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VEHICLE GENERAL

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VEHICLE GENERAL

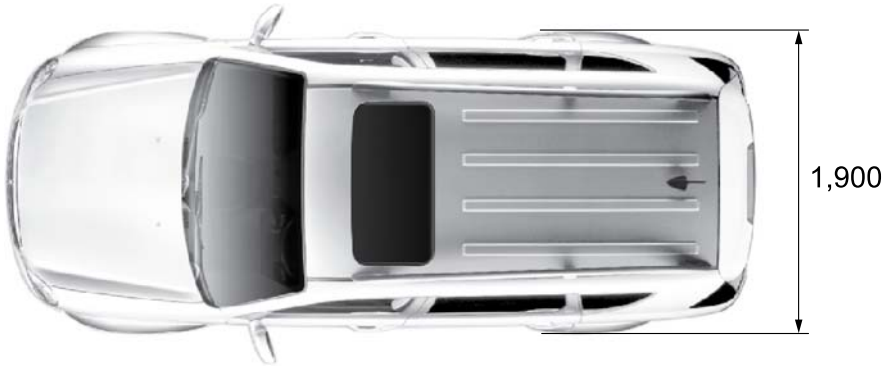
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GENERAL INFORMATION

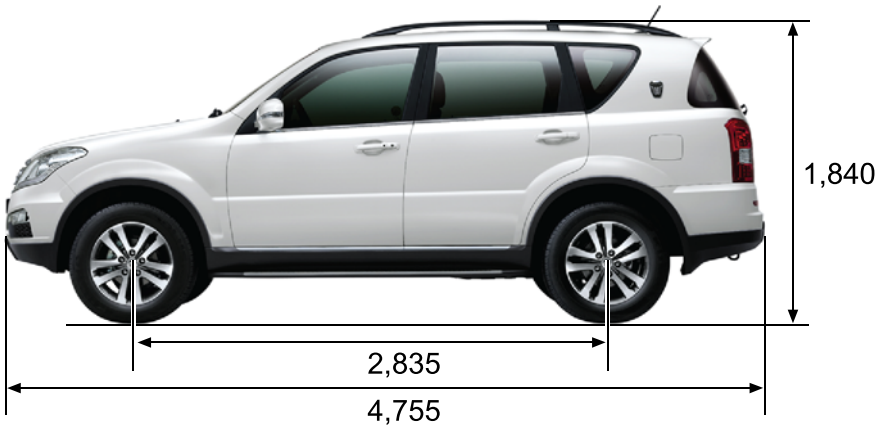
1. DIMENSIONS

Unit: mm

Top view



Side view



Front view



Rear view



2. SPECIFICATIONS

* ( ): Optional, [ ]: 2WD, < >: DPF
D20DTR: Diesel 2.0 (EU5), D20DT: Diesel 2.0,
D27DTP: Diesel 2.7 Power-Up, D27DT: Diesel 2.7, G32D: Gasoline

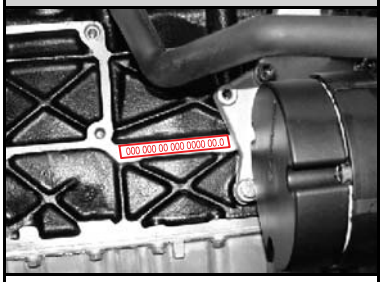
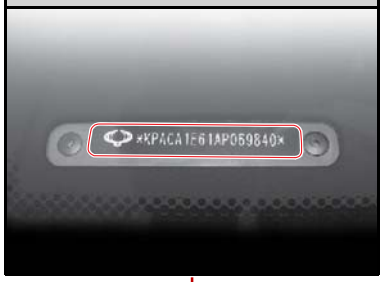
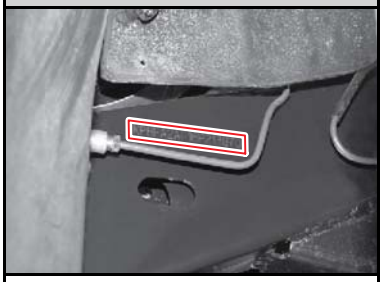
Descriptions			D20DTR	D27DT	D27DTP	G32D
General	Overall length (mm)		4,755	←	←	←
	Overall width (mm)		1,900	←	←	←
	Overall height (mm)		1,840	←	←	←
	Gross vehicle weight (kg)		2,710 [2,650]	2,740	←	←
	Curb vehicle weight (kg)	A/T	1,985 (2,053) [1,925 (1,993)]	2,033 (2,098)	2,008 (2,082)	2,021 (2,095)
		M/T	1,960 (2,020) [1,901 (1,960)]	2,007 (2,072)	–	–
	Fuel		Diesel	←	←	Gasoline
	Fuel tank capacity (ℓ)		78	←	←	←
	Minimum turning radius		5.7m	←	←	←
Engine	Numbers of cylinders/ Compression ratio		4 / 16.5:1	5 / 18:1 (EURO IV 17.5:1)	5 / 17.5:1	6 / 10:1
	Total displacement (cc)		1,998	2,696	←	3,199
	Camshaft arrangement		DOHC	←	←	←
	Max. power	A/T	<153 PS / 3,400 ~ 4,000 rpm>	165 PS / 4,000 rpm <161 PS / 4,000 rpm>	186 PS / 4,000 rpm <180 PS / 4,000 rpm>	220 PS / 6,100 rpm
		M/T		165 PS / 4,000 rpm	–	–
	Max. torque	A/T	<360 Nm / 1,500 ~ 2,800 rpm>	340 Nm / 1,800 ~ 3,250 rpm	402 Nm / 1,600 ~ 3,000 rpm	312 Nm / 4,600 rpm
		M/T		340 Nm / 1,800 ~ 3,250 rpm	–	–
	Idle speed		780 ± 50 rpm	750 ± 20 rpm	←	700 ± 50 rpm
	Cooling system		Water- cooled / forced circulation	←	←	←
Engine	Coolant capacity (ℓ)		8.5	11.0 ~ 11.5	←	11.5 ~ 12.0
	Lubrication type		Gear pump, forced circulation	←	←	←
	Max. oil capacity (ℓ) **(when shipping)**		6.0	9.2	←	9.8
	Turbocharger and cooling type		Turbocharger, air-cooled	←	←	–
Manual Transmis-sion	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	–	–

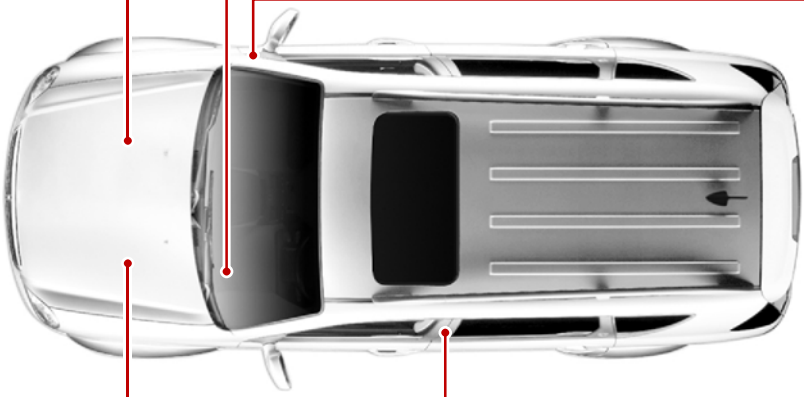
Modification basis	
Application basis	
Affected VIN	

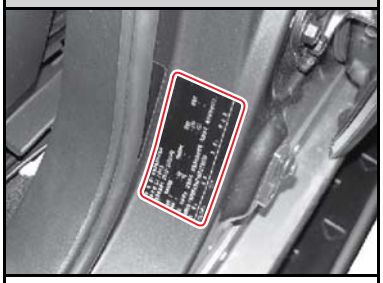
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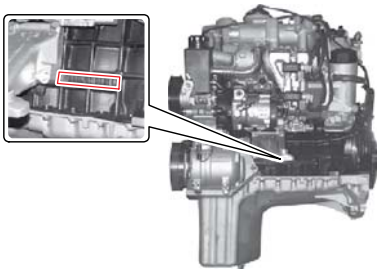
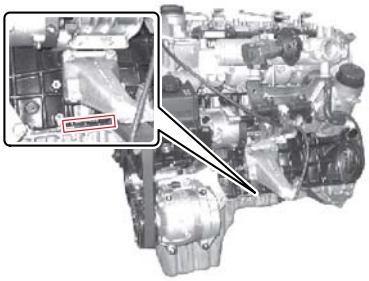
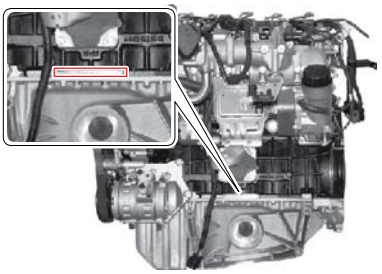
Descriptions			D20DTR	D27DT	D27DTP	G32D
Automatic Transmission	Model		Electronic, 5-speed	←	←	←
	Operating type		Floor change type	←	←	←
	Gear ratio	1st	3.595	←	←	3.951
		2nd	2.186	←	←	2.423
		3rd	1.405	←	←	1.486
		4th	1.000	←	←	1.000
		5th	0.831	←	←	0.833
		Reverse 1st	3.167	←	←	3.147
		Reverse 2nd	1.926	←	←	1.930
Transfer Case	Model		Part-time	Part-time (TOD)	AWD	Part-time (AWD)
	Type		Planetary gear type	←	–	Planetary gear type
	Gear ratio	High (4H)	1.000 : 1	←	–	1.000 : 1
		Low (4L)	2.483 : 1	←	–	2.483 : 1 (AWD: –)
Clutch (M/T)	Operating type		Hydraulic type	←	–	–
	Disc type		Dry single diaphragm type	←	–	–
Power Steering	Type		Rack and pinion	←	←	←
	Steering angle	Inner	38.2°	←	←	←
		Outer	34.1°	←	←	←
Front Axle	Drive shaft type		Ball joint type	←	←	←
	Axle housing type		Build-up type	←	IOP type	Build-up type (IOP type)
Rear Axle	Drive shaft type		Semi-floating type	Semi-floating type (Ball joint type)	←	←
	Axle housing type		Build-up type (IRS type)	←	←	←
Brake	Master cylinder type		Tandem type	←	←	←
	Booster type		Vacuum assisted booster type	←	←	←
	Brake type	Front wheels	Disc type	←	←	←
		Rear wheels	Disc type	←	←	←
	Parking brake		Cable type	←	←	←
Suspension	Front suspension		Double - wish-bone + coil spring	←	←	←
	Rear suspension		5-link + coil spring (Multi-link + Coil spring)	←	←	←
Air Conditioner	Refrigerant (capacity)		R-134a / 720 ± 30g (R-134a / 1120 ± 30g)	←	←	←
Electrical	Battery type / Capacity (V-AH)		MF / 12 - 90	←	←	←
	Starter capacity (V-kW)		12 - 2.3	12 - 2.2	←	12 - 1.8
	Alternator capacity (V-A)		12-120	12-140	←	12-115

3. VEHICLE IDENTIFICATION

Engine Number	Vin Label	Chassis Number
		
Gasoline Engine: The engine number is stamped on the lower area of cylinder block in exhaust manifold side.		The chassis number is stamped on the frame behind the front right tire.



Certification Label

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

D20DTR	D27DT	D27DTP
		

Diesel Engine (D20DTR, D27DT, D27DTP): The engine number is stamped on the lower area of cylinder block behind the Intake manifold.

Modification basis	
Application basis	
Affected VIN	

4. MAINTENANCE

1) Scheduled Maintenance Services (EU) - Diesel Engine (D20DTR)

* 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
	Initial check: 5,000 km, and replenish if necessary. 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 200,000 km or 5 years. And, inspect and replenish if necessary.							
* Fuel filter (1)*	I	R*	I	R*	I	R*	I	R*
	Draining water from fuel fliter: 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 3,000 km (2,000 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".

* Use only approved Ssangyong genuine parts.

* 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
		Inspect every 20,000 km or 1 years, adjust or replace if necessary							
Brake line & connections (including booster) (4)*		I	I	I	I	I	I	I	I
		Inspect every 20,000 km or 1 years, adjust or replace if necessary							
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
		Frequnt check of oil leak							
Front & Rear differential fluid (3)*	Front	Inspect frequently, change every 30,000 km							
	Rear Rigid	Inspect frequently, change every 30,000 km							
	Rear IRS	Periodic check: every 20,000 km, adjust or replace if necessary.							
Automatic transmission fluid (6)*		I	I	I	I	I	I	I	I
		Change every 60,000 km under severe condition							
Chassis & underbody bolts & nuts tight / Secure (6)*		Check frequntly and adjust or replace if necessary							

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

Modification basis	
Application basis	
Affected VIN	

* Use only approved Ssangyong genuine parts.

* 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

Tire condition & inflation pressure	Check frequntly 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
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 frequntly 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”.

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

(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
- In heavy city traffic where the outside temperature regularly reaches 32°C (90°F) or higher

2) Scheduled Maintenance Services (GEN) - Diesel Engine (D20DTR)

* 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	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
		Initial check: 5,000 km, and replenish if necessary. 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 200,000 km or 5 years. And, inspect and replenish if necessary.							
* Fuel filter (1)*		I	I	R*	I	I	R*	I	I
		Draining water from fuel fliter: 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 3,000 km (2,000 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	

* Use only approved Ssangyong genuine parts.

* 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	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
		Inspect every 15,000 km or 1 years, adjust or replace if necessary							
Brake line & connections (including booster) (4)*		I	I	I	I	I	I	I	I
		Inspect every 15,000 km or 1 years, adjust or replace if necessary							
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
		Frequnt check of oil leak							
Front & Rear differential fluid (3)*	Front	Inspect frequently, change every 30,000 km							
	Rear – Rigid	Inspect frequently, change every 30,000 km							
	Rear – IRS	Periodic check: every 15,000 km, adjust or replace if necessary.							
Automatic transmission fluid (6)*		I	I	I	I	I	I	I	I
		Change every 60,000 km under severe condition							
Chassis & underbody bolts & nuts tight / Secure (6)*		Check frequntly and adjust or replace if necessary							

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

* Use only approved Ssangyong genuine parts.

* 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	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

Tire condition & inflation pressure	Check frequntly 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
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 frequntly 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”.

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

(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
- In heavy city traffic where the outside temperature regularly reaches 32°C (90°F) or higher

Modification basis	
Application basis	
Affected VIN	

3) Scheduled Maintenance Services (GEN) - Diesel Engine (D27DT/D27DTP)

* 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	10	20	30	40	50	60	70	80
x1000 miles	6.25	12.5	18.75	25	31.25	37.5	43.75	50
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)*		Initial change: 5,000 km, change every 10,000 km or 12 months (But, 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 200,000 km or 5 years. And, inspect and replenish if necessary.							
* Fuel filter	Direct Injection (Diesel Engine)								
		Replace every 25,000 km (Draining water from fuel filter: whenever replacing the engine oil)							
Additional water separator (if equipped)		Replace every 150,000 km or 5 years (Drain the water whenever replacing the engine oil)							
Fuel line & connections		I	I	I	I	I	I	I	I
Air cleaner (2)*		Initial clean: 5,000 km, clean every 10,000 km, replace every 30,000 km (But, shorten the service interval under severe conditions)							
Injection timing (See NOTE 1)		I	I	I	I	I	I	I	I

NOTE 1: Adjust as required;
- When excessive smoke is visible (black or white)
- Poor performance/economy

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 3,000 km (2,000 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".

* Water separator: When replace the engine oil, also drain the water from the fuel filter.

* Use only approved Ssangyong genuine parts.

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	6.25	12.5	18.75	25	31.25	37.5	43.75	50
	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)*			Periodic check: every 10,000 km, adjust or replace if necessary.							
Brake line & connections (including booster)			Inspect every 15,000 km or 1 years, adjust or replace if necessary							
Manual transmission oil (5)*			I	I	I	I	I	R	I	I
Clutch & brake pedal free play			I	I	I	I	I	I	I	I
Front & Rear differential fluid (3)*	Front	Non IOP	Inspect frequently, change every 30,000 km							
		IOP	Periodic check: every 10,000 km, adjust or replace if necessary.							
	Rear	Rigid	Inspect frequently, change every 30,000 km							
		IRS	Periodic check: every 10,000 km, adjust or replace if necessary.							
Transfer case fluid (3)*			Inspect every 15,000 km, change every 60,000 km (Frequnt check of oil leak)							
Automatic transmission fluid (6)*			Inspect every 30,000 km or 12 month (But change every 60,000 km under severe condition)							

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 manual transmission fluid every 15,000 km (Inspect the leak of fluid at any time,occasionally), then change every 60,000 km

(6)* Change automatic transmission fluid and every 60,000 km if the vehicle is mainly driven under severe conditions: Towing a trailer or off-road driving (Inspect the leak of fluid at any time, occasionlly)

Modification basis	
Application basis	
Affected VIN	

* Use only approved Ssangyong genuine parts.

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	6.25	12.5	18.75	25	31.25	37.5	43.75	50
	Months	12	24	36	48	60	72	84	96

CHASSIS AND BODY

Chassis & underbody bolts & nuts tight / Secure (6)*	Check frequntly and adjust or replace if necessary							
Tire condition & inflation pressure	Check frequntly 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
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 frequntly and adjust or replace if necessary							
Wheel bearing grease	I	I	I	I	I	I	I	I
Propeller shaft grease - Front / Rear (9)*	Inspect every 10,000 km							
Air conditioner filter	Change every 10,000 km (But, 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”.

(6)* After completion of off-road operation, the underbody of the vehicle should be throughly inspected. Examine threaded fasteners for looseness.

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

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

(9)* Inspect propeller shaft grease every 5,000 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.

Severe Conditions in Air Conditioner Filter

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

4) Scheduled Maintenance Services (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.

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 & engine oil filter (1)* (3)* (Initial change: 10,000 km)		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)*		I	I	I	R	I	I	I	R
Ignition timing		I	I	I	I	I	I	I	I
Spark plugs		Change every 160,000 km or 5 years.							
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: short distance driving, extensive idling or driving in dusty condition, shorten the service interval.

(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".

* Use only approved Ssangyong genuine parts.

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)*			Periodic check: every 10,000 km, adjust or replace if necessary.							
Brake line & connections (including booster)			Inspect every 15,000 km or 1 years, adjust or replace if necessary							
Manual transmission oil (5)*			I	I	I	R	I	I	I	R
Clutch & brake pedal free play			I	I	I	I	I	I	I	I
Front & Rear differential fluid (3)*	Front	Non IOP	Inspect frequently, change every 30,000 km							
		IOP	Periodic check: every 10,000 km, adjust or replace if necessary.							
	Rear	Rigid	Inspect frequently, change every 30,000 km							
		IRS	Periodic check: every 10,000 km, adjust or replace if necessary.							
Transfer case fluid (3)*			Inspect every 15,000 km, change every 60,000 km (Frequnt check of oil leak)							
Automatic transmission fluid (6)*			Inspect every 30,000 km or 12 month (But change every 60,000 km under severe condition)							

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 manual transmission fluid every 15,000 km (Inspect the leak of fluid at any time,occasionally), then change every 60,000 km

(6)* Change automatic transmission fluid and every 60,000 km if the vehicle is mainly driven under severe conditions: Towing a trailer or off-road driving (Inspect the leak of fluid at any time, occasionlly)

* Use only approved Ssangyong genuine parts.

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

Chassis & underbody bolts & nuts tight / Secure (6)*	Check frequntly and adjust or replace if necessary							
Tire condition & inflation pressure	Check frequntly 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
Power steering fluid & lines (3)*	I	I	I	I	I	I	I	I
Drive shaft boots	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 frequntly and adjust or replace if necessary							
Wheel bearing grease	I	I	I	I	I	I	I	I
Propeller shaft grease - Front / Rear (8)*	Inspect every 10,000 km							
Air conditioner filter	Change every 10,000 km (But, 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”.

(6)* After completion of off-road operation, the underbody of the vehicle should be throughly inspected. Examine threaded fasteners for looseness.

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

(8)* Inspect propeller shaft grease every 5,000 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.

Severe Conditions in Air Conditioner Filter

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

Modification basis	
Application basis	
Affected VIN	

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)
		D20DT	≒ 7.5ℓ	Quality class: Ssangyong genuine engine oil (Approved by MB Sheet 229.1 or 229.3 or 229.31 for DSL/GSL ENG without CDPF) (Approved by MB Sheet 229.31 for DSL ENG with CDPF)
		D27DT/ D27DTP	≒ 8.5ℓ	
		G32D	≒ 9.0ℓ	
Engine Coolant		D20DTR	8.5ℓ	Ssangyong genuine coolant Anti-Freeze SYC-1025, Anti-Freeze:Water = 50:50 ORGANIC ACID TYPE, COLOR:BLUE
		D20DT	10.5 ~ 11.0ℓ	
		D27DT/ D27DTP	11.0 ~ 11.5ℓ	
		G32D	11.5 ~ 12.0ℓ	
Automatic Transmission Fluid		5A/T	≒ 8.0ℓ	Ssangyong genuine oil (Shell ATF 134 or Fuchs ATF 134)
		6A/T	≒ 9.5ℓ	Ssangyong genuine oil (FUCHS TITAN ATF 3292)
Manual Transmission Fluid		5M/T	≒ 3.4ℓ	Ssangyong genuine oil (ATF DEXRON II)
		6M/T	≒ 2.2ℓ	Ssangyong genuine oil (HD MTF 75W/85 (SHELL) or HK MTF 75W/85(SK))
Transfer Case Fluid		AWD	≒ 1.1ℓ	Ssangyong genuine oil (ATF DEXRON II or III)
		TOD	≒ 1.4ℓ	
		Part Time	≒ 1.4ℓ	
Axle Oil	Front	Non IOP	≒ 1.4ℓ, ≒ 1.5ℓ	Ssangyong genuine oil (API GL-5 & SAE 80W/90)
		IOP	≒ 0.78ℓ	Ssangyong genuine oil (Shell synthetic fuel efficient GL 75W/90)
	Rear	Rigid	≒ 2.0ℓ	Ssangyong genuine oil (API GL-5 & SAE 80W/90)
		IRS	≒ 1.5ℓ	Ssangyong genuine oil (Shell synthetic fuel efficient GL 75W/90)
Brake / Clutch Fluid			As required	Ssangyong genuine oil (DOT4)
Power Steering Fluid			≒ 1.1ℓ	Ssangyong genuine oil (PSF-3) * TOTAL FLUIDE DA (Extreme cold condition only)

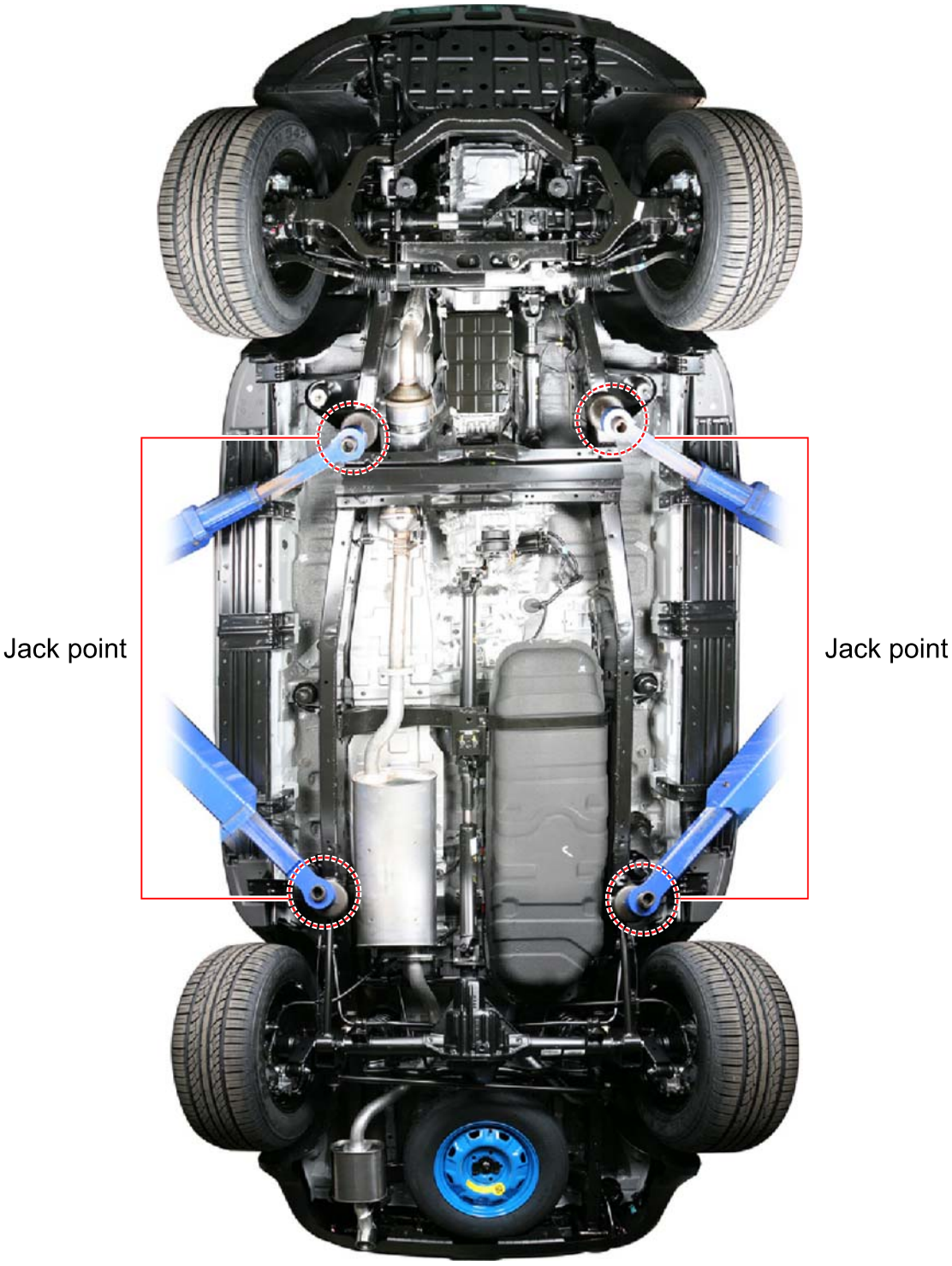
WARNING

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

D20DTR: Diesel 2.0 (EU5), D20DT: Diesel 2.0, D27DTP: Diesel 2.7 Power-Up,
D27DT: Diesel 2.7, G32D: Gasoline

6. JACK POINTS

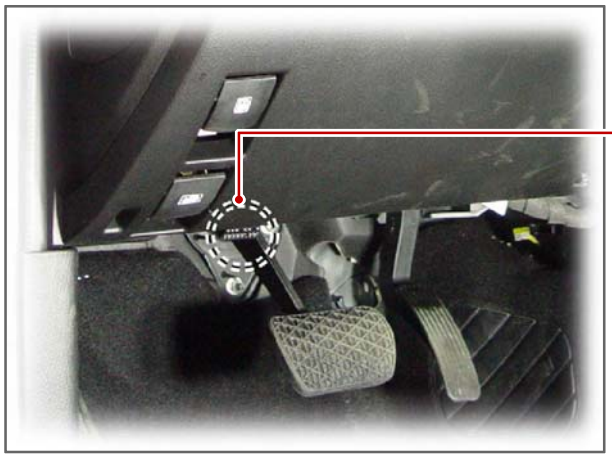
Front: Double wishbone Rear: 5-link

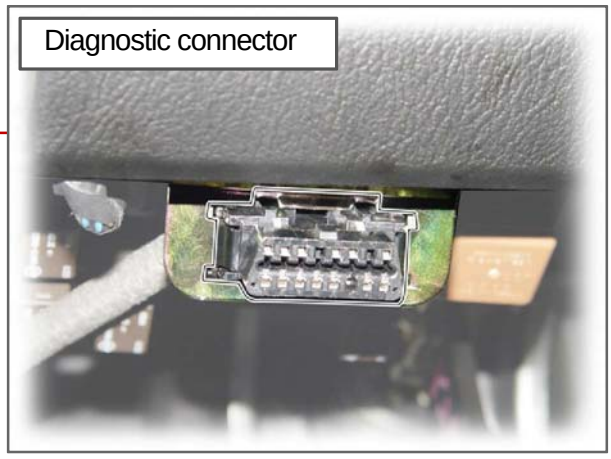


Modification basis	
Application basis	
Affected VIN	

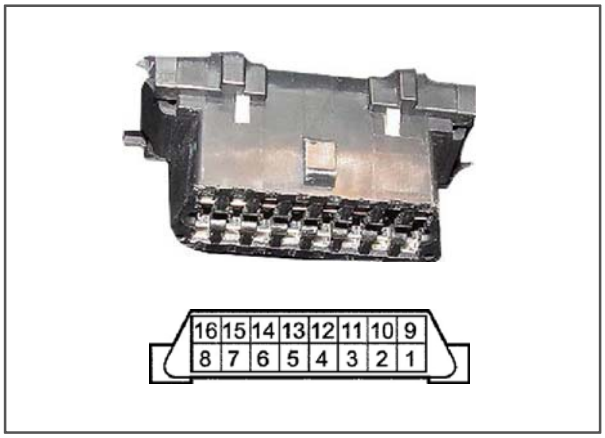
7. PIN ARRANGEMENT OF DIAGNOSTIC CONNECTOR

The diagnostic connector is located at bottom of instrument panel. It consists of 16 pins.
The REKES key should be coded by the scan tool.





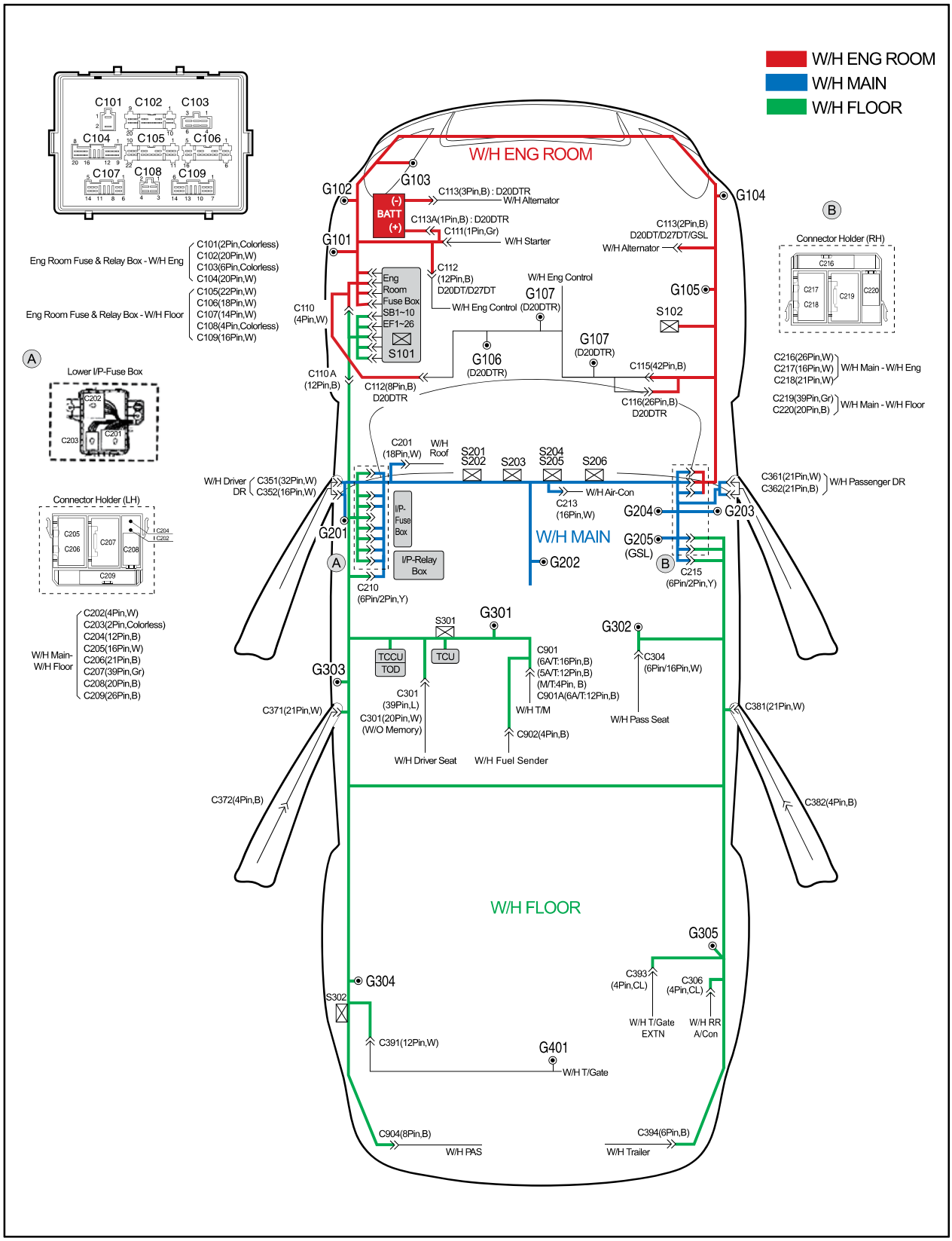
▶ **Connector Pin**



Pin No.	Function
1	CAN HI S203 "18"
2	CAN LO S203 "8"
3	-
4	Ground
5	Ground
6	CAN HI S202 "14"
7	-
8	ABS/ESP unit “2”
9	Air bag unit “9”
10	-
11	TCU "A18"(5-A/T)
12	SSPS unit “8”
13	TCCU "21"
14	CAN LO S202 "4"
15	STICS "B21"
16	B+

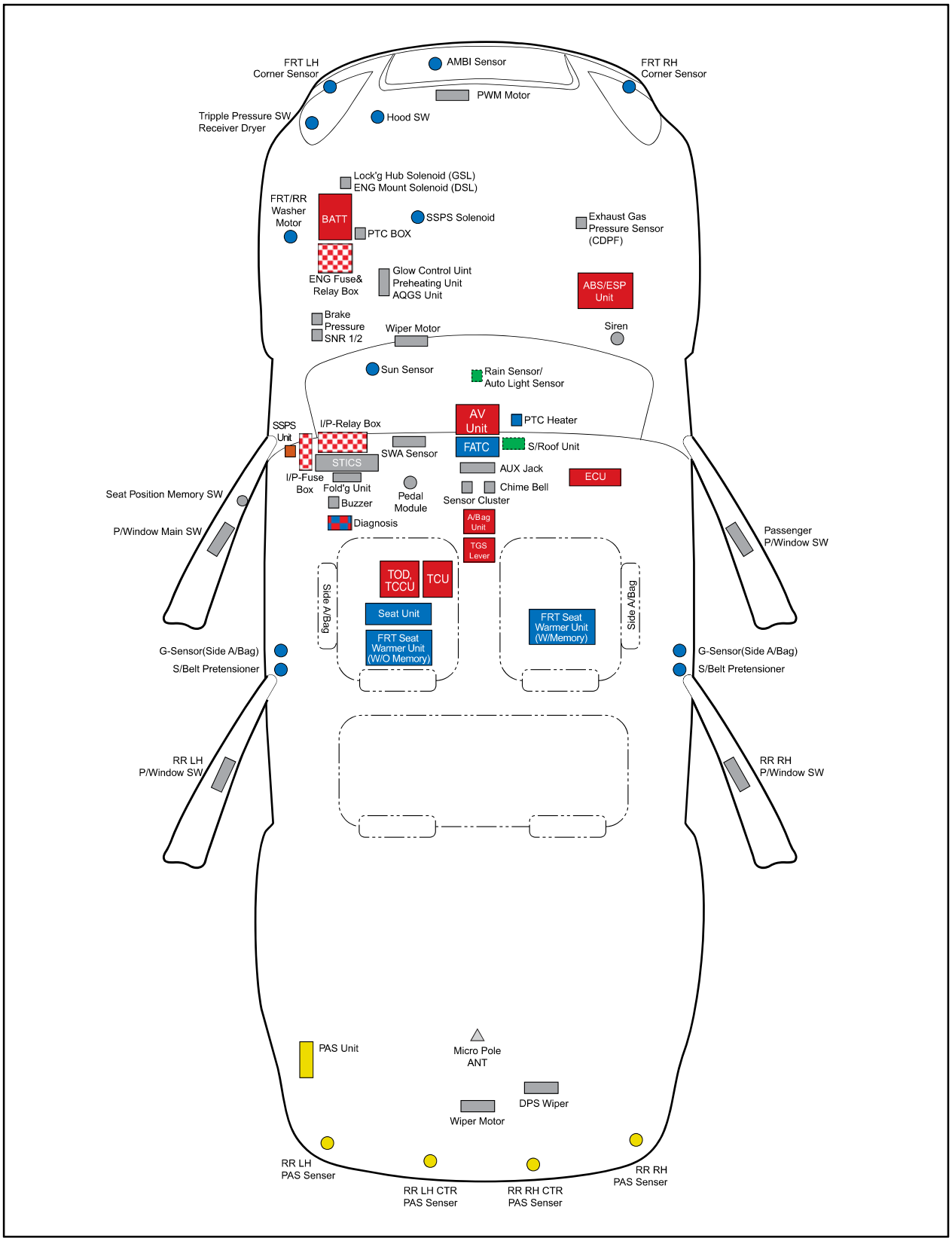
8. ELECTRIC COMPONENTS AND LAYOUT

1) Wiring Harness Arrangement



Modification basis	
Application basis	
Affected VIN	

2) Components Locator

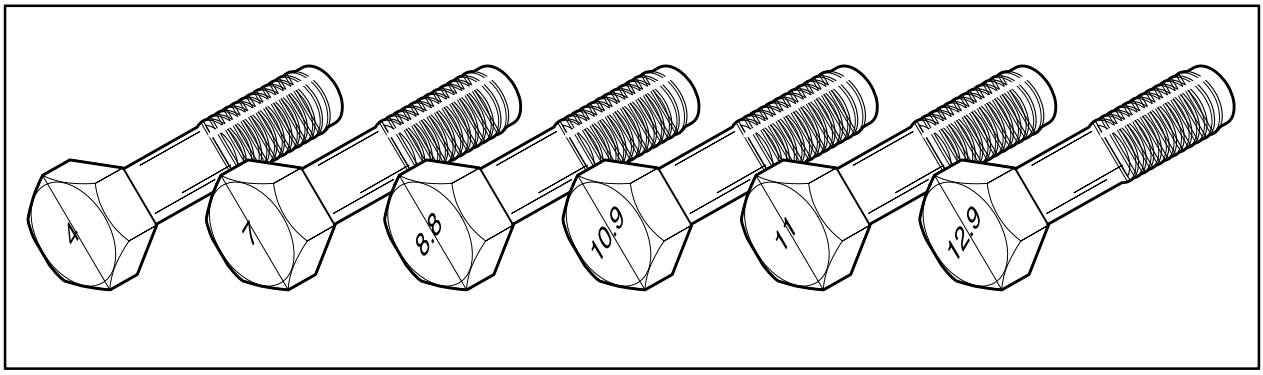


Modification basis	
Application basis	
Affected VIN	

9. TIGHTENING TORQUE OF STANDARD BOLTS

▶ Tightening Torque By Bolt Specification

Bolt Diameter	Pitch	Tightening Torque (kg·cm)					
		Standard Tightening Torque			Max. Allowable Tightening Torque		
		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.
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.
   - Aluminum alloy: Tighten to 80 % of above torque table.
   - Plastics: Tighten to 20 % of above torque table.

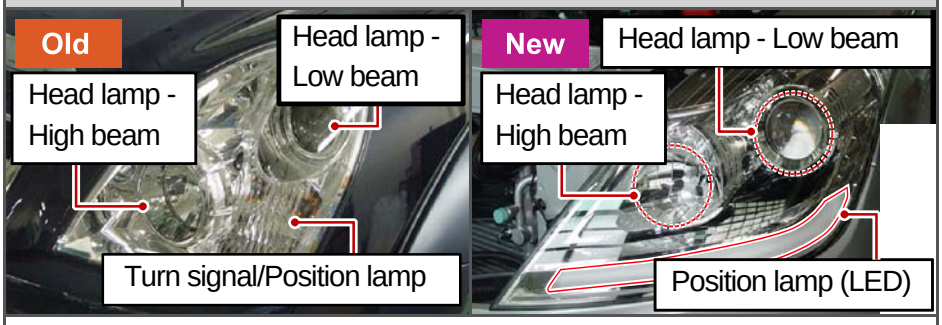
Modification basis	
Application basis	
Affected VIN	

MAJOR CHANGES COMPARED TO MODEL (03. 2012)

1. EXTERIOR

▶ **Font Side**

8310-01	Head Lamp



- Changed the head lamp design and functions.
- Turn signal lamp integrated with front fog lamp

7910-01	Radiator Grille

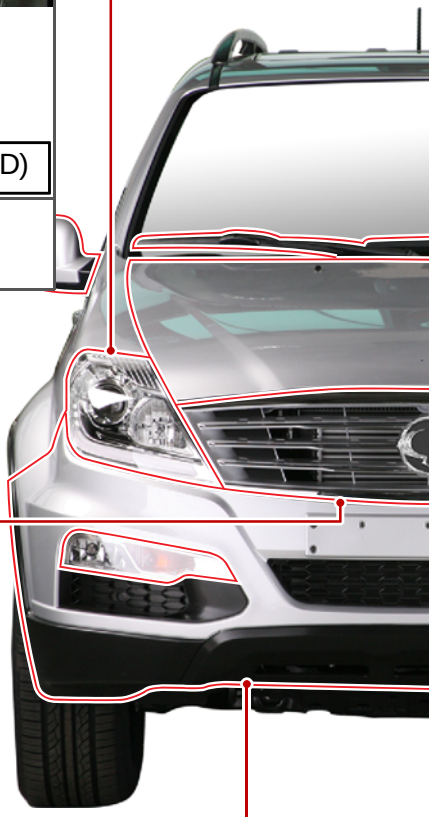
Old



New

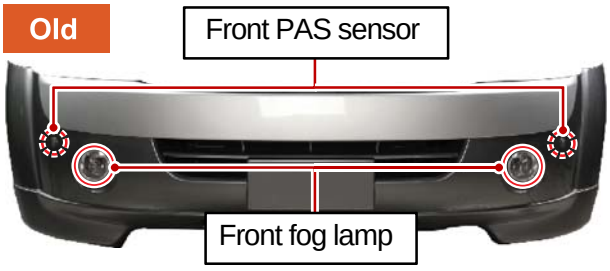


- Changed the mounting type (from on hood to on bumper).
- Changed the radiator grill design.

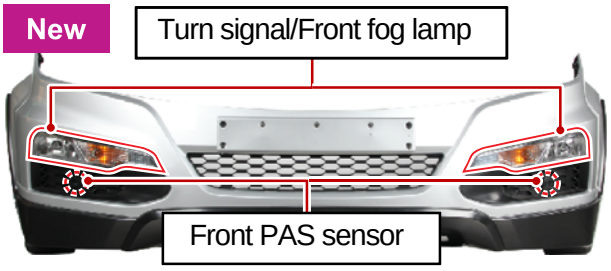


7871-01	Front Bumper and Front PAS Sensor

Old

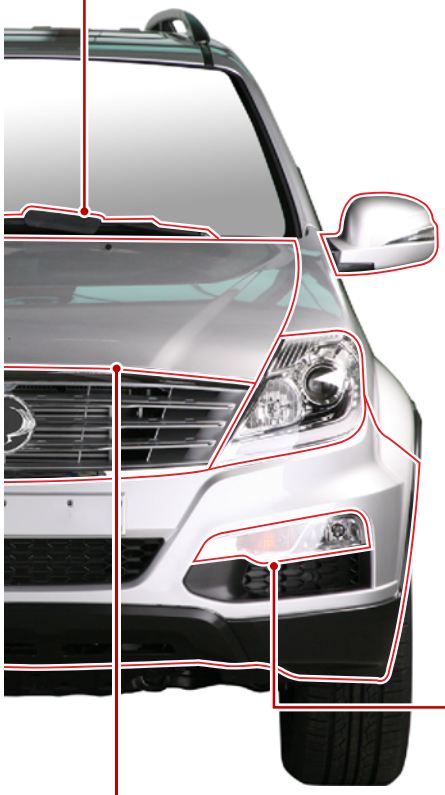


New

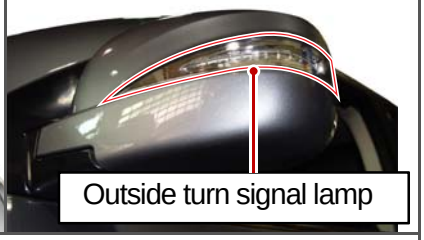


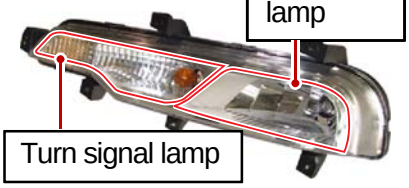
- Changed the front bumper design according to the design changes of front combination lamp and radiator grille.
- Changed the location of front PAS sensor.

Modification basis	
Application basis	
Affected VIN	



7810-04	Windshield Wiper Blade
Old	New
	
- Changed the aero-blade material (from steel to rubber).	

7850-11	Outside Rearview Mirror
Old	New
	
- Introduced the turn signal lamp on outside rearview mirror.	

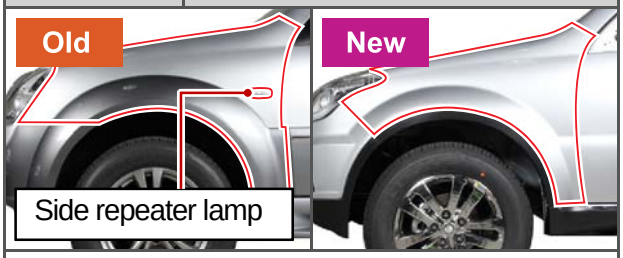
8310-23	Front Combination Lamp
Old	
New	
- Front fog lamp and turn signal lamp have been integrated in combination lamp assembyl.	

6110-01	Hood Panel
Old	New
	
- Changed the hood panel design.	

Modification basis	
Application basis	
Affected VIN	

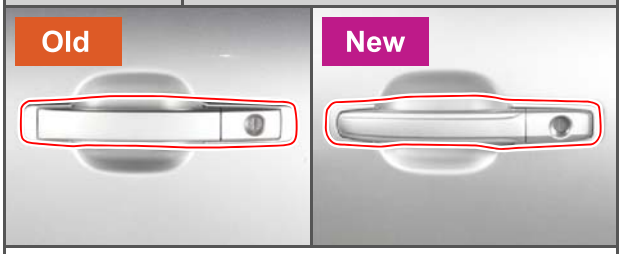
▶ Side

5720-03	Fender Panel & Side Repeater Lamp



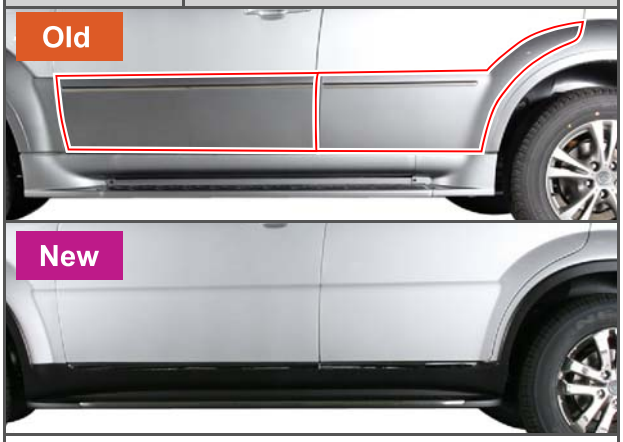
- Changed the fender panel design according to the changes of head lamp and front bumper.
- Moved the side repeater lamp to the outside rearview mirror.

7110-10	Door Outside Handle

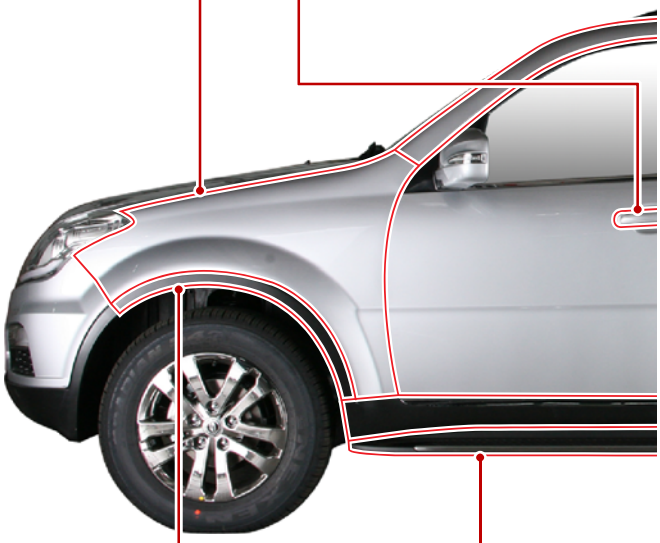


- Changed the door outside handle design.

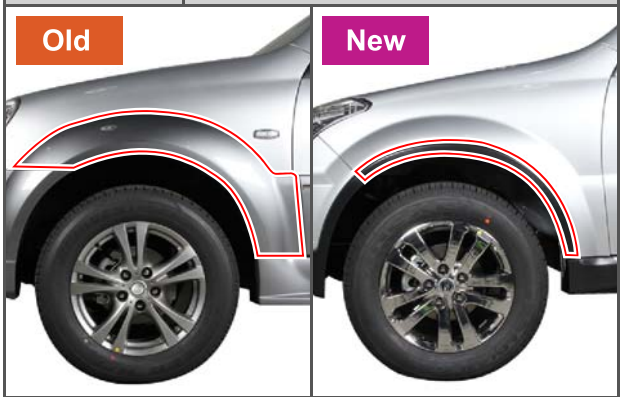
7930-11	Door Garnish



- Deleted the front and rear door garnishes.

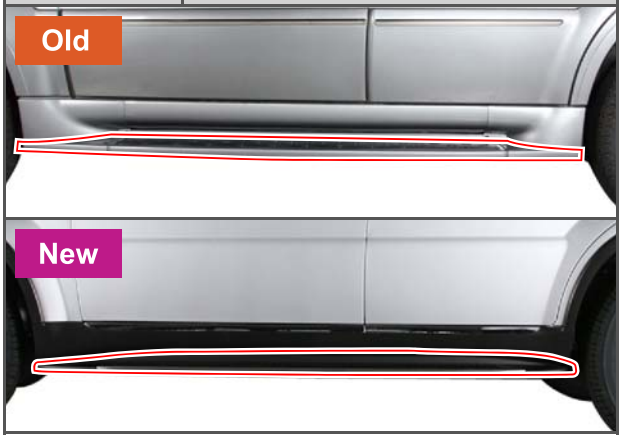


7931-06	Front Wheel Arch Garnish



- Changed the front wheel arch garnish design.

7931-20	Side Lower Step



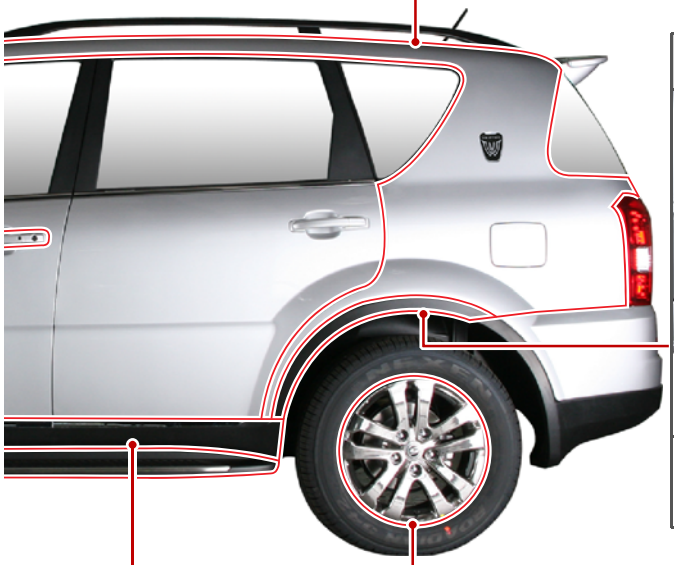
- Changed the side lower step design.

Modification basis	
Application basis	
Affected VIN	

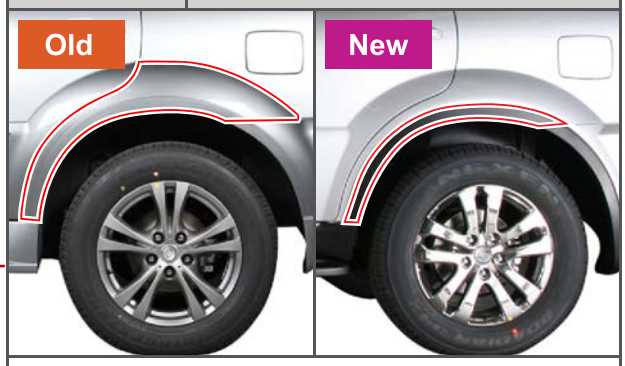
5210-18	Side Outer Rear Panel



- Changed the side outer rear panel design according to the changes of rear combination lamp.



7931-09	Rear Wheel Arch Garnish



- Changed the rear wheel arch garnish design.

7931-01	Side Sill Garnish

Old



New



- Changed the garnish design (from independent type to integrated type).

4170-34	Wheel

Sputtering type



Diamond cut type



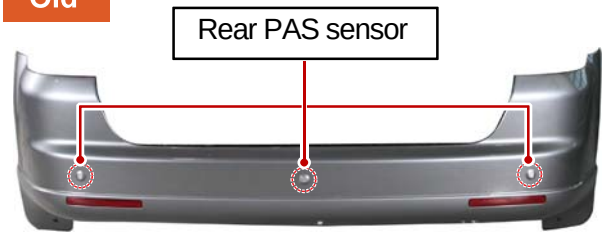
- Added the wheel types (sputtering type & diamond cut type). Standard wheel: Alloy wheel
- Unify the wheel & tire specification (255/60R18)

▶ Rear Side

8912-26	Audio Antenna
Old 	New 
- Changed the antenna type from shark type to pole type.	



7950-39	Quarter Badge
	
- Installed the brand logo on LH rear quarter panel (Rexton W).	

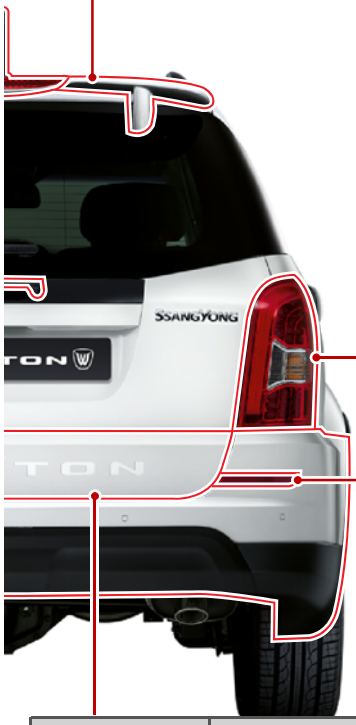
7881-01	Rear Bumper and Rear PAS Sensor
Old 	New 
- Changed the rear bumper design. – Added additional rear PAS sensor (3→4).	

Modification basis	
Application basis	
Affected VIN	

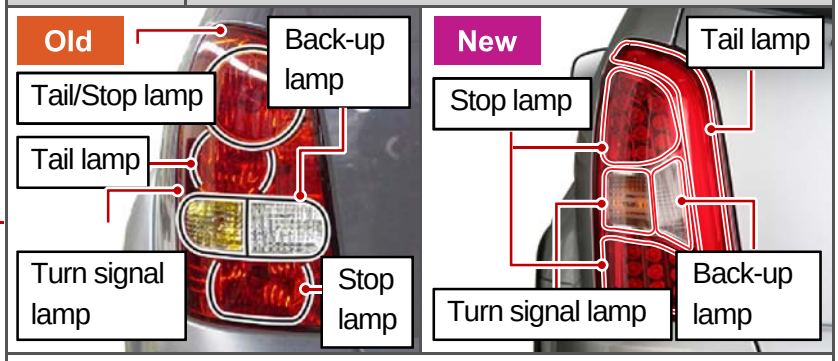
7940-02	Spoiler



- Added the wing type rear spoiler.



8320-01	Rear Combination Lamp



- Changed the rear combination lamp design and functions.
- Changed the stop lamp and tail lamp to LED type.

7940-34	Tailgate Lower Garnish



- Changed the tailgate lower garnish design.

7880-13	Reflex Reflector



- Changed the reflex reflector according to the changes of rear bumper.

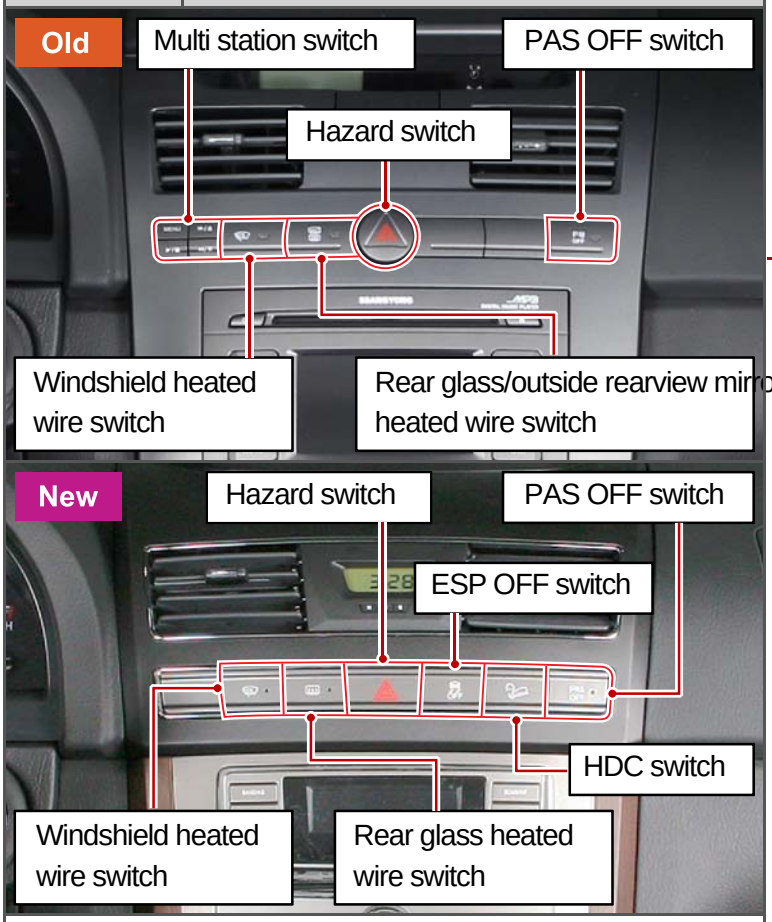
2. INTERIOR

7610-01	Steering Wheel and Center Fascia Panel



- Changed the center fascia panel design.
- Changed the color of steering wheel wood grain.

8511-50	Center Fascia Switch and Bezel

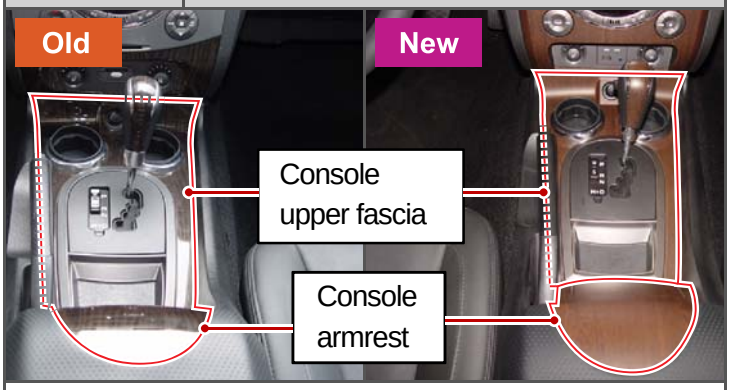




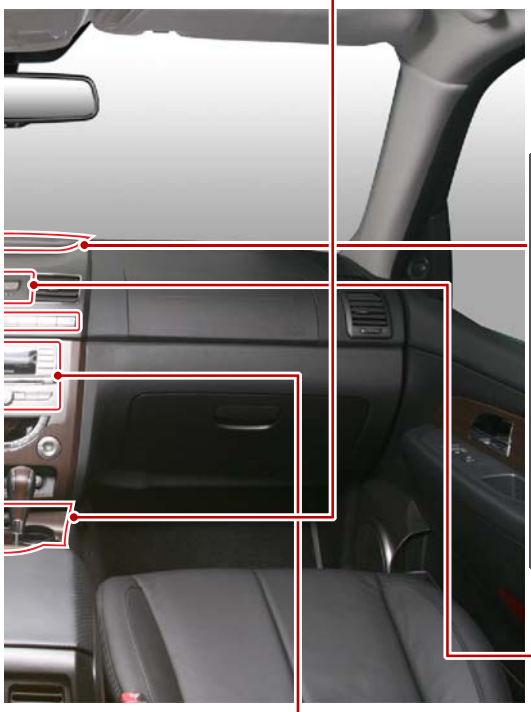
- Changed the center fascia design, switches and location.
- Changed to independent type switch from integrated type switch.
- Introduced the ESP OFF and HDC switch.

Modification basis	
Application basis	
Affected VIN	

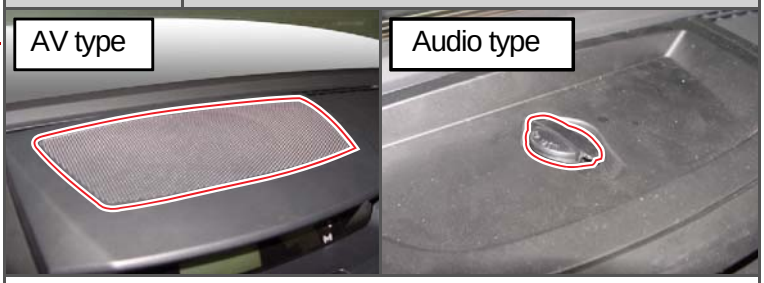
7632-00	Console Upper Fascia & Console Armrest



- Changed the color of console upper fascia and console armrest wood grain.



8510-30	Power Outlet Socket



- For audio type, the power outlet is added on the top of center fascia panel.

8912-01	Audio

Old



New



- Changed the audio type (added Bluetooth hands-free function).

Digital Clock

Old



New



- Deleted the multi-station and added the digital clock.

7410-03	Front Seat

Old



New



- Changed the seatback and seat cushion design.

7410-12	Front Headrest

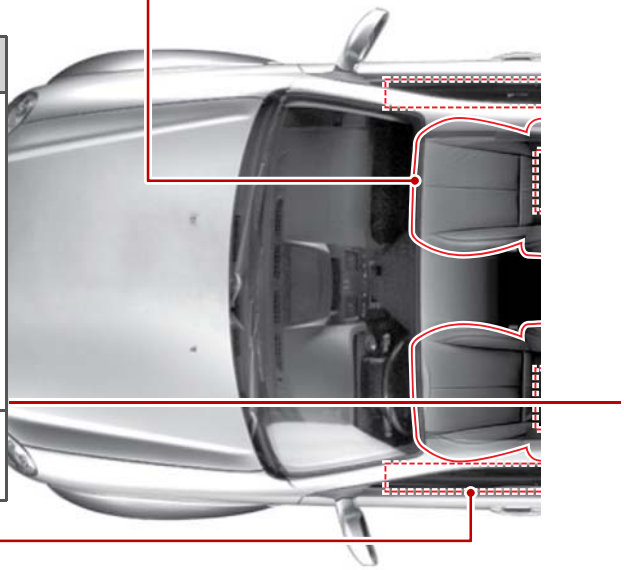
Old



New



- Changed the front headrest design.
- Changed the tilting type from swing type to sliding type.



7115-01	Door Panel

Old



New



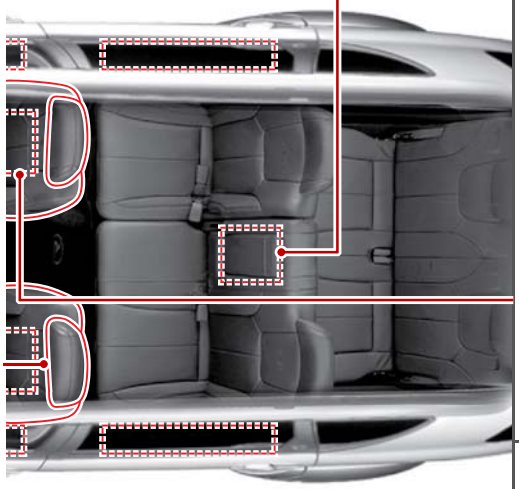
- Changed the front headrest design.
- Changed the color of front/rear door panel wood grain.

Modification basis	
Application basis	
Affected VIN	

7510-05	Rear Center Armrest



- Changed the rear armrest design.



7410-24	Front Seat Back-board



- Changed the seat back-board and seatback pocket design.

7410-05	Front Seat Cover Shield



- Changed the front seat cover shield from integrated type to split type.

Modification basis	
Application basis	
Affected VIN	

3. ELECTRIC SYSTEM

8010-01	Instrument Cluster

Old



New



- Added TPMS related warning lamp and indicator.

8410-32	ICM Box

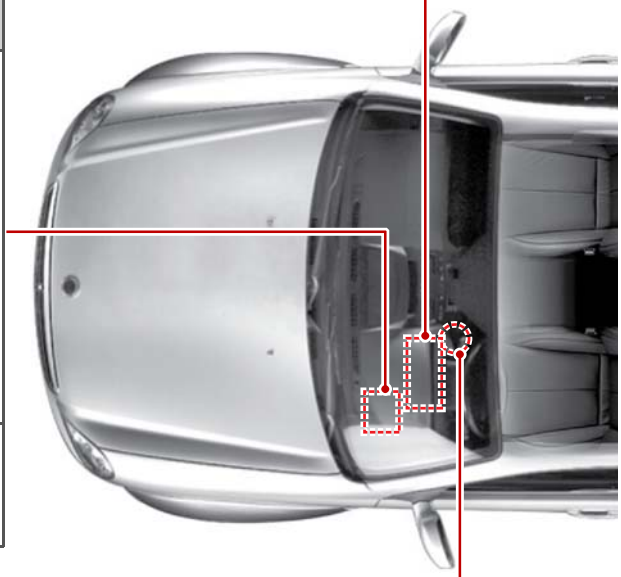
Old



New



- Deleted the hazard lamp relay and added some relays (rear side seat warmer, blower, rear washer/wiper)



7010-03	Blanking Key

Old



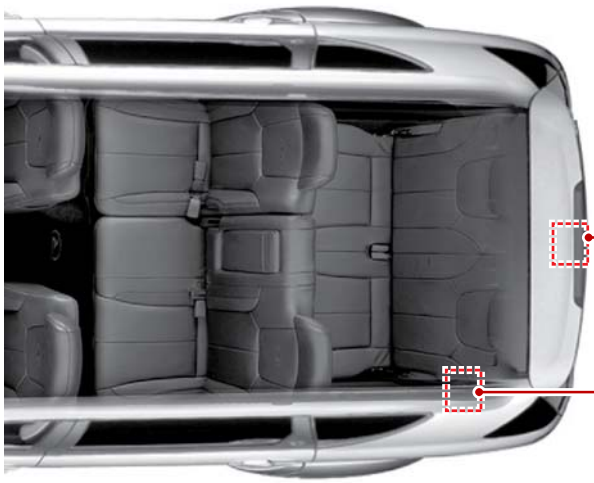
New



- Changed mechanical key design.

Modification basis	
Application basis	
Affected VIN	

8790-03	PAS Sensor
Old	New
	
- Changed the locking type from spring type to holder type.	



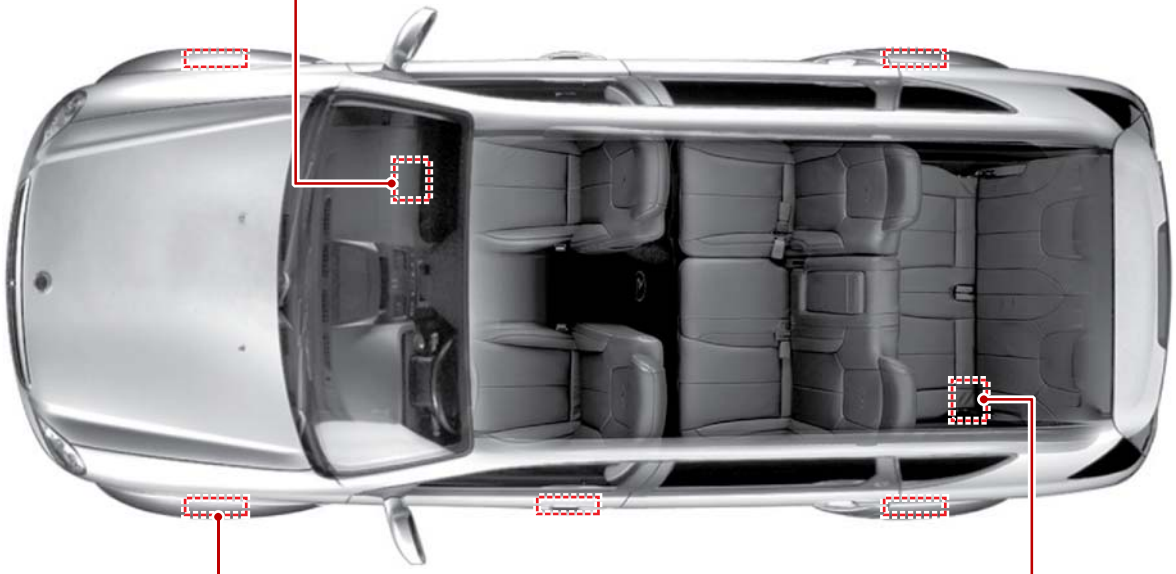
8790-01	PAS Unit
Old	New
	
- Changed the PAS sensor operating voltage (12V→8V) and added one PAS sensor (rear center).	

4. ENGINE AND CHASSIS

1491-01	Engine Control Unit



- Changed the logic according to introduction of TPMS.



4190-06	Wheel Module



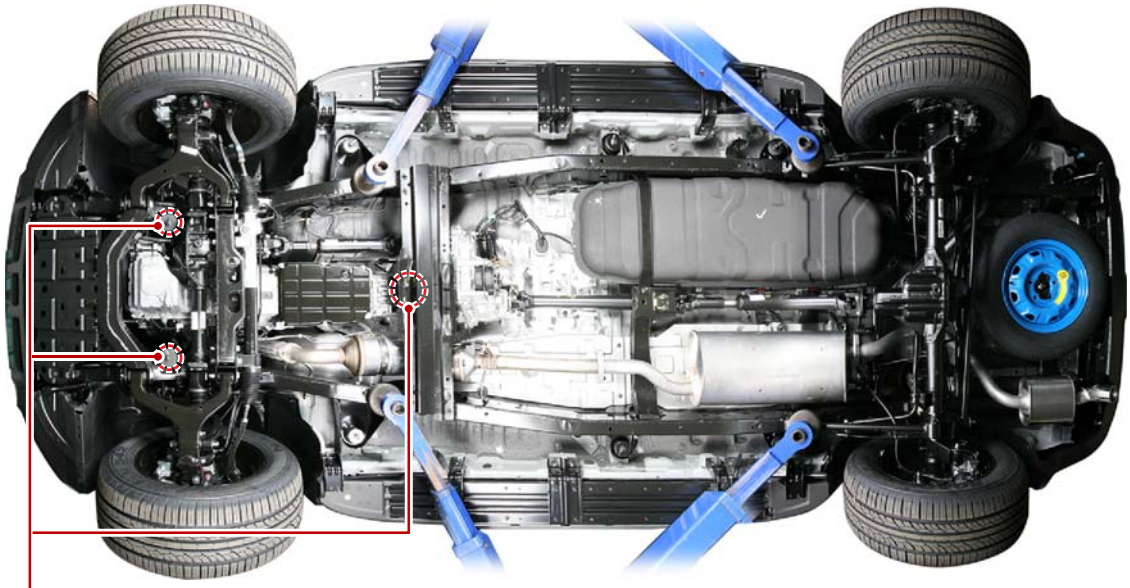
- Added the wheel module in each wheel according to introduction of TPMS.

4190-13	TPMS Unit



- Installed TPMS unit with antenna according to introduction of TPMS.

Modification basis	
Application basis	
Affected VIN	



1990-00	Engine Mounting Insulator

Old

LH	RH	Rear
		

New

LH	RH	Rear
		

- Adopted the optimized engine mounting insulators based on system analysis and on-board test.

Memo

ENGINE GENERAL

0000-00

GENERAL INFORMATION

1. LOCATION OF MAJOR SENSORS ON ENGINE

▶ **Major sensors and devices**

Injector



Glow plug

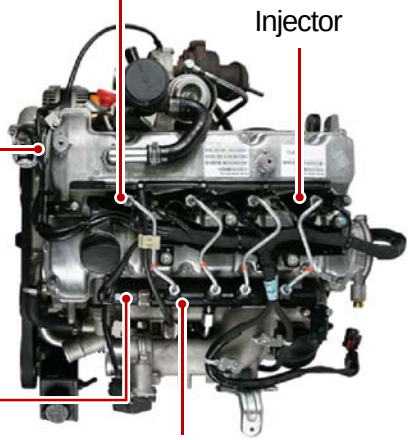


Common rail



Camshaft position sensor





Boost pressure sensor



Fuel rail sensor (common rail)

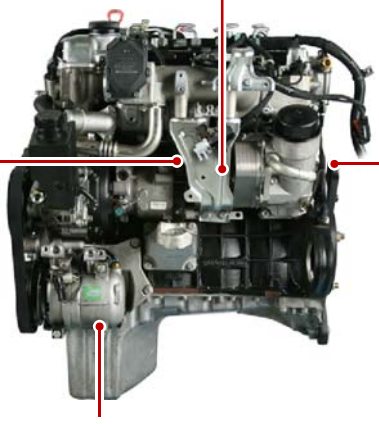


Turbocharger vacuum modulator



Knock sensor (one) and water temperature sensor



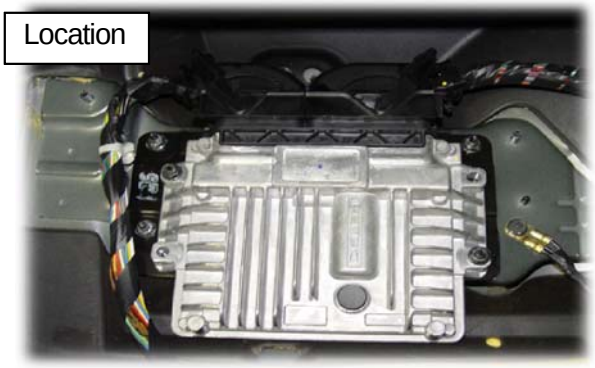


Crankshaft position sensor



Modification basis	
Application basis	
Affected VIN	

2. ENGINE ACCESSORIES RELATED TO ECU

Engine ECU	
	Location 

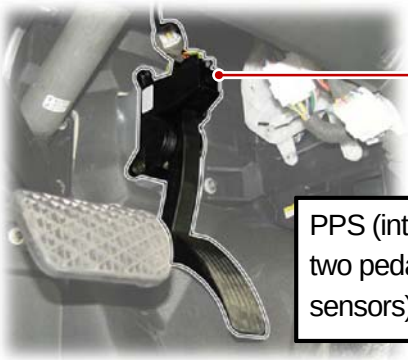


HFM sensor (HFM 6.0)


To control the engine more precisely, new functions such as digital signal for intake air mass have been introduced.

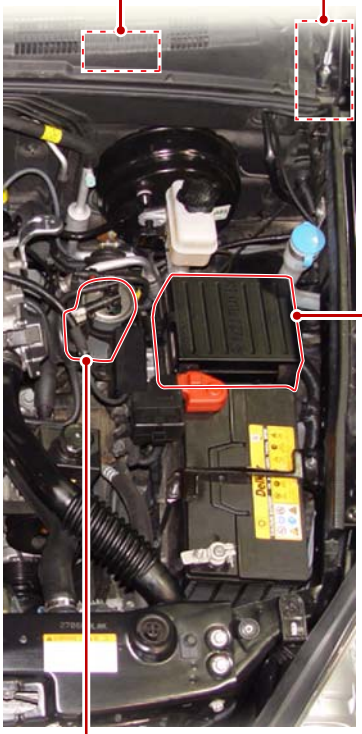
Modification basis	
Application basis	
Affected VIN	

Accelerator pedal module

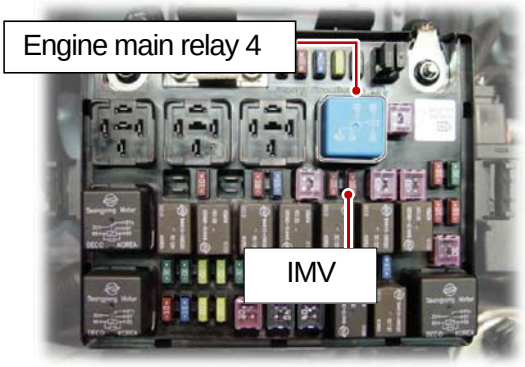


Fuse

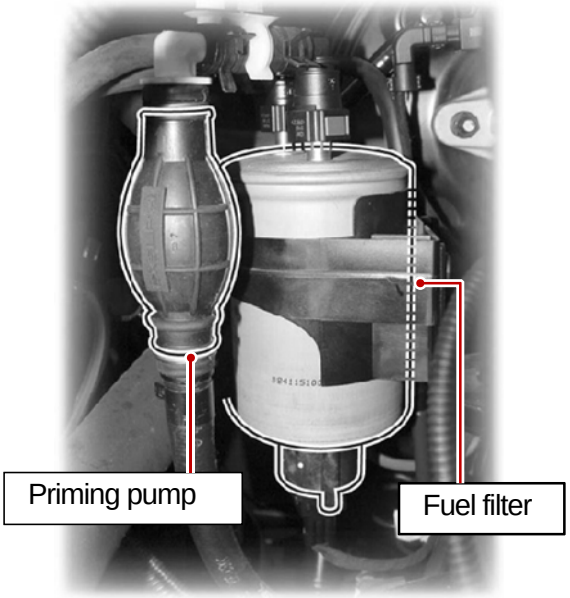




Relay



Engine main relay 4



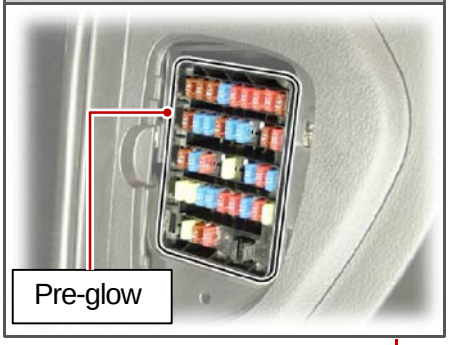
Modification basis	
Application basis	
Affected VIN	

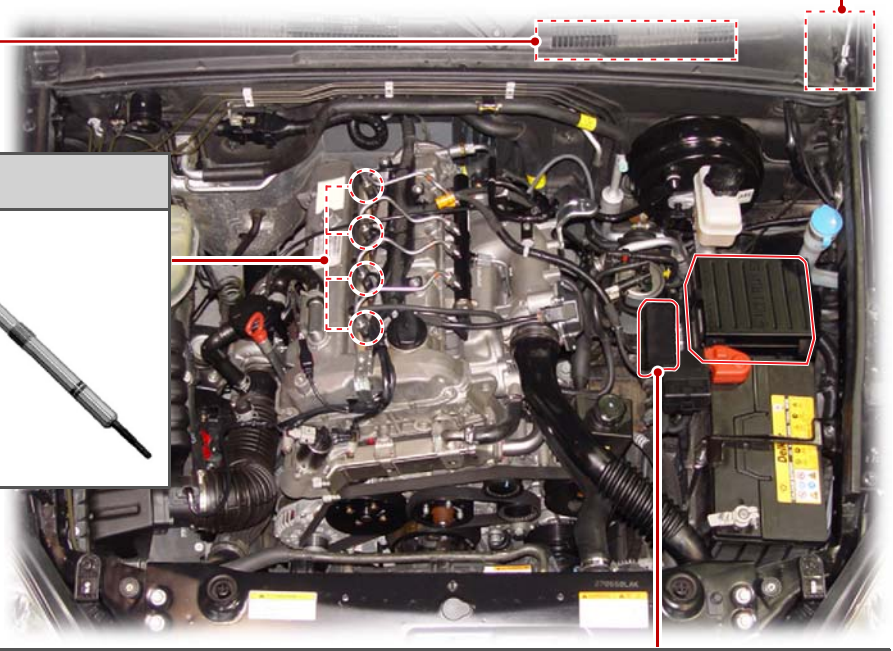
3. LAYOUT OF PRE-GLOW SYSTEM

Pre-glow indicator (on instrument cluster)

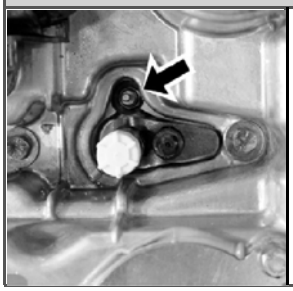


Fuse





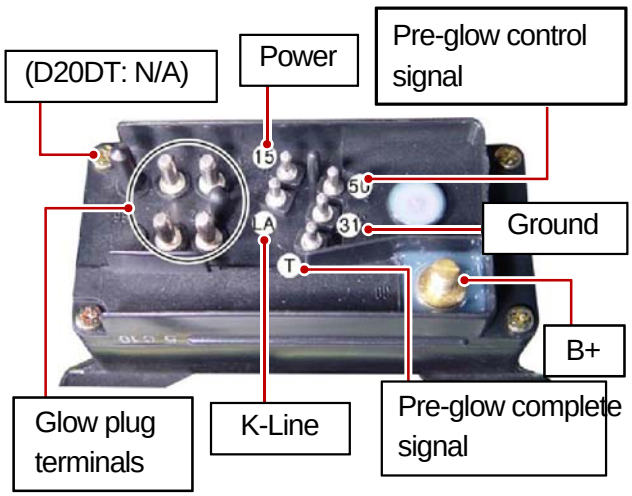
Glow plug





Pre-glow control unit

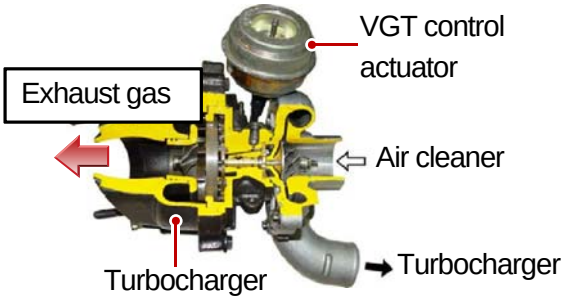




Modification basis	
Application basis	
Affected VIN	

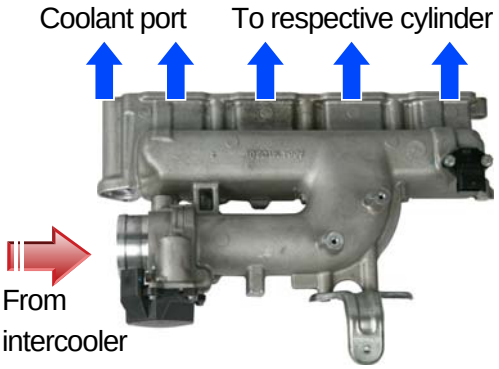
4. LAYOUT OF INTAKE SYSTEM

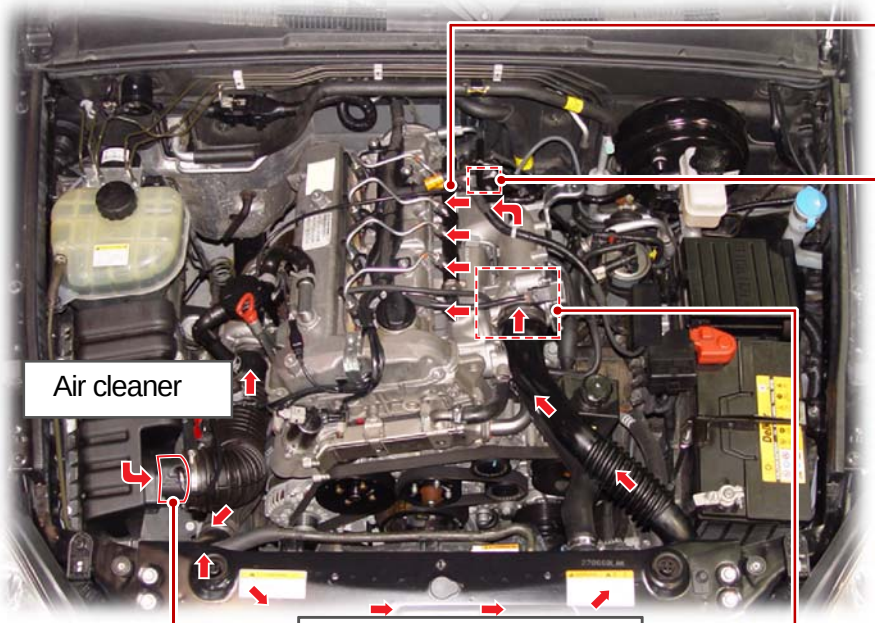
Turbocharger



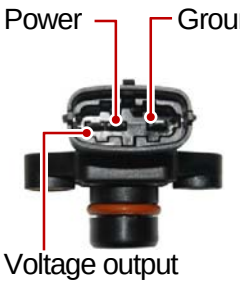
Supplying the compressed air by turbocharger

Intake manifold



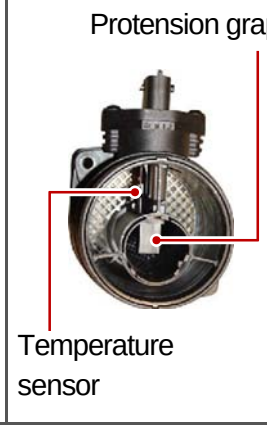


Boost pressure sensor



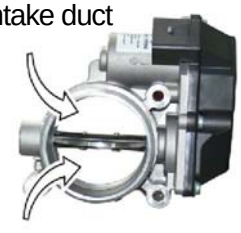
HFM sensor (HFM 6.0)





Throttle body

Engine operating: Flap open



Engine stopped: Flap closed

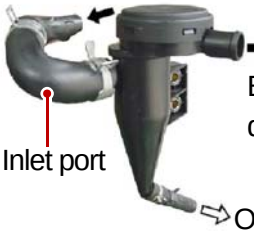


Modification basis	
Application basis	
Affected VIN	

5. LAYOUT OF EXHAUST SYSTEM

PCV oil separator

Cylinder head cover (oil + gas)

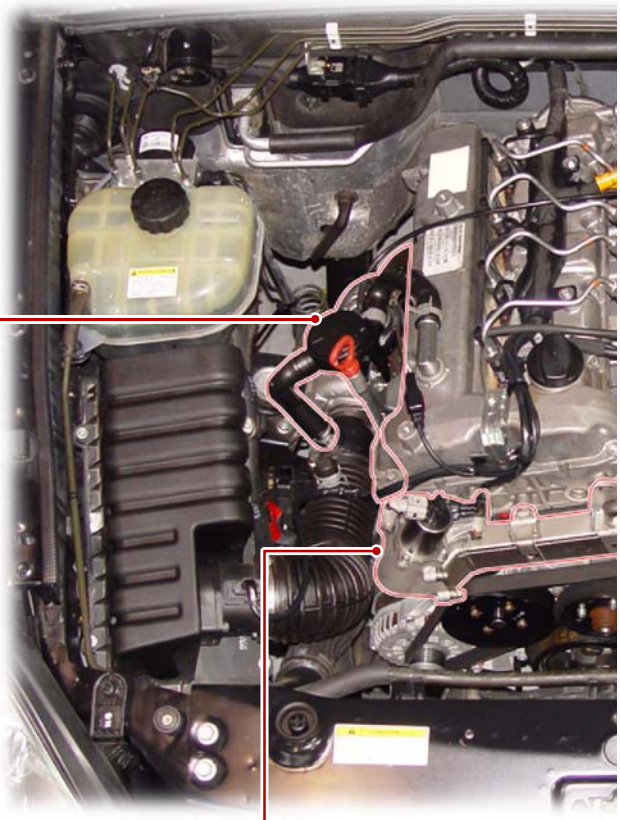


Blow-by gas (air duct hose)

Inlet port

Oil (oil gauge pipe)

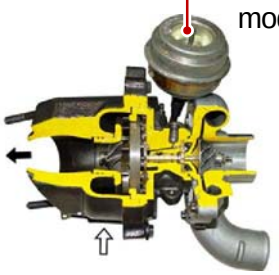
The first separation will happen when blow-by gas passes through baffle plates in cylinder head cover. Then oil and gas will be separated due to cyclone effect after entering the oil separator inlet port. Separated oil returns to oil pan via oil drain port and the gas will be burnt again after entering the combustion chamber through air duct hose via PCV valve that opens/closes due to pressure differences between the intake side and crankcase.



VGT Turbocharger

Vacuum modulator

To exhaust pipe (DOC)



From exhaust manifold

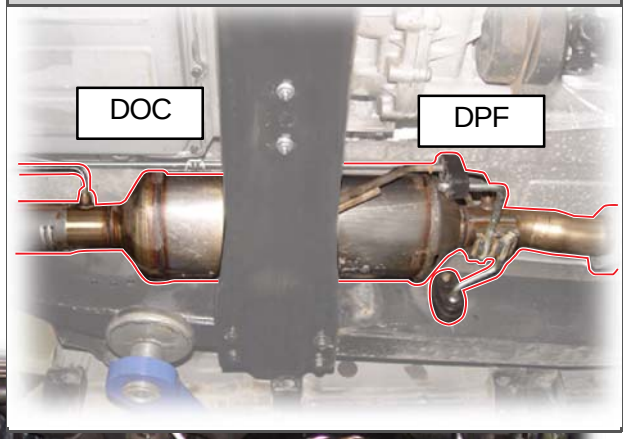
E-EGR Valve



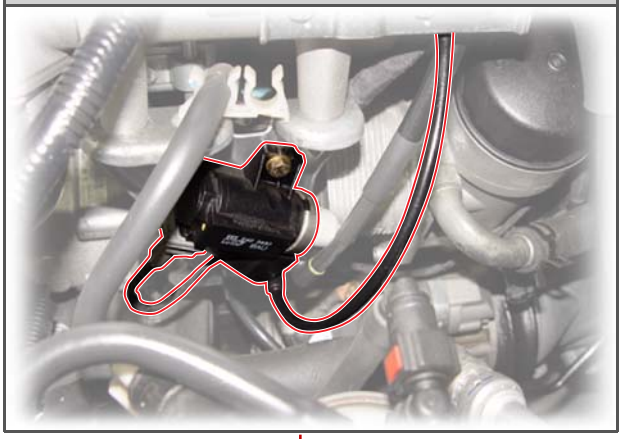
EGR cooler

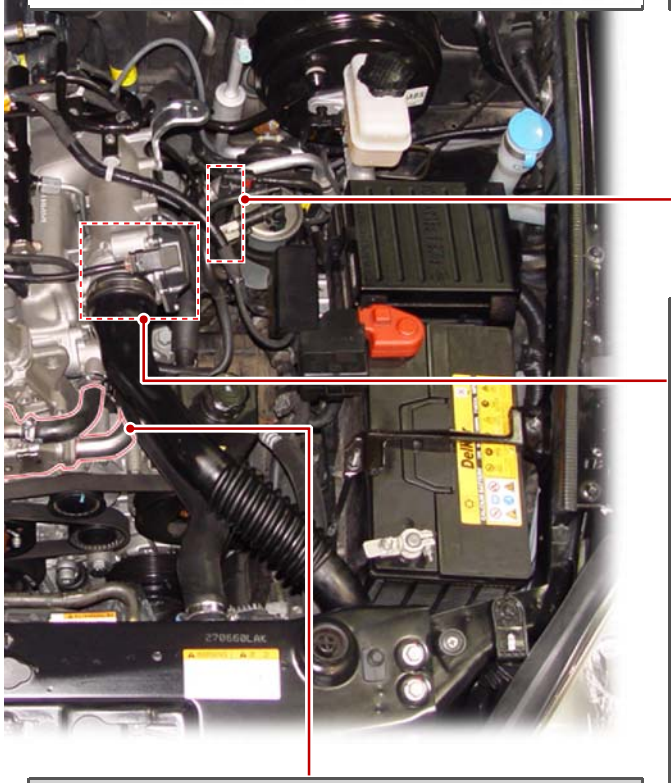
Modification basis	
Application basis	
Affected VIN	

CDPF

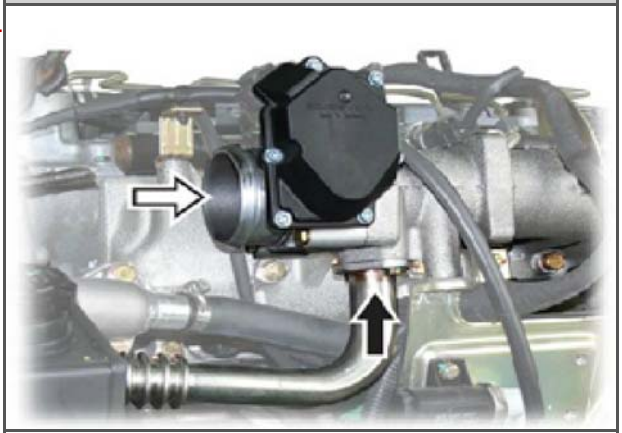


Turbocharger vacuum modulator





Throttle body



EGR cooler

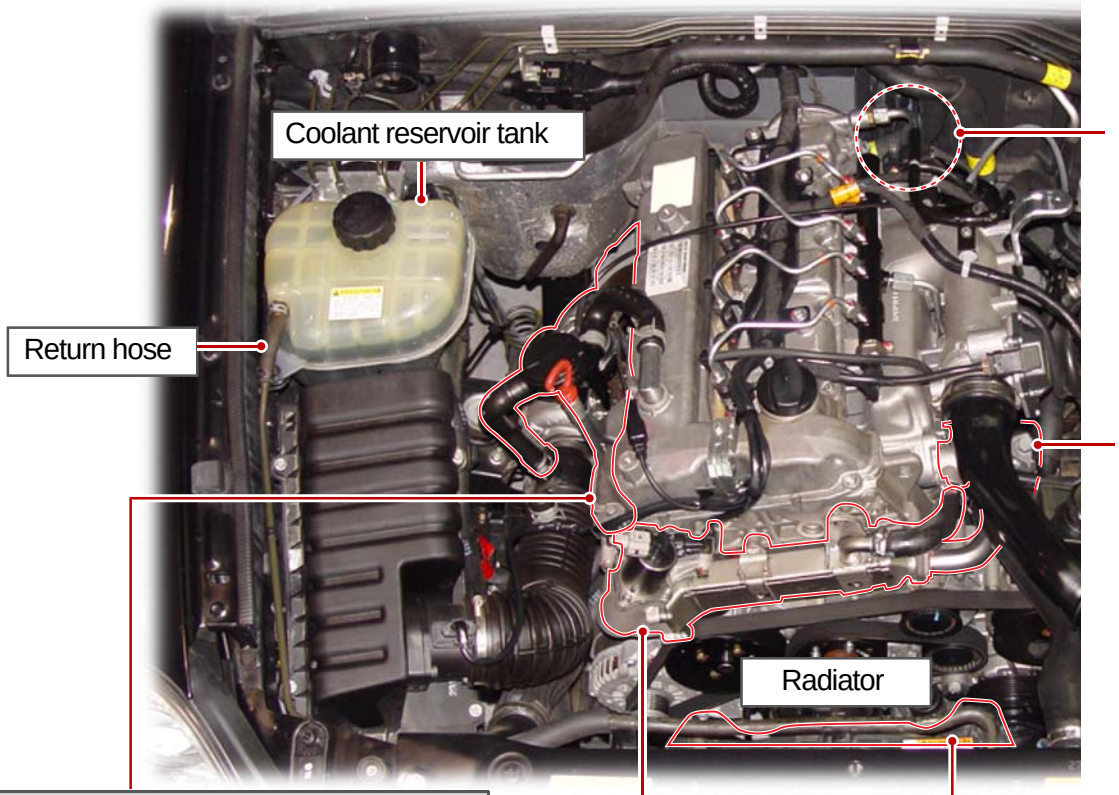


EGR pipe: Exhaust gas passage for recirculating the exhaust gas

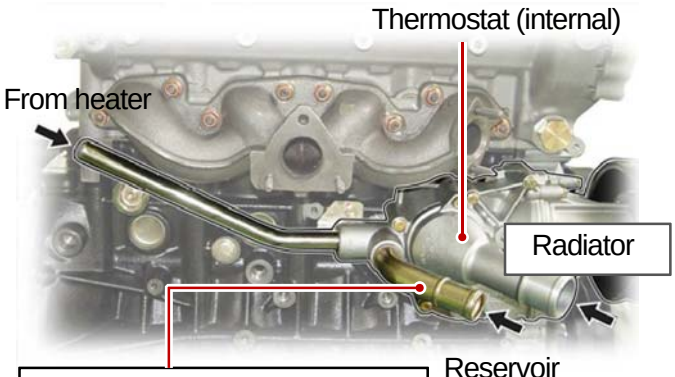


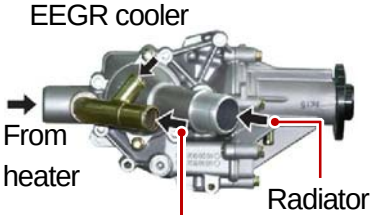
Modification basis	
Application basis	
Affected VIN	

6. LAYOUT OF COOLING SYSTEM

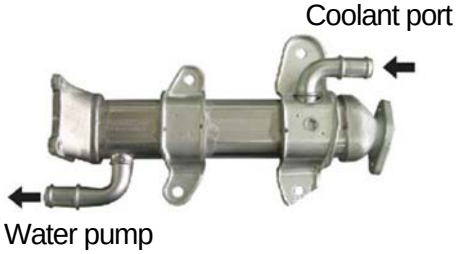


Water pump and pipe

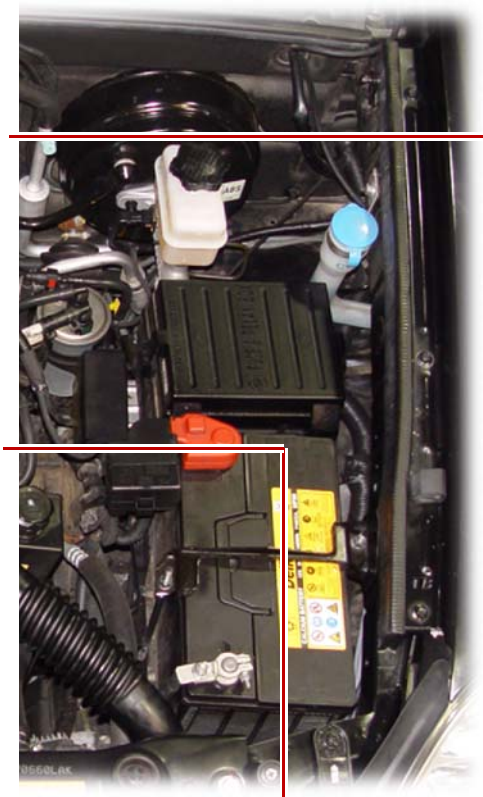




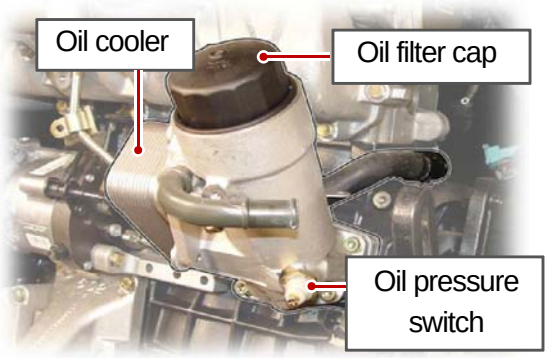
EGR cooler

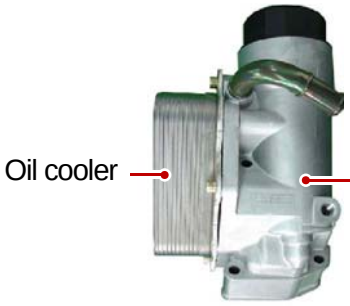


Modification basis	
Application basis	
Affected VIN	

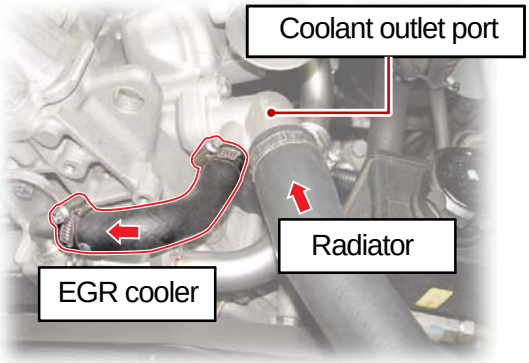


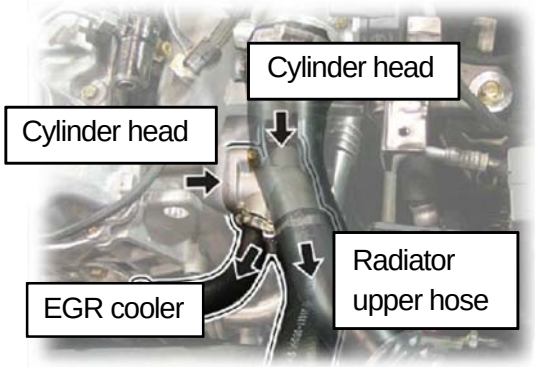
Oil cooler



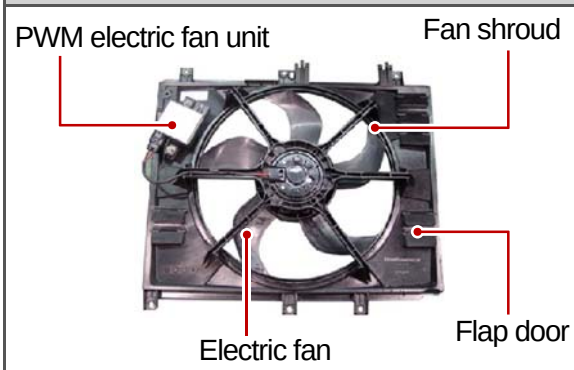


Coolant port





PWM electric fan



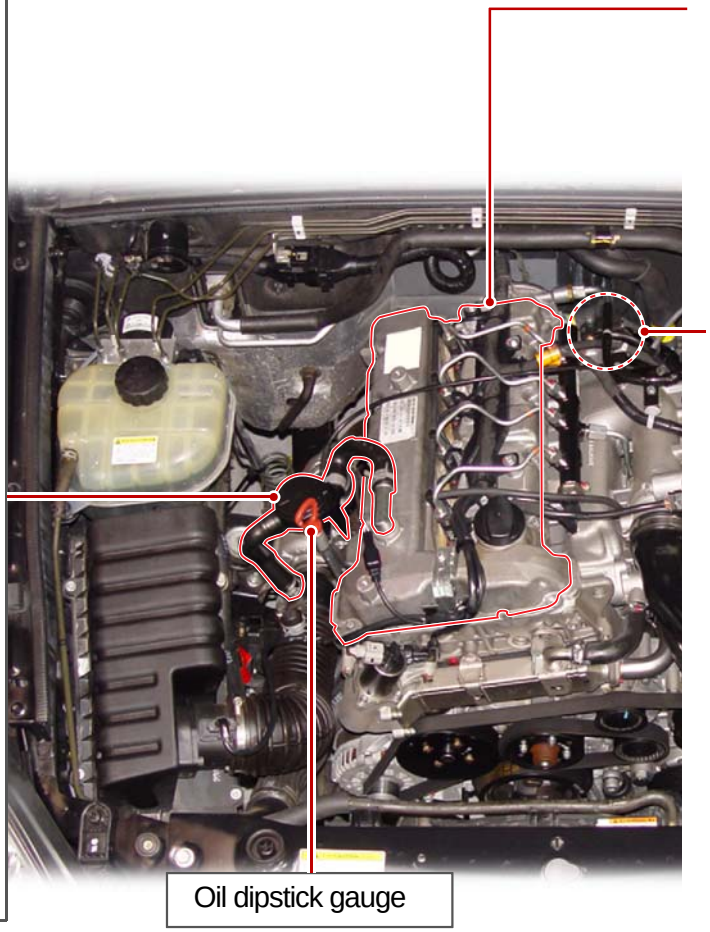
Modification basis	
Application basis	
Affected VIN	

7. LAYOUT OF LUBRICATION SYSTEM

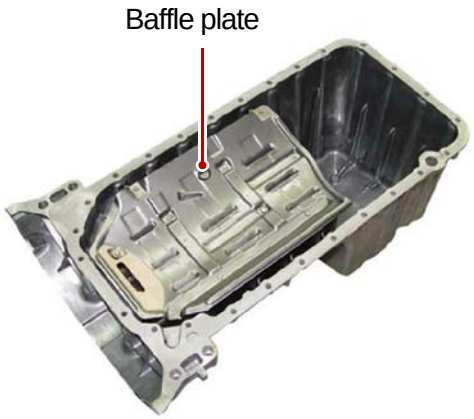
Heavy-duty PCV oil separator



The first separation will happen when blow-by gas passes through baffle plates in cylinder head cover. Then oil and gas will be separated due to cyclone effect after entering the oil separator inlet port. Separated oil returns to oil pan via oil drain port and the gas will be burnt again after entering the combustion chamber through air duct hose via PCV valve that opens/closes due to pressure differences between the intake side and crankcase.



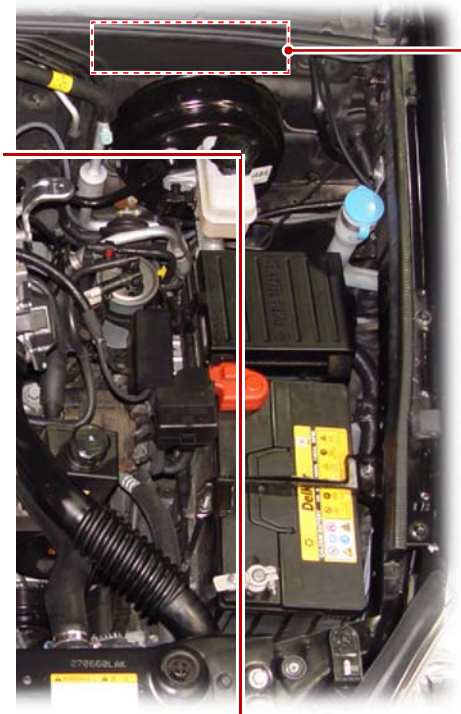
Oil pan and baffle plate (integrated type)



Oil strainer



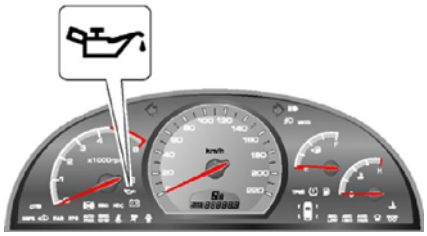
Modification basis	
Application basis	
Affected VIN	



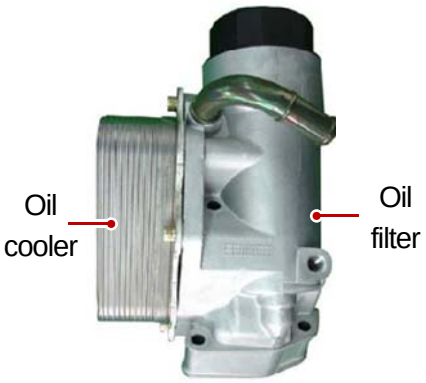
Cylinder head cover



Low oil pressure warning lamp (on instrument cluster)



Oil filter and oil cooler



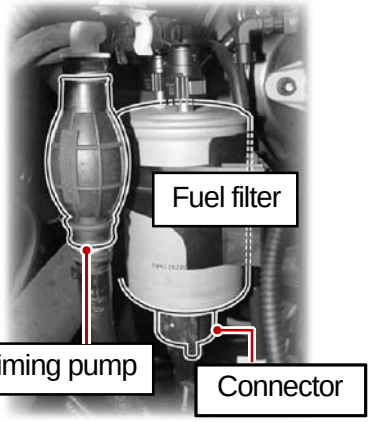
8. LAYOUT OF FUEL SYSTEM

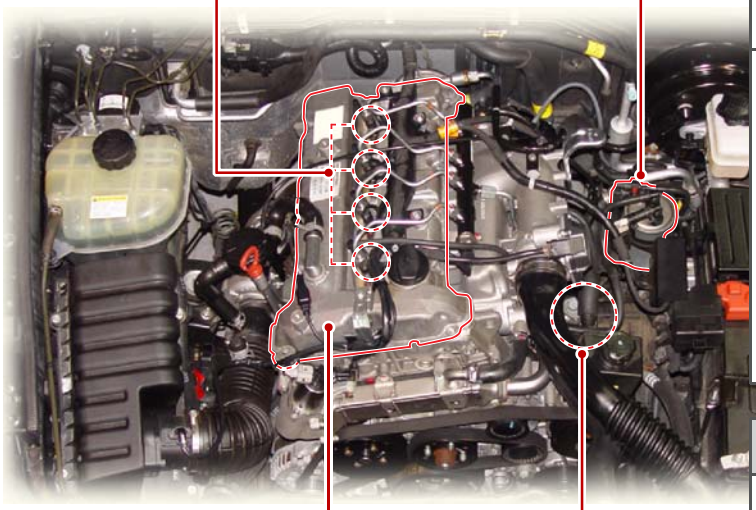
▶ **Components**

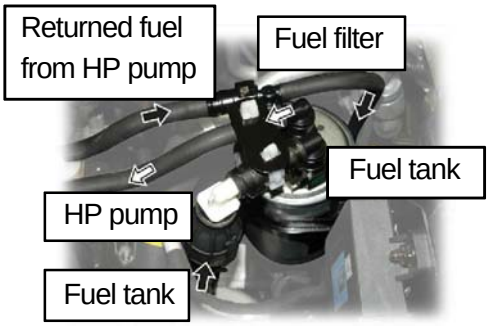
Injector



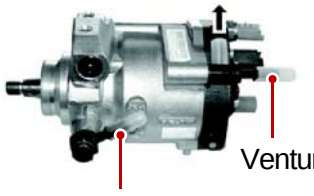
Fuel filter and priming pump



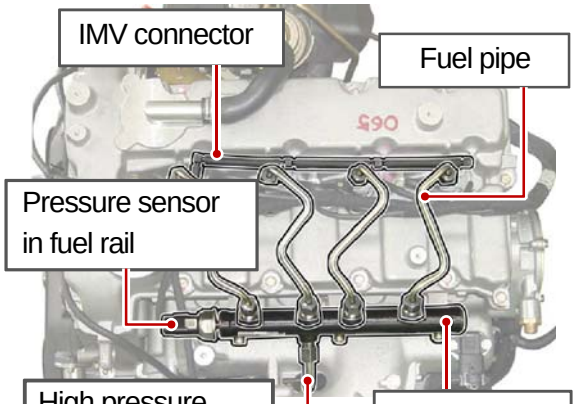


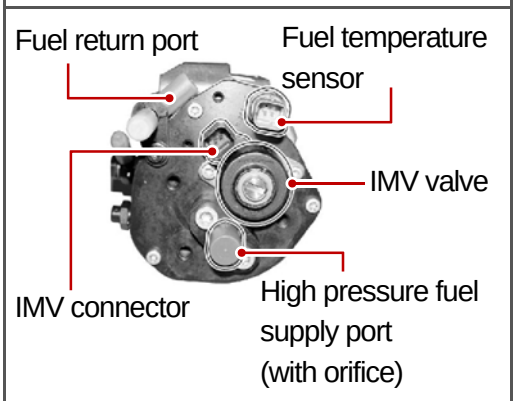


HP pump



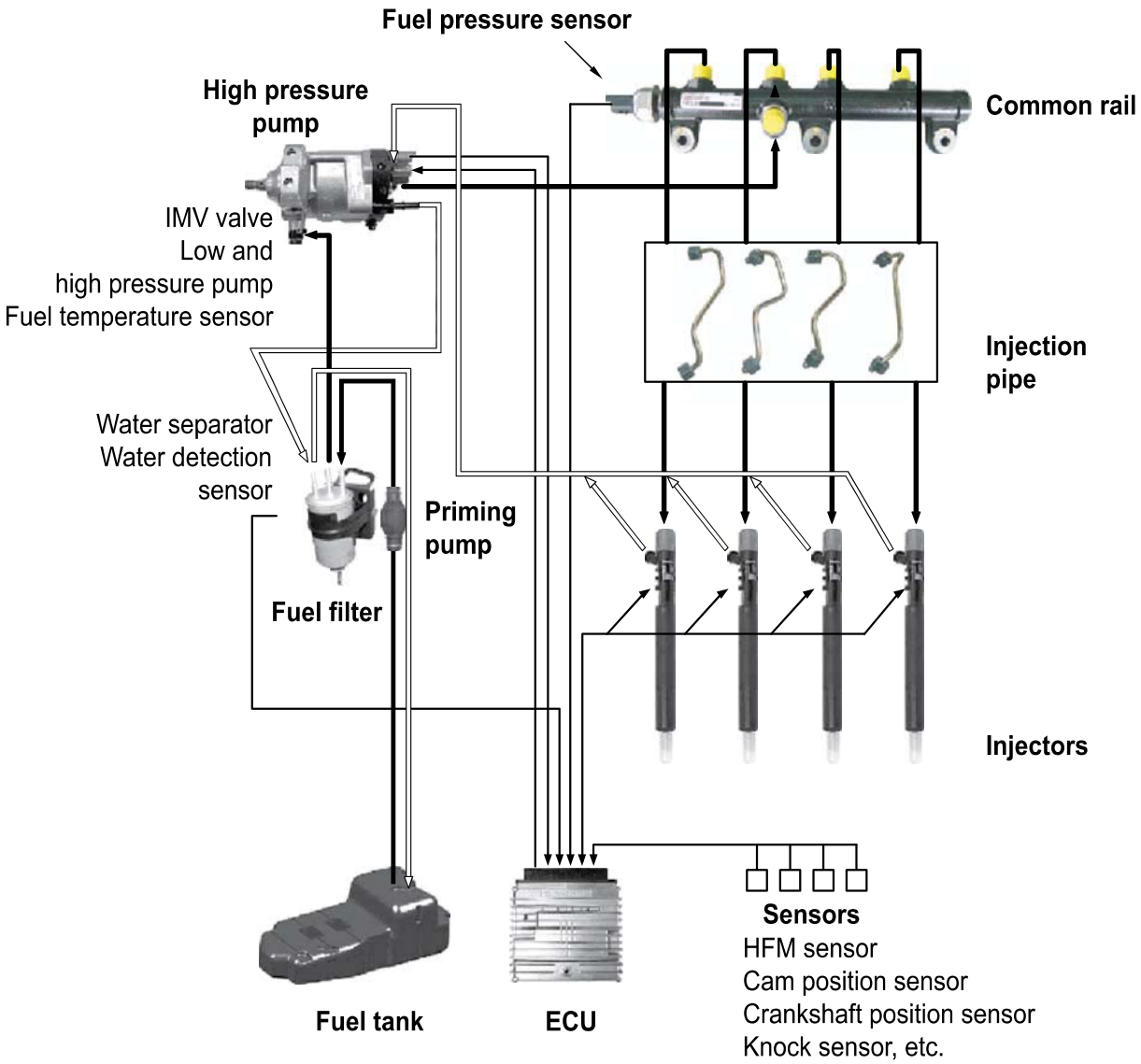
IMV connector





Modification basis	
Application basis	
Affected VIN	

▶ Schematic Diagram



Components

- High pressure fuel pump
- Fuel injectors
- Fuel rail
- Electronic control unit(ECU)
- Fuel pressure sensor
- Various sensors and actuators

: Supply line
: Return line
: ECU connecting line

Memo

ENGINE ASSEMBLY

2112-01

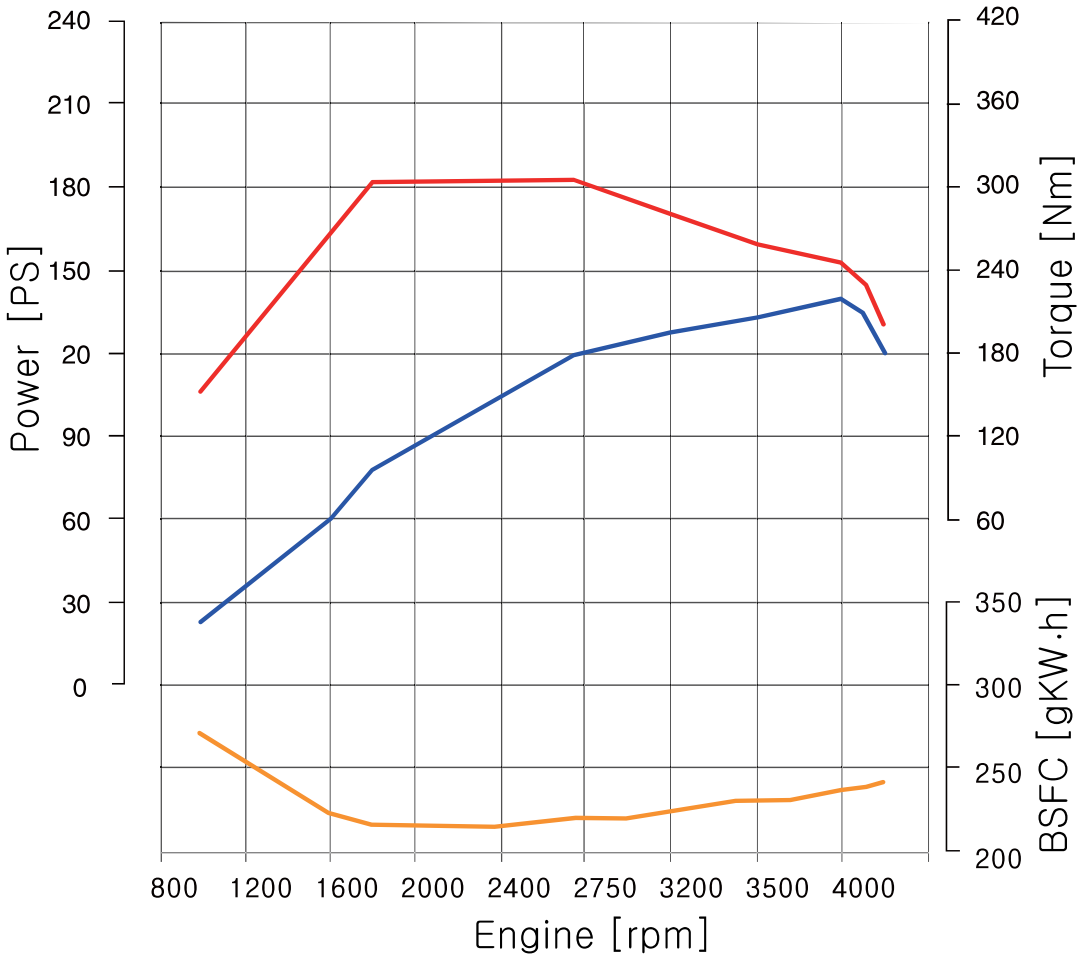
GENERAL INFORMATION

1. SPECIFICATIONS

Description			Unit	D20DT
Start motor	Type		-	WP220
	Output (Capacity)		Kw	2.2
	Performance test without load(12V)		A	160
	Pinion gear rotating speed without load		rpm	4500
	Pinion gear rotating speed with load		rpm/A	1700/430
	Length of brush		mm	18
	Diameter of armature		mm	55
	Run-out of armature		mm	0.1
	Depth of segment groove		mm	21.7
Alternator	Type		-	CS128D
	Output (Capacity)		V/A	with PTC : 12V-140A
	Regulator type		-	←
	Regulator voltage		V	14.6
	Length of brush	Length	mm	12.5
		Numbers	-	2
		Wear limit	mm	7
Battery	Type		-	MF
	Capacity		AH	12V-90AH
Glow plug	Discharge capacity (rechargeable)		TC	160
	Type		-	Shield type
	Operating voltage		-	11.5
	Wiring connection		-	Parallel
	Pre-glow time		sec	60~90

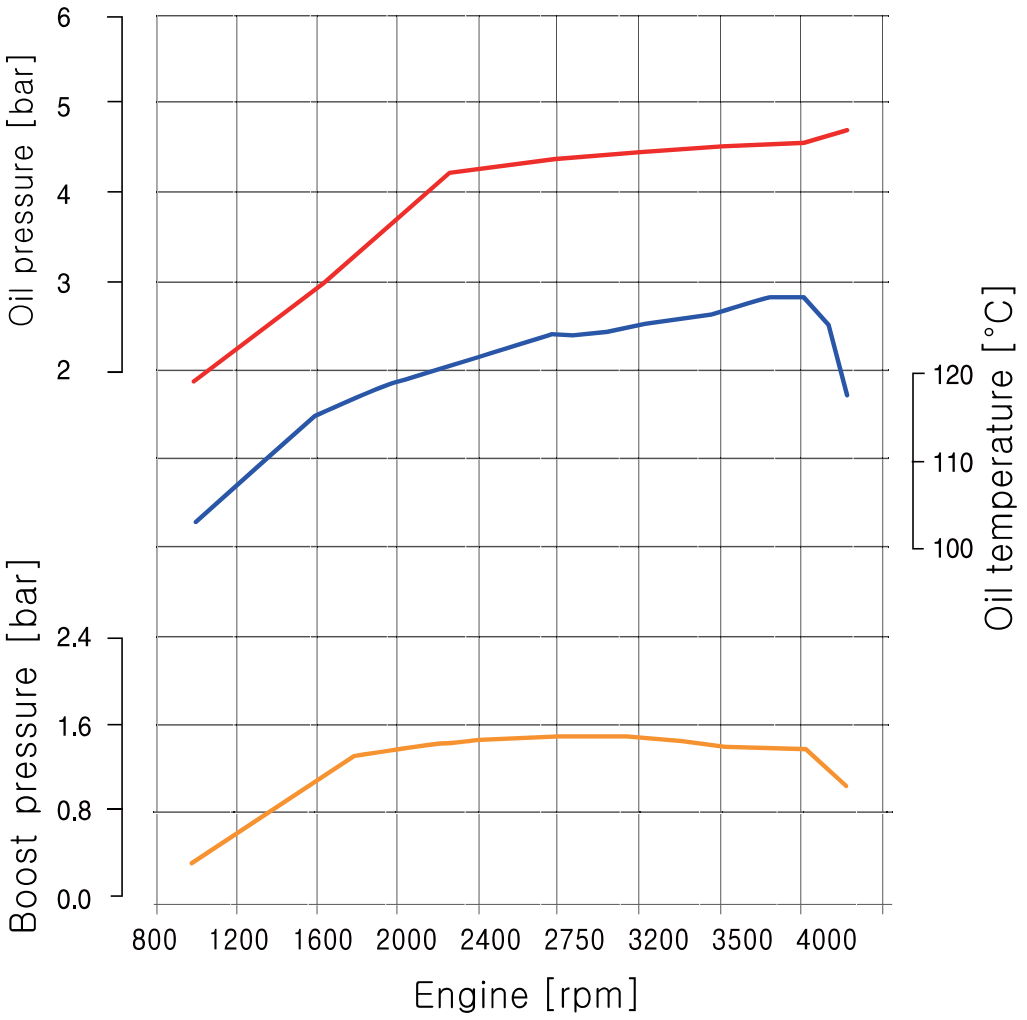
2) Engine Performance Curve

▶ **Output and Torque**



Modification basis	
Application basis	
Affected VIN	

▶ Oil Temperature/Pressure and Boost Pressure



Modification basis	
Application basis	
Affected VIN	

2. SPECIAL SERVICE TOOLS

1) Using the Special Service Tools on Engine

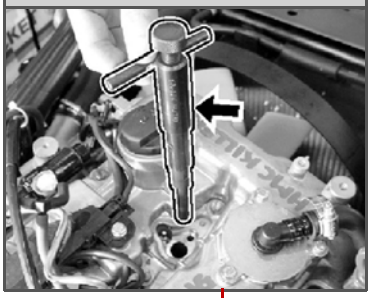
Injector puller



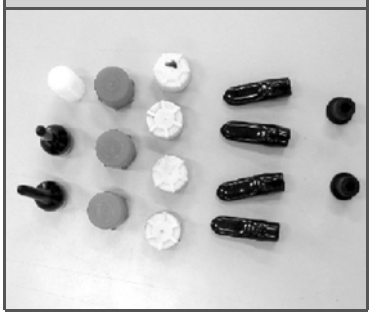
Glow plug socket



Injector washer puller



Sealing caps
(fuel line)





HP remover/installer



High pressure pipe
remover/installer



Cylinder head bolt wrench



Modification basis	
Application basis	
Affected VIN	

3. TIGHTENING TORQUE

Name	Bolt Size	Quantity	Tightening Torque (Nm)	
			D20DT (EURO 4)	D20DT
Main bearing cap	M11 x 67	10	55 ± 5 120° ± 10°	55 ± 5 120° ± 10°
Connecting rod cap	M9 x 51	8	40 ± 5 90° ± 10°	40 ± 5 90° ± 10°
Rear cover	M6 x 20	6	10 ± 1	10 ± 1
Oil pump	M8 x 35SOC	3	25 ± 2.5	25 ± 2.5
T.G.C.C	M6 x 40	6	10 ± 1	10 ± 1
	M6 x 60	3	10 ± 1	10 ± 1
	M6 x 70	2	10 ± 1	10 ± 1
Flywheel	M10 x 22	8	45 ± 5 90° ± 10°	45 ± 5 90° ± 10°
Crankshaft hub	M20 x 85	1	200 180° ± 10°	200 180° ± 10°
Oil pan	M6 x 20	20	10 ± 1	10 ± 1
	M6 x 35	3	10 ± 1	10 ± 1
	M6 x 85	3	10 ± 1	10 ± 1
	M8 x 40	4	25 ± 2.5	25 ± 2.5
High pressure pump mounting bolt	M8 x 55	3	25 ± 2.5	25 ± 2.5
High pressure pump main nut (intershaft)	M14 x 1.5	1	65 ± 5	65 ± 5
Cylinder head	M8 x 25	2	25 ± 2.5	25 ± 2.5
	M8 x 50	2		
	M10 x 158	1	85 ± 5 270° + 10°	85 ± 5 270° + 10°
	M10 x 177	9		
Camshaft sprocket (Intake)	M11 x 40	1	25 ± 2.5 90° ± 10°	25 ± 2.5 90° ± 10°
Camshaft sprocket (Exhaust)				
Chain tensioner	M24	1	65 ± 5	65 ± 5
Auto tensioner	M12 x 90 (UP)	1	82 ± 6	82 ± 6
	M8 x 45 (LOWER)	1	32 ± 3	32 ± 3
Water pump assembly	M6 x 50	7	10 ± 1	10 ± 1
Water pump pulley	M6 x 10	4	10 ± 1	10 ± 1
Hot water inlet pipe assembly	M6 x 12	2	10 ± 1	10 ± 1
Alternator bracket	M8 x 80	1	25 ± 2.5	25 ± 2.5
	M8 x 34	2	25 ± 2.5	25 ± 2.5
	M8 x 30	2	25 ± 2.5	25 ± 2.5
Alternator	M10 x 90	1	46 ± 4.6	46 ± 4.6
	M10 x 116	1	46 ± 4.6	46 ± 4.6

Name	Bolt Size	Quantity	Tightening Torque (Nm)	
			D20DT (EURO 4)	D20DT
Air conditioner compressor bracket assembly	M8 x 25	1	25 ± 2.5	25 ± 2.5
	M8 x 60	3	25 ± 2.5	25 ± 2.5
Air conditioner compressor sub bracket assembly	M6 x 16	1	10 ± 1.0	10 ± 1.0
	M8 x 20	1	25 ± 2.5	25 ± 2.5
Intake manifold	M8 x 50	5	25 ± 2.5	25 ± 2.5
	M8 x 133	5	25 ± 2.5	25 ± 2.5
Acoustic cover bracket	M6 x 16	2	25 ± 2.5	25 ± 2.5
	M8 x 105	1	25 ± 2.5	25 ± 2.5
Knock sensor	M8 x 28	1	20 ± 2.6	20 ± 2.6
Camshaft position sensor	M8 x 14	1	12 ± 1.7	12 ± 1.7
Booster pressure sensor	M6 x 20	2	10 ± 1.0	10 ± 1.0
Exhaust manifold stud bolt	M8 x 46	8	15 ± 1.5	15 ± 1.5
	M8 x 35	2	15 ± 1.5	15 ± 1.5
Exhauster manifold nut	M8	8	40 ± 4.0	40 ± 4.0
Turbo charger assembly	M8	3	25 ± 2.5	25 ± 2.5
Turbocharger hollow bolt	M10 x 1.0	1	18 ± 1.8	18 ± 1.8
Turbocharger oil feed pipe	M16 (Cylinder block side)	1	25 ± 2.5	25 ± 2.5
Turbocharger support bar (nut)	M8	1	23 ± 2.3	23 ± 2.3
Turbocharger support bar (bolt)	M8 x 20	1	25 ± 2.5	25 ± 2.5
Turbocharger return pipe	M6 x 16 (T/C side)	2	10 ± 1.0	10 ± 1.0
	M6 x 16 (Cylinder block side)	2	10 ± 1.0	10 ± 1.0
EGR valve assembly	M6 x 25	4	10 ± 1.0	10 ± 1.0
EGR-LH pipe nut	M8	2	35 ± 3.5	35 ± 3.5
EGR-RH pipe nut	M6 x 16	2	10 ± 1.0	10 ± 1.0
EGR center bolt	M6 x 16	4	10 ± 1.0	10 ± 1.0
EGR center pipe	M8 x 25	2	25 ± 2.5	25 ± 2.5
	M8 x 30	2	25 ± 2.5	25 ± 2.5
Glow plug	M5	5	15 ± 3.0	15 ± 3.0
Vacuum pump	M6 x 20	3	10 ± 1.0	10 ± 1.0
	M6 x 25	5	10 ± 1.0	10 ± 1.0
Cooling fan bracket assembly	M6 x 55	1	10 ± 1.0	10 ± 1.0
	M6 x 85	3	10 ± 1.0	10 ± 1.0
Cylinder head cover	M6 x 35	18	10 ± 1.0	10 ± 1.0
Vacuum modulator	M6 x 16	4	10 ± 1.0	10 ± 1.0

Modification basis	
Application basis	
Affected VIN	

Name	Bolt Size	Quantity	Tightening Torque (Nm)	
			D20DT (EURO 4)	D20DT
Oil dipstick tube	M6 x 16	1	10 ± 1.0	10 ± 1.0
	M8 x 35	1	25 ± 2.5	25 ± 2.5
Oil filter assembly	M8 x 55	2	25 ± 2.5	25 ± 2.5
	M8 x 125	1	25 ± 2.5	25 ± 2.5
Fuel rail assembly	M8 x 35	2	25 ± 2.5	25 ± 2.5
Injector	M6 x 60	4	10 ± 1.0 180° + 20°	10 ± 1.0 180° + 20°
Fuel pipe clip (H-C)	M14	2	40 ± 4.0	40 ± 4.0
Fuel pipe clip (C-I)	M14	8	40 ± 4.0	40 ± 4.0
Crankshaft position sensor	M6 x 14	1	0.8 ± 0.4	0.8 ± 0.4
	GAP	-	0.7 ± 1.5 mm	0.7 ± 1.5 mm
Power steering pump	M8 x 100	2	25 ± 2.5	25 ± 2.5
Head screw plug	-	1	25 ± 2.5	25 ± 2.5
Cam shaft cap bolt	M8 x 60	20	25 ± 2.5	25 ± 2.5
Piston topping	-	-	0.765 ~ 1.055 mm	0.765 ~ 1.055 mm
Connecting rod end play	-	-	0.500 ~ 1.500 mm	0.500 ~ 1.500 mm
Cam shaft end play	-	-	0.100 ~ 0.350 mm	0.100 ~ 0.350 mm
Crank shaft end play	-	-	0.100 ~ 0.254 mm	0.100 ~ 0.254 mm

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.

(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.

Modification basis	
Application basis	
Affected VIN	

(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.

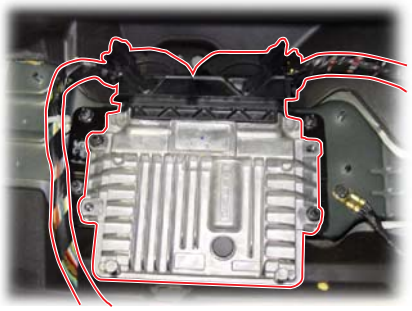
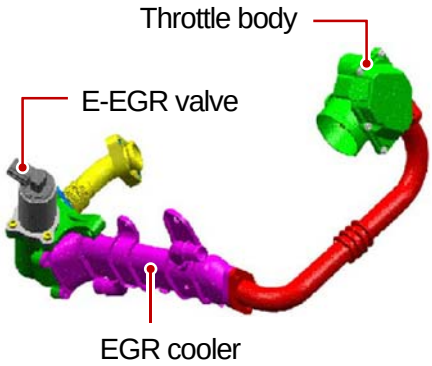
5. MAJOR CHANGES IN D20DT (EU-IV) ENGINE (COMPARED TO D20DT)

1) Engine Assembly

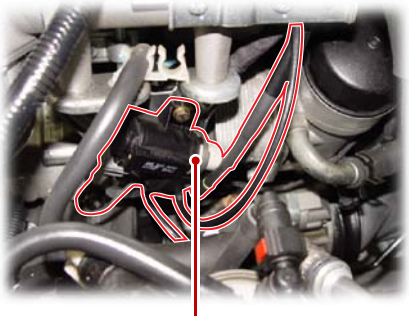
D20DT Engine	EU IV D27DTP Engine
Front view 	
Left side view 	
Right side view 	

Modification basis	
Application basis	
Affected VIN	

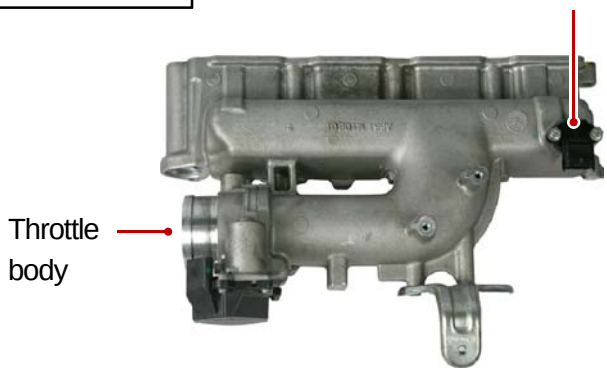
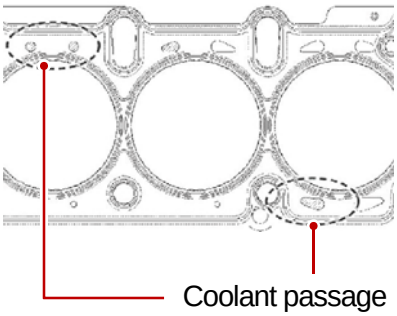
2) Major Changes and Summary

D20DT Engine	Remarks
ECU Engine ECU - Version 3.2  	ECU version 3.2 in D20DT engine has two connectors. 1. E-EGR valve system 2. Throttle body system 3. C3I injector system
Injector 	* Injection nozzle (hole): 7 * Injector label and coding - D27DTP, D20DT (20 digits: C3I coding)
Layout of E-EGR system 	* To meet the emission regulation, especially for reducing NOx, same E-EGR valve and EGR cooler in power-up engine (Rexton II) have been introduced.

Modification basis	
Application basis	
Affected VIN	

D20DT Engine	Remarks
HFM 6.0 	- HFM 6-ID (Added digital signal function)
Electrically controlled E-EGR valve 	* ECU controls the EGR valve directly. It provides precise EGR control by transmitting the electric signal of EGR valve operating position.
Vacuum modulator  Vacuum modulator for turbocharger control	* The vacuum modulator for controlling EGR valve has been deleted.
Throttle body 	* Throttle body is used to prevent the engine from turning off with fluttering noise at the moment the air to intake manifold is blocked by closed flap when the engine is switched off.

Modification basis	
Application basis	
Affected VIN	

D20DT Engine	Remarks
EGR cooler 	* To enhance the EGR performance by making the temperature of exhaust gas into the intake manifold down, the EGR cooler has been introduced.
Intake manifold 	* The throttle body and boost pressure sensor have been installed on the intake manifold.
Cylinder head 	* To enhance the cooling performance, the coolant port has been introduced.
Cylinder head gasket 	* To enhance the cooling performance, the coolant passage has been made in the cylinder block.

Modification basis	
Application basis	
Affected VIN	

ENGINE FUEL SYSTEM

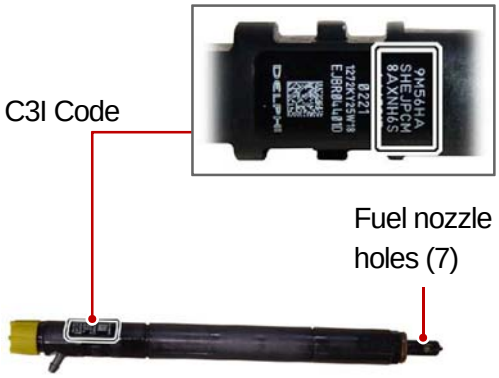
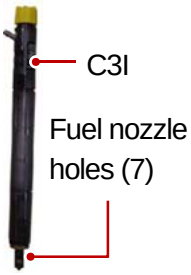
1881-01

GENERAL INFORMATION

1. FUEL SYSTEM - K2006

The C3I injector system is used in D20DT engine.

▶ **Injector**

	Injector (7-way Injection and C3I Coding)	
		

- Two nozzle holes are added (currently 7) to the tip of the injector to increase the amount of fuel injection and to improve injection efficiency according to the increased engine power.
  The existing C2I coding (16 digits) is changed to C3I coding (20 digits) to monitor fuel injection and follow the target value.
- For the D20DT engine, the injector MDP (minimum current for the solenoid in the injector to lift the nozzle) is leaned only when the engine is running. However, for the D20DT (EURO 4) engine, it is learned when the vehicle is in motion and the engine is at idle speed.

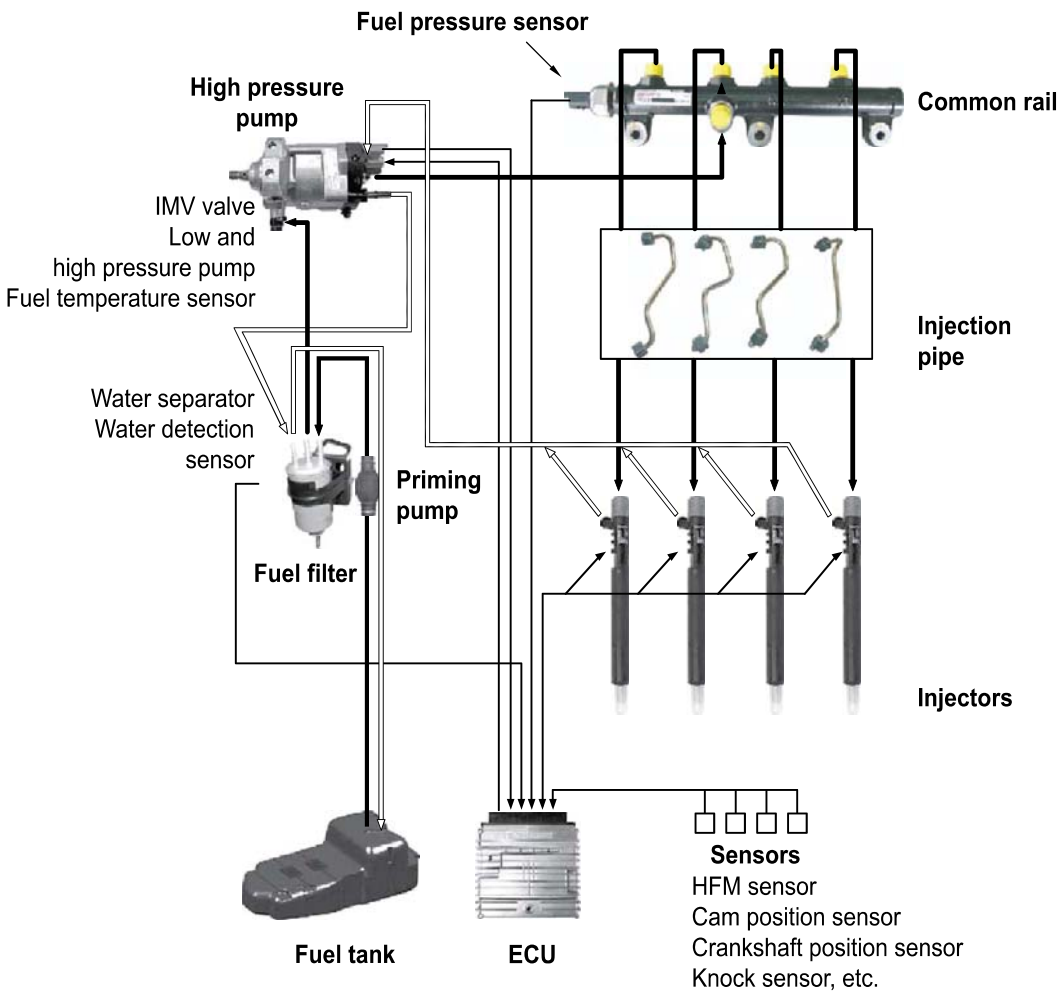
▶ **C3I Label**

C3I Label


Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATION PROCESS

1. FUEL FLOW OF D20DT (EURO 4) ENGINE



Components

- High pressure fuel pump
- Fuel injectors
- Fuel rail
- Electronic control unit(ECU)
- Fuel pressure sensor
- Various sensors and actuators

: Supply line
: Return line
: ECU connecting line

According to input signals from various sensors, engine ECU calculates driver's demand (position of the accelerator pedal) and then controls overall operating performance of engine and vehicle on that time. ECU receives the signals from sensors via data line and then performs effective engine air-fuel ratio controls based on those signals. Engine speed is measured by crankshaft speed (position) sensor and camshaft speed (position) sensor determines injection order and ECU detects driver's pedal position (driver's demand) through electrical signal that is generated by variable resistance changes in accelerator pedal sensor. HFM (Hot Film Air Mass) sensor detects intake air volume and sends the signals to ECU. Especially, the engine ECU controls the air-fuel ratio by recognizing instant air volume changes from air flow sensor to decrease the emissions (EGR valve control). Furthermore, ECU uses signals from coolant temperature sensor and air temperature sensor, booster pressure sensor and atmospheric pressure sensor as compensation signal to respond to injection starting, pilot injection set values, various operations and variables.

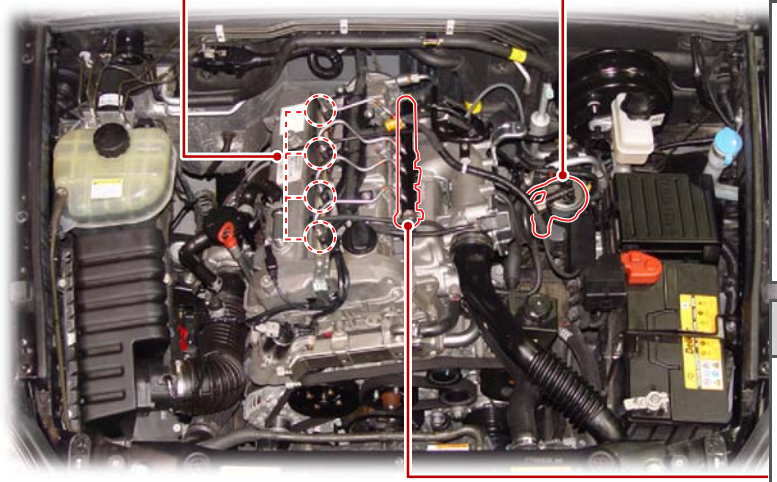
Modification basis	
Application basis	
Affected VIN	

2. COMPONENTS OF FUEL SYSTEM

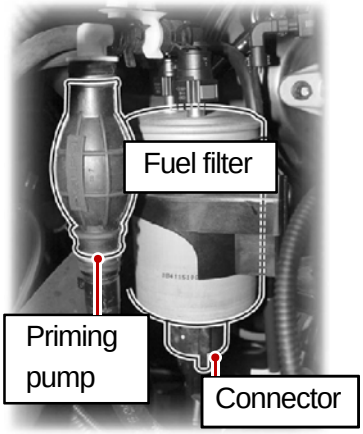
Injector (7-way Injection and C3I Coding)

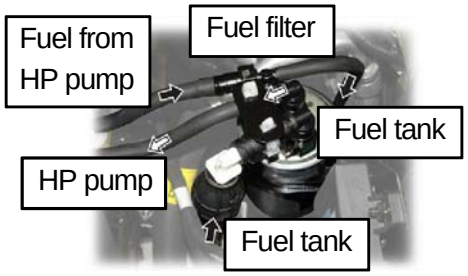






Fuel filter Priming Pump

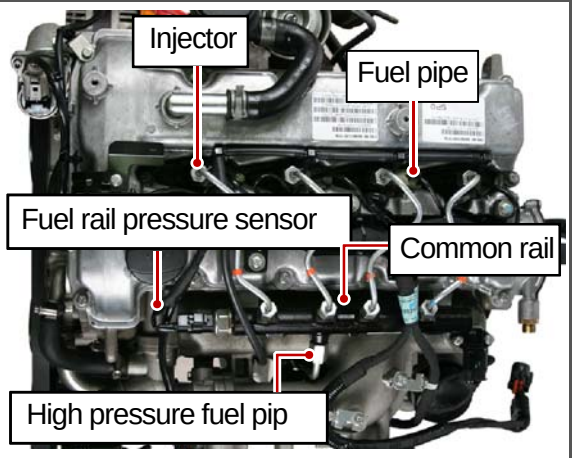




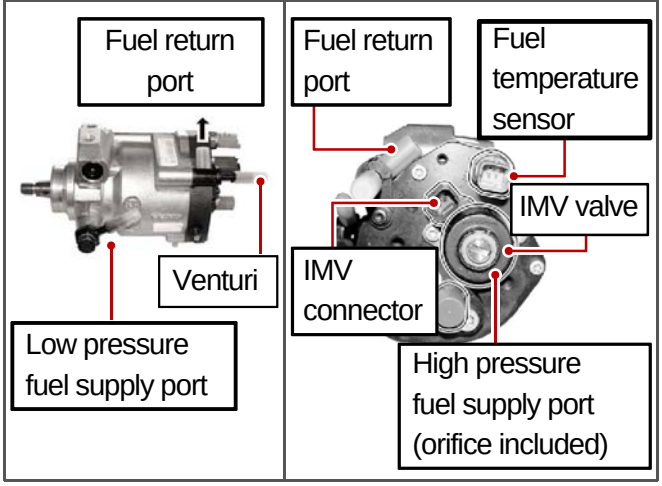
Common Rail



Fuel Line

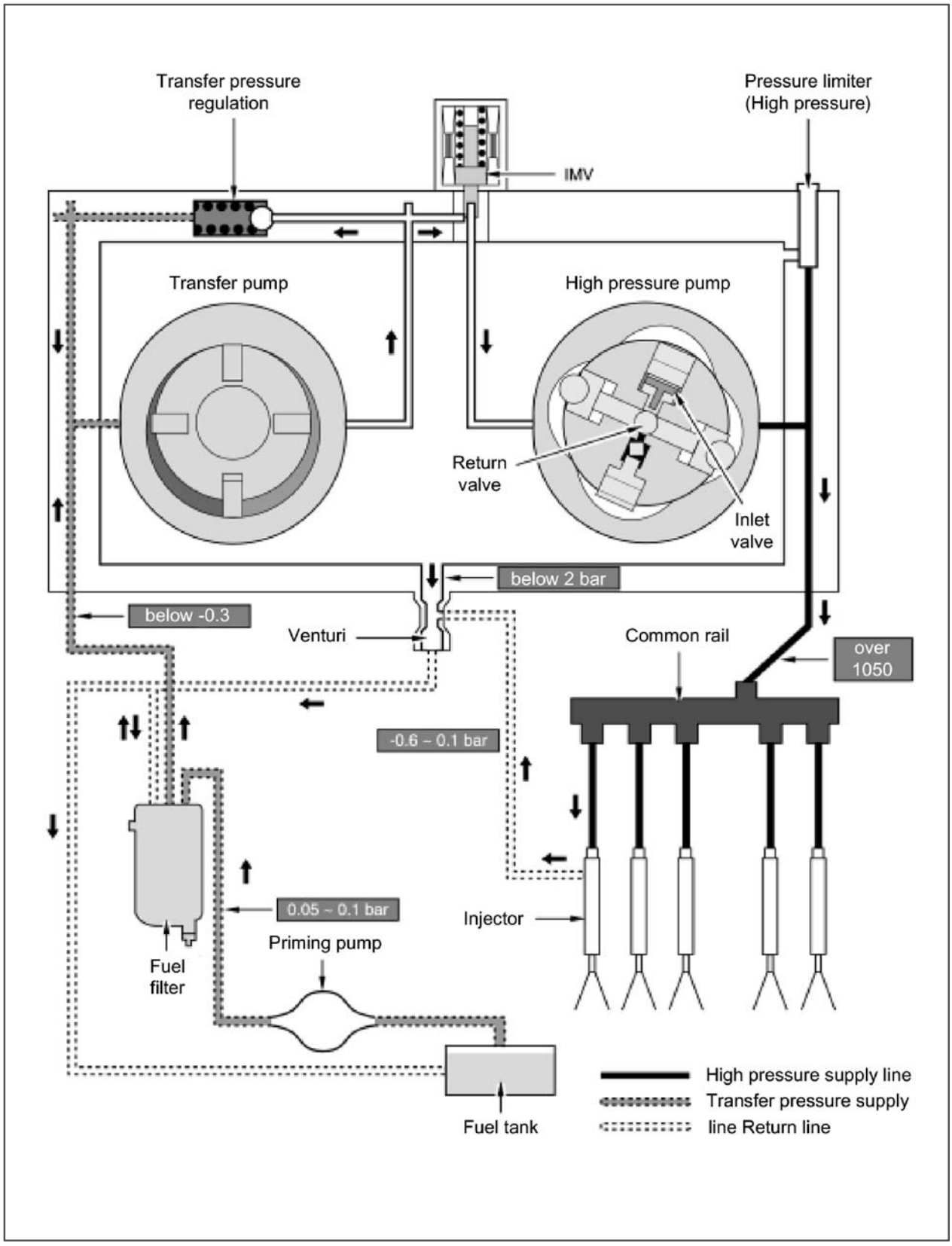


HP Pump



Modification basis	
Application basis	
Affected VIN	

3. HYDRAULIC CYCLE IN FUEL LINE (TRANSFER AND HIGH PRESSURE LINE)



Modification basis	
Application basis	
Affected VIN	

ENGINE INTAKE SYSTEM

2313-01

GENERAL INFORMATION

1. TIGHTENINF TORQUE

The hose clamps and fasteners should be tightened to the specified tightening torque when installing/removing the engine and/or components for intake system.

1. Hose between air cleaner and turbocharger

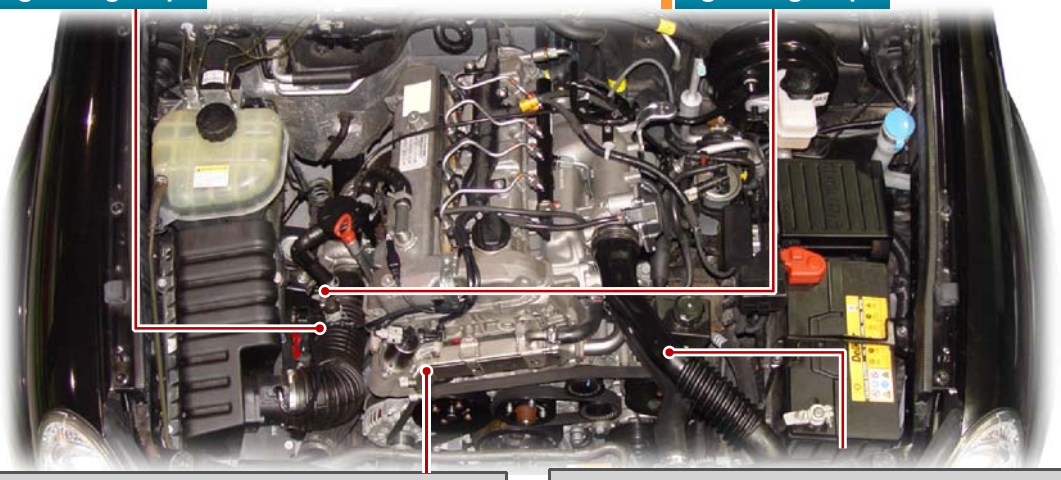


Tightening torque 6 ~ 7 Nm

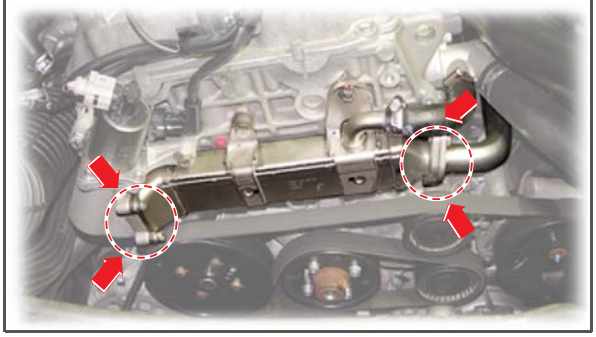
2. Hose between turbocharger and intercooler



Tightening torque 6 ~ 7 Nm



3. Connection on EGR pipes



Tightening torque 10 ±1.0 Nm

4. Clamp on inlet hose to intake manifold and inlet hose to intercooler

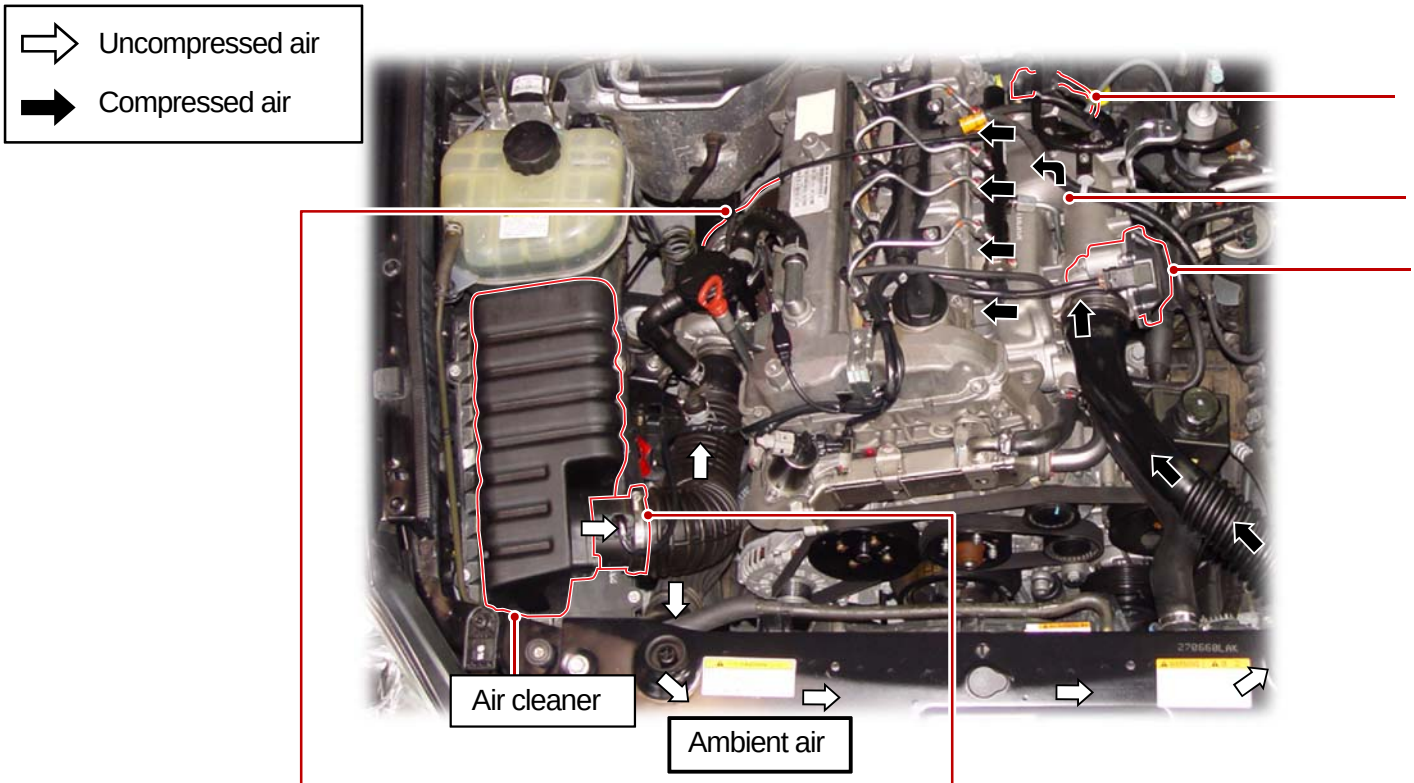


Tightening torque 6 ~ 7 Nm

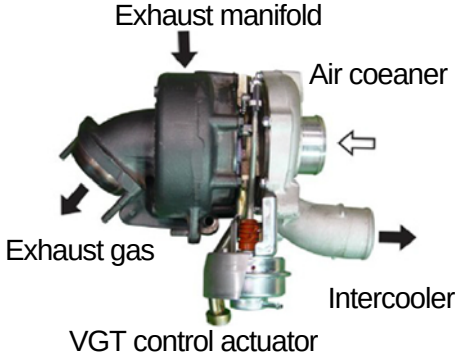
OVERVIEW AND OPERATION PROCESS

1. INTAKE SYSTEM LAYOUT

The intake system is equipped with an electric 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. And, the improved HFM sensor has been adopted to control the intake air volume more precisely.

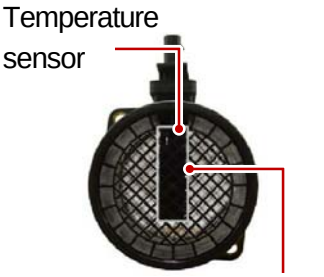


VGT Turbo Chargera



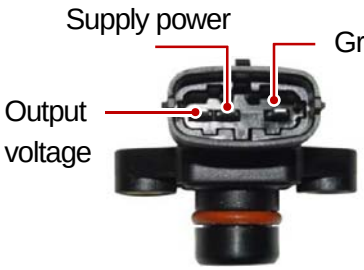
HFM Sensor (ver. 6.0)



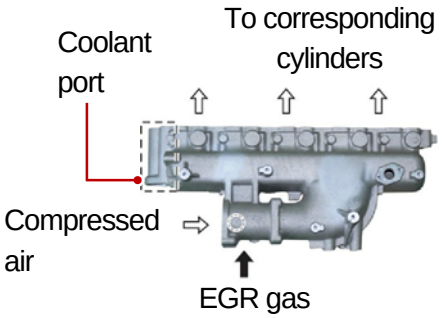


Modification basis	
Application basis	
Affected VIN	

Booster Pressure Sensor

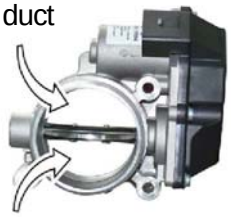


Intake Manifold



Throttle body

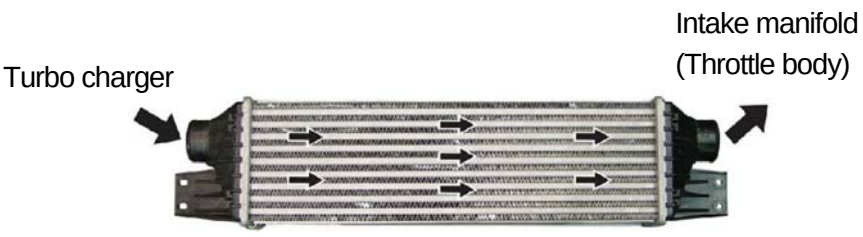
Normal: flap open



Engine stopped: flap closed



Intercooler

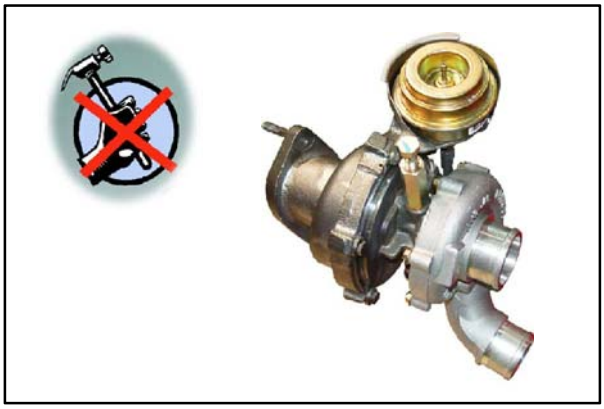


ENGINE EXHAUST SYSTEM

1791-01

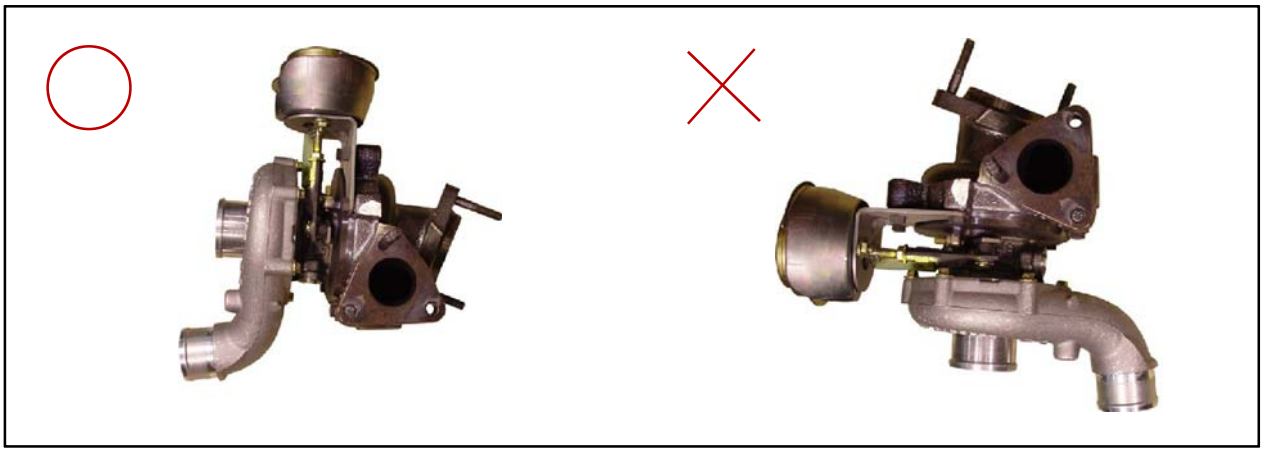
GENERAL INFORMATION

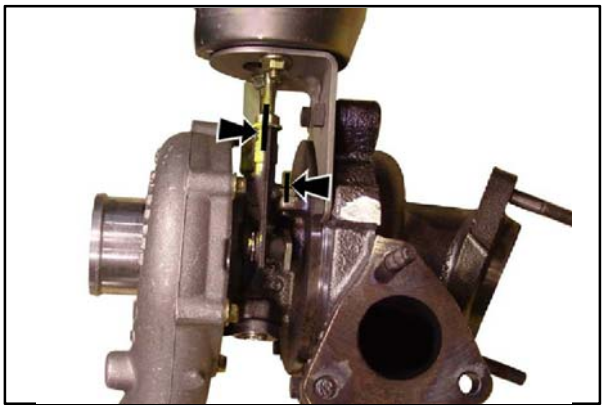
1. TURBO CHARGER CHECK FOR VGT



1. The turbocharger is sensitive to excessive vibration coming from external impact. When exposed to excessive impact or vibration, the inside mechanism may be damaged even though the outside is intact.

2. The turbocharger should be kept horizontally. If there is much engine oil in the turbocharger and it is kept vertically with the turbine housing downward, the engine oil may be provided to variable mechanism assembled towards the turbine housing, which may lead to a malfunction of the variable mechanism.





3. Never re-adjust the adjusting screw marked with yellow paint or the axial end of actuator. Renew them if you found looseness of the screw or actuator axle, because they are shipped after precisely adjusting from the factory.
4. Do not move or assemble the actuator axle by grasping it in hands. The actuator axle may be deformed, which affects the precisely adjusted value.

Modification basis	
Application basis	
Affected VIN	



5. After installing to the engine, replenish a small amount of clean engine oil to the inlet before connecting the oil inlet pipe of the turbocharger.
6. Do not let any metal debris enter when installing to the engine.
7. The engine oil may be provided to the compressor housing if you rapidly operate the turbocharger with excessive revolutions immediately after installing to the engine.

- Do not raise the engine rpm rapidly after starting the engine.
- Do not raise the engine rpm rapidly after renewing the engine oil and filter element.
- Do not stop the turbocharger rapidly after operating at high engine speed.

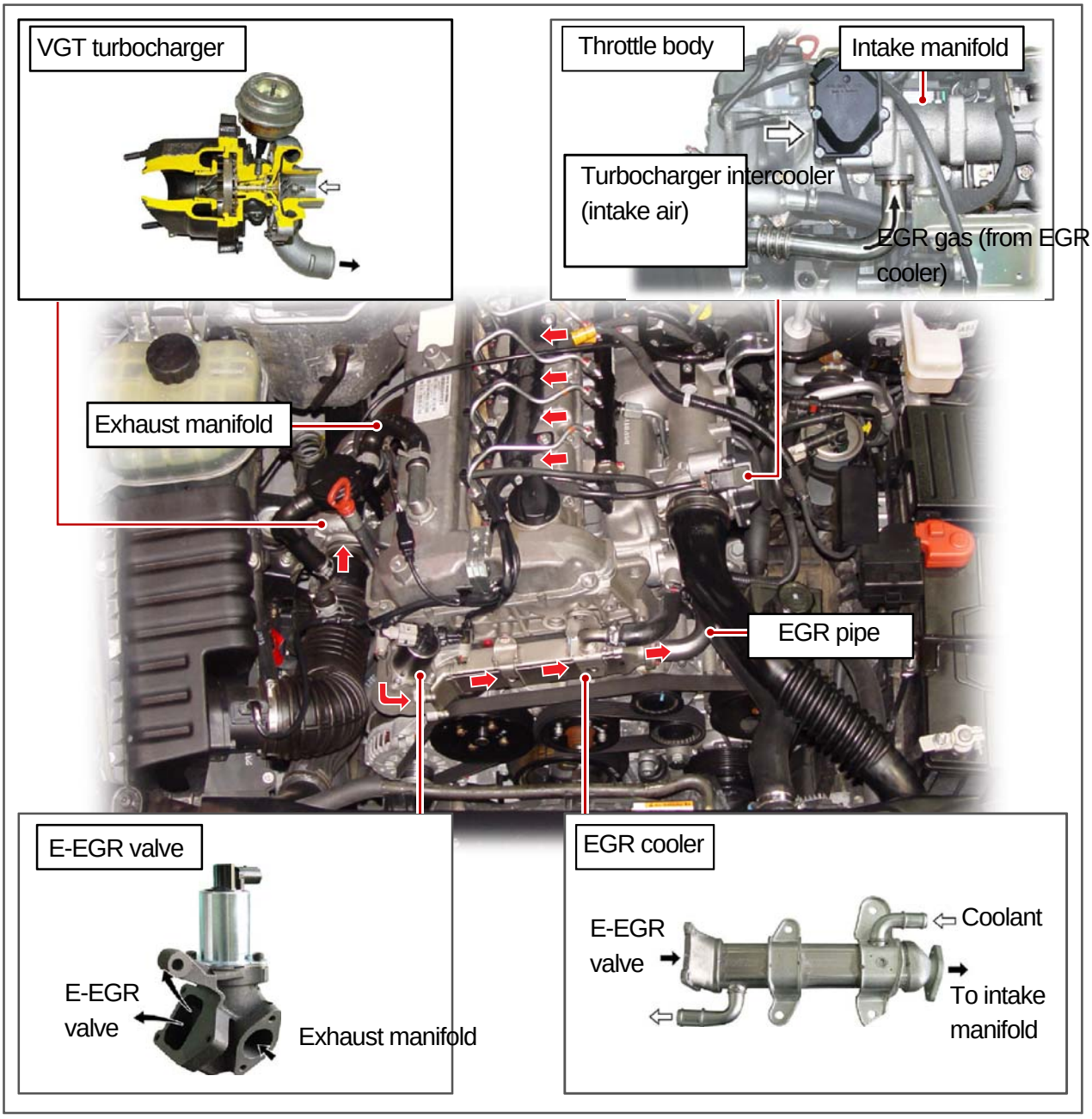
Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATION PROCESS

1. COMPONENTS

The components of the exhaust system consist of:

1. E-EGR valve: Controlling the EGR valve electrically and sends the valve location signal to ECU (vacuum modulator control has been deleted).
2. EGR cooler: Decreasing EGR gas (NOx) efficiently by cooling the EGR gas and let it flow to the intake manifold.



CDF (EURO IV)

1881-09

GENERAL INFORMATION

1. OVERVIEW FOR CDPF (EURO IV)

1) General Description

The CDPF (Catalyst & Diesel Particulate Filter) was installed to the Rexton II D27DTP engine previously. However, it is now installed to the all 2009 DI engine models, except the Actyon Sports. The DI engine type sinstalled to Rexton are D27DTP, D27DT and D20DT, and their CDPF, related sensor and operation logic are the same.This section describes the CDPF system (based on Euro IV) which is installed to the Rexton II D27DTPengine (older model).

2) Compatibility of CDPF System by Vehicle Model

Rexton II: Same CDPF system for D27DTP and D27DT engines (including its components)
Kyron & Actyon: Same CDPF system for D27DT and D20DT engines (including its components)

NOTE

- The CDPF assemblies installed to the Euro IV D27DTP Rexton II and 2009 Rexton II are different in their mounting layout, but their front/rear exhaust temperature sensors and differential pressure sensors are same.

3) System Met with EURO IV Regulations

The Ssangyong vehicles installed with the D27DT engine manufactured from July 2007 to December 2007 comply with the EURO IV regulations. Modified components from the old engine model are as follow:

- E-EGR valve
- EGR cooler
- Engine ECU (Ver. 3.2)
- HFM senso
- C3I injector
- Electronic throttle valve (body)
- Other engine mounting components

For details about the modified components and system related to the EURO IV regulations, refer to the 2008 Rodius engine service manual.

Modification basis	
Application basis	
Affected VIN	

2. CDPF (EURO IV) SYSTEM

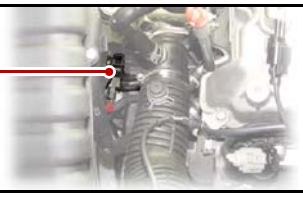
The CDPF system is only installed to the D27DT engine, and the major changes comparing to the previous D27DT engine is as follows:

CDPF (Catalyst & Diesel Particulate Filter) and Sensors

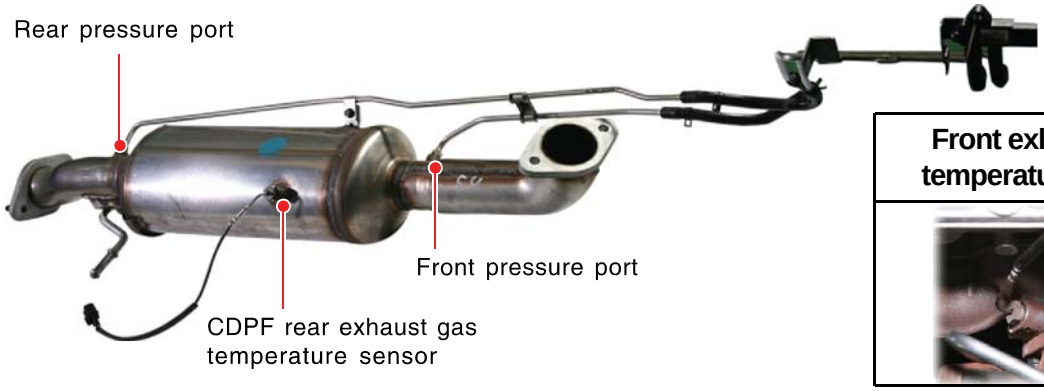
Differential Pressure Sensor (ΔP sensor)



Under air cleaner in right side of engine compartment



As the soot is filtered in the CDPF, the pressure between the front side and the rear side of the filter is different from each other. If the amount of soot is over 28 g, the soot is burnt in the CDPF. The combustion is determined depending on the pressure difference, temperature of exhaust gas and EGR ratio. According to these, the soot filtered by post injection of injector is burnt at 600°C.



Front exhaust gas temperature sensor



CDPF Exhaust Gas Temperature Sensor



The two temperature sensors in-side the CDPF are installed inexhaust manifold (front exhaustgas temperature sensor) and inDOC (rear exhaust gas tempera-ture sensor), and perform the following functions.

Front Exhaust Gas Tempera-ture Sensor:
Measures the exhaust gas temperature of the exhaust manifold. As it is installed in front of the VGT turbocharger, it also monitors the exhaust gas tempera-ture coming to the turbocharger. If the temperature of the exhaust gas flowing to the turbocharger is higher than the specification, the engine lowers the exhaust gas temperature.

Rear Exhaust Gas Tempera-ture Sensor:
Measures the increased exhaust gas temperature after the oxidation process of DOC. If the temperature is below 600°C, the post injection amount is increased to increase the temperature.

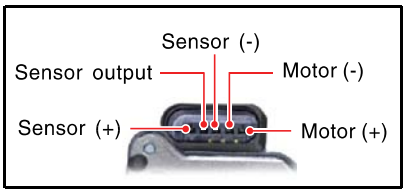
Modification basis	
Application basis	
Affected VIN	

Throttle Body



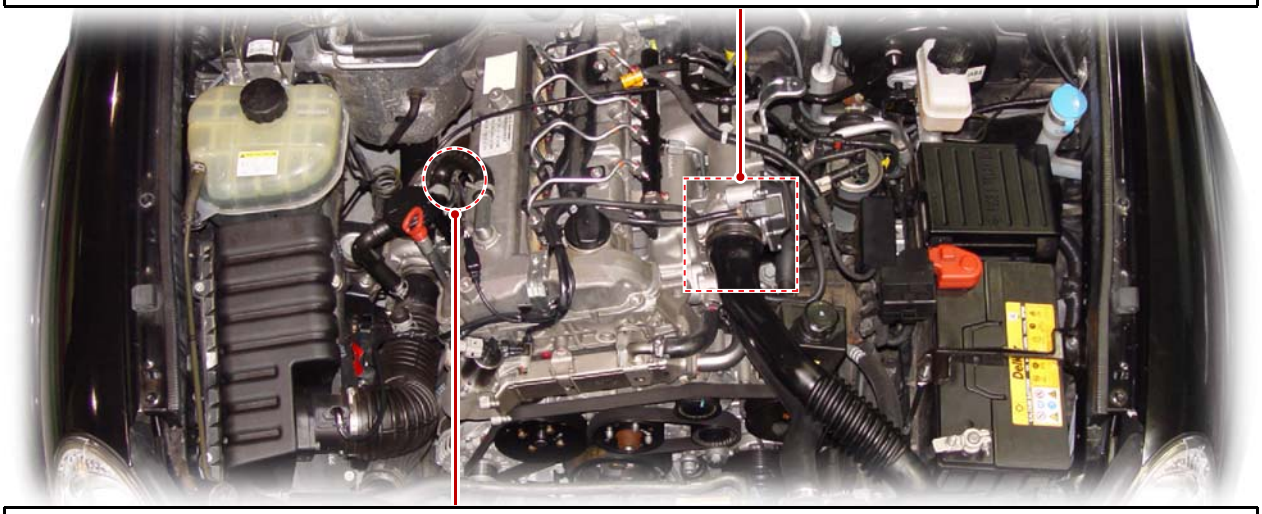
CDPF system controls the amount of intake air by controlling the electronic throttle body. The electronic throttle body has the following main functions.

CDPF control - added a function that increases the exhaust gas temperature by closing the throttle valve flap to minimize the intake air amount by the fuel injection amount during the CDPF regeneration range with the low engine load range.



ON/OFF control - prevents the engine from turning off with vibration and noise by closing the throttle body flap to block the intake air when the engine is stopped.

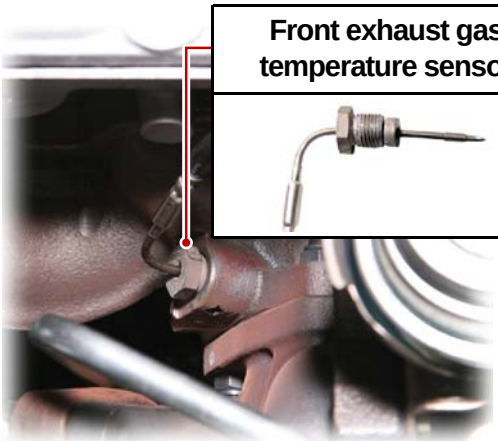
Duty control - controls the valve inside the throttle body to burn more EGR gas in the EGR valve operating range.



VGT Turbocharger and Front Exhaust Gas Temperature Sensor

Turbocharger may become weaker if high temperature exhaust gas passes through the turbocharger for DPF regeneration process.
The front exhaust gas temperature sensor moni-tors the temperature of the exhaust gas that flows into the turbocharger.
If the temperature of the exhaust gas that passes through the exhaust manifold is higher than the specification, the ECU decreases the fuel injection amount and increases the EGR gas intake amount to decrease the exhaust gas temperature.

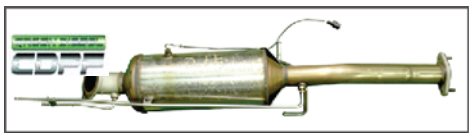
Front exhaust gas temperature sensor



Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATION PROCESS

1. OVERVIEW



As the solution for environmental regulations and PM (Particla 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 Oxydation Catalyst) is reduced. The CDPF (**C**atalyst & **D**iesel **P**articulate **F**ilter) is anintegrated filter including DOC (Diesel Oxydation Catalyst) and DPF (Diesel Particulate Filter).

▶ **Comparison of throttle body functions based on exhaust emission regulation**

Regulated parts are carbon monoxide (CO), nitrogen oxide (NOx), particular matter (PM) and soot in the exhaust emission, and the particulars of the regulations are prescribed in the following table.

Engine	Control method	Function
D27DTP + CDPF **D27DT + CDPF** **D20DT + CDPF**	ECU's electric signal (Duty and On/Off control) + Throttle flap control during CDPF operation	**ON/OFF control -** prevents the engine from turning off with vibration and noise by closing the throttle body flap to block the intake air when the engine is stopped **Duty control -** controls the valve inside the throttle body to burn more EGR gas in the EGR valve operating range. **CDPF control -** added a function that increases the exhaust gas temperature by closing the throttle valve flap to minimize the intake air amount by the fuel injection amount during the CDPF regeneration range with the low engine load range.
D27DT engine (EU IV)	ECU's electric signal (Duty and On/Off control)	**ON/OFF control -** prevents the engine from turning off with vibration and noise by closing the throttle body flap to block the intake air when the engine is stopped **Duty control -** controls the valve inside the throttle body to burn more EGR gas in the EGR valve operating range.

Modification basis	
Application basis	
Affected VIN	

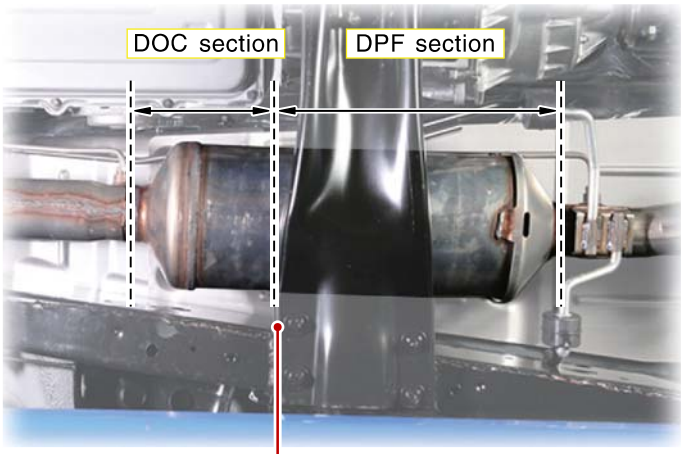
2.CDPF (EURO IV) SYSTEM CONTROL

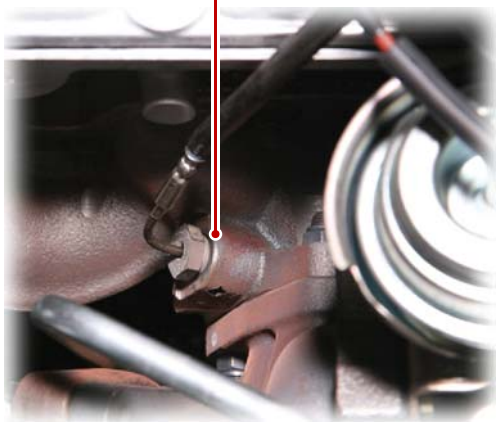
1) General Description

As the soot is filtered in the CDPF, it is burnt and removed, and the CDPF is returned to the initial state to collect the soot. Therefore, the burning procedures in the CDPF can be called as regeneration.
The CDPF assembly is integrated with DOC (at front side) and DPF (at rear side).
The DPF burns the soot with high-temperature exhaust gas (over 600°C). The rear exhaust gas temperature sensor monitors the temperature of DPF section. If this temperature is below the regeneration temperature, the ECU increases the post injection period to increase the fuel injection amount, and consequently to increase the exhaust gas temperature.



Front exhaust gas temperature sensor
(Measuring temperature of exhaust gas in exhaust manifold)





Rear exhaust gas temperature sensor
(Measuring temperature of exhaust gas escaping DOC)

CAUTION

- Normally, when the vehicle is driven for 600 ~ 1,200 km, the enough amount of soot to be burnt is filtered and accumulated in the CDPF. The ECU increase the amount of post injection to increase the tempeature of exhaust gas up to 600°C so that the soot is burnt. The soot is burnt for 15 ~ 20 minutes.

Modification basis	
Application basis	
Affected VIN	

2) System Composition for Soot Combustion

When the engine is running in low load range, the temperature of exhaust gas is decreased as the amount of fuel supplied is decreased. To burn the soot filtered in the CDPF, the control system should be installed to check the operating range and increase the temperature of exhaust gas by controlling the amount of fuel supplied and intake air.

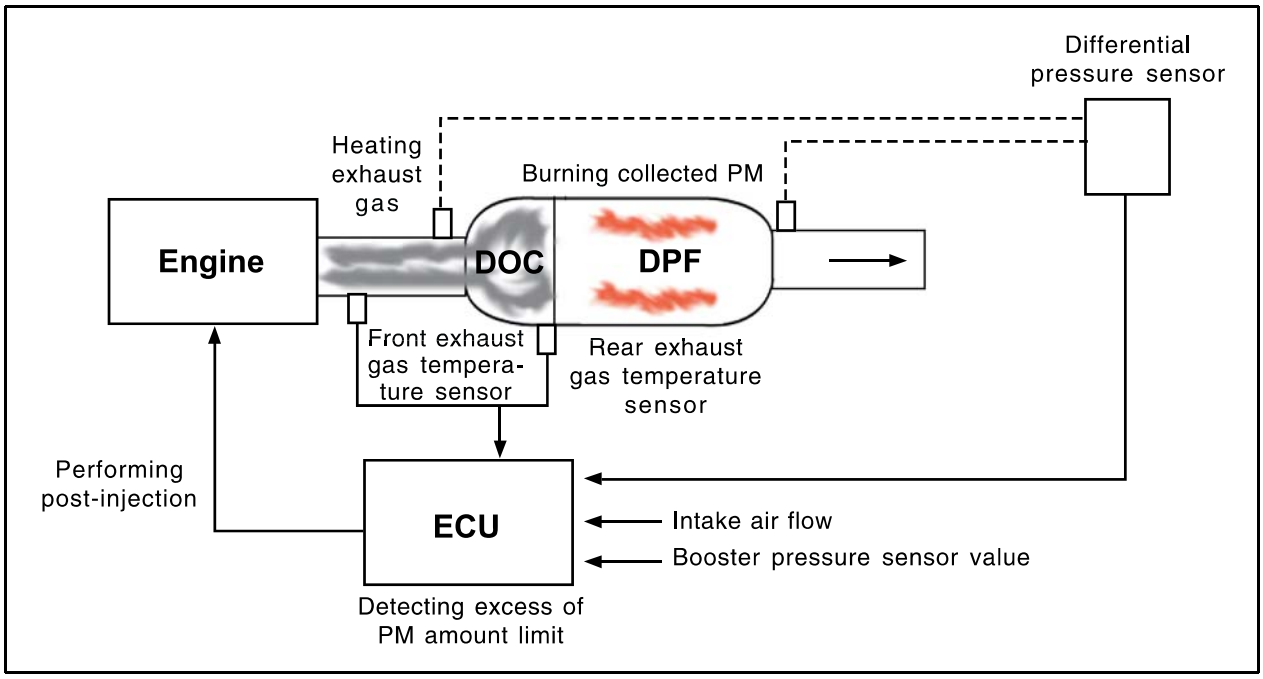
Two temperature sensors and one differential pressure sensor monitor the CDPF's operating range. According to these sensors' information, the throttle flap decreases the intake air entered to the throttle body. Also, the fuel injection pattern is added to increase the temperature of exhaust gas for soot combustion.

There are three fuel injection patterns (pilot injection, pre-injection and main injection). As the CDPF is installed, the post injection pattern is added.

3) Post Injection and Air Mass Control

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 acumulated 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.



Modification basis	
Application basis	
Affected VIN	

NOTE

Throttle bodies by engine type

- The throttle valve is controlled by electric signals sent from the engine ECU for optimal fuel injection volume, engine load and effective combustion of EGR gas according to the Euro 4 regulations. It has following functions by the engine type.

Engine	Control Method	Function
D27DTP + CDPF **D27DT + CDPF** **D20DT + CDPF**	ECU's electric signal (Duty and On/Off control) + Throttle flap control during CDPF operation	**CDPF control -** added a function that increases the exhaust gas temperature by closing the throttle valve flap to minimize the intake air amount by the fuel injection amount during the CDPF regeneration range with the low engine load range. **ON/OFF control -** prevents the engine from turning off with vibration and noise by closing the throttle body flap to block the intake air when the engine is stopped. **EGR gas amount control -** Close the valve to decrease the intake air amount and lets more EGR gas flows to burn more EGR gas at EGR valve operating range.
D27DT engine (EU IV)	ECU's electric signal (Duty and On/Off control)	**ON/OFF control -** prevents the engine from turning off with vibration and noise by closing the throttle body flap to block the intake air when the engine is stopped. **EGR gas amount control -** Close the valve to decrease the intake air amount and lets more EGR gas flows to burn more EGR gas at EGR valve operating range.
D27DT engine	No throttle body installed	

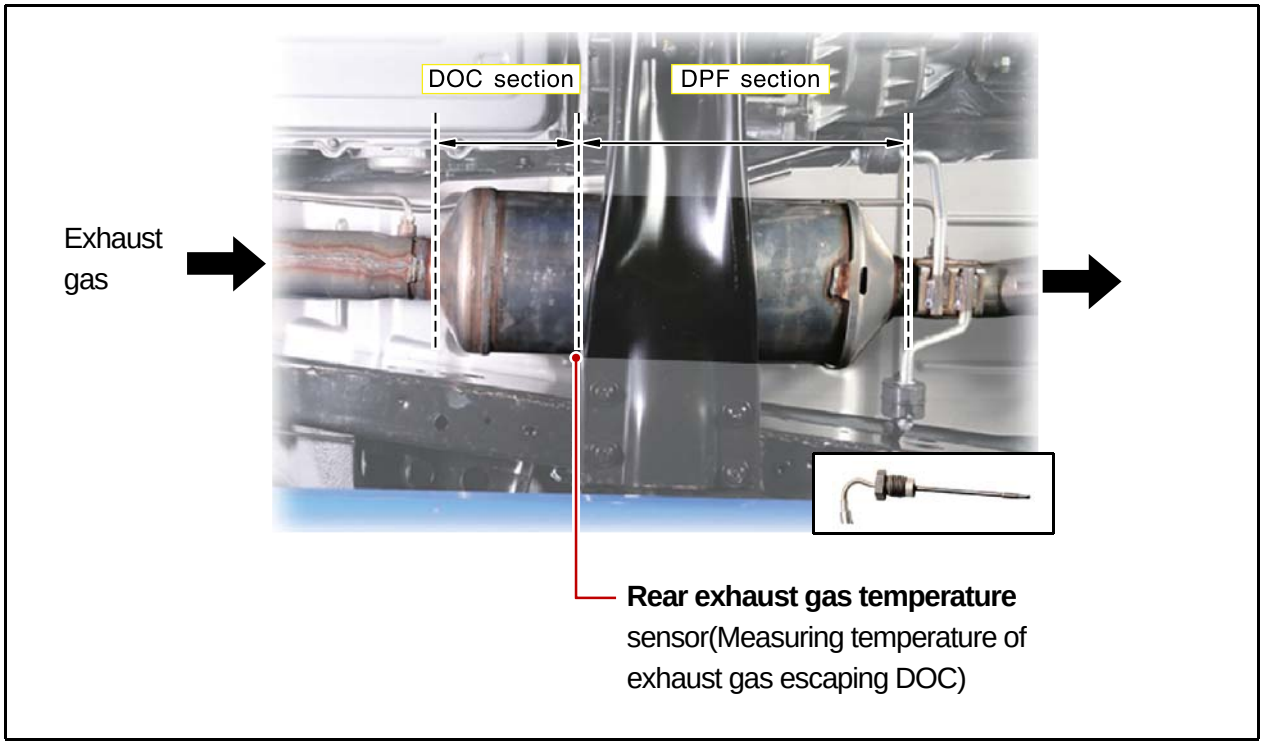
3. SOOT FILTERING AND BURNING PROCEDURES

1) Operating Procedures of CDPF

The most efficient and practical technology for now is adopted to the diesel particulate filter (DPF).
This system collects the soot from the diesel engine to the filter and burns the soot so that over than 95% of soot can be removed from the exhaust gas. However, the durability and the cost of additional system remainas problems.

Firstly, the exhaust gas is passed through the DOC and its temperature is increased as it is oxidized. The ECU detects the temperature change with two temperature sensors. The CO, HC and partial particulate material are removed from the exhaust gas (this procedures are the sames as the ones for the conventional DOC and no sensor is required).

After the exhaust gas is passed through the DOC and oxidized, most of the harmful material is removed from the exhaust gas. However, to meet the environmental regulations in the future, the soot is filtered and burnt again in DPF to decrease the particulate material further.



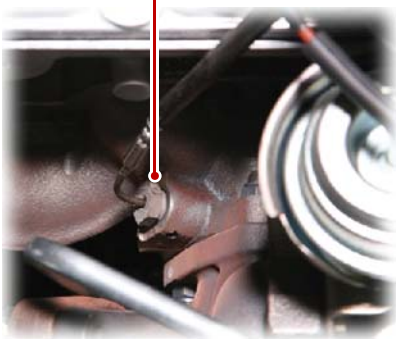
CAUTION

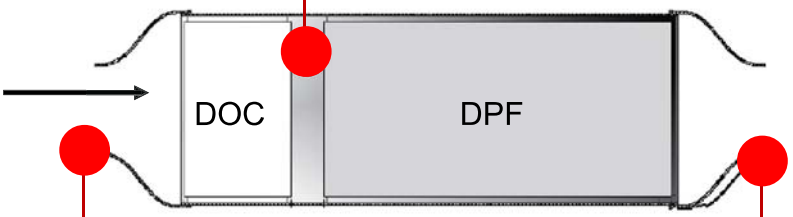
- The filtered soot is burned whenever the vehicle is driven for 600 ~ 1200 km. The driving distance can be differed depending on the vehicle's driving conditions. The soot is burnt for 15 ~ 20 minutes.

Modification basis	
Application basis	
Affected VIN	

Front temperature sensor
(Measuring the temperature of exhaust gas passedthrough exhaust manifold)

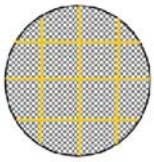
Rear temperature sensor
(Measuring the temperature of exhaust gas passed through DOC)



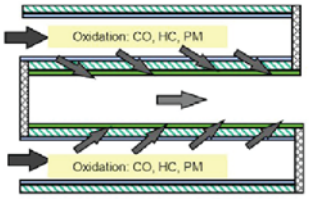


Differrential pressure sensor
(Front pressure port)

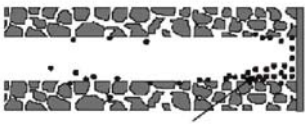
Differrential pressure sensor
(Rear pressure port)



The exhaust gas enters intoCDPF assembly after passing through the exhaust manifold. (Normal temperature of ex-haust gas: approx. 250°C)



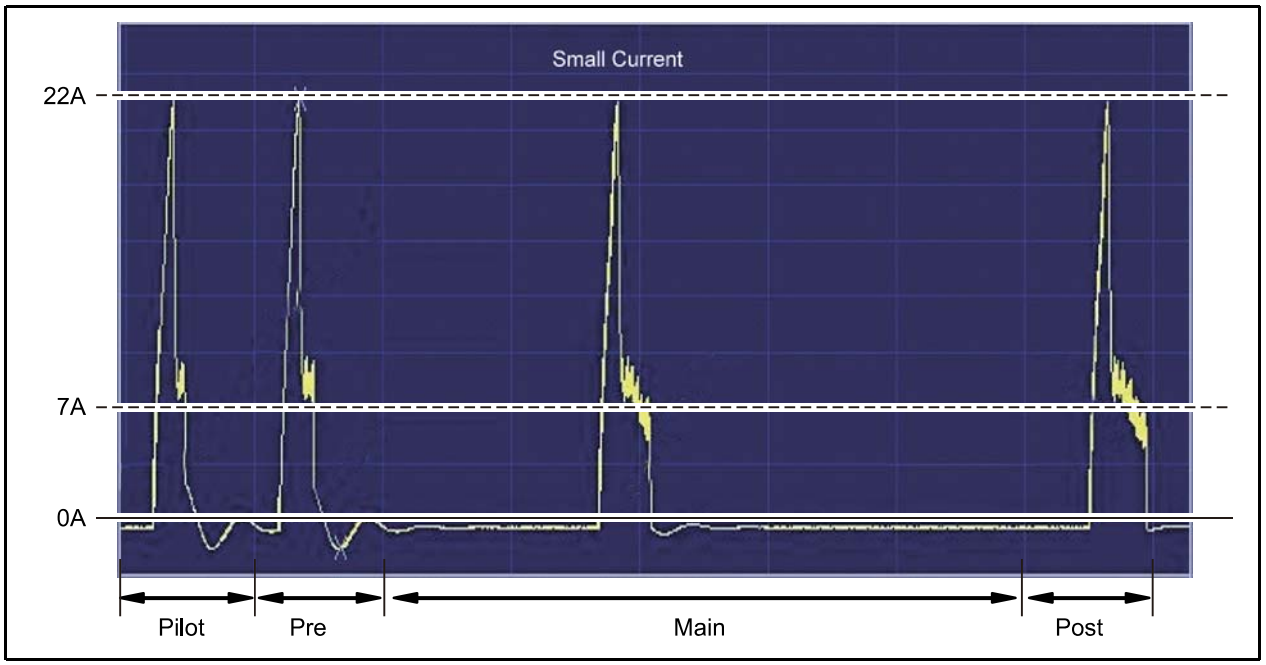
When the exhaust gas enters into the CDPF assembly, its CO, HC and particulate mate-rial are reduced as it is oxi-dized in DOC. The remaining particulate material is filtered and collected in DPF and the temperature of exhaust gas is increased to approx. 450 ~500°C.



The engine ECU detects the amount of particulate material colected by the information from temperature sensors and differential pressure snesor. When the soot is accumulated, the pressure difference be-tween the front and the rear side occurs. Then, the engineECU performs the post injec-tion to raise the exhaust gas temperature and burn the collected soot at approx. 600°C.

Modification basis	
Application basis	
Affected VIN	

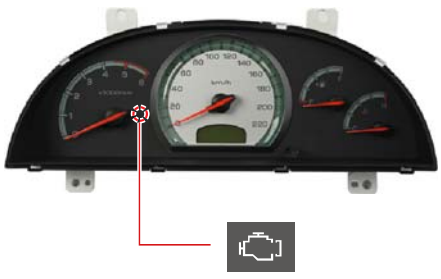
2) Fuel Injection During CDPF Regeneration



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 supply-ing reduction material

3) Warning Lamp Related To CDPF

▶ **CDPF regeneration process (warning lamp NOT illuminated)**

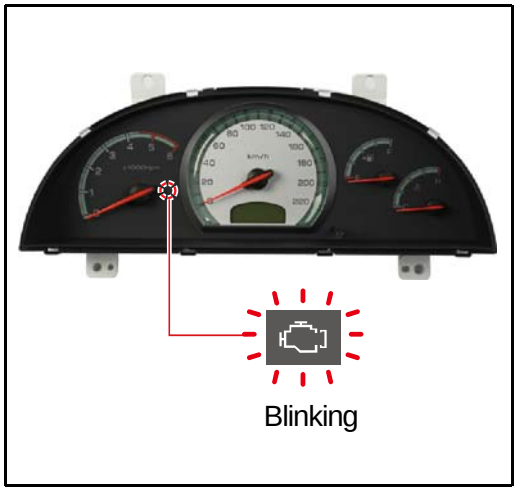


No illumination

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 in-formed 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 tem-perature of the exhaust gas. The driver may not feel any particular difference from the vehicle.

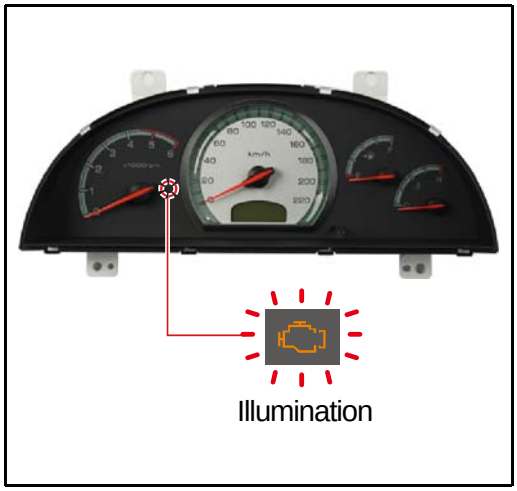
Modification basis	
Application basis	
Affected VIN	

▶ Overload of CDPF (warning lamp blinking)


Blinking

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

▶ Excessive overload of CDPF (warning lamp illuminated)

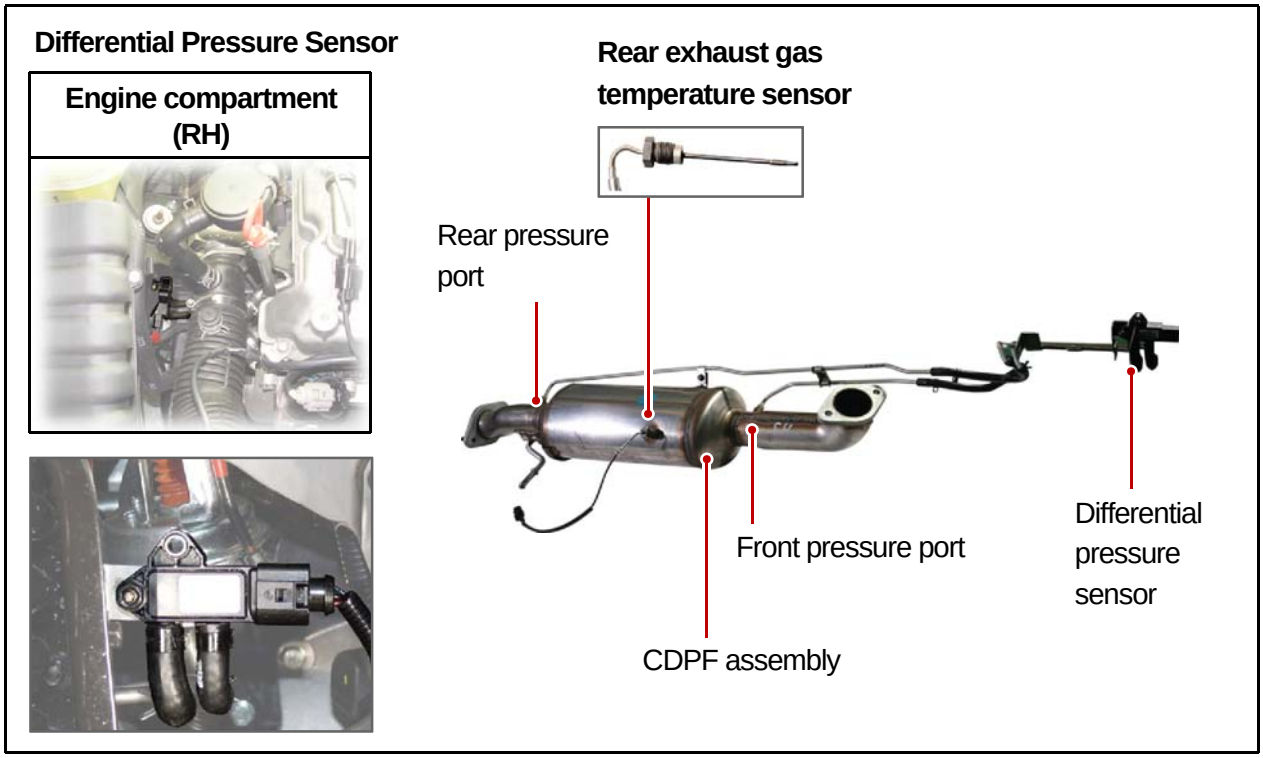

Illumination

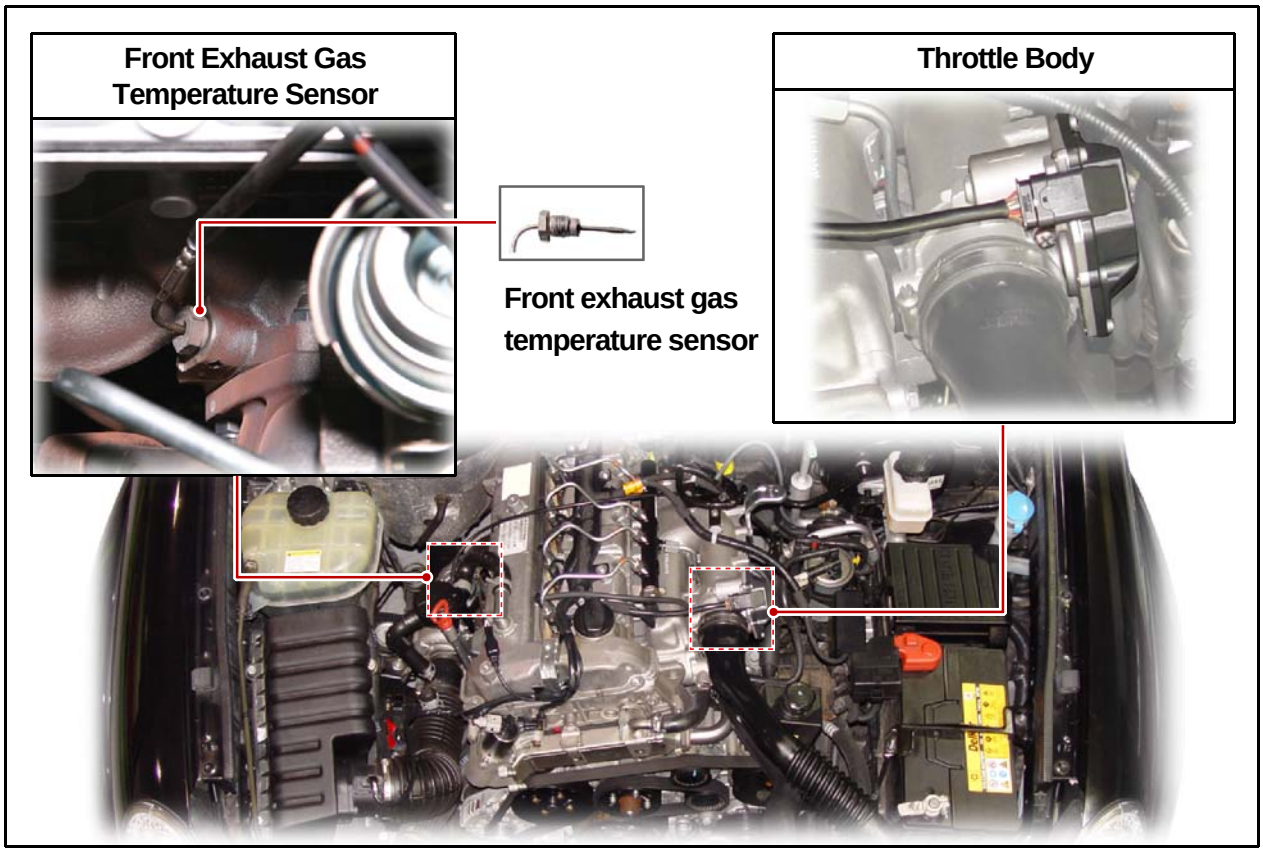
1. If the vehicle is driven at a speed of 5 to 10 km/h for an extended period of time, the soot accumu-lated in the CDPF cannot be burnt as the CDPF cannot reach the regeneration temperature. Then, an excessive amount of soot can be accumulated in the CDPF.
2. This case is much worse than the simple 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.
3. To solve this problem, blow soot between the en-gine and exhaust system several times and erase the related DTC. Then, check if the same DTC is regenerated again. If so, check the DTC related to the differential pressure sensor.

Actually, the DTC for the CDPF is generated more often by the component related to the CDPF system, such as the differential pressure sensor, than by excessive soot in the CDPF.

4. COMPONENTS OF CDPF SYSTEM

1) Mounting Condition and Location





Modification basis	
Application basis	
Affected VIN	

LUBRICATION SYSTEM

1533-01

GENERAL INFORMATION

1. SPECIFICATIONS

Engine Oil	**Quality class**		Ssangyong genuine engine oil (Approved by MB Sheet 229.1 or 229.3 or 229.31 for DSL/GSL ENG without CDPF) (Approved by MB Sheet 229.31 for DSL ENG with CDPF) Viscosity: MB sheet No. 224.1
	Capacity		Standard: 9.3ℓ (max: 8.3 ℓ, min: 6.8 ℓ)
	Service interval	**EU**	Initial check: 5,000 km, and replenish if necessary, change every 20,000 km or 12 months (But, shorten the service interval under severe condition)
		General	Initial change: 5,000 km, change every 15,000 km or 12 months (But, shorten the service interval under severe conditions)
Engine oil filter			Same interval with the engine oil
Oil filter relief valve opening pressure			5.8±0.3 bar

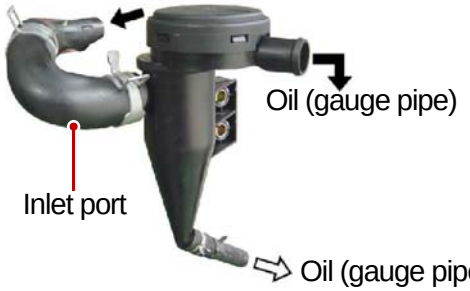
* What's Severe Driving Condition?
- Frequent stop-and-go traffic, extended idling, short driving distance below 6 km, driving distance below 16 km when the outside temperature remains below freezing
- Driving in a hilly or mountainous terrain, sandy, or dusty area
- High load driving such as trailer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

OVERVIEW AND OPERATION PROCESS

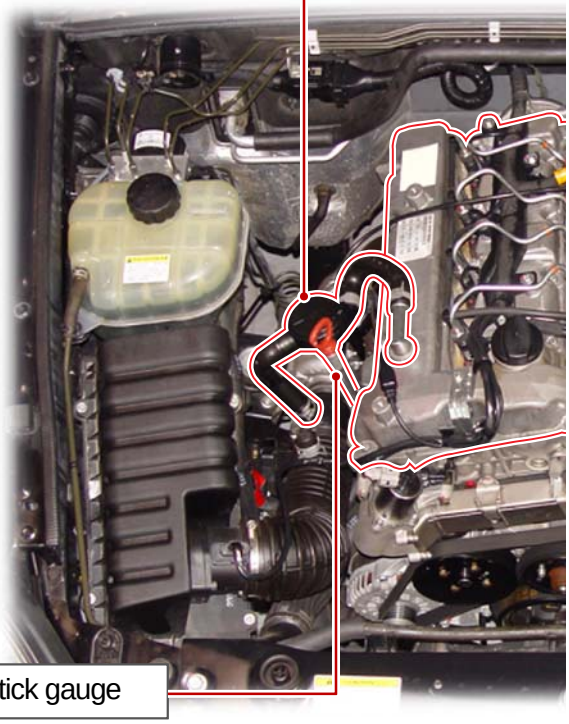
1. LAYOUT OF LUBRICATION SYSTEM

PCV Oil Separator

Cylinder head cover (oil + gas)

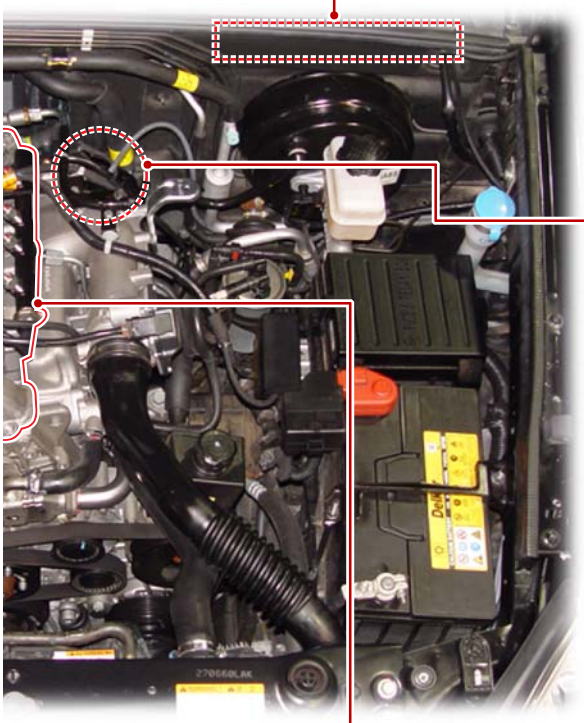


The first separation will happen when blow-by gas passes through baffle plates in cylinder head cover. Then oil and gas will be separated due to cyclone effect after entering the oil separator inlet port. Separated oil returns to oil pan via oil drain port and the gas will be burnt again after entering the combustion chamber through air duct hose via PCV valve that opens/closes due to pressure differences between the intake side and crankcase.

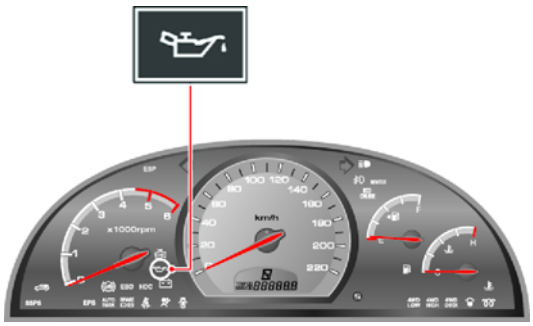


Oil Pan & Baffle Plate (Integrated type)	Oil Strainer
	

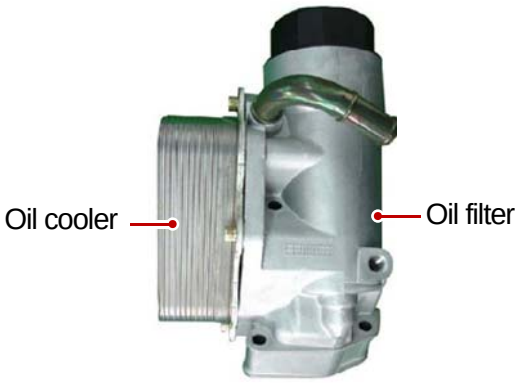
Modification basis	
Application basis	
Affected VIN	



Low Oil Pressure Warning Lamp (Instrument Cluster)



Oil Filter & Oil Cooler



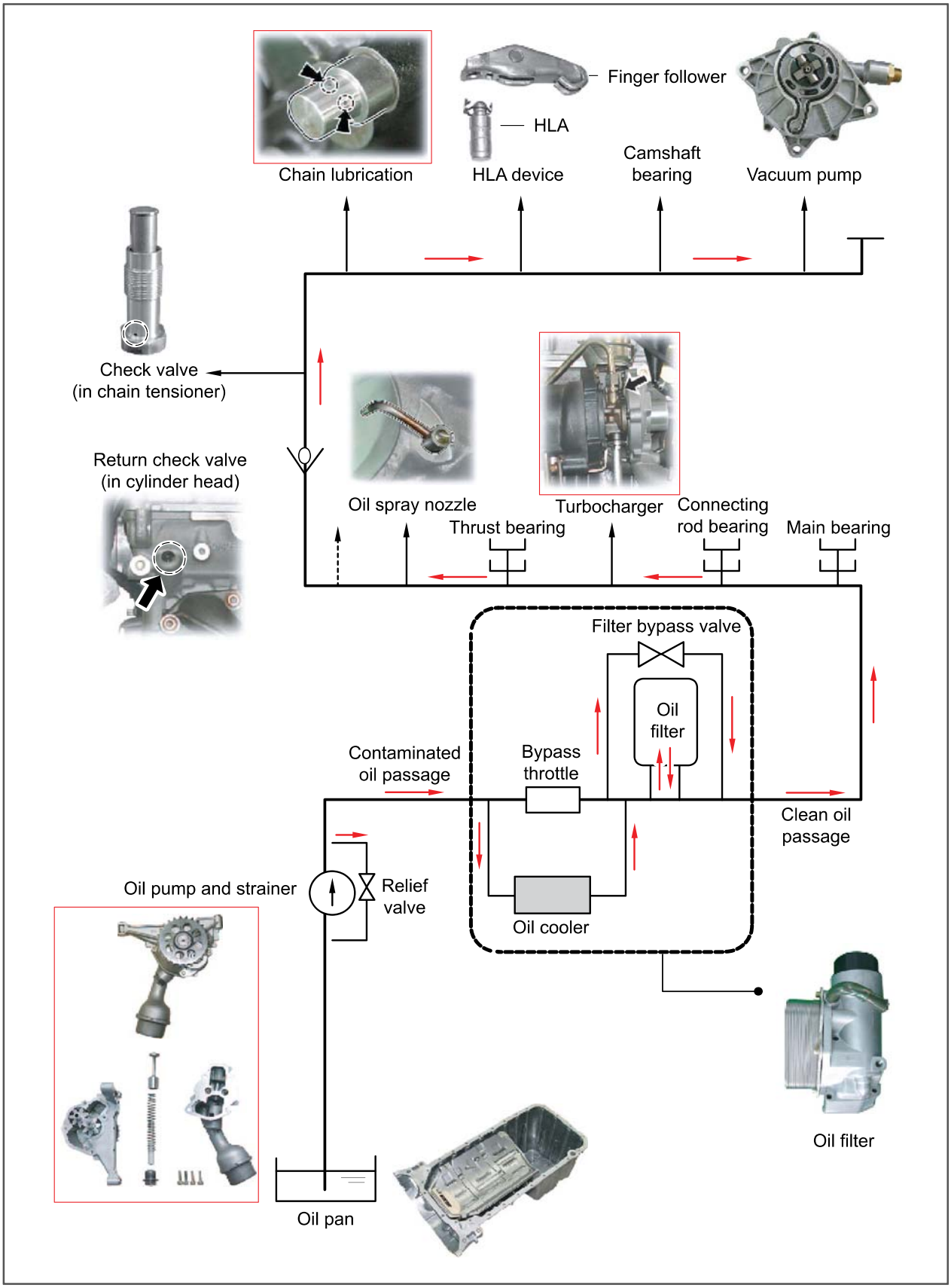
Cylinder Head Cover



Oil Pressure Switch

Modification basis	
Application basis	
Affected VIN	

2. SCHEMATIC DIAGRAM



Modification basis	
Application basis	
Affected VIN	

COOLING SYSTEM

9210-05

GENERAL INFORMATION

1. LAYOUT OF COOLING SYSTEM

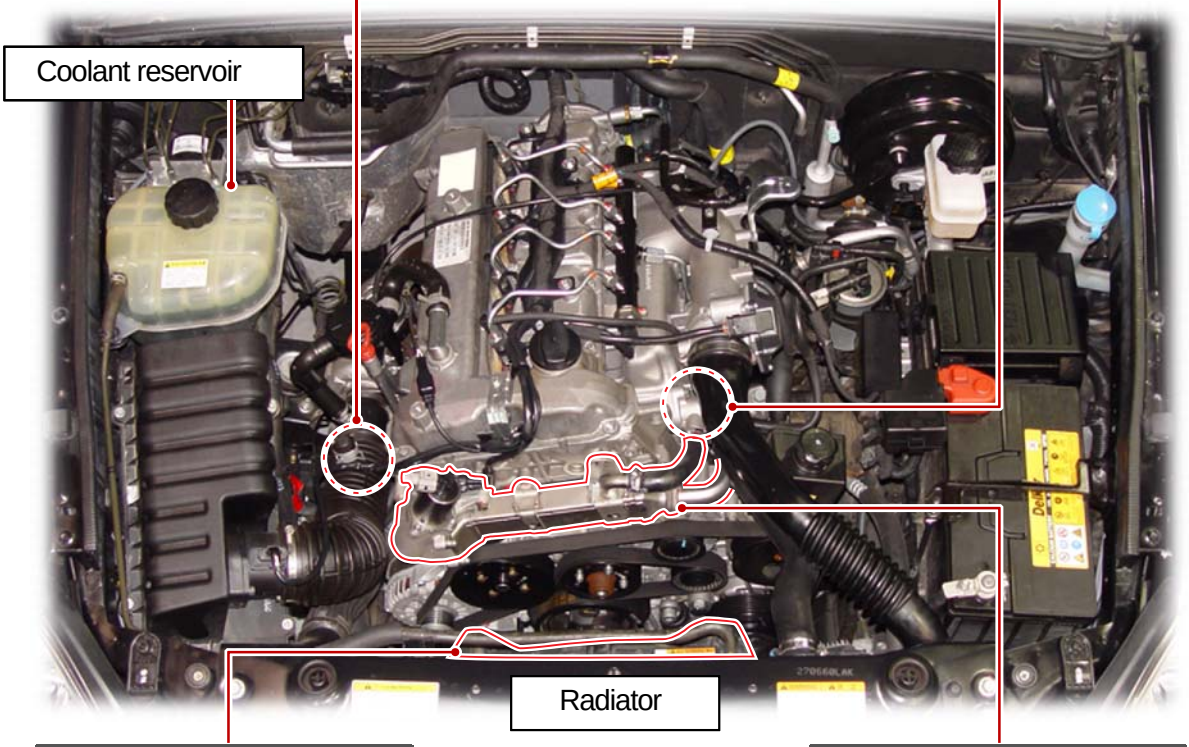
Water Pump

Port to EGR cooler



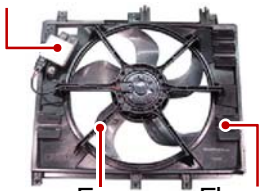
Coolant Port





PWM Fan Assembly

PWM fan unit



EGR Cooler

From coolant port



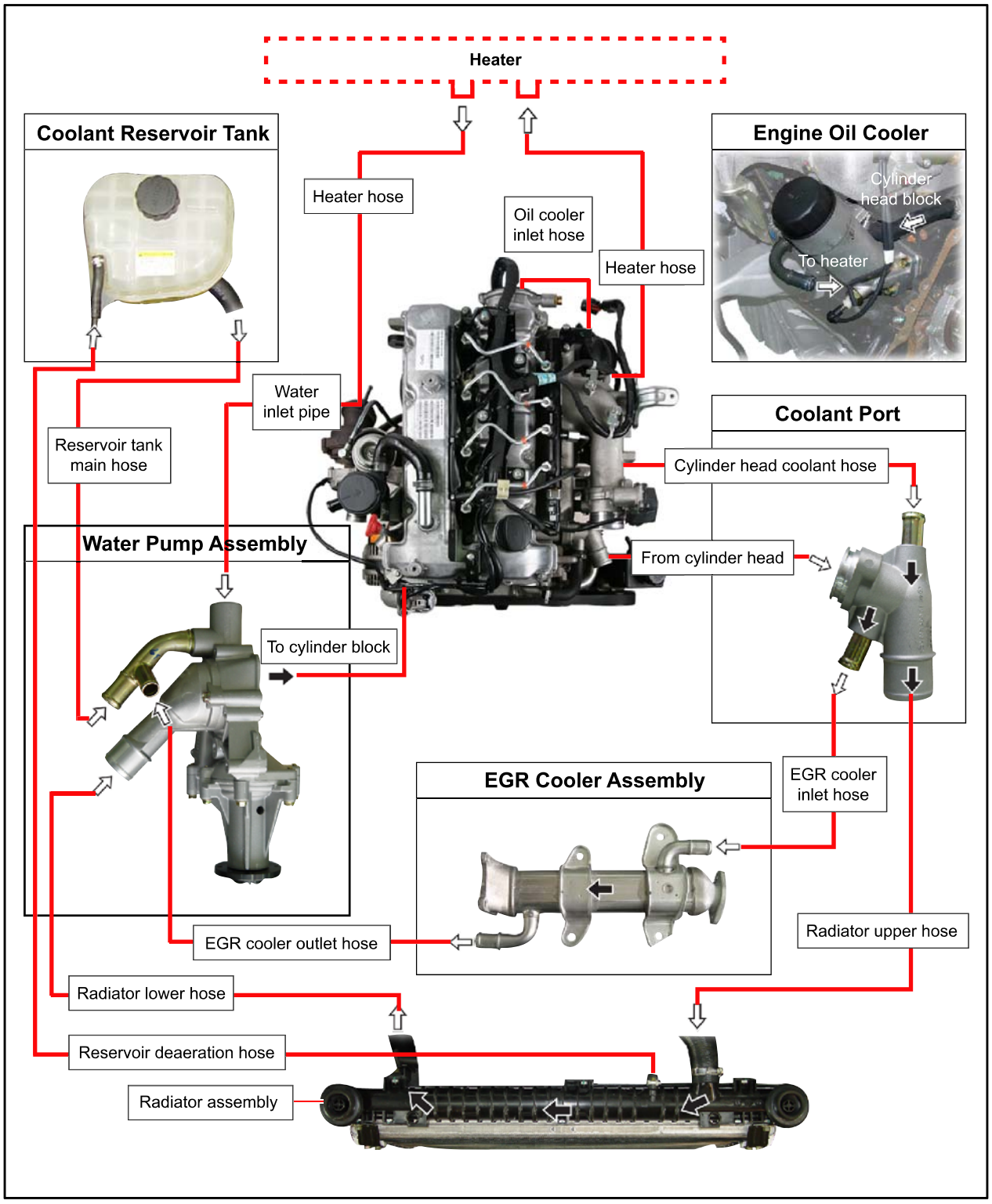
To water pump

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATION PROCESS

1. COMPARISON IN COOLING SYSTEM FOR EACH ENGINE

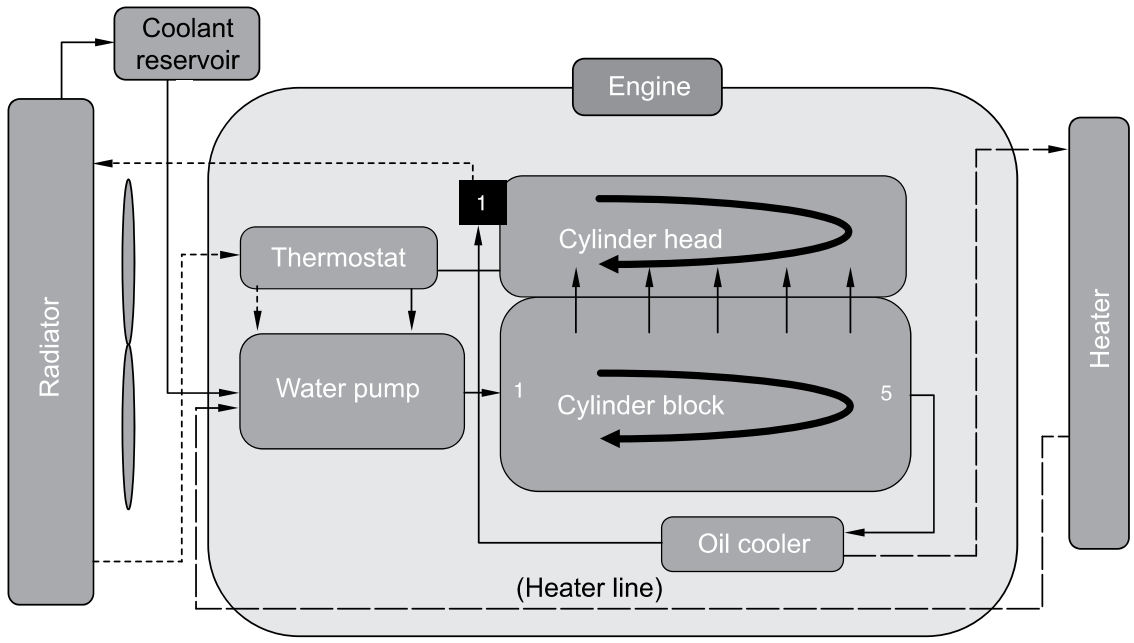
For the D20DT (EURO4) engine, the cooling system is equipped with E-EGR cooler and the water pump which its capacity is improved according to the additional coolant line in the cylinder block.



Modification basis	
Application basis	
Affected VIN	

2. SCHEMATIC DIAGRAM

Coolant Flow in Engine



- Cylinder block side
  Block #5 → Oil cooler → Heater → Heater water pump inlet pipe → Water pump
- Cylinder head side
  Cylinder head → Coolant outlet port (intake #1) → Radiator → Water pump

ENGINE ELECTRIC SYSTEM

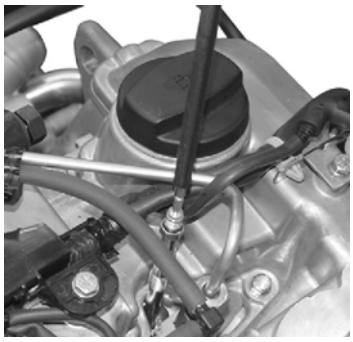
0000-00

GENERAL INFORMATION

1. SPECIFICATIONS

Description			Unit	Specification
Starter	Type		-	WP220
	Output power		KW	2.2
	No load test (12 volts)		A	160
	Drive pinion speed at no load		rpm	4500
	Drive pinion speed at load		rpm/A	1700/430
	Brush length		mm	18
	Armature diameter		mm	55
	Armature run-out		mm	0.1
	Segment groove depth		mm	21.7
Alternator	Type		-	CSI128D
	Output voltage/current		V/A	PTC equipped vehicle: 12V-140A FFH equipped vehicle: 12V-115A
	Regulator type		-	←
	Regulating voltage		V	14.6
	Brush	Length	mm	12.5
		Quantity	-	2
		Wear limit	mm	7
Battery	Type		-	M F
	Capacity		AH	12V - 90AH
Glow plug	Reserved capacity		RC	160
	Type		-	Seized type
	Rated voltage		-	11.5
	Circuit connection		-	Parallel
	Preheating time		sec	Max. 60 (at-35℃)

2. SPECIAL SERVICE TOOL

Name	Description
Glow plug remover	Tool for removing the glow plug from cylinder head 

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATION PROCESS

1. LAYOUT OF PRE-GLOW SYSTEM

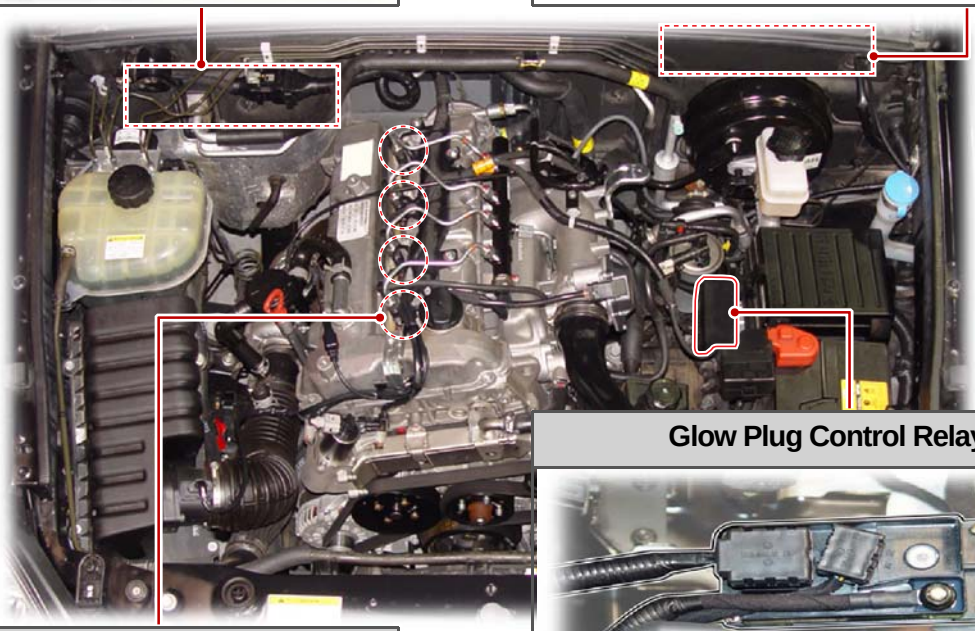
The pre-glow system in D20DT engine has four glow plugs. And, the terminal T for pre-glow completion signal is not used since the remote start function has been deleted.

Engine ECU



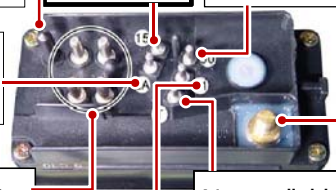
Pre-glow Indicator (Instrument cluster)



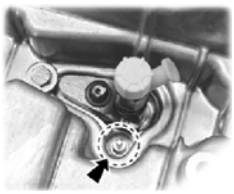


Glow Plug Control Relay





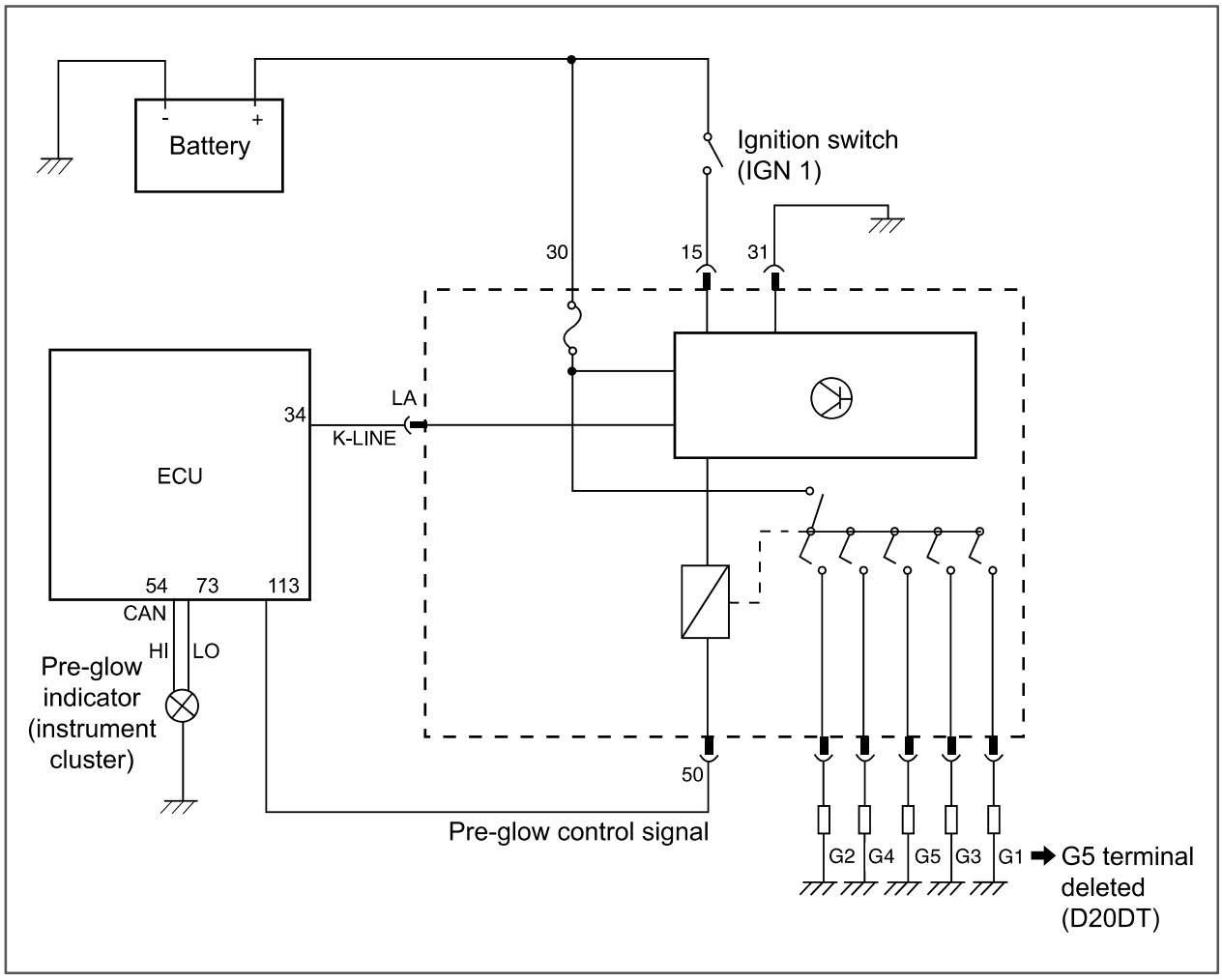
Glow Plug



Tightening torque
15 ±3 Nm



▶ Circuit Diagram



▶ Specifications

Description	Specification
Rated voltage	DC 12V
Operating voltage	DC 8~15V
Operating temperature	−40 ~ 100°C
Relay operating voltage	Over 6.5V
Relay OFF voltage	OVER 1.5v
Relay coil resistance	11.3Ω
Voltage drop	Below 150Mv in each glow plug (Current: 16A)
Parasitic current	Max. 1mA

Modification basis	
Application basis	
Affected VIN	

2. OPERATION

1) Operation

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

1. Pre-heating

If normal communication with the ECU is established 2 seconds after the power is supplied to the IGN terminal from the battery, the ECU supplies the battery voltage to glow plugs.

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

Pre-heating	Coolant temperature	−35°C	−25°C	−20°C	−10°C	0°C	10°C	20°C
	Operating time	31s	22s	19s	17s	14s	0s	0s
	Operating conditions	- IGN: ON - B+: below 15.2 V			Stop conditions	- Time-out - IGN: OFF - when engine cranking		

2. Post-heating during engine running

The post-heating controlled by ECU begins its operation after engine start

- The time for post-heating controlled by the ECU starts from engine start. This improves the idling conditions and reduces the emission and noise.

Post-heating	Coolant temperature	−30°C	−20°C	−10°C	0°C	10°C	20°C	35°C
	Operating time	115s	80s	30s	19s	11s	11s	0s
	Operating conditions	- after engine start			Stop conditions	-Time-out - Torque: 190/170Nm - rpm: 2100/2050		

2) System Check

▶ **Glow Plug**

- Check for short in each glow plug
- Check for open due to over-voltage in each glow plug
- Check for open to ground in glow plug

▶ **Forced Shut-off of Relay**

- When the glow plug circuit is open to ground.

▶ **K-Line Communication**

- ECU starts to communicate by sending the result to pre-glow timer relay through K-Line.
- Pre-glow timer relay sends the message with self-diagnosis data for glow plug to ECU.
- The glow plug responses only for request.
- ECU starts self-diagnosis operation from 2 seconds after power input.
- Communication error occurs when:
  - · No response from pre-glow module for a certain period of time
  - · Checksum error
  - · Insufficient byte

3) DTC

DTC	Description	Error
P1678	GCU circuit is open	GCU circuit is open
P1679	GCU circuit is short	GCU circuit is short
P1680	GCU circuit is short to ground	GCU circuit is short to ground
P1676	Communication error	Communication error between ECU and GCU
P1677	Defective GCU	Communication error between ECU and GCU
P0671	GCU channel 3 opened circuit	GCU channel 3 circuit is open
P0672	GCU channel 4 opened circuit	GCU channel 4 circuit is open
P0674	GCU channel 1 opened circuit	GCU channel 1 circuit is open
P0675	GCU channel 2 opened circuit	GCU channel 2 circuit is open

Modification basis	
Application basis	
Affected VIN	

CRUISE CONTROL

8510-23

OVERVIEW AND OPERATING PROCESS

1. SYSTEM DESCRIPTION

1) System Description



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 38 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.

Modification basis	
Application basis	
Affected VIN	

2) 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

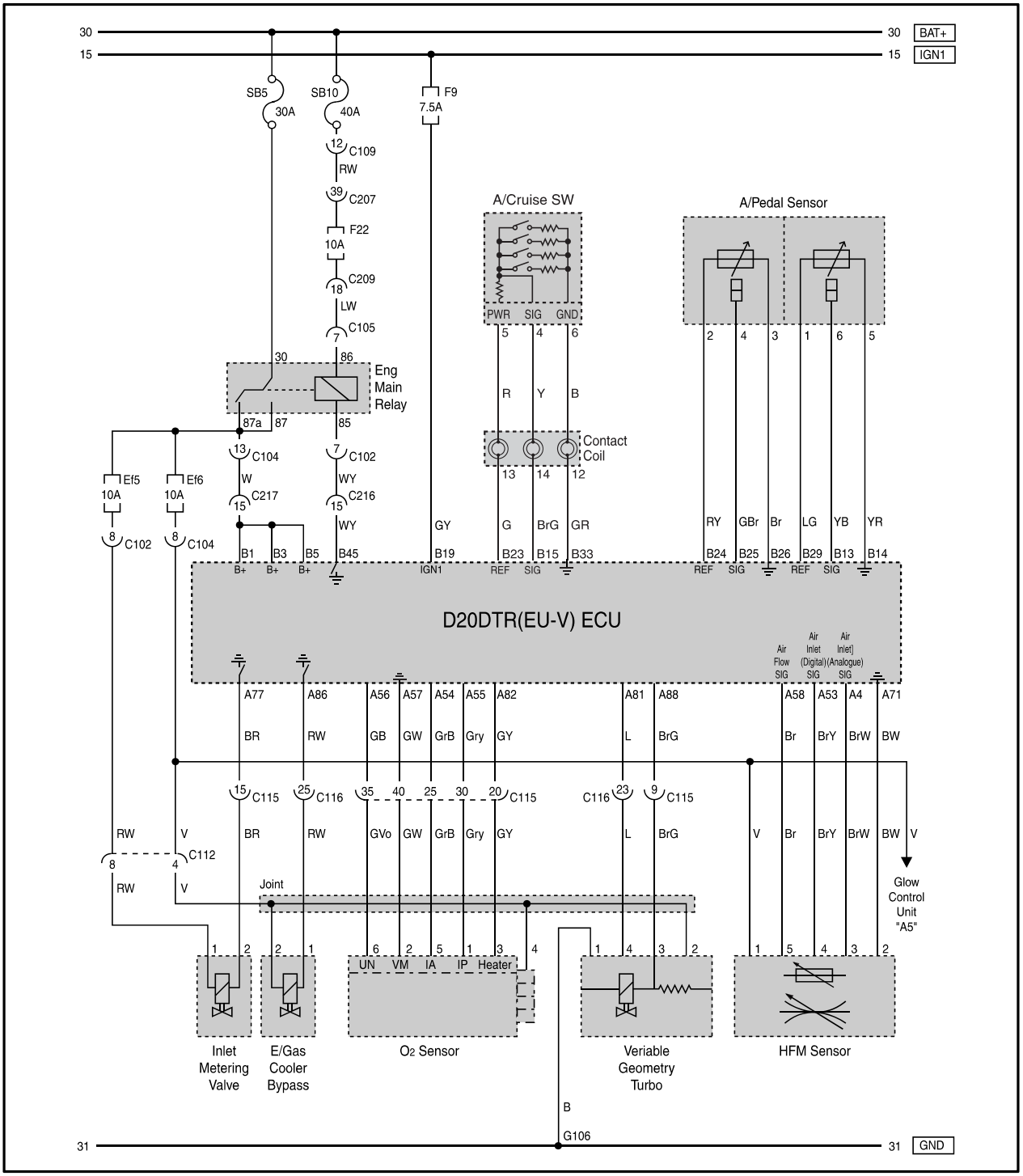
Improper use of the cruise control could be dangerous.
- Do not use on winding roadsyy .
- Do not use in heavy traffic.
- Do not use on slippery, wet roads.

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

Modification basis	
Application basis	
Affected VIN	

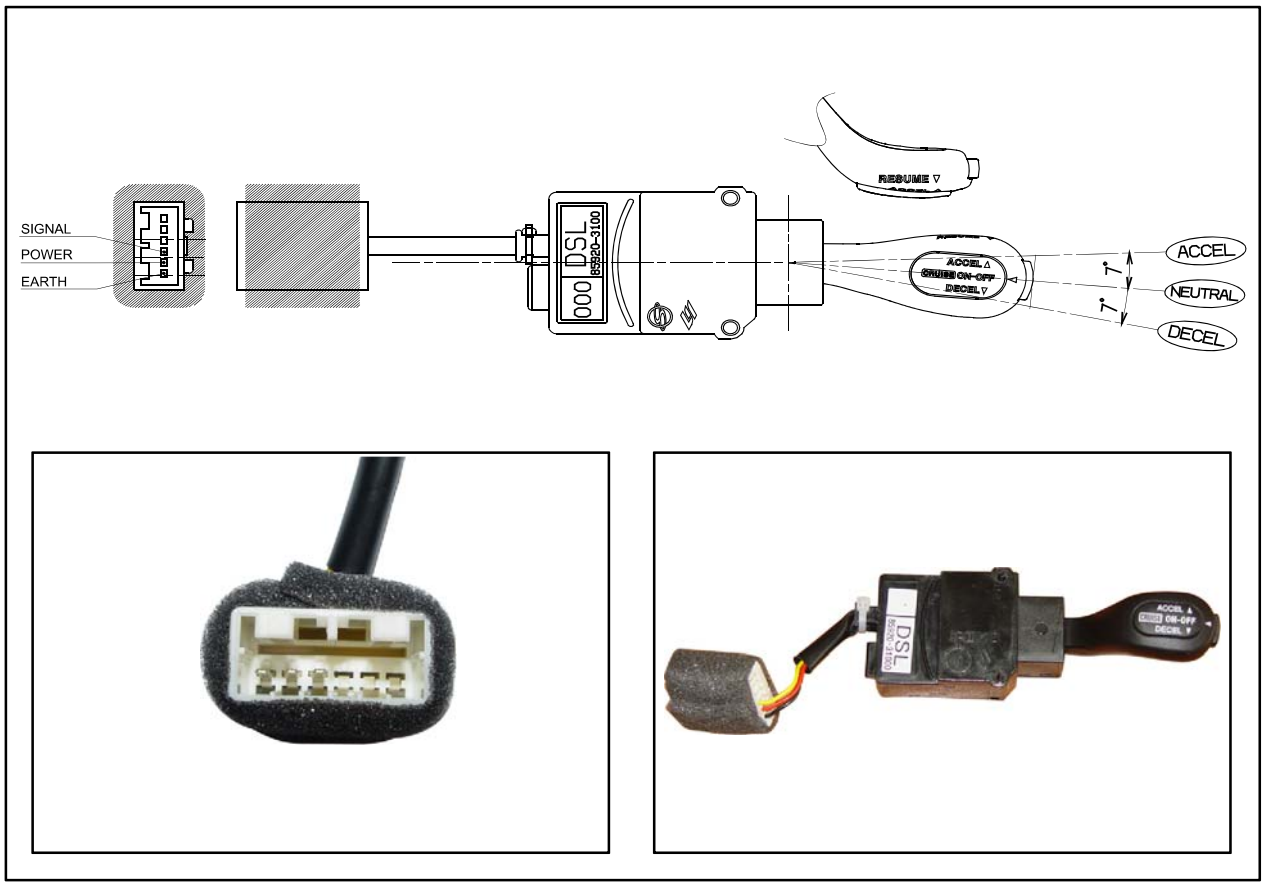
2. CONFIGURATION

1) Circuit Diagram



The engine ECU detects the operating conditions of cruise control system, and monitors the braking performance, vehicle speed, road conditions and ESP system operation. If the engine ECU determines that there are not any problem to drive in cruise control mode, the vehicle can be operated by cruise switch signals (decelerating, accelerating, cruising).

2) Configuration



▶ **Test voltage(VCC 5V)**

FUNCTION	KEY VOLUE	REMARK
MAIN	0.15 ~ 0.55V	-
DECEL	0.7 ~ 1.1V	-
ACCEL	1.6 ~ 2.0V	-
RESUME	2.52 ~ 2.92V	-

Modification basis	
Application basis	
Affected VIN	

3. OPERATION

1) Setting a Desired Speed



1. To operate the cruise control, accelerate to the desired speed, which must be more than 36 km/h and less than 150 km/h.
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. Now, the vehicle is cruised by this system with the set speed. You don't need to use the accelerator
3. pedal.
   Refer to the following pages for details of operation.
4.

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.

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) When the cruise control system is not running

To increase the speed with the cruise control system while the system is not running, follow the procedures below.

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

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

To increase the vehicle speed in stages while the cruise control system is running, follow the procedures below.

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. When you operate a tap-up switching, the vehicle is accelerated for 1.3 km/h over the previous set speed.
2. If you want to accelerate for 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

To decrease the vehicle speed with the cruise control system when the system is not running, follow the procedures below.

1. Push down the cruise control switch lever to DECEL side and hold it until the desired speed is reached while the vehicle speed is over 36 km/h.
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

To decrease the vehicle speed in stages while the cruise control system is running, follow the procedures below.

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. When you operate a tap-down switching, the vehicle is decelerated for 1.0 km/h below the previous set speed.
   If you want to decelerate for 10 km/h, operate the tap-down switching ten times without the brake pedal
2. intervention.

4) Recovery of Set Speed (RESUME)



Even if the cruise control is cancelled, the previous set cruise speed can be recovered by pulling up 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

But the driver should know the previous set speed to react to the changed vehicle speed properly. If the vehicle speed increases abruptly, depress the brake pedal to adjust the vehicle speed properly.

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 or When ESP is activated.
2. When the cruising speed is downed less than 34 km/h
3. When applying the parking brake during driving.
4. When using the clutch in order to shift (M/T only).

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.
   When the rapid acceleration is applied without acceleration pedal intervention.
2. When the cruise control lever is faulty.
3. When the brake switch and the brake light switch input signal are implausible.

When the cruise control function is cancelled abnormally or intermittent problems occur, stop the vehicle and turn off the ignition switch and remove the key to reset the system. After a while, turn on the ignition switch again to operate the cruise control system.

CAUTION

1. Do not move the shift lever to Neutral position while driving with the cruise control turned on. Otherwise, it may result in system malfunction or accidents.
2. Always be prepared to use the brake or accelerator pedal for safe driving while the cruise control system is running.
3. The actual speed can be different from the set speed momentarily when driving on a uphill or downhill. So, it is recommended to disable the cruise control function on a uphill or downhill. hen driving on a steep hill use the engine brake and foot brake properly to protect the vehicle system and for a safe driving.
4. Ensure that the safe distance is maintained and use the brake pedal if needed.

Modification basis	
Application basis	
Affected VIN	

NO DATA

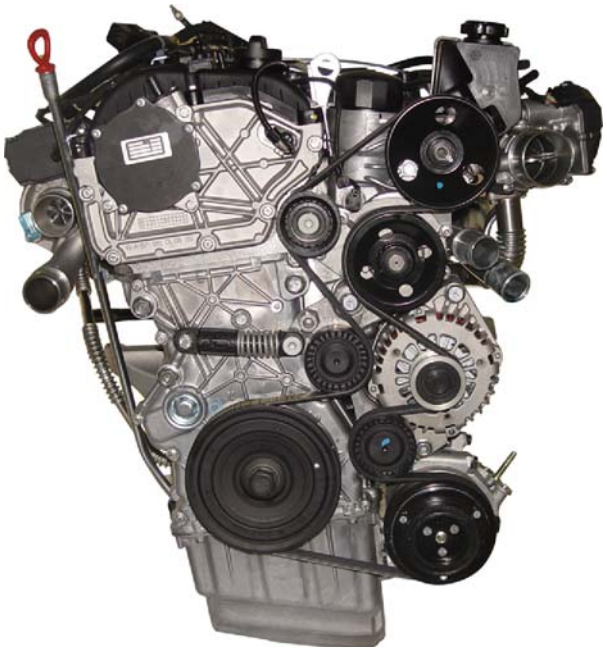
ENGINE GENERAL

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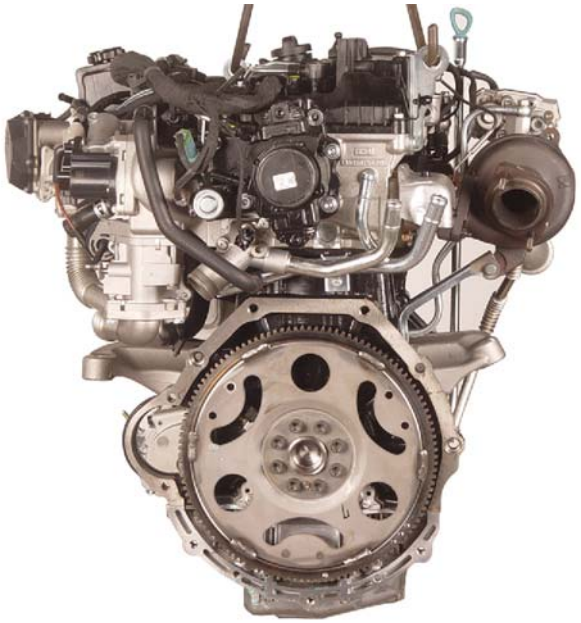
GENERAL INFORMATION

1. ENGINE LAYOUT

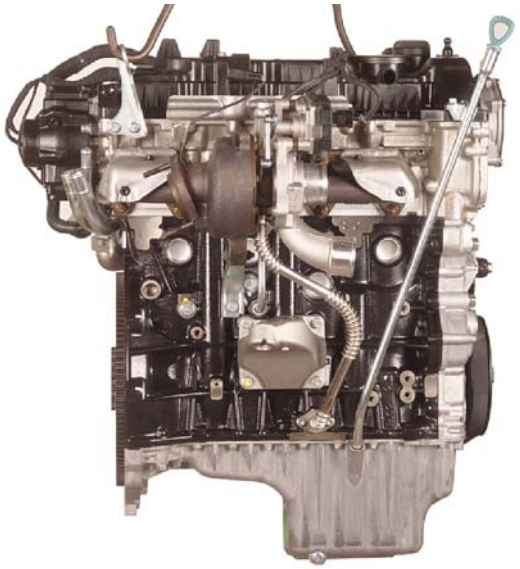
Front view



Rear view



Right view



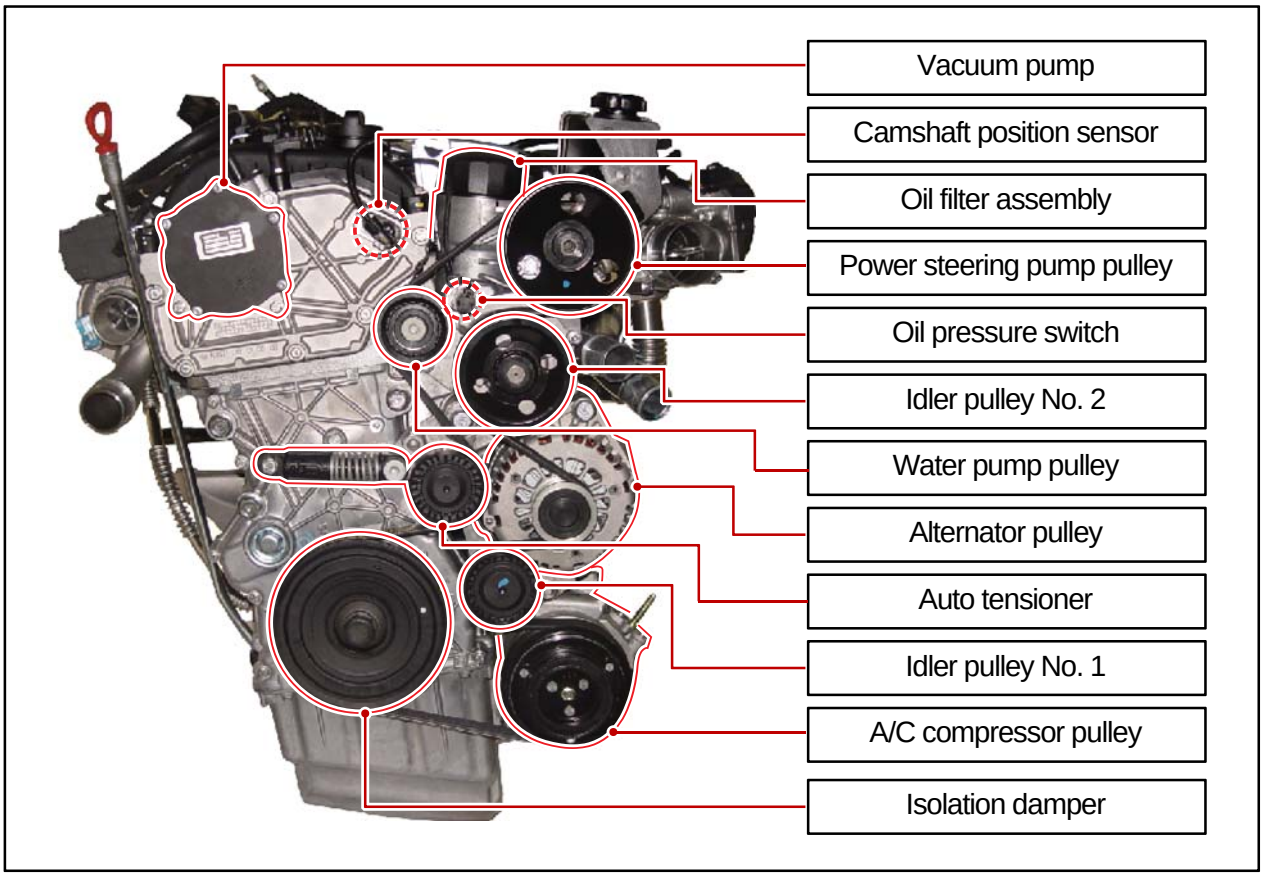
Left view



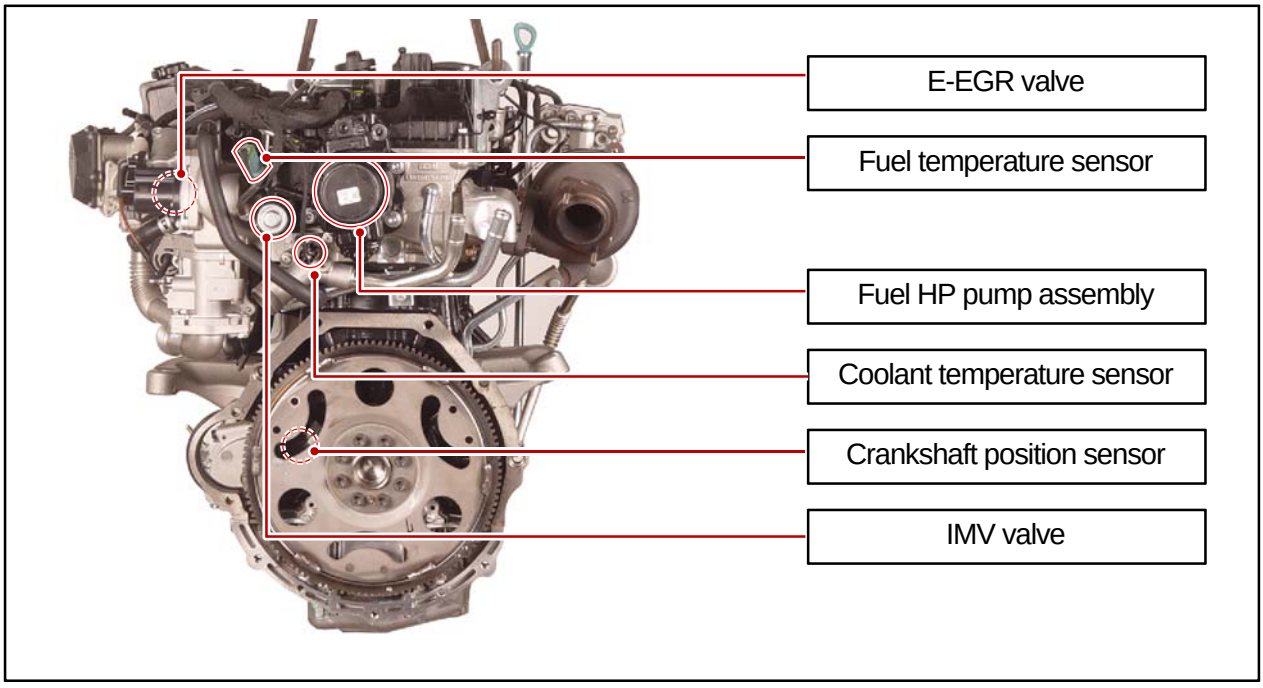
Modification basis	
Application basis	
Affected VIN	

2. MAJOR COMPONENTS

▶ **Front view**

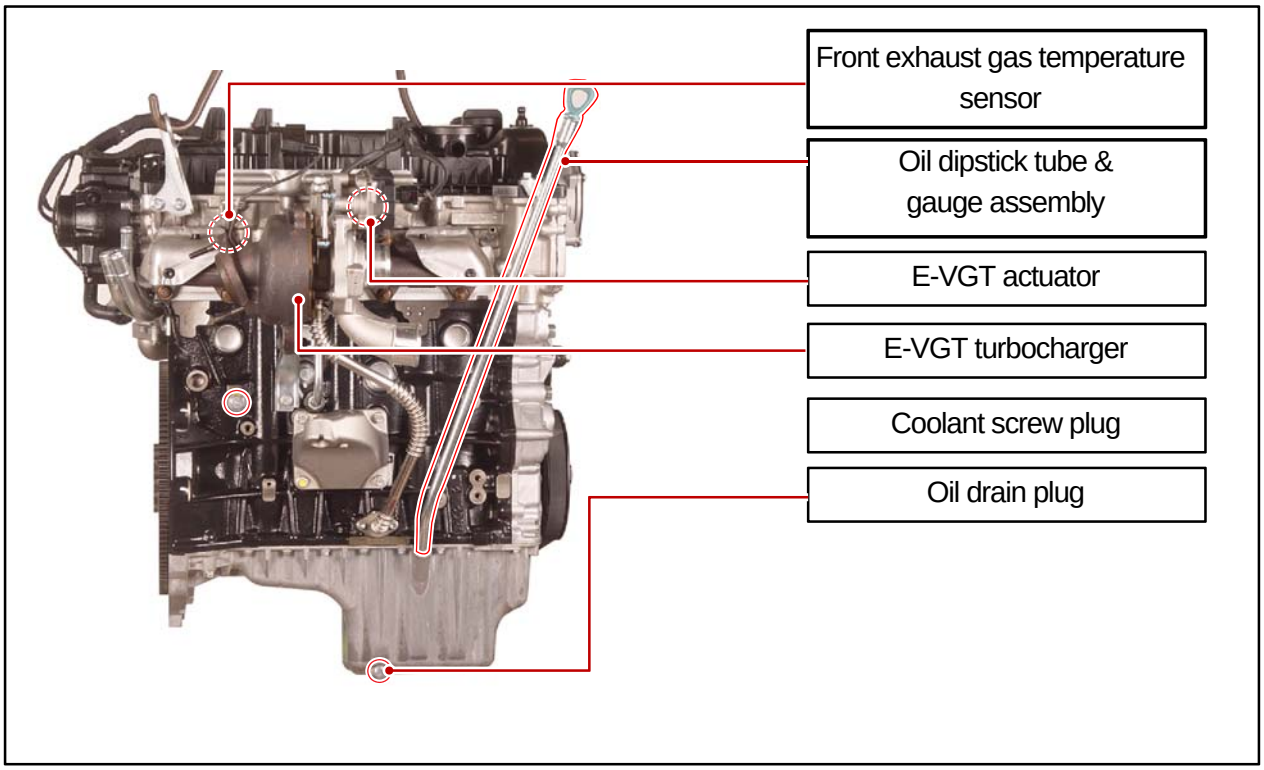


▶ **Rear view**

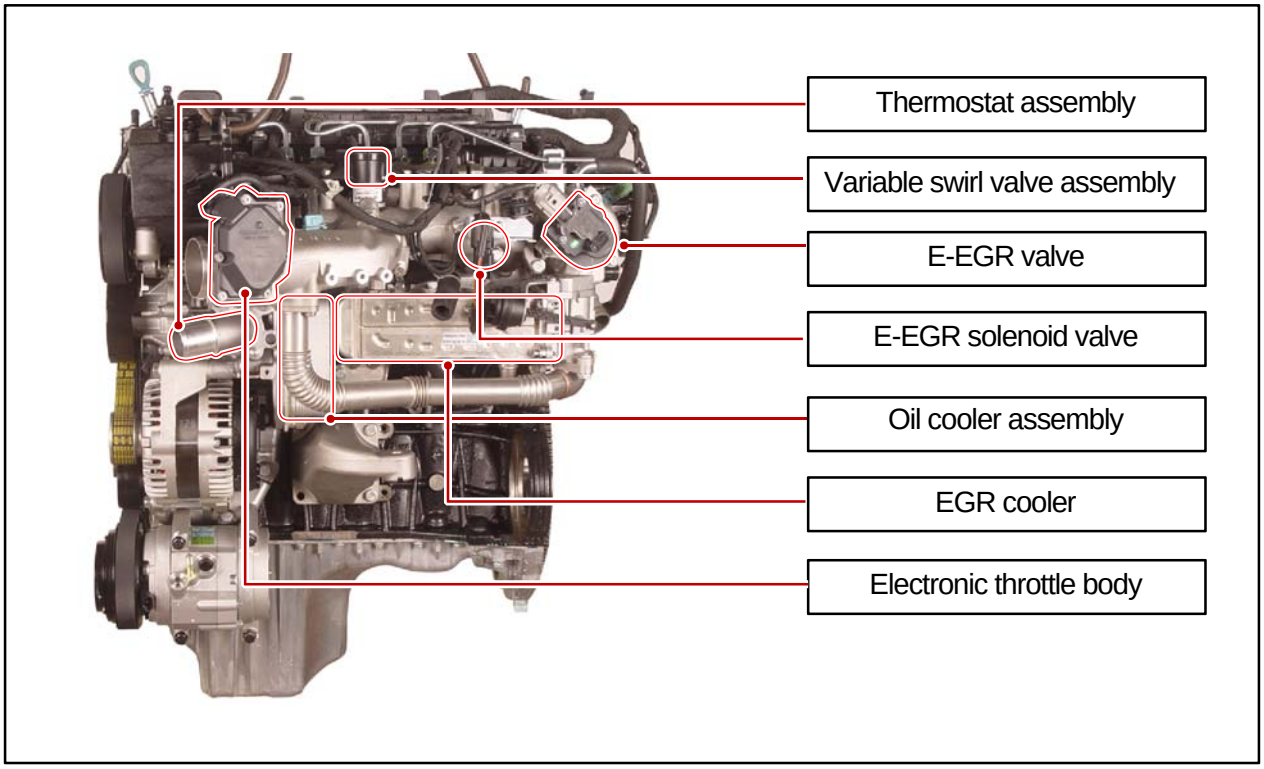


Modification basis	
Application basis	
Affected VIN	

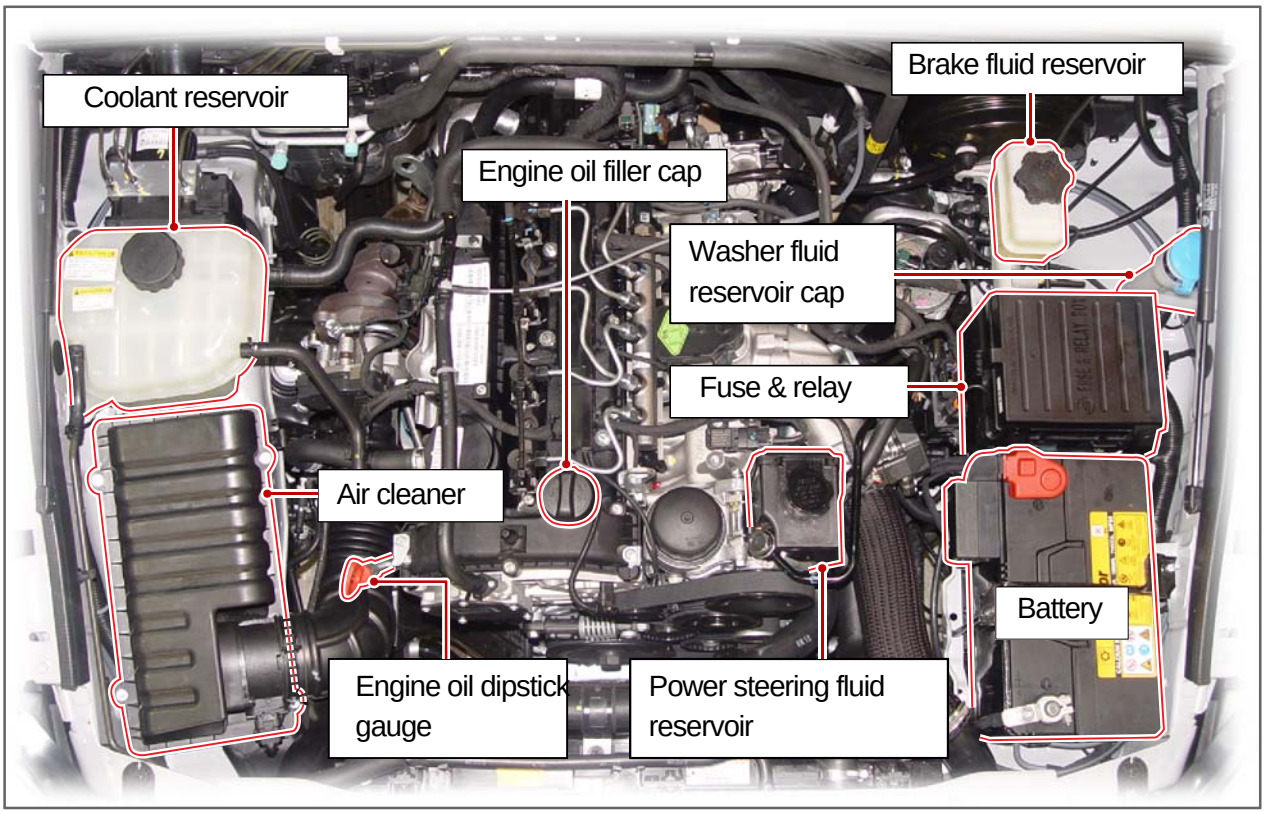
▶ Right view



▶ Left view



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	Diesel	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)
			Gasoline	Clean every 15,000 km, replace every 60,000 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 (Total Quartz INEO ECS 5W 30, SK ZIC SY 5W 30) or oil Approved by MB Sheet 229.51
	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)

Modification basis	
Application basis	
Affected VIN	

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.

(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.

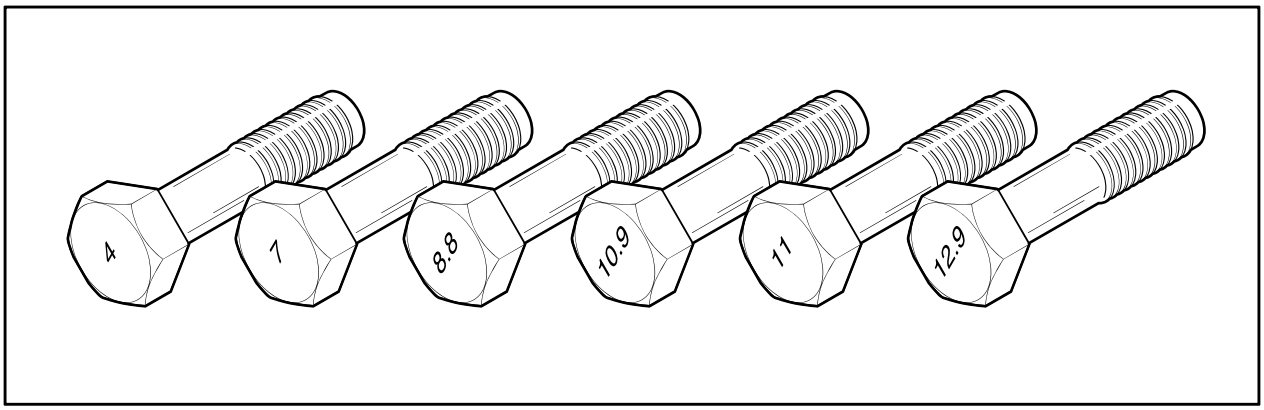
NOTE

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.

Modification basis	
Application basis	
Affected VIN	

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.

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	-

Modification basis	
Application basis	
Affected VIN	

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	-

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	-

Modification basis	
Application basis	
Affected VIN	

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

D20DTR ENGINE ASSEMBLY

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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		0.5 to 0.31 mm	-
Camshaft	Axial end play	Intake	0.1 to 0.35 mm	-
		Exhaust	0.1 to 0.35 mm	-
Camshaft position sensor	Distance between Camshaft position sensor and sprocket		0.20 to 1.80 mm	-
Valve	Clearance between valve and piston	Intake	0.6 to 1.0mm	-
		Exhaust	0.6 to 1.0mm	-
	Valve recess	Intake	0.6 to 1.0mm	-
		Exhaust	0.6 to 1.0mm	-
Cylinder block	Piston protrusion		0.475 to 0.745mm	-
Piston ring	TOP ring end gap		0.20 to 0.35 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	0.475~0.540	1.2t	-
		0.541 to 0.649	1.3t	-
		0.650 to 0.745	1.4t	-

Modification basis	
Application basis	
Affected VIN	

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**

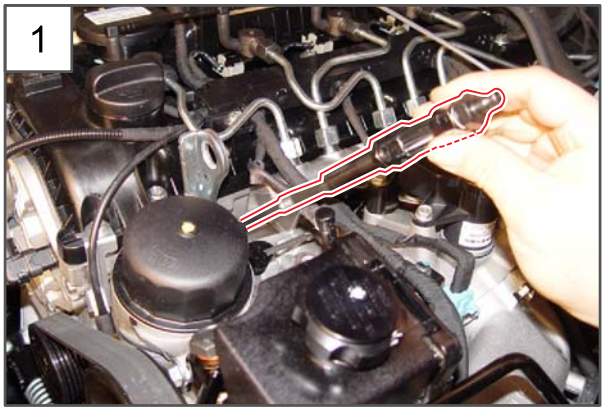
Compression ratio		16.5 : 1
Test condition		at normal operating temperature (80°C)
Compression pressure	**Standard**	32 bar
	Minimum	18 bar
Differential limit between cylinders		Maximum 3 bar

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%

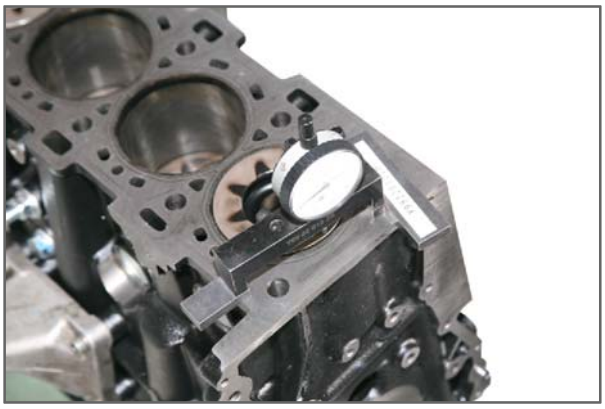
If the measured value of the compression pressure test is not within the specifications, perform the cylinder pressure leakage test.

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

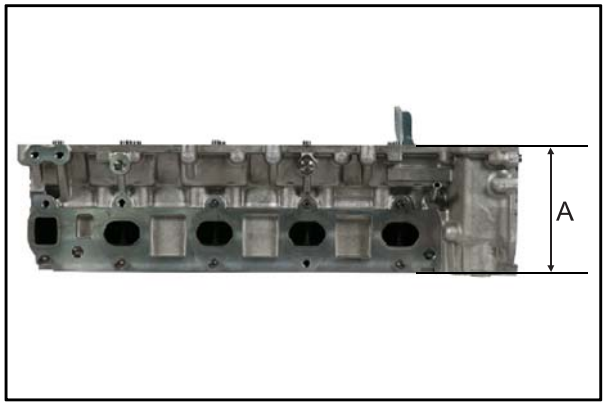
- Measure it at both ends of crankshaft.

2) Cylinder Head

(1) Cylinder head mating surface check

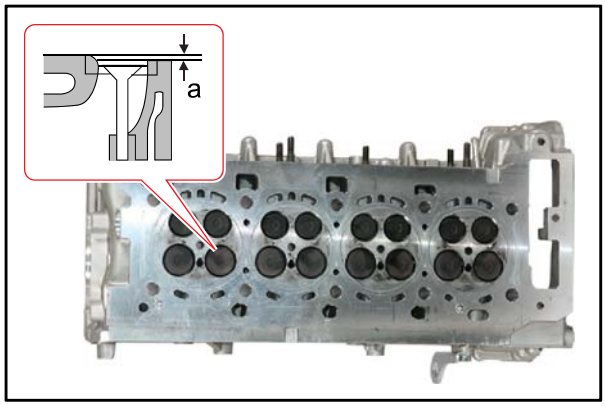
▶ **Specified value**

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.

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

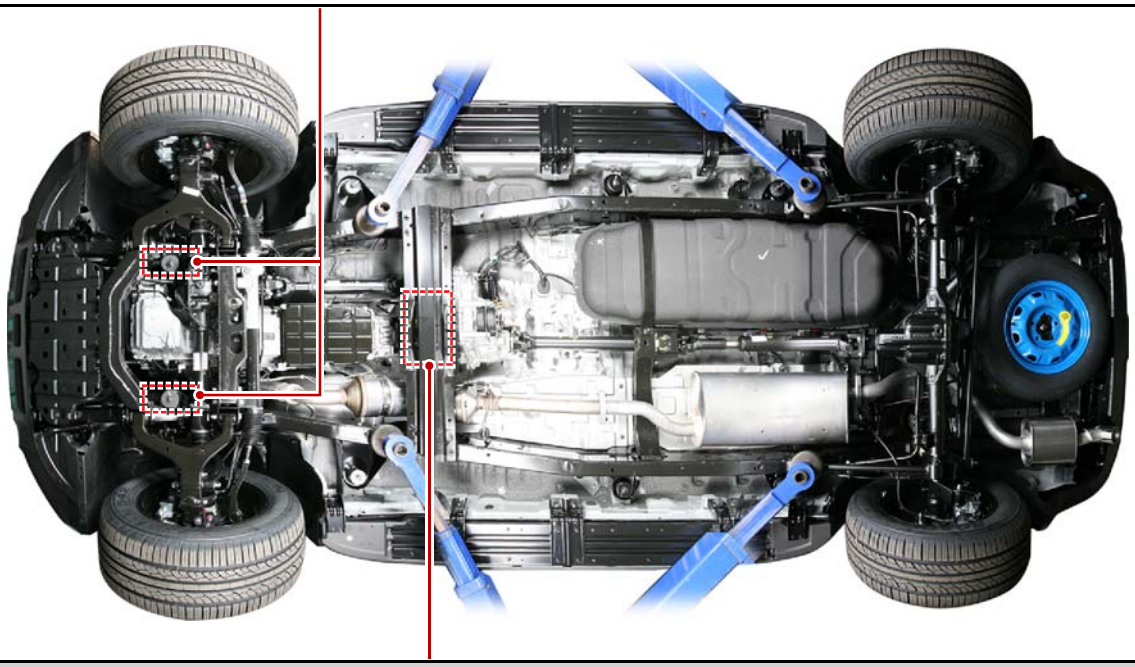
Electric devices should be handled more carefully.
Currently, the engine has a lot of electric devices. there could be poor engine performance, incomplete combustion and other abnormal symptoms due to short circuit or poor contact.

- 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	

5. MAJOR CHANGES

Front mounting insulator(LH, RH)			
Old		New	
LH	RH	LH	RH
			
- The optimized engine mountings have been introduced after performing the system analysis and on-vehicle test.			



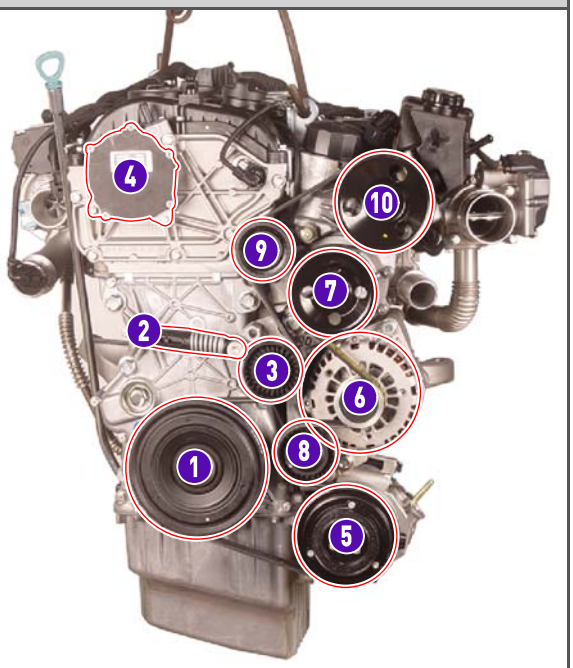
Rear mounting insulator	
Old	New
	
- The optimized engine mountings have been introduced after performing the system analysis and on-vehicle test.	

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

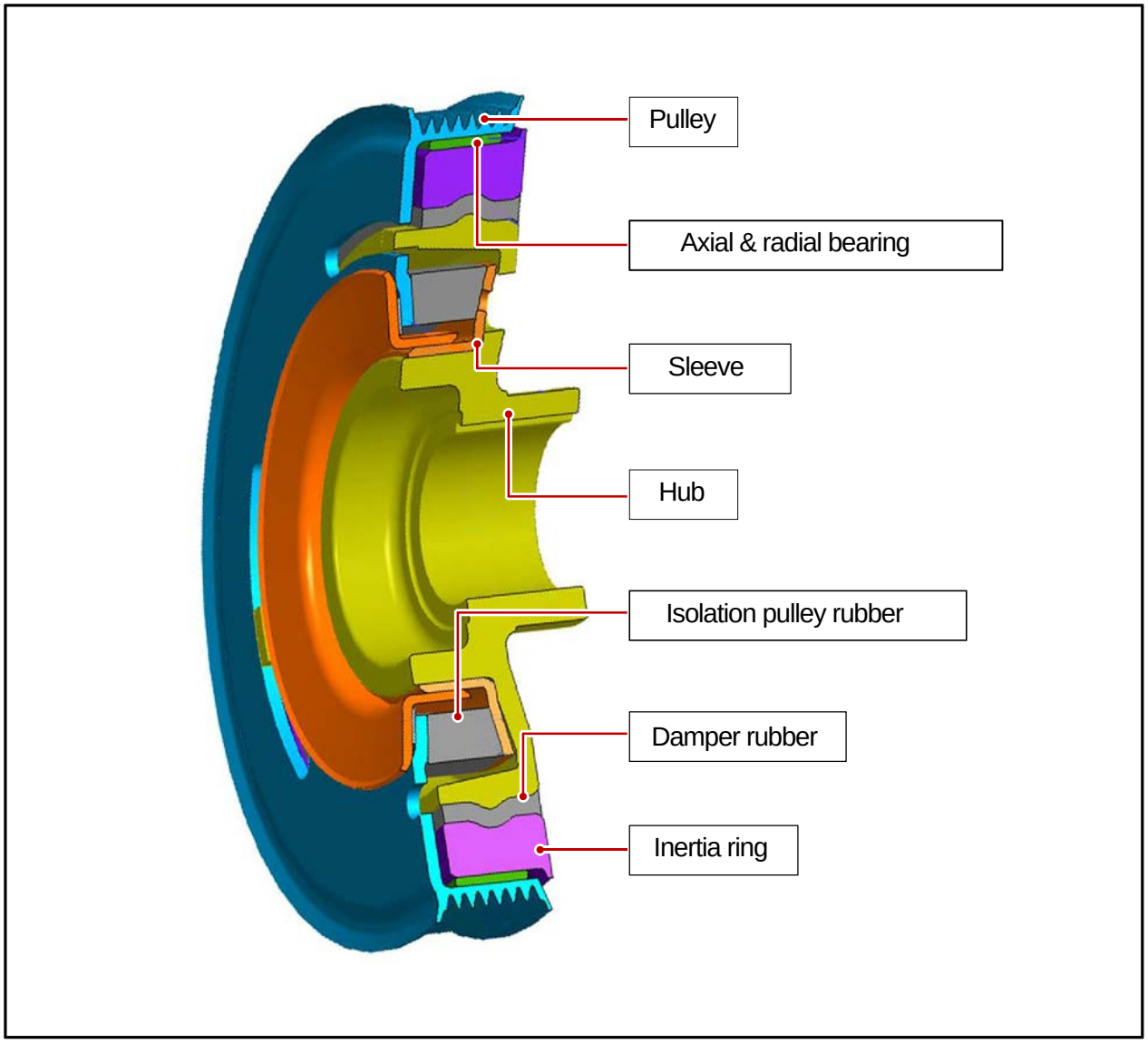
Modification basis	
Application basis	
Affected VIN	

1) Crankshaft Pulley (Isolation Damper)

(1) Overview

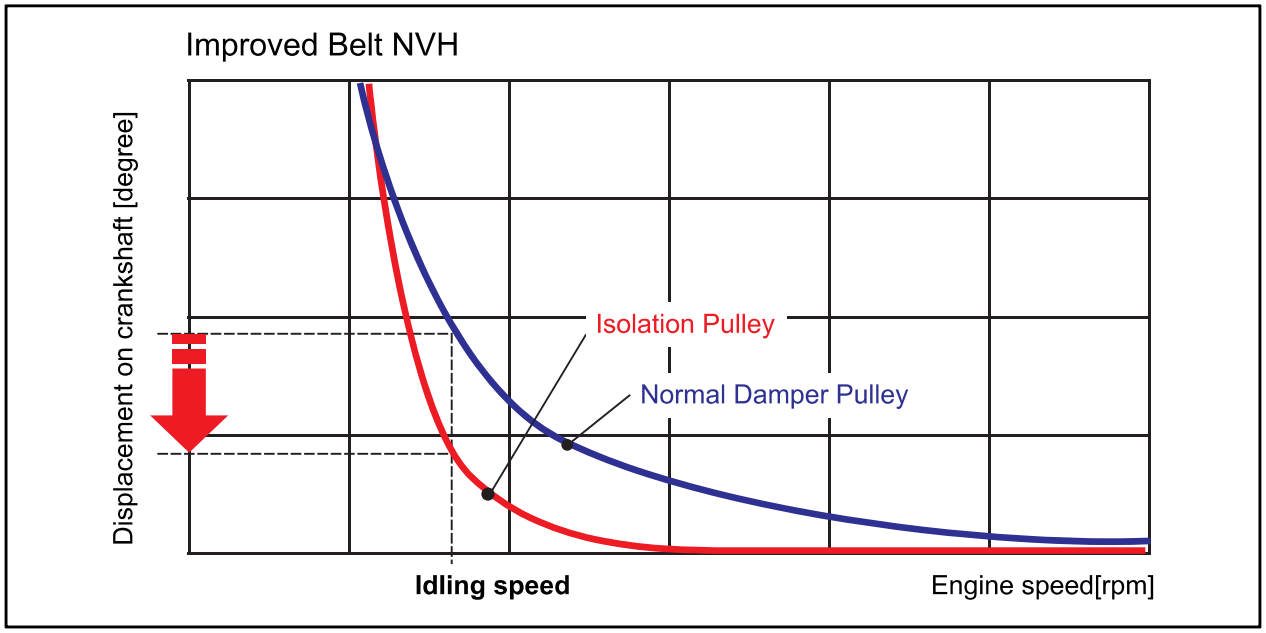
The strut type tensioner automatically adjusts the belt tension to provide the reliability and durability for the system. And, the belt tension is decreased to minimize the friction loss and improve the belt operating noise.

(2) Sectional drawing



(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



Modification basis	
Application basis	
Affected VIN	

2) Belt Tensioner

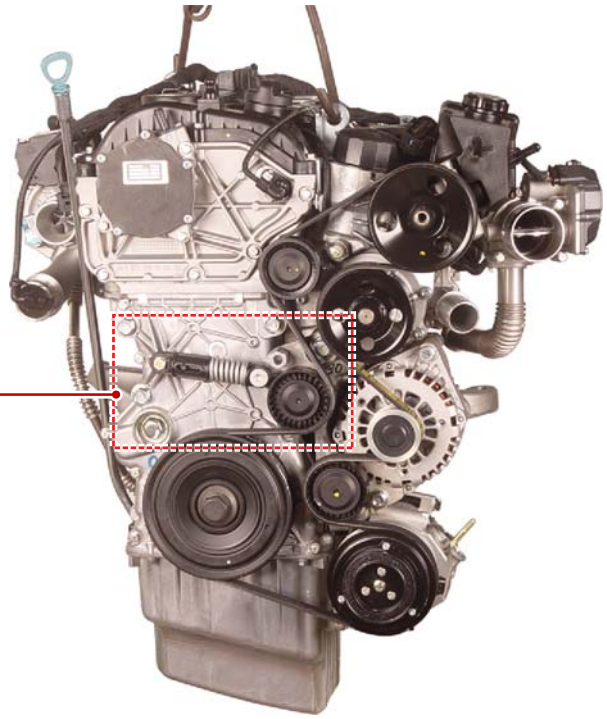
(1) Overview

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

Belt tensioner





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**

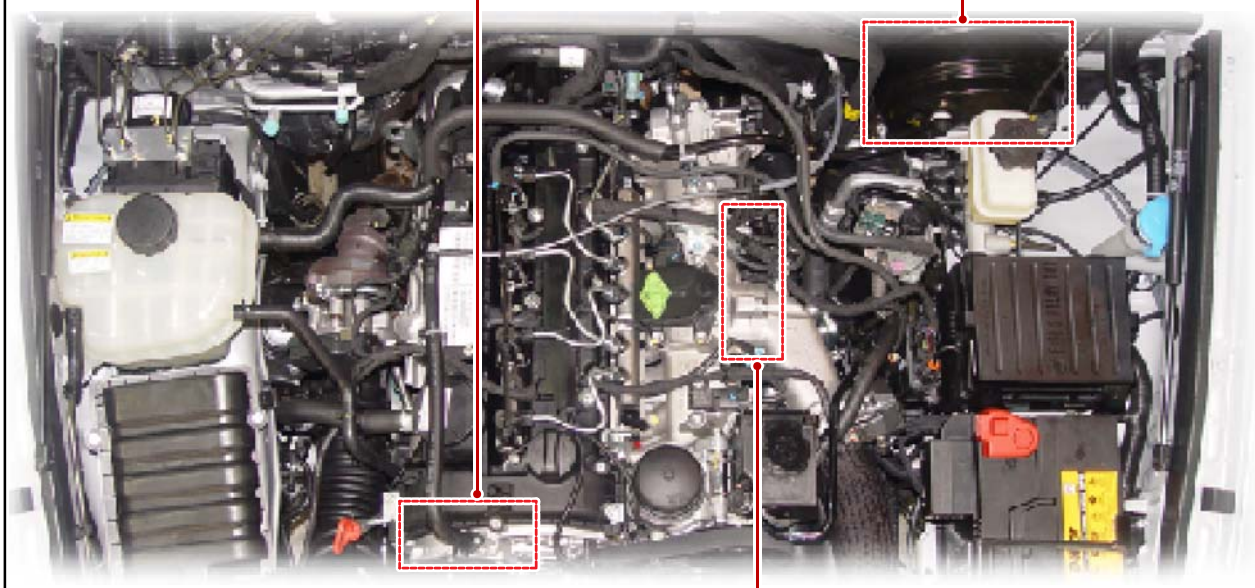
Vacuum pump



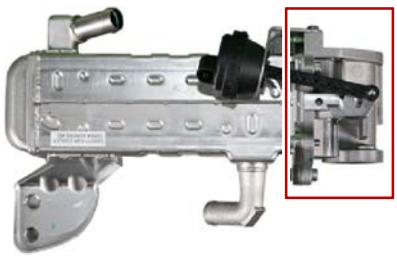
Pump capacity: 210 cc/rev
Camshaft speed: 375 to 3,000 rpm
Lubrication temperature: -40 to 155°C
Oil: 5W30
Drive type: Driven by exhaust Camshaft sprocket

Brake booster and naster cylinder





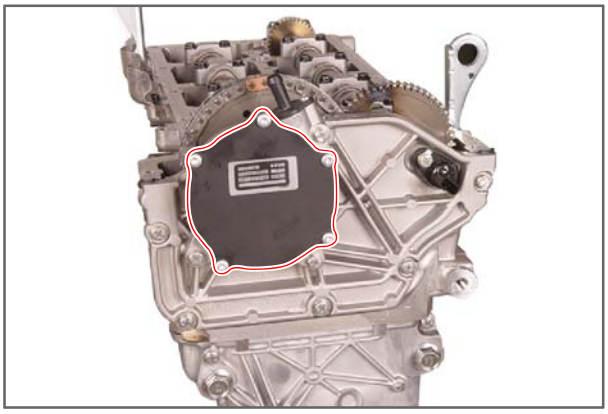
EGR cooler bypass valve



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.

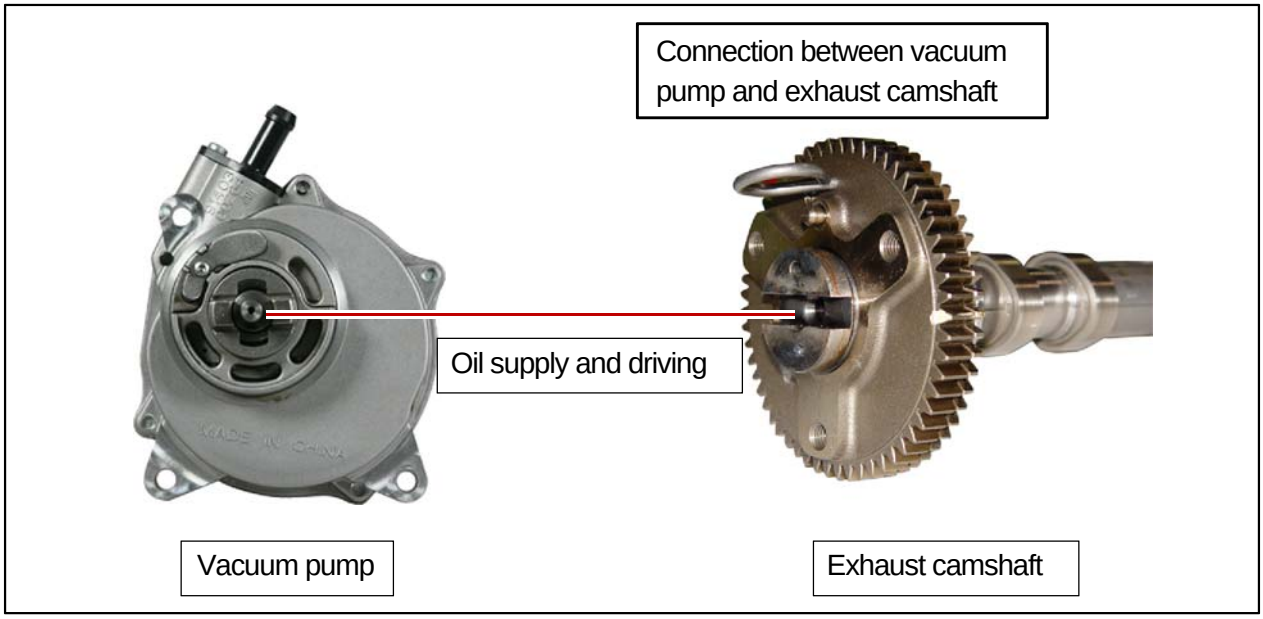
Modification basis	
Application basis	
Affected VIN	

1) Location



2) Operation

The vacuum pump is engaged to the exhaust camshaft.



Modification basis	
Application basis	
Affected VIN	

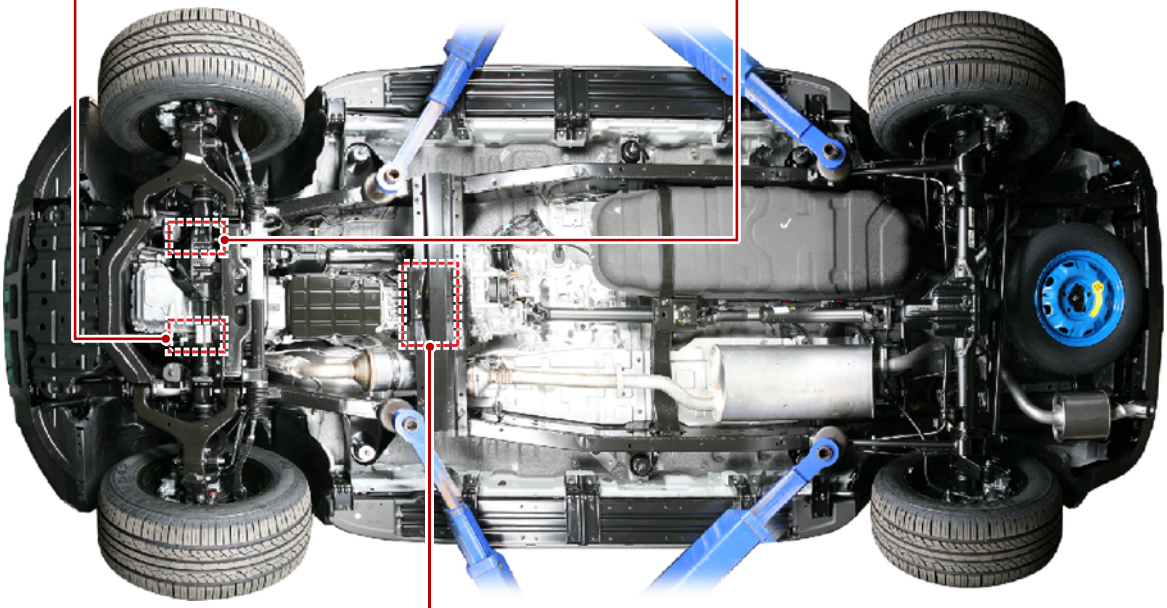
3. ENGINE MOUNTING

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
			

Modification basis	
Application basis	
Affected VIN	

1) Functions

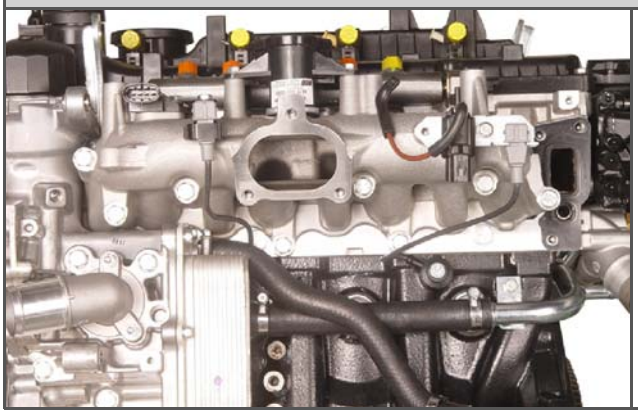
Appearance	Type and function
Front mounting insulator (Right side) 	Type: Rubber mounting Function: Supports the torque reaction
Front mounting insulator (Left side) 	Type: Rubber mounting Function: Supports the torque reaction
Rear mounting insulato 	Type: Rubber mounting Function: Supports the powertrain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

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**

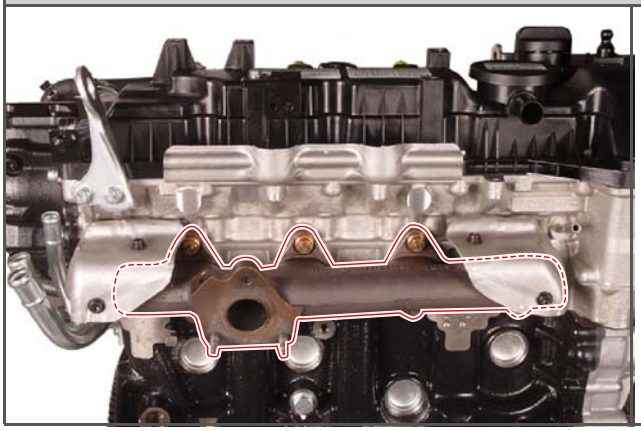
Intake manifold	
	

* 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".

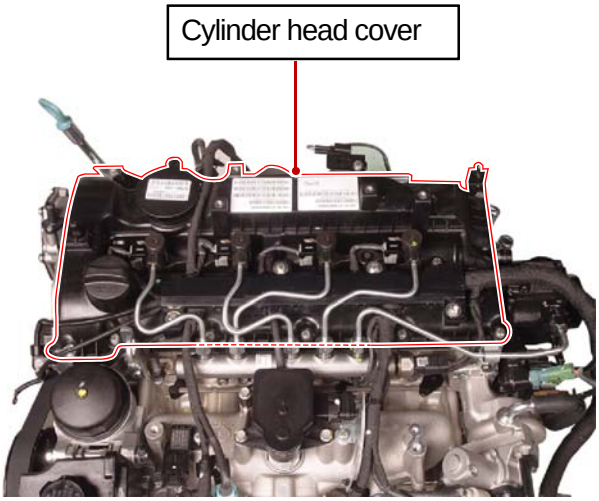
Modification basis	
Application basis	
Affected VIN	

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

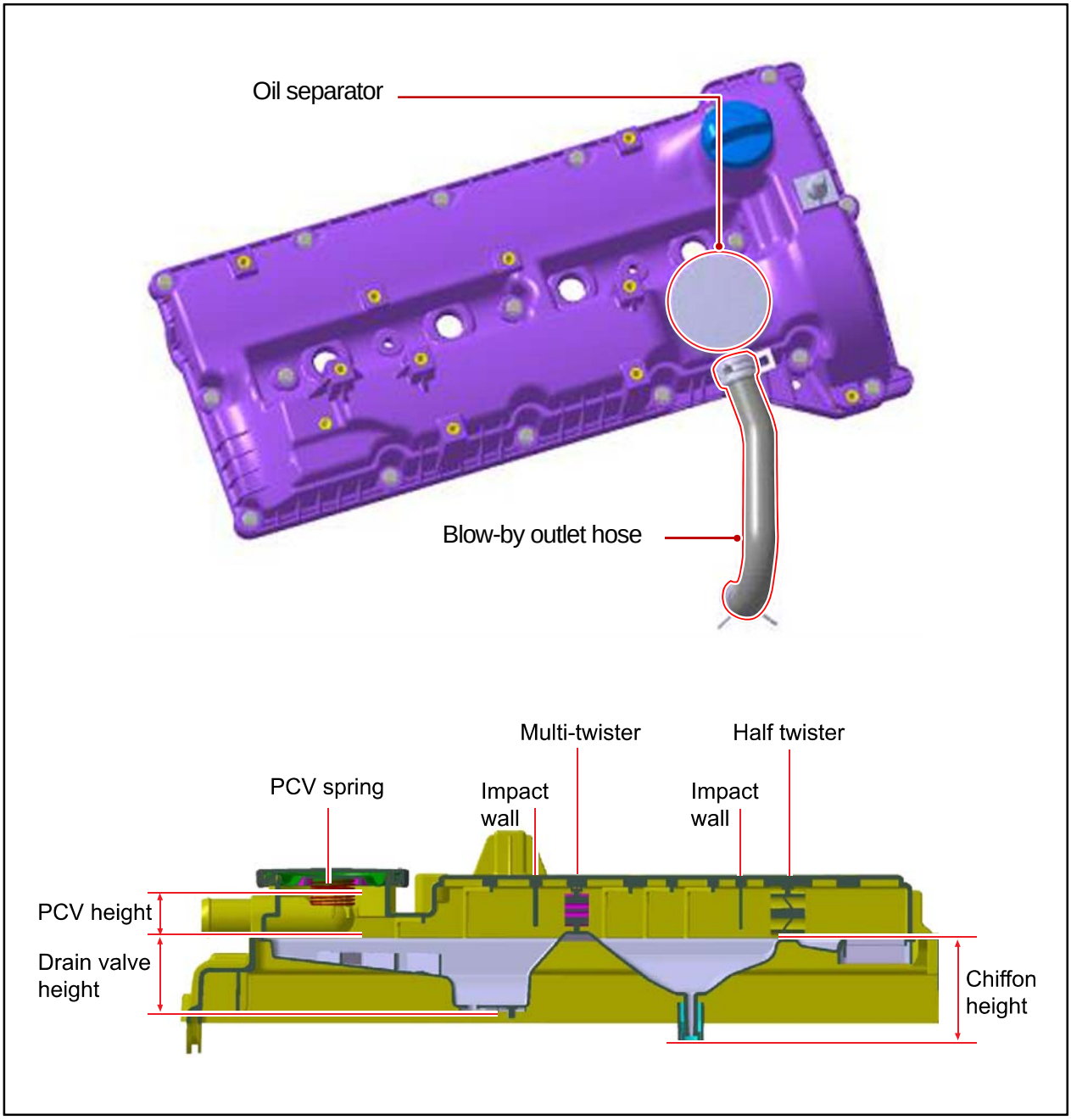


2) Oil Separator

(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



Modification basis	
Application basis	
Affected VIN	

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

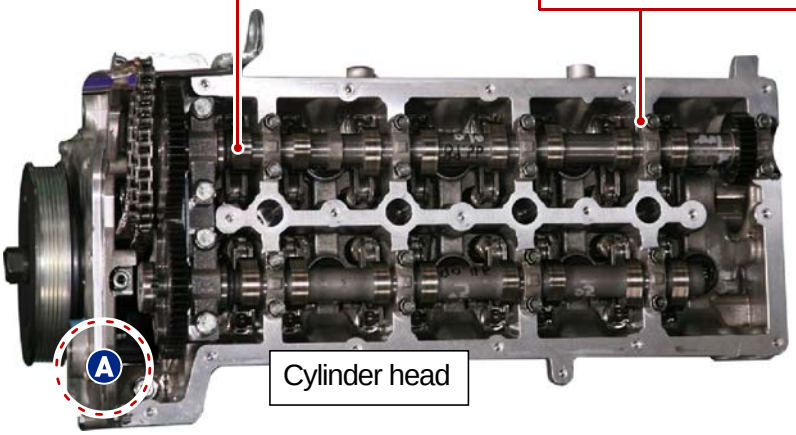


Intake/exhaust Camshafts



Camshaft sprocket





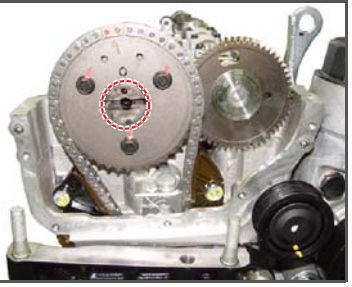
Camshaft position sensor



HP pump drive gear



Vacuum pump drive



Cylinder head gasket

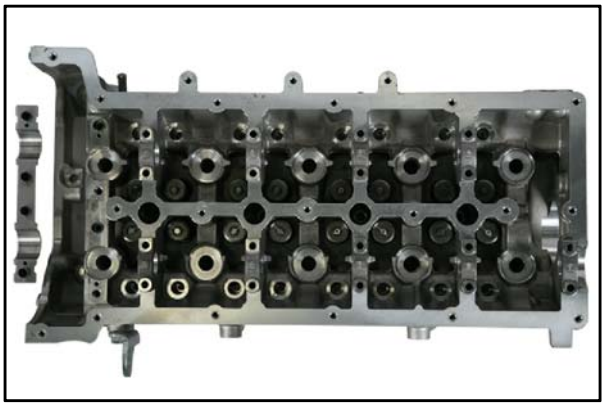


1) Cylinder Head

(1) Overview

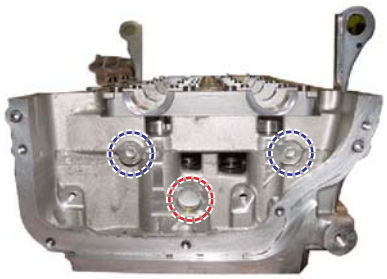
The cylinder is made by gravity casting and the water jacket is integrated type.
The cylinder oil passage is drilled and sealed by cap.
The Camshaft bearing cap is also made by casting and installed on the cylinder head.

(2) Features

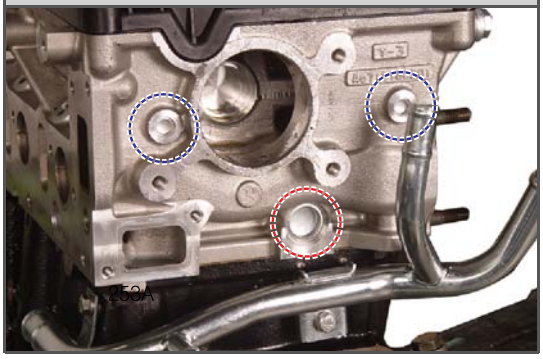


Location of Expansion Plugs

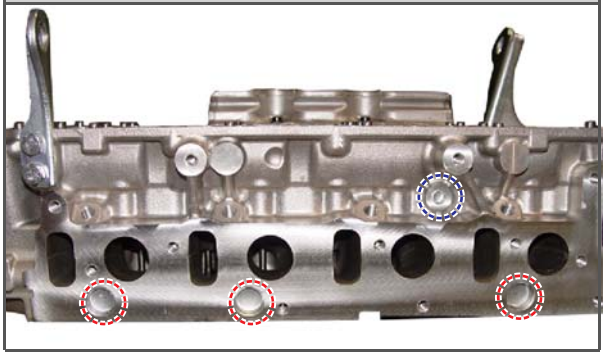
Front



Rear



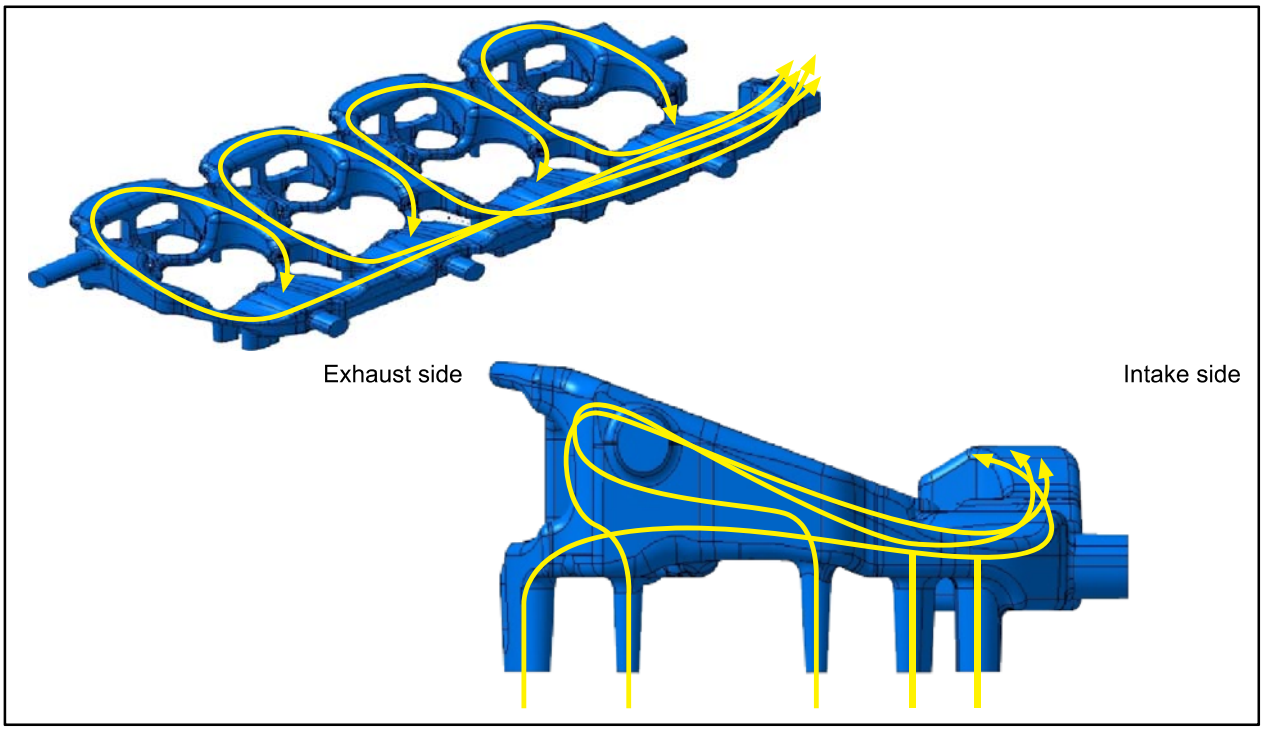
Intake side



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

Modification basis	
Application basis	
Affected VIN	

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



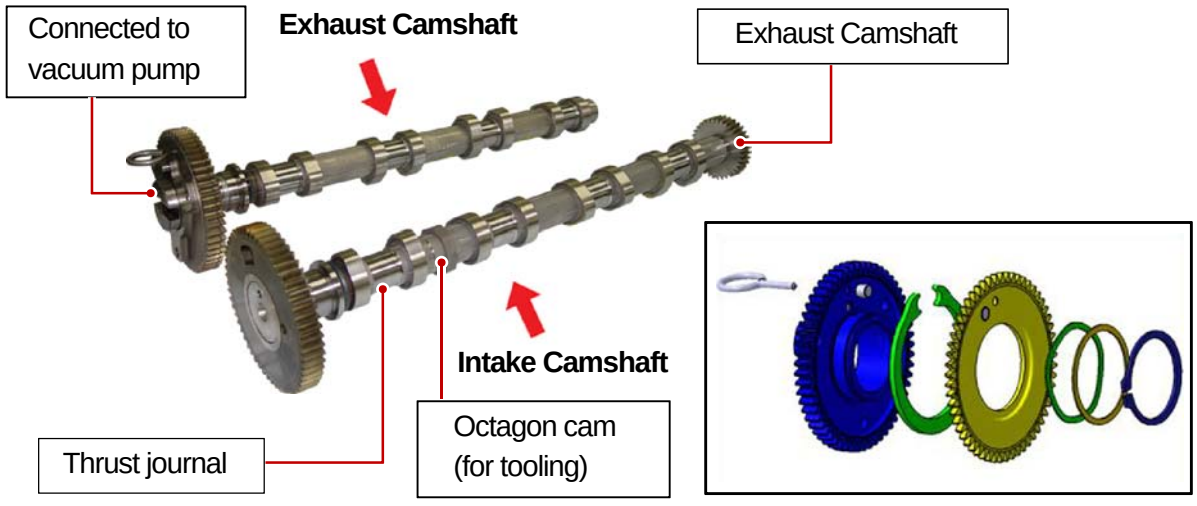
2) Camshaft

(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

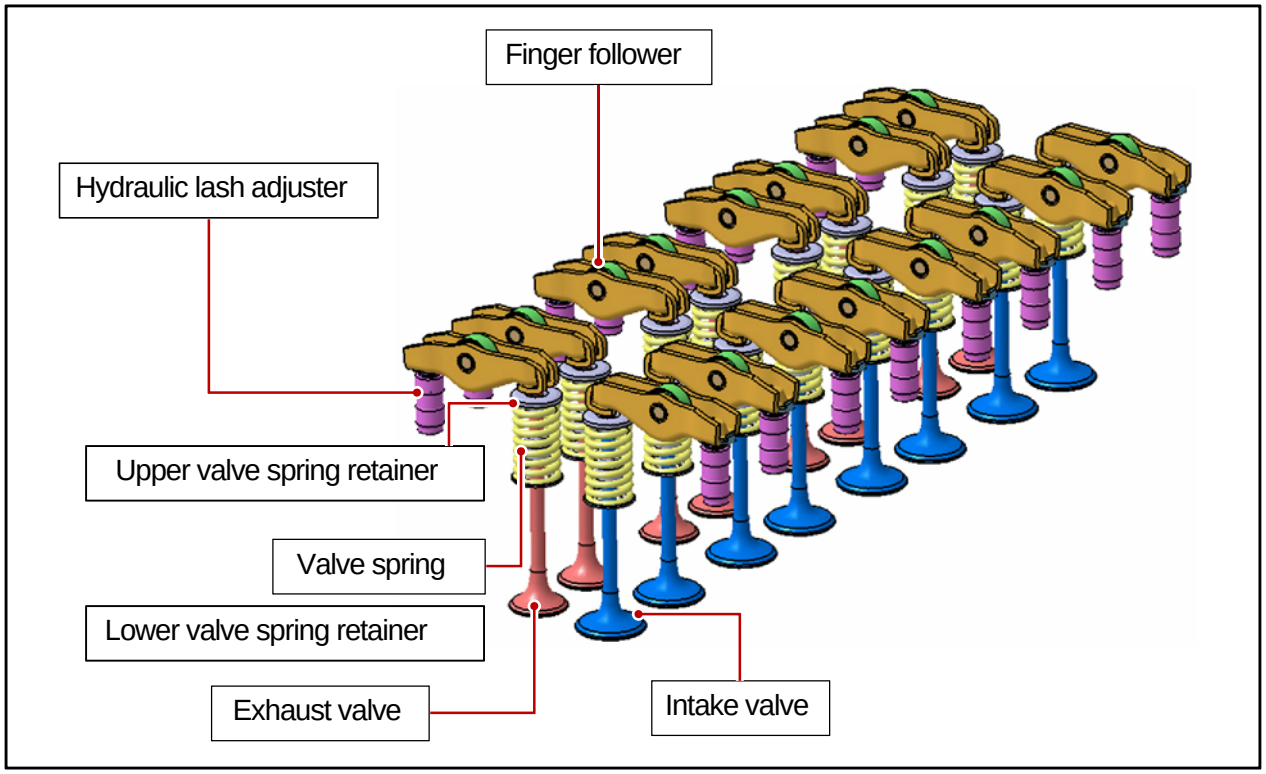


3) Valve Assembly (Installed in Cylinder Head)

(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

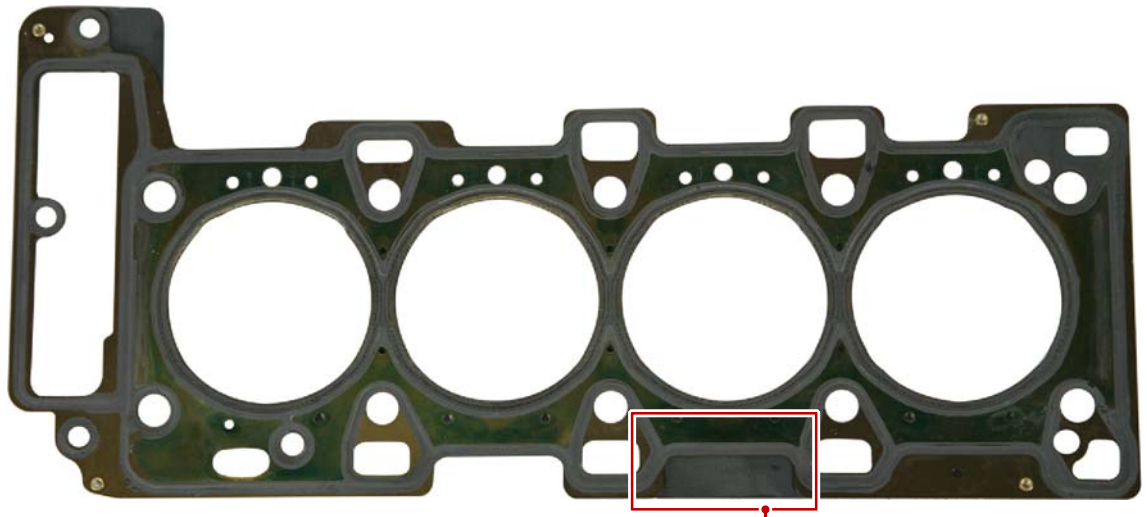


Modification basis	
Application basis	
Affected VIN	

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

7. CHAIN AND GEAR DRIVE SYSTEM

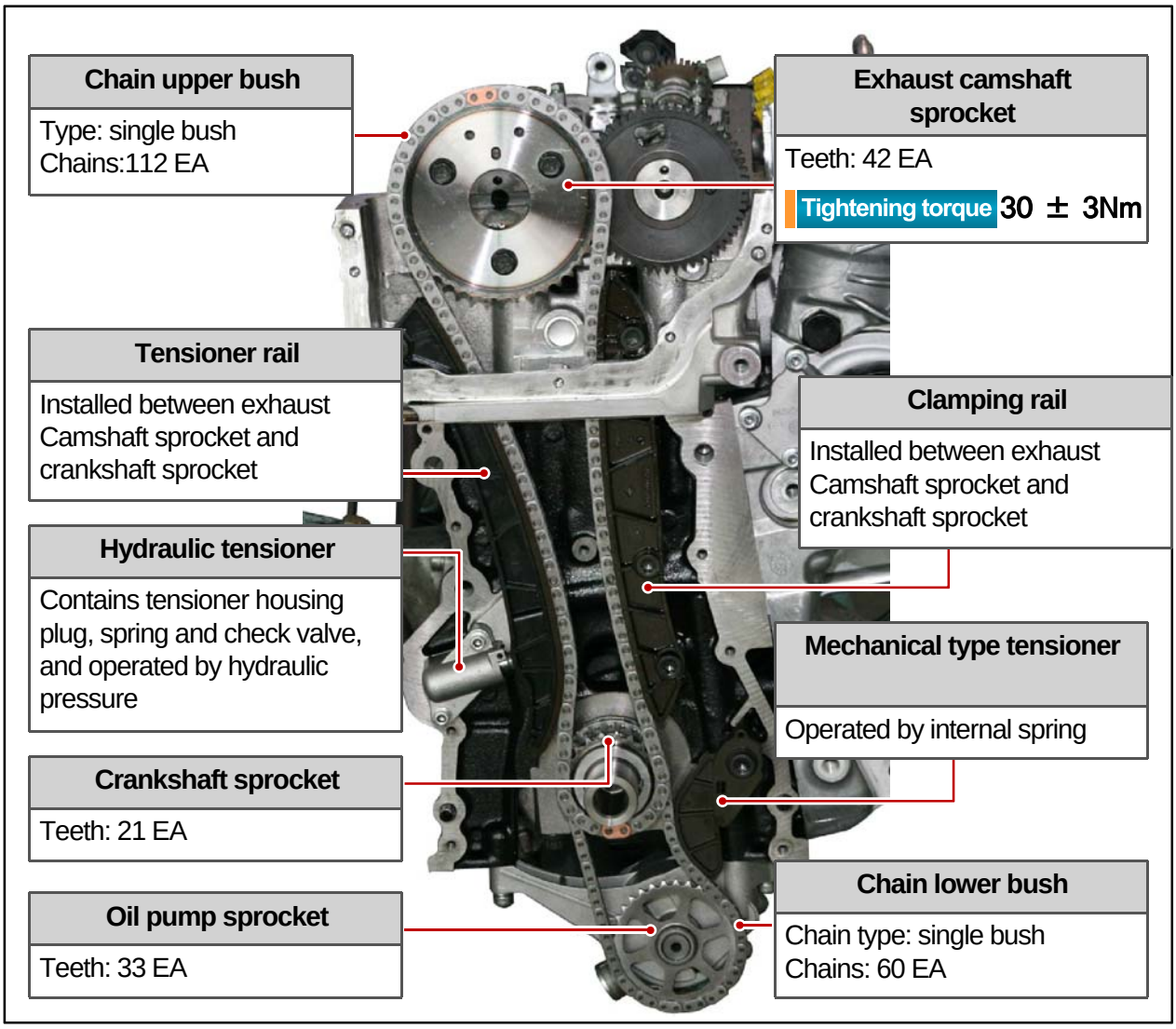
D20DTR engine uses single stage chain drive system. Timing chain drives the exhaust side and gear drive the intake side. Timing chain is single bush type. Upper chain drives HP pump connected to intake Camshaft by driving exhaust cam shift sprocke, and lower chain drives oil pump to lubricate the engine.

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.

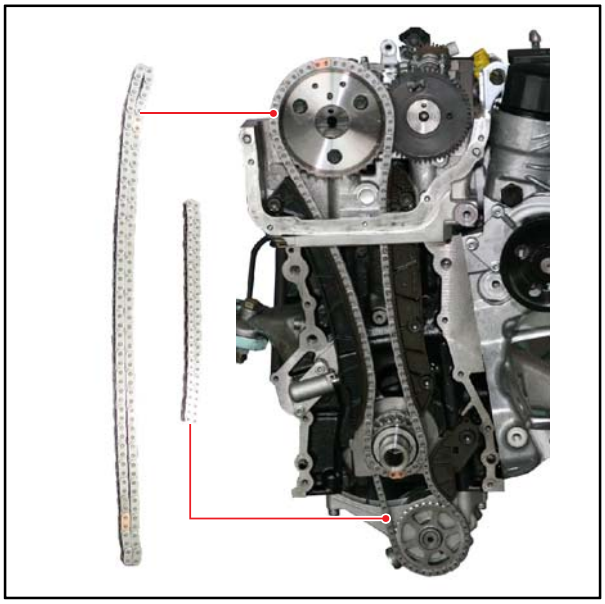
(2) Layout



Modification basis	
Application basis	
Affected VIN	

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)

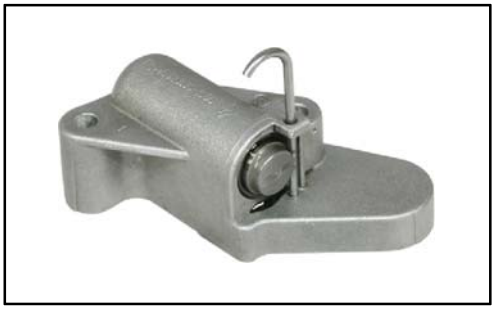
Chain lower bush
- Single bush type (60 EA)

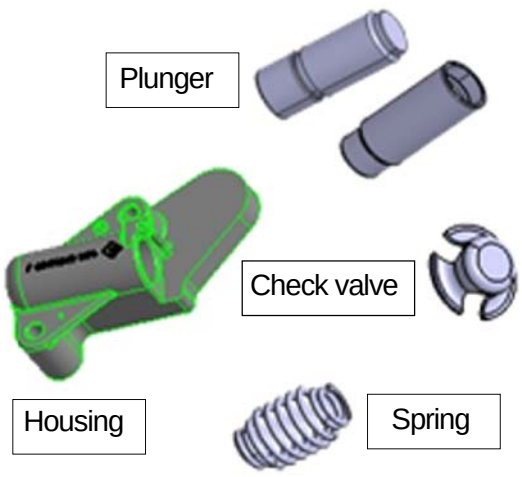
(2) Tensioner

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





(3) Mechanical Tensioner Assembly



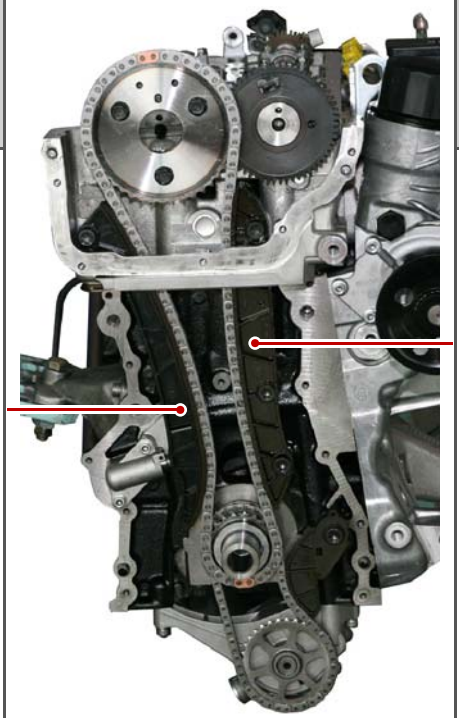
Operating principle
- Use only spring tension

Tensioner type
- Compensation and impact absorbing

Static and dynamic force
- Spring

(4) Guide rail

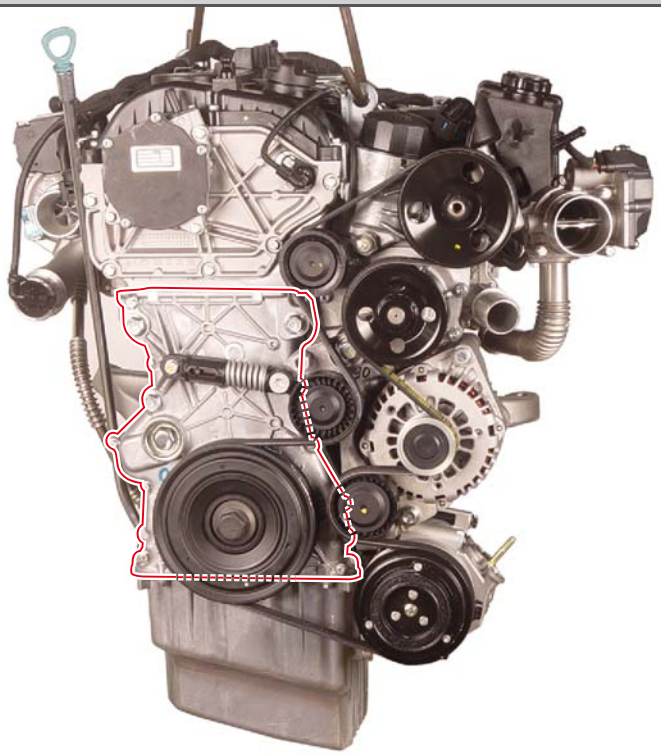
The guide rail is used for optimizing the movement of chain drive system. And it also prevents the chain from contacting each other when the chain is loose, and reduces the chain wear.
The guide rail is made of plastic, nylon, Teflon, etc. The guide rail is specially required when the distance between 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
		

Modification basis	
Application basis	
Affected VIN	

(5) Timing gear case cover

Timing gear case cover (TGCC)



Timing gear case cover



Oil seal



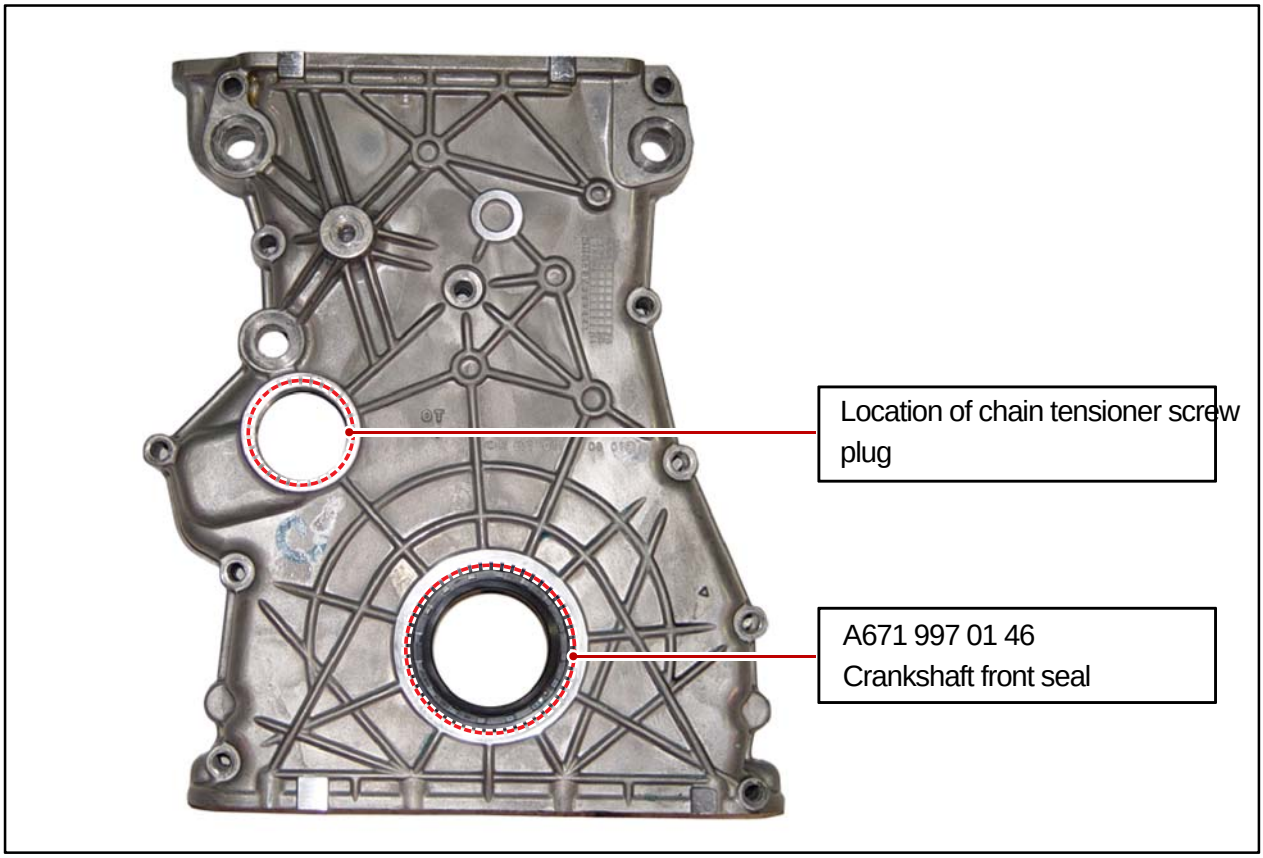
Screw plug



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

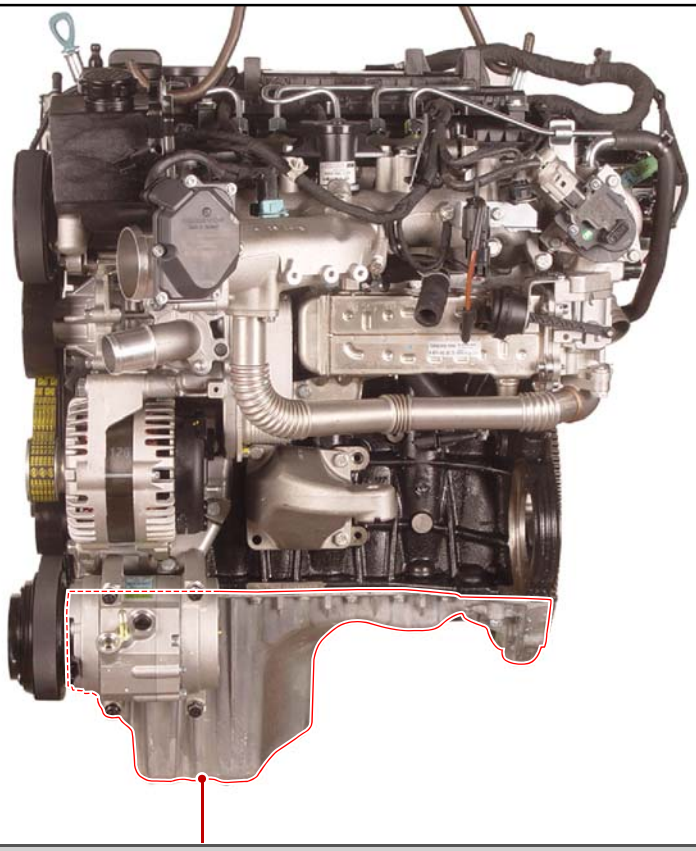
- Do not touch the inner lip of crankshaft front seal.
- Be careful not to damage the screw thread when removing the lock pin to release the chain tensioner.
- Be careful not to damage the O-ring when installing the screw plug.

Modification basis	
Application basis	
Affected VIN	

8. OIL PAN

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

▶ Components



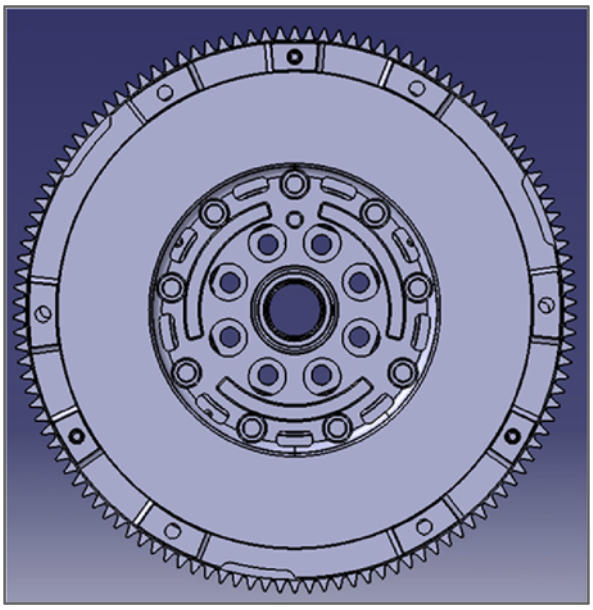
Oil pan sassembly





9. DUAL MASS FLYWHEEL (DMF) & DRIVE PLATE

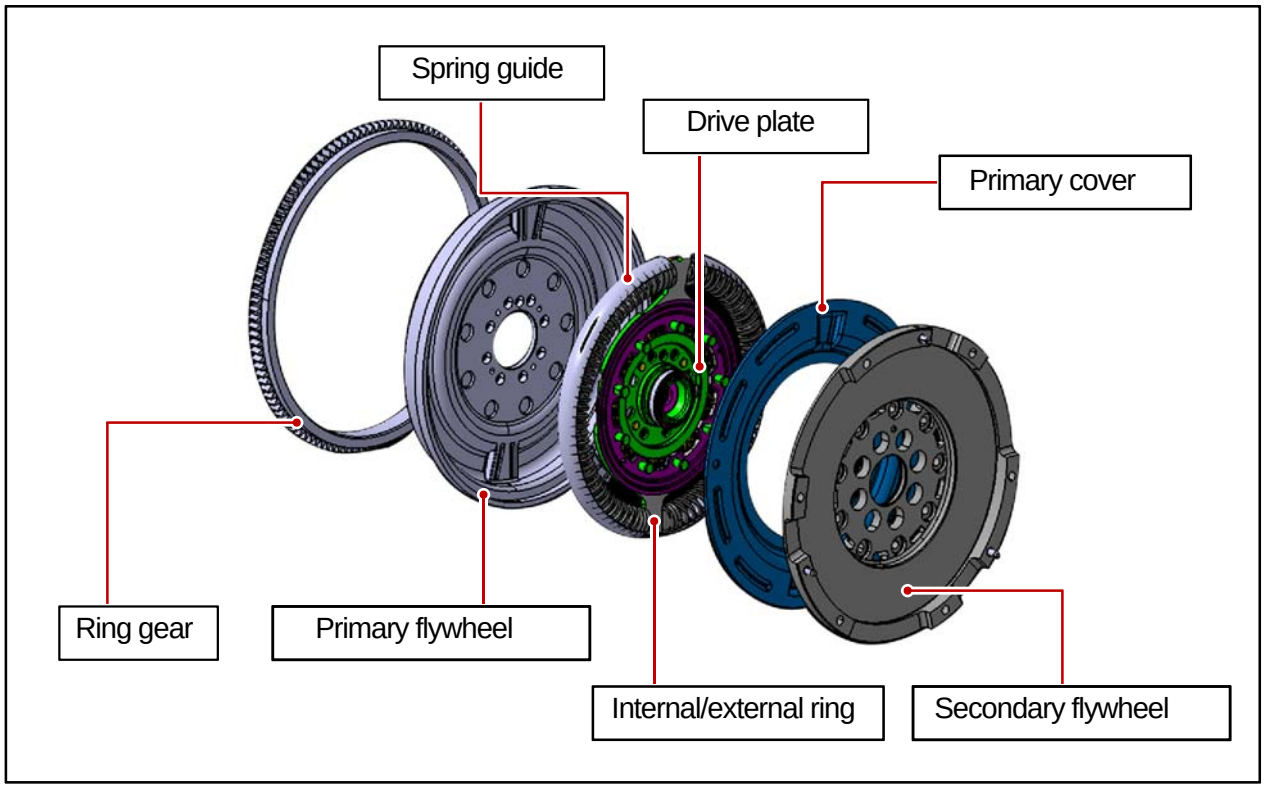
1) Overview



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

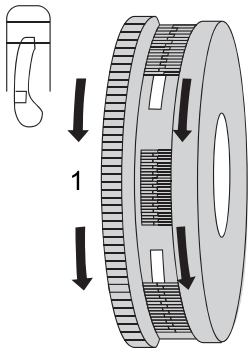
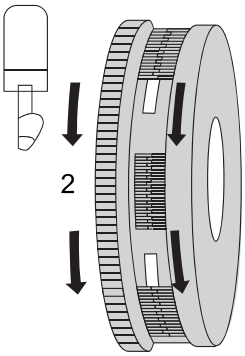
2) Layout



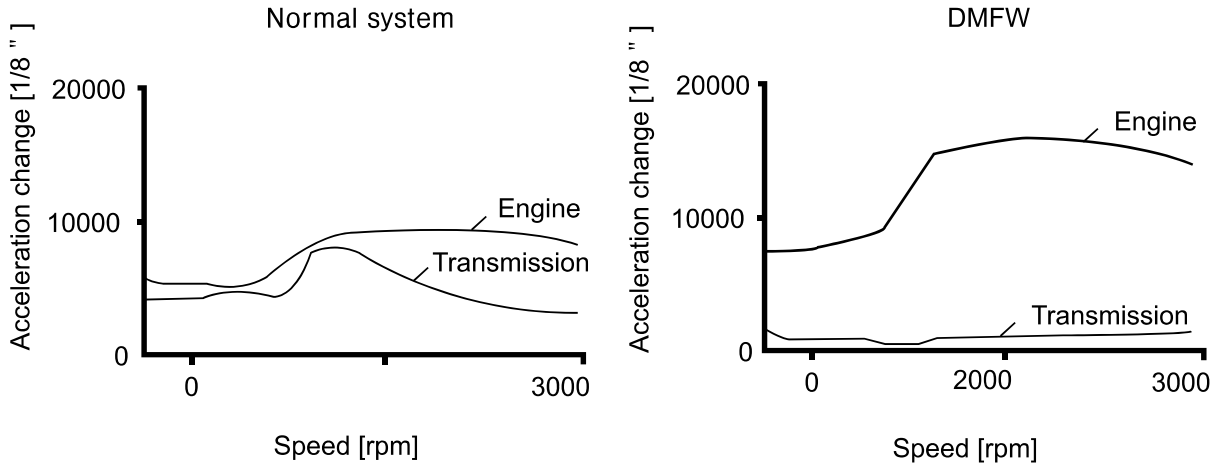
Modification basis	
Application basis	
Affected VIN	

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



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

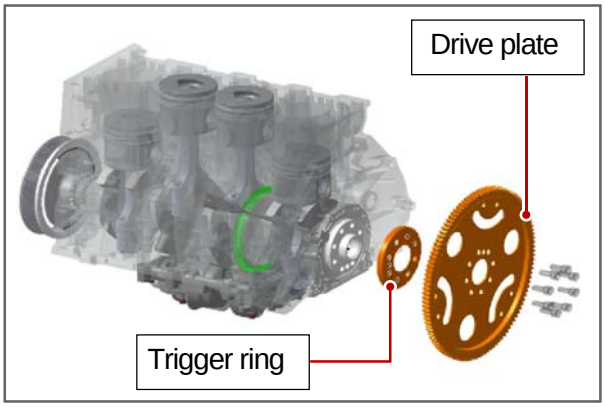
5) Advantages

- 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**

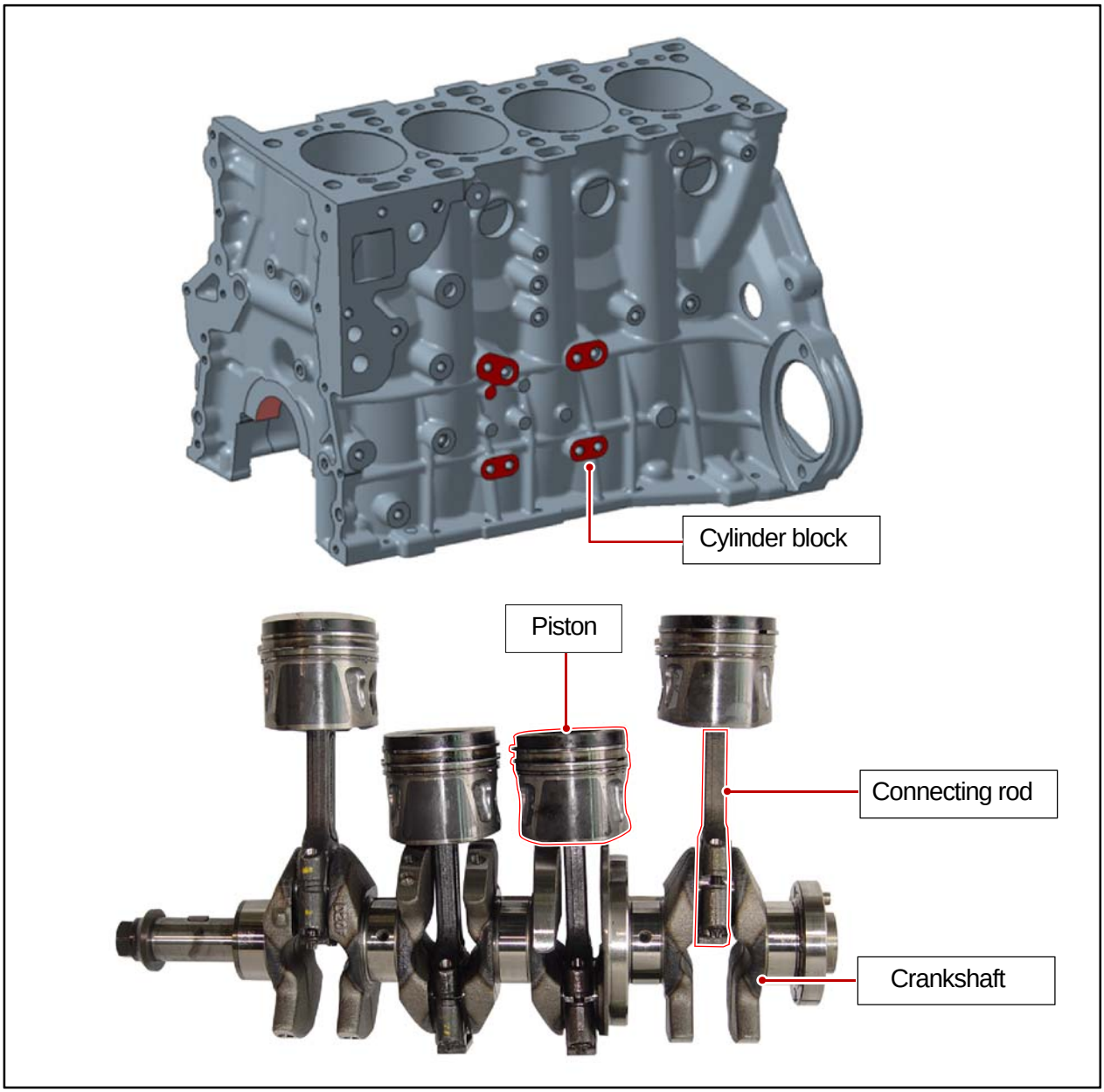


Modification basis	
Application basis	
Affected VIN	

10. PISTON/CRANKSHAFT/CYLINDER BLOCK

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

▶ Components



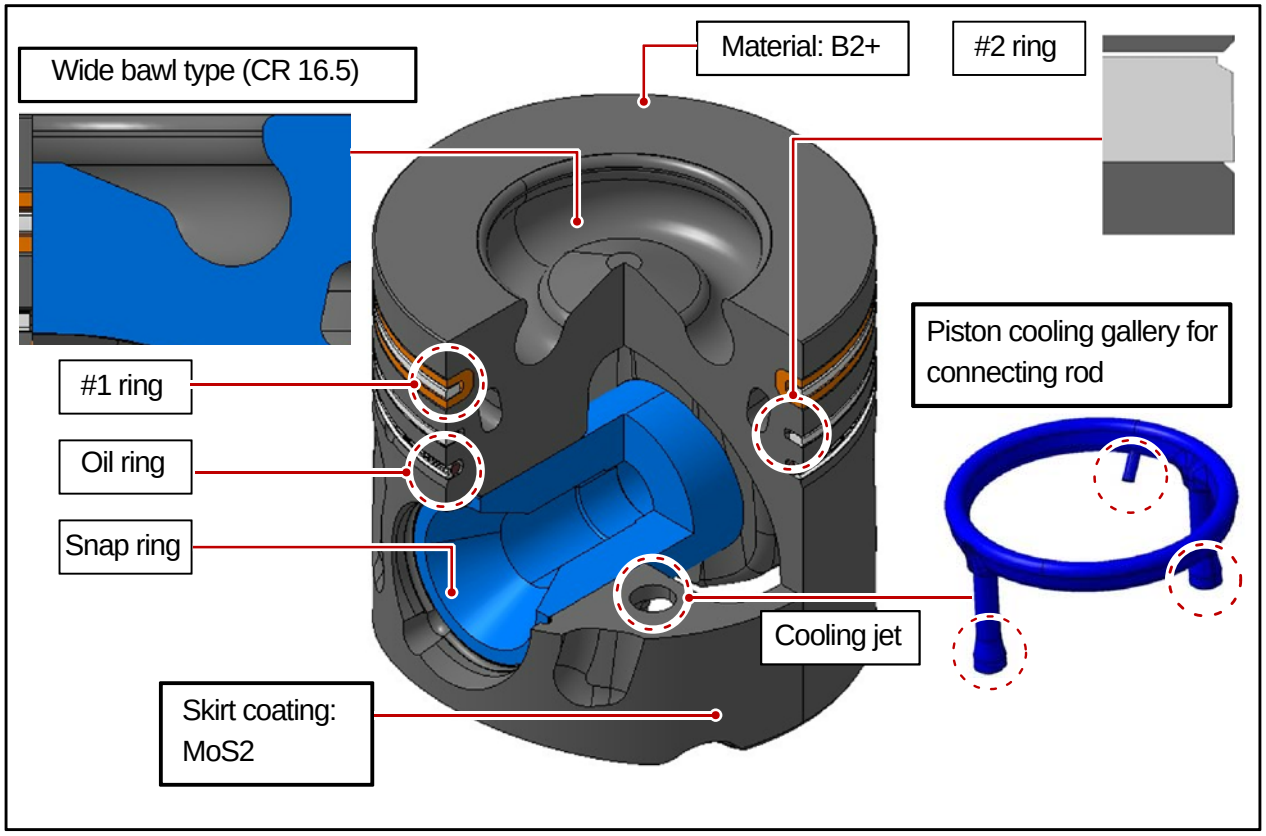
1) Piston

(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



Modification basis	
Application basis	
Affected VIN	

(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.

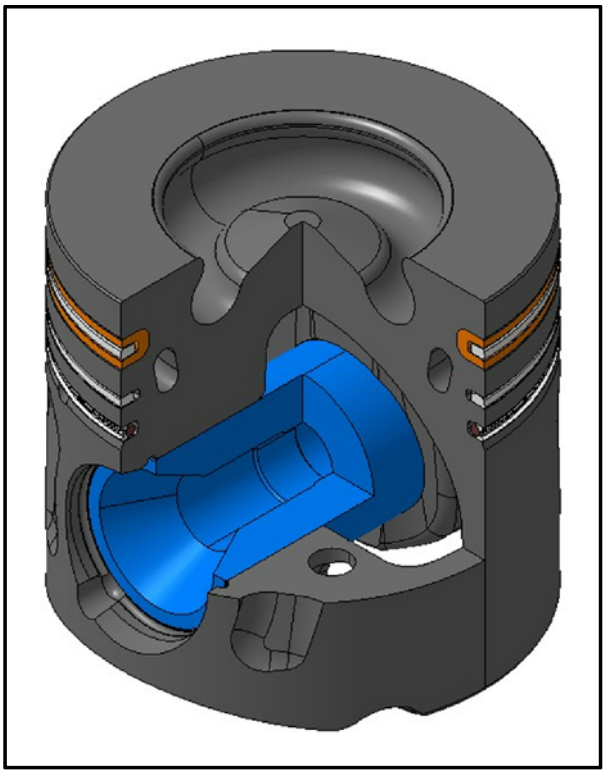
▶ **Piston pin**

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

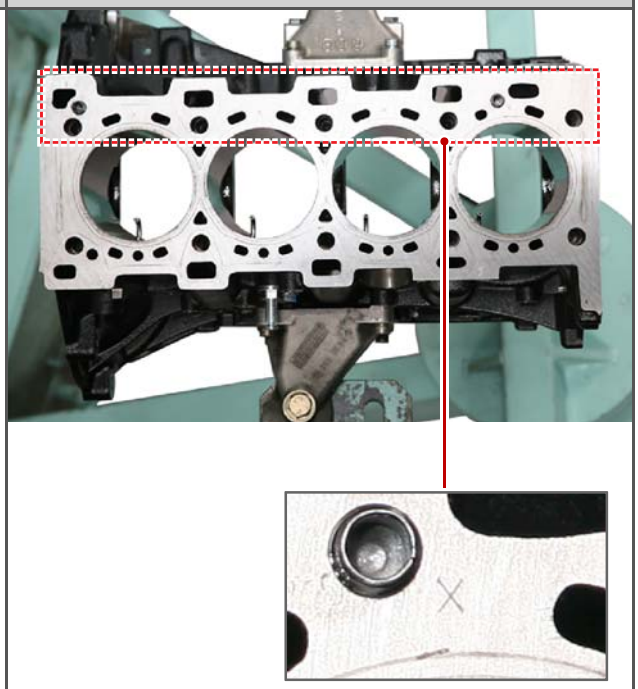
▶ **Snap pin**

- 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.

Selecting piston oversize	
Top of piston	**Top of cylinder block**
	

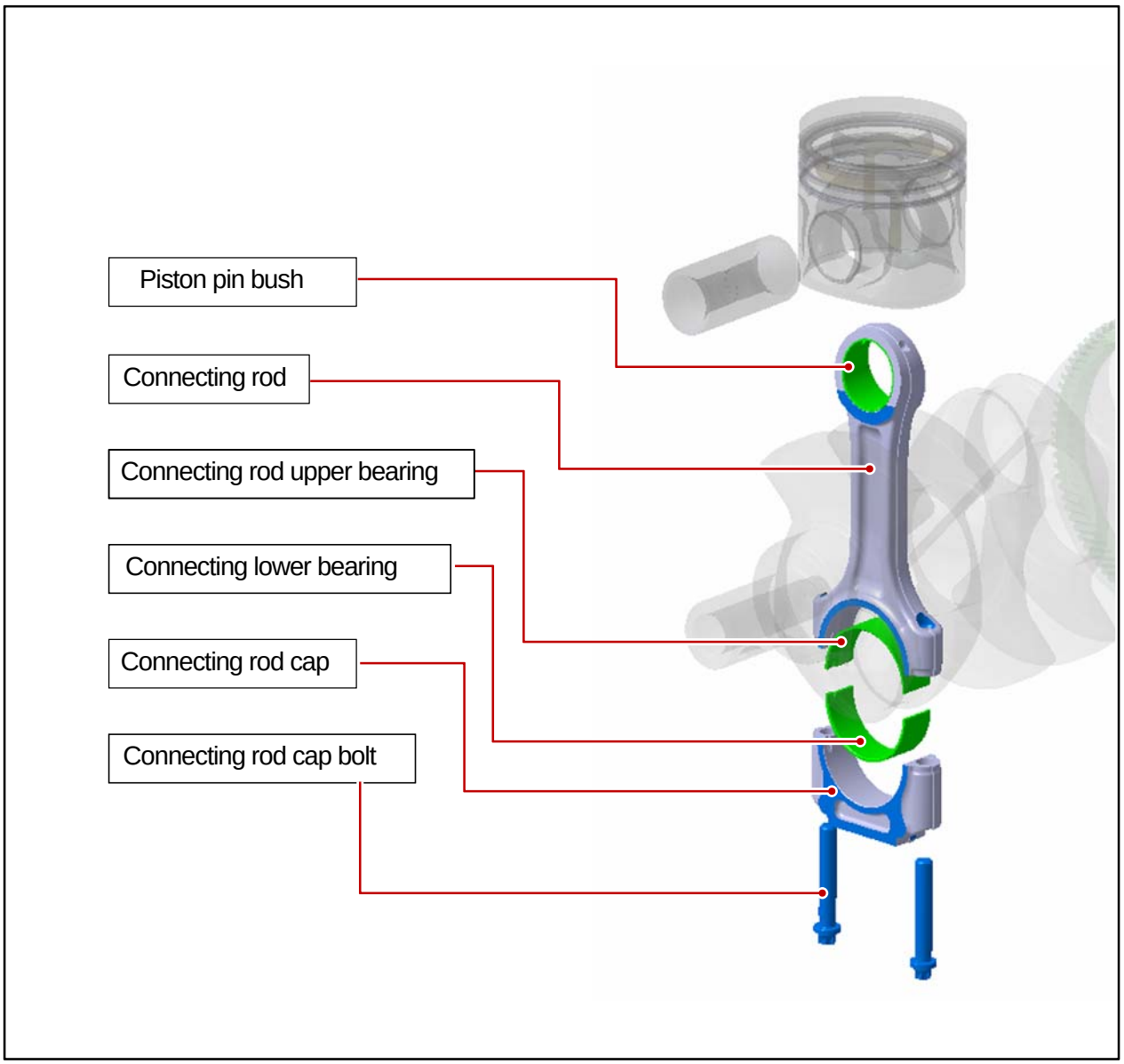
Engine	Piston		Cylinder bore
	Part NO	Marking NO.	-
D20DTF	671 030 06 17	-	-
	671 037 07 01	A	A
	671 037 08 01	X	X
	671 037 09 01	B	B
	671 037 10 01	+5	-
	671 037 11 01	+10	-

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

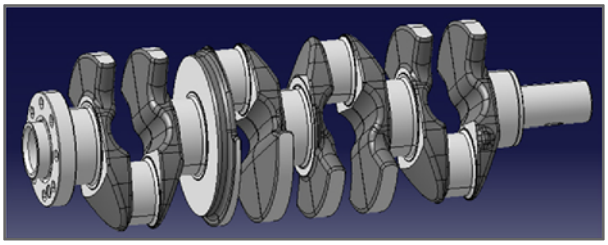
- The connecting rod bearing contains 3 sets of 3 grades in upper and lower sections.
- Three sets in the table below have nearly same oil clearance (0.015~0.063 mm) of bearing.
- Identification: Coloe mark on bearing side surface

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

Modification basis	
Application basis	
Affected VIN	

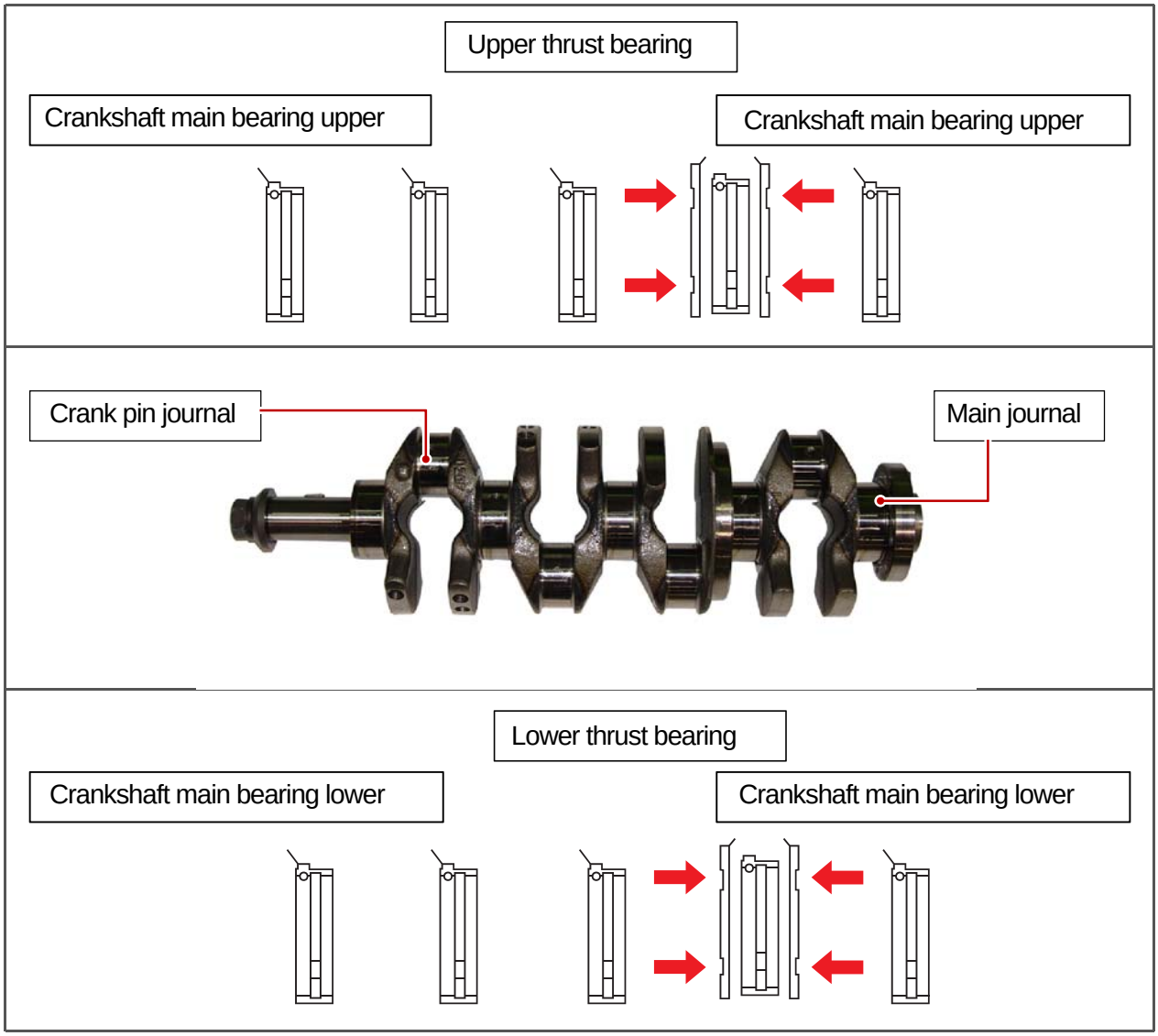
3) Crankshaft

(1) Overview

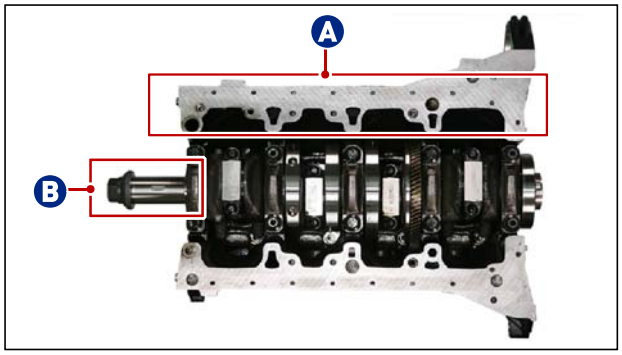


Crankshaft is installed on the cylinder block.

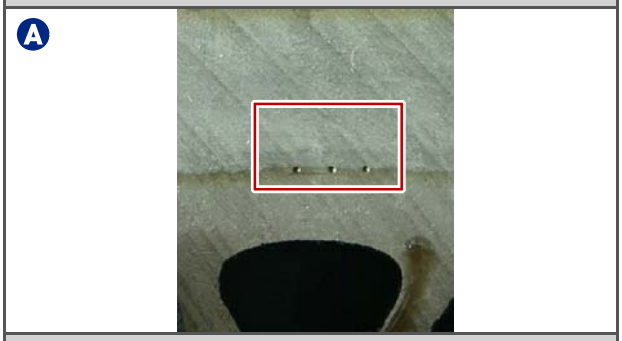
(2) Arrangement



(3) Selection of crankshaft main bearing



Bottom of cylinder block

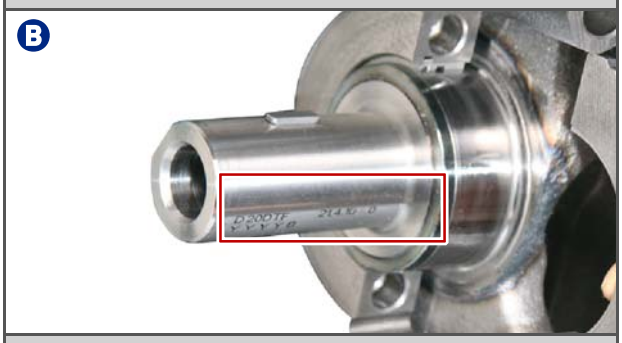


Selection of upper main bearing



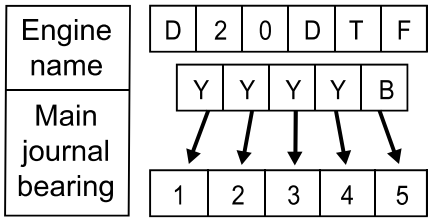
Selection of bearing according to pin punch & color		
Mark	Color	Thickness of main bearing
*	Blue	66.500~66.506
**	Yellow	66.506~66.513
***	Red	66.513~66.519

Mating surface of crankshaft sprocket



Selection of lower main bearing



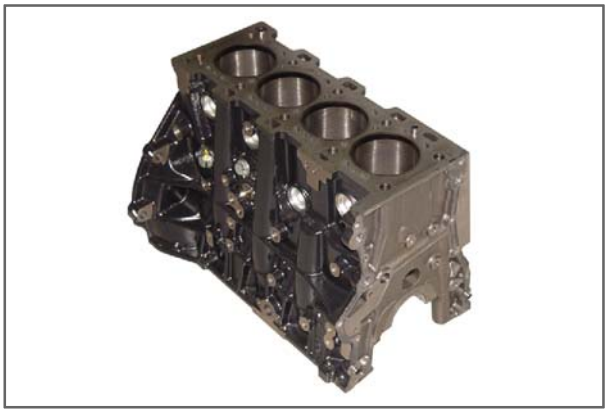


Mark	Color	Thickness of main bearing (mm)
V	Violet	2.25 +0.030 +0.025
W	White	2.25 +0.025 +0.020
R	Red	2.25 +0.020 +0.015
Y	Yellow	2.25 +0.015 +0.010
B	Blue	2.25 +0.010 +0.005

Modification basis	
Application basis	
Affected VIN	

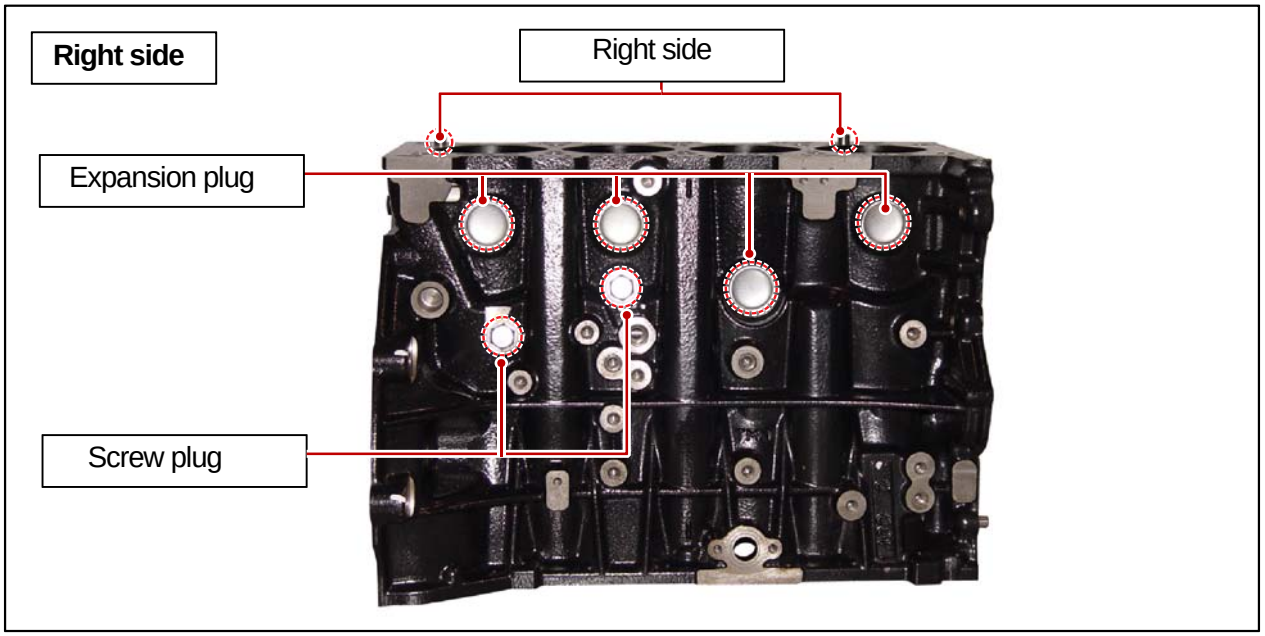
4) Cylinder Block

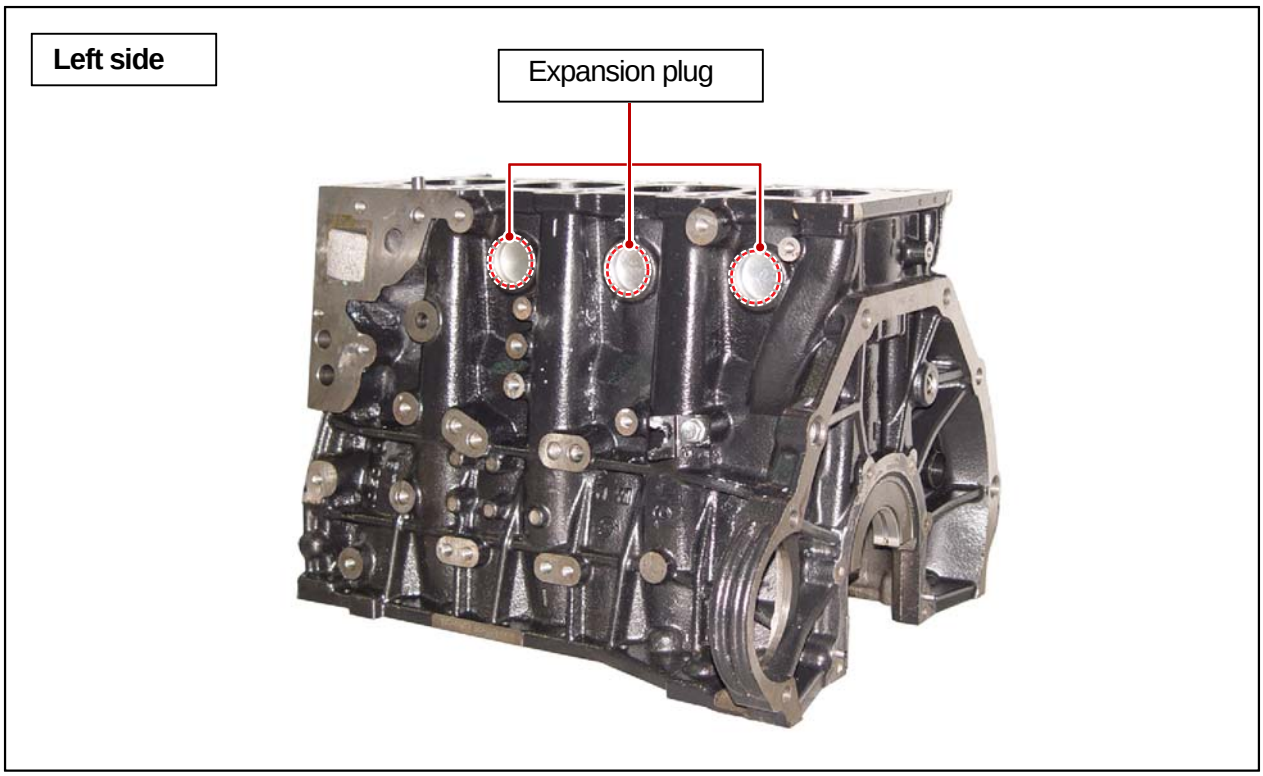
(1) Overview



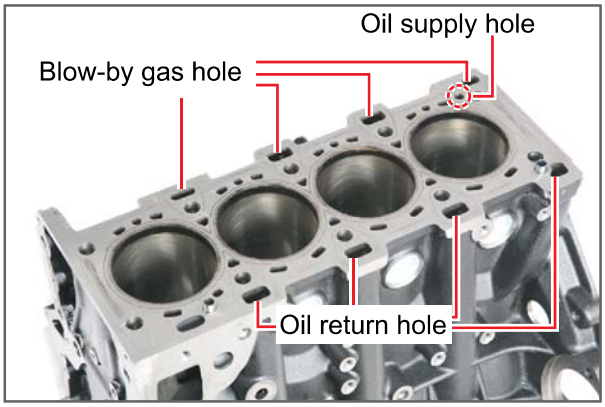
The major dimensions in D20DTR are similar to D20DT engine. It has two mounting bosses for knock sensor and meets the requirements for EURO5 regulation.

(2) Layout





(3) Features

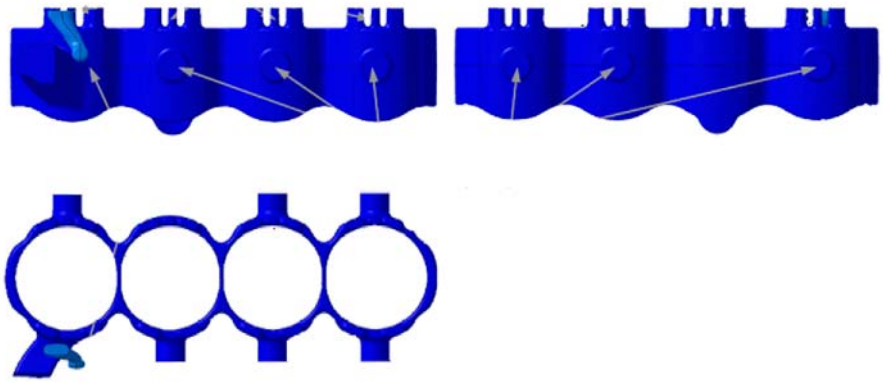


For simple manufacturing, the crankcase blow-by gas passage and the oil return hole are made by casting on the cylinder block.

Modification basis	
Application basis	
Affected VIN	

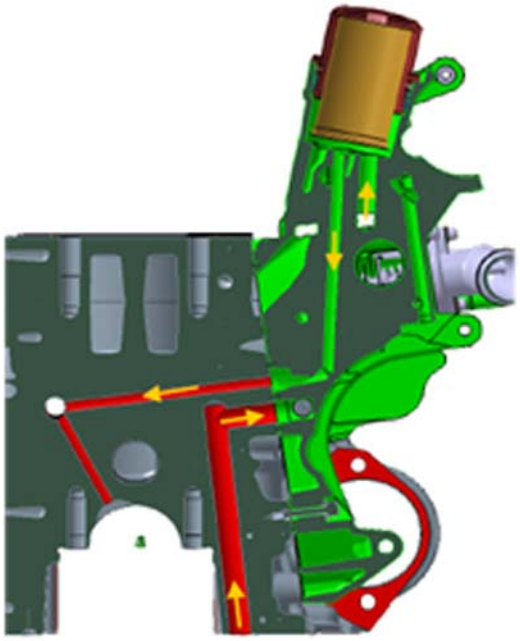
The bottom side of water jacket is desgined as sine wave to strengthen the structure of crankcase. The main flow of coolant starts from outlet port of water pump and goes along the longitudinal direction of engine. The coolant passage from cylinder head to inlet port of water pump is integrated in cylinder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



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 3 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.

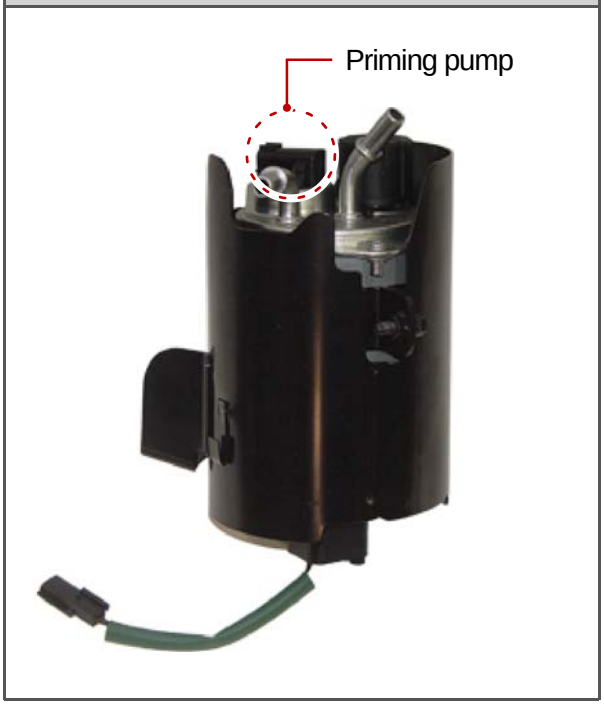
Use special tools and torque wrench to perform the correct works.

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.

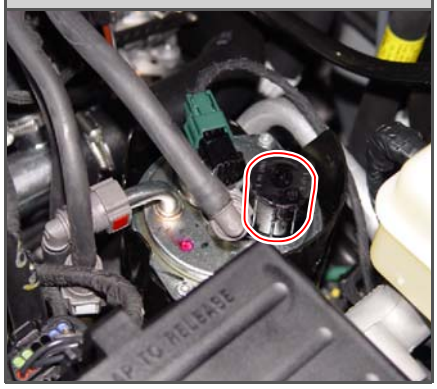
6. Plug the removed components with clean and undamaged sealing caps and store it into the box to keep the conditions when it was installed.

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



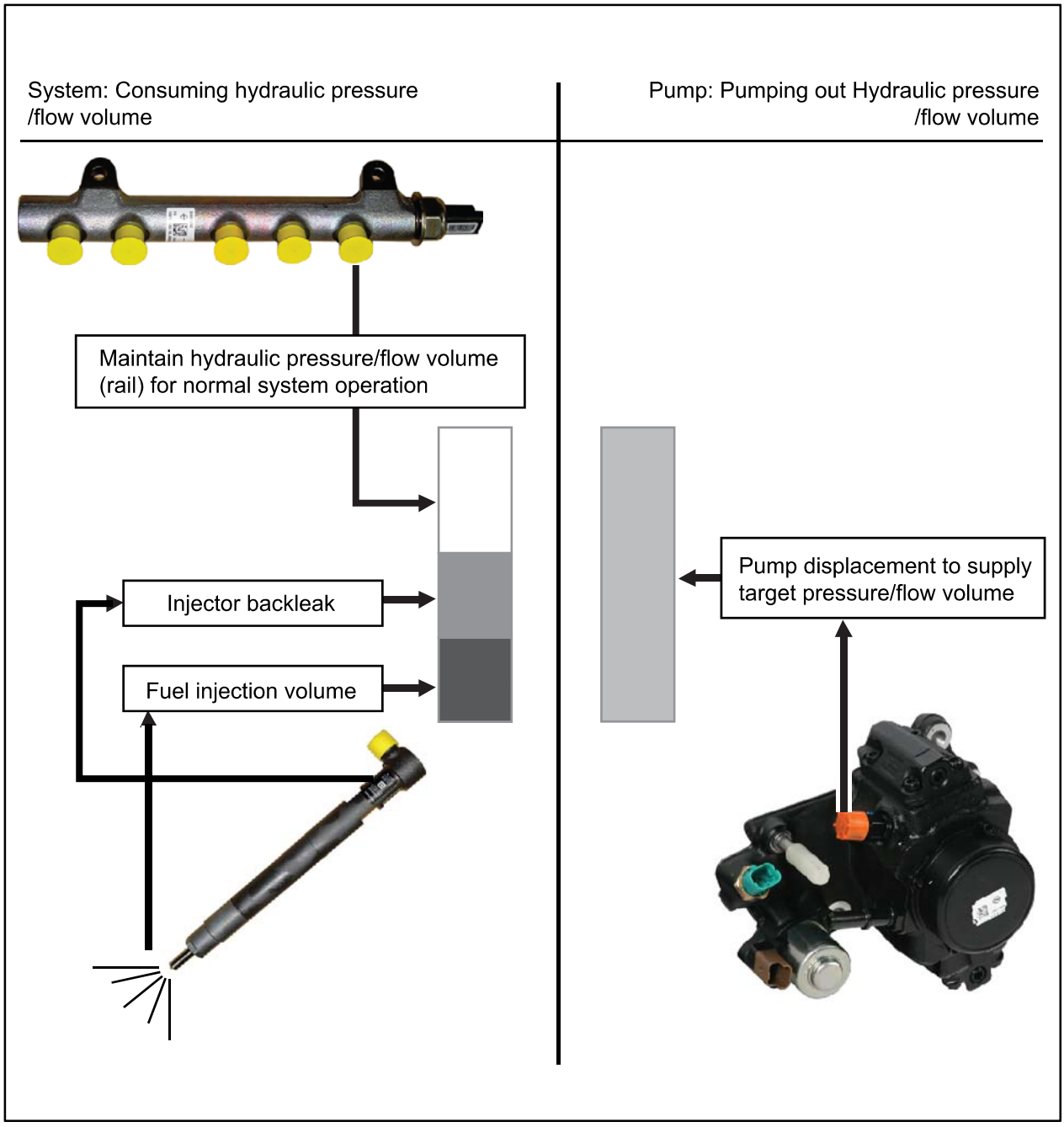
8. Check the installed components again and connect the negative battery cable. Start the engine and check the operating status.
9. With Scan Tool, check if there are current faults and erase the history faults.

2) Diagnostic Test for Engine Fuel System

(1) Overview

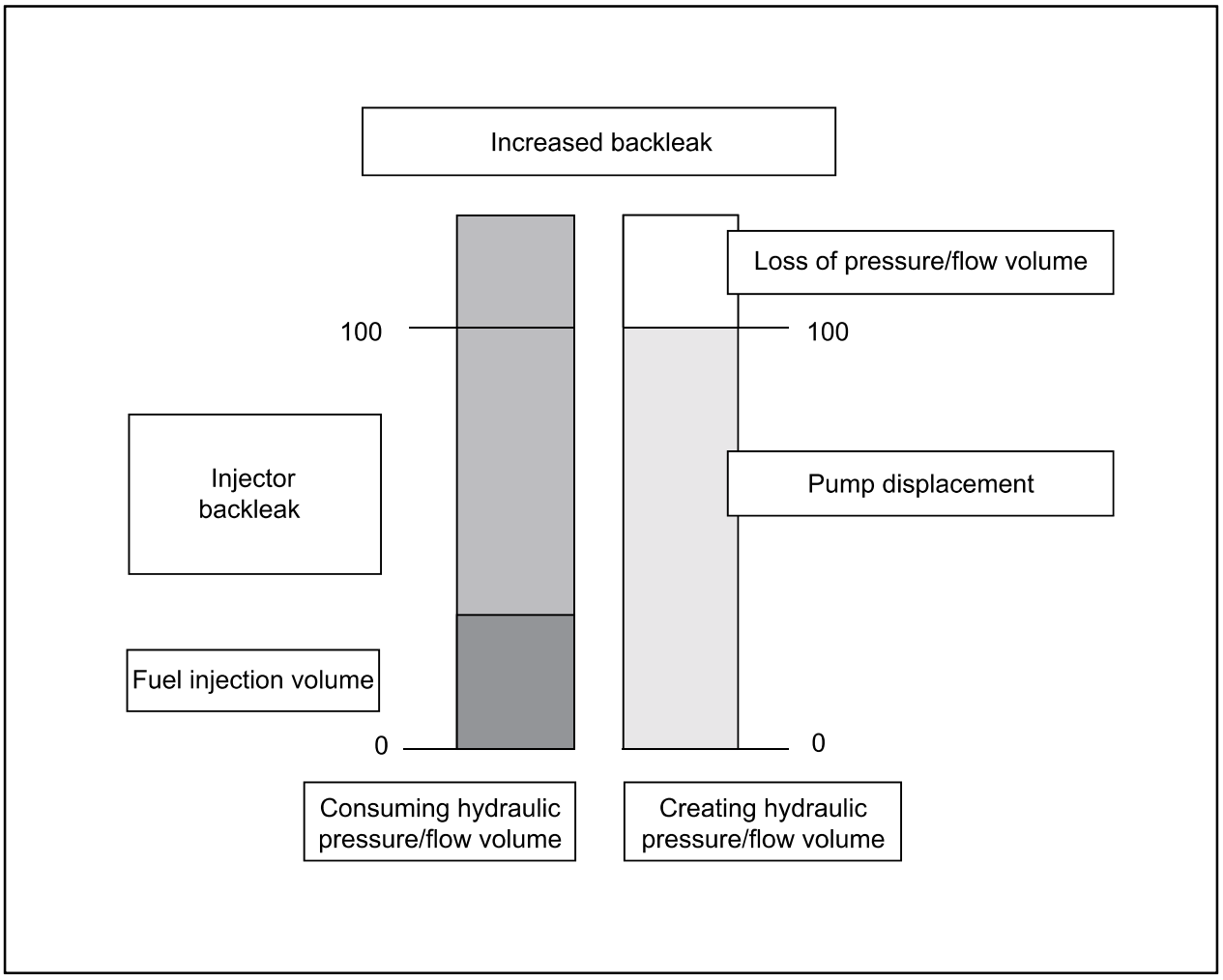
If a DTC is displayed on the diagnostic device, check the low pressure- and high pressure fuel systems before removing the components.
To run the system properly, the electric system must be intact but for the DI engine, the fuel pressure should be measured also when there is a malfunction even after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

(2) Hydraulic system



Modification basis	
Application basis	
Affected VIN	

(3) Excessive backleak of injector



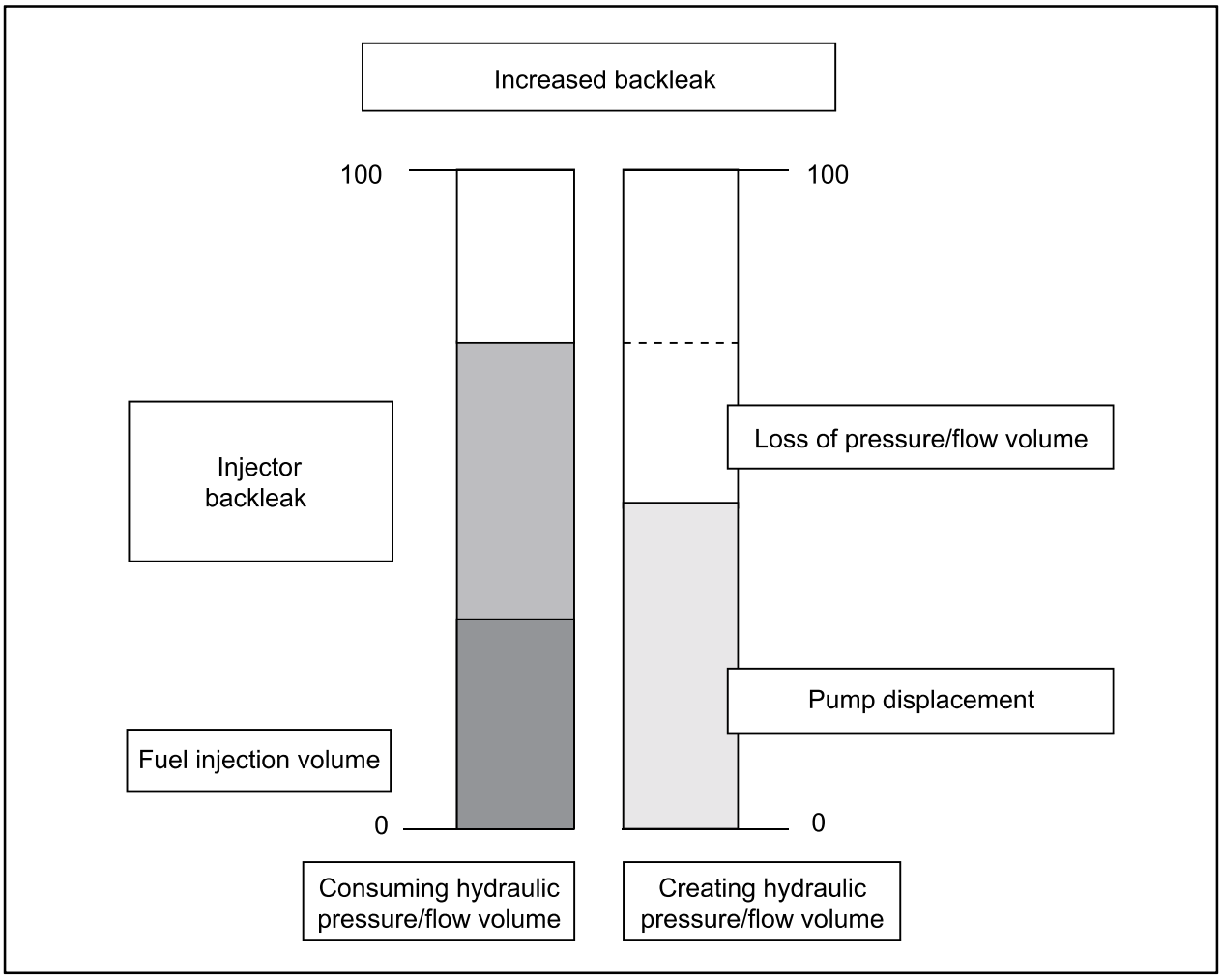
▶ **Excessive injector backleak**

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)

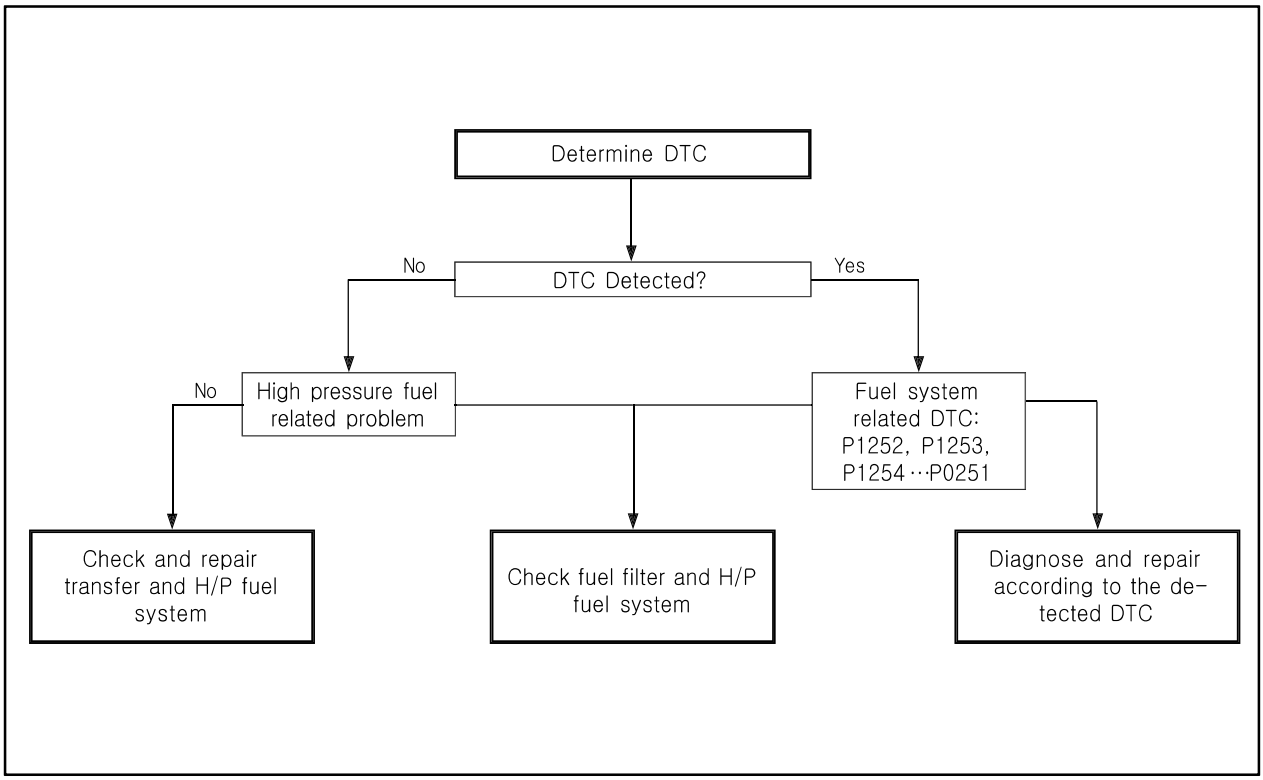
Device for high pressure

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

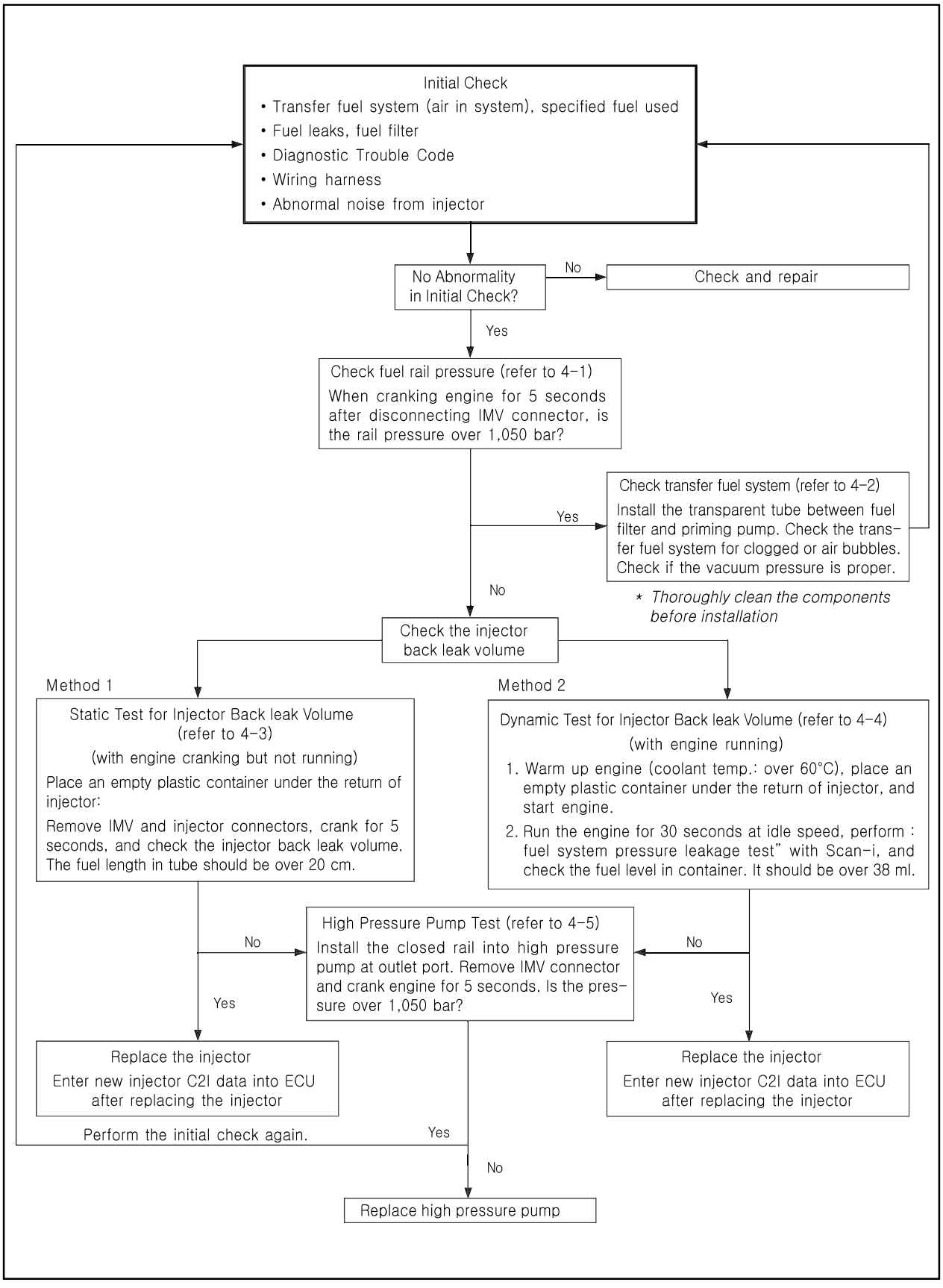


CAUTION

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	

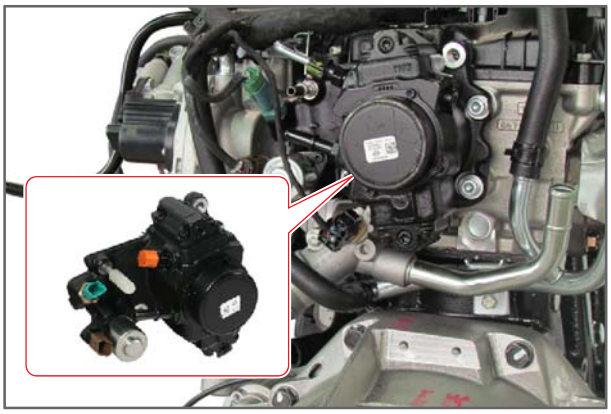
(4) Fuel System Check Procedure



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



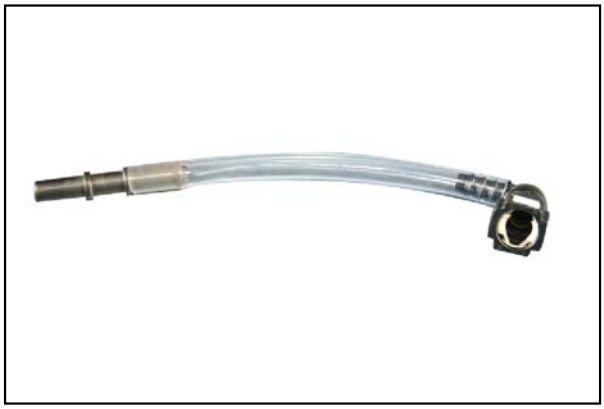
1. Press the "TEST" button on the tester to check if the message "TEST?" is displayed. If the button is pressed again at 4 seconds
2. after starting engine cranking, the highest pressure is displayed on the tester.

NOTE

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

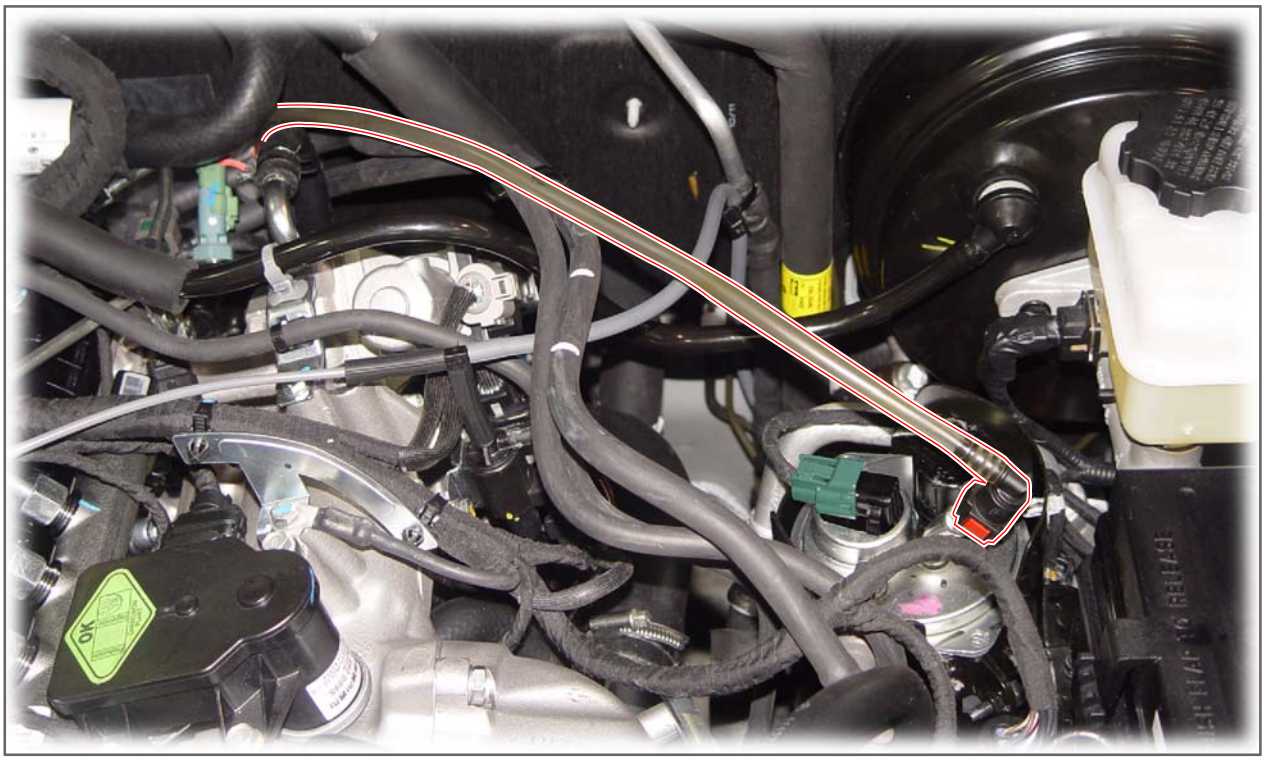
(6) Low Pressure System Pressure Test

▶ **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.

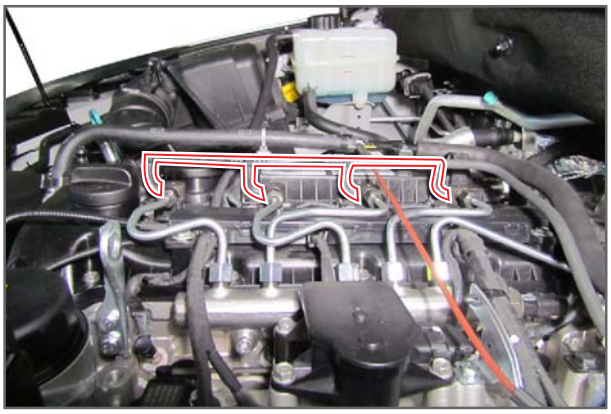
3. Disconnect the key connector for fuel filter connection, and connect both connectors to the fuel filter and hose.



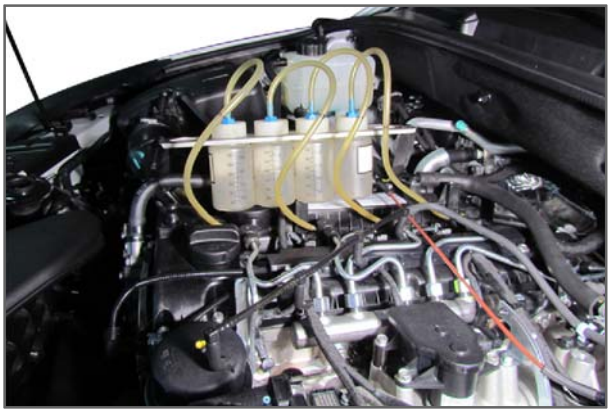
4. Start the engine and check visually for clogged low pressure fuel system, excessive air or air entry. If the fuel flow is not sufficient or air is in the fuel, repair the leak area.
5.

Modification basis	
Application basis	
Affected VIN	

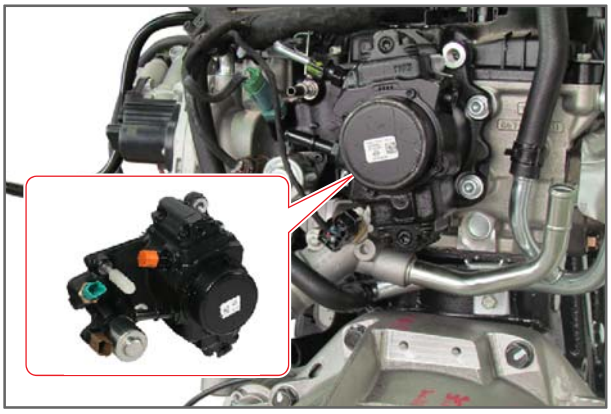
▶ Static test for backleak of injector



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.

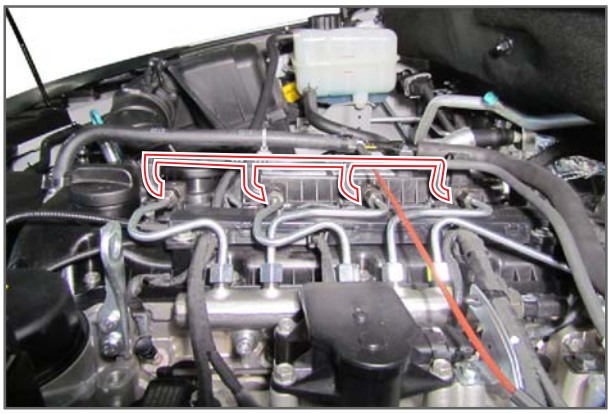


4. Crank the engine 2 times for 5 seconds.
5. Check the time for flow if injector backleak and confirm that it is within the specified range.

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

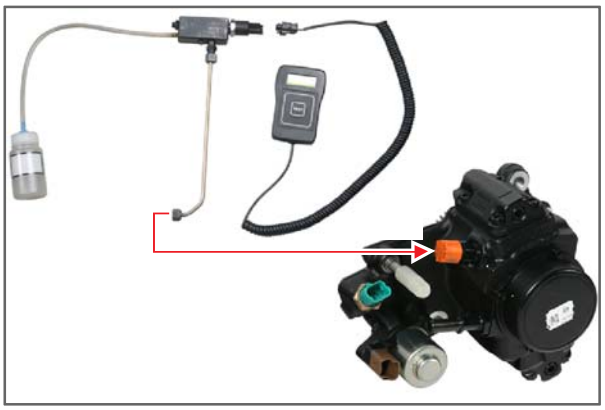


Modification basis	
Application basis	
Affected VIN	

▶ 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.

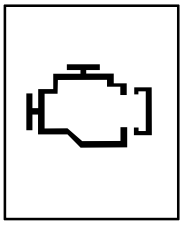
1. DI Engine

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

2. System Safety Mode

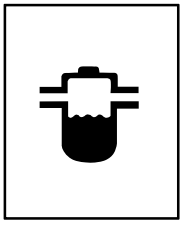
When a severe failure has been occurred in a vehicle, the system safety mode is activated to protect the system. It reduces the driving force, restricts the engine speed (rpm) and stops engine operation. Refer to "Diagnosis" section in this manual.

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.

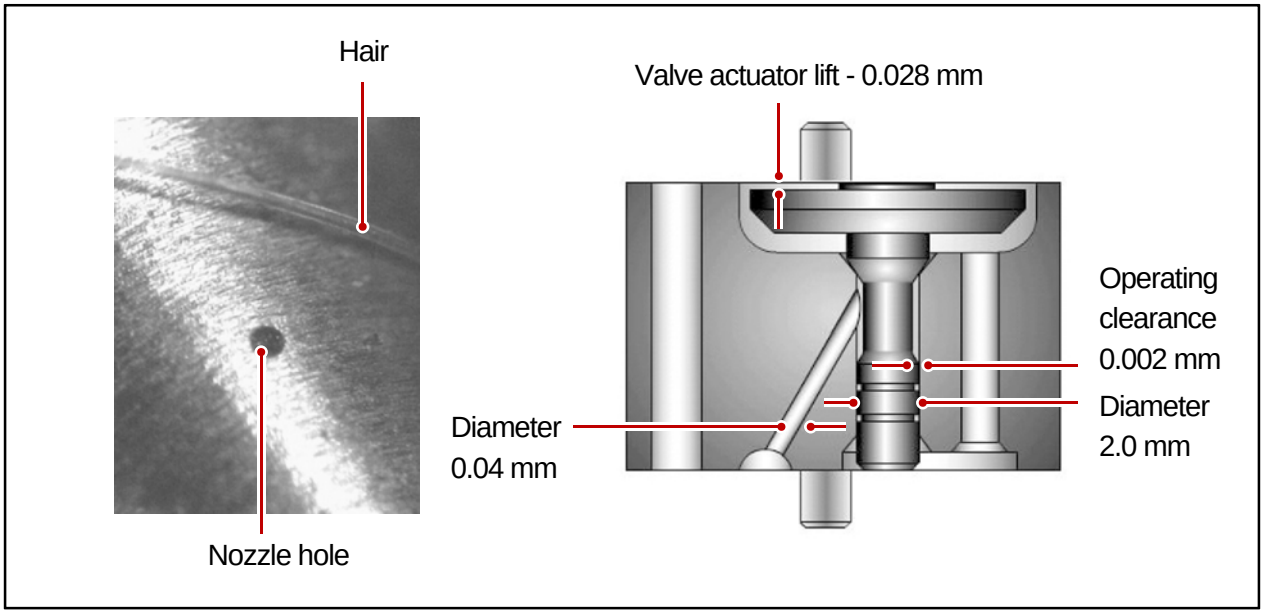
Modification basis	
Application basis	
Affected VIN	

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

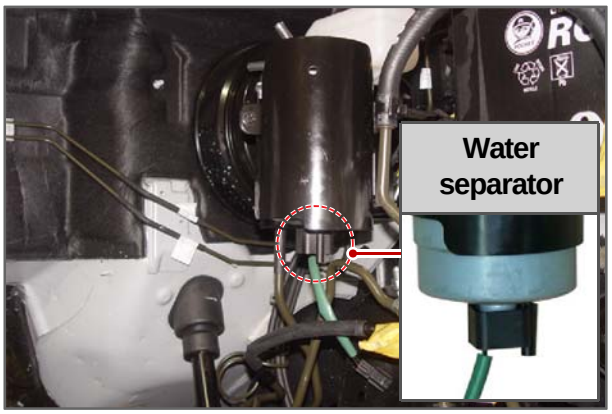
In case of Diesel fuel, paraffin, one of the elements, can be separated from fuel during winter and then can stick on the fuel filter blocking fuel flow and causing difficult starting finally. Oil companies supply summer fuel and winter fuel by differentiating mixing ratio of kerosene and other elements 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.

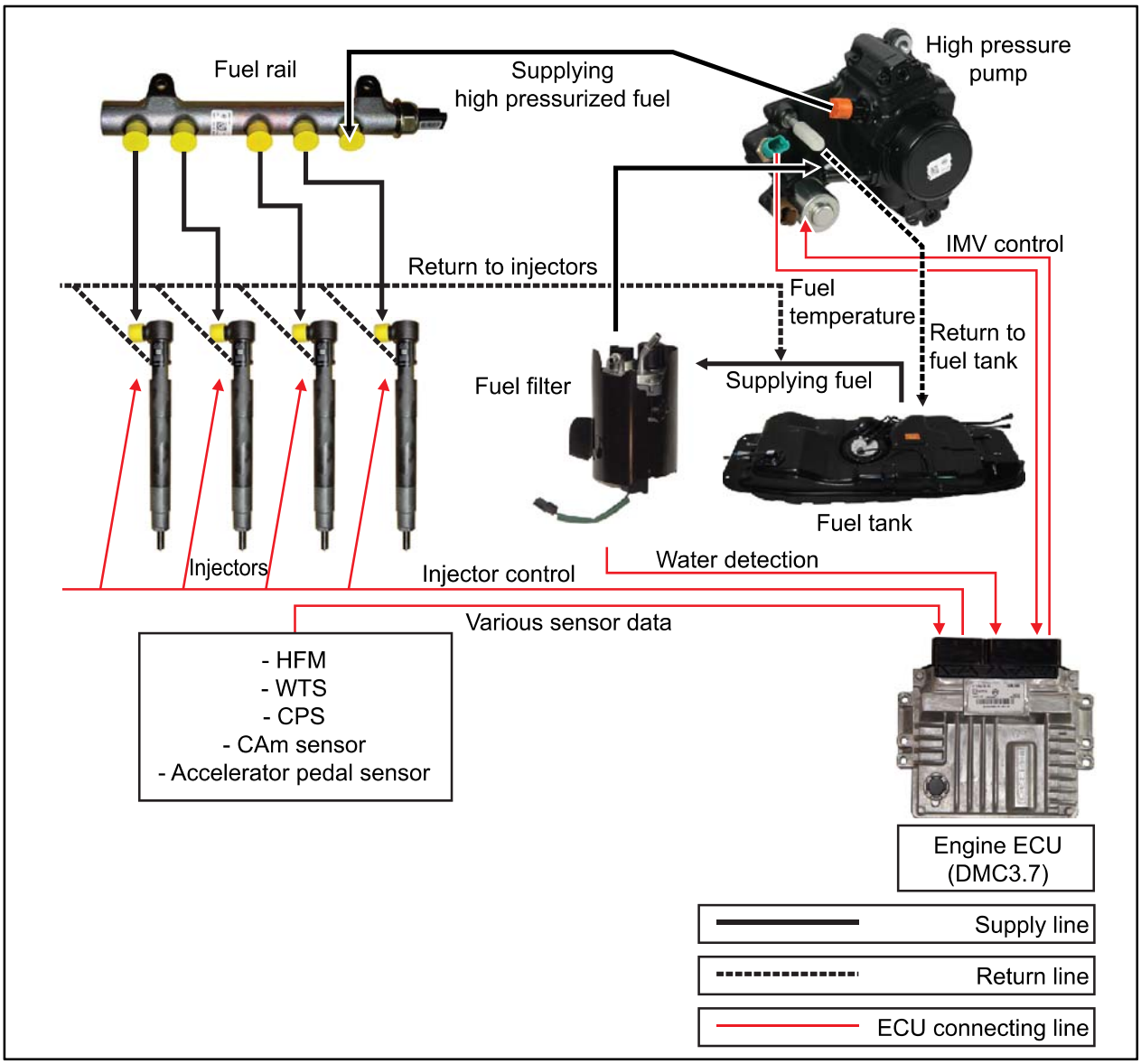
Modification basis	
Application basis	
Affected VIN	

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

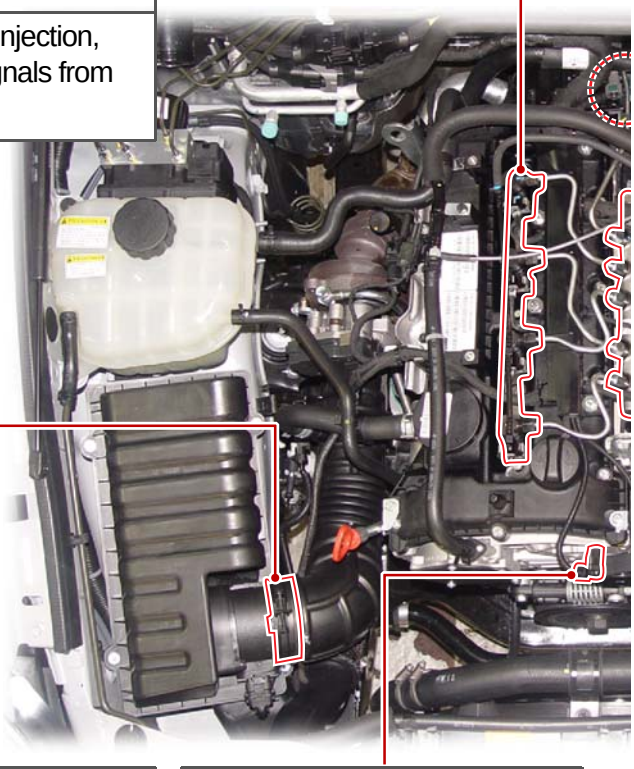
For sensor and actuator control logic, refer to Chapter "Engine Control".

Engine ECU (D20DTR)

Engine control by various signals

Injector (C3I)

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



HFM sensor

Measuring intake air mass and temperature

Crankshaft position sensor

Measuring engine rpm

Fuel tank

Fuel metering by sender

Camshaft position sensor

Determining injection order

Modification basis	
Application basis	
Affected VIN	

High pressure pump

Plunger type HP pump (1,800 bar)



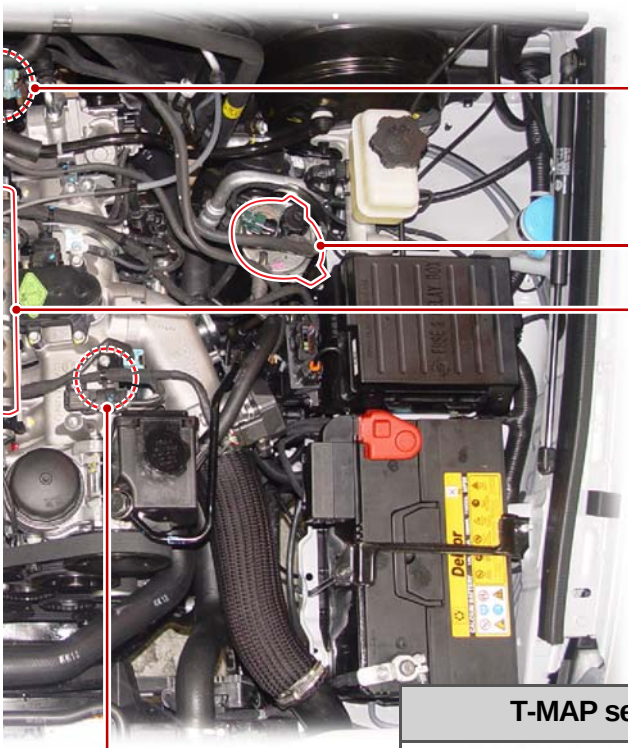
Vane type LP pump (6 bar)

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



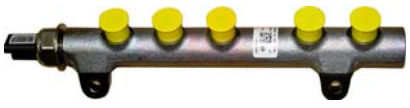
Supplying clean fuel/fuel heating/water separation by priming pump

T-MAP sensor



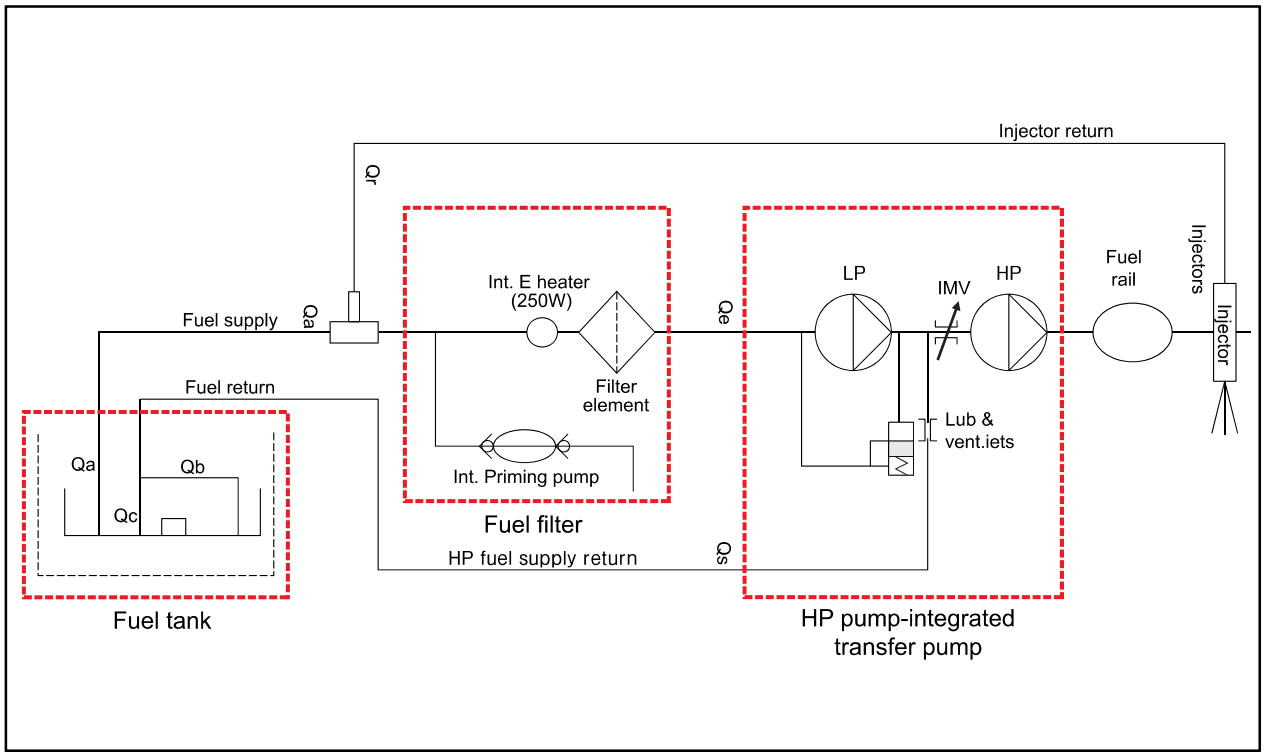
Measuring booster pressure and temperature

Fuel rail assembly



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

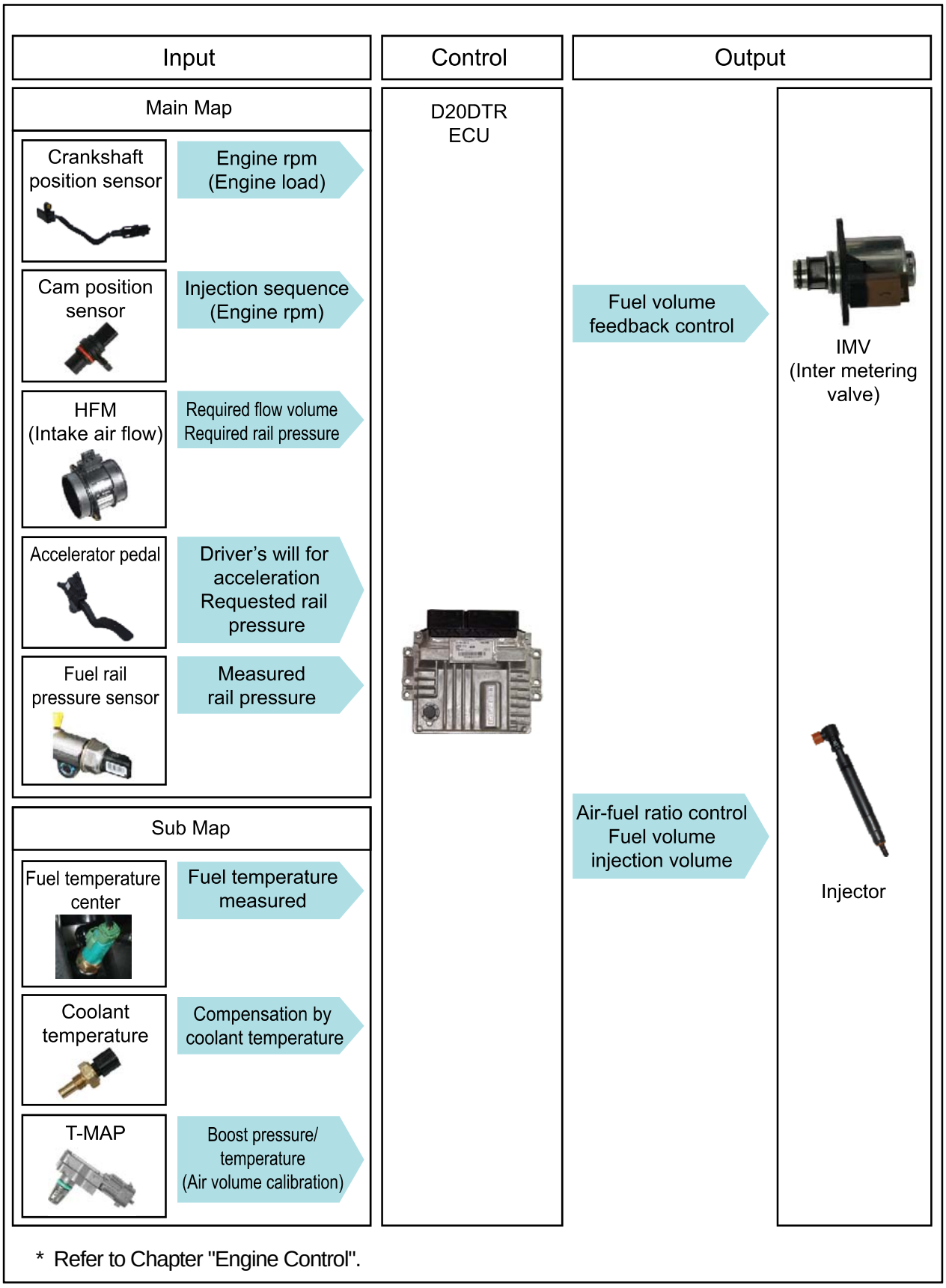
2) Fuel System Flow Diagram



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



* Refer to Chapter "Engine Control".

Modification basis	
Application basis	
Affected VIN	

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: Change every 20,000 km
		GEN: Change every 15,000 km
Air cleaner assembly	Weight	103.9 kg
	Operating temperature	−30 ~ 100˚C
Intercooler	Core material	Aluminum
	Size	614W x 192H x 30T
	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

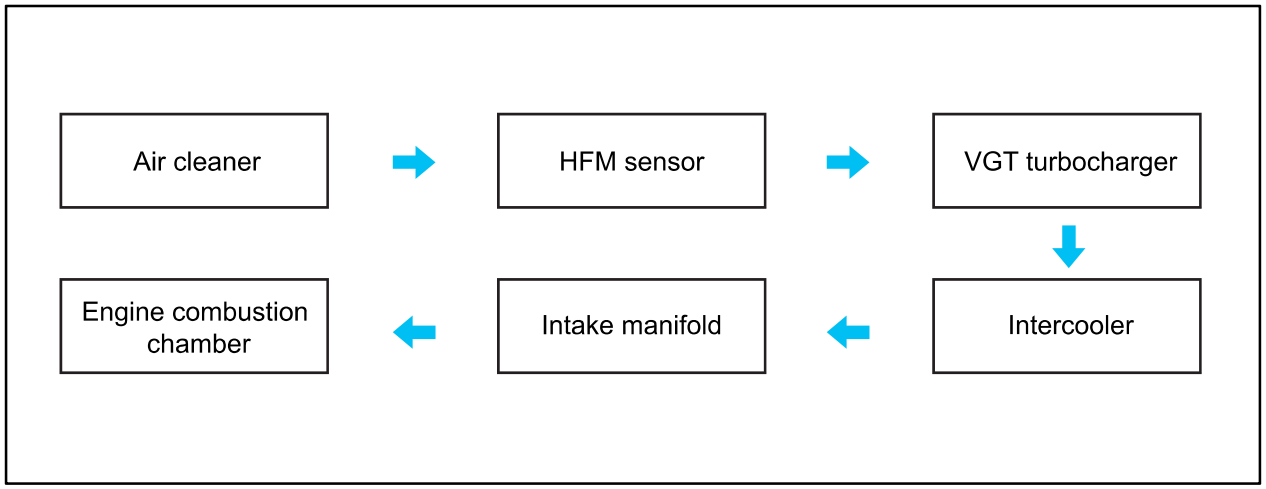
1) Troubleshooting

▶ **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

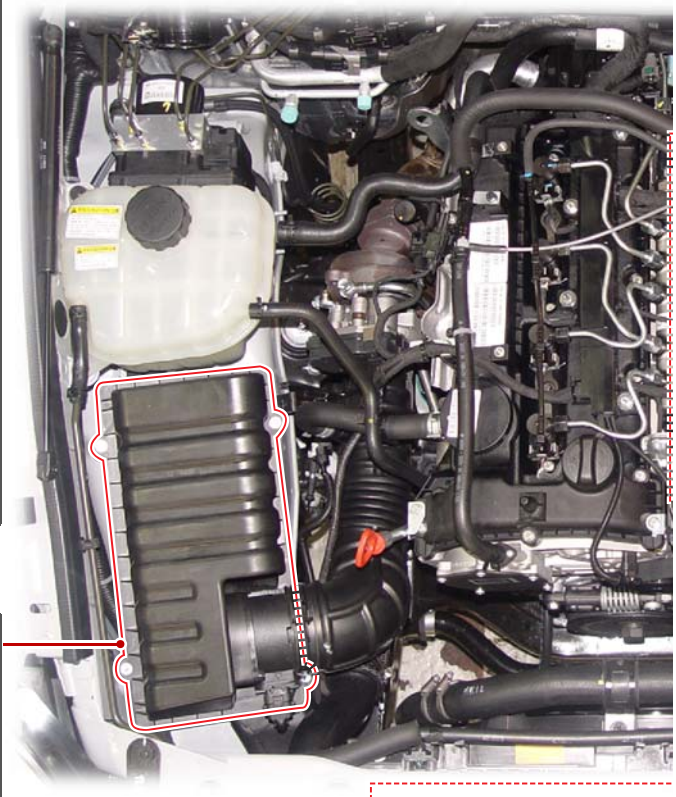
The intake system for D20DTR engine is equipped with a throttle body which includes a flap. This flap is controlled by an electrical signal to cut off the intake air entering to the engine when the ignition switch is turned off. Because of this, the shape of the intake manifold has been changed and improved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



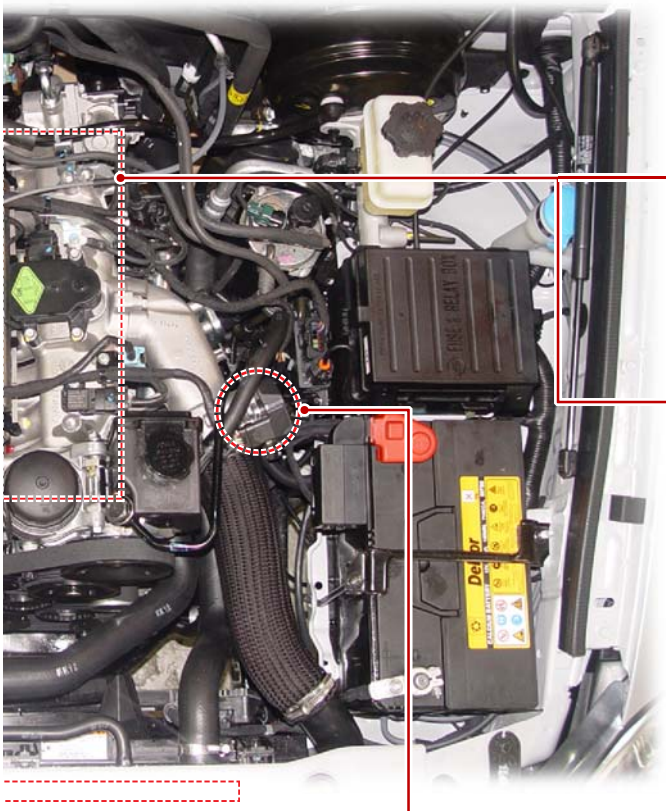
2313-01	Air cleaner assembly



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

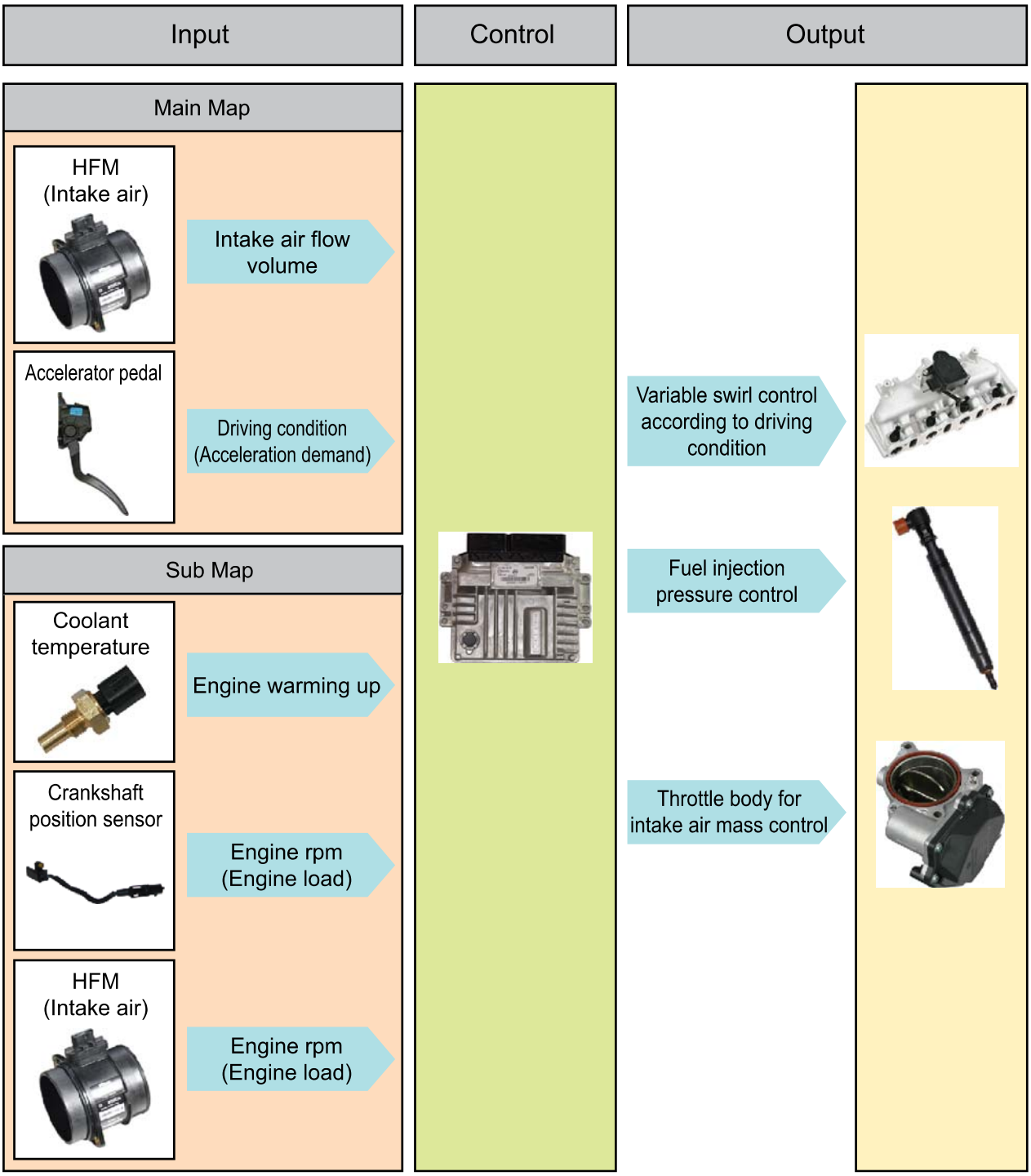
1719-16	Electric throttle body



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

Modification basis	
Application basis	
Affected VIN	

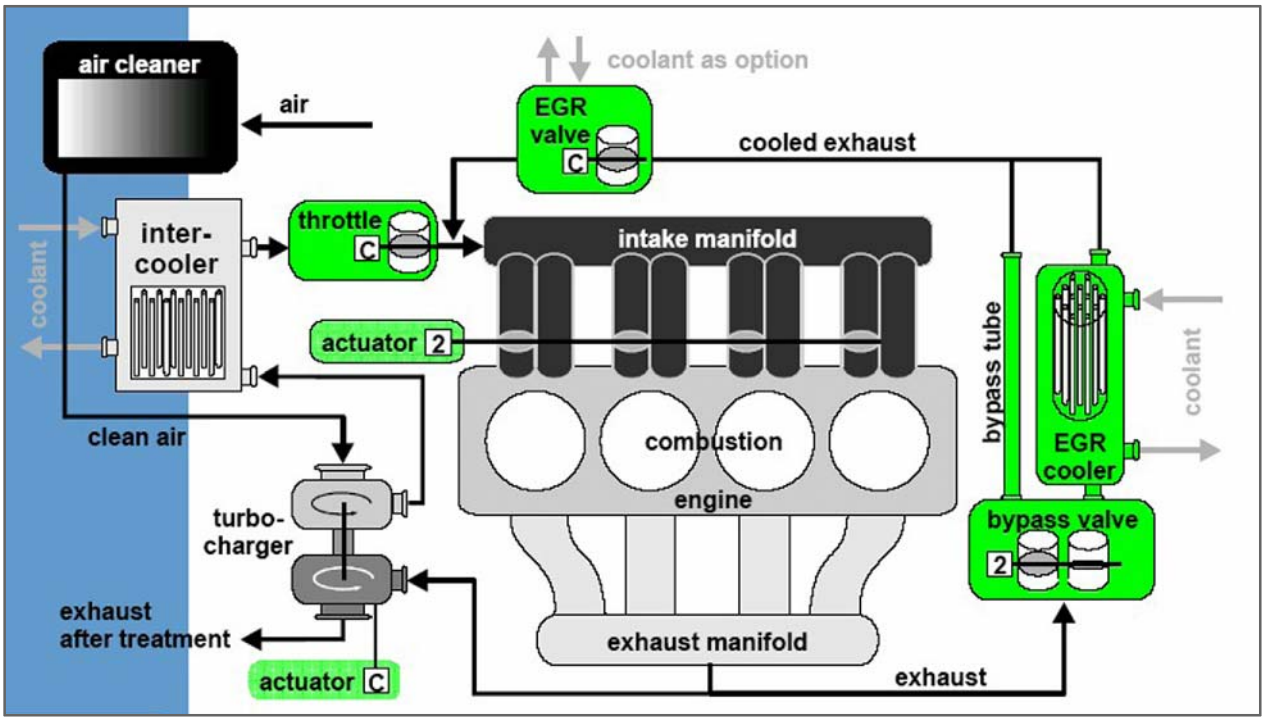
3. INPUT/OUTPUT OF INTAKE SYSTEM



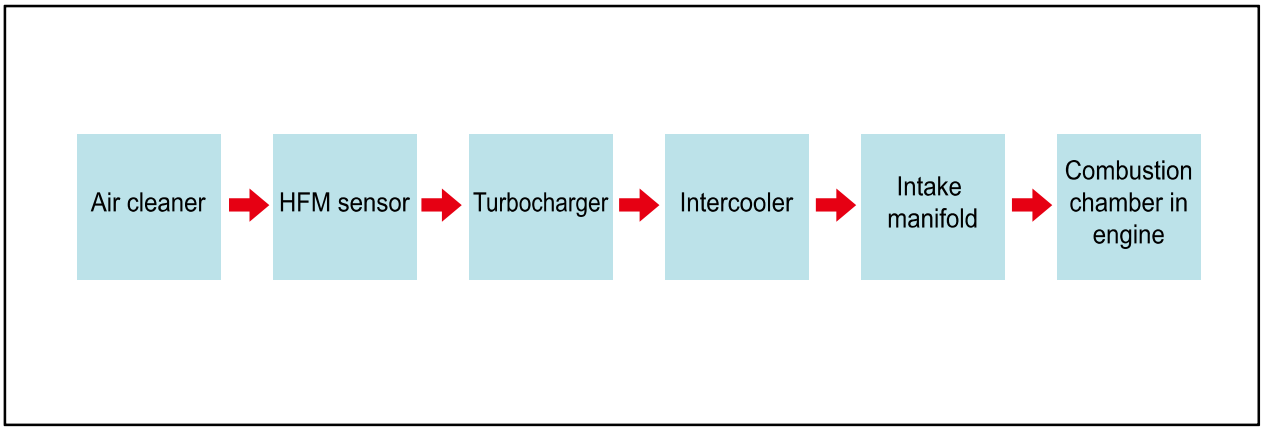
* For more information, refer to Chapter " Engine Control".

Modification basis	
Application basis	
Affected VIN	

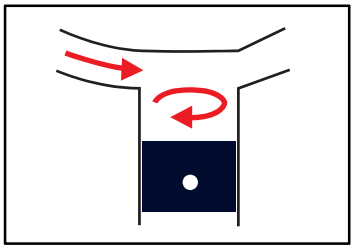
4. OPERATING PROCESS



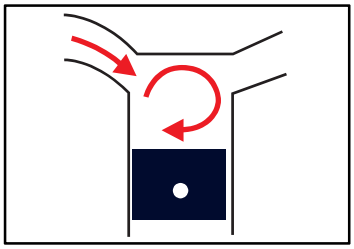
▶ **Work Flow**



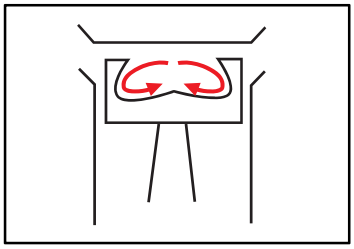
1) Types of swirl



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.



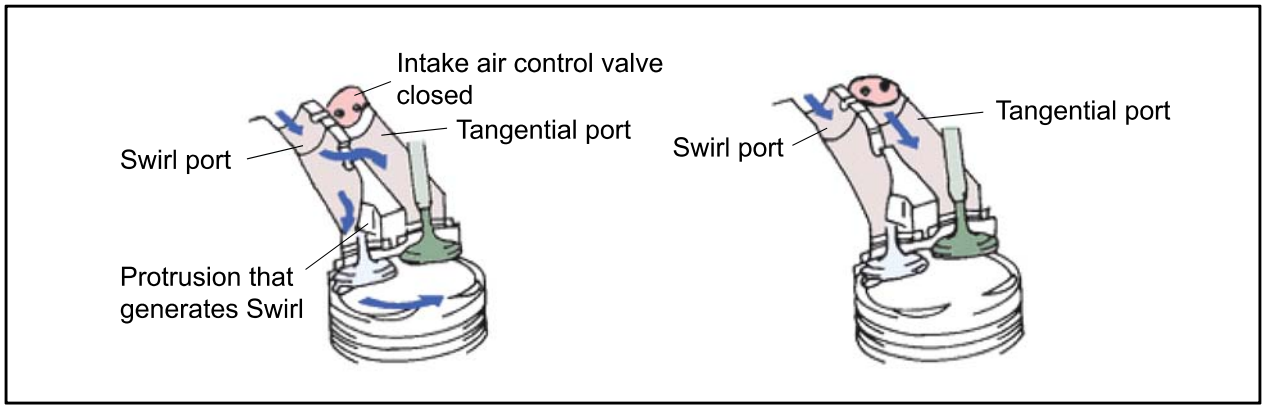
Tumble: Tumble is the vertical air flows in cylinder due to the vertical intake air port



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.

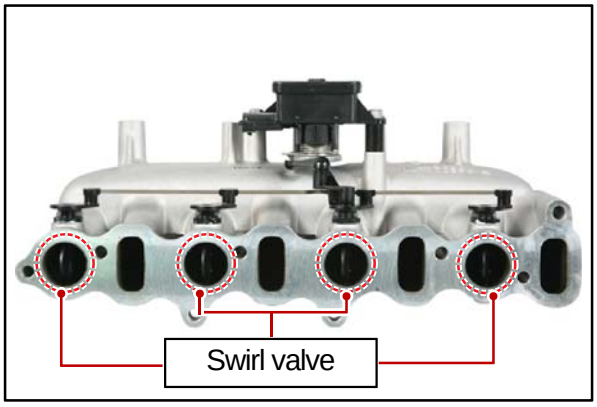
2) Swirl control

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.

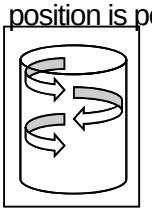


Modification basis	
Application basis	
Affected VIN	

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.

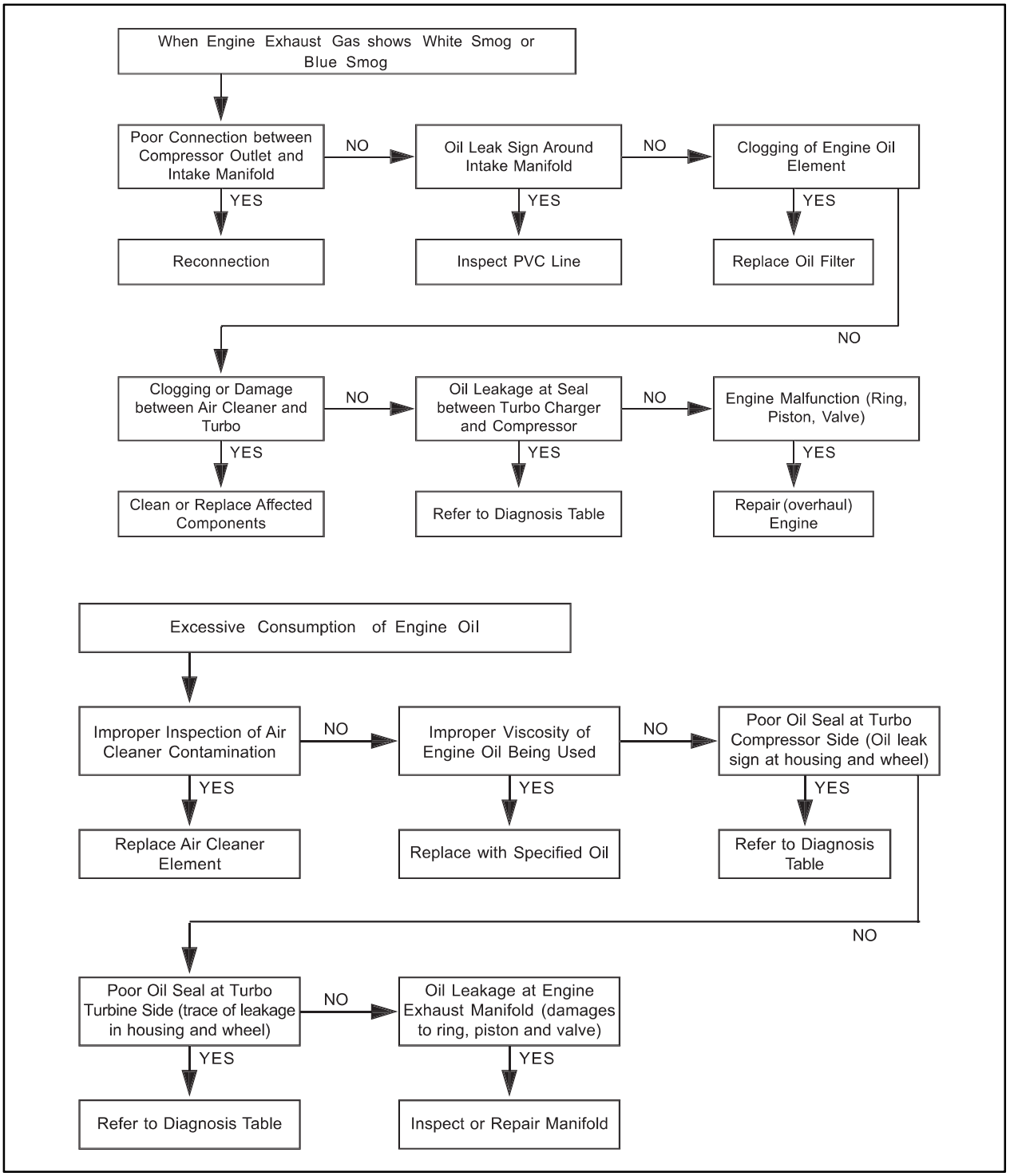
ENGINE EXHAUST SYSTEM

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.

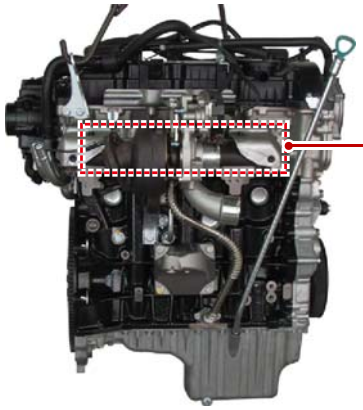
Modification basis	
Application basis	
Affected VIN	

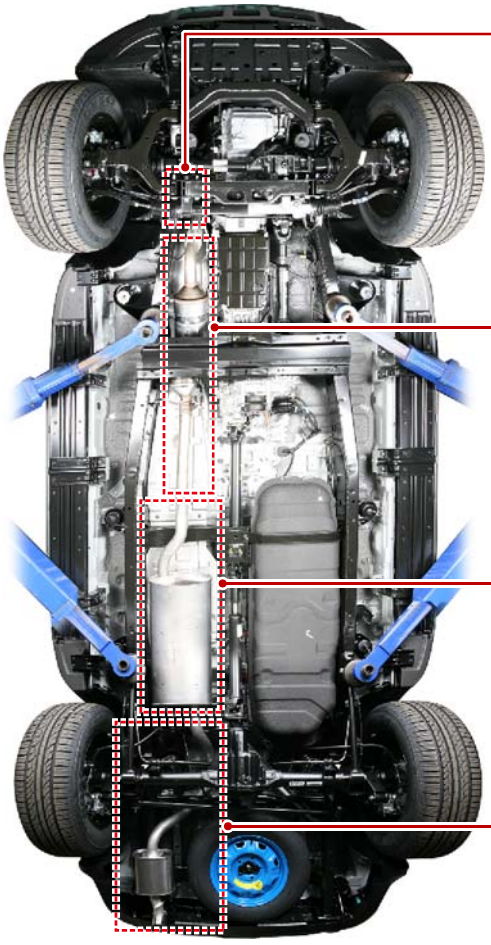
OVERVIEW AND OPERATING PROCESS

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



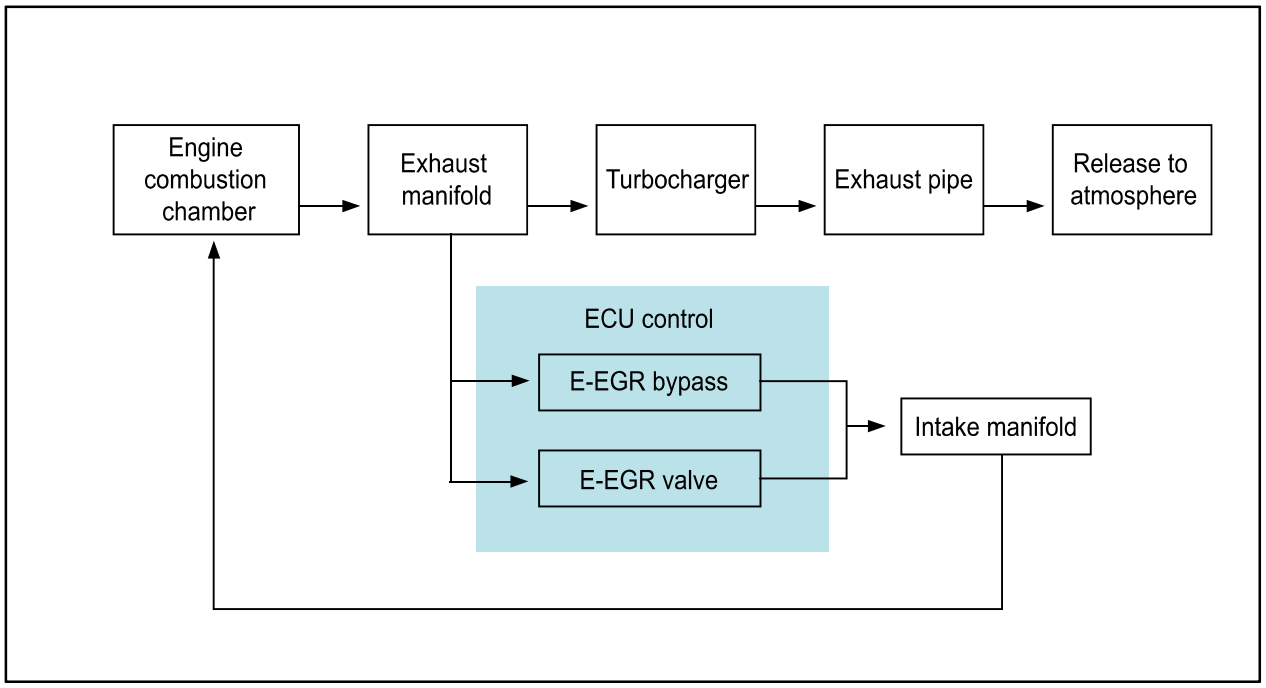
Exhaust tail pipe assembly



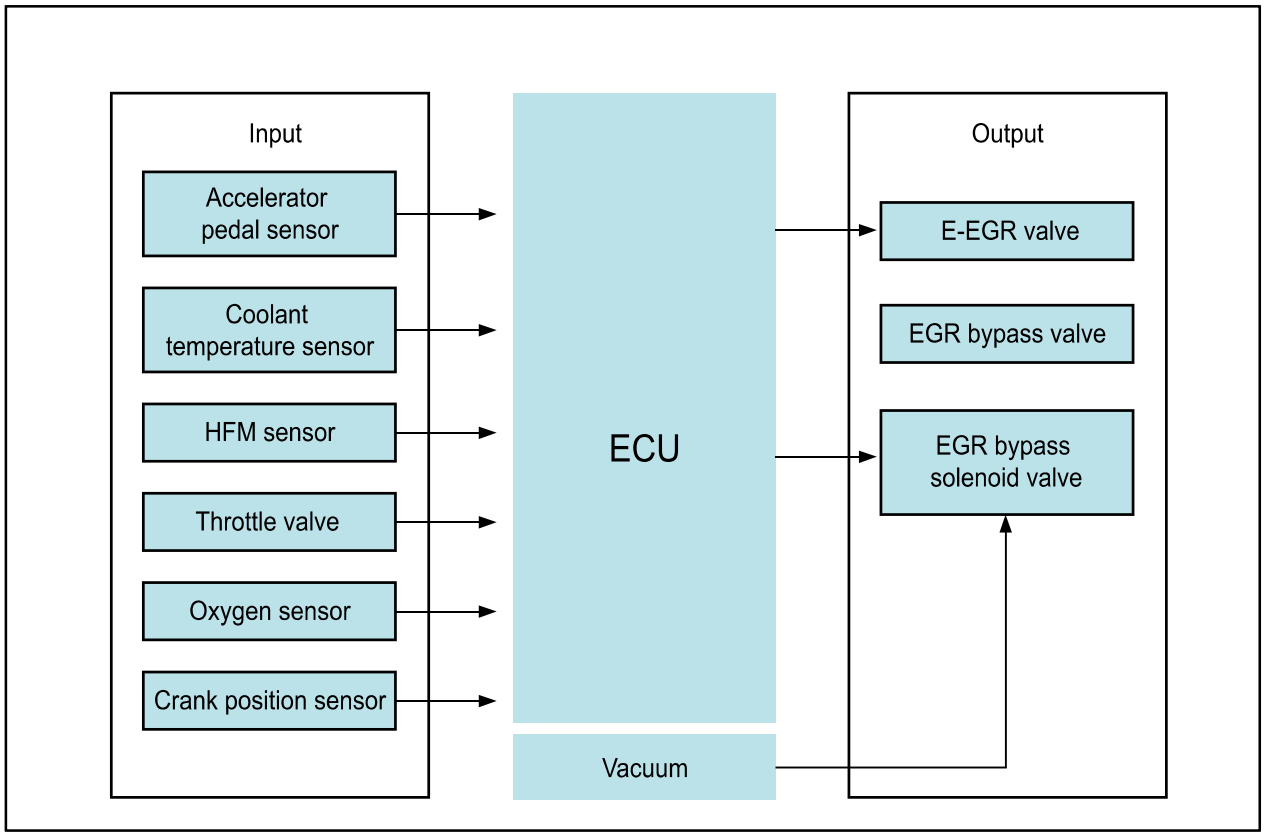
Modification basis	
Application basis	
Affected VIN	

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

Modification basis	
Application basis	
Affected VIN	

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.

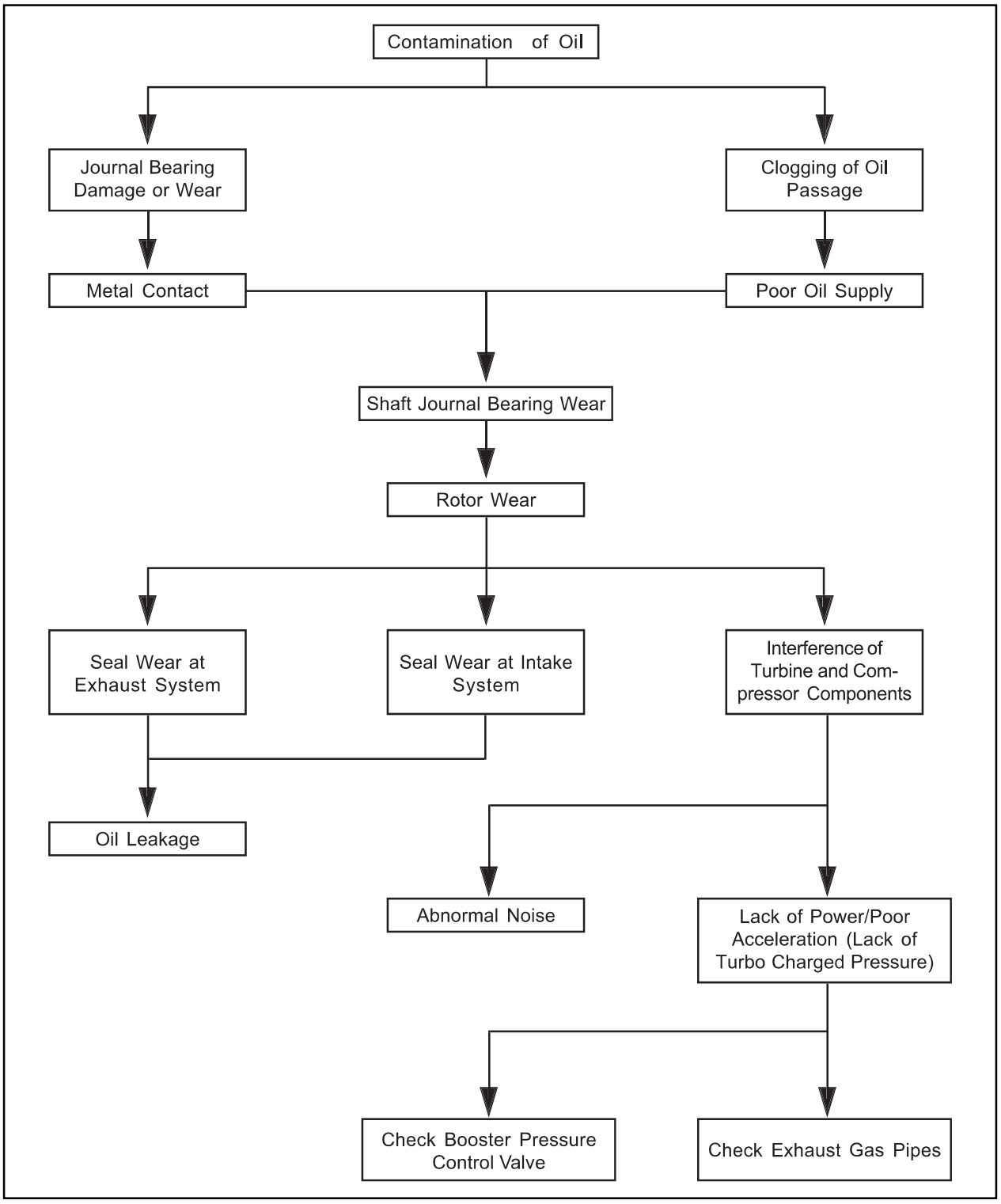
Damages by foreign materials: In case where the compressor wheel is damaged by foreign materials requires having an overhaul. At this time, it's necessary to check whether the foreign materials have contaminated intake/exhaust manifold or inside of engine.

Modification basis	
Application basis	
Affected VIN	

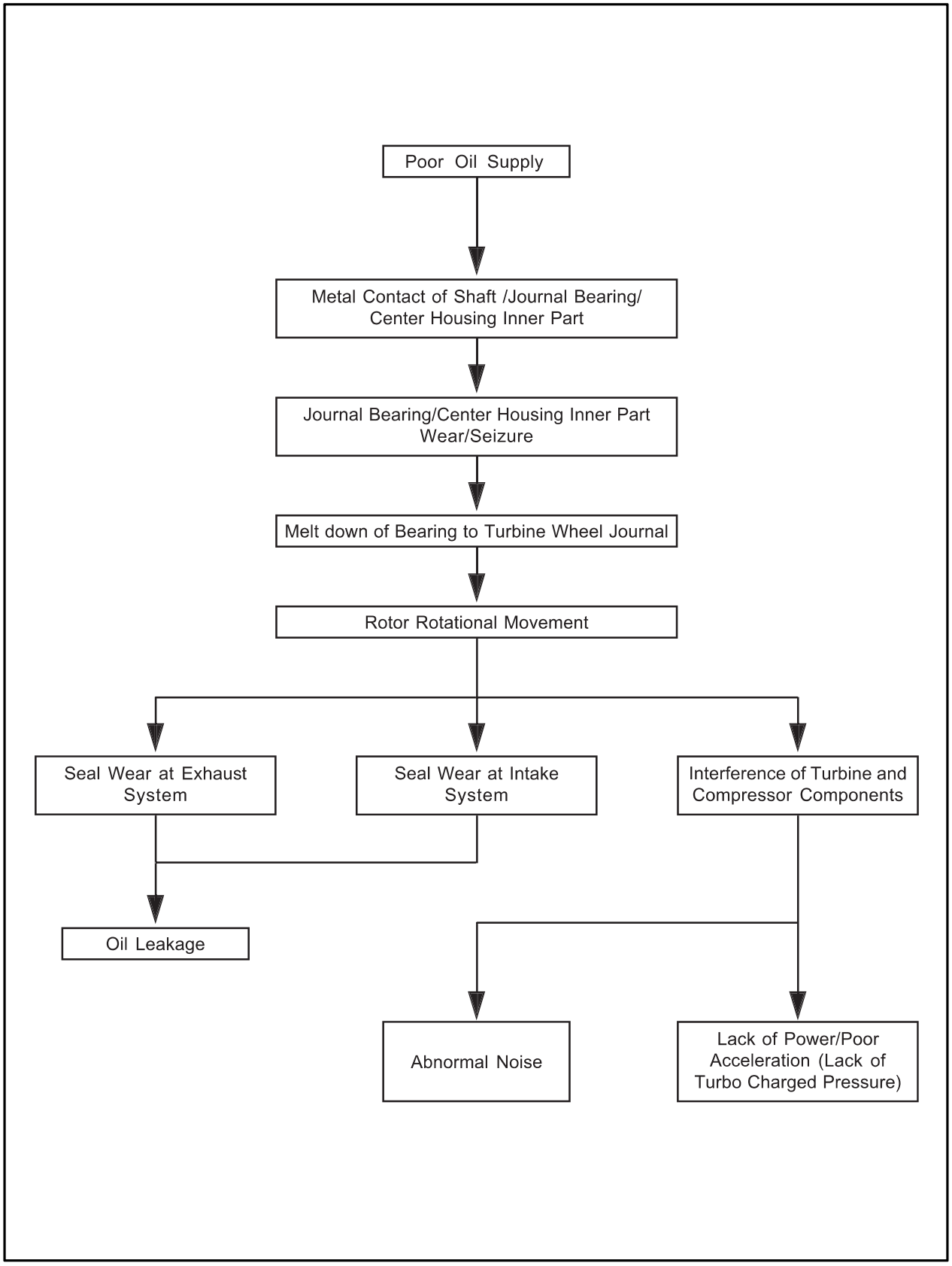
4) Possible Causes of Defect

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.

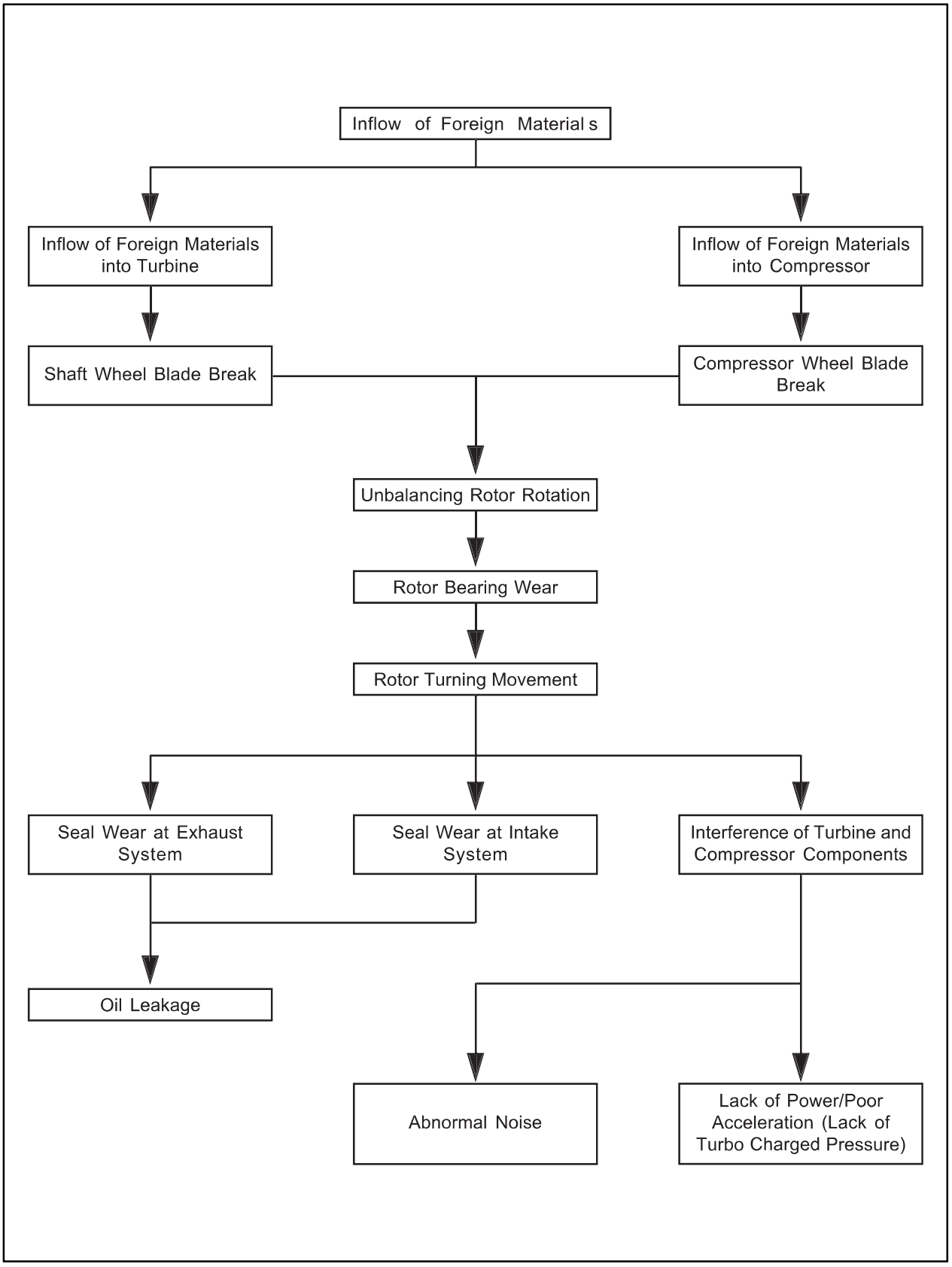


2. Oil Pump Defect: Rapid over-loaded driving after replacing oil filter and oil and clogging of oil line.

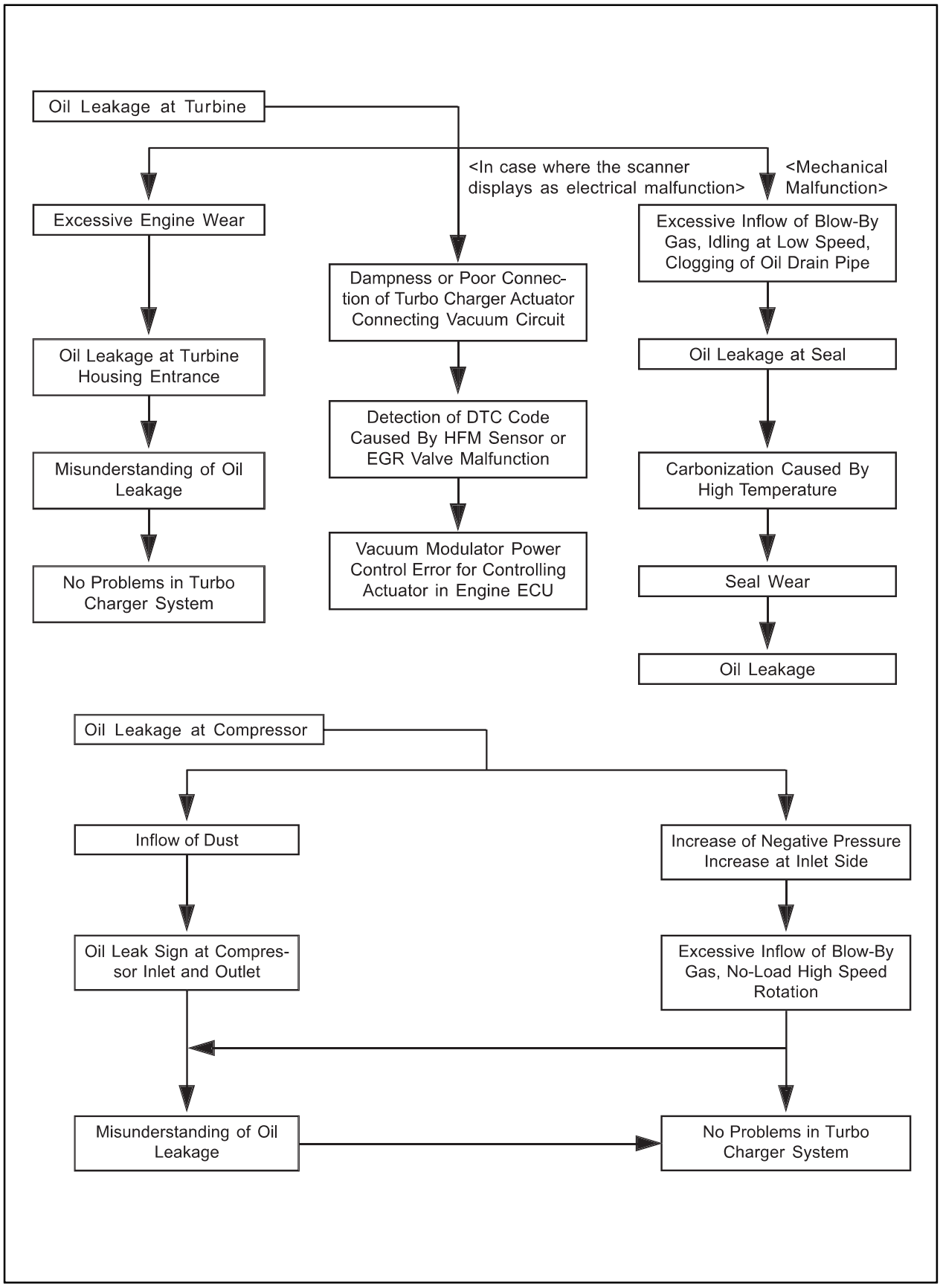


Modification basis	
Application basis	
Affected VIN	

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	

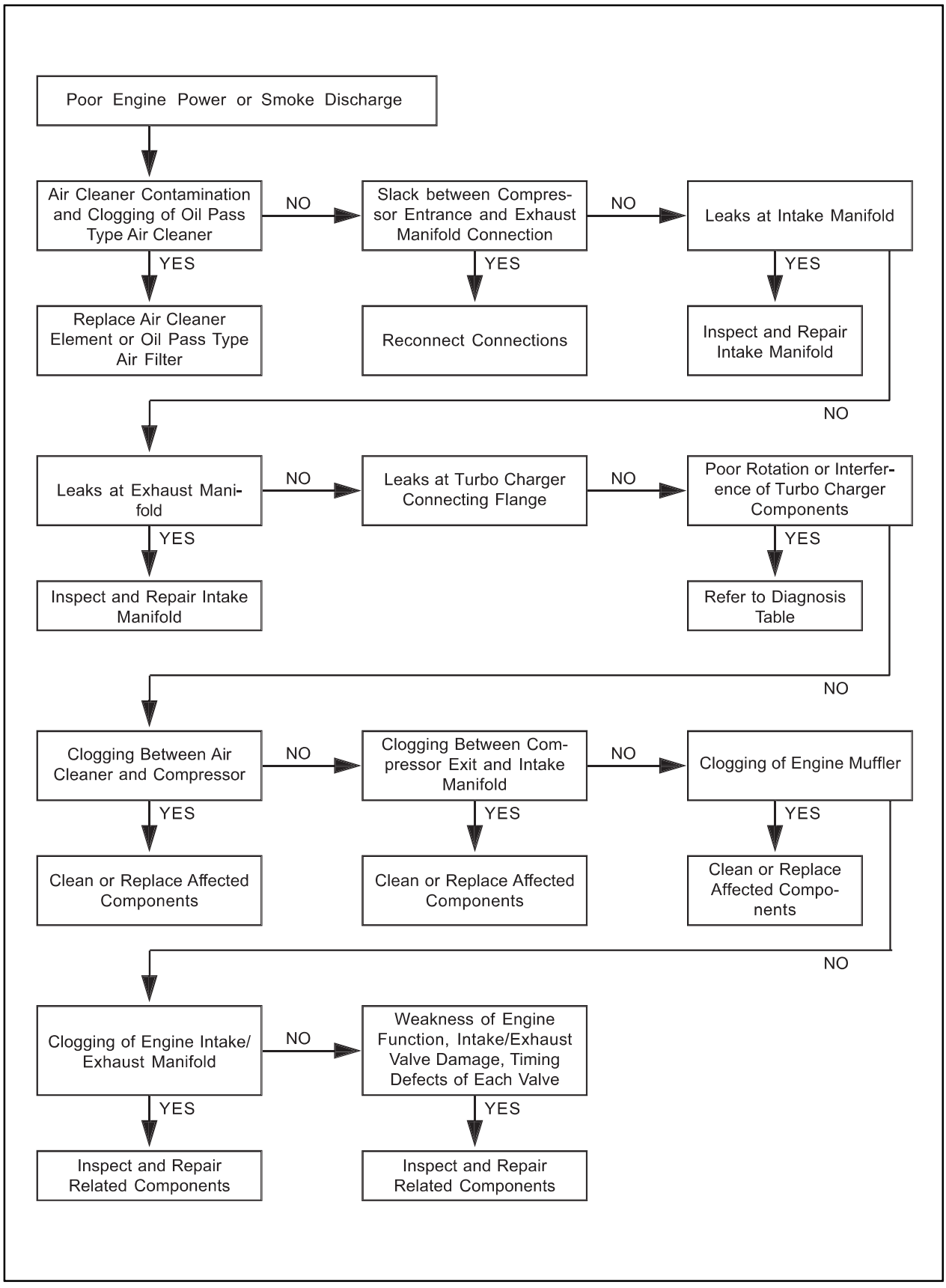
3. TROUBLESHOOTING

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

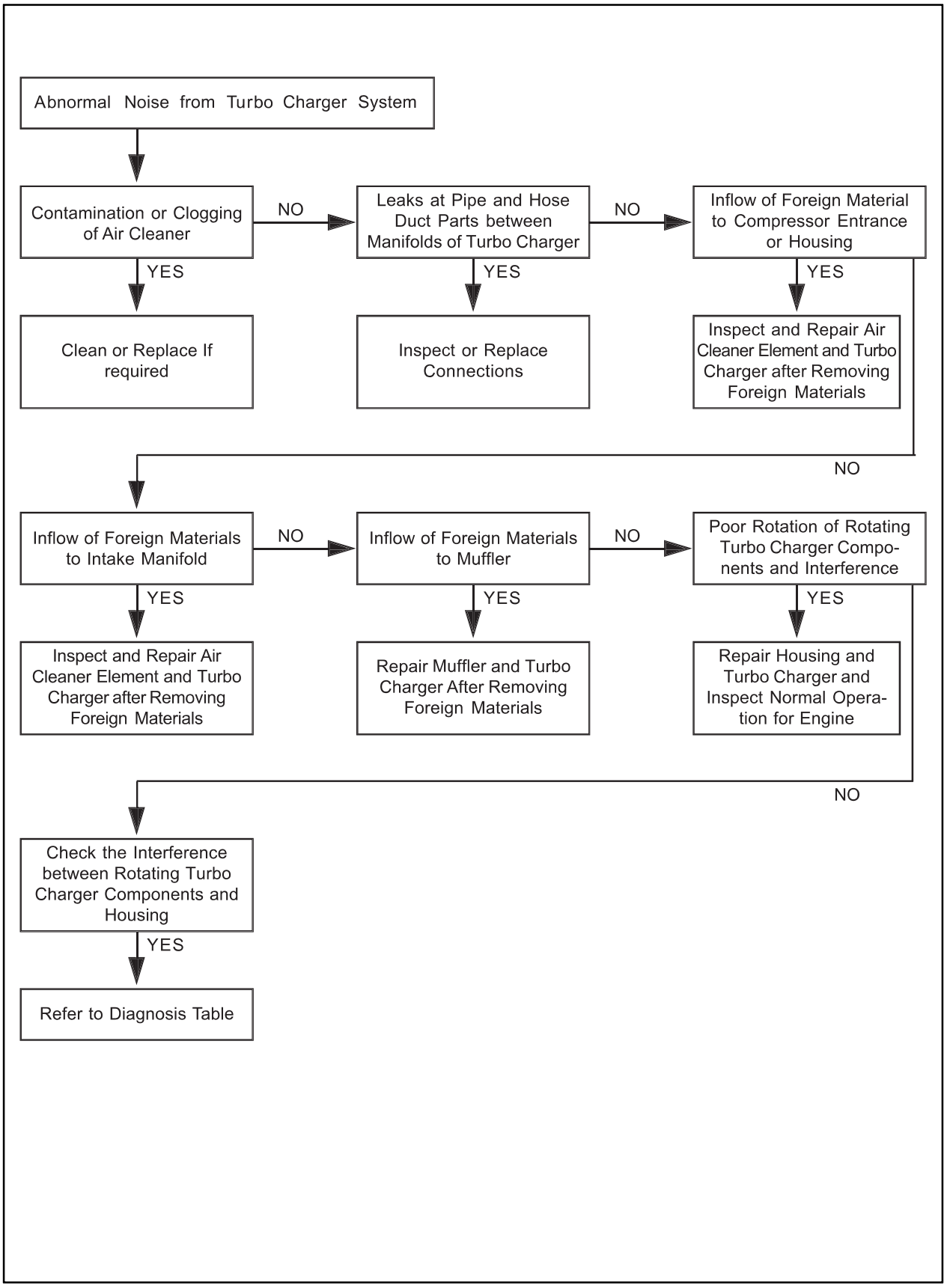
1) Cautions

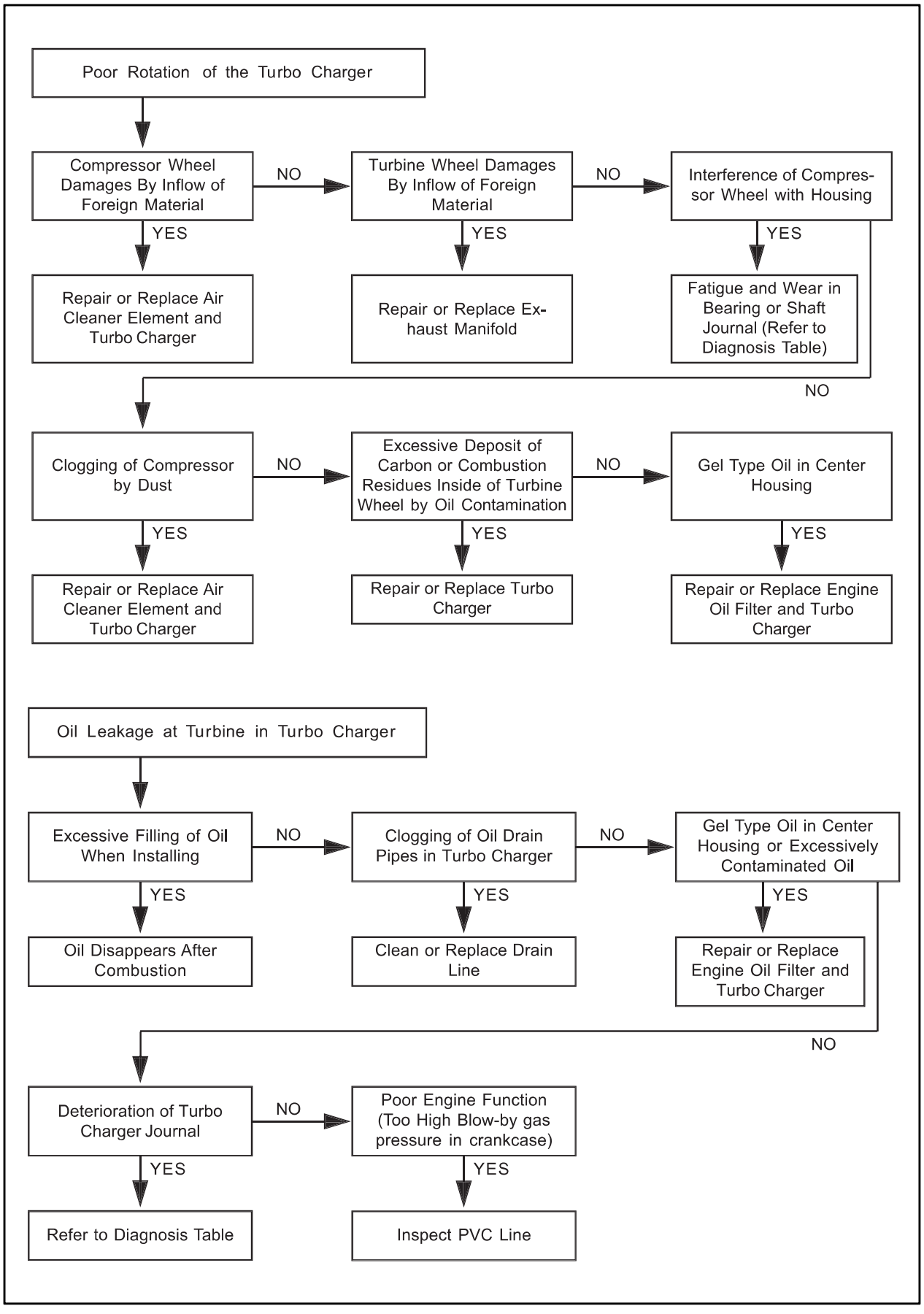
1. After stopping the engine, check whether the bolts on pipe connecting section are loose as well as the connecting condition of vacuum port and modulator, which is connected to the actuator.
2. During idling of the engine, check for leakage in the connecting section of pipe (hoses and pipes, duct connections, 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

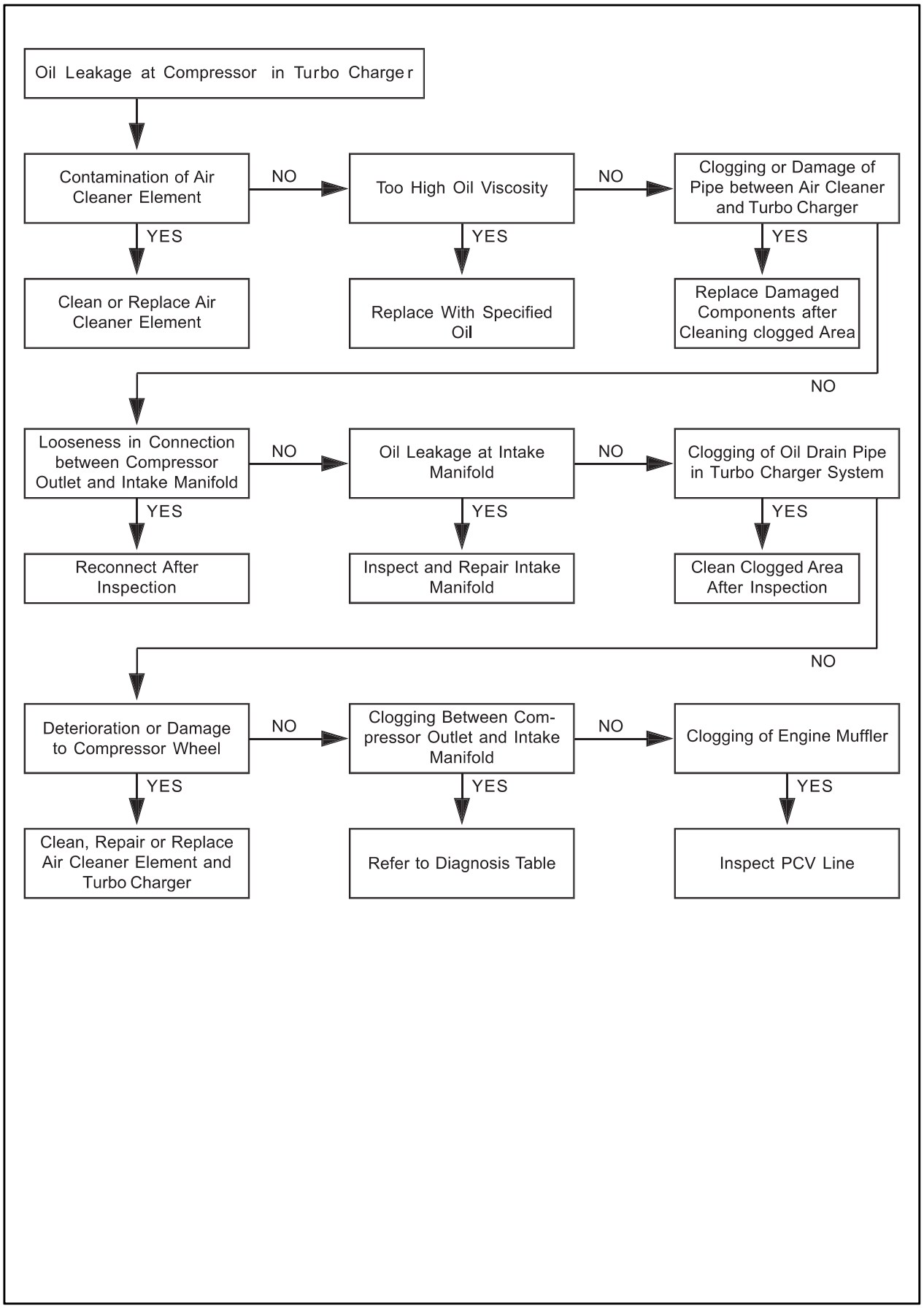


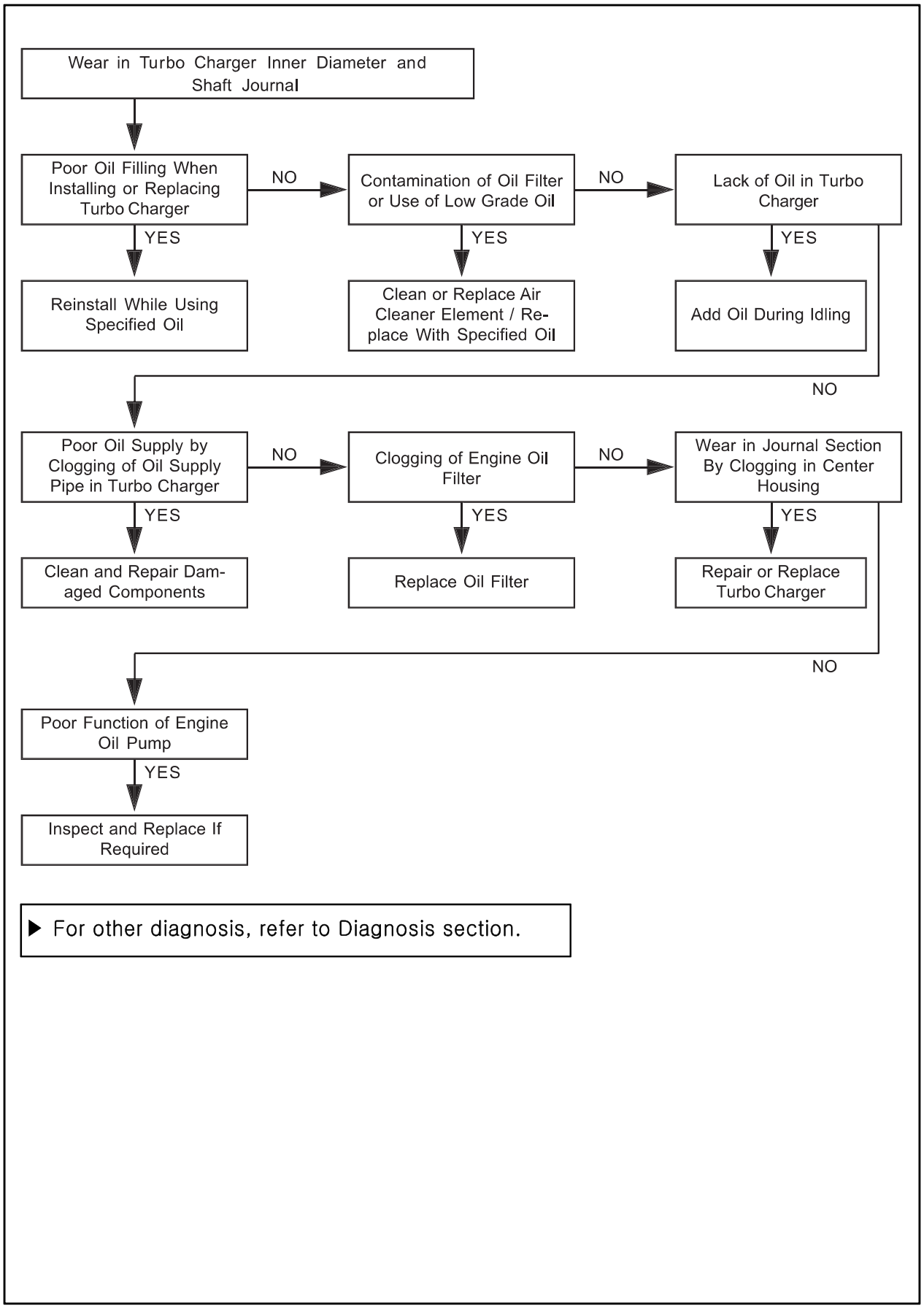
Modification basis	
Application basis	
Affected VIN	


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



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

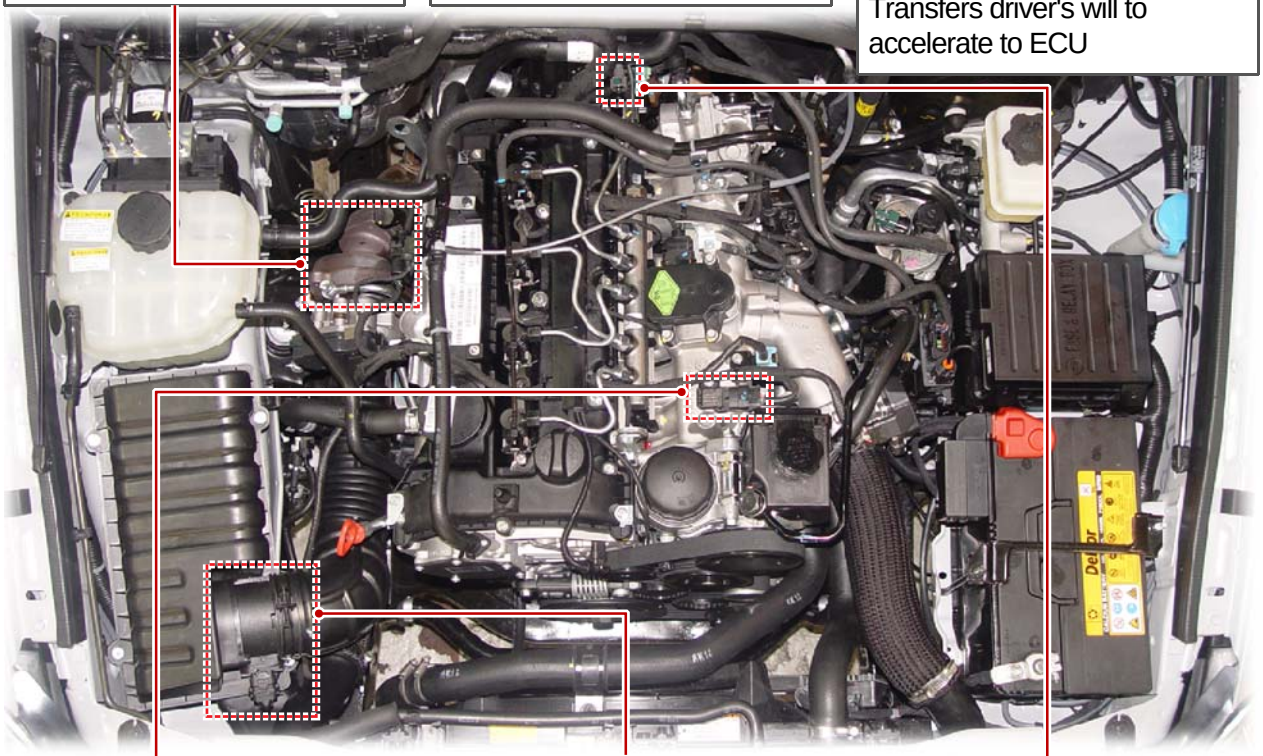
- Improved low speed torque and power
- Reduced exhaust gas
- Improved fuel consumption
- Improved acceleration performance

Modification basis	
Application basis	
Affected VIN	

2. COMPONENTS

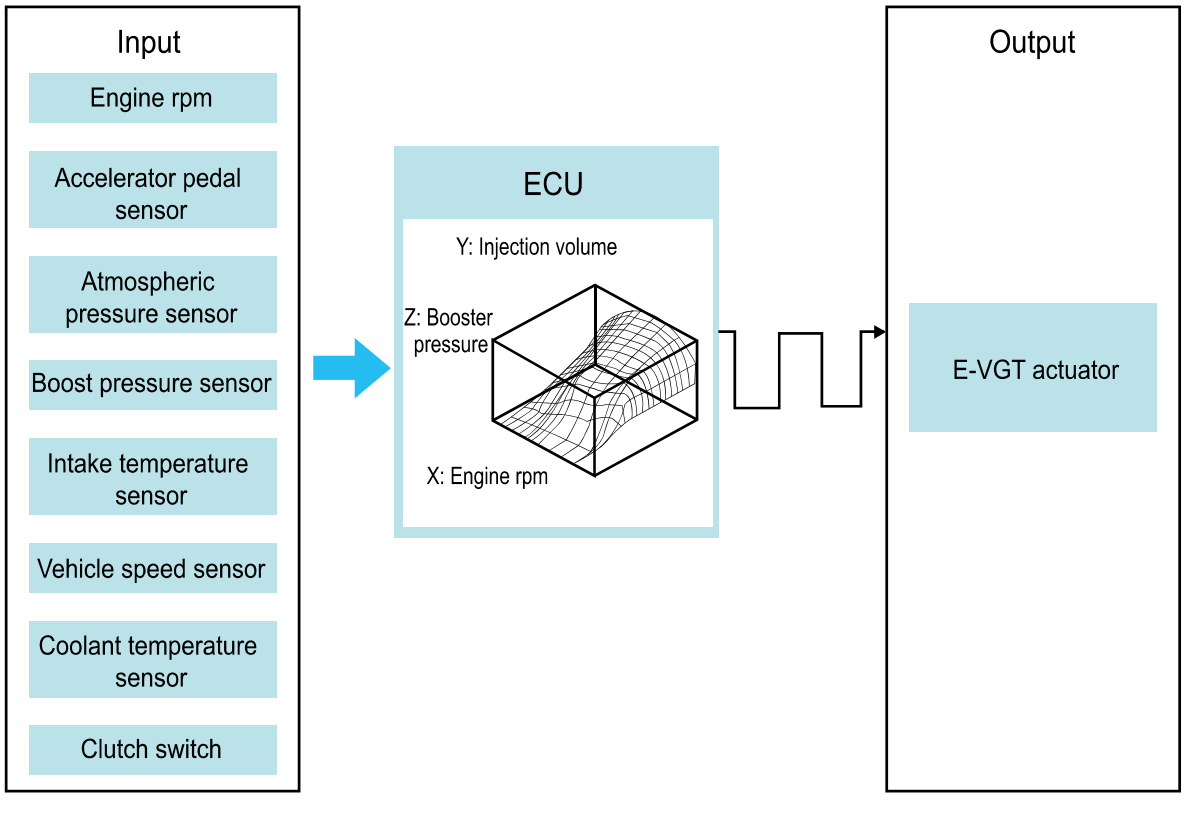
* 세부제어로직은 엔진제어편 참조

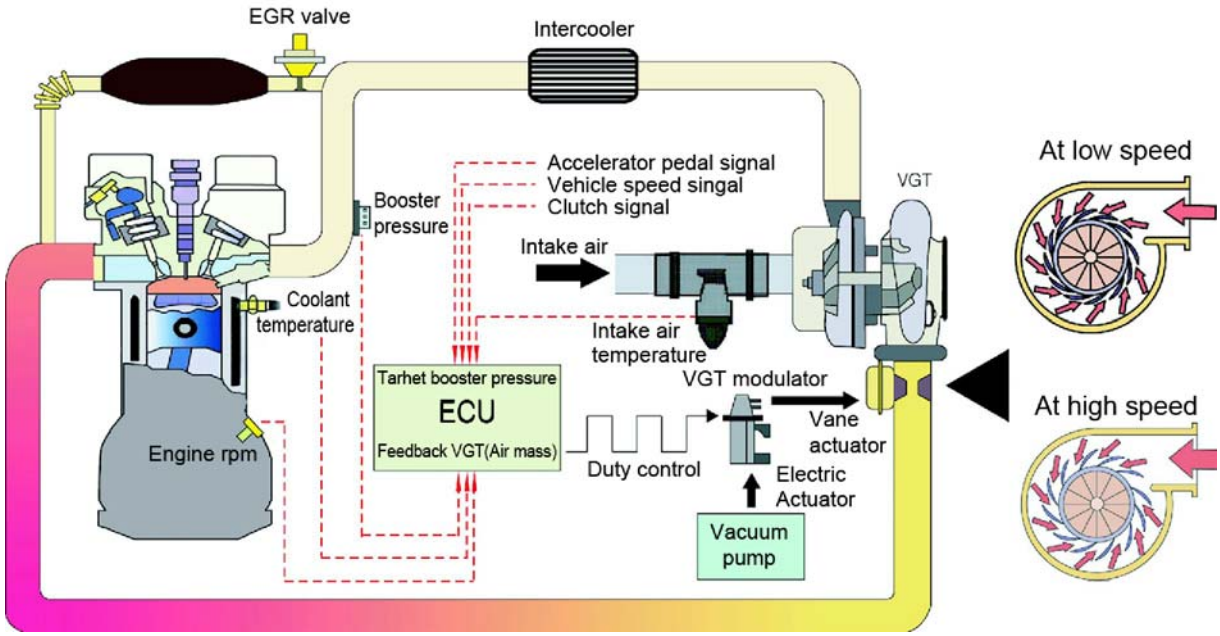
E-VGT turbocharger	Engine ECU (D20DTR)	Accelerator pedal position sensor
	 Atmospheric pressure, RPM signal	
Improves engine power	E-VGT duty control	Transfers driver's will to accelerate to ECU



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

3. INPUT/OUTPUT DEVICES





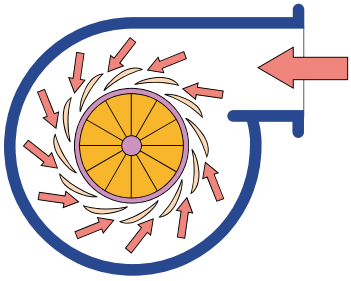
Modification basis	
Application basis	
Affected VIN	

4. OPERATING PRINCIPLES

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

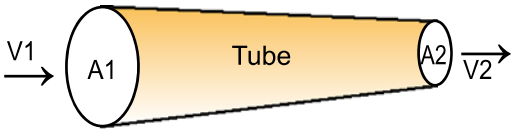
1) How it Works at Low Speed

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

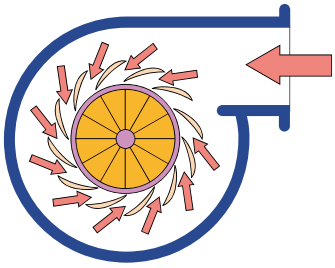
NOTE

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

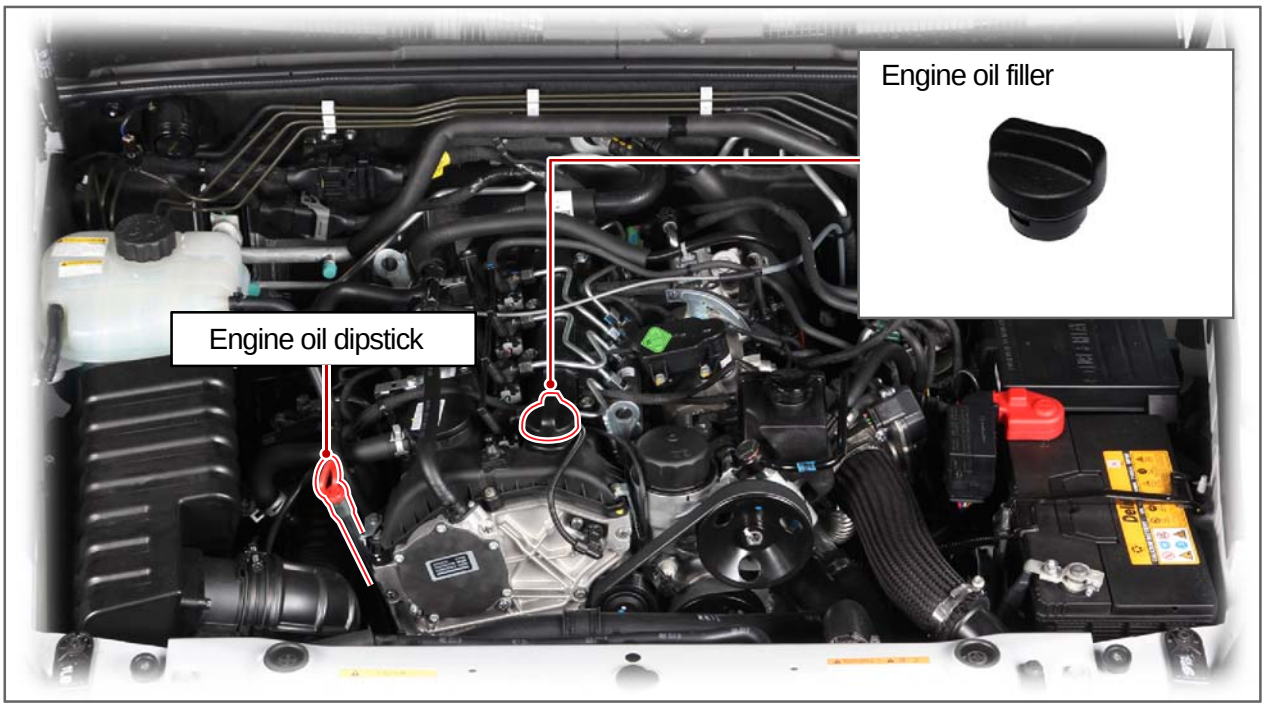
1) Level Check

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	

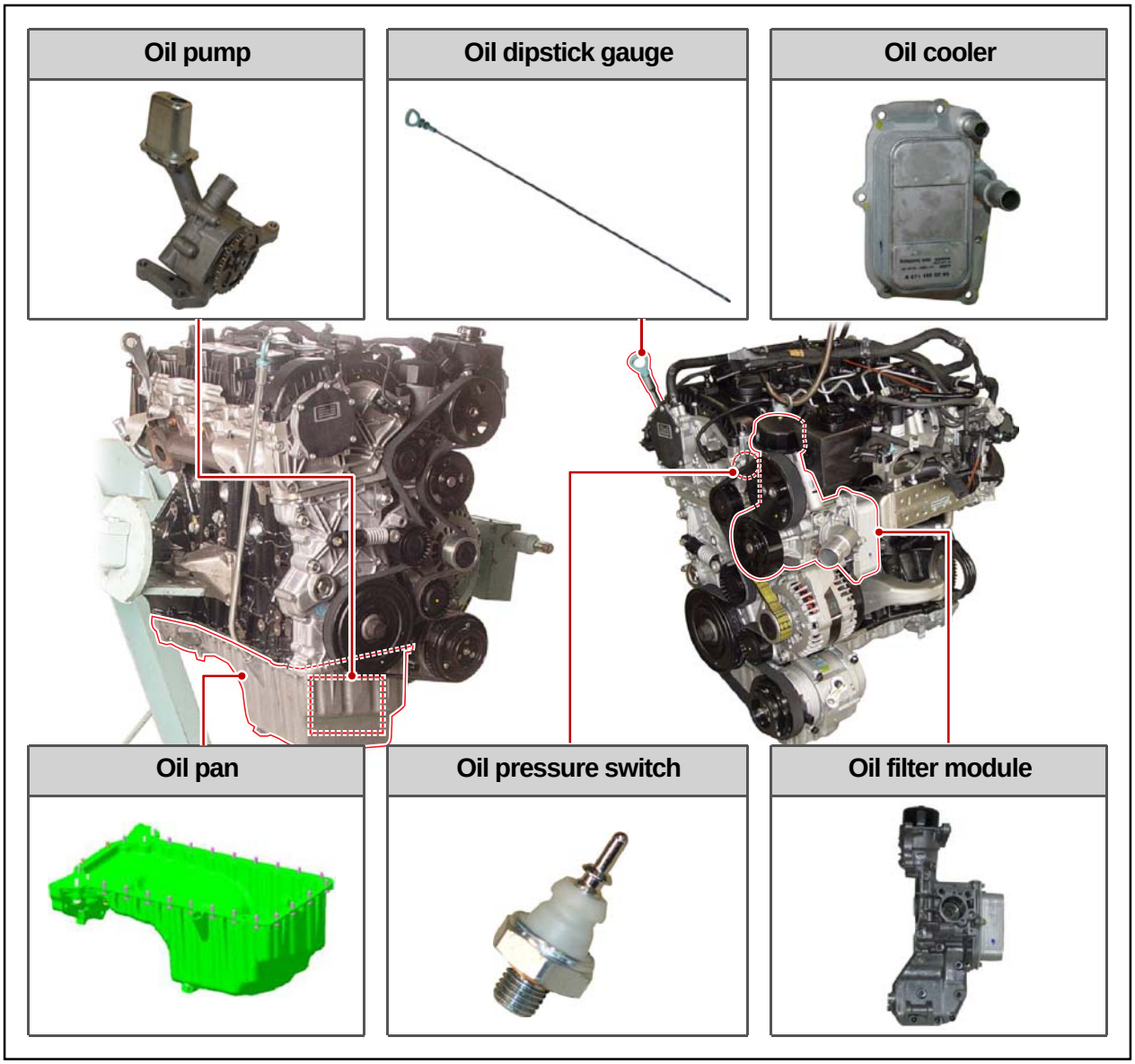
OVERVIEW AND OPERATING PROCESS

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	662.1W x 510H x 27T (over 337,600mm²)
	Flow type	Cross flow
	Min. cooling capacity	over 72,000 kcal/h
Antifreeze	Type	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.

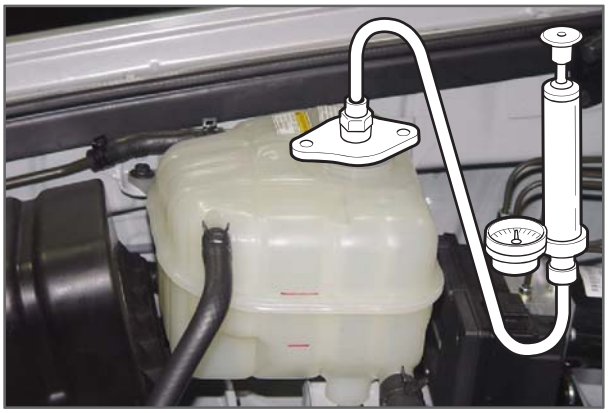
2) Leak Test



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

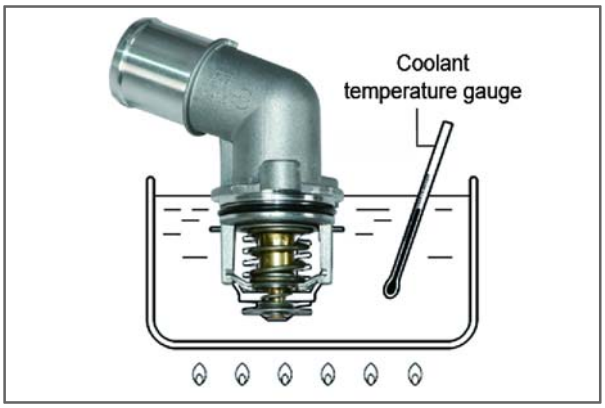
CAUTION

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

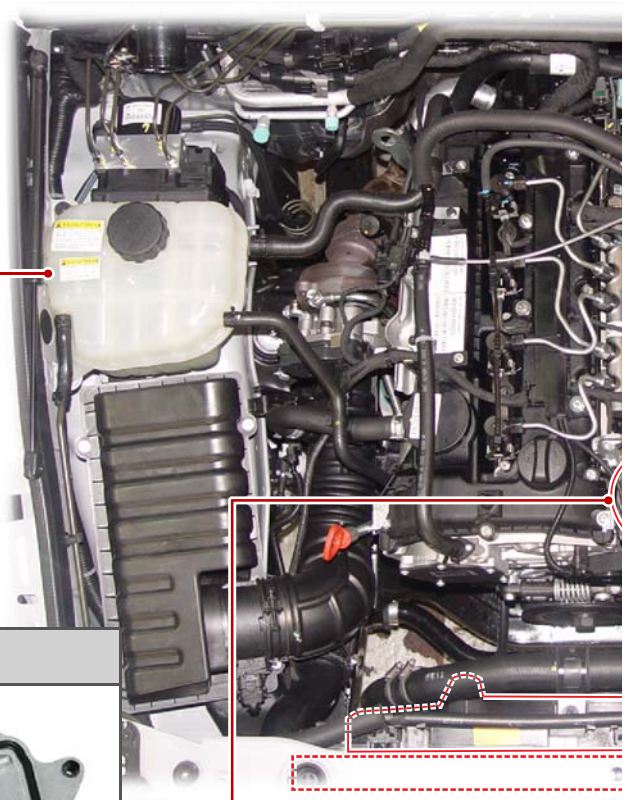
CAUTION

- 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



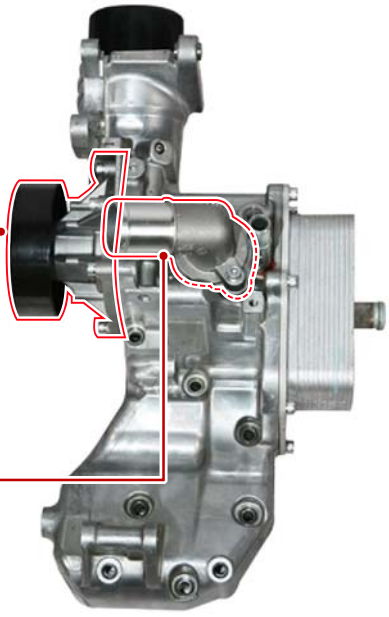
The water pump is driven by the engine drive belt and supplies the coolant to each area of the engine.

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.

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

Modification basis	
Application basis	
Affected VIN	

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

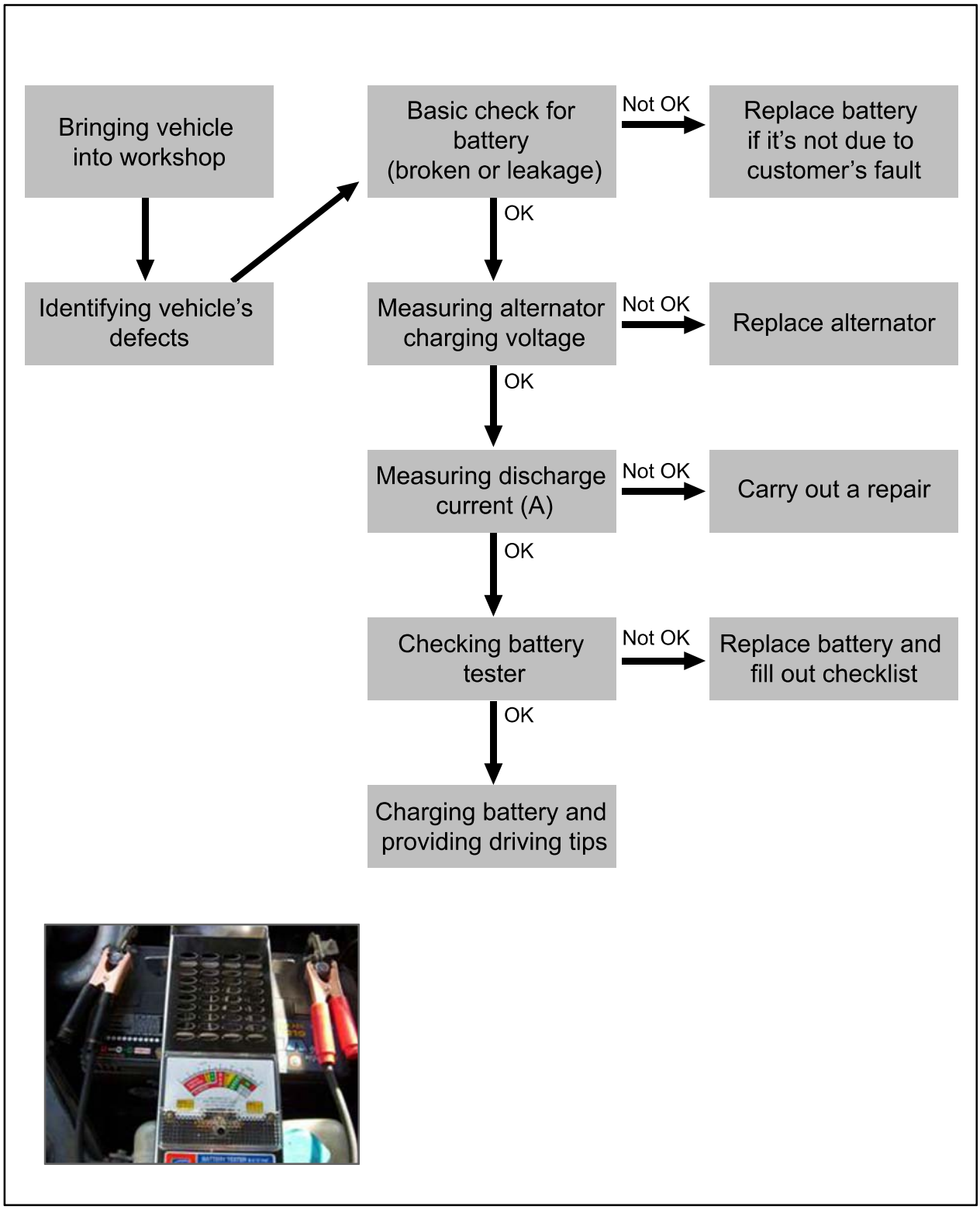
- Disconnect the negative battery cable.
- Connect the negative cable again after connecting the ammeter.

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**

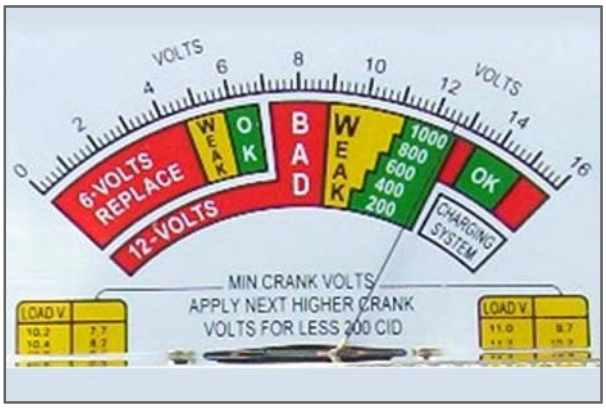
- PASS (11.0 V or more): Explain to the customer that the battery is reusable.
- Need to be charged (9.0 to 11.0 V): Charge the battery with a charger and reinstall it. Explain it to the customer.
- Need to be replaced (9.0 V or more): The battery should be replaced due to overdischarging.

(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

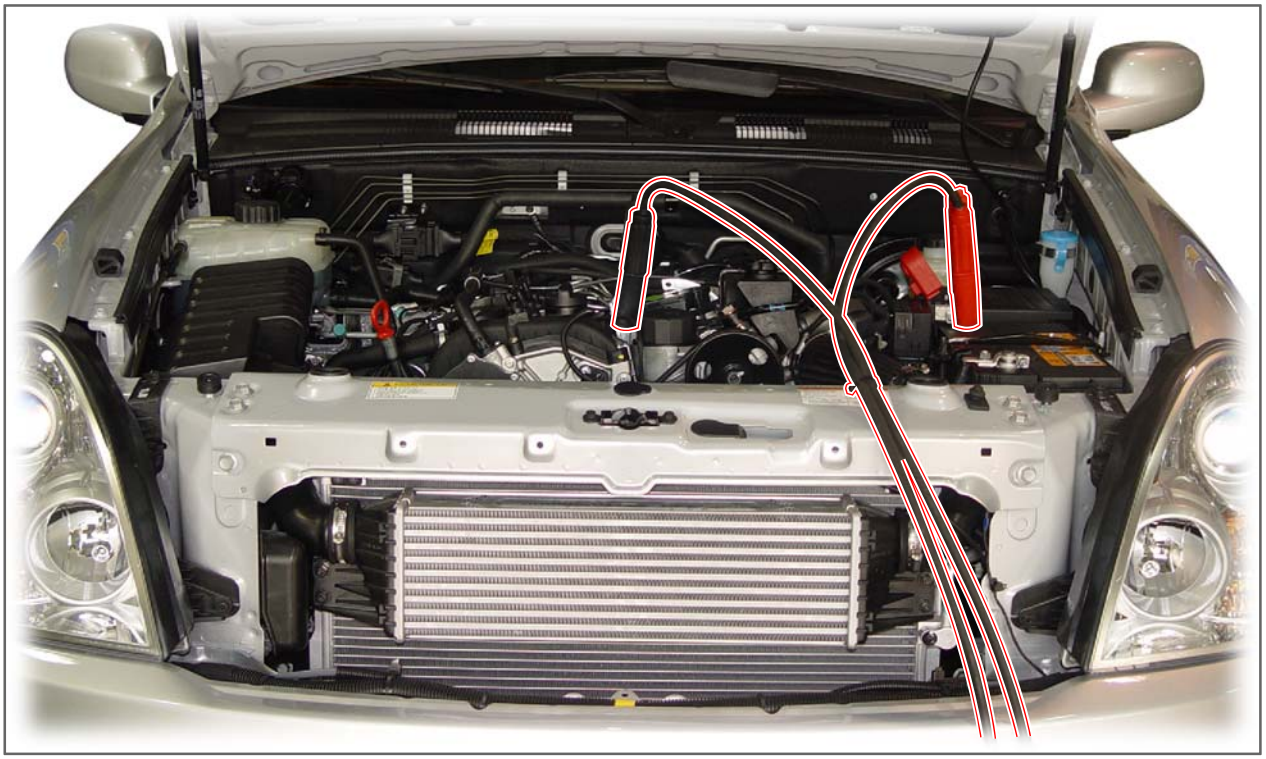
If the battery is weak or terminated, the battery from another vehicle can be used with jumper cables to start the engine.

▶ 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

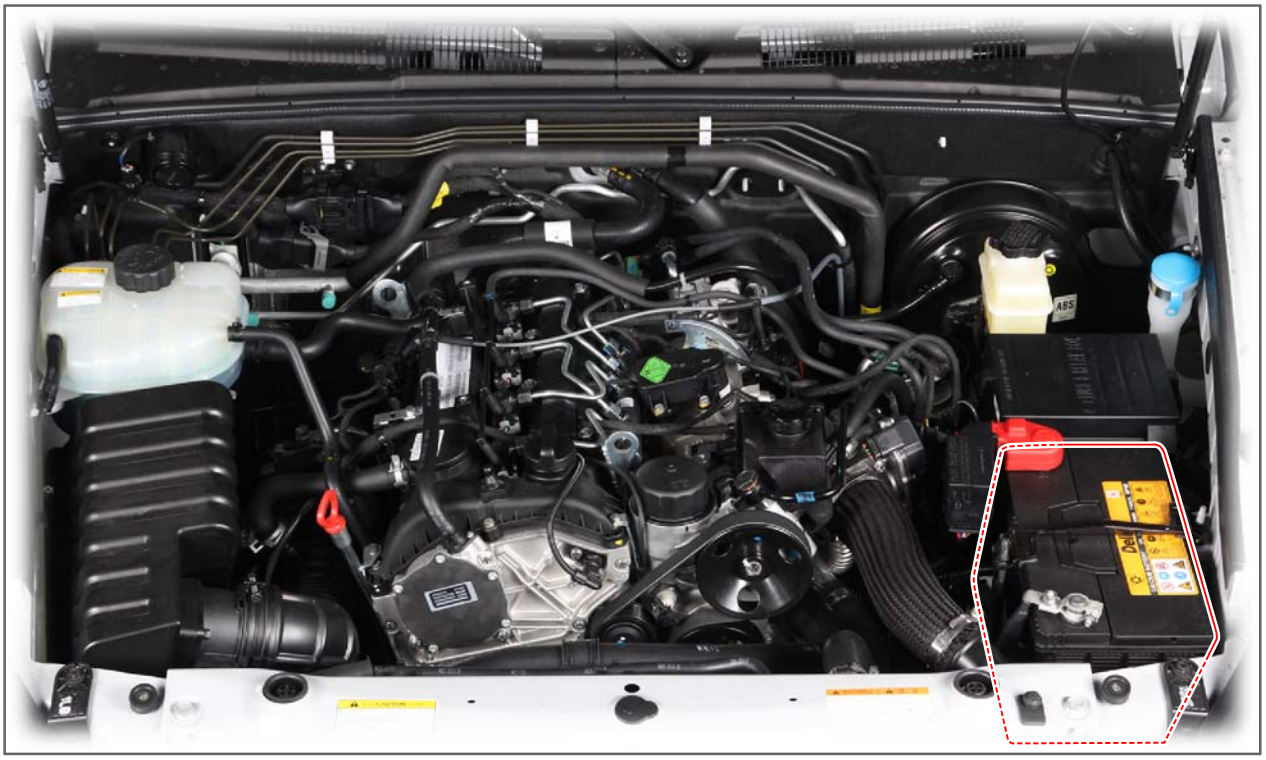
1. Prepare a set of jumper cables.
2. Place another vehicle that has the same 12 V of power near to the discharged vehicle.
3. Switch off all electrical accessories for the discharged vehicle.
4. Apply the parking brake and shift the transaxle to the P position (automatic transaxle) or neutral (N) position (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.

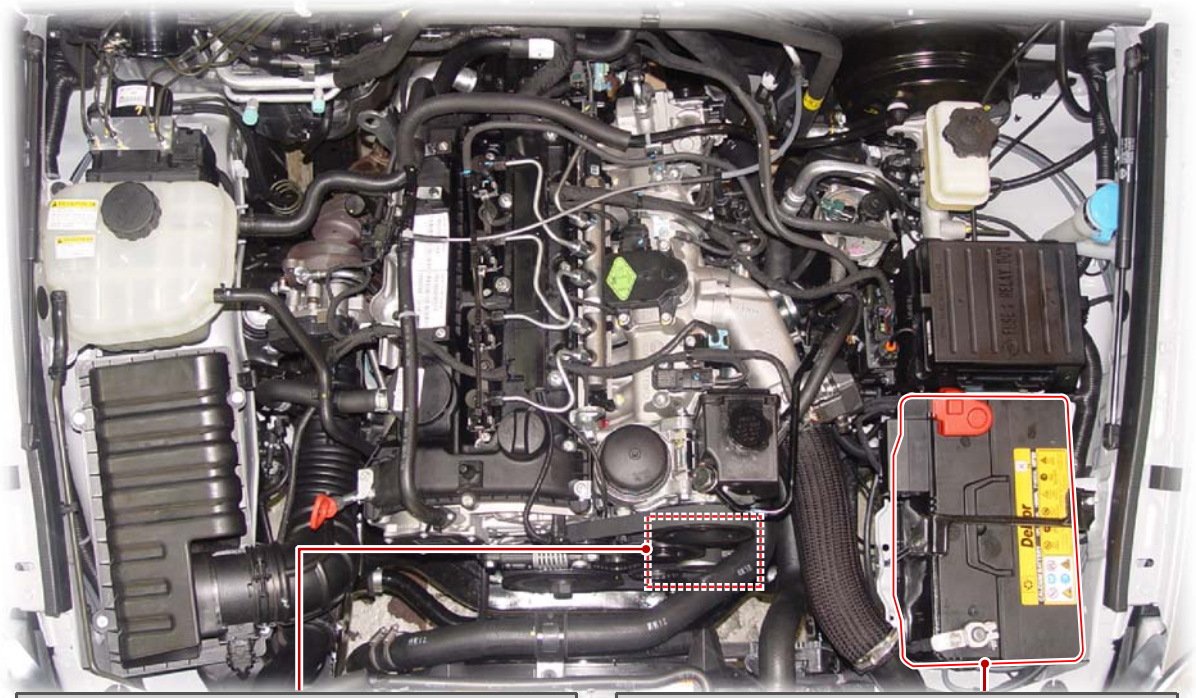
OVERVIEW AND OPERATING PROCESS

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)

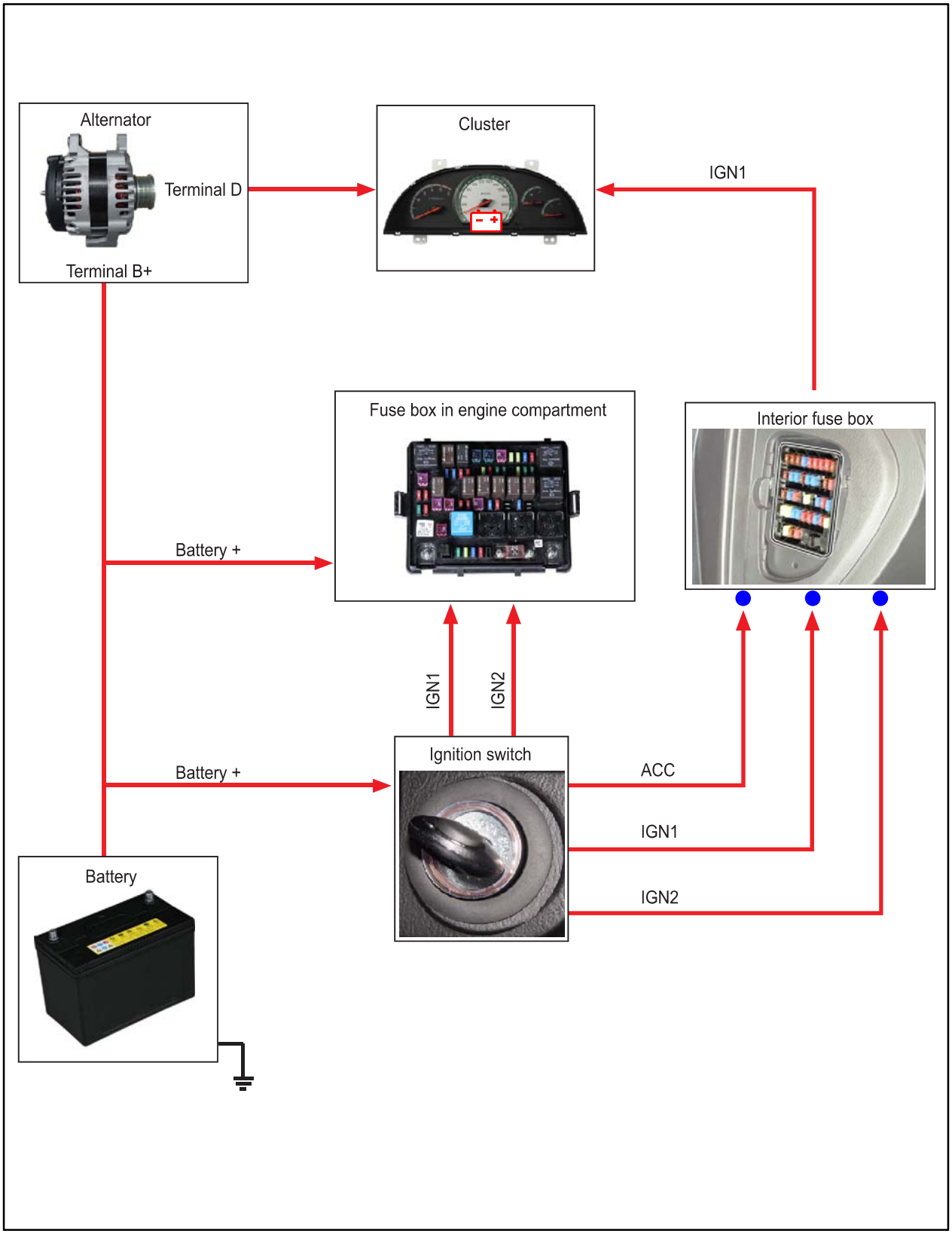


Alternator	Battery
	
The alternator charges the battery and supplies power to each electric unit by converting the mechanical energy to the electrical energy.	It converts the chemical energy to the electrical energy and supplies power to the corresponding electric units when starting the engine.

Modification basis	
Application basis	
Affected VIN	

2. OPERATING PROCESS

1) Charging Flow



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**

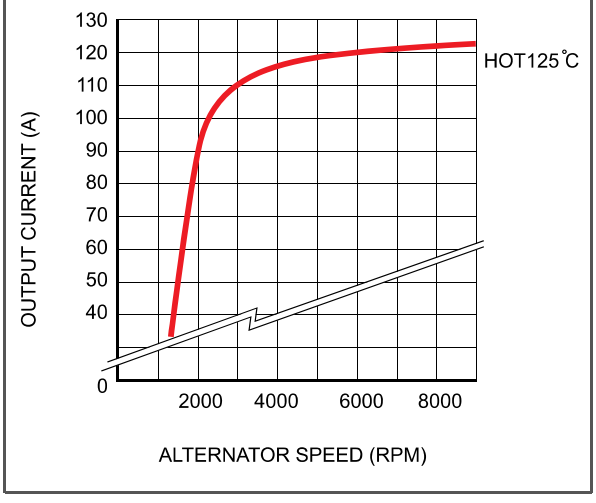


Specification: Charging a fully depleted high-capacity battery takes twice or more as long as charging a fully depleted battery for small vehicles.
Temperature: The lower the temperature is, the longer the time taken to charge the battery. When connecting the battery charger to the cold battery, the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

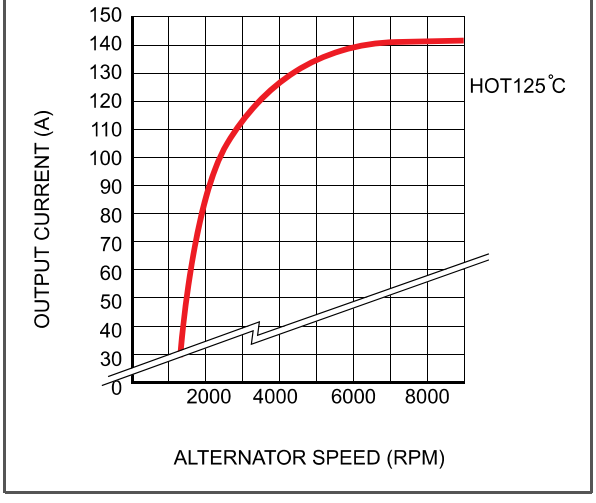
Charging capacity: Charging a battery with a low-capacity charger takes longer time than charging with a high-capacity charger.
Charging status: Charging a fully depleted battery takes twice or more as long as charging a half-depleted battery. Since the electrolyte in a fully depleted battery consists 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)

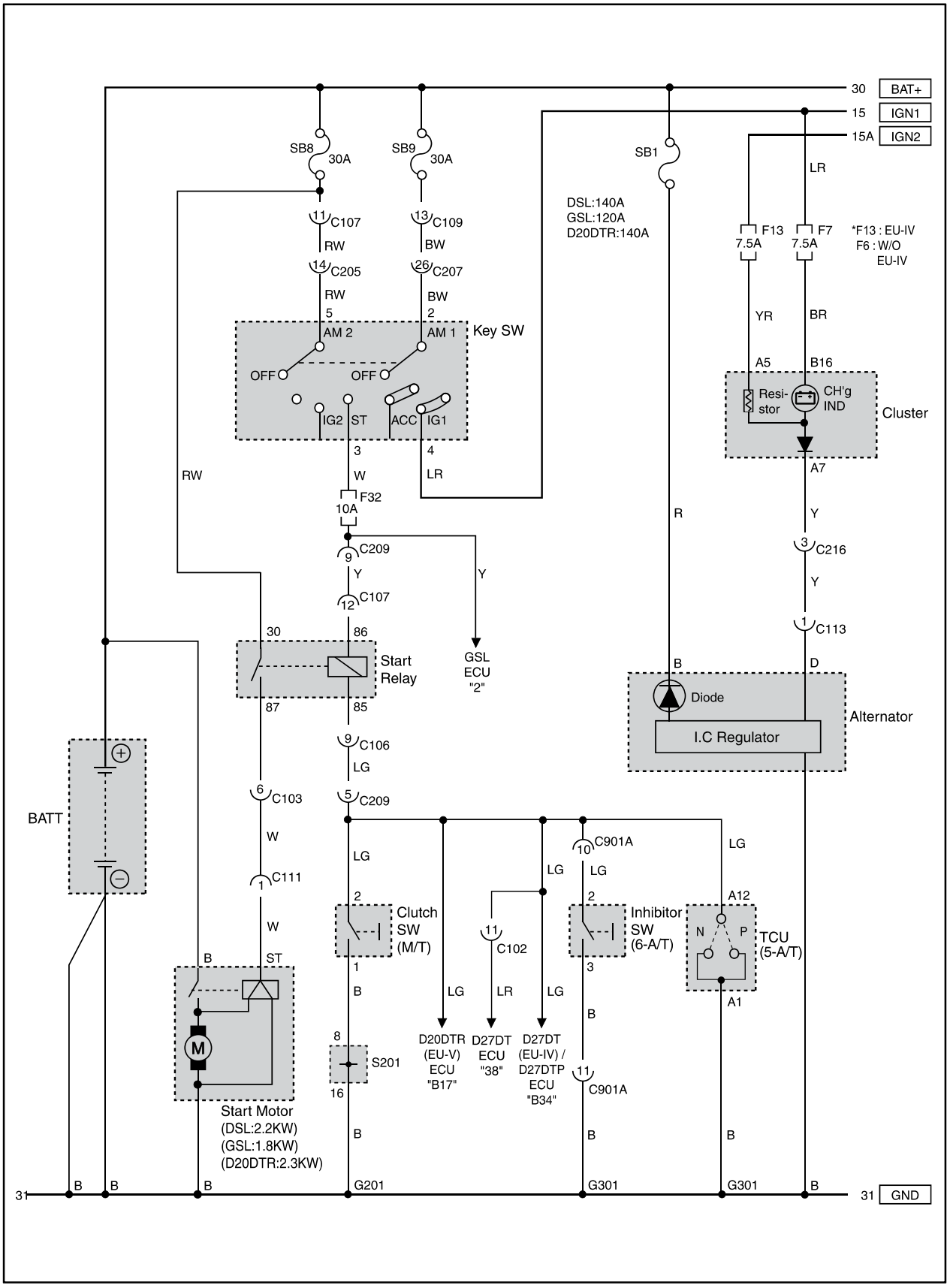


Alternator (140 A)



Modification basis	
Application basis	
Affected VIN	

3. CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	

PRE-GLOW SYSTEM

1413-00

GENERAL INFORMATION

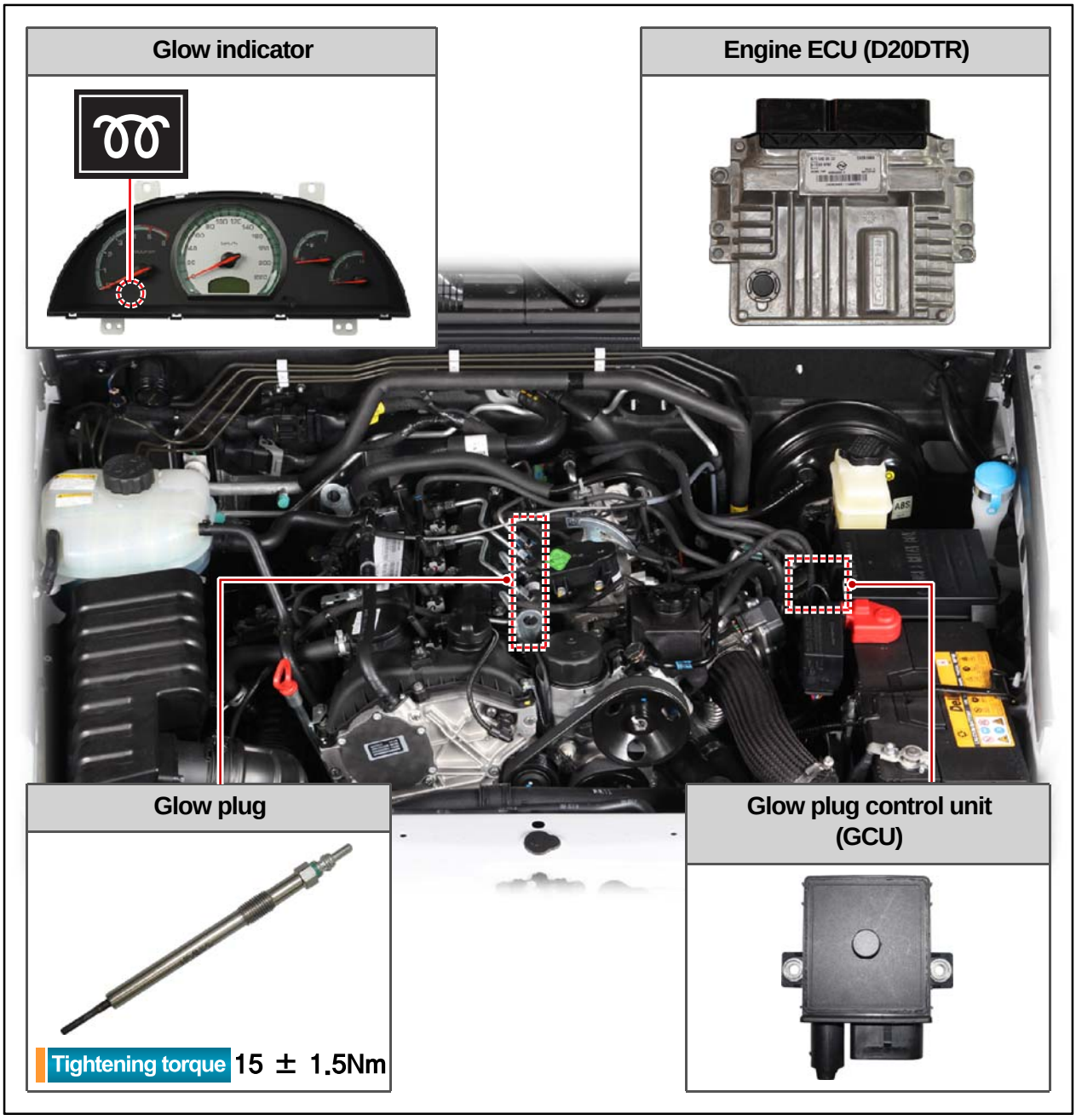
1. SPECIFICATION

Description		Specification
Glow plug	Rated voltage	12 V
	Operating voltage	6 ~ 16 V
	Maximum temperature	1000 ~ 1115°C
	Operating temperature	18 seconds after ignition ON: 980~1100°C 60 seconds after ignition ON: 980~1100°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

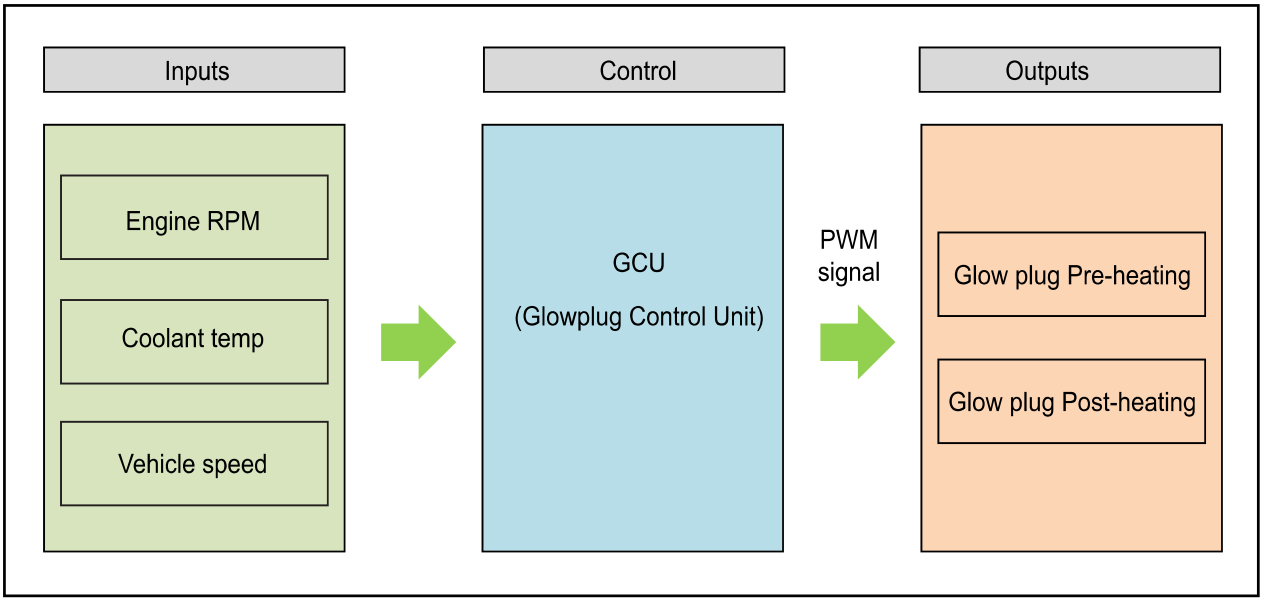
The pre-heating system for D20DTR engine has the glow plug to the cylinder head (combustion chamber), and improves the cold start performance and reduces the emission level.
The pre-heating resistor (air heater) is used to heat the intake air.
This enables the diesel fuel to be ignited in low temperature 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.



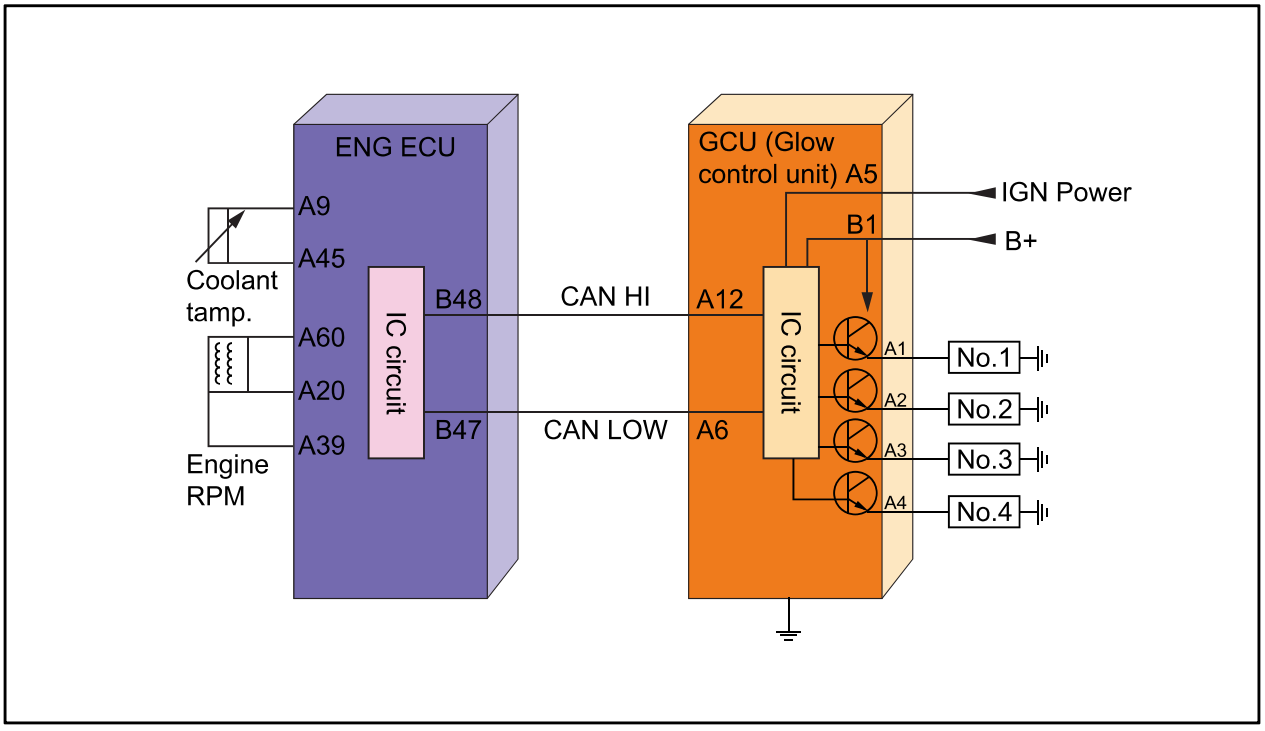
Modification basis	
Application basis	
Affected VIN	

2. SYSTEM OPERATION

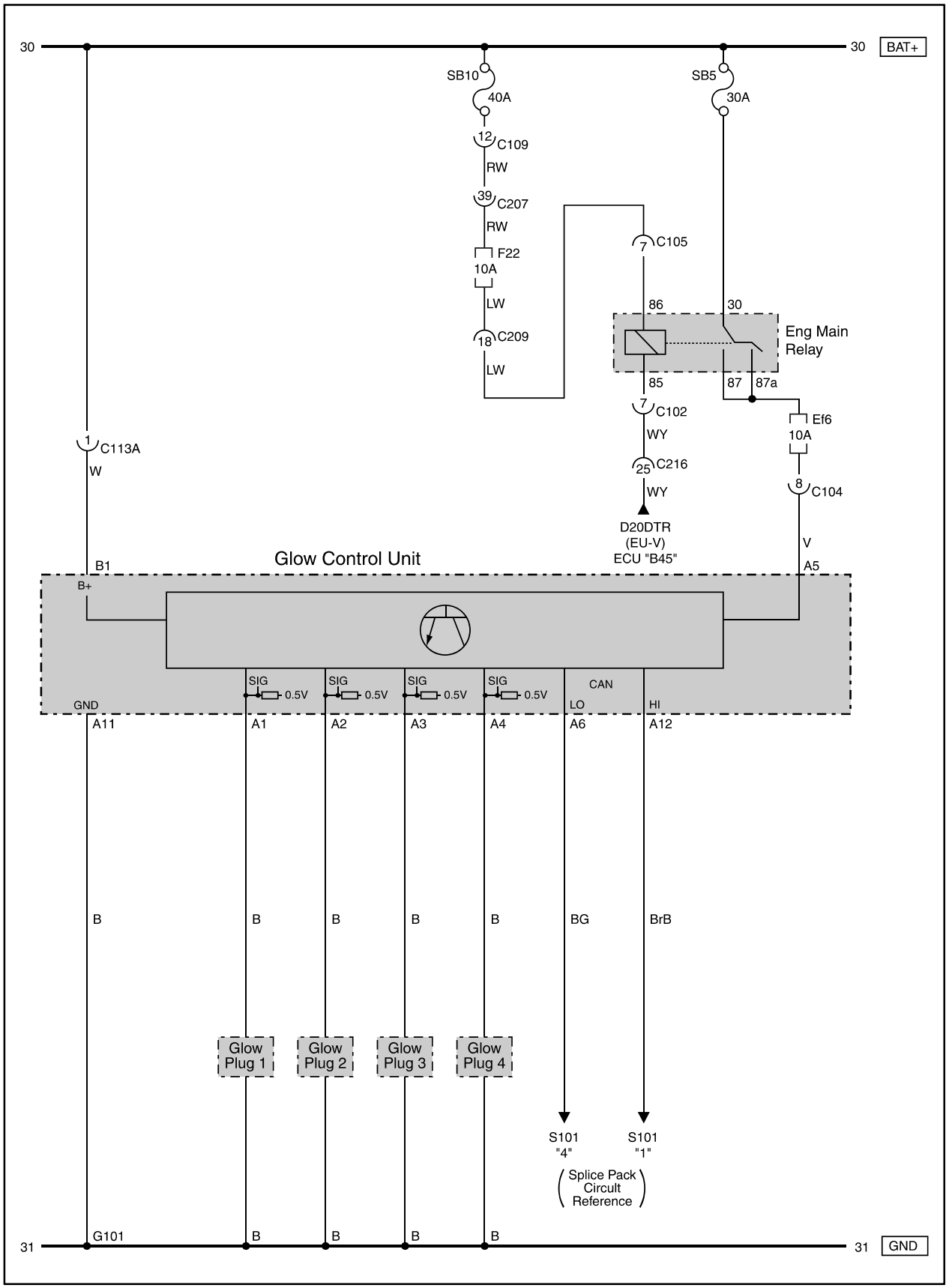
1) Input/Output Diagram of Glow Plug Control Unit



2) System Diagram



3) Circuit Diagram



Modification basis	
Application basis	
Affected VIN	

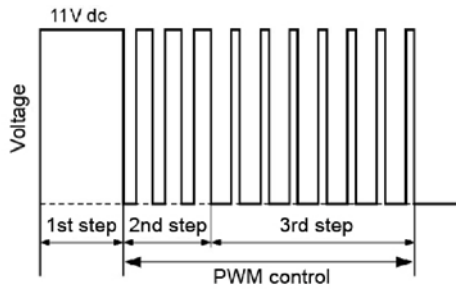
4) Operation

Glow plug is installed in the cylinder head. It enhances the cold starting performance and reduces the exhaust gas during cold starting.
ECU receives the data (engine rpm, coolant temperature, vehicle speed) through CAN lines. Based on the data, GCU controls the pre-glow, cranking and post-glow. It also checks the glow plugs, and sends the result to ECU.

(1) Temperature/Current Properties of GCU

1. GCU increases the temperature of glow plug very rapidly (approx. 2 seconds up to 1000°C)
2. FETs (similar to transistor) for each cylinder are integrated in GCU. During the pre-glow period, battery voltage is supplied to the glow plugs directly to heat them rapidly.
3. After getting the desired temperature by pre-glowing, the temperature is controlled by duty ratio.

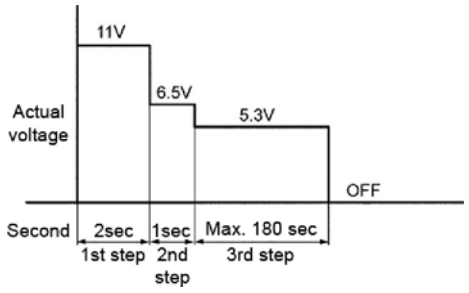
GCU PWM control



Frequency:
20~33Hz
PWM control duty ratio
- 1st step: 100%
- 2nd step: 35%
- 3rd step: 23%

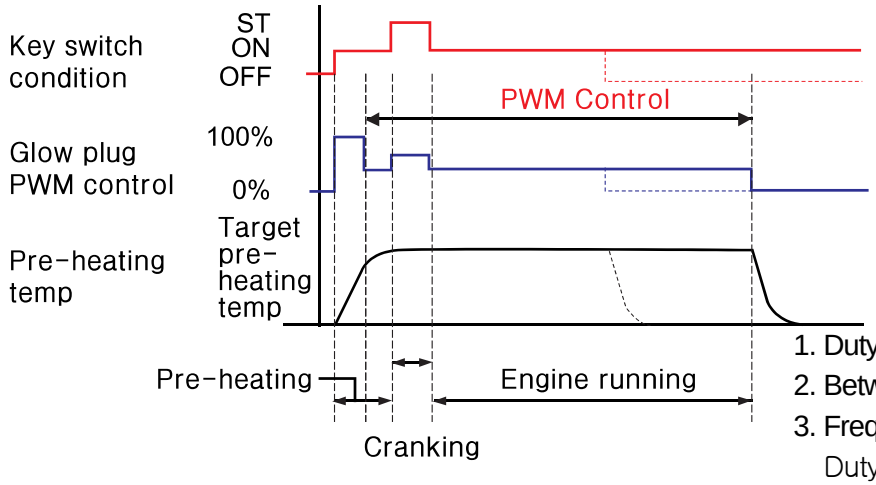
This describes the voltage supplying types to glow plugs.

Voltage pattern in actual step



This shows the supplying voltage and time by GCU in each step. The 3rd step is the period to keep the temperature.

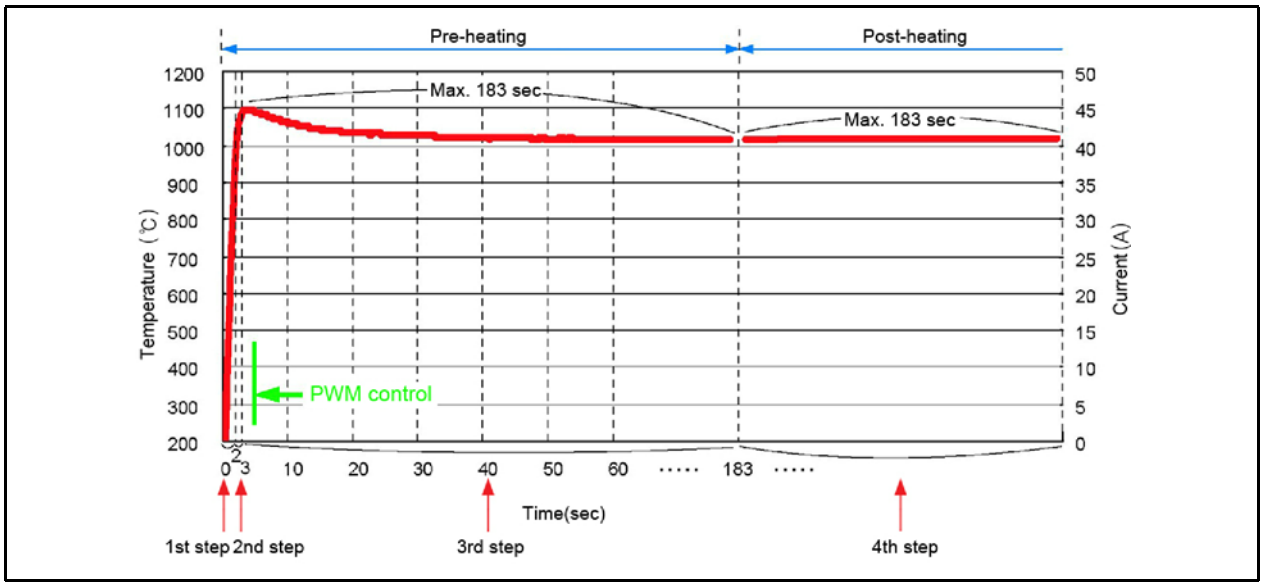
(2) Operation Type of GCU



1. Duty control area:
2. Between 5 and 100%
3. Frequency: 20 Hz

Duty ratio = $\frac{(\text{RMS voltage})^2}{(\text{Battery voltage})^2}$

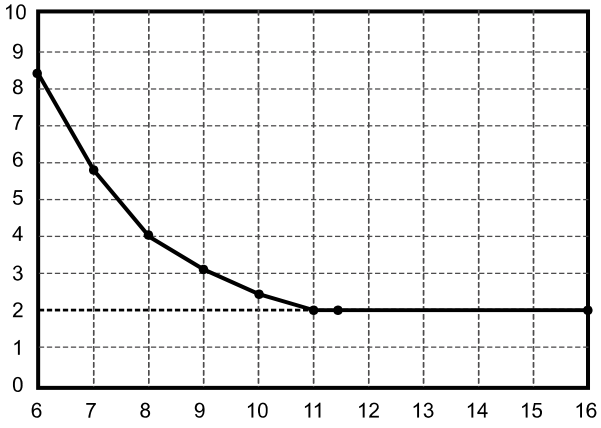
(3) Operation



▶ 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.



Input power VB(V)	Arrival time T1(s)
6	8.27
7	5.8
8	4.1
9	3.15
10	2.4
11	1.95
≥ 11.5	1.9

- 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 (T1).

NOTE

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

Modification basis	
Application basis	
Affected VIN	

▶ 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.

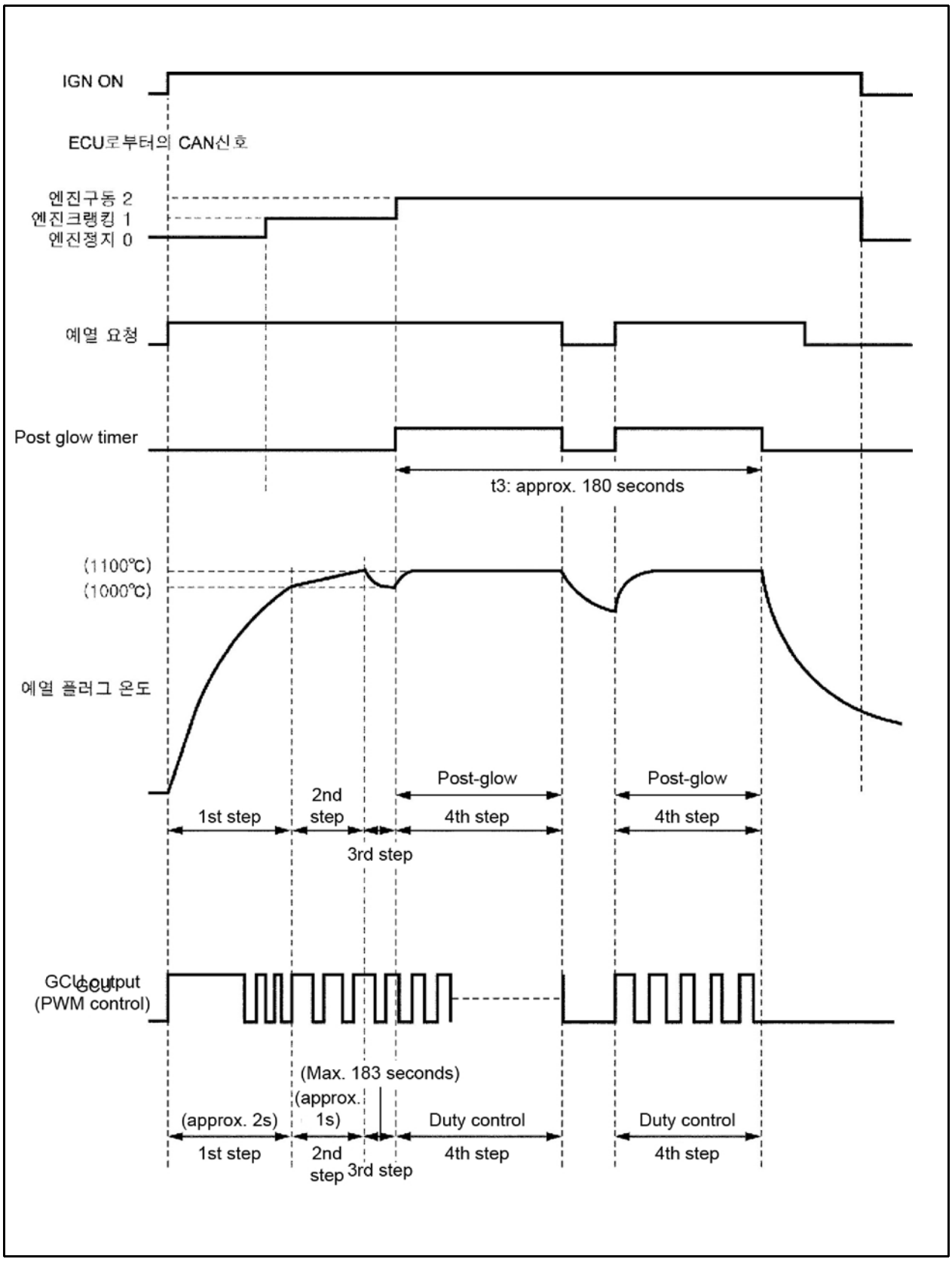
Post-heating	**Operating time (approx.)**	−20°C	−10°C	0°C	20°C	80°C
	Operating time (approx.)	100 s	50 s	25 s	10 s	10 s

▶ 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.

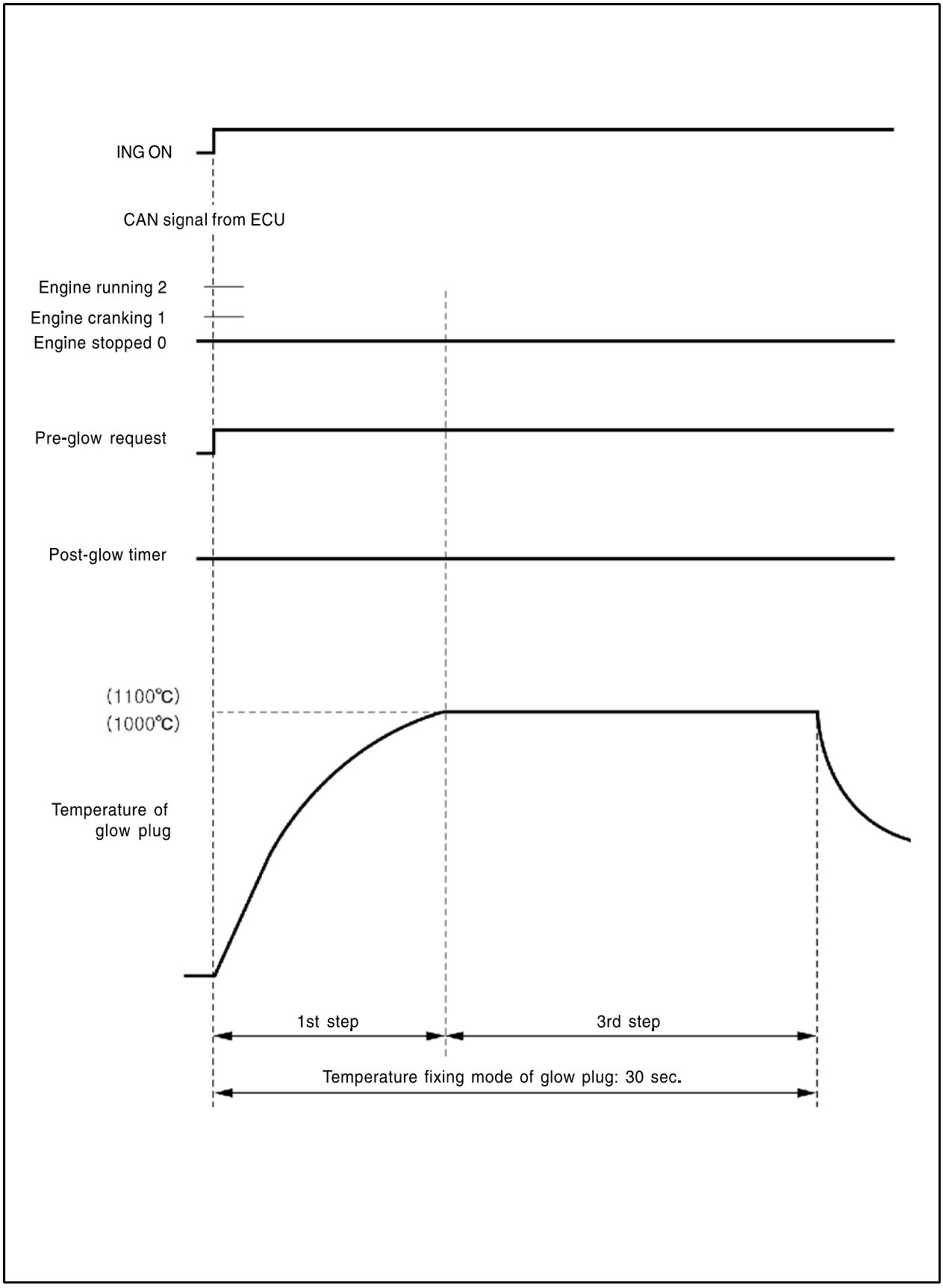
▶ Normal operation mode

This shows the pre-glow and post-glow step as a chart.



Modification basis	
Application basis	
Affected VIN	

▶ Operation when there is no engine start signal (cranking) after ignition ON



Modification basis	
Application basis	
Affected VIN	

STARTING SYSTEM

1461-01

GENERAL INFORMATION

1. SPECIFICATION

Description	Specification
Capacity	12 V, 2.3 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	

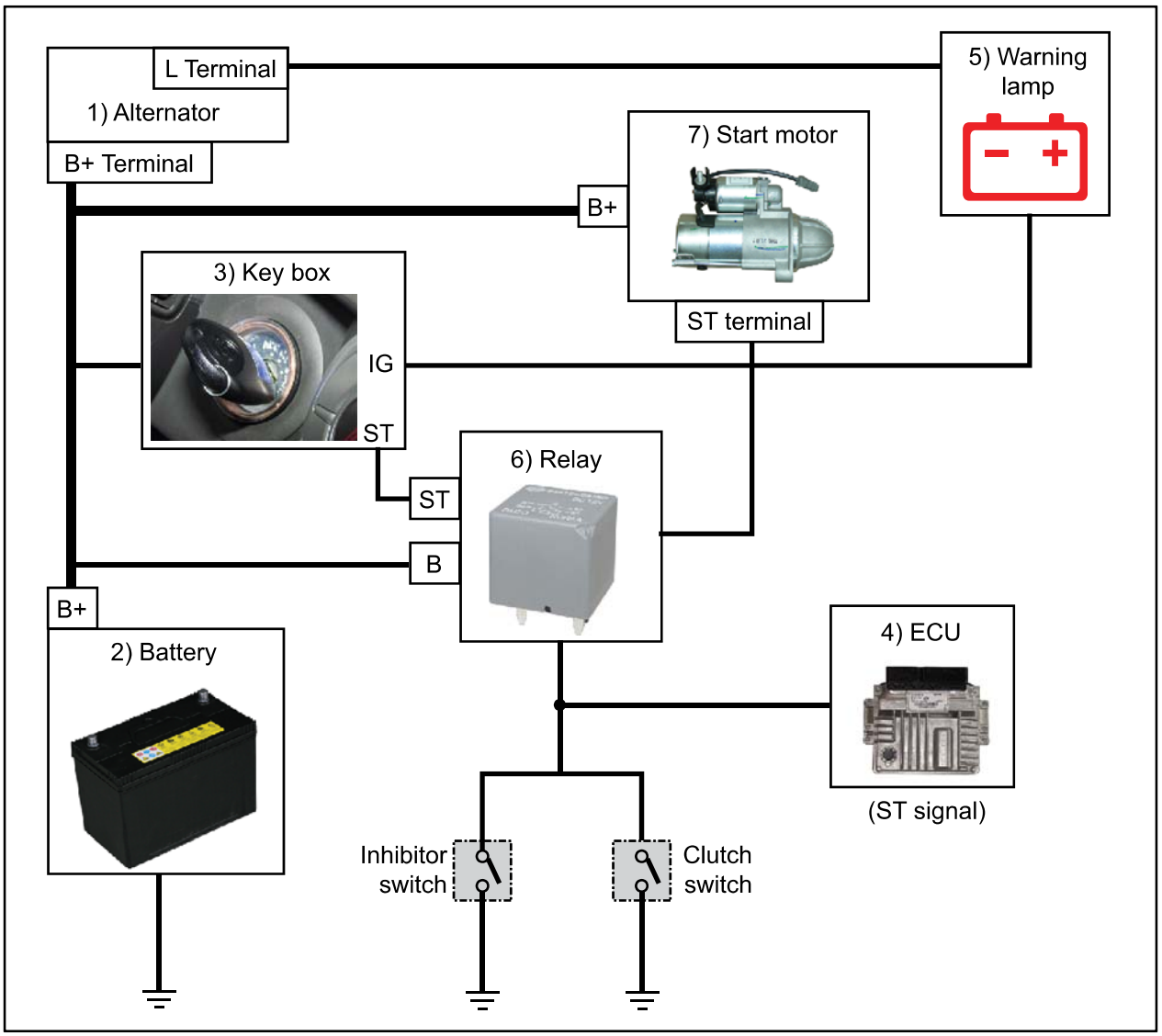
OVERVIEW AND OPERATING PROCESS

1. SYSTEM DESCRIPTION

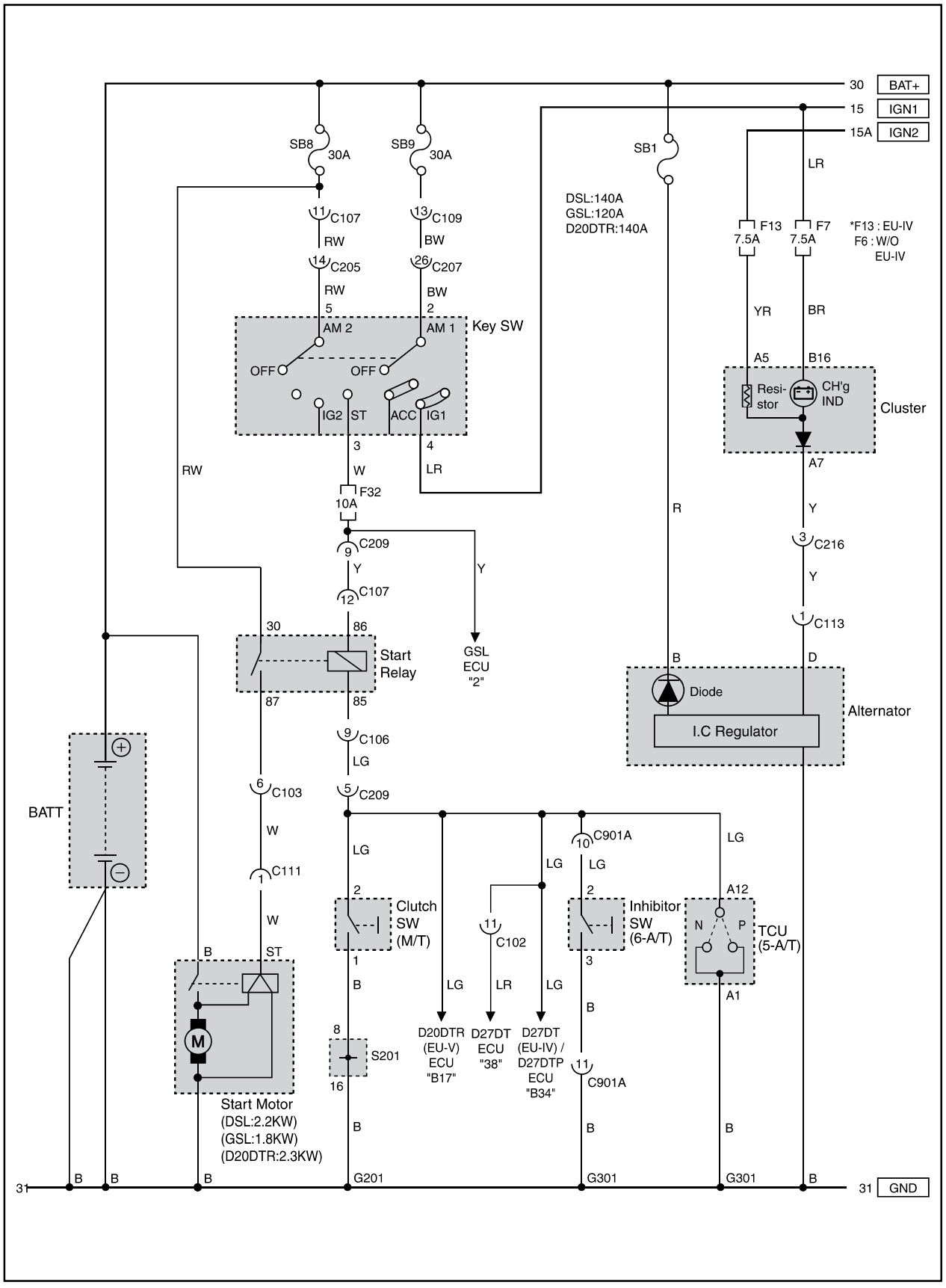
The starter (start motor) starts the engine with rotational power by converting the electric energy to the mechanical energy.
When the engine is cranking, the pinion gear meshes with the ring gear. If the ring gear overruns, the pinion gear clutch overruns to protect the pinion gear.

2. OPERATING PROCESS

1) System Layout



2) Circuit Diagram



Modification basis	
Application basis	
Affected VIN	

CRUISE CONTROL

8510-23

OVERVIEW AND OPERATING PROCESS

1. SYSTEM DESCRIPTION

1) System Description



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 38 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.

Modification basis	
Application basis	
Affected VIN	

2) 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

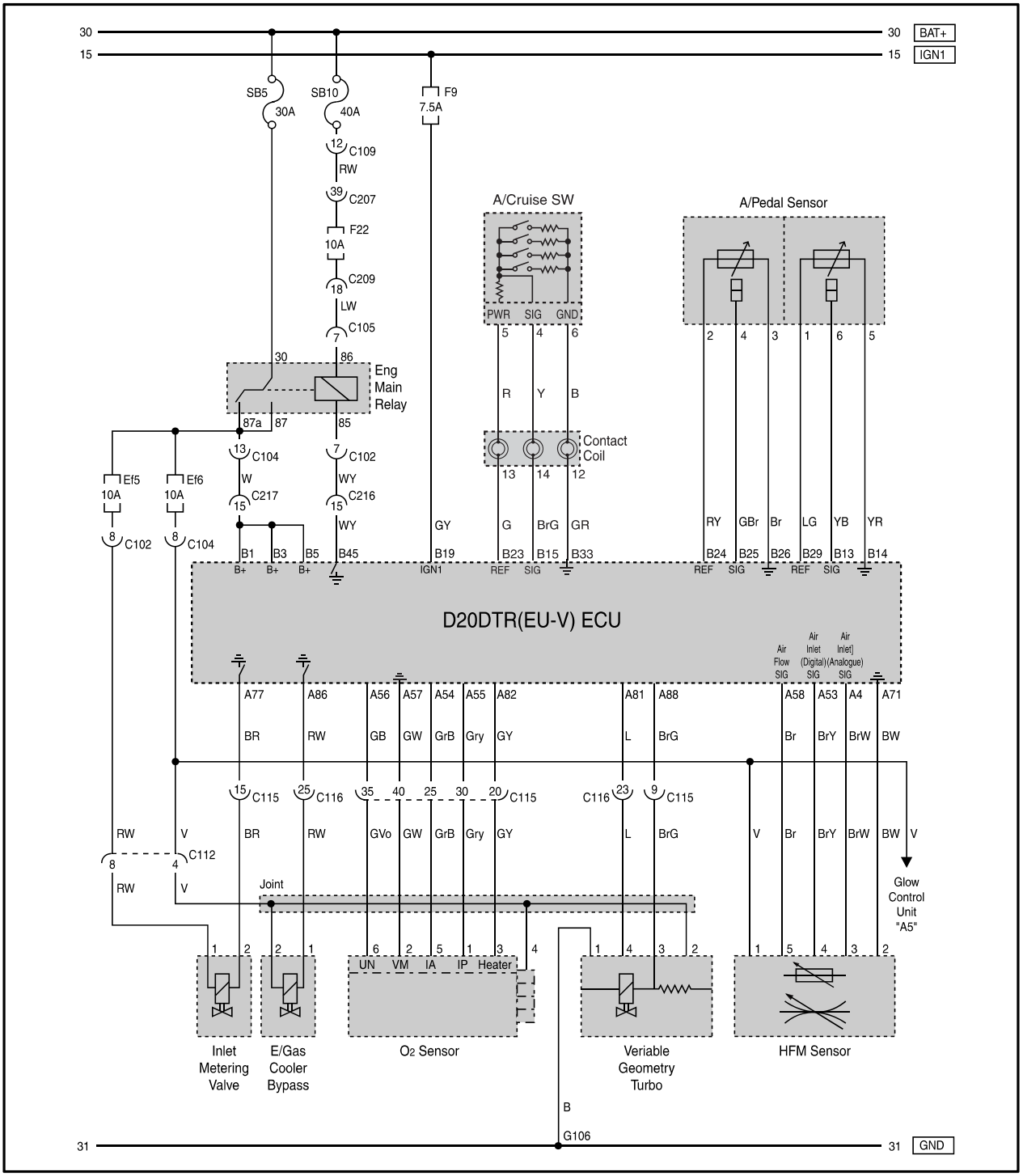
Improper use of the cruise control could be dangerous.
- Do not use on winding roadsyy .
- Do not use in heavy traffic.
- Do not use on slippery, wet roads.

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

Modification basis	
Application basis	
Affected VIN	

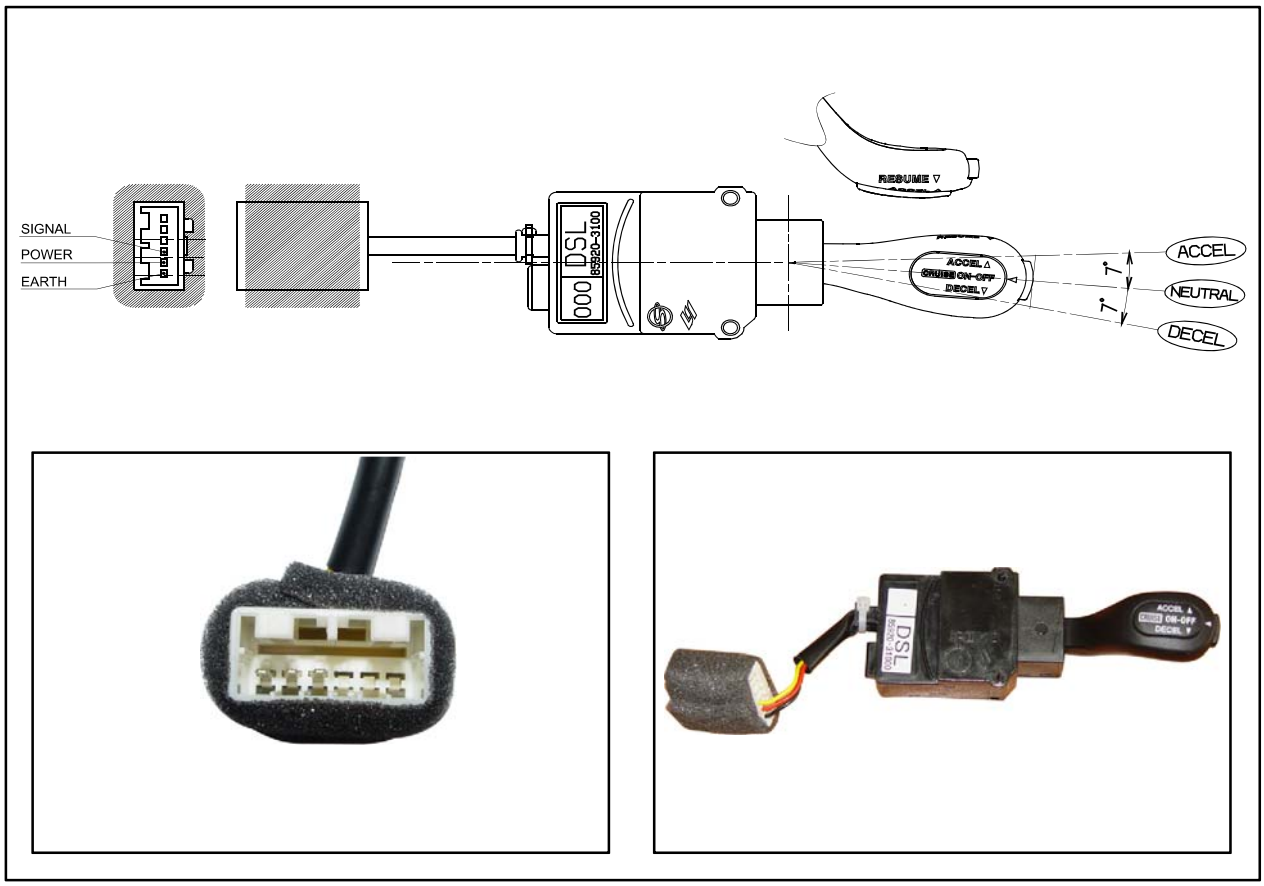
2. CONFIGURATION

1) Circuit Diagram



The engine ECU detects the operating conditions of cruise control system, and monitors the braking performance, vehicle speed, road conditions and ESP system operation. If the engine ECU determines that there are not any problem to drive in cruise control mode, the vehicle can be operated by cruise switch signals (decelerating, accelerating, cruising).

2) Configuration



▶ **Test voltage(VCC 5V)**

FUNCTION	KEY VOLUE	REMARK
MAIN	0.15 ~ 0.55V	-
DECEL	0.7 ~ 1.1V	-
ACCEL	1.6 ~ 2.0V	-
RESUME	2.52 ~ 2.92V	-

Modification basis	
Application basis	
Affected VIN	

3. OPERATION

1) Setting a Desired Speed



1. To operate the cruise control, accelerate to the desired speed, which must be more than 36 km/h and less than 150 km/h.
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. Now, the vehicle is cruised by this system with the set speed. You don't need to use the accelerator
3. pedal.
   Refer to the following pages for details of operation.
4.

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.

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) When the cruise control system is not running

To increase the speed with the cruise control system while the system is not running, follow the procedures below.

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

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

To increase the vehicle speed in stages while the cruise control system is running, follow the procedures below.

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. When you operate a tap-up switching, the vehicle is accelerated for 1.3 km/h over the previous set speed.
2. If you want to accelerate for 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

To decrease the vehicle speed with the cruise control system when the system is not running, follow the procedures below.

1. Push down the cruise control switch lever to DECEL side and hold it until the desired speed is reached while the vehicle speed is over 36 km/h.
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

To decrease the vehicle speed in stages while the cruise control system is running, follow the procedures below.

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. When you operate a tap-down switching, the vehicle is decelerated for 1.0 km/h below the previous set speed.
   If you want to decelerate for 10 km/h, operate the tap-down switching ten times without the brake pedal
2. intervention.

4) Recovery of Set Speed (RESUME)



Even if the cruise control is cancelled, the previous set cruise speed can be recovered by pulling up 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

But the driver should know the previous set speed to react to the changed vehicle speed properly. If the vehicle speed increases abruptly, depress the brake pedal to adjust the vehicle speed properly.

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 or When ESP is activated.
2. When the cruising speed is downed less than 34 km/h
3. When applying the parking brake during driving.
4. When using the clutch in order to shift (M/T only).

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.
   When the rapid acceleration is applied without acceleration pedal intervention.
2. When the cruise control lever is faulty.
3. When the brake switch and the brake light switch input signal are implausible.

When the cruise control function is cancelled abnormally or intermittent problems occur, stop the vehicle and turn off the ignition switch and remove the key to reset the system. After a while, turn on the ignition switch again to operate the cruise control system.

CAUTION

1. Do not move the shift lever to Neutral position while driving with the cruise control turned on. Otherwise, it may result in system malfunction or accidents.
2. Always be prepared to use the brake or accelerator pedal for safe driving while the cruise control system is running.
3. The actual speed can be different from the set speed momentarily when driving on a uphill or downhill. So, it is recommended to disable the cruise control function on a uphill or downhill. hen driving on a steep hill use the engine brake and foot brake properly to protect the vehicle system and for a safe driving.
4. Ensure that the safe distance is maintained and use the brake pedal if needed.

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
	Position sensor	Sensing type	Hole sensor
		Supplied voltage	5V ± 10%
		Maximum signal range	5% ~ 95%
		Maximum power consumption	< 15mA
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	

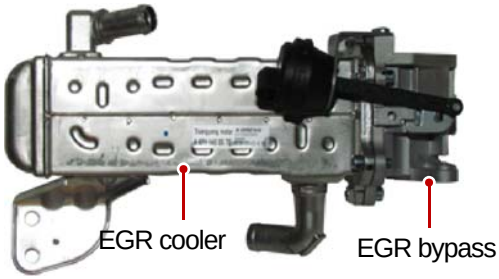
2) Location and Components

HFM sensor



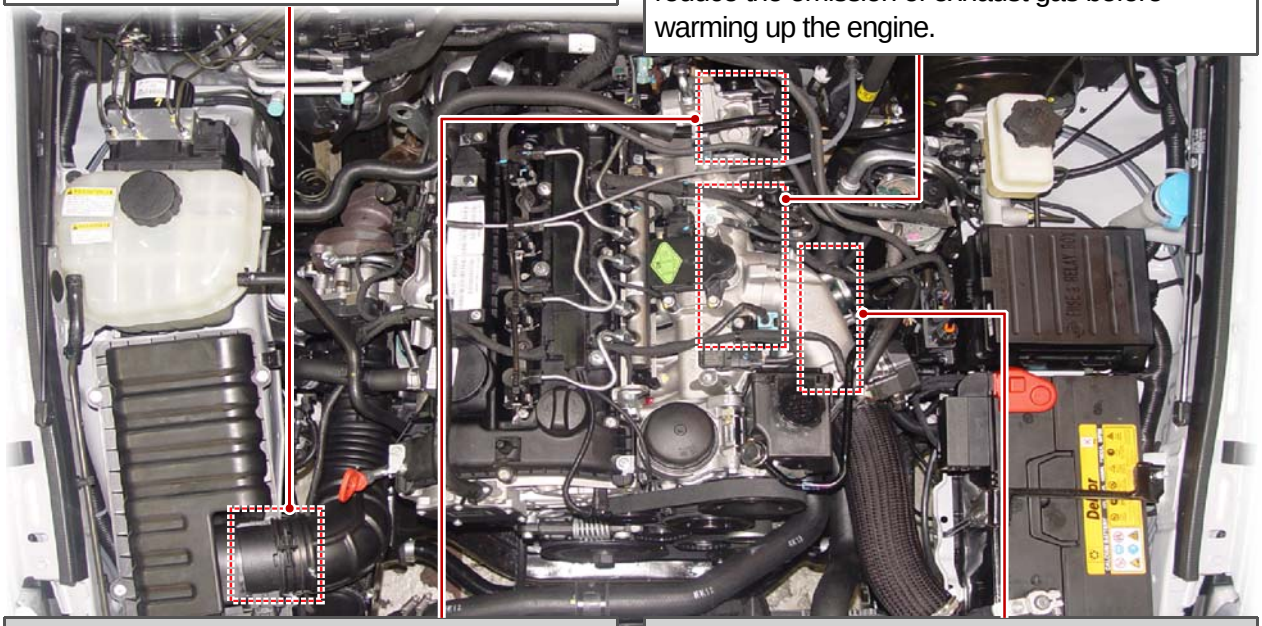
Used as a main map value to control the EGR. The coolant temperature, engine rpm, engine load, intake air temperature (HFM: decreased at 60˚C or more), atmospheric pressure (atmospheric pressure sensor: altitude compensation) are used as auxiliary map values.

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

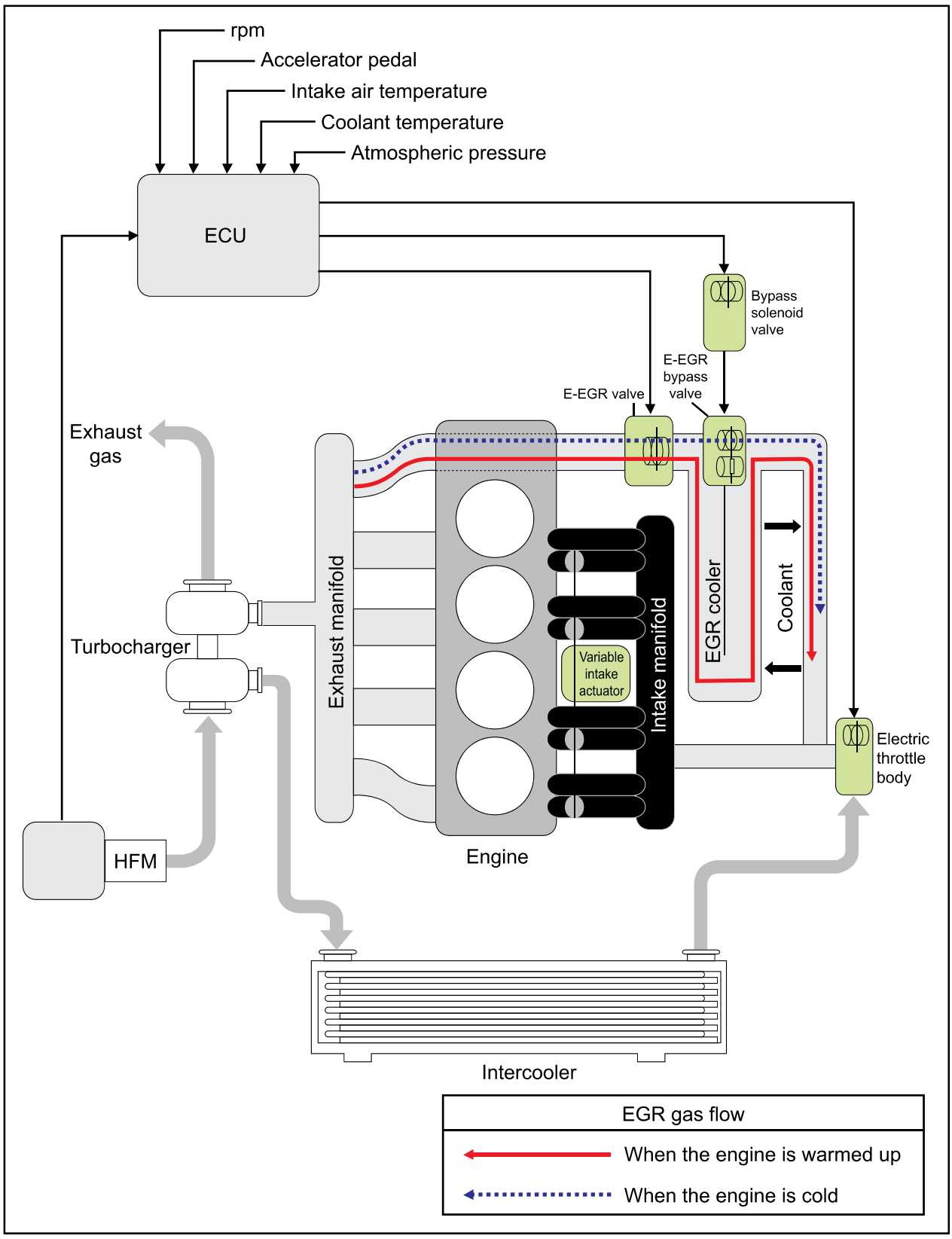


Transports the exhaust gas from the EGR cooler and EGR bypass valve to the intake duct.

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

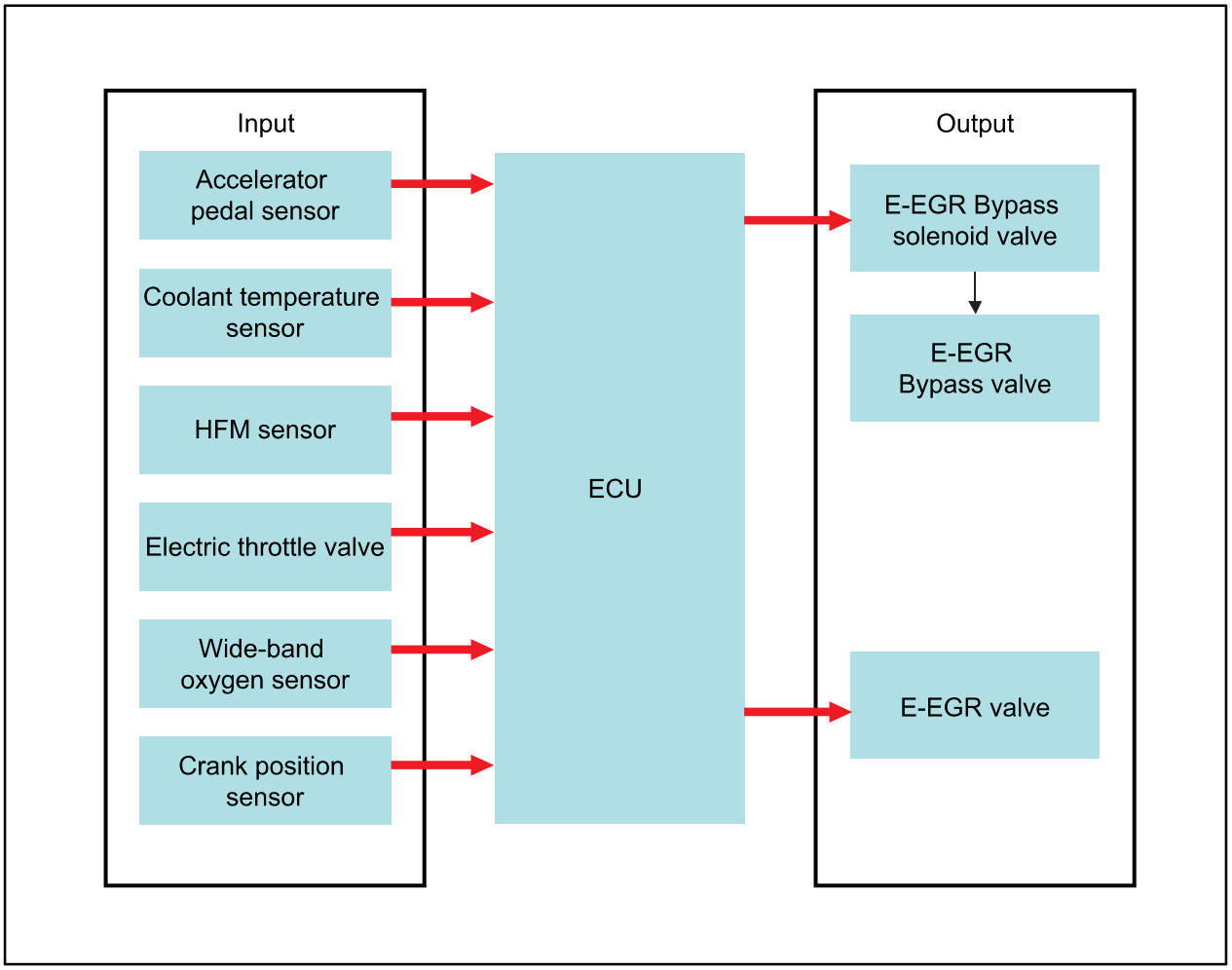
2. OPERATING PROCESS

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	

CDPF SYSTEM

2412-02

GENERAL INFORMATION

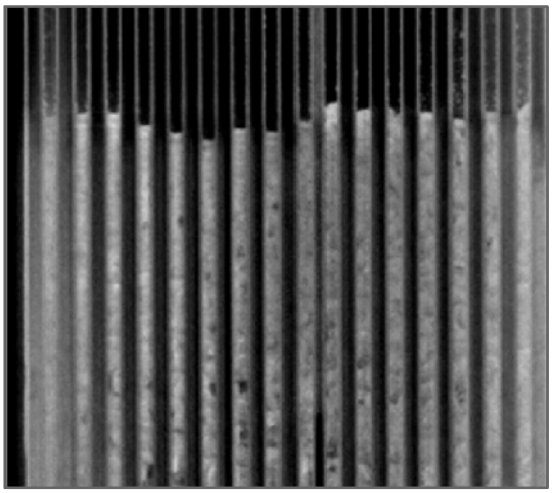
1. SPECIFICATION

Emission Regulation		Euro-V
Front Area		154.06㎠
Size	DOC	158 X 124 X 78L
	DPF	158 X 124 X 195L
CDPF Canister	Shell	SUS430J1L X 1.5t
	End Cone	SUS430J1L X 2.0t (Single)
CDPF	Catalyst Capacity	4.2L
	Material of Filter	AT (Aluminum-Titanium Alloy)

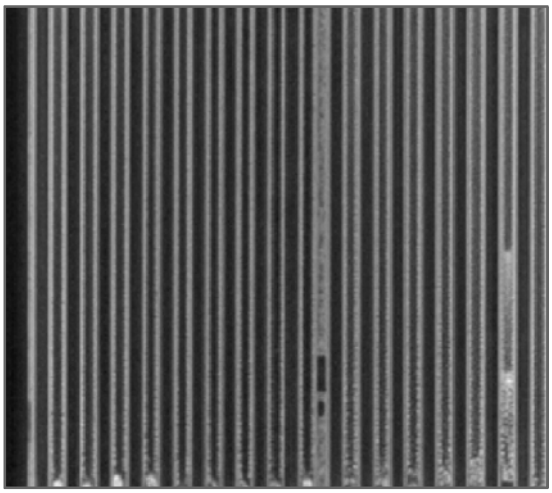
2. CAUTIONS

▶ **Standard pattern of soot accumulation**

(1) Abnormal Soot Accumulation



(2) Normal Soot Combustion



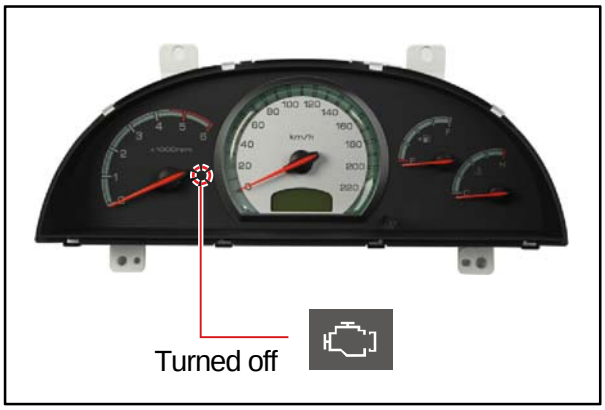
▶ **Cautions to protect the catalyst filter**

- 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	

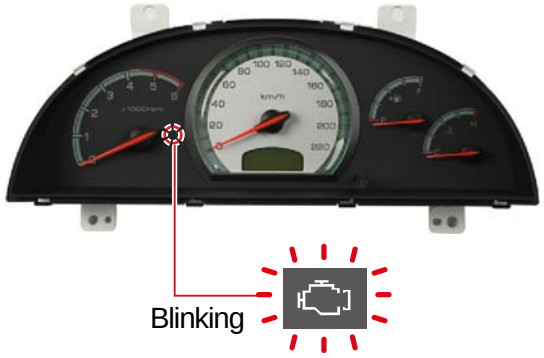
(3) Warning Lamp Related to CDPF

▶ CDPF regeneration process (warning lamp NOT illuminated)

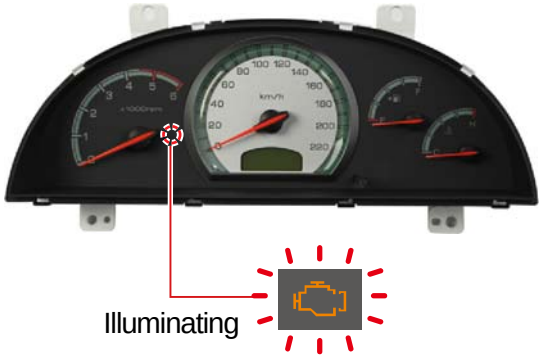


The CDPF system enters the regeneration mode when the driving distance becomes approx. 600 to 1,200 km (may differ by the driving condition and driving style). Then, the engine ECU performs the CDPF regeneration operation. However, the driver is not informed with this operation by any engine warning 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.

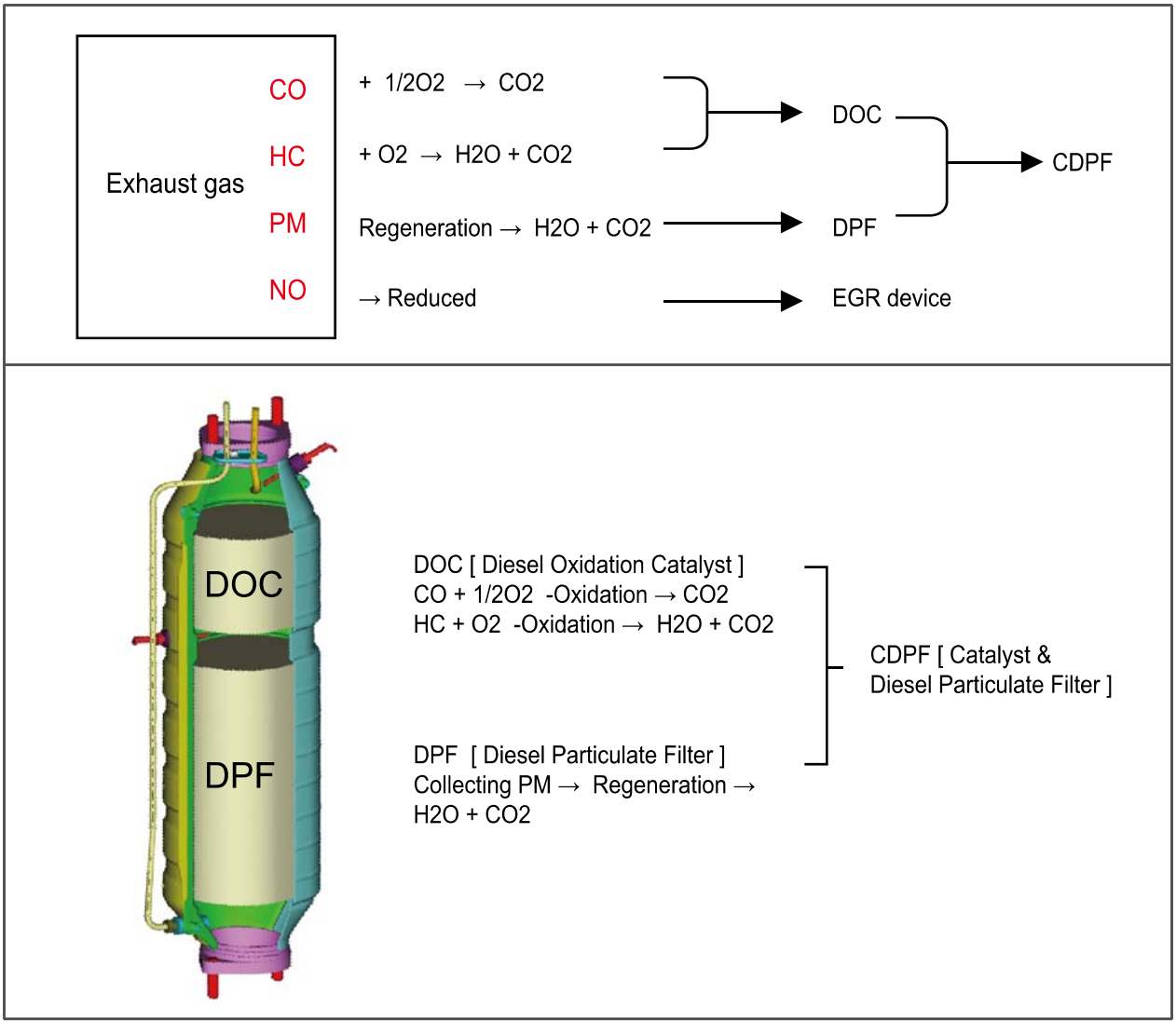
Excessive overload of CDPF (warning lamp illuminated)

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.



Modification basis	
Application basis	
Affected VIN	

2. COMPONENT

Front temperature sensor



Protects the turbocharger.

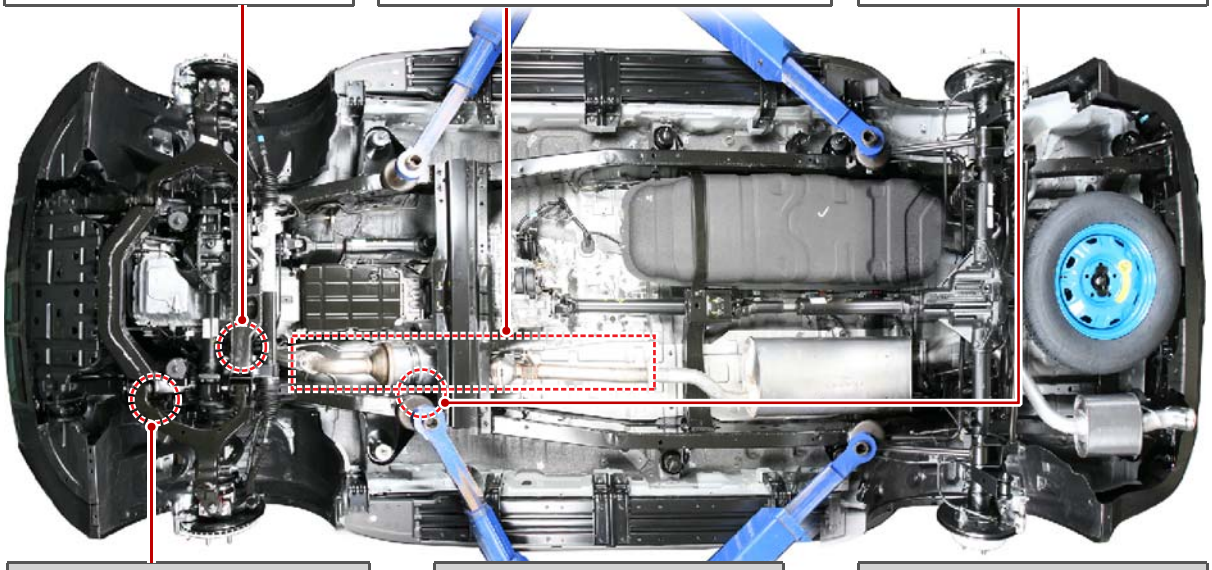
CDPF DOC+DPF



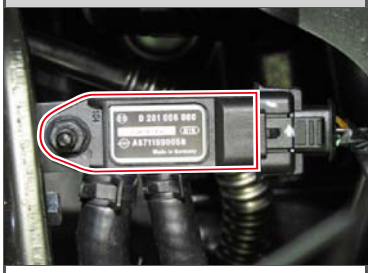
Rear temperature sensor



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

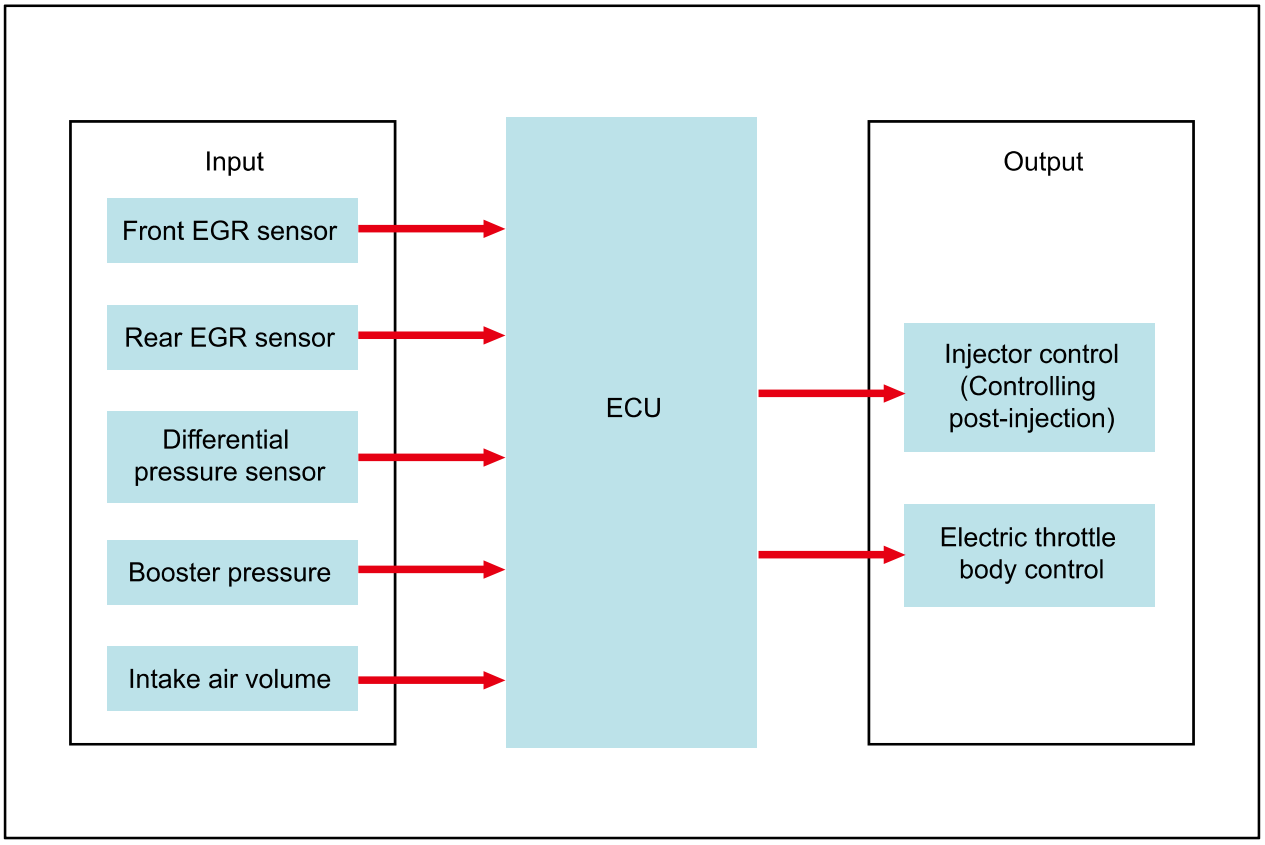


Regulates the rate of air intake.

* 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.

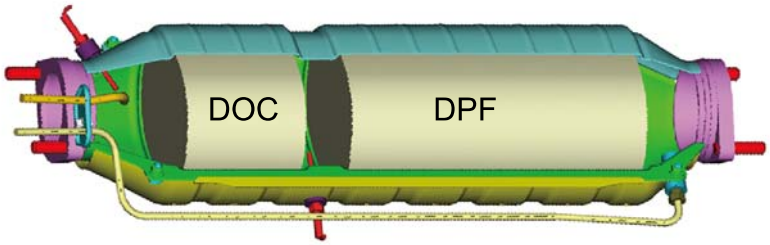
Electric throttle body

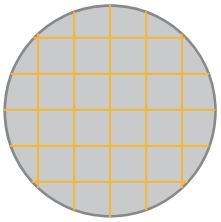


Controls the intake air mass.

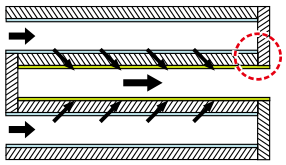
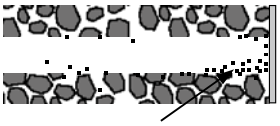
5. OPERATING PROCESS

[Configuration and principle of operation]





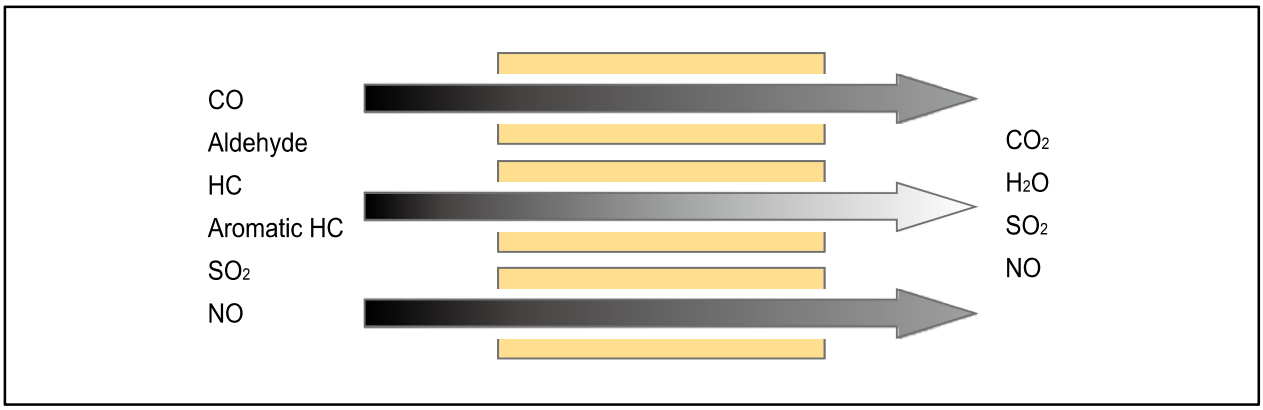
The exhaust gas passed through the exhaust manifold enters into the CDPF assembly (at approx 250℃).

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.

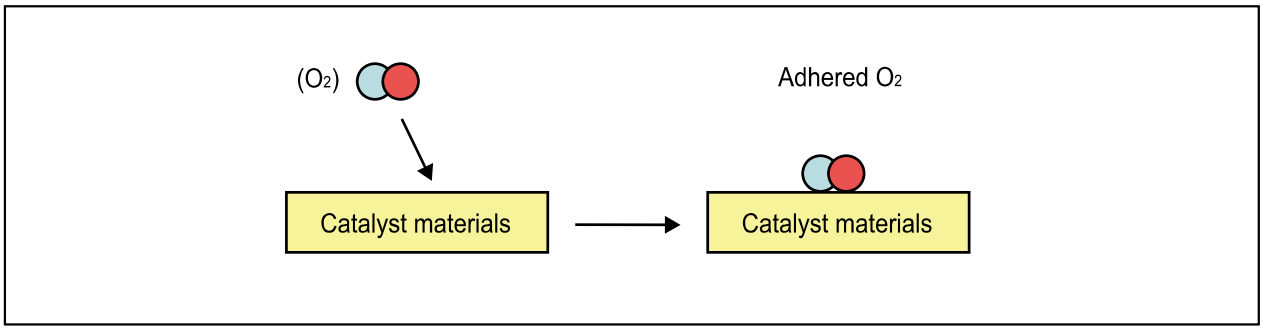
Modification basis	
Application basis	
Affected VIN	

1) Oxidation of DOC

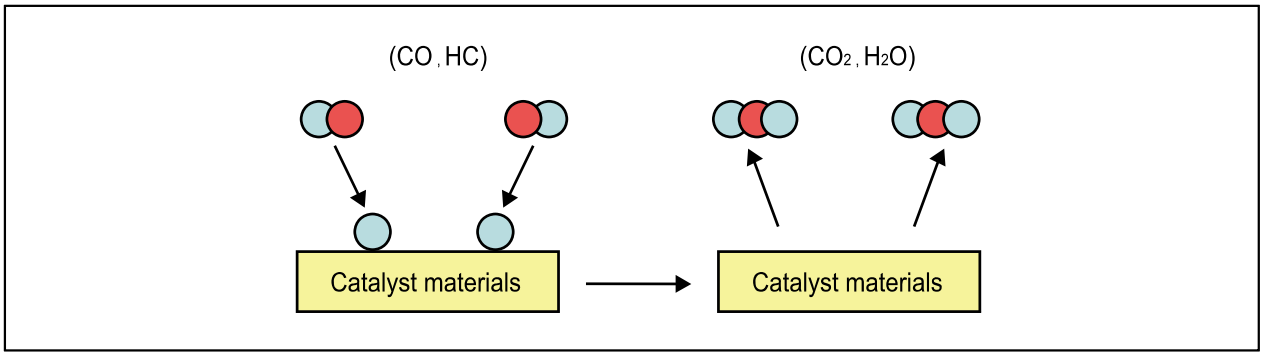
The DOC oxidizes HC and CO of the exhaust gas in the two-way catalytic converter at 180℃ or more, and performs best at the temperature between 400 and 500℃. The front EGT sensor detects whether the DOC can burn (oxidize) the post-injected fuel or not, and sends the signal to the ECU to maintain the DOC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



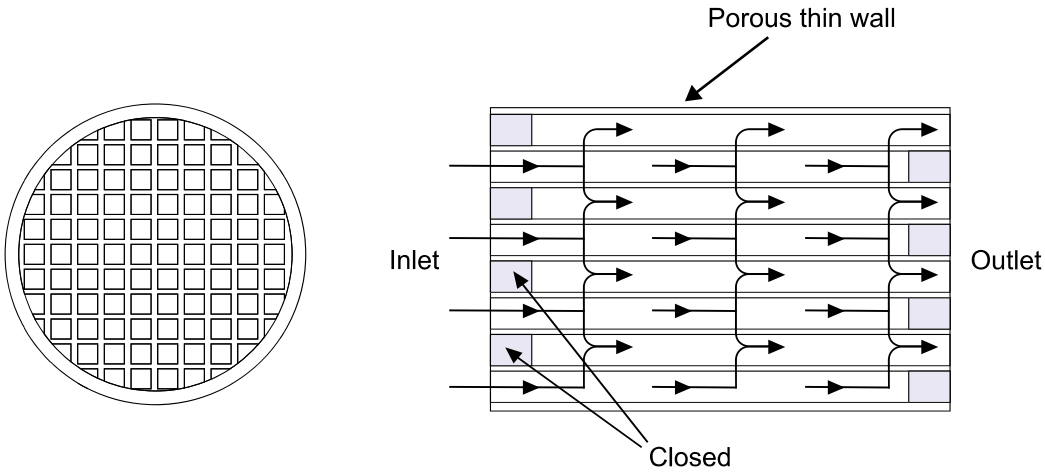
2. CO and HC are oxidized by the catalyst materials: More than 180℃

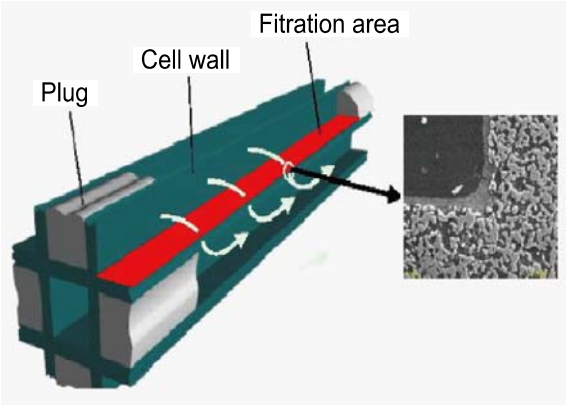


2) Collecting PM of DPF

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

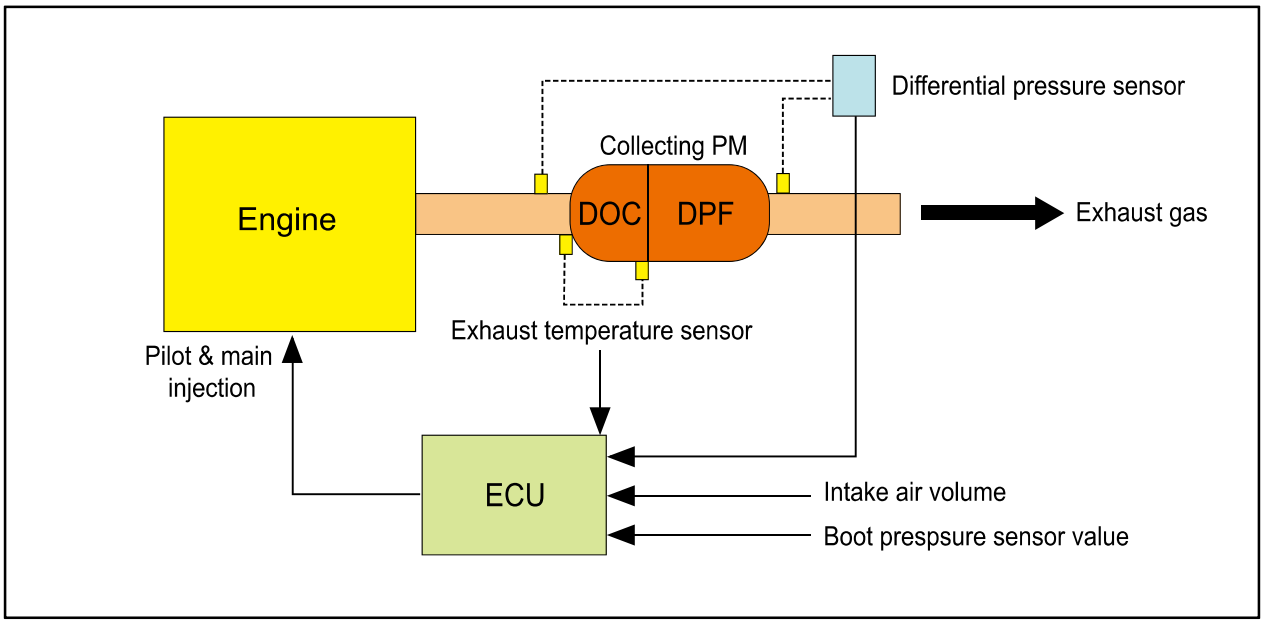
Normally, when the driving distance becomes approx. 600 to 1,200 km, enough amount of soot to be burned is filtered and accumulated in the CDPF. The ECU increases the amount of fuel post-injection to increase the temperature of the exhaust gas up to 600°C, so that the soot is burned. The soot is burned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

Modification basis	
Application basis	
Affected VIN	

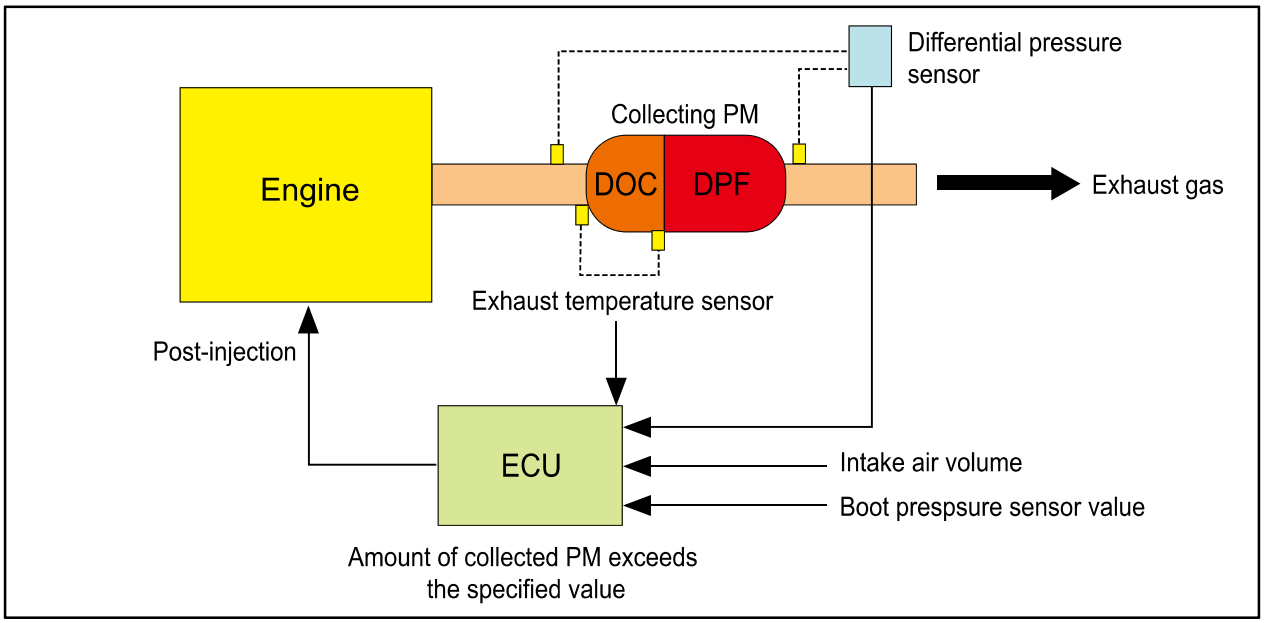
3) PM Regeneration of DPF

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.

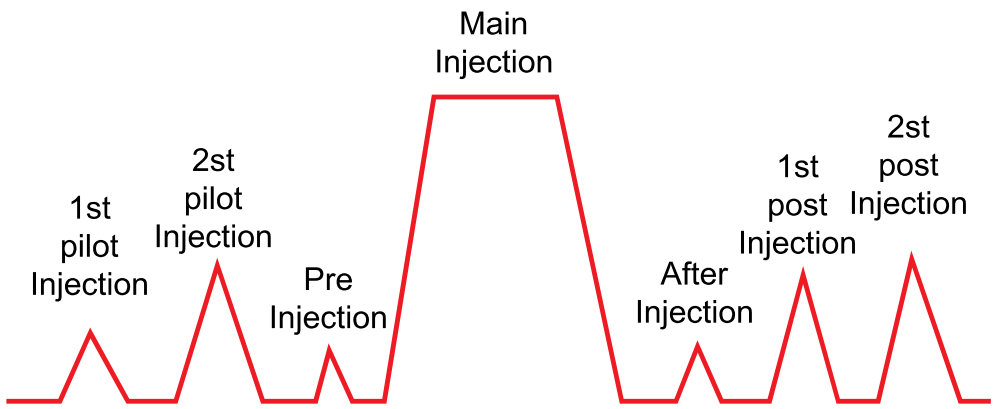


2. When enough amount of PM is collected: The ECU commands post-injection and increase the exhaust gas temperature to start regeneration.



4) Fuel Injection During CDPF Regeneration

The injection method in D20DTR engine has three steps;
Pilot injection, Main injection, Post injection



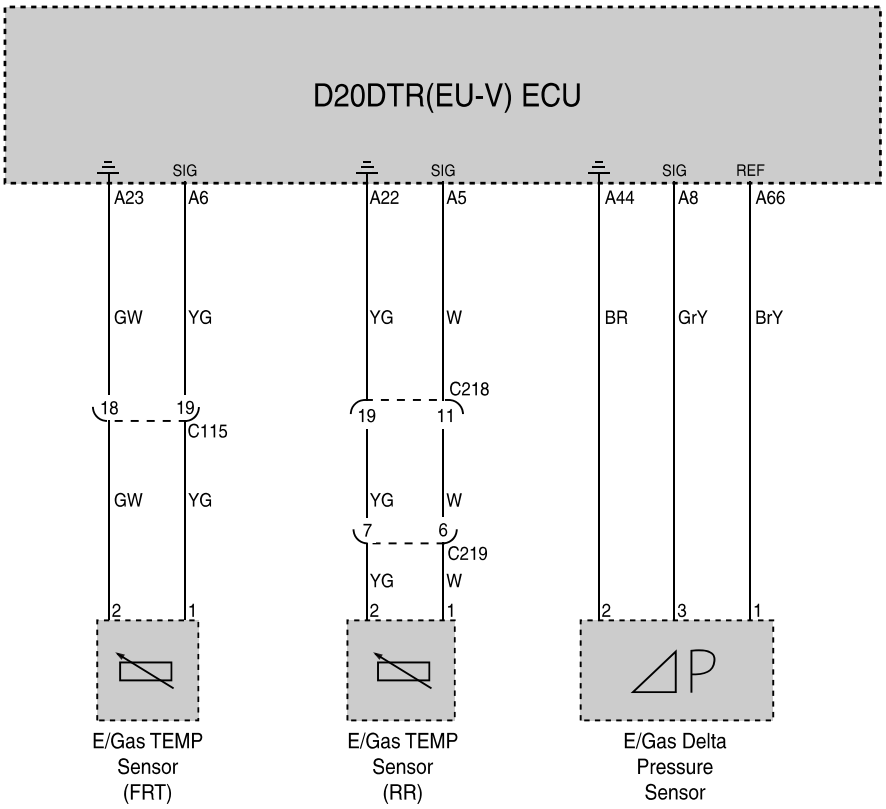
Injection	Effect
Pilot injection	Decrease of PM by fuel mixture Decrease of noise from engine combustion
Pre-injection	Decrease of NOx by shortening main injection delay due to flammability Decrease of noise from engine combustion
Main injection	Main power source
Post-injection	Activation of CDPF by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

▶ Post injection

The post injection is the injection process after main injection and consists of 'After injection", "Post 1 injection" and "Post 2 injection". All of post injections are to reduce the PM and harmful exhaust gas. The post injection does not make the actual output. The post injection activates the fuel by injecting the fuel to the incompletely combusted gas after primary combustion. Through the process, the PM and smoke in the exhaust gas could be reduced. There are totally 7 injections as shown in the figure. However, all of 7 injections are not performed during driving because it decreases the fuel economy. Totally 5 injections can be performed in one cycle.

Modification basis	
Application basis	
Affected VIN	

6. ELECTRIC CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	

7. CAUTIONS

1) Designated Engine Oil for CDPF (Low Ash Oil)

1. Need to use the designated engine oil for CDPF
   - The smoke from the vehicle may generate the particle material in the ambient air. CDPF is the device to reduce the smoke by collecting and recycling it. To ensure the performance of CDPF, the designated engine oil should be used.
   - The smoke including combusted sulfur in fuel cannot be recycled in CDPF. This smoke generates the ash, resulting in clogging the filter.
2. Advantages when using the designated engine oil for CDPF
   - Reduces the amount of ash
   - Improves the fuel economy and reduces the CO2
   - Increases the life span of engine oil
   - Available for all engines (diesel and gasoline)
3. Problems when using non-designated engine oil for CDPF
   - Decreases the life span of engine oil due to accumulated ash in DPF (around 30%)
   - Decreases the fuel economy due to friction resistance, exhaust gas resistance and frequent recycling process of DPF

> **CAUTION**
> The fuel containing high sulfur may cause the same problems.

2) Do Not Use the Fuel Containing High Sulfur

1. Producing white smoke during recycling
   - The sulfur in exhaust gas is changed to sulfate gas during exhaust process. This sulfate gas is shown as white smoke.
2. Producing odor during recycling
   - The sulfur after oxidation may produce the odor.
3. Accumulation of ash
   - The sulfur accumulated in DPF cannot be recycled. It reduces the life span of DPF.

3) White Smoke

The white smoke can be generated when the exhaust gas is recycled in DPF. There are two reasons as below.

- Saturated vapor
- Sulfate

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	700 ± 50 (P/N), 600 ± (D)
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

Rear EGT sensor



Oxygen sensor



Glow plug

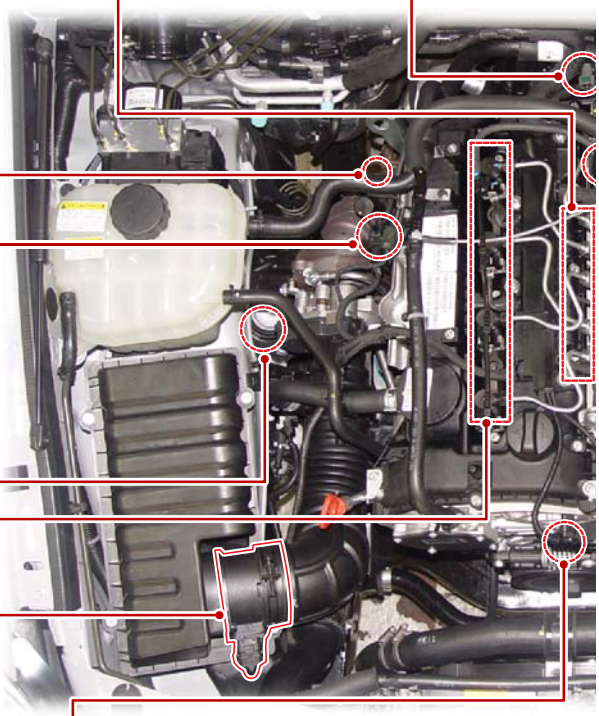


IMV



Front EGT sensor





Differential pressure sensor



Injector (C3I)



HFM (air mass/ temperature)



Camshaft position sensor



Variable swirl valve actuator



Modification basis	
Application basis	
Affected VIN	

Fuel temperature sensor



Coolant temperature sensor

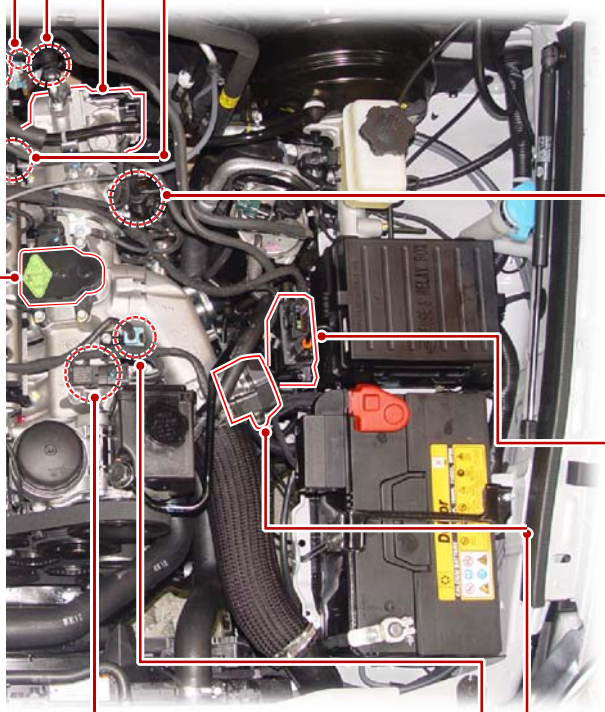


EGR valve



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

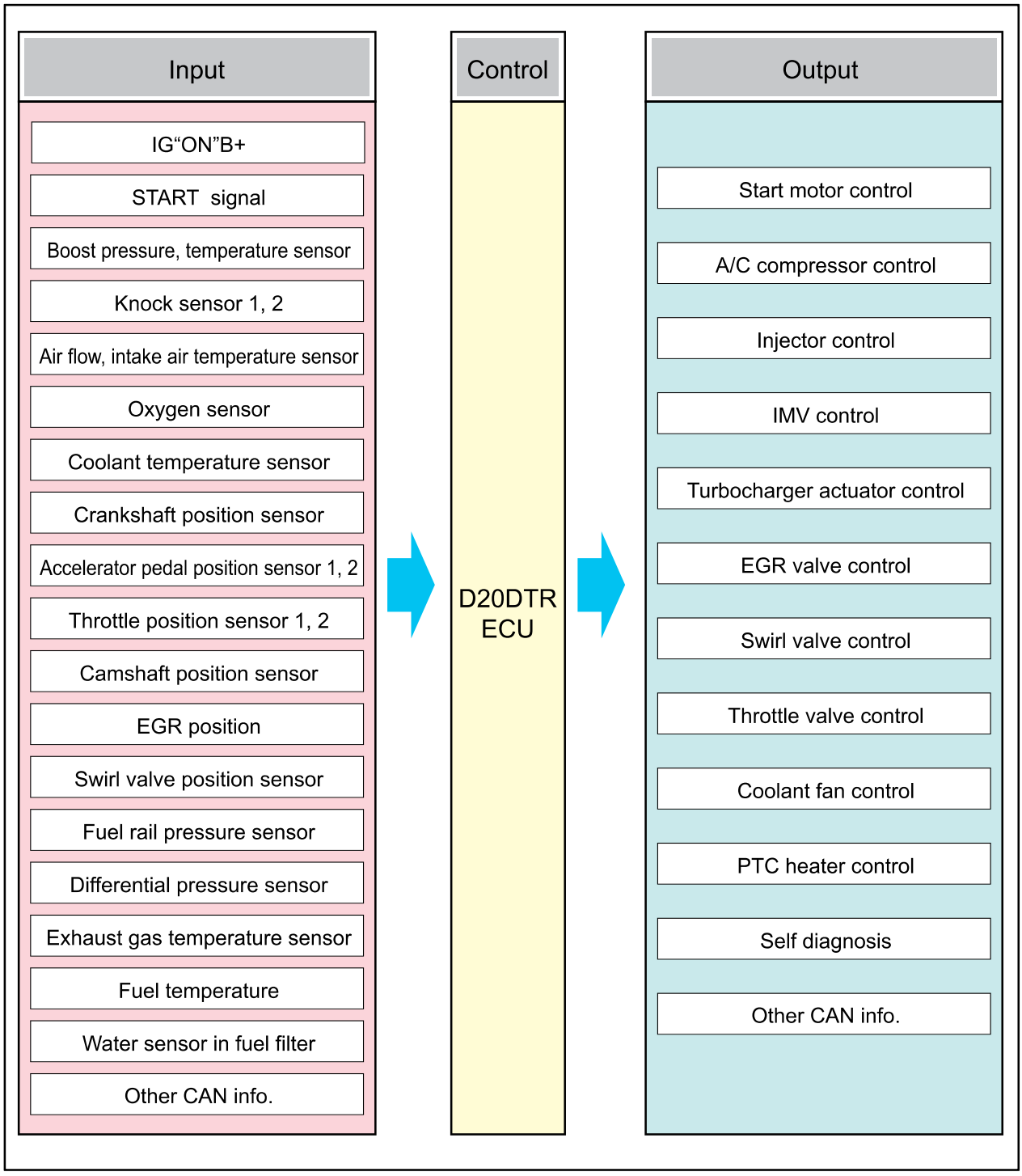


Modification basis	
Application basis	
Affected VIN	

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 - STICS

Modification basis	
Application basis	
Affected VIN	

(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.

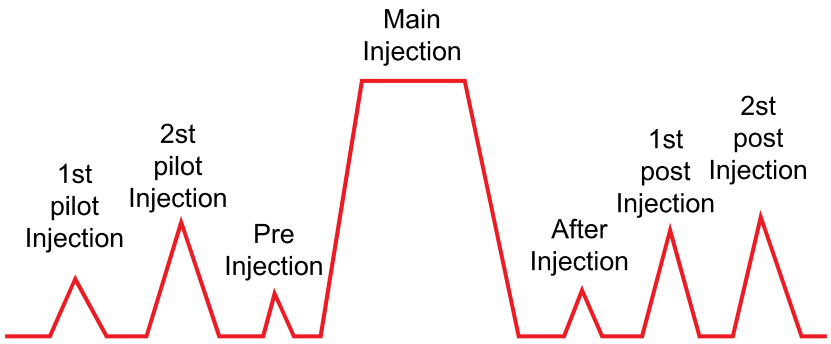
b. Control Function

- 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

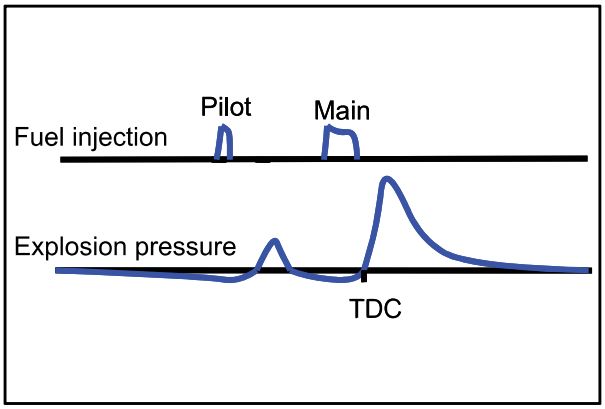
a. Multi injection

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

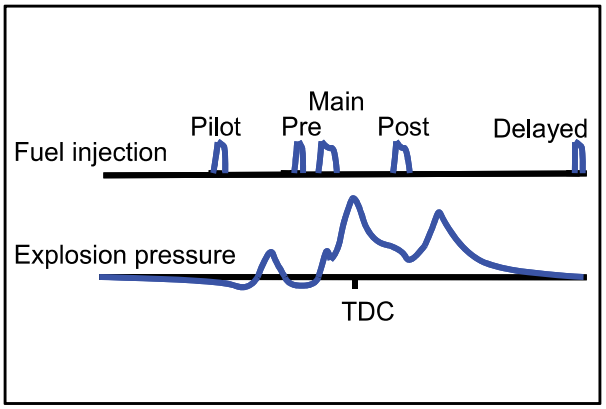


Injection	Function	Main	Produces engine power
Pilot 1	Reduces PM by injecting before main injection.	**After**	PM control
Pilot 2	Reduces NOx and noise by shortening main injection delay due to flammability	**Post 1**	Reduces PM by enabling fuel activation.
Pre	Controls NOx emission level, Combustion 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	

This is the injection before main injection. This consists of 1st and 2nd pilot injection, and Pre-injection. The steps are normally used to control the NOx, noise, idle stability and engine vibration. Inject a small amount of fuel before main injection prevents the instant high combustion temperature. It reduces the NOx and decreases the engine noise and vibration. The main injection produces the actual output. The vehicle output is based on the main injection. The post injection is the injection process after main injection and consists of ‘After injection”, “Post 1 injection” and “Post 2 injection”. All of post injections are to reduce the PM and harmful exhaust gas. The post injection does not make the actual output. The post injection activates the fuel by injecting the fuel to the incompletely combusted gas after primary combustion. Through the process, the PM and smoke in the exhaust gas could be reduced. There are totally 7 injections as shown in the figure. However, all of 7 injections are not performed during driving because it decreases the fuel economy. Totally 5 injections can be performed in one cycle.

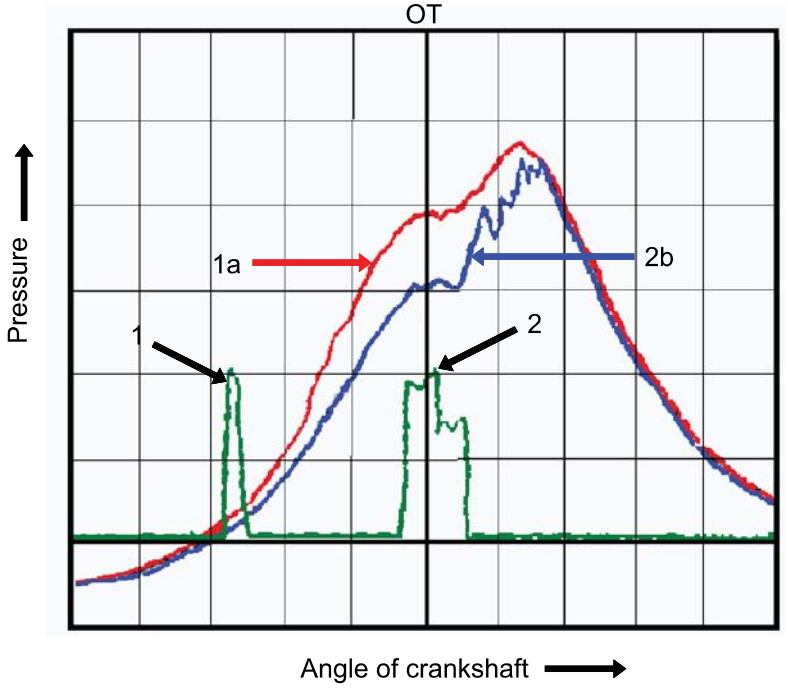
b. Pilot Injection

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

Modification basis	
Application basis	
Affected VIN	

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.

(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.

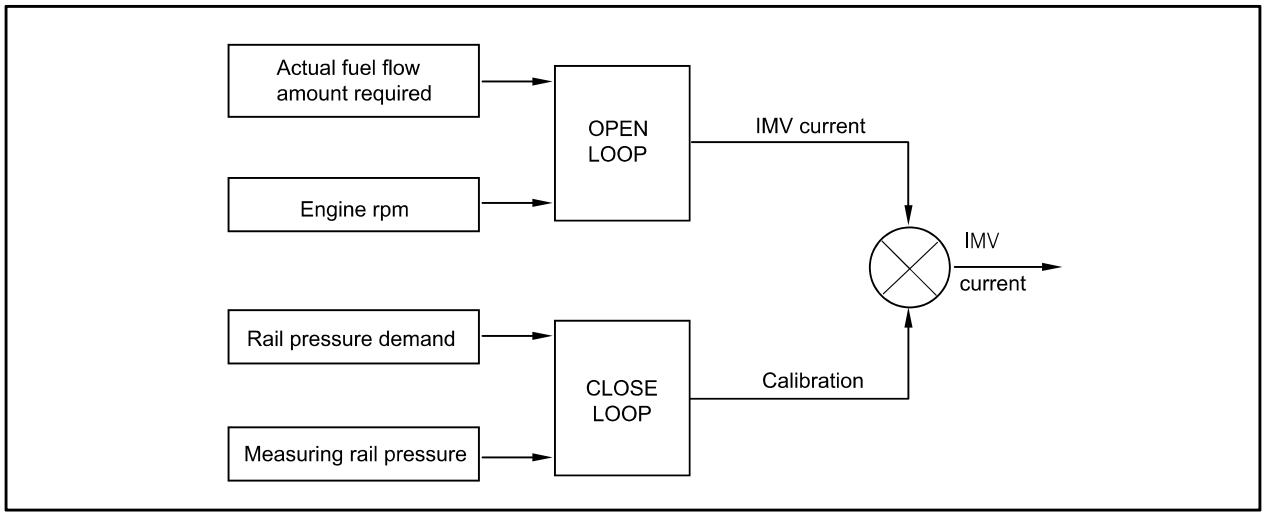
- When engine speed and load are high
  The degree of turbulence is very great and the fuel can be injected at very high pressure in order to optimize combustion.
- When engine speed and load are low
  The degree of turbulence is low. If injection pressure is too high, the nozzle's penetration will be 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.



Modification basis	
Application basis	
Affected VIN	

(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.

- 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.

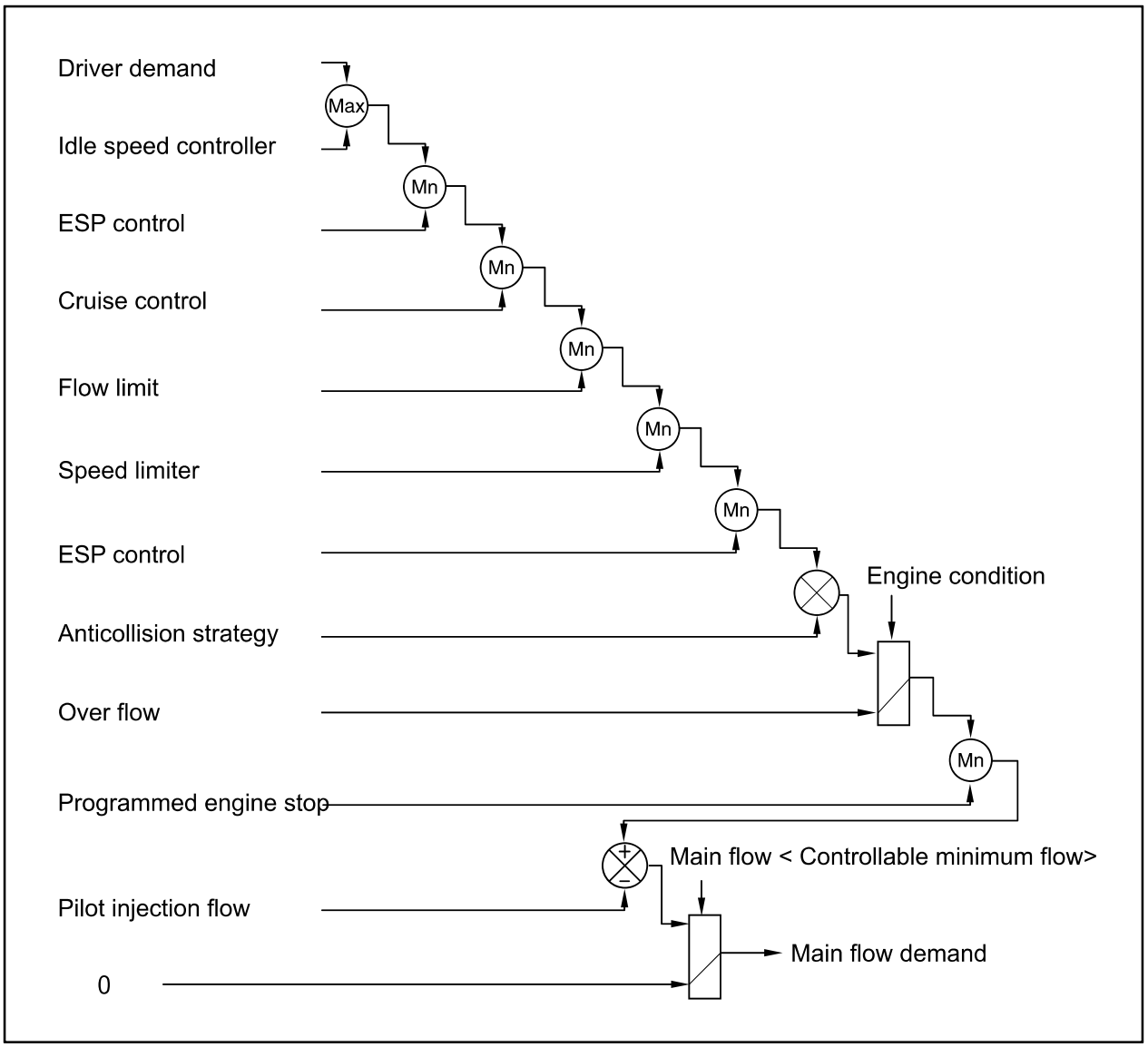
As soon as the injected fuel becomes lower than the flow limit determined by the ESP system, the antagonistic torque (engine brake) transmitted to the drive wheels exceeds the adherence capacity of the vehicle and there is therefore a risk of the drive wheels locking.
The system thus chooses the greater 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.

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

Modification basis	
Application basis	
Affected VIN	

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

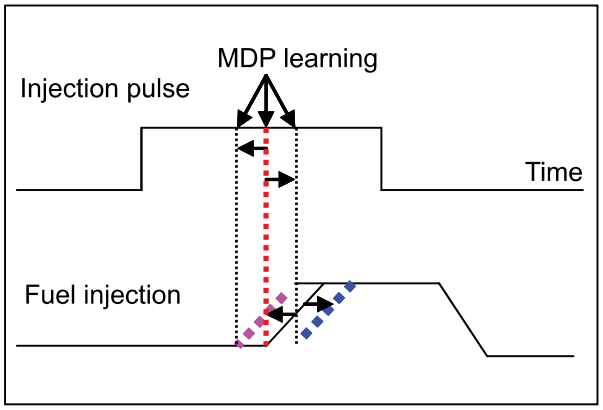
The pulse of each injector is corrected according to the difference in instantaneous speed measured between 2 successive injectors.

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.

(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.

Modification basis	
Application basis	
Affected VIN	

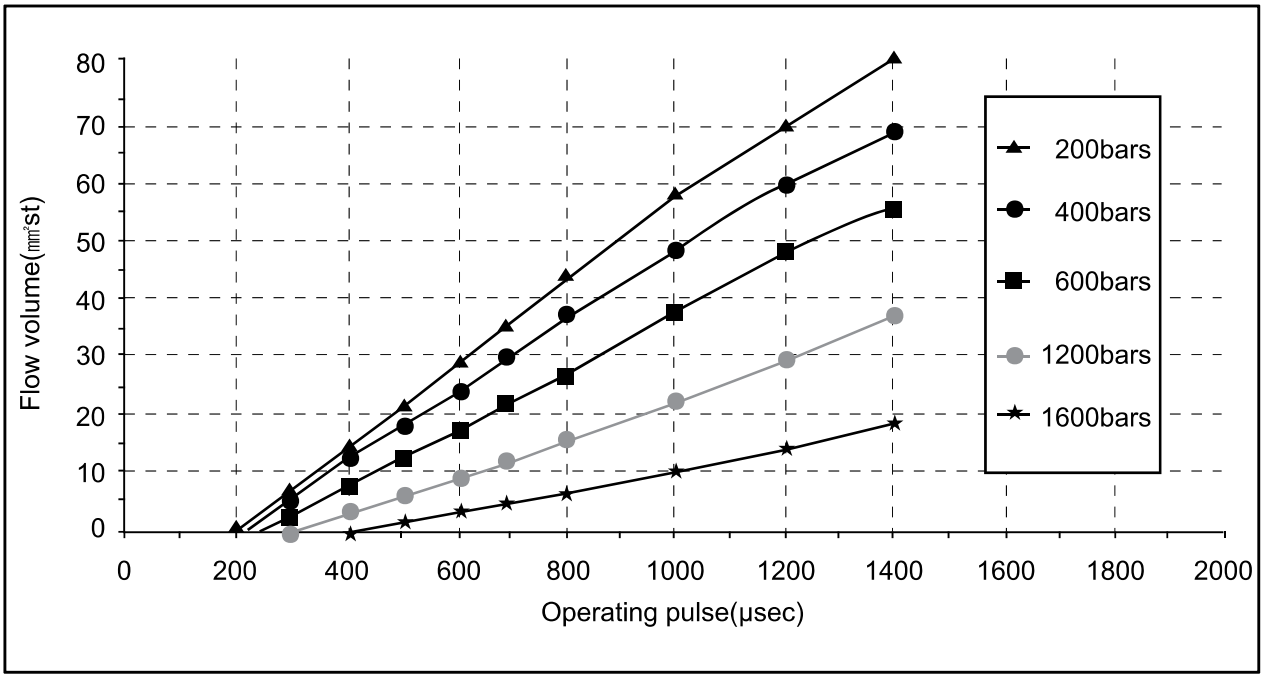
C. Learning Conditions

	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



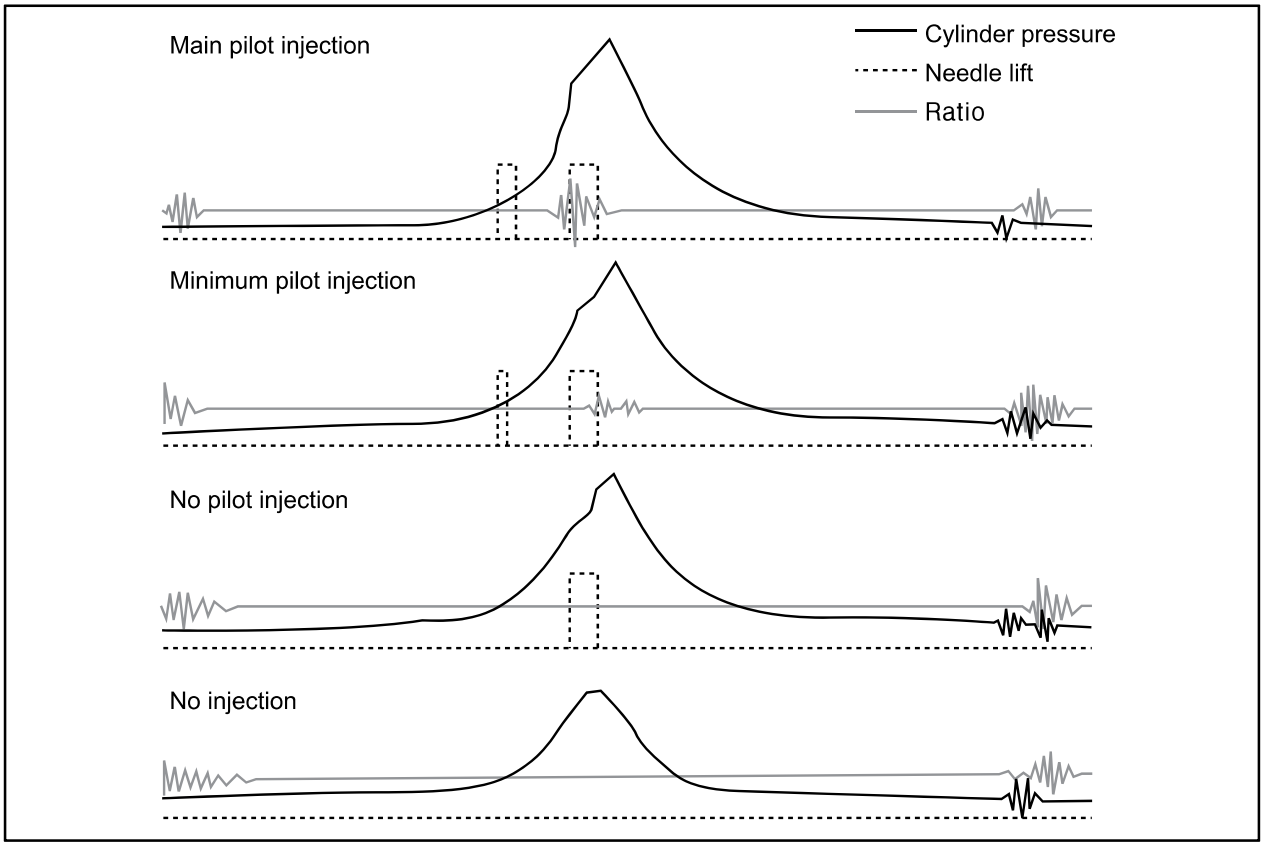
(7) Knocking Control

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).



Modification basis	
Application basis	
Affected VIN	

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.

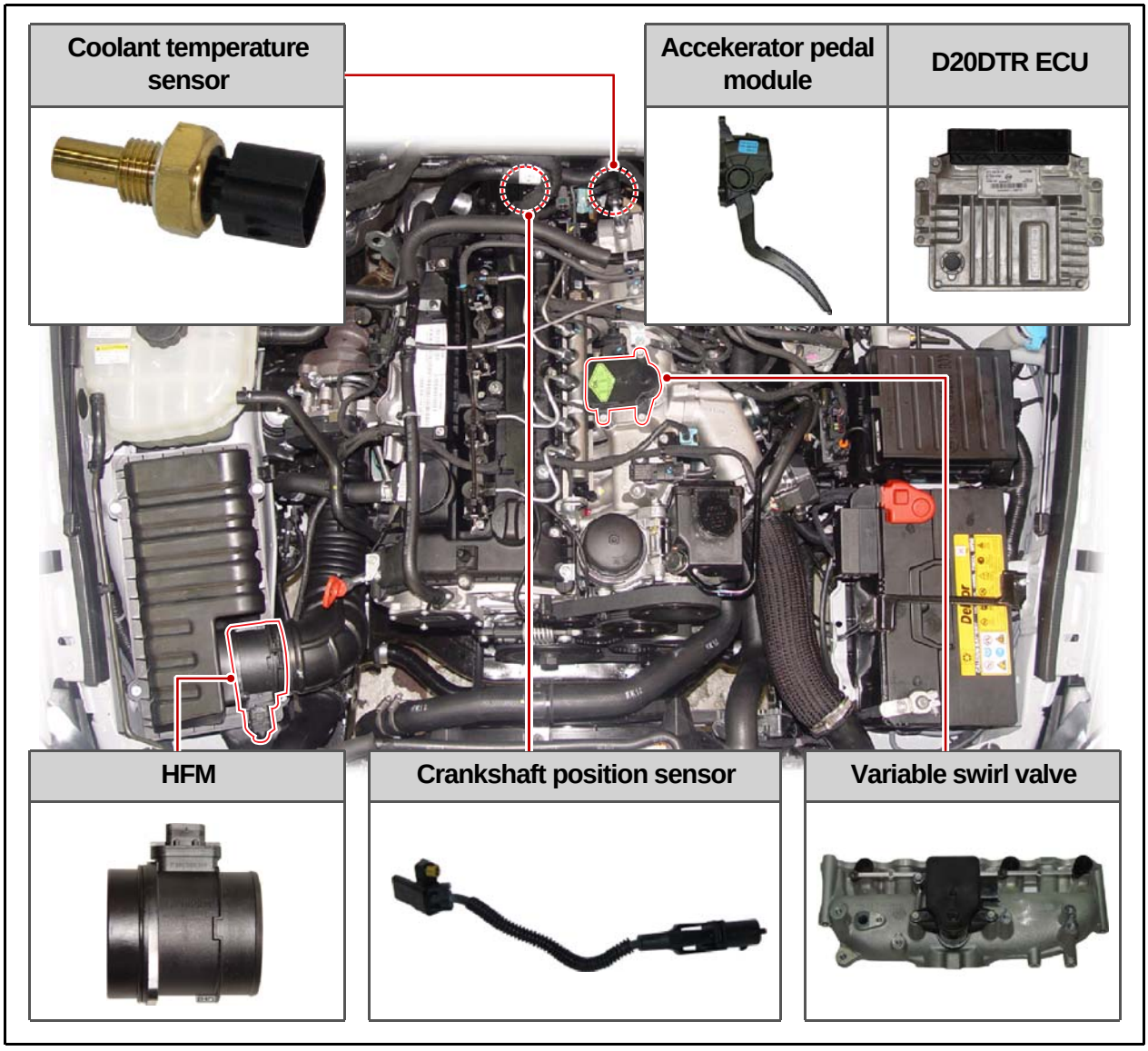
(8) Swirl control

A. Overview

▶ Variable swirl valve

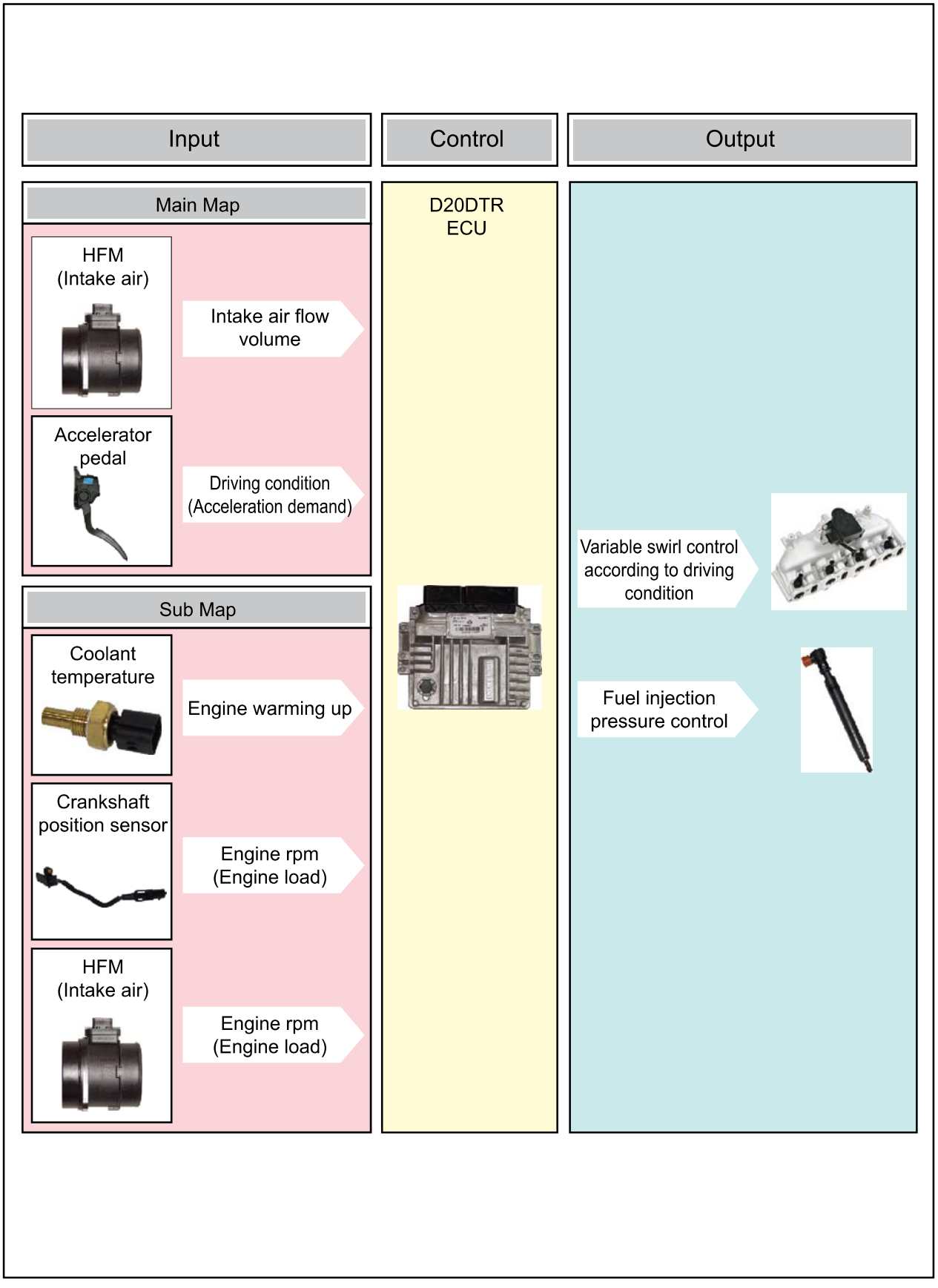
The strong swirl caused by intake air is important element for anti-locking function in diesel engine. The swirl control valve partially closes the intake port to generate the swirl according to the engine conditions. When the engine load is in low or medium range, the swirl could not be generated because 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

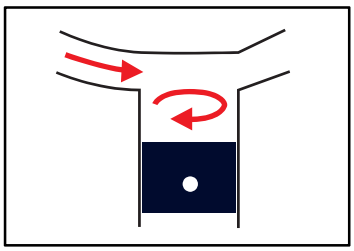


Modification basis	
Application basis	
Affected VIN	

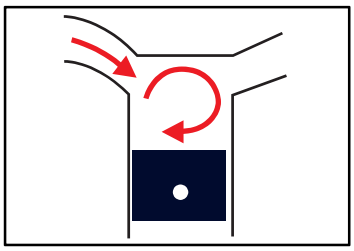
B. Input/Output for variable swirl valve



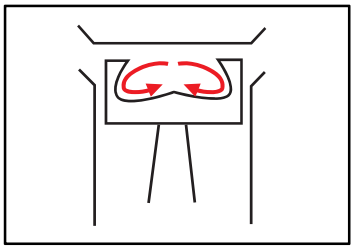
C. Types of swirl



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.



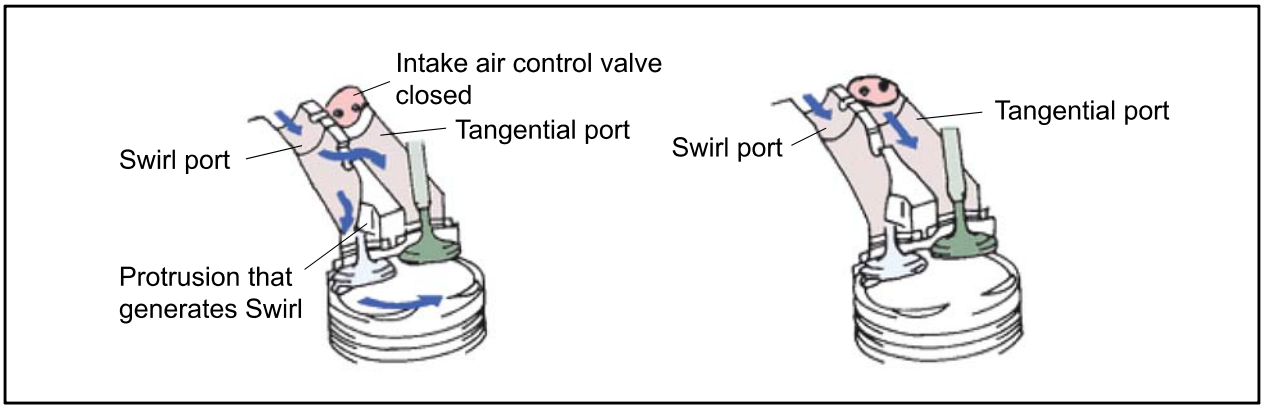
Tumble: Tumble is the vertical air flows in cylinder due to the vertical intake air port



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

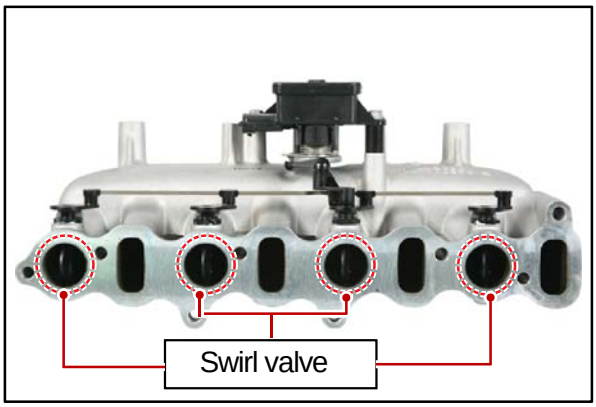
D. Swirl control

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.

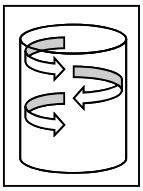


Modification basis	
Application basis	
Affected VIN	

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.

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

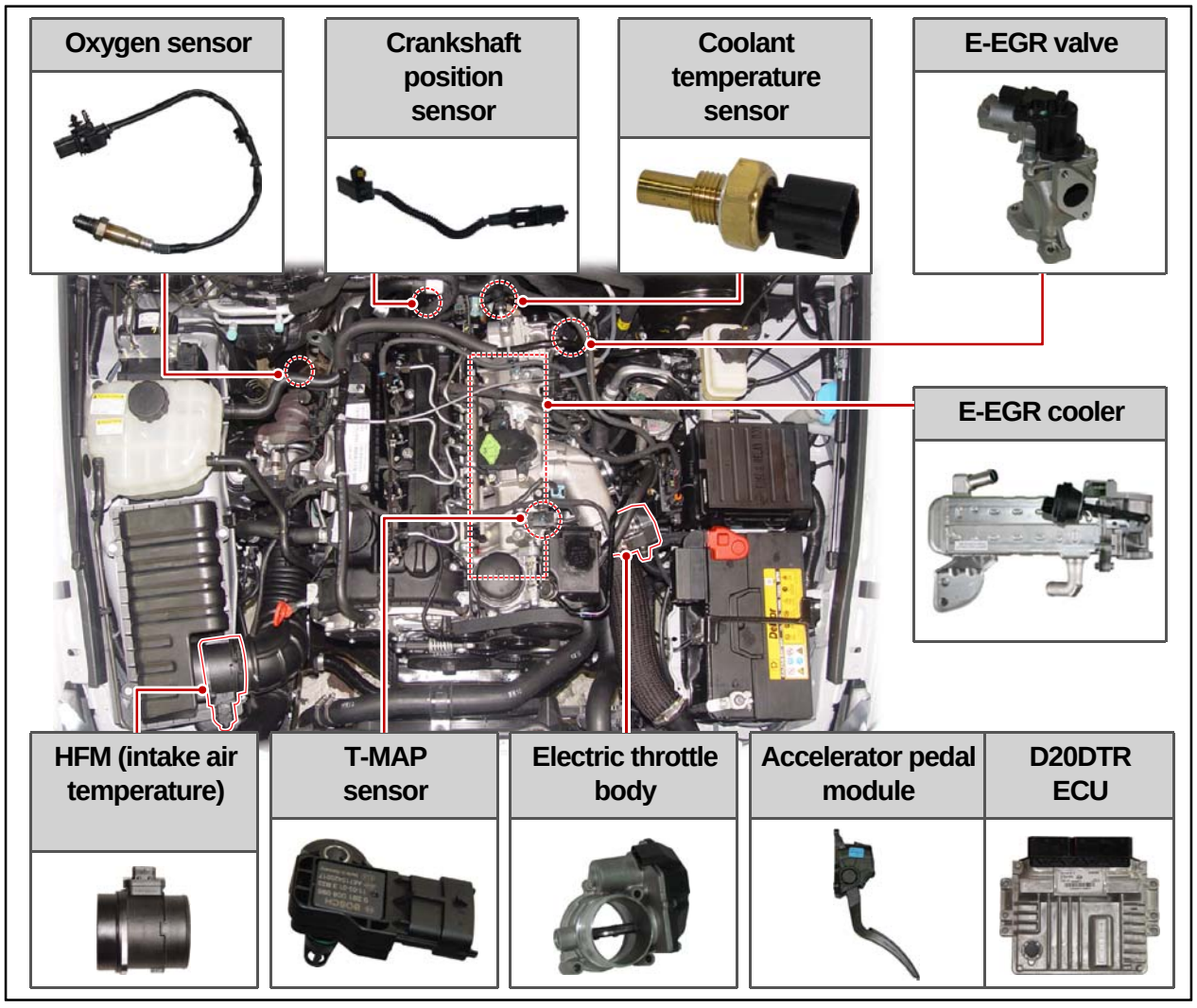
The injector for DI engine uses the multi hole design. For this vehicle, there are 8 holes in injector. If the swirl is too strong, the injection angles might be overlapped and may cause the increased PM and insufficient engine power. Also, if the injection pressure is too high during strong swirl, the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

(9) EGR control

A. Overview

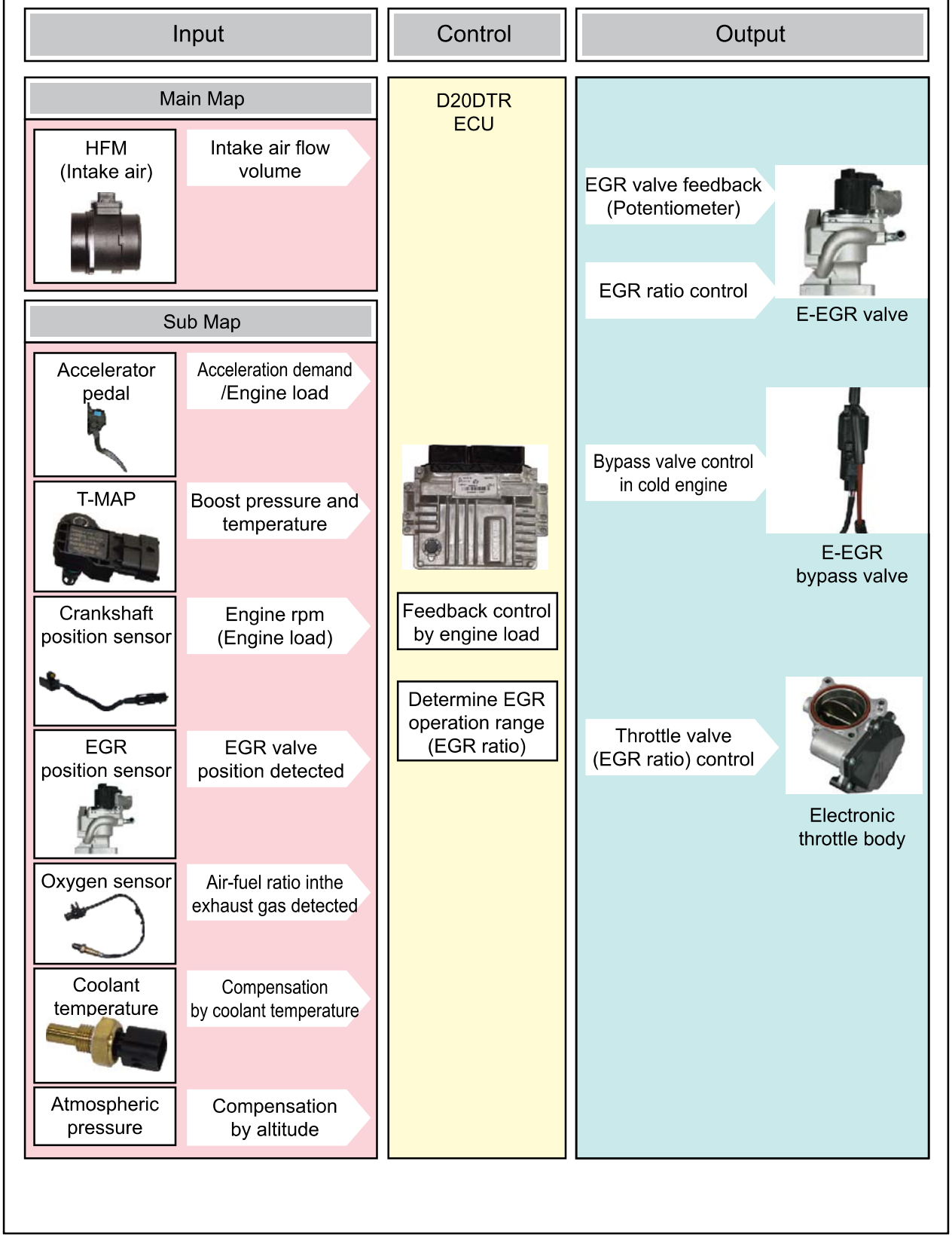
The EGR (Electric-Exhaust Gas Recirculation) valve reduces the NOx emission level by recirculating some of the exhaust gas to the intake system.
To meet Euro-V regulation, the capacity and response rate of E-EGR valve in D20DTR engine have been greatly improved. The EGR cooler with high capacity reduces 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



Modification basis	
Application basis	
Affected VIN	

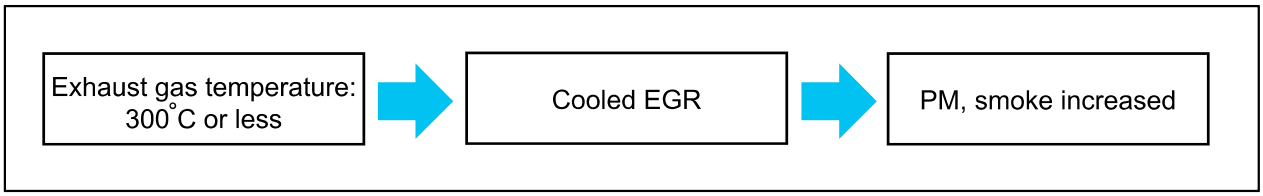
C. Input/Output of E-EGR system



D. Bypass control for EGR cooler

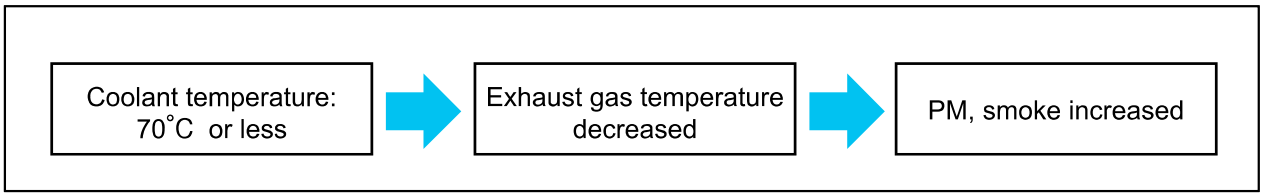
▶ Cooler temperature

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.

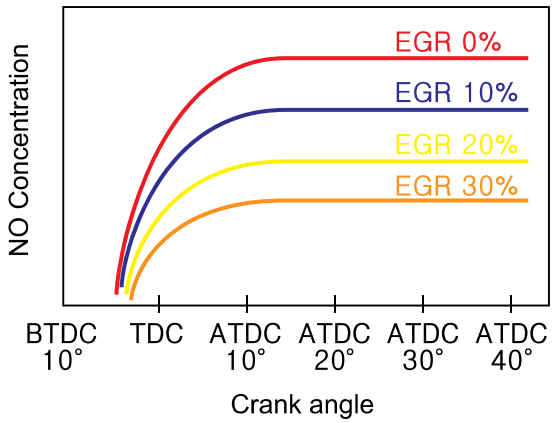


E. Control elements for EGR system

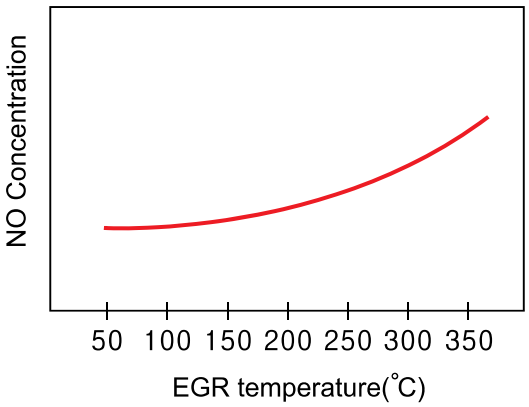
- Accelerator pedal (engine load) - Indicates the driver's intention and engine load. If the load goes up, the EGR ratio is decreased.
- T-MAP (boost pressure map stored in ECU) - Compensates the difference in boost pressure by adjusting EGR ratio.
- Engine rpm - Used as the signal for determining EGR 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).

Modification basis	
Application basis	
Affected VIN	

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.



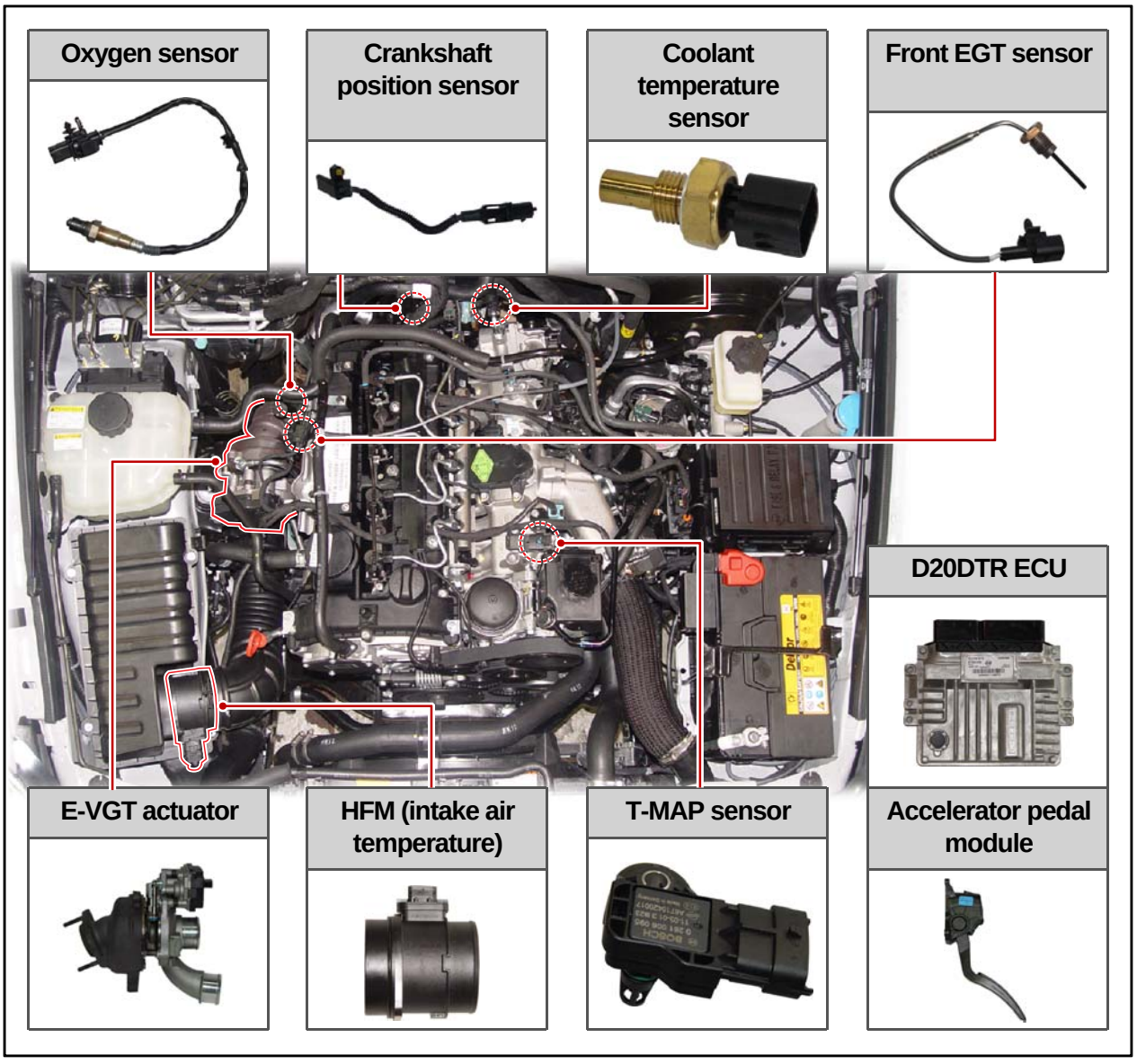
As EGR temperature goes up, the concentration of NOx will be higher. Thus, it is necessary to cool down the exhaust gas. However, during engine cooled, it may cause large amount of PM. To prevent this, the exhaust gas is bypassed the EGR cooler.

(10) E-VGT control

A. Overview

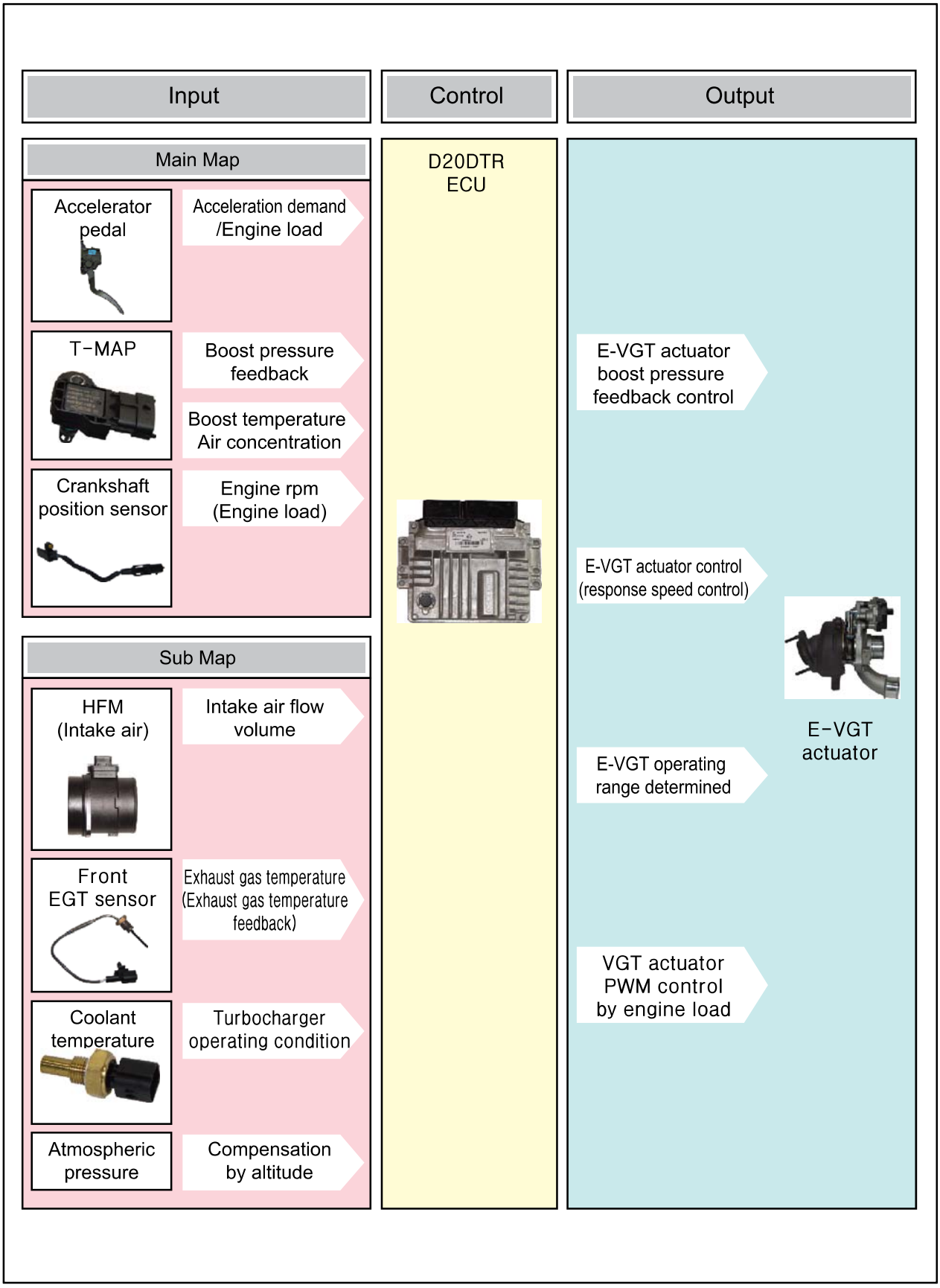
E-VGT (Electric-Variable Geometry Turbine) turbocharger system in D20DTF engine uses the venturi effect that controls the flow rate of exhaust gas by adjusting the passage in turbine housing. The newly adopted DC motor actuator (E-actuator) controls the E-VGT system more precisely and faster. To get 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



Modification basis	
Application basis	
Affected VIN	

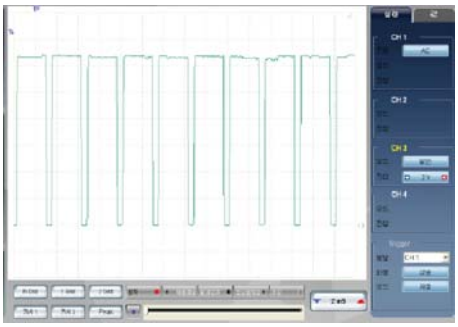
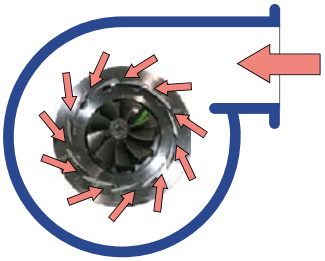
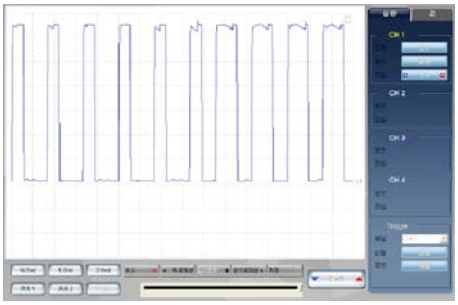
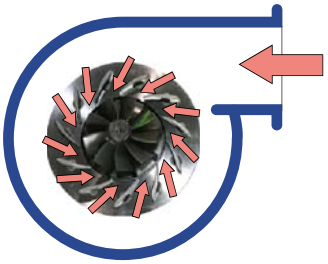
C. Input/Output for E-VGT system



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.

Modification basis	
Application basis	
Affected VIN	

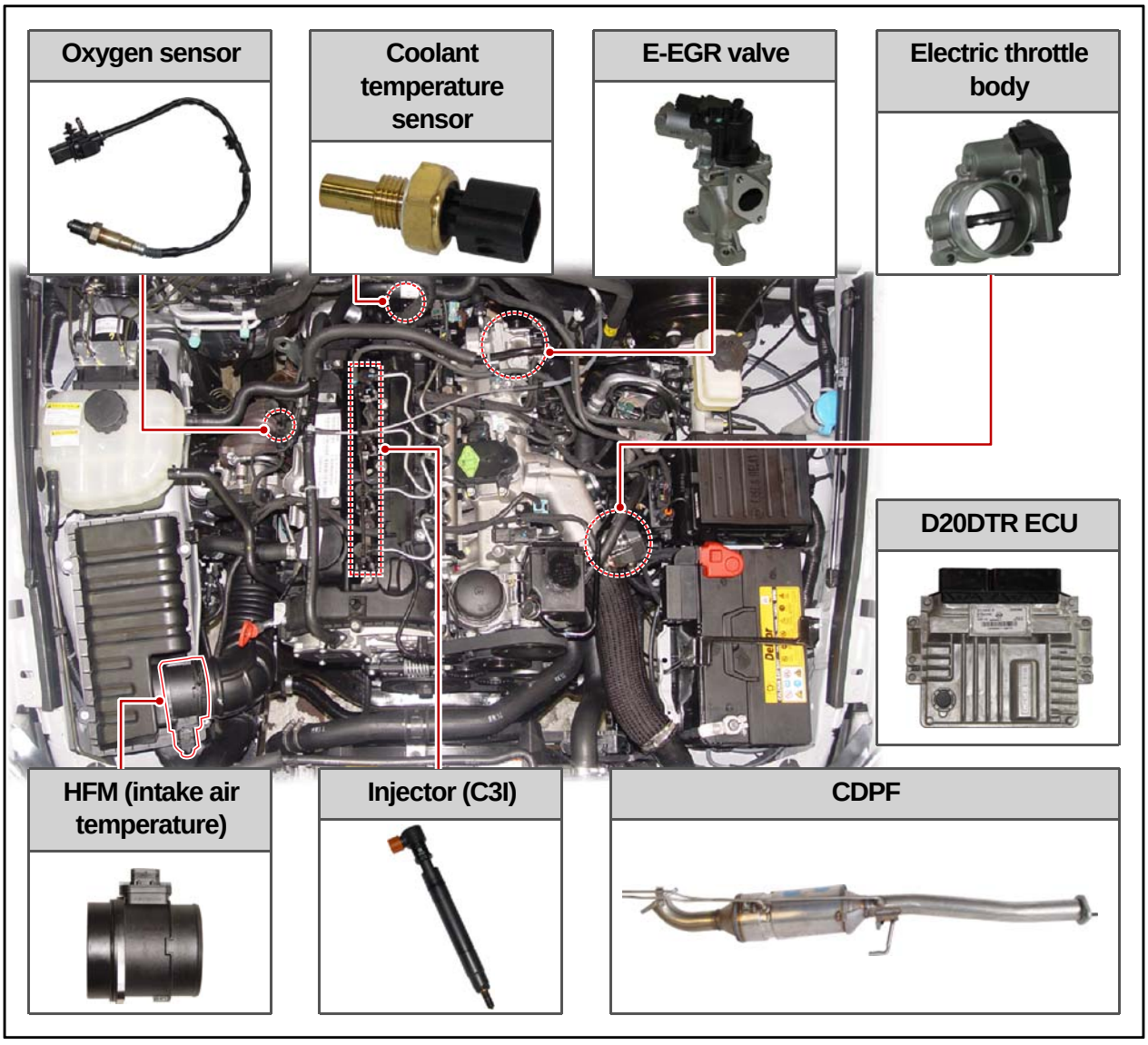
(11) Wide band oxygen sensor control

A. Overview

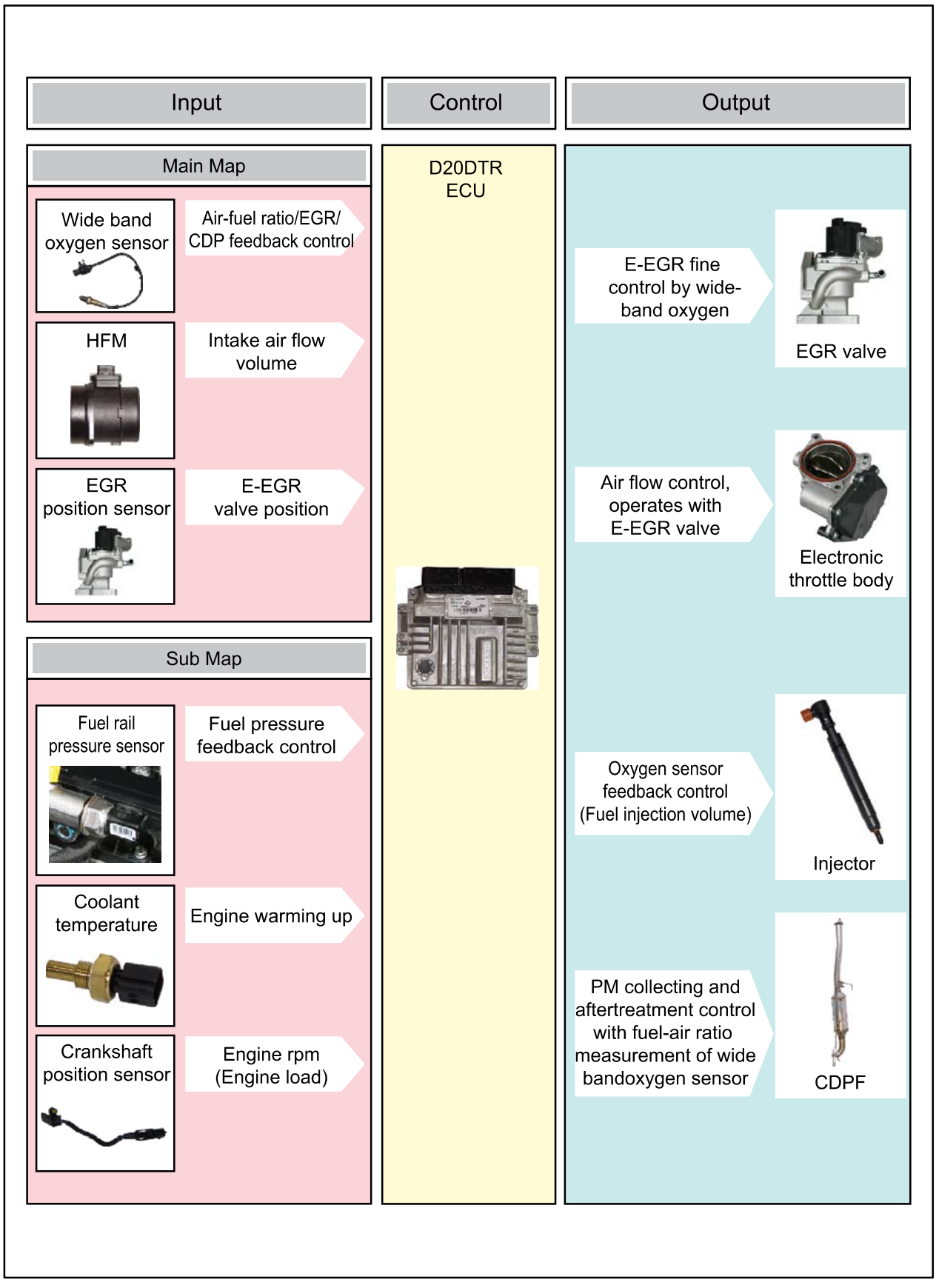
For diesel engine, combustion is not performed at the optimum (theoretically correct) air-fuel ratio and the oxygen concentration is thin in most cases. So the wide-band oxygen sensor is used for this kind of engine, and this sensor is a little different from the one that used for gasoline engine. The 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



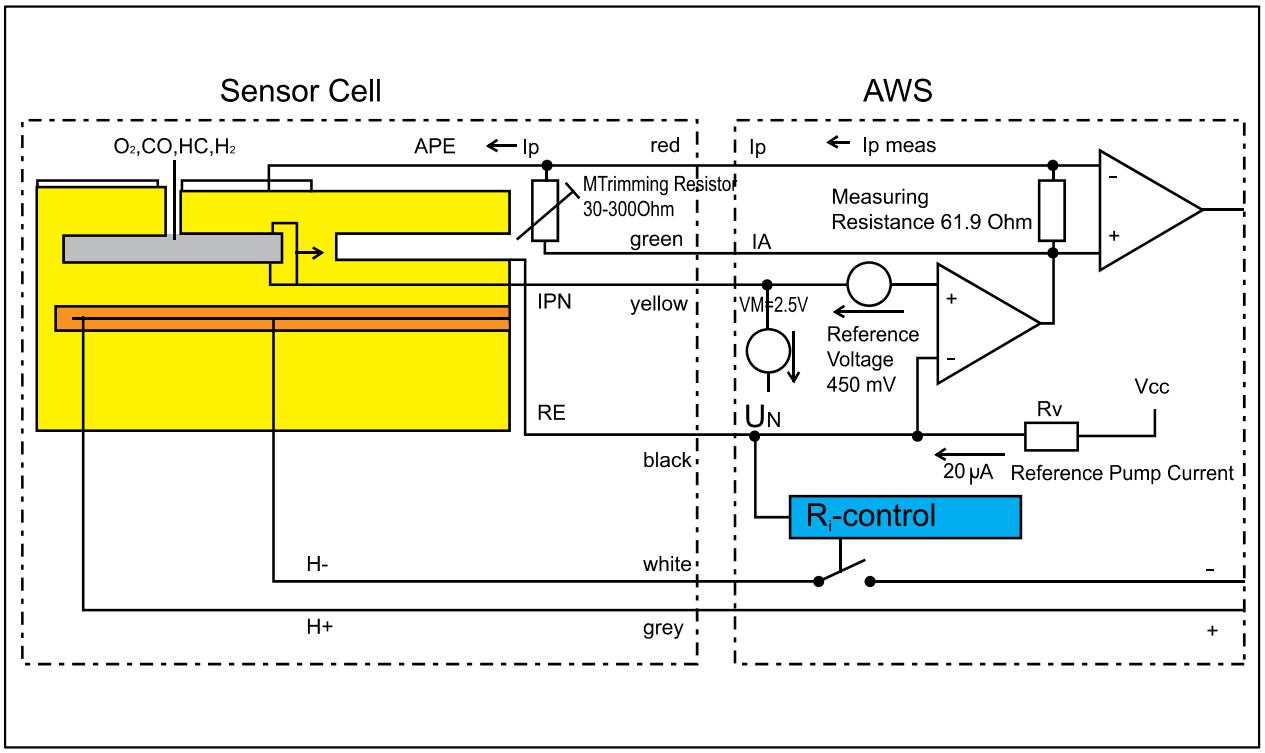
C. Input/Output for oxygen sensor



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.



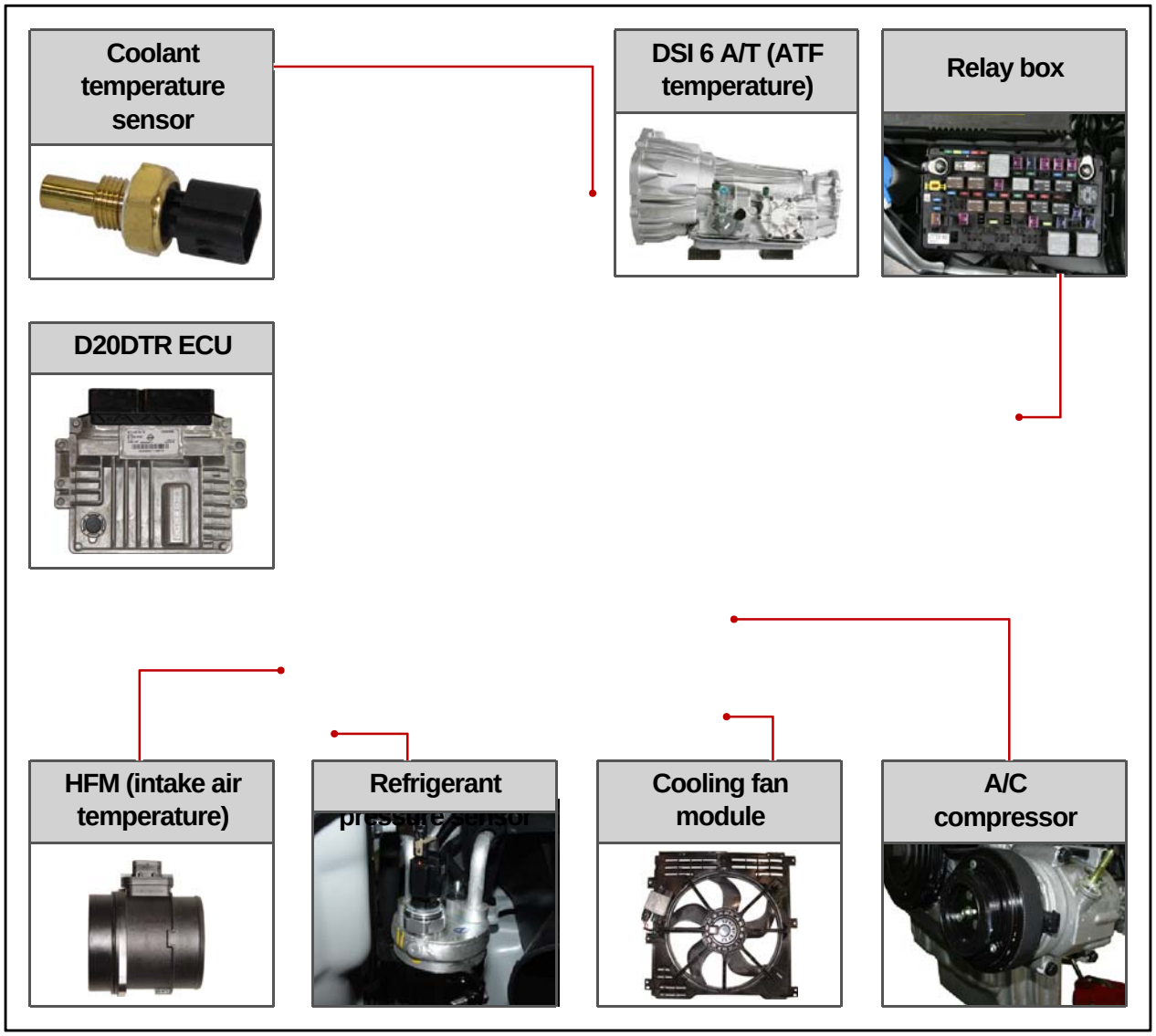
(12) Cooling fan control

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.

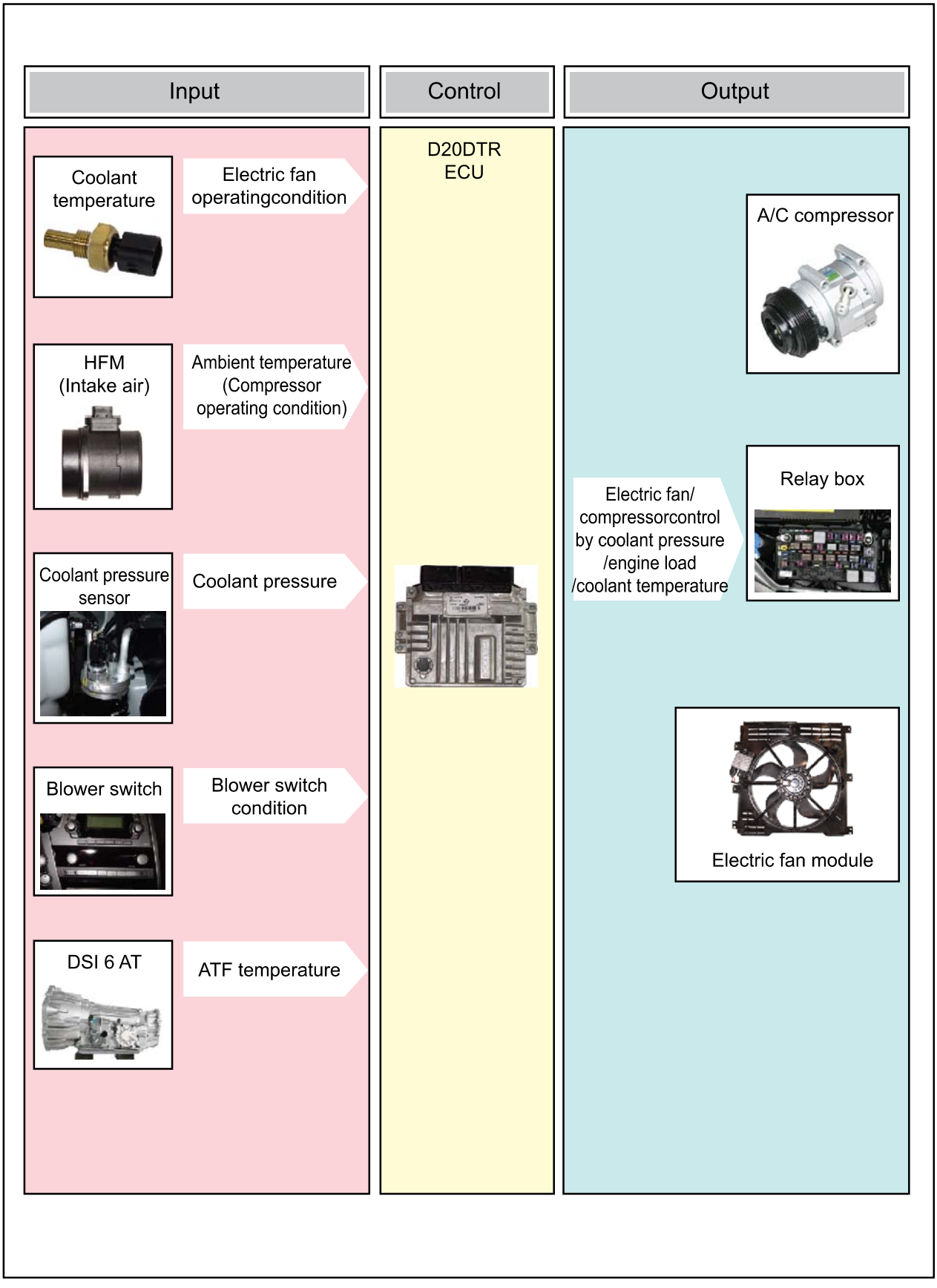
reference For detailed information, refer to Chapter "Air Conditioning System".

B. Components



Modification basis	
Application basis	
Affected VIN	

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



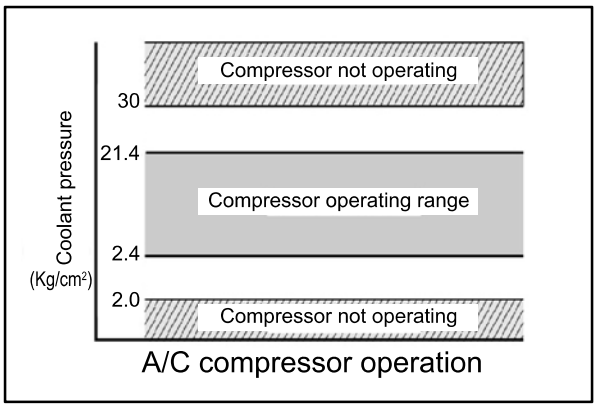
D. Cooling fan and A/C compressor control

▶ 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



- 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	-

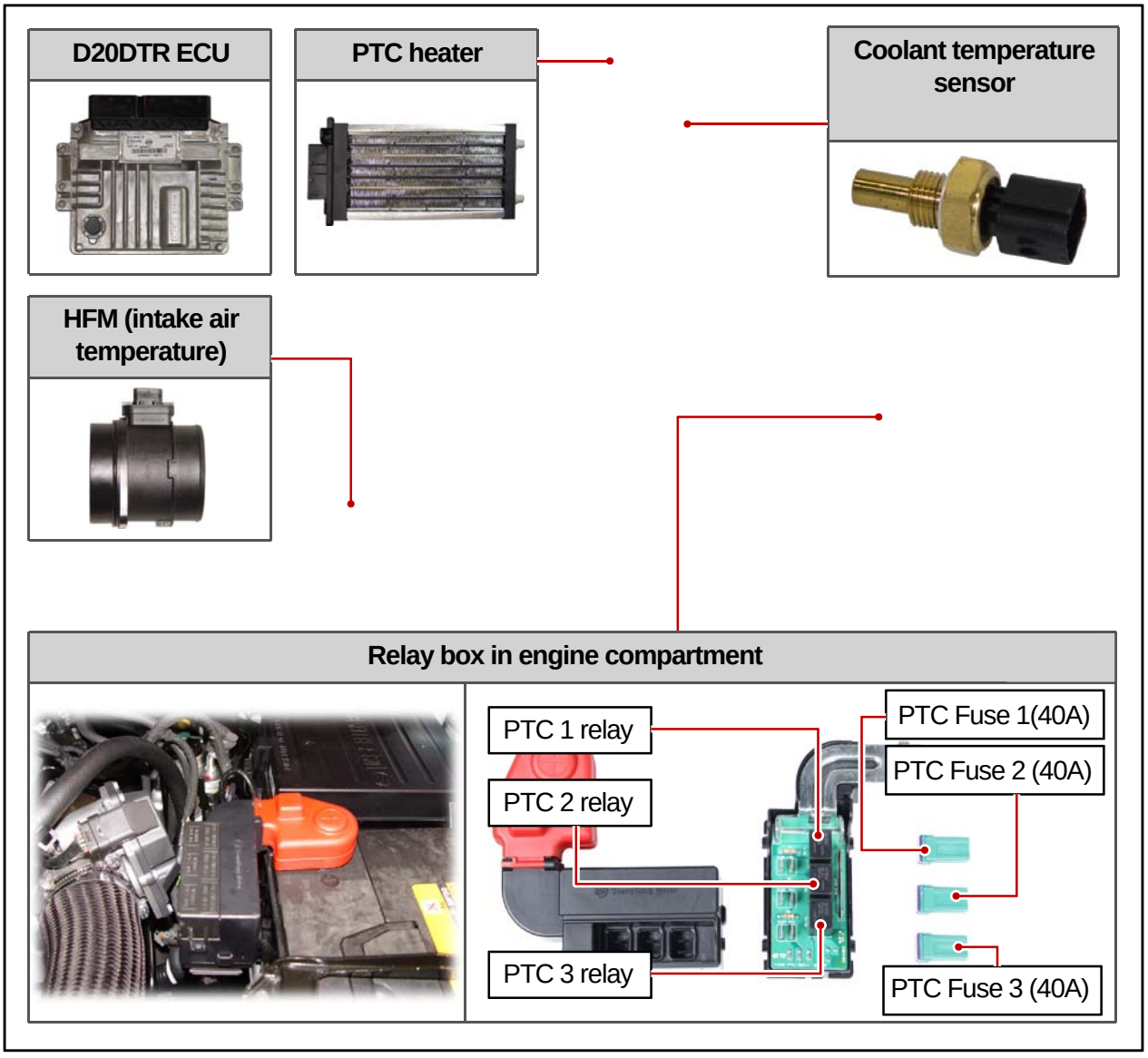
Modification basis	
Application basis	
Affected VIN	

(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.

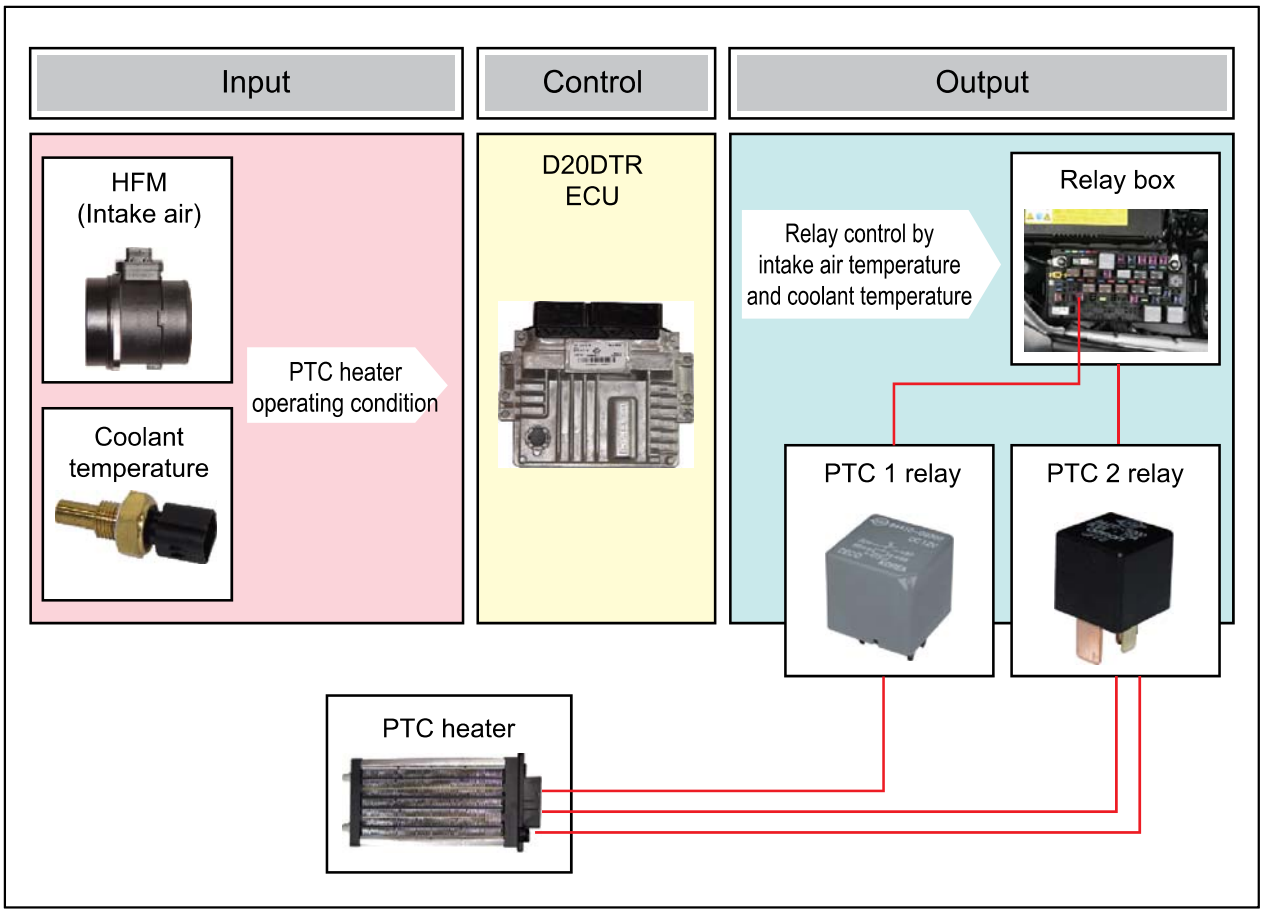
B. Components



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



Modification basis	
Application basis	
Affected VIN	

D. PTC operation process

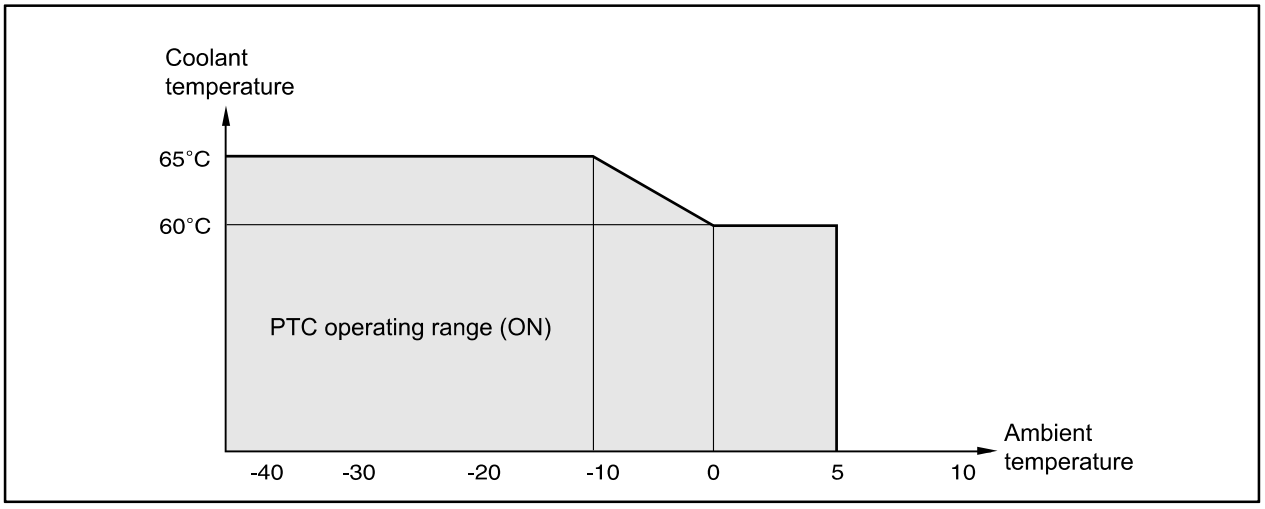
The PTC operating condition (ON) is controlled in two steps.
Basically, the engine ECU controls the relay to supply the power to PTC according to the coolant temperature sensor and ambient temperature sensor.

▶ 1st step (initial operation of PTC)

- Coolant temperature < 15°C: PTC ON
- Coolant temperature ≥ 15°C: PTC ON after satisfying the conditions in 2nd step

▶ 2ndt step (coolant temperature ≥ 15°C)

- Coolant temperature ≤ 65°C and intake air temperature ≤ −10°C: PTC ON
- Coolant temperature < 60~65°C and intake air temperature < −10~0°C: PTC ON
- Coolant temperature ≤ 60°C and intake air temperature ≤ 0~5°C: PTC ON



▶ Stop (OFF) conditions

- 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)

(14) Immobilizer control

A. Overview

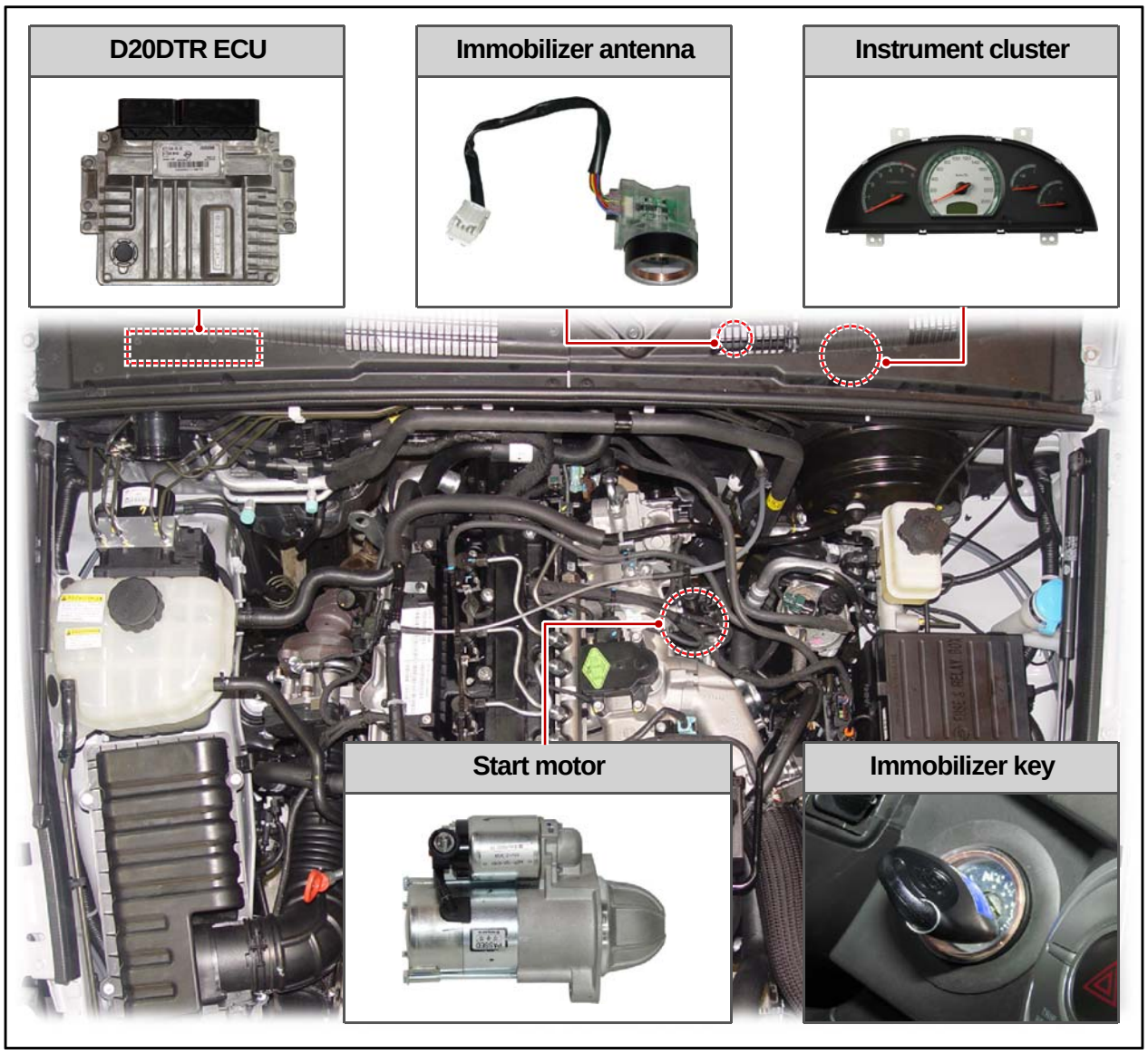
The Immobilizer System provides an additional theft deterrent to the vehicle in which it is installed and prevents it from being started by unauthorized persons. The transponder integrated in the key and the engine control unit have the same code. When the ignition key with the integrated transponder 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

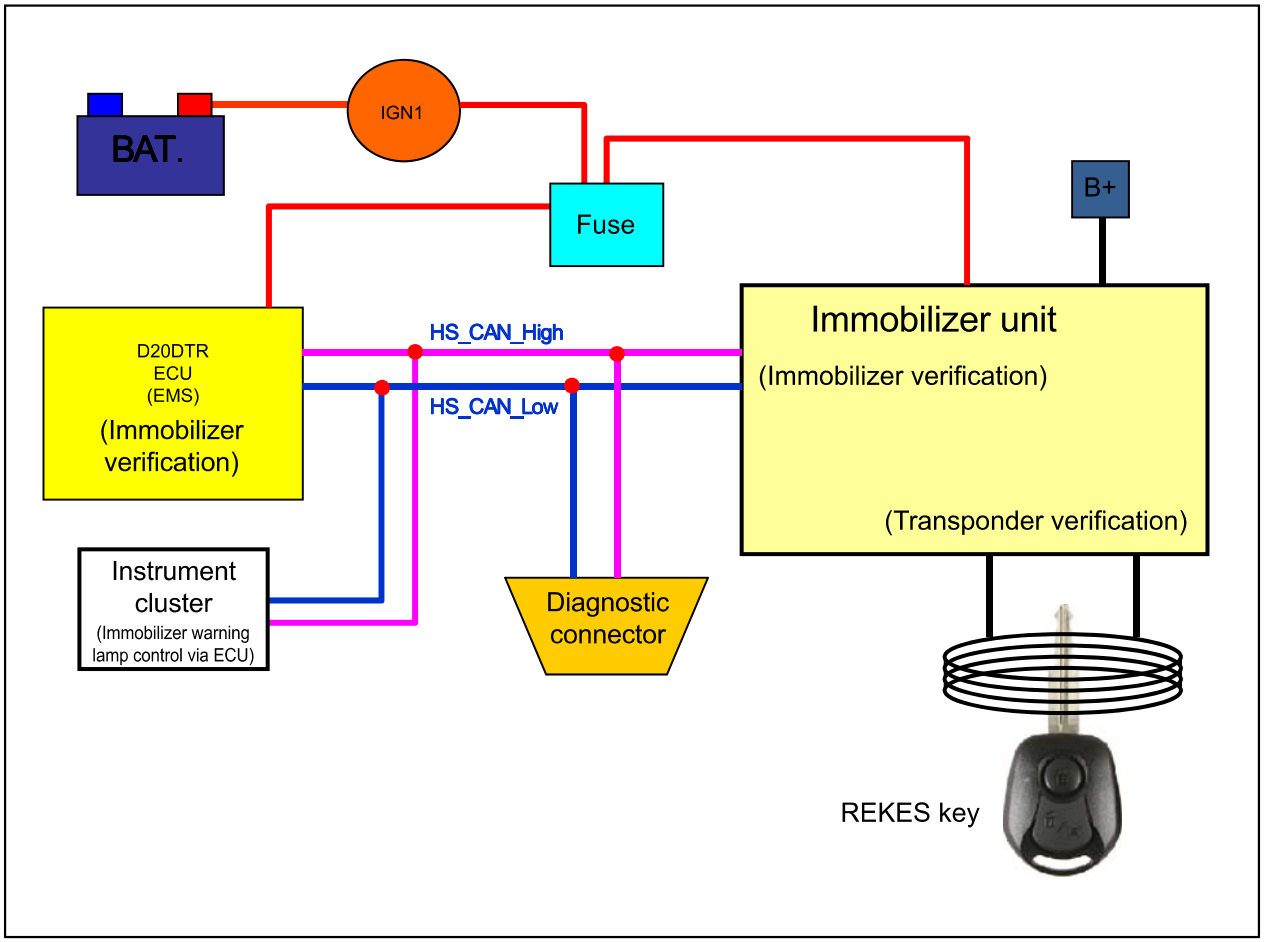
▶ **Basic components (ignition key system)**



Modification basis	
Application basis	
Affected VIN	

▶ 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.



(15) CDPF control

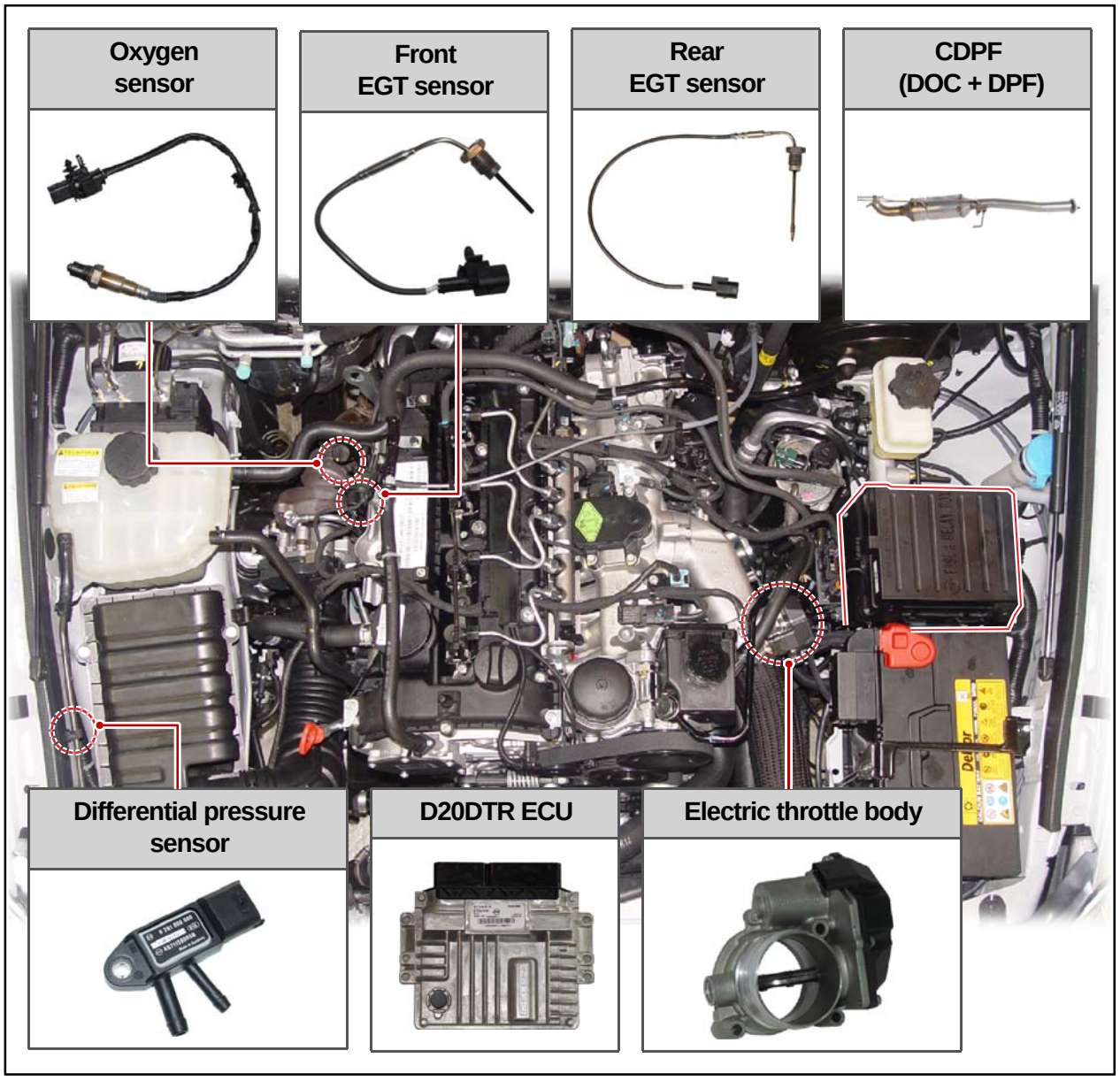
A. Overview

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

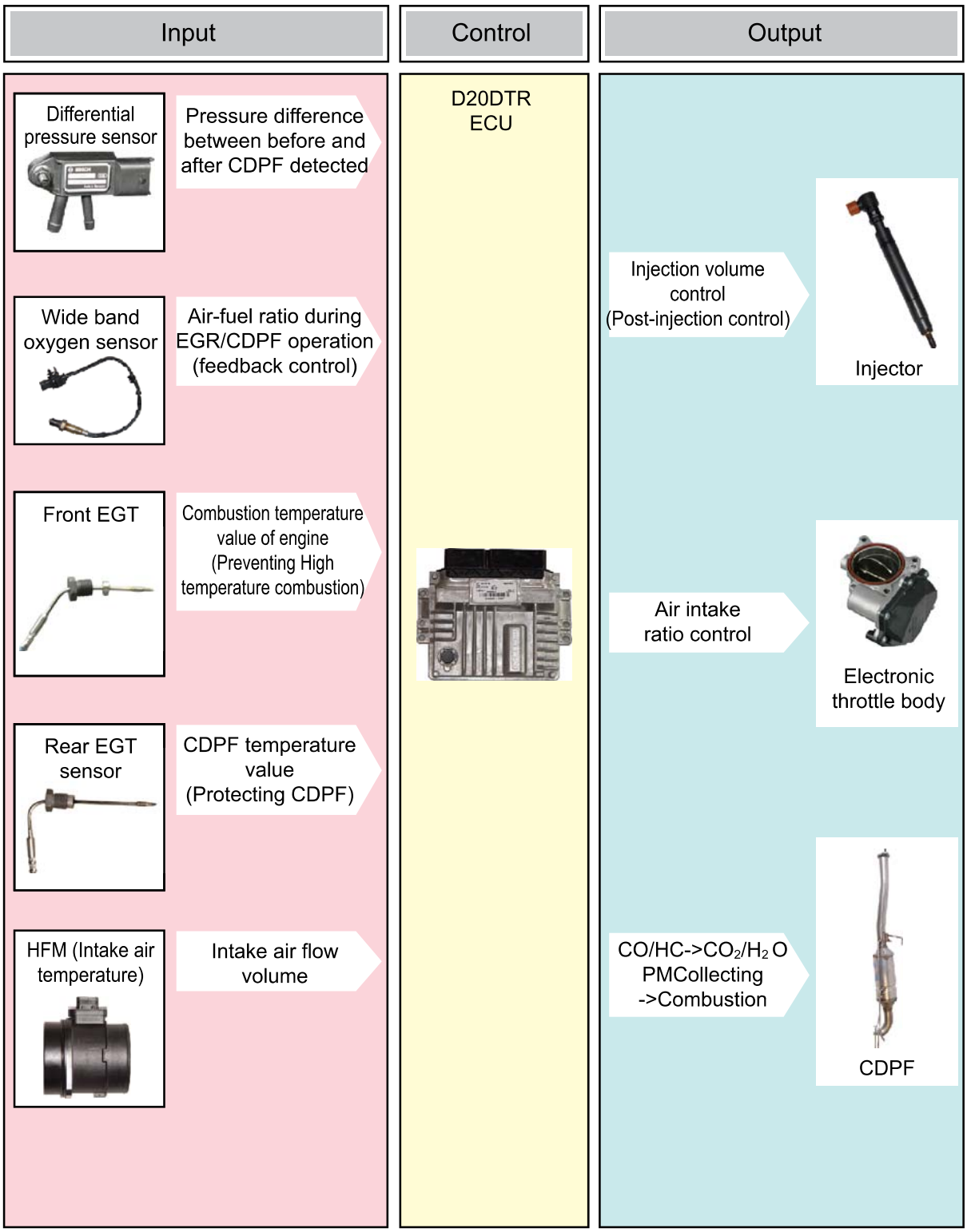
For details, refer to Chapter "CDPF".

B. Components



Modification basis	
Application basis	
Affected VIN	

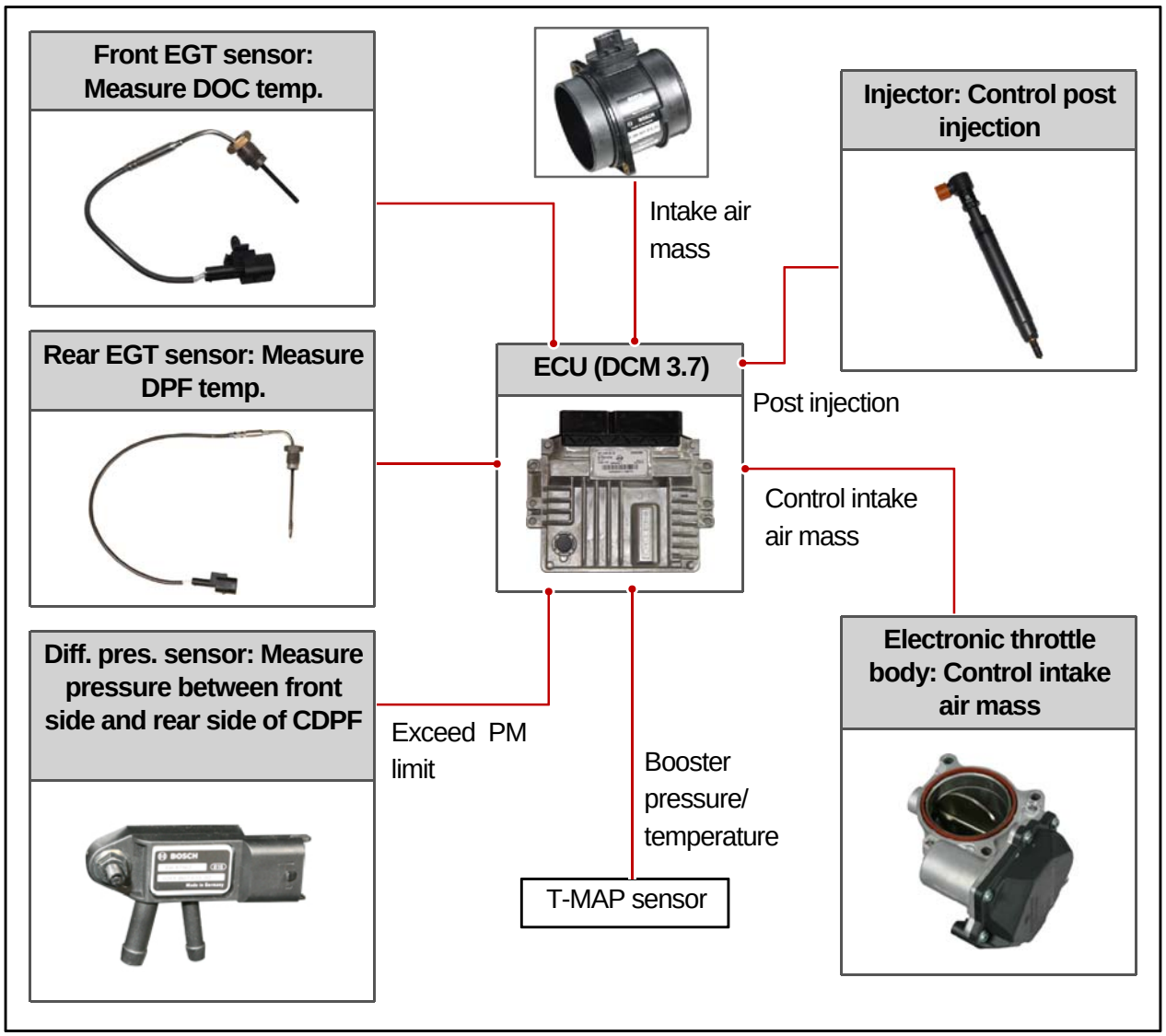
C. Input/Output for CDPF control



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.



Modification basis	
Application basis	
Affected VIN	

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

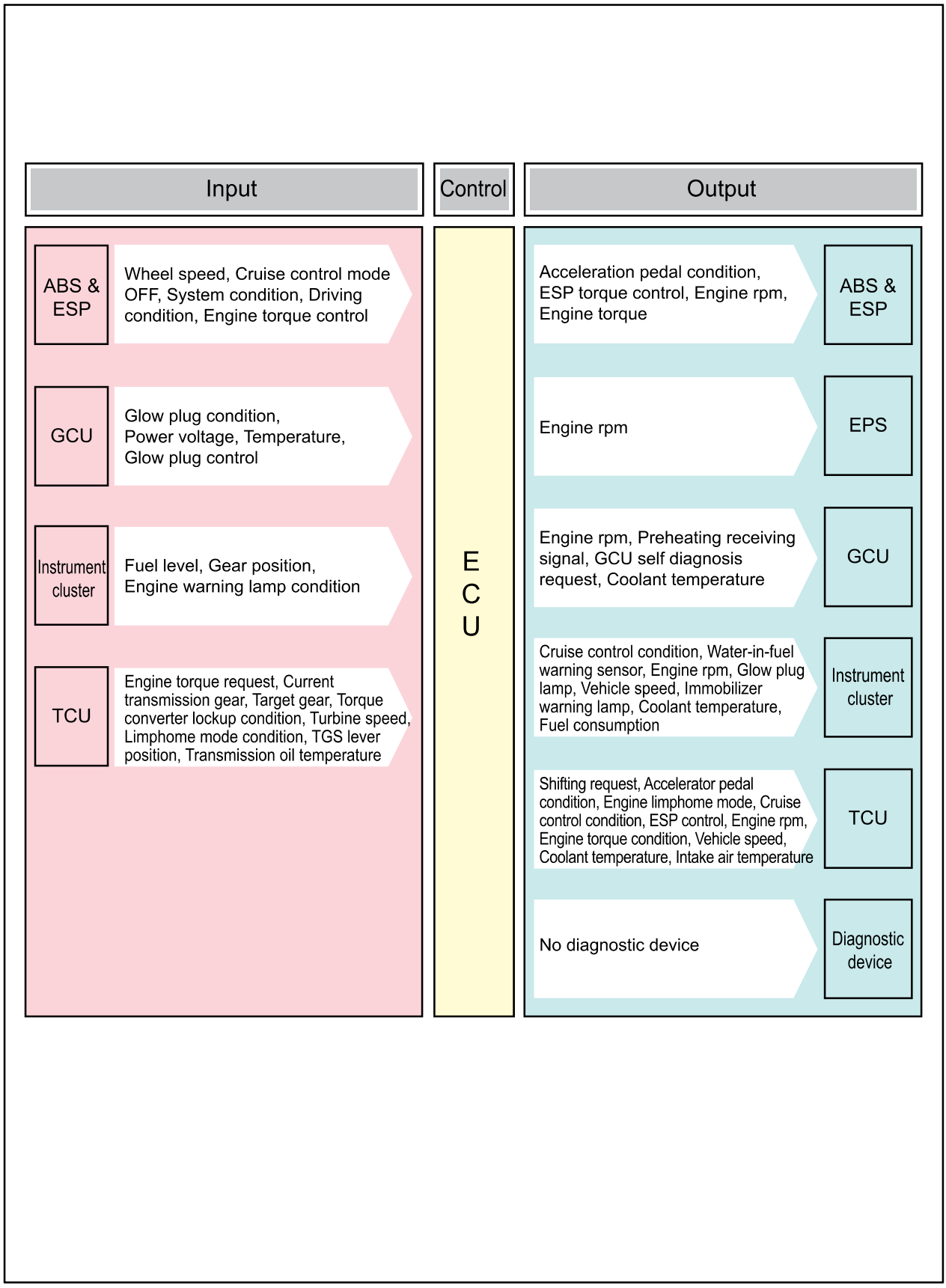
- Minimized the sulfur content of engine oil which reduces the service life.
- Improved fuel economy and emission level of CO2 with high performance and low viscosity.
- Increased service life of engine oil with high resistance to temperature.

▶ 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.

3) Input/Output for CAN communication



Modification basis	
Application basis	
Affected VIN	

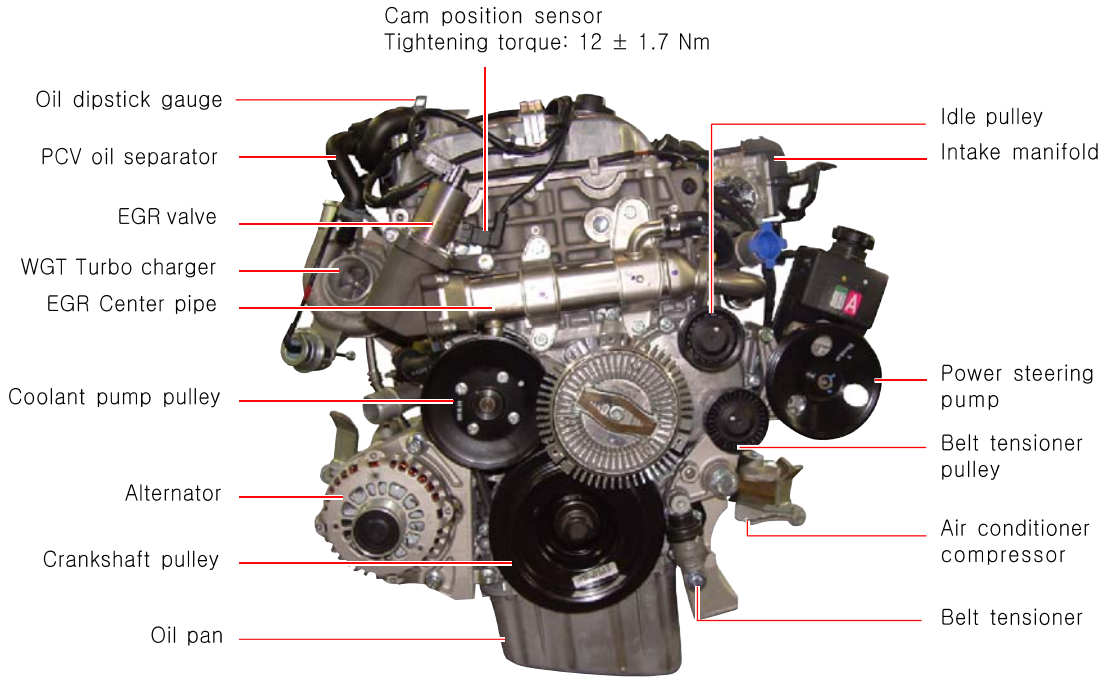
ENGINE GENERAL

0000-00

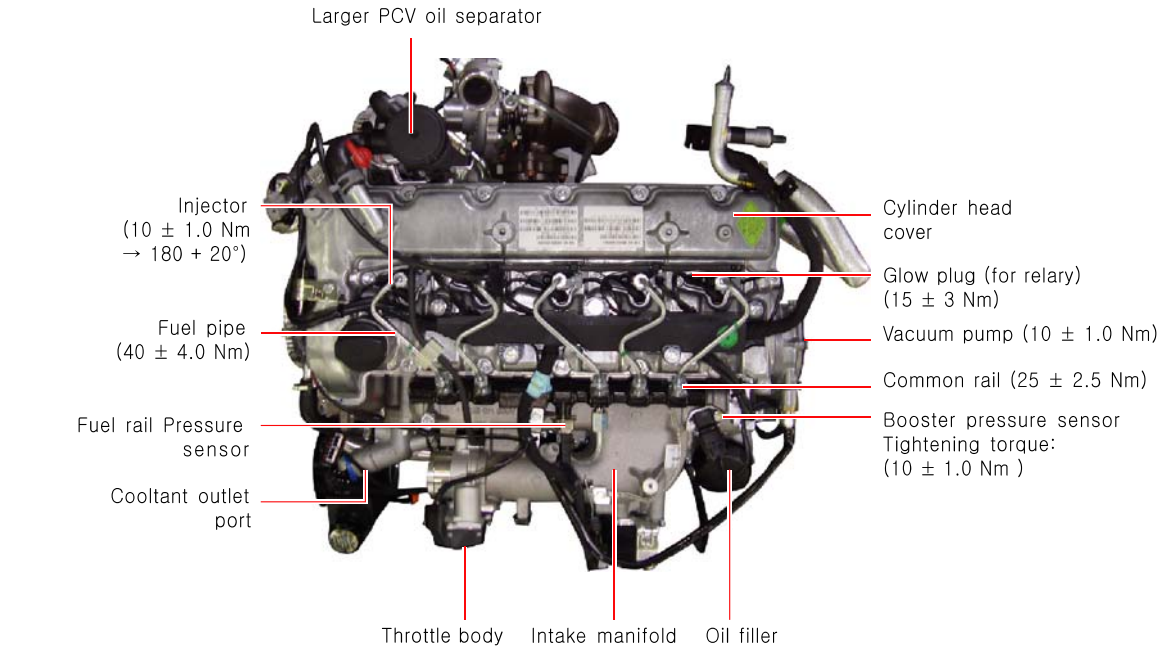
GENERAL

1. STRUCTURE AND COMPARISON

▶ D27DT (EU IV) Engine - Front View

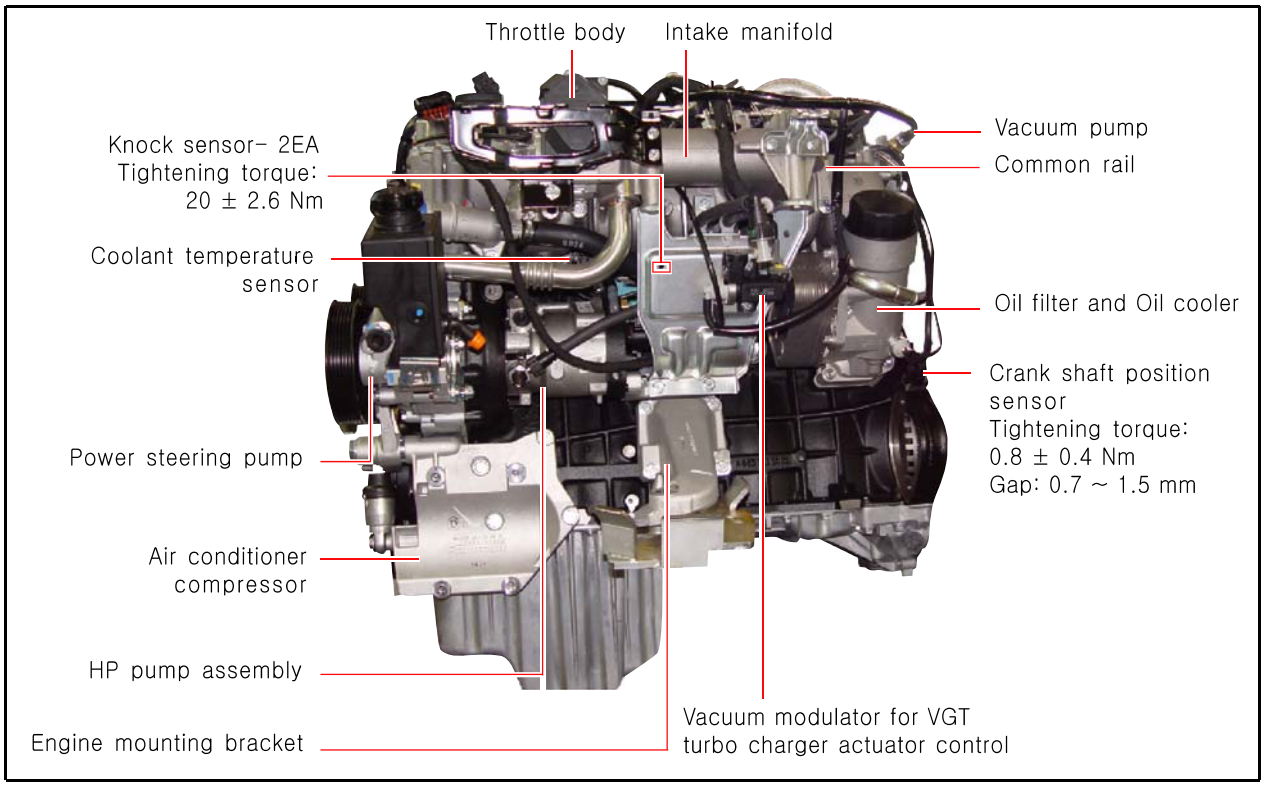


▶ D27DT (EU IV) Engine - Top View

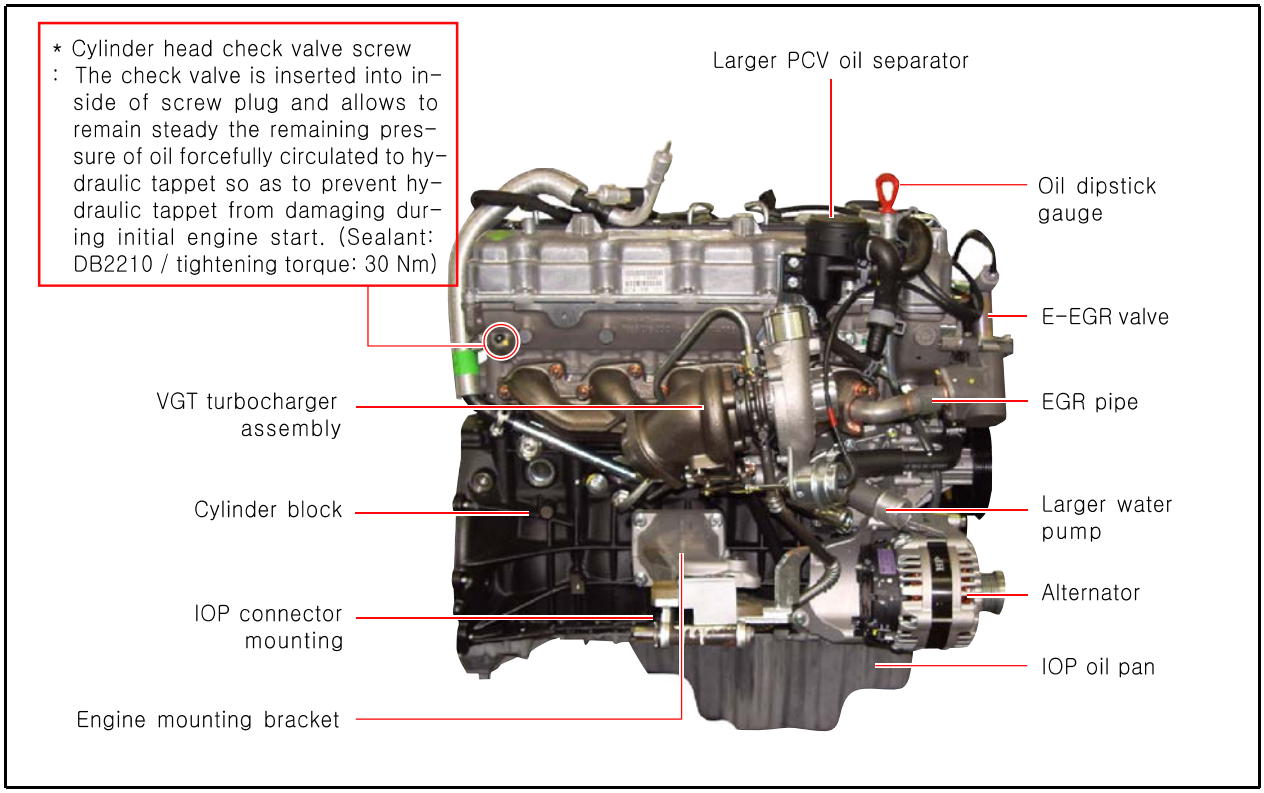


Modification basis	
Application basis	
Affected VIN	

▶ D27DT (EU IV) Engine - Side View

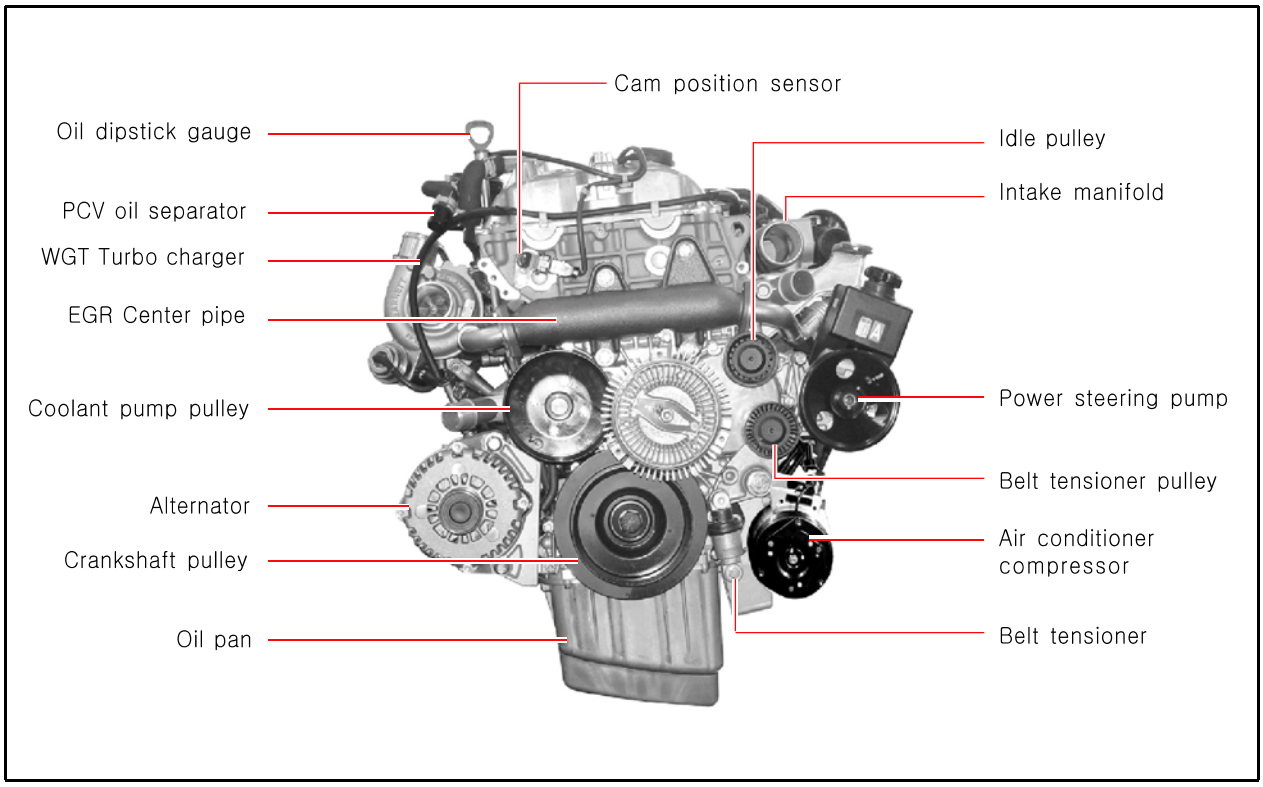


▶ D27DT (EU IV) Engine - Left Side View

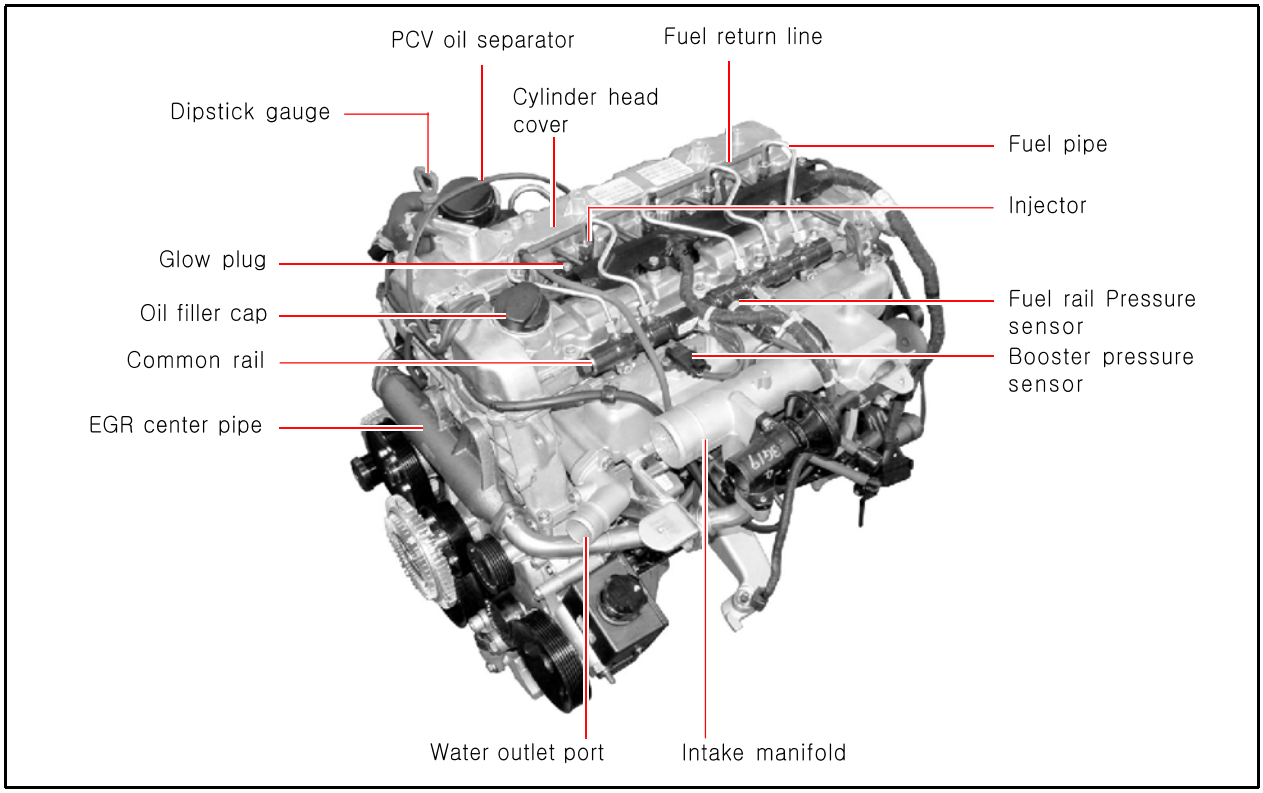


Modification basis	
Application basis	
Affected VIN	

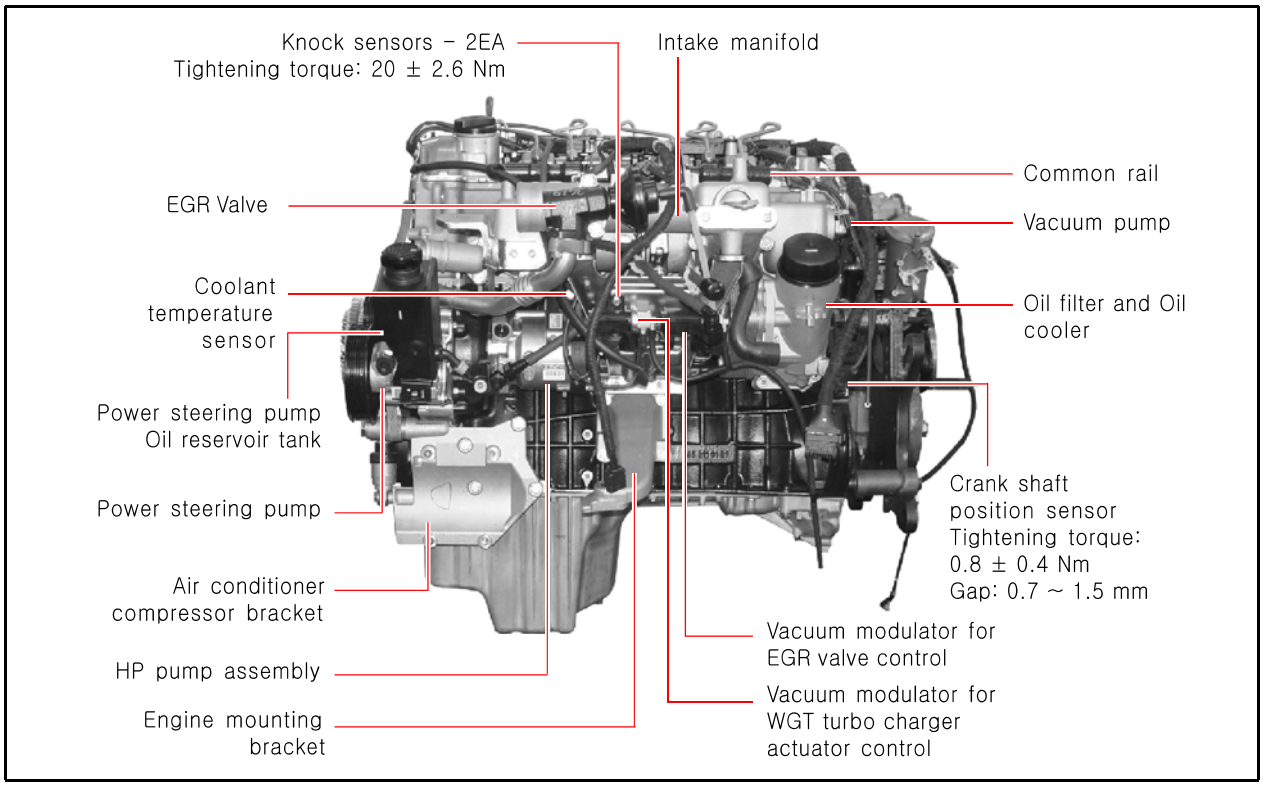
▶ D27DT Engine (General) - Front View



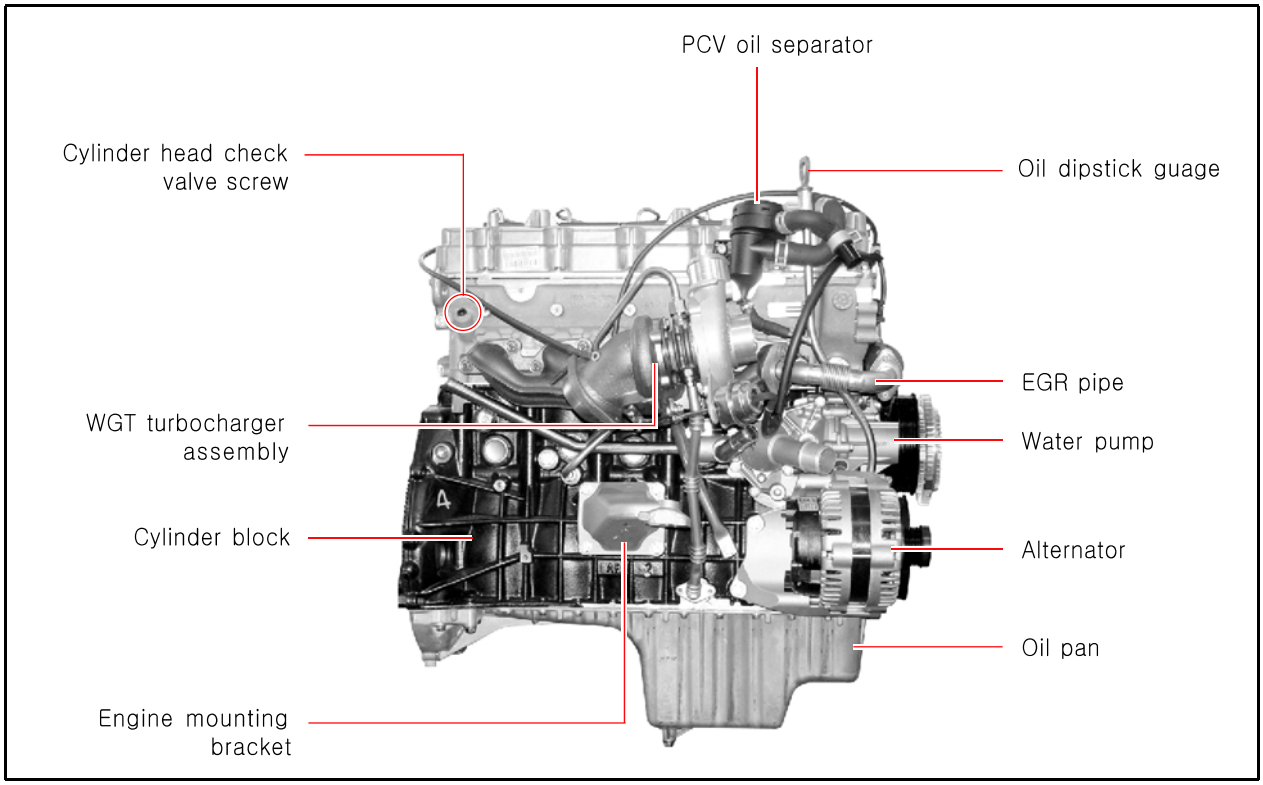
▶ D27DT Engine (General) - Top View



▶ D27DT Engine (General) - Side View



▶ D27DT Engine (General) - Left Side View



Modification basis	
Application basis	
Affected VIN	

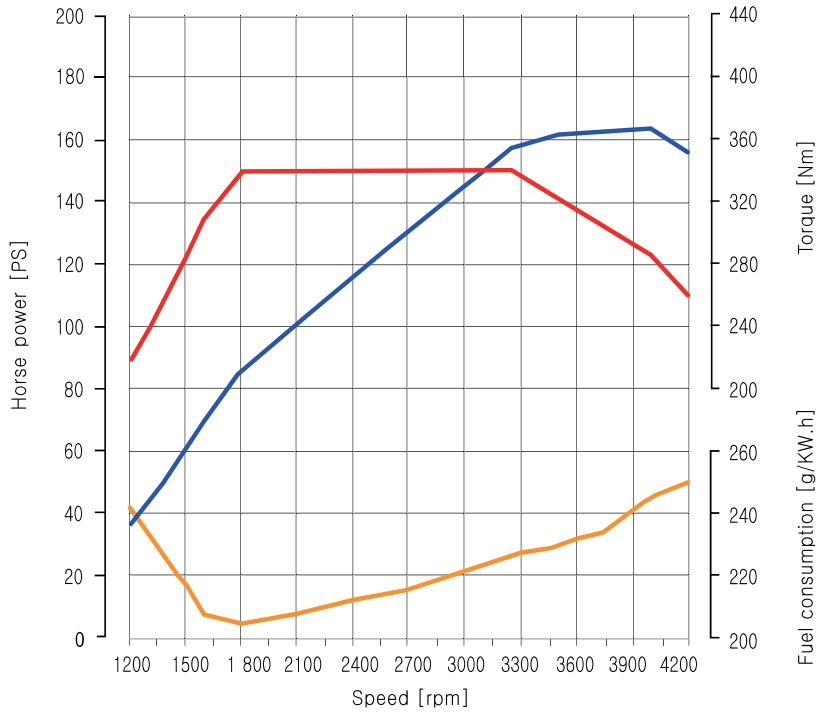
2. ENGINE SPECIFICATIONS AND PERFORMANCE CURVE

1) Specifications

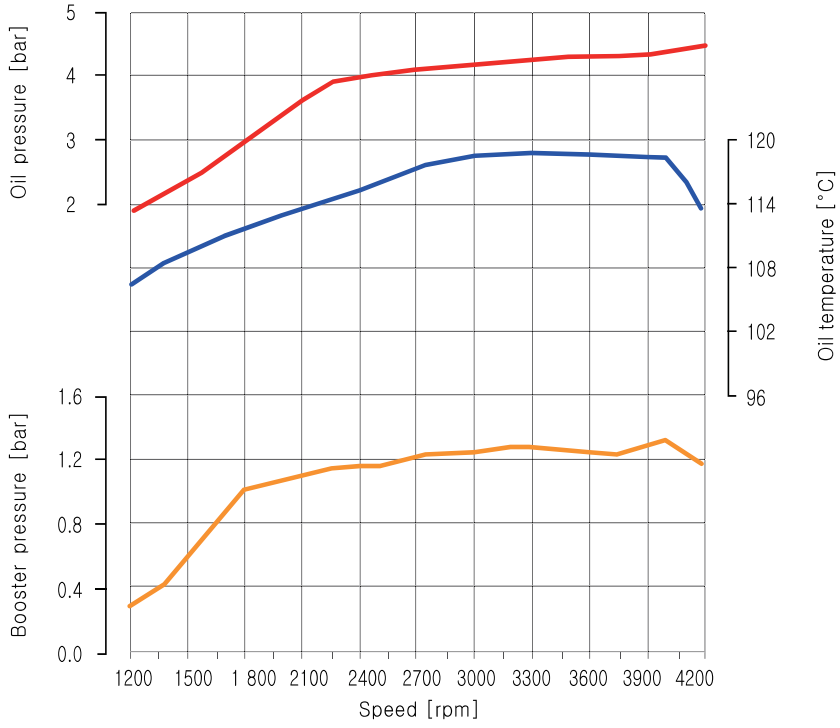
Descriptions			D27DTP (POWER UP) + CDPF Engine * ( ) : CDPF	D27DT (EU IV) Engine	D27DT Engine
Engine	Type/Number of cylinders		D27DT/5-cylinder	←	←
Cylinder	Inner diameter (mm)		86.2	←	←
	Stroke (mm)		92.4	←	←
Displacement (cc)			2696	←	←
Compression ratio			17.5:1	←	←
Maximum output (ps/rpm)		For Automatic	186 (180) / 4,000	165 / 4,000	←
		Transmission	-	165 / 4,000	←
Maximum torque (kg ·m/rpm)		For Manual	41 / 1,600 ~ 3,000	35.7 / 1,800 ~ 3,250	←
		Transmission	-	34.7 / 1,800 ~ 3,250	←
Idle speed	For Manual Transmission		-	750 ± 20 rpm	760 ± 50 rpm
	For Automatic Transmission		750 ± 20 rpm	←	←
Valve	Intake	Opens (btdc)	9°	←	←
		Closes (abdc)	26°	←	←
	Exhaust	Opens (bbdc)	38°	←	←
		Closes (atdc)	16°	←	←
Camshaft	Type		DOHC	←	←
Fuel system	Fuel type		Low sulfur diesel	←	←
	Fuel pump type		Vane pump in HP pump	←	←
	Fuel supply pressure	HP pump Inlet port	-0.4 ~ 0 mbar	Max. 400 mbar	←
		HP pump outlet port (with IMV fully open)	Below 1,600 bar	Above 1,050 bar	←
	Water separation in fuel filter		Every 10,000 km	←	←
	Fuel tank capacity (ℓ)		78	←	←
Lubrication system	Oil specification		SAE 10W40, 5W40 (MB Sheet 229.1, 229.3 approved oil)	←	←
	Lubrication type		Gear pump Forced circulation	←	←
	Oil filter type		Full flow type, filter element type	←	←
	Oil capacity (ℓ)		≒ 8.5	←	←
Cooling system	Cooling type		Water cooling type/ Forced circulation	←	←
	Cooling fan operation type		Belt operated type	←	←
	Thermostat (* Note: Fully opened at 100°C)	Opening temperature	85 °C	←	←
		Type	WAX Pellet Type	←	←
	Coolant capacity (ℓ)		≒ 11.0 ~ 11.5	←	←

2) D27DT Engine Performance Curve

(1) Output and Torque



(2) Oil Temperature/Pressure and Boost Pressure



Modification basis	
Application basis	
Affected VIN	

3. TIGHTENING TORQUE

This table shows the tightening torques for removal/mounting and disassembly/reassemly of the engine.

Name	Size	Quantity	Tightening Torque (Nm)		
			D20DT	D27DT	D27DTP
Main bearing cap	M11 x 67	10	55 ± 5 120° ± 10°	←	←
Connecting rod cap	M9 x 51	8	40 ± 5 90° ± 10°	←	←
Rear cover	M6 x 20	6	10 ± 1	←	←
Oil pump	M8 x 35SOC	3	25 ± 2.5	←	←
T.G.C.C	M6 x 40	6	10 ± 1	←	←
	M6 x 60	3	10 ± 1	←	←
	M6 x 70	2	10 ± 1	←	←
Flywheel	M10 x 22	8	45 ± 5 90° ± 10°	←	←
Crankshaft hub	M20 x 85	1	200 180° ± 10°	←	←
Oil pan	M6 x 20	24	10 ± 1	←	←
	M6 x 35	3	10 ± 1	←	←
	M6 x 85	3	10 ± 1	←	←
	M8 x 40	4	25 ± 2.5	←	←
High pressure pump mounting bolt	M8 x 55	3	25 ± 2.5	←	←
High pressure pump main nut (Intermediate shaft)	M14 x 1.5	1	65 ± 5	←	←
Cylinder head	M8 x 25	2	25 ± 2.5	←	←
	M8 x 50	2			
	M10 x 158	1	85 ± 5 270° ± 10°	←	←
	M10 x 177	9			
Camshaft sprocket (Intake)	M11 x 40	1	25 ± 2.5 90° ± 10°	←	←
Camshaft sprocket (Exhaust)					
Chain tensioner	M24	1	65 ± 5	←	←
Auto tensioner	M12 x 90(UP)	1	82 ± 6	←	←
	M8 x 45(LOW)	1	32 ± 3	←	←
Water pump	M6 x 50	7	10 ± 1	←	←
Water pump pulley	M6 x 10	4	10 ± 1	←	←
Hot water inner pipe	M6 x 12	2	10 ± 1	←	←
Alternator brackrt	M8 x 80	1	25 ± 2.5	←	←
	M8 x 34	2	25 ± 2.5	←	←
	M8 x 30	2	25 ± 2.5	←	←
Alternator	M10 x 90	1	46 ± 4.6	←	←
	M10 x 116	1	46 ± 4.6	←	←

Name	Size	Quantity	Tightening Torque (Nm)		
			D20DT	D27DT	D27DTP
Air conditioner compressor bracket	M8 x 25	1	25 ± 2.5	←	←
	M8 x 60	3	25 ± 2.5	←	←
Air conditioner compressor sub bracket	M6 x 16	1	10 ± 1.0	←	←
	M8 x 20	1	25 ± 2.5	←	←
Intake manifold	M8 x 50	5	25 ± 2.5	←	←
	M8 x 133	5	25 ± 2.5	←	←
Acoustic cover bracket	M6 x 16	2	25 ± 2.5	←	←
	M8 x 105	1	25 ± 2.5	←	←
Knock sensor	M8 x 28	1	20 ± 2.6	←	←
Camshaft position sensor	M8 x 14	1	12 ± 1.7	←	←
Booster pressure sensor	M6 x 20	2	10 ± 1.0	←	←
Exhauster manifold stud bolt	M8 x 46	10	15 ± 1.5	←	←
	M8 x 35	2	15 ± 1.5	←	←
Exhaust manifold nut	M8	10	40 ± 4.0	←	←
Turbo charger assembly	M8	3	25 ± 2.5	←	←
Turbo charger hollow bolt	M10 x 1.0	1	18 ± 1.8	←	15 ± 1.0
Turbo charger oil supply pipe	M16 (BLOCK side)	1	25 ± 2.5	←	←
Turbo charger support bar (nut)	M8	1	23 ± 2.3	←	←
Turbo charger support bar (bolt)	M8 x 20	1	25 ± 2.5	←	←
Turbo charger return pipe	M6 x 16 (T/C side)	2	10 ± 1.0	←	←
	M6 x 16 (BLOCK side)	2	10 ± 1.0	←	←
EGR Valve	M6 x 16	4	10 ± 1.0	←	-
EGR pipe (RH) nut	M8	2	35 ± 3.5	←	-
EGR pipe (RH) bolt	M6 x 16	2	10 ± 1.0	←	-
EGR cooler bolt	M8 x 16	4	25 ± 1.0	←	-
EGR valve & EGR cooler	M6 x 20	3	25 ± 2.5	←	-
	M6 x 20	2	25 ± 2.5	←	-
Glow plug	M5	5	15 ± 3.0	←	←
Vacuum pump	M6 x 20	3	10 ± 1.0	←	←
Cooling pan bracket	M6 x 25	5	10 ± 1.0	←	←
	M6 x 55	1	10 ± 1.0	←	←
	M6 x 85	3	10 ± 1.0	←	←
Cylinder head cover	M6 x 35	21	10 ± 1.0	←	←
Vacuum modulator	M6 x 16	4	10 ± 1.0	←	←
Oil dipstick gage	M6 x 16	1	10 ± 1.0	←	←
Oil filter	M8 x 35	1	25 ± 2.5	←	←
	M8 x 55	2	25 ± 2.5	←	←
	M8 x 125	1	25 ± 2.5	←	←

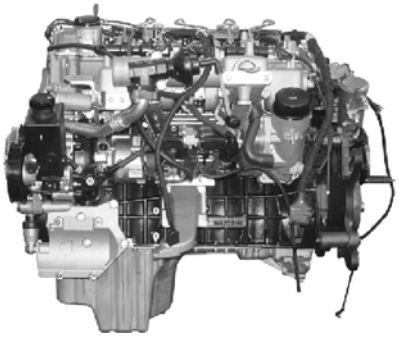
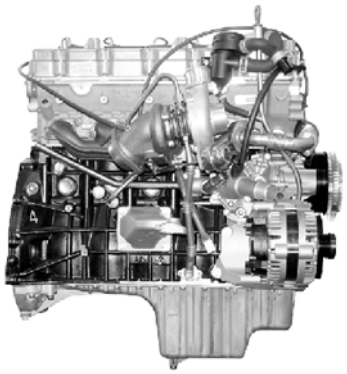
Modification basis	
Application basis	
Affected VIN	

Name	Size	Quantity	Tightening Torque (Nm)		
			D20DT	D27DT	D27DTP
Fuel rail	M8 x 35	2	25 ± 2.5	←	←
Injector	M6 x 60	4	10 ± 1.0 180° ± 20°	←	←
Fuel pipe nut (H -> C)	M14	2	40 ± 4.0	←	←
Fuel pipe nut (C -> I)	M14	8	40 ± 4.0	←	←
Crank position sensor	M6 x 14	1	0.8 ± 0.4	←	←
	Gap	-	0.7 ± 1.5 mm	←	←
Power steering pump	M8 x 100	2	25 ± 2.5	←	←
Head screw plug	-	1	25 ± 2.5	←	←
Camshaft cap bolt	M8 x 60	20	25 ± 2.5	←	←
Piston topping	-	-	0.765 mm ~ 1.055 mm		
Connecting rod end play	-	-	0.500 mm ~ 1.500 mm		
Camshaft end play	-	-	0.100 mm ~ 0.350 mm		
Crank shaft end play	-	-	0.100 mm ~ 0.254 mm		
E-EGR valve assembly	M8 x 60	1	-	25 ± 2.5 (EU IV)	←
	M8 x 35	1	-	25 ± 2.5 (EU IV)	←
	M6 x 20	3	-	10 ± 1.0 (EU IV)	←
E-EGR cooler	M8 x 16	4	-	25 ± 2.5 (EU IV)	←
EGR pipe combination bolt	M6 x 16	6	-	10 ± 1.0 (EU IV)	←
Throttle body	M6 x 45	3	-	10 ± 1.0 (EU IV)	←

4. MAJOR CHANGES IN D27DTP (POWER UP) ENGINE (COMPARED TO D27DT)

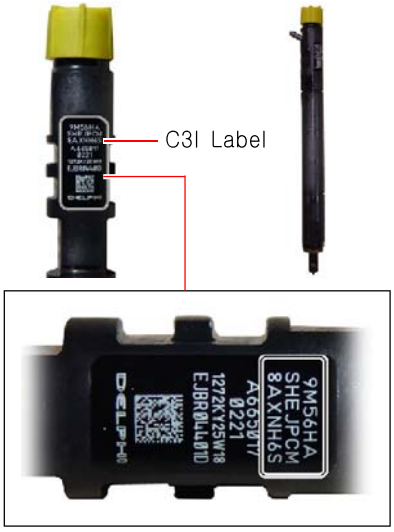
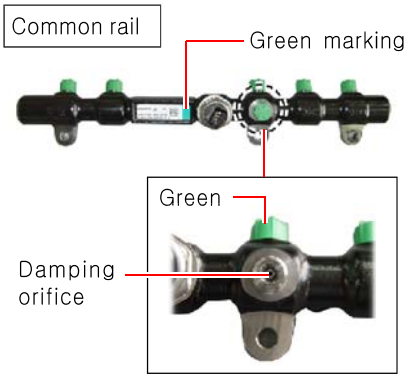
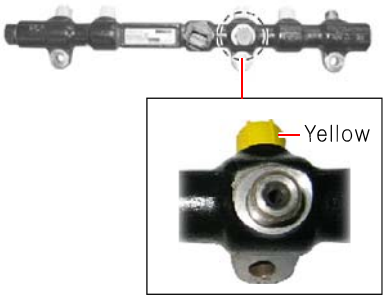
The shape and size of D27DTP (POWER UP) are slightly different from those of D27DT engine but the basic configuration of two systems is almost same.

1) Engine Assembly

D27DTP (POWER UP) + CDPF Engine	D27DT (EU IV) Engine	D27DT Engine (General)
Front Side View 		
Right Side View 		
Left Side View 		

Modification basis	
Application basis	
Affected VIN	

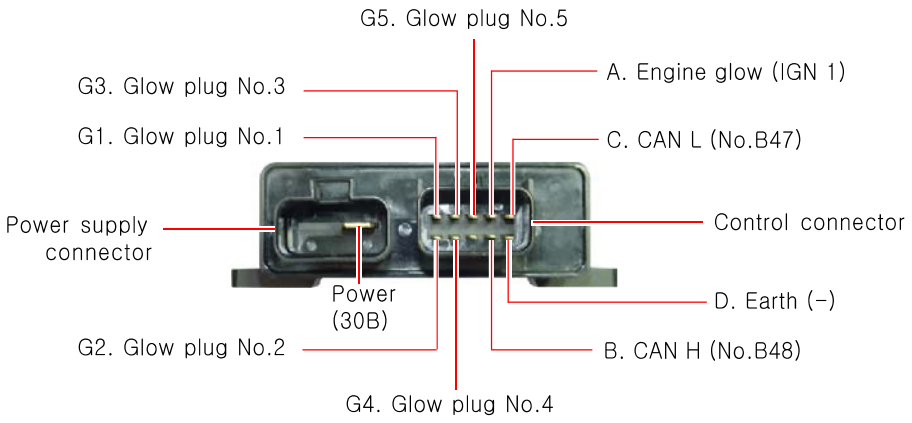
2) Major Changes and Summary

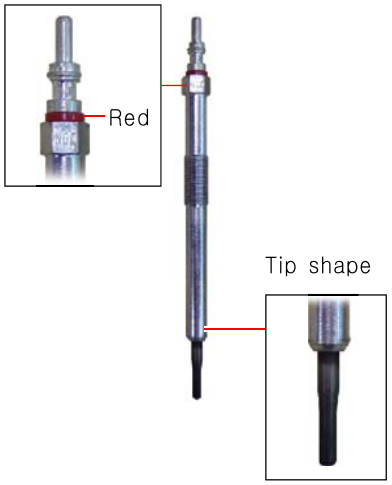
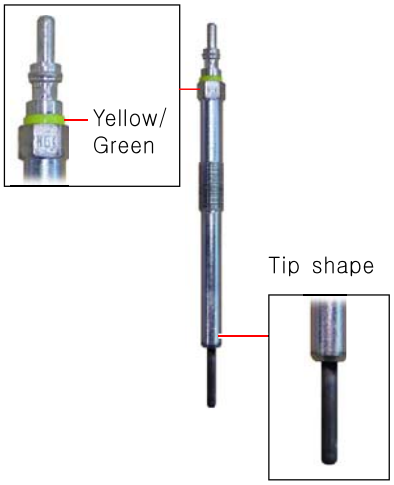
D27DTP (POWER UP) + CDPF Engine D27DT (EU IV) Engine	D27DT Engine (General)	Remarks
ECU D27DTP Engine ECU - Ver. 3.2  	D27DT Engine ECU - Ver. 3.1  	ECU version of D27DTP (POWER UP) & D27DT (EU IV) engine: Changed to 3.2 from 3.1. Number of connectors of D27DTP (POWER UP) & D27DT (EU IV) engine: Changed to 2 from 1. 1.E-EGR valve and related system 2.Throttle body and related system 3.AQGS and related system
Injector 		* Injection nozzle (holes) - D27DT (General) (5) - D27DTP & D27DT (EU IV) (7) * Injector label - D27DT (General) (16 digits: C2I value) - D27DTP & D27DT (EU IV) (20 digits: C3I value)
Common rail 		* D27DTP: Added damping orifice. (Orifice is added to fuel inlet/ outlet ports in order to dampen the pulsation in fuel flow caused by multi-injections.)

Modification basis	
Application basis	
Affected VIN	

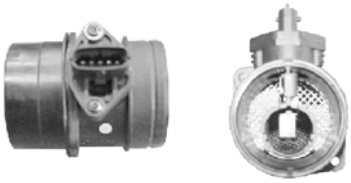
D27DTP (POWER UP) + CDPF Engine D27DT (EU IV) Engine	D27DT Engine (General)	Remarks
Fuel pipe 		* Surface coating color - D27DT: Yellow - D27DTP & D27DT (EU IV): Chrome * Diameter increased - D27DT: ID (2.4 mm), OD (6.0 mm) - D27DTP & D27DT (EU IV): ID (3 mm), OD (6.35 mm)

AQGS unit pin function

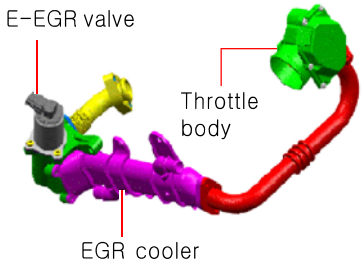
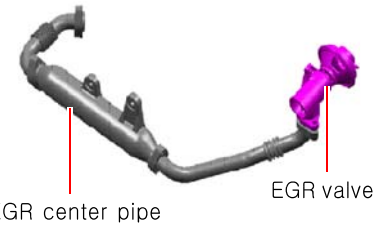
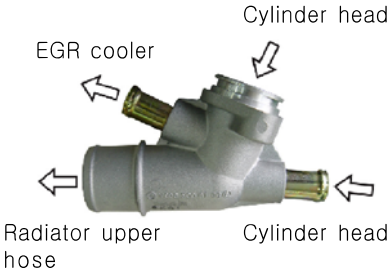
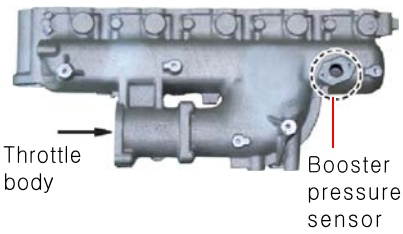
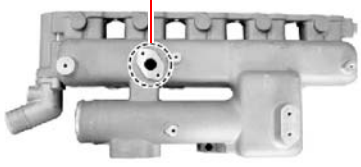
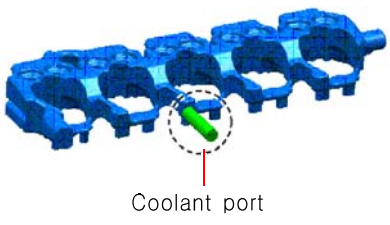


Glow plug 		* Insulator color - D27DT: Yellow (NGK) or green (BERU) - D27DTP & D27DT (EU IV): Red * Tip diameter and shape changed - D27DT: ϕ 3.5 / 4.0 mm - D27DTP & D27DT (EU IV): ϕ 4.4 mm

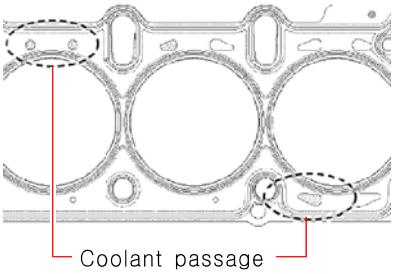
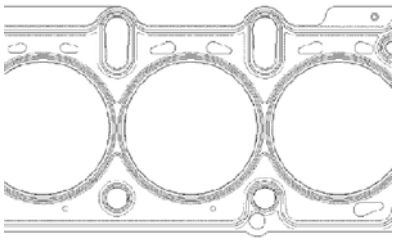
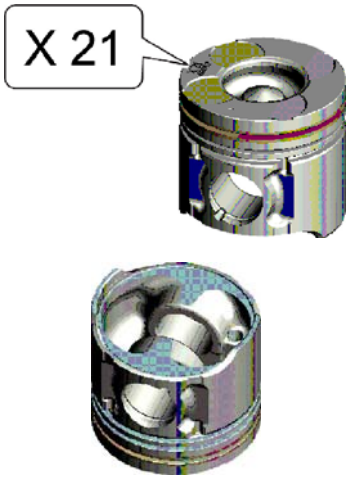
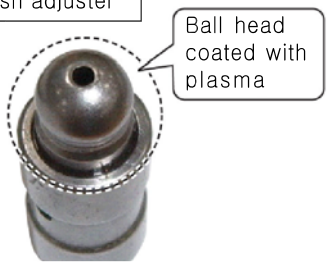
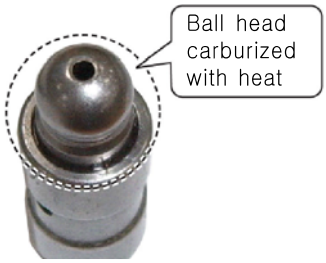
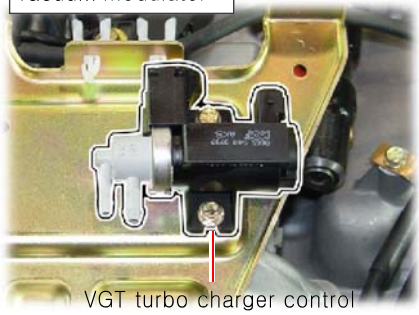
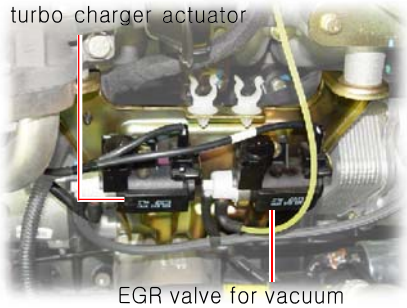
Modification basis	
Application basis	
Affected VIN	

D27DTP (POWER UP) + CDPF Engine D27DT (EU IV) Engine	D27DT Engine (General)	Remarks
HFM 6.0 	HFM 5.0 	* Version up - D27DT (General): HFM5-CI (Analog signal) - D27DTP & D27DT (EU IV): HFM6-ID (Digital signal added)
Electric controlled E-EGR valve 	Vacuum modulator controlled EGR valve 	* E-EGR valve: ECU controls the EGR valve directly without any media. It provide more precise EGR control by transmitting the electric signal of EGR valve operating position.
Throttle body 	N/A	* Throttle body is for future regulation requiring emission reductions. Currently, it is used to prevent the engine from turning off with fluttering noise at the moment the air to intake manifold is blocked by closed flap when the engine is switched off.
EGR cooler EGR Gas  Coolant	EGR center pipe  EGR Gas	* To enhance EGR function, coolant EGR cooler is adopted to reduce the temperature of exhaust gas into the intake manifold.

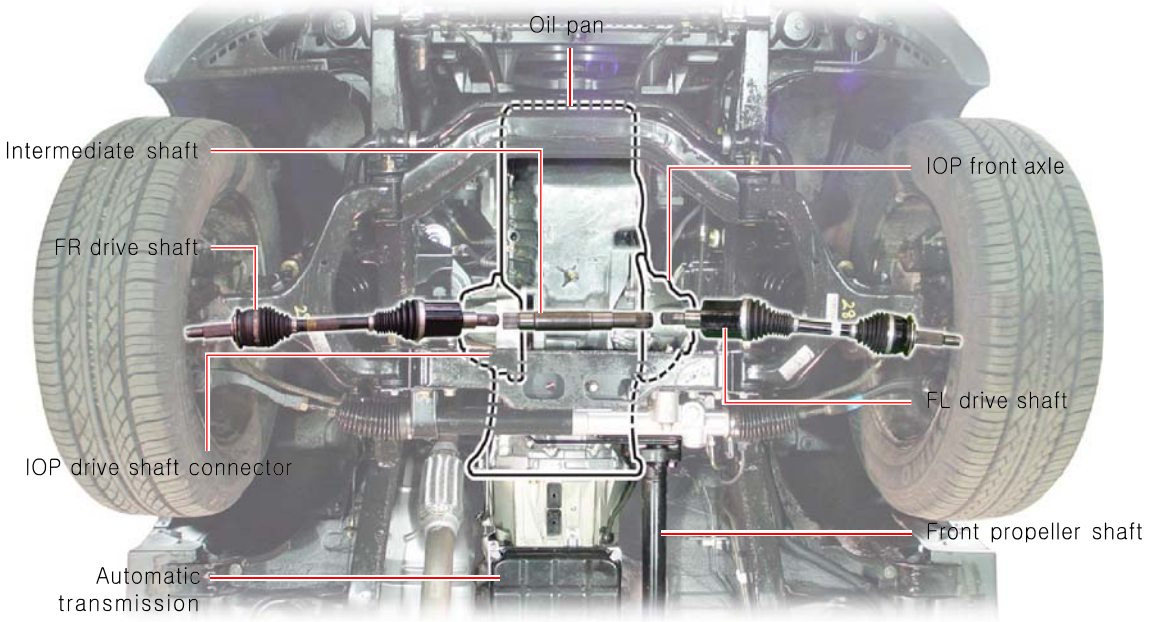
Modification basis	
Application basis	
Affected VIN	

D27DTP (POWER UP) + CDPF Engine D27DT (EU IV) Engine	D27DT Engine (General)	Remarks
E-EGR system layout  	EGR system layout  	* Reason of changes – To satisfy the emission regulation, E-EGR valve and EGR cooler are adopted. And the layout also has a great difference from D27DT.
Water pump  		* For D27DTP engine: Additional connecting port for EGR cooler hose
Coolant outlet port  		* For D27DTP (POWER UP) engine: Additional port for coolant of EGR cooler
Intake manifold  	Booster pressure sensor 	* The appearance of intake manifold is changed to the round type due to the throttle body. Also, the mounting location of booster pressure sensor is changed.
Cylinder head  		* The cooling port is added to improve cooling performance for D27DTP (POWER UP) & D27DT (EU IV) engine.

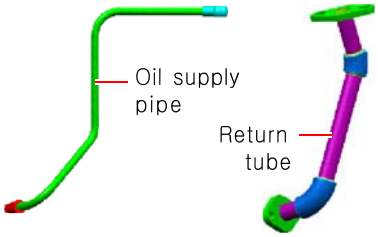
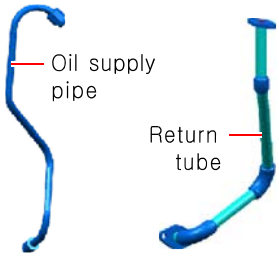
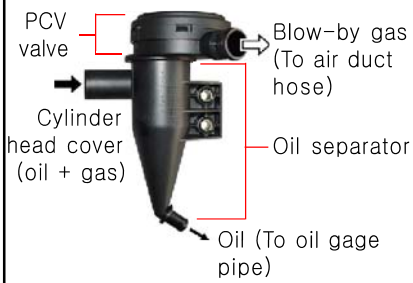
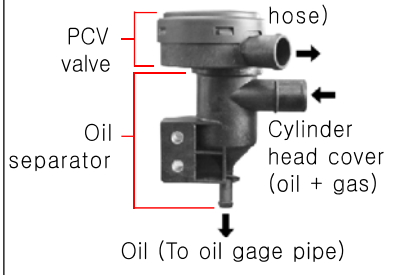
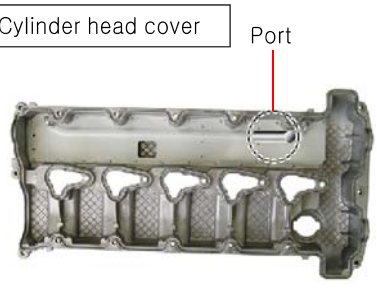
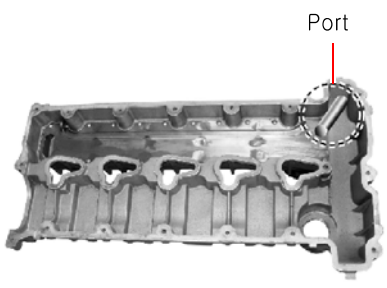
Modification basis	
Application basis	
Affected VIN	

D27DTP (POWER UP) + CDPF Engine D27DT (EU IV) Engine	D27DT Engine (General)	Remarks
Cylinder head gasket  		* The appearance of gasket is changed and the coolant passages are added to improve cooling performance for D27DTP (POWER UP) & D27DT (EU IV) engine.
Piston  	 	* Changed compression ratio - D27DT (General) (18:1) - D27DTP & D27DT (EU IV) (17.5:1) (The appearance of bowl is changed and the color mark is added due to the new compression ratio.) * The appearance fo bowl is changed and the color mark is added due to the new com-pression ratio (18 → 17.5). * The piston pin bending side and the appearance of piston pin hole taper is changed for reinforcement.
Lash adjuster  	 	* The ball head is coated with plasma to prevent the lash adjuster from wearing.
Vacuum modulator  	Vacuum modulator for controlling turbo charger actuator  	* D27DTP (POWER UP) & D27DT (EU IV) engine uses electric ally controlled E-EGR valve. Thus, the vacuum modulator for controlling EGR valve has been deleted.

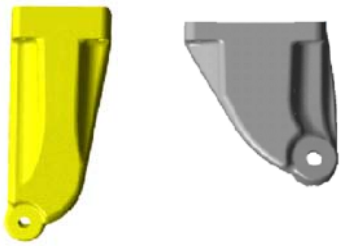
Modification basis	
Application basis	
Affected VIN	

D27DTP (POWER UP) + CDPF Engine	D27DT Engine (General) D27DT (EU IV) Engine	Remarks
IOP oil pan 	Oil pan 	* The vehicle with D27DTP (POWER UP) engine is equipped with IOP axle. Refer to the figure below.
Glow system- AQGS unit 	Glow system - Glow control relay 	* D27DTP (POWER UP) engine adopts AQGS (Advanced Quick Glow System), which controls the quick preheating of glow plugs and CAN communication with engine ECU.
		
VGT turbocharger 	WGT turbocharger 	* D27DTP (POWER UP) engine is equipped with the enhanced VGT turbocharger.

Modification basis	
Application basis	
Affected VIN	

D27DTP (POWER UP) + CDPF Engine	D27DT Engine (General) D27DT (EU IV) Engine	Remarks
1.Support bar of Turbocharger 		* Support bar is changed due to VGT turbocharger mounting.
2.Oil supply pipe and return tube of Turbocharger 		* The shape of oil supply pipe and return tube is changed due to VGT turbocharger mounting.
PCV oil separator  	 	* Increase of Oil separator capacity (approx. 10%) - D27DT & D27DT (EU IV): 120ℓ/min - D27DTP: 160ℓ/min
Cylinder head cover 		* The direction of blow-by outlet port is changed due to the introduction of larger oil separator.

Modification basis	
Application basis	
Affected VIN	

D27DTP (POWER UP) + CDPF Engine	D27DT Engine (General) D27DT (EU IV) Engine	Remarks
Switchable engine mounting 	Engine mounting 	* The switchable engine mounting system (SEM) controls the engine in soft mode or hard mode by dividing the speed to the low speed range and mid-high speed range according to the vehicle speed and the engine rpm. This is only available in D27DTP (POWER UP) engine.
Engine bracket LH RH 	LH RH 	* The bracket is changed due to the mounting location of D27DTP (POWER UP) engine and the switchable engine mounting.

Modification basis	
Application basis	
Affected VIN	

5. GUIDELINES FOR SERVICE WORKS

1) For Safety





To perform the service works easily and safely, the service technicians must keep the proper working procedures and rules.
This manual provides the useful instructions to the service technicians so that they can perform the service works with standard working process, skills, tips in time.
Please read this manual and follow the instructions carefully.

Signal words such as “CAUTION” and “NOTE” have special meanings.

NOTE
indicates information to assist maintenance and instructions.

WARNING
indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION
indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury or property damage.

However, above references and cautions cannot be inclusive measures, so should have habits of paying attentions and cautions based on common senses.

2) Cautions on Service Procedures

1. Before lifting up the vehicle with a lift, correctly support the lifting points.
2. When using a jack, park the vehicle on a level ground and place the wheel chocks under the tires. Position the jack under the frame and lift up the vehicle and then support with chassis stand before service work.
3. Make sure to disconnect the negative (-) cable from the battery to prevent any damage to electric systems.
4. If you have to work on vehicle, cover the seats and floor with protection covers to avoid any damage and contamination.
5. Brake fluid and anti-freeze can damage the painted surface of body. So carefully handle them during service work.
6. To improve the efficiency of service work, use only recommended and specified tools.
7. Use only Ssangyong genuine spare parts.
8. Never reuse the cotter pin, gasket, O-ring, oil seal, lock washer and self-locking nut. Replace them with new ones. If reused, normal functions cannot be maintained.
9. Store the disassembled parts as a set based on disassembly order and unit.
10. Pay particular attention not to miss or mix the fasteners.
11. If necessary, especially for inspection, clean the removed parts completely.
12. Apply the oil or grease on the running and sliding surfaces before installation. Use the specified sealant and gasket to prevent leakage if necessary.
13. Tighten the fasteners with the specified tightening torque.
14. As a final stage of service work, check if the serviced system is working properly and the problem has been eliminated clearly.

Modification basis	
Application basis	
Affected VIN	

3) 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 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 is 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.

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.

▶Electrical equipment

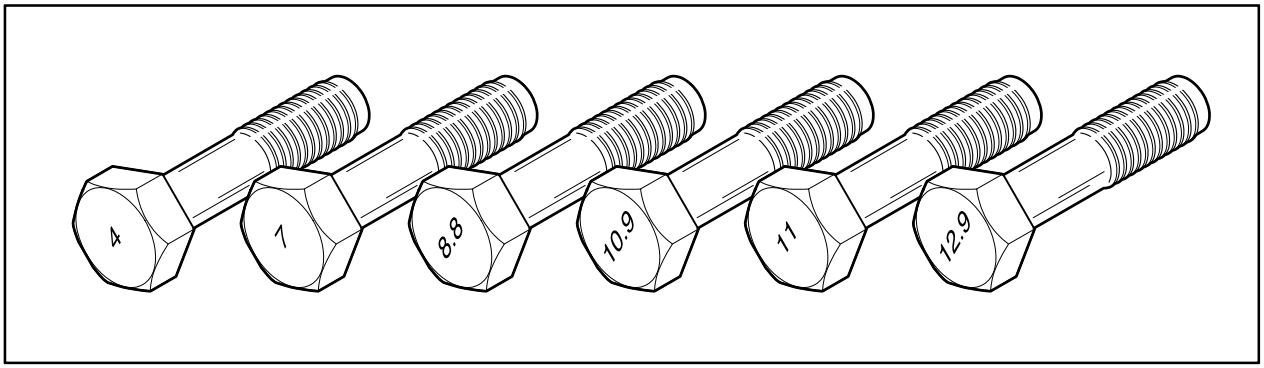
Electric devices should be handled more carefully.
Currently, the engine has a lot of electric devices. There could be poor engine performance, incomplete combustion and other abnormal symptoms due to short circuit or poor contact.

- Before work on engine and 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 makes cause a fire and personal injury.

Modification basis	
Application basis	
Affected VIN	

6. 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.
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.
   - Aluminum alloy: Tighten to 80 % of above torque table.
   - Plastics: Tighten to 20 % of above torque table.

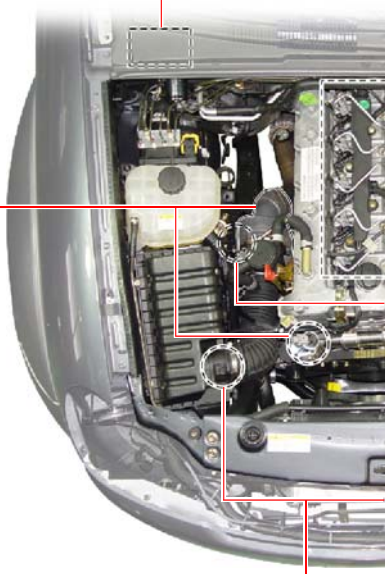
OVERVIEW AND OPERATION PROCESS

1. ENGINE COMPARTMENT

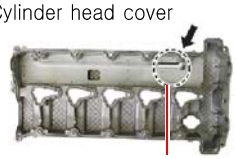
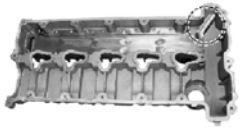
The major changes due to the newly adopted engine compared to D27DT engine are as follows:

Intake System	
D27DTP & D27DT (EU IV)	D27DT
HFM sensor (Ver. 6.0) 	Throttle body 

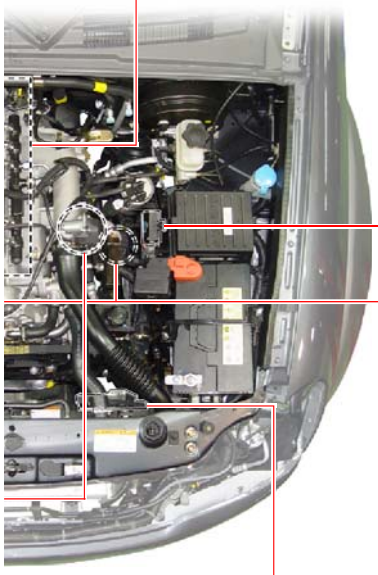
Engine Control (Engine ECU-3.2)	
D27DTP & D27DT (EU IV)	D27DT
 Connector A Connector B	 Connector A Connector B



Exhaust System		
VGT turbo charger	E-EGR valve	EGR cooler
		

Lubrication System		
D27DTP Cylinder head cover  Modification in blow-by gas outlet port	Larger PCV oil separator 	OP oil pan  * Axle integral type
D27DT (EU IV) & D27DT 		

Modification basis	
Application basis	
Affected VIN	



Fuel System

D27DTP & D27DT (EU IV)

Injector



D27DTP & D27DT (EU IV)

Fuel pipe



D27DTP & D27DT (EU IV)

Common rail



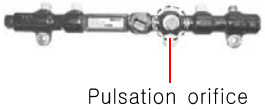
D27DT



D27DT



D27DT



Preheat System

AQGS unit



D27DTP & D27DT (EU IV)

Glow plug



D27DT



Switchable Engine M ounting (SEM)

D27DTP

LH



RH



D27DT (EU IV) & D27DT



Cooling System

D27DTP & D27DT (EU IV)

Large water pump



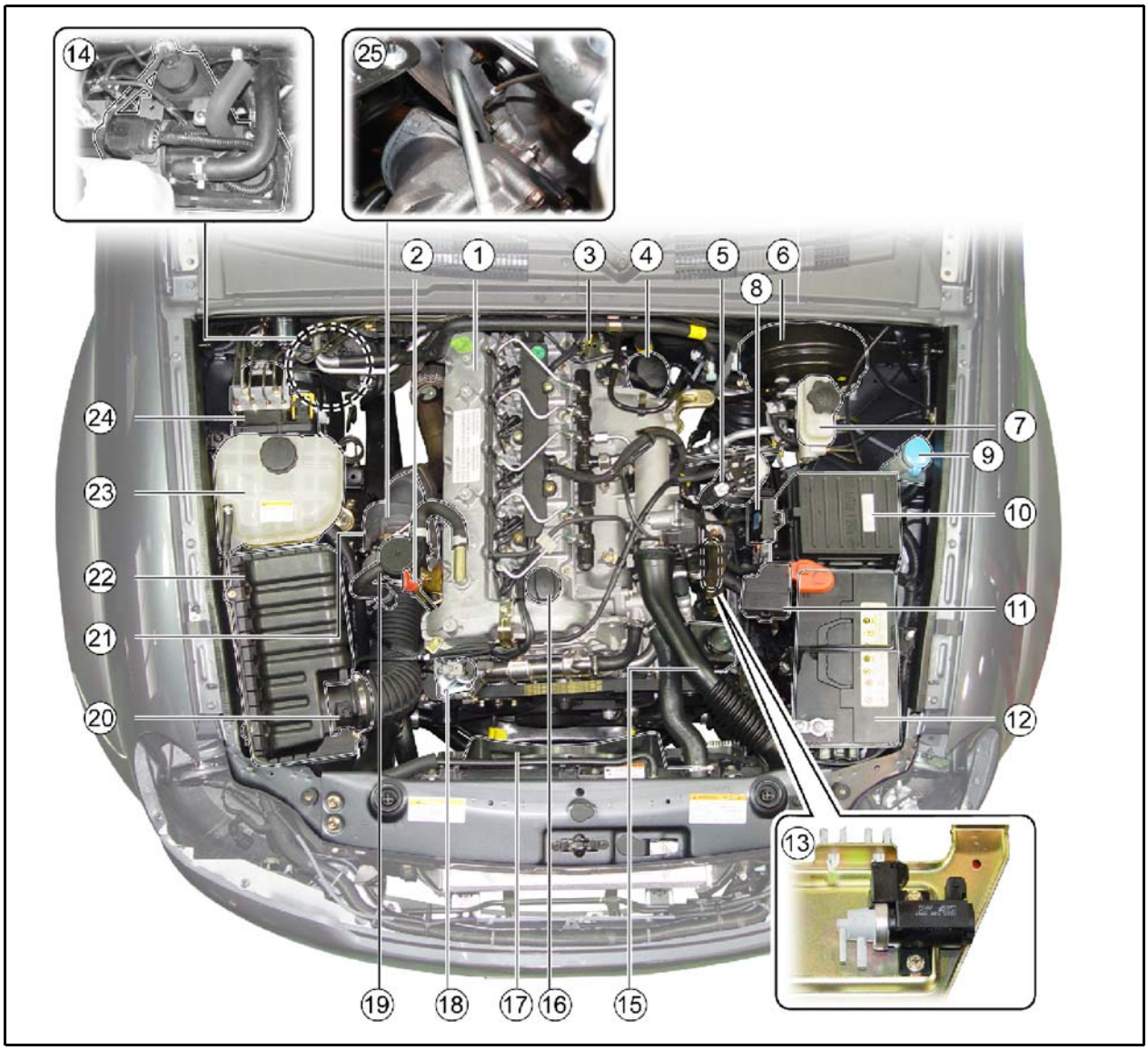
* EGR cooler port included

D27DT



Modification basis	
Application basis	
Affected VIN	

▶ Engine Compartment Layout



1. Engine assembly
2. Engine oil dipstick
3. Vacuum pump
4. Oil filter and cooler
5. Fuel filter and priming pump
6. Brake booster
7. Brake oil tank
8. AQGS unit
9. Washer fluid filler cap
10. Engine compartment fuse box
11. PTC relay box
12. Battery
13. Vacuum modulator (for VGT turbo charger)
14. FFH Assembly (Only for vehicle with FFH)
15. Power steering oil tank
16. Engine oil filler cap
17. Fan shroud
18. E-EGR Valve
19. High-capacity PCV oil separator
20. HFM sensor (6.0)
21. VGT turbo charger
22. Air cleaner housing
23. 2Coolant surge tank
24. ABS/ESP HECU (Including TPMS function: optional)
25. Exhaust gas FRT Temp. sensor (T3)

Modification basis	
Application basis	
Affected VIN	

▶ Major Sensors and Components

Injector

D27DTP & D27DT (EU IV)



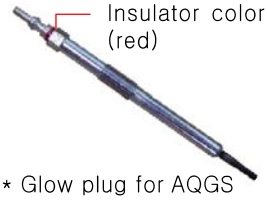
* 2 additional injection holes (currectly 7 holes)

D27DT



Glow Plug

D27DTP & D27DT (EU IV)



* Glow plug for AQGS (quick preheat)

D27DT



Common Rail

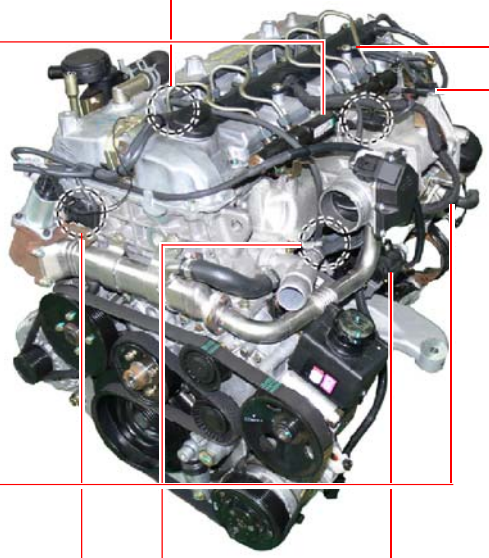
D27DTP & D27DT (EU IV)



* Orifice for preventing fuel pulsation

D27DT





Fuel Pressure Sensor (Common Rail)



Booster Pressure Sensor



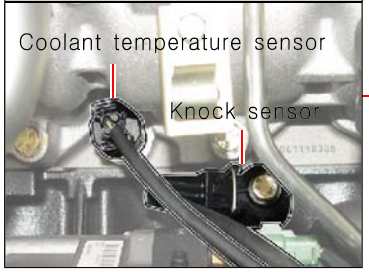
Crankshaft Position Sensor



Camshaft Position Sensor



Knock Sensor (2EA) & Coolant Temperature Sensor



Vacuum Modulator for VGT Turbo Charger

D27DTP & D27DT (EU IV)



* Vacuum modulator for EGR valve deleted

D27DT



D27DTP

VGT Turbo Charger



D27DT (EU IV) & D27DT

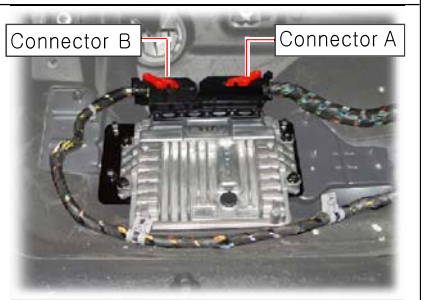
WGT Turbo Charger

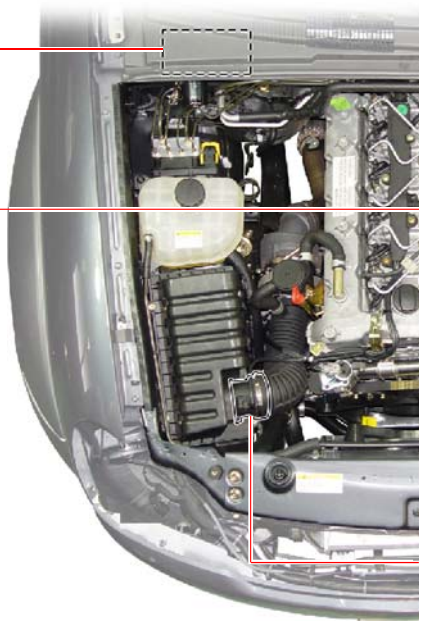


Modification basis	
Application basis	
Affected VIN	

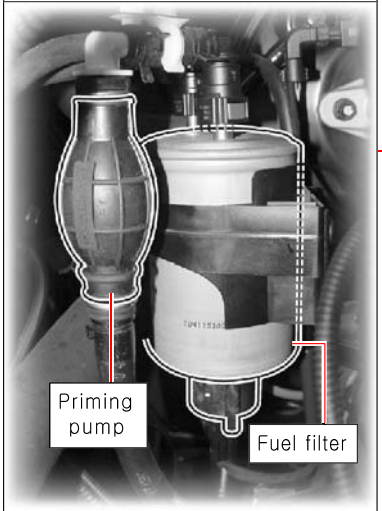
2. SYSTEMS IN ENGINE COMPARTMENT

1) Engine Accessories Related to ECU

Engine ECU – Ver. 3.2	Engine ECU Mounting Location
D27DTP & D27DT (EU IV) 	
D27DT 	



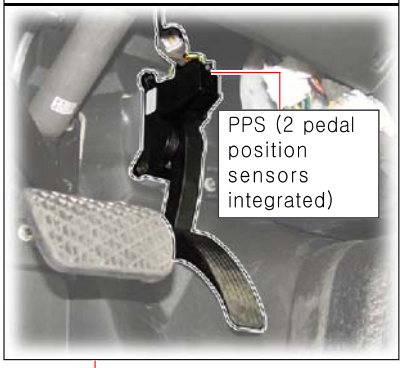
Fuel Filter (Water Detecting) Seneor



Draining water from fuel filter: every 10,000 km

Modification basis	
Application basis	
Affected VIN	

Accelerator Pedal Module

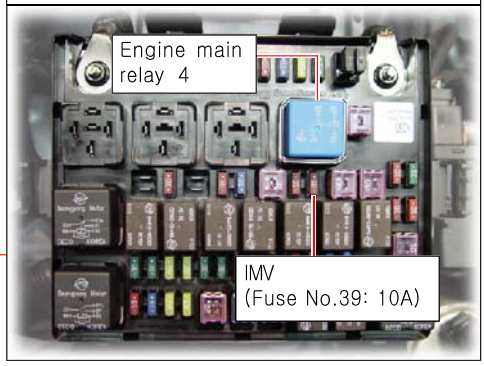


Interior Fuse Box (Driver's Side)





Engine Compartment Fuse Box



HFM Sensor (Ver. 6.0)

D27DTP & D27DT (EU IV)





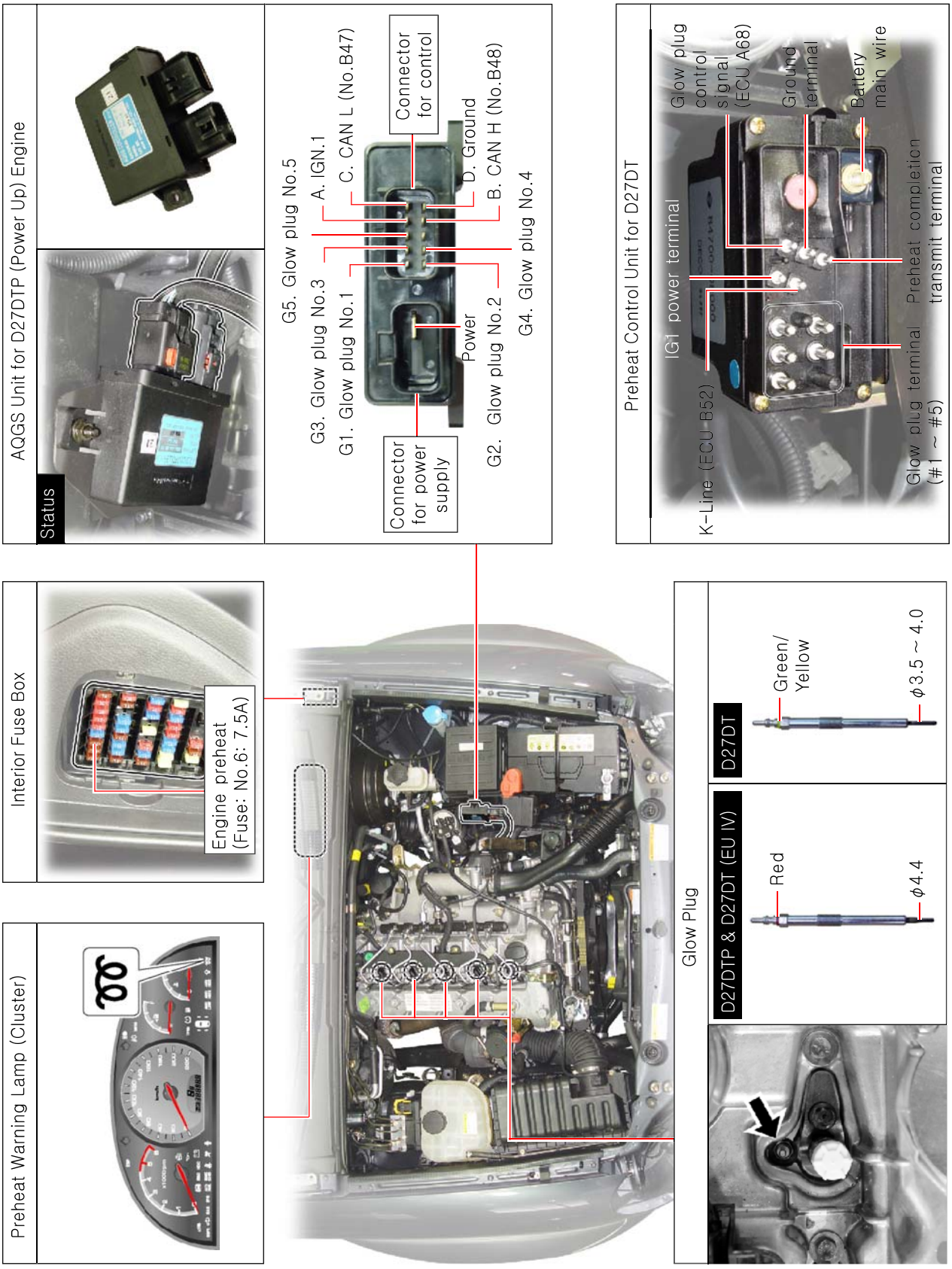
Additional function: The digital signal about intake air volume is transfered to control the engine precisely.

D27DT



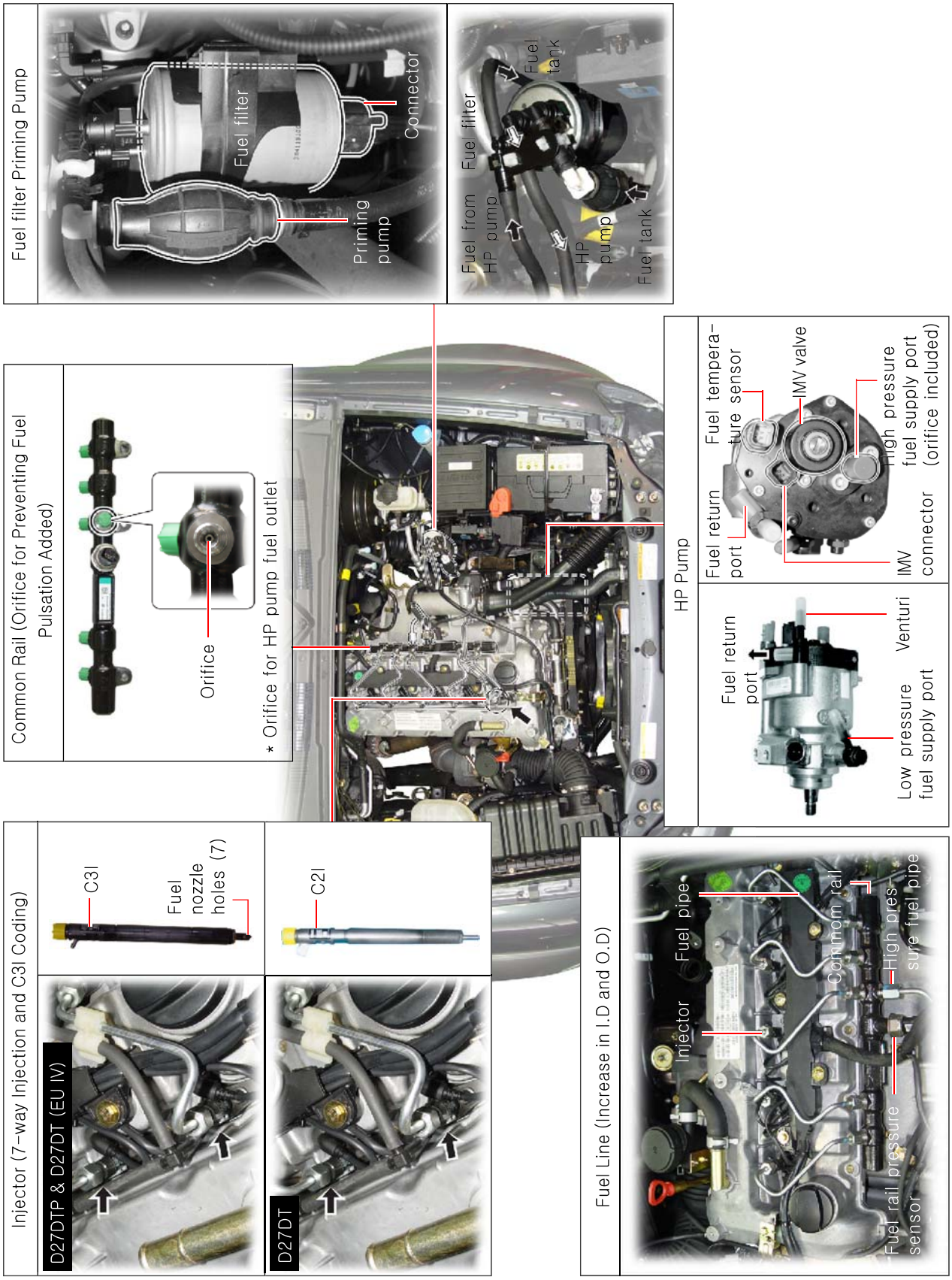


2) Preheat System



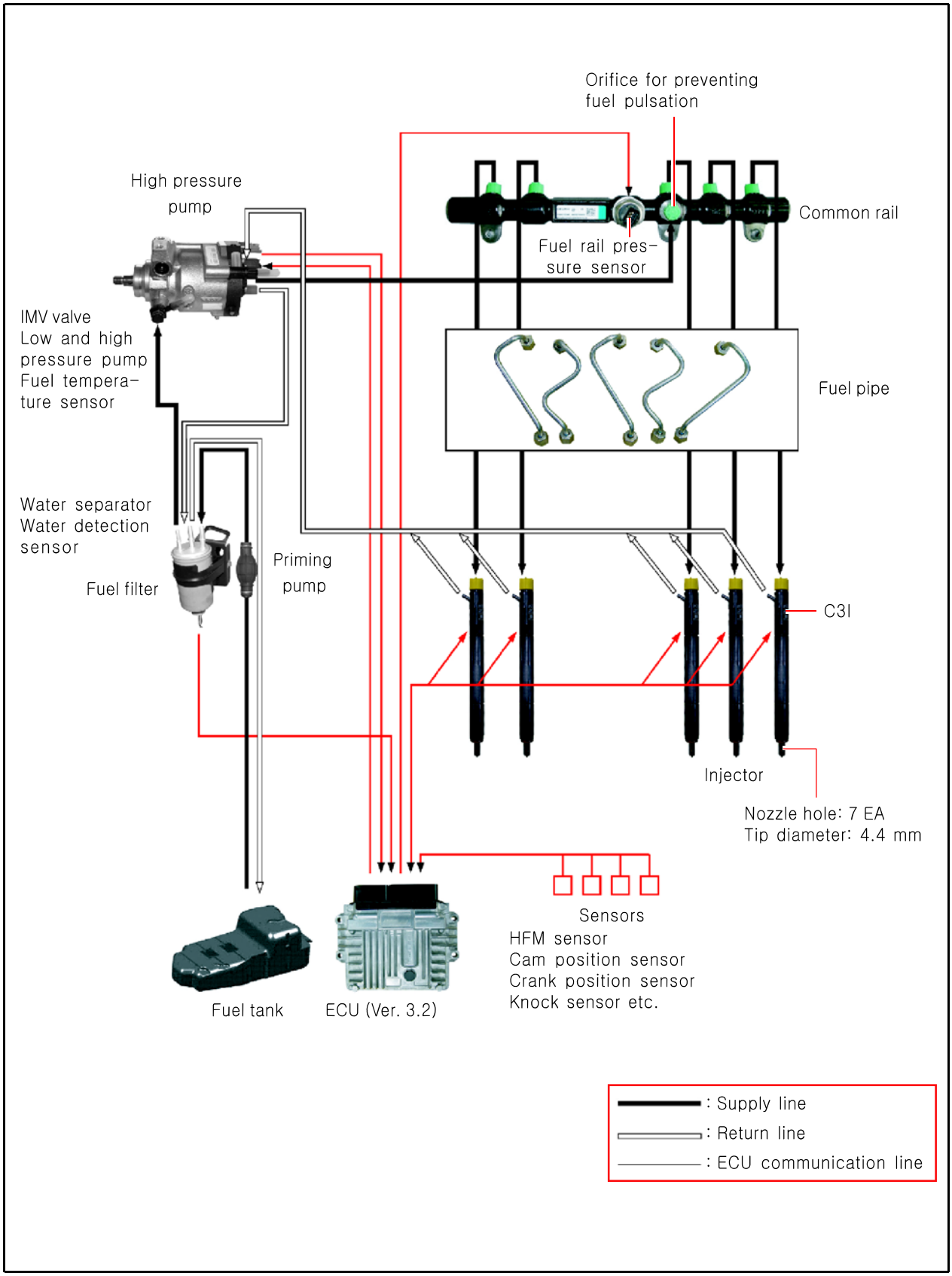
Modification basis	
Application basis	
Affected VIN	

3) Fuel System



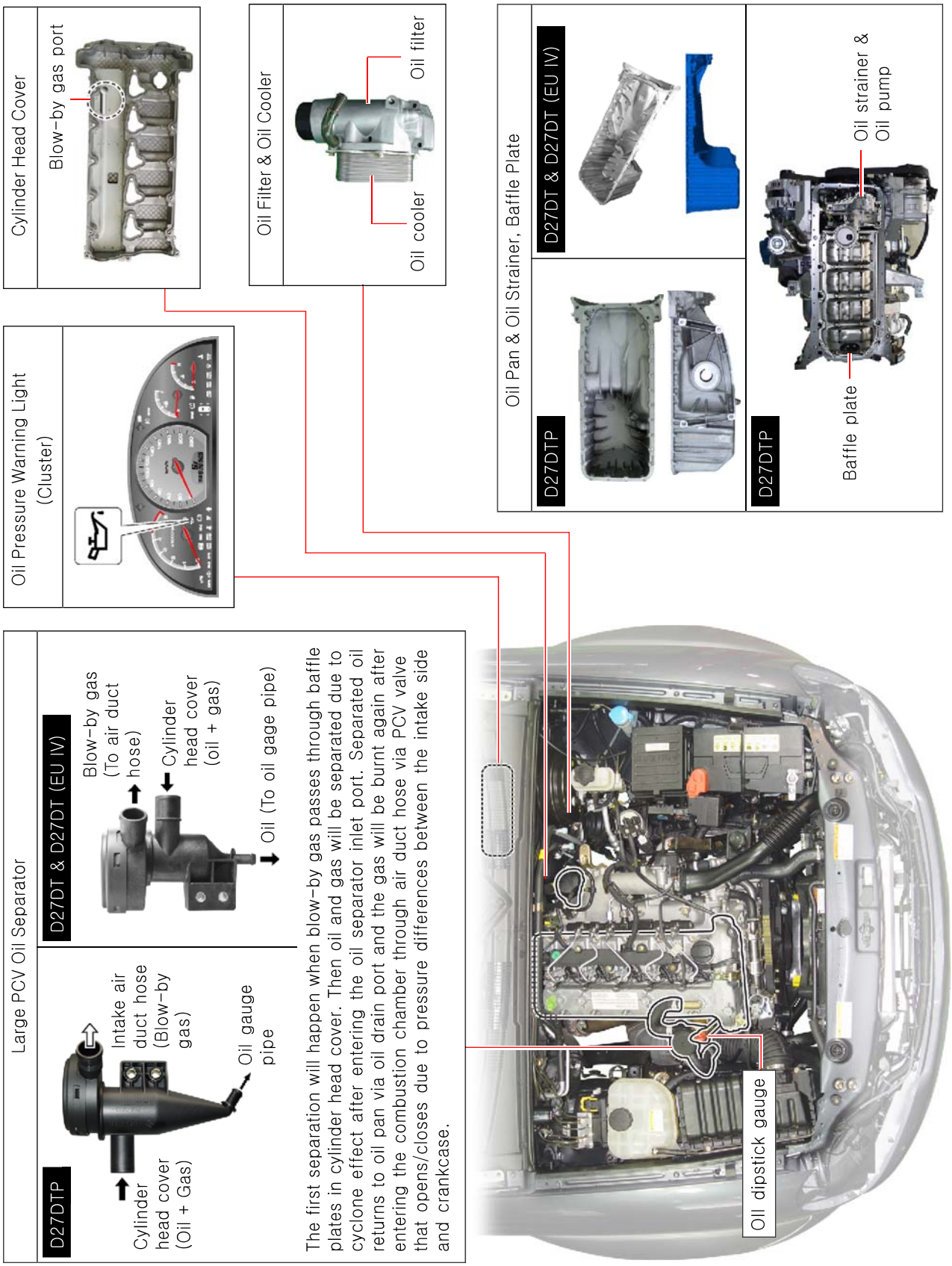
Modification basis	
Application basis	
Affected VIN	

▶ Fuel Supply System



Modification basis	
Application basis	
Affected VIN	

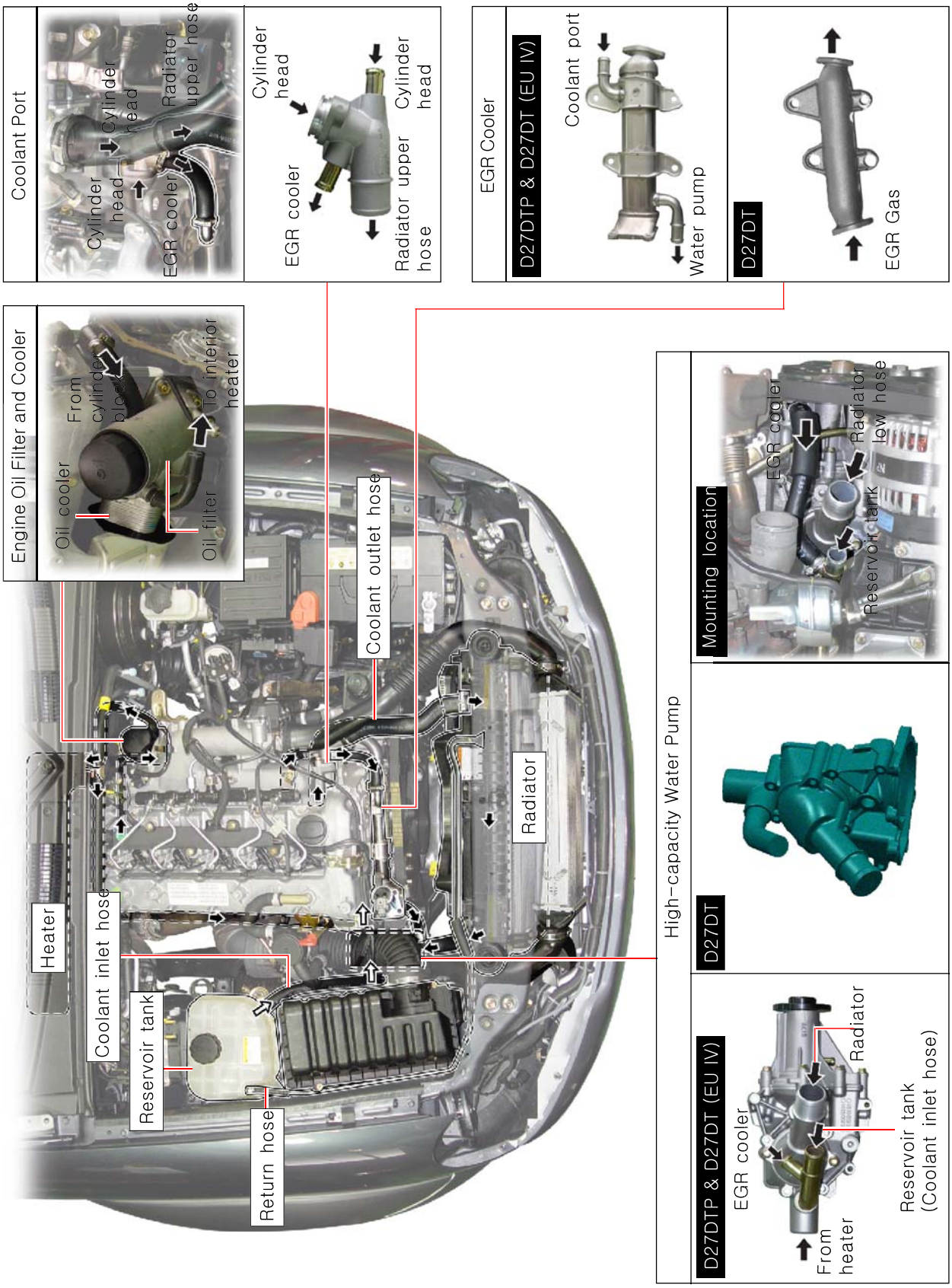
4) Lubrication System



The first separation will happen when blow-by gas passes through baffle plates in cylinder head cover. Then oil and gas will be separated due to cyclone effect after entering the oil separator inlet port. Separated oil returns to oil pan via oil drain port and the gas will be burnt again after entering the combustion chamber through air duct hose via PCV valve that opens/closes due to pressure differences between the intake side and crankcase.

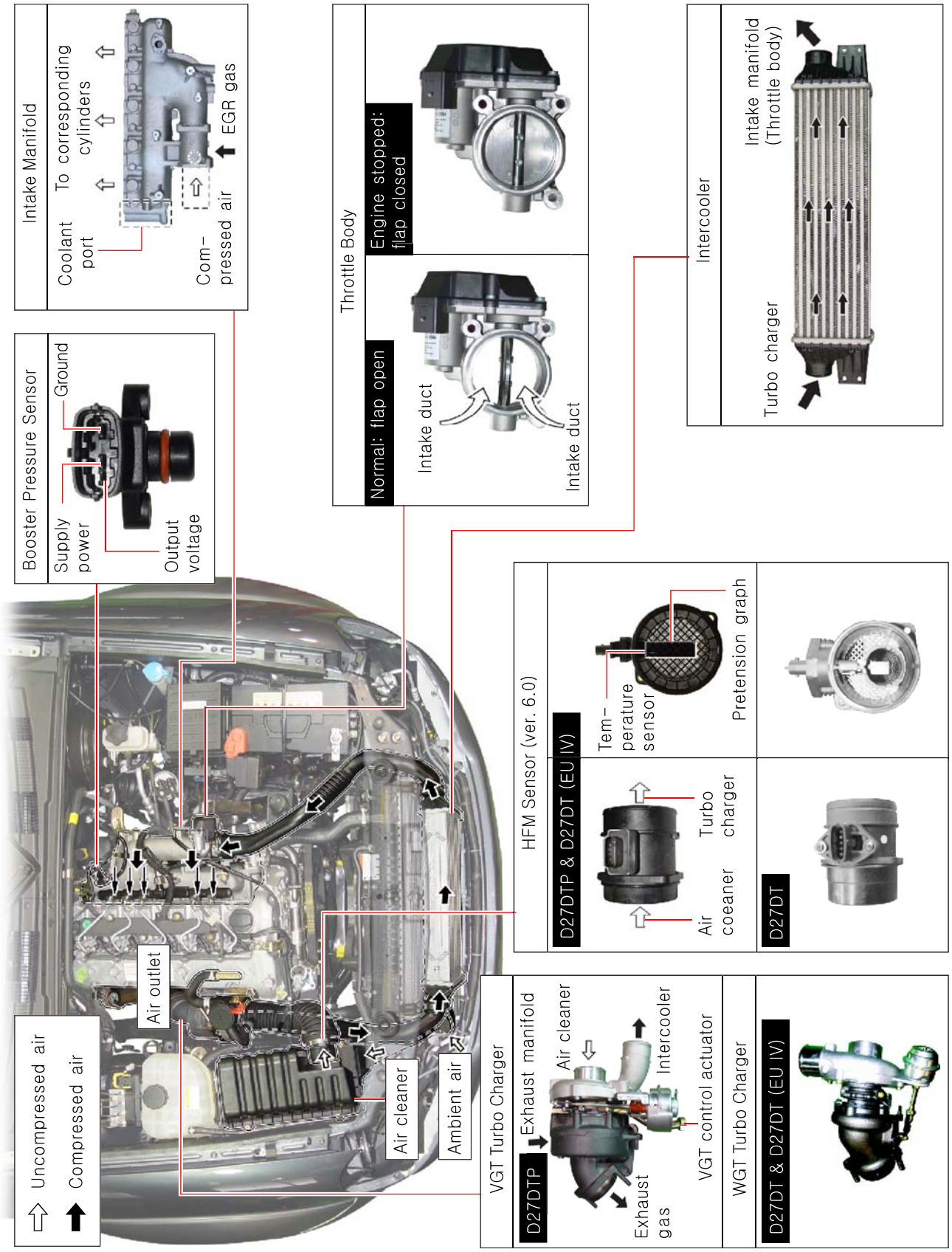
Modification basis	
Application basis	
Affected VIN	

5) Cooling System



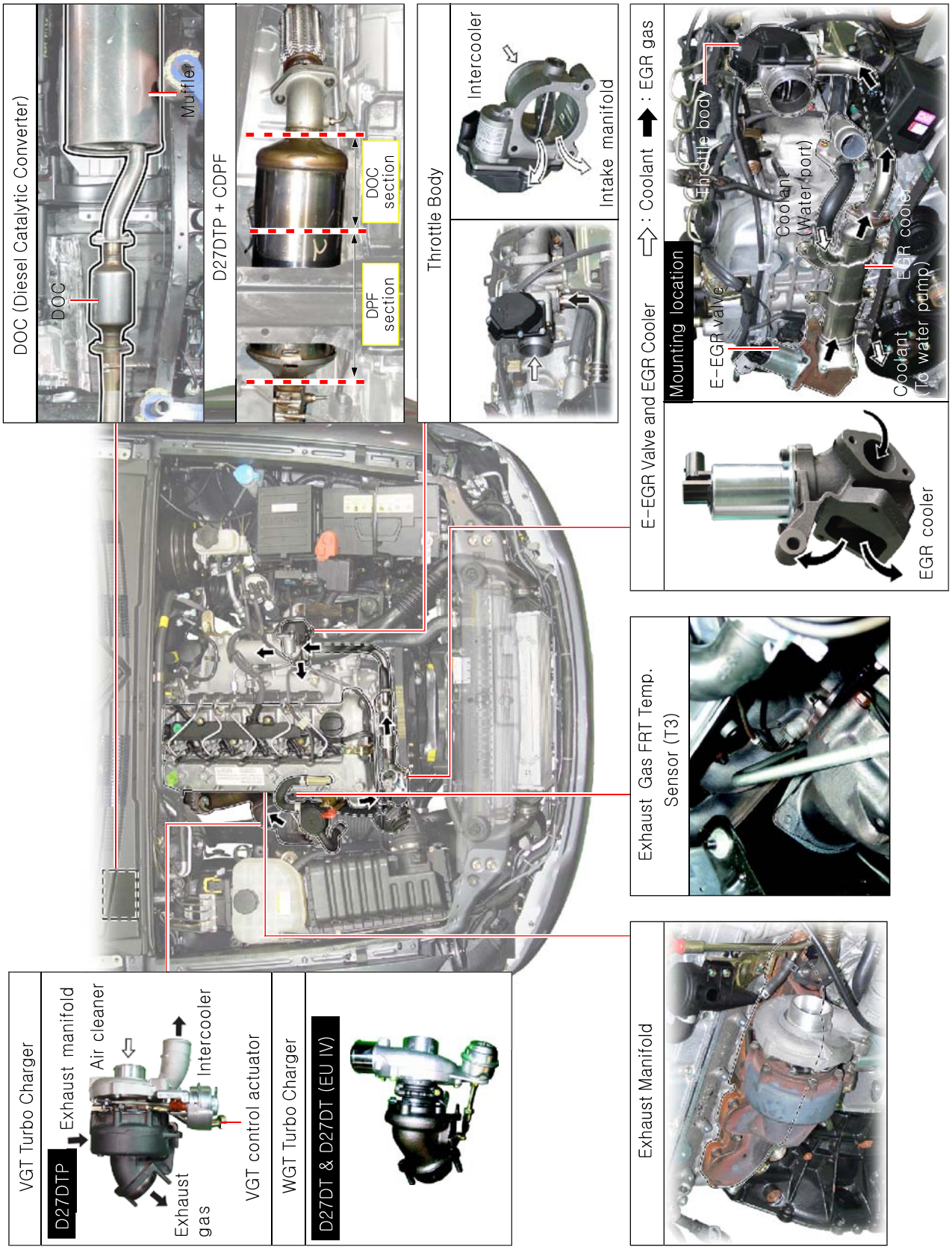
Modification basis	
Application basis	
Affected VIN	

6) Intake System



Modification basis	
Application basis	
Affected VIN	

7) Exhaust System



Modification basis	
Application basis	
Affected VIN	

ENGINE ASSEMBLY

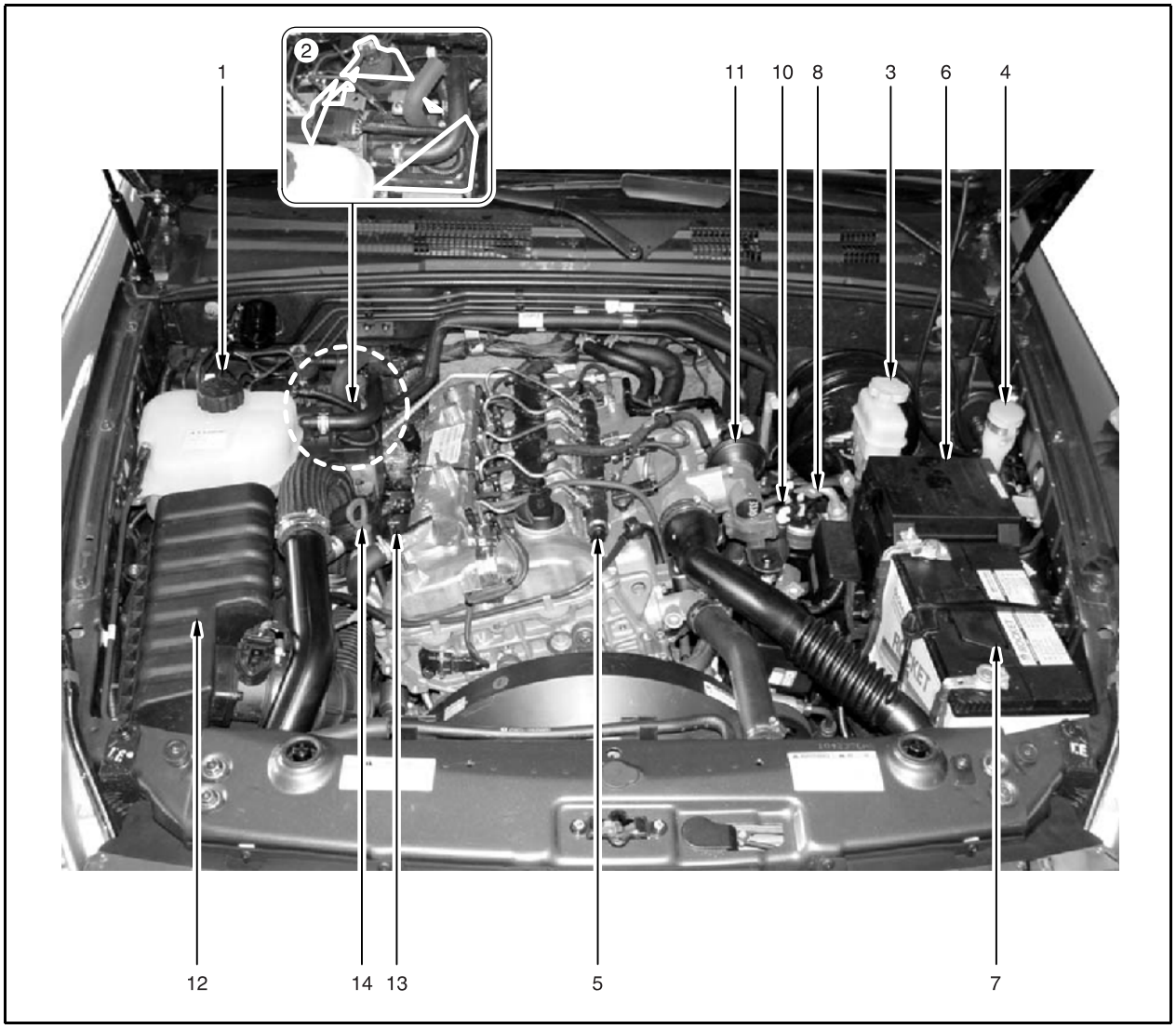
1212-01

GENERAL

1. D27DT ENGINE STRUCTURE

1) Major Components in Engine and Engine Compartment

The advanced electronically controlled D27DT engine that has high pressure fuel system has been introduced to this vehicle. It satisfies the strict emission regulation and provides improved output and maximum torque.

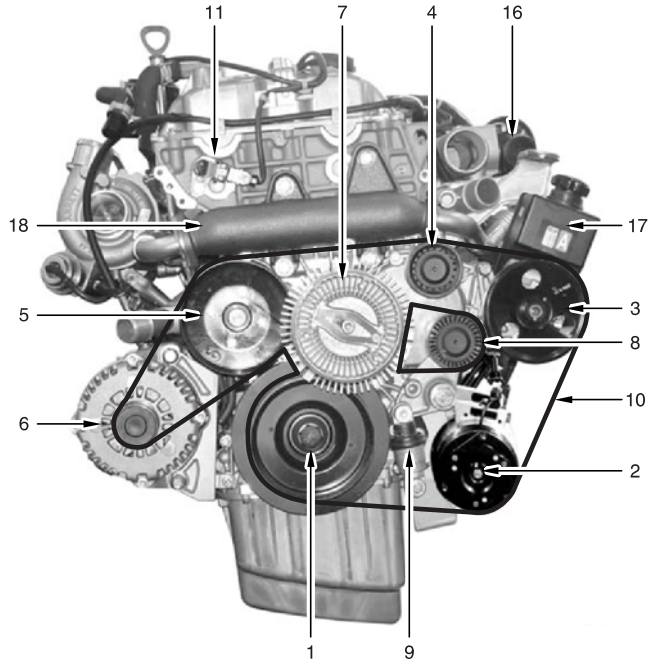


1. Coolant reservoir
2. FFH device
3. Brake fluid reservoir
4. Washer fluid reservoir
5. Common rail
6. Fuse box
7. Battery
8. Fuel filter
9. Power steering pump
10. Priming pump
11. EGR valve
12. Air cleaner assembly
13. Turbo charger
14. Oil dipstick

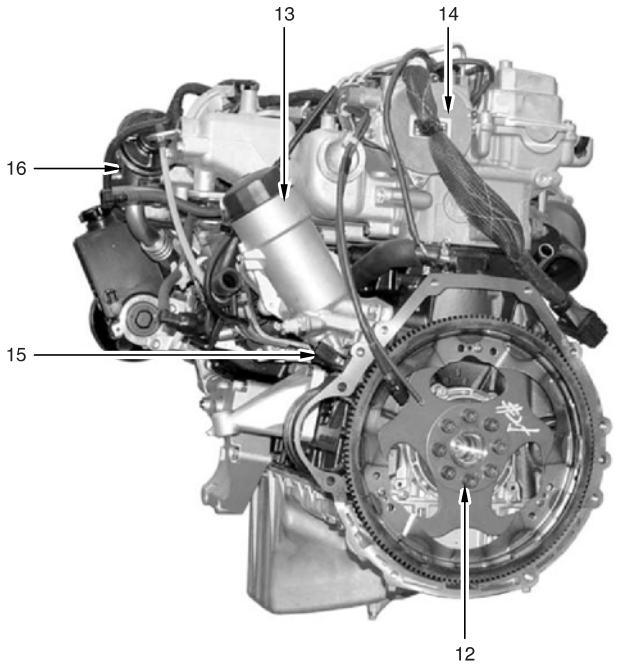
Modification basis	
Application basis	
Affected VIN	

2) Engine Structure

Front View



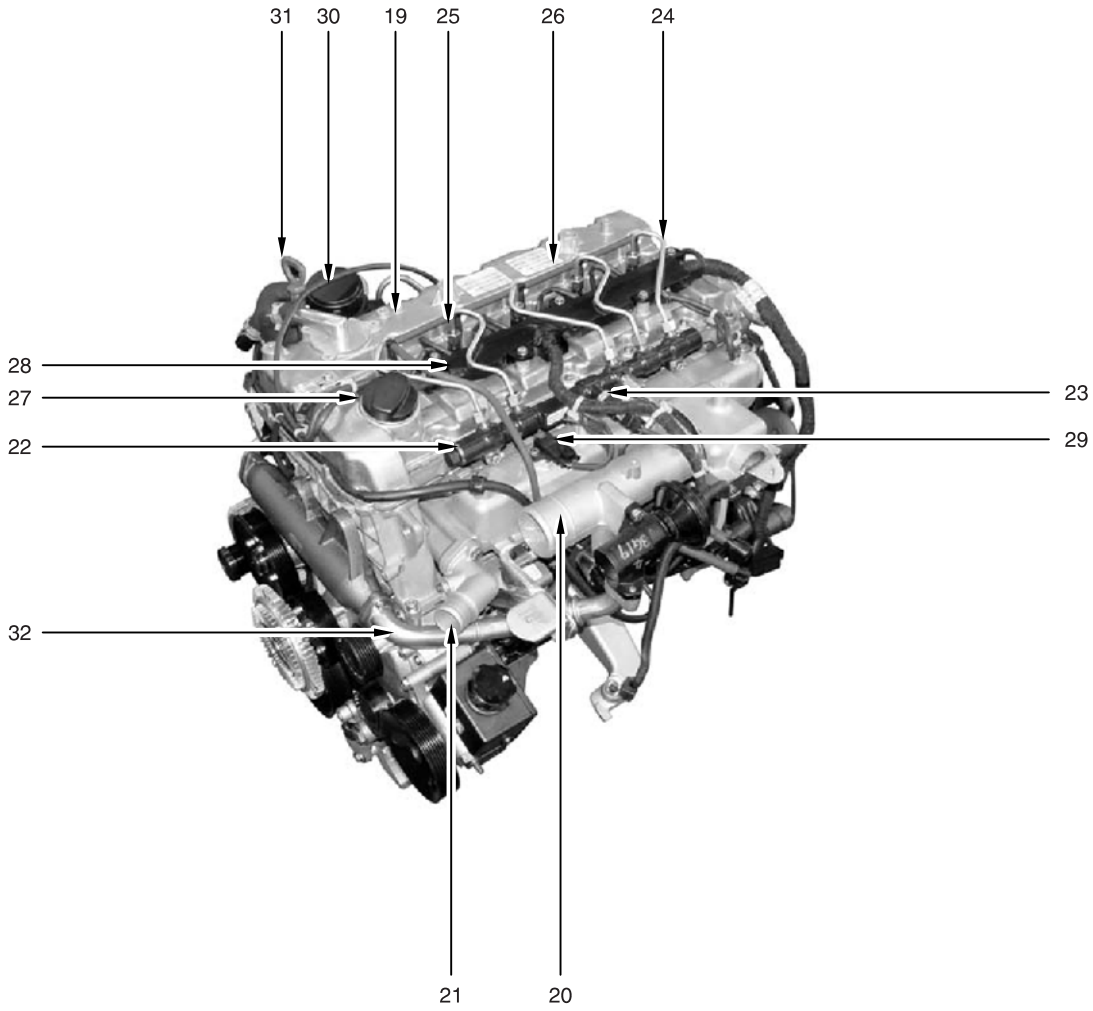
Rear View



1. TVD (Torsional Vibration Damper)
2. Air conditioner compressor
3. Power steering pump pulley
4. Idle pulley
5. Coolant pump pulley
6. Alternator
7. Viscos fan clutch
8. Auto tensioner pulley
9. Auto tensioner
10. Poly-grooved belt
11. Cam position sensor
12. Drive plate (MT: DMF)
13. Oil filter
14. Vacuum pump
15. Crank position sensor
16. EGR valve
17. Power steering pump
18. EGR to center pipe

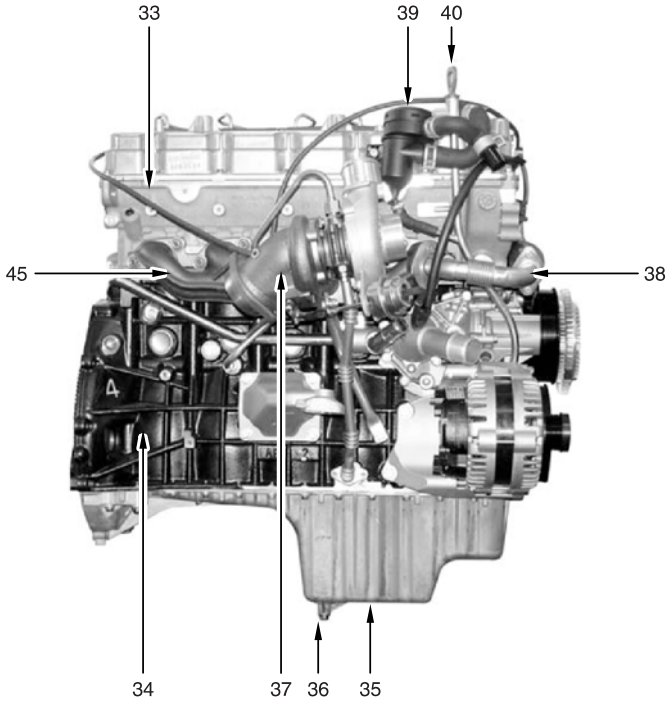
Modification basis	
Application basis	
Affected VIN	

Top View

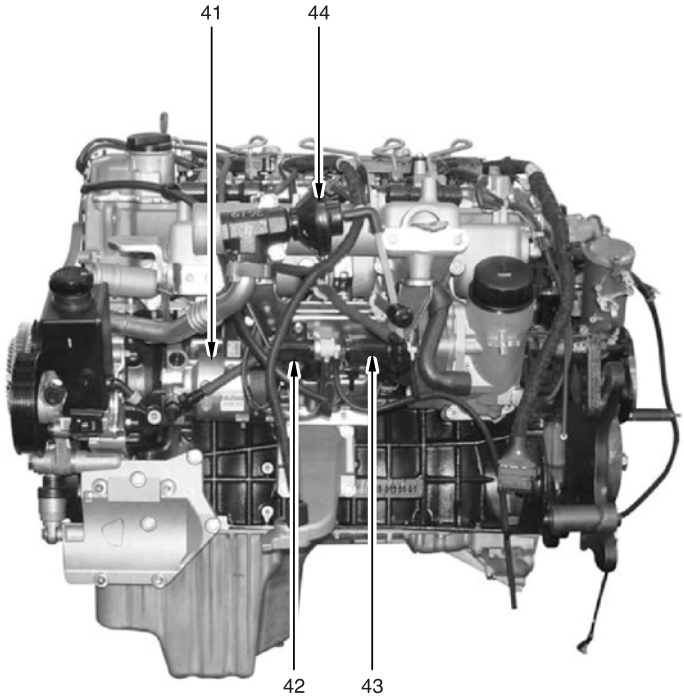


19. Cylinder head cover
20. Intake manifold
21. Water outlet port
22. Common rail
23. Fuel pressure sensor
24. Fuel pipe
25. Injector
26. Fuel return line
27. Oil filler cap
28. Glow plug
29. Booster pressure sensor
30. PCV valve and oil separator
31. Oil dipstick
32. EGR-LH (#1) pipe

Left Side View



Right Side View



33. Cylinder head
34. Cylinder block
35. Oil pan
36. Drain plug
37. Turbo charger
38. EGR-RH (#3) pipe
39. PCV valve and oil separator
40. Oil dipstick
41. High pressure pump
42. Turbo charger booster vacuum modulator
43. EGR valve vacuum modulator
44. EGR valve
45. Exhaust manifold

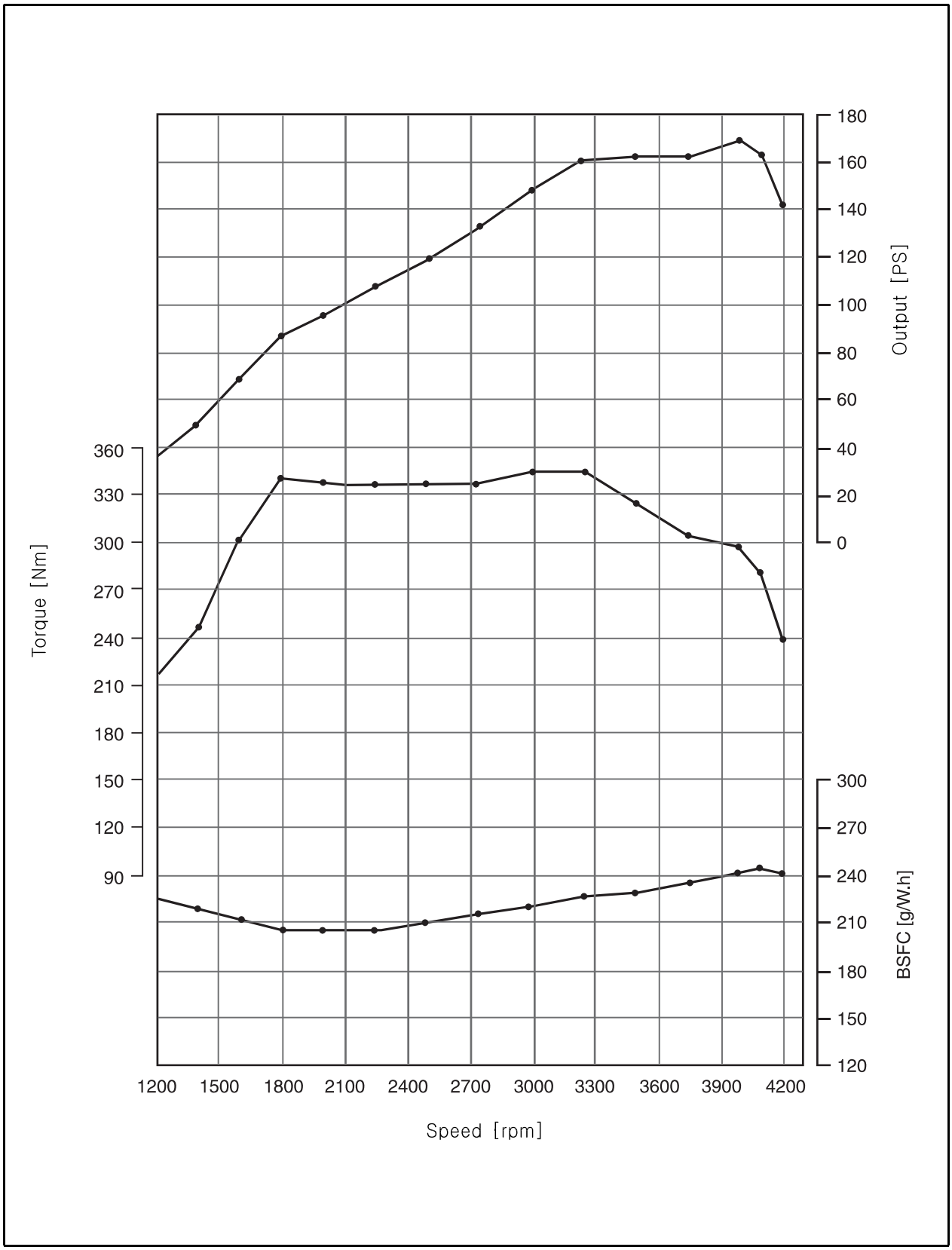
Modification basis	
Application basis	
Affected VIN	

2. SPECIFICATIONS

Description			Specification
Engine	Type/Number of cylinders		D27DT/5-cylinder
Cylinder	Inner diameter (mm)		86.2
	Stroke (mm)		92.4
Displacement (cc)			2696
Compression ratio			18:1
Maximum output (ps/rpm)			170/4,000
Maximum torque (kg·m/rpm)			34.7/1,800
Idle speed	For Manual Transmission		750 ± 50 rpm
	For Automatic Transmission		750 ± 50 rpm
Valve	Intake	Opens (BTDC)	16°
		Closes (ABDC)	33°
	Exhaust	Opens (BBDC)	46°
		Closes (ATDC)	21°
Camshaft	Type		DOHC
Fuel system	Fuel type		Low sulfur diesel
	Fuel pump type		Vane pump in HP pump
	Fuel supply pressure		HP pump inlet port: max. 400 mbar HP pump outlet port (with IMV fully open): over 1,050 bar
	Water separation in fuel filter		at every 10,000 km
	Fuel tank capacity (ℓ)		80
Lubrication system	Oil specification		SAE 10W40, 5W40 (MB Sheet 229.1, 229.3 approved oil)
	Lubrication type		Forced delivery
	Oil filter type		Full flow, filter element type
	Oil capacity (ℓ)		6.8 ~ 8.3
Cooling system	Cooling type		Water cooling type
	Cooling fan operation type		Belt operated typr
	Thermostat: Fully Open: 100°C)	Opening temperature (°C)	85
		Type	WAX pellet type
	Coolant capacity (ℓ)		≒11.5

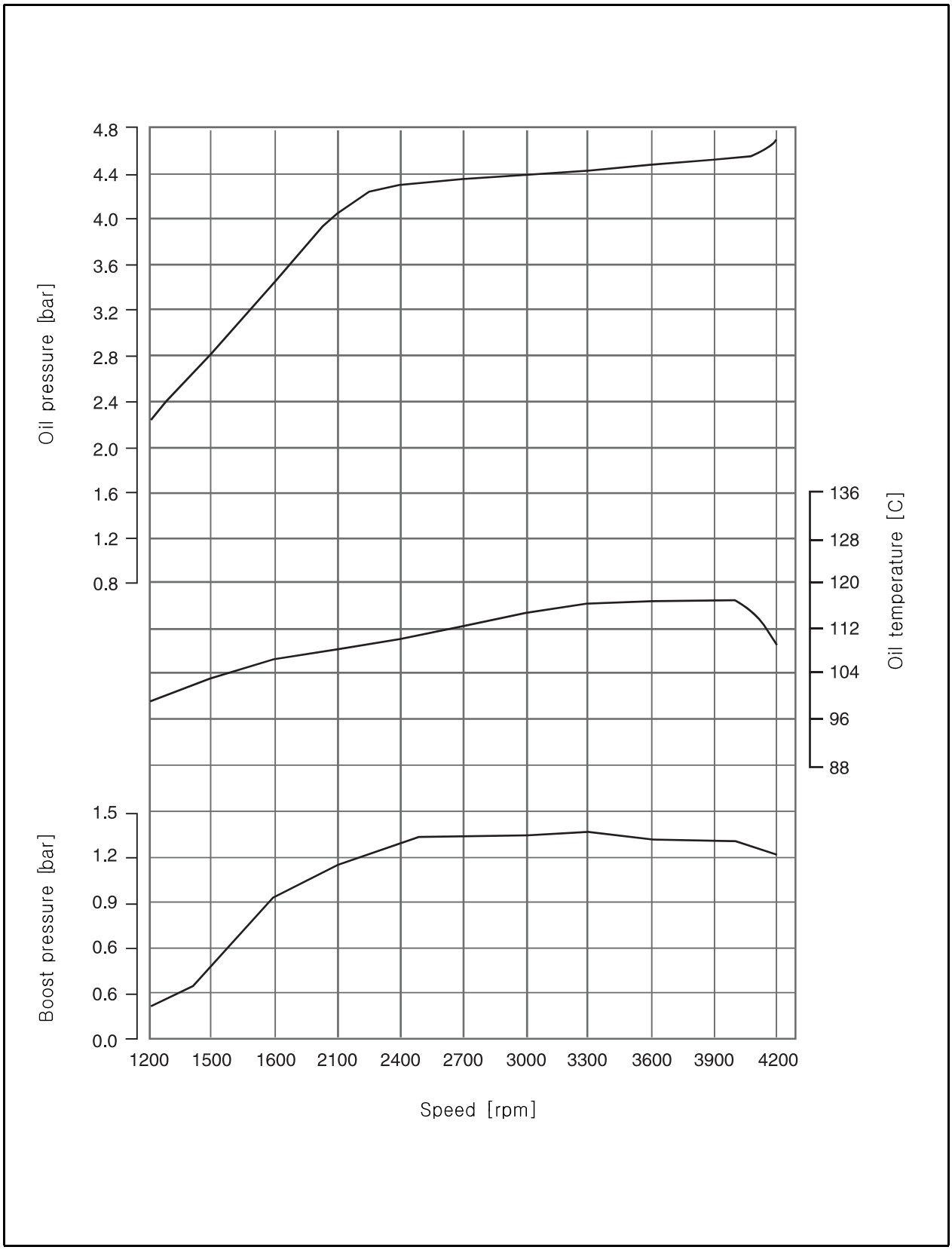
3. ENGINE PERFORMANCE CURVE

▶Output and Torque



Modification basis	
Application basis	
Affected VIN	

▶Oil Temperature/Pressure and Boost Pressure



4. TIGHTENING TORQUE

NO.	Name	Size	Quantity	Tightening Torque
1	Oil nozzle	M6 x 22	5	10 ± 1
2	Main bearing cap	M11 x 62	12	55 ± 5
				90° ± 10°
3	Connecting rod cap	M9 x 52	5	40 ± 5
				90° ± 10°
4	Rear cover	M6 x 20	6	10 ± 1
5	Oil pump	M8 x 35SOC	3	25 ± 2.5
6	Oil baffle plate assembly	M6 x 20	10	10 ± 1
7	T.G.C.C	M6 x 16	1	10 ± 1
		M6 x 40	6	10 ± 1
		M6 x 60	3	10 ± 1
		M6 x 70	2	10 ± 1
		M8 x 80SOC	1	25 ± 2.5
8	Flywheel	M10 x 30	8	45 ± 5
				90° ± 10°
9	Crankshaft hub	M18 x 50	1	325 ± 33
				90° ± 10°
10	Oil pan	M6 x 20	24	10 ± 1
		M6 x 35	3	10 ± 1
		M6 x 38	3	10 ± 1
		M6 x 40	4	25 ± 2.5
11	High pressure pump assembly	M8 x 40	4	25 ± 2.5
12	High pressure pump sprocket assembly	M14 x 1.5-8-1	1	65 ± 5
13	High pressure pump bracket	M7 x 16	3	20 ± 2 x 90° + 10°
14	Cylinder head assembly	M8 x 25	2	25 ± 2.5
		M8 x 50	2	
		M12 x 177	11	Step1: 20 Nm ± 2 Nm Step2: 85 Nm ± 5 Nm
		M12 x 158	1	Step3: 3 x 90° + 10°
15	Camshaft cap	M8 x 60	24	25 ± 2.5
16	Stud bolt	M8	10	15 ± 1.5
17	Camshaft sprocket (Intake)	M11 x 52	1	25 ± 2.5
	Camshaft sprocket (Exhaust)		1	90° ± 10°
18	Chain tensioner	M22	1	65 ± 5
19	Coolant temperature sensor	M14	1	22 ± 2.2

Modification basis	
Application basis	
Affected VIN	

NO.	Name	Size	Quantity	Tightening Torque
20	Auto tensioner	M8 x 45(LOWER)	1	32 ± 3
		M12 x 90	1	82 ± 6
21	Water pump assembly	M6 x 50	7	10 ± 1
22	Water pump pulley	M6 x 12	4	10 ± 1
23	Hot water inlet pipe assembly	M6 x 12	2	10 ± 1
24	Alternator bracket	M8 x 32	4	25 ± 2.5
25	Alternator	M10 x 90	2	46 ± 4.6
26	Air conditioner compressor assembly	M8 x 95	4	46 ± 4.6
27	Air conditioner compressor bracket assembly	M8 x 25	1	25 ± 2.5
		M8 x 60	3	25 ± 2.5
28	Air conditioner compressor sub bracket assembly	M6 x 14	1	10 ± 1.0
		M8 x 16	1	25 ± 2.5
29	Intake manifold	M8 x 45	6	25 ± 2.5
		M8 x 130	6	25 ± 2.5
30	Bracket	M6 x 16	1	10 ± 1.0
31	Knock sensor	M8 x 28	2	20 ± 2.6
32	Camshaft position sensor	M8 x 16	1	12 ± 1.7
33	Booster pressure sensor	M6 x 16	2	10 ± 1.0
34	Exhauster manifold	M8	10	40 ± 4
35	Turbo charger assembly	M8	4	25 ± 2.5
36	Turbo charger adaptor piece		1	32 ± 3.2
37	Nut	M8	1	25 ± 2.5
38	Combination bolt	M8 x 22	1	25 ± 2.5
39	T/C oil supply pipe	M6 x 16 (Cylinder block side)	1	25 ± 2.5
		M16 (T/C side)	1	20 ± 2.0
40	T/C oil return pipe	M6 x 16 (T/C side)	2	10 ± 1.0
		M6 x 16 (Cylinder block side)	2	10 ± 1.0
41	EGR valve assembly	M8 x 22	2	25 ± 2.5
42	EGR-LH pipe bolt	M6 x 16	2	10 ± 1.0
		M8 x 22	2	35 ± 2.0
43	EGR combination bolt	M6 x 16	4	10 ± 1.0
		M8 x 16	4	25 ± 2.5
	EGR-RH pipe nut	M8	2	35 ± 2.0
44	Glow plug cable nut	M5	5	15 ± 3
45	Vacuum pump	M6 x 20	3	10 ± 1.0
46	Cooling fan bracket assembly	M6 x 25	5	10 ± 1.0
		M6 x 65	1	10 ± 1.0
		M6 x 85	3	10 ± 1.0
47	Cylinder head cover	M6 x 35	21	23 ± 2.3

NO.	Name	Size	Quantity	Tightening Torque
48	Vacuum modulator	M6 x 16SOC	4	10 ± 1.0
49	WDT combination bolt	M6 x 16	3	10 ± 1.0
50	Oil dipstick tube	M6 x 16	1	10 ± 1.0
51	Oil filter assembly	M8 x 35SOC	1	25 ± 2.5
		M8 x 50SOC	2	25 ± 2.5
		M8 x 55SOC	1	25 ± 2.5
52	Fuel rail assembly	M8 x 35SOC	3	25 ± 2.5
53	Injector clamp washer	M6 x 60	5	10 ± 1.0 180 + 20°
54	Fuel pipe clip (H-C)	M6 x 19	1	10 ± 1.0
55	Fuel pipe clip (C-I)	M6 x 16	5	10 ± 1.0
56	Crankshaft position sensor	M5 x 17	1	0.8 ± 0.4
57	Crankshaft position sensor	GAP		0.7 ~ 1.5
58	Fuel pressure sensor		1	
59	Wiring	M6 x 16	5	10 ± 1.0
60	Intake manifold bracket	M8 x 16	2	25 ± 2.5
		M8 x 40	2	25 ± 2.5
61	Power steering pump	M8 x 100	2	25 ± 2.5
		NUT	2	25 ± 2.5
62	Piston protrusion		5	0.765 ~ 1.055
63	Clearance between connecting rod and pin boss		5	0.05 ~ 0.31
64	End play of crankshaft	NEW: 0.100 ~ 0.245 mm // USED: 0.300 mm		

Modification basis	
Application basis	
Affected VIN	

ENGINE FUEL SYSTEM

1881-09

OVERVIEW AND OPERATION PROCESS

1. MAJOR CHANGES IN FUEL SYSTEM OF D27DTP (POWER UP) ENGINE

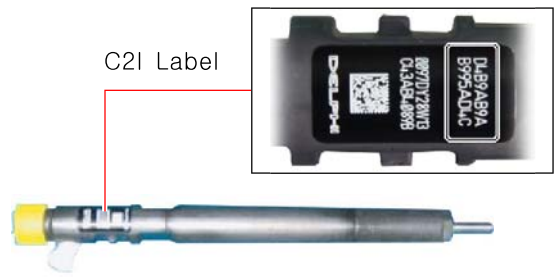
There are some changes in the parts related to the fuel system due to the newly adopted D27DTP (POWER UP) engine. The major changes are as follows. Refer to the next pages for further details.

1) Injector

D27DTP & D27DT (EU IV)



D27DT

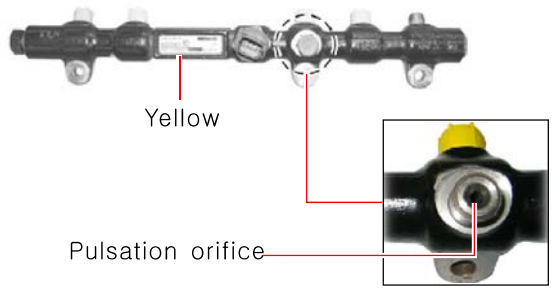


- Two nozzle holes are added (currently 7) to the tip of the injector to increase the amount of fuel injection and to improve injection efficiency according to the increased engine power.
- The existing C2I coding (16 digits) is changed to C3I coding (20 digits) to monitor fuel injection and follow the target value.
- For the D27DT engine, the injector MDP (minumum current for the solenoid in the injector to lift the nozzle) is leaned only when the engine is running. However, for the D27DTP engine, it is learned when the vehicle is in motion and the engine is at idle speed.

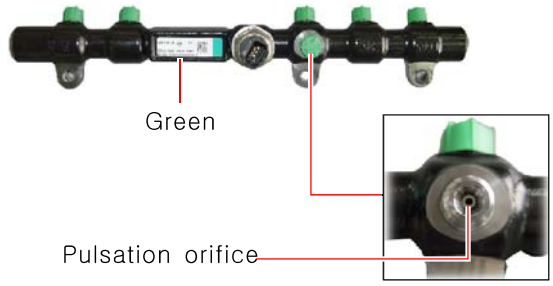
Modification basis	
Application basis	
Affected VIN	

2) Common Rail

D27DTP & D27DT (EU IV)



D27DT



· The orifice is added to the connection to the fuel pipe of the HP pump to prevent the fuel pulsation by the fuel supply and fuel cut according to the increase of injected fuel volume. (It is also installed on the connection of the high pressure fuel supply line of the HP pump.)

Modification basis	
Application basis	
Affected VIN	

3) Fuel Rail - Chrome Color

D27DTP & D27DT (EU IV)

* Fuel pipe (Common rail → Injector)



* Fuel high pressure pipe (HP pump → Common rail)



D27DT

* Fuel pipe (Common rail → Injector)



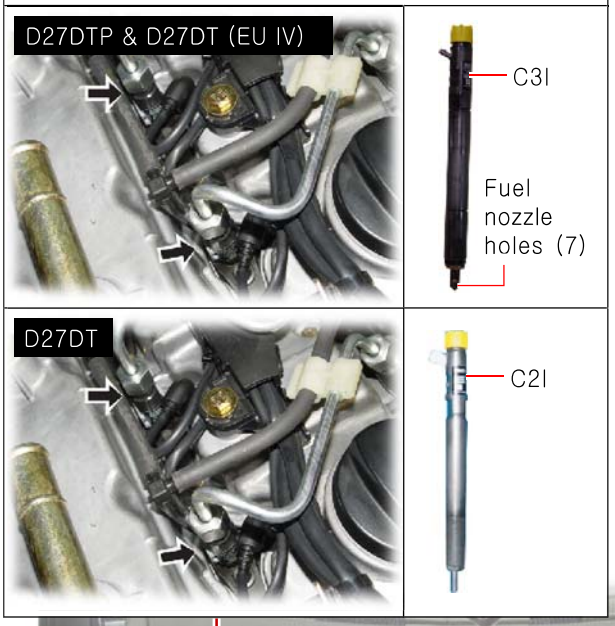
* Fuel high pressure pipe (HP pump → Common rail)



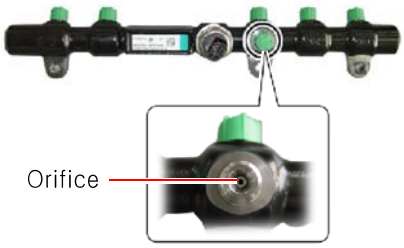
· The I.D and O.D of the fuel rail between HP pump and common rail are increased according to the increased amount of fuel injection.
Also, the engine ECU, HFM sensor and EGR system are changed to control the fuel injection volume and engine more precisely.

2. COMPONENTS OF FUEL SYSTEM

Injector (7-way Injection and C3I Coding)

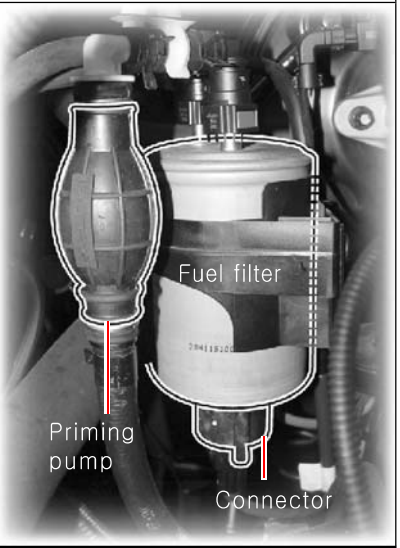


Common Rail (Orifice for Preventing Fuel Pulsation Added)

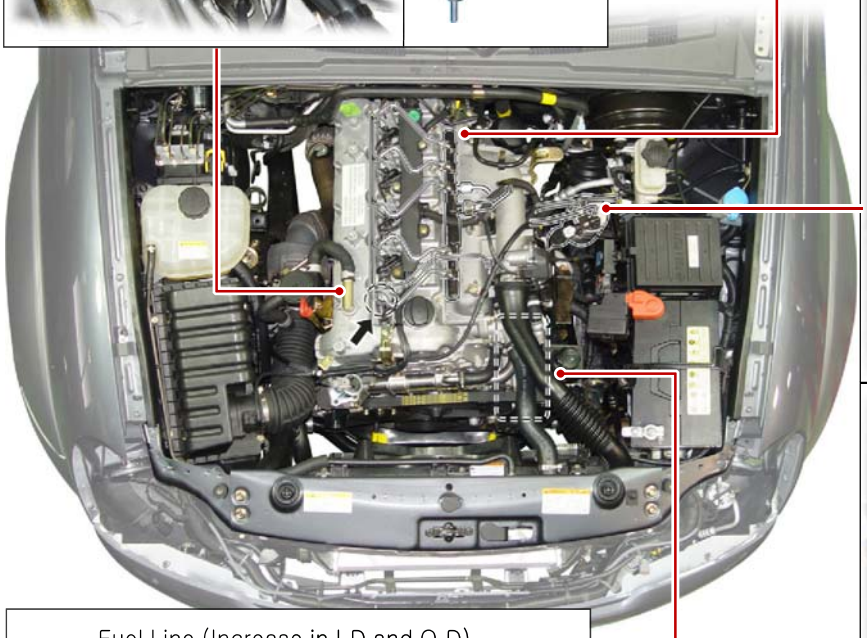


* Orifice for HP pump fuel outlet

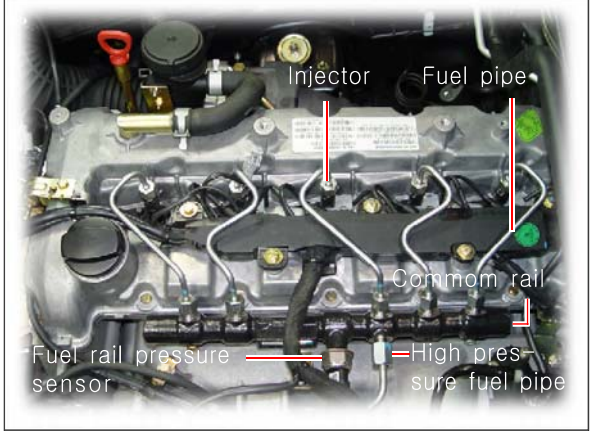
Fuel filter Priming Pump



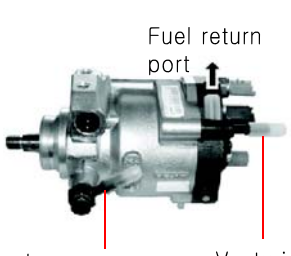


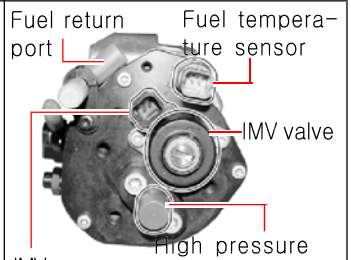


Fuel Line (Increase in I.D and O.D)



HP Pump

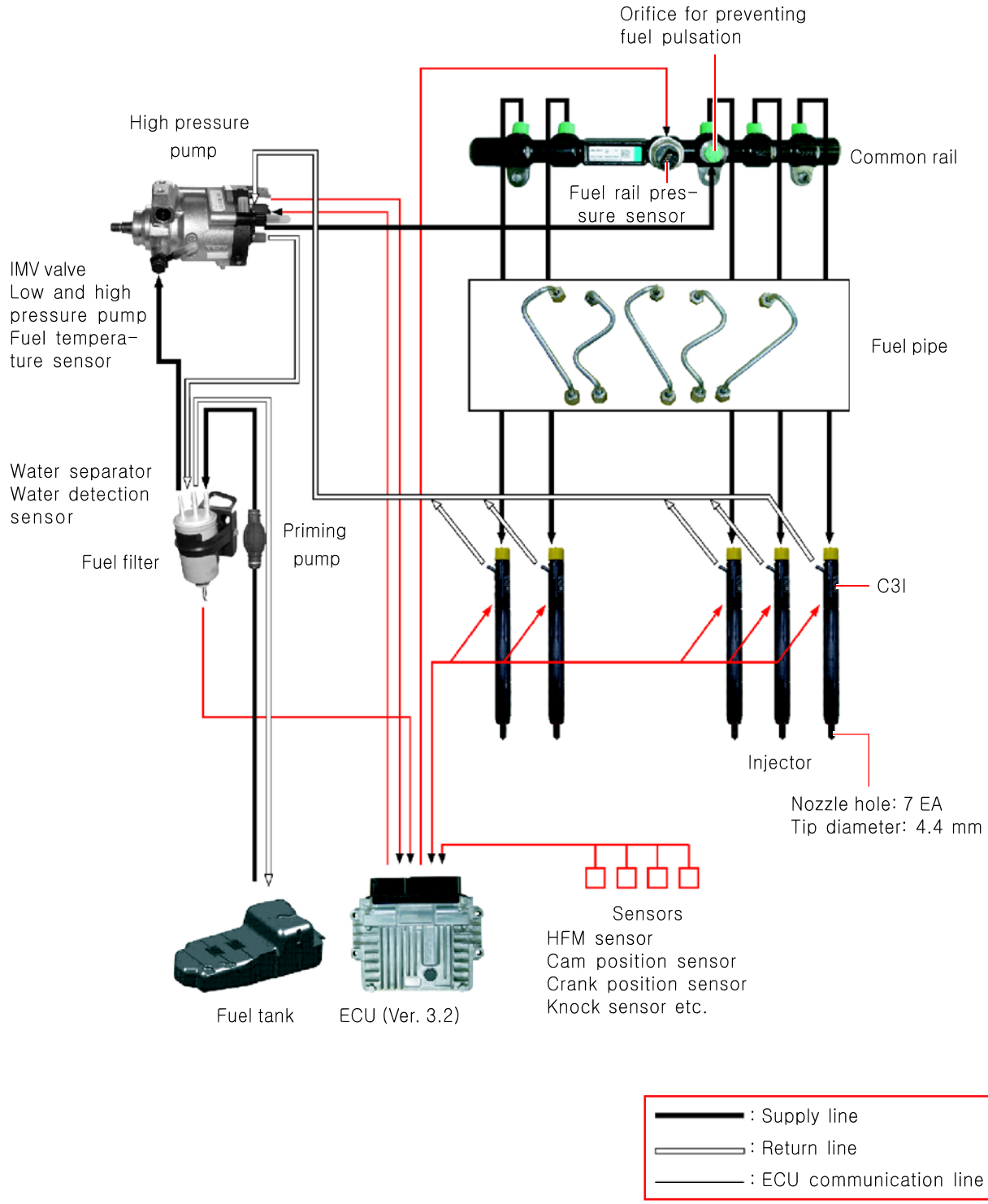




Modification basis	
Application basis	
Affected VIN	

▶Fuel Flow of D27DTP (Power Up) Engine

Fuel Supply System



Modification basis	
Application basis	
Affected VIN	

ENGINE INTAKE SYSTEM

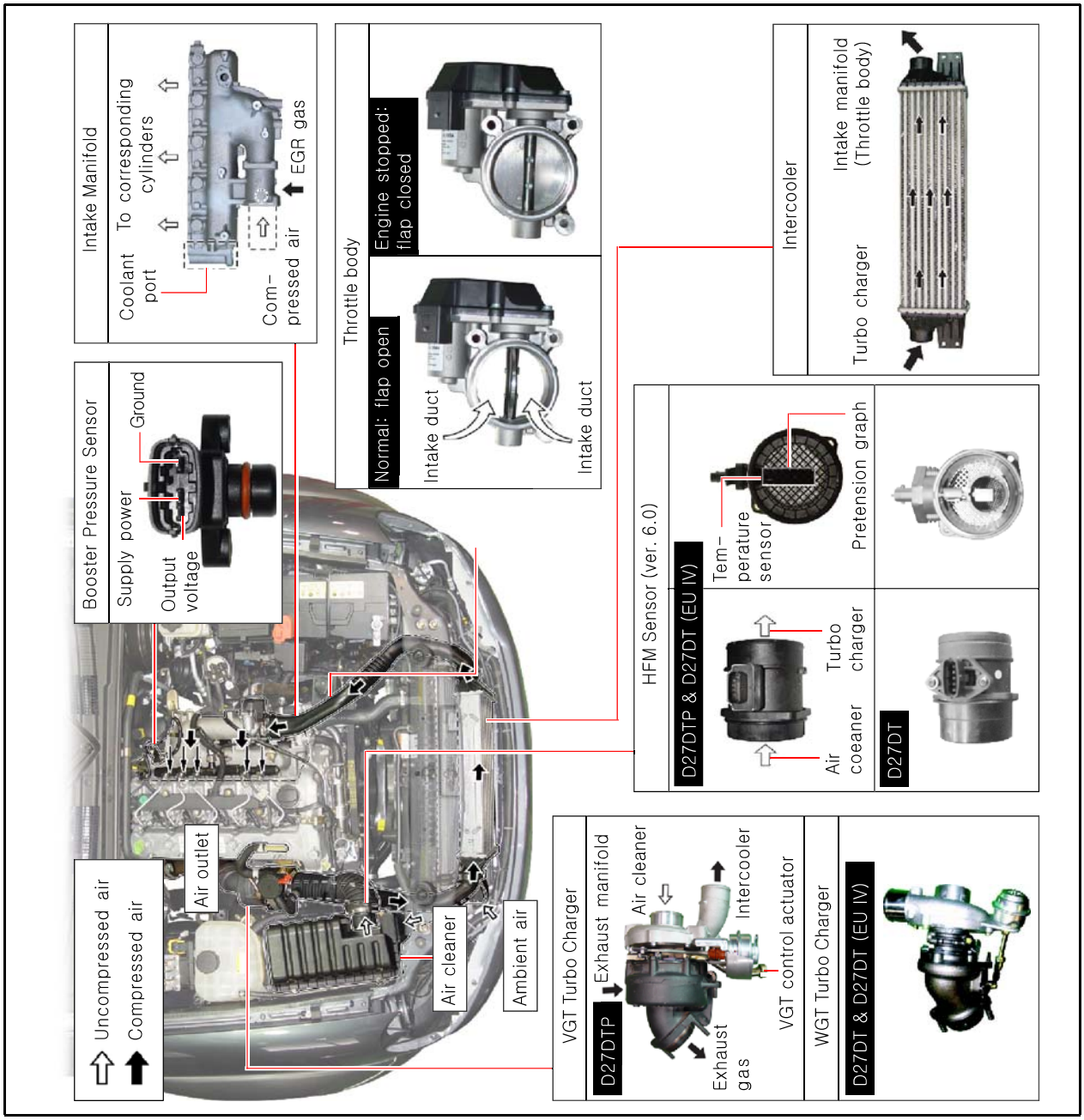
2321-01

OVERVIEW AND OPERATION PROCESS

1. INTAKE SYSTEM LAYOUT

The intake system for the D27DTP (POWER UP) engine is equipped with the throttle body that has a flap to block the air coming to the engine when the engine is switched off. Therefore, the structure of the intake manifold has been changed.

Also, the improved HFM sensor (from HFM5.0 to HFM6.0) has been installed to control the intake air precisely so that the NOx in the exhaust gas can be decreased.



Modification basis	
Application basis	
Affected VIN	

ENGINE EXHAUST SYSTEM

1792-01

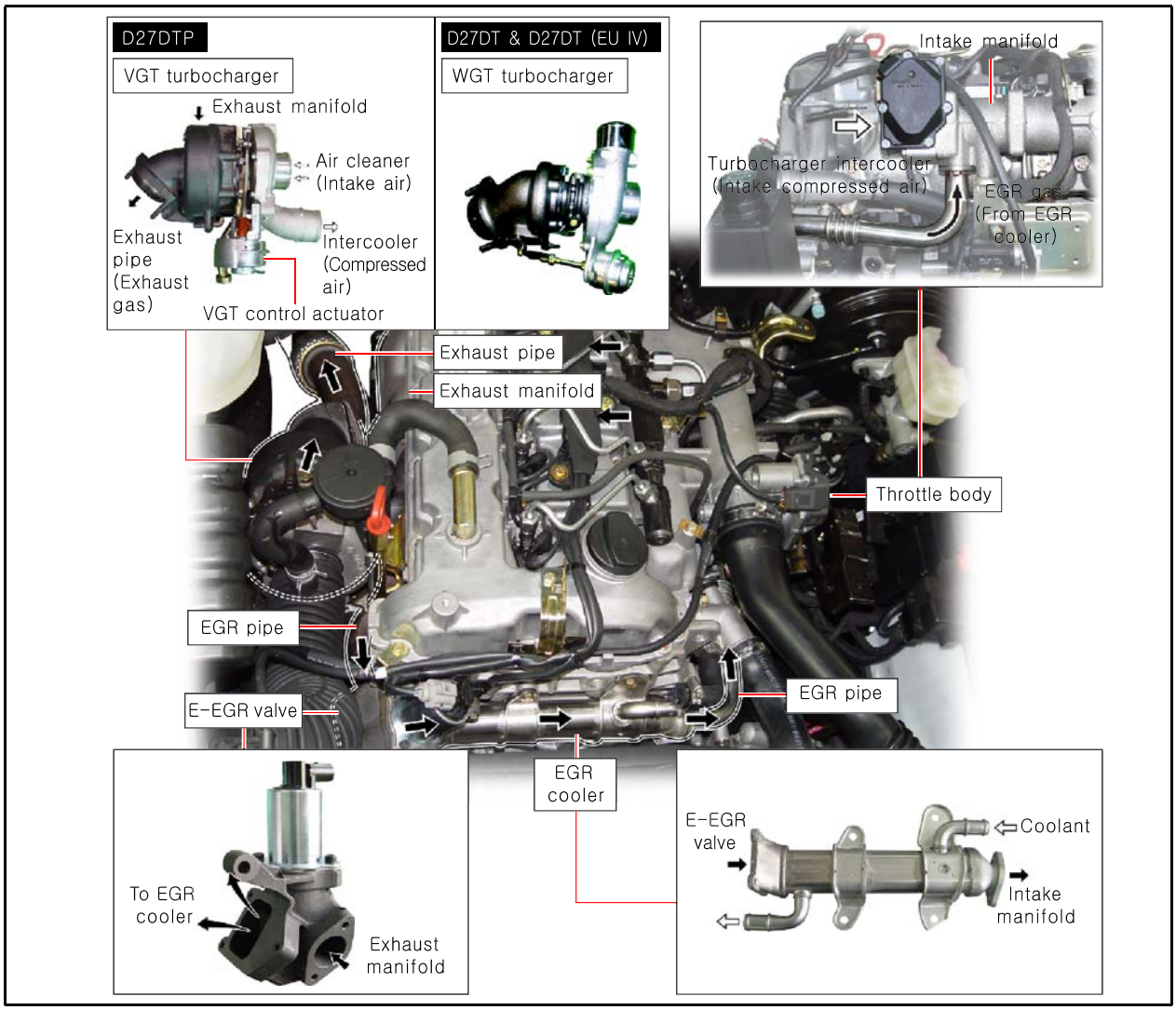
OVERVIE AND OPERATION PROCESS

1. COMPONENTS

The components of the exhaust system for the D27DTP (POWER UP) engine have been changed as follows:

1. E-EGR valve: Controlling the EGR valve electrically and sends the valve location signal to ECU (vacuum modulator control has been deleted)
2. EGR cooler: Decreasing EGR gas (NOx) efficiently by cooling the EGR gas and let it flow to the intake pipe
3. VGT turbocharger: Increase in capacity and performance compared to D27DTP & D20DT engine

The EGR system has been changed to control NOx more efficiently and the VGT turbo charger has been changed to increase the engine power. For more details, refer to the next description.
The exhaust system for D27DTP (POWER UP) engine is as follows:



Modification basis	
Application basis	
Affected VIN	

CDPF(EURO IV) 2412-02

GENERAL INFORMATION

1. OVERVIEW FOR CDPF (EURO IV)

1) General Description

The CDPF (Catalyst & Diesel Particulate Filter) was installed to the Rexton II D27DTP engine previously. However, it is now installed to the all 2009 DI engine models, except the Actyon Sports. The DI engine types installed to Rexton are D27DTP, D27DT and D20DT, and their CDPF, related sensor and operation logic are the same.
This section describes the CDPF system (based on Euro IV) which is installed to the Rexton II D27DTP engine (older model).

2) Compatibility of CDPF System by Vehicle Model

Rexton II: Same CDPF system for D27DTP and D27DT engines (including its components)
Kyron & Actyon: Same CDPF system for D27DT and D20DT engines (including its components)

NOTE
- The CDPF assemblies installed to the Euro IV D27DTP Rexton II and 2009 Rexton II are different in their mounting layout, but their front/rear exhaust temperature sensors and differential pressure sensors are same.

3) System Met with Euro IV Regulations

- E-EGR valve
- EGR cooler
- Engine ECU (Ver. 3.2)
- HFM sensor
- C3I injector
- Electronic throttle valve (body)
- Other engine mounting components

For details about the modified components and system related to the Euro IV regulations, refer to the 2008 Rodius engine service manual.

2. CDPF(EURO IV) SYSTEM

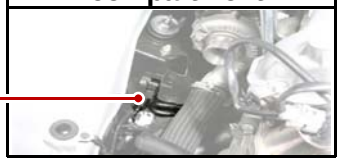
The CDPF system is only installed to the D27DT engine, and the major changes comparing to the previous D27DT engine is as follows:

CDPF (Catalyst & Diesel Particulate Filter) and sensors

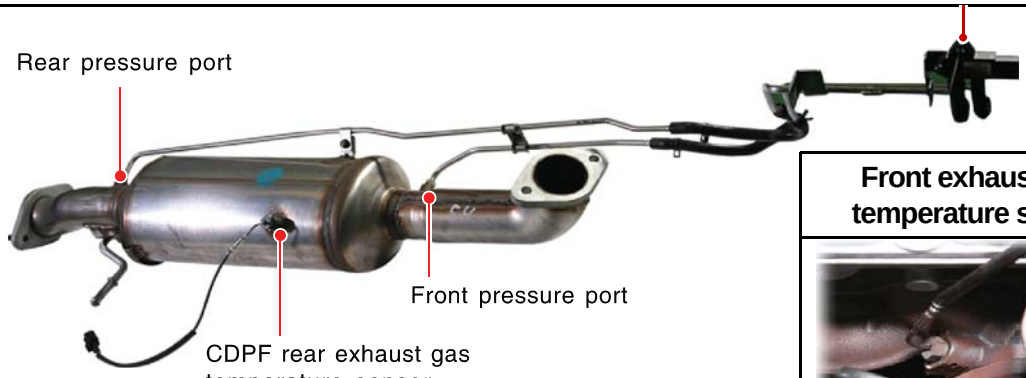
Differential pressure sensor (△P sensor)



Under air cleaner in righ side of engine compartment



As the soot is filtered in the CDPF, the pressure between the front side and the rear side of the filter is different from each other. If the amount of soot is over 28 g, the soot is burnt in the CDPF. The combustion is determined depending on the pressure difference, temperature of exhaust gas and EGR ratio. According to these, the soot filtered by post injection of injector is burnt at 600°C.



Front exhaust gas temperature sensor



CDPF Exhaust Gas Temperature Sensor



The two temperature sensors inside the CDPF are installed in exhaust manifold (front exhaust gas temperature sensor) and in DOC (rear exhaust gas temperature sensor), and perform the following functions.

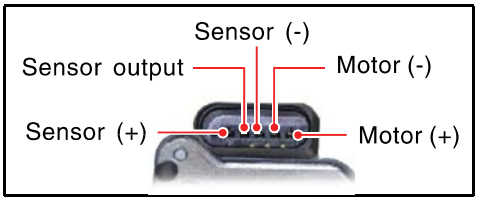
Front Exhaust Gas Temperature Sensor:
Measures the exhaust gas temperature of the exhaust manifold. As it is installed in front of the VGT turbocharger, it also monitors the exhaust gas temperature coming to the turbocharger. If the temperature of the exhaust gas flowing to the turbocharger is higher than the specification, the engine lowers the exhaust gas temperature.

Rear Exhaust Gas Temperature Sensor:
Measures the increased exhaust gas temperature after the oxidation process of DOC. If the temperature is below 600°C, the post injection amount is increased to increase the temperature.

Modification basis	
Application basis	
Affected VIN	

Throttle Body



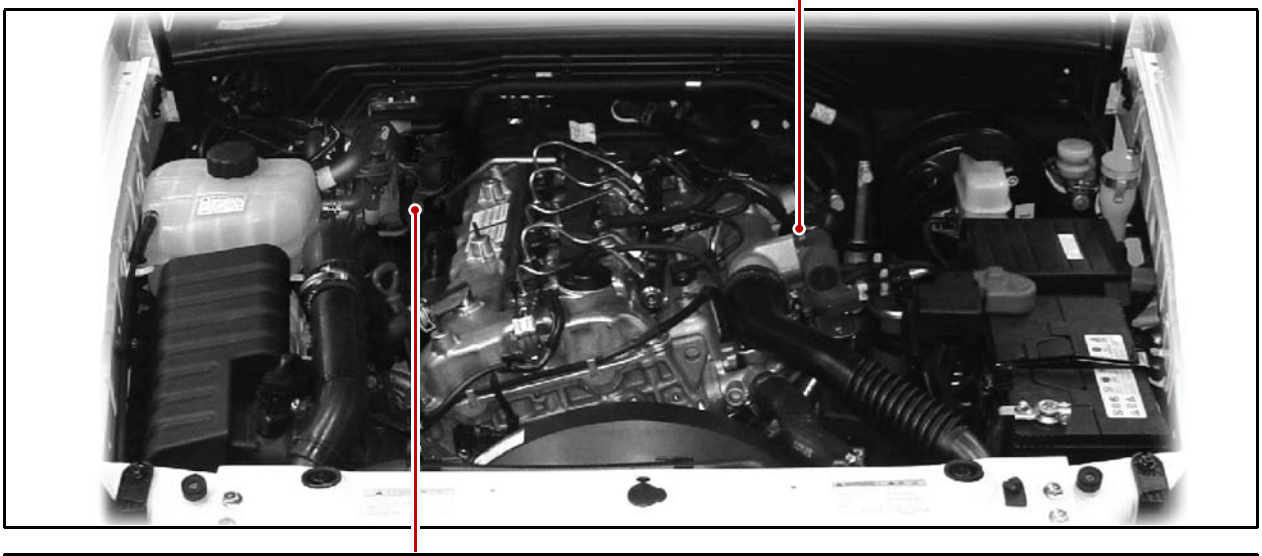


CDPF system controls the amount of intake air by controlling the electronic throttle body. The electronic throttle body has the following main functions.

CDPF control- added a function that increases the exhaust gas temperature by closing the throttle valve flap to minimize the intake air amount by the fuel injection amount during the CDPF regeneration range with the low engine load range.

ON/OFF control - prevents the engine from turning off with vibration and noise by closing the throttle body flap to block the intake air when the engine is stopped.

Duty control- controls the valve inside the throttle body to burn more EGR gas in the EGR valve operating range.

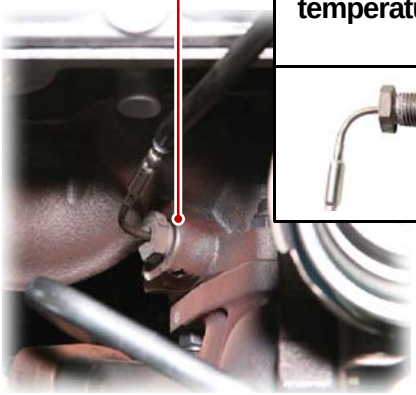


VGT Turbocharger and Front Exhaust Gas Temperature Sensor

Turbocharger may become weaker if high temperature exhaust gas passes through the turbocharger for DPF regeneration process.
The front exhaust gas temperature sensor monitors the temperature of the exhaust gas that flows into the turbocharger.
If the temperature of the exhaust gas that passes through the exhaust manifold is higher than the specification, the ECU decreases the fuel injection amount and increases the EGR gas intake amount to decrease the exhaust gas temperature.

Front exhaust gas temperature sensor

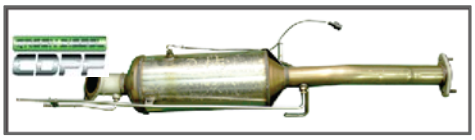




Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATION PROCESS

1. OVERVIEW



As the solution for environmental regulations and PM (Particla 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 Oxydation Catalyst) is reduced. The CDPF (Catalyst & Diesel Particulate Filter) is an integrated filter including DOC (Diesel Oxydation Catalyst) and DPF (Diesel Particulate Filter).

▶Comparison of throttle body functions based on exhaust emission regulation

Regulated parts are carbon monoxide (CO), nitrogen oxide (NOx), particular matter (PM) and soot in the exhaust emission, and the particulars of the regulations are prescribed in the following table.

Engine	Control method	Function
D27DTP + CDPF **D27DT + CDPF** **D20DT + CDPF**	ECU's electric signal (Duty and On/Off control) + Throttle flap control during CDPF operation	**ON/OFF control -** prevents the engine from turning off with vibration and noise by closing the throttle body flap to block the intake air when the engine is stopped **Duty control -** controls the valve inside the throttle body to burn more EGR gas in the EGR valve operating range. **CDPF control -** added a function that increases the exhaust gas temperature by closing the throttle valve flap to minimize the intake air amount by the fuel injection amount during the CDPF regeneration range with the low engine load range.
D27DT engine **(EU IV)**	ECU's electric signal (Duty and On/Off control)	**ON/OFF control -** prevents the engine from turning off with vibration and noise by closing the throttle body flap to block the intake air when the engine is stopped **Duty control -** controls the valve inside the throttle body to burn more EGR gas in the EGR valve operating range.

Modification basis	
Application basis	
Affected VIN	

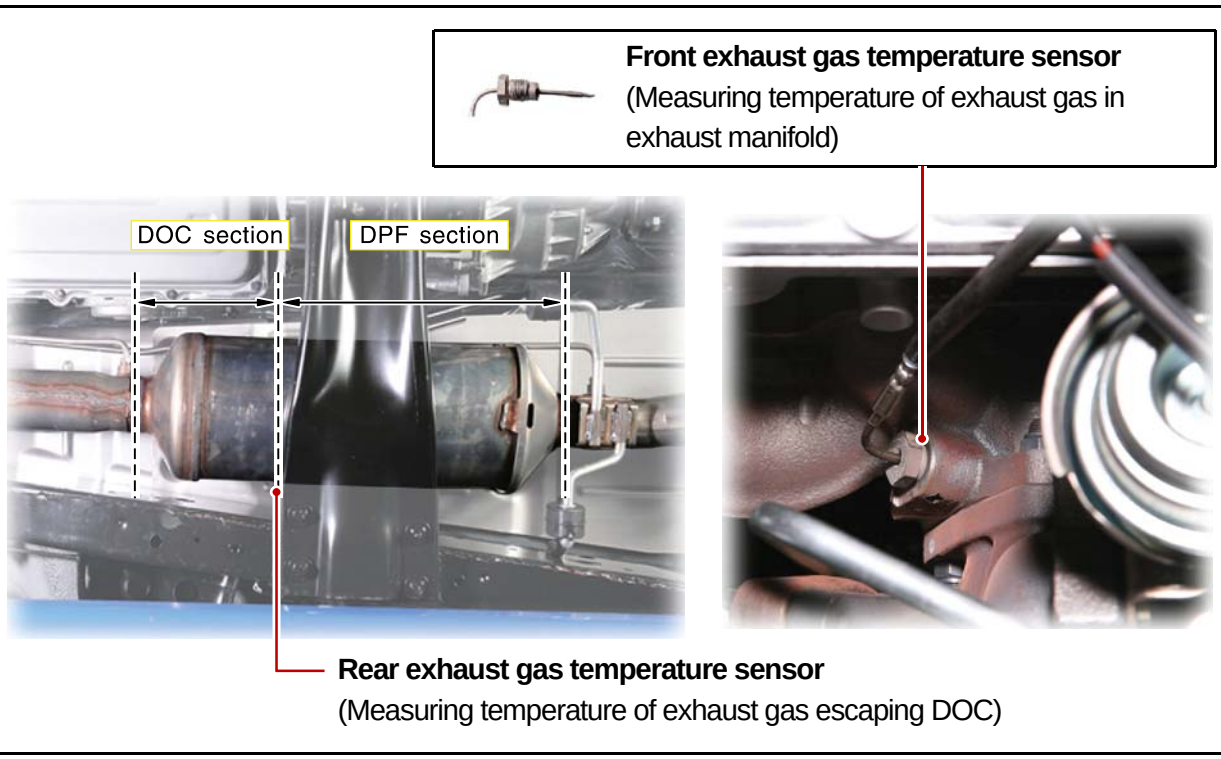
2. CDPF (EURO IV) SYSTEM CONTROL

1) Combustion Temperature and Procedures

As the soot is filtered in the CDPF, it is burnt and removed, and the CDPF is returned to the initial state to collect the soot. Therefore, the burning procedures in the CDPF can be called as regeneration.

The CDPF assembly is integrated with DOC (at front side) and DPF (at rear side).

The DPF burns the soot with high-temperature exhaust gas (over 600°C). The rear exhaust gas temperature sensor monitors the temperature of DPF section. If this temperature is below the regeneration temperature, the ECU increases the post injection period to increase the fuel injection amount, and consequently to increase the exhaust gas temperature.



NOTE

- Normally, when the vehicle is driven for 600 ~ 1,200 km, the enough amount of soot to be burnt is filtered and accumulated in the CDPF. The ECU increase the amount of post injection to increase the tempeature of exhaust gas up to 600°C so that the soot is burnt. The soot is burnt for 15 ~ 20 minutes.

2) Sytem Composition for Soot Combustion

When the engine is running in low load range, the temperature of exhaust gas is decreased as the amount of fuel supplied is decreased. To burn the soot filtered in the CDPF, the control system should be installed to check the operating range and increase the temperature of exhaust gas by controlling the amount of fuel supplied and intake air.

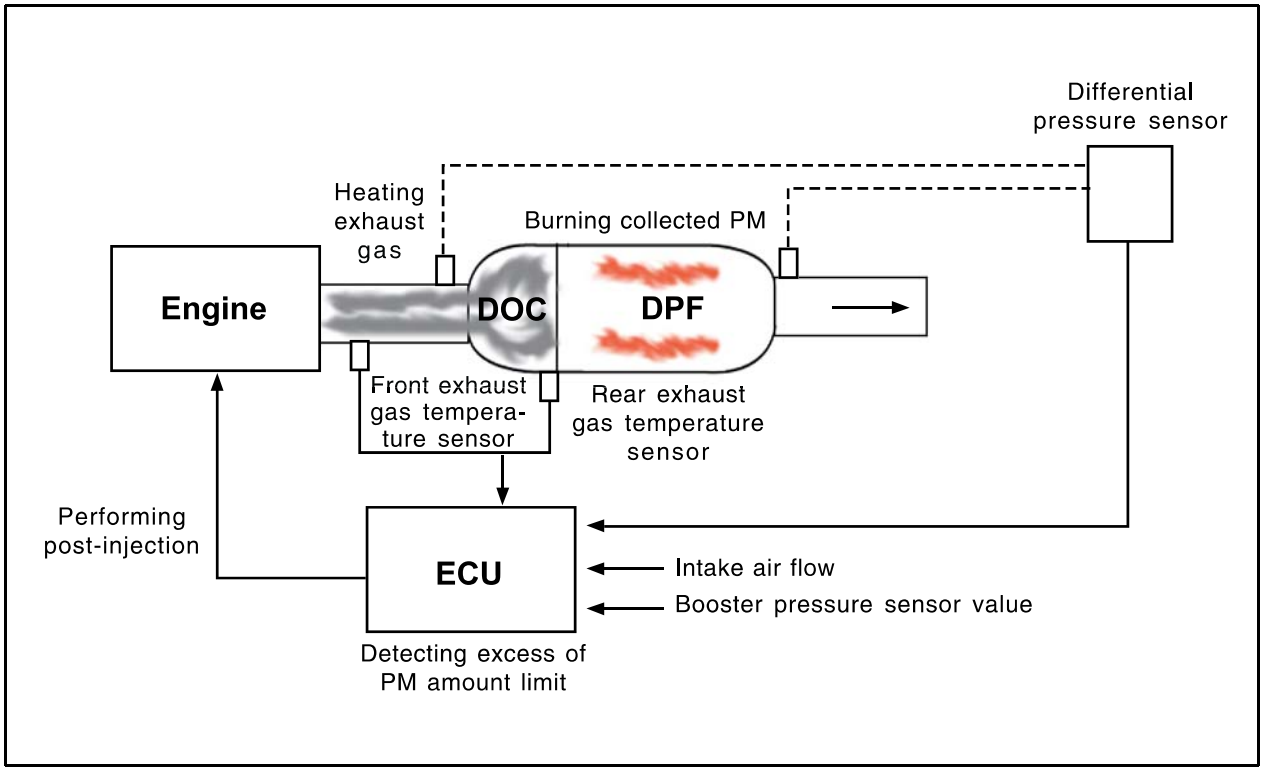
Two temperature sensors and one differential pressure sensor monitor the CDPF's operating range. According to these sensors' information, the throttle flap decreases the intake air entered to the throttle body. Also, the fuel injection pattern is added to increase the temperature of exhaust gas for soot combustion.

There are three fuel injection patterns (pilot injection, pre-injection and main injection). As the CDPF is installed, the post injection pattern is added.

3) Post Injection and Air Mass Control

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 acumulated 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.



Modification basis	
Application basis	
Affected VIN	

NOTE

Throttle bodies by engine type

- The throttle valve is controlled by electric signals sent from the engine ECU for optimal fuel injection volume, engine load and effective combustion of EGR gas according to the Euro 4 regulations. It has following functions by the engine type.

Engine	Control Method	Function
D27DTP + CDPF **D27DT + CDPF** **D20DT + CDPF**	ECU's electric signal (Duty and On/Off control) + Throttle flap control during CDPF operation	**CDPF control -** added a function that increases the exhaust gas temperature by closing the throttle valve flap to minimize the intake air amount by the fuel injection amount during the CDPF regeneration range with the low engine load range. **ON/OFF control -** prevents the engine from turning off with vibration and noise by closing the throttle body flap to block the intake air when the engine is stopped. **EGR gas amount control -** Close the valve to decrease the intake air amount and lets more EGR gas flows to burn more EGR gas at EGR valve operating range.
D27DT engine (EU IV)	ECU's electric signal (Duty and On/Off control)	**ON/OFF control -** prevents the engine from turning off with vibration and noise by closing the throttle body flap to block the intake air when the engine is stopped. **EGR gas amount control -** Close the valve to decrease the intake air amount and lets more EGR gas flows to burn more EGR gas at EGR valve operating range.
D27DT engine	No throttle body installed	

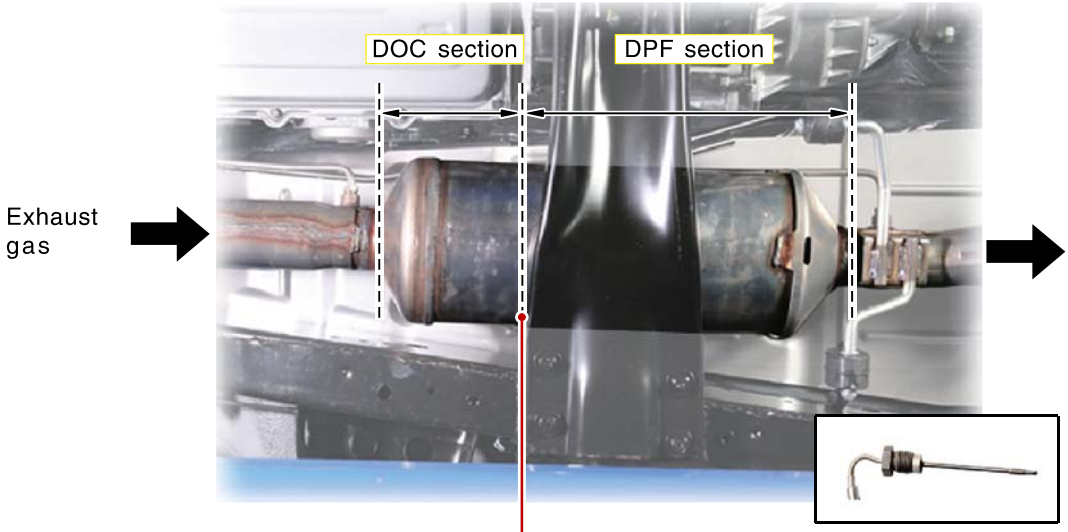
3. SOOT FILTERING AND BURNING PROCEDURES

1) Operating Procedures of CDPF

The most efficient and practical technology for now is adopted to the diesel particulate filter (DPF).
This system collects the soot from the diesel engine to the filter and burns the soot so that over than 95% of soot can be removed from the exhaust gas. However, the durability and the cost of additional system remain as problems.

Firstly, the exhaust gas is passed through the DOC and its temperature is increased as it is oxidized. The ECU detects the temperature change with two temperature sensors. The CO, HC and partial particulate material are removed from the exhaust gas (this procedures are the sames as the ones for the conventional DOC and no sensor is required).

After the exhaust gas is passed through the DOC and oxidized, most of the harmful material is removed from the exhaust gas. However, to meet the environmental regulations in the future, the soot is filtered and burnt again in DPF to decrease the particulate material further.



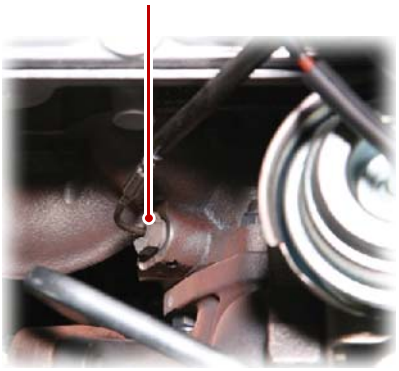
NOTE

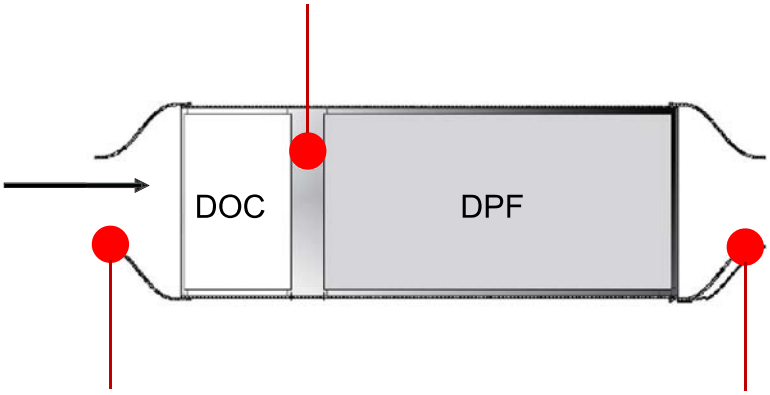
- The filtered soot is burned whenever the vehicle is driven for 600 ~ 1200 km. The driving distance can be differed depending on the vehicle's driving conditions. The soot is burnt for 15 ~ 20 minutes.

Modification basis	
Application basis	
Affected VIN	

Front temperature sensor
(Measuring the temperature of exhaust gas passed through exhaust manifold)

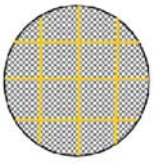
Rear temperature sensor
(Measuring the temperature of exhaust gas passed through DOC)



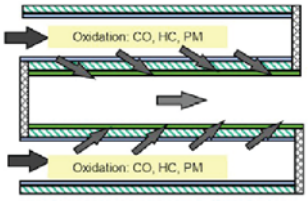


Differential pressure sensor (Front pressure port)

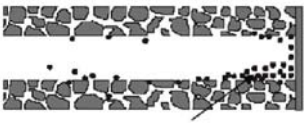
Differential pressure sensor (Rear pressure port)



The exhaust gas enters into CDPF assembly after passing through the exhaust manifold.
(Normal temperature of exhaust gas: approx. 250°C)

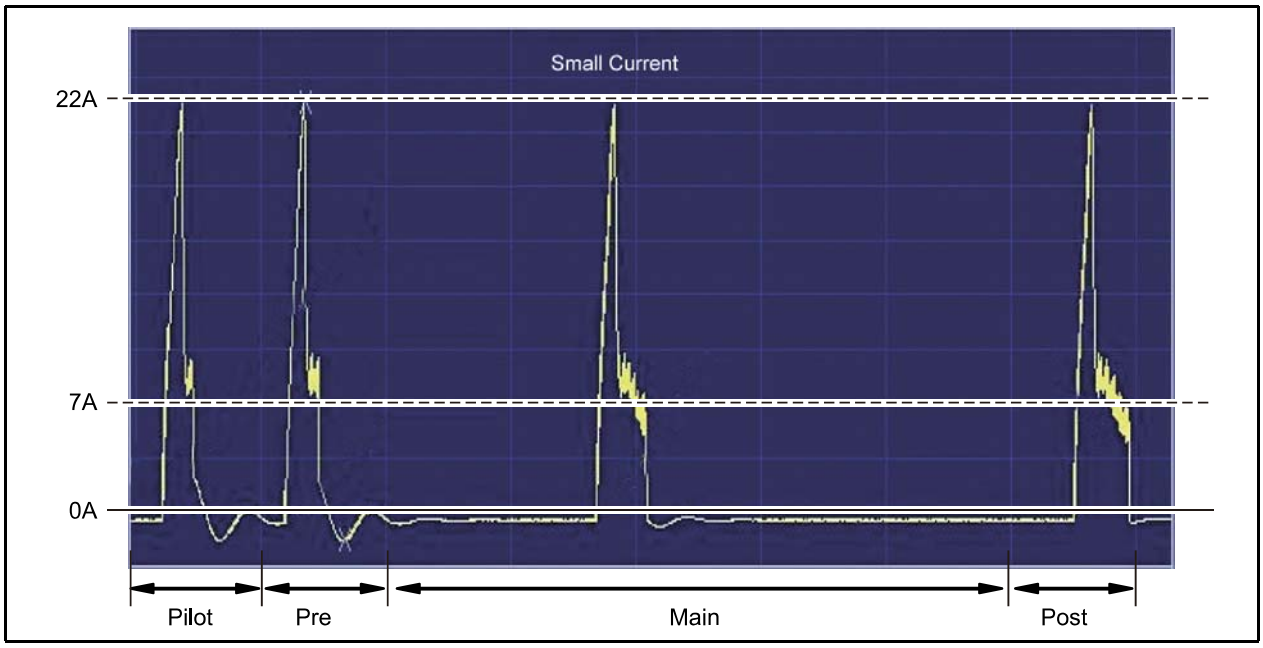


When the exhaust gas enters into the CDPF assembly, its CO, HC and particulate material are reduced as it is oxidized in DOC. The remaining particulate material is filtered and collected in DPF and the temperature of exhaust gas is increased to approx. 450 ~ 500°C.



The engine ECU detects the amount of particulate material colected by the information from temperature sensors and differential pressure snesor. When the soot is accumulated, the pressure difference between the front and the rear side occurs. Then, the engine ECU performs the post injection to raise the exhaust gas temperature and burn the collected soot at approx. 600°C.

2) Fuel Injection During CDPF Regeneration



3) Warning Lamp Related To CDPF

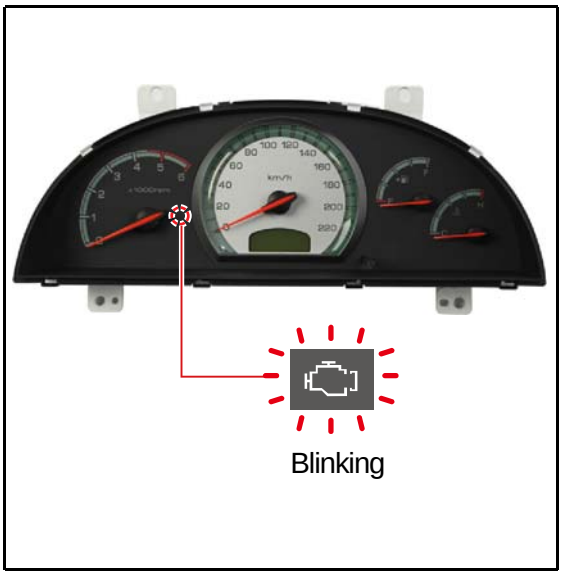
▶CDPF regeneration process (warning lamp NOT illuminated)



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 during 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.

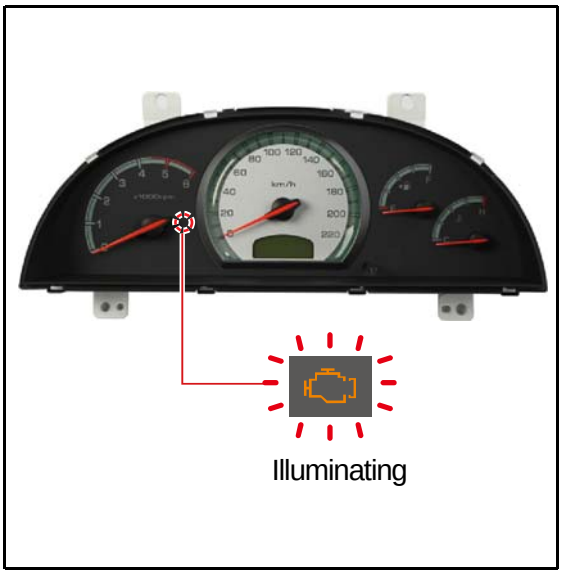
Modification basis	
Application basis	
Affected VIN	

▶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 condition continues and the CDPF is overloaded with soot, the engine warning lamp blinks to inform this situation to the driver.
2. 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 burnt 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 overload 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
3. engine and exhaust system several times and erase the related DTC. Then, check if the same DTC is regenerated again. If so, check the DTC related to the differential pressure sensor.

Actually, the DTC for the CDPF is generated more often by the component related to the CDPF system, such as the differential pressure sensor, than by excessive soot in the CDPF.

4. COMPONENTS OF CDPF SYSTEM

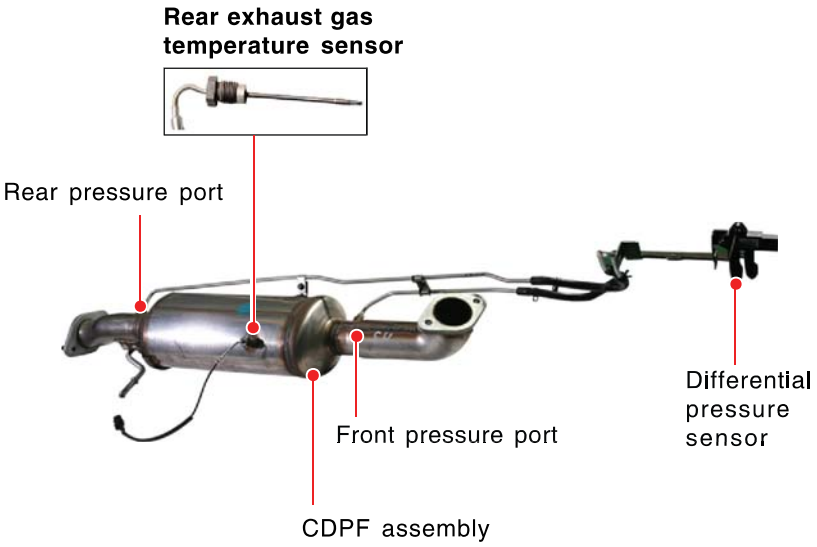
▶Mounting condition and location

Differential Pressure Sensor

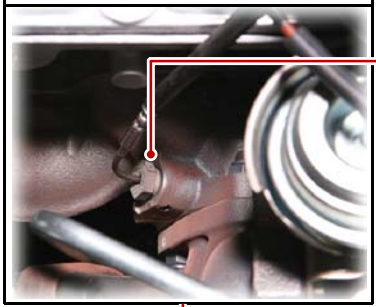
Engine compartment (RH)







Front Exhaust Gas Temperature Sensor

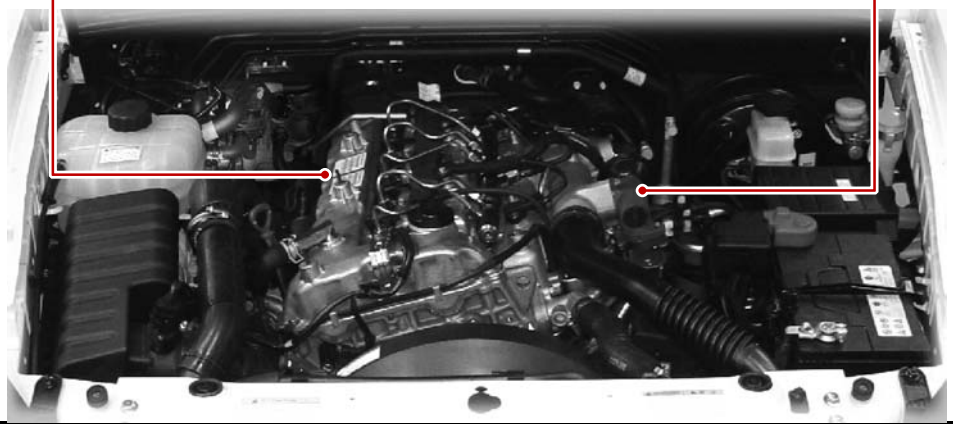




Front exhaust gas temperature sensor

Throttle Body





Modification basis	
Application basis	
Affected VIN	

NO DATA

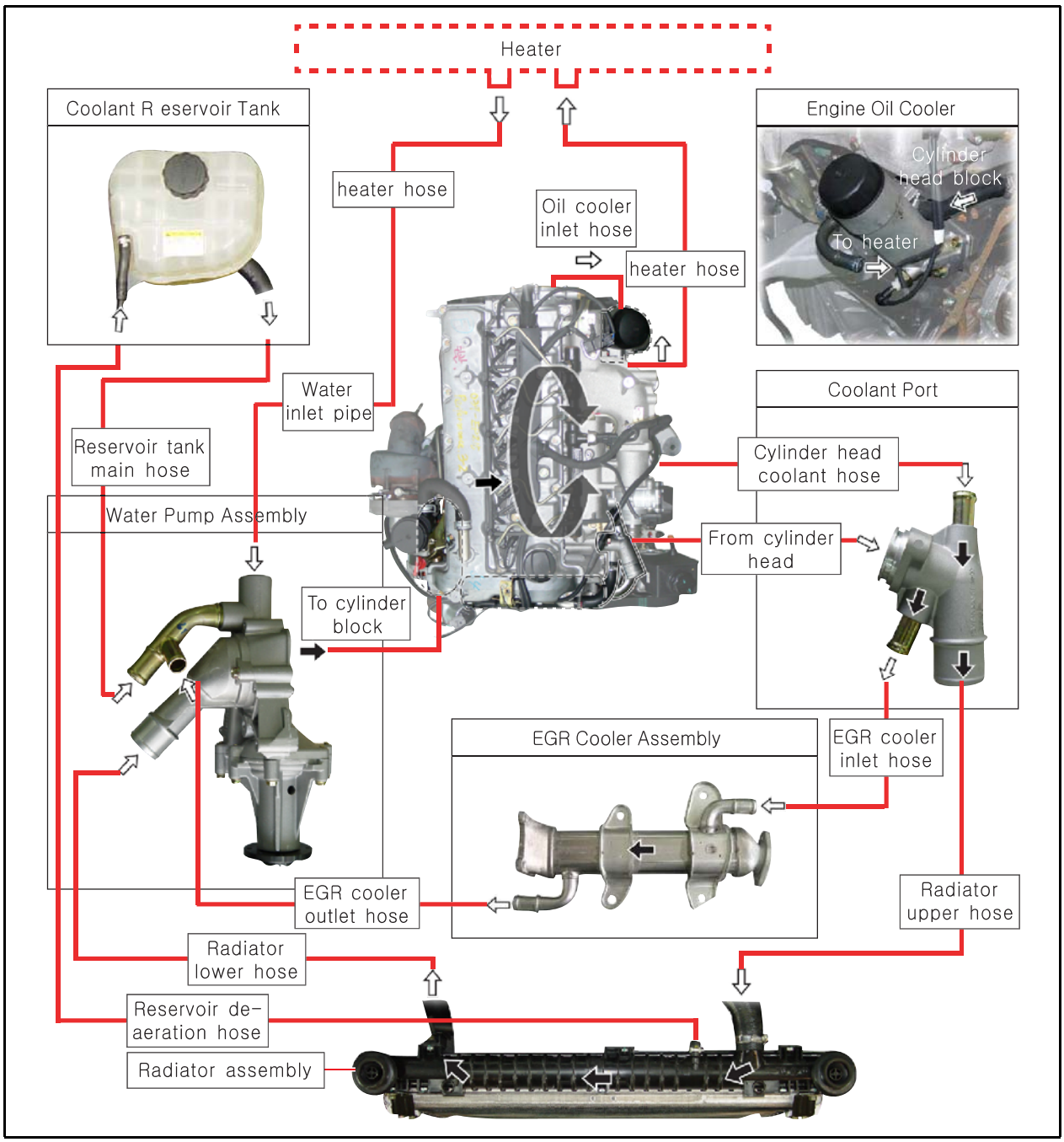
ENGINE COOLING SYSTEM 1520-01

OVERVIEW AND OPERATION PROCESS

1. COMPARISON IN COOLING SYSTEM FOR EACH ENGINE

For the D27DTP (POWER UP) engine, the cooling system is equipped with E-EGR cooler and the water pump which its capacity is improved according to the additional coolant line in the cylinder block. For the D27DT engine, the cooling system uses the fan clutch.

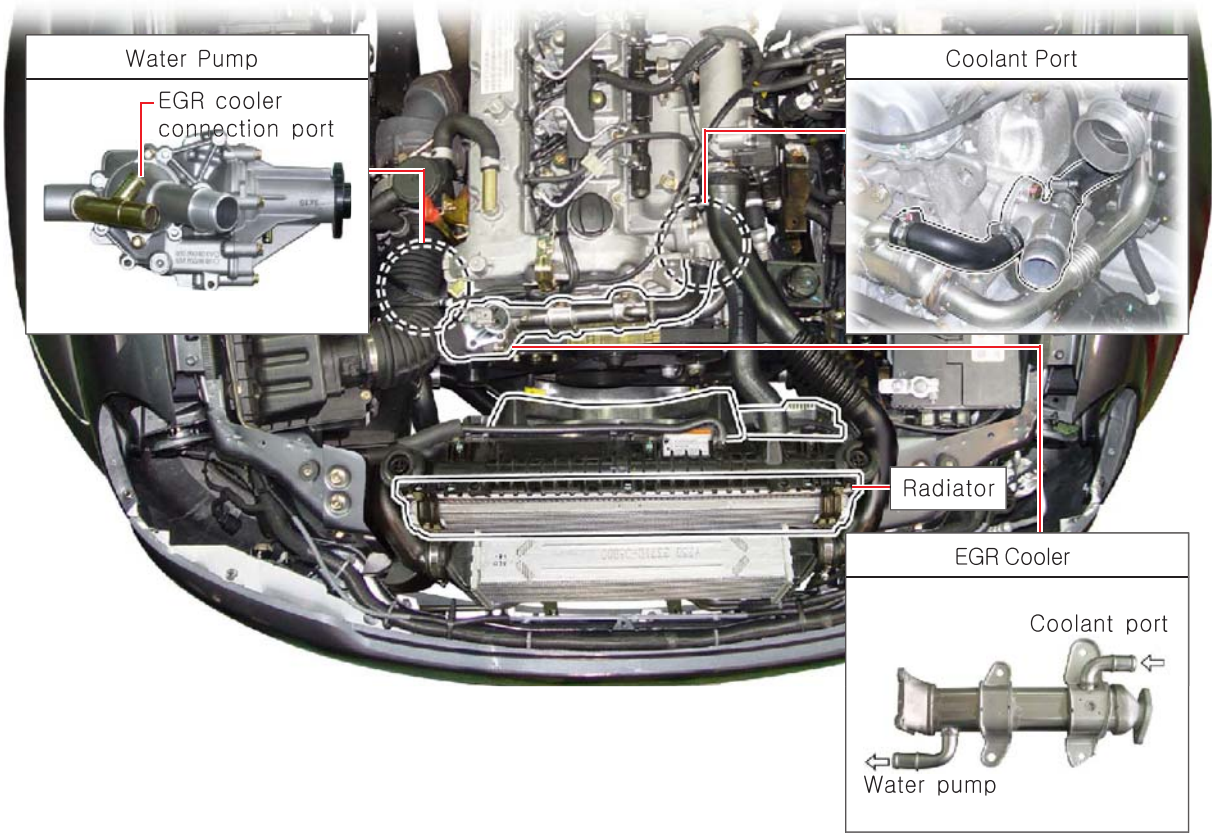
▶ **Cooling System for D27DTP (POWER UP) Engine**



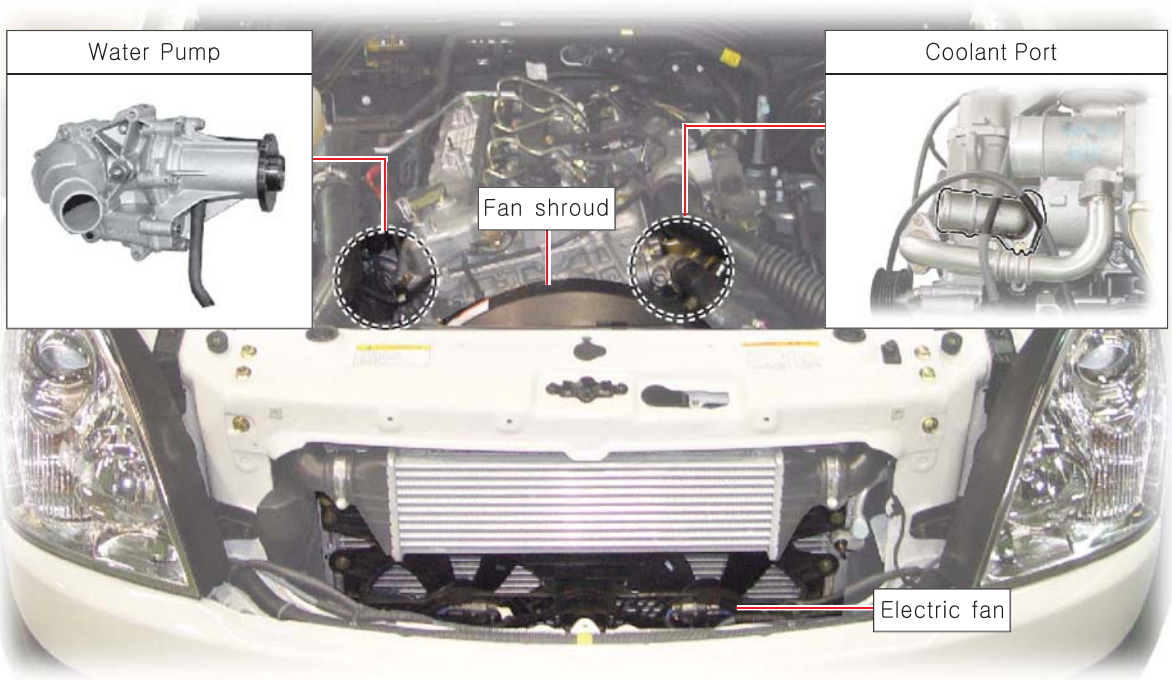
Modification basis	
Application basis	
Affected VIN	

▶ **Comparison**

D27DTP (POWER UP) & D27DT (EU IV) Engine



D27DT Engine



Modification basis	
Application basis	
Affected VIN	

NO DATA

NO DATA

CRUISE CONTROL

8510-23

OVERVIEW AND OPERATING PROCESS

1. SYSTEM DESCRIPTION

1) System Description



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 38 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.

2) 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

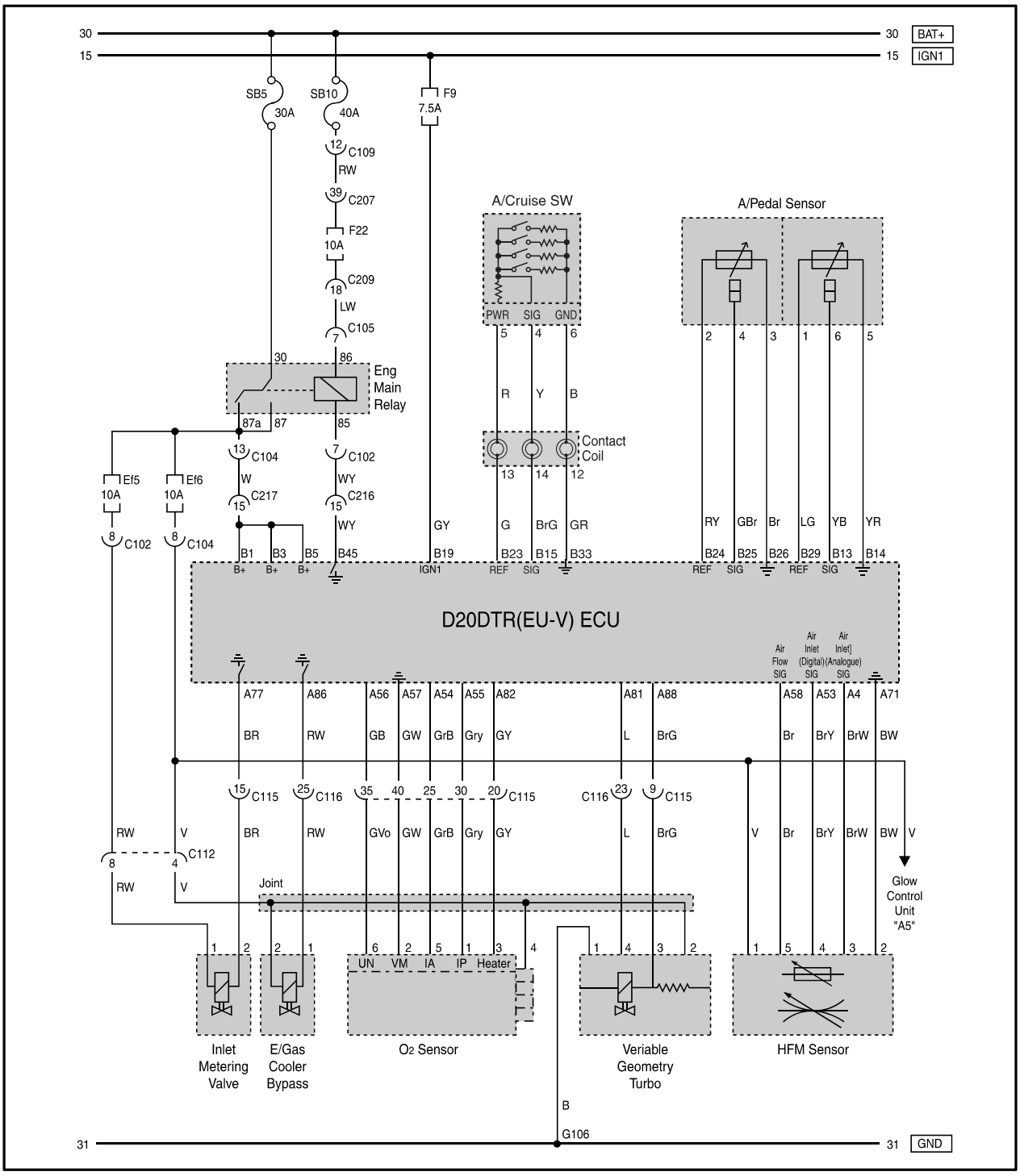
Improper use of the cruise control could be dangerous.
- Do not use on winding roadsyy .
- Do not use in heavy traffic.
- Do not use on slippery, wet roads.

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

Modification basis	
Application basis	
Affected VIN	

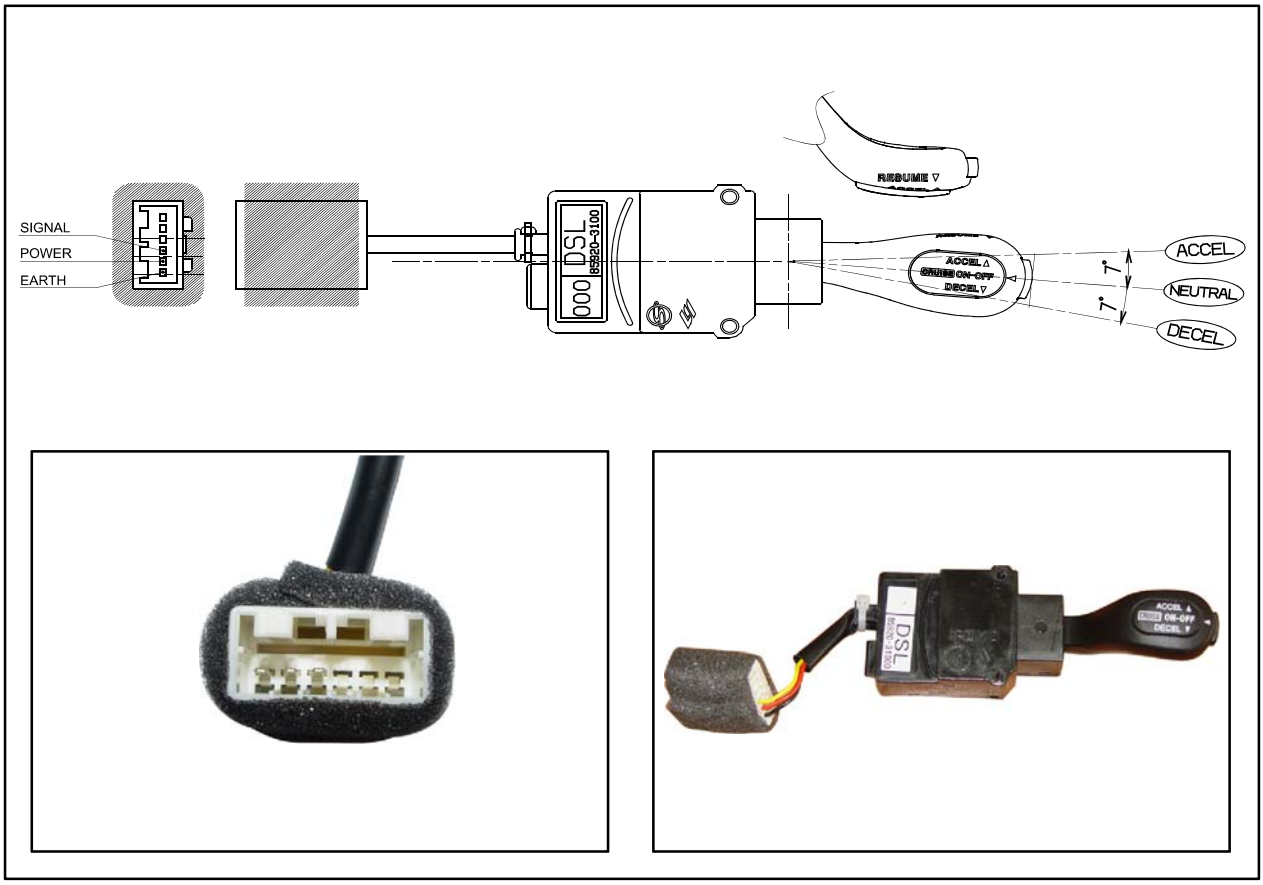
2. CONFIGURATION

1) Circuit Diagram



The engine ECU detects the operating conditions of cruise control system, and monitors the braking performance, vehicle speed, road conditions and ESP system operation. If the engine ECU determines that there are not any problem to drive in cruise control mode, the vehicle can be operated by cruise switch signals (decelerating, accelerating, cruising).

2) Configuration



▶ **Test voltage(VCC 5V)**

FUNCTION	KEY VOLUE	REMARK
MAIN	0.15 ~ 0.55V	-
DECEL	0.7 ~ 1.1V	-
ACCEL	1.6 ~ 2.0V	-
RESUME	2.52 ~ 2.92V	-

Modification basis	
Application basis	
Affected VIN	

3. OPERATION

1) Setting a Desired Speed



1. To operate the cruise control, accelerate to the desired speed, which must be more than 36 km/h and less than 150 km/h.
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. You don't need to use the accelerator pedal.
4. Refer to the following pages for details of operation.

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.

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) When the cruise control system is not running

To increase the speed with the cruise control system while the system is not running, follow the procedures below.

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

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

To increase the vehicle speed in stages while the cruise control system is running, follow the procedures below.

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. When you operate a tap-up switching, the vehicle is accelerated for 1.3 km/h over the previous set speed.
2. If you want to accelerate for 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

To decrease the vehicle speed with the cruise control system when the system is not running, follow the procedures below.

1. Push down the cruise control switch lever to DECEL side and hold it until the desired speed is reached while the vehicle speed is over 36 km/h.
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

To decrease the vehicle speed in stages while the cruise control system is running, follow the procedures below.

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. When you operate a tap-down switching, the vehicle is decelerated for 1.0 km/h below the previous set speed.
   If you want to decelerate for 10 km/h, operate the tap-down switching ten times without the
2. 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 pulling up 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

But the driver should know the previous set speed to react to the changed vehicle speed properly. If the vehicle speed increases abruptly, depress the brake pedal to adjust the vehicle speed properly.

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 or When ESP is activated.
2. When the cruising speed is downed less than 34 km/h
3. When applying the parking brake during driving.
4. When using the clutch in order to shift (M/T only).

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.
   When the rapid acceleration is applied without acceleration pedal intervention.
2. When the cruise control lever is faulty.
3. When the brake switch and the brake light switch input signal are implausible.

When the cruise control function is cancelled abnormally or intermittent problems occur, stop the vehicle and turn off the ignition switch and remove the key to reset the system. After a while, turn on the ignition switch again to operate the cruise control system.

CAUTION

1. Do not move the shift lever to Neutral position while driving with the cruise control turned on. Otherwise, it may result in system malfunction or accidents.
2. Always be prepared to use the brake or accelerator pedal for safe driving while the cruise control system is running.
3. The actual speed can be different from the set speed momentarily when driving on a uphill or downhill. So, it is recommended to disable the cruise control function on a uphill or downhill. hen driving on a steep hill use the engine brake and foot brake properly to protect the vehicle system and for a safe driving.
4. Ensure that the safe distance is maintained and use the brake pedal if needed.

Modification basis	
Application basis	
Affected VIN	

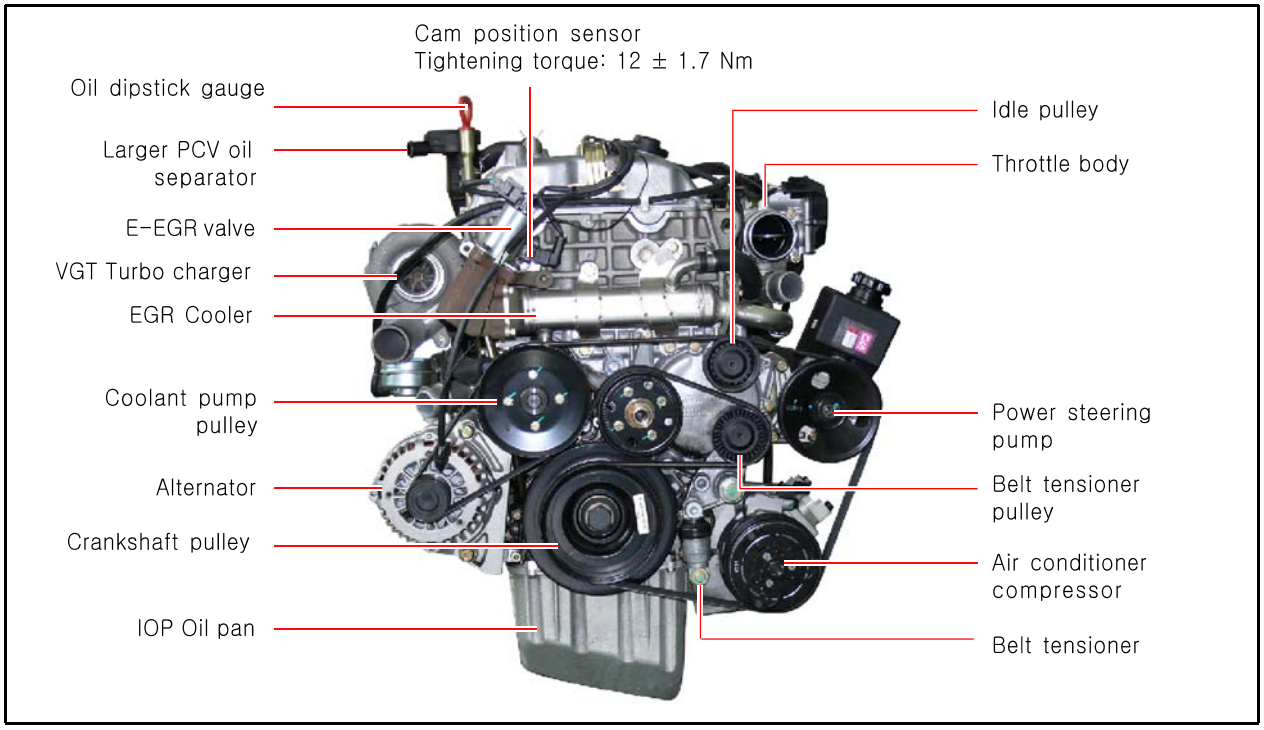
ENGINE GENERAL

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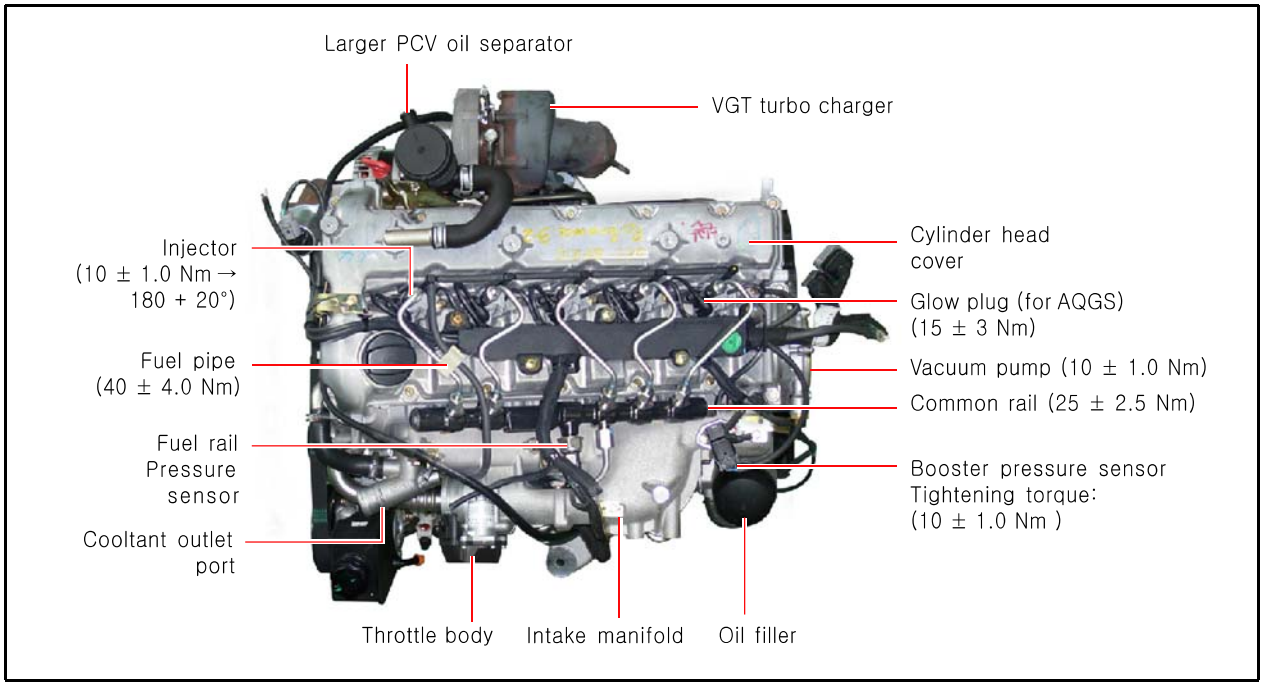
GENERAL

1. STRUCTURE AND COMPARISON

▶ D27DTP (POWER UP) + CDPF Engine - Front View

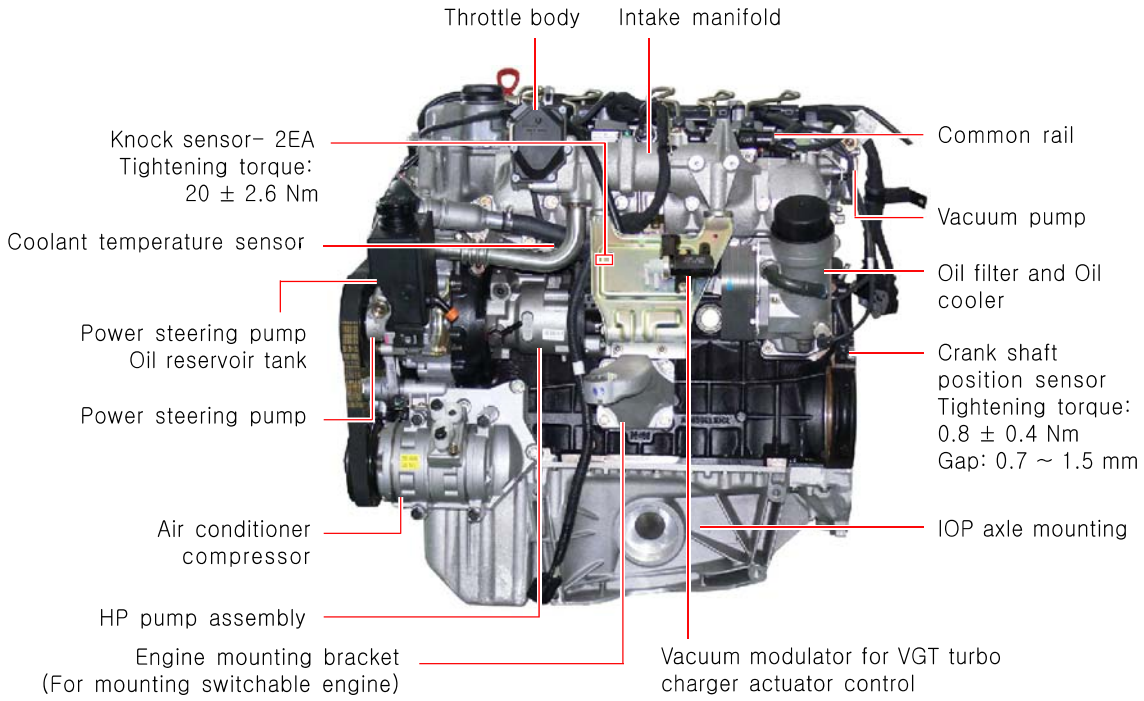


▶ D27DTP (POWER UP) + CDPF Engine - Top View

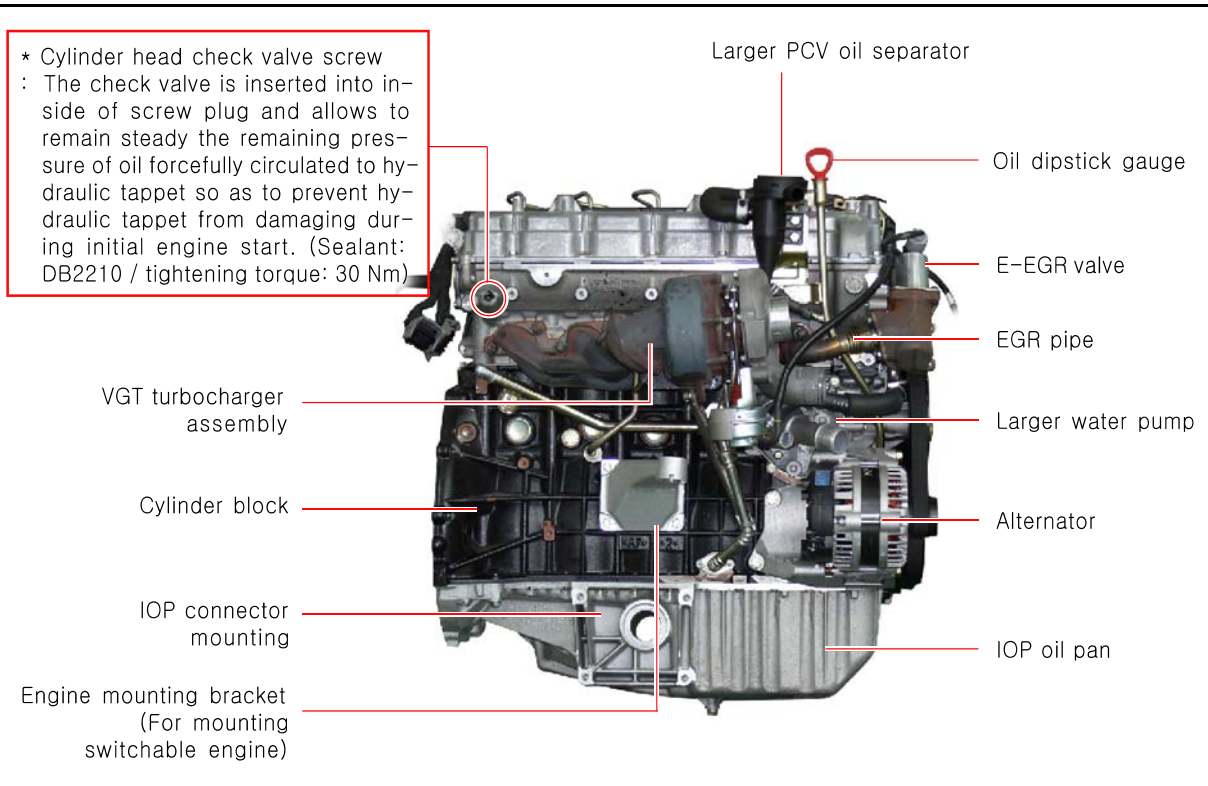


Modification basis	
Application basis	
Affected VIN	

▶ D27DTP (POWER UP) + CDPF Engine - Side View

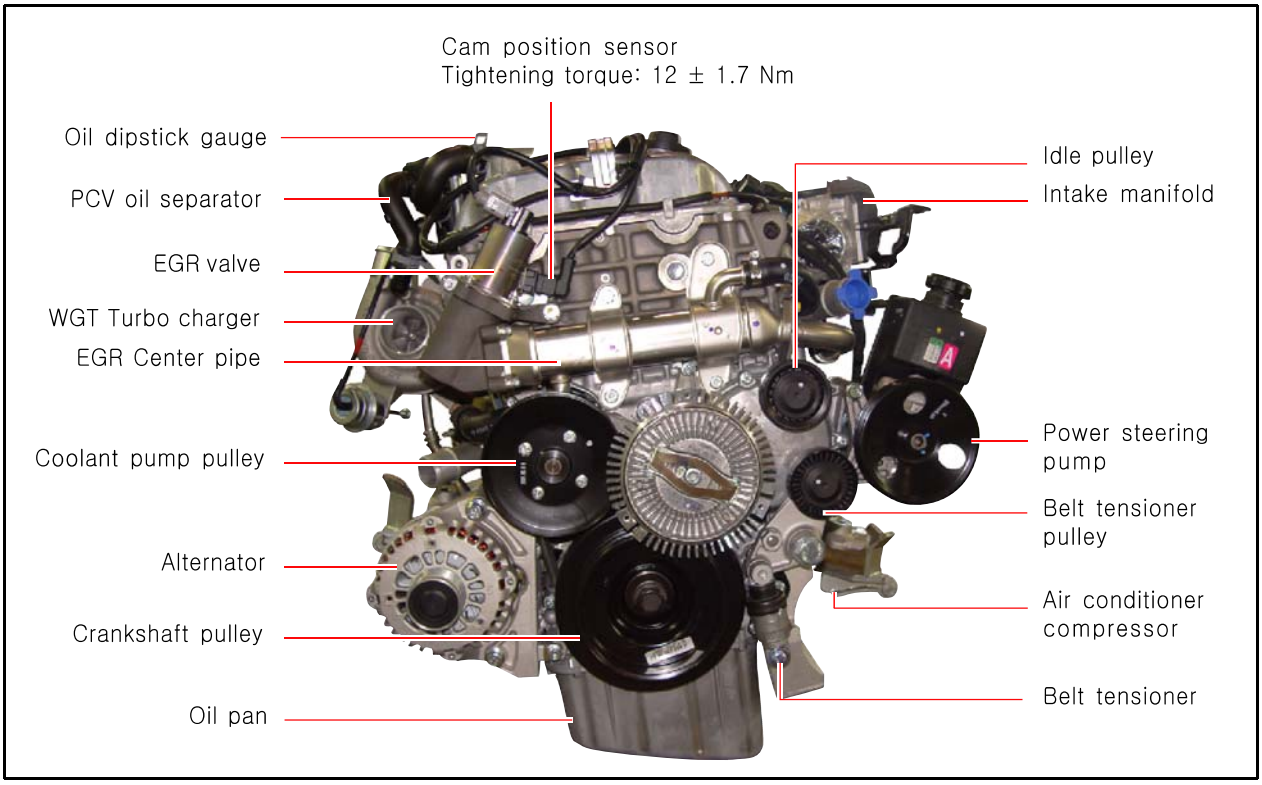


▶ D27DTP (POWER UP) + CDPF Engine - Left Side View

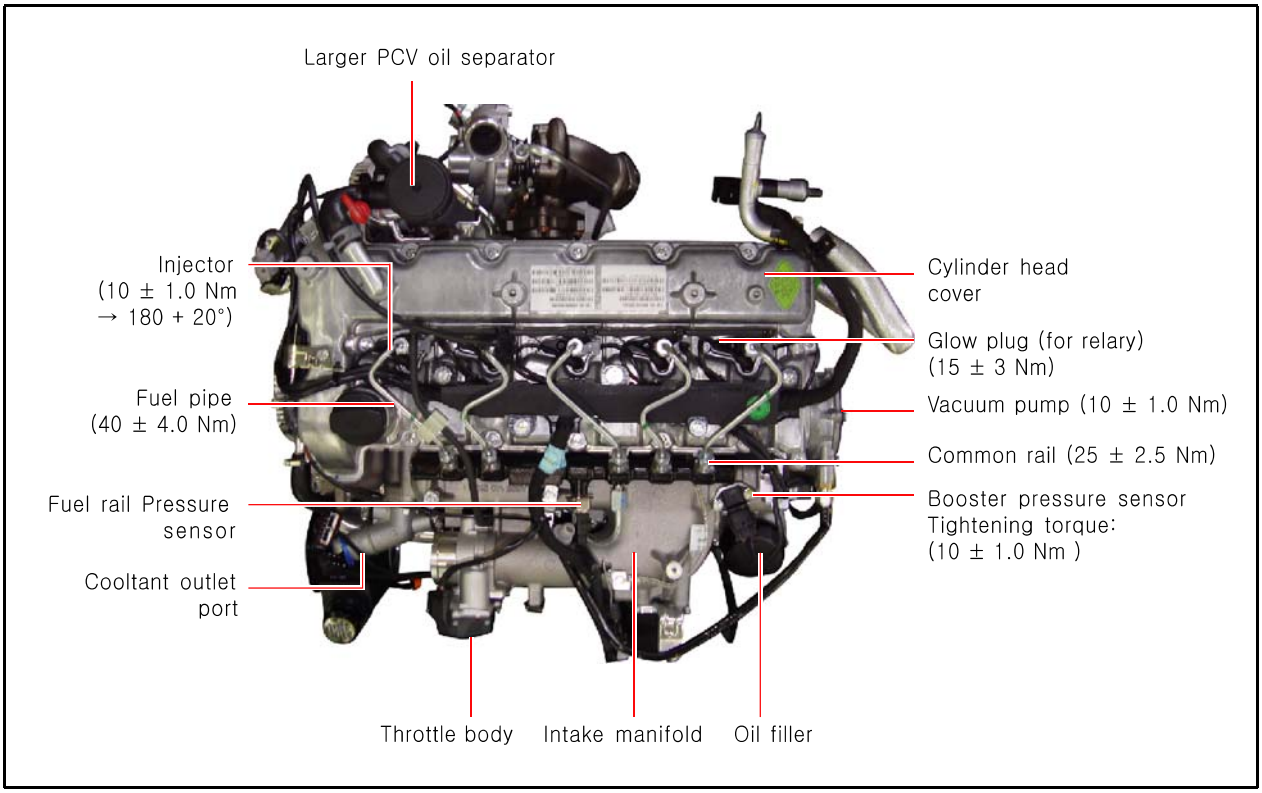


Modification basis	
Application basis	
Affected VIN	

▶ D27DT (EU IV) Engine - Front View

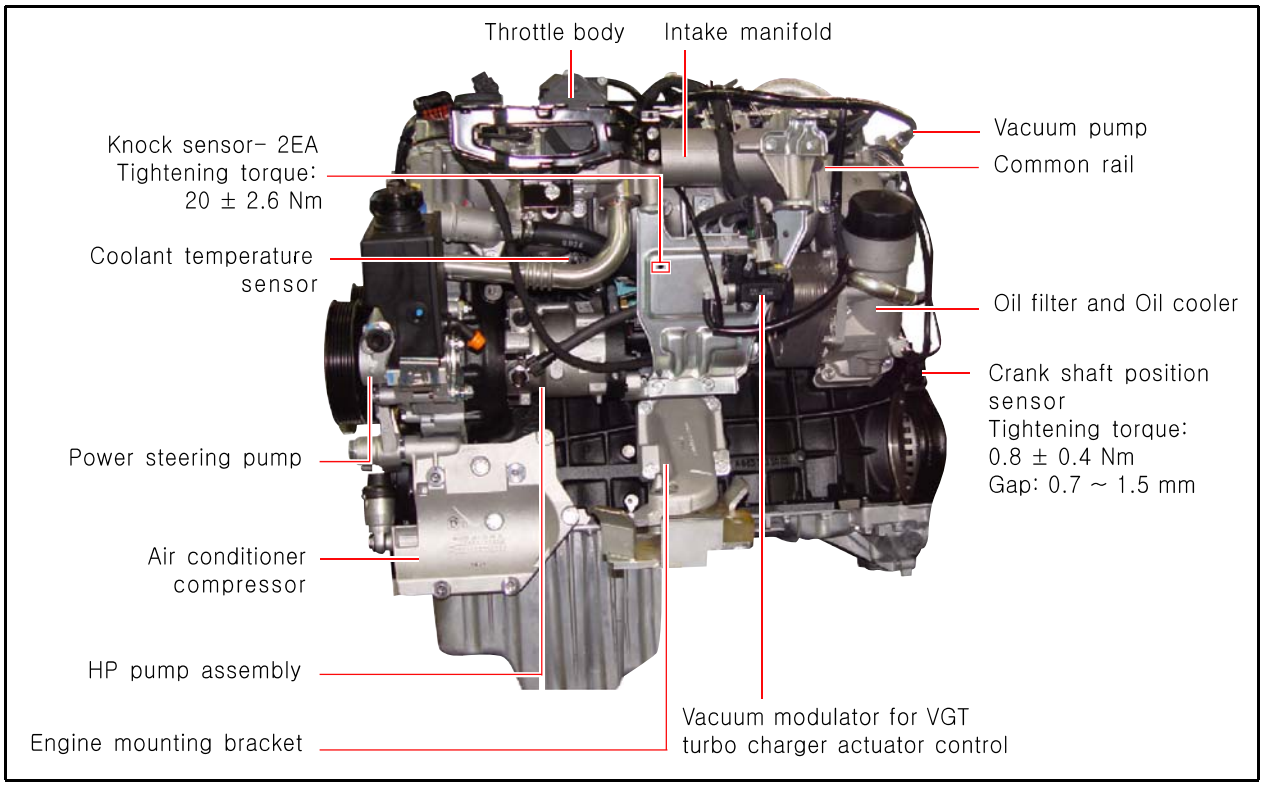


▶ D27DT (EU IV) Engine - Top View

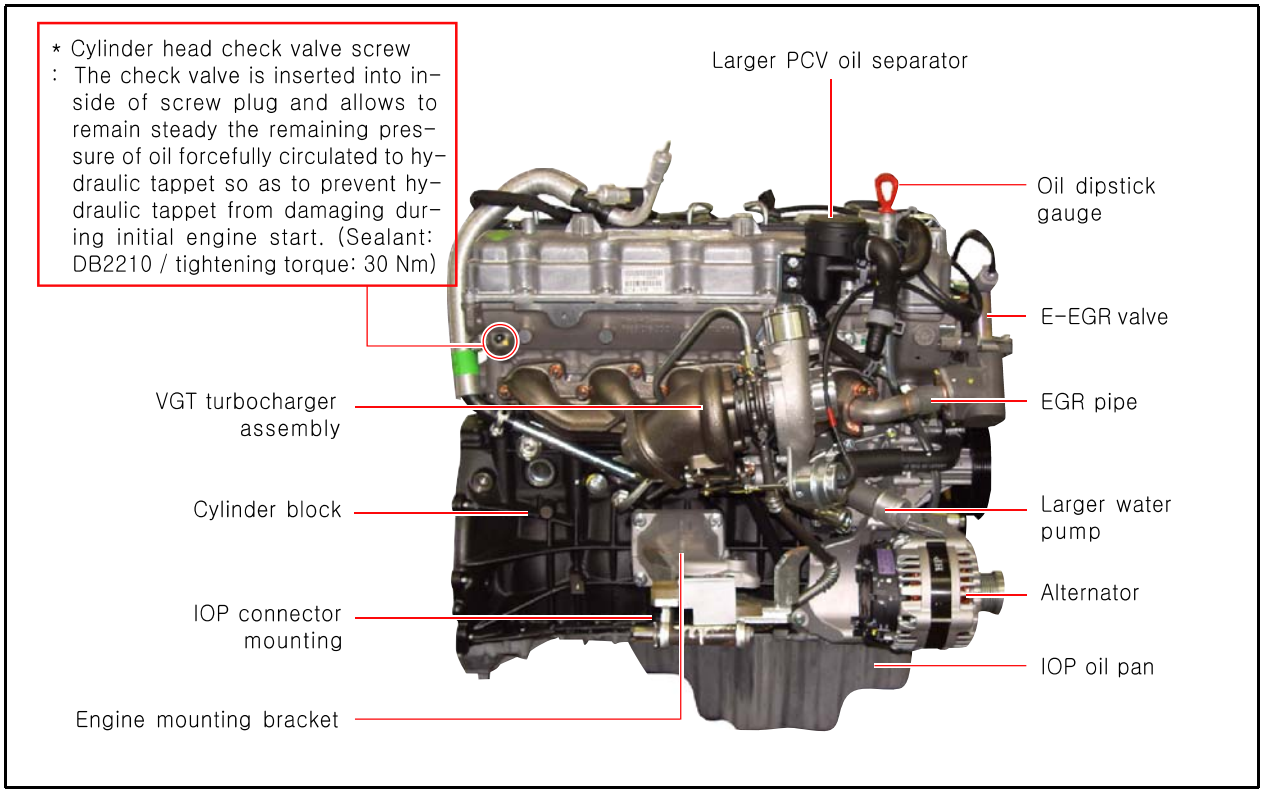


Modification basis	
Application basis	
Affected VIN	

▶ D27DT (EU IV) Engine - Side View

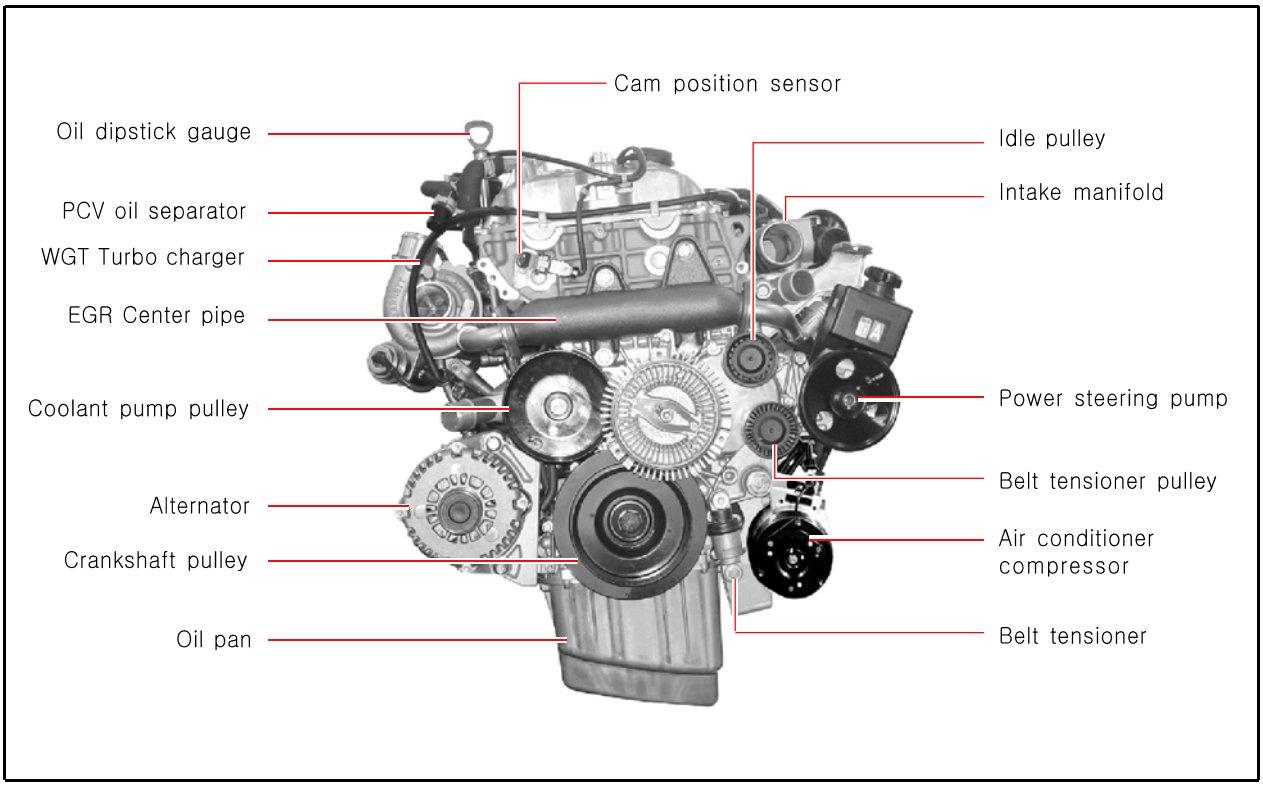


▶ D27DT (EU IV) Engine - Left Side View

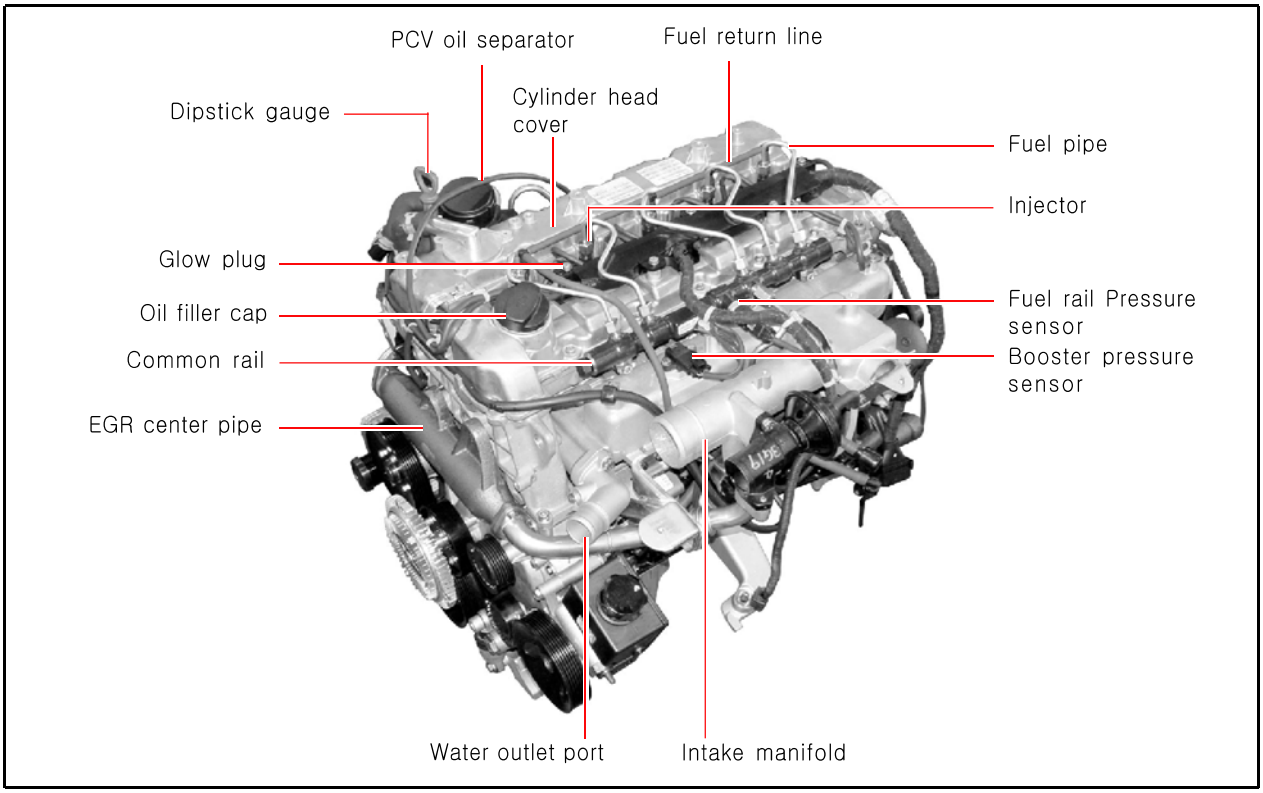


Modification basis	
Application basis	
Affected VIN	

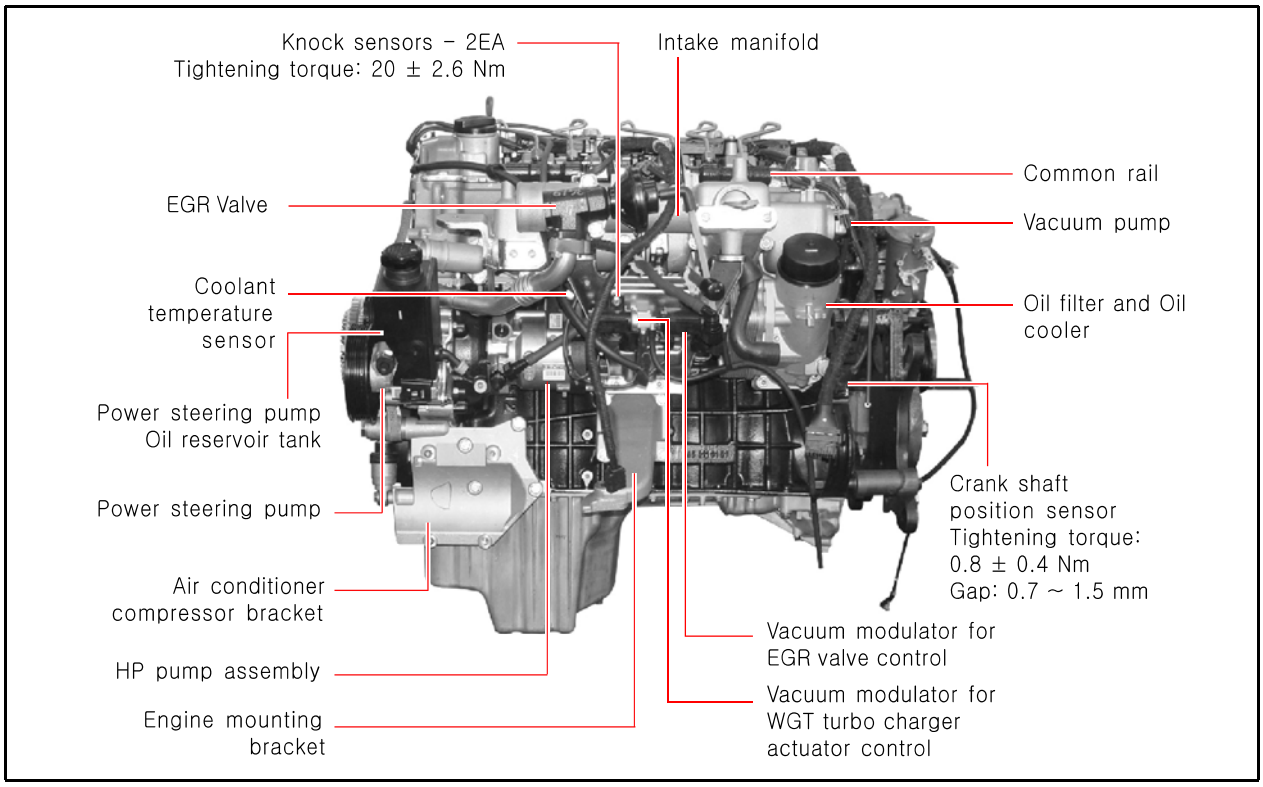
▶ D27DT Engine (General) - Front View



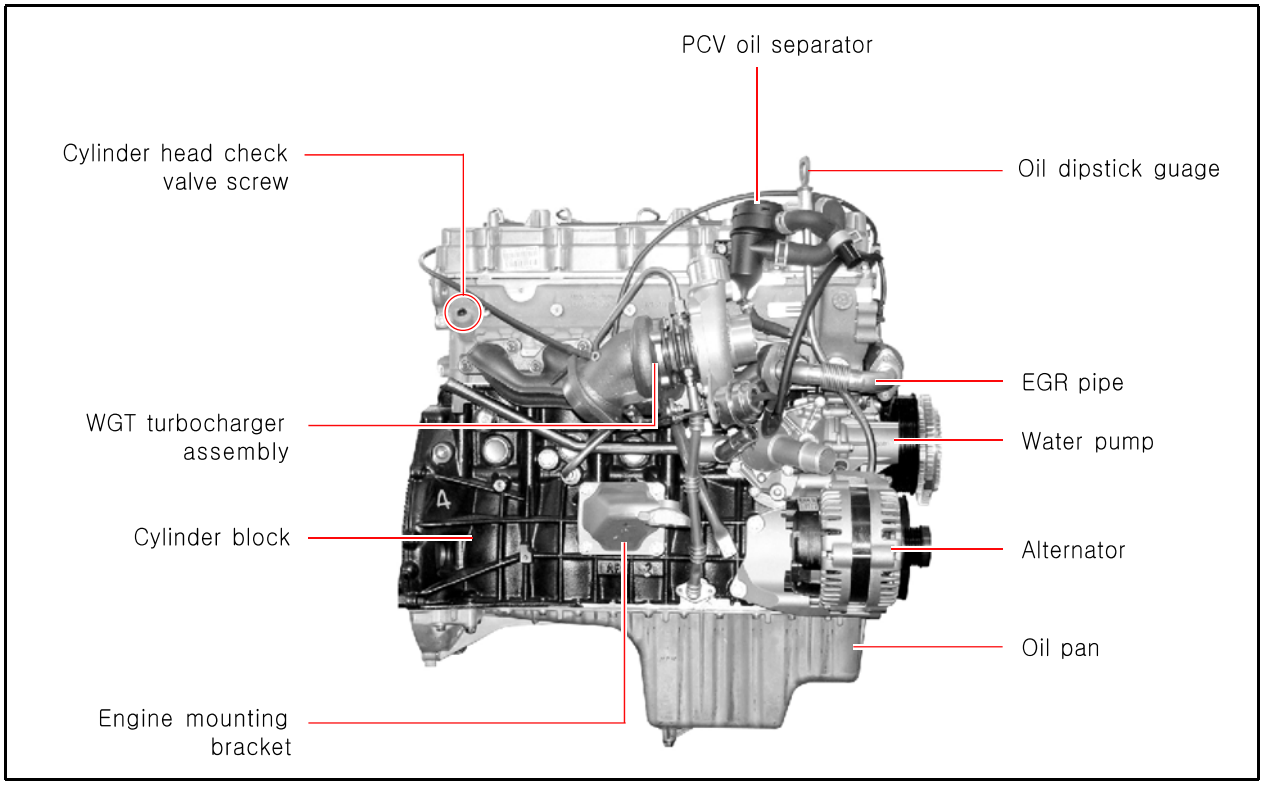
▶ D27DT Engine (General) - Top View



▶ D27DT Engine (General) - Side View



▶ D27DT Engine (General) - Left Side View



Modification basis	
Application basis	
Affected VIN	

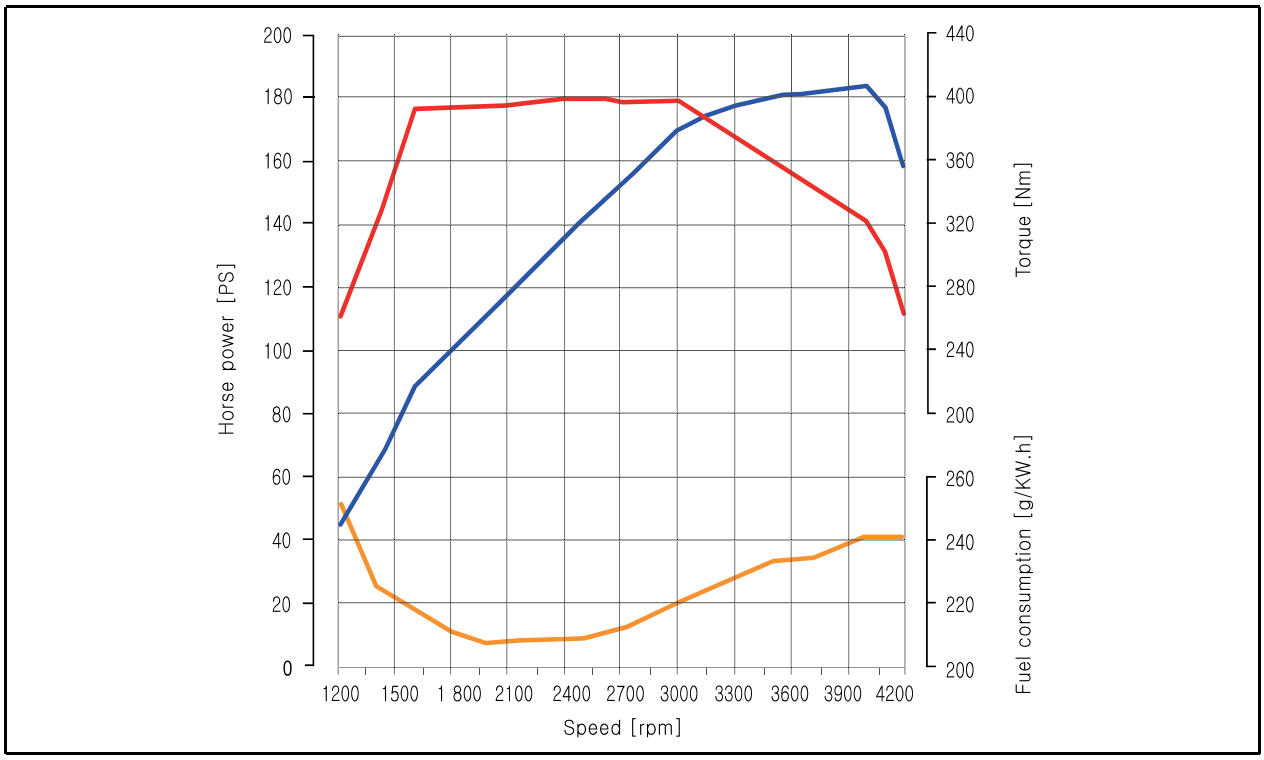
2. ENGINE SPECIFICATIONS AND PERFORMANCE CURVE

1) Specifications

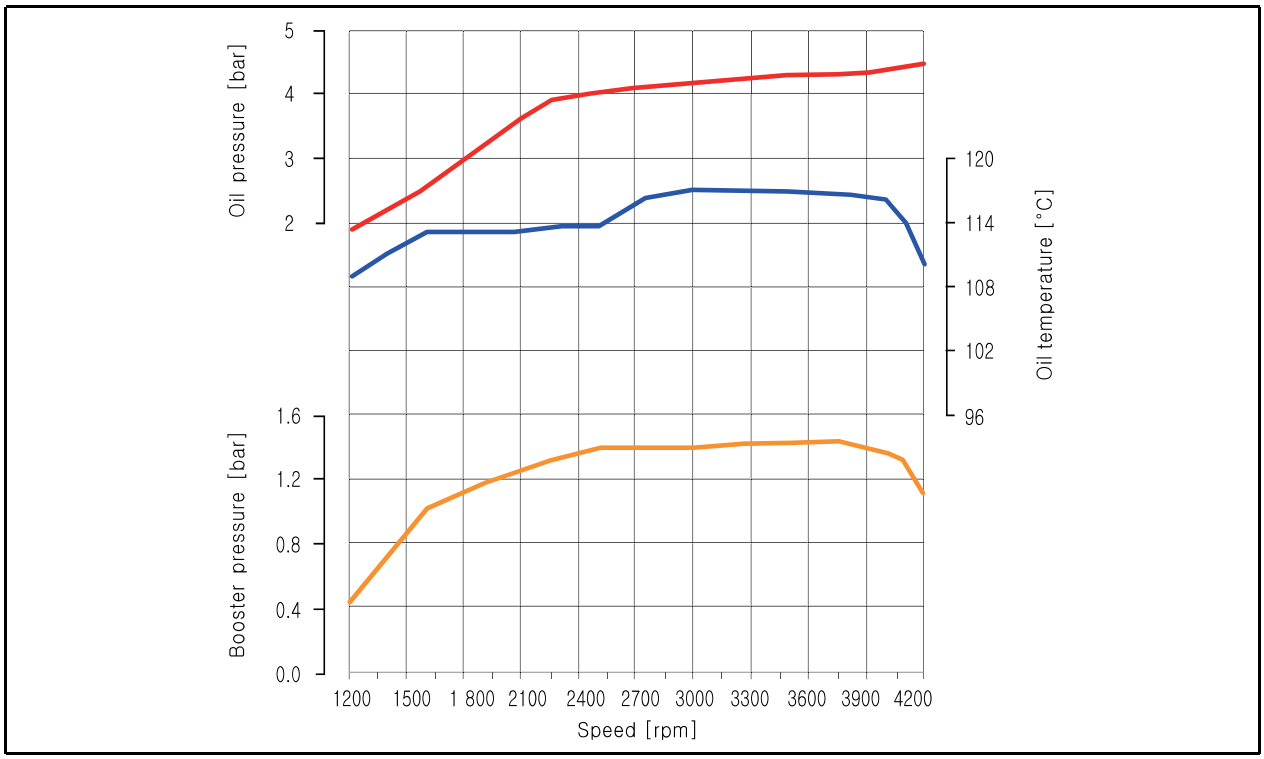
Descriptions			D27DTP (POWER UP) + CDPF Engine * ( ) : CDPF	D27DT (EU IV) Engine	D27DT Engine
Engine	Type/Number of cylinders		D27DT/5-cylinder	←	←
Cylinder	Inner diameter (mm)		86.2	←	←
	Stroke (mm)		92.4	←	←
Displacement (cc)			2696	←	←
Compression ratio			17.5:1	←	←
Maximum output (ps/rpm)		For Automatic	186 (180) / 4,000	165 / 4,000	←
		Transmission	-	165 / 4,000	←
Maximum torque (kg ·m/rpm)		For Manual	41 / 1,600 ~ 3,000	35.7 / 1,800 ~ 3,250	←
		Transmission	-	34.7 / 1,800 ~ 3,250	←
Idle speed	For Manual Transmission		-	750 ± 20 rpm	760 ± 50 rpm
	For Automatic Transmission		750 ± 20 rpm	←	←
Valve	Intake	Opens (btdc)	9°	←	←
		Closes (abdc)	26°	←	←
	Exhaust	Opens (bbdc)	38°	←	←
		Closes (atdc)	16°	←	←
Camshaft	Type		DOHC	←	←
Fuel system	Fuel type		Low sulfur diesel	←	←
	Fuel pump type		Vane pump in HP pump	←	←
	Fuel supply pressure	HP pump Inlet port	-0.4 ~ 0 mbar	Max. 400 mbar	←
		HP pump outlet port (with IMV fully open)	Below 1,600 bar	Above 1,050 bar	←
	Water separation in fuel filter		Every 10,000 km	←	←
	Fuel tank capacity (ℓ)		78	←	←
Lubrication system	Oil specification		SAE 10W40, 5W40 (MB Sheet 229.1, 229.3 approved oil)	←	←
	Lubrication type		Gear pump Forced circulation	←	←
	Oil filter type		Full flow type, filter element type	←	←
	Oil capacity (ℓ)		≒ 8.5	←	←
Cooling system	Cooling type		Water cooling type/ Forced circulation	←	←
	Cooling fan operation type		Belt operated type	←	←
	Thermostat (* Note: Fully opened at 100°C)	Opening temperature	85 °C	←	←
		Type	WAX Pellet Type	←	←
	Coolant capacity (ℓ)		≒ 11.0 ~ 11.5	←	←

2) D27DTP (Power Up) Engine Performance Curve

(1) Output and Torque: vehicle with automatic transmission



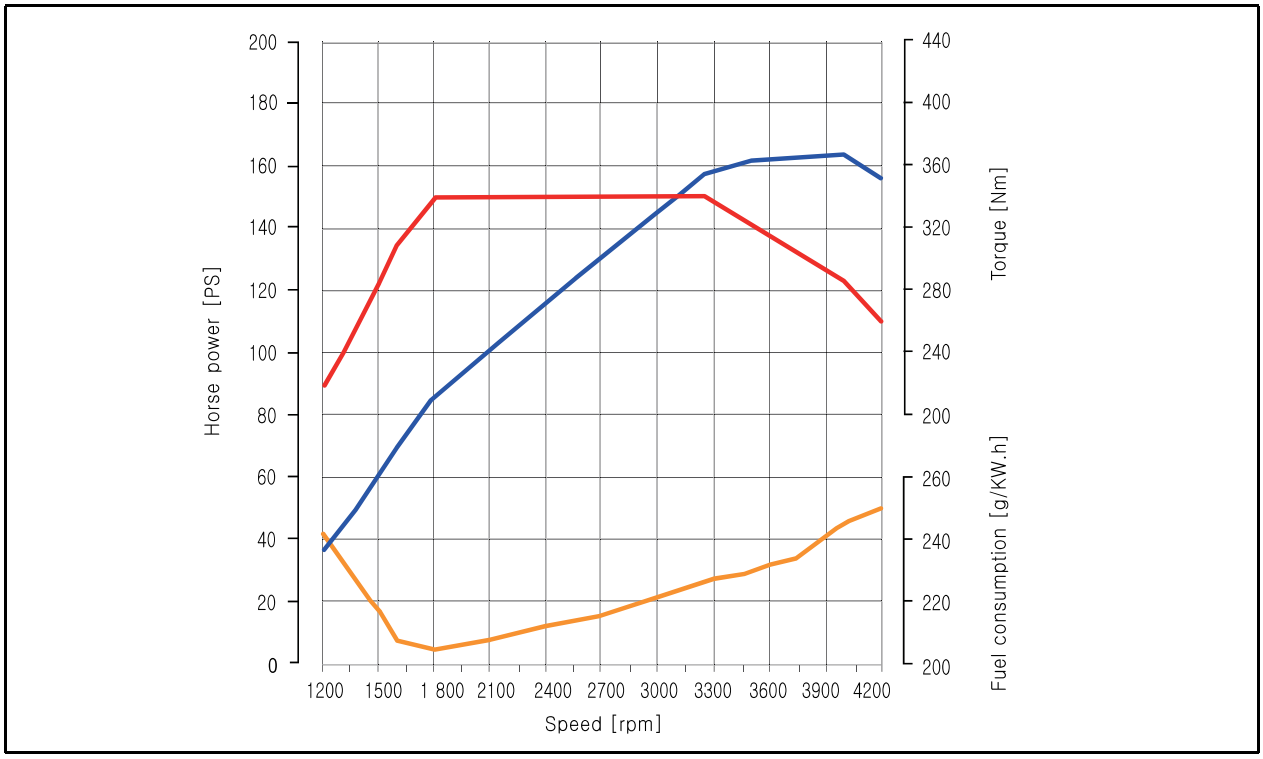
(2) Oil Temperature/Pressure and Boost Pressure: vehicle with automatic transmission



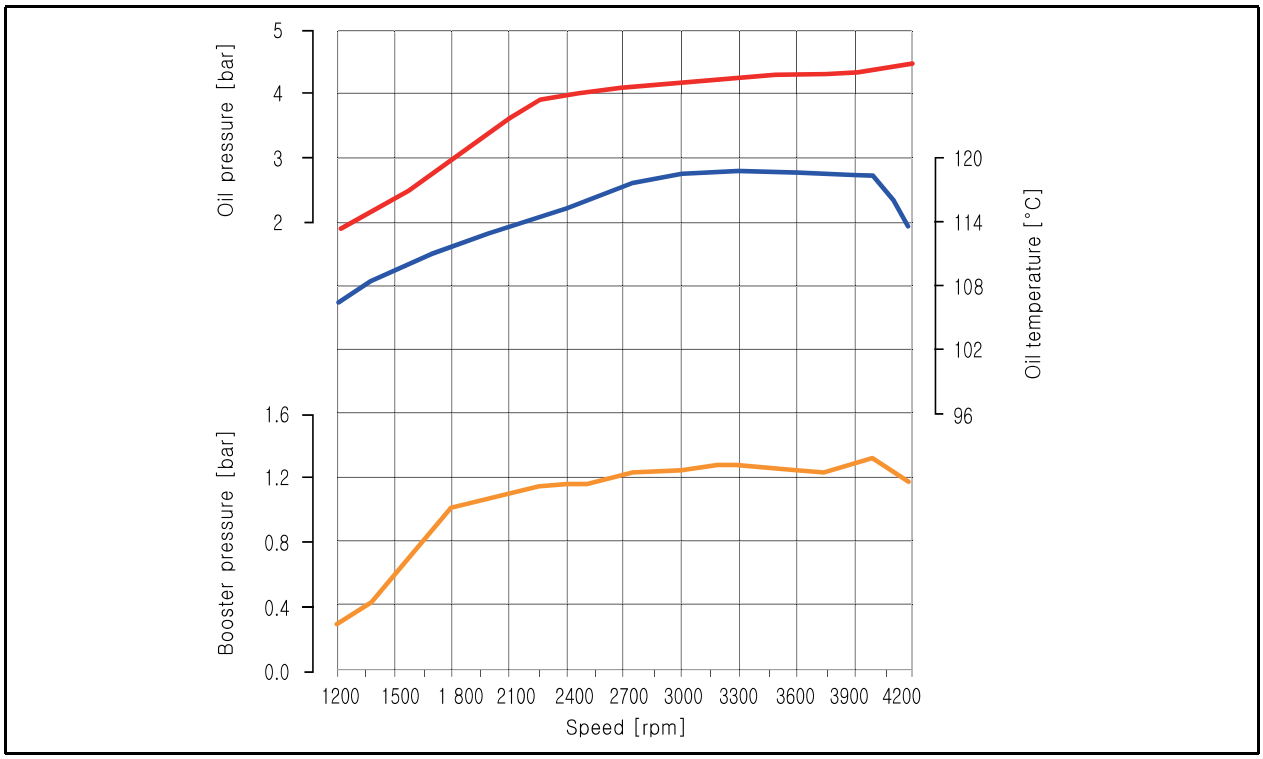
Modification basis	
Application basis	
Affected VIN	

3) D27DT Engine Performance Curve

(1) Output and Torque



(2) Oil Temperature/Pressure and Boost Pressure



3. TIGHTENING TORQUE

This table shows the tightening torques for removal/mounting and disassembly/reassemly of the engine.

Name	Size	Quantity	Tightening Torque (Nm)		
			D20DT	D27DT	D27DTP
Main bearing cap	M11 x 67	10	55 ± 5 120° ± 10°	←	←
Connecting rod cap	M9 x 51	8	40 ± 5 90° ± 10°	←	←
Rear cover	M6 x 20	6	10 ± 1	←	←
Oil pump	M8 x 35SOC	3	25 ± 2.5	←	←
T.G.C.C	M6 x 40	6	10 ± 1	←	←
	M6 x 60	3	10 ± 1	←	←
	M6 x 70	2	10 ± 1	←	←
Flywheel	M10 x 22	8	45 ± 5 90° ± 10°	←	←
Crankshaft hub	M20 x 85	1	200 180° ± 10°	←	←
Oil pan	M6 x 20	24	10 ± 1	←	←
	M6 x 35	3	10 ± 1	←	←
	M6 x 85	3	10 ± 1	←	←
	M8 x 40	4	25 ± 2.5	←	←
High pressure pump mounting bolt	M8 x 55	3	25 ± 2.5	←	←
High pressure pump main nut (Intermediate shaft)	M14 x 1.5	1	65 ± 5	←	←
Cylinder head	M8 x 25	2	25 ± 2.5	←	←
	M8 x 50	2			
	M10 x 158	1	85 ± 5 270° ± 10°	←	←
	M10 x 177	9			
Camshaft sprocket (Intake)	M11 x 40	1	25 ± 2.5 90° ± 10°	←	←
Camshaft sprocket (Exhaust)					
Chain tensioner	M24	1	65 ± 5	←	←
Auto tensioner	M12 x 90(UP)	1	82 ± 6	←	←
	M8 x 45(LOW)	1	32 ± 3	←	←
Water pump	M6 x 50	7	10 ± 1	←	←
Water pump pulley	M6 x 10	4	10 ± 1	←	←
Hot water inner pipe	M6 x 12	2	10 ± 1	←	←
Alternator brackrt	M8 x 80	1	25 ± 2.5	←	←
	M8 x 34	2	25 ± 2.5	←	←
	M8 x 30	2	25 ± 2.5	←	←
Alternator	M10 x 90	1	46 ± 4.6	←	←
	M10 x 116	1	46 ± 4.6	←	←

Modification basis	
Application basis	
Affected VIN	

Name	Size	Quantity	Tightening Torque (Nm)		
			D20DT	D27DT	D27DTP
Air conditioner compressor bracket	M8 x 25	1	25 ± 2.5	←	←
	M8 x 60	3	25 ± 2.5	←	←
Air conditioner compressor sub bracket	M6 x 16	1	10 ± 1.0	←	←
	M8 x 20	1	25 ± 2.5	←	←
Intake manifold	M8 x 50	5	25 ± 2.5	←	←
	M8 x 133	5	25 ± 2.5	←	←
Acoustic cover bracket	M6 x 16	2	25 ± 2.5	←	←
	M8 x 105	1	25 ± 2.5	←	←
Knock sensor	M8 x 28	1	20 ± 2.6	←	←
Camshaft position sensor	M8 x 14	1	12 ± 1.7	←	←
Booster pressure sensor	M6 x 20	2	10 ± 1.0	←	←
Exhauster manifold stud bolt	M8 x 46	10	15 ± 1.5	←	←
	M8 x 35	2	15 ± 1.5	←	←
Exhaust manifold nut	M8	10	40 ± 4.0	←	←
Turbo charger assembly	M8	3	25 ± 2.5	←	←
Turbo charger hollow bolt	M10 x 1.0	1	18 ± 1.8	←	15 ± 1.0
Turbo charger oil supply pipe	M16 (BLOCK side)	1	25 ± 2.5	←	←
Turbo charger support bar (nut)	M8	1	23 ± 2.3	←	←
Turbo charger support bar (bolt)	M8 x 20	1	25 ± 2.5	←	←
Turbo charger return pipe	M6 x 16 (T/C side)	2	10 ± 1.0	←	←
	M6 x 16 (BLOCK side)	2	10 ± 1.0	←	←
EGR Valve	M6 x 16	4	10 ± 1.0	←	-
EGR pipe (RH) nut	M8	2	35 ± 3.5	←	-
EGR pipe (RH) bolt	M6 x 16	2	10 ± 1.0	←	-
EGR cooler bolt	M8 x 16	4	25 ± 1.0	←	-
EGR valve & EGR cooler	M6 x 20	3	25 ± 2.5	←	-
	M6 x 20	2	25 ± 2.5	←	-
Glow plug	M5	5	15 ± 3.0	←	←
Vacuum pump	M6 x 20	3	10 ± 1.0	←	←
Cooling pan bracket	M6 x 25	5	10 ± 1.0	←	←
	M6 x 55	1	10 ± 1.0	←	←
	M6 x 85	3	10 ± 1.0	←	←
Cylinder head cover	M6 x 35	21	10 ± 1.0	←	←
Vacuum modulator	M6 x 16	4	10 ± 1.0	←	←
Oil dipstick gage	M6 x 16	1	10 ± 1.0	←	←
Oil filter	M8 x 35	1	25 ± 2.5	←	←
	M8 x 55	2	25 ± 2.5	←	←
	M8 x 125	1	25 ± 2.5	←	←

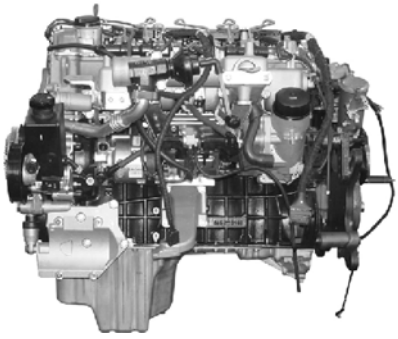
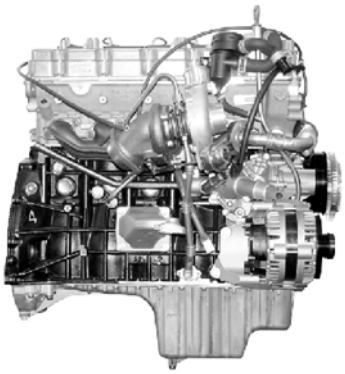
Name	Size	Quantity	Tightening Torque (Nm)		
			D20DT	D27DT	D27DTP
Fuel rail	M8 x 35	2	25 ± 2.5	←	←
Injector	M6 x 60	4	10 ± 1.0 180° ± 20°	←	←
Fuel pipe nut (H -> C)	M14	2	40 ± 4.0	←	←
Fuel pipe nut (C -> I)	M14	8	40 ± 4.0	←	←
Crank position sensor	M6 x 14	1	0.8 ± 0.4	←	←
	Gap	-	0.7 ± 1.5 mm	←	←
Power steering pump	M8 x 100	2	25 ± 2.5	←	←
Head screw plug	-	1	25 ± 2.5	←	←
Camshaft cap bolt	M8 x 60	20	25 ± 2.5	←	←
Piston topping	-	-	0.765 mm ~ 1.055 mm		
Connecting rod end play	-	-	0.500 mm ~ 1.500 mm		
Camshaft end play	-	-	0.100 mm ~ 0.350 mm		
Crank shaft end play	-	-	0.100 mm ~ 0.254 mm		
E-EGR valve assembly	M8 x 60	1	-	25 ± 2.5 (EU IV)	←
	M8 x 35	1	-	25 ± 2.5 (EU IV)	←
	M6 x 20	3	-	10 ± 1.0 (EU IV)	←
E-EGR cooler	M8 x 16	4	-	25 ± 2.5 (EU IV)	←
EGR pipe combination bolt	M6 x 16	6	-	10 ± 1.0 (EU IV)	←
Throttle body	M6 x 45	3	-	10 ± 1.0 (EU IV)	←

Modification basis	
Application basis	
Affected VIN	

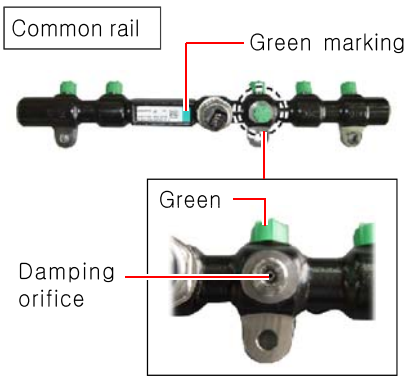
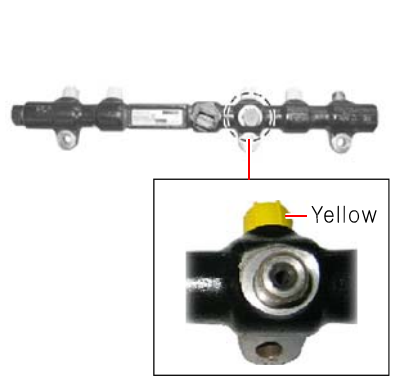
4. MAJOR CHANGES IN D27DTP (POWER UP) ENGINE (COMPARED TO D27DT)

The shape and size of D27DTP (POWER UP) are slightly different from those of D27DT engine but the basic configuration of two systems is almost same.

1) Engine Assembly

D27DTP (POWER UP) + CDPF Engine	D27DT (EU IV) Engine	D27DT Engine (General)
Front Side View 		
Right Side View 		
Left Side View 		

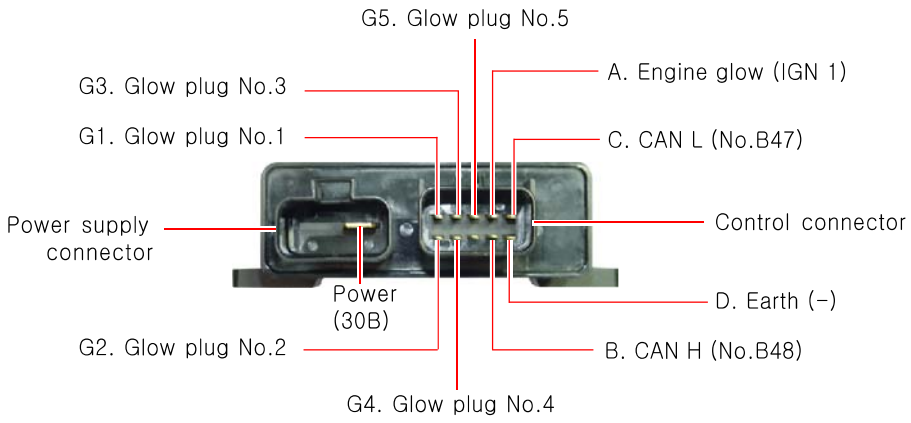
2) Major Changes and Summary

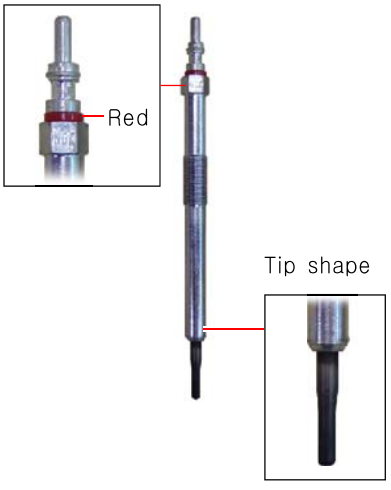
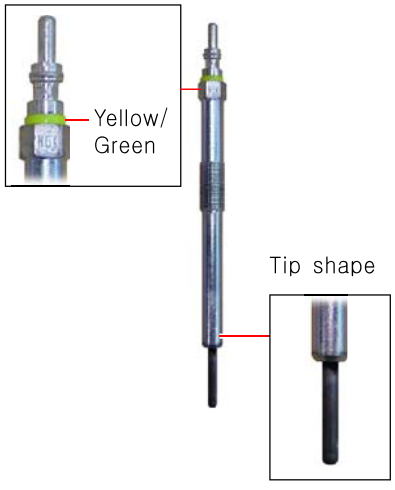
D27DTP (POWER UP) + CDPF Engine D27DT (EU IV) Engine	D27DT Engine (General)	Remarks
ECU D27DTP Engine ECU - Ver. 3.2 	D27DT Engine ECU - Ver. 3.1 	ECU version of D27DTP (POWER UP) & D27DT (EU IV) engine: Changed to 3.2 from 3.1. Number of connectors of D27DTP (POWER UP) & D27DT (EU IV) engine: Changed to 2 from 1. 1.E-EGR valve and related system 2.Throttle body and related system 3.AQGS and related system
Injector 		* Injection nozzle (holes) - D27DT (General) (5) - D27DTP & D27DT (EU IV) (7) * Injector label - D27DT (General) (16 digits: C2I value) - D27DTP & D27DT (EU IV) (20 digits: C3I value)
Common rail 		* D27DTP: Added damping orifice. (Orifice is added to fuel inlet/ outlet ports in order to dampen the pulsation in fuel flow caused by multi-injections.)

Modification basis	
Application basis	
Affected VIN	

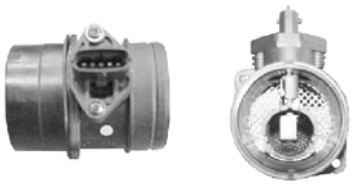
D27DTP (POWER UP) + CDPF Engine D27DT (EU IV) Engine	D27DT Engine (General)	Remarks
Fuel pipe 		* Surface coating color - D27DT: Yellow - D27DTP & D27DT (EU IV): Chrome * Diameter increased - D27DT: ID (2.4 mm), OD (6.0 mm) - D27DTP & D27DT (EU IV): ID (3 mm), OD (6.35 mm)

AQGS unit pin function

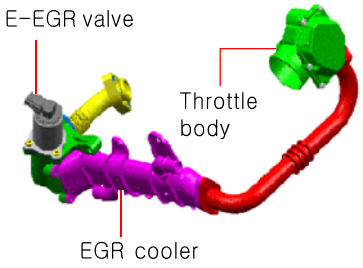
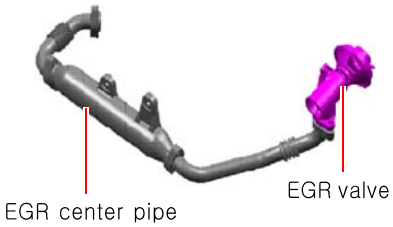
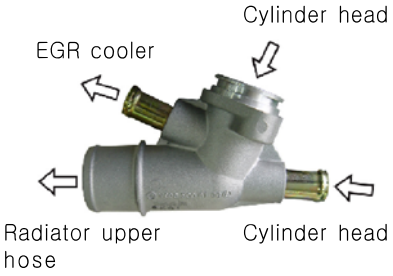
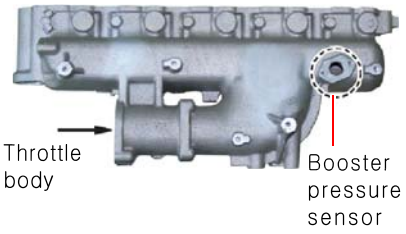
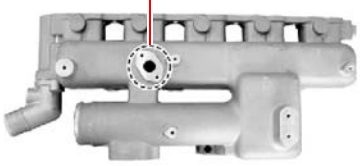
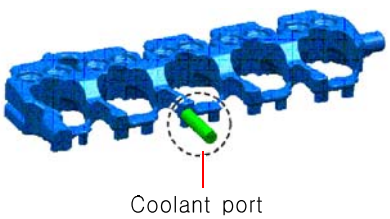


Glow plug 		* Insulator color - D27DT: Yellow (NGK) or green (BERU) - D27DTP & D27DT (EU IV): Red * Tip diameter and shape changed - D27DT: ϕ 3.5 / 4.0 mm - D27DTP & D27DT (EU IV): ϕ 4.4 mm

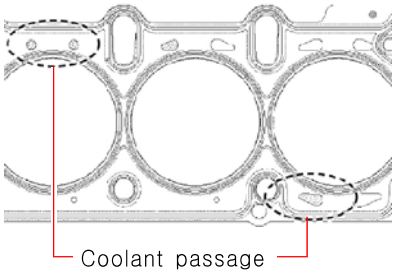
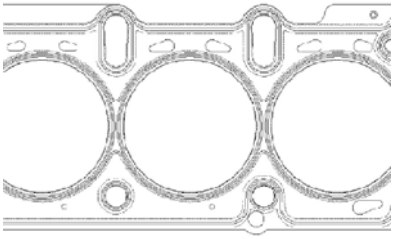
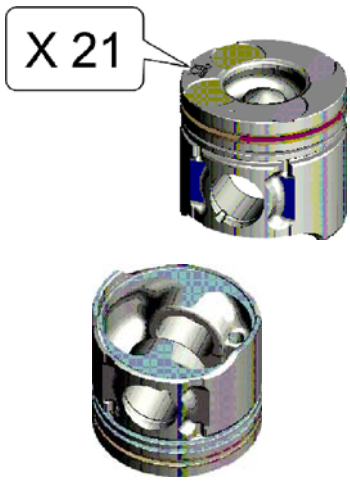
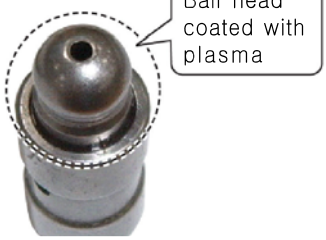
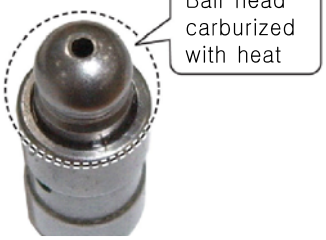
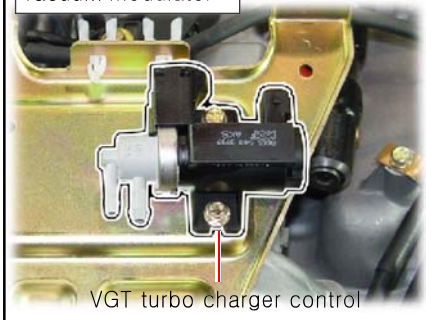
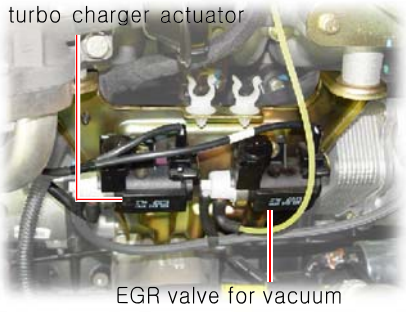
Modification basis	
Application basis	
Affected VIN	

D27DTP (POWER UP) + CDPF Engine D27DT (EU IV) Engine	D27DT Engine (General)	Remarks
HFM 6.0 	HFM 5.0 	* Version up - D27DT (General): HFM5-CI (Analog signal) - D27DTP & D27DT (EU IV): HFM6-ID (Digital signal added)
Electric controlled E-EGR valve 	Vacuum modulator controlled EGR valve 	* E-EGR valve: ECU controls the EGR valve directly without any media. It provide more precise EGR control by transmitting the electric signal of EGR valve operating position.
Throttle body 	N/A	* Throttle body is for future regulation requiring emission reductions. Currently, it is used to prevent the engine from turning off with fluttering noise at the moment the air to intake manifold is blocked by closed flap when the engine is switched off.
EGR cooler EGR Gas  Coolant	EGR center pipe  EGR Gas	* To enhance EGR function, coolant EGR cooler is adopted to reduce the temperature of exhaust gas into the intake manifold.

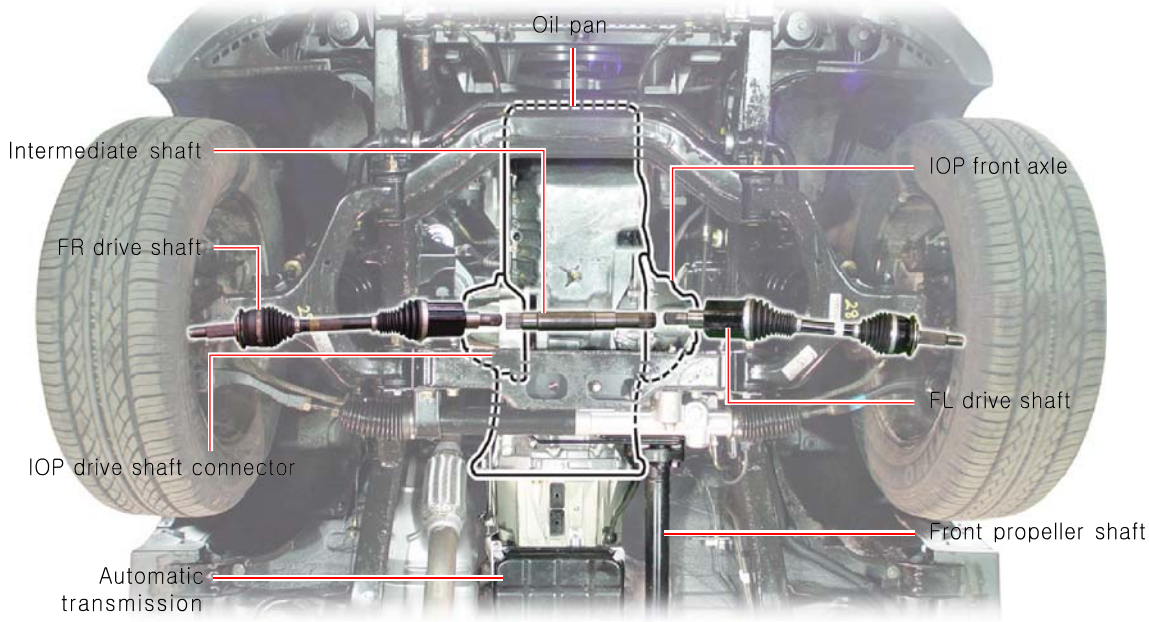
Modification basis	
Application basis	
Affected VIN	

D27DTP (POWER UP) + CDPF Engine D27DT (EU IV) Engine	D27DT Engine (General)	Remarks
E-EGR system layout 	EGR system layout 	* Reason of changes – To satisfy the emission regulation, E-EGR valve and EGR cooler are adopted. And the layout also has a great difference from D27DT.
Water pump 		* For D27DTP engine: Additional connecting port for EGR cooler hose
Coolant outlet port 		* For D27DTP (POWER UP) engine: Additional port for coolant of EGR cooler
Intake manifold 	Booster pressure sensor 	* The appearance of intake manifold is changed to the round type due to the throttle body. Also, the mounting location of booster pressure sensor is changed.
Cylinder head 		* The cooling port is added to improve cooling performance for D27DTP (POWER UP) & D27DT (EU IV) engine.

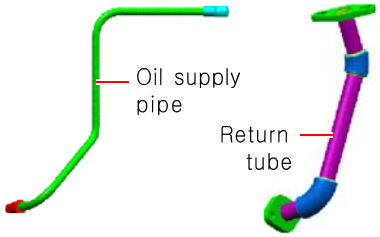
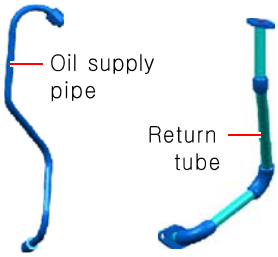
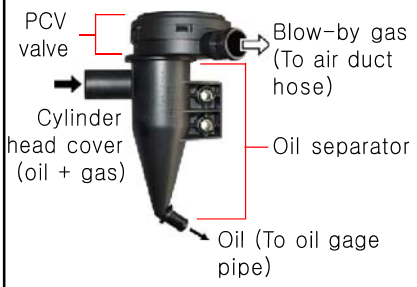
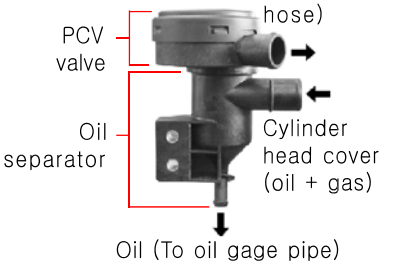
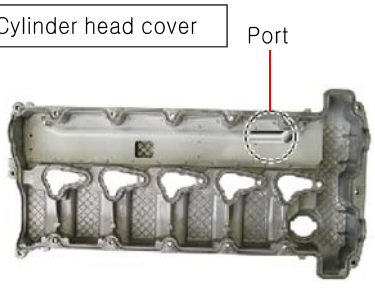
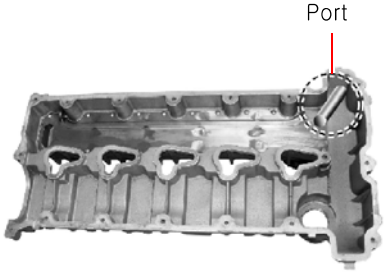
Modification basis	
Application basis	
Affected VIN	

D27DTP (POWER UP) + CDPF Engine D27DT (EU IV) Engine	D27DT Engine (General)	Remarks
Cylinder head gasket  		* The appearance of gasket is changed and the coolant passages are added to improve cooling performance for D27DTP (POWER UP) & D27DT (EU IV) engine.
Piston  	 	* Changed compression ratio - D27DT (General) (18:1) - D27DTP & D27DT (EU IV) (17.5:1) (The appearance of bowl is changed and the color mark is added due to the new compression ratio.) * The appearance fo bowl is changed and the color mark is added due to the new com-pression ratio (18 → 17.5). * The piston pin bending side and the appearance of piston pin hole taper is changed for reinforcement.
Lash adjuster  	 	* The ball head is coated with plasma to prevent the lash adjuster from wearing.
Vacuum modulator  	Vacuum modulator for controlling turbo charger actuator  	* D27DTP (POWER UP) & D27DT (EU IV) engine uses electric ally controlled E-EGR valve. Thus, the vacuum modulator for controlling EGR valve has been deleted.

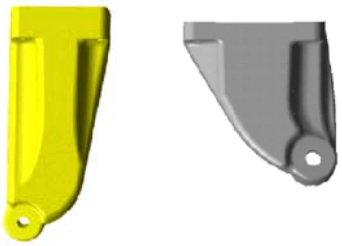
Modification basis	
Application basis	
Affected VIN	

D27DTP (POWER UP) + CDPF Engine	D27DT Engine (General) D27DT (EU IV) Engine	Remarks
IOP oil pan 	Oil pan 	* The vehicle with D27DTP (POWER UP) engine is equipped with IOP axle. Refer to the figure below.
Glow system- AQGS unit 	Glow system - Glow control relay 	* D27DTP (POWER UP) engine adopts AQGS (Advanced Quick Glow System), which controls the quick preheating of glow plugs and CAN com-munication with engine ECU.
		
VGT turbocharger 	WGT turbocharger 	* D27DTP (POWER UP) engine is equipped with the enhanced VGT turbocharger.

Modification basis	
Application basis	
Affected VIN	

D27DTP (POWER UP) + CDPF Engine	D27DT Engine (General) D27DT (EU IV) Engine	Remarks
1.Support bar of Turbocharger 		* Support bar is changed due to VGT turbocharger mounting.
2.Oil supply pipe and return tube of Turbocharger 		* The shape of oil supply pipe and return tube is changed due to VGT turbocharger mounting.
PCV oil separator  	 	* Increase of Oil separator capacity (approx. 10%) - D27DT & D27DT (EU IV): 120ℓ/min - D27DTP: 160ℓ/min
Cylinder head cover 		* The direction of blow-by outlet port is changed due to the introduction of larger oil separator.

Modification basis	
Application basis	
Affected VIN	

D27DTP (POWER UP) + CDPF Engine	D27DT Engine (General) D27DT (EU IV) Engine	Remarks
Switchable engine mounting 	Engine mounting 	* The switchable engine mounting system (SEM) controls the engine in soft mode or hard mode by dividing the speed to the low speed range and mid-high speed range according to the vehicle speed and the engine rpm. This is only available in D27DTP (POWER UP) engine.
Engine bracket LH RH 	LH RH 	* The bracket is changed due to the mounting location of D27DTP (POWER UP) engine and the switchable engine mounting.

5. GUIDELINES FOR SERVICE WORKS

1) For Safety





To perform the service works easily and safely, the service technicians must keep the proper working procedures and rules.
This manual provides the useful instructions to the service technicians so that they can perform the service works with standard working process, skills, tips in time.
Please read this manual and follow the instructions carefully.

Signal words such as “CAUTION” and “NOTE” have special meanings.

NOTE
indicates information to assist maintenance and instructions.

WARNING
indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION
indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury or property damage.

However, above references and cautions cannot be inclusive measures, so should have habits of paying attentions and cautions based on common senses.

Modification basis	
Application basis	
Affected VIN	

2) Cautions on Service Procedures

1. Before lifting up the vehicle with a lift, correctly support the lifting points.
2. When using a jack, park the vehicle on a level ground and place the wheel chocks under the tires. Position the jack under the frame and lift up the vehicle and then support with chassis stand before service work.
3. Make sure to disconnect the negative (-) cable from the battery to prevent any damage to electric systems.
4. If you have to work on vehicle, cover the seats and floor with protection covers to avoid any damage and contamination.
5. Brake fluid and anti-freeze can damage the painted surface of body. So carefully handle them during service work.
6. To improve the efficiency of service work, use only recommended and specified tools.
7. Use only Ssangyong genuine spare parts.
8. Never reuse the cotter pin, gasket, O-ring, oil seal, lock washer and self-locking nut. Replace them with new ones. If reused, normal functions cannot be maintained.
9. Store the disassembled parts as a set based on disassembly order and unit.
10. Pay particular attention not to miss or mix the fasteners.
11. If necessary, especially for inspection, clean the removed parts completely.
12. Apply the oil or grease on the running and sliding surfaces before installation. Use the specified sealant and gasket to prevent leakage if necessary.
13. Tighten the fasteners with the specified tightening torque.
14. As a final stage of service work, check if the serviced system is working properly and the problem has been eliminated clearly.

3) 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 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 is not any interference while servicing.

Modification basis	
Application basis	
Affected VIN	

▶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.

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.

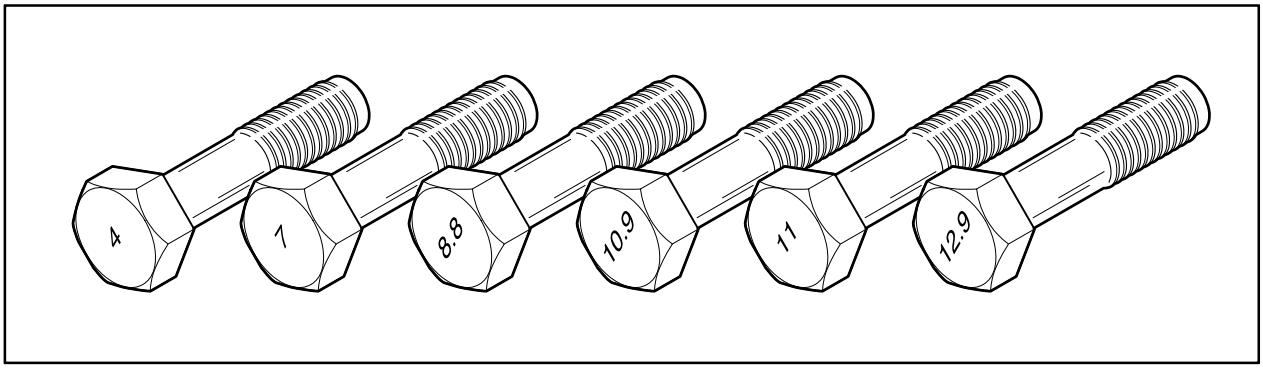
▶Electrical equipment

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 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 makes cause a fire and personal injury.

6. 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.
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.
   - Aluminum alloy: Tighten to 80 % of above torque table.
   - Plastics: Tighten to 20 % of above torque table.

Modification basis	
Application basis	
Affected VIN	

Memo

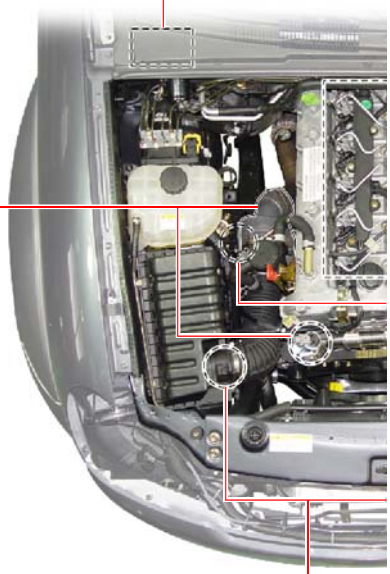
OVERVIEW AND OPERATION PROCESS

1. ENGINE COMPARTMENT

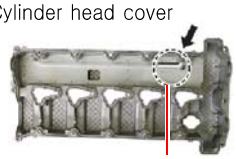
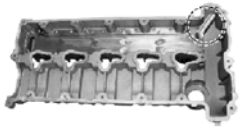
The major changes due to the newly adopted engine compared to D27DT engine are as follows:

Intake System	
D27DTP & D27DT (EU IV)	D27DT
HFM sensor (Ver. 6.0) 	Throttle body 

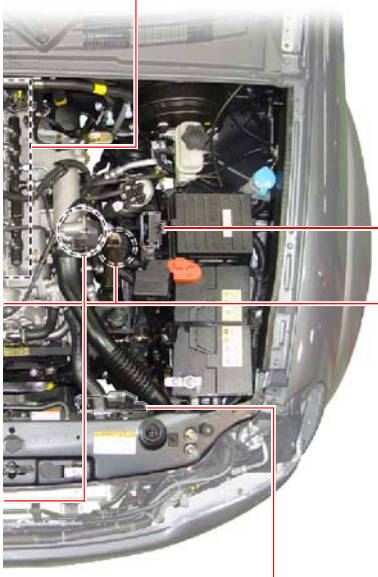
Engine Control (Engine ECU-3.2)	
D27DTP & D27DT (EU IV)	D27DT
 Connector A Connector B	 Connector A Connector B



Exhaust System		
VGT turbo charger	E-EGR valve	EGR cooler
		

Lubrication System		
D27DTP	Larger PCV oil separator	OP oil pan
Cylinder head cover  Modification in blow-by gas outlet port		 * Axle integral type
D27DT (EU IV) & D27DT		
		

Modification basis	
Application basis	
Affected VIN	



Fuel System

D27DTP & D27DT (EU IV)

Injector



D27DTP & D27DT (EU IV)

Fuel pipe



D27DTP & D27DT (EU IV)

Common rail



D27DT



D27DT



D27DT



Preheat System

AQGS unit



D27DTP & D27DT (EU IV)

Glow plug



D27DT



Switchable Engine M ounting (SEM)

D27DTP

LH



RH



D27DT (EU IV) & D27DT



Cooling System

D27DTP & D27DT (EU IV)

Large water pump



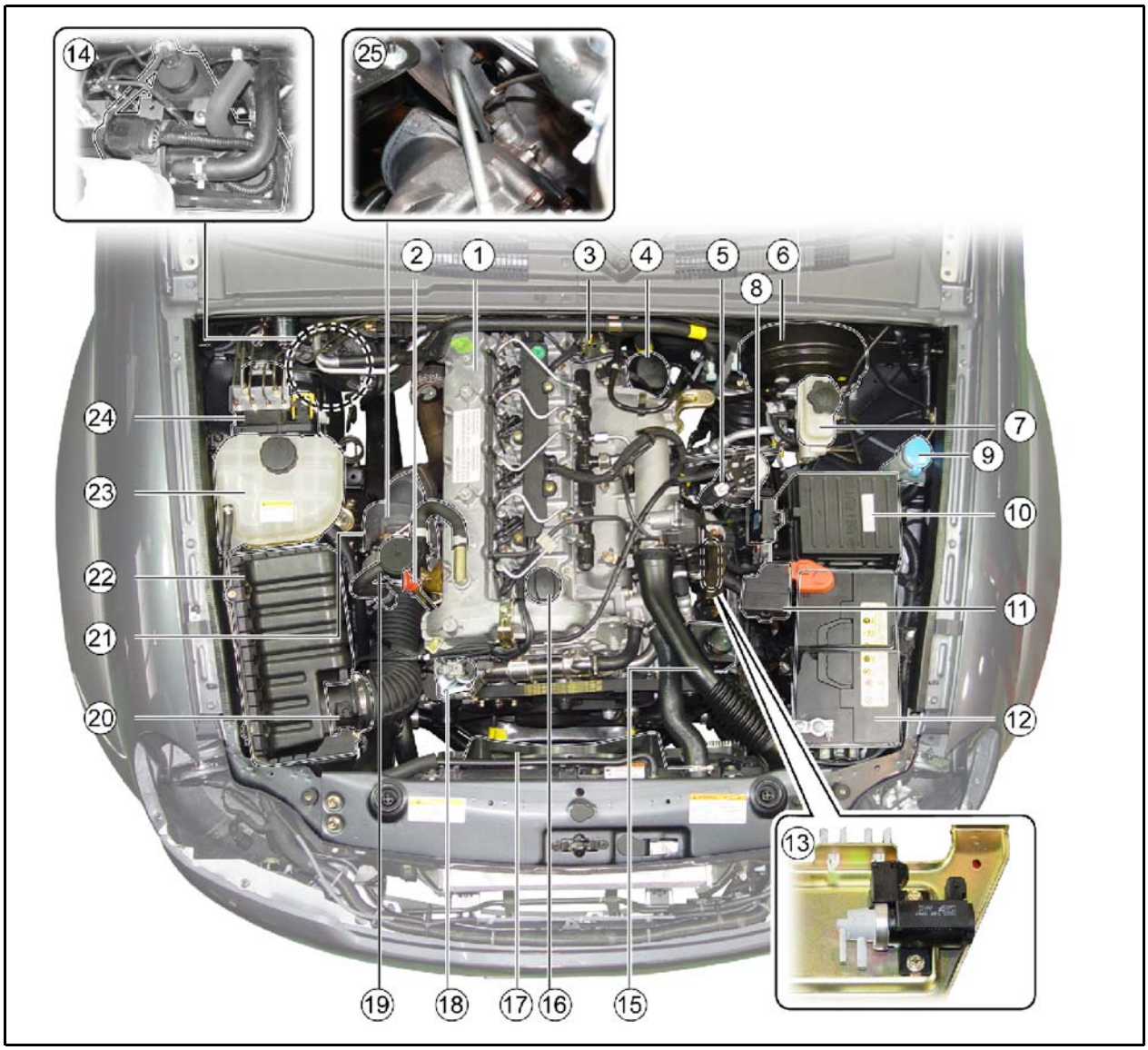
* EGR cooler port included

D27DT



Modification basis	
Application basis	
Affected VIN	

▶ Engine Compartment Layout



1. Engine assembly
2. Engine oil dipstick
3. Vacuum pump
4. Oil filter and cooler
5. Fuel filter and priming pump
6. Brake booster
7. Brake oil tank
8. AQGS unit
9. Washer fluid filler cap
10. Engine compartment fuse box
11. PTC relay box
12. Battery
13. Vacuum modulator (for VGT turbo charger)
14. FFH Assembly (Only for vehicle with FFH)
15. Power steering oil tank
16. Engine oil filler cap
17. Fan shroud
18. E-EGR Valve
19. High-capacity PCV oil separator
20. HFM sensor (6.0)
21. VGT turbo charger
22. Air cleaner housing
23. 2Coolant surge tank
24. ABS/ESP HECU (Including TPMS function: optional)
25. Exhaust gas FRT Temp. sensor (T3)

Modification basis	
Application basis	
Affected VIN	

▶ Major Sensors and Components

Injector

D27DTP & D27DT (EU IV)



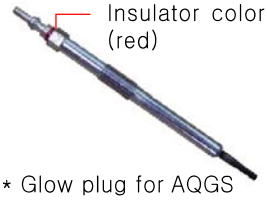
* 2 additional injection holes (currectly 7 holes)

D27DT



Glow Plug

D27DTP & D27DT (EU IV)



* Glow plug for AQGS (quick preheat)

D27DT



Common Rail

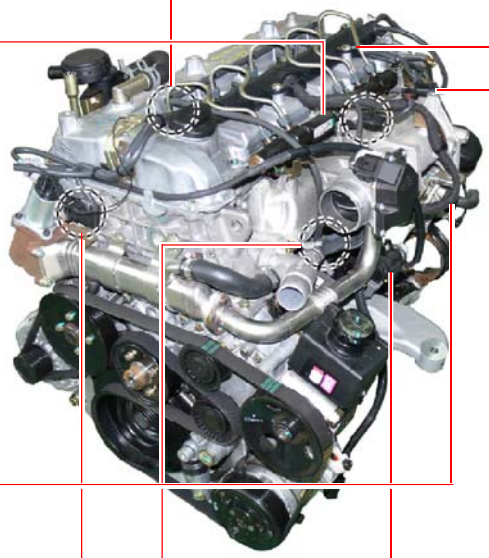
D27DTP & D27DT (EU IV)



* Orifice for preventing fuel pulsation

D27DT





Fuel Pressure Sensor (Common Rail)



Booster Pressure Sensor



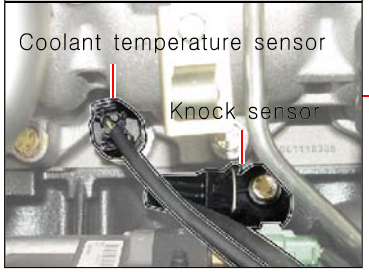
Crankshaft Position Sensor



Camshaft Position Sensor



Knock Sensor (2EA) & Coolant Temperature Sensor



Vacuum Modulator for VGT Turbo Charger

D27DTP & D27DT (EU IV)



* Vacuum modulator for EGR valve deleted

D27DT



D27DTP

VGT Turbo Charger



D27DT (EU IV) & D27DT

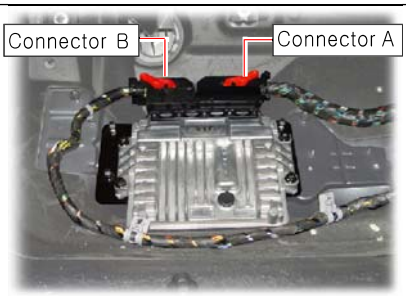
WGT Turbo Charger

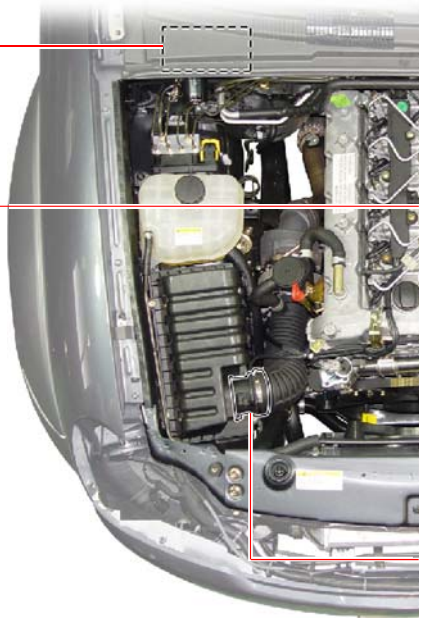


Modification basis	
Application basis	
Affected VIN	

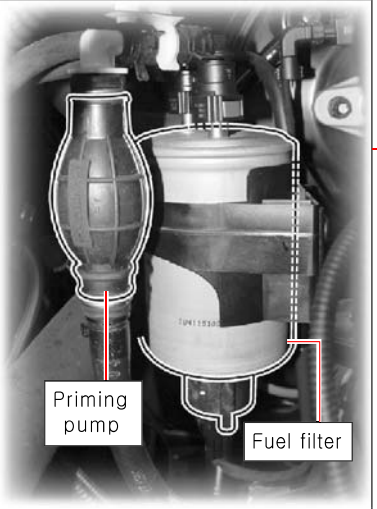
2. SYSTEMS IN ENGINE COMPARTMENT

1) Engine Accessories Related to ECU

Engine ECU – Ver. 3.2	Engine ECU Mounting Location
D27DTP & D27DT (EU IV) 	
D27DT 	



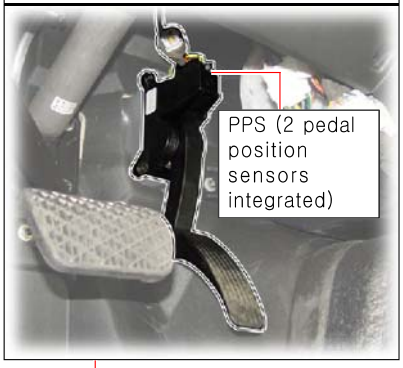
Fuel Filter (Water Detecting) Seneor



Draining water from fuel filter: every 10,000 km

Modification basis	
Application basis	
Affected VIN	

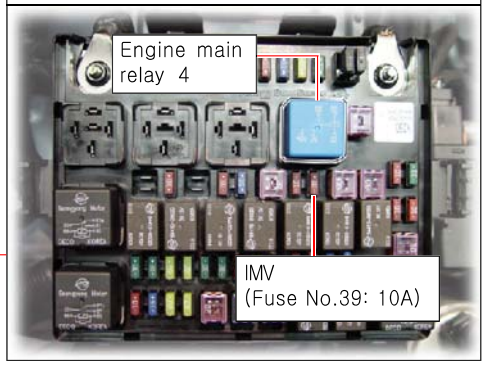
Accelerator Pedal Module



Interior Fuse Box (Driver's Side)



Engine Compartment Fuse Box





HFM Sensor (Ver. 6.0)

D27DTP & D27DT (EU IV)





Additional function: The digital signal about intake air volume is transfered to control the engine precisely.

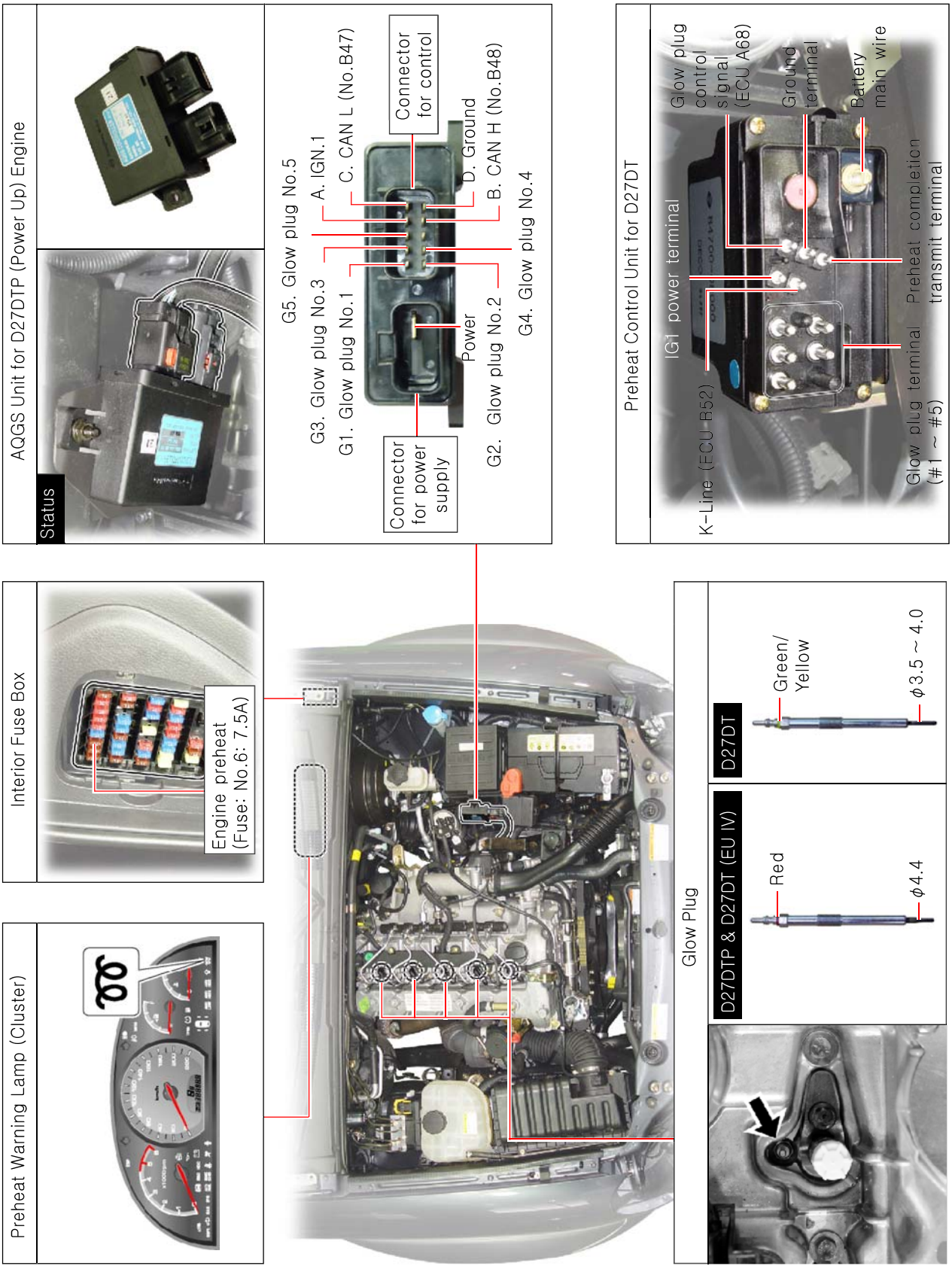
D27DT





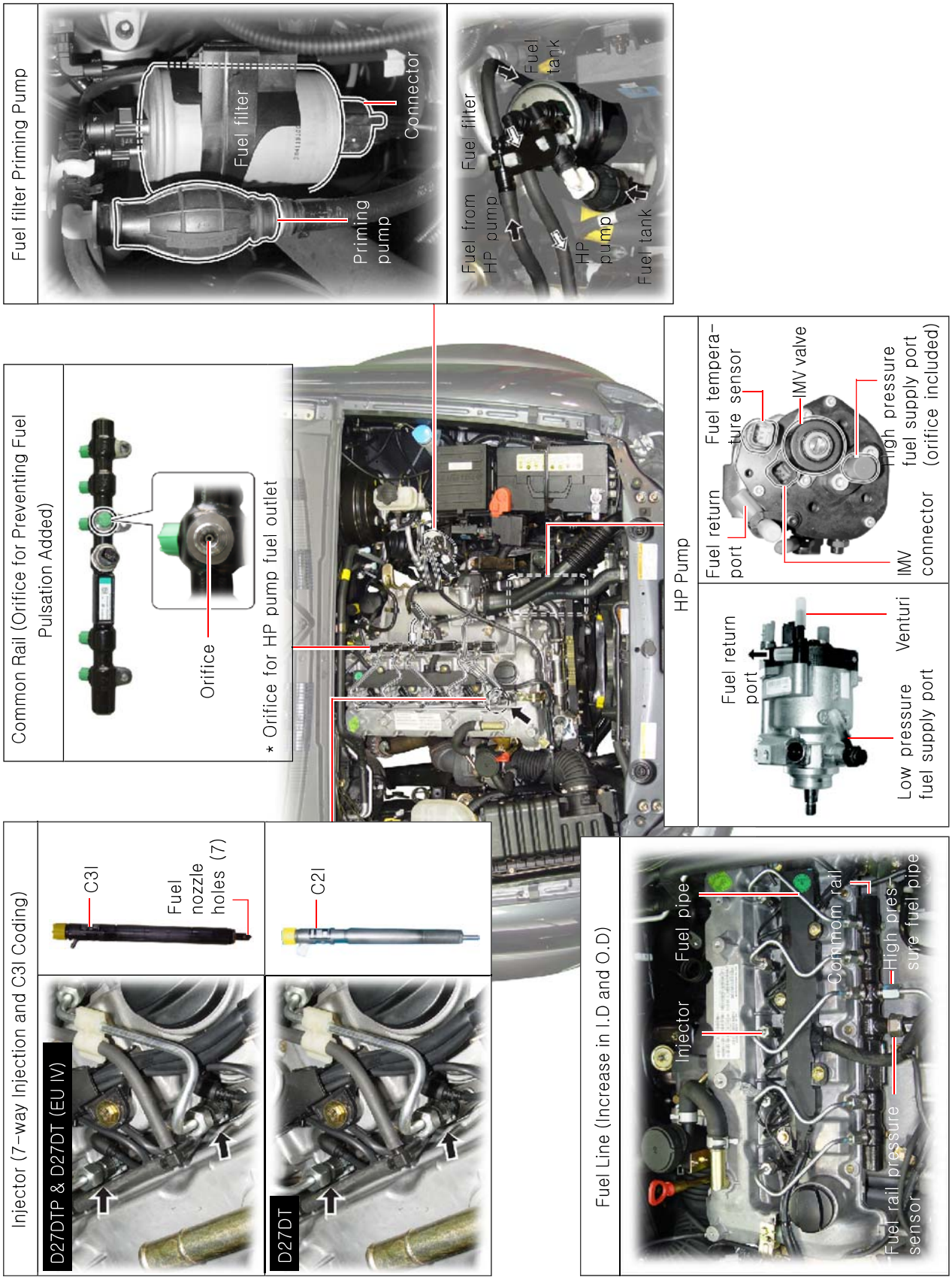
Modification basis	
Application basis	
Affected VIN	

2) Preheat System



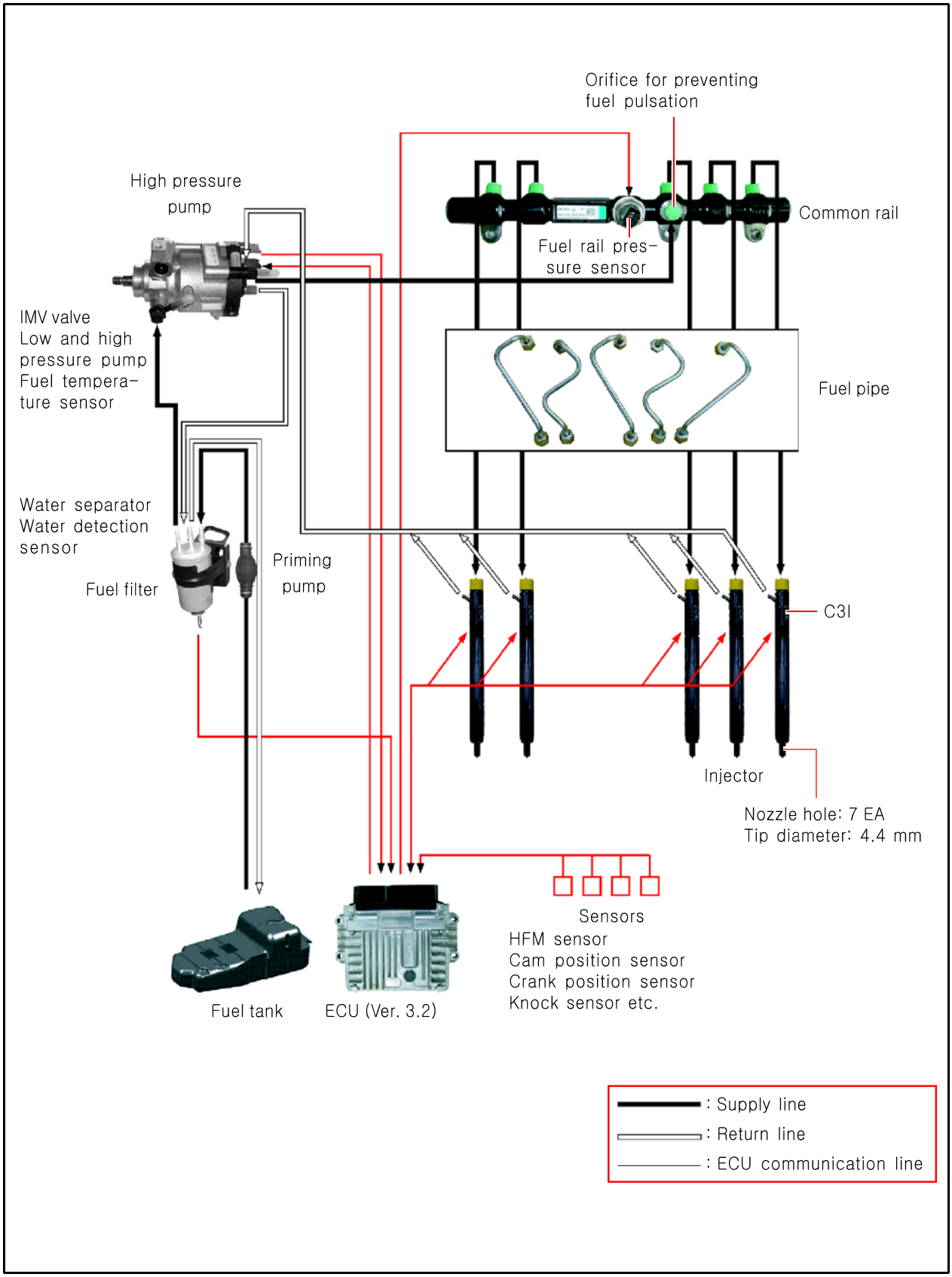
Modification basis	
Application basis	
Affected VIN	

3) Fuel System



Modification basis	
Application basis	
Affected VIN	

▶ Fuel Supply System



Modification basis	
Application basis	
Affected VIN	

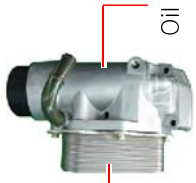
4) Lubrication System

Cylinder Head Cover

Blow-by gas port



Oil Filter & Oil Cooler



Oil Pan & Oil Strainer, Baffle Plate

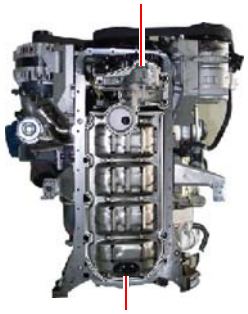
D27DT & D27DT (EU IV)



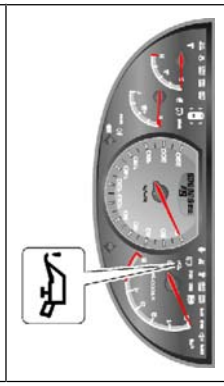
D27DTP



D27DTP

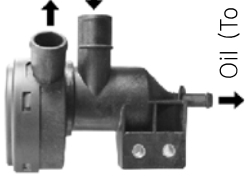


Oil Pressure Warning Light (Cluster)

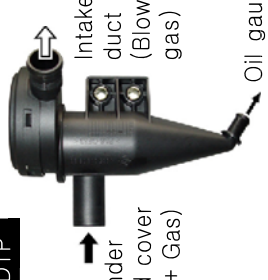


Large PCV Oil Separator

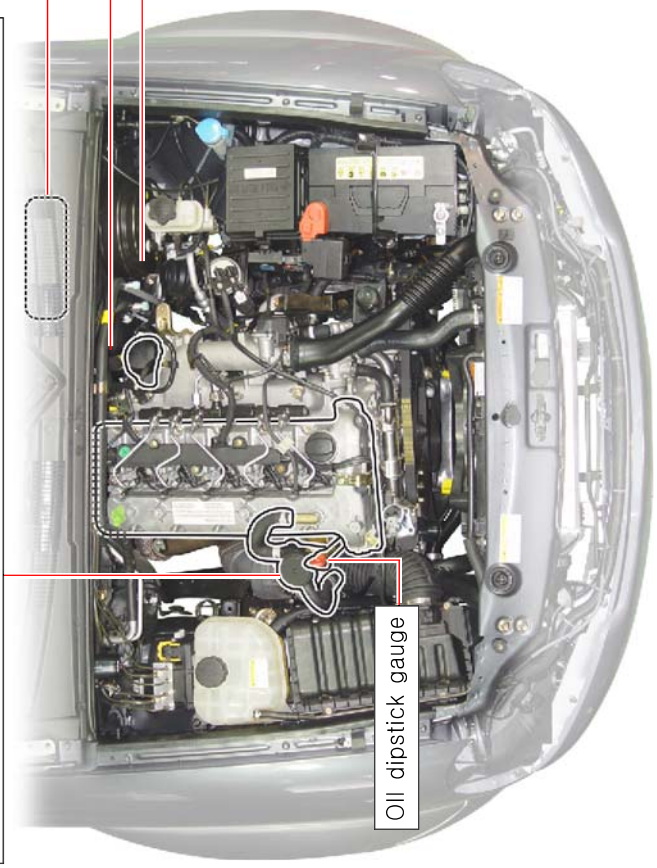
D27DT & D27DT (EU IV)



D27DTP

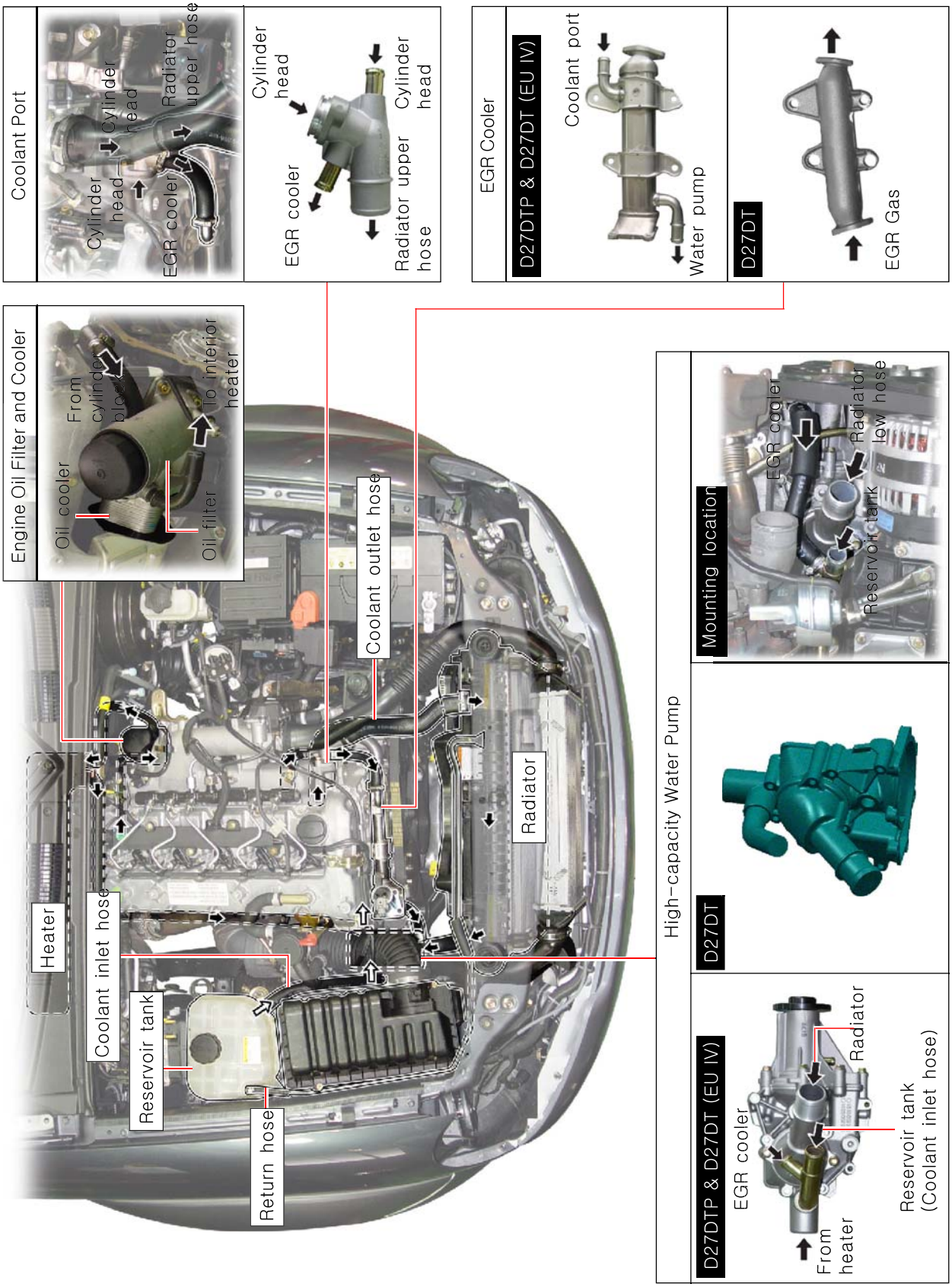


The first separation will happen when blow-by gas passes through baffle plates in cylinder head cover. Then oil and gas will be separated due to cyclone effect after entering the oil separator inlet port. Separated oil returns to oil pan via oil drain port and the gas will be burnt again after entering the combustion chamber through air duct hose via PCV valve that opens/closes due to pressure differences between the intake side and crankcase.



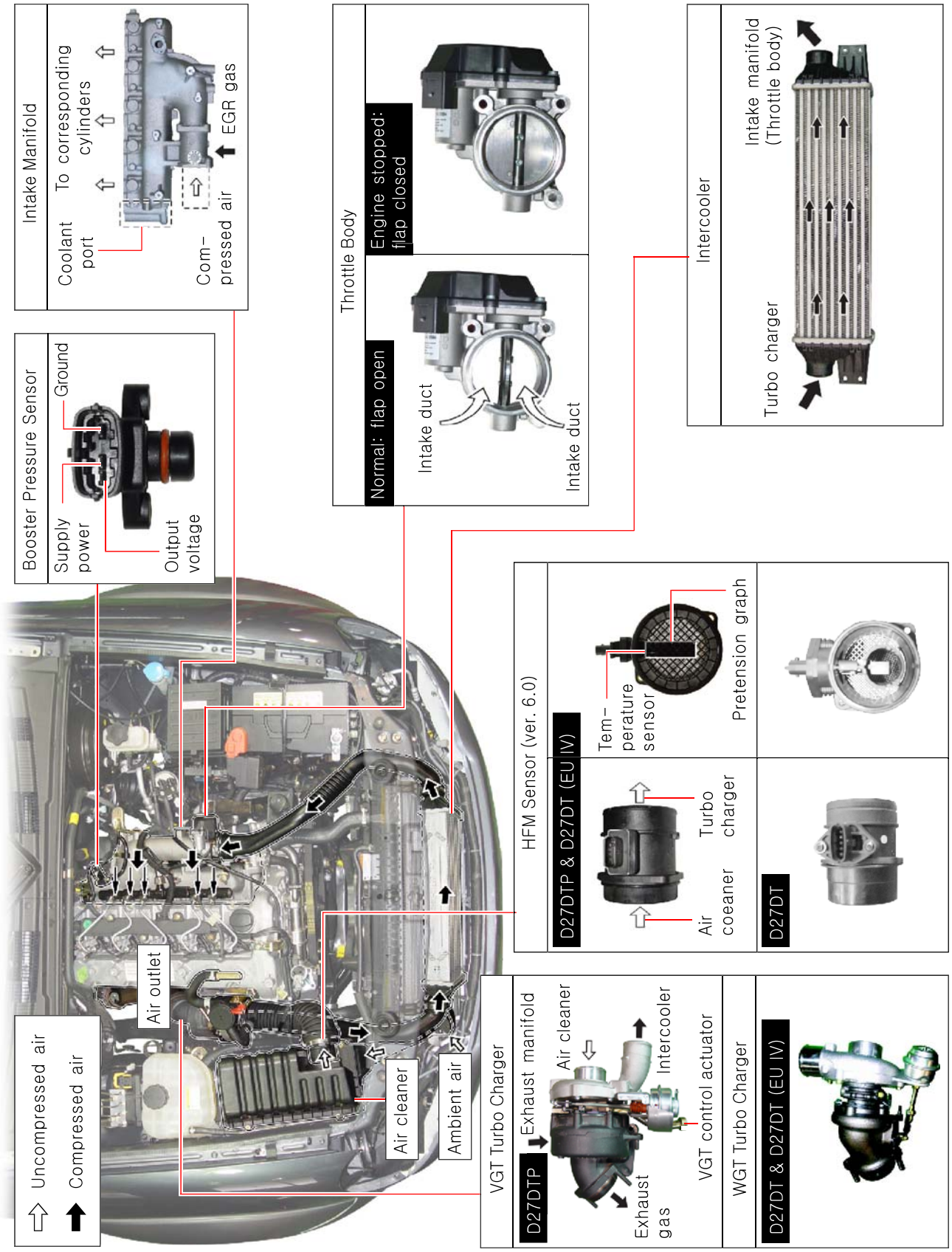
Modification basis	
Application basis	
Affected VIN	

5) Cooling System



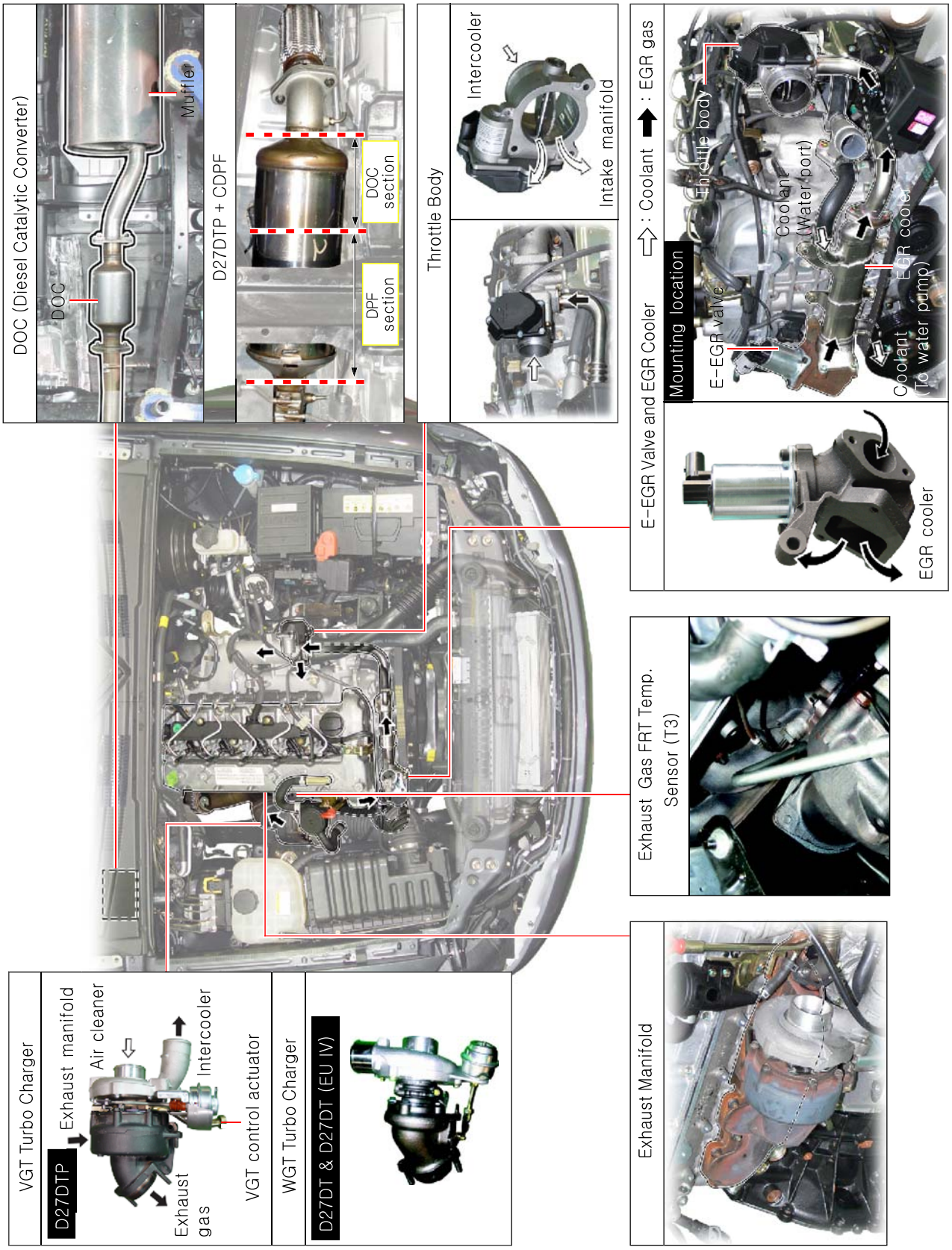
Modification basis	
Application basis	
Affected VIN	

6) Intake System



Modification basis	
Application basis	
Affected VIN	

7) Exhaust System



Modification basis	
Application basis	
Affected VIN	

ENGINE ASSEMBLY

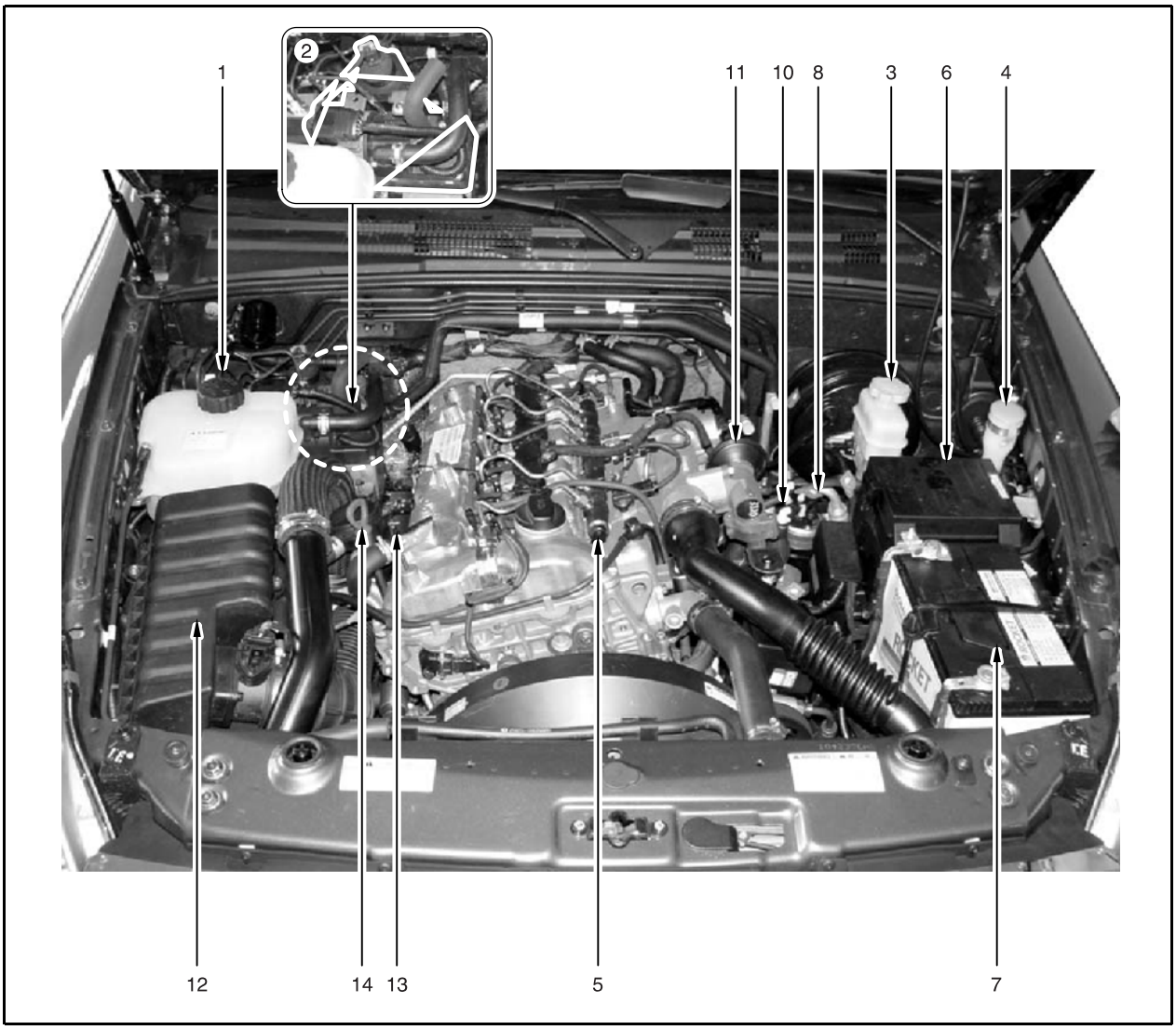
1212-01

GENERAL

1. D27DT ENGINE STRUCTURE

1) Major Components in Engine and Engine Compartment

The advanced electronically controlled D27DT engine that has high pressure fuel system has been introduced to this vehicle. It satisfies the strict emission regulation and provides improved output and maximum torque.

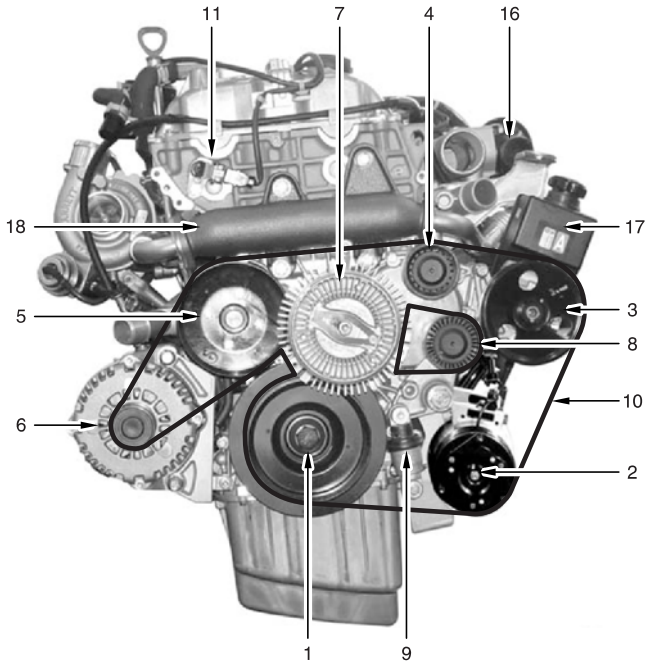


1. Coolant reservoir
2. FFH device
3. Brake fluid reservoir
4. Washer fluid reservoir
5. Common rail
6. Fuse box
7. Battery
8. Fuel filter
9. Power steering pump
10. Priming pump
11. EGR valve
12. Air cleaner assembly
13. Turbo charger
14. Oil dipstick

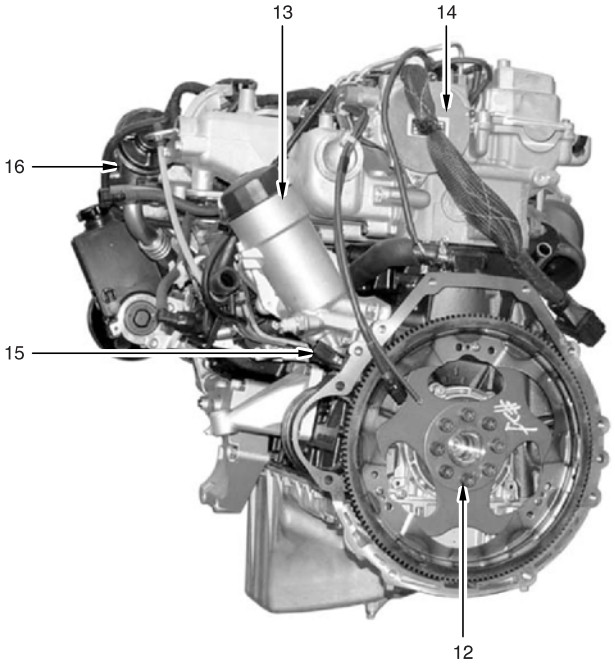
Modification basis	
Application basis	
Affected VIN	

2) Engine Structure

Front View



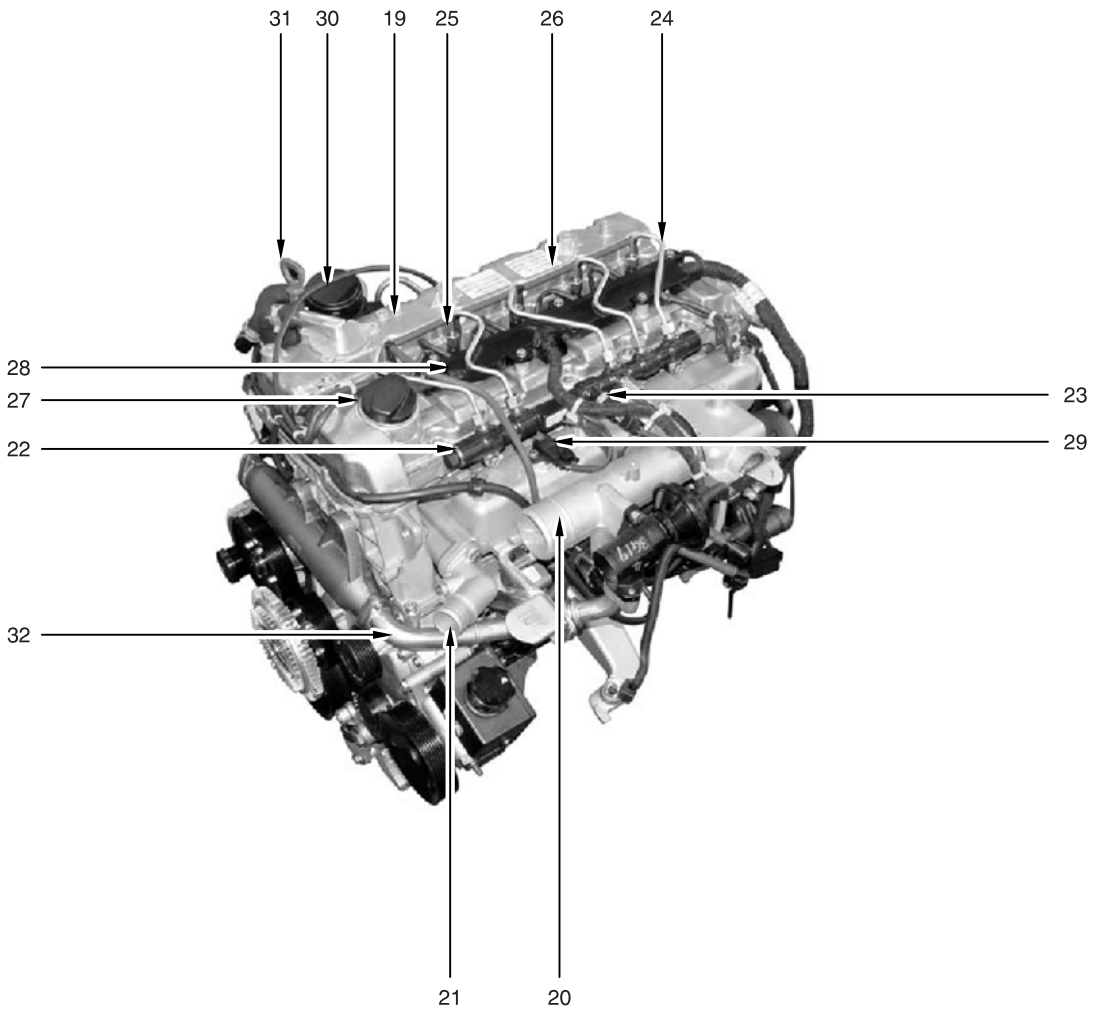
Rear View



1. TVD (Torsional Vibration Damper)
2. Air conditioner compressor
3. Power steering pump pulley
4. Idle pulley
5. Coolant pump pulley
6. Alternator
7. Viscos fan clutch
8. Auto tensioner pulley
9. Auto tensioner
10. Poly-grooved belt
11. Cam position sensor
12. Drive plate (MT: DMF)
13. Oil filter
14. Vacuum pump
15. Crank position sensor
16. EGR valve
17. Power steering pump
18. EGR to center pipe

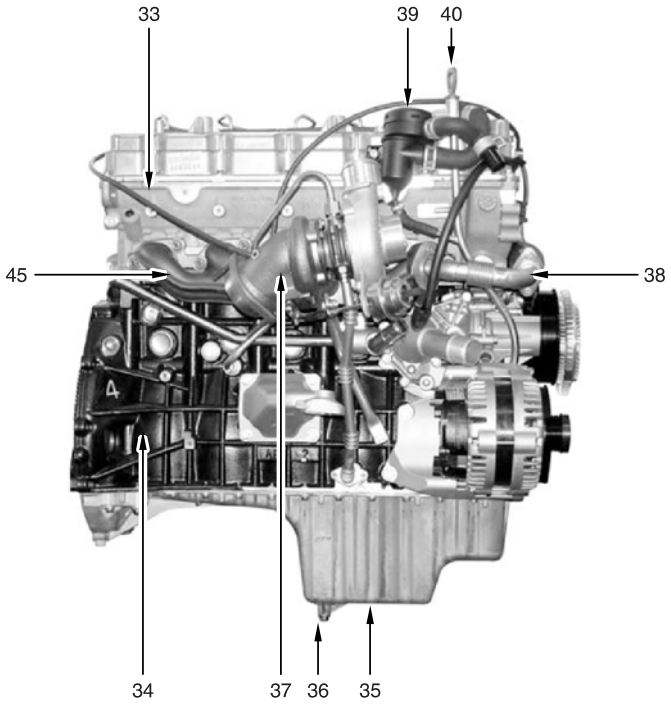
Modification basis	
Application basis	
Affected VIN	

Top View

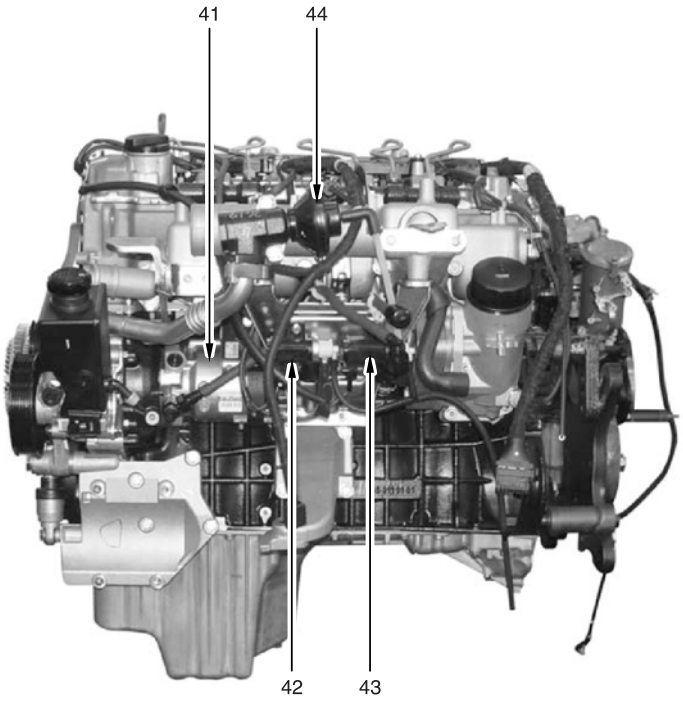


19. Cylinder head cover
20. Intake manifold
21. Water outlet port
22. Common rail
23. Fuel pressure sensor
24. Fuel pipe
25. Injector
26. Fuel return line
27. Oil filler cap
28. Glow plug
29. Booster pressure sensor
30. PCV valve and oil separator
31. Oil dipstick
32. EGR-LH (#1) pipe

Left Side View



Right Side View



33. Cylinder head
34. Cylinder block
35. Oil pan
36. Drain plug
37. Turbo charger
38. EGR-RH (#3) pipe
39. PCV valve and oil separator
40. Oil dipstick
41. High pressure pump
42. Turbo charger booster vacuum modulator
43. EGR valve vacuum modulator
44. EGR valve
45. Exhaust manifold

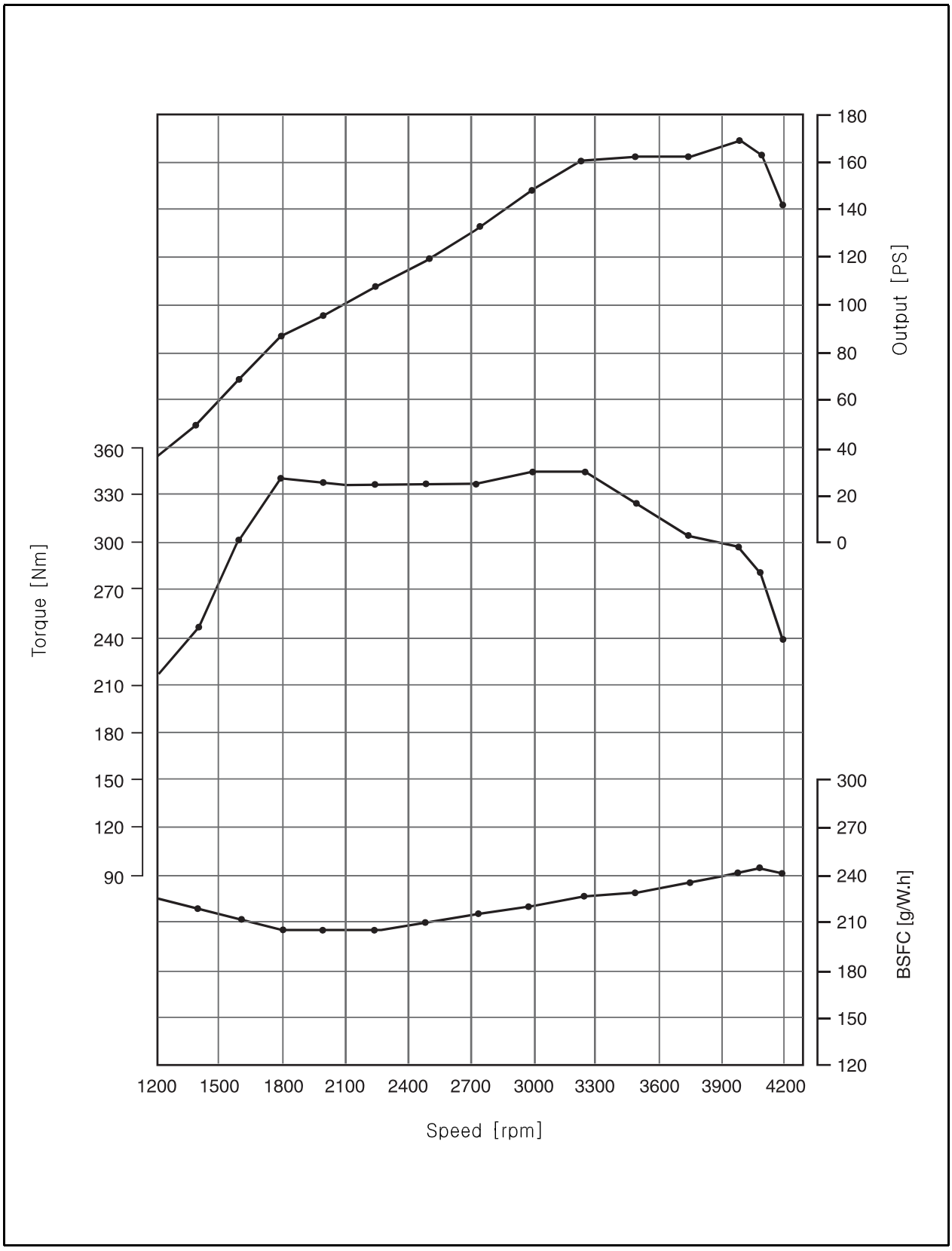
Modification basis	
Application basis	
Affected VIN	

2. SPECIFICATIONS

Description			Specification
Engine	Type/Number of cylinders		D27DT/5-cylinder
Cylinder	Inner diameter (mm)		86.2
	Stroke (mm)		92.4
Displacement (cc)			2696
Compression ratio			18:1
Maximum output (ps/rpm)			170/4,000
Maximum torque (kg·m/rpm)			34.7/1,800
Idle speed	For Manual Transmission		750 ± 50 rpm
	For Automatic Transmission		750 ± 50 rpm
Valve	Intake	Opens (BTDC)	16°
		Closes (ABDC)	33°
	Exhaust	Opens (BBDC)	46°
		Closes (ATDC)	21°
Camshaft	Type		DOHC
Fuel system	Fuel type		Low sulfur diesel
	Fuel pump type		Vane pump in HP pump
	Fuel supply pressure		HP pump inlet port: max. 400 mbar HP pump outlet port (with IMV fully open): over 1,050 bar
	Water separation in fuel filter		at every 10,000 km
	Fuel tank capacity (ℓ)		80
Lubrication system	Oil specification		SAE 10W40, 5W40 (MB Sheet 229.1, 229.3 approved oil)
	Lubrication type		Forced delivery
	Oil filter type		Full flow, filter element type
	Oil capacity (ℓ)		6.8 ~ 8.3
Cooling system	Cooling type		Water cooling type
	Cooling fan operation type		Belt operated typr
	Thermostat: Fully Open: 100°C)	Opening temperature (°C)	85
		Type	WAX pellet type
	Coolant capacity (ℓ)		≒11.5

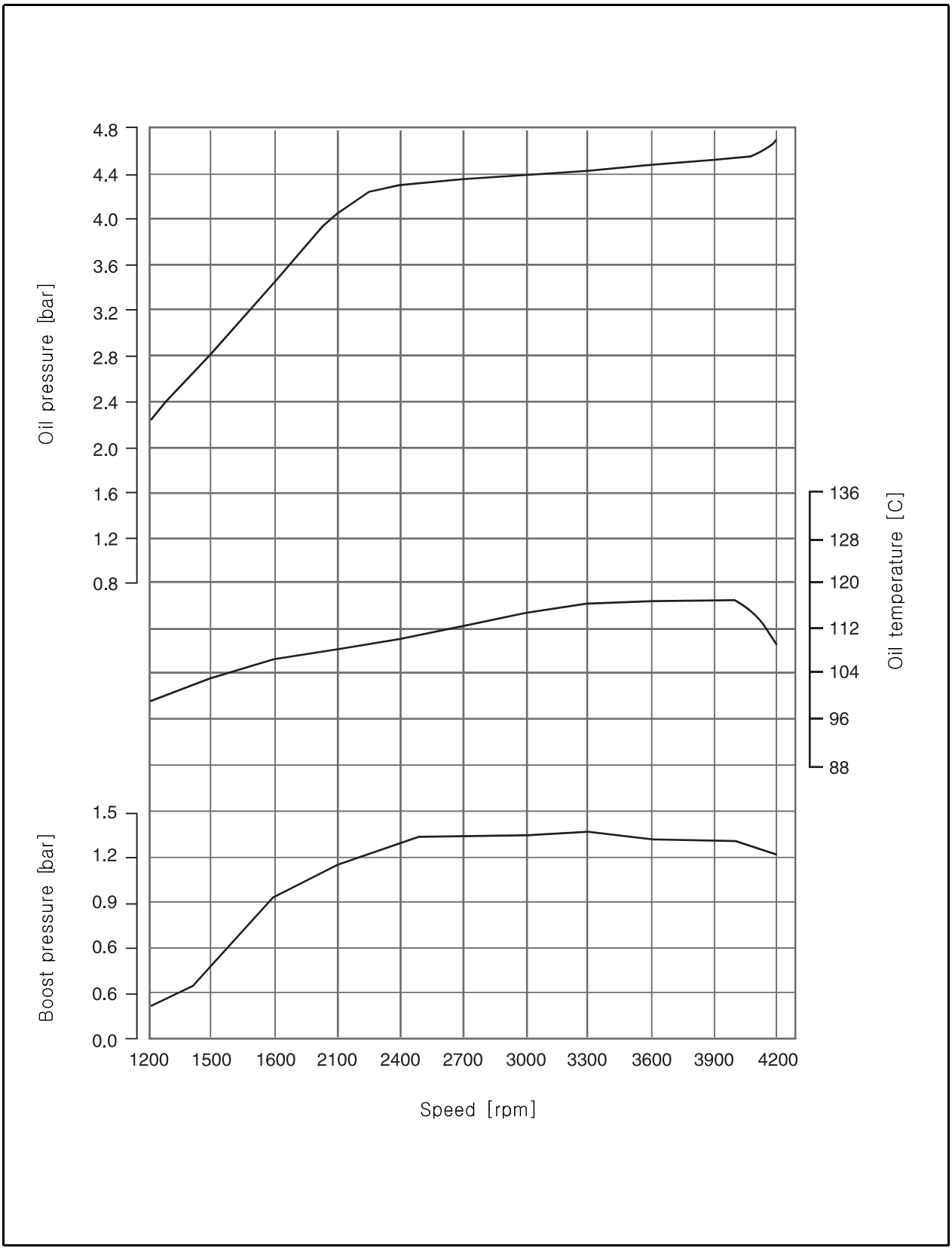
3. ENGINE PERFORMANCE CURVE

▶Output and Torque



Modification basis	
Application basis	
Affected VIN	

▶Oil Temperature/Pressure and Boost Pressure



4. TIGHTENING TORQUE

NO.	Name	Size	Quantity	Tightening Torque
1	Oil nozzle	M6 x 22	5	10 ± 1
2	Main bearing cap	M11 x 62	12	55 ± 5 90° ± 10°
3	Connecting rod cap	M9 x 52	5	40 ± 5 90° ± 10°
4	Rear cover	M6 x 20	6	10 ± 1
5	Oil pump	M8 x 35SOC	3	25 ± 2.5
6	Oil baffle plate assembly	M6 x 20	10	10 ± 1
7	T.G.C.C	M6 x 16	1	10 ± 1
		M6 x 40	6	10 ± 1
		M6 x 60	3	10 ± 1
		M6 x 70	2	10 ± 1
		M8 x 80SOC	1	25 ± 2.5
8	Flywheel	M10 x 30	8	45 ± 5 90° ± 10°
9	Crankshaft hub	M18 x 50	1	325 ± 33 90° ± 10°
10	Oil pan	M6 x 20	24	10 ± 1
		M6 x 35	3	10 ± 1
		M6 x 38	3	10 ± 1
		M6 x 40	4	25 ± 2.5
11	High pressure pump assembly	M8 x 40	4	25 ± 2.5
12	High pressure pump sprocket assembly	M14 x 1.5-8-1	1	65 ± 5
13	High pressure pump bracket	M7 x 16	3	20 ± 2 x 90° + 10°
14	Cylinder head assembly	M8 x 25	2	25 ± 2.5
		M8 x 50	2	
		M12 x 177	11	Step1: 20 Nm ± 2 Nm Step2: 85 Nm ± 5 Nm
		M12 x 158	1	Step3: 3 x 90° + 10°
15	Camshaft cap	M8 x 60	24	25 ± 2.5
16	Stud bolt	M8	10	15 ± 1.5
17	Camshaft sprocket (Intake)	M11 x 52	1	25 ± 2.5
	Camshaft sprocket (Exhaust)		1	90° ± 10°
18	Chain tensioner	M22	1	65 ± 5
19	Coolant temperature sensor	M14	1	22 ± 2.2

Modification basis	
Application basis	
Affected VIN	

NO.	Name	Size	Quantity	Tightening Torque
20	Auto tensioner	M8 x 45(LOWER)	1	32 ± 3
		M12 x 90	1	82 ± 6
21	Water pump assembly	M6 x 50	7	10 ± 1
22	Water pump pulley	M6 x 12	4	10 ± 1
23	Hot water inlet pipe assembly	M6 x 12	2	10 ± 1
24	Alternator bracket	M8 x 32	4	25 ± 2.5
25	Alternator	M10 x 90	2	46 ± 4.6
26	Air conditioner compressor assembly	M8 x 95	4	46 ± 4.6
27	Air conditioner compressor bracket assembly	M8 x 25	1	25 ± 2.5
		M8 x 60	3	25 ± 2.5
28	Air conditioner compressor sub bracket assembly	M6 x 14	1	10 ± 1.0
		M8 x 16	1	25 ± 2.5
29	Intake manifold	M8 x 45	6	25 ± 2.5
		M8 x 130	6	25 ± 2.5
30	Bracket	M6 x 16	1	10 ± 1.0
31	Knock sensor	M8 x 28	2	20 ± 2.6
32	Camshaft position sensor	M8 x 16	1	12 ± 1.7
33	Booster pressure sensor	M6 x 16	2	10 ± 1.0
34	Exhauster manifold	M8	10	40 ± 4
35	Turbo charger assembly	M8	4	25 ± 2.5
36	Turbo charger adaptor piece		1	32 ± 3.2
37	Nut	M8	1	25 ± 2.5
38	Combination bolt	M8 x 22	1	25 ± 2.5
39	T/C oil supply pipe	M6 x 16 (Cylinder block side)	1	25 ± 2.5
		M16 (T/C side)	1	20 ± 2.0
40	T/C oil return pipe	M6 x 16 (T/C side)	2	10 ± 1.0
		M6 x 16 (Cylinder block side)	2	10 ± 1.0
41	EGR valve assembly	M8 x 22	2	25 ± 2.5
42	EGR-LH pipe bolt	M6 x 16	2	10 ± 1.0
		M8 x 22	2	35 ± 2.0
43	EGR combination bolt	M6 x 16	4	10 ± 1.0
		M8 x 16	4	25 ± 2.5
	EGR-RH pipe nut	M8	2	35 ± 2.0
44	Glow plug cable nut	M5	5	15 ± 3
45	Vacuum pump	M6 x 20	3	10 ± 1.0
46	Cooling fan bracket assembly	M6 x 25	5	10 ± 1.0
		M6 x 65	1	10 ± 1.0
		M6 x 85	3	10 ± 1.0
47	Cylinder head cover	M6 x 35	21	23 ± 2.3

NO.	Name	Size	Quantity	Tightening Torque
48	Vacuum modulator	M6 x 16SOC	4	10 ± 1.0
49	WDT combination bolt	M6 x 16	3	10 ± 1.0
50	Oil dipstick tube	M6 x 16	1	10 ± 1.0
51	Oil filter assembly	M8 x 35SOC	1	25 ± 2.5
		M8 x 50SOC	2	25 ± 2.5
		M8 x 55SOC	1	25 ± 2.5
52	Fuel rail assembly	M8 x 35SOC	3	25 ± 2.5
53	Injector clamp washer	M6 x 60	5	10 ± 1.0 180 + 20°
54	Fuel pipe clip (H-C)	M6 x 19	1	10 ± 1.0
55	Fuel pipe clip (C-I)	M6 x 16	5	10 ± 1.0
56	Crankshaft position sensor	M5 x 17	1	0.8 ± 0.4
57	Crankshaft position sensor	GAP		0.7 ~ 1.5
58	Fuel pressure sensor		1	
59	Wiring	M6 x 16	5	10 ± 1.0
60	Intake manifold bracket	M8 x 16	2	25 ± 2.5
		M8 x 40	2	25 ± 2.5
61	Power steering pump	M8 x 100	2	25 ± 2.5
		NUT	2	25 ± 2.5
62	Piston protrusion		5	0.765 ~ 1.055
63	Clearance between connecting rod and pin boss		5	0.05 ~ 0.31
64	End play of crankshaft	NEW: 0.100 ~ 0.245 mm // USED: 0.300 mm		

Modification basis	
Application basis	
Affected VIN	

ENGINE FUEL SYSTEM

1881-09

OVERVIEW AND OPERATION PROCESS

1. MAJOR CHANGES IN FUEL SYSTEM OF D27DTP (POWER UP) ENGINE

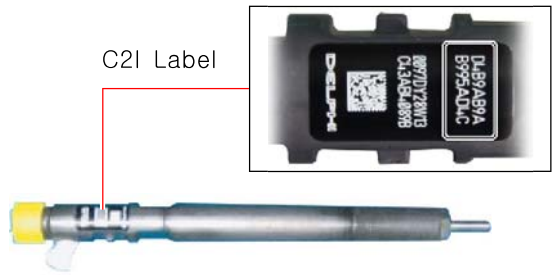
There are some changes in the parts related to the fuel system due to the newly adopted D27DTP (POWER UP) engine. The major changes are as follows. Refer to the next pages for further details.

1) Injector

D27DTP & D27DT (EU IV)



D27DT

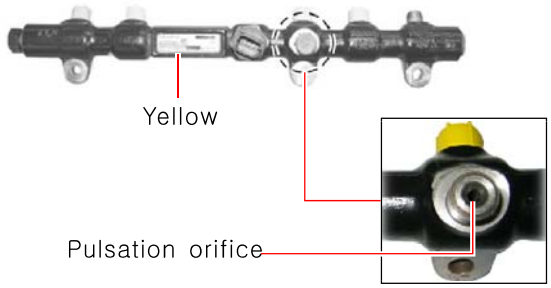


- Two nozzle holes are added (currently 7) to the tip of the injector to increase the amount of fuel injection and to improve injection efficiency according to the increased engine power.
- The existing C2I coding (16 digits) is changed to C3I coding (20 digits) to monitor fuel injection and follow the target value.
- For the D27DT engine, the injector MDP (minumum current for the solenoid in the injector to lift the nozzle) is leaned only when the engine is running. However, for the D27DTP engine, it is learned when the vehicle is in motion and the engine is at idle speed.

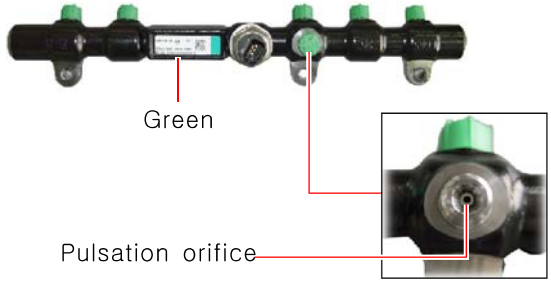
Modification basis	
Application basis	
Affected VIN	

2) Common Rail

D27DTP & D27DT (EU IV)



D27DT



· The orifice is added to the connection to the fuel pipe of the HP pump to prevent the fuel pulsation by the fuel supply and fuel cut according to the increase of injected fuel volume. (It is also installed on the connection of the high pressure fuel supply line of the HP pump.)

Modification basis	
Application basis	
Affected VIN	

3) Fuel Rail - Chrome Color

D27DTP & D27DT (EU IV)

* Fuel pipe (Common rail → Injector)



* Fuel high pressure pipe (HP pump → Common rail)



D27DT

* Fuel pipe (Common rail → Injector)



* Fuel high pressure pipe (HP pump → Common rail)



· The I.D and O.D of the fuel rail between HP pump and common rail are increased according to the increased amount of fuel injection.
Also, the engine ECU, HFM sensor and EGR system are changed to control the fuel injection volume and engine more precisely.

Modification basis	
Application basis	
Affected VIN	

2. COMPONENTS OF FUEL SYSTEM

Injector (7-way Injection and C3I Coding)

D27DTP & D27DT (EU IV)



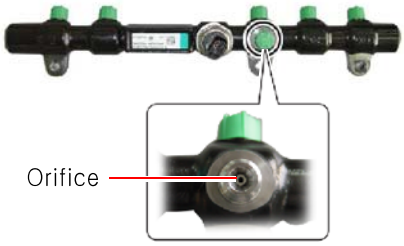


D27DT



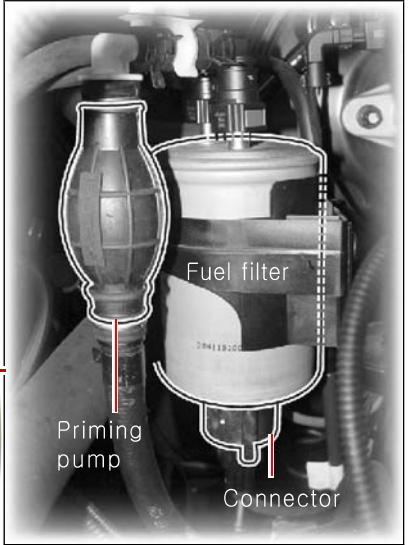


Common Rail (Orifice for Preventing Fuel Pulsation Added)

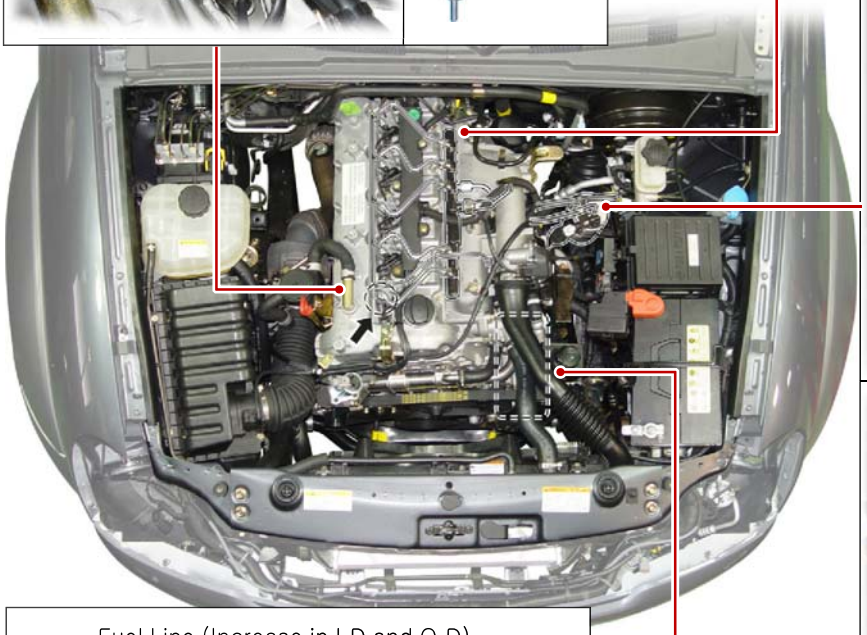


* Orifice for HP pump fuel outlet

Fuel filter Priming Pump



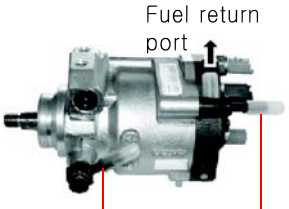


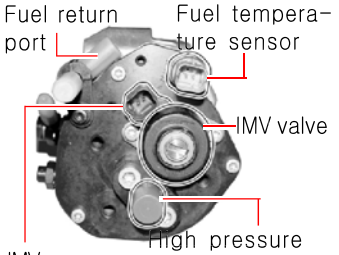


Fuel Line (Increase in I.D and O.D)



HP Pump

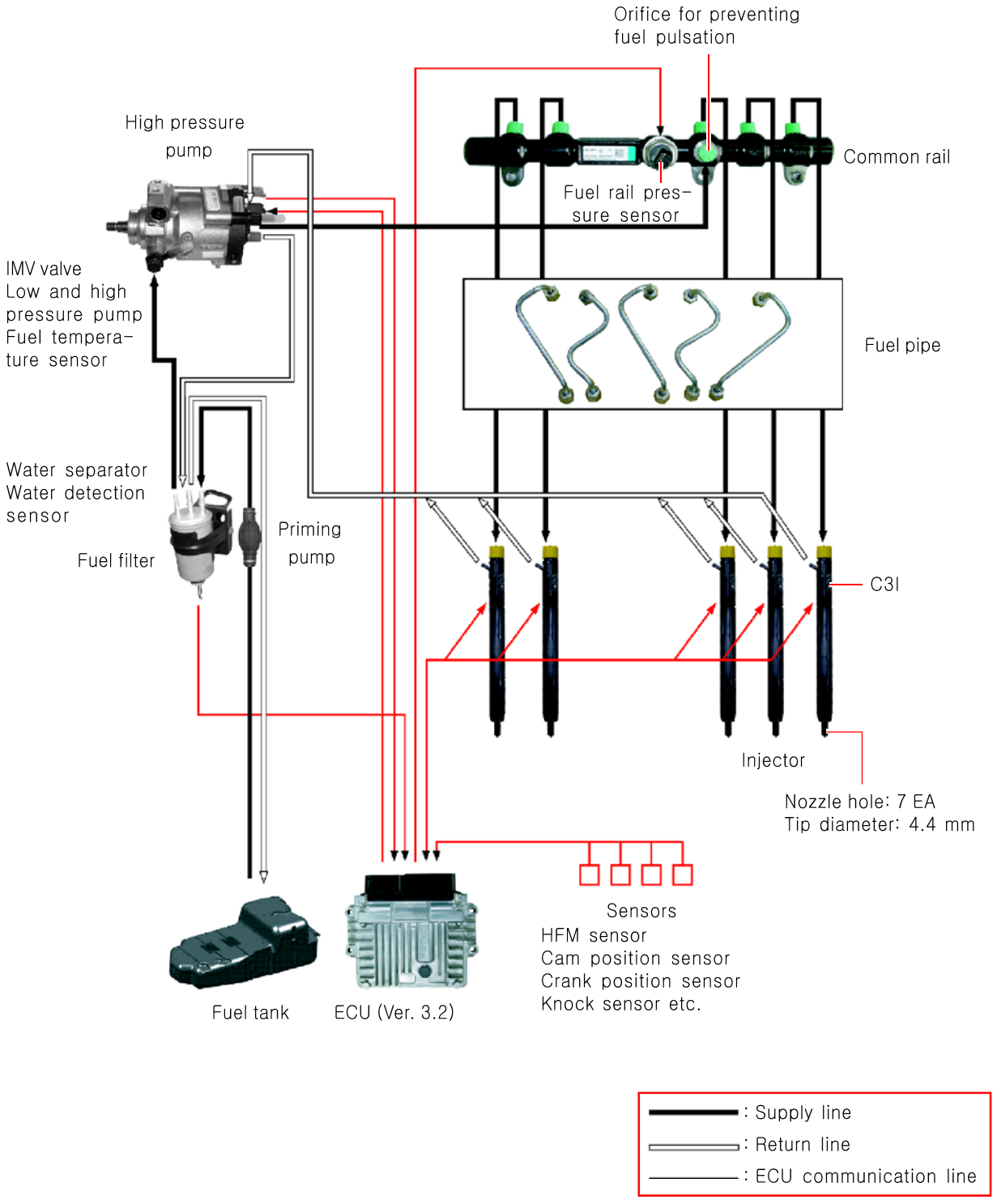




Modification basis	
Application basis	
Affected VIN	

▶ Fuel Flow of D27DTP (Power Up) Engine

Fuel Supply System



ENGINE INTAKE SYSTEM

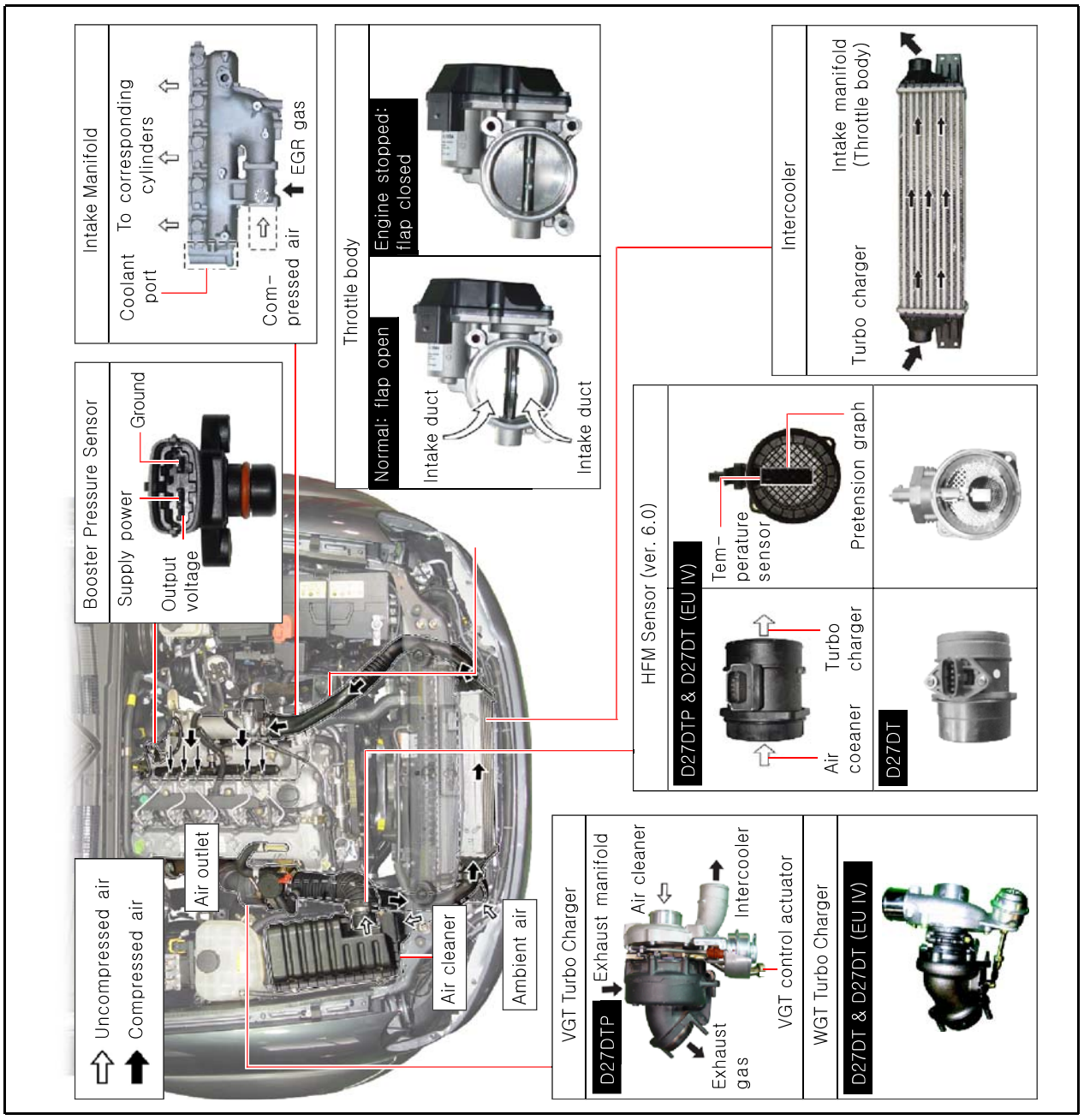
2321-01

OVERVIEW AND OPERATION PROCESS

1. INTAKE SYSTEM LAYOUT

The intake system for the D27DTP (POWER UP) engine is equipped with the throttle body that has a flap to block the air coming to the engine when the engine is switched off. Therefore, the structure of the intake manifold has been changed.

Also, the improved HFM sensor (from HFM5.0 to HFM6.0) has been installed to control the intake air precisely so that the NOx in the exhaust gas can be decreased.



Modification basis	
Application basis	
Affected VIN	

ENGINE EXHAUST SYSTEM

1792-01

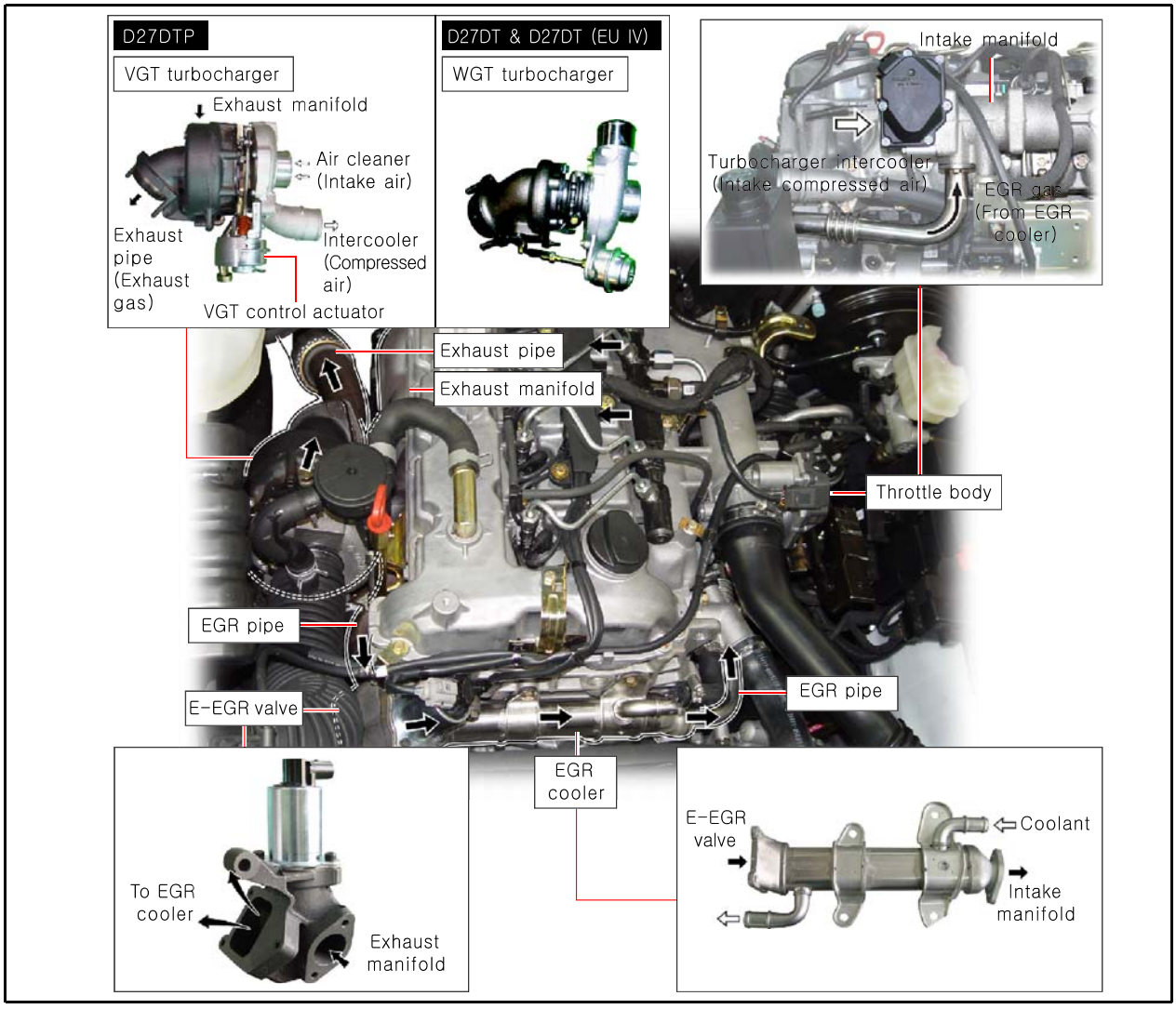
OVERVIE AND OPERATION PROCESS

1. COMPONENTS

The components of the exhaust system for the D27DTP (POWER UP) engine have been changed as follows:

1. E-EGR valve: Controlling the EGR valve electrically and sends the valve location signal to ECU (vacuum modulator control has been deleted)
2. EGR cooler: Decreasing EGR gas (NOx) efficiently by cooling the EGR gas and let it flow to the intake pipe
3. VGT turbocharger: Increase in capacity and performance compared to D27DTP & D20DT engine

The EGR system has been changed to control NOx more efficiently and the VGT turbo charger has been changed to increase the engine power. For more details, refer to the next description. The exhaust system for D27DTP (POWER UP) engine is as follows:



Modification basis	
Application basis	
Affected VIN	

CDPF(EURO IV)

2412-02

GENERAL INFORMATION

1. OVERVIEW FOR CDPF (EURO IV)

1) General Description

The CDPF (Catalyst & Diesel Particulate Filter) was installed to the Rexton II D27DTP engine previously. However, it is now installed to the all 2009 DI engine models, except the Actyon Sports. The DI engine types installed to Rexton are D27DTP, D27DT and D20DT, and their CDPF, related sensor and operation logic are the same.
This section describes the CDPF system (based on Euro IV) which is installed to the Rexton II D27DTP engine (older model).

2) Compatibility of CDPF System by Vehicle Model

Rexton II: Same CDPF system for D27DTP and D27DT engines (including its components)
Kyron & Actyon: Same CDPF system for D27DT and D20DT engines (including its components)

NOTE

- The CDPF assemblies installed to the Euro IV D27DTP Rexton II and 2009 Rexton II are different in their mounting layout, but their front/rear exhaust temperature sensors and differential pressure sensors are same.

3) System Met with Euro IV Regulations

- E-EGR valve
- EGR cooler
- Engine ECU (Ver. 3.2)
- HFM sensor
- C3I injector
- Electronic throttle valve (body)
- Other engine mounting components

For details about the modified components and system related to the Euro IV regulations, refer to the 2008 Rodius engine service manual.

Modification basis	
Application basis	
Affected VIN	

2. CDPF(EURO IV) SYSTEM

The CDPF system is only installed to the D27DT engine, and the major changes comparing to the previous D27DT engine is as follows:

CDPF (Catalyst & Diesel Particulate Filter) and sensors

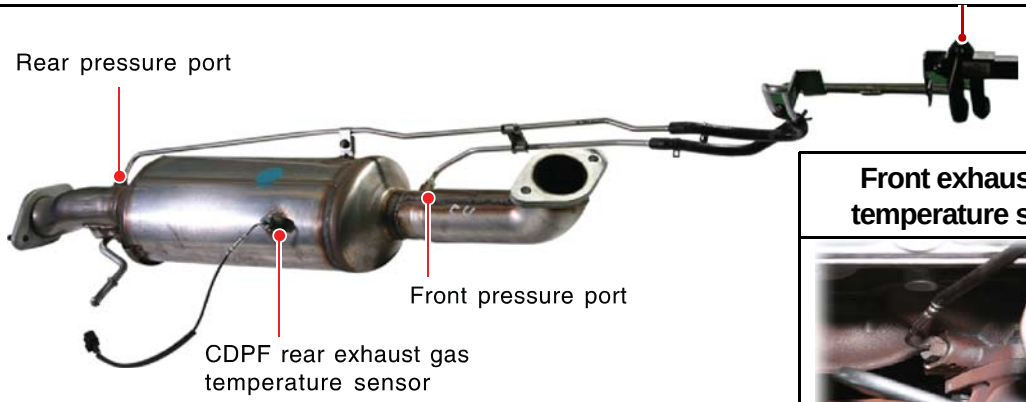
Differential pressure sensor (△P sensor)



Under air cleaner in righ side of engine compartment



As the soot is filtered in the CDPF, the pressure between the front side and the rear side of the filter is different from each other. If the amount of soot is over 28 g, the soot is burnt in the CDPF. The combustion is determined depending on the pressure difference, temperature of exhaust gas and EGR ratio. According to these, the soot filtered by post injection of injector is burnt at 600°C.



Front exhaust gas temperature sensor



CDPF Exhaust Gas Temperature Sensor



The two temperature sensors inside the CDPF are installed in exhaust manifold (front exhaust gas temperature sensor) and in DOC (rear exhaust gas temperature sensor), and perform the following functions.

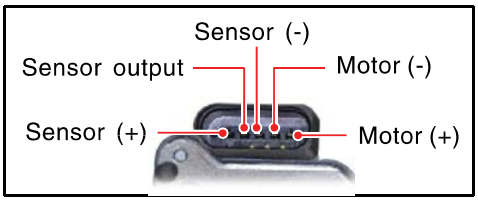
Front Exhaust Gas Temperature Sensor:
Measures the exhaust gas temperature of the exhaust manifold. As it is installed in front of the VGT turbocharger, it also monitors the exhaust gas temperature coming to the turbocharger. If the temperature of the exhaust gas flowing to the turbocharger is higher than the specification, the engine lowers the exhaust gas temperature.

Rear Exhaust Gas Temperature Sensor:
Measures the increased exhaust gas temperature after the oxidation process of DOC. If the temperature is below 600°C, the post injection amount is increased to increase the temperature.

Modification basis	
Application basis	
Affected VIN	

Throttle Body



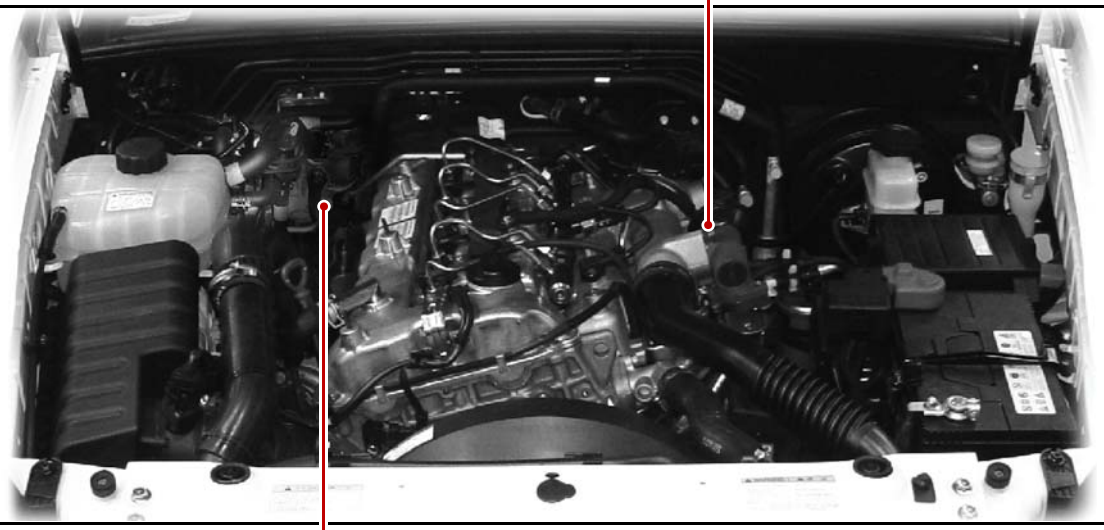


CDPF system controls the amount of intake air by controlling the electronic throttle body. The electronic throttle body has the following main functions.

CDPF control- added a function that increases the exhaust gas temperature by closing the throttle valve flap to minimize the intake air amount by the fuel injection amount during the CDPF regeneration range with the low engine load range.

ON/OFF control - prevents the engine from turning off with vibration and noise by closing the throttle body flap to block the intake air when the engine is stopped.

Duty control- controls the valve inside the throttle body to burn more EGR gas in the EGR valve operating range.

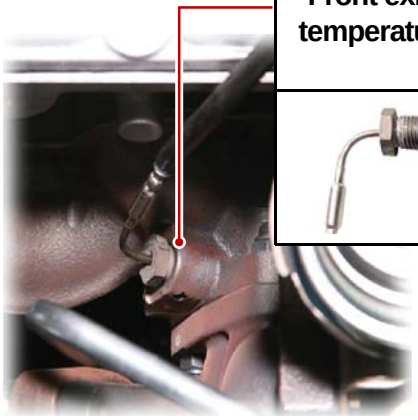


VGT Turbocharger and Front Exhaust Gas Temperature Sensor

Turbocharger may become weaker if high temperature exhaust gas passes through the turbocharger for DPF regeneration process.
The front exhaust gas temperature sensor monitors the temperature of the exhaust gas that flows into the turbocharger.
If the temperature of the exhaust gas that passes through the exhaust manifold is higher than the specification, the ECU decreases the fuel injection amount and increases the EGR gas intake amount to decrease the exhaust gas temperature.

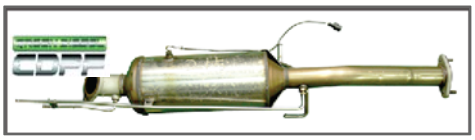
Front exhaust gas temperature sensor





OVERVIEW AND OPERATION PROCESS

1. OVERVIEW



As the solution for environmental regulations and PM (Particla 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 Oxydation Catalyst) is reduced. The CDPF (Catalyst & Diesel Particulate Filter) is an integrated filter including DOC (Diesel Oxydation Catalyst) and DPF (Diesel Particulate Filter).

▶Comparison of throttle body functions based on exhaust emission regulation

Regulated parts are carbon monoxide (CO), nitrogen oxide (NOx), particular matter (PM) and soot in the exhaust emission, and the particulars of the regulations are prescribed in the following table.

Engine	Control method	Function
D27DTP + CDPF **D27DT + CDPF** **D20DT + CDPF**	ECU's electric signal (Duty and On/Off control) + Throttle flap control during CDPF operation	**ON/OFF control -** prevents the engine from turning off with vibration and noise by closing the throttle body flap to block the intake air when the engine is stopped **Duty control -** controls the valve inside the throttle body to burn more EGR gas in the EGR valve operating range. **CDPF control -** added a function that increases the exhaust gas temperature by closing the throttle valve flap to minimize the intake air amount by the fuel injection amount during the CDPF regeneration range with the low engine load range.
D27DT engine **(EU IV)**	ECU's electric signal (Duty and On/Off control)	**ON/OFF control -** prevents the engine from turning off with vibration and noise by closing the throttle body flap to block the intake air when the engine is stopped **Duty control -** controls the valve inside the throttle body to burn more EGR gas in the EGR valve operating range.

Modification basis	
Application basis	
Affected VIN	

2. CDPF (EURO IV) SYSTEM CONTROL

1) Combustion Temperature and Procedures

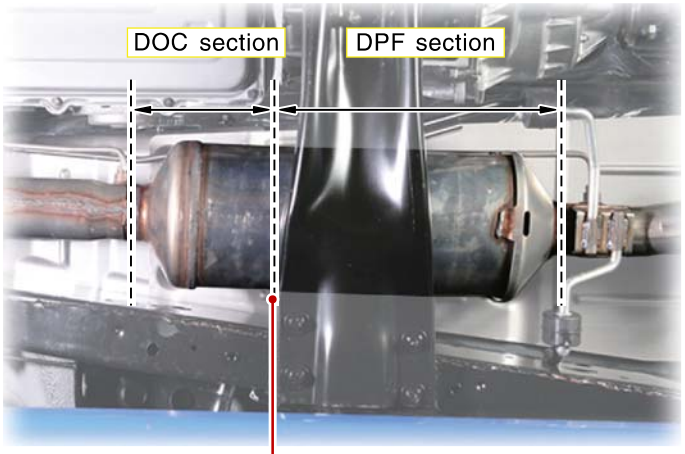
As the soot is filtered in the CDPF, it is burnt and removed, and the CDPF is returned to the initial state to collect the soot. Therefore, the burning procedures in the CDPF can be called as regeneration.

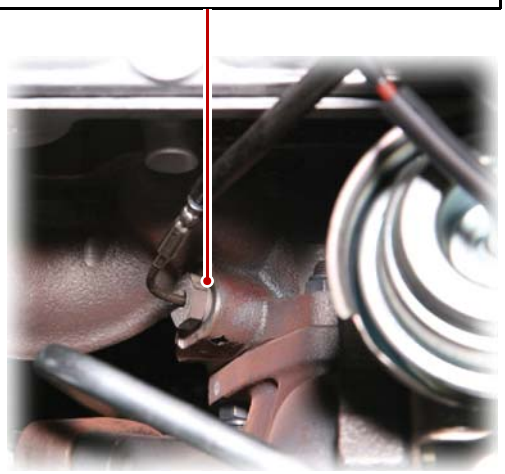
The CDPF assembly is integrated with DOC (at front side) and DPF (at rear side).

The DPF burns the soot with high-temperature exhaust gas (over 600°C). The rear exhaust gas temperature sensor monitors the temperature of DPF section. If this temperature is below the regeneration temperature, the ECU increases the post injection period to increase the fuel injection amount, and consequently to increase the exhaust gas temperature.



Front exhaust gas temperature sensor
(Measuring temperature of exhaust gas in exhaust manifold)





Rear exhaust gas temperature sensor
(Measuring temperature of exhaust gas escaping DOC)

NOTE

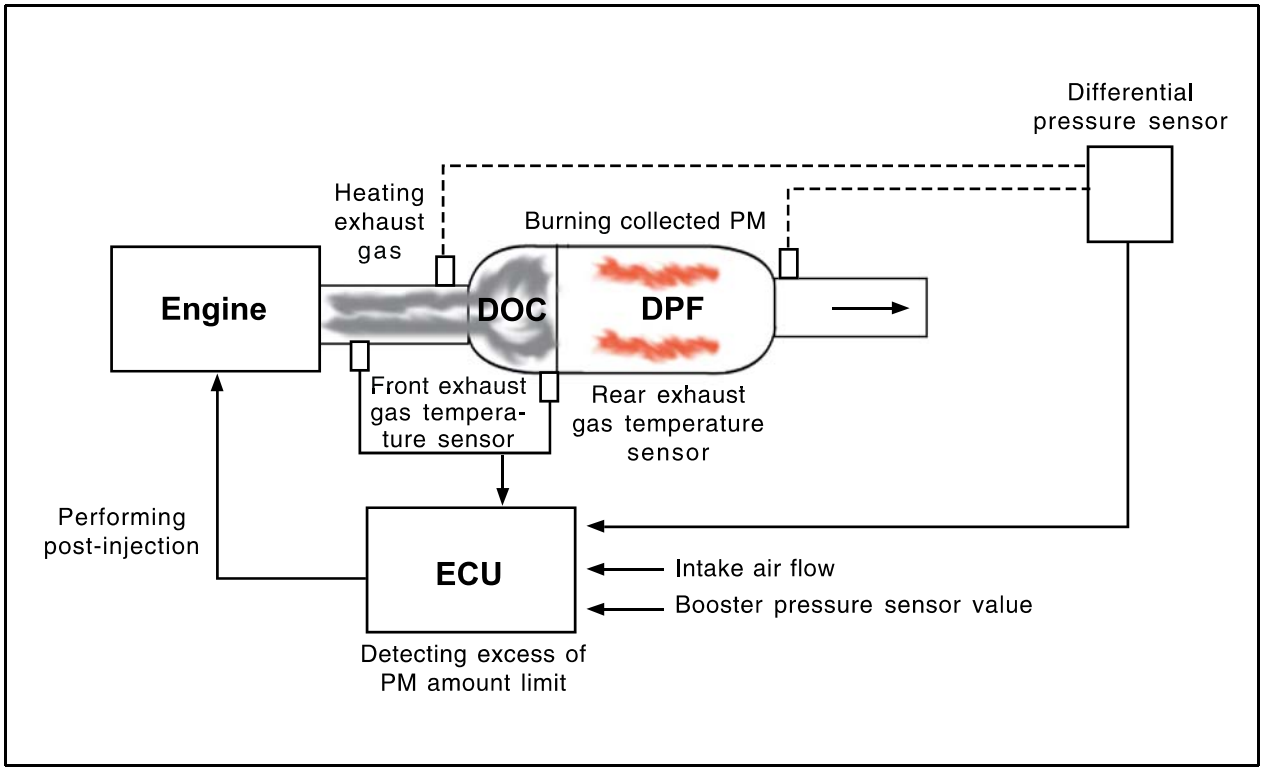
- Normally, when the vehicle is driven for 600 ~ 1,200 km, the enough amount of soot to be burnt is filtered and accumulated in the CDPF. The ECU increase the amount of post injection to increase the tempeature of exhaust gas up to 600°C so that the soot is burnt. The soot is burnt for 15 ~ 20 minutes.

2) Sytem composition for Soot Combustion

When the engine is running in low load range, the temperature of exhaust gas is decreased as the amount of fuel supplied is decreased. To burn the soot filtered in the CDPF, the control system should be installed to check the operating range and increase the temperature of exhaust gas by controlling the amount of fuel supplied and intake air.
Two temperature sensors and one differential pressure sensor monitor the CDPF's operating range. According to these sensors' information, the throttle flap decreases the intake air entered to the throttle body. Also, the fuel injection pattern is added to increase the temperature of exhaust gas for soot combustion.
There are three fuel injection patterns (pilot injection, pre-injection and main injection). As the CDPF is installed, the post injection pattern is added.

3) Post Injection and Air Mass Control

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 acumulated 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.



Modification basis	
Application basis	
Affected VIN	

NOTE

Throttle bodies by engine type

- The throttle valve is controlled by electric signals sent from the engine ECU for optimal fuel injection volume, engine load and effective combustion of EGR gas according to the Euro 4 regulations. It has following functions by the engine type.

Engine	Control Method	Function
D27DTP + CDPF **D27DT + CDPF** **D20DT + CDPF**	ECU's electric signal (Duty and On/Off control) + Throttle flap control during CDPF operation	**CDPF control -** added a function that increases the exhaust gas temperature by closing the throttle valve flap to minimize the intake air amount by the fuel injection amount during the CDPF regeneration range with the low engine load range. **ON/OFF control -** prevents the engine from turning off with vibration and noise by closing the throttle body flap to block the intake air when the engine is stopped. **EGR gas amount control -** Close the valve to decrease the intake air amount and lets more EGR gas flows to burn more EGR gas at EGR valve operating range.
D27DT engine (EU IV)	ECU's electric signal (Duty and On/Off control)	**ON/OFF control -** prevents the engine from turning off with vibration and noise by closing the throttle body flap to block the intake air when the engine is stopped. **EGR gas amount control -** Close the valve to decrease the intake air amount and lets more EGR gas flows to burn more EGR gas at EGR valve operating range.
D27DT engine	No throttle body installed	

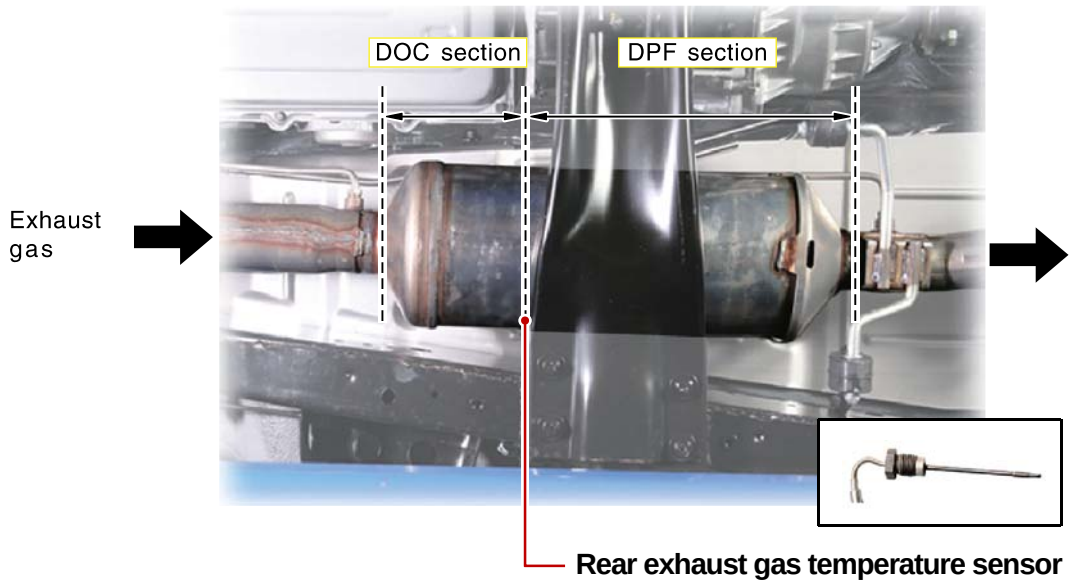
3. SOOT FILTERING AND BURNING PROCEDURES

1) Operating Procedures of CDPF

The most efficient and practical technology for now is adopted to the diesel particulate filter (DPF).
This system collects the soot from the diesel engine to the filter and burns the soot so that over than 95% of soot can be removed from the exhaust gas. However, the durability and the cost of additional system remain as problems.

Firstly, the exhaust gas is passed through the DOC and its temperature is increased as it is oxidized. The ECU detects the temperature change with two temperature sensors. The CO, HC and partial particulate material are removed from the exhaust gas (this procedures are the sames as the ones for the conventional DOC and no sensor is required).

After the exhaust gas is passed through the DOC and oxidized, most of the harmful material is removed from the exhaust gas. However, to meet the environmental regulations in the future, the soot is filtered and burnt again in DPF to decrease the particulate material further.



Rear exhaust gas temperature sensor
(Measuring temperature of exhaust gas escaping DOC)

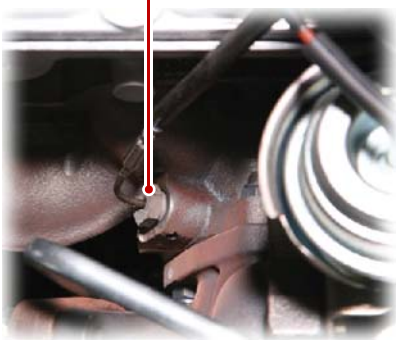
NOTE

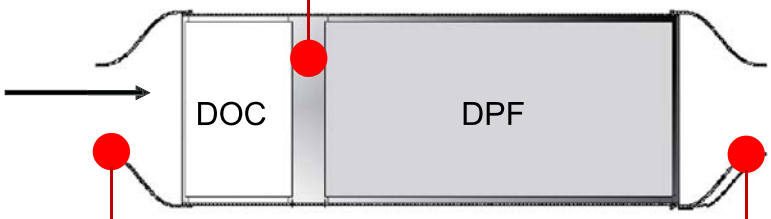
- The filtered soot is burned whenever the vehicle is driven for 600 ~ 1200 km. The driving distance can be differed depending on the vehicle's driving conditions. The soot is burnt for 15 ~ 20 minutes.

Modification basis	
Application basis	
Affected VIN	

Front temperature sensor
(Measuring the temperature of exhaust gas passed through exhaust manifold)

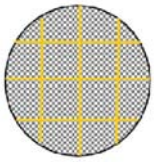
Rear temperature sensor
(Measuring the temperature of exhaust gas passed through DOC)



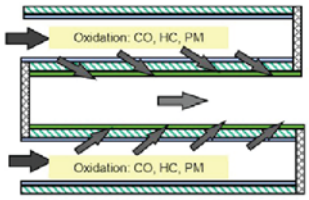


Differrential pressure sensor(Front pressure port)

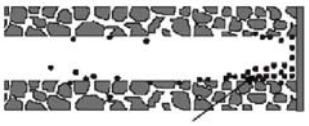
Differrential pressure sensor(Rear pressure port)



The exhaust gas enters into CDPF assembly after passing through the exhaust manifold.
(Normal temperature of exhaust gas: approx. 250°C)

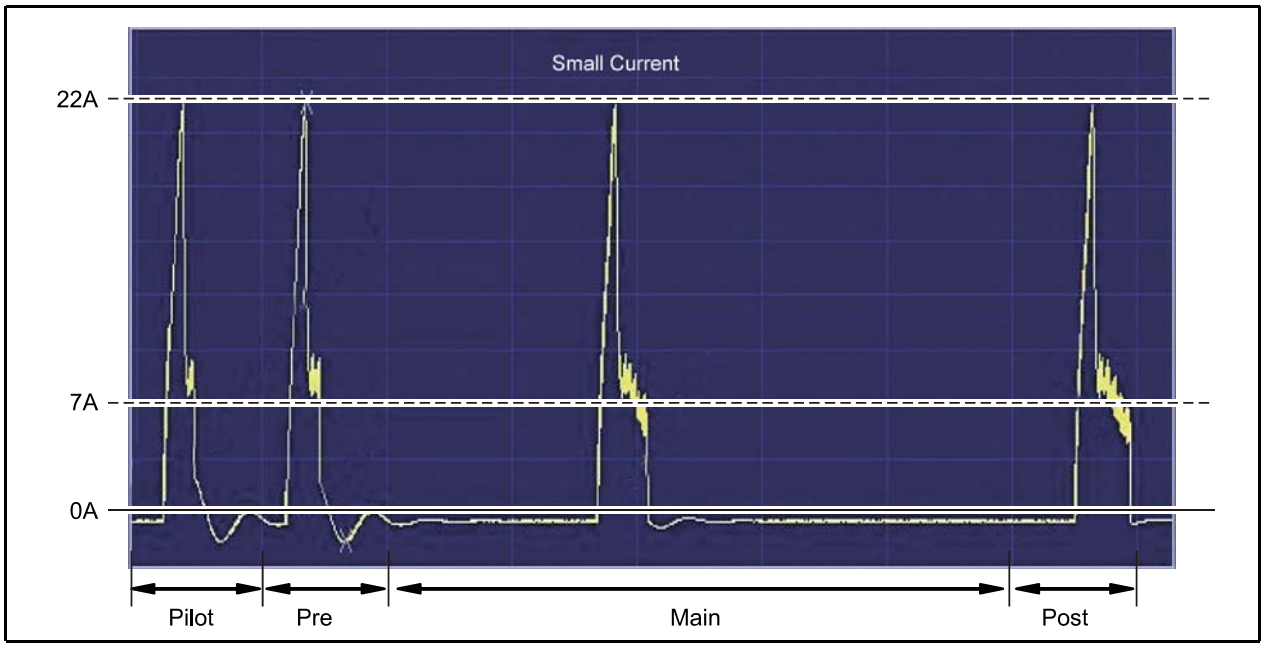


When the exhaust gas enters into the CDPF assembly, its CO, HC and particulate material are reduced as it is oxidized in DOC. The remaining particulate material is filtered and collected in DPF and the temperature of exhaust gas is increased to approx. 450 ~ 500°C.



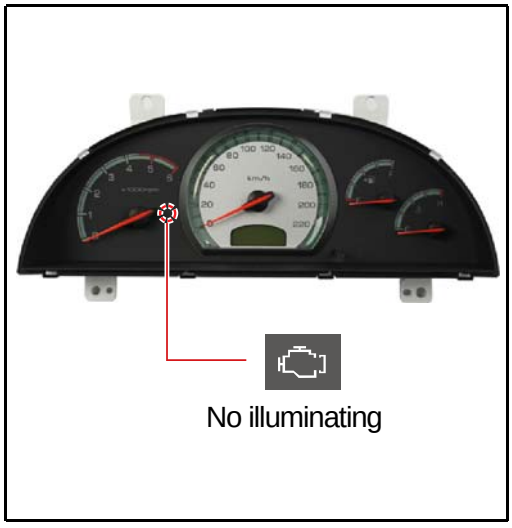
The engine ECU detects the amount of particulate material colected by the information from temperature sensors and differential pressure snesor. When the soot is accumulated, the pressure difference between the front and the rear side occurs. Then, the engine ECU performs the post injection to raise the exhaust gas temperature and burn the collected soot at approx. 600°C.

2) Fuel Injection During CDPF Regeneration



3) Warning Lamp Related To CDPF

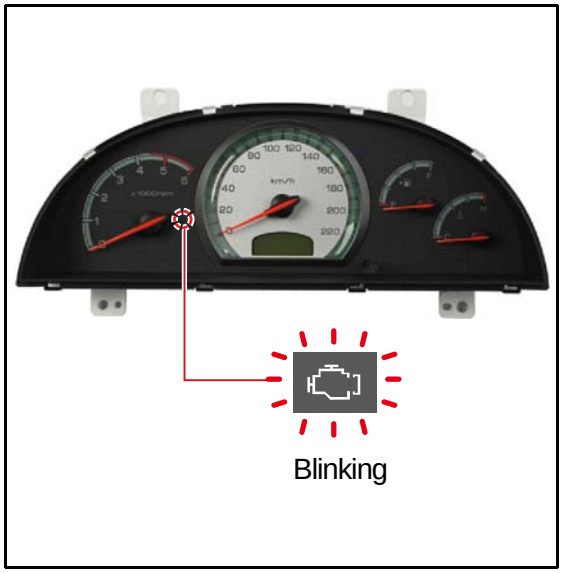
▶CDPF regeneration process (warning lamp NOT illuminated)



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 during 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.

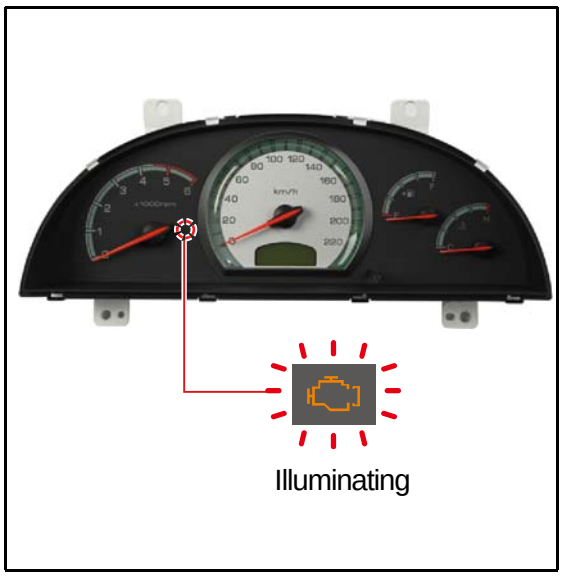
Modification basis	
Application basis	
Affected VIN	

▶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 condition continues and the CDPF is overloaded with soot, the engine warning lamp blinks to inform this situation to the driver.
2. 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 burnt 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 overload 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.
3. To solve this problem, blow soot between the engine and exhaust system several times and erase the related DTC. Then, check if the same DTC is regenerated again. If so, check the DTC related to the differential pressure sensor.

Actually, the DTC for the CDPF is generated more often by the component related to the CDPF system, such as the differential pressure sensor, than by excessive soot in the CDPF.

4. COMPONENTS OF CDPF SYSTEM

▶Mounting condition and location

Differential Pressure Sensor

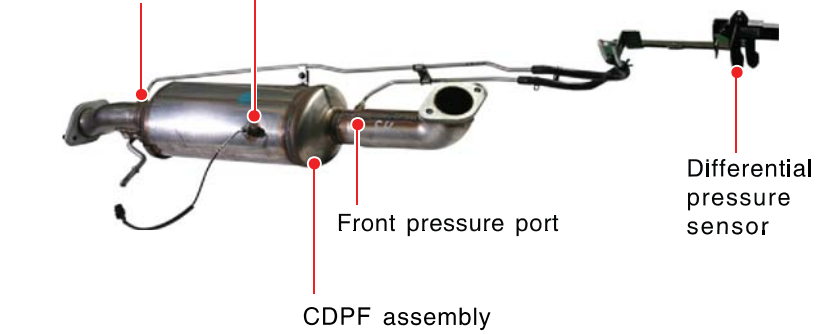
Engine compartment (RH)



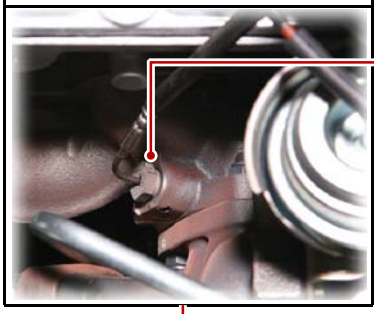


Rear exhaust gas temperature sensor





Front Exhaust Gas Temperature Sensor

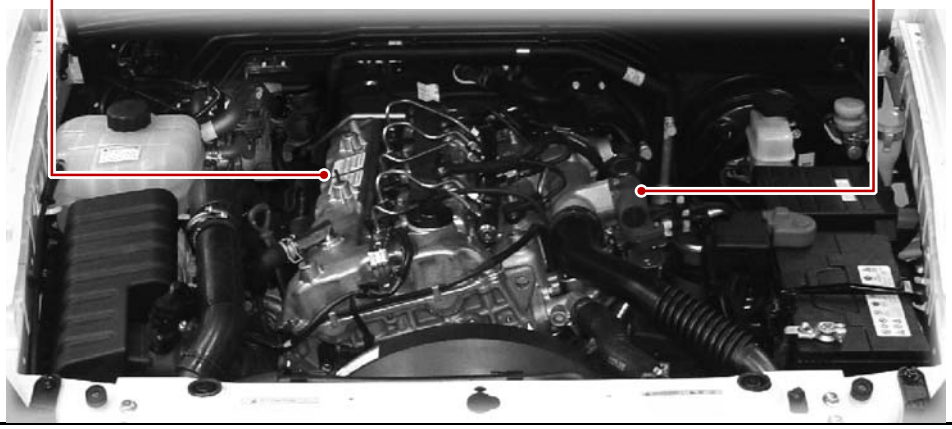




Front exhaust gas temperature sensor

Throttle Body





Modification basis	
Application basis	
Affected VIN	

NO DATA

ENGINE COOLING SYSTEM

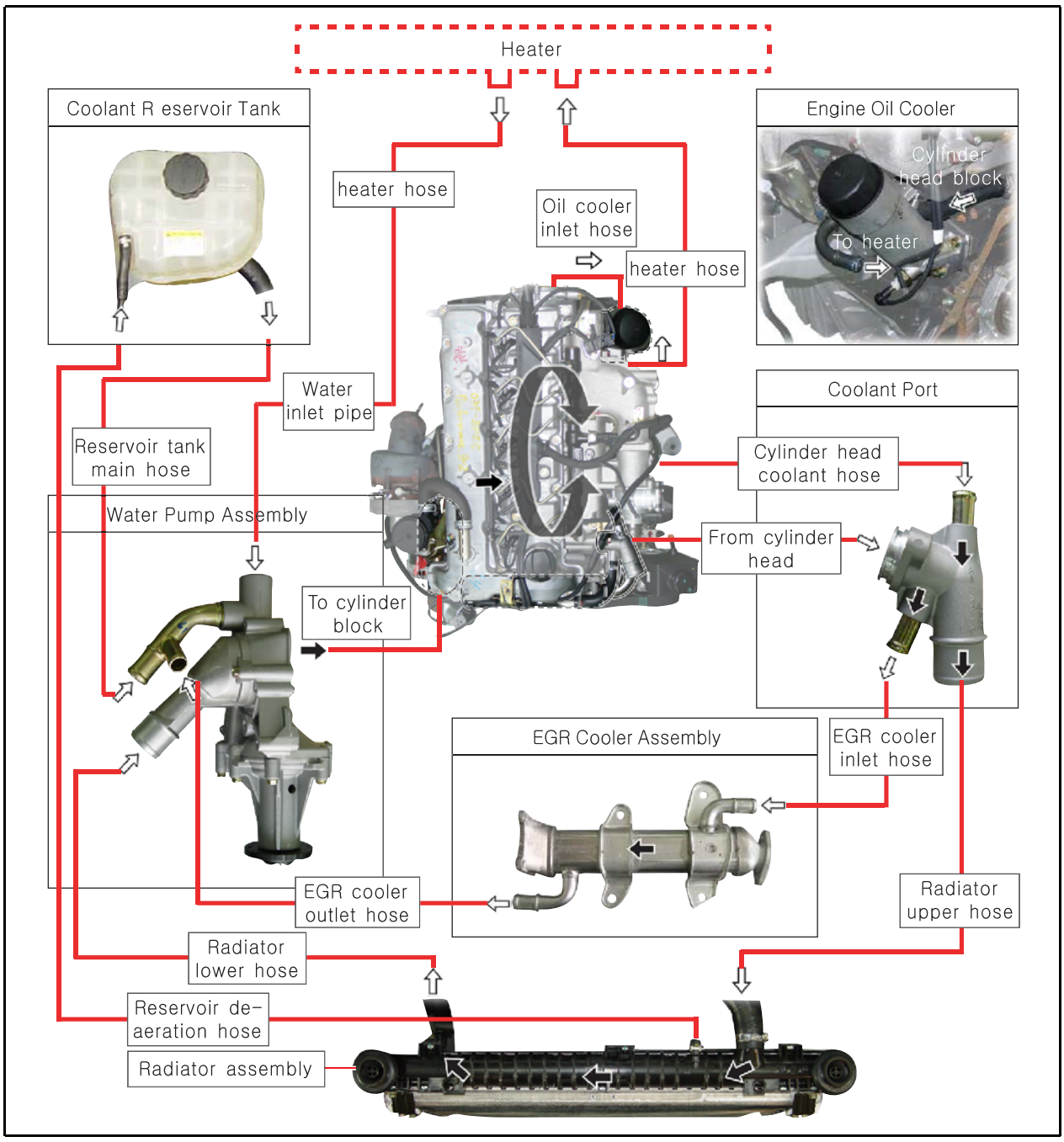
1520-01

OVERVIEW AND OPERATION PROCESS

1. COMPARISON IN COOLING SYSTEM FOR EACH ENGINE

For the D27DTP (POWER UP) engine, the cooling system is equipped with E-EGR cooler and the water pump which its capacity is improved according to the additional coolant line in the cylinder block. For the D27DT engine, the cooling system uses the fan clutch.

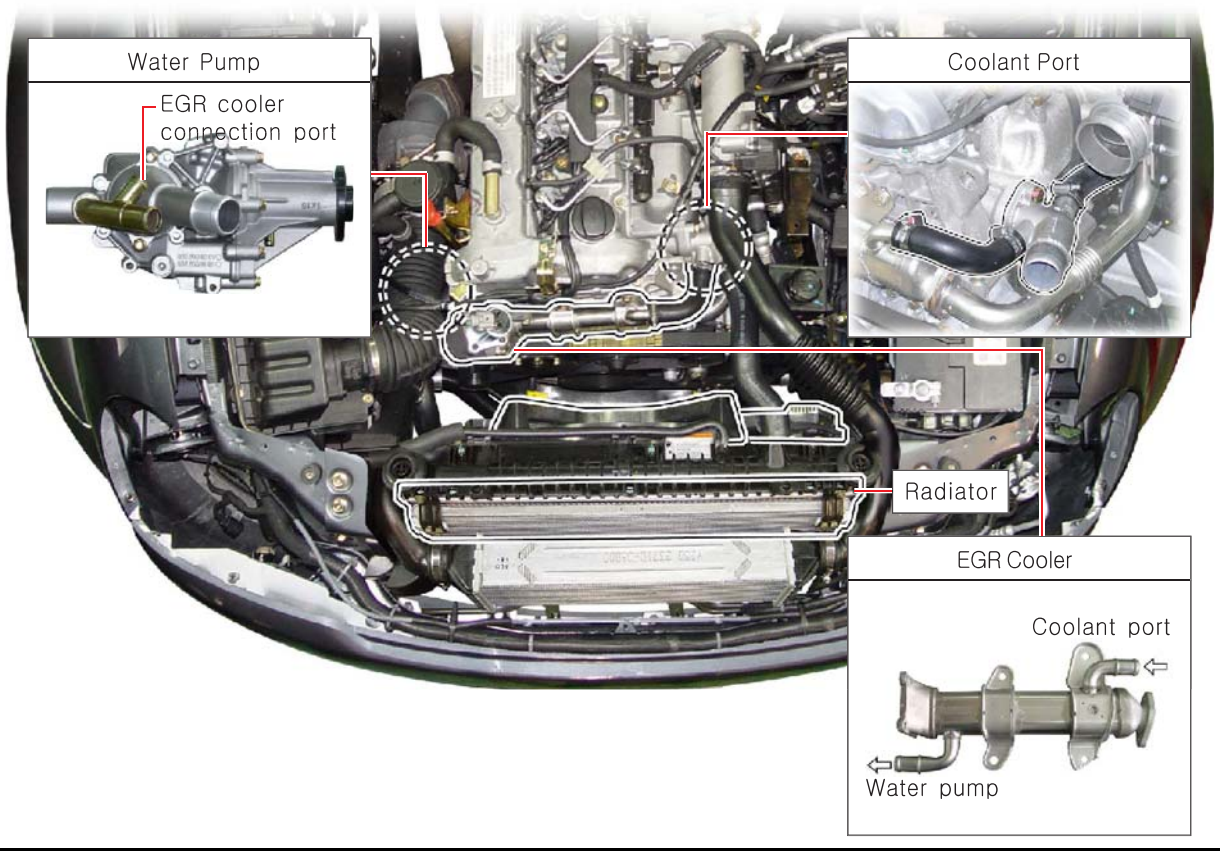
▶ **Cooling System for D27DTP (POWER UP) Engine**



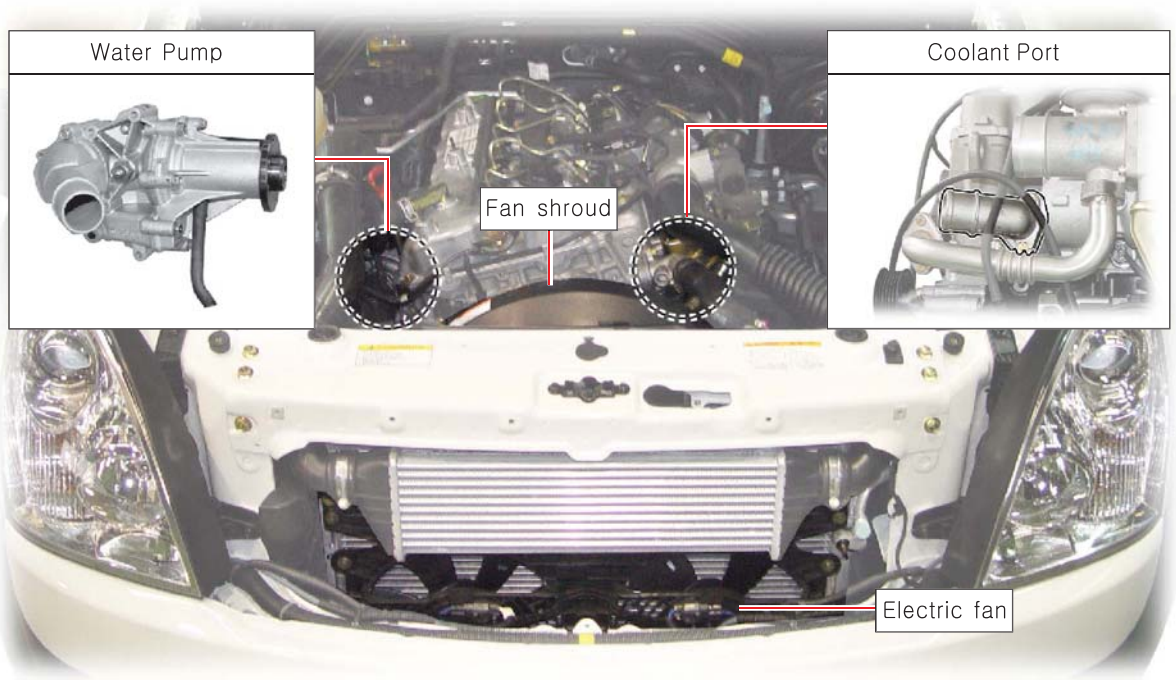
Modification basis	
Application basis	
Affected VIN	

▶ Comparison

D27DTP (POWER UP) & D27DT (EU IV) Engine



D27DT Engine



Modification basis	
Application basis	
Affected VIN	

NO DATA

NO DATA

CRUISE CONTROL

8510-23

OVERVIEW AND OPERATING PROCESS

1. SYSTEM DESCRIPTION

1) System Description



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 38 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.

2) 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

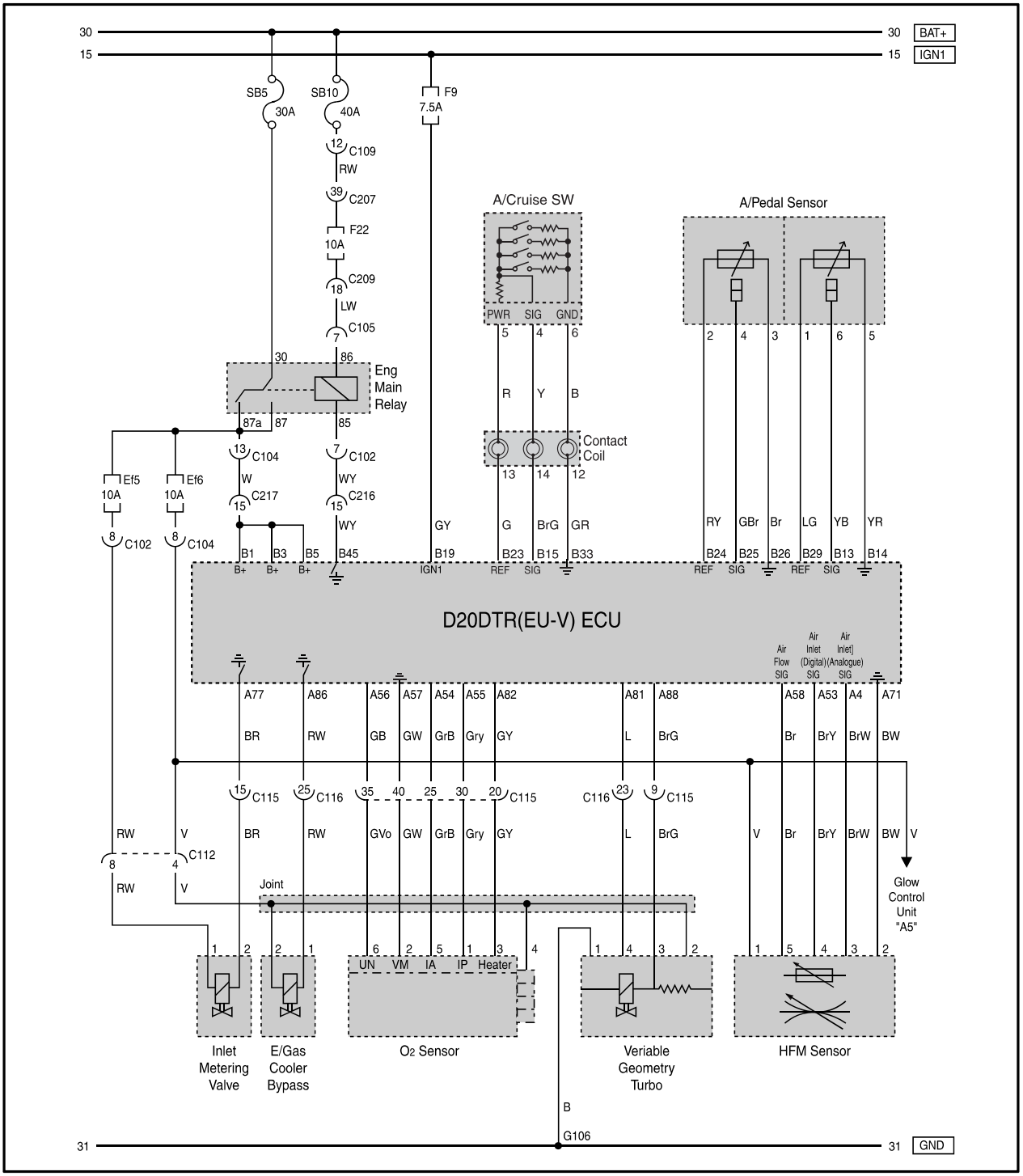
Improper use of the cruise control could be dangerous.
- Do not use on winding roadsyy .
- Do not use in heavy traffic.
- Do not use on slippery, wet roads.

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

Modification basis	
Application basis	
Affected VIN	

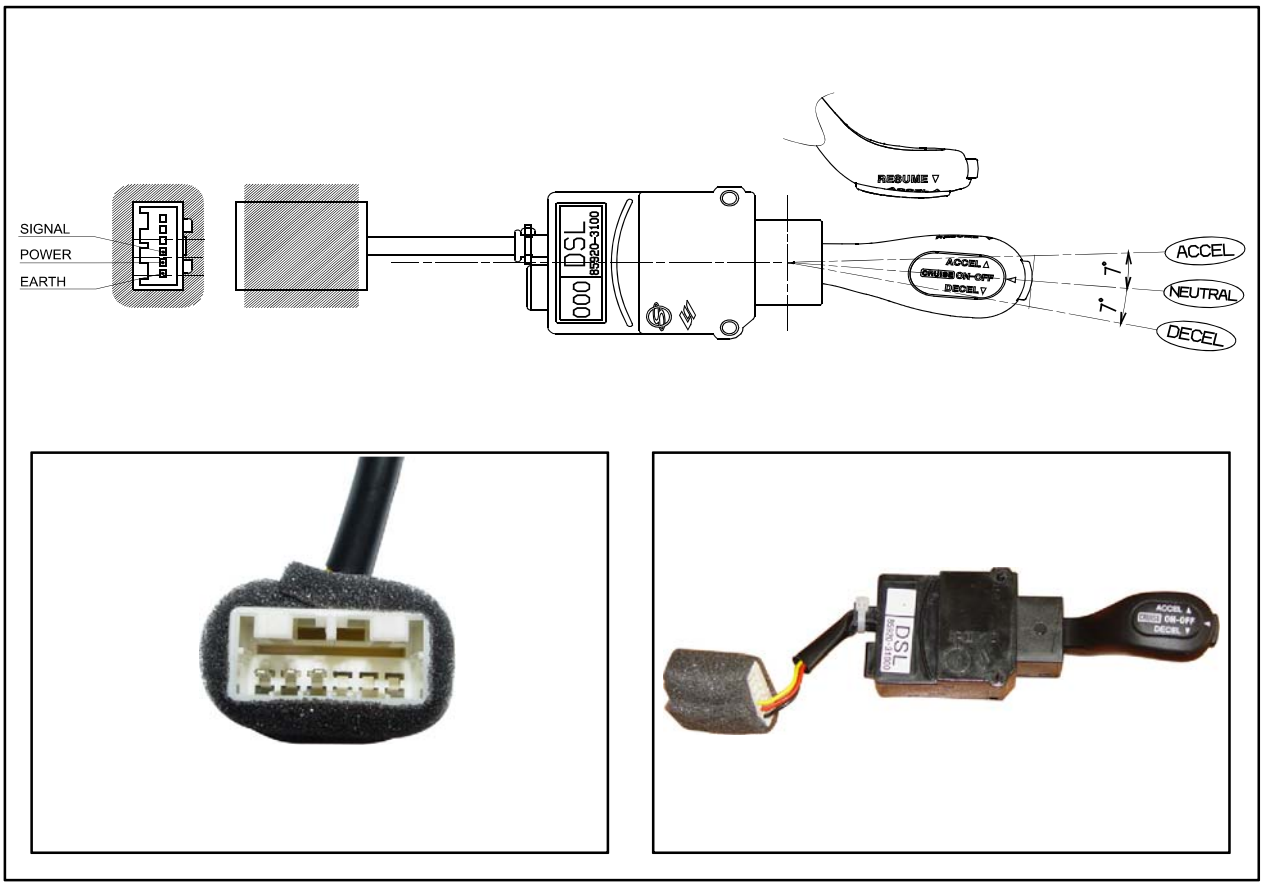
2. CONFIGURATION

1) Circuit Diagram



The engine ECU detects the operating conditions of cruise control system, and monitors the braking performance, vehicle speed, road conditions and ESP system operation. If the engine ECU determines that there are not any problem to drive in cruise control mode, the vehicle can be operated by cruise switch signals (decelerating, accelerating, cruising).

2) Configuration



▶ **Test voltage(VCC 5V)**

FUNCTION	KEY VOLUE	REMARK
MAIN	0.15 ~ 0.55V	-
DECEL	0.7 ~ 1.1V	-
ACCEL	1.6 ~ 2.0V	-
RESUME	2.52 ~ 2.92V	-

Modification basis	
Application basis	
Affected VIN	

3. OPERATION

1) Setting a Desired Speed



1. To operate the cruise control, accelerate to the desired speed, which must be more than 36 km/h and less than 150 km/h.
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. You don't need to use the accelerator pedal.
4. Refer to the following pages for details of operation.

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.

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) When the cruise control system is not running

To increase the speed with the cruise control system while the system is not running, follow the procedures below.

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

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

To increase the vehicle speed in stages while the cruise control system is running, follow the procedures below.

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. When you operate a tap-up switching, the vehicle is accelerated for 1.3 km/h over the previous set speed.
2. If you want to accelerate for 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

To decrease the vehicle speed with the cruise control system when the system is not running, follow the procedures below.

1. Push down the cruise control switch lever to DECEL side and hold it until the desired speed is reached while the vehicle speed is over 36 km/h.
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

To decrease the vehicle speed in stages while the cruise control system is running, follow the procedures below.

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. When you operate a tap-down switching, the vehicle is decelerated for 1.0 km/h below the previous set speed.
   If you want to decelerate for 10 km/h, operate the tap-down switching ten times without the
2. 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 pulling up 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

But the driver should know the previous set speed to react to the changed vehicle speed properly. If the vehicle speed increases abruptly, depress the brake pedal to adjust the vehicle speed properly.

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 or When ESP is activated.
2. When the cruising speed is downed less than 34 km/h
3. When applying the parking brake during driving.
4. When using the clutch in order to shift (M/T only).

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.
   When the rapid acceleration is applied without acceleration pedal intervention.
2. When the cruise control lever is faulty.
3. When the brake switch and the brake light switch input signal are implausible.

When the cruise control function is cancelled abnormally or intermittent problems occur, stop the vehicle and turn off the ignition switch and remove the key to reset the system. After a while, turn on the ignition switch again to operate the cruise control system.

CAUTION

1. Do not move the shift lever to Neutral position while driving with the cruise control turned on. Otherwise, it may result in system malfunction or accidents.
2. Always be prepared to use the brake or accelerator pedal for safe driving while the cruise control system is running.
3. The actual speed can be different from the set speed momentarily when driving on a uphill or downhill. So, it is recommended to disable the cruise control function on a uphill or downhill. hen driving on a steep hill use the engine brake and foot brake properly to protect the vehicle system and for a safe driving.
4. Ensure that the safe distance is maintained and use the brake pedal if needed.

Modification basis	
Application basis	
Affected VIN	

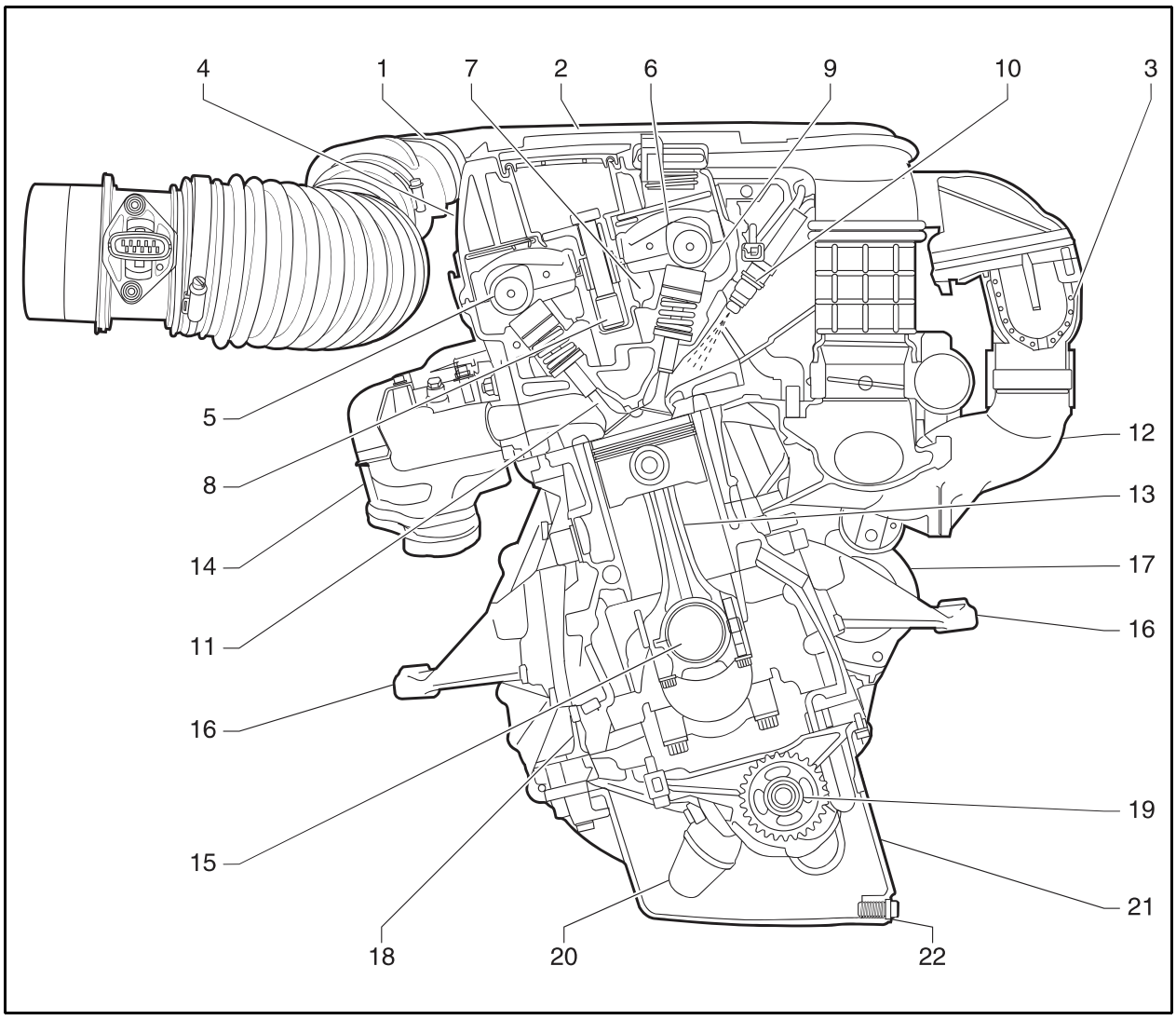
ENGINE GENERAL

0000-00

GENERAL

1. COMPONENT LOCATOR

1) Front View

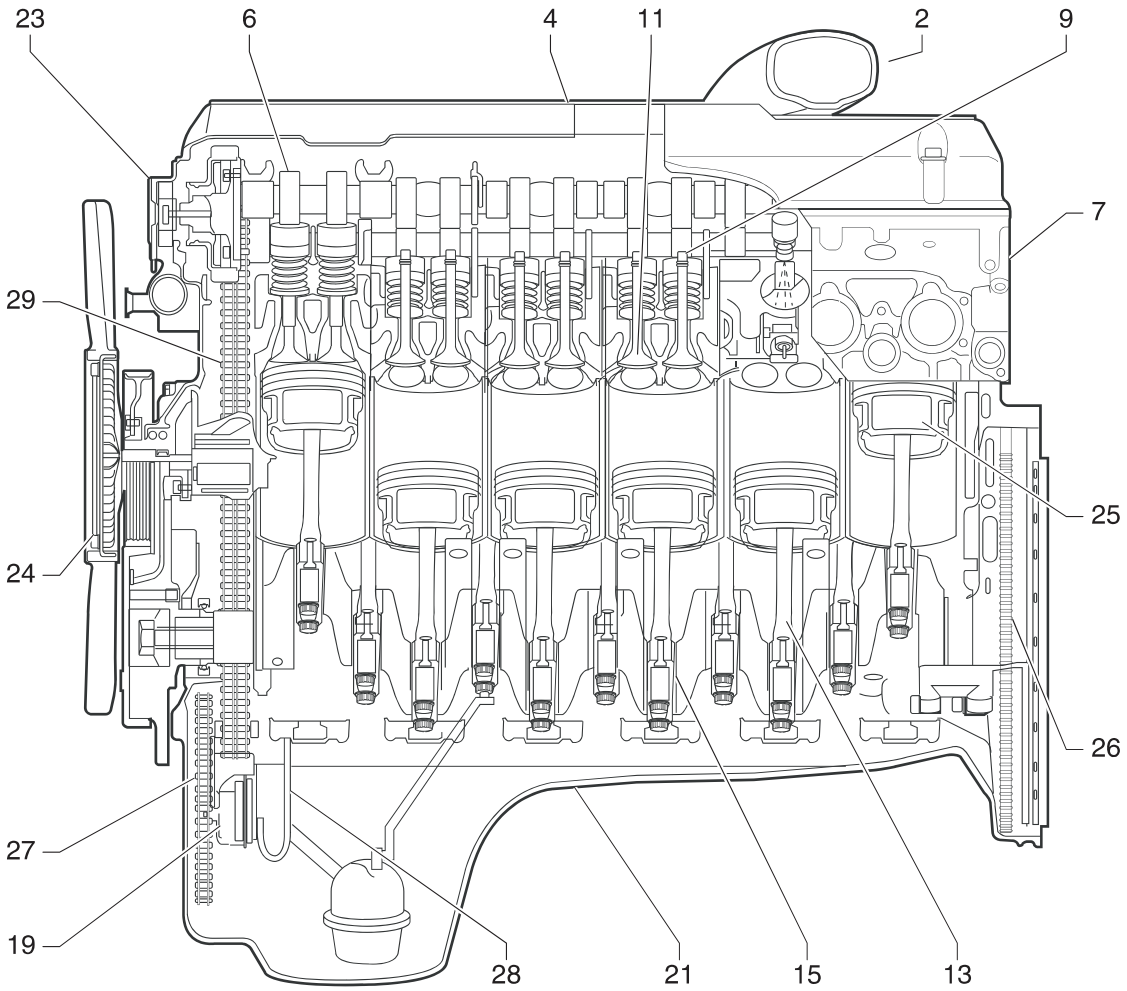


Modification basis	
Application basis	
Affected VIN	

▶ **Front View**

NO.	FUNCTION	NO.	FUNCTION
1	HFM sensor	12	Intake manifold
2	Intake air duct	13	Connecting rod
3	Resonance flap	14	Exhaust manifold
4	Cylinder head cover	15	Crankshaft
5	Exhaust camshaft	16	Engine mounting
6	Intake camshaft	17	Starter
7	Cylinder head	18	Crankcase
8	Spark plug connector	19	Oil pump sprocket
9	Valve tappet	20	Oil strainer
10	Injector	21	Oil pan
11	Exhaust valve	22	Drain plug

2) Side View



NO.	FUNCTION	NO.	FUNCTION
23	Camshaft adjuster	27	Oil pump drive chain
24	Cooling fan and viscous clutch	28	Oil return pipe
25	Piston	29	Timing chain
26	Flywheel of drive plate		

Modification basis	
Application basis	
Affected VIN	

2. 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.
  Notice Any time the air cleaner is removed, the intake opening

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.g

ENGINE ASSEMBLY

1113-01

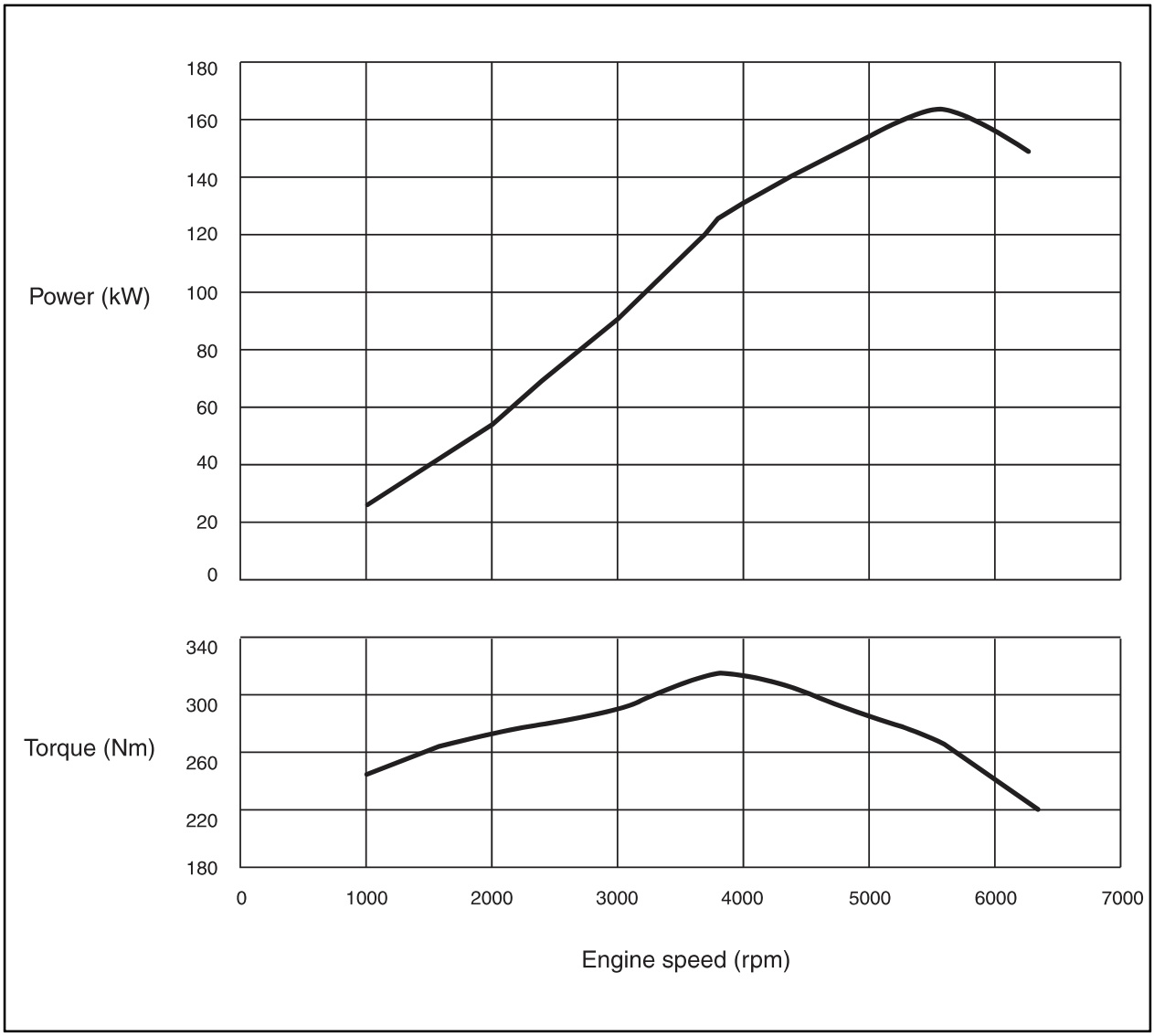
GENERAL

1. SPECIFICATIONS

1) Engine Specifications

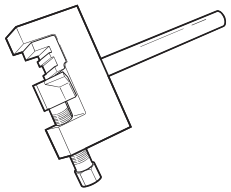
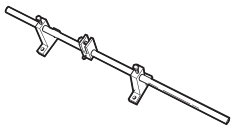
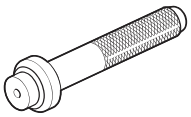
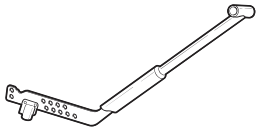
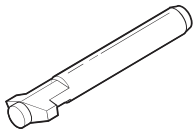
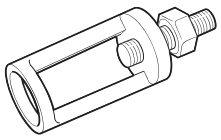
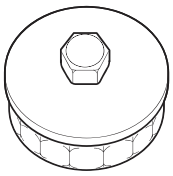
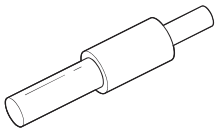
Application			M162 Engine
Engine model			M162.990
Displacement		(CC)	3199
Cylinder (Bore x Stroke)		(mm)	89.9 x 84.0
Fuel injection / Ignition system			MSE 3.63D
Compression ratio			10 : 1
Number of cylinders			6
Camshaft valve arrangement			DOHC
Camshaft drive type			Chain-Driven
Max. output		(ps/rpm)	220 / 6000
Max. torque		(kg•m/rpm)	31.6 / 3900
Firing order			1 - 5 - 3 - 6 - 2 - 4
Ignition type			Distributorless double ignition
Ignition timing			BTDC 8°
Valve timing	Intake	Open/Close	ATDC 11° / ABDC 34°
Valve clearance adjustment			Automatic control
Idle speed		(rpm)	700 ± 50
Fuel injection pressure		(kg/cm^2)	3 ~ 4
Oil capacity		(liter)	9
Lubrication type			Forced by gear pump
Oil filter type			Full flow with paper filter
Fuel			Unleaded gasoline

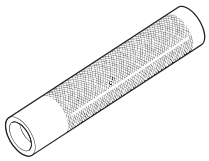
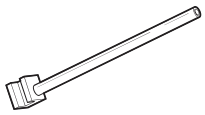
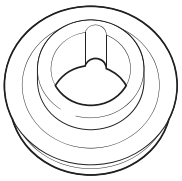
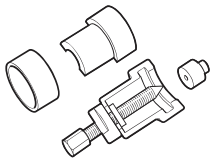
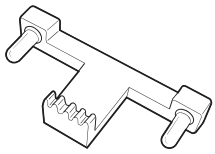
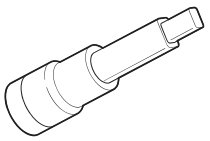
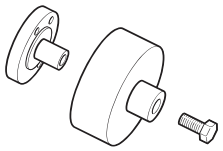
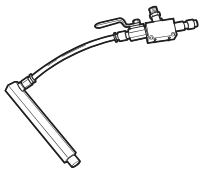
2) Performance Curve



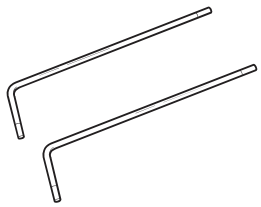
Modification basis	
Application basis	
Affected VIN	

2. SPECIAL TOOLS AND EQUIPMENT

Name and Part Number	Name and Part Number
000 589 58 43 00 Chain Assembly 	A9917 0101B (111 589 01 59 00) Supporting Bar 
W991 1 0010B (102 589 00 15 00) Drift 	A9917 0111B (111 589 18 61 00) Lever Pusher 
A991 1 0050B (102 589 12 15 00) Drift 	A9917 0121B (111 589 25 63 00) Thrust Piece 
A9910 0050A (103 589 02 09 00) Oil Filter Remover 	A9913 0061B (116 589 01 34 00) Threaded Pin 

Name and Part Number	Name and Part Number
A9917 0171B (119 589 00 43 00) Drift 	A9910 0150A (603 589 00 40 00) Fan Clutch Holder 
A991 1 0060B (601 589 03 14 00) Crankshaft Front Seal Installer 	W9910 0150A (615 589 01 33 00) Crankshaft Sprocket Puller 
A9910 0150B (602 589 00 40 00) Engine Lock 	A9912 0080B (617 589 00 10 00) Allen Wrench Socket 
W991 1 0020B (601 589 03 43 00) Crankshaft Rear Seal Installer 	A991 1 0012B (DW1 10-090) Connecting Hose 

Modification basis	
Application basis	
Affected VIN	

Name and Part Number
A9917 0012B (DW110-120)Holding Pin 

3. FASTENER TIGHTENING SPECIFICATIONS

Application	Nm	Lb-Ft	Lb-In
A/C bracket bolt	22.5 ~ 27.5	16.6 ~ 20.3	-
Armature bolt in camshaft actuator	35	26	-
Belt tensioning pulley nut	40.5 ~ 49.5	29.9 ~ 36.5	-
Camshaft actuator bolt	9 ~ 11	-	80 ~ 97
Camshaft adjuster mounting nut	60 ~ 70	44 ~ 52	-
Camshaft bearing cap bolt	22.5 ~ 27.5	16.6 ~ 20.3	-
Chain tensioner assembly	72 ~ 88	53 ~ 65	-
Chain tensioner screw plug	40	30	-
Connecting rod bearing cap bolt	40 + 5 90° + 10°	30 + 3.7 90° + 10°	-
Cooling fan bracket bolt	22.5 ~ 27.5	16.6 ~ 20.3	-
Crankshaft bearing cap bolt	50 ~ 60 90° + 5°	37 ~ 44 90° + 5°	-
Crankshaft sealing rear cover mounting bolt	9 - 11	-	80 ~ 97
Cylinder block drain plug	30	22	-
Cylinder head bolt	55 +90° +90°	41 +90° +90°	-
Cylinder head cover bolt	9 ~ 11	-	80 ~ 97
Cylinder head front cover bolt	22.5 ~ 27.5	16.6 ~ 20.3	-
Engine mounting bracket nut	70	52	-
Exhaust camshaft sprocker bolt	18 ~ 22 90° ± 5°	13 ~ 16 90° ± 5°	-
Exhaust manifold and pipe	30	22	-
Flywheel mounting bolt	45 + 5 90° + 10°	33 + 3.7 90° + 10°	-
Fuel feed and return hose to fuel rail	21 ~ 25	15 ~ 18	-
Generator carrier bolt	25	18	-
Intake air duct nut	9 ~ 11	-	80 ~ 97
Intake flange shaft bolt	18 ~ 22 90° ± 5°	13 ~ 16 90° ± 5°	-
Lower engine mounting nut	38	28	-
Oil dipstick guide tube bolt	9 ~ 11	-	80 ~ 97
Oil drain plug	22.5 ~ 27.5	16.6 ~ 20.3	-

Modification basis	
Application basis	
Affected VIN	

1) Fastener Tightening Specifications (Cont'd)

Application		Nm	Lb-Ft	Lb-In
Oil filter bolt		22.5 ~ 27.5	16.6 ~ 20.3	-
Oil filter cover		25	18	-
Oil gallery screw plug in cylinder head		15	11	-
Oil pan bolt	M10	40	30	-
	M8	22.5 ~ 27.5	16.6 ~ 20.3	-
	M6	9 ~ 11	-	80 ~ 97
Oil pressure relief valve screw plug		50	37	-
Oil pump drive sprocket bolt		29 ~ 35	21 ~ 26	-
Oil pump mounting bolt		22.5 ~ 27.5	16.6 ~ 20.3	-
Oil pump sprocket bolt		29 ~ 35	21 ~ 26	-
Spark plug cover bolt		9 ~ 11	-	80 ~ 97
Steering pump bolt		22.5 ~ 27.5	16.6 ~ 20.3	-
Tensioning device bolt		26 ~ 32	19 ~ 24	-
Timing gear case cover bolt	M8	22.5 ~ 27.5	16.6 ~ 20.3	-
	M6	9 ~ 11	-	80 ~ 97
Torque converter mounting bolt		42	31	-
Transmission mounting nut		54 ~ 68	40 ~ 50	-
Under cover		28 ~ 47	21 ~ 35	-
Upper engine mounting nut		70	52	-
Vibration damper center bolt		180 ~ 220 90° + 10°	133 ~ 162 90° + 10°	-
Water pump pulley bolt		22.5 ~ 27.5	16.6 ~ 20.3	-

ENGINE FUEL SYSTEM 2211-22

OVERVEIW AND OPERATION PROCESS

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 theengine. 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 sys-tem.

▶ 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

℃	°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

Modification basis	
Application basis	
Affected VIN	

NO DATA

ENGINE EXHAUST SYSTEM

2420-01

GENERAL

1. OVERVIEW OF 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. OVERVIEW OF MUFFLER

Aside from the exhaust manifold connection, the exhaust system uses a flange and seal joint design rather than a slip joint coupling design with clamp and U-bolts.
If hole, open seams, or any deterioration is discovered upon inspection of the front muffler and pipe assembly, the complete assembly should be replace, the complete assembly should be replaced.
The same procedure is applicable to the rear muffler assembly. Heat shields for the front and rear muffler assembly and catalytic converter protect the vehicle and the environment from the high temperatures that the exhaust system develops.

3. OVERVIEW OF CATALYTIC CONVERTER

CAUTION

- 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.

CAUTION

- Use of anything other than unleaded fuel will damage the catalyst in the catalytic converter.
  · The catalytic converter are emission-control devices added to the exhaust system to reduce pollutants from the exhaust pipes.
  · The oxidation catalyst is coated with a catalytic material containing platinum and palladium, which reduces levels of hydrocarbon (HC) and carbon monoxide (CO) from the exhaust gas. The three-way catalyst has coatings which contain platinum and rhodium, which additionally lower the levels of oxides of nitrogen (NOx).

4. FASTENER TIGHTENING SPECIFICATIONS

Application	Nm	Lb-Ft	Lb-In
Exhaust manifold to front exhaust pipe nut	15 ~ 28	11 ~ 21	-
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

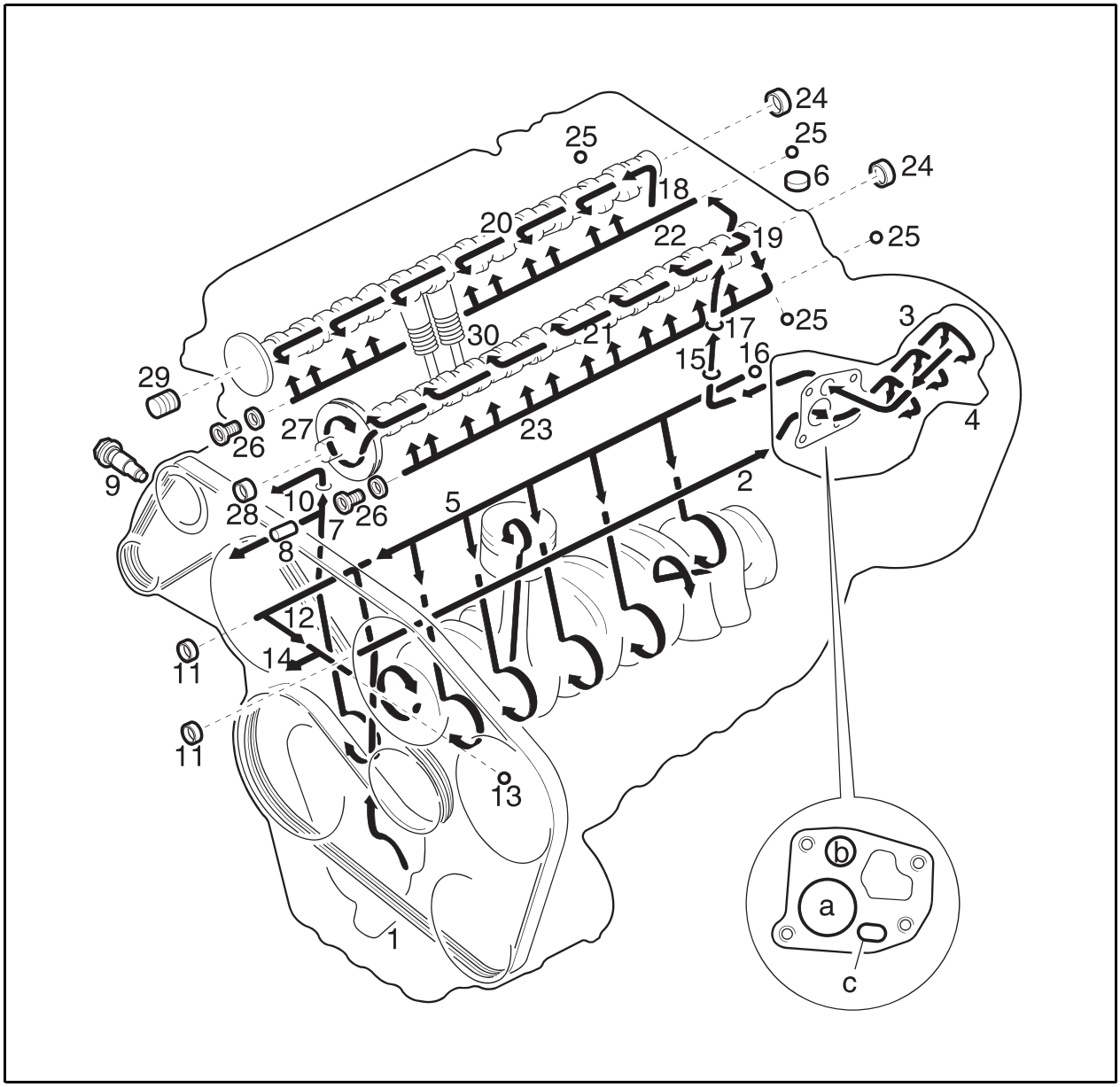
Modification basis	
Application basis	
Affected VIN	

ENGINE LUBRICATION SYSTEM

9210-01

OVERVIEW AND OPERATION PROCESS

1. OIL CIRCULATION



▶ OIL CIRCULATION

NO.	FUNCTION	NO.	FUNCTION
1	Oil pump	18	Oil supply (to exhaust camshaft)
2	Oil gallery (to oil filter)	19	Oil supply (to intake camshaft)
3	Oil filter	20	Oil supply (to exhaust camshaft bearing)
4	Oil pressure switch	21	Oil supply (to intake camshaft bearing)
5	Main oil gallery	22	Oil gallery (oil supply to exhaust valve tappet)
6	Cylinder head closing cover	23	Oil gallery (oil supply to intake valve tappet)
7	Oil gallery (at chain tensioner)	24	Camshaft closing cover
8	Oil non-return valve	25	Ball (ϕ 8 mm)
9	Chain tensioner	26	Screw plug
10	Vent (chain tensioner)	27	Camshaft adjuster
11	Front closing cover (ϕ 17 mm)	28	Front closing cover (intake camshaft)
12	Oil gallery (perpendicular to the shaft)	29	Front treaded bushing (exhaust camshaft)
13	Ball (ϕ 6 mm)	30	Valve tappet
14	Oil spray nozzle (timing chain)	a	Oil gallery (from oil pump to oil filter)
15	Oil gallery (at cylinder head)	b	Main oil gallery
16	Ball (ϕ 15mm)	c	Oil return line (oil returns to the oil pan when replacing the filter element)
17	Oil restriction inner (ϕ 4mm)		

Modification basis	
Application basis	
Affected VIN	

ENGINE COOLING SYSTEM

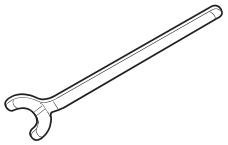
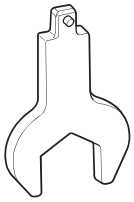
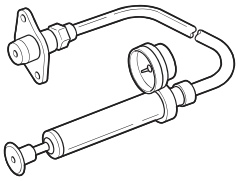
2110-01

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.	℃ (℉)	82 (180)
	Fully opening temp.	℃ (℉)	95 (203)
	Fully closing temp.	℃ (℉)	80 (176)
	Stroke	mm	7
Cooling fan	Type	-	Electric cooling
	Blades	-	5
	Diameter	mm	320
	Low speed ON temp.	℃ (℉)	95 (203)
	Low speed OFF temp.	℃ (℉)	90 (194)
	High speed ON temp.	℃ (℉)	105 (221)
	High speed OFF temp.	℃ (℉)	100 (212)
	High speed ON temp. (By A/C pressure)	kPa (psi)	269.8 (1860)
Coolant 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
	Minimum radiation capability	Kcal/h	45,000
Coolant temperature gauge	Resistance (at 50℃ (122℉))	Ω	185.2
	Resistance (at 80℃ (176℉))	Ω	47.4
	Resistance (at 105℃ (221℉))	Ω	28.2
Engine coolant temperature sensor	Resistance (at 20℃ (68℉))	K Ω	3.33 ~ 37.8
	Resistance (at 80℃ (176℉))	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

2. SPECIAL TOOLS AND EQUIPMENT

Name and Part Number	Name and Part Number
A9910 0060A (111 589 00 40 00) Holder 	A9910 0070A (111 589 02 01 00) Open End Wrench 
A9921 0012A (124 589 15 21 00) Leakage Te ster 	A9910 0150A (603 589 00 40 00) Fan Clutch Holder 

Modification basis	
Application basis	
Affected VIN	

3. 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
Engine hanger bracket and coolant outlet port bolt	22.5 ~ 27.5	16.6 ~ 20.3	-
Radiator mounting bracket bolt	3 ~ 7	-	27 ~ 62
Thermostat cover bracket bolt	9 ~ 11	-	80 ~ 97
Viscous clutch mounting bolt	40.5 ~ 49.5	29.8 ~ 36.5	-
Water pump mounting bolt	22.5 ~ 27.5	16.6 ~ 20.3	-

OVERVIEW AND OPERATION PROCESS

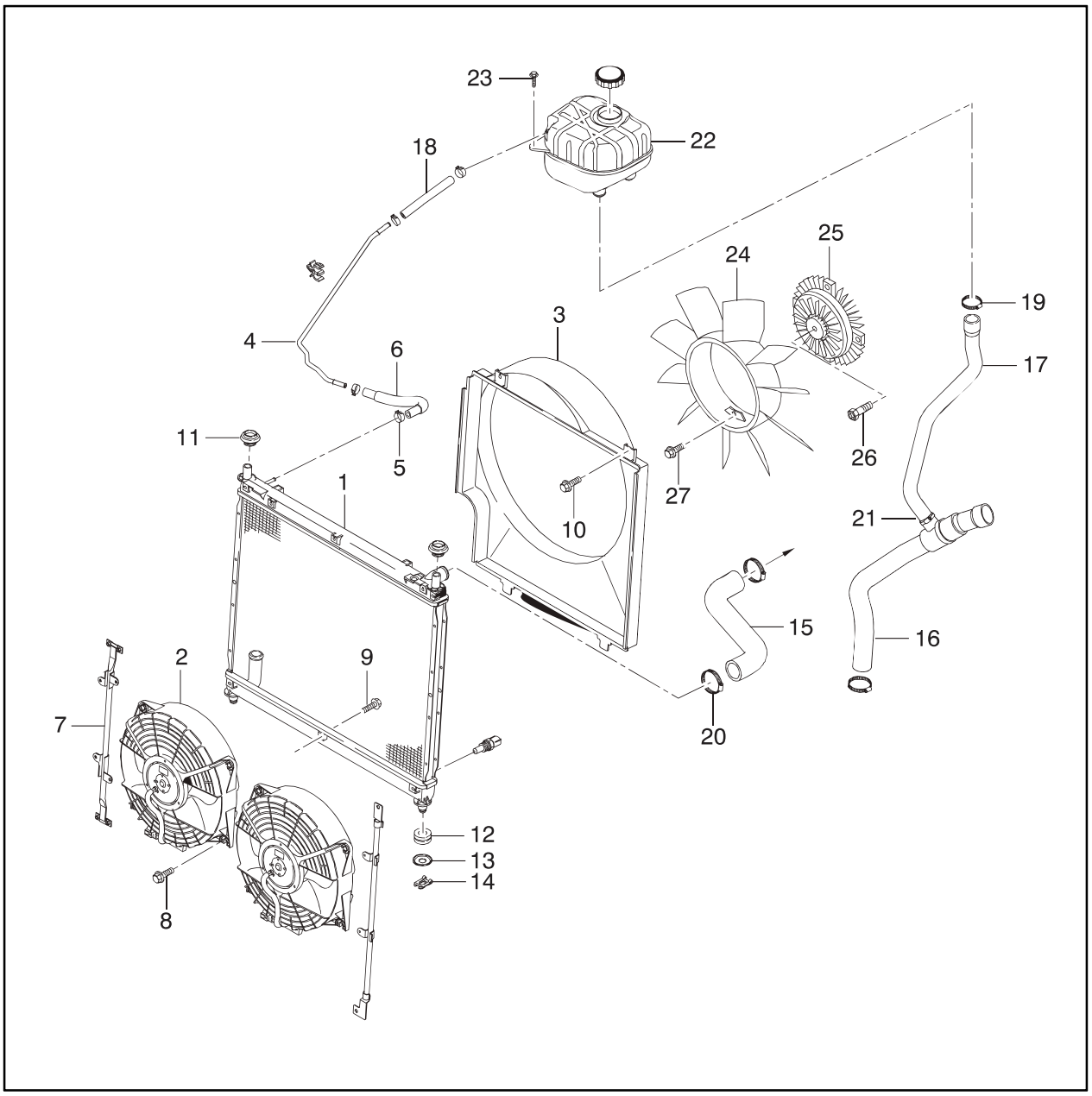
1. GENERAL DESCRIPTION

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.

Modification basis	
Application basis	
Affected VIN	

2. COMPONENT LOCATOR



1. Radiator
2. Electric fan
3. Shroud
4. Deaeration tube
5. Clamp
6. Deaeration hose (radiator)
7. Electric fan mounting bracket
8. Bolt (M6, 8 pieces)
9. Bolt (M6, 4 pieces)
10. Bolt (M6, 4 pieces)
11. Upper radiator insulator
12. Lower radiator insulator
13. Plate
14. Clip
15. Inlet hose
16. Outlet hose
17. 3 way hose
18. Deaeration hose (reserver tank)
19. Clamp
20. Clamp
21. Make up hose holder
22. Reserver tank
23. Bolt (M6, 2 piece)
24. Cooling fan
25. Viscous clutch
26. Bolt (M6, 1 piece)
27. Bolt (M6, 3 piece)

Modification basis	
Application basis	
Affected VIN	

ENGINE ELECTRIC DEVICES

1452-01

GENERAL

1. GENERAL SPECIFICATIONS

Application			Unit	Gasoline Engine
Starter	Type		-	PG170S
	Output power		Kw	1.8
	No load test @ 12 volts		A	98
	Drive pinion speed at no load		rpm	2,600
	Drive pinion speed at load		rpm/A	1,087/380
	Brush length		mm	16.1
	Armature diameter		mm	54.1
	Armature run-out		mm	0.08
	Segment groove depth		mm	19.6
Alternator	Type		-	SG135
	Output voltage / current		V/A	14/115
	Regulator type		-	HYBRID
	Regulating voltage		V	14.7
	Brush	Length	mm	18.5
		Quantity	-	2
		Abrasion limit	mm	13.5
Battery	Type		-	MF
	Capacity		AH	75
	Reserve capacity		RC	130
Ignition coil	Type		-	DIS
	Primary coil resistance		W	0.3 ~ 0.9
	Secondary coil resistance		KW	6 ~ 8.5
Spark plug	Type		-	WR8DC
	Clearance		-	0.8 ~ 0.9
High tension cable	Resistance		KW/m	1.9

2. FASTENER TIGHTENING SPECIFICATIONS

Application	Nm	Lb-Ft	Lb-In
Batter cable nut	12 ~ 18	9 ~ 13	-
Battery cable nut on starter	12 ~ 15	9 ~ 11	-
Batter mounting bracket nut	12 ~ 18	9 ~ 13	-
Engine electric wire nut on starter	6 ~ 7	-	53 ~ 62
Alternator combination bolt	42 ~ 50	31 ~ 37	-
Alternator terminal b+ nut	14 ~ 18	10 ~ 13	-
Alternator terminal d+ nut	4 ~ 5	-	35 ~ 44
Ignition cable cover bolt	9 ~ 11	-	80 ~ 97
Ignition coil bolt	9 ~ 11	-	80 ~ 97
Spark plug	25 ~ 30	15 ~ 22	-
Starter mounting bolt	35 ~ 48	26 ~ 35	-

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATION PROCESS

1. CHARGING SYSTEM OPERATION

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

1) 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.

2. STARTING SYSTEM OPERATION

The engine electrical system includes the battery, the ignition, the starter, the alternator, 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.

3. IGNITION SYSTEM OPERATION

This ignition system does not use a conventional distributor and coil. It uses a crankshaft position sensor input to the Engine Control Module (ECM).
The ECM then determines Electronic Spark Timing (EST) and triggers the electronic ignition system ignition coil.
This type of distributorless ignition system uses a "waste spark" method of spark distribution. Each cylinder is paired with the cylinder that is opposite it (2.3L DOHC: 2 - 3 or 1 - 4, 3.2L DOHC: 1 - 6 or 2 - 5 or 3 - 4).
The spark occurs simultaneously in the cylinder coming up on the compression stroke and in the cylinder coming up on the exhaust stroke.
The cylinder on the exhaust stroke requires very little of the available energy to fire the spark plug.
The remaining energy is available to the spark plug in the cylinder on the compression stroke. These systems use the EST signal from the ECM to control the EST.
The ECM uses the following information: Engine load (mass air flow sensor, manifold air pressure sensor).

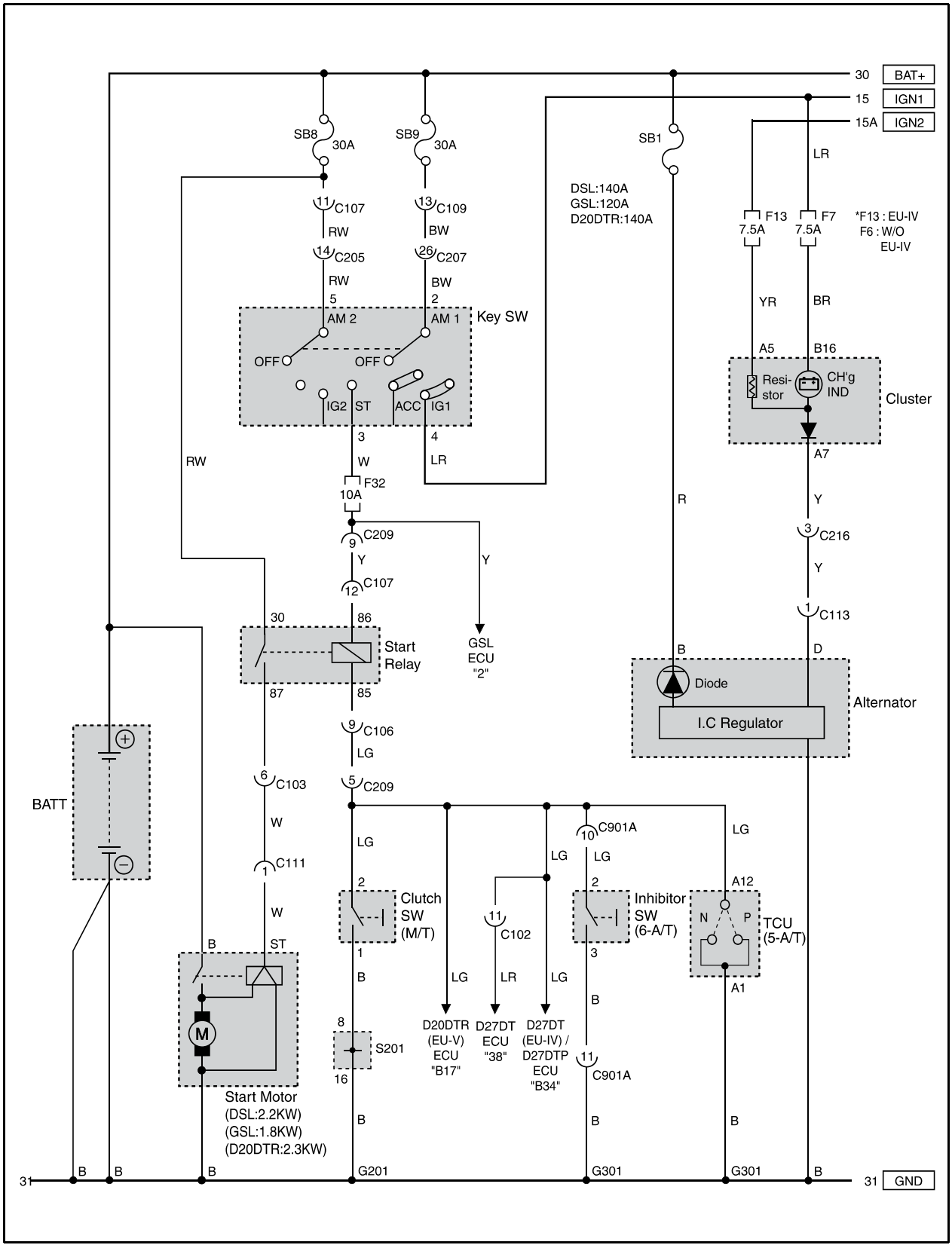
Engine coolant temperature.
Intake air temperature.
Crankshaft position.
Engine speed (rpm).

1) Electronic Ignition System Ignition Coil

The Electronic Ignition (EI) system ignition coil is located on the cylinder head cover.
The double ended coils re ceive the signal for the ECM which controls the spark advance. Each EI system ignition coil provides the high voltage to two spark plugs simultaneously;
3.2L DOHC
T1/1: cylinder 2 and 5
T1/2: cylinder 3 and 4
T1/3: cylinder 1 and 6
The EI system ignition coil is not serviceable and must be replaced as an assembly.

Modification basis	
Application basis	
Affected VIN	

4. STARTING AND CHARGING SYSTEM (GASOLINE ENGINE) CIRCUIT



Modification basis	
Application basis	
Affected VIN	

ENGINE CONTROL SYSTEM

1522-16

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	

CRUISE CONTROL

8510-23

OVERVIEW AND OPERATING PROCESS

1. SYSTEM DESCRIPTION

1) System Description



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 38 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.

2) 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

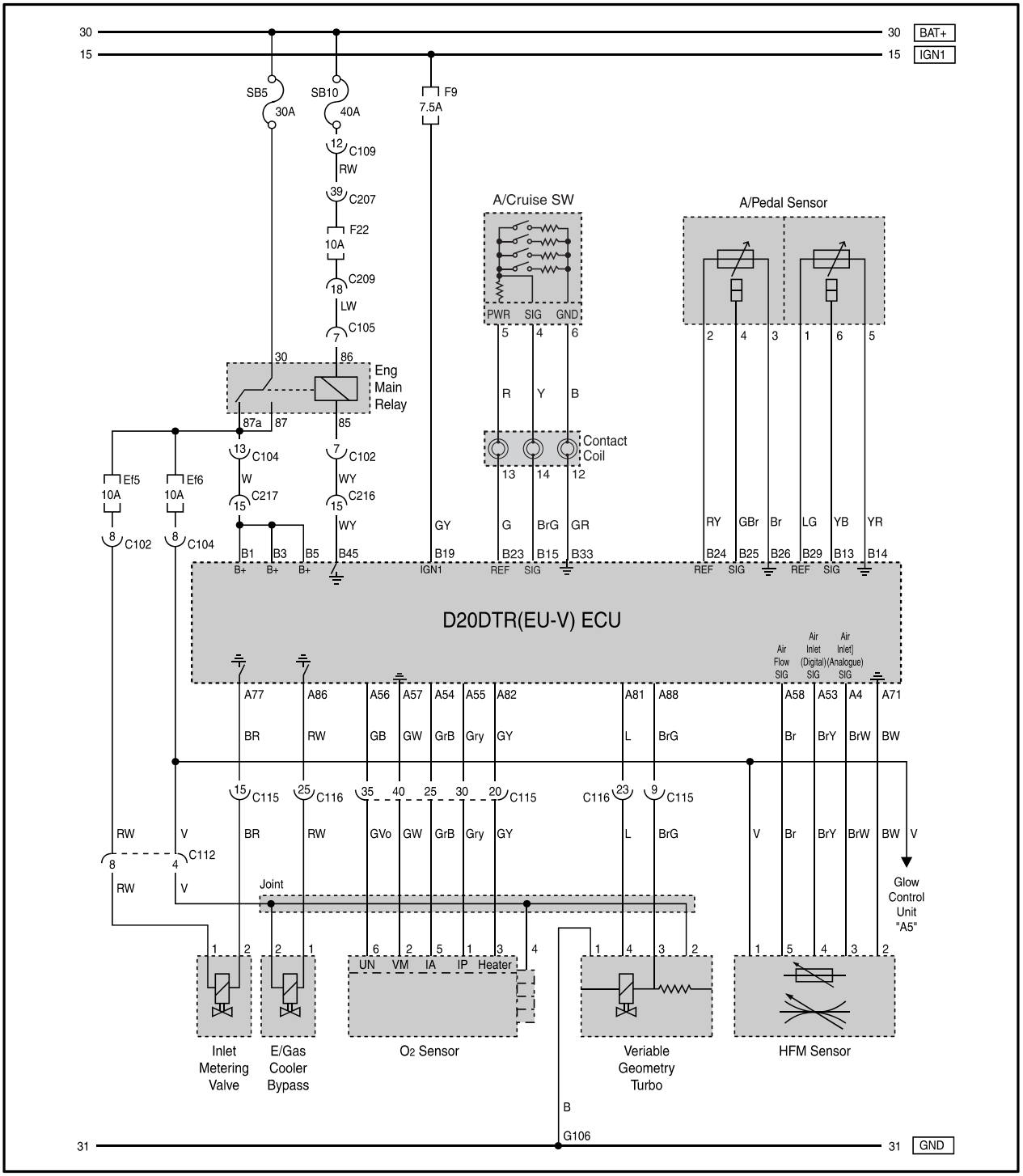
Improper use of the cruise control could be dangerous.
- Do not use on winding roadsyy .
- Do not use in heavy traffic.
- Do not use on slippery, wet roads.

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

Modification basis	
Application basis	
Affected VIN	

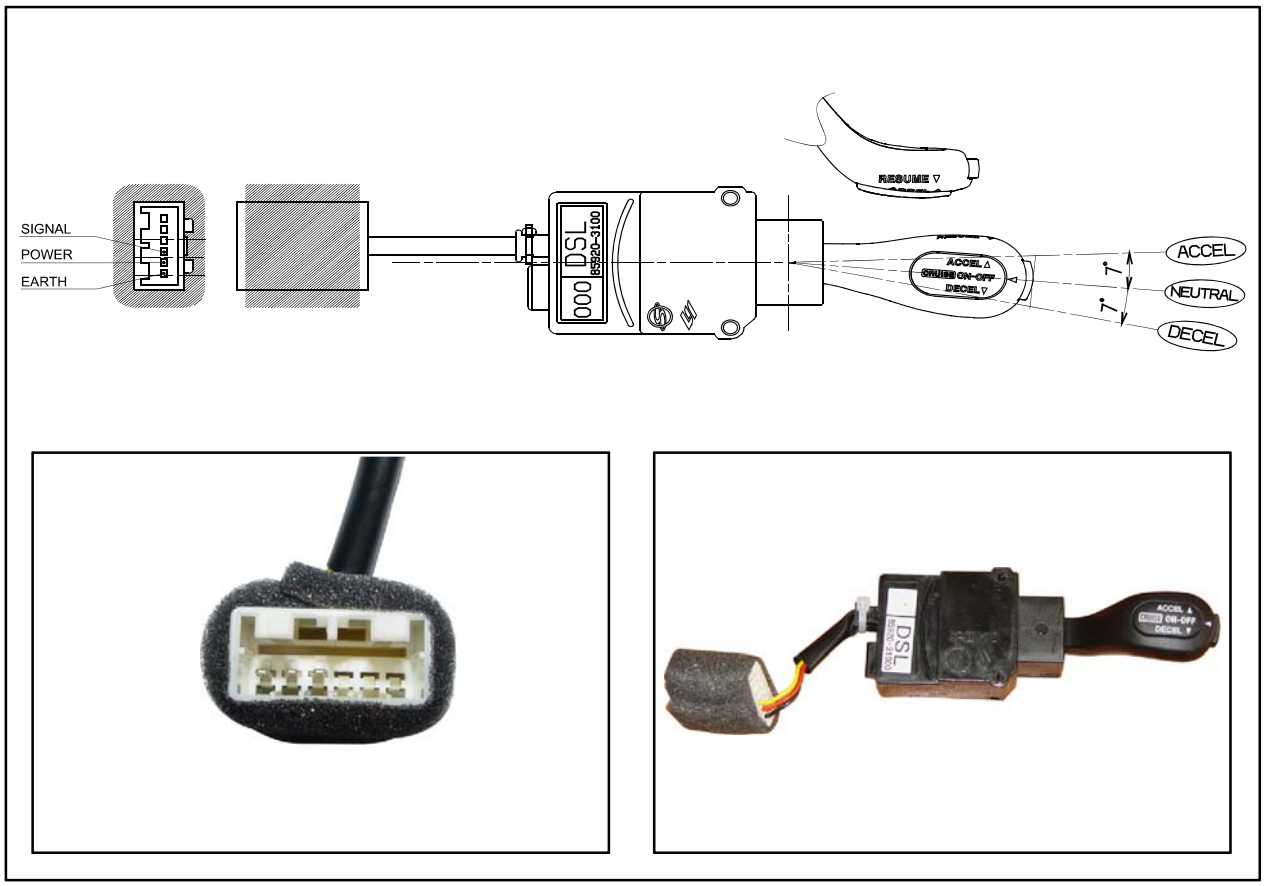
2. CONFIGURATION

1) Circuit Diagram



The engine ECU detects the operating conditions of cruise control system, and monitors the braking performance, vehicle speed, road conditions and ESP system operation. If the engine ECU determines that there are not any problem to drive in cruise control mode, the vehicle can be operated by cruise switch signals (decelerating, accelerating, cruising).

2) Configuration



▶ **Test voltage(VCC 5V)**

FUNCTION	KEY VOLUE	REMARK
MAIN	0.15 ~ 0.55V	-
DECEL	0.7 ~ 1.1V	-
ACCEL	1.6 ~ 2.0V	-
RESUME	2.52 ~ 2.92V	-

Modification basis	
Application basis	
Affected VIN	

3. OPERATION

1) Setting a Desired Speed



1. To operate the cruise control, accelerate to the desired speed, which must be more than 36 km/h and less than 150 km/h.
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. Now, the vehicle is cruised by this system with the set speed. You don't need to use the accelerator
3. pedal.
   Refer to the following pages for details of operation.
4.

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.

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) When the cruise control system is not running

To increase the speed with the cruise control system while the system is not running, follow the procedures below.

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

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

To increase the vehicle speed in stages while the cruise control system is running, follow the procedures below.

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. When you operate a tap-up switching, the vehicle is accelerated for 1.3 km/h over the previous set speed.
2. If you want to accelerate for 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

To decrease the vehicle speed with the cruise control system when the system is not running, follow the procedures below.

1. Push down the cruise control switch lever to DECEL side and hold it until the desired speed is reached while the vehicle speed is over 36 km/h.
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

To decrease the vehicle speed in stages while the cruise control system is running, follow the procedures below.

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. When you operate a tap-down switching, the vehicle is decelerated for 1.0 km/h below the previous set speed.
   If you want to decelerate for 10 km/h, operate the tap-down switching ten times without the brake pedal
2. intervention.

4) Recovery of Set Speed (RESUME)



Even if the cruise control is cancelled, the previous set cruise speed can be recovered by pulling up 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

But the driver should know the previous set speed to react to the changed vehicle speed properly. If the vehicle speed increases abruptly, depress the brake pedal to adjust the vehicle speed properly.

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 or When ESP is activated.
2. When the cruising speed is downed less than 34 km/h
3. When applying the parking brake during driving.
4. When using the clutch in order to shift (M/T only).

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.
   When the rapid acceleration is applied without acceleration pedal intervention.
2. When the cruise control lever is faulty.
3. When the brake switch and the brake light switch input signal are implausible.

When the cruise control function is cancelled abnormally or intermittent problems occur, stop the vehicle and turn off the ignition switch and remove the key to reset the system. After a while, turn on the ignition switch again to operate the cruise control system.

CAUTION

1. Do not move the shift lever to Neutral position while driving with the cruise control turned on. Otherwise, it may result in system malfunction or accidents.
2. Always be prepared to use the brake or accelerator pedal for safe driving while the cruise control system is running.
3. The actual speed can be different from the set speed momentarily when driving on a uphill or downhill. So, it is recommended to disable the cruise control function on a uphill or downhill. hen driving on a steep hill use the engine brake and foot brake properly to protect the vehicle system and for a safe driving.
4. Ensure that the safe distance is maintained and use the brake pedal if needed.

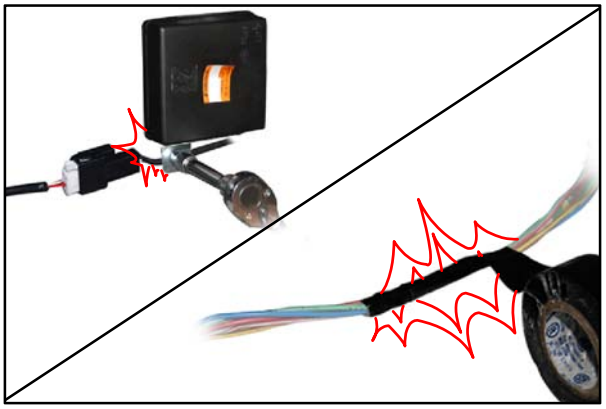
Modification basis	
Application basis	
Affected VIN	

Fuse and relay

8410-00

GENERAL INFORMATION

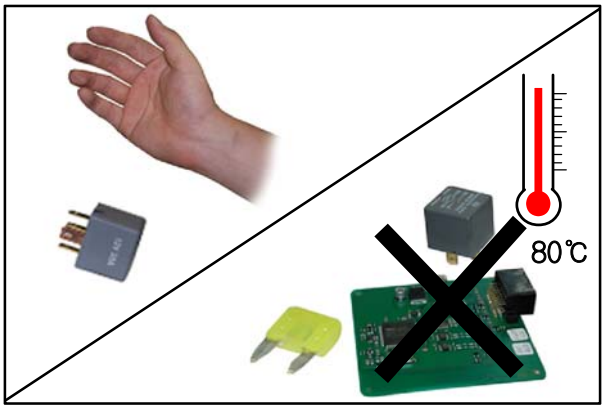
1. CAUTIONS WHEN WORKING ON ELECTRICAL UNITS



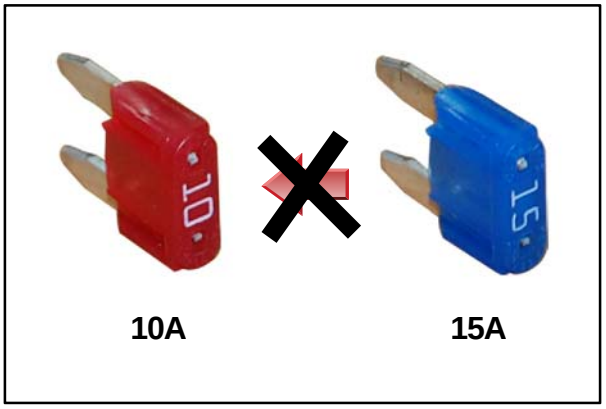
- Disconnect the negative cable from the battery in advance when working on electrical units.

CAUTION

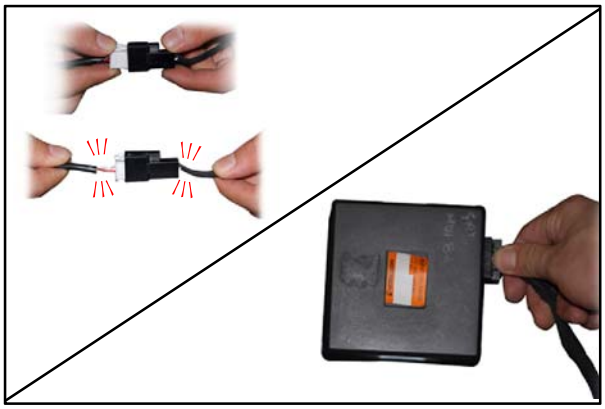
Make sure to turn "OFF" the ignition switch and other lamp switches before disconnecting or connecting the negative battery cable. (Otherwise, semiconductor parts can be damaged.)



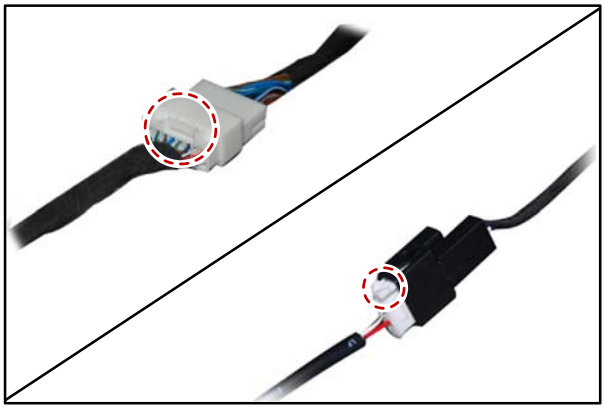
- Do not drop or appy excessive impact to sensors and relays.



- 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.



- 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. CHECKING CABLES AND WIRES

- Check for loose connection or rust.
- Check terminals and wires for corrosion due to electrolyte leakage.
- Check terminals and wires for open circuit.
- Check the wire insulation and coat for damage, cracks or deterioration.
- Check if the conductive parts of the terminals do not contact with vehicle body or other metal parts. Check that the grounding part has continuity with mounting bolts and vehicle body.
- Check that wires are properly routed.
- Make sure that wires are securely fixed to avoid contact with sharp body parts and high-temperature
- parts, such as the exhaust manifold and exhaust pipes. The rotating parts, such as fan pulley and fan belt, perturbative parts and wiring should be secured
- tightly at regular intervals. Secure the wiring between the fixed parts, such as the vehicle body, and vibrating parts, such as the
- engine, after slackening it slightly to prevent it from being damaged.

3. MAJOR CHANGES

ICM Box Assembly	
Old	**New**
	
Deleted hazard relay and added some relays (HDC, Rear LH/RH seat warmers, Blower, Rear washer/wiper, IGN 1, IGN 2, ACC)	

STICS

8710-08

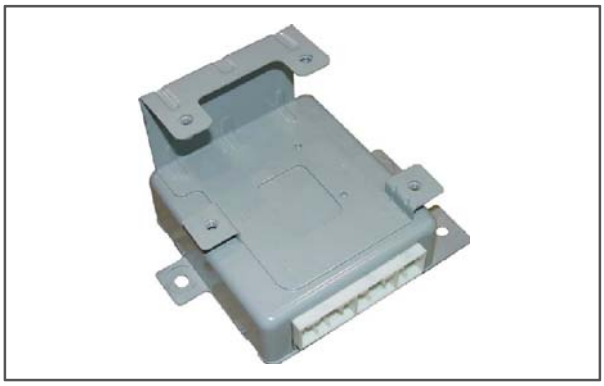
GENERAL INFORMATION

1. SPECIFICATIONS

1) Electrical Performance

Item	Requirement	Remark
Rated voltage	DC 12.0V	
Operatiing voltage	DC 9.0V ~ 16.0V DC 7.0V ~ 18.0V (CAN)	Should operate normally within this range.
Operating temperature	−30°C ~ +80°C	Should operate normally within this range.
Reserved temperature	−40°C ~ +85°C	
Max. operating humidity	95%	
Resistible voltage	24V	
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 1.0V	A Connector Pin No. 31 and A Connector (15, 16, 17, 18, 19, 20, 29), B Connector (7, 9, 10, 11, 12, 13, 14, 15, 16, 19), C Connector (2, 8, 9, 11)
	below 1.5V	A Connector Pin No. 31 and A Connector (1, 2, 3, 4, 6, 21, 24, 25, 26, 27, 28), B Connector (1, 3, 4, 6, 18, 20, 23, 24), C Connector (3, 6, 16,17)

2) 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
   Modulation method: FSK (Frequency Shift Keying)
4. Receiving distance: Approx. 10 ~ 15 m (In case there are not obstacles around the system)

3) Rated Load

NO	Description	Rated Load
1	Chime bell/ Buzzer	DC 12V 350mA/DC 12V 40mA (Inductive load)
2	Front room lamp	DC 12V 16W (Lamp load)
3	Ignition key hole illumination	DC 12V 1.2W (Lamp load)
4	Seat belt warning lamp	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 200mA (Inductive load)
9	Door unlock relay	DC 12V 200mA (Inductive load)
10	Siren	DC 12V 260W (Inductive load)
11	Tail lamp relay	DC 12V 200mA (Inductive load)
12	Hazard relay	DC 12V 200mA (Inductive load)
13	Power window relay	DC 12V 200W (Inductive load)
14	Rear defogger relay	DC 12V 200W (Inductive load)
15	Wiper LOW relay	DC 12V 250W (Inductive load)
16	Wiper HIGH relay	DC 12V 250W (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 200mA (Inductive load)
21	SPWM easy access button illumination	DC 12V 1.2 W (Lamp load)

Modification basis	
Application basis	
Affected VIN	

4) Input Signals

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 switch	IN=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 seat)=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	- OPEN (one of rear seat)=GND - CLOSE (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	Theft deterrent alarm select switch	ON=GND, OFF=OPEN
17	Parking brake switch	ON=GND, OFF=OPEN
18	Air bag collision sensor	ON=200 ms Low signal, OFF = OPEN
19	Wiper motor-parking switch	Parking=BAT, Rotating=GND
20	Washer switch	ON=BAT, OFF=OPEN
21	AUTO switch	ON=BAT, OFF=OPEN
22	Auto washer switch	ON=BAT, OFF=OPEN
23	AUTO resistance	0W~51Kw (for intermittent wiping)
24	Speed sensor	ON=GND (PWM), OFF=OPEN
25	IDR (saving the code)	ON=BAT, ORR=OPEN

NO.	Input Signal Name	Logic Status
26	Front defogger switch	ON=GND, OFF=OPEN
27	Central door lock switch	ON=GND, OFF=OPEN
28	SPWM easy access switch	ON=GND, OFF=OPEN
29	Multifunction auto light switch	ON=GND, OFF=OPEN
30	Turn signal light switch	ON=BAT/GND, OFF=OPEN (5.1V~9.2V)
31	SPWM (Seat Position with Memory)	ON=GND (PWM), OFF=OPEN
32	Rain sensor	ON=GND (DATA), OFF=BAT
33	Diagnosis	ON=GND (DATA), OFF=BAT
34	Immobilizer	ON=GND (DATA), OFF=BAT
35	Front door key cylinder switch	ON=GND, OFF=OPEN

5) Chattering of Input Signals

1. Vehicle speed: Average speed for 4 pulses from 6 pulses (ignore the input signal for 10 seconds from IGN1 ON)
   The speed maintaining time does not contain the speed calculation time.
2. 20 ms target input:
   Wiper motor A/S (parking) terminal
3. 100 ms target input switch
   All switches except wiper motor A/S (parking) terminal

6) Time Tolerance

1. If not indicated, time tolerance will be ± 0%.
   However, if less than 500 ms, time tolerance will be ± 50 ms.
2. The time indicated in each function does not include chattering processing time from switch input changing point.

Modification basis	
Application basis	
Affected VIN	

2. MAJOR CHANGES

REKES Key	
Old	**New**
 Front Back	 Front Back
Changed the appearance of mechanical key and the company symbol	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

STICS (Super Time & Integrated Control System)) communicates with the transmitter (remote controller) and other electronic units to transmit and receive the signals and data.
The STICS includes the following functions:

- Wiper control
- Ignition key reminder
- Door locking/unlocking
- Lamp control
- Defogger control
- Time lagging control for power window
- Theft deterrent system control
- REKES key

Modification basis	
Application basis	
Affected VIN	

2. LOCATION



A ICM Relay Box	B STICS	C Chime
		

Modification basis	
Application basis	
Affected VIN	

3. OPERATION

1) Function Description

(1) Wiper control

▶ **Wiper and Washer Operations**

Front wiper operation

MIST

When moving the wiper switch to "MIST" position and release it, the windshield wipers operate one wiping cycle. The wipers will operate continuously if the switch is held in this position.

OFF

Wipers are not in operation.

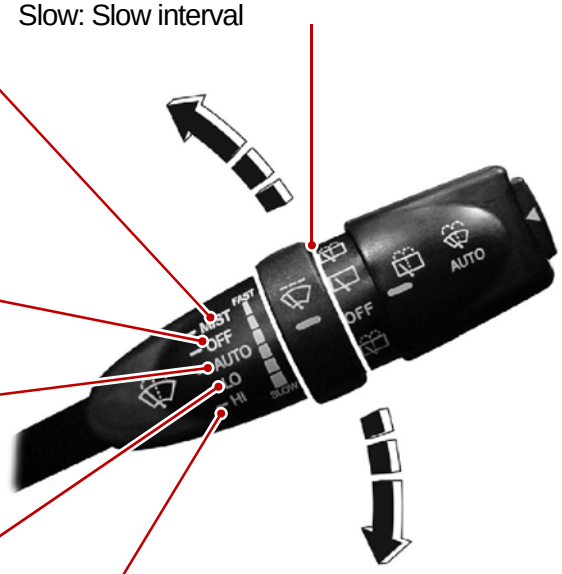
AUTO

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

LO

Continuous wipe.
slow operation.

Front Automatic Wiping Speed Control Switch
The interval of wiping speed can be adjusted by turning the control knob upward or downward when the windshield wiper switch is in AUTO position.
Fast: Fast interval
Slow: Slow interval



HI

Continuous wipe.
fast operation.

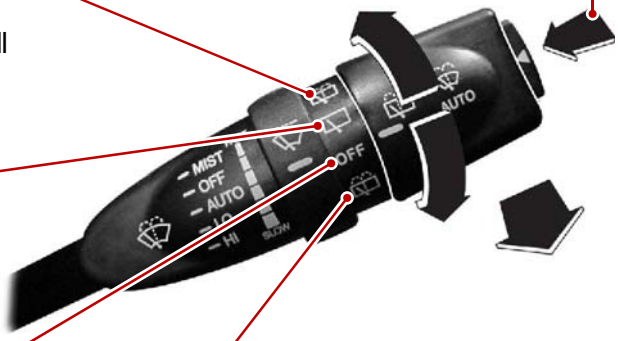
Modification basis	
Application basis	
Affected VIN	

Front auto washer switch

When pressing this switch with the front wiper switch in "OFF" position, 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.

Rear washer and wiper

When the switch is fully turned, washer fluid will be sprayed onto the rear window glass and the wiper will also operate. When the switch is released, it will return to the Rear Wiper Operation mode and only the wiper will keep operating.



Rear wiper operation

Rear wiper is not in operation.

Windshield washer operation

In the "OFF" position, pull the lever toward you to spray washer fluid on the windshield and to operate the wipers 1~3 cycles.

Pull the lever briefly (for less than 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

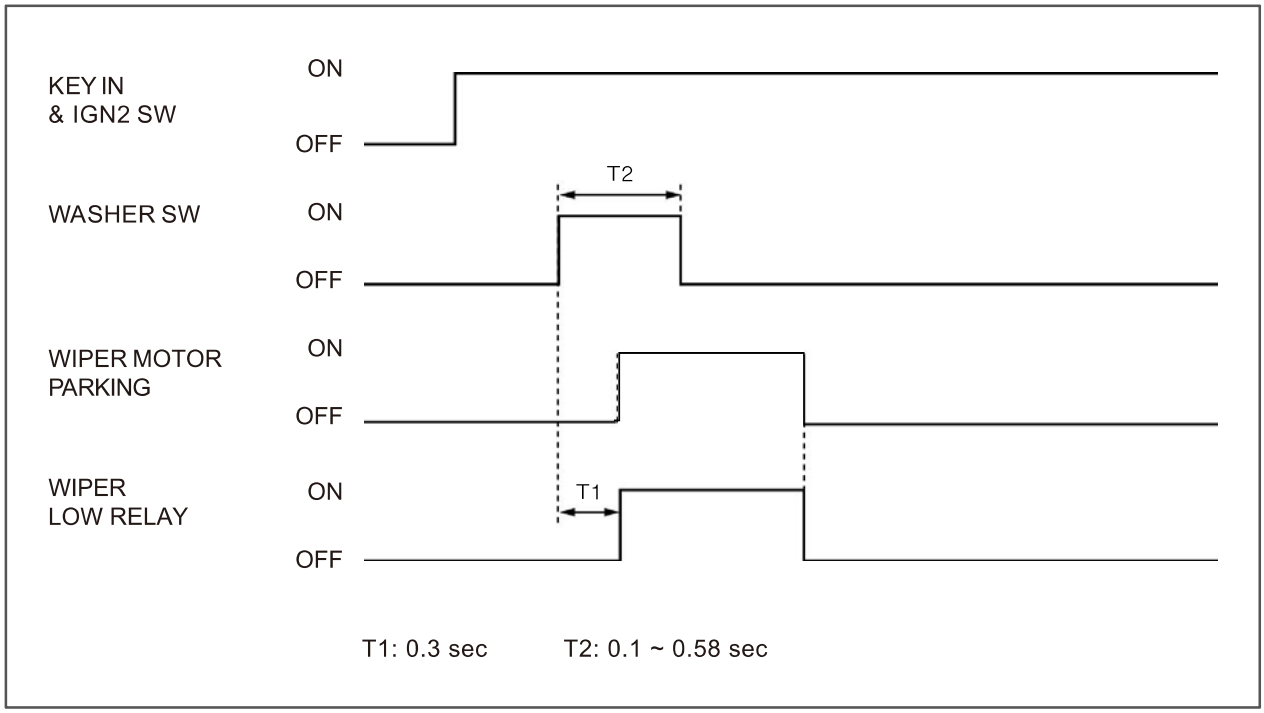
The spray and wiper operation will continue until you release the lever.

Rear washer and wiper

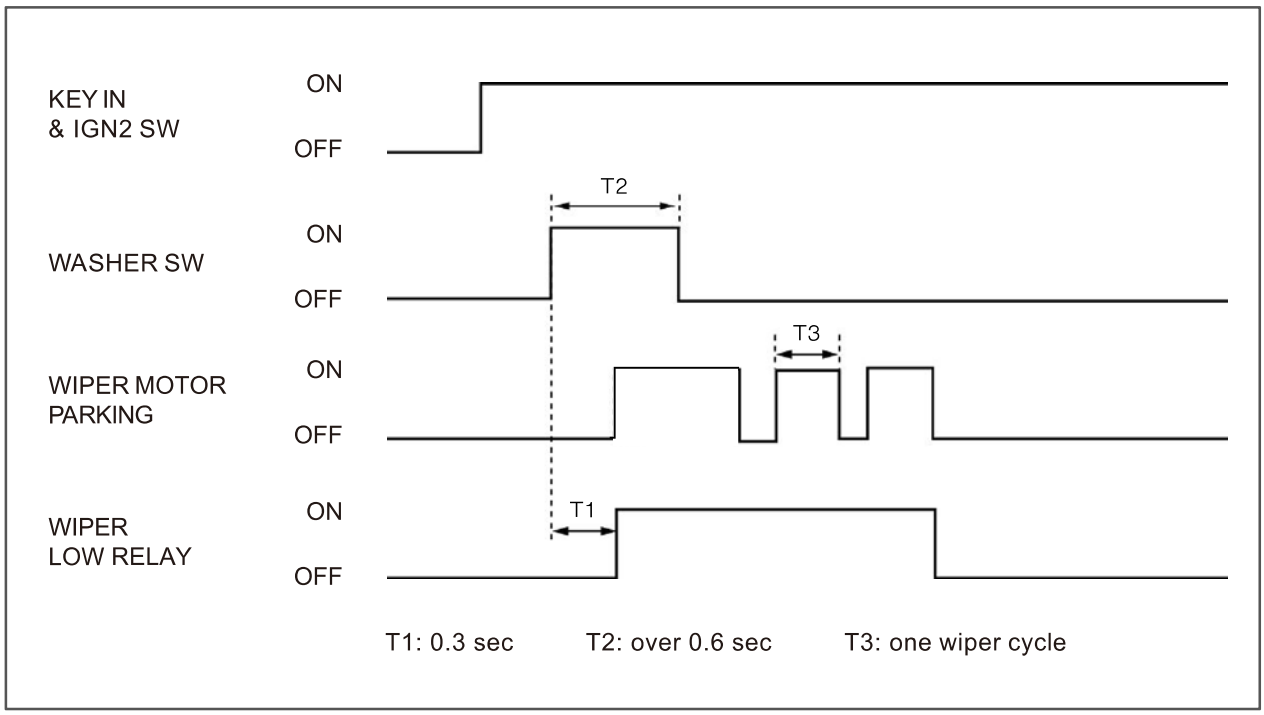
When the switch is fully turned, washer fluid will be sprayed onto the rear window glass and the wiper will also operate. When the switch is released, it will return to the "OFF" position and turn off the wiper and washer.

▶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.

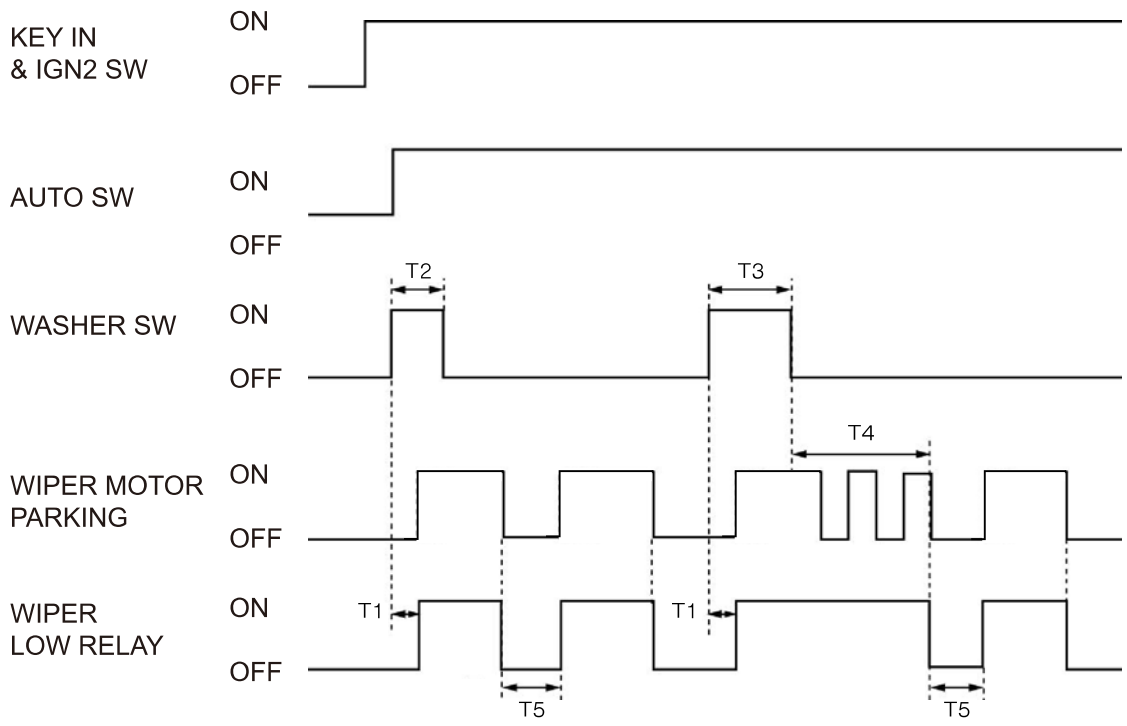


2. The wiper relay is turned on at 0.3 seconds (T1) after from the time when the washer switch is turned on for more than 0.6 seconds (T2) with the ignition switch "ON". The wiper relay gets on 3 times immediately after turning off the washer switch.



Modification basis	
Application basis	
Affected VIN	

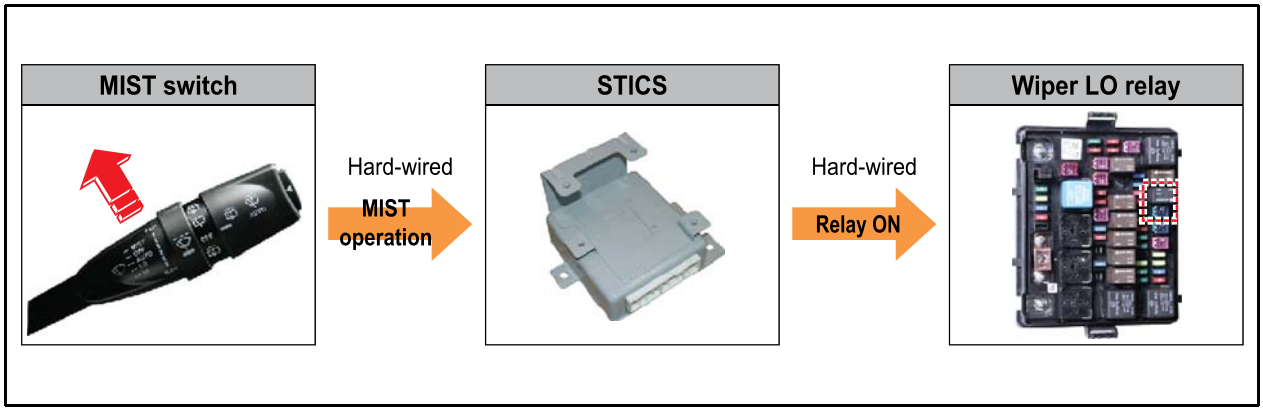
3. When the washer switch is turned on for more than 0.6 seconds during the wiper operation by AUTO switch, the wiper operates three times. When it is turned on for a certain period of time (0.1 to 0.59 seconds), the wiper operates once.



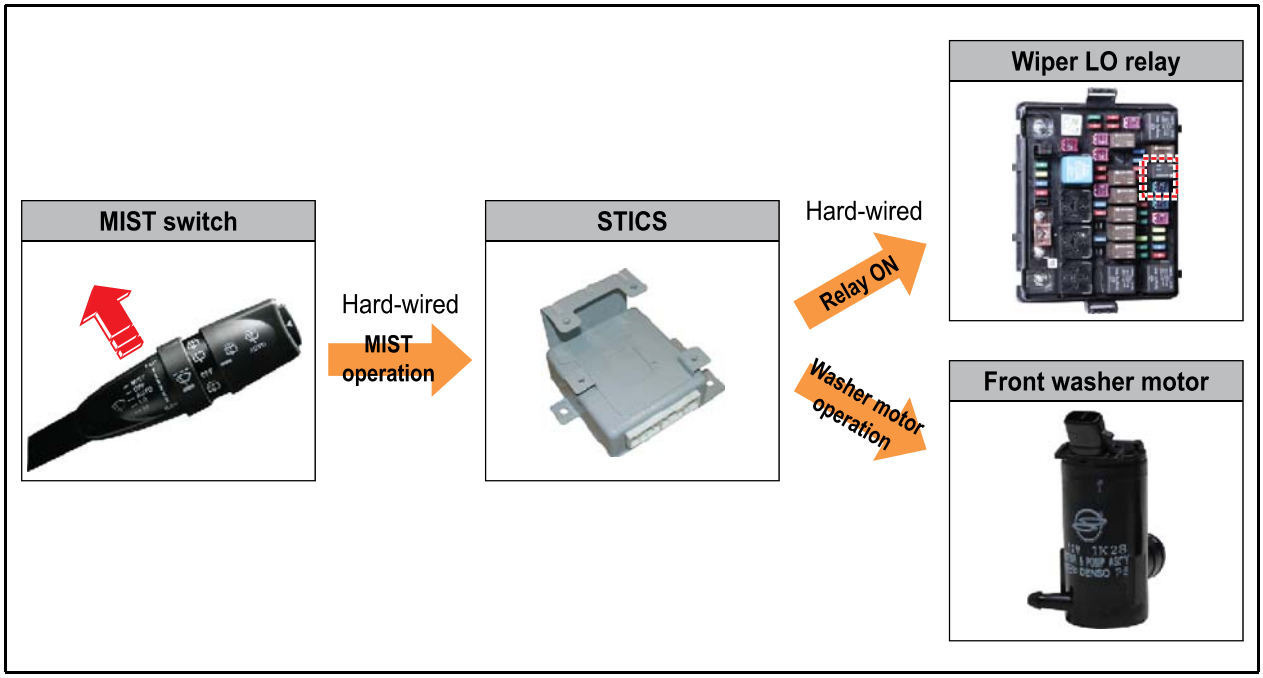
T1: 0.5 sec T2: 0.1 ~ 0.59 sec T3: over 0.6 sec
T4: 3 cycles T5: pause

System Diagram

- Operating MIST switch for 0.1 to 0.59 second



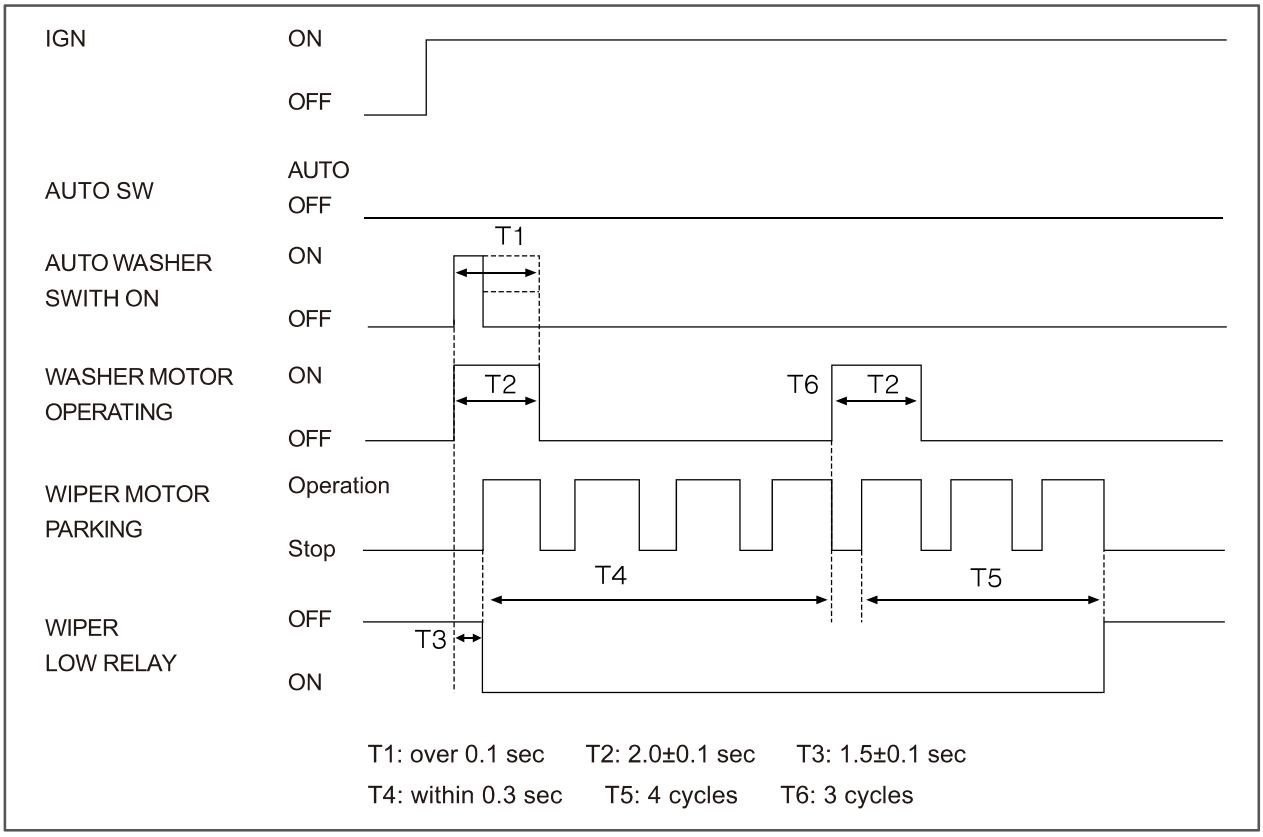
- Operating MIST switch for more than 0.59 second



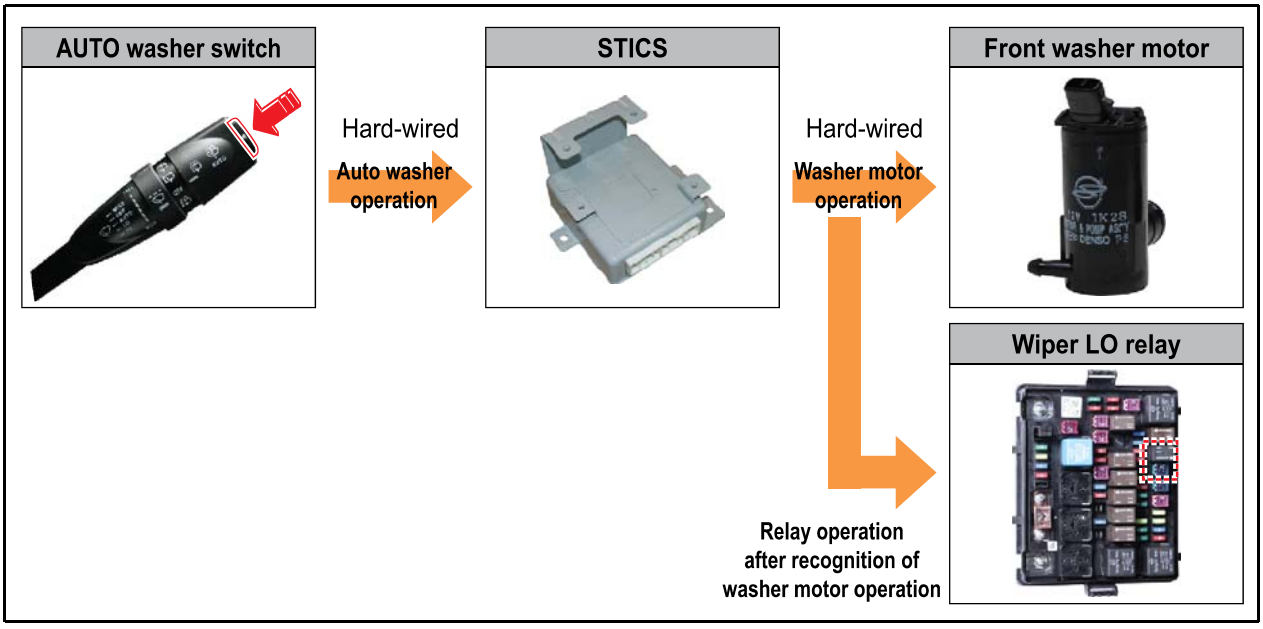
Modification basis	
Application basis	
Affected VIN	

▶Auto Washer and Wiper Switch

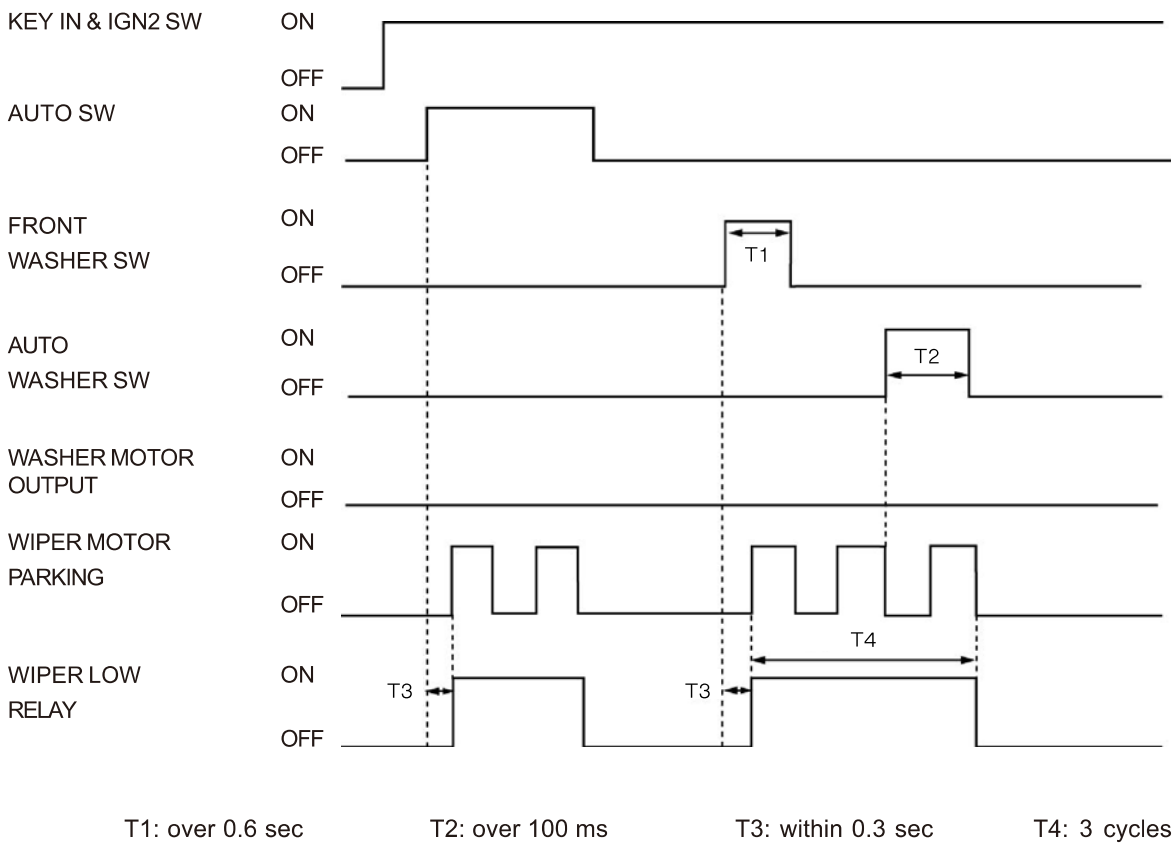
1. When the auto washer switch is turned on with the ignition switch "ON" and the AUTO switch "OFF", the washer motor output gets ON for 2 second. If the system recognizes the output signal, the wiper low relay output gets ON during 4 cycles and the washer motor output gets ON for 2 second. Then, the wiper relay output gets OFF after 3 cycles.



System Diagram

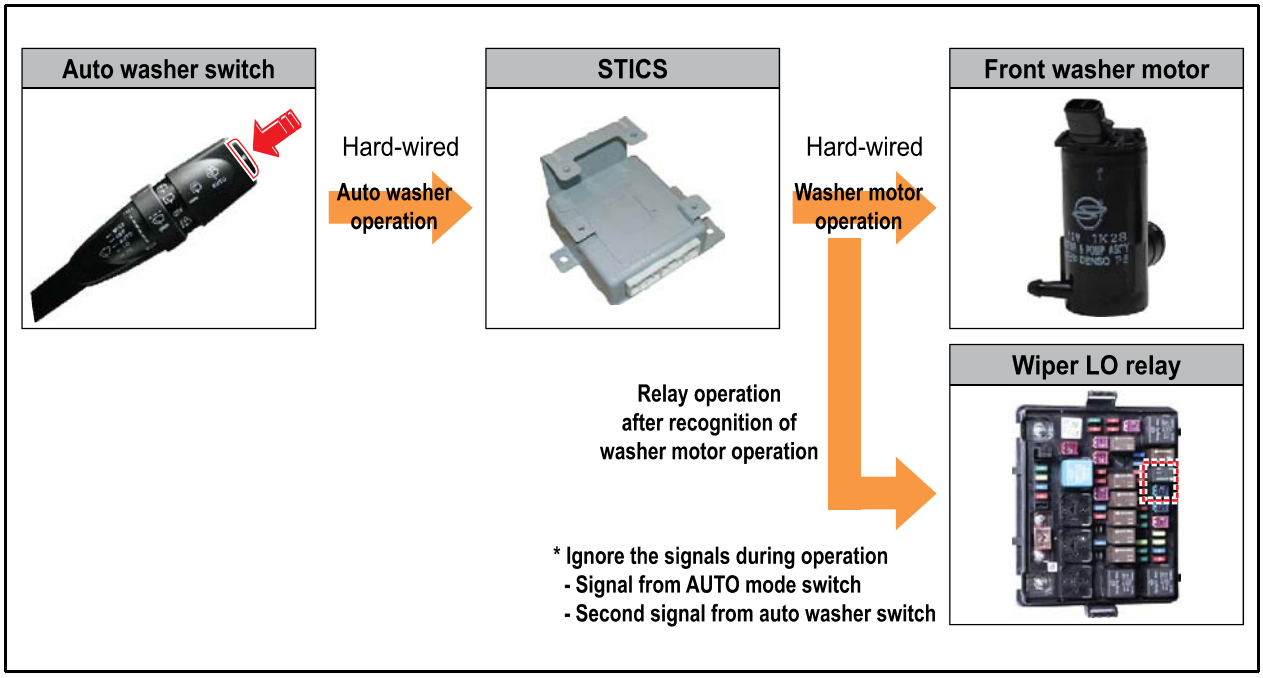


2. The auto washer switch output is overridden during the washer coupled wiper operation.
3. The auto washer switch input is overridden during the auto washer coupled wiper operation.
4. The auto washer switch input is overridden during the rain sensor coupled wiper or vehicle speed sensitive AUTO wiper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



Modification basis	
Application basis	
Affected VIN	

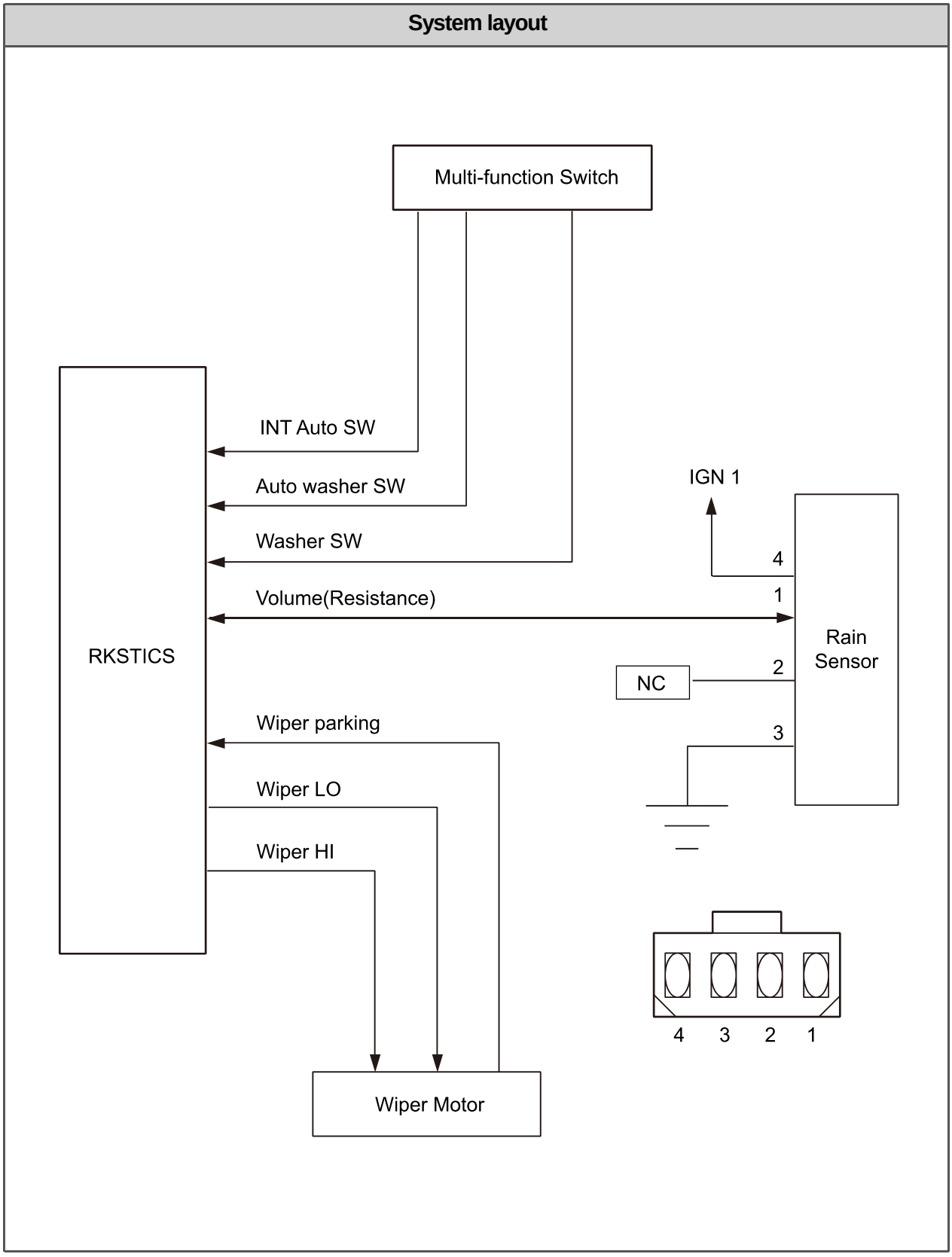
System Diagram



▶Wiper Operation with Rain Sensor & Auto Light Sensor (except for EU market)

RKSTICS with rain sensing function has the system layout as shown in the figure below.

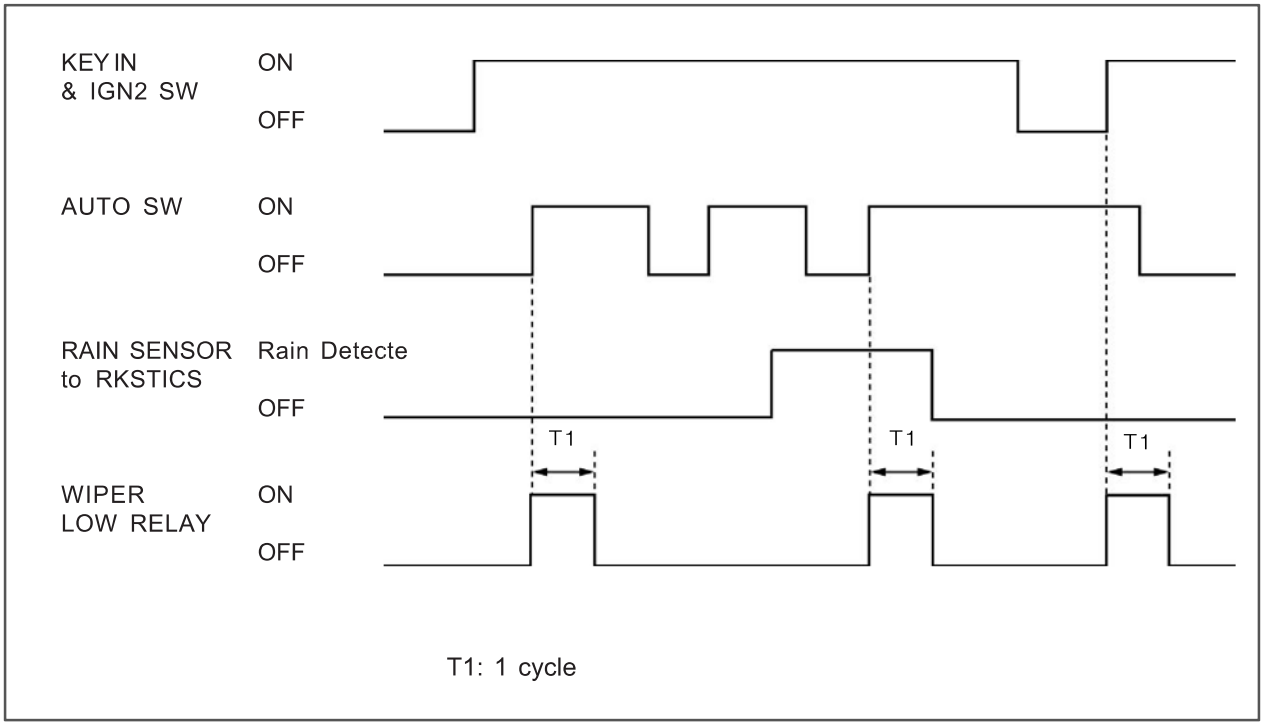
System layout



Modification basis	
Application basis	
Affected VIN	

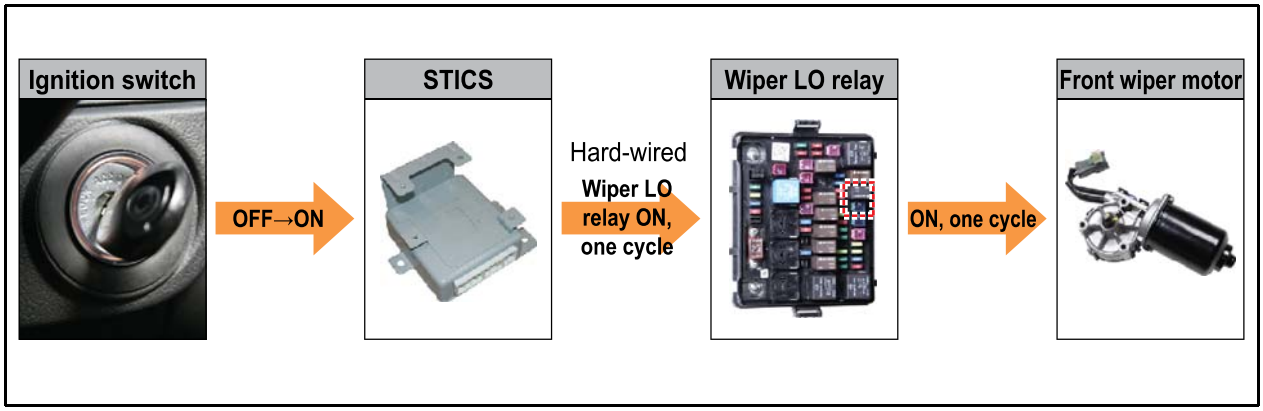
▶ Auto Switch Position Reminder (Power-Up Reminder Wiper)

1. When turning off and on the IGN2 switch with the auto switch on, the system drives the wiper motor through LOW relay one cycle regardless of communication with rain sensor.
2. The wiper relay (LOW) is turned on and the wiper motor runs one cycle when changing the auto switch from "OFF" to "ON" position regardless of communication with rain sensor(while the ignition key is in the "ON" position).
   When the auto switch is turned to the "ON" position again from the "OFF" position, the system drives the wiper motor through LOW relay one cycle only when the rain sensor detects the "Rain Detected" signal.

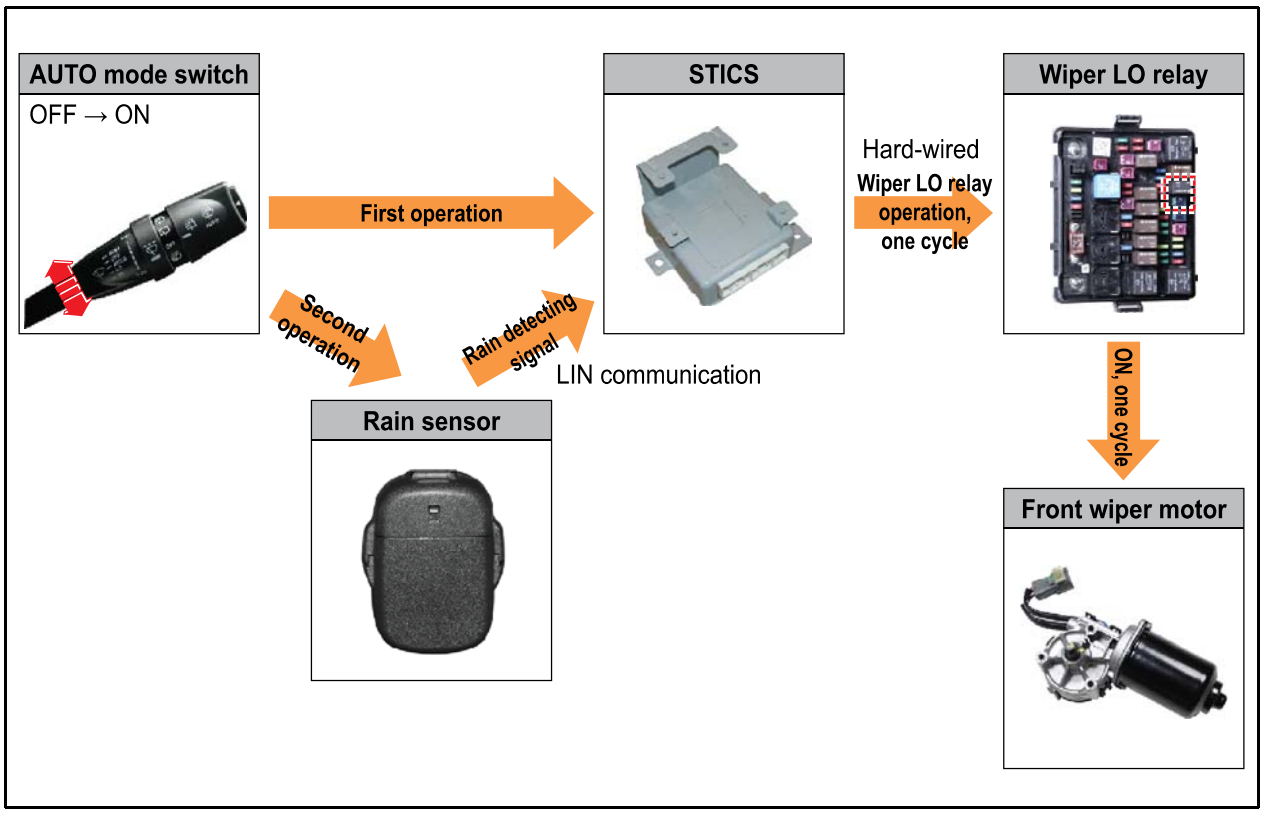


System Diagram

- AUTO Mode Switch ON



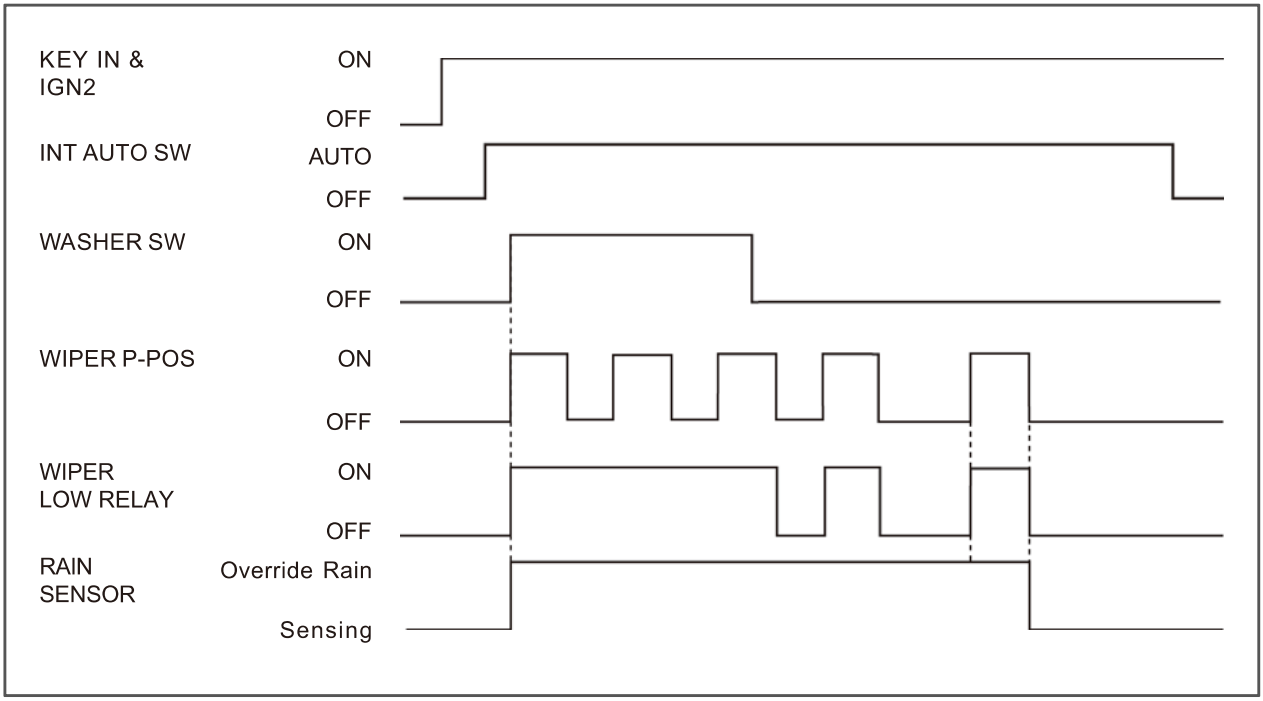
- Ignition Switch ON



Modification basis	
Application basis	
Affected VIN	

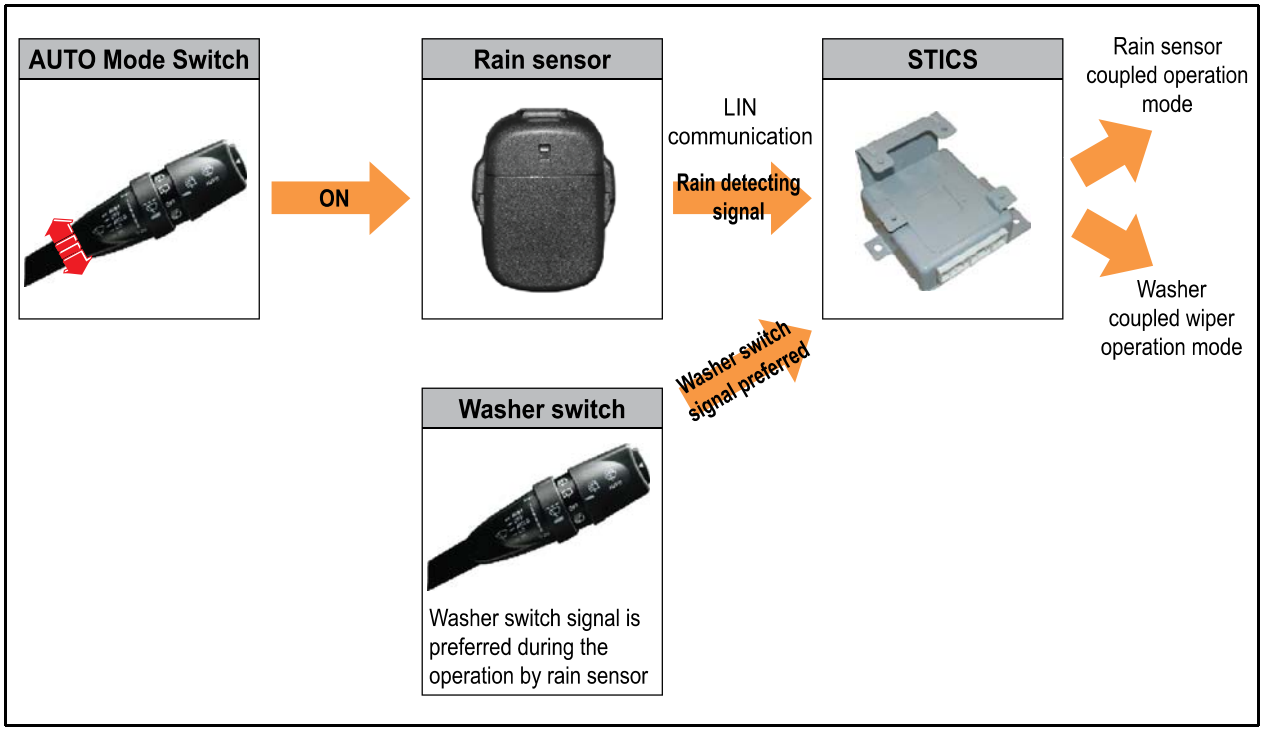
▶ Washer Coupled Wiper in Rain Sensing Mode

1. The washer coupled wiper is operated when receiving the washer switch input with the ignition switch "ON" and the AUTO 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.



System Diagram

- IGN ON & AUTO Mode Switch ON

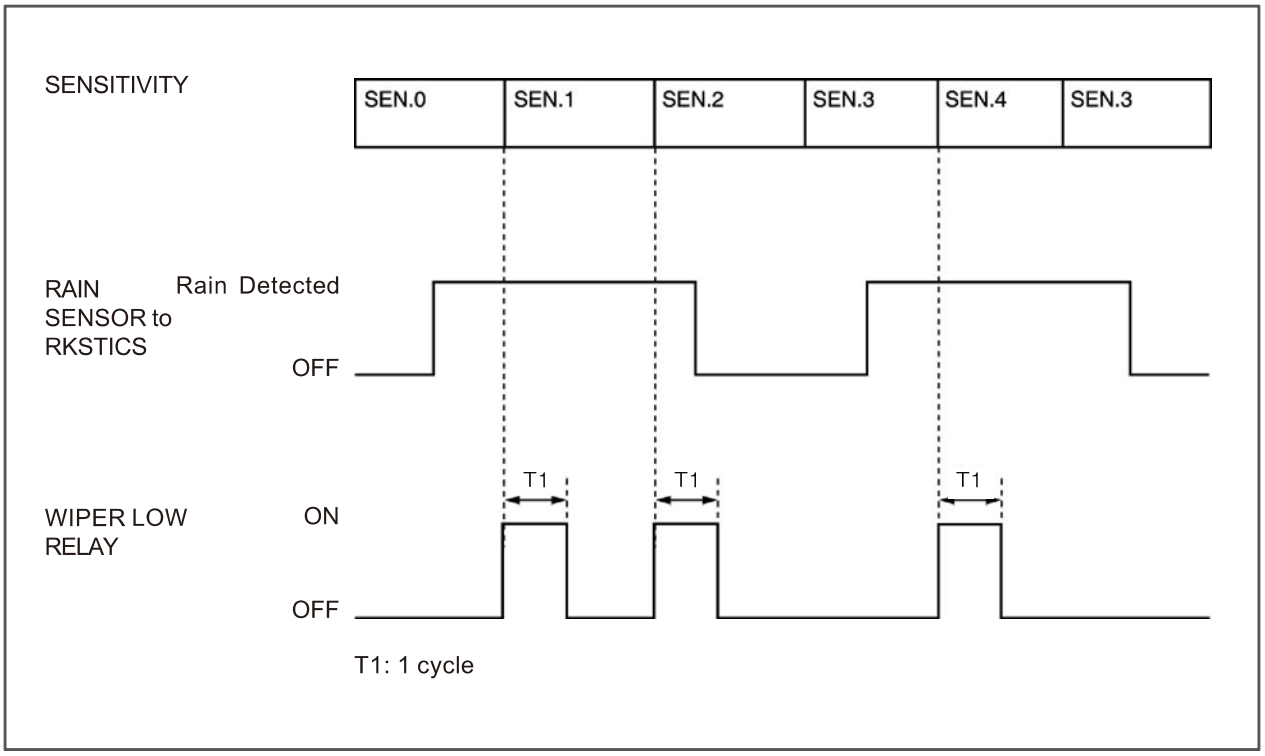


Modification basis	
Application basis	
Affected VIN	

▶ Rain Sensing Sensitivity Control

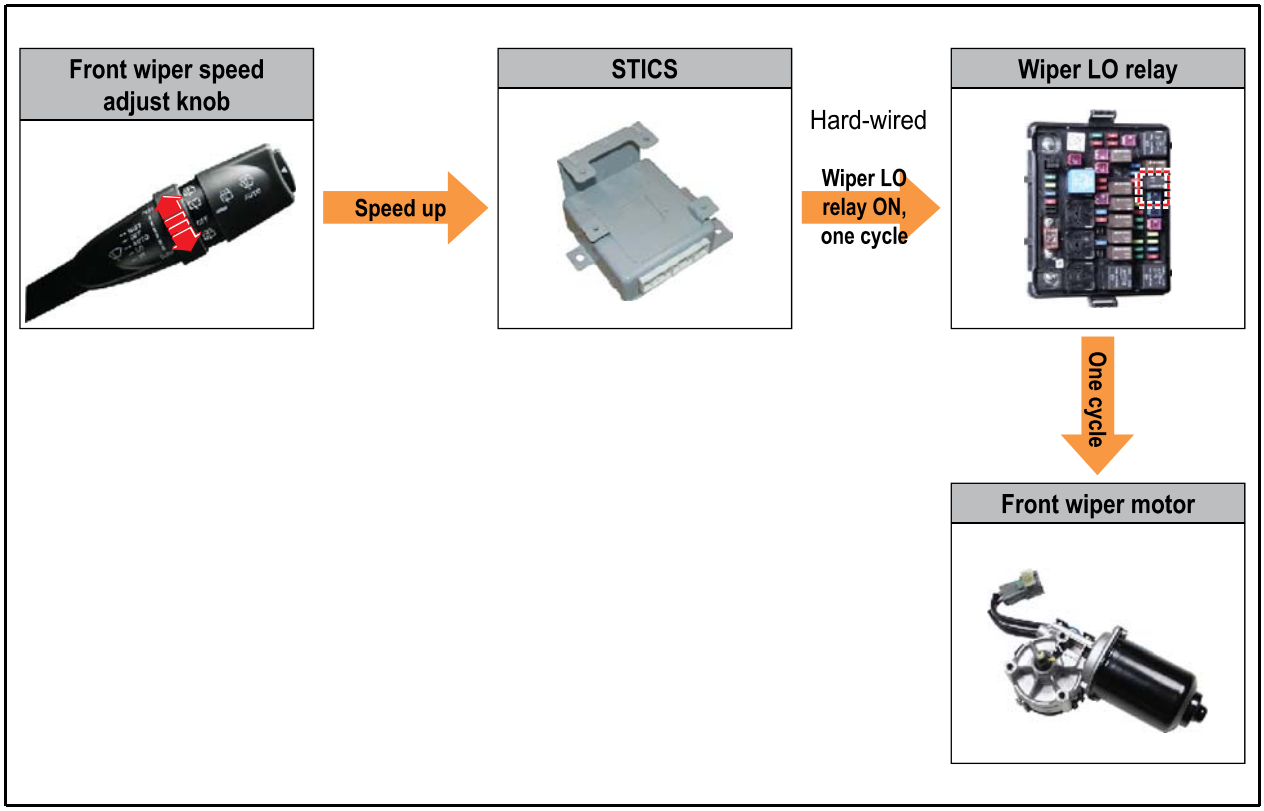
1. The wiper LOW relay is turned on and the wiper motor runs one cycle when the volume sensitivity is increased (while the ignition key is in the "ON" position, the AUTO switch is in the "ON" position, and the wiper motor is in "Parked" position). However, the wiper motor can be operated only when the 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.



IGN ON & AUTO Mode Switch ON

- IGN ON, AUTO Mode Switch ON, Wiper Motor Parked

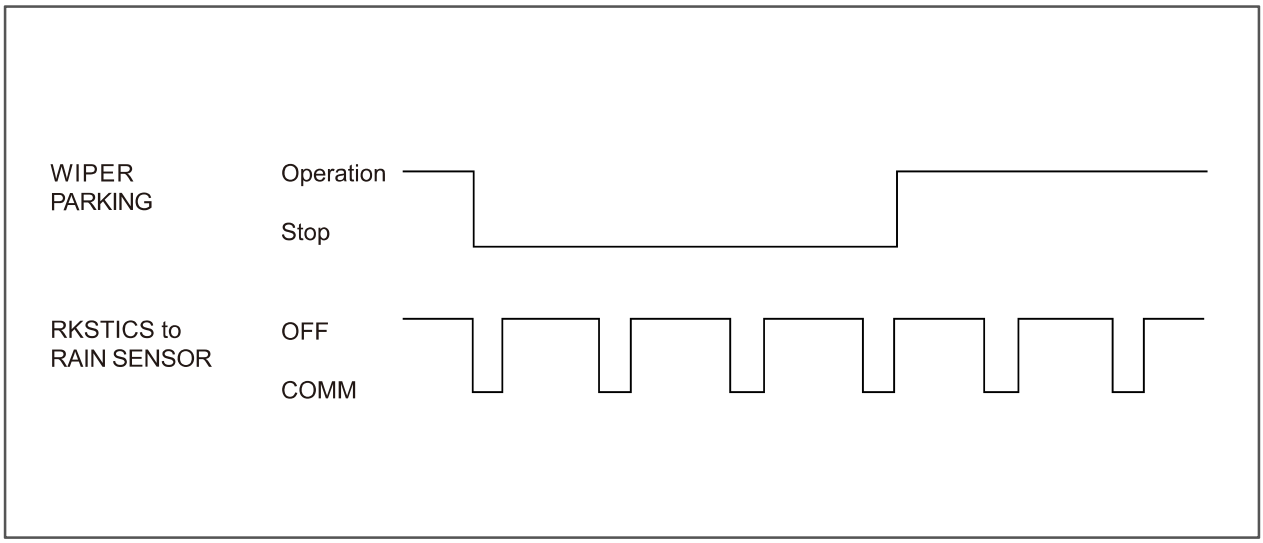


Modification basis	
Application basis	
Affected VIN	

▶ When the Wiper Parking Signal is Abnormal

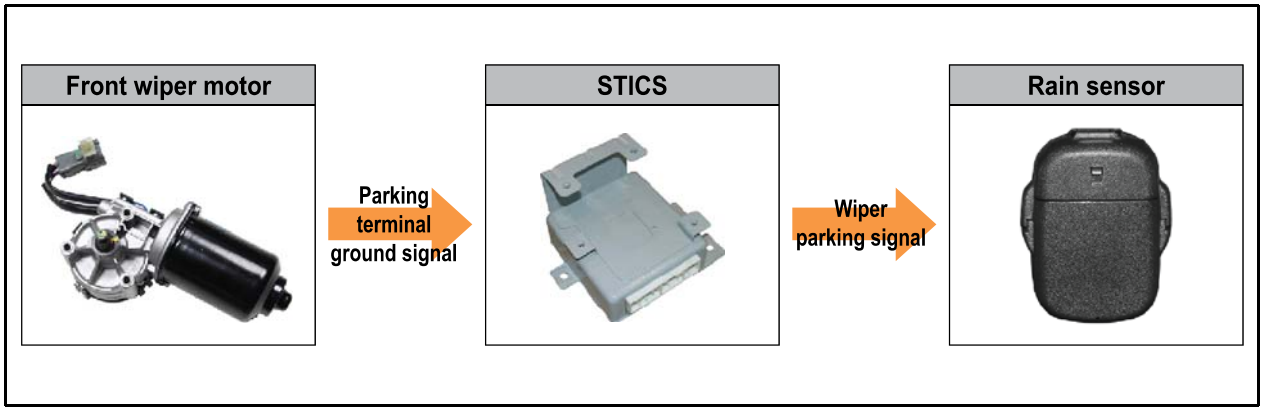
1. The wiper system continuously outputs the wiper parking signal when the wiper parking terminal is grounded (while the ignition key is in "ON" position and the AUTO switch is in "ON" position). * The wiper motor runs only when the rain sensor requires the wiper operation.

   * The wiper motor runs only when the rain sensor requires the wiper operation.



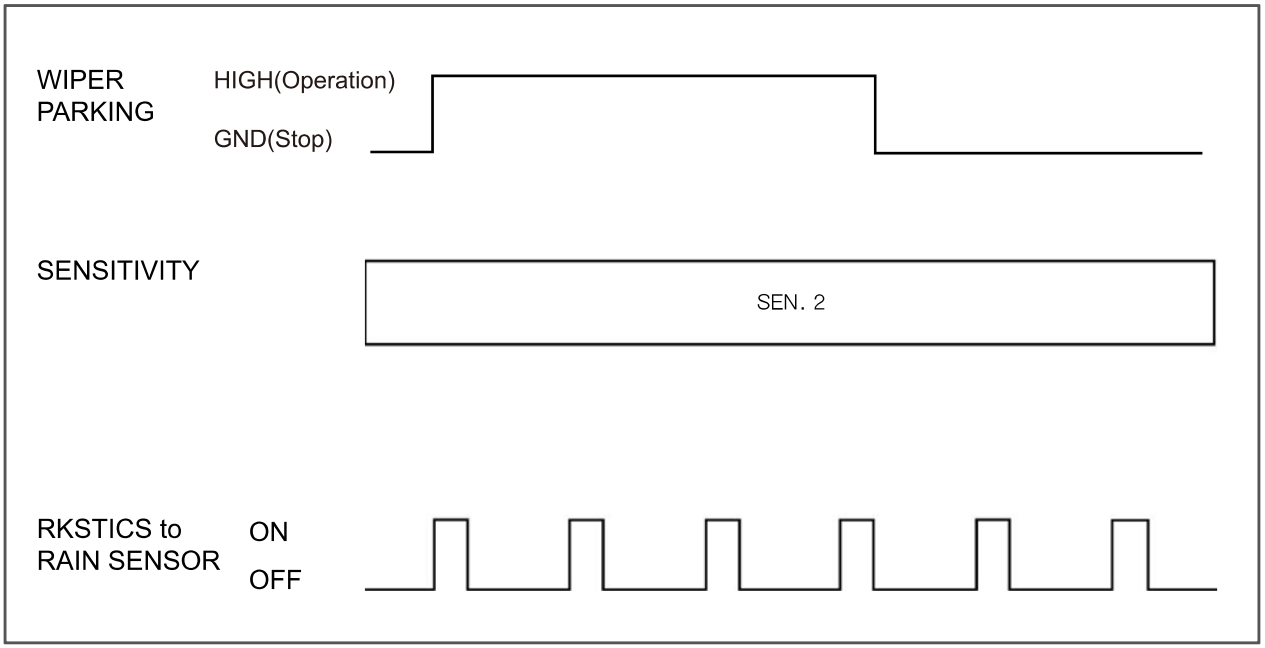
System Diagram

- IGN ON, AUTO Mode Switch ON, Wiper Motor Parking Terminal Stuck in Ground



2. When the parking terminal is fixed to HIGH with the ignition key and the AUTO switch in "ON" position, the wiper system outputs the wiper operating signal for 2 seconds, then continuously outputs the wiper parking signal.

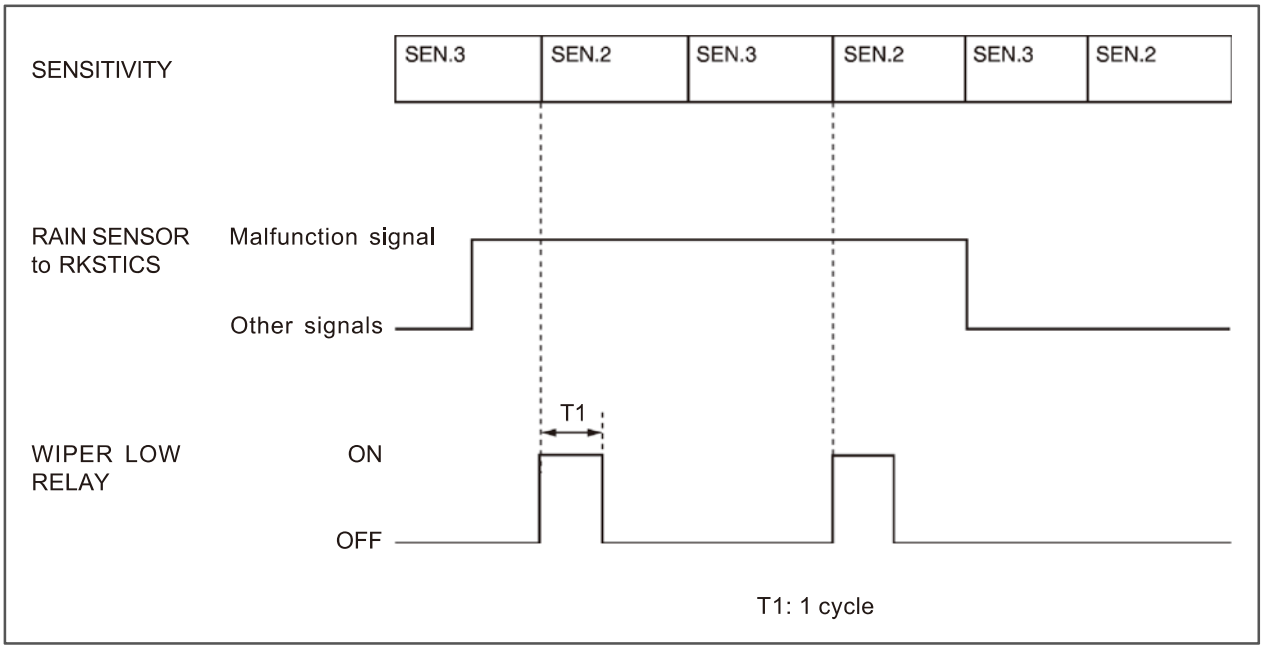
   * The wiper motor runs only when the rain sensor requires the wiper operation.



Modification basis	
Application basis	
Affected VIN	

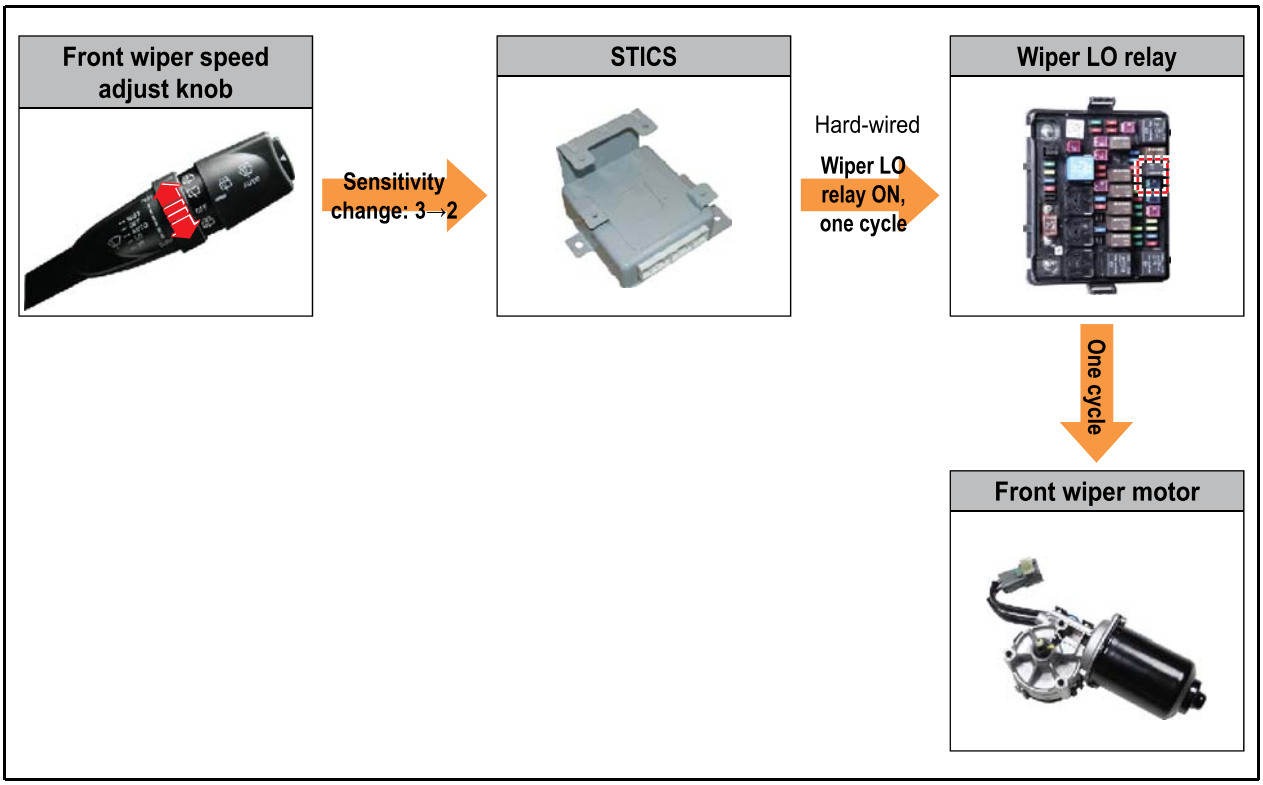
▶Defective Rain Sensor

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 AUTO switch is in "ON" position).



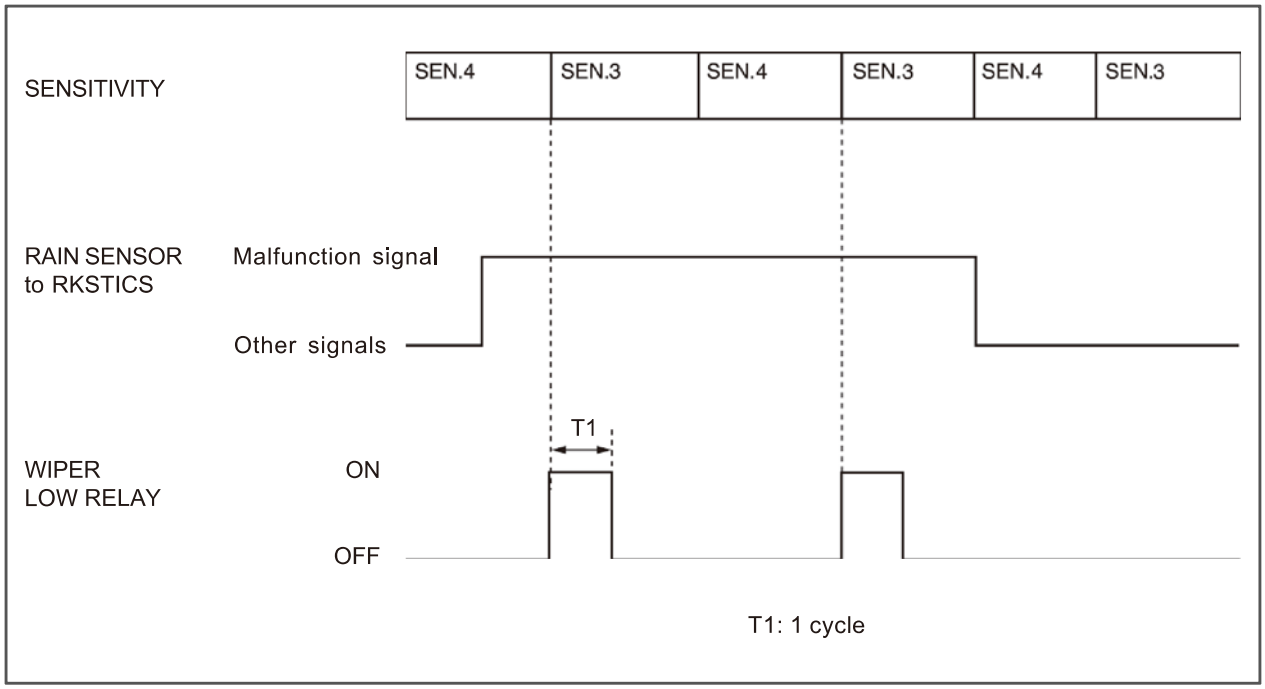
System Diagram

- IGN ON, AUTO Mode Switch ON, Rain Sensor Defective Signal Received



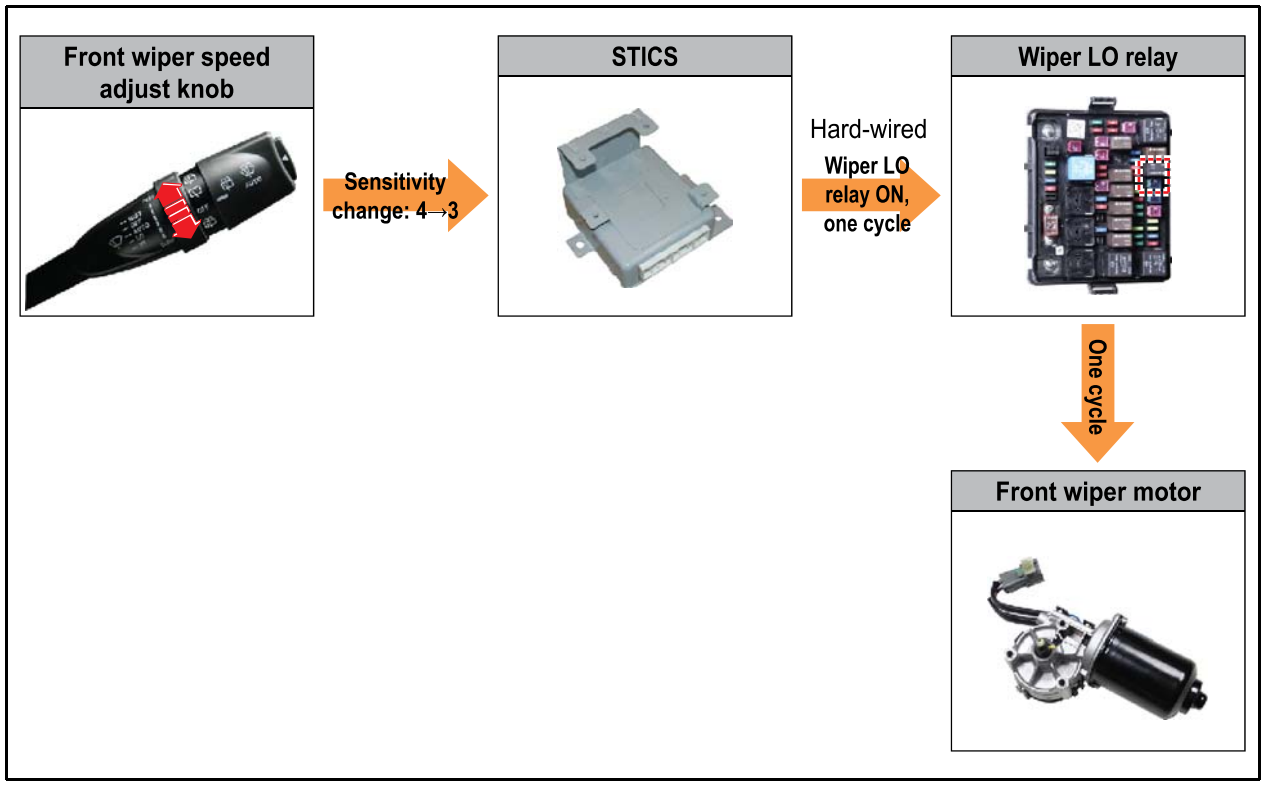
Modification basis	
Application basis	
Affected VIN	

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 AUTO switch is in "ON" position).



System Diagram

- IGN ON, AUTO Mode Switch ON, Rain Sensor Defective Signal Received



Modification basis	
Application basis	
Affected VIN	

▶Troubleshooting

Symptom 1: There is no signal wiping in AUTO mode.

1. The windshield wiper should operate one wiping cycle when the engine is started with the wiper switch in AUTO.
2. The windshield wiper should operate one wiping cycle when the wiper switch is turned to AUTO from OFF. However, this cannot be done after first operation, if it is not raining. The wiper system regards the additional 5 minutes after raining as the raining period. Thus, the signal wiping should be performed even in this period. If this fails, check the pin number 12 (B+) in connector. If the pin is not defective, check the wiper relay terminals.

Symptom 2: No wiper operation with the wiper switch in AUTO position

1. Check the operation mode of wiper switch.
2. Check the power supply (pin number 3: Ground, pin number 4: IGN) to sensor.
3. Check the wiper relay.

Symptom 3: Abrupt wiper operation (3~4 times) at high speed

If the wiping speed control knob is positioned at FAST position, this may happen because the sensitivity in FAST mode is extremely high. In that case, move the knob to another position.

Symptom 4: Continuous operation on dry windshield

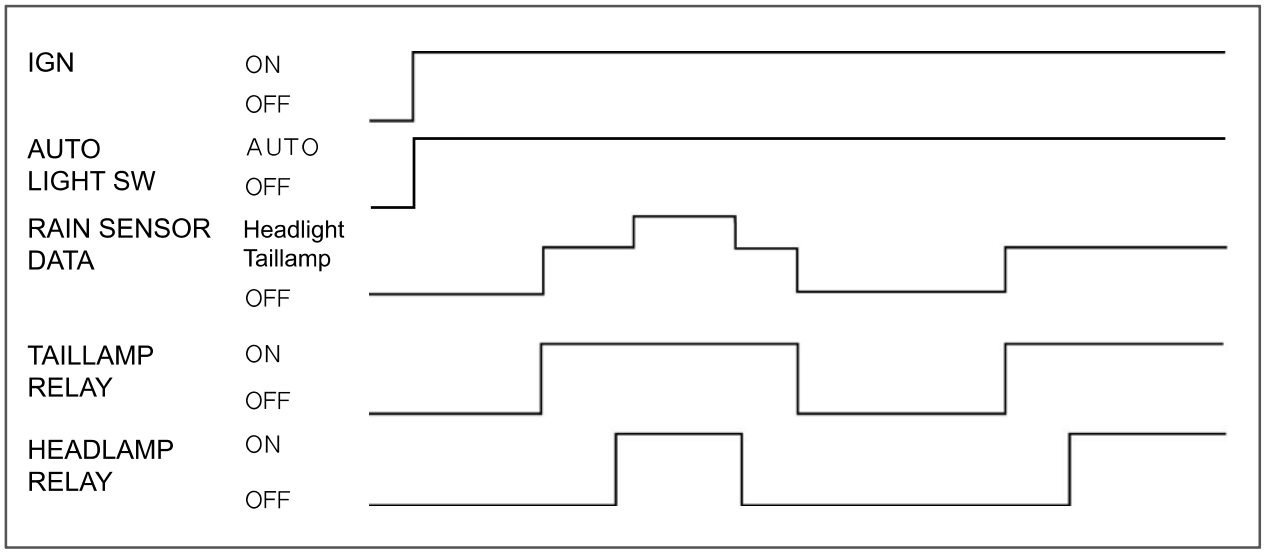
1. Check if the wiper blade is worn. This symptom may happen when the wiper cannot sweep the whole wiping range completely. If the wiper blade is worn, replace it with new one.
2. If the wiping speed control knob is positioned at FAST position, this may happen because the sensitivity in FAST mode is extremely high. In that case, move the knob to another position.

Symptom 5: Too slow or fast wiping operation

Check the wiper operation mode. If the wiping speed control knob is FAST or SLOW position, adjust it to medium speed mode.

▶Auto Light Control (except for EU market)

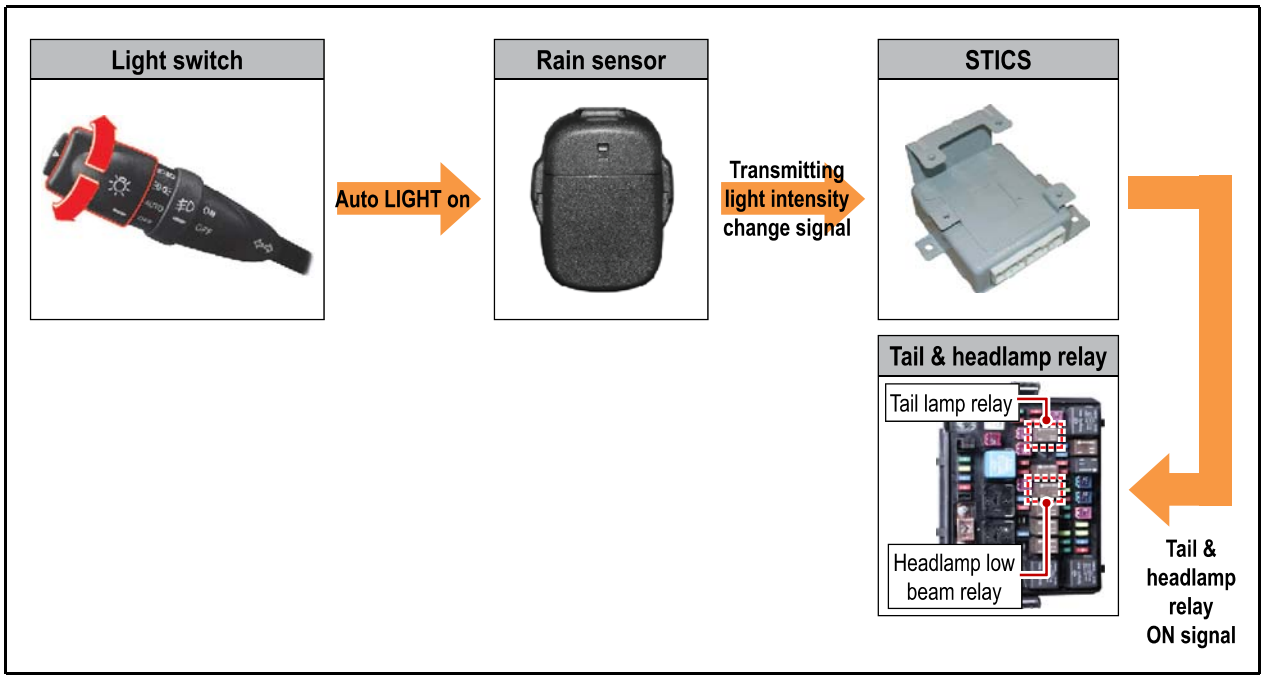
1. The tail lamps and headlamps can be controlled by the communication with the rain sensor only when the auto light switch is in "AUTO" position with the ignition switch "ON".



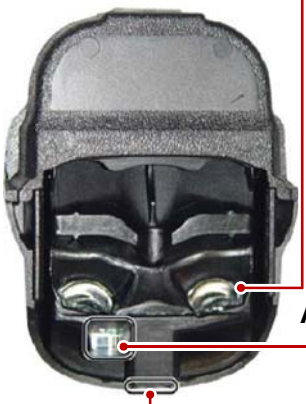
2. Rain detected headlamp: If it rains heavy which requires the highest AUTO speed, the headlamps are turned on automatically (while the light switch is in "AUTO" position and the wiper switch is in "AUTO" position).
3. Night detected wiping: When the auto light control turns on the headlamps and the 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.)

System Diagram

- IGN ON, AUTO Light Switch ON



Modification basis	
Application basis	
Affected VIN	



Emitter lense

The emitter lens located at bottom of rain sensing unit guides the infrared rays from the LED to the target point.

Auto light sensor (Vertical)

Auto light sensor (Horizon)



Auto light sensor

Modification basis	
Application basis	
Affected VIN	

▶ **Speed Sensitive AUTO Wiper**

For RKSTICS without the rain sensor, perform the following operation:

1. 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 AUTO VOLUME when the ignition switch is in the "ON" position and the AUTO switch is in the "ON" position. The wipers are operated in vehicle speed sensitive mode when turning the AUTO switch to the
- "ON" position with the engine running or starting the engine with the AUTO switch positioned to "ON".
  Intermittent interval (at 0 km/h): 3 ± 0.5 ~ 19 ± 2 seconds
-

2. Vehicle speed calculation
   [Input the vehicle speed]
   It is calculated by the numbers of input pulses for one second.

$$1\ [\text{PULSE/SEC}] = \frac{60\ [\text{km/h}] \times 60\ [\text{sec}]}{637 \times 4\ \text{PULSE}} \fallingdotseq 1.41\ [\text{km/h}]$$

3. VOLUME calculation

- The pause time of the vehicle speed sensitive AUTO wiper is calculated by the AUTO volume (input voltage). Each level has the hysteresis.

4. Pause time calculation

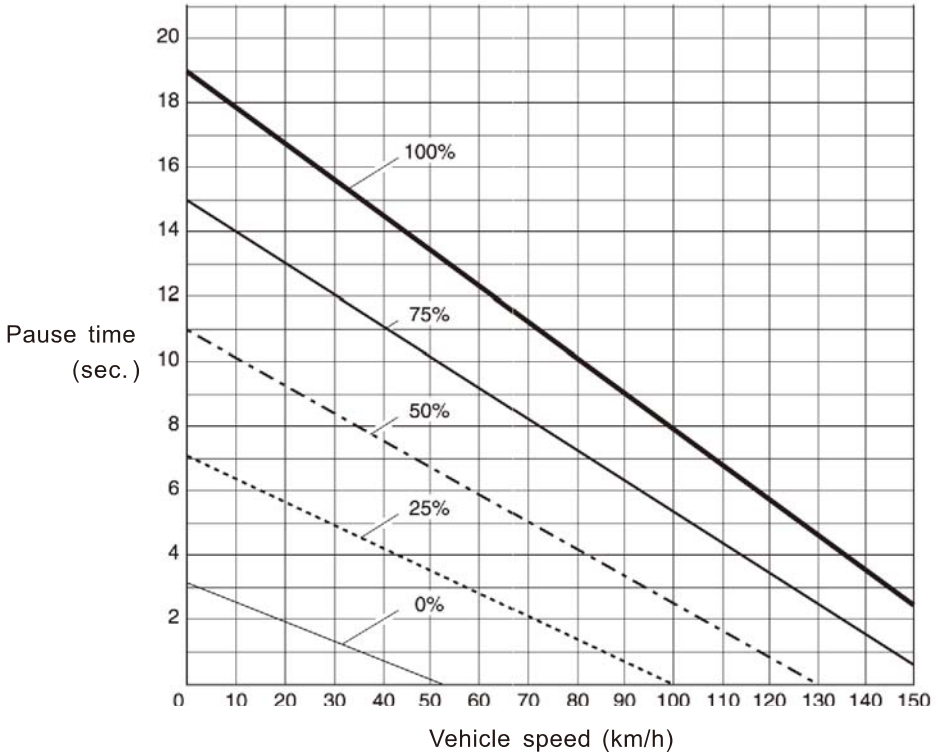
- Pause time: the duration that wipers are stopped at parking position
- Elapsed time: the duration after the wiper motor started to operate from parking position
- The pause time is calculated by the vehicle speed and the VOLUME.
  · If the pause time is below 1.0 second, the wipers operate without pause.
  · If the pause time is over 1.5 seconds, the wipers operate intermittently.

Modification basis	
Application basis	
Affected VIN	

[Pause time of vehicle speed sensitive INT wiper AUTO]

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

Pause time

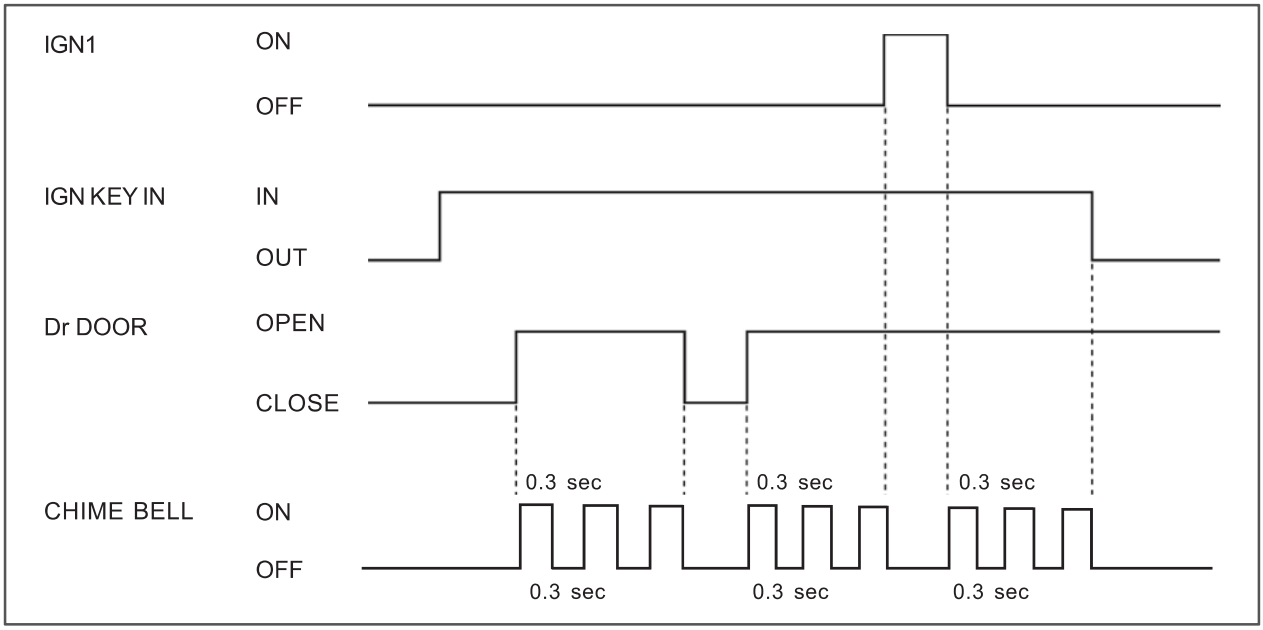


CAUTION

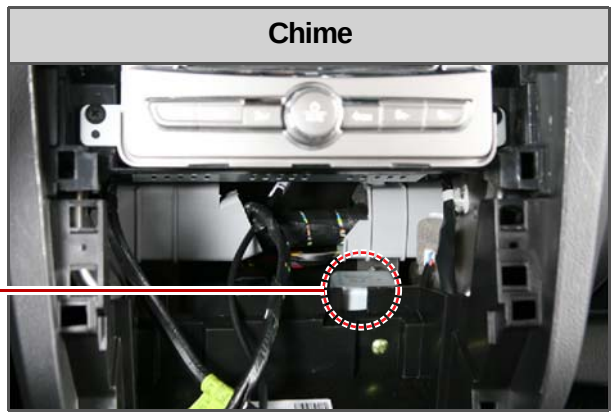
1. Speed Sensitive INT Wiper
   - The wiper relay stays ON for remaining period specified INT switch when turning off the INT switch during INT operation.
   - The wiper operates in previously set speed when turning ON the INT switch from OFF position with the IGN ON.
   - The wiper operates in previously set speed when turning ON the Ignition switch with the switch ON.
2. Control during Faulty Wiper Motor Parking Function
   - The wiper system continuously outputs (wiper Low relay ON) when the wiper parking terminal is stuck in ground or IGN with INT switch ON or washer switch ON. The relays is turned off immediately after turning off the INT switch.

(2) Ignition Key Reminder

1. When opening the driver's door while the ignition key is inserted into the key cylinder, the chime sounds (0.02 s ON and 1.38 s OFF).
2. When removing the ignition key or closing the driver's door during the chime operation, the buzzer stops its operation.
3. This function is not available when the ignition switch (IGN1) is in "ON" position.



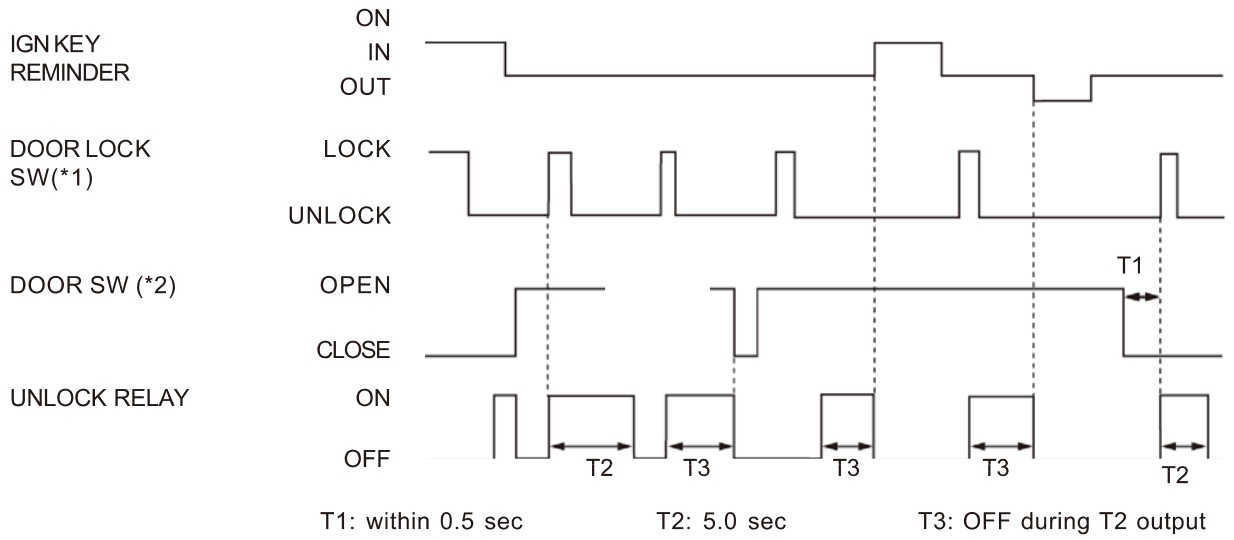




▶ Ignition Key Reminder

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.

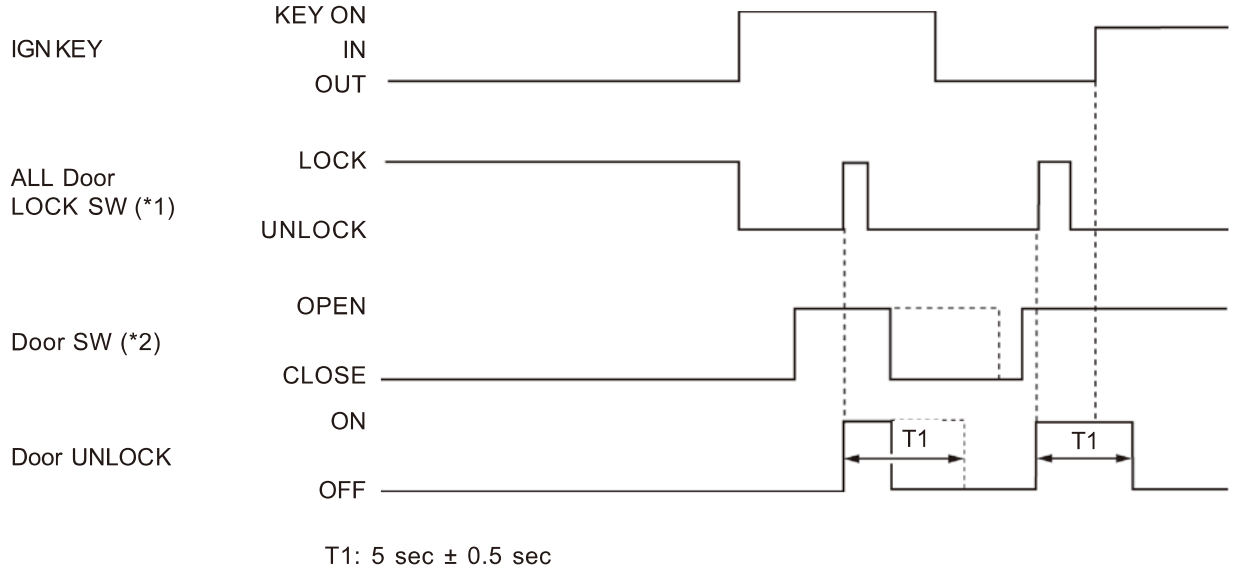
Modification basis	
Application basis	
Affected VIN	



(*1): Driver's or passenger's door lock switch
(*2): Driver's or passenger's door switch

▶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 UNLOCK output, the output continues for approx. 5 seconds.
4. If the ignition switch is in the "ON" position or the ignition switch is removed, the above steps are performed. If the key is in the key cylinder, the ignition key reminder function is activated.
5. This function does not work if the vehicle speed is over 10 km/h.

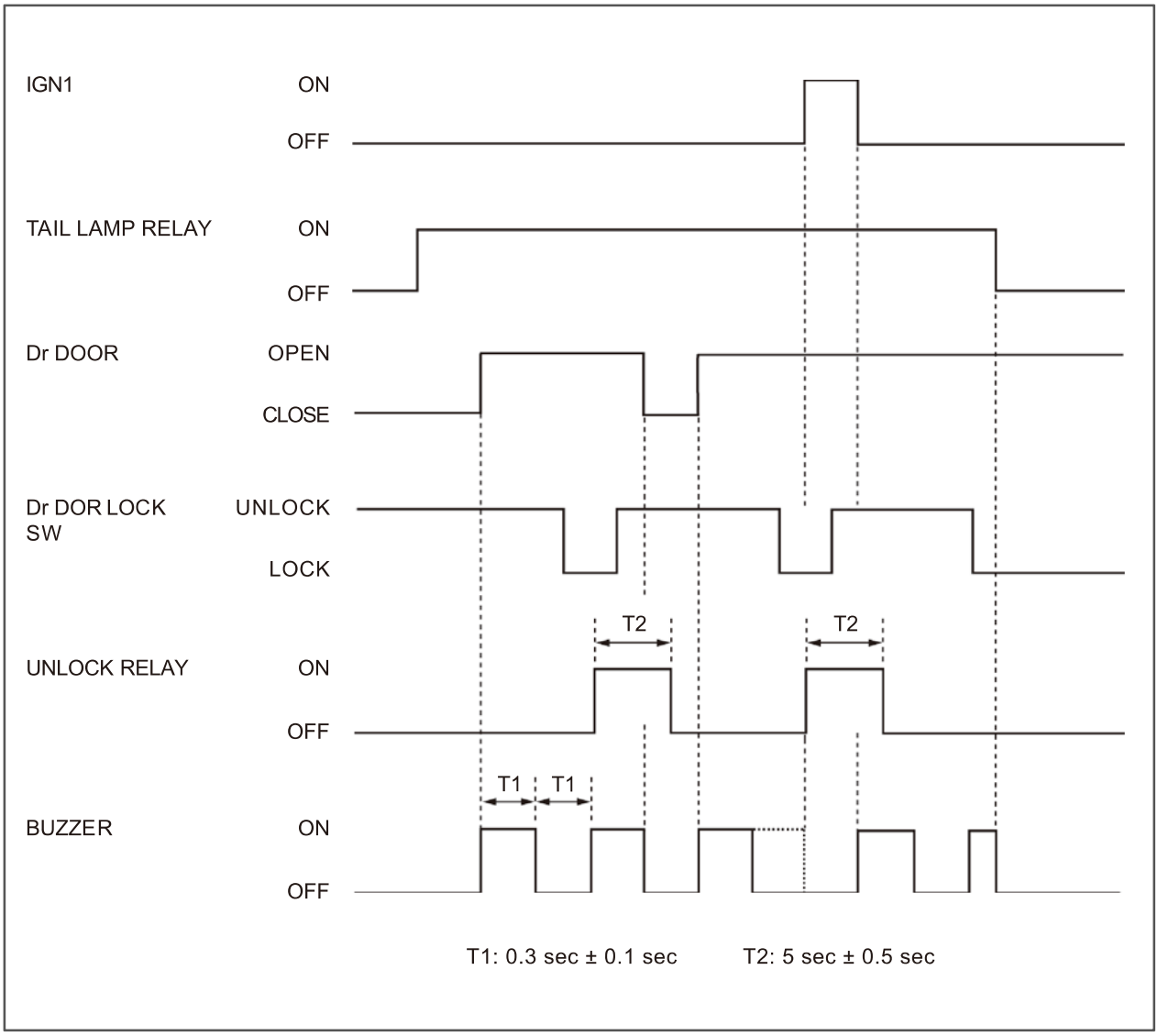


(*1) LOCK switches in all doors including tailgate
(*2) Door switches in all doors excluding tailgate

(3) Warning Buzzer Related Functions

▶ Tail Lamp Left On Warning

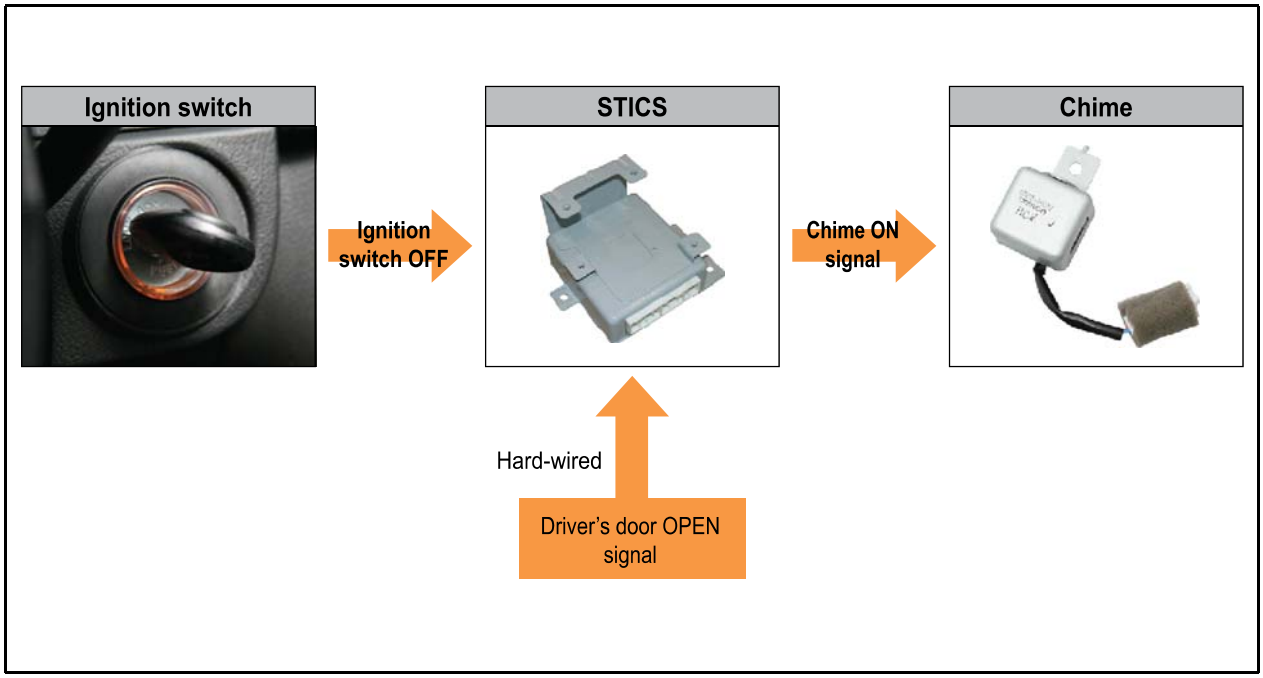
1. The buzzer sounds with the interval of 0.3 second when opening the driver's door while the tail lamp is turned on and the ignition key is removed.
2. The buzzer output stops when turning off the tail lamp and closing the driver's door.
3. The system outputs "UNLOCK" signal for 5 seconds when the driver's 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.



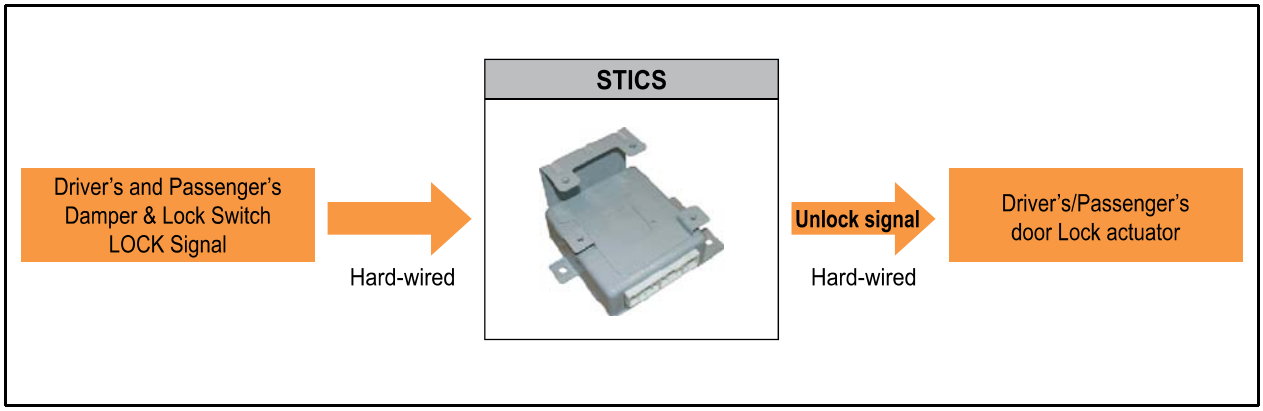
Modification basis	
Application basis	
Affected VIN	

System Diagram

- Tail Lamp Relay ON

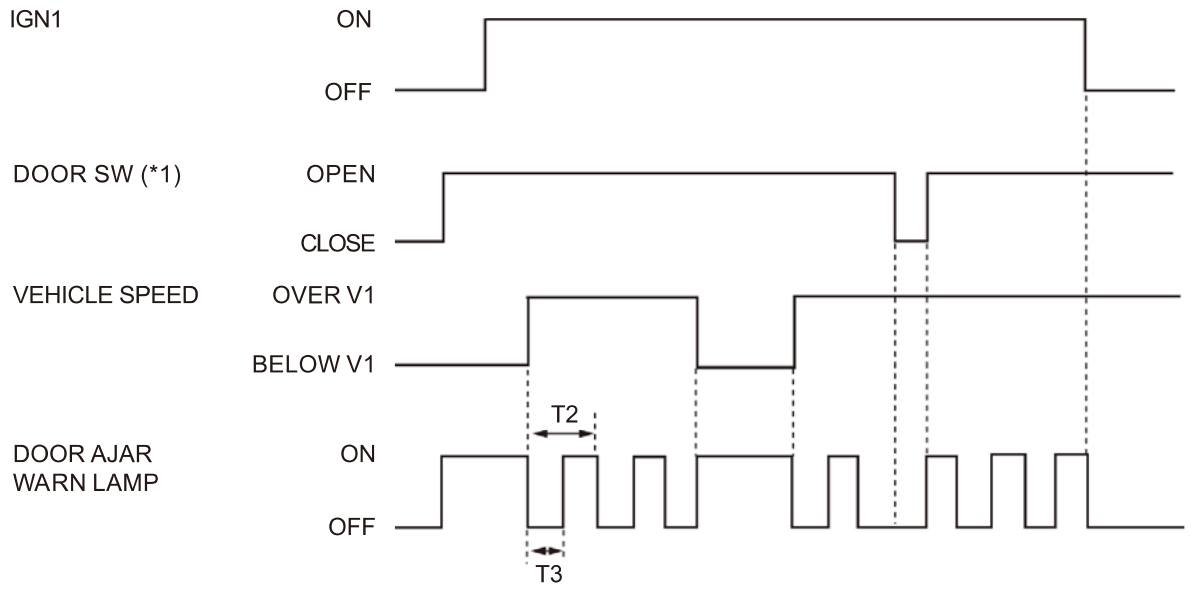


- Tail Lamp Relay ON & Driver's Door Open



▶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.

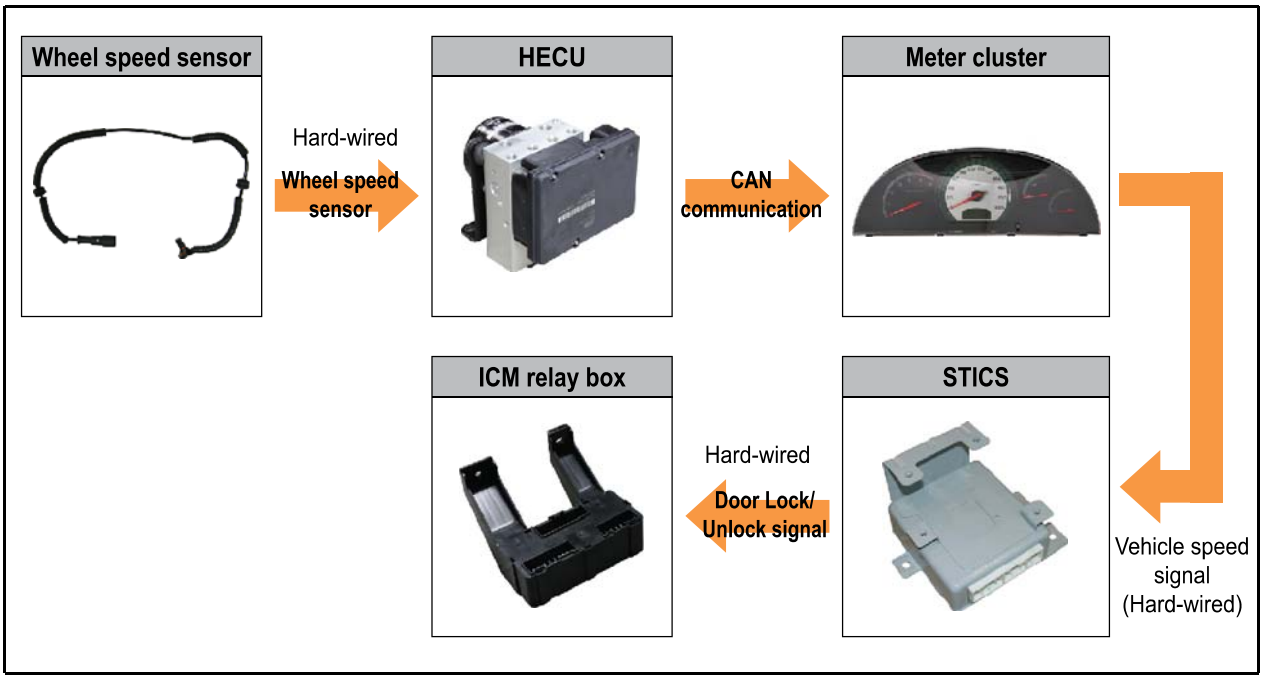


T1: 0.6±0.2 sec T2: 0.3±0.1 sec V1:= 10 km/h

(*1): Door OPEN: Any door (including tailgate)
Door CLOSE: Any door (including tailgate)

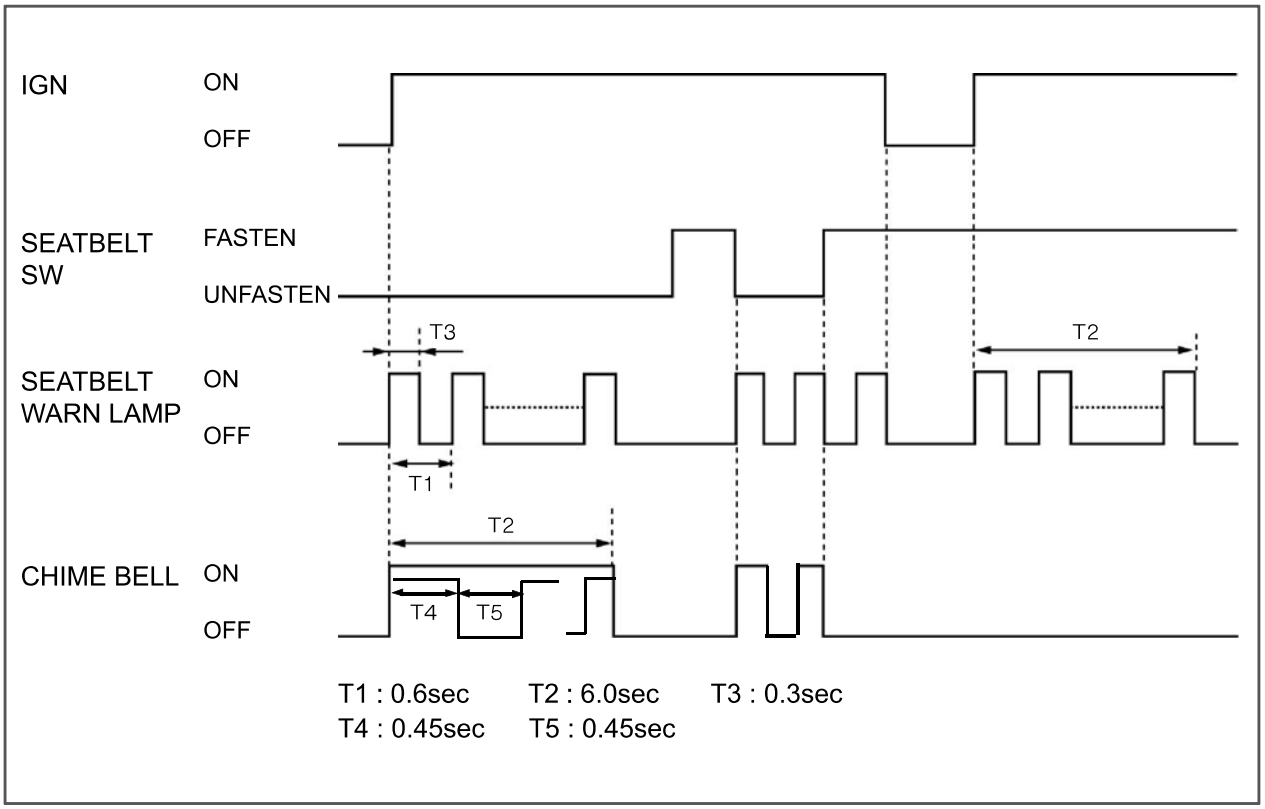
Modification basis	
Application basis	
Affected VIN	

System Diagram



▶ Seat Belt Warning

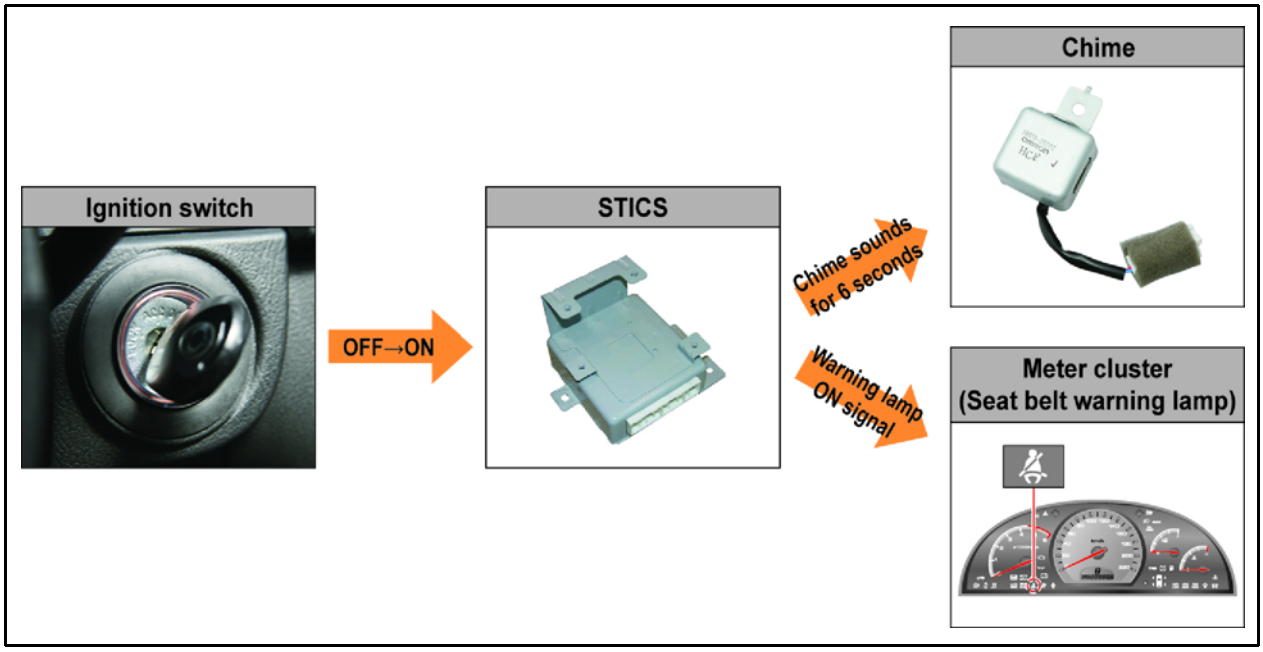
1. The seat belt warning light comes on and the chime bell sounds for 6 seconds when turning the ignition key to "ON" from "OFF". If the seat belt is fastened before turning the ignition key to the the "ON" position, the warning light in the instrument panel blinks, however, the chime bell does not sound.
2. The seat belt warning light goes off and the chime bell stops when turning the ignition switch to the "OFF" position.
3. The chime bell stops and the seat belt warning light stays on for the specified period of time when fastening the seat belt during the warning operation.
4. The seat belt warning light comes on and the chime bell sounds for 6 seconds again when unfastening the seat belt during fastening operation while the ignition key is "ON" position.



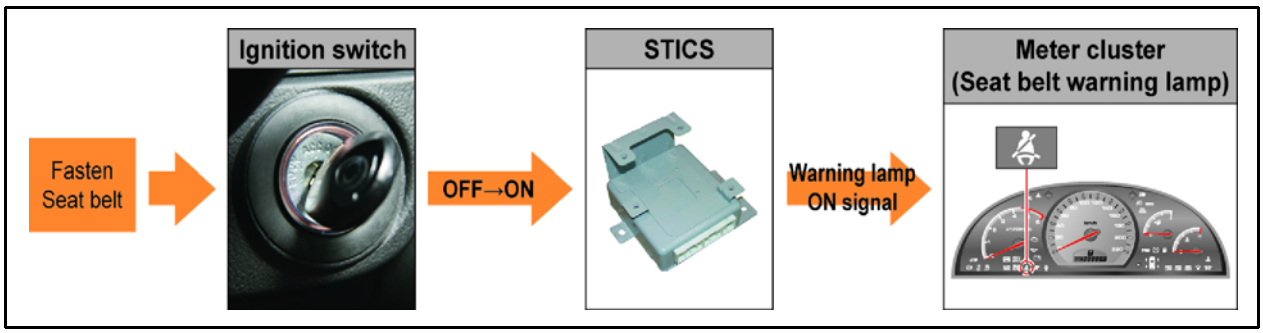
Modification basis	
Application basis	
Affected VIN	

System Diagram

- Before Fastening Seat Belt



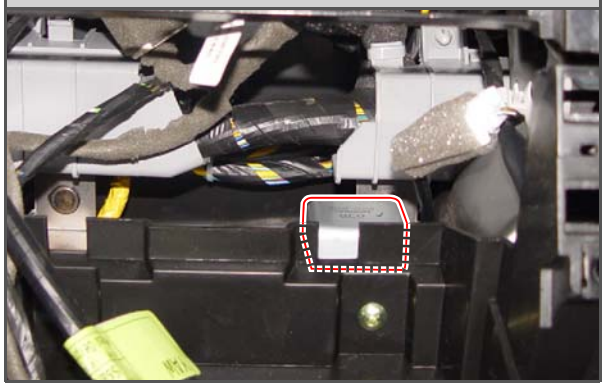
- Turning the Ignition Switch to ON after Fastening Seat Belt



Seat Belt Warning Light



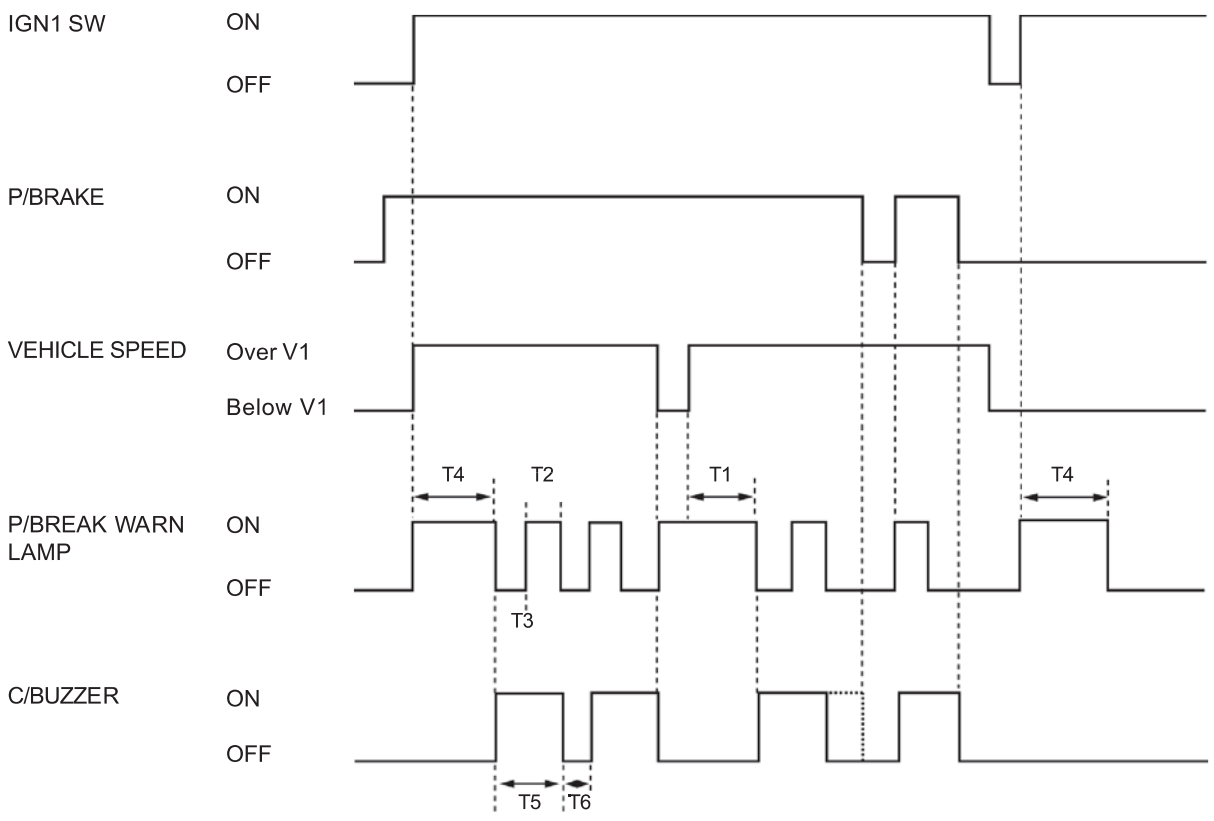
Chime



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 bell stops.

▶ Parking Brake Warning

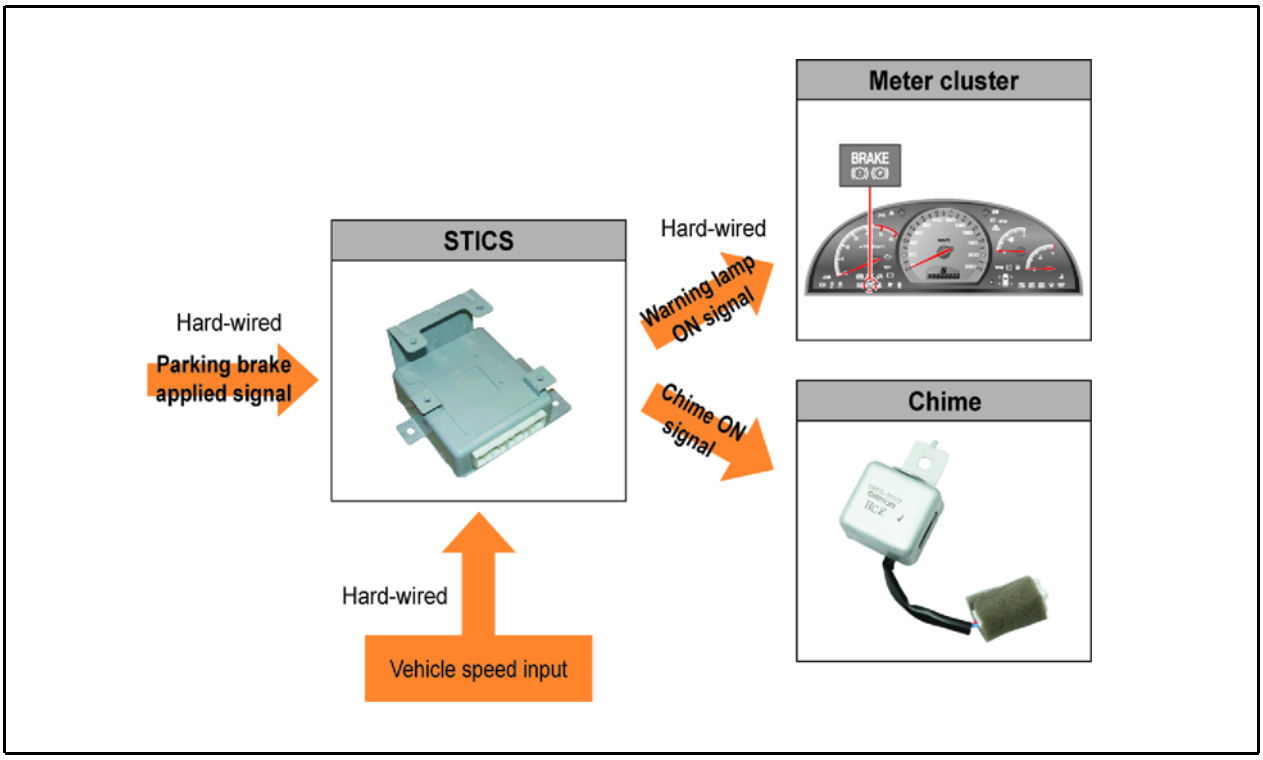
1. The parking brake warning light comes on for approx. 4 seconds when turning the ignition key from the "OFF" to the "ON" position regardless of the vehicle speed and the parking brake switch position. After this 4 seconds, the warning lamp comes on, goes off or blinks according to the vehicle speed 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 bell sounds for 0.6 seconds and stops for 0.3 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: 0.6 sec ± 0.1 sec T6: 0.3 sec ± 0.1 sec

Modification basis	
Application basis	
Affected VIN	

System Diagram

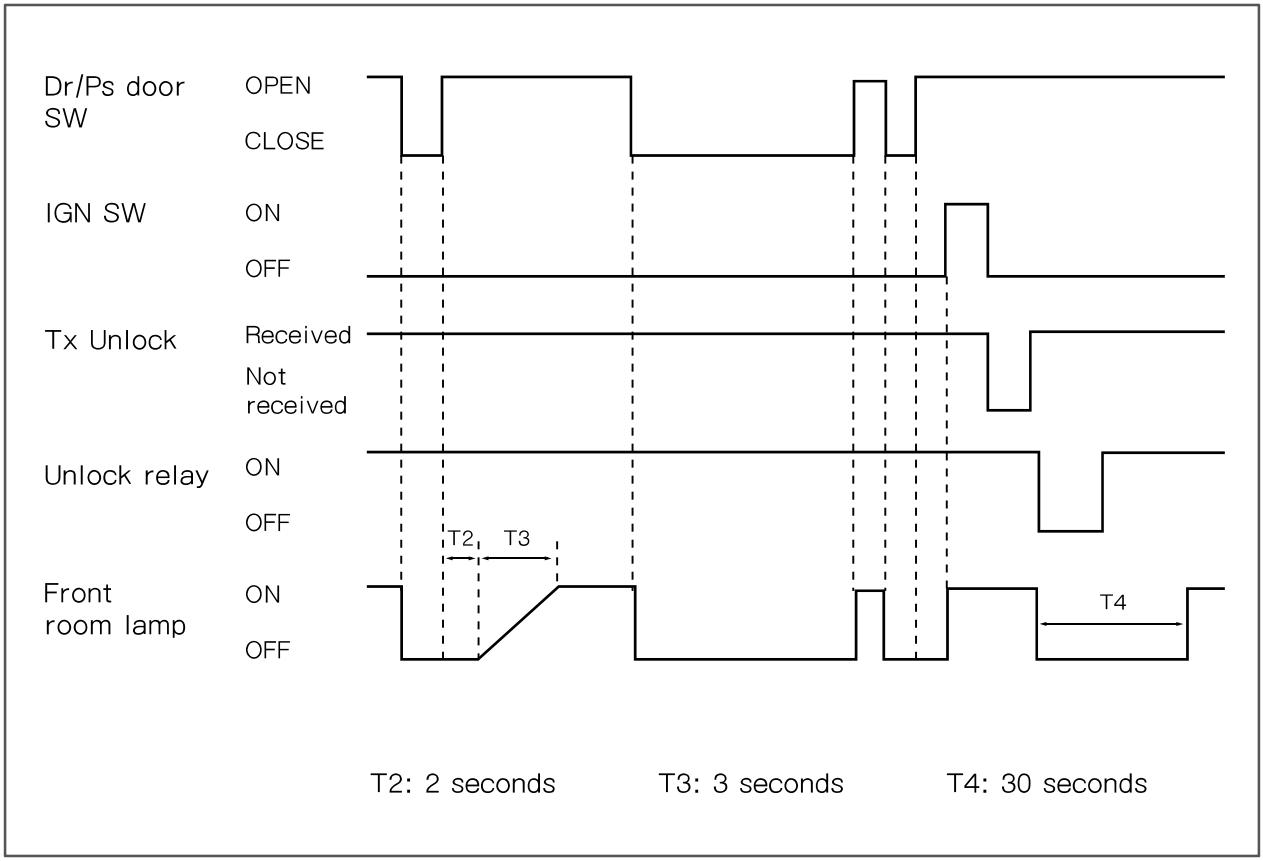


(4) Lamp Control Function

▶ Front Room Lamp

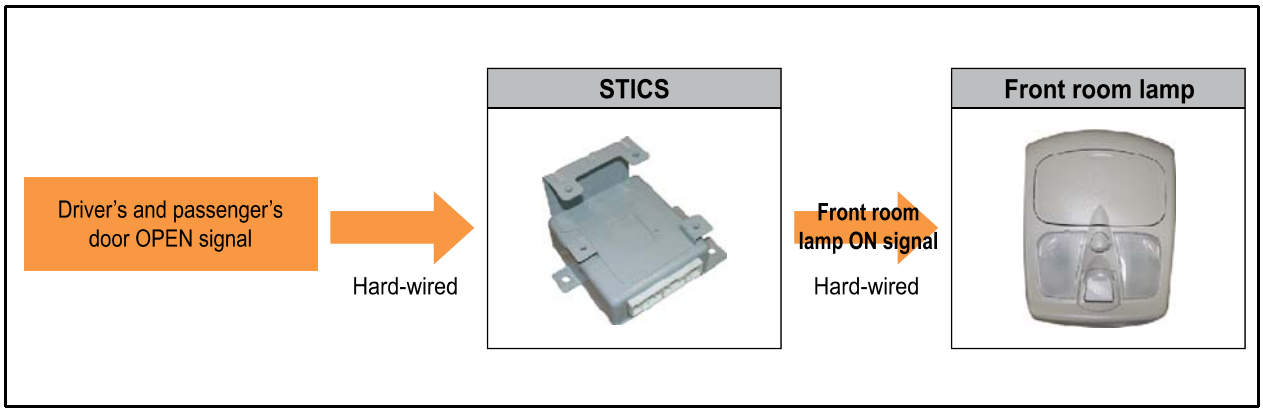
The front room lap comes on when opening a front door with the “Door” switch ON.

1. The front room lamp comes on when opening a front door.
2. The front room lamp goes out immediately after closing the door with the ignition ON.
3. The front room lamp stays on for 2 seconds after closing the door, and then dims out in 3 seconds.
   The front room lamp goes out immediately after turning the ignition ON during the dimming period.
4. The front room lamp comes on for 30 seconds when unlocking the doors with REKES key.
   The front room lamp stays on for additional 30 seconds during lamp operation in Step 5 when
5. receiving the UNLOCK signal from REKES again.
6. The front room lamp stays on when opening a front door, and operates as in Step 3 and 4.
   The front room lamp dims out when closing the opened door. However, it goes out immediately when
7. getting into the theft deterrent mode.
8. The front room lamp comes on when opening a front door with the ignition ON. And, it goes out immediately when closing the opened door with the ignition ON.
9.

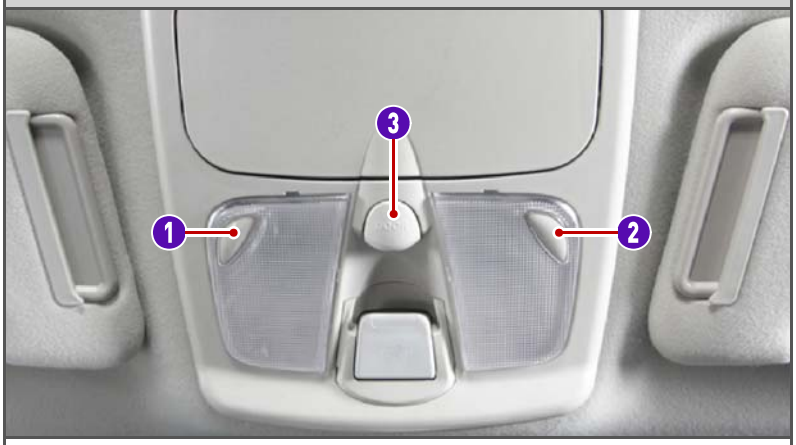


Modification basis	
Application basis	
Affected VIN	

System Diagram

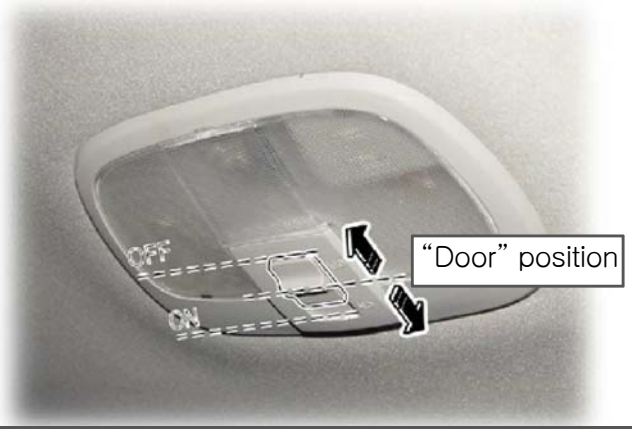


Front Room Lamp



The driver's spot lamp and passenger's spot lamp comes on when pressing appropriate lamp switch (1, 2) in. The front room lamp comes on when pressing the "Door" switch (3) in.

Center Room Lamp

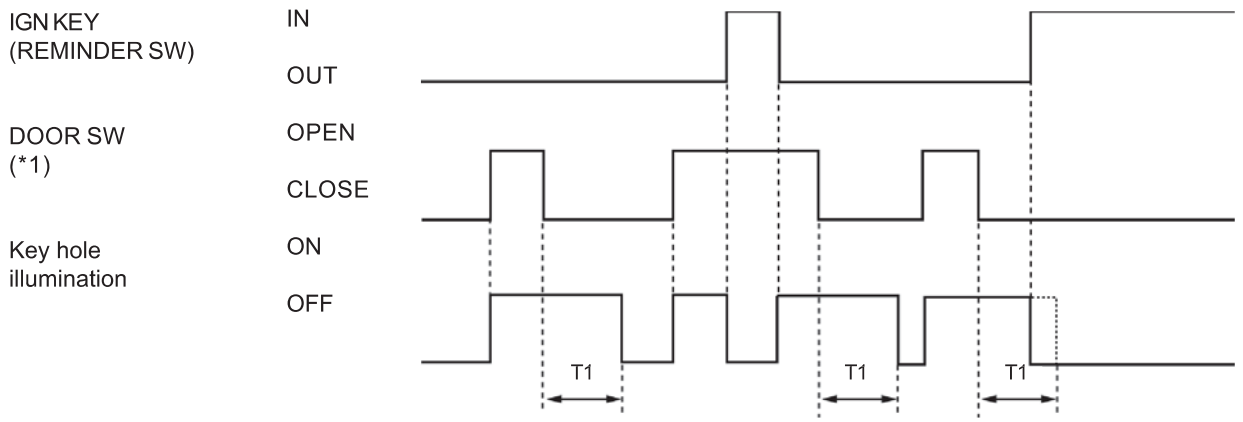


The center room lamp comes on when opening a rear door with the center room lamp switch in "Door" position.

Modification basis	
Application basis	
Affected VIN	

▶ Ignition Key Hole Illumination

1. The ignition key hole illumination comes on when opening the driver's door or passenger's door when 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 "ON" position.
4. The output stops when receiving the lock signal from the remote control key (under anti-theft mode).



T1: 10 sec

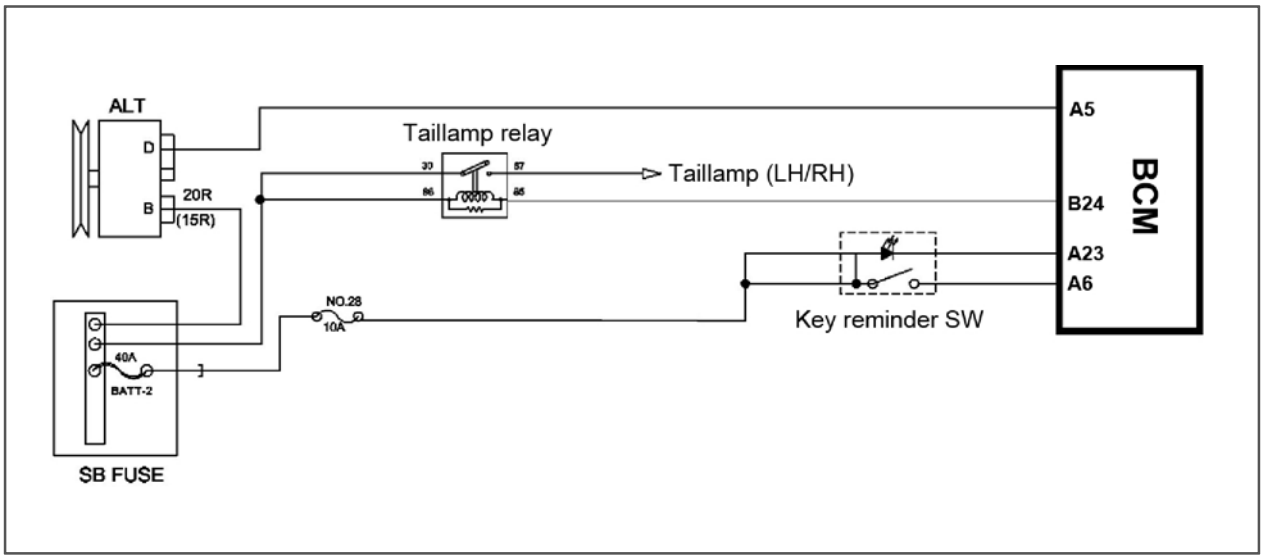
(*1) Door OPEN: Driver's door or passenger's door
Door CLOSE: Driver's door and passenger's door

▶ Ignition Key Hole Lamp ON When opening a Front Door



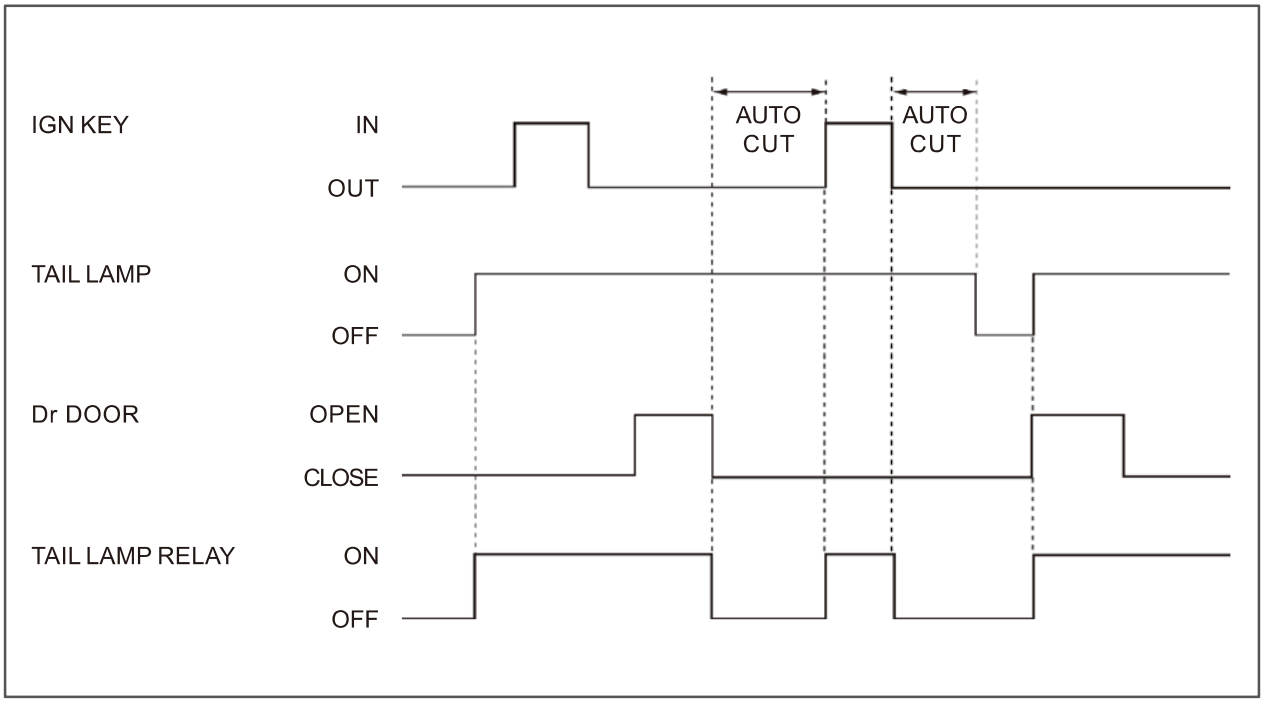
Modification basis	
Application basis	
Affected VIN	

▶ Circuit Diagram of Tail Lamp Auto-Cut (Battery Saver)



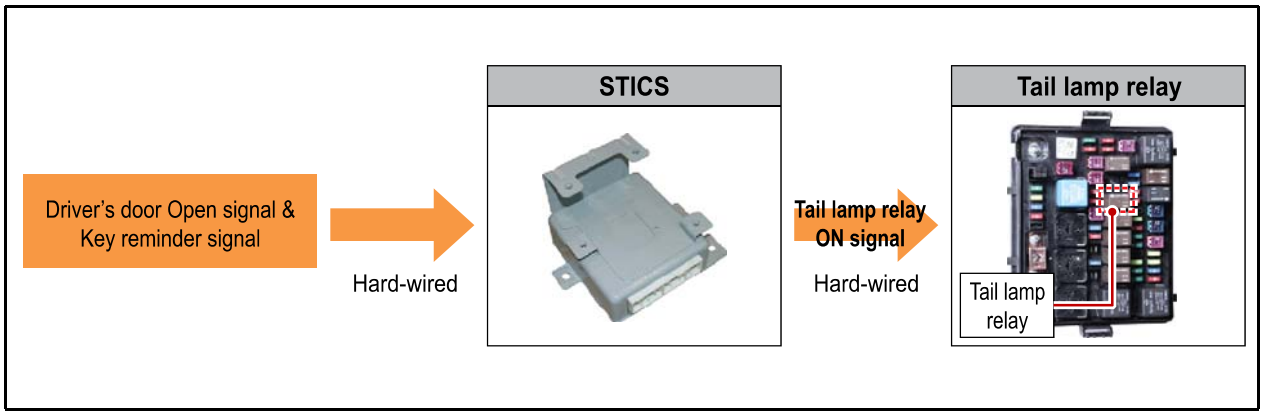
▶ Tail Lamp Auto Cut (Battery Saver)

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 not turned off automatically (auto cut) when opening and closing the driver's door while the ignition is removed and the tail lamp is turned on.



System Diagram

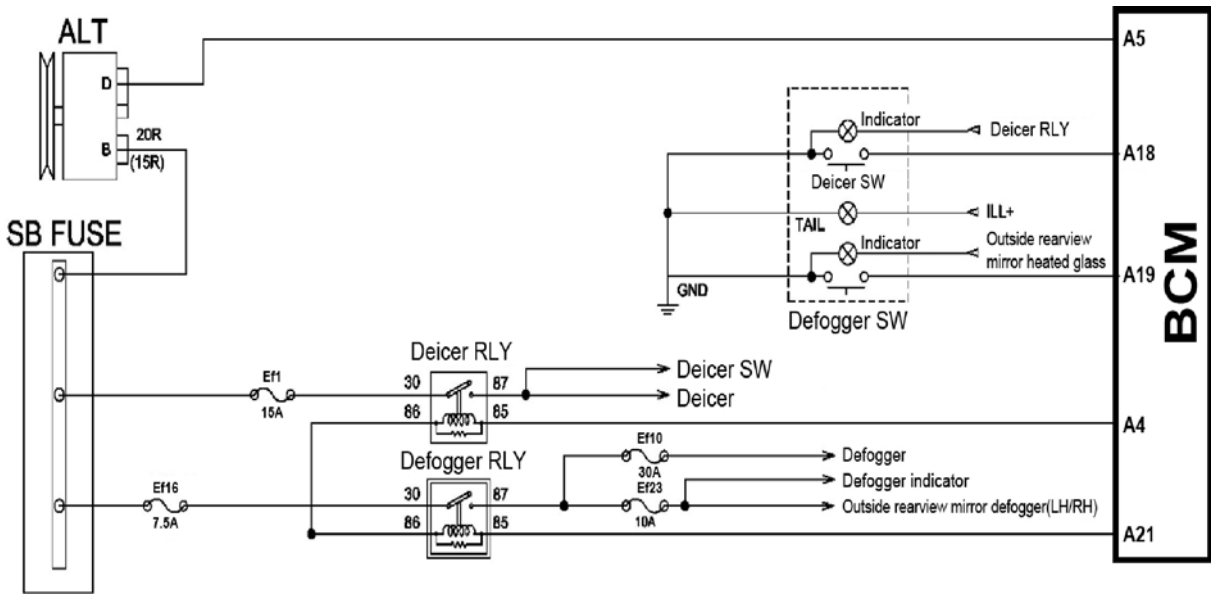
- Power OFF, IGN ON and Tail Lamp Switch ON with Driver's Door Open



Modification basis	
Application basis	
Affected VIN	

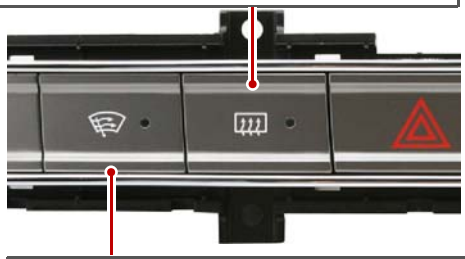
(5) Defogging Function

▶ Circuit Diagram of Front/Rear Defogger



- The defogger system defrosts or demists the window glass with the heated wire integrated in glass.
- When operating the defogger switch, STICS controls the operating time only in IGN2 position.

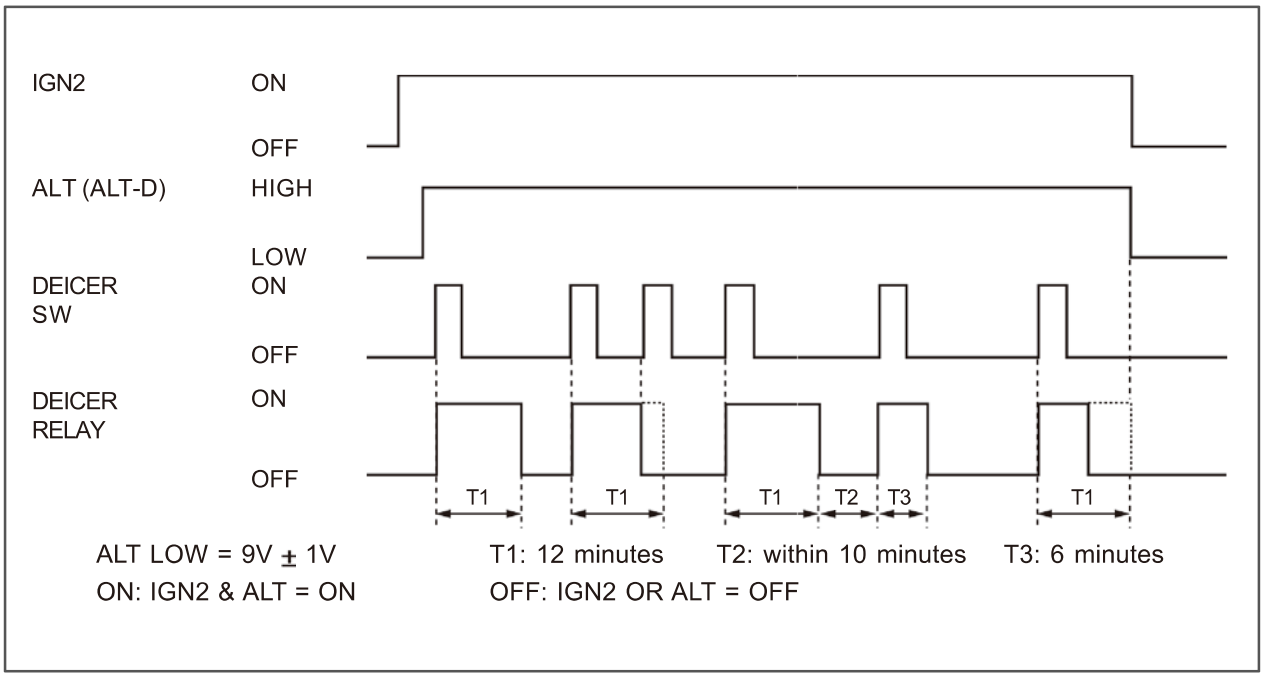
Rear defogger switch
(Tailgate window and outside rearview mirror heated glass switch) The tailgate window and outside rearview mirror heated glass is turned on for 12 minutes when pressing this



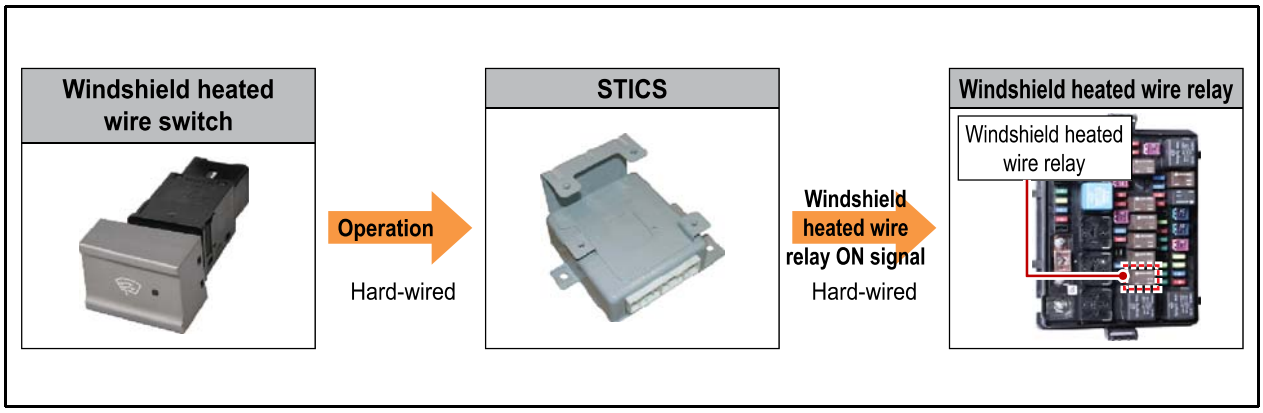
Windshield heated glass switch
The windshield heated glass is turned on for 12 minutes when pressing this switch.

▶ Windshield heated glass (deicer) switch

1. The front defogger output is "ON" when turning "ON" the front defogger (heated glass) switch while the ignition switch is "ON" (with engine running).
2. The output stops when turning on the front defogger (heated glass) switch again during its operation. The output is "ON" only for 6 minutes when turning "ON" the front defogger (heated glass) switch within
3. 10 minutes after completion of output for 12 minutes. This can be done only once.



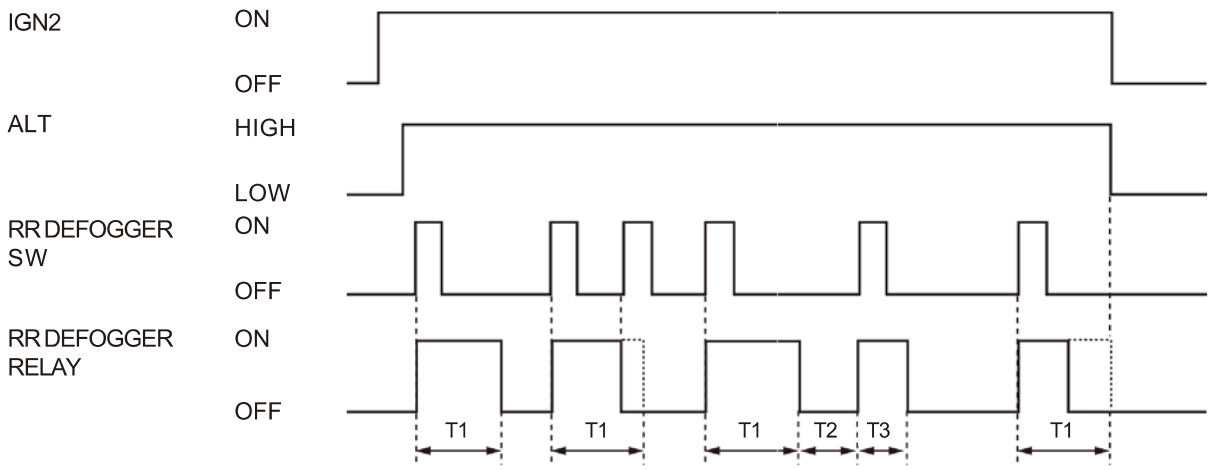
System Diagram



Modification basis	
Application basis	
Affected VIN	

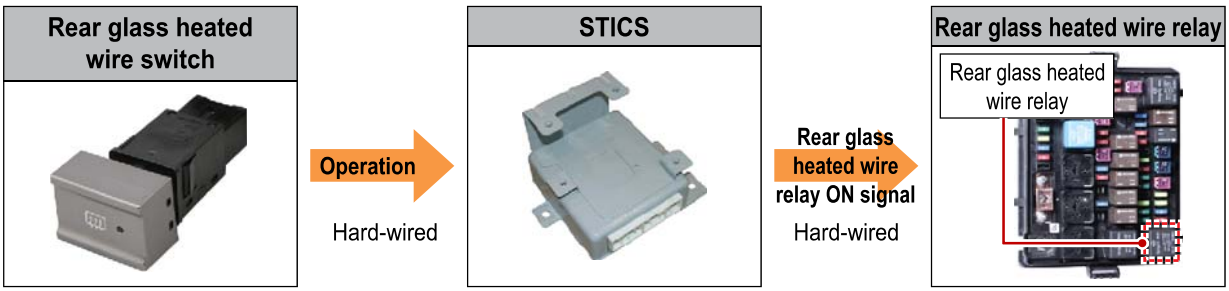
▶ Rear Defogger Timer

1. The rear defogger output is "ON" when turning "ON" the rear defogger switch while the IGN 2 switch is "ON" (with engine running).
2. The output is "OFF" when turning "ON" the rear defogger switch again during output.
3. 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.
4. The output is "OFF" when the IGN 2 switch is "OFF".



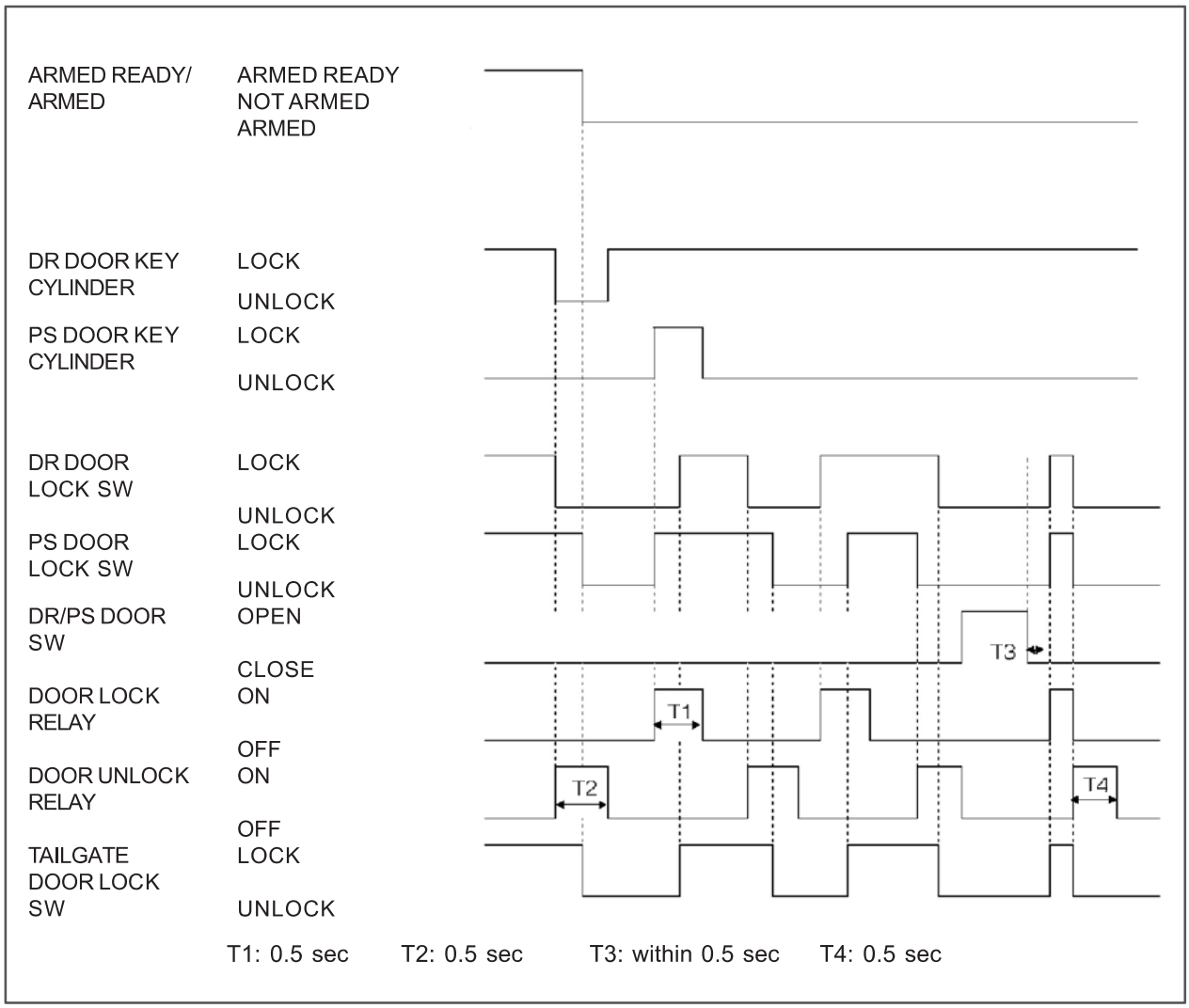
ALT LOW LOW = 9V ± 1V T1: 12 minutes T2: within 10 minutes T3: 6 minutes
ON: IGN 2 & ALT = ON OFF: IGN 2 or ALT = OFF

System Diagram



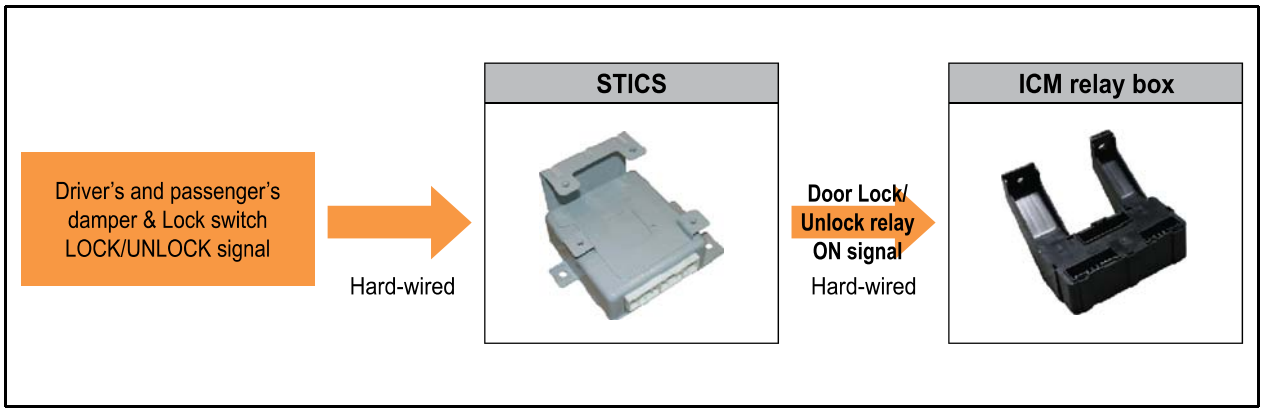
(6) Central Door Lock/Unlock

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. The door lock system outputs "LOCK" signal for 0.5 seconds when switching from LOCK to UNLOCK by the driver's or passenger's door key cylinder.
4. The door lock system outputs "UNLOCK" signal for 0.5 seconds when switching from UNLOCK to LOCK by the driver's or passenger's door key cylinder.
5. The alarm will not be activated when switched to UNLOCK by driver's or passenger's door key cylinder switch in theft deterrent mode.
6. It does not occur abnormal operation when reconnecting the battery after disconnecting the battery cable.
7. 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.



Modification basis	
Application basis	
Affected VIN	

System Diagram

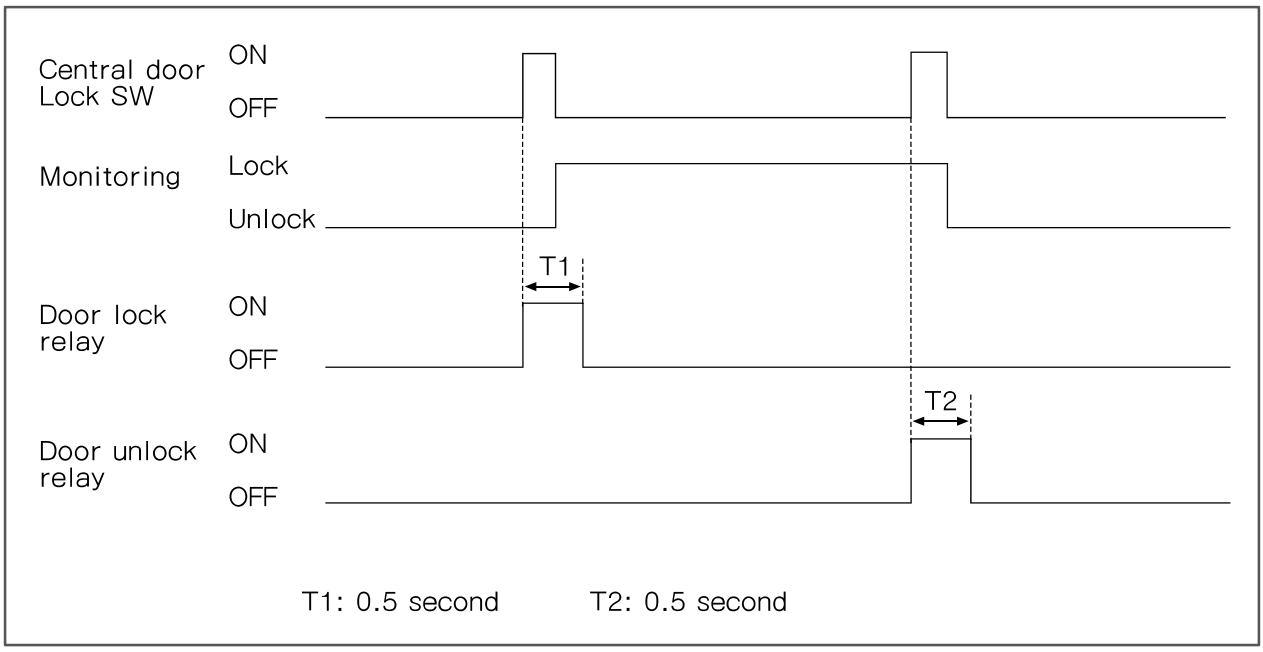






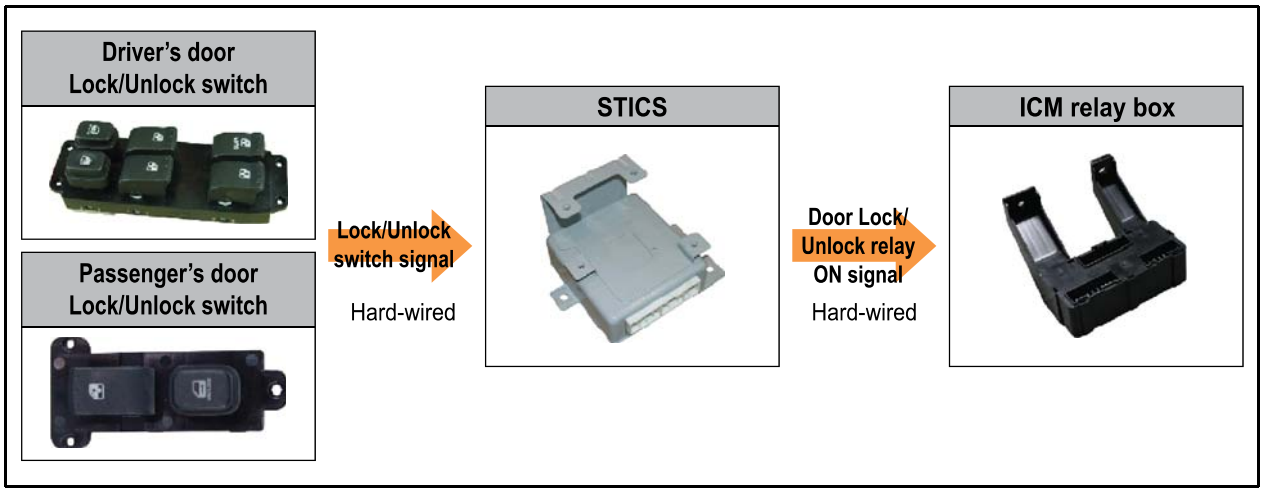
▶Door Lock/Unlock by Central Door Lock Switch

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.



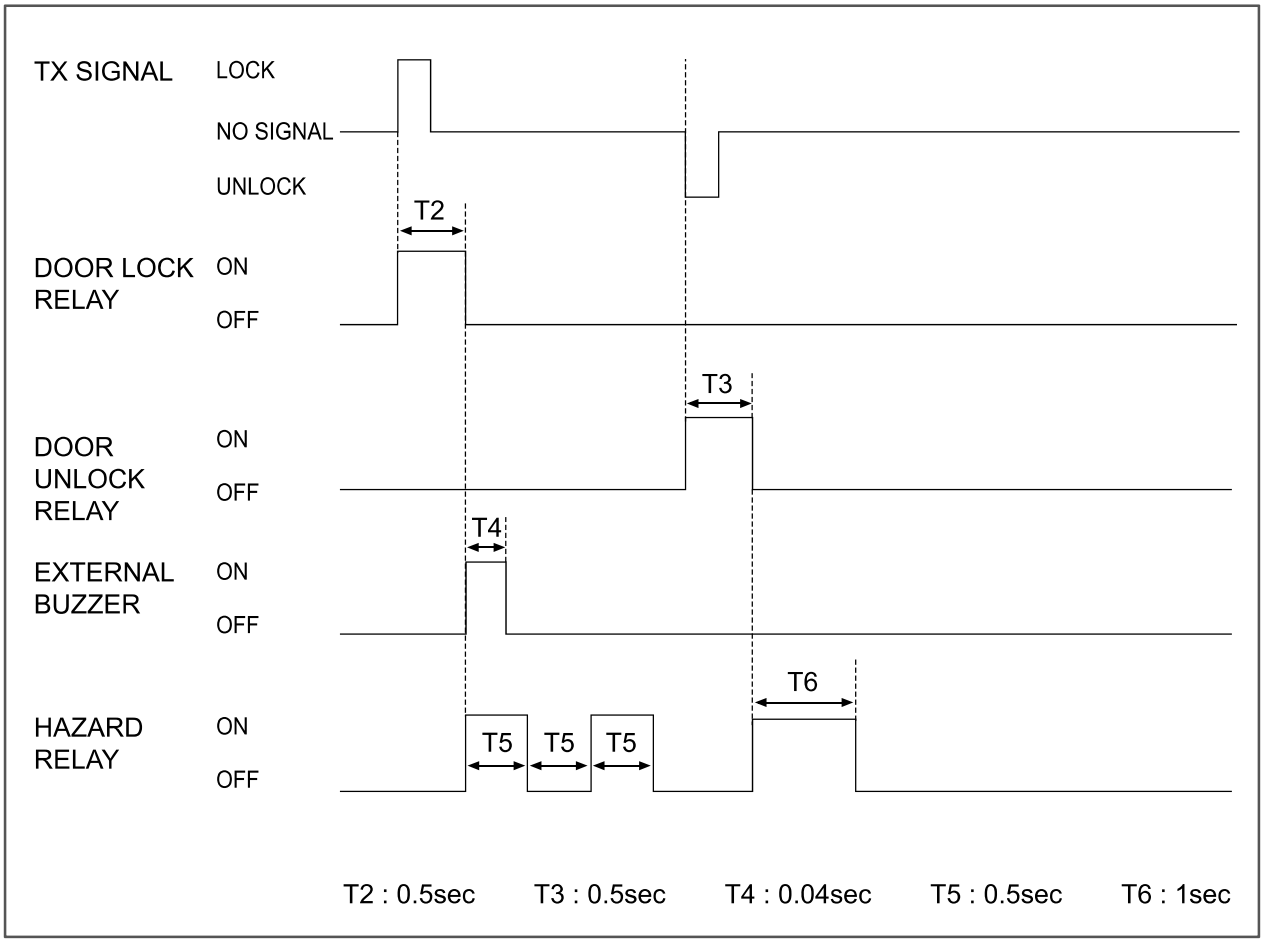
Modification basis	
Application basis	
Affected VIN	

System Diagram



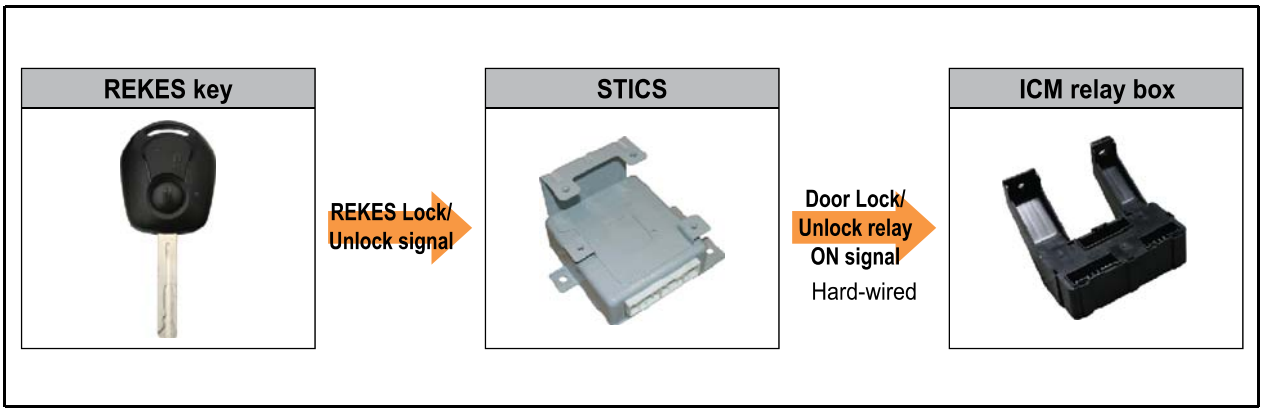
▶ Door LOCK/UNLOCK by Remote Control Key

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
2. signal.



Modification basis	
Application basis	
Affected VIN	

System Diagram



Door Unlock/Panic Button
Door unlock & Disarming theft deterrent mode: briefly press
Panic: press for more than 2 seconds (operative only when the ignition key is in key cylinder)

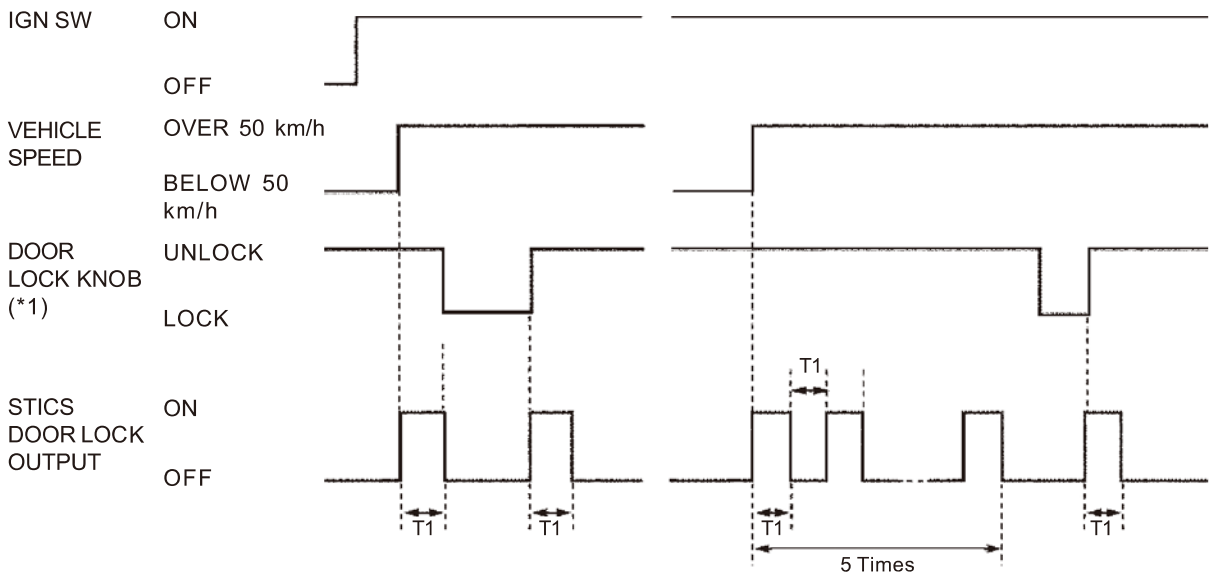
Door LOCK Function
Briefly press: Locking the doors and Arming the theft deterrent mode



Indicator
Briefly press: Blinks once
Press and hold: Blinks twice

▶ 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 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
8. UNLOCK signal unconditionally when turning the ignition switch to OFF position.)



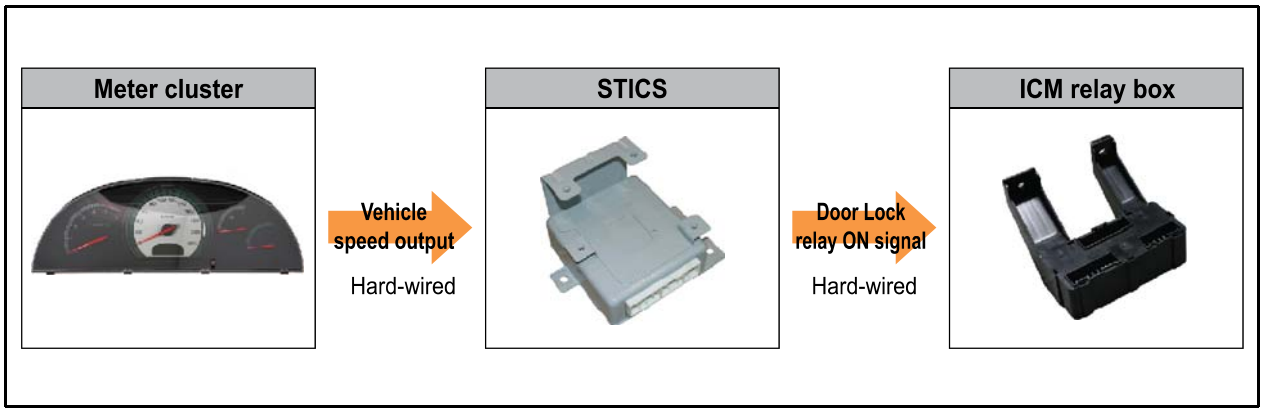
T1: 0.5 sec

(*1) LOCK: All door lock switches (including tailgate) = LOCK
UNLOCK: Any of all door lock switches = UNLOCK

Modification basis	
Application basis	
Affected VIN	

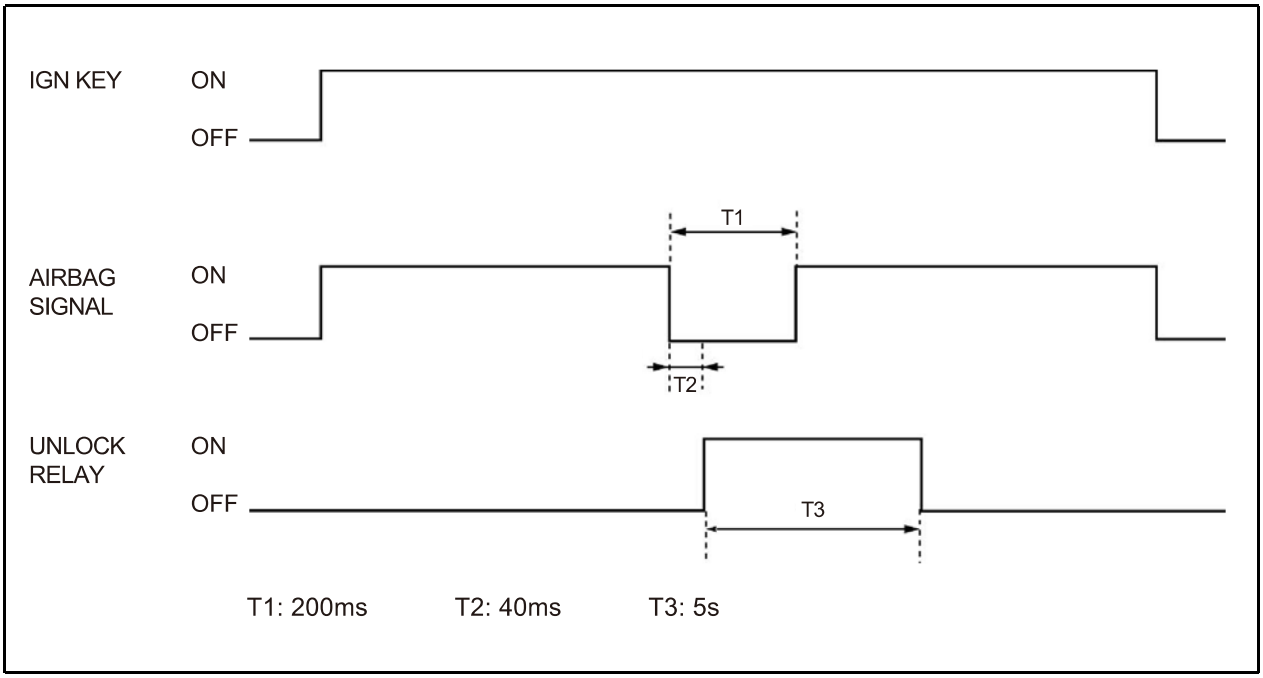
System Diagram

- Power OFF, ACC ON, IGN ON



▶ Auto Door Unlock (Crash Unlock)

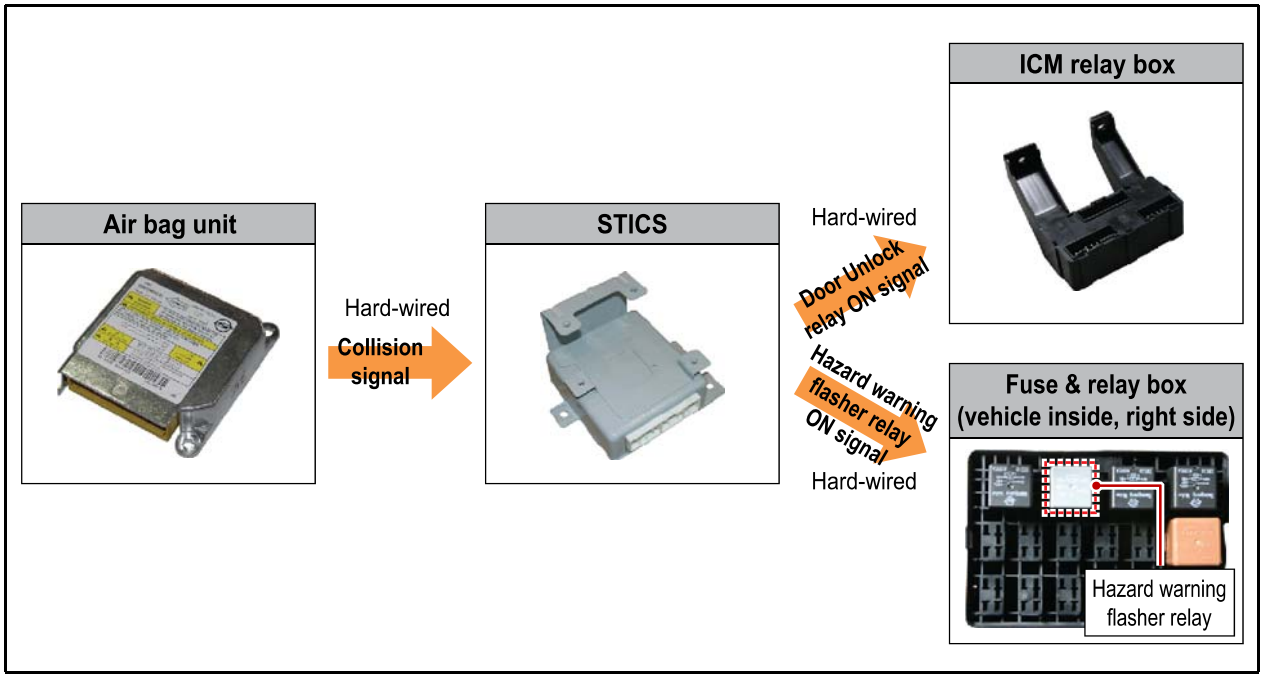
1. The air bag collision signal input cannot be accepted within 7 seconds after turning the ignition key to "ON" position.
2. After this period, the door lock system outputs "UNLOCK" for all doors for 5 seconds from 40ms after receiving the air bag collision signal.
3. Even though the key is turned to "OFF" position during the output of "UNLOCK", the output continues on for remaining period.
4. The room lamps come on when receiving the collision signal from the air bag collision sensor (except room lamp switch OFF).
5. The hazard warning flasher relay ON when receiving the collision signal from the air bag collision sensor.
6. This function reset when disconnecting the battery cables.



Modification basis	
Application basis	
Affected VIN	

System Diagram

- IGN ON

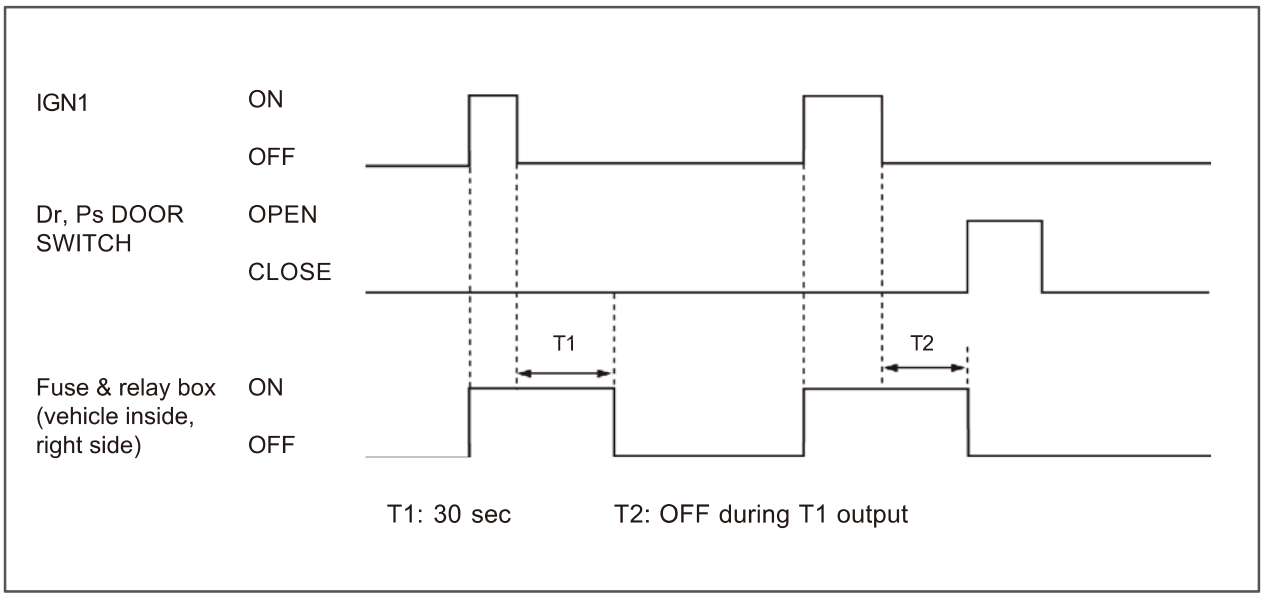


CAUTION

- 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.

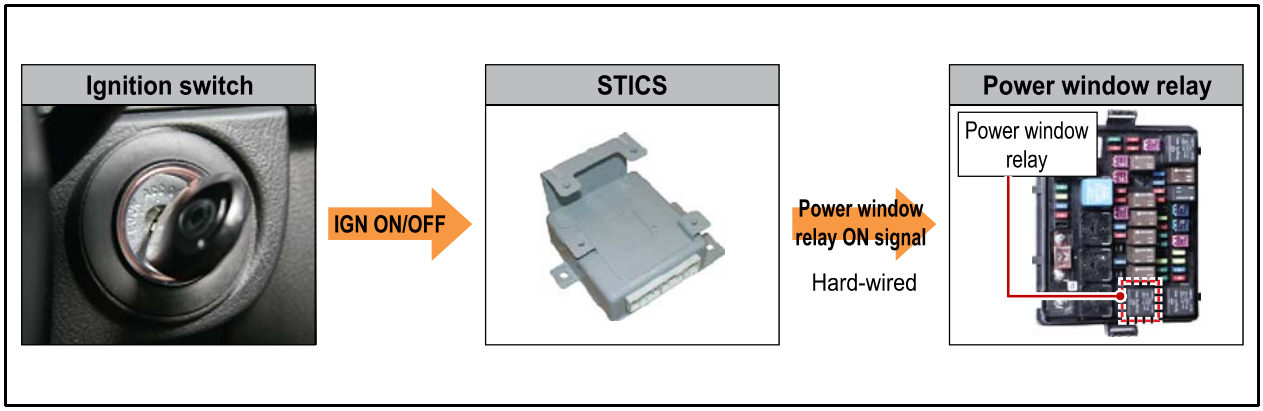
(7) Time Lag Power Window Control

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.
3. The power window relay is turned "OFF" when receiving the remote control key lock signal (armed mode) during its extended operation period of 30 seconds.



System Diagram

- IGN ON/OFF



Modification basis	
Application basis	
Affected VIN	

NOTE

▶ **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.

▶ **Power Sleep Mode**

1. **Entering Condition**

1) When all the doors including the hood are closed.
2) When the ignition key is in "OFF" position.
3) When there is no key in the driver's/passenger's door key cylinder.
4) The system enters into the sleep mode for saving power if there is any change for 6 seconds while the driver's/passenger's/rear doors and tailgate are locked with the above three conditions met.

2. **The sleep mode is deactivated immediately if any of them is out of the specified conditions (wake-up mode).**
   Also, the sleep mode is deactivated when receiving the UNLOCK signal from the remote control key.

3. **The sleep mode in Step 1 is deactivated on following conditions:**
   - Operation of room lamp, key hole illumination, headlamp, siren, tail lamp or power window
   - Unlock signal from REKES key (deactivated for 30 seconds)

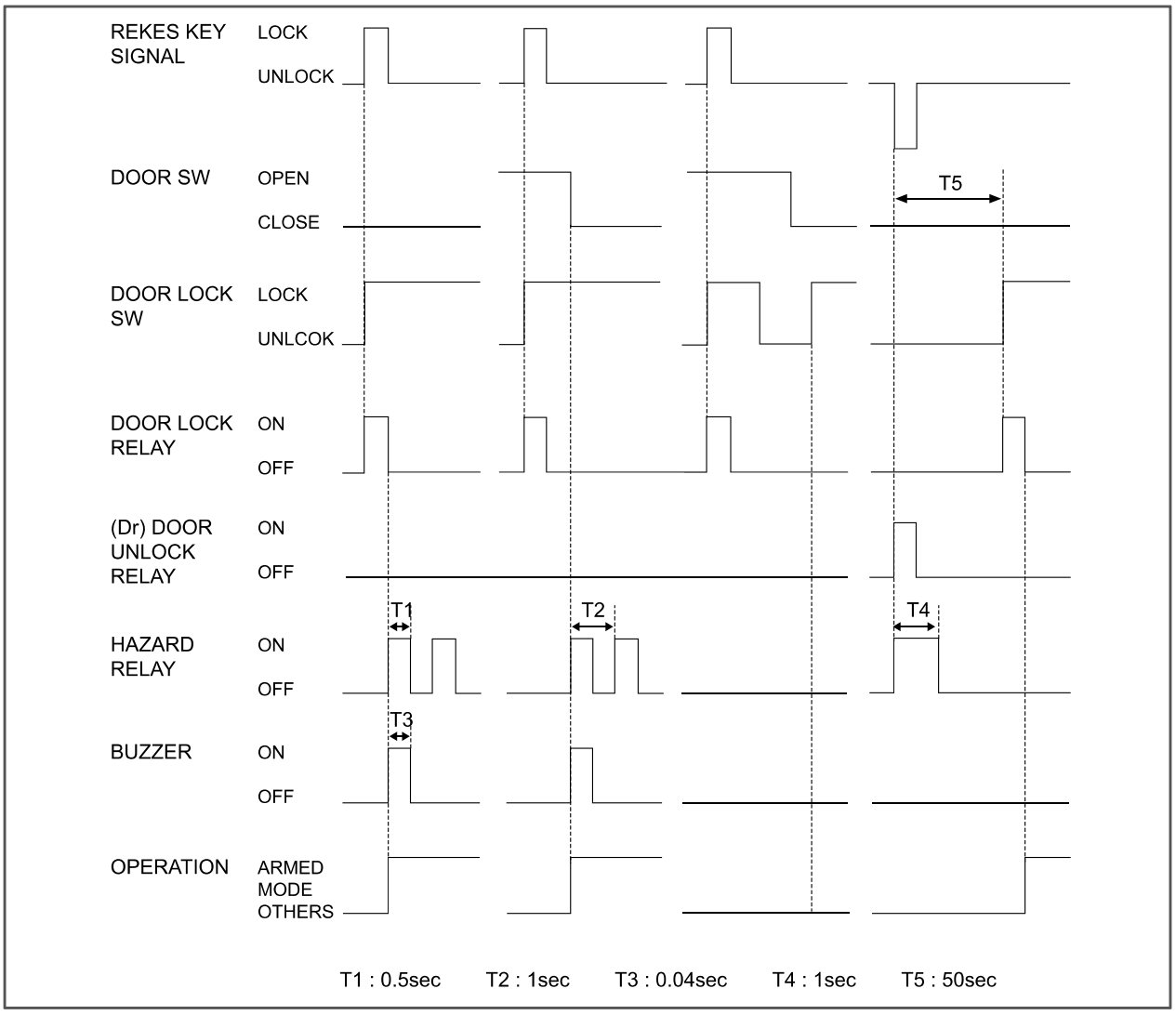
4. **The sleep mode is deactivated when a door is opened.**

Modification basis	
Application basis	
Affected VIN	

(8) Theft Deterrent

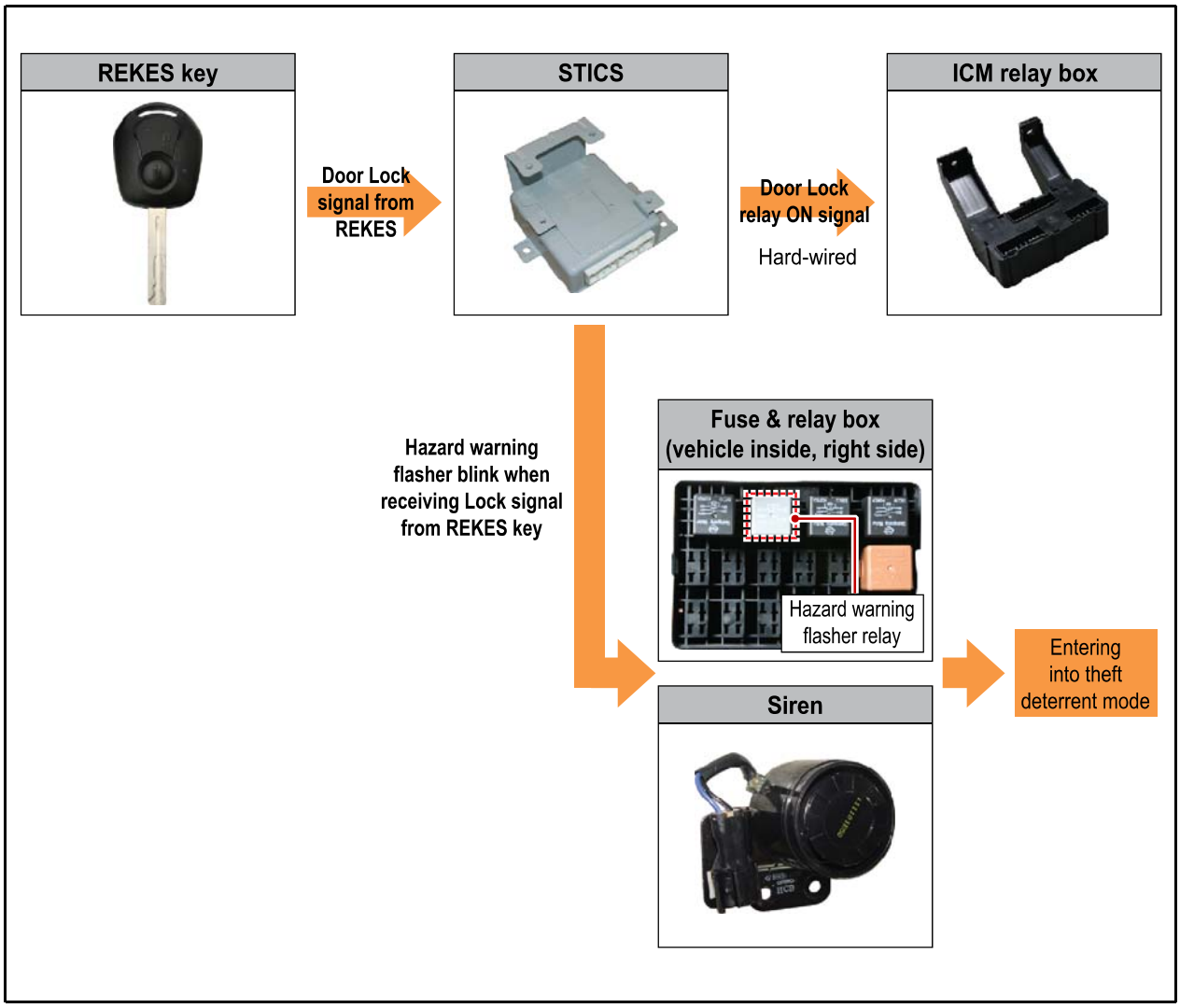
▶ Arming Conditions of Theft Deterrent Mode

1. When receiving the door lock signal with the key removed, all doors are locked and the theft deterrent mode is activated. At this moment, the turn signal lamps blink twice.
2. When pressing the lock switch on remote control key again in the theft deterrent mode, the turn signal lamps blink twice and the horn sounds once.
3. When receiving the door lock signal with any door open, the doors are locked but the theft deterrent mode is not activated. This is called "Ready" mode. In "Ready" mode, the theft deterrent mode is cancelled when the ignition key is inserted into key cylinder or the door lock button is placed to unlock position. However, when closing the opened door in 'Ready" mode, the theft deterrent mode is activated with two blinks of turn signal lamps and one buzzer signal.
   If any door is not opened within 30 seconds after unlocking the doors with remote control key in theft
4. deterrent mode, all doors will be automatically locked again (re-lock operation).
   To arm the theft deterrent mode, any of conditions above should be met.
5. (Ex.: The deterrent cannot be activated when locking the doors with a mechanical key.)



System Diagram

- Ignition Key Removed, Door Closed



Modification basis	
Application basis	
Affected VIN	

▶ Disarming Conditions

1. The theft deterrent mode is disarmed when unlocking the doors with unlock button on REKES key or when moving the driver's door lock switch to unlock position from lock position. When the deterrent mode is disarmed, the hazard warning flashers blink once.
2. The doors can be unlocked by using a mechanical key in theft deterrent mode. However, the siren sounds and hazard warning flashers blink for 27 seconds.
3. To disarm the theft deterrent mode, insert the ignition key into ignition key cylinder and turn it to position.

▶ Alarm Conditions

1. When any door is open in theft deterrent mode
2. When a door switch is moved to unlock position.
3. When a door is open after completion of siren operation (for 27 seconds).

▶ Alarm (Buzzer and Hazard warning flasher Operation)

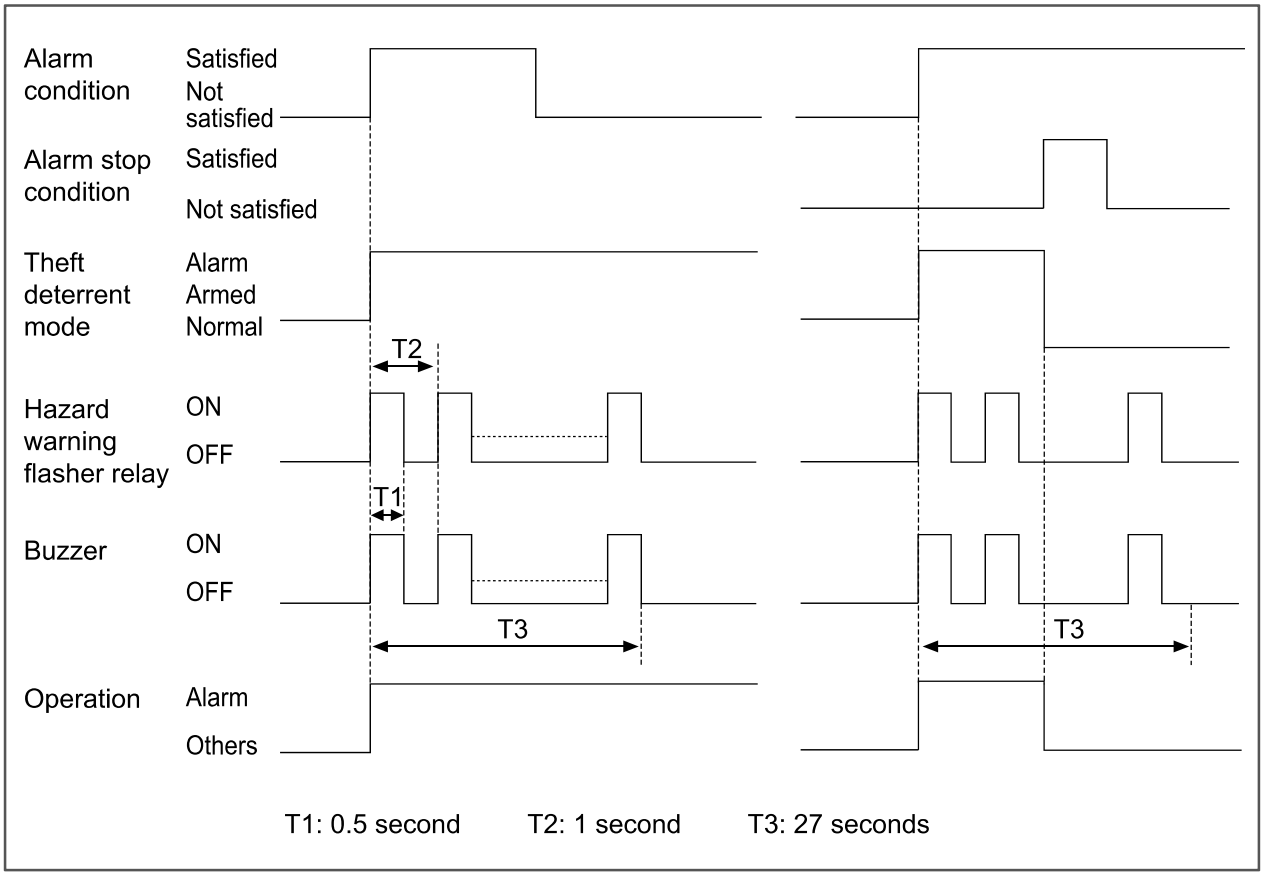
1. The siren sounds for 27 seconds with the interval of 1 second ON and 1 second OFF.

▶ Alarm Stop Conditions

1. The alarm stops when pressing any button on REKES key.
2. When turning the ignition key to ON position, the theft deterrent mode is disarmed but the siren sounds until the alarm period (27 seconds) will be elapsed.
3. When unlocking the doors with a mechanical key during alarming period, the alarm stops.

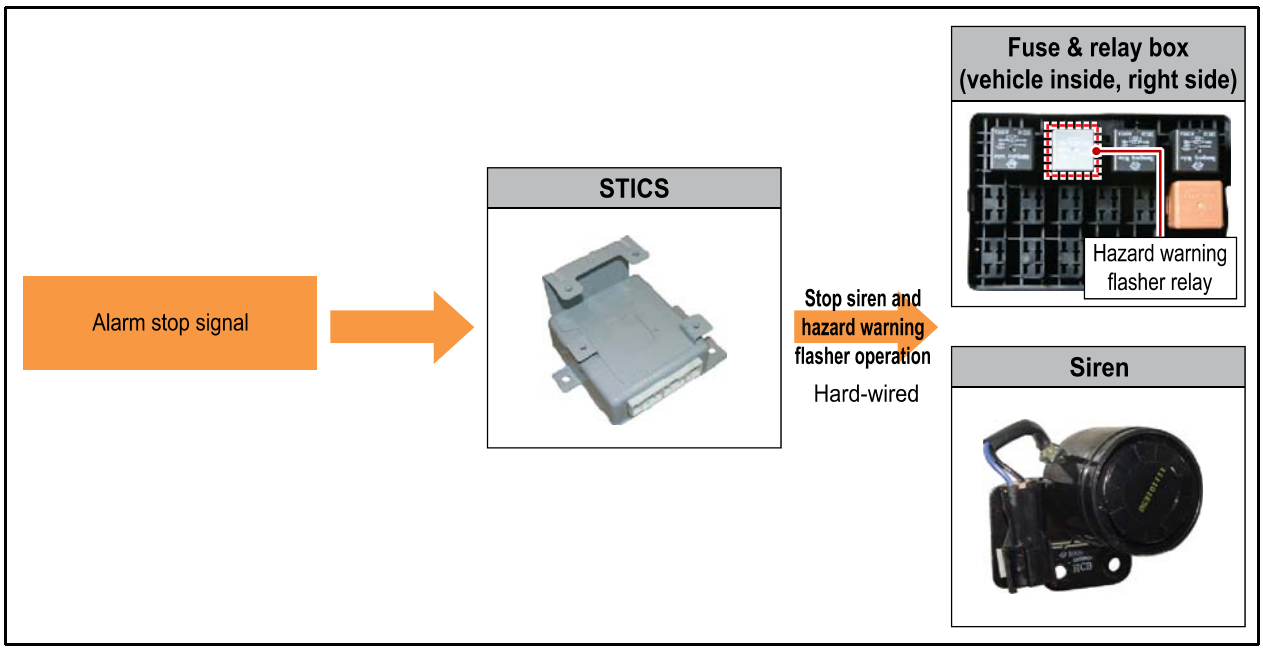
▶ After Alarm Period

1. The siren and hazard warning flashers will be turned off.



System Diagram

- Alarm Stop Conditions are Met



Modification basis	
Application basis	
Affected VIN	

▶ **Operations when removing and installing the battery**

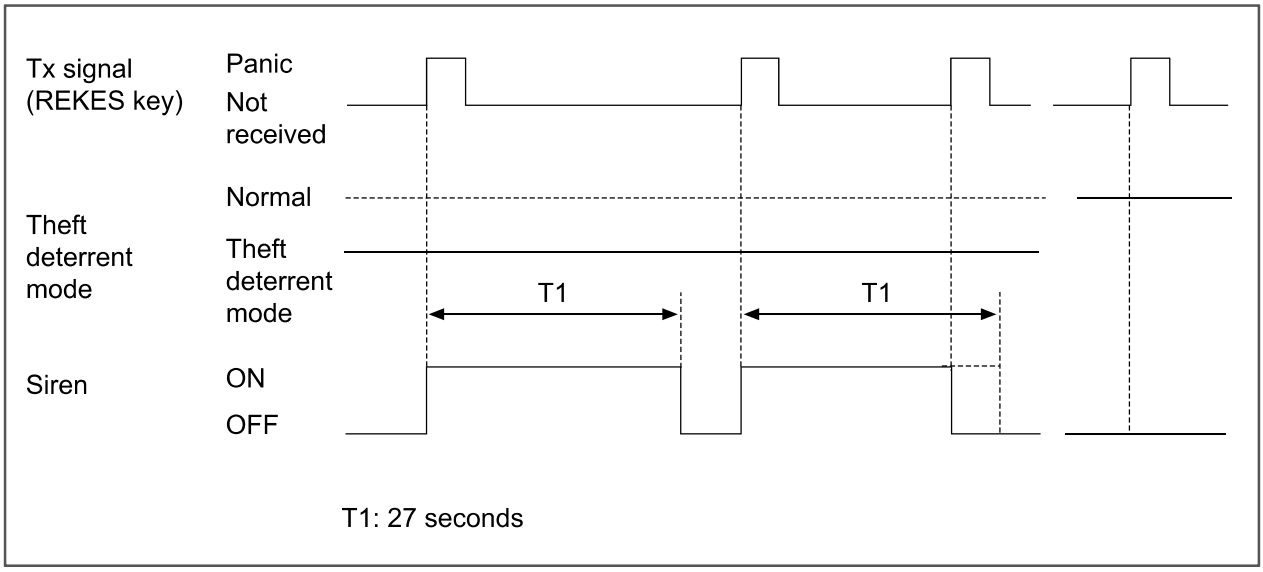
Installed / Removed	Normal	Armed	Warning	Remark
Normal	O			
Armed Ready	O			
Armed		O		
Warning			O	
Warning Completion	O	O	O	
RELOCK Ready	O			

NOTE

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.

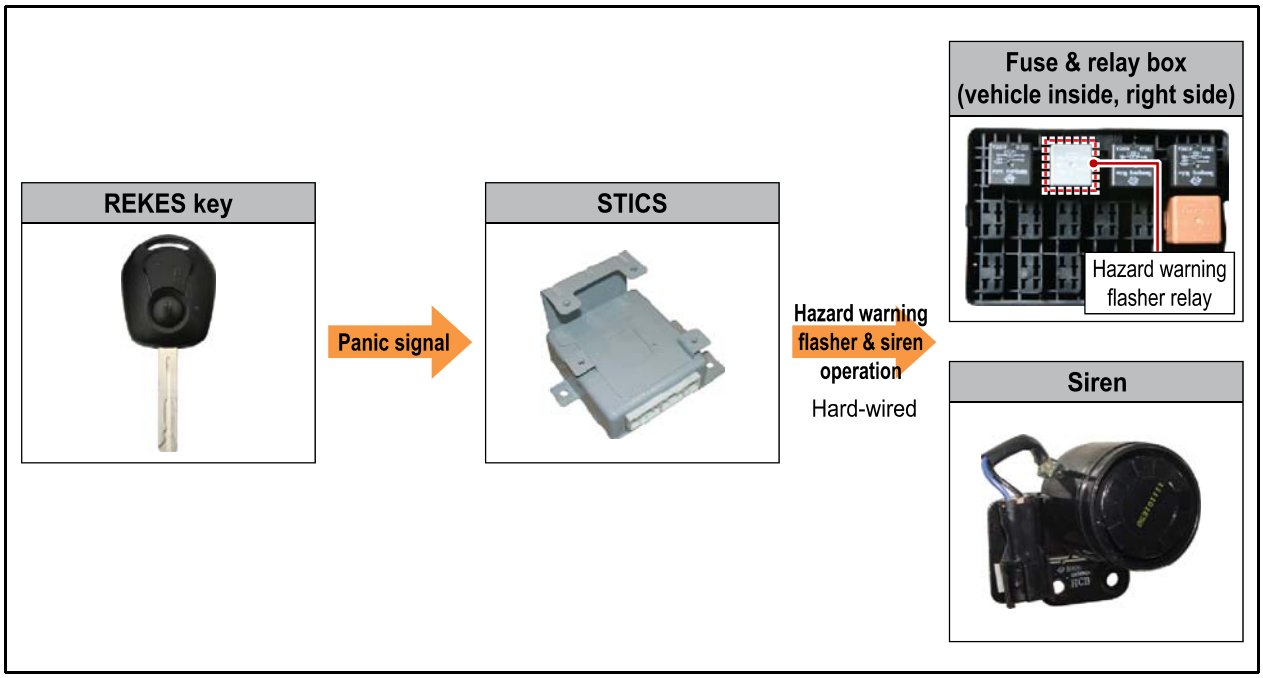
▶PANIC Alarm

1. When receiving the panic signal with Power OFF, ACC and IGN ON, the siren and turn signal lamps operate for 27 seconds (ignition key should be in ignition key cylinder).
2. When pressing any button on REKES key during the panic operation, the panic alarm stops. (Other commands are overridden)



System Diagram

- In Theft Deterrent Mode



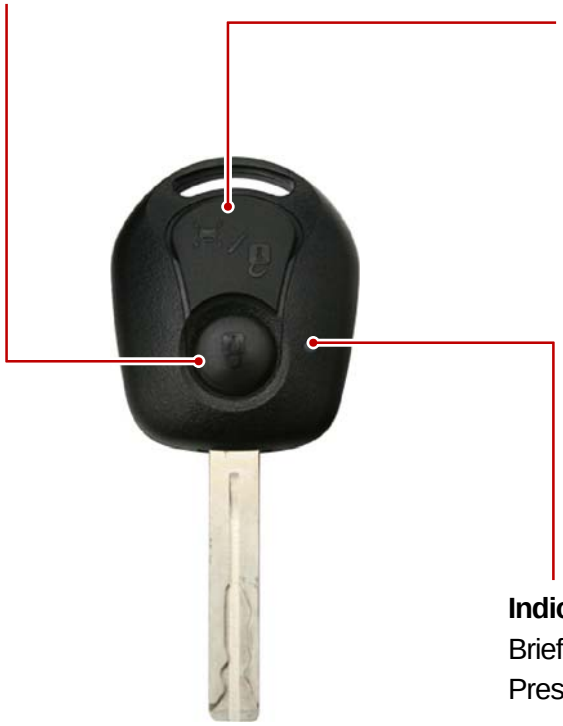
Modification basis	
Application basis	
Affected VIN	

(9) 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.

▶Door Lock

1. Lock (briefly press)
   If the Lock button is briefly pressed (0.1~0.5 sec), all doors and the tailgate are locked and the theft deterrent mode is activated.



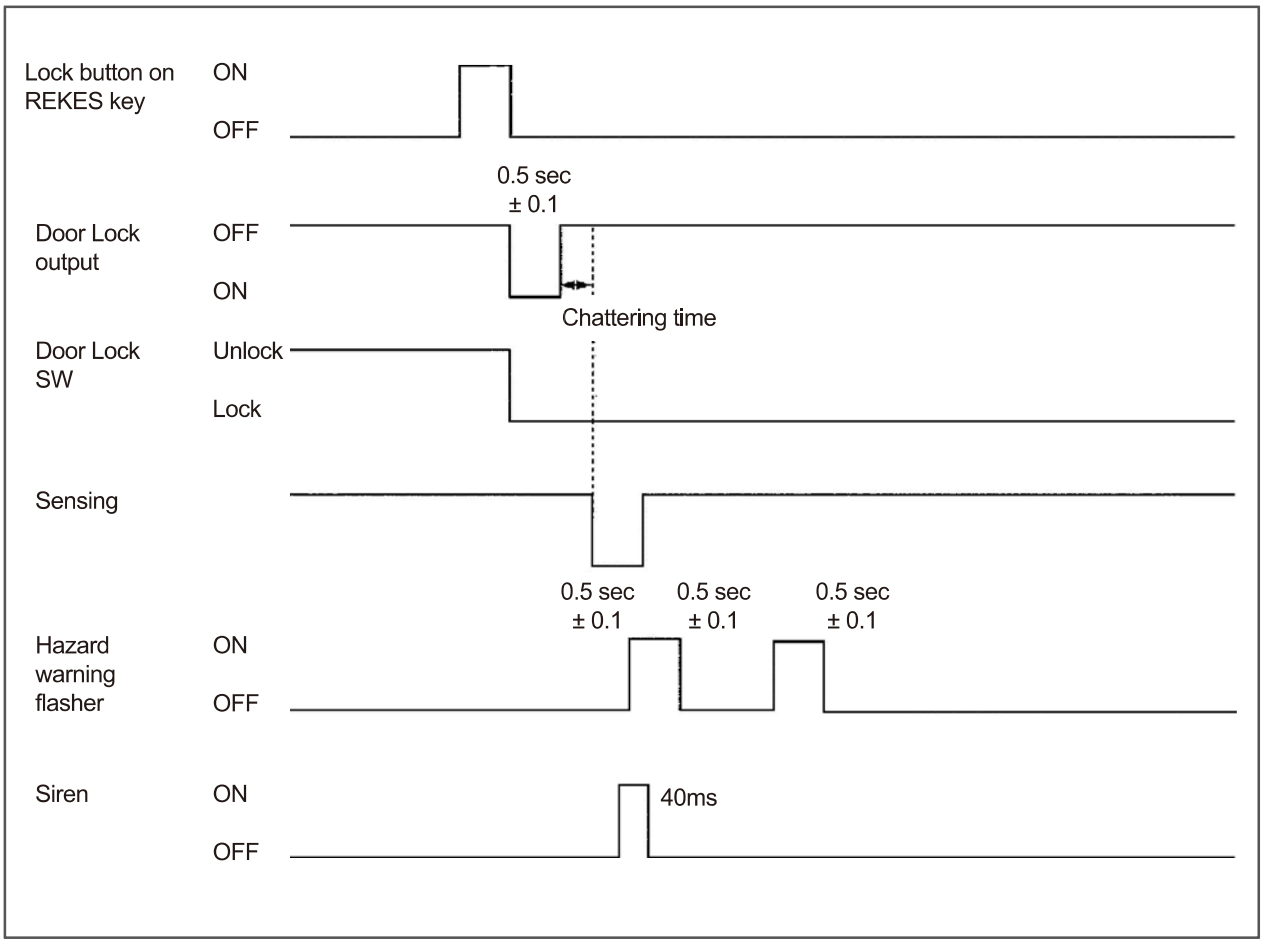
▶Door Unlock/ Panic Button

1. Unlock (briefly press)
   - If the Unlock button is briefly presses (below 0.5 sec), all doors and the tailgate are unlocked and the theft deterrent mode is deactivated.
   - The front room lamp comes on for 30 seconds when unlocking doors with REKES key.
2. Panic Function (press and hold)
   - When pressing the Panic button for more than 2 seconds with the ignition key inserted in ignition key cylinder, the siren sounds for 27 seconds

Indicator
Briefly press: Blinks once
Press and hold: Blinks twice

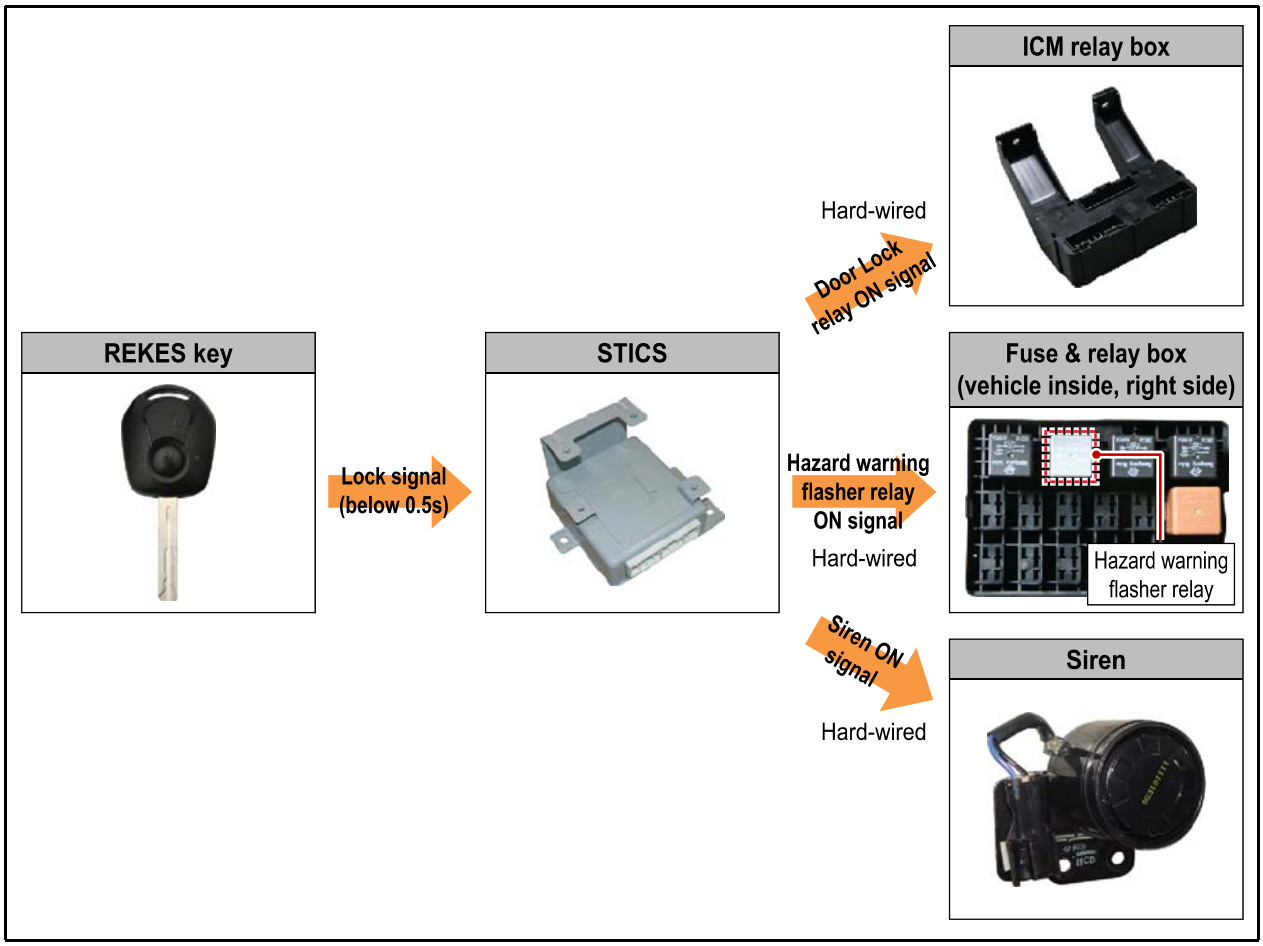
▶ Remote Door Lock

1. All doors are locked when briefly pressing the door LOCK switch on remote control key (less than 0.5 seconds).
2. The theft deterrent mode is activated when locking the doors with Lock button on REKES key. (Hazard warning flashers blink twice)



Modification basis	
Application basis	
Affected VIN	

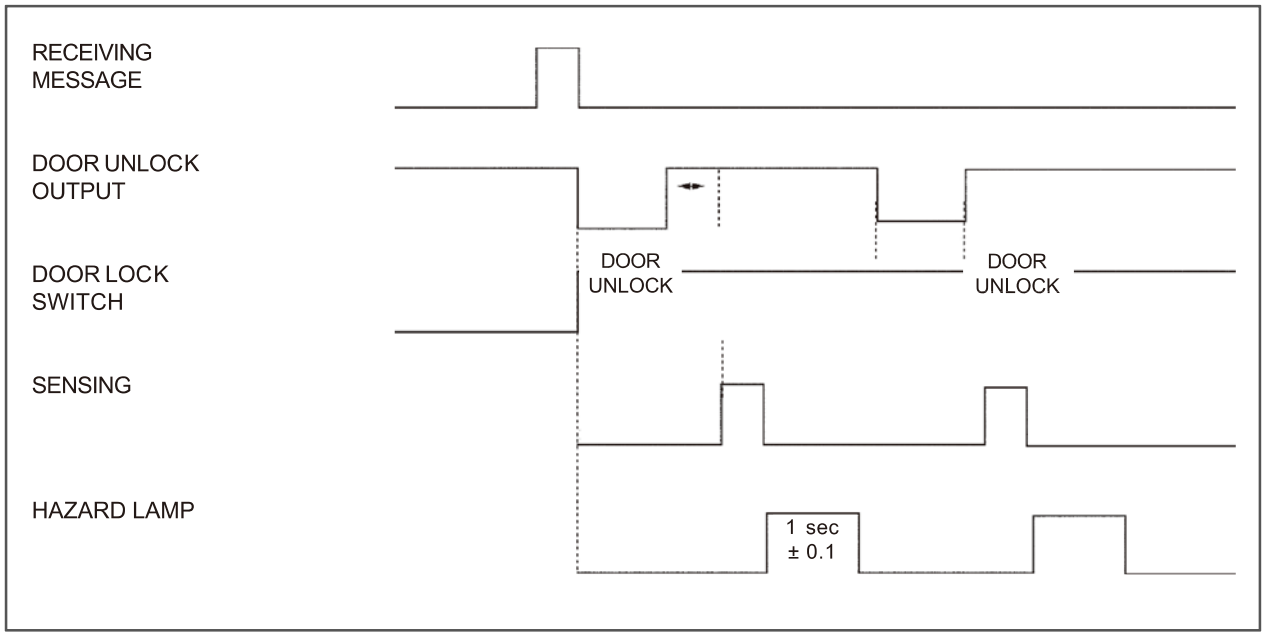
System Diagram



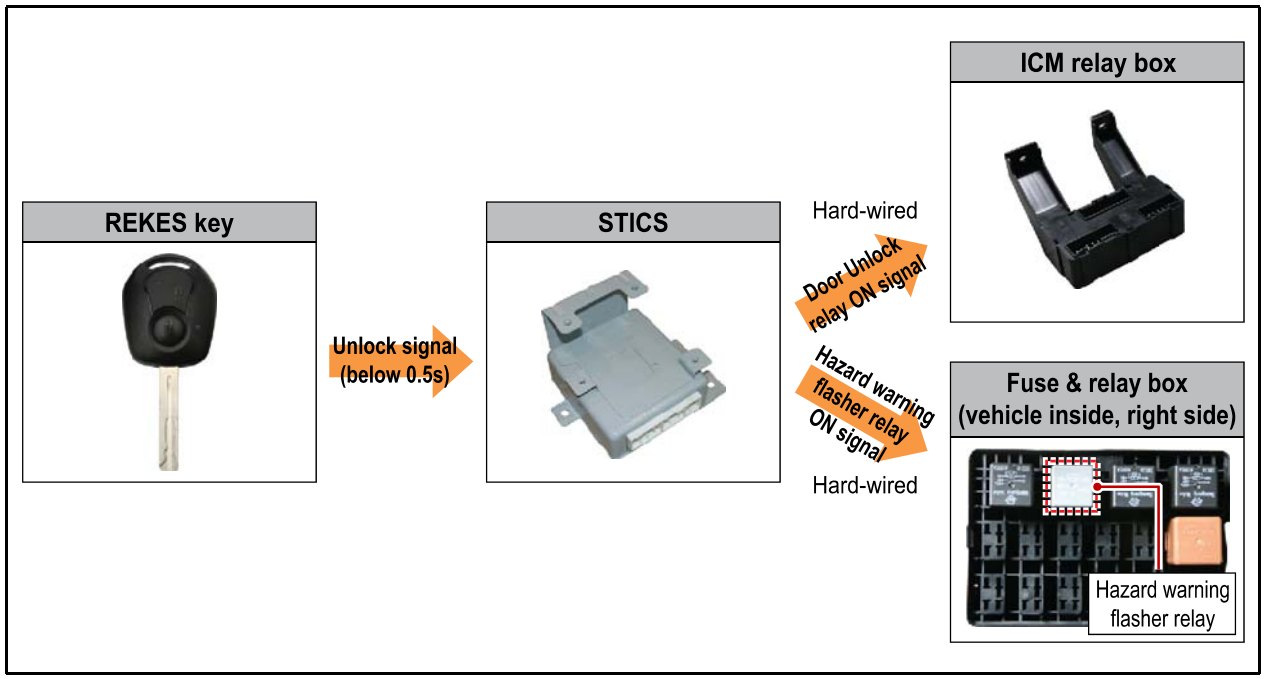
Modification basis	
Application basis	
Affected VIN	

▶ Door Unlock

1. The door unlock operates when pressing the door unlock switch on the remote control key for less 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.



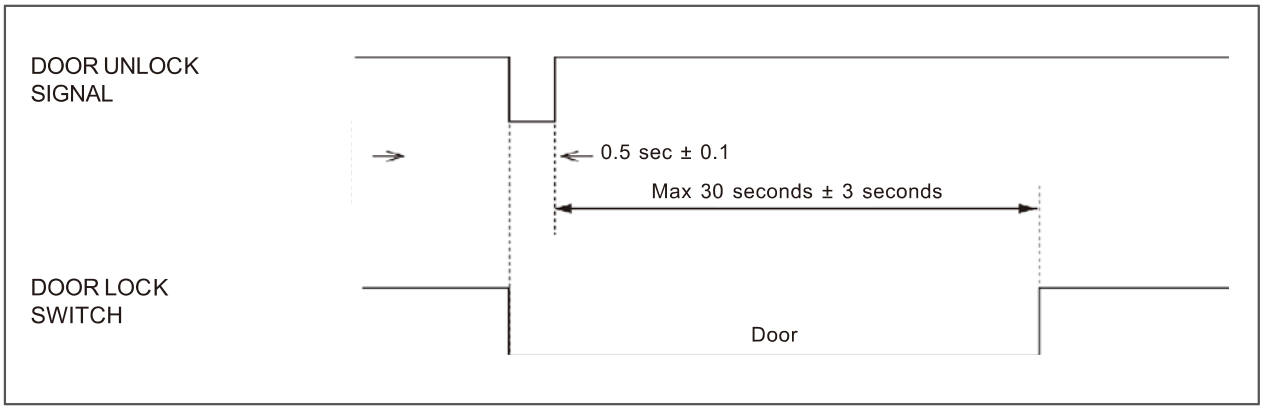
System Diagram



Modification basis	
Application basis	
Affected VIN	

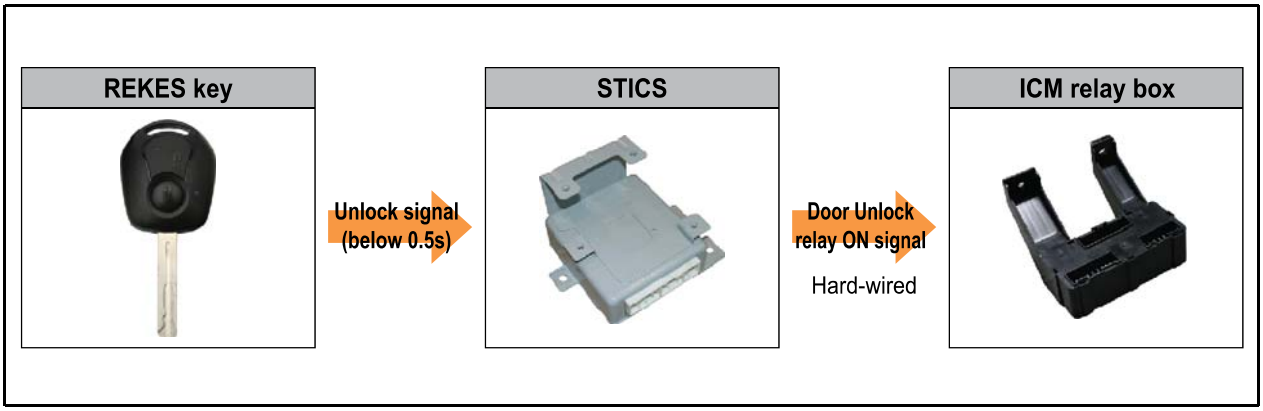
▶ Auto Door Lock in 30 Seconds after Pressing Door Unlock Button

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.

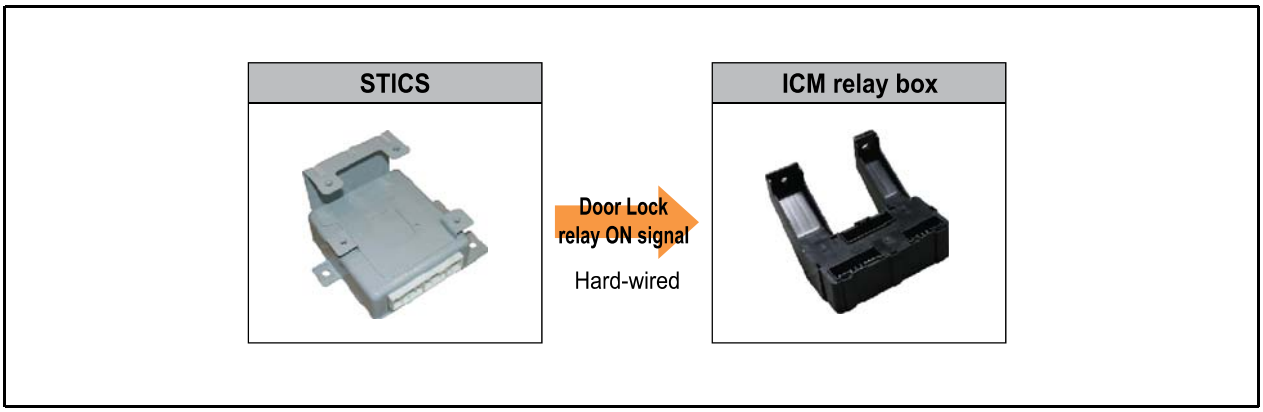


System Diagram

- In Theft Deterrent Mode

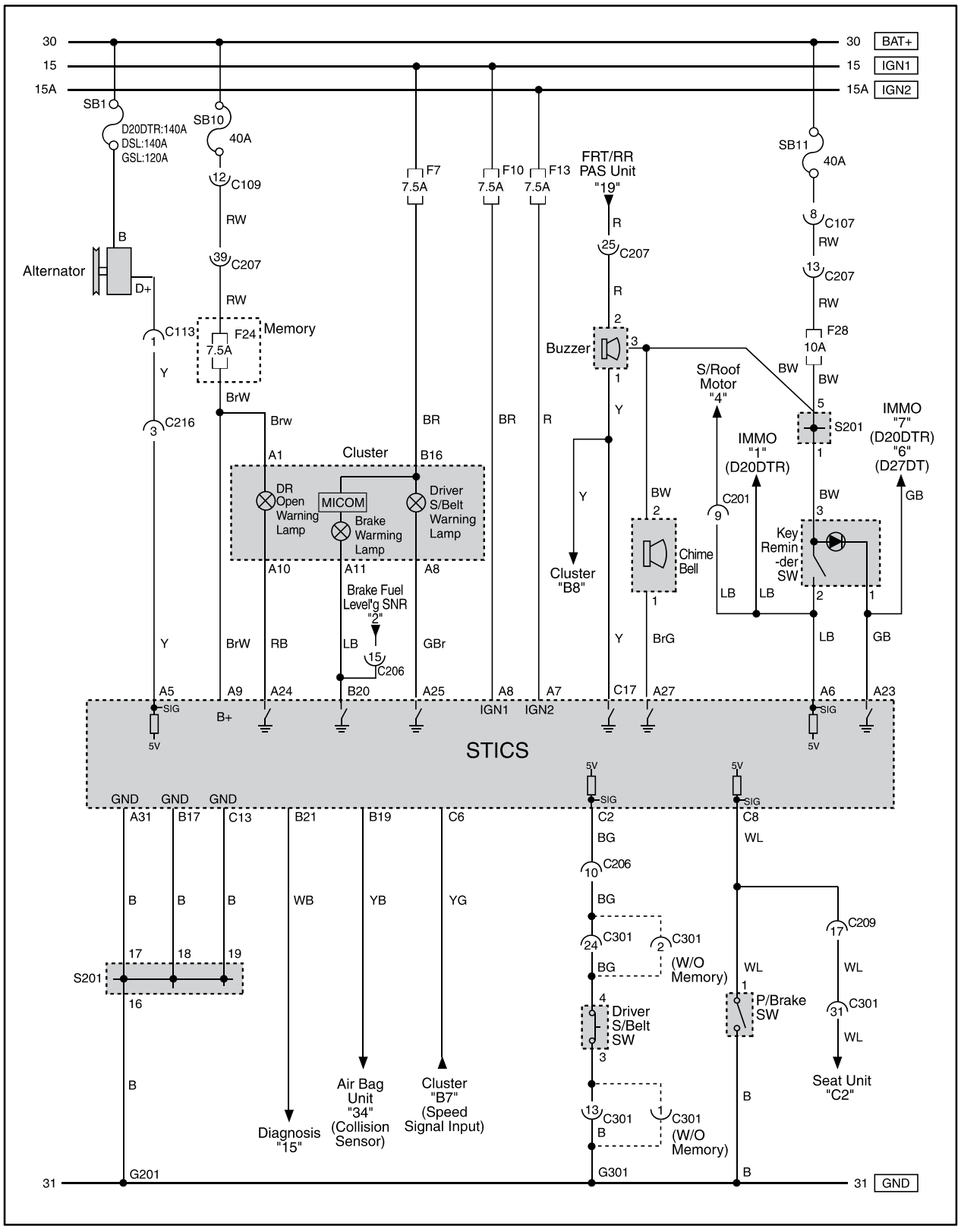


- Any Door is Not Open in 30 Seconds after Unlocking Doors



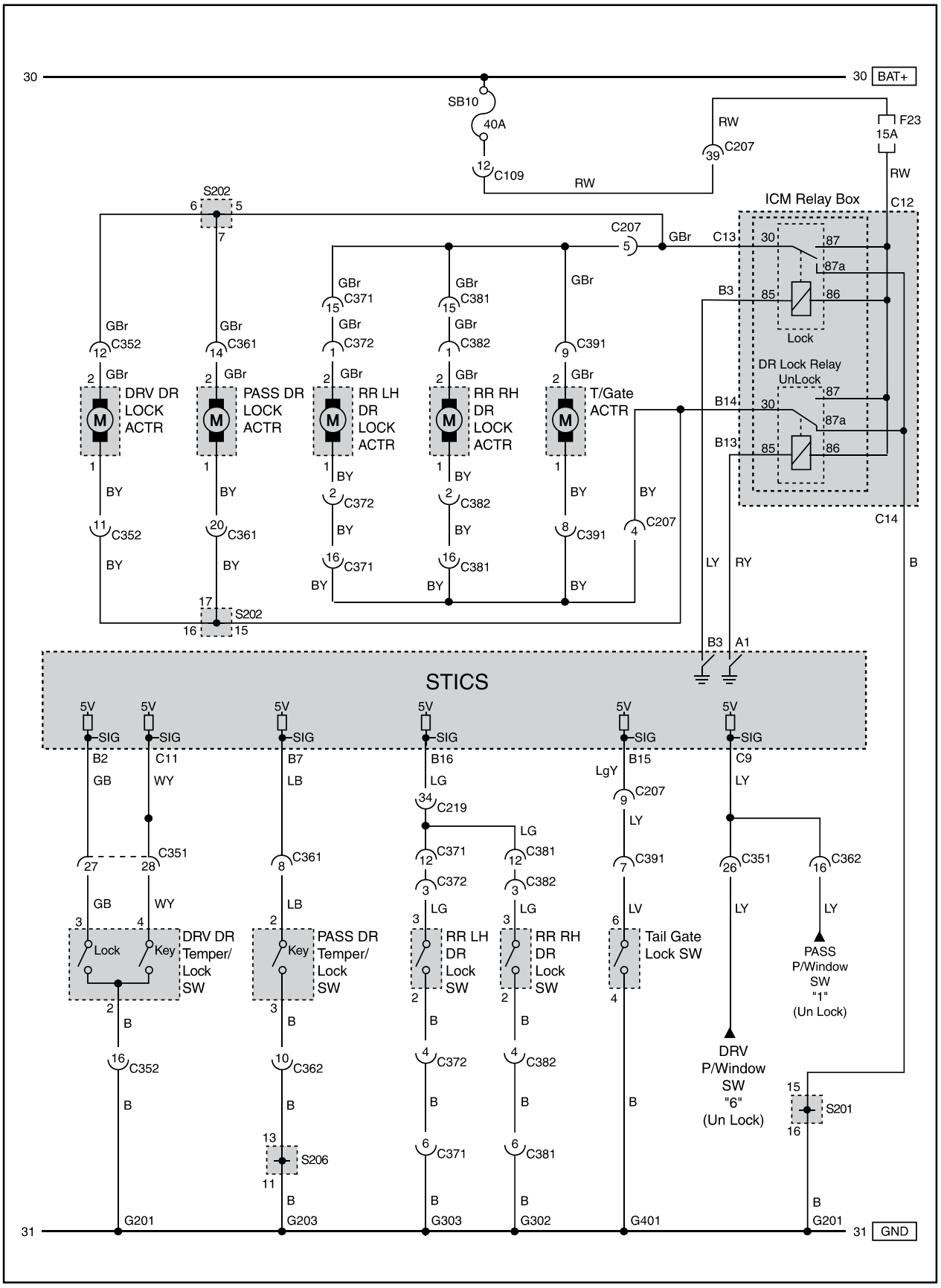
4. CIRCUIT DIAGRAM

▶ Power/Ground, Diagnostic, Chime, Buzzer, Warning lamps (Brake, Seat belt, Door ajar)



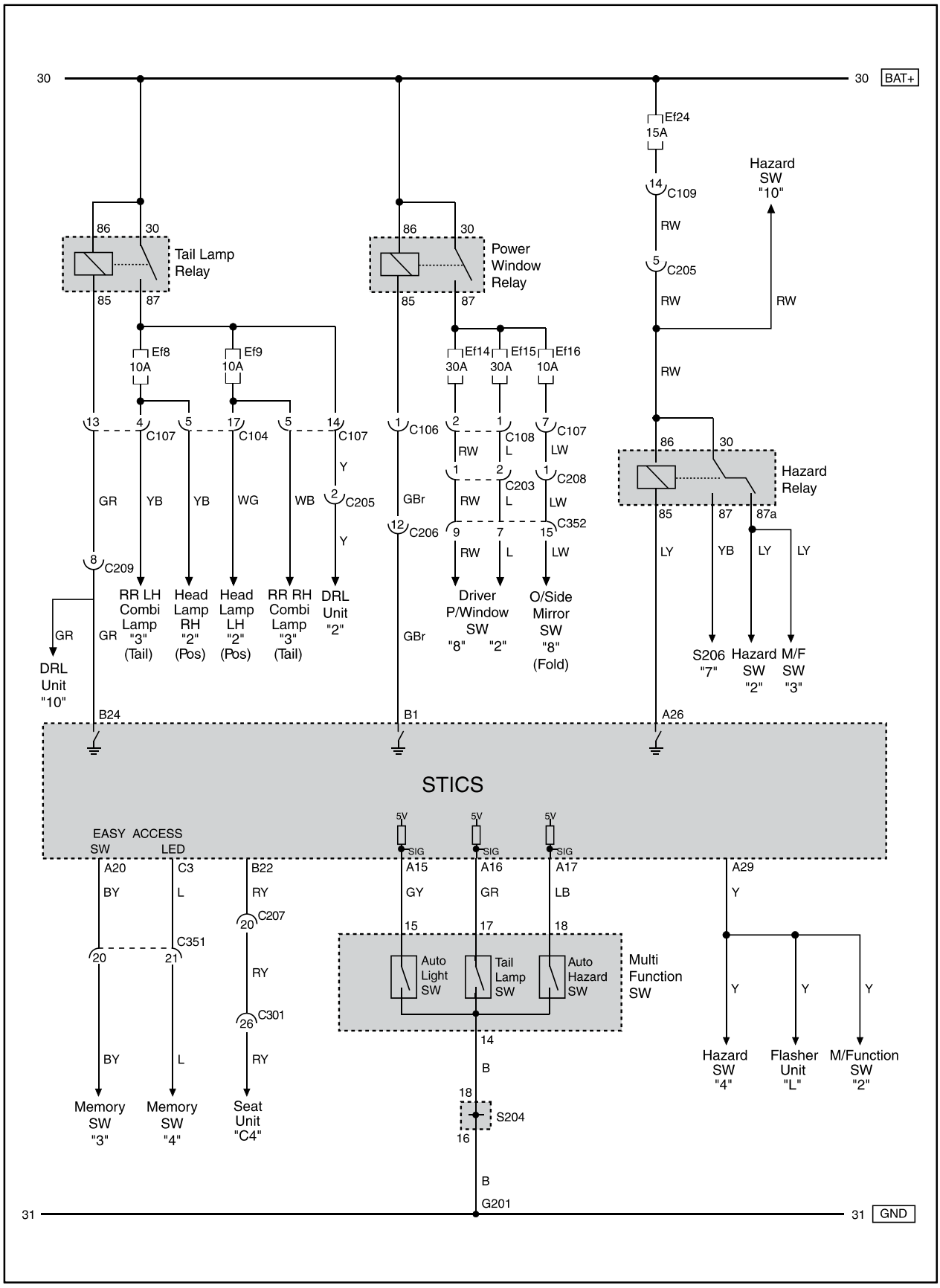
Modification basis	
Application basis	
Affected VIN	

▶ Central Door Locking



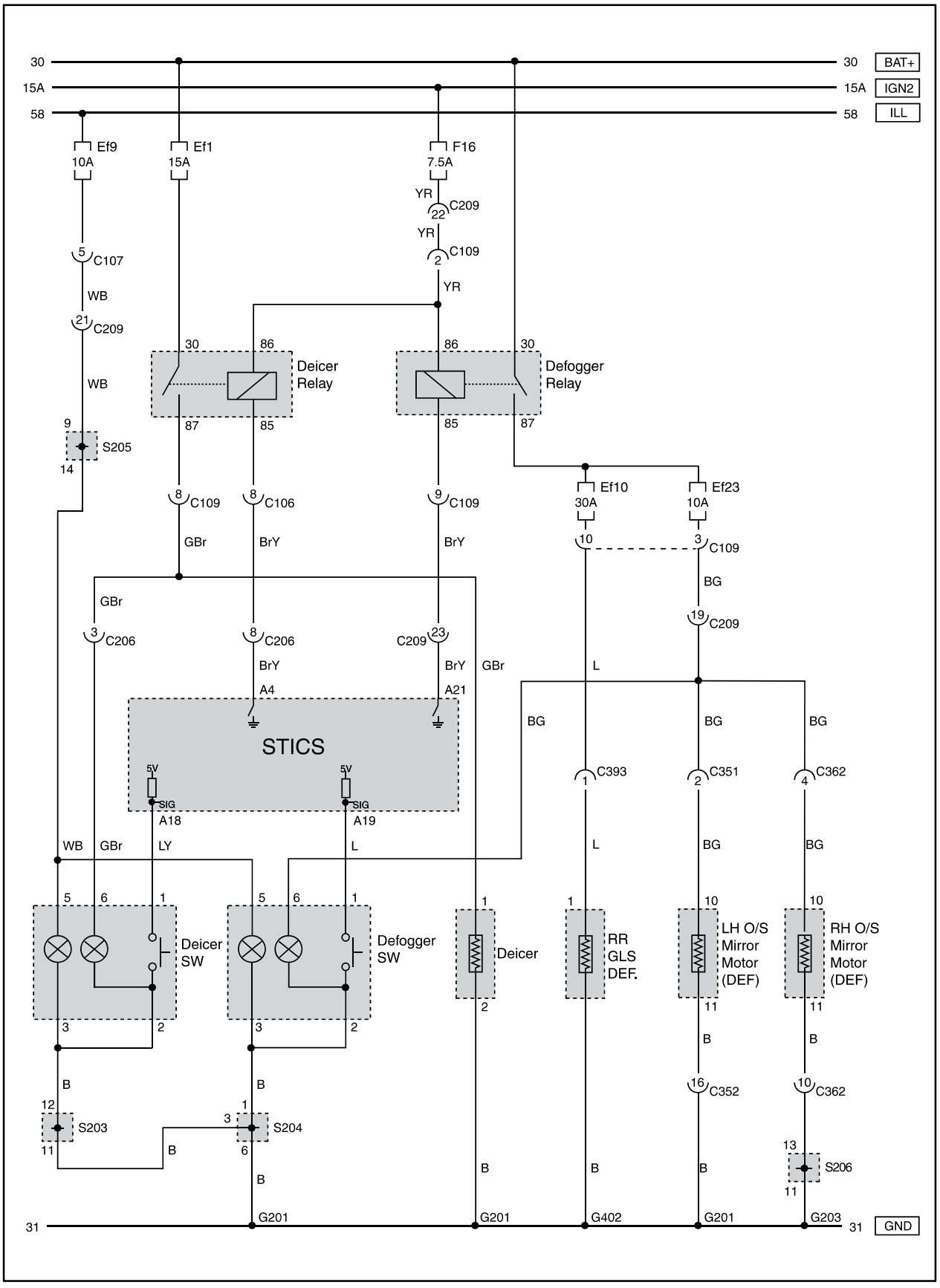
Modification basis	
Application basis	
Affected VIN	

▶ Tail Lamp, Hazard Warning Flasher, Power Window



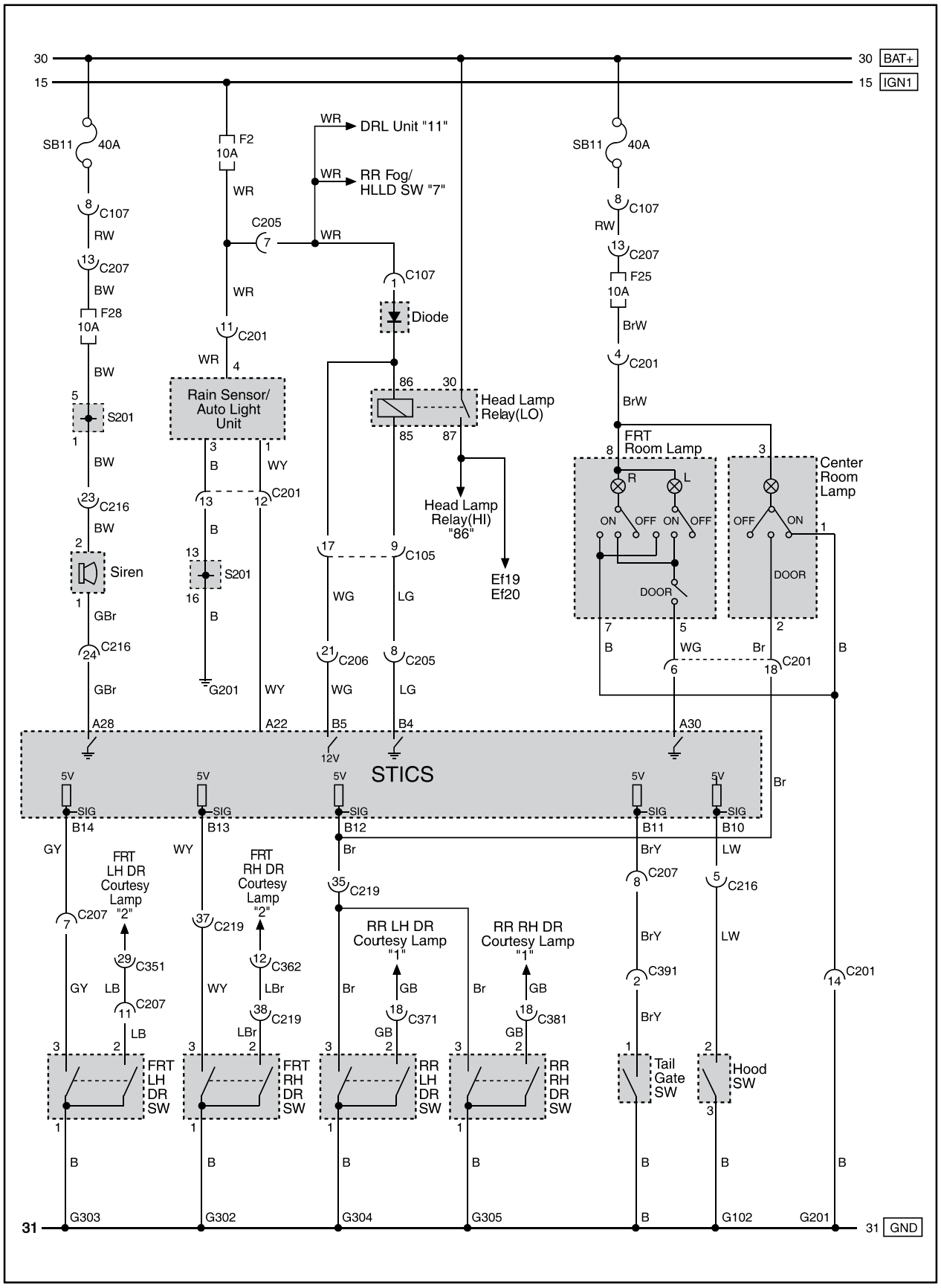
Modification basis	
Application basis	
Affected VIN	

▶ Defogger



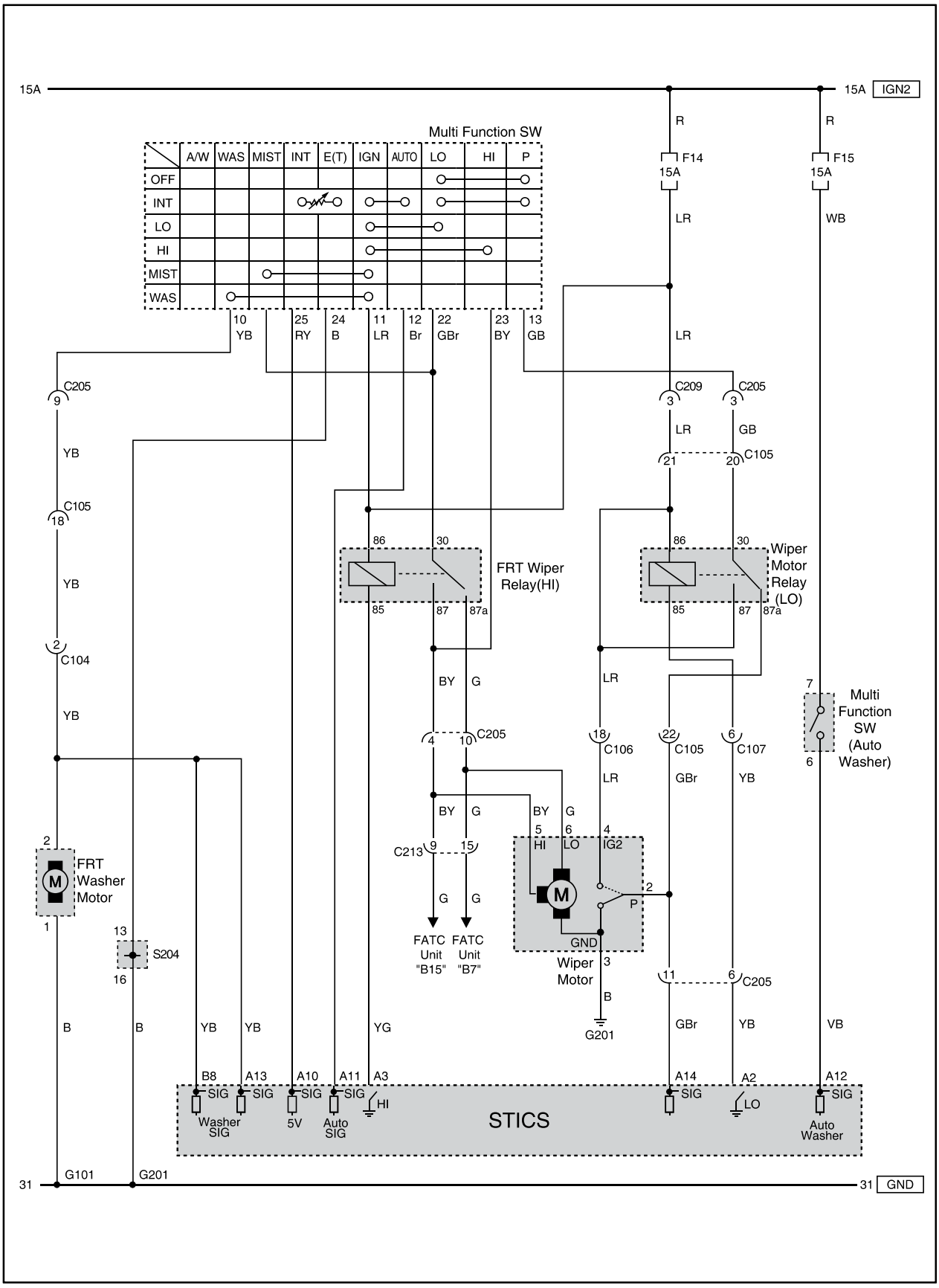
Modification basis	
Application basis	
Affected VIN	

▶ Panic, Auto Light/Rain Sensing, Room Lamp



Modification basis	
Application basis	
Affected VIN	

▶ FRT Wiper/Washer



Modification basis	
Application basis	
Affected VIN	

5. REKES CODING

1) Operating Condition

- The ignition key should be removed from the ignition key cylinder.

2) Code Registration

- The code can be registered only by the scan tool.

3) Transmitter Coding

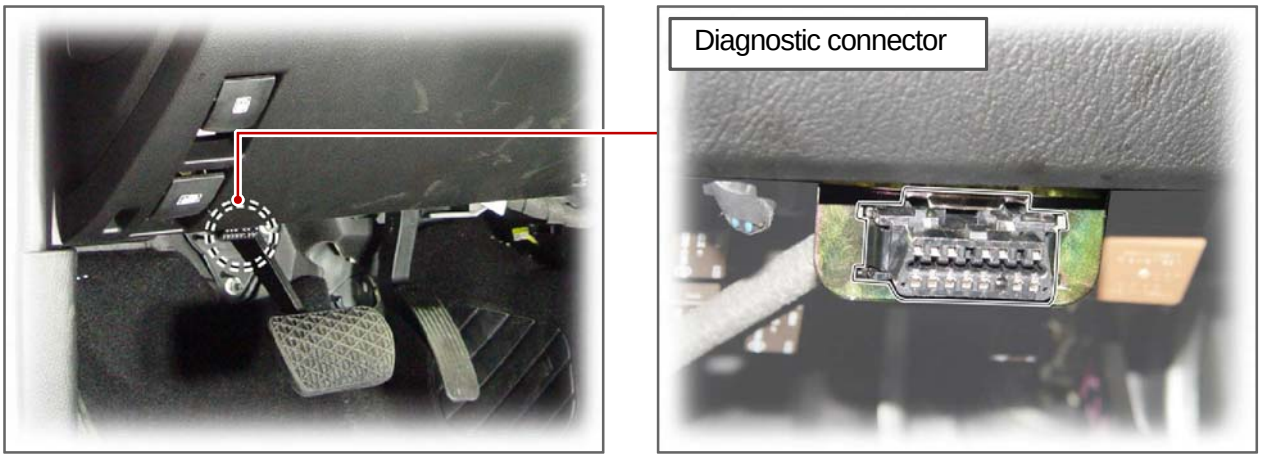
1. Up to five transmitter can be registered.
2. The received code cannot be output during registration.
3. The REKES key should be coded by the scan tool.



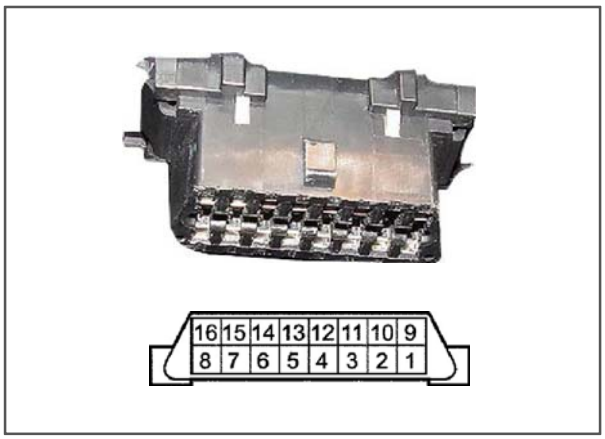
Modification basis	
Application basis	
Affected VIN	

4) Diagnostic Connector

The diagnostic connector is located at bottom of instrument panel. It consists of 16 pins.
The REKES key should be coded by the scan tool.



▶ **Connector Pin**

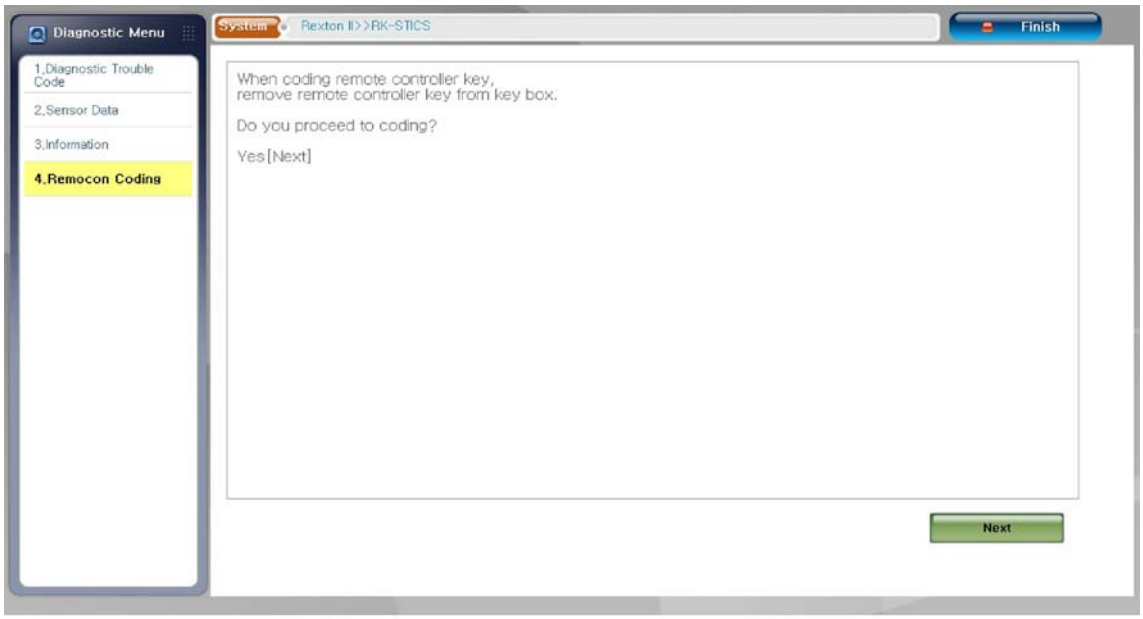


Pin No.	Function
1	CAN HI S203 "18"
2	CAN LO S203 "8"
3	-
4	Ground
5	Ground
6	CAN HI S202 "14"
7	-
8	ABS/ESP unit “2”
9	Air bag unit “9”
10	-
11	TCU "A18"(5-A/T)
12	SSPS unit “8”
13	TCCU "21"
14	CAN LO S202 "4"
15	STICS "B21"
16	B+

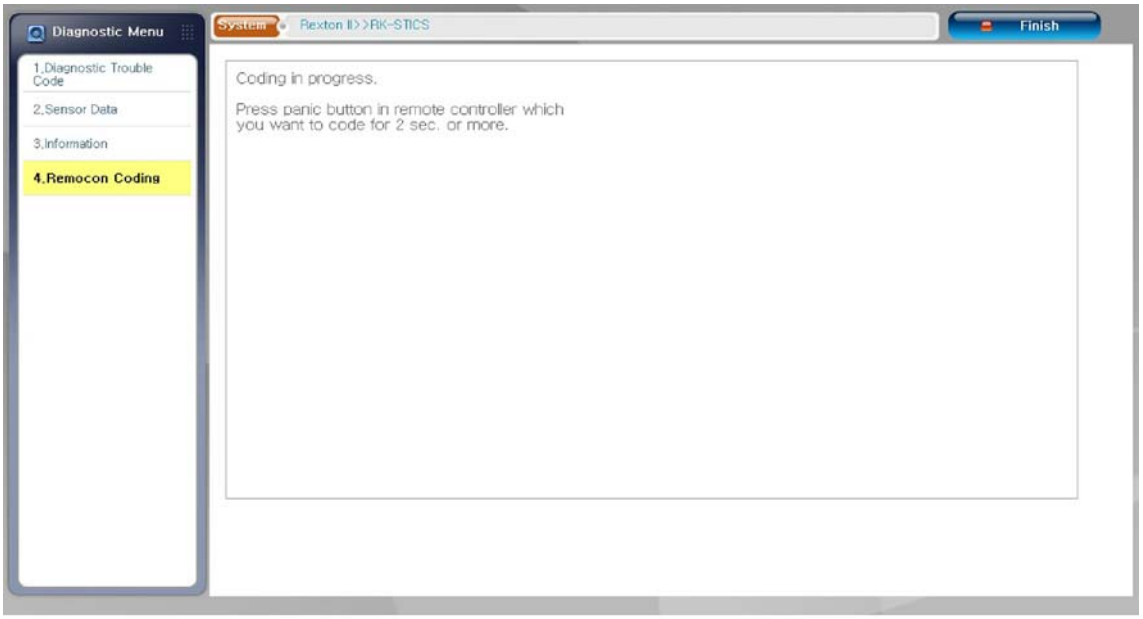
5) Coding Procedure

The REKES key should be coded (up to 5 keys) by the scan tool when replacing it with new one.

1. Connect the scan tool to the diagnostic connector. Select “RK-STICS” on the screen, and “Remote Control Coding” in Diagnosis screen.

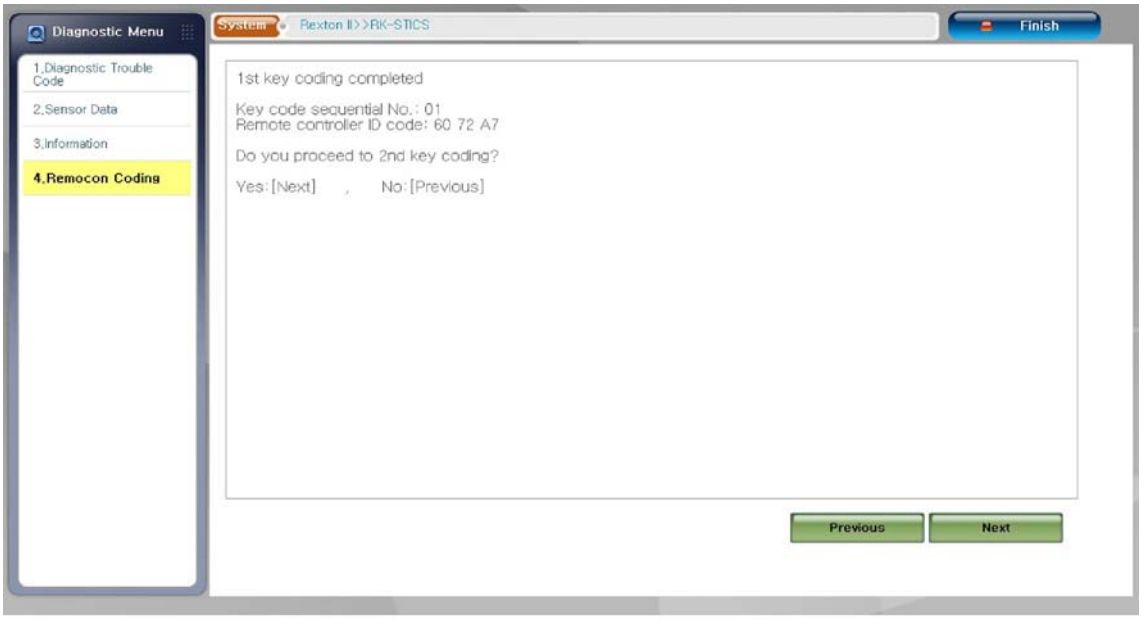


2. Remove the ignition key from the key cylinder and press “NEXT’. Press UNLOCK (PANIC) button on the REKES key for more than 2 seconds.

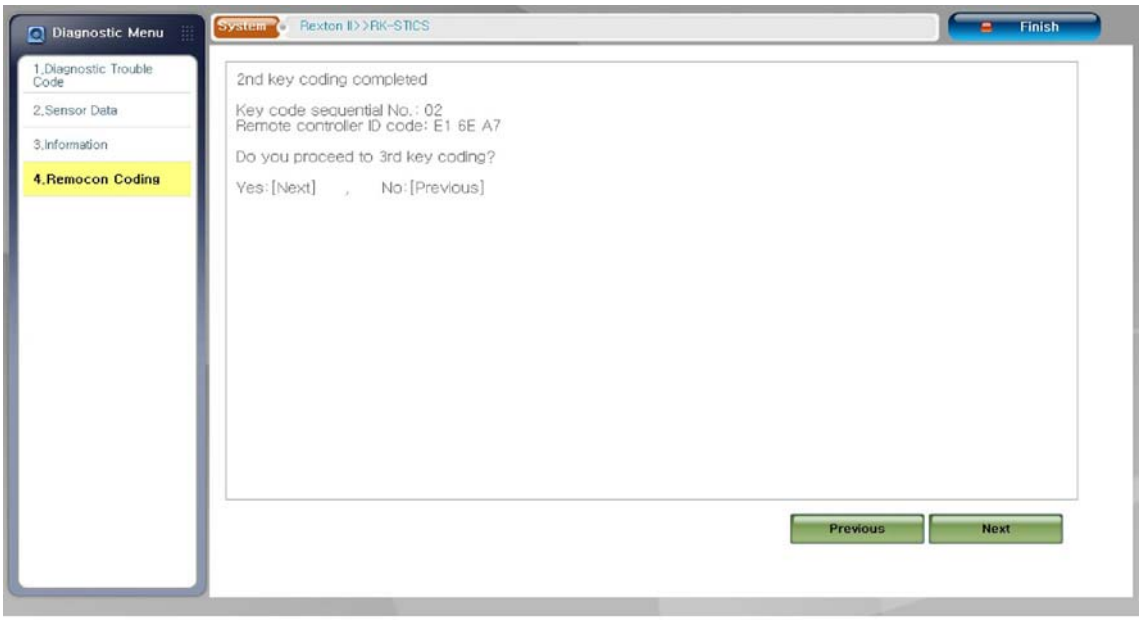


Modification basis	
Application basis	
Affected VIN	

3.The first key coding screen below is displayed with a beep. Press "NEXT" to perform the second key coding.



4.The screen below will be displayed after completion of second key coding. Press "PREVIOUS" to complete the key coding.



5.Exit from the diagnosis program and disconnect the scan tool from the diagnostic connector. Make sure that the buttons on the REKES key operate properly.

CAUTION

When coding new REKES key:
When one of REKES keys is lost and a new REKES is purchased, all REKES keys should be coded.

IMMOBILIZER

7010-09

GENERAL INFORMATION

1. SPECIFICATIONS (D20DTR)

Unit	Description	Specification
Immobilizer control unit	Coil inductance	420uH ± 20
	Coil turns	95T
	Coil wire	Rich wire (TBD)
	Modulation	FSK
	Input/Output frequency	134.2kHz ± 4KHz/PWM
	Antenna cable	Twisted rich wire (TBD)
Transponder	Frequency	134.2kHz ± 4KHz
	Operating temperature	-40℃ ~ +85℃

2. MAJOR CHANGES

Blanking Key	
Old	**New**
	
- Changed the material of key fob. - Changed the key plate design.	

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

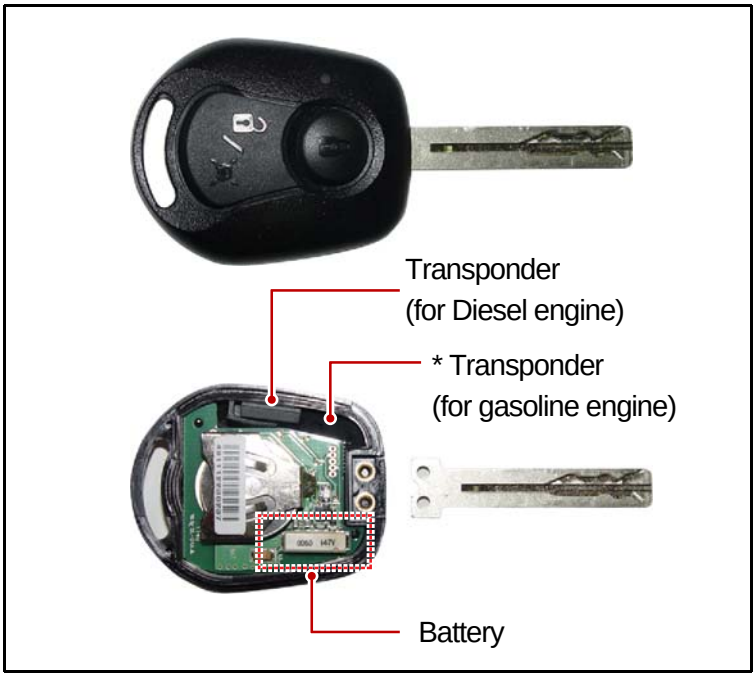
The Immobilizer System provides an additional theft deterrent to the vehicle in which it is installed and prevents it from being started by unauthorized persons. The transponder integrated in the key and the engine control unit has the same code. When the ignition key with the integrated transponder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



▶ What is the immobilizer system?(D20DT, D27DT, D27DTP, G32D)

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.

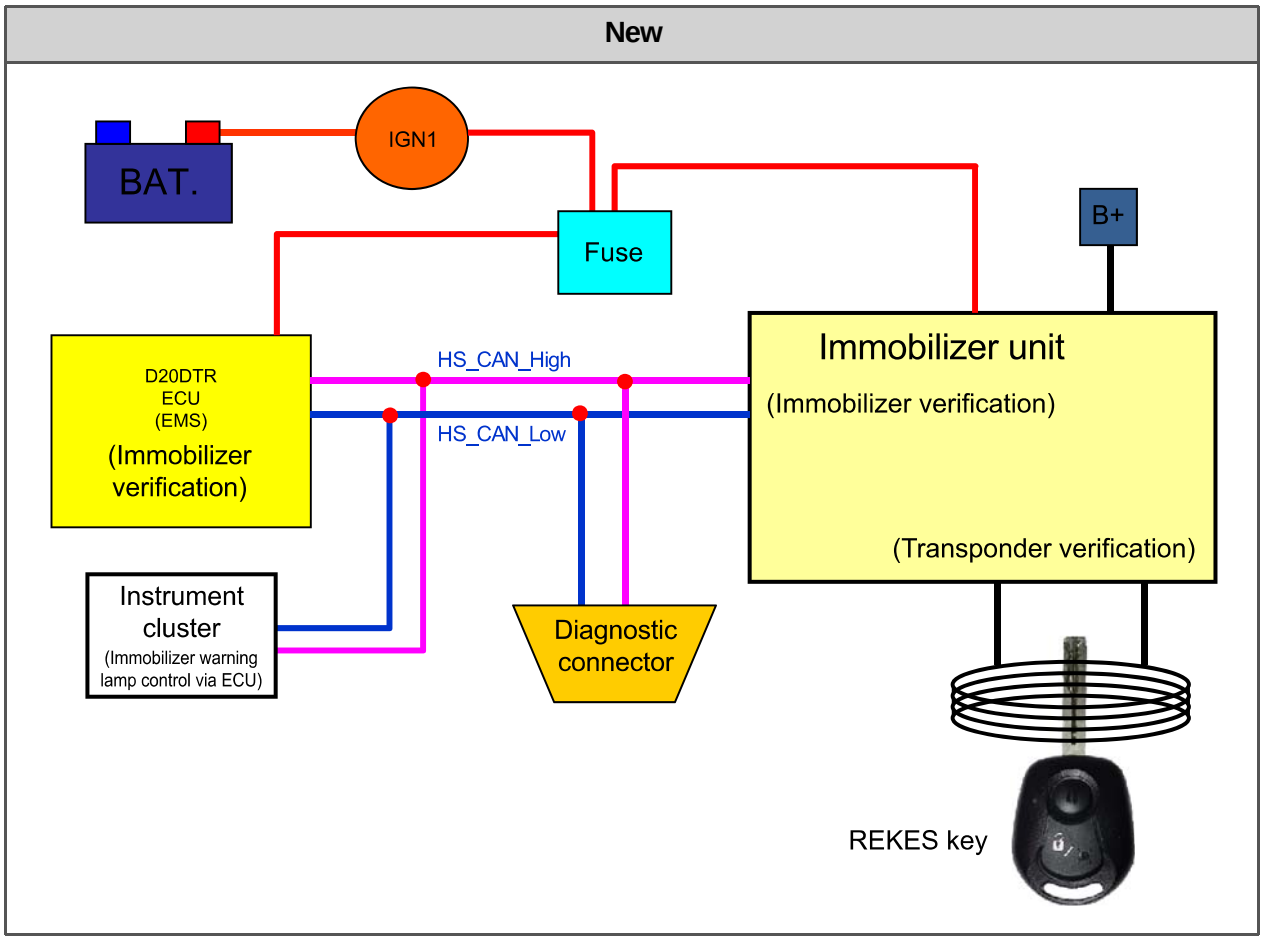




Modification basis	
Application basis	
Affected VIN	

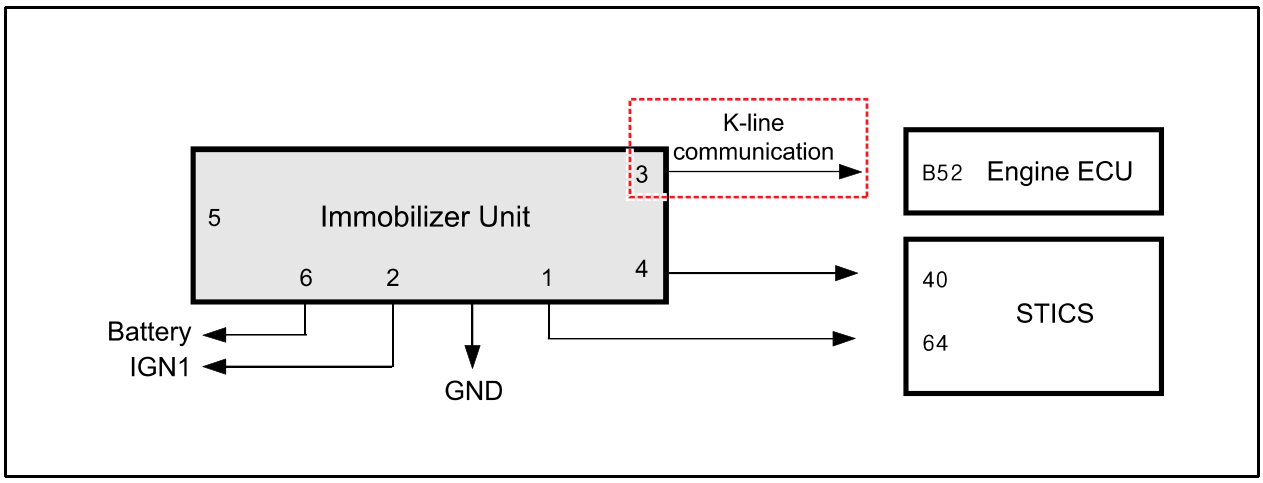
2. SYSTEM DIAGRAM

▶ **D20DTR**



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.

▶ **D20DT, D27DT, D27DTP, G32D**

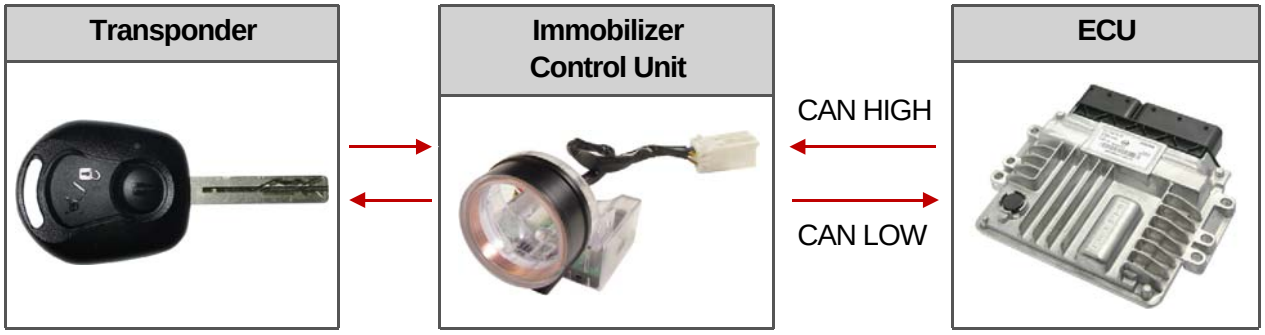


3. OPERATING PROCESS (D20DTR)

1) Operation and Warning Lamp

(1) Operating process

1. The ECU sends the challenge message to immobilizer control unit when turning on the ignition. (It requests the validation of key. If failed, sends validation signal 3 times in 2 seconds again. If the validation is failed again, stop the validation and wait for 10 seconds, and then start new validation process.)
2. The immobilizer control unit sends the crypto code to the transponder.
3. The transponder sends back the crypto signal to the immobilizer control unit as a response.
4. The immobilizer control unit converts the signal to crypto signal.
5. The immobilizer control unit compares the crypto signal with the signal from the transponder.
6. If two signals are identical, the immobilizer control unit determines the key is valid, and it sends the positive message to the ECU.
7. The ECU allows starting the engine.



In the following cases, you may be unable to start the engine 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 lighting 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	

(2) Immobilizer and Warning Lamp

Instrument cluster


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.

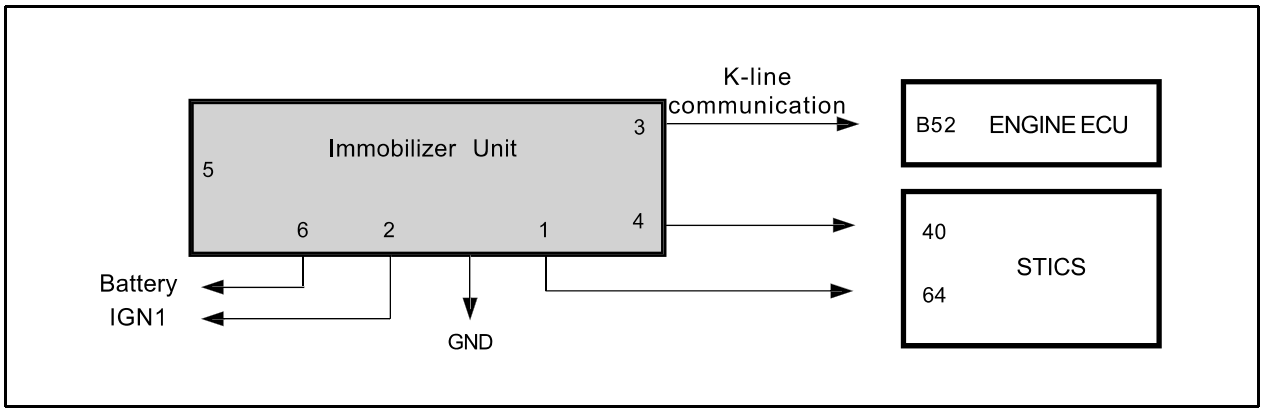
- Lamp ON: in communication
- Blinking twice for one second: immobilizer system failure
- Blinking once for two seconds: immobilizer unit is not coded

CAUTION

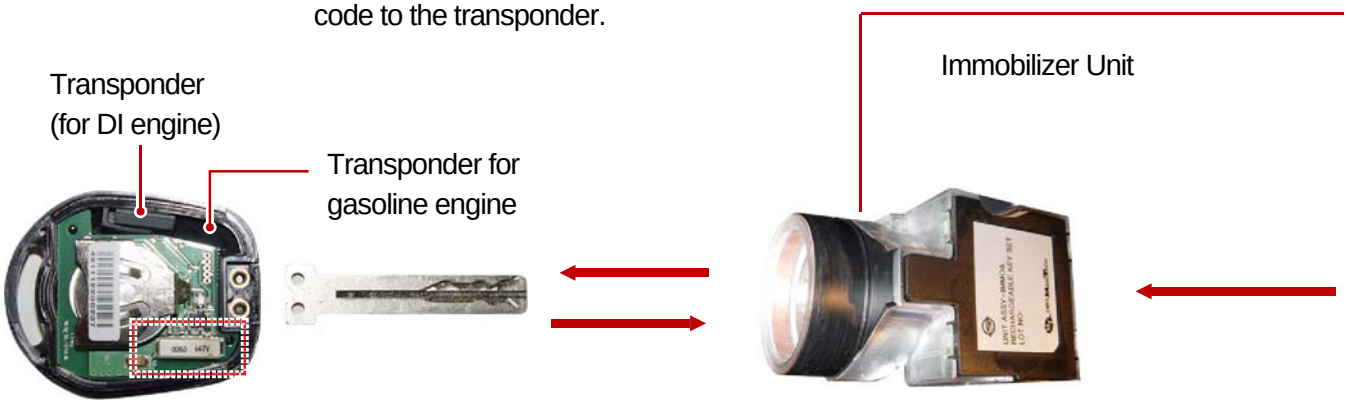
The immobilizer indicator does not come on if the communication time between immobilizer key and ECU is too short.

▶ Immobilizer Function (D20DT, D27DT, D27DTP, G32D)

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.



❷ The immobilizer unit transmits the encrypted code to the transponder.



❸ The transponder sends an encrypted signal to the unit as a response.

❹ The transmitted code is changed to an encrypted signal in the unit.

❺ The system compares the signal from transponder and the encrypted signal in immobilizer unit.

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.



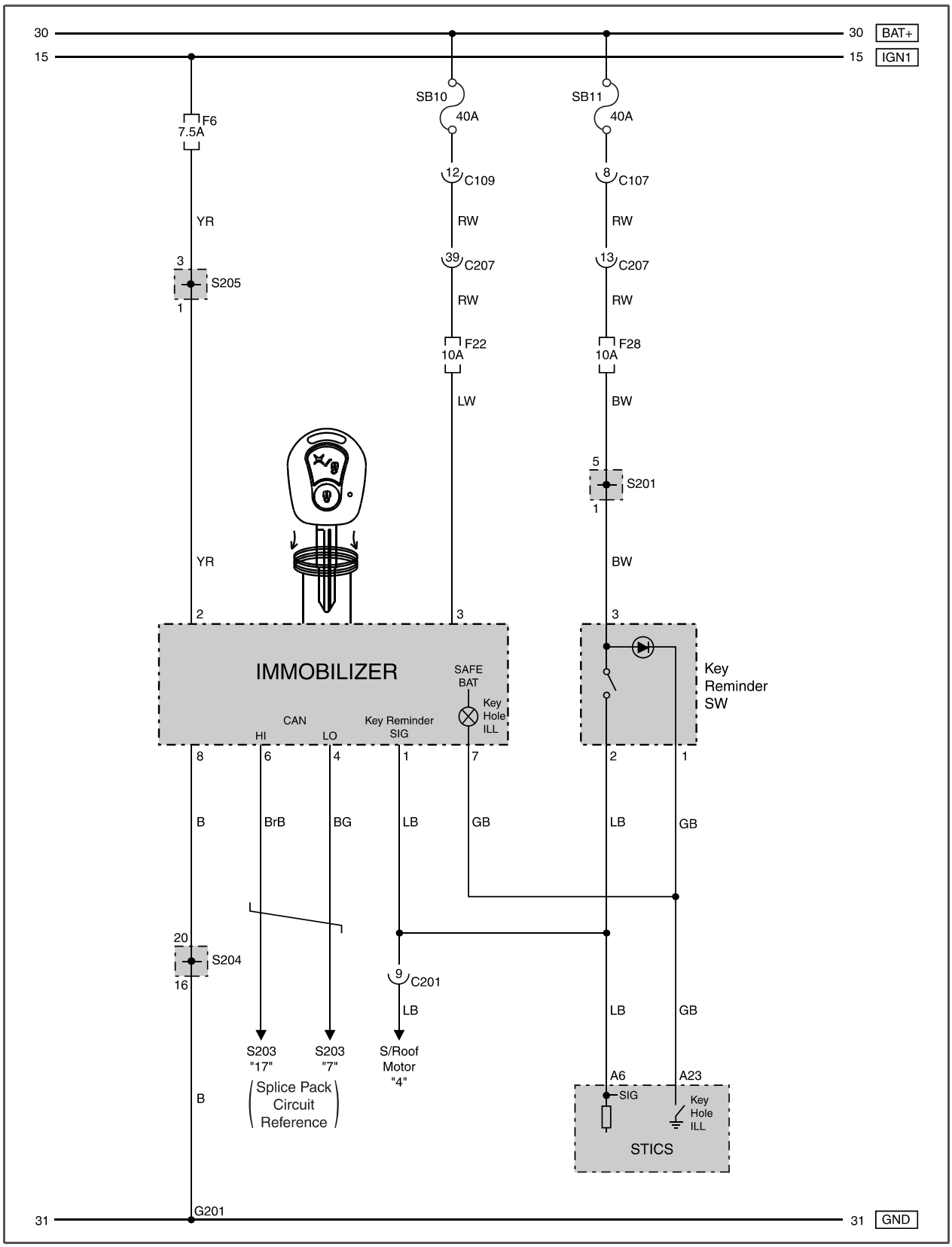
7. The ECU enable the engine to be started.

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.
  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.

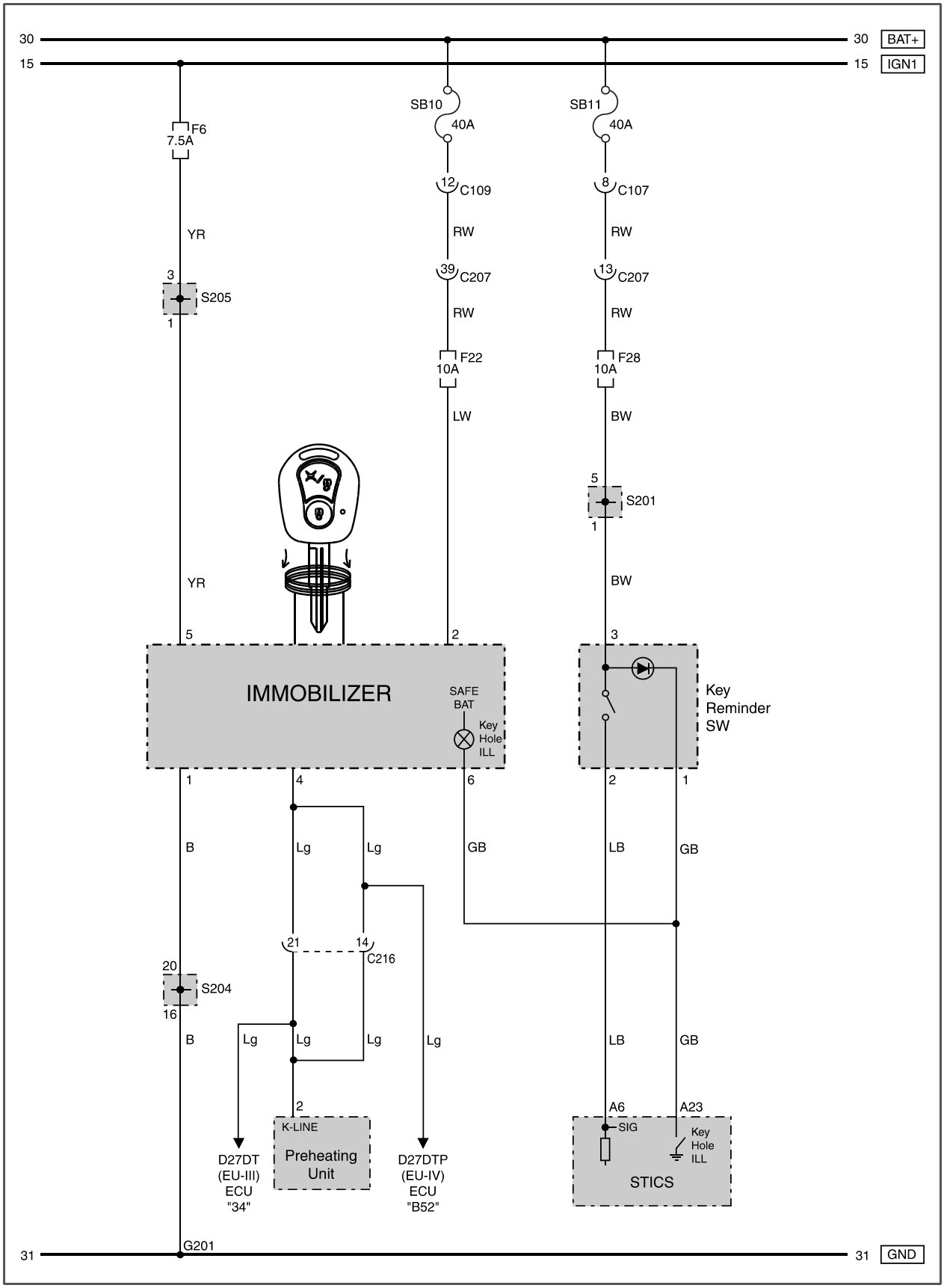
4. CIRCUIT DIAGRAM

▶ **D20DTR**



Modification basis	
Application basis	
Affected VIN	

▶ D27DT/D27DTP



Modification basis	
Application basis	
Affected VIN	

5. FUNCTION

1) Overview

The information below is the function that applies to the REKES key and immobilizer key.

Indicator

Briefly press: blinking once
Press and hold: Blinking twice

Door Unlock/Panic

1. Unlock (briefly press)
   - If you press this button briefly, all doors and the tailgate are unlocked and the theft deterrent mode is deactivated. When the deterrent mode is
   - deactivated, hazard warning flashers blink once. If a door is not opened within 30
   - seconds after unlocking the doors with remote control key in theft deterrent mode, all doors will be automatically locked again (change to theft deterrent mode)



Door Lock

2. Panic Function (press and hold)
   - If you are in your vehicle and feel threatened while the ignition key is inserted into the key switch, you may activate the alarm to call attention. If you press this button, the warning siren will sound for approx. 30 seconds.
   - The panic function will stop when any of the buttons on the remote control key is pressed.

1. Lock (briefly press)
   - If you press this button briefly, all doors and the tailgate are locked and the theft deterrent mode is activated. When the theft deterrent mode is activated, the hazard warning flashers blink twice.

Modification basis	
Application basis	
Affected VIN	

SPWM(Seat Position With Memory) UNIT 7410-32

GENERAL INFORMATION

1. SPECIFICATIONS

1) Driver's Power Seat

Inputs	Specification		
Position sensor	Type		Reed switch type
	ON:OFF ratio		50 ± 20 %
	Contact current		Max. 0.5 A
	Chattering		Max. 0.2 msec
	Stroke	Sliding	228 mm ± 3 mm
		Reclining	23˚ (front) ↔ 0˚ ↔ 48˚ (rear)
		Lift (FRT/RR)	30 ± 3mm
	Total number of pulses	Sliding	1,200 Pulse
		Lift (FRT/RR)	46.93 Pulse
	Operation speed	Sliding	17. 9 mm / Sec
		Reclining	3.50˚ / Sec
		Lift (FRT/RR)	7.0 mm / Sec
	Resolution	Sliding	0.188 / Pulse
		Lift (FRT/RR)	0.64 / Pulse
	Variable resistance		REC
SPWM memory switch	Type		Self-return type (Active low)
	Contact current		Min. 10mA
	Chattering		Max. 10 msec
Manual switch	Type		Self-return type (Active low)
	Contact current		Max 7A
	Chattering		Max 10 msec

2) Actuator

Actuator	Specifications		
For sliding/ reclining/raising front and rear (DC motor)	Rated voltage		DC 12V
	Operation current	Sliding	Max 2A (No-load)
		Reclining (REC)	Max 3.6A (AT 1.5 Nm) Max 8.0A (AT 12 Nm)
		Lift (FRT/RR)	Max 3A
	Limited current	Sliding	Max 16A
		Reclining	Max 13A
		Lift	Max 11A

3) Outside Rearview Mirror

▶ **Manual Mode (Normal): 12V**

Inputs / Controls	Horizontal	Center	Vertical
UP	GND	12V	GND
DOWN	12V	GND	12V
OFF	GND	GND	GND
RIGHT	GND	12V	12V
LEFT	12V	GND	GND

Modification basis	
Application basis	
Affected VIN	

▶ Position Sensor and Folding Switch

Inputs	Specification	
Position sensor	Type	Variabel resistance
	Rated voltage	DC 5V
	Output tolerance	± 0.1 V (± 2% from max. output)
	Supply current	Max 20 mA, 0.25W
	Operation range	Vertically and horizontally: ± 8˚
Folding switch	Type	Self-return type (active high)
	Contact current	Min 10mA
	Chattering	Max 10 msec
Manual switch	Type	Self-return type (Active low)
	Contact current	Max 7A
	Chattering	Max 10 msec

▶Electric Specifications of Motors

Inputs	Specification	
Mirror position motor	Rated voltage	DC 12V
	Operating current	Max 0.2A
	Limited current	Max 1.5A
	Mirror operating speed	2.5˚ ± 0.5˚ / sec (at 12V)
Folding motor	Rated voltage	DC 12V
	Operating current	Max 3A
	Limited current	Max 3.4A
	Turn over torque (by hand)	Manual folding: min. 50 kgf?cm
		Electric folding: max. 100kgf?cm

▶ Outputs from Mirror Position Motor (Normal mode: Grounded)

Inputs / Controls	Horizontal	Center	Vertical
UP	GND	GND	12V
DOWN	12V	12V	GND
RIGHT	GND	12V	12V
LEFT	12V	GND	GND

4) Buzzer

▶Electric Specifications

Output	Specification	
Buzzer	Rated voltage	DC 12V
	Rated current	Max 30 mA
	Acoustic pressure	MIN 92 dB
	Base frequency	2200 ± 150 Hz

▶Outputs

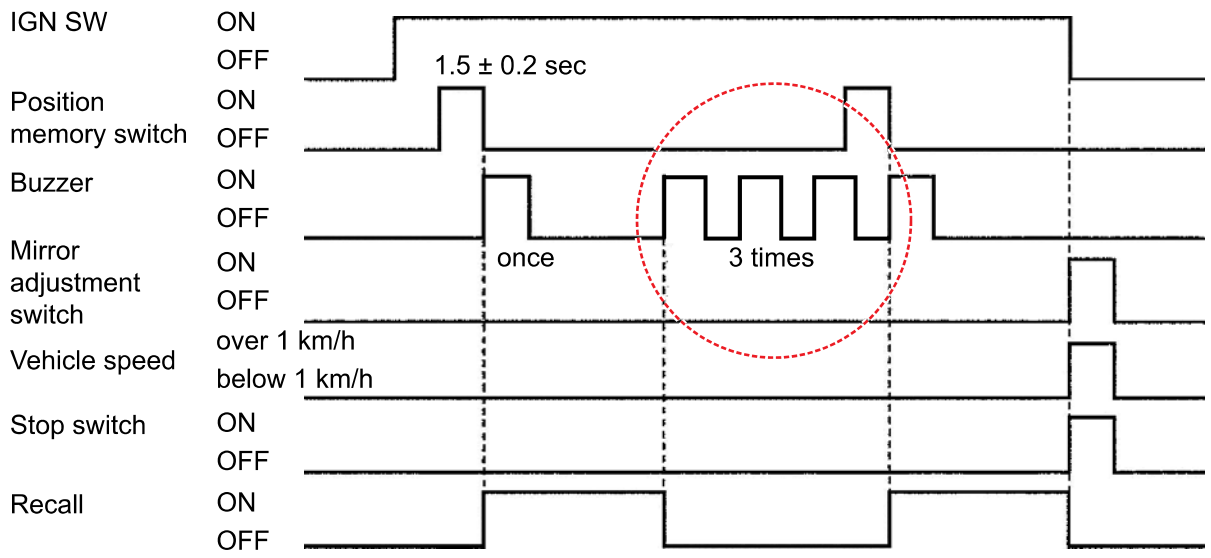
SPWM unit



1. Output time: 2Hz, DUTY 20% (ON: 0.1 sec., OFF: 0.4 sec.)
2. Buzzer output conditions
   - When the memory operation is permitted (memory switch ON): once
   - After completing the memory recall (position switch ON): three times
   - When starting to recall the memory (position switch ON): once
   - When pressing the position switch button twice consecutively: three times
   - When detecting a sensor error while recalling (position switch ON): three times
   - No buzzer output for the easy access memory/recall operations
   - No buzzer output for the outside mirror position recall by the auto down operation when reversing

Modification basis	
Application basis	
Affected VIN	

2. MAJOR CHANGES

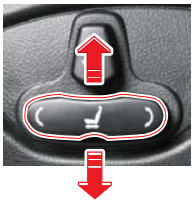
Changed the memory recall logic
Changed logic

Changed the number of buzzer operation (2→3) after recall of memory setting for driver's seat & outside rearview mirror.

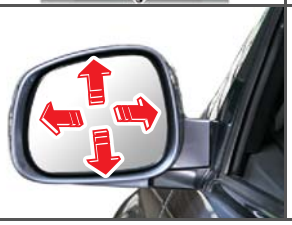
OVERVIEW AND OPERATING PROCESS

1. OPERATION

1) Switch Operation

1. Seat position control: Sliding, Seatback reclining, Seat height adjustment, Seat cushion angle adjustment.

Sliding	Seatback reclining	Seat height & Seat cushion angle adjustment	
			
			

Outside rearview mirror position control	Outside rearview mirror folding
	
	

2. Outside rearview mirror position switch operation: Up/Down/Left/Right (venter position: not operative)
3. Mirror folding switch operation: Folding and Unfolding
4. Operations in step 1 & 2 override the memory operation and memory recall operation.

CAUTION

To prevent the redundant current consumption during motor running, the motor starting point in each process is delayed for 100 ms in automatic control (memory recall). The operation sequence is as below:

Slide → Reclining → Lift (Front) → Lift **(Rear)**

Modification basis	
Application basis	
Affected VIN	

2) Driver's Seat and Outside Rearview Mirror Memory Setting and Recalling

▶ Setting Conditions

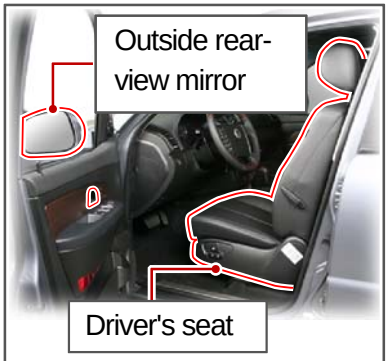
- Parking brake : Applied
- Shift lever : In "P" position
- Vehicle speed : lower than 1 km/h
- Ignition: ON (Don't start the engine for safety)

*** Data source**

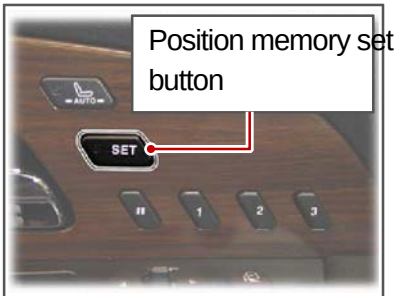
- Parking brake & IGN ON: STICS → SPWM
- Shift lever position & vehicle speed: Meter cluster → SPWM

In the conditions above, the memory setting for driver's seat and outside rearview mirror is available.

▶ Memory Setting (driver's seat and outside rearview mirror)

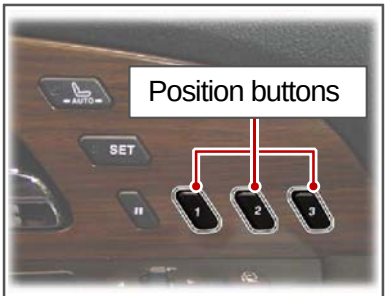


Adjust the positions of the driver's seat and the outside rearview mirrors.



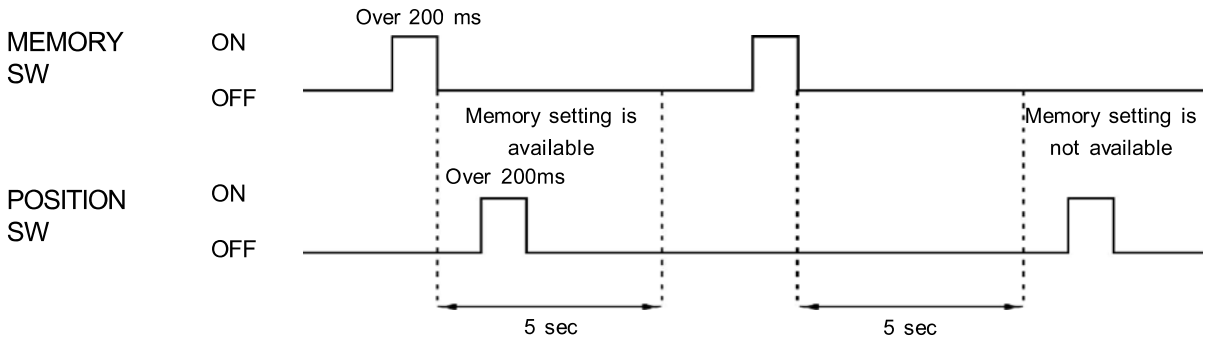
Press the set switch for over 200ms to enter the memory setting mode.

The buzzer sounds once



Within 5 seconds, press one of the position buttons (1,2,3) for over 200 ms to complete the memory setting procedure.

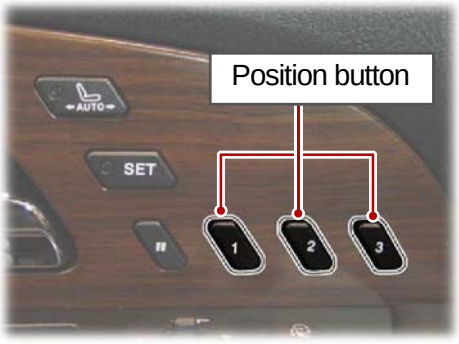
The buzzer sounds twice



▶ Cancellation of Memory Setting

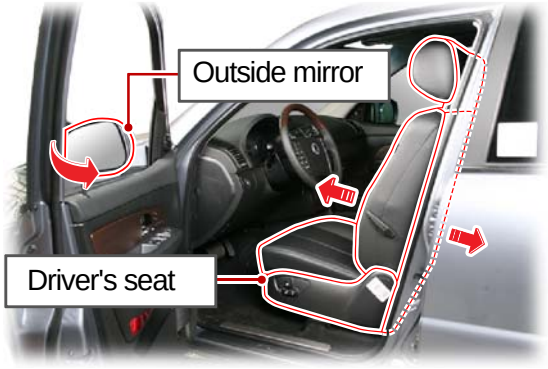
- When no position button is pressed within 5 seconds after pressing the memory set button
- When operating the driver's seat and the outside rearview mirror manually
- When turning the ignition OFF while setting the memory
- When the parking brake is relased or the shift lever is moved from the "P" position to any other positions while setting the memory
- When driving the vehicle (at speed over 1 km/h)
- When the memory setting procedure is completed, the memory setting procedure is automatically cancelled and the buzzer sounds twice.
- All the stored positions (position switch 1, 2, 3) get erased when removing the battery.

▶ Recalling the Memory Setting



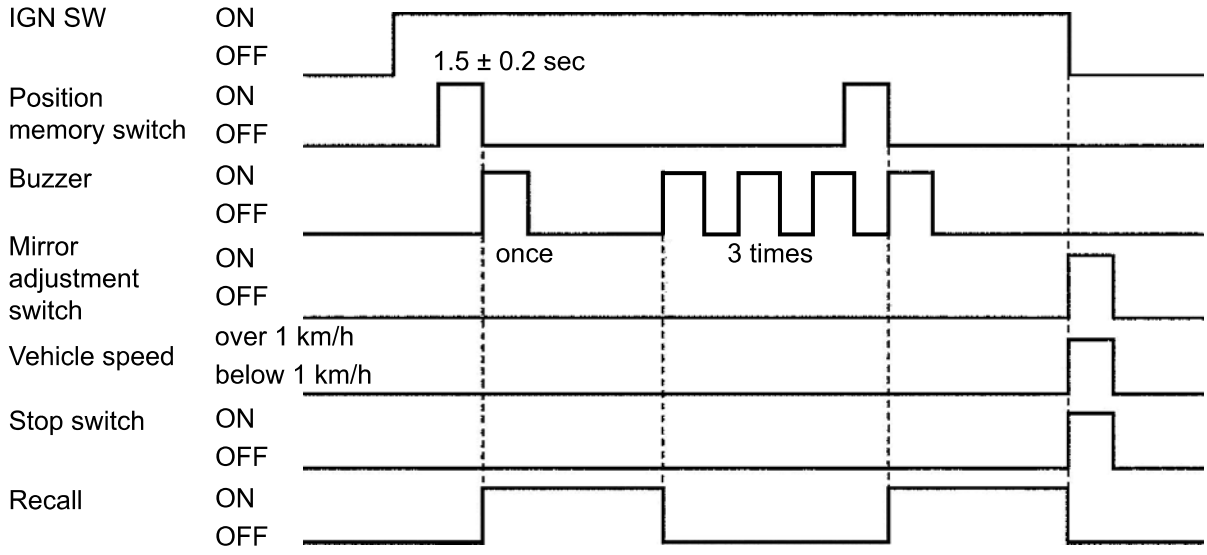
Press one of the position buttons for over 1.5 seconds.

The buzzer sounds once



The driver's seat and outside rear view mirrors start to move to the stored positions. When the process is completed, a buzzer sounds third.

The buzzer sounds three times



Modification basis	
Application basis	
Affected VIN	

▶ **Conditions that cannot recall the memory settings**

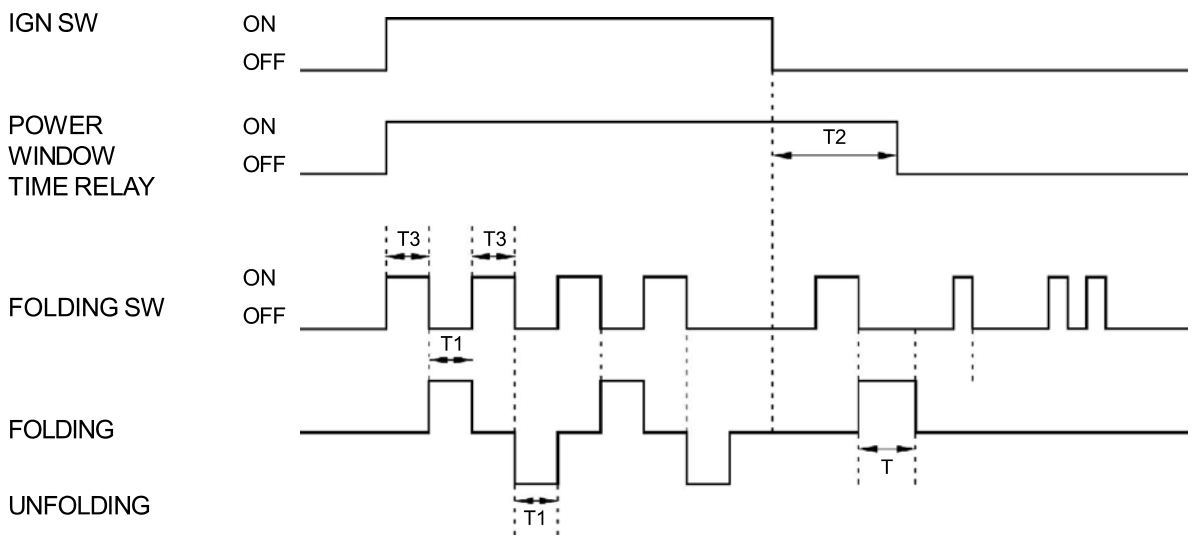
- Ignition OFF
- Vehicle with A/T: The shift lever is any position other than "P" with the parking brake released.
  Vehicle with M/T: The parking lever is released
- The seat memory stop button (stop switch) is pressed during the recall process
- If the seat position is manually adjusted during recall process, the seat recall operation stops but the outside rearview mirror continues to move to the set position.
- If the outside rearview mirror is adjusted during recall process, the outside rearview mirror recall operation stop but the seat continues to move to the set position.

3) Outside Rearview Mirror Folding/Unfolding Function

(1) Folding/Unfolding

1. When pressing the folding switch for approx. 1 second, the outside rearview mirrors are folded/unfolded.
2. This folding/unfolding function can be used for 24 to 30 seconds even after turning off the ignition switch (However, this delayed operating time stops when opening the driver's door).
3. To prevent the motor from stopping during folding/unfolding process, this delayed operating time is extended for additional 13 seconds if pressing the switch within 30 seconds (T2) after turning the ignition OFF. If pressing the switch again during the additional operating time, the delayed operating time is extended again for additional 13 seconds.

▶ **Timing Chart**



T: T < T1, T1: 13 ± 3 sec T2: 30 ± 6 sec T3: 1 sec ± 0.2 sec

CAUTION

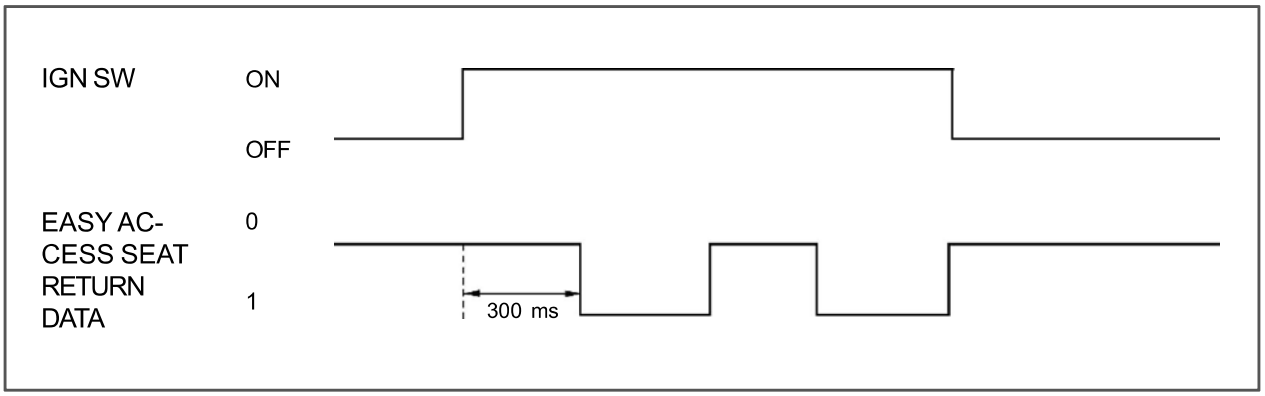
The outside rearview mirror folding switch is supplied the power from the power window relay. Therefore, the maximum extended time is 30 seconds. If the driver's or passenger's door is opened during this extended time, the relay cuts the power OFF.

Modification basis	
Application basis	
Affected VIN	

4) Easy Access Function

▶ Seat Return Operation When Turning the Ignition Switch to ON Position

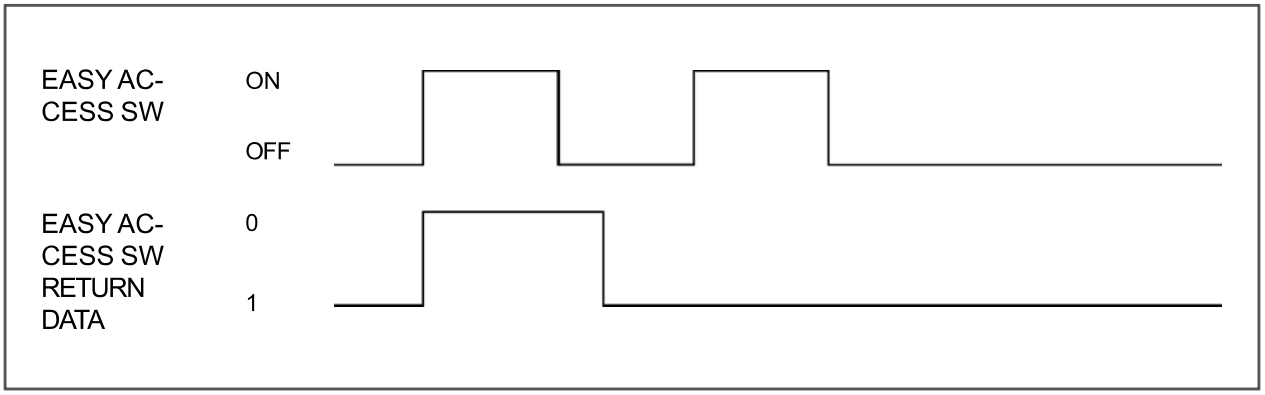
When turning the ignition switch to ON from OFF position with the easy access switch pressed, after 30 ms, STICS starts to send the return signal to SPWM unit. If SPWM receives the data properly, it operates the return operation.



CAUTION

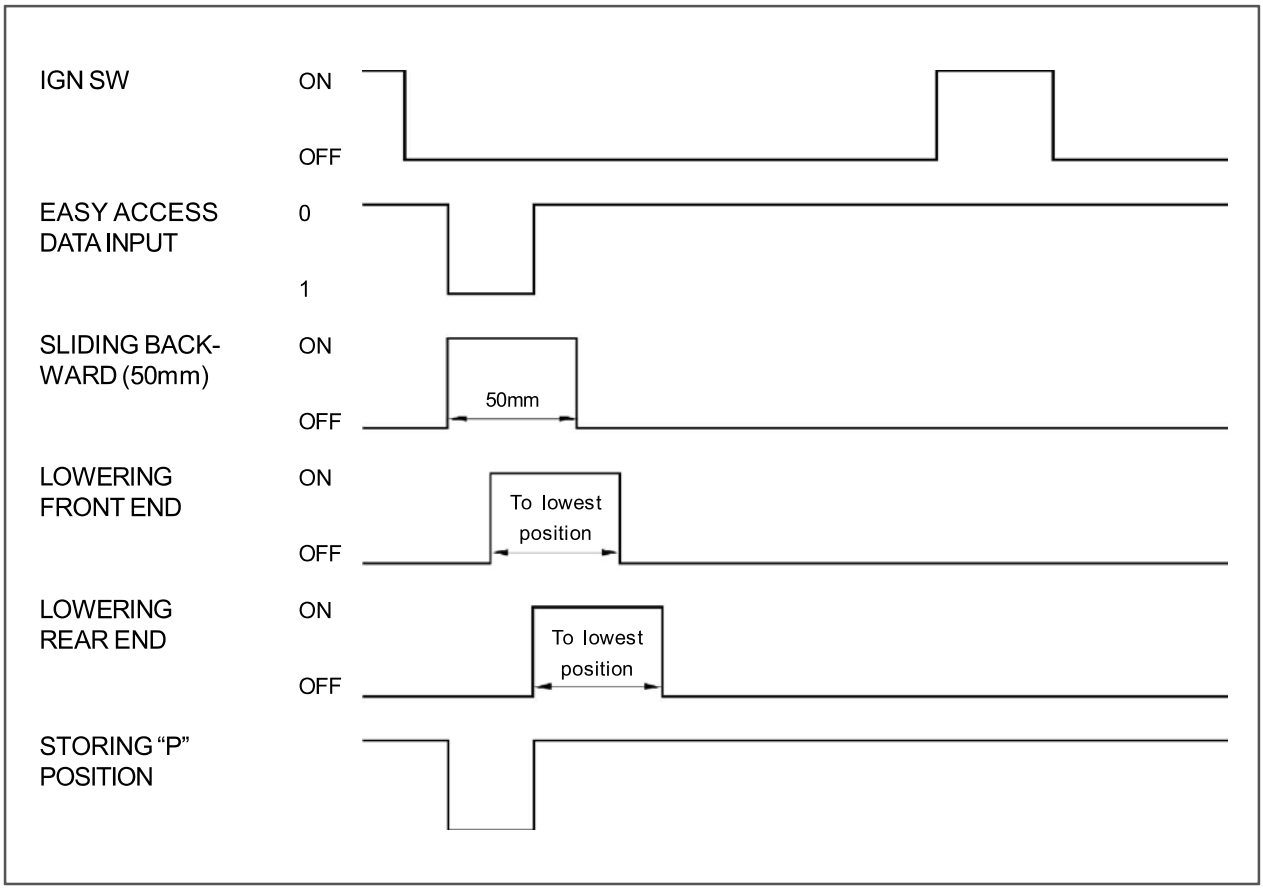
The prohibit conditions for the easy access seat return operation are as follows:

- The parking brake is released or the shift lever is in any position other than "P".
- Any of seat switch is operated during the return operation.
- Ignition switch is cycled (ON and OFF) with short interval (approx. 1 ~ 1.5 seconds) for over 3 seconds.



▶ Easy Access Operation When Getting Off

When removing the ignition key (key reminder switch OFF) from the ignition switch with the easy access switch pressed, STICS sends the easy access data to SPWM unit.
The SPWM unit immediately moves the seat backwards for approx. 50 mm and lowers it as far as it goes.



CAUTION

- If an error is detected from the motors (sliding motor/cushion front motor/cushion rear motor) during operation after removing the ignition key, the motor with error stops its operation and other motors continue to complete their operations.
- If cycling the key reminder switch (OFF → ON → OFF) within 1 second, STICS sends the easy access stop signal to SPWM unit.
- The SPWM overrides all STICS data signals in one second after receiving the easy access stop signal.

Modification basis	
Application basis	
Affected VIN	

▶ Conditions for Stop and Prohibition of Easy Access Operation

1. The easy access switch is in "OFF" position.
2. The STICS sends "Stop" signal to SPWM unit when turning off the easy access switch during the easy access operation.
3. If STICS receives the easy access switch signal in sequence of ON, OFF, then OFF within one second during the easy access operation, STICS overrides the third signal and doesn't send any date to SPWM unit.
4. If an error is detected on a sensor, the affected motor doesn't operate until it receives normal sensor input.
5. The vehicle speed is over 1 km/h.
6. When the seat switch is operated.
7. If the shift lever is any position other than "P" or the parking brake is disengaged

▶ LED on Easy Access Switch

1. LED "ON": Easy access operation is activated.
2. LED "OFF": Easy access operation is stopped or prohibited.

▶ Easy Access Operation Order

1. Moving the seat backward > Raising the front end seat cushion > Raising the rear end seat cushion
   There is a 10 ms of pause time between "Moving the seat backward" and "Raising the front end seat
2. cushion" operations.

SEAT WARMER SYSTEM

8611-31

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

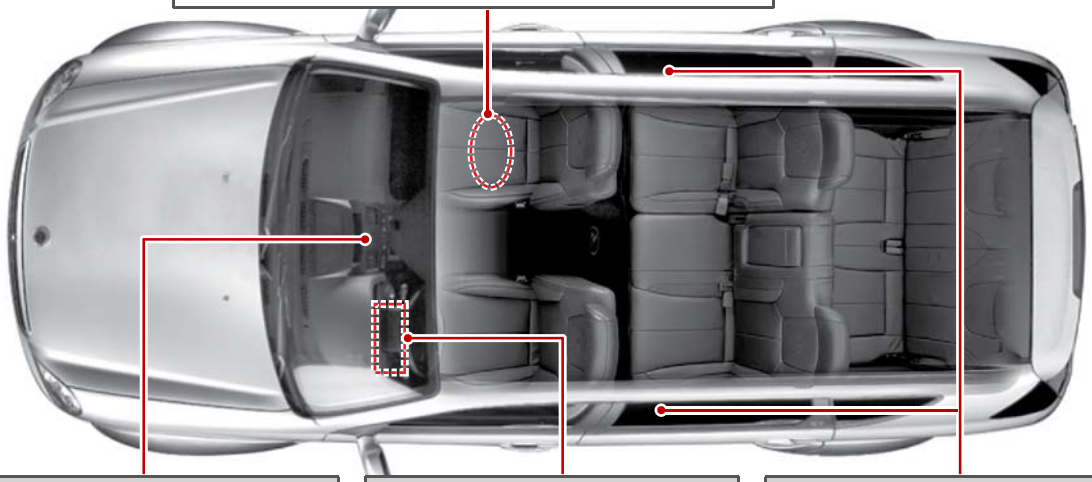
The front seat warmer system consists of the variable control type front seat warmer unit and its operation switch. The rear seat warmer unit is not variable control type but ON/OFF control type. The rear seat warmer switches LH/RH control the rear seat warmer relays LH/RH in the ICM.

2. LAYOUT

Front seat warmer unit



Front seat heated wire: seat and seatback
Rear 1st seat heated wire: seat



Front seat warmer switch



ICM box



Rear for rear seat warmer

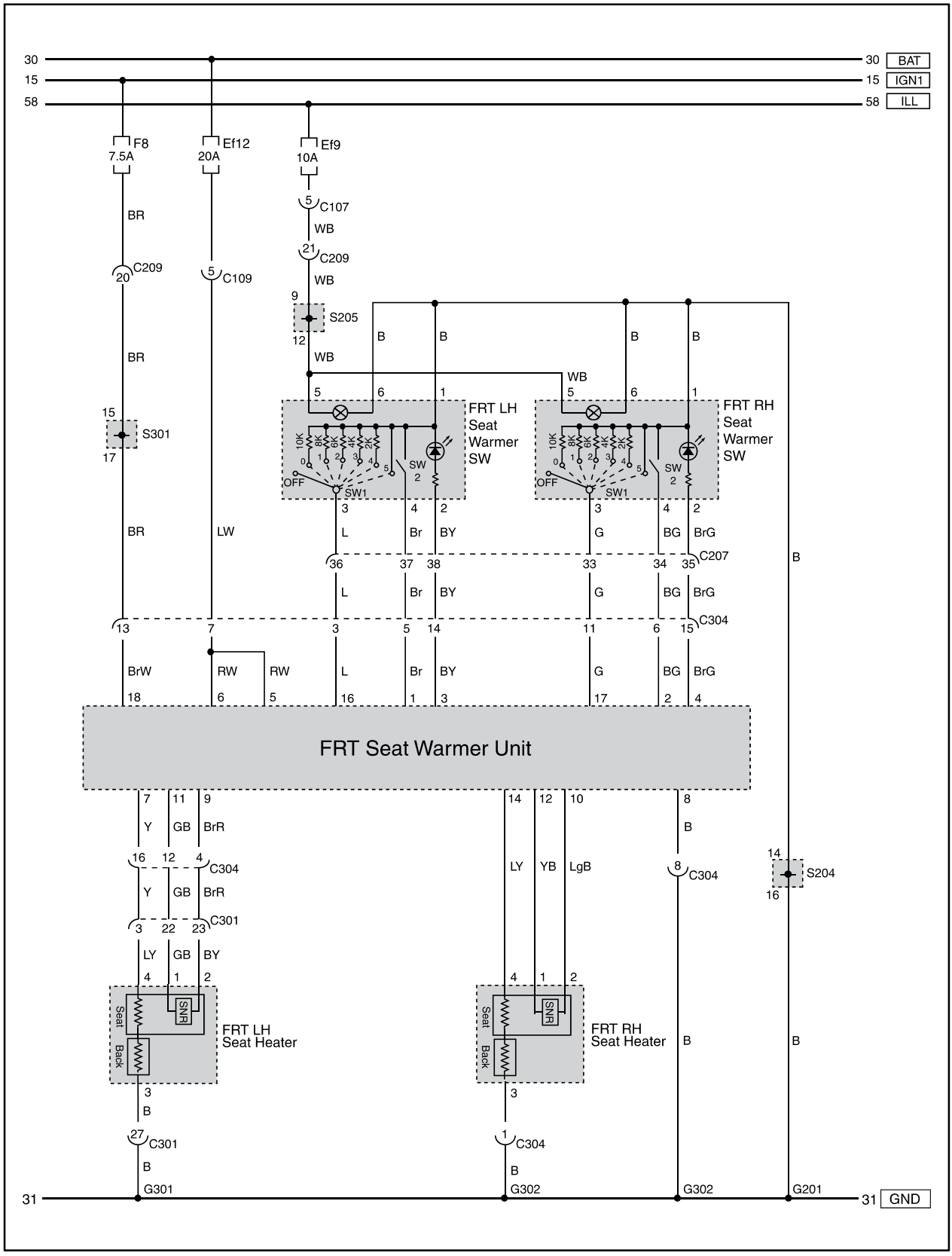
Rear seat warmer switch



Modification basis	
Application basis	
Affected VIN	

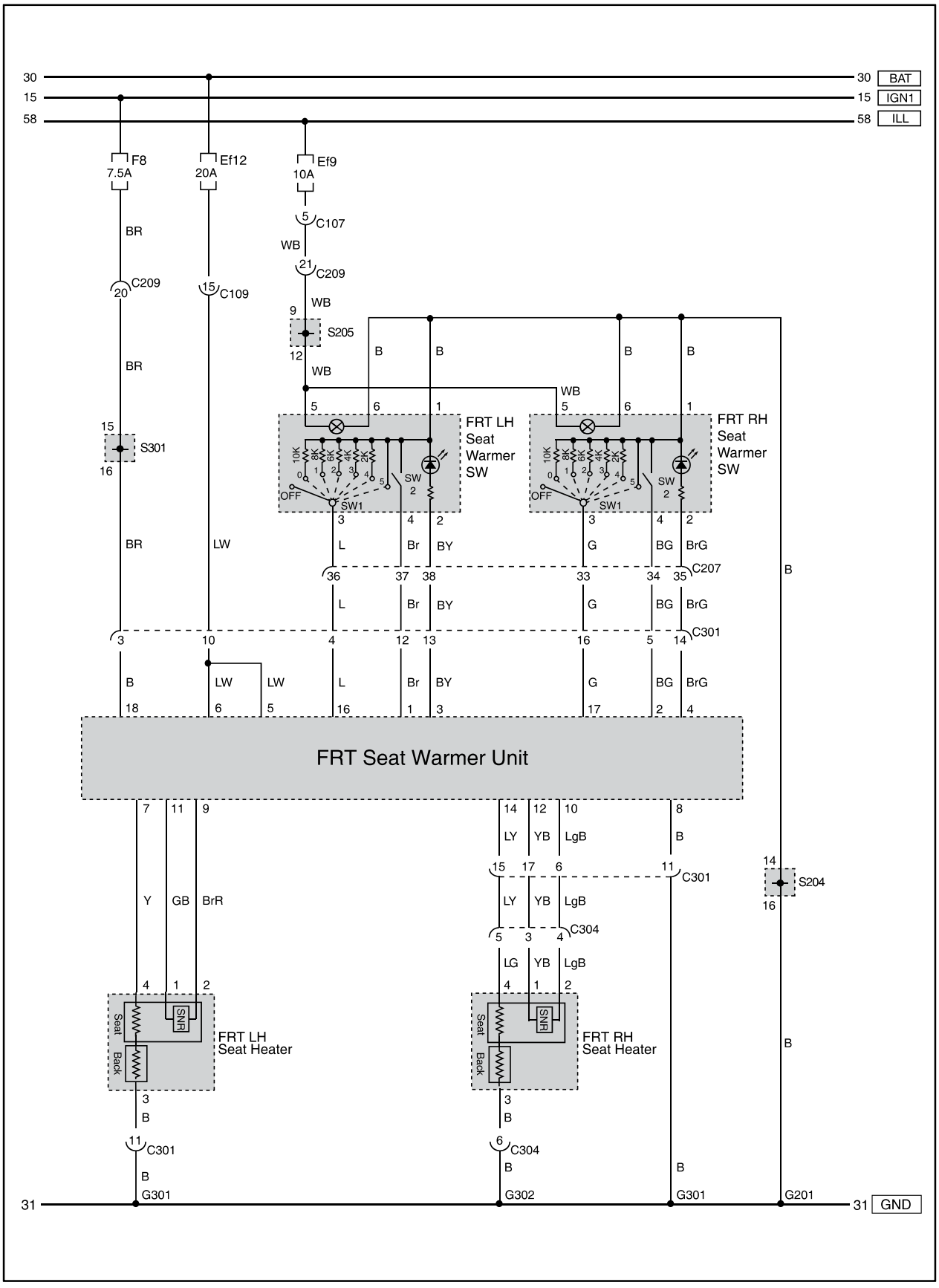
3. CIRCUIT DIAGRAM

▶ Front variable seat warmer (Seat/outside mirror memory)



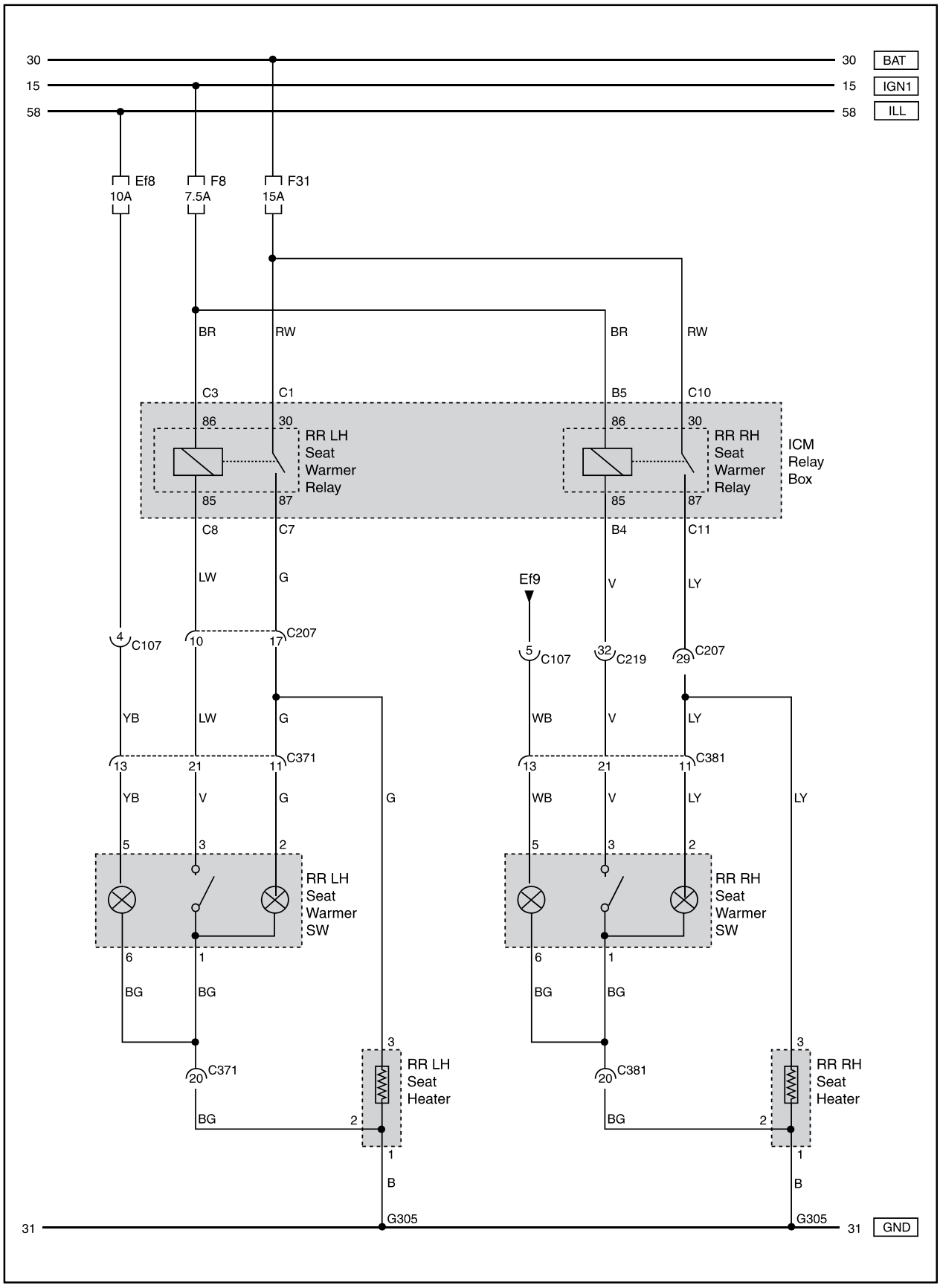
Modification basis	
Application basis	
Affected VIN	

▶ Front variable seat warmer (Seat/outside mirror non-memory)



Modification basis	
Application basis	
Affected VIN	

▶ Rear seat warmer



Modification basis	
Application basis	
Affected VIN	

INSTRUMENT CLUSTER

8010-01

GENERAL INFORMATION

1. SPECIFICATIONS

1) Power, Voltage, Current

Description	Specification
Rated voltage	DC 12V
Operating voltage	DC 9V ~ 16V
Inspection voltage	DC 13.5V
Operating temperature	−30°C ~ +75°C (during driving)
Storage temperature	−40°C ~ +85°C
Performance reserve temperature	DC 10V ~ 15V
Dark current	below 3 mA at stable status (stand-by mode) after 180 seconds from IGN OFF

2) Illumination Level

(1) Black-Face Model

Classification	When Tail Lamp ON	Illumination level (%)
Day	100%	100~25, 6 steps
Night	40% compared to the level in daytime	40~10, 6 steps

3) Color and Specification for Indicators and Warning Lamps

Name	Color	Specification	Name	Color	Specification
Turn signal indicator (L, R)	Green	3.3V 20 mA	4WD HIGH indicator (P/TIME)	Green	3.3V 20 mA
Seat belt reminder	Red	2.0V 20 mA	4WD LOW indicator (TOD, P/TIME)	Yellow	2.0V 20 mA
Battery charge warning lamp	Red	2.0V 20 mA	Winter mode indicator	Green	3.3V 20 mA
Low fuel level warning lamp	Yellow	2.0V 20 mA	Engine check warning lamp	Yellow	2.0V 20mA
High beam indicator	Blue	3.8V 20 mA	EBD warning lamps	Yellow/Red	2.0V 20 mA
Engine oil pressure warning lamp	Red	2.0V 20 mA	Front fog light indicator	Green	3.3V 20 A
Brake warning lamp	Red	2.0V 20 mA	Immobilizer indicator	Yellow	2.0V 20 mA
Door ajar warning lamp	Red	2.0V 20 mA	Hazard indicator	Red	2.0V 20 mA
ABS warning lamp	Yellow	2.0V 20 mA	Engine overheat warning lamp	Red	2.0V 20 mA
Glow indicator	Yellow	2.0V 20 mA	Water separator warning lamp	Red	2.0V 20 mA
Air bag warning lamp	Red	2.0V 20mA	SSPSwarning lamp	Yellow	2.0V 20 mA
Auto cruise indicator	Green	3.3 V 20 mA	Low tire pressure warning (Global warning)	Yellow	2.0V 20 mA
4WD CHECK warning lamp (TOD, P/TIME)	Red	2.0V 20 mA	TPMS warning lamp	Yellow	2.0V 20 mA
HDC indicator	Green	3.3V 20 mA	Light indicator	Green	3.3V 20 mA

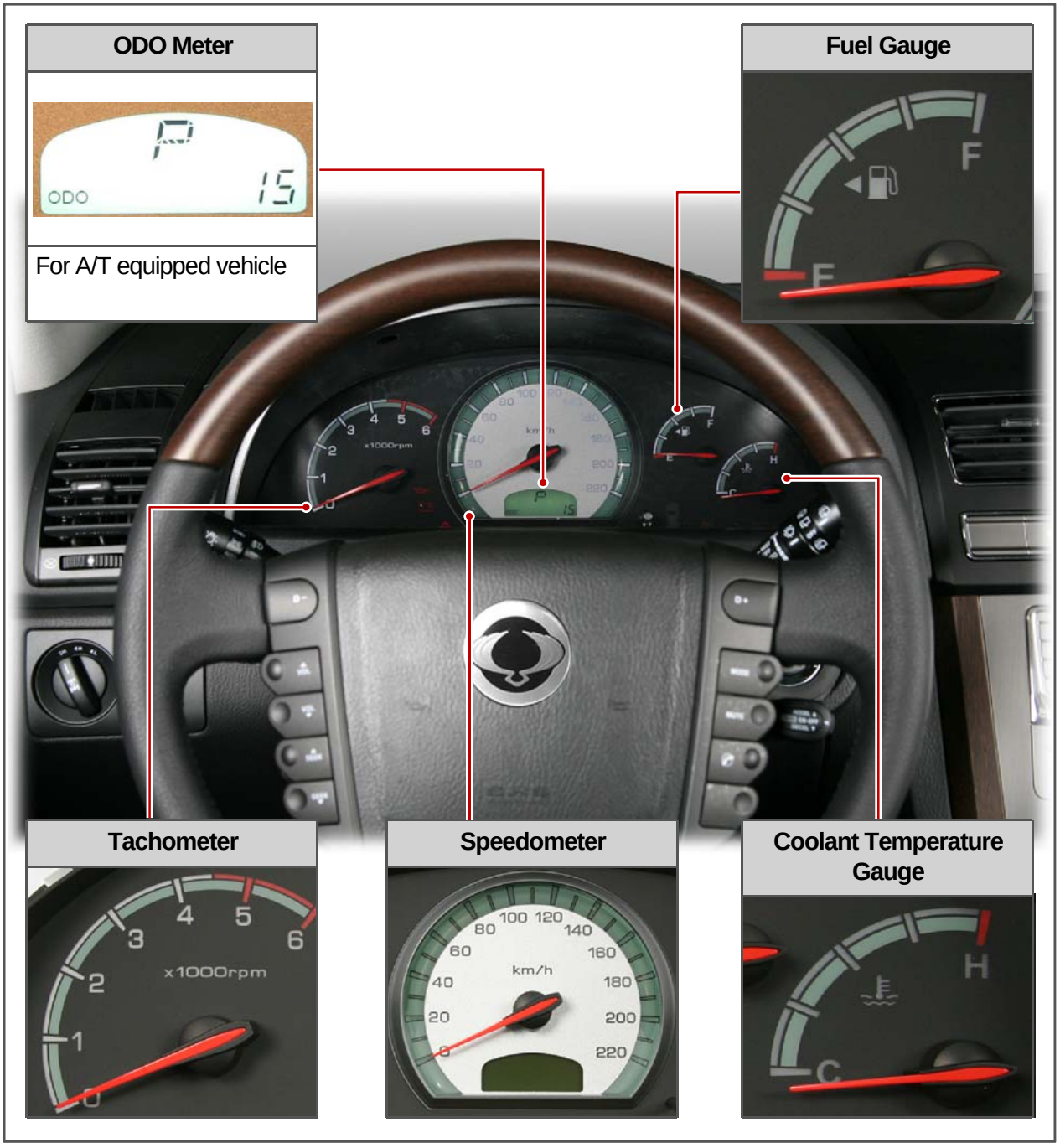
Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

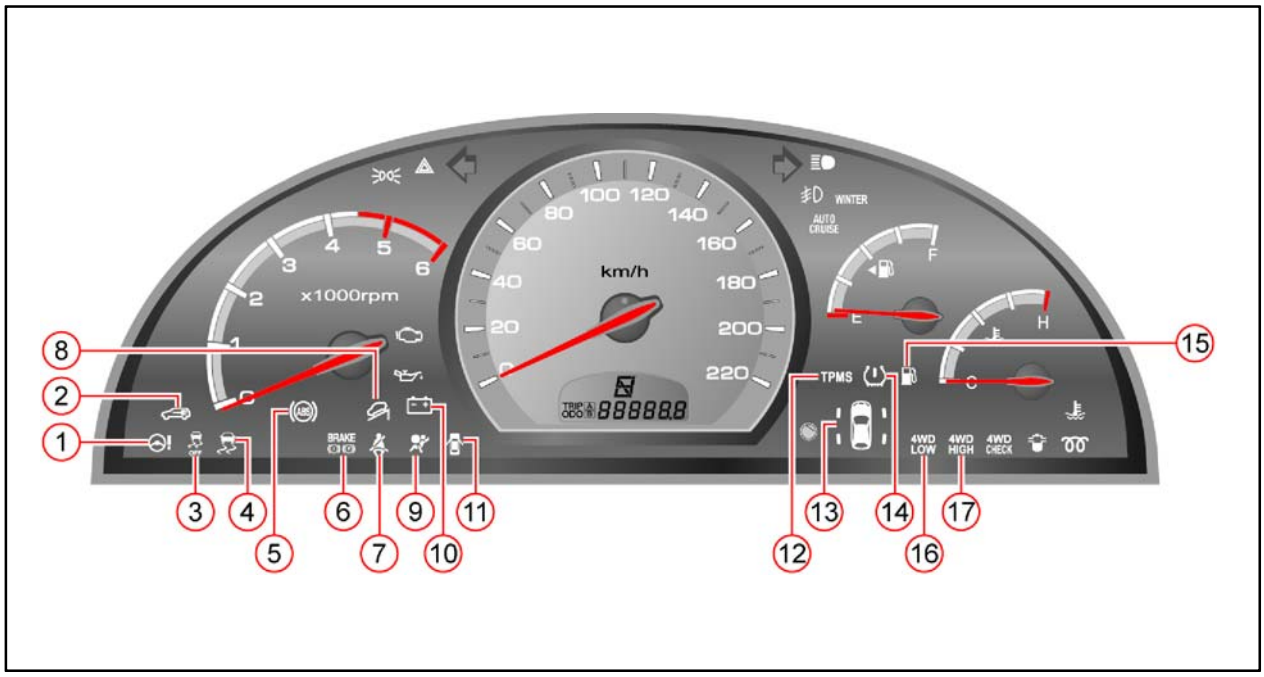
Two types (Black-Face type and Clear type) of meter cluster are used in this model. The meter clusters uses CAN communication lines with the electric units and the LCD display window is located on the lower side of the meter cluster.

2. SYSTEM LAYOUT



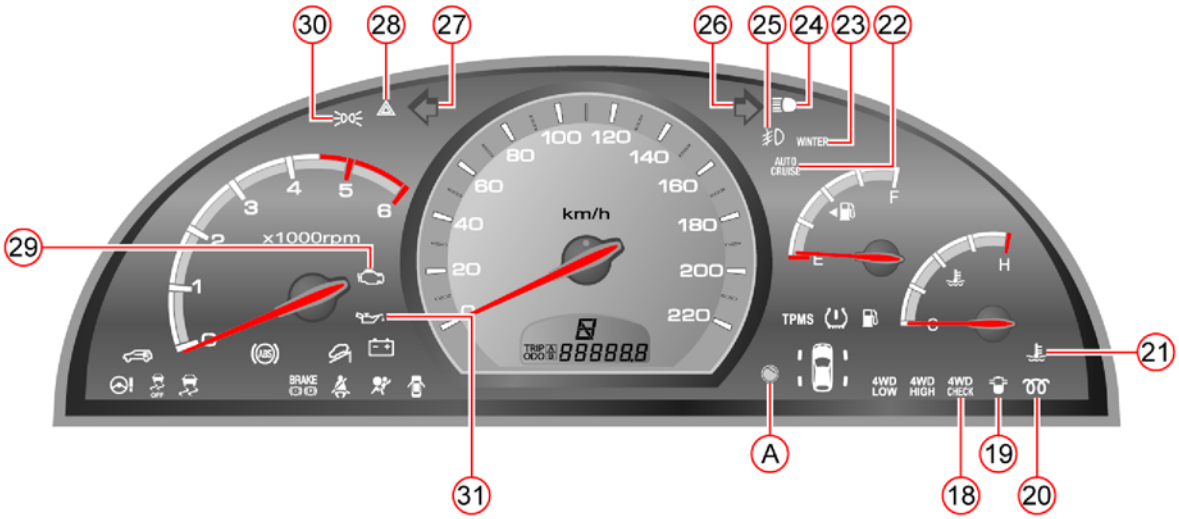
3. WARNING LAMPS AND INDICATORS

1) Black-Face Type



No.	Symbol	Description	No.	Symbol	Description
1		SSPS warning lamp	10		Battery charge warning lamp
2		Immobilizer indicator	11		Door ajar warning lamp
3	OFF	ESP OFF indicator	12	TPMS	TPMS warning lamp
4		ESP indicator/warning lamp	13		Tire inflation pressure indicator
5	ABS	ABS warning lamp	14		Low tire pressure warning (Global warning)
6	BRAKE	Brake warning lamp	15		Low fuel level warning lamp
7		Seat belt reminder	16	4WD LOW	4WD LOW indicator (TOD, P/TIME)
8		HDC indicator	17	4WD HIGH	4WD HIGH indicator (P/TIME)
9		Air bag warning lamp			

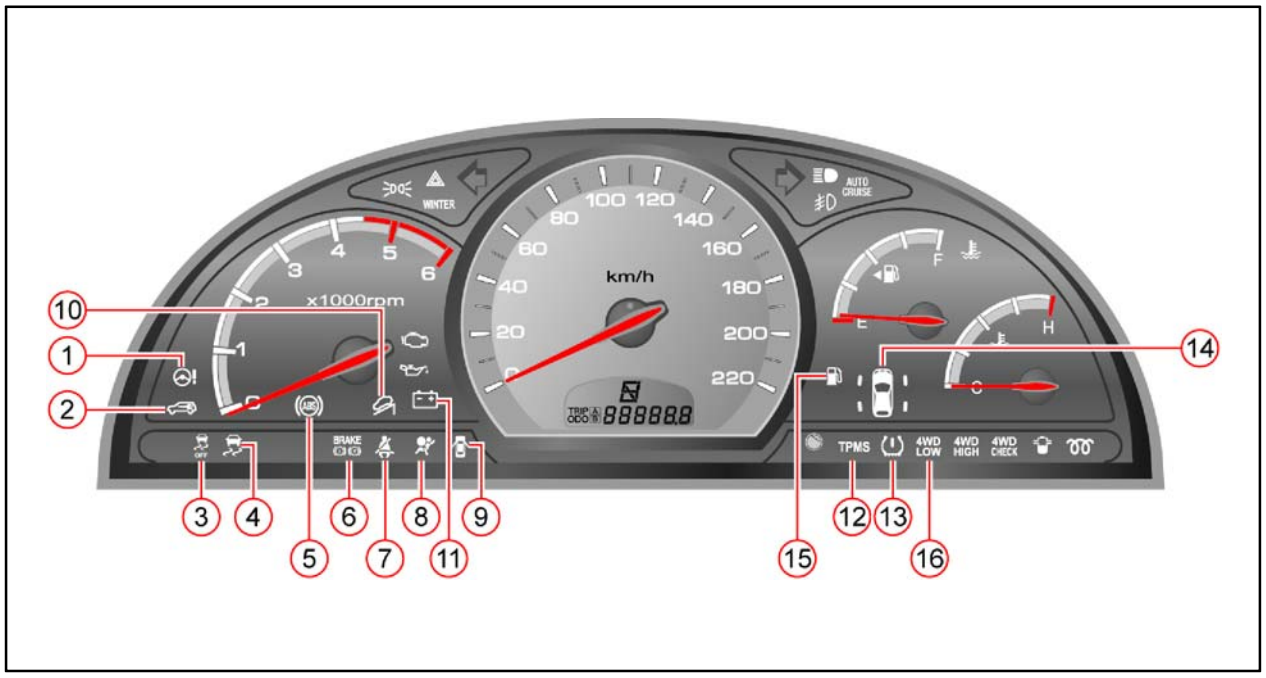
Modification basis	
Application basis	
Affected VIN	



A Trip switch

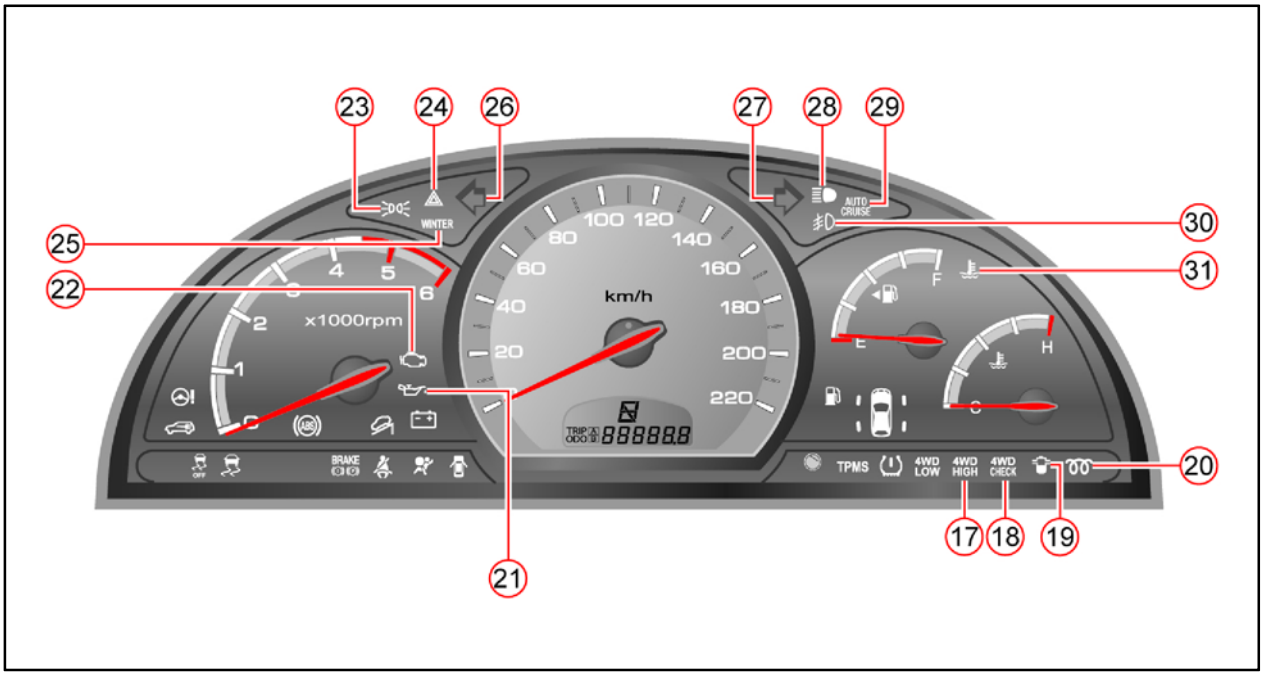
No.	Symbol	Description	No.	Symbol	Description
18	4WD CHECK	4WD CHECK warning lamp (TOD, P/TIME)	26		Turn signal indicator (R)
19		Water separator warning lamp	27		Turn signal indicator (L)
20		Glow indicator	28		Hazard indicator
21		Engine overheat warning lamp	29		Engine check warning lamp
22	AUTO CRUISE	Auto cruise indicator	30		Light indicator
23	WINTER	Winter mode indicator	31		Engine oil pressure warning lamp
24		High beam indicator	32	ABS BRAKE	EBD warning lamps
25		Front fog light indicator			

2) Clear Type



No.	Symbol	Description	No.	Symbol	Description
1		SSPS warning lamp	9		Door ajar warning lamp
2		Immobilizer indicator	10		HDC indicator
3	OFF	ESP OFF indicator	11		Battery charge warning lamp
4		ESP indicator/warning lamp	12	TPMS	TPMS warning lamp
5	ABS	ABS warning lamp	13		Low tire pressure warning (Global warning)
6	BRAKE	Brake warning lamp	14		Tire inflation pressure indicator
7		Seat belt reminder	15		Low fuel level warning lamp
8		Air bag warning lamp	16	4WD LOW	4WD LOW indicator (TOD, P/TIME)

Modification basis	
Application basis	
Affected VIN	



No.	Symbol	Description	No.	Symbol	Description
17	4WD HIGH	4WD HIGH indicator (P/TIME)	25	WINTER	Winter mode indicator
18	4WD CHECK	4WD CHECK warning lamp (TOD, P/TIME)	26		Turn signal indicator (L)
19		Water separator warning lamp	27		Turn signal indicator (R)
20		Glow indicator	28		High beam indicator
21		Engine oil pressure warning lamp	29	AUTO CRUISE	Auto cruise indicator
22		Engine check warning lamp	30		Front fog light indicator
23		Light indicator	31		Engine overheat warning lamp
24		Hazard indicator	32	ABS BRAKE	EBD warning lamps

2) Description for Warning Lamps and Indicators

▶ High beam indicator

Blue	
	This indicator comes on when the high beam headlamp is switched on.

▶ Front fog light indicator

Green	
	This indicator comes on when the front fog light is switched on.

▶ Light indicator

Green	
	This indicator comes on when the tail lamp or headlamp is switched on.

▶ Glow indicator

Yellow	
	- When the ignition switch is turned to “ON”, this indicator comes on and stays for a short time or may go off right away. - When the pre-glow system is faulty, this indicator comes on.

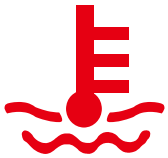
▶ Water separator warning lamp

Red	
	- This warning lamp comes on when the ignition switch is turned to “ON” and should go off in a few seconds. - When the water level inside the water separator in the fuel filter exceeds a certain level, this warning lamp comes on.

▶ Low fuel level warning lamp

Yellow	
	- This warning lamp indicates that the fuel level in the tank is getting exhausted (GSL: below 12 liters, DSL: below 9.5 liters). - The illuminating point of this warning lamp varies according to the driving conditions such as driving angle and road conditions.

▶ Engine overheat warning lamp

Red	
	This warning lamp comes on when the ignition switch is turned on and goes off when the engine is started. When the engine coolant temperature is abnormally hot (over 120°C), the engine overheat warning lamp blinks and a warning buzzer sounds.

▶ Door ajar warning lamp

Red	
	This lamp comes on when a door or the tailgate is either opened or not closed securely.

▶ Seat belt reminder (Driver's)

Red	
	This warning lamp blinks and the warning buzzer sounds for 6 seconds when the ignition switch is turned to the "ON" position unless the driver's seat belt is securely fastened.

▶ Air bag warning lamp

Red	
	- When the ignition is switched on, this warning lamp illuminates and then should go off, to confirm that the air bag is operational. - If it does not come on, or if it does not go off, or if it flashes or illuminates continuously while driving, it means that there is a malfunction in the system.

▶ ESP indicator/warning lamp

Yellow	
	ON: This warning lamp comes on when ESP system is defective. Blinking: This indicator blinks when the ESP system is operating. This warning lamp comes on when the ignition switch is turned to "ON" and should go off in a few seconds.

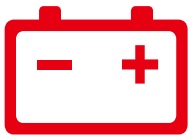
▶ ESP OFF indicator

Yellow	
	- This warning lamp comes on when the ignition switch is turned to "ON" and should go off in a few seconds. - This indicator comes on when pressing the ESP OFF switch to deactivate the ESP function.

▶ Engine check warning lamp

Yellow	
	- If the lamp stays on or comes on while driving, some of the engine control components including sensors and devices are defective. - This warning lamp is blinking when the CDPF (Emission collecting filter) is contaminated with carbon.

▶ Battery charge warning lamp

Red	
	- This warning lamp comes on when the ignition switch is turned on and it goes off when the engine is started. - If this lamp doesn't go off after engine starting or comes on while driving, it means there is a malfunction in the system.

▶ Engine oil pressure warning lamp

Red	
	- This warning lamp comes on when the ignition switch is turned on and it goes off when the engine is started. - If this warning lamp comes on during driving, check the engine oil level.

Modification basis	
Application basis	
Affected VIN	

▶ Brake warning lamp

Red	
	- This warning lamp comes on when the ignition switch is turned to "ON" and should go off in a few seconds. - This warning lamp comes on when the parking brake is applied and/or the brake fluid level is lower than a specified level. - If the ABS warning lamp and the brake warning lamp come on simultaneously, EBD system is defective.

▶ ABS warning lamp

Yellow	
	- This warning lamp comes on when the ignition switch is turned to "ON" and should go off in a few seconds. - This warning lamp comes on when the ABS system is defective.

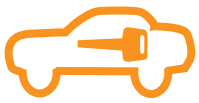
▶ EBD warning lamps

Yellow/Red	
	If the ABS warning lamp and the brake warning lamp come on simultaneously, EBD (Electronic Brake force Distribution) system is defective.

▶ SSPSwarning lamp

Yellow	
	This warning lamp comes on when the SSPS system is defective.When this warning lamp comes on, the steerability becomes heavier.

▶ Immobilizer indicator

Yellow	
	- This indicator comes on when the ignition key is communicating with the engine control unit (during engine starting) for 0.5 seconds. - The time needed for communication between the immobilizer key and ECU may vary. When the time is very short, the immobilizer indicator does not come on.

▶ Hazard indicator

Red	
	This indicator blinks when the hazard warning flashers are switched on.

▶ Auto cruise indicator

Green	
AUTO CRUISE	This indicator comes on when the cruise control system is switched on.

▶ Left Turn signal indicator

Green	
	This indicator blinks when the left turn signal switch is turned on. Both indicators blink when the hazard warning switch is turned on.

▶ Right Turn signal indicator

Green	
	This indicator blinks when the right turn signal switch is turned on. Both indicators blink when the hazard warning switch is turned on.

▶ Winter mode indicator

Green	
WINTER	- The indicator comes on with the Winter mode symbol in LCD display when the Winter mode (W) switch near the gear selector lever is pressed. Use this mode to drive off smoothly on an icy and slippery road. -

Modification basis	
Application basis	
Affected VIN	

▶ HDC indicator

Red/Green	
	This indicator comes on or blinks according to HDC operations.

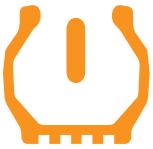
▶ TPMS warning lamp

Yellow	
TPMS	- This warning lamp comes on when the ignition switch is turned to "ON" and should go off in a few seconds. - This indicator comes on when the TPMS is defective. - This indicator comes on when the global warning lamps comes on (blinks for 70 seconds, 0.4s ON/OFF)

▶ Tire inflation pressure indicator

Green/Yellow	
	This indicator illuminates in green when the ignition switch is turned to "ON" and should go off in 15 seconds. If a specific tire indicator illuminates in yellow or blinks, the tire inflation pressure may be abnormal or the tire inflation pressure sensor is defective.

▶ Low tire pressure warning (Global warning)

Yellow	
	- This warning lamp comes on when the ignition switch is turned to "ON" and should go off in a few seconds. - Lamp ON: over-inflated (over 48 psi) - Lamp ON: under-inflated (24~26 psi for more than 10 minutes) - Lamp ON: under-inflated (below 24 psi)

▶ 4WD LOW indicator (TOD, P/TIME)

Yellow	
4WD LOW	When shifting the driving mode to “4L”, this indicator blinks until the shifting operation is completed. After completion of the mode change to 4L, the indicator comes on.

▶ 4WD HIGH indicator (P/TIME)

Green	
4WD HIGH	When shifting the driving mode from “4L” to “4H”, this indicator blinks until the shifting operation is completed. After completion of the mode change to 4H, the indicator comes on.

▶ 4WD CHECK warning lamp (TOD, P/TIME)

Red	
4WD CHECK	This warning lamp comes on when the ignition switch is turned to “ON” and should go out if the system is normal. If the “4WD CHECK” warning lamp stays on, 4WD system is defective.

Modification basis	
Application basis	
Affected VIN	

3) Display Sequence

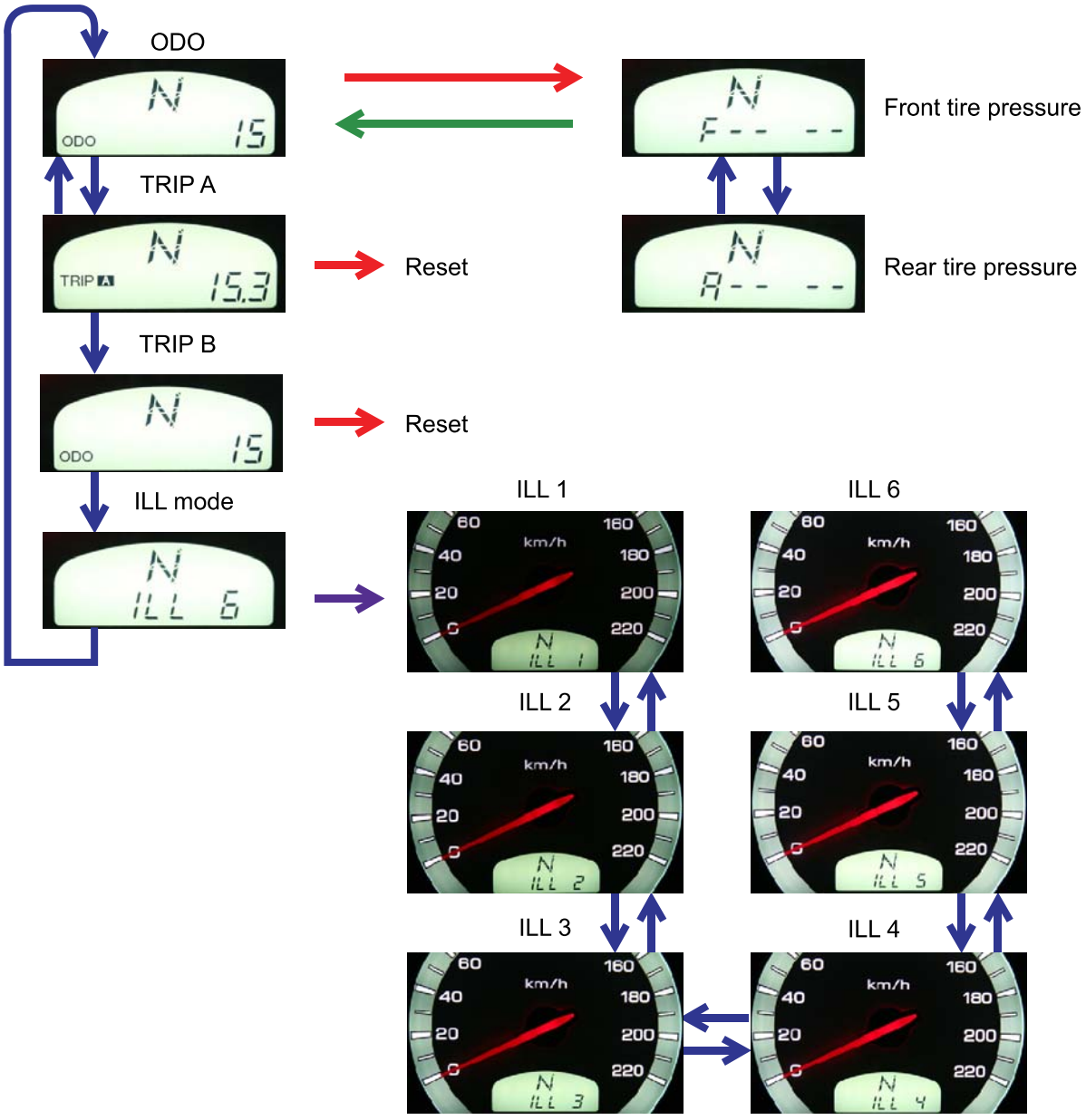


: Press TRIP switch for less than 1 second

: Press TRIP switch for more than 1 second and release it

: Press TRIP switch for more than 3 seconds

: No TRIP switch operation for more than 10 seconds

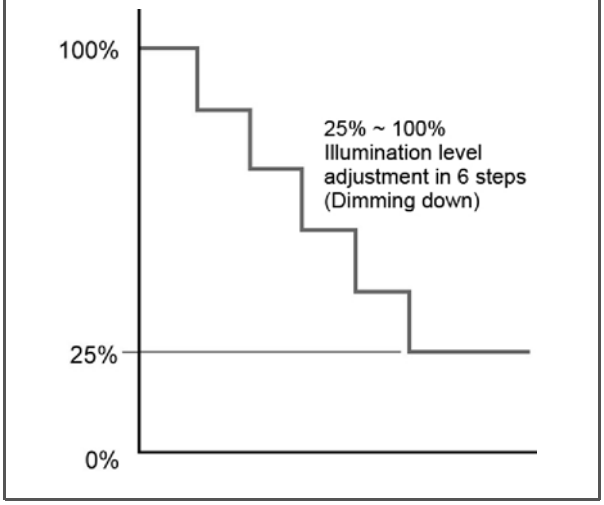


Modification basis	
Application basis	
Affected VIN	

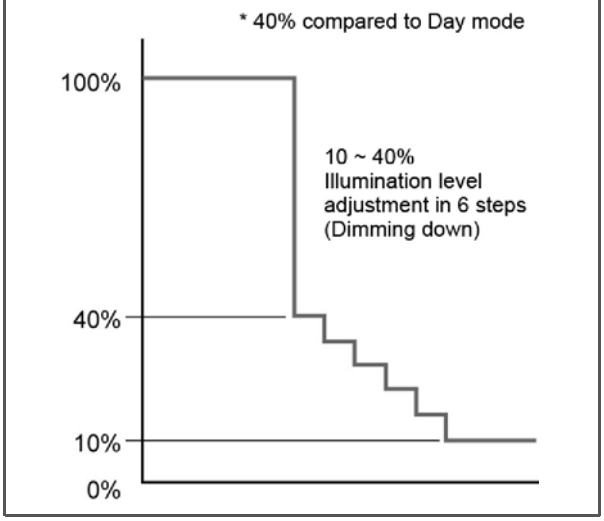
4) Illumination Level Adjustment

The illumination level for instrument cluster can be adjusted by TRIP switch in 6 steps in day mode and night mode.

Day Mode (Tail Lamp OFF)



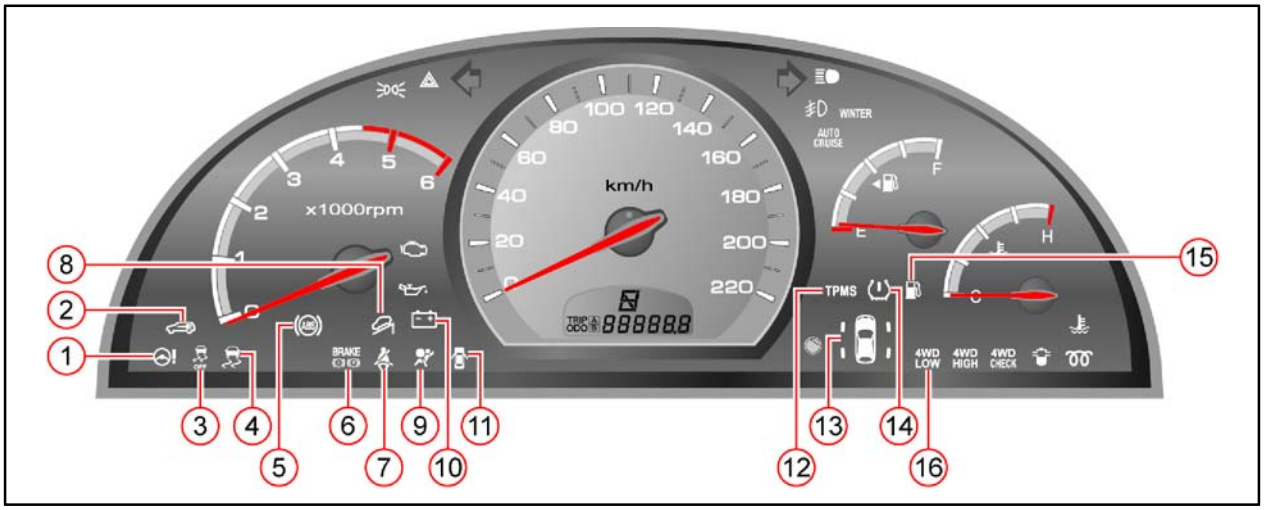
Night Mode (Tail Lamp ON)



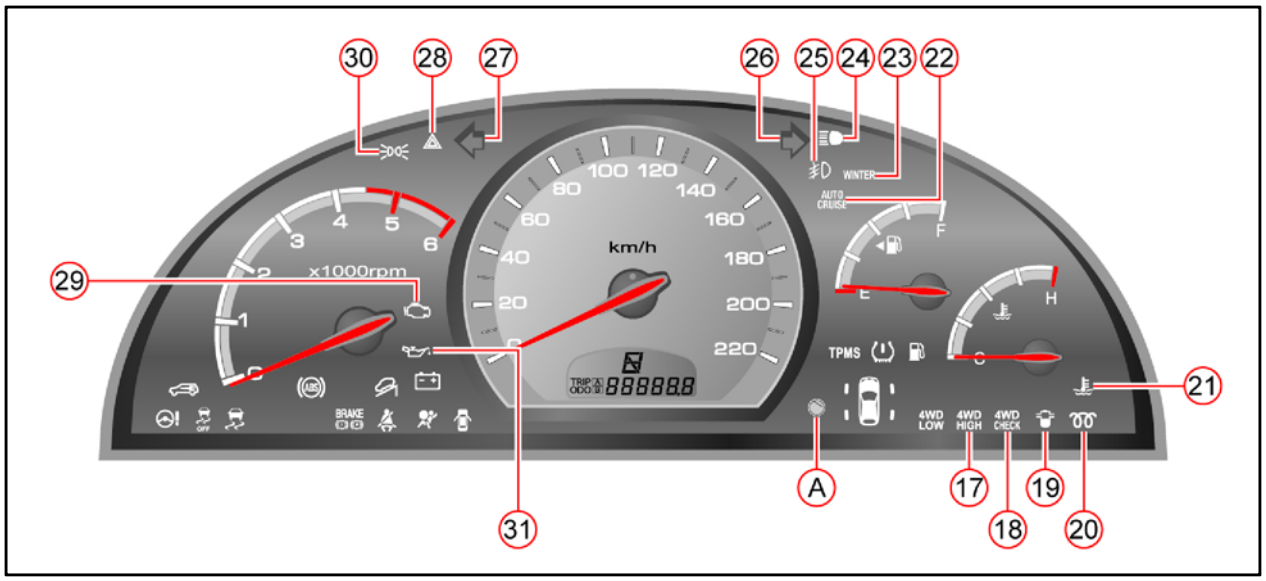
The illumination level for instrument cluster can be adjusted by TRIP switch in 6 steps.

Modification basis	
Application basis	
Affected VIN	

5) System Analysis



No.	Waning lamp/Indicator	Color	Control	Pre-warning
1	SSPS warning lamp	Yellow	Ground signal	
2	Immobilizer indicator	Yellow	CAN	
3	ESP OFF indicator	Yellow	CAN	IGN ON (4±0.2s)
4	ESP indicator/warning lamp	Yellow	CAN	IGN ON (4±0.2s)
5	ABS warning lamp	Yellow	CAN	IGN ON (4±0.2s)
6	Brake warning lamp	Red	Microprocessor	IGN ON (4±0.2s)
7	Seat belt reminder	Red	(-) switch ground	
8	HDC indicator	Red/Green	CAN	
9	Air bag warning lamp	Red (Bulb)	Ground signal	
10	Battery charge warning lamp	Red	Ground signal	
11	Door ajar warning lamp	Red	(-) switch ground	
12	TPMS warning lamp	Red	CAN	IGN ON (4±0.2s)
13	Tire inflation pressure indicator	Green/Yellow		
14	Low tire pressure warning (Global warning)	Yellow	CAN	
15	Low fuel level warning lamp	Yellow	Microprocessor	
16	4WD LOW indicator (TOD, P/TIME)	Yellow	CAN	IGN ON (4±0.2s)

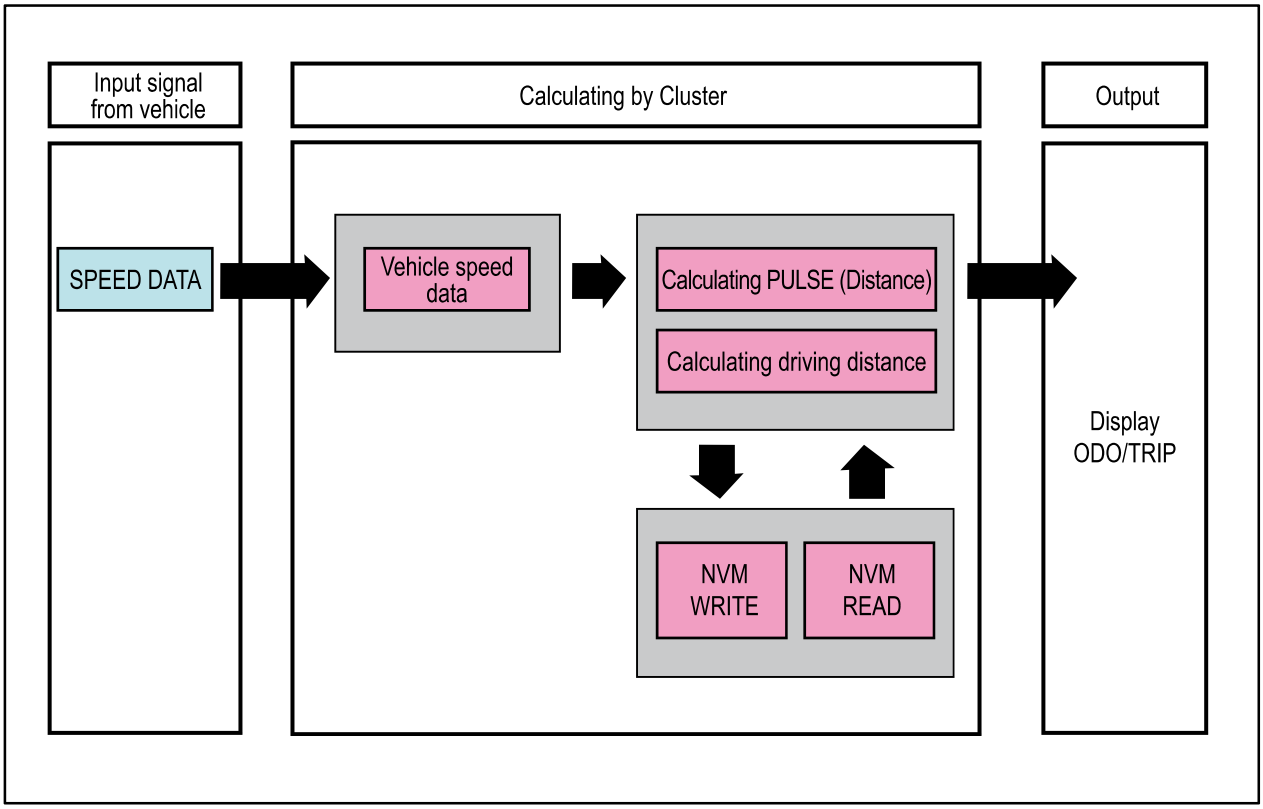


No.	Waning lamp/Indicator	Color	Control	Pre-warning
17	4WD HIGH indicator (P/TIME)	Green	CAN	IGN ON (4±0.2s)
18	4WD CHECK warning lamp (TOD, P/TIME)	Red	CAN	IGN ON (4±0.2s)
19	Water separator warning lamp	Red	CAN	IGN ON (4±0.2s)
20	Glow indicator	Yellow	CAN	
21	Engine overheat warning lamp	Red	CAN	
22	Auto cruise indicator	Green	CAN	
23	Winter mode indicator	Green	CAN	
24	High beam indicator	Blue	External signal	
25	Front fog light indicator	Green	(+) switch ground	
26	Turn signal indicator (R)	Green	(+) switch ground	
27	Turn signal indicator (L)	Green	(+) switch ground	
28	Hazard indicator	Red	Ground signal	
29	Engine check warning lamp	Yellow	CAN, (-) signal	IGN ON (4±0.2s)
30	Light indicator	Green	CAN	
31	Engine oil pressure warning lamp	Red	(-) switch ground	

Modification basis	
Application basis	
Affected VIN	

6) Odometer (ODO) and Trip Meter (TRIP)

The total driving distance (0 to 999,999 km or 0 to 999,999 miles) and the trip distance (0.0 to 999.9 km or 0.0 to 9,999.9 miles) are calculated by using the value of pulse per 1 km which is programmed in the EEPROM.



7) Buzzer

▶ **Specifications**

Function	Signal
Operating temperature	−20 ~ +70 ℃
Storage temperature	−30 ~ +80 ℃
Sound pressure level	70dB/min (2kHz, square wave, 10cm)

▶ **Output**

Description	Buzzer		Priority	Remark
	ON_TIME	OFF_TIME		
Buzzer output (R position)	160ms	-	1	Available only in "R" (M/T) and Non-PAS (outputs 610ms after entering "R" position)
Over-speed warning	500ms	200ms	2	
ESP	100ms	100ms	3	
High temp. warning	500ms	500ms	4	over 120°C
Fuel filter	500ms	500ms	5	ON for 6 seconds then OFF when starting engine (over 400 rpm)

NOTE

The buzzer with lower priority outputs when the buzzer with higher priority is turned off.

Modification basis	
Application basis	
Affected VIN	

8) Functions of HDC Indicator



The brake system operates properly even if the HDC system is defective.
HDC indicator ON when;

- Turning the ignition ON
- There is an error in HDC system
- The brake system overheats

HDC Operation			HDC Indicator	HDC Warning Lamp
			Green	Red
				
Turning the ignition ON (From hence, this signifies the operation mode with engine running. If the ignition is turned OFF, HDC stops the operation even HDC switch is still ON.)			OFF	ON
Not available	HDC switch OFF		ON	OFF
	HDC system is defective		OFF	ON
Stand-by	HDC switch ON		ON	OFF
	HDC switch is turned ON, but it does not operate because the operating requirements (road steep grade or vehicle speed) are not met.			
In operation	HDC is operating		Blinking (0.5s)	OFF
	HDC switch ON and the operating requirements are met.			
System overheats	High temperature of brake system (over 350°C)	Stand-by	OFF	OFF
		In operation	The indicator blinks in green and red (0.5s)	
	Too high temperature of brake system (450°C)		OFF	ON
	No independent temperature sensor, but the programmed logic in HECU estimates the temperature based on the frequency and conditions of HDC.			

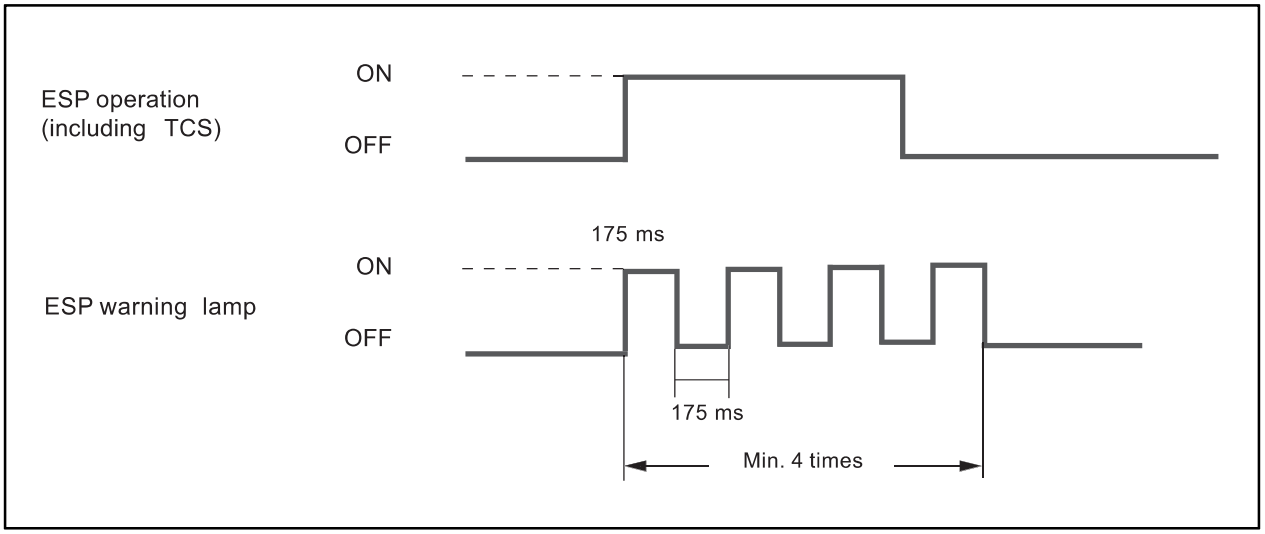
Modification basis	
Application basis	
Affected VIN	

9) 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 at least four times every 175 milliseconds.



▶ ESP System Cancellation Using the ESP OFF Switch



When the ESP switch is pressed (for over approximately 150ms), 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 150ms. The switch returns to normal position when
2. the OFF switch is released. The ESP system will be cancelled after
3. approximately 150ms.

Based on the above procedures, we can see that the ESP system will be cancelled after a certain period (approx. 150ms) 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 pressingthe ESP OFF switch. When you turn the ESP system off by pressing the ESP switch for over 150ms, the TCS system is turned off. And the basic ABS system will operate.

Modification basis	
Application basis	
Affected VIN	

10) TPMS Indicator and Warning Lamps

▶ Tire Pressure Indication



The tire pressure cannot be displayed on the meter cluster immediately after starting the engine. TPMS start to recognize the tire pressures in 10 minutes of continuous driving (over 20 km/h) after starting the engine.If the system is not ready yet, LCD display shows "--".

▶ TPMS Warning Lamp

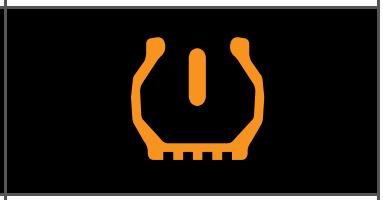
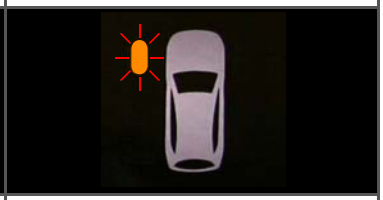
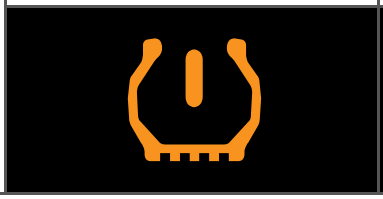
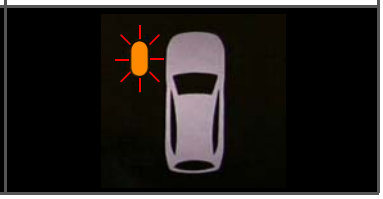
- This warning lamp comes on for 15 seconds (initially) or 10 seconds (resumed from tire pressure indication, alarm or warning condition) when the tire pressure in each wheel is in the specified value.

▶ Tire Pressure Indicator

- The tire pressure indicator appears when pressing the TRIP switch for more than one second in ODO mode.
- The tire pressure indicator returns ODO mode when pressing the TRIP switch for more than one second or wait for more than 10 seconds without any switch input. The tire pressure indicator changes its mode between Front tire mode and Rear tire mode when pressing the TRIP switch for less than one second.
- The LCD display changes to the Trip A mode when pressing the TRIP switch for less than one second in ODO mode.

4. WARNING

▶ **TPMS Warning Lamp and Tire Pressure Warning (Global Warning)**

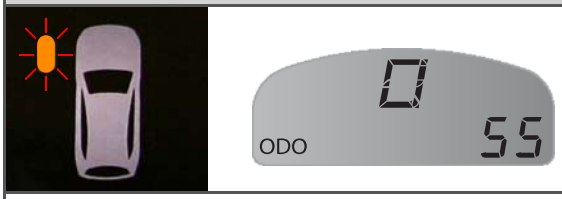
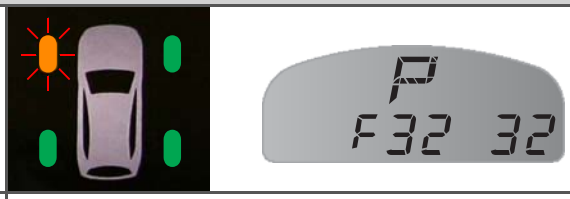
Failure	Warning ON Conditions	
	Warning Lamp	
- Error in TPMS system	- Yellow - Comes on immediately	- Yellow - Blinks (0.4s ON/OFF) for 70 seconds and the stays on
		
- Defective wheel module	- Yellow - Comes on immediately	- Yellow - Affected tire symbol
		
- Error in TPMS system - Low tire pressure - Flat Tire	- Yellow - Blinks (0.4s ON/OFF) for 70 seconds and the stays on	- Yellow - Affected tire symbol
		

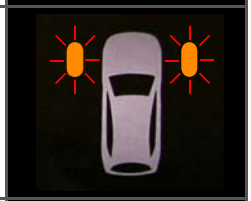
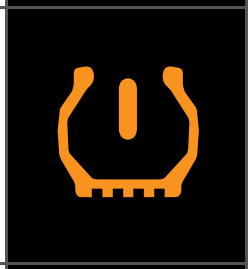
There could be the condition that turns on two warning lamps at a time. In this case, follow the priority as below:

Puncture detected > Low tire pressure > High tire pressure > Imbalance

Modification basis	
Application basis	
Affected VIN	

▶ Tire Pressure Indicator

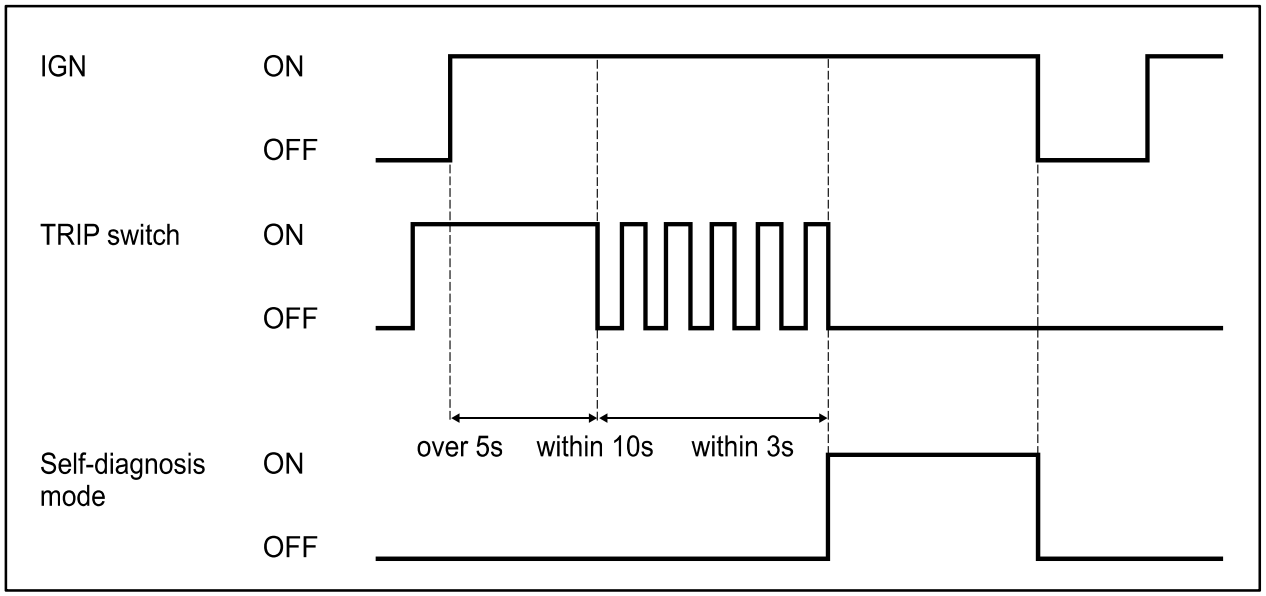
Tire Pressure Indicator (Changed from ODO mode to Tire pressure display mode)	
	
In ODO mode, the symbol for abnormal tire comes on in yellow.	In tire pressure display mode, the symbol for abnormal tire comes on in yellow and the other symbols come on in green.

Tire Pressure	Condition		LED color/ON condition/Indication	
Normal	- Specified tire pressure: 32 psi - 10 minutes of continuous driving (over 20 km/h) * The tire pressure should be measured at 18°C in CVW.		- Comes on in green (10~15 s) and then goes off	
High pressure	- The tire pressure exceeds 48 psi		- Yellow - Blinks (0.2 s ON/OFF)	
Imbalance	- Too high pressure imbalance in tires - Imbalance: over 4 psi		- Yellow - Blinks (1.0 s ON/OFF)	
Insufficient pressure, Low pressure, Punctured tire	- Too low tire pressure		- Yellow - Blinks (0.4 s ON/OFF) for 70 seconds and then stays on	
	Insufficient	Maintained 24~26 psi for more than 10 minutes		
	Low	Below 24 psi	- Yellow - Comes on immediately	
	Punctured	Changes 3 psi a minute while the vehicle is moving		

5. SELF DIAGNOSIS

Activation: 1. Turn the ignition ON with the TRIP switch pressed.
2. Press and hold the TRIP switch 5 to 10 seconds after engine start, and then press it 5 times briefly.
3. The system starts the self-diagnosis.

Deactivation: IGN OFF or engine start



1. Self-diagnosis for gauge

- Speedometer: Check the whole speed range (minimum to maximum).
- Tachometer: Check the whole rpm range (minimum to maximum).

2. Self-diagnosis for symbols

- All symbols ON
  (except the wired type symbols: air bag, passenger air bag, turn signal, hazard, high beam, front fog light)

3. Others

- When entering into the self-diagnosis mode, the instrument cluster illumination output will be 100%. All the remaining segments are ON.
- The mode and illumination switch inputs are overridden.
-

5. VARIANT CODING

- The instrument cluster enables all functions by receiving the vehicle's variant codes through CAN lines when turning the ignition switch to ON position.
- The verified system by variant code activates the pre-warning and time-out operation. If not verified, all data for the systems, even exiting in CAN network, are overridden.

Modification basis	
Application basis	
Affected VIN	

SWITCH

8511-29

GENERAL INFORMATION

1. SPECIFICATIONS

1) Multi-Function Switch

Description			Specifications
Multifunction switch	Rated voltage		DC 12V
	Operating temperature range		−30℃ ~ +80℃
	Rated load	Light switch	Turning on: 1 A (Relay load)
		Dimmer and passing switch	High beam: 9.2 A (Realy load)
			Low beam: 1 A (Realy load)
			Passing: 10 A (Relay load)
		Turn signal light switch	6.6 ± 0.5A (Relay load)
		Wiper switch	Low: 5 A, High: 7 A (Motor load)
			Intermittent: 0.22 ± 0.05 A (Relay load)
			Fixed: Max. 28 A (Motor load)
		Washer switch	4A(Motor load)
		Intermittent wiper switch	Max. 25 mmA
		Horn connector	1A (Relay load)

2) Center Switch Cluster

Description		Specification
Center switch cluster	Hazard switch	DC 12V, 10A (Lamp load)
	Windshield heated glass switch	DC 12V, 0.1A (Indicator load)
	Tailgate and outside rearview mirror heated glass switch	
	ESP OFF switch	
	HDC switch	
	PAS OFF switch	

2. MAJOR CHANGES

Center Switch Cluster	
Old	**New**
	
Changed to independent switch type from integrated switch type	

Hazard Switch	
Old	**New**
	
Changed the design of hazard switch	

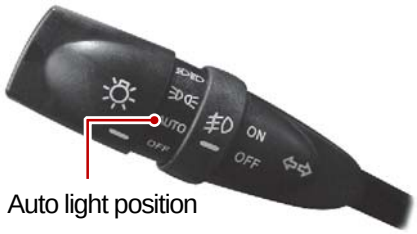
Modification basis	
Application basis	
Affected VIN	

Memo

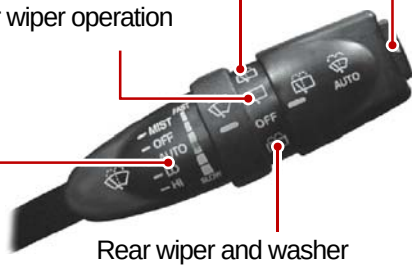
OVERVIEW AND OPERATION PROCESS

1. OVERVIEW

Multifunction Switch



Auto light position



Rear wiper and washer coupled operation

Rear wiper operation

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 automatically operate 3 times.

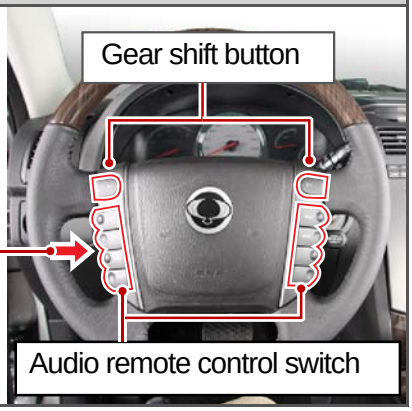
Rear wiper and washer coupled operation.

Front wiper operation range(move the wiper lever up/down)

Remote Audio Controls & Gear Shift Button (A/T) on Steering Wheel

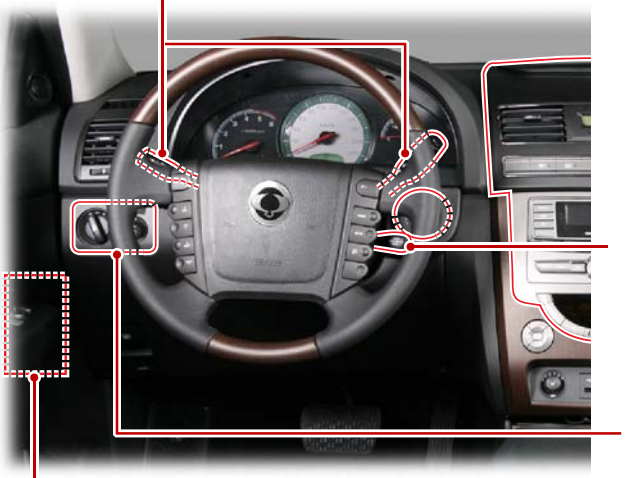
Audio power switch





Gear shift button

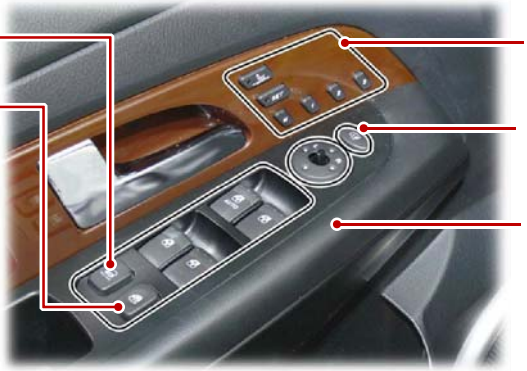
Audio remote control switch



Door Switches (Driver side)

Door lock/unlock switch

Driver's Power Window Switch
Driver can controls all door windows (Open/Close/Lock/Unlock) and doors (Lock/Unlock) with this switch unit.



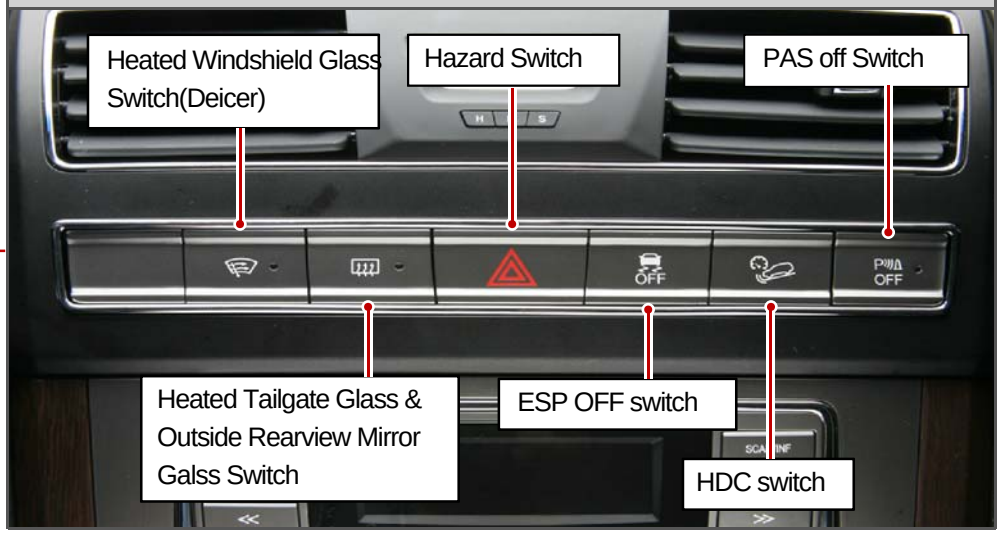
Easy access & seat memory switch

Outside rearview mirror folding switch

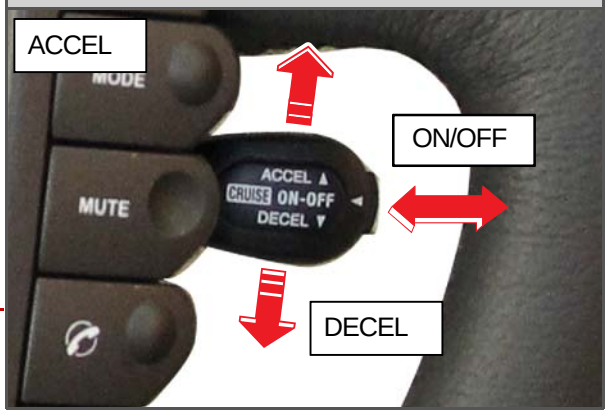
Outside rearview mirror adjustment switch

Modification basis	
Application basis	
Affected VIN	

Center Switch Cluster

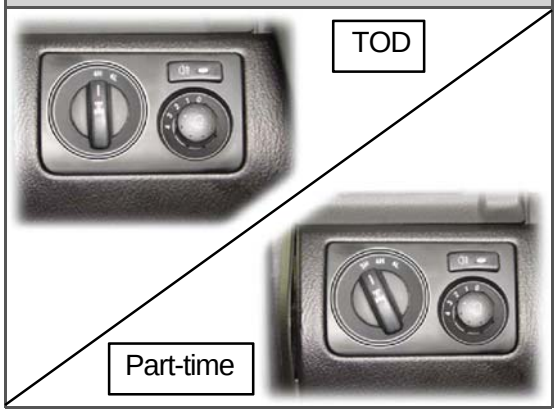


Cruise Control Switch

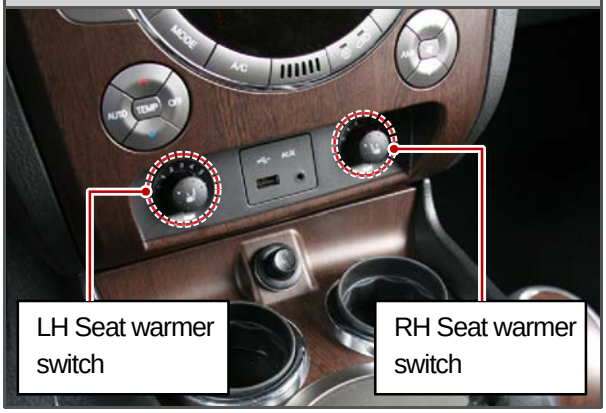




4WD Switch



Front Seat Heating Switch



Modification basis	
Application basis	
Affected VIN	

LAMP

8310-00

GENERAL INFORMATION

1. SPECIFICATIONS OF LAMPS

▶ **Exterior Lamps**

Description		Numbers	GEN	EU
Headlamp	High beam	2	55W	55W/15W
	Low beam	2	55W	55W
	Tail/Position lamp	4	LED	LED
Front combination lamp	Front fog lamp	2	35W	35W
	Turn signal lamp	2	21W	21W
Outside turn signal lamp (supplemental turn signal lamp)		10	LED	LED
Rear combination lamp	Stop lamp (Upper)	32	LED	LED
	Stop lamp (Lower)	24	LED	-
	Tail lamp	16	LED	LED
	Turn signal lamp	2	21W	21W
	Back-up lamp	2	16W	16W
	Rear fog lamp	2	-	21W
High mounted stop lamp	Stop lamp	18	LED	LED
High mounted stop lamp		2	16W	16W

▶ **Interior Lamps**

Description	Specification	Numbers
Front room lamp	10W	2
Glove box lamp	10W	1
Center room lamp	10W	1
Rear room lamp	10W	1
Door courtesy lamp	5W	4
Sun visor lamp	0.15A	2

2. SPECIFICATIONS OF AUTO LIGHT

Description	Specification
Operating voltage	9V ~ 16V
Load	Maximum 200 mA (relay load)
Operating temperature	−30℃ ~ 85℃
Operating temperature	−40℃ ~ ±120℃
Location	Top center of inner side of windshield glass

reference In vehicle for EU market, the auto light function is not available.

NOTE

▶ LED

- The LED stands for "Light Emitting Diode" or "Luminescent Diode." LED is a semiconductor diode that emits incoherent narrow-spectrum light when electrically biased in the forward direction of the p-n junction, as in the common LED circuit. In short, it is an element that converts electric signals into light signals. Yellow, blue, red and white LEDs are currently available.
  The followings are the advantages of LED.
- It is not glaring and doesn't have short circuit unlike the conventional lamps.
  It is semi-permanent and doesn't generate heat.
  Its power consumption is much lower than those of conventional bulbs.

▶ **Luminous Intensity**

- Luminous intensity is a measure for the amount of light which passes through the unit area per time unit. The SI unit of luminous intensity is the candela (cd), an SI base unit.

▶ **Luminance**

- Luminance describes the amount of light that passes through or is emitted from a particular area, and falls within a given solid angle. It is measured in stilb (sb) or nit (nt).

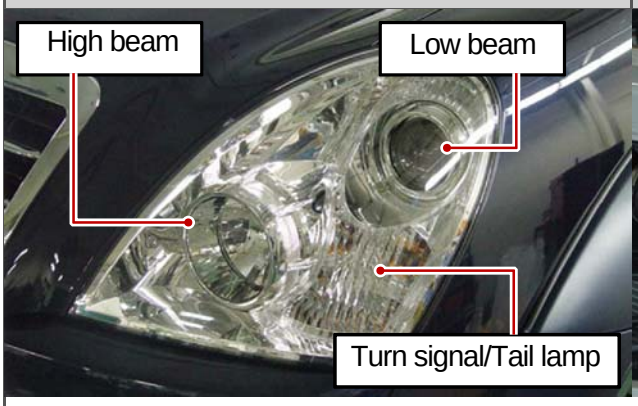
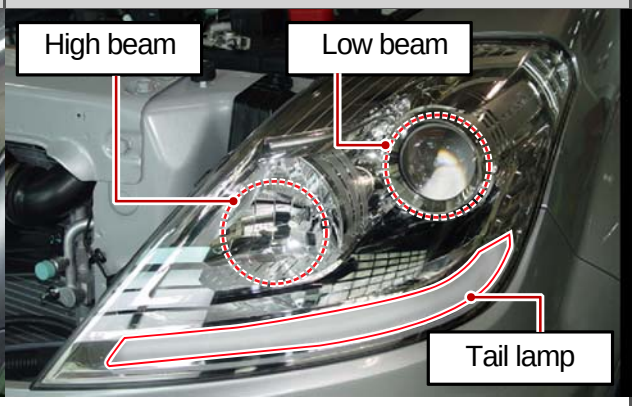
▶ **Intensity of illumination**

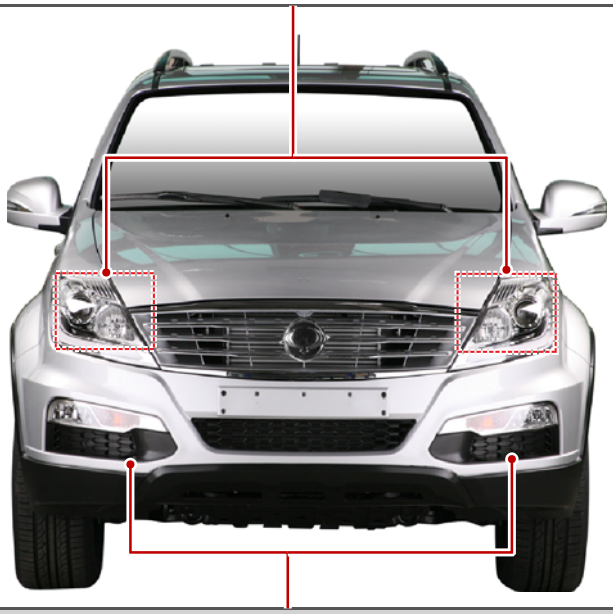
- This indicates the amount of light reaching a given area. Measuring unit is lux (lx) and it is not directly proportional to the brightness of the area as the reflection rate is not included.

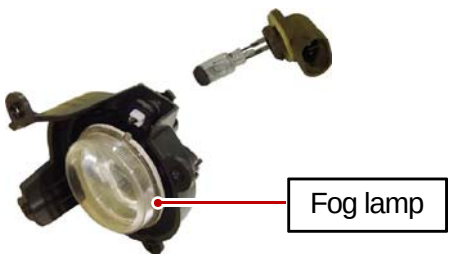
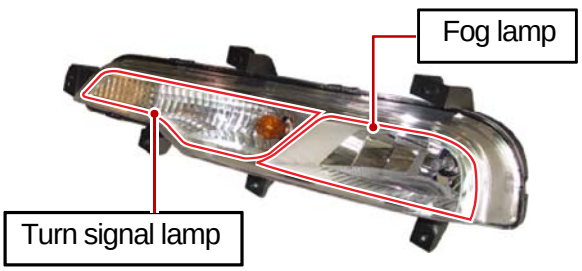
Modification basis	
Application basis	
Affected VIN	

3. MAJOR CHANGES

▶ Front Side

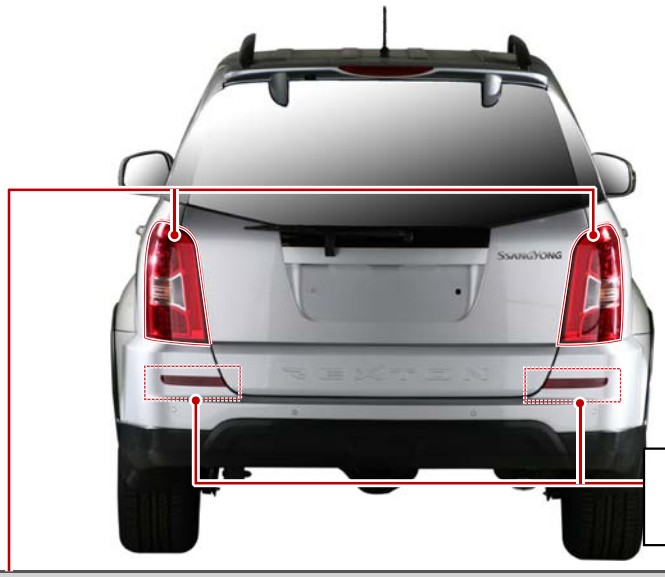
Head Lamp	
Old	**New**
	
- Changed the head lamp design and functions. - Deleted the turn signal lamp and changed the tail lamp to LED type from bulb type.	

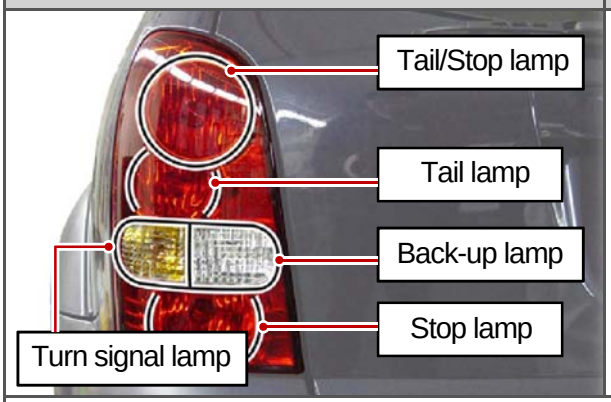
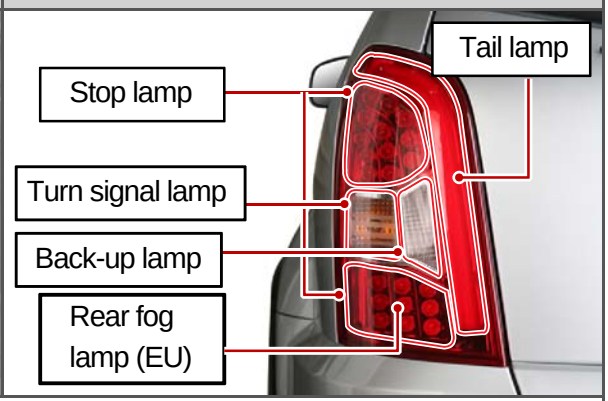


Front Combination Lamp	
Old	**New**
	
- Integrated the fog lamp and turn signal lamp.	

Modification basis	
Application basis	
Affected VIN	

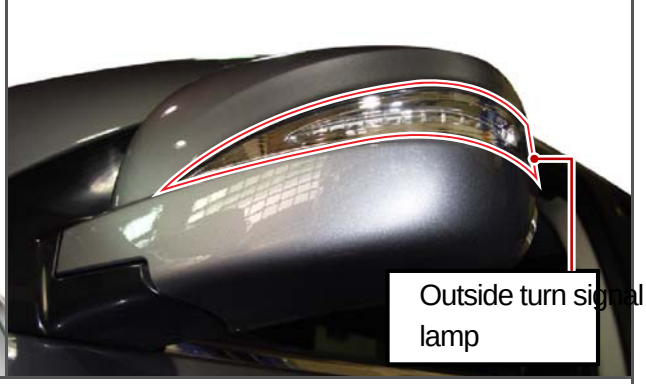
▶ Rear Side



Rear Combination Lamp	
Old	**New**
	
- Changed the design and functions of rear combination lamp. - Changed the stop lamp and tail lamp to LED type from bulb type.	

Modification basis	
Application basis	
Affected VIN	

▶ Others

Outside Turn Signal Lamp	
Old	**New**
	
- Introduced new outside turn signal lamp (LED type).	



Side Repeater Lamp

- Deleted the side repeater lamp.

OVERVIEW AND OPERATING PROCESS

1. EXTERIOR LAMPS

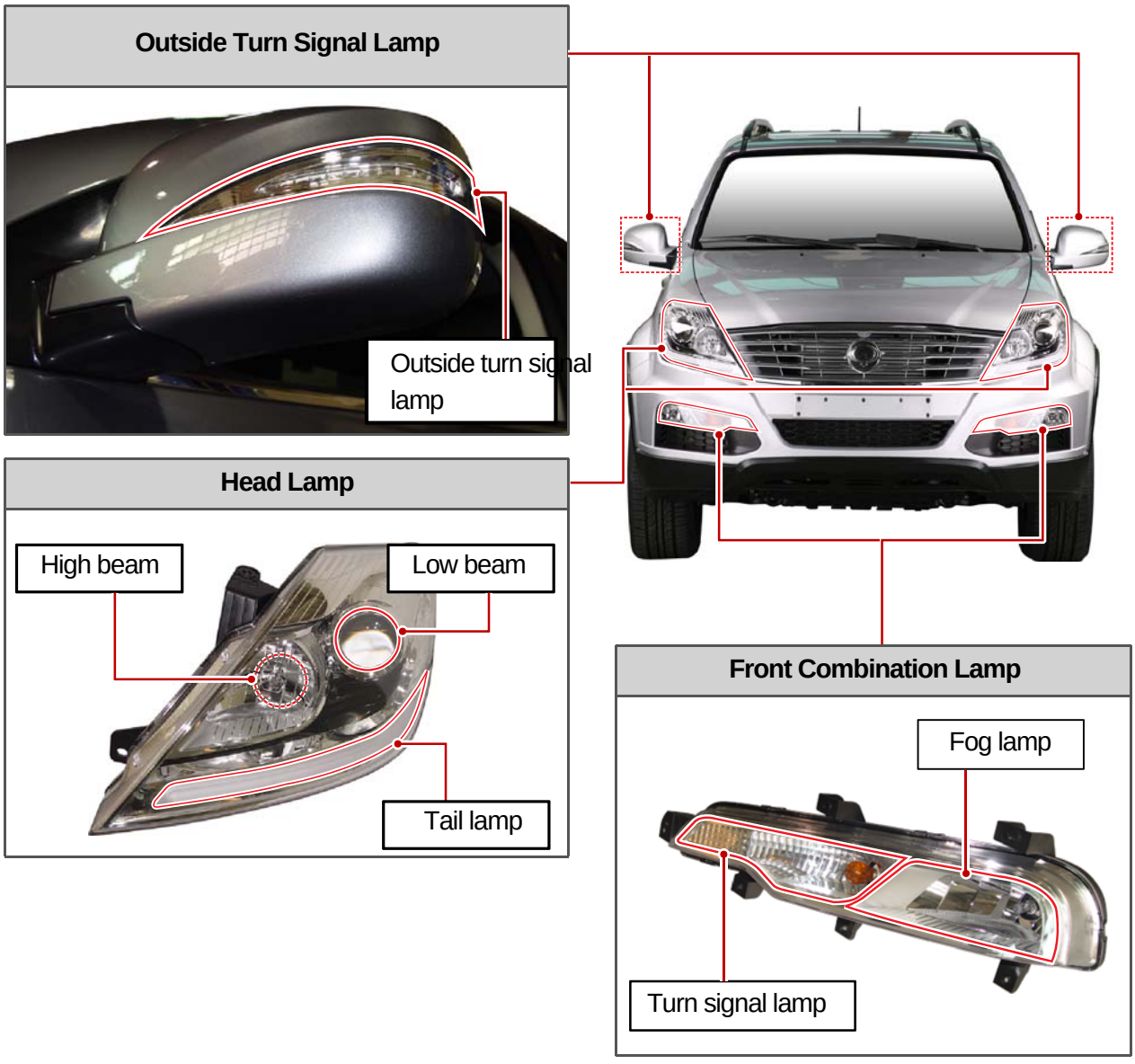
1) Overview

The exterior lamps consist of front lamps, rear lamps and side lamps.

- Front lamps: Head lamp, Front combination lamp
- Rear lamps: Rear combination lamp, License plate lamp, High mounted stop lamp, Reflex reflector
  Side lamps: Outside turn signal lamp
-

2) Layout

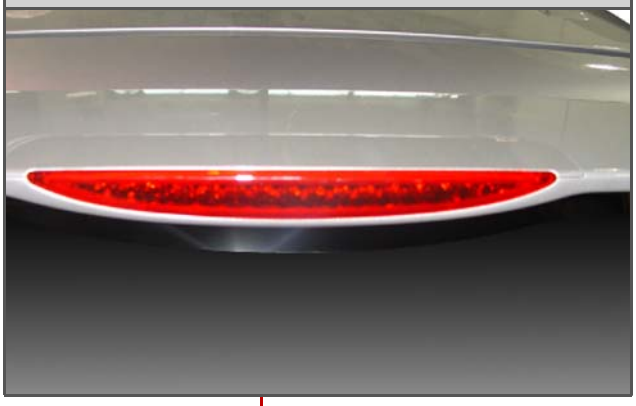
▶ Front Side



Modification basis	
Application basis	
Affected VIN	

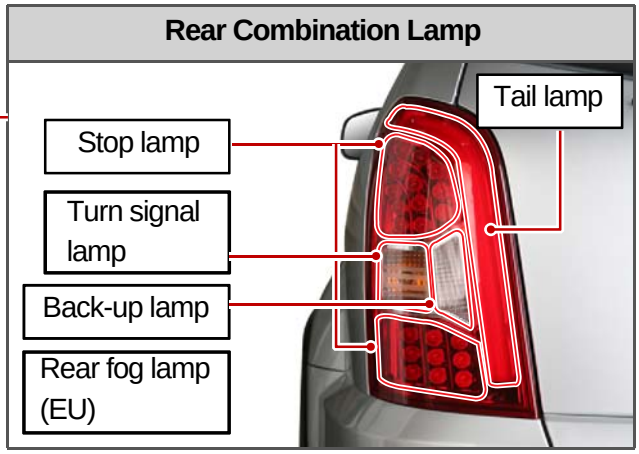
▶ Rear Side

High Mounted Stop Lamp





Rear Combination Lamp



License Plate Lamp



Reflex Reflector

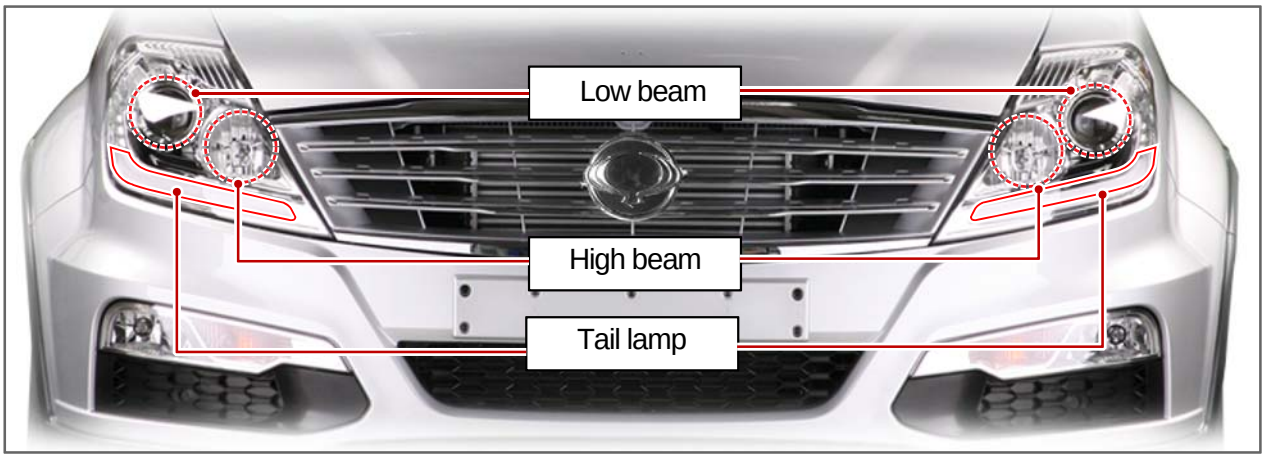


Modification basis	
Application basis	
Affected VIN	

3) Operating Process

(1) Head lamp aiming (Up/Down)

Ordinary operations of head lamp are controlled by the light switch on multifunction switch. The operations by REKES are controlled by STICS.
STICS controls the head lamp and tail lamp with LIN data from the auto light sensor when the light switch is in "AUTO" position.



▶ DRL (Day Time Running Light)

DRL is the function to turn on the high beam and tail lamp without any intervention from the light switch. DRL turns off the lamps when turning off the light switch. This is an additional safety device to prevent the accident.

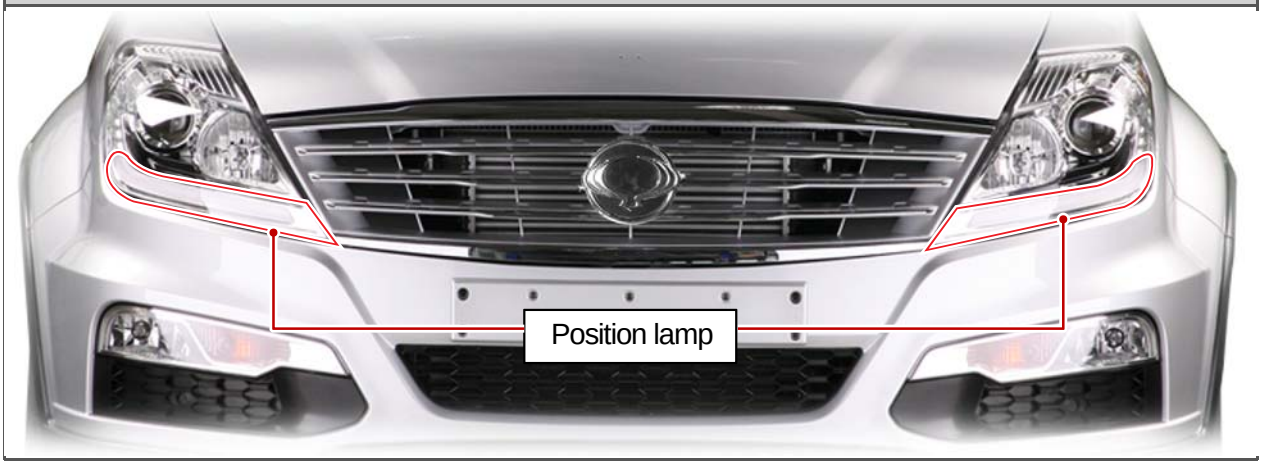
reference Available only for EU market.

Modification basis	
Application basis	
Affected VIN	

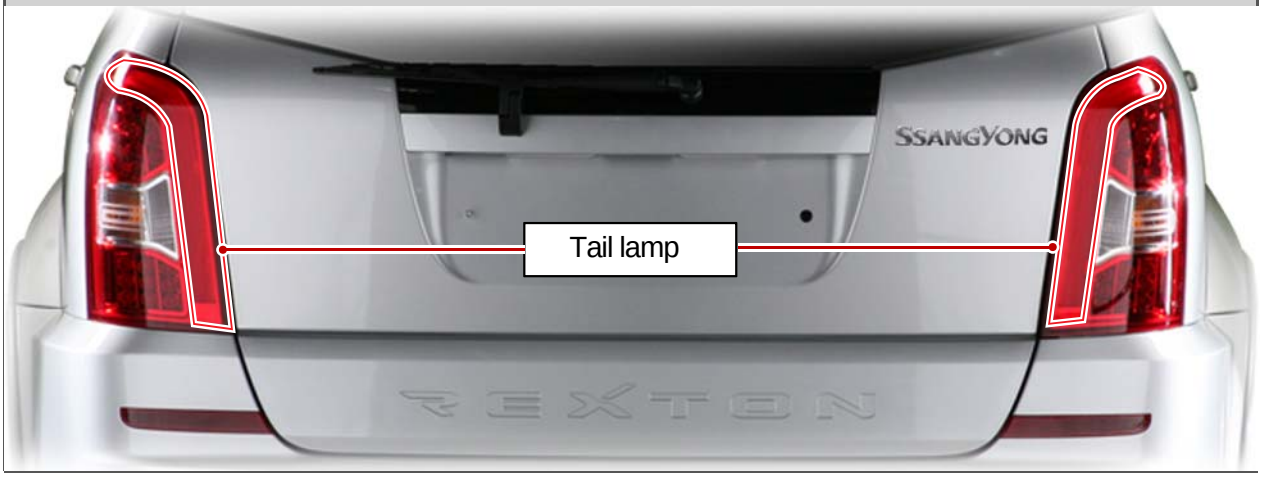
(2) Tail Lamp

STICS turns on the tail (position) lamp relay when receiving the lamp on signal from the light switch.

Front Side



Rear side

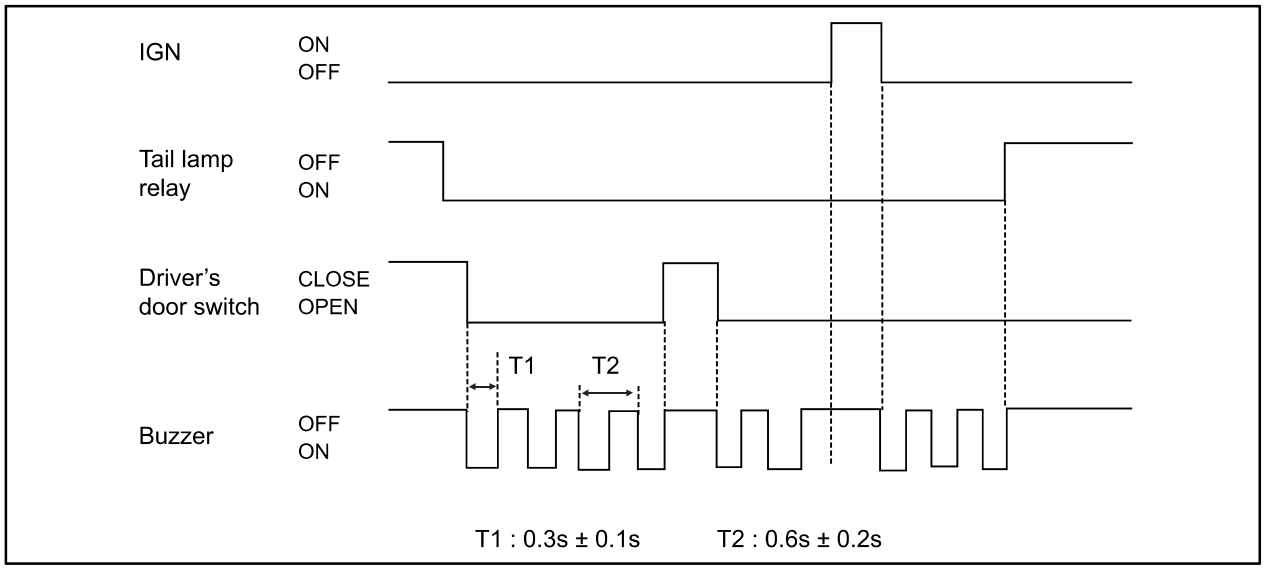


reference In vehicle for EU market, the tail (position) lamp comes on when turning the ignition switch to ON position regardless of light switch operation.

▶ Control by STICS

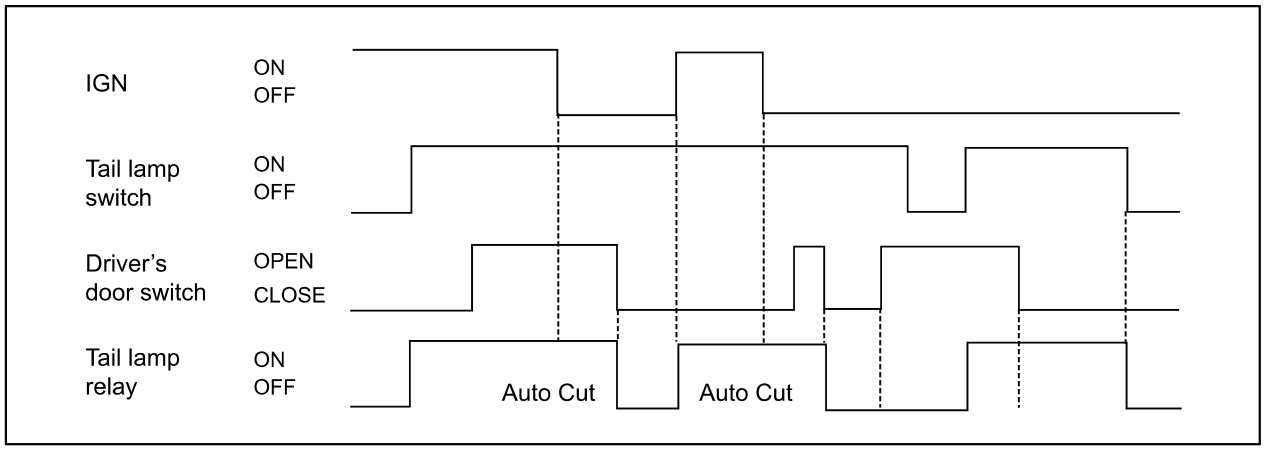
- **Tail Lamp Left ON Warning**

1. The buzzer sounds with the interval of 0.3 second when opening the driver's door while the tail lamp is turned on and the ignition key is removed.
2. The 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.



- **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 not turned off automatically (auto cut) when opening and closing the driver's door while the ignition is removed and the tail lamp is turned on.

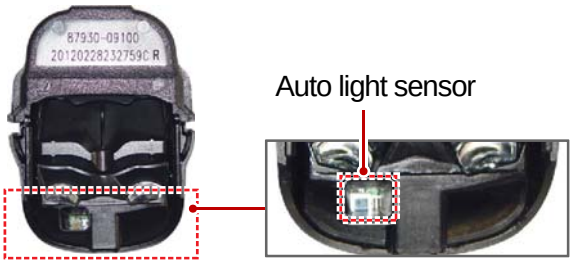


reference Not available for EU market.

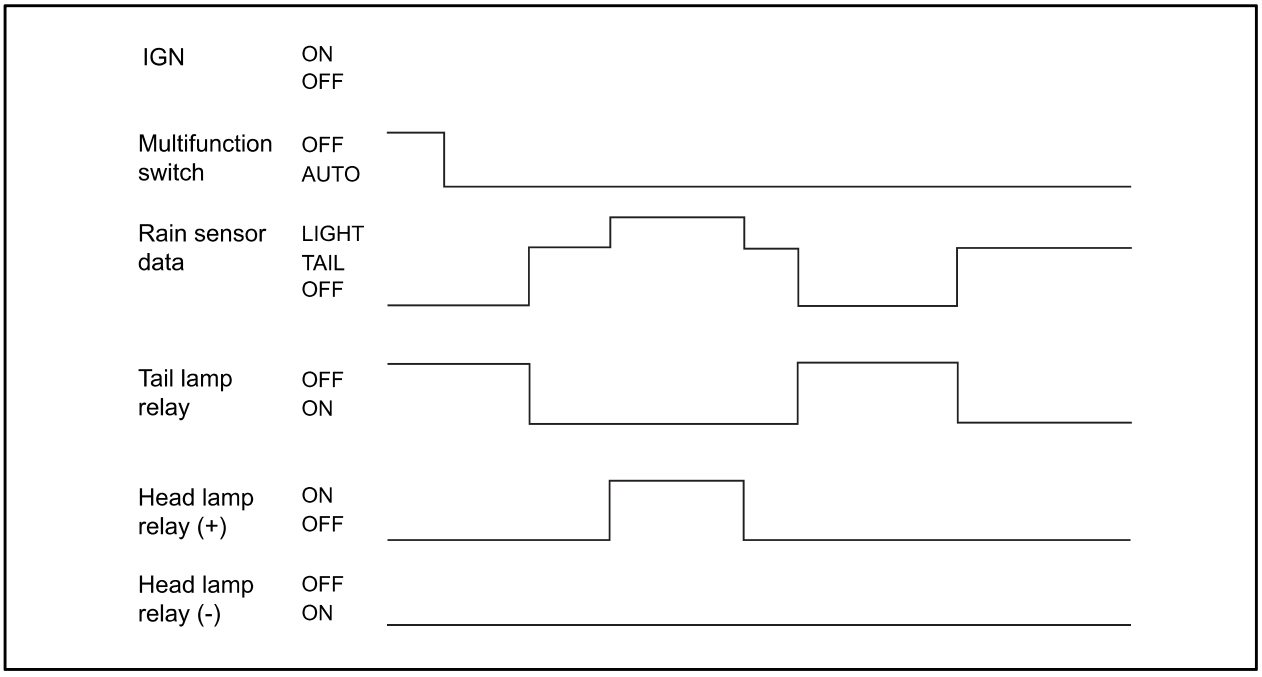
Modification basis	
Application basis	
Affected VIN	

(3) Auto Light

The auto light sensor unit is installed to the back side of the ECM mirror located upper center of the windshield, and detects the illuminance change. The STICS communicates with the auto light sensor when the ignition is turned on, and turns on or off the tail lamp and headlamp automatically according to the signals from the sensor when the light switch is set to AUTO position.

Light Switch	Rain Sensor Unit (Integrated auto light sensor)
	

▶ **STICS controls the head lamp and tail lamp with LIN data with IGN ON and the light switch** in "AUTO" position.



reference Not available for EU market.

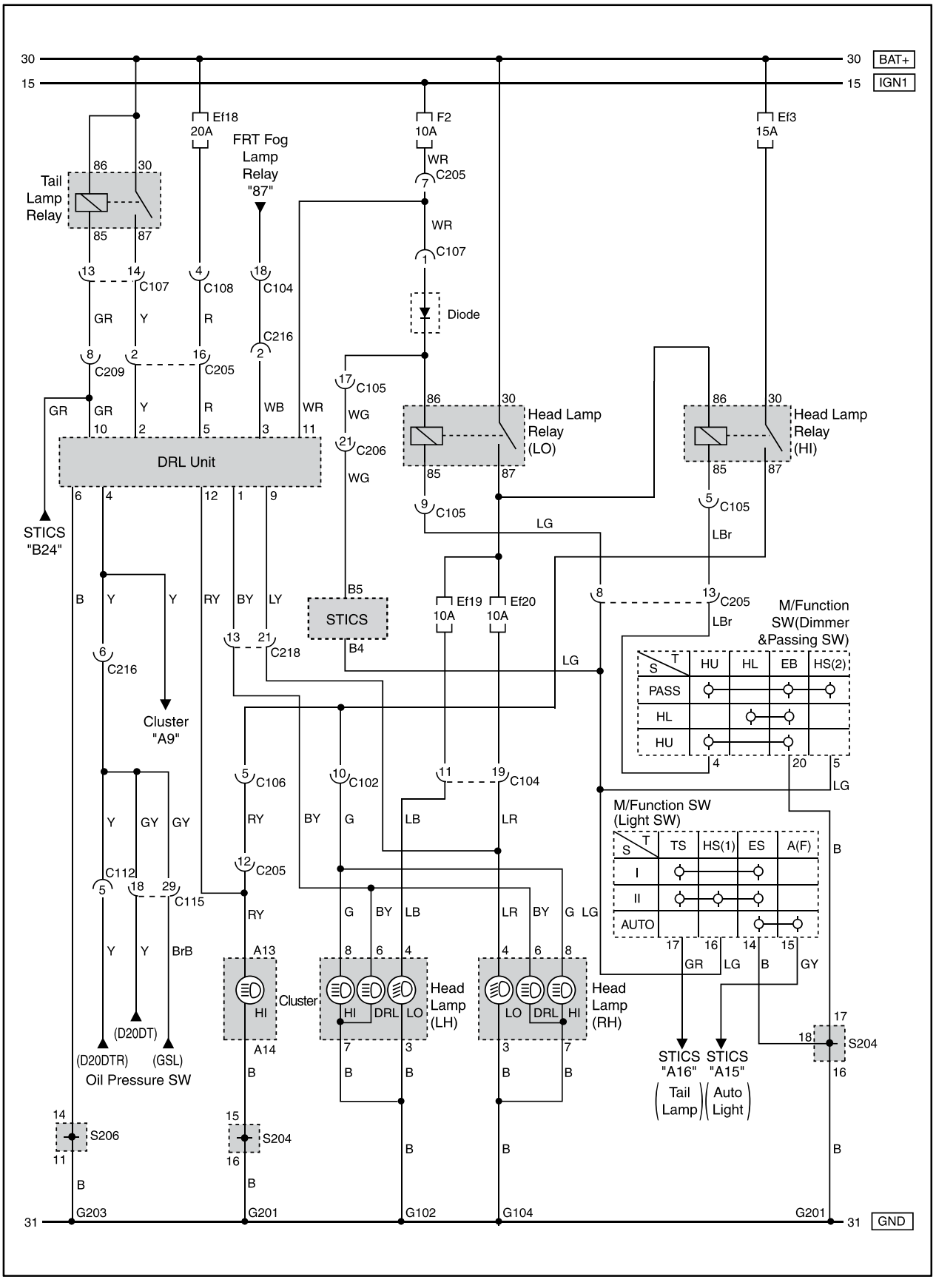
(4) License Plate Lamp



The license plate lamp comes on when the light switch is turned on (Tail, AUTO, Low, High).

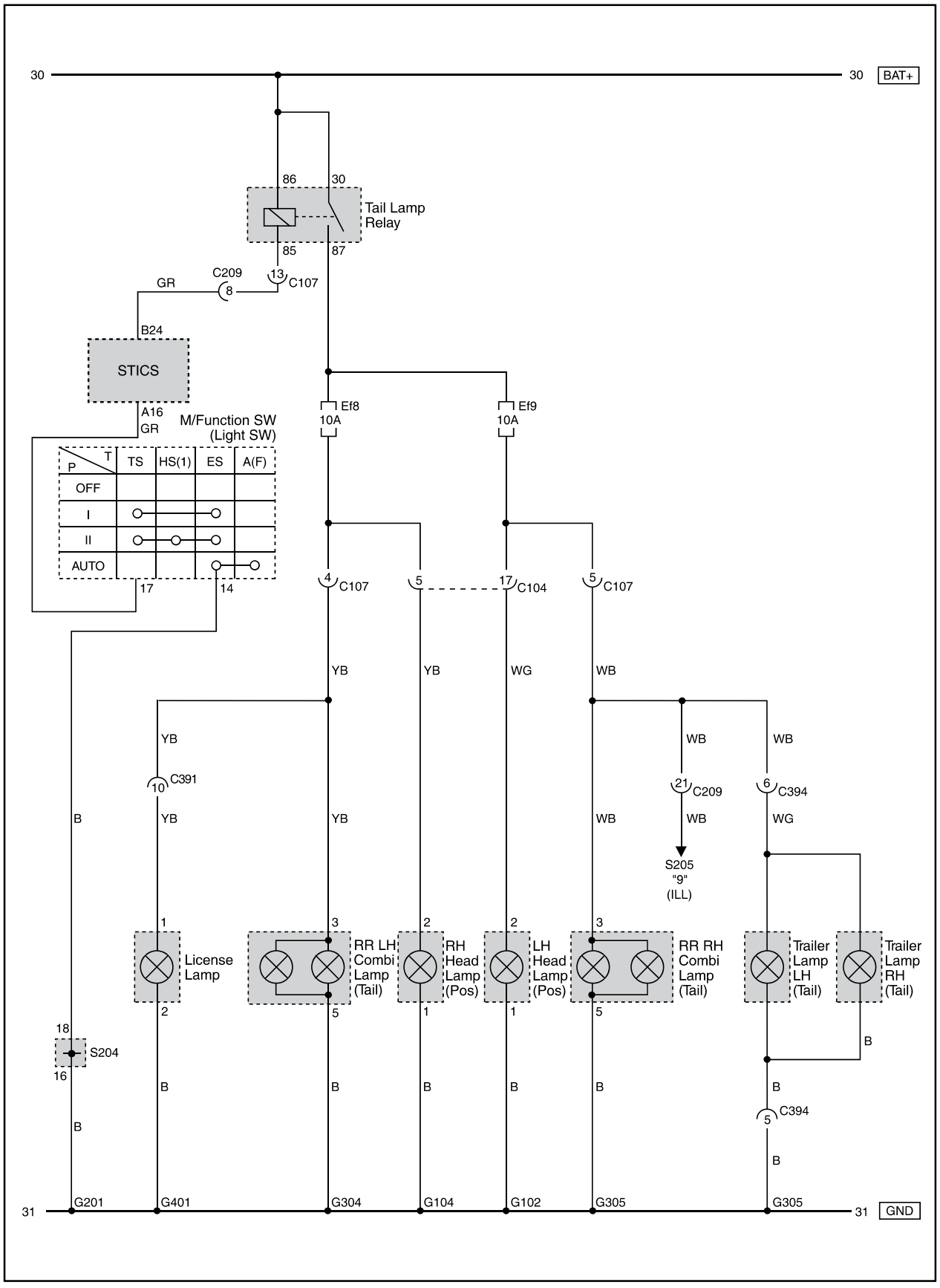
Modification basis	
Application basis	
Affected VIN	

▶ Circuit Diagram of Head Lamp



Modification basis	
Application basis	
Affected VIN	

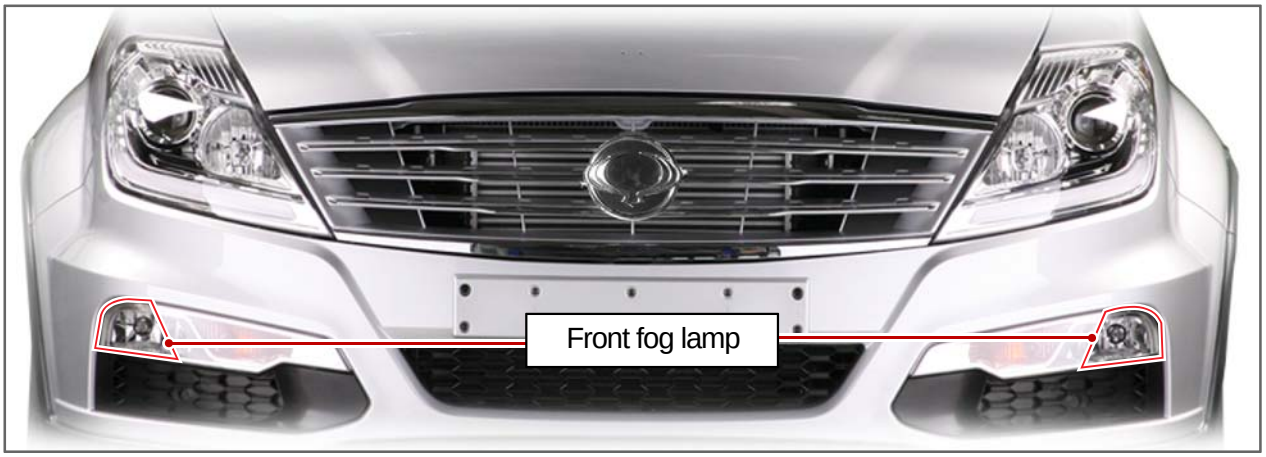
▶ Circuit Diagram of Tail Lamp



Modification basis	
Application basis	
Affected VIN	

(5) Front Fog Lamp

The front fog lamp comes on when the front fog lamp is turned on only with the light switch ON.
The front fog lamp goes out when turning off the ignition or light switch.



▶ **Rear Fog Lamp (for EU)**



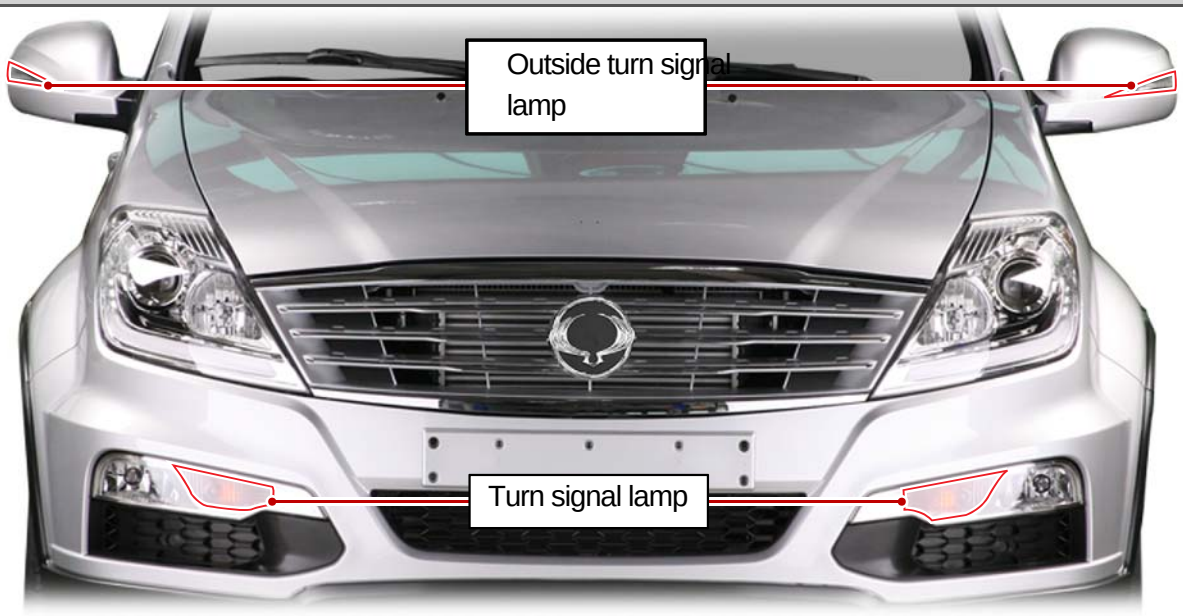
Rear Fog Lamp Switch


- The rear fog lamp comes on when the rear fog lamp is turned on only while the front fog lamp is ON.

(6) Turn Signal Lamp

The left or right turn signal lamp blinks when moving the light switch to appropriate direction. When pressing the hazard switch, both turn signal lamps come on simultaneously.

Front Side



Rear Side

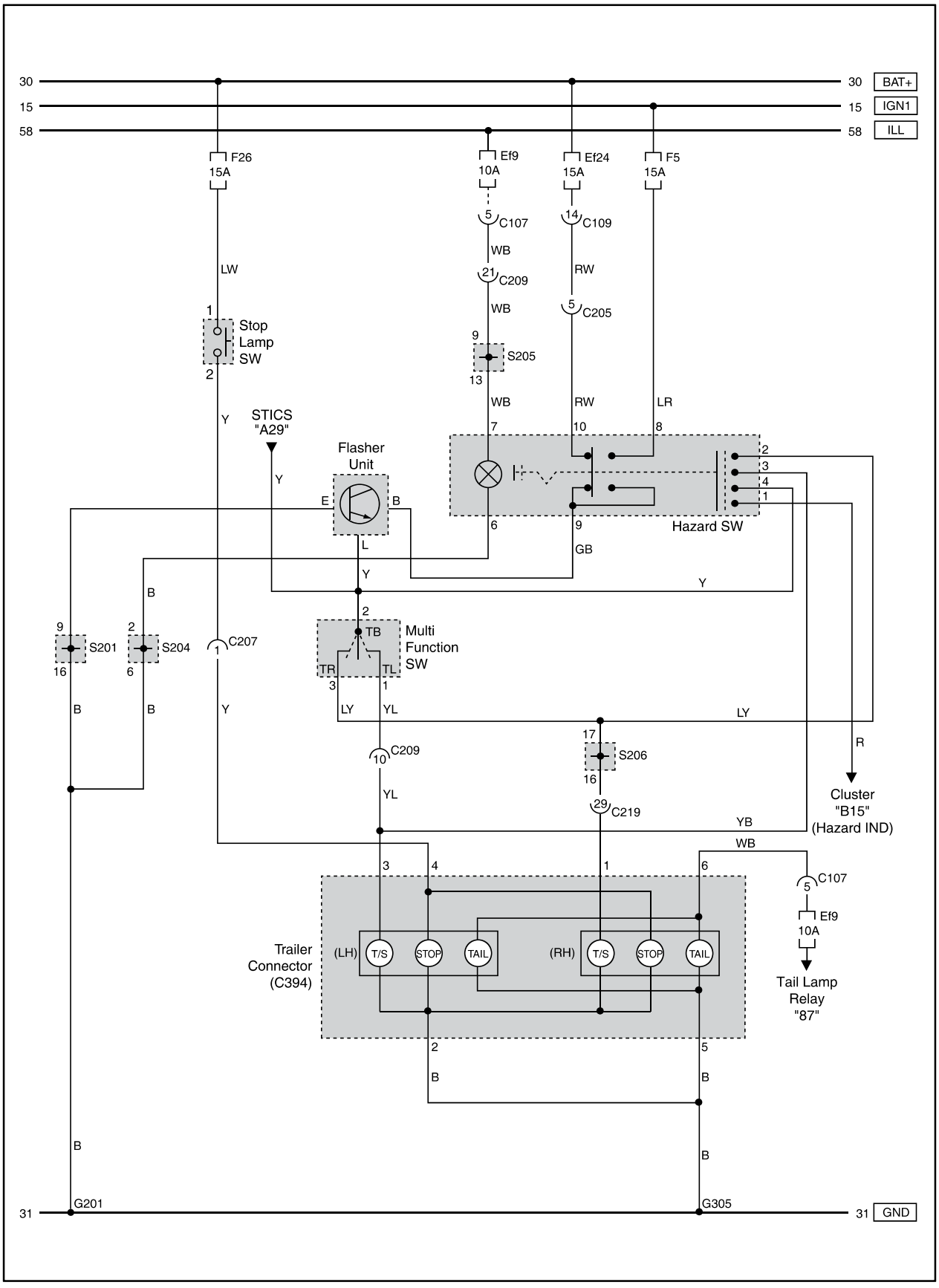


▶ Turn Signal Lamp OFF Conditions

- The turn signal lamp goes out when the steering wheel angle (same direction with turning direction) becomes below 60° from over 70° after turning on a turn signal lamp.
- The turn signal lamp goes out when the steering wheel angle (opposite direction with turning direction) becomes over 70° from below 70° after turning on a turn signal lamp.

Modification basis	
Application basis	
Affected VIN	

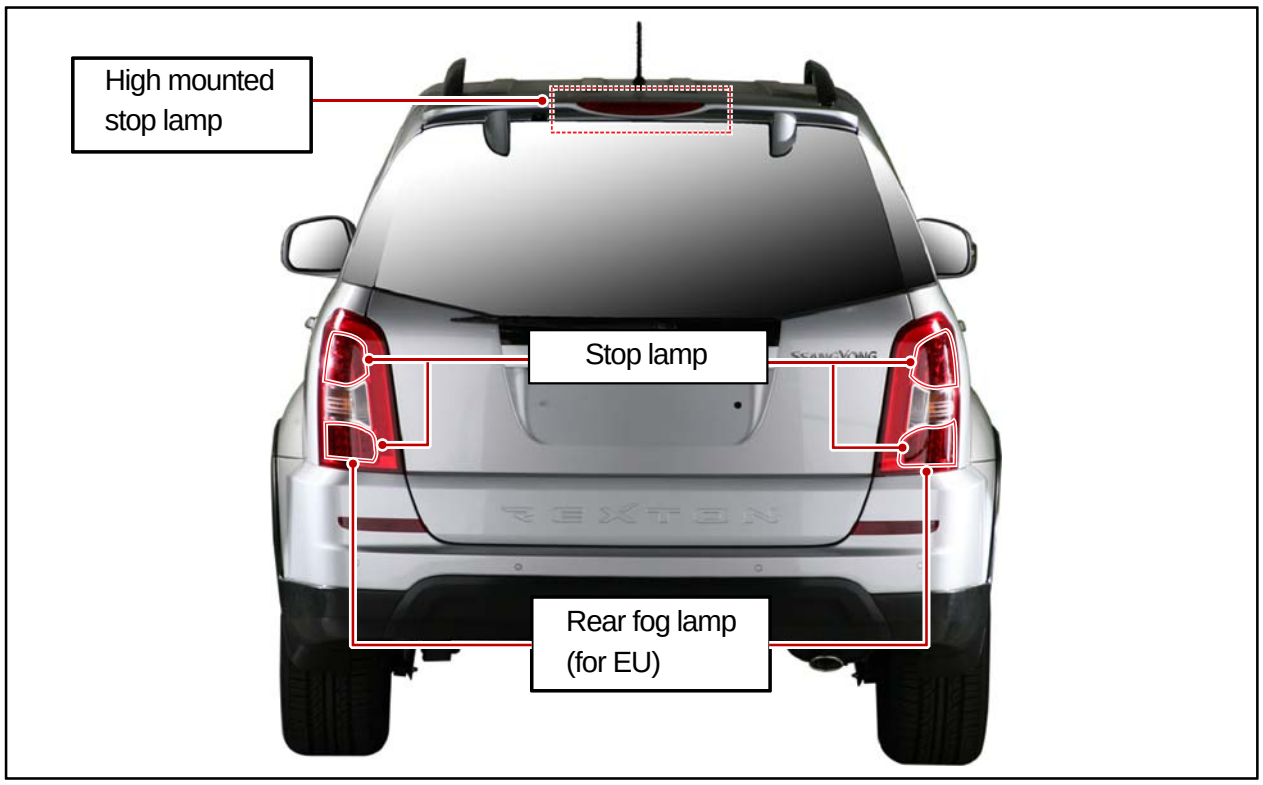
▶ Circuit Diagram of Turn Signal Lamp



Modification basis	
Application basis	
Affected VIN	

(7) Stop Lamp

The stop lamp switch turns on the stop lamp when depressing the brake pedal. When releasing the brake pedal, the stop lamp goes out.



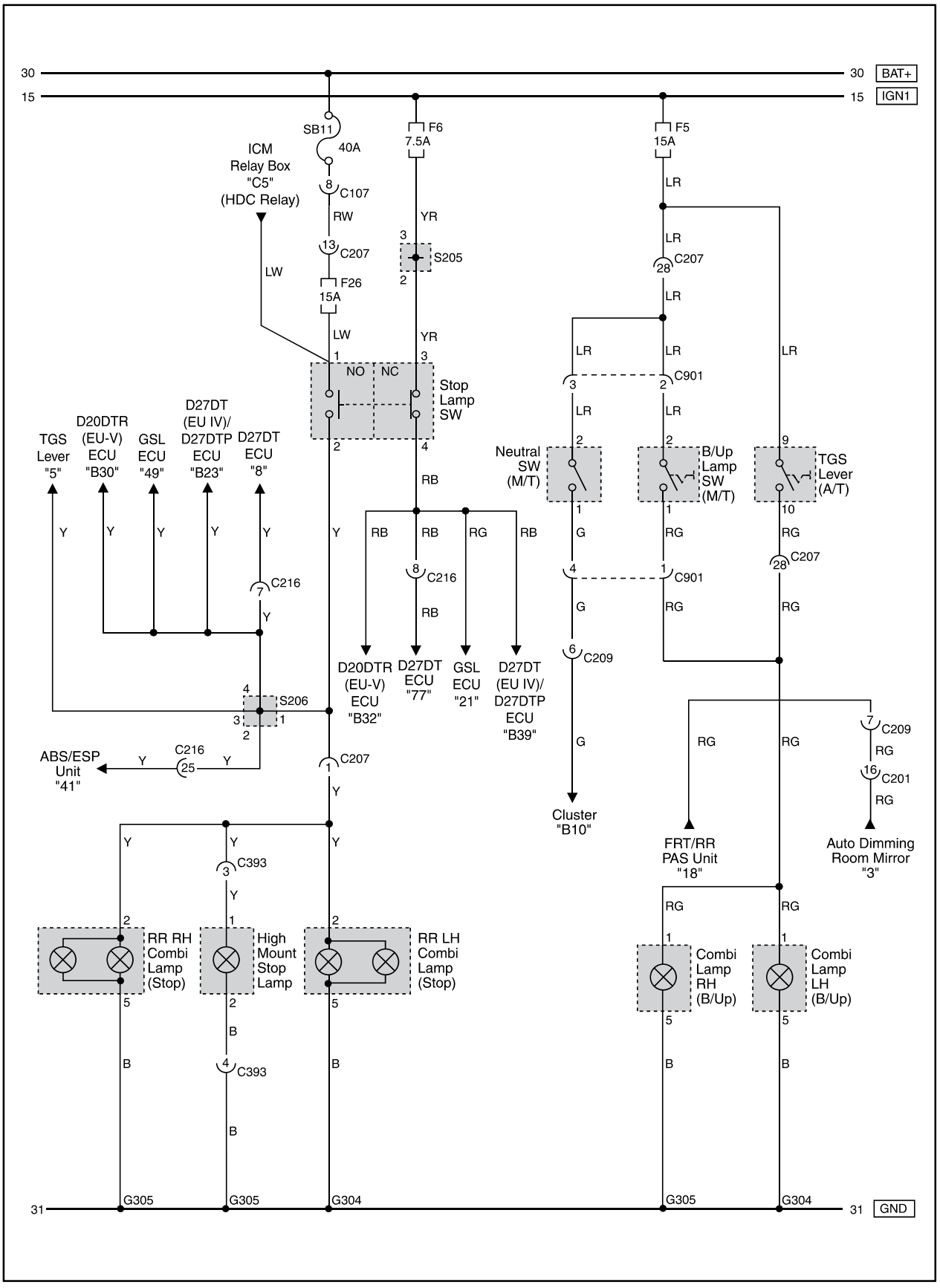
(8) Back-up Lamp

The back-up lamp comes on when moving the gear shift lever to “R” position with IGN ON.



Modification basis	
Application basis	
Affected VIN	

▶ Circuit Diagram of Stop Lamp and Back-up Lamp



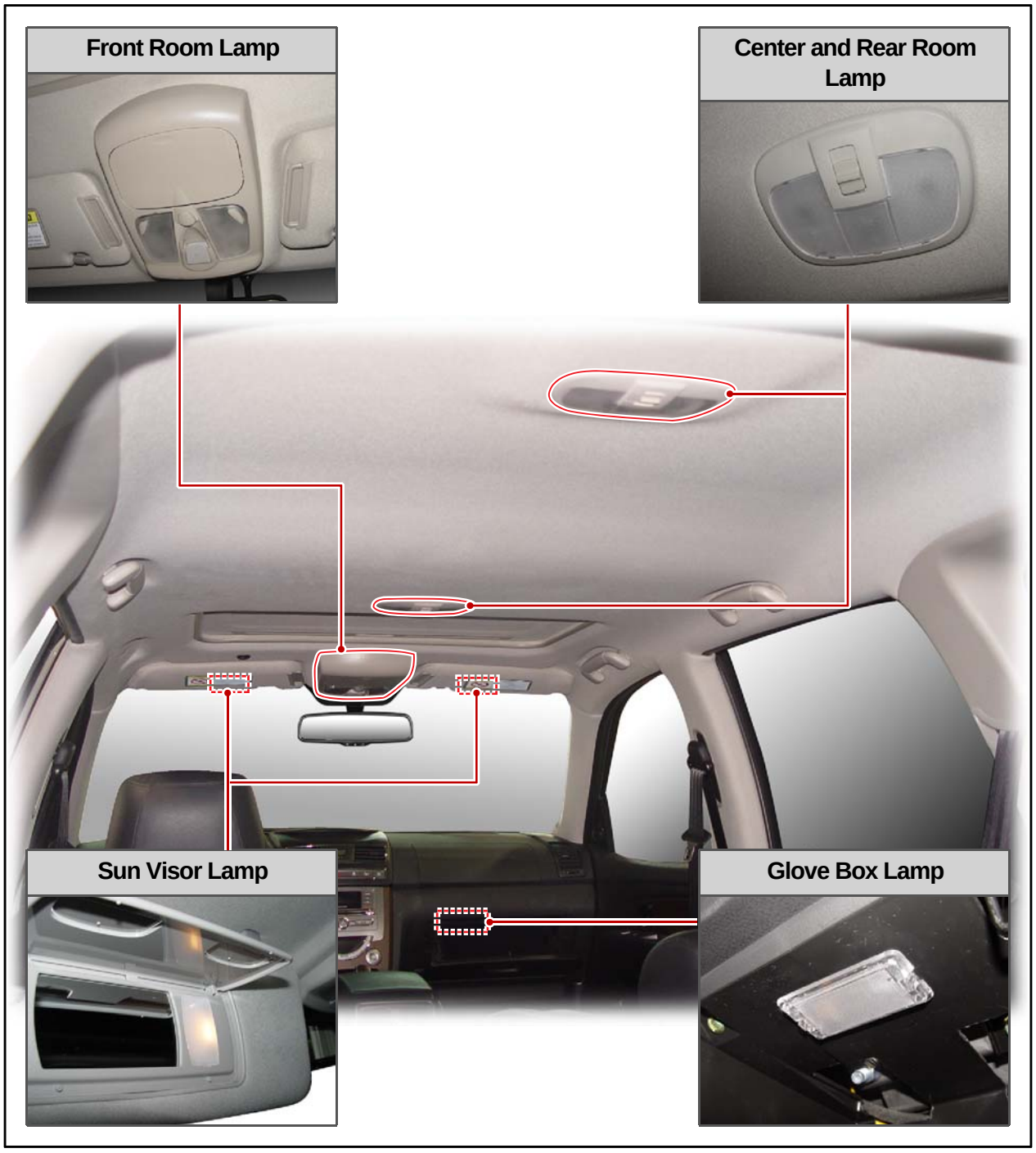
Modification basis	
Application basis	
Affected VIN	

2. INTERIOR LAMPS

1) Overview

The interior lamps consist of front room lamps (2), center room lamp, rear room lamp, glove box lamp, sun visor lamps (2), courtesy lamps (4), and scuff lamps (4).

2) Layout



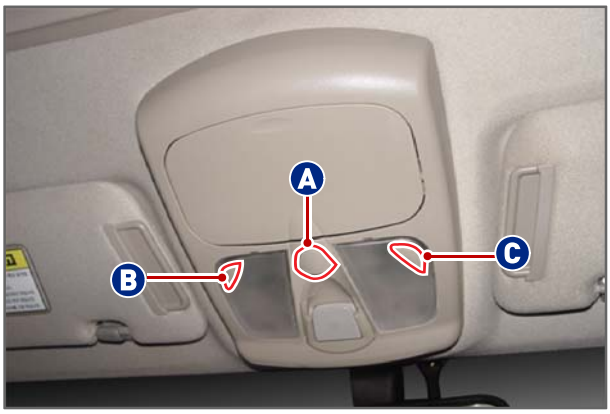
Modification basis	
Application basis	
Affected VIN	



Modification basis	
Application basis	
Affected VIN	

3) Operating Process

(1) Front Room Lamp

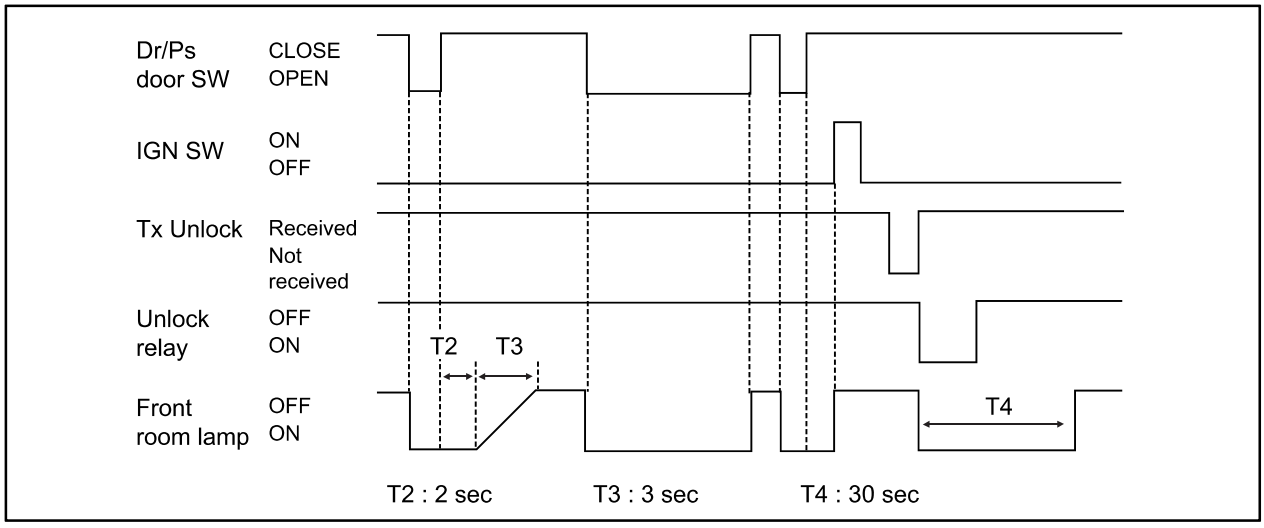


A. Door switch: The front room lamps come on when opening a front door with the switch pressed in.
B. Driver's spot lamp switch: The front room lamp (driver's) comes on when pressing this switch.
C. Passenger's spot lamp switch: The front room lamp (passenger's) comes on when pressing this switch.

▶ Door Switch Coupled Front Room Lamp Operation

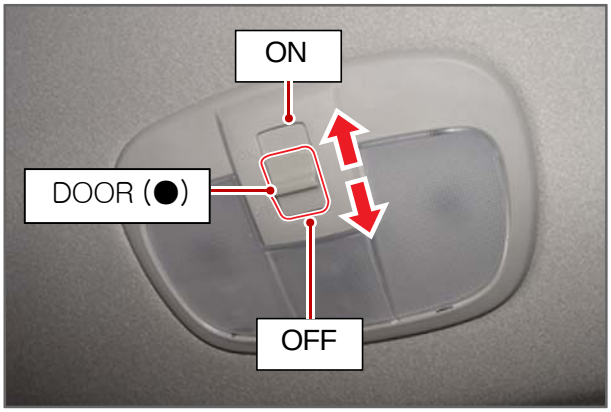
The front room lap comes on when opening a front door with the "Door" switch ON.

1. The front room lamp comes on when opening a front door.
2. The front room lamp goes out immediately after closing the door with the ignition ON.
3. The front room lamp stays on for 2 seconds after closing the door, and then dims out in 3 seconds.
   The front room lamp goes out immediately after turning the ignition ON during the dimming period.
4. The front room lamp comes on for 30 seconds when unlocking the doors with REKES key.
5. The front room lamp stays on for additional 30 seconds during lamp operation in Step 5 when receiving
6. the UNLOCK signal from REKES again.
   The front room lamp stays on when opening a front door, and operates as in Step 3 and 4.
7. The front room lamp dims out when closing the opened door. However, it goes out immediately when
8. getting into the theft deterrent mode.
   The front room lamp comes on when opening a front door with the ignition ON. And, it goes out
9. immediately when closing the opened door with the ignition ON.



Modification basis	
Application basis	
Affected VIN	

(2) Center and Rear Room Lamp



- OFF position: The lamp does not come on.
- ON position: The lamp stays on.
- DOOR position (●): The lamp comes on when the door is opened. The lamp goes out when closing the opened door.

▶ Center room lamp control by door coupled room lamp operation

The center room lamp comes on when opening a rear door with the DOOR switch pressed in.

1. The center room lamp comes on when opening a rear door.
2. The center room lamp goes out when closing the rear doors.

▶ Rear room lamp control by tailgate coupled room lamp operation

The rear room lamp comes on when opening the tailgatewith the Tailgate lamp switch pressed in.

1. The rear room lamp comes on when opening the tailgate.
2. The rear room lamp goes out when closing the tailgate.

(3) Room Lamp Auto Cut

1. When the vehicle enters into theft deterrent mode (STICS sleep mode), the ground circuit of room lamp is turned off. Or the ground circuit of room lamp is turned off 10 minutes after power off. (This is to prevent the battery from discharging when the front room lamp switch or center room lamp switch is in ON position.)
   The STICS sleep mode is released when unlocking the doors or turning on the ignition.
2. The ground circuit of room lamp is turned on when turning on the ignition while the room lamp auto cut is off.

(4) Glove Box Lamp



The glove box lamp comes on when opening the glove box with the tail lamp on.

(5) Door Courtesy Lamp and Scuff Lamp



The door courtesy lamp comes on when opening the door.

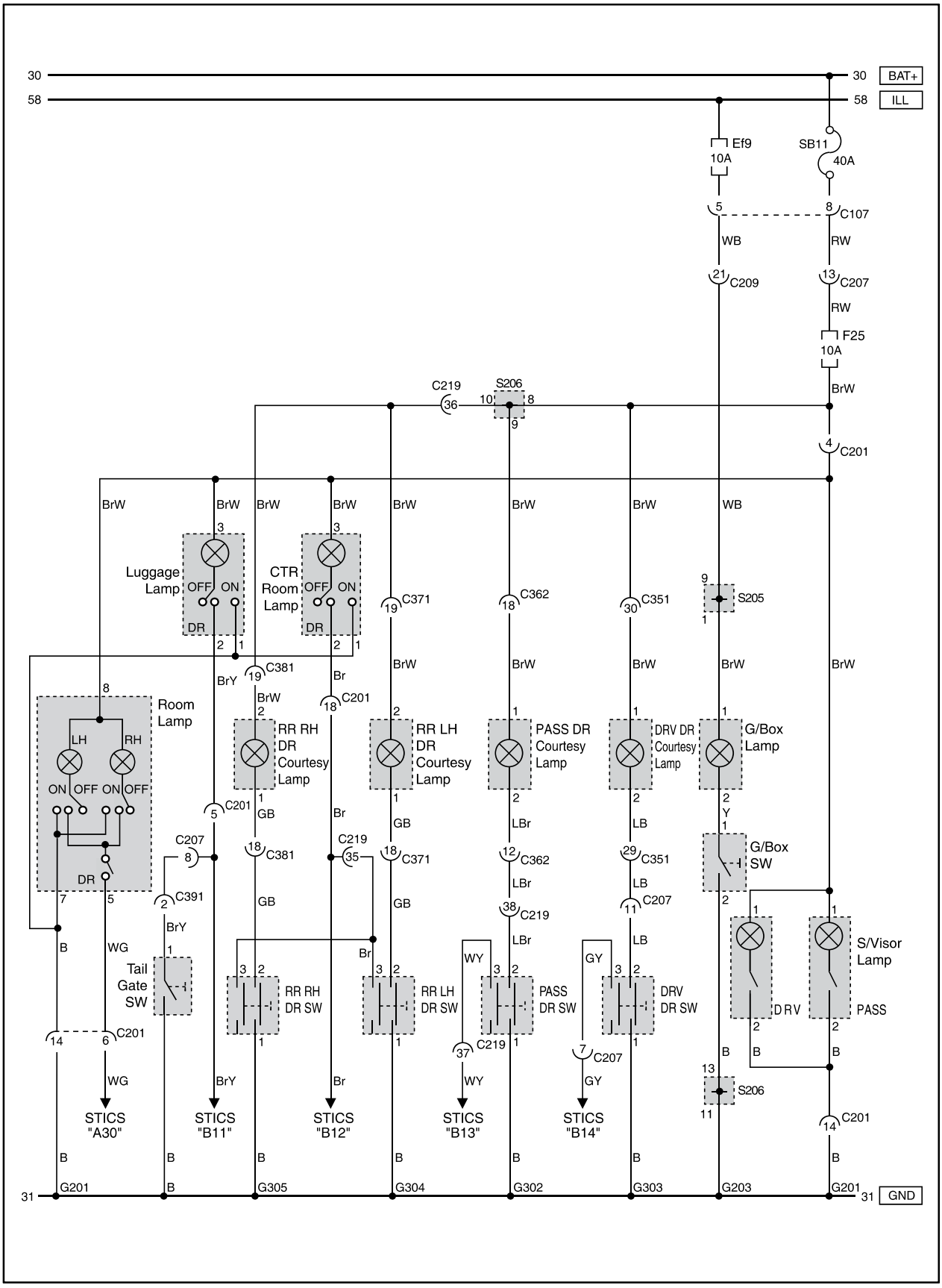
(6) Sun Visor



The sun visor lamp comes on when opening the vanity mirror.

Modification basis	
Application basis	
Affected VIN	

(7) Circuit Diagram of Room Lamp



Modification basis	
Application basis	
Affected VIN	

WIPER AND WASHER SYSTEM

7810-00

GENERAL INFORMATION

1. WIPER CONTROL

- **Wiper mist & washer coupled wiper**
- **Auto washer coupled wiper**
- **Rain sensor coupled wiper operation (LIN)**
- **Speed sensitive intermittent wiper**
- **Wiper low/high control**

2. CAUTIONS ON RAIN SENSOR

- When the wiper switch is in the AUTO position, the wiper will operate for 1 cycle if the initial engine start is made. This may cause the wiper blades to wear prematurely. Therefore, other than rainy days, set the switch to the OFF position. Especially during the winter time, check if the wiper blades are not frozen to the windshield.
  Operating the wiper with the blades frozen can damage the wiper motor.
- If you operate the wipers when the windshield is dry without spraying washer fluid, the windshield can be scratched and the wiper blades can wear prematurely. Use the wiper with the washer fluid when the windshield is dry.
- When it does not rain, turn the wiper switch to the OFF position.
- Turn the wiper switch to the OFF position before any car wash to avoid unwanted operation of the wipers.

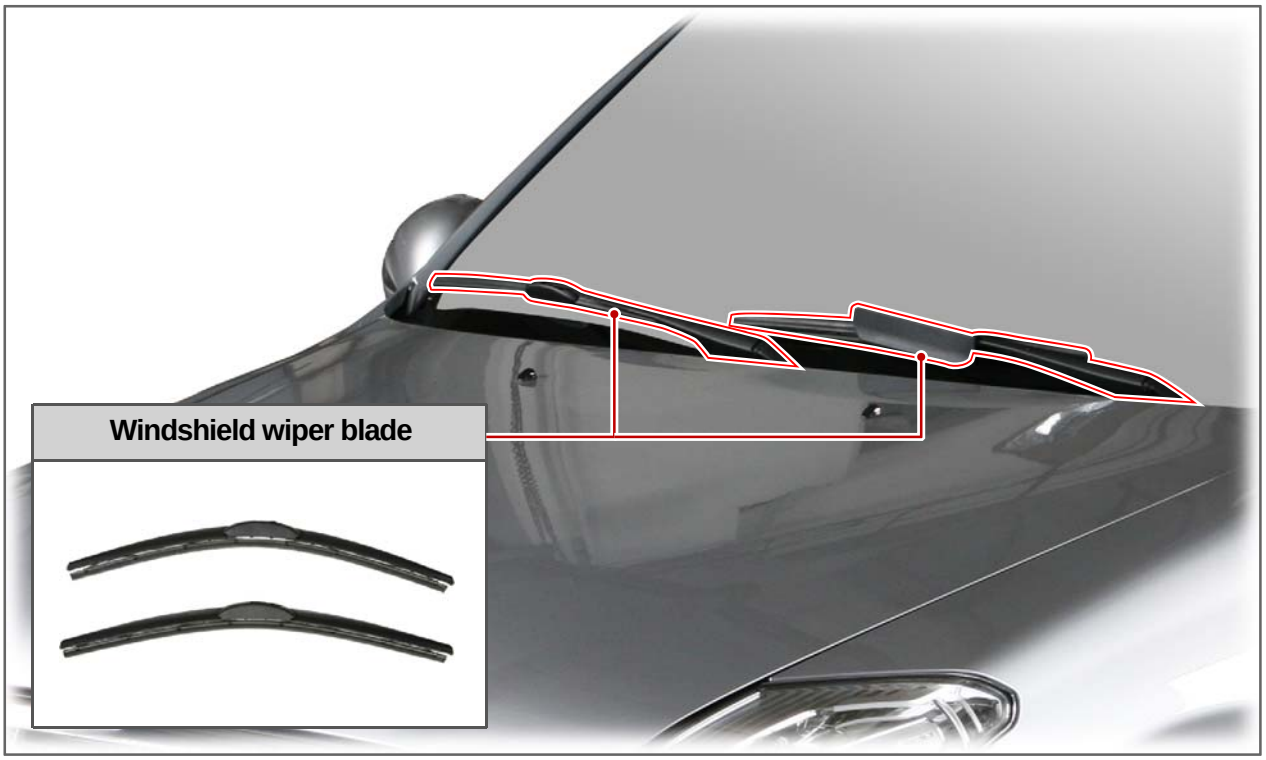
WARNING

When cleaning the windshield over the sensor with damp clothes, the wiper may operate suddenly. It could cause serious injury. Make sure to place the wiper switch to the OFF position and ignition switch OFF when not in use.

▶ **Irregular operation (abrupt operation)**

- Check if the sensor is off the position.
- Check if the rain sensor cover is securely installed.
- Check if the customer is familiar to how to control the wiper sensitivity.
  Check if the wiper sensitivity control is set to the FAST side (step 5).
  Check the wiper blade for wear.
- If the wiper blade cannot wipe the glass uniformly and clearly, it may cause the rain sensor to
- work irregularly. Therefore, in this case, replace the wiper blade with a new one.

3. MAJOR CHANGES



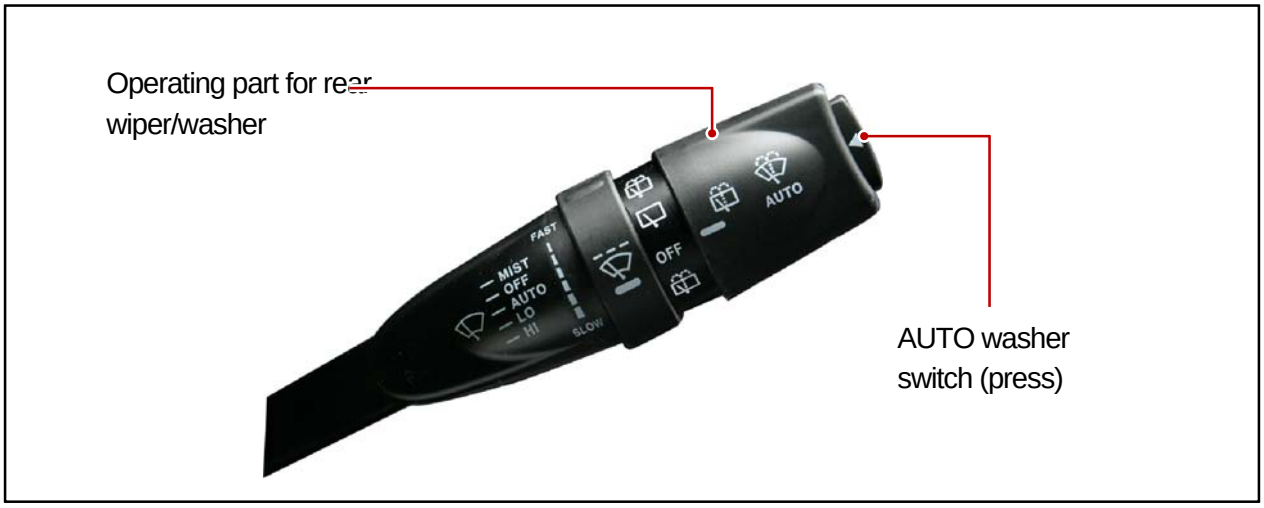
Wiper blade design and wiper arm pressure	
Previous	**Current**
	
	Wiper arm pressure: Driver: 850±50gn Passenger: 750±50g
Steel blade → Rubber blade **- Wiper blade design changed (blade size is same)** Driver side: 20inch Passenger side: 20inch	

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. WIPER AND WASHER SYSTEM

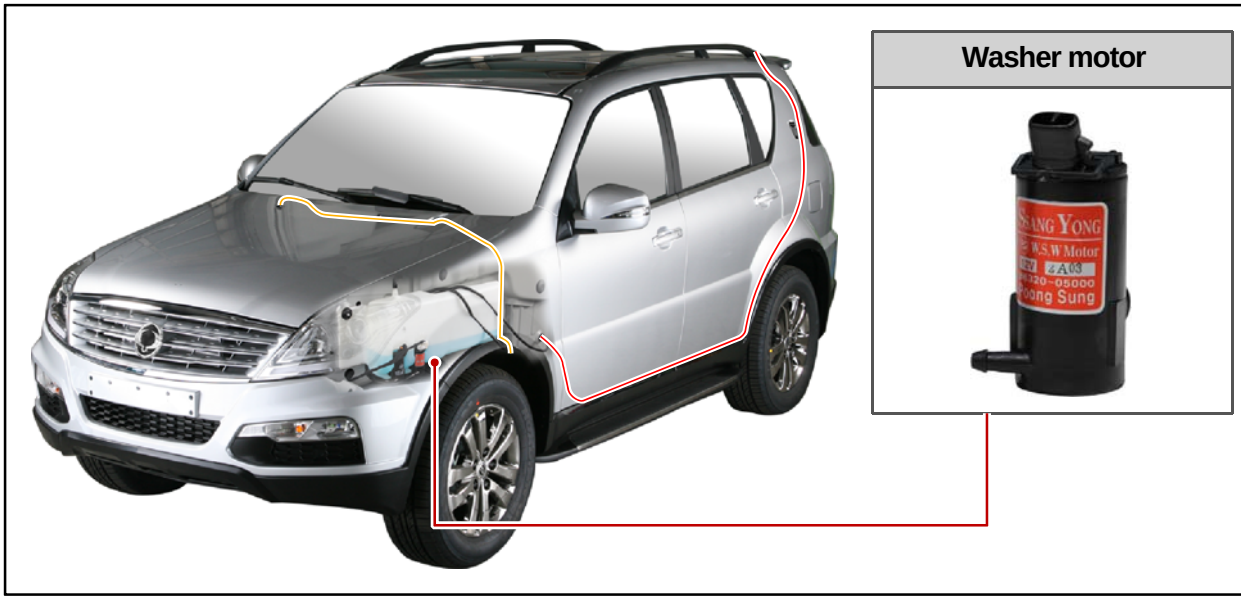
1) AUTO Washer Coupled Wiper Function



If you press the AUTO washer switch briefly with the ignition key ON and INT-AUTO switch "OFF", the washer motor is operated for about 1 seconds to spray washer fluid once after the switch is turned ON and the wiper relay is turned ON for 4 cycles. After that, the washer motor is operated for about 1 seconds to spray the washer fluid again and the relay is turned ON for 3 cycles and then the relay is turned OFF.

2) Rear Washer Fluid Supply System

The front washer fluid reservoir supplies the rear washer fluid without additional washer fluid reservoir.



Modification basis	
Application basis	
Affected VIN	

2. RAIN SENSING SYSTEM

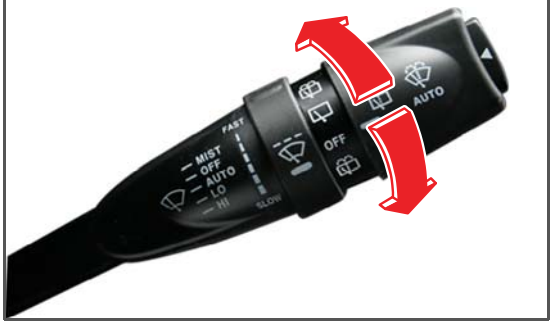
In the rain sensing wiper operation system, the rain sensing unit only sends the information about the amount of rain drops to the STICS, and it does not operate the wiper directly. The wiper and washer are controlled by the STICS according to the driver's choice.

Rain sensing unit



This sensor emits infrared rays through LED and then detects the amount of rain drops by receiving the rays reflected off the sensing section (rain sensor mounting section on the windshield) with photodiode.

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 the sensitivity for the amount of rains on the windshield and transmit the wiping request signal accordingly.



NOTE

In the vehicle for EU market, the auto light sensor is not available.

Modification basis	
Application basis	
Affected VIN	

▶ STICS

The rain sensor detects the amount of rain drops and sends the operating request signal to the STICS, which drives the wiper directly. At this moment, the STICS also sends the information on whether the wiper is in operation mode or whether the multifunction wiper switch is in AUTO position to the rain sensor.

STICS	Underhood Fuse Box
	

3. SYSTEM LAYOUT (INCLUDING RAIN SENSOR)

Wiper and washer switch


Rain sensor unit

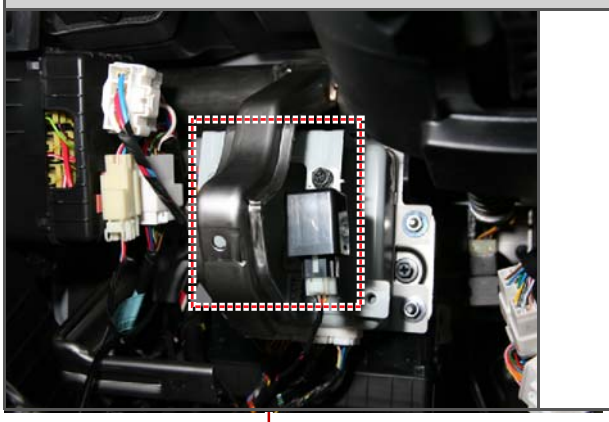

Wiper
Front wiper  **Rear wiper** 



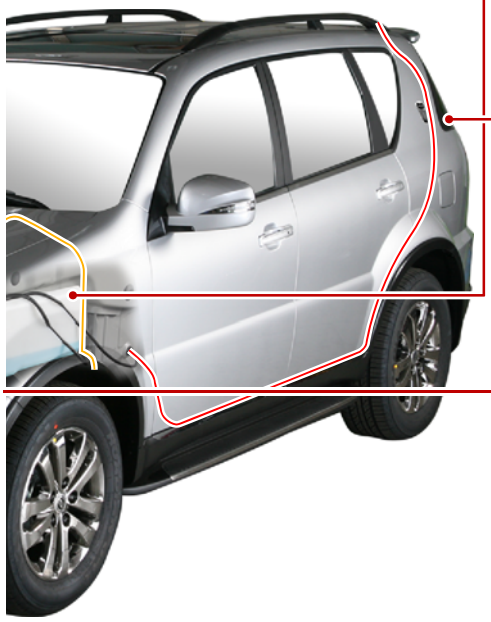
Wahser nozzle	
Front	**Rear**
	

Modification basis	
Application basis	
Affected VIN	

STICS







Windshield washer reservoir tank assembly



Rear wiper (DPS)



Wahser motor

Front	Rear
	

Modification basis	
Application basis	
Affected VIN	

4. WIPER AND WASHER OPERATION

1) Windshield Wiper Control Function

MIST

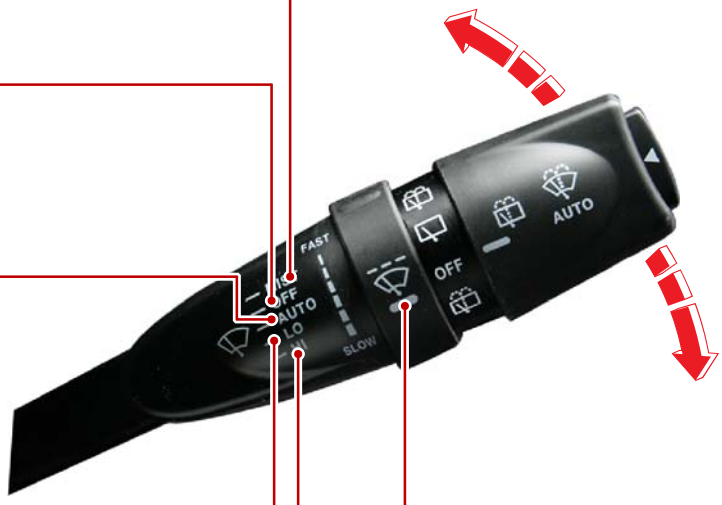
The wiper operates for 1 cycle when pushing up the lever. The lever will return to the "OFF" position when released.

OFF

Stop the operation.

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" position.

HI

Wiping speed gets faster when placing the pointer at the "HI" position.

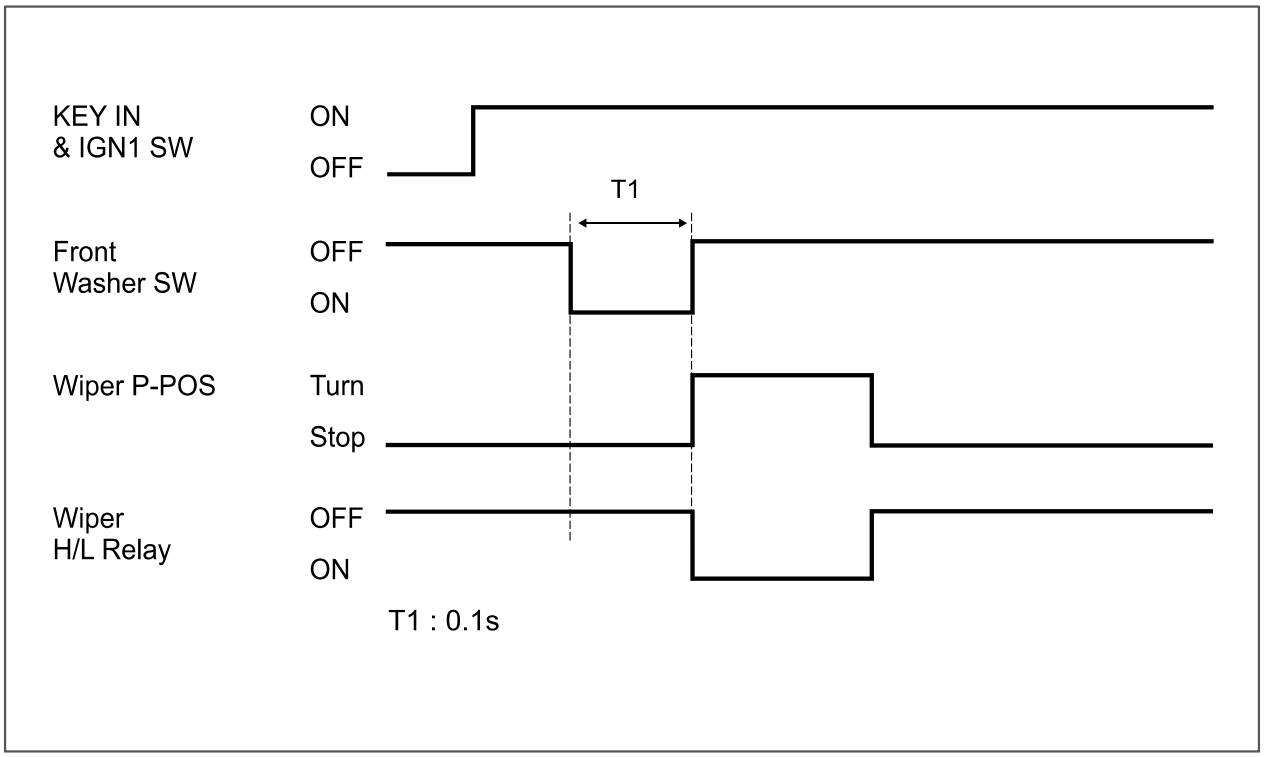
Wiping speed control switch

When turning to FAST, wiping speed gets faster and when turning to SLOW, wiping speed gets slower.

Modification basis	
Application basis	
Affected VIN	

(1) Wiper mist

1. When the multifunction switch is pushed to the MIST position for 0.1 sec. or more with the IGN1 ON, the wiper relay is turned on after 0.1 sec. has passed. When the wiper returns to the park position, the wiper relay is turned off.
2. When the MIST switch signal is input the wiper is operated at high speed. When the switch is release from the MIST position, the wiper is operated at low speed.



(2) Wiper LO/HI control

1. The wiper LOW relay is turned on when the multifunction wiper switch is at the LO position. The wiper HIGH relay is turned on when the wiper switch is at the HI position. When the wiper switch is at the HI position, both the LOW relay (constant operation) and HIGH relay are operated.
2. The wiper motor returns to parking position and stops, even when turning off the ignition switch during wiper operation.
3. The wiper relay should stay ON in low/high wiper operation mode even if the parking signal for the wiper motor is not received. In INT/AUTO wiper operation mode, the wiper relay should be turned OFF after 5 seconds if there is no parking signal for the wiper for 3 seconds and informs the driver of parking position signal abnormality.
4. While the wiper operates at low/high speed, the front/rear washer switch can be operated but the auto washer switch cannot.
5. The wiper motor returns to parking position and stops when turning off the ignition switch during wiper operation in high mode.

Modification basis	
Application basis	
Affected VIN	

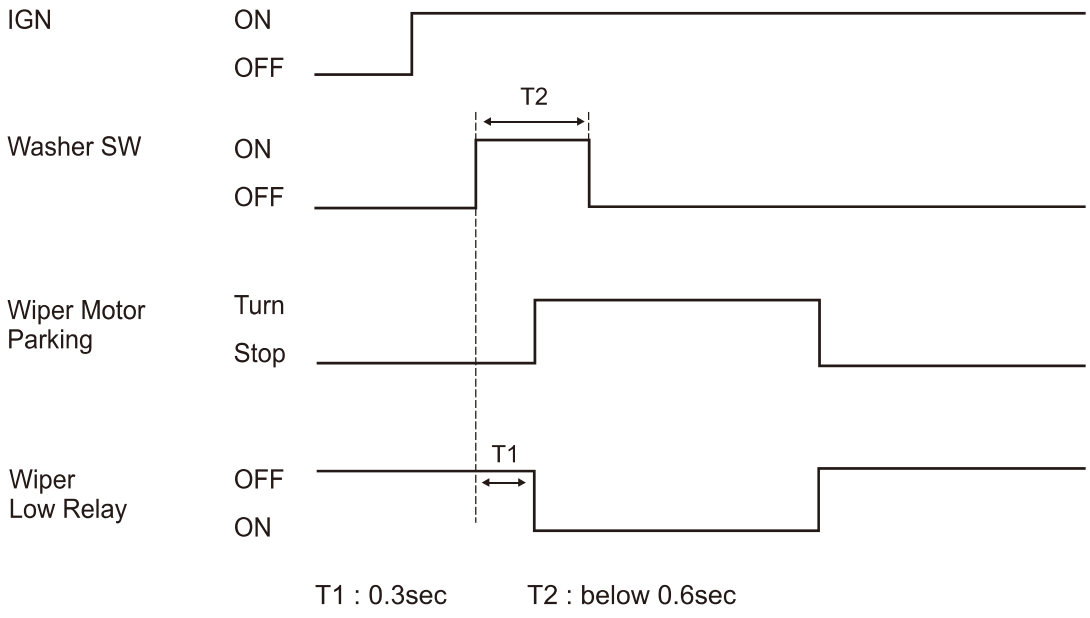
2) Windshield Washer Control Function

(1) Windshield washer coupled wiper

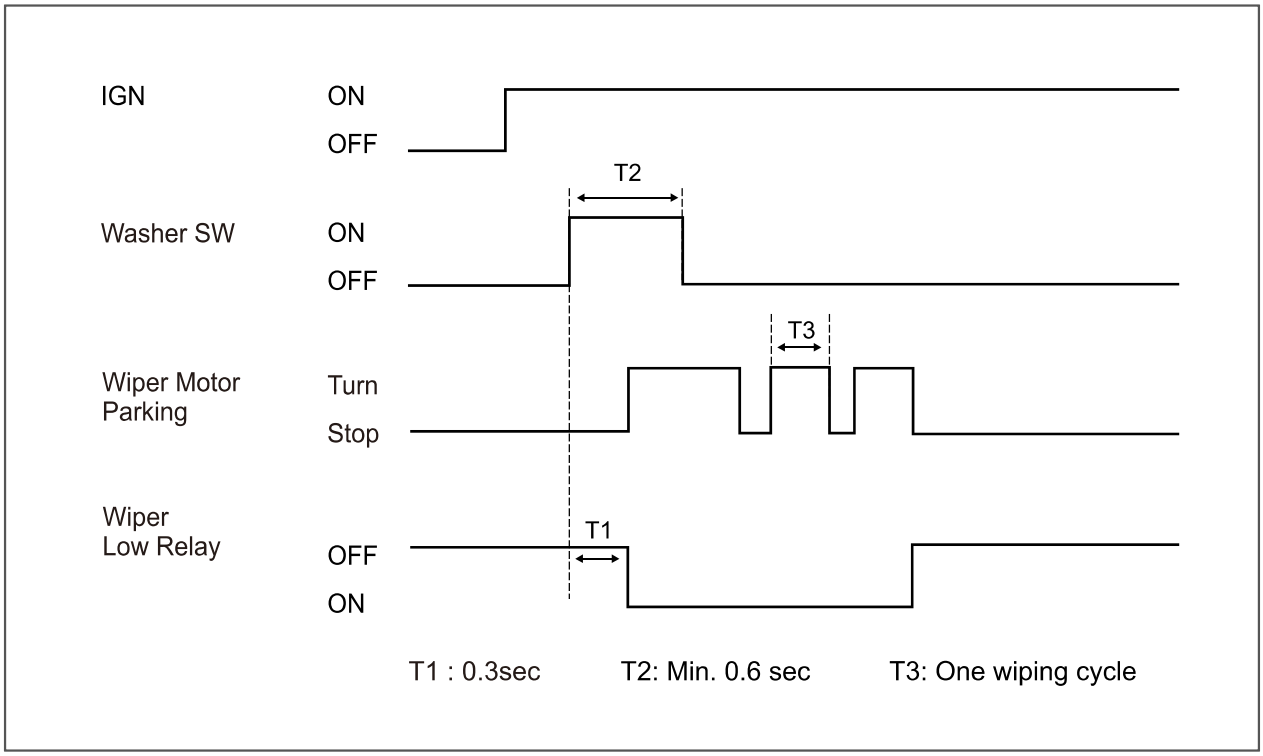


Wiper and Washer Coupled Operation
Pull the switch briefly (for less than 0.6 sec.)
: One wiping cycle
Pull and hold the switch for more than 0.6 sec.
: Three wiping cycles with washer fluid spray

1. The wiper relay turns ON when turning on the front washer switch with IGN ON. If the operation time of front washer switch is below 0.6 second, the wipers operate only one cycle.

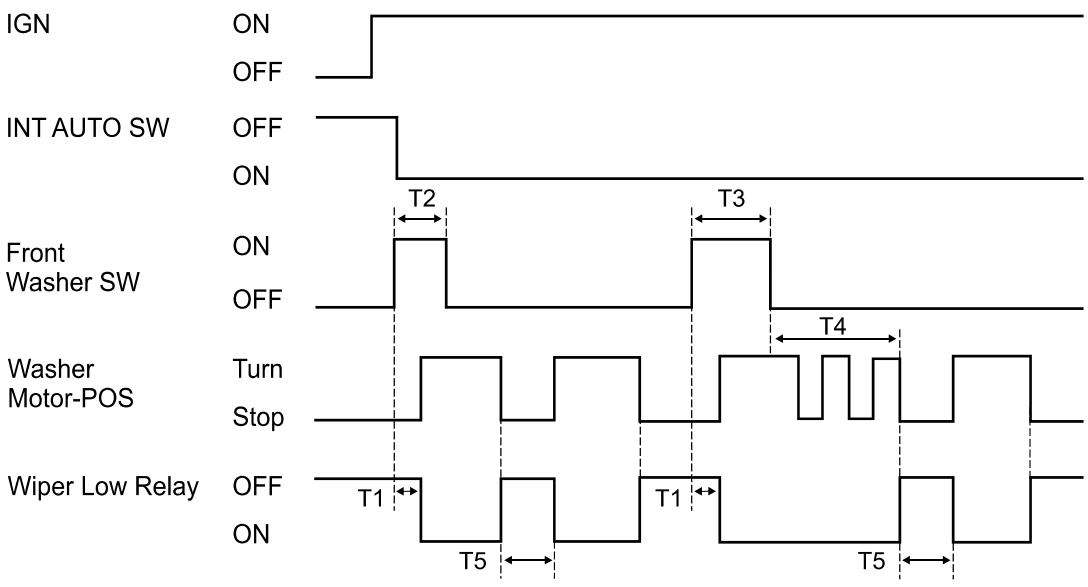


2. The wiper relay is turned on 0.3 seconds after pulling up the washer switch to ON position with IGN ON. If the washer switch is turned on for more than 0.6 seconds, the wiper relay is activated three times after releasing the washer switch and then the wiper motor is set to parking position.



Modification basis	
Application basis	
Affected VIN	

3. If the wiper switch is in Auto position (sensing the vehicle speed and rain drops), the wiper operates three times when the washer switch is turned on for more than 0.6 seconds, and it operates once when the washer switch is turned on for less than 0.6 seconds.



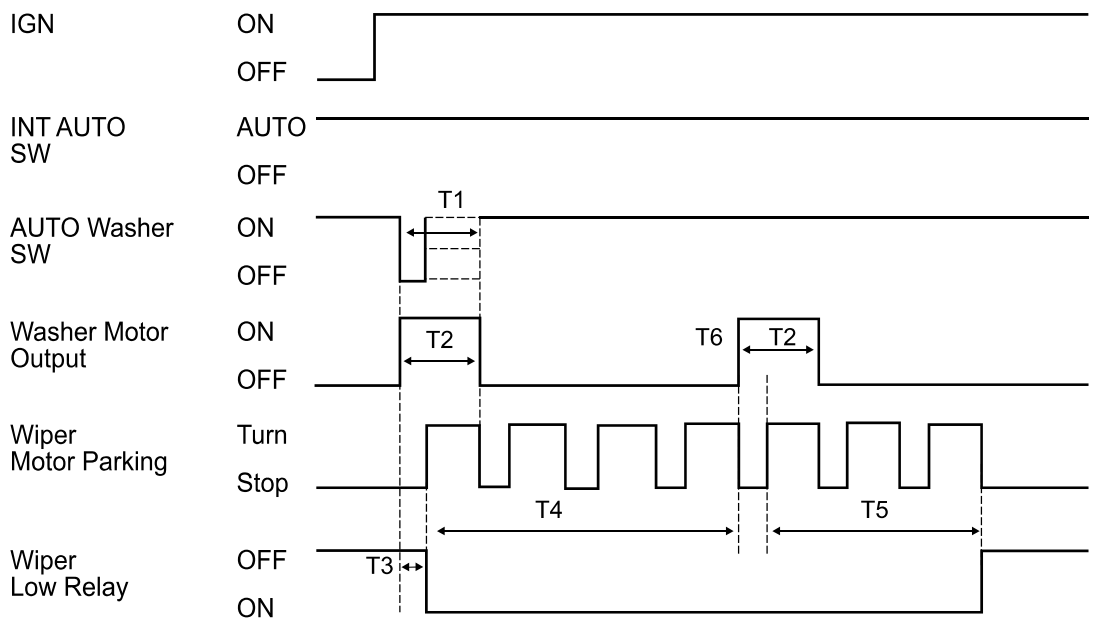
T1: 0.5 sec T2: 0.1~0.59 sec T3: Over 0.6 sec T4: 3 wiping cycles T5: Pause time

(2) AUTO washer coupled wiper



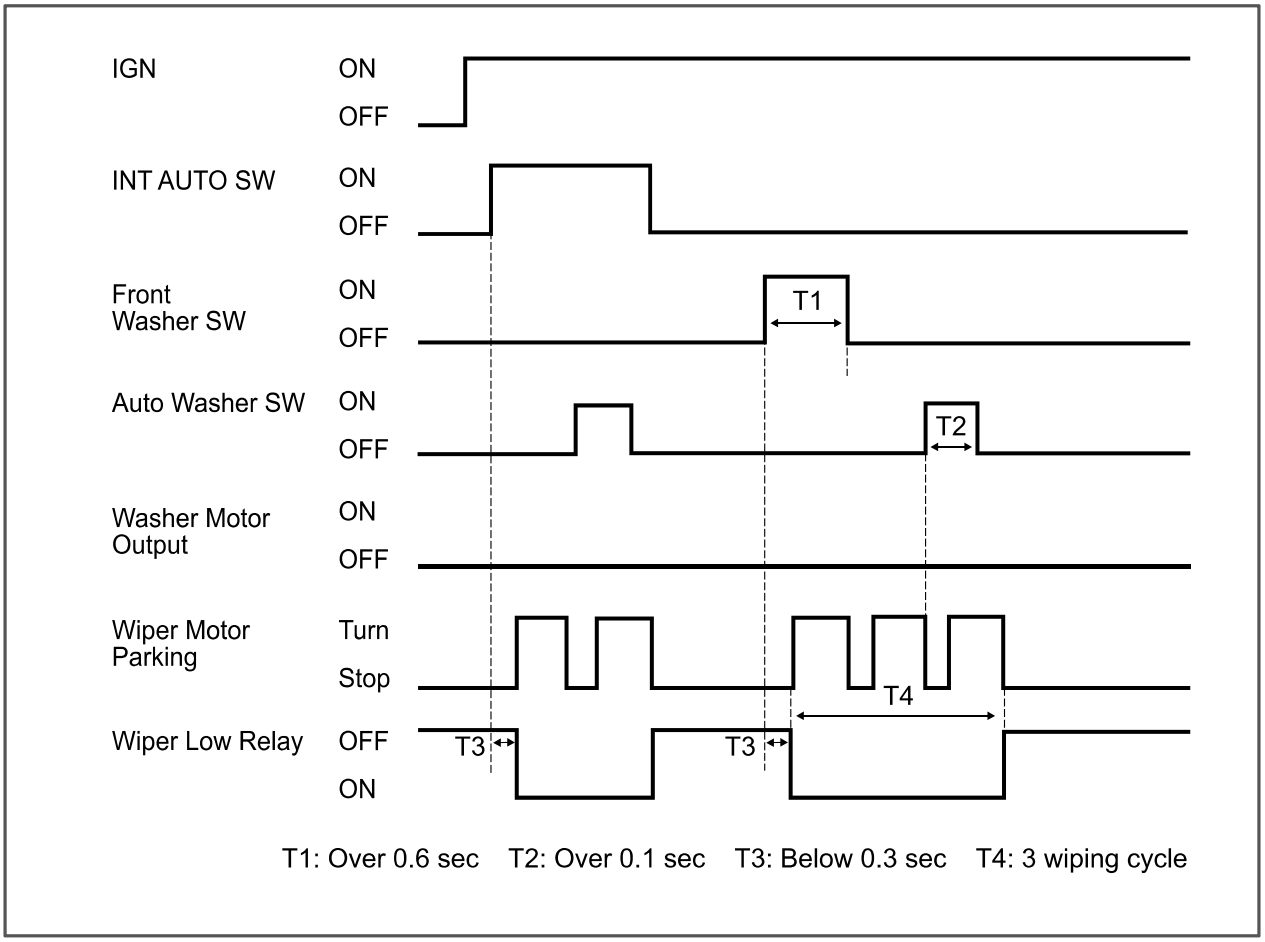
Auto washer switch
If pressing the switch when the wiper switch turns to the "OFF" position, washer fluid is sprayed once and wiper operates 4 times. After a while, washer fluid is sprayed once more and the wiper operates 3 times.

1. When the AUTO washer switch is pressed on with IGN ON and INT/AUTO switch OFF, the washer motor operates for 1.0±0.1 second and the wiper operates 4 times. And then the washer motor operates for 1.0±0.1 second again and the wiper operates 3 times.
2. The auto washer switch signal is overridden during washer coupled wiper operation.
3. The second auto washer switch signal is overridden during first auto washer coupled wiper operation.
4. When turning the wiper switch to AUTO position during the operation of auto washer, the auto washer stops its operation and the intermittent/automatic wiping mode will be started.



T1: Over 0.1 sec T2: 1.0±0.1 sec T3: Below 0.3 sec T4: 4 wiping cycle T5: 3 wiping cycle

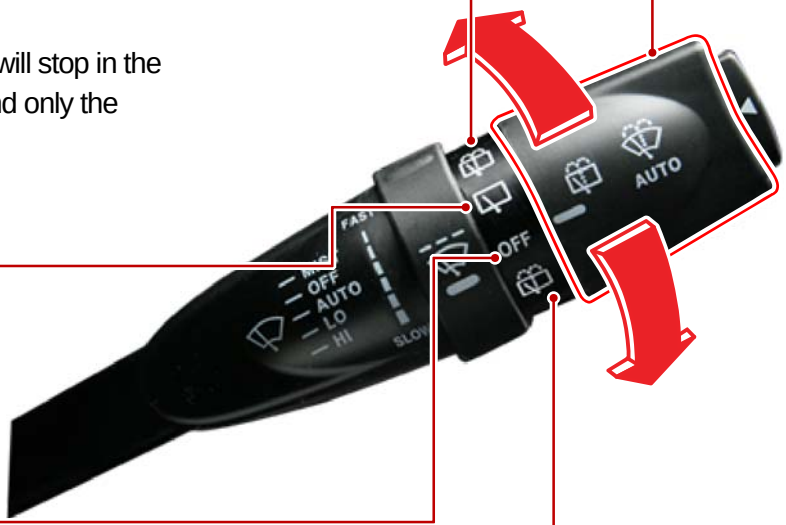
Modification basis	
Application basis	
Affected VIN	


IGN
ON
OFF
INT AUTO SW
ON
OFF
Front Washer SW
ON
OFF
T1
Auto Washer SW
ON
OFF
T2
Washer Motor Output
ON
OFF
Wiper Motor Parking
Turn
Stop
T4
Wiper Low Relay
OFF
ON
T3
T3
T1: Over 0.6 sec T2: Over 0.1 sec T3: Below 0.3 sec T4: 3 wiping cycle

3) Rear Wiper Control Function

Rear wiper switch

When the switch is fully turned, washer fluid will be sprayed onto the rear window glass and the wiper will also operate.
When the switch is released, it will stop in the Rear Wiper Operation mode and only the wiper will keep operating.



Rear wiper operation

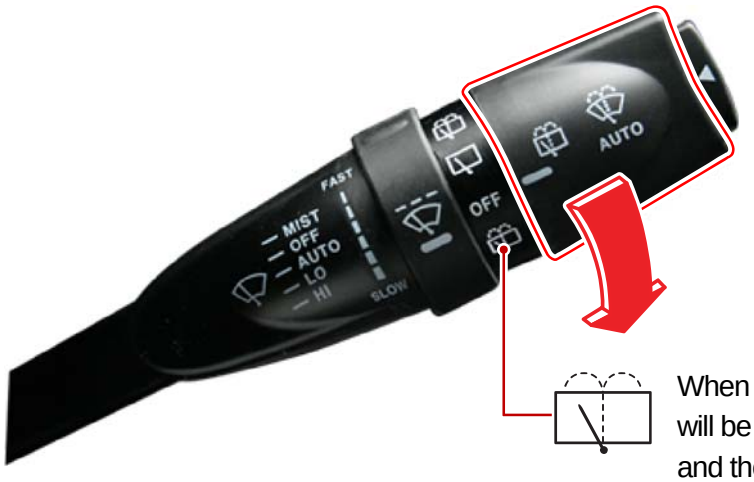
OFF

Rear wiper stops

When the switch is fully turned, washer fluid will be sprayed onto the rear window glass and the wiper will also operate. When the switch is released, it will return to the "OFF position and turn off the wiper and washer.

Modification basis	
Application basis	
Affected VIN	

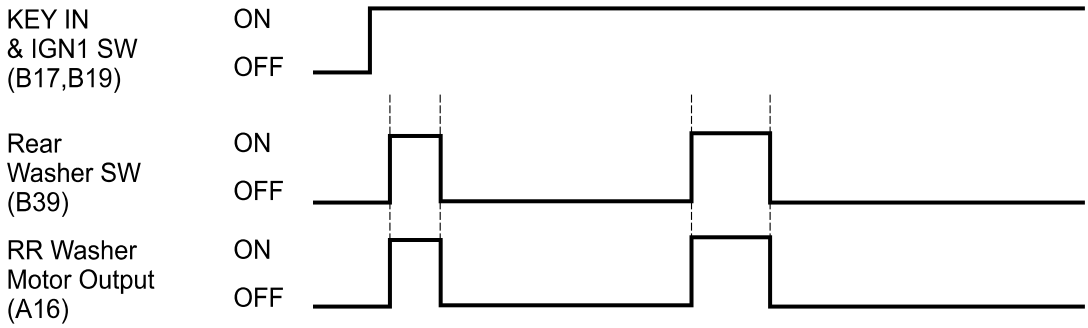
4) Rear Washer Control Function



When the switch is fully turned, washer fluid will be sprayed onto the rear window glass and the wiper will also operate. When the switch is released, it will return to the "OFF" position and turn off the wiper and washer.

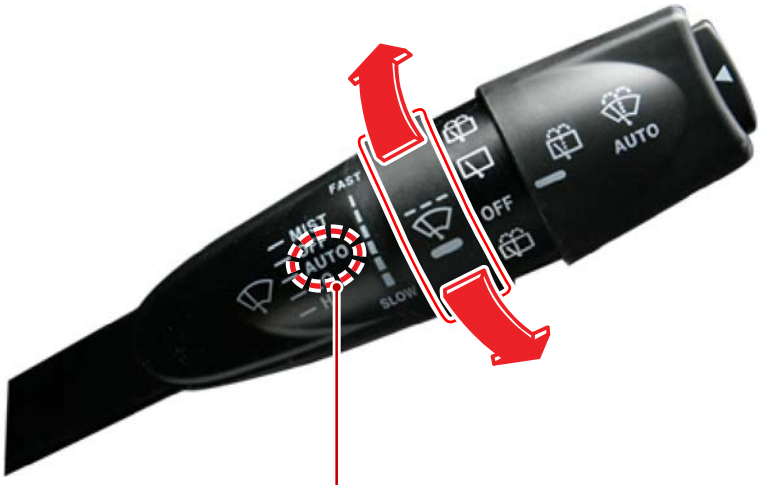
▶ Rear washer motor control

1. The rear washer motor is operated only when the rear washer switch is activated with the ignition key ON.
2. If the front washer or automatic washer switch signal is received during the rear washer switch operation, the washer motor stops and the front washer or automatic washer motor begins to operate.



5) Rain Sensor Coupled Wiper Control Function

AUTO operation and sensitivity control

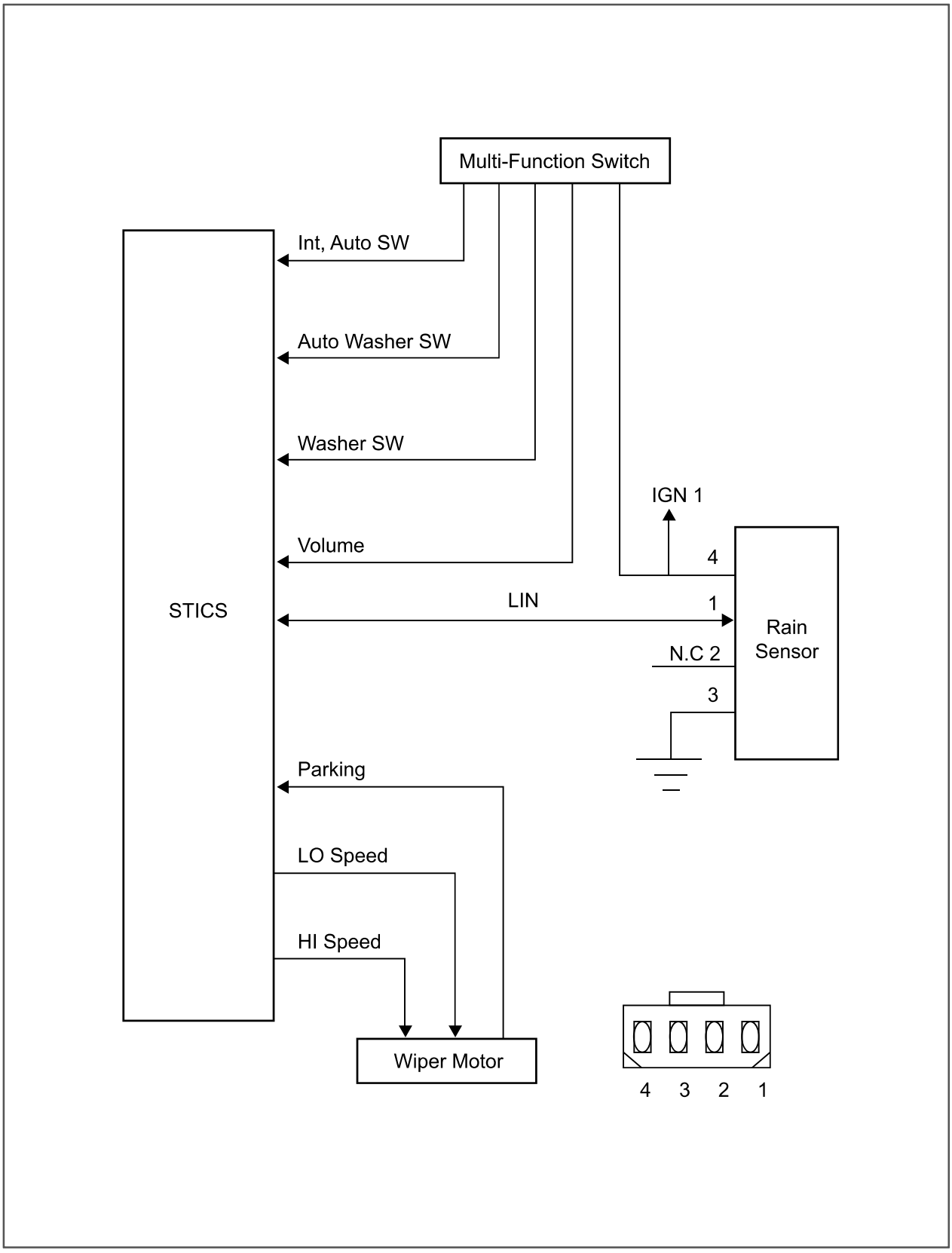


AUTO: Wiper operates automatically by rain sensor
FAST <----> Auto delay/auto speed control
A position that can control sensitivity against rains on the windshield and transmits wiping demand signal accordingly.

Modification basis	
Application basis	
Affected VIN	

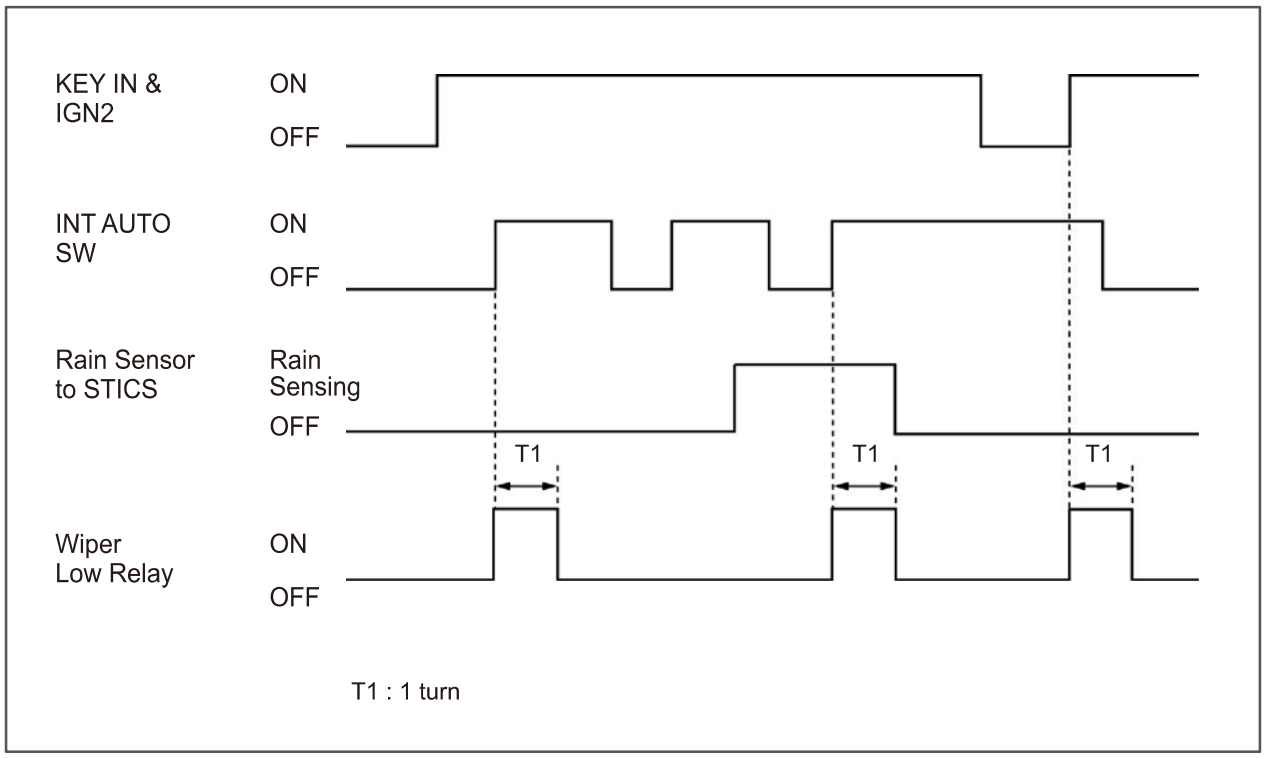
(1) Rain sensor coupled wiper operation (LIN)

▶ **System layout**



(2) Power-up reminder wiper

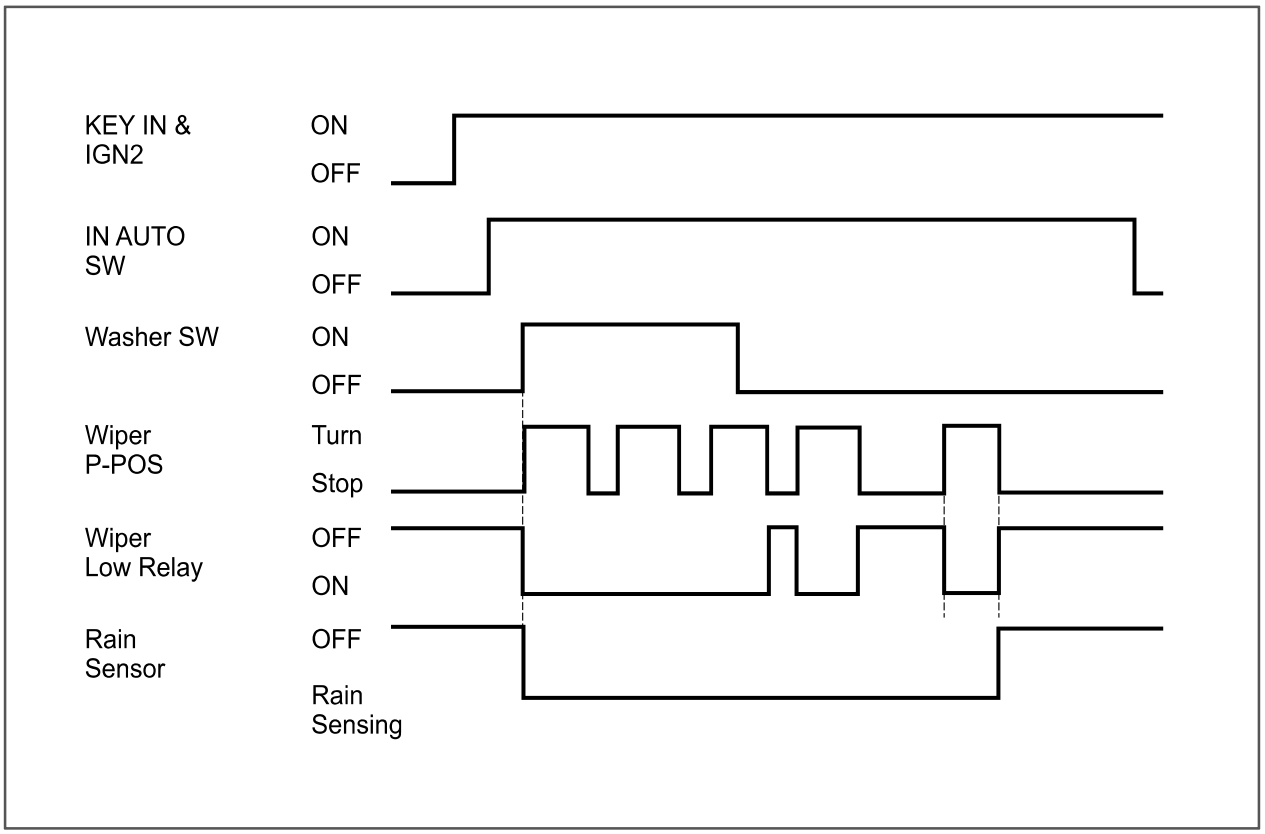
1. When turning off and on the INT auto switch, the system drives the wiper motor for one cycle through LOW relay regardless of communication with rain sensor.
2. When the INT/AUTO wiper switch is turned on from off with the ignition switch ON, the wiper low relay is turned on once to operate the wiper motor regardless of the rain sensor signals. After then, the wiper does not operate even when the INT/AUTO wiper switch is turned on from off. The wiper operates at low speed only when the rain sensor detects the rain drops.



Modification basis	
Application basis	
Affected VIN	

(3) Washer coupled wiper operation during rain sensor coupled operation

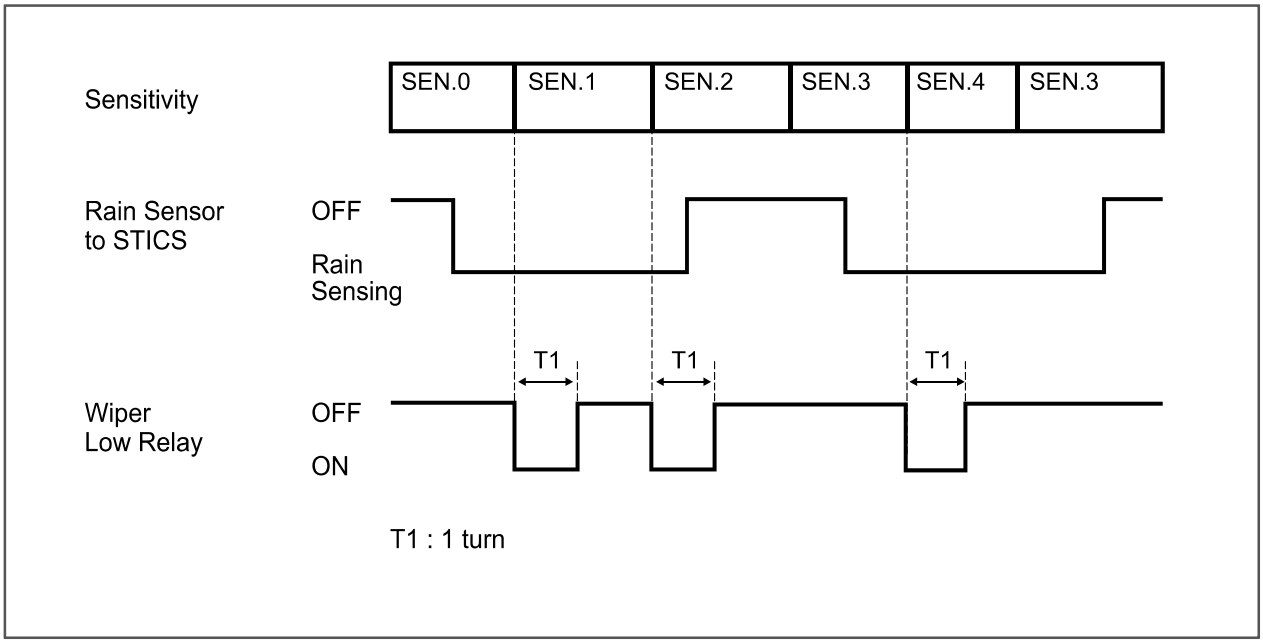
1. When the washer switch is turned on during rain sensor coupled operation with IGN ON and INT/AUTO switch ON, the communication with rain sensor is overridden and the wiper system operates in washer coupled wiper operation mode. However, if the signal from rain sensor is the continuous operation, the washer relay is turned on and the wiper keeps on running when the washer switch is ON.
2. Even though the wiper system is in washer coupled wiper operation mode, the operating data should be sent to rain sensor.



(4) Sensitivity control (instant wiping)

1. When the wiping speed control switch is turned to "FAST (ex: 0→1)" with IGN ON, INT/AUTO switch ON and wiper motor STOP (parking position), the wiper motor operates one cycle at low speed. (Only when the rain sensor detects rain drops)

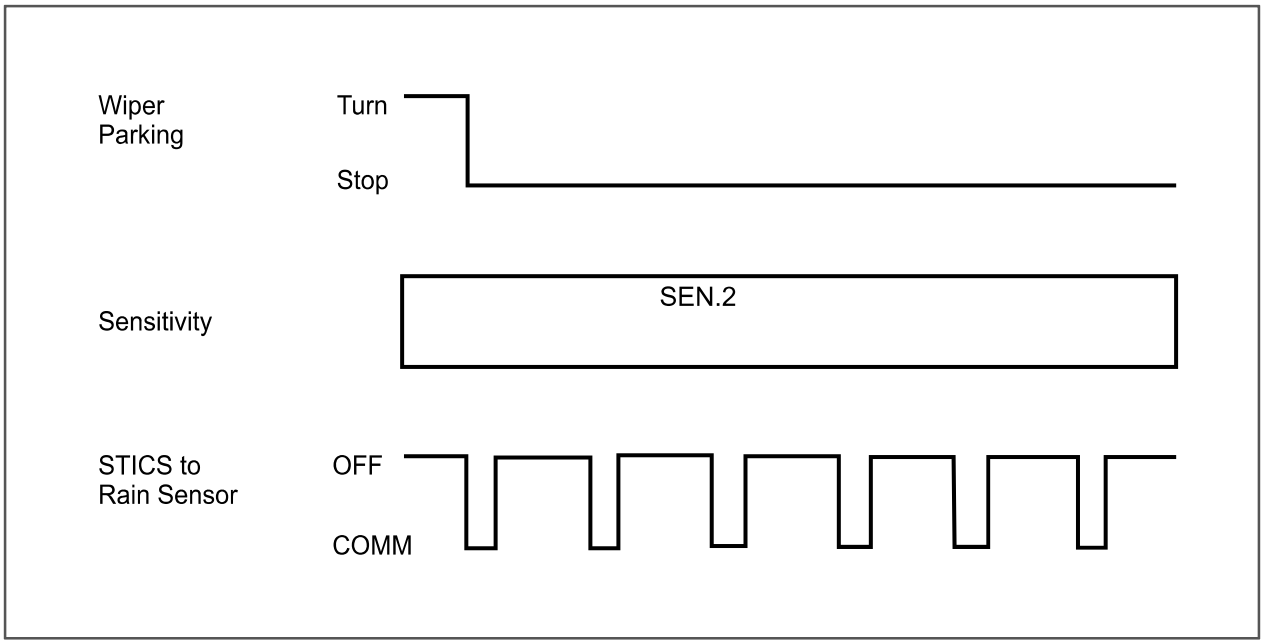
* If the wiping speed control switch is changed more than 1 stages within 2 seconds, the wiper motor operates only one cycle.



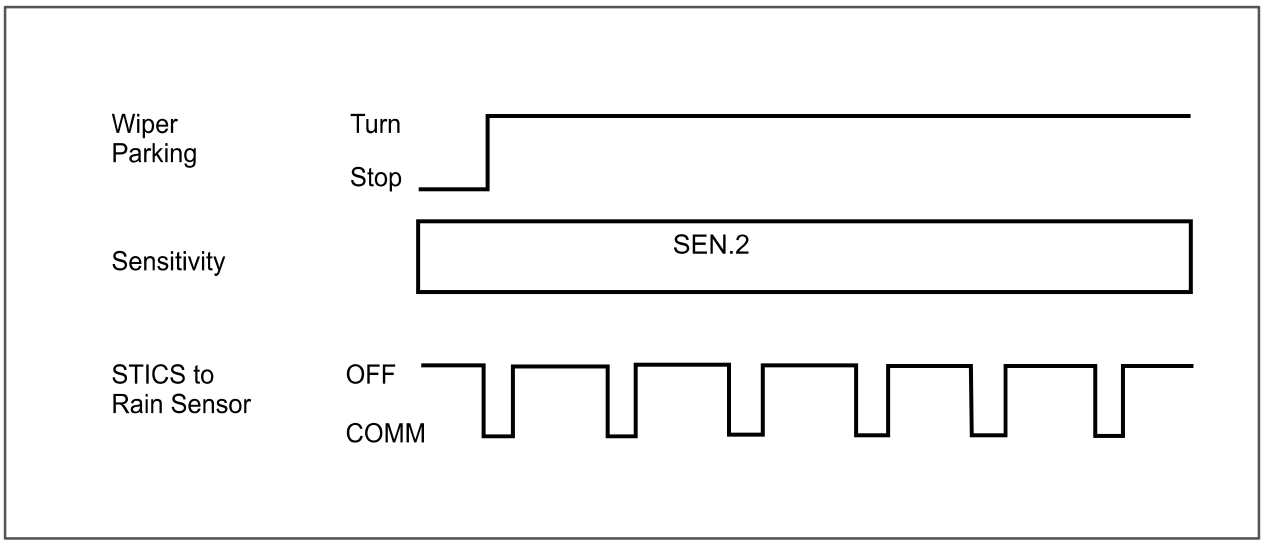
Modification basis	
Application basis	
Affected VIN	

(5) For abnormal wiper parking signal

1. The wiper system sends continuously the signal for current status when the wiper parking terminal is shorted to ground with IGN2 ON and intermittent wiper switch in "ON" position.
   * The wiper motor is operated only when there is a request from the rain sensor.

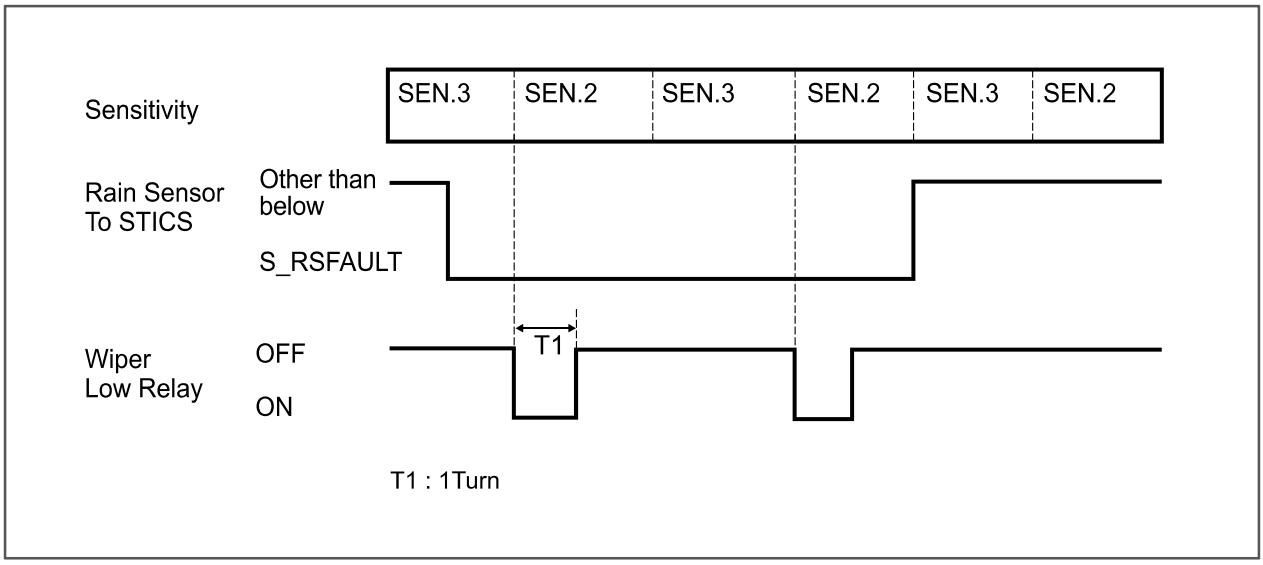


2. When the parking terminal is shorted to power with IGN2 ON and intermittent wiper switch in "ON" position, the wiper system sends the signal for current wiping status for 2 seconds. After that, it sends the current signal for parking status continuously.
   * The wiper motor is operated only when there is a request from the rain sensor.

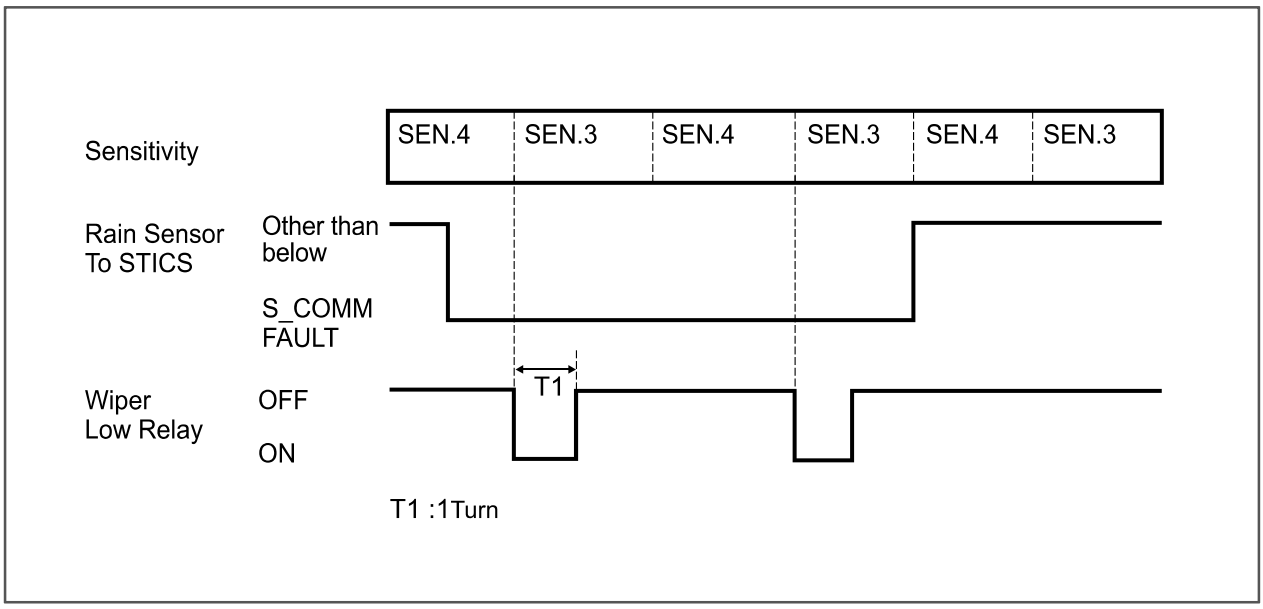


(6) For faulty rain sensor

1. When the wiper speed control switch is turned to step 2 from step 3, the wiper motor operates one cycle at low speed if STICS receives a faulty sensor signal (S_RSFAULT) from rain sensor unit with IGN ON and INT/AUTO switch ON.



2. When the wiper speed control switch is turned to step 3 from step 4, the wiper motor operates one cycle at low speed if STICS receives a faulty sensor signal (S_COMMFAULT) from rain sensor unit with IGN ON and INT/AUTO switch ON.

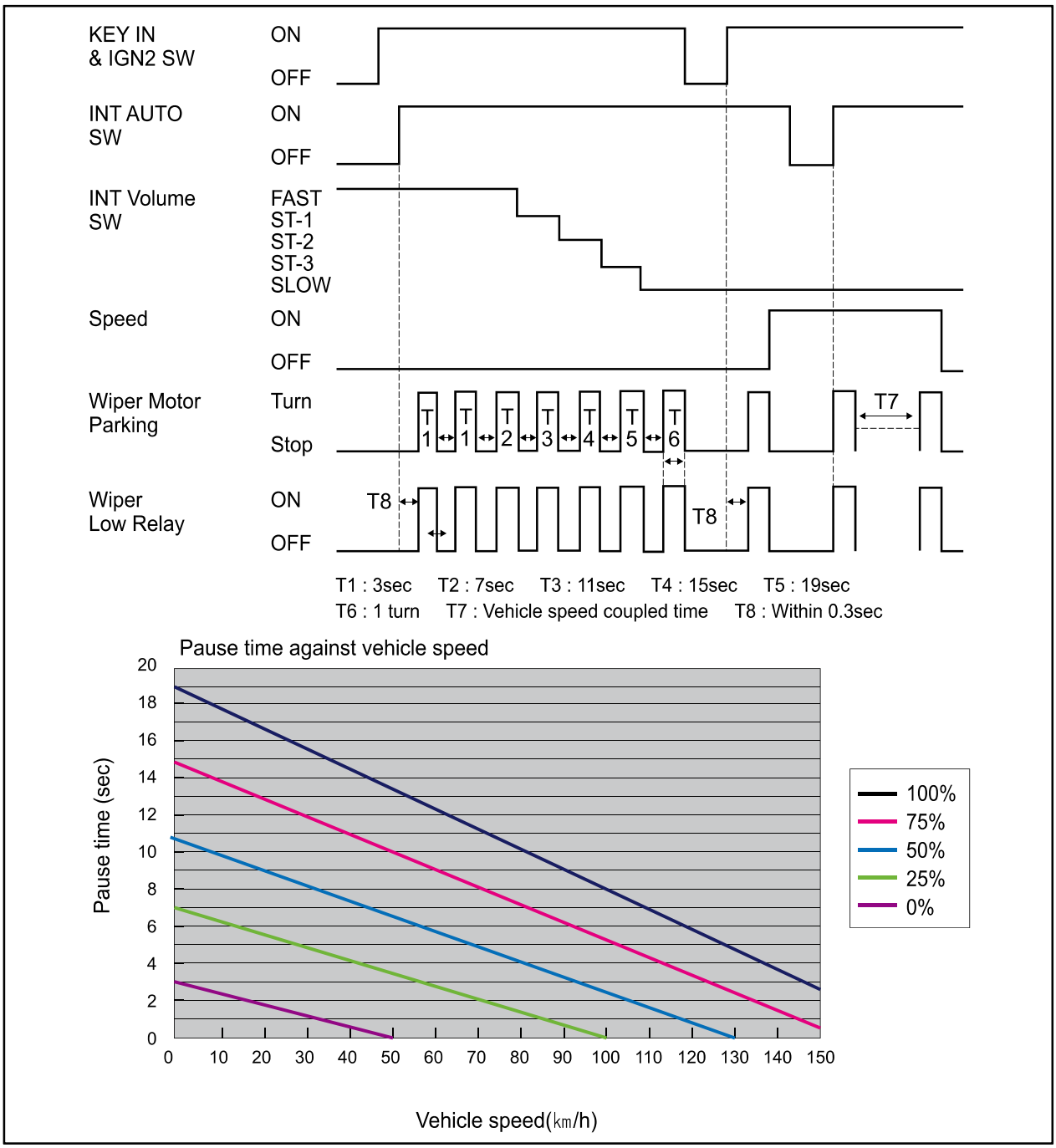


Modification basis	
Application basis	
Affected VIN	

(7) Speed sensitive intermittent wiper

For the vehicles without rain sensor, the stics operate the wiper as follows:

1. When turning the ignition switch to ON from OFF position with the intermittent wiper switch in "ON" position, the wipers do not operate.
2. When turning the wiper switch to ON from OFF position after turning the ignition switch to ON position, the wipers operate one cycle.
3. The wiper's operation cycle depends on the vehicle speed (CAN communication with instrument cluster) and wiping speed the side fascia panel.
   - Wiping cycle: 3 ± 0.5 sec. (FAST) to 19 ± 2 sec. (SLOW)



▶ **Speed sensitive intermittent wiper interval**

SPEED / VIR	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

4. Calculation of Pause Time
- Pause time: The period while the wiper motor is at parking position
- Elapsed time: Total operating time after the wiper motor has started its operation from parking position
  The graph for pause time in previous page is generated by vehicle speed and wiping speed control
- switch.

NOTE

INT wiper switch ON time
* below 1 sec: Continuous wiper operation
* over 1.5 sec: Intermittent wiper operation

Modification basis	
Application basis	
Affected VIN	

RAIN SENSING SYSTEM (EXCEPT FOR EU MARKET) 8611-09

OVERVIEW AND OPERATING 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)

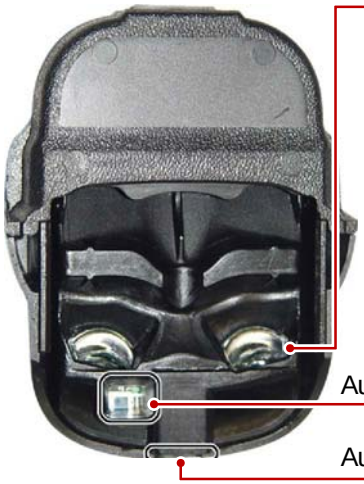


A sensor that emits infrared rays through LED and then detects the amount of rain drops by receiving reflected rays against sensing section (rain sensor mounting section on the windshield) with photodiode. The auto light sensor is Integrated into the rain sensor.

Multifunction Wiper Switch: AUTO and Sensitivity Control



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)

Auto light sensor



Enlarged auto light sensor section

Modification basis	
Application basis	
Affected VIN	

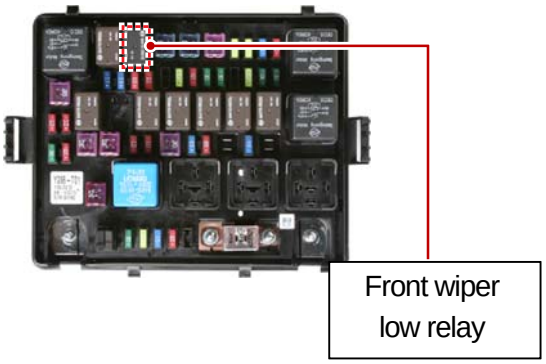
▶ STICS

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.

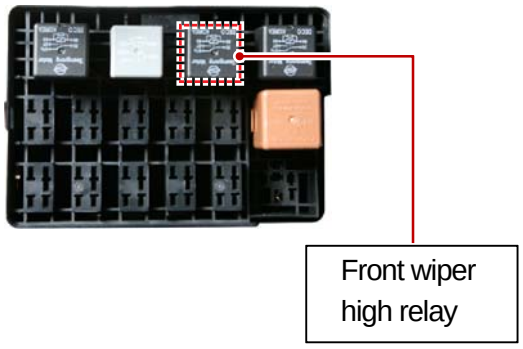
STICS



Engine Compartment Fuse



Interior Relay Box



▶ Auto Light Sensor and Rain Sensor Coupled Control

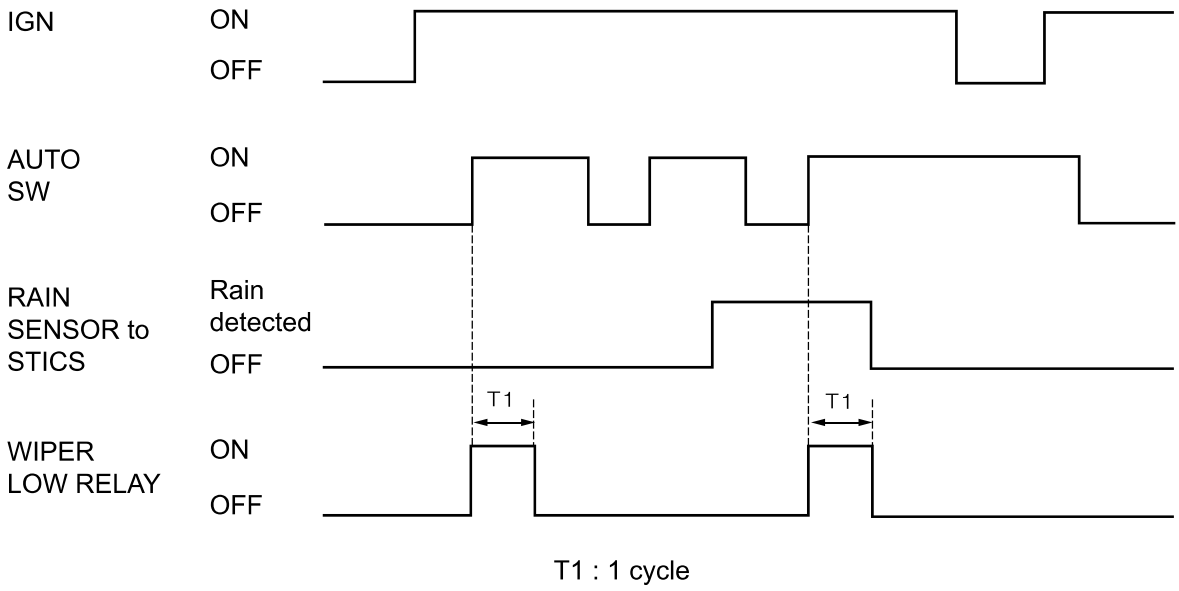
- Rain detected headlamp:
  If it rains heavy which requires the intermediate INT speed, the headlamps are turned on automatically.
  Night detected wiping:
- When the auto light control turns on the headlamps and the rain sensor detects the rain, the wiper sensitivity is automatically increased by one 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. FUNCTIONS OF RAIN SENSING WIPER SYSTEM

1) Power-up Reminder Wiper

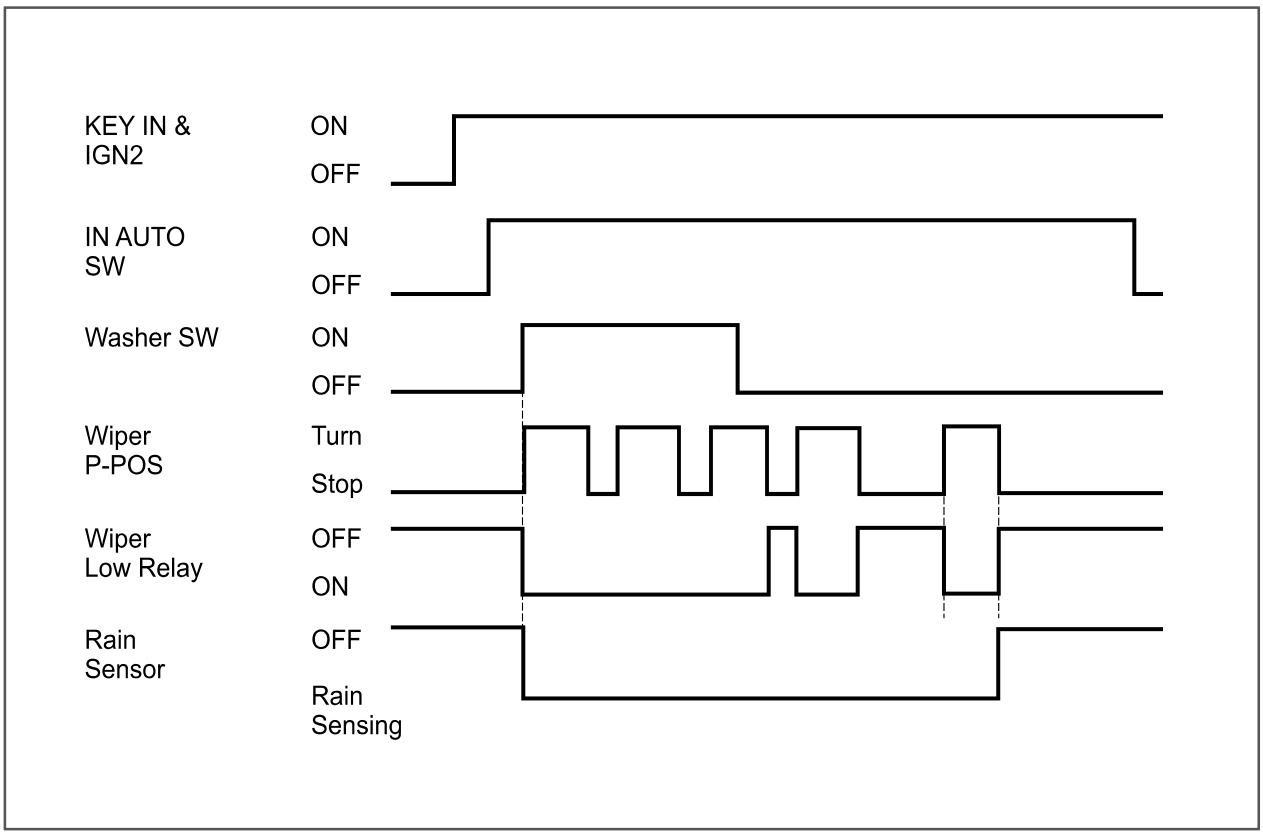
1. When turning off and on the INT auto switch, the system drives the wiper motor for one cycle through LOW relay regardless of communication with rain sensor.
2. When the INT/AUTO wiper switch is turned on from off with the ignition switch ON, the wiper low relay is turned on once to operate the wiper motor regardless of the rain sensor signals. After then, the wiper does not operate even when the INT/AUTO wiper switch is turned on from off. The wiper operates at low speed only when the rain sensor detects the rain drops.



T1 : 1 cycle

2) Washer Coupled Wiper Operation During Rain Sensor Coupled Operation

1. When the washer switch is turned on during rain sensor coupled operation with IGN ON and INT/AUTO switch ON, the communication with rain sensor is overridden and the wiper system operates in washer coupled wiper operation mode. However, if the signal from rain sensor is the continuous operation, the washer relay is turned on and the wiper keeps on running when the washer switch is ON.
2. Even though the wiper system is in washer coupled wiper operation mode, the operating data should be sent to rain sensor.

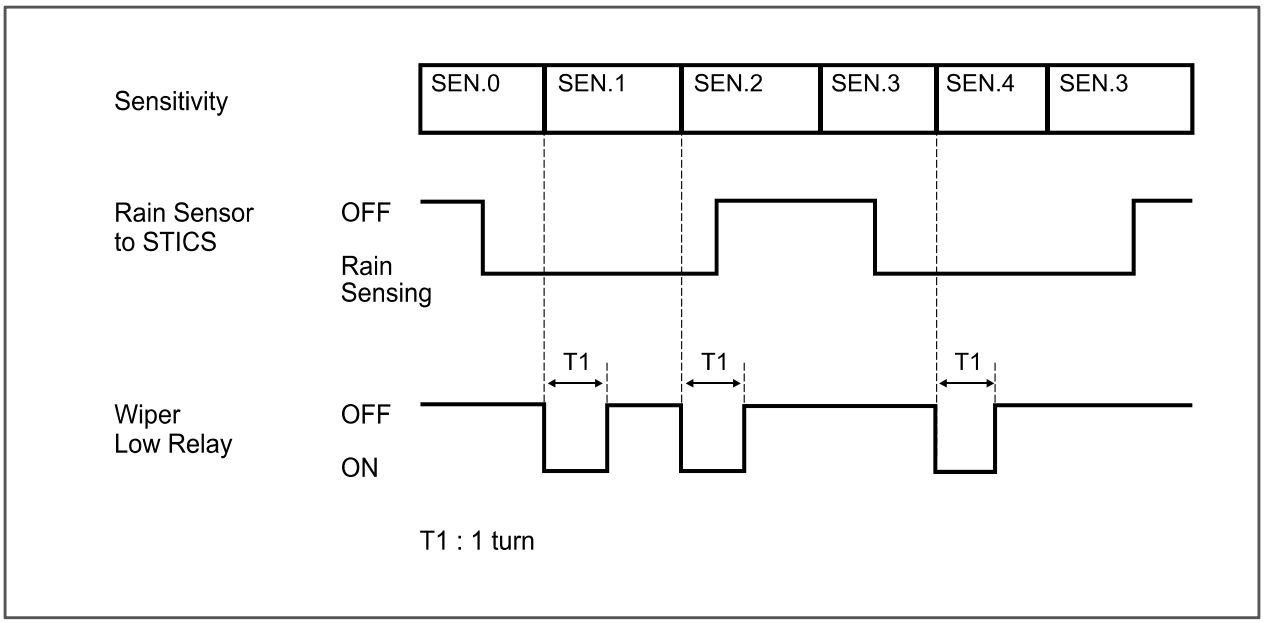


Modification basis	
Application basis	
Affected VIN	

3) Sensitivity Control (Instant Wiping)

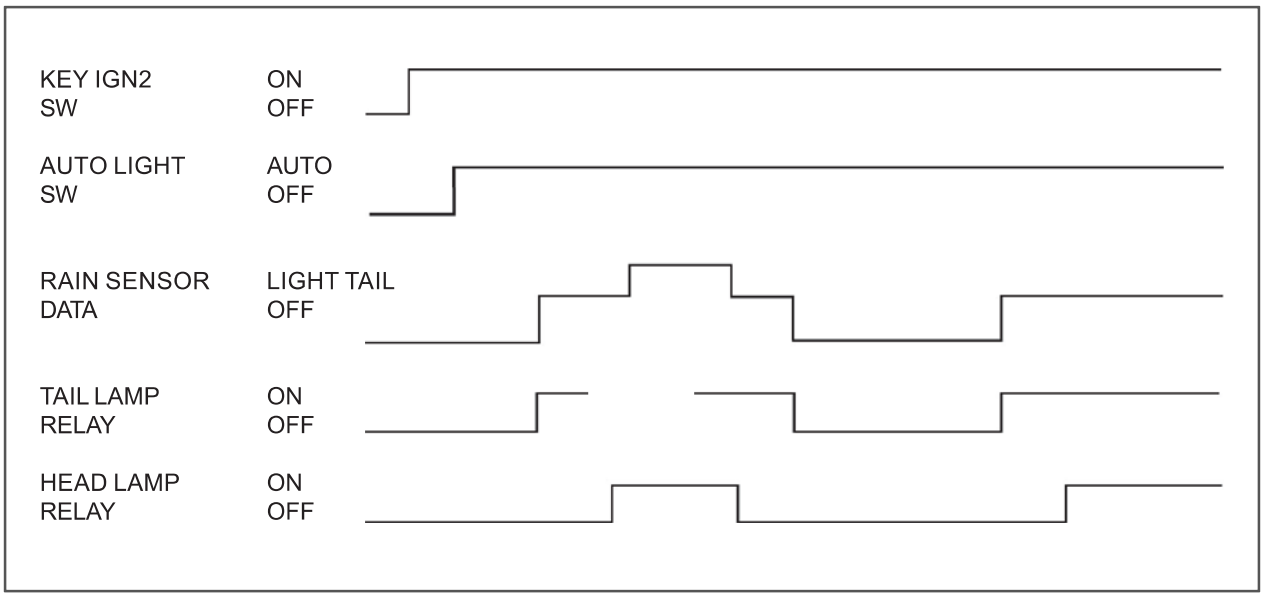
1. When the wiping speed control switch is turned to "FAST (ex: 0→1)" with IGN ON, INT/AUTO switch ON and wiper motor STOP (parking position), the wiper motor operates one cycle at low speed. (Only when the rain sensor detects rain drops)

* If the wiping speed control switch is changed more than 1 stages within 2 seconds, the wiper motor operates 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).

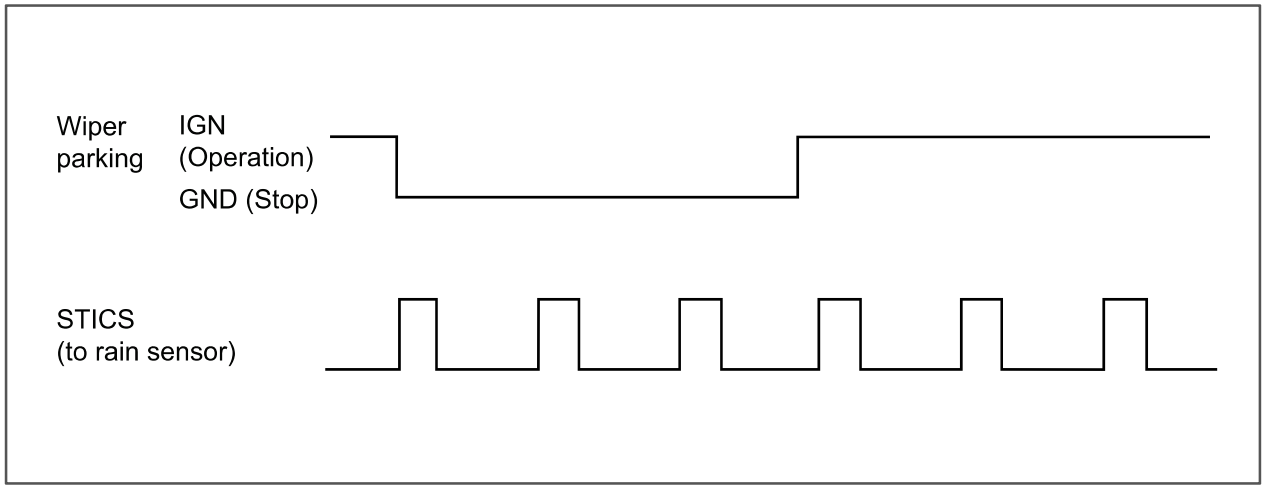


Modification basis	
Application basis	
Affected VIN	

5) For Abnormal Wiper Parking Signal

1. The wiper system continuously sends the signal for current status when the wiper parking terminal is stuck in ground with IGN2 ON and intermittent wiper switch in "AUTO" position.

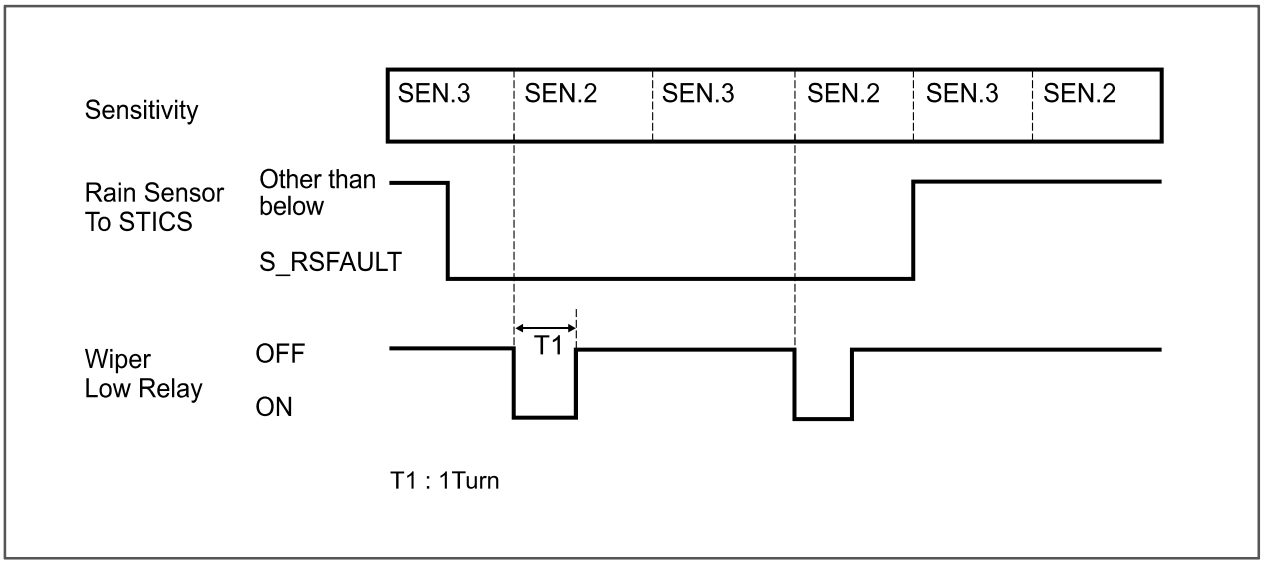
* The wiper motor is operated only when there is a request from the rain sensor.



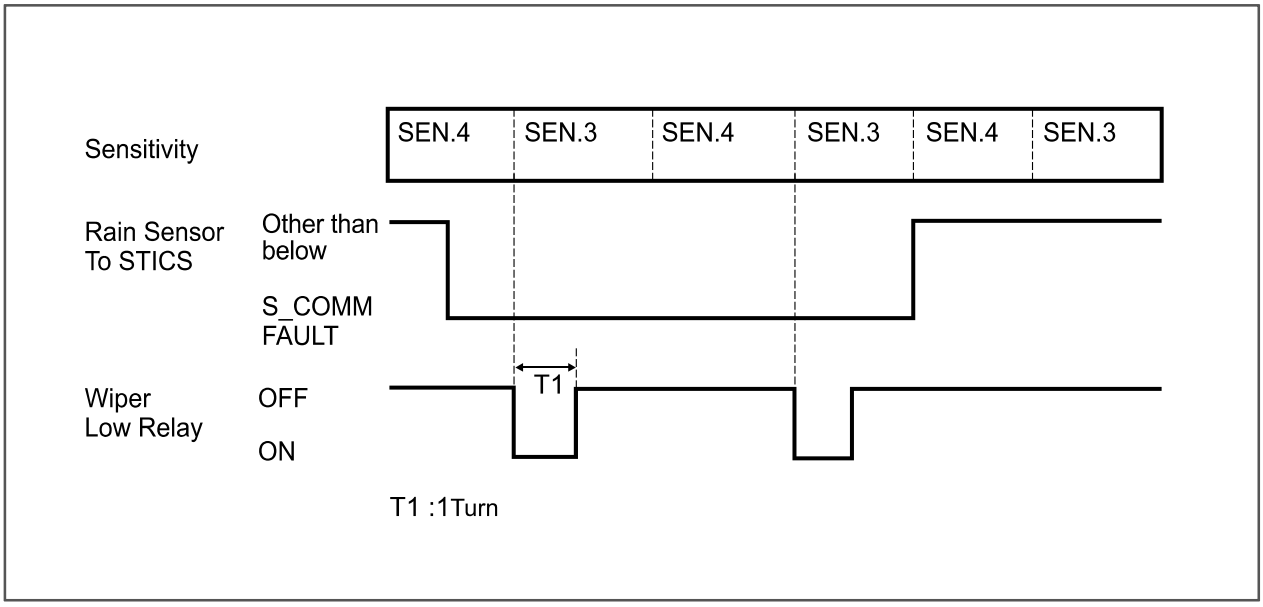
Modification basis	
Application basis	
Affected VIN	

6) For faulty rain sensor

1. When the wiper speed control switch is turned to step 2 from step 3, the wiper motor operates one cycle at low speed if STICS receives a faulty sensor signal (S_RSFAULT) from rain sensor unit with IGN ON and INT/AUTO switch ON.



2. When the wiper speed control switch is turned to step 3 from step 4, the wiper motor operates one cycle at low speed if STICS receives a faulty sensor signal (S_COMMFAULT) from rain sensor unit with IGN ON and INT/AUTO switch ON.



3. 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 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	

PAS

8790-04

GENERAL INFORMATION

1. SPECIFICATION

Description	Specification
Rated voltage	DC 13.5V (IGN voltage)
Operating voltage	DC 9.0V ~ 16.0V
Operating temperature	−30℃ ~ +80℃
Storage temperature	−40℃ ~ +85℃
Maximum humidity	95%
Maximum resistance voltage	24V
Insulating resistance	No heat & fire due to current leak
Max. permissible current	Unit: 200mA or less (DC 13.5V) Sensor: 30mA (DC 13.5V)

2. CAUTIONS

▶ **Sensor Cannot Detect**

- When the sensor is frozen (operate normally when it's thawed)
- When the sensor is covered with foreign materials such as snow or condensation (if the foreign materials are removed, the sensor operates normally.)

▶ **Not defective but improperly working**

- When the sensing portion is frozen (operates normally after thawed)
- When reversing on rough roads, gravel roads, hills, or grass.
- When receiving other ultrasonic signals (metal sounds or air braking noises from heavy commercial vehicles).
- When there is heavy rainfall or water drops.
- When the sensor is covered with snow.

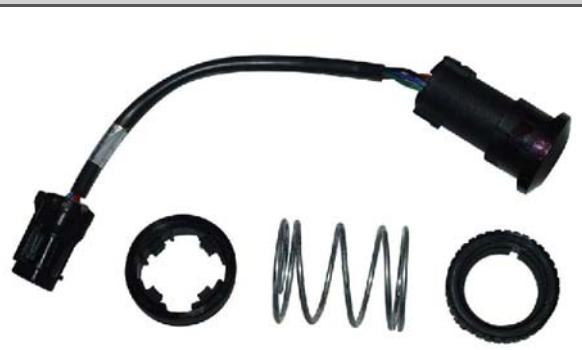
▶ **Certain obstacles that sensors cannot detect**

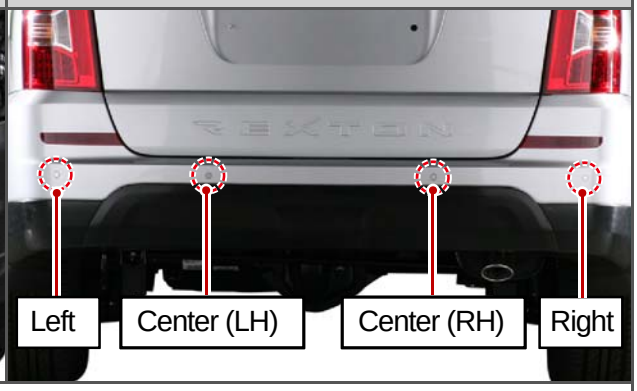
- Thin and narrow objects, such as wires, ropes, or chains
- Cotton, sponge, clothes, snow that absorb ultrasonic waves.

▶ **Weak Sensing Scopes**

- When the ambient temperature is too high or too low.
- When a 1 m or less long small object with a diagmeter of 100 mm or less is detected.

3. MAJOR CHANGES

PAS sensor holding type	
Old	**New**
	
Spring type lock → Holder type lock	

Number of Rear PAS sensors	
Old	**New**
	
3 sensors → 4 sensors	

PAS Unit	
Old	**New**
	
Operating voltage: 12V → 8V, Connector pin: 3 pins → 4 pins	

Modification basis	
Application basis	
Affected VIN	

Memo

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

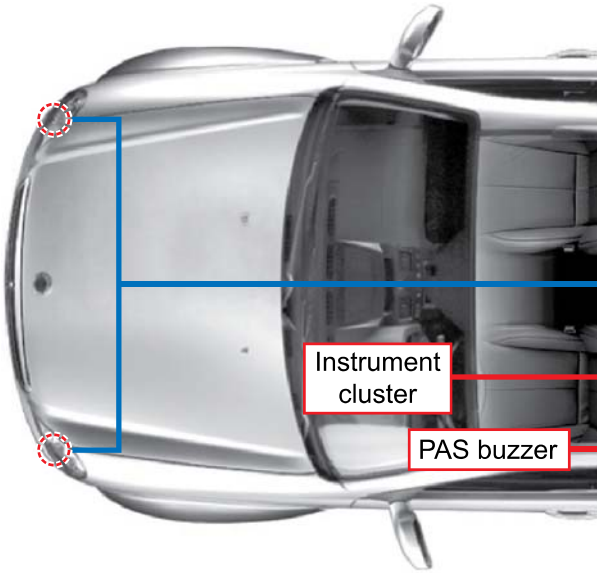
When the gear selector lever is shifted into "D" or "R" position, the parking aid system (PAS) is activated and the sensors in the front or rear bumper detect the distance to any obstacle. Driver can figure out the distance from the obstacle to the vehicle by the alarming sound. The alarm interval becomes faster as the vehicle approaches the object.

2. LAYOUT

- Two sensors in front bumper
- Activated when the gear selector lever is "D' or "R" position.
- Operated only when the vehicle speed is below 10 km

Location of front PAS sensors





Front PAS sensor



PAS buzzer



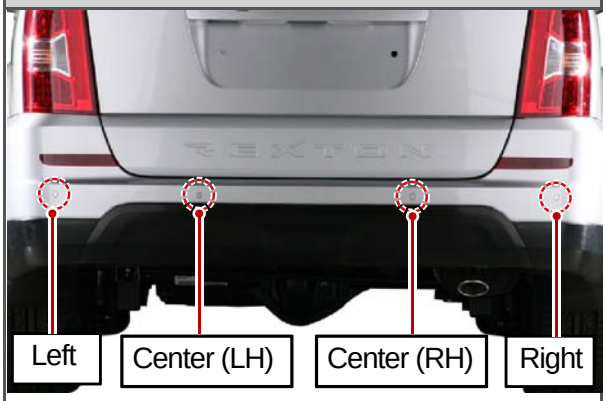
Modification basis	
Application basis	
Affected VIN	

PAS buzzer

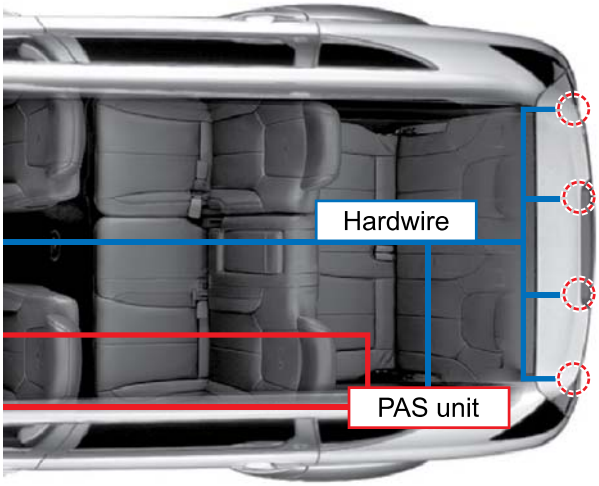


This switch turns the front PAS sensor ON and OFF. When the LED on the switch is ON, PAS system is not available.

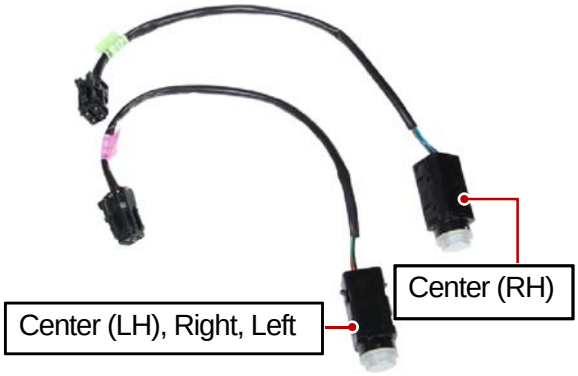
Location of Rear PAS Sensor



- 4 sensors
- Operable only when reverse driving



Rear PAS Sensor



TGS Lever



PAS Unit



-Controls the PAS sensor and sends the sensing signals to the instrument cluster and buzzer

Modification basis	
Application basis	
Affected VIN	

3. OPERATING PROCESS

1) Detection Range

Front + Rear PAS



Rear PAS



Modification basis	
Application basis	
Affected VIN	

(1) Sensing Distance: 30cm ~120cm (Straight distance from sensor)

▶ **Front sensor**

	0cm	30cm	40cm	60cm	70cm
Front sensors	N/A	Alarm Level 3	Alarm Level 2	N/A	

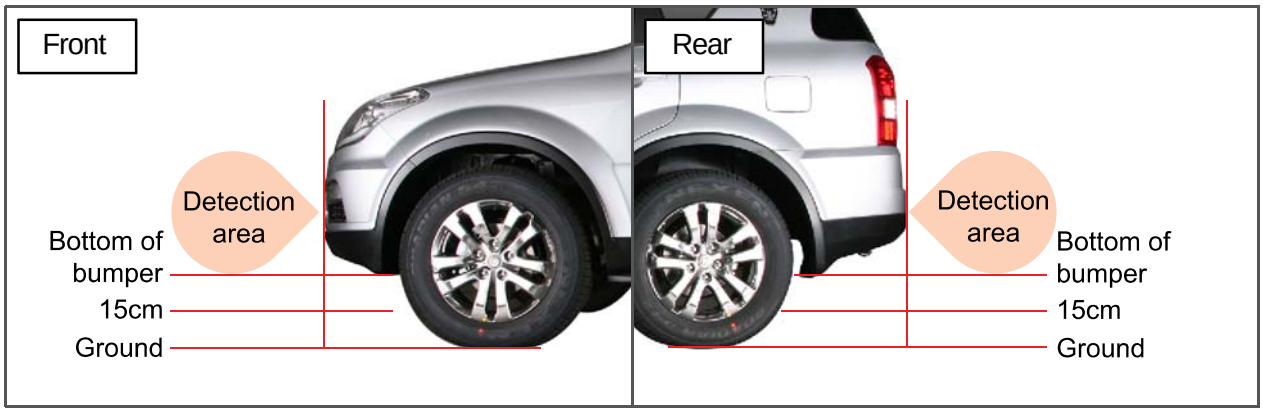
▶ **Rear sensor**

	0cm	30cm	50cm	80cm	120cm	130cm
Rear center (LH/RH) sensors	N/A	Alarm Level 3	Alarm Level 2	Alarm Level 1	N/A	
Rear (LH/RH) sensors	N/A	Alarm Level 3	Alarm Level 2	N/A		

▶ **Detecting range and alarm interval (alarm from external buzzer)**

Level	Rear sensor (Center left, Center right)	Rear (Left, Right)	Front (Left, Right)	Alarm interval
3	30~50cm	30~50cm	30~40cm	Stays ON
2	50~80cm	50~80cm	40~60cm	ON & OFF (0.065 s)
1	80~120cm			ON (0.065 s) & OFF (0.196 s)
Tolerance	±5cm			±10%

(2) Vertical Detection Range

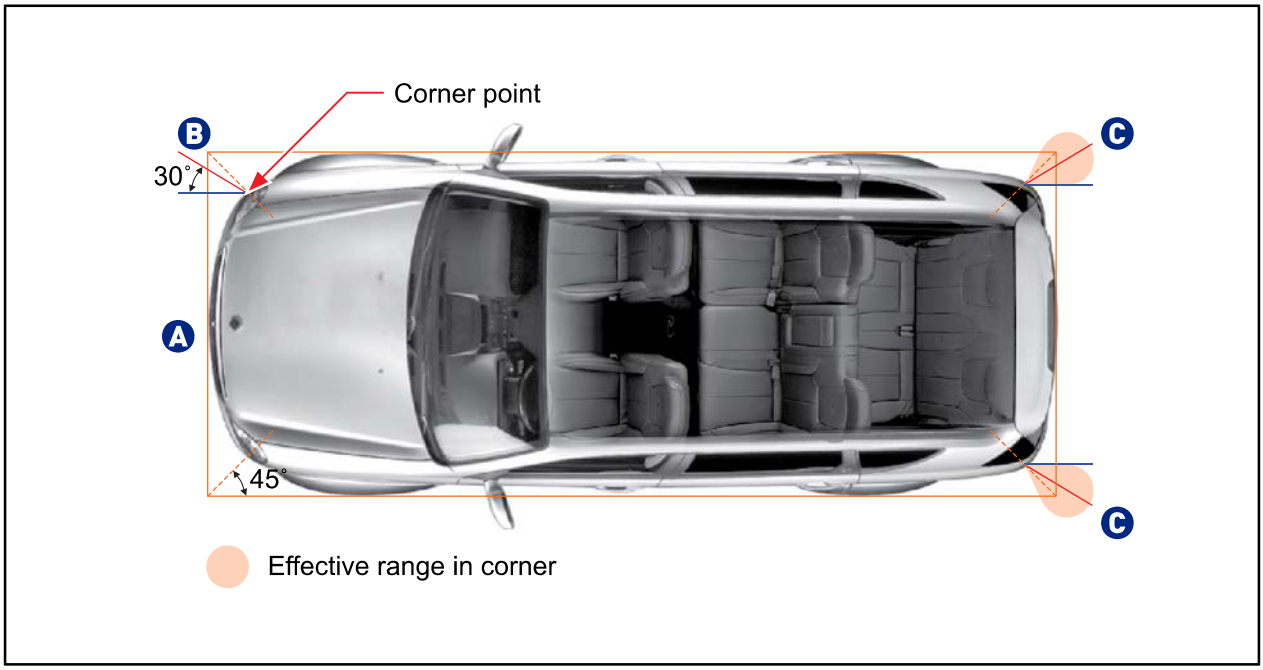


Height	0~Bottom of bumper (Range B)	From bottom of bumper (Range C)
Detection	No detectable	Detection area
Tolerance	±5cm	±5cm

NOTE

The sensors may not detect the obstacle when it is above the range "A" (80cm).

(3) Horizontal Detection Range



Modification basis	
Application basis	
Affected VIN	

2) Function

▶ **Operating conditions**

- IGN ON

▶ **Operations**

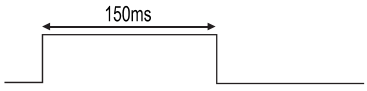
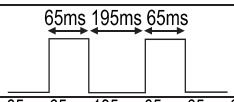
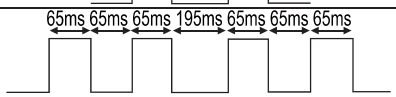
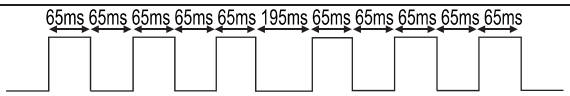
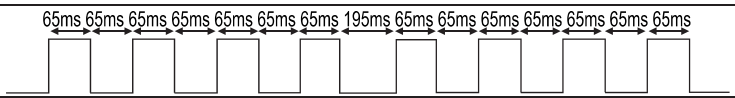
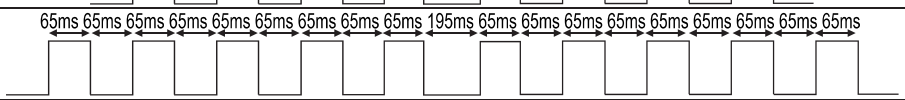
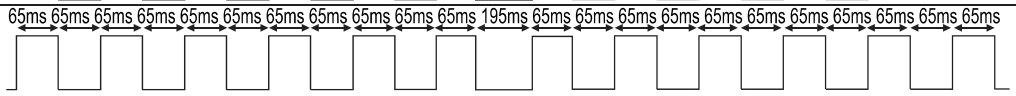
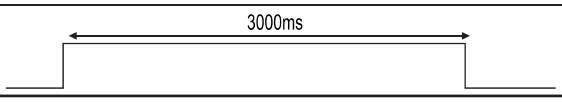
- The front PAS sensors are available when the gear selector lever is in "D" position.
- The front and rear PAS sensors are available when the gear selector lever is in "D", "R" position.
- The front PAS ON/OFF switch turns on and off the front PAS sensors.
- The front PAS sensors are turned off when the vehicle speed exceeds 15km/h.

(1) Self-Diagnosis (Buzzer indication)

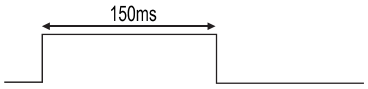
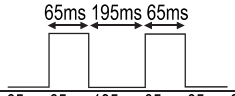
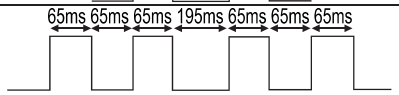
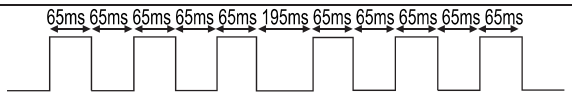
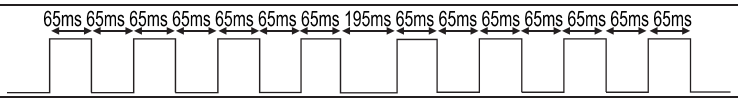
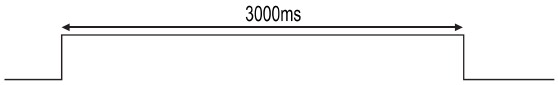
- Starts the self-diagnosis mode when turning the ignition on
- Starts the self-diagnosis mode when moving the gear selector lever into 'R" position
- Fail conditions of self-diagnosis
  a. Sensor circuit is open/short
  b. Power circuit is open/short
  c. Sensor is defective.
- If the sensors are working properly, the buzzer sounds for 150ms.

▶ **Alarm interval during self-diagnosis**

- Front + Rear PAS system

Defective	Alarm interval
Normal	
Defective rear LH sensor	
Defective rear center-LH sensor	
Defective rear center-RH sensor	
Defective rear RH sensor	
Defective front LH sensor	
Defective front RH sensor	
Defective two or more sensors	

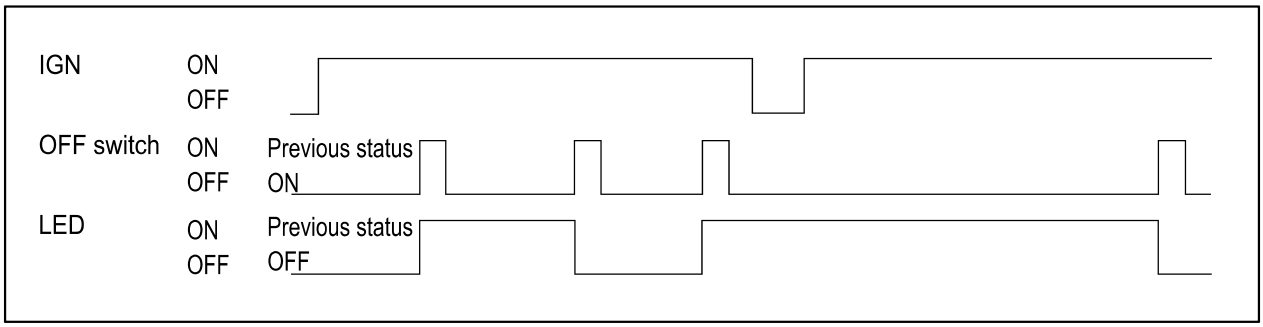
- **Rear PAS system**

Defective	Alarm interval
Normal	
Defective rear LH sensor	
Defective rear center-LH sensor	
Defective rear center-RH sensor	
Defective rear RH sensor	
Defective two or more sensors	

Modification basis	
Application basis	
Affected VIN	

4. OPERATION MODE

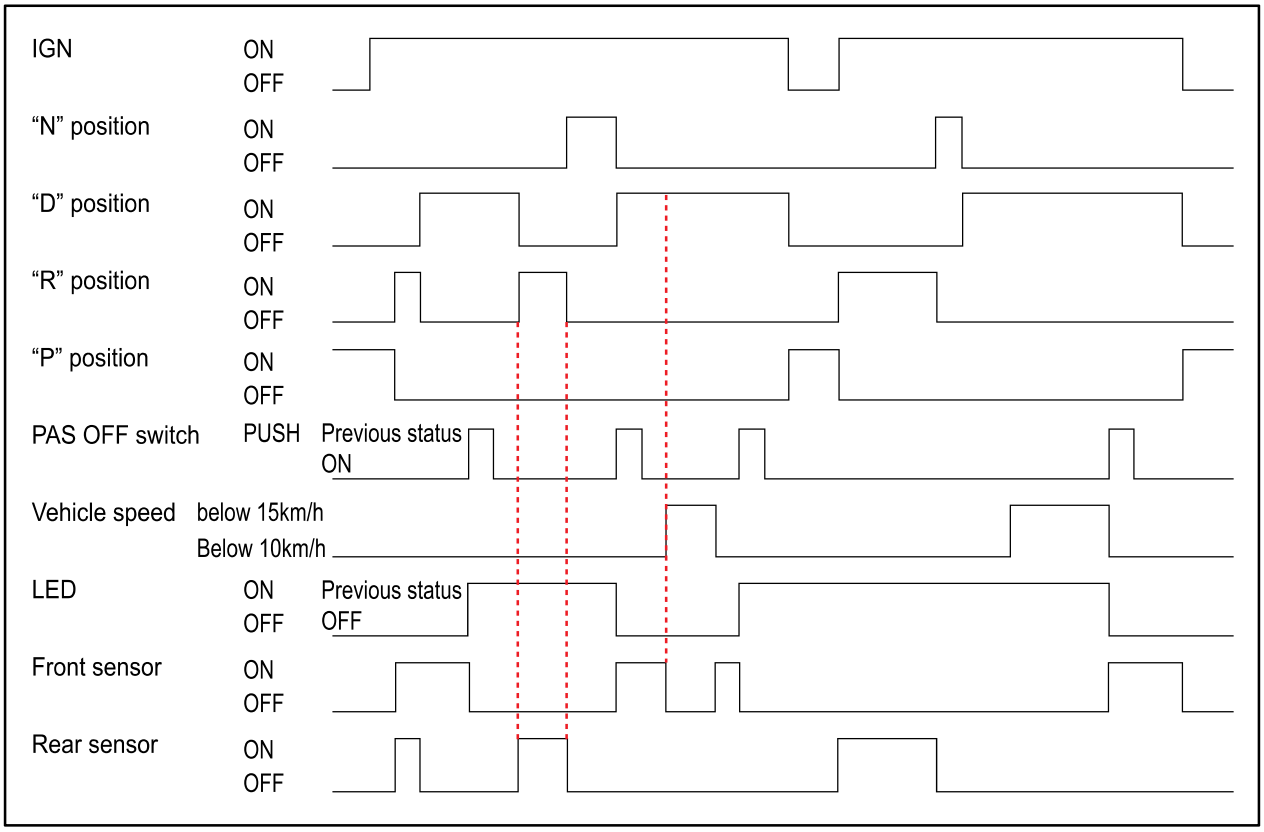
▶ Operation of LED



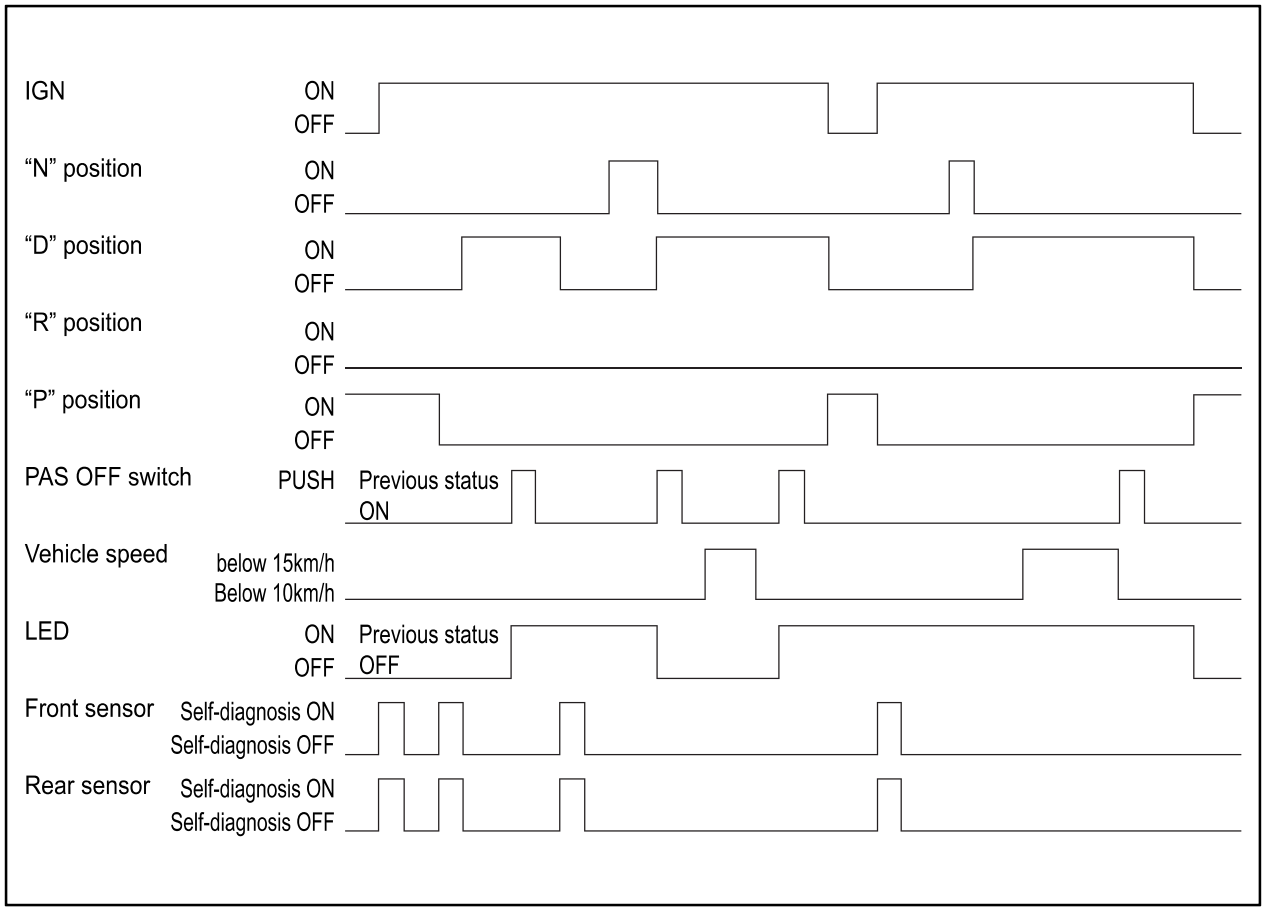
▶ Operation of front PAS OFF switch

Switch	Sensor	P	R	N	D
OFF(LED ON)	Front	OFF	ON	OFF	ON
	Rear	OFF	ON	OFF	ON
ON(LED OFF)	Front	OFF	ON	OFF	ON
	Rear	OFF	ON	OFF	ON

▶ Operation when detecting the obstacle



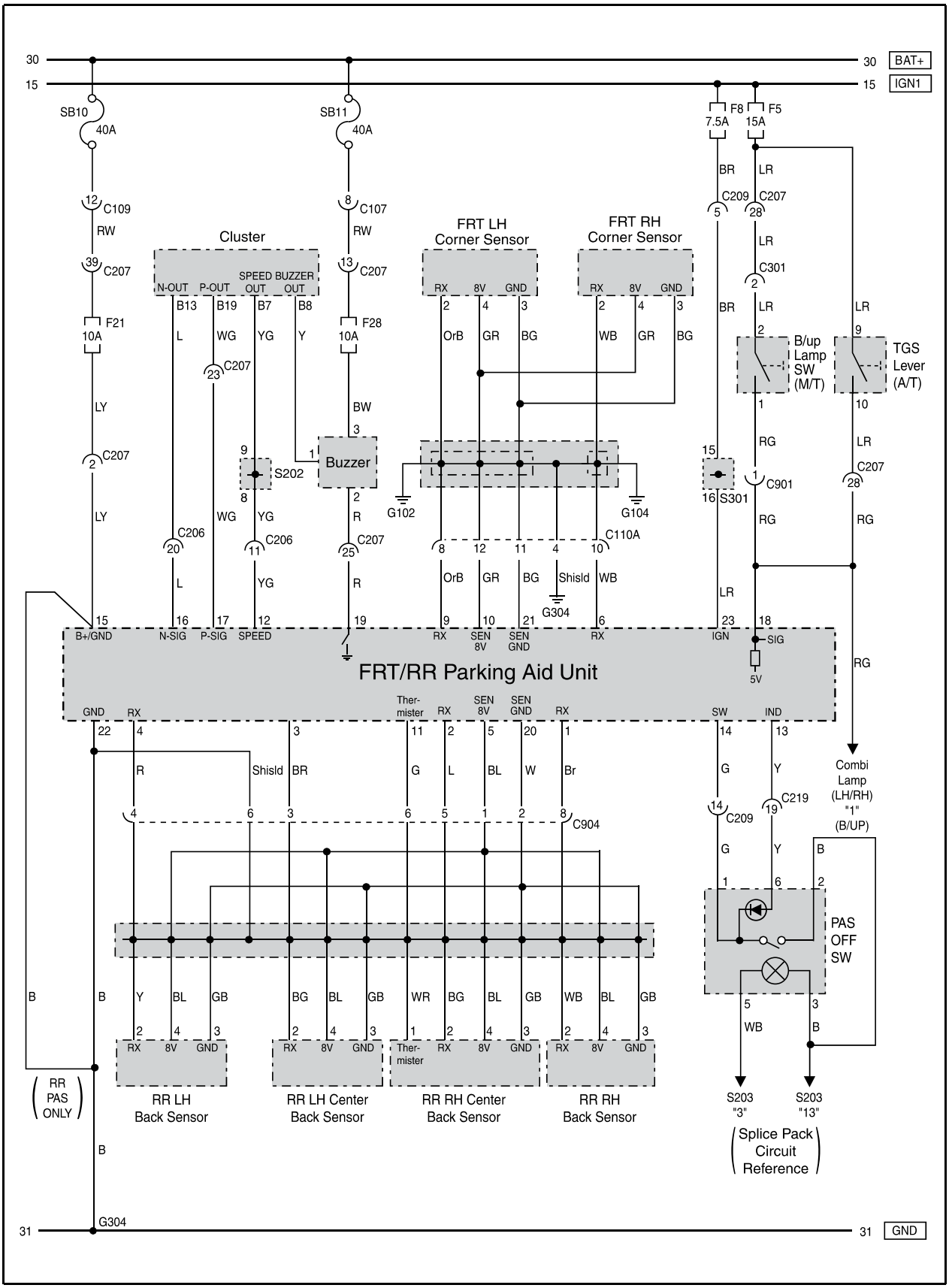
▶ Operation of self-diagnosis



- If the vehicle speed exceeds 15km/h, the front sensors are turned off. If it goes below 10km/h, the sensors start their operation again. (Gear selector lever in "D" position & Front PAS OFF switch in "OFF" position)
- When turning on the ignition, the self-diagnosis is performed, but no buzzer output.

Modification basis	
Application basis	
Affected VIN	

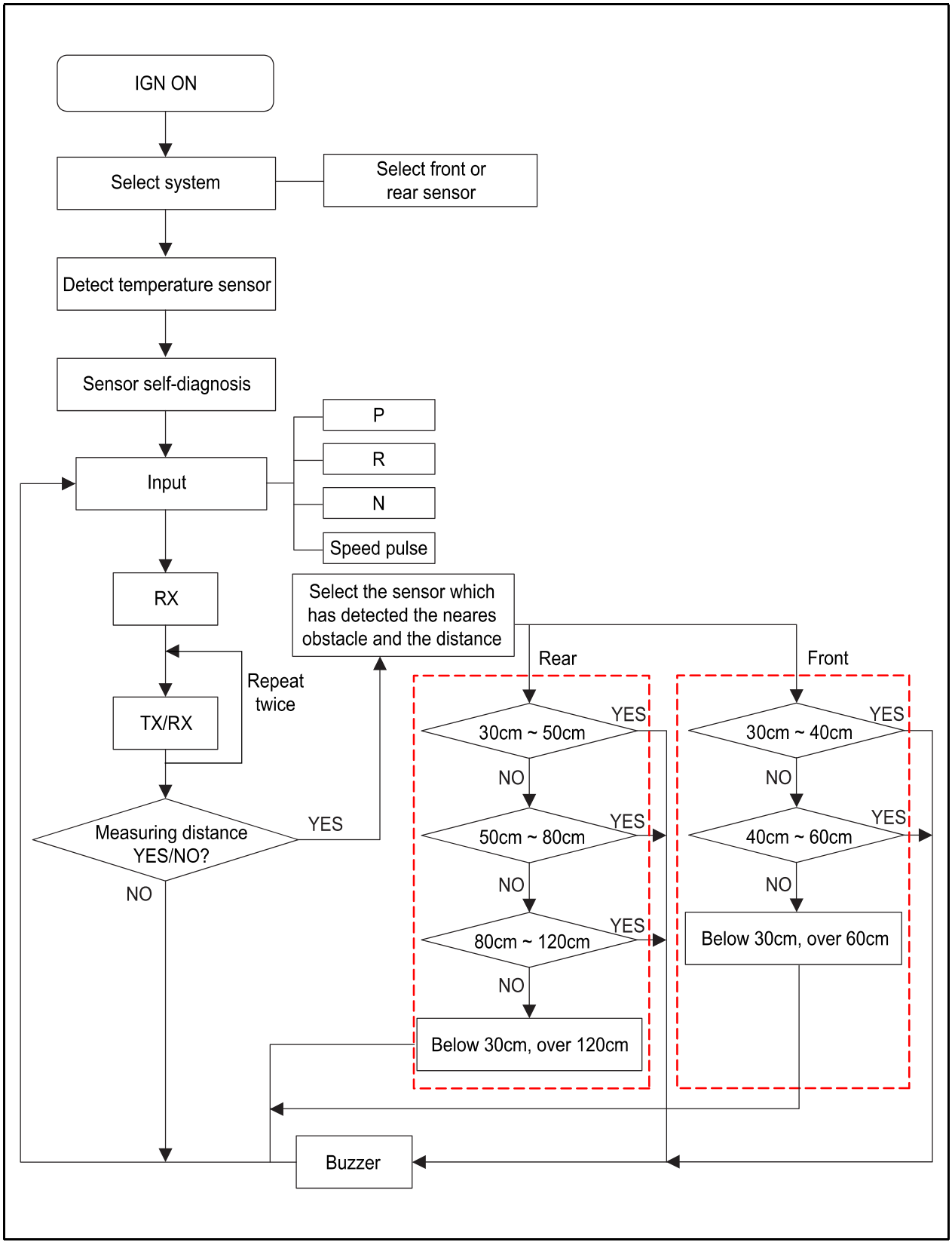
5. CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	

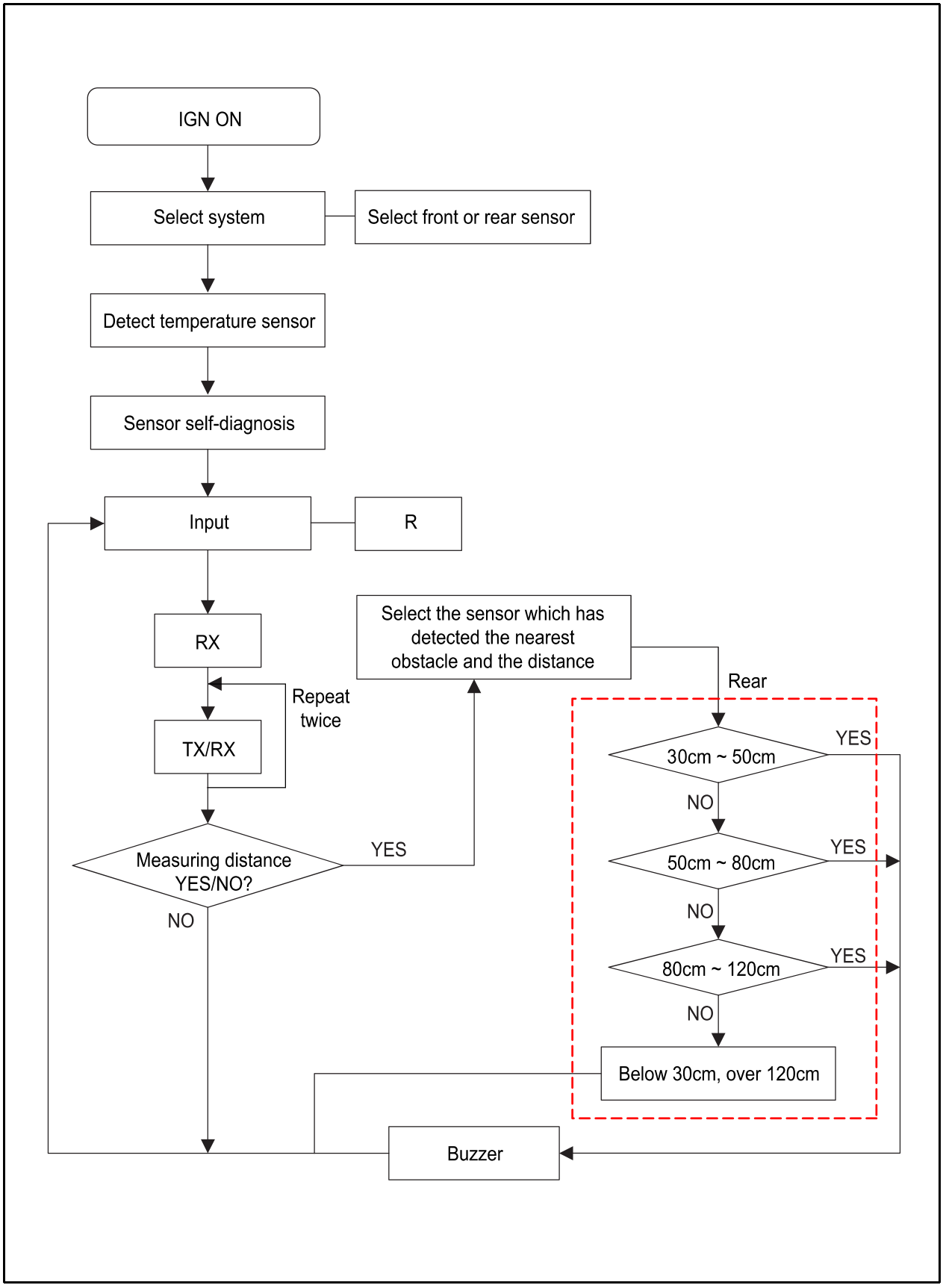
6. FLOW CHART

▶ **Front + Rear PAS System**



Modification basis	
Application basis	
Affected VIN	

▶ Rear PAS System



AUDIO SYSTEM

8910-05

GENERAL INFORMATION

1. SPECIFICATION

Unit	Description		Specification
Audio	Voltage		DC 14.4V
	Operating voltage		DC 10.8V~16.0V
	Output		45W/ch (4Ω)
Speaker	Impedance		4Ω
Current consumption			below 5A, max. 10A
Dark current			below 3mA
Radio	Frequency	EU	FM : 87.5 ~ 108MHz MW: 522 ~ 1620 KHz LW : 144 ~ 290 KHz
		Latin America	FM : 87.5 ~ 108 MHz AM : 520 ~ 1620 MHz
	Preset		FM1: 6ch FM2: 6ch MW: 6ch LW: 6ch AM: 6ch
	Sensitivity		AM: 25dBu FM: 10dBu
	S/N ratio (limit)		AM: 54dB FM: 60dB
LCD	Type		ISTN
	Operating voltage		9.0V VDD: 3.0~3.3V
	Operating temperature		−30℃ ~ +75℃
	Storage temperature		−40℃ ~ +85℃
	Size (width x height)		132X36
Bluetooth	Composition		MD-5XR
	Technology		Bluetooth 2.0 + EDR
	Product name		HFP A2DP.AVRCP

Unit	Description		Specification
Micro pole antenna	Audio	Operating current	max. 150mA
		Operating voltage	DC 10.5V ~ 16V
		Operating temperature	−30℃ ~ +60℃
		Storage temperature	−40℃ ~ +80℃
		Input/Output impedance	75Ω(FM)

Modification basis	
Application basis	
Affected VIN	

2. MAJOR CHANGES

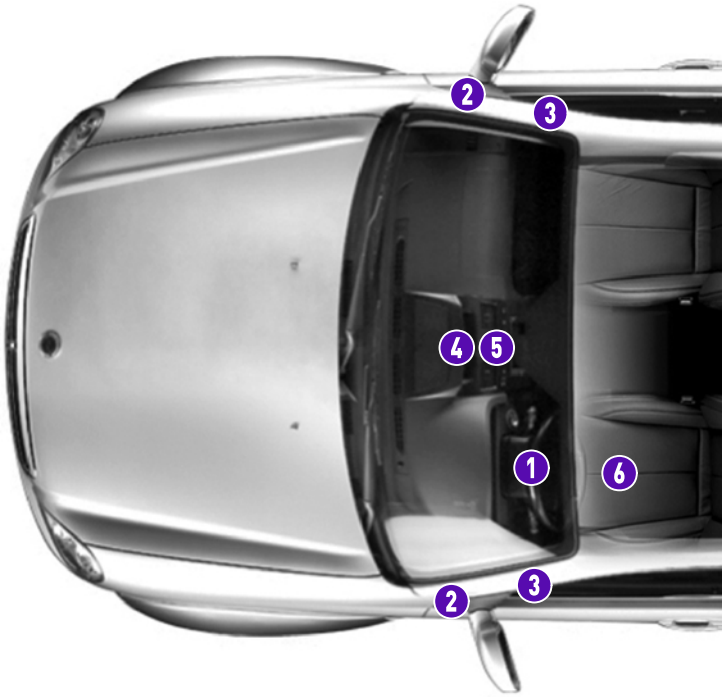
Audio Assembly	
Old	**New**
	
Changed the audio assembly (added Bluetooth hands-free function)	

Audio Antenna		
Old	**New**	
	Audio type 	AVN type 
Changed the antenna from integrated type to micro pole type.		

OVERVIEW AND OPERATING PROCESS

1. LAYOUT

- Audio
- CD
- Radio
- USB/AUX
- Bluetooth hands-free



1 Audio Remote Control Switches



2 Front Door Tweeter Speaker



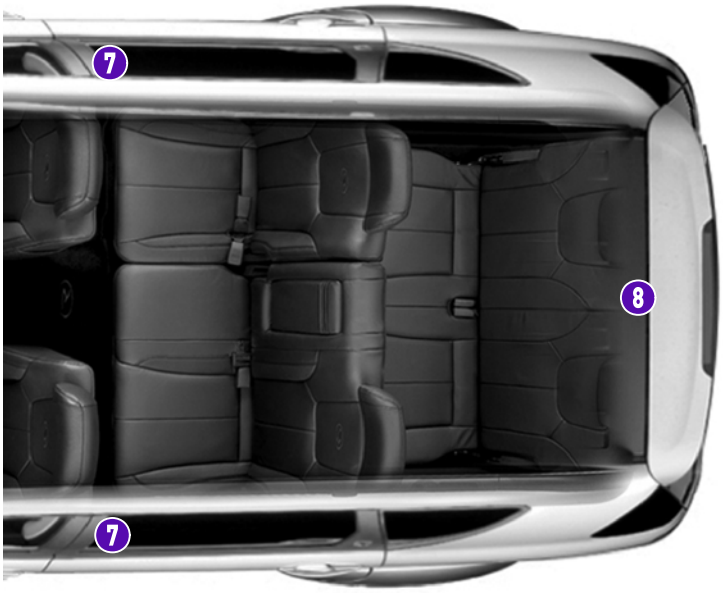
3 Front Door Speaker



4 Audio Assembly



Modification basis	
Application basis	
Affected VIN	



8 Micro Pole Antenna



5 USB/AUX



6 Hands-free Microphone

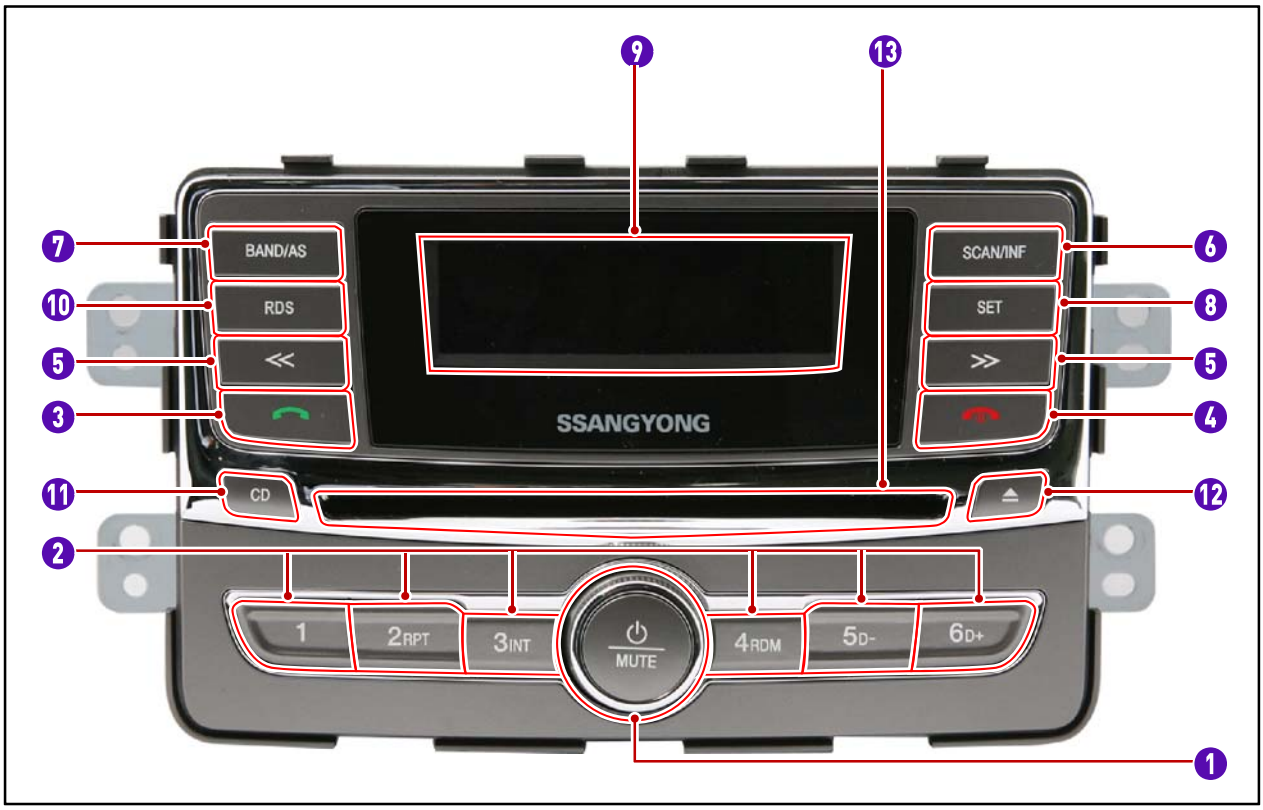


7 Rear Door Speaker



Modification basis	
Application basis	
Affected VIN	

1) Switches



No.	Name
1	Power/Mute/Pause/Enter/Volume button
2	Station memory button (1~6) and Audio function button
3	Bluetooth hands-free CALL button
4	Bluetooth hands-free END button
5	Previous (≪) and Next (≫) button
6	SCAN/INFO button
7	BAND/AS button
8	SETTING button
9	Display window (LCD)
10	RDS setup
11	Disc Play button
12	Disc Eject button
13	Disc slot

Modification basis	
Application basis	
Affected VIN	

ELECTRIC ACCESSORIES

8510-00

GENERAL INFORMATION

1. SPECIFICATIONS

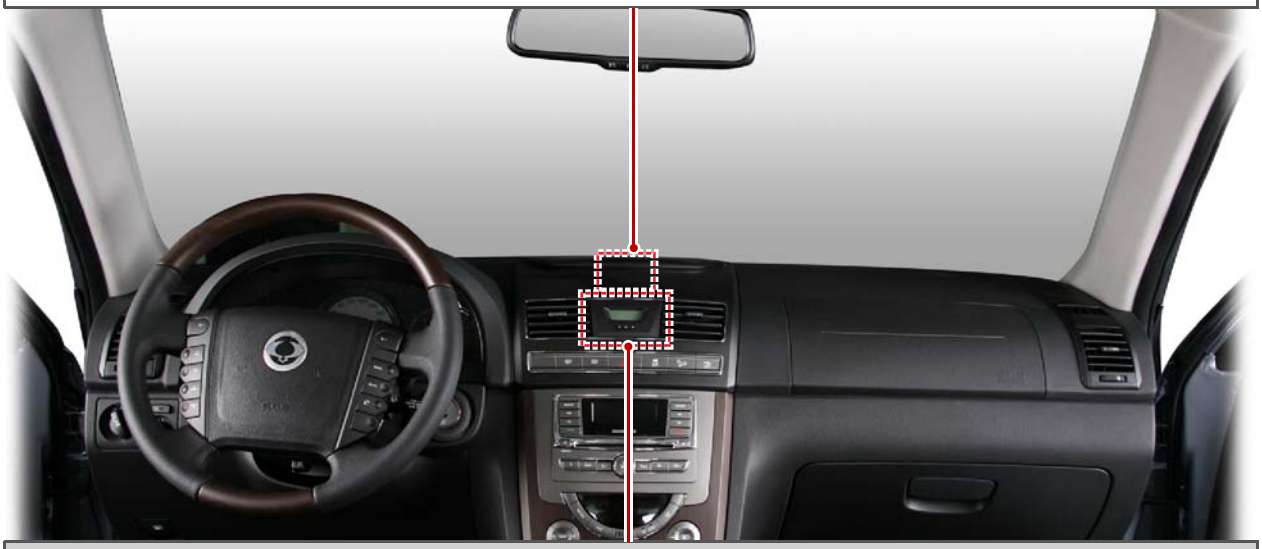
Unit	Description		Specification
Horn	Rated voltage		12V
	Current consumption		MAX 3.5A
	Frequency	LOW	415 ± 20HZ
		HIGH	350 ± 20HZ
	Sound level		110 ± 5dB
	Operating voltage		12V~15V
Cigarette lighter	Rated voltage		12V
	Maximum operating current		10A
	Isolated resistance		5MΩ
	Return time		13±5 sec after pushing it
Power outlet	Rated voltage		12V
	Maximum operating current		10A
	Isolated resistance		5MΩ
Digital clock	Rated voltage		12V
	Operating voltage		8V~ 16V
	Operating temperature		-30~80℃
	Time tolerance		± 0.25 SEC
	Current consumption	IGN ON	MAX 150 mA
		IGN OFF	MAX 2.5 mA
	Display color		Yellow green
	Display type		LCD

Modification basis	
Application basis	
Affected VIN	

2. MAJOR CHANGES

1) Power Outlet & Digital Clock

Power Outlet	
Old	**New**
	
- Deleted the speaker and installed new power outlet on top of center instrument panel.	



Digital Clock	
Old	**New**
	
- Deleted the multi-station and installed new digital clock.	

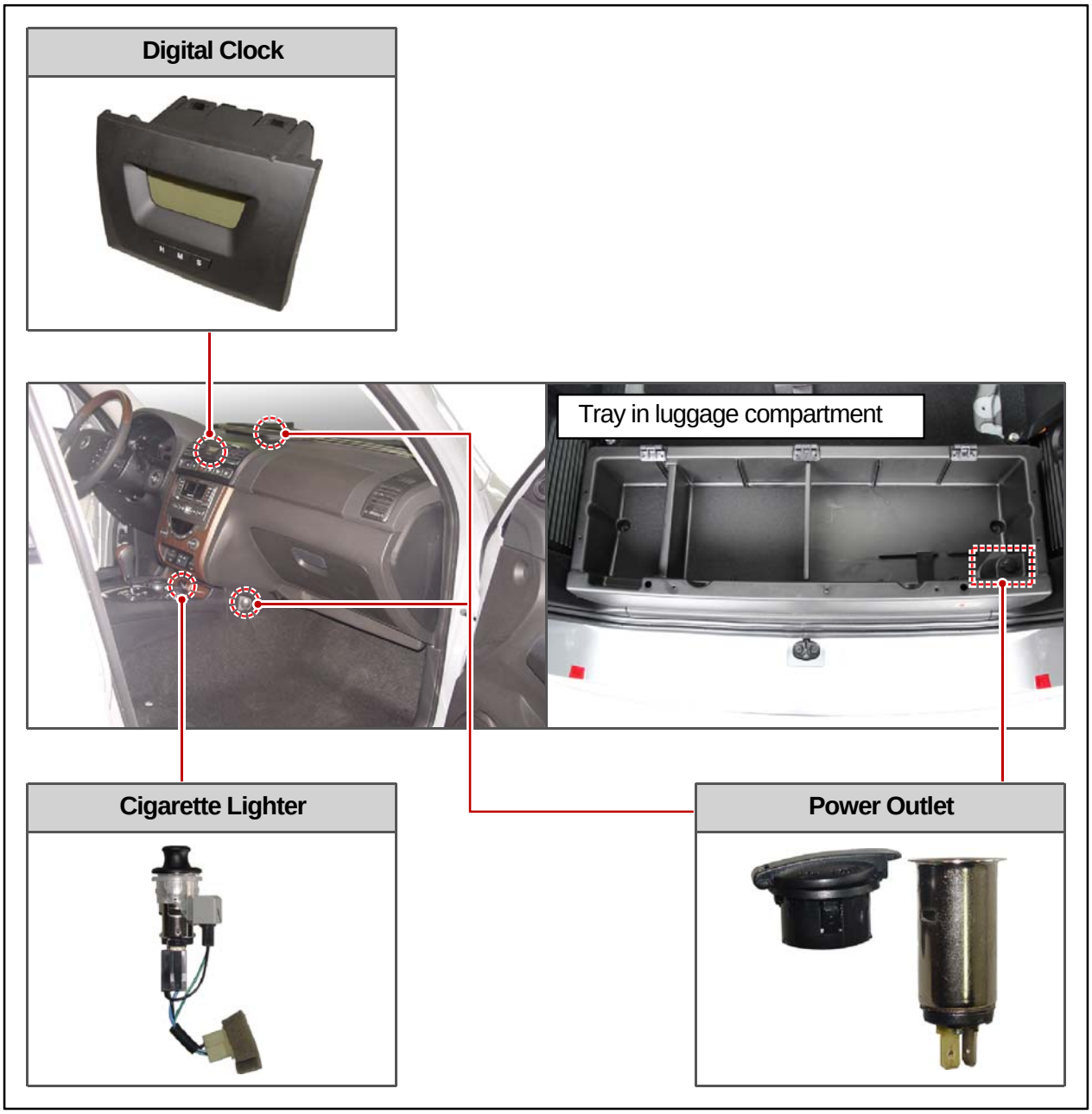
Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

The electric accessories are: Horn, Cigarette lighter, Power outlet, Digital clock and Siren (Theft deterrent alarm)

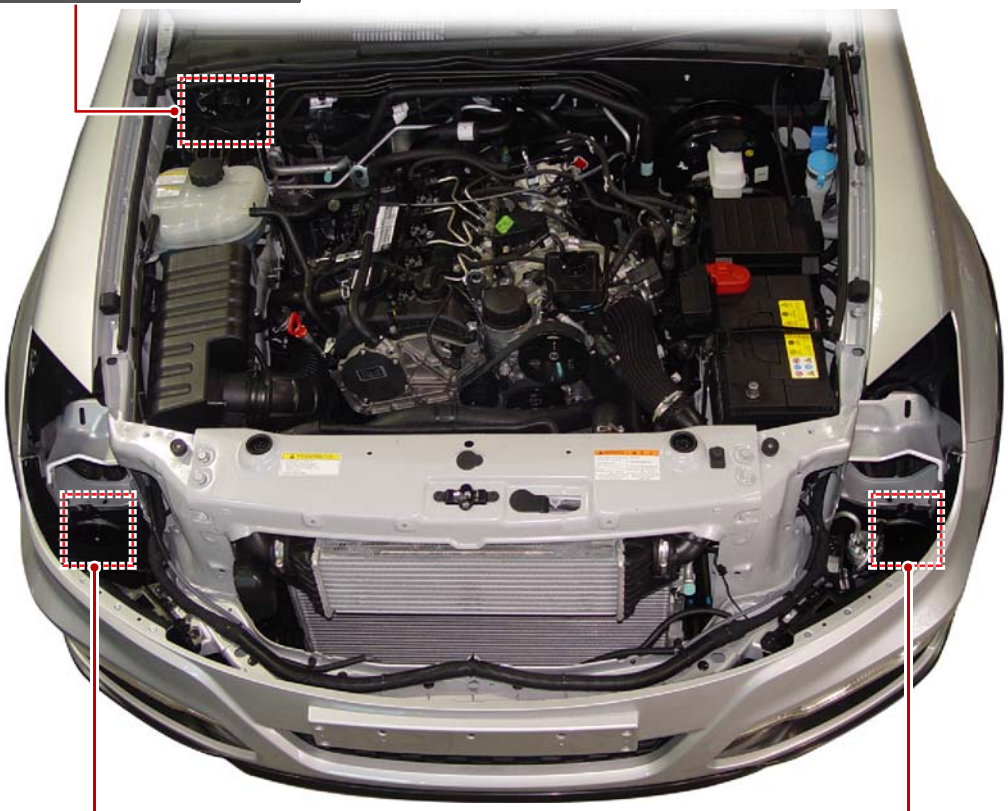
1) Interior Electric Accessories



2) Exterior Electric Accessories

Siren (Theft Deterrent Alarm)





RH Horn (Low)



LH Horn (High)



Modification basis	
Application basis	
Affected VIN	

2. OPERATING PROCESS

1) Horn

(1) Operating Condition

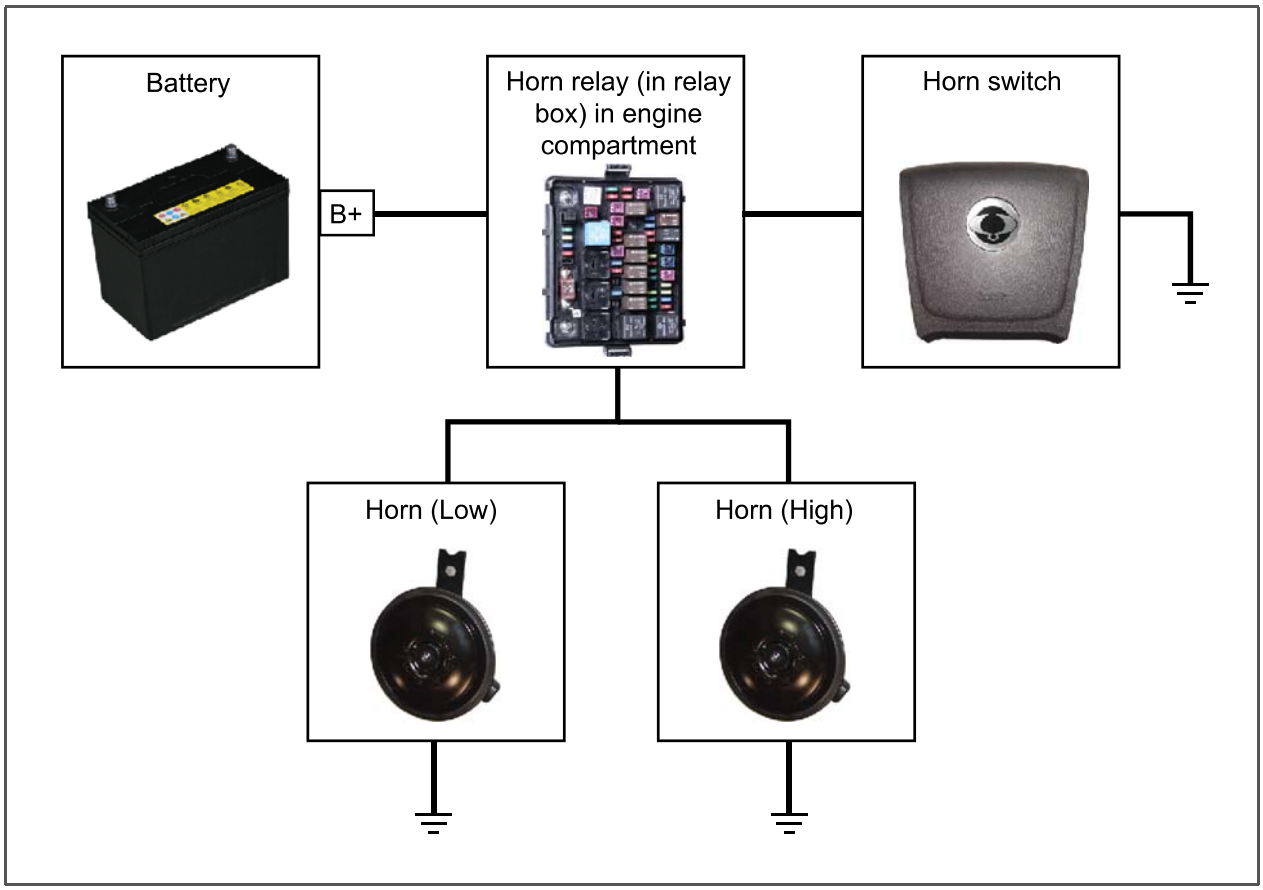
- B+ (always ON)

(2) Operation



- The horn sounds when pressing the horn switch on the steering wheel.

(3) Operating Process



2) Cigarette Lighter & Power Outlet

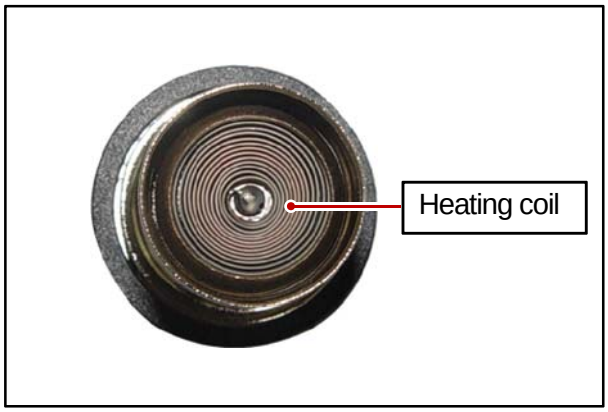
(1) Operating Conditions

- Cigarette lighter & Power outlet: ACC, IGN ON
- Indicator in cigarette lighter: Tail lamp ON

(2) Operation of Cigarette Lighter

- Press in the cigarette lighter and wait until it pops out.





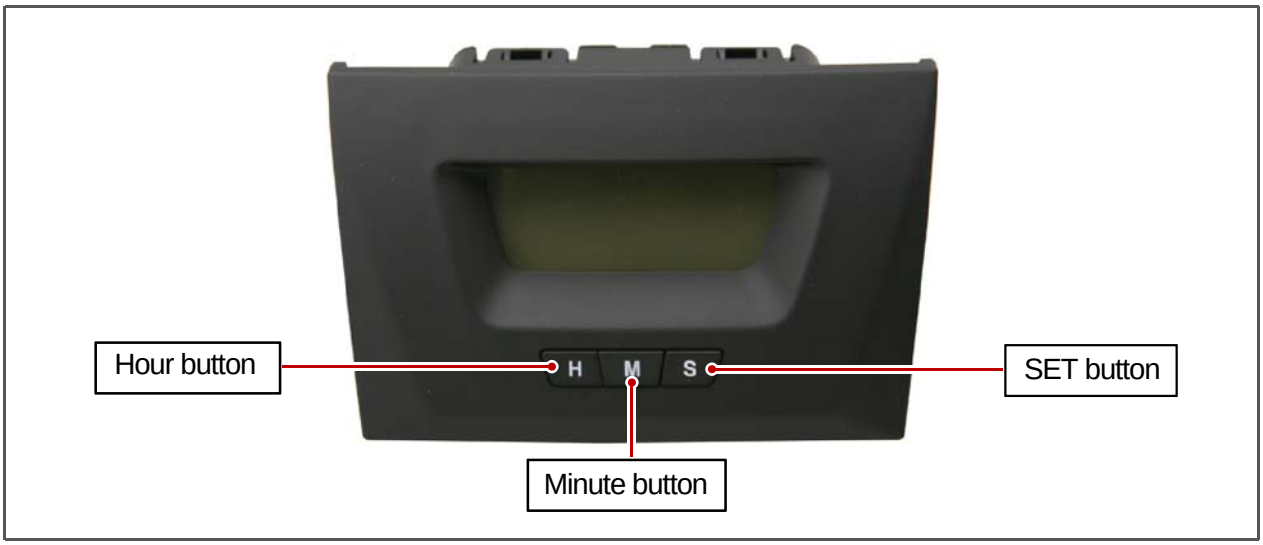
CAUTION

The barrel of the cigarette lighter becomes very hot when it is fully charged. When touched by or dropped on bare skin, this may cause burns. Dropping the hot cigarette lighter can cause damage to a car seat or even start a fire.

Modification basis	
Application basis	
Affected VIN	

3) Digital Clock

(1) Adjustment



▶ **How to change the time on digital clock**

- "S" button: Reset the "Minute". To change the time indication type between 24-hour and 12-hour, press this button for more than 3 seconds.
- "H" button: Increases the "Hour"
- "M" button: Increases the "Minute"
  When the time is between 00 and 29 minutes of a certain hour, the minute indicator will show if this button is pressed.
  When the time is between 30 and 59 minutes of a certain hour, the minute indicator will show and one hour will be added to the hour indicator if this button is pressed.

4) Siren (Theft Deterrent Alarm)

(1) Operating Condition



- This horn sounds once when the vehicle is armed (into theft deterrent mode).
- This horn sounds for 27 seconds when there is an unauthorized access to the vehicle in theft deterrent mode.

NOTE

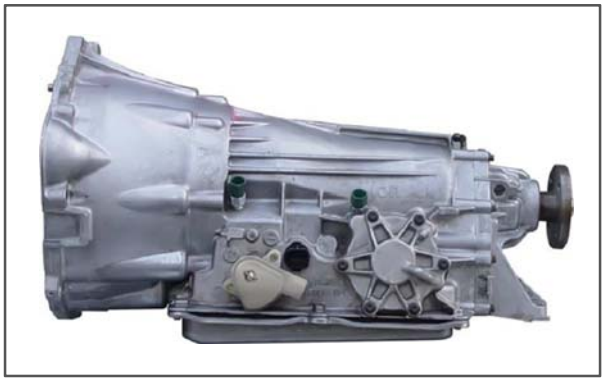
For detailed information about theft deterrent system, refer to Chapter "STICS".

DSI 6 SPEED AUTO TRANSMISSION 3650-01

GENERAL INFORMATION

1. GENERAL INFORMATION

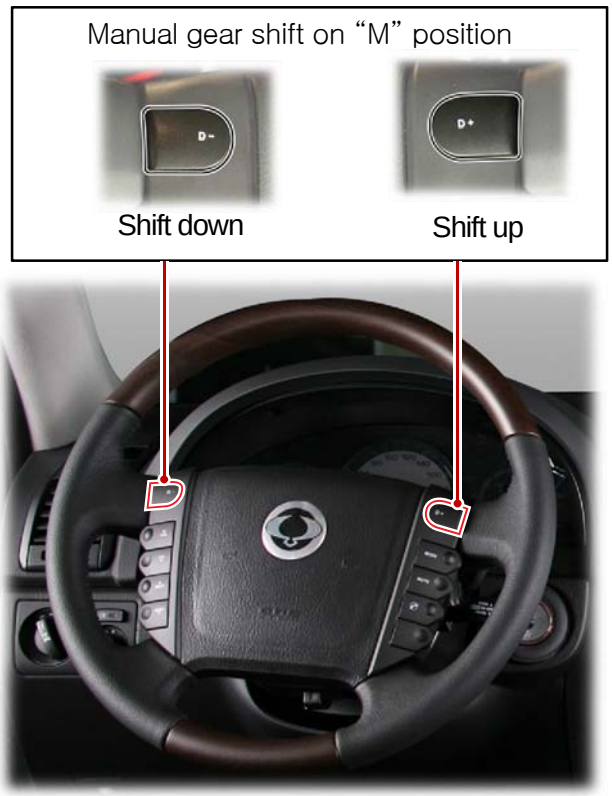
▶ **Automatic transaxle (DSI M78)**



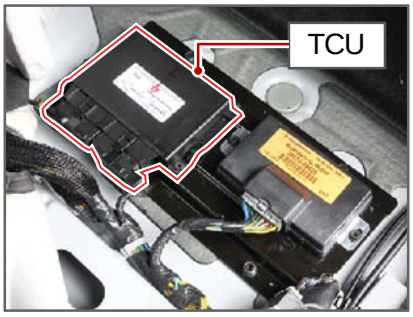
The six speed automatic (M78) transmission is available in two variants: four wheel drive and two wheel drive.
The transmission has the following features:

- Six forward speeds
- One reverse gear
- A 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
  - · Engagement feel
  - · Shift feel
  - · Shift scheduling
  - · Modulated torque converter clutch applications

▶ **Tip switch on steering wheel**



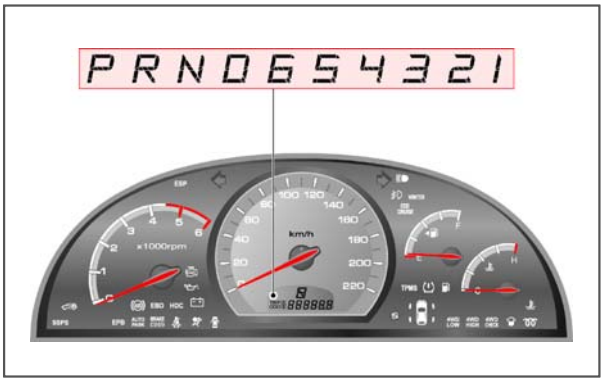
▶ TCU (under driver's seat)



TCU is located under the driver's seat and controls the transmission.
TCU use the power from the ignition power supply to start and stop its operation. TCU is connected to the transmission with 26-pin connector. TCU processes the signals and information (analog and digital) through CAN bus from the sensors.

Modification basis	
Application basis	
Affected VIN	

▶ Gear position display on instrument cluster



Gear position indicator (for A/T)
The gear position indicator shows the currently selected gear position.



Positions of gear select lever
P : Parking
R : Reverse
N : Neutral
D : Drive



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.

2. FEATURES AND SPECIFICATIONS

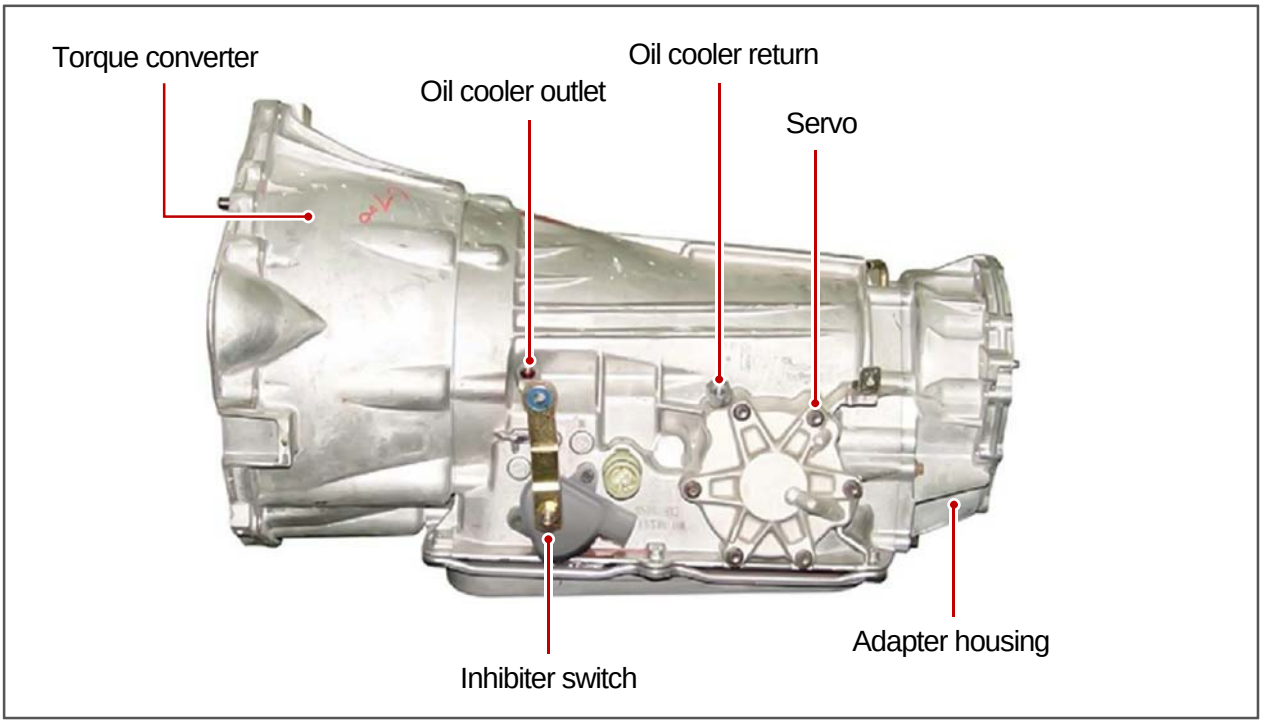
1) Specifications

Description		DSI M78 (6-speed)	Remarks
Gear ratio	1st	3.536:1	
	2nd	2.143:1	
	3rd	1.478:1	
	4th	1.156:1	
	5th	0.866:1	
	6th	0.677:1	
	Reverse	3.094:1	
Transmission fluid	Fluid	Fuchs ATF 3292 ATF	
	Capacity	Approx. 9.5 L	
	Change interval	Check the fluid at every 30,000 km or 1 year, and change it if necessary.	
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%	

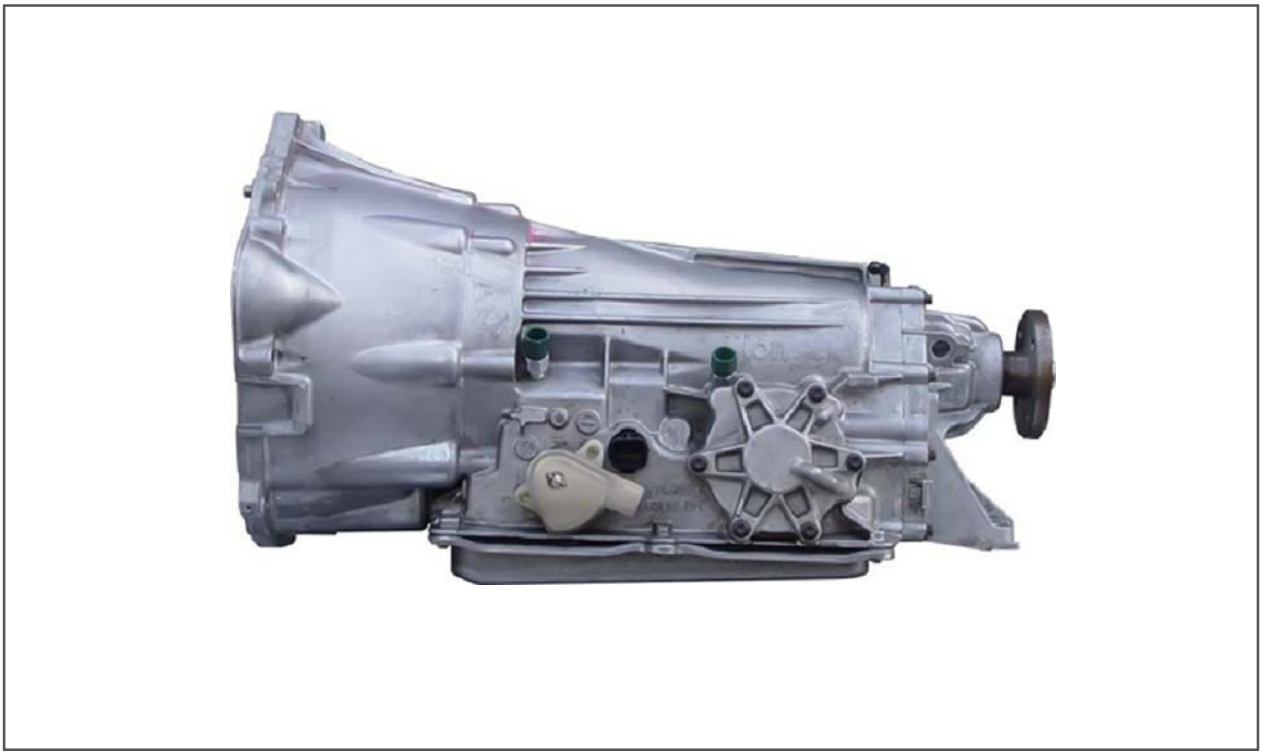
Modification basis	
Application basis	
Affected VIN	

2) Appearance

▶ **4WD Automatic Transmission**

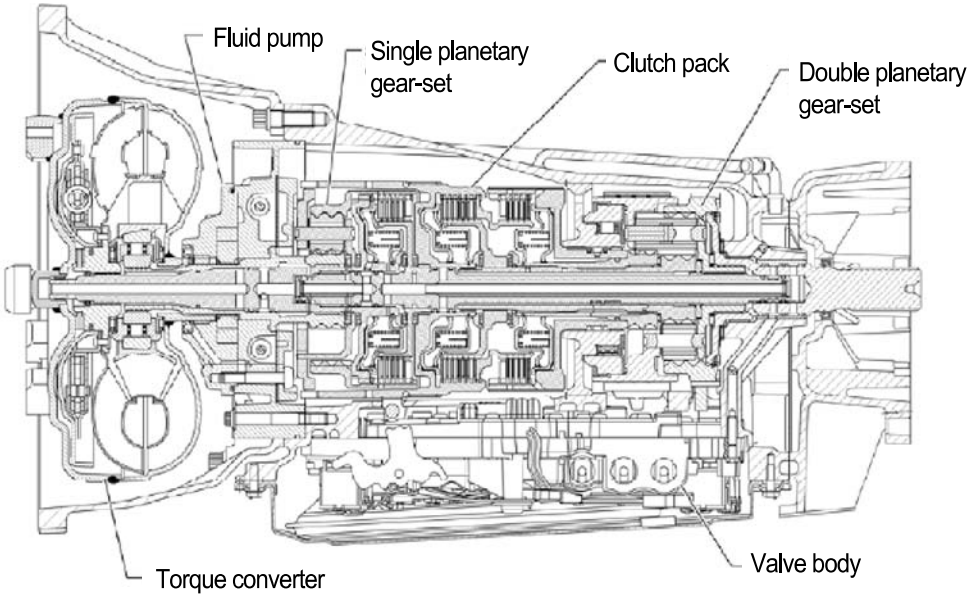


▶ **2WD Automatic Transmission**

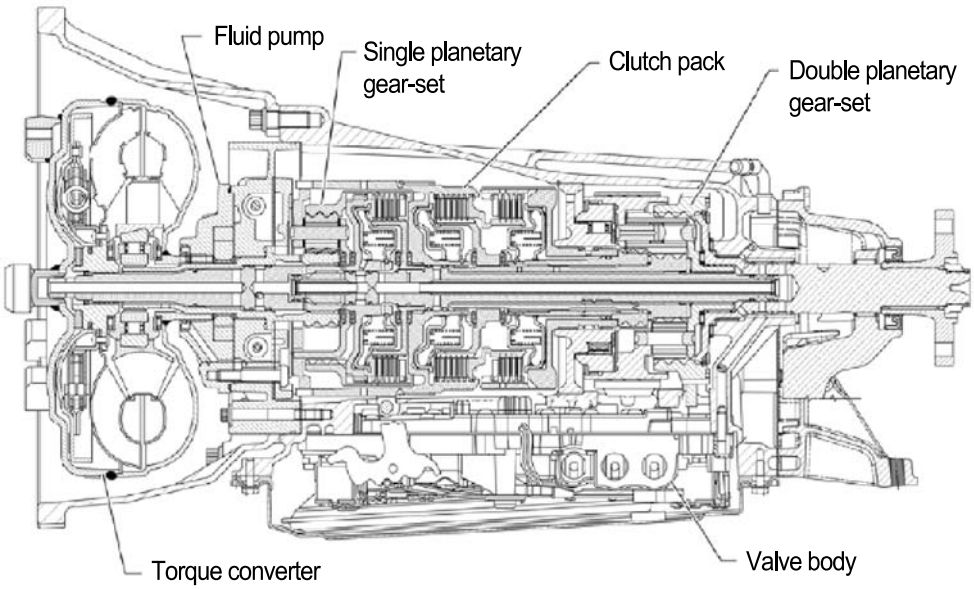


3) Sectional Diagram

4WD

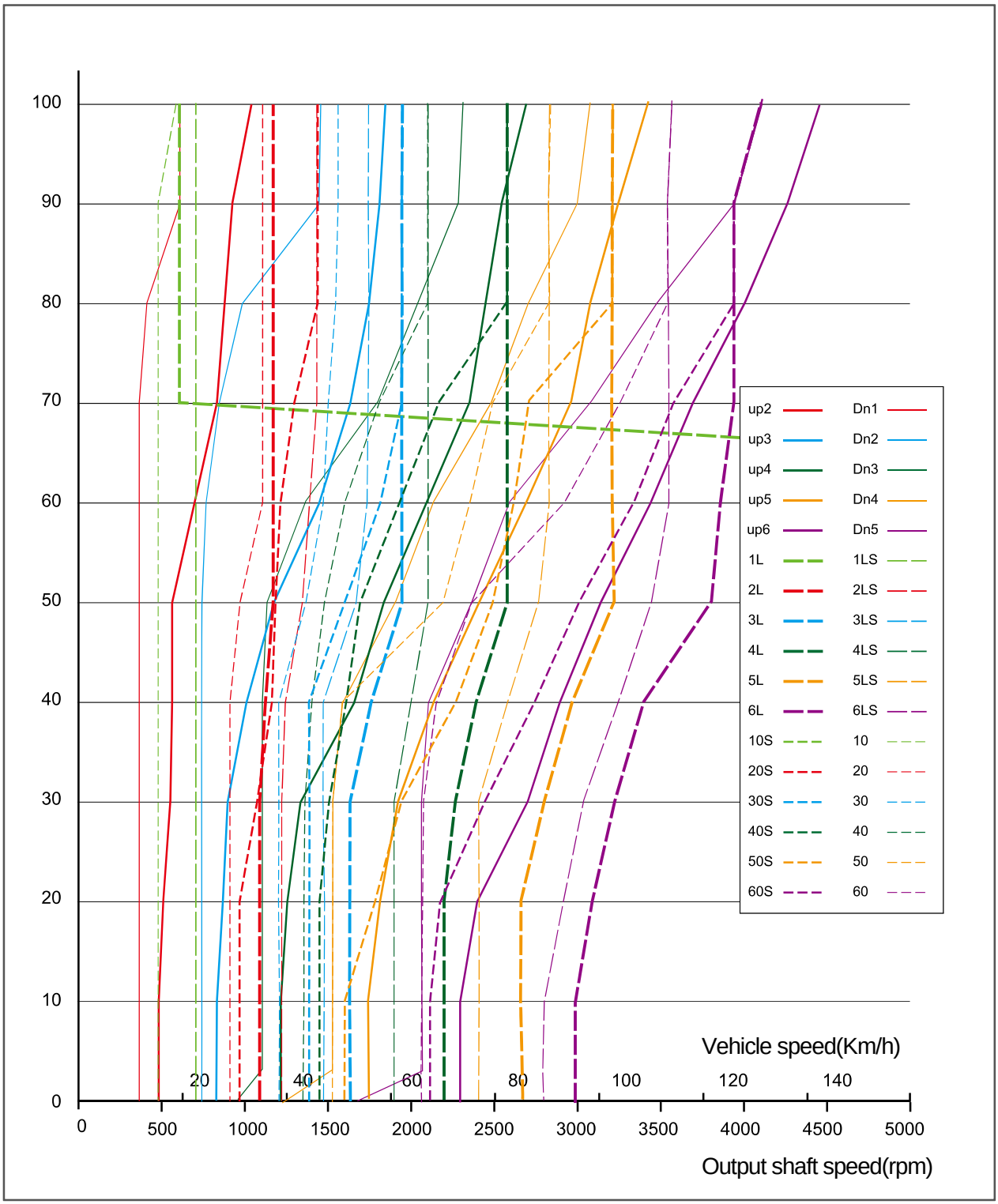


2WD



Modification basis	
Application basis	
Affected VIN	

4) Shift Pattern Diagram



Modification basis	
Application basis	
Affected VIN	

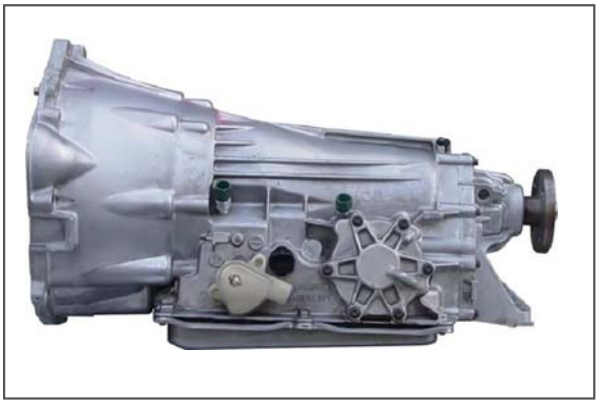
3. TIGHTENING TORQUE

Description	Size	Tightening torque(Nm)
Transfer case housing	M12 x 32	54 ~ 68
Extension 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

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 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

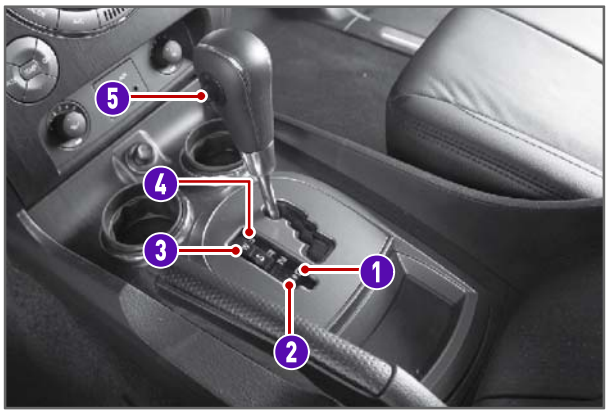
1. **Shift Lock Release Button Hole when Locked in the "P" Position (1)**
   If you cannot move the gear select lever from the "P" position, try to move the lever while pushing down here with a sharp object such as a ballpoint pen. For your safety, turn off the engine and depress the brake pedal before 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)

TCU is located under the driver's seat and controls the transmission.
TCU use the power from the ignition power supply to start and stop its operation. TCU is connected to the transmission with 26-pin connector. TCU processes the signals and information (analog and digital) through CAN bus from the sensors.

- Transmission input speed
- Transmission output speed
- Accelerator pedal position
- Gear selector position
- Engine torque
- Engine speed
- Transmission oil temperature
- Brake pedal status
- Engine oil temperature
- Engine coolant temperature
- Ambient air temperature
- Barometric pressure

This information is used by the TCU to decide which shift pattern to select and for shift energy management. Electro-hydraulic solenoid valves and variable bleed solenoids control the transmission gear changes.
Six variable bleed solenoids and four on/off solenoids are used to direct transmission fluid flow to control the fluid pressure within the three clutches and two bands. Separate pressure regulators are used exclusively for torque converter clutch control and main transmission line pressure.
The TCU monitors all TCU inputs and outputs to confirm correct system operation. If a fault occurs the TCU is able to perform default action and inform the driver of the problem through the instrument cluster warning lights. Detailed information is available via trouble codes which can be read with the service tool.

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.

▶ **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.

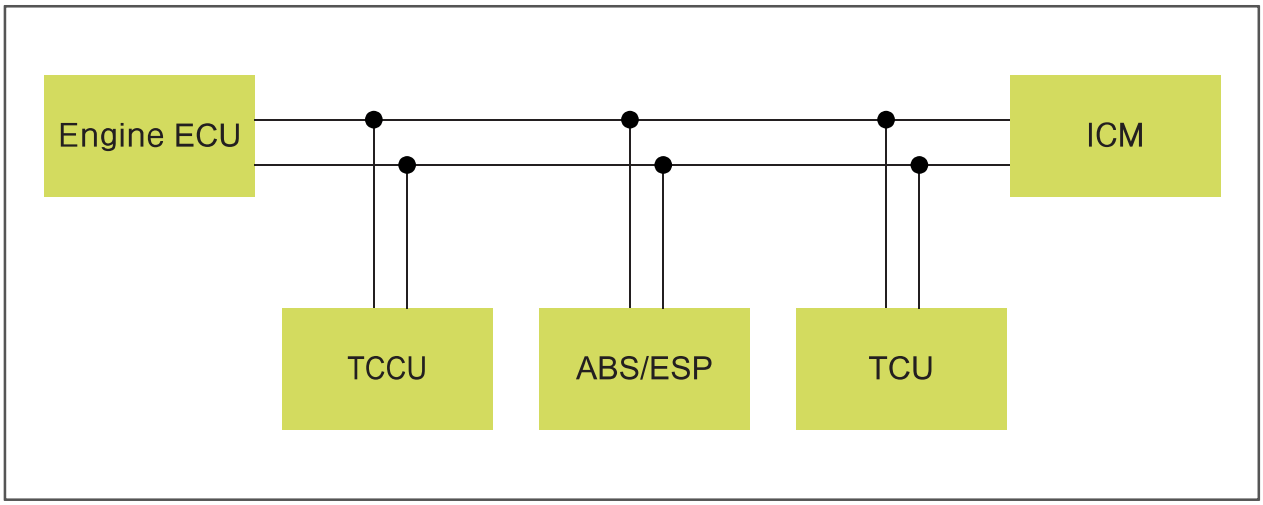
▶ Auto Cruise Control

When the auto cruise control is activated, the engine ECU requests the downshift to increase the engine brake effect.

Modification basis	
Application basis	
Affected VIN	

6. CAN NETWORK

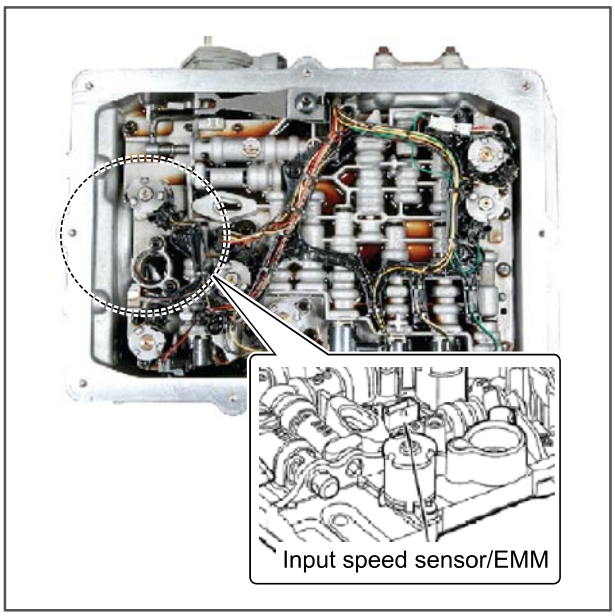
1) Network Communication



The TCU sends signals to be used by other vehicle systems via the CAN bus, such as:

- Selector lever position
- Selected gear state
- Manual mode activation
- Output torque
- Transmission fluid temperature
- Engine torque reduction requests

2) 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.

7. 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)

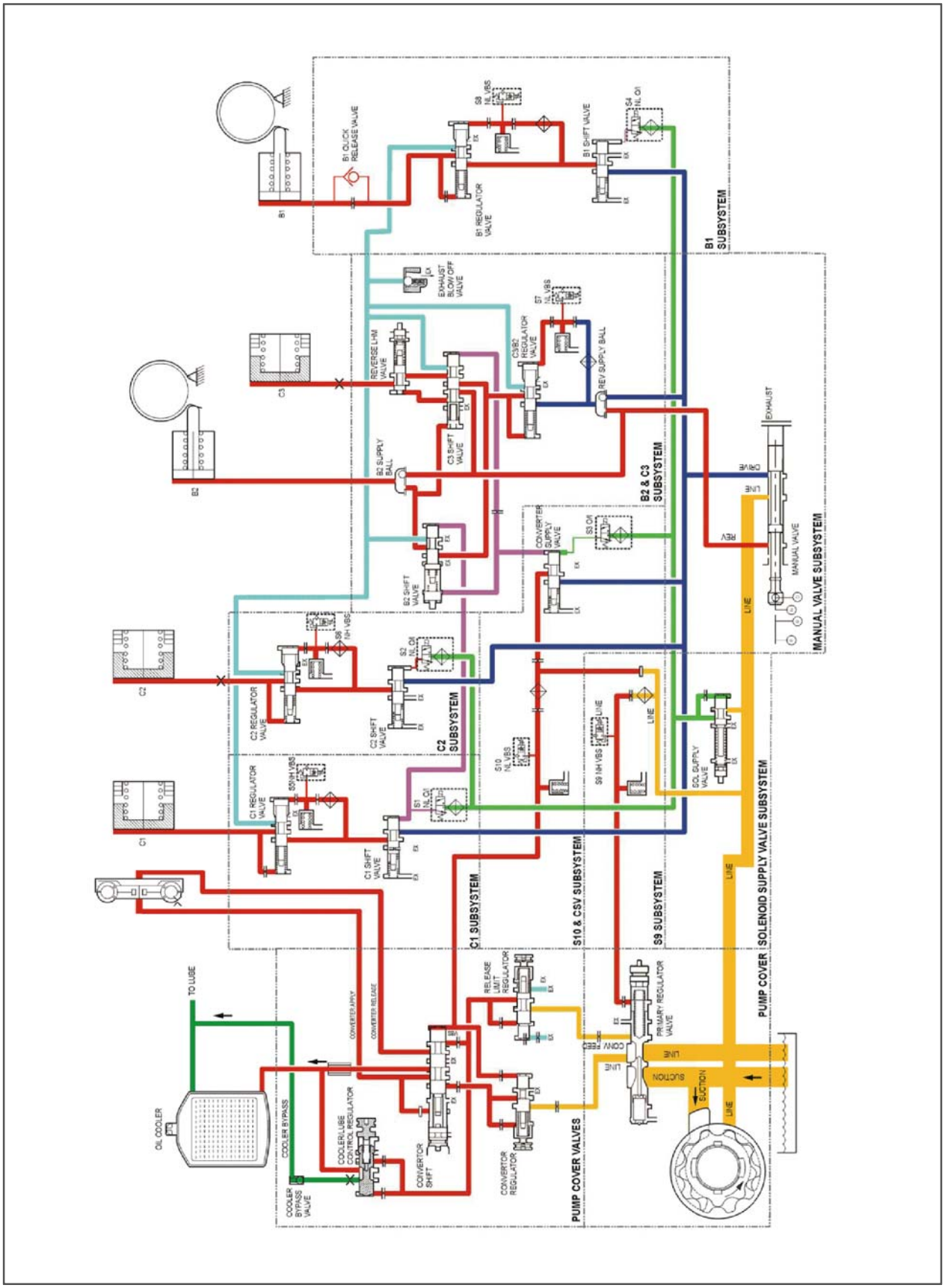
▶ Gear Selection and Engaged Element

Gear	Gear ratio	Engaged element (clutch & band)					
		C1	C2	C3	B1	B2	1-2OWC
M1	3.536		ON			ON	
1st	3.536		ON				ON
2nd	2.143		ON		ON		
3rd	1.478		ON	ON			
4th	1.156	ON	ON				
5th	0.866	ON		ON			
6th	0.677	ON			ON		
Reverse	-3.094			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	

Modification basis	
Application basis	
Affected VIN	

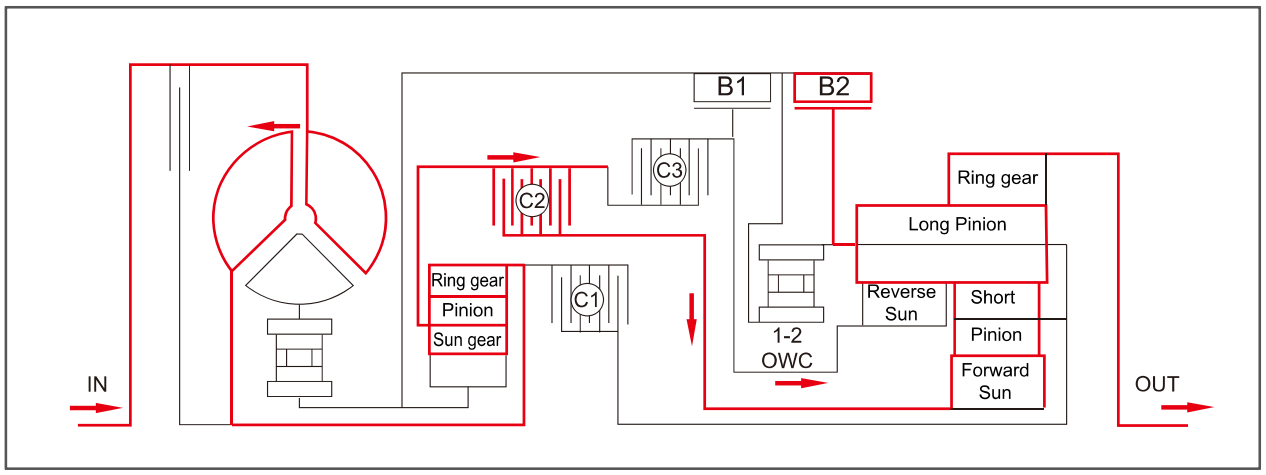
▶ Hydraulic Circuit Diagram



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

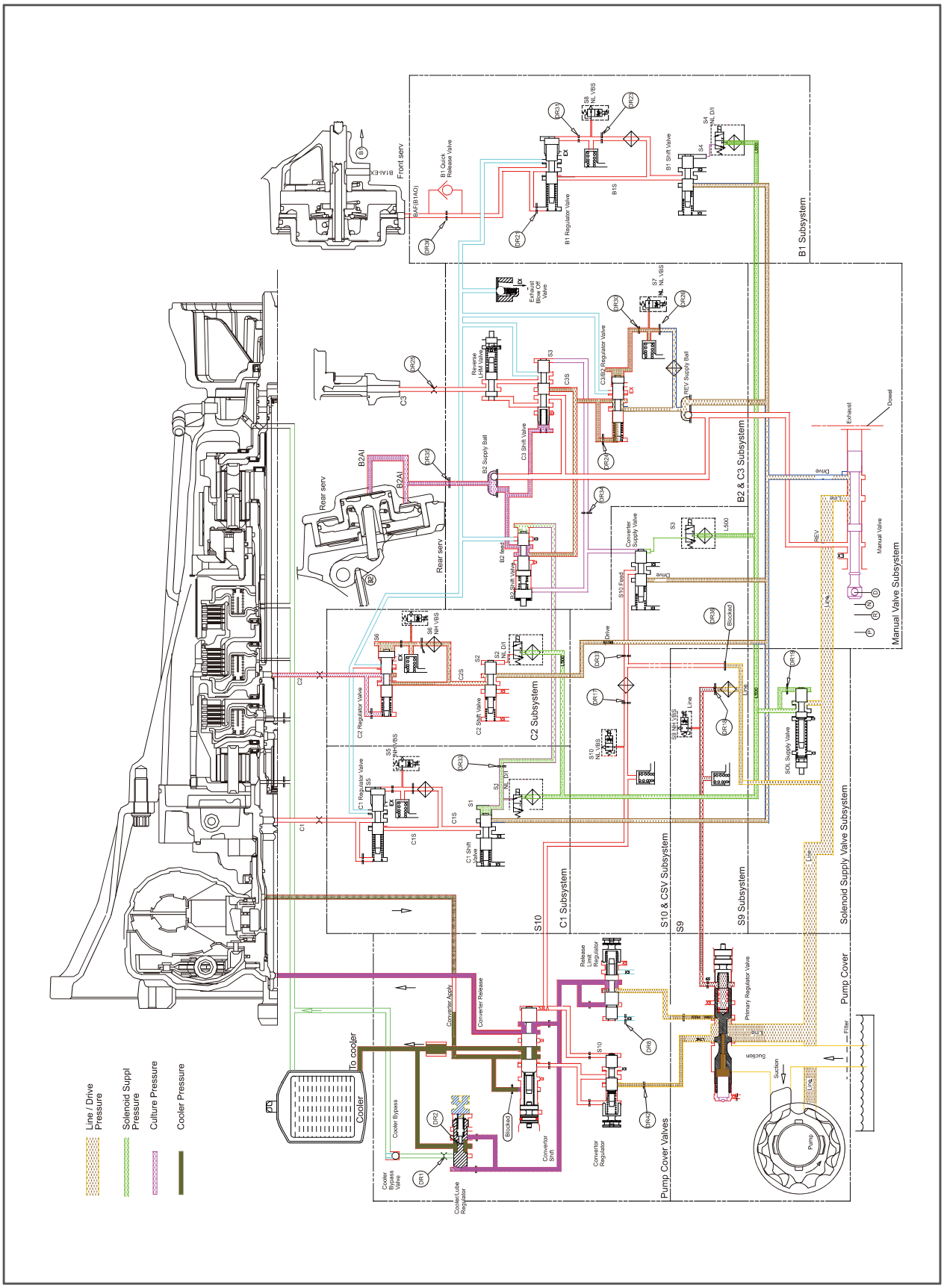
▶ Connecting Components

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	

Modification basis	
Application basis	
Affected VIN	

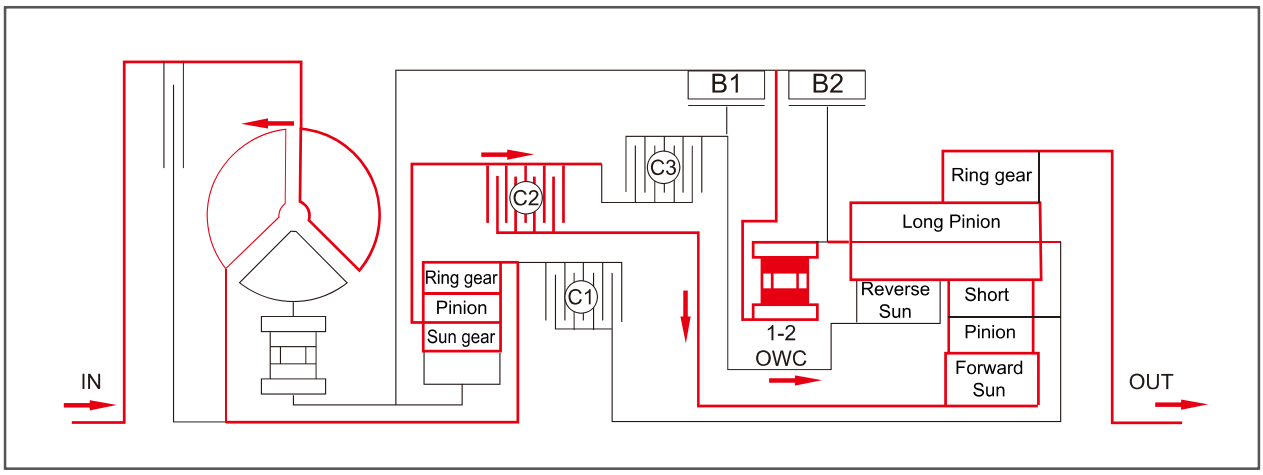
▶ 1st Gear (M) (3.53:1)



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

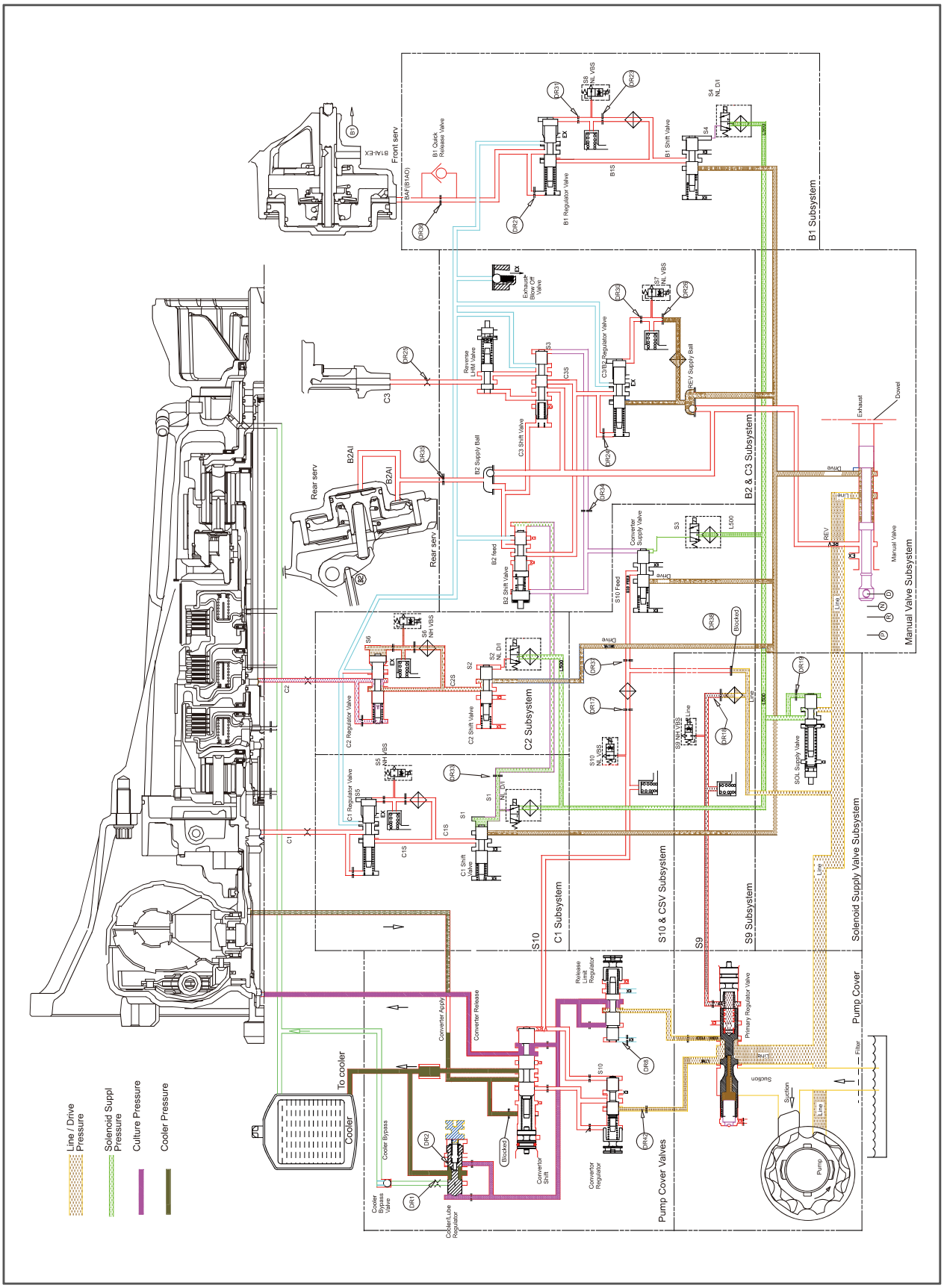
▶ Connecting Components

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	

Modification basis	
Application basis	
Affected VIN	

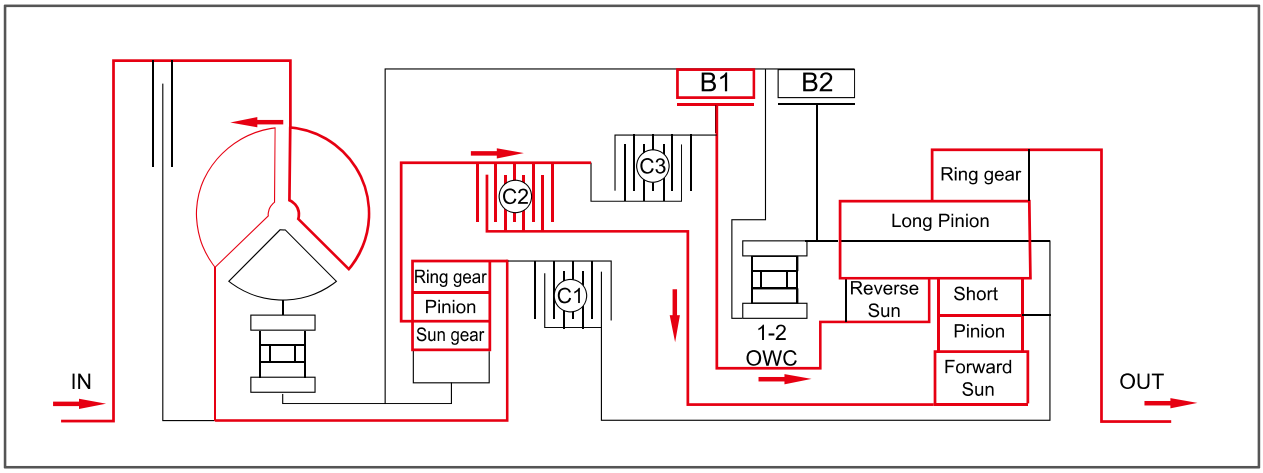
▶ 1st Gear (D) (3.53:1)



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

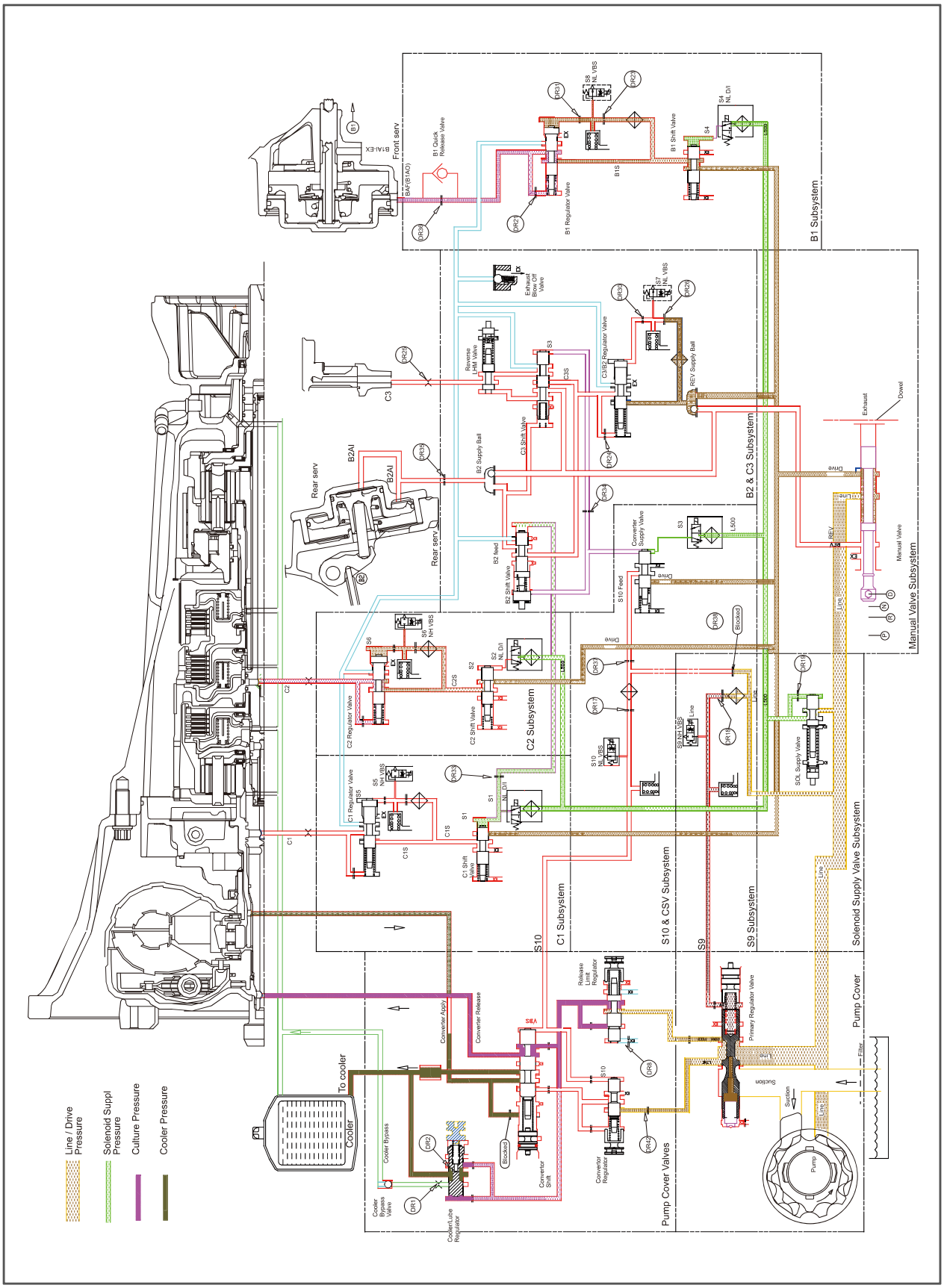
▶ Connecting Components

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	

Modification basis	
Application basis	
Affected VIN	

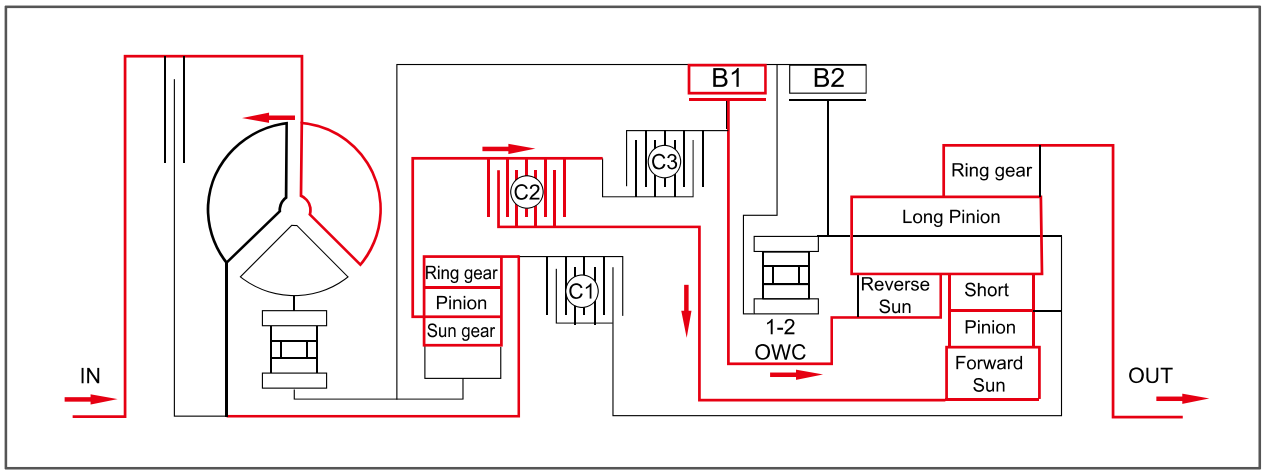
▶ 2nd Gear (D) (2.14:1)



Modification basis	
Application basis	
Affected VIN	

4) Power Flow - 2nd Gear (D) Lock-Up

▶ Power Flow Diagram



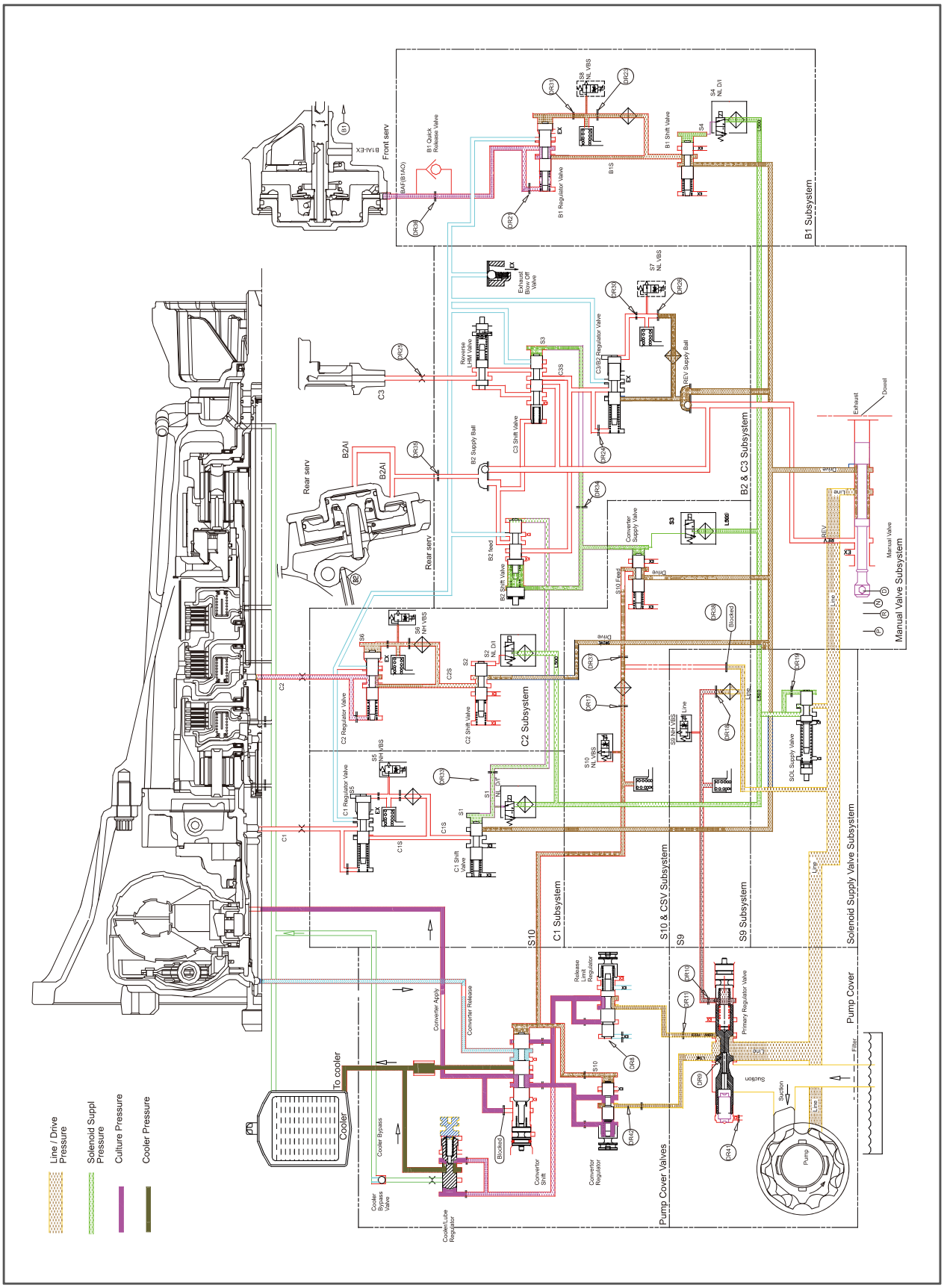
▶ Connecting Components

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

Modification basis	
Application basis	
Affected VIN	

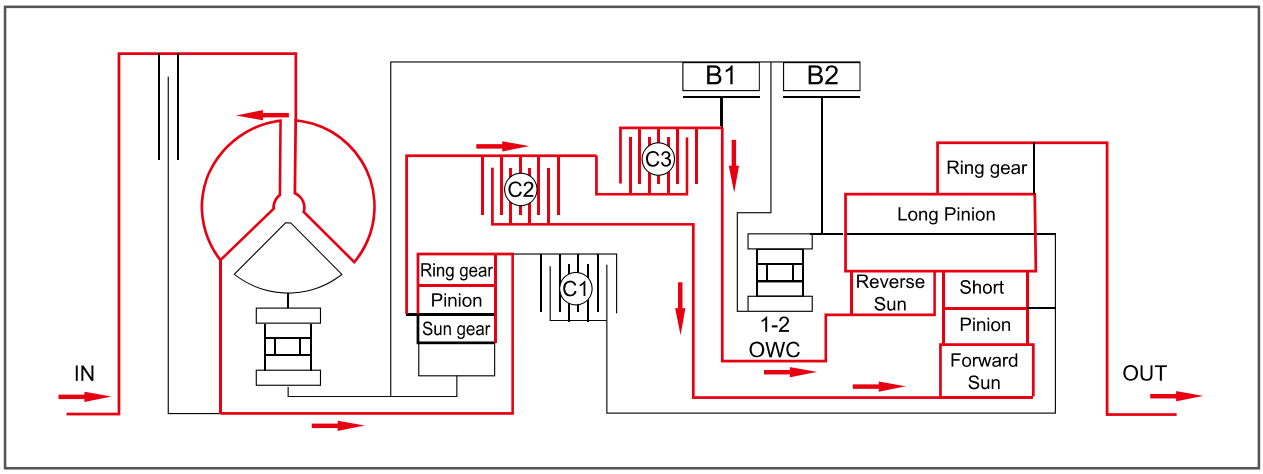
▶ 2nd Gear (D) Lock-Up



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

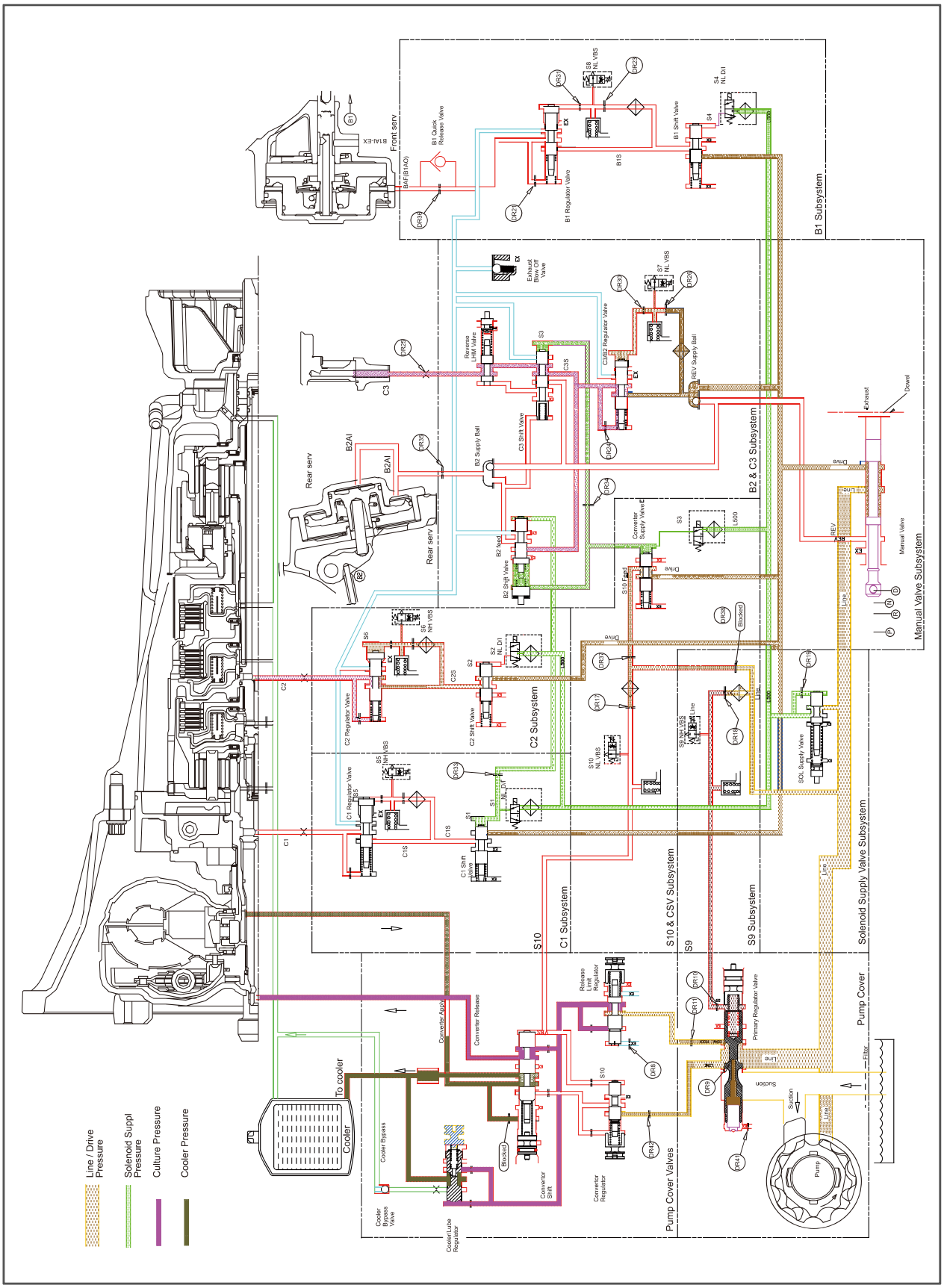
▶ Connecting Components

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	

Modification basis	
Application basis	
Affected VIN	

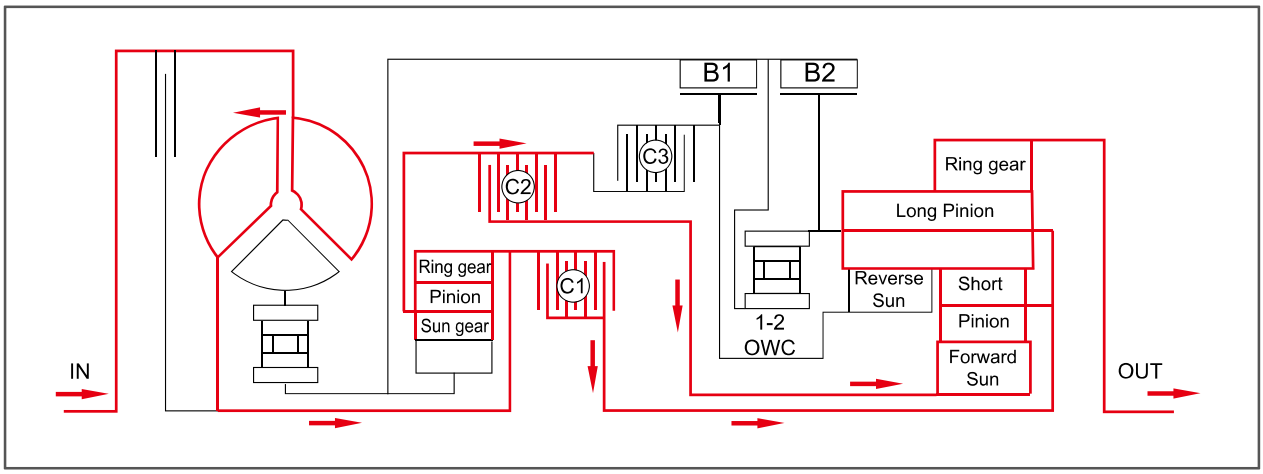
▶ 3rd Gear (D) (1.48:1)



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

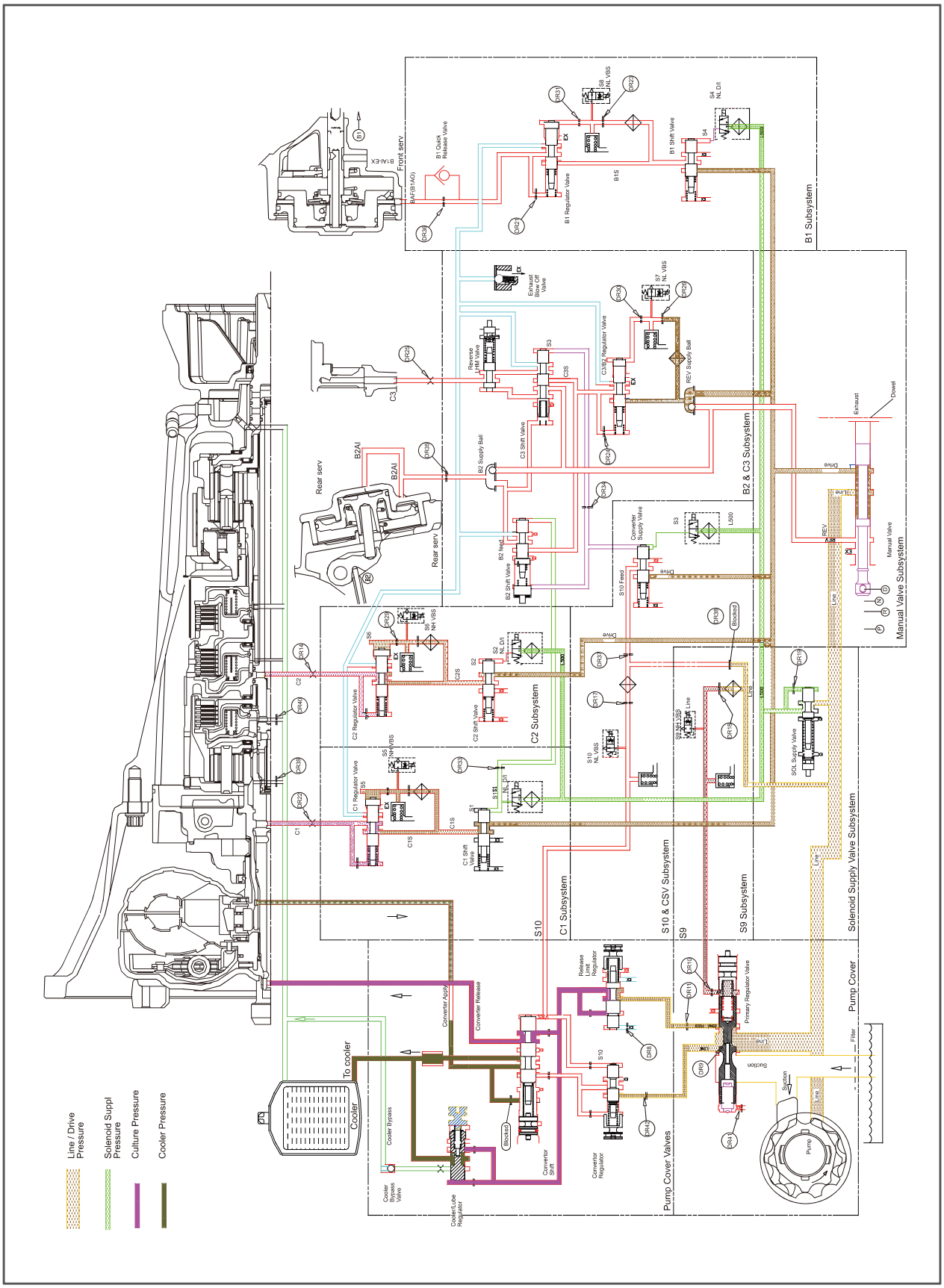
▶ Connecting Components

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	

Modification basis	
Application basis	
Affected VIN	

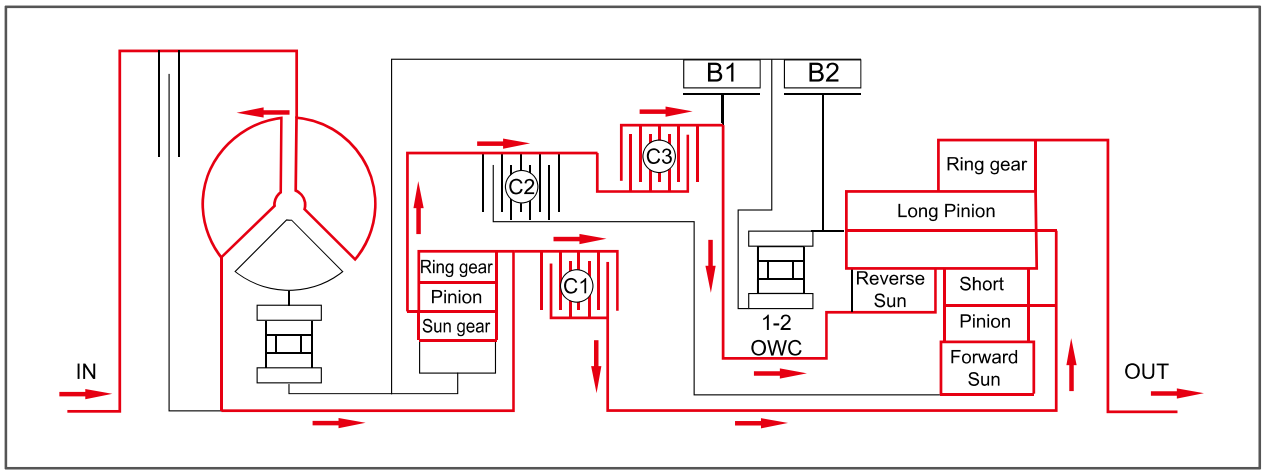
▶ 4th gear (D) & 4th gear (D) in Limp home mode (1.16:1)



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

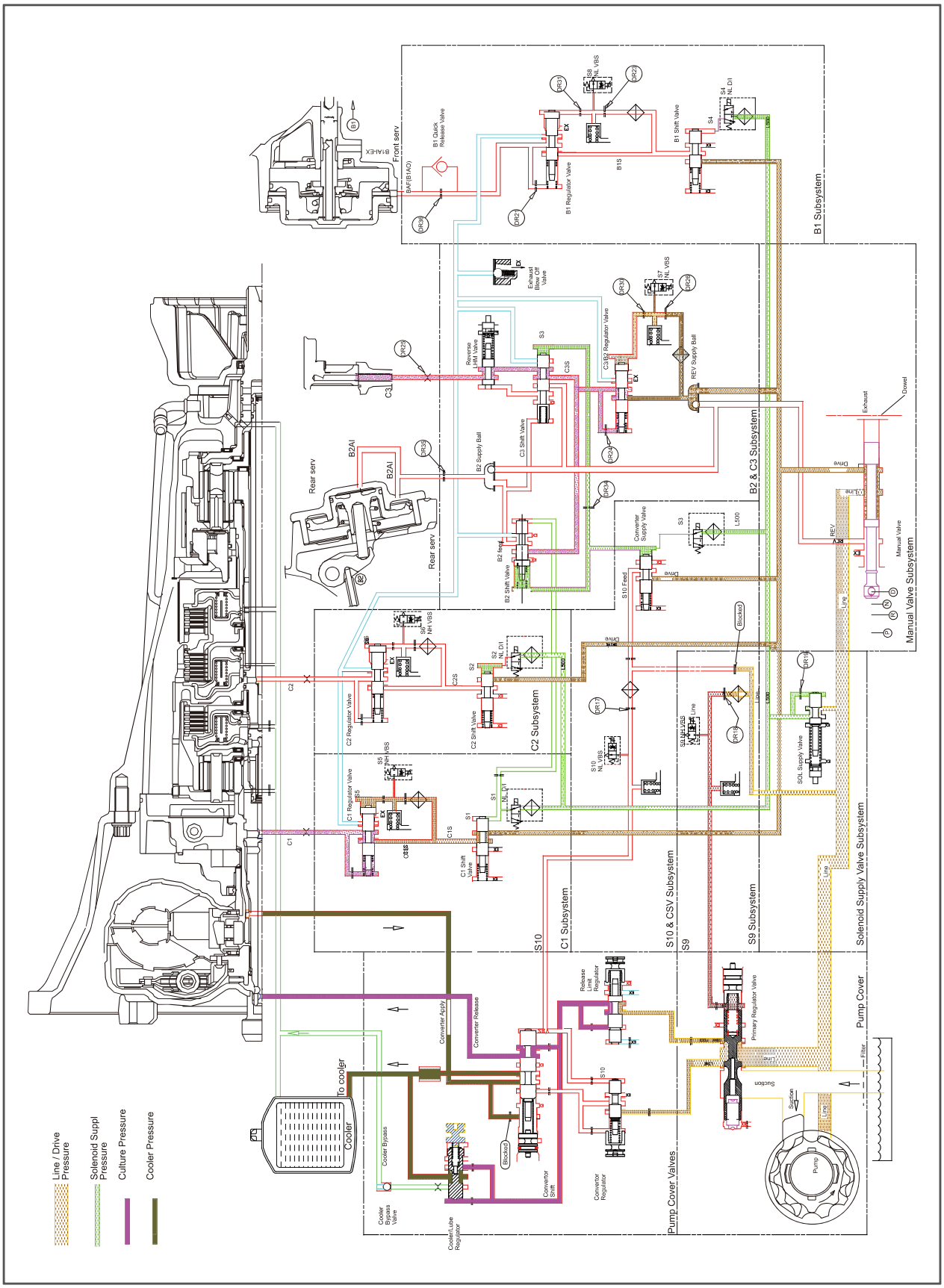
▶ Connecting Components

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	

Modification basis	
Application basis	
Affected VIN	

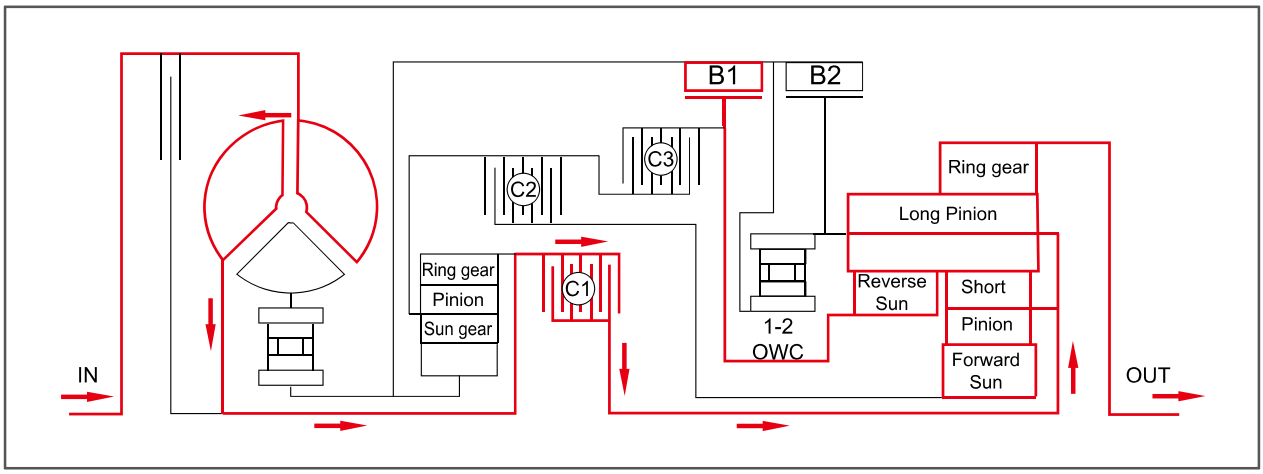
▶ 5th gear (D) (0.87:1)



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

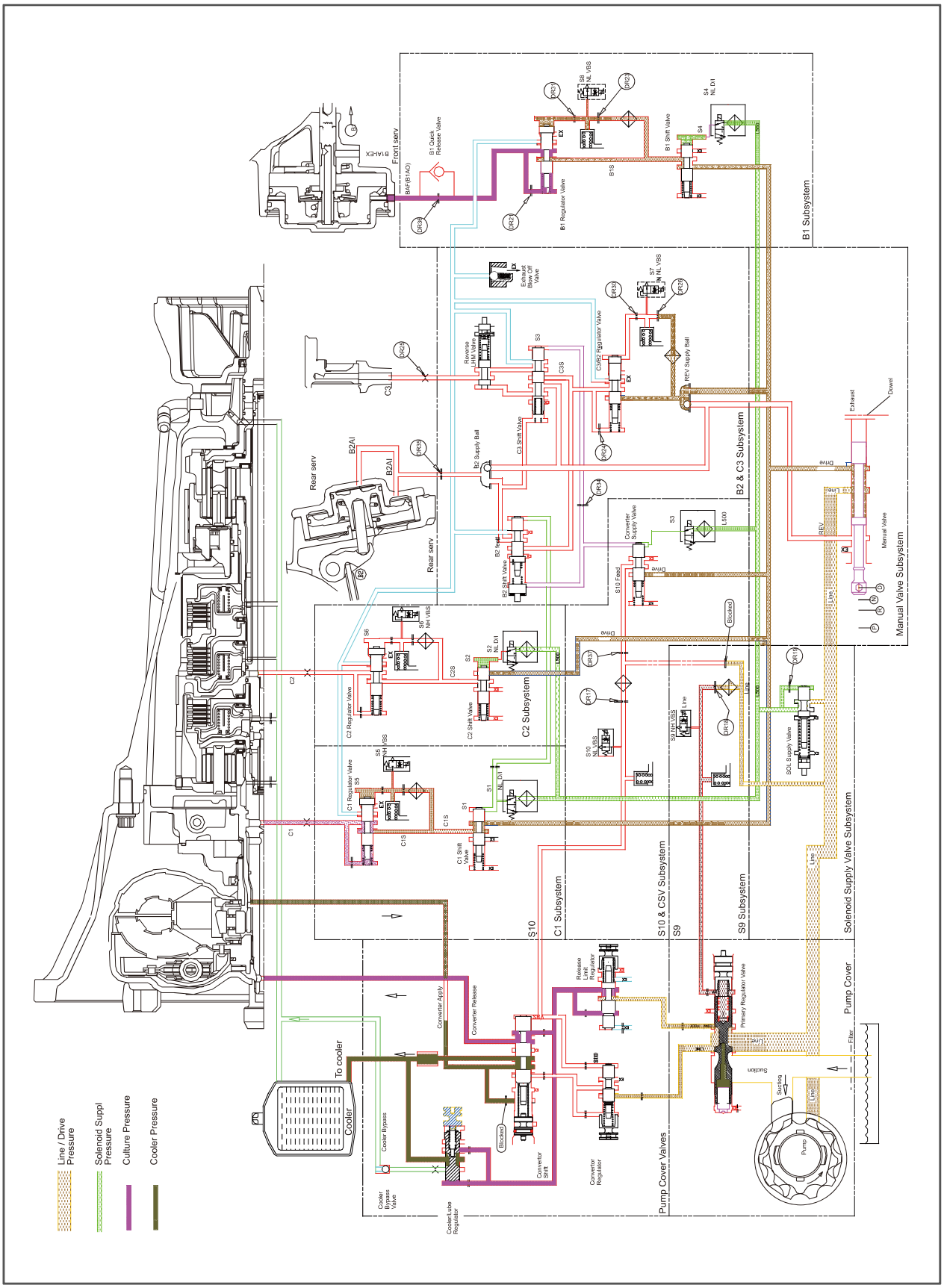
▶ Connecting Components

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	

Modification basis	
Application basis	
Affected VIN	

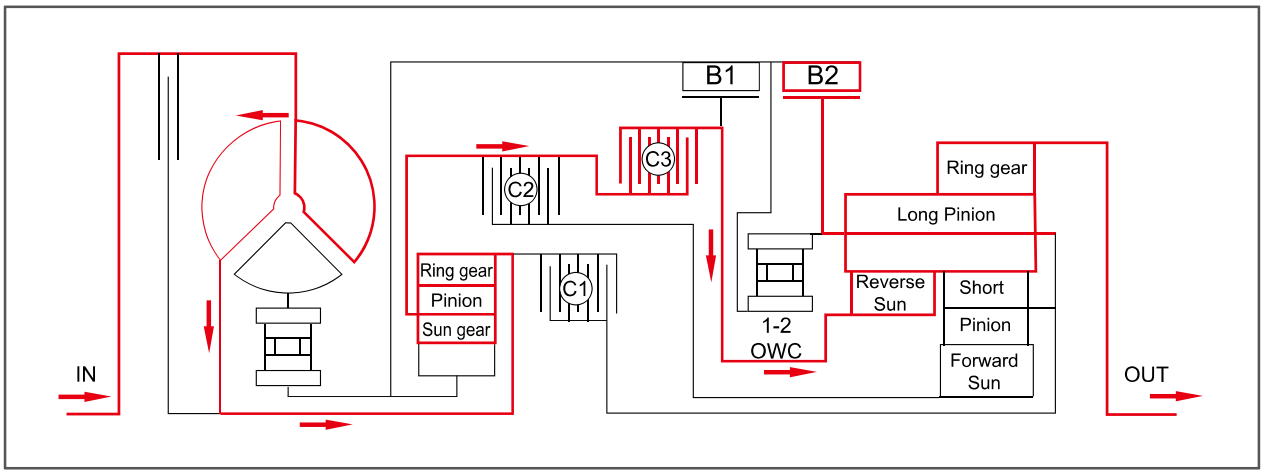
▶ 6th gear (D) (0.68:1)



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

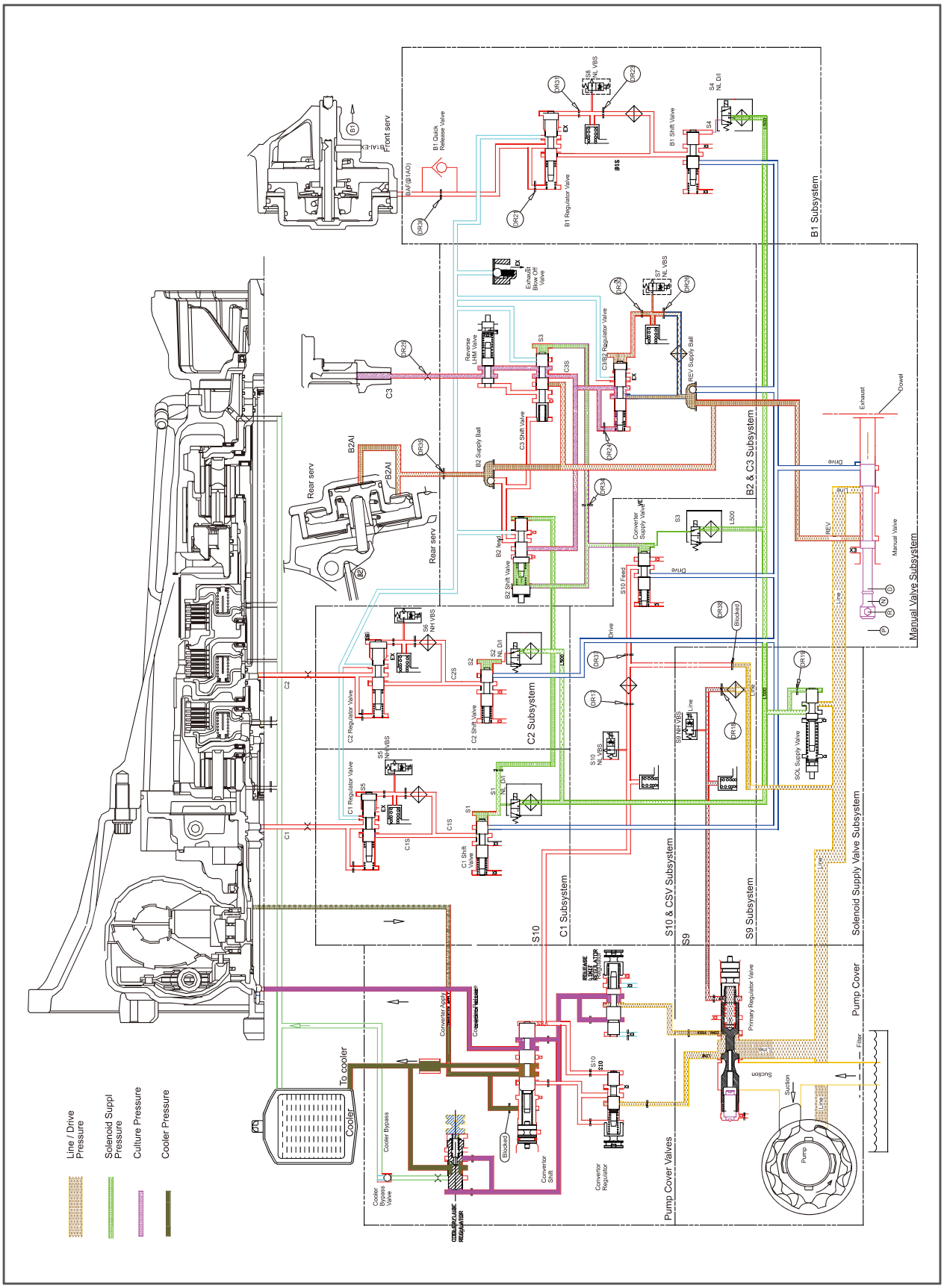
▶ Connecting Components

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	

Modification basis	
Application basis	
Affected VIN	

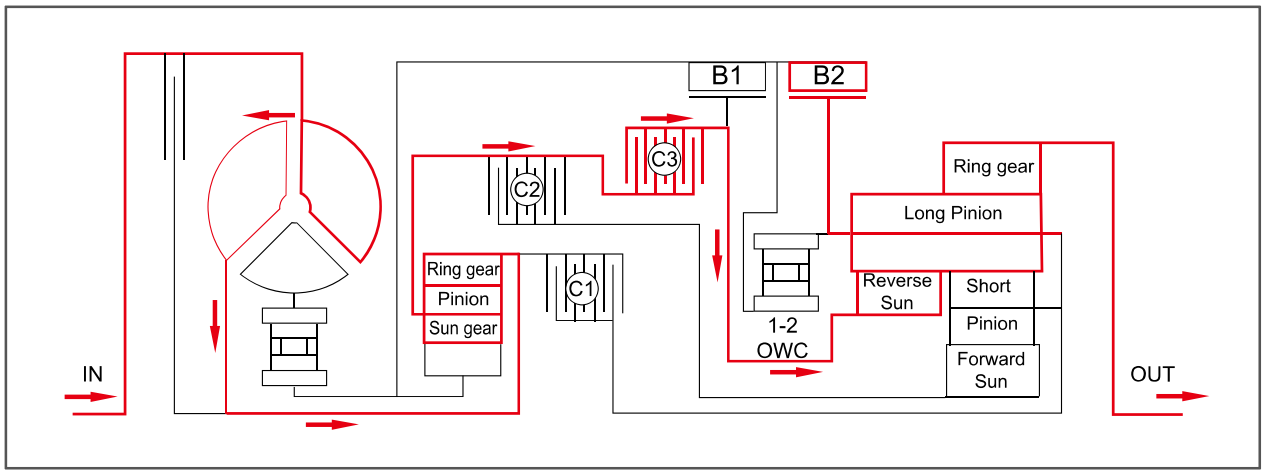
▶ Reverse gear (R) (3.09:1)



Modification basis	
Application basis	
Affected VIN	

10) Power Flow - Reverse (R) Limp Home Mode

▶ Power Flow Diagram



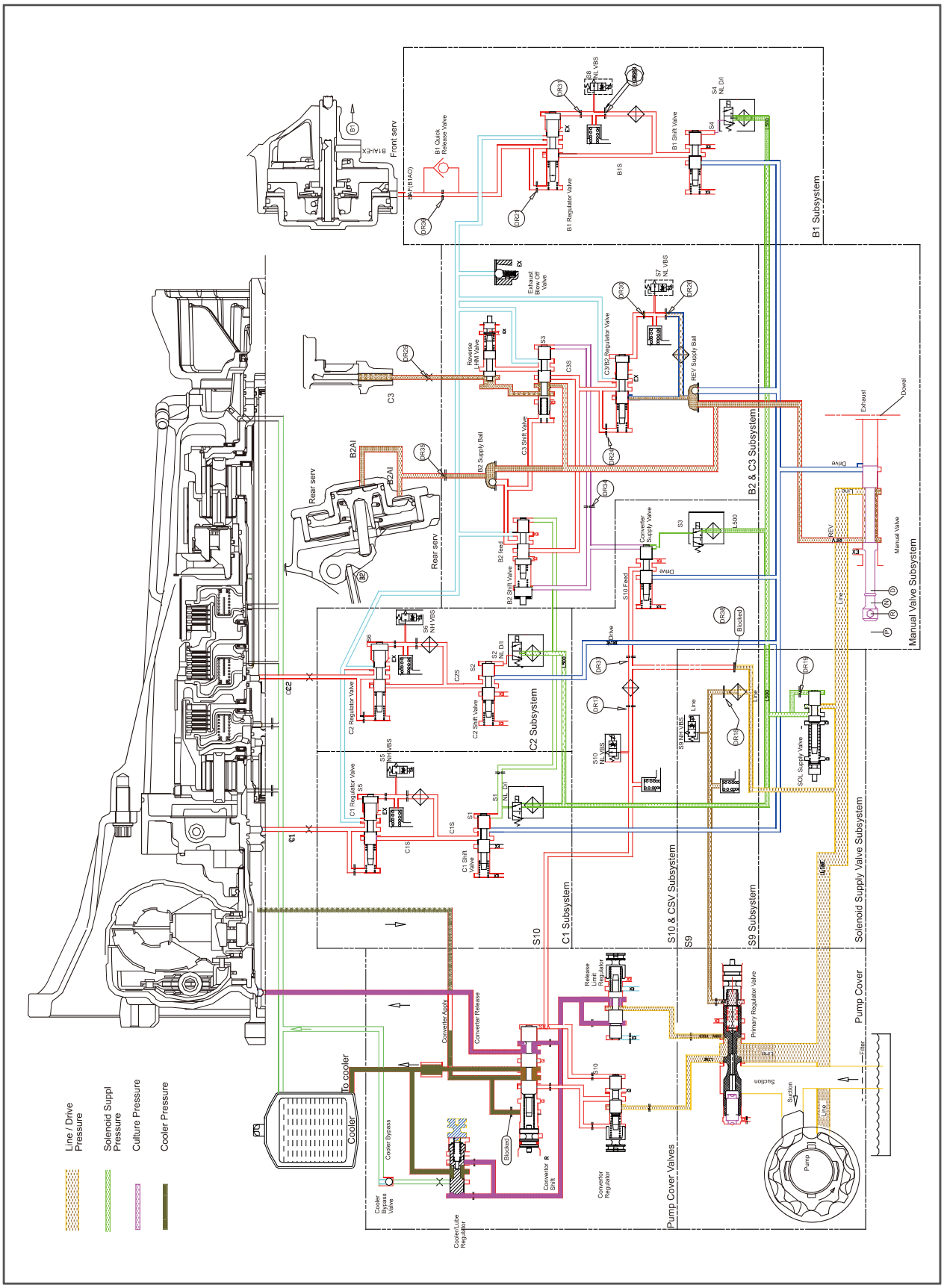
▶ Connecting Components

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

Modification basis	
Application basis	
Affected VIN	

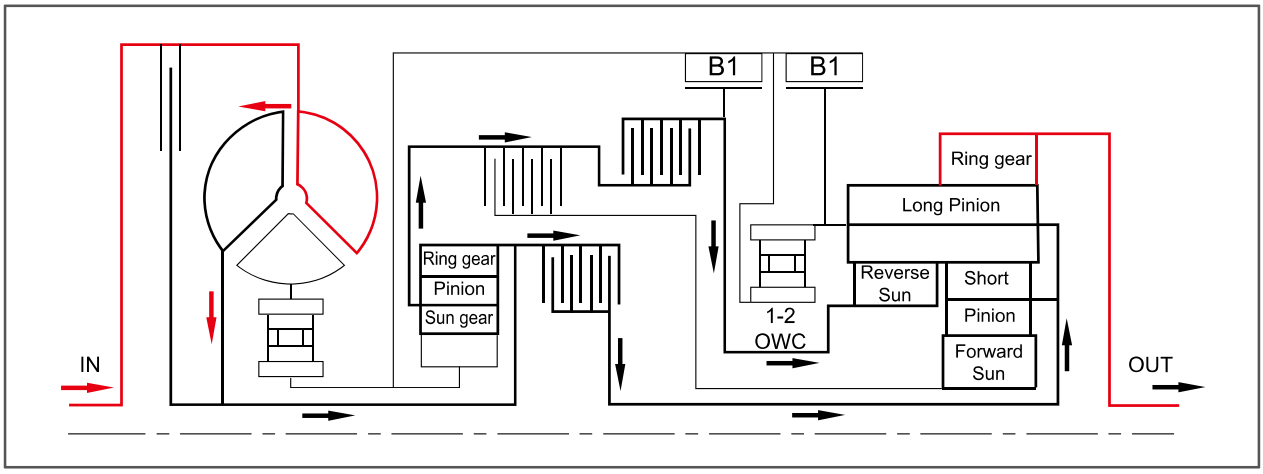
▶ Reverse (R) Limp Home Mode



Modification basis	
Application basis	
Affected VIN	

11) Power flow - Park (P)

▶ Power Flow Diagram



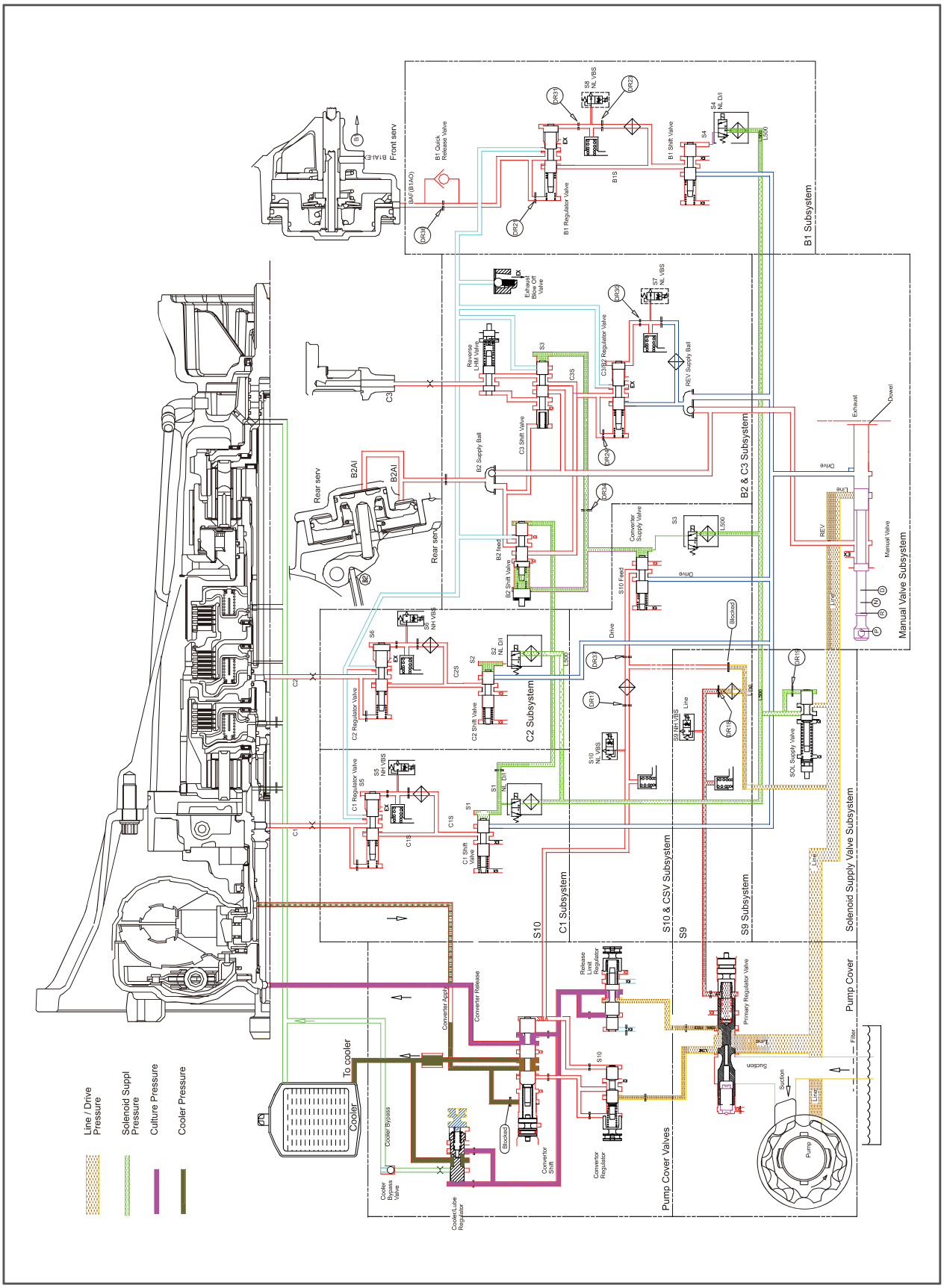
▶ Connecting Components

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							

Modification basis	
Application basis	
Affected VIN	

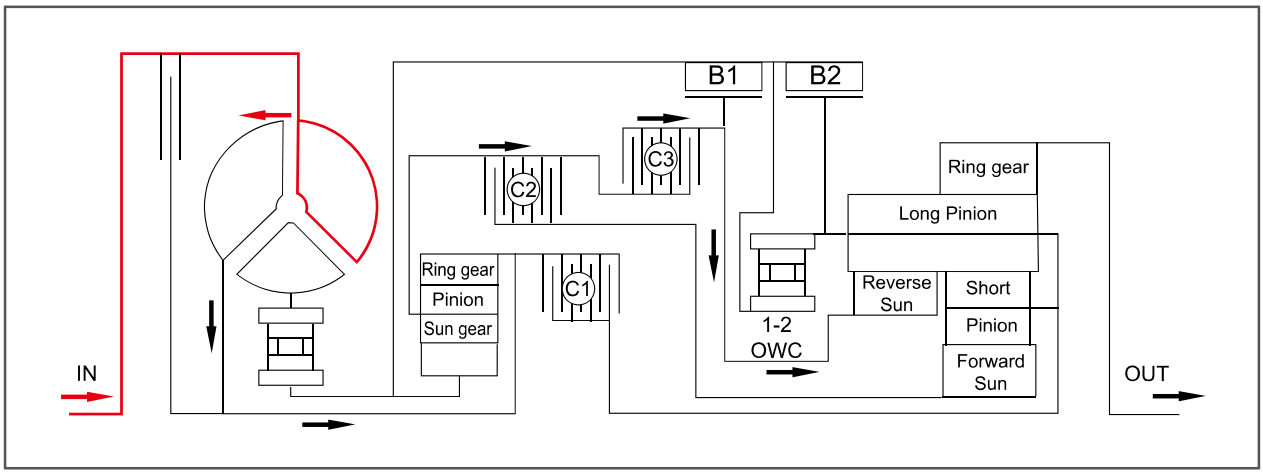
▶ Park



Modification basis	
Application basis	
Affected VIN	

12) Neutral (N)

▶ Power Flow Diagram



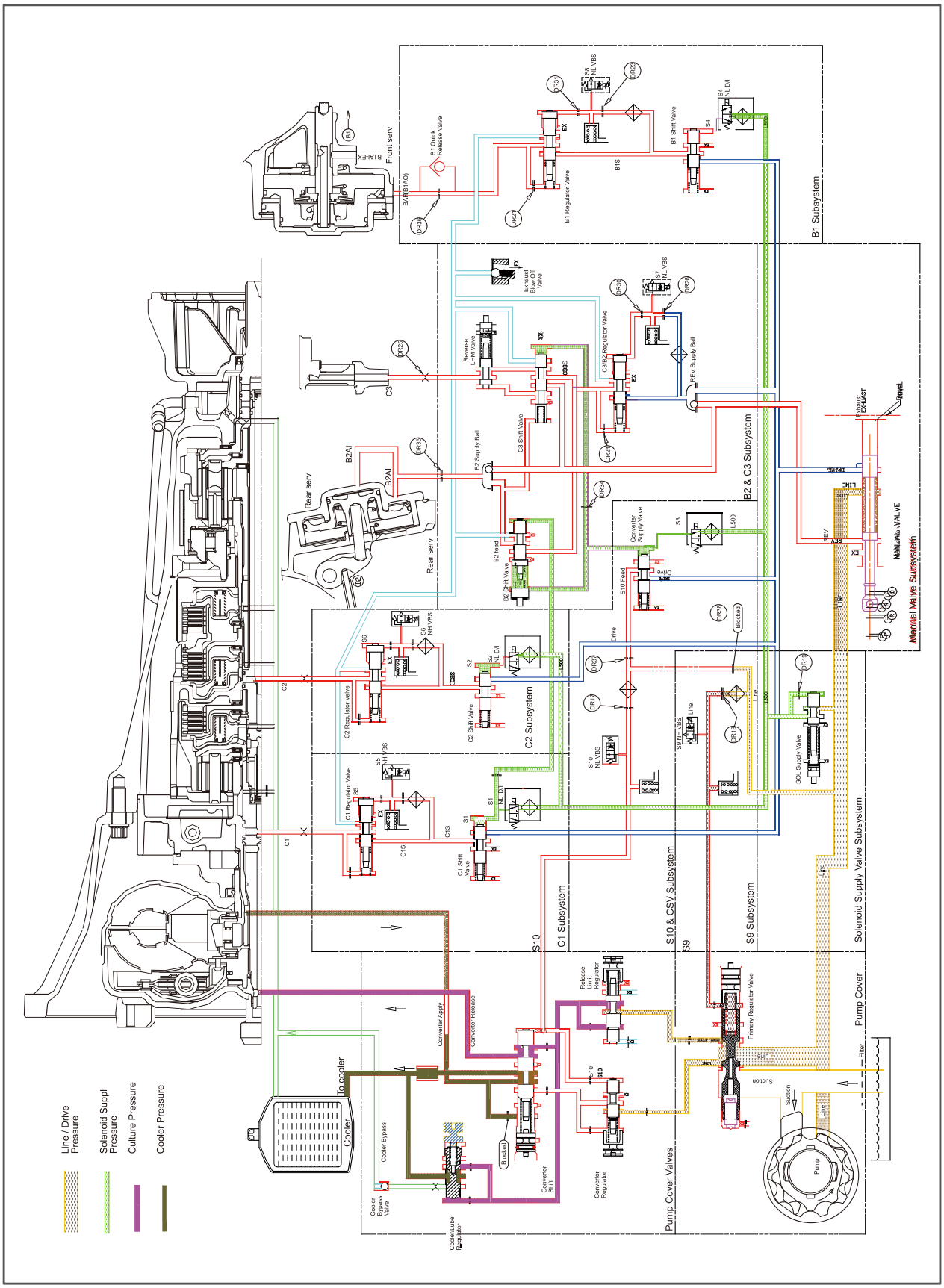
▶ Connecting Components

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	

Modification basis	
Application basis	
Affected VIN	

▶ Neutral



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

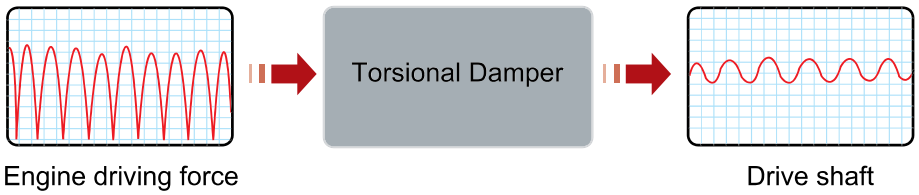
Item		W5A580(2WD)/W5A400(4WD)	
M/P, S/P solenoid valve(23℃)	Resistance	5.0 ± 0.2Ω	
	Operating distance	0.6mm	
	Operating current	0 ~ 1A	
Lockup solenoid valve(25℃)	Resistance	2.5 ± 0.2Ω	
	Operating distance	0.2mm	
	Operating current	1.5 ~ 2.0A	
	Operating range	3rd to 5th gears	
RPM sensor	Resistance	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	-

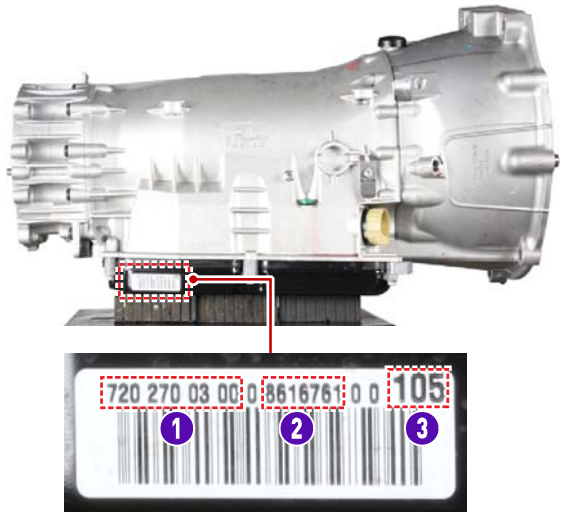
3. MAJOR CHANGES

Introduced Torsion Damper in Torque Converter
   
- The torsion damped has been newly installed in the torque converter. - The torsion damper absorbs the shock, vibration and noise when delivering the engine driving force. This improves NVH performance in this vehicle.

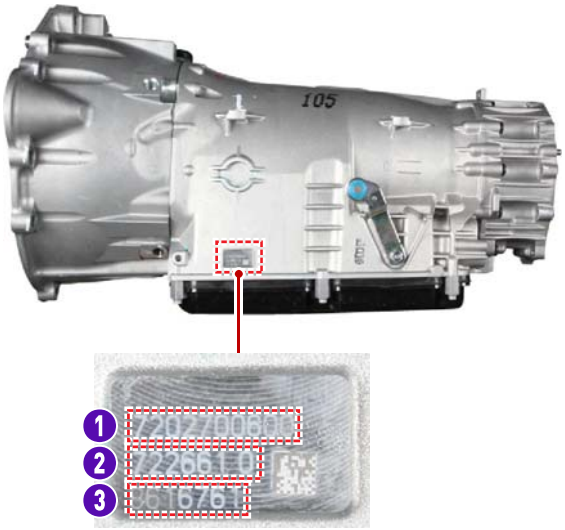
Modification basis	
Application basis	
Affected VIN	

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

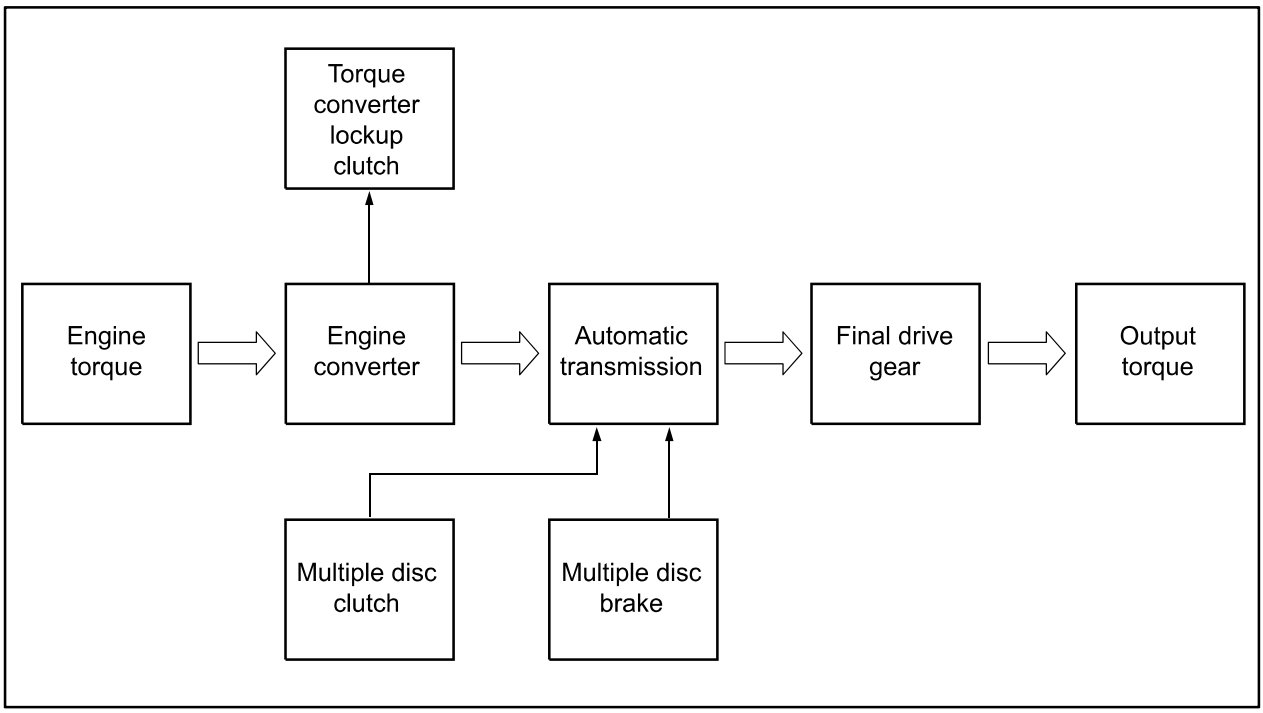
NOTE

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

▶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

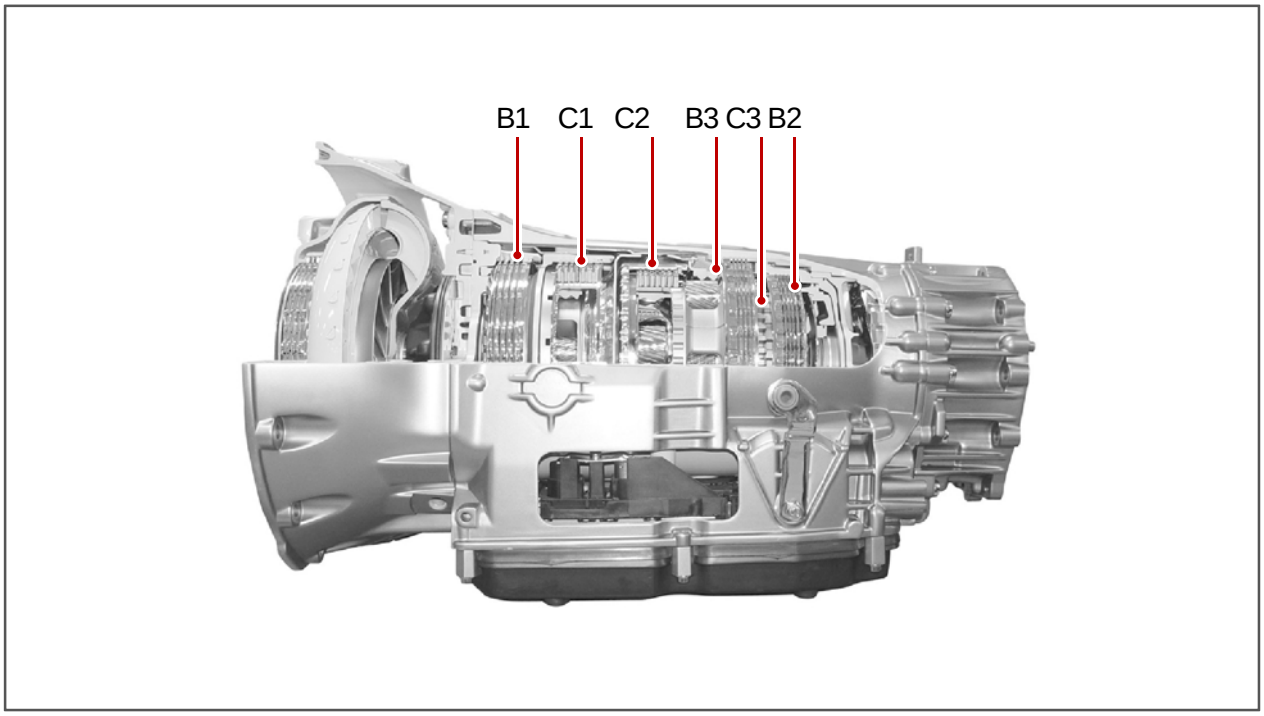


Modification basis	
Application basis	
Affected VIN	

2. POWER FLOW

1) Power Flow

▶Sectional View

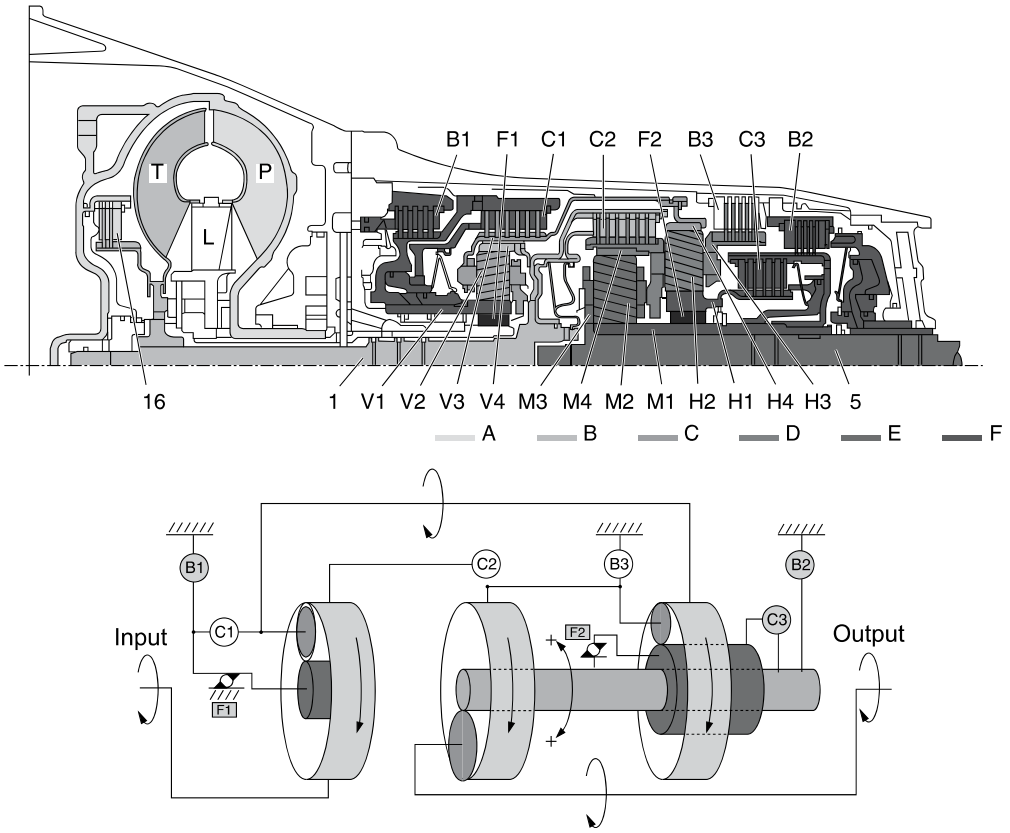


▶Shifting elements

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

▶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

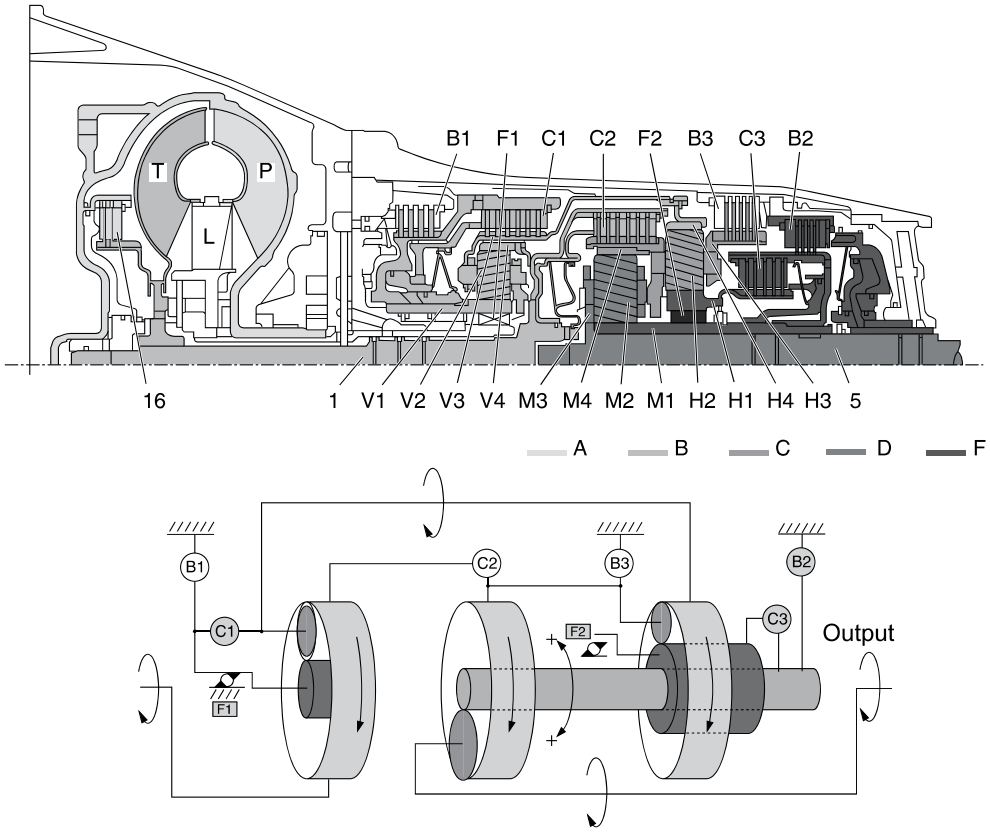
- Input shaft: Clockwise rotation
- Front sun gear: Locked by F1 and B1, Planetary gear carrier: Rotation with reduced speed
- Rear ring gear: Counterclockwise rotation
- Rear sun gear: Locked by F2 and B2, Planetary gear carrier: Clockwise rotation with reduced speed
- Center ring gear: Clockwise rotation
- 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)	●		●	●	

Modification basis	
Application basis	
Affected VIN	

▶2nd Gear (2.408)



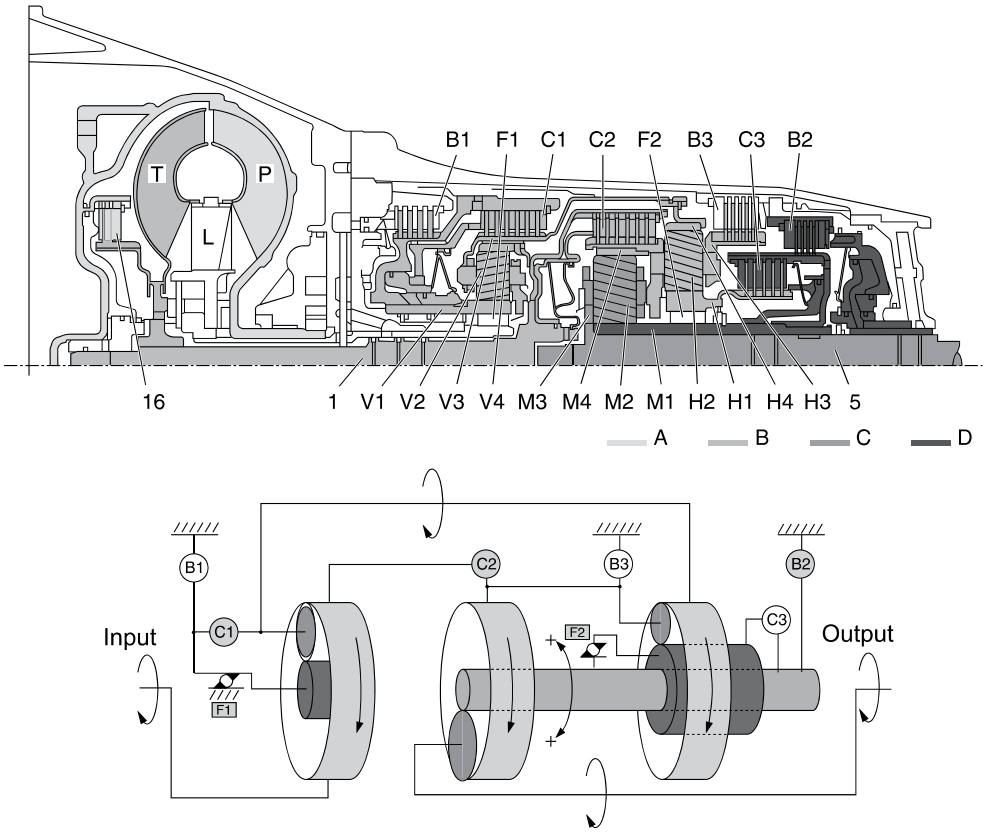
16. Torque converter lockup clutch
A. Engine speed
B. Transmission, input shaft
C. 1st gear ratio
D. 2nd gear ratio
E. Mounting elements
H. Rear planetary gear set
L. Stator
M. Center planetary gear set
P. Impeller
T. Turbine wheel
V. Front planetary gear set

- 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)		●			●

▶3rd Gear (1.486)



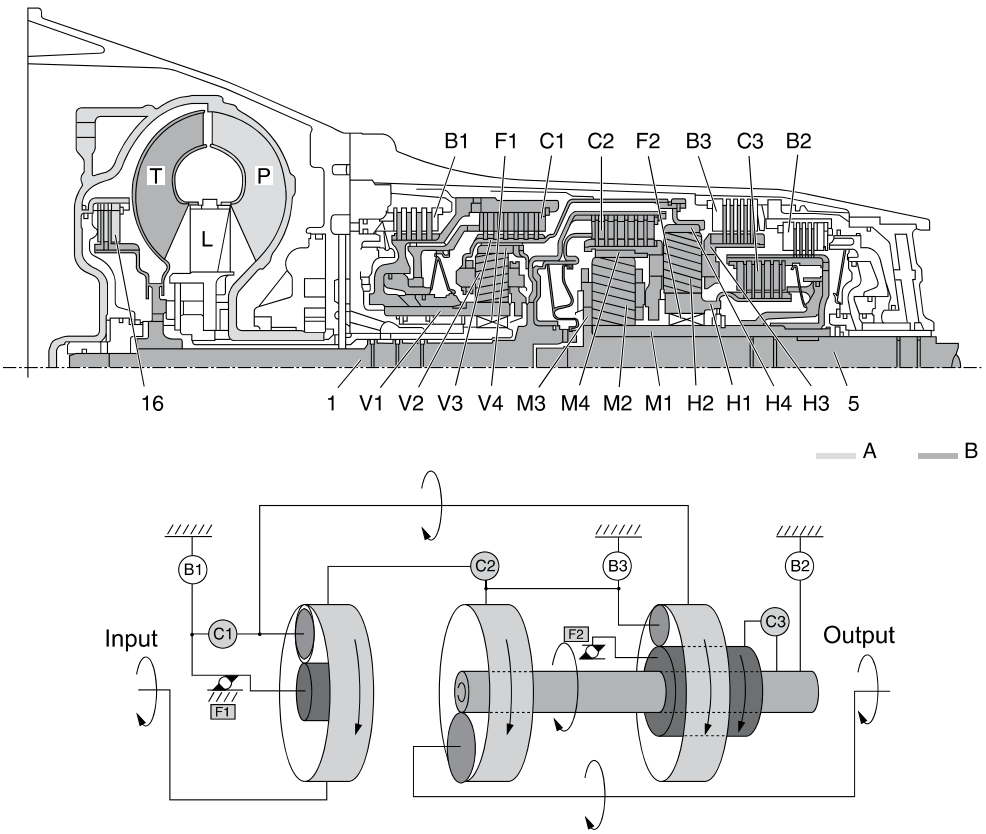
16. Torque converter lockup clutch
A. Engine speed
B. Transmission, input shaft
C. 1st gear ratio
D. Mounting elements
H. Rear planetary gear set
L. Stator
M. Center planetary gear set
P. Impeller
T. Turbine wheel
V. Front planetary gear set

- 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	●	●			●			

Modification basis	
Application basis	
Affected VIN	

▶4th Gear (1.000)

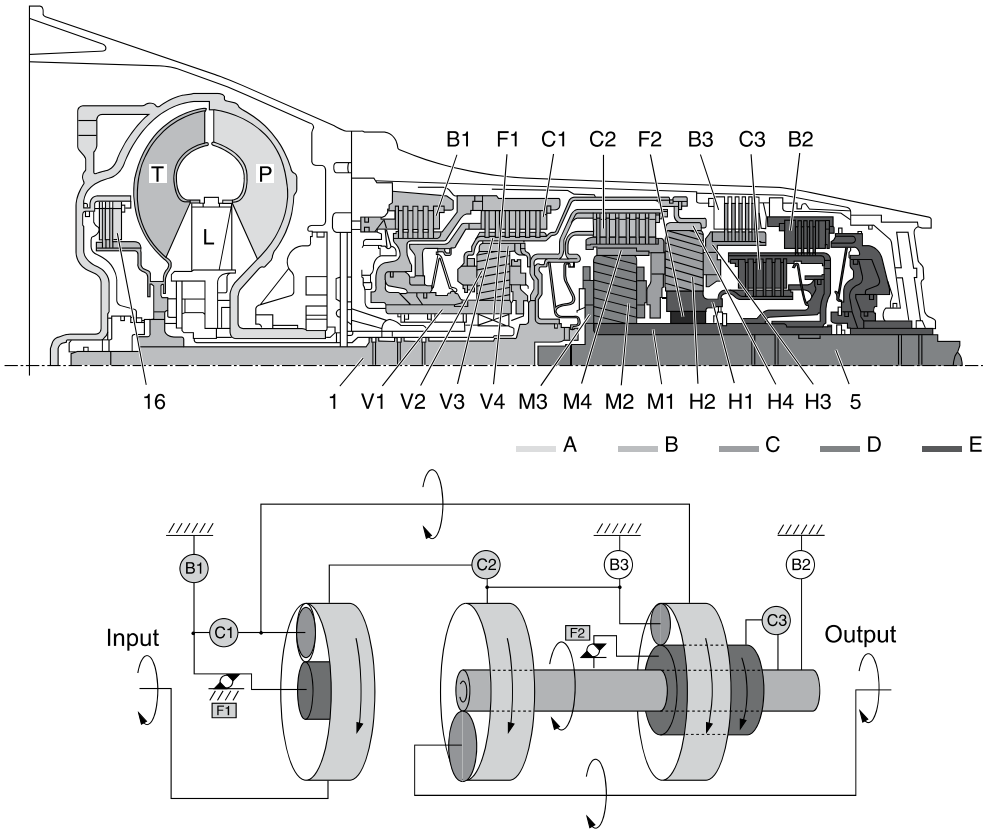


16. Torque converter lockup clutch
A. Engine speed
B. Planetary gear set
L. Stator
M. Center planetary gear set
P. Impeller
T. Turbine wheel
V. Front planetary gear set

- Input shaft: Clockwise rotation
- Front ring gear: Clockwise rotation
- Center ring gear 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	●	●	●					

▶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

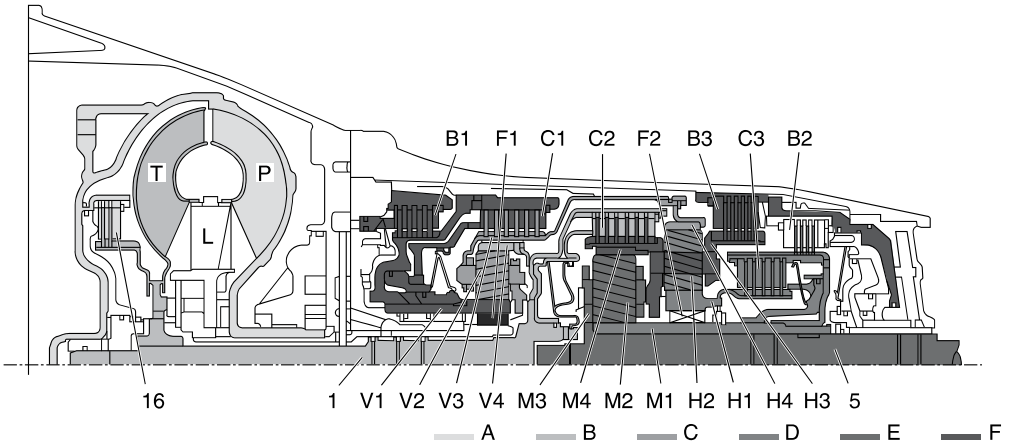
- Input shaft: Clockwise rotation
- Front sun gear: Locked, Planetary gear carrier: Rotation with reduced speed
- Rear planetary gear carrier: Clockwise rotation with reduced speed
- Center ring gear and rear planetary gear carrier: Clockwise rotation by clutch C2 activation
- Rear sun gear: Clockwise 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)

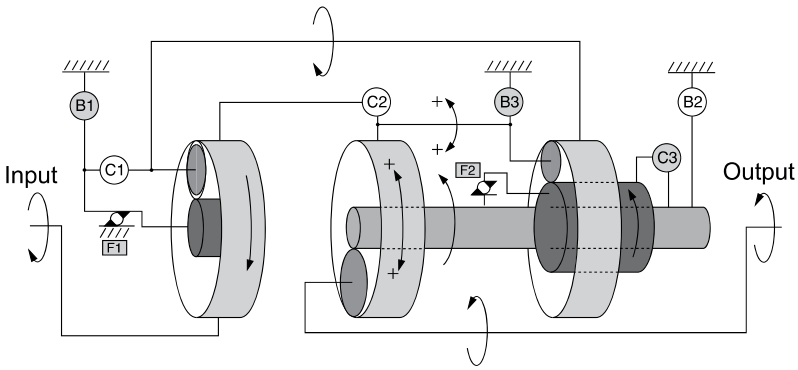
3) Overrun

Gear	C1	C2	C3	B1	B2	B3	F1	F2
5		●	●	●3)			●	

Modification basis	
Application basis	
Affected VIN	

▶Reverse 1st Gear (3.167, "S" Mode)





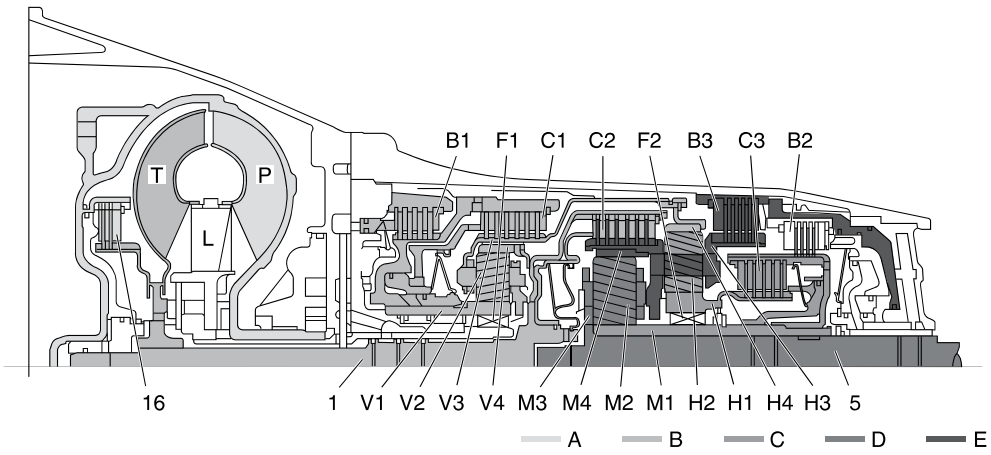
16. Torque converter lockup clutch
A. Engine speed
B. Transmission, input shaft
C. 1st gear ratio
D. 2nd gear ratio
E. Mounting elements
F. Mounting elements
H. Rear planetary gear set
L. Stator
M. Center planetary gear set
P. Impeller
T. Turbine wheel
V. Front planetary gear set

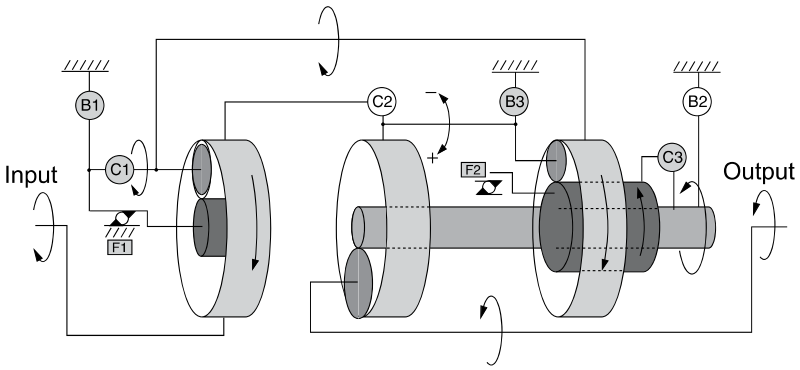
- Input shaft: Clockwise rotation
- Front ring gear: Clockwise rotation
- Front sun gear: Locked by one-way clutch F1
- Front planetary gear carrier: Clockwise rotation (reduced speed)
- Rear planetary gear ring gear: Clockwise rotation
- Rear planetary gear carrier: Locked by B3
- Rear sun gear and 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)		●	●	

▶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

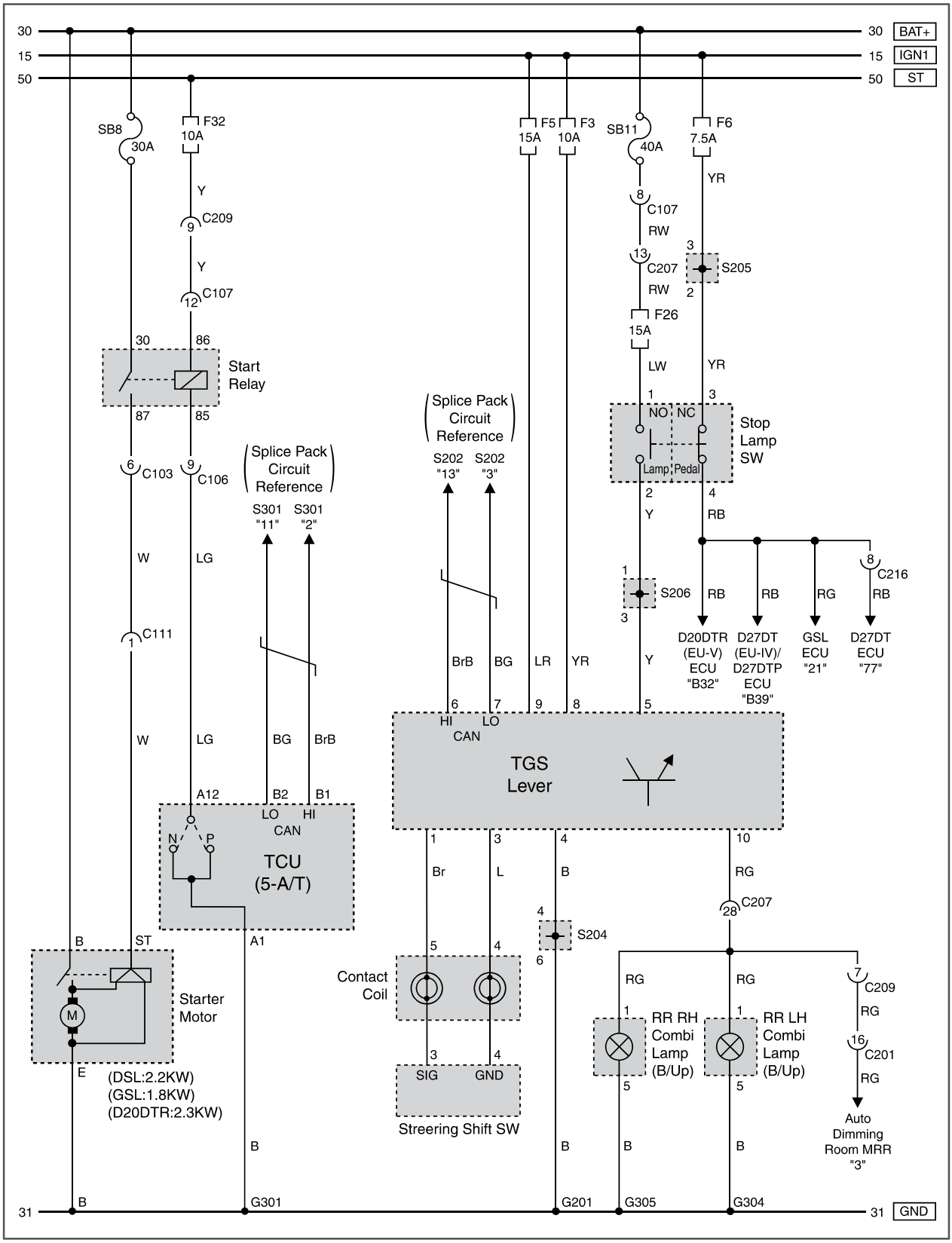
- Input shaft: Clockwise rotation
- Front ring gear: Clockwise rotation
- Front planetary gear carrier: Clockwise rotation by clutch C1 activation (direct connection)
- Rear ring gear: Clockwise rotation
- Rear planetary gear carrier and center ring gear: Locked by brake B3
- Rear sun gear and center 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)	●		●			●		

Modification basis	
Application basis	
Affected VIN	

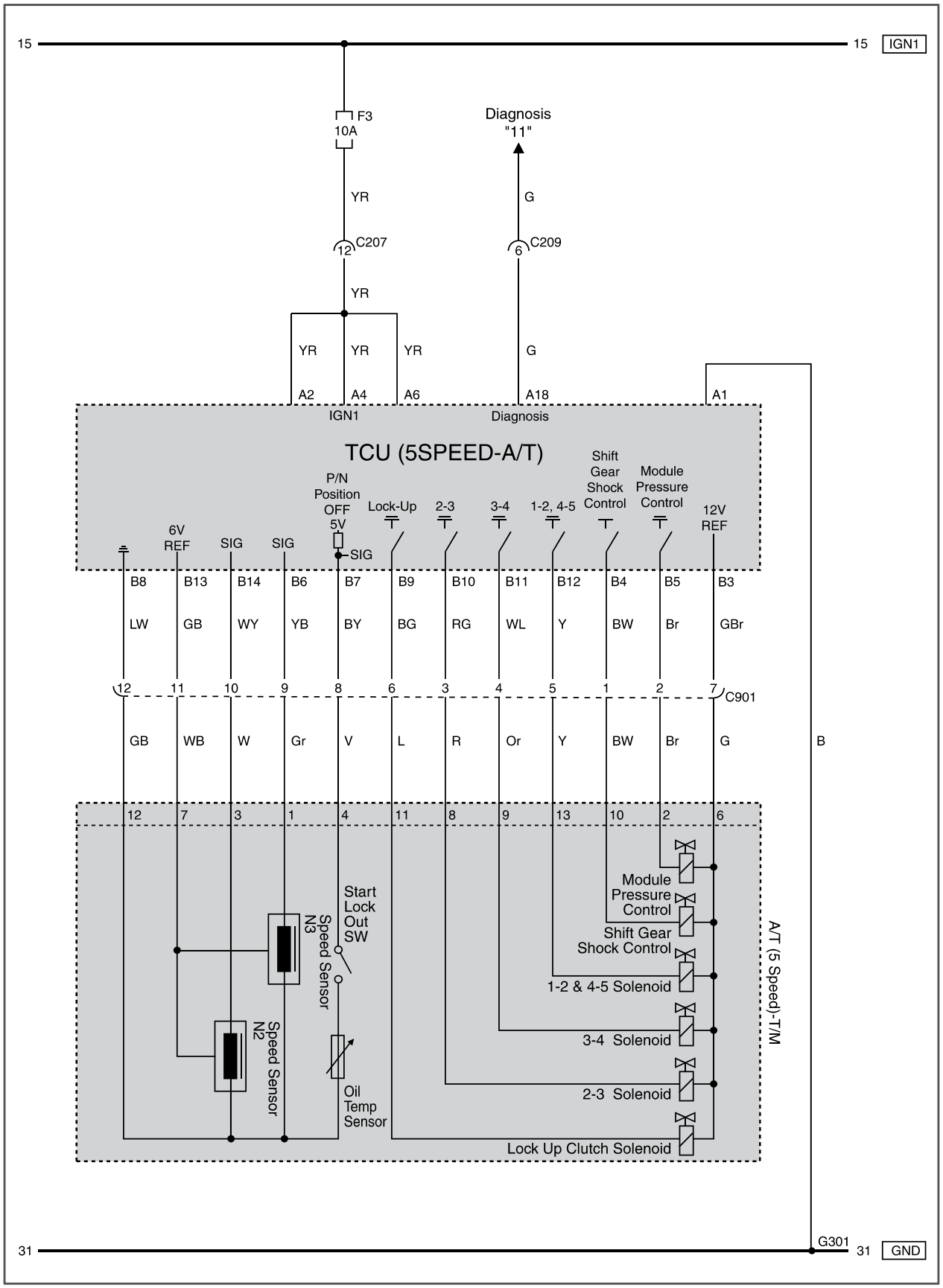
3. CIRCUIT DIAGRAM

▶Start Motor, Selector Lever, CAN Communication



Modification basis	
Application basis	
Affected VIN	

▶Solenoid, Oil temperature sensor, Speed sensor (N2, N3)



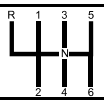
Modification basis	
Application basis	
Affected VIN	

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	
	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

Modification basis	
Application basis	
Affected VIN	

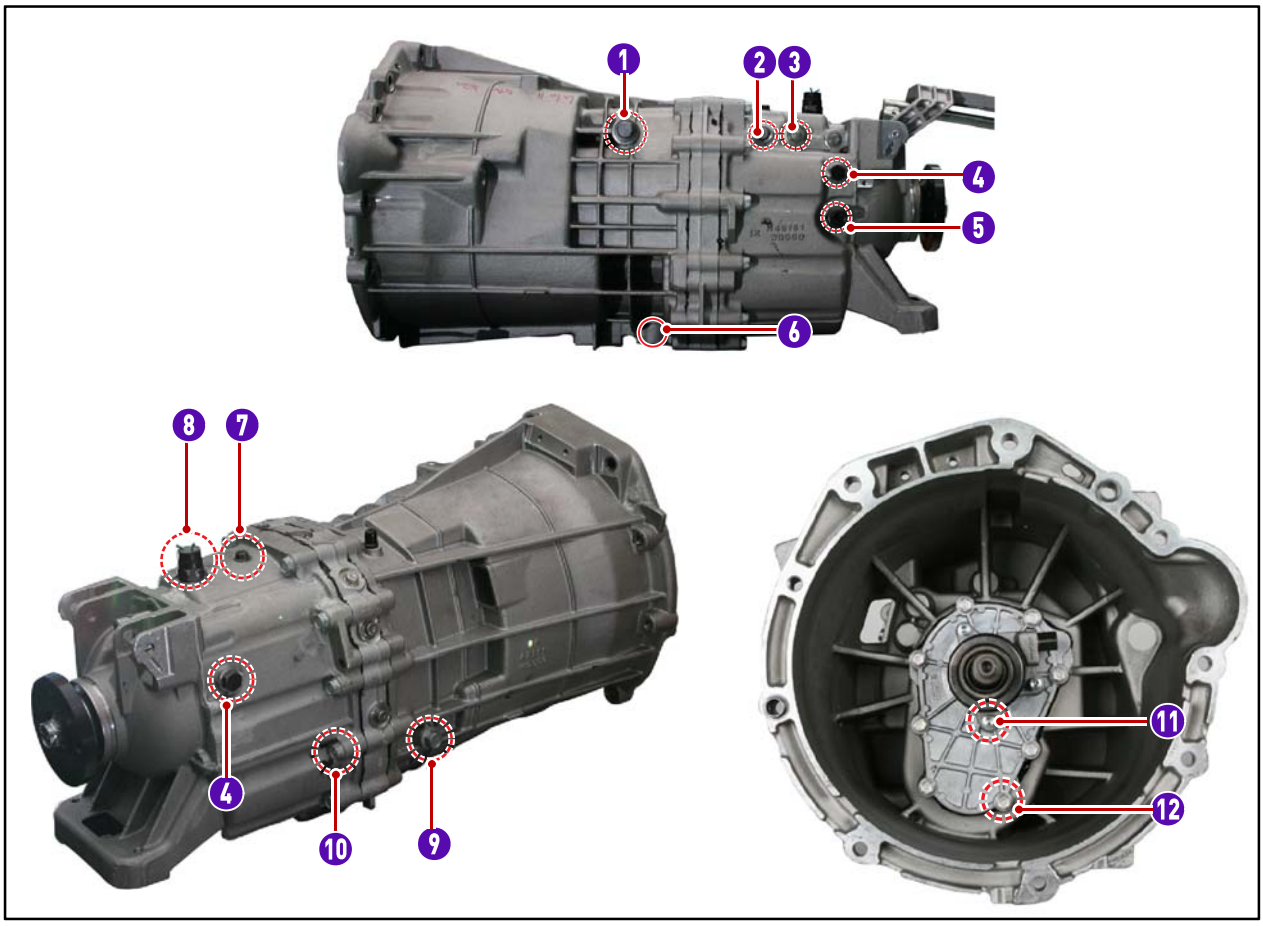
2. SPECIAL SERVICE TOOLS

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

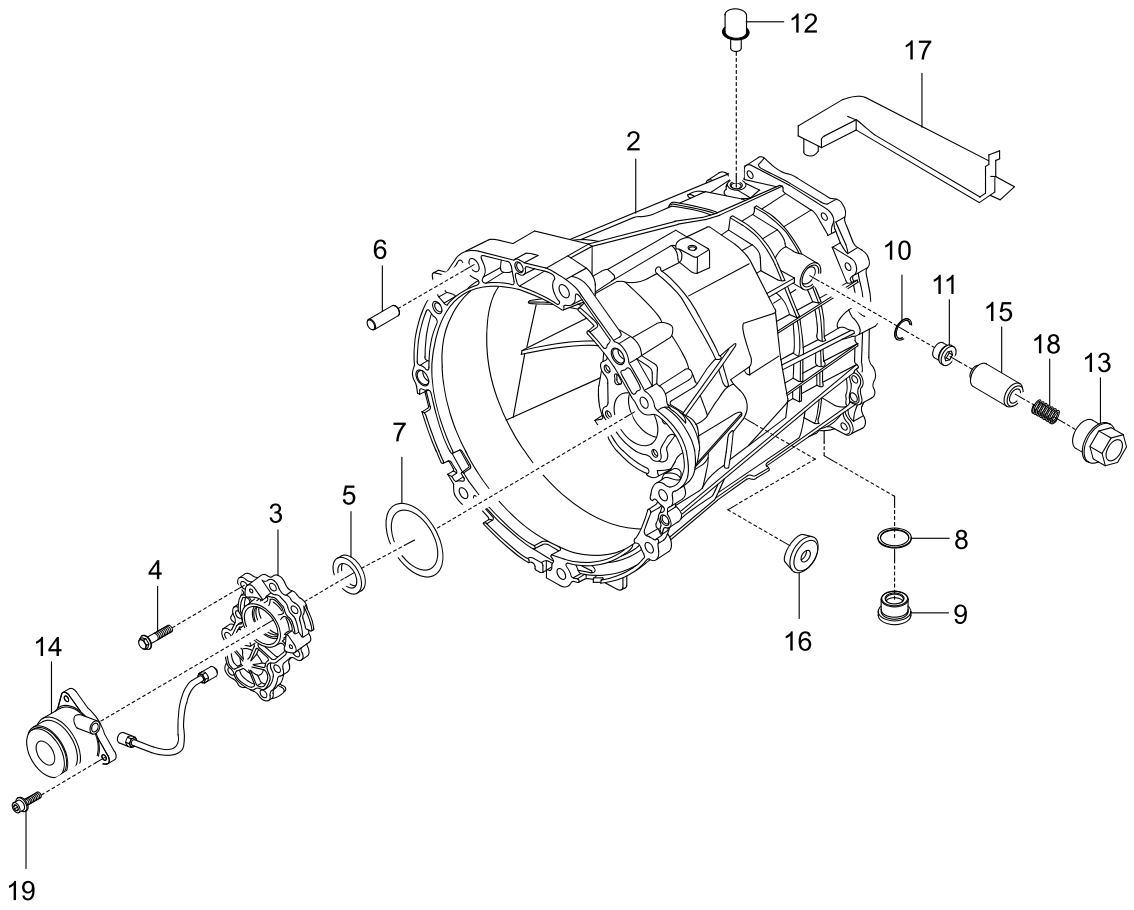
3. TIGHTENING TORQUE



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	

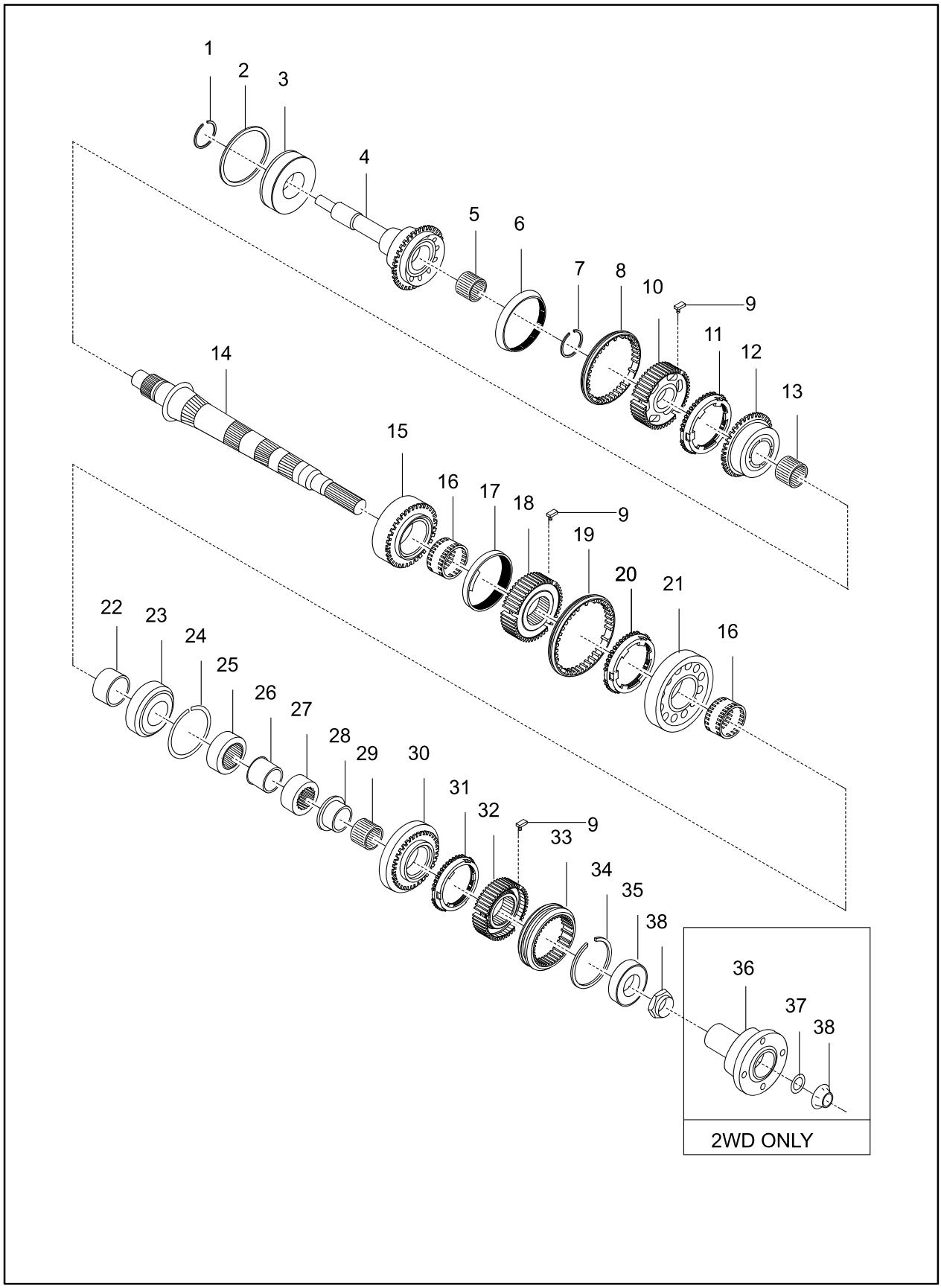
▶ 3163161-00 Housing



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	

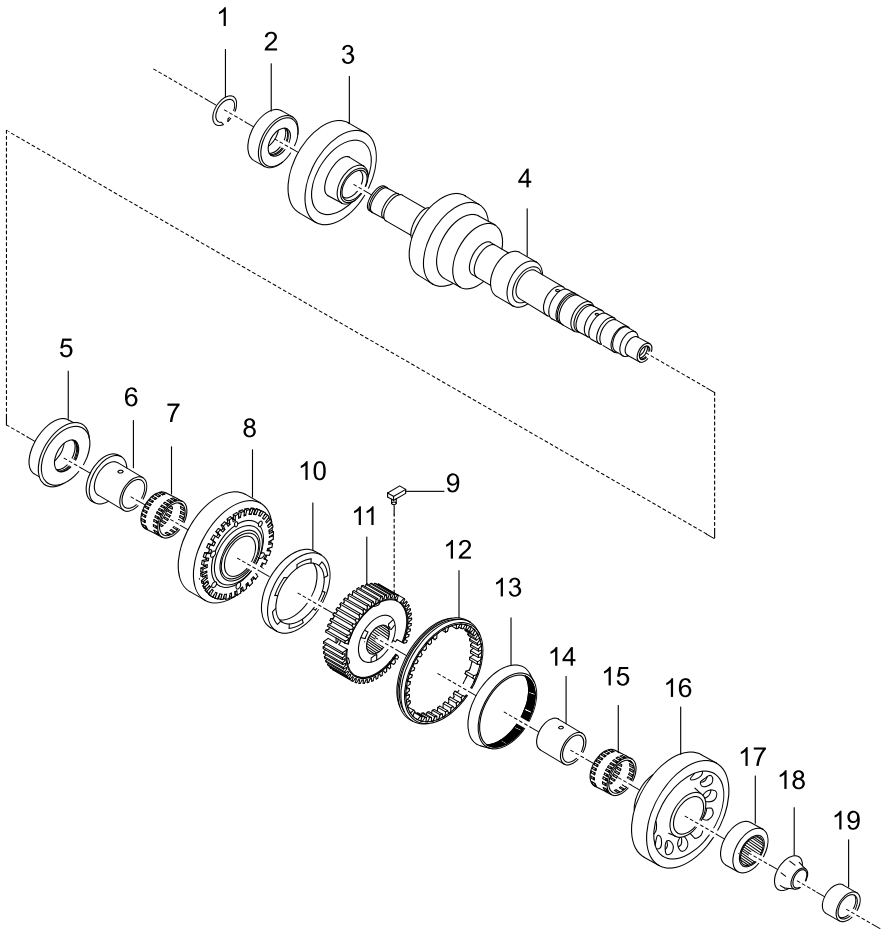
▶ 3162-00 Main shaft



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)

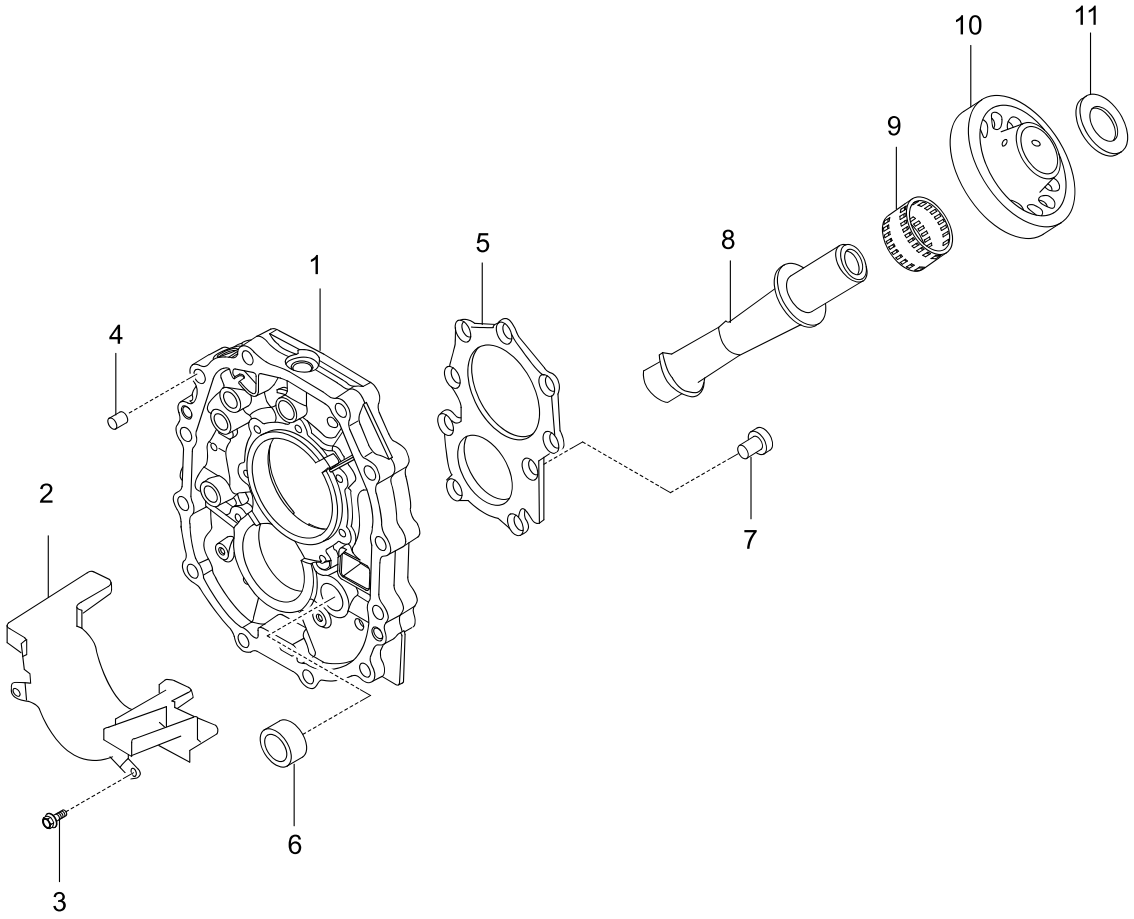
▶ 33163-00 Counter shaft



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	

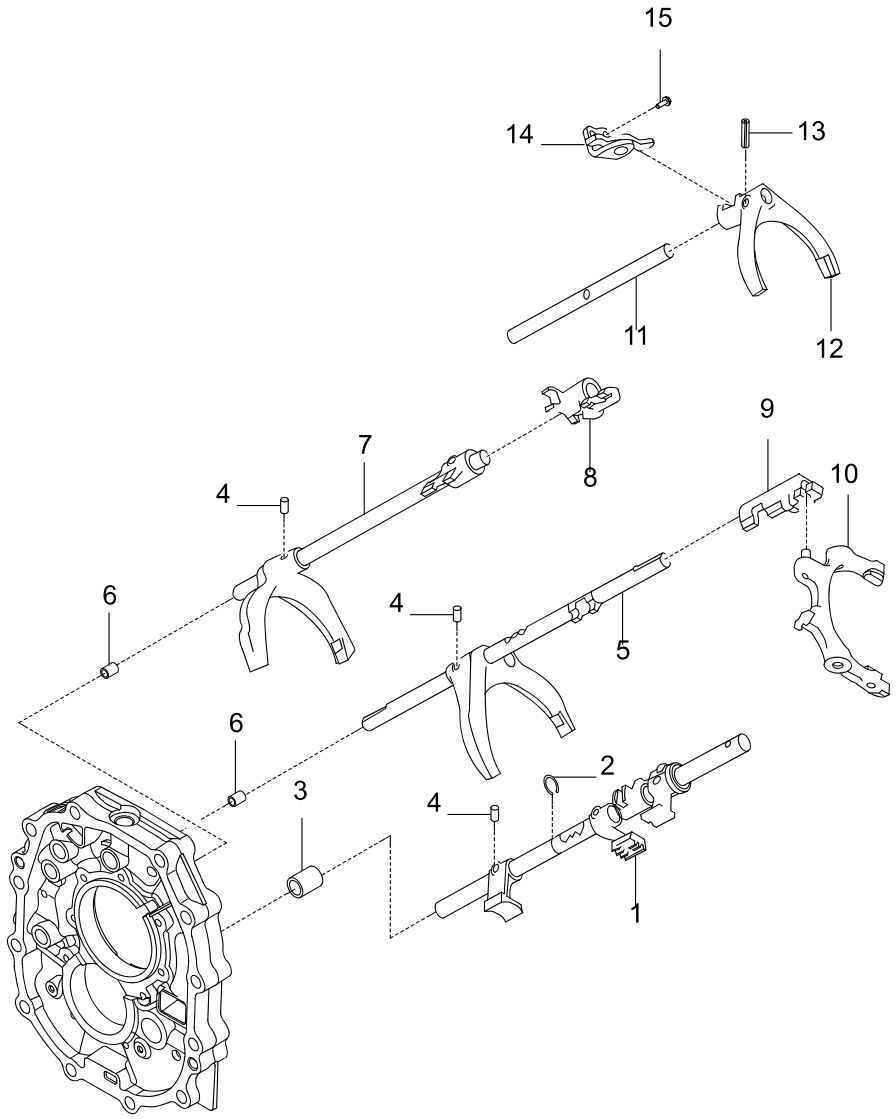
▶ 3164-00 Adapter assembly



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

Modification basis	
Application basis	
Affected VIN	

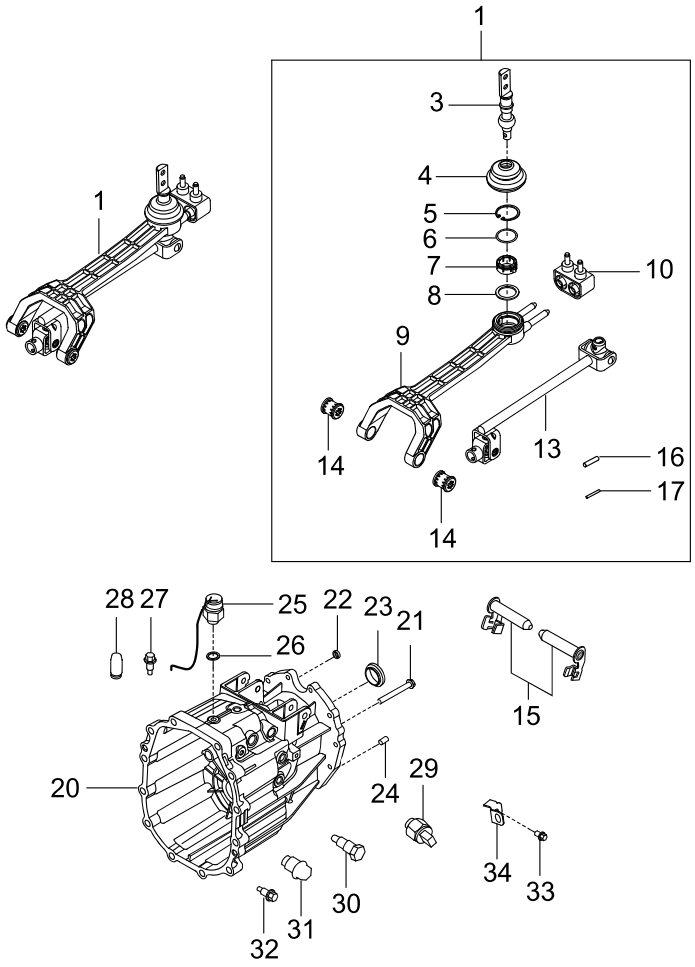
▶ 3165-00 Rail and shift fork



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

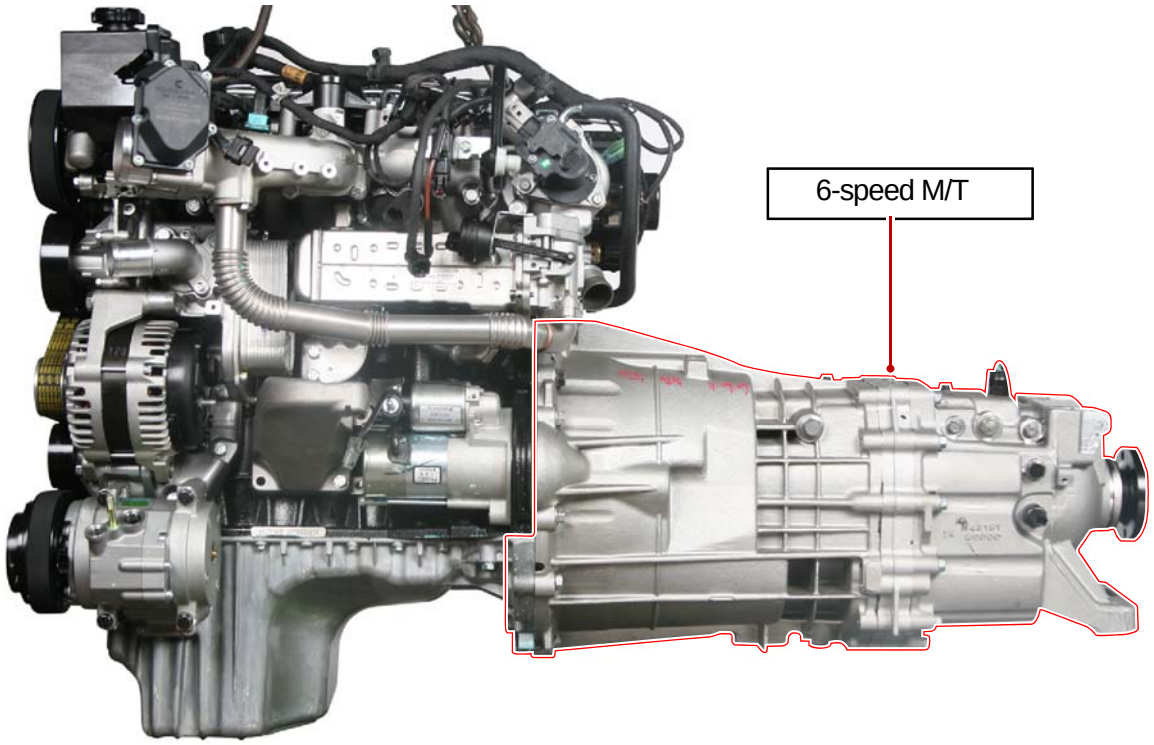


1. Lever assembly - Semi remote
3. Lever - Shift
4. Boot - Rubber
5. Ring - Retainer
6. O-ring
7. Bearing
8. Shim
9. Arm - Control
10. Damper assembly
13. Rod assembly
14. Bushing assembly - TGS mounting
15. Pin - TGS mounting
16. Pin - Spring
17. Pin - Spring
20. Adapter - Case
21. Bolt - Flange (42.1 ~ 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
30. Nm)
31. Bolt - Fork hinge (53.9 ~ 67.6 Nm)
32. Bearing - Poppet ball (29.4 ~ 41.1
33. Nm)
34. Bolt - Guide (14.7 ~ 21.5 Nm)
Bolt (2.9 ~ 4.9 Nm)
Bracket - Wiring

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW



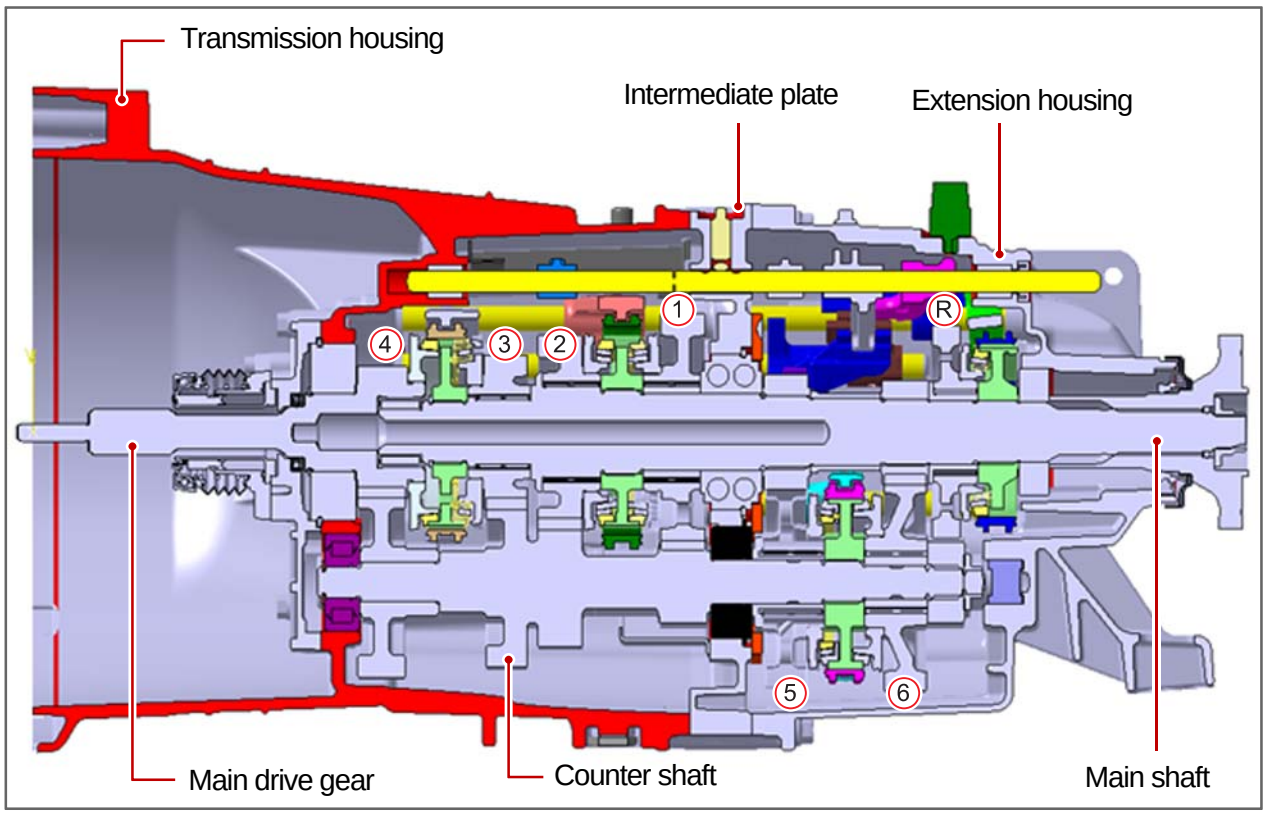
Front view	Sectional view
	

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

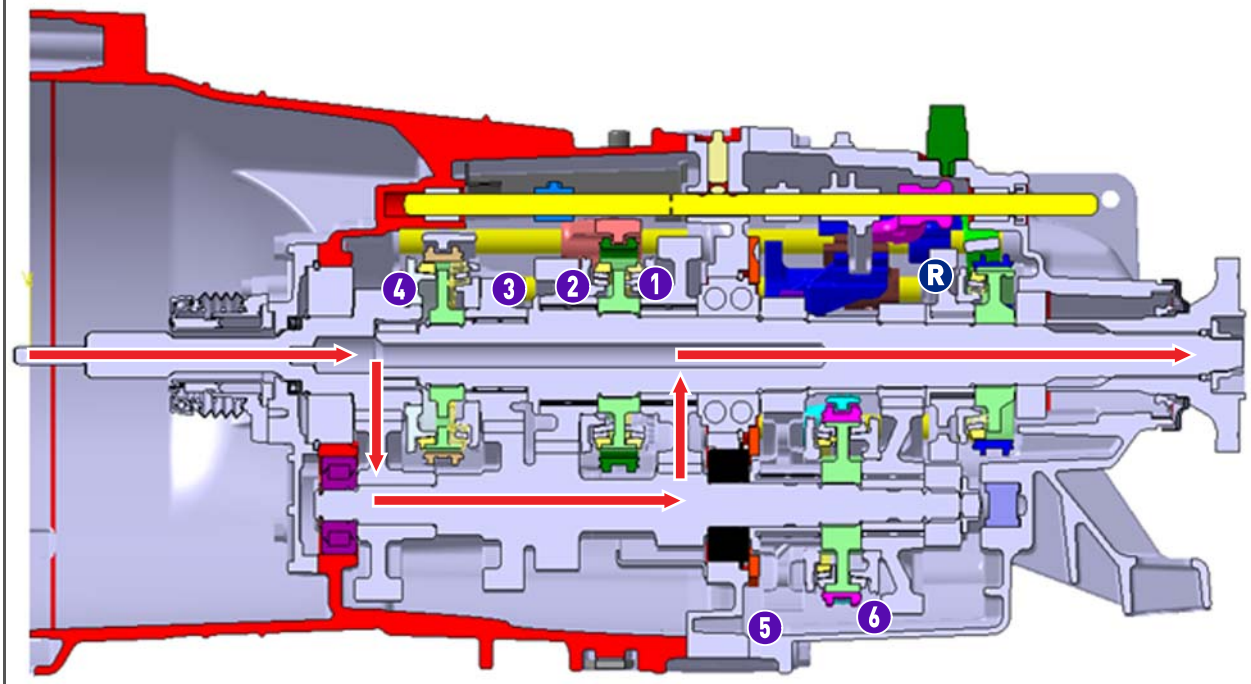


3) Gear Ratio

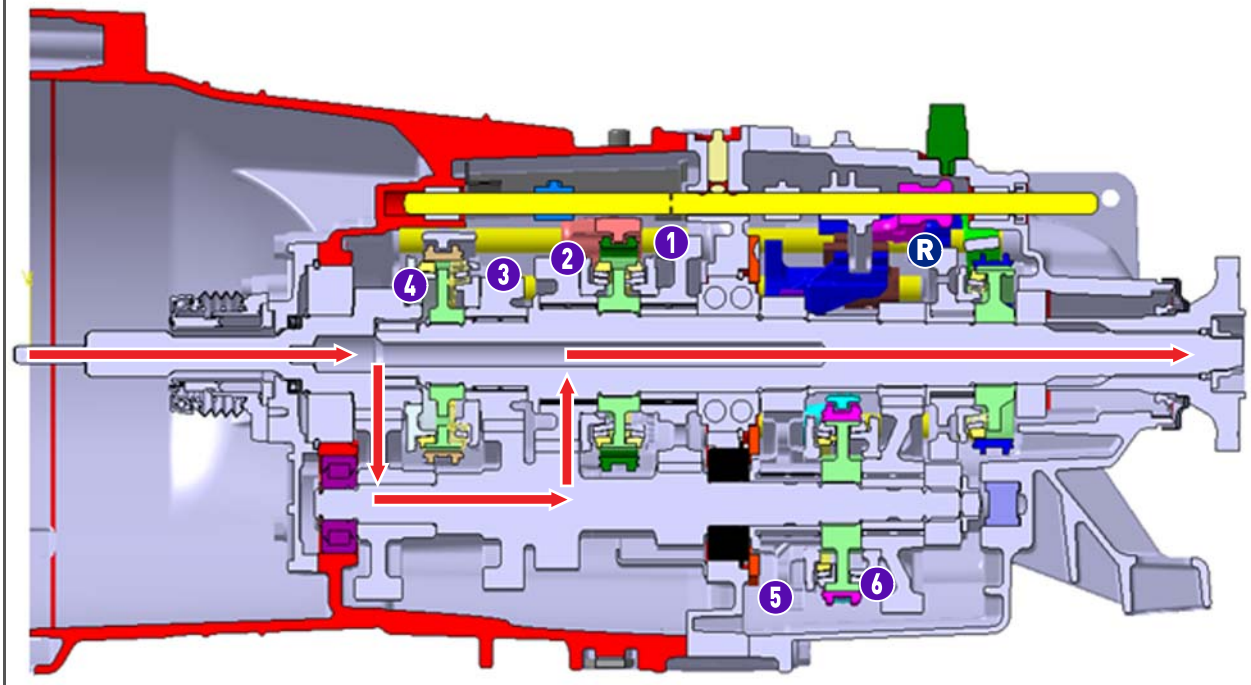
Gear	Teeth		Final gear ratio
	Input	Output	
1st	13	38	4.489
2nd	23	35	2.337
3rd	33	29	1.350
4th	28	43	1.000
5th	47	24	0.784
6th	52	23	0.679
R	13	36	4.253
	Idle: 25		

2. POWER FLOW

1st speed

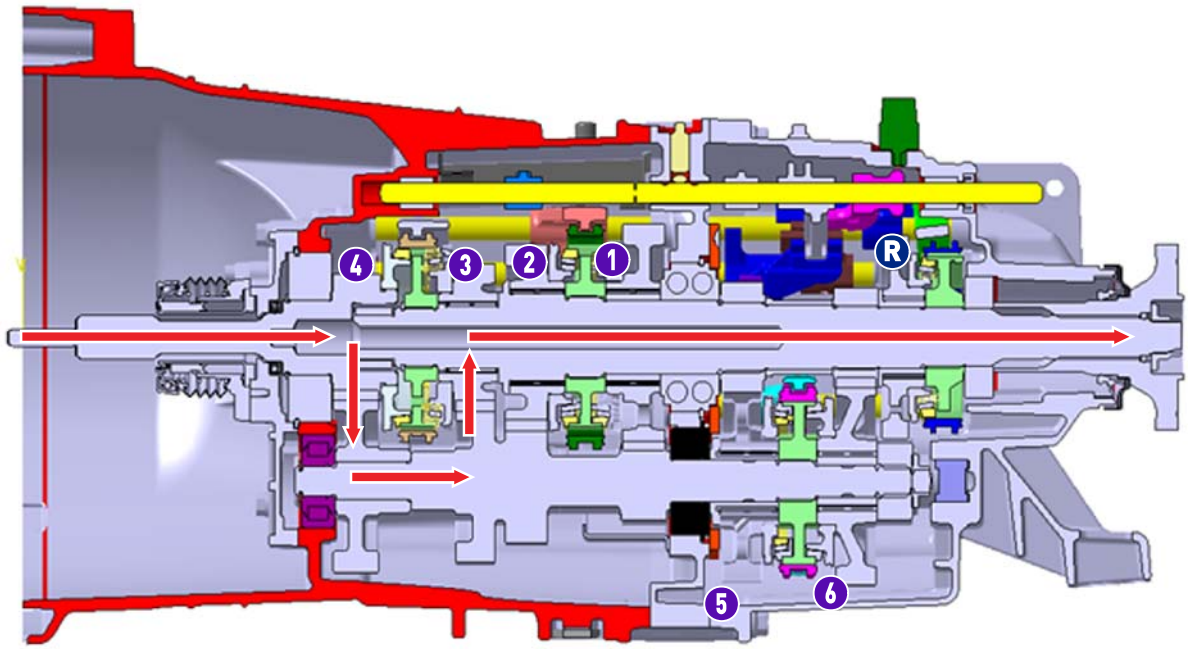


2nd speed

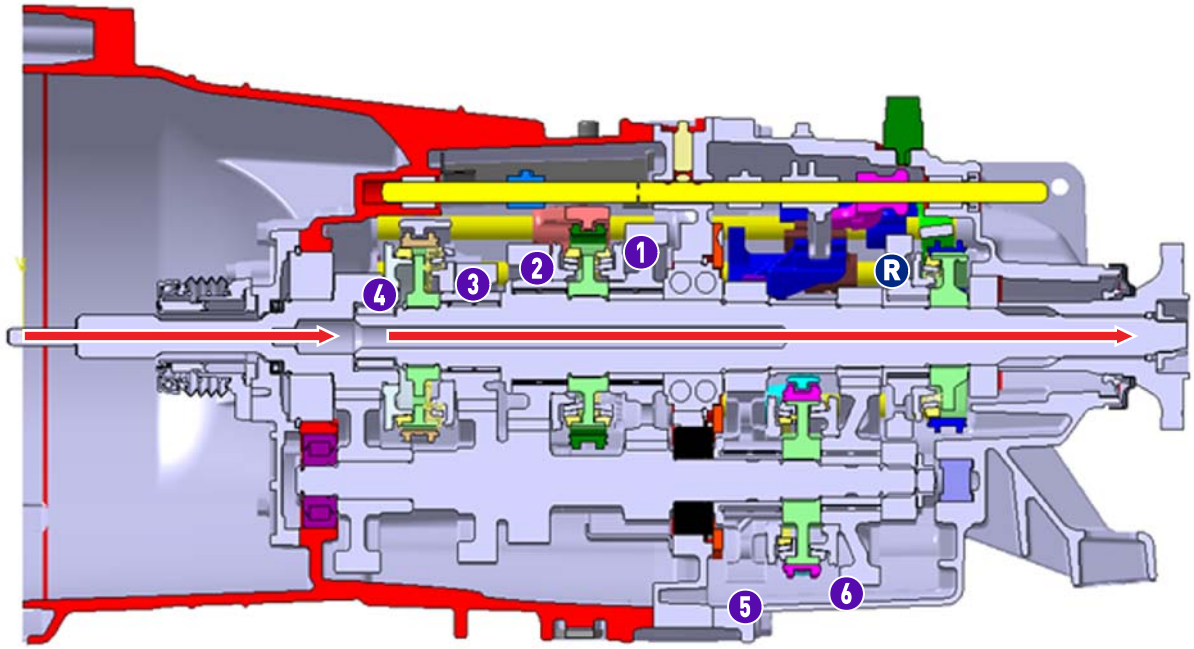


Modification basis	
Application basis	
Affected VIN	

3rd speed

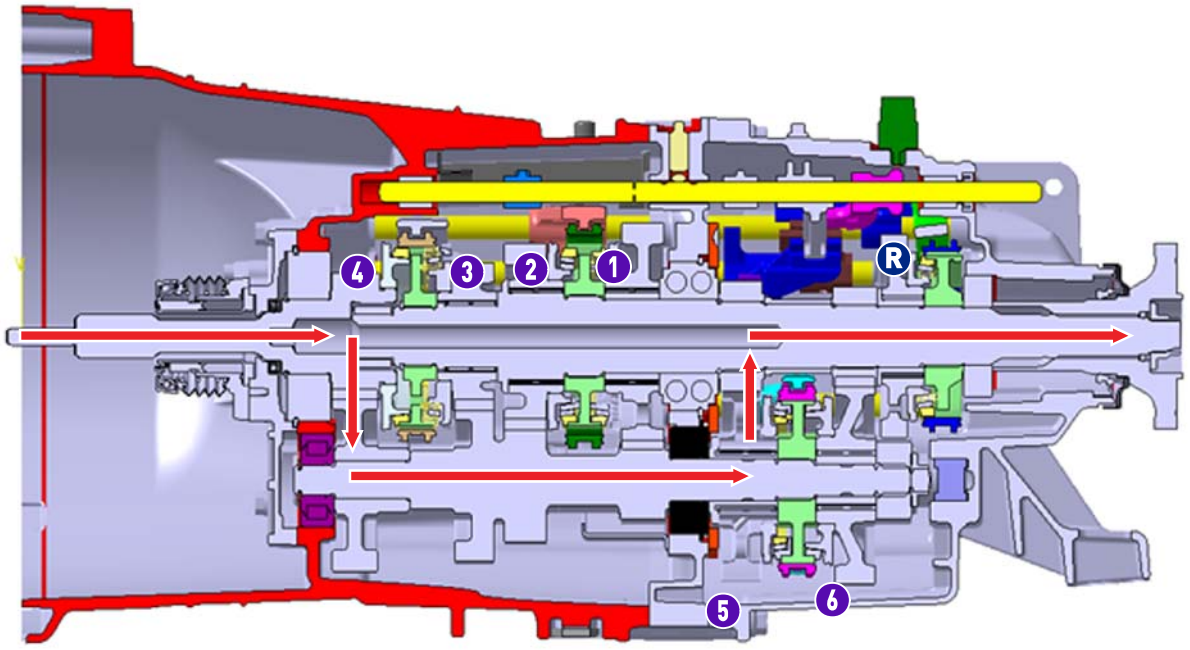


4th speed

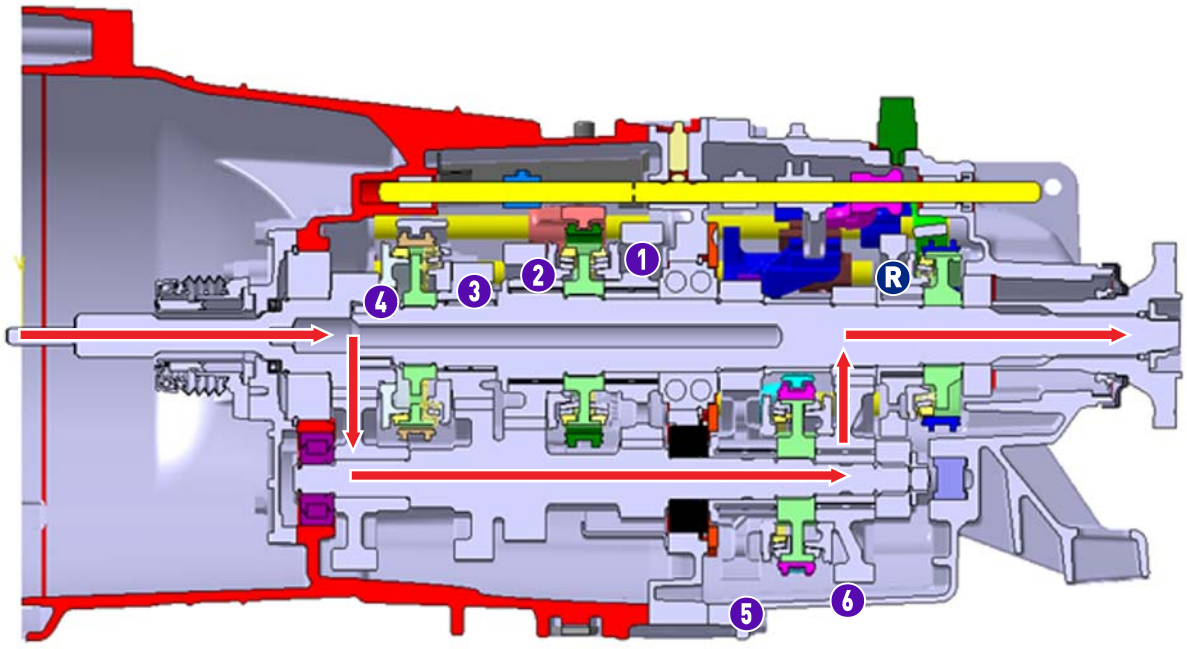


Modification basis	
Application basis	
Affected VIN	

5th speed

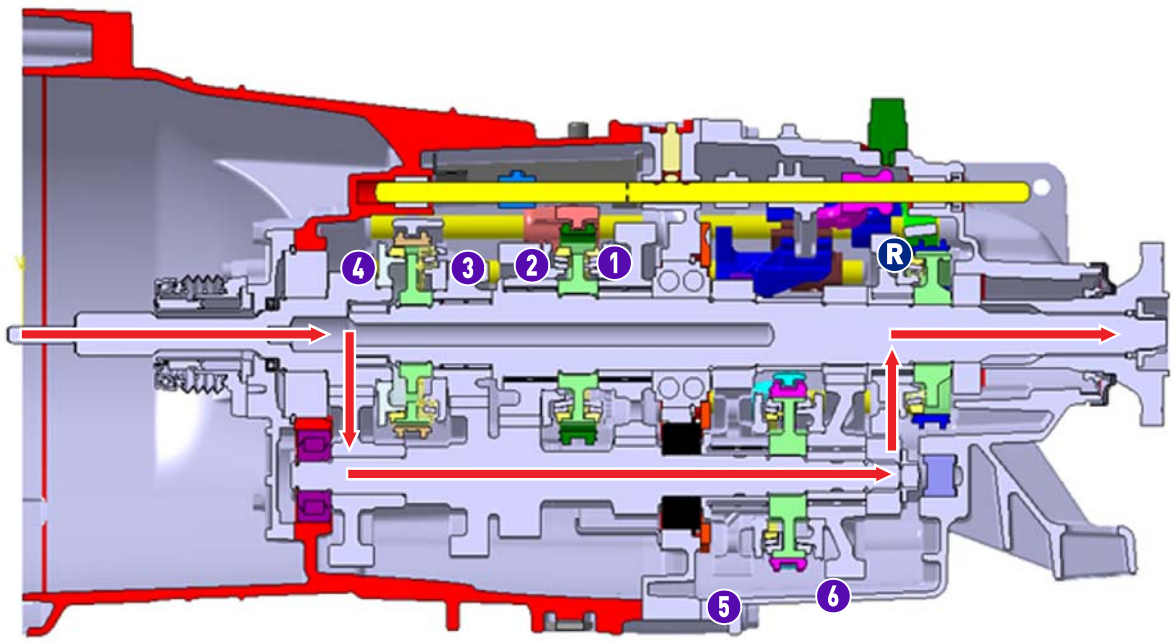


6th speed



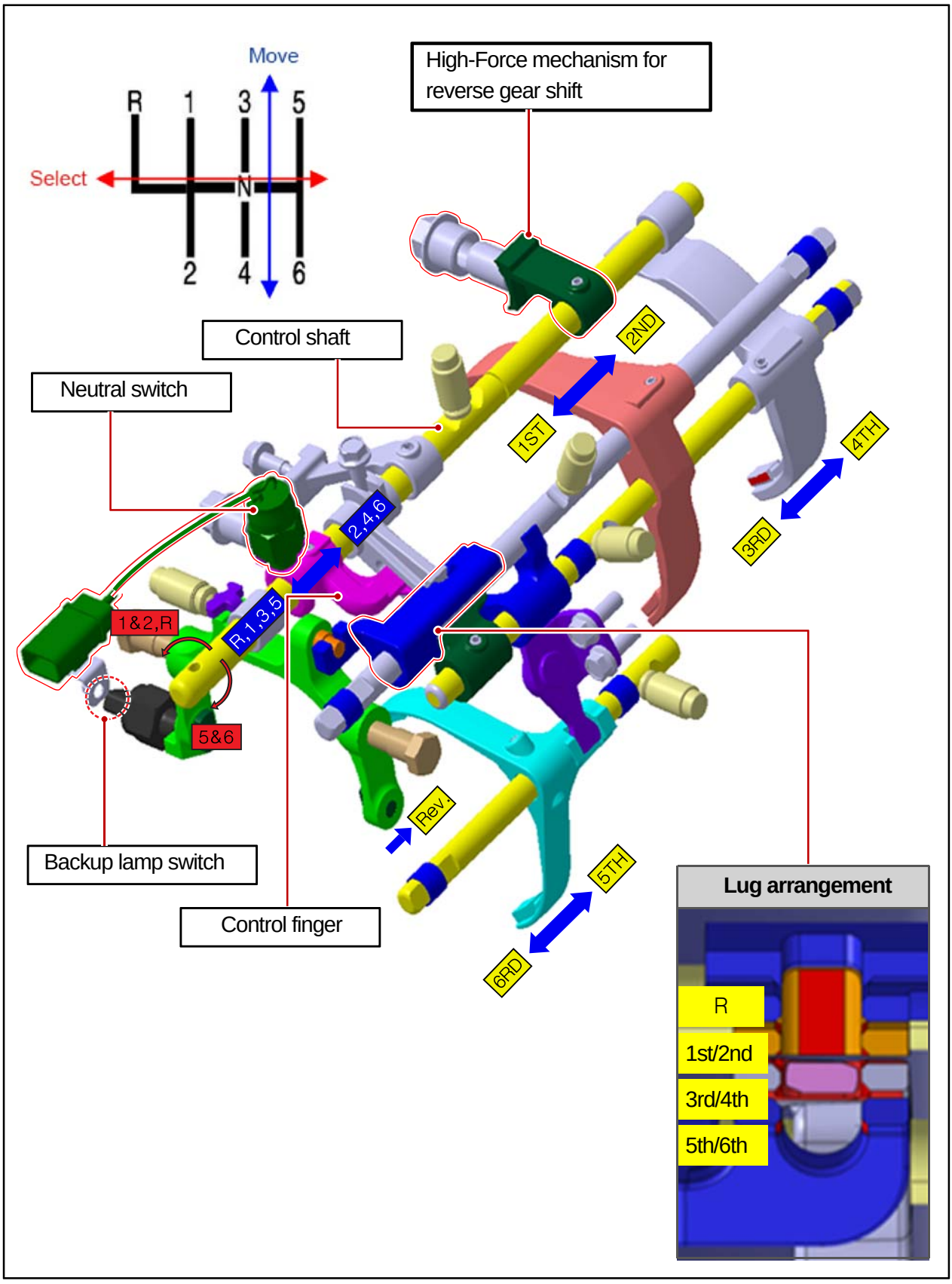
Modification basis	
Application basis	
Affected VIN	

Reverse gear



Modification basis	
Application basis	
Affected VIN	

3. SHIFTING MECHANISM



Modification basis	
Application basis	
Affected VIN	

MTMANUAL TRANSMISSION

3170-01

GENERAL INFORMATION

1. SPECIFICATIONS

1) General Specifications

Description		DI engine
Length(mm)		4WD: 628.3, 2WD: 672
Distance between shafts(mm)		81
Input torque(kg.m)		34.7(340Nm)
Transmission control type		Semi-remote
Weight(kg) - not including transmission fluid(kg.m)		4WD: 44, 2WD: 45
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	3.591
Transmission fluid	Specification	ATF DEXRON II
	Fapacity(ℓ)	4WD: 3.6, 2WD: 3.4
	Change interval	Inspect at every 10,000km, replace at every 60,000km(add or replace if necessary)

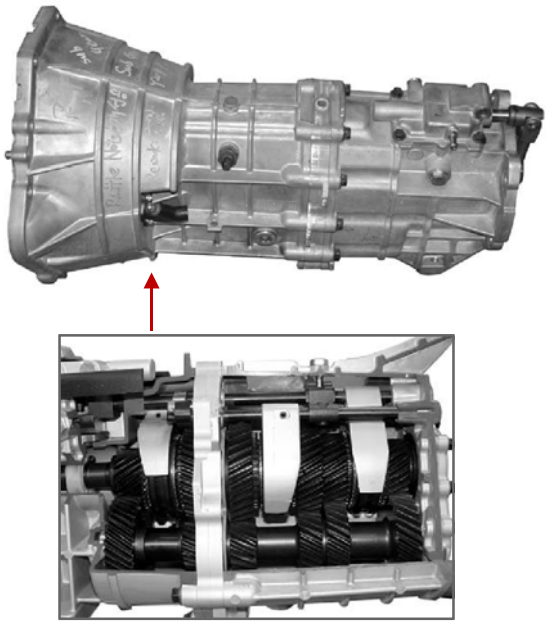
2) Tightening Torque

Description	Tightening torque	
Oil drain plug	4 ~ 5kgf.m	39.22 ~ 49.03Nm
Backup lamp switch	3 ~ 4kgf.m	29.42 ~ 39.22Nm
Extension housing bolt	4.2 ~ 5.7kgf.m	41.18 ~ 55.89Nm
Selector lever lower cover bolt	1.7 ~ 5kgf.m	16.67 ~ 49.03Nm
Extension housing spring plug	3.0 ~ 3.5kgf.m	29.42 ~ 34.32Nm
Offset plate countersunk screw	0.4 ~ 0.6kgf.m	3.92 ~ 5.88Nm

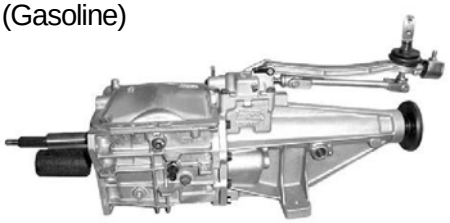
OVERVIEW AND OPERATION PROCESS

1. OVERVIEW

4WD

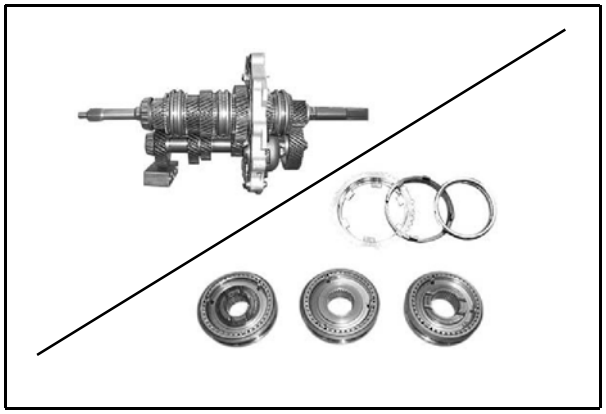


2WD (Gasoline)



1. TSM54/52 transmission is designed to link the gearratio, installation dimensions and shapes with current T5 transmission and BTRA automatic transmission.
   It provides maximum drivability by the optimized engine torque and gear ratio.
2. TSM54/52 transmission uses linkage type shift elements directly connected to the transmission. It prevent the transmission from shifting to the reverse gear from 5th gear when shifting to reverse gear. It also prevents the break and wear.

▶ **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 synchronizing devices are installed in 1/2, 3/4, 5/R gears. To prevent the double engagement, the independent interlock devices are installed.

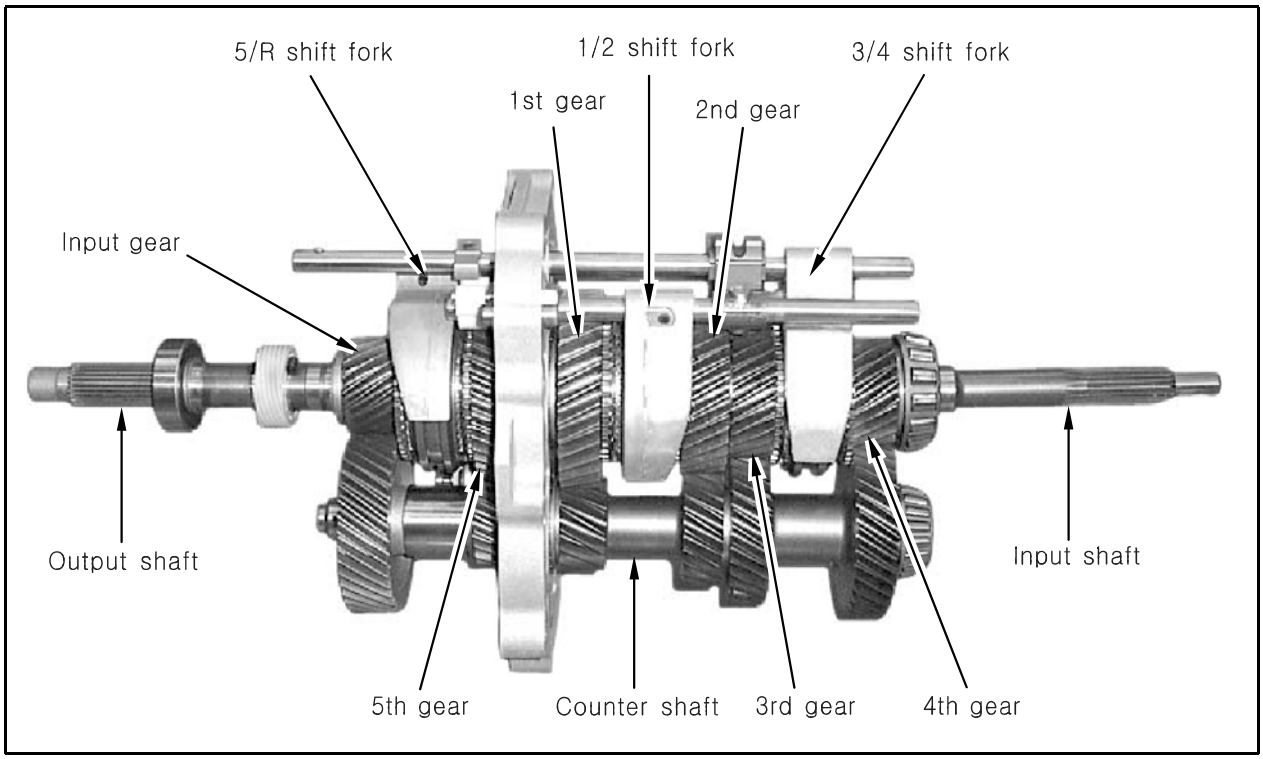
CAUTION
TSM54/52 transmission uses the inertia lock type key to make smooth gear engagement and to provide silent gear engagement.

3. The clutch release system is available to use CSC (Concentric Slave Cylinder) or Fork type according to the vehicle model. New Rexton uses the fork type clutch release system.
4. The semi-remote control type gear shift mechanism is used to prevent incorrect shifting.

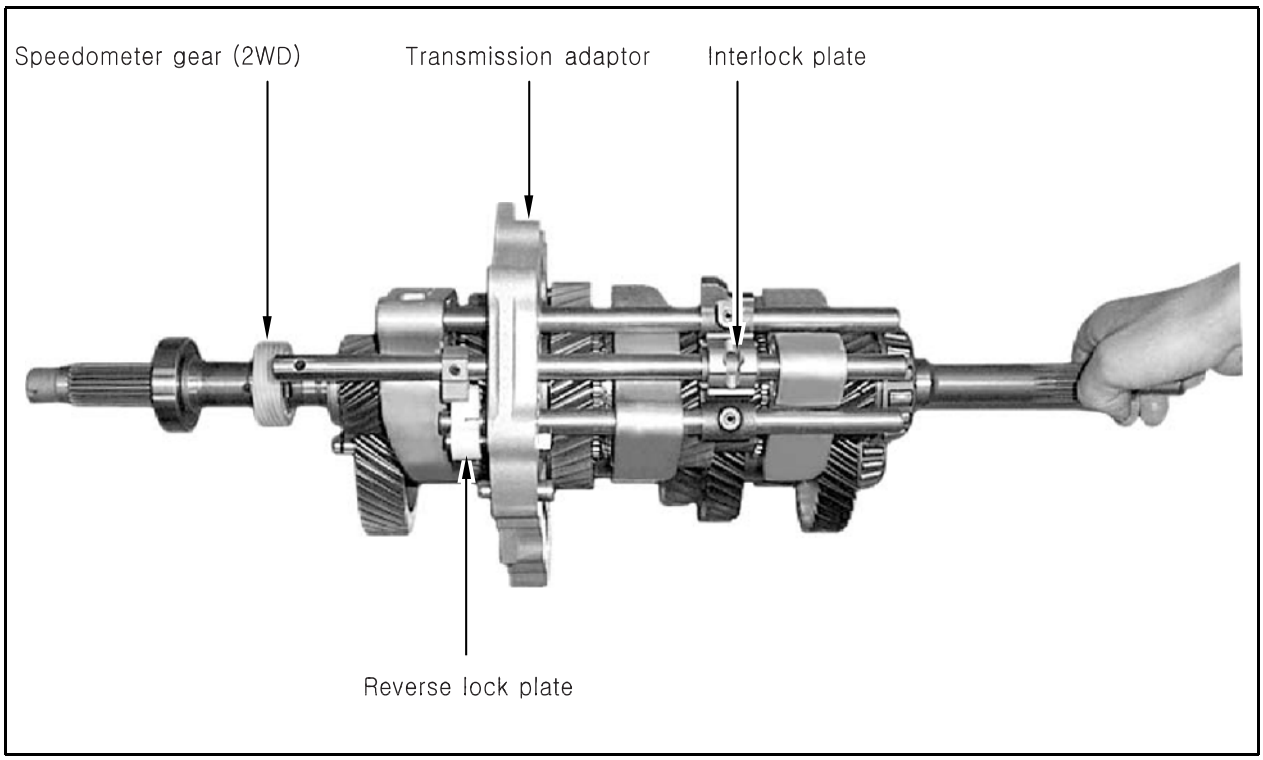
Modification basis	
Application basis	
Affected VIN	

2. SYSTEM COMPONENTS

1) Gear Combinations

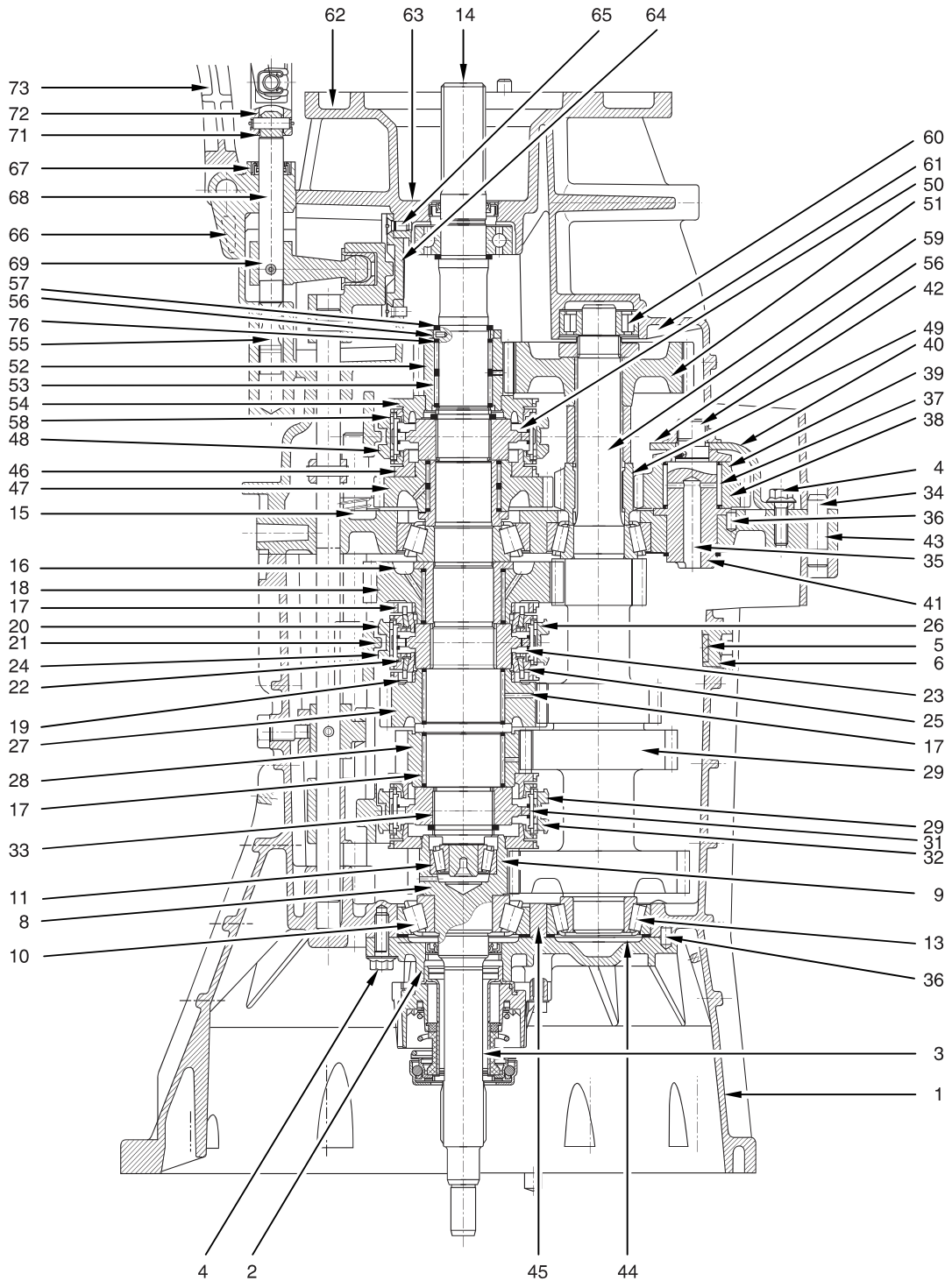


2) Shift Fork and Rail Combinations



Modification basis	
Application basis	
Affected VIN	

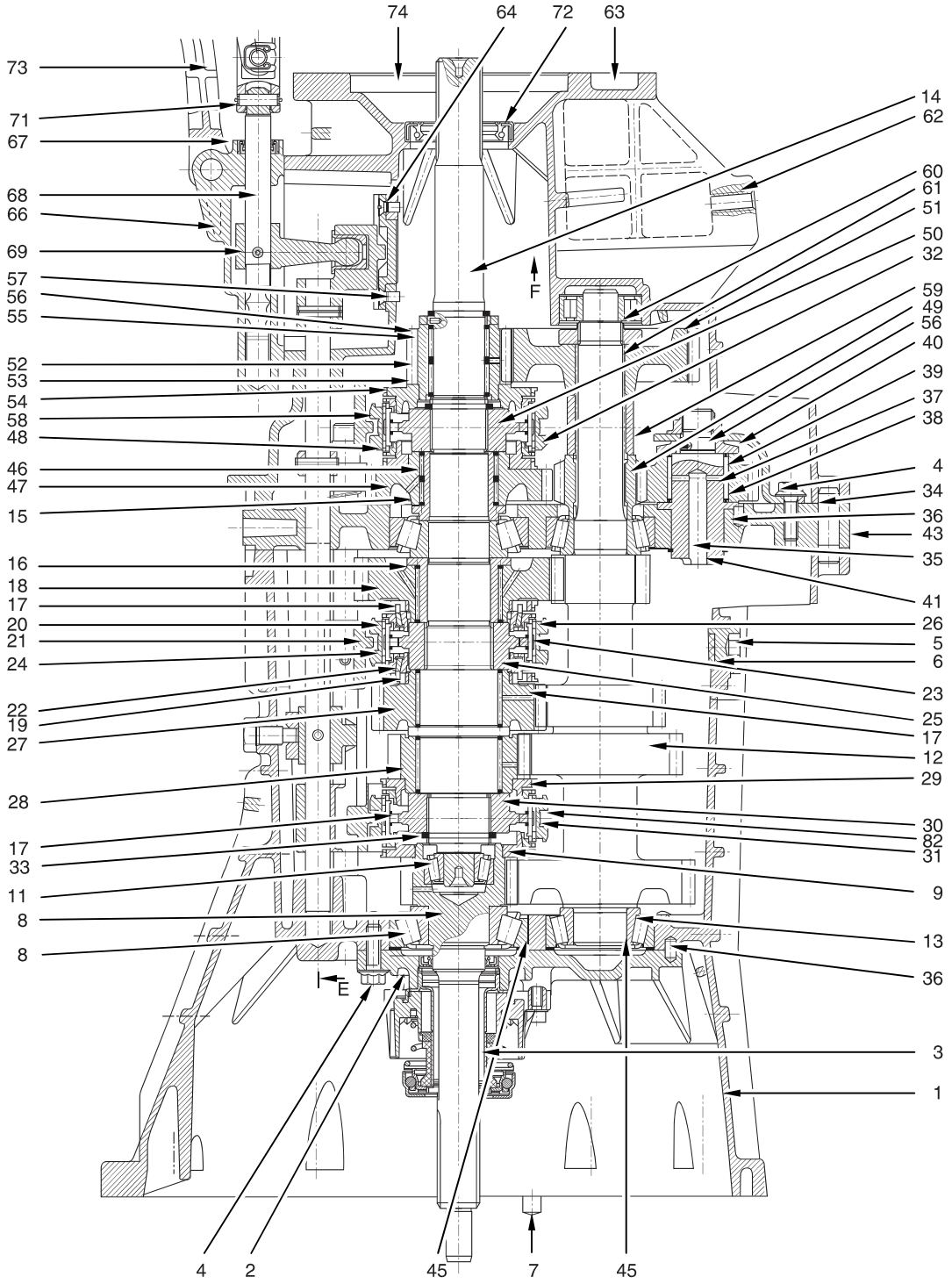
3) Sectional View



Modification basis	
Application basis	
Affected VIN	

1. Transmission front housing
2. Input shaft oil seal
3. Front cover
4. Hexagon flange bolt (17 ~ 26 Nm)
5. Oil drain plug
6. Sealing
7. Pin
8. Input shaft
9. Clutch 4th gear
10. Taper roller bearing (main)
11. Taper roller bearing
12. Counter shaft
13. Taper roller bearing (counter)
14. Output shaft
15. Inner race (reverse)
16. Inner race (1st)
17. Needle bearing
18. 1st gear
19. 1st clutch gear
20. Synchro outer ring
21. Synchro - middle cone
22. Synchro inner ring
23. Synchro spring
24. Synchro key
25. Synchro hub
26. Double synchro sleeve
27. 2nd gear
28. 3rd gear
29. 3rd clutch gear
30. Synchro hub (3 & 4th)
31. Synchro ring (4/5/R)
32. Single synchro sleeve
33. Retainer ring
34. Adaptor dowel pin
35. Reverse idler shaft
36. Dowel pin
37. Needle bearing
38. Reverse idler gear
39. Reverse idler spacer
40. Reverse idler bracket
41. Retainer ring
42. Reverse lock nut
43. Transmission adaptor
44. Input shaft spacer
45. Counter spacer
46. Reverse needle bearing
47. Reverse gear
48. Reverse clutch gear
49. Reverse counter gear
50. Synchro hub
51. Counter 5th gear
52. 5th needle bearing
53. 5th gear
54. 5th clutch gear
55. Thrust washer
56. Spring pin
57. 5th outside retainer ring
58. 5th retainer ring
59. Counter shaft bushing
60. Counter roller bearing assembly
61. Retainer ring
62. Extension housing
63. Output shaft oil seal
64. Offset plate
65. Counter screw
66. Top cover
67. Counter oil seal
68. Shift shaft
69. Shift lever
70. Detent pin
71. Joint pin
72. Retainer ring
73. Semi remote lever assembly

▶ IDI Engine equipped vehicle - 4WD

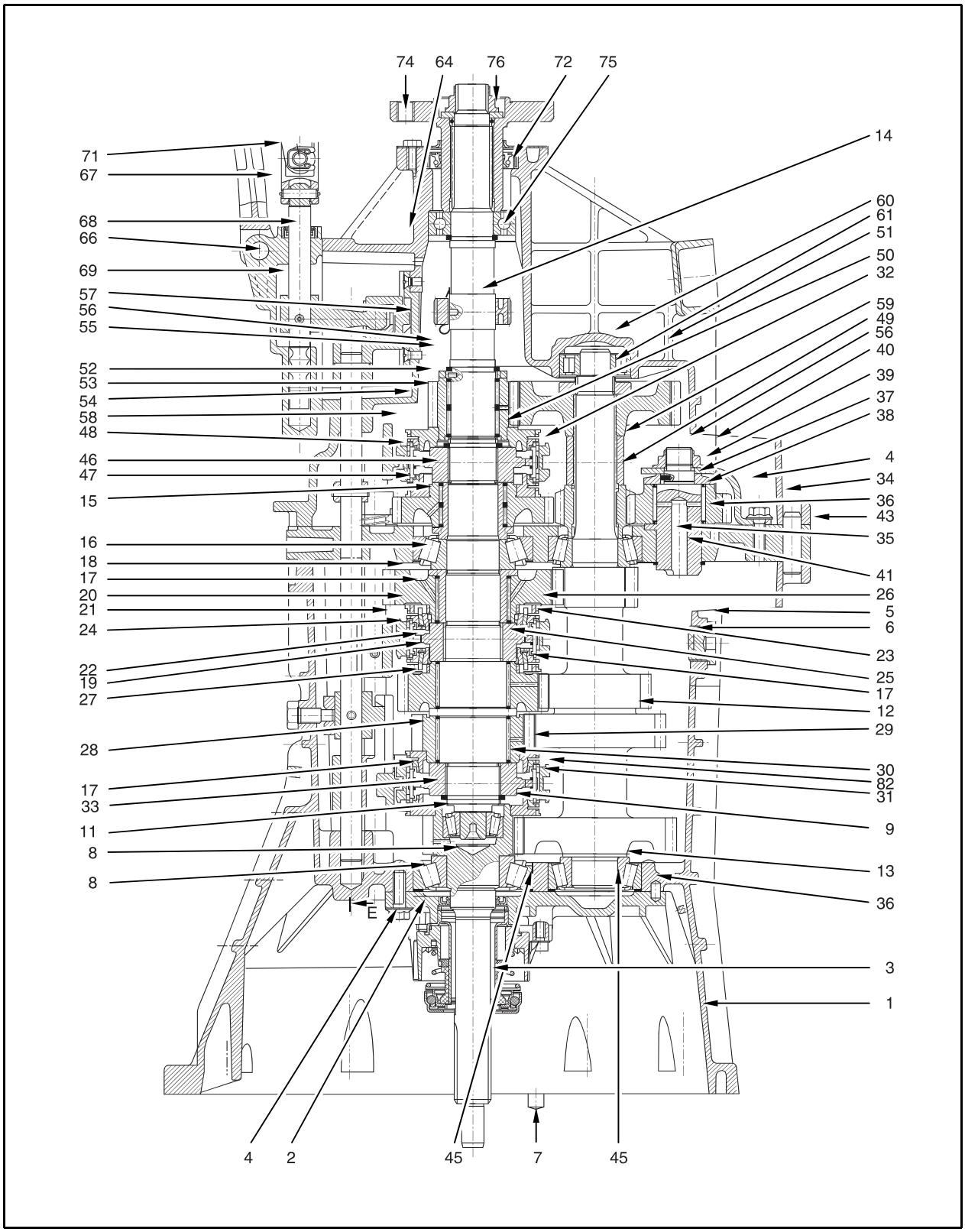


Modification basis	
Application basis	
Affected VIN	

1. Transmission front housing
2. Input shaft oil seal
3. Front cover
4. Hexagon flange bolt (17~26 Nm)
5. Oil drain plug
6. Sealing
7. Pin
8. Input shaft
9. Clutch 4th gear
10. Taper roller bearing (main)
11. Taper roller bearing
12. Counter shaft
13. Taper roller bearing (counter)
14. Output shaft
15. Inner race (reverse)
16. Inner race (1st)
17. Needle bearing
18. 1st gear
19. 1st clutch gear
20. Synchro outer ring
21. Synchro - middle cone
22. Synchro inner ring
23. Synchro spring
24. Synchro key
25. Synchro hub
26. Double synchro sleeve
27. 2nd gear
28. 3rd gear
29. 3rd clutch gear
30. Synchro hub (3 & 4th)
31. Synchro ring (4/5/R)
32. Single synchro sleeve
33. Retainer ring
34. Adaptor dowel pin
35. Reverse idler shaft
36. Dowel pin
37. Bearing
38. Reverse idler gear
39. Reverse idler spacer
40. Reverse idler bracket
41. Retainer ring
42. Reverse lock nut
43. Transmission adaptor
44. Input shaft spacer
45. Counter spacer
46. Reverse needle bearing
47. Reverse gear
48. Reverse clutch gear
49. Reverse counter gear
50. Synchro hub
51. Counter 5th gear
52. 5th needle bearing
53. 5th gear
54. 5th clutch gear
55. Thrust washer
56. Spring pin
57. 5th outside retainer ring
58. 5th retainer ring
59. Counter shaft bushing
60. Counter roller bearing assembly
61. Retainer ring
62. Extension housing
63. Output shaft oil seal
64. Offset plate
65. Counter screw
66. Top cover
67. Counter oil seal
68. Shift shaft
69. Shift lever
70. Detent pin
71. Joint pin
72. Retainer ring
73. Semi remote lever assembly
74. Rear flange

Modification basis	
Application basis	
Affected VIN	

▶ IDI Engine equipped vehicle - 2WD

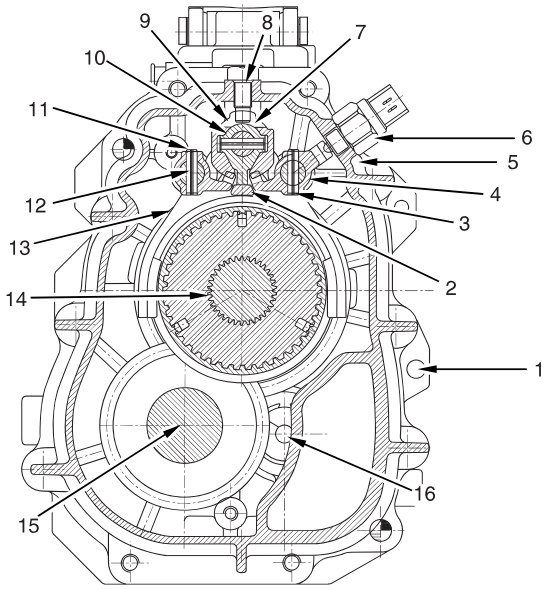


Modification basis	
Application basis	
Affected VIN	

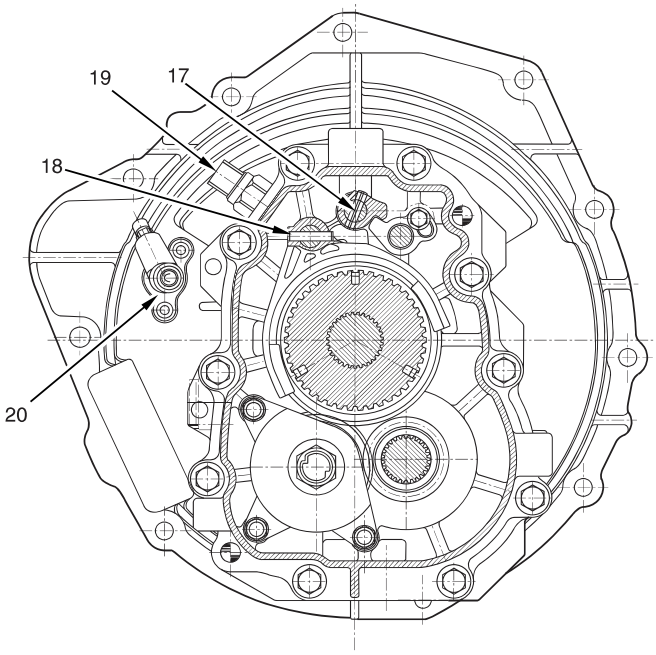
1. Transmission front housing
2. Input shaft oil seal
3. Front cover
4. Hexagon flange bolt (17 ~ 26 Nm)
5. Oil drain plug
6. Sealing
7. Pin
8. Input shaft
9. Clutch 4th gear
10. Taper roller bearing (main)
11. Taper roller bearing
12. Counter shaft
13. Taper roller bearing (counter)
14. Output shaft
15. Inner race (reverse)
16. Inner race (1st)
17. Needle bearing
18. 1st gear
19. 1st clutch gear
20. Synchro outer ring
21. Synchro - middle cone
22. Synchro inner ring
23. Synchro spring
24. Synchro key
25. Synchro hub
26. Double synchro sleeve
27. 2nd gear
28. 3rd gear
29. 3rd clutch gear
30. Synchro hub (3 & 4th)
31. Synchro ring (4/5/R)
32. Single synchro sleeve
33. Retainer ring
34. Adaptor dowel pin
35. Reverse idler shaft
36. Dowel pin
37. Bearing
38. Reverse idler gear
39. Reverse idler spacer
40. Reverse idler bracket
41. Retainer ring
42. Reverse lock nut
43. Transmission adaptor
44. Input shaft spacer
45. Counter spacer
46. Reverse needle bearing
47. Reverse gear
48. Reverse clutch gear
49. Reverse counter gear
50. Synchro hub
51. Counter 5th gear
52. 5th needle bearing
53. 5th gear
54. 5th clutch gear
55. Thrust washer
56. Spring pin
57. 5th outside retainer ring
58. 5th retainer ring
59. Counter shaft bushing
60. Counter roller bearing assembly
61. Retainer ring
62. Extension housing
63. Output shaft oil seal
64. Offset plate
65. Counter screw
66. Top cover
67. Counter oil seal
68. Shift shaft
69. Shift lever
70. Detent pin
71. Joint pin
72. Retainer ring
73. Semi remote lever assembly
74. Rear flange
75. Ball bearing
76. Lock nut

4) Front View and Rear View

Front view



Rear view



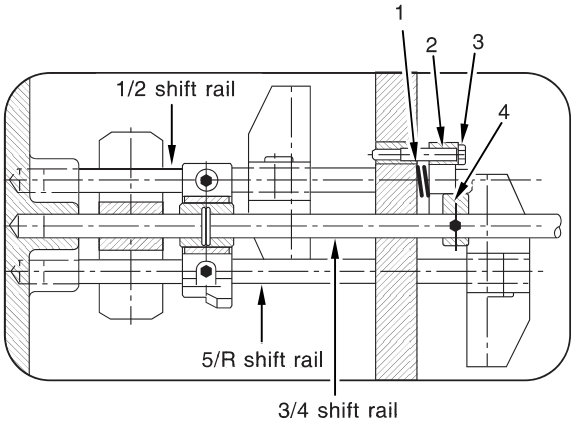
1. Oil filler plug (tightening torque: 40 ~ 50 Nm)
2. Shift rug (3 & 4th)
3. Spring pin (6 x 25)
4. Shift rug (5 & reverse)
5. Shift rail (5 & reverse)
6. Backup lamp switch (tightening torque: 30 ~ 40 Nm)
7. Shift rail (3 & 4th)
8. Interlock bolt (tightening torque: 40 ~ 50 Nm)
9. Shift lever
10. Interlock plate
11. Shift rail (1 & 2nd)
12. Shift rug (1& 2nd)
13. Shift fork (3 & 4th)
14. Input shaft
15. Counter shaft
16. Reverse idler assembly
17. Spring pin (6 x 25)
18. Spring pin (6 x 25)
19. Backup lamp switch
20. Concentric slave cylinder adaptor

(8) Apply Loctite 243
(6) Apply Loctite DRI LOC 200

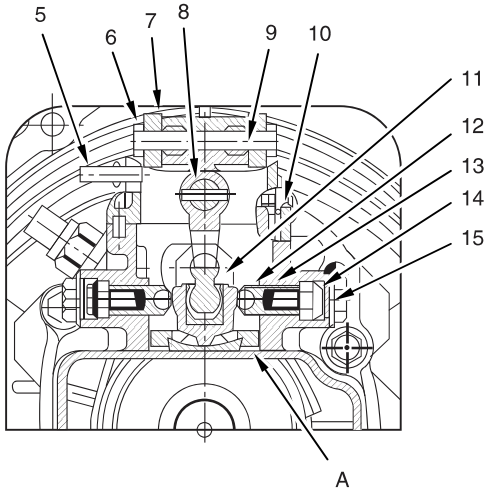
Modification basis	
Application basis	
Affected VIN	

5) Cross Sectional Diagram of Major Components

Shift rail and 5/R gear



Offset lever

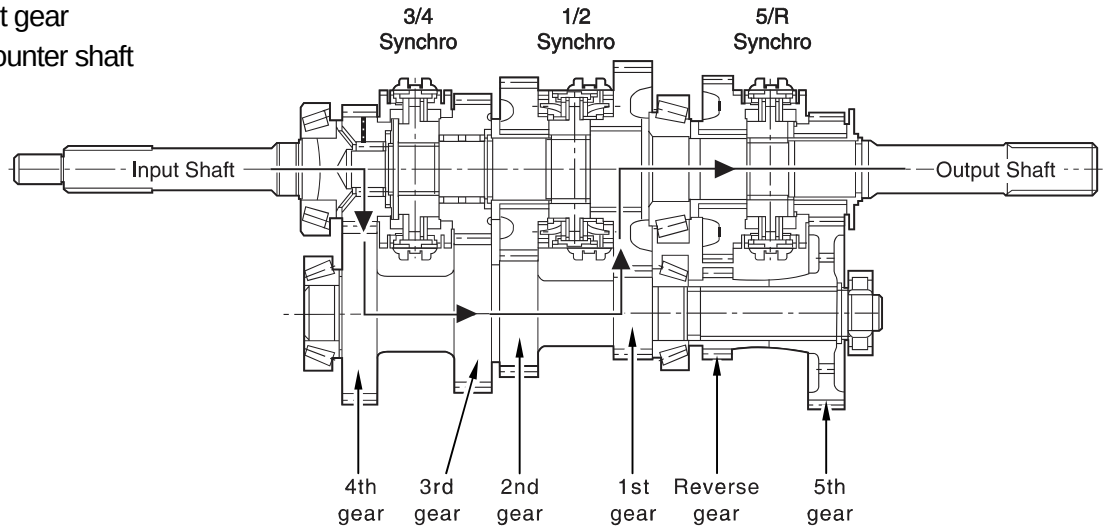


1. Reverse lock spring
2. Reverse lock plate
3. Reverse lock bolt
4. Stopper plate
5. Air vent
   (tightening torque: 30 ~ 40 Nm)
6. Lock washer
7. TGS bushing
8. Outer spring pin
9. TGS pin
10. Lock bolt
    (tightening torque: 17 ~ 26 Nm)
11. Offset lever
12. Offset lever bushing
13. Rolling plunger
14. Return spring
15. Spring plug
    (tightening torque: 30 ~ 35 Nm)

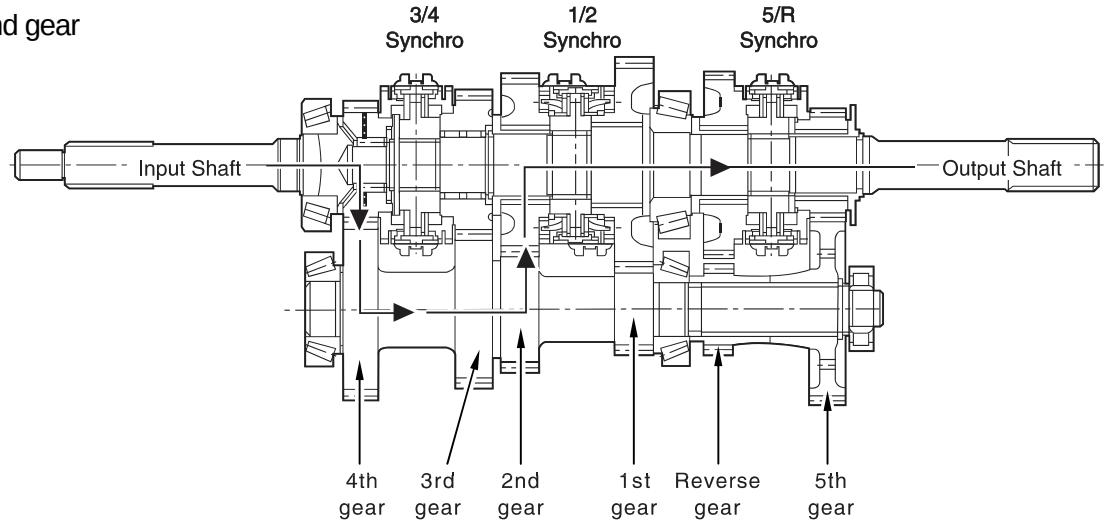
A. Apply Long-term grease MoS2 when installing the offset lever.

6) Power Flows

1st gear
Counter shaft



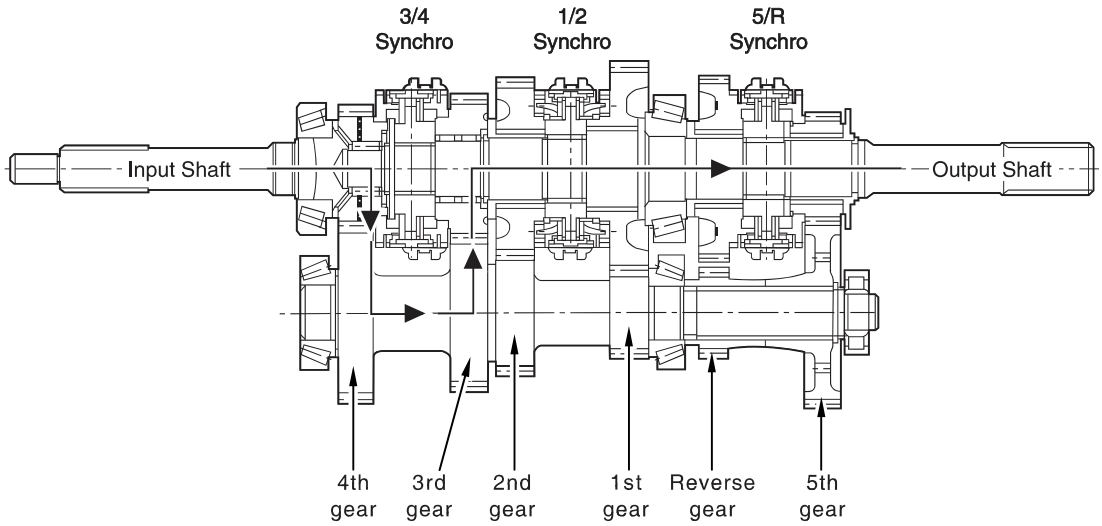
2nd gear



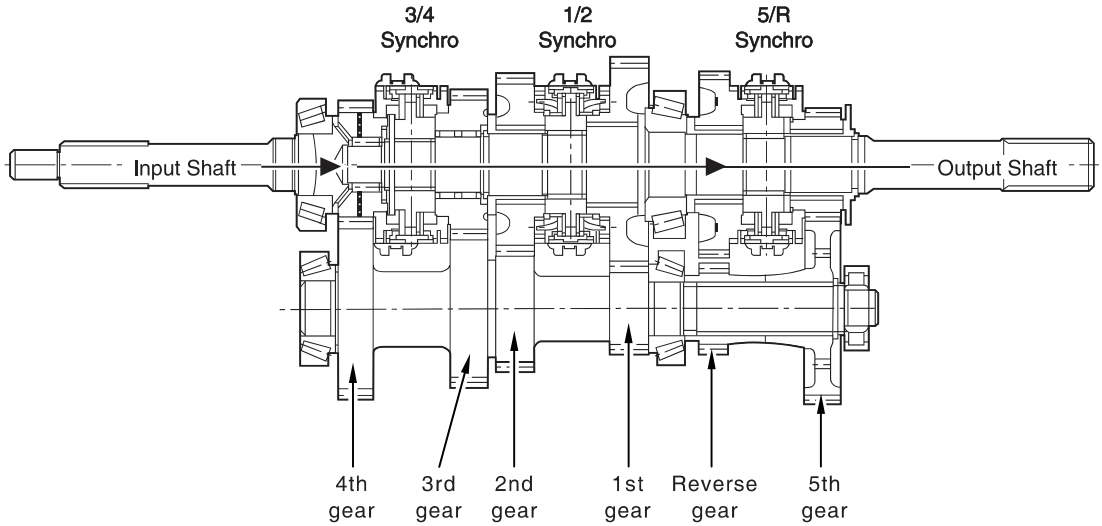
Modification basis	
Application basis	
Affected VIN	

7) Power Flows (Cont'd)

3rd gear

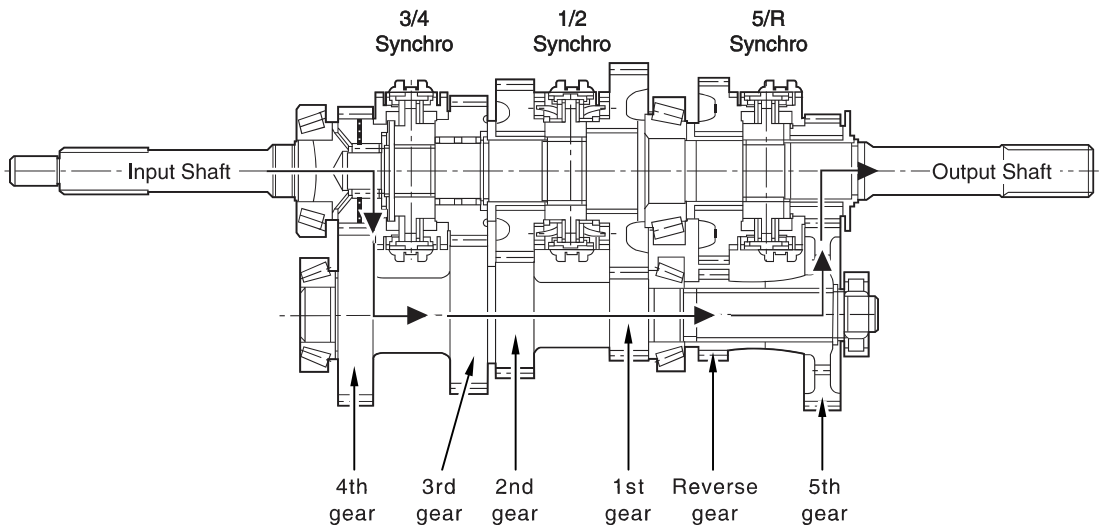


4th gear

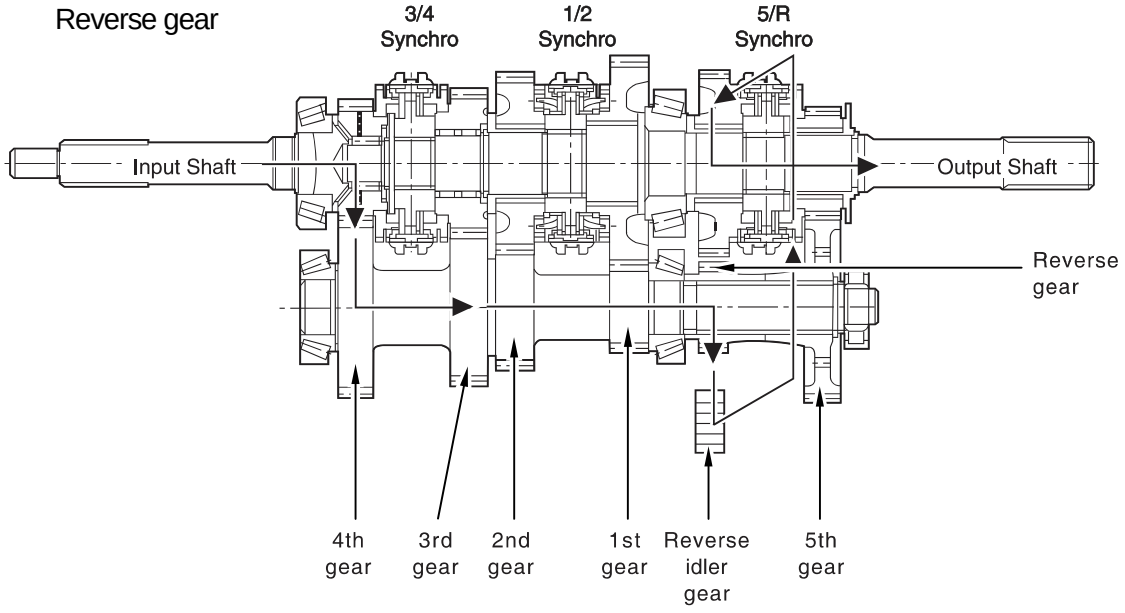


8) Power Flows (Cont'd)

5th gear



Reverse gear

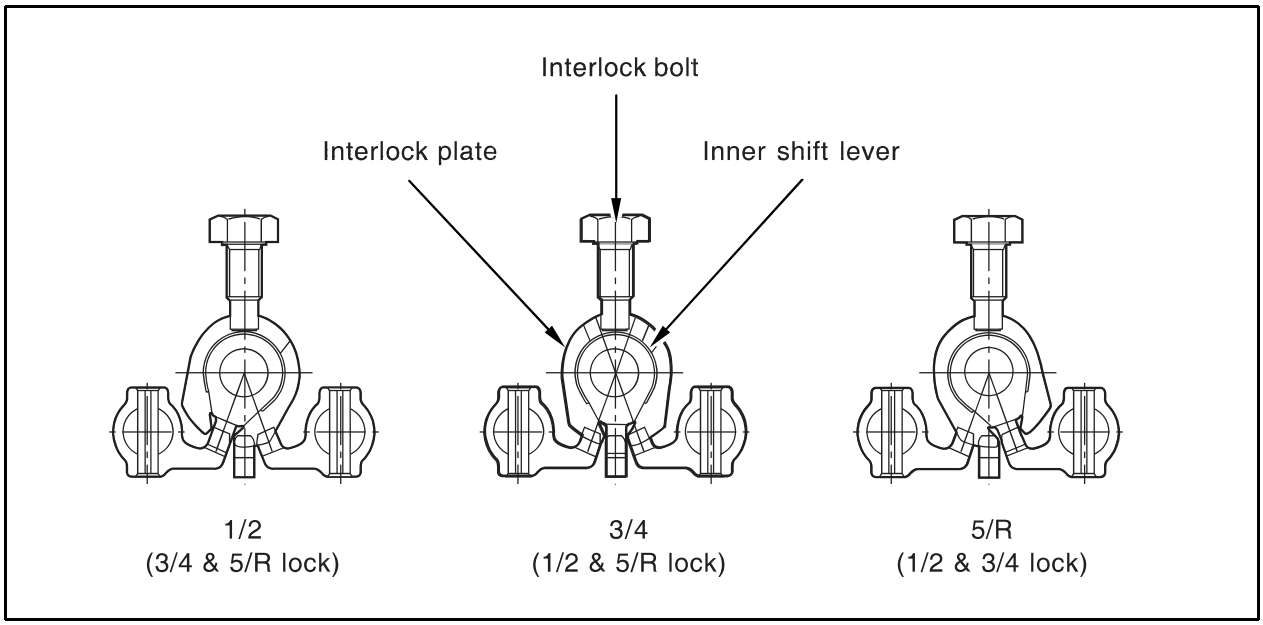


Modification basis	
Application basis	
Affected VIN	

3. SHIFTING MECHANISM

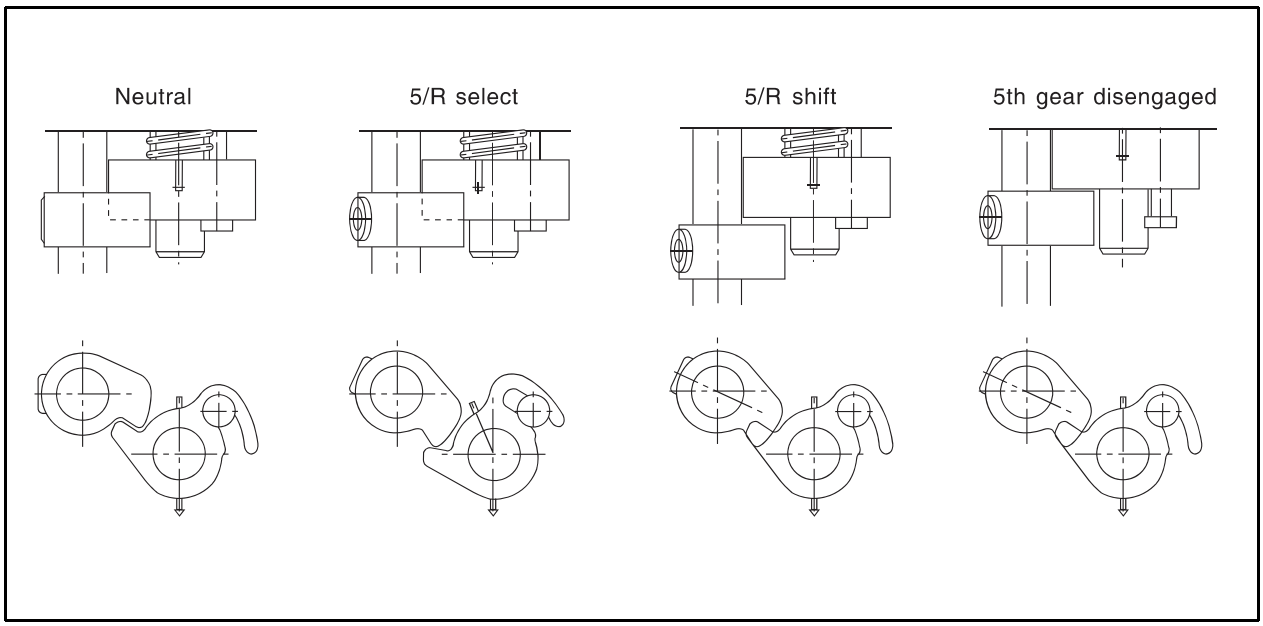
1) Interlock System

Interlock system prevents the gears from meshing over two sets.



2) Reverse Interlock System

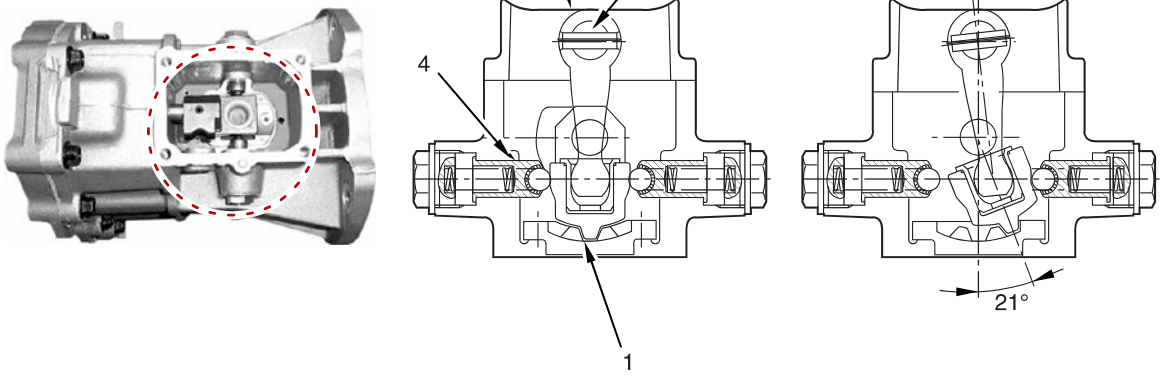
Reverse interlock system prevents the gear from shifting to reverse driving position while driving forward.



Modification basis	
Application basis	
Affected VIN	

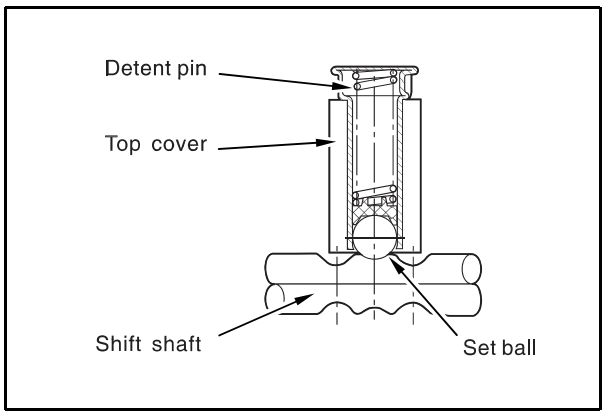
3) Offset Lever and Rolling Plunger

To make the next shift easier, the offset lever applies a reaction force to shift lever toward center position of gear selection gate after a gear has been selected.

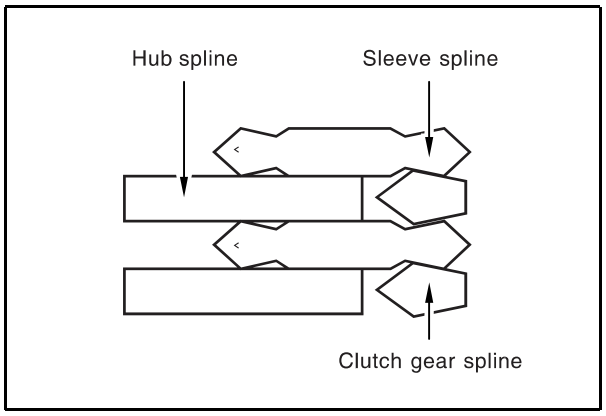


1. Offset lever	3. Shift shaft
2. Shift lever	4. Rolling plunger (rolling plunger return spring and ball)

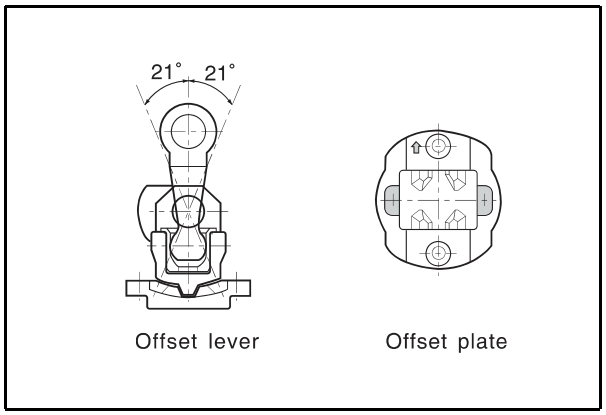
Modification basis	
Application basis	
Affected VIN	



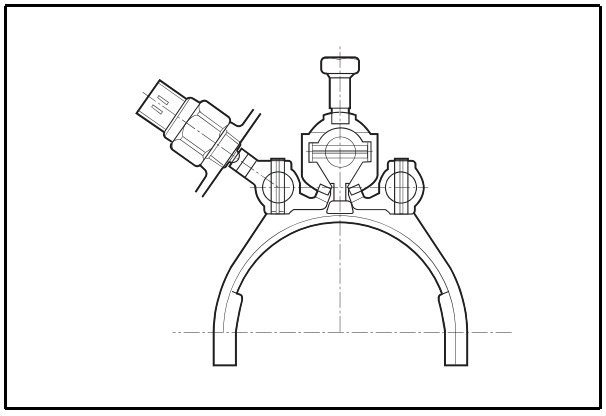
1. Shift check device
   It determines the shift fork position (N or each gear) and gives a detent movement to notice a shift lever seating when operating the shift lever.
   Also, it prevent the selected gear from getting out of its meshed position.



2. Gear pump out locking device
   It prevents the shift lever is beyond the correct shift position while shifting.



3. Guiding a control direction and preventing an over stroke



4) Backup Lamp Switch

It is normal open type switch. Its circuit is formed when the reverse gear is selected.

CAUTION
- Sealant: Loctite DRI LOC 200
- Tightening torque: 3 kg.m ~ 4 kg.m

Modification basis	
Application basis	
Affected VIN	

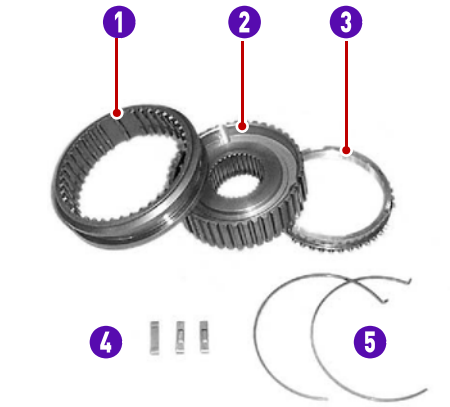
5) Synchronizer

▶ Composition

It consists of synchronizer hub, sleeve, ring, key and spring (1/2, 5/R, and 3/4 synchronizer are different from each other).

- 3/4 and 5/R shift: Single cone type
- 1/2 shift: Double cone type - Improving the capacity to bigger engine torque of 1/2 shift (added synchronizer inner cone and middle cone)

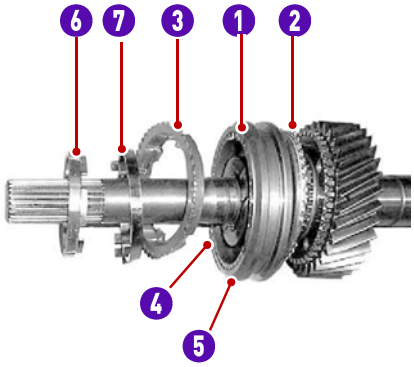
Single cone type





1/2 shift 3/4 shift 5/R shift

Double cone type





1/2 shift 3/4 shift 5/R shift

1.Synchronizer sleeve
2. Synchronizer hub
3. Synchronizer ring
4. Synchronizer key
5. Synchronizer key locking ring
6. Synchronizer inner cone
7. Synchronizer middle cone

CAUTION

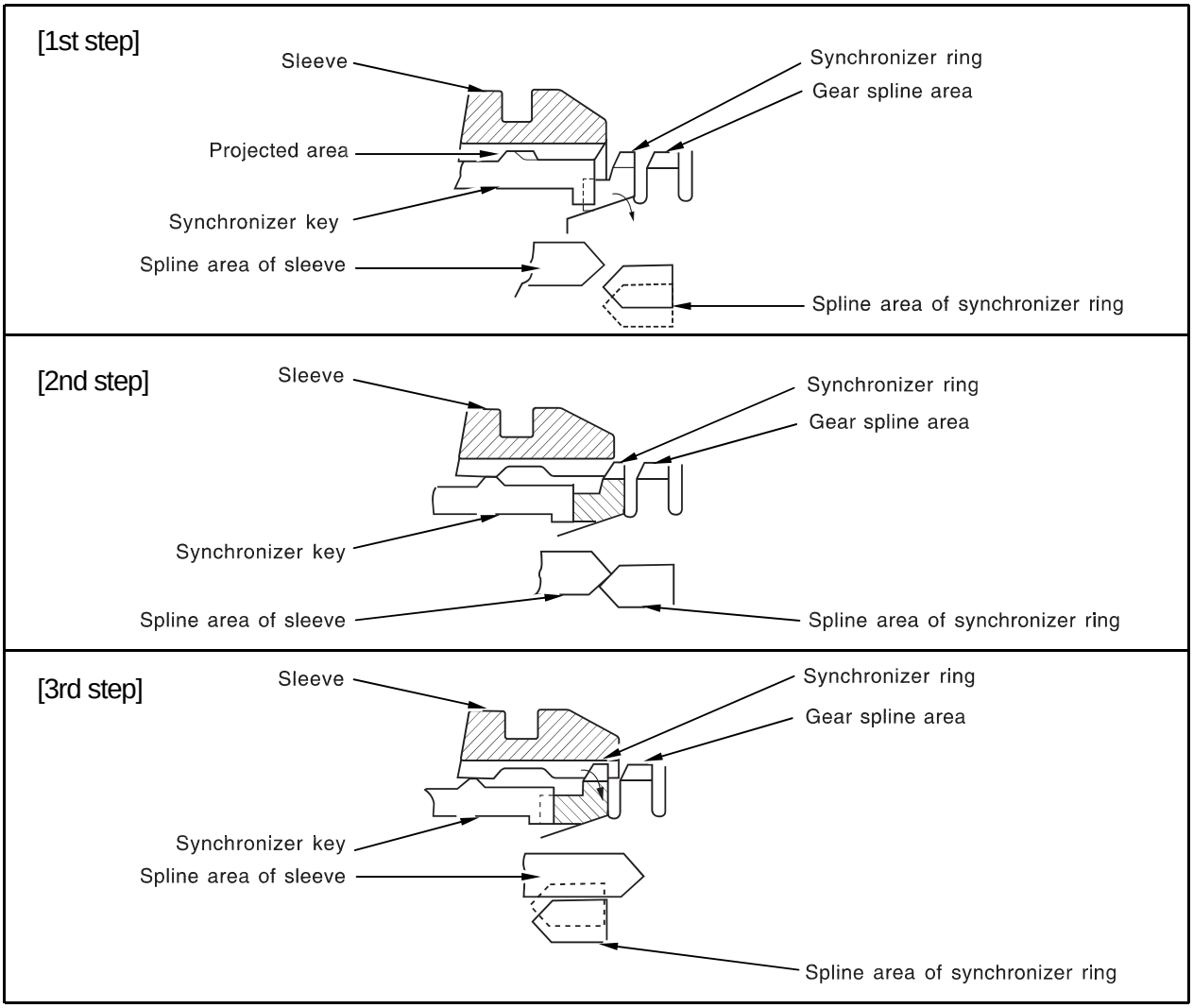
Be careful not to mix up the 1/2 shift synchronizer sleeve with 3/4 or 5/R shift synchronizer sleeve.

The 3/4 synchronizer hub also different from 1/2 and 5/R synchronizer hub (different oil gallery).

Modification basis	
Application basis	
Affected VIN	

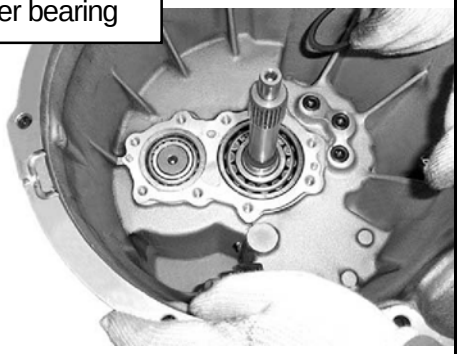
▶ Synchronizer element

A cone or sleeve that slides to and fro on the transmission main shaft and makes the gears rotate at the same speed to prevent clash when the gears are about to mesh. Whenever a vehicle is rolling, the transmission main shaft is turning and the clutch gear is spinning. Even though the clutch is disengaged, the clutch gear continues to spin until friction slows it down or stops it. Thus when the driver shifts into another gear he is trying to mesh gears that may be moving at different speeds. By using synchronizers, the possibility of broken or damaged teeth is reduced and shifting effort is lowered.



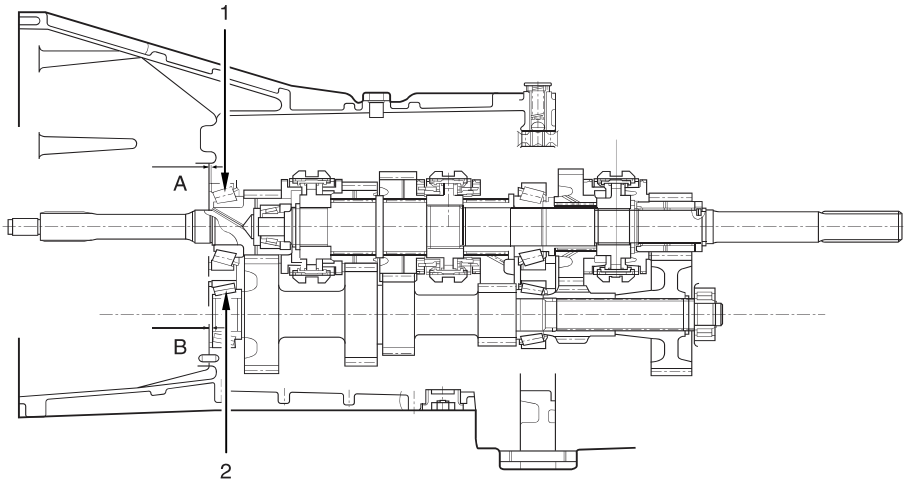
6) Bearing

The needle bearings are introduced to each gear and the taper roller bearings are used for input and counter shaft in transmission housing.

Taper roller bearing	Needle bearing
	

1. Taper roller bearing (input shaft, counter shaft and output shaft)
2. Needle bearings for 1/2 and 3/4 shift
3. Needle bearing for reverse gear (with cut out area)
4. Needle bearing for 5th gear

7) End Play of Taper Roller Bearing



1. Taper roller bearing for input shaft
2. Taper roller bearing for counter shaft

A. End play A: 0.85 ~ 2.28 mm
B. End play B: 1.17 ~ 1.97 mm

CAUTION

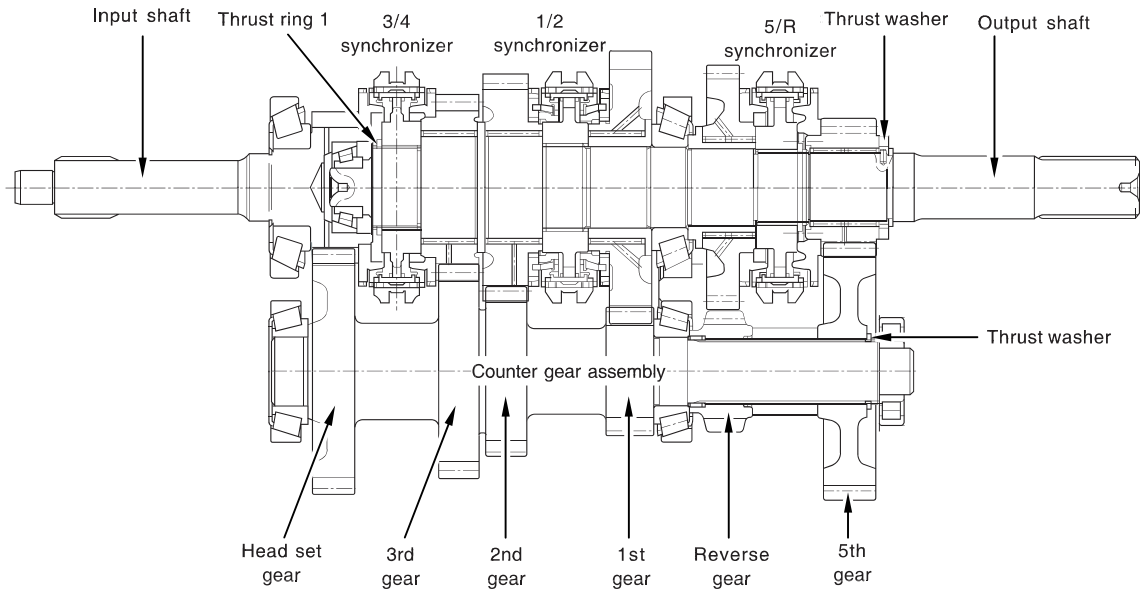
Use the following spacers to adjust the end play (A or B) between input shaft and counter shaft. (Specified range of end play: 0.05 ~ 0.1 mm)

- For input shaft: 0.75 ~ 1.45 mm (15 spacers with increment of 50 μm)
- For output shaft: 0.4 ~ 1.45 mm (10 spacers with increment of 50 μm)

Modification basis	
Application basis	
Affected VIN	

8) Thrust Ring (Washer)

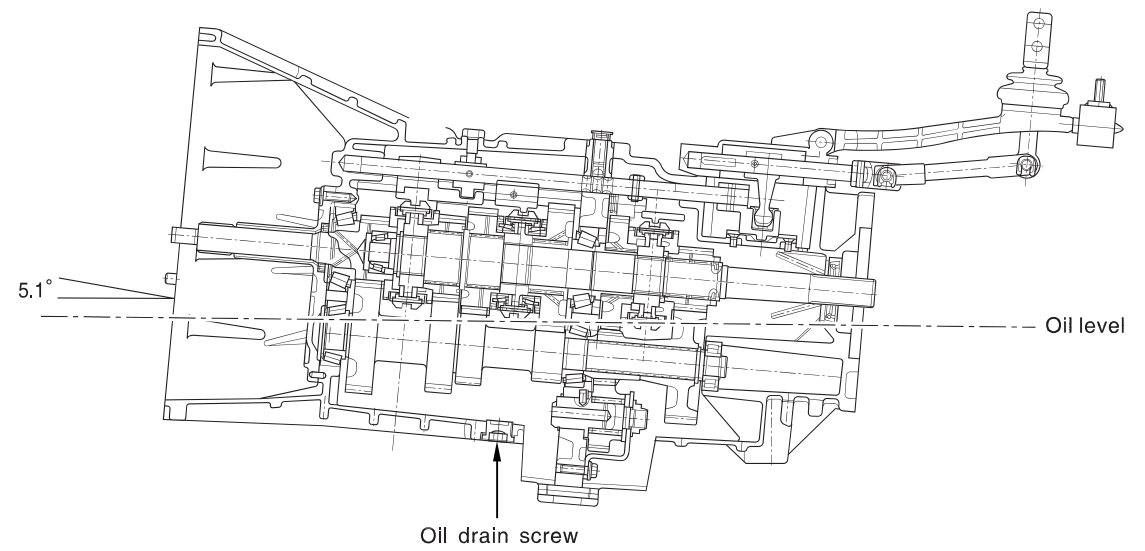
When the driving force from engine is transmitted to the output shaft of transmission, each shaft and gear assembly receives the axial force and this force acts as a resistance to rotating gears.



9) Lubrication

Transmission oil: SAE 75W/90

Initial installation for taper roller bearing and needle roller bearing, lubrication for shift rail: MoS2 Grease

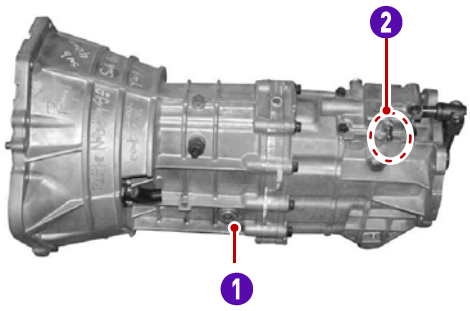
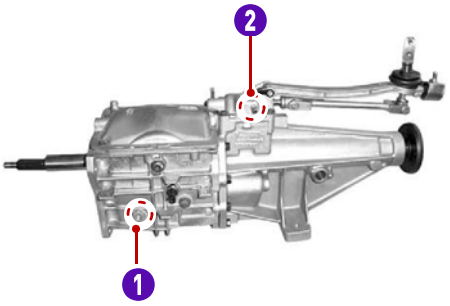


CAUTION

Sealant on oil drain screw during installation: Loctite DRI LOC 200

Tightening torque: 40 ~ 50 Nm

Modification basis	
Application basis	
Affected VIN	

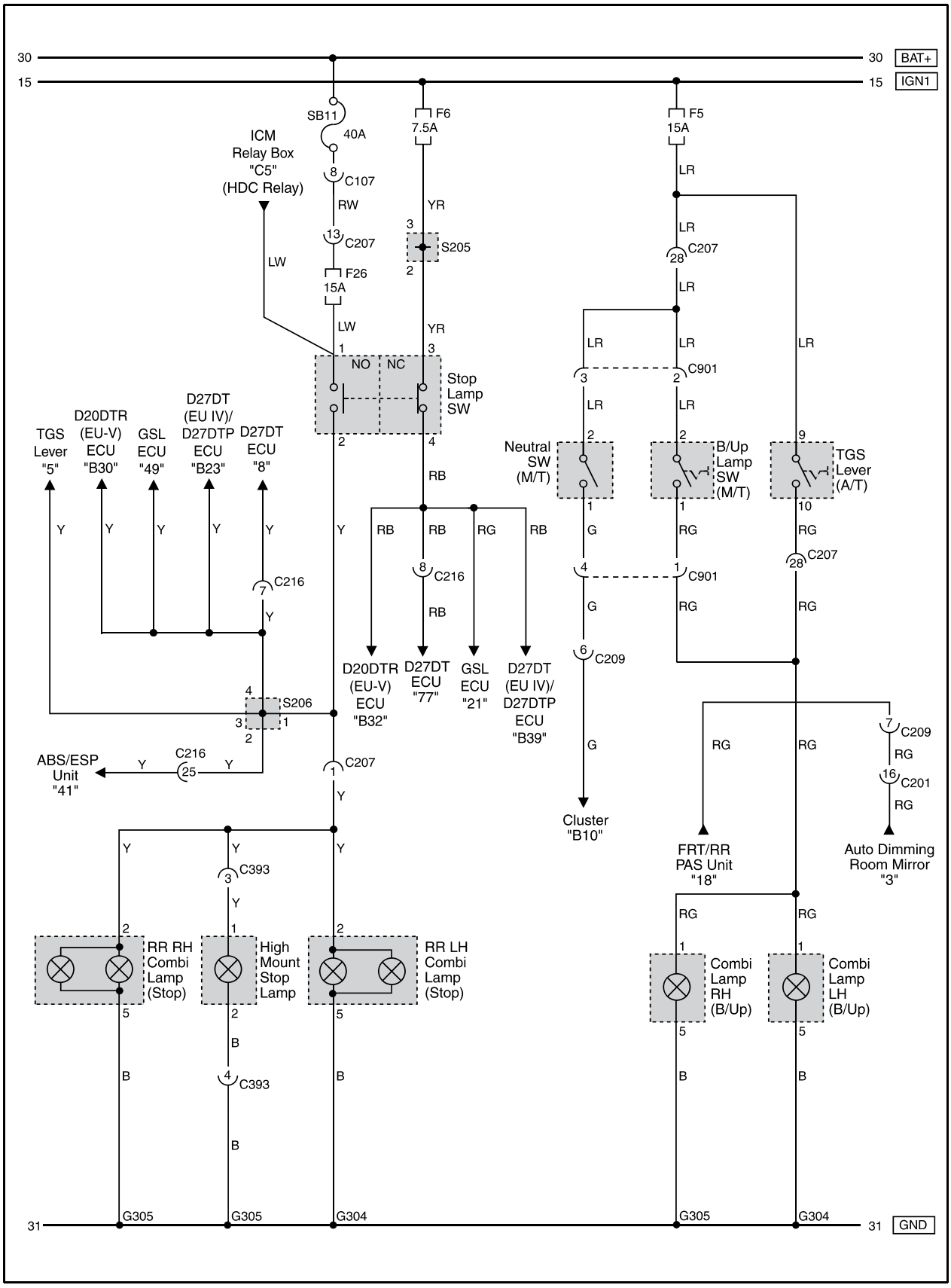
4WD	2WD
	
1. Oil filler plug	2. Air vent

CAUTION

Sealant on oil drain screw during installation: Loctite DRI LOC 200

Tightening torque: 40 ~ 50 Nm

4. CIRCUIT DIAGRAM (BACKUP LAMP)



Modification basis	
Application basis	
Affected VIN	

AXLE

4121-01

GENERAL INFORMATION

1. SPECIFICATIONS

▶Front Axle

Description		Specification
Drive shaft type		CV joint
Axle housing type		Build up
Differential	Type	Conventional type
	gear type	Hypoid Gear
Final gear reduction ratio	DI engine + M/T	3.73
	DI engine + A/T	3.54
	Gasoline engine + A/T	4.27
Oil	Capacity	1.4L
	Specification	SAE 80W / 90 or API GL-5

▶Rear Axle

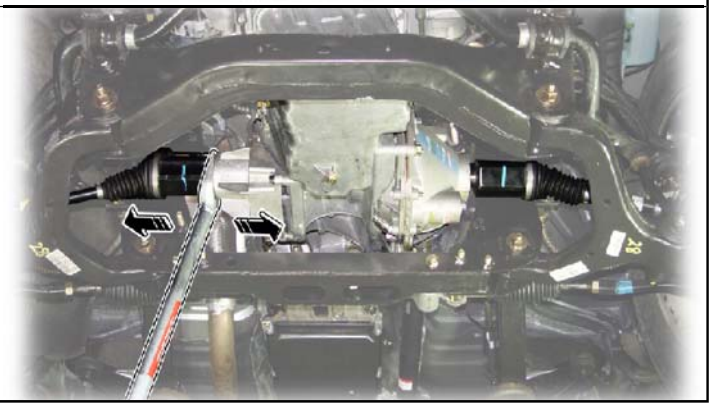
Description		Specification
Axle shaft type		Semi-floating
Axle housing type		Build up
Differential	Type	Conventional type
	Gear type	Hypoid Gear
Final gear reduction ratio	DI engine + M/T	3.73
	DI engine + A/T	3.31
	Gasoline engine + A/T	4.27
Oil	Capacity	2.0L
	Specification	SAE 80W/90 or API GL-5

IOP/IRDA AXLE

4122-01

GENERAL

1. SPECIAL TOOLS AND EQUIPMENT

Name and Part Number	Application
Y99410030C IOP axle oil seal installation tool 	
Y99410020C IOP axle oil measuring and filling tool  Oil measuring container  IOP axle oil filling tool	
Y99410010C Drive shaft removal tool 	

ALL WHEEL DRIVE

3260-01

GENERAL

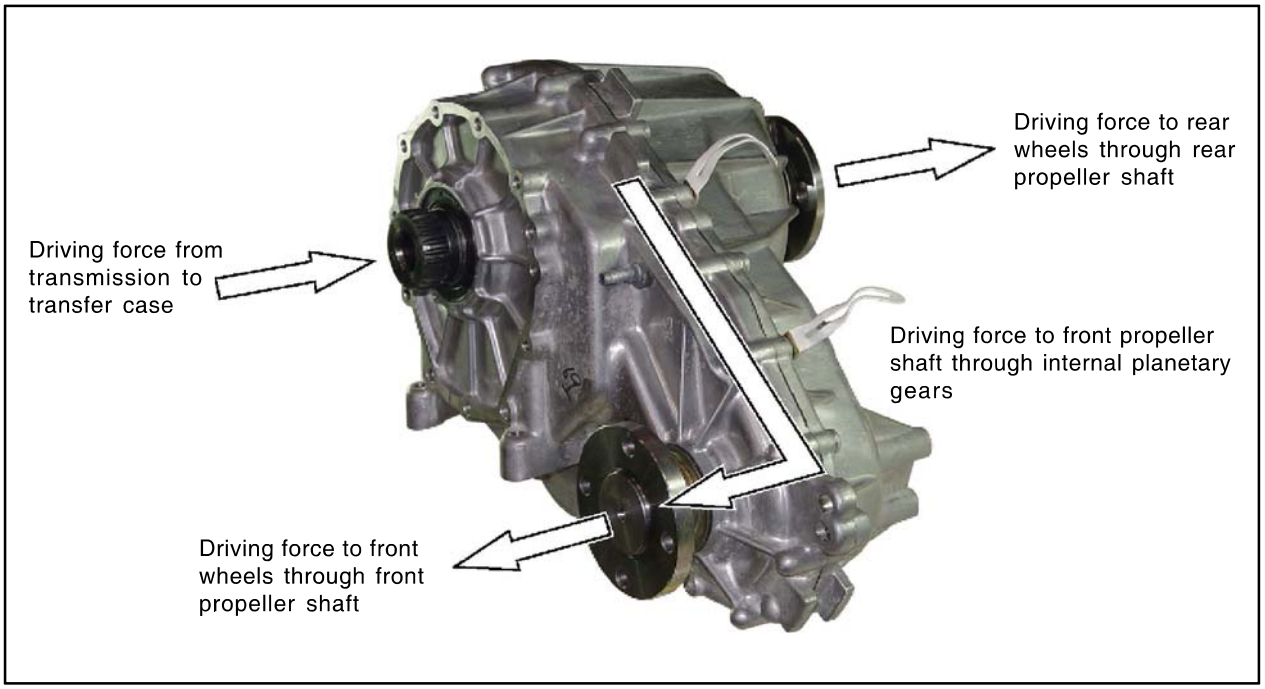
1. SPECIFICATIONS

Description	AWD	
Total length	271 mm	
Mating surface of front flange	11.9 mm	
Weight	27.1 Kg (with oil)	26.5 Kg (without oil)
Oil capacity and Service Interval	1.1 L (Inspect at every 10,000 km, Change at every 60,000 km)	
Oil specification	ATF DEXRON III	
Distribution ratio of driving force	40 (Front) : 60 (Rear)	
Bolt	11EA, M8 x 1.25	

OVERVIEW AND OPERATION PROCESS

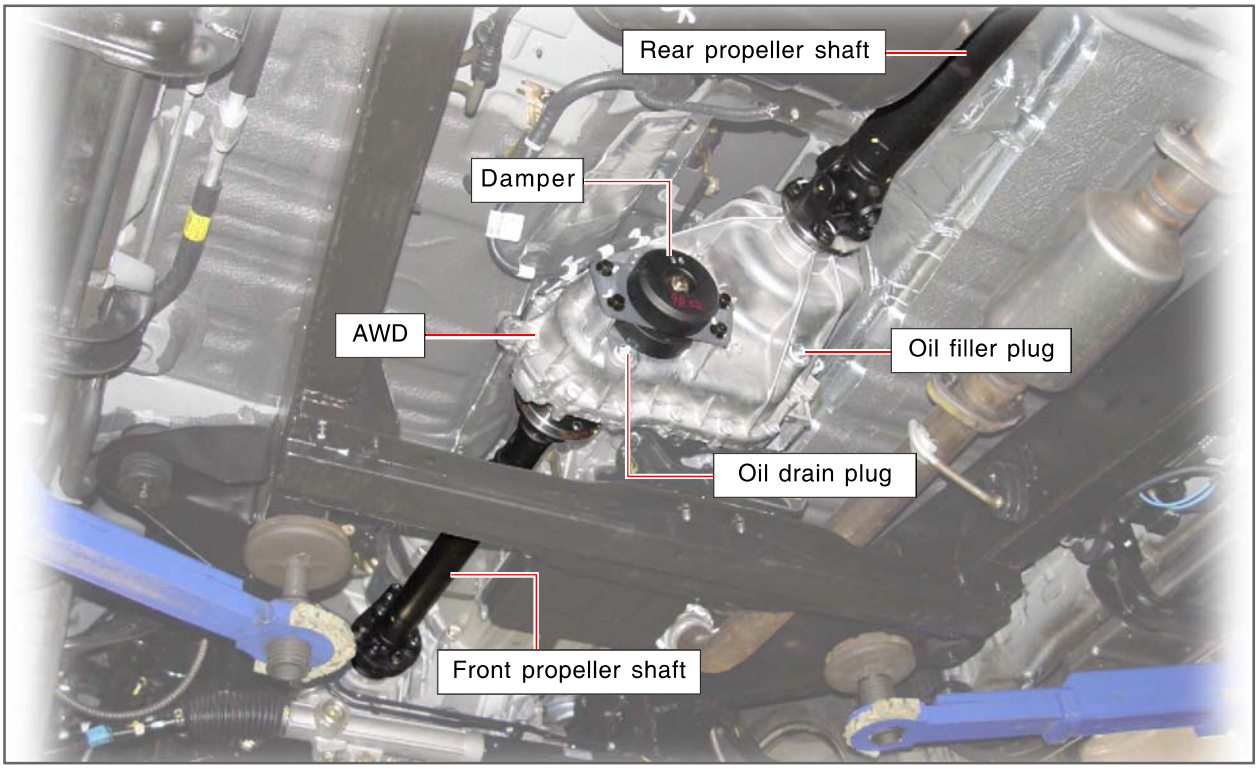
1. OVERVIEW

The AWD transfer case is installed to the full time 4WD vehicle. Unlike the TOD (Torque On Demand) transfer case, it delivers the driving force to the front wheels through the internal planetary gears without a control unit to operate AWD function. It also doesn't have the TC (Transfer Case) shift motor and 4WD transfer switch. Since it doesn't have a control unit such as TCCU (Transfer Case Control Unit), it delivers the driving force to the front and rear propeller shafts according to the gear ratio based on the gear combinations. The distribution ratio of driving force is 40:60 (front wheels:rear wheels).

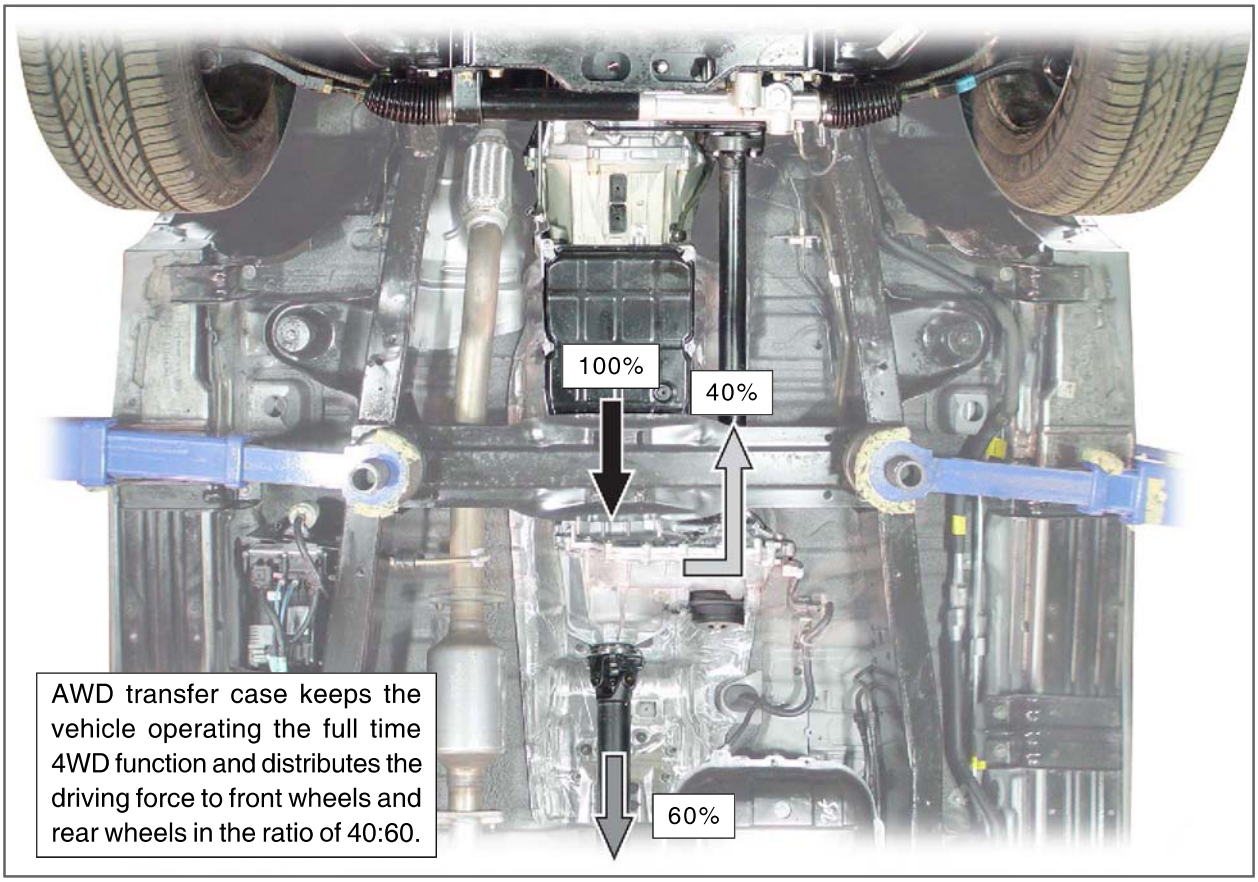


Modification basis	
Application basis	
Affected VIN	

2. LOCATION



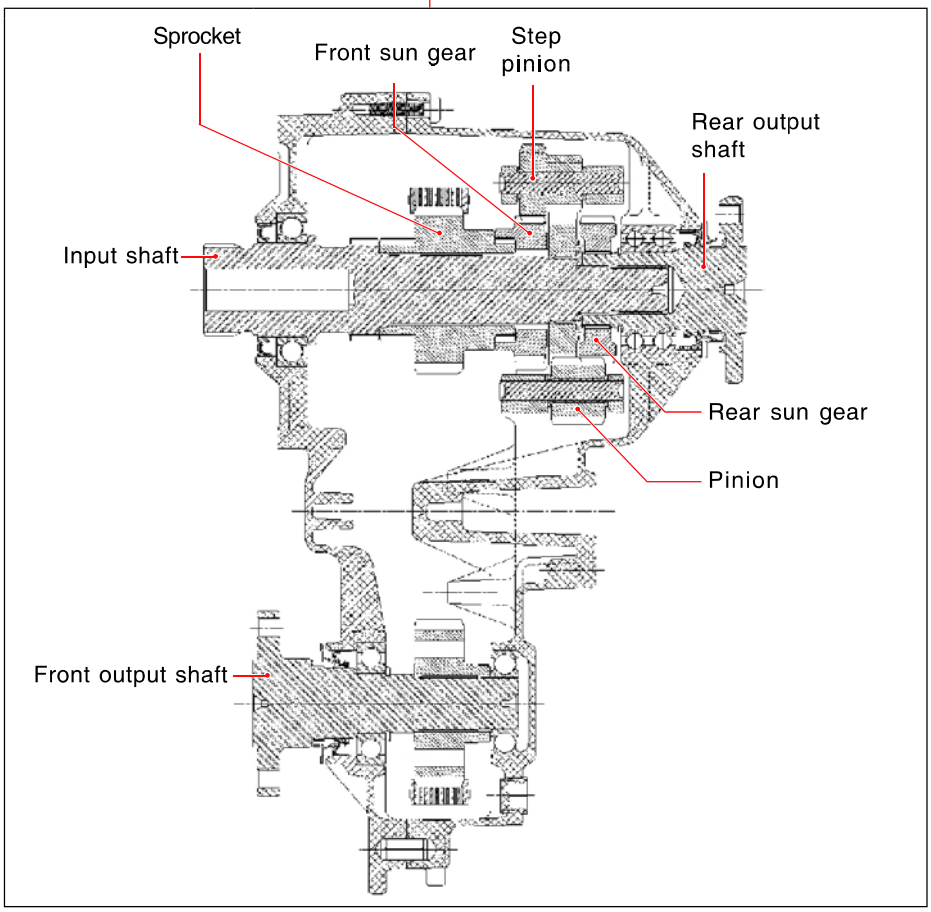
▶ **Distribution of Driving Force in AWD**



3. STRUCTURE

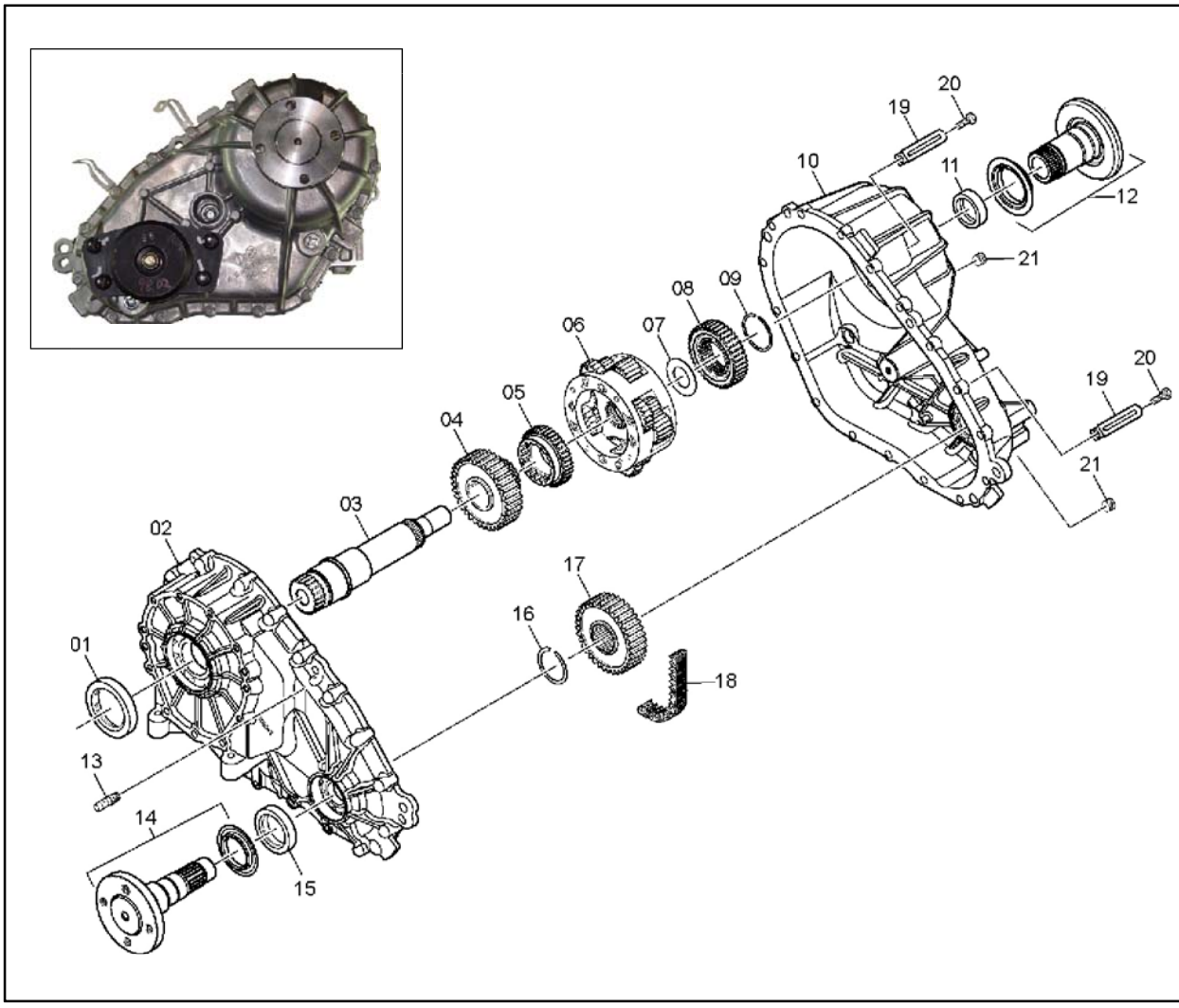
1) Sectional View





Modification basis	
Application basis	
Affected VIN	

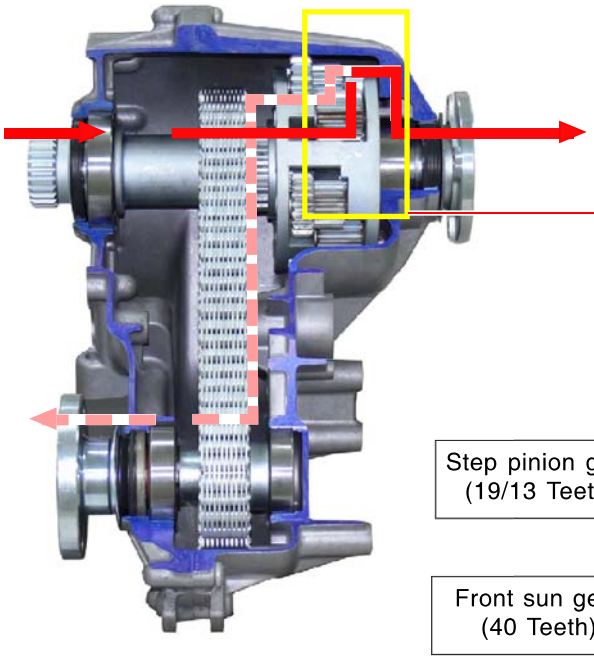
2) Exploded View



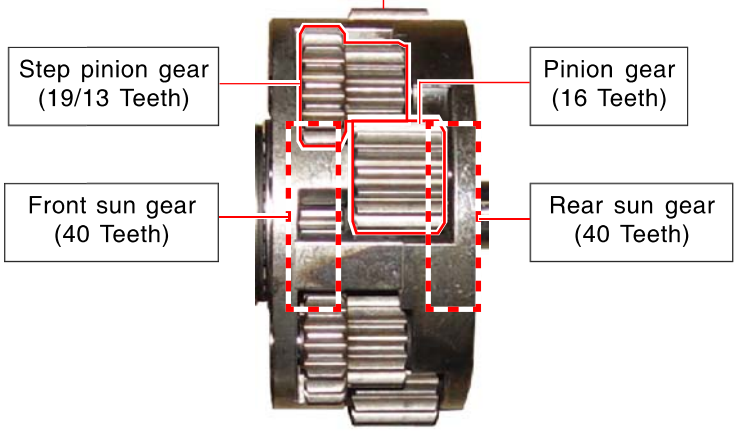
1. Oil seal
2. Case assembly
3. Input shaft
4. Sprocket
5. Front sun gear
6. Differential carrier assembly
7. Thrust washer
8. Rear sun gear
9. Snap ring
10. Cover assembly
11. Oil seal
12. Rear output shaft assembly
13. Air breather
14. Front output shaft assembly
15. Oil seal
16. Retaining ring
17. Driven sprocket
18. Chain
19. Clip
20. Bolt
21. Plug

Modification basis	
Application basis	
Affected VIN	

4. POWER FLOW



Rear output shaft
Input shaft →Carrier →Pinion (16T) →
Rear sun gear (40T) →Rear output shaft



Front output shaft
Input shaft →Carrier →Step pinion (19T/13T) →Front sun gear (40T) → Sprocket →Chain →Front output shaft

▶ Distribution of Front Output Torque

$$\frac{\dfrac{\text{Front sun gear (40T)}}{\text{Step pinion (19T)}}}{\left(\dfrac{\text{Front sun gear (40T)}}{\text{Step pinion (19T)}}\right) + \left(\dfrac{\text{Rear sun gear (40T)}}{\text{Pinion (16T)}} \times \dfrac{\text{Pinion (16T)}}{\text{Step pinion (13T)}}\right)} = 0.40625$$

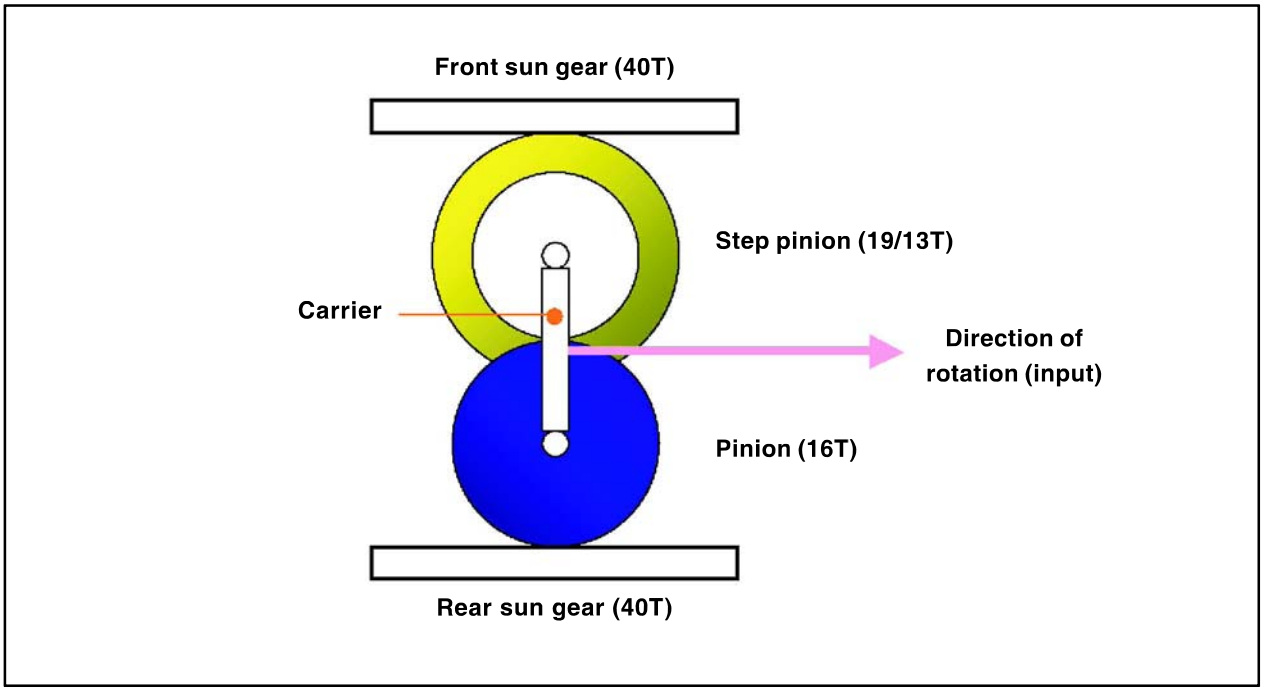
▶ Distribution of Rear Output Torque

$$\frac{\left(\dfrac{\text{Rear sun gear (40T)}}{\text{Pinion (16T)}}\right) \times \left(\dfrac{\text{Pinion (16T)}}{\text{Step pinion (13T)}}\right)}{\left(\dfrac{\text{Front sun gear (40T)}}{\text{Step pinion (19T)}}\right) + \left(\dfrac{\text{Rear sun gear (40T)}}{\text{Pinion (16T)}} \times \dfrac{\text{Pinion (16T)}}{\text{Step pinion (13T)}}\right)} = 0.59375$$

Modification basis	
Application basis	
Affected VIN	

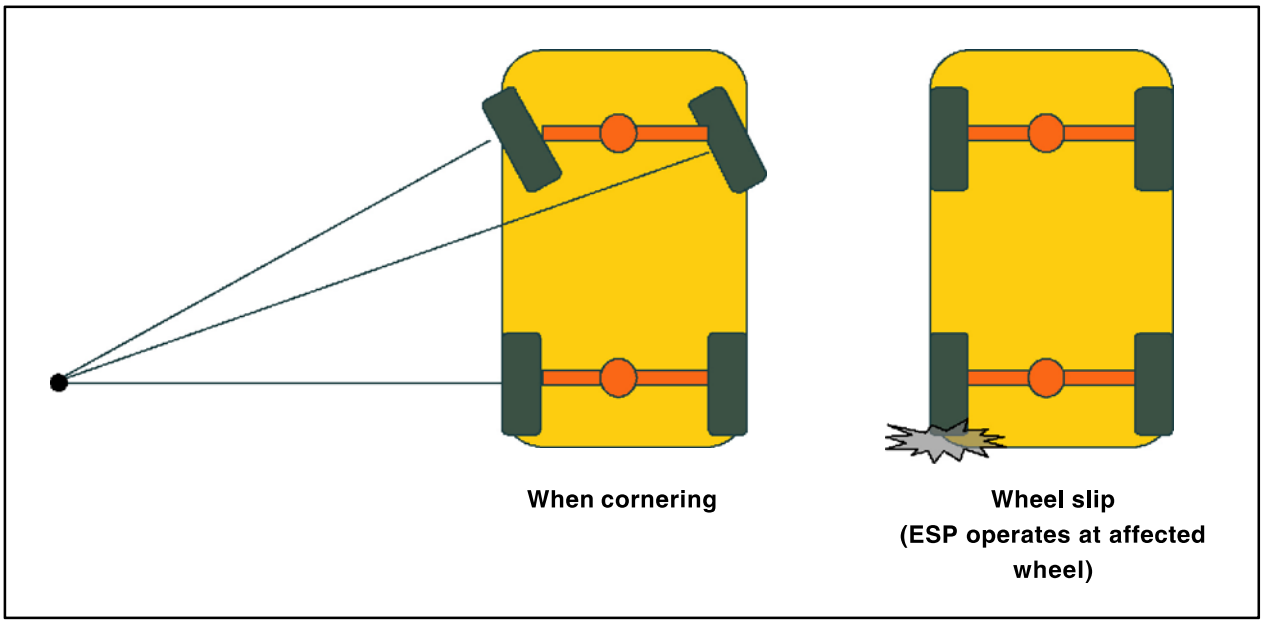
5. OPERATION OF DIFFERENTIAL

1) Systematic Diagram



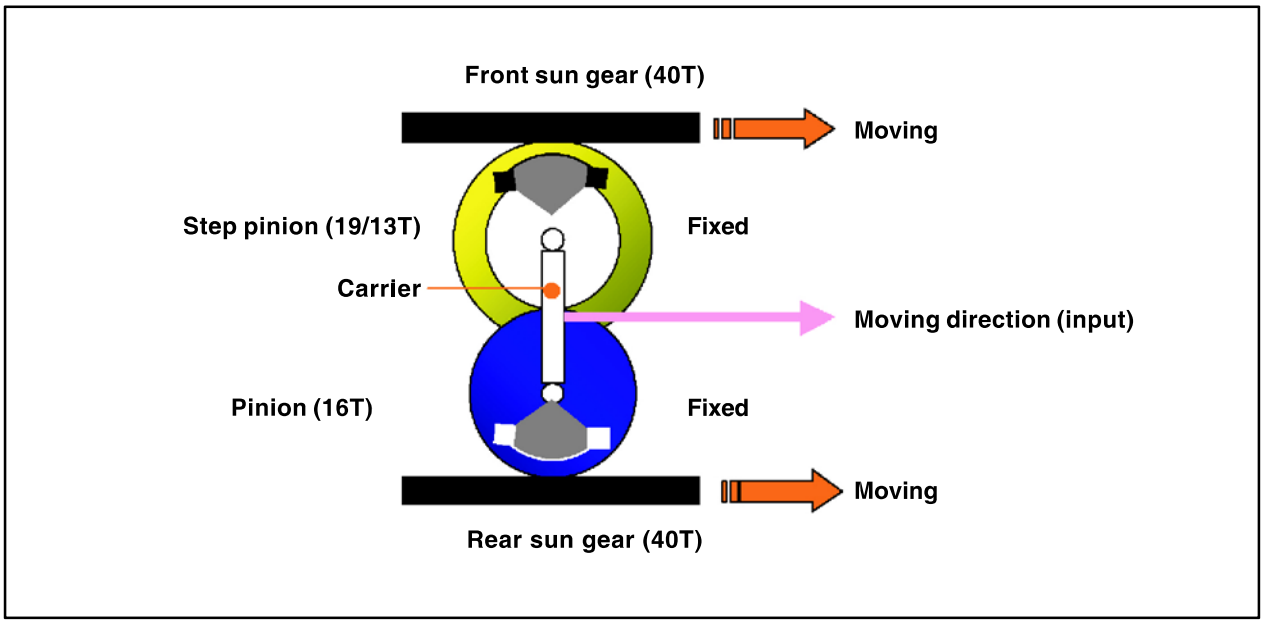
2) Revolution Control

When there is a revolution difference due to the gap of turning radius while cornering, the tight corner braking symptom occurs in part time transfer case. However, for the AWD, this gap of turning radius is compensated by the differential so that the tight corner braking symptom will not occur. The ESP also operates the wheel slip under control in order to keep the vehicle stable under severe conditions such as icy road.



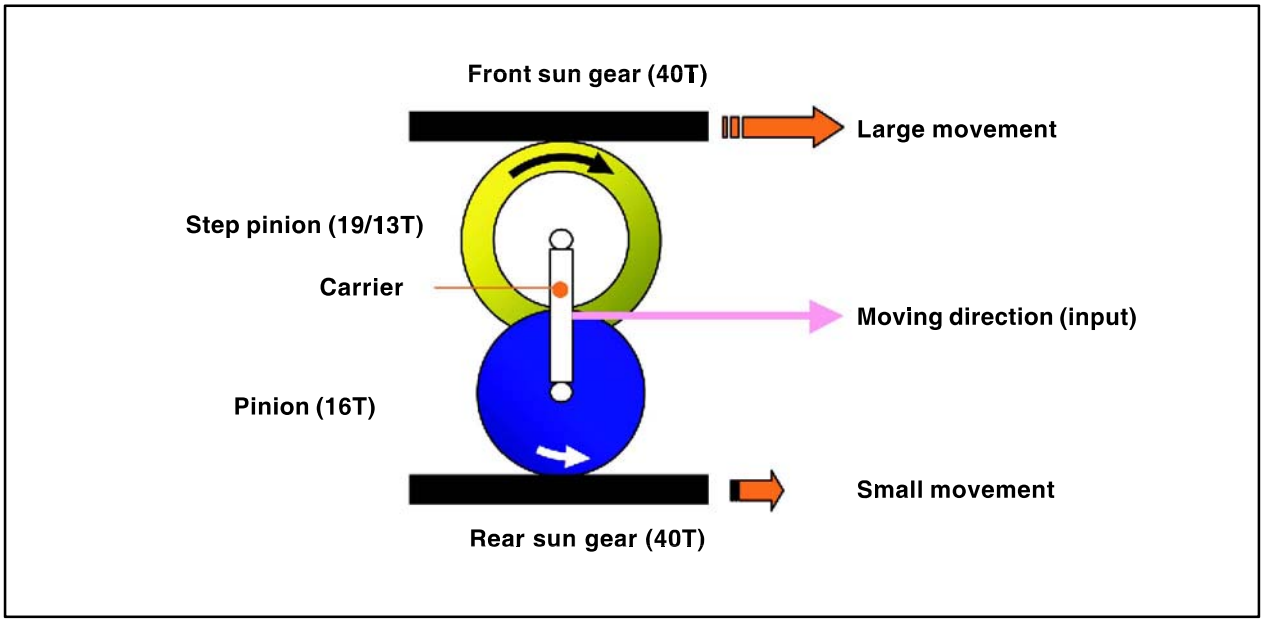
Modification basis	
Application basis	
Affected VIN	

▶ When Revolution Difference Does not Occur



If there is no revolution difference in front and rear shafts, the step pinion (19T/13T) and the pinion (16T) are fixed (integrated to the carrier) even when the carrier rotates. It makes the front sun gear and the rear sun gear move toward the moving direction with the torque ratio of 40:60.

▶ When Revolution Difference Occurs



The front wheels should rotate faster than the rear wheels while cornering (including wheel slip) since the front wheels' turning radius is larger than the rear wheels'. At this moment, the step pinion (19T/13T) should rotate faster than the pinion (13T) in relation to the carrier's movement. This function is similar to the regular differential function, which also compensates the revolution difference while maintaining the torque ratio in 40:60 (front:rear).

Modification basis	
Application basis	
Affected VIN	

TORQUE ON DEMAND(TOD)

3240-01

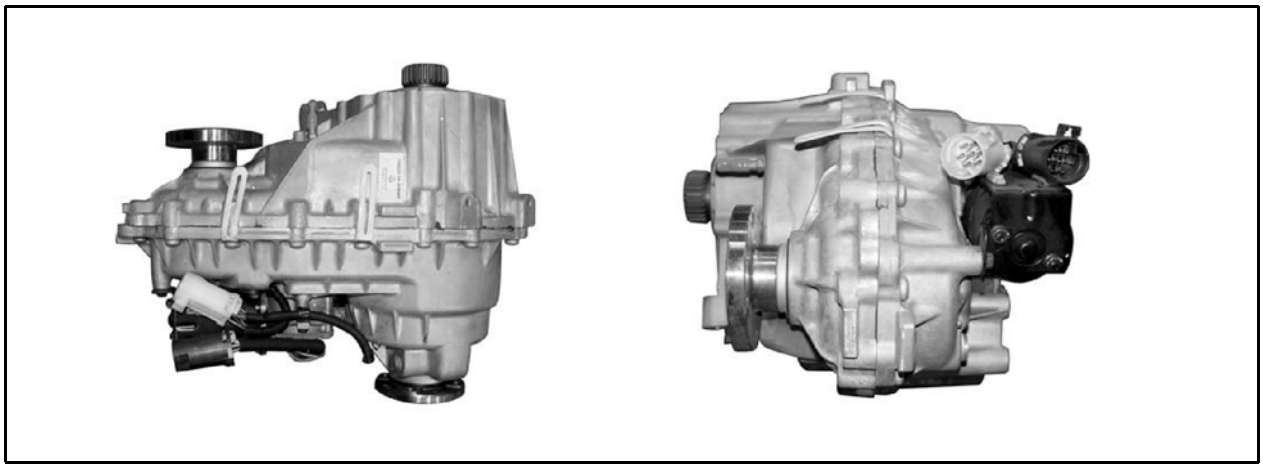
GENERAL

1. SPECIFICATIONS

Description			Specification
TOD	Model		TOD transfer case
	Overall length		343.0 mm
	Weight (including oil)		37.9 kg
	Shifting mode		4H and 4L
	Gear ratio	High	1:1
		Low	2.48:1
	Oil specification	Specification	Ssangyong genuine oil (ATF S-3, S-4 or Dexron II/III)
		Capacity	≒1.4ℓ
		Change interval	Check at every 15,000 km, replace at every 60,000 km
TOD control unit	Maximum torque (front)		Approx. 76 kg•m
	Voltage	Normal operating range	9 ~ 16 V
		CAN communication	6 ~ 16 V
	Current (below maximum operating voltage)	IG switch OFF	2 mA
		IG switch ON	1 A
	Maximum operating current	Motor OFF	7 A
		Motor ON	20 A

OVERVIEW AND OPERATION PROCESS

1. OVERVIEW



TOD system means the full time 4WD system and the registered trade mark of Borg Warner.
TOD is an abbreviation of Torque On Demand.

TOD (Torque On Demand) system, which is superior than existing Full Time 4WD, checks the road surface and vehicle conditions via various sensors and, subsequently, according to the situations and conditions, distributes the most optimal driving force to front wheels and rear wheels by activating the electro-magnetic clutch located inside of TOD Transfer Case.

TOD receives the speed signals from speed sensors installed in front axle and rear axle, the TPS signals from engine, and the operating signals from ABS control unit via CAN. Based on these data, TOD control unit controls the electro-magnetic clutch to distribute the 3:97 ~ 44:56 of driving force to front wheels and rear wheels.

The conventional system uses "FR driving" (theoretically, the 100% of driving force is transferred to rear wheels) on normal paved road. When the system detects a slip in the rear wheels, a proper percentage of driving force is transferred to front wheels.

TOD control unit receives the wheel speed signals from the speed sensors in propeller shaft of transfer case and engine output information from the engine control unit. TOD control unit changes the pressure force of the electromagnetic clutch based on the analyzed data.

Modification basis	
Application basis	
Affected VIN	

1) Distribution of Driving Force According to Road Surface

1. On normal road surface In vehicle with existing part time transfer case, when a driver turns the steering wheel to park in the 4WD mode, the vehicle may halt sensation of tight corner braking phenomena. However, in vehicle with TOD system, this phenomena does not occur and the driving force is properly and automatically distributed.
2. On paved road with high speed Driving at high speed on roads such as highway mainly uses rear wheels as driving wheel. At this moment, some of torques is also distributed to front wheels so that the vehicle could maintain safe ground grab capacity against side winds and rain. Distribution ratio: 15% for front wheels and 85% for rear wheels.
3. When turning on the road with low friction rate During cornering on roads such as unpaved, snowy, icy and muddy, ground grab capacity is increased by distributing required torque and, at the same time, comfortable steering operation is maintained by controlling the ground grab capacity at high level.
   Distribution ratio: 30 % for front wheels and 70 % for rear wheels.
4. When climbing or starting off on the road with low friction rate In order to secure the maximum ground grab capacity and driving force during climbing or starting off on the roads such as unpaved, snowy and icy road, the system controls the driving force to distribute properly in full 4WD mode. Distribution ratio: 50 % for front wheels and 50 % for rear wheels.

2) Function

Selection Mode

The TOD system has 2 selectable mode, 4H and 4L. 4H is the normal operating mode when drive of which gear ratio is 1:1 and 4L mode distributes power to front and rear wheels 50 : 50 of which gear ratio is 2.48:1.

▶ 4L Mode

When selecting 4L mode, EMC is locked to apply maximum torque into front and rear propeller shafts. Shift motor rotates also 4L position by rotation of cam thus propeller shaft torque changes from 1:1 to 2.48:1 by planetary gear set.

▶ Releasing the 4L Mode

When selecting 4H mode, 4L drive mode is released and 4H mode is resumed.

- "4H" switch: Self-return type
- "4L" switch: Push lock type

3) 4WD Operation Overview

Application	Mode Position		Operation Condition
Driving type	4H	4WD Drive (High Speed)	Normal Driving on the normal road or highway, or high speed driving. Slipped road such as snow, rainy, sand, mud etc.
	4L	4WD Drive (Low Speed)	Max driving force requiring condition such as towing, rough road. Same function as part time transfer case 4L.
Transferring	4H ↔ 4L	4WD Drive High Speed ↔ Low Speed	A vehicle should stop for transfer. Manual Transmission • Transfer starts after the vehicle stops and the clutch is applied Automatic Transmission • Transfer starts after the vehicle stops and the shift lever is shifted [N] position.

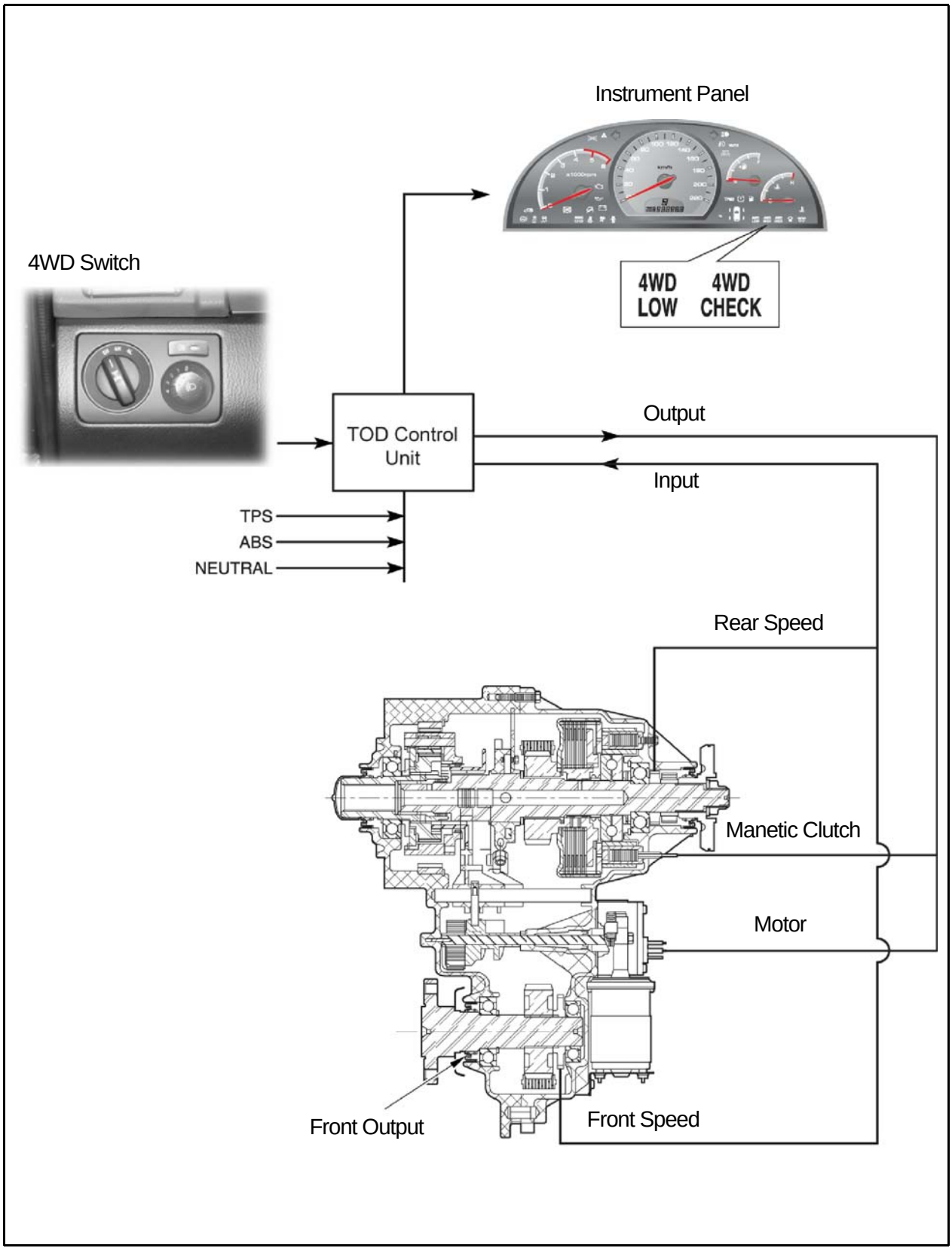
CAUTION

- To make the mode shift easier, stop the vehicle, depress the brake pedal, select the mode switch, and move the selector lever with the sequence of [N-P-N].

Modification basis	
Application basis	
Affected VIN	

2. POWER FLOW

▶ **System Layout**



Modification basis	
Application basis	
Affected VIN	

3. TOD OPERATION

1) Distribution of Driving Force According to Road Surface

1. **On normal road surface**
   In vehicle with existing part time transfer case, when a driver turns the steering wheel to park in the 4WD mode, the vehicle may halt sensation of tight corner braking phenomena. However, in vehicle with TOD system, this phenomenon does not occur and the driving force is properly and automatically distributed.

2. **On paved road with high speed**
   Driving at high speed on roads such as highway mainly uses rear wheels as driving wheel. At this moment, some of torques is also distributed to front wheels so that the vehicle could maintain safe ground grab capacity against side winds and rain. Distribution ratio: 15% for front wheels and 85% for rear wheels.

3. **When turning on the road with low friction rate**
   During cornering on roads such as unpaved, snowy, icy and muddy, ground grab capacity is increased by distributing required torque and, at the same time, comfortable steering operation is maintained by controlling the ground grab capacity at high level.
   Distribution ratio: 30 % for front wheels and 70 % for rear wheels.

4. **When climbing or starting off on the road with low friction rate**
   In order to secure the maximum ground grab capacity and driving force during climbing or starting off on the roads such as unpaved, snowy and icy road, the system controls the driving force to distribute properly in full 4WD mode. Distribution ratio: 50 % for front wheels and 50 % for rear wheels.

2) Mode Selection



The TOD system has 2 selectable mode, 4H and 4L. 4H is the normal operating mode when drive of which gear ratio is 1:1 and 4L mode distributes power to front and rear wheels 50:50 of which gear ratio is 2.48:1.

Modification basis	
Application basis	
Affected VIN	

▶ 4L Mode

When selecting 4L mode, EMC is locked to apply maximum torque into front and rear propeller shafts. Shift motor rotates also 4L position by rotation of cam thus propeller shaft torque changes from 1:1 to 2.48:1 by planetary gear set.

▶ Releasing the 4L Mode

When selecting 4H mode, 4L drive mode is released and 4H mode is resumed.

- "4H" switch: Self-return type
- "4L" switch: Push lock type

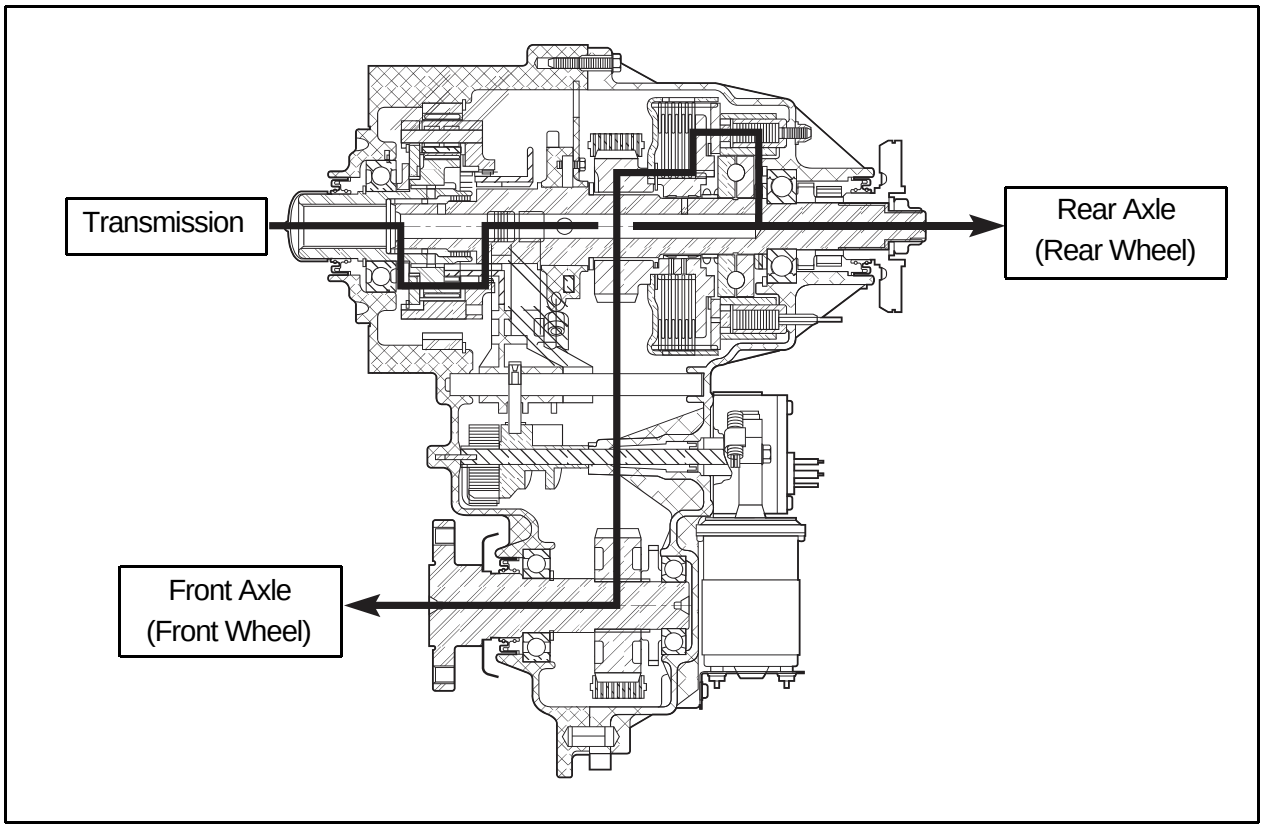
3) 4WD Operation Overview

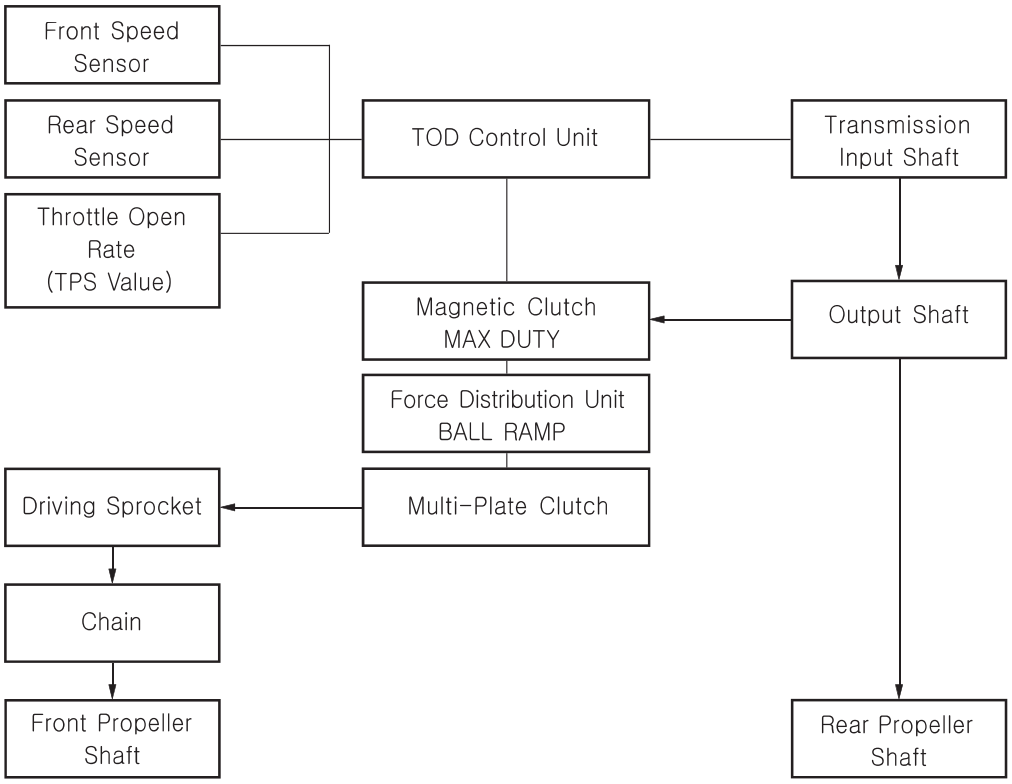
Application	Mode Position		Operation Condition
Driving type	4H	4WD Drive (High Speed)	Normal Driving on the normal road or highway, or high speed driving. Slipped road such as snow, rainy, sand, mud etc.
	4L	4WD Drive (Low Speed)	Max driving force requiring condition such as towing, rough road. Same function as part time transfer case 4L.
Transferring	4H ↔ 4L	4WD Drive High Speed ↔ Low Speed	A vehicle should stop for transfer. Manual Transmission • Transfer starts after the vehicle stops and the clutch is applied Automatic Transmission • Transfer starts after the vehicle stops and the shift lever is shifted [N] position.

NOTE

To make the mode shift easier, stop the vehicle, depress the brake pedal, select the mode switch, and move the selector lever with the sequence of [N-P-N].

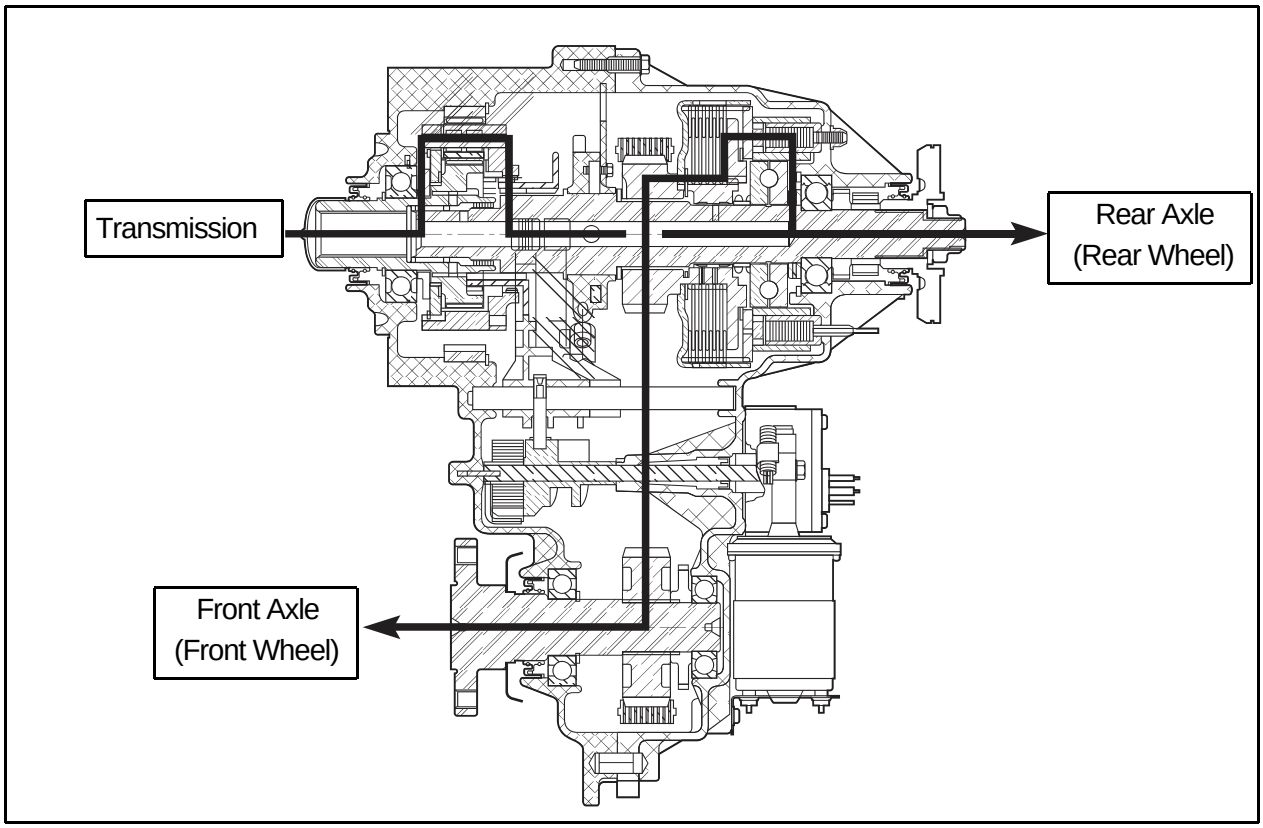
▶ 4H Mode (4WD Drive - High Speed)

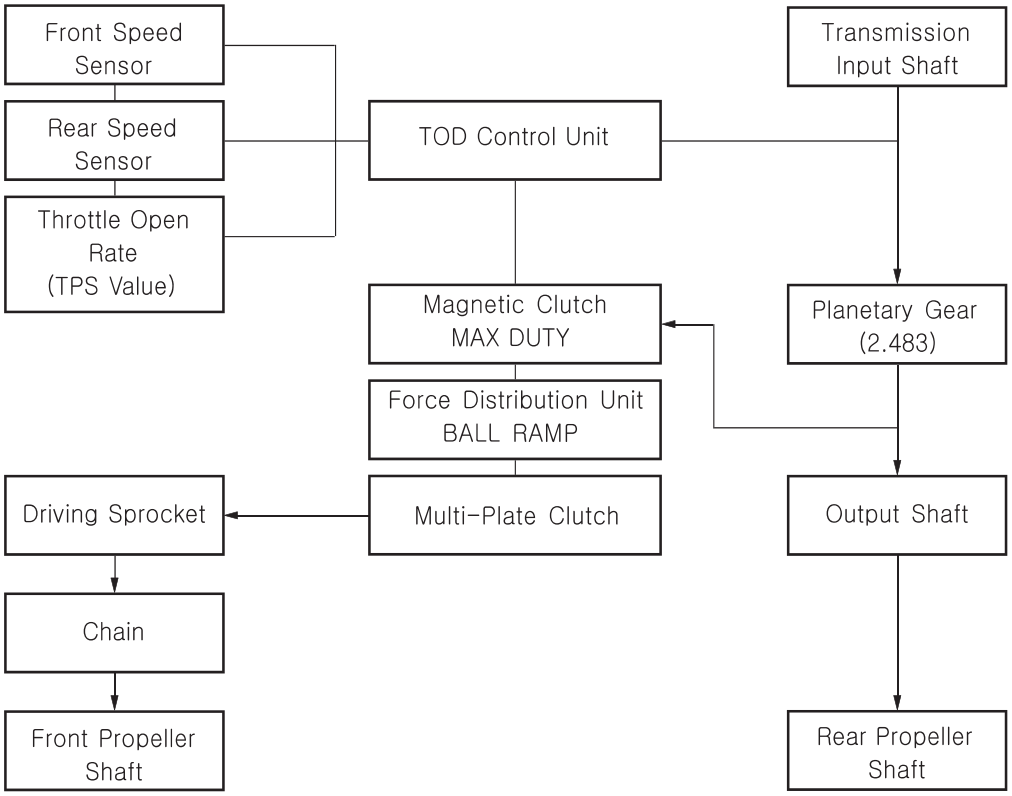




Modification basis	
Application basis	
Affected VIN	

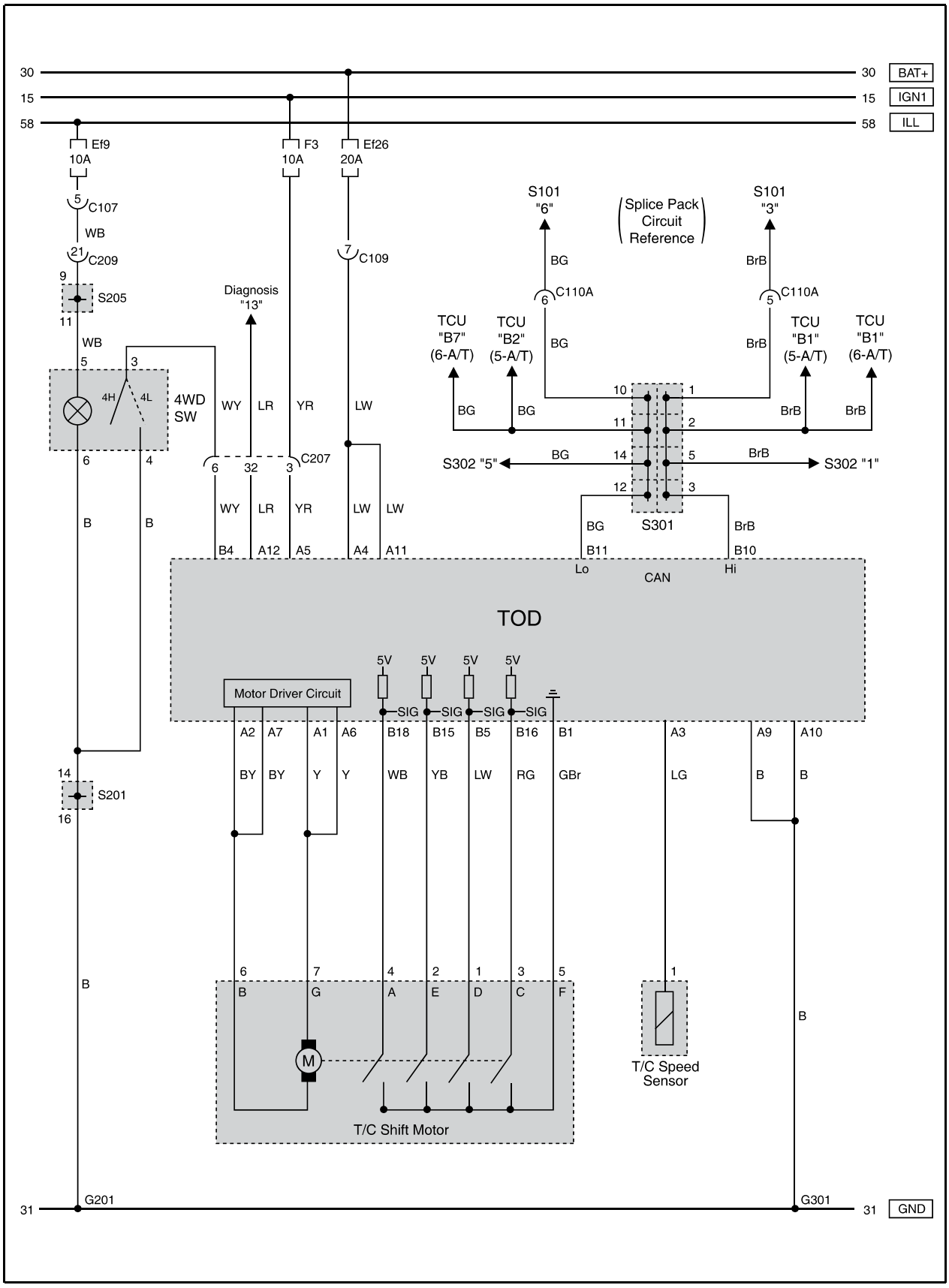
▶ 4L Mode (4WD Drive - Low Speed)





Modification basis	
Application basis	
Affected VIN	

3. CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	

TRANSFER CASE

3240-01

GENERAL INFORMATION

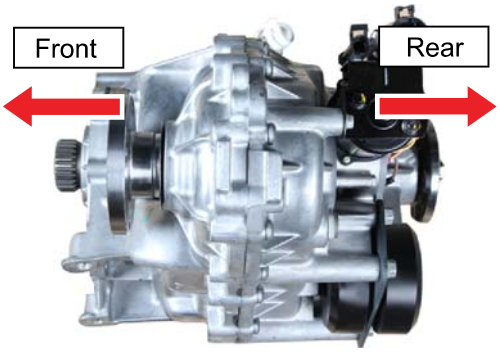
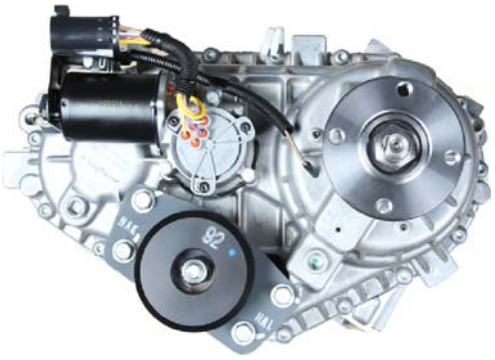
1. SPECIFICATIONS

Description		Specifications
Total length		343mm
Mating surface of front flange		40mm
Weight		32.4 kg (including oil)
Oil capacity		1.4L
Oil type		ATF DEXRON II or III
Location		Transfer case
Major element	Housing	Part-time & TOD
	Bolt	11EA, M8 x 1.25
	Input shaft	A/T: outer spline M/T: inner spline

OVERVIEW AND OPERATING PROCESS

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.

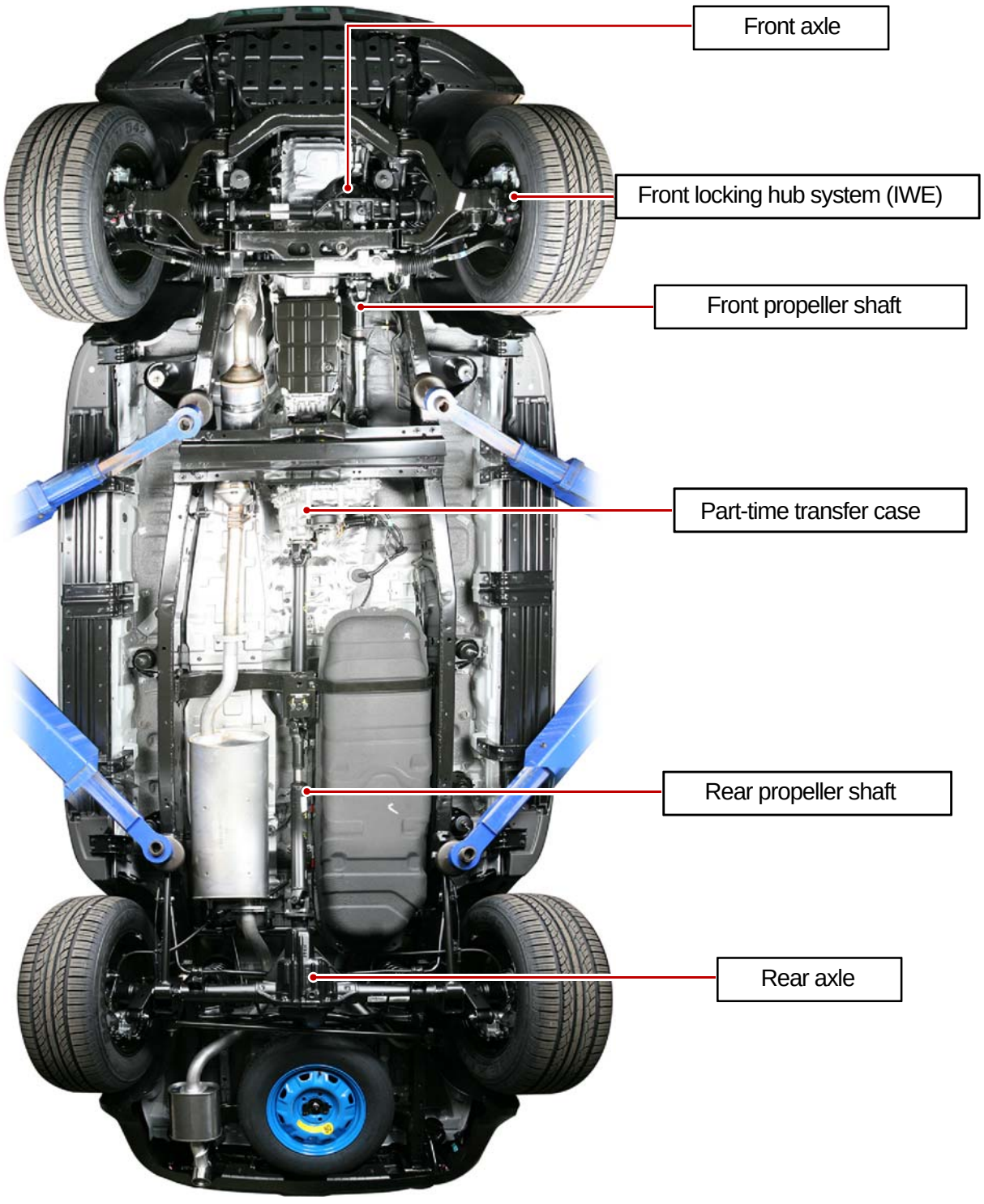
Side View	Rear View
	

Modification basis	
Application basis	
Affected VIN	

▶ **Operation**

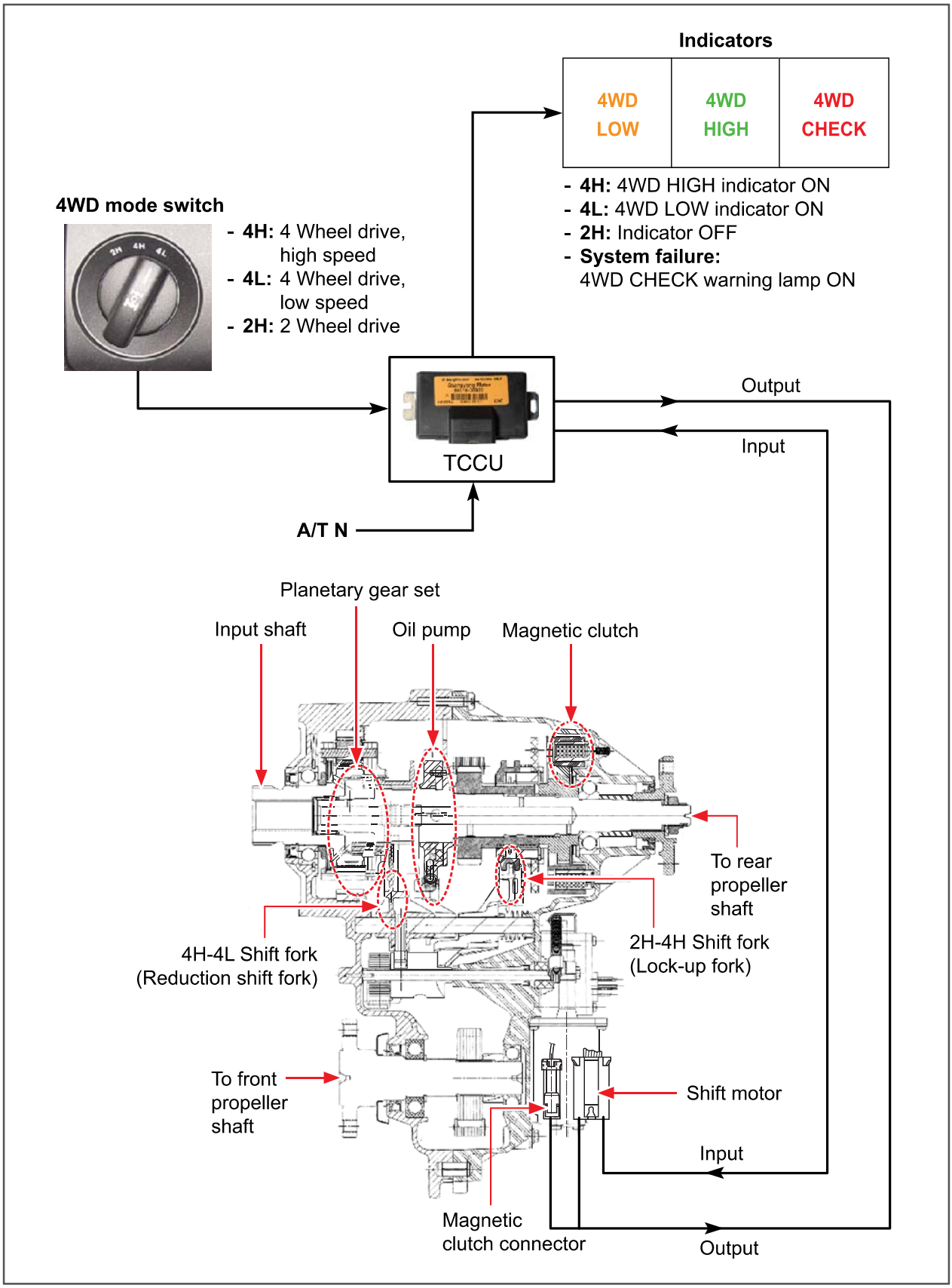
Description	Mode		Conditions
Driving mode	2H	2 Wheel drive (rear wheel)	Rear-wheel drive mode. This is used under normal or high-speed driving conditions on public roads or highways.
	4H	4 Wheel drive (high speed)	This is used under sandy, muddy or snow-covered road conditions
	4L	4 Wheel drive (low speed)	This is used for maximum traction. When cornering with low speed in 4WD condition, there could be tire dragging, some mechanical shocks and resistances in vehicle's drive train. These are normal conditions due to internal resistance in the drive train when the 4WD system is properly working
Mode change	2H ↔ 4H	2 Wheel drive ↔4 Wheel drive	Shifting is possible while driving at the speed of 70 km/h or less
	2H, 4H ↔ 4L	2 Wheel drive, 4 Wheel drive (high speed) ↔4 Wheel drive (low speed)	**For Automatic Transmission:** -Stop the vehicle on level ground and move the gear selector lever into the "N" position. Turn the switch to the desired position. **For Manual Transmission:** -Stop the vehicle on level ground and move the gear selector lever into the "N" position. Then turn the switch to the desired position while depressing the clutch pedal. **NOTE** To make the mode change easily, stop the vehicle on level ground and turn the mode switch to the desired position and move the shift lever to "N"-"R"-"N" while depressing the brake pedal.

2. LAYOUT



Modification basis	
Application basis	
Affected VIN	

3. SYSTEM LAYOUT

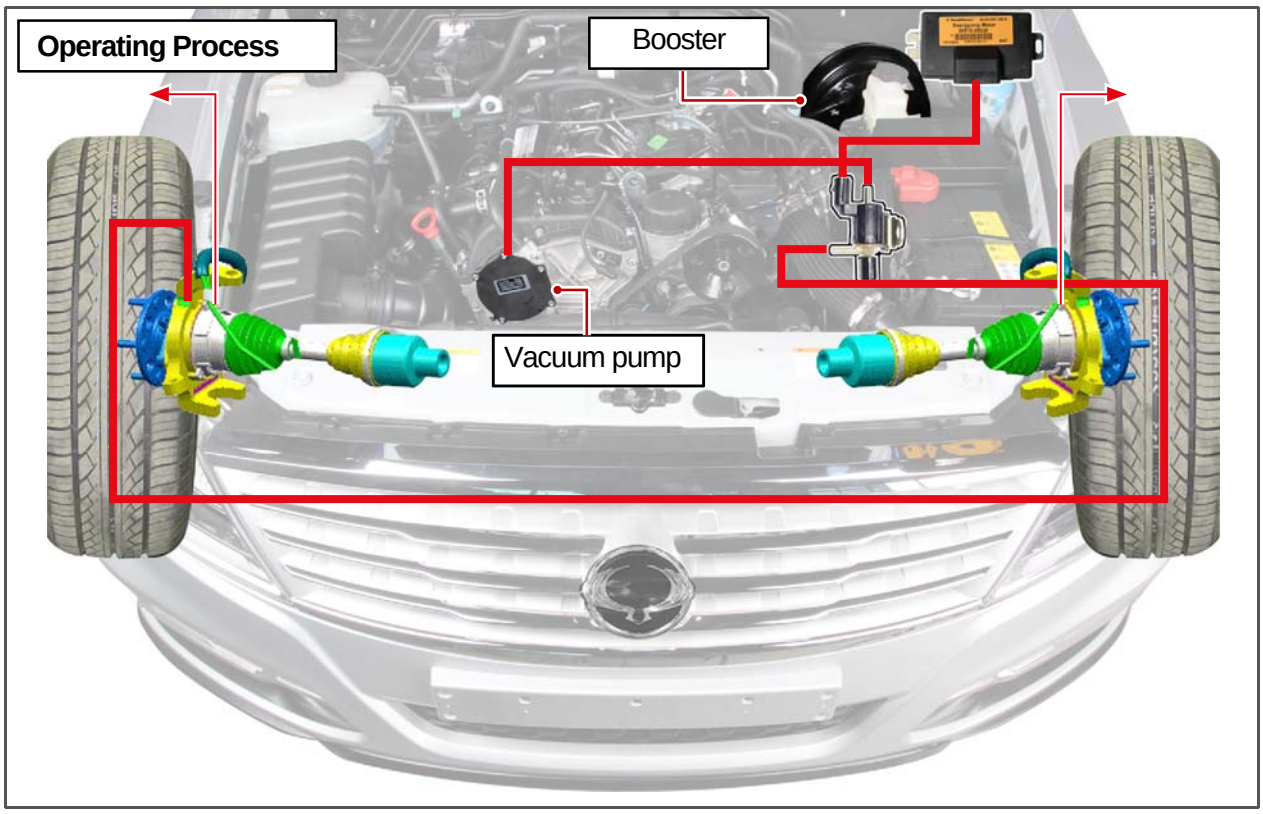


Modification basis	
Application basis	
Affected VIN	

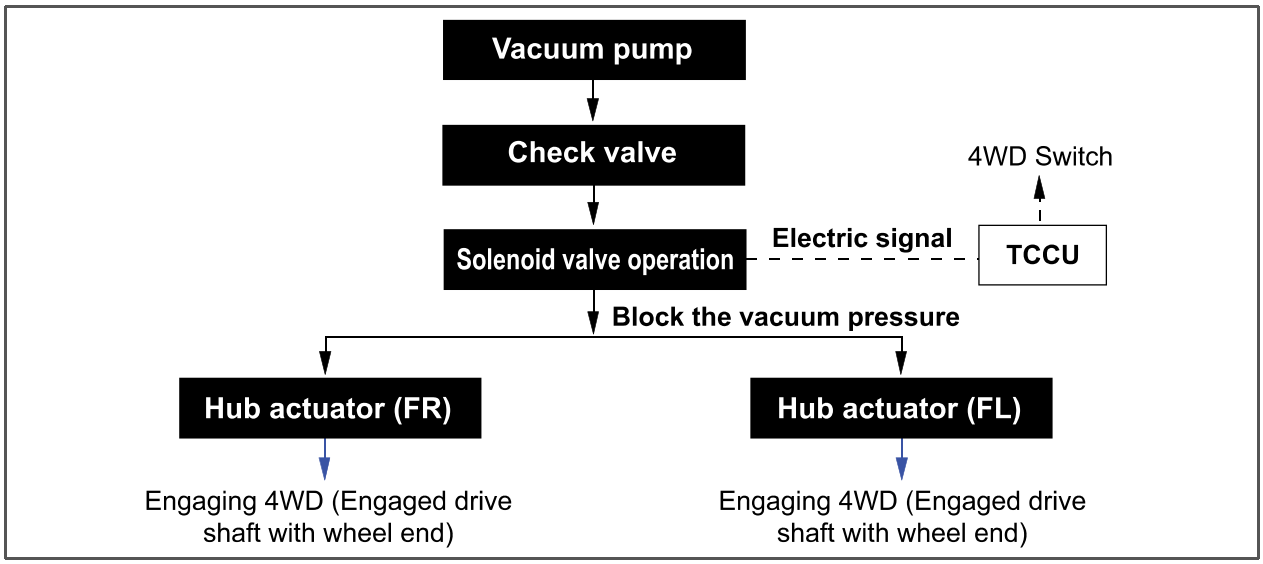
4. IWE LOCKING HUB SYSTEM

1) Overview

The vacuum locking hub 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

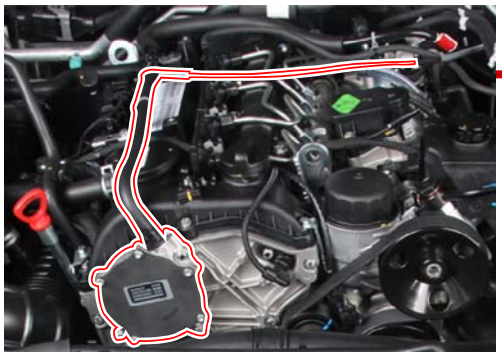


▶ **Vacuum generation process in front hub actuator**



Modification basis	
Application basis	
Affected VIN	

(2) Vacuum System Related to 4WD

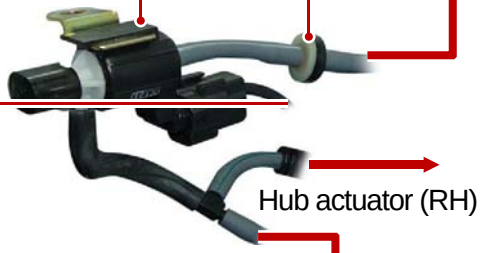


During 2WD mode, the vacuum pressure from vacuum pump is continuously transmitted to the locking hub system. This vacuum pressure pulls in the locking hub actuator so that it will not be engaged with the front end hub gear.

Check valve
This valve allows the vacuum pressure to flow through it in only one direction. This prevent the vacuum from abruptly releasing due to faulty vacuum pump.

Vacuum solenoid valve



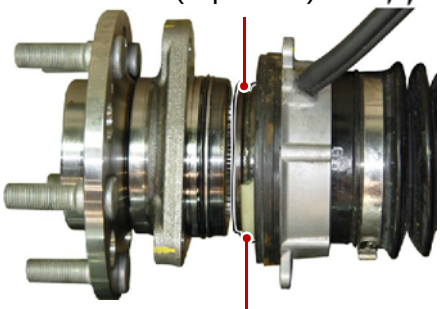


Hub actuator (RH)

In 4WD mode, the TCCU blocks the transferring of vacuum pressure from vacuum pump to locking hub by supplying the power to solenoid valve.

Block the vacuum pressure
To atmosphere

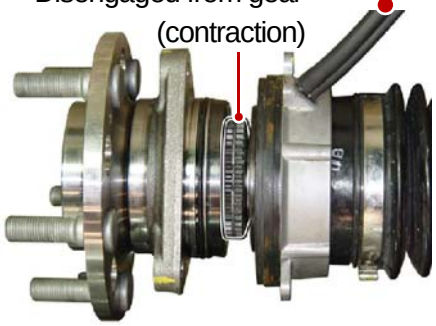
Engaged with gear
(expansion)



The vacuum pressure is released from the hub actuator. At this time, the front hub end gear is engaged.

Hub actuator (LH)

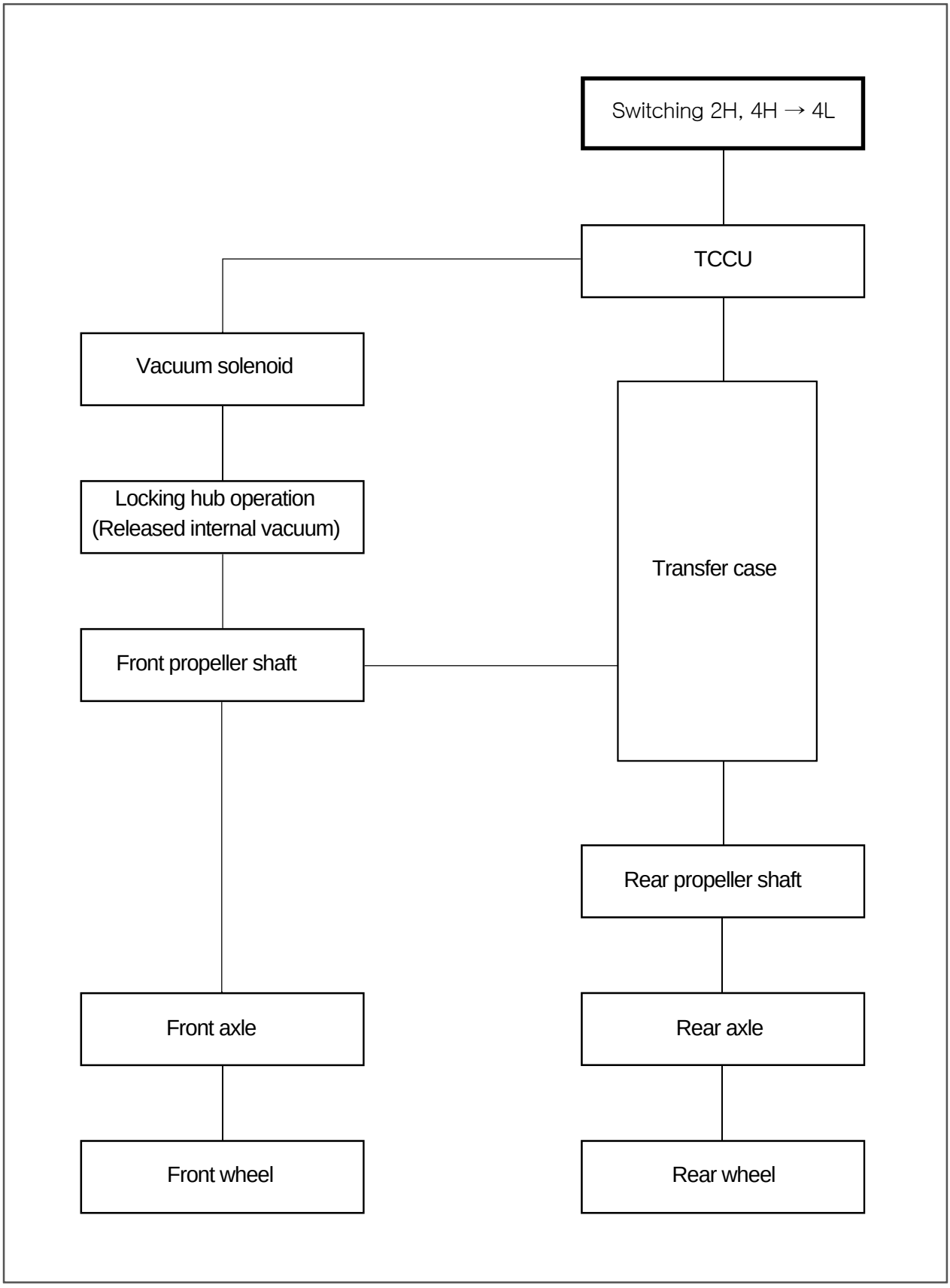
Disengaged from gear
(contraction)



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.

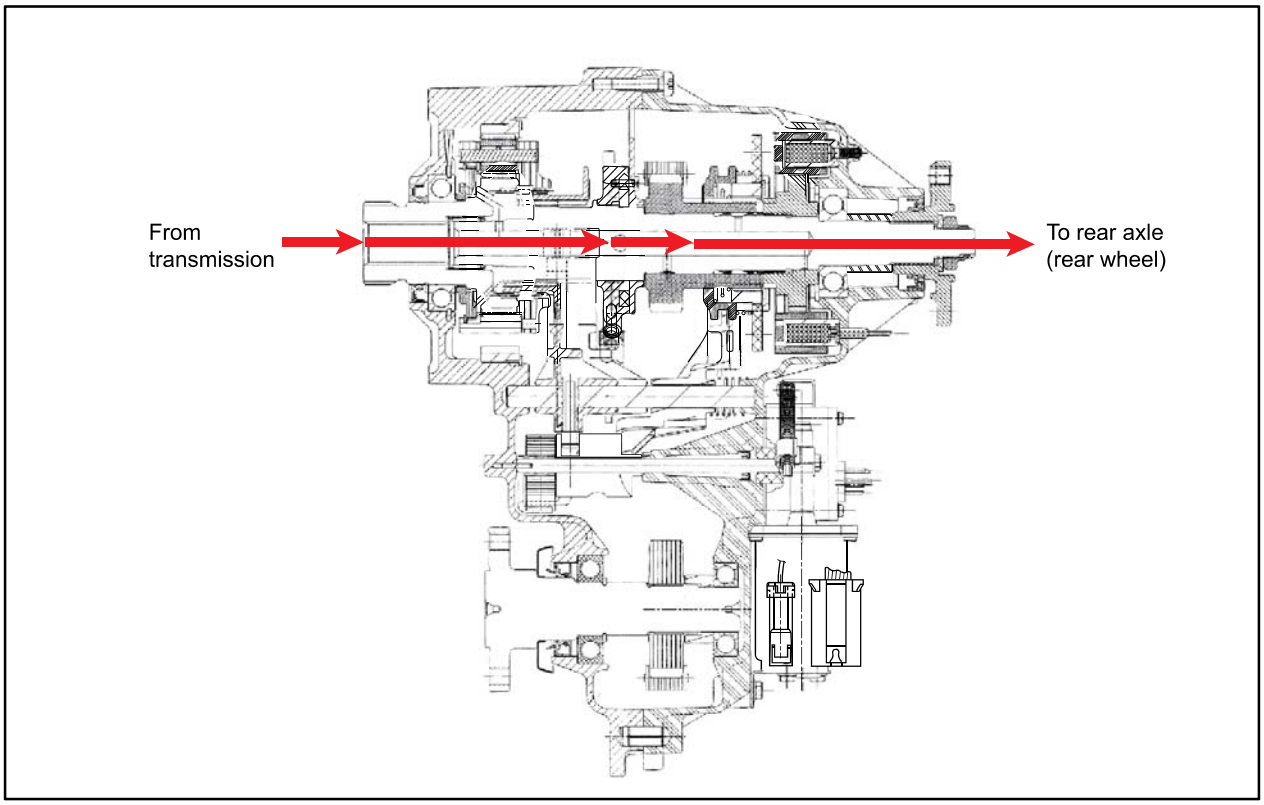
Modification basis	
Application basis	
Affected VIN	

5. POWER FLOW

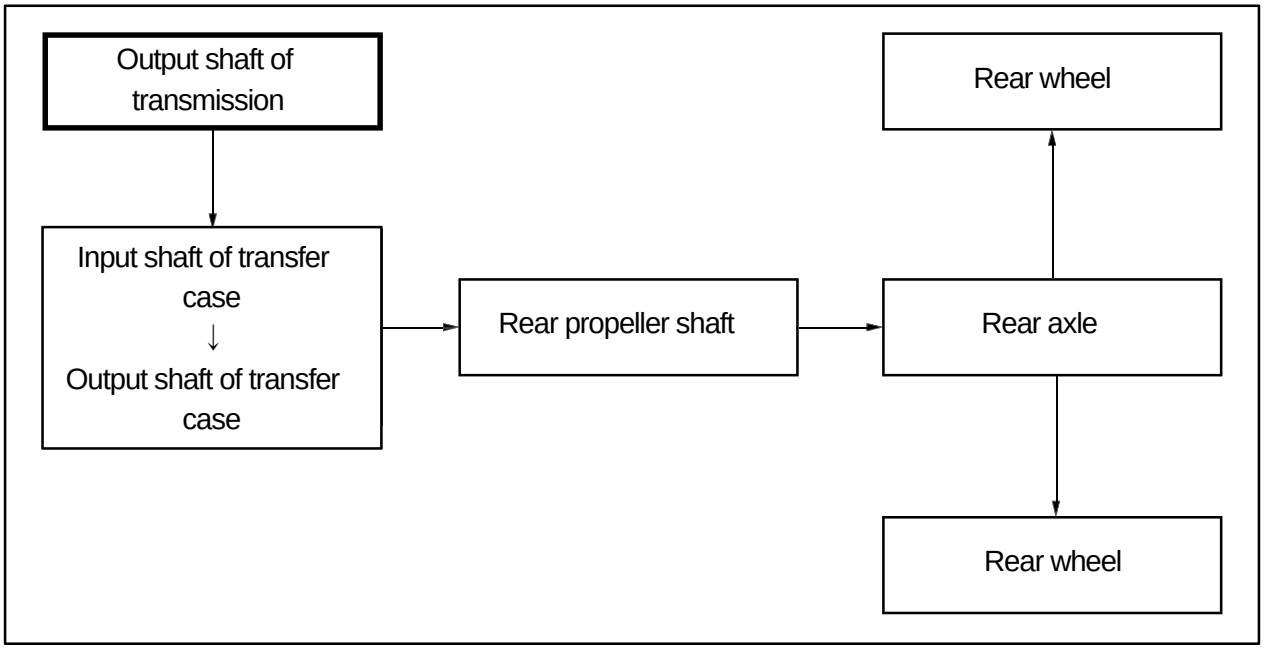


Modification basis	
Application basis	
Affected VIN	

1) 2H Mode (2 Wheel Drive)

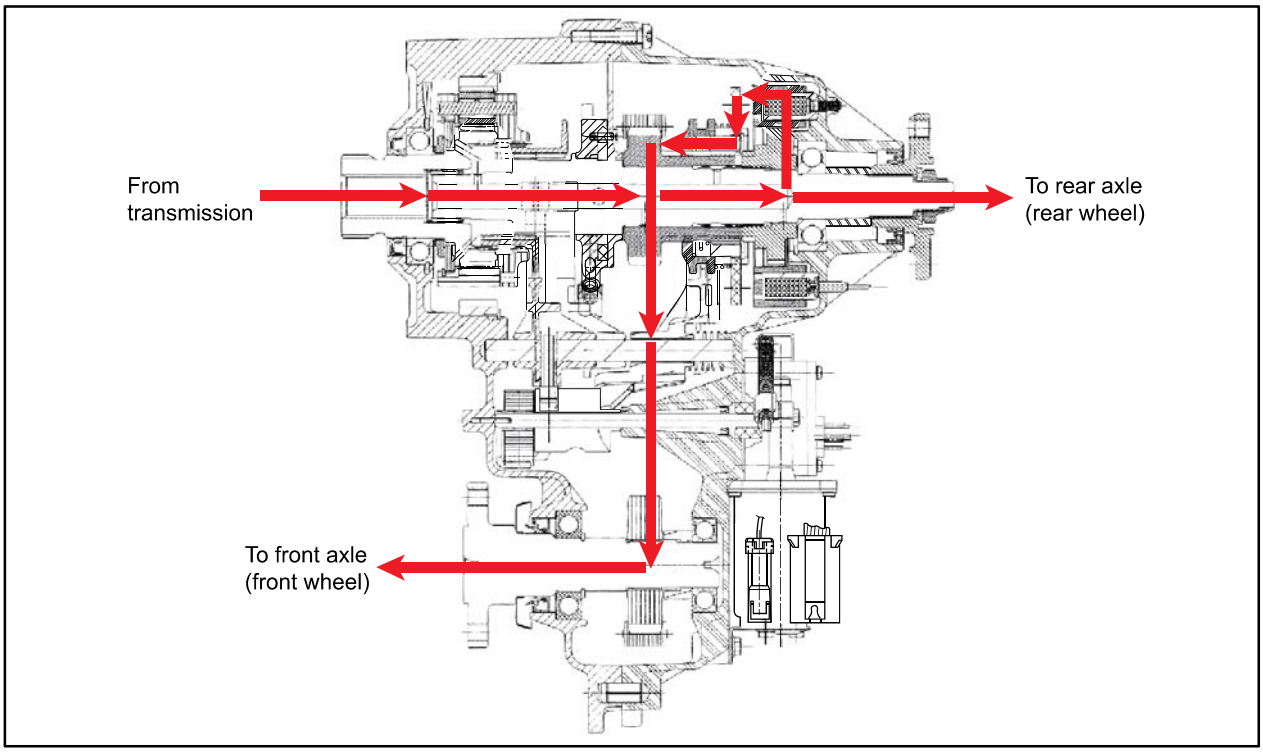


▶ **Power Flow**

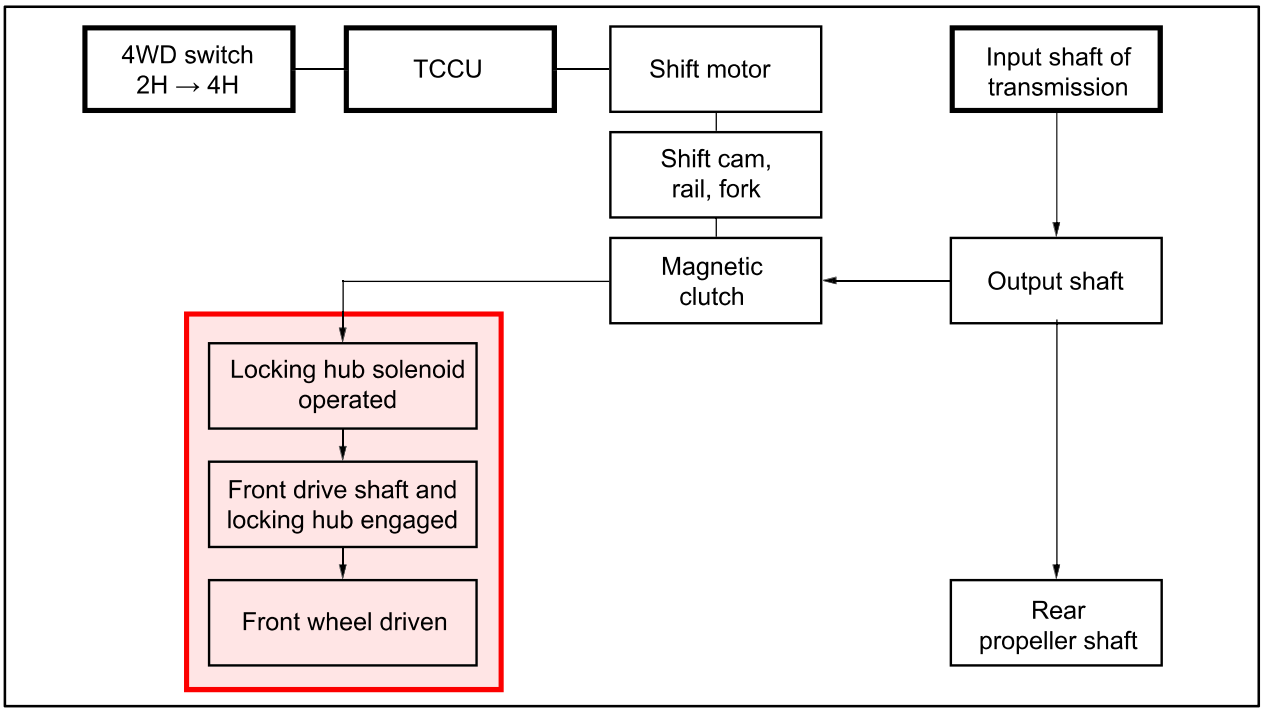


NOTE
The driving force is directly engaged (1:1) to rear axle and is transferred only to the rear wheels.

2) 4H Mode (4 Wheel Drive - High Speed)



▶ Power Flow

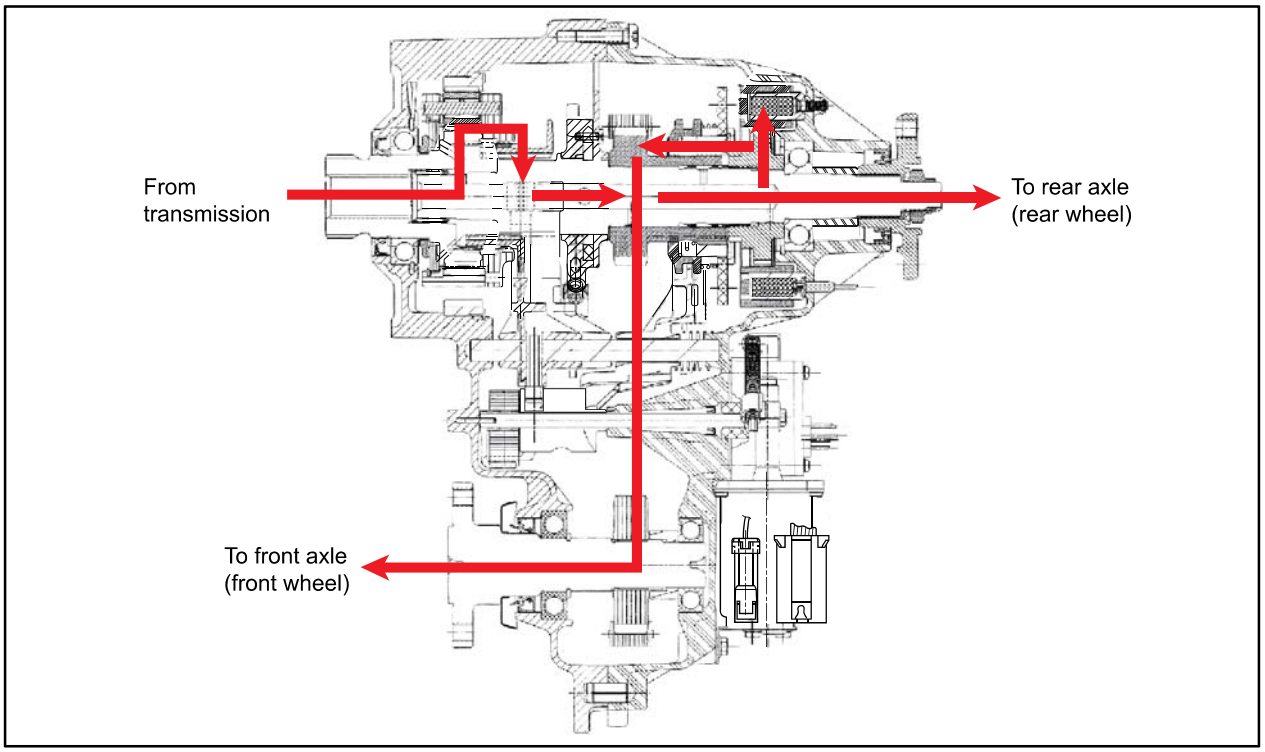


NOTE

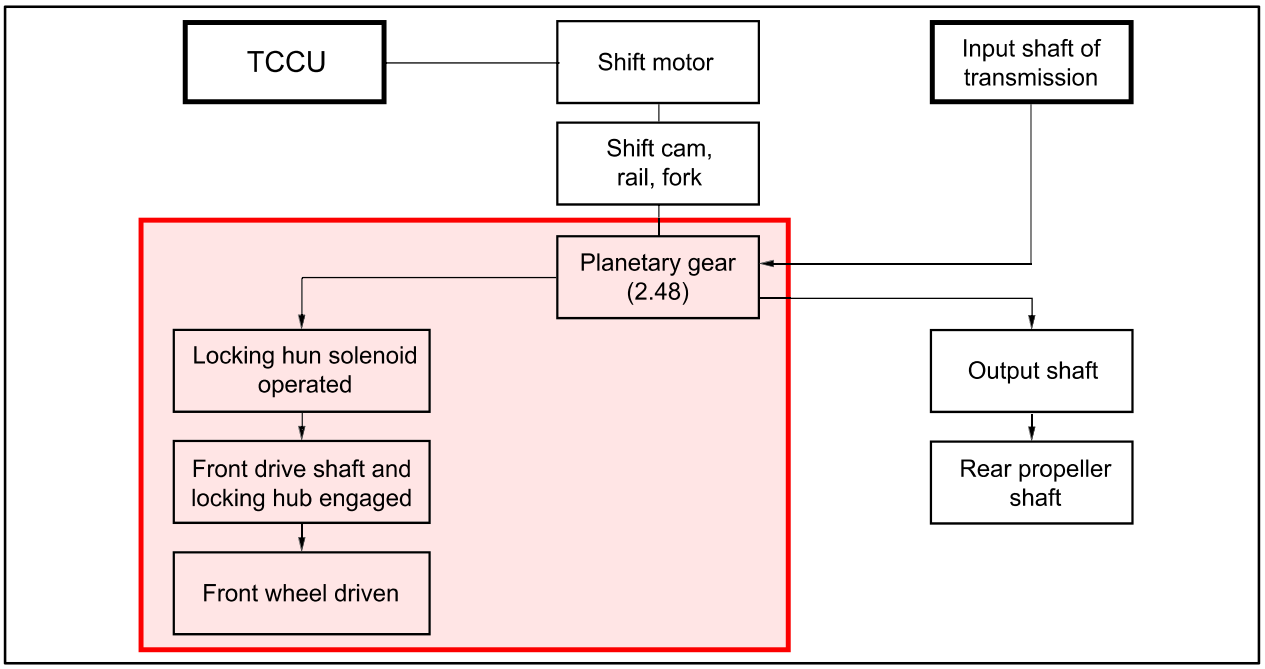
The driving force is pass through 4WD High magnetic clutch in transfer case and is distributed on front wheels and rear wheels (50;50).

Modification basis	
Application basis	
Affected VIN	

3) 4L Mode (4 Wheel Drive - Low Speed)



▶ Power Flow



NOTE

The gear ratio is reduced to 2.48;1 while passing through 4WD Low range and planetary gear set in transfer case and the driving force is distributed on front wheels and rear wheels (50;50).

Modification basis	
Application basis	
Affected VIN	

PROPELLER SHAFT

3310-01

GENERAL INFORMATION

1. SPECIFICATION

Description			Specification
Structure			Yoke and spider type universal joint
Number of spiders	Front	Part time T/C	2
	Rear		3
Tube run-out			below 0.3 mm
Unbalance			Max. 18 g.cm / 4,500 rpm (30 g.cm when re-measuring)
Front propeller shaft length * outer diameter (mm)	A/T		607.1 * Φ63.5 (at compressed condition)
Rear propeller shaft length * outer diameter (mm)	2WD (A/T)	Front axle	1078.2 * Φ63.5
		Rear axle	561.4 * Φ63.5 (at compressed condition)
	4WD (A/T)	Front axle	696.3 * Φ63.5
		Rear axle	561.4 * Φ63.5 (at compressed condition)

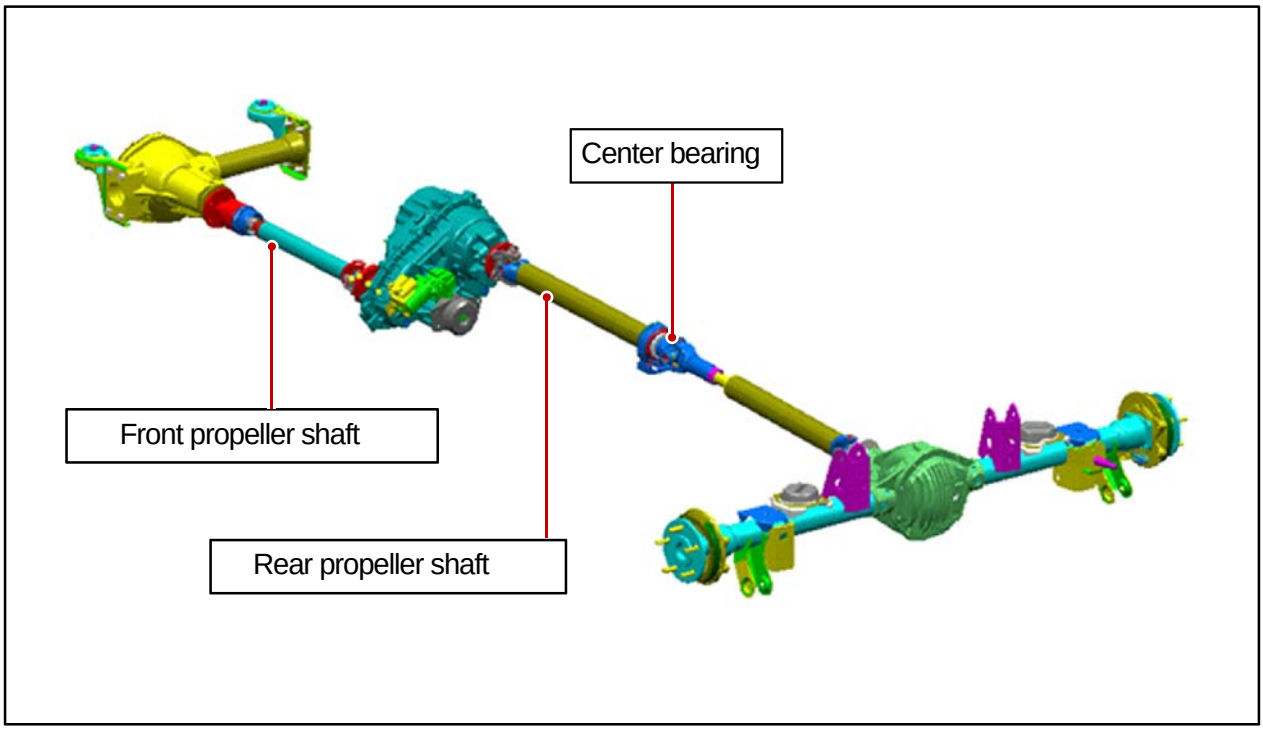
2. TIGHTENING TORQUE

Item	Tightening torque
Mounting bolt on front/rear axle	66.6 ~ 73.5 Nm
Mounting bolt on transfer case	79.4 ~ 87.2 Nm
Center bearing mounting bolt	78.4 ~ 93.1 Nm

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	

SUSPENSION

4411-01

GENERAL INFORMATION

1. SPECIFICATIONS

	Description	Specification
Front Suspension	Suspension type	Double wishbone
	Spring type	Coil spring
	Shock absorber type	Reciprocating cylindrical type (gas type)
	Stabilizer bar type	Torsion bar type
Rear Suspension	Suspension type	5-link type / multi-link type
	Spring type	Coil spring
	Shock absorber type	Reciprocating cylindrical type (gas type)
	Stabilizer bar type	Torsion bar type

2. WHEEL ALIGNMENT

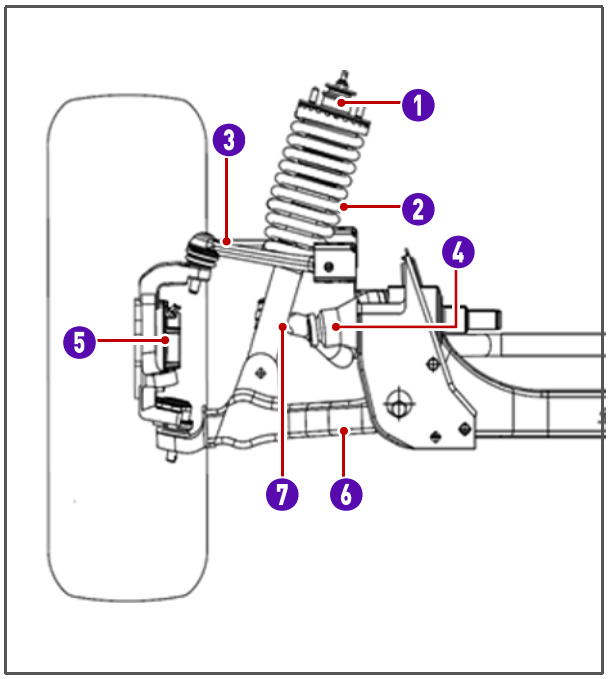
	LH	RH
Camber	0.12 ± 0.25°	0 ± 0.25°
Caster	4.28° ± 0.4°	4.38° ± 0.4°
Toe-in	2 ± 2mm	

NOTE

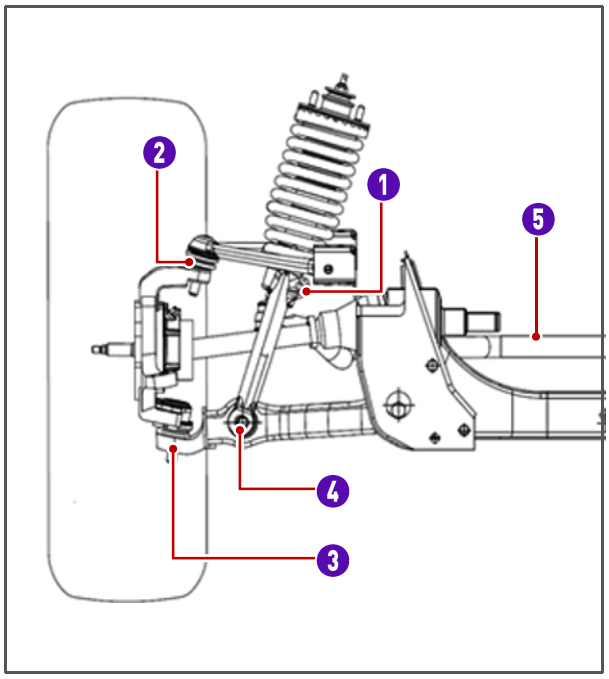
Inspect the tire inflation pressure and underbody before checking the wheel alignment.
- Tire inflation pressure: 32 psi

3. LAYOUT AND COMPONENTS

▶ **Front View**



1. Shock absorber assembly
2. Coil spring
3. Upper arm assembly
4. Axle shaft assembly
5. Steering knuckle
6. Lower arm assembly
7. Shock absorber yoke assembly

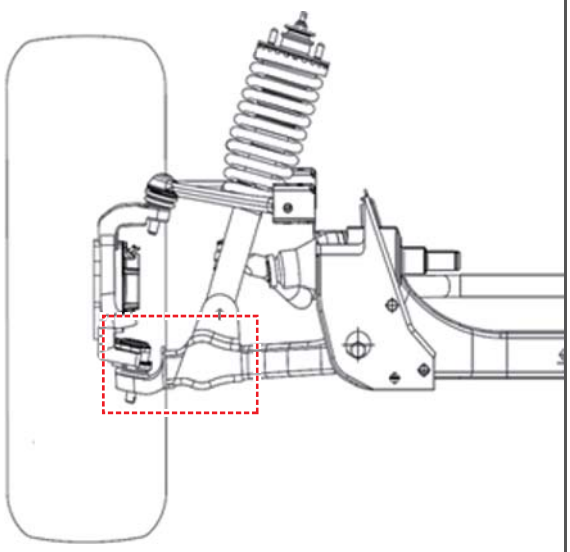
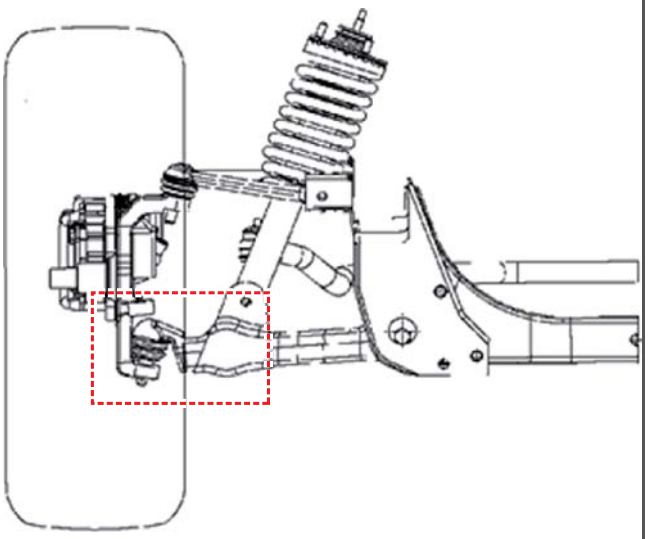


1. Shock absorber (to yoke) bolt:
   122.5 ~ 142.1 Nm
2. Upper arm (knuckle side) nut:
   137.2 ~ 156.8 Nm
3. Lower arm (knuckle side) nut:
   137.2 ~ 156.8 Nm
4. Yoke lower (lower arm side) nut:
   147.0 ~ 166.6 Nm

Modification basis	
Application basis	
Affected VIN	

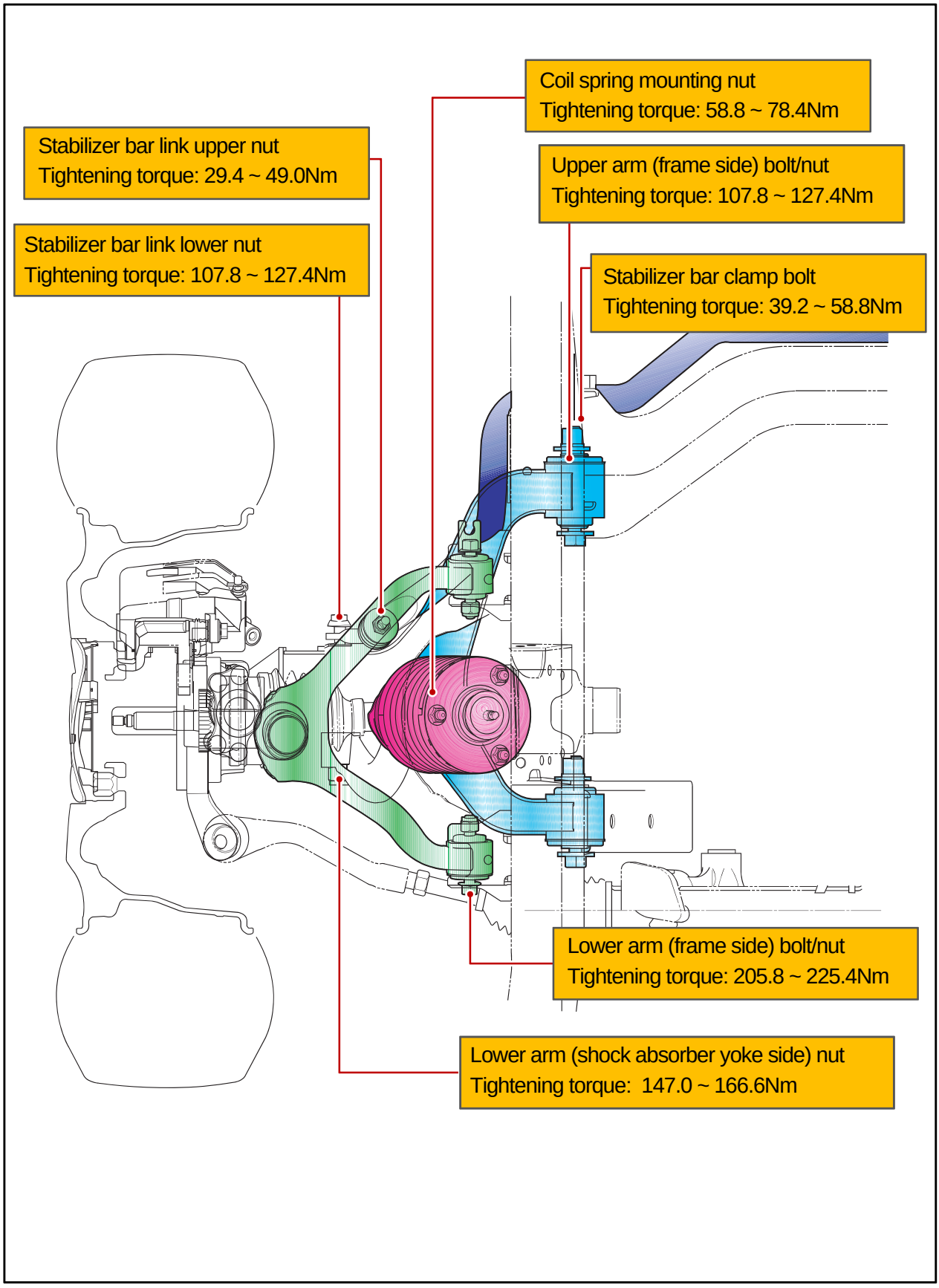
NOTE

In lower arm design, the current mass production vehicle (A) is different from the new model (B) from July 2012.

A . 5-Link type	B. Multi-link type (changed lower arm ball joint)
	

Modification basis	
Application basis	
Affected VIN	

▶ **Top View**

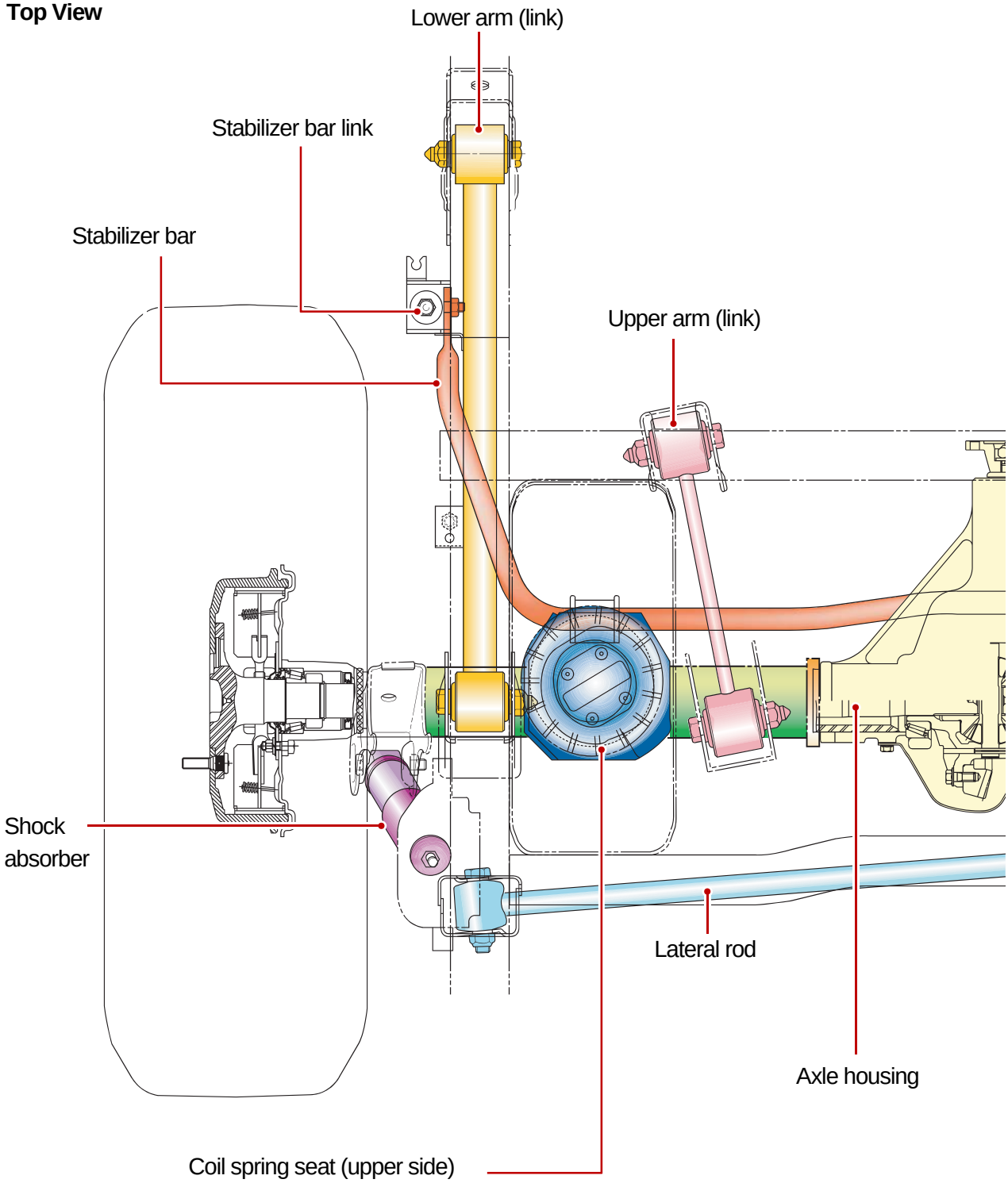


Modification basis	
Application basis	
Affected VIN	

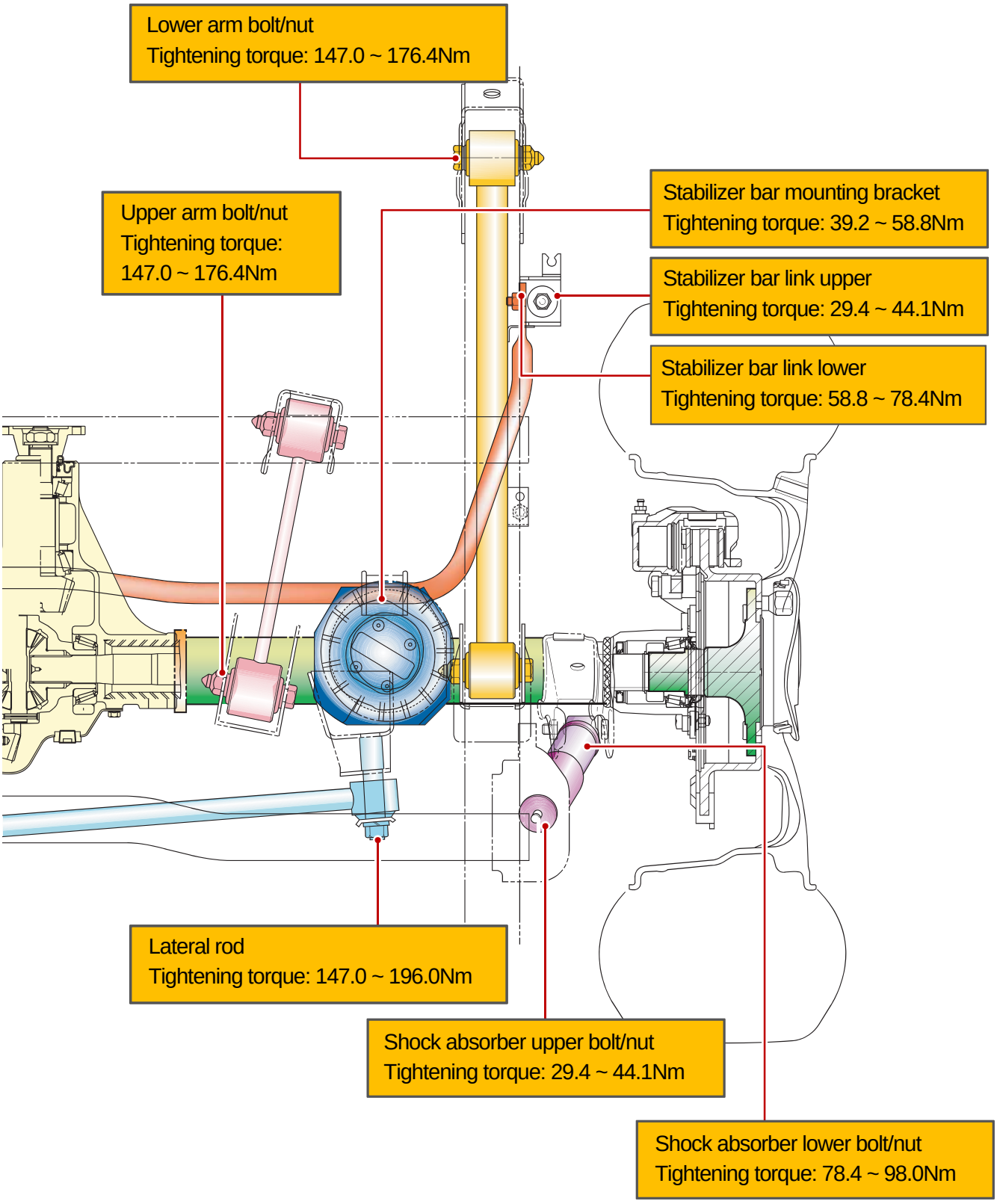
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4. SYSTEM LAYOUT AND TIGHTENING TORQUE OF REAR SUSPENSION

▶ **Top View**



Modification basis	
Application basis	
Affected VIN	



Modification basis	
Application basis	
Affected VIN	

5. TROUBLESHOOTING

Problem	Cause	Action
Vehicle rolling	Broken stabilizer bar	Replace
	Faulty shock absorber	Replace
Abnormal noise.	Loosening mounting	Retighten
	Damaged or worn wheel bearing	Replace
	Damaged shock absorber	Replace
	Damaged tire	Replace
Poor riding	Over inflated tire	Adjust
	Faulty shock absorber	Replace
	Loosened wheel nut	Tighten as specified torque
	Bent or broken coil spring	Replace
	Damaged tire	Replace
	Worn bushing	Replace
Vehicle pulls to one side	Deformed arm assembly	Replace
	Worn bushing	Replace
	Bent or broken coil spring	Replace
Hard steering	Excessive resistance of lower arm ball joint	Replace
	Insufficient tire pressure	Replace
	Faulty power steering	Replace
Unstable steering	Worn or loosened lower arm bushing	Retighten or replace
Vehicle bottoming	Worn or broken coil spring	Replace
Vehicle height lowered	Over loaded on the vehicle	-
	Defective shock absorber	Replace
	Defective coil spring	Replace

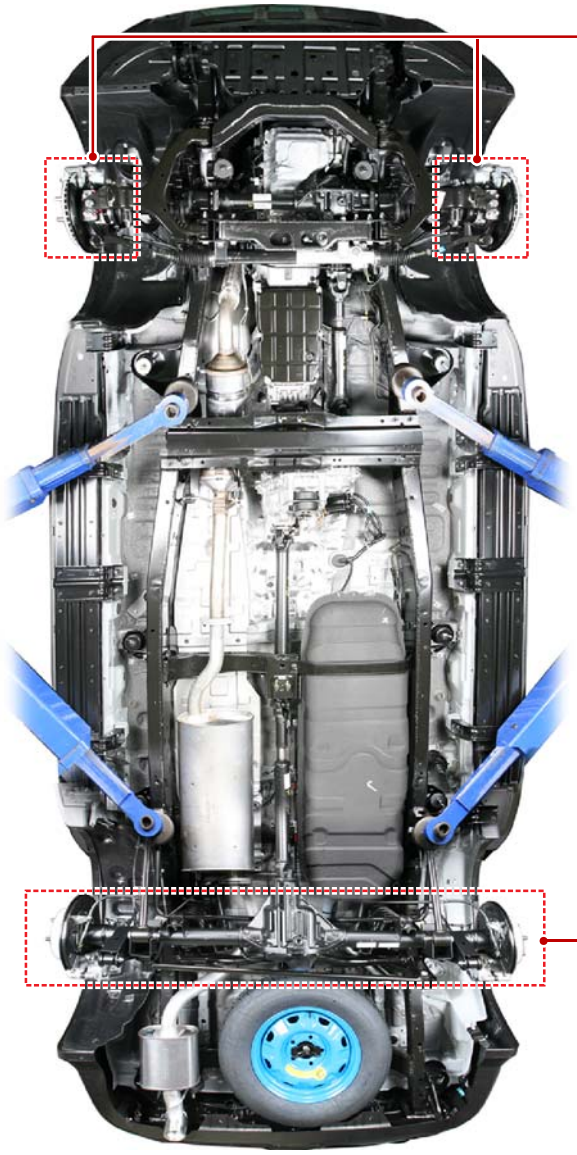
Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

Suspension is the term given to the system of springs, shock absorbers and linkages that connects a vehicle to its wheels. Suspension systems serve a dual purpose ? contributing to the vehicle's road holding/handling and braking for good active safety and driving pleasure, and keeping vehicle occupants comfortable and reasonably well isolated from road noise, bumps, and vibrations, etc. These goals are generally at odds, so the tuning of suspensions involves finding the right compromise. It is important for the suspension to keep the road wheel in contact with the road surface as much as possible, because all the forces acting on the vehicle do so through the contact patches of the tires. The design of front and rear suspension of a vehicle may be different.

Under View (4WD, Automatic Transmission)



Front suspension



Rear suspension



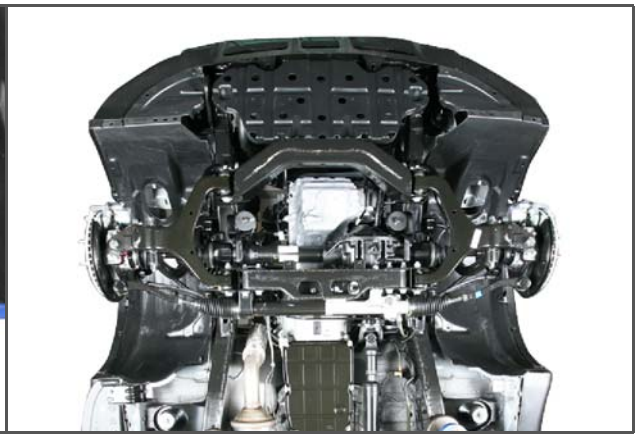


Modification basis	
Application basis	
Affected VIN	

2. FRONT SUSPENSION (DOUBLE WISHBONE)

Double wishbone suspension is an independent suspension design using two (occasionally parallel) wishbone-shaped arms to locate the wheel. Each wishbone or arm has two mounting points to the chassis and one joint at the knuckle. The shock absorber and coil spring mount to the wishbones to control vertical movement. Double wishbone designs allow the engineer to carefully control the motion of the wheel throughout suspension travel, controlling such parameters as camber angle, caster angle, toe pattern, roll center height, scrub radius, scuff and more.





Lower arm	Upper arm	Shock absorber	Stabilizer
			

▶ Advantage

1. The advantage of a double wishbone suspension is that it is fairly easy to work out the effect of moving each joint, so the kinematics of the suspension can be tuned easily and wheel motion can be optimized.
2. It is also easy to work out the loads that different parts will be subjected to which allows more optimized lightweight parts to be designed.
3. They also provide increasing negative camber gain all the way to full jounce travel unlike the MacPherson strut which provides negative camber gain only at the beginning of jounce travel and then reverses into positive camber gain at high jounce amounts.

▶ Disadvantage

1. The disadvantage is that it is slightly more complex than other systems like a MacPherson strut.
2. Due to the increased number of components within the suspension setup it takes much longer to service and is heavier than an equivalent MacPherson design.

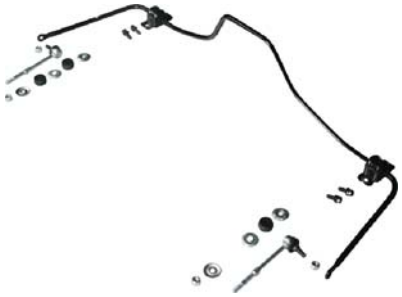
Modification basis	
Application basis	
Affected VIN	

3. REAR SUSPENSION (MULTI LINK TYPE)

Multi-link (5-Link) type suspension is the independent suspension. It provides good ride comfort and drivability by reducing the coil spring weight. Also, it increases the space for passenger compartment by lowering the floor. This type of suspension consists of multiple links such as coil spring, shock absorber, upper and lower arms, lateral rod and stabilizer bar.





Shock absorber	Stabilizer bar	Rear coil spring
		

Lower arm	Upper arm	Lateral rod
		

Modification basis	
Application basis	
Affected VIN	

4. WHEEL ALIGNMENT

Wheel alignment (adjustment of Camber, Caster and Toe) is part of standard automobile maintenance that consists of adjusting the angles of the wheels so that they are set to the specification. The purpose of these adjustments is to reduce tire wear, and to ensure that vehicle travel is straight and true (without "pulling" to one side). Alignment angles can also be altered beyond the specifications to obtain a specific handling characteristic.

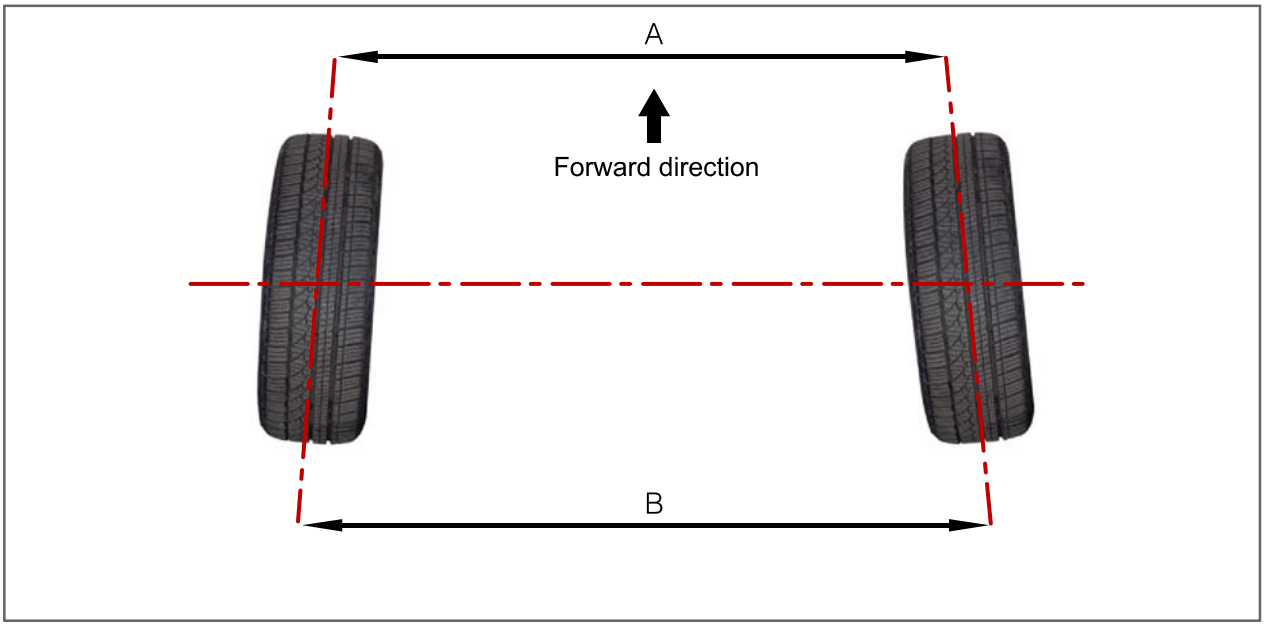
▶ Necessity for Wheel Alignment

Wheel alignment consists of adjusting the angles of the wheels so that they are perpendicular to the ground and parallel to each other. The purpose of these adjustments is maximum tire life and a vehicle that tracks straight and true when driving along a straight and level road.
The symptoms of a vehicle that is out of alignment are:
Uneven or rapid tire wear
Pulling or drifting away from a straight line
Wandering on a straight level road
Spokes of the steering wheel off to one side while driving on a straight and level road.

Modification basis	
Application basis	
Affected VIN	

1) Toe-in

The difference of measured distances between the front ends of the tires (A) and the rear ends of the tires (B) along the same axle when viewed the wheels from the top.



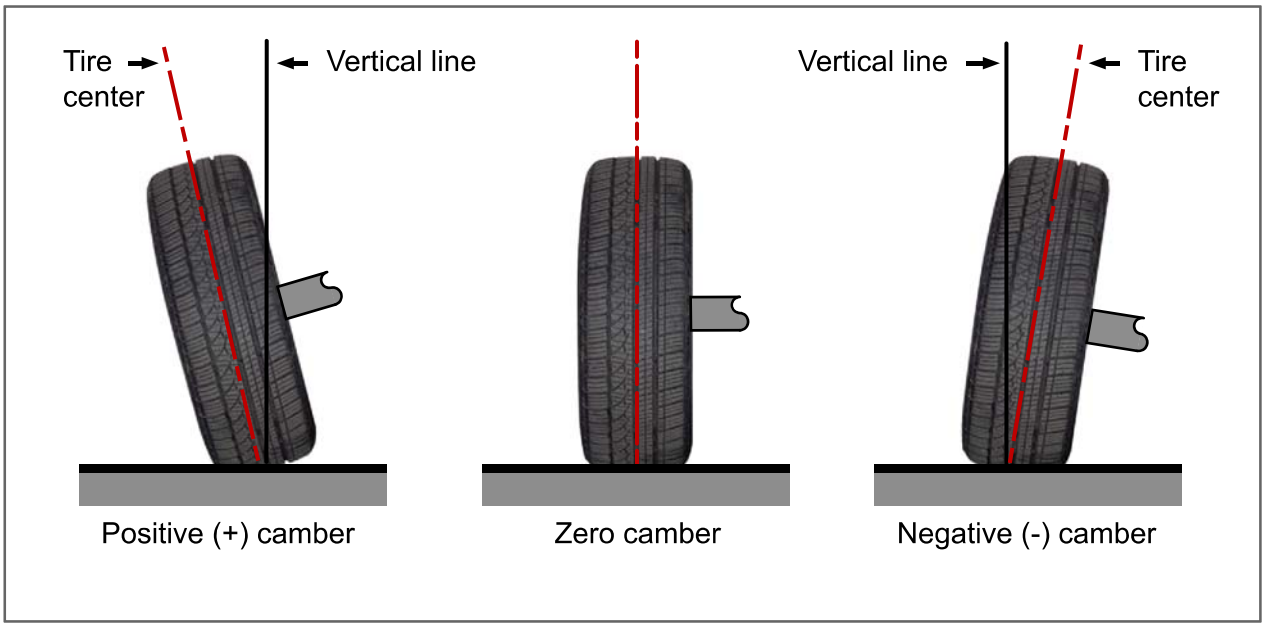
Toe-in	2 ± 2mm

▶ **When viewed from the top, the distance between the tire centers is smaller in the front than in the rear.**

- Side slip protection
- Parallel front wheels rotation (straight ahead driving is ensured by toe-in to prevent the wheels from tilting outwards by the camber while driving)
- Prevention of uneven (outward) tire wear
  Prevention of toe-out from wearing of steering linkage

2) Camber

The angle between the center line of the tire and the vertical line when viewed from the front of the vehicle



Camber	LH	0.12 ± 0.25°
	RH	0 ± 0.25°

▶ **Positive camber: Top of the tire is tilted outward**

Advantages:
- The axle is not bent when it is loaded.
- The force required to operate the steering wheel is reduced due to smaller contact area (or load area) of the tire.
- Restoring force of the steering wheel is gained (when turning the steering wheel, the tire circles and the force to lift the frame is applied. In this case, the shock absorber contracts and the restoration force is applied to the steering wheel.)

Disadvantages:
- Cornering force decreases as the positive camber increases when the vehicle makes turn.
- The hub bearing is worn unevenly if camber is excessive.

▶ **Zero camber: When the tire center line is perpendicular to the ground level**

▶ **Negative camber**

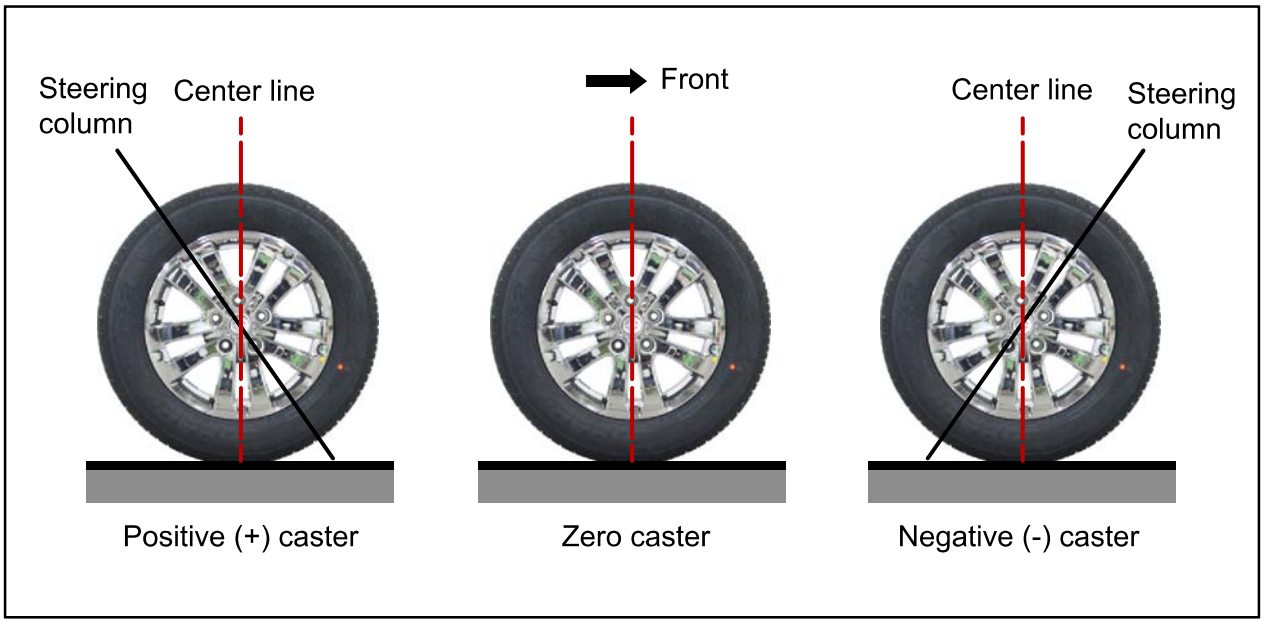
Advantages:
- Better traction force due to wide load area (applicable for off-road vehicle)
- Better corner driving when the vehicle makes turn as the cornering force

Disadvantages:
- The axle is easy to be bent or deviated in the negative camber than in the positive camber when load is applied on the axle.
- Difficult to control due to wide load area.

Modification basis	
Application basis	
Affected VIN	

3) Caster

The angle between the vertical line and king pin, which fixes the steering knuckle and front axle, (steering column which connects the top and bottom ball joints in the independent axle type) when viewed the tires from the side.



Caster	LH	4.28 ± 0.4°
	RH	4.38 ± 0.4°

▶ **Caster:** With considering the height difference between the wheel centers of the front and rear wheels. (Under standard condition that the vehicle is on a level ground)

▶ **Positive caster:** Top of the king pin is tilted backward from the vertical line of the wheel center when viewed the tires from the side

Advantages:
- Directional force to go straight (following control)
- Restoring force of the wheel (restored to the straight ahead direction)
- Prevention of wheel shimmy (wheels wobble left and right)

▶ **Negative caster:** Top of the king pin is tilted forward from the vertical line of the wheel center when viewed the tires from the side

Advantages:
- Smaller turning radius

Disadvantages:
- Impact from the road is transferred to the steering wheel (steering wheel turns)
- Poor straightness

NO DATA

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	Ø45.0 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 (5-Link) (Rigid Axle)	Type	Solid disc
	Outer diameter of disc	Ø299 m
	Thickness of disc	10.4 mm (wear limit: 8.5 mm)
	Area of brake pad	28.8cm²
	Pad wear indicator	Mechanical type
Rear brake (Multi-Link) (IRS Axle)	Type	Ventilated disc
	Outer diameter of disc	Ø307 mm
	Thickness of disc	20 mm (wear limit: 18.4 mm)
	Area of brake pad	42.5cm²
	Pad wear indicator	Mechanical type
Brake booster	Type	Vacuum assist type
Master cylinder	ype	Tandem type(integrated level sensor)
	Inner diameter of cylinder	Ø25.4 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 ~ 0.8 ℓ

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.

Modification basis	
Application basis	
Affected VIN	

2. 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

Modification basis	
Application basis	
Affected VIN	

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

Modification basis	
Application basis	
Affected VIN	

▶ 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.

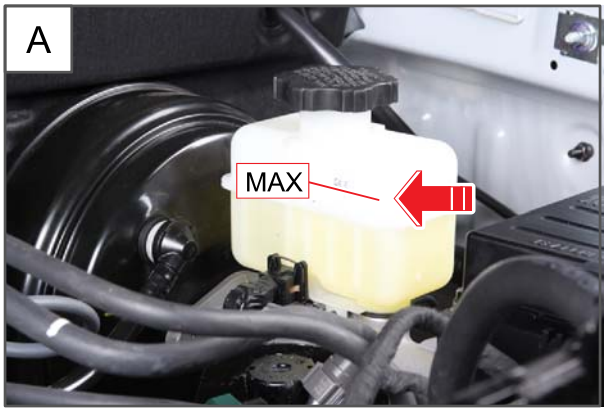
Symptom 3. "Groaning" sound occurs in the automatic transmission vehicle when slightly taking the foot off the brake pedal to slowly start after waiting for the signal, or slightly depressing the brake pedal.

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.

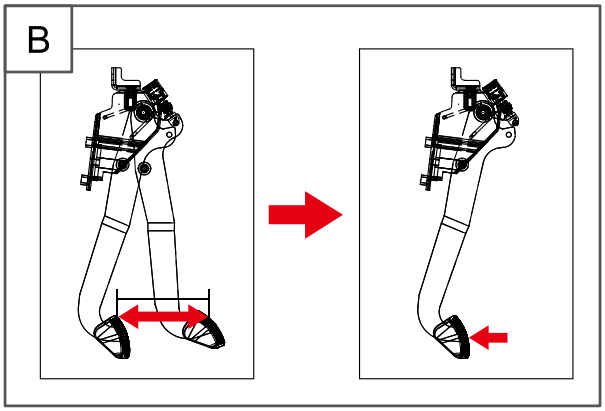
3. AIR BLEEDING

CAUTION

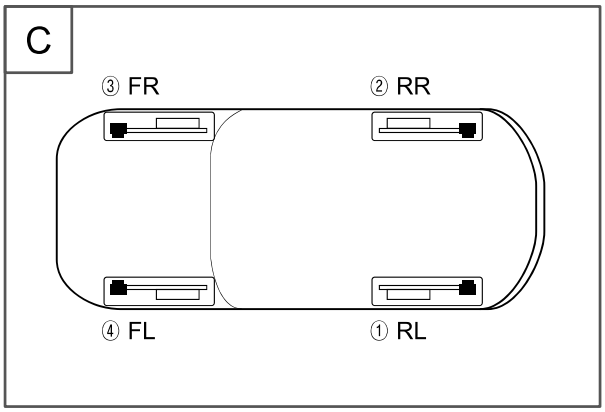
- Never reuse the used brake fluid.
- Use only specifies brake fluid (DOT 4). Add brake fluid between MAX and MIN lines on the reservoir (0.7 to 0.8 liters).
- Be careful not to splash the brake fluid on painted area or body.
- Make sure that any foreign material does not get into brake line.
- Always work with another staff.



A. Fill up the brake fluid up to "MAX" line on the reservoir.



B. Fill the reservoir with brake fluid and pump the brake pedal several times. Then keep it depressed.

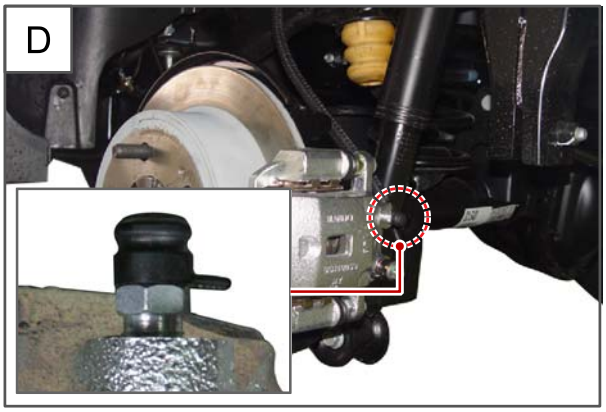


C. Loosen the bleed screw and collect the bleeding brake fluid from the brake line with the order in the figure.

CAUTION

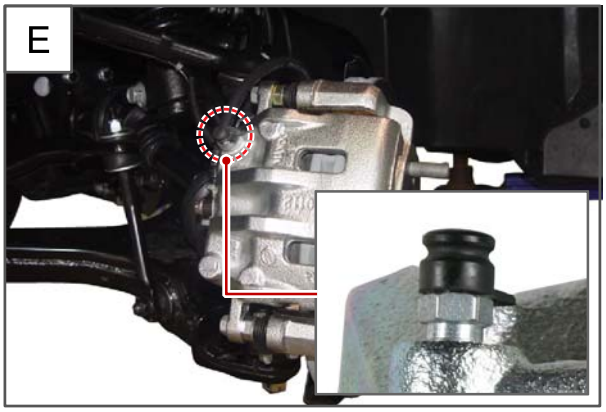
Fill the reservoir with the brake fluid as much as it bleeded, and continue to bleeding operation.

Modification basis	
Application basis	
Affected VIN	



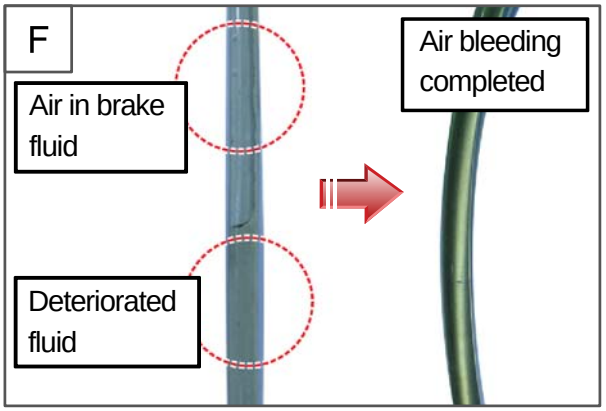
D. ir bleed screw at rear brake

Tightening torque 9.8~11.2Nm



E. Air bleed screw at front brake

Tightening torque 9.8~11.2Nm

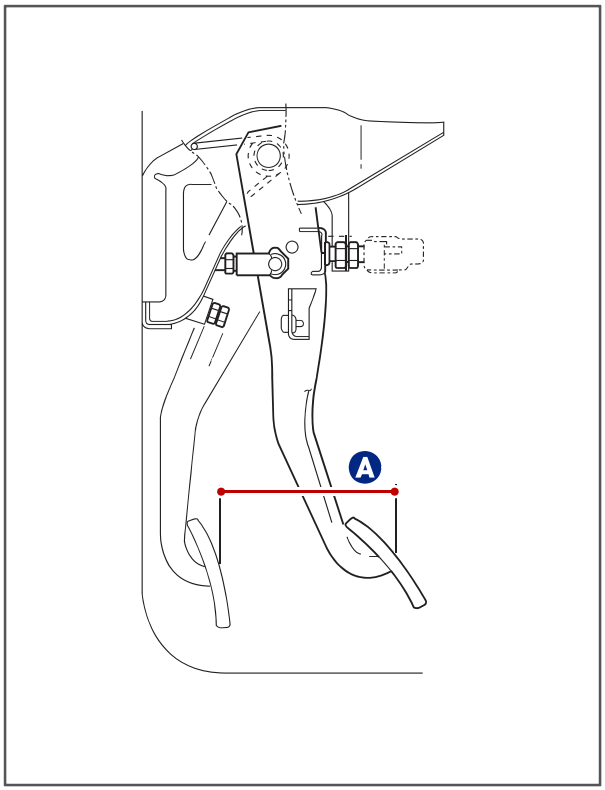


F. Repeat the air bleeding procedures until clear brake fluid comes out of air bleed screw.

G. Check for oil leaks from the brake lines.

4. RAKE SYSTEM CHECK

▶ **Maximum Stroke of Brake Pedal**



- Check the brake pedal with below procedures:

A. Start the engine.
B. Pump the brake pedal around 3 times.
C. 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.
D. If the measured value is out of the specified value, adjust the length.

Specified value (A)	138 mm

▶ Over the specified value

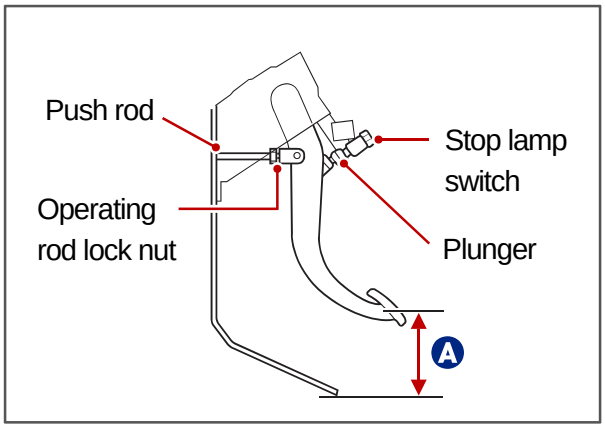
Cause	Action
Worn brake pad	Replace
Worn brake shoe	Replace
Improper stroke of hand brake	Adjust
Air in brake line	Air bleeding
Oil leak	Repair or replace
Brake booster push rod	Replace or adjust
Improperly adjusted stopper bolt	Adjust

▶ Below the specified value

Cause	Action
Brake booster push rod	Replace or adjust
Air in brake fluid	Replace
Improperly adjusted stopper bolt	Adjust

Modification basis	
Application basis	
Affected VIN	

▶ Pedal Height



- Check the pedal height with below procedures:

A. Start the engine and measure the length (A) between floor mat and pedal.
B. If the measured value is out of the specified value, adjust the length.

Specified value (A)	179 mm (from carpet)

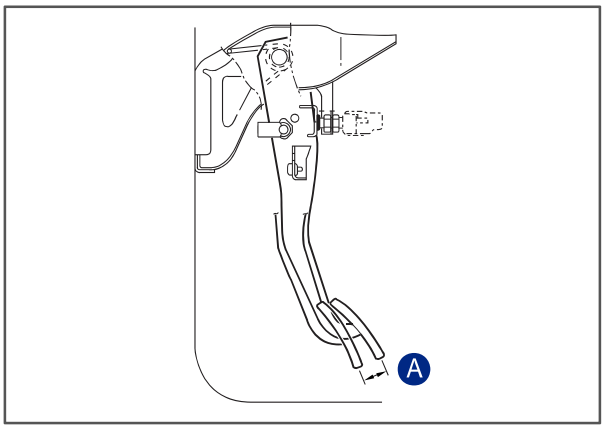
CAUTION
Remove the service mat before measuring the pedal height.

- Adjust the pedal height with below procedures:

A. Disconnect the stop lamp switch connector.
B. Unscrew the lock nut and remove the stop lamp switch assembly.
C. Loosen the lock nut on the pedal push rod.
D. Turn the pedal push rod to adjust the pedal height.
E. Tighten the lock nut.
F. Install the stop lamp switch assembly.
G. Connect the stop lamp switch connector.
Check if the stop lamps come on when
H. pressing the brake pedal around 5 mm.
If the stop lamp dpes not come on,
I. adjust the stop lamp switch assembly again.
J. If the stop lamps come on, tighten the lock nut and measure the pedal height again.

CAUTION
If the measurement is out of the specified value, loosen the lock nut and adjust the pedal height.

▶ Pedal Free Play



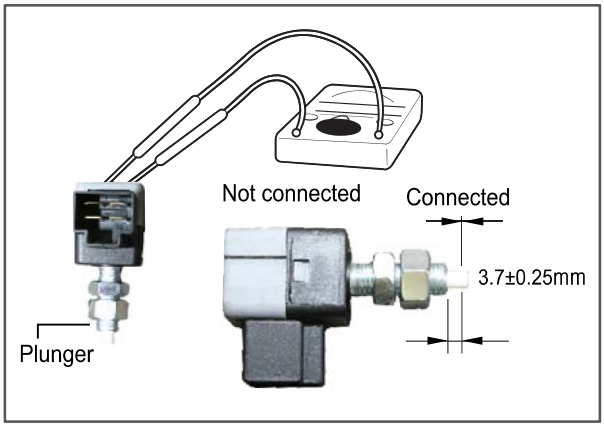
- Check the pedal free play with below procedures:

A. Stop the engine.
B. Depress the brake pedal several times to discharge the vacuum pressure of the brake booster.
C. Depress the brake pedal until you feel the resistance, and measure the movement (A).

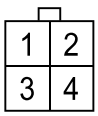
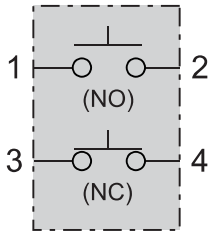
Specified value (A)	3 ~ 8 mm

If the free play is below the specified value, check if the clearance between the outer case of the stop lamp and the brake pedal is within the specified range. If the clearance is out of the specified range, the clearance between the clevis pin and the brake pedal arm is too large. Check the components and repair if needed.

▶ Stop Lamp Switch



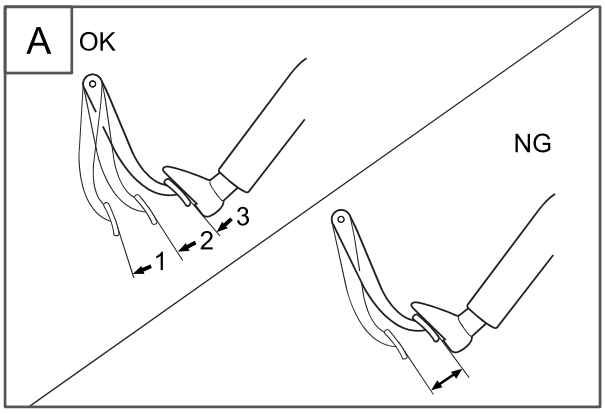
A. Connect the multimeter to stop lamp switch connector (N.O.) and check if the continuity exists when pushing in the plunger. If the continuity doesn't exist, the stop lamp switch is normal.
B. Connect the multimeter to stop lamp switch connector (N.C.) and check if the continuity exists when pushing in the plunger. If the continuity doesn't exist, the stop lamp switch is normal.

Stop Lamp Switch	
	
Connector	Internal circuit

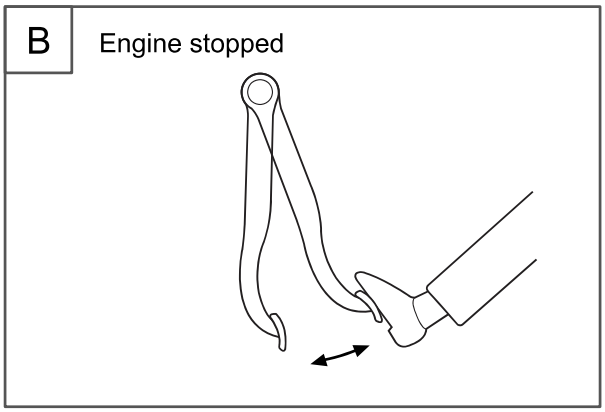
Type	Plunger	
	Pushed	Not pushed
N.C	Continuity	Not continuity
N.O	Not continuity	Continuity

Modification basis	
Application basis	
Affected VIN	

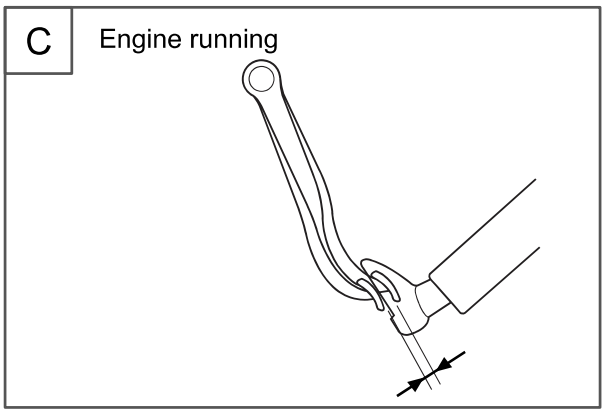
▶ Brake Booster



A. 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.



B. 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.



C. 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.

▶ Brake Fluid

A. Color

- Ligh gold (New oil) → Brown → Black

B. Service Interval/Type

- Change: every 2 years, Type: DOT4

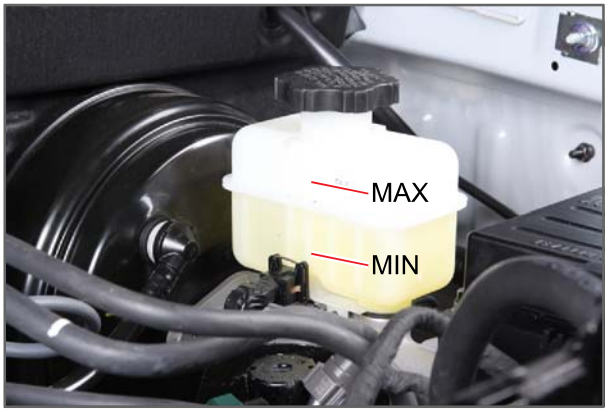
NOTE

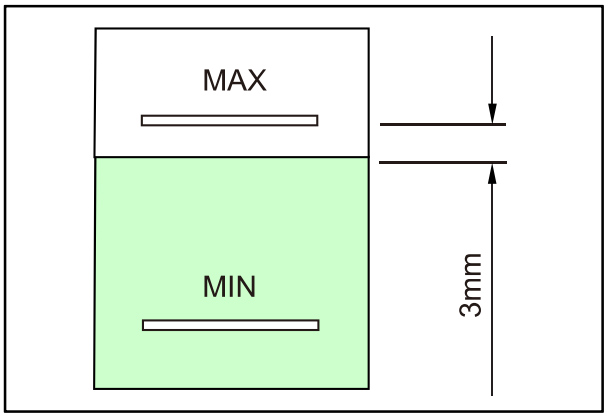
The water in the brake fluid has an adverse effect to the brake system. If the fluid contains around 3% of water, the boiling point of the brake fluid goes down by 25%. It will cause the vapor lock frequently.
Water content in fluid: around 3% after 18 months, around 7~10% after few years
The water ib 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



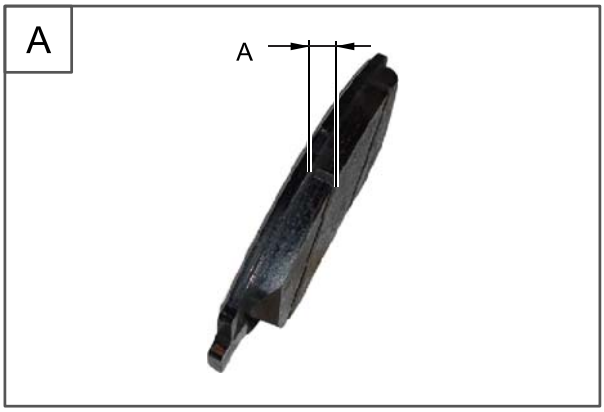


The brake fluid level should be between "MAX" and "MIN" on the reservoir. If it is below "MIN" mark, check for oil leaks and refill the reservoir with the specified fluid.

Modification basis	
Application basis	
Affected VIN	

▶ Front Brake

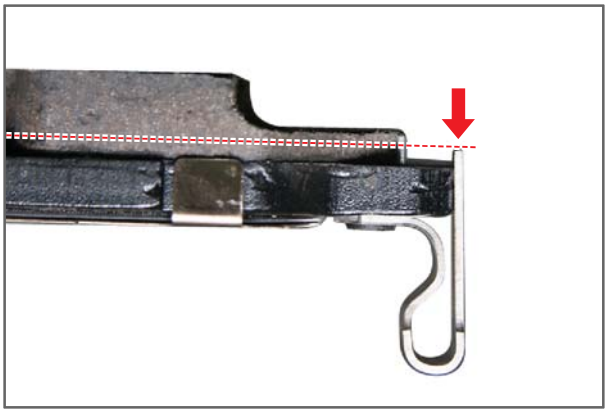
A



A. 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

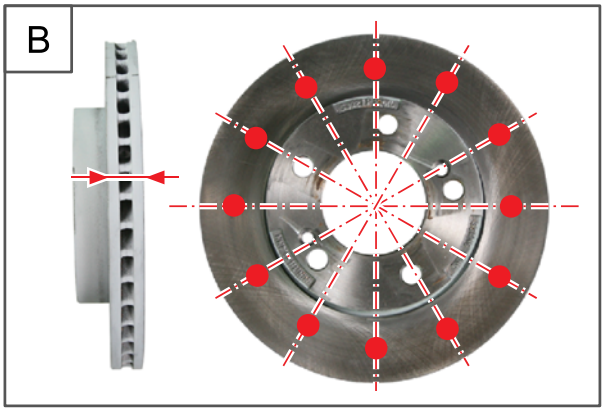


- Wera limit point.

NOTE

If a brake pad is worn beyond the wear limit, replace both front brake pads.

B



B. Disc Thickness

- Measure the disc thickness at over ten 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

C

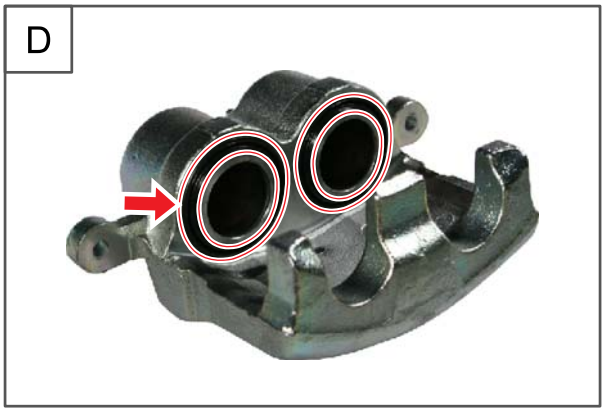


C. Disc Run-Out

- 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 brakin

Limit	0.03 mm (before installation)
	0.07 mm (when installed)

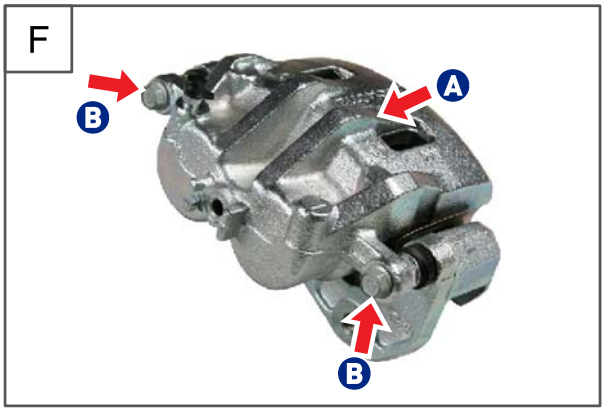
Clean the dissembled components and visually check the followings:



D. Damage and tear on boot



E. Uneven wear and oil contamination



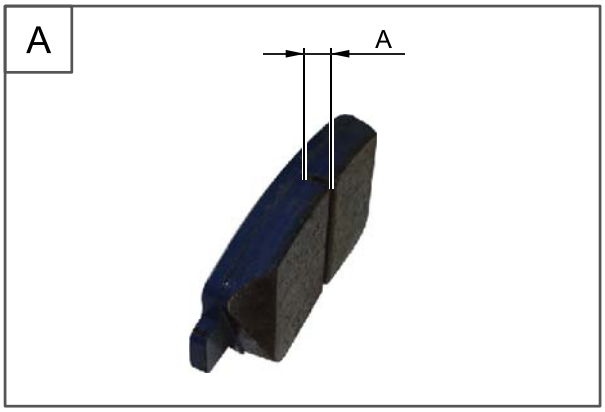
F. Damage, crack and wear on cylinder body (A) and guide pin (B)

G. Wear, rust and damage on the cylinder and piston

H. Scratch and bending on disc plate

Modification basis	
Application basis	
Affected VIN	

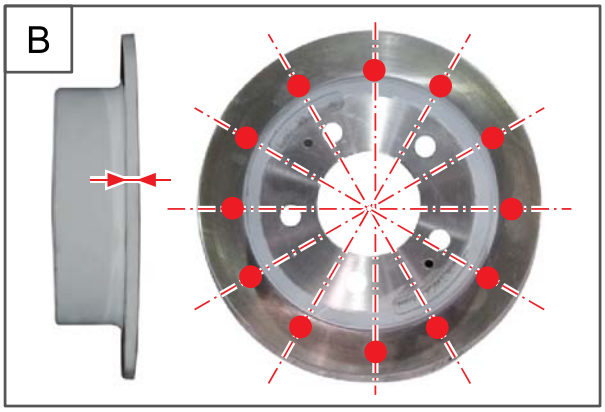
▶ Rear Brake



A. Pad Thickness

- Remove the front tire.
- 2. Measure the pad thickness and replace it if it is below the wear limit.

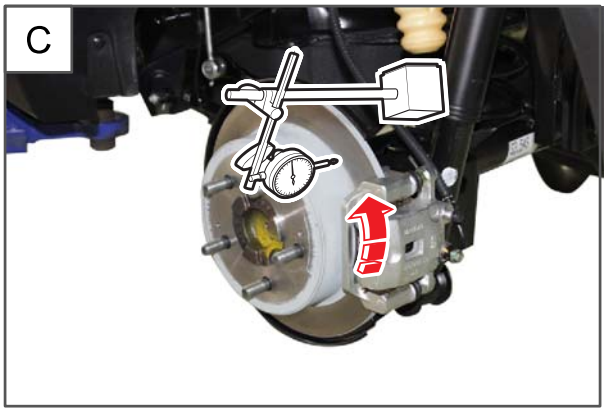
New pad	Wear limit
10 mm	2 mm



B. Disc thickness

- Measure the disc thickness at over ten points.
- If any of measured points is below the wear limit, replace the brake disc with new one.

New disc		Wear limit
5-link	10.4mm	8.5mm
Multi-link	20.0mm	18.4mm



C. 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)

▶ Parking Brake







Check the brake force with below procedures:

A. Count the number of the clicks (notches) when pulling up the parking brake with 19.0 ± 1.5kgf of force.

Specified notches	5

B. If the clicks are over or below the specified value, adjust the clicks to the specified value with the parking brake

C. adjusting nut.
Check the parking brake force after

D. adjustment.
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.

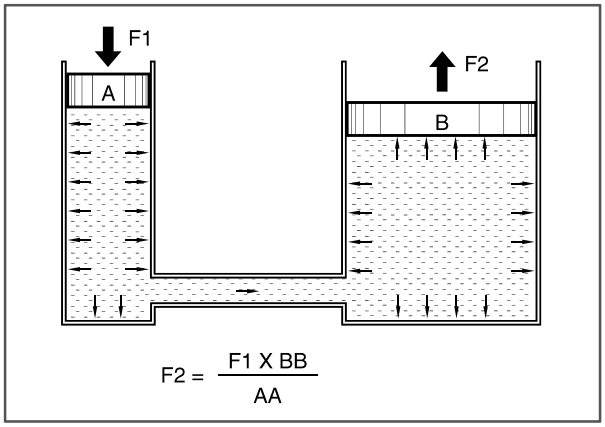
Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

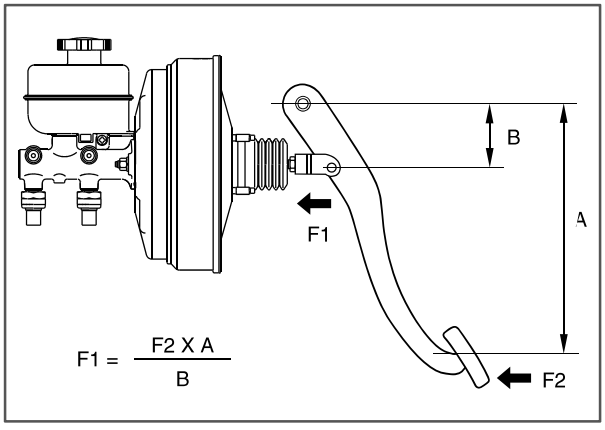
Even though a driver cuts off the power, while driving, the vehicle continues to move due to the law of inertia. Therefore, a braking device is needed to stop the vehicle. The brake system normally uses the frictional discs that converts the kinetic energy to the thermal energy by frictional operation. 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.

Modification basis	
Application basis	
Affected VIN	

Memo

2. SYSTEM LAYOUT

HECU Assembly

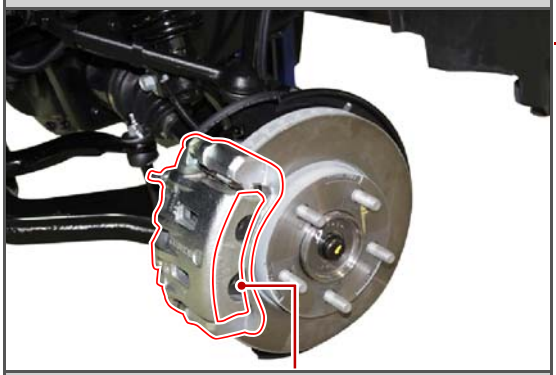


Brake Master Cylinder & Booster





Front Brake Caliper Assembly



Front Brake Pad

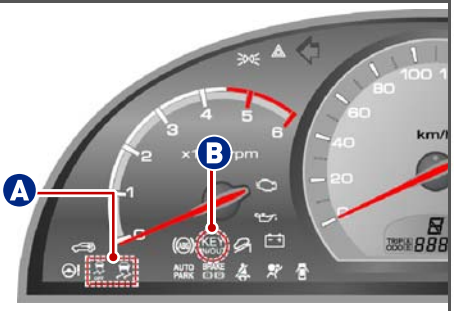


Wheel Speed Sensor(4WD)

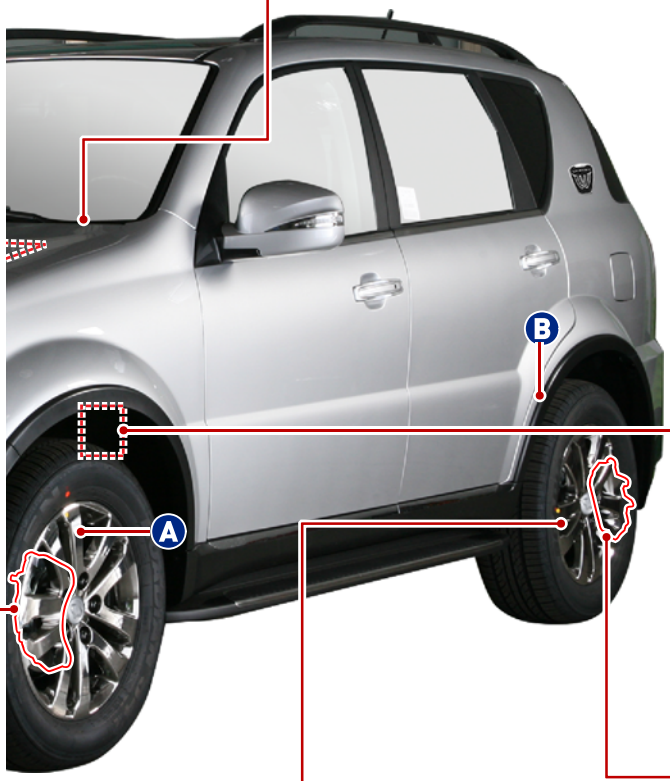
A. Front	B. Rear
	

Modification basis	
Application basis	
Affected VIN	

Indicator & Warning Lamp



A. ABS indicator/warning lamp
B. Parking brake indicator



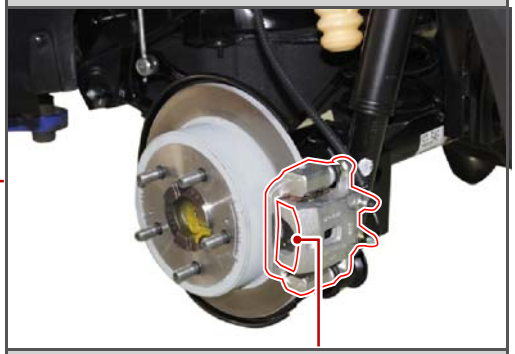
Parking Brake Lever



Brake Pedal



Rear Brake Caliper Assembly



Rear Brake Pad



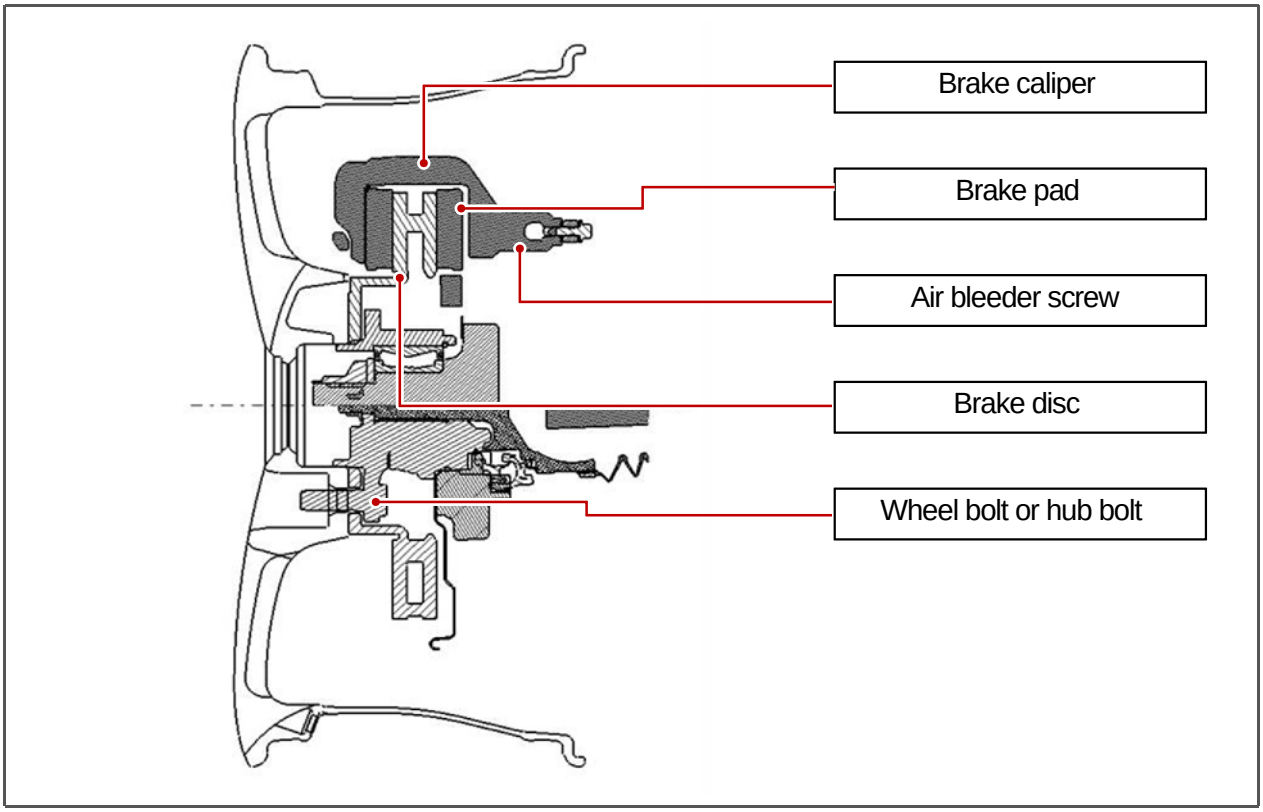
Parking Brake Assembly

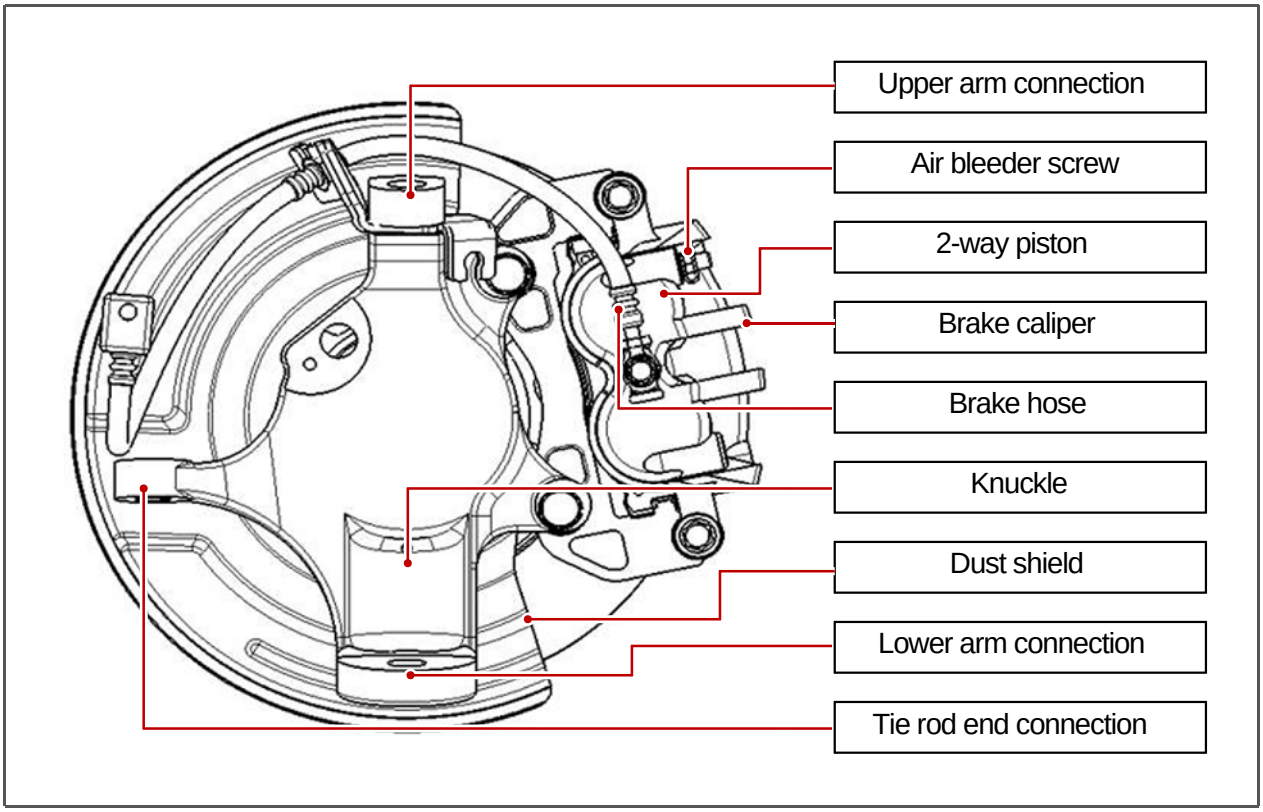


Modification basis	
Application basis	
Affected VIN	

3. SECTIONAL DIAGRAM

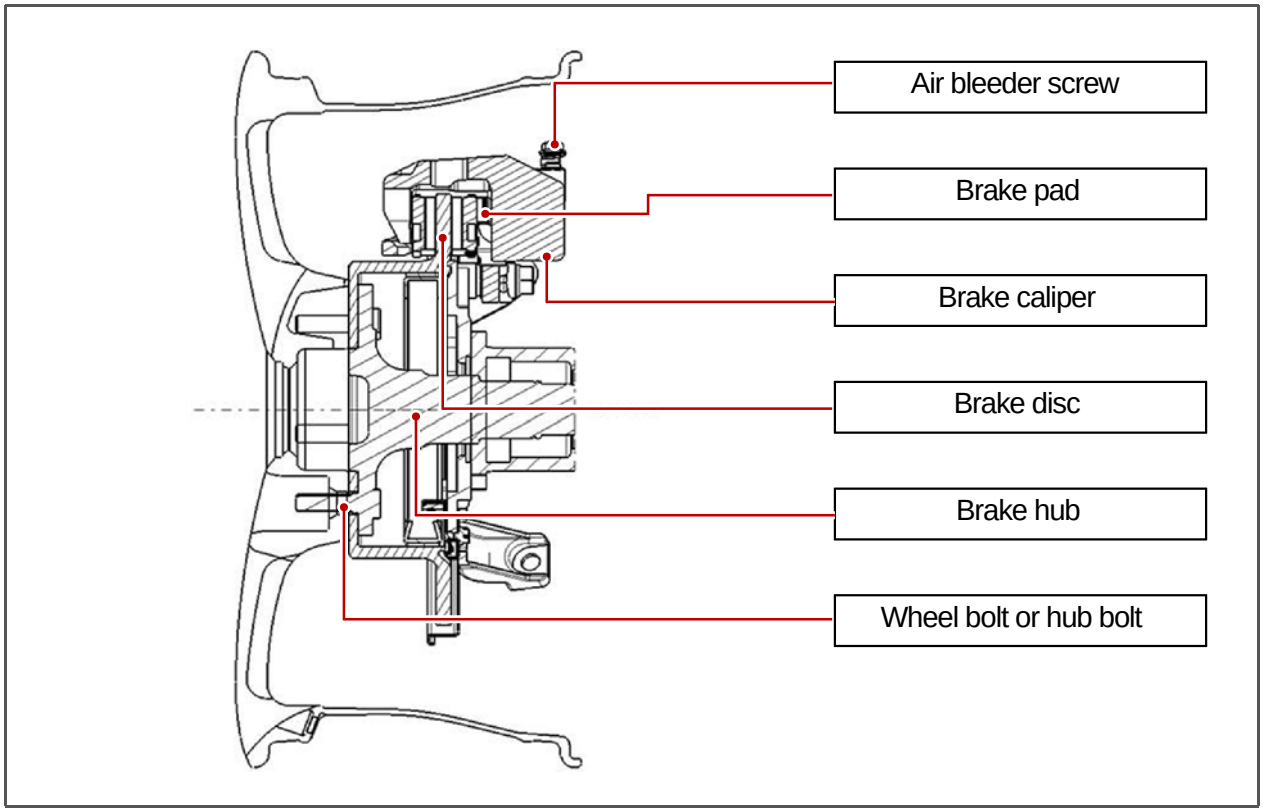
▶ **Front Disc Brake**

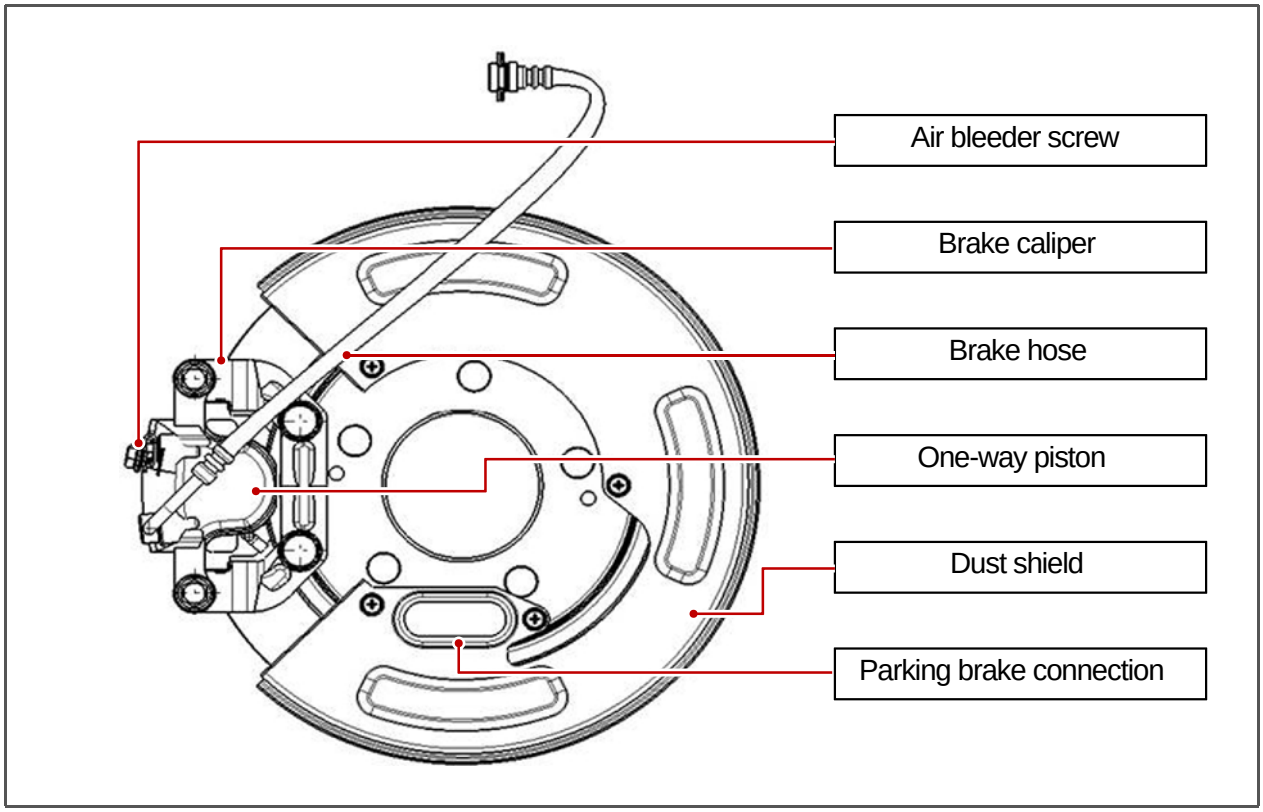




Modification basis	
Application basis	
Affected VIN	

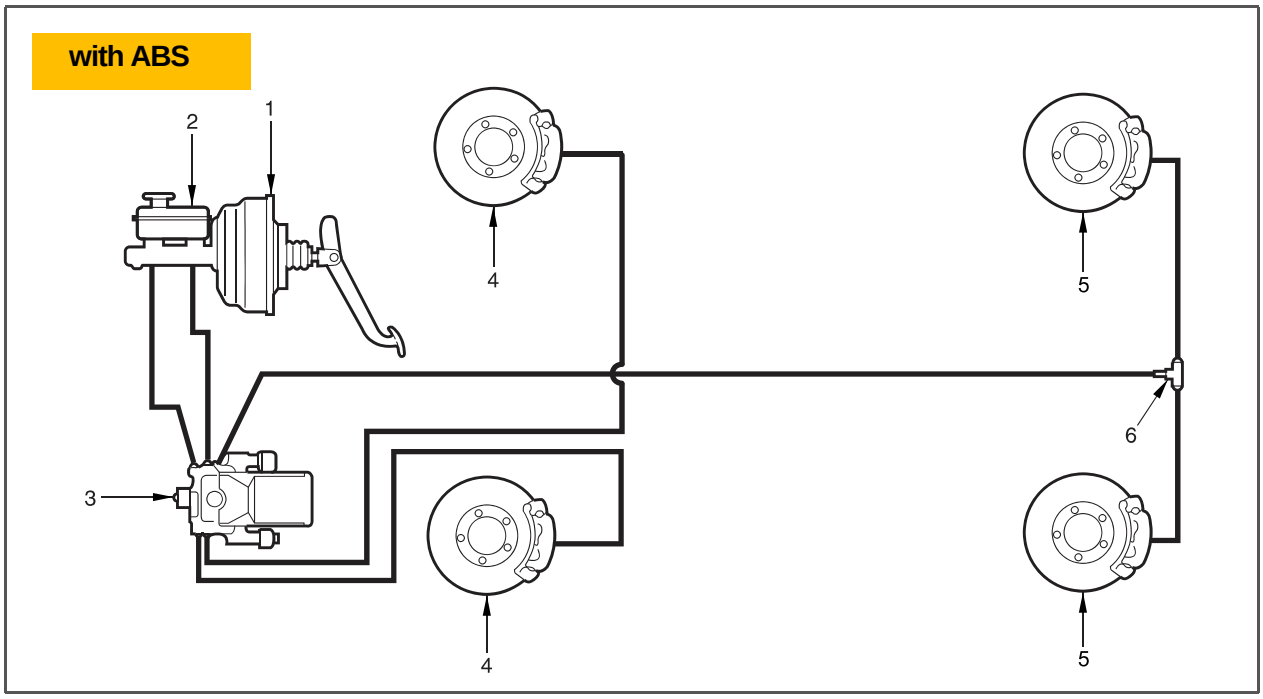
▶ Rear Disc Brake





Modification basis	
Application basis	
Affected VIN	

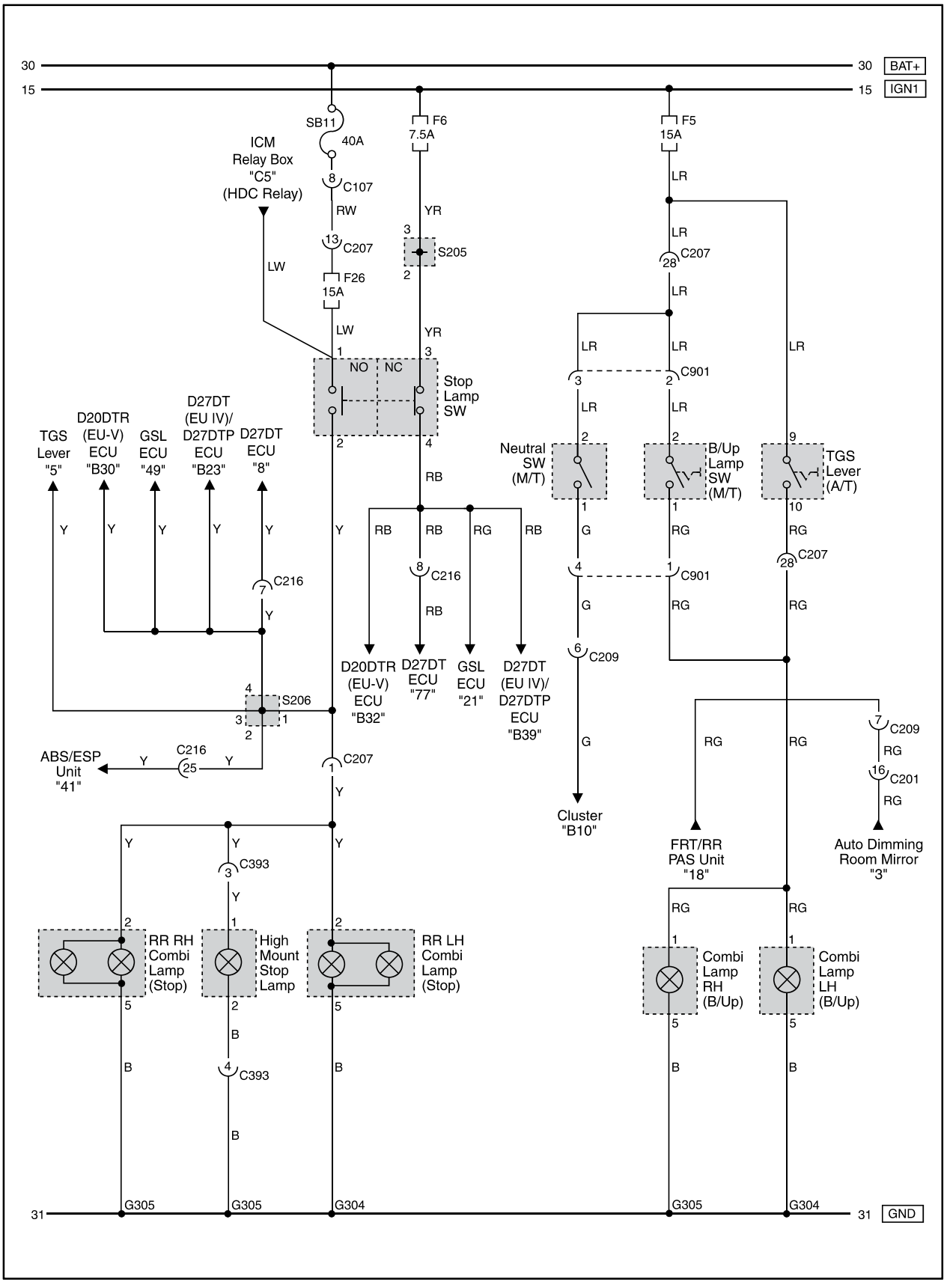
4. HYDRAULIC CIRCUIT



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

Modification basis	
Application basis	
Affected VIN	

5. CIRCUIT DIAGRAM OF STOP LAMP



Modification basis	
Application basis	
Affected VIN	

ABS

4892-01

GENERAL INFORMATION

1. SPECIFICATIONS

Description	Specification	Remark
	ABS	
HECU	Clock frequency: 28 MHz	
	CPU: MCU60 (32bit)	
	Memory: 128~256 kb	
	Switch orifice	
Wheel speed sensor	Active type	Output: 7~14 mA
Steering wheel angle sensor	None	
Sensor cluster	None	
Longitudinal G sensor	4WD only (integrated in ABS HECU)	
Pressure sensor	None	

1) Specifications of Active Wheel Speed Sensor

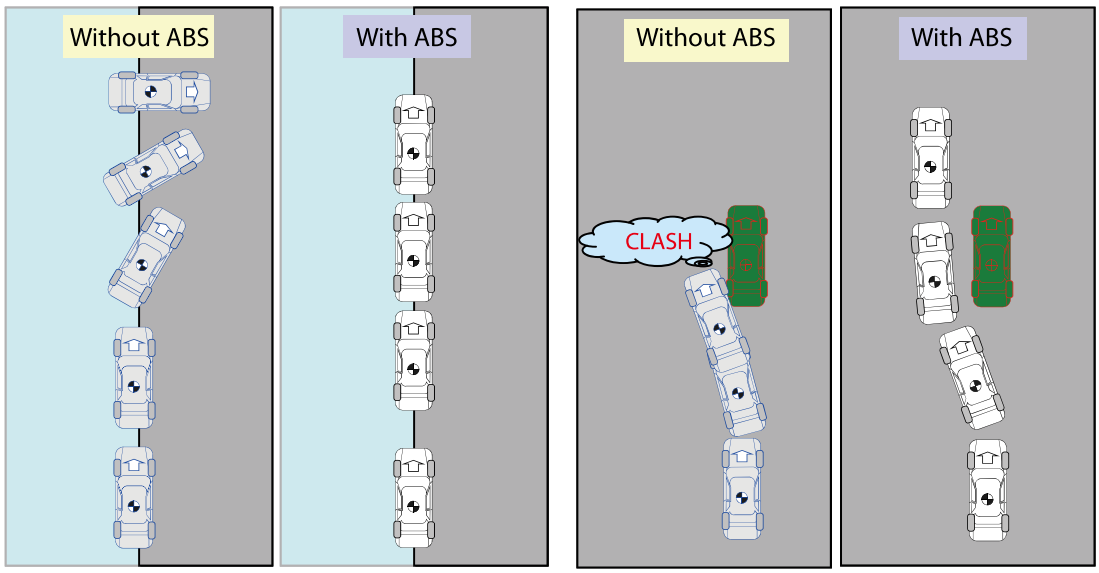
Description	Specification	Remark
Supplying voltage	4.5 ~ 16.0V	
Output current (vehicle speed: approx. 2.75km/h)	7mA(Lo) ~ 14mA(Hi)	
Operating temperature	−40 ~ 150℃	
Operating frequency	1 ~ 2,500Hz	
Tightening torque	Front: 7.8~11.7 Nm	
	Rear: 7.8~11.8 Nm	

OVERVIEW AND OPERATING PROCESS

1. SYSTEM OVERVIEW

When braking suddenly or braking on slippery roads, the vehicle keeps moving forward but the wheels are locking and not rotating. If these happen, the vehicle may lose stability or rotate resulting in an accident. ABS helps to maintain directional stability and control of the vehicle. ABS is designed to secure more safety and increase the control of steering wheel during emergency braking situation. But, ABS does not guarantee perfect safety beyond its physical limit. ABS in this vehicle contains EBD function. In normal driving conditions, the brake system operates without ABS function.

▶ **ABS effect according to braking conditions**



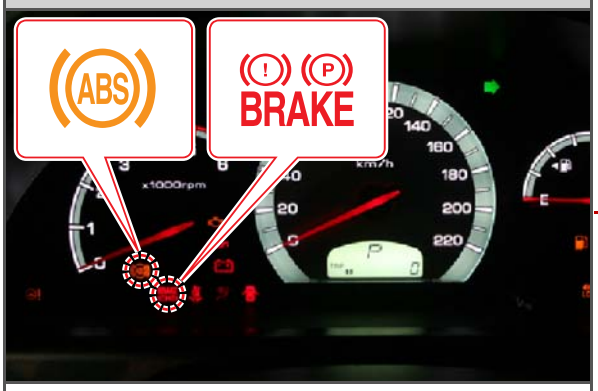
Braking on split road **Maneuvering while braking**

Modification basis	
Application basis	
Affected VIN	

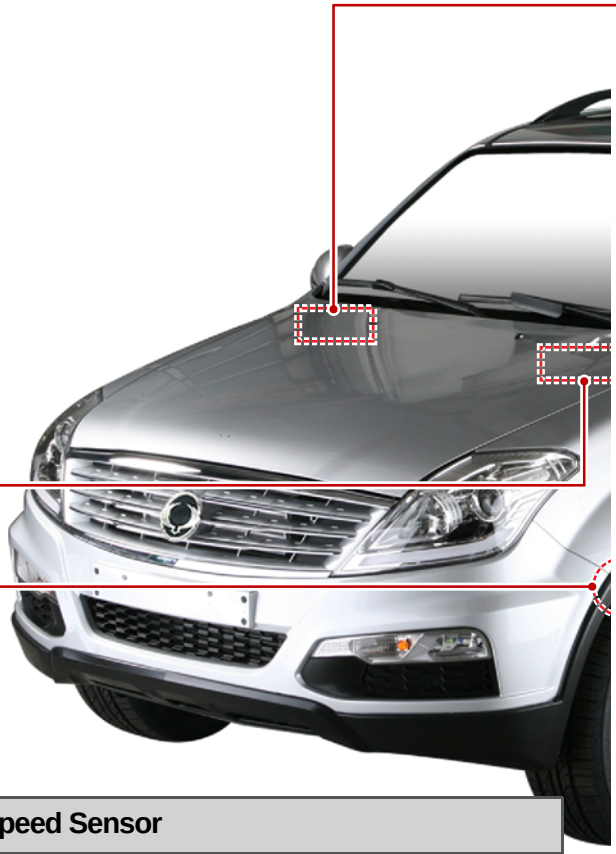
Memo

2. COMPONENTS AND LAYOUT

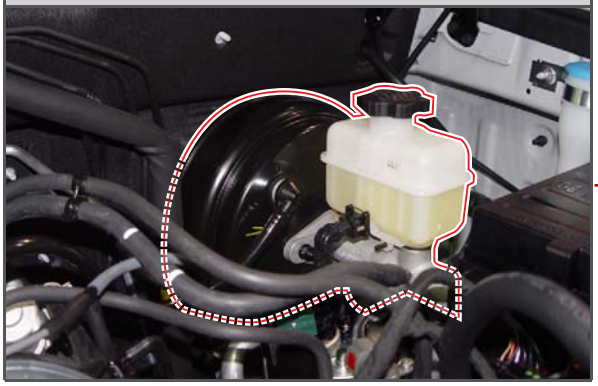
ABS Warning Lamp



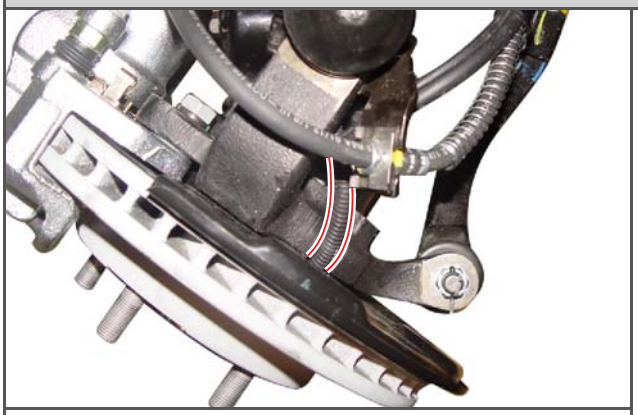
EBD warning lamp (ABS warning lamp and Brake warning lamp ON together



Brake Master Cylinder and Booster



Front Active Wheel Speed Sensor



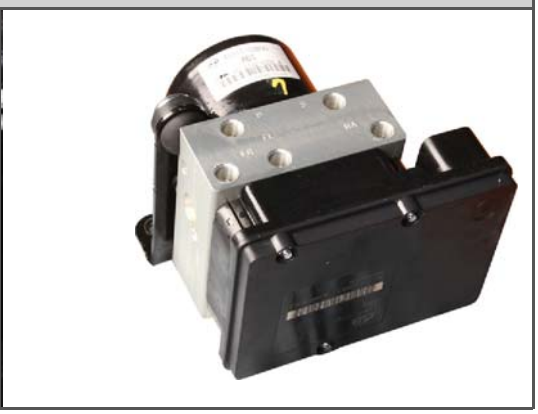
It is installed on the front hub assembly.

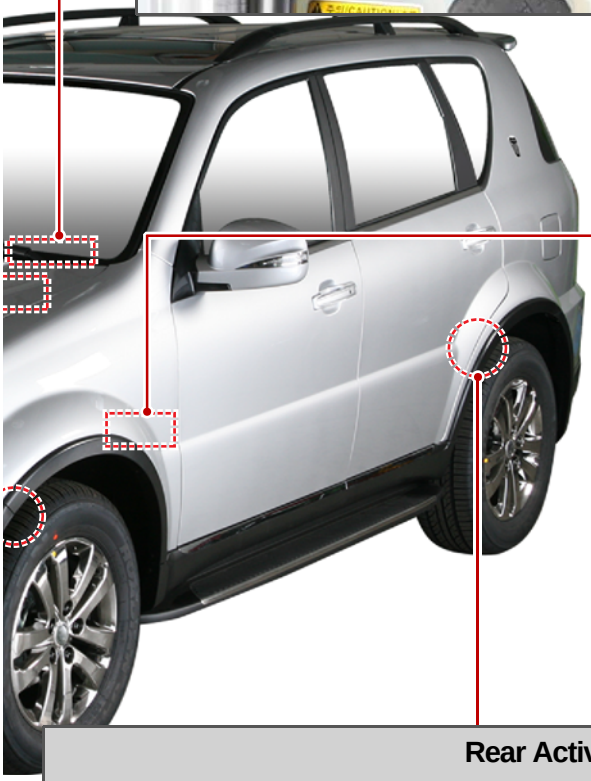


Modification basis	
Application basis	
Affected VIN	

HECU (Hydraulic & Electronic Control Unit)







Diagnostic Connector



Rear Active Wheel Speed Sensor

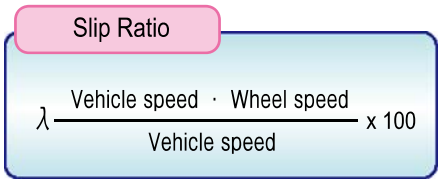


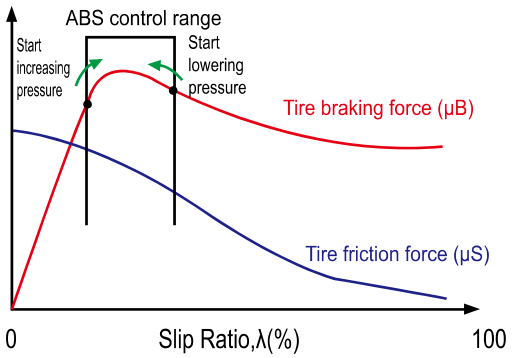
It is installed on the rear axle.



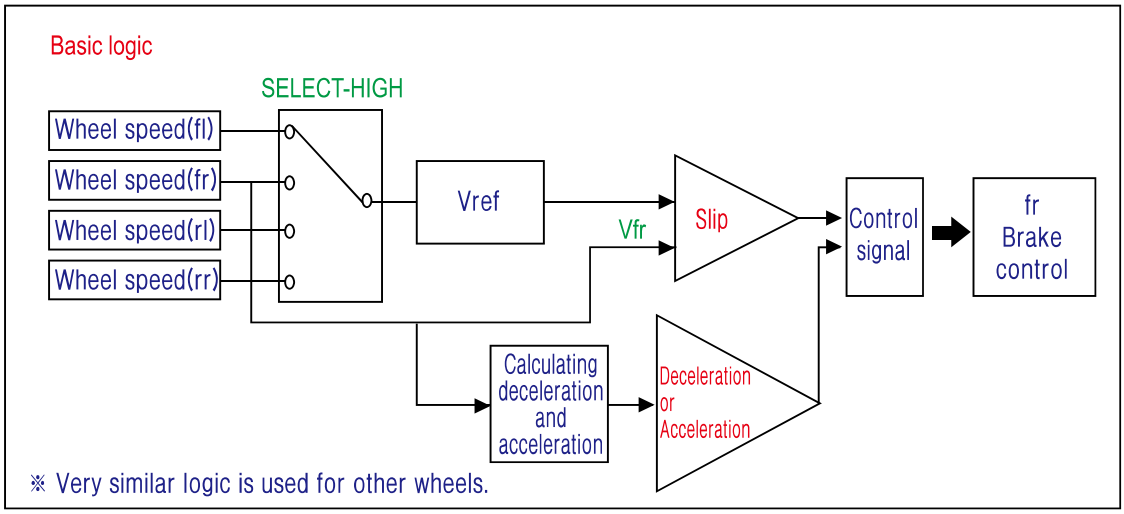
Modification basis	
Application basis	
Affected VIN	

3. ABS CONTROL LOGIC





λ=0% : Brake not in operation λ=100% : Wheel fully locked



The principal ABS control logic is the determination of the reference speed by choosing one wheel meeting a certain condition, while sensing the speed information from 4 wheel speed sensors when the vehicle is being driven.
For example, when the comparison of the reference speed with front right wheel speed shows a slip, the control signal is determined according to whether it's deceleration or acceleration. If the control conditions are met, the brake for the front right wheel will be got under control.

Modification basis	
Application basis	
Affected VIN	

4. WARNING LAMPS



A. ABS warning lamp B. Brake warning lamp
(EBD warning lamp: ABS warning lamp + Brake warning lamp)

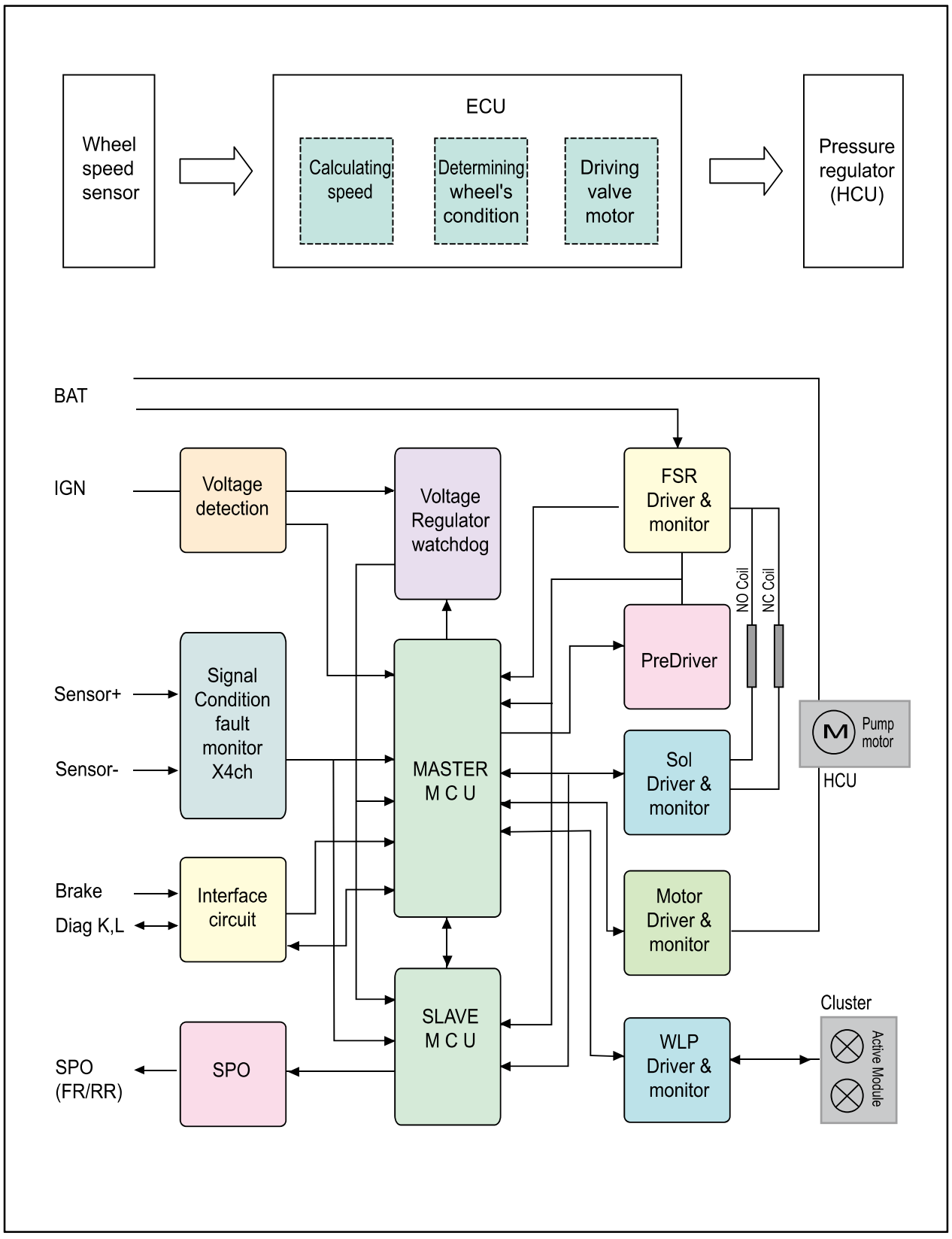
1) ABS Warning Lamp

ABS warning lamp module indicates the self diagnosis and malfunction.
ABS warning lamp ON:

1. When turning the ignition switch to ON position, ABS warning lamp comes on for 3 seconds for self-diagnosis and goes off if the system is OK (initialization mode).
2. When the system is defective, the warning lamp comes on.
3. When the self-diagnosis is performing, the warning lamp comes on.
4. When the HECU connector is disconnected, the warning lamp comes on.
5. ABS is not available during lamp ON. In this condition, Only normal brake system without ABS function is available.
6. When the communication between warning lamp CAN module in meter cluster, the warning lamp comes on.

5. SYSTEM OPERATION

1) Block Diagram of ABS HECU



Modification basis	
Application basis	
Affected VIN	

2) Basic Theory of ABS Function

To give you a better understanding of the tasks and functions of ABS, we will first look at the physics principles.

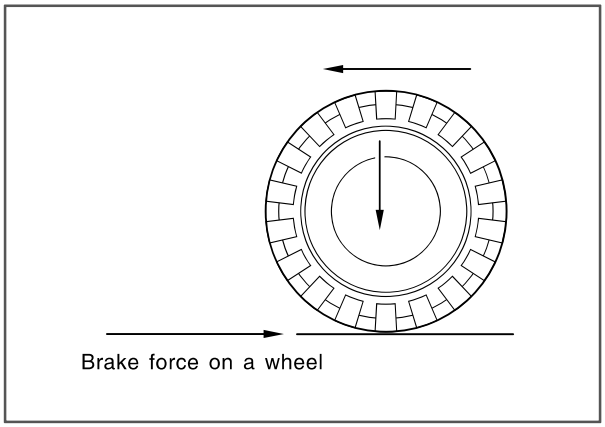
(1) Stopping distance

The stopping distance depends on the vehicle weight and initial speed when braking starts. This also applies for vehicle with ABS, where ABS always tries to set an optimum brake force on each wheel. As great forces are exerted between the tires and the carriageway when braking, even with ABS the wheels may scream and rubber is left on the road. With an ABS skid mark one may be able to clearly recognize the tire profile. The skid mark of an ABS vehicle does not however leave any hint of the speed of the vehicle in the case of an accident, as it can only be clearly drawn at the start of braking.

(2) Brake force on a wheel

The maximum possible brake force on a wheel depends on the wheel load and the adhesion coefficient between tire and carriageway. With a low adhesion coefficient the brake force, which can be obtained is very low. You are bound to know the result already from driving on winter roads. With a high adhesion coefficient on a dry road, the brake force, which can be obtained, is considerably higher. The brake force, which can be obtained, can be calculated from below formula:

▶ **Maximum brake force**



Brake force on a wheel

FBmax =
wheel load FR x coefficient of frictionMh

The braking process cannot be described sufficiently accurately with the brake forces calculated. The values calculated only apply if the wheel is not locked. In the case of a locking wheel, the static friction turns into lower sliding friction, with the result that the stopping distance is increased. This loss of friction is termed "slip" in specialist literature.

▶ Slip

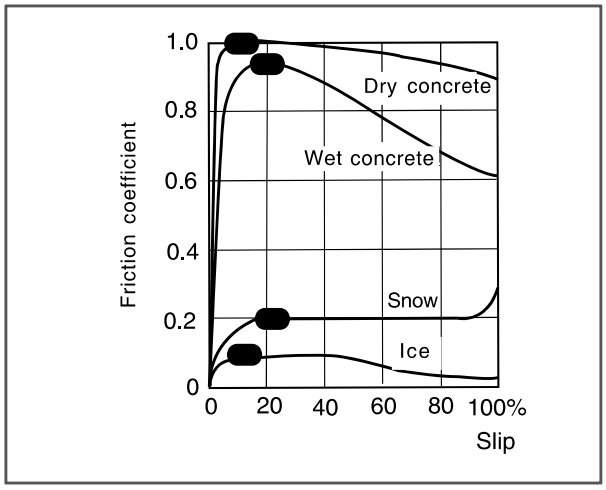
The brake slip is the difference between the vehicle speed and the wheel circumference speed. If the wheel locks, the slip is greatest, that is 100 %. If the wheel is running freely and un-braked, the slip is the lowest, equal to 0 %. Slip can be calculated from the vehicle speed Vveh and the wheel speed Vw. The equation for this is:

Vveh = 100 km/h, Vw = 70 km/h

$$\text{Slip ratio (S)} = \frac{\text{Vveh - Vw}}{\text{Vveh}} \times 100\%$$

S = 30%

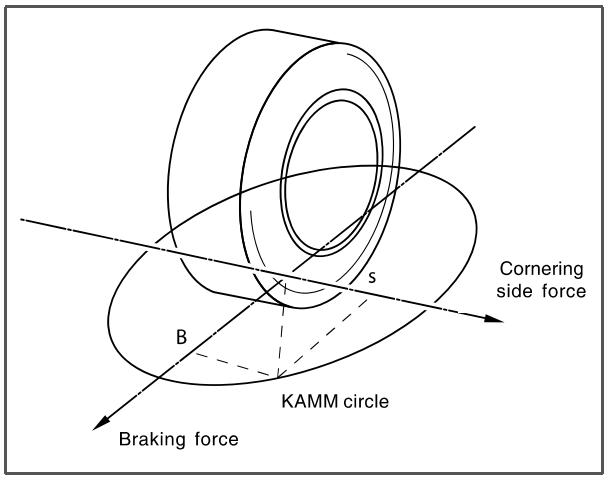
▶ Typical Slip Curves



For the various road conditions, the friction coefficients were plotted. The typical course of the curves is always the same. The only special feature is shown by the curve for freshly fallen snow, for this curve increases at 100 % slip. In a vehicle without ABS, the wheel locks on braking and therefore pushes a wedge before it. This wedge of loose surface or freshly fallen snow means and increased resistance and as a result the stopping distance is shorter. This reduction in stopping distance is not possible with a vehicle with ABS, as the wheel does not lock. On these surfaces the stopping distance with ABS is longer than without ABS. The reason for this is based in physics and not in the Anti-Lock System.
However, as mentioned before, ABS is not about the stopping distance, but maneuverability and driving stability, for the vehicle with locking wheels without ABS cannot be steered.

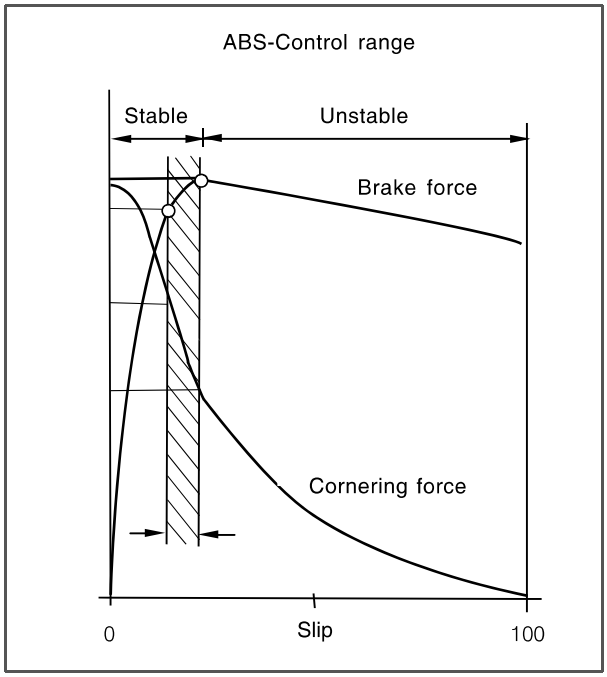
Modification basis	
Application basis	
Affected VIN	

▶ KAMM circle



Before we go into the Kamm circle, you should know that a tire offers a maximum of 100 % transmissibility. It is all the same for the tire whether we require 100 % in the direction of braking or in the direction of the acting lateral force, e.g. when driving round curves. If we drive into a curve too fast and the tire requires 100 % transmissibility as cornering force, the tire cannot transmit any additional brake force. In spite of the ABS the car is carried out of the curve. The relationship between brake force B and cornering force S is shown very clearly in the Kamm circle. If we put a vehicle wheel in this circle, the relationship becomes even clearer. In this relationship: as long as the acting forces and the resulting force remain within the circle, the vehicle is stable to drive. If a force exceeds the circle, the vehicle leaves the road.

▶ Brake and cornering force

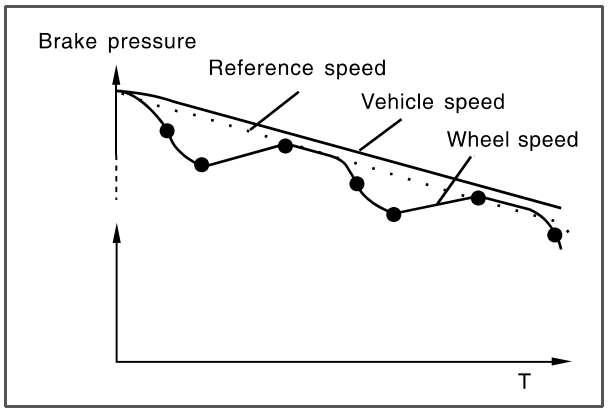


- Brake force
  When depressing the brake pedal the brake force increases to the maximum, then the brake force decreases until the wheel locks.
  Cornering force
- The cornering force is a maximum when the wheel is turning freely with zero slip. When braking the cornering force falls to zero if the wheel locks (slip 100 %).
  ABS operating range
  The operating range starts just before the
- maximum brake force and ends in maximum, for the unstable range then begins, in which no further modulation is possible. The ABS controls the regulation of the brake pressure so that the brake force only becomes great enough for a sufficient proportion of cornering force to remain. With ABS we remain in the Kamm circle as long as the car is driving sensibly. We will leave driving physics with these statements and turn to the braking systems with and without ABS.

Modification basis	
Application basis	
Affected VIN	

3) Basic ABS Control

▶ Operation of ABS control unit



Applications of the ABS control unit The signals produced by the wheel sensors are evaluated in the electronic control unit. From the information received, the control unit must first compute the following variables:

- Wheel speed
- Reference speed
- Deceleration
- Slip

▶ Reference speed

The reference speed is the mean, I.e. average speed of all wheel speeds determined by simple approximation.

▶ Simplified ABS control

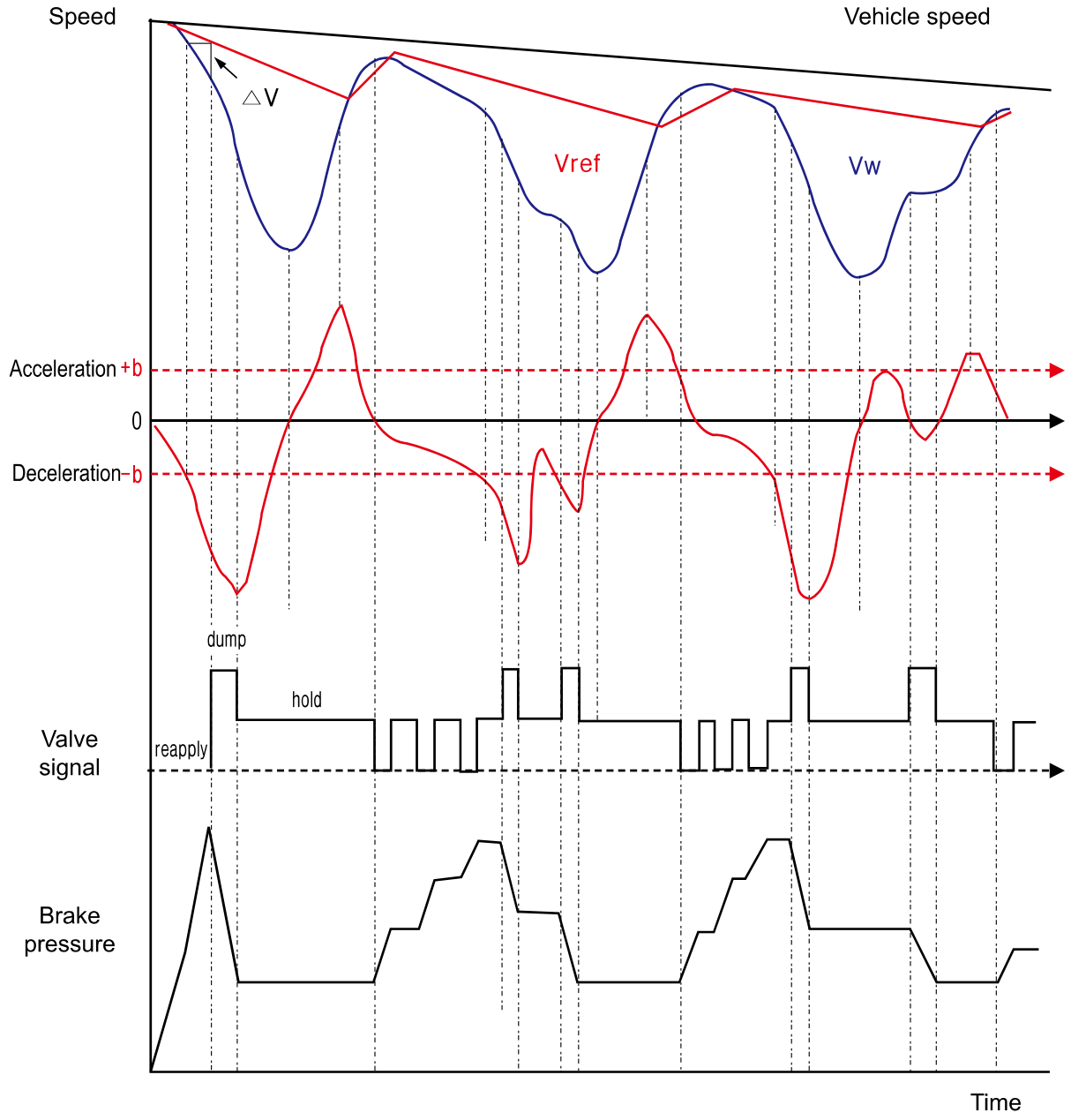
If, during braking, one wheel speed deviates from the reference speed, the ABS control unit attempts to correct that wheel speed by modulating the brake pressure until it again matches the reference speed. When all four wheels tend to lock, all four wheels speeds suddenly deviate from the previously determined reference speed. In that case, the control cycle is initiated again in order to again correct the wheel speed by modulating the brake pressure.

▶ Select Low control

This control is used for the rear axle. This controls the brake pressure on the rear wheels so that the rear wheels will not be locked.

Modification basis	
Application basis	
Affected VIN	

4) ABS Control Pattern

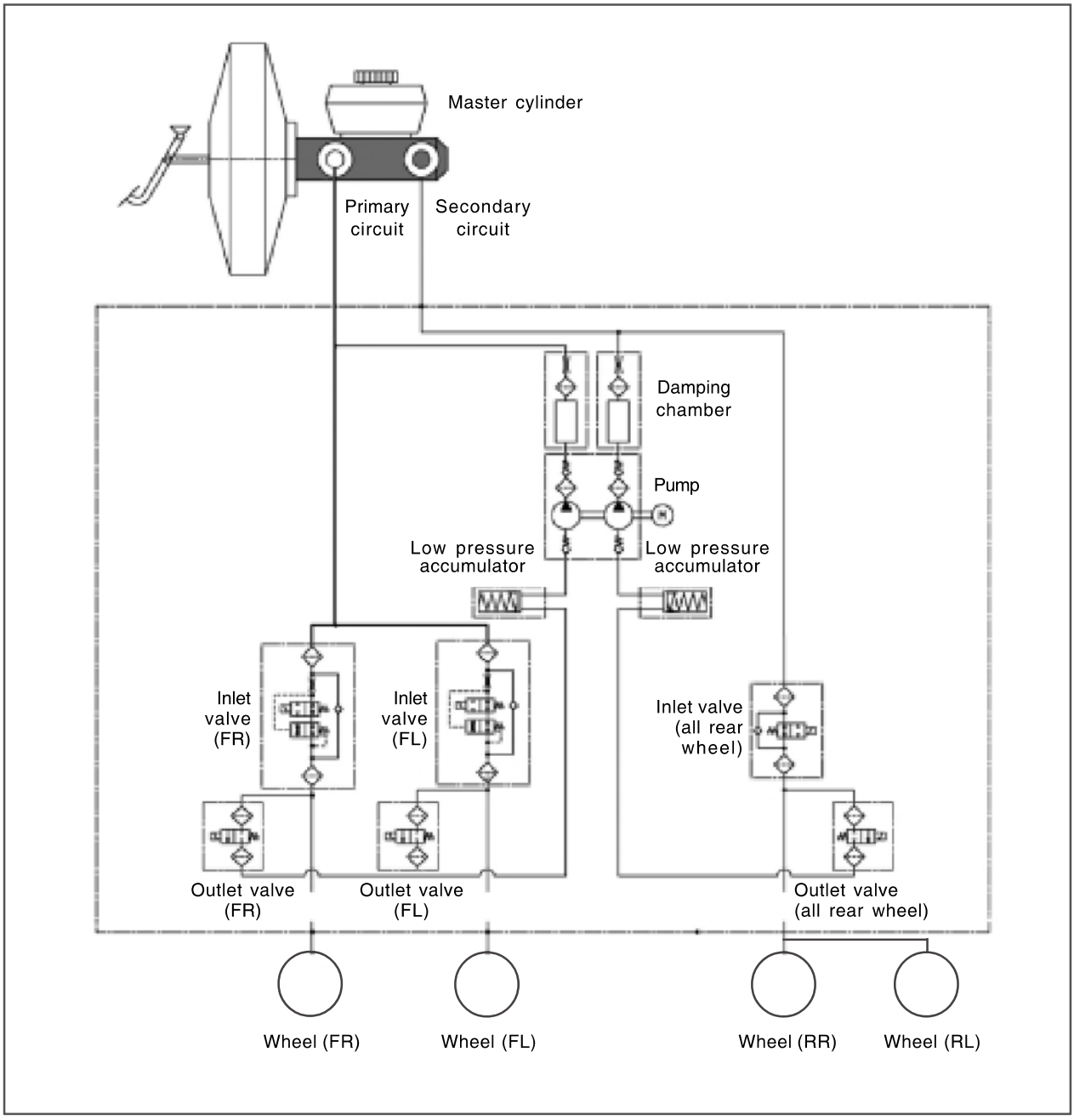


△V: Vehicle speed
Vref: Reference speed
Vw: Wheel speed

The ABS control is performed by comparing the reference speed with each wheel speed. Firstly, it is determined whether the vehicle is in the deceleration or acceleration state using the wheel speed change ratio. Then, a signal is transmitted to the valve.
Finally, the brake pressure is adjusted via the signal.

Modification basis	
Application basis	
Affected VIN	

6. HYDRAULIC CIRCUIT DIAGRAM

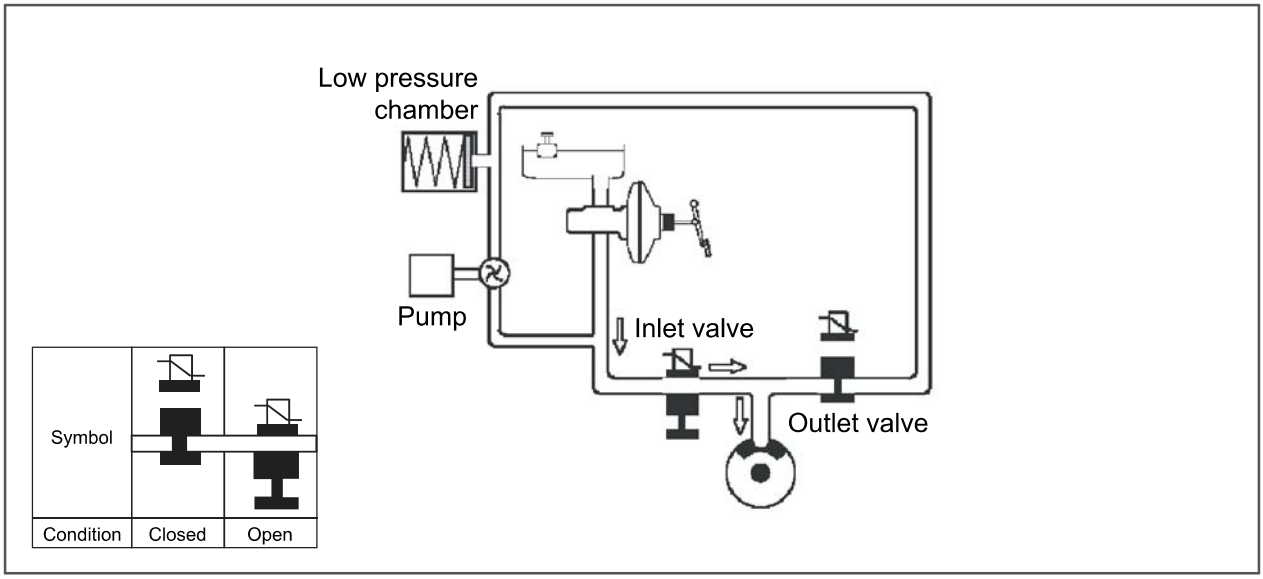


The vehicle equipped only with the ABS controls the wheel's braking force using three 3-channel 4-sensor method. The front wheels that are the primary circuit of the brake system is composed of two wheel speed sensors and two channel valves system with two inlet valves and two outlet valves. The rear 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	

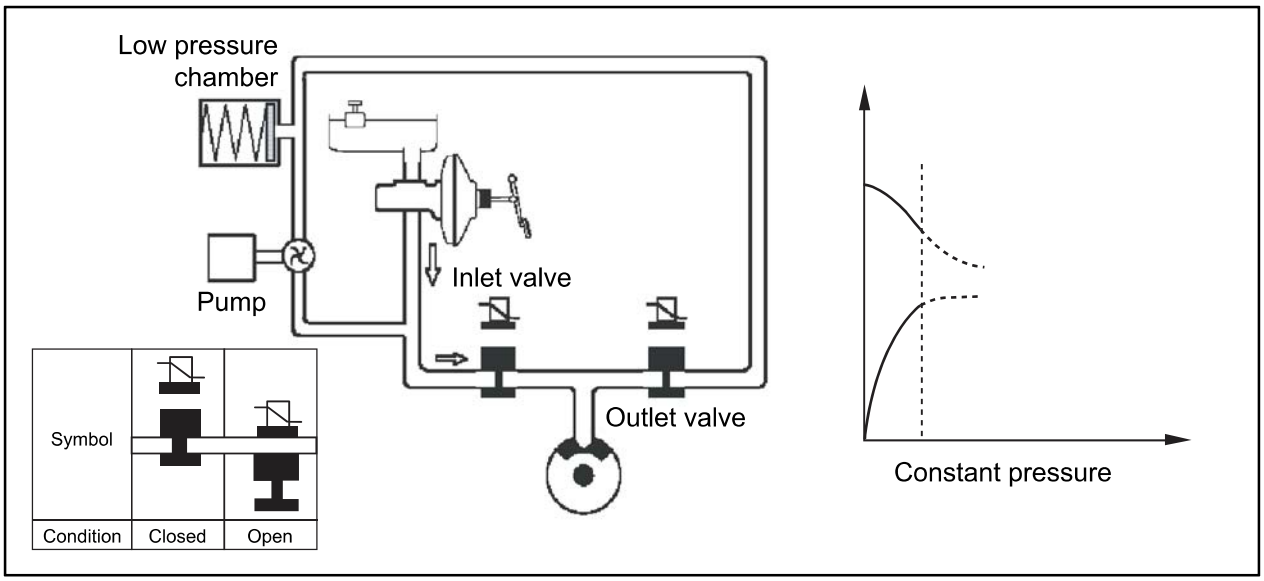
7. HYDRAULIC CIRCUIT DIAGRAM IN EACH OPERATION

▶Hydraulic Pressure Circuit when ABS is Not Operating



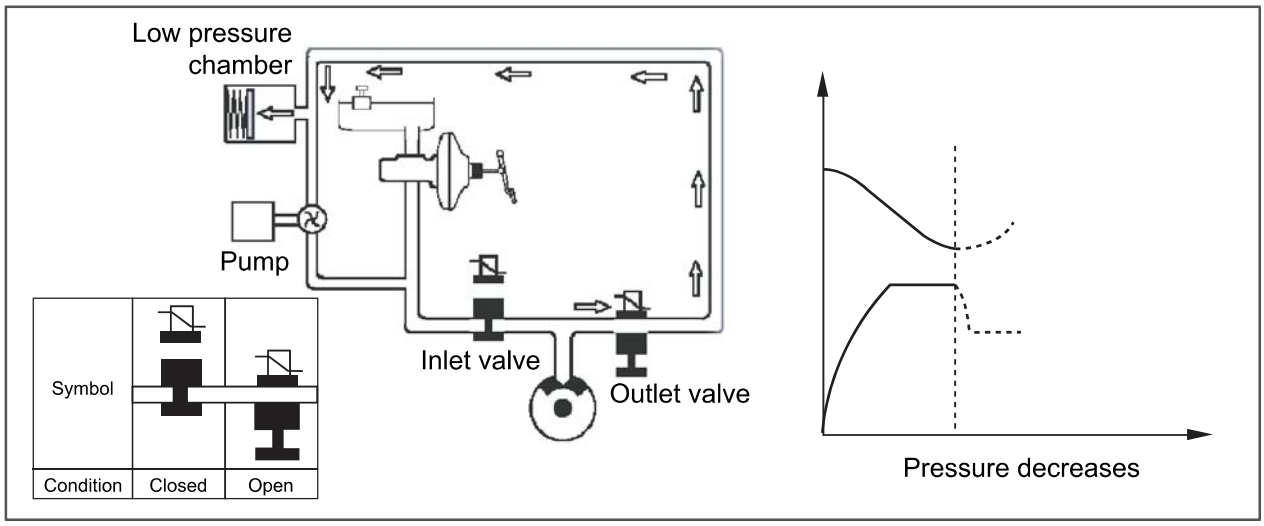
The hydraulic pressure in the master cylinder increases through the vacuum booster and it is delivered to the wheel via the normal open inlet valve. At this moment, the normally-closed outlet valve is closed. The speed of the wheel that hydraulic pressure is delivered reduces gradually .

▶No Hydraulic Pressure Circuit when ABS is Operating



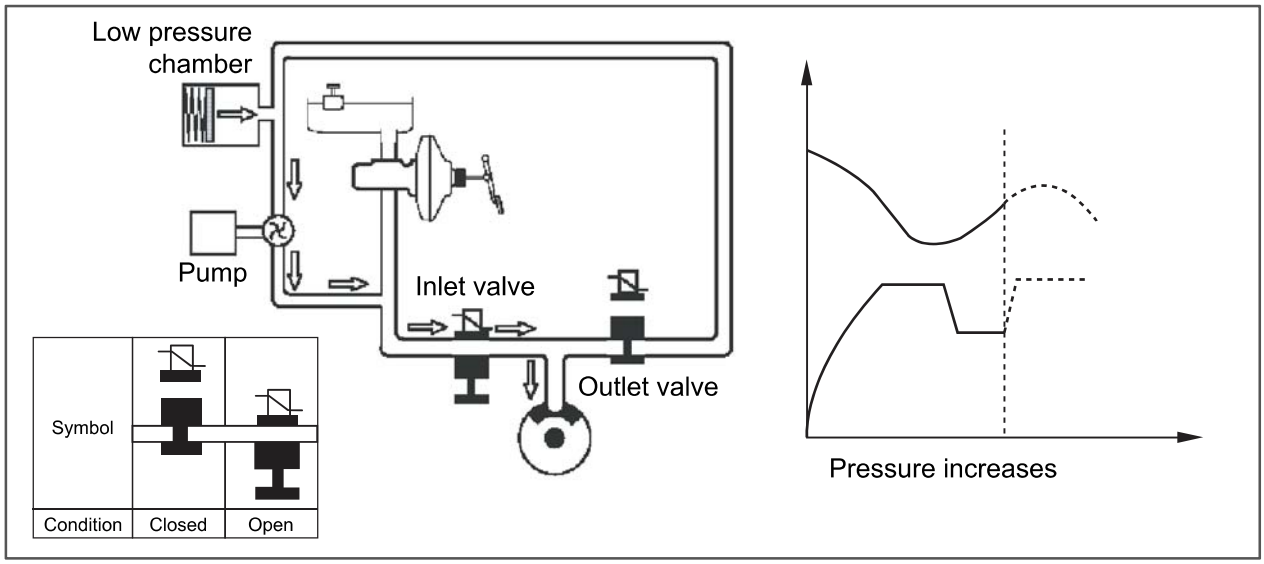
As hydraulic pressure on each wheel increases, the wheel tends to lock. In order to prevent the wheel from locking, the hydraulic valve modulator operates the inlet valve control solenoid to close the inlet valve and stop the hydraulic pressure increases. At this moment, the outlet valve is closed. This procedure helps the wheel to maintain a stable hydraulic pressure.

▶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 changer 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 noises

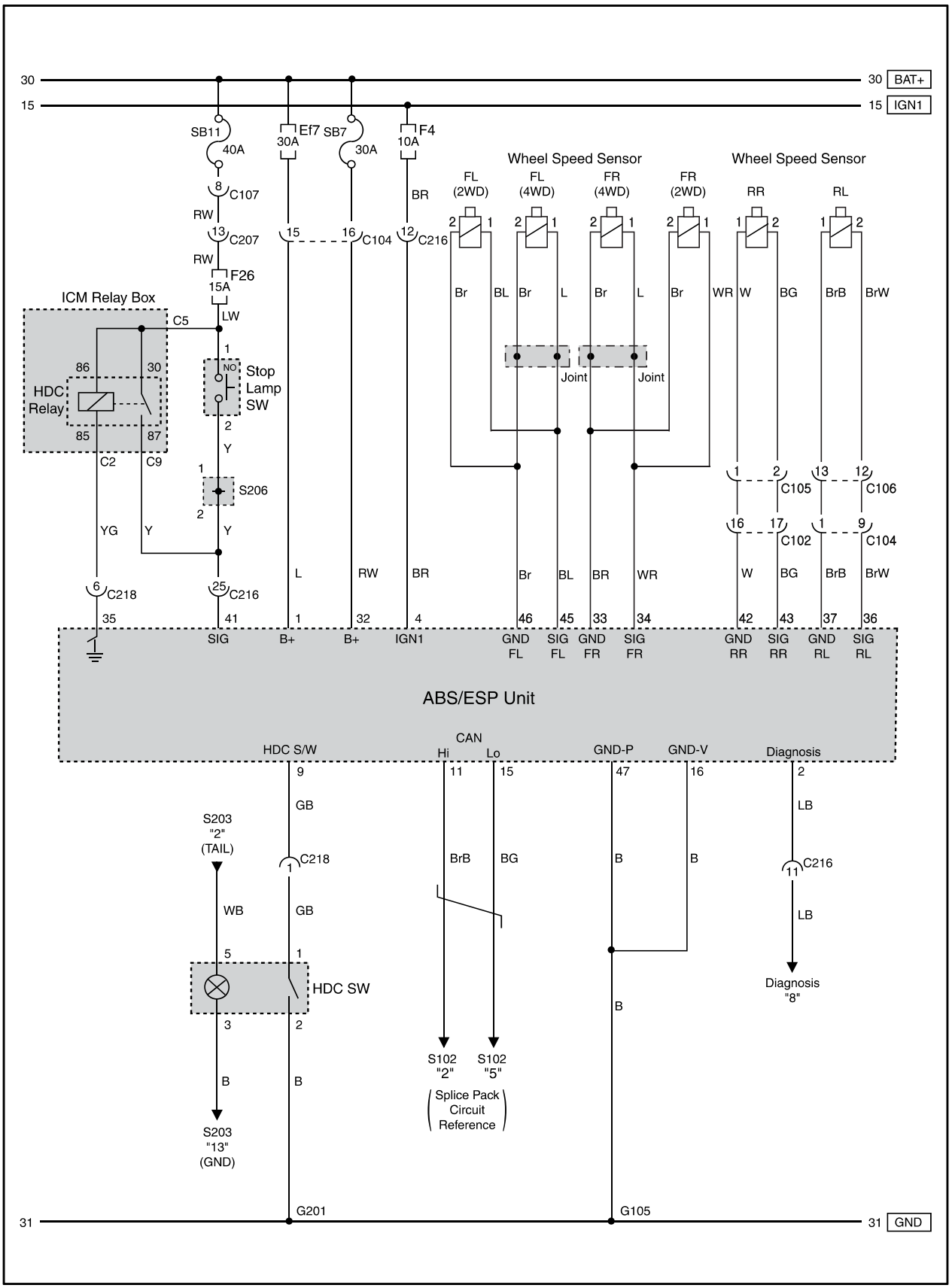
▶Pressure Increases in the Circuit when ABS is Operating



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 and the wheel speed decreases as the hydraulic pressure at wheel increases. This operation continues repetitively until there are no signs that the 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	

8. ELECRTRIC CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	

ABS

REXTON W 2012.06

ESP 4892-01

GENERAL INFORMATION

1. SPECIFICATION

Unit	Description		Specification
	ABS	ESP	
HECU	Clock frequency: 28MHz	Clock frequency: 33MHz	
	CPU : MCU60(32bit)	CPU : MCU6(32bit)	
	Memory: 128 ~ 256KB	Memory: 256 ~ 512KB	
	Switched Orifice	Switched Orifice	
Wheel speed sensor	Active type	Active type	Output: 7~14mA
Steering wheel angle sensor	None	Max. detection angle speed: 1500° / sec	
		Operating voltage: 9~12V	
Sensor cluster	None	Yaw rate sensor + lateral G sensor + longitudinal G sensor (4WD)	
Longitudinal G sensor	4WD only	None	
Pressure sensor	None	Installed on master cylinder	

1) Specification of Active Wheel Sensor

Description	Specification	Remark
Supplying voltage	4.5 ~ 16.0V	
Output current (at 2.75 km/h of vehicle speed)	7mA(Lo) ~ 14mA(Hi)	
Operating temperature	−40 ~ 150℃	
Operating frequency	1 ~ 2,500Hz	
Tightening torque	Front : 7.8~11.8Nm	
	Rear : 7.8~11.8Nm	

2) Specification of Steering Wheel Angle Sensor

Description	Specification	Remark
Operating voltage	9 to 16 V	
Maximum output current	10mA	
Maximum detection angle speed	±100°/Sec	
Operating temperature	−30 ~ 75℃	
Supplying voltage	9 to 16 V (battery voltage)	
Output voltage (HI)	approx. 3.50 V (3.0 to 4.1 V)	
Output voltage (LO)	approx. 1.50 V (1.3 to 2.0 V)	
Pulses/rev	45 pulses/rev	

3) Specification of Sensor Cluster

Description	Specification	Remark
Supplying voltage	approx. 5V (4.75~5.25V)	
Output voltage at standstill	approx. 2.5V (IGN ON)	
Operating range	0.2 ~ 4.8V	
Initial velocity	4 /s	

Modification basis	
Application basis	
Affected VIN	

2. FUNCTIONS AND COMPONENTS

1) Terms and Acronyms

- 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
- HBA: Hydraulic Brake Assistant
- ARP: Active Rollover Protection
- HDC: Hill Descent Control

2) Functions

Function	ABS/EBD	ESP
ABS	Available	Available
EBD	Available	
ABD	Not available	
ASR		
AYC		
HBA		
ARP		
HDC		

3) Components

Component	ABS/EBD	ESP
HECU	Available	Available
Front wheel speed sensor		
Rear wheel speed sensor		
ABS warning lamp		
EBD indicator		
G-sensor	2WD: Not available, 4WD: Available	Not available
Sensor cluster (Yaw-rate sensor, Lateral/Longitudinal G sensor)	Not available	Available
ESP warning lamp & indicator		
ESP OFF switch and indicator		
Steering wheel angle sensor		

4) Operation of Components

	ABS		ESP+ARP	
	2WD	4WD	2WD	4WD
Wheel speed sensor	4 sensors	4 sensors	4 sensors	4 sensors
Sensor cluster	Not applied	Not applied	Applied	Applied
G-sensor	Not applied	Applied	Not applied	Not applied
2H G-sensor	-	Operable	-	-
4H G-sensor	-	Operable	-	-
4L G-sensor	-	Operable	-	-
2H sensor cluster	-	-	Operable	Operable
4H sensor cluster	-	-	Operable	Operable
4L sensor cluster	-	-	Operable	Operable

Modification basis	
Application basis	
Affected VIN	

3. WARNING LAMPS



1. ABS warning lamp
2. Brake warning lamp
3. ESP OFF indicator
4. ESP warning lamp/indicator
5. EBD warning lamp

Name	Color	Symbol	Operating Condition
ESP OFF indicator	Amber	OFF	ESP OFF switched ON
ESP indicator (blinks)	Amber		ESP operating
ESP warning lamp			ESP malfunctioning
ABS warning lamp	Amber	ABS	ABS malfunctioning
EBD warning lamp	Amber + Red	ABS BRAKE	EBD malfunctioning
HDC indicator	Red, Green		Red: HDC operating Green: HDC switched ON

Modification basis	
Application basis	
Affected VIN	

1) ABS Warning Lamp

ABS warning lamp module indicates the self diagnosis and malfunction.
ABS warning lamp ON:

A. When turning the ignition switch to ON position, ABS warning lamp comes on for 4 seconds for self-diagnosis and goes off if the system is OK (initialization mode).
B. When the system is defective, the warning lamp comes on.
C. During self-diagnosis.
D. When disconnecting the HECU connector, the warning lamp comes on.
E. ABS is not available during lamp ON. In this condition, only normal brake system without ABS function is available.
F. When the communication between warning lamp CAN module in meter cluster cannot be established, the warning lamp comes on.

2) EBD (Electronic Brake-force Distribution) Warning Lamp (Brake Warning Lamp)

EBD warning lamp when the system perform the self diagnosis and when it detects the malfunction of EBD system. However, the brake warning lamp comes on regardless of EBD when the parking brake is applied.
EBD warning lamp ON:

A. When turning the ignition switch to ON position, ABS warning lamp and the brake warning lamp comes on for 4 seconds for self-diagnosis and goes off if the system is OK (initialization mode).
B. When applying the parking brake, the brake warning lamp comes on.
C. When the brake fluid is not sufficient, the brake warning lamp comes on.
D. During self-diagnosis.
E. When disconnecting the HECU connector, the warning lamp comes on.
F. When the system is defective, ABS warning lamp and the brake warning lamp come on simultaneously.
   a. When the solenoid valve is defective
   b. When one or more wheel sensors are defective
   c. When ABS HECU is defective
   d. When the voltage is abnormal
   e. When valve relay is defective
G. When the communication between warning lamp CAN module in meter cluster, the warning lamp comes on.

Modification basis	
Application basis	
Affected VIN	

3) ESP OFF Indicator

ESP OFF indicator ON:

1. When turning the ignition switch to ON position, ESP warning lamp comes on for 4 seconds for self-diagnosis and goes off if the system is OK (initialization mode).
2. When the ESP OFF switch is pressed to turn off ESP function, ESP OFF indicator comes on.

4) ESP OFF Switch

If ESP OFF switch is pressed, ESP function is deactivated and the ESP OFF indicator in the instrument cluster comes on.
To resume the ESP function, press the switch again. At this time, ESP OFF indicator goes out.

5) ESP Warning Lamp

ESP warning lamp ON:

A. When turning the ignition switch to ON position, ESP warning lamp comes on for 3 seconds for self diagnosis and goes off if the system is OK (initialization mode).
B. When the system is defective, the warning lamp comes on.
C. When the ESP function is activated, ESP warning lamp blinks with the interval of 2 Hz.
D. When the communication between warning lamp CAN module in meter cluster, the warning lamp comes on.

4. PRECAUTIONS

CAUTION

- **The warning lamp flashes and warning beep sounds when the ESP is operating**
  When the ESP operates during vehicle movement, the ESP warning lamp on the instrument panel flashes and beep comes on every 0.1 second. 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.
  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 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.

CAUTION

- **ARP Operation**
  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.

CAUTION

- HDC is designed for driving on off-road steep grades (over 10%).
- Unnecessary usage of HDC can cause malfunctions inthe brake system or ESP. Do not use HDC when drivingon normal roads.
- If driving on a level road with HDC on and ready foruse, HDC may be applied during sharp cornering orpassing over a speed bump. There¬fore, do not activateHDC while driving on normal roads.
- If the red HDC indicator illuminates, HDC is overheatedor malfunctioning. If the indicator is on even after thesystem has cooled down enough, have the nearestauthorized dealer or service center check the system.
- It is normal to have strong vibrations and noise fromthe brake system when HDC is applied.
- In case of a manual transmission vehicle, the gear shiftis in the forwarding “1” or “Reverse”
- position. If HDC isattempted in the “2” position, the engine may turn off.

Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. ESP (Electronic Stability Program)

1) Overview

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.
Integrated functions in ESP system:
- HBA: Hydraulic Brake Assist System (Increases braking force)
- ARP: Active Rollover Protection System (Controls the engine output and braking force)
- HDC: Hill DescentControl System (Allows the vehicle to go down the steep hill slowly)

NOTE

For example, when the brakes are applied during cornering at the speed of 100 km/h, the ABS 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. This may cause a problem in vehicle control system due to multi-operation of systems, thus there is a priority as below:
TCS (ASR or ABD) > ESP > ABS (This is subject to the driving and vehicle conditions.)

2) Location of Components and Layout

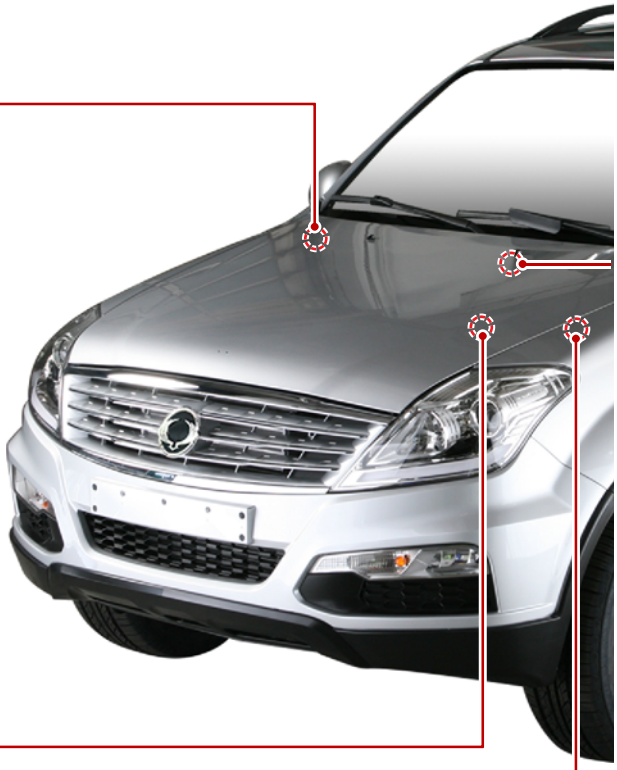
Meter Cluster



1. ESP OFF indicator
2. ESP warning lamp/indicator
3. ABS warning lamp
4. Parking brake warning lamp
5. HDC indicator
   * EBD warning lamp: 3 + 4

ABS/ESP HECU

ESP	ABS
	
	



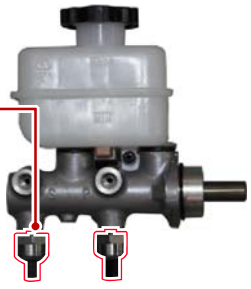
Sensor Cluster (ESP only)



Brake Oil Pressure Sensor (ESP only)



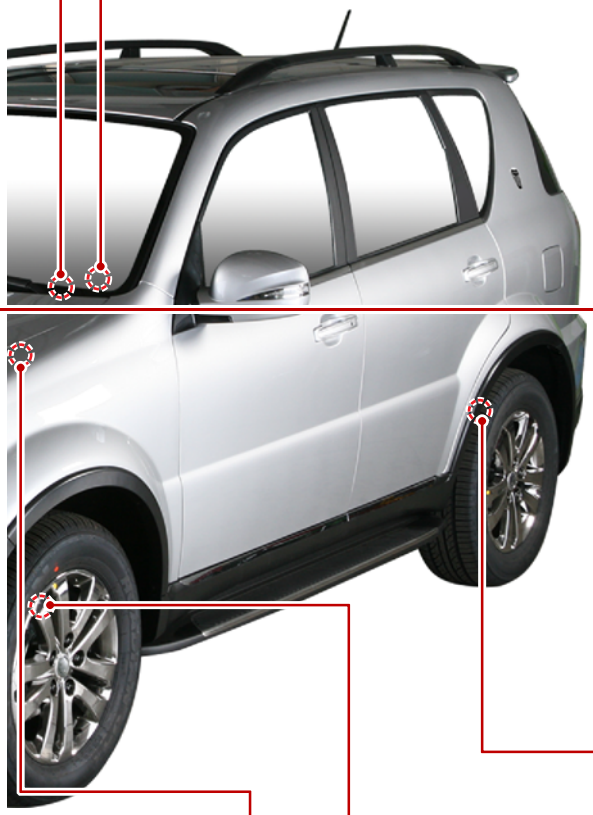
Brake Master Cylinder (ESP only)



Modification basis	
Application basis	
Affected VIN	

Steering Wheel Angle Sensor (ESP only)





ESP OFF/HDC Switch (ESP only)



ESP OFF Switch



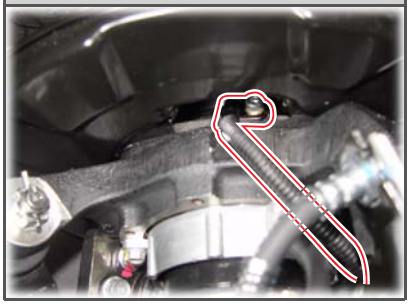
HDC Switch



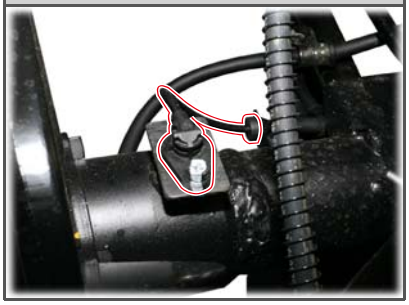
Brake Booster Assembly



Front Wheel Speed Sensor (4WD)



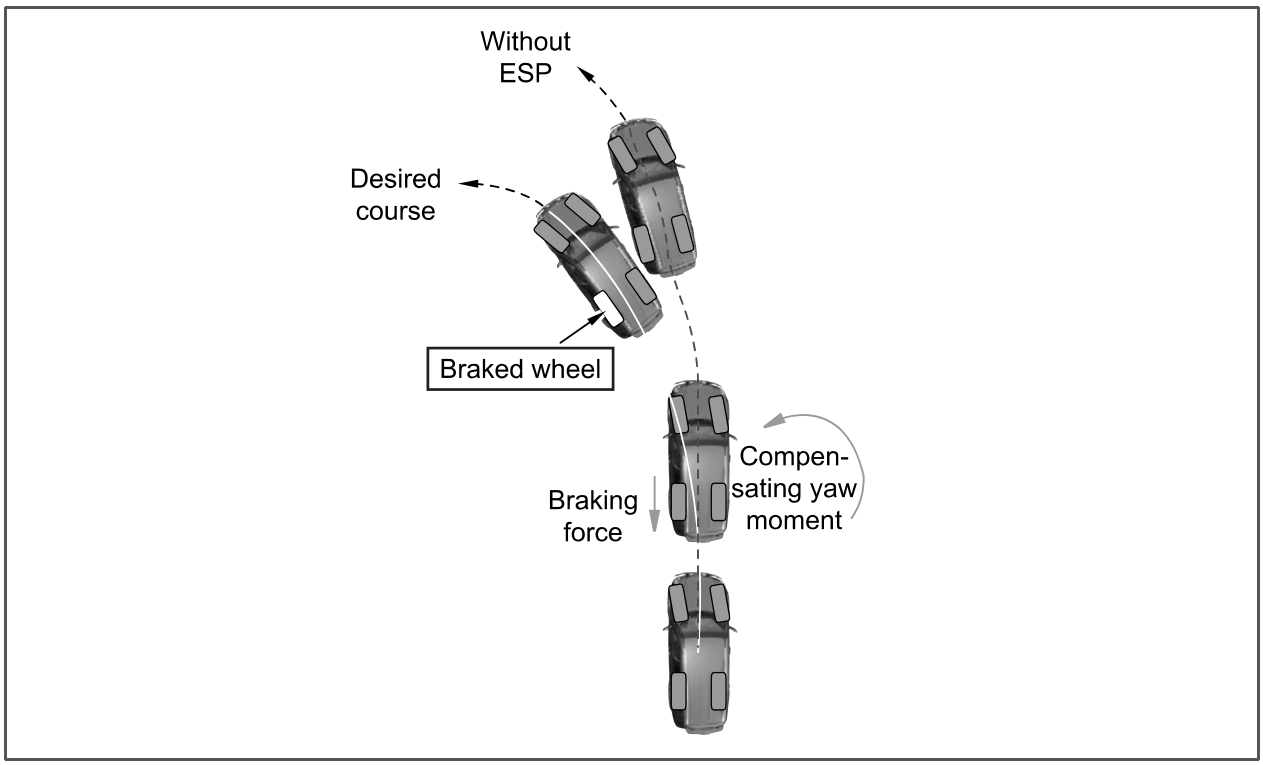
Rear Wheel Speed Sensor (4WD)



Modification basis	
Application basis	
Affected VIN	

3) Operation of ESP System

(1) Under steering



▶ What is understeering?

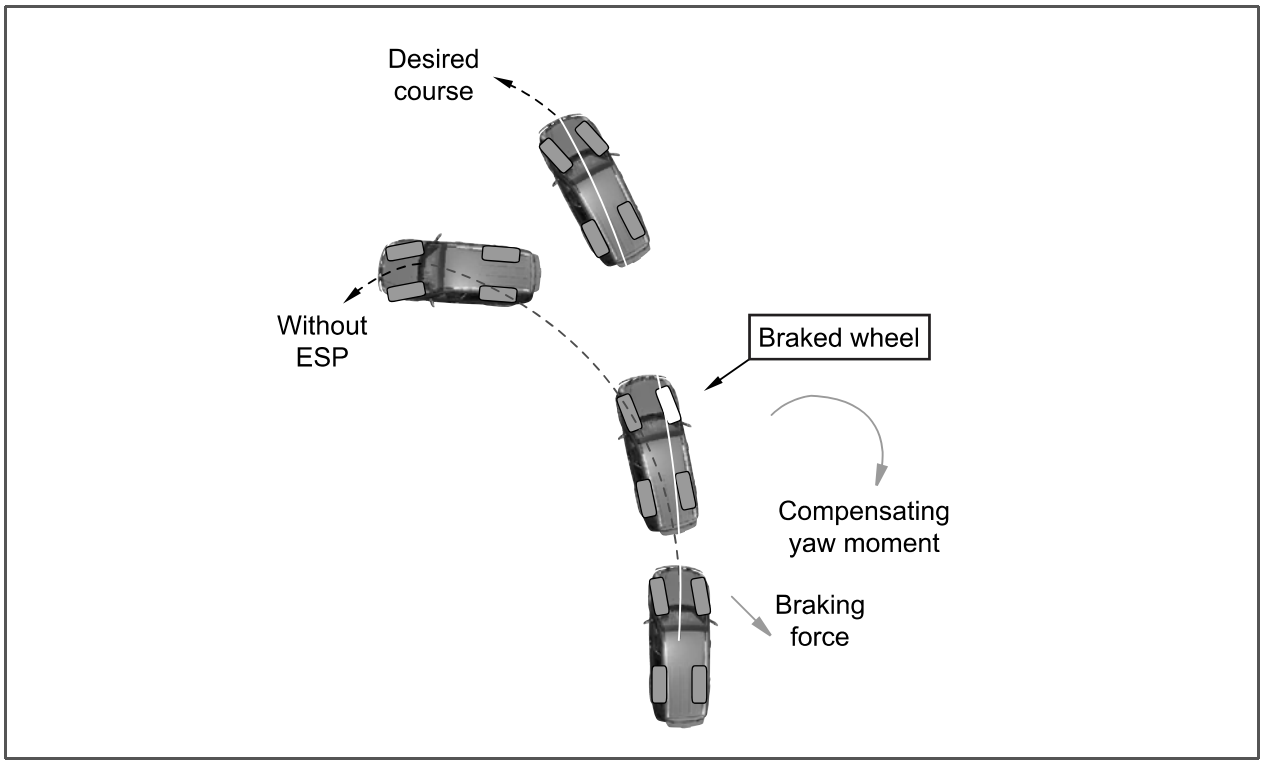
Understeer is a term for a condition in which the steering wheel is steered to a certain angle during driving and the front tires slip toward the reverse direction of the desired direction. Generally, vehicles are designed to have understeer. It is because that the vehicle can return back to inside of cornering line when the steering wheel is steered toward the inside even when the front wheels are 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.

▶ ESP controls during understeer

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 understeer with the yaw rate sensor and lateral sensor. Then, the ESP system applies the braking force to 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 intended.

Modification basis	
Application basis	
Affected VIN	

(2) Over steering



▶ What is oversteering?

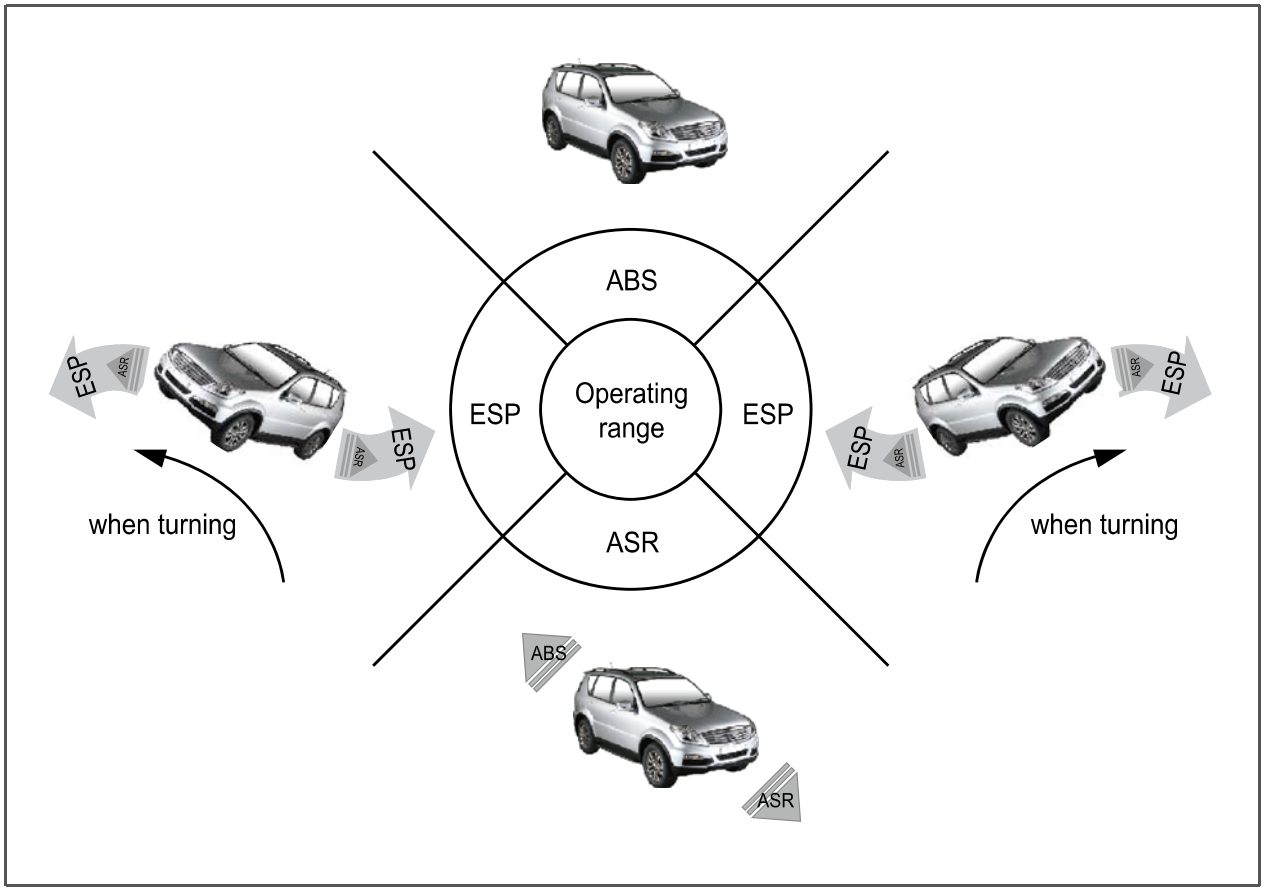
Oversteer is a term of a condition in which the steering wheel is steered to a certain angle during driving and the rear tires slip outward losing traction.
Compared to understeering vehicles, it is hard to control the vehicle during cornering and the vehicle can spin due to rear wheel moment when the rear tires lose traction and the vehicle speed increases.

▶ ESP controls during oversteer

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 oversteer with the yaw rate sensor and lateral sensor. Then the ESP system applies the braking force to 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 intended.

(3) ESP Operation

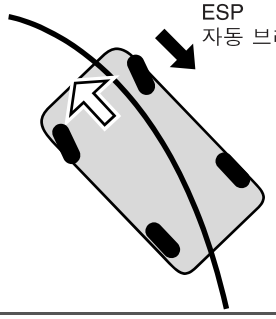
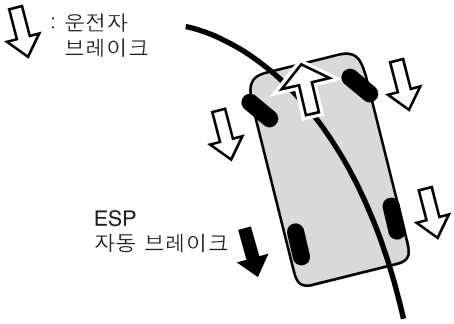
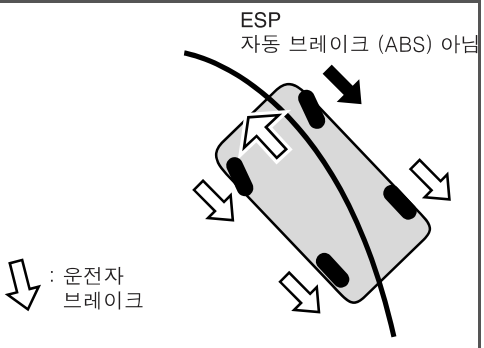
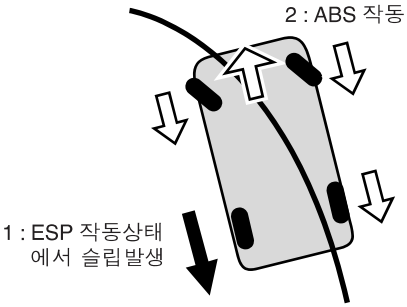
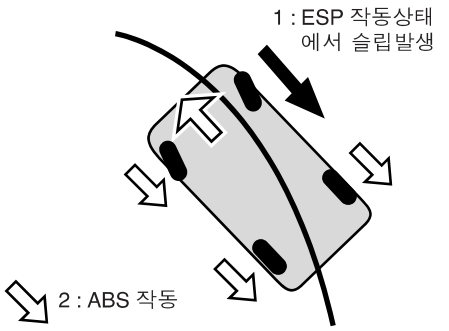
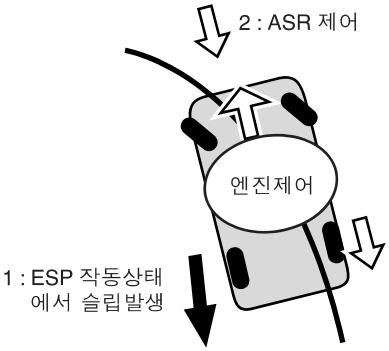
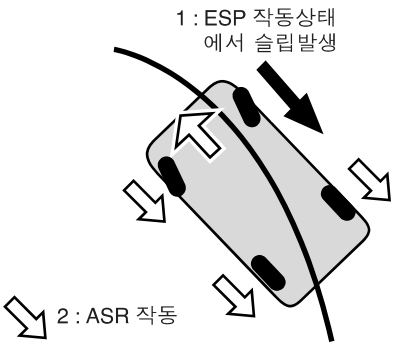
The ESP (Electronic Stability Program) has been developed to help a driver avoid danger of losing control of the vehicle stability due to understeer or oversteer during cornering. The yaw rate sensor, lateral sensor and longitudinal sensor in the sensor cluster and the steering wheel angle sensor under the steering column detect the vehicle conditions when the inner or outer wheels are spinning during oversteer, understeer or cornering. The ESP ECU controls against oversteer or understeer during cornering by controlling the vehicle stability using input values from these sensors and applying the braking force to the corresponding wheels independently. The system also controls the engine power right before the wheel spin synchronized to decelerate the vehicle automatically in order to maintain the vehicle stable during cornering.



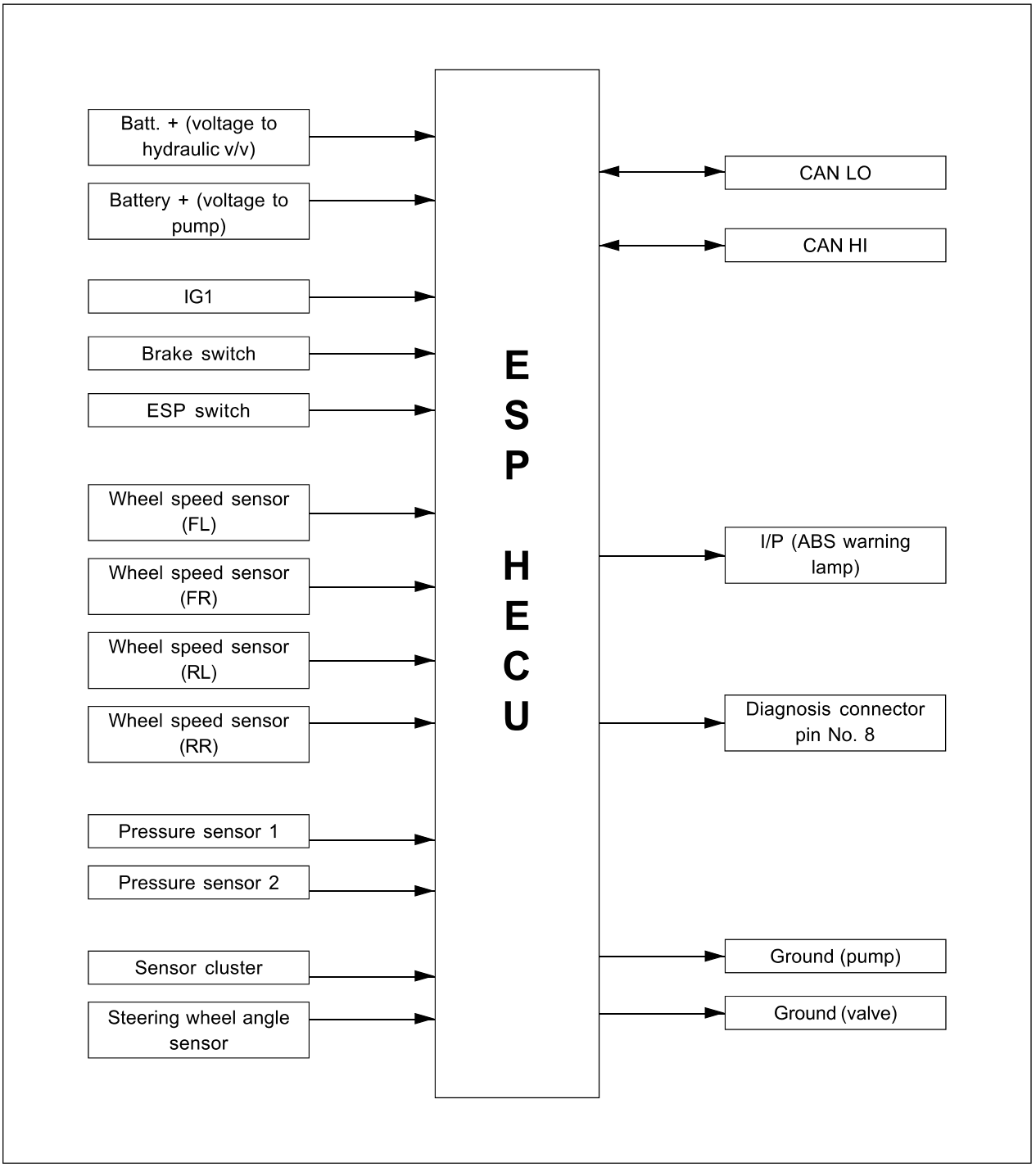
Modification basis	
Application basis	
Affected VIN	

(4) ESP controls during understeer

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 understeer with the yaw rate sensor and lateral sensor. Then, the ESP system applies the braking force to 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 intended.

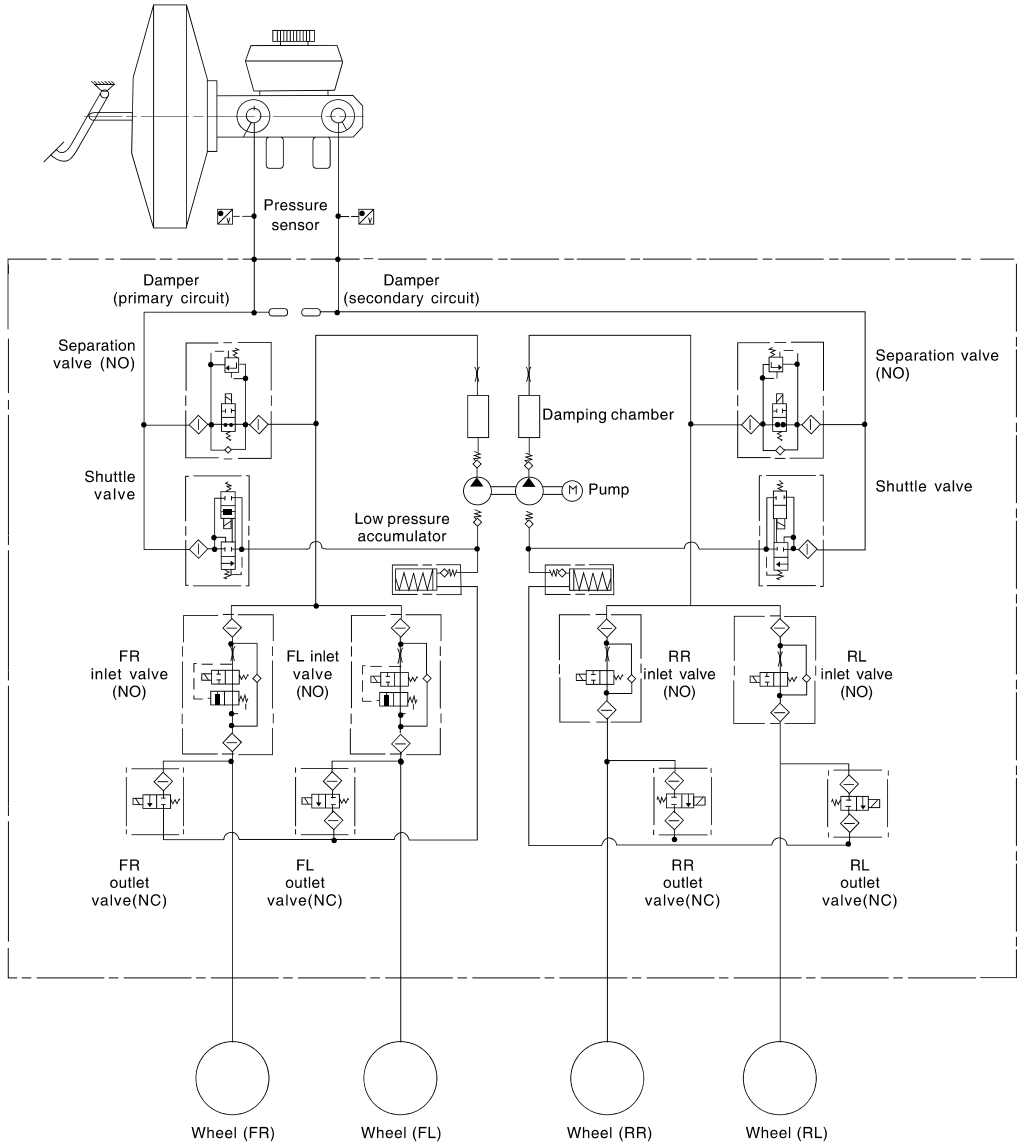
Condition	Understeer control	Oversteer control
Only ESP in operation No braking by driver		
ESP + Normal braking (no ABS operation)		
ESP + ABS brake		
ESP + ASR		

4) Input and Output Diagram of ESP unit



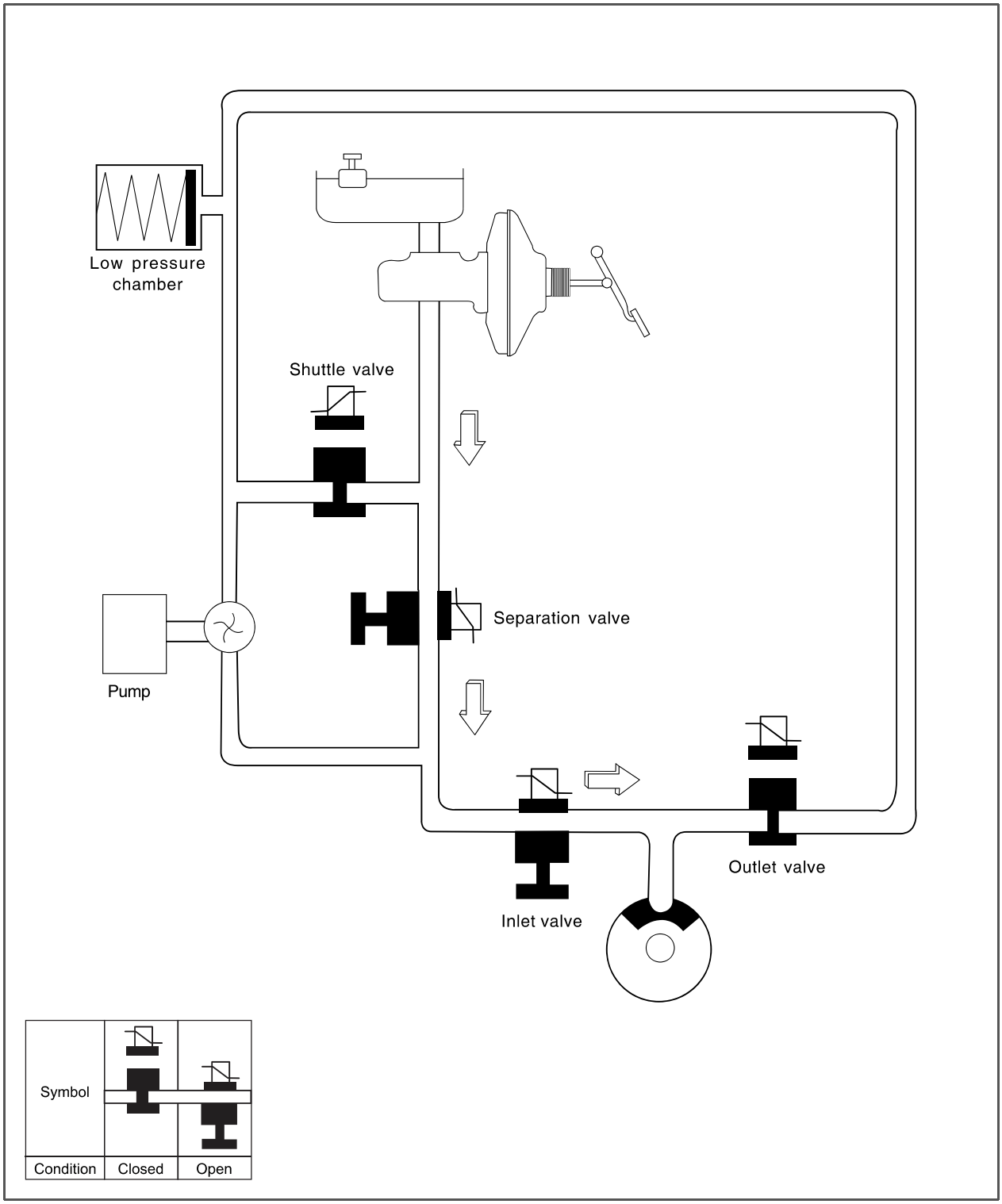
Modification basis	
Application basis	
Affected VIN	

5) Hydraulic Diagram of ESP



When equipped with ABS, the braking force at each wheel will be controlled with 3-channel 4-sensor method. And when 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/EBD 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 circuit by ESP operation range".

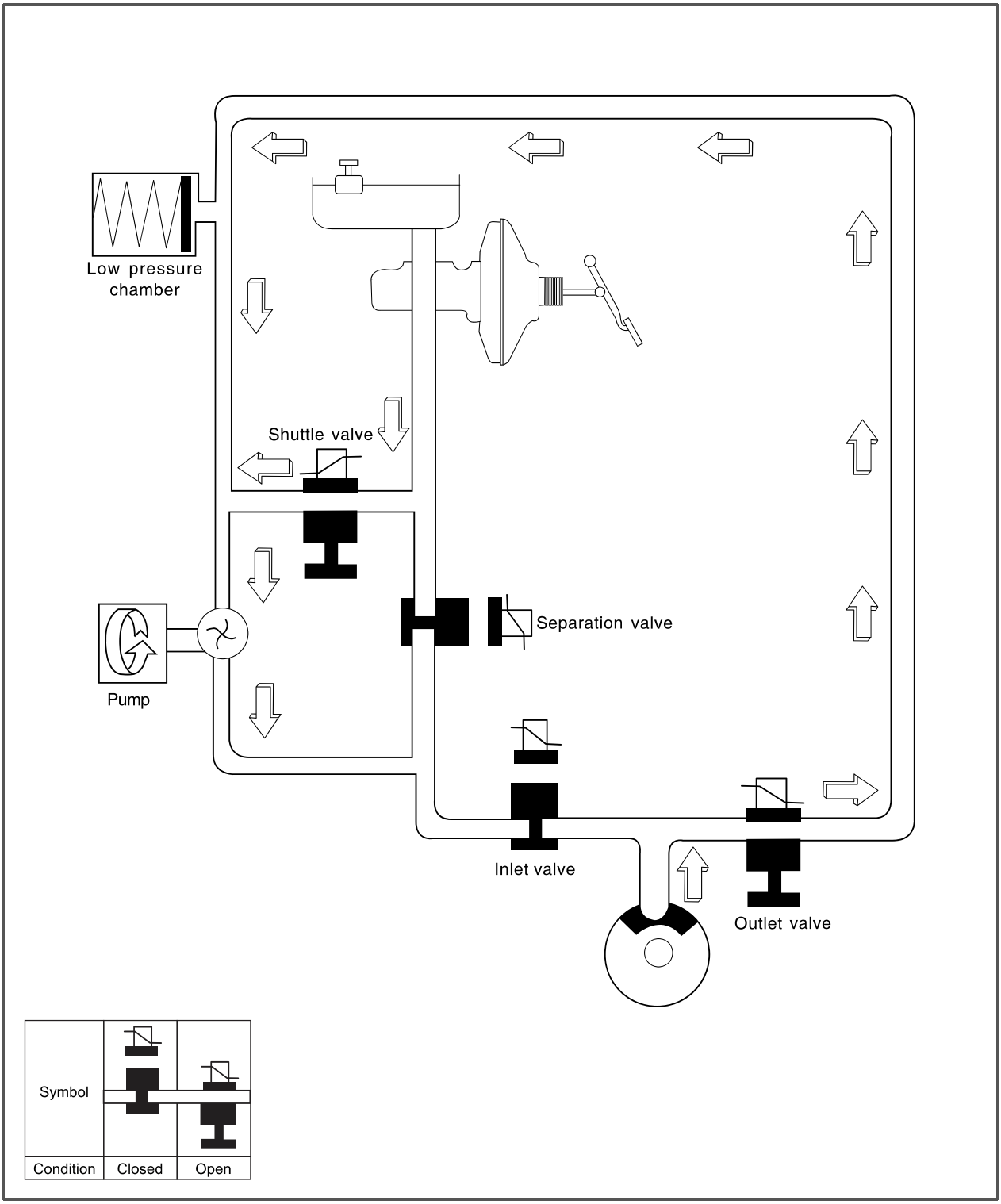
(1) ESP Hydraulic Unit in Idling and Bormal Braking Position



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.

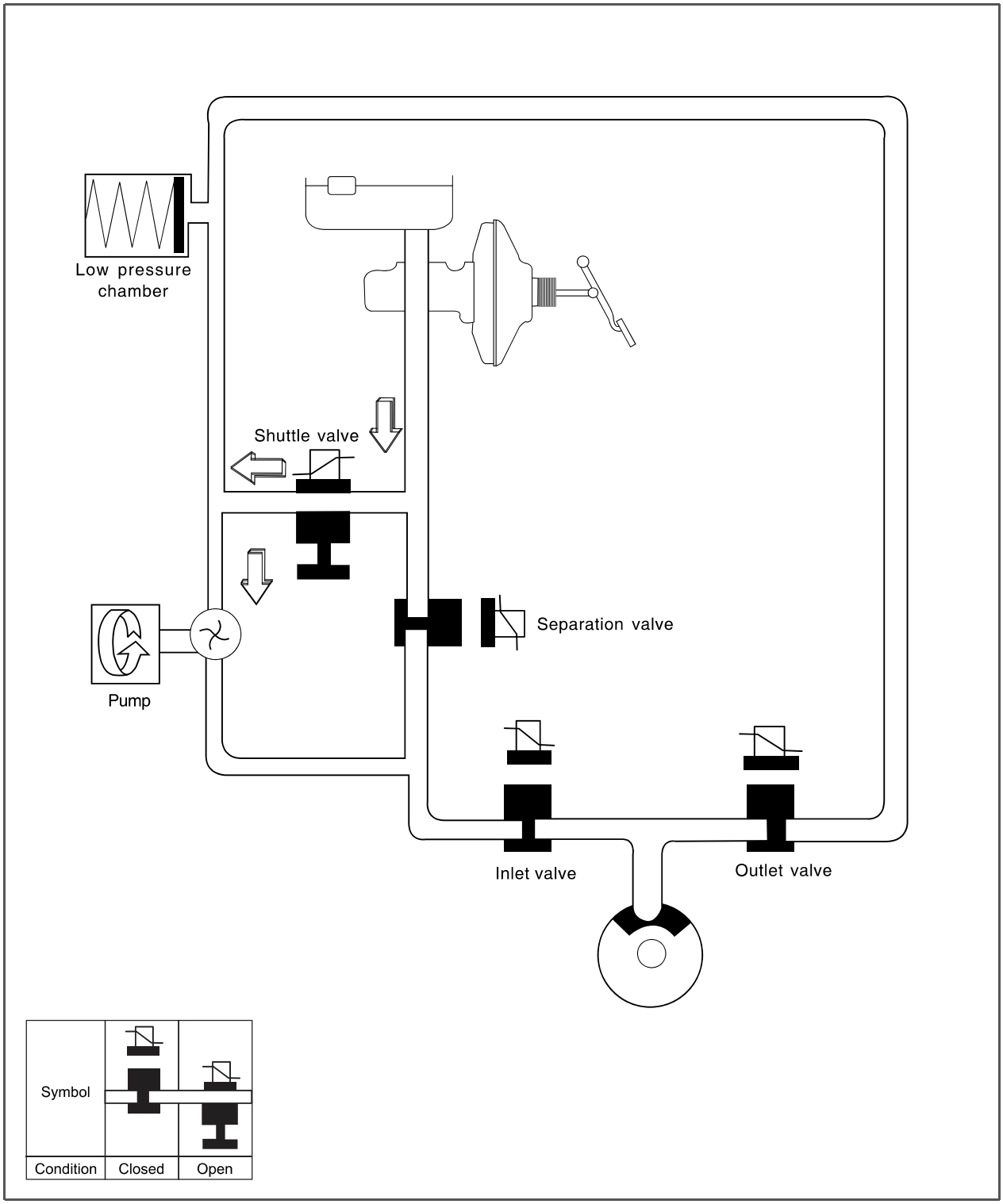
Modification basis	
Application basis	
Affected VIN	

(2) When applied ESP (decreased pressure)



The pressure decreases just before the wheel speed drops and the wheels. 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 .

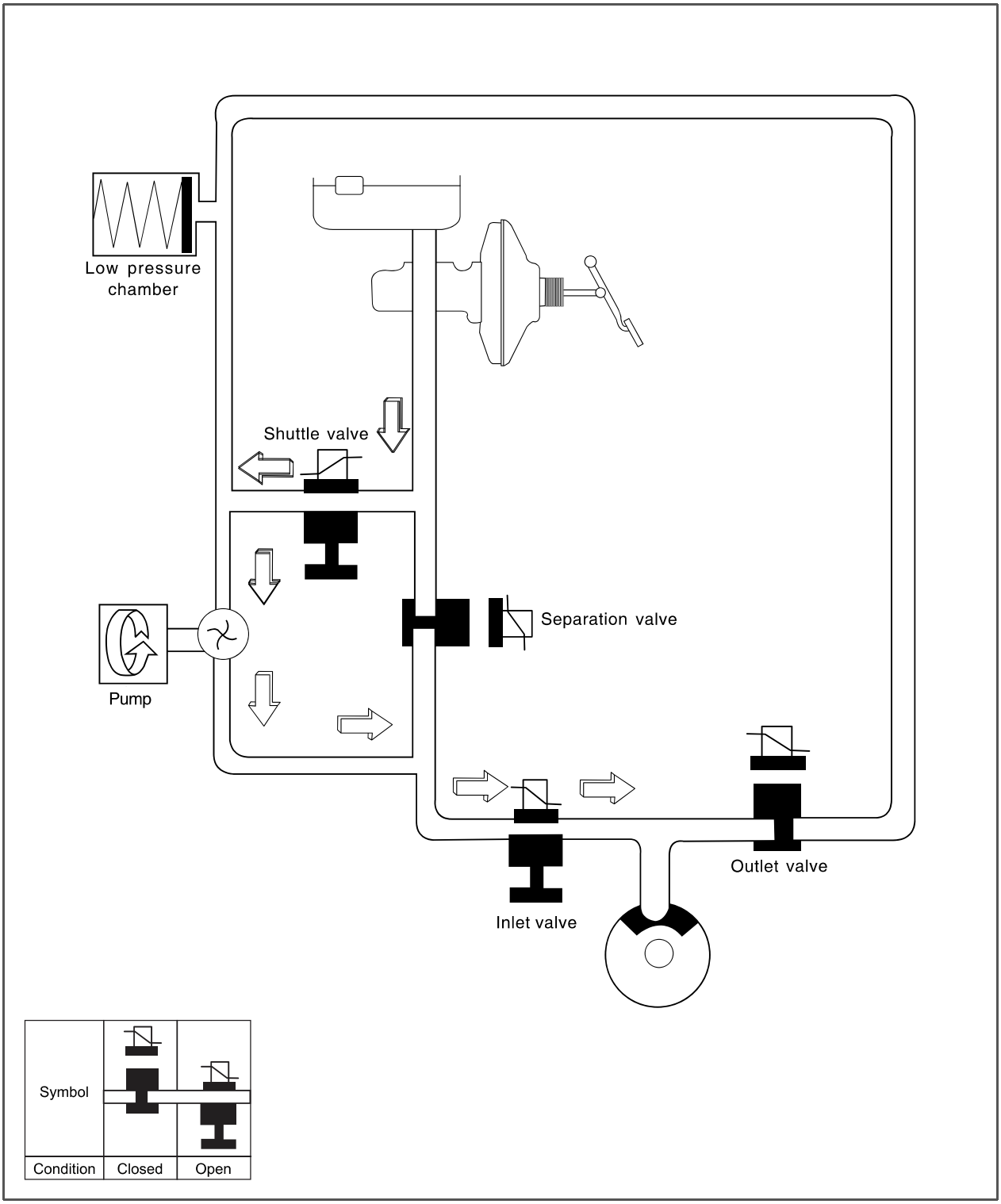
(3) When applied ESP (maintained pressure)



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.

Modification basis	
Application basis	
Affected VIN	

(4) When applied ESP (increased pressure)

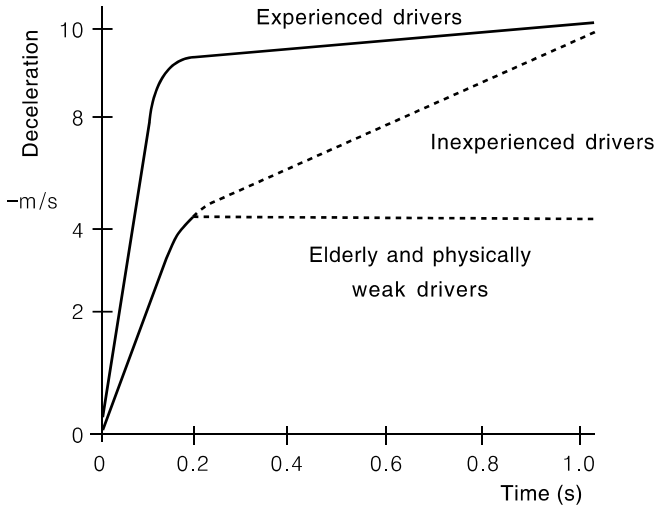


The shuttle valve and inlet valve will be open and the separation valve and outlet valve will be closed. Then, the pump is operated.
When ESP operates while the ABS is operating, the pressure will be increased continuously until just before the corresponding wheel gets locked.

2. HBA (Hydraulic Brake Assist System)

1) Operation

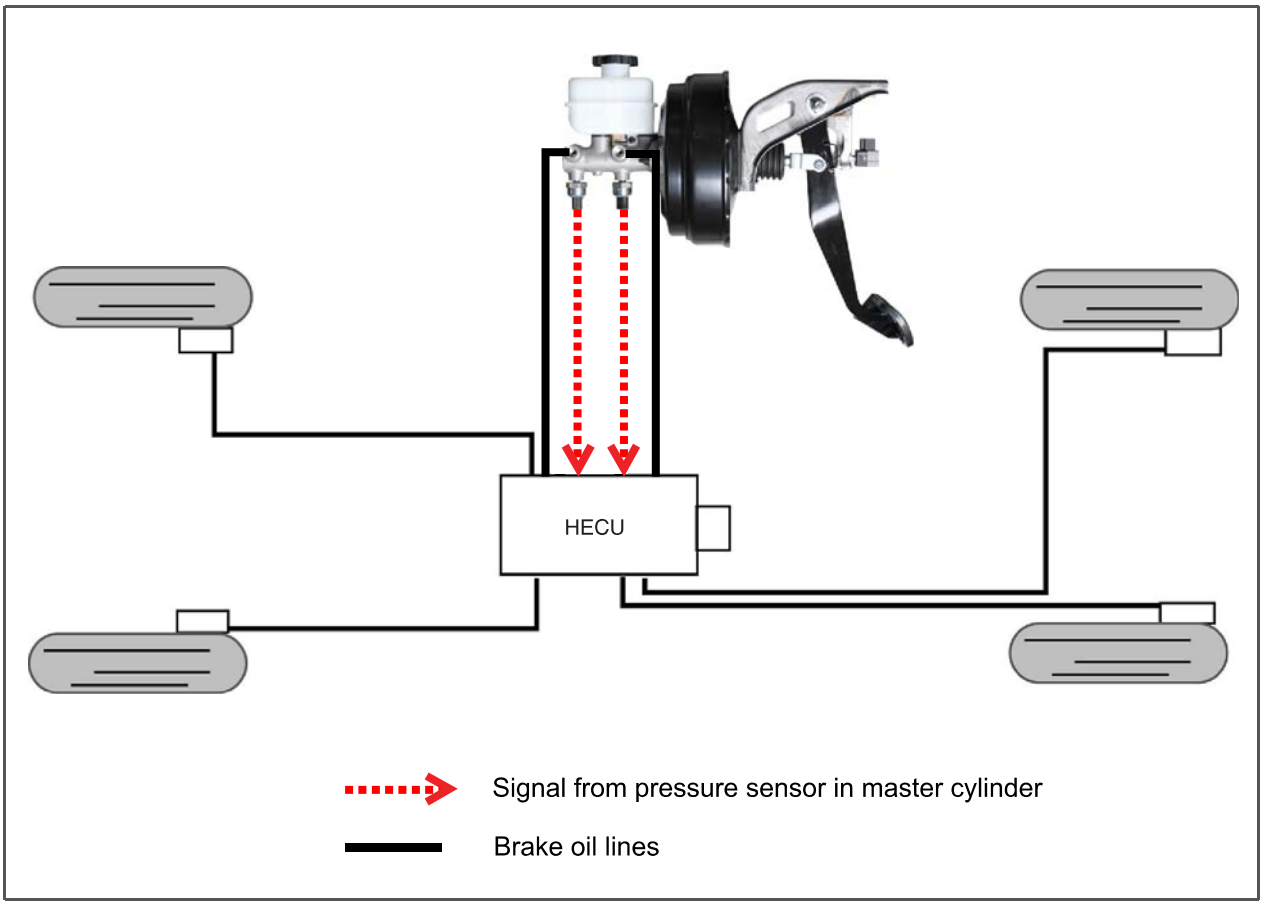
The brake pressure value and the changed value of the pressure sensor are the conditions in which the HBA System operates. There are 2 pressure sensors under the master cylinder. When the ESP ECU system determines that emergency braking is present, the pump operates, the brake fluid in the master cylinder is sent to the pump and the braking pressure is delivered to the wheels via the inlet valves .
If the drive depress the brake pedal slowly, the pressure change is not high. In this case, only the conventional brake system with booster is activated.



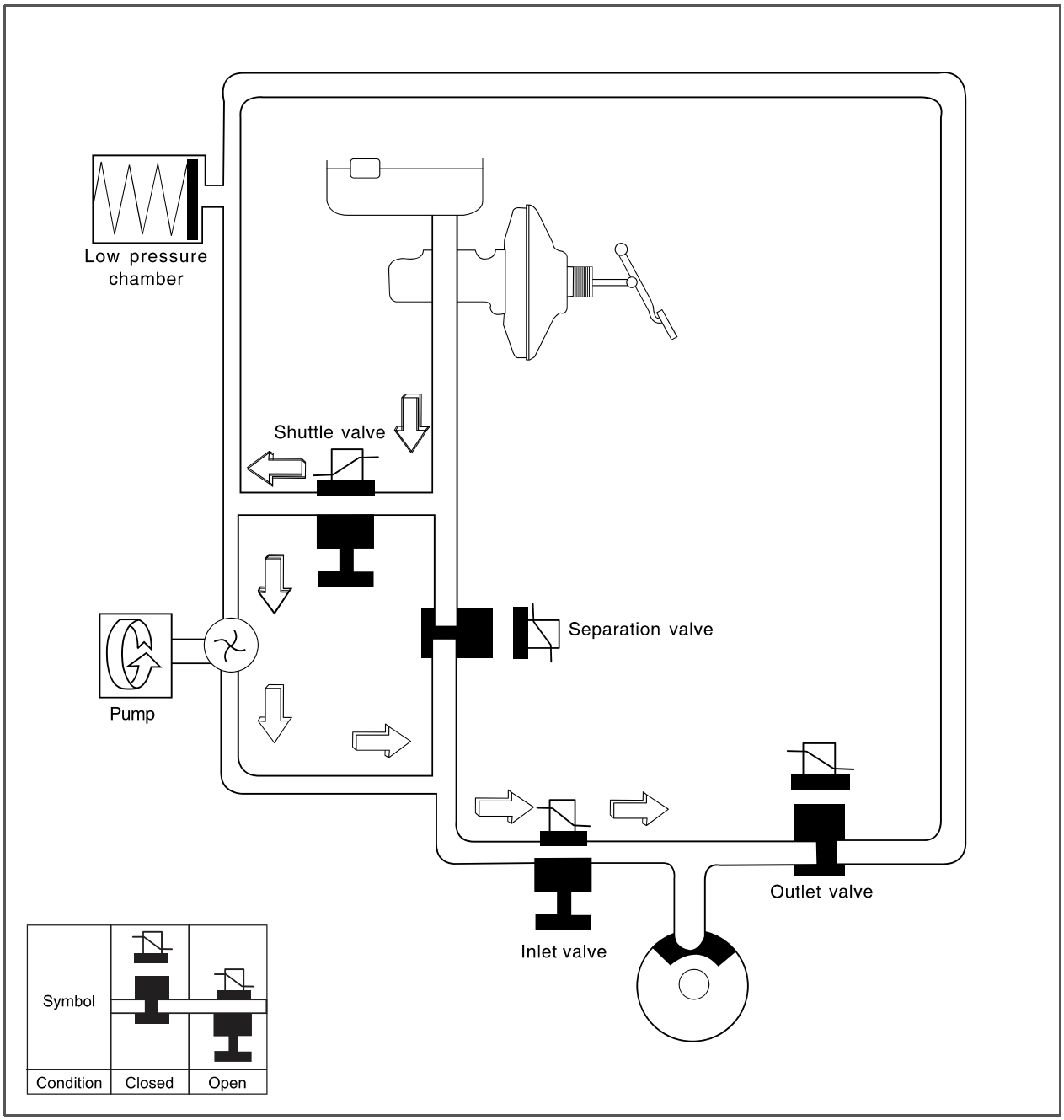
Modification basis	
Application basis	
Affected VIN	

2) Purpose

HBA (Hydraulic Brake Assist) 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 HBA 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.



3) Hydraulic Diagram of HBA



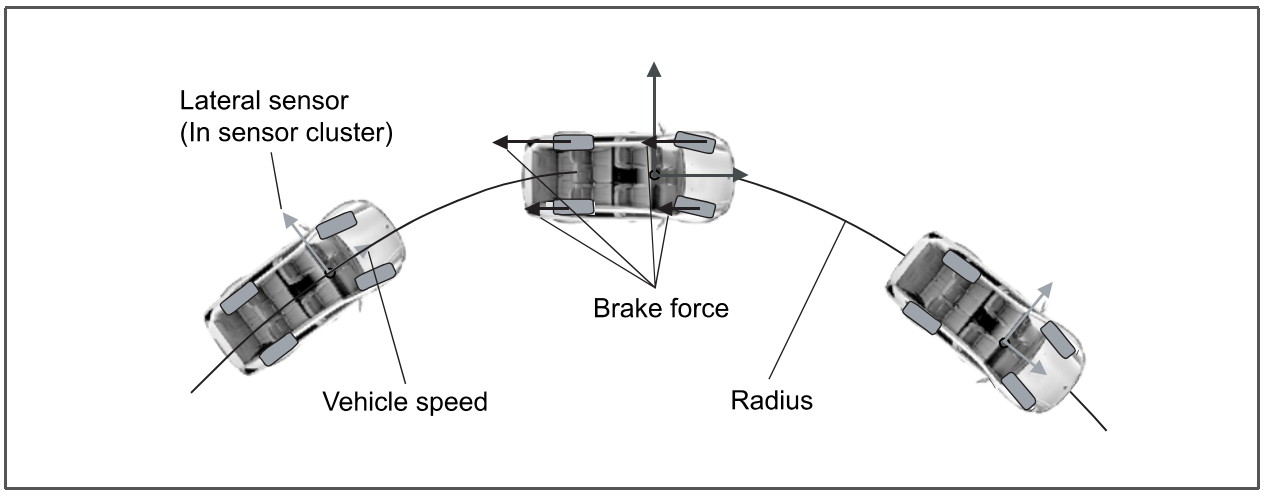
The above figure shows one front and one rear wheel and the same hydraulic circuit forms as in the ESP operation.
When HECU recognizes that it is an emergency and it is required for hard braking, depending on the pressure value of the brake pressure sensor and pressure changes caused by the pressure 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 are will stay closed. When the wheel starts to lock, the HBA function cancels and switches to ABS operation

Modification basis	
Application basis	
Affected VIN	

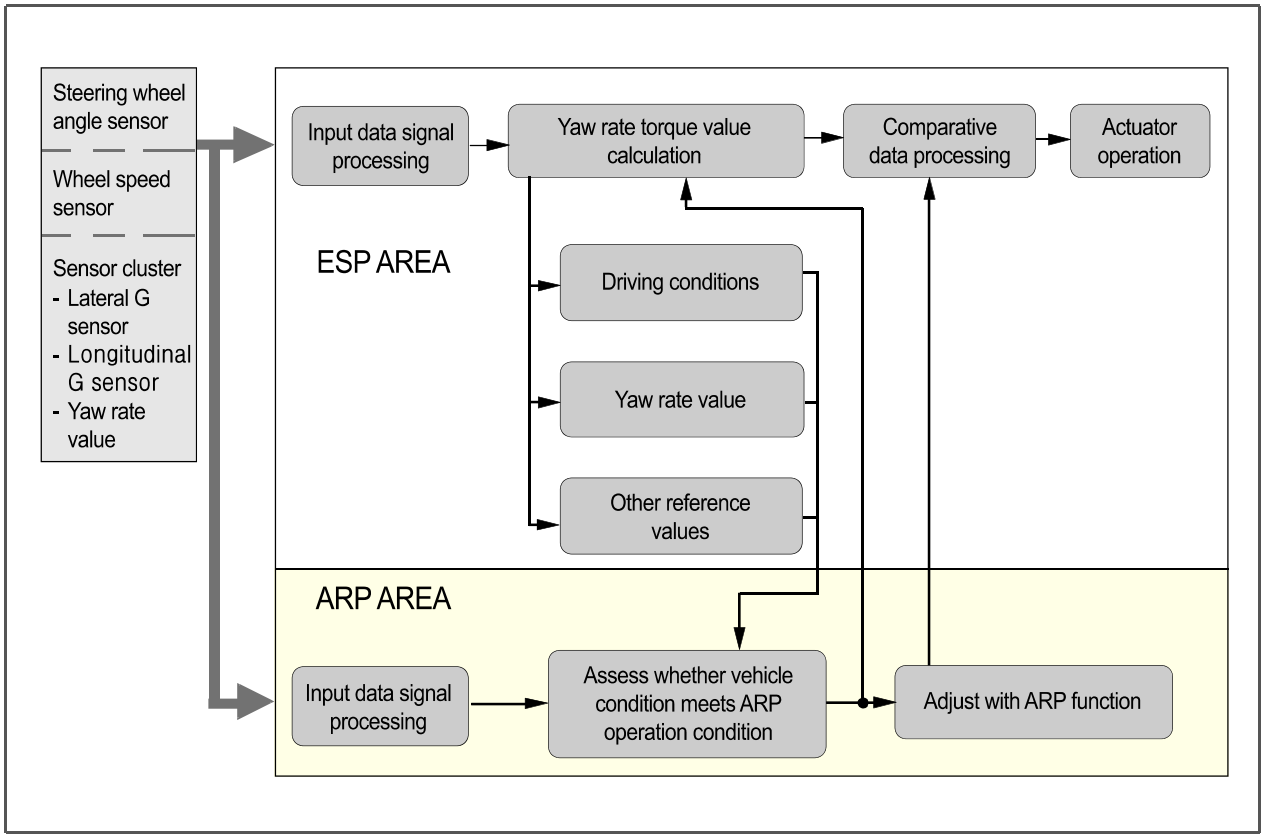
3. ARP (Active Roll-Over Protection)

1) Overview

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 still available even when turning off the ESP system by ESP OFF switch. However, if the ESP system is shut off due to a system failure, the ARP system is also not available.

Modification basis	
Application basis	
Affected VIN	

4. 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.

2) Components



HDC Indicator	Sensor Cluster	HDC Switch
		
Green light on: HDC is ready for use (by pressing the HDC switch). Green light blinking: HDC is being applied. Red light on: the HDC system is overheated or malfunctioning.	The G sensor in sensor cluster detects the gradient of the roads. When the HDC is ready by HDC switch, G sensor sends the HDC request signal to ESP HECU if the vehicle is driving on a downhill with over 10% gradient.	When this switch is pressed once, HDC is ready for use. The green HDC indicator on the instrument cluster comes on. When the button is pressed again, HDC is deactivated and the indicator goes off. When the HDC is operating on a steep downhill, When the HDC is operating on a steep downhill, the HDC indicator in meter cluster blinks with heavy operating sound.

CAUTION

The G sensor in sensor cluster measures the actual gradient of roads. However, it may recognize a sharp turn or rough road as a steep downhill with over 10% of gradient. Thus, it may cause an operation of HDC system.

3) Operating Description

(1) HDC (Hill Descent Control) System Operating Conditions

HDC is operable only when the conditions below are met:

a. When HDC switch is turned ON
b. Gearshift lever position (Forward/Reverse)
   Automatic transmission: operates in any position except for P (parking) or N (neutral) positions.
c. When not depressing the accelerator pedal or brake pedal.
d. The vehicle speed is above 7 km/h (in Automatic transmission/4H mode).

NOTE

The vehicle conditions in Step (d) are subject to the vehicle driving conditions. Refer to below:

A. Speed available in HDC mode (slope)
- 2H/4H mode: vehicle speed below 50 km/h
  (operation slope level: 10%, termination slope level: when it reaches 8%)
- 2H/4H mode: vehicle speed below 50 km/h
  (operation slope level: 8%, termination slope level: when it reaches 5%)

B. 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)

e. Vehicle position control function in ESP and HBA function are not in operation:
- 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.

f. The gradient of downhill should be over 10%.
- When the gradient of downhill exceeds 10%, the HDC operates until the vehicle speed reaches speed 7 km/h.
- The HDC returns Ready status when depressing the accelerator pedal or brake pedal during its operation. When releasing the pedal, the HDC resumes the operation. Therefore, the driver can control the vehicle speed as desired.

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 depressing the accelerator pedal again, HDC starts its operation again. Therefore, drivers can control the vehicle speed to a desired level by operating the accelerator pedal.

When the slope level exceeds 20% during the HDC operation

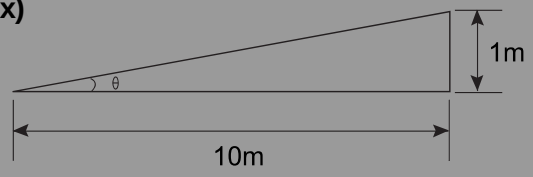
Modification basis	
Application basis	
Affected VIN	

NOTE

The percentage for gradient as below:

tanθ x 100 = Gradient (%)

ex)



$\tan\theta \times 100 = \frac{1}{100} \times 100 = 10\ (\%)$

* 1G = 9.8 m/s : acceleration

In other words, the gradient of 10% means that a road has 10 m of width and 1 m of altitude from level ground.

(2) HDC (Hill Descent Control) System Non-Operation Conditions

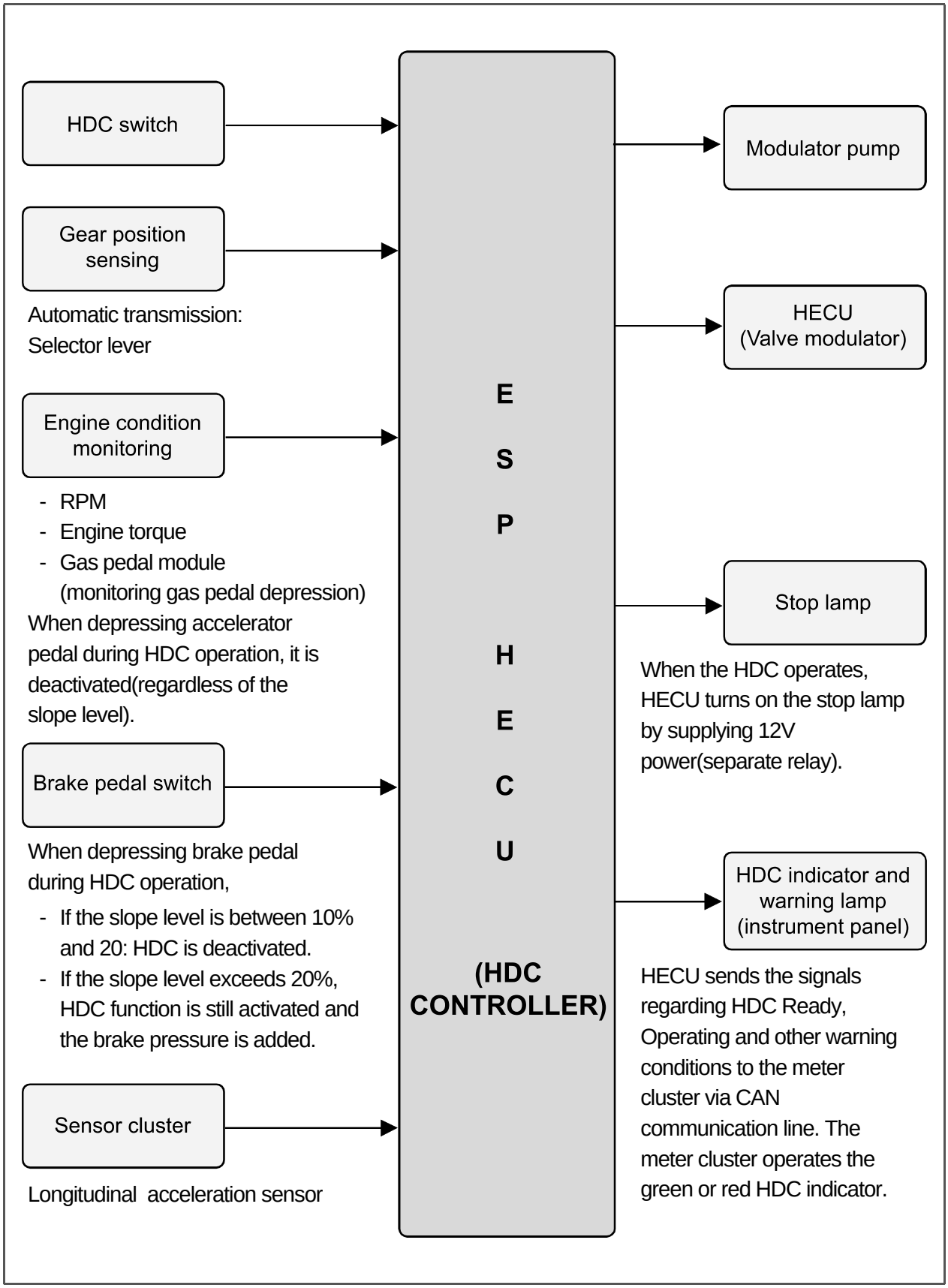
The HDC stops its operation when any of conditions below occurs:

a. When HDC switch is turned OFF
b. Gearshift lever has passed neutral (N) position.
   Vehicle with automatic transmission: Sensing at the selector lever unit
c. When the vehicle speed is out of the specified values. (Below 7 km/h)
d. When the ESP related functions, e.g. vehicle position control, HBA, ARP is activated during HDC operation.
e. When the internal temperature of HDC system goes over 450°C, due to long downhill driving on a steep hill with HDC operated.
   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.
f. When the slope level is below 10%

CAUTION

The red HDC warning lamp blinks when the internal temperature goes over 350°C. When it reaches 450°C, the HDC warning lamp comes on. The HDC can be operated in the range even where the HDC warning lamp blinks.

(3) Input/Output Signals for HDC Operation



Modification basis	
Application basis	
Affected VIN	

(4) 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>  </td><td>  </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
(goes off after 1.8 seconds)</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="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

(5) Warnings for HDC Operation

HDC system is a supplemental system for brake system. The operating conditions should be kept. The operating noise is much different from that from ABS/ESP system.

Make sure to remember the warning conditions below:

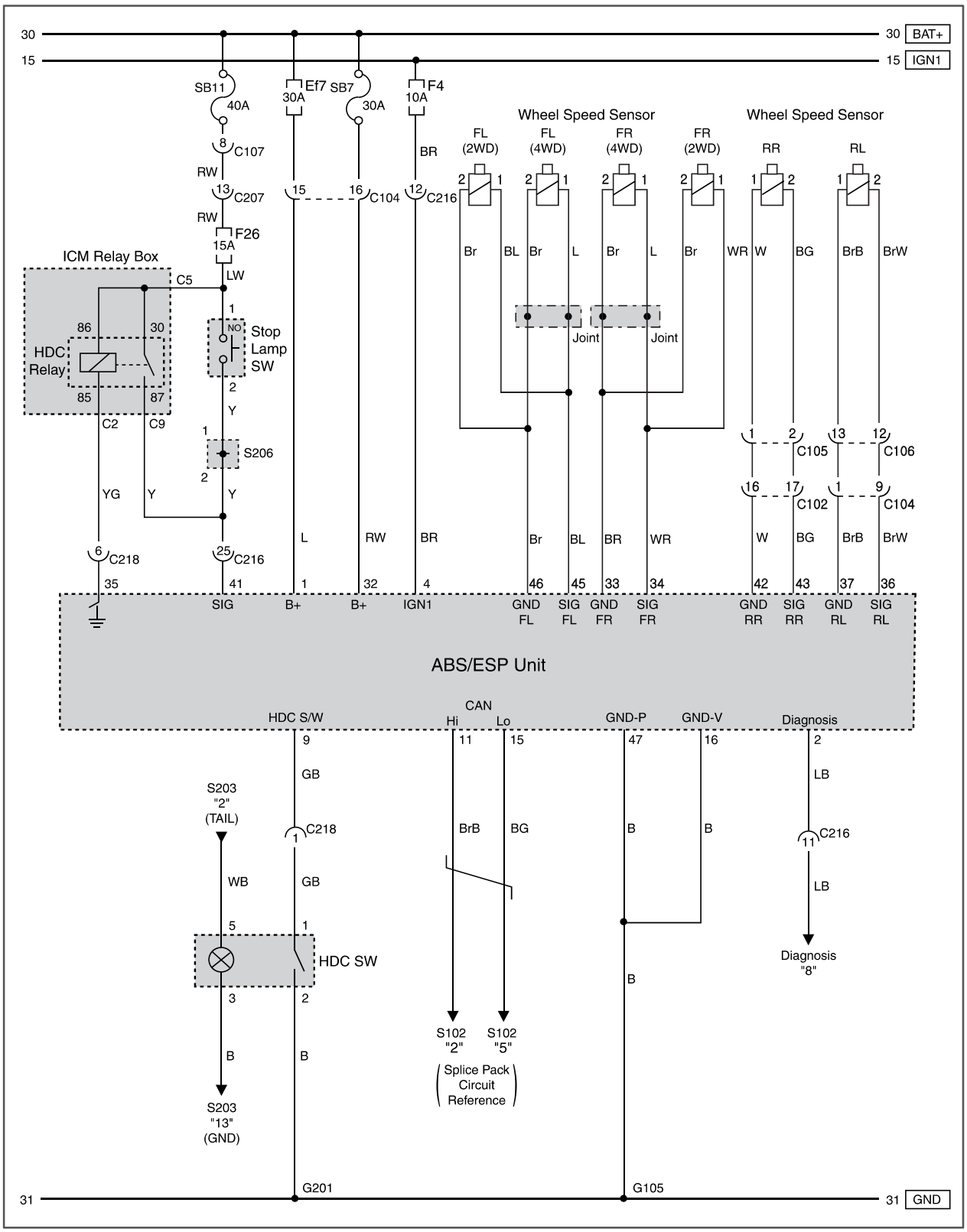
NOTE

- The HDC system has been developed to enhance the driving safety on steep downhill. Therefore, avoid using the HDC system on level roads.
- If the HDC system is used frequently, the internal components of ESP HECU and related parts could be damaged.
- Place the HDC switch at OFF position while the vehicle is driving on level; roads. As mentioned earlier, the HDC system is operable even when the vehicle is driving on level roads. This could cause the driver to lose control of the vehicle resulting in an accident.
- The heavy noise from HECU and brake system during HDC operation is normal operating conditions and is not hazardous.

Modification basis	
Application basis	
Affected VIN	

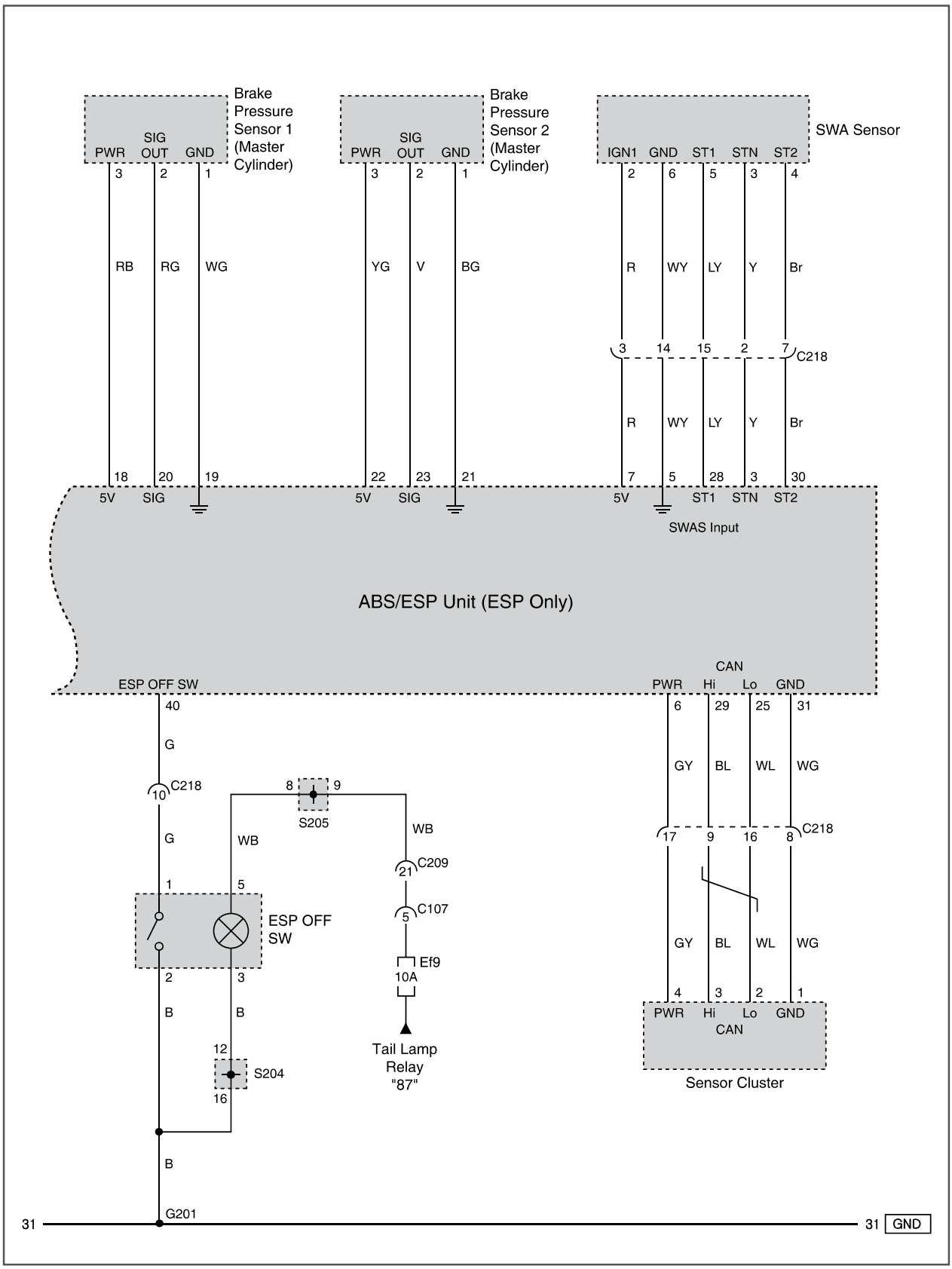
5. CIRCUIT DIAGRAM

▶ Wheel speed sensor, Stop lamp switch, Self-diagnosis connector, Warning lamps **(ABS/ESP)**



Modification basis	
Application basis	
Affected VIN	

▶ Brake pressure sensor, Steering wheel angle sensor, Sensor cluster, **ESP OFF switch**



Modification basis	
Application basis	
Affected VIN	

STEERING 4610-00

GENERAL INFORMATION

1. SPECIFICATIONS

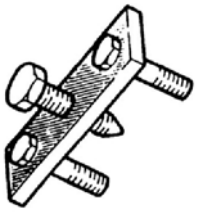
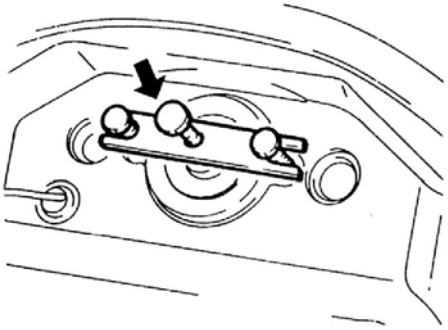
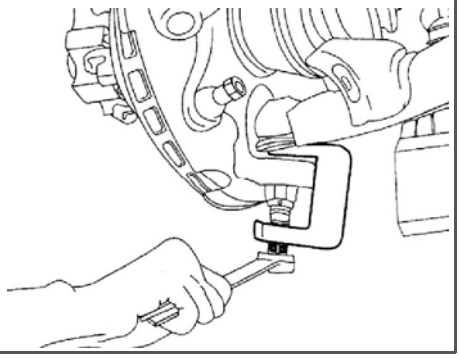
Description	Specification		
Steering wheel	Type		4-spoke type
	Outer diameter (mm)		390
Steering gear box	Type		Rack and pinion type
	Steering angle	Inner	38.2°
		Outer	34.1°
Oil pump	Type		Vane type
	Maximum pressure (kgf/cm2)		90 ± 3
	Pulley size (mm)		ø115
	Operating temperature		-40℃ ~ 150℃
Tilting angle	Up		4°
	Down		8°
Minimum turning radius	(m)		5.7
Steering oil	Type		PSF-3
	Capacity (L)		1.1
	Service interval		Daily check and add if necessary.
Lower shaft	Type		Double cardan CV joint type
	Angle (°)		62 ~ 68°
	Components		CV joint (upper) Hook joint (lower) Elastic sleeve

2. TIGHTENING TORQUE

Description		Nm
Steering column shaft	Steering column mounting bolt (upper)	19.6 ~ 24.5
	Steering column mounting bolt (lower)	17.6 ~ 24.5
	Steering wheel and steering column shaft lock nut	39.2 ~ 59.8
	Steering column and lower shaft connection bolt.	24.5 ~ 29.4
Power steering gear box	Steering gear box and gear box cross member mounting bolt	98.0 ~ 127.4
	Steering gear box and lower shaft connection bolt	24.5 ~ 29.4
	Steering gear box and lower shaft connection nut	34.3 ~ 44.1
	Tie rod end lock nut	63.7 ~ 78.4
	Steering gear box and pressure hose connection nut	11.8 ~ 17.6
	Steering gear box and return line connection nut	11.8 ~ 17.6
Power steering pump	Eye bolt for oil supply pipe to power steering pump	19.6 ~ 22.5
	Power steering pump bolt	39.2 ~ 49.0
Power steering line	Return line and clip connection bolt	8.8 ~ 13.7

Modification basis	
Application basis	
Affected VIN	

3. SPECIAL SERVICE TOOLS

Part Number & Name	Description
661 589 00 33 00 **(L 99 46 001 0A)** **Steering wheel puller** 	Removing the steering wheel 
661 589 13 33 00 **(W 99 44 002 0A)** **Ball joint puller** 	Removing the upper and lower end from front suspension 

4. TROUBLESHOOTING

Problem	Possible Cause	Action
Movements of steering feels heavy	Unregular wear or binding of steering ball joint due to lack of lubrication or foreign material insertion	Lubricate or replace
	Damaged or defective steering gear	Replace the steering gear assembly
	Incorrect steering pinion preload	Adjust
	Defective steering shaft join	Replace
	leakage of steering fluid	Repair or replace
	Insuffcient steering fluid or air insertion	Fill up fluid or bleed air
	Defective steering oil pump	Replace
	Damaged or loosened pump drive belt	Adjust or replace
	Clogging of fluid line	Repair or replace
	Damaged wheel or tire	Repair or replace
	Defective suspension	Repair or replace
Steering wheel pulls to one side	Damaged steering linkage	Replace
	Damaged wheel or tire	Repair or replace
	Defective brake system	Repair or replace
	Defective suspension	Repair or replace
Excessive free play of steering wheel	Worn steering gear	Replace the steering gear assembly
	Worn or damaged steering ball joint	Replace
	Looseness of steering gear box	Retighten
Poor returning of steering wheel	Broken or binding of steering ball joint	Replace
	Improper correct steering pinion preload	Replace the steering gear assembly
	Damaged wheel or tire	Repair or replace
	Defective suspension	Repair or replace

Modification basis	
Application basis	
Affected VIN	

Problem	Possible Cause	Action
Excessive vibration of steering wheel (shimming)	Broken steering linkage	Replace
	Looseness of steering gear box	Retighten
	Broken or binding of steering ball joint	Replace
	Worn or damaged front wheel bearing	Replace
	Damaged wheel or tire	Repair or replace
	Defective suspension	Repair or replace
Abnormal noise from steering system	Looseness of steering gear box	Retighten
	Defective steering gear	Replace the gear assembly
	Interference between steering column and parts	Repair
	Looseness of steering linkage	Retighten
	Loosened or damaged oil pump drive belt	Repair or replace
	Looseness of oil pump bracket	Retighten
	Looseness of oil pump	Retighten
	Air insertion into system	Bleed air
	Defective oil pump	Replace
Abnormal noise when turning steering wheel	Looseness of steering column	Retighten
	Worn or damaged steering shaft bearing	Replace the steering column
	Looseness of intermediate shaft	Retighten
Too heavy steering wheel	Worn or damaged steering shaft bearing	Replace the steering column
Ignition key cannot be inserted into key cylinder	Defective lock cylinder	Replace the steering column
	Defective ignition switch	Replace the ignition switch

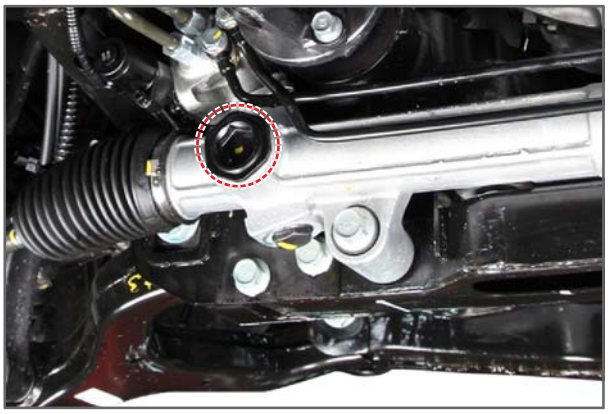
5. INSPECTION AND MAINTENANCE

▶ Gear Preload Check

Preload is the term used in mechanical engineering to describe the load applied to a fastener merely as a result of being fastened (and before any external loads are applied)

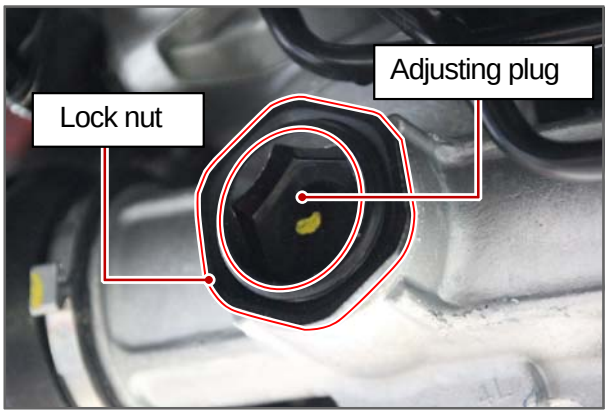


A. Place the wheels at straight ahead
B. direction.
Lift up the vehicle with a lift.
C. Unscrew the adjusting plug lock nut.
D. Measure the torque of the adjusting plug.

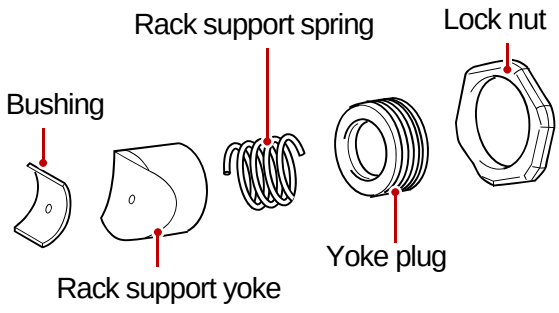


E. If the torque is excessive or too low, adjust to the specified torque.

- Place the rack gear to the center position.
- Tighten the adjusting plug to 10.2 Nm.
- Turn the pinion gear so that the rack gear is turned to lock to lock 5 times.
- Unscrew the adjusting plug.
- Tighten the adjusting plug to 4.6 to 5.6 Nm.
- Unscrew the adjusting plug to 67.5°.



Adjusting plug



Modification basis	
Application basis	
Affected VIN	

▶ Free Play Check



A. Start the engine and place the wheels at straight ahead direction.
B. Turn the steering wheel until the tires starts to move and measure the distance on the circumference of the steering wheel.

Free play	30mm

CAUTION
If the free play is out of the specified value, check the free play in steering column shaft connection and steering linkage. Replace or repair if necessary.

▶ Steering Effort Check

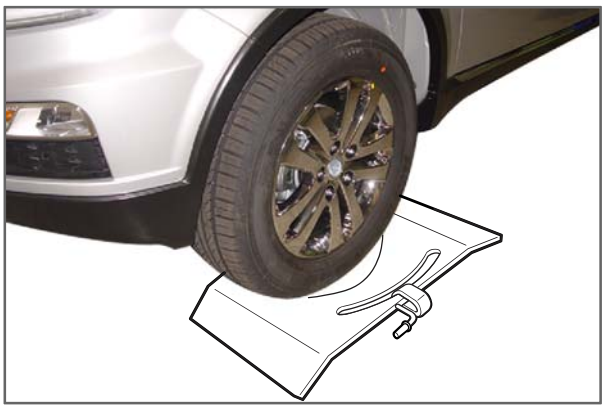


A. Park the vehicle on a paved and flat ground and place the front wheels at straight ahead direction.
B. Start the engine and let it run around 1,000 rpm.
C. Install the spring scale on the circumference of the steering wheel and measure the steering effort in both directions.

Steering effort in standstill	below 3.0 kg

CAUTION
The difference between both sides should be within 0.6 kg.

▶ Steering Angle Check

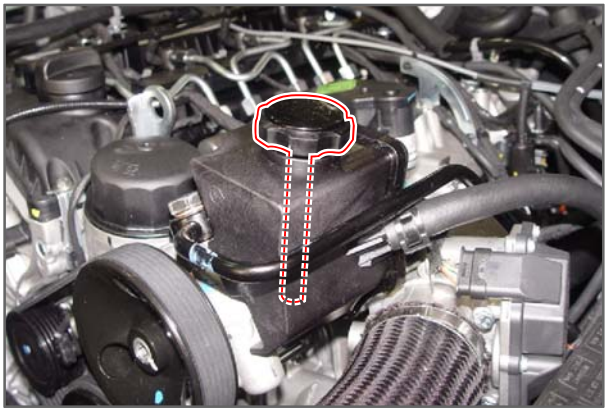


A. Place the front wheel on a turning radius measuring tool.
B. Turn the steering wheel to the its both ends and measure the maximum steering angle.

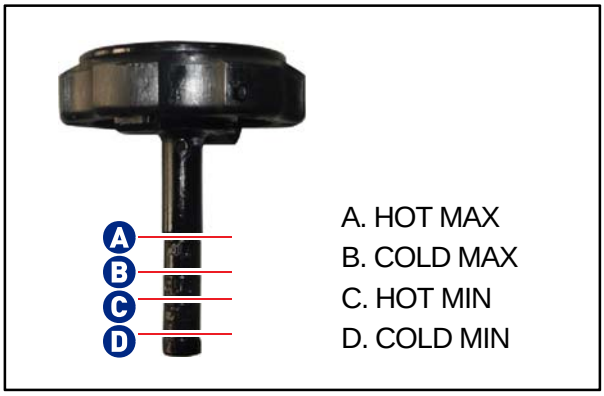
Steering angle	Inner	38.2°
	Outer	34.1°

CAUTION
If the steering angle is out of the specified value, check and adjust the toe-in.

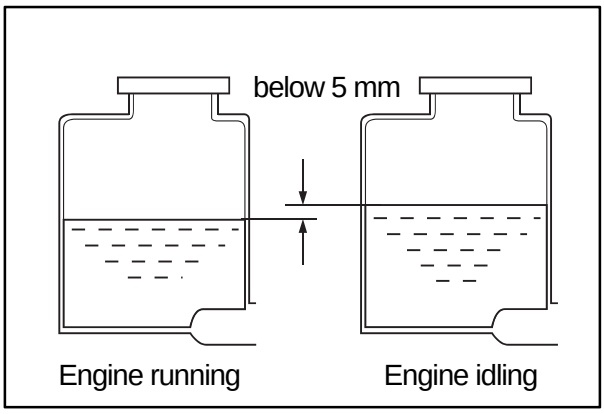
▶ Oil Level Check



Check the fluid level on a level ground with the engine turned off. The fluid level should be between the MIN and MAX marks on the reservoir cap gauge.



A. Place the vehicle on a level ground and start the engine and let it run at idle speed.
B. Turn the steering wheel several times so that the oil temperature reaches to normal operating level (75~85°C).
C. Place the steering wheel at straight ahead direction.
D. Check the oil level in the power steering oil reservoir. Adjust the oil level between MAX and MIN.



CAUTION

If the difference between two measurements is below 5 mm and the level is between MAX and MIN level, it's normal. If it is over 5 mm, bleed air from the system.

▶ Oil Change

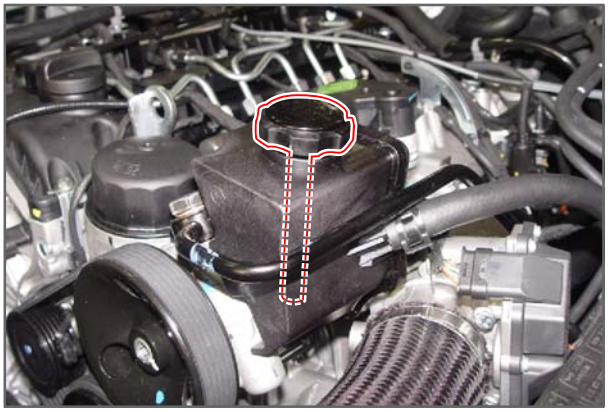


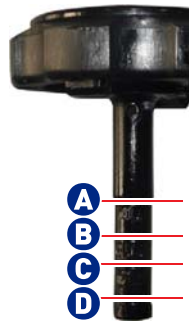
A. Open the power fluid reservoir cap and drain the fluid completely with oil suction device. To make it easy, turn the steering wheel to its both ends several times.
B. Fill up the specified fluid into fluid reservoir and bleed air from the steering system.

Oil type	PSF-3
Capacity	approx. 1.1ℓ (including reservoir)

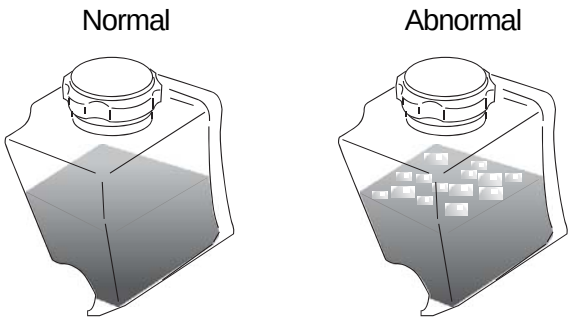
Modification basis	
Application basis	
Affected VIN	

▶ Air Bleeding





A. HOT MAX
B. COLD MAX
C. HOT MIN
D. COLD MIN



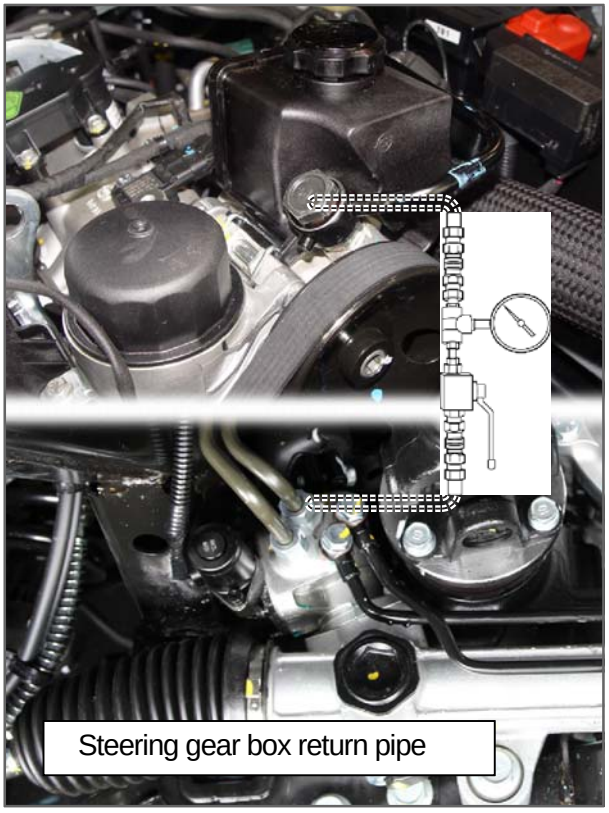
The air bleeding should be done after servicing the power steering system and when the difference between two measurements (cooled and normal temperature) is prominent.

A. Lift up the vehicle very carefully.
B. Turn the steering wheel to its both ends several times and add the oil up to MAX line in the steering oil reservoir.
C. Periodically crank the starting motor and turn the steering wheel to its both ends without any interruption.
D. Check the oil level again. If the oil level is fluctuated, repeat the procedures from step 3 to step 5.
E. Start the engine.
F. Turn the steering wheel to its both ends until any bubble can be found in the steering oil reservoir.
G. Perform the test drive and check the steering wheel for normal operation and noise.
H. If the oil level abruptly goes up, bleed the air from the system again.

CAUTION

- If the air bleeding is not properly performed, the life span of the power steering pump may be shortened.

▶ Oil Pump Pressure Check

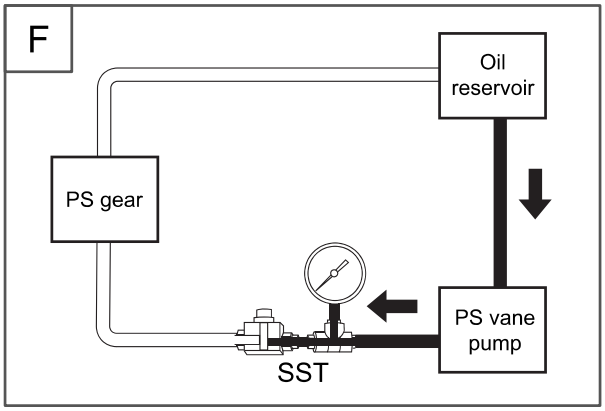


Check the oil pump pressure to locate any defect in oil pump.

CAUTION

Before checking the pressure, check the oil level and belt tension. Prepare the empty container to collect the spilled oil during the service.

A. Unscrew the pressure line fitting in power steering pump.
B. Install the pressure gauge between the power steering pump and the power steering oil pressure line.
C. Place the shift lever to neutral position.
D. Apply the parking brake.
   Open the valve in pressure gauge. Start the engine and let it run at idle speed.
E. Turn the steering wheel several times so that the oil temperature reaches to normal operating level.



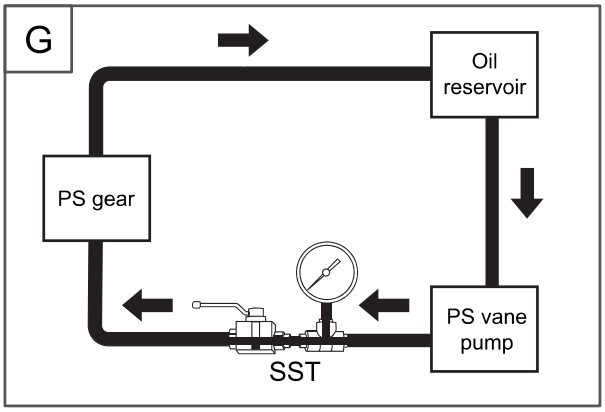
F. Fully close the valve in pressure gauge and measure the oil pressure.

CAUTION

- To prevent internal damage, do not close the gauge valve over 10 seconds.
- Keep the oil temperature at proper range.

Relief pressure	90 ± 3 bar

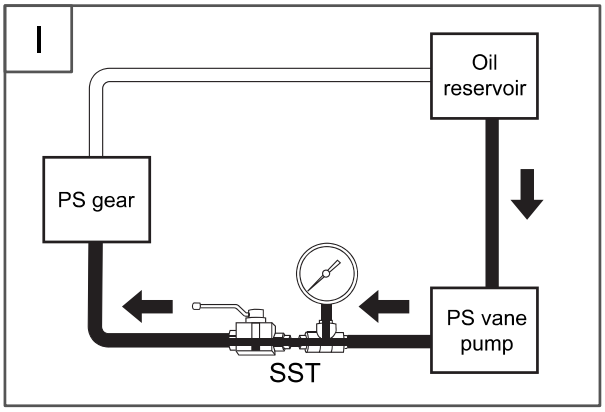
Modification basis	
Application basis	
Affected VIN	



G. Measure the oil pressure with the gauge valve fully open.

Pressure at no load	3 ~ 5bar

H. If the pump pressure is in specified range, the pump is normal. If not, replace the power steering pump



I. Turn the steering wheel righ or left until it stops with the engine idling ans valve fully open.

Oil pressure	78 ~ 83Bar

OVERVIEW AND OPERATING PROCESS

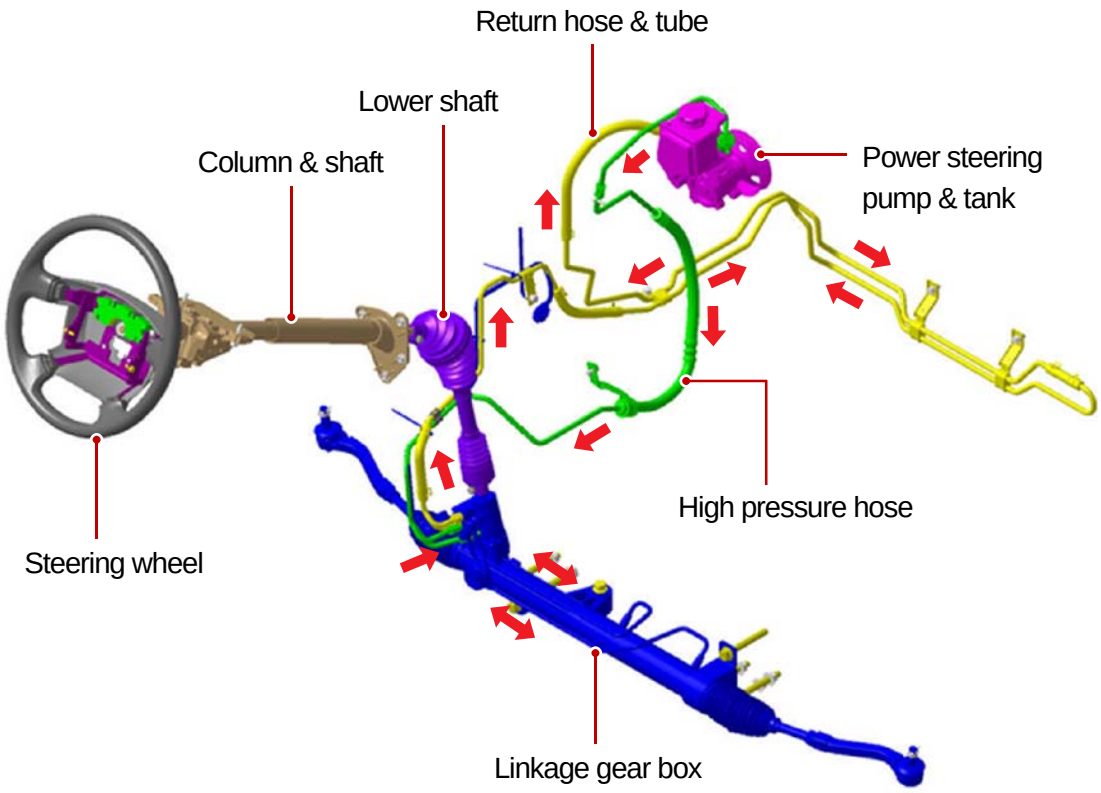
1. SYSTEM DESCRIPTION

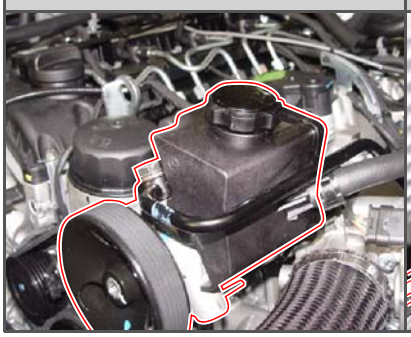
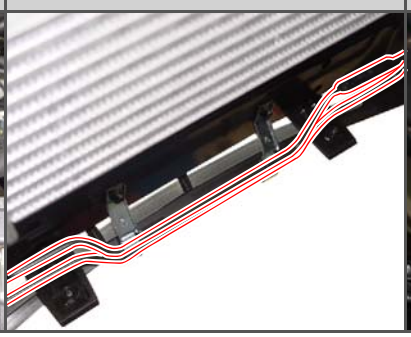
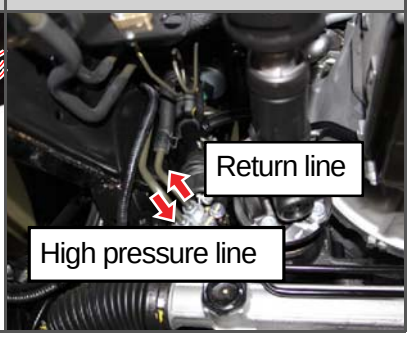
The power steering has been designed to make the wheel move more easily than in a manual steering system. The hydraulic power assists the process utilizing hydraulic fluid. The fluid increases pressure in the power steering pump and aids the movement of the steering mechanism. The power steering system 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 valve in the rack and the 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.

Modification basis	
Application basis	
Affected VIN	

2. SYSTEM LAYOUT

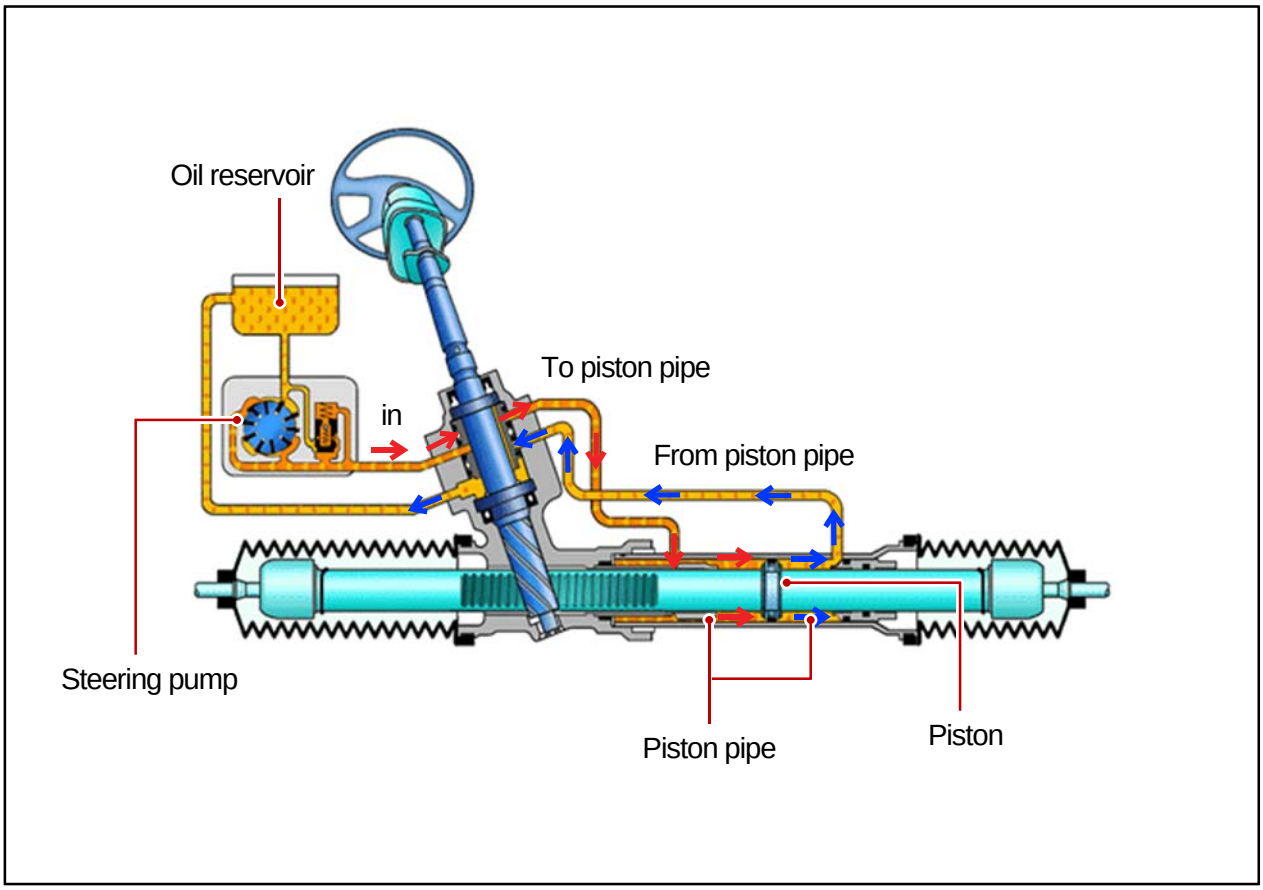
The steering pump is driven by the engine power through a belt. This pump circulates the power steering oil from the reservoir -> steering pump -> oil supply pipe -> steering gear box -> oil return pipe -> reservoir to perform steering operations



Steering pump	Steering return pipe	Steering cylinder
		

Modification basis	
Application basis	
Affected VIN	

▶ Oil Flows during Right Turn



Modification basis	
Application basis	
Affected VIN	

SSPS

4620-01

GENERAL INFORMATION

1. SPECIFICATIONS

1) Specifications

Description	Specification
Voltage Rating	DC 12V
Current Rating	1.0A
Resistance	6.7 ± 1Ω

OVERVIEW AND OPERATION PROCESS

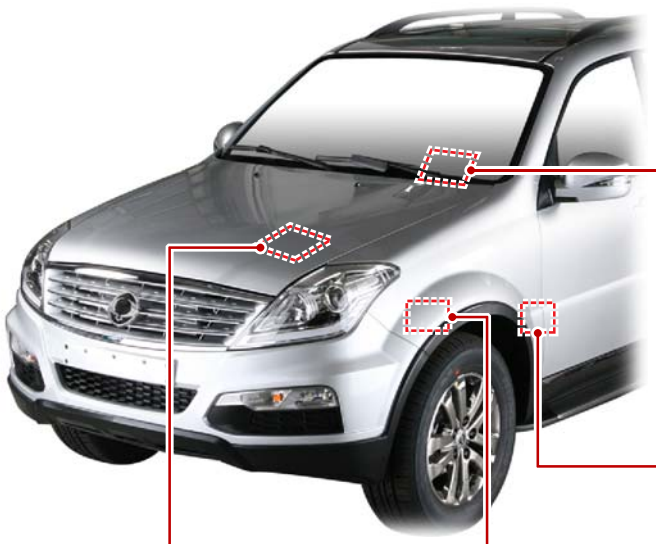
1. OVERVIEW

The speed-sensitive power-assisted steering system can automatically adjust the boosts according to the speed changes, automatically induct the high-speed or low-speed status, and relatively adjust the reasonable steering boosts, enhance the operation precision, reduce the driving pressure of drivers. No matter for steering, parking or reversing, it becomes much easier. The adjustable safety steering column attached possesses the functions of electrically adjusting height and transverse position, has brought much more abundant and comfortable spaces for legs, and has provided the great convenience to get in or out the car.

The Speed Sensitive Power Steering (SSPS) unit controls the SSPS solenoid vale in steering gear box to get proper power steering force.

Modification basis	
Application basis	
Affected VIN	

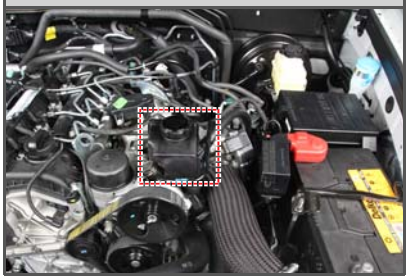
2. COMPONENTS



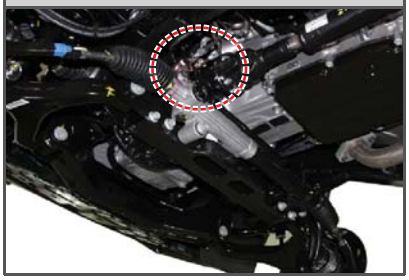
SSPS Warning Lamp



Location of Power Steering Pump



Location of SSPS Solenoid Valve



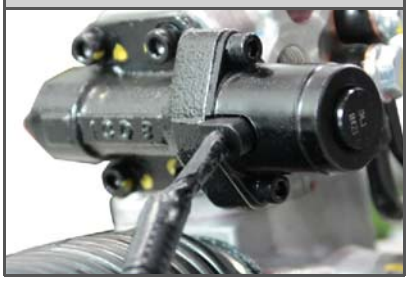
Location of SSPS Control Uni



Power Steering Pump



SSPS Solenoid Valve

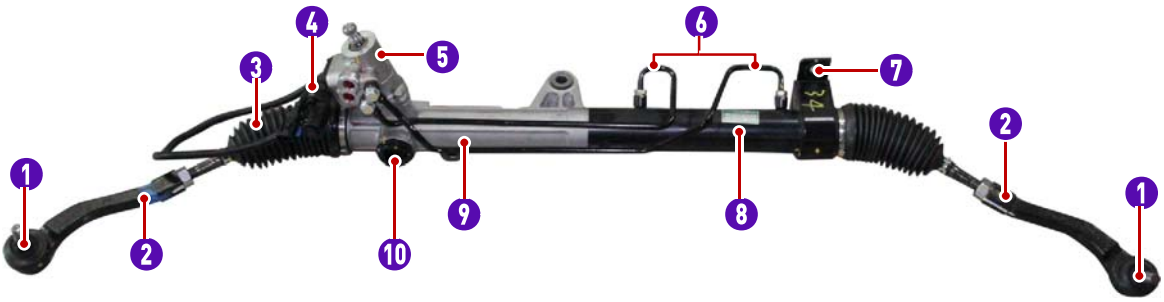


SSPS Control Unit

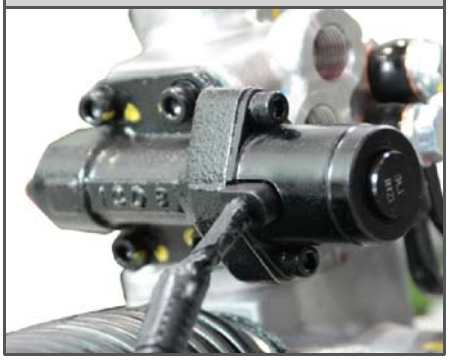


Modification basis	
Application basis	
Affected VIN	

▶ Steering Gear Box



SSPS Solenoid Valve

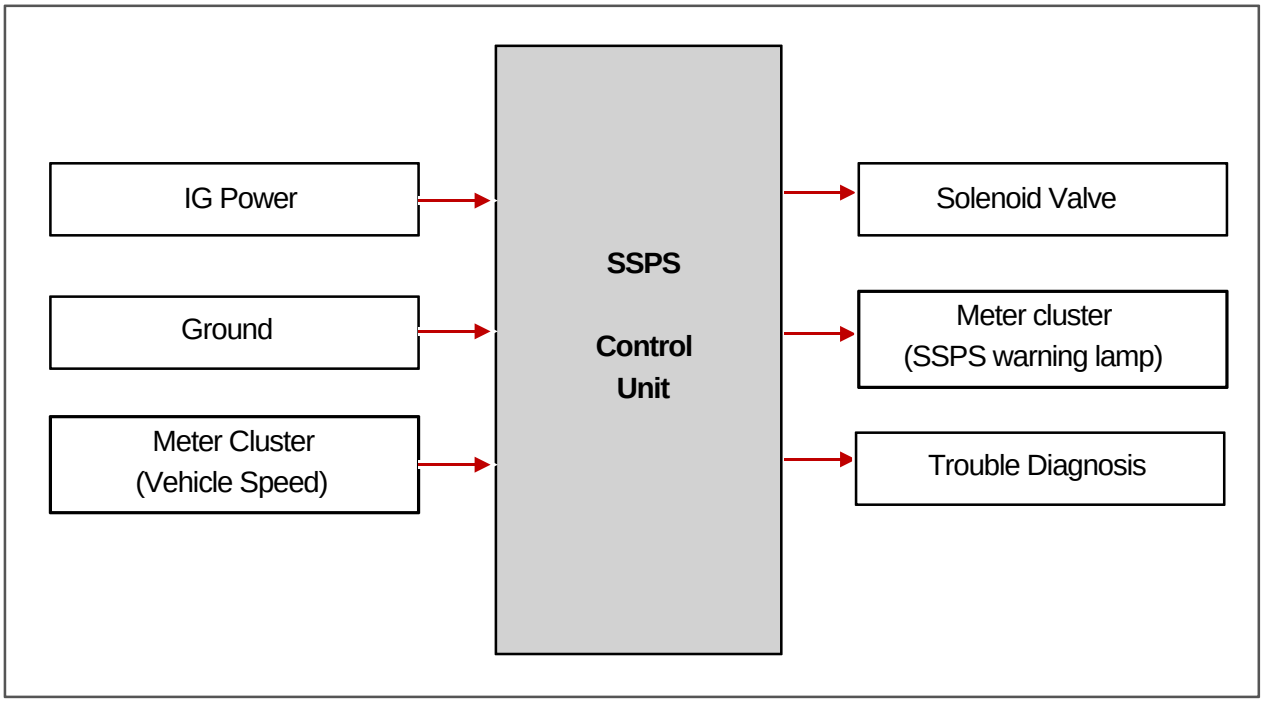


1. Tie rod end
2. Tie rod
3. Bellows
4. SSPS solenoid valve
5. Valve assembly
6. Feed tube
7. Mounting bracket
8. Cylinder tube
9. Rack housing
10. Adjusting plug

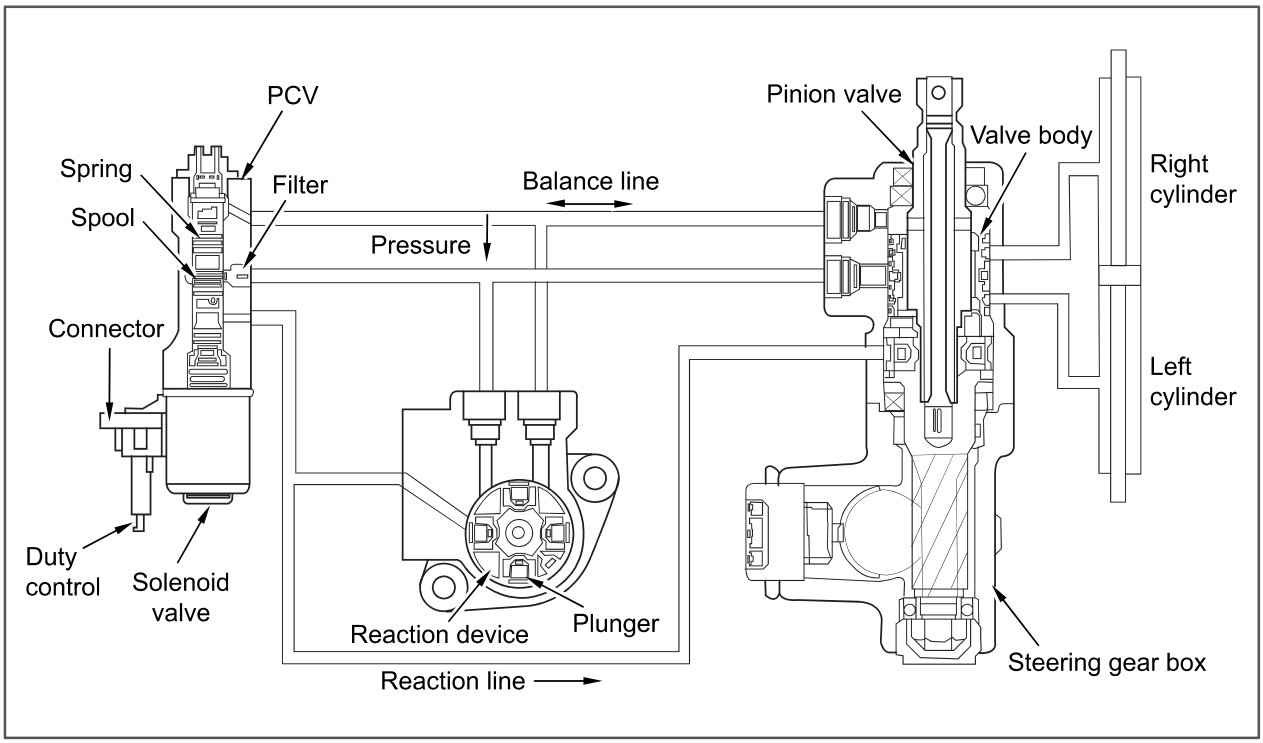
Modification basis	
Application basis	
Affected VIN	

3. OPERATING PROCESS

1) Input/Output of ECPS Control Unit



2) ECPS Configuration



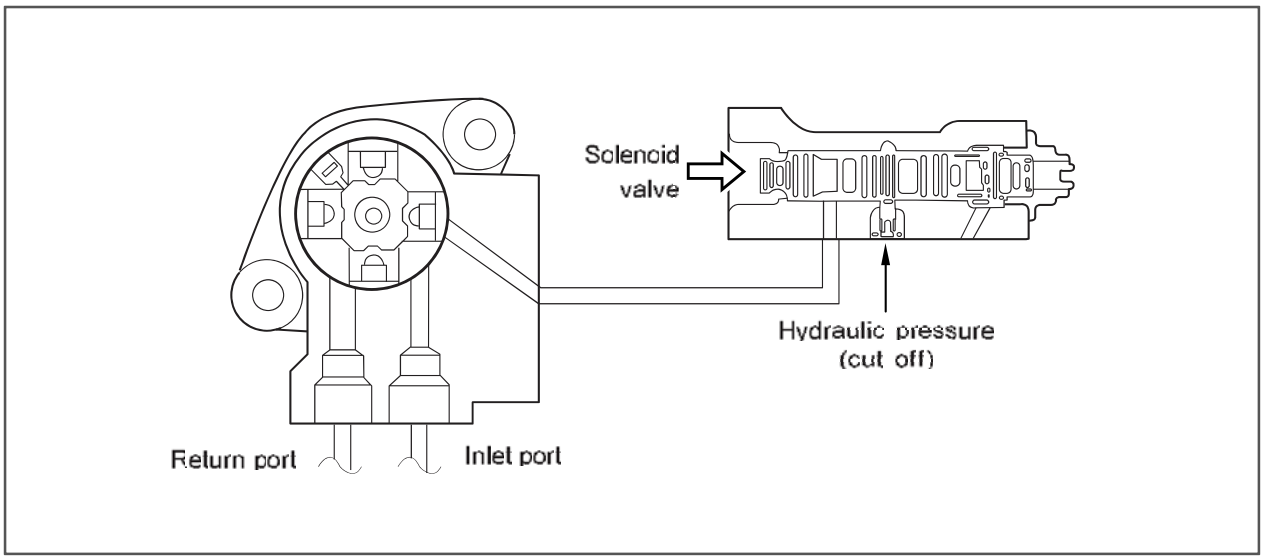
▶Components

1. **PCV (Pressure Control Valve)**
   This valve controls the hydraulic pressure supplied to reaction device by moving the spool valve according to the changes of solenoid valve.
2. **Reaction device**
   This device increases the steerability effect by binding the input shaft with supplied hydraulic pressure from PCV.
3. **Solenoid valve**
   This valve determines the valve spool position in PCV with the electric current supplied from ECPS control unit.

3) Operation of Solenoid Valve

SSPS control unit controls the current to solenoid valve according to the vehicle speed. Based on this current, the solenoid valve changes the position of valve spool to control the hydraulic pressure to the reaction plunger. Accordingly, the SSPS system can get the desired steering force according to the vehicle speed.

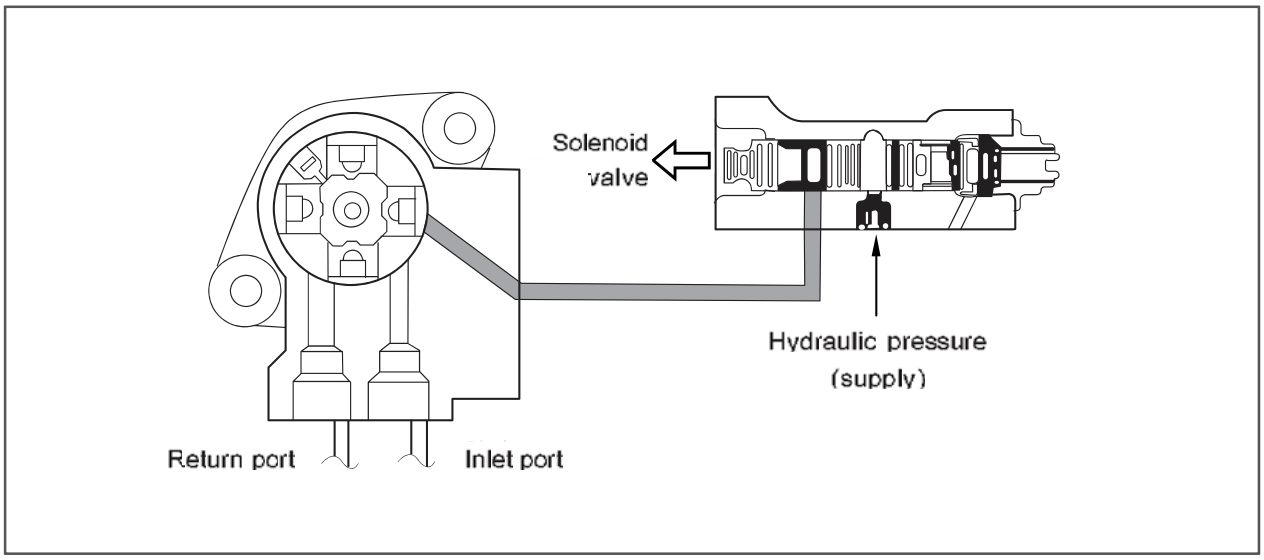
▶During parking and low speed driving



1. SSPS control unit outputs nearly maximum electrical current.
2. The solenoid rod pushes PCV spool to right side.
3. The hydraulic pressure coming from pump is not supplied to the reaction device as the spool orifice is cut off.
4. The hydraulic pressure is cut off and the manipulation of steering wheel becomes lighter.

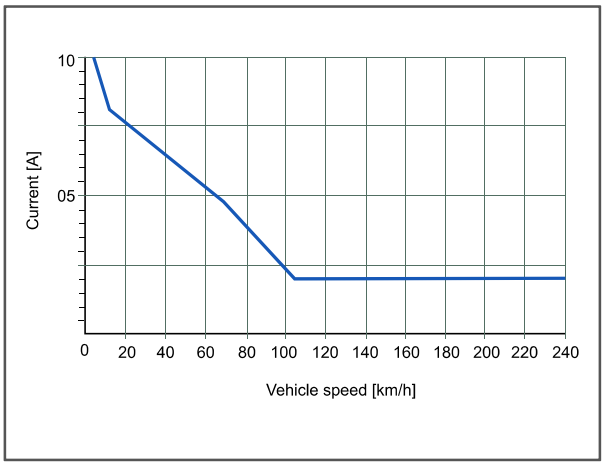
Modification basis	
Application basis	
Affected VIN	

▶ In medium and high speed driving



1. The shaft operation force of solenoid rod is reduced due to the reduction of output current from SSPS control unit.
2. The coil spring pulls the PCV spool toward solenoid valve to open it.
3. The hydraulic pressure from pump flows to pinion reaction area through orifice and applies reaction force to reaction plunger.
4. At this time, the reaction plunger transmits the reaction force to V-groove in input shaft to provide heavy steerability.

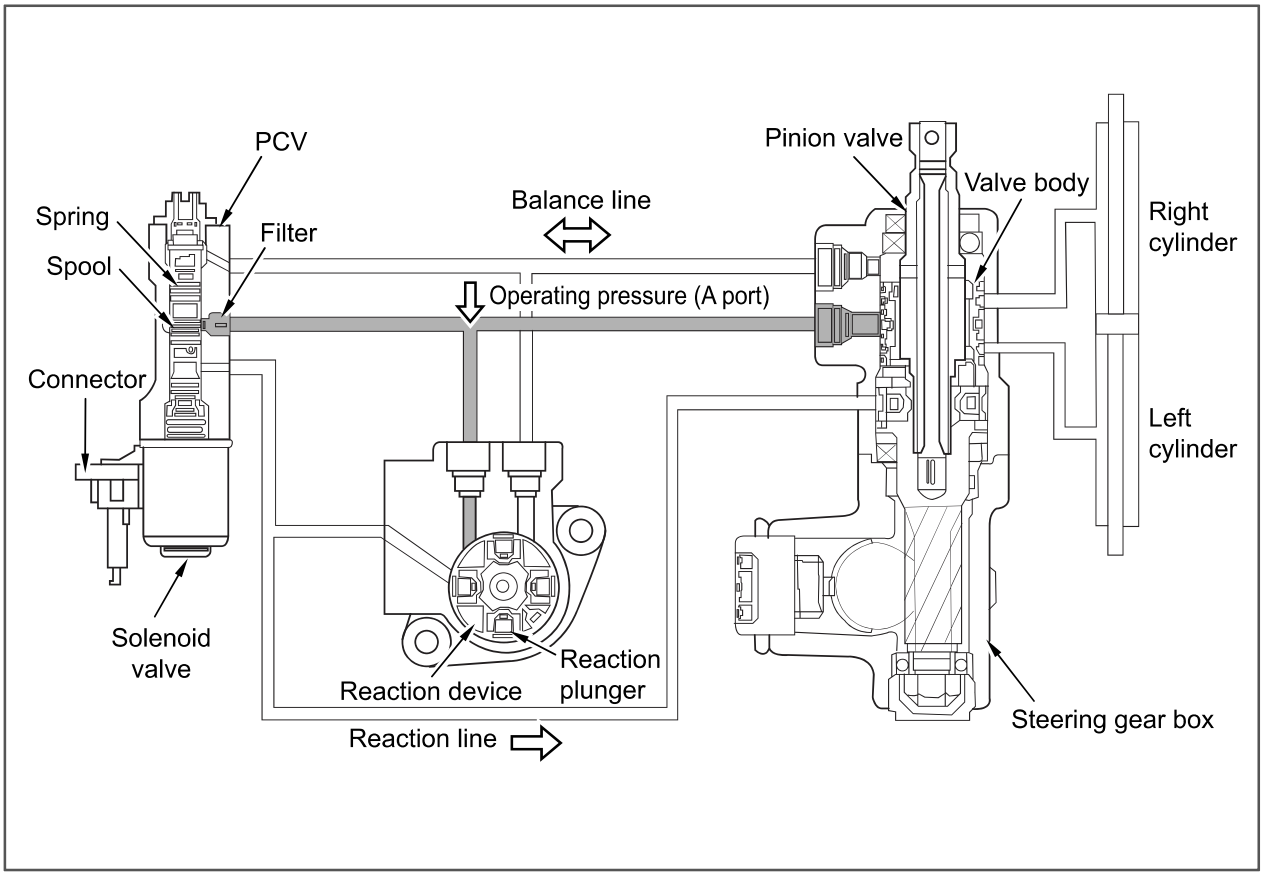
4) System Control



ECPS system, according to the vehicle speed, enables to achieve proper steering characteristics by controlling hydraulic pressure to reaction plunger located in input shaft of power steering gear box. In other words, ECPS control unit enhances the parking conveniences by controlling duty type current control. It provides heavy steerability with low current as the vehicle speed increases. And, it provides light steerability with high current as the vehicle speed decreases.

▶During parking and low speed driving

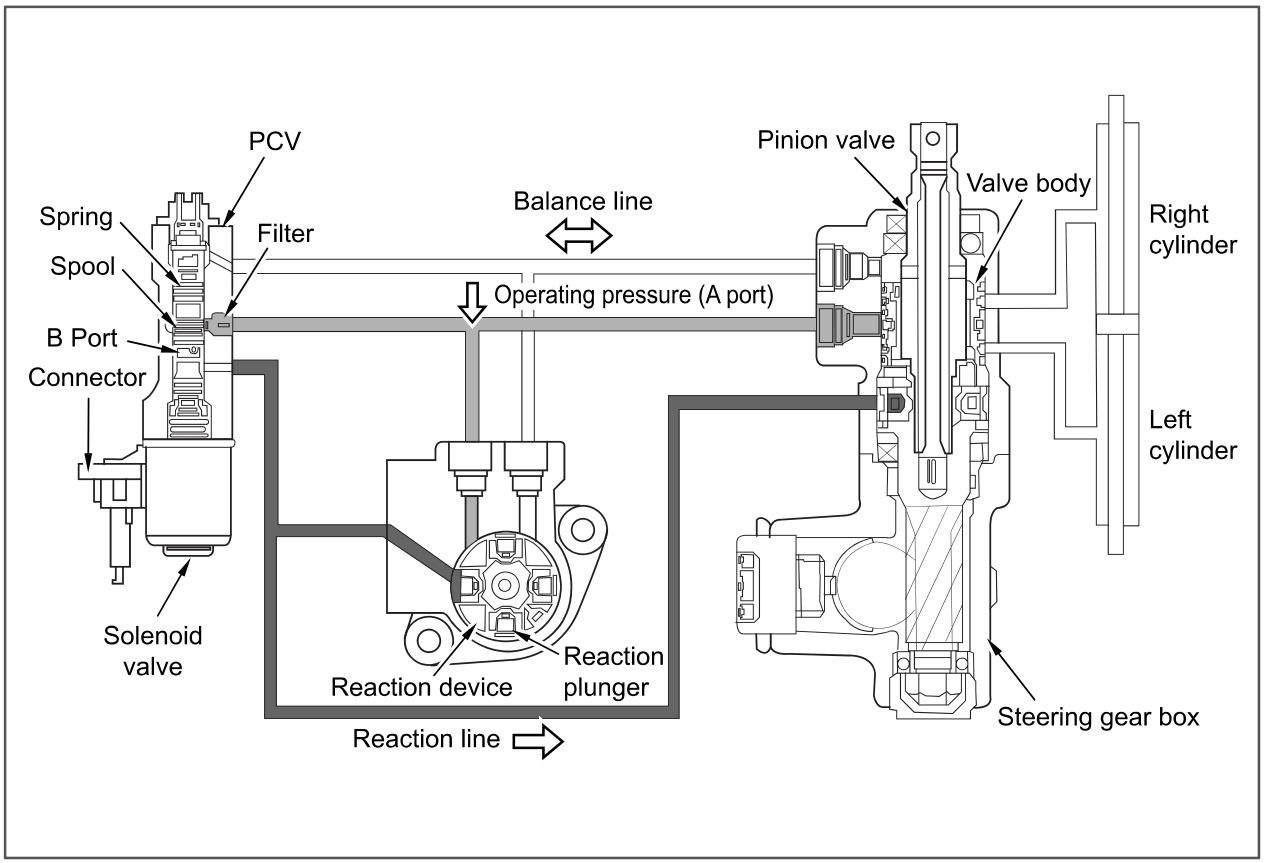
During parking and driving in low speed, the control unit supplies approx. 1 A of electric current to solenoid valve. Then, the spool located in PCV compresses the upper spring and elevates upward and, the working pressure from oil pump (A port) is not able to flow to the reaction plunger (C port). As a result, the pressing force from reaction plunger disappears and the steerability enhances.



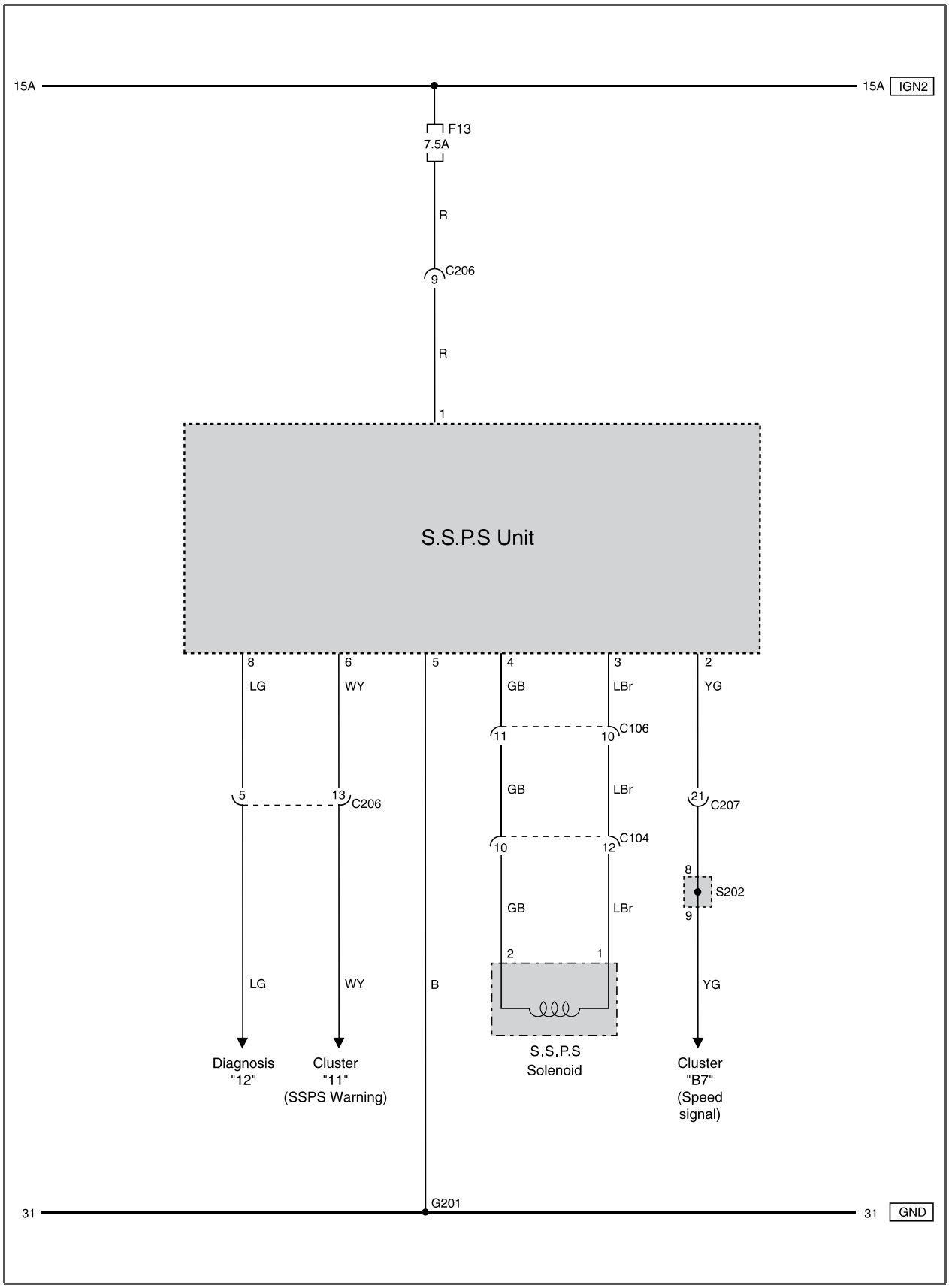
Modification basis	
Application basis	
Affected VIN	

▶During high speed driving

During high speed driving, the control unit supplies weak electric current to solenoid valve. Then, the spool located PCV moves from top to bottom, and the working pressure (A port) from oil pump is applied to reaction plunger (C port) through B port. As a result, the pressing force from reaction plunger against input shaft is increased and the steerability becomes heavier.



4. CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	

TPMS

4190-00

GENERAL INFORMATION

1. SPECIFICATIONS

1) Wheel Module

Description	Specification	Remark
Pressure measuring range	0~6.375bar (0~92.43psi)	1 bar = approx. 14.5 psi
Pressure measuring tolerance	±5% (−40℃ ~ −10℃) ±2% (−10℃ ~ 70℃) ±5% (70℃ ~ 100℃)	
Temperature measuring range	−50℃ ~ 205℃	
Temperature measuring tolerance	±5% (−40℃ ~ −10℃) ±2% (−10℃ ~ 70℃) ±5% (70℃ ~ 100℃)	
Transmit frequency	433.92 MHz	
Battery life	Lithium battery (approx. 3.0~3.2V) 160,000 km or 10 years	Subject to operating conditions
Tire pressure	32psi	

2. SPECIAL SERVICE TOOLS

The tightening torque for wheel module is 1.4 Nm.
To tighten the bolts for wheel module without any damage, you must use the special service tool as below.



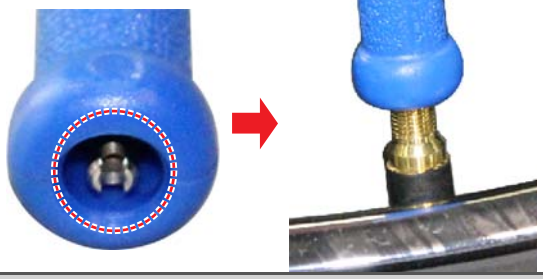
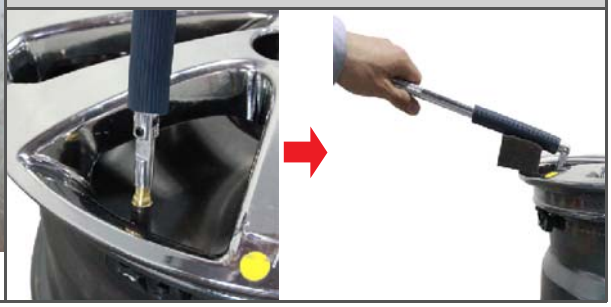
Torque wrench (0.1~5.0 Nm)



Torx socket T-10

Tire valve remover/installer



How To Use	
Torque Wrench	**Removing/Installing Valve Insert**
	
	Removing/Installing Valve Body
	

Modification basis	
Application basis	
Affected VIN	

3. CAUTIONS

CAUTION

- The tire pressure cannot be displayed on the meter cluster immediately after starting the engine. TPMS start to recognize the tire pressures in 10 minutes of continuous driving (over 20 km/h) after starting the engine.If the system is not ready yet, LCD display shows "--".

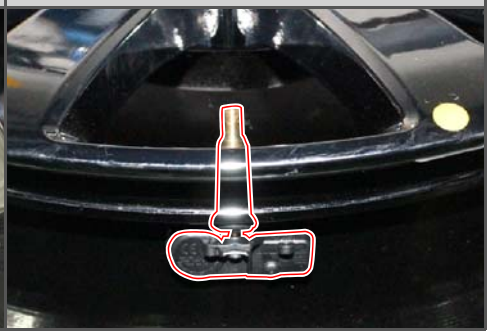
Initial Engine Start	Tire Pressure Indicated
Front Tire Pressures 	Front Tire Pressures 
Rear Tire Pressures 	Rear Tire Pressures 

- If the vehicle is moving around electric power supply cable or radio transmitter which can interferewith normal operation of TPMS, the TPMS may not work properly.
- After replacing the low pressure tirewith the spare tire without TPMS, the TPMSmalfunction indicator will illuminate afterrestarting and about 20 minutes ofcontinuous driving because the spare tire without TPMS does not have a sensor. In this case, LCD display shows "--" instead of tire pressure.

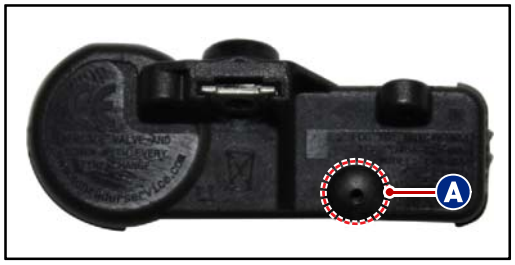
Front Tire Pressures	Rear Tire Pressures
	

CAUTION

- Use only the TPMS wheel approved by SYMC for replacement. Even though the replacement wheel has same size with factory installed wheel, TPMA may not be usable due to interference on rim.

External View for Wheel Module	Internal View for Wheel Module
	

- Do not use any tire sealant if the vehicle is equipped with a TPMS. The liquid sealant can damagethe tire pressure sensors.



Modification basis	
Application basis	
Affected VIN	

Memo

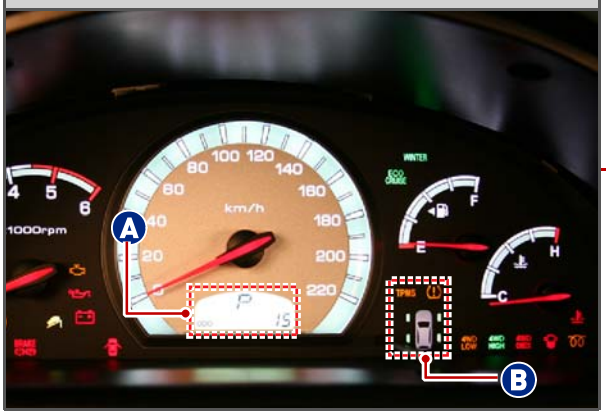
OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

As an additional safety feature, this vehicle has been equipped with a tire pressure monitoring system (TPMS) that illuminates an abnormal tire pressure telltale when one or more of tires are significantly under-inflated or over-inflated.Driving on a significantly under-inflatedtire causes the tire to overheat and canlead to tire failure. Under-inflation alsoreduces fuel efficiency and tire treadlife, and may affect the vehicle's handlingand stopping ability.
The wheel module is located under valve body in each tire and periodically sends the data to TPMS ECU with radio frequency. TPMS ECU converts the signals and sends them to the meter cluster through CAN line so that the driver can recognize the tire conditions. TPMS ECU can identify the positions of wheel module in each tire.

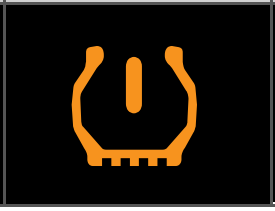
2. SYSTEM LAYOUT

Meter Cluster





A Tire Pressure Display	
Front Tire Pressures	**Rear Tire Pressures**
	

B Warning Lamp/Indicator		
TPMS Warning Lamp	**Tire Pressure Warning Lamp**	**Tire Pressure Indicator**
		

Modification basis	
Application basis	
Affected VIN	

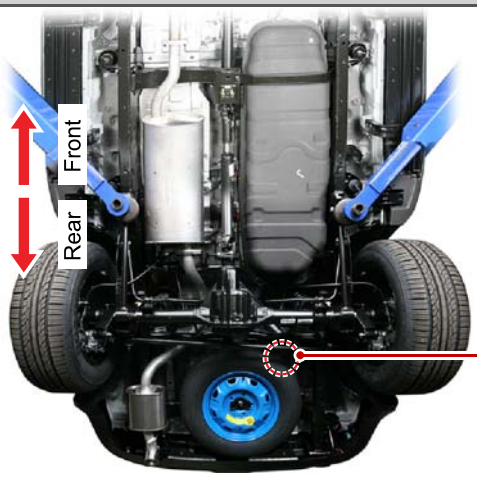
Location of Wheel Module



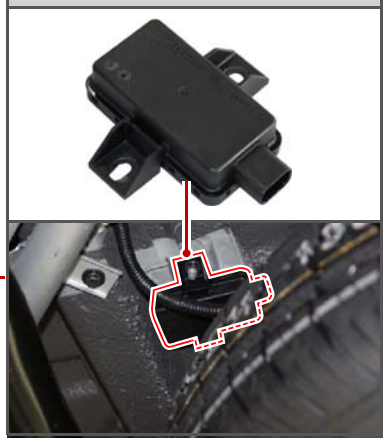
Wheel Module Sensor	Wheel Module Assembly
	



Location of TPMS ECU

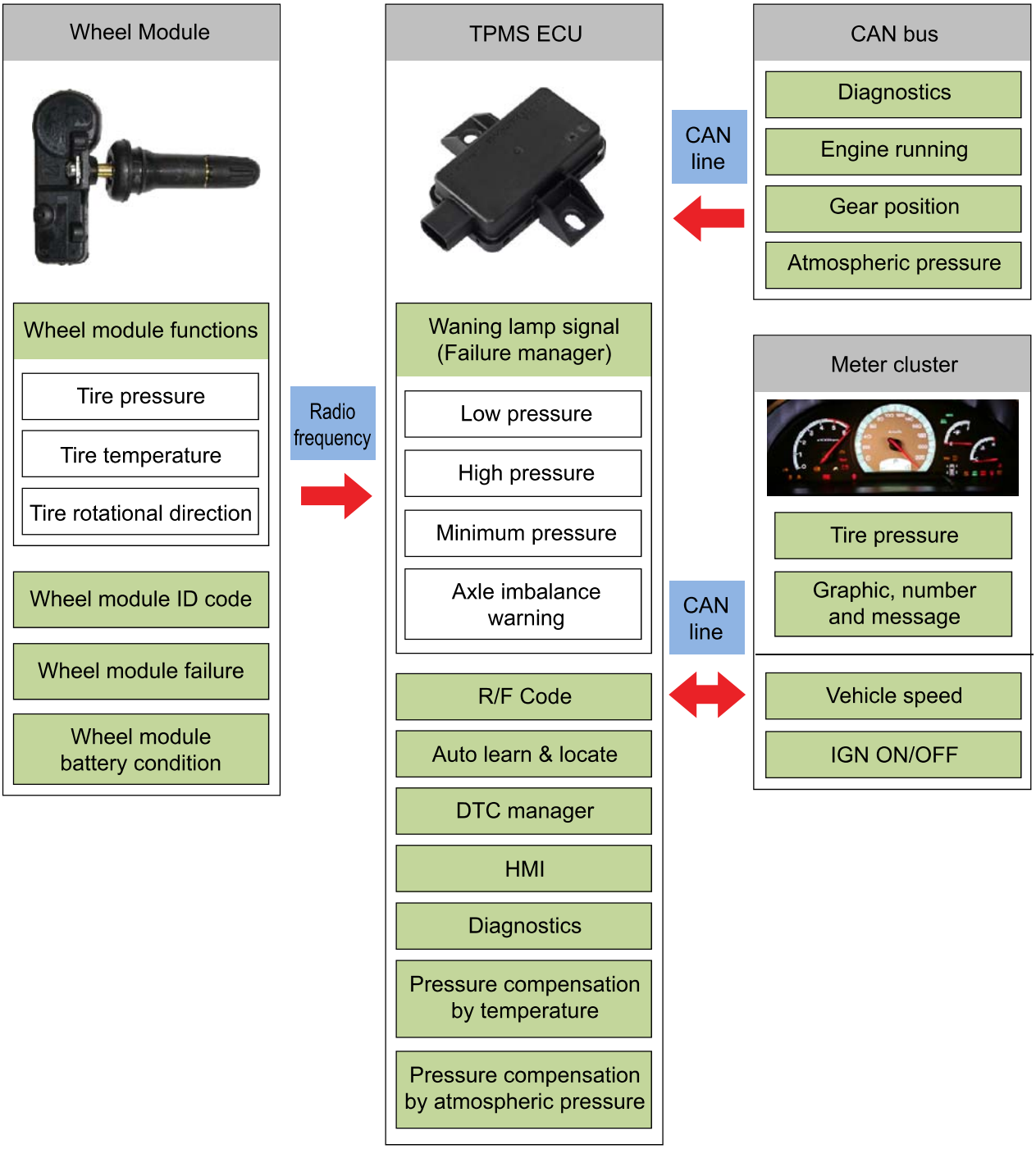


TPMS ECU



Modification basis	
Application basis	
Affected VIN	

3. BLOCK DIAGRAM



Modification basis	
Application basis	
Affected VIN	

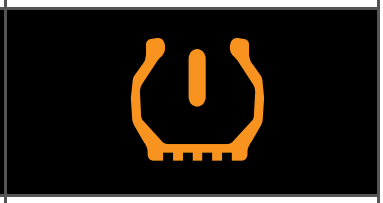
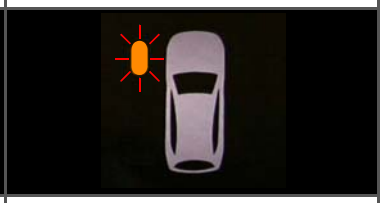
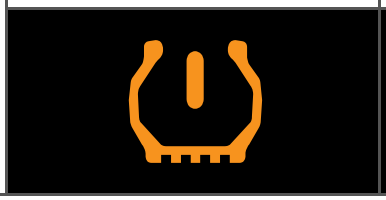
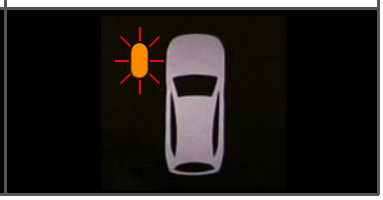
4. WARNING LAMP AND INDICATOR



Meter Cluster	
TPMS Warning Lamp 	- This warning lamp comes on when the ignition switch is turned to "ON" and should go off in 4 seconds. - This warning lamp comes on and stays on when there is a problem with the TPMS. - For details, refer to "5. WARNING".
Tire Pressure Warning Lam (Global Warning) 	- This warning lamp comes on when the ignition switch is turned to "ON" and should go off in 4 seconds. - This warning lamp blinks (0.4s ON/OFF) for 70 seconds and then stays on when one or more tires is significantly under-inflated or flat tire. - For details, refer to "5. WARNING".
Tire Pressure Indicator 	- This warning lamp comes on when the ignition switch is turned to "ON" and should go off in 4 seconds. - This indicator illuminates in green when the ignition switch is turned to "ON" and should go off in 15 seconds. - If a specific tire indicator illuminates in yellow or blinks, the tire inflation pressure may be abnormal or the tire inflation pressure sensor is defective. - For details, refer to "5. WARNING".
TPMS Mode Initialized 	When pressing the trip switch for more than one second in ODO mode, LCD display shows the tire pressure for front wheels. To see the tire pressure for rear wheels, briefly press the trip switch again. * For details, refer to "6. TIRE PRESSURE DISPLAY".

5. WARNING

▶ **TPMS Warning Lamp and Tire Pressure Warning (Global Warning)**

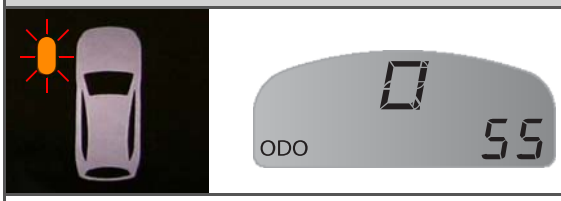
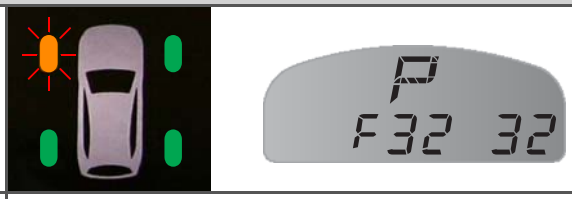
Failure	Warning ON Conditions	
	Warning Lamp	
- Error in TPMS system	- Yellow - Comes on immediately	- Yellow - Blinks (0.4s ON/OFF) for 70 seconds and the stays on
		
- Defective wheel module	- Yellow - Comes on immediately	- Yellow - Affected tire symbol
		
- Error in TPMS system - Low tire pressure - Flat Tire	- Yellow - Blinks (0.4s ON/OFF) for 70 seconds and the stays on	- Yellow - Affected tire symbol
		

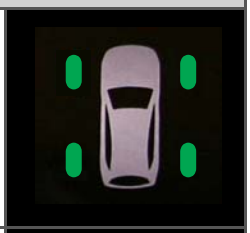
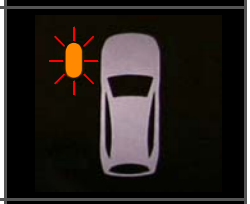
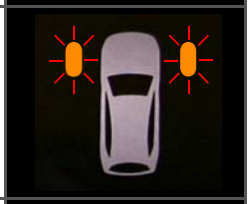
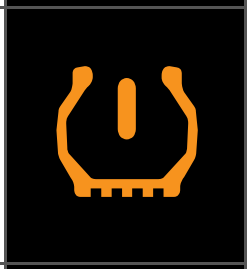
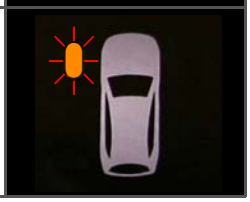
There could be the condition that turns on two warning lamps at a time. In this case, follow the priority as below:

Puncture detected > Low tire pressure > High tire pressure > Imbalance

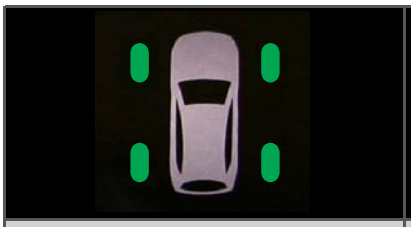
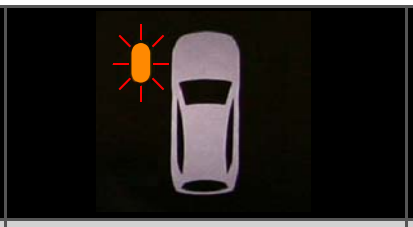
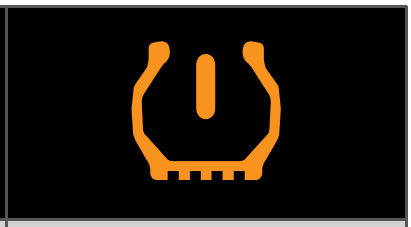
Modification basis	
Application basis	
Affected VIN	

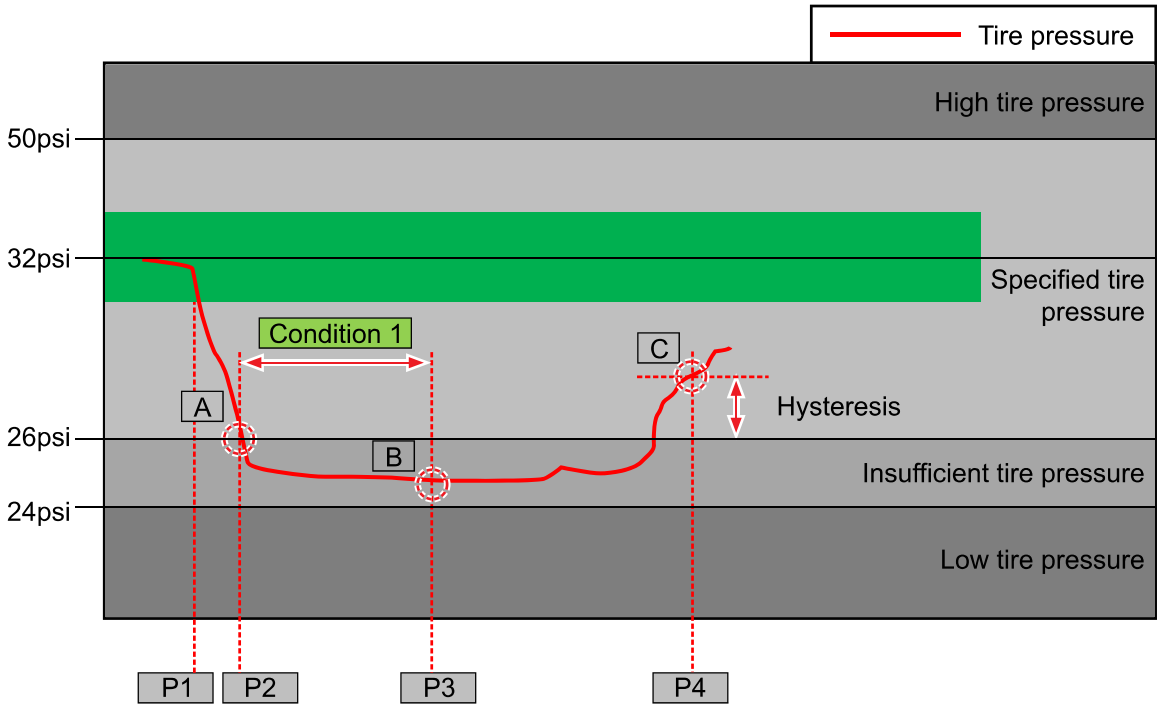
▶ Tire Pressure Indicator

Tire Pressure Indicator (Changed from ODO mode to Tire pressure display mode)	
	
In ODO mode, the symbol for abnormal tire comes on in yellow.	In tire pressure display mode, the symbol for abnormal tire comes on in yellow and the other symbols come on in green.

Tire Pressure	Condition		LED color/ON condition/Indication	
Normal	- Specified tire pressure: 32 psi - 10 minutes of continuous driving (over 20 km/h) * The tire pressure should be measured at 18°C in CVW.		- Comes on in green (10~15 s) and then goes off	
High pressure	- The tire pressure exceeds 48 psi		- Yellow - Blinks (0.2 s ON/OFF)	
Imbalance	- Too high pressure imbalance in tires - Imbalance: over 4 psi		- Yellow - Blinks (1.0 s ON/OFF)	
Insufficient pressure, Low pressure, Punctured tire	- Too low tire pressure		- Yellow - Blinks (0.4 s ON/OFF) for 70 seconds and then stays on	
	Insufficient	Maintained 24~26 psi for more than 10 minutes		
	Low	Below 24 psi	- Yellow - Comes on immediately	
	Punctured	Changes 3 psi a minute while the vehicle is moving		

▶ Low Tire Pressure

		
A, C	B	B (Blinks (0.4 s ON/OFF) for 70 seconds and then stays on)



P1→P2 range	Slowly decreasing pressure from specified pressure
P2→P3 range	Meets the warning lamp ON condition 1
P3	Warning lamp ON
P4	Warning lamp OFF (Hysteresis range)

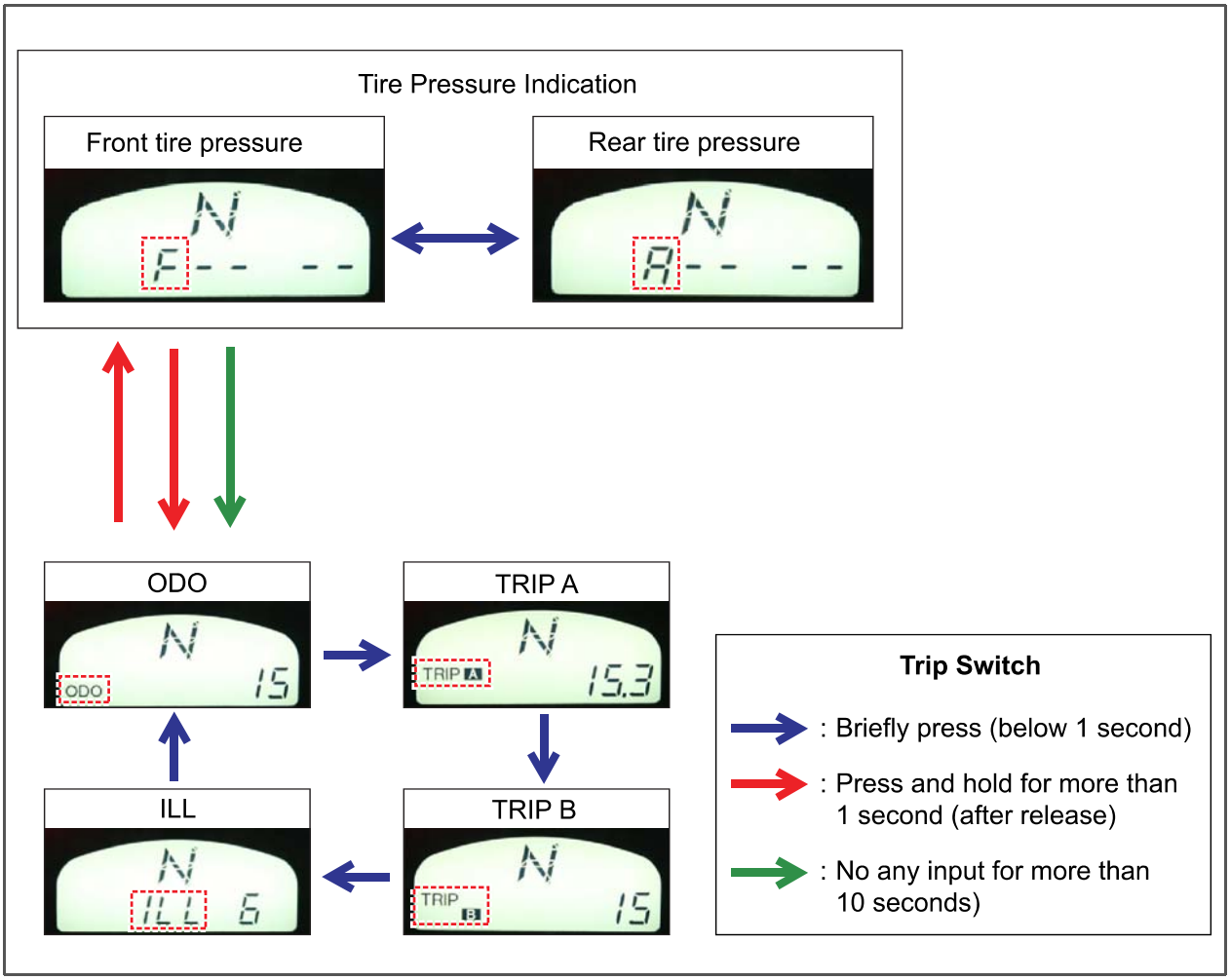
* **Condition 1**: continuous driving for 10 minutes (tire pressure: 24~26 psi (low), vehicle speed: 20 km/h or higher)

Modification basis	
Application basis	
Affected VIN	

6. TIRE PRESSURE DISPLAY



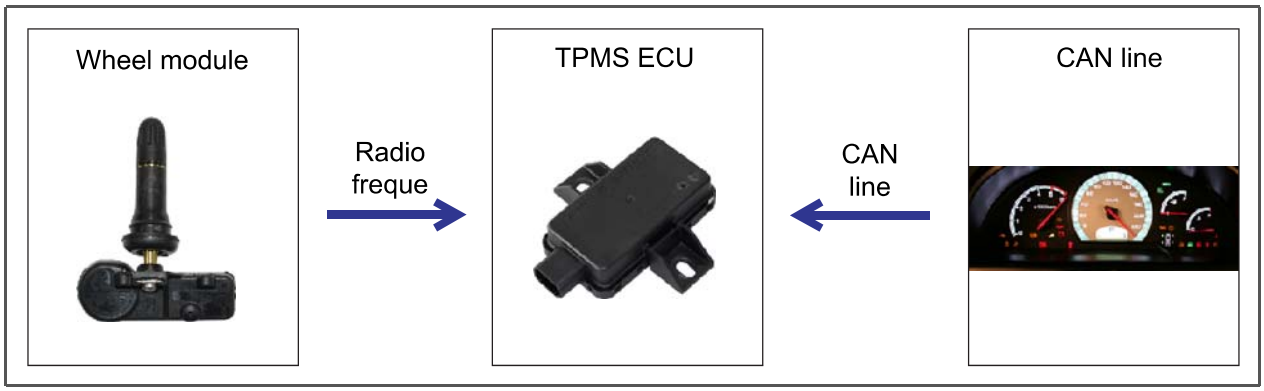
A. LCD display
B. Trip switch



Modification basis	
Application basis	
Affected VIN	

7. TIRE PRESSURE INDICATION PROCEDURE

The TPMS ECU receives the tire pressure value from the wheel module with radio frequency at every 30 seconds and sends the signal to meter cluster via CAN line to show it to driver.



NOTE

To reduce the battery current consumption, in normal driving conditions, each wheel module sends the tire pressure and temperature with its own ID (Identification) to TPMS ECU at every 30 seconds.
However, in emergency situation (e.g., pressure drop of 1 psi a second), it sends the data to TPMS ECU at every one second. In this case, the batter current consumption increases dramatically. Have the system check immediately.

▶ **Tire Pressure Indication Procedure (Simultaneously processed)**

Wheel module check (Auto Learning)	TPMS ECU identifies ID for each wheel module with the signal (2 times a minute) from wheel module.
Wheel module location check (Auto Location)	TPMS ECU identifies the location of each wheel module.

Modification basis	
Application basis	
Affected VIN	

8. TIRE INFLATION PROCEDURE

1) Overview

A tire equipped with wheel module should be inflated in a unique method other than conventional one. As the tire pressure on tire pressure gauge and could be different from the value displayed on meter cluster, the tire pressure should be checked and adjusted after specific period (transmitting time for wheel module). In addition, the displayed value could be changed after driving even if it was set to the specified value.

2) Tire Inflation Procedure

A. Park the vehicle on a level ground and let everyone get off the vehicle.



CAUTION

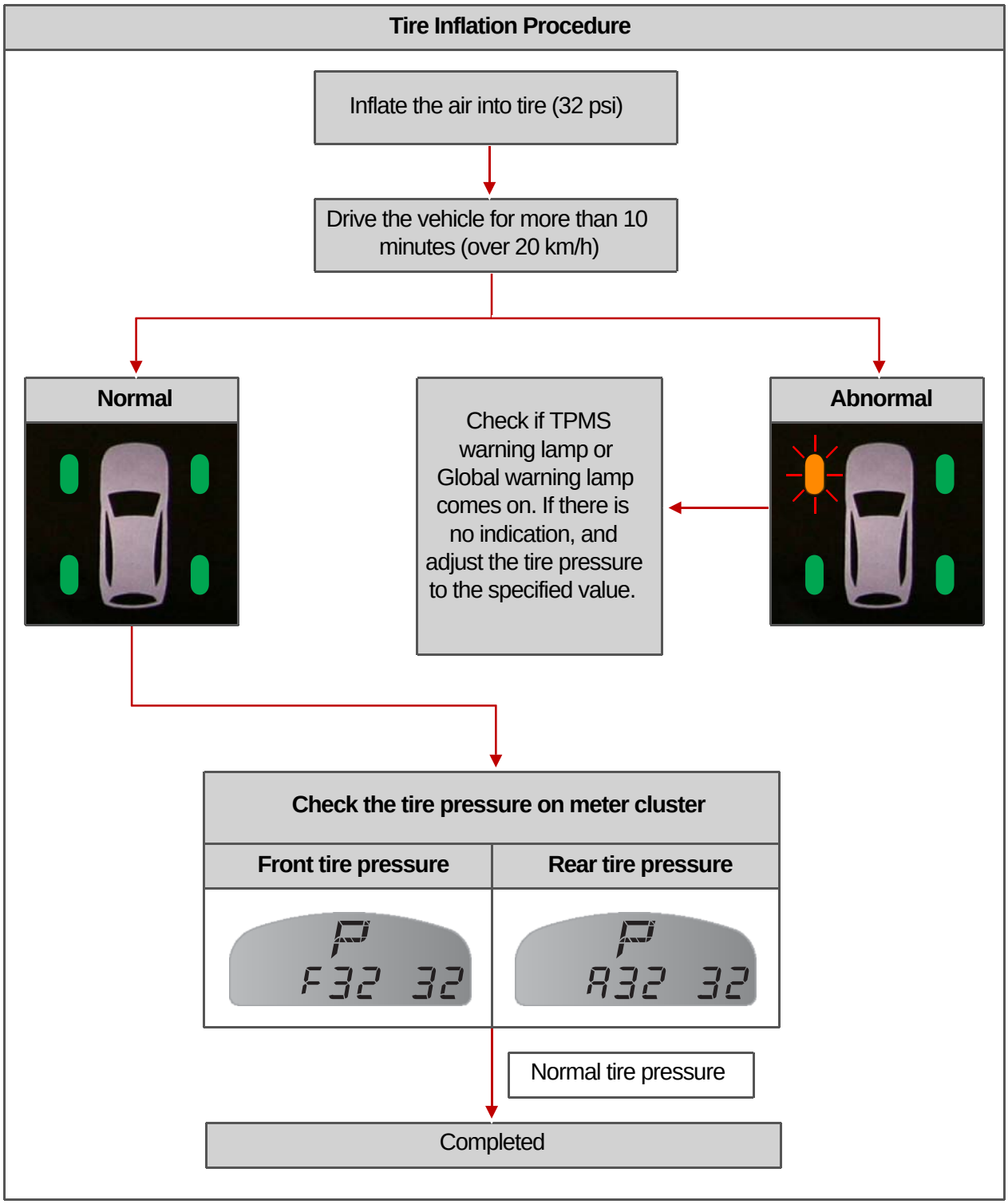
- If there is another vehicle equipped with the TPMS, keep the distance from this vehicle at least 5 m to prevent interference of wheel module transmitting.
- Unload the cargo if not necessary.
- Even though you adjusted the tire pressure, the changed value cannot be displayed on the meter cluster immediately because the wheel module sends the data with a specific interval. And, if there are interfering conditions for radio frequency such as other vehicles equipped with TPMS around the vehicle and severe weather changes, the indication needs few minutes to be displayed.

NOTE

Carefully explain the TPMS system and its usage to customers. The tire pressure can be changed frequently due to driving conditions, passengers, internal temperature changes and loads.

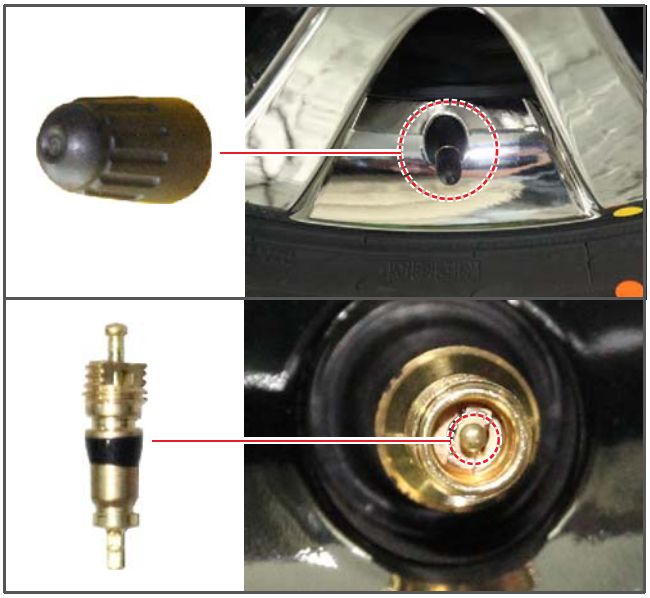
B. Tire Inflation and Inspection for Tire Pressure

- Inflate the air into the tire according to the specified procedure.



Modification basis	
Application basis	
Affected VIN	

Caution When Inflating



- If the tire pressure is 10 psi lower than the specified value, remove the valve insert from the wheel module valve body and replace it with new one. Then, inflate the air into the tire.

WHEEL AND TIRE

4170-34

GENERAL INFORMATION

1. SPECIFICATIONS

Description		Specification
Tire	EU,GEN : 16inch/18inch	EU,GEN : 235/75R/16, 255/70R/16, 255/60R18, 255/60R18(BR)
Tire inflation pressure		32psi
Wheel	EU,GEN : 16inch/18inch	EU,GEN : 7.0J * 16 , 7.5J * 18(TYPE A) , 7.5J * 18(DIAMOND CUT)
Spare tire	16inch	175/90R/16
Balance weight	18inch	Inner: Adherence type Outer: Adherence type
Tightening torque of wheel bolt		127.4~156.8 Nm

2. WHHEL DESIGNS

18 inch: 255/60R 18	18 inch: 255/60R 18	18 inch: 255/60R 18
		
Type-A	Sputtering	Diamond cut

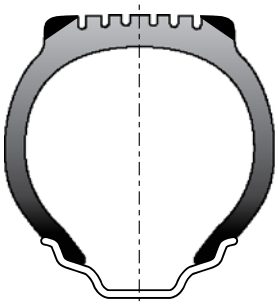
3. TROUBLE DIAGNOSIS

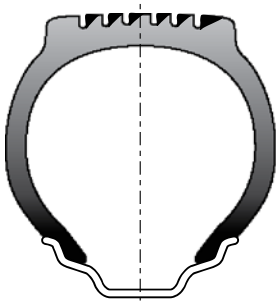
Problem	Possible Cause	Action
Uneven tire wear	Incorrect tire pressure	Adjust
	Unbalanced wheel	Adjust
	Improper location change of tire	Change tire location in specified interval
	Incorrect toe adjustmen	Adjust
	Incorrect wheel bearing preload adjustment	Adjust
	Malfunction of brake syste	Replace
Tire squeal, vibration	Too low tire pressure	Adjust
	Unbalanced wheel or tire	Adjust
	Heavy vibration of wheel or tire	Replace
	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	

4. 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

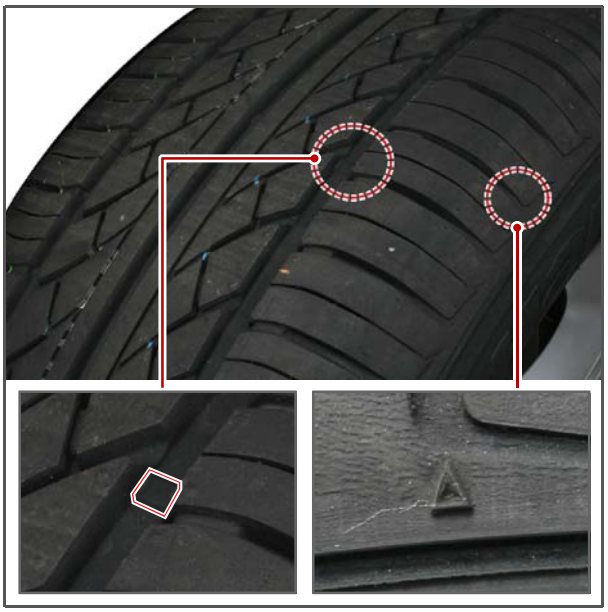
Symptom		Possible Cause
Blade type wear from outer side toward inner side of the tread 		Excessive toe-in, Deflection of knuckle arm, Difference in tie rod length between left and right sides
Blade type wear from inner side toward outer side of the tread 		Excessive toe-in, Deflection of knuckle arm, 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

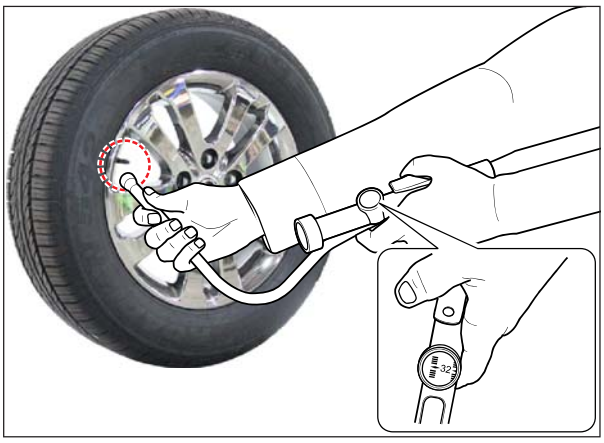
Wear limit	1.6mm

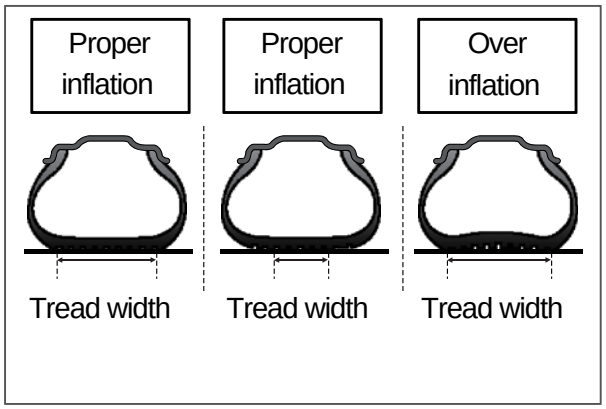


- You can see the protruded part in the groove at the point with mark "▲", which is the indicator of the tread wear limit. The limit of the tread wear for all season
- tires are 1.6 mm, which is the same as the general tires, but the wear limit mark is indicated as '↓'.

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	32psi

- 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	2.66mm

- Measure free radial runout on the tire tread.

Specified value	2.03mm

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.

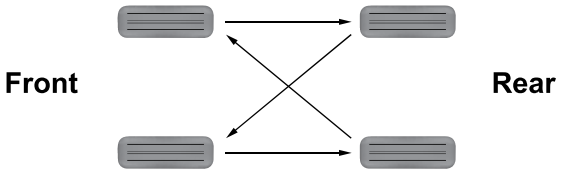
NOTE

- Make sure to read the manual of the manufacturer thoroughly before using wheel balance tester.

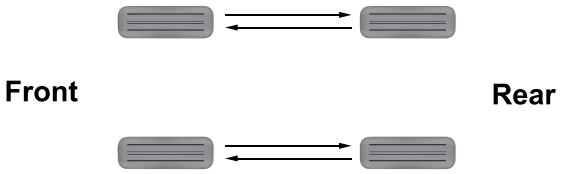
6. **Change tire location**

To avoid uneven wear of tires and to prolong tire life, inspect and rotate your tires every 5,000 km.

Regular Tire



Regular Tire



CAUTION

Mixing tires could cause the driver to lose control while driving. Be sure to use the same size and type tires of the same manufacturer on all wheels. Otherwise, the rack stroke (maximum transverse distance) of the steering gear could be changed.

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.

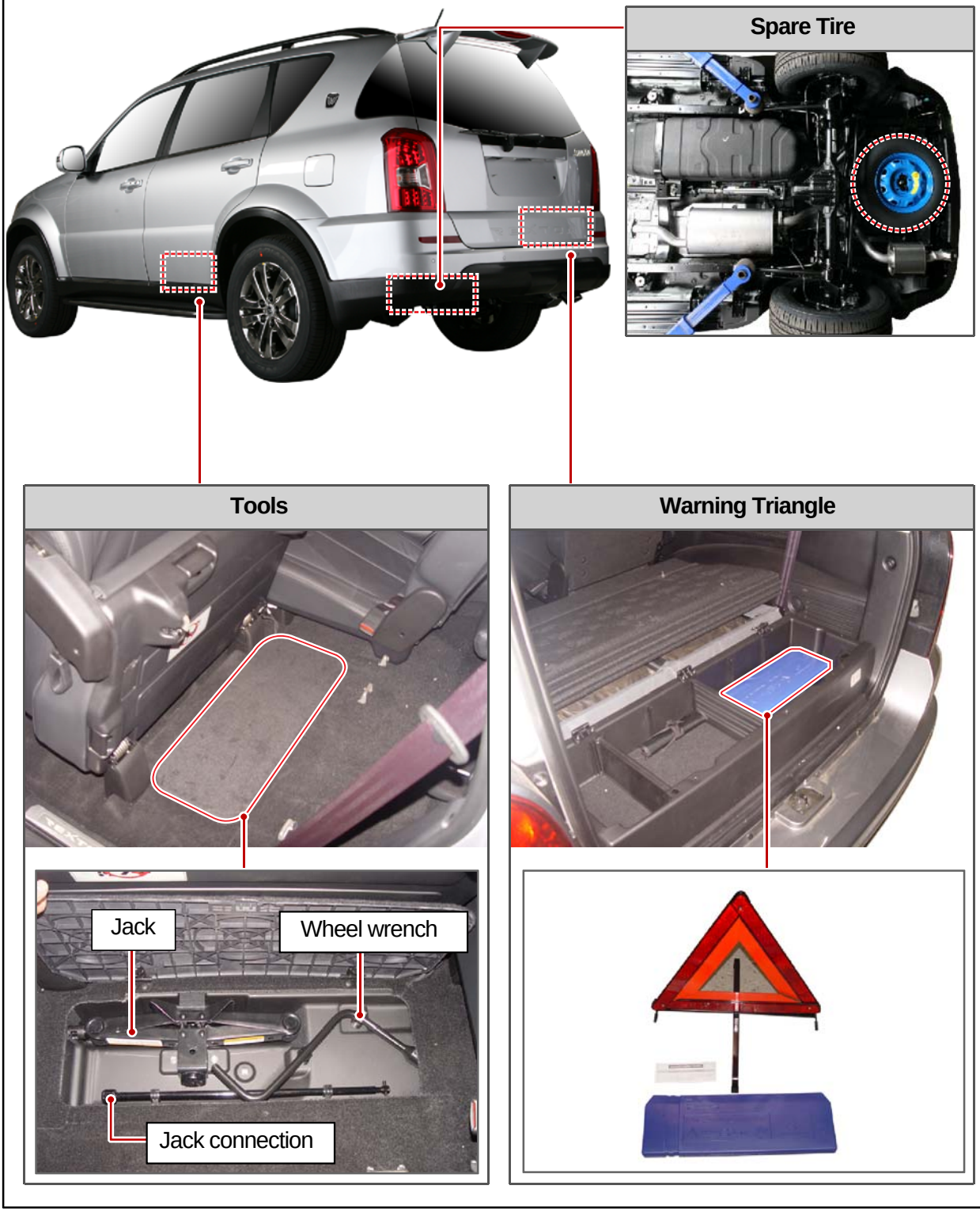
Tire supports the weight of the vehicle, reduces the impact from the road and at the same time, transmits the power to propel, brake and steer on the road. It also functions to maintain a vehicle's movement. In order to complete such tasks, a tire must be structured to be a resilient vessel of air.

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.

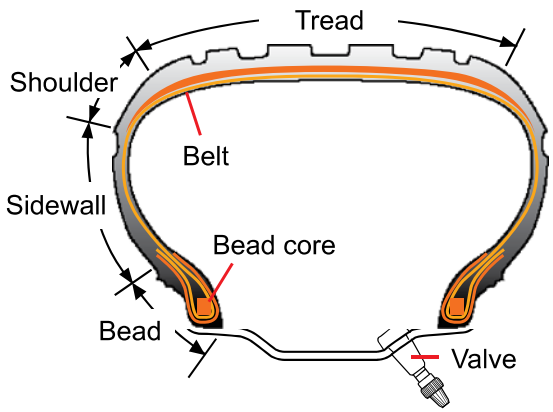
The tire is worn unevenly according to the driver's driving habit, improper servicing, low tire inflation pressure, changed tire location, etc.

Modification basis	
Application basis	
Affected VIN	

▶ Location of Components



▶ 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.

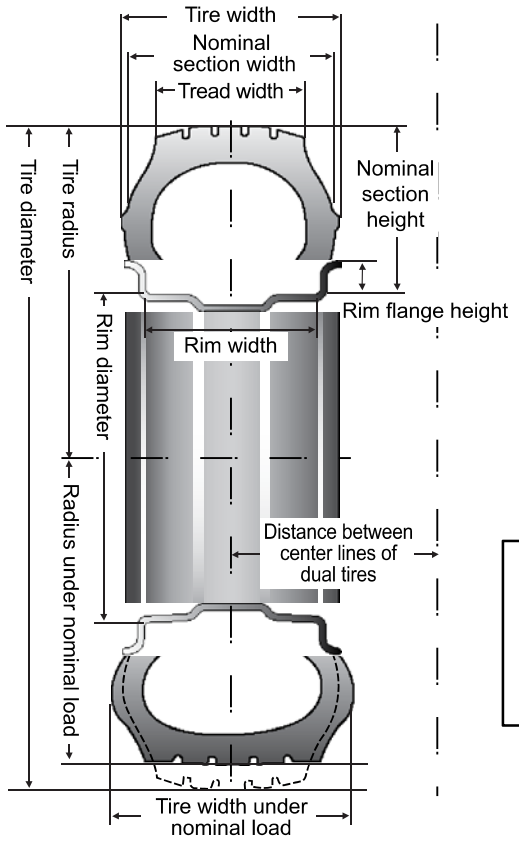
Bead
The bead attaches the tire to the rim and wraps the end of the cord fabric. Comprised of the bead wire, core, flipper and other parts, the bead is generally designed to be slightly tight around the rim so that in the case of a sudden drop in inflation pressure, the tire will not fall off the rim.

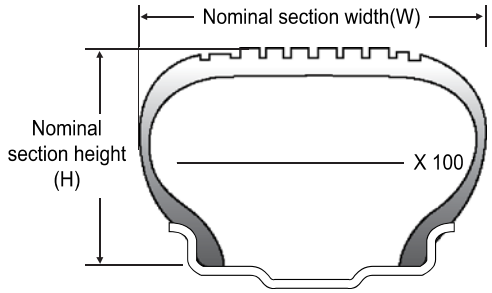
Carcass
As the most important framework of a tire, the entire inner layer of cord fabric is called the carcass. The carcass acts to support air pressure, vertical load and absorb shocks.

Belt
The belt is made by steel wire. This reduces the impact from the road and provides the wide tread.

Modification basis	
Application basis	
Affected VIN	

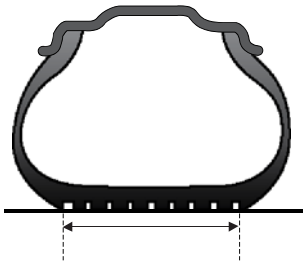
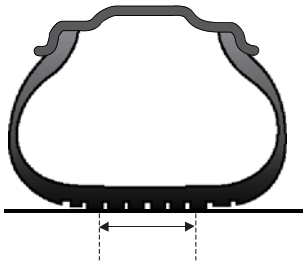
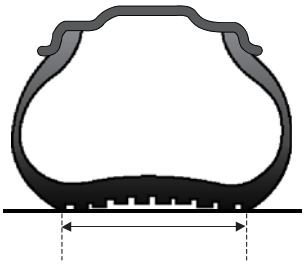
▶ Tire Unit Indication





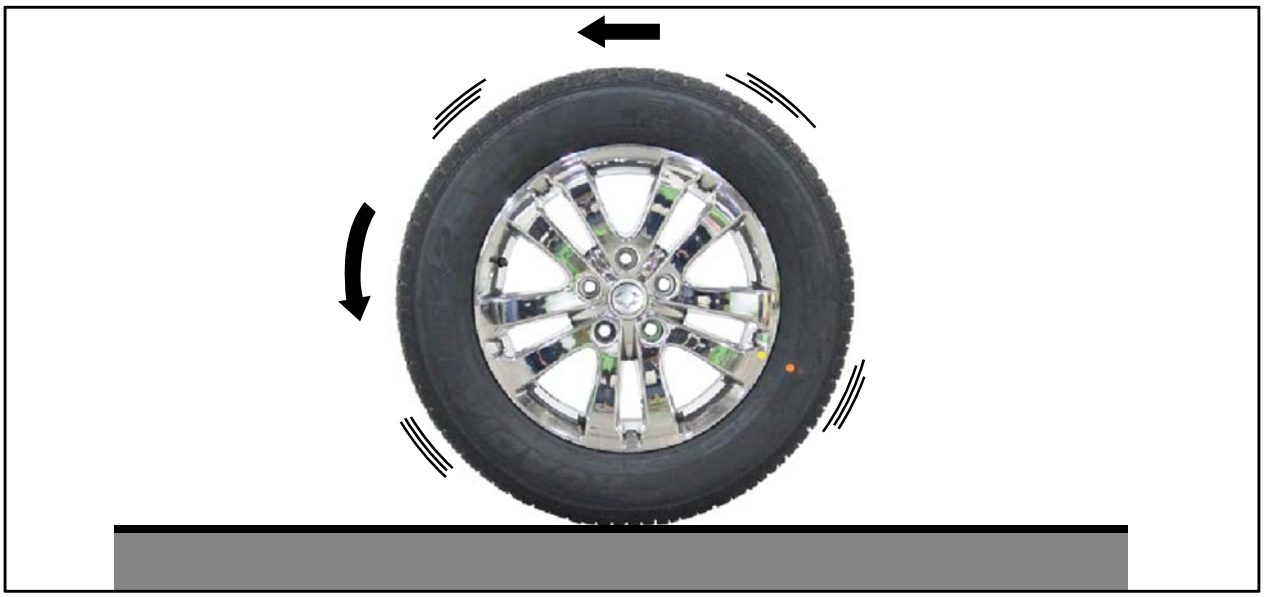
Aspect ratio (%)
= Nominal section height (H) / Nominal section width (W)
X 100

▶ Tire Inflation Pressure (32 psi)

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.

2. ABNORMAL TIRE SYMPTOM

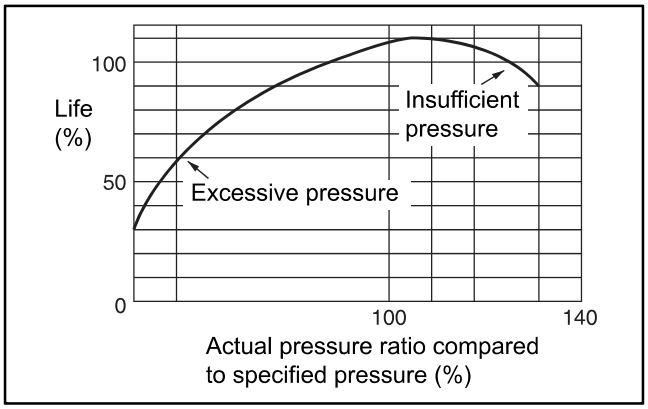
▶ **Standing Wave**



Specified tire inflation pressure	32psi

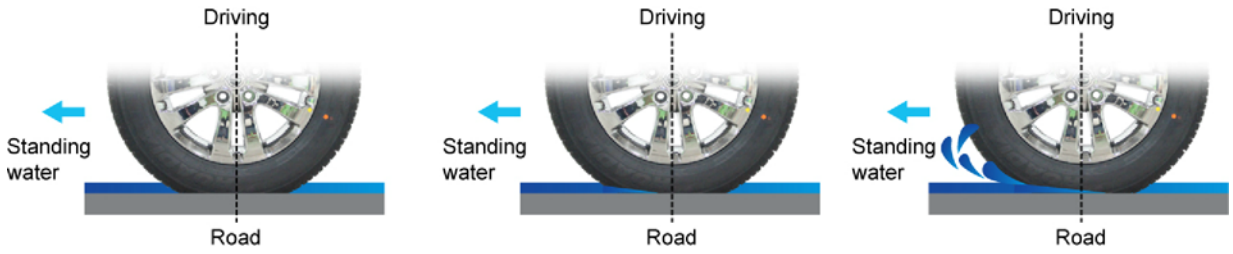
During driving, the rotating tire repeats deformation and restoring movement in is tread. This happens when the tire pressure is low in high speed driving.
However, when the wheel rotating speed is fast, the tire is deformed even before it is restored to its original shape and the trembling wave appears 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.

▶ **Tire Pressure vs. Tire Life**



Modification basis	
Application basis	
Affected VIN	

▶ Hydro Planing



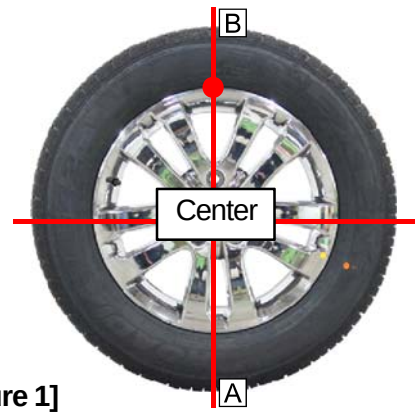
Vehicle speed ≤ 60 km/h	Vehicle speed = 80 km/h	Vehicle speed ≥ 100 km/h
No Hydro planning	Partial Hydro planning	Full Hydro planing

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.

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.

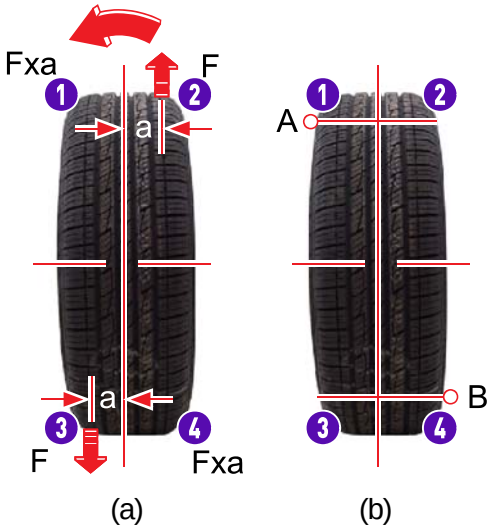
▶ Static Balance



[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]

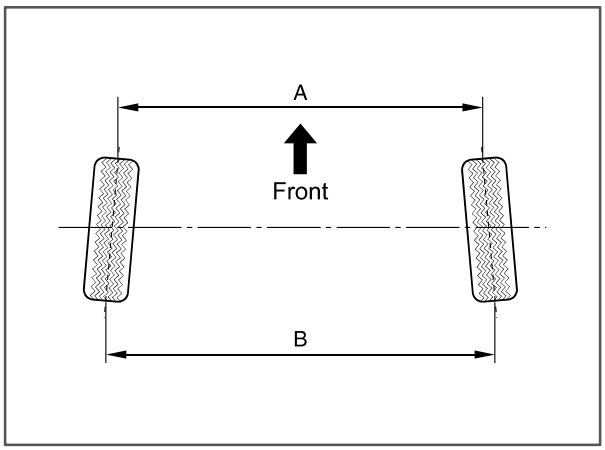
The static unbalance of the wheel creates the vibration in the vertical direction, but the dynamic unbalance creates the vibration in the lateral direction. As shown in the figure 2 (a), if two parts, (2) and (3), are heavier when the wheels are under the static balance condition, dynamic unbalance is 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.

Modification basis	
Application basis	
Affected VIN	

4. WHEEL ALIGNMENT

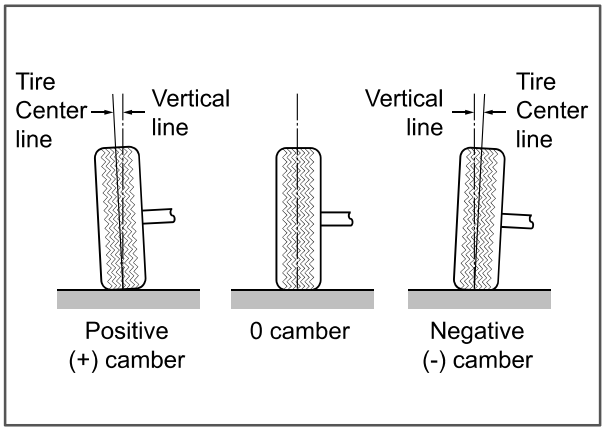
Wheel alignment consists of adjusting the angles of the wheels so that they are parallel to each other and perpendicular to the ground, thus maximizing tire life and ensures straight and true tracking along a straight and level road.

▶Toe-in



In automotive engineering, toe, also known as tracking, is the symmetric angle that each wheel makes with the longitudinal axis of the vehicle, as a function of static geometry, and kinematic and compliant effects. This can be contrasted with steer, which is the anti-symmetric angle, i.e. both wheels point to the left or right, in parallel (roughly). Positive toe, or toe in, is the front of the wheel pointing in towards the center line of the vehicle. Negative toe, or toe out, is the front of the wheel pointing away from the center line of the vehicle. Toe can be measured in linear units, at the front of the tire, or as an angular deflection.

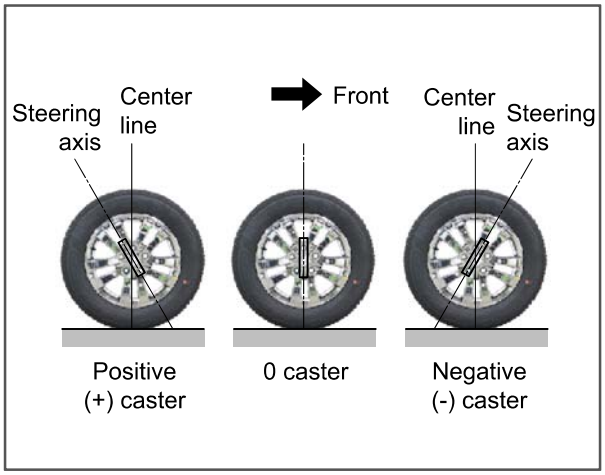
▶Camber



Camber is the angle made by the wheels of a vehicle; specifically, it is the angle between the vertical axis of the wheels used for steering and the vertical axis of the vehicle when viewed from the front or rear. It is used in the design of steering and suspension. If the top of the wheel is farther out than the bottom (that is, away from the axle), it is called positive camber; if the bottom of the wheel is farther out than the top, it is called negative camber.

Camber angle alters the handling qualities of a particular suspension design; in particular, negative camber improves grip when cornering. This is because it places the tire at a better angle to the road, transmitting the forces through the vertical plane of the tire rather than through a shear force across it. Another reason for negative camber is that a rubber tire tends to roll on itself while cornering. Negative camber can also be caused by excessive weight on the front wheels. This is commonly seen on modified cars with larger engines than standard; the weight of the modified engine can make the wheels negatively camber. The inside edge of the contact patch would begin to lift off of the ground if the tire had zero camber, reducing the area of the contact patch. This effect is compensated for by applying negative camber, maximizing the contact patch area. Note that this is only true for the outside tire during the turn; the inside tire would benefit most from positive camber.

▶Caster

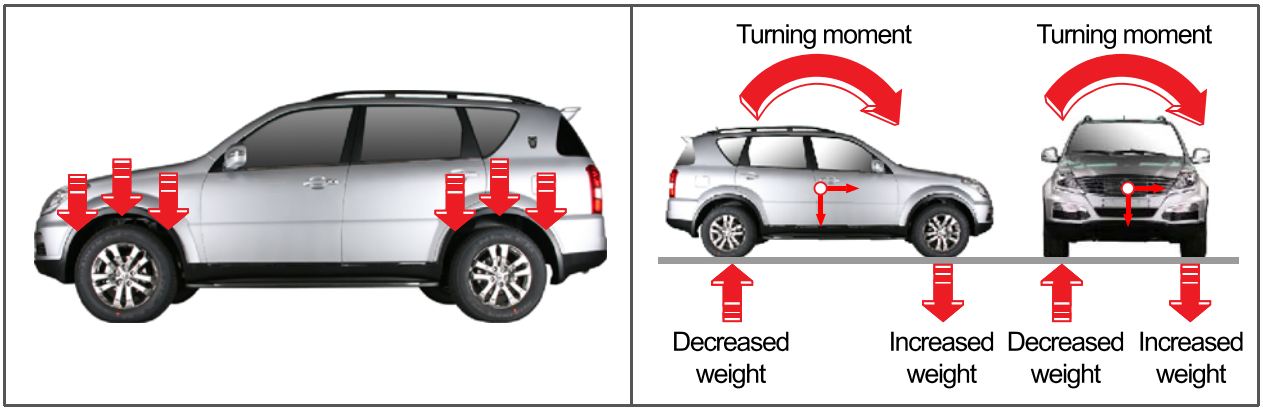


Caster is the angle to which the steering pivot axis is tilted forward or rearward from vertical, as viewed from the side. If the pivot axis is tilted backward (that is, the top pivot is positioned farther rearward than the bottom pivot), then the caster is positive; if it's tilted forward, then the caster is negative.
Positive caster tends to straighten the wheel when the vehicle is traveling forward, and thus is used to enhance straight-line stability. The mechanism that causes this tendency is clearly illustrated by the castering front wheels of a vehicle. The steering axis of a vehicle wheel is set forward of where the wheel contacts the ground. As the vehicle is driving forward, the steering axis pulls the wheel along, and since the wheel drags along the ground, it falls directly in line behind the steering axis. The force that causes the wheel to follow the steering axis is proportional to the distance between the steering axis and the wheel-to-ground contact patch-the greater the distance, the greater the force. This distance is referred to as "trail."

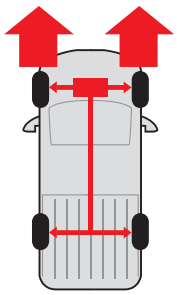
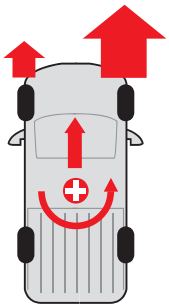
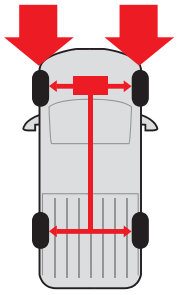
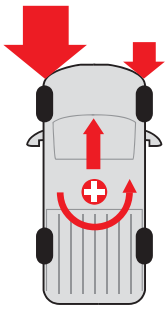
Modification basis	
Application basis	
Affected VIN	

5. FUNCTIONS OF TIRE

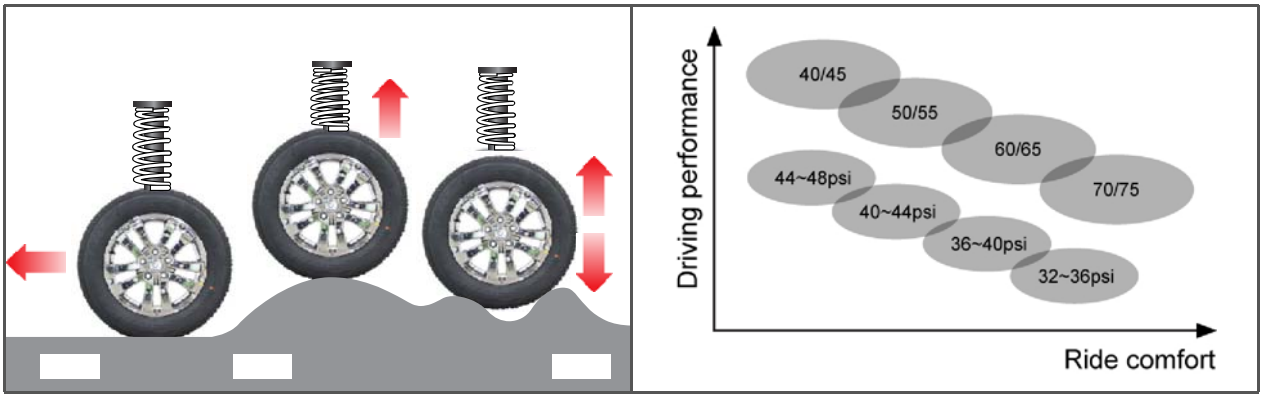
▶ Supporting the Vehicle Weight



▶ Transferring the Driving Force & Braking Force to Road

	Even friction coefficient road	Uneven friction coefficient road
Driving Force		
Braking Force		

▶ Absorbing the Impact from Road



AIR CONDITIONER SYSTEM

6810-00

GENERAL INFORMATION

1. SPECIFICATIONS

Description		FATC	
Air conditioner control panel	Rated voltage	DC 12V	
	Operating voltage	DC 9~16V	
	Current consumption	2A	
	Operating temperature	−30~75℃	
	Output current from air mix door motor	0.4A	
	Output current from high relay	0.5	
	Base current for power transistor	1A	
	Output current from air source motor	0.55A	
	Output current from mode motor	0.55A	
	Dark current	Below 2 mA	Below 1.1 mA
Compressor	Pulley diameter	120mm	
	Maximum speed	8000RPM	
	Rated voltage	DC 12V	
	Current consumption	2.2A	
	Compressor oil	PAG RL 897 150cc	
Condenser	Type	MFC(6-PASS)	
	Size	636wX455hX16t	
Receiver drier	Capacity	250cc	
	Desiccant	XH-9(35cc)	
	Pressure switch	Refrigerant pressure sensor	
Heater & A/C unit	Heating capacity	Min 4600 kcar/hr (5.5㎥/Min)	
	Cooling capacity	Min 4700 kcar/hr (7.5㎥/Min)	
	Expansion valve	Block type	
	Current consumption	180W	
Refrigerant	Type	R134a	
	Capacity	720±30g	

Modification basis	
Application basis	
Affected VIN	

Description		FATC
PTC	Heating type	Air heating type
	Material	BaTiO3
	Weight	500g

Modification basis	
Application basis	
Affected VIN	

Memo

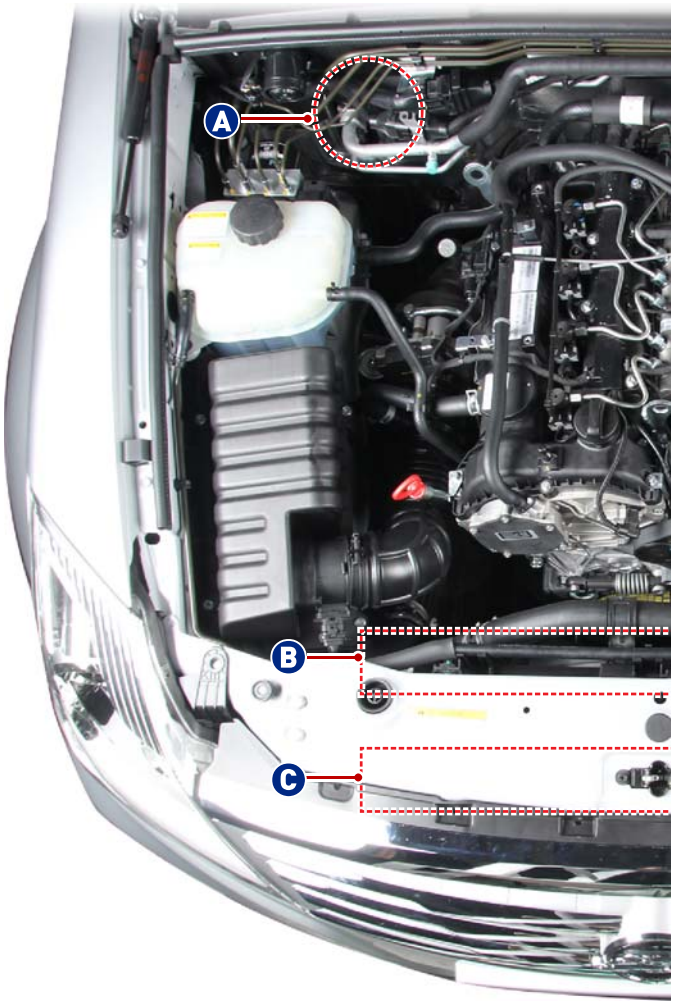
OVERVIEW AND OPERATING PROCESS

1. SYSTEM LAYOUT (EXTERNAL)

Expansion Valve
A 
Controls the refrigerant volume and sends it to evaporator.

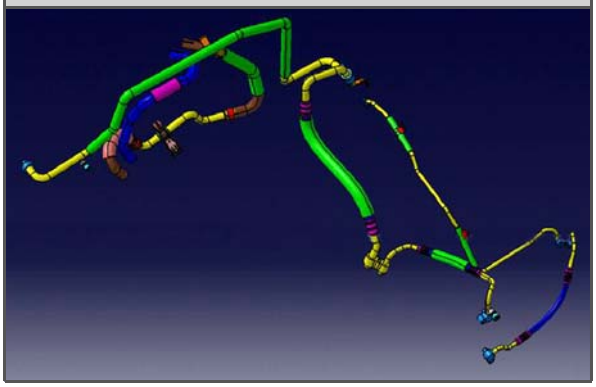
PWM Electric Fan
B 
Cools the radiator and condenser down.

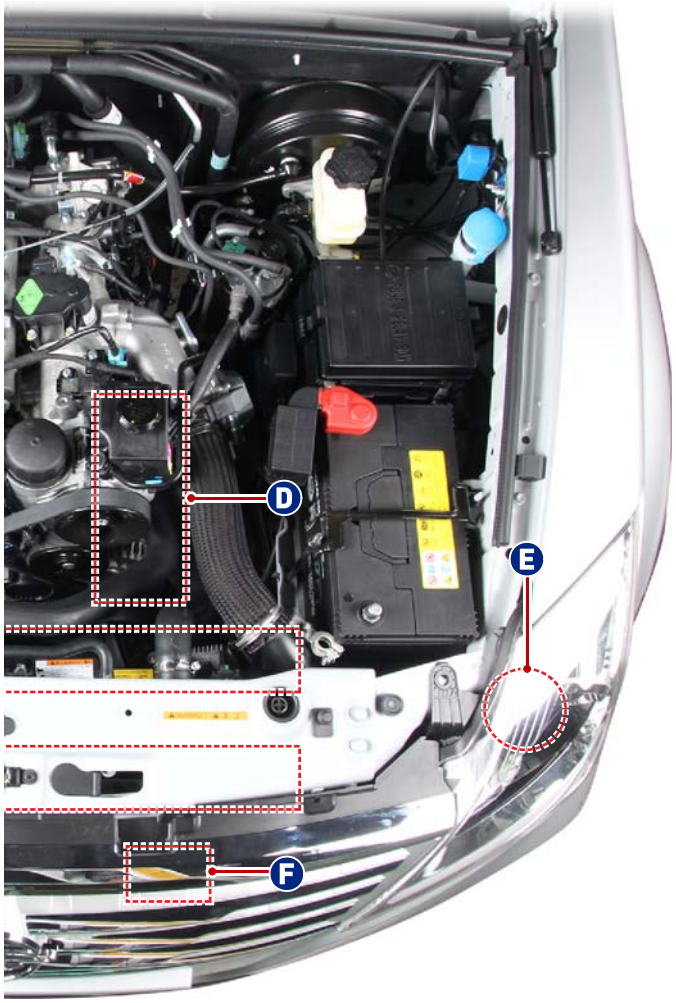
Condenser
C 
Installed on the front of vehicle and converts the gaseous refrigerant to liquid refrigerant by condensing it.



Modification basis	
Application basis	
Affected VIN	

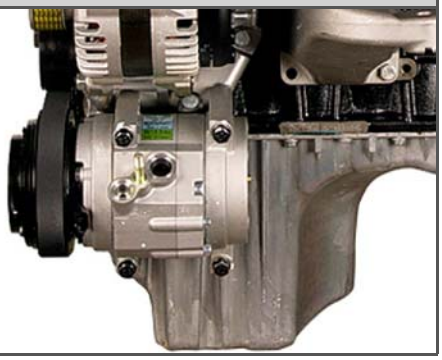
A/C Hose &Pipe Lines





A/C Compressor

D



Receiver drier & Refrigerant Pressure Sensor

E



Absorbs the moisture from the refrigerant and accumulates it for supplying.

AQS Sensor/Ambient Temperature Sensor

F



Measures the air contamination value and ambient temperature and sends the data to FATC controller.

Modification basis	
Application basis	
Affected VIN	

2. SYSTEM LAYOUT (INTERNAL)

Sun Sensor

B



Heater & A/C Module

A





A/C Control

Automatic Control

C



Mode Door Actuator

D



Air Mix Actuator

E



Modification basis	
Application basis	
Affected VIN	

ECU

V



Duct Temperature Sensor

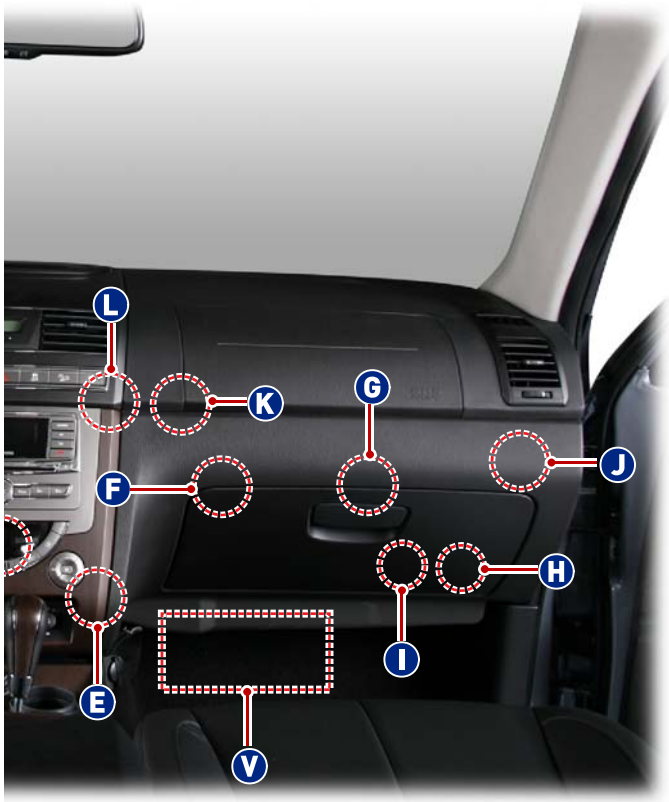
L



PTC

K





Air Source Actuator

J



Power Transistor

I



Thermo Amplifier

F



A/C Filter

G



Blower Motor

H



Modification basis	
Application basis	
Affected VIN	

3. VENTILATION SYSTEM

1) Location



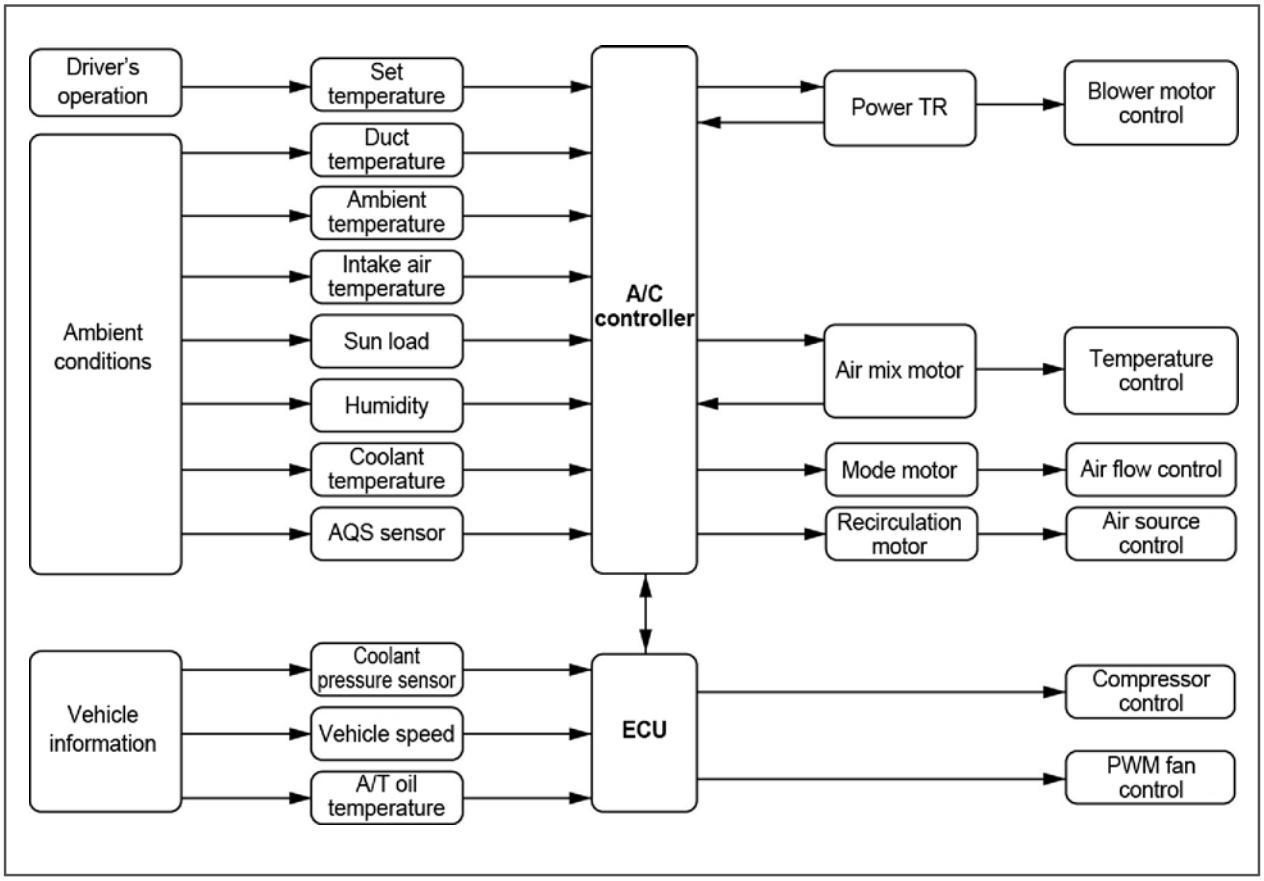
2) Duct Layout



Modification basis	
Application basis	
Affected VIN	

4. BLOCK DIAGRAM

Below diagram shows the input/output mapping between the components of FATC A/C and A/C controller briefly.

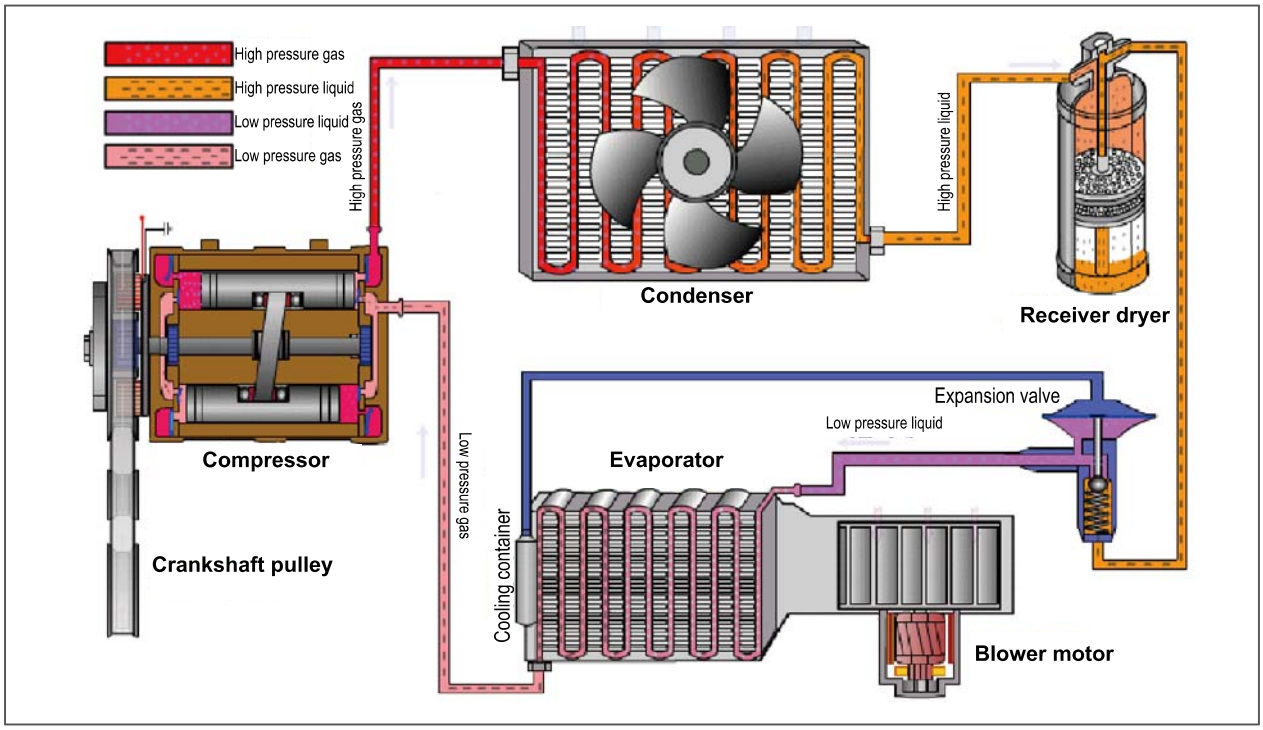


▶ **A/C Compressor OFF Conditions**

- Coolant temperature: 20℃ or lower
- Coolant temperature: 115℃ or higher
- For approx. 4 seconds after starting the engine
- Engine speed: 650 rpm or lower
- Engine speed: 4,500 rpm or higher

5. A/C COOLING CYCLE

1) Basic Operating Principle



(1) System flow

- "Compression -> Condensation -> Expansion -> Evaporation"

(2) Functions

▶ Compressor

Condition: Gas
Function: Circulates the refrigerant and increases the pressure and temperature for easier evaporation.

▶ Condenser

Condition: Gas/Liquid
Function: Cools and condenses the refrigerant by using ambient air to liquefy it under high pressure.

▶ Receiver drier

Condition: Gas/Liquid
Function: Keeps the refrigerant free from moisture by separating/collecting the moisture from it.

▶ Expansion valve

Condition: Liquid/Liquefied gas
Function: Performs adiabatic expansion and flow control for easier evaporation.

Modification basis	
Application basis	
Affected VIN	

▶ Evaporator

Condition: Liquefied gas/Gas
Function: Cools the air by absorbing the heat from the air around the evaporator.

(3) Description for Each Cycle

▶ Compression

- The evaporated refrigerant in the evaporator enters to the compressor. And the refrigerant gas is compressed until it can be liquefied at ambient temperature.
- Thus, the low refrigerant pressure is maintained so that the liquid refrigerant can be evaporated actively at low temperature (around 0℃).

▶ Condensation

- The high pressure and high temperature gas (refrigerant) from the compressor is cooled down by the fresh air entered into the condenser. Then, this gas is converted to liquid and collected in the receiver drier.
- The heat generated from the high pressure refrigerant is dissipated to the ambient air, and it is called "heat of condensation".
  The heat of condensation is the summation of the heat of vaporization (heat that the refrigerant absorbs from the inside of the vehicle) and the calorific value converted from the amount of work which is needed to compress.

▶ Expansion

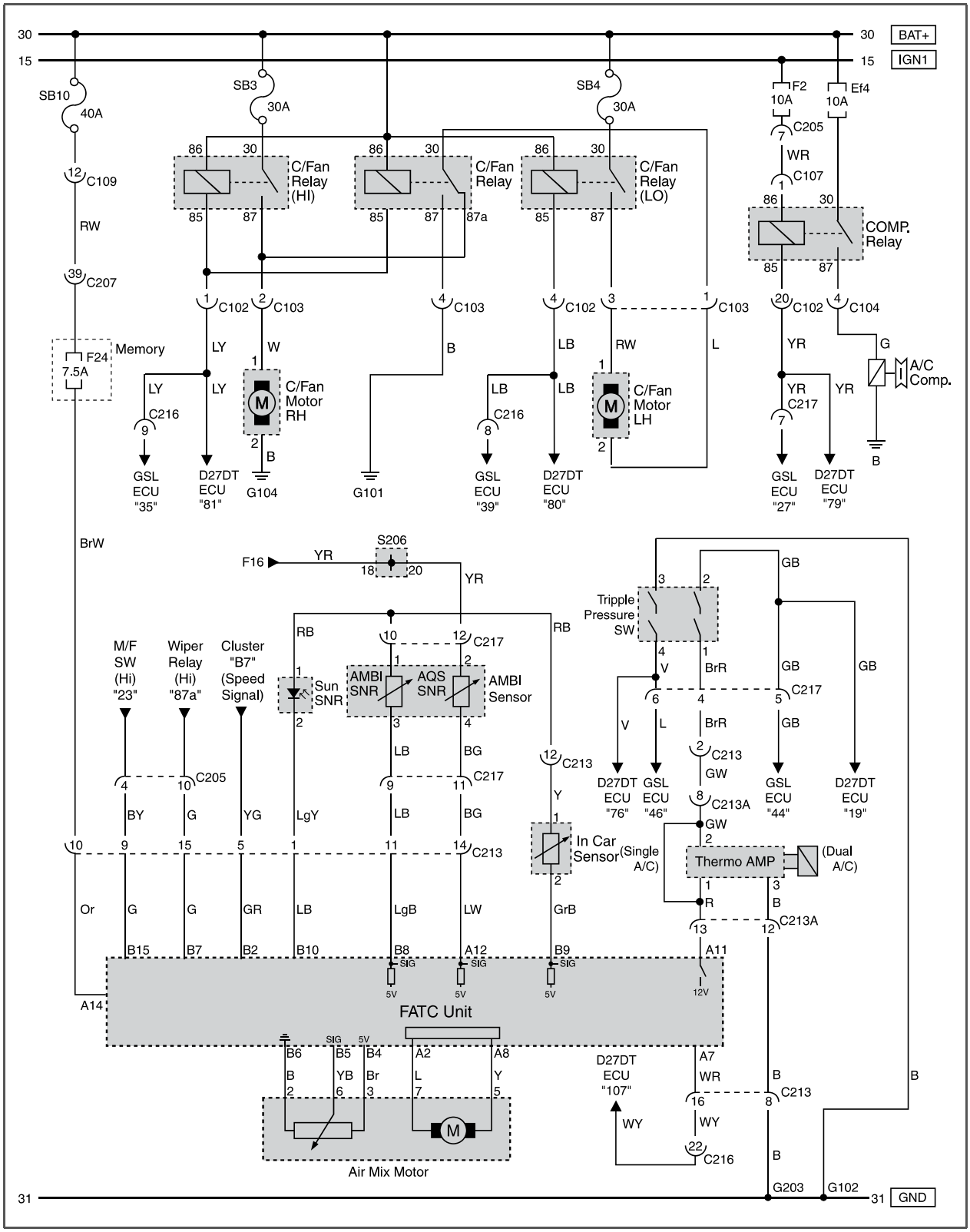
- The liquid refrigerant lowers the pressure making its evaporation easily accomplished.
- This process (lowering the pressure to the level at which evaporation easily takes place before the liquid refrigerant is sent to the evaporator) is called "Adiabatic Expansion".
- During adiabatic expansion, the expansion valve lowers the pressure of the refrigerant and determines the correct amount of refrigerant going into the air conditioning evaporator.
- That is, the amount of heat, which is needed to stop the evaporation, is determined according to the cooling load.
- The expansion valve detects this and regulates the amount of the refrigerant exactly.

▶ Evaporator

- The refrigerant is converted from liquid to gas in the evaporator.
  (The refrigerant in the form of fog in the evaporator is vaporized actively)
- At this time the refrigerant, in the form of liquid, absorbs the heat in the air which is need for evaporation (latent heat) and is cooled down. Then the blower blows the cooled air inside the vehicle to lower the temperature.
- There are liquid refrigerant from the expansion valve and evaporated refrigerant in the evaporator.
  The evaporation temperature can be predicted from the evaporation pressure (i.e. relationship
- between saturation pressure and saturation temperature).
  It is important to keep the pressure inside the evaporator low, so that the refrigerant is evaporated
- at low temperature to make sure the completely evaporated refrigerant is entered into the compressor.

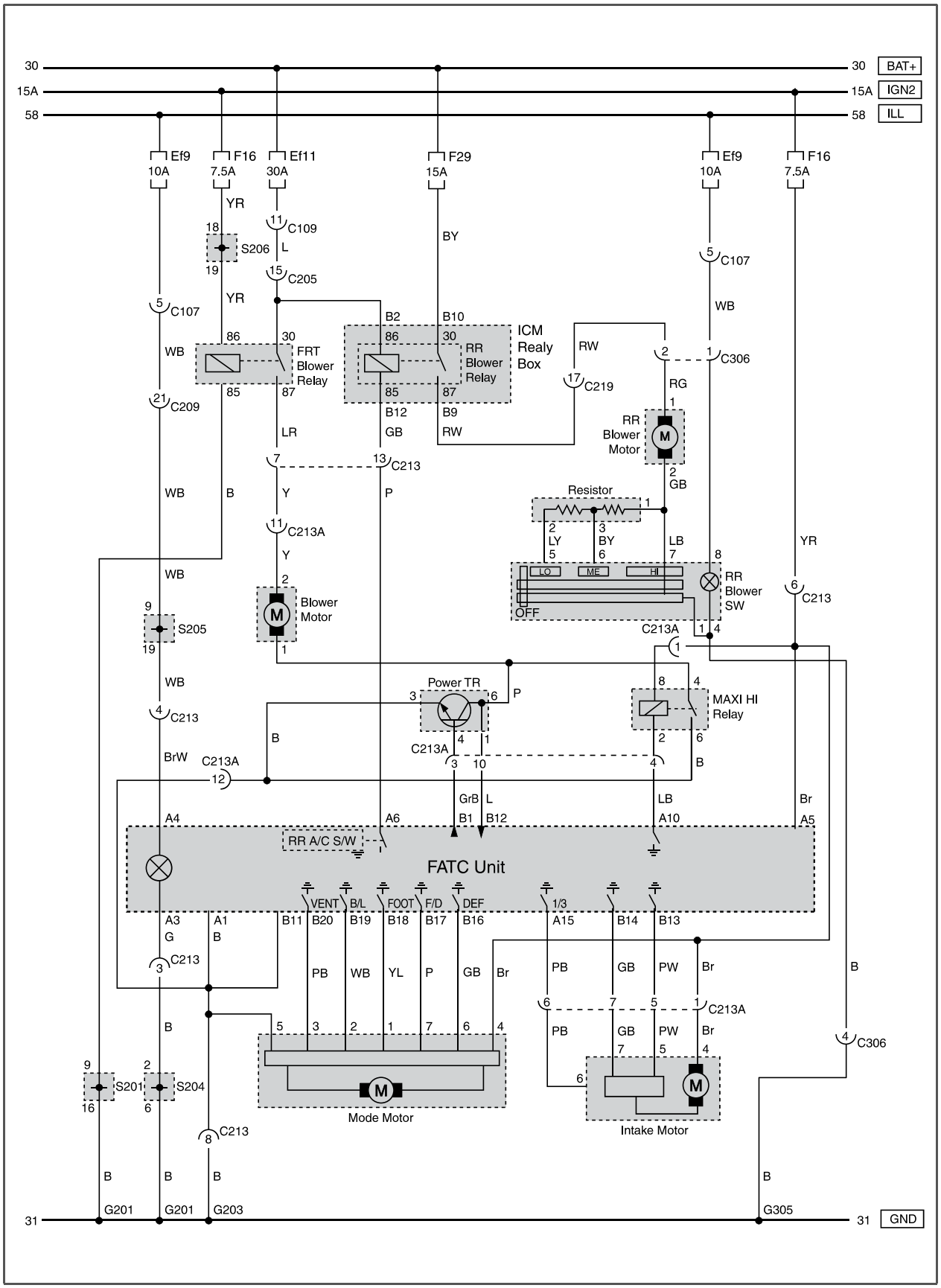
S.G.N.
6810-18 CIRCUIT DIAGRAM OF FATC

▶ Air Conditioner: Compressor, PWM Electric Fan, Air Mix Motor, Sun Sensor, Coolant Temperature Sensor, AQS Sensor, Thermo Amplifier

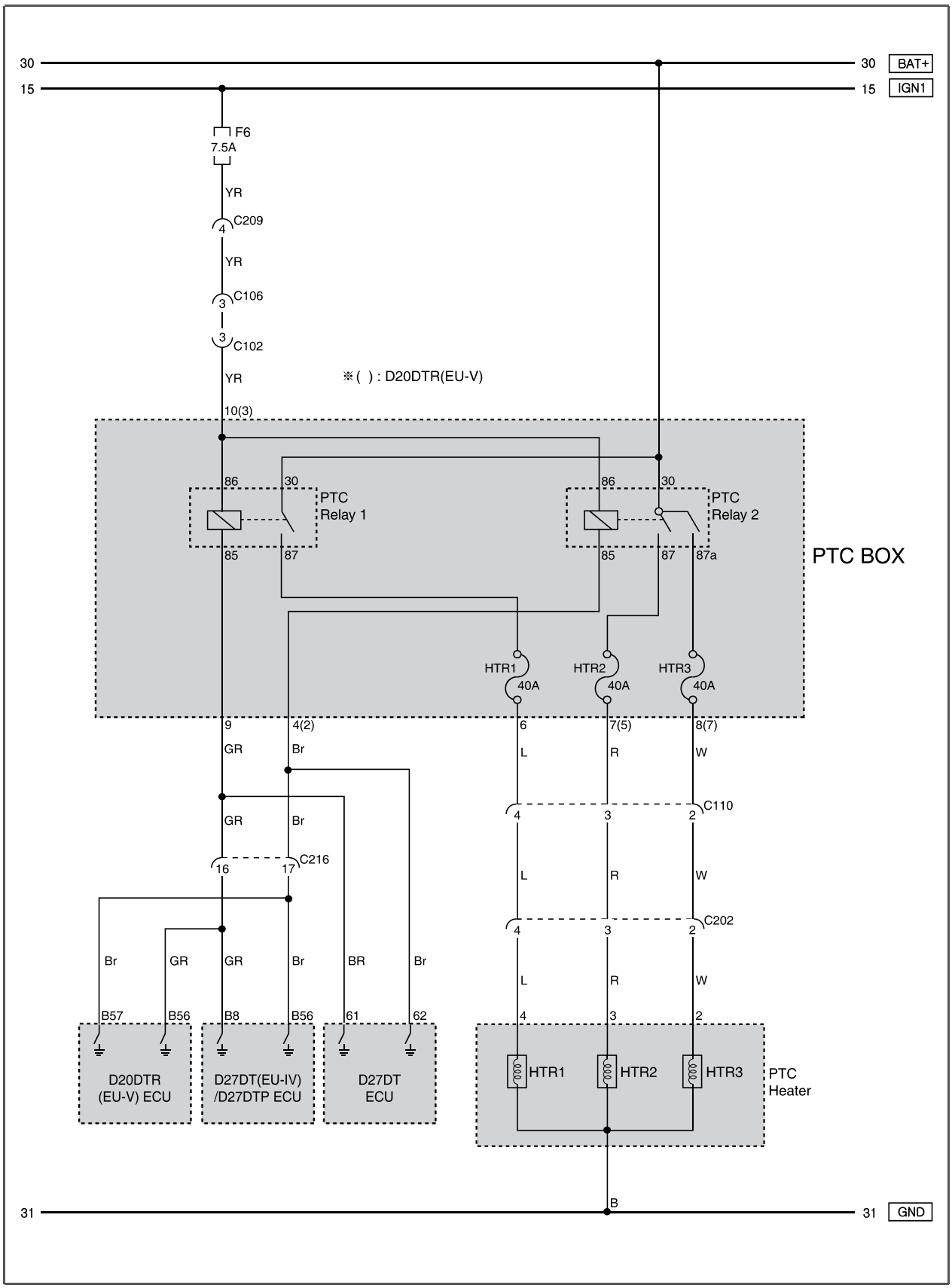


Modification basis	
Application basis	
Affected VIN	

▶ 2/2 Motor (Mode, Fresh/Recirculation)



S.G.N.
6810-15 CIRCUIT DIAGRAM OF PTC HEATER



Modification basis	
Application basis	
Affected VIN	

AIR BAG

8810-00

GENERAL INFORMATION

1. WARNINGS FOR AIRBAG

- Do not diagnose the circuit with a circuit tester. Do not attempt to modify any air bag components including the steering wheel, air bag mounting area, and harness.
- Do not impact any air bag components including the steering wheel, air bag mounting area, and harness by hand or tools. You may get injured by sudden deployment.
- The air bag components will be very hot after deployment. Do not touch them.
- Once the air bag system is triggered, the triggered air bag assembly should be removed from the vehicle and replaced with new one.
- The air bag contains explosive materials, so contact Ssangyong Dealer or Ssangyong Authorized Service Operation when trashing or replacing it.
- Incorrect air bag inspection can be dangerous and cause injuries. The air bag system must be disposed only by Ssangyong Dealer or Ssangyong Authorized Service Operation.
- Replace the steering wheel with only Ssangyong genuine part.
- When the engine starts, the air bag warning lamp comes on for a system check. It goes out after 3 to 7 seconds when the system is normal. If this warning lamp stays ON, then the system may be defective. Have the air bag system checked immediately by Ssangyong Dealer or Ssangyong Authorized Service Operation.
- The seat belt and air the bags are the most effective when you are sitting well back and upright in the seat.
- A child restraint system must not be placed on the front seat. The infant or child can be severely injured by an air bag inflation in case of an accident.
- Do not carry your child on your lap while driving. You cannot resist against the impact pressure in an accident.
  The child could be crushed between you and the parts of the vehicle.
- Do not place any objects on the air bag inflation location. You may get injured by those objects during deployment.
- Do not attach any objects such as a sticker, scent bottle, or phone holder on the steering wheel pad and to the dashboard.
- Do not put the seat cover on the front seatbacks. It may interfere with the side air bag inflation.
  When sitting in the rear seat, do not hold onto the seatback of the front seat. If the side air bag
- inflates, the occupant may get seriously injured.
  Do not lean on the door. When the side air bag inflates, the occupant may get seriously
- injured.
  Do not place any objects such as an umbrella or a bag between the side air bag and the door.
- Do not place the part of your body near the side air bag. You may obstruct the side air bag or get injured by the inflation impact.

- Do not slam the front doors. It may lead to an unintended inflation of the side air bag.
- Do not move your seat too close to the steering wheel or dashboard. If you lower your head, the air bag can hit your head during inflation and can cause severe injury or even death.
- Hold only the outer rim of the steering so that the air bag can inflate without any hinderances.
- Do not place your face or chest near the steering wheel and dashboard. Also, do not allow anyone to place their hands, leg or face on the dashboard. The air bag cannot work properly.
- Do not hold and operate the steering wheel by crossing your arms. You could get seriously injured when the air bag deploys.
- When the air bag inflates, it makes a loud noise and smoke. However, the smoke is a non-toxic nitrogen gas.
- When the air bag is deployed, non-toxic gas will come out. This gas may cause skin, eyes or nose irritation.
  Wash it out with cold and clean water and consult the doctor if irritation continues.
- When any repairs are needed for the steering wheel, or when an accident occured without the air bag deployment, have the air bag system checked by Ssangyong Dealer or Ssangyong Authorized Service Operation.
- The windshield glass may be broken when the passenger's air bag is deployed.
- The air bag deployment can cause abrasion on your hands and face.

2. MAJOR REPLACEMENT PARTS AFTER AIR BAG DEPLOYMENT

▶ In Case Of Front Air Bag Deployment

Instrument panel, deployed air bag module, air bag unit, seat belt pretensioner, wirings (including connectors), damaged trim and components

▶ In Case Of Curtain Air Bag Deployment

Deployed side bag, air bag unit,, side air bag sensor, wirings (including connectors), damaged trim and seat components

Modification basis	
Application basis	
Affected VIN	

Memo

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

- The air bag unit (SDM) includes the lateral G sensor and longitudinal G sensor. The side air bag sensor is installed in both B pillars.
- The front air bag module, side air bag module and seat belt pretensioner are installed for each seat.
- The pretensioner operates with the front seat. The side air bag operates according to the signal from the lateral G sensor, longitudinal G sensor and side air bag sensor.
- The front air bags operate independently.

2. COMPONENTS

Passenger's Air Bag Module

A



STICS

B





Air Bag Unit (SDM)

C



Modification basis	
Application basis	
Affected VIN	

Air Bag Warning Lamp (Meter Cluster)





Seat Belt Pretensioner

G



Side Air Bag Module

F



Driver's Air Bag Module

D



Side Air Bag Sensor Assembly

E



Modification basis	
Application basis	
Affected VIN	

3. OPERATING CONDITIONS

1) Front Air Bag System



▶ **The air bag deploys when:**

- A front collision occurs, which occupants cannot be protected by seat belt.

▶ **The air bag can deploy when:**

- Underbody impact from the road surface, impact against the curb at a very high speed, or dropping impact onto the road surface with a large angle occurs.

▶ **The air bag does not deploy when:**

- The vehicle rolls over or tips over sideward, or a side/rear collision occurs.
- the impact of the collision is low enough for the seat belt to protect the occupant properly.

▶ **Seldom oeprate**

- A collision to diagonal direction (not a front collision) occurs or the vehicle tips over.
- A weak collision, which the sensor cannot detect, occurs (under the activation requirements).
- A collision against narrow objects such as a telegraph pole or a tree occurs.
- The vehicle falls into a drainage or a puddle.
- The front of the vehicle crashes into high impact point vehicle such as a truck.
- The hood is hit by falling stones.
- The air bag warning lamp is on.

Modification basis	
Application basis	
Affected VIN	

2) Side Air Bag System

Driver's	Passenger's
	

CAUTION

The curtain air bags are installed to the upper end of both doors. The air bags provide head protection for the front and rear outboard occupants in a side collision.

▶ **The air bag deploys when:**

- a severe oblique collision occurs with a specific severity, angle, speed, and position.

▶ **The air bag can deploy when:**

- the vehicle rolls over or tips over sideward with a severe impact.
- The vehicle is stationary or a front collision occurs with low speed.
- A rear collision occurs.
- The impact of the collision is low enough for the seat belt to protect the occupant properly.

▶ **The air bag does not deploy when:**

- The vehicle is stationary or a front collision occurs with low speed.
- A rear collision occurs.
- The impact of the collision is low enough for the seat belt to protect the occupant properly.

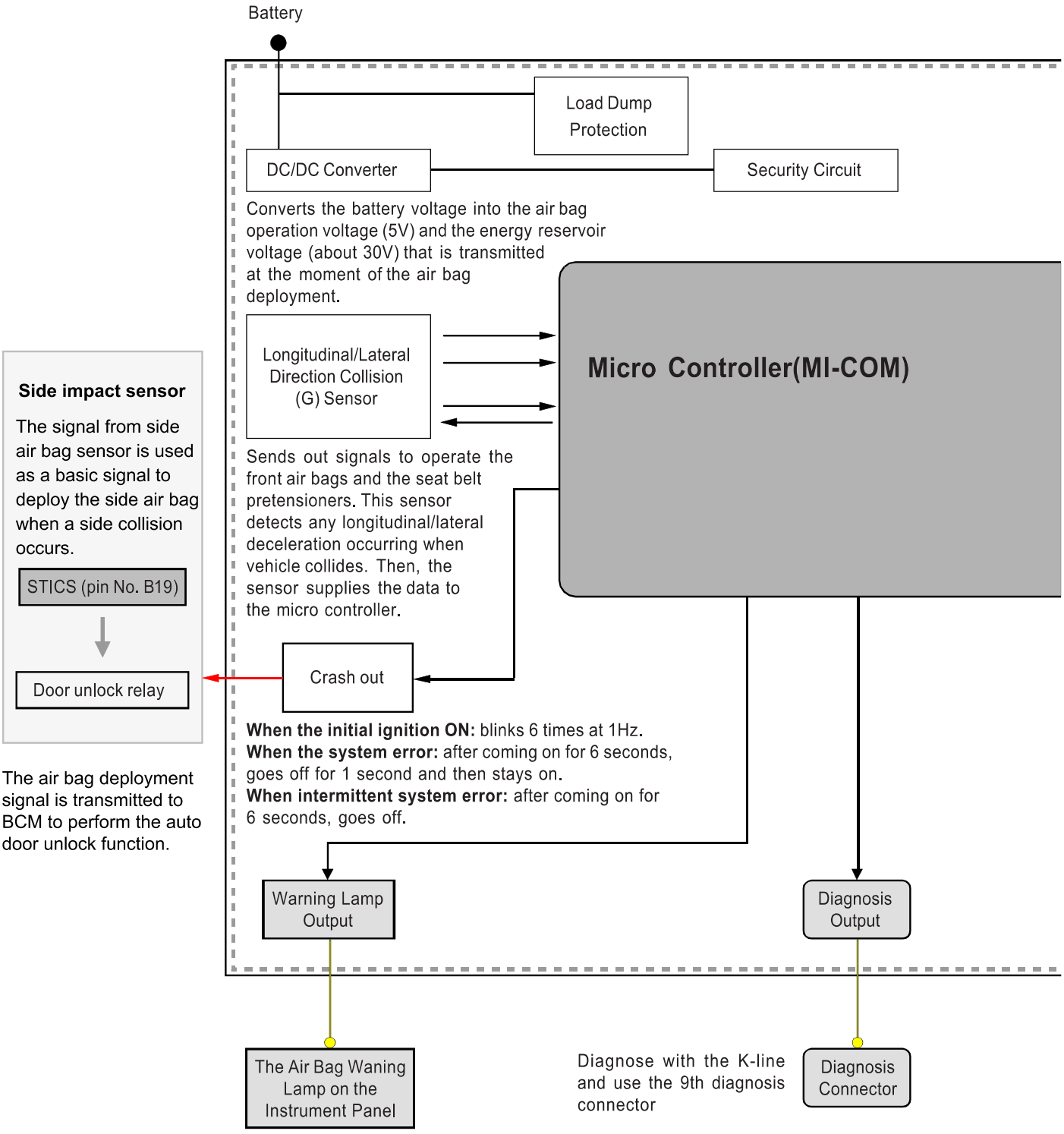
▶ **Seldom oeprate**

- A collision with oblique impact to the front seat direction or a front collision to the diagonal direction occurs.
- a frontal or rear collision occurs.
- The vehicle rolls over or tips over sideward with minor impact.
- The air bag warning lamp is on.

4. OPERATION PROCESS

1) Air Bag System Block Diagram

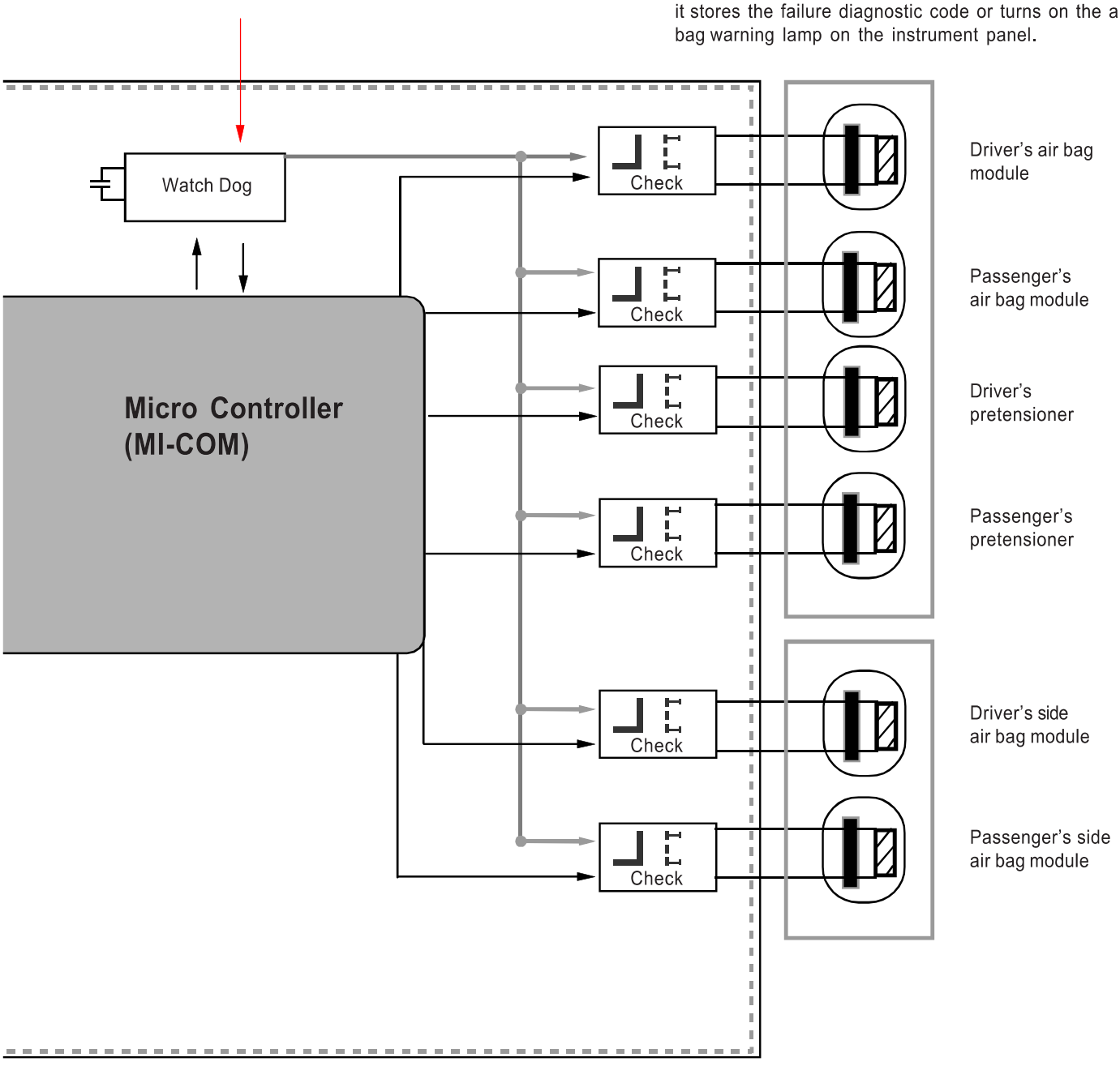
- The overall air bag operation process and its functions and roles are broadly explained in this block diagram. This diagram summarizes and highlights the functions adopted by Ssangyoung Motors.



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 front air bags deploy, the seat belt pretensioners simultaneously work too.
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.



5. DEPLOYING CONDITIONS

- Once the ignition starts, the SDM starts to diagnose the air bag system during the ignition process.If the system is OK, the SDM is armed for a specific impact on the vehicle. The ignition time takes about 6 sec.

1) Front Air Bag Deploying Conditions When a Frontal Impact Occurs

Impact to	Front side
Air bag module - Driver side	Ignite
Air bag module - Passenger side	Ignite
Seat belt pretensioner - Driver side	Ignite
Seat belt pretensioner - Passenger side	Ignite
Side air bag module - Driver side	Ignite
Side air bag module - Passenger side	Ignite

2) Side Air Bag Operating Conditions When a Side Impact Occurs

Impact to	Left direction	Right direction
Side air bag module - Driver side	Ignite	Not ignite
Side air bag module - Passenger side	Not ignite	Ignite
Seat belt pretensioner - Driver side	Ignite	Not ignite
Seat belt pretensioner - Passenger side	Not ignite	Ignite

Modification basis	
Application basis	
Affected VIN	

6. DEPLOYMENT

1) 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.

▶ **The table shows the basic inner resistance of the air bag related module and the basic instant current necessary for firing.**

Air bag module	DAB /PAB	Seat belt pretensioner(BPA)	Driver/Passenger side ai bag module
Resistance (at −30 ~ 85°C)	2.0 ± 0.3 Ω	2.15 ± 0.35 Ω	2.0 ± 0.3 Ω
Firing current	1.2 Amps	1.2 Amps	0.8 Amps

CAUTION

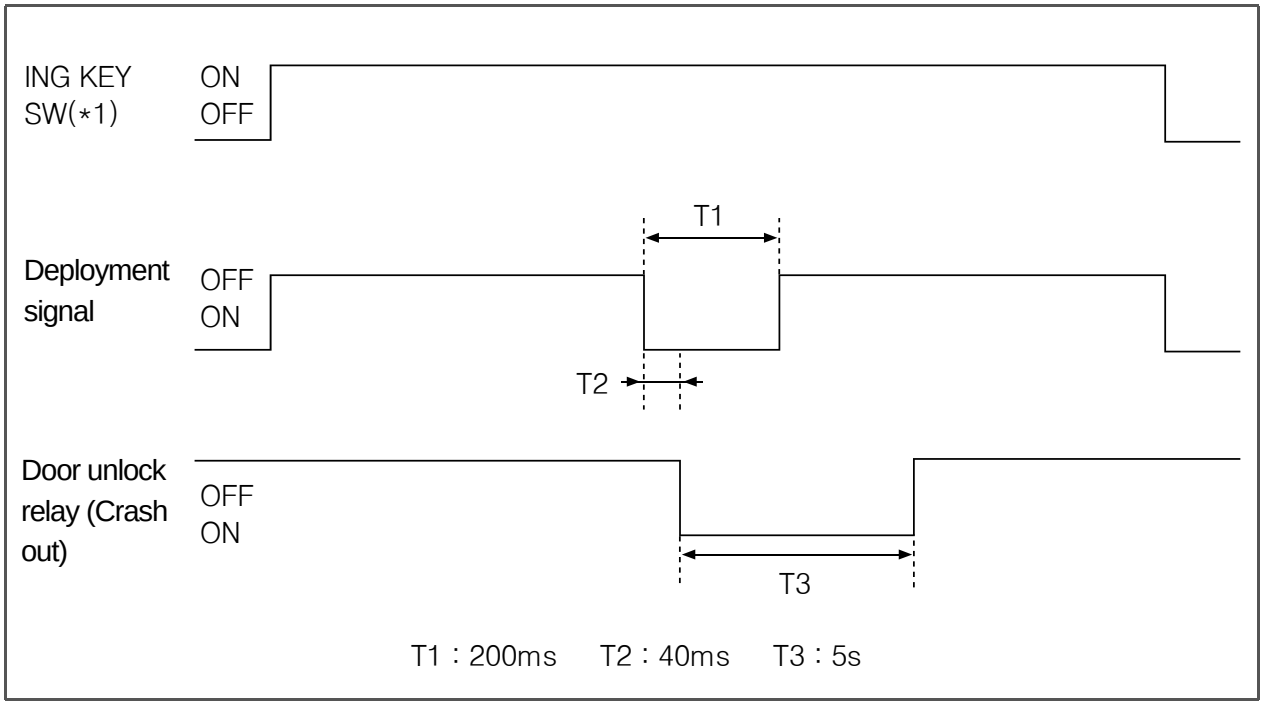
- Please do not connect a tester to any air bag connector or single item to measure the supplied power or resistance. The detonator may explode due to a sudden extra power supplied by the tester.
- Before removing or installing any air bag related components, disconnect the negative battery cable.

2) Air Bag Deployment Signal Output (Crash Out)

▶ **For the safety reason, the system outputs the air bag deployment signal to STICS to unlock the doors automatically.**

▶ **Automatic Door Unlock (Crash unlock: unlock when colliding)**

- The air bag collision signal input cannot be accepted within 7 seconds after turning the ignition key to "ON" position.
- After this period, the door lock system outputs "UNLOCK" for all doors for 5 seconds from 40 ms after receiving the air bag collision signal.
- Even though the key is turned to "OFF" position during the output of "UNLOCK", the output continues on for remaining period.
- The function is erased when turning "OFF" the ignition switch.



CAUTION

▶ **Cautions for Door Lock/Unlock Control**

- 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".

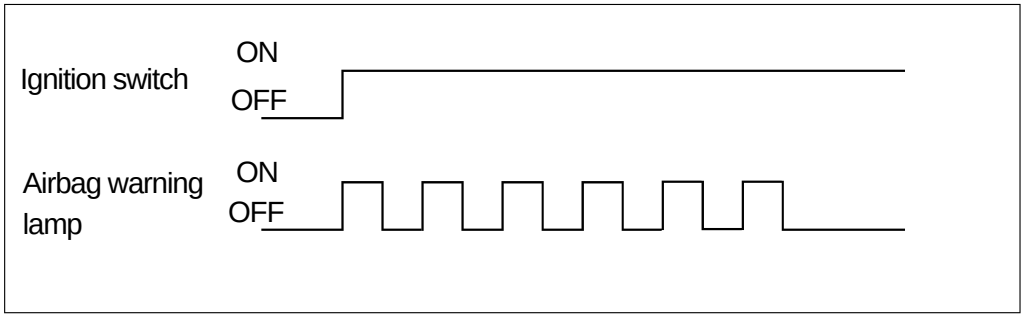
Modification basis	
Application basis	
Affected VIN	

7. 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:

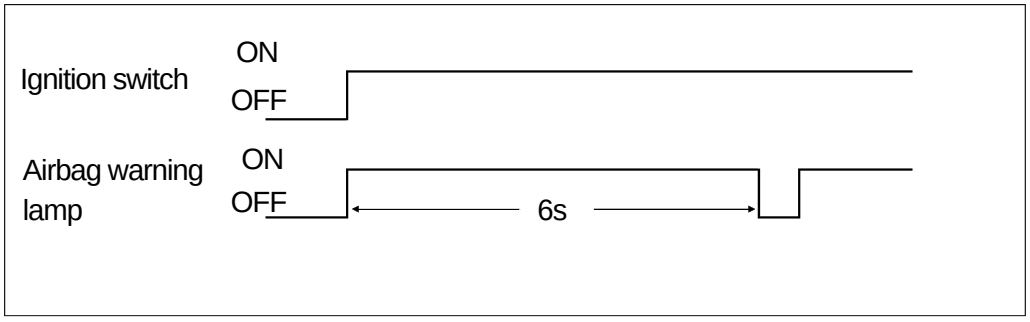
▶ When Turning the Ignition Switch to ON Position Initially

The air bag unit performs a turn-on test when the ignition is turned on initially. The air bag unit flashes the air bag warning lamp 6 times at 1 Hz interval. After that, the air bag warning lamp will go off if no malfunction have been detected.



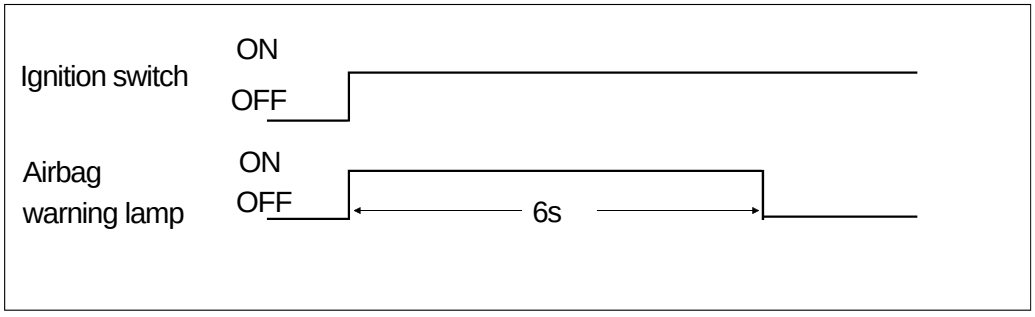
▶ When the Air Bag Unit Detects Any Malfunctions in Unit

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.



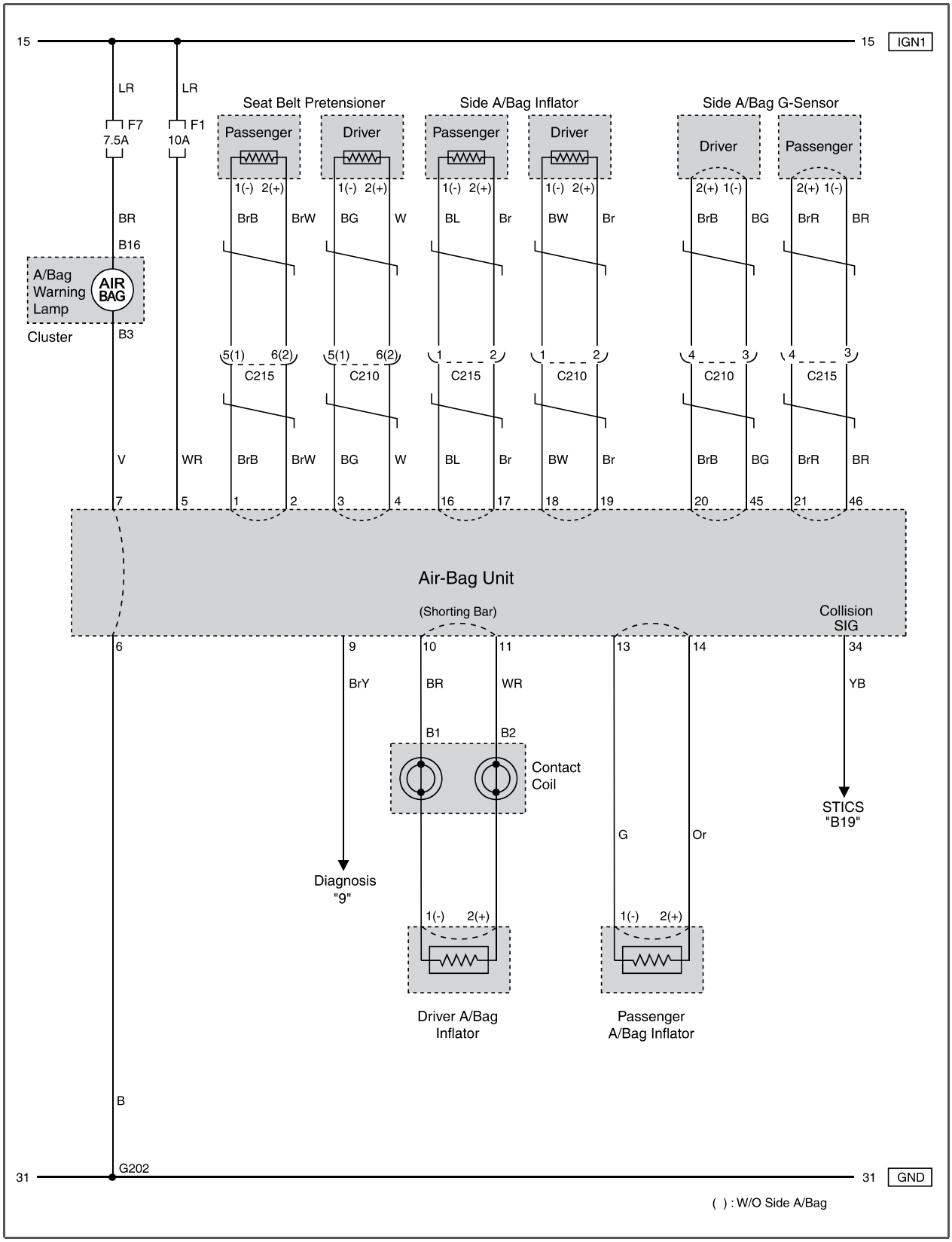
▶ When the Air Bag Unit Detects Any Intermittent Failure

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.



8. CIRCUIT DIAGRAM

▶ 8810-01 Air Bag (including Side Air Bag)



Modification basis	
Application basis	
Affected VIN	

SEAT

4170-00

GENERAL INFORMATION

1. WARNINGS FOR POWER SEAT

1. Adjust the driver's seat before driving.
2. Make sure that the seat is firmly secured after adjusting.
3. Never drive the vehicle with the head restraint removed or lowered excessively. Otherwise, your neck, spine or other parts of the body can be severely injured in the event of an accident.
4. If you recline the seatback excessively, you could slide under the seat belt and be injured severely in a collision.
5. Do not put any object that could damage the seat on the seat.
6. The front and rear seats are equipped with the heated wire (seat warmer) system. Using the seat warmer system excessively may cause minor burns. The following occupants should exercise special care when using the heated wire seat.
   - Infant, child, old or handicapped person
   - Person with sensitive skin
   - Exhausted person
   - Persons who is drunk or took medicine which causes drowsiness such as sleeping pills, cold tablets, etc.
7. Do not place anything on the seat that insulates against the heat, such as a blanket or cushion.
8. Make sure that the head restraints are in place and secured properly. Never drive the vehicle with the head restraint removed.
9. To minimize the injuries in a collision or an abrupt stop, make sure the seatback is in the upright position before driving. If the seatback is reclined too much, the occupant could slide under the seat belt in a collision or an abrupt stop and cannot be protected properly by the airbag system.

2. CAUTIONS FOR POWER SEAT

1. You can operate the power seat with the ignition switch OFF. However, frequent operation of the seat switch with the engine stopped can result in battery becoming discharged.
2. Operating more than one seat adjustment switch at the same time can cause damage to the seat motor. Therefore, operate the seat switch only one at a time.
3. Do not use organic solvents such as benzene, thinner, alcohol or gasoline to prevent the seat cover from being damaged while cleaning.
4. Do not operate the seat position adjustment switch forcefully when the seat does not move or it contacts an object.
5. If the power seat is not operated, check and correct the problem before driving off.

3. MAJOR CHANGES

1) Front Headrest

Front Headrest	
Old	**New**
	
Swing type tilting	Sliding type tilting
Changed the design of headrest.	

2) Front Seat Assembly

Front Seat Assembly	
Old	**New**
	
Changed the design of seatback and seat cushion.	

Changed the design of headrest.

Modification basis	
Application basis	
Affected VIN	

3) Front Seat Back Board

Front Seat Back Board	
Old	**New**
	
Changed the design of seat back board and seat back pocket.	

4) Front Seat Cover Shield

Front Seat Cover Shield	
Old	**New**
	
Integrated type	Split type
Changed the design of seat cover shield.	

5) Front Seat Frame Cover

Front Seat Frame Cover	
Old	**New**
	
Changed the design of seat frame covers (front & rear).	

6) Rear Center Armrest Assembly

Rear Center Armrest	
Old	**New**
	
Changed the location and appearance of armrest band.	

Modification basis	
Application basis	
Affected VIN	

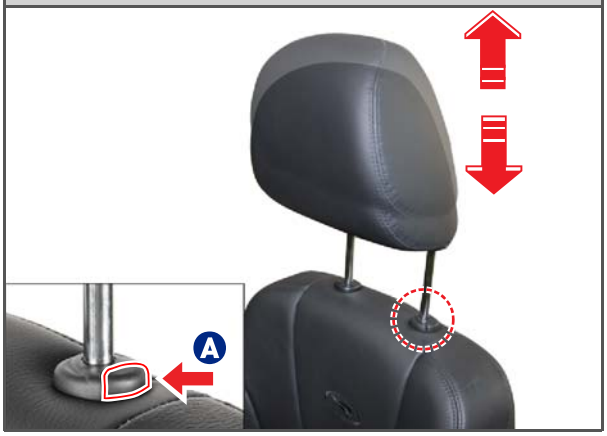
OVERVIEW AND OPERATION PROCESS

1. DRIVER'S SEAT ASSEMBLY

1) Adjustment



Height Adjustment of Headrest



▶ **How to operate**

To raise the headrest, pull it up without pressing the release button. To lower the headrest, press the release button (A) on top of the seatback and push the headrest down.

Forward and Backward Adjustment of Headrest



▶ **How to operate**

The headrest can be adjusted forward to three different positions by pulling the headrest forward. To adjust the headrest backward, pull it fully forward to the farthest position and release it. Adjust the headrest so that it properly supports the head and neck.

Seat Slide Adjustment (Power Seat)



▶ **How to operate**

To move the seat forward or backward, push the seat slide switch to desired direction.

Seat Slide Adjustment (Manual Seat)



▶ **How to operate**

To move the seat forward or backward, pull and hold the seat slide lever up and move the seat as desired. Then, release the lever.

Seatback Reclining Adjustment (Power Seat)



▶ **How to operate**

To change the seatback angle, lean forward slightly and push the seatback reclining switch to desired direction.

Seatback Reclining Adjustment (Manual Seat



▶ **How to operate**

To change the seatback angle, lean forward slightly and raise the lever. Then, lean back to the desired angle and release the lever. After adjusting, make sure the lever is returned to its original position and the seatback is locked.

Modification basis	
Application basis	
Affected VIN	

Seat Cushion Angle Adjustment (Power Seat

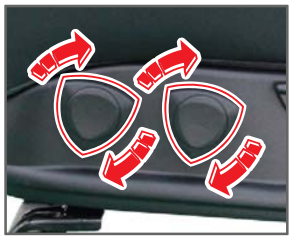




▶ **How to operate**

To adjust the seat cushion angle, raise or lower the seat cushion angle adjusting switch to desired direction.

Seat Height & Cushion Angle Adjustment (Manual Seat)

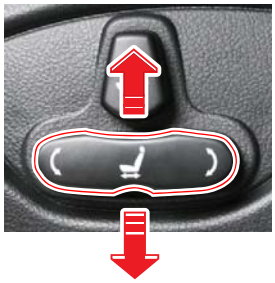




▶ **How to operate**

To adjust the angle and height of the front or rear section of the seat cushion, rotate the adjustment knob on the side of the seat clockwise or counterclockwise.

Seat Height Adjustment (Power Seat)

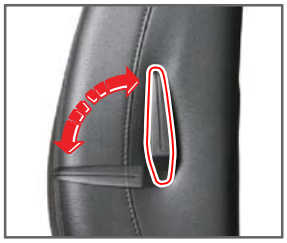




▶ **How to operate**

To adjust the seat height, raise or lower the seat height adjusting switch to desired direction.

Lumbar Support Adjustment (Power/Manual Seat)





▶ **How to operate**

Turn the lever forward to increase the amount of lumbar support. To decrease it, turn the lever backward.

2) Driver's Seat Heater

Seat Heater ON	Driver's Seat Heater Switch
	

▶ Operating conditions

- IGN ON / Engine running
- If the engine is cranking during the heater operation, the seat heater stops the operation for cranking period.

▶ How to operate

- The seat heater has 5 heating levels.
- Turning clockwise: Higher heating level
- Turning counterclockwise: Lower heating level

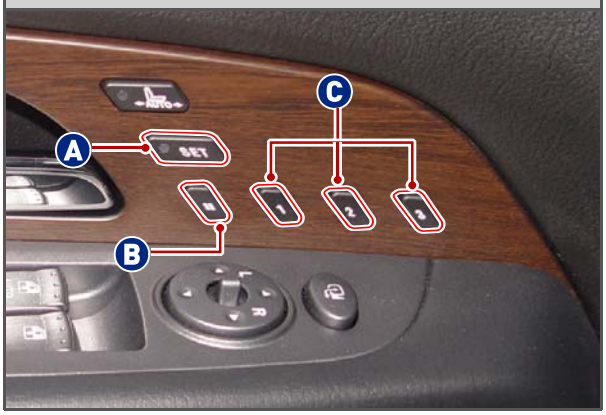
▶ Operating process

- The seat heating unit under the passenger's seat controls the seating process according to the signals from the seat heater switch. The unit turns ON and OFF the seat heating element to keep the set heating level.

Modification basis	
Application basis	
Affected VIN	

3) Position Memory Setting

Seat Position Memory Switch



▶ **Seat position memory function**

The position memory is available for up to three drivers. Each driver can set his/ her own driver's seat and outside rearview mirror positions. The information will individually be stored in the integrated computer. If somebody has moved the seat, the memory positions can be recalled automatically by pressing the position button.

A: Seat position SET button
B: stop BUTTON
C: Position buttons (1, 2, 3)

▶ **Operating conditions**

- IGN ON / Engine running

▶ **To store the memory settings**

- Position the transmission shift lever to "P" with the ignition switch "ON" In case of a manual transmission vehicle, you must apply the parking brake too.
- Adjust the driver's seat and outside rearview mirrors to the desired positions.
- Press the (SET) switch. The indicator on the switch comes on.
- Within 5 seconds, press and hold one of the position buttons (1, 2, 3) you want to set.
- When the memory setting is completed, a buzzer sounds twice.

▶ **To recall the memory settings**

- Press and hold one of the position buttons (),(),() you want until the buzzer sounds.
- The driver's seat and outside rear view mirrors start to move to the stored positions. If you drive off during this recalling process, this automatic memory setting stops operating.
- Wait until they stop moving.
- When the process is completed, a buzzer sounds twice.

▶ **Operating process**

- The SPWM unit under the driver's seat controls the driver's seat position sensor and outside rearview mirror position sensor to recall the set position appointed to respective button.

CAUTION

- Do not set or recall the seat position memory when the vehicle is in motion.
- The memory setting is cancelled when operating any seat adjusting switch or outside rearview mirror adjusting switch during setting process.
- If you do not press any position button within 5 seconds after pressing "SET" switch, the memory setting is cancelled.
- To recall the memory setting, press the position switch for more than 1.5 second.
- The automatic positioning operation stops when operating STOP switch, any seat adjusting switch or outside rearview mirror adjusting switch during its operation.

4) Easy Access (Driver's Seat)

Easy Access Switch



▶ Easy access function

- This system is designed to provide the driver sufficient space to access and exit.

▶ Operating conditions

- Easy access switch ON
- Shift lever in "P" position

▶ Operating process

- When turning the IGN ON and OFF with the Easy Access switch pressed in, The SPWM unit operates the seat sliding motor to slide backward the driver's seat.

CAUTION

- The moving distance of the seat is based on when the seat is located at its front end. It varies according to the initial position.
- There could be some differences when the seat moves back to its original position. The difference of the passenger weights and electrical loads can cause the differences in its distance, and this is normal, not defective.

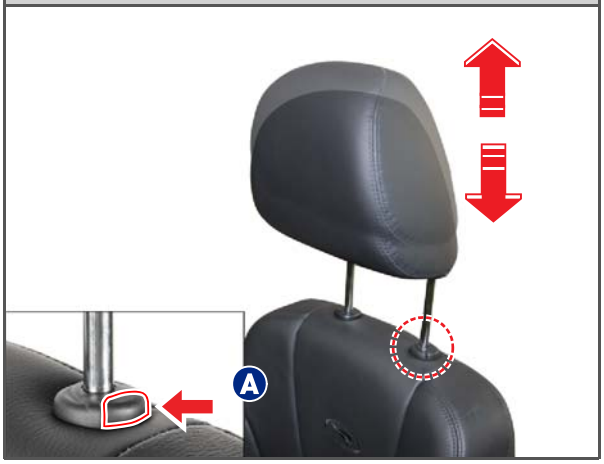
Modification basis	
Application basis	
Affected VIN	

2. PASSENGER'S SEAT ASSEMBLY

1) Adjustment



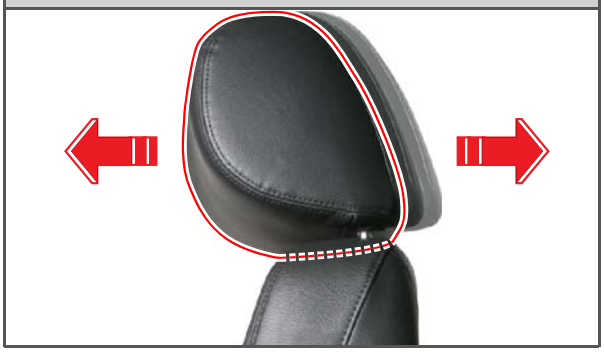
Height Adjustment of Headrest



▶ **How to operate**

To raise the headrest, pull it up without pressing the release button. To lower the headrest, press the release button (A) on top of the seatback and push the headrest down.

Forward and Backward Adjustment of Headrest



▶ **How to operate**

The headrest can be adjusted forward to three different positions by pulling the headrest forward. To adjust the headrest backward, pull it fully forward to the farthest position and release it. Adjust the headrest so that it properly supports the head and neck.

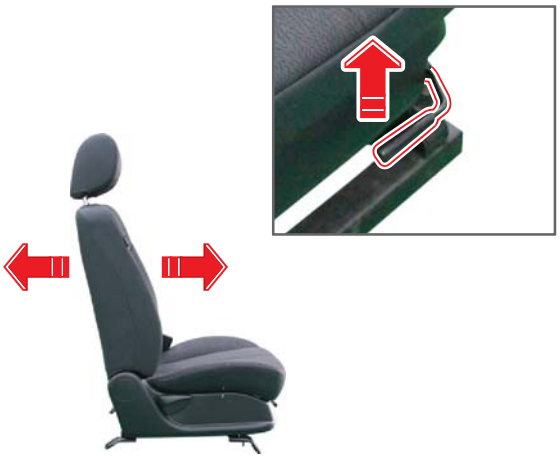
Seat Slide Adjustment (Power Seat)



▶ **How to operate**

To move the seat forward or backward, push the seat slide switch to desired direction.

Seat Slide Adjustment (Manual Seat)



▶ **How to operate**

To move the seat forward or backward, pull and hold the seat slide lever up and move the seat as desired. Then, release the lever.

Seatback Reclining Adjustment (Power Seat)



▶ **How to operate**

To change the seatback angle, lean forward slightly and push the seatback reclining switch to desired direction.

Seatback Reclining Adjustment (Manual Seat



▶ **How to operate**

To change the seatback angle, lean forward slightly and raise the lever. Then, lean back to the desired angle and release the lever. After adjusting, make sure the lever is returned to its original position and the seatback is locked.

Modification basis	
Application basis	
Affected VIN	

2) Passenger's Seat Heater

Seat Heater ON	Passenger's Seat Heater Switch
	

▶ Operating conditions

- IGN ON / Engine running
- If the engine is cranking during the heater operation, the seat heater stops the operation for cranking period.

▶ How to operate

- The seat heater has 5 heating levels.
- Turning clockwise: Higher heating level
- Turning counterclockwise: Lower heating level

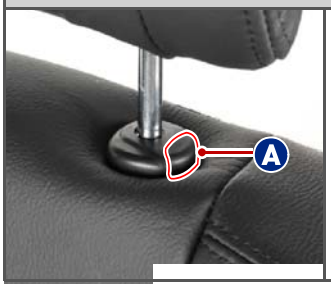
▶ Operating process

- The seat heating unit under the passenger's seat controls the seating process according to the signals from the seat heater switch. The unit turns ON and OFF the seat heating element to keep the set heating level.

3. SECOND ROW SEAT ASSEMBLY

1) Adjustment

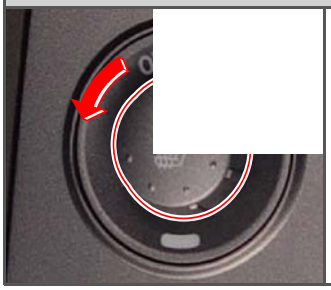
Headrest Adjustment



To raise the headrest, pull it up without pressing the release button. To lower the headrest, press the release button (A) on top of seatback and push the headrest down.

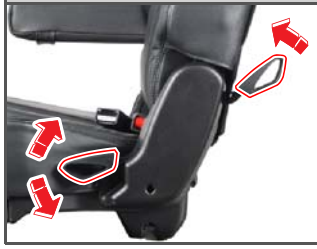


Second Row Seat Heating switch



The heating switches for the rear seats are located on the rear door trims. During heating the seats, the seat heater indicator comes on.

Seatback Reclining Adjustment



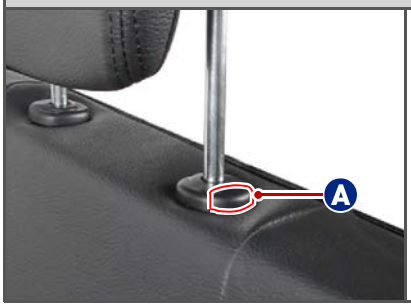
Pull up the lever and adjust the seatback angle to the desired position. After adjustment, release the lever and make sure that the lever is returned to its original position and the setback is securely locked.

Modification basis	
Application basis	
Affected VIN	

4. THIRD ROW SEAT ASSEMBLY

1) Adjustment

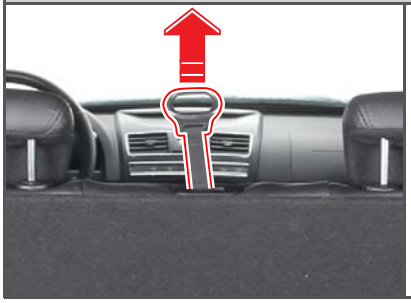
Headrest Adjustment



To raise the headrest, pull it up without pressing the release button. To lower the headrest, press the release button (A) on top of seatback and push the headrest down.



Seatback Folding

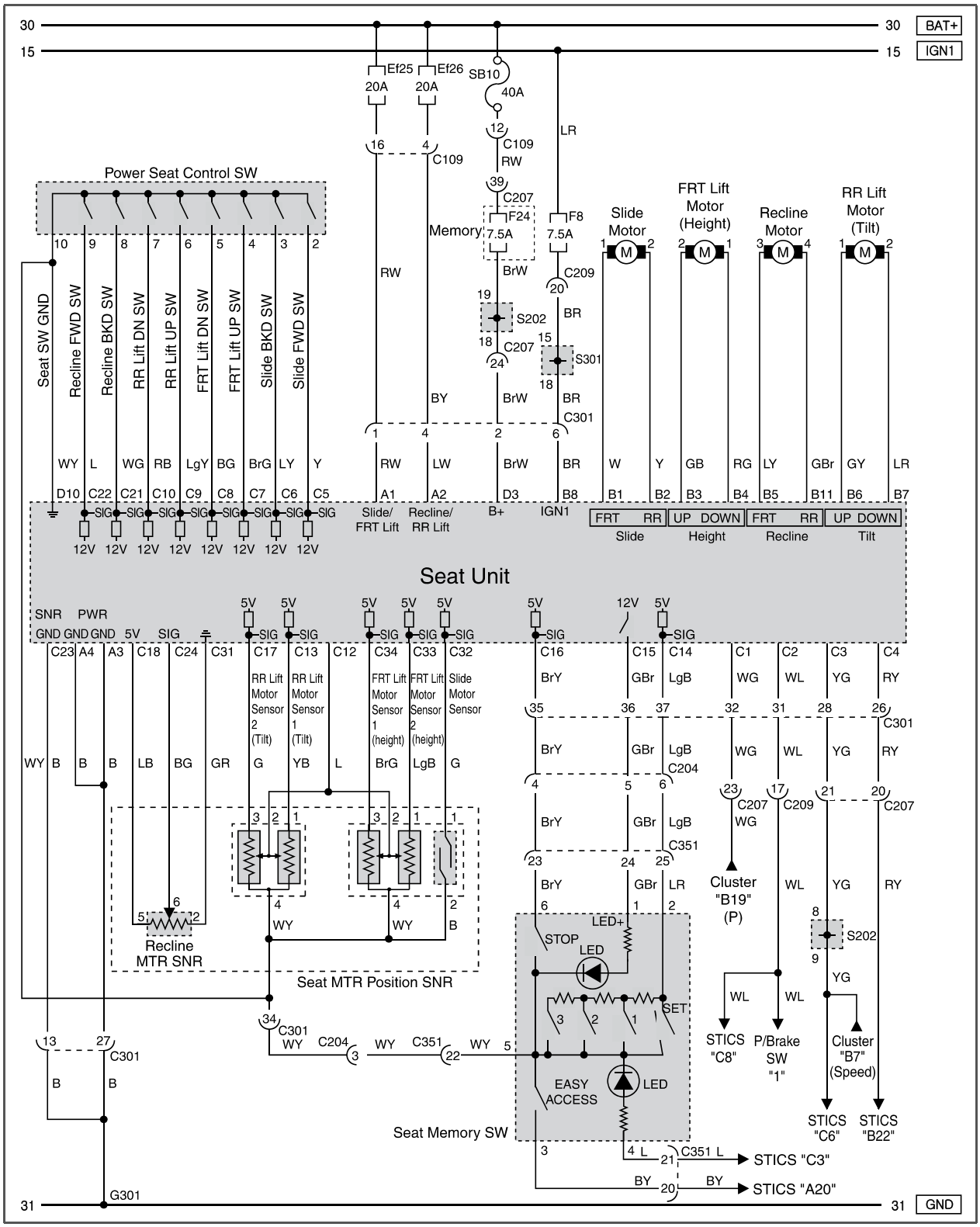


Pull up the folding lever to fold down the third row seat.

5. CIRCUIT DIAGRAM

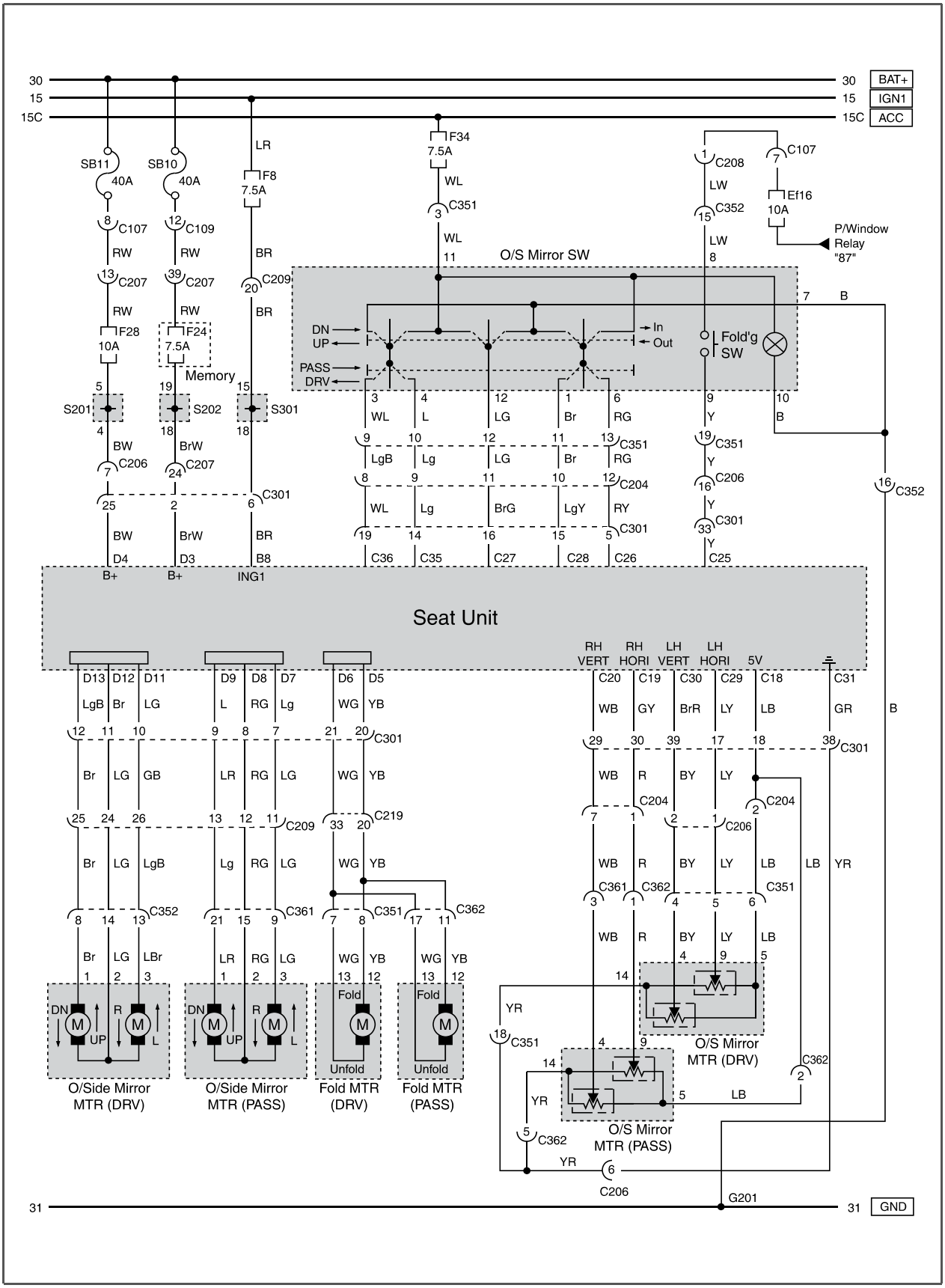
S.G.N. 7410-32 DRIVER'S POWER SEAT (MEMORY)

▶ **Power Seat/Seat Position Memory**



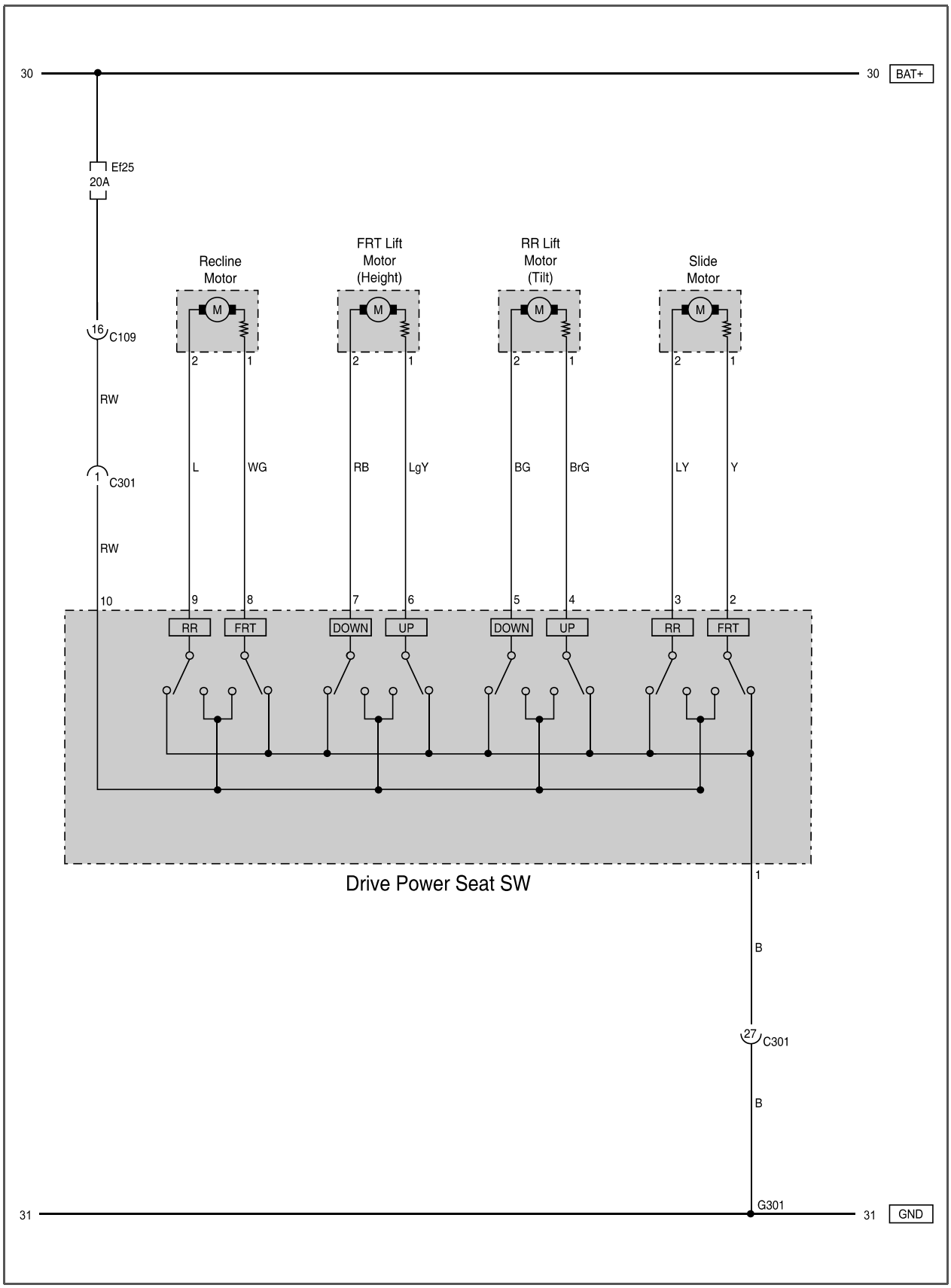
Modification basis	
Application basis	
Affected VIN	

▶ Outside Rearview Mirror, Folding



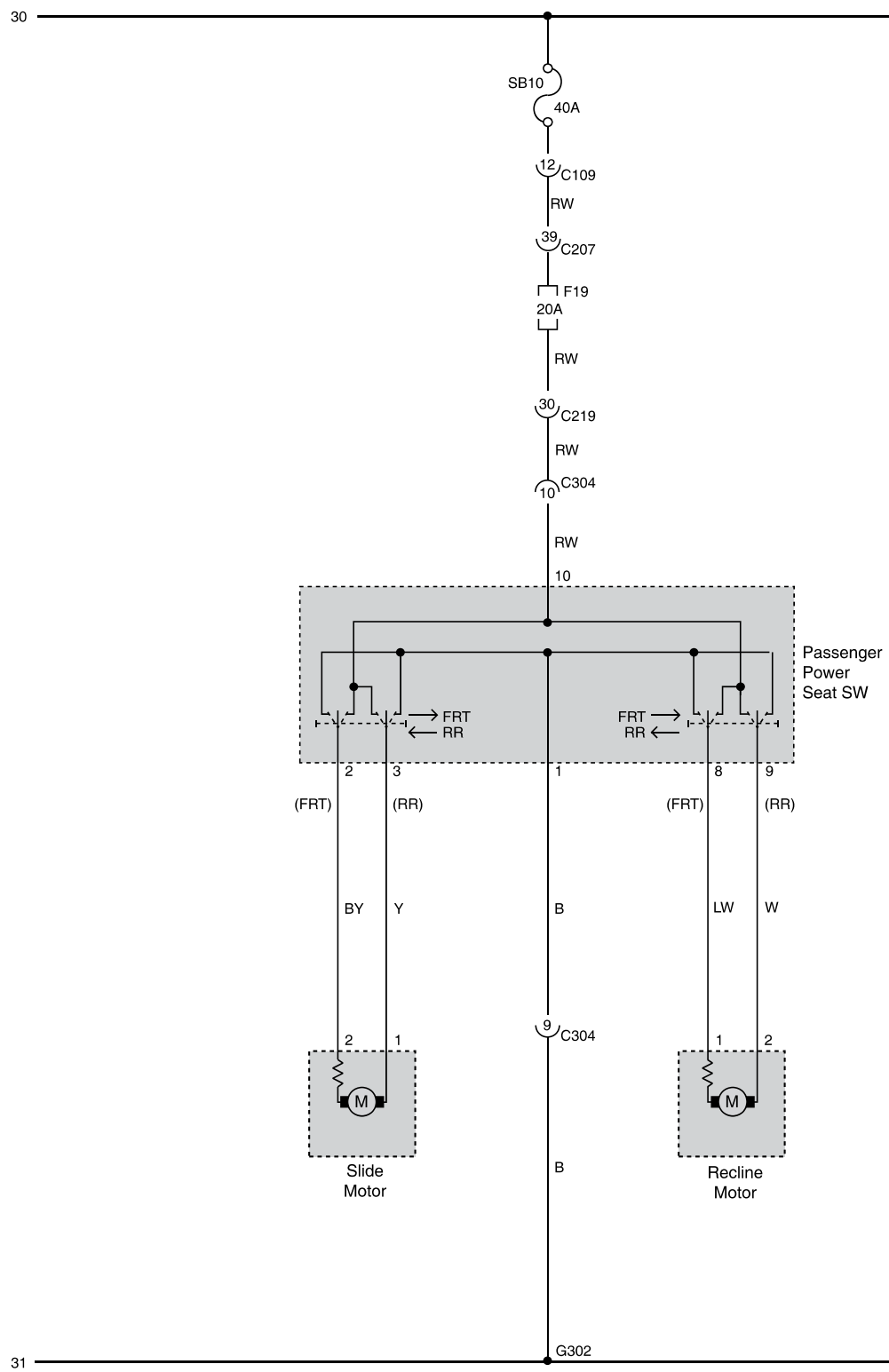
Modification basis	
Application basis	
Affected VIN	

S.G.N.
7410-02 DRIVER'S POWER SEAT (NON-MEMORY)



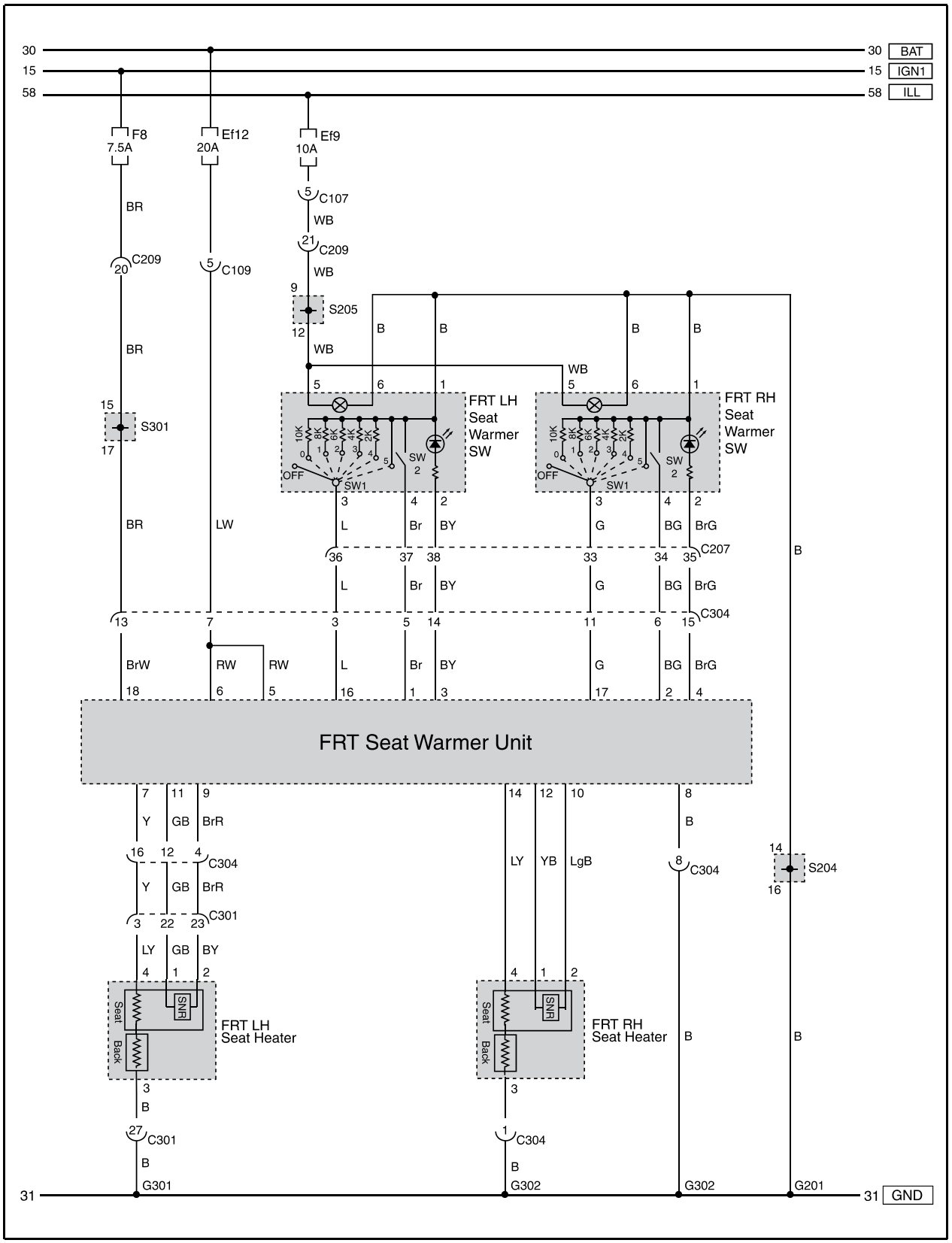
Modification basis	
Application basis	
Affected VIN	

S.G.N.
7410-04 PASSENGER'S POWER SEAT



Modification basis	
Application basis	
Affected VIN	

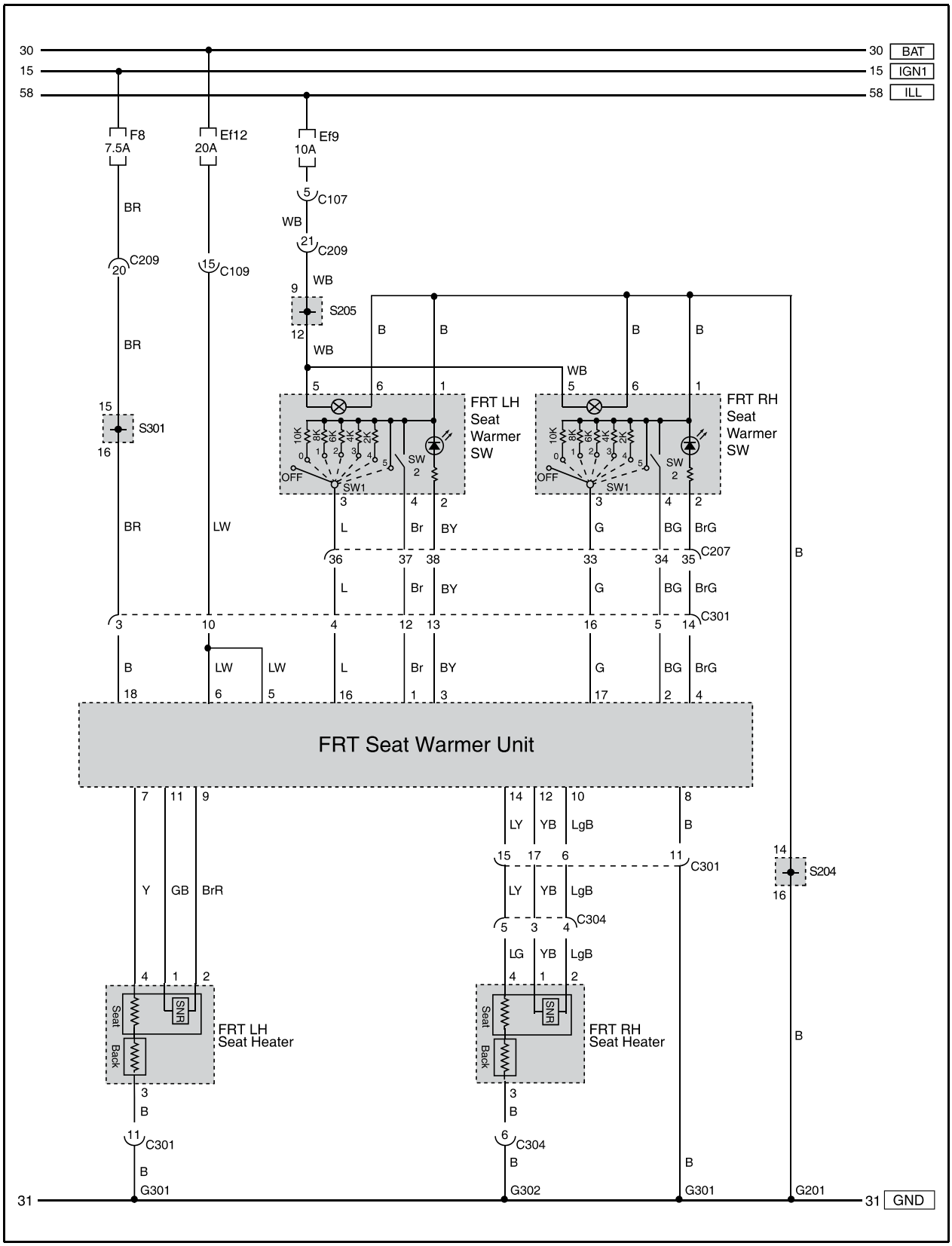
S.G.N.
8611-31 FRONT VARIABLE SEAT HEATER (SEAT/ OUTSIDE REARVIEW MIRROR MEMORY)



Modification basis	
Application basis	
Affected VIN	

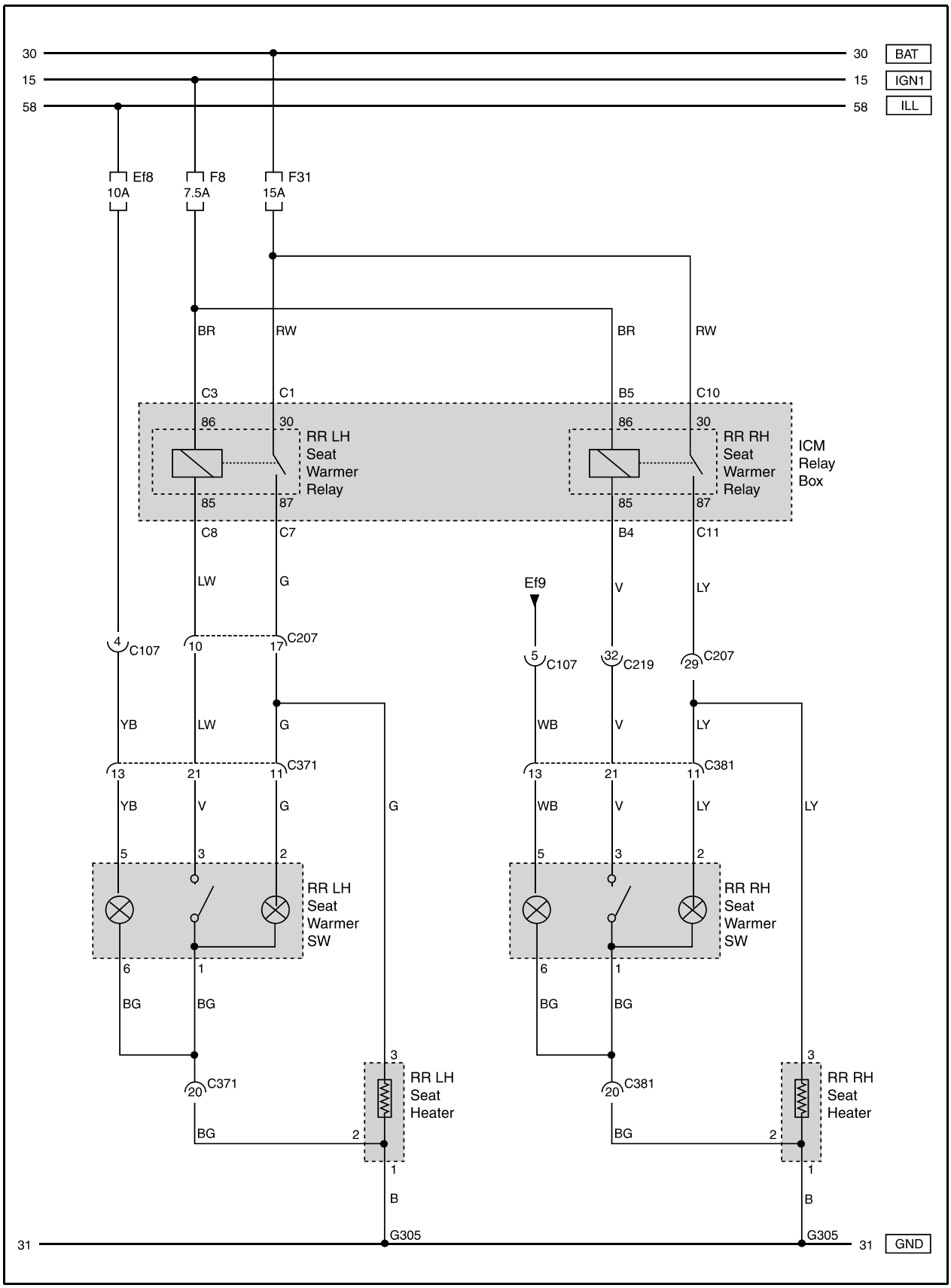
S.G.N. 8611-31

FRONT VARIABLE SEAT HEATER (SEAT/ OUTSIDE REARVIEW MIRROR NON-MEMORY)



Modification basis	
Application basis	
Affected VIN	

S.G.N.
8611-31 REAR SEAT HEATER



Modification basis	
Application basis	
Affected VIN	

SUNROOF 7340-01

GENERAL INFORMATION

1. CAUTIONS WHEN WORKING

- Wear clean work clothes and gloves.
- Any unauthorized modification or operational test is not allowed since the sunroof motor and control unit are preset at the factory.
- Pay attention not to drop the sunroof assembly when removing it and do not keep it right up.

2. CAUTIONS FOR OPERATION

- Even though the sunroof can be operated when the engine is not running, operating the sunroof repeatedly with the engine turned off will run down the battery. Operate the sunroof while the engine is running.
- When the sunroof operation is completed, release the switch. Keeping pressing the switch can result in malfunction.
- Especially in winter, never operate the sunroof if operation areas are iced. Wait until melted.
- To prevent a theft, make sure that the sunroof is completely closed when leaving the vehicle. In addition, rain or snow can get into the vehicle through the open sunroof.
- When the sunroof is fully open, wind buffeting symptom can be worse. In this case, try to adjust the sunroof position manually or open the sunroof until the wind buffeting is disappeared Parts of the body can be trapped in the sunroof and can be struck by passing objects. Do not
- stick hands, head or anything else out of the openings.
  Remove any dirt and foreign material stuck on the edge of the sunroof glass periodically.
-

3. MAJOR CHANGES

1) Sunroof Switch

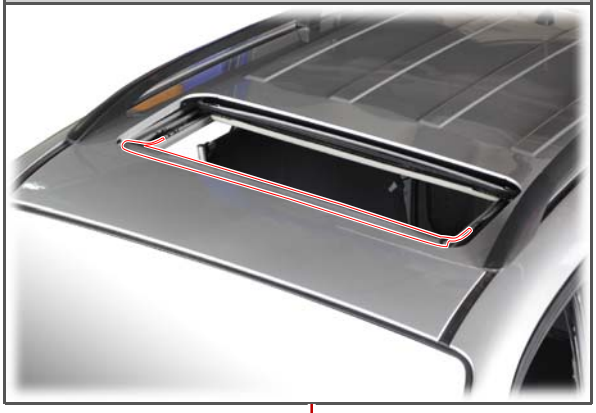
Sunroof Switch	
Old	**New**
	
Changed the appearance of sunroof switch.	

Modification basis	
Application basis	
Affected VIN	

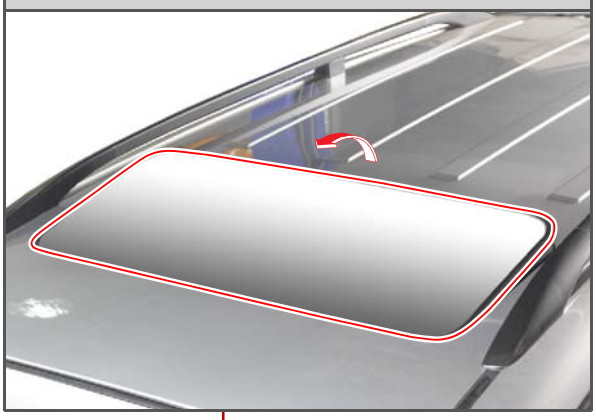
OVERVIEW AND OPERATING PROCESS

1. COMPONENTS AND LAYOUT

OPEN



TILT





Sunroof Assembly

D



Sunroof Motor Assembly

A



Overhead Console Assembly (Sunroof Switch)

B



Sunroof Control Unit

C



Modification basis	
Application basis	
Affected VIN	

2. OPERATING PROCESS

1) Sunroof switch



▶ **Sunroof switch**

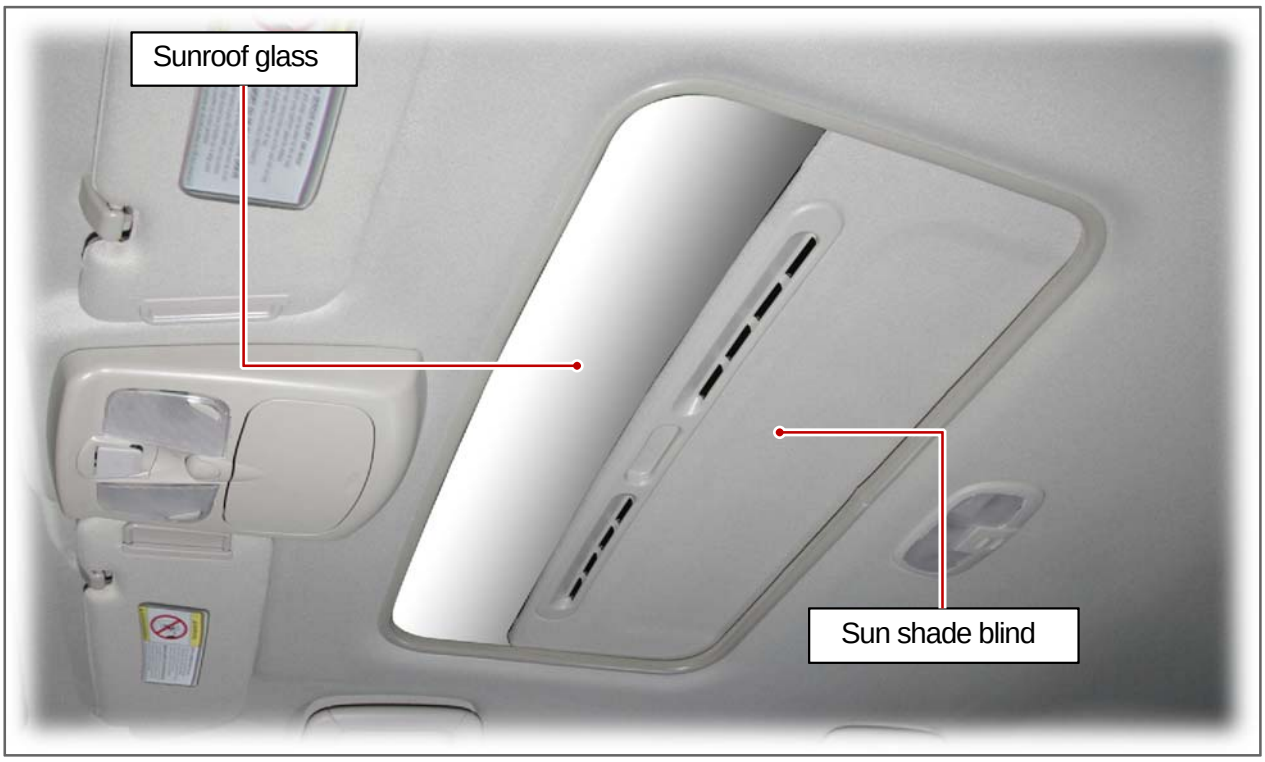
- The sunroof switches are included in the overhead console assembly.

▶ **CLOSE**

- Closes the sunroof.

▶ **OPEN**

- Opens the sunroof.



▶ **Sunroof glass**

- The sunroof glass can be opened automatically and can be tilted by the switch operation..

▶ **Sun shade blind**

- The sun shade blind can be closed or opened manually to block sunlight when the sunroof function is not in use.

Modification basis	
Application basis	
Affected VIN	

2) Sunroof Sliding Opening/Closing



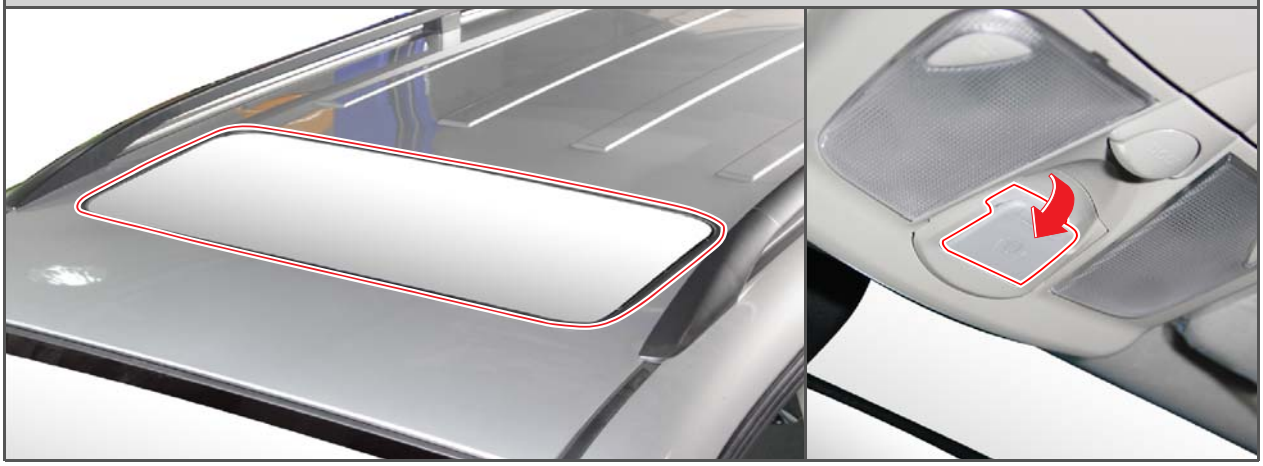
▶ **Push up the switch briefly: 2-step auto sliding open**

- Sunroof operation has two steps; if you push the switch briefly, the sunroof is opened by its first operating stroke (approx. 326 mm). If you push it again, the sunroof is opened completely. When the switch is operated while the sunroof is moving, the sunroof stops sliding open.

▶ **Push up and hold the switch: manual sliding open**

- The sunroof is opened only as long as pushing up the switch.

Closing sunroof (Sliding close)



▶ **Pull down the switch briefly: auto sliding close**

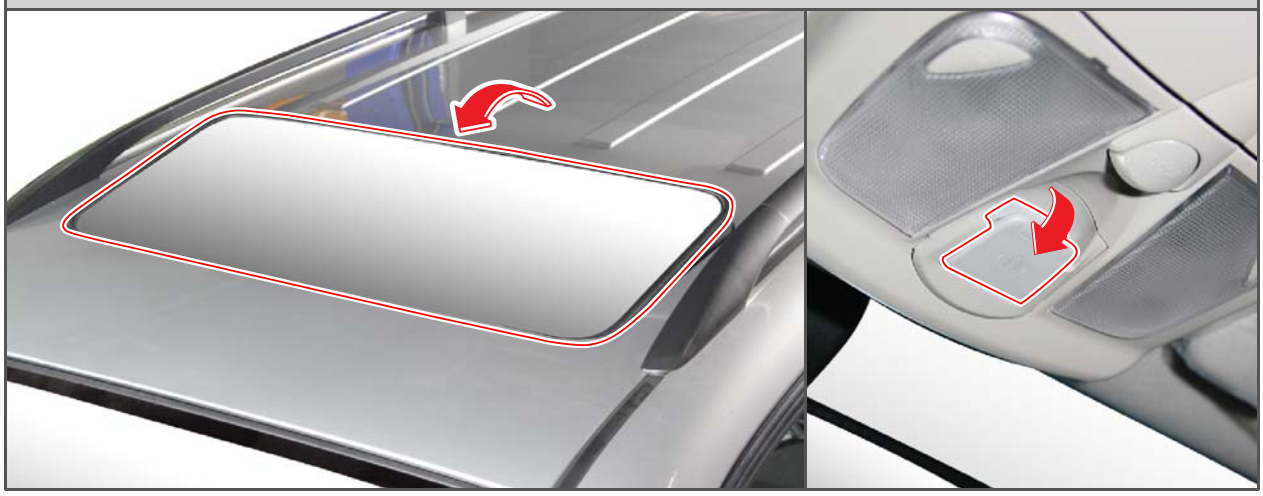
- When pulling down the switch briefly, the sunroof is automatically closed. To stop the closing sunroof, operate the switch to either direction.

▶ **Pull down and hold the switch: manual sliding close**

- The sunroof is closed as long as pulling down the switch.

3) Sunroof Tilt Up/Down

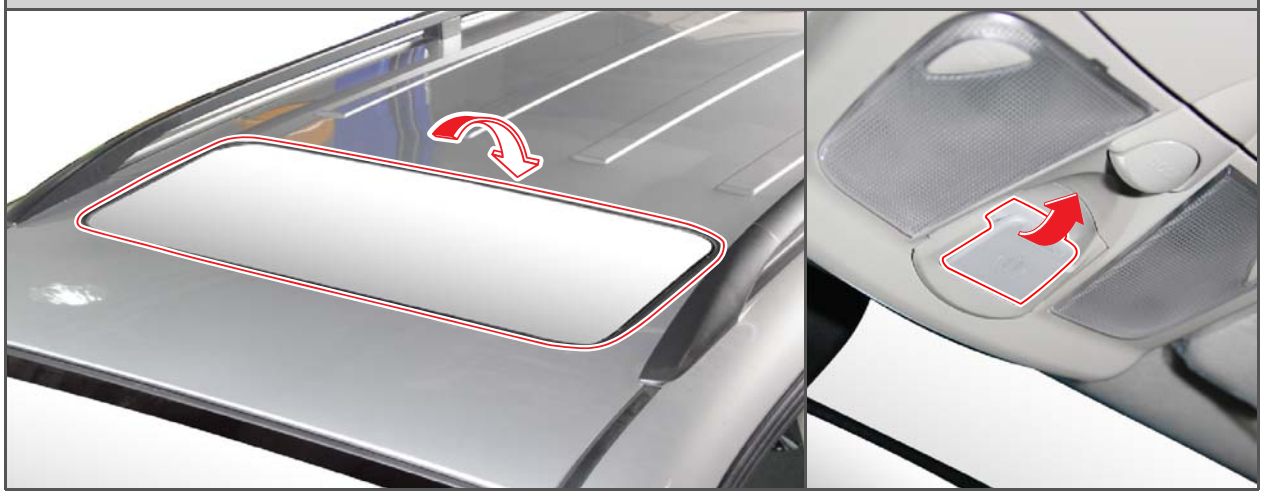
Tilt Up



▶ **Pull down the switch**

- The rear side of the sunroof is tilted up when pulling down the sunroof switch with the sunroof closed.

Tilt Down



▶ **Push up the switch**

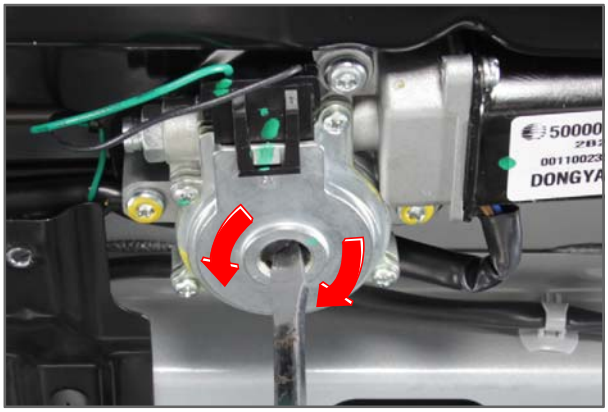
- The rear side of the sunroof is tilted down when pushing up the sunroof switch with the sunroof tilted up.

Modification basis	
Application basis	
Affected VIN	

4) Sunroof Safety Function (Anti-Trap)

To prevent any body parts from being trapped by the sliding sunroof, an Anti-Pinch Function automatically opens the sunroof when an object is trapped. However, when the anti-trap function has been activated consecutively 3 times, the auto closing mode will be changed to the manual operation mode and then resume its function..

5) Emergency Operation



If the sunroof becomes out of order while it is open or tilted, the sunroof can be operated through the motor operating hole of the sunroof motor.

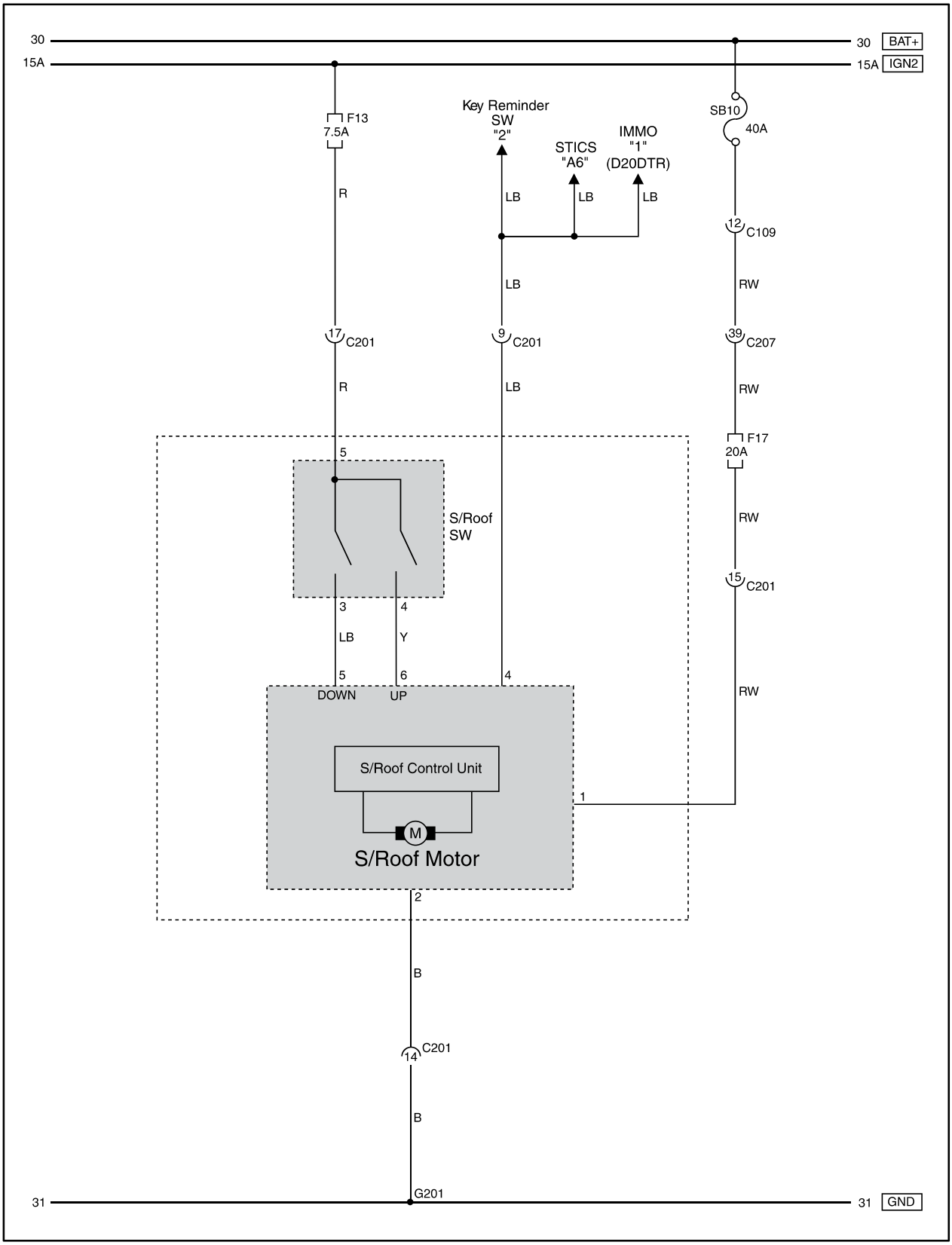
NOTE

▶ **Wind buffeting**

When you drive this 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. 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.

3. CIRCUIT DIAGRAM

▶ **7304-03 Sunroof**



Modification basis	
Application basis	
Affected VIN	

BODY INTERIOR

7610-00

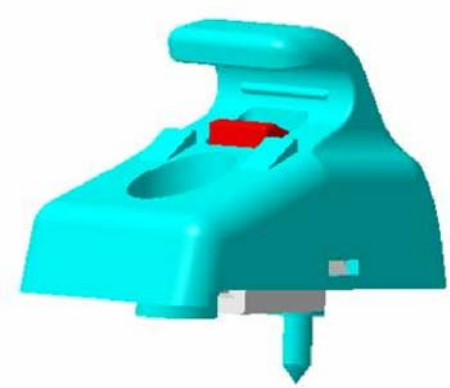
GENERAL INFORMATION

1. MAJOR CHANGES

1) Center Fascia Panel

Center fascia panel	
Old model	**New model**
	
Changed design	

2) Sun Visor Retainer

Sun Visor Retainer	
Old model	**New model**
	
Changed design	

BODY EXTERIOR

5110-00

GENERAL INFORMATION

1. SPECIFICATIONS

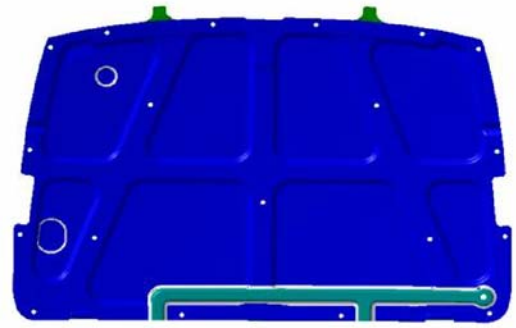
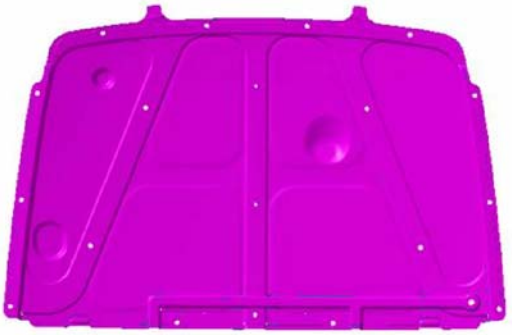
Description			Specification
Hood	Type		Gas lifter type
Front door	Structure		Frame door
	Window regulator type		Wire-drum
	Locking device		Pin-fork device
Rear door	Structure		Frame door
	Window regulator type		Wire-drum
	Locking device		Pin-fork device
Tailgate	Type		Gas lifter type
Thickness of glass	Windshield		5mm
	Front door glass		4mm
	Tailgate glass		4mm
	Tailgate	Fixed glass	4mm
		Flip-up glass	5mm
Requirements for leak test stand	Nozzle type		Full jet spray nozzle #1/2 GG-25 or 60°
	Nozzle height		1,600 mm from ground
	Displacement		14 liters per minute
	Nozzle injection pressure		155 kPa (22.5 PSI)
	Location of windshield & A-pillar test stand		Down 30° & Rear 45° (at center of windshield corner)
	Location of B-pillar test stand		Down 30° & Rear 45° (at center of rear door)
	Location of tailgate glass & tailgate test stand		Down 30° & Rear 45° (at 60 mm from center of windshield corner)

Modification basis	
Application basis	
Affected VIN	

2. MAJOR CHANGES

1) Hood Panel

Hood Panel	
Old	**New**
	
Changed the design	

Hood Insulator	
Old	**New**
	
Changed the design to eliminate the interference	

Modification basis	
Application basis	
Affected VIN	

2) Radiator Grille

Radiator Grille	
Old	**New**
	
Changed the design and location	

3) Front Bumper

Front Bumper
Old

New

Changed the design

4) Outside Rearview Mirror

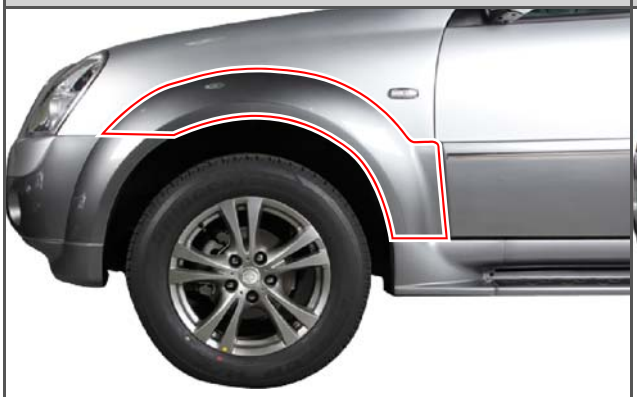
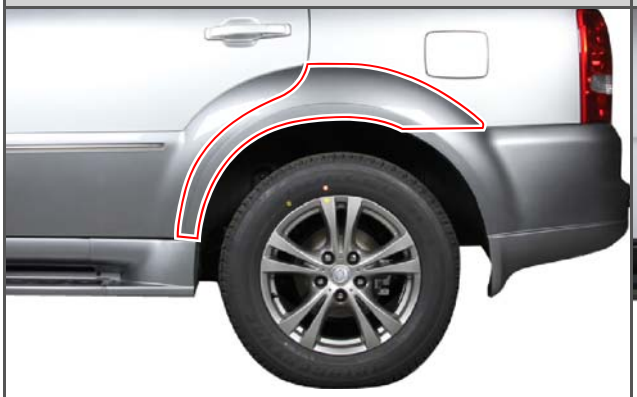
Outside Rearview Mirror	
Old	**New**
	
Introduced the LED side repeater and changed the design	

5) Door Garnish

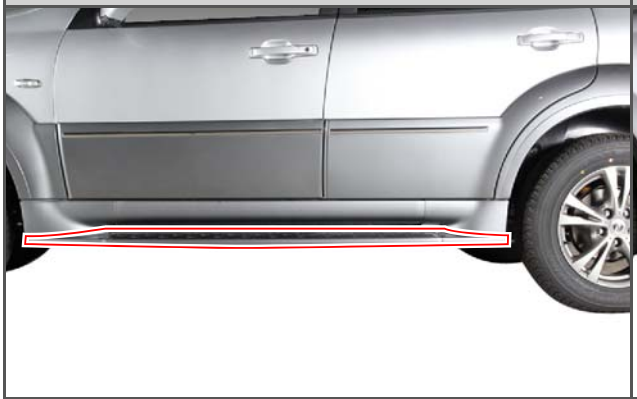
Door Garnish	
Old	**New**
	
Deleted the front and rear garnish	

Modification basis	
Application basis	
Affected VIN	

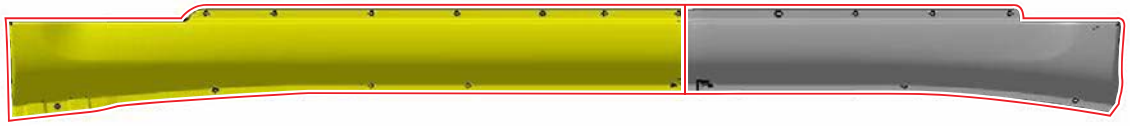
6) Wheel Arch Garnish

Wheel Arch Garnish	
Old (Front)	New (Front)
	
Old (Rear)	New (Rear)
	
Changed the design	

7) Center Lower Step

Center Lower Step	
Old	New
	
Changed the design	

8) Side Sill Garnish

Side Sill Garnish
Old

Split type
New

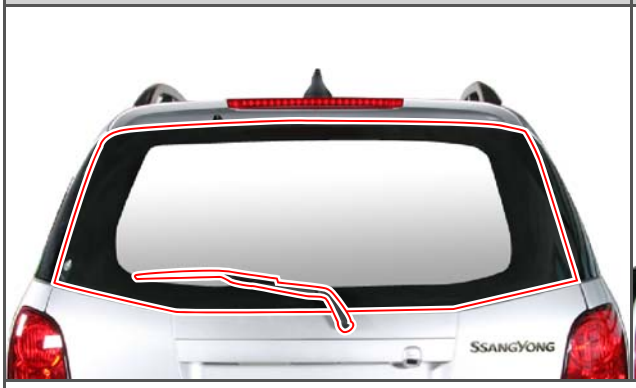
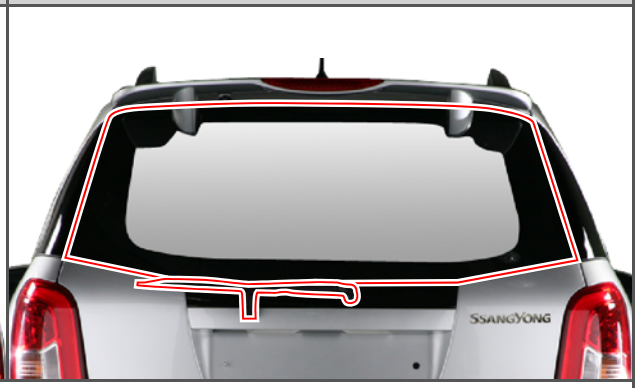
Integrated type

9) Side Outer Rear Panel

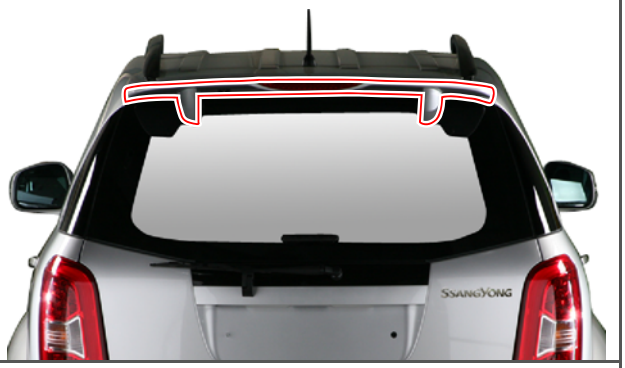
Side Outer Rear Panel	
Old	**New**
	
Changed the design of rear combination lamp	

Modification basis	
Application basis	
Affected VIN	

10) Tailgate Glass

Tailgate Glass	
Old	**New**
	
Added the window open lever for flip-up glass and changed the location of rear wiper	

11) Rear Spoiler

Rear Spoiler	
Old	**New**
	
Introduced the wing type rear spoiler	

12) Tailgate Lower Garnish

Tailgate Lower Garnish	
Old	**New**
	
Changed the design	

13) Rear Bumper

Rear Bumper
Old

New

Changed the design

Modification basis	
Application basis	
Affected VIN	

BODY DIMENSIONS

5110-01

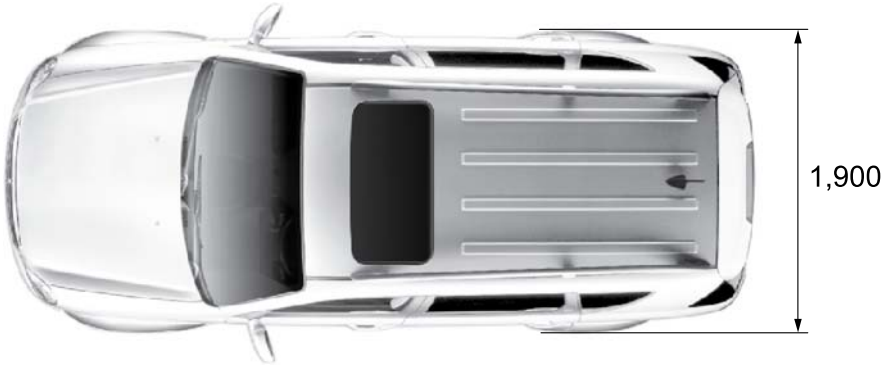
GENERAL INFORMATION

1. MAJOR EXTERNAL DIMENSIONS

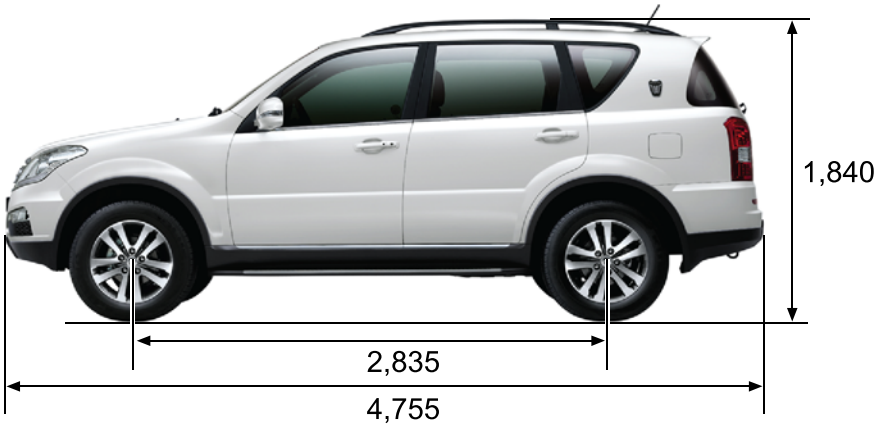
▶ **General dimensions**

Unit: mm

Top view

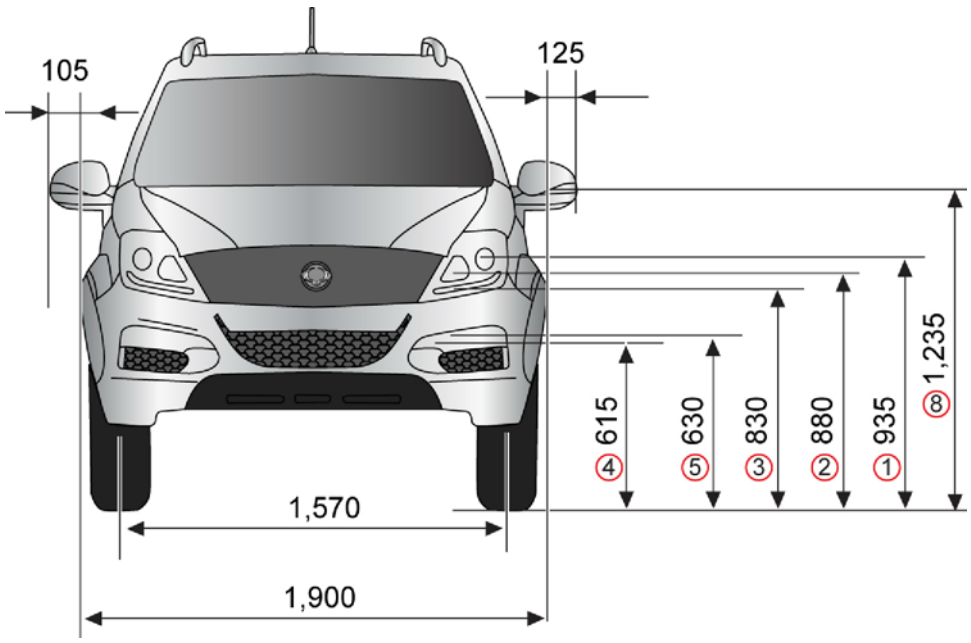


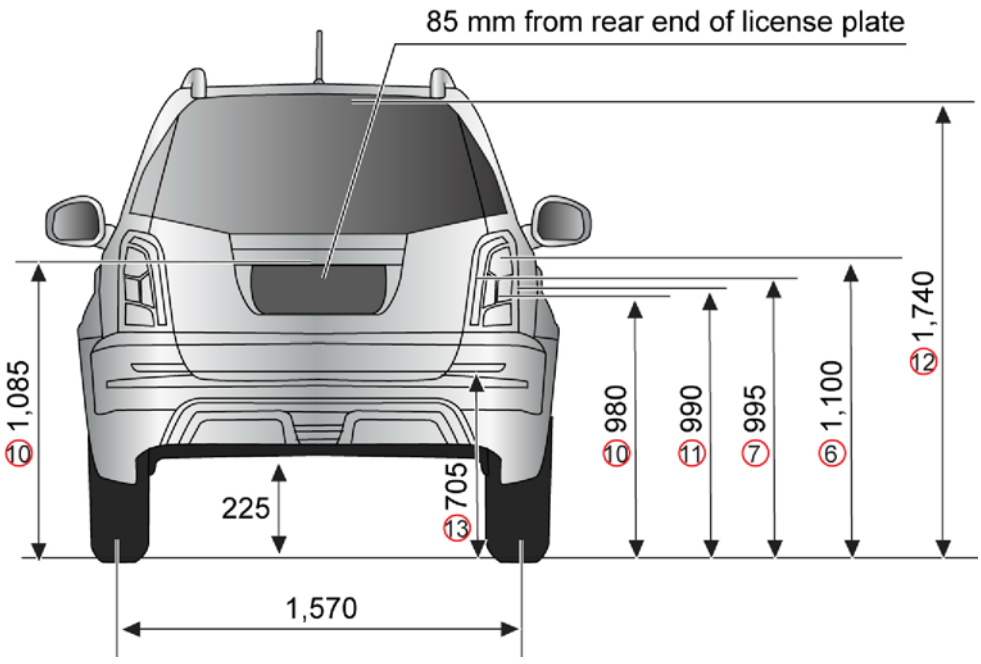
Side view



Front view	Rear view
	
1,570	1,570

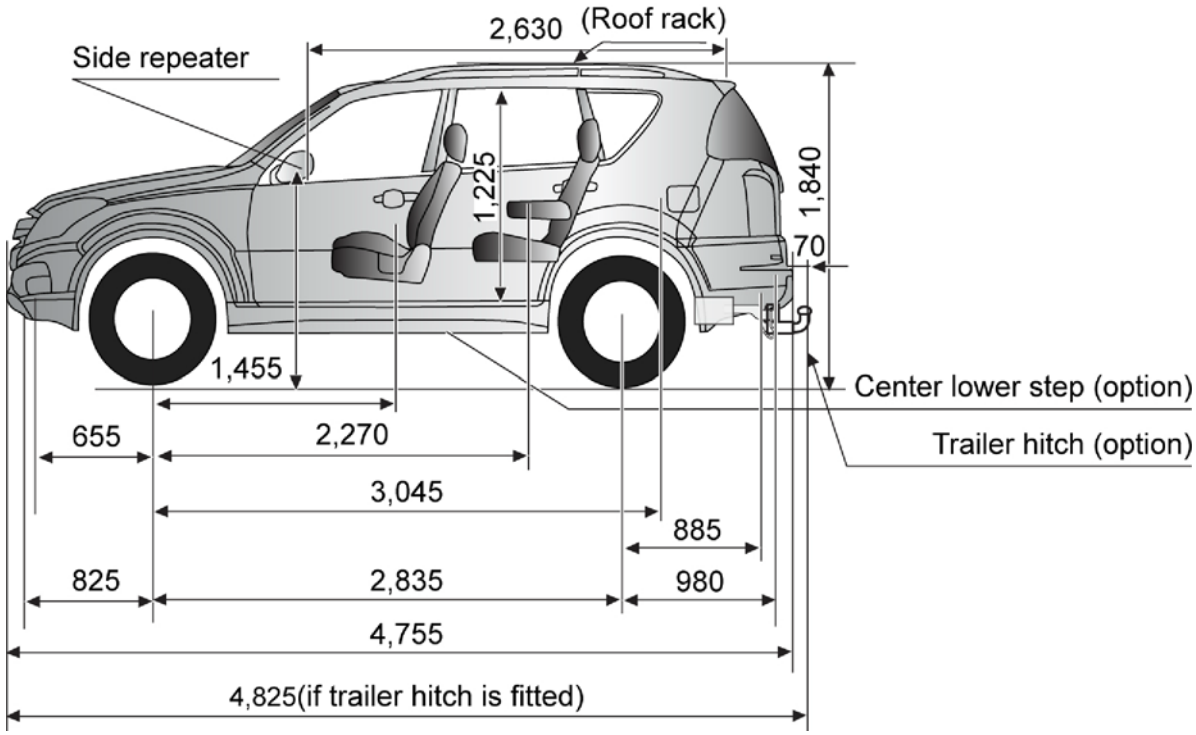
▶ Detailed dimensions

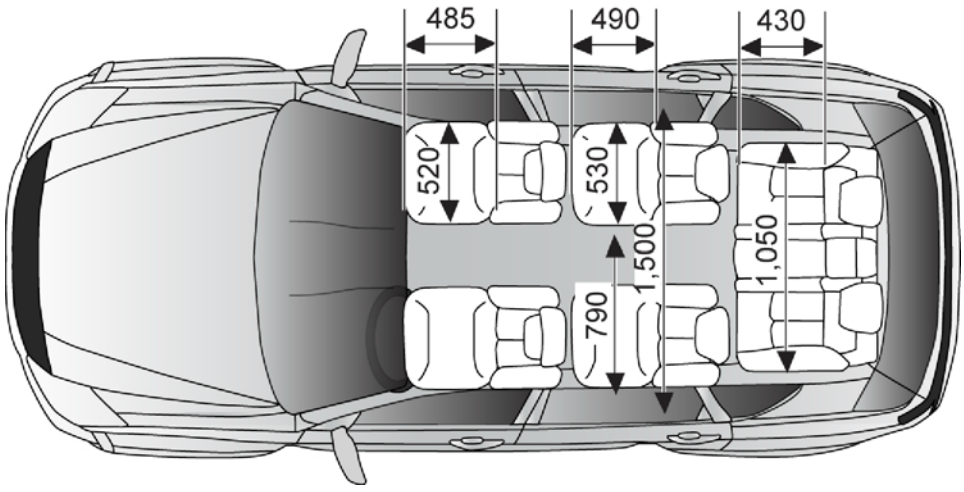




1. Head lamp (low)
2. Head lamp (high)
3. Tail lamp
4. Turn signal lamp
5. Front fog lamp
6. Stop lamp
7. Tail lamp
8. Side repeater
9. License plate lamp
10. Turn signal lamp (rear lamp)
11. Backup lamp
12. Extra stop lamp
13. Reflex reflector

Modification basis	
Application basis	
Affected VIN	

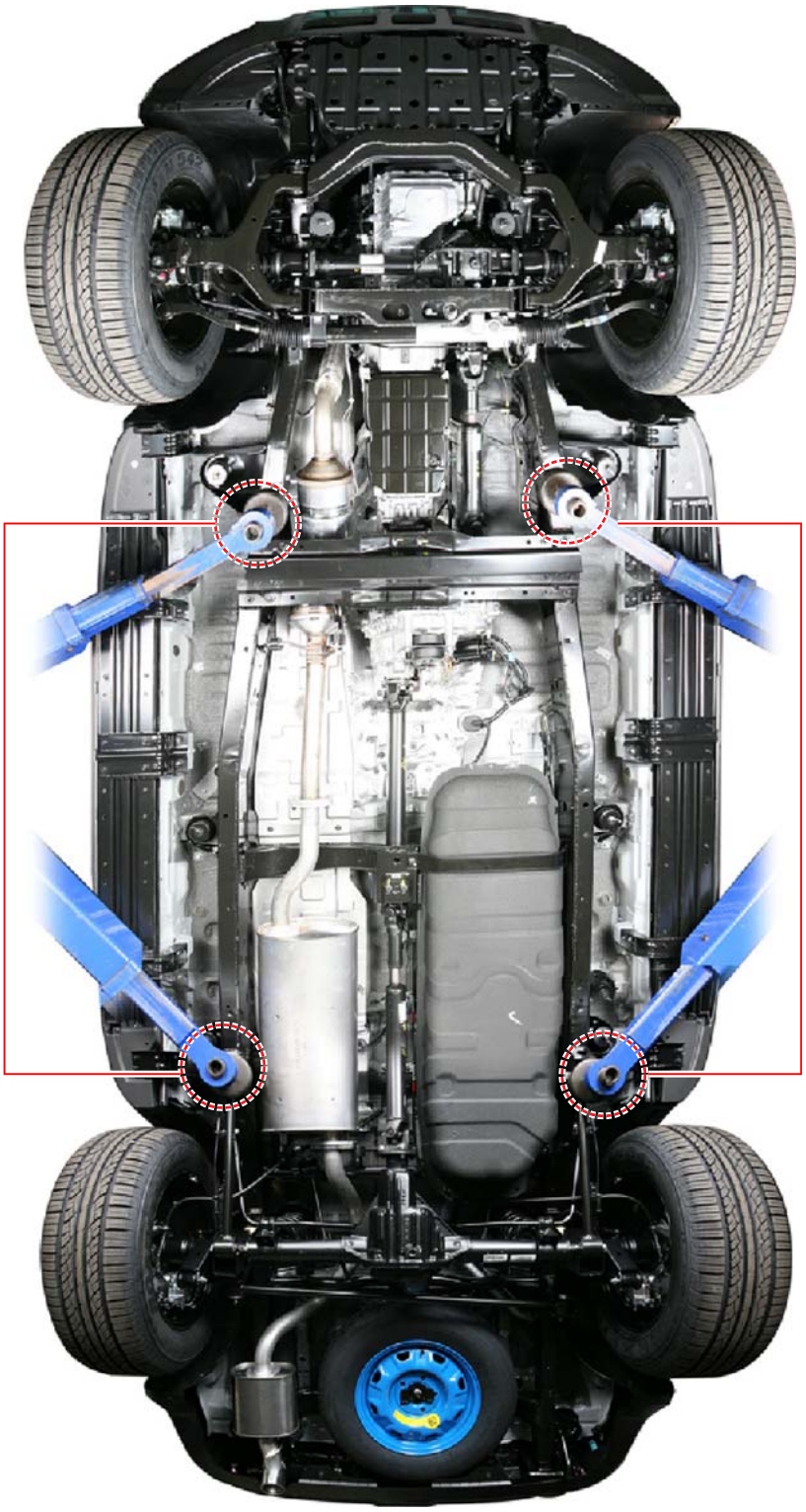




Modification basis	
Application basis	
Affected VIN	

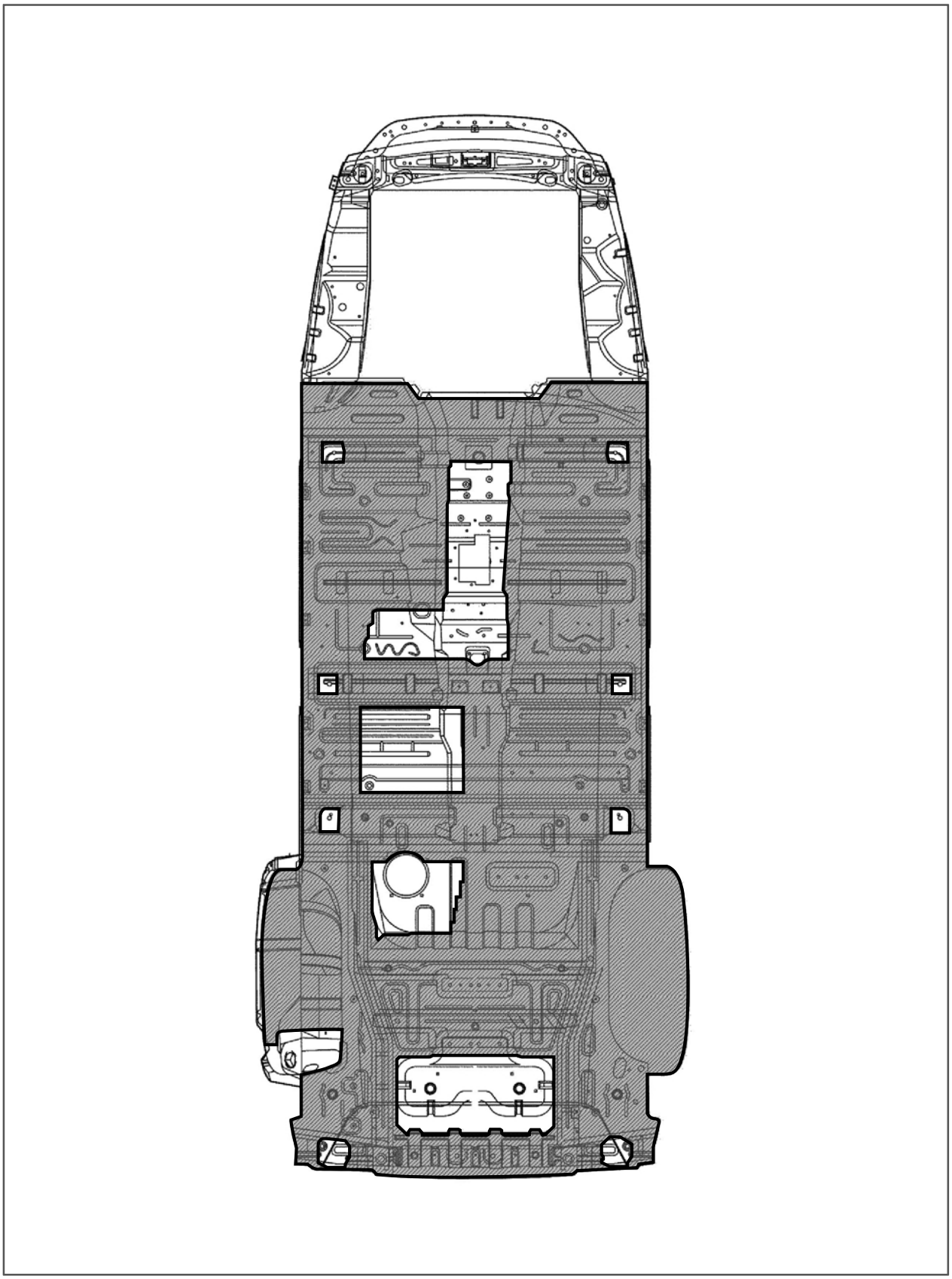
2. JACK POINTS

Front: Double wishbone Rear: 5-link



Modification basis	
Application basis	
Affected VIN	

3. UNDER COATING APPLICATIONS



Modification basis	
Application basis	
Affected VIN	