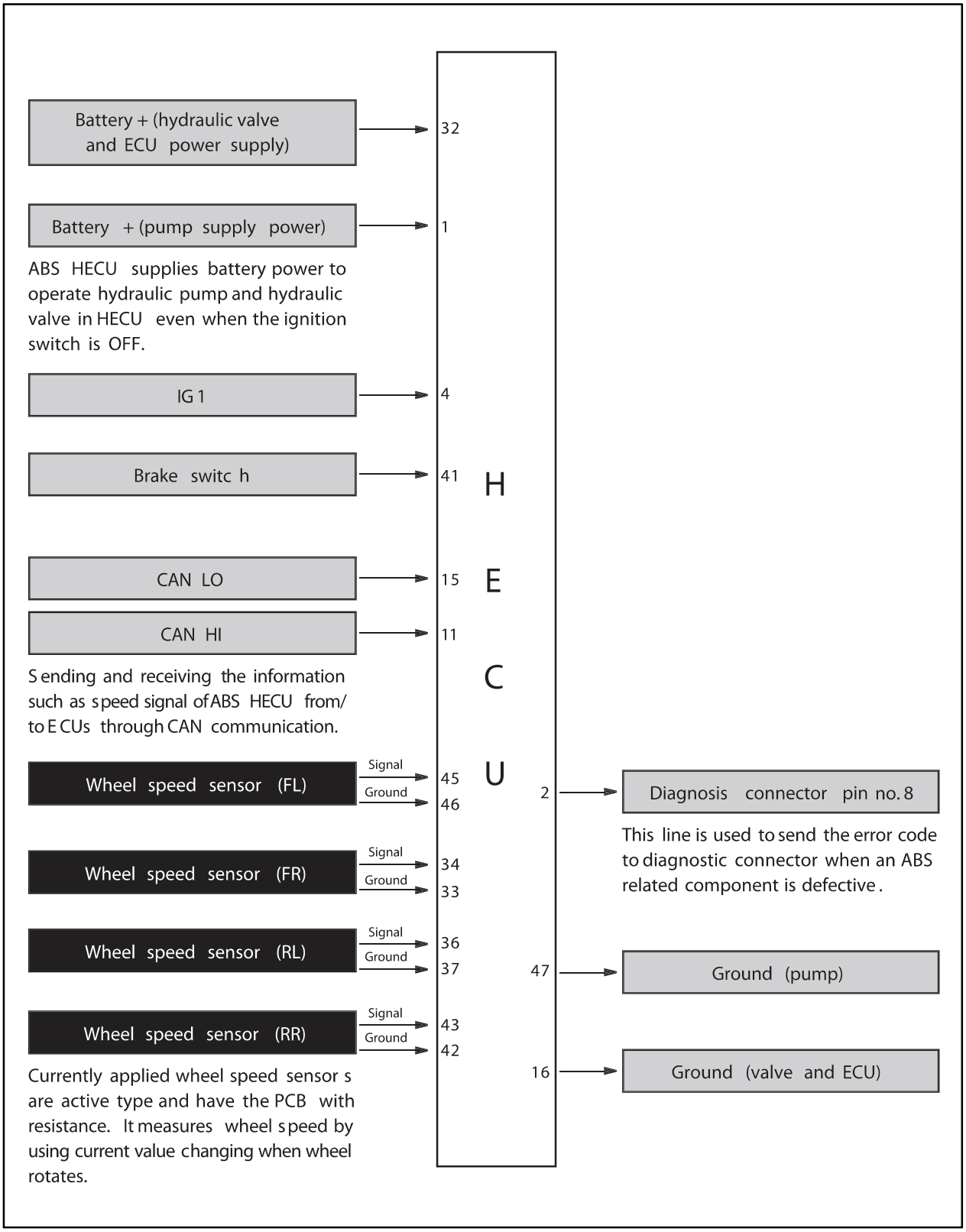


Rear Wheel Speed Sensor



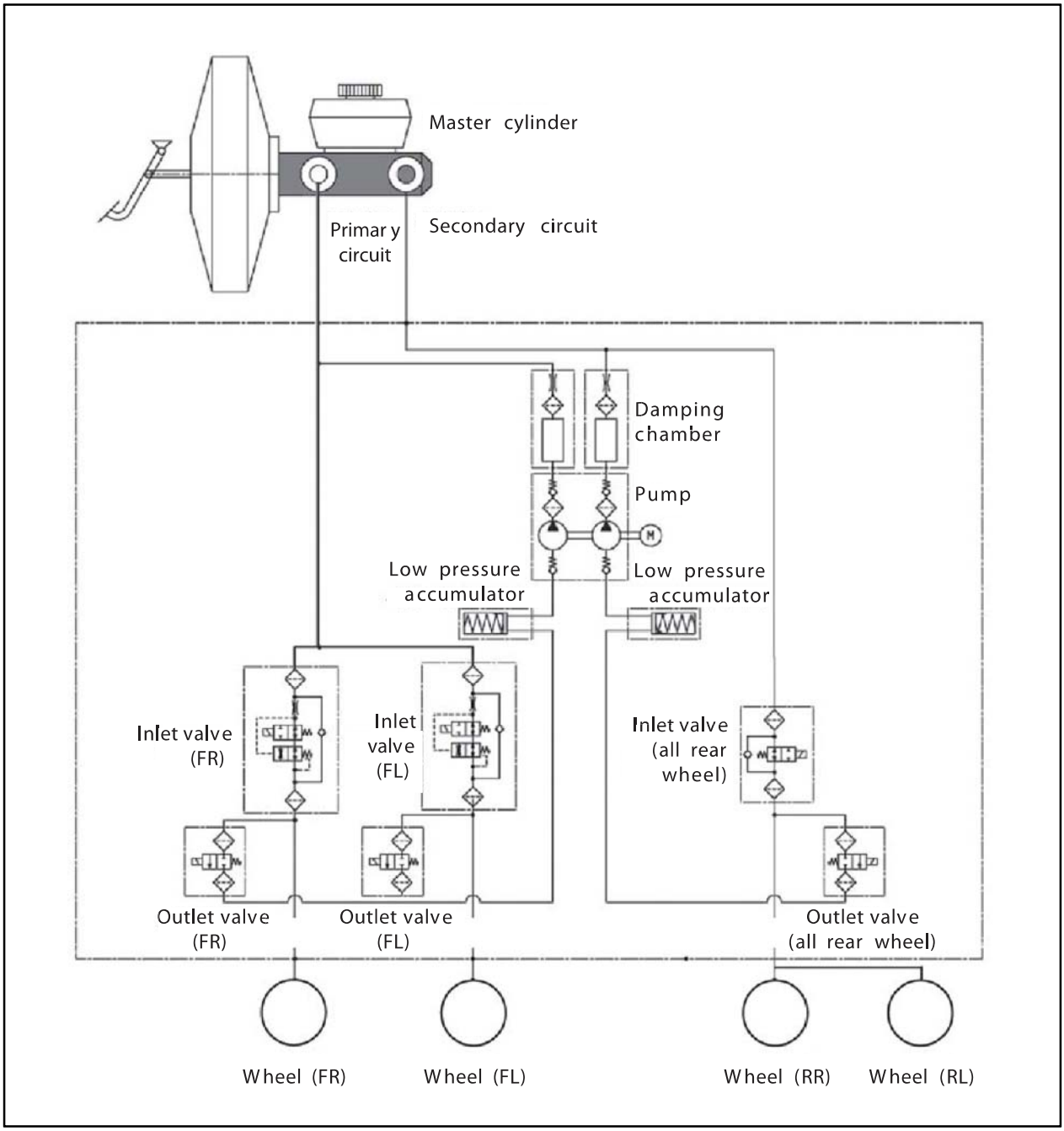
Modification basis	
Application basis	
Affected VIN	

1) Input and Output Diagram Of ABS System



Modification basis	
Application basis	
Affected VIN	

2) Hydraulic Circuit Of ABS



The vehicle equipped only with the ABS controls the wheel's braking force using 3-channel 4-sensor method.

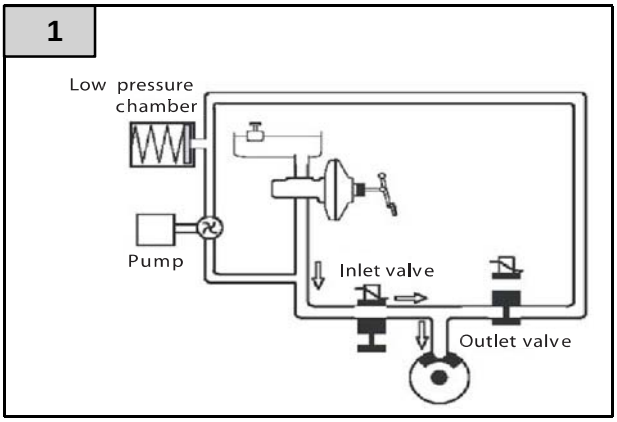
The front wheels that are the primary circuit of the brake system is composed of two wheel speed sensors and two channel valves system with two inlet valves and two outlet valves. The rear wheels that are the secondary circuit of the brake system is composed of two wheel speed sensors, one inlet valve and one outlet valve.

This system is similar to the one from the previous model.

Modification basis	
Application basis	
Affected VIN	

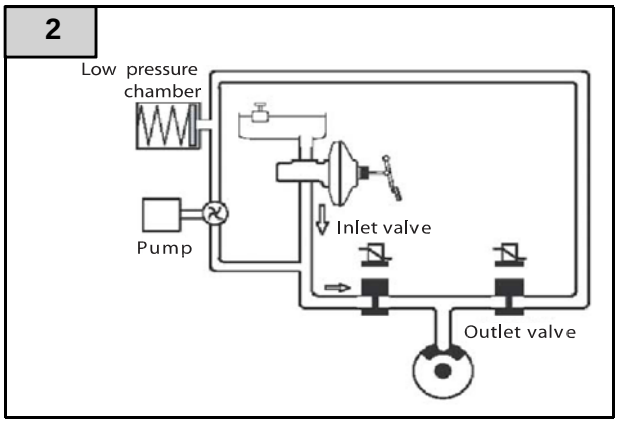
3) ABS Circuit in Each Operation Range

1



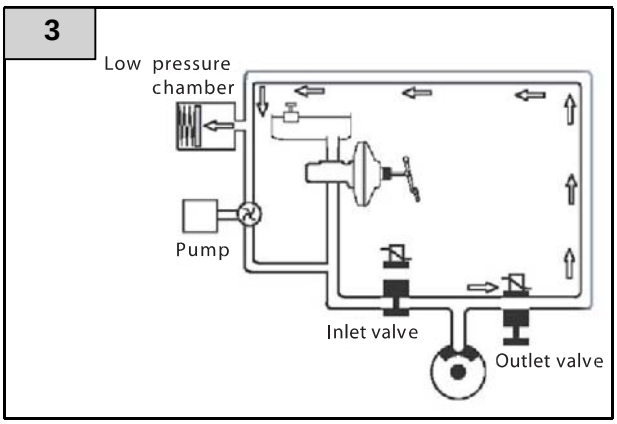
Hydraulic Pressure Circuit when ABS is Not Operating The hydraulic pressure in the master cylinder increases through the vacuum booster and it is delivered to the wheel via the normal open inlet valve. At this moment, the normally-closed outlet valve is closed.
The speed of the wheel that hydraulic pressure is delivered reduces gradually.

2

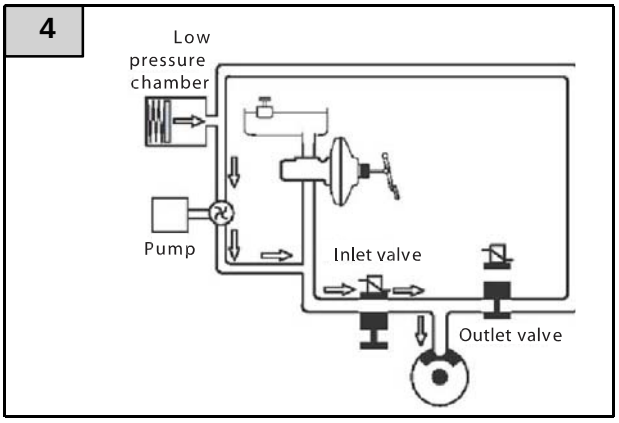


Hydraulic Pressure Locked in Circuit when ABS is Operating As hydraulic pressure on each wheel increases, the wheel tends to lock.
In order to prevent the wheel from locking, the hydraulic valve modulator operates the inlet valve control solenoid to close the inlet valve and stop the hydraulic pressure increases.
At this moment, the outlet valve is closed.
This procedure helps the wheel to maintain a stable hydraulic pressure.

3



Pressure Decreases in the Circuit when ABS is Operating Even when the hydraulic pressure on each circuit is stable, the wheel can be locked as the wheel speed decreases.
This is when the ABS ECU detects the wheel speed and the vehicle speed and gives the optimized braking without locking the wheels. In order to prevent from hydraulic pressure increases, the inlet valve is closed and the outlet valve is opened.
Also, the oil is sent to the low pressure chamber and the wheel speed increases again.
The ABS ECU operates the pump to circulate the oil in the low pressure chamber to the master cylinder.
This may make the driver to feel the brake pedal vibration and some noise.



Pressure Increases in the Circuit when ABS is Operating As the wheel speed increases, the inlet valve opens and the wheel's pressure increases due to the master cylinder pressure.
The oil in the low pressure chamber circulates to the wheel by the pump (no pressure increase in wheel).
Therefore, when depressing the brake pedal, the pressure generated in the master cylinder is transferred to the disc and then the outlet valve decreases this pressure
intermittently.
This operation continues repetitively until there are no signs that the ABS ECU is locking the wheels.
When the ABS hydraulic pressure control takes place, there may be some vibration and noises at the brake pedal.

Modification basis	
Application basis	
Affected VIN	

STEERING 4610-01

GENERAL

1. OVERVIEW

When a driver turns the steering wheel, the front wheels are steered and the vehicle moves to the desired direction. However, there is a certain limitation to increase the steering efficiency only with the mechanical methods. A steering system using hydraulic pressure has been introduced to decrease the driver's steering effort while using the normal gear ratio.

The power steering system consists of pump, oil reservoir, rack and gear box.

The power steering pump is a vane type and delivers hydraulic pressure to operate the power steering system. The pressure relief valve in the pump controls the discharging pressure.

The rotary control valve in the rack and pinion gear directs the oil from the power steering pump to one side of the rack piston. The integrated rack piston converts the hydraulic pressure to linear movement.

The operating force of the rack moves the wheels through the tie rod, the tie rod end and the steering knuckle. Even though the hydraulic pressure cannot be generated, a driver can steer the vehicle without power assist but it needs very high steering force.

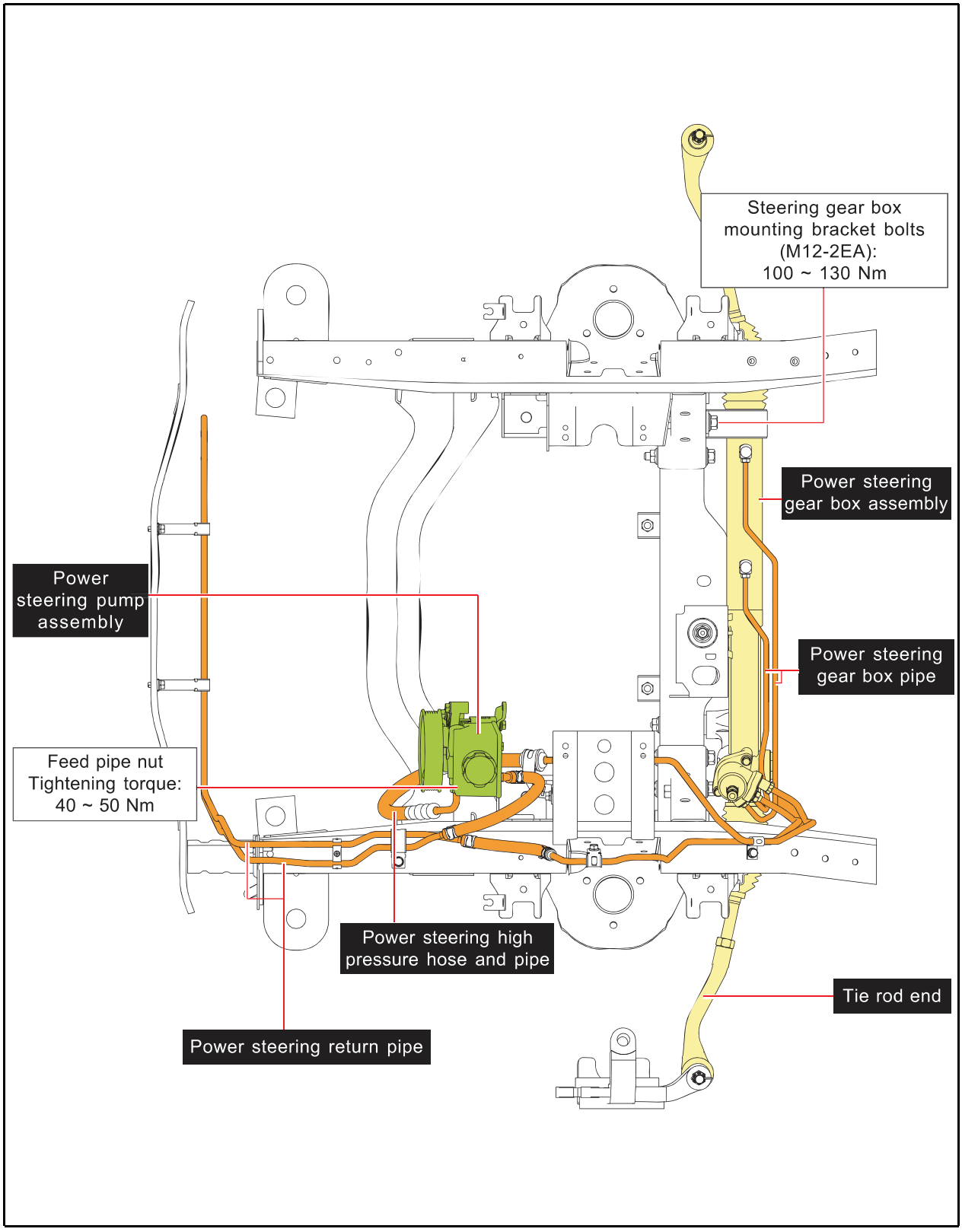
In this case, the operating force of the steering wheel is conveyed to the pinion, and the movement of the pinion moves the rack through the pinion gear combined to the rack gear.

2. SPECIFICATIONS

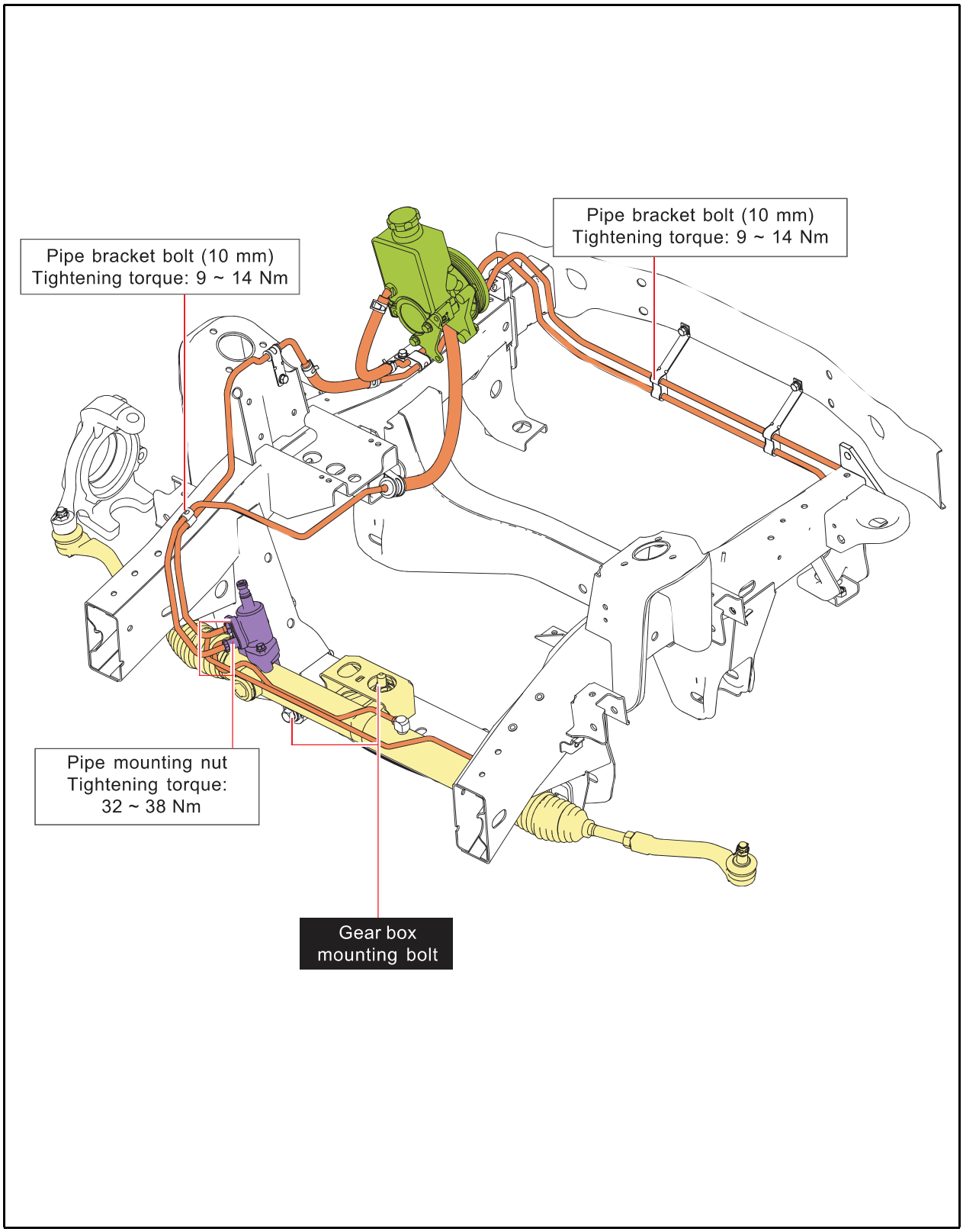
Description			Specification
Steering wheel	Type		4-spoke type
	Outer diameter		390 mm
Steering gear box	Type		Rack and pinion
	Gear ratio		∞
	Steering angle	Inner	36.2˚
		Outer	32.4˚
Oil pump	Type		Vane type
	Maximum pressure		88.2 ~ 95.3 kgf/cm²
	Displacement		11.3 cm³/rev
	Pulley size		124 mm
Tilt column adjusting angle	Up		4˚
	Down		8˚
Minimum turning radius			5.6
Oil	Specification		S-PSF3
	Capacity		1.0ℓ

OVERVIEW AND OPERATION

1. SYSTEM LAYOUT

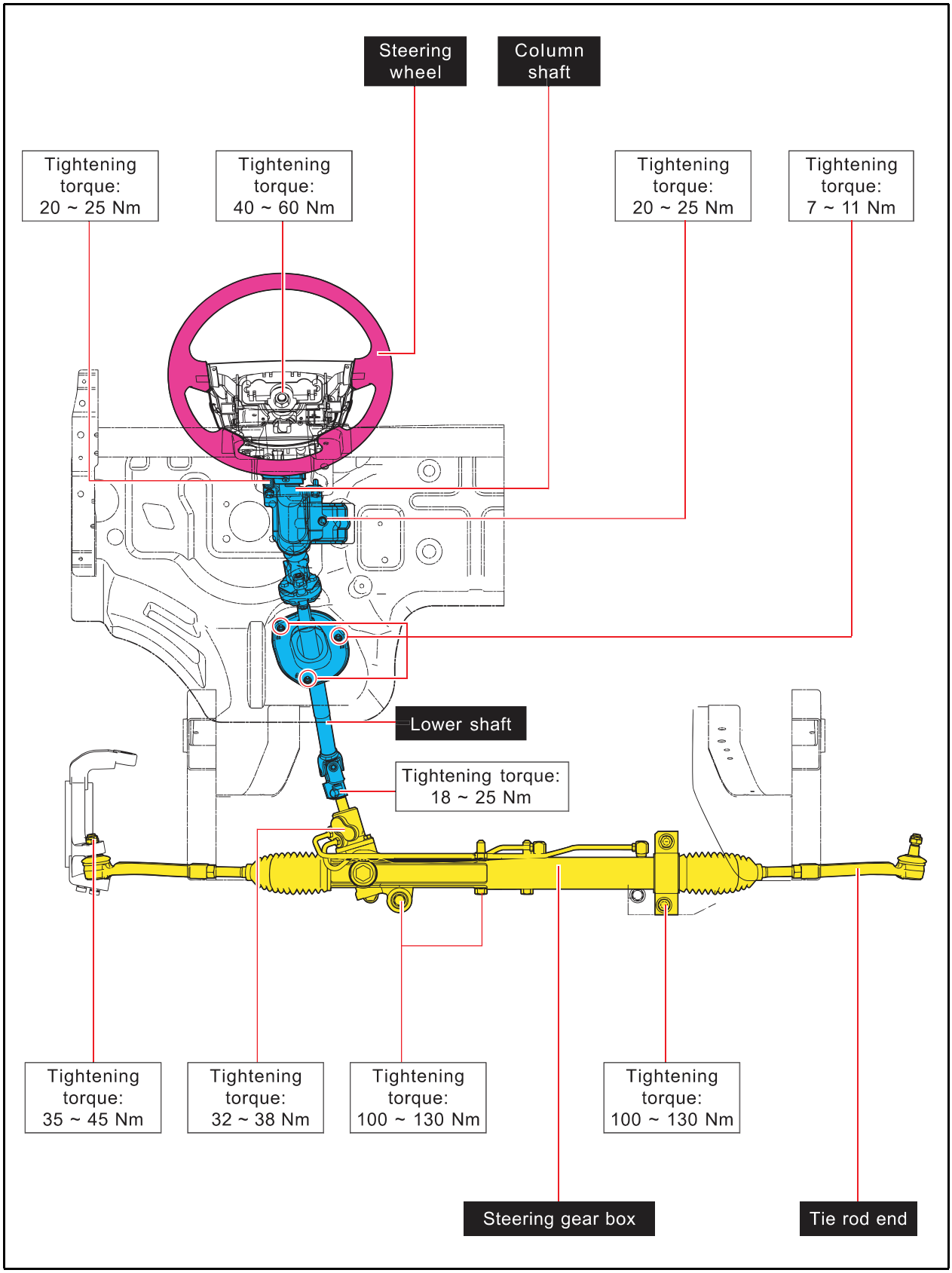


Modification basis	
Application basis	
Affected VIN	

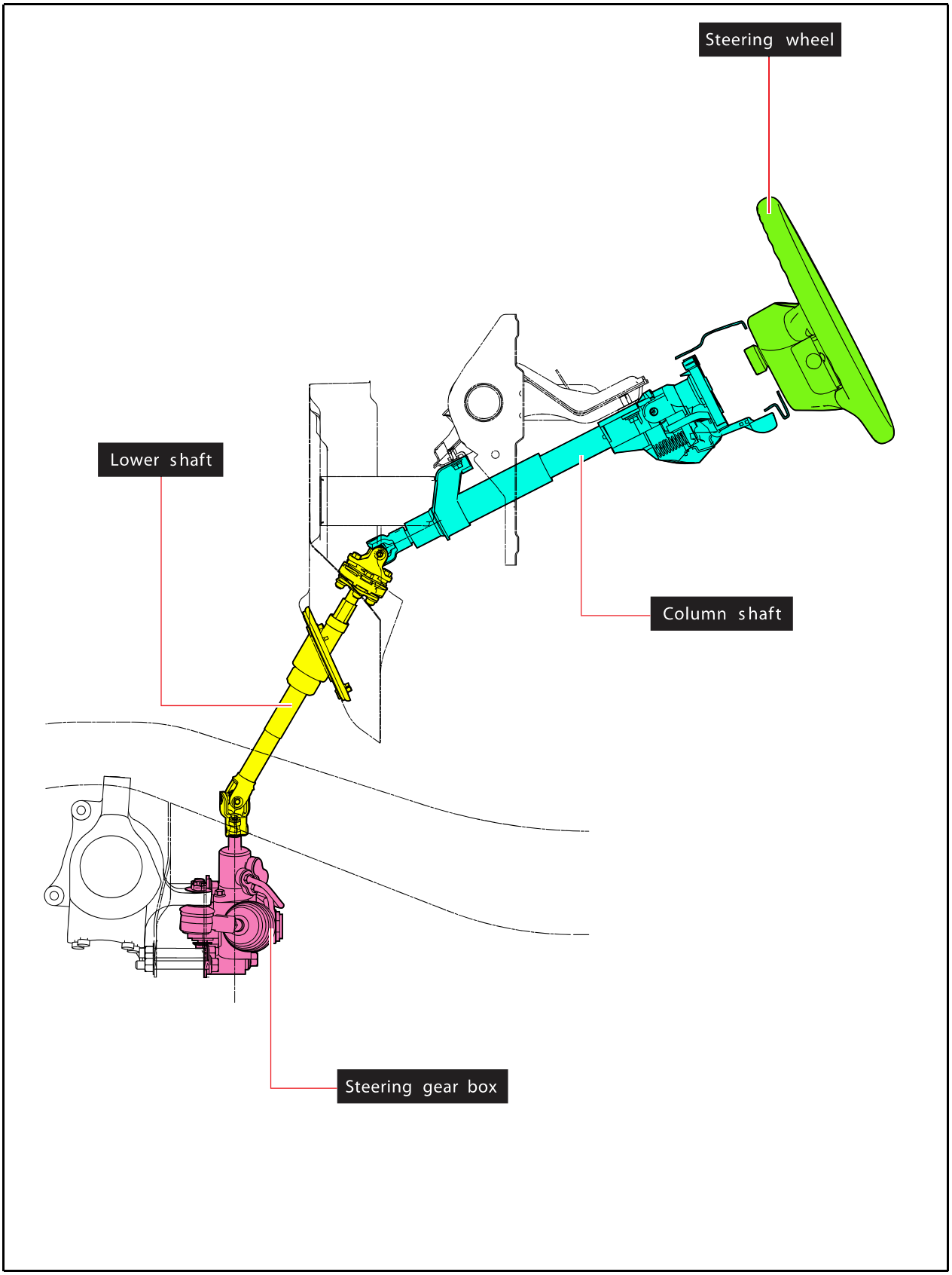


Modification basis	
Application basis	
Affected VIN	

2. COMPONENTS



Modification basis	
Application basis	
Affected VIN	



Modification basis	
Application basis	
Affected VIN	

WHEEL TIRE 4170-01

GENERAL INFORMATION

1. SPECIFICATIONS

Description		Specification
Tire	16 inch	225/75R 16
	18 inch	255/60R 18
Temporary tire		175/90R 16
Tire inflation pressure		Full Size : 32psi,2.21bar Temporary : 60psi,4.13bar
Wheel	16 inch	6.5J x 16
	18 inch	7.5J x 18
Balance weight	16 inch	Inner: Attachment type Outer: Clip type
	18 inch	Inner: Attachment type Outer: Attachment type
Tightening torquse of wheel bolt		120 ~ 140 Nm

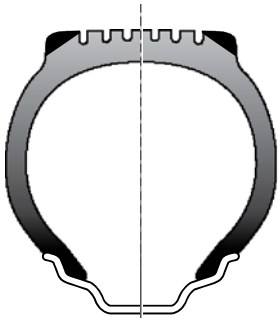
2. TROUBLE DIAGNOSIS

Problem	Possible Cause	Action
Uneven tire wear	Incorrect tire pressure	Adjust
	Unbalanced wheel	Adjust
	Improper location change of tire	Change tire location in specified interval
	Incorrect toe adjustmen	Adjust
	Incorrect wheel bearing preload adjustment	Adjust
	Malfunction of brake syste	Adjust
Tire squeal, vibration	Too low tire pressure	Adjust
	Unbalanced wheel or tire	Adjust
	Heavy vibration of wheel or tire	Uneven tire wear
	Uneven tire wear	Check and adjust
Premature tire wear	Too high tire pressure	Adjust
	Fast driving with low pressure tire	Adjust
	Overload	Adjust

Modification basis	
Application basis	
Affected VIN	

3. INSPECTION

1) Appearance Check

Symptom		Possible Cause
Wear at tread edge 		Insufficient tire inflation pressure or overload
Wear at tread center 		Excessive tire inflation pressure
Excessive wear in the outer side of the tread than in the inner side 		Excessive camber or deflection of knuckle arm
Excessive wear in the inner side of the tread than in the outer side 		Insufficient camber or deflection of knuckle arm

Symptom		Possible Cause
Blade type wear from outer side toward inner side of the tread 		Excessive toe-in, Deflection of knuckle arm, Difference in tie rod length between left and right sides
Blade type wear from inner side toward outer side of the tread 		Excessive toe-in, Deflection of knuckle arm, Difference in tie rod length between left and right sides
Corrugation wear of tread 		Poor wheel balance, Loose wheel bearing, poor wheel alignment

Modification basis	
Application basis	
Affected VIN	

2) Typical Inspection



1. **Tread**
   Inspect the tread condition on the tire surface and various damages resulting from the foreign materials, crack, stone or nail etc. If there is any damage in the tire, repair or replace it.



2. **Wear limit**
   - Measure the depth of the tire tread. If the depth of the tread is below the specified value, replace the tire

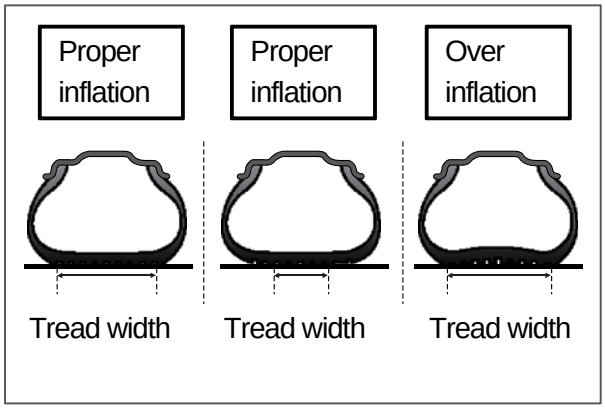
Wear limit	1.6 mm



- You can see the protruded part in the groove at the point with mark "▲", which is the indicator of the tread wear limit.
- The limit of the tread wear for all season tires are 1.6 mm, which is the same as the general tires, but the wear limit mark is indicated as '↓'.

CAUTION
- Higher than recommended pressure can cause hard ride, tire bruising or damage and rapid tread wear at the center of the tire.
- Excessive tire wear over the limit of the tread wear (1.6 mm) can cause lower sliding friction due to longer braking distance, easy tire burst by foreign materials, tire hydroplaning, and tough brake and steering wheel handling.





3. **Tire inflation pressure**

- Tire inflation pressure

Specified value	32 psi, 2.21 bar

- Check the tire inflation pressure by inspecting the tread width.

CAUTION

Maintaining the specified tire ressure is essential for comfortable riding, driving safety, and long tire life. Incorrect inflation pressures will increase tire wear and will impair safety, vehicle handling, comfortable driving and fuel economy. Always make sure that the tire inflation pressure is correct.

4. **Wheel runout**

If wheel runout or tire runout is excessive, it could result in abnormal wear of the tire. Measure the runout with a dial gauge.

- Measure the dial runout and lateral runout on both the inboard and outboard rim flanges.

Specified value	2.66 mm

- Measure free radial runout on the tire tread.

Specified value	2.03 mm

CAUTION

- If any measurement exceeds the above specifications, replace the applicable tires or wheels

Modification basis	
Application basis	
Affected VIN	

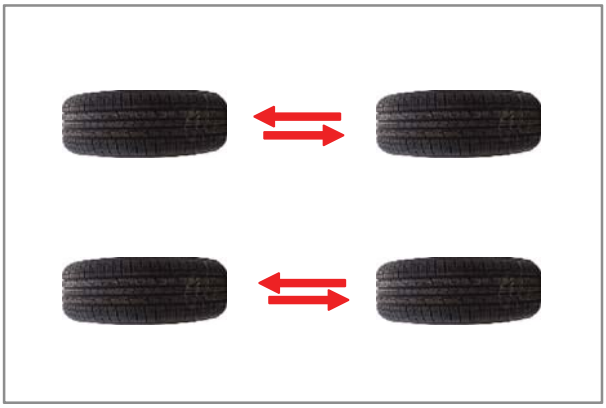


5. **Wheel balance**

- Check the wheel balance when the wheel is unbalanced or the tire is repaired.
  The total weight of the wheel weight
- should not exceed 150 g.
  Ensure that the balance weight installed is
- not projected over 3mm from the wheel surface.
  Use the specified aluminum wheel balance
- weights for aluminum wheels.
  Weight balance can be added by 5 g.
- There are two types of weight balance,
- tape type and adhesion type.

NOTE

- Make sure to read the manual of the manufacturer thoroughly before using wheel balance tester.



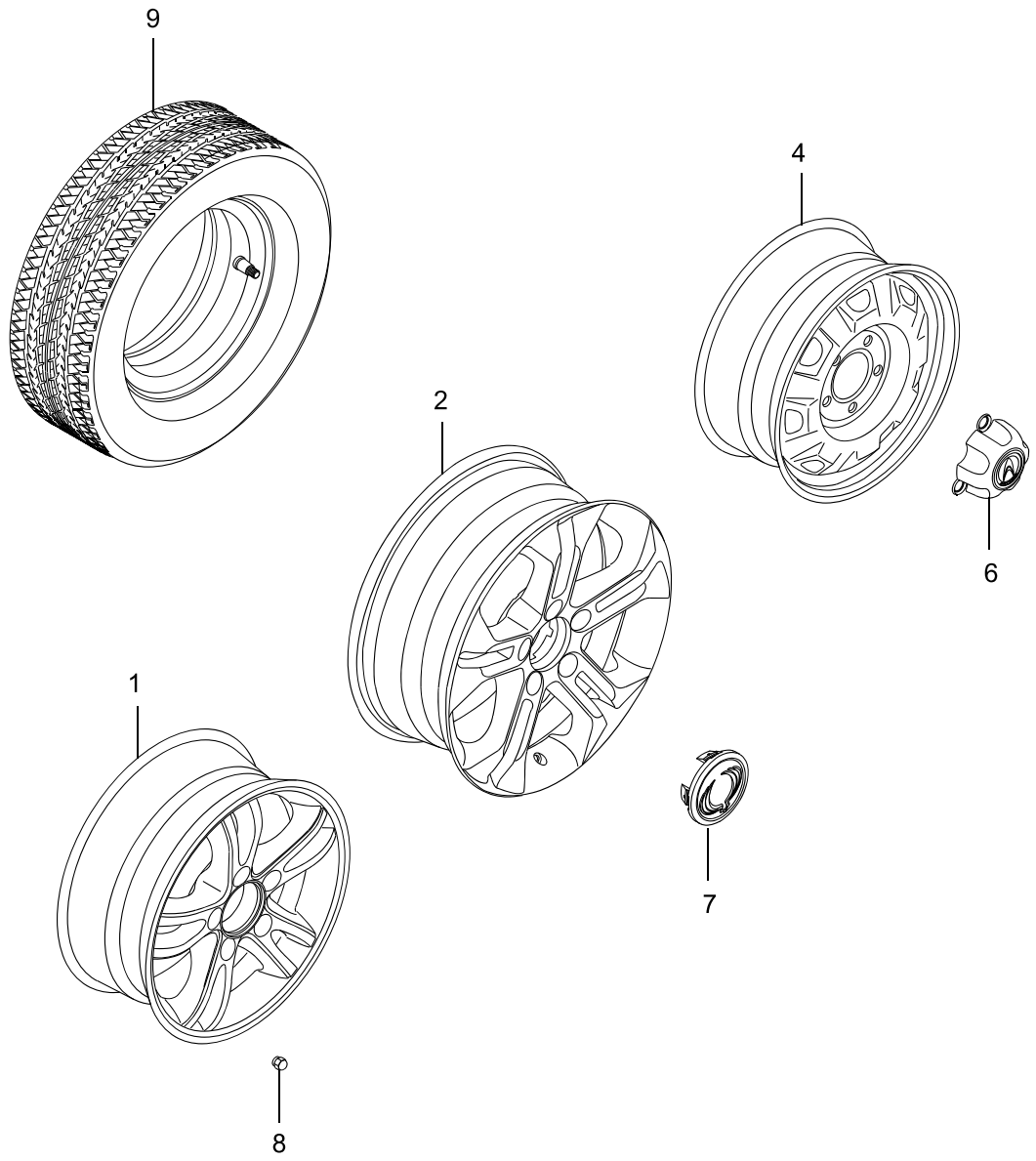
6. **Change tire location**

To avoid uneven wear of tires and to prolong tire life, inspect and rotate your tires every 5,000 km.

CAUTION

- Mixing tires could cause to lose control while driving. Be sure to use the same size and type tires of the same manufacturer on all wheels.

4. COMPONENTS



1. Alloy wheel
2. Alloy wheel
3. Steel wheel
6. Cap assembly - wheel
7. Cap assembly - wheel
8. Nut (120 ~ 140 Nm)
9. Tire

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

A radial tire uses a cord angle of 90 degrees. That is, the cord material runs in a radial or direct line from one bead to the other across the tread. In addition, a radial tire has a belt overwrap under the tread surface to provide greater structural stability. The belt overwrap of a radial tire distortion while the radial structure enables high speed driving.

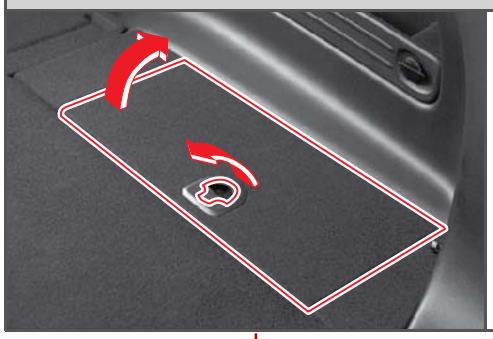
Tire supports the weight of the vehicle, reduces the impact from the road and at the same time, transmits the power to propel, brake and steer on the road. It also functions to maintain a vehicle's movement. In order to complete such tasks, a tire must be structured to be a resilient vessel of air.

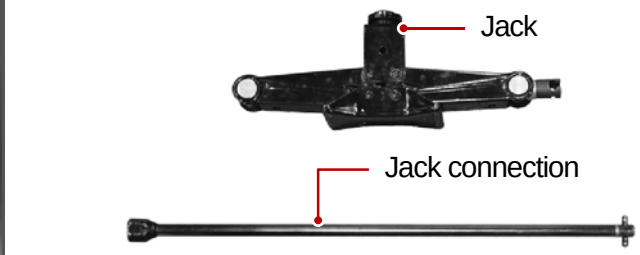
There is wear limit mark on the tire, which protrudes as a strip shape located approximately 1.6 mm from the groove bottom. This wear limit mark is not seen from the outside so there is additional "▲" mark on the shoulder to let the driver find the wear mark easily. To measure the tire groove depth, measure at any point other than the point which has a wear limit mark.

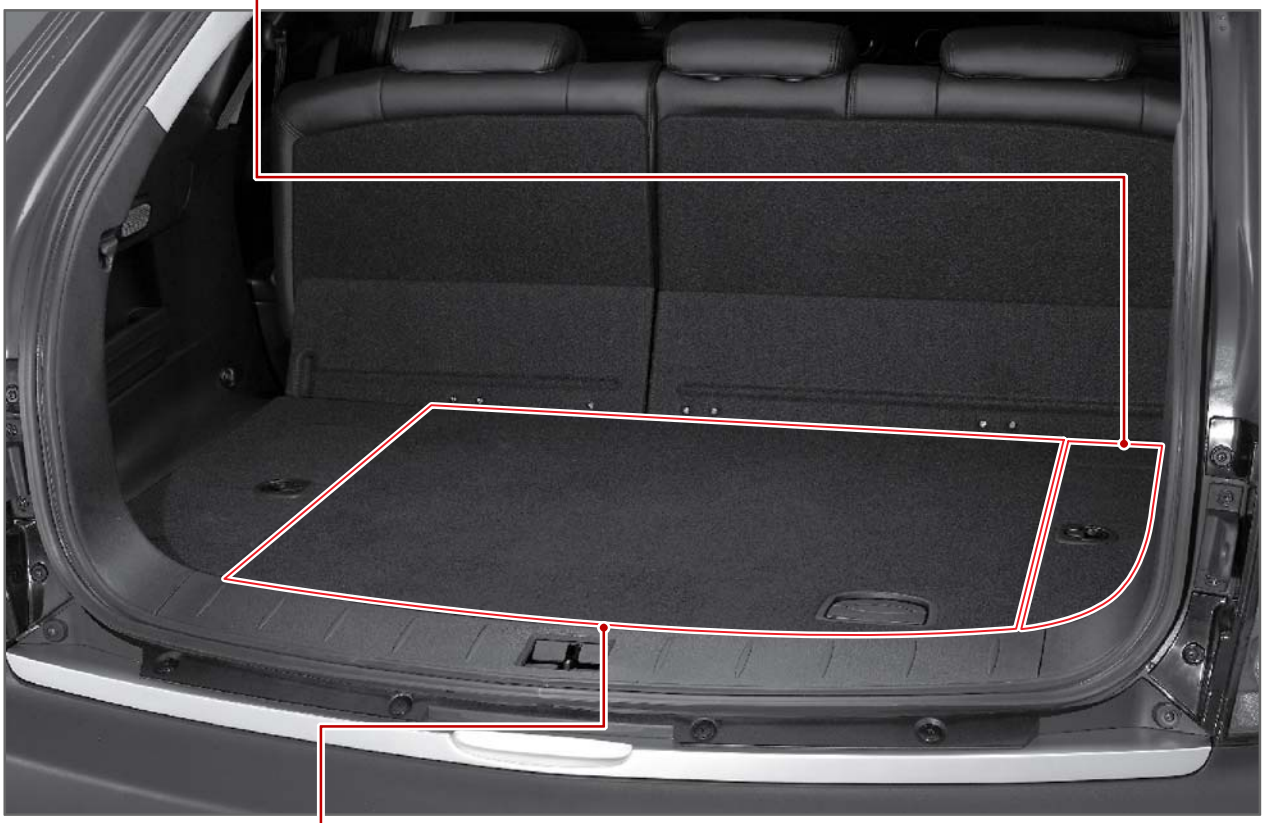
The tire is worn unevenly according to the driver's driving habit, improper servicing, low tire inflation pressure, changed tire location, etc.

▶ Location

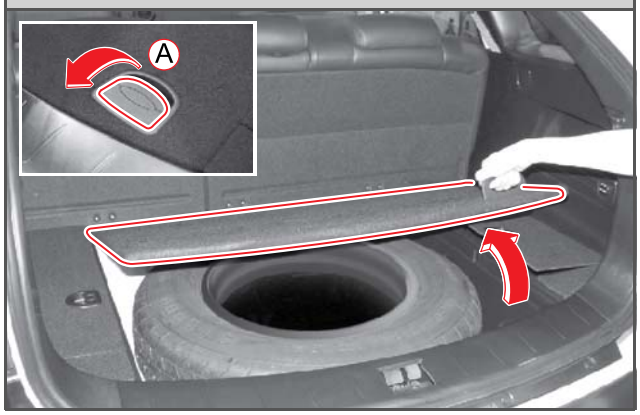
OVM Tools





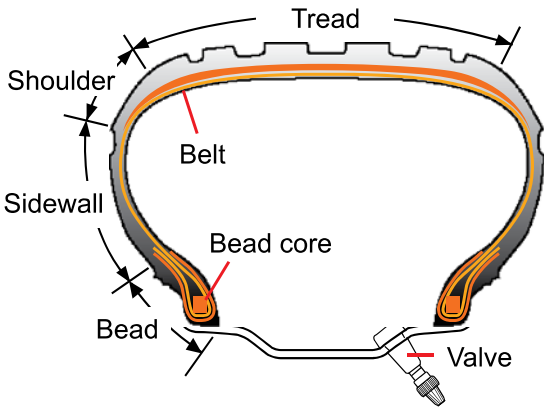


Spare tire



Modification basis	
Application basis	
Affected VIN	

▶ Structure of Tire



Tread

This thick layer of rubber provides the interface between the tire and the road. Wear-resistant rubber is used to protect the carcass and belt against fractures and impacts and to deliver a long driving life.

Shoulder

Located between the tread and sidewall, the shoulder rubber is the thickest so that the design must allow for the easy diffusion of heat generated within the tire while driving.

Sidewall

The part between the shoulder and bead, the flexible sidewall protects the carcass and enhances the ride. A tire's type, size, structure, pattern, manufacturing company, product name and various characters are indicated here.

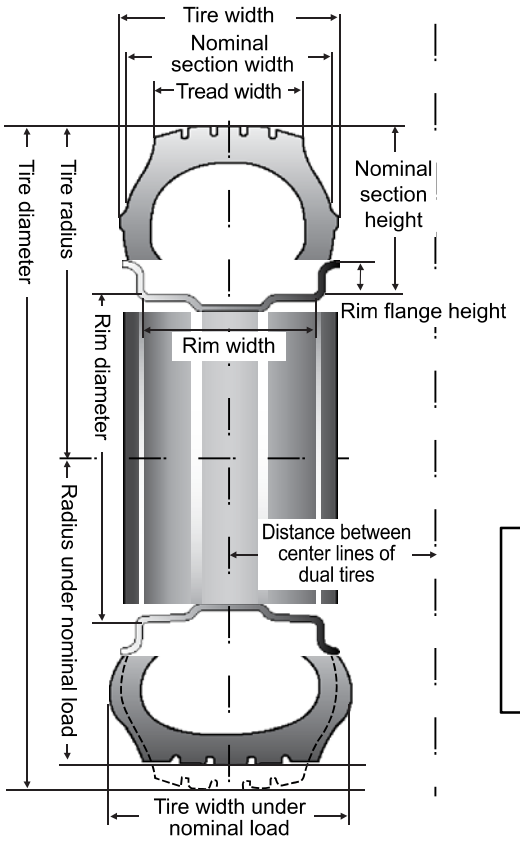
Bead

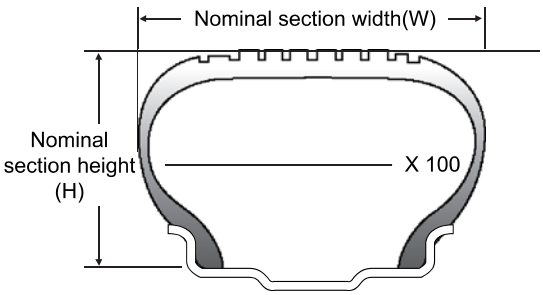
The bead attaches the tire to the rim and wraps the end of the cord fabric. Comprised of the bead wire, core, flipper and other parts, the bead is generally designed to be slightly tight around the rim so that in the case of a sudden drop in inflation pressure, the tire will not fall off the rim.

Carcass

As the most important framework of a tire, the entire inner layer of cord fabric is called the carcass. The carcass acts to support air pressure, vertical load and absorb shocks.

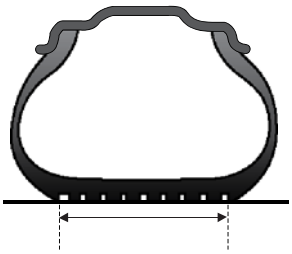
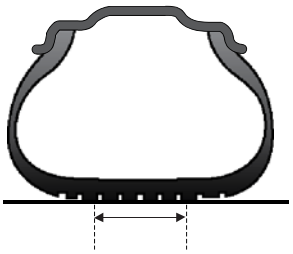
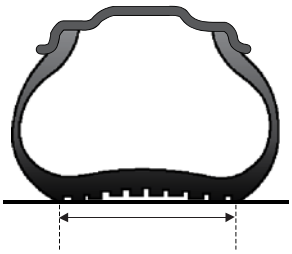
▶ Tire Unit Indication





Aspect ratio (%)
= Nominal section height (H) / Nominal section width (W)
X 100

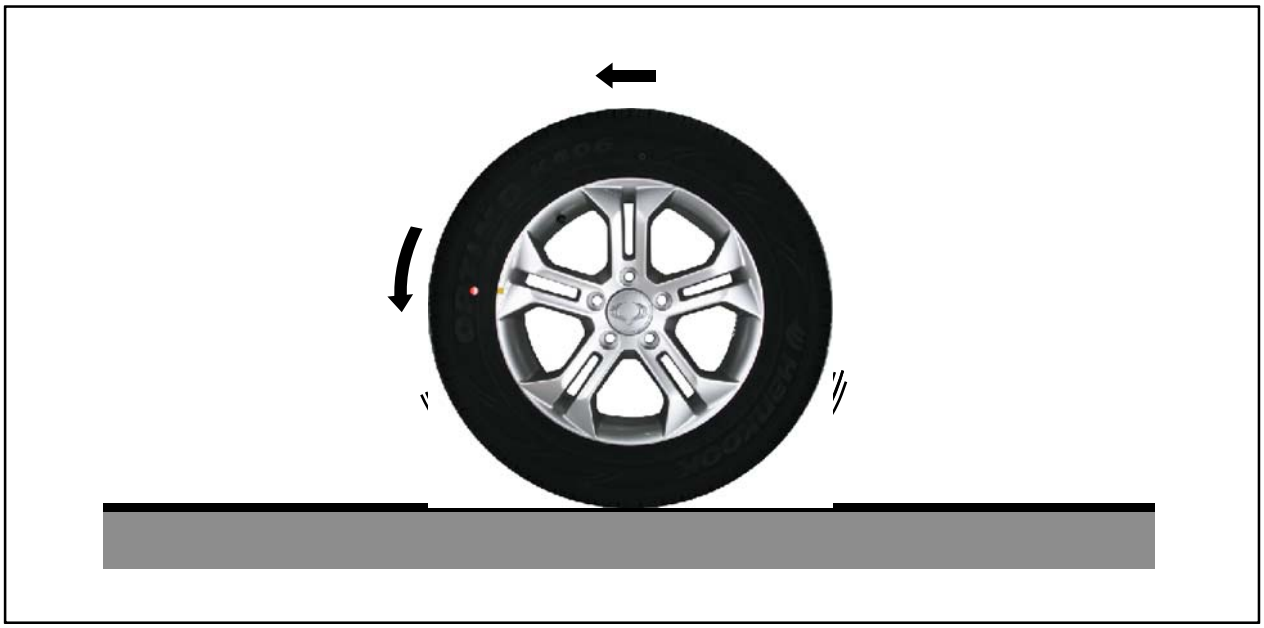
▶ Tire Inflation Pressure (32 psi, 2.21 bar)

Proper inflation pressure	Excessive inflation pressure	Low inflation pressure
 Tread width	 Tread width	 Tread width
The contact area between the ground and tire faces the tread layer completely. Thus the driving force and the braking force are optimized, and the tire is worn out evenly resulting in increased life.	The contact area between the ground and tire is not enough, so the tire is worn out unevenly and the tire is vulnerability to outside influence.	The contact area between the ground and tire is excessive, so a lot of heat is generated and the tire is worn out unevenly and abnormally.

Modification basis	
Application basis	
Affected VIN	

2. ABNORMAL TIRE SYMPTOM

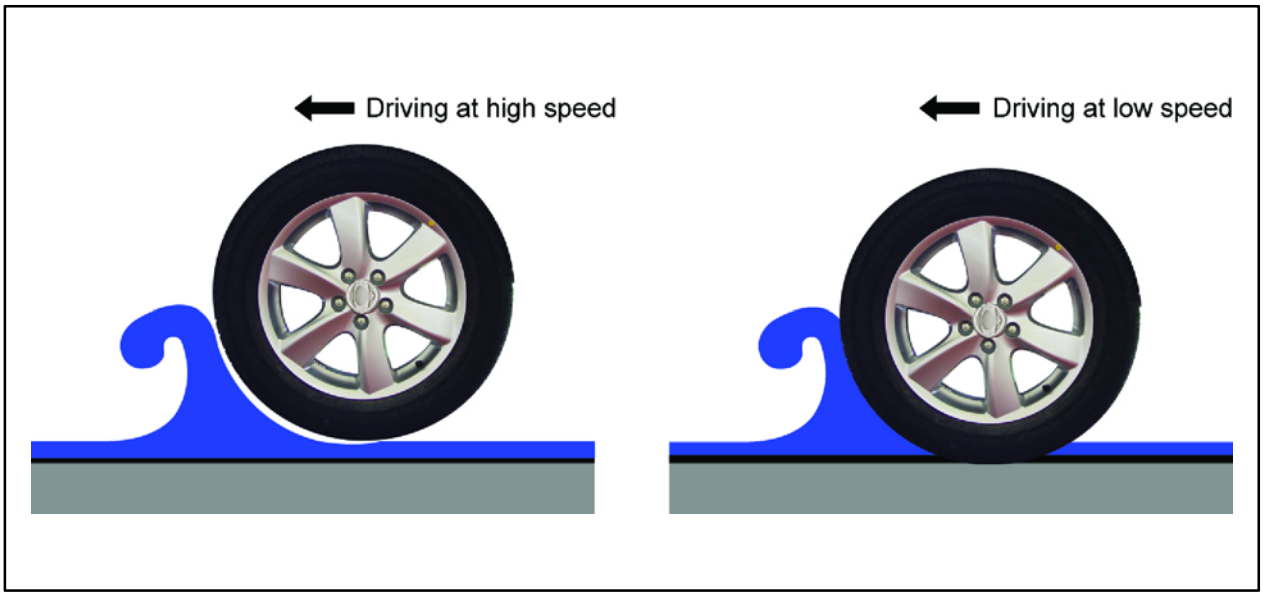
▶ **Standing Wave**



Specified tire inflation pressure	32psi, 2.21bar

During driving, the rotating tire repeats deformation and restoring movement in is tread. This happens when the tire pressure is low in high speed driving.
However, when the wheel rotating speed is fast, the tire is deformed even before it is restored to its original shape and the trembling wave appears on the tread portion. If this symptom lasts for an extended period of time, the tire can be blown out in a short period of time.
If the standing wave symptom occurs on the tire, rubber on the tread comes off and eventually the tire can be blown out which is very dangerous. When driving at high speed, the inflation pressure should be increased to decrease heat generation due to extension and contraction motion, to decrease hydroplaning and to prevent standing wave.
To prevent this symptom, it is recommended to increase the tire pressure 10 ~ 30 % higher than the specified pressure value in high speed driving.

▶ Hydro Planing



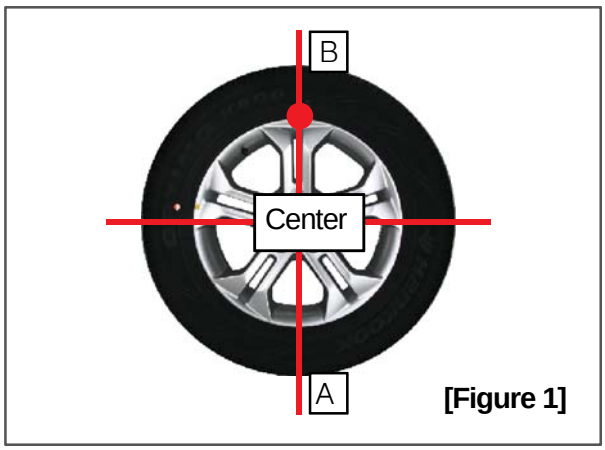
When the vehicle is driven on a road surface covered with water at high speed, tires do not contact with the road surface but rotate floating on a thin film of water.
It causes brake failure, lower traction force and losing the steering performance.
To prevent this, increase the tire inflation pressure, use tires with leaf shape tread which is not worn.
However, it is a best measure to drive slowly.

Modification basis	
Application basis	
Affected VIN	

3. WHEEL BALANCE

If weight is not equally distributed around the wheel, unbalance centrifugal force by the wheel rotation produces vibration. As the centrifugal force is produced proportional to the square of the rotating speed, the wheel weight should be balanced even at high speed. There are two types of the tire and wheel balancing: static and dynamic. Abnormal vibration may also occur due to unbalanced rigidity or size of tires.

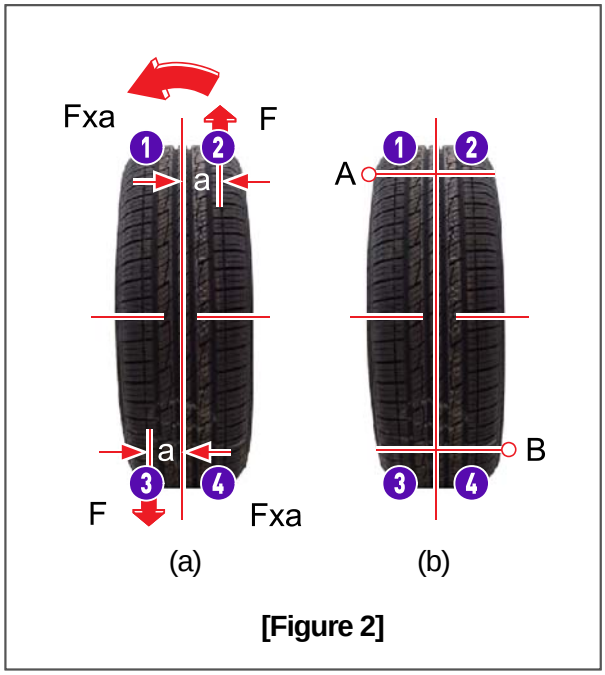
▶ Static Balance



[Figure 1]

When the free rotation of the wheel is allowed, the heavier part is stopped on the bottom if the wheel weight is unbalanced and this is called "Static Unbalance". Also, the state at which tire's stop position is not same is called "Static Balance" when the wheel is rotated again. If the part A is heavier as shown in the figure 1, add the balance weight of a weight corresponding to unbalanced weight from B to A to maintain the static balance. If the static balance is not maintained, tramping, up and down vibration of the wheels, occurs.

▶ Dynamic Balance



[Figure 2]

The static unbalance of the wheel creates the vibration in the vertical direction, but the dynamic unbalance creates the vibration in the lateral direction. As shown in the figure 2 (a), if two parts, (2) and (3), are heavier when the wheels are under the static balance condition, dynamic unbalance is created, resulting in shimmy, left and right vibration of the wheels, and the torque Fxa is applied in the axial direction. To correct the dynamic unbalance, add the balance weight of a same weight for two points of the circumference of the rim, A and B, as shown in the figure 2 (b), and apply the torque in the opposite direction to the torque Fxa to offset in order to ensure smooth rotation of the wheel.

AIR CONDITIONER 6810-01

OVERVIEW AND OPERATION PROCESS

1. SYSTEM LAYOUT AND COMPONENTS

Type	Air Conditioner Controller
FATC	
Manual air conditioner	

Compressor



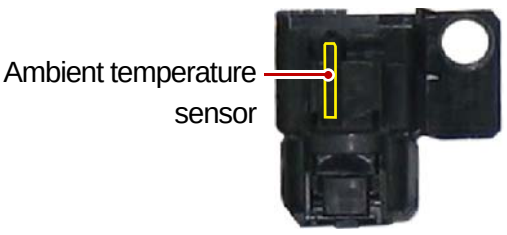
Sun Sensor - Instrument Panel Upper Left





It changes sun load coming through front windshield into current to input to FATC controller.

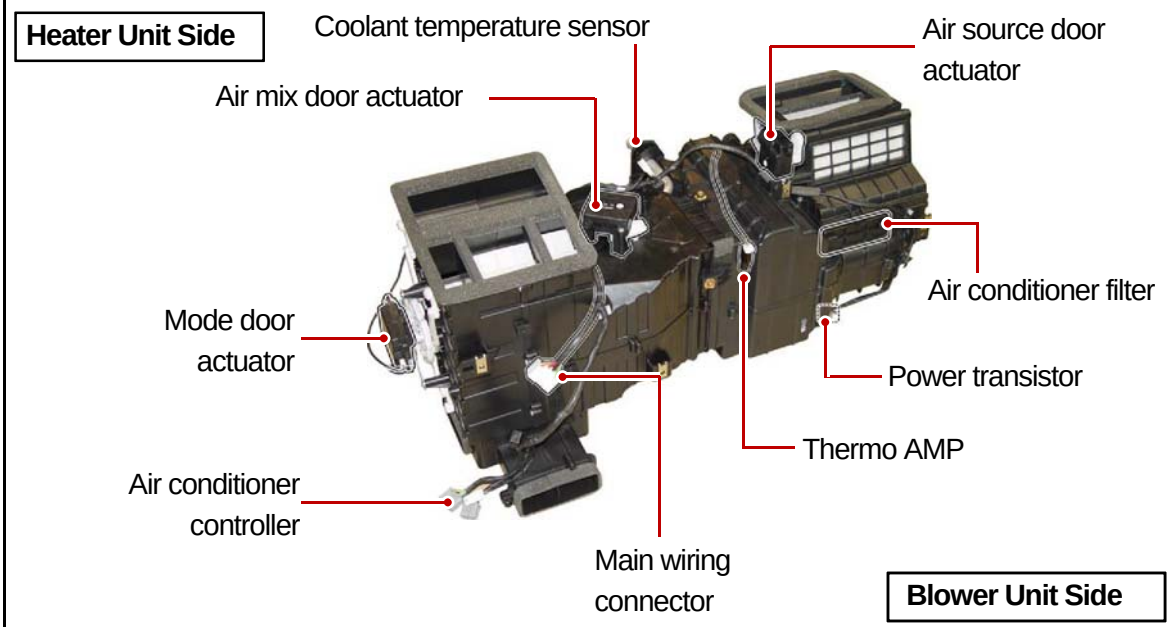
Ambient Temperature Sensor

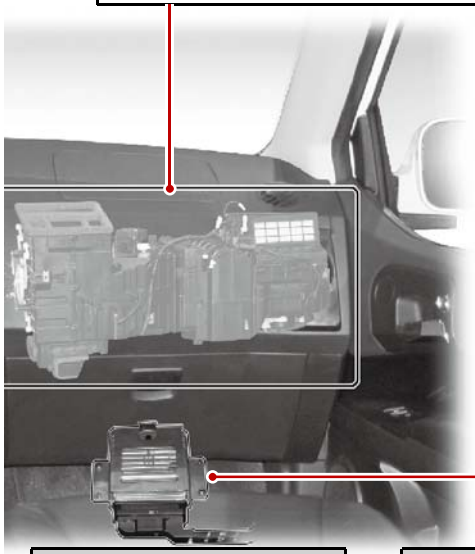


This sensor is installed at the front bottom of engine compartment.

Modification basis	
Application basis	
Affected VIN	

Air Conditioner Module Assembly - Inside of Instrument Panel





Condenser

Installed in front of vehicle and condenses vapor refrigerant into low temperature and high pressure liquid refrigerant.

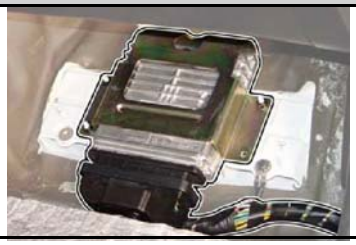


Receiver Drier (LH)



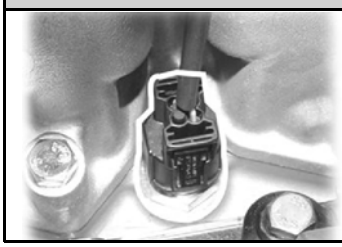
Absorbs moisture in the refrigerant and reserves refrigerant to supply smoothly.

Engine ECU (Passenger Footstep)



Detects A/C switch position, coolant temperature, engine condition and driving condition to control the air conditioner.

Coolant Temperature Sensor (On Engine)



A sensor that detects coolant temperature and transmits it to engine ECU.

2. VENTILATION SYSTEM

1) Locations of Vents

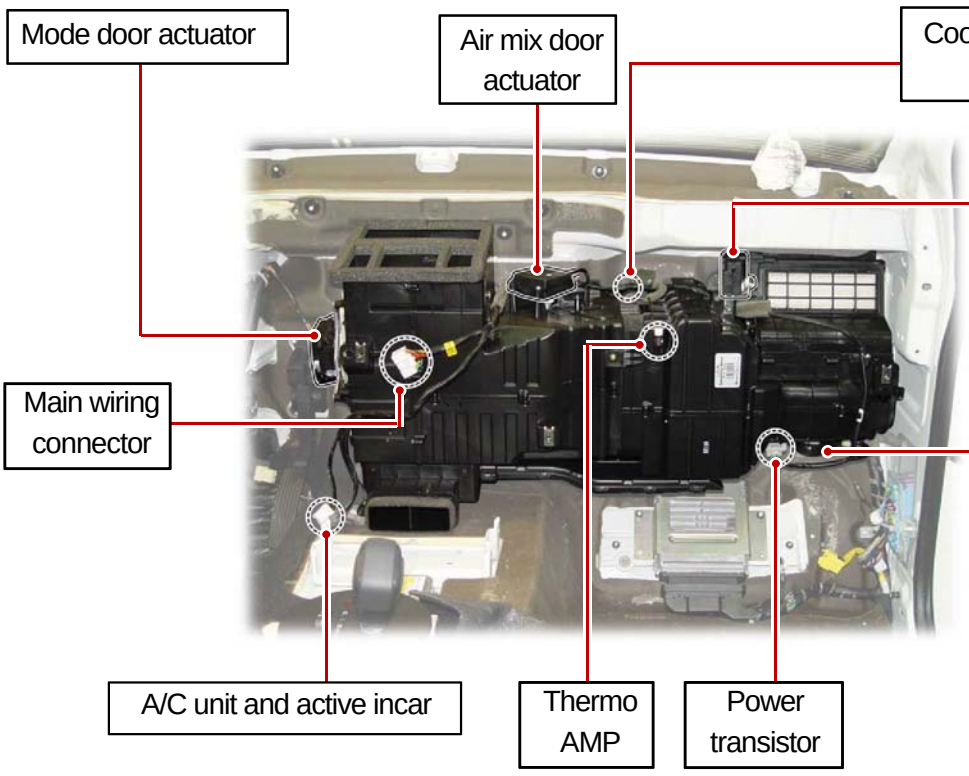


2) Air Duct

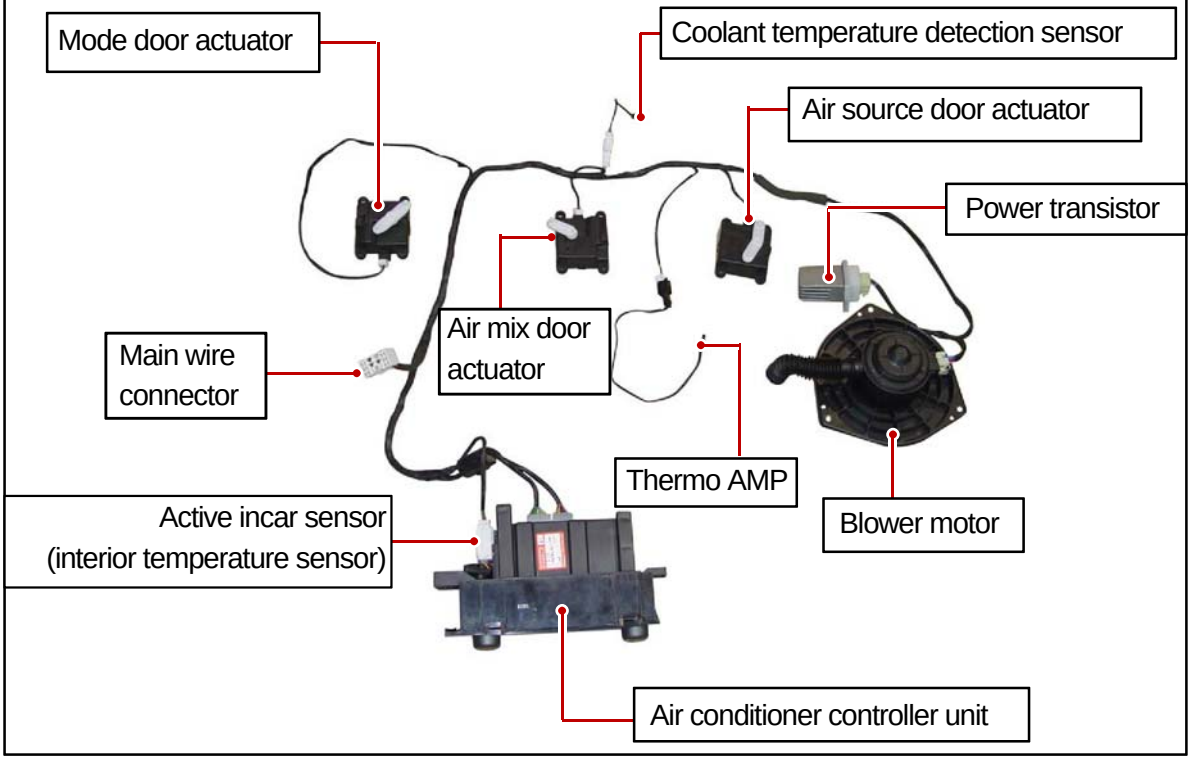


Modification basis	
Application basis	
Affected VIN	

3) Air Duct Layout

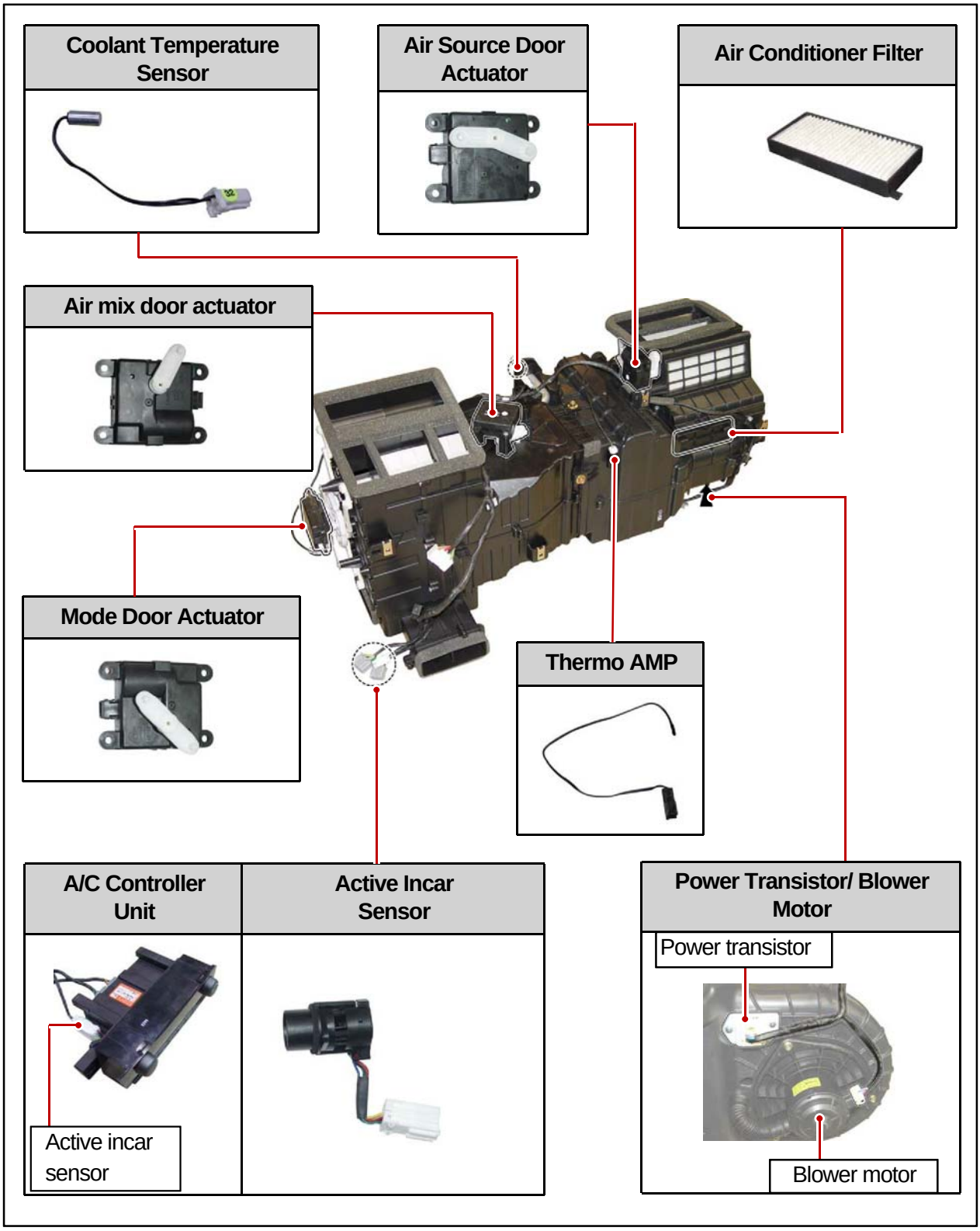


Front Air Conditioner Module Wiring Layout



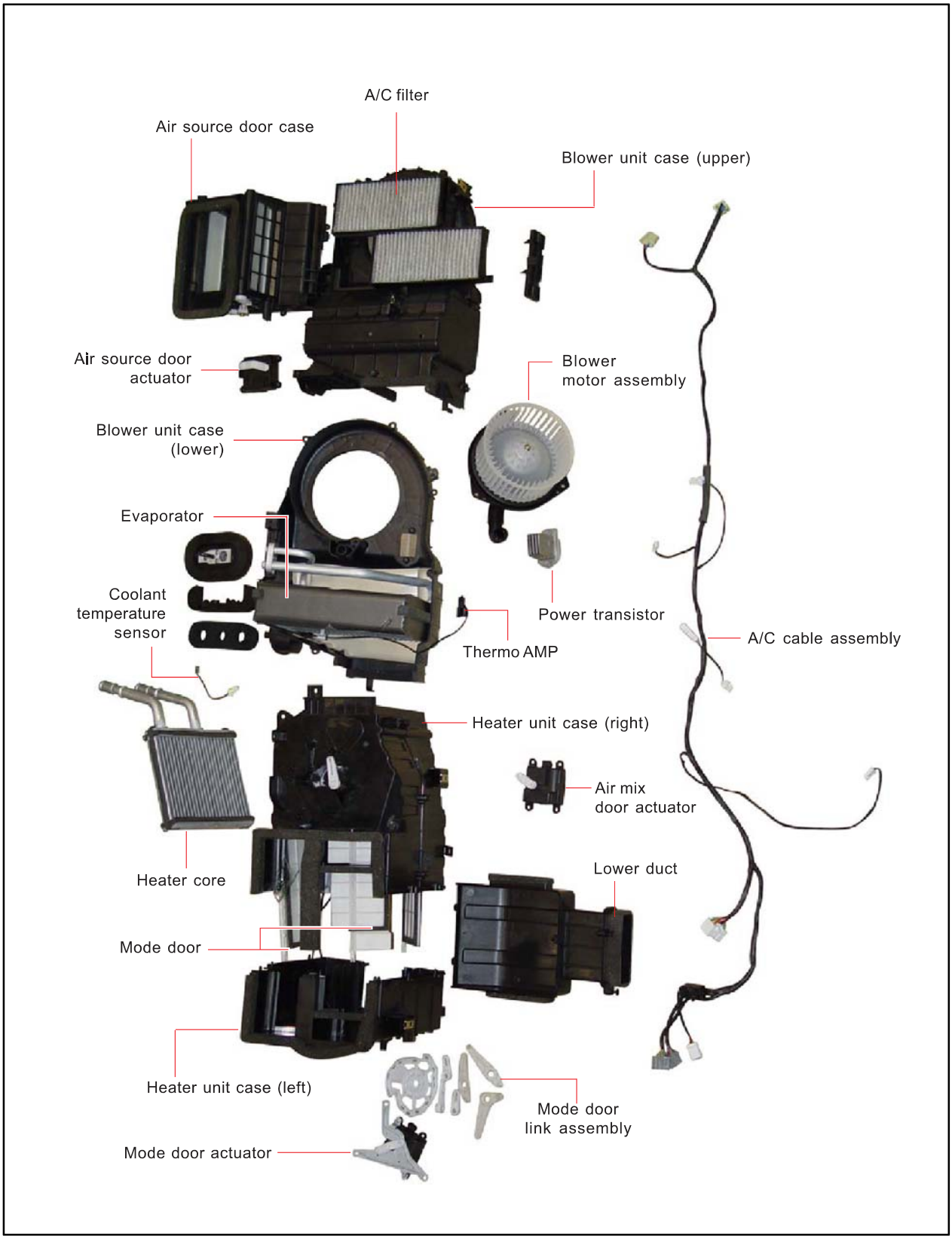
3. AIR CONDITIONER MODULE AND SENSORS

1) Locations



Modification basis	
Application basis	
Affected VIN	

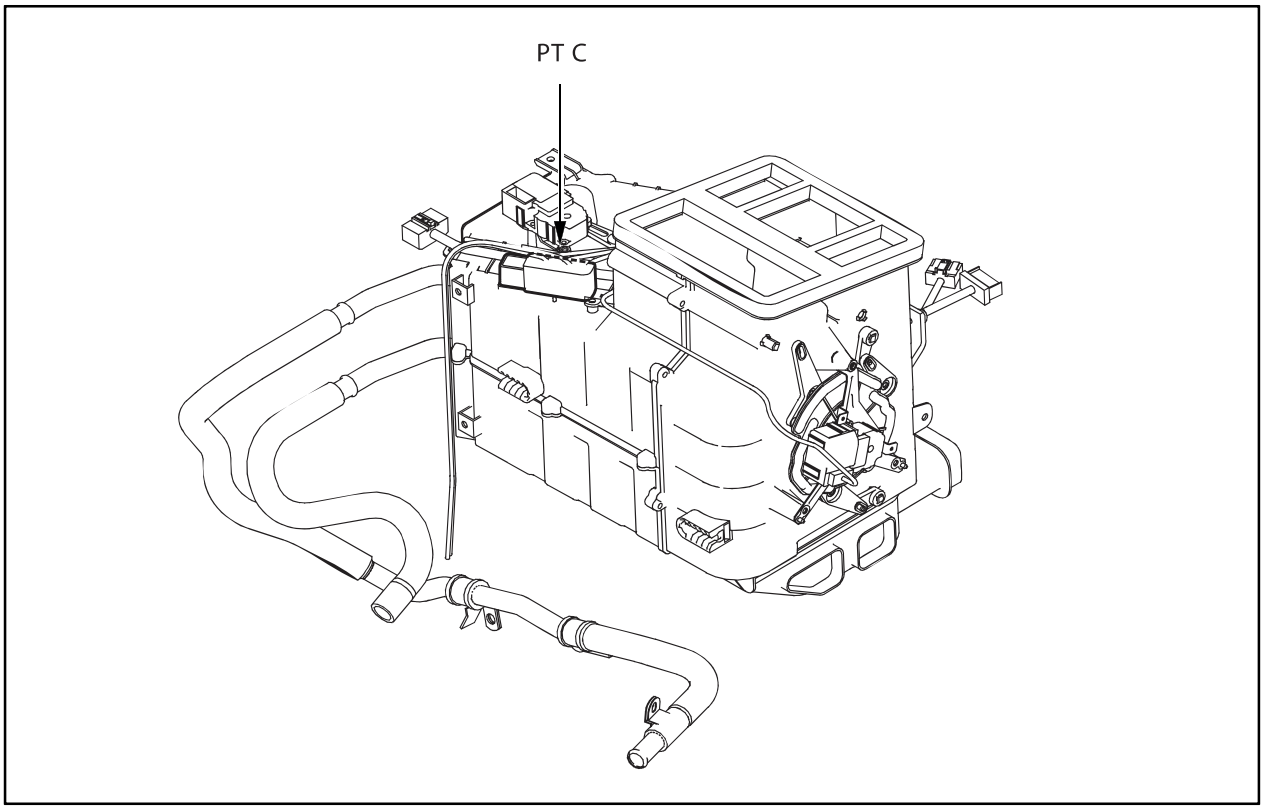
2) Components



Modification basis	
Application basis	
Affected VIN	

3) PTC Heater Layout

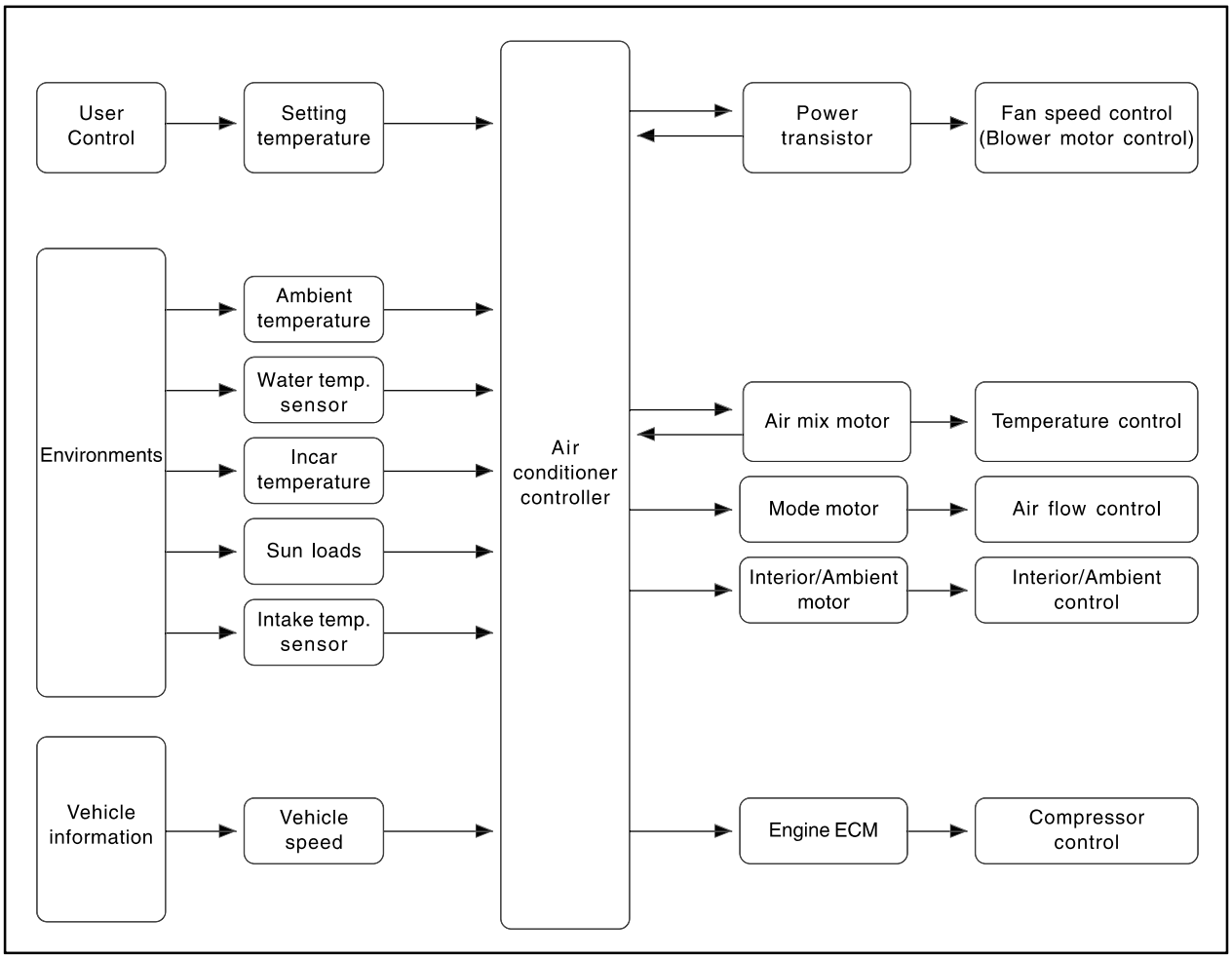
(1) PTC Heater Assembly Layout



Modification basis	
Application basis	
Affected VIN	

4. SYSTEM DIAGRAM

This figure shows the input and output system between FACT A/C components and A/C controller.



1) Air Conditioner Compressor Control by Engine ECU

In case of conventional vehicle models, the system turns ON/OFF the compressor switch according to refrigerant pressure, ambient temperature and condenser temperature to protect air conditioner circuits. However, for the vehicle equipped with DI engine, the engine ECU turns off air conditioner compressor as below in addition to above conditions.

1. Coolant temperature: below −20°C
2. Coolant temperature: over 115°C
3. For approx. 4 seconds after starting the engine
4. When engine speed is below 650 rpm
5. When engine speed is over 4,500 rpm
6. During abrupt acceleration for the vehicle equipped with manual transmission

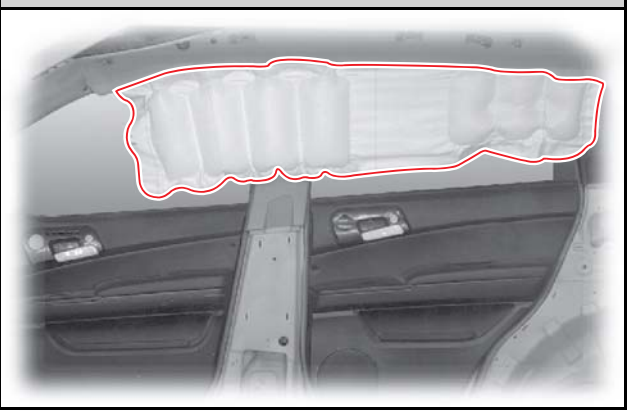
Memo

AIR BAG

8810-03

GENERAL

1. OVERVIEW (INCLUDING CURTAIN AIR BAGS)

Front air bag inflation	Curtain air bag inflation
	

The air bag systems for this vehicle are not much different from the previous air bag system installed in other vehicles. The curtain air bags are installed at the bottom of the roof trim instead of the side air bag and they enhance the passenger's safety. The driver's and passenger's curtain air bags individually deploy.

When the front air bags deploy, the seat belt pretensioners retract the seat belts too.

Collision sensors, a kind of impact G (acceleration) sensor, detect the front and longitudinal collisions and determine whether or not to deploy air bags. The roles of each collision sensor are as below:

Front G sensors (inside the air bag unit)

1. Send signals to the front air bags and the driver's and front passenger's seat belt pretensioners. By the signal from this sensor, front air bags (driver's and passenger's air bags) deploy and the seat
2. belt pretensioners of the driver's and passenger's seat belts retract seat belts.

Curtain air bag G sensors

1. These are located inside the left and right B-pillar panel bottoms. When a collision occurs, the air bag at the side of collision deploys accordingly. Please pay attention to that, in the case of the curtain air bag, only the air bag at the side of collision deploys, not both.

Once an air bag deploys, its repair parts vary according to the deployment situation and damage to the vehicle from collision. Needed repairs also slightly vary between the front air bags and the curtain air bags. The following are the differences:

Replacement parts when the front air bags deploy: the air bag units and their connection wires (connectors included), the seat belt pretensioners and their connection wires (connectors included), the entire front air bags, and the instrument panel (IP).

Replacement parts when a curtain air bag deploys: the new curtain air bag for the deployed side, the air bag unit and its connection wires (connectors included), the collision G sensor assembly for the curtain air bag, and the trims and roof headlining for the broken parts.

OVERVIEW AND OPERATION PROCESS

1. LOCATIONS AND RELATED COMPONENTS

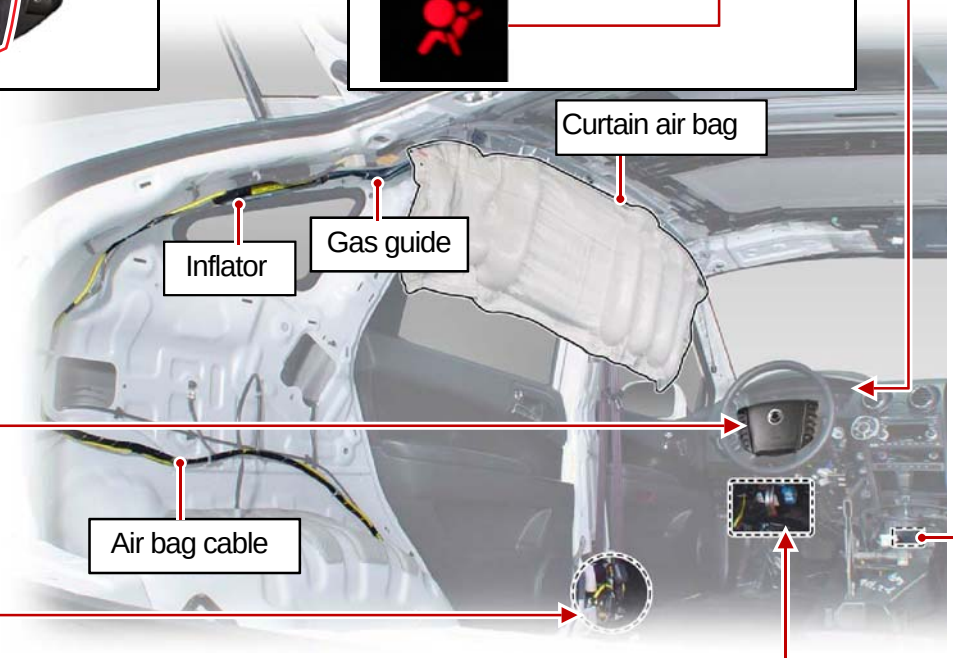
1) LH

DAB: Driver Air Bag

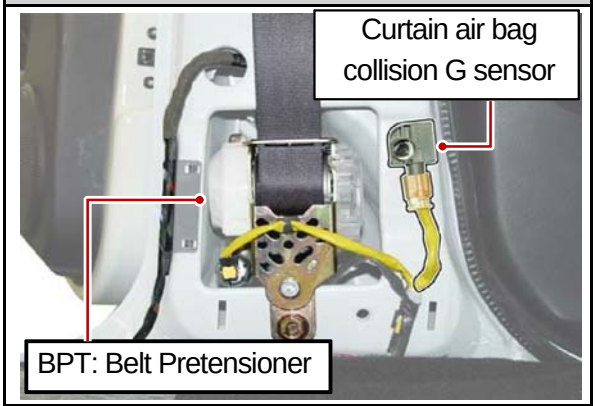


Air Bag Warning Lamp (Cluster)

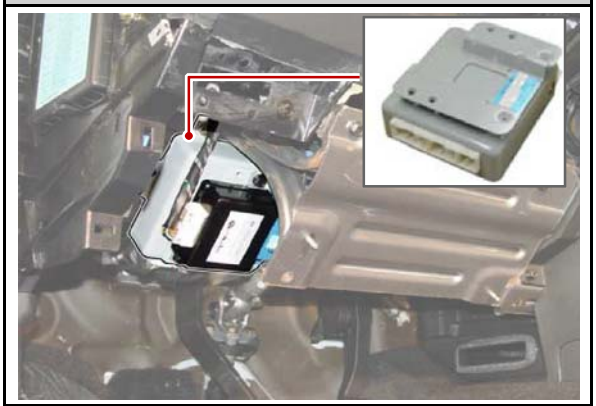




Driver side



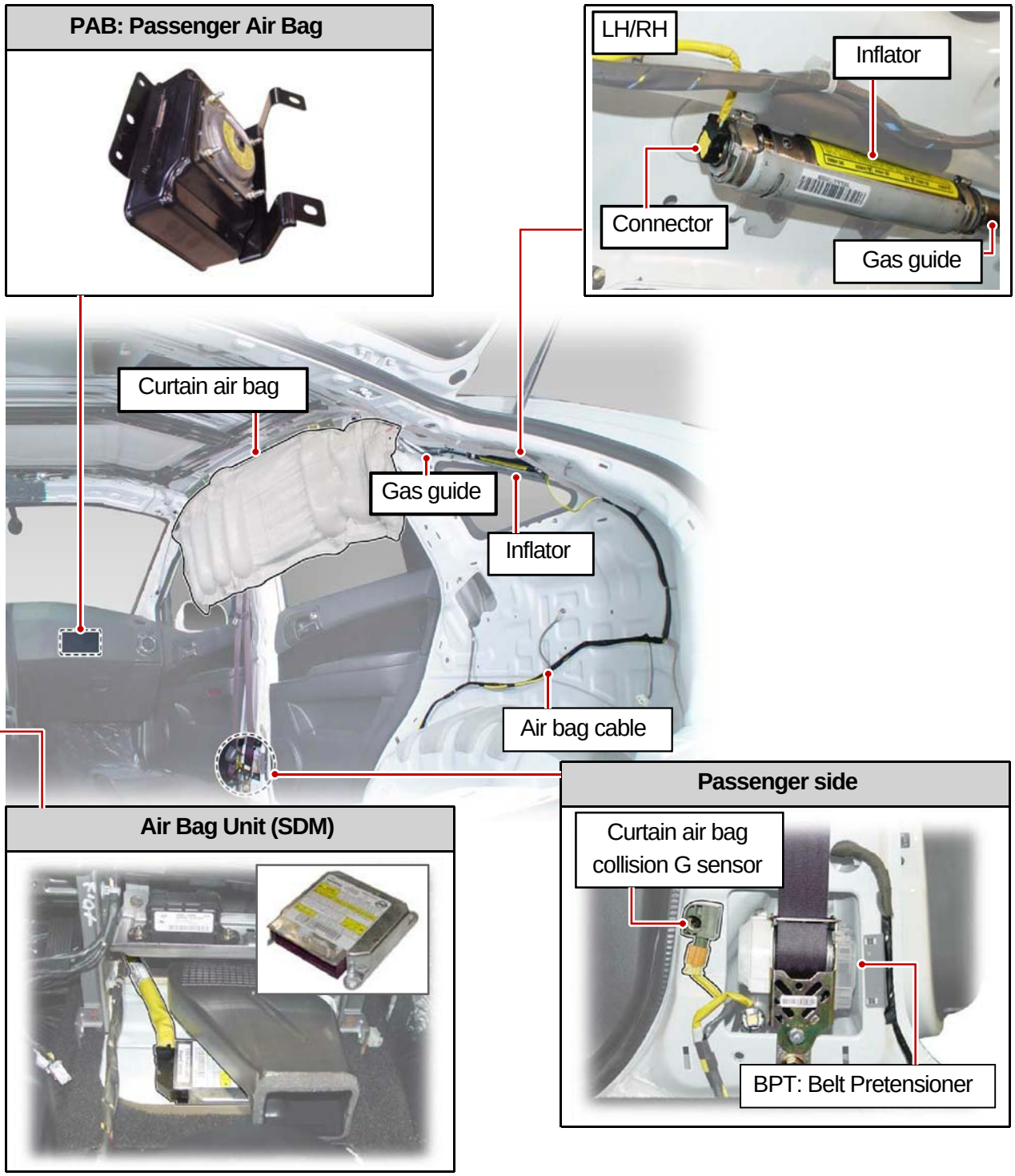
STICS



40 ms after receiving the air bag deployment signal at the vehicle speed 3 km/h or higher, it sends out the door UNLOCK signal for 5 seconds.

Modification basis	
Application basis	
Affected VIN	

2) RH

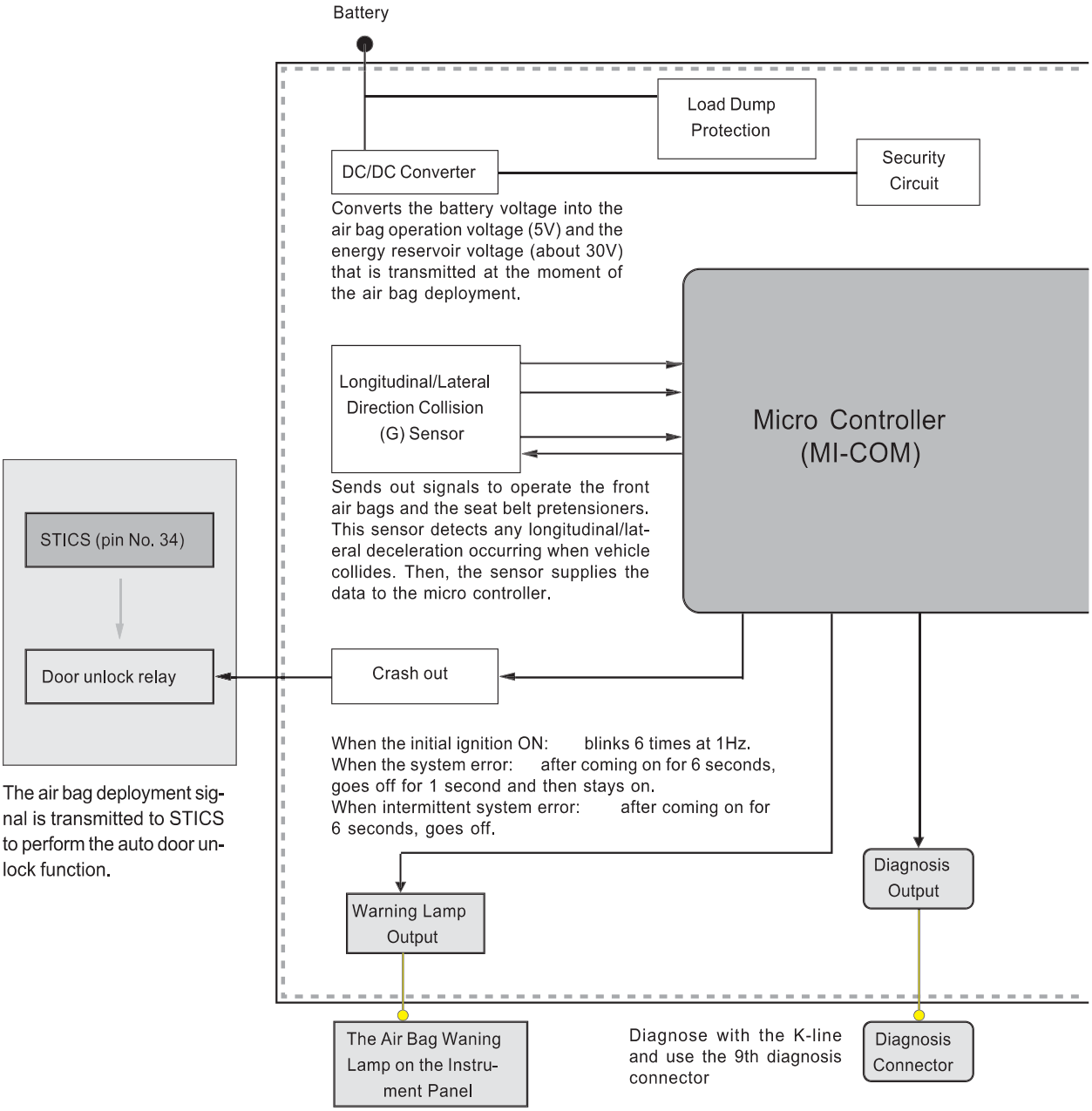


The collision G sensor is installed inside this. And it sends out signals to deploy the front air bags (driver's and passenger's air bags) and (or) the driver's and passenger's seat belt retensioners. When the front collision G sensor sends out only the air bag deployment signal, the signal deploys the two front air bags and ctivates their seat belt pretensioners.

2. AIR BAG SYSTEM OPERATION PROCESS

The overall air bag operation process and its functions and roles are broadly explained in this block diagram.
This diagram summarizes and highlights the functions adopted by Ssangyoung Motors.

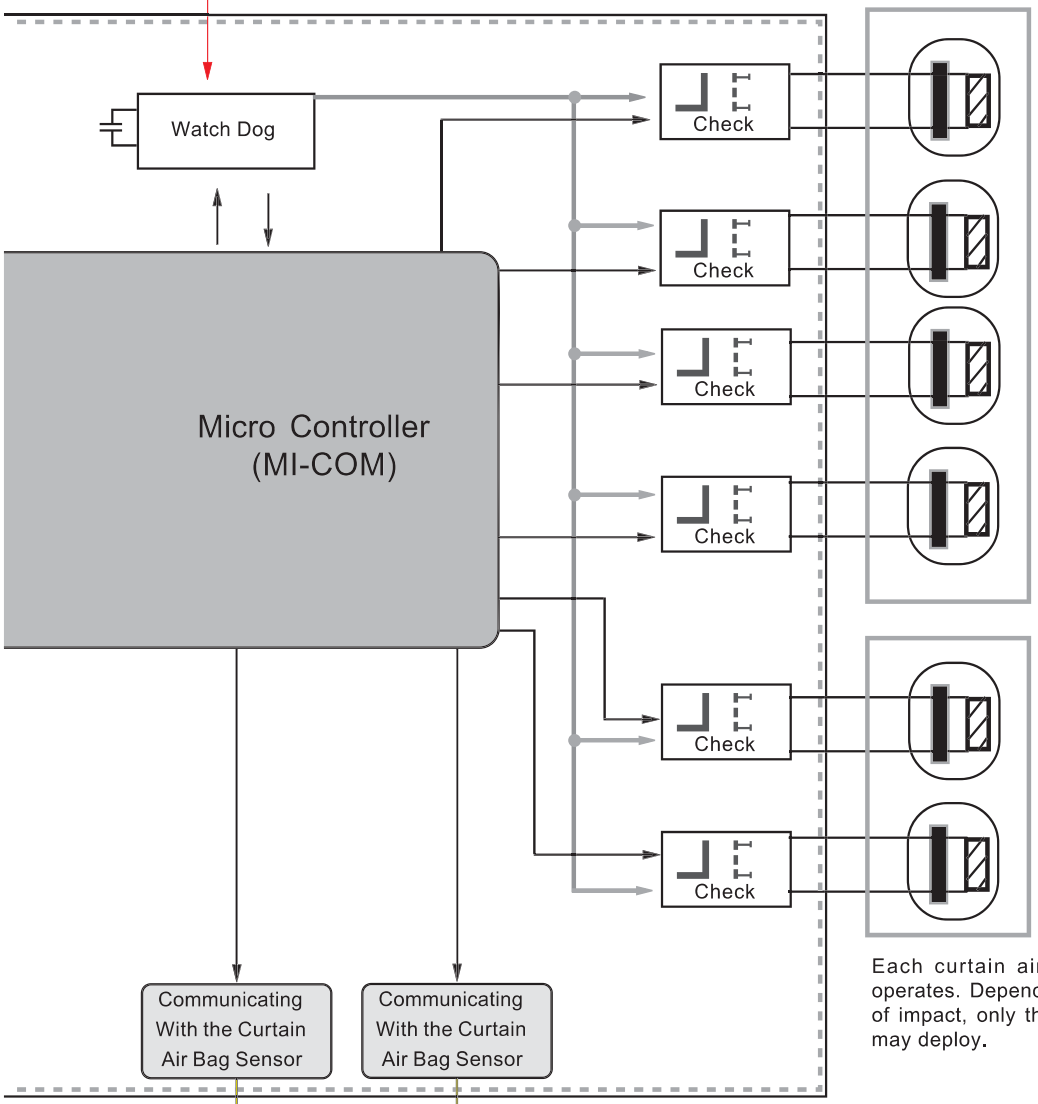
1) Air Bag System Block Diagram (Functions and Roles Included)



Modification basis	
Application basis	
Affected VIN	

The watch dog monitors the micro controller, the air bags, and the seat belt pretensioners in the air bag unit. When any error occurs, it turns on the air bag warning lamp.

When the front air bags deploy, the driver's air bag and the front passenger's air bag deploy simultaneously and their seat belt pretensioners also simultaneously retract their seat belts.
The air bag unit monitors conditions of the air bags and the seat belt pretensioners. When any error occurs, it stores the failure diagnostic code or turns on the air bag warning lamp on the instrument panel.



Each curtain air bag independently operates. Depending upon the severity of impact, only the left or right air bag may deploy.

The collision G sensors for the curtain air bags are installed at the bottom of left and right B-pillars. Each measures deceleration rate at time of collision and supplies information about the collision to the air bag unit. Each sensor measures the G value from its side and transmits the value to its air bag unit.

3. AIR BAG MODULE AND RELATED COMPONENTS

This section describes the air bag module installed in ACTYON. The module consists of the inflator, the cushion, and the mounting cover.

1) DAB (Driver Air Bag)

The driver's air bag is installed inside the steering wheel. If the acceleration sensor (inside the air bag unit) is activated by the deceleration from vehicle collision, the detonation is fired by the electrical signal of the air bag unit.
Then, the detonation sets off explosives and nitrogen gas is generated.

At this point, the air bag very quickly deploys and the gas is emitted from the relieving hole to absorb impact upon the driver.

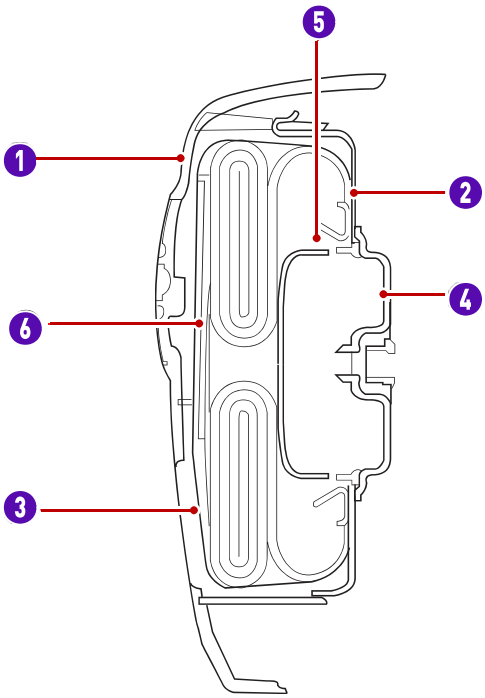


Front View



Rear View

(1) Components



1. Air bag cover
2. Air bag housing
3. Air bag cushion (approx. 50 liters)
4. Inflator* (approx. 190 Kpa)
5. Retainer ring
6. Horn switch

Inflator*
The inflator is composed of the detonator, explosives, and the gas generator. It inflates air bag when vehicle collides.

Modification basis	
Application basis	
Affected VIN	

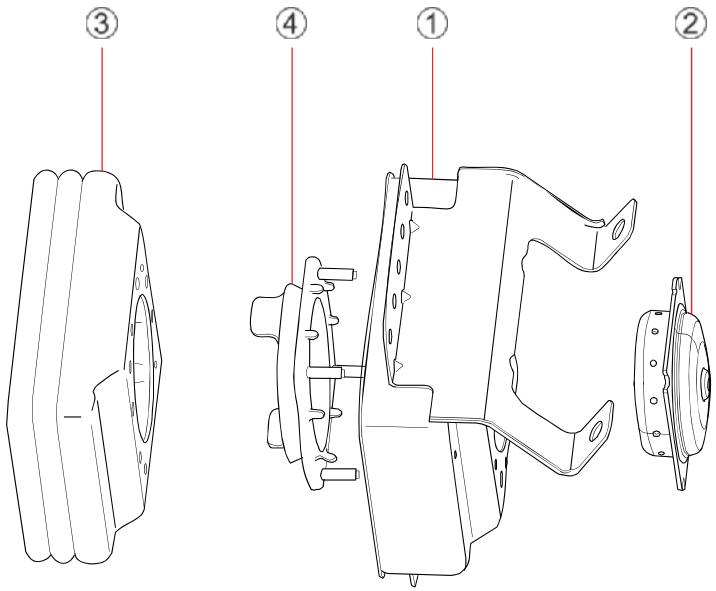
2) PAB (Passenger Air Bag)

The passenger's air bag is installed inside the instrument panel above the glove box. Its operation process is the same as the driver's one. The driver's air bag, the passenger's air bag, and the seat belt pretensioners on both seats are made to operate together.

When the collision G sensor inside the air bag unit sends a collision signal, the air bag unit instantaneously applies a high current to the driver's and passenger's air bags and the seat belt pretensioners on both seats, fires the detonator in the inflator, and inflates the air bag cushions (curtain air bags independently operate in case of the side collisions).

Front View	Rear View
	

(1) Components



1. Passenger's air bag module housing
2. Inflator
3. Air bag cushion
4. Retainer
5. Nut

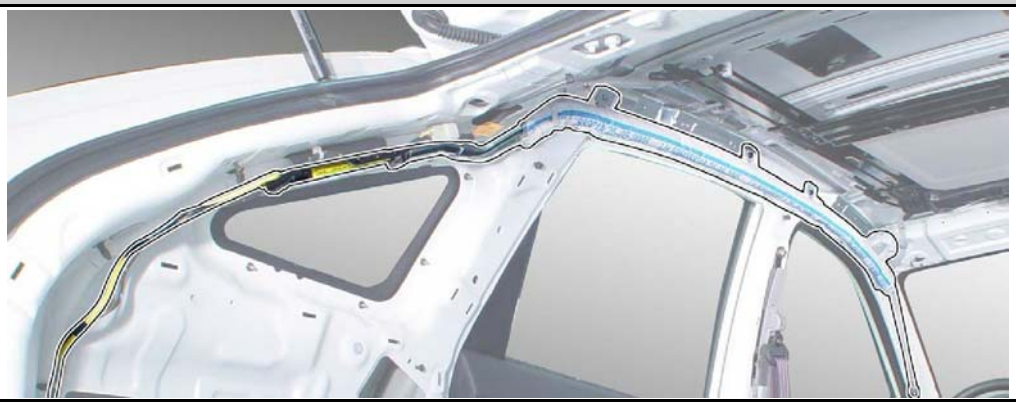
3) CAB (Curtain Air Bag)

The curtain air bags are installed on both sides of the roof side rails (inside the headlinings). Each curtain air bag is also composed of the air bag cushion and the inflator that has the detonator, explosives, and the gas generator.

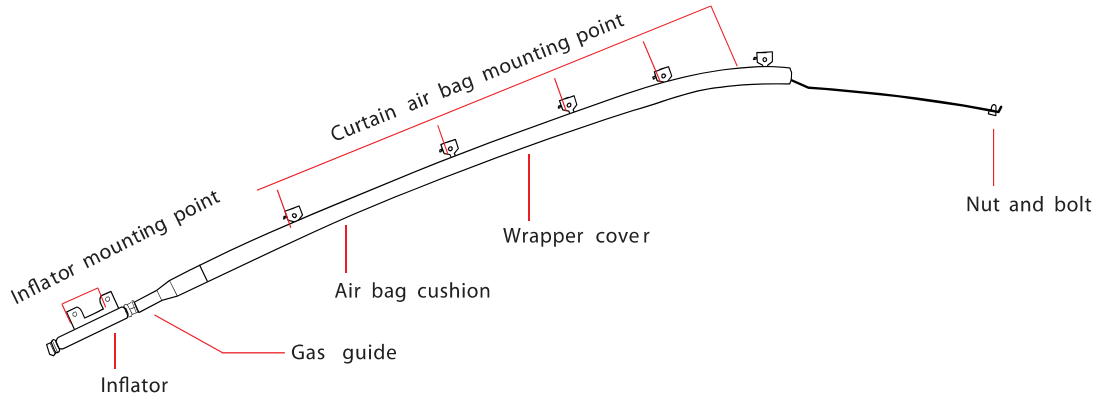
The deployment process logic of the curtain air bag is slightly different from the one of the front air bag (including pretensioner), but it is the same as the conventional side air bag.

A collision situation is detected by the curtain air bag collision G sensor installed at the lower side of the B-pillar. The signal is transmitted to the air bag unit. The air bag unit instantly inflates the necessary air bag necessary by sending a high current.

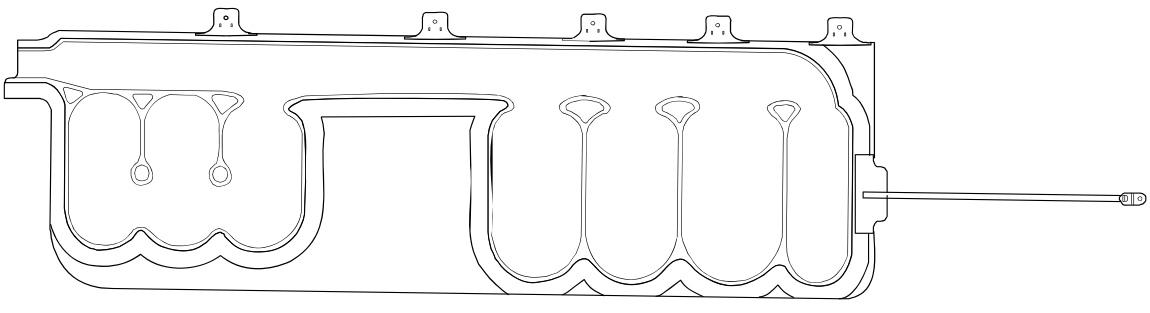
When the Curtain Air Bag is Installed



Terms of the Curtain Air Bag

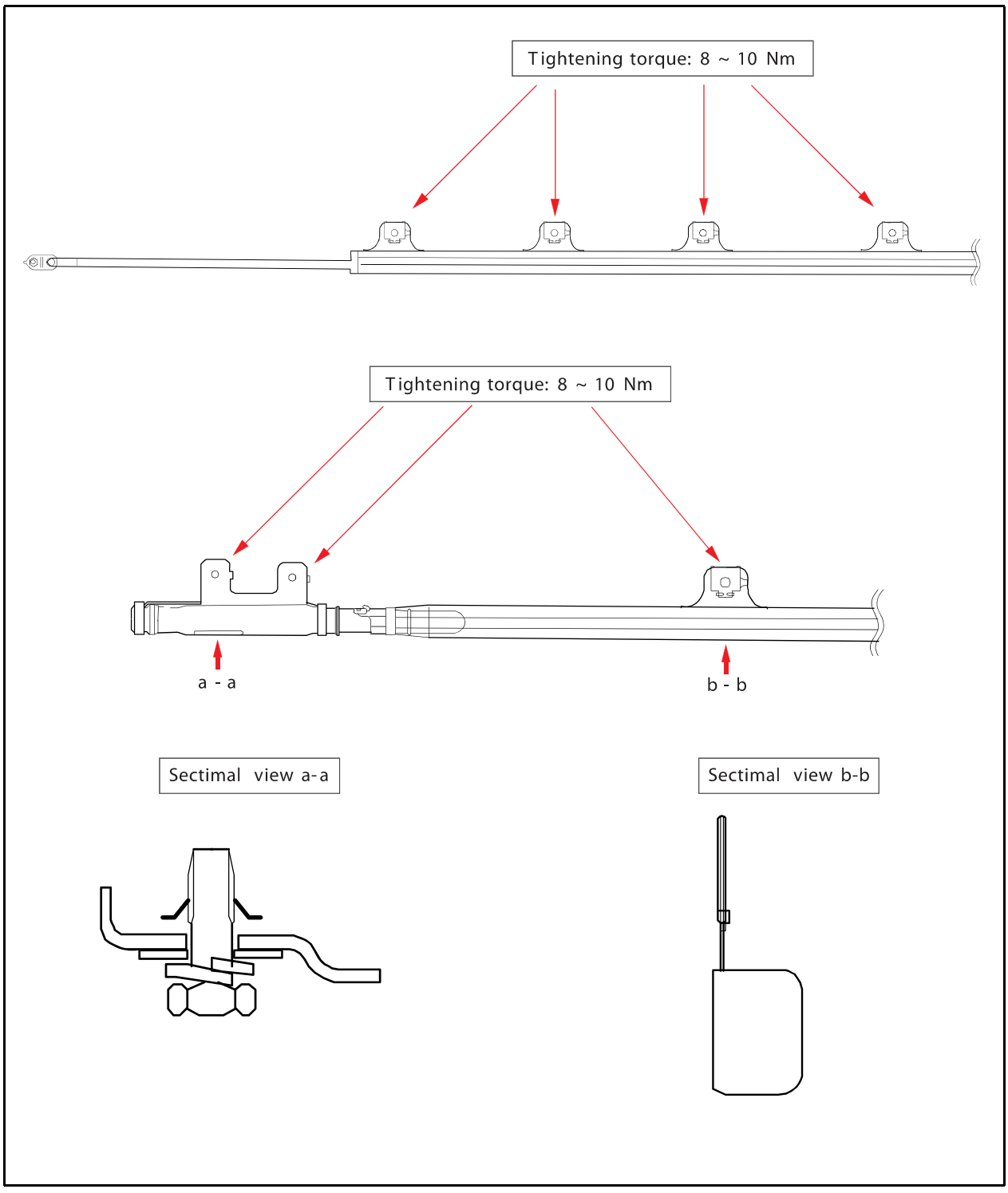


When the Curtain Air Bag Deploys



Modification basis	
Application basis	
Affected VIN	

(1) Components



4) Driver and Passenger BPT (Belt Pre-Tensioner)

The belt pretensioner is installed at the lower side of the B-pillar and operates simutaneously when the front air bags deploy. When a collision occurs or when brakes are applied, a seat belt with a pretensioner detects the stopping action and tightens the belt before the wearer is propelled forward. This holds the occupant more securely in the seat.

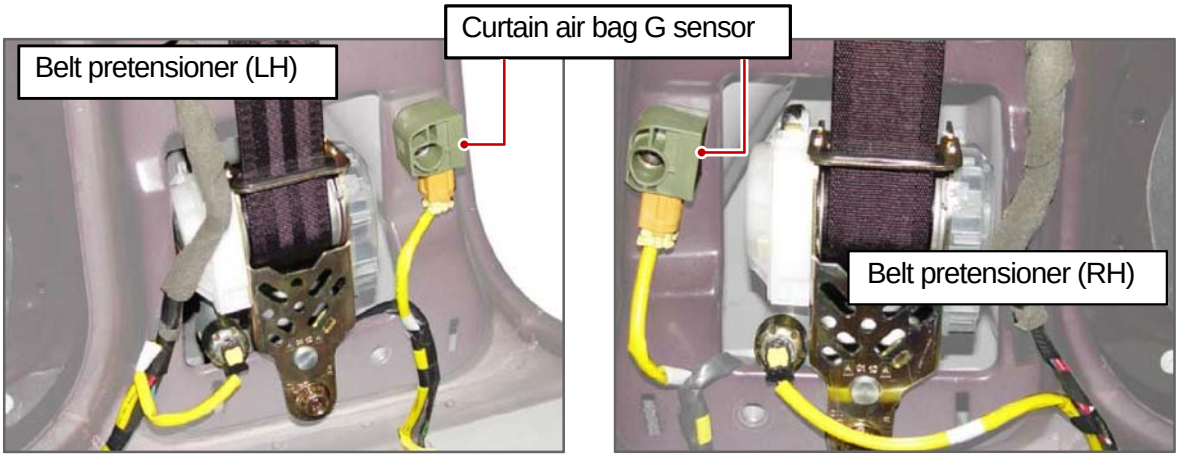
Belt Pretensioner (Driver Side)



Belt Pretensioner (Passenger Side)



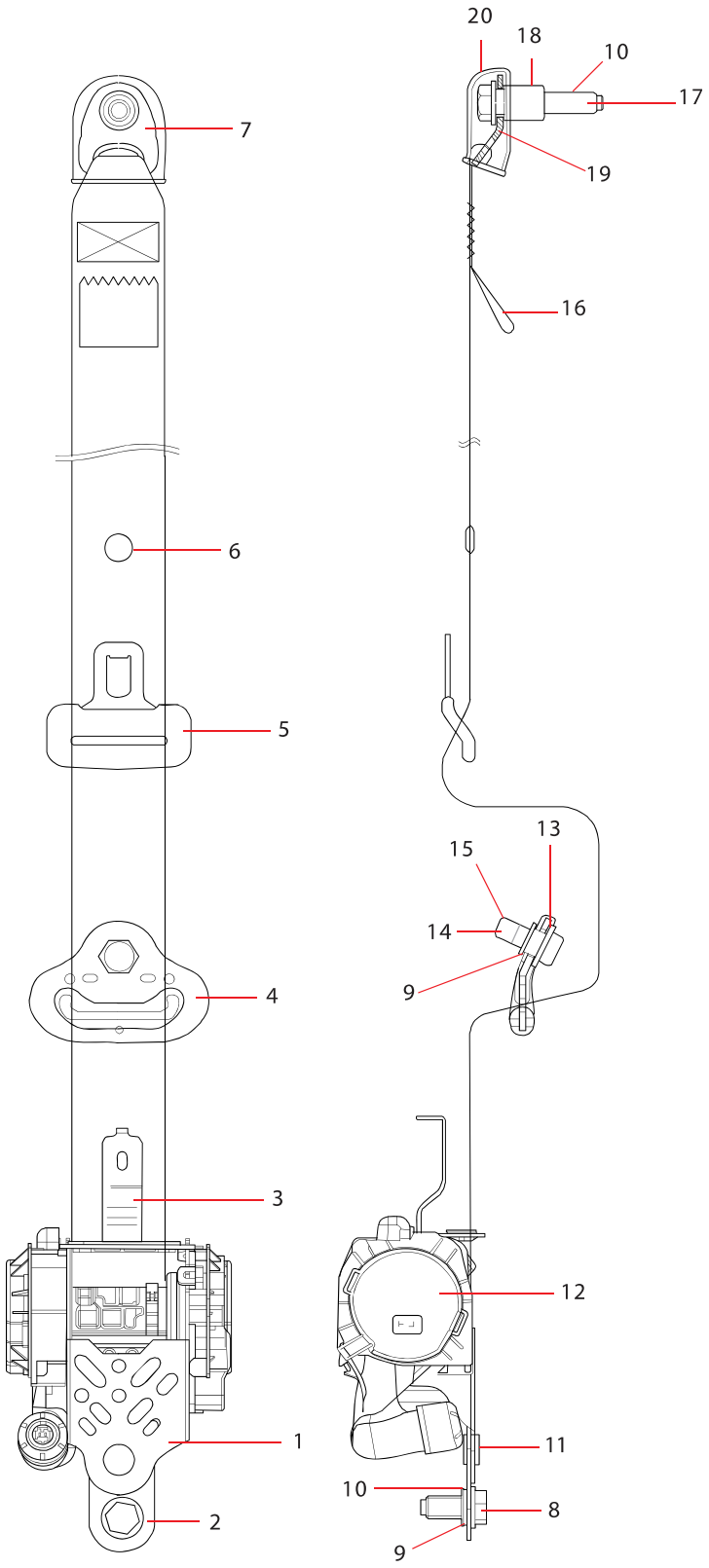
Tightening torque 35 ~ 55 Nm



Modification basis	
Application basis	
Affected VIN	

(1) Components

Belt Pretensioner



1. Pretensioner reel assembly
2. Reel bracket
3. Upper stay
4. D-ring
5. Bending tongue
6. Tongue stopper
7. Lower anchor
8. D-bolt
9. Washer
10. Fiber washer
11. Rivet
12. ID label
13. Plastic washer
14. Steel washer
15. D-bolt
16. Label
17. D-bolt
18. Spacer
19. Bush
20. Lower anchor cover

Modification basis	
Application basis	
Affected VIN	

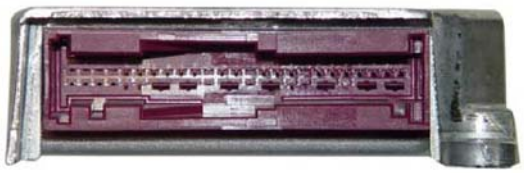
5) Air Bag Unit



CAUTION Air bag unit is installed under the AV head unit in center fascia panel.



The sensor that detects collision is integrated into the air bag unit.

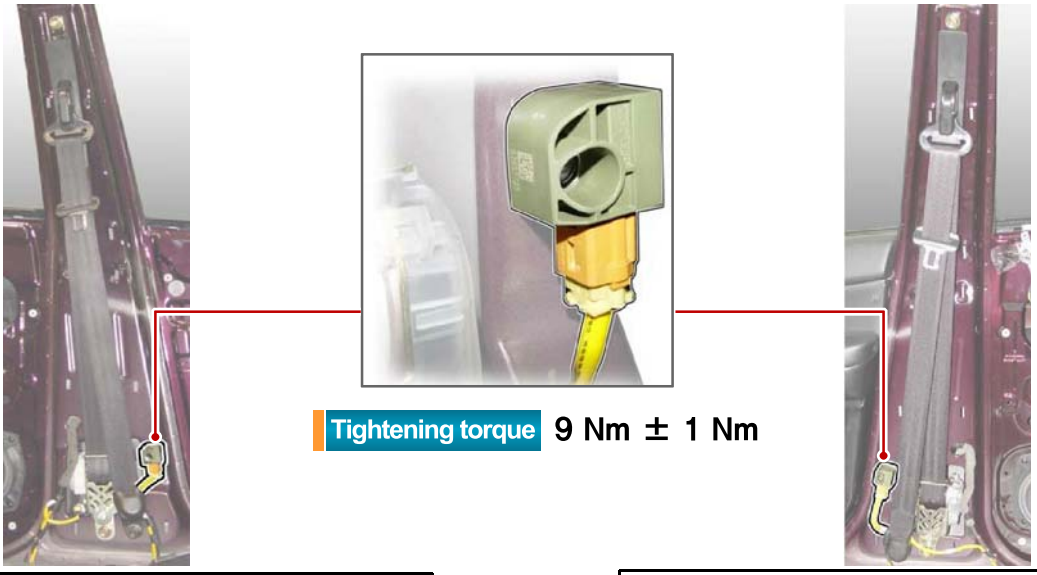
Air Bag Unit	Connector
	

Modification basis	
Application basis	
Affected VIN	

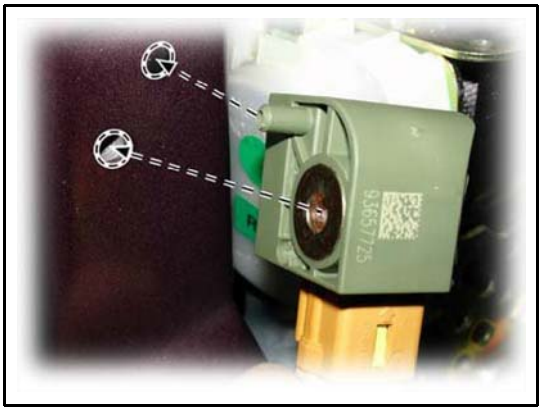
6) Curtain Air Bag Sensor

The curtain air bag sensor is installed inside each B-pillar of the driver's and passenger's seats (that is, around the pretensioner reel). The body panel has guiding holes to ensure its correct installation. But incorrect tightening torque may break the sensor or make it insecure. As a result, the sensor may have inaccurate judgment and have the air bag deployed inaccurately.

Driver's Side **Passenger's Side**



Tightening torque 9 Nm ± 1 Nm





Connector	
Signal terminal  Ground	

7) Air Bag System Deployment (Firing Loop)

According to the collision deceleration rate that each collision G sensor reads, the air bag unit sends out about 2~4 or higher Amp current. This current generates some heat, which fires the detonator in the inflator.
This table shows the basic inner resistance of the air bag related module and the basic instant current necessary for firing.

Air bag module	Driver/passenger air bag (DAB / PAB)	Belt pretensioner (BPT)	Curtain air bag (CAB)
Resistance (at -30 ~ 85°C)	2 ± 0.3 Ω	2.15 ± 0.35 Ω	2 ± 0.3 Ω
Firing current	1.2 Amp	0.8 Amp	1.0 Amp

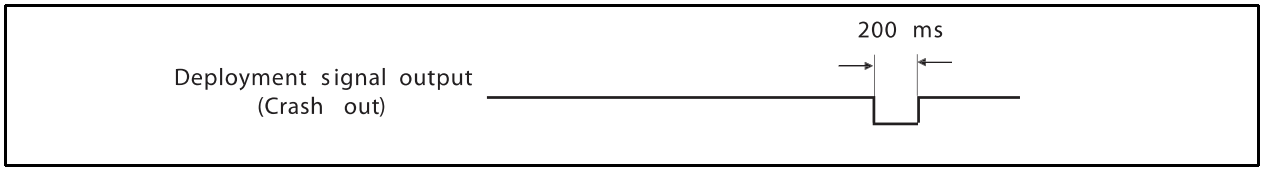
CAUTION

- Please do not connect a tester to any air bag connector or single item to measure the supplied power or resistance. The detonator may explode due to a sudden extra power supplied by the tester.
- Before removing or installing any air bag related components, disconnect the negative battery cable.

Modification basis	
Application basis	
Affected VIN	

8) Air Bag Deployment Signal Output (Crash Out)

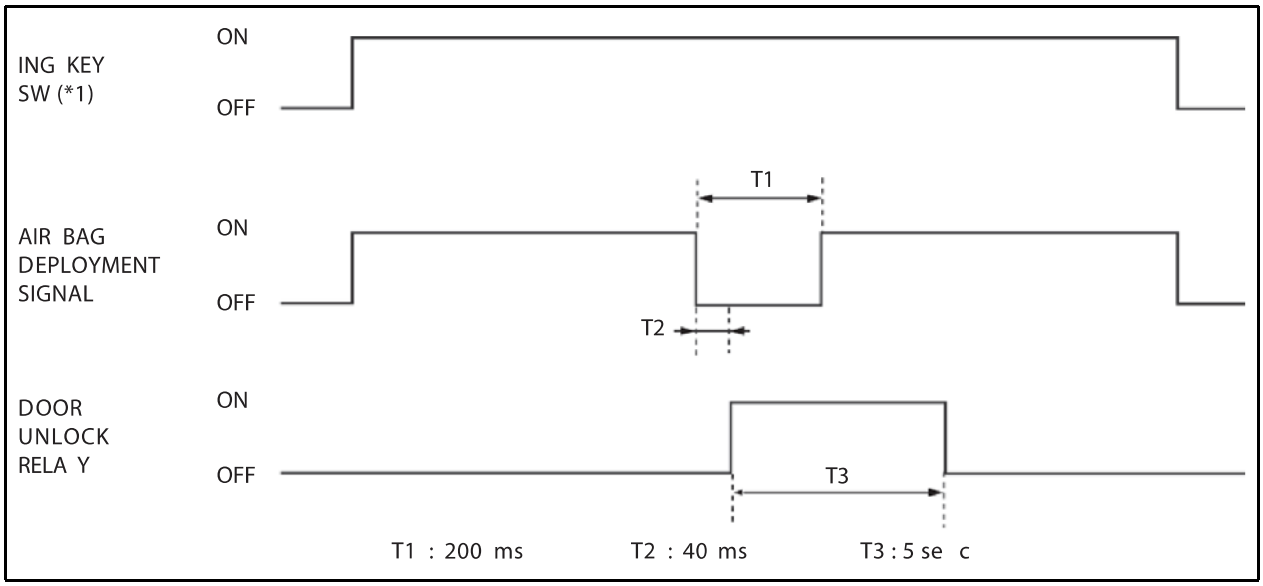
When the air bag deploys, the signal is sent to STICS to perform the basic security operation which is the automatic door unlock function that release the automatic door lock mode.



(1) Automatic Door Unlock (Crash unlock: unlock when colliding)

1. When the ignition key is the ON position, the air bag signal is not accepted for the first 7 seconds. When the ignition key is the ON position and the vehicle speed is 3 km/h or higher, 40 ms after
2. receiving the air bag deployment signal, the STICS sends out the door UNLOCK signal for 5 seconds. Even though the ignition switch is turned off in the middle of the unlock signal being sent out, the unlock signal continues for the remaining time.
3. This function cancels when the ignition key is withdrawn.

4.



CAUTION

Reminder for door lock/unlock control

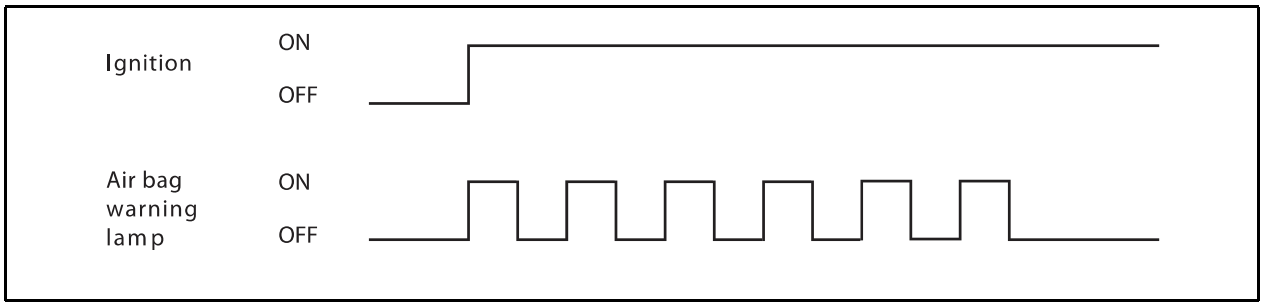
- The unlock function by the air bag signal takes priority over any other lock/unlock operations. While or after the automatic unlock is made by the air bag system, any lock or unlock request by
- other functions is ignored unless the ignition key switch is turned off. When another lock or unlock output is requested while the door is being either locked or unlock, the
- new request will be ignored. But, if an unlock request is made by the air bag signal or the remote control key, the request will be accepted. When the lock and unlock functions are simultaneously requested, the lock function will be
- performed and the unlock function will be ignored.

9) Air Bag Warning Lamp Operational Conditions

The air bag warning lamp on the instrument panel has a few operational conditions. The following are the conditions:

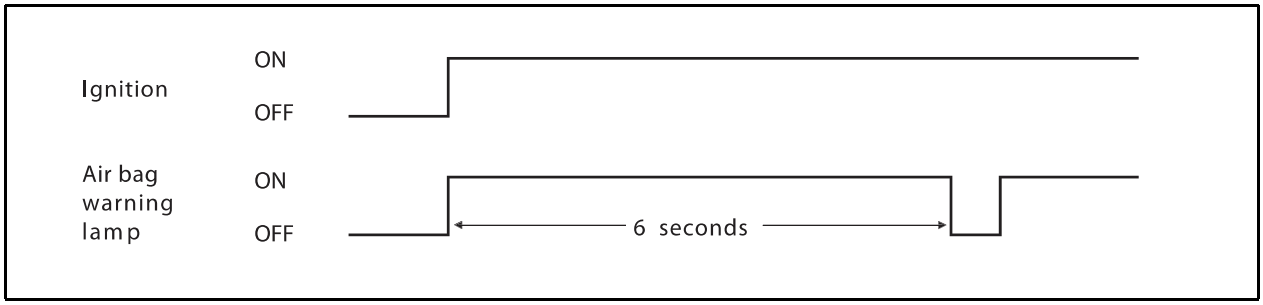
(1) When Turning the Ignition Switch to ON Position

The air bag unit performs a turn-on test when the ignition is turned on. The air bag unit flashes the air bag warning lamp six times at 1Hz interval. After flashing it six times, the air bag warning lamp will turn off if no malfunction have been detected.



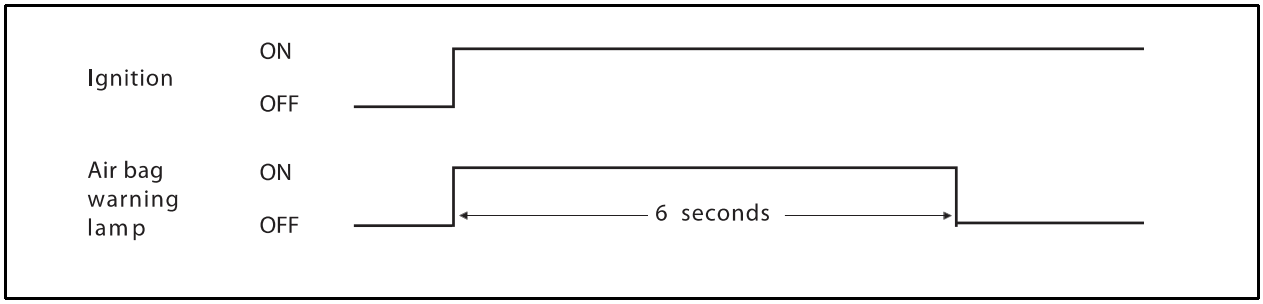
(2) When the Air Bag Unit Detects Any Malfunctions in Unit

When it is recorded as a system failure in the air bag unit, the air bag warning lamp on the instrument panel comes on for about 6 seconds and goes off for 1 second. Then the waning lamp stays on.



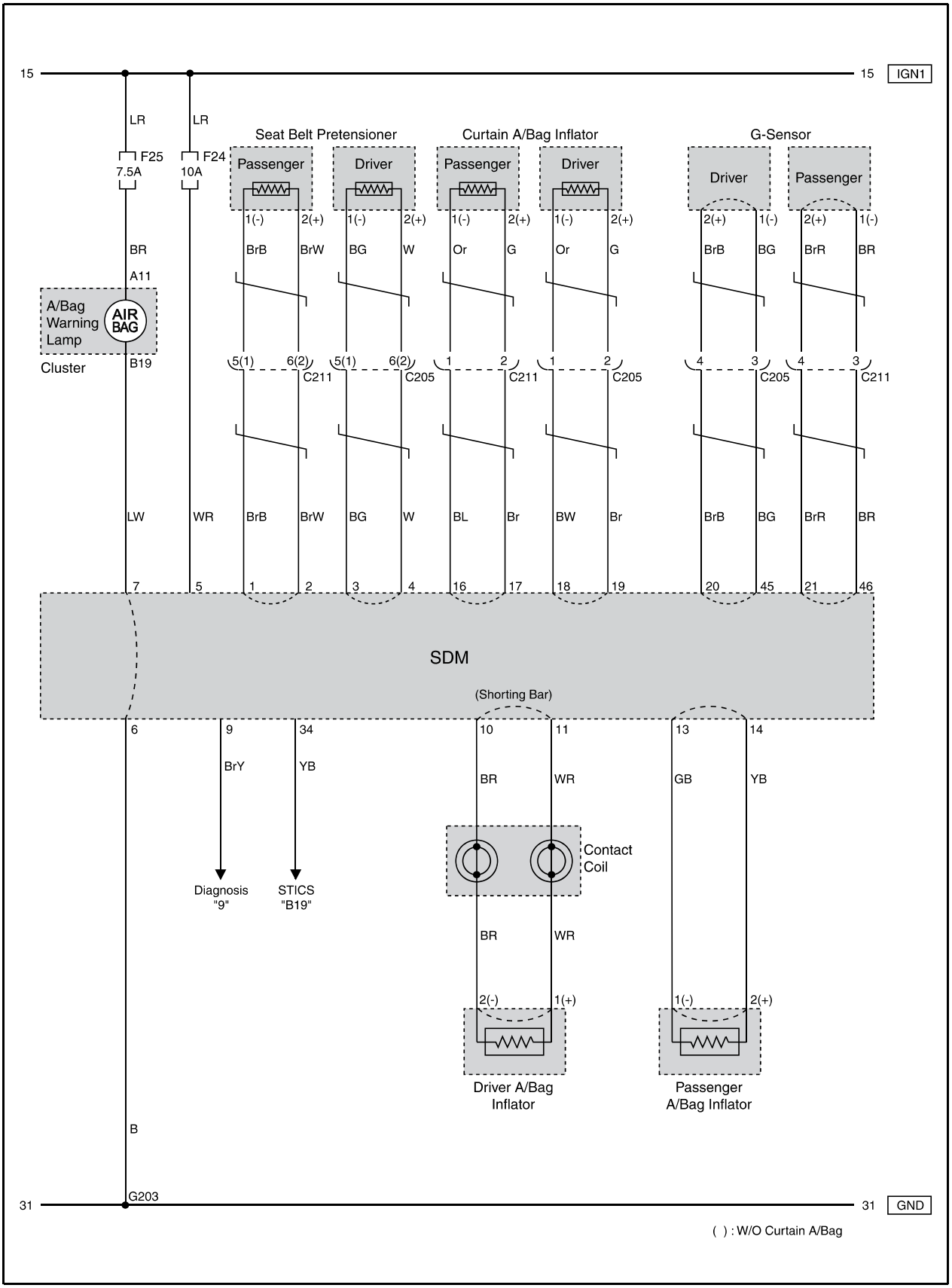
(3) When the Air Bag Unit Receives Any Malfunction Signals from the Other Systems

When, due to an error from outside the system, the intermittent failure signal is received 5 times or less, the air bag warning lamp comes on for about 6 seconds and then, goes off.



Modification basis	
Application basis	
Affected VIN	

10) Electrical Wiring Diagram



Modification basis	
Application basis	
Affected VIN	

SEAT 7410-01

OVERVIEW AND OPERATION PROCESS

1. COMPOSITION OF SEAT

1) Front Seat

(1) Driver Seat



Lumbar Support Lever

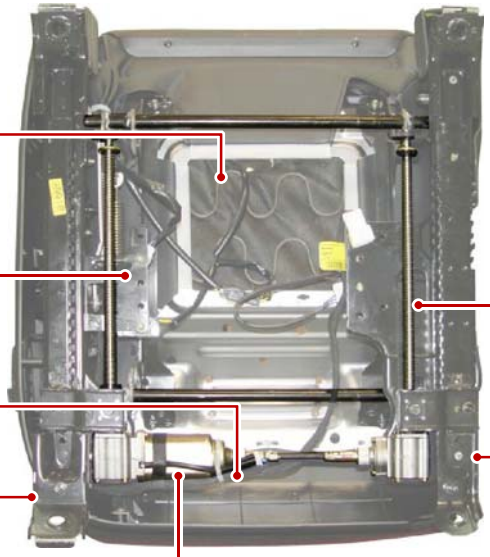
Reclining Motor



Seat cushion (rear area) up/ down bar

Sliding rail

Seat cushion (front area) up/ down bar



Sliding rail

Sliding motor

Seat Cushion (Rear Area) Up/Down Motor

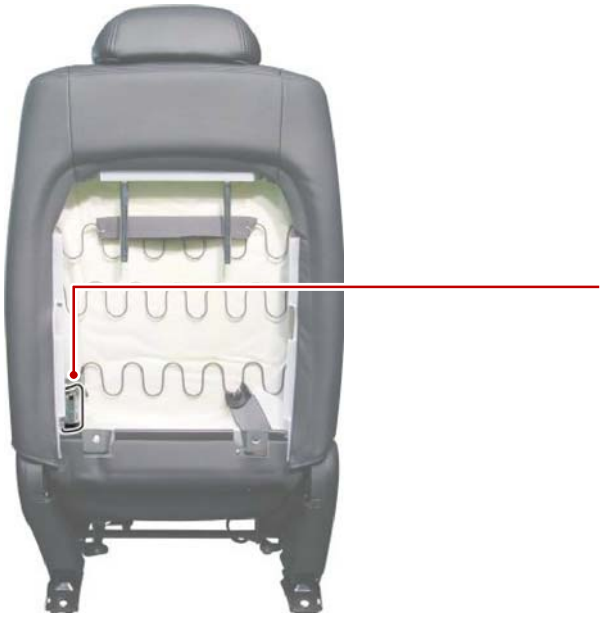


Seat Cushion (Front Area) Up/Down Motor



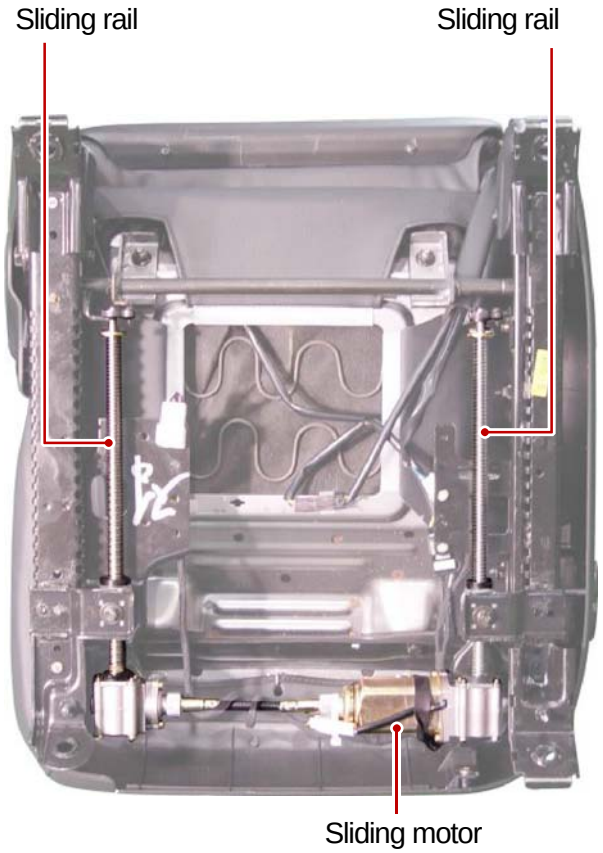
Modification basis	
Application basis	
Affected VIN	

(2) Passenger Seat

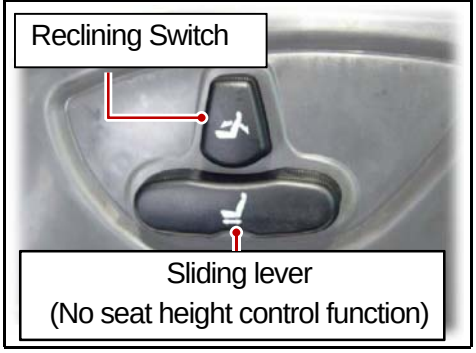


Reclining Motor





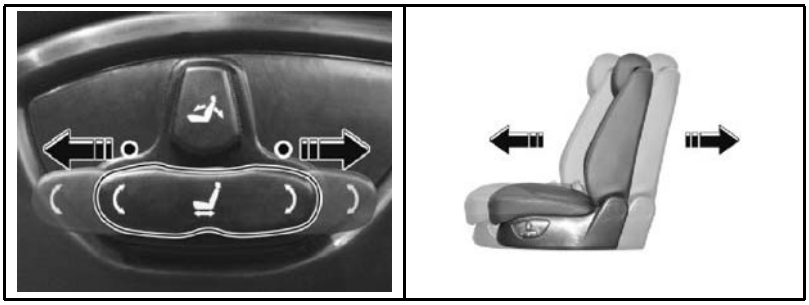
Power Seat Switch



Modification basis	
Application basis	
Affected VIN	

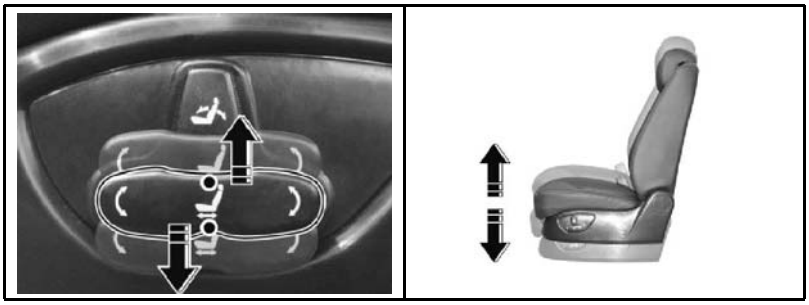
2. FUNCTIONS OF SEAT

1) Switches and Functions of Driver Seat



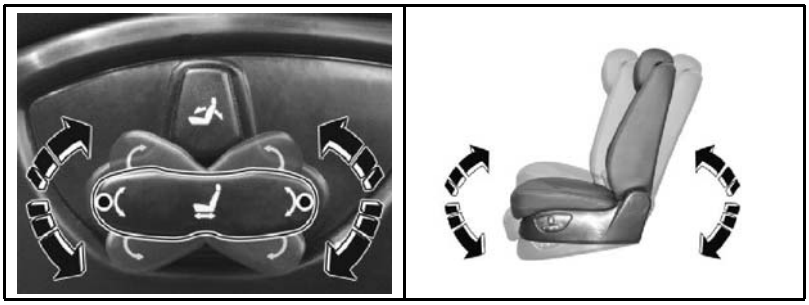
*** Driver and passenger seats**

1. Seat Sliding Adjustment
   When sliding the switch forward or rearward, the seat slides forward or rearward by the sliding motor.



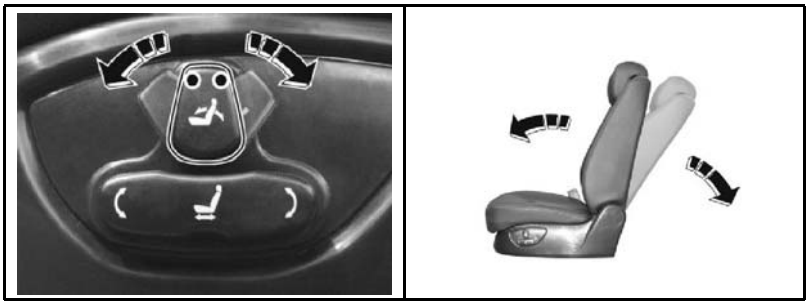
*** Only for driver seat**

2. Seat Cushion Height Adjustment
   When moving the center of the switch up or down, the whole seat cushion moves up or down.



*** Only for driver seat**

3. Seat Cushion Angle Adjustment
   When moving the front side of the seat cushion switch up or down, the front side of the seat cushion moves up or down. When moving the rear side of the switch up or down, the rear side of the seat cushion moves up or down.



*** Driver and passenger seats**

4. Seatback Reclining Adjustment
   When moving the upper side of the reclining switch forward or rearward, the seatback moves forward or rearward by the motor.

2) Rear Seat



Headrest Height Adjustment



To raise the headrest, pull it up without pressing the release button. To lower the headrest, press the release button (1) on top of seatback and push the headrest down.

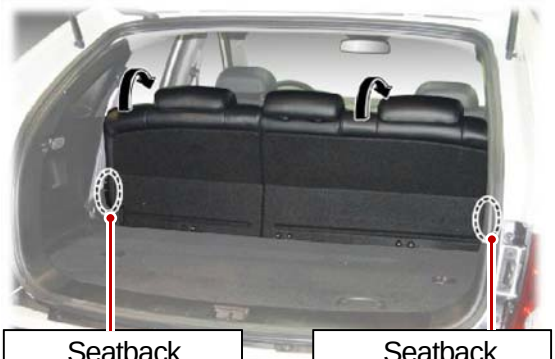
Seatback Reclining Adjustment





To change the seatback angle, push the lever rearward. Then, release the lever at the desired position. The seat is locked at the position

Full Flatting the Seat

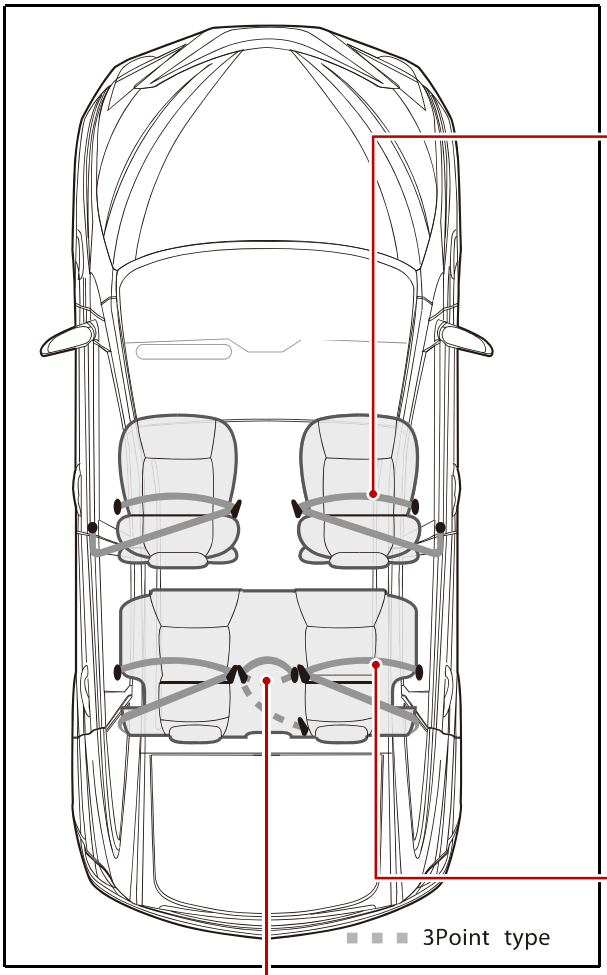




Modification basis	
Application basis	
Affected VIN	

3. COMPONENTS OF SEAT BELT

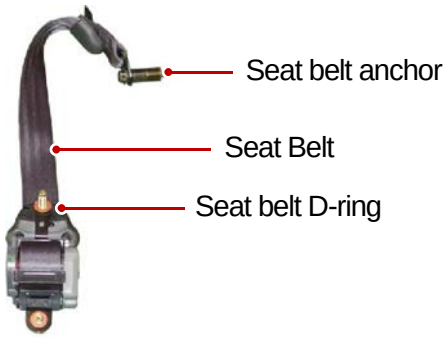
3 Point Type seat belt: Driver, Passenger seat, Rear side and Rear Center
2 Point Type seat belt: Rear Center
Pretensioner: Installed at front seats. The seat belt pretensiner rewinds the seat belt immediately to protect occupant's head and chest when a frontal collision occurs.



Seat Belt in Front Seats (3 point type)



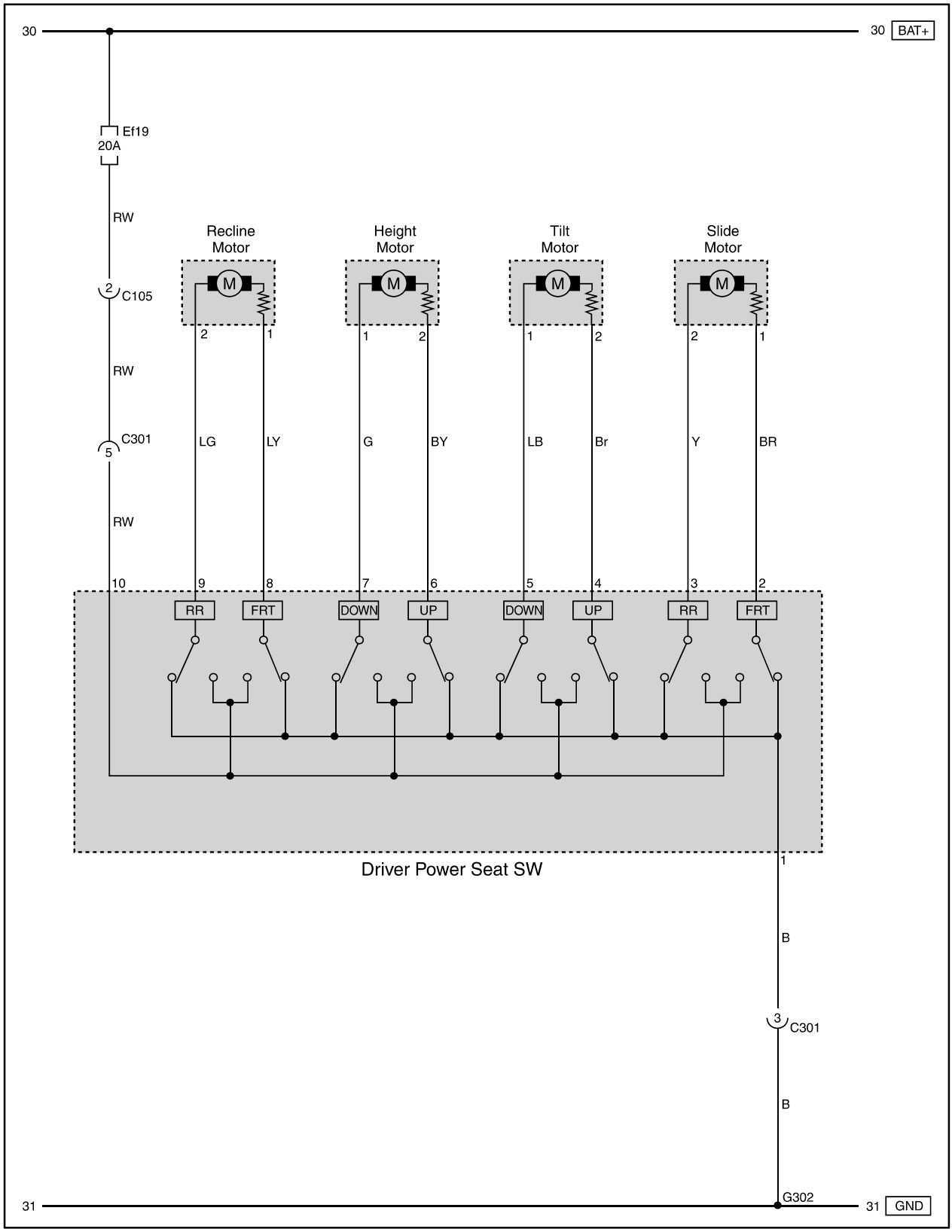
Seat Belt in Rear Seat (3 Point Type) (LH/RH)



Seat Belt in Rear Seat (2Point Type-Center)		Seat Belt in Rear Seat (3Point Type-Center)	
Rear-Center-LH	**Rear-Center-RH**	**Rear-Center-LH**	**Rear-Center-RH**
Buckle of 3-point type seat belt  Buckle of 2-point type seat belt	Buckle of 3-point type seat belt  2-point type seat belt	Buckle for rear side  Buckle for 3-point rear center	Buckle for 3-point rear center  Buckle for 3-point rear side

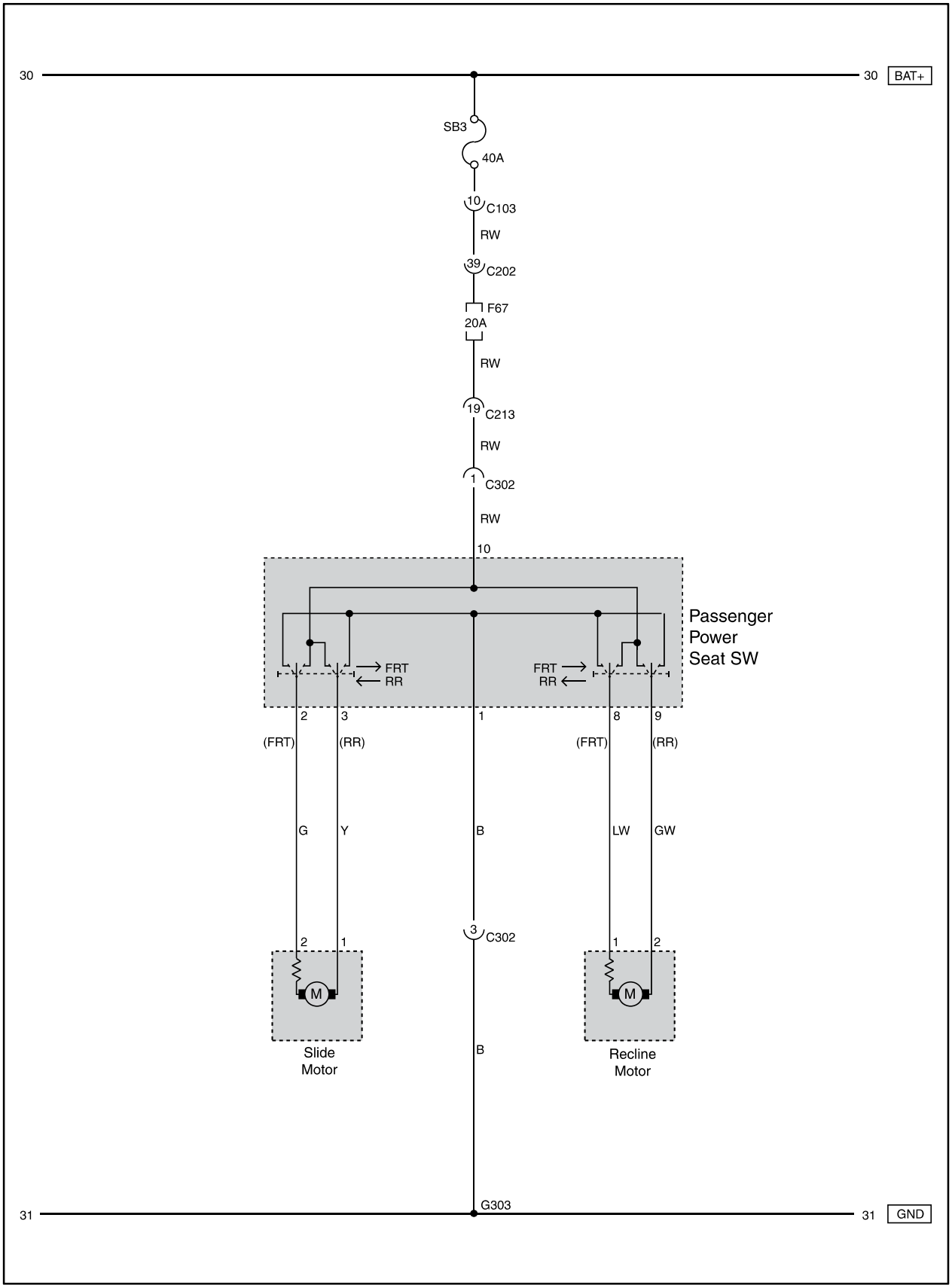
4. CIRCUIT DIAGRAM

1) Power Seat - Driver



Modification basis	
Application basis	
Affected VIN	

2) Power Seat - Passenger

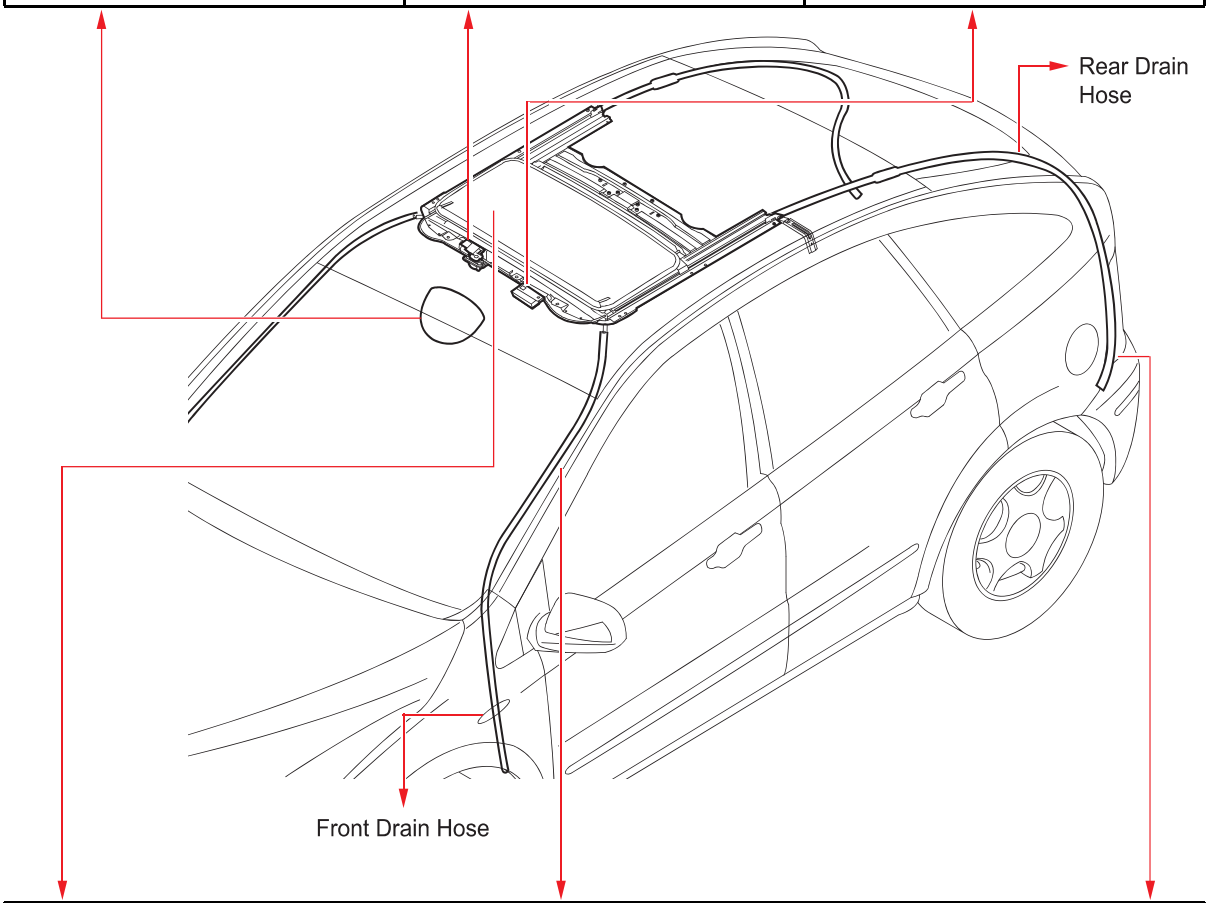


SUNROOF 7340-01

OVERVIEW AND OPERATION PROCESS

1. COMPONENTS AND LOCATIONS

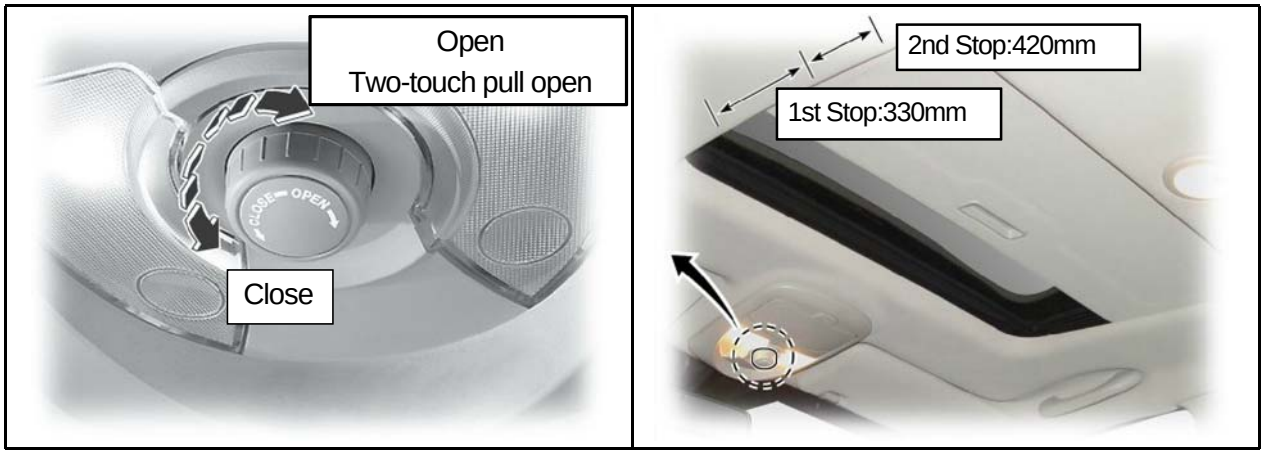
Sunroof Switch	Sunroof Motor	Sunroof Control Unit (SCU)
		



Sunroof Assembly	Front Drain Hose	Rear Drain Hose
		

2. OPERATION AND FUNCTION

When driving the vehicle with the window or sunroof open at a certain position, you may feel some pressure upon your ears or hear some noises similar to those from a helicopter (wind buffeting effect). This happens because of an influx in air through the window or sunroof and its resonance effect. If this happens, adjust by opening the window or sunroof. Actyon introduced two-touch function to the sunroof. When the sunroof is at the 1st stop position, it
minimizes the wind buffeting effect. To open the sunroof fully, move the switch to the second stop.



1) Sunroof Sliding Operation

(1) Two-touch Open

If you rotate the sunroof switch clockwise (OPEN direction) for less than 0.5 seconds, the sunroof slides back and opens until it reaches at the 1st stop position (330 mm). Then, if you continue to rotate the switch to its stop, the sunroof is pull opened (420 mm). To stop the operation while moving, operate the sunroof switch to any direction.

(2) Close

To fully close the sunroof, briefly (for approx. 0.5 sec.) rotate the sunroof switch counterclockwise (CLOSE direction) with the sunroof open. To partially close the sunroof, rotate and hold the sunroof switch until it reaches at the desired position.

2) Sunroof Tilting Operation

(1) Tilt-up

To tilt-up the sunroof, rotate the sunroof switch counterclockwise (CLOSE direction) with the sunroof fully closed.

(2) Tilt-down

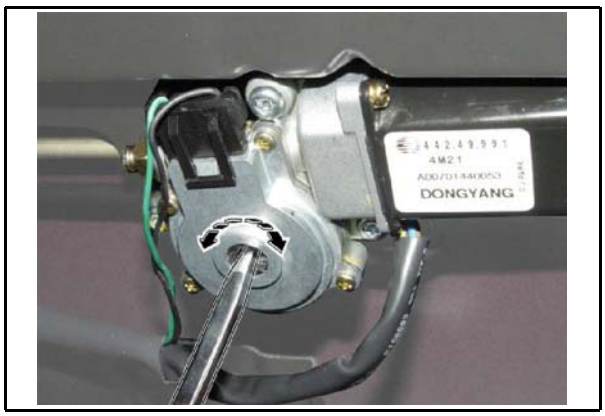
To tilt-down the sunroof, rotate the sunroof switch clockwise (OPEN direction) with the sunroof tilted-up.

Modification basis	
Application basis	
Affected VIN	



3) Anti-trap Function

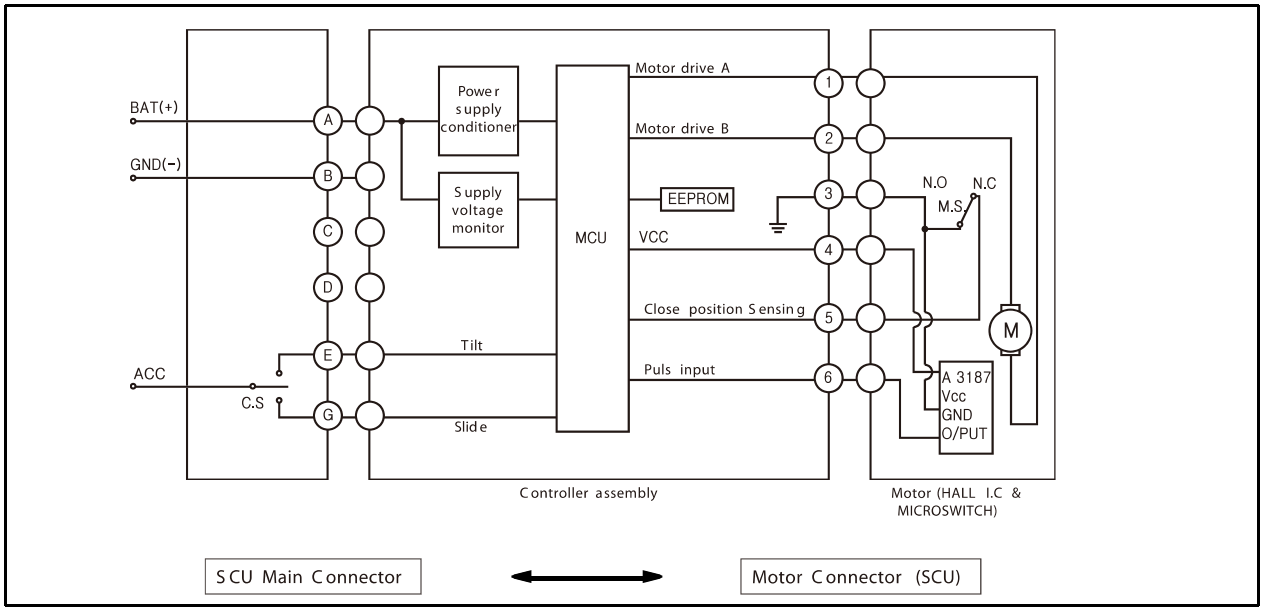
To prevent any body parts from being trapped by the sliding sunroof, an Anti-Trap function automatically opens the sunroof when an object is trapped. However, if the Anti-Trap function operates 3 times consecutively, the function switches to the manual operation and the sunroof goes back to the original position.
However, if the force against the sunroof is less than the specified value or the continuous resistance is detected, the Anti-Trap function doesn't operate. Therefore, make sure that there is no obstacle such as hand, head or part of body before operating the sunroof.



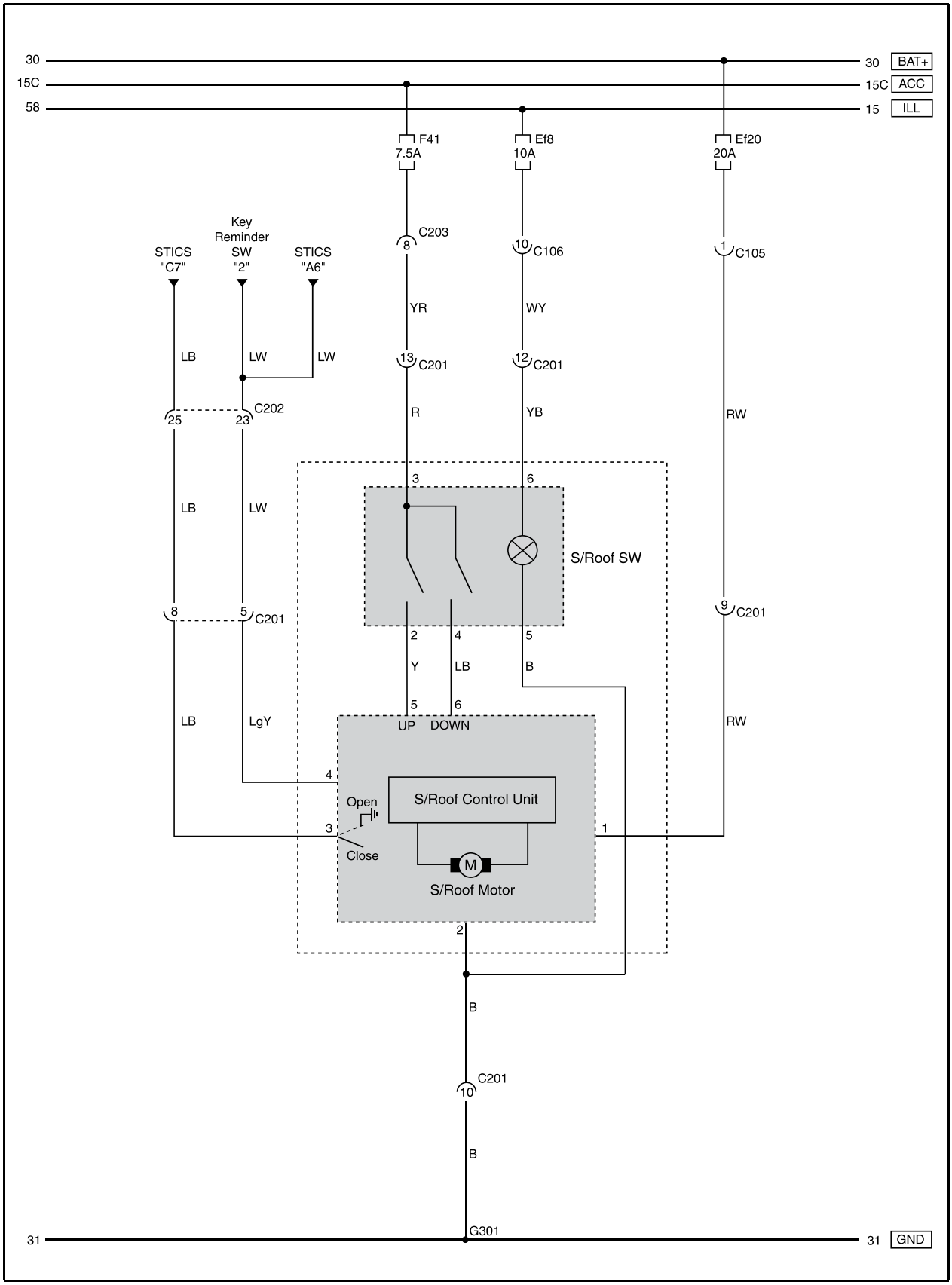
4) Hazard (Manual) Operation

The sunroof can be operated by rotating the screw in motor operating hole on the sunroof motor with a proper tool.

5) Circuit Diagram of Sunrrof Motor and SCU



6) Circuit Diagram of Sunroof



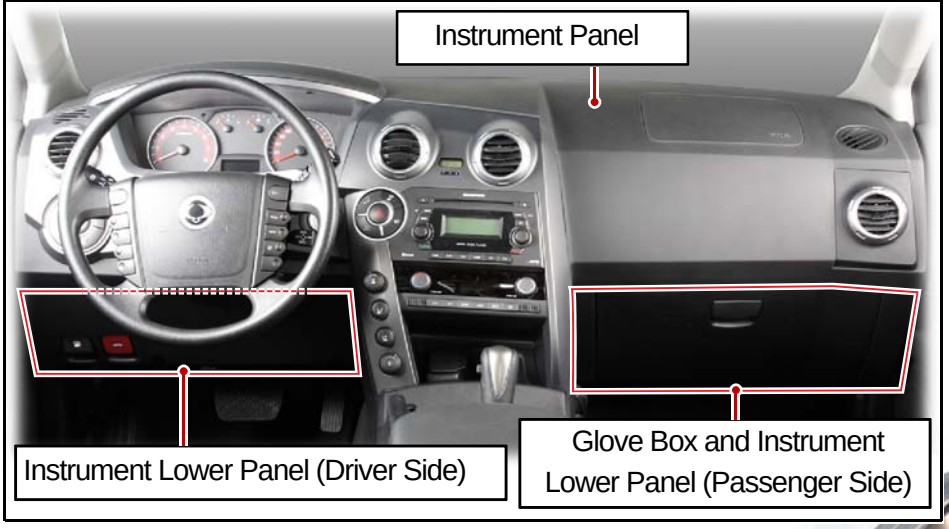
Modification basis	
Application basis	
Affected VIN	

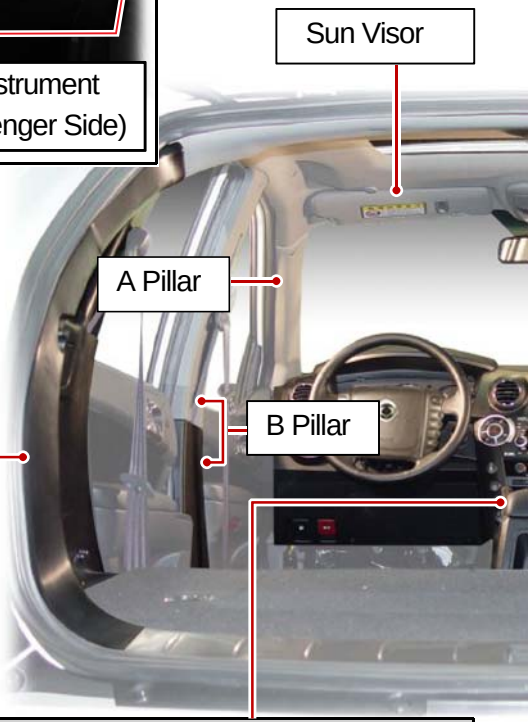
BODY INTERIOR 7610-01

OVERVIEW AND OPERATION PROCESS

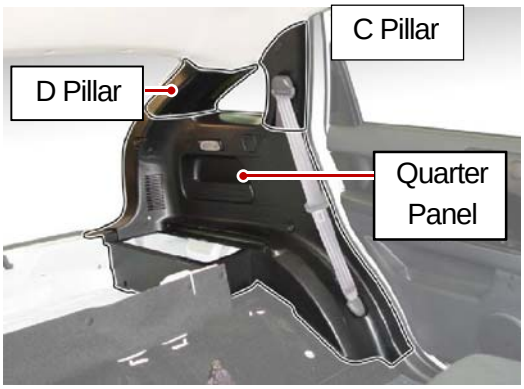
1. LOCATIONS

Instrument Panel Assembly





C Pillar/D Pillar and Rear Quarter Panel

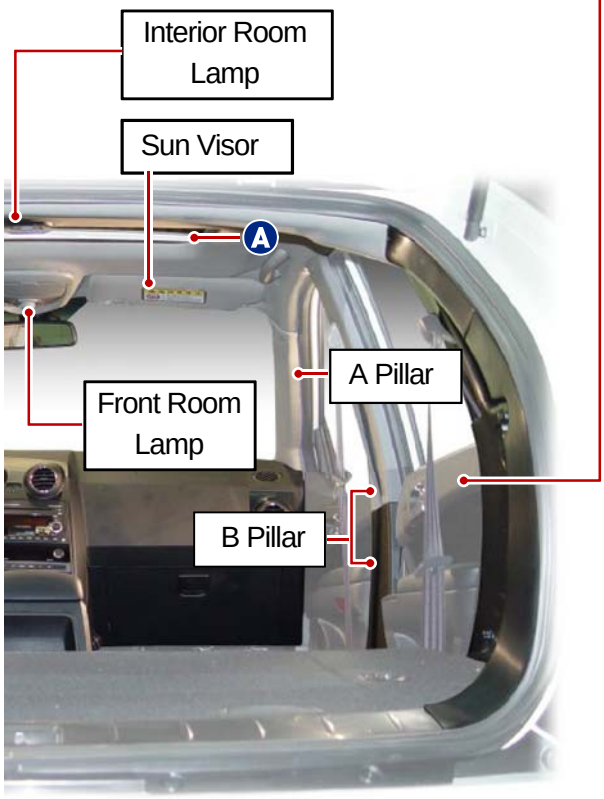


Center Console Assembly



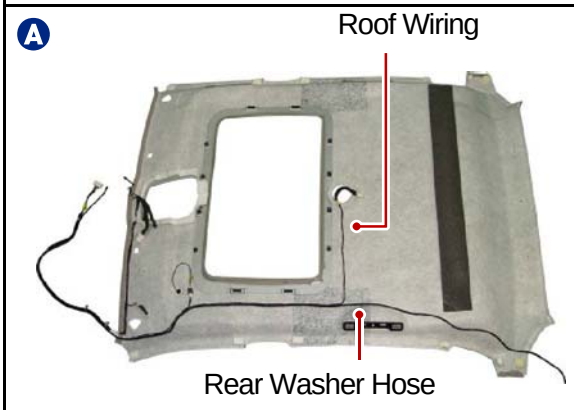
Modification basis	
Application basis	
Affected VIN	

Door Trim (Front Door)	Rear Door Trim
	



Headlining Assembly





BODY EXTERIOR

7870-00

OVERVIEW AND OPERATION PROCESS

1. COMPOSITION OF BODY EXTERIOR

Hood Assembly	Front Fender Assembly
	



Front Door Assembly



Front Bumper Assembly



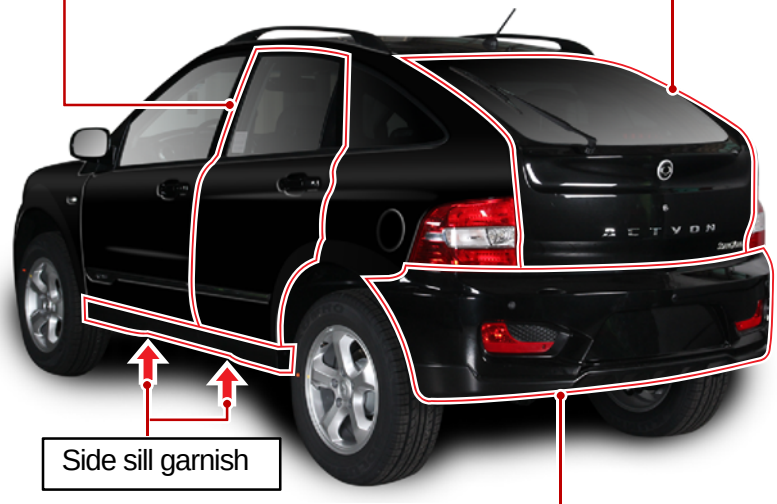
Modification basis	
Application basis	
Affected VIN	

Rear Door Assembly



Tailgate Assembly





Rear Bumper Assembly



Modification basis	
Application basis	
Affected VIN	

BODY REPAIR 4110-01

GENERAL INFORMATION

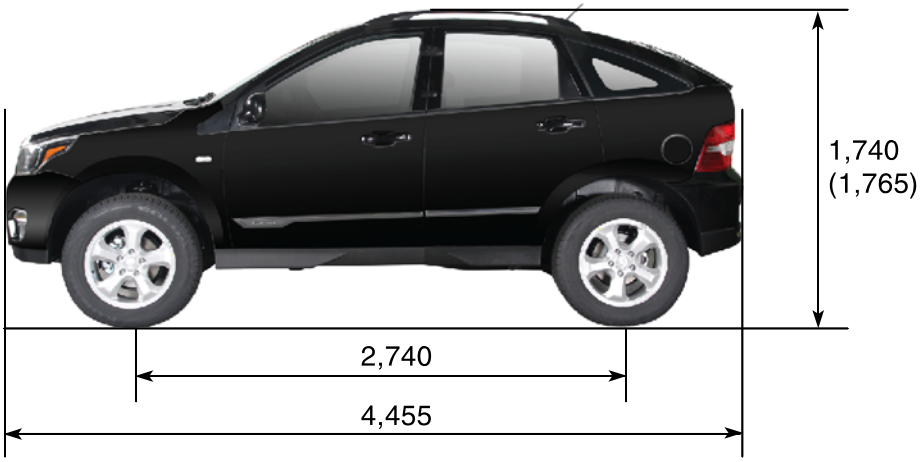
1. DIMENSIONS

Unit: mm

Top view



Side view



Front view

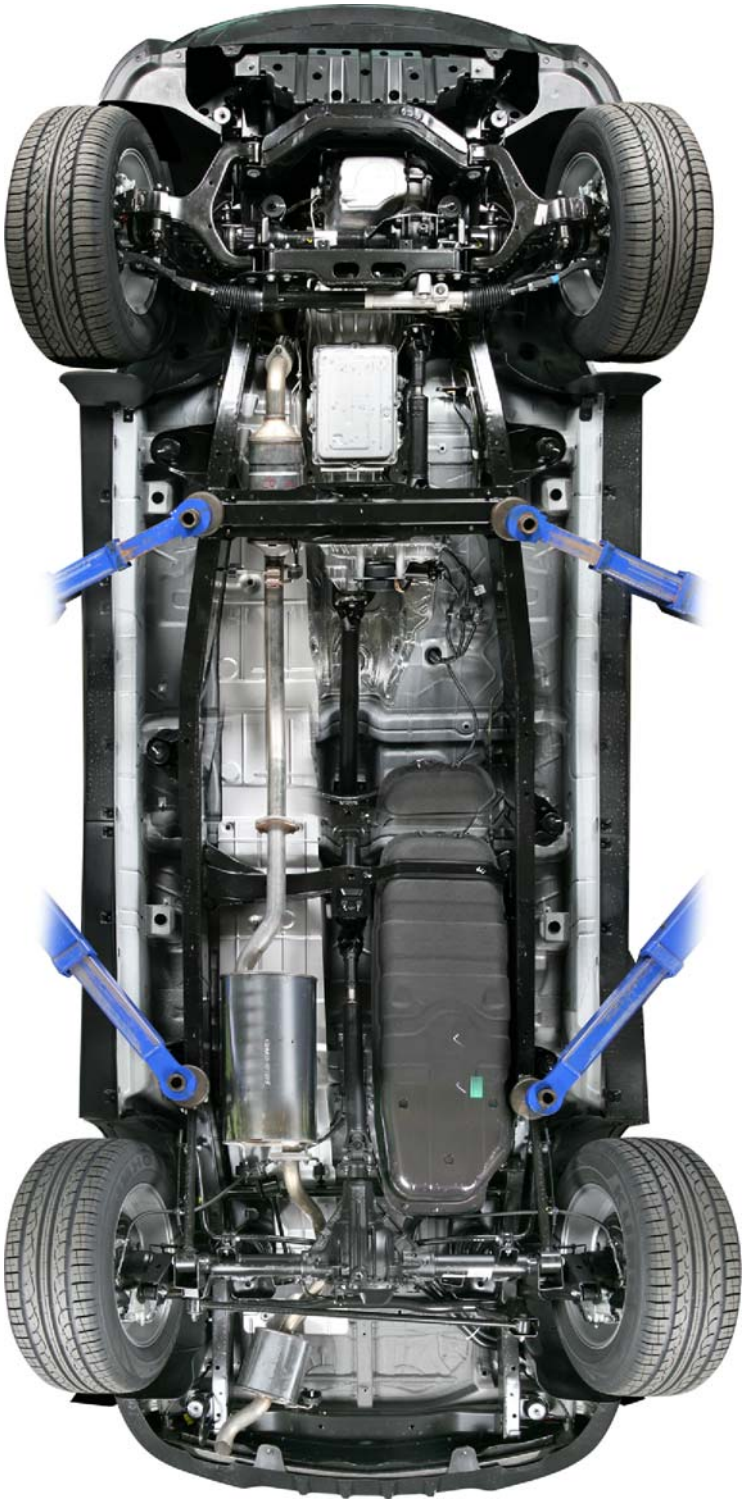


Rear view



Modification basis	
Application basis	
Affected VIN	

2. JACK-UP POINTS

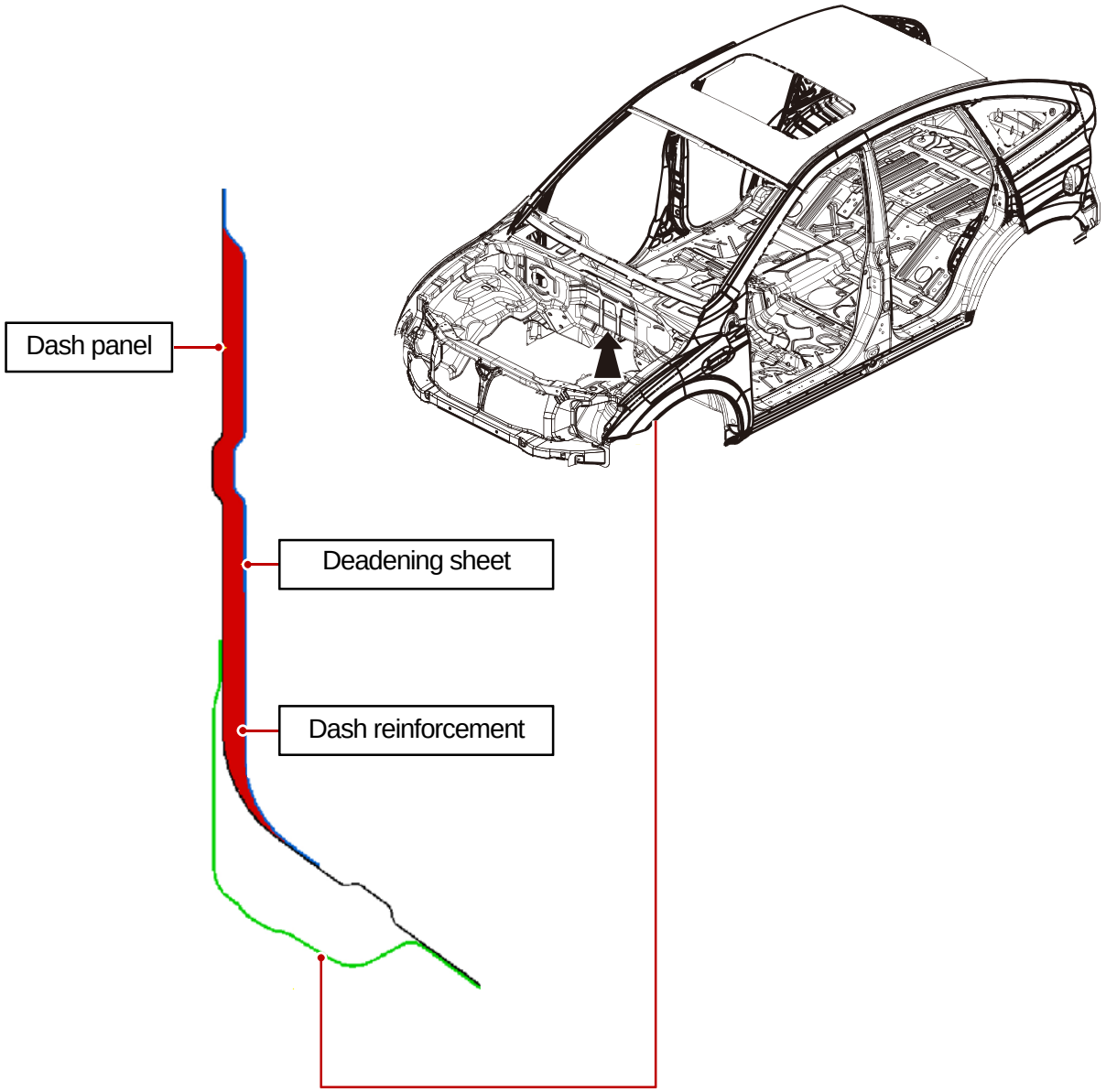


Modification basis	
Application basis	
Affected VIN	

3. DESIGN CHANGES FOR IMPROVING NVH PERFORMANCE

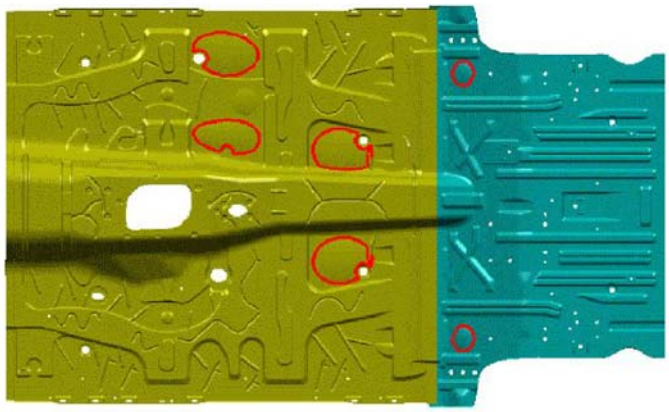
1) Dual Type Dash Panel and Engine Tunnel with Foaming Pad

Blocks the noise from engine and transmission and improves the reinforcement of vehicle body.

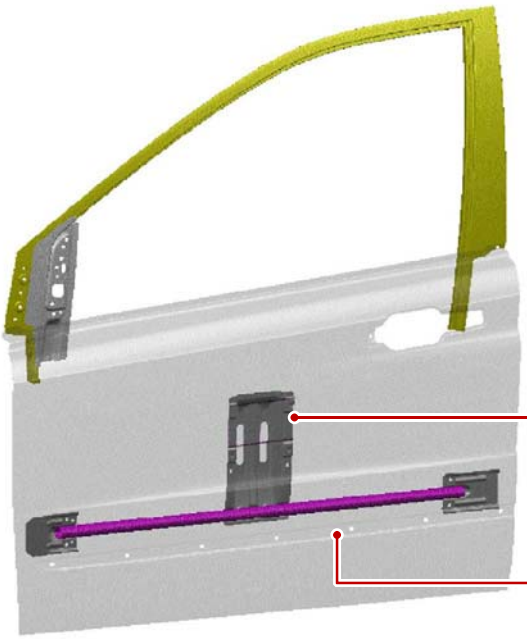


Added an additional member to the bottom of dash panel to minimize the possibility of engine retreat when collision.

2) Improved Reinforcement and NVH According to the Introducing of Front Floor and Rear Floor



3) Applied the Door Outer Panel



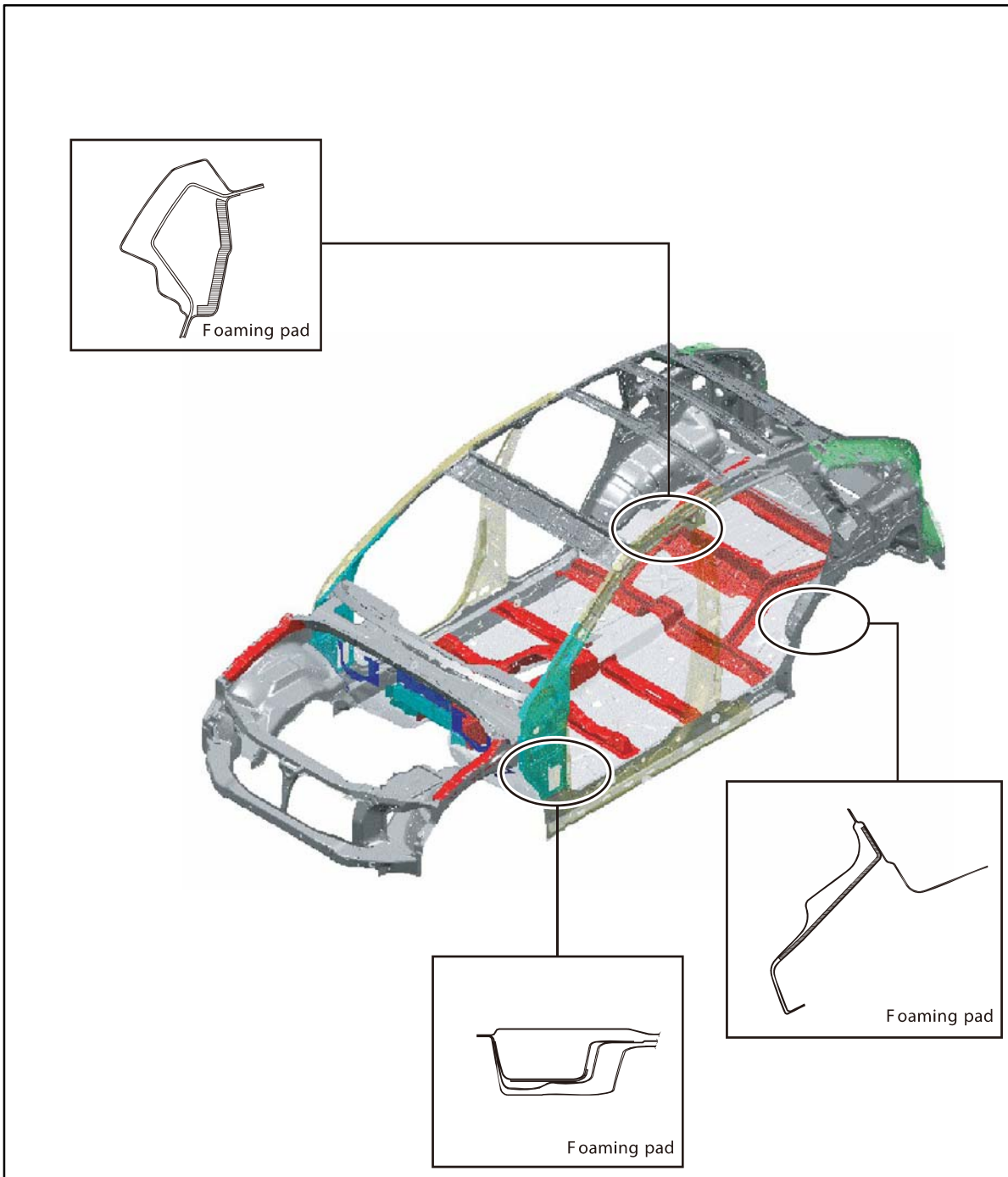
Door impact beam reinforcement
to reinforce the door impact beam

Door impact beam
to protect the passengers in case of side collision

Modification basis	
Application basis	
Affected VIN	

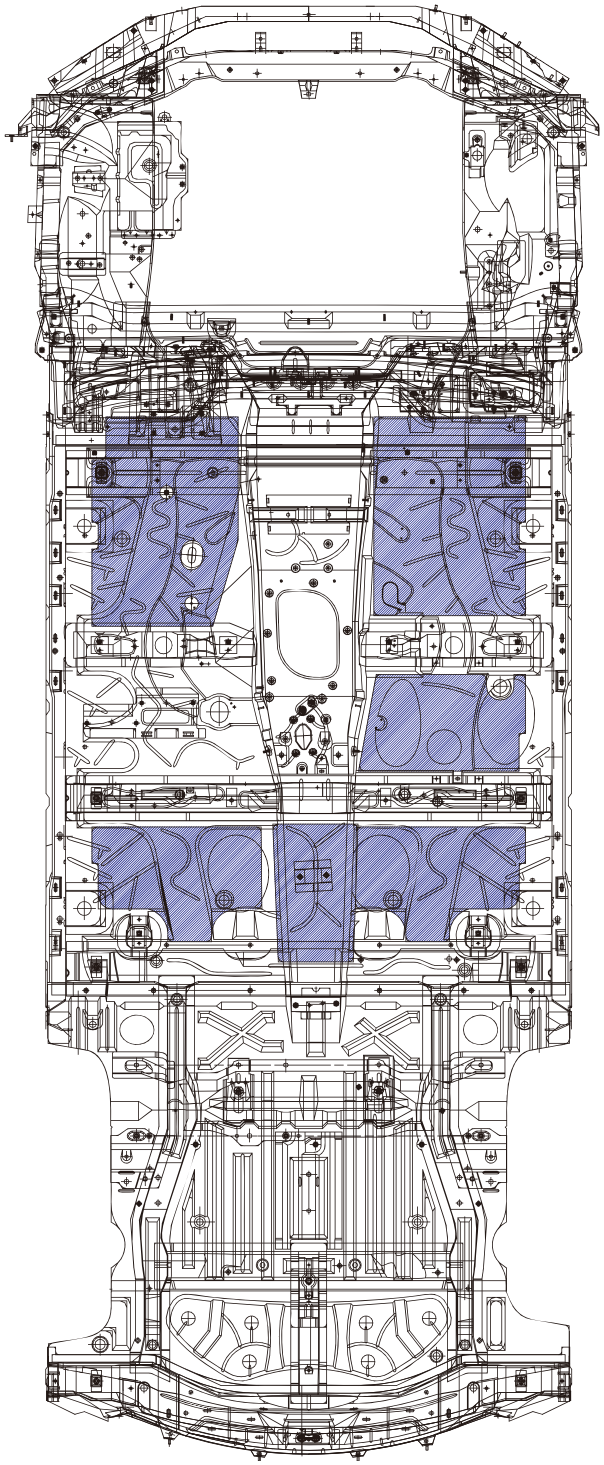
4) Applied BPR (Body Panel Reinforcement) Sealer to the Body Panel

BPR sealer is sprayed by robot and is designed to reinforce the body panel and reduce the noise.



Modification basis	
Application basis	
Affected VIN	

5) Applied the Asphalt to the Body Panel (Improved Anti-Vibration)



Modification basis	
Application basis	
Affected VIN	

Memo