INDEX

GENERAL INFORMATION

GENERAL

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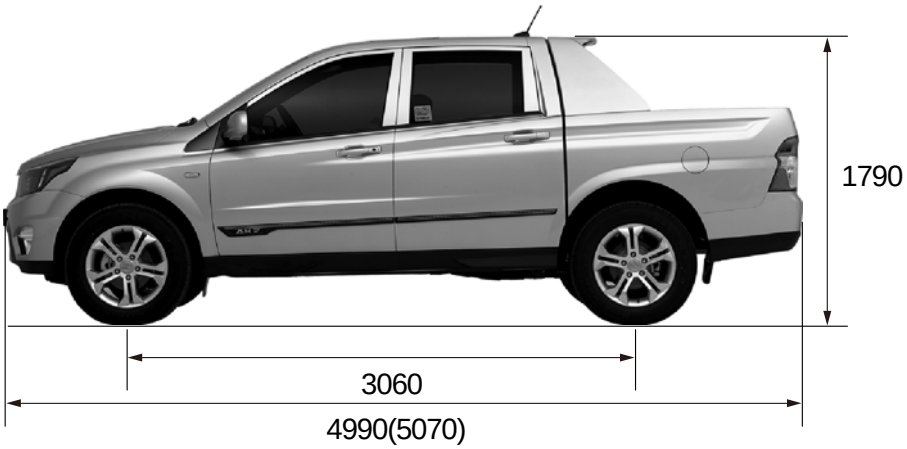
GENERAL INFORMATION

1. DIMENSIONS

Unit: mm

Top view

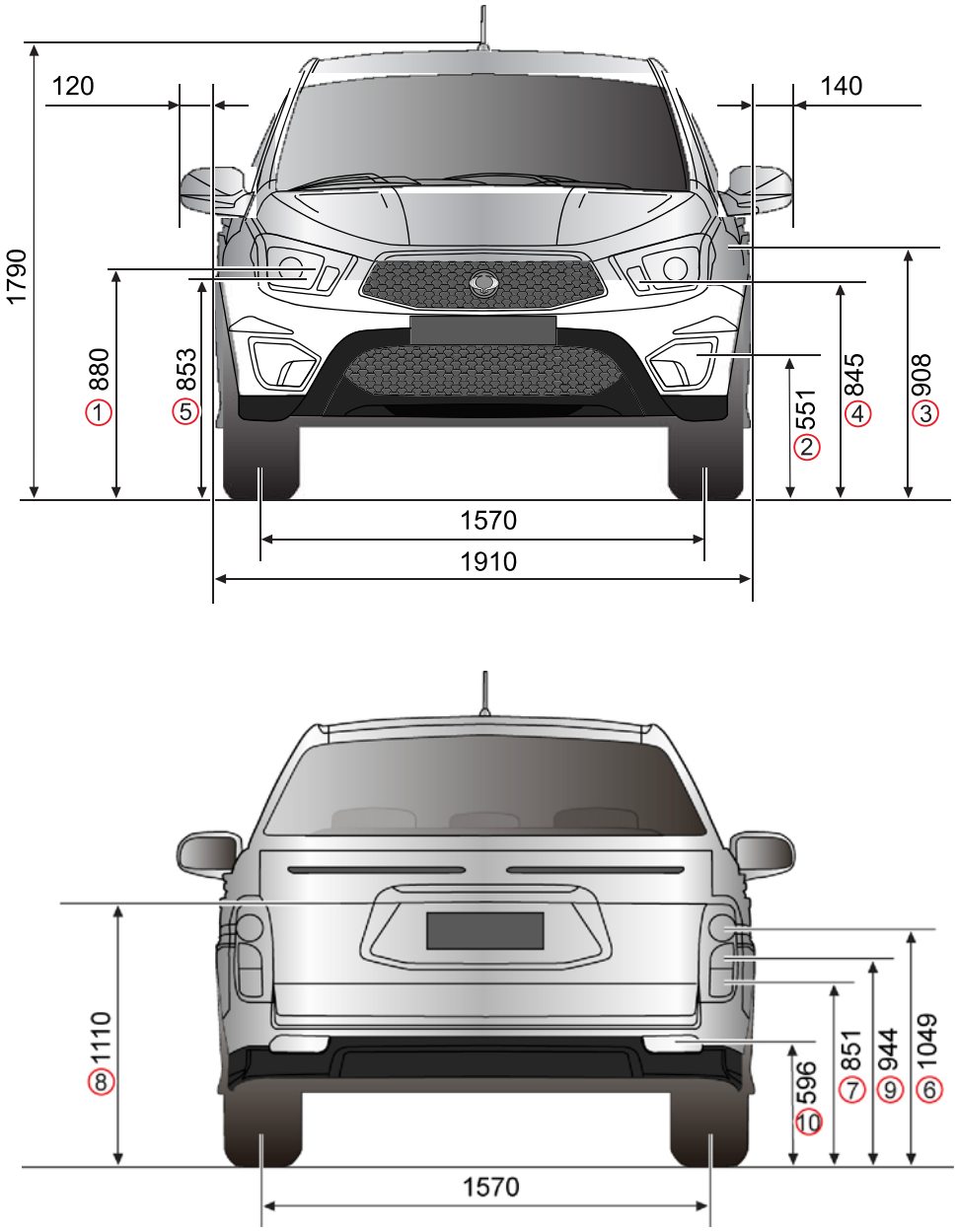
Side view



Front view	Rear view
	
1570	1570

▶ Detailed Dimensions

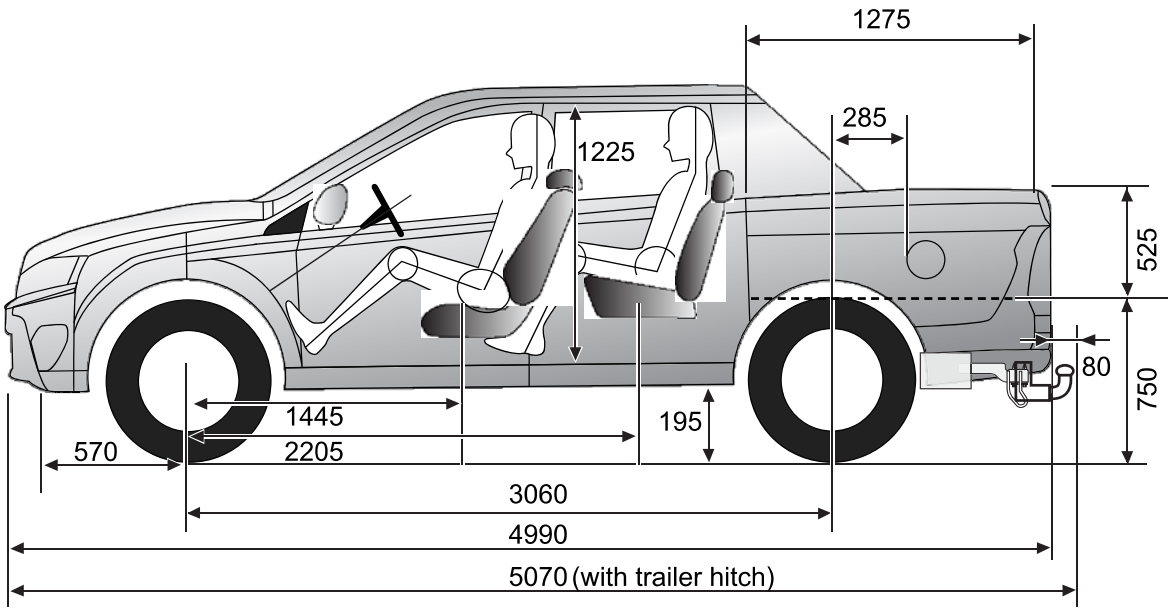
Unit:mm

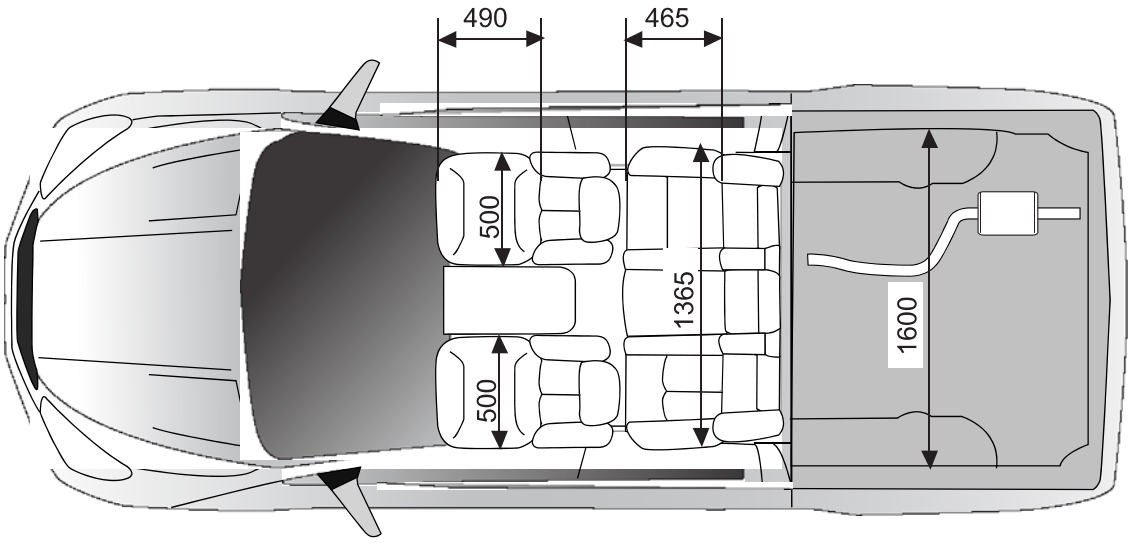


1. Headlamp
2. Front fog lamp
3. Side repeater
4. Tun signal lamp (front)
5. Position lamp
6. Stop/Tail lamp
7. Back-up lamp
8. License plate lamp
9. Turn signal lamp (rear)
10. Reflector

Modification basis	
Application basis	
Affected VIN	

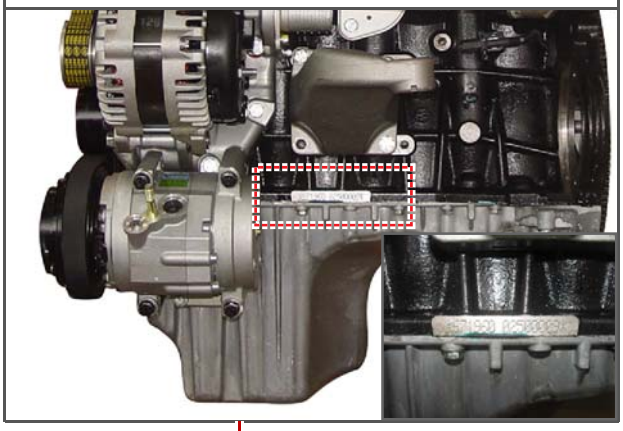
Unit:mm


1275
285
1225
525
80
750
1445
2205
570
195
3060
4990
5070 (with trailer hitch)

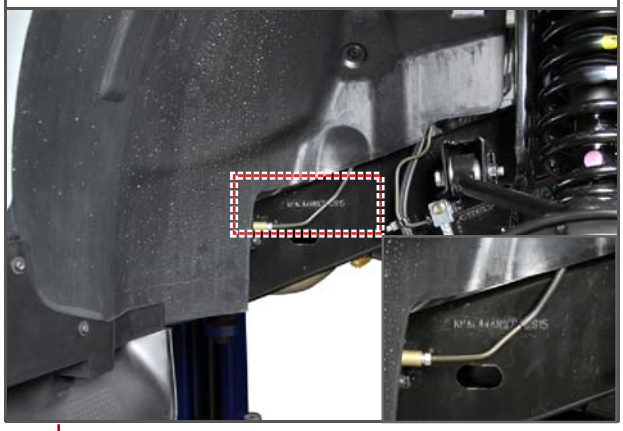

490
465
500
1365
1600
500

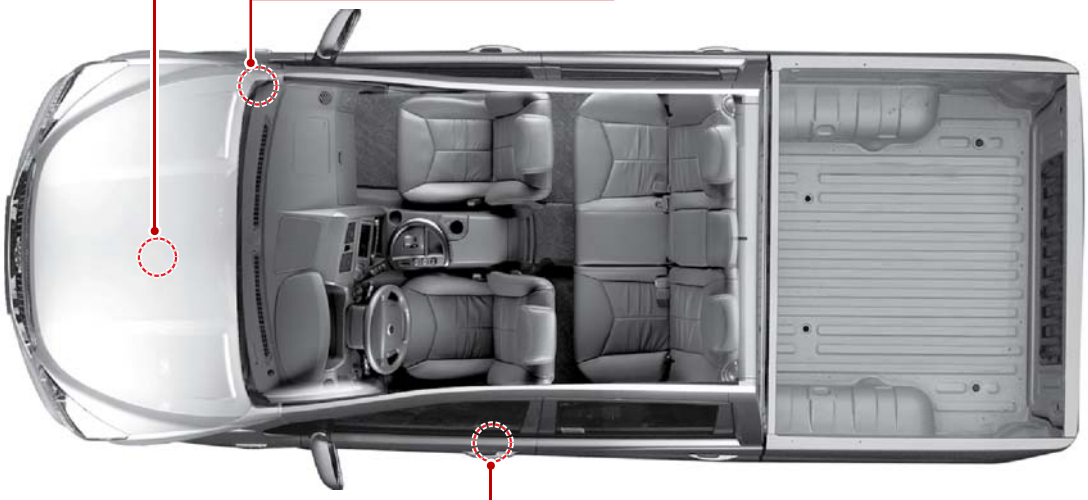
2) Vehicle Identification

- Engine number
The engine number is stamped on the cylinder block behind the A/C compressor.

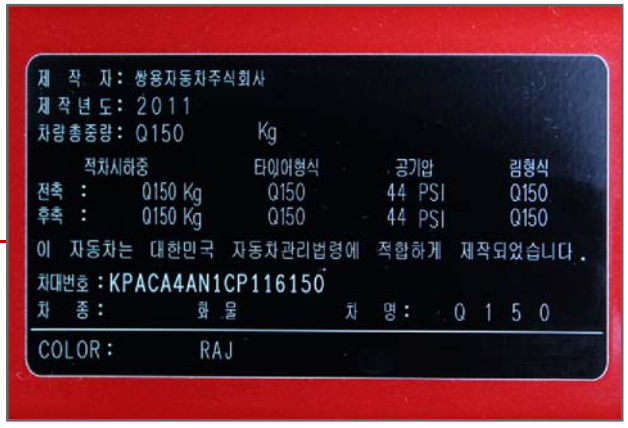


- Chassis number
The chassis number is stamped on the frame behind the front right tire.





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



Modification basis	
Application basis	
Affected VIN	

2. SPECIFICATION

1) Specifications in Unit

- ( ): Optional item
- Vehicle weight and gross vehicle weight may vary according to the options and vehicle types.

Descriptions				D20DTR	G23D
General	Overall length (mm)			4,990	←
	Overall width (mm)			1,910	←
	Overall height (mm)			1,790	←
	Gross vehicle weight (kg)		A/T	2WD: 2,640, 4WD: 2,740	–
			M/T	2WD: 2,640, 4WD: 2,740	2WD: 2,600, 4WD: 2,700
	Curb vehicle weight (kg)		A/T	2WD: 1,895 (1,935) 4WD: 1,995 (2,035)	–
			M/T	2WD: 1,873 (1,913) 4WD: 1,982 (2,022)	2WD: 1,835 (1,898) 4WD: 1,944 (1,984)
	Full load (kg)		A/T	370 (300: with trailer)	–
			M/T	383 (300: with trailer)	381 (300: with trailer)
	Fuel			Diesel	Gasoline
	Fuel tank capacity (ℓ)			75	←
	Min. turning radius (m)			5.95	←
Engine	Numbers of cylinders/Compression ratio			4 / 16.5:1	4 / 10.0:1
	Total displacement (cc)			1,998	2,295
	Camshaft arrangement			DOHC	←
	Max. power	Normal power		155 ps / 3,400 ~ 4,000 rpm	150 ps / 5,500 rpm
		Low power		141 ps / 4,000 rpm	–
	Max. torque	Normal power		360 Nm / 1,500 ~ 2,800 rpm	214 Nm / 3,500 ~ 4,600 rpm
		Low power		310 Nm / 1,800 ~ 2,700 rpm	–
	Idle speed			750 ± 20 rpm	750 ± 50 rpm
	Cooling system			Water- cooled / forced circulation	←
	Coolant capacity (ℓ)			8.5	10.5 ~ 11.0
	Lubrication type			Gear pump, forced circulation	←
	Max. oil capacity (ℓ) (when shipping)			6.0	7.9
	Turbocharger and cooling type			Turbocharger, air-cooled	–
Manual Transmission	Operating type			Floor change type	←
	Gear ratio	5-speed	1st	–	4.315
			2nd	–	2.475
			3rd	–	1.536
			4th	–	1.000
			5th	–	0.807
			Reverse	–	3.919
		6-speed	1st	4.489	–
			2nd	2.337	–
			3rd	1.350	–
			4th	1.000	–
			5th	0.784	–
			6th	0.679	–
			Reverse	4.253	–

Descriptions			D20DTR	G23D
Automatic Transmission	Model		Electronic, 6-speed	–
	Operating type		Floor change type	–
	Gear ratio	1st	3.536	–
		2nd	2.143	–
		3rd	1.478	–
		4th	1.156	–
		5th	0.866	–
		6th	0.677	–
		Reverse	3.094	–
Transfer Case	Model		Part-time	←
	Type		Planetary gear type	←
	Gear ratio	High (4H)	1.000 : 1	←
		Low (4L)	2.483 : 1	←
Clutch (M/T)	Operating type		Hydraulic type	←
	Disc type		Dry single diaphragm type	←
Power Steering	Type		Rack and pinion	←
	Steering angle	Inner	37.59°	←
		Outer	33.48°	←
Front Axle	Drive shaft type		Ball joint type	←
	Axle housing type		Build-up type	←
Rear Axle	Drive shaft type	Solid axle suspension	Semi-floating type	←
	Axle housing type		Build-up type	←
Brake	Master cylinder type		Tandem type	←
	Booster type		Vacuum assisted booster type	←
	Brake type	Front wheels	Disc type	←
		Rear wheels	Drum & DISC	←
	Parking brake		Cable type (internal expansion)	←
Suspension	Front suspension		Wishbone + coil spring	←
	Rear suspension	Solid axle suspension	5-link + coil spring	←
Air Conditioner	Refrigerant (capacity)		R-134a (650 ± 30g)	←
Electrical	Battery type / Capacity (V-AH)		MF / 12 - 90	←
	Starter capacity (V-kW)		12 - 2.2	12 - 1.2
	Alternator capacity (V-A)		12 - 120 (140*)	12 - 115
Tire	Regular tire	Front	32 psi	←
		Rear	32 psi (44 psi: when the vehicle is fully laden with luggage)	←
Wiper Blade	Driver side		22 inch	←
	Passenger side		19 inch	←

Modification basis	
Application basis	
Affected VIN	

2) Recommended Fluids and Lubricants

Descriptions			Capacity	Specifications
Engine Oil		D20DTR	≒ 6.0ℓ	Quality class: Ssangyong genuine engine oil (Approved by MB Sheet 229.51) Viscosity: MB sheet No. 224.1
		G23D	≒ 7.5ℓ	
Engine Coolant		D20DTR	≒ 8.5ℓ	Ssangyong genuine coolant Anti-Freeze SYC-1025, Anti-Freeze:Water = 50:50 ORGANIC ACID TYPE, COLOR:BLUE
		G23D	10.5~11.0ℓ	
Automatic Transmission Fluid		6 A/T	≒ 9.5ℓ	Ssangyong genuine oil (FUCHS FES 209 ATF 3292)
Manual Transmission Fluid		6-speed	≒ 2.2ℓ	Ssangyong genuine oil (HD MTF 75W/85 (SHELL) or HK MTF 75W/85(SK))
		5-speed	≒ 3.4ℓ	Ssangyong genuine oil (ATF DEXRON II)
Transfer Case Fluid			≒ 1.4ℓ	Ssangyong genuine oil (ATF DEXRON III)
Axle Oil	Front		≒ 1.4ℓ	Ssangyong genuine oil (SAE 80W/90, API GL-5)
			≒ 1.4ℓ	
	Rear	2WD	≒ 2.0ℓ	Ssangyong genuine oil (SAE 80W/90, API GL-5)
		4WD	≒ 2.0ℓ	
Brake / Clutch Fluid			As required	Ssangyong genuine oil (DOT4)
Power Steering Fluid			≒ 1.0ℓ	Ssangyong genuine oil (ATF DEXRON II or III) *TOTAL FLUIDE DA(Extreme cold condition only)
Tailgate Hinge Spring Oil			As required	Heat fluorine resistance grease (PTFE Grease, refer to KS M 2130)

WARNING

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

3) Scheduled Maintenance Services - Diesel Engine

* Use only approved Ssangyong genuine parts.

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

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

MAINTENANCE INTERVAL / MAINTENANCE ITEM	Kilometers (miles) or time in months, whichever comes first								
	x1000 km	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	I
* Engine oil & filter *1	R	R	R	R	R	R	R	R	R
(1)* (3)* (4)*	Shorten the service interval under severe conditions								
Cooling system hose & connections	I	I	I	I	I	I	I	I	I
Engine coolant (3)* (4)	Change every 200000 km or 5 years. And, inspect and replenish if necessary.								
Fuel filter (1)*	I	R	I	R	I	R	I	R	
	Drain the water from fuel filter: whenever replacing the engine oil								
Fuel line & connections	I	I	I	I	I	I	I	I	I
Air cleaner (2)*	R	R	R	R	R	R	R	R	R
	Shorten the service interval under severe conditions								

Chart Symbols:

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

*1 Check the engine oil level and leak every 3000 km (2000 miles) or before starting a long trip.

R- Replace or change.

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

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

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

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

Modification basis	
Application basis	
Affected VIN	

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

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

Chart Symbols:

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

R- Replace or change.

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

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

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

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

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

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

MAINTENANCE INTERVAL / MAINTENANCE ITEM	Kilometers (miles) or time in months, whichever comes first								
	x1000 km	20	40	60	80	100	120	140	160
	x1000 miles	12.5	25	37.5	50	62.5	75	87.5	100
	Months	12	24	36	48	60	72	84	96
CHASSIS AND BODY									
Power steering fluid & lines (3)*	I	I	I	I	I	I	I	I	
Drive shaft boots (8)*	I	I	I	I	I	I	I	I	
Seat belts, buckles & anchors	I	I	I	I	I	I	I	I	
Lubricate locks, hinges & bonnet latch	Check frequently and adjust or replace if necessary								
Wheel bearing grease	I	I	I	I	I	I	I	I	
Propeller shaft grease - Front / Rear (9)*	I	I	I	I	I	I	I	I	
Air conditioner filter (10)*	R	R	R	R	R	R	R	R	
	Shorten the service interval under severe conditions								
Tailgate hinge spring	Apply grease when you hear a noise from the tailgate. Maintenance schedule: check the hinge spring at every 20,000 km or 1 year (under severe conditions: check the hinge spring and lubricant frequently)								

Chart Symbols:

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

R- Replace or change.

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

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

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

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

(10)*Severe Conditions in Air Conditioner Filter

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

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

Chart Symbols:

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

R- Replace or change.

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

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

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

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

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

CHASSIS AND BODY

Exhaust pipes & mountings		I	I	I	I	I	I	I	I
Brake / Clutch fluid (3)*		Change every 2 years (inspect frequently)							
Parking brake / Brake pads (Front & Rear) (4)*		I	I	I	I	I	I	I	I
Brake line & connections (including booster)		I	I	I	I	I	I	I	I
Manual transmission oil (5)*					I				I
Clutch & brake pedal free play		I	I	I	I	I	I	I	I
Transfer case fluid (3)*		I	I	I	I	I	I	I	I
Axle oil	Front	I	I	I	I	R	I	I	R
	Rear	I	R	I	R	I	R	I	R
Automatic transmission fluid (6)*		Inspect every 30000 km or 12 month (But change every 60000 km under severe condition)							
Chassis & underbody bolts & nuts tight / Secure (6)*		Check frequently and adjust or replace if necessary							
Tire condition & inflation pressure		Check frequently and adjust or replace if necessary							
Wheel alignment (7)*		Inspect when abnormal condition is noted							
Steering wheel & linkage		I	I	I	I	I	I	I	I

Chart Symbols:

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

R- Replace or change.

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

(4)* More frequent maintenance is required if the vehicle is operated under any of the following conditions:

- In heavy city traffic where the outside temperature regularly reaches 32°C (90°F) or higher, or
- In hilly or moutainous terrain, or
- When doing frequent trailer towing, or
- Uses such as found in taxi, police or delivery service.

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

(6)* If vehicle is operated under severe condition: Shorten the service interval.

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

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

Modification basis	
Application basis	
Affected VIN	

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

CHASSIS AND BODY

Power steering fluid & lines (3)*	I	I	I	I	I	I	I	I
Drive shaft boots (8)*	I	I	I	I	I	I	I	I
Seat belts, buckles & anchors	I	I	I	I	I	I	I	I
Lubricate locks, hinges & bonnet latch	Check frequently and adjust or replace if necessary							
Wheel bearing grease	I	I	I	I	I	I	I	I
Propeller shaft grease - Front / Rear (9)*	I	I	I	I	I	I	I	I
Air conditioner filter (10)*	R	R	R	R	R	R	R	R
	Shorten the service interval under severe conditions							
Tailgate hinge spring	Apply grease when you hear a noise from the tailgate. Maintenance schedule: check the hinge spring at every 20,000 km or 1 year (under severe conditions: check the hinge spring and lubricant frequently)							

Chart Symbols:

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

R- Replace or change.

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

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

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

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

(10)* Severe Conditions in Air Conditioner Filter

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

5) 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.

* 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 & 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 (G23D)		-	R	-	R	-	R	-	R
Charcoal canister & vapor lines		-	-	I	-	-	I	-	-

Chart Symbols:

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

R- Replace or change.

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

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

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

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

Modification basis	
Application basis	
Affected VIN	

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

MAINTENANCE INTERVAL / MAINTENANCE ITEM		Kilometers (miles) or time in months, whichever comes first							
	x1000 km	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 15,000 km, adjust or replace as 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	I	R	I	R	I	R	I	R
	Rear	I	R	I	R	I	R	I	R
Transfer case fluid (3)*		Inspect every 15,000 km, change every 60,000 km (Frequent check of oil leak)							

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

* 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

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)*	EU	I	I	I	I	I	I	I	I
	General	Inspect every 10,000 km							
Air conditioner filter		Change every 10,000 km (The service interval should be shortened under severe conditions)							
Tailgate hinge spring		Apply grease when you hear a noise from the tailgate. Maintenance schedule: check the hinge spring at every 20,000 km or 1 year (under severe conditions: check the hinge spring and lubricant frequently)							

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

MODIFIED ITEMS

0000-00

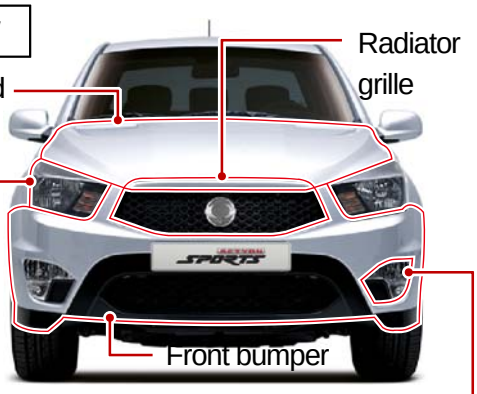
MODIFIED ITEMS

1. EXTERIOR

Front view

Old

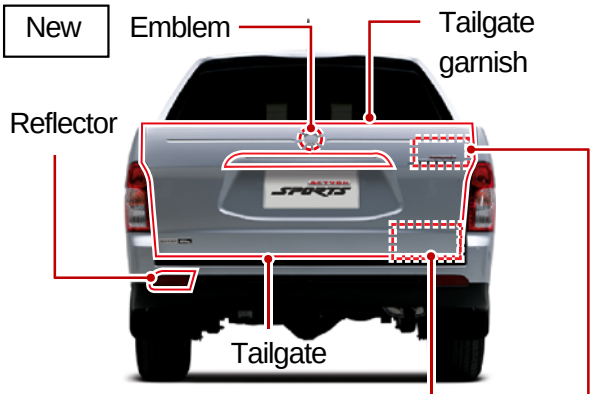
New



Rear view

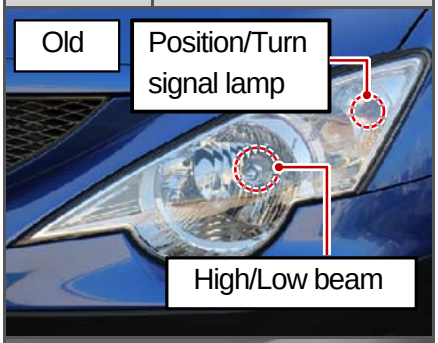
Old

New

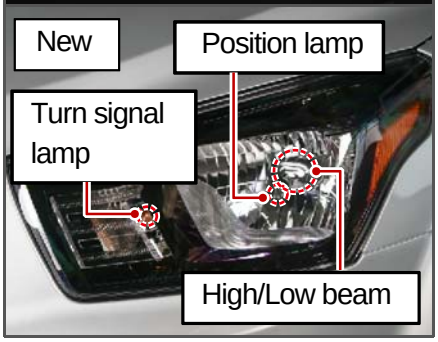


8310-01 Headlamp

Old



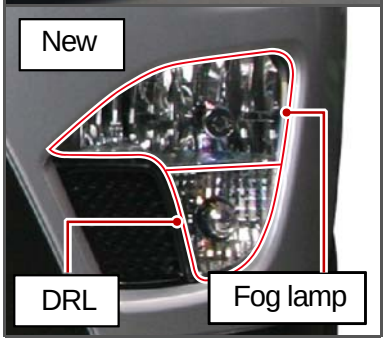
New



8310-10 Fog lamp

Old

New



6410-02 Hinge (with spring)

7950-08 Emblem

Old

New

MODIFIED ITEMS

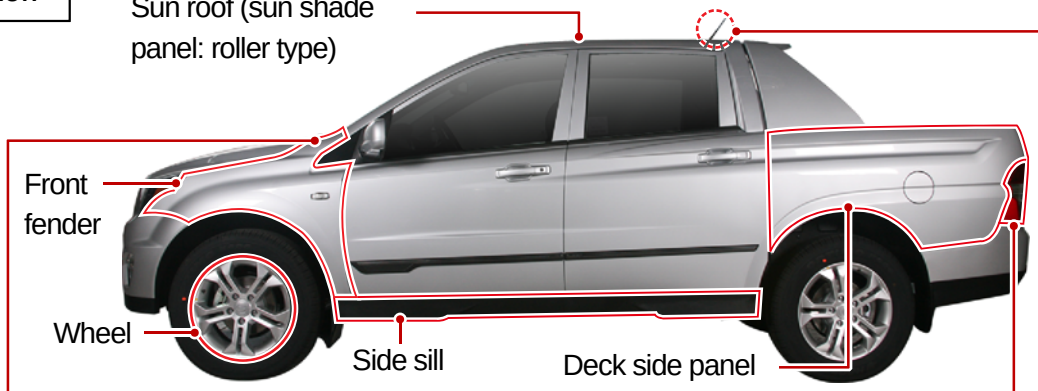
ACTYON SPORTS II 2012.01

Modification basis	
Application basis	
Affected VIN	

Side view

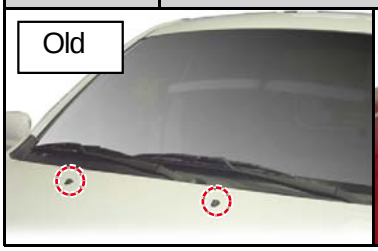
Old

New

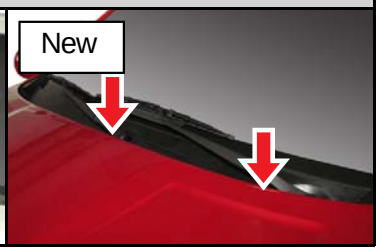


7820-22 Washer nozzle

Old

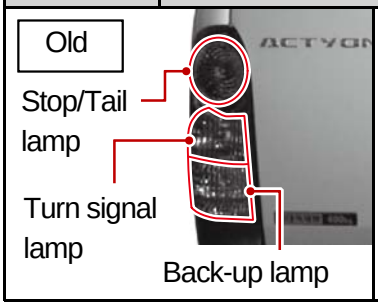


New

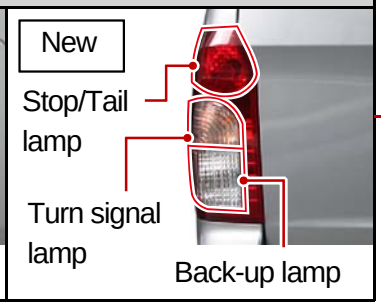


8320-01 Rear combination lamp

Old



New



8910-26 Micro pole antenna

Old

New

Modification basis	
Application basis	
Affected VIN	

2. INTERIOR

2330-01	Intercooler

Old

New

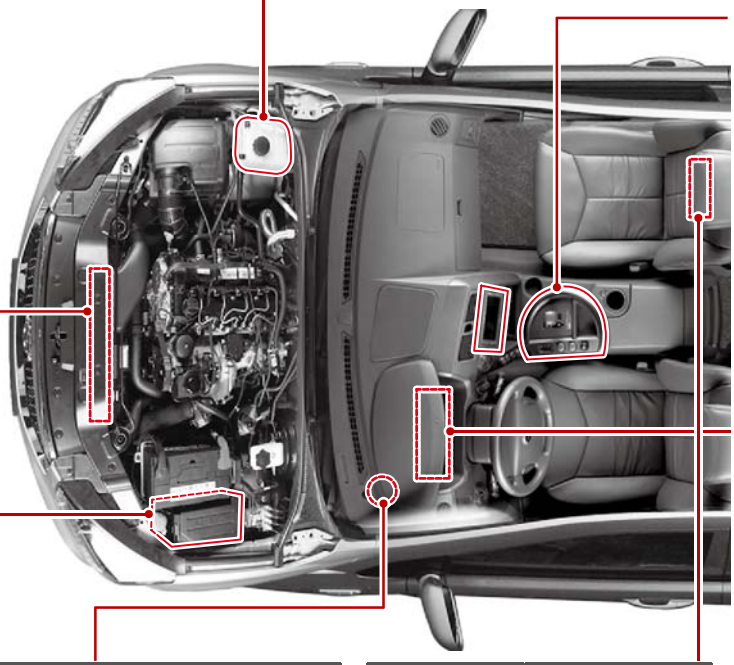
Changed the bracket and core size

2130-07	Coolant reservoir

Old

New

Changed the appearance and capacity (2.8 L)



8410-02	Fuse box in engine compartment

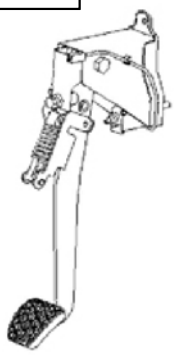
Old

New

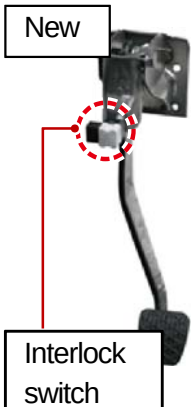
Changed the layout of relays

3030-01	Clutch pedal

Old



New



Add clutch ECU switch

7410-12	Seat logo

Old

New

Modification basis	
Application basis	
Affected VIN	

3722-02	Gear selector lever (A/T)

Old

New

7610-01	Instrument panel

Old

New

8210-01	Instrument cluster

Old

New

3710-01	Gear shift lever (M/T)

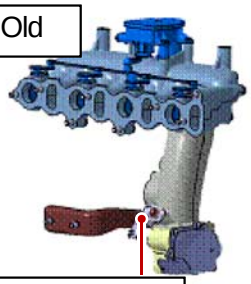
Old

New

3. MAJOR CHANGES IN ENGINE (RH)

1719-29	Intake duct and bracket

Old



T-MAP sensor

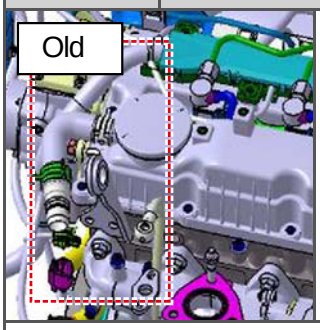
New

T-MAP sensor

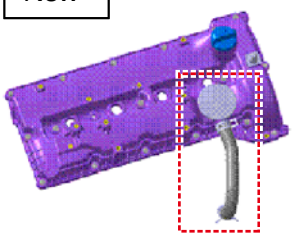
Changed intake duct, air intake direction, location of T-MAP sensor

1225-01	Cylinder head cover & PCV valve

Old



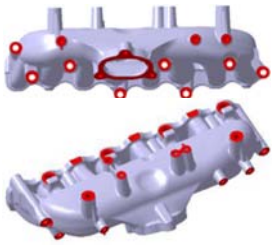
New



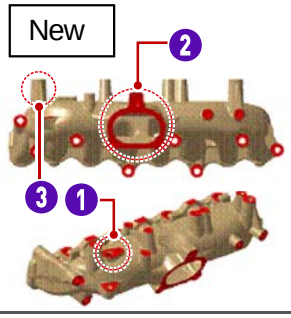
Changed the location of blow-by hose and PCV valve

1719-40	Intake manifold

Old

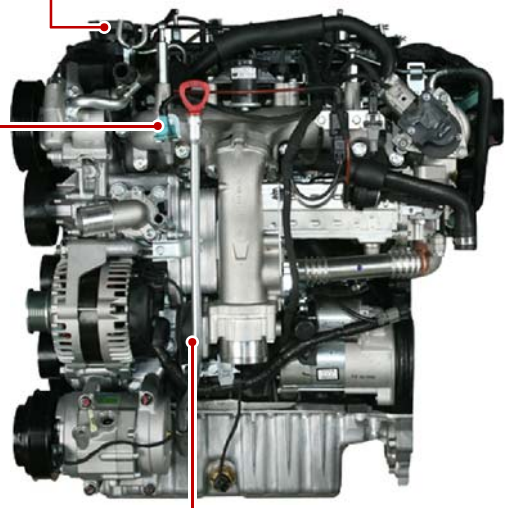


New



T-MAP sensor installing hole (1), intake duct mounting flange (2), intake duct mounting boss (3)

D20DTF (Korando C)

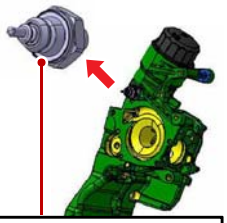


1533-30	Oil level sensor & oil pressure switch

Old

Oil level sensor

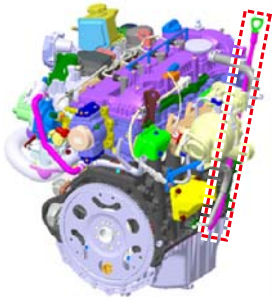
New



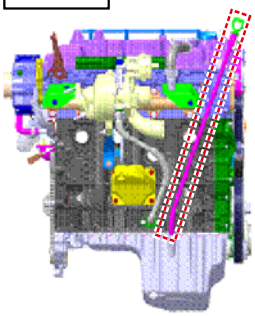
Oil pressure switch

1533-31	Oil dipstick gauge

Old



New



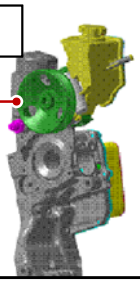
Changed the location

Modification basis	
Application basis	
Affected VIN	

1543-01	Steering pump assembly

Old

New



Power steering pump

Introduced reservoir integrated tpe steering pump

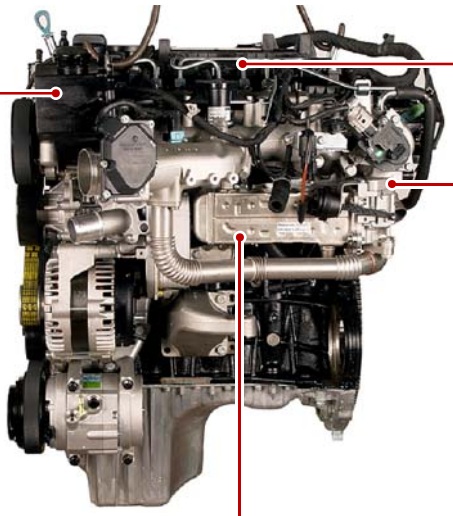
1719-09	Acoustic cover

Old

New

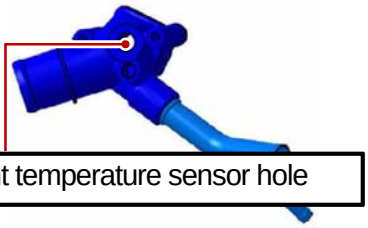
Changed the design

D20DTR (Actyon Sports)



1520-21	Coolant outlet port

Old



Coolant temperature sensor hole

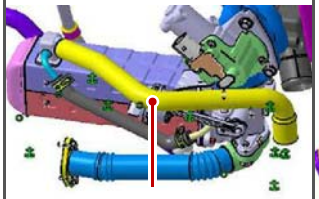
New

Coolant temperature sensor hole

Changed the location of coolant temperature sensor and deleted the coolant outlet port from turbocharger

1793-23	EGR cooler & coolant outlet hose

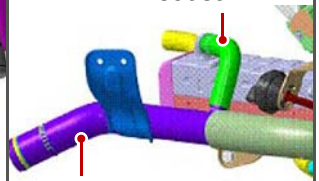
Old



EGR cooler outlet

New

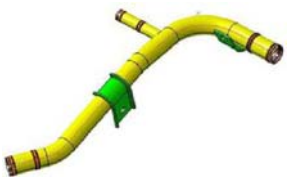
EGR cooler outlet



Coolant outlet pipe

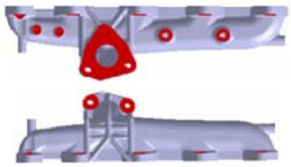
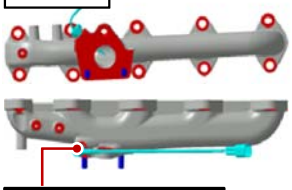
1533-30	Coolant outlet pipe

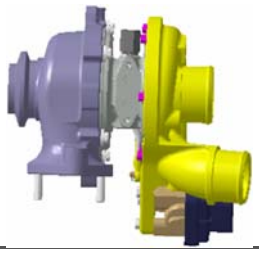
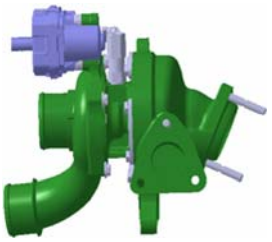
Old



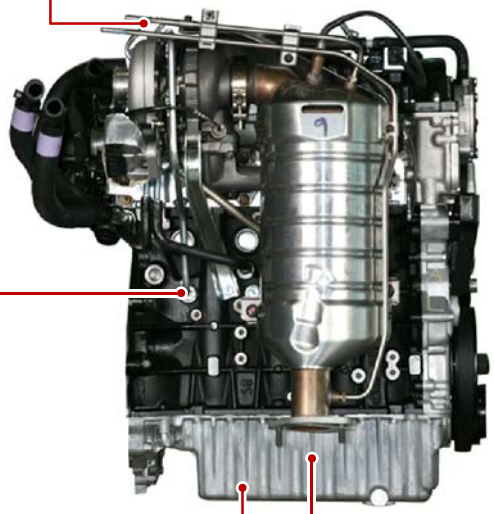
New

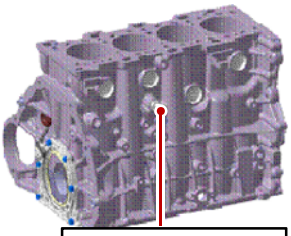
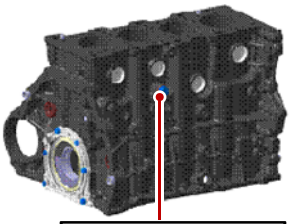
4. MAJOR CHANGES IN ENGINE (LH)

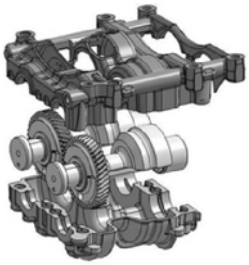
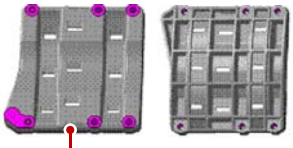
1729-01	Exhaust manifold
Old	New
	
Changed the location of mounting flange and exhaust gas temperature sensor mounting hole	

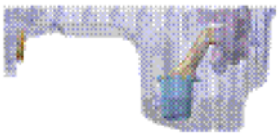
1914-01	Turbocharger
Old	New
	
Changed the cooling type (water cooling → air cooling)	

D20DTF (Korando C)



1127-01	Cylinder block
Old	New
	

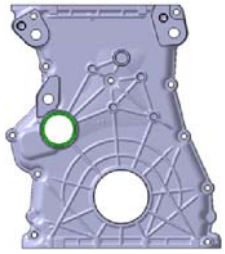
1533-48	Ladder frame
Old	New
	
Deleted MBU, introduced ladder frame	

1533-08	Oil pan
Old	New
	

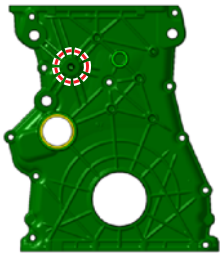
Modification basis	
Application basis	
Affected VIN	

1336-01	Timing gear case cover

Old



New

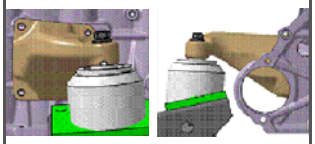


Added the belt tension mounting boss

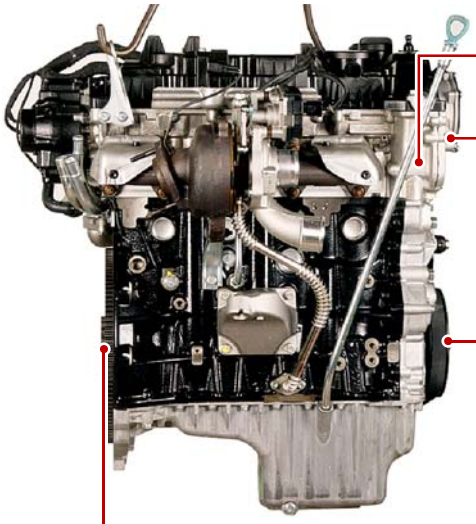
1115-02	Engine mounting bracket

Old

New

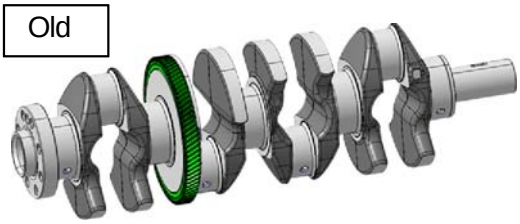


D20DTR (Actyon Sports)

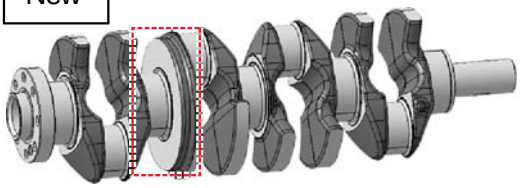


1130-01	Crankshaft assembly

Old



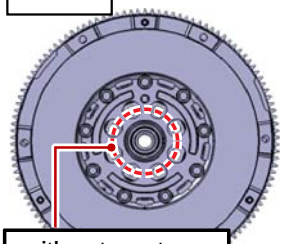
New



- Reduced weight
- Deleted ring gear

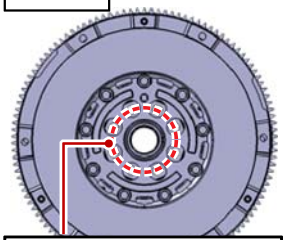
1130-13	Dual mass flywheel

Old



without center bearing

New



with center bearing

Deleted centering sleeve

1130-18	Drive plate assembly (A/T)

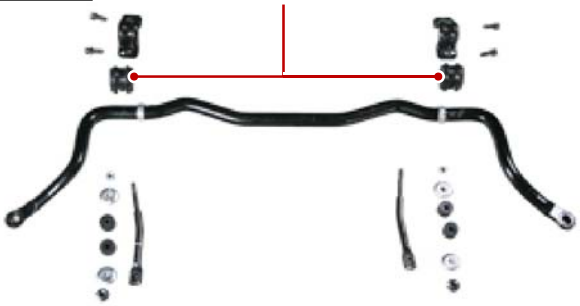
Old

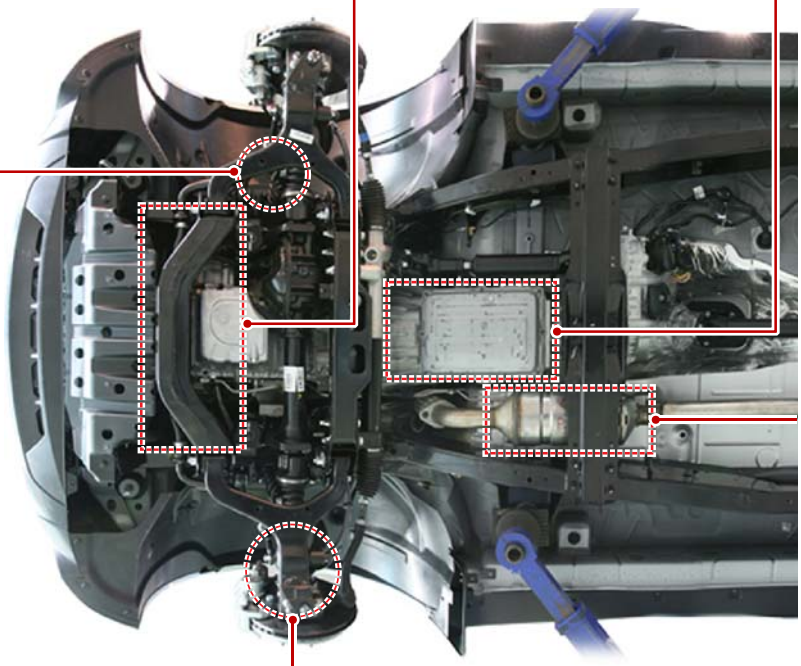
New

Changed the location of torque converter mounting hole

Modification basis	
Application basis	
Affected VIN	

5. MAJOR CHANGES IN CHASSIS

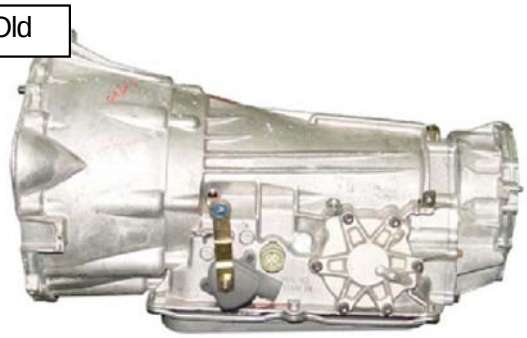
4420-01	Stabilizer bar
Old 	New Dual peak bush 
Introduced dual peak bush	

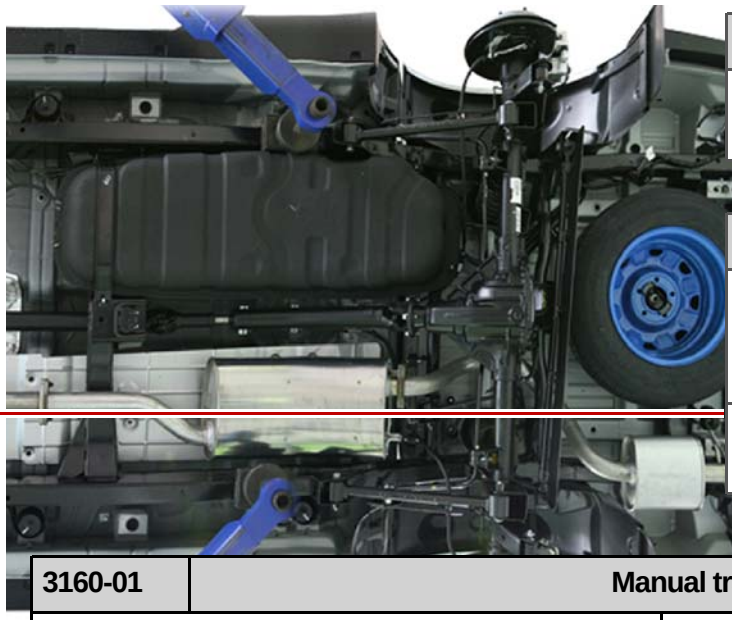


4892-01	ABS/ESP module
	
Introduced ESP system	

4411-01	Shock absorber spring
Old 	New 
Spring height and rate changed Height: 345.7 (4WD), 341.7 (2WD)	

Modification basis	
Application basis	
Affected VIN	

3680-01	Automatic transmission
Old 	New 
Changed the torque conver & torque converter housing due to new engine	



2411-01	DOC
Introduced DOC to meet EURO III or EURO IV regulation.	

2412-02	CDPF
	
Introduced CDPF to meet EURO-5 regulation	

3160-01	Manual transmission
Old 	New G23D  D20DTR 
Added 5 and 6-speed transmission	

Memo

ENGINE GENERAL

0000-00

GENERAL INFORMATION

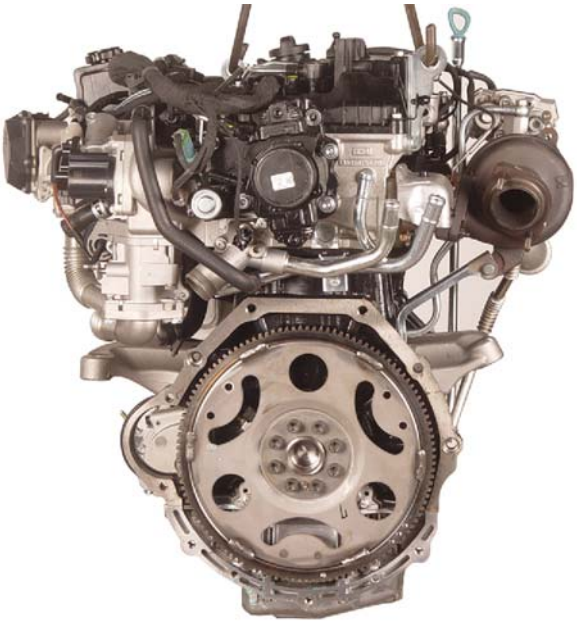
SPECIAL SERVICE TOOLS

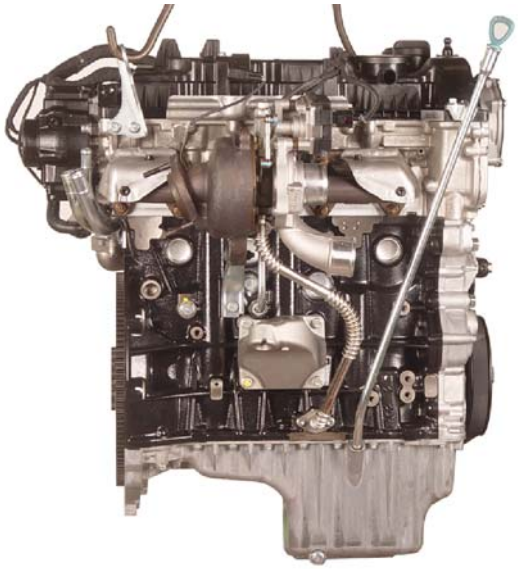
ENGINE GENERAL

0000-00

GENERAL INFORMATION

1. ENGINE LAYOUT

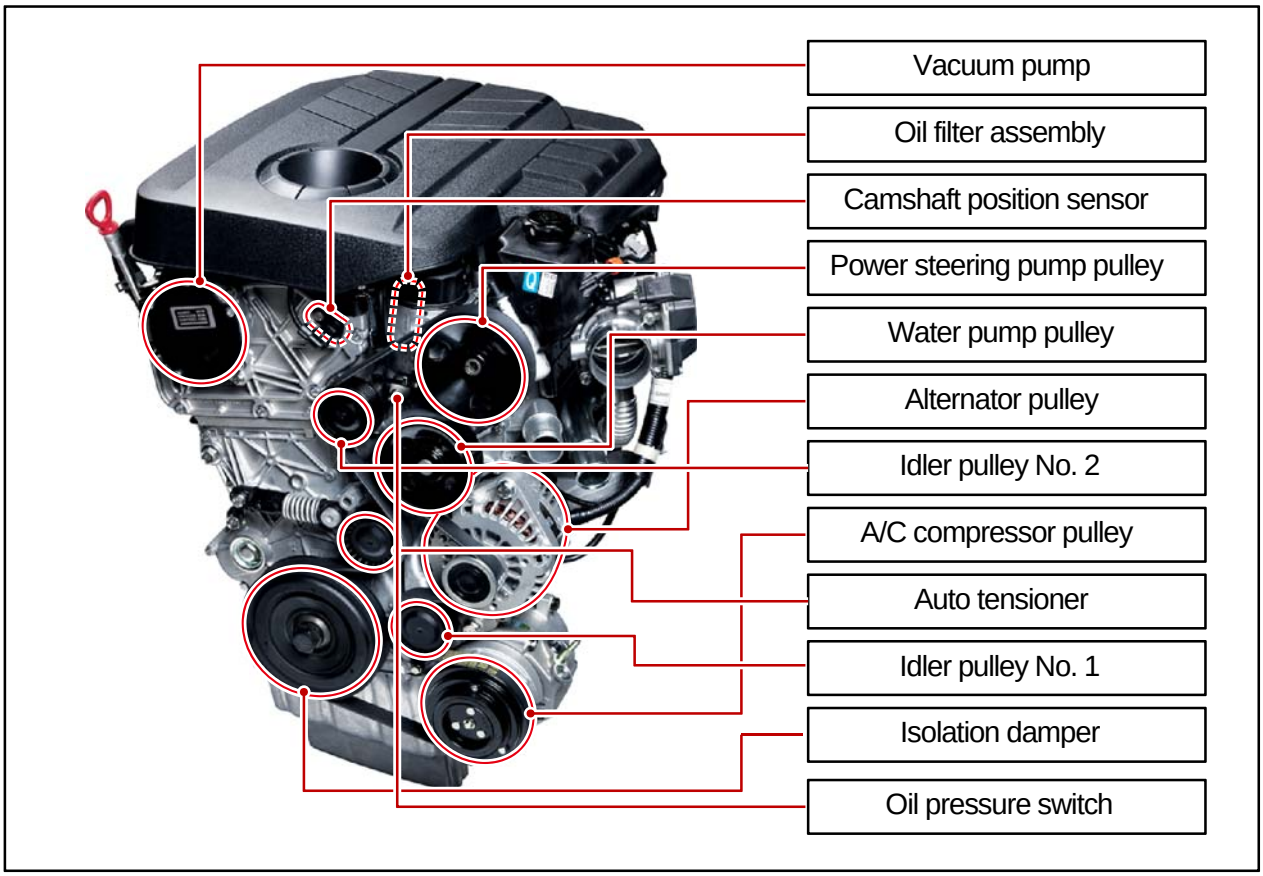
Front view	Rear view
	

Right view	Left view
	

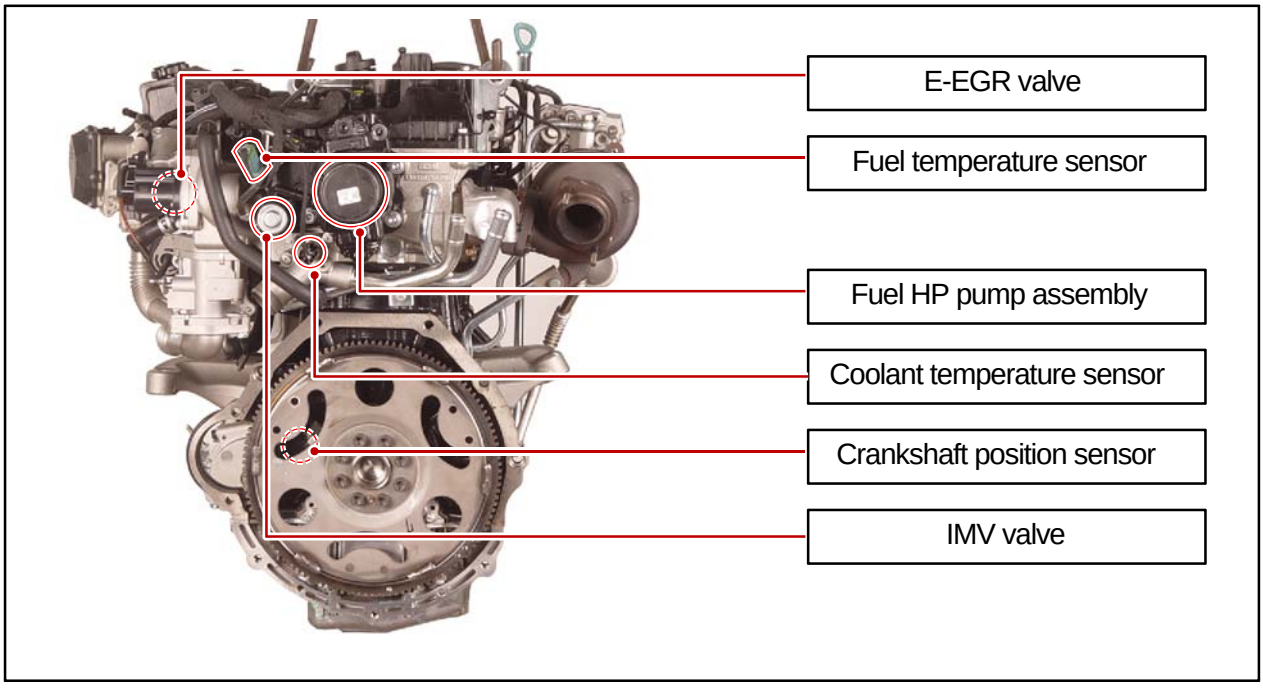
Modification basis	
Application basis	
Affected VIN	

2. MAJOR COMPONENTS

▶ **Front view**

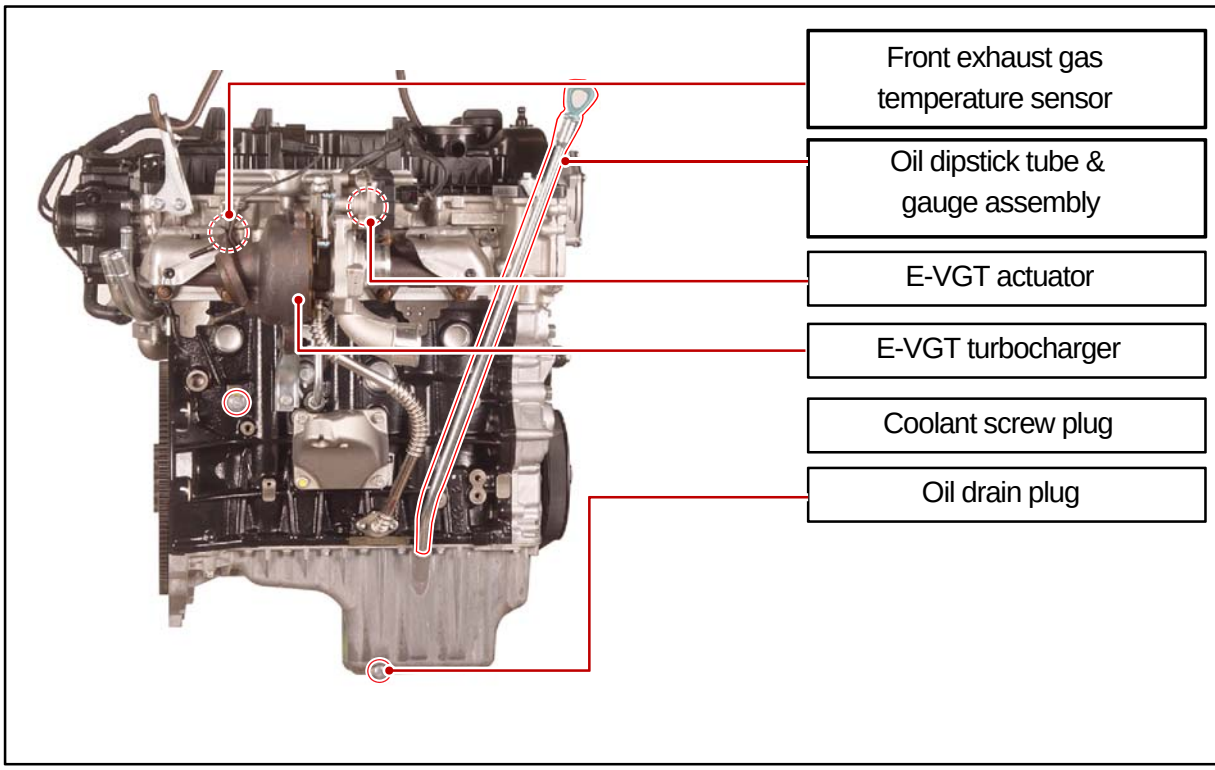


▶ **Rear view**

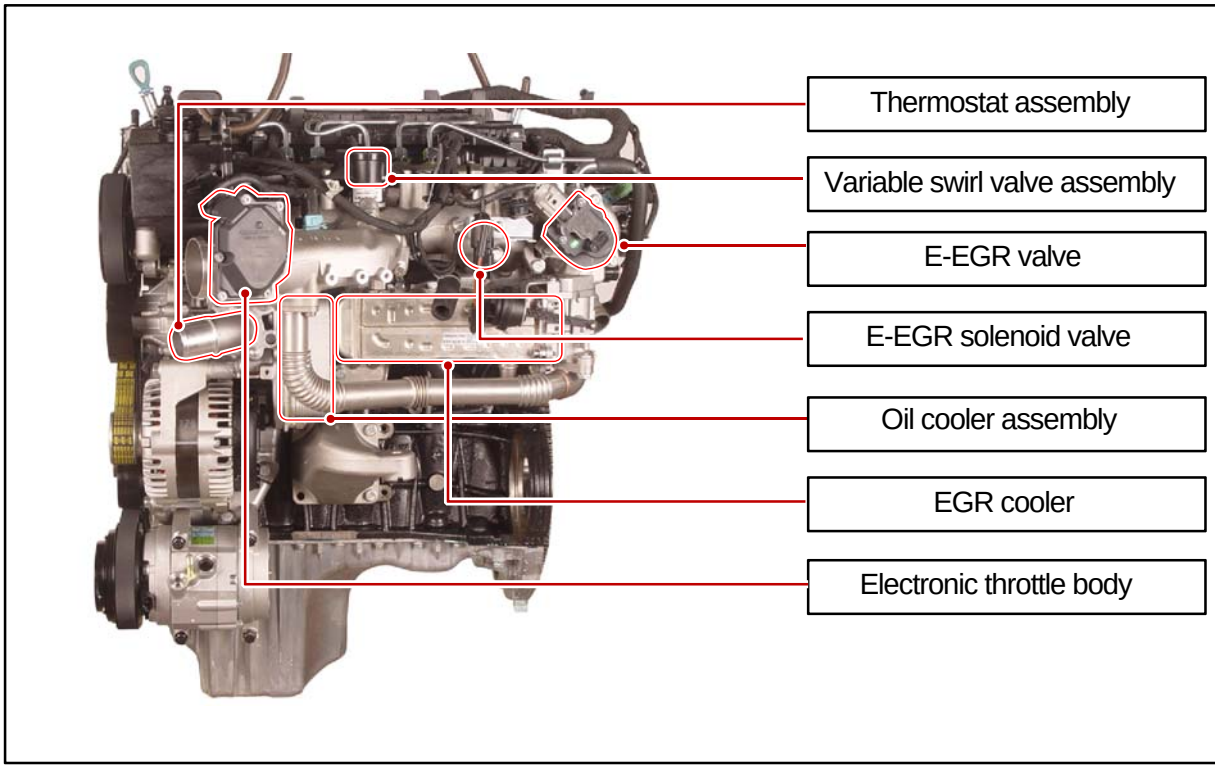


Modification basis	
Application basis	
Affected VIN	

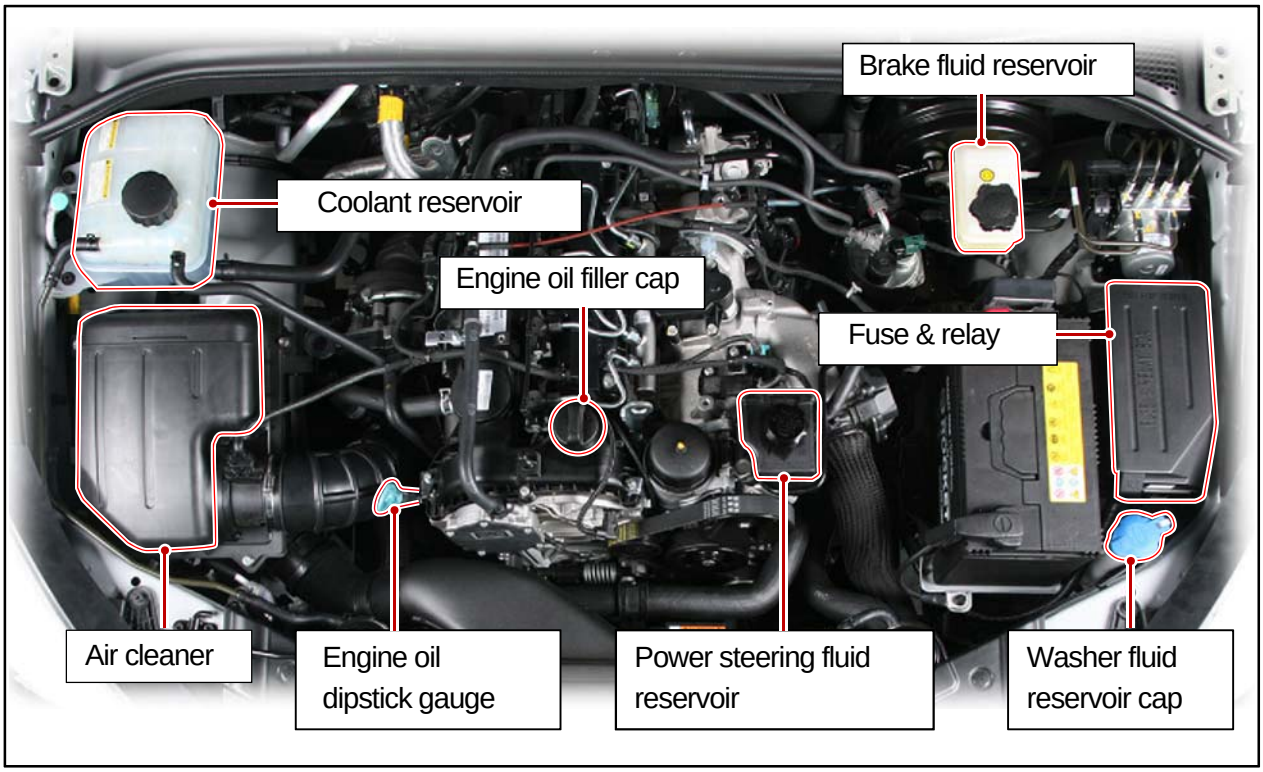
▶ Right view



▶ Left view



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)

4. CAUTION WHEN SERVICING THE ENGINE

1) Cleaness

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

2) Servicing

CAUTION

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

(1) Lifting up the vehicle

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

(2) Exhaust system

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

Modification basis	
Application basis	
Affected VIN	

(3) Cautions before service

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

(4) Lubrication system

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

(5) Tightening the fastener

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

3) Fuel and Oil System

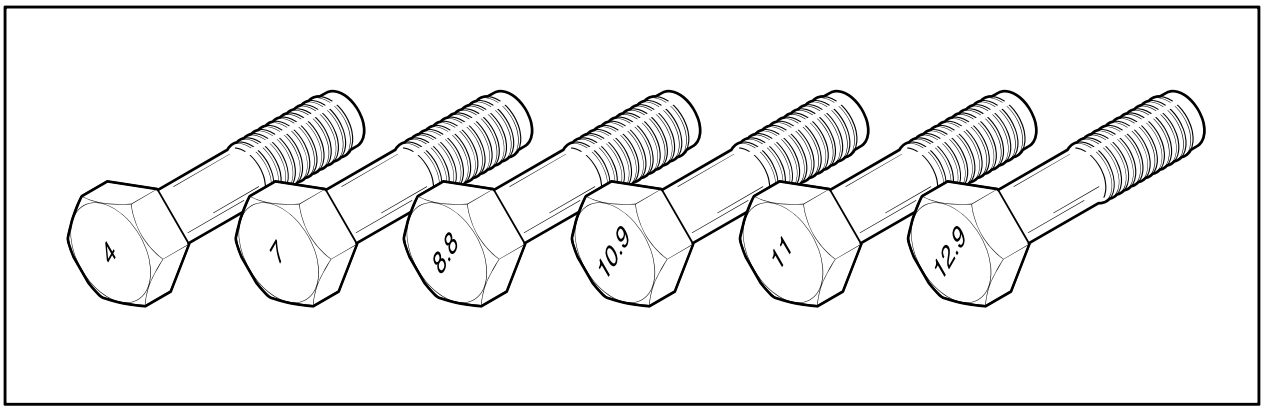
- If work on the fluid system such as fuel and oil, working area should be well ventilated and smoking should be prohibited.
- Gasket or seal on the fuel/lubrication system should be replaced with new ones and bolts and nuts should be tightened as specified.

NOTE

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

5. STANDARD BOLTS SPECIFICATIONS

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



1) Metric bolt strength is embossed on the head of each bolt. The strength of bolt can be classified as 4T, 7T, 8.8T, 10.9T, 11T and 12.9T in general.
2) Observe standard tightening torque during bolt tightening works and can adjust torque to be proper within 15 % if necessary. Try not to over max. allowable tightening torque if not required to do so.
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	

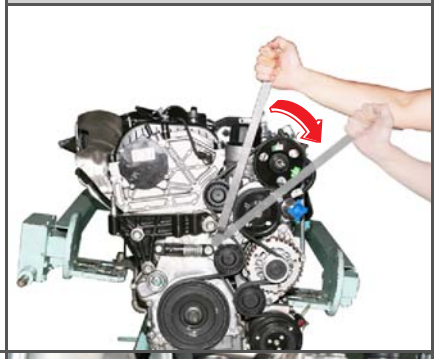
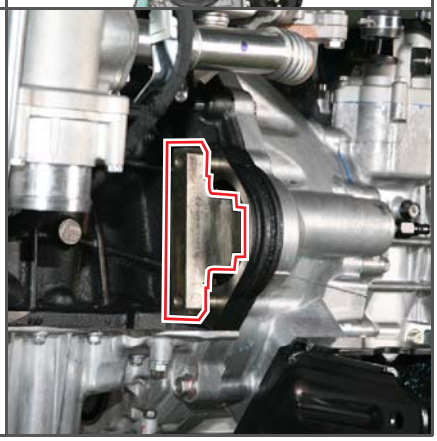
6. CODING AND INITIALIZATION

1) Engine Variant Coding

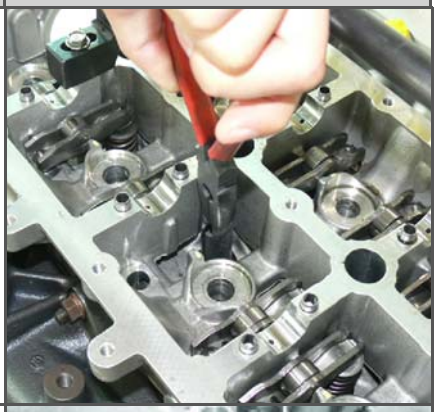
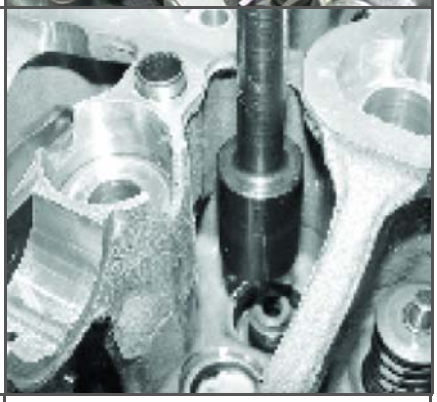
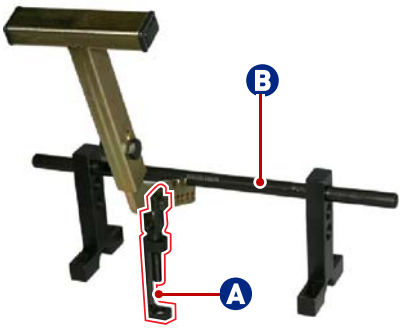
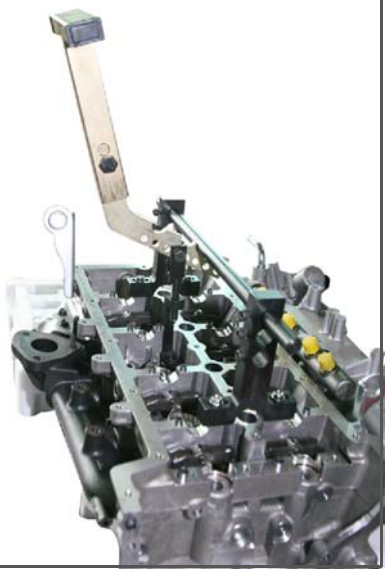
Unit	Selection	Description	Remarks
PTC auxilary heater	NO	For PTC auxilary heater equipped vehicle, select "YES".	-
	YES		YES
Glow plug	Relay (K-line)	Select "AQGS".	-
	AQGS (CAN)		AQGS (CAN)
Transmission	6-speed M/T	"DSI 6 AT" is selected automatically.	Select
	5-speed A/T (DC 5 AT)		-
	6-speed A/T (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

SPECIAL SERVICE TOOLS

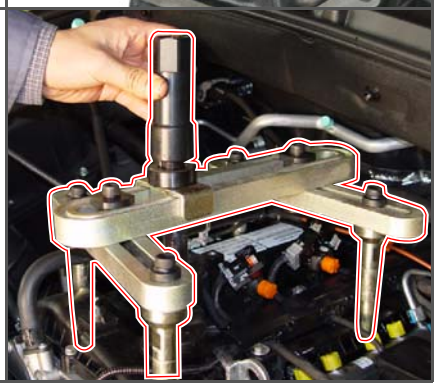
1. SPECIAL SERVICE TOOLS

Name & Part number	Tool	How to use (on vehicle)
Part number: T99410010A Name: Belt tension adjuster Use to release tension without removing belt when replacing pulley or pump.		 **How to use (on engine)** 
Part number: T9941 0010A Name: Flywheel fixing device Use to fix flywheel or drive shaft to prevent engine from rotating when removing crankshaft pulley		

Modification basis	
Application basis	
Affected VIN	

Name & Part number	Tool	How to use
Part number: Y9922 018 Name: Remover Use to remove the valve stem seal.		
Part number: Y9922 008 Name: Installer Use to install the valve stem seal.		
Part number: Y9922 082B, W9911 0230A, Y9922 018 Name: Valve spring complete Use: Used to compress the valve spring.	  Y9922 082B  W99110230A	

Modification basis	
Application basis	
Affected VIN	

Name & Part number	Tool	How to use
Part number: Y9922 012 Name: Dial gauge Use: Used to measure the protrusion of piston.		
Part number: Y9922 0172B Name: Piston install guide Use: Used to slide the piston into cylinder.		
Part number: W9911 0120A Name: Inserting guide Use: Used to install the rear crankshaft oil seal.		
Part number: T9918 0010A Name: Injector remover (Euro-V)		

Modification basis	
Application basis	
Affected VIN	

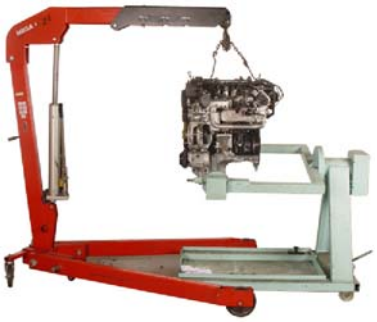
▶ Components

No	Part name	Amount	Tool
1	Injector remover set	1	
2	Main bar	1	
3	Cross bar	2	
4	Main bolt holder	1	
5	Ball bearing	1	
6	Main nut - A	1	
7	Main bolt - A	1	

No	Part name	Amount	Tool
8	Injector holder - A	1	
9	Injector - B	1	
10	Injector holder cover	1	
11	Bar holder assembly	2	
12	Support mounting bolt	4	
13	Main support	4	

Modification basis	
Application basis	
Affected VIN	

2. NORMAL EQUIPMENTS

Name & Part number	Tool	How to use
Name: Engine stand (1 tone or more) Use to fix the removed engine or engine with transmission.		
Name: Engine crane (1 tone or more) Use to move the engine module (including transmission) to working space or engine stand.		
Name: Oil pan gasket remover Use to separate oil pan and minimize damage when removing oil pan.		
Name: Torque angle gauge Use to angle-tighten correctly after torque-tightening		

Name & Part number	Tool	How to use
Name: High pressure pump gear & nut remover Use to remove & install the high pressure pump sprocket.		 
Name: Adapter & gauge Use to measure the compression pressure by inserting it into glow plug hole.		

Modification basis	
Application basis	
Affected VIN	

D20DTR ENGINE ASSEMBLY

0000-00

GENERAL INFORMATION

1. SPECIFICATION

Unit	Description		Specification	Remark
Cylinder head	Height		142.9 to 143.1 mm	-
	Flatness		below 0.1 mm	-
	Valve protrusion	Intake valve	0.1 to 0.7 mm	-
		Exhaust valve	0.1 to 0.7 mm	-
	Flatness on manifold side	Intake manifold	0.08 mm	-
		Exhaust manifold	0.08 mm	-
Connecting rod	End play		0.5 to 1.5 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	Approx. 0.7 mm	-
		Exhaust	Approx. 0.8 mm	-
	Valve recess	Intake	0.1 to 0.7 mm	-
		Exhaust		-
Cylinder block	Piston protrusion		0.541 to 0.649 mm	-
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	-

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

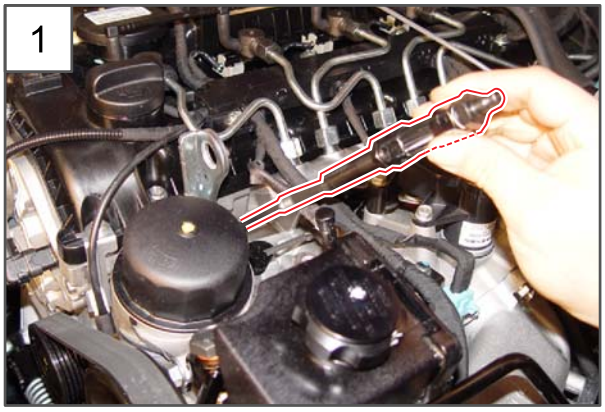
The compression pressure test is to check the conditions of internal components (piston, piston ring, intake and exhaust vale, cylinder head gasket). This test provides current engine operating status.

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%

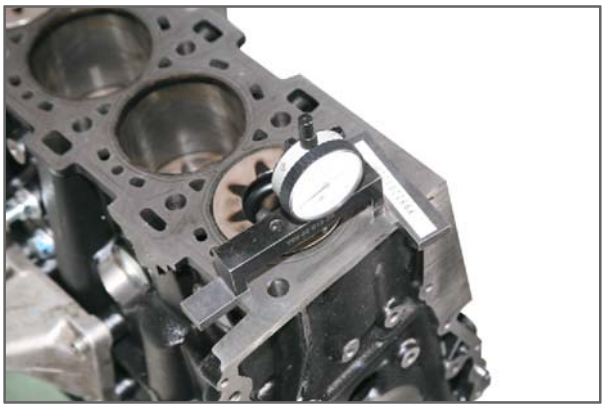
If the measured value of the compression pressure test is not within the specifications, perform the cylinder pressure leakage test.

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	0.541 to 0.649 mm

CAUTION

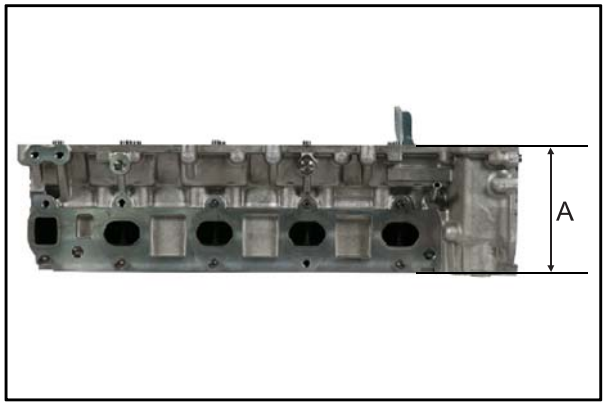
- Measure it at both ends of crankshaft.

2) Cylinder Head

(1) Cylinder head mating surface check

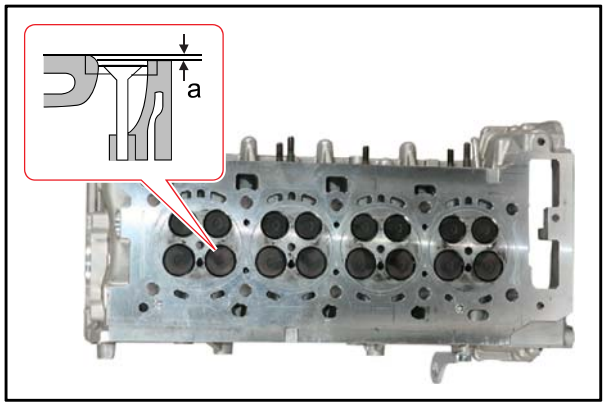
▶ **Specified value**

Total height "A"		142.9 to 143.1 mm
Minimum height after machining		142.4 mm
Flatness	**Longitudinal direction**	0.08 mm
	Transverse direction	0.0 mm
Parallel deviation of cylinder head		below 0.1 mm
Peak-to valley of surface		0.004 mm
valve recess "a"	**Intake valve**	0.1 to 0.7 mm
	Exhaust valve	0.1 to 0.7 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	0.1 to 0.7 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.

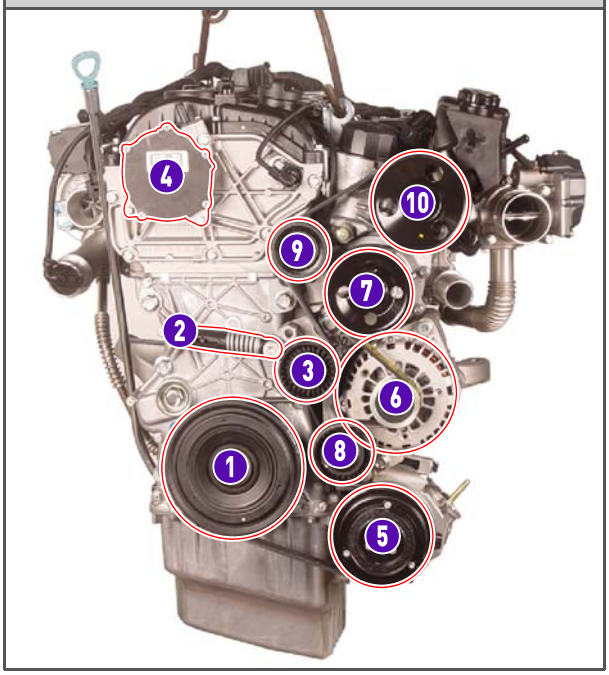
- Before work on engine and each electrical equipment, be sure to disconnect battery negative (-) terminal.
- When replacing the electric device, use only genuine part and check the conditions of connections and grounds. Loosened connection or ground make cause a fire and personal injury.

OVERVIEW AND OPERATING PROCESS

1. BELT LAYOUT

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

▶ Components

D20DTR Engine


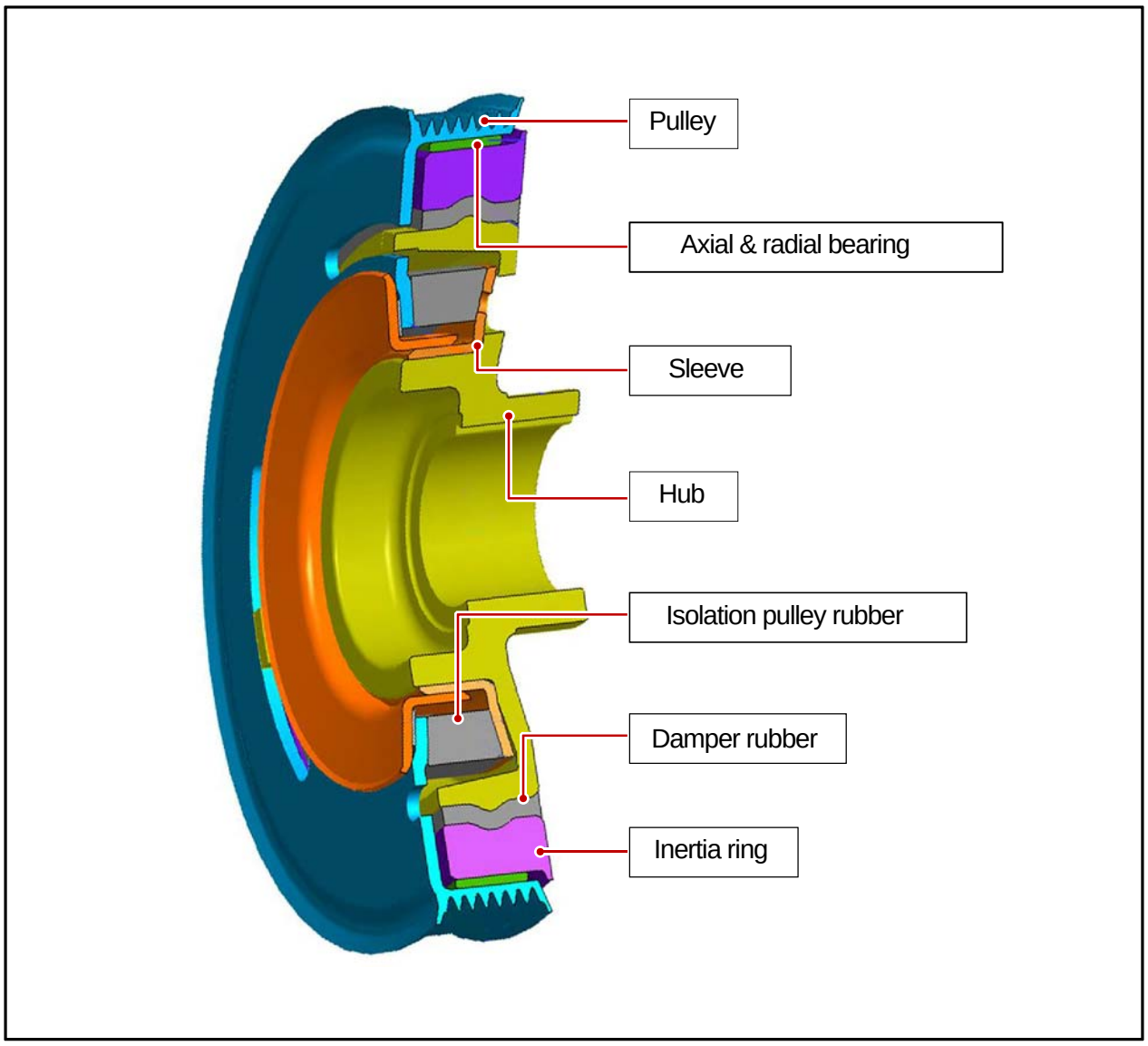
	HPS (Hydraulic Power Steering)
1	Crankshaft pulley (DDU)
2	Auto tensioner
3	Tensioner pulley
4	Vacuum pump
5	A/C compressor pulley
6	Alternator pulley
7	Water pump pulley
8	Idle pulley #1
9	Idle pulley #2
10	Power steering pump pulley

1) Crankshaft Pulley (Isolation Damper)

(1) Overview

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

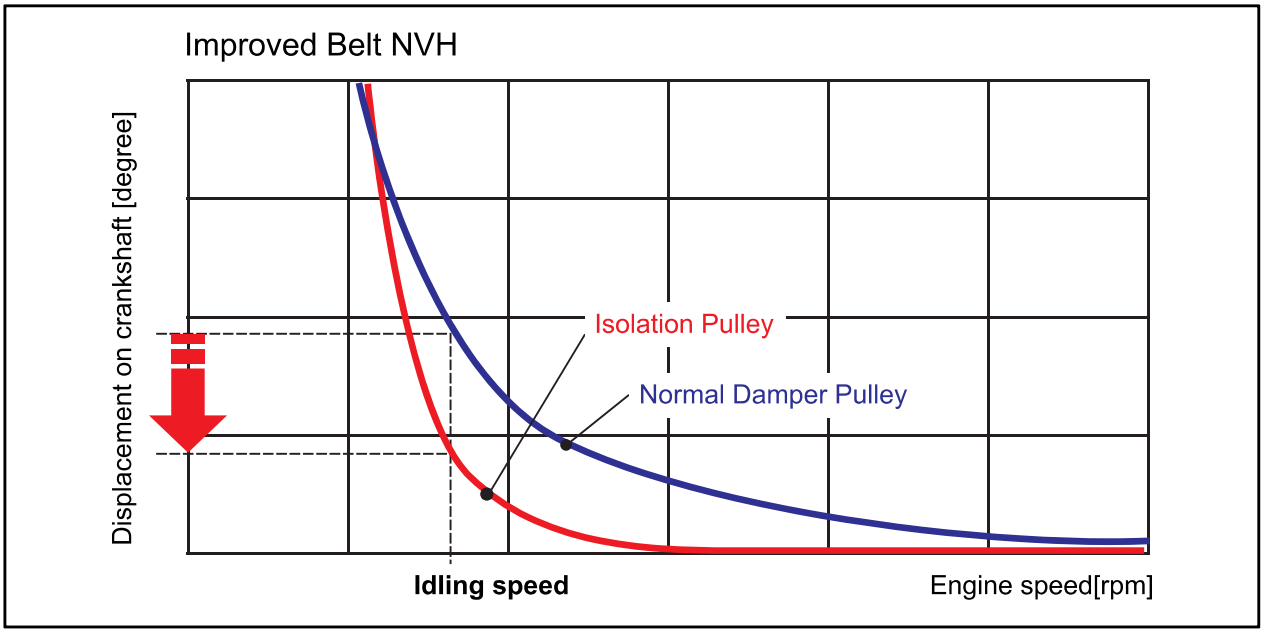
(2) Sectional drawing



Modification basis	
Application basis	
Affected VIN	

(3) Features

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

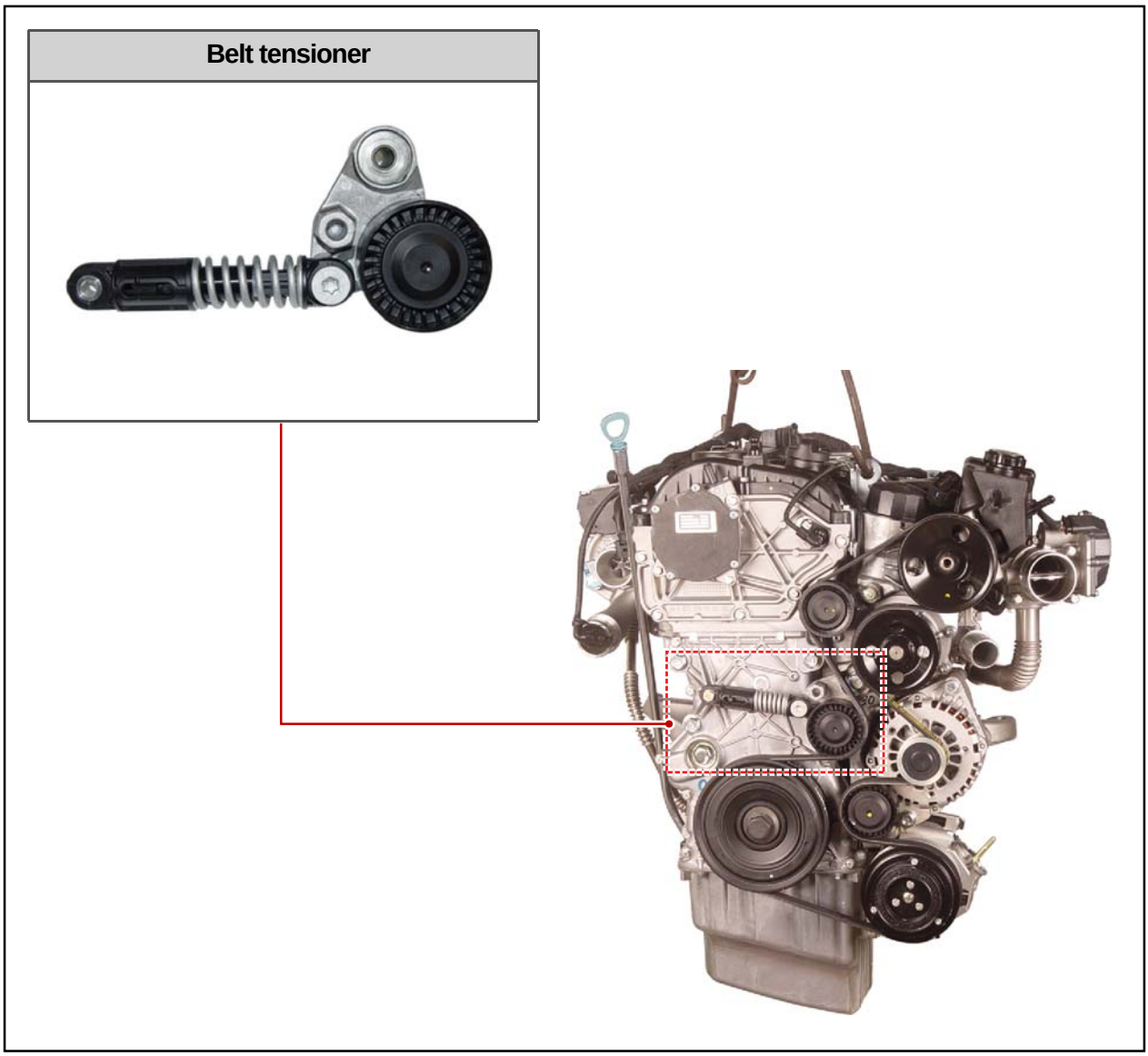


2) Belt Tensioner

(1) Overview

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

(2) Location



Modification basis	
Application basis	
Affected VIN	

2. VACUUM PUMP

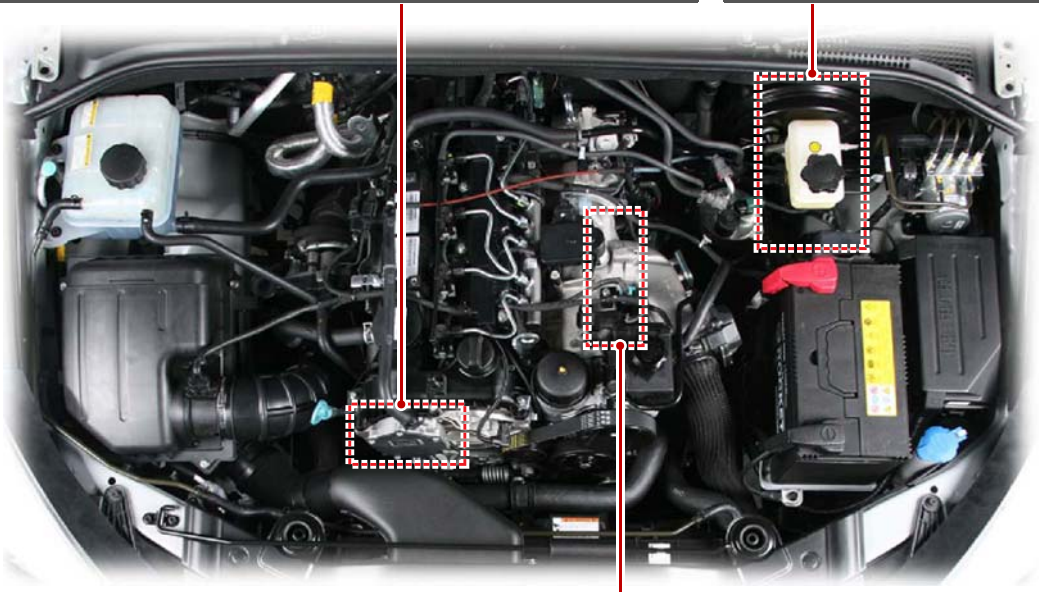
Vacuum pump generates the vacuum pressure and supplies it to EGR cooler bypass solenoid. This pump is single vane type and displacement is 210 cc/rev. The lubrication oil is supplied through the hole in hollow shaft.

▶ Components

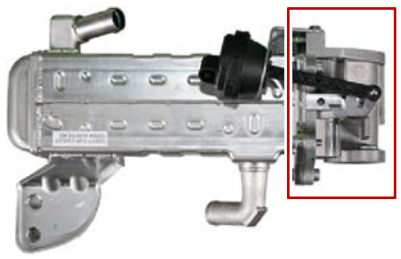
Vacuum pump

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

Brake booster and naster cylinder

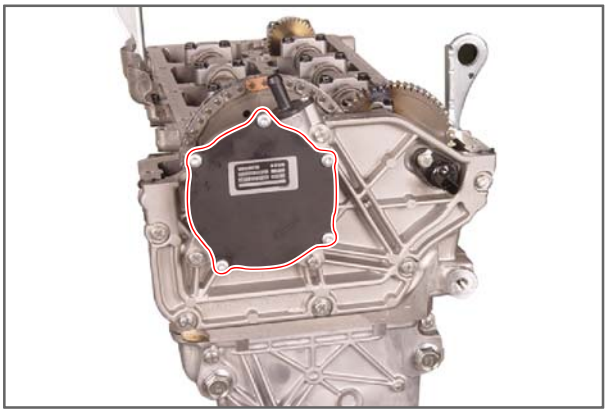


EGR cooler bypass valve



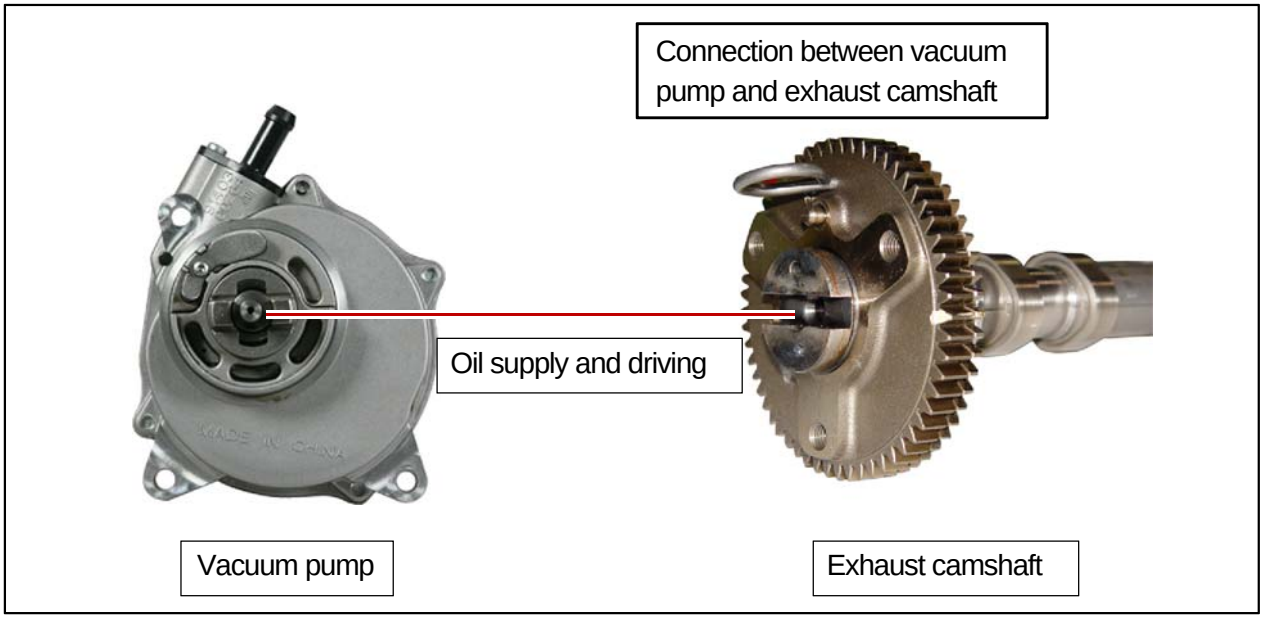
This valve is controlled by ECU. When the engine is cooled, the exhaust gas goes to combustion chamber without passing through EGR cooler because the valve is closed by vacuum pressure.

1) Location



2) Operation

The vacuum pump is engaged to the exhaust camshaft.



Modification basis	
Application basis	
Affected VIN	

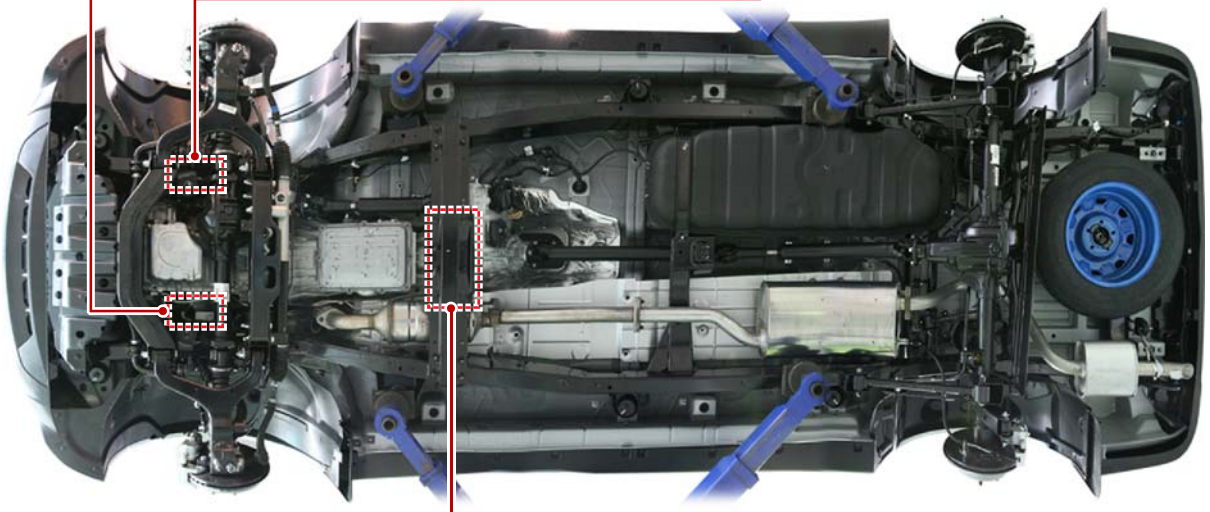
3. ENGINE MOUNTING

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

▶ **Components**

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

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



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

1) Functions

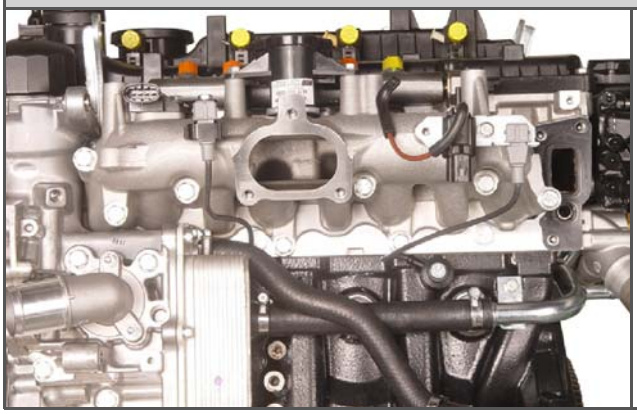
Appearance	Type and function
Front mounting insulator (Right side) 	Type: Rubber mounting Function: Supports the torque reaction
Front mounting insulator (Left side) 	Type: Rubber mounting Function: Supports the torque reaction
Rear mounting insulato 	Type: Rubber mounting Function: Supports the powertrain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

4. INTAKE/EXHAUST MANIFOLD

1) Intake Manifold

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

▶ **Components**

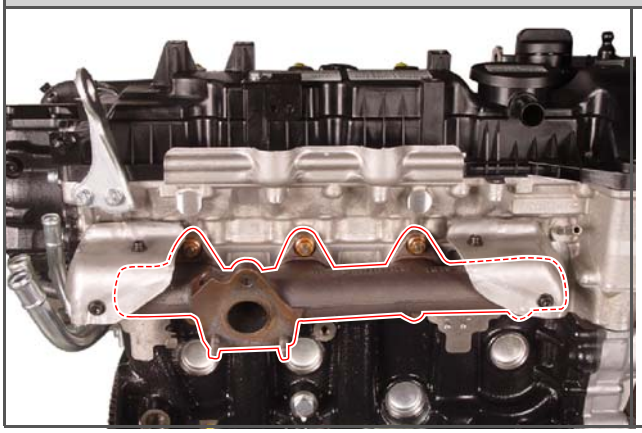
Intake manifold	
	

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

2) Exhaust Manifold

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

▶ **Components**

Exhaust manifold	
	

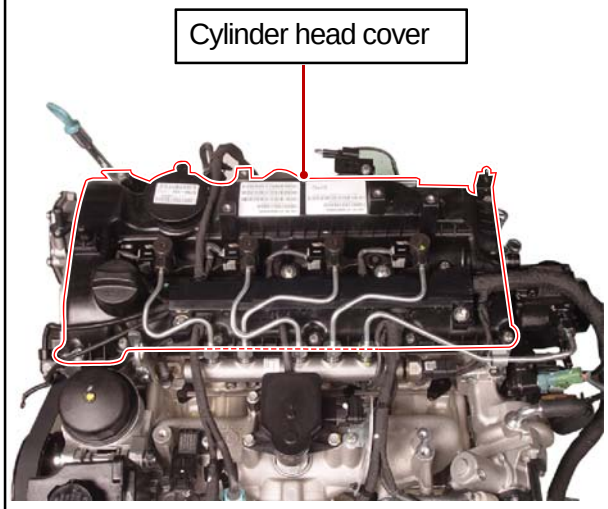
* For detailes, refer to Chapter "Exhaust System".

5. CYLINDER HEAD COVER AND OIL SEPARATOR

1) Cylinder Head Cover

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

▶ **Components**



Front view

Rear view

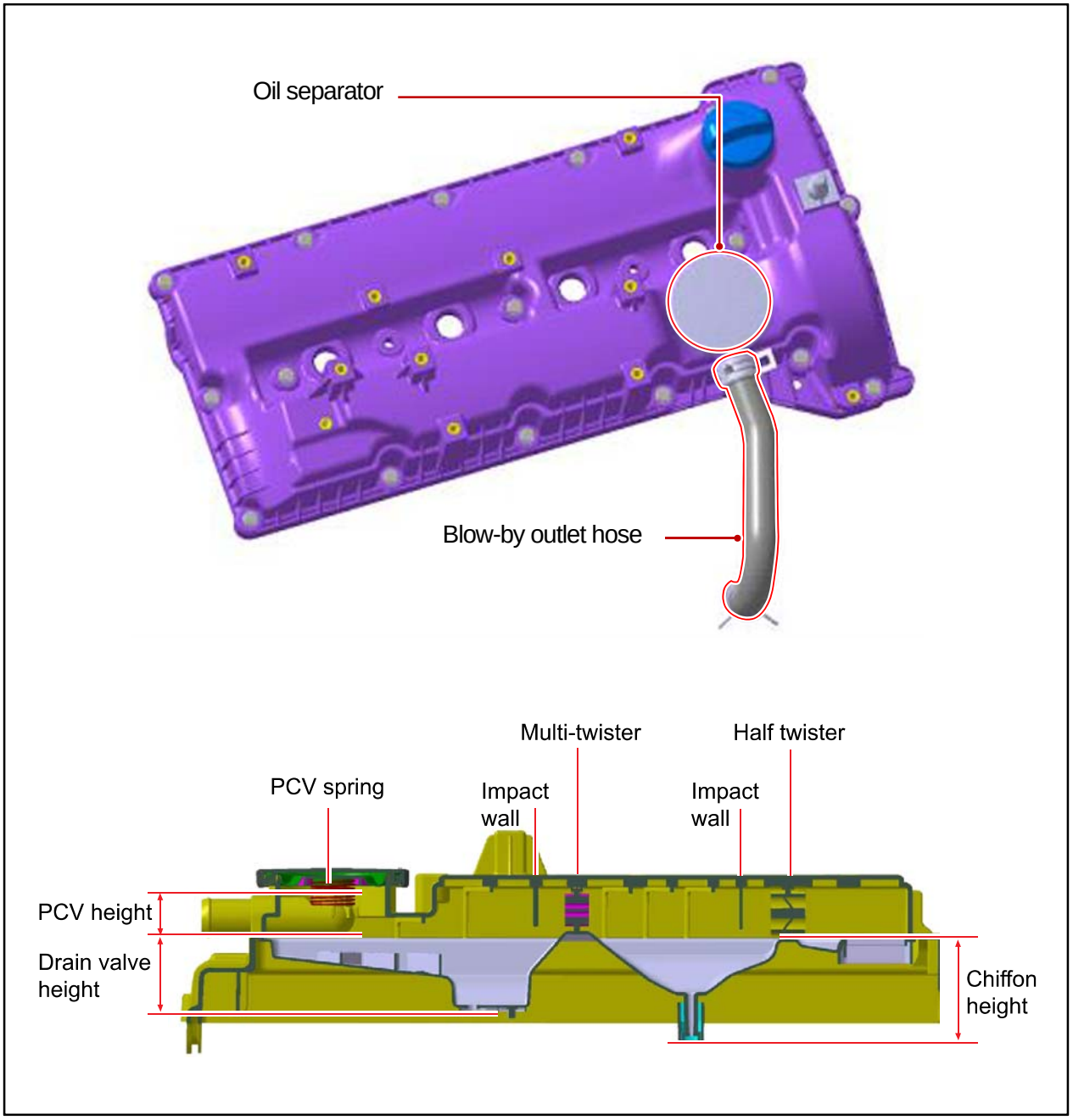
Modification basis	
Application basis	
Affected VIN	

2) Oil Separator

(1) Overview

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

(2) Layout



6. CYLINDER HEAD

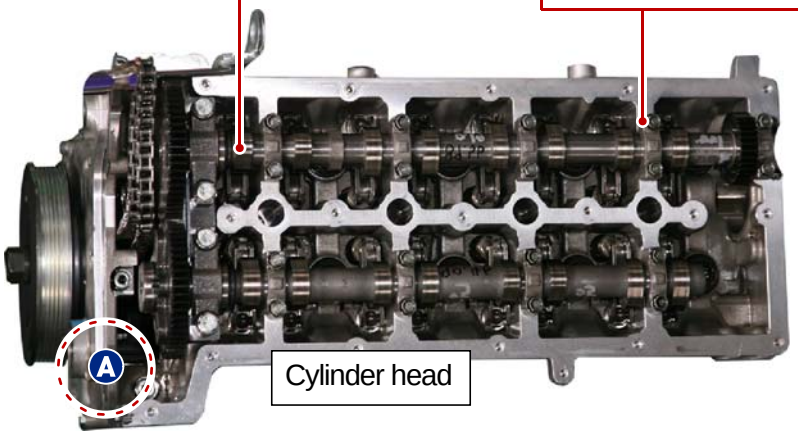
Cylinder head contains cam position sensor, vacuum pump, intake manifold, exhaust manifold and valve assembly. Vacuum pump and the high pressure (HP) pump are driven by Camshaft and valves are install in vertical direction. This enables the compact layout in cylinder head assembly.

▶ **Components**

Finger follower & HLA

Intake/exhaust Camshafts

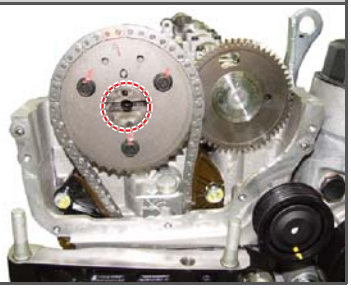
Camshaft sprocket



Camshaft position sensor

HP pump drive gear

Vacuum pump drive



Cylinder head gasket

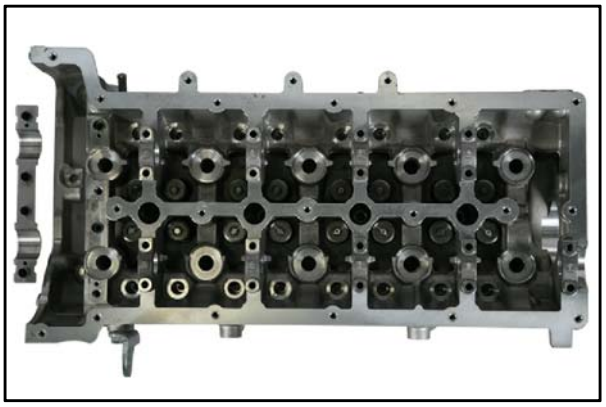
Modification basis	
Application basis	
Affected VIN	

1) Cylinder Head

(1) Overview

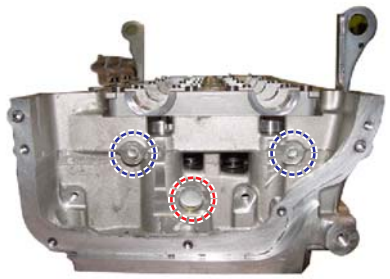
The cylinder is made by gravity casting and the water jacket is integrated type.
The cylinder oil passage is drilled and sealed by cap.
The Camshaft bearing cap is also made by casting and installed on the cylinder head.

(2) Features

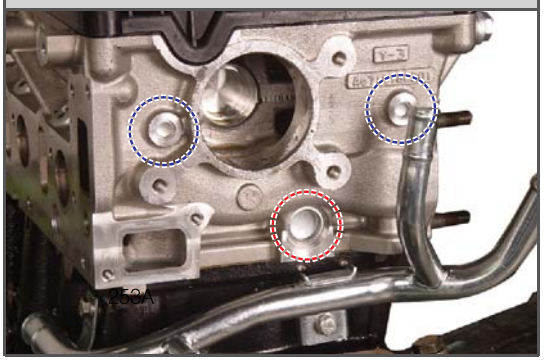


Location of Expansion Plugs

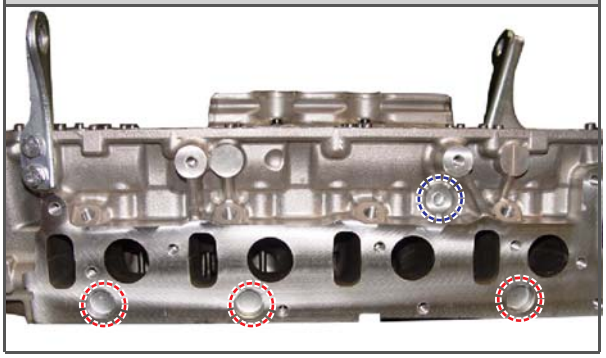
Front



Rear

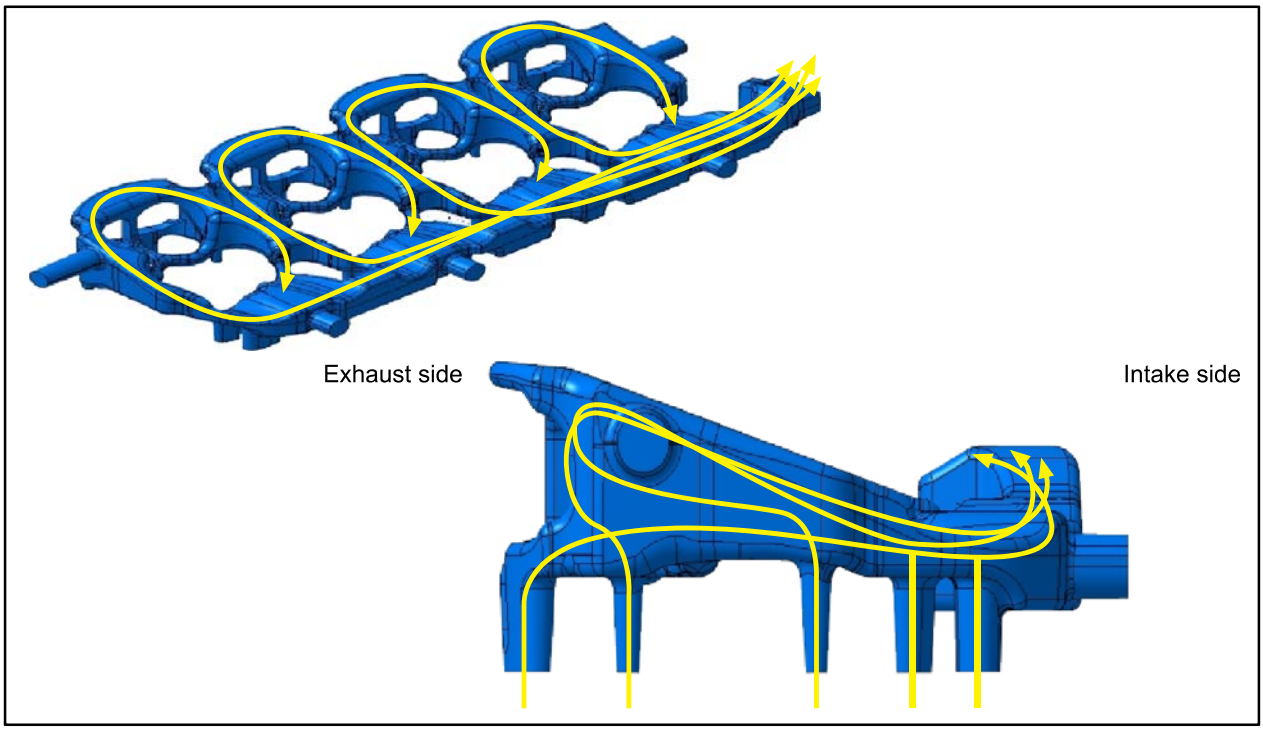


Intake side



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

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



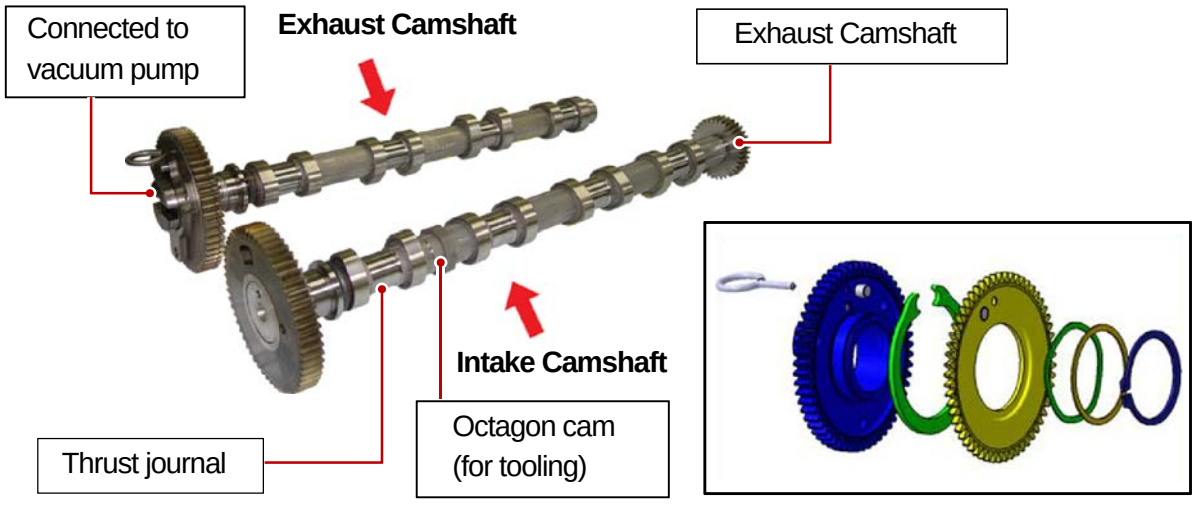
2) Camshaft

(1) Overview

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

(2) Location

Intake/Exhaust Camshafts



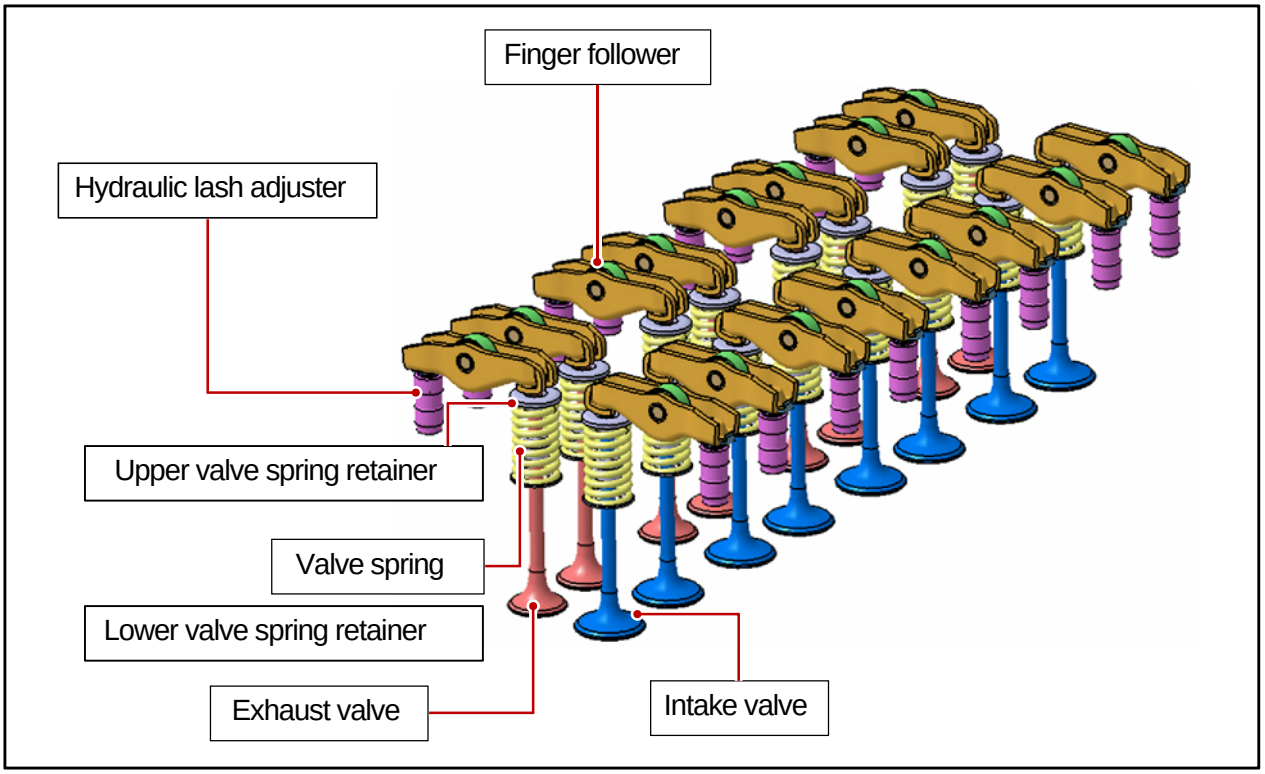
Modification basis	
Application basis	
Affected VIN	

3) Valve Assembly (Installed in Cylinder Head)

(1) Features

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

(2) Arrangement



4) Cylinder Head Gasket

(1) Features

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

Thickness marking	
	Ex: 1.3t

(2) Thickness of cylinder head gasket

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

▶ **Piston protrusion**

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

Modification basis	
Application basis	
Affected VIN	

7. CHAIN AND GEAR DRIVE SYSTEM

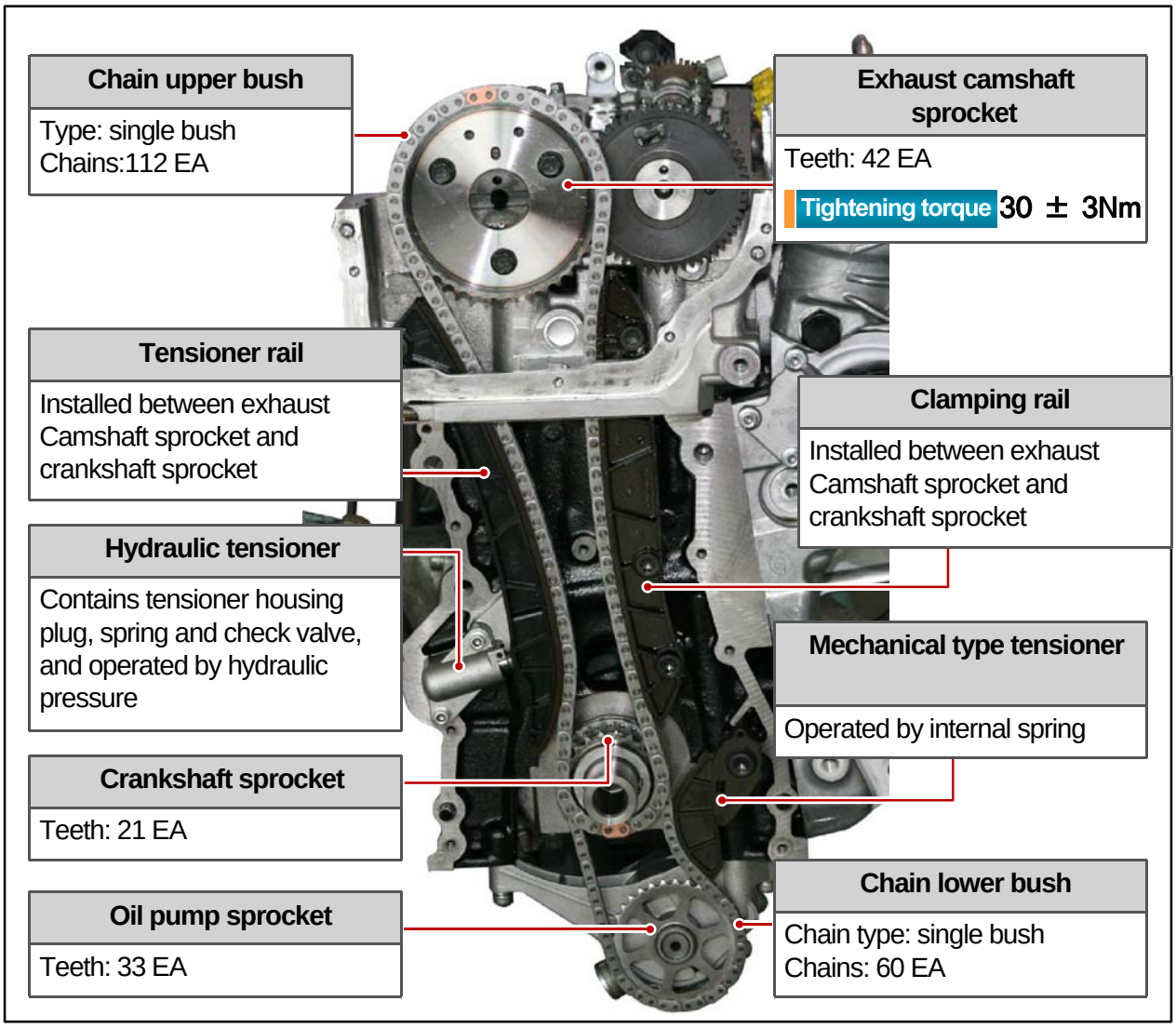
D20DTR engine uses single stage chain drive system. Timing chain drives the exhaust side and gear drive the intake side. Timing chain is single bush type. Upper chain drives HP pump connected to intake Camshaft by driving exhaust cam shift sprocke, and lower chain drives oil pump to lubricate the engine.

1) Chain Drive

(1) Overview

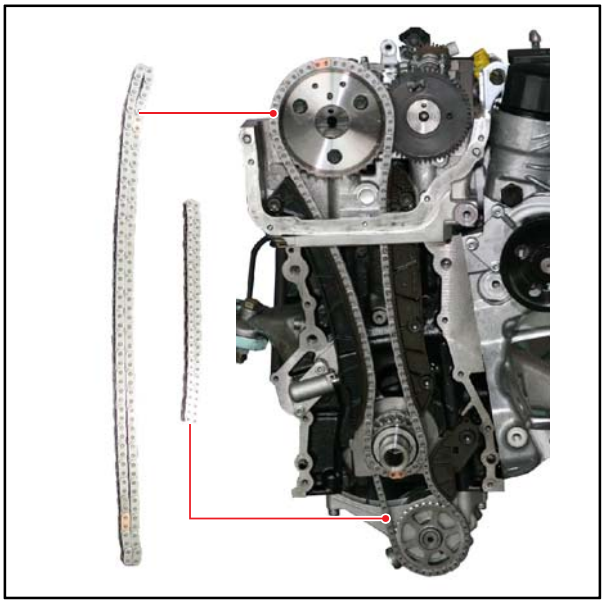
The drive chain is single chain drive system with simple design and variable performance, and it utilizes the hydraulic tensioner to reduce the wave impact generated by the chain. This chain is light weight and has high durability through single bush chain. Shoulder bolts are used for better NHV.

(2) Layout



2) Timing Chain and Gear

(1) Timing chain



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

Chain upper bush
- Single bush type (112 EA)

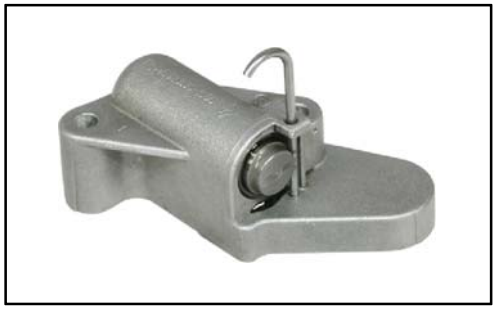
Chain lower bush
- Single bush type (60 EA)

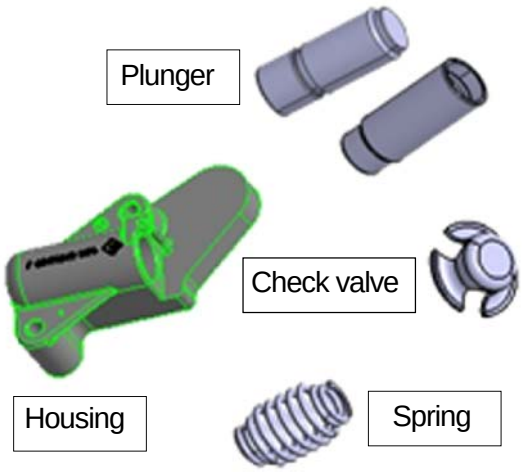
(2) Tensioner

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

▶ **Hydraulic tensioner assembly**

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





Modification basis	
Application basis	
Affected VIN	

(3) Mechanical Tensioner Assembly

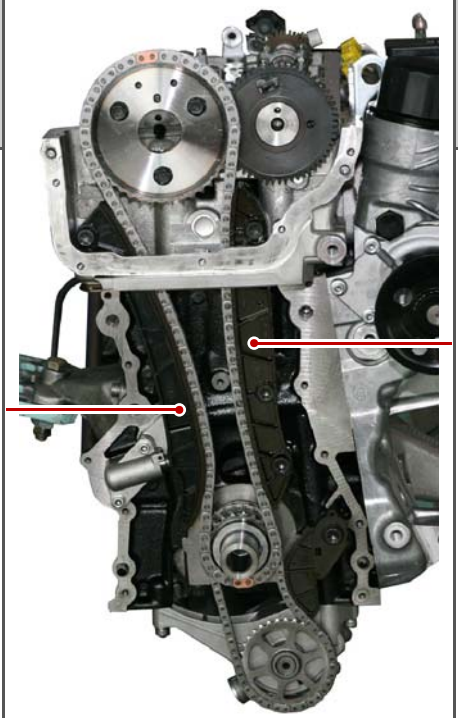
Operating principle
- Use only spring tension

Tensioner type
- Compensation and impact absorbing

Static and dynamic force
- Spring

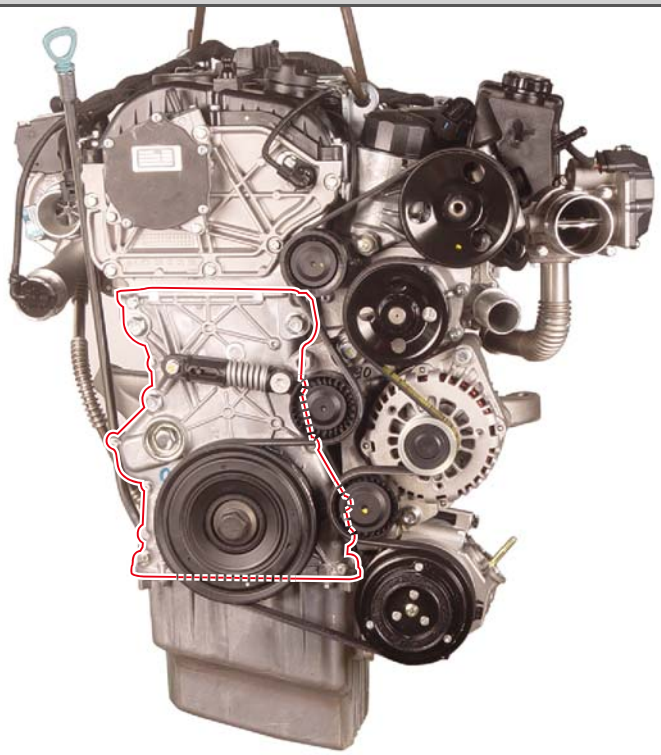
(4) Guide rail

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

Tensioner guide rail Installed between exhaust Camshaft sprocket and crankshaft sprocket		**Clamping guide rail** Installed between exhaust Camshaft sprocket and crankshaft sprocket
		

(5) Timing gear case cover

Timing gear case cover (TGCC)



Timing gear case cover

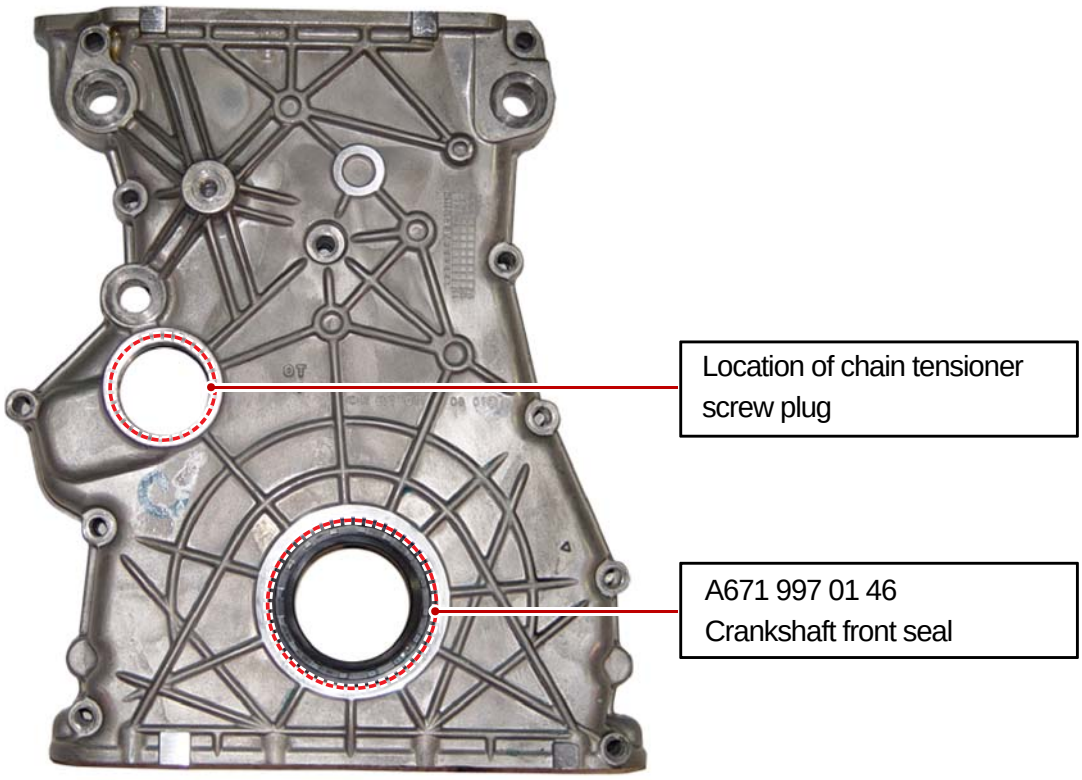
Oil seal

Screw plug

Modification basis	
Application basis	
Affected VIN	

▶ Features

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



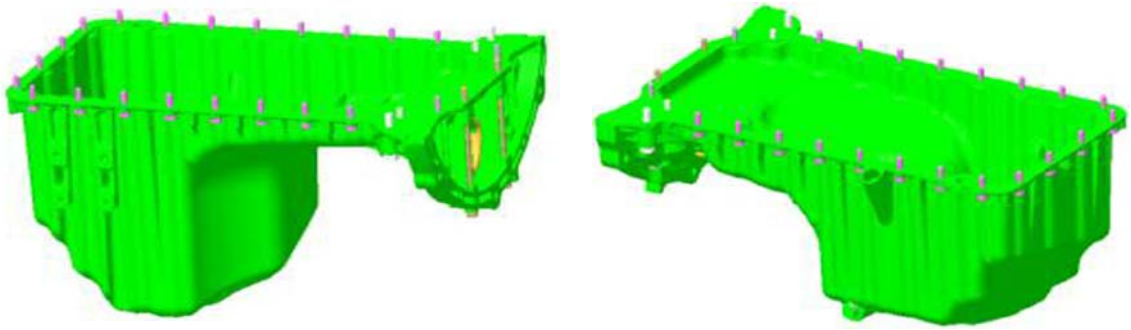
CAUTION

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

8. OIL PAN

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

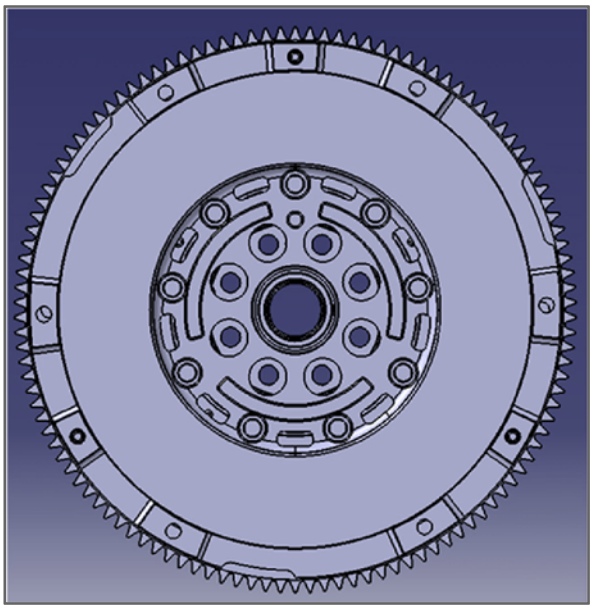
▶ **Components**

Oil pan sassembly


Modification basis	
Application basis	
Affected VIN	

9. DUAL MASS FLYWHEEL (DMF) & DRIVE PLATE

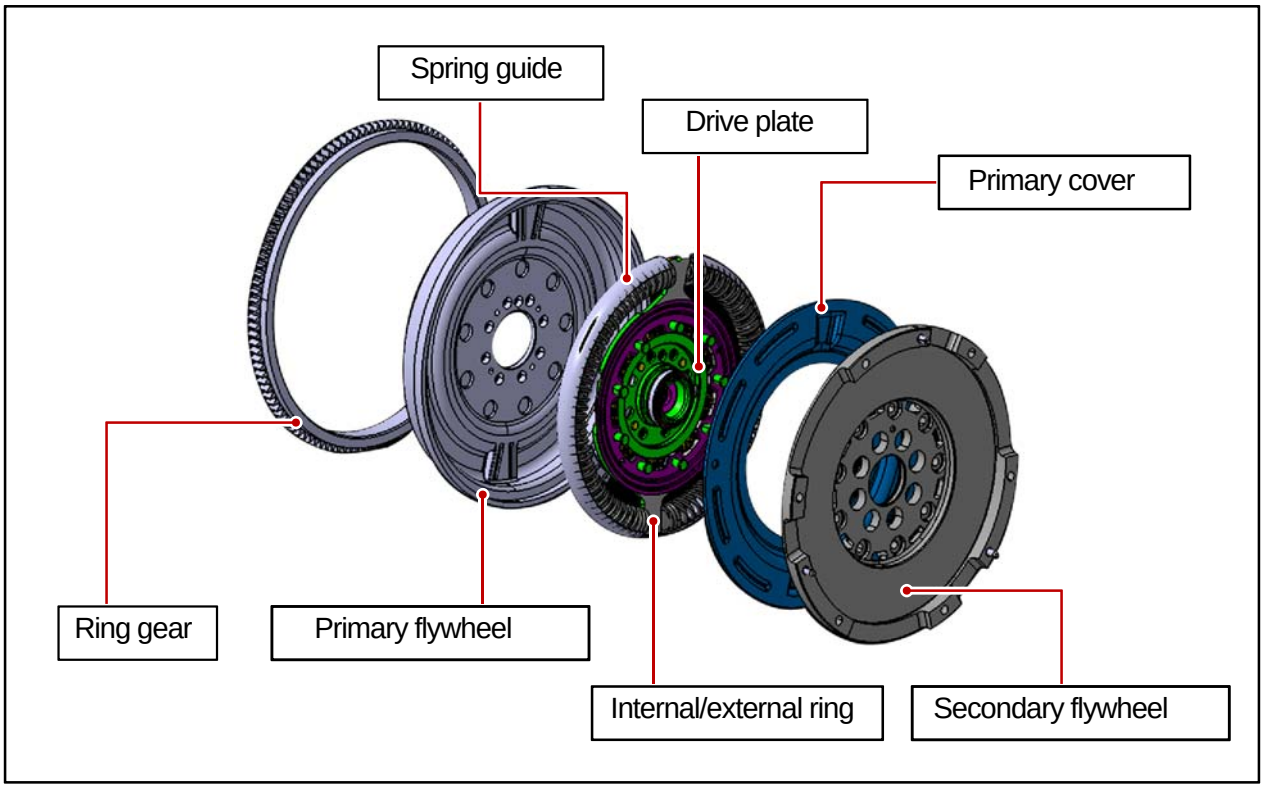
1) Overview



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

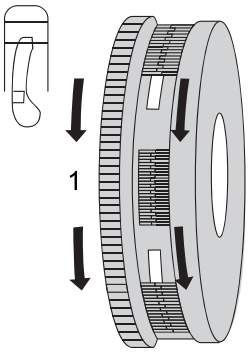
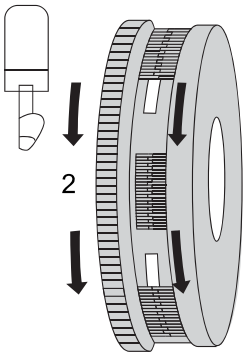
- Reducing the irregular speed of crankshaft due to unbalanced combustion -> Improving the power train NVH, Improving the driving performance
- Reducing the clutch noise by using ball bearing
- Improving the durability of DMF by using strong arch spring

2) Layout

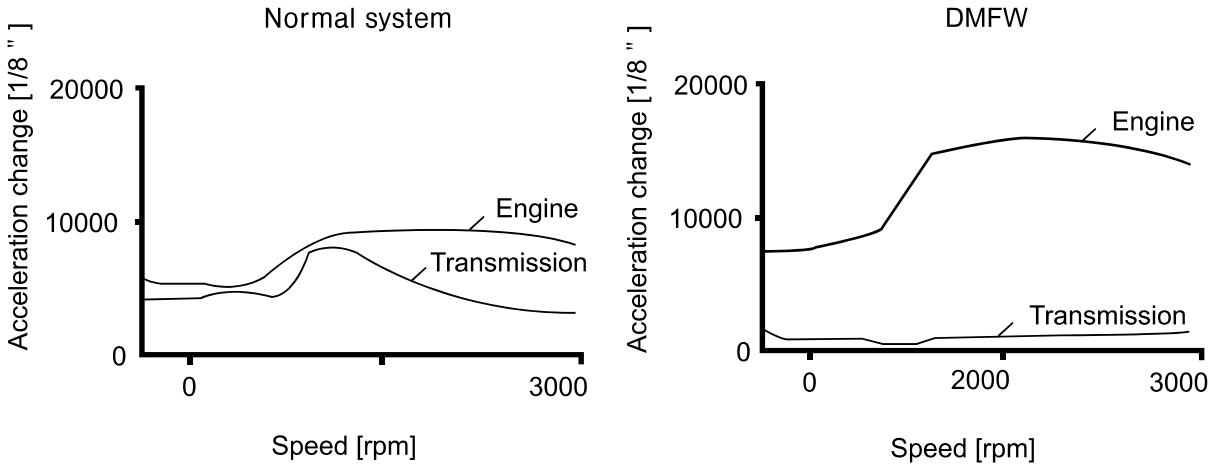


3) Operation

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

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

Torque change curve of engine and drive shaft



Modification basis	
Application basis	
Affected VIN	

4) Features

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

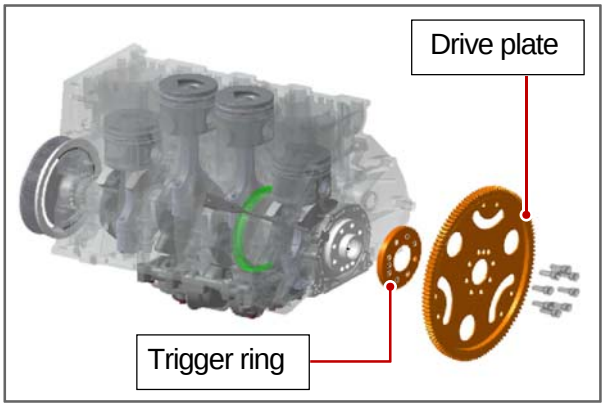
5) Advantages

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

6) Drive Plate

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

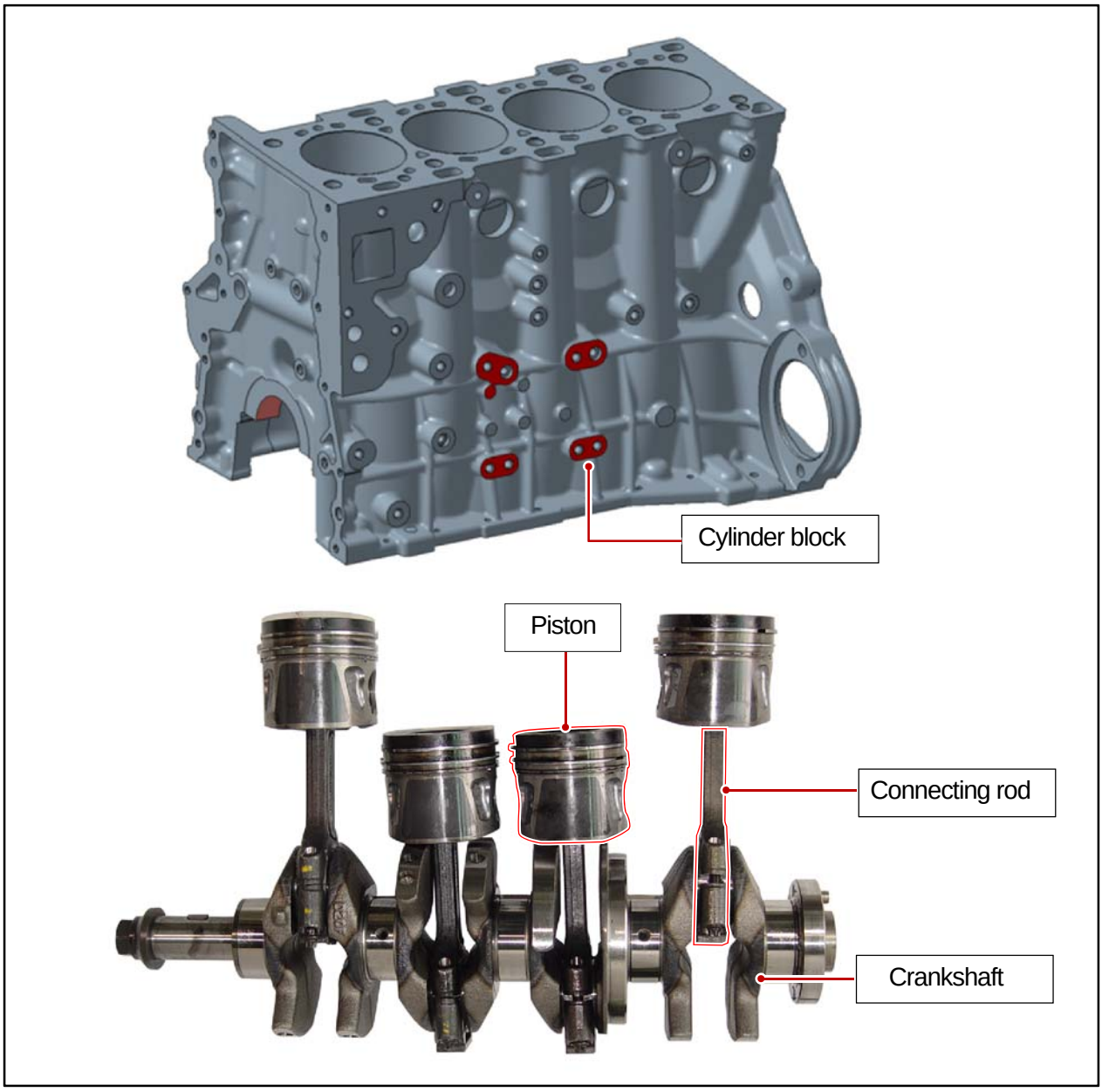
▶ **Components**



10. PISTON/CRANKSHAFT/CYLINDER BLOCK

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

▶ Components



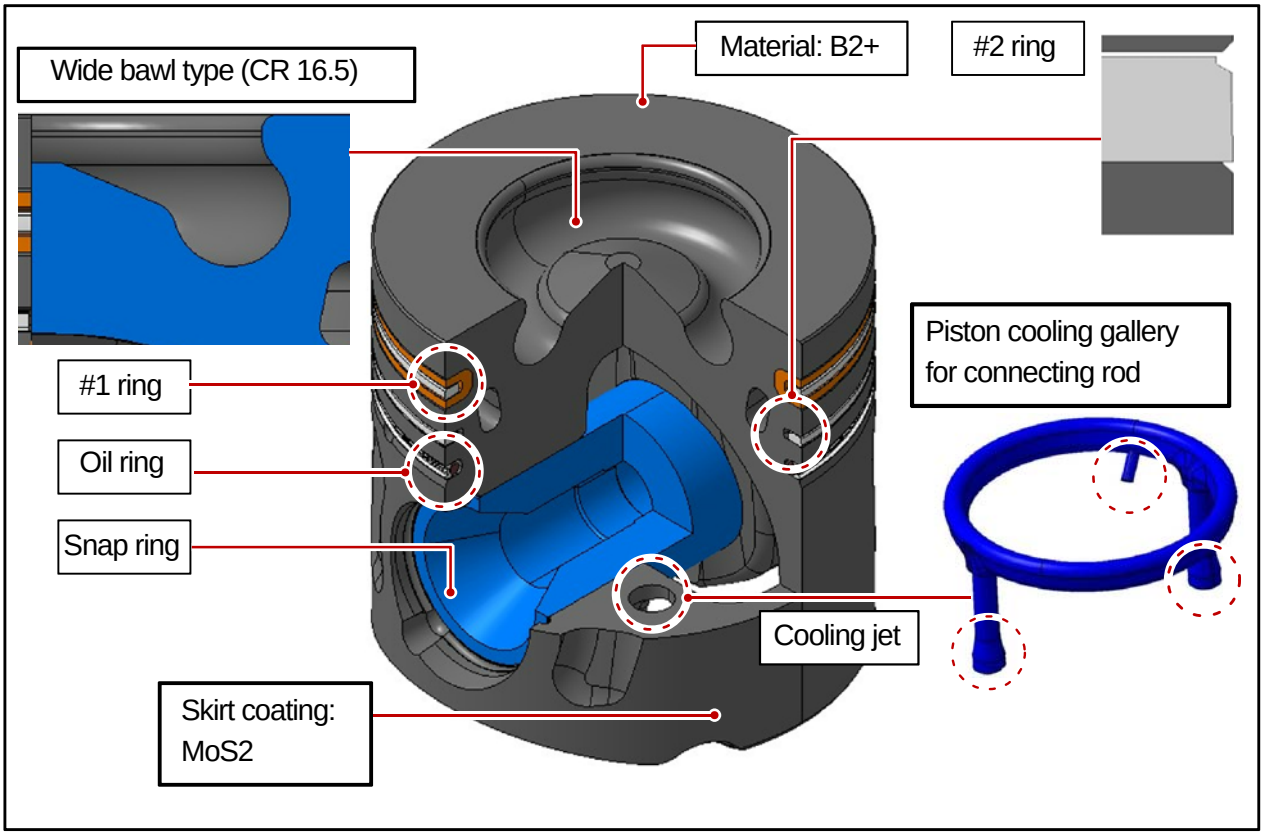
Modification basis	
Application basis	
Affected VIN	

1) Piston

(1) Overview

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

(2) Layout



(3) Functions

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

▶ **Piston ring**

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

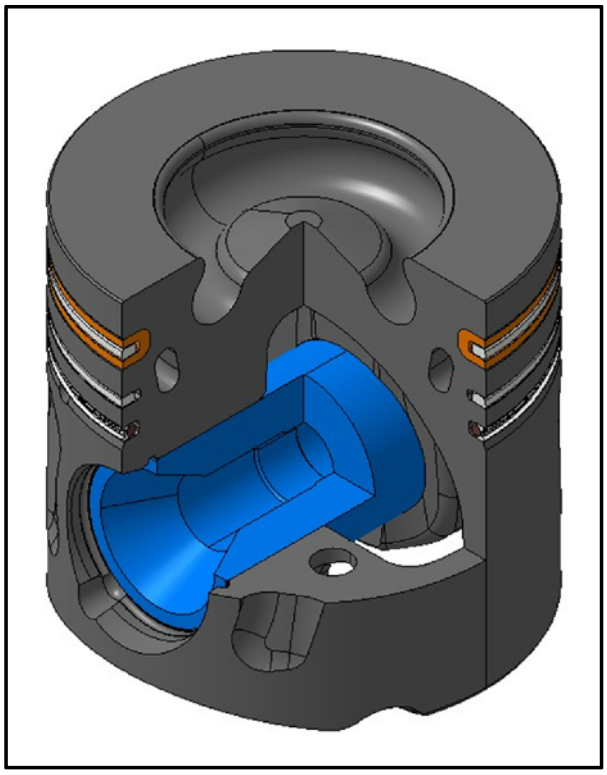
▶ **Piston pin**

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

▶ **Snap pin**

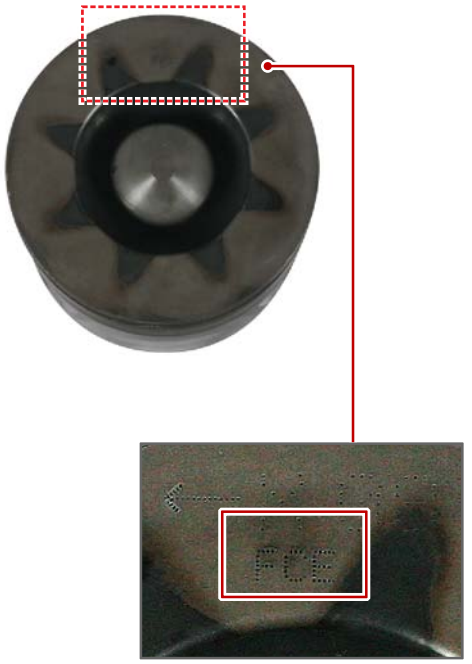
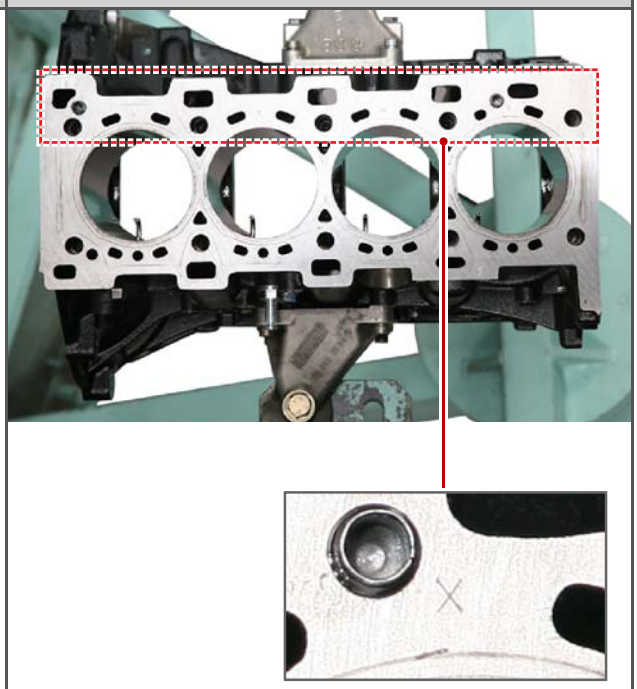
- Locks the piston pin.

(4) Assembling the piston



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

Modification basis	
Application basis	
Affected VIN	

Selecting piston oversize	
Top of piston	Top of cylinder block
	

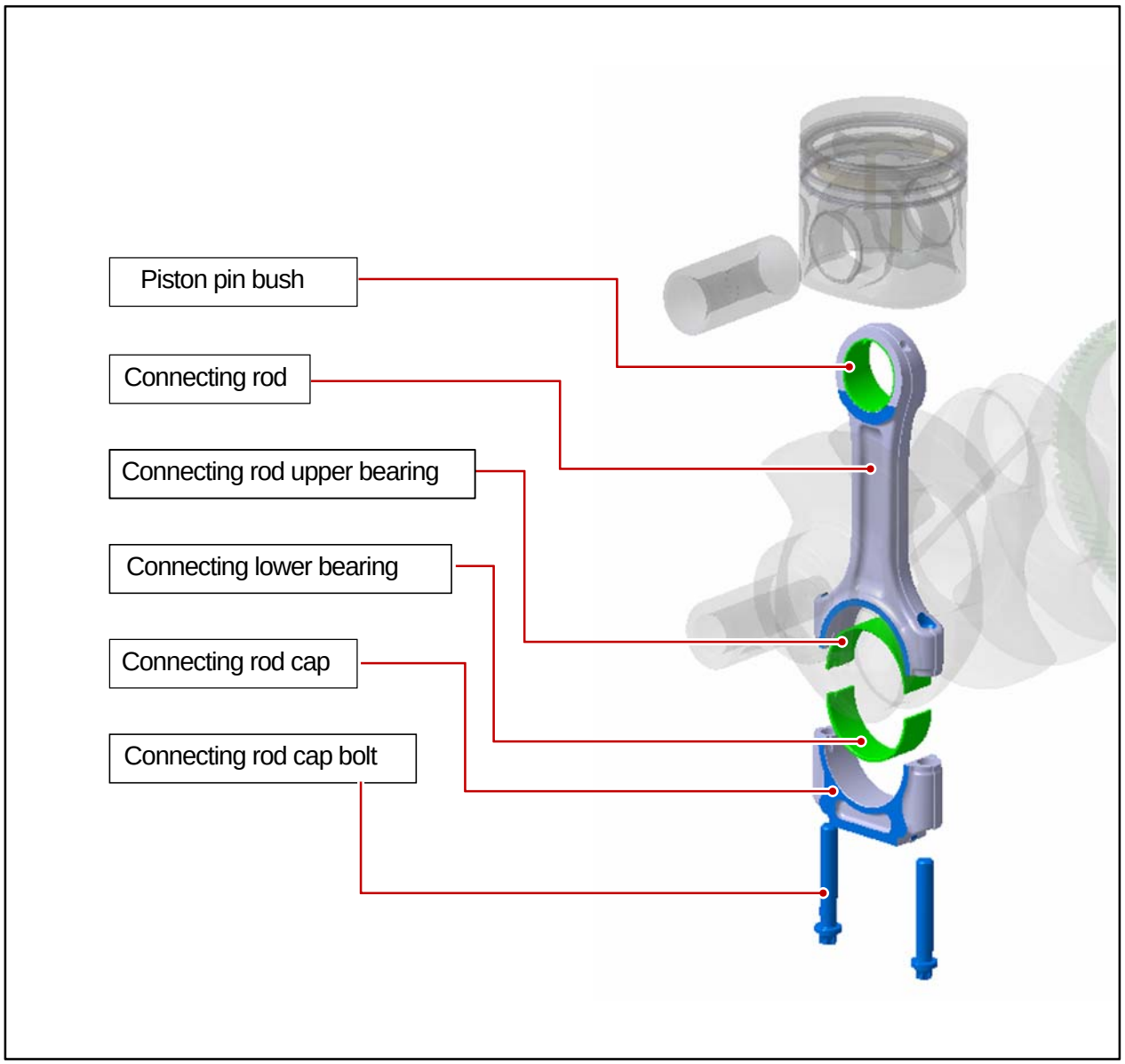
Engine	Piston		Cylinder bore
	Part NO	Marking NO.	-
D20DTF	671 030 06 17	-	-
	671 037 07 01	A	A
	671 037 08 01	X	X
	671 037 09 01	B	B
	671 037 10 01	+5	-
	671 037 11 01	+10	-

2) Connecting Rod

(1) Overview

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

(2) Components



Modification basis	
Application basis	
Affected VIN	

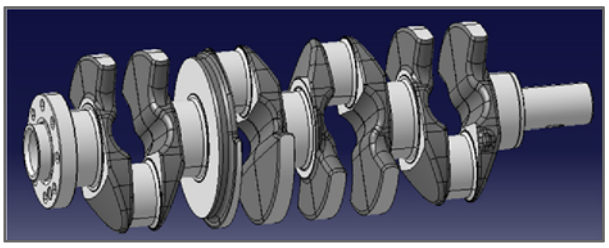
(3) Selection of crankshaft pin journal bearing

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

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

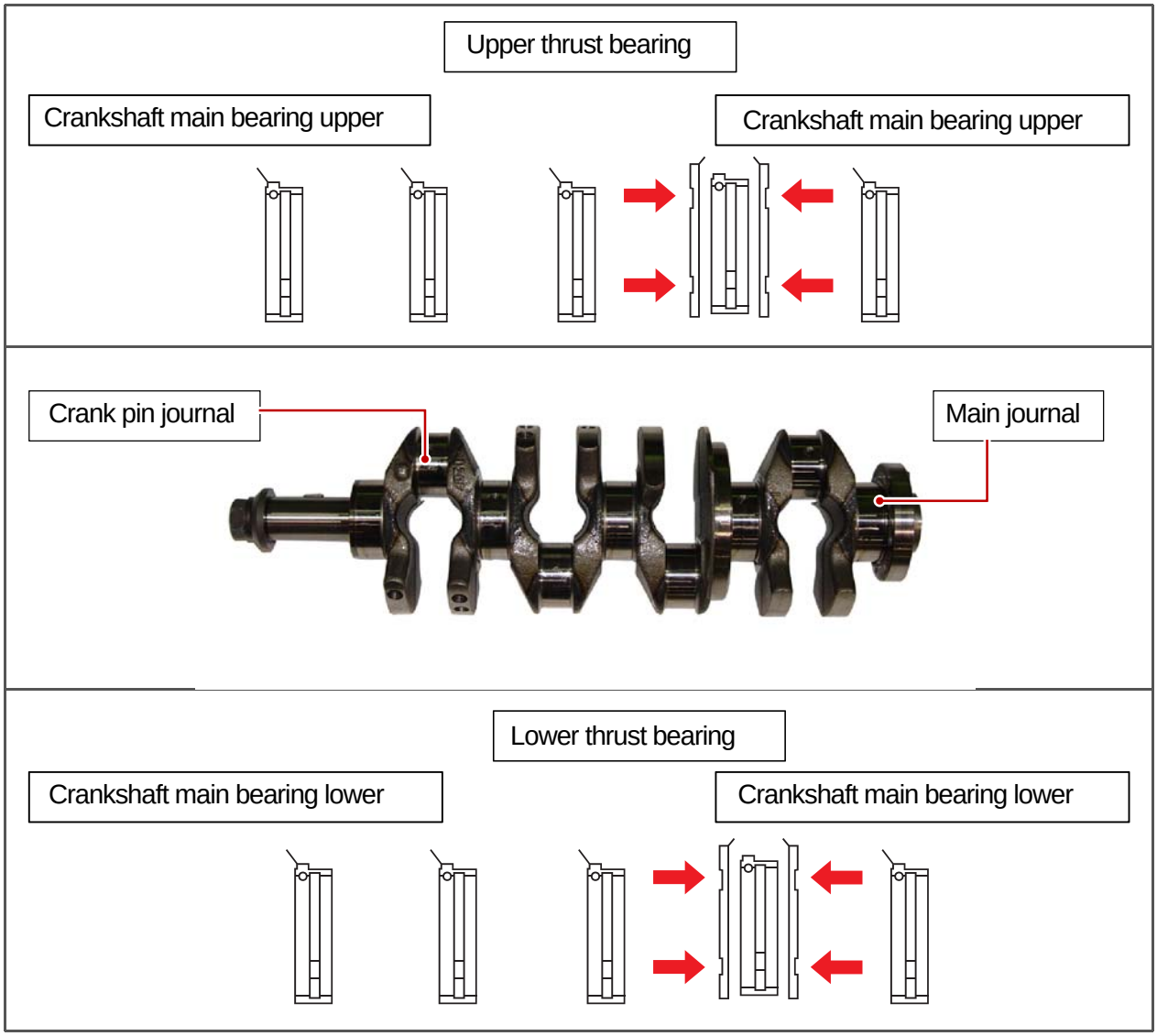
3) Crankshaft

(1) Overview



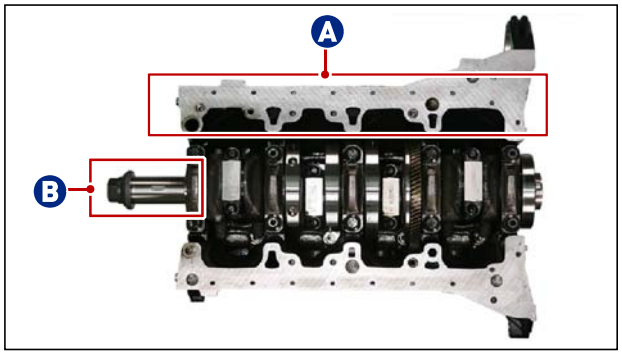
Crankshaft is installed on the cylinder block.

(2) Arrangement

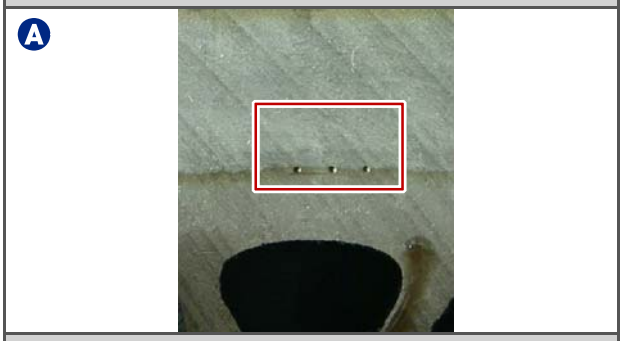


Modification basis	
Application basis	
Affected VIN	

(3) Selection of crankshaft main bearing



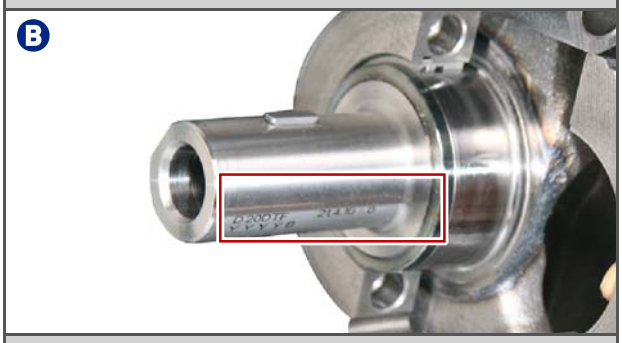
Bottom of cylinder block



Selection of upper main bearing

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

Mating surface of crankshaft sprocket



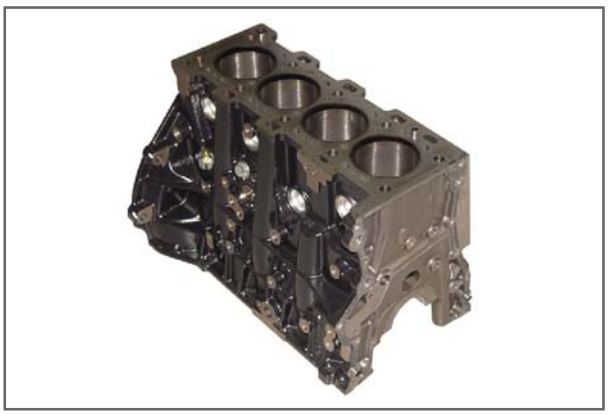
Selection of lower main bearing

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

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

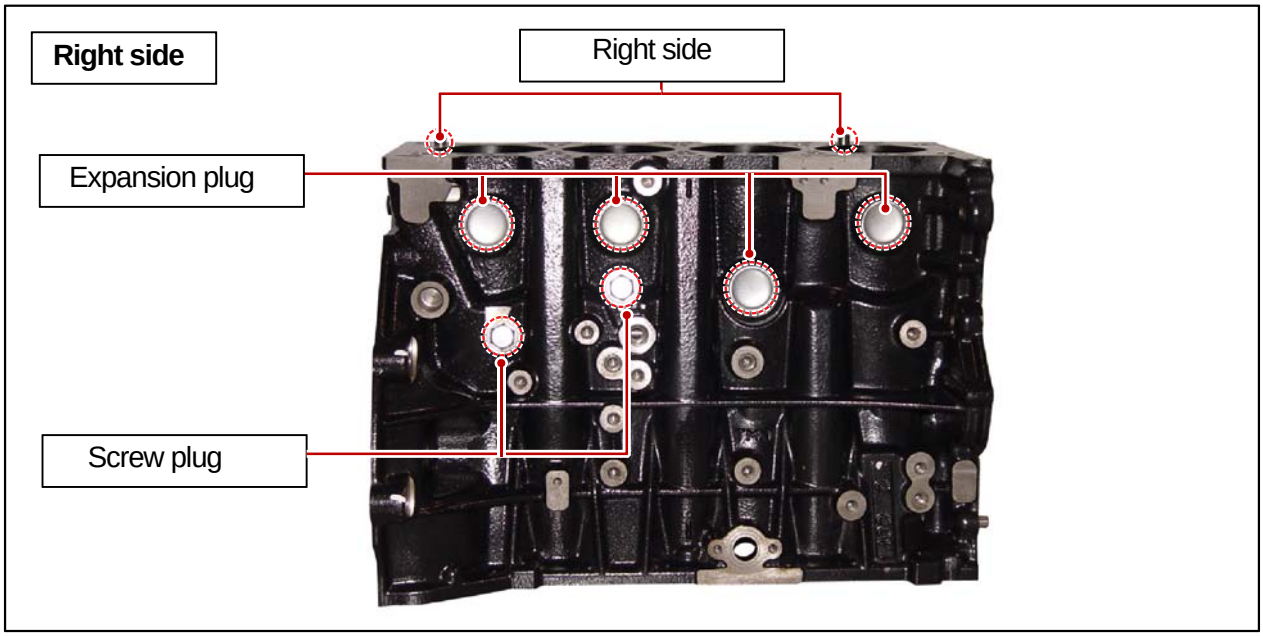
4) Cylinder Block

(1) Overview

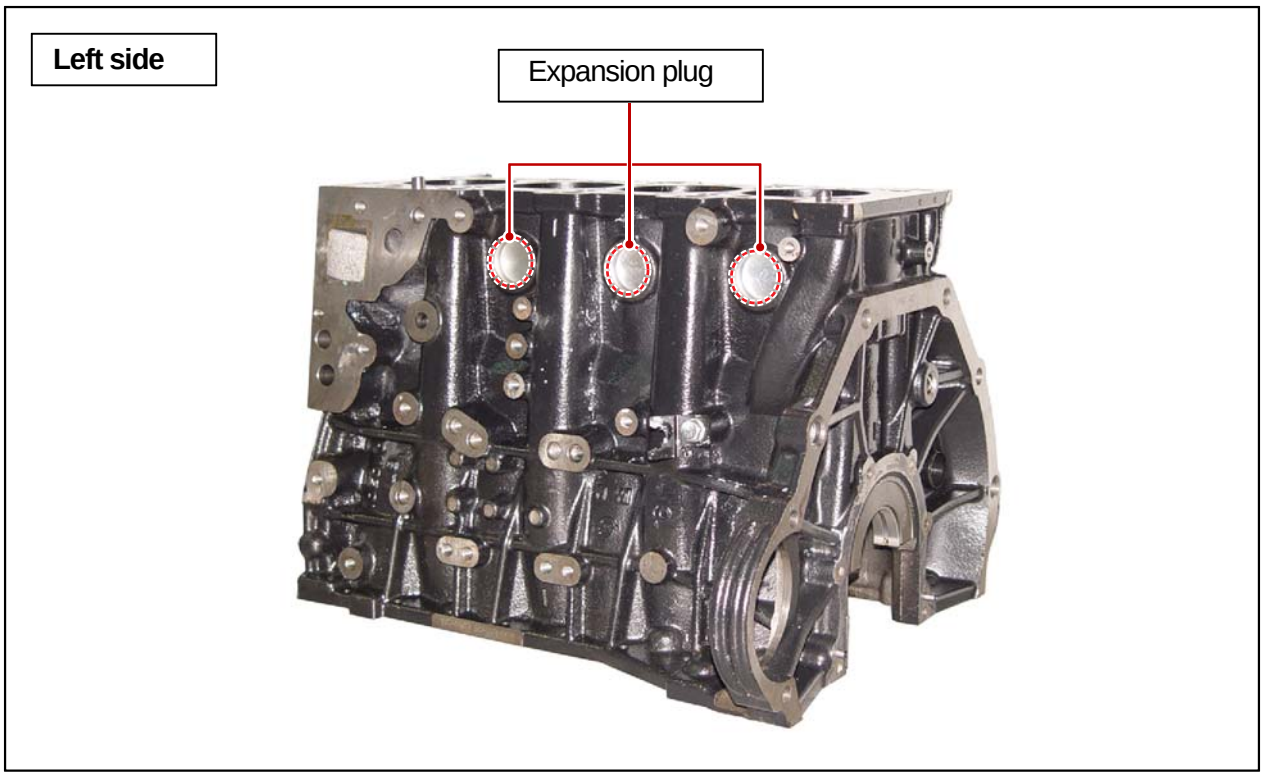


The major dimensions in D20DTR are similar to D20DT engine. It has two mounting bosses for knock sensor and meets the requirements for EURO5 regulation.

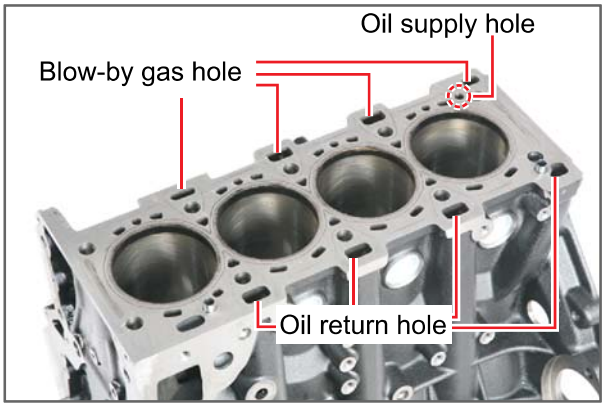
(2) Layout



Modification basis	
Application basis	
Affected VIN	



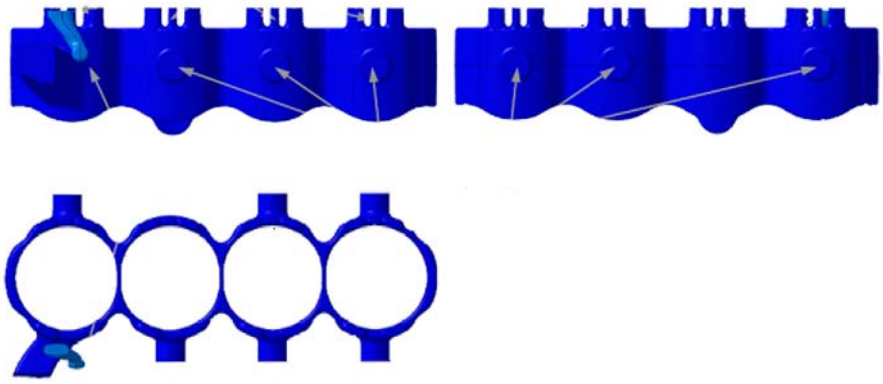
(3) Features



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

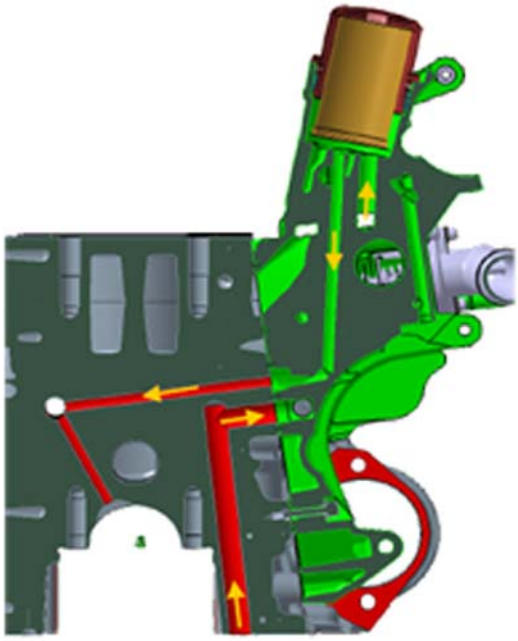
The bottom side of water jacket is desgined as sine wave to strengthen the structure of crankcase. The main flow of coolant starts from outlet port of water pump and goes along the longitudinal direction of engine. The coolant passage from cylinder head to inlet port of water pump is integrated in cylinder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

Water jacket core



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

Crankcase cross bore for oil supply



Modification basis	
Application basis	
Affected VIN	

FUEL SYSTEM

2210-01

GENERAL INFORMATION

1. SPECIFICATION

Description		Specification
Fuel		Diesel
Fuel filter	Type	Fuel heater + priming pump + water separator integrated type
	Filter type	Changeable filter element type
	Change interval	every 50,000 km
	Water separation interval	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.

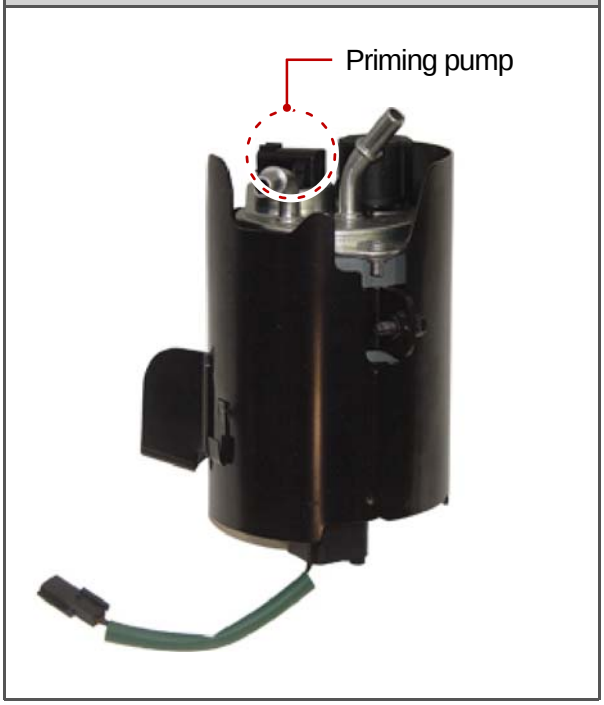
Use special tools and torque wrench to perform the correct works.

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.

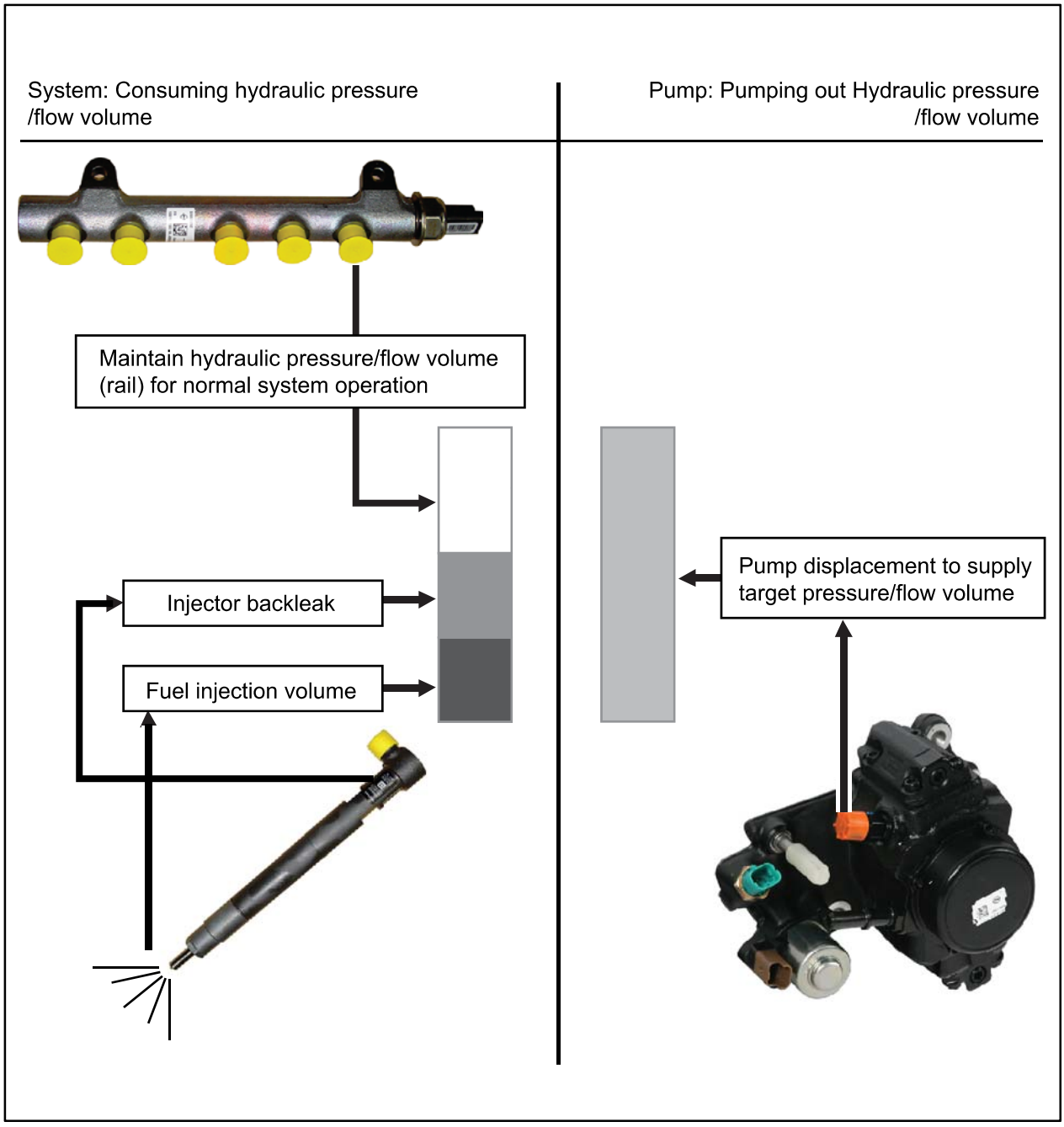
Modification basis	
Application basis	
Affected VIN	

2) Diagnostic Test for Engine Fuel System

(1) Overview

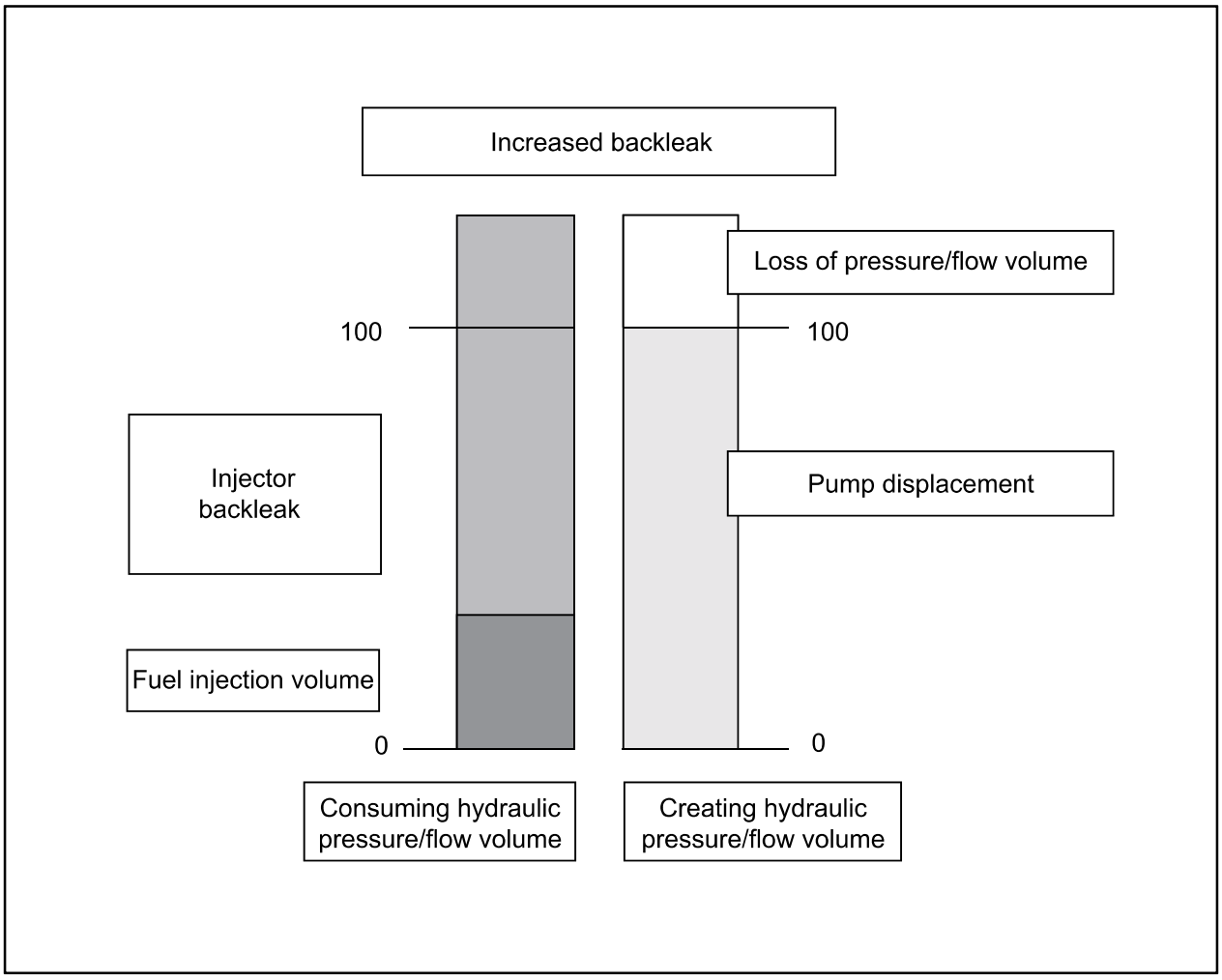
If a DTC is displayed on the diagnostic device, check the low pressure- and high pressure fuel systems before removing the components.
To run the system properly, the electric system must be intact but for the DI engine, the fuel pressure should be measured also when there is a malfunction even after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

(2) Hydraulic system



Modification basis	
Application basis	
Affected VIN	

(3) Excessive backleak of injector



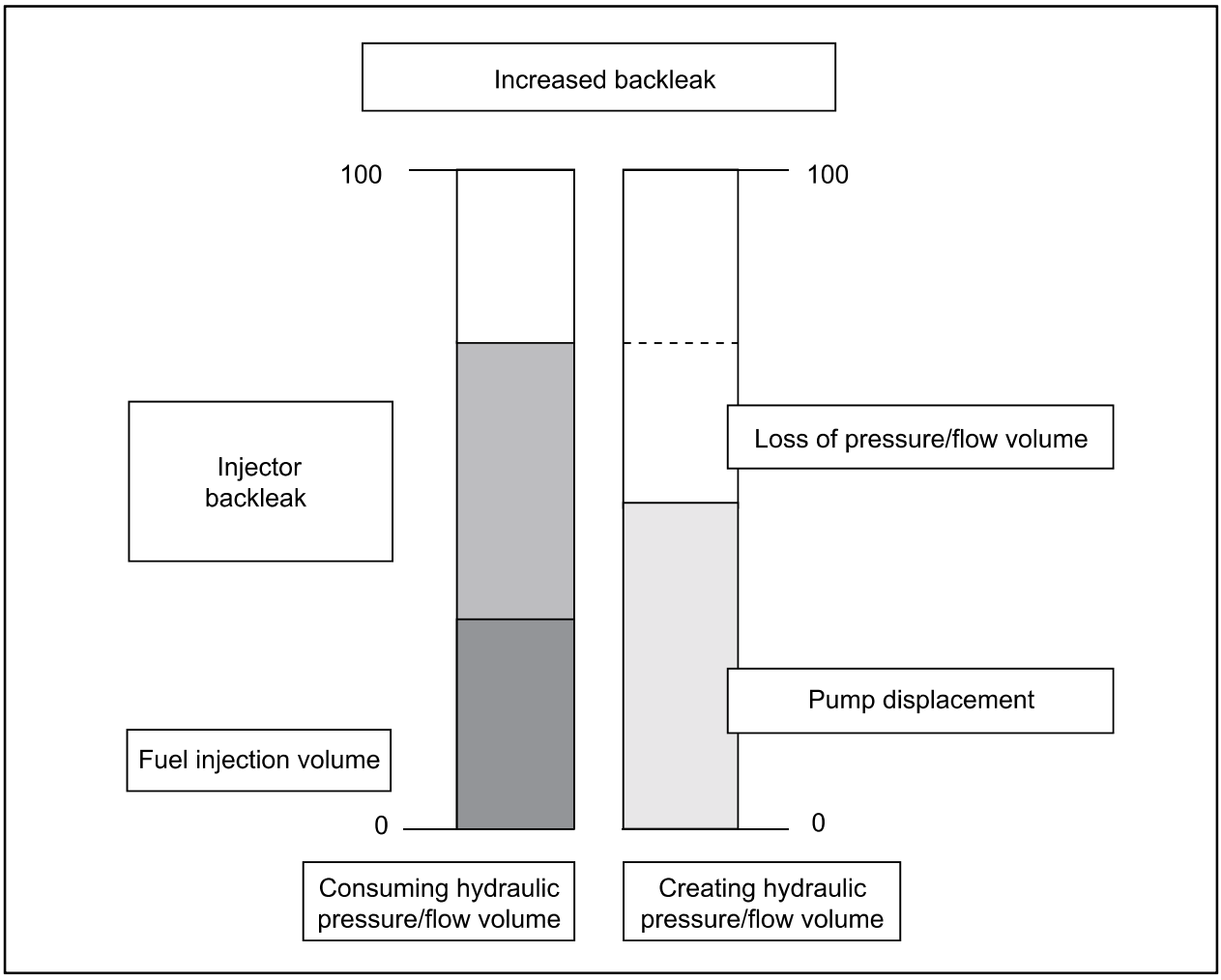
▶ **Excessive injector backleak**

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)

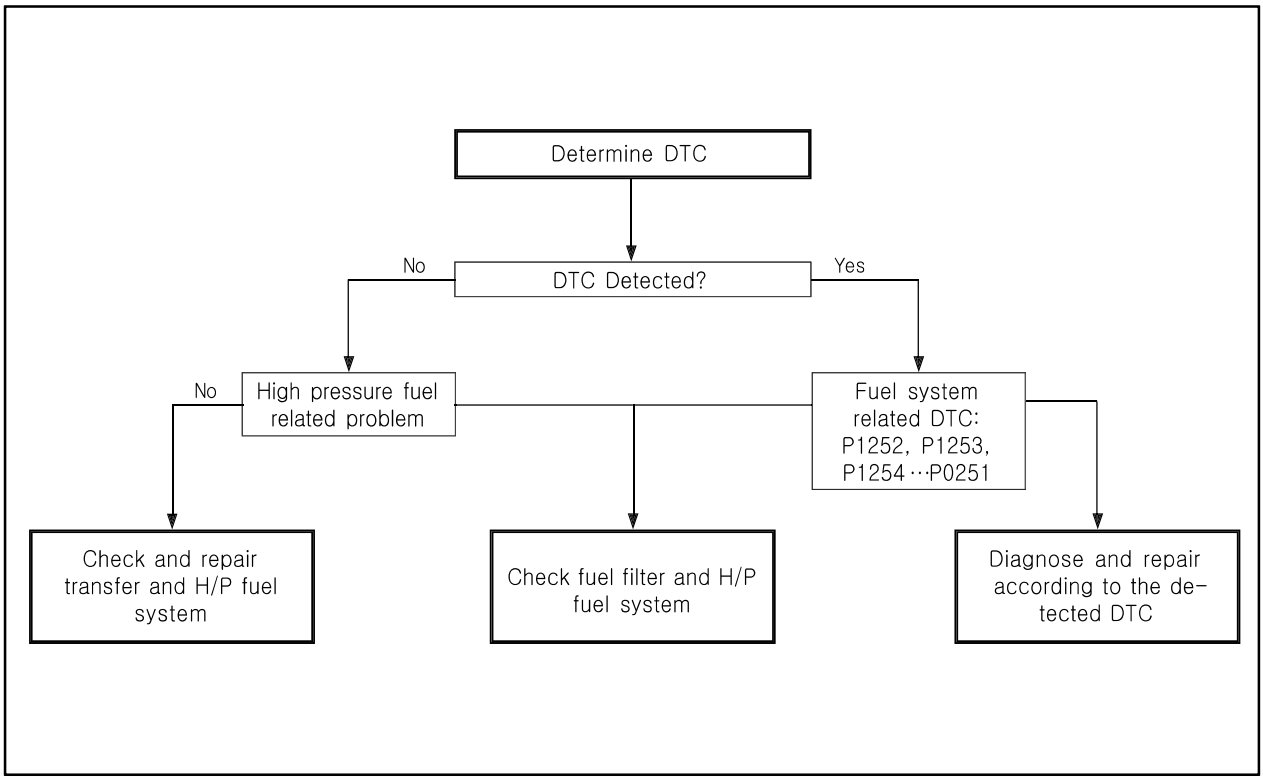
Device for high pressure

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

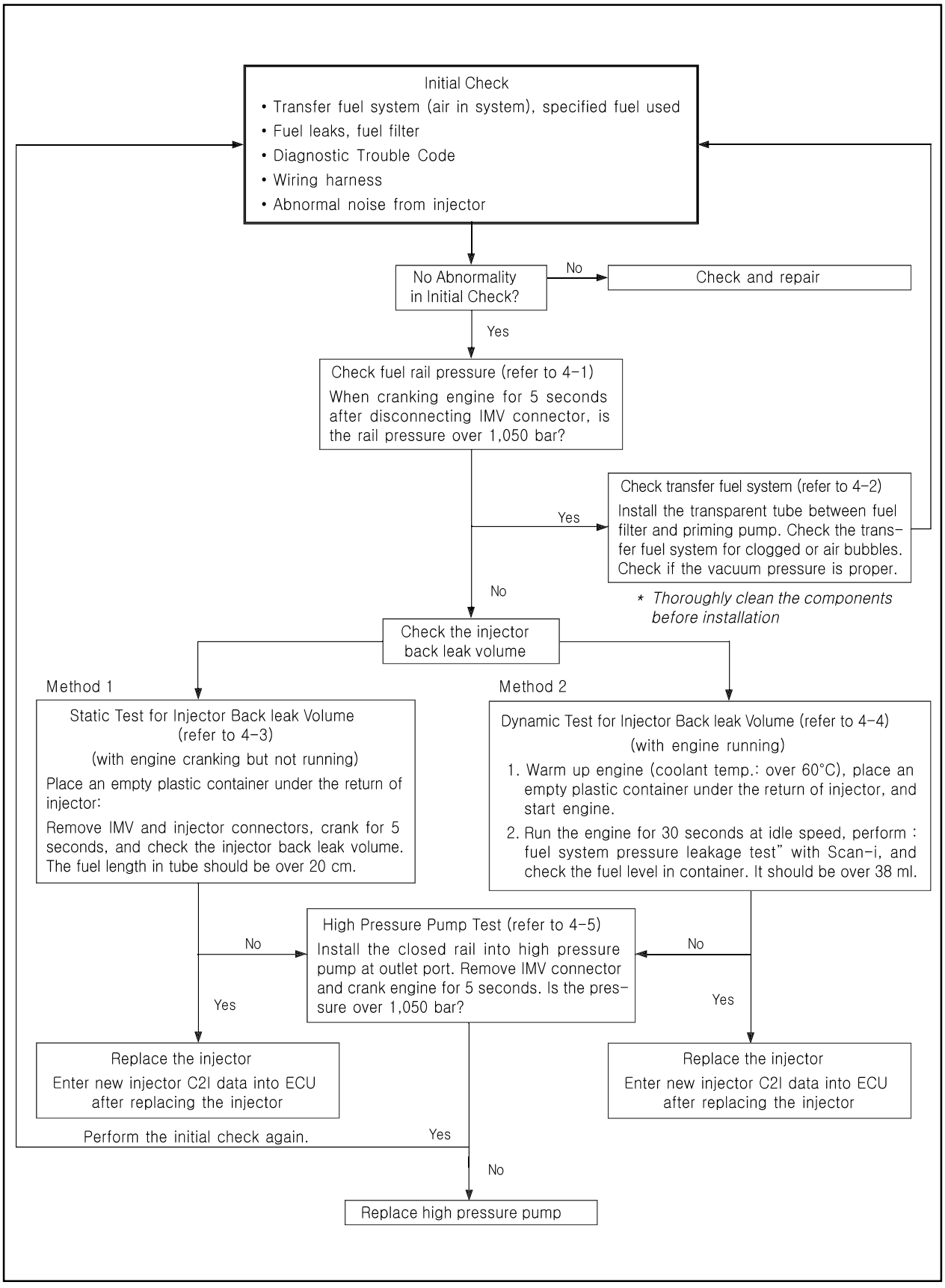


CAUTION

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.

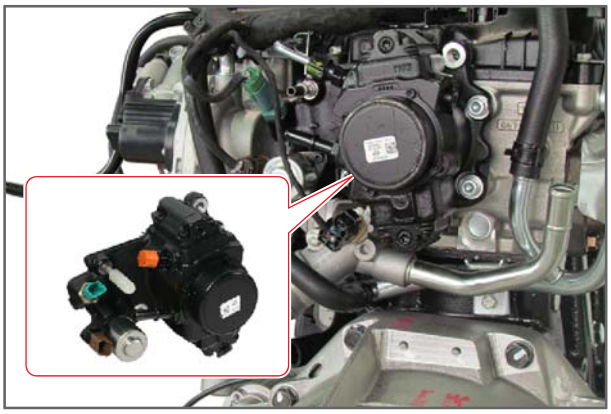
Modification basis	
Application basis	
Affected VIN	

(4) Fuel System Check Procedure



(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

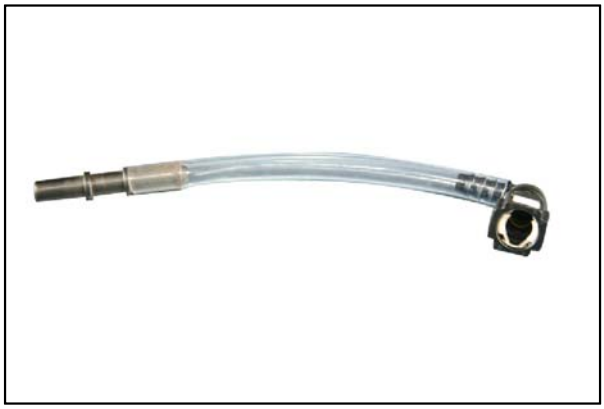
1. Press the "TEST" button on the tester to check if the message "TEST?" is displayed.
2. If the button is pressed again at 4 seconds after starting engine cranking, the highest pressure is displayed on the tester.

NOTE

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

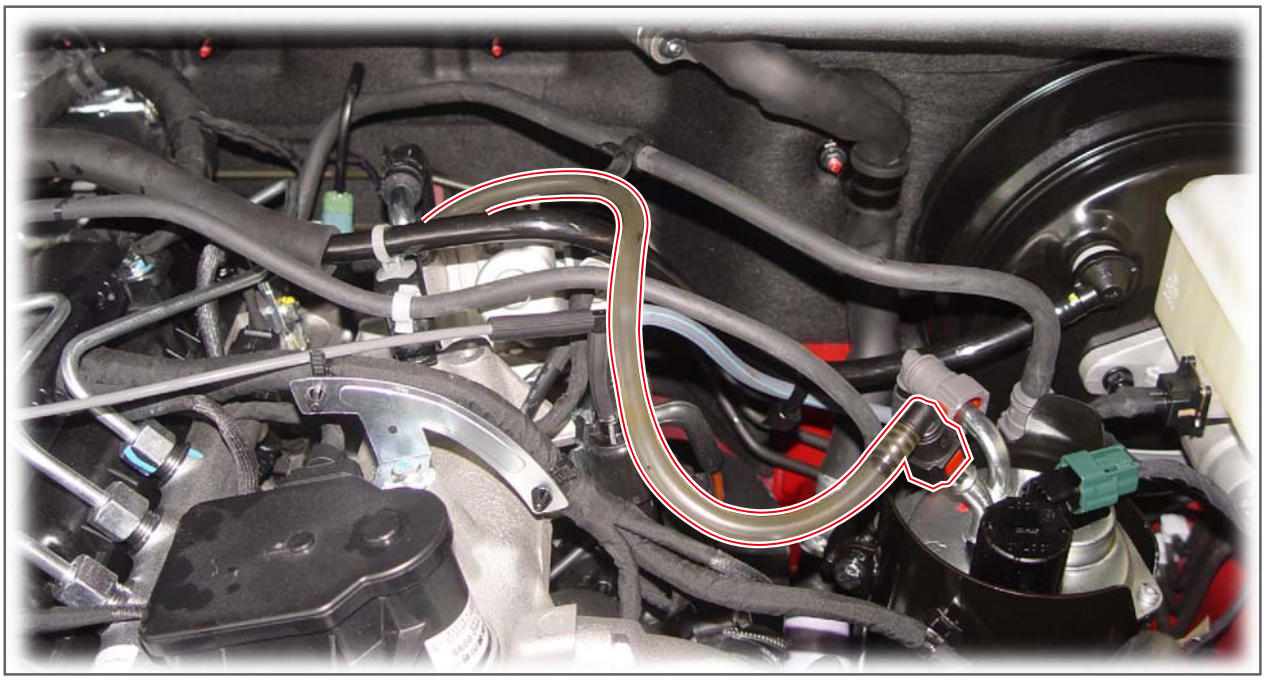
(6) Low Pressure System Pressure Test

▶ **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.

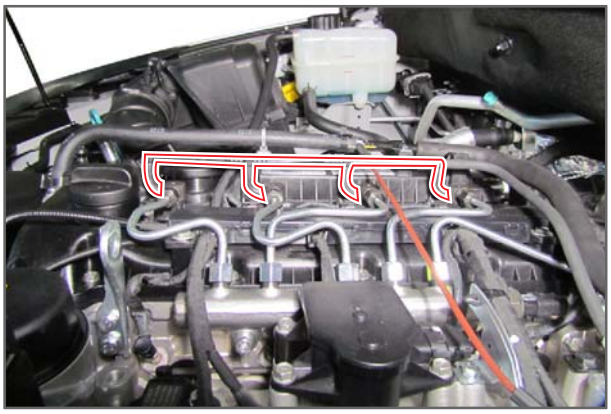
3. Disconnect the key connector for fuel filter connection, and connect both connectors to the fuel filter and hose.



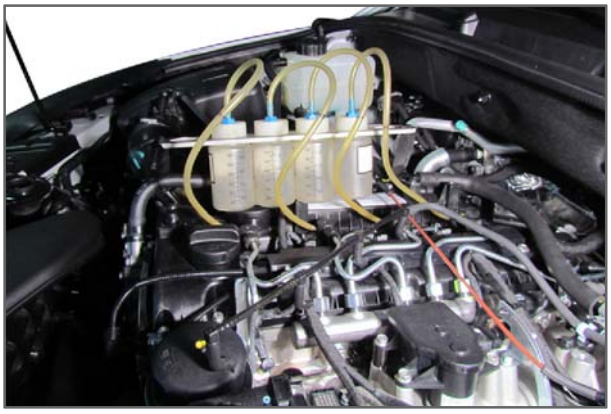
4. Start the engine and check visually for clogged low pressure fuel system, excessive air or air entry.
5. If the fuel flow is not sufficient or air is in the fuel, repair the leak area.

Modification basis	
Application basis	
Affected VIN	

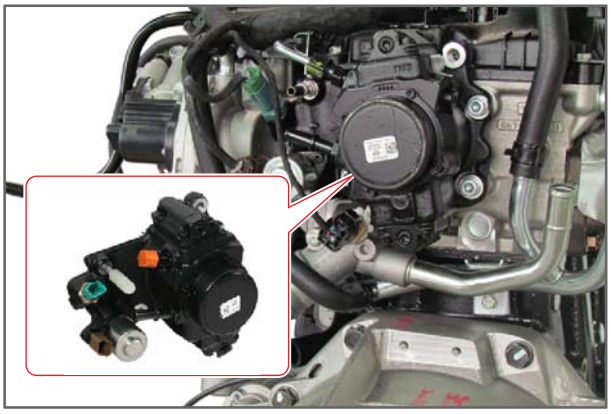
▶ Static test for backleak of injector



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



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



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

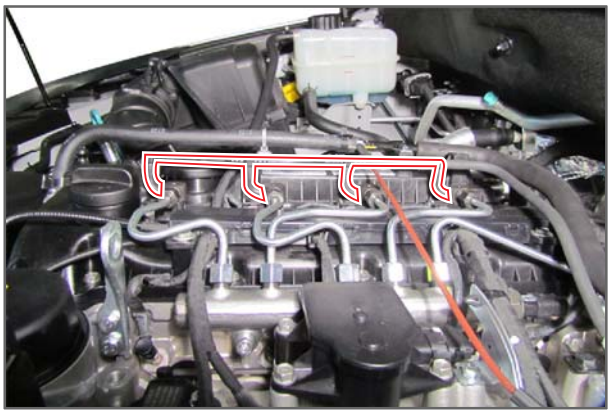
CAUTION
The connector of the injector can be easily contaminated. Always keep it clean.

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

Specification	Below 20 sec.

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

▶ Dynamic test for backleak of injector



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

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

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

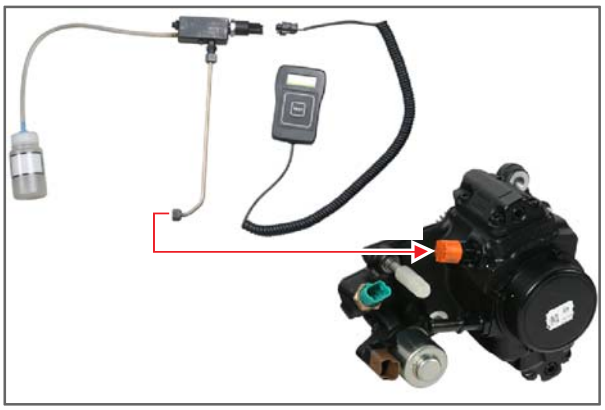
6. Check the amount of backleak collected into the container and confirm that it is within the specified range.

Specification	38 ml or less

Modification basis	
Application basis	
Affected VIN	

▶ HP pump pressure test

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



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

Tightening torque 30Nm

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

Tightening torque 30Nm

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

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

Specification	1,050 bar or more

3. CAUTIONS FOR DI ENGINE

1) Cautions for DI Engine

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

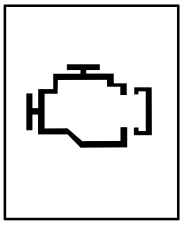
1. DI Engine

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

2. System Safety Mode

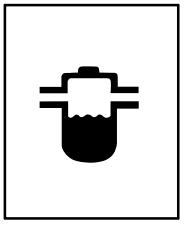
When a severe failure has been occurred in a vehicle, the system safety mode is activated to protect the system. It reduces the driving force, restricts the engine speed (rpm) and stops engine operation. Refer to "Diagnosis" section in this manual.

3. Engine CHECK Warning Lamp



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

4. Water Separator Warning Lamp



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

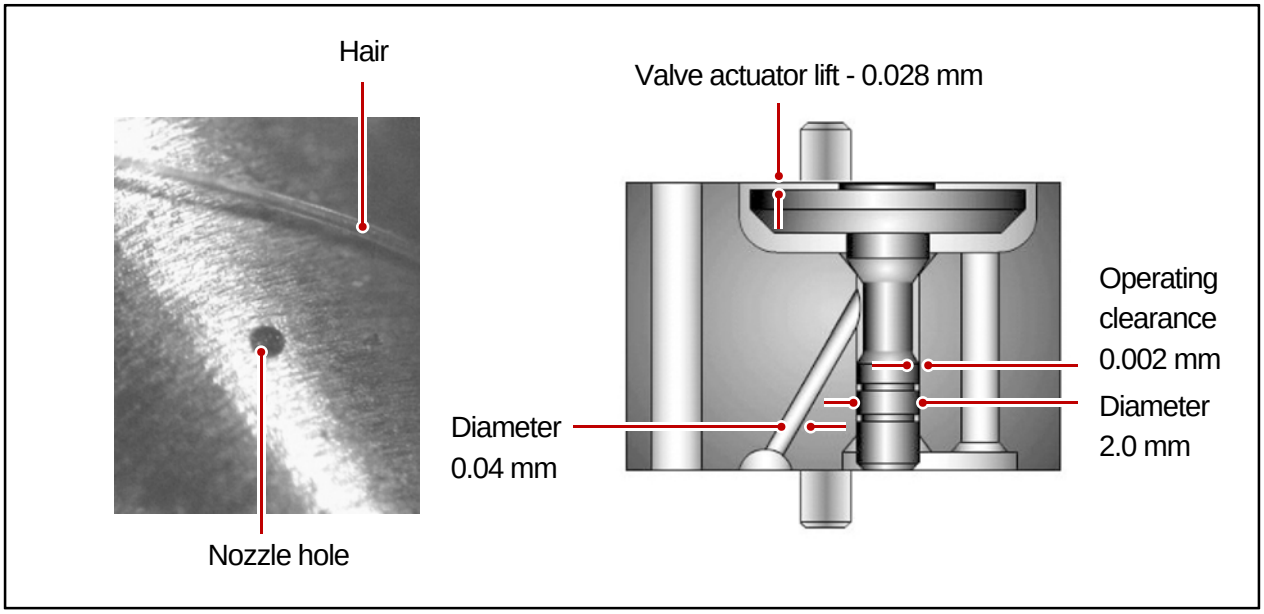
Modification basis	
Application basis	
Affected VIN	

2) Cleanness

(1) Cleanness of DI engine fuel system

▶ Cleanness of DI engine fuel system and service procedures

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



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

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

▶ System supplement against paraffin separation

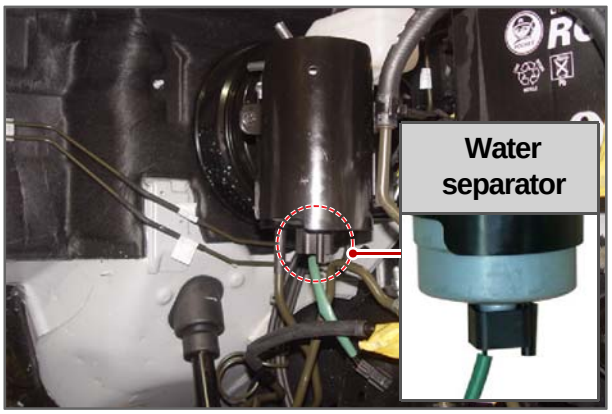
In case of Diesel fuel, paraffin, one of the elements, can be separated from fuel during winter and then can stick on the fuel filter blocking fuel flow and causing difficult starting finally. Oil companies supply summer fuel and winter fuel by differentiating mixing ratio of kerosene and other elements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

▶ System supplement and remedy against water in fuel

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

▶ Water drain from water separator

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



NOTE

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

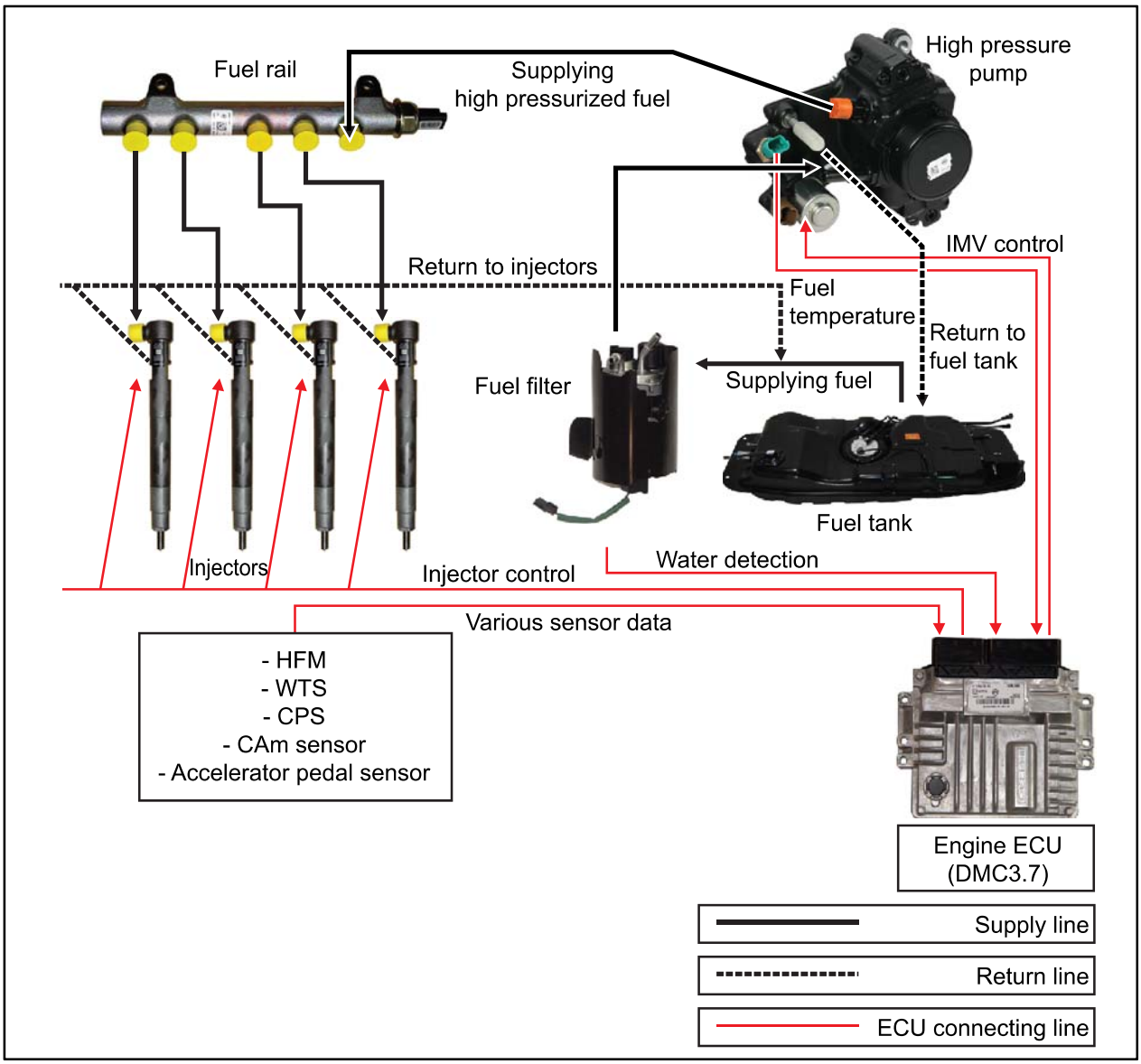
Modification basis	
Application basis	
Affected VIN	

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

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

1) Fuel Flow Diagram



2. SYSTEM LAYOUT AND OPERATION

1) Layout

NOTE

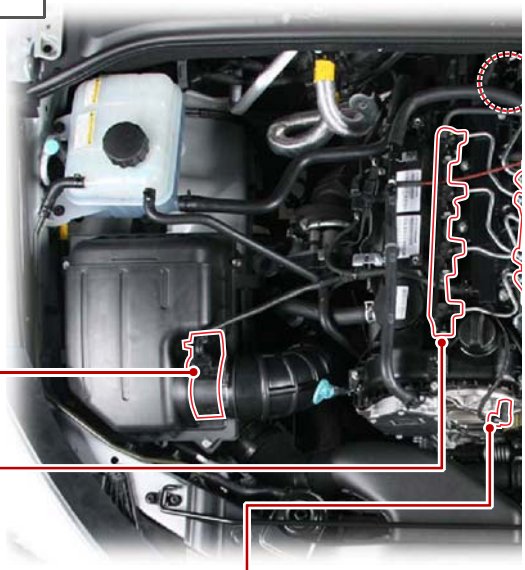
For sensor and actuator control logic, refer to Chapter "Engine Control".

Engine ECU (D20DTR)

Engine control by various signals

Fuel tank

Fuel metering by sender



HFM sensor

Measuring intake air mass and temperature

Crankshaft position sensor

Measuring engine rpm

Injector (C3I)

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

Camshaft position sensor

Determining injection order

Modification basis	
Application basis	
Affected VIN	

High pressure pump

Plunger type HP pump (1,800 bar)

Vane type LP pump (6 bar)

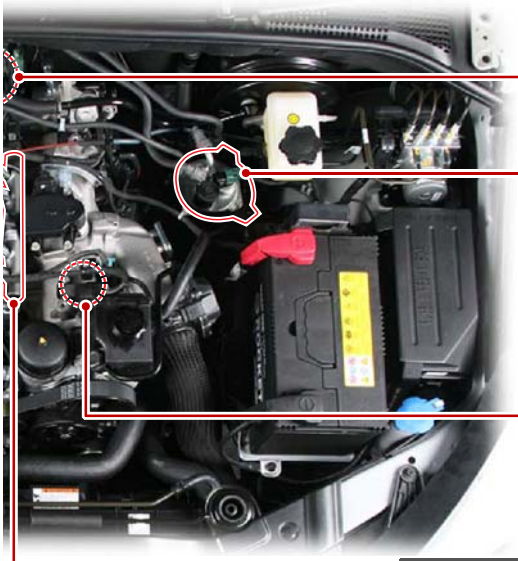
Generating high pressurized fuel and supplying it according to engine rpm, required volume, required pressure

Accelerator pedal position sensor

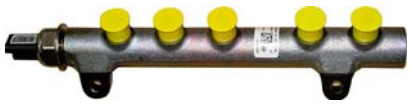
Detecting driver's intention for speed up/down

Fuel filter assembly

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



Fuel rail assembly



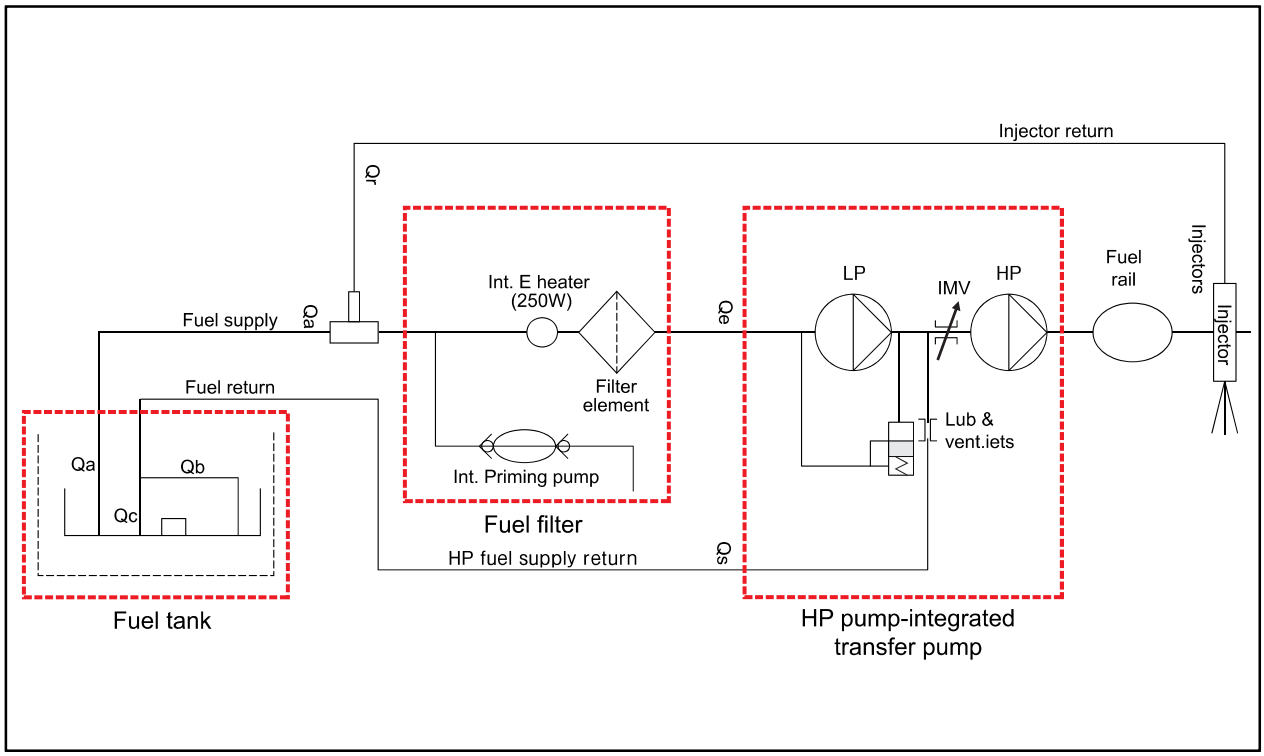
Relieving the pulsation.
Measuring the fuel pressure.
Distributing the fuel to injectors.

T-MAP sensor

Measuring booster pressure and temperature

Modification basis	
Application basis	
Affected VIN	

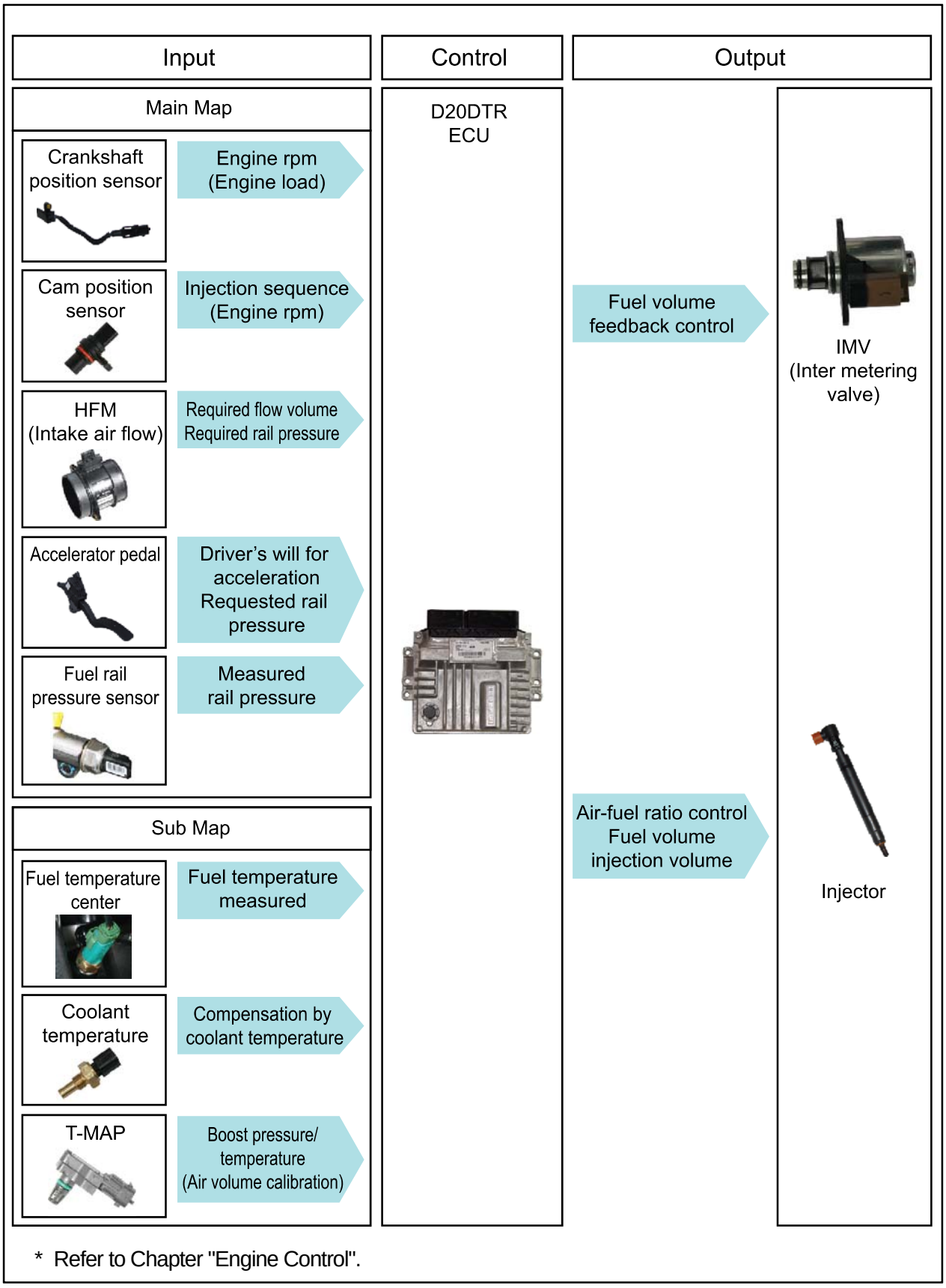
2) Fuel System Flow Diagram



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

Modification basis	
Application basis	
Affected VIN	

3) Input/Output devices



* 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; Clean or change every 20,000 km
		GEN: Clean or 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

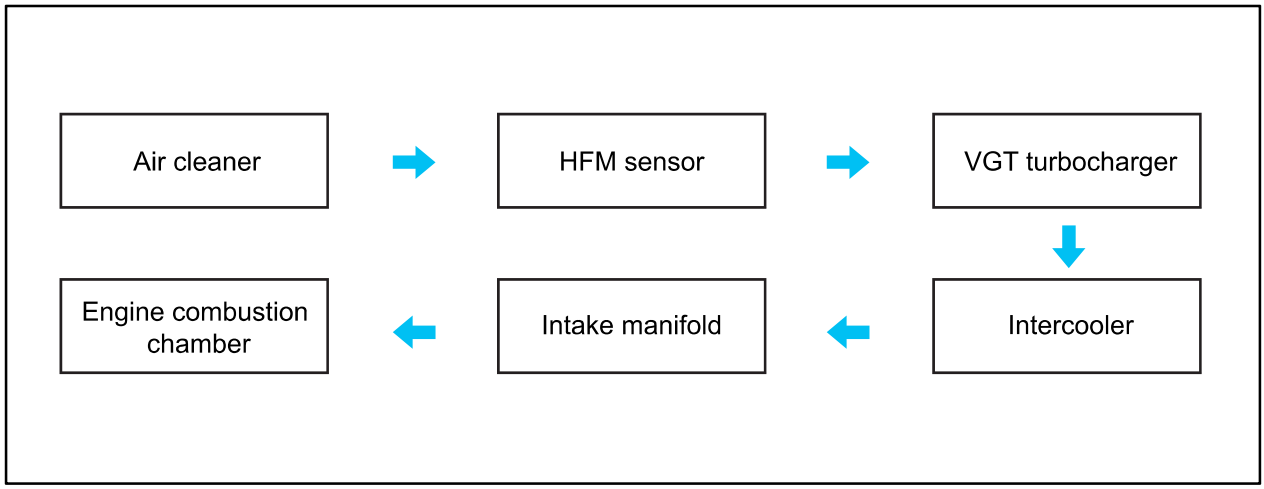
1) Troubleshooting

▶ **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

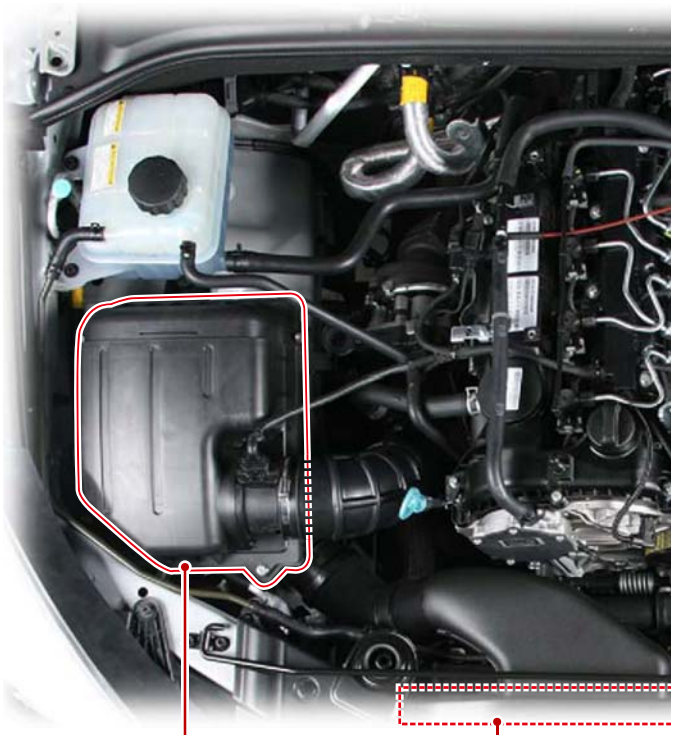
1. OVERVIEW

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

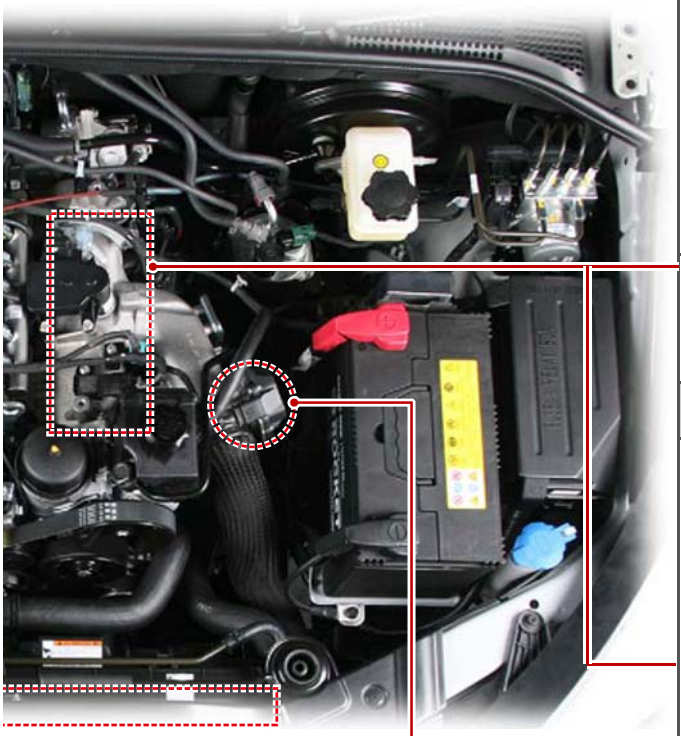
HFM sensor, version 6
*For more information, refer to Chapter "Engine Control".



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

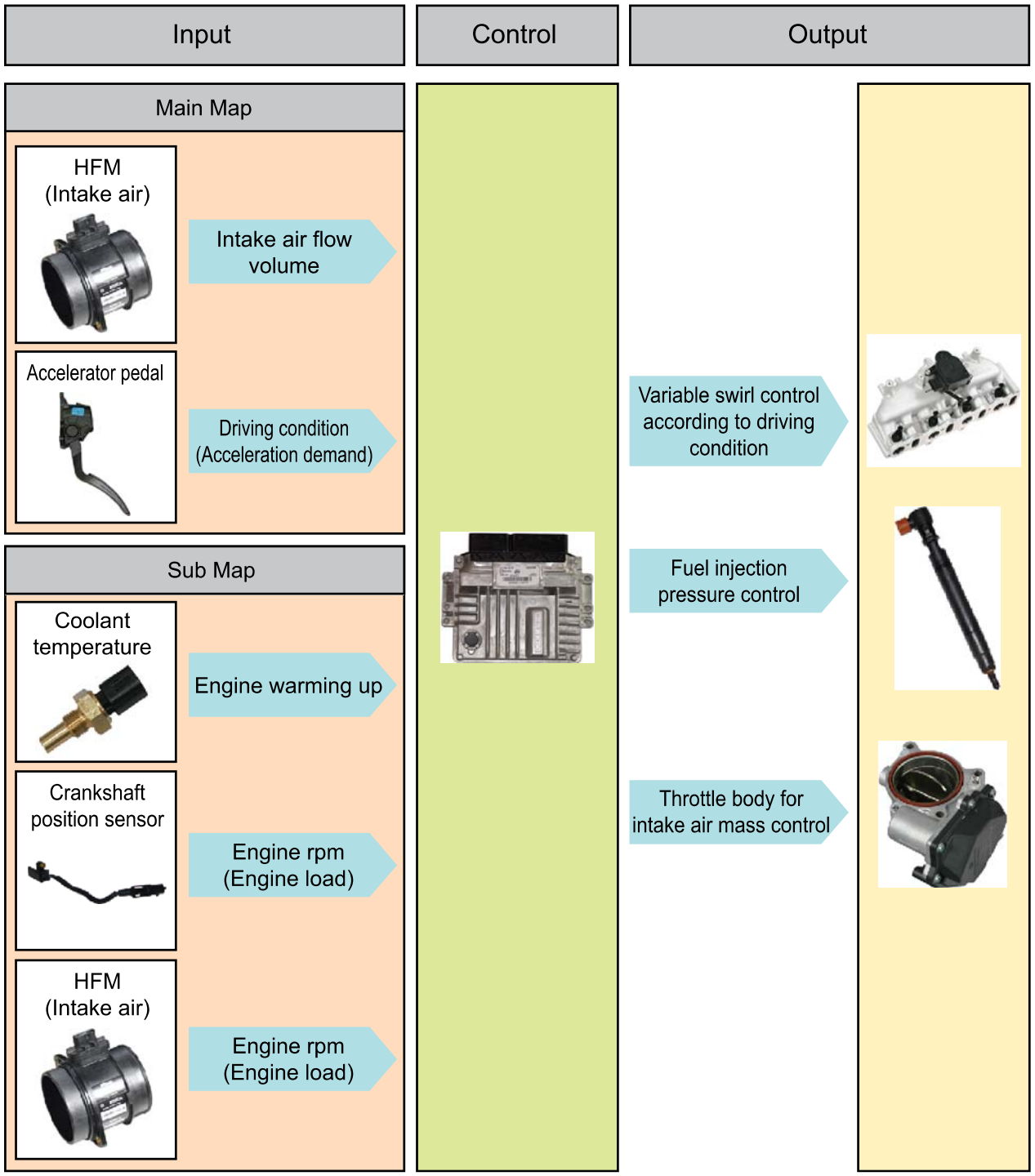
Passage for variable swirl valve and for intake air

1719-16	Electric throttle body

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

Modification basis	
Application basis	
Affected VIN	

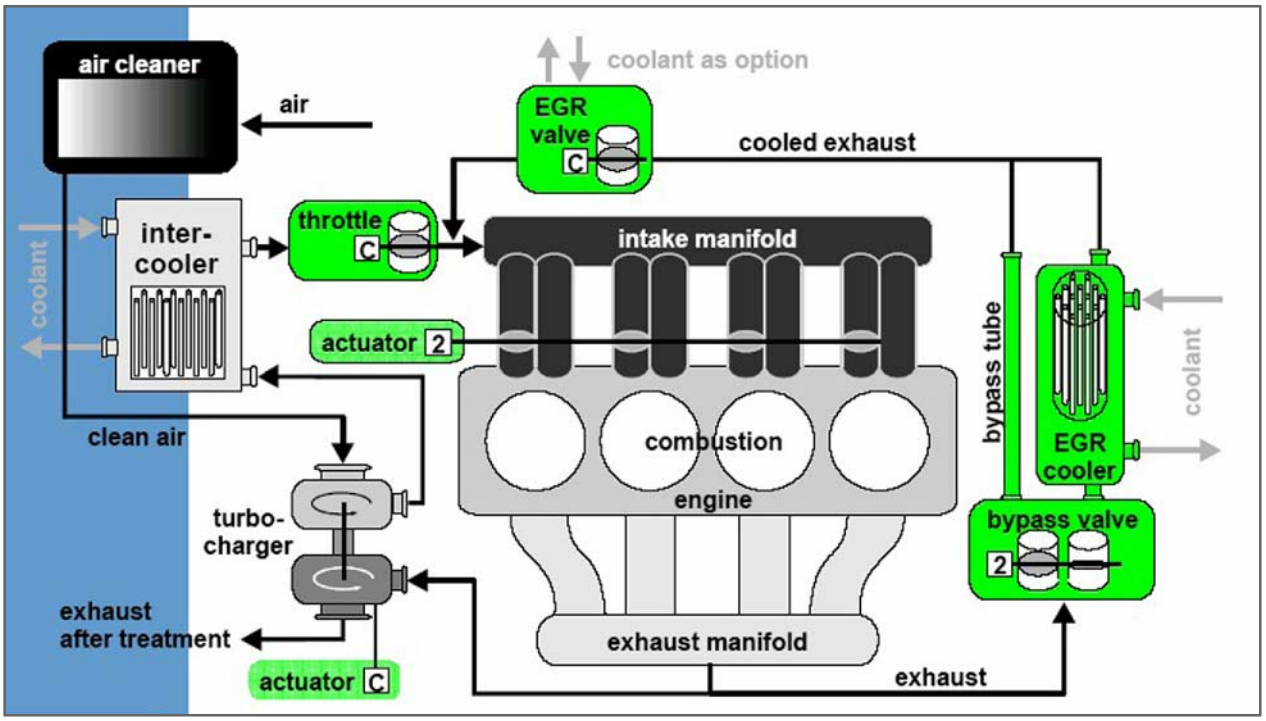
3. INPUT/OUTPUT OF INTAKE SYSTEM



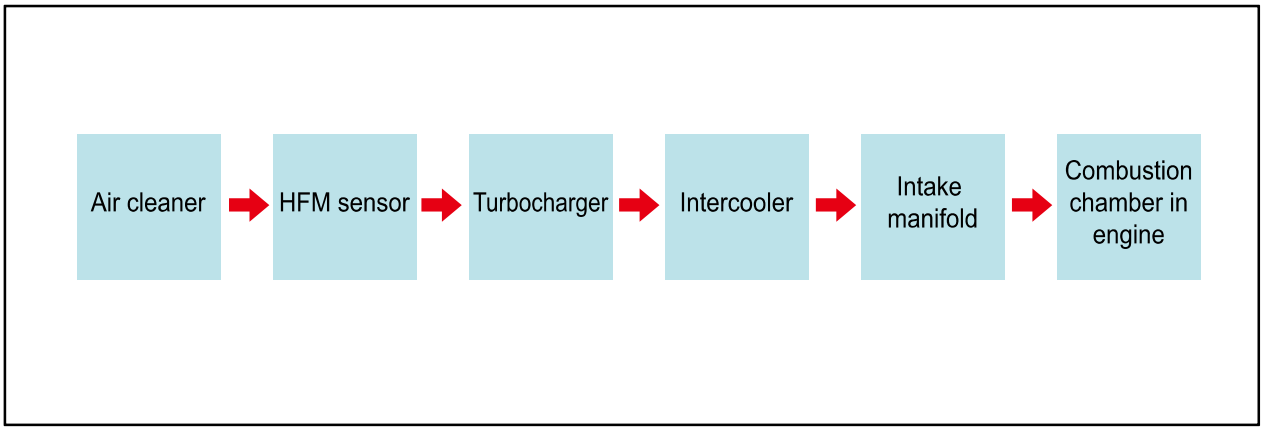
* For more information, refer to Chapter " Engine Control".

Modification basis	
Application basis	
Affected VIN	

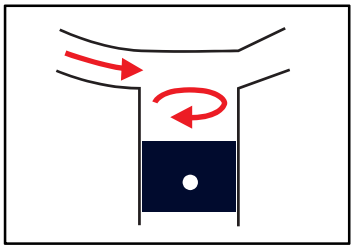
4. OPERATING PROCESS



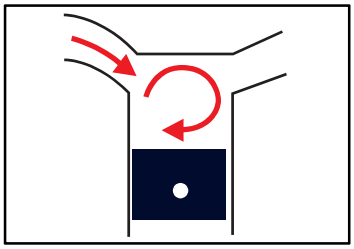
▶ **Work Flow**



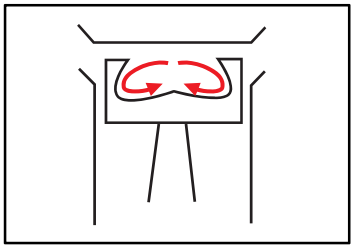
1) Types of swirl



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.



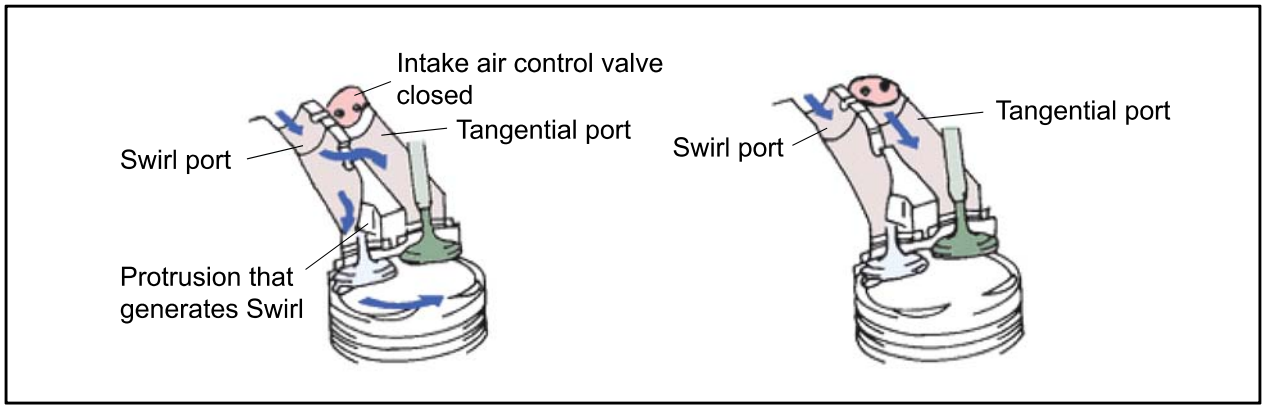
Tumble: Tumble is the vertical air flows in cylinder due to the vertical intake air port



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.

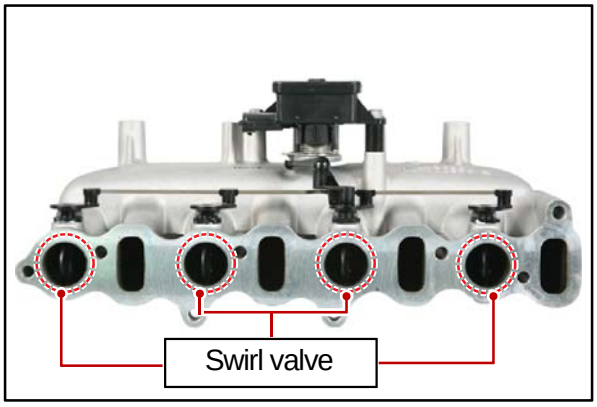
2) Swirl control

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.

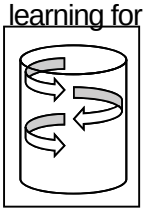


Modification basis	
Application basis	
Affected VIN	

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.

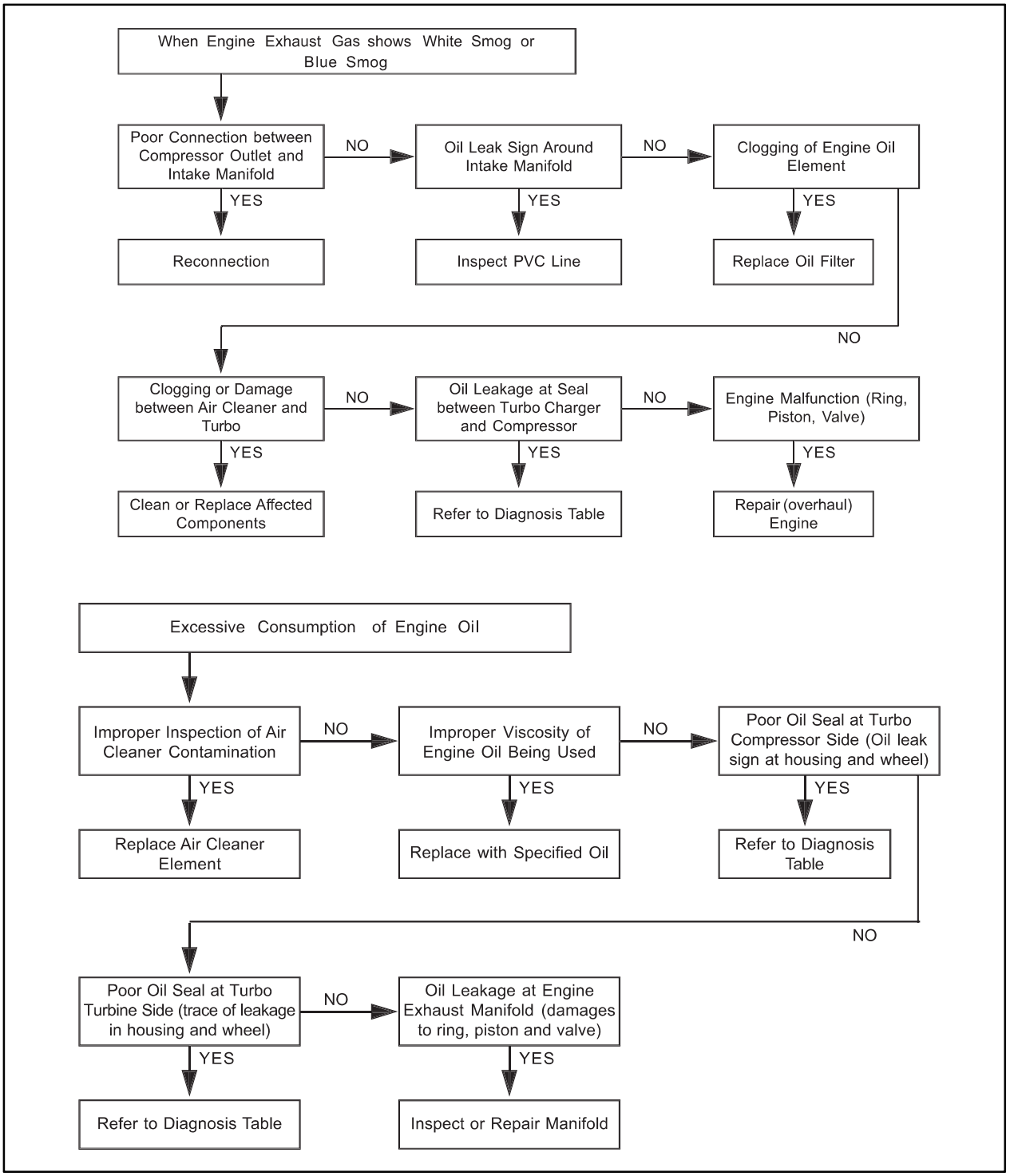
ENGINE EXHAUST SYSTEM

1729-01

GENERAL INFORMATION

1. TROUBLESHOOTING

1) Work Flow



Modification basis	
Application basis	
Affected VIN	

2. CAUTIONS

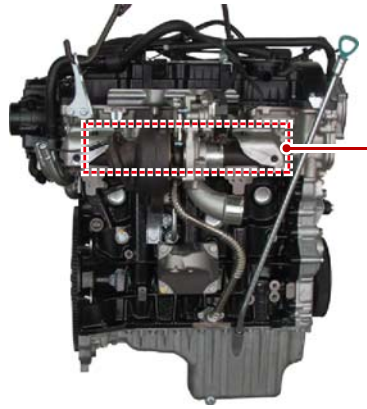
- Do not park the vehicle on flammable materials, such as grass, leaves and carpet.
- Do not touch the catalyst or the exhaust gas ignition system when the engine is running.
- If a misfire occurs in the combustion chamber or the emission of pollutant exceeds the specified level, the catalyst can be 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.

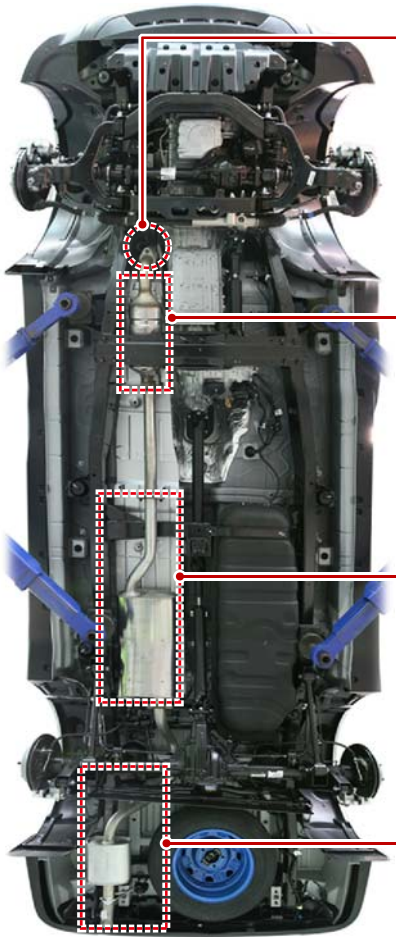
OVERVIEW AND OPERATING PROCESS

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".

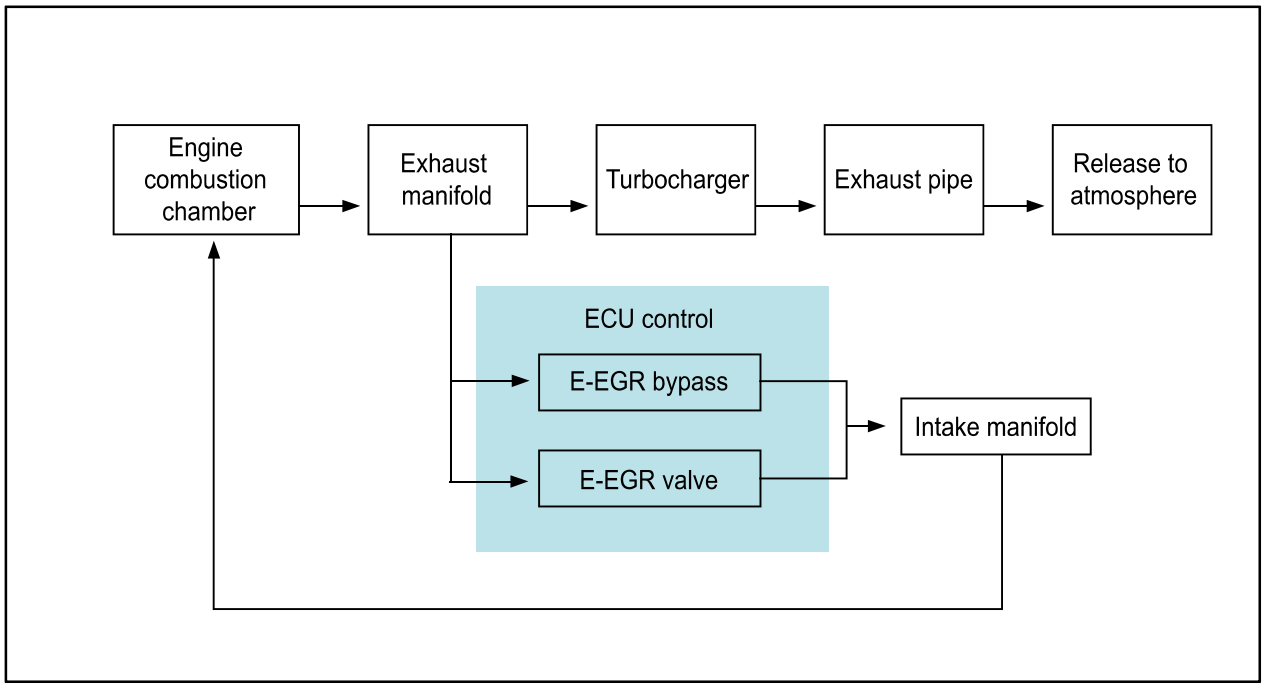
Muffler assembly

Exhaust tail pipe assembly

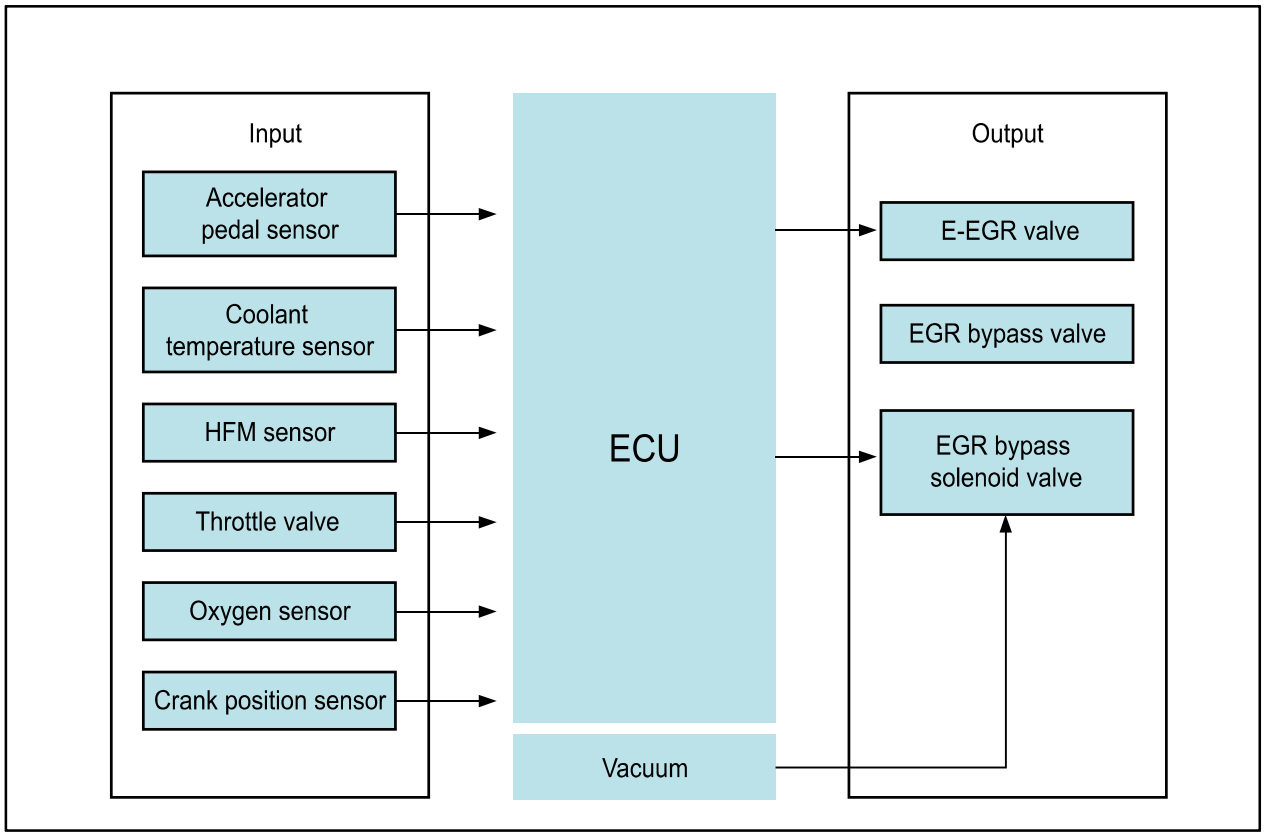
Modification basis	
Application basis	
Affected VIN	

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.
2. If the engine is running radically after replacing the engine oil or oil filter brings poor oil supply 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.
3. When the engine is stopped abruptly after driving at high speed, the turbocharger continues to rotate 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.

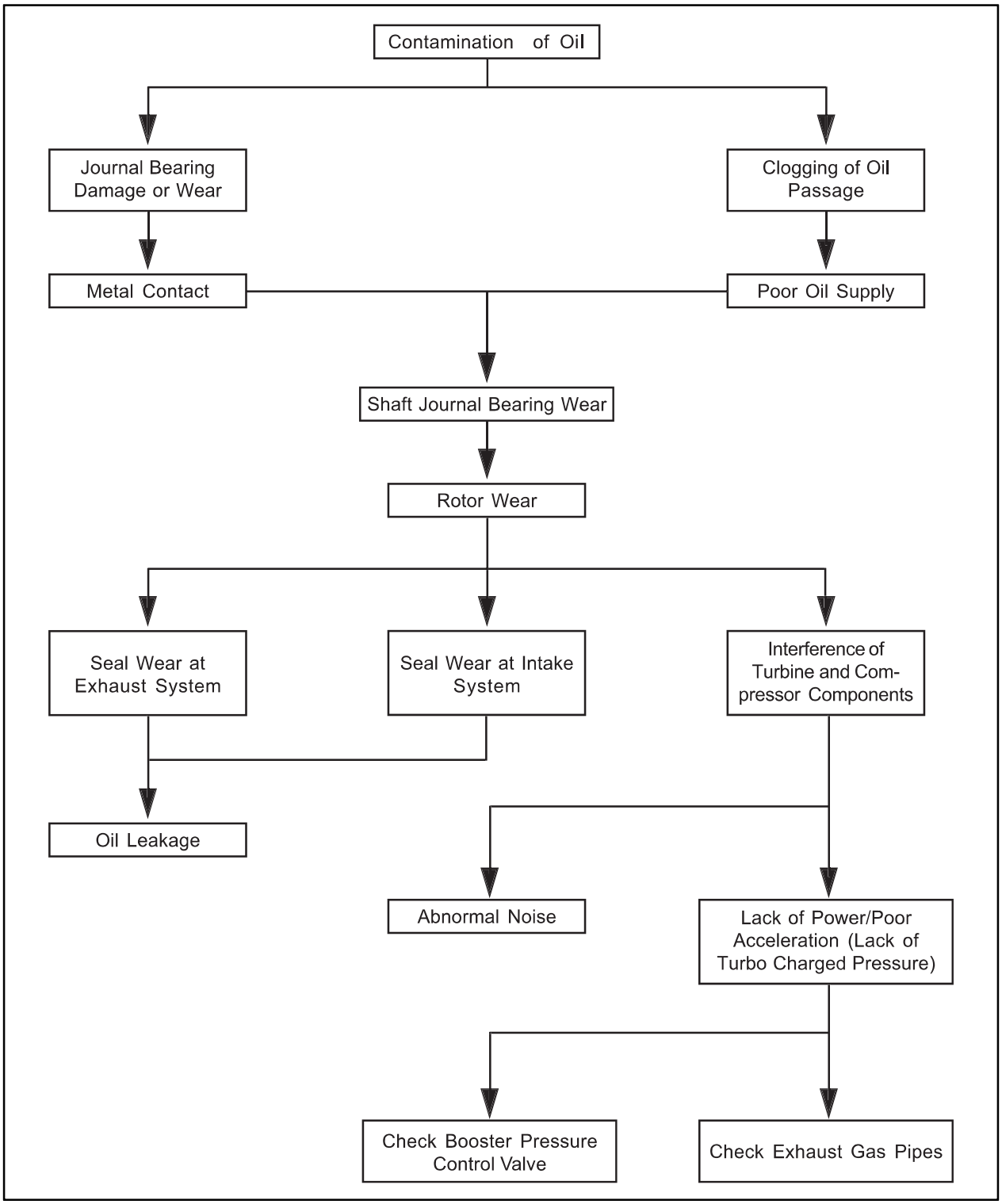
Damages by foreign materials: In case where the compressor wheel is damaged by foreign materials requires having an overhaul. At this time, it's necessary to check whether the foreign materials have contaminated intake/exhaust manifold or inside of engine.

Modification basis	
Application basis	
Affected VIN	

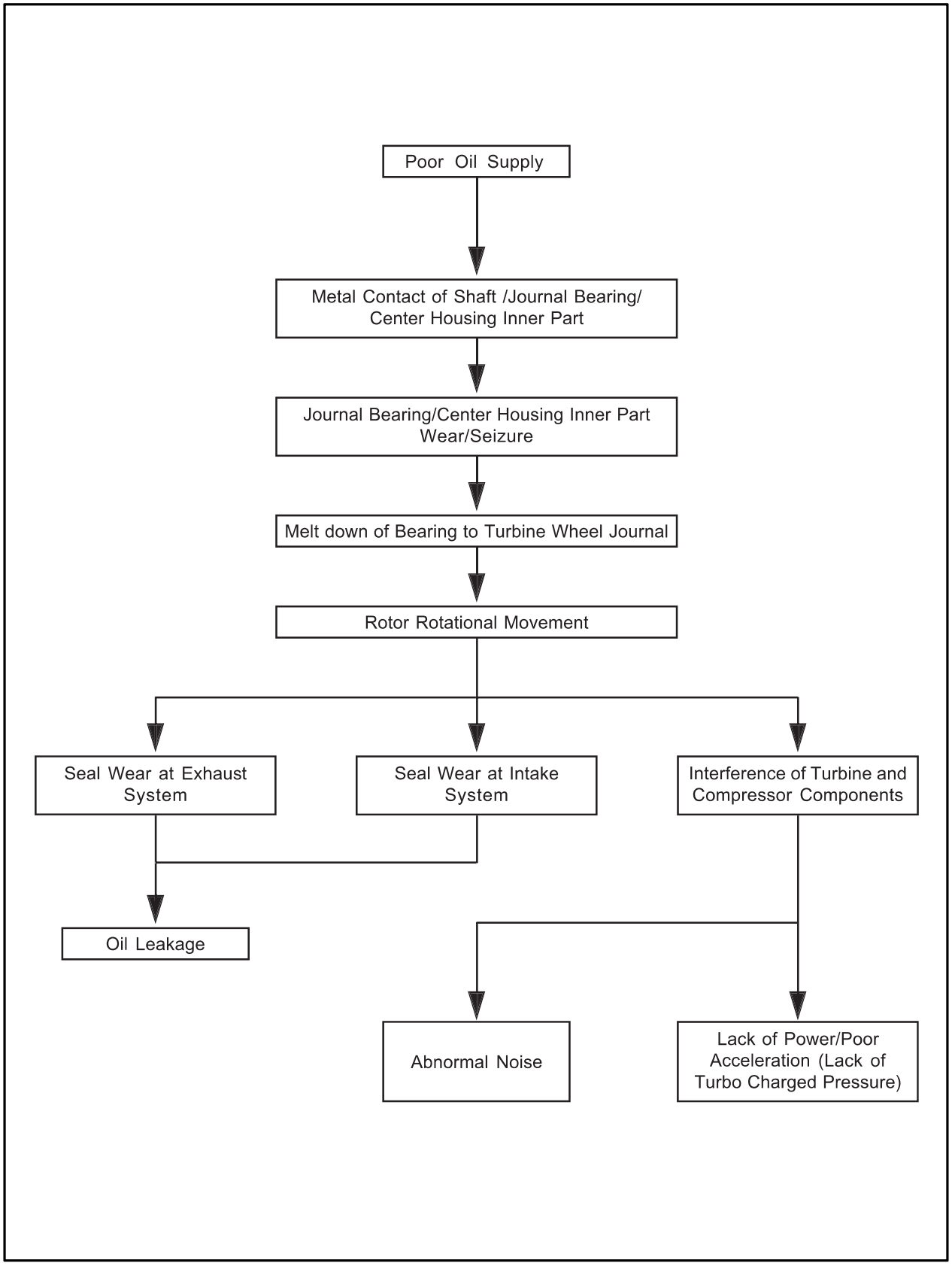
4) Possible Causes of Defect

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.

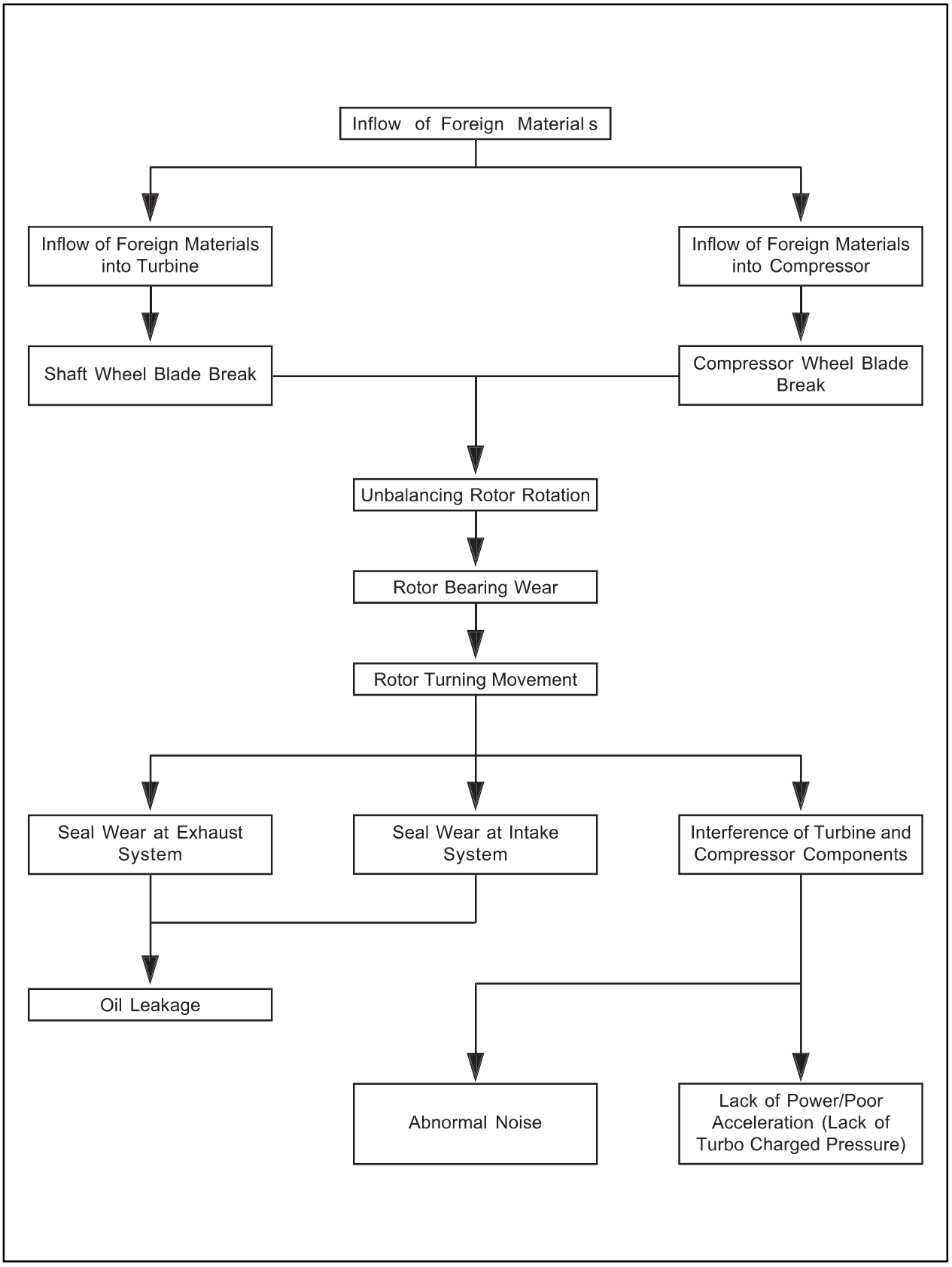


2. Oil Pump Defect: Rapid over-loaded driving after replacing oil filter and oil and clogging of oil line.

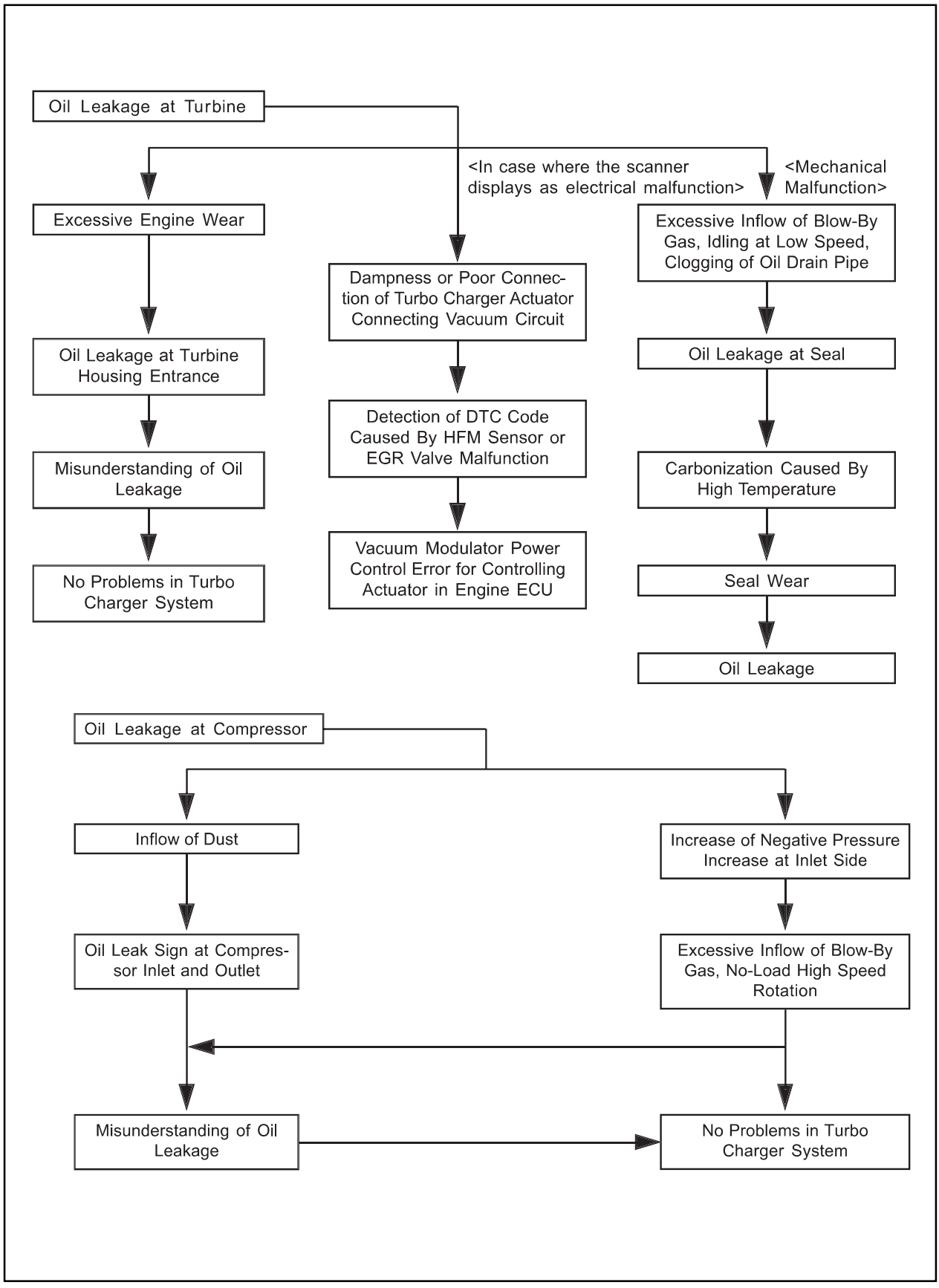


Modification basis	
Application basis	
Affected VIN	

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	

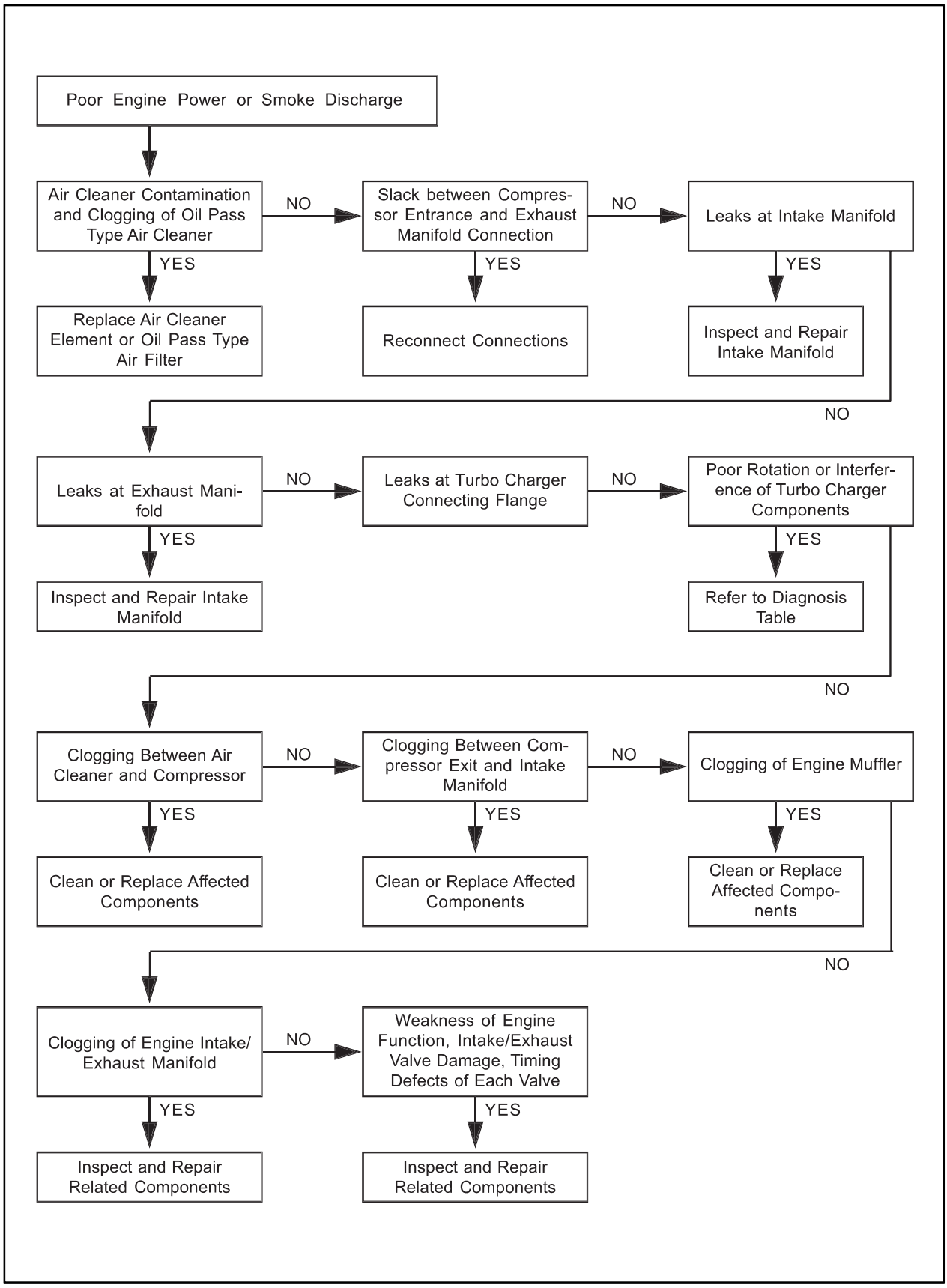
3. TROUBLESHOOTING

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

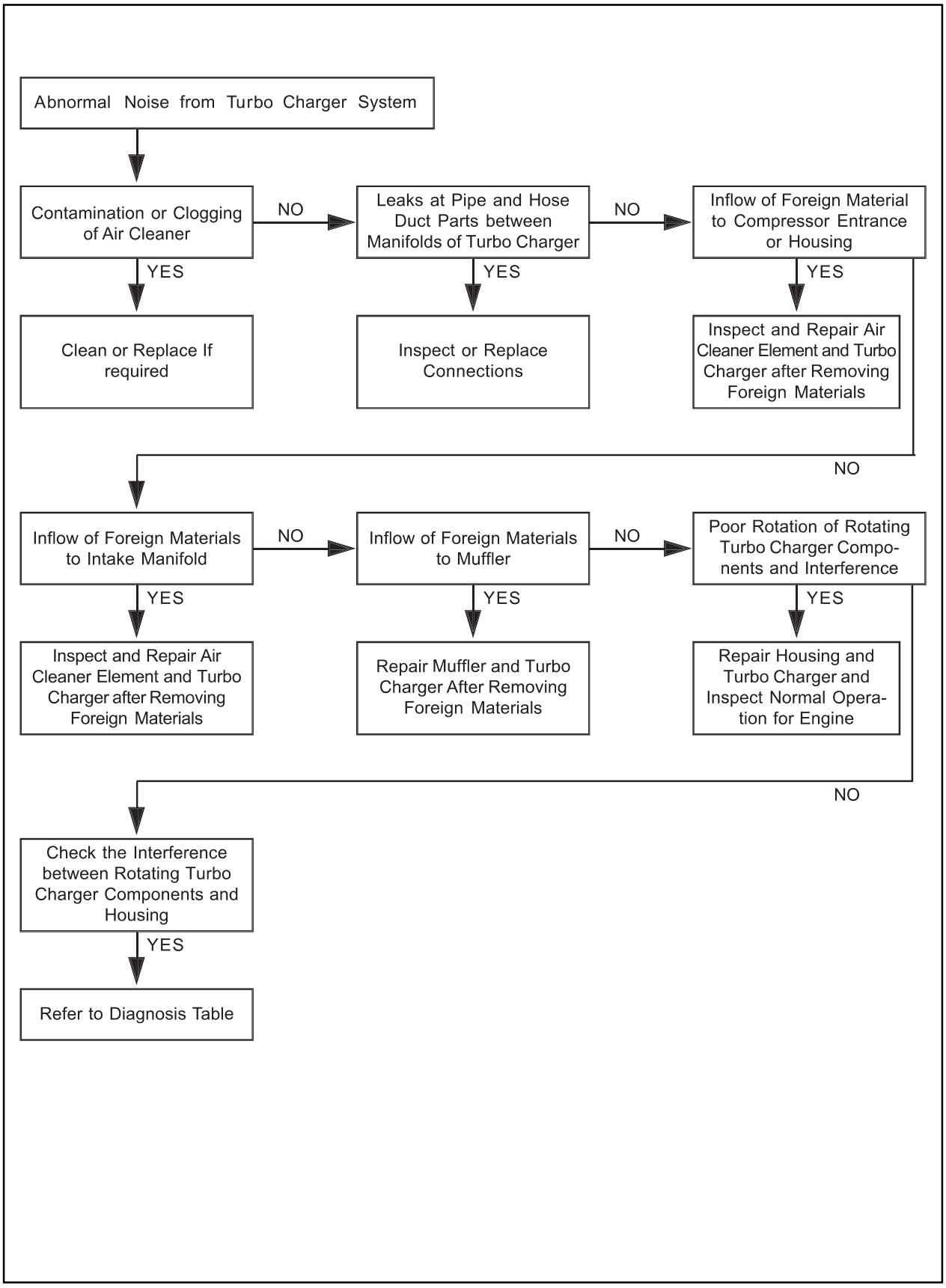
1) Cautions

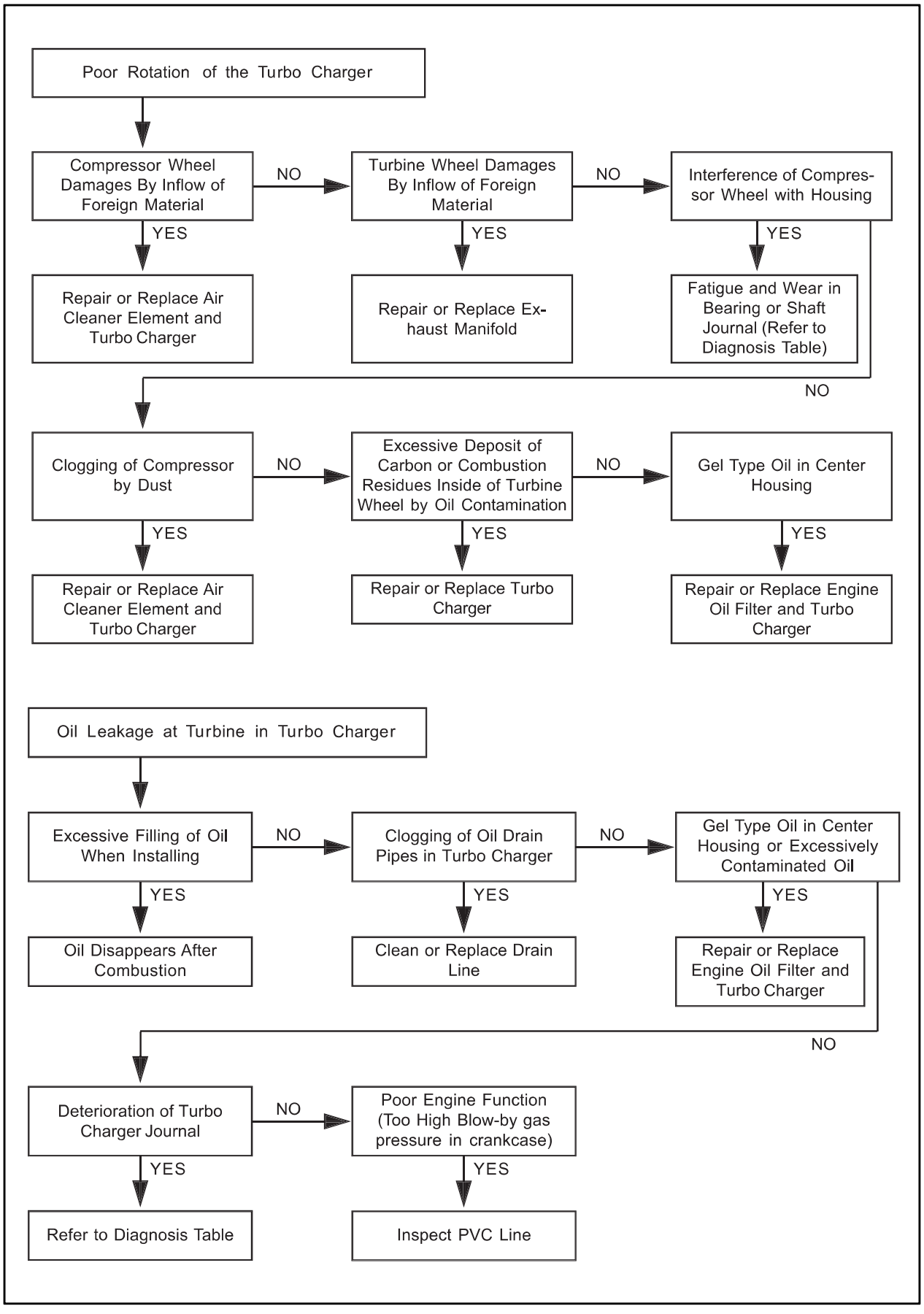
1. After stopping the engine, check whether the bolts on pipe connecting section are loose as well as the connecting condition of vacuum port and modulator, which is connected to the actuator.
2. During idling of the engine, check for leakage in the connecting section of pipe (hoses and pipes, duct connections,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

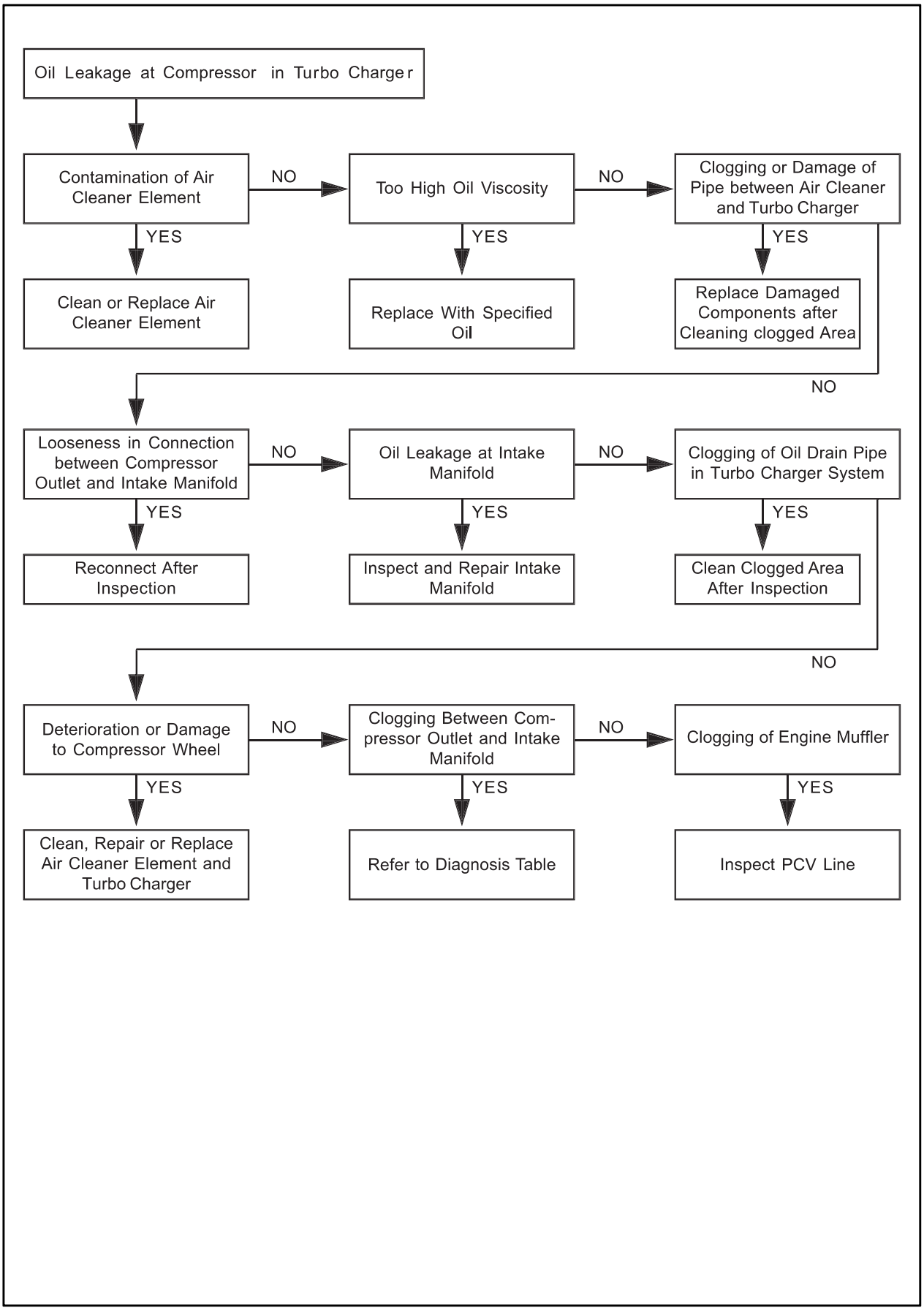


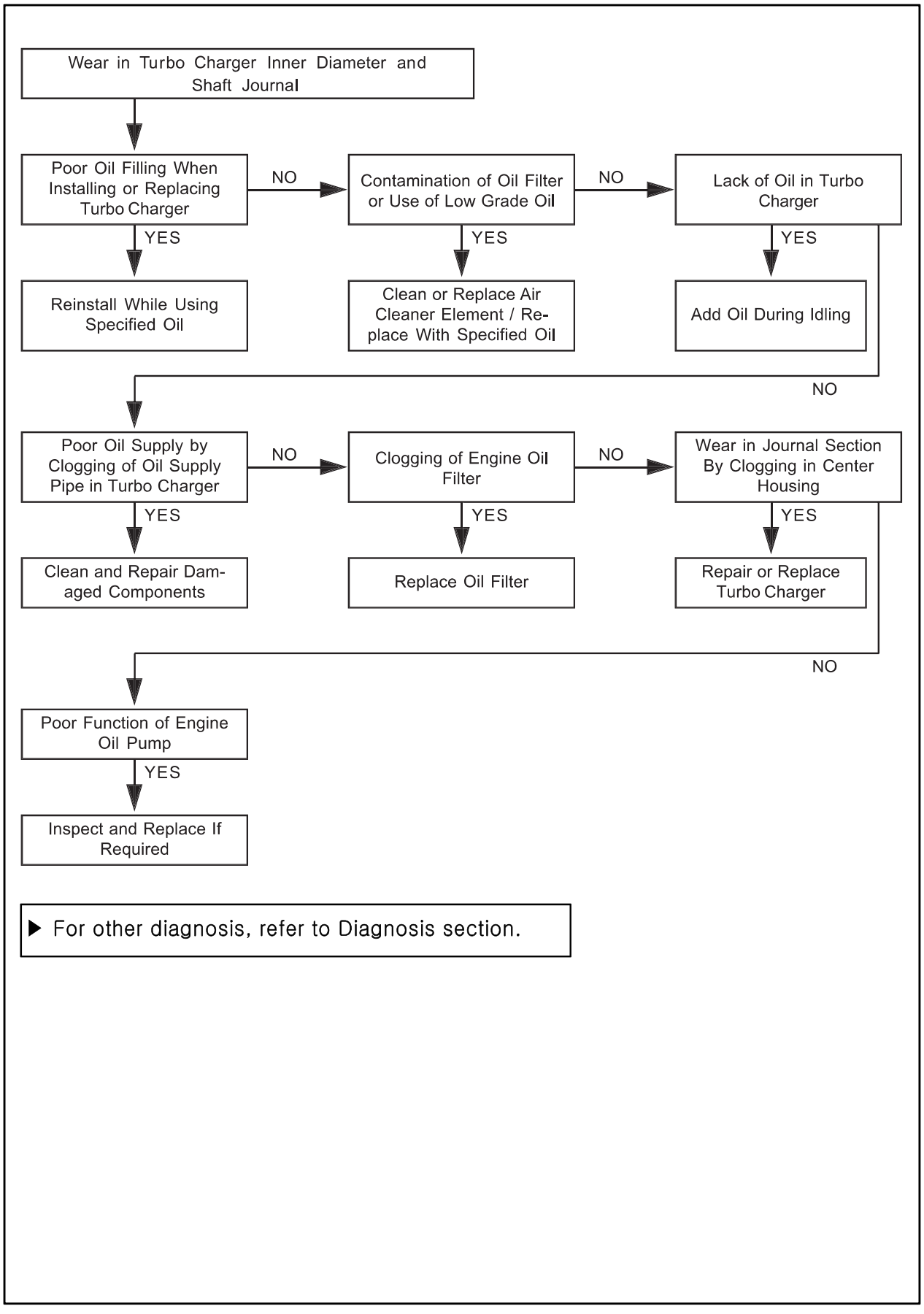
Modification basis	
Application basis	
Affected VIN	


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

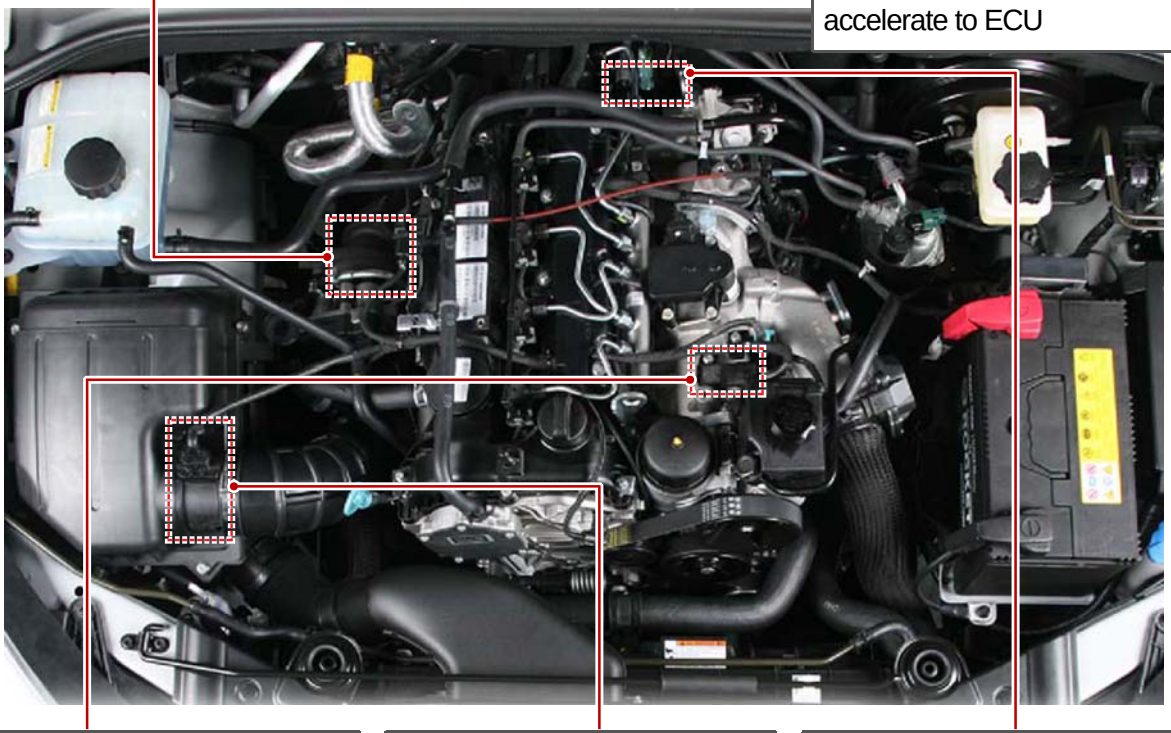
- Improved low speed torque and power
- Reduced exhaust gas
- Improved fuel consumption
- Improved acceleration performance

Modification basis	
Application basis	
Affected VIN	

2. COMPONENTS

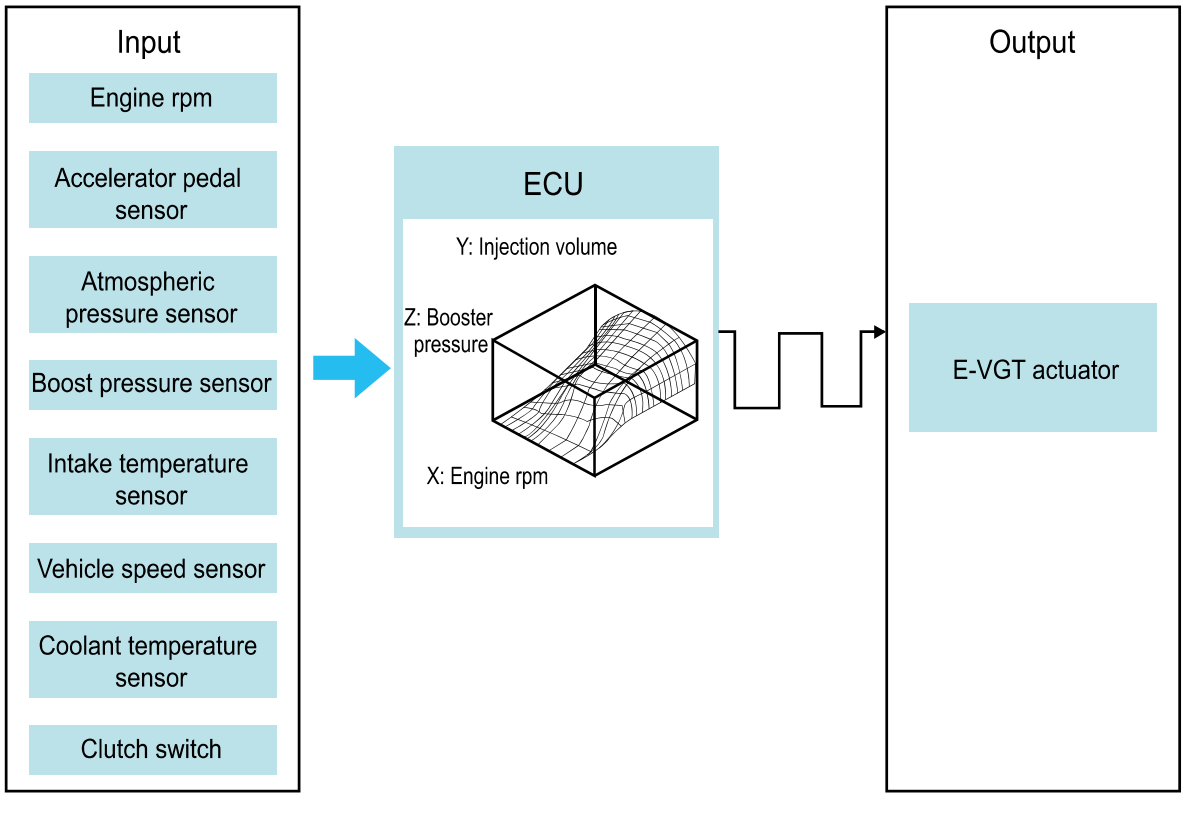
* 세부제어로직은 엔진제어편 참조

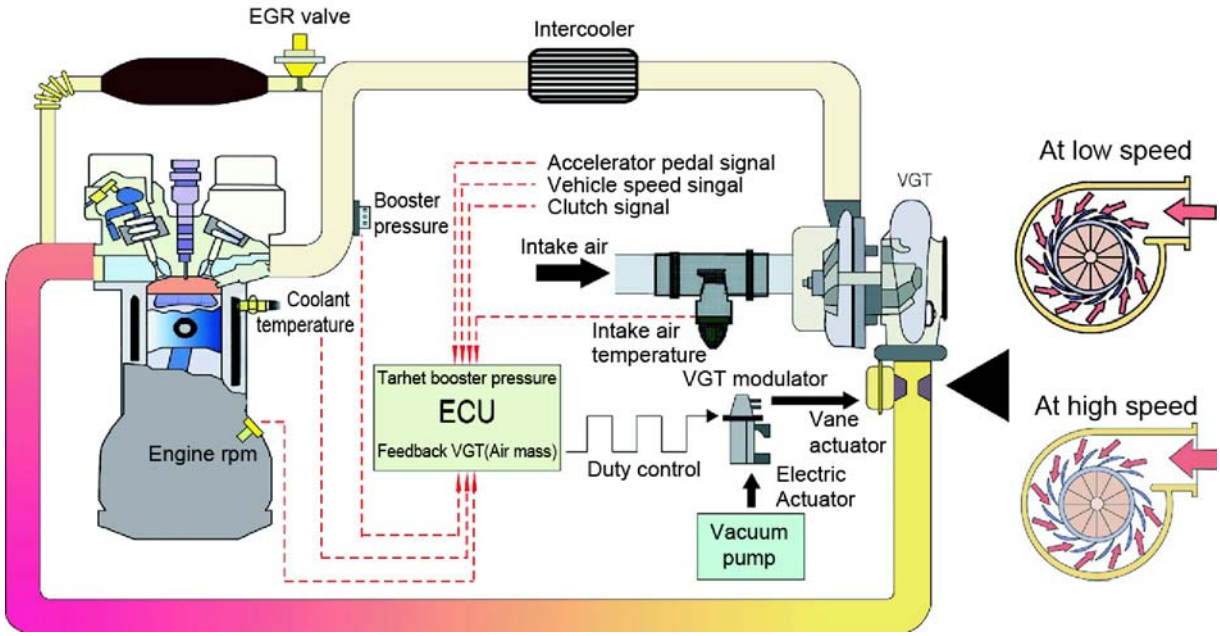
E-VGT turbocharger	Engine ECU (D20DTR)	Accelerator pedal position sensor
	 Atmospheric pressure, RPM signal	
Improves engine power	E-VGT duty control	Transfers driver's will to accelerate to ECU



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





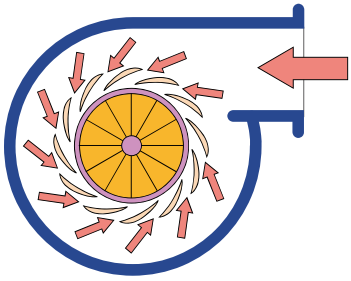
Modification basis	
Application basis	
Affected VIN	

4. OPERATING PRINCIPLES

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

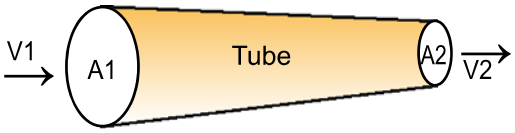
1) How it Works at Low Speed

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

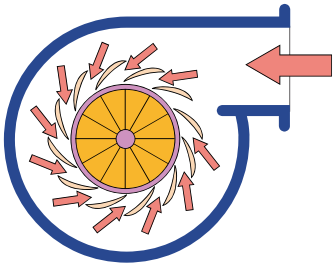
Turbocharger lag

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

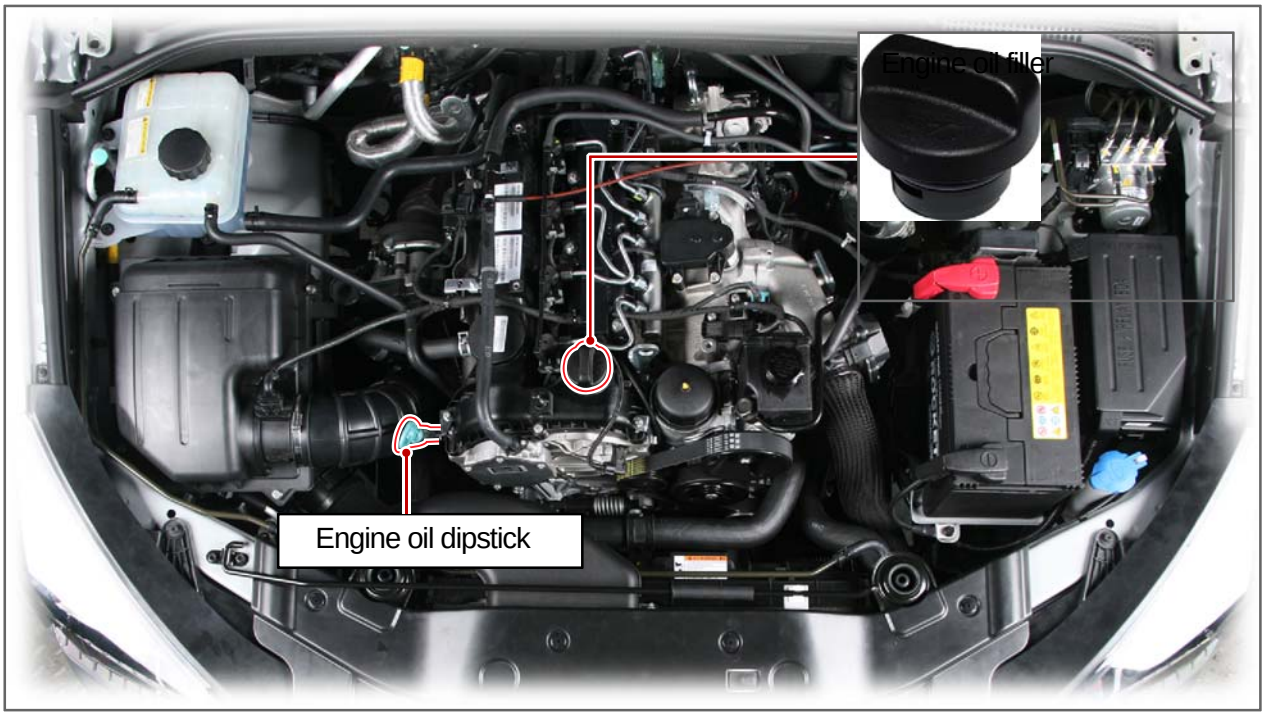
1) Level Check

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	

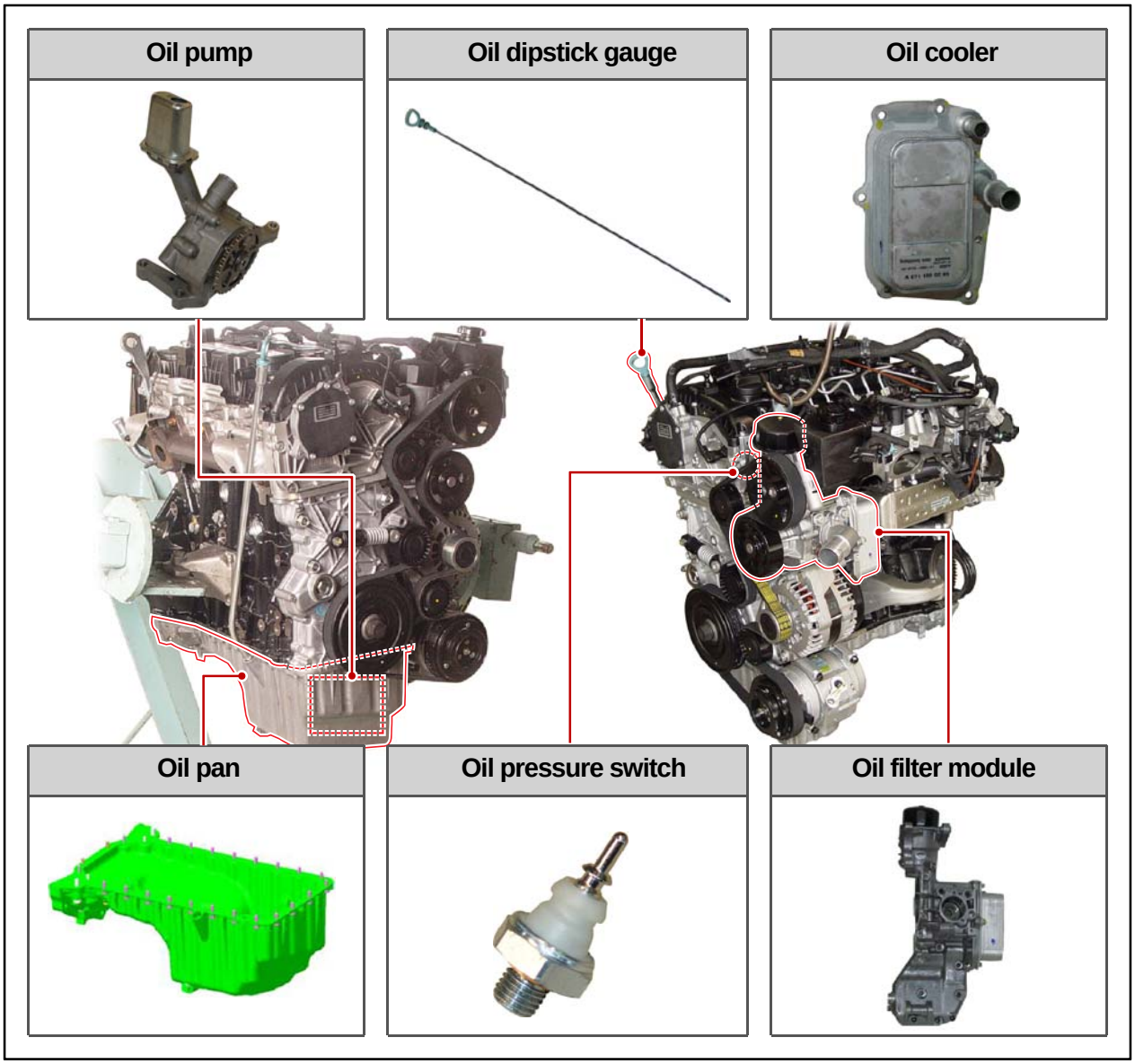
OVERVIEW AND OPERATING PROCESS

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	

COOLING SYSTEM

1520-00

GENERAL INFORMATION

1. SPECIFICATION

Unit	Description	Specification
Cooling system	Type	Water cooling, forced circulation
Coolant	Capacity	approx. 8.5 L
Radiator	Core size	555W x 582.4H x 27T (over 326,250mm2)
	Flow type	Cross flow
	Min. cooling capacity	over 68,000 kcal/h
Antifreeze	Type	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

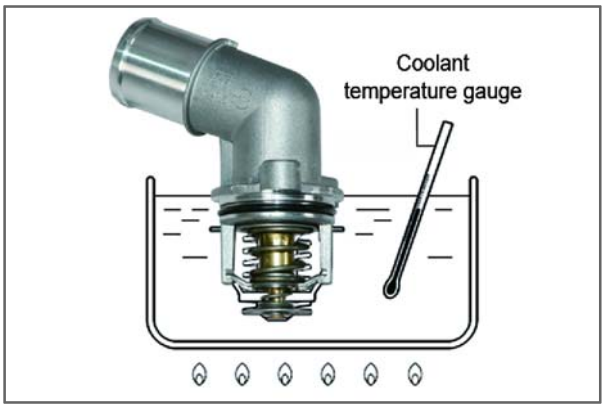
1. Release the pressure in the system by loosening the pressure cap of the coolant reservoir slightly. Then, remove the pressure cap completely.

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.

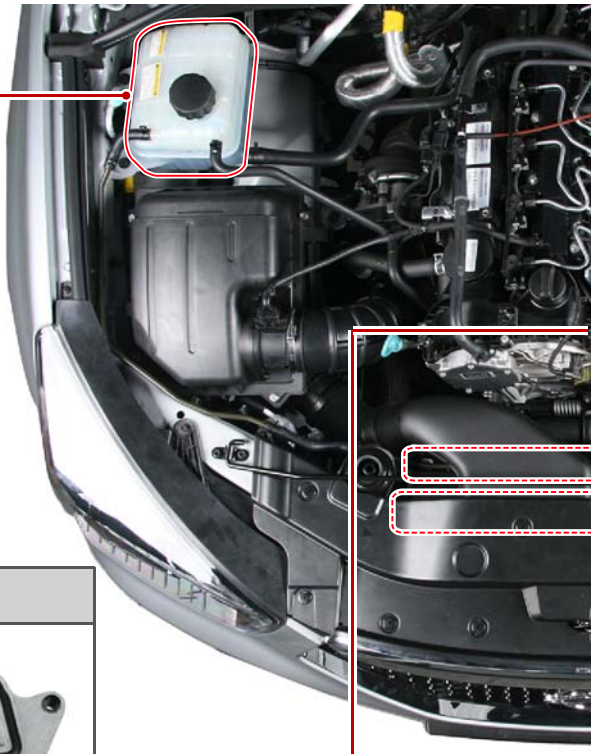
OVERVIEW AND OPERATING PROCESS

1. SYSTEM DESCRIPTION

1) Overview

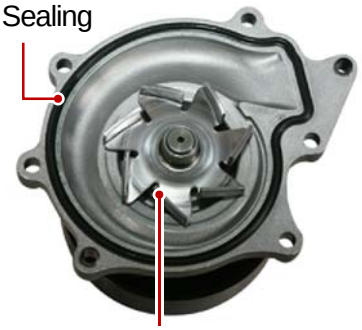
Coolant reservoir

Long life coolant is used.



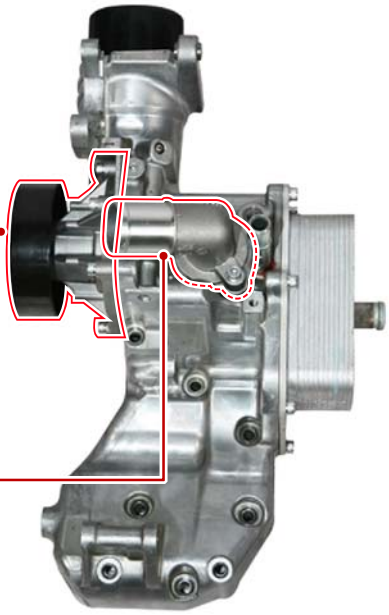
Water pump

Water pump



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

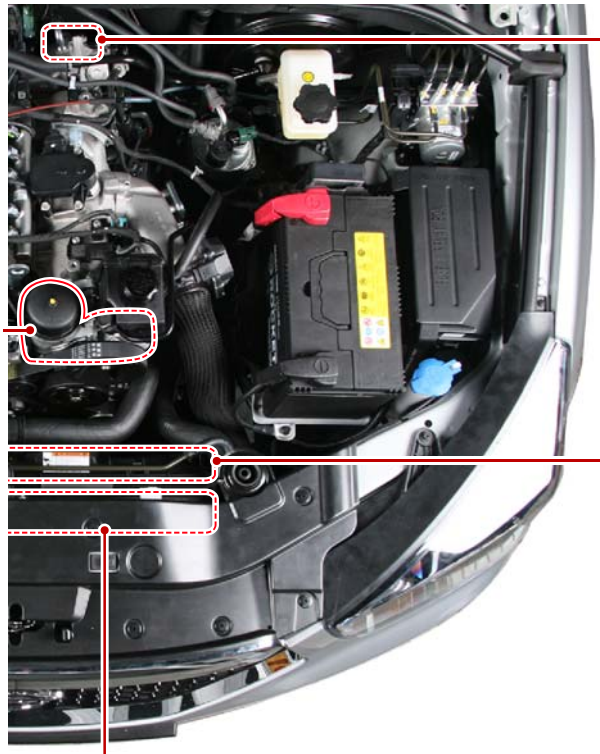
Oil filter module



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.

Modification basis	
Application basis	
Affected VIN	



Coolant temperature sensor

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

Electric fan

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

Radiator

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

Modification basis	
Application basis	
Affected VIN	

CHARGING SYSTEM

1451-01

GENERAL INFORMATION

1. SPECIFICATION

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

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

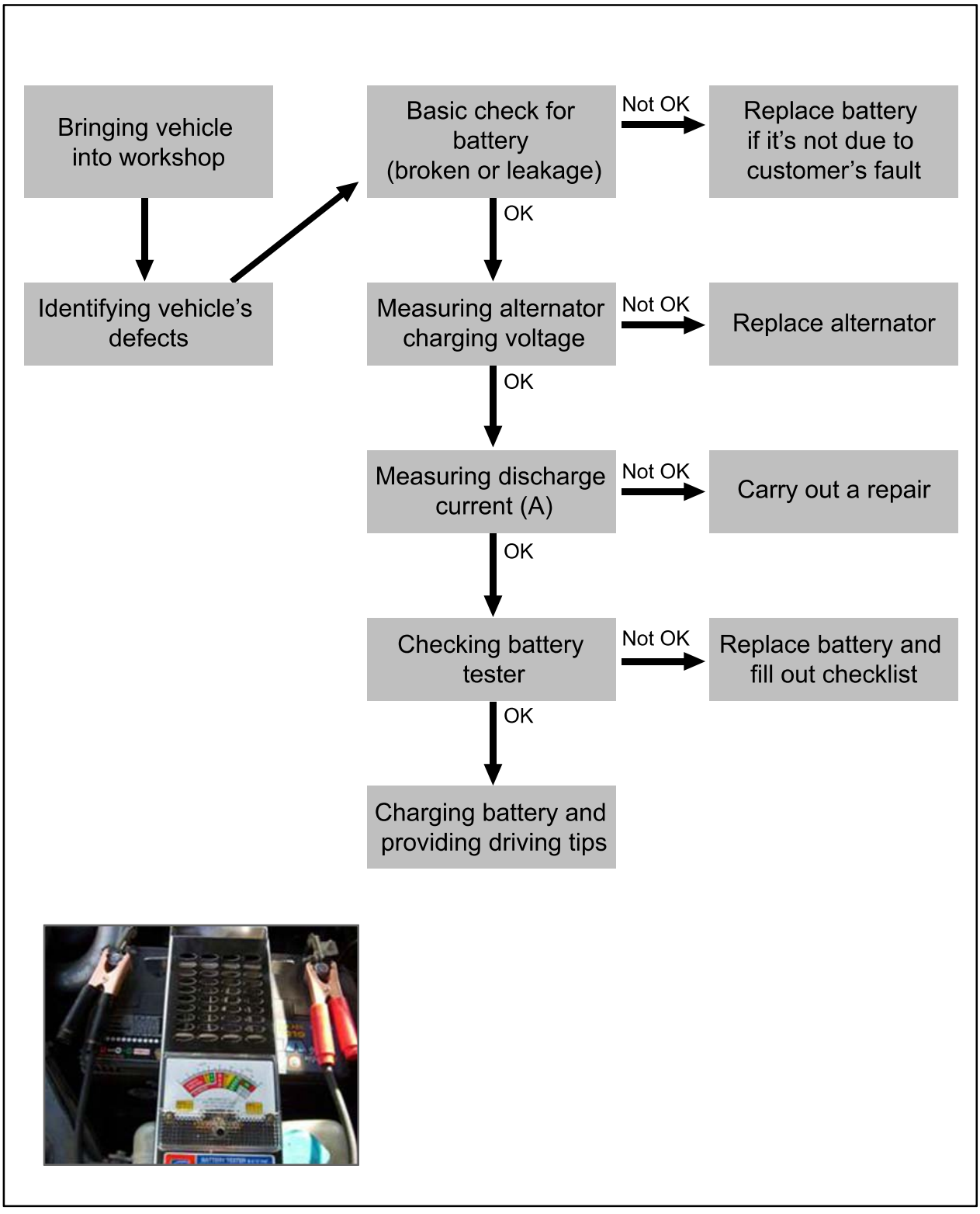
- Disconnect the negative battery cable.
- Connect the negative cable again after connecting the ammeter.

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

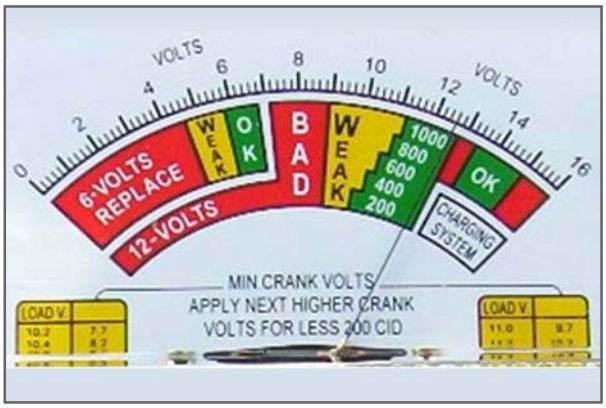
▶ **Using battery tester**

- 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

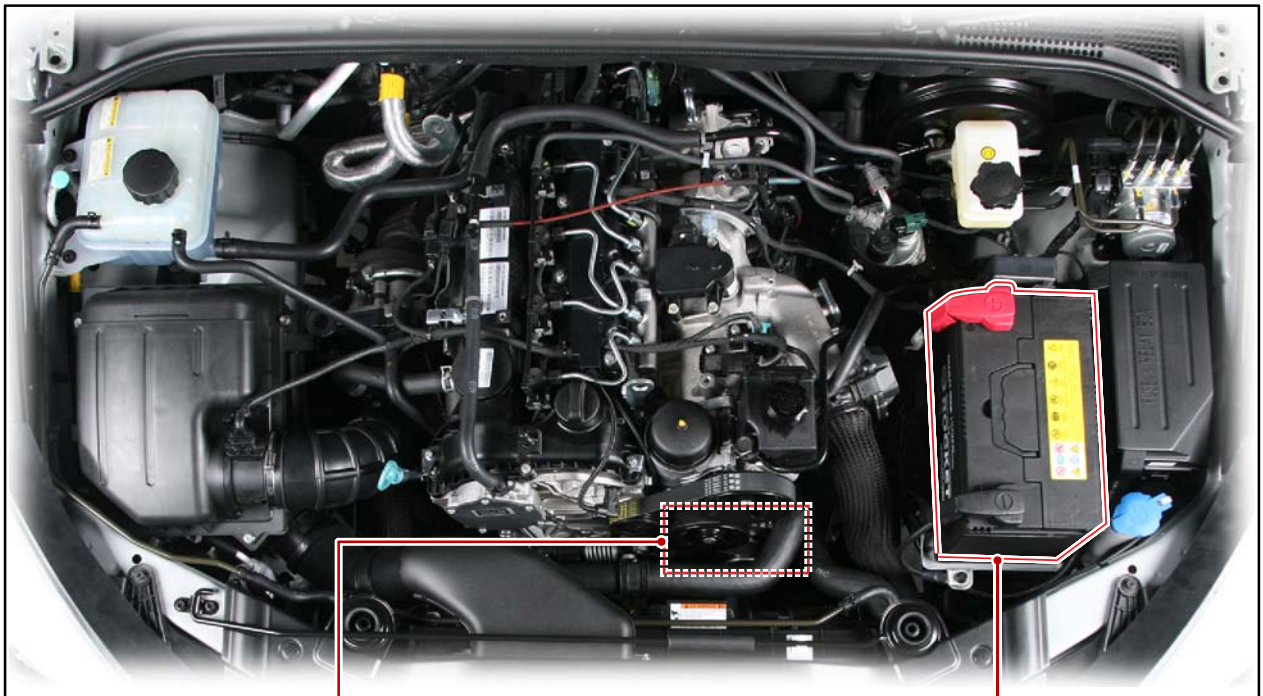
1. SYSTEM DESCRIPTION

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)

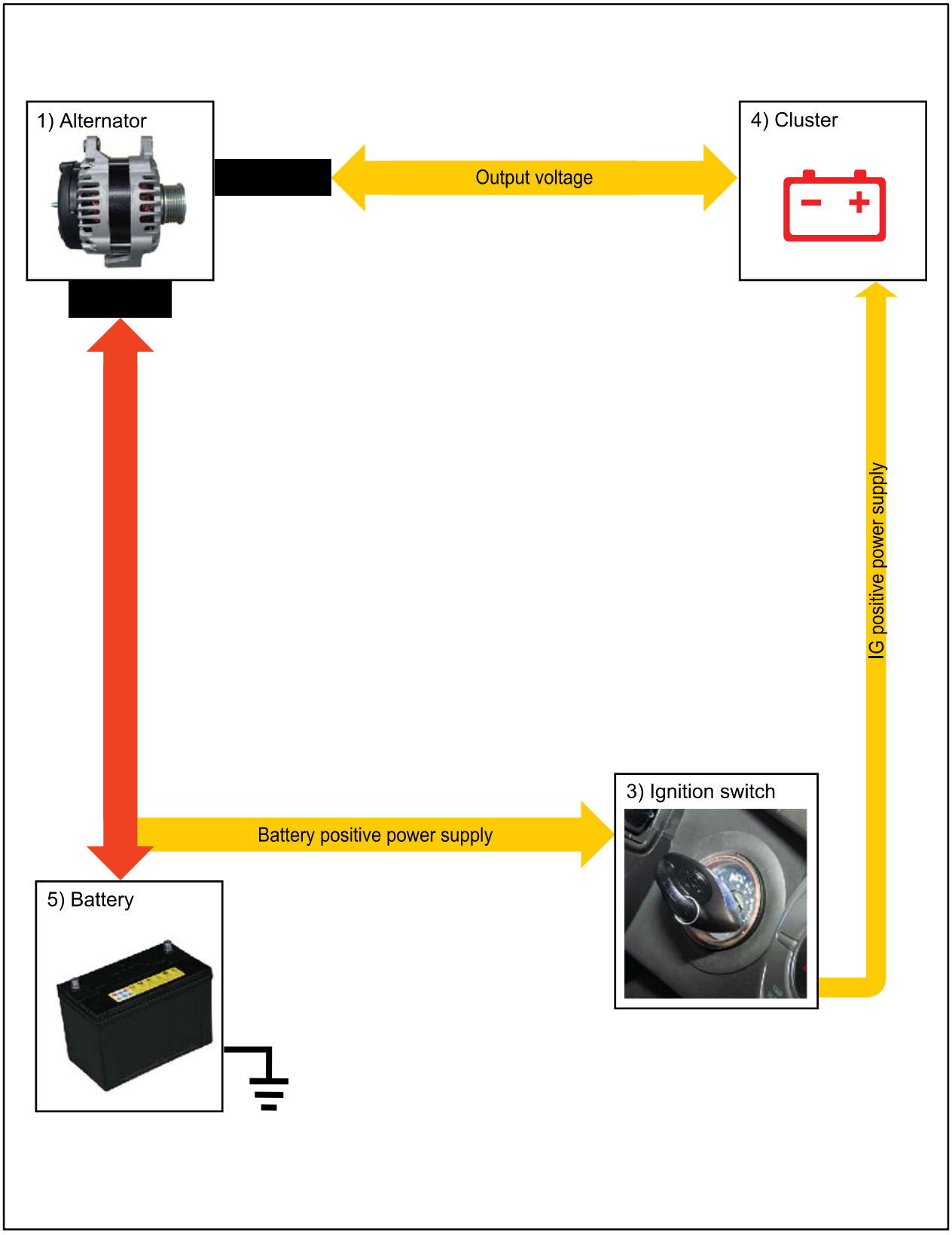


Alternator	Battery
	
The alternator charges the battery and supplies power to each electric unit by converting the mechanical energy to the electrical energy.	It converts the chemical energy to the electrical energy and supplies power to the corresponding electric units when starting the engine.

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.

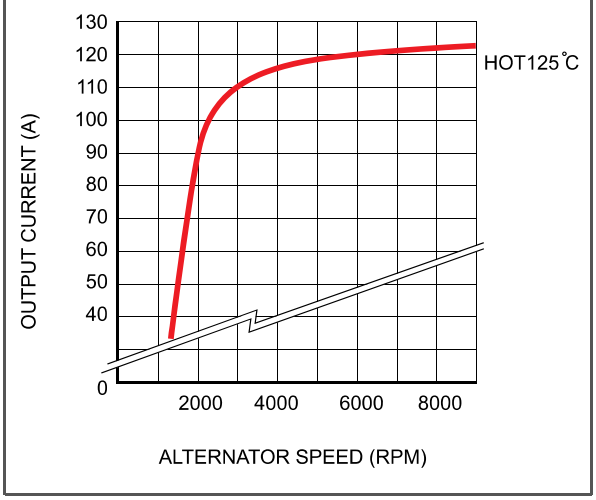
Temperature The lower the temperature is, the longer the time taken to charge the battery. When connecting the battery charger to the cold battery, the amount of current the battery can accept initially is very small. As the battery gets warmer, it can accept more current.

Charging capacity: Charging a battery with a low-capacity charger takes longer time than charging with a high-capacity charger.

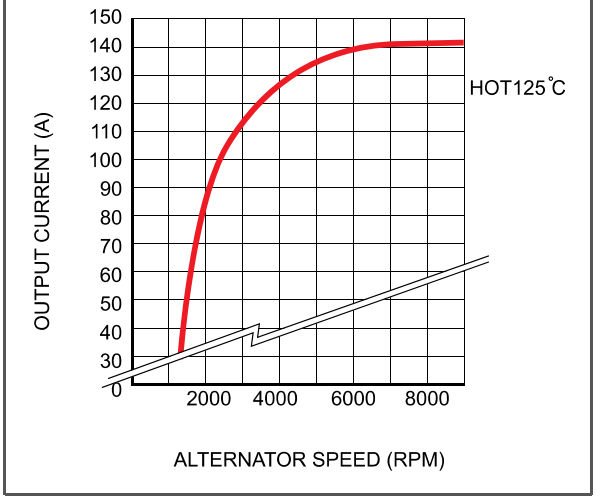
Charging status: Charging a fully depleted battery takes twice or more as long as charging a half-depleted battery. Since the electrolyte in a fully depleted battery consists of nearly pure water and conductor, only a very small amount of current can be accepted by the battery initially. The charging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

3) Output Characteristics

Alternator (120 A)

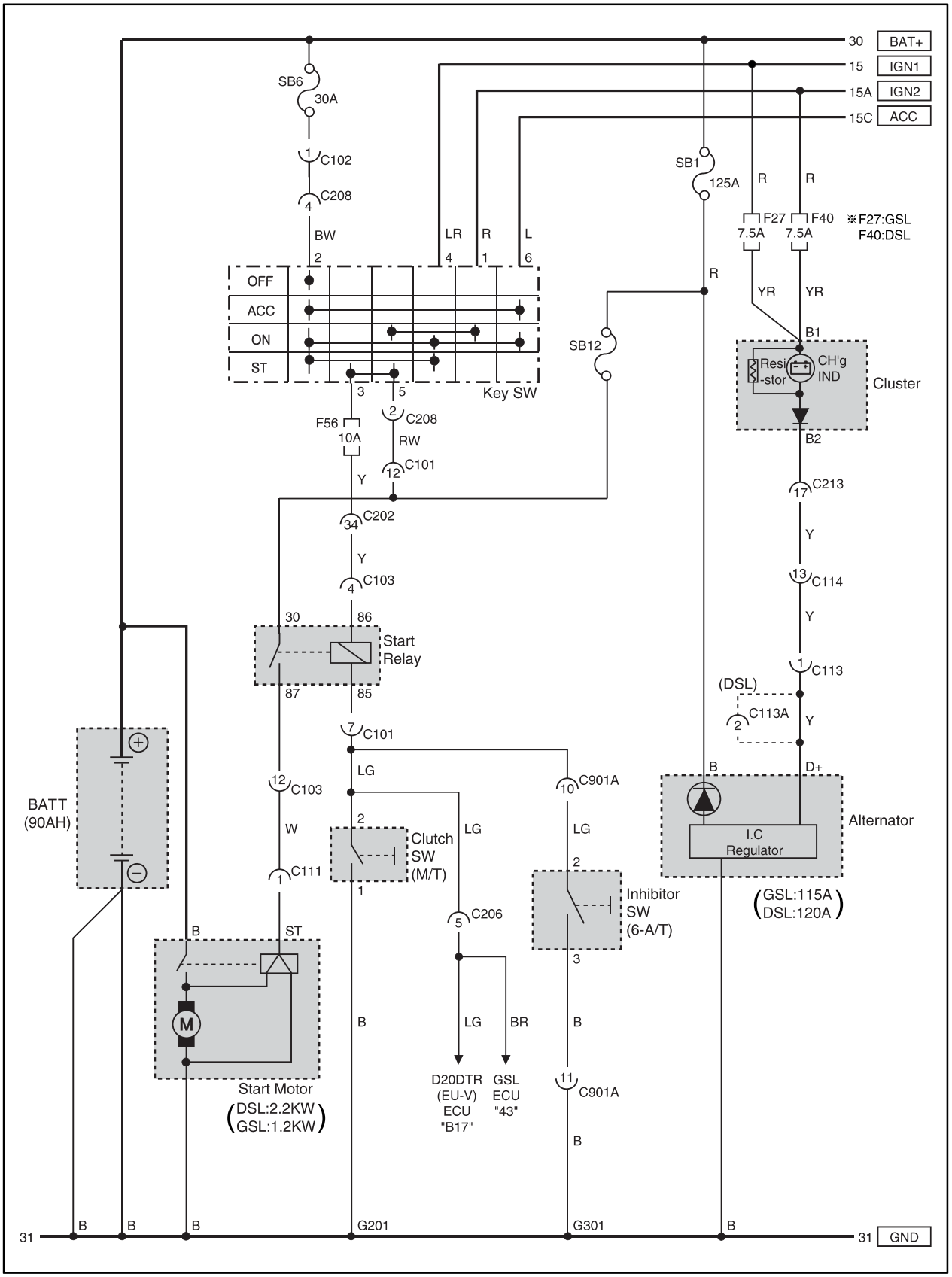


Alternator (140 A)



Modification basis	
Application basis	
Affected VIN	

3. CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	

D20DTR PRE-HEATING

1413-00

GENERAL INFORMATION

1. SPECIFICATION

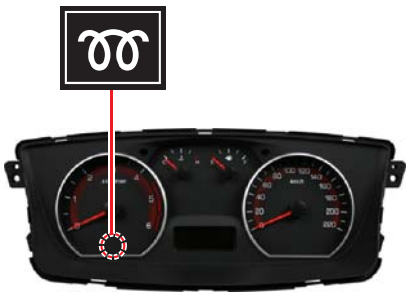
Description		Specification
Glow plug	Rated voltage	12 V
	Operating voltage	6 ~ 16 V
	Maximum temperature	1300°C
	Operating temperature	1100°C
Glow plug control unit	EMS operating voltage	6 ~ 16 V
	Operating temperature	−40°C ~ 110°C
	Dark current	Max. 1 mA

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW

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

Glow indicator



Engine ECU (D20DTR)

Glow plug

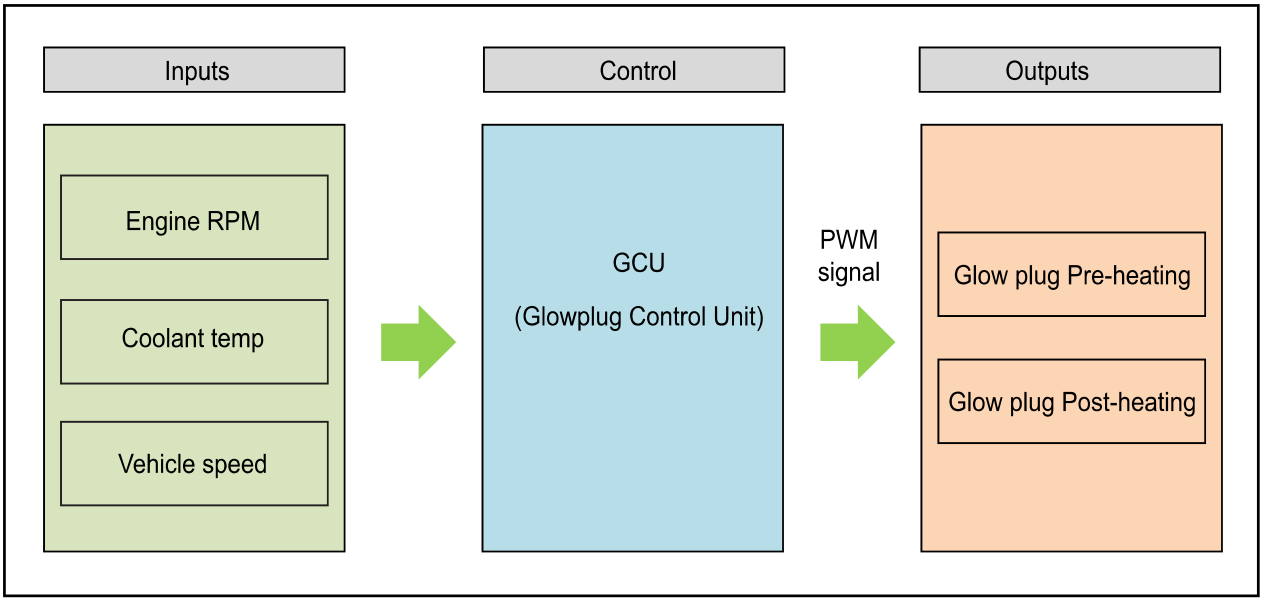
Tightening torque 20 ± 2.0Nm

Glow plug control unit (GCU)

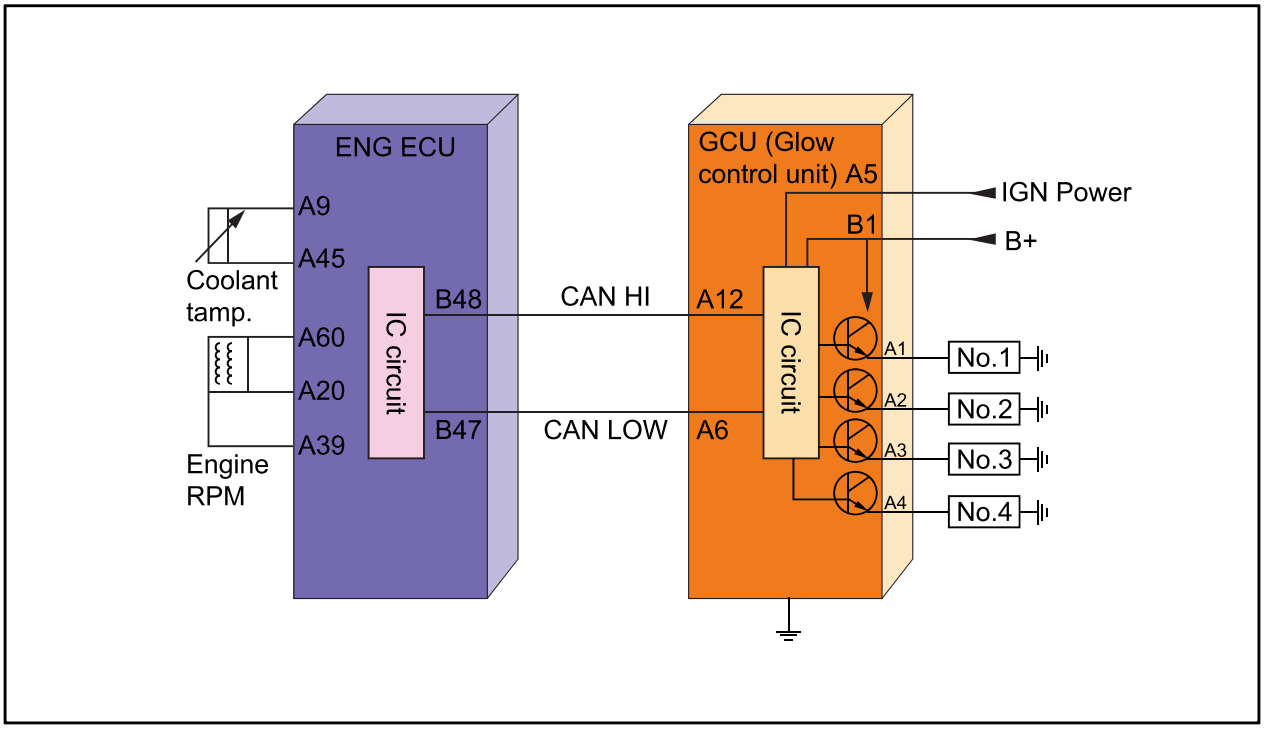
Modification basis	
Application basis	
Affected VIN	

2. SYSTEM OPERATION

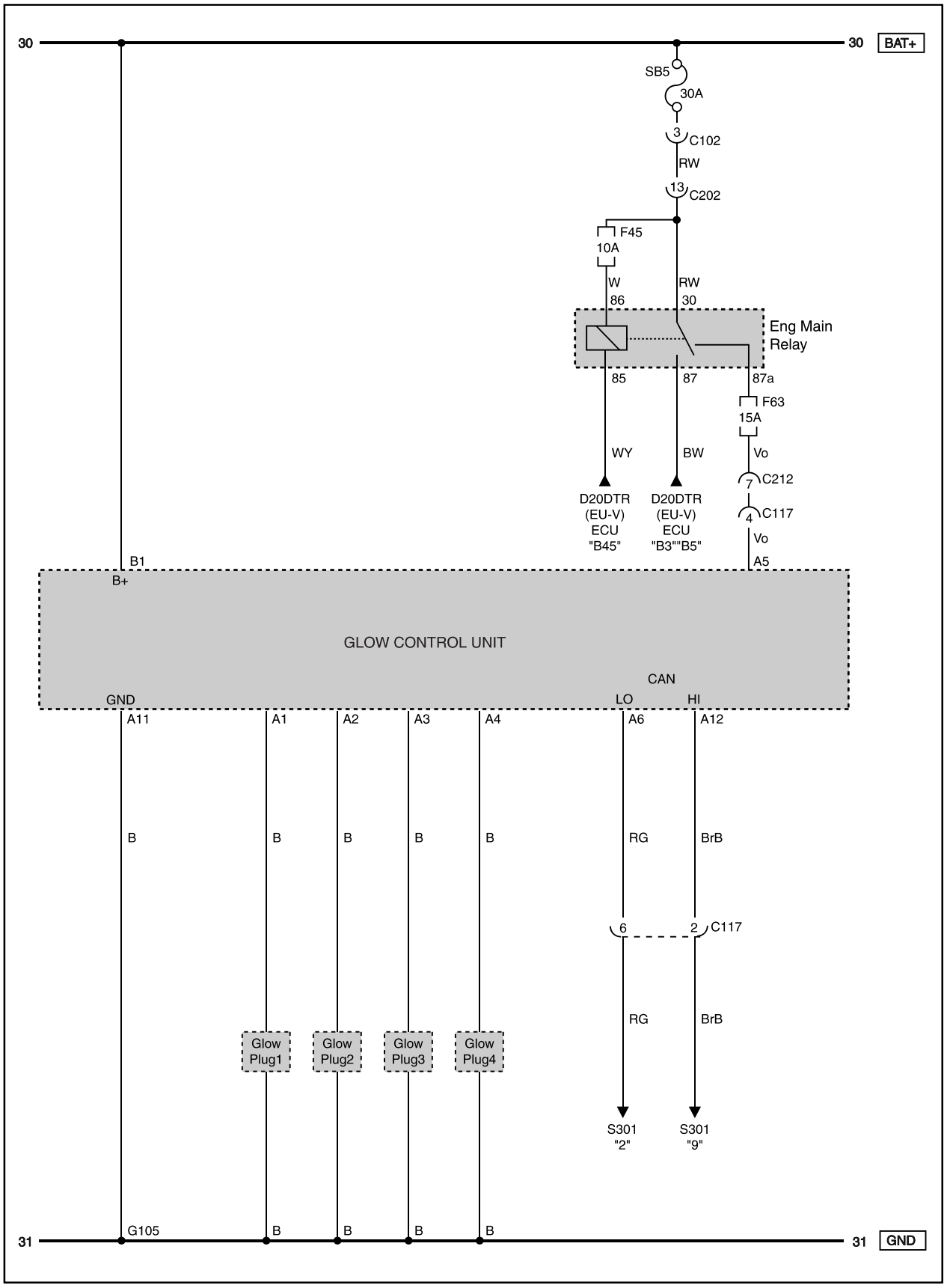
1) Input/Output Diagram of Glow Plug Control Unit



2) System Diagram



3) Circuit Diagram

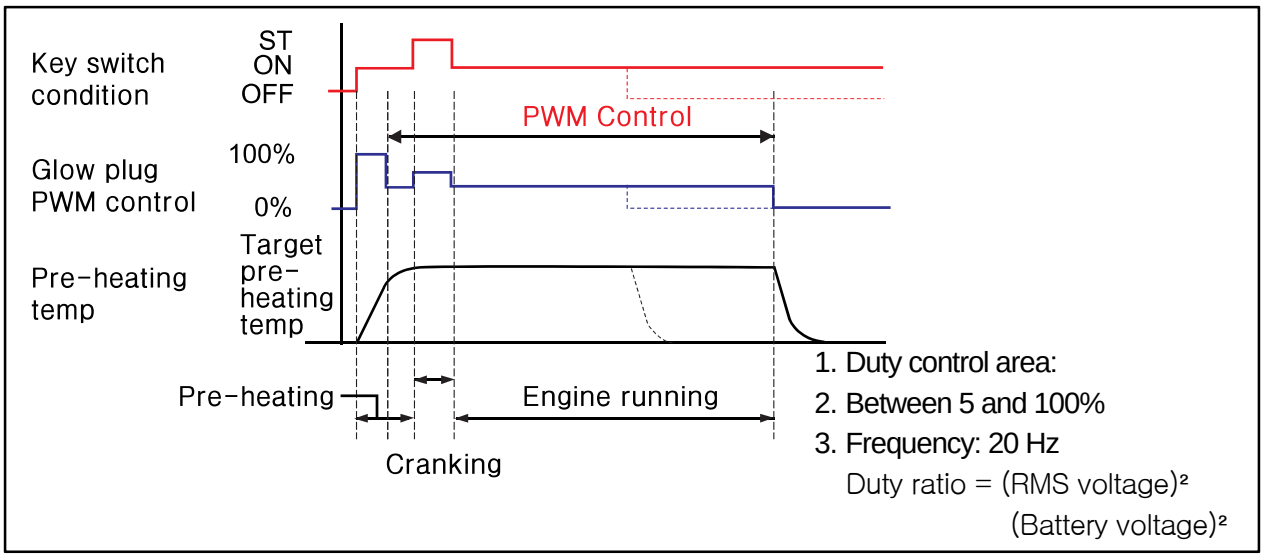


Modification basis	
Application basis	
Affected VIN	

4) Operation

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

(1) Operation



▶ **Pre-Glow: Step 1**

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

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

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

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

▶ During cranking: Step 2 and step 3

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

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

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

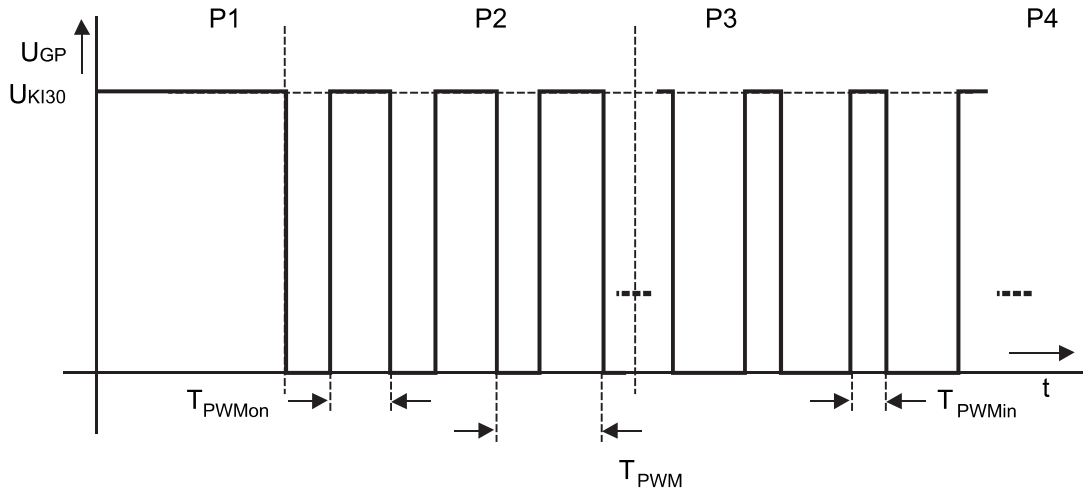
▶ Post-glow: Step 4:

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

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

▶ Emergency glow

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



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

Modification basis	
Application basis	
Affected VIN	

STARTING SYSTEM

1461-01

GENERAL INFORMATION

1. SPECIFICATION

Description	Specification
Capacity	12 V, 2.3 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	

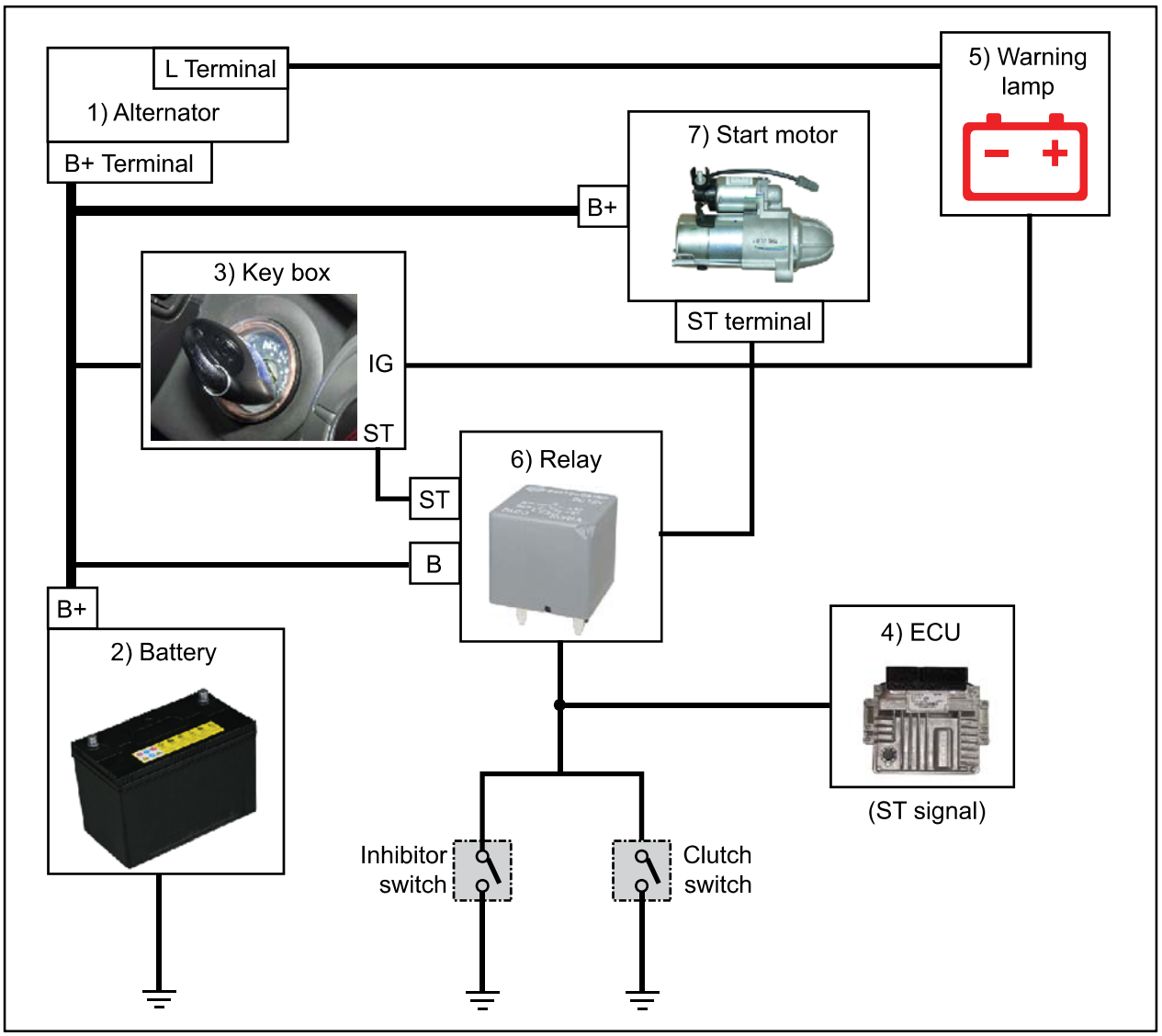
OVERVIEW AND OPERATING PROCESS

1. SYSTEM DESCRIPTION

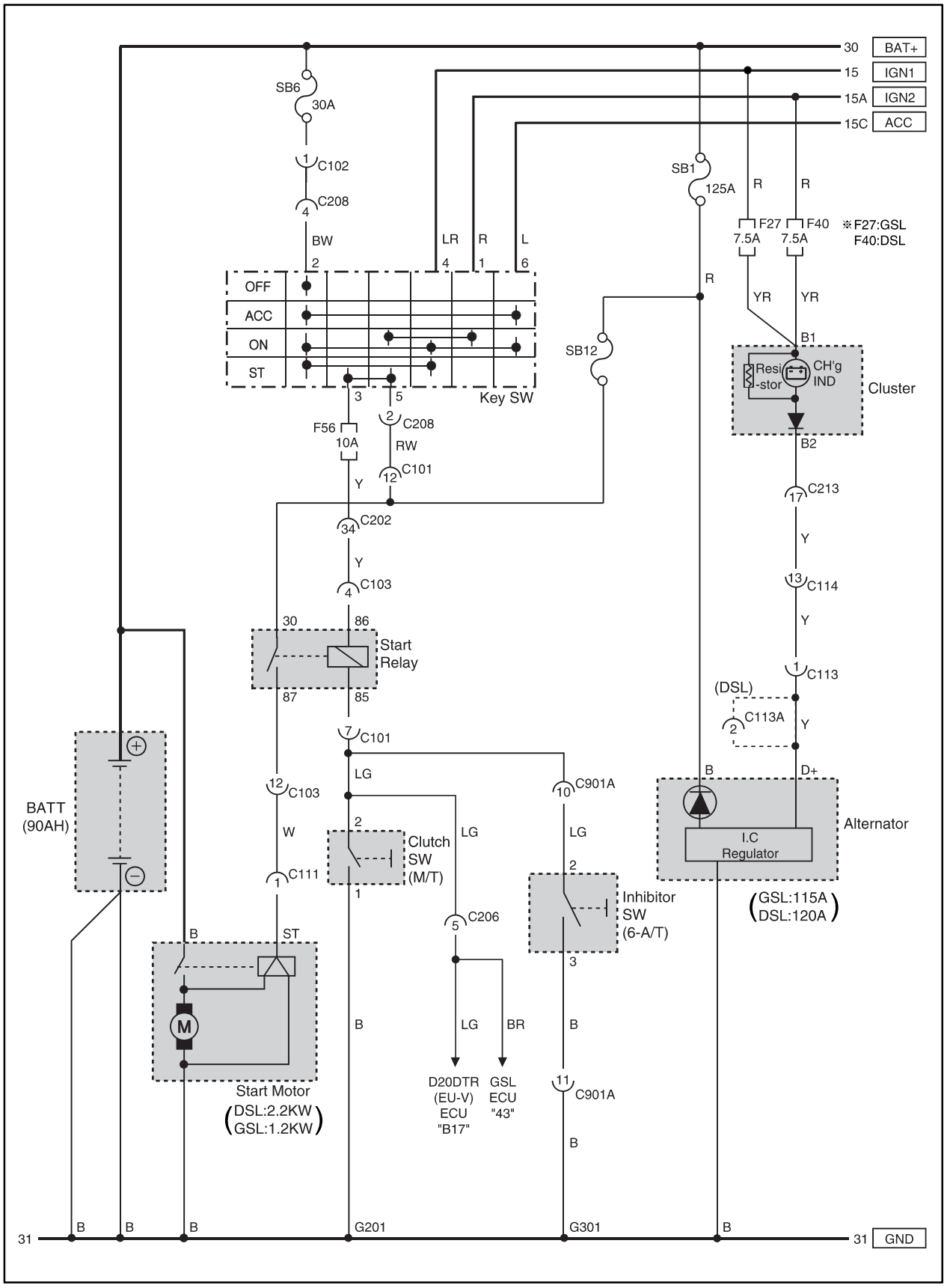
The starter (start motor) starts the engine with rotational power by converting the electric energy to the mechanical energy.
When the engine is cranking, the pinion gear meshes with the ring gear. If the ring gear overruns, the pinion gear clutch overruns to protect the pinion gear.

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.

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

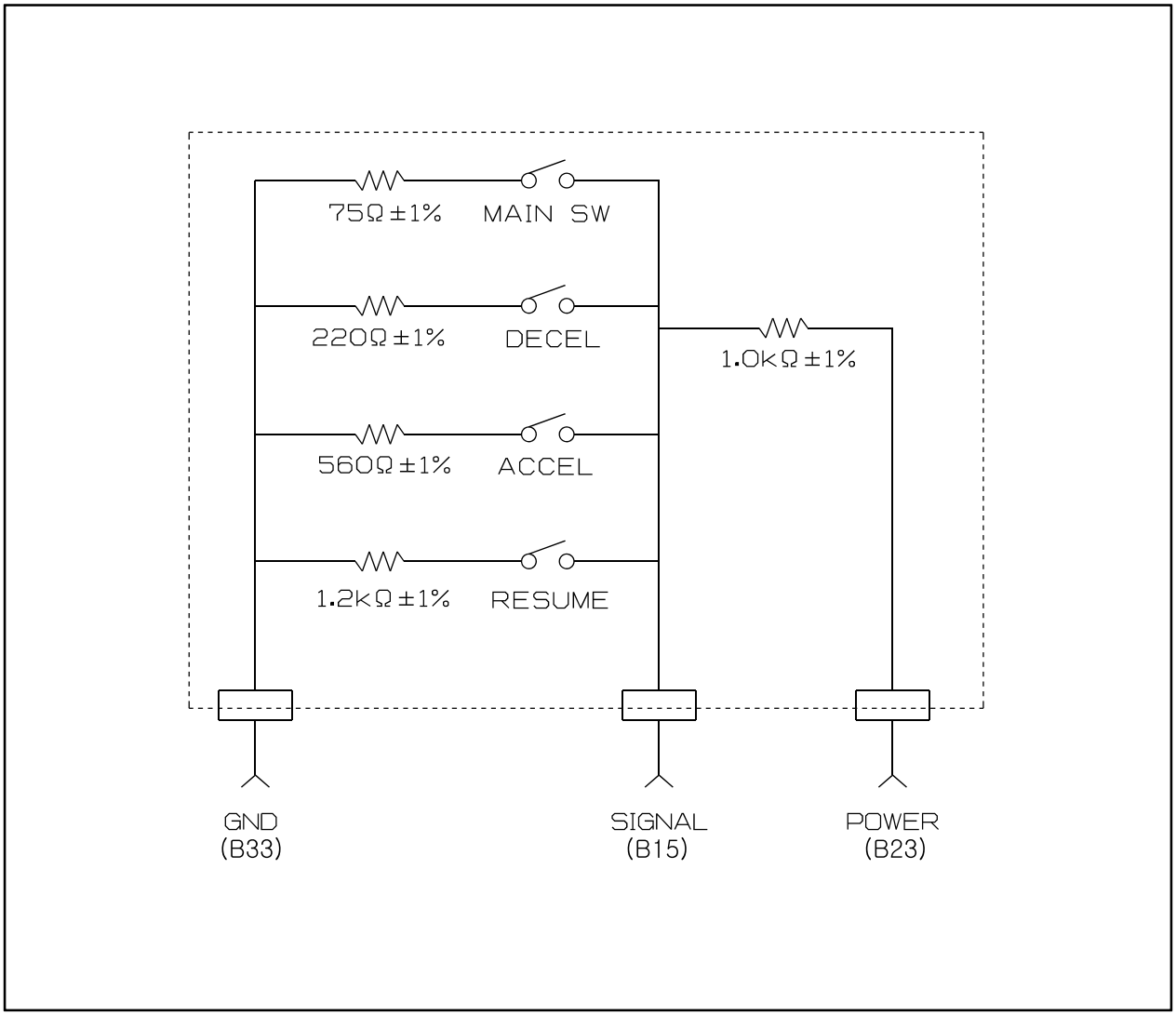
Improper use of the cruise control could be dangerous.
- Do not use on winding roadsyy .
- Do not use in heavy traffic.
- Do not use on slippery, wet roads.

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

Modification basis	
Application basis	
Affected VIN	

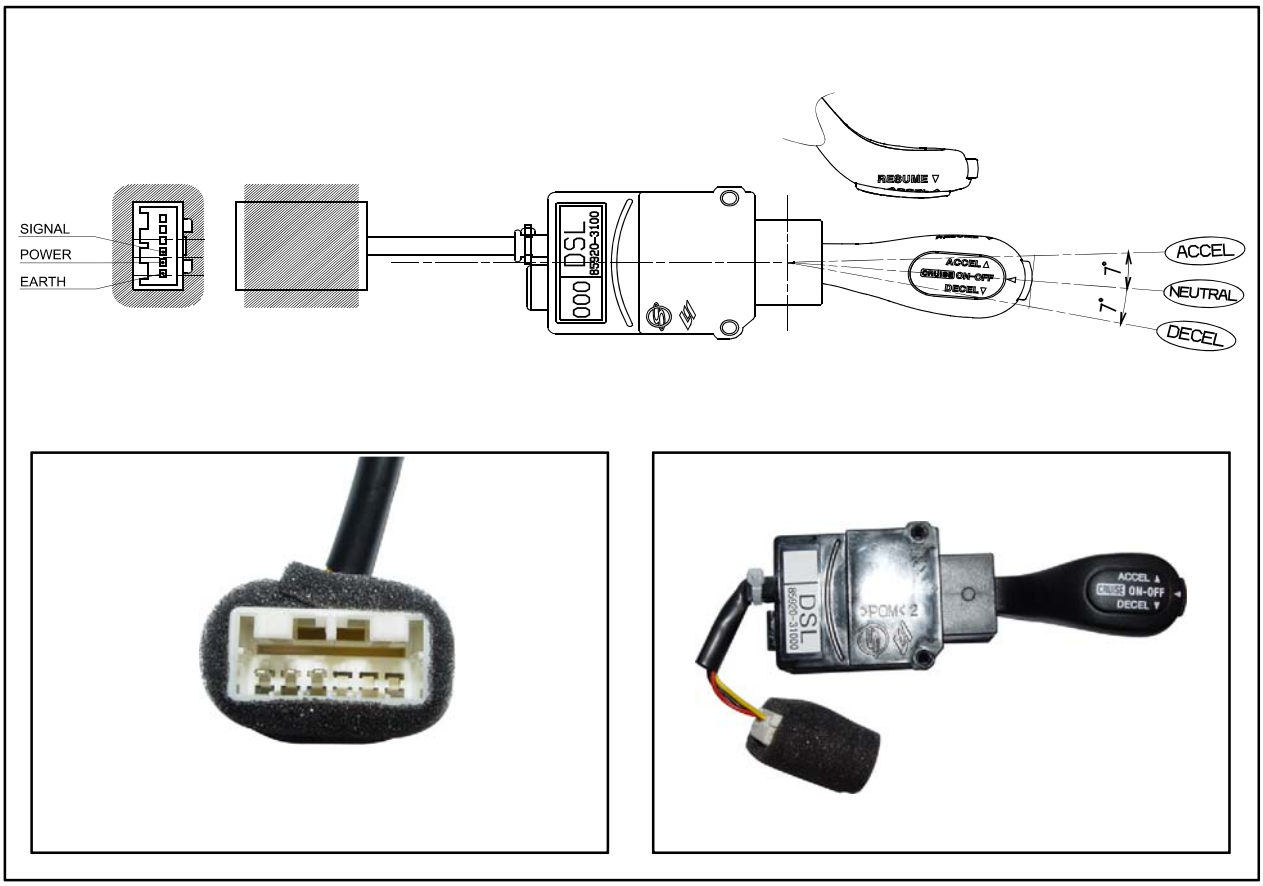
2. CONFIGURATION

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



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.

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	

E-EGR SYSTEM

1793-00

GENERAL INFORMATION

1. SPECIFICATION

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

OVERVIEW AND OPERATING PROCESS

1. SYSTEM DESCRIPTION

1) Overview

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

▶ **Benefits of E-EGR valve**

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

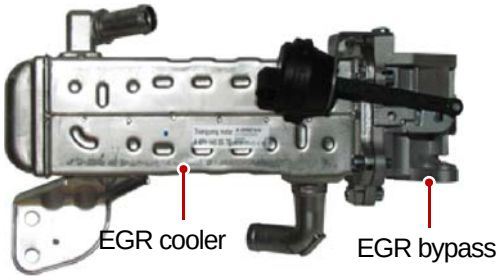
Modification basis	
Application basis	
Affected VIN	

2) Location and Components

HFM sensor

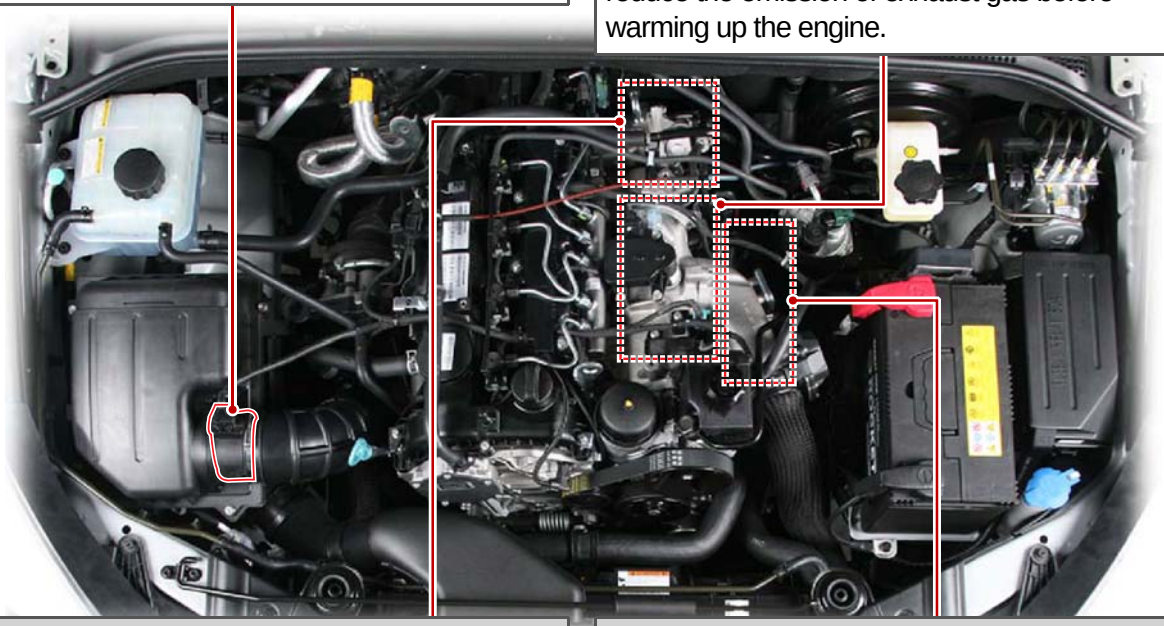
Used as a main map value to control the EGR. The coolant temperature, engine rpm, engine load, intake air temperature (HFM: decreased at 60˚C or more), atmospheric pressure (atmospheric pressure sensor: altitude compensation) are used as auxiliary map values.

E-EGR cooler and bypass valve



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

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



E-EGR valve

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

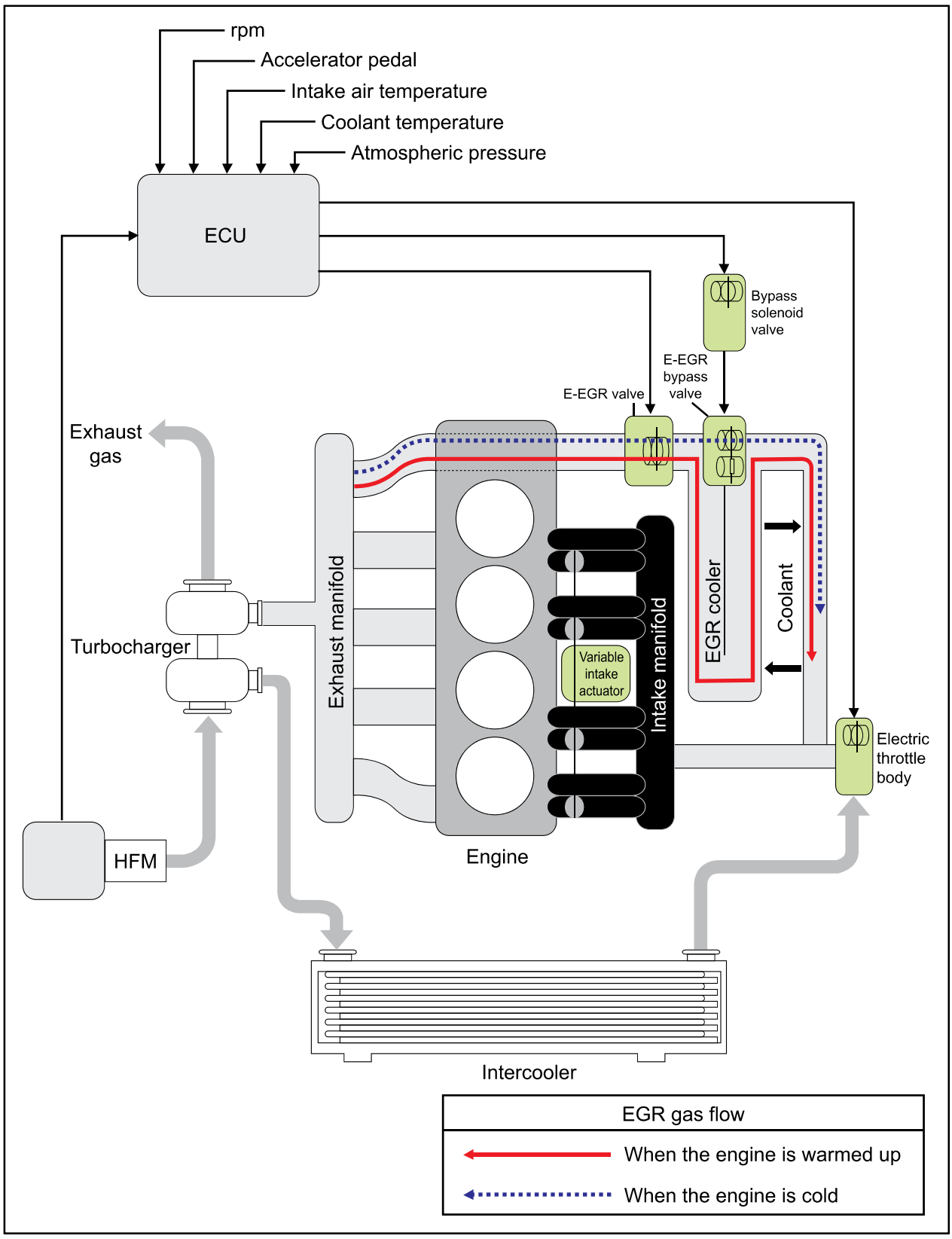
EGR pipe

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

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

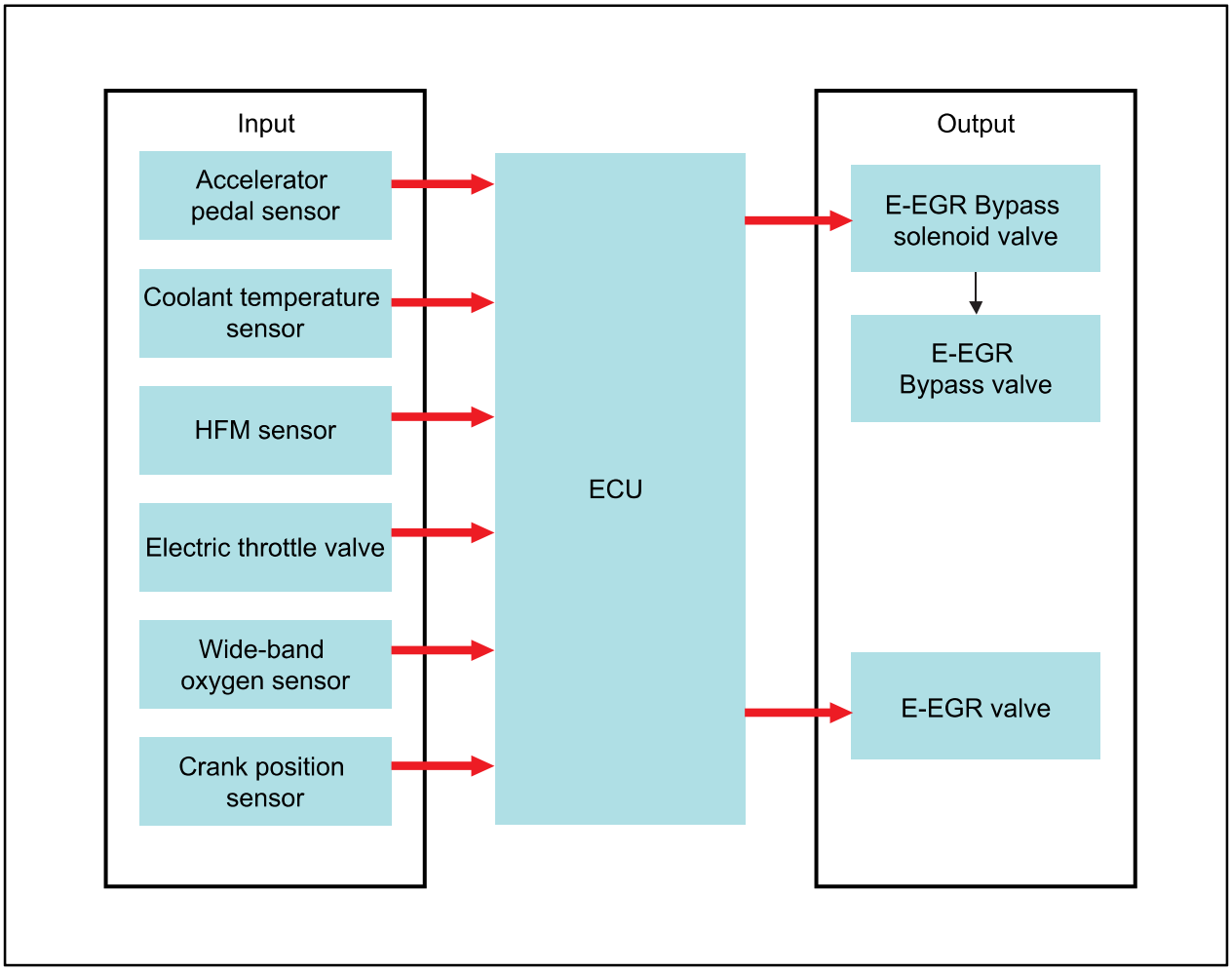
2. OPERATING PROCESS

1) Schematic Diagram



Modification basis	
Application basis	
Affected VIN	

2) Input/Output Devices



3) Control Logic

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

※ Main map value: Intake air volume

※ Auxiliary map value:

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

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

(1) Operating conditions

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

(2) Shut off conditions

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

Modification basis	
Application basis	
Affected VIN	

Memo

CDPF SYSTEM

2412-02

GENERAL INFORMATION

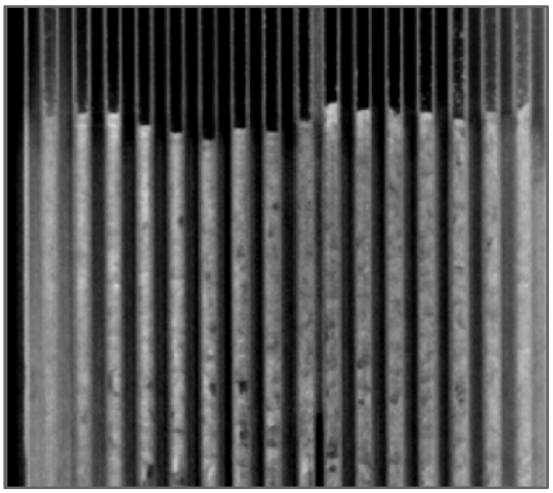
1. SPECIFICATION

Emission Regulation		Euro-V
Front Area		154.06㎠
Size	DOC	158 X 124 X 78L
	DPF	158 X 124 X 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)

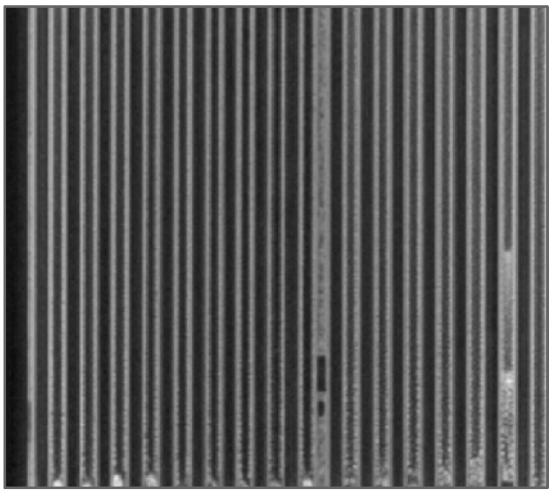
2. CAUTIONS

▶ **Standard pattern of soot accumulation**

(1) Abnormal Soot Accumulation



(2) Normal Soot Combustion



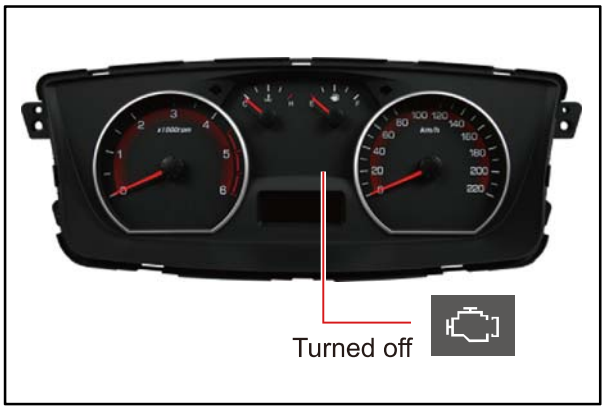
▶ **Cautions to protect the catalyst filter**

- 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	

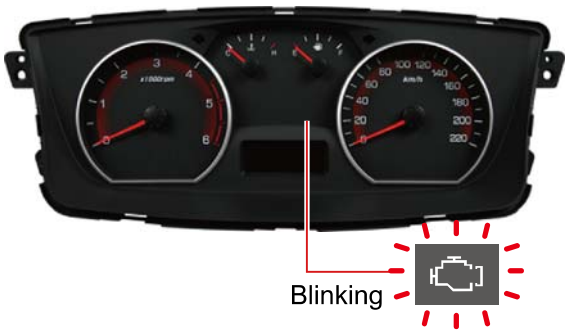
(3) Warning Lamp Related to CDPF

▶ **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.
2. When this 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)

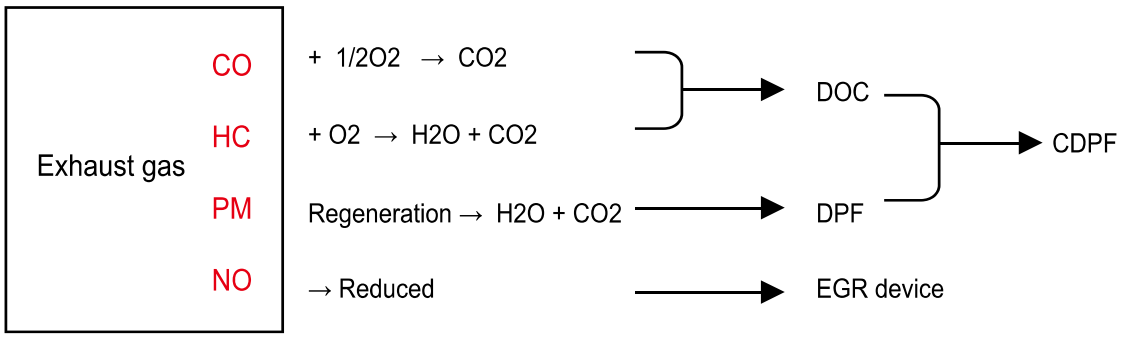

1. If the vehicle is driven at a speed of 5 to 10 km/h for an extended period of time, the soot accumulated in the CDPF cannot be burned as the CDPF cannot reach the regeneration temperature. Then, an excessive amount of soot can be accumulated in the CDPF.
2. This case is much worse than the simple 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.
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.

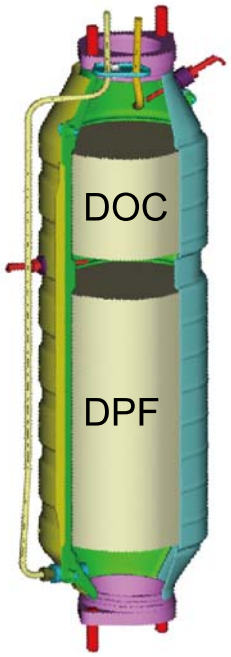
Modification basis	
Application basis	
Affected VIN	

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.





DOC [Diesel Oxidation Catalyst]
CO + 1/2O2 -Oxidation → CO2
HC + O2 -Oxidation → H2O + CO2

DPF [Diesel Particulate Filter]
Collecting PM → Regeneration → H2O + CO2

CDPF [Catalyst & Diesel Particulate Filter]

Modification basis	
Application basis	
Affected VIN	

2. COMPONENT

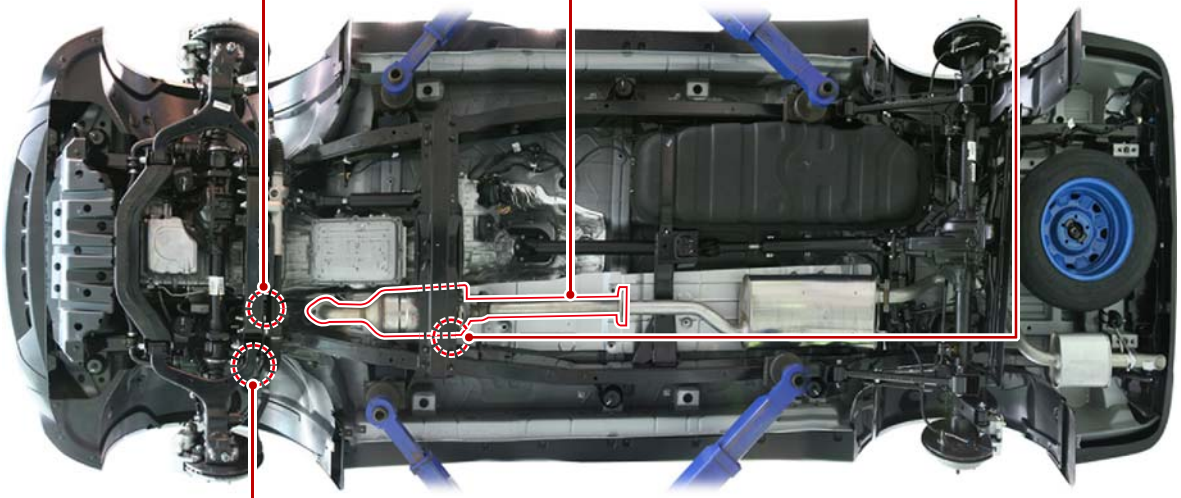
Front temperature sensor

Protects the turbocharger.

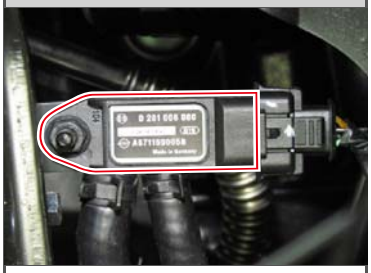
CDPF
DOC+DPF

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

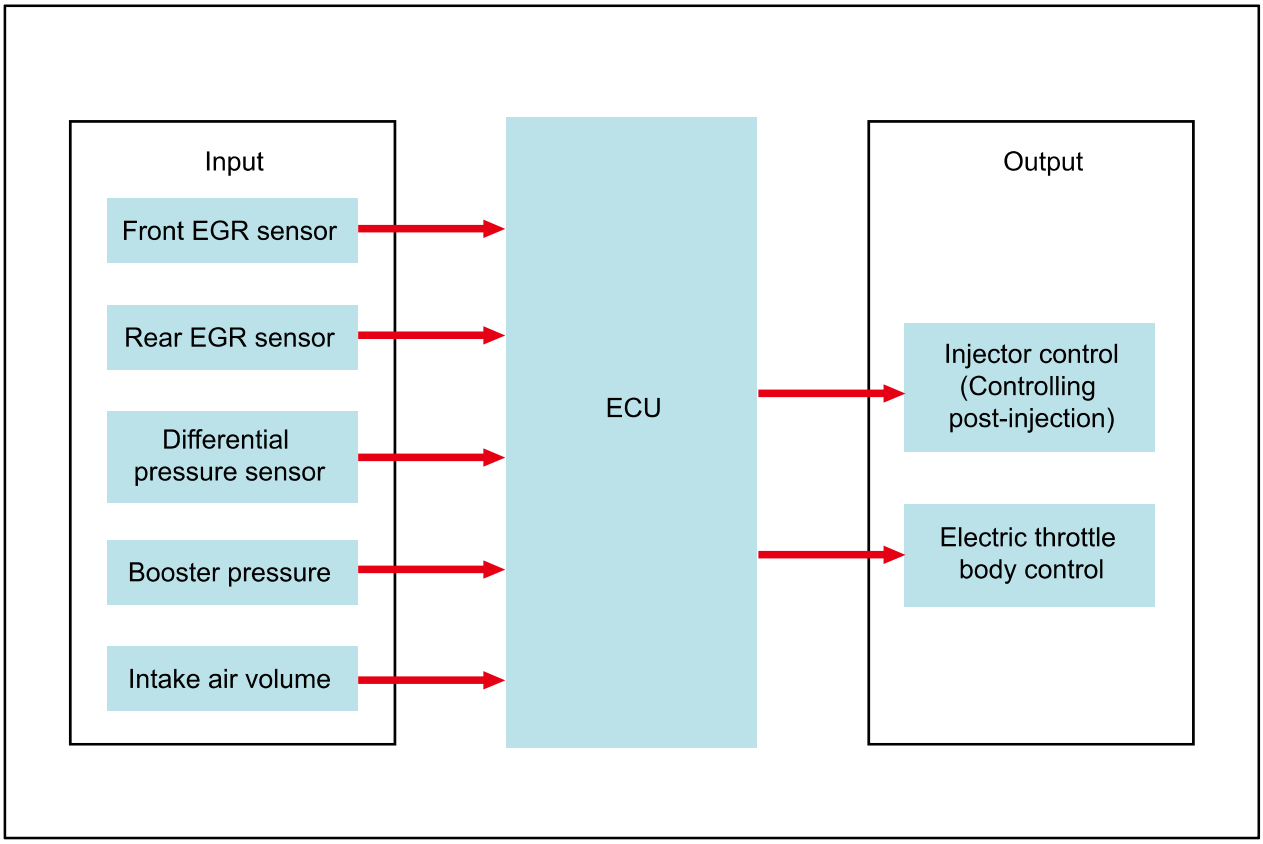
Throttle valve

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.

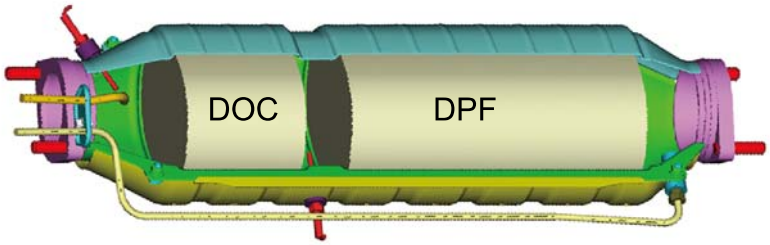
Electric throttle body

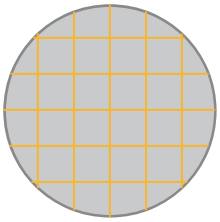
Controls the intake air mass.

Modification basis	
Application basis	
Affected VIN	

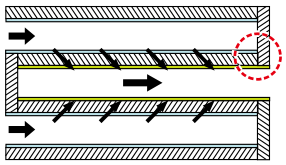
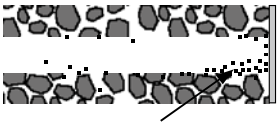
5. OPERATING PROCESS

[Configuration and principle of operation]





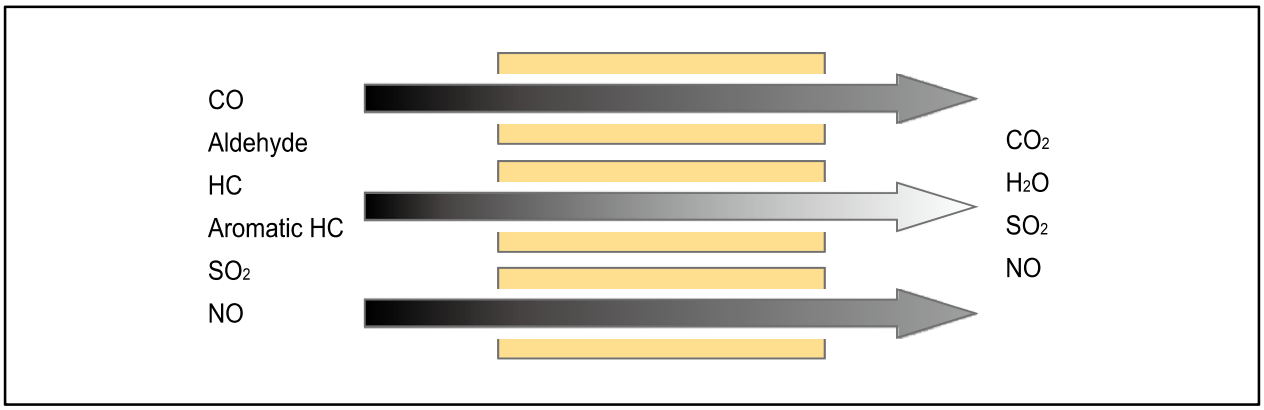
The exhaust gas passed through the exhaust manifold enters into the CDPF assembly (at approx 250℃).

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

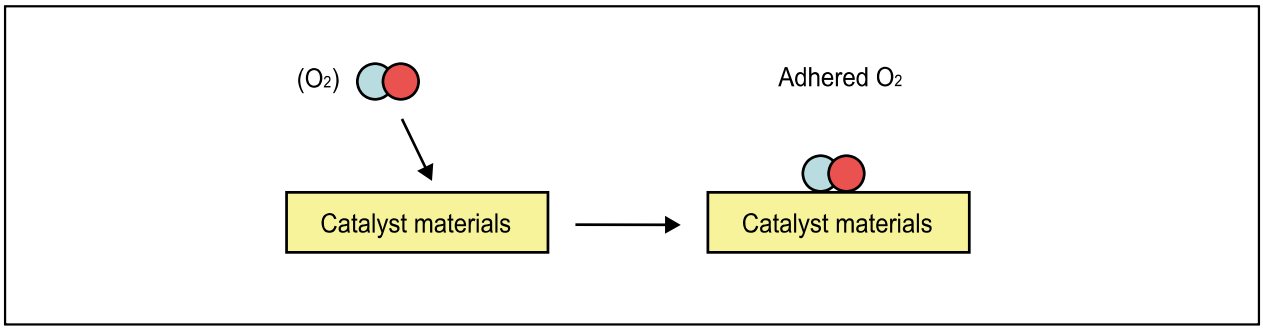
Modification basis	
Application basis	
Affected VIN	

1) Oxidation of DOC

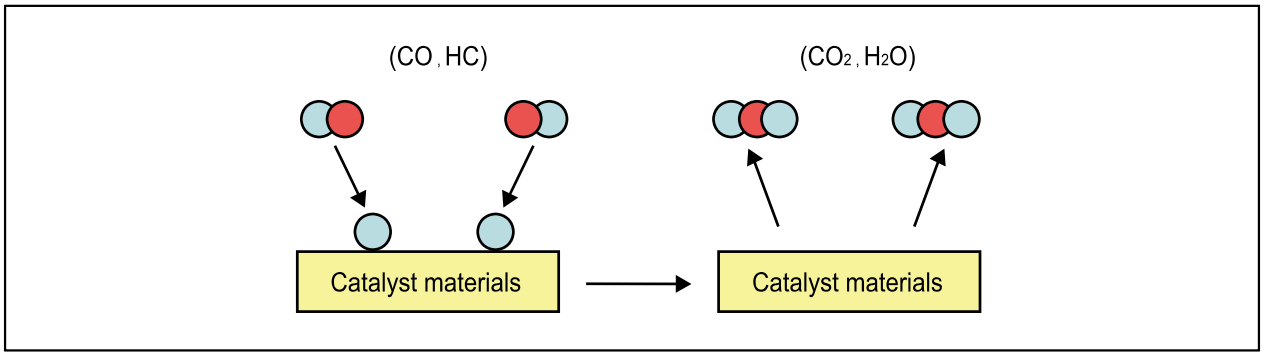
The DOC oxidizes HC and CO of the exhaust gas in the two-way catalytic converter at 180℃ or more, and performs best at the temperature between 400 and 500℃. The front EGT sensor detects whether the DOC can burn (oxidize) the post-injected fuel or not, and sends the signal to the ECU to maintain the DOC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



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



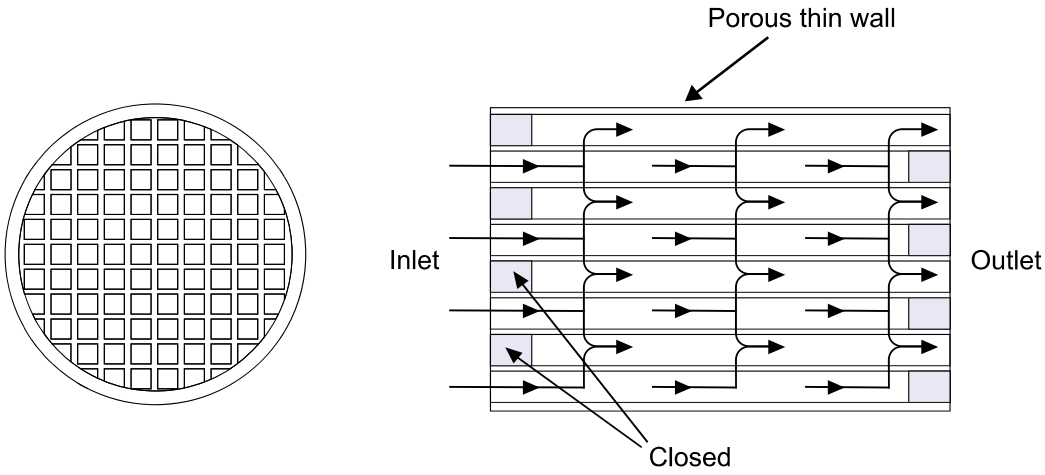
2. CO and HC are oxidized by the catalyst materials: More than 180℃

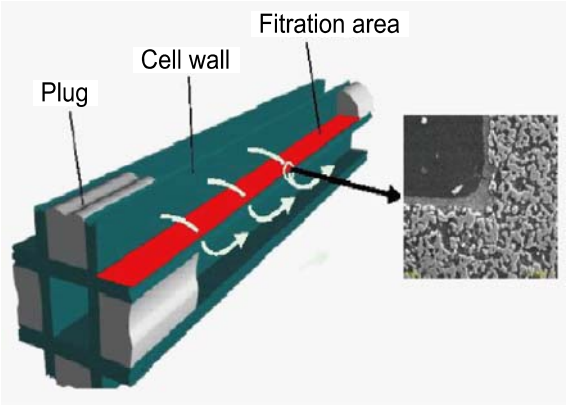


2) Collecting PM of DPF

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

[Collecting PM of CDPF]





NOTE

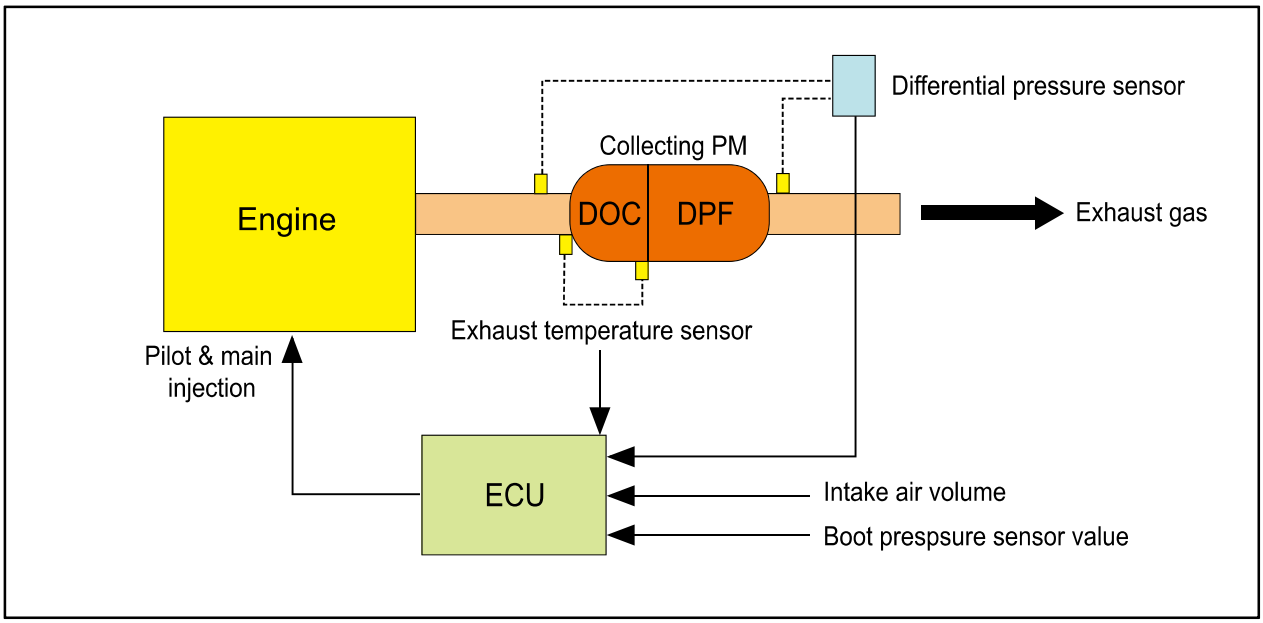
Normally, when the driving distance becomes approx. 600 to 1,200 km, enough amount of soot to be burned is filtered and accumulated in the CDPF. The ECU increases the amount of fuel post-injection to increase the temperature of the exhaust gas up to 600°C, so that the soot is burned. The soot is burned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

Modification basis	
Application basis	
Affected VIN	

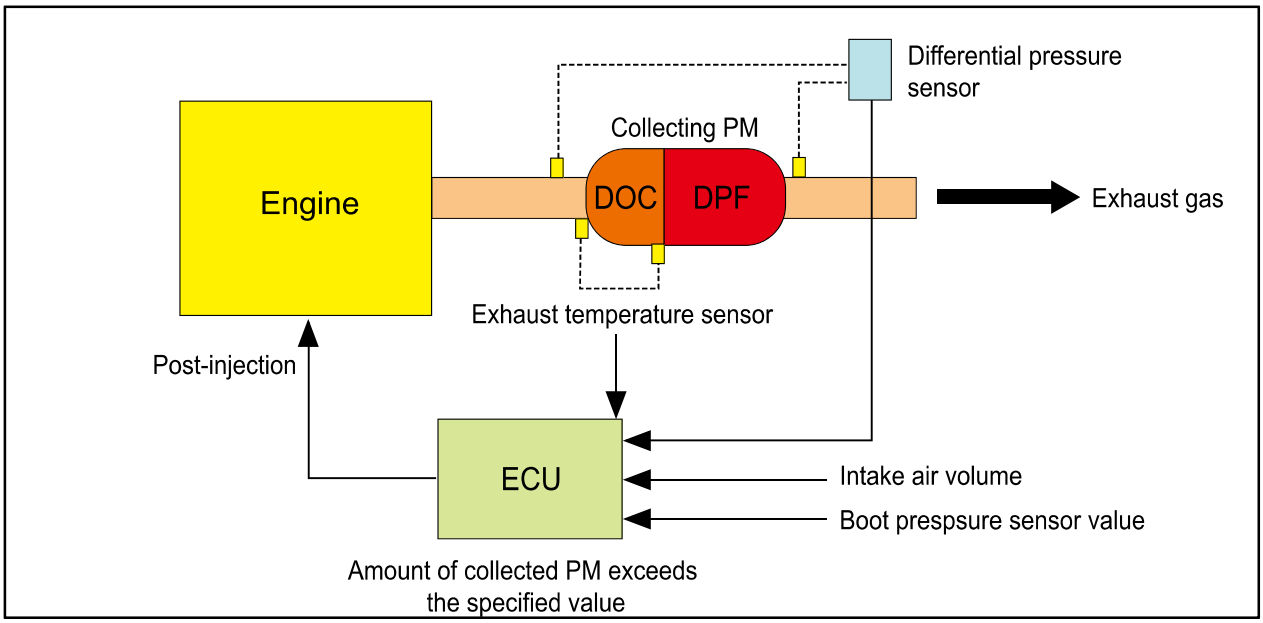
3) PM Regeneration of DPF

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

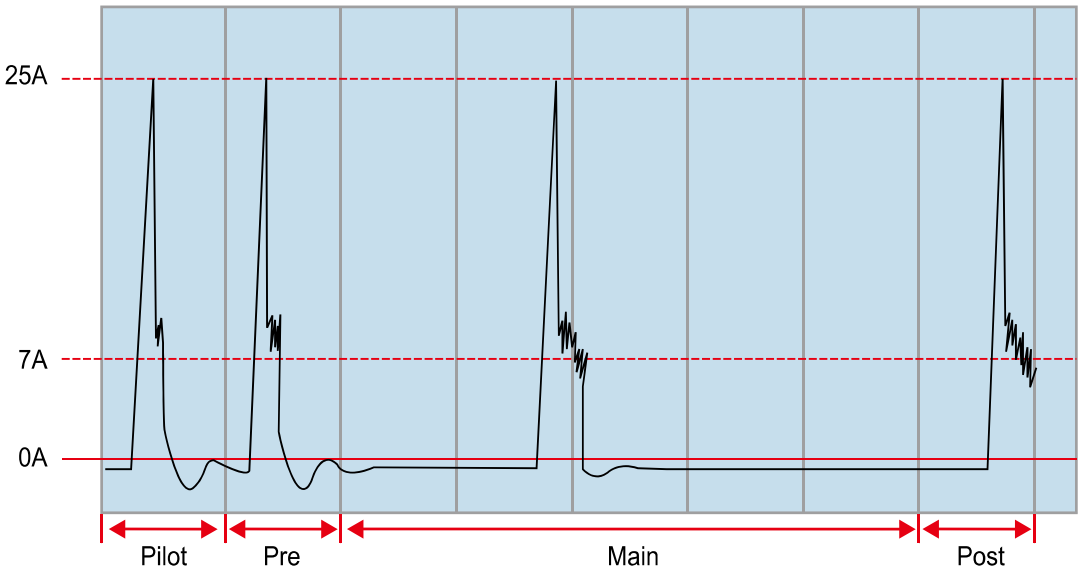
1. When the amount of the collected PM is not enough: The DPF works as a filter.



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



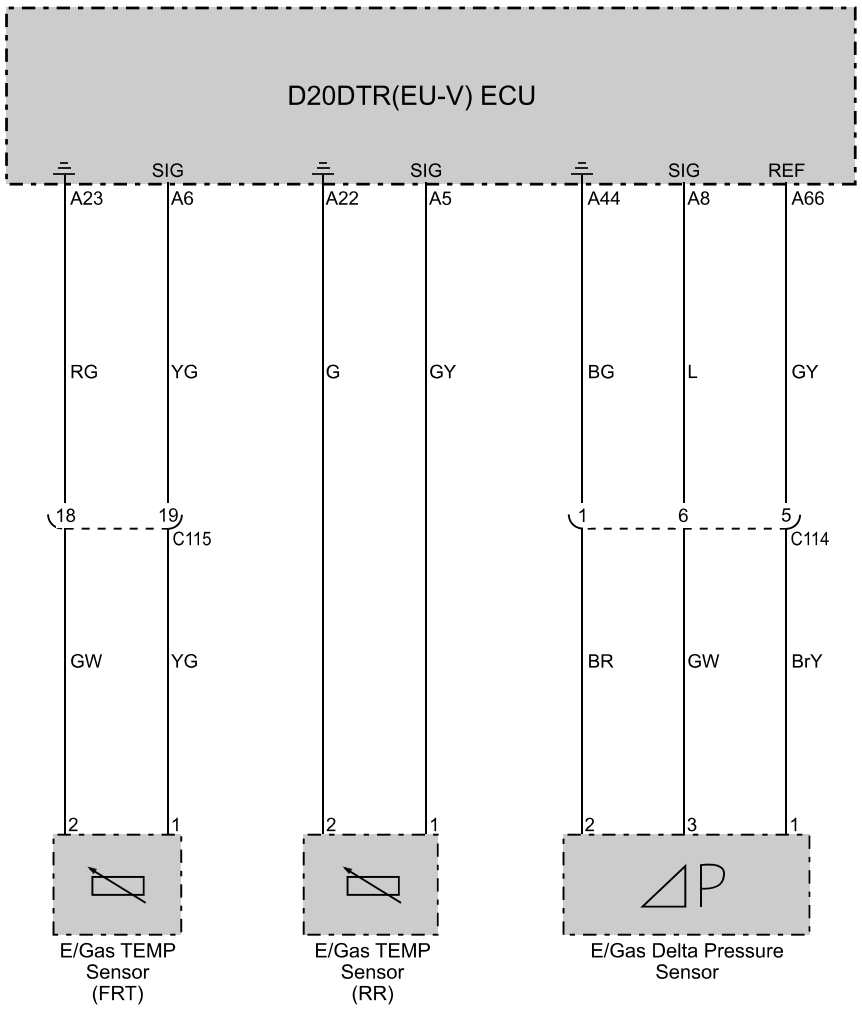
4) Fuel Injection During CDPF Regeneration



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

Modification basis	
Application basis	
Affected VIN	

6. ELECTRIC CIRCUIT DIAGRAM



Modification basis	
Application basis	
Affected VIN	

ENGINE CONTROL

0000-00

GENERAL INFORMATION

1. ENGINE DATA LIST

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

OVERVIEW AND OPERATINF PROCESS

1. MAJOR COMPONENTS

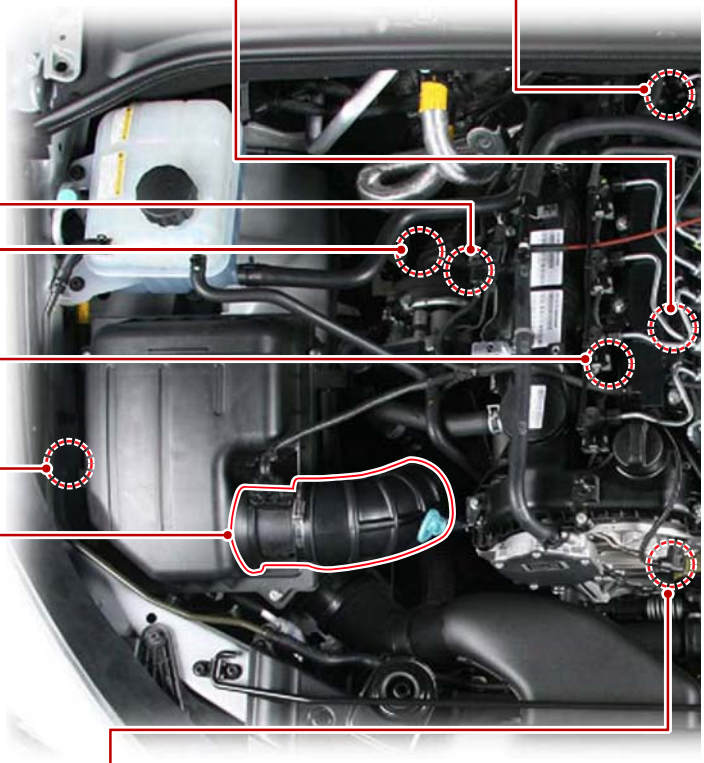
Rear EGT sensor

Front EGT sensor

Glow plug

IMV

Oxygen sensor



Injector (C3I)

Differential pressure sensor

HFM (air mass/ temperature)

Camshaft position sensor

Variable swirl valve actuator

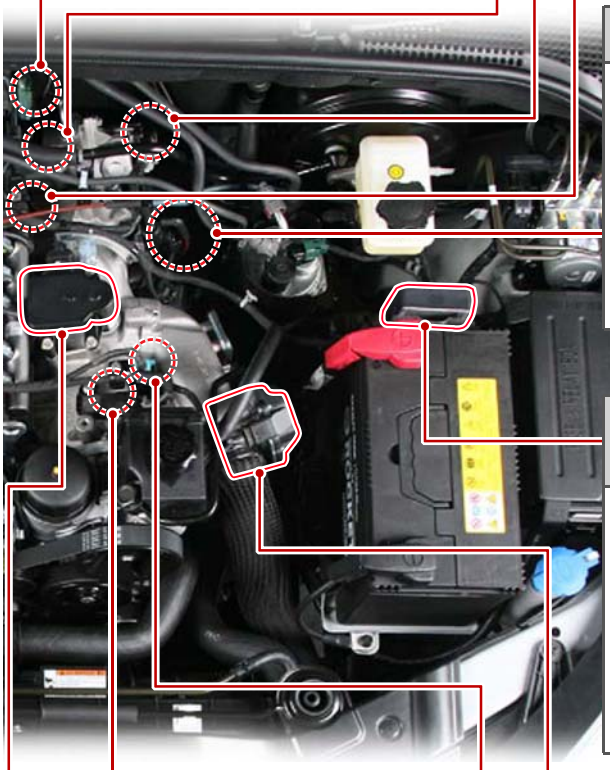
Modification basis	
Application basis	
Affected VIN	

Coolant temperature sensor

Fuel temperature sensor

EGR valve

Fuel rail pressure sensor



E-EGR bypass valve

E-VGT actuator

GCU (Preglow control unit)

Water sensor

T-MAP sensor

Knock sensor (2 ea)

Electric throttle body

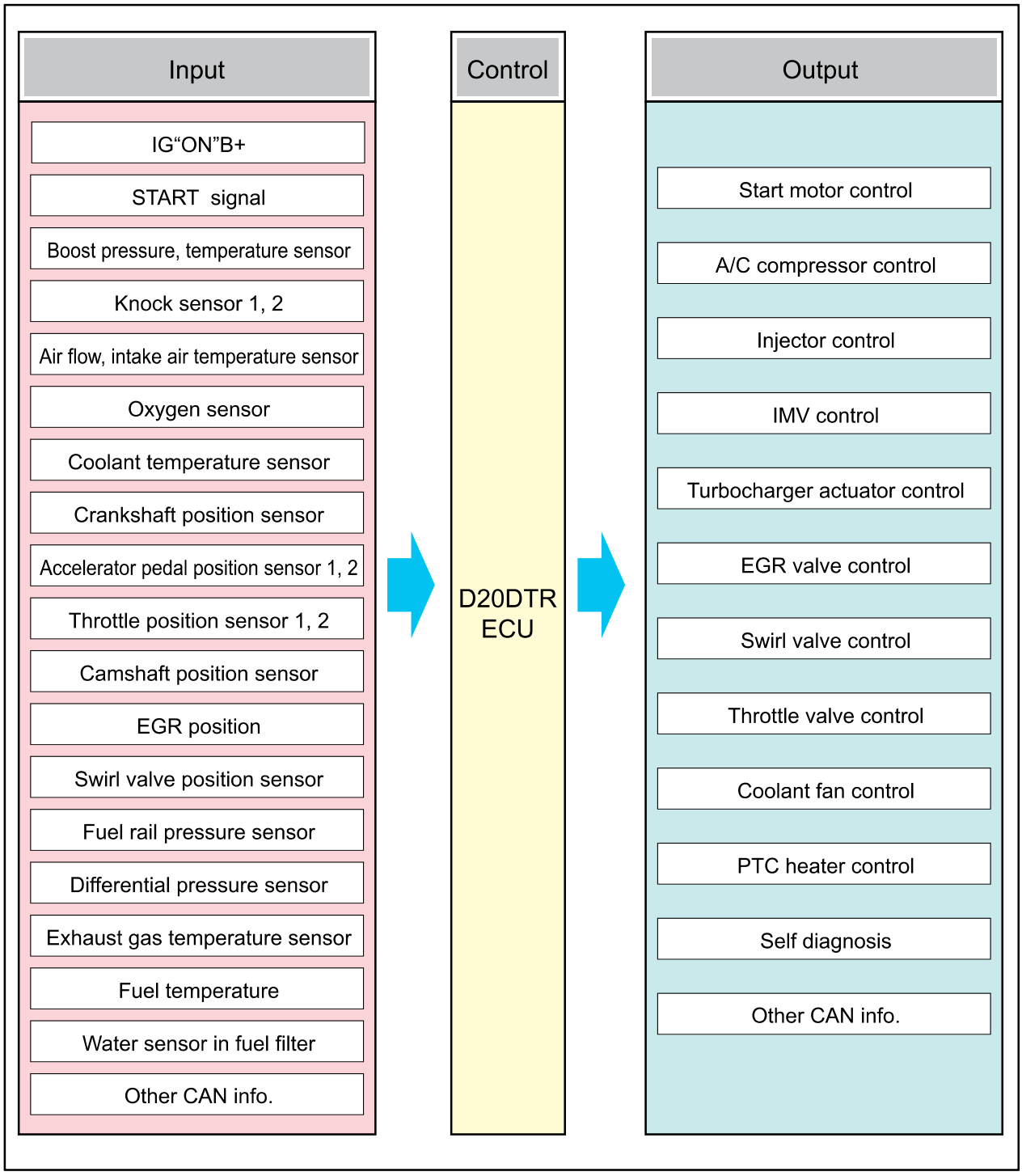
D20DTR ECU

Modification basis	
Application basis	
Affected VIN	

2. SYSTEM OPERATION

1) Input/Output of ECU

(1) ECU Block diagram



Modification basis	
Application basis	
Affected VIN	

(2) Components for ECU Input

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

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

(3) Components for ECU Output

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

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

PTC heater	Cooling fan
	

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

Modification basis	
Application basis	
Affected VIN	

2) ECU Control

(1) Function

a. ECU Function

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

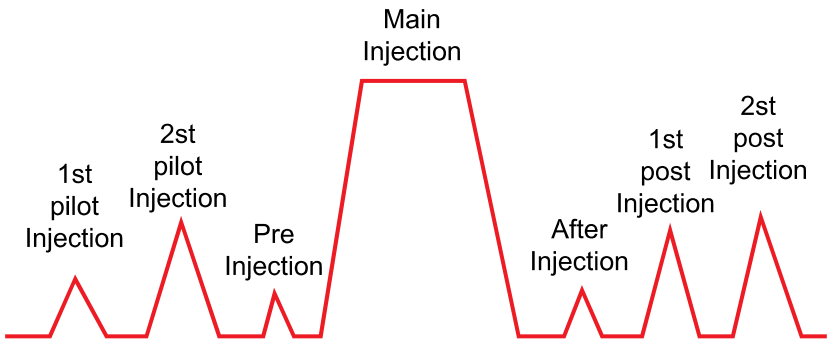
b. Control Function

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

(2) Fuel injection control

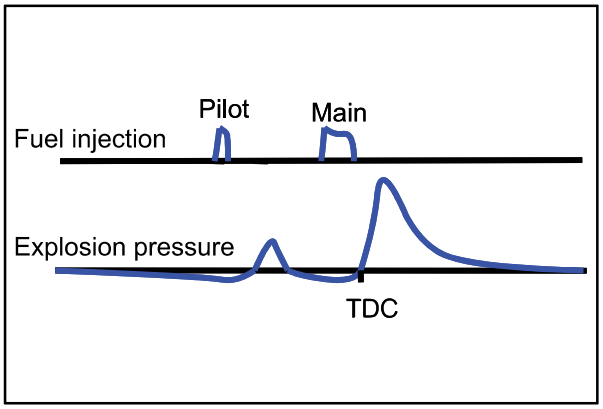
a. Multi injection

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

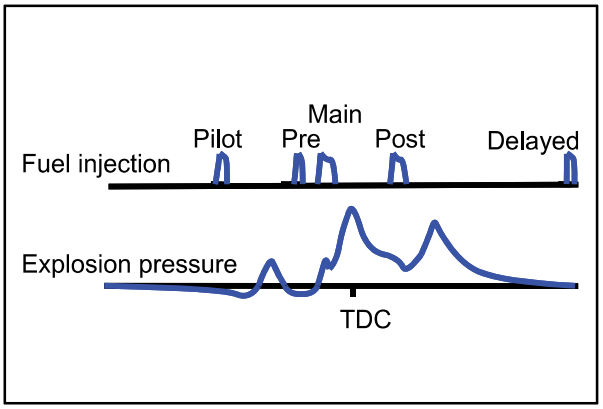


Injection	Function	Main	Produces engine power
Pilot 1	Reduces PM by injecting before main injection.	**After**	PM control
Pilot 2	Reduces NOx and noise by shortening main injection delay due to flammability	**Post 1**	Reduces PM by enabling fuel activation.
Pre	Controls NOx emission level, Combustion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

▶ **Pilot injection**



▶ **Multi injection**



Modification basis	
Application basis	
Affected VIN	

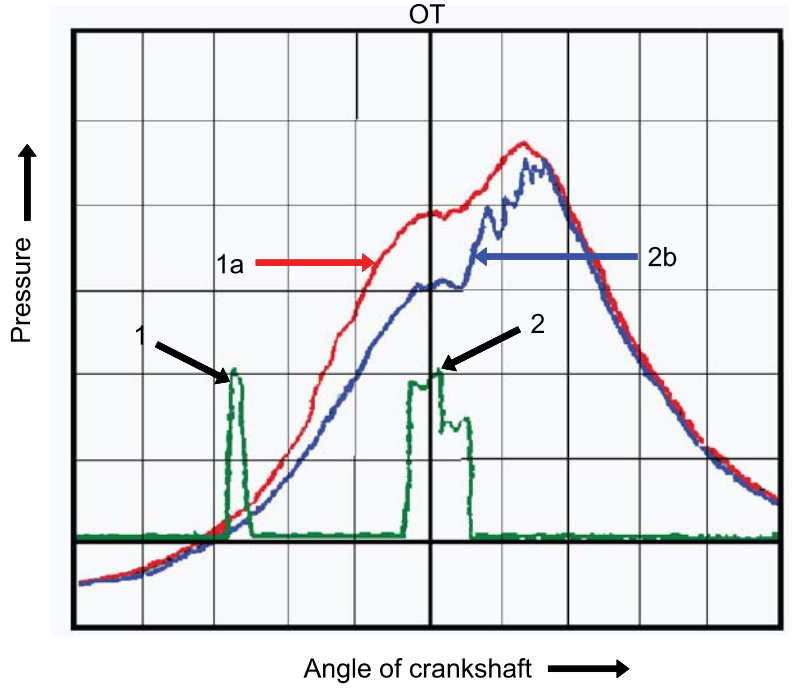
b. Pilot Injection

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

Stop conditions

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

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



1. Pilot injection
2. Main injection

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

c. Main Injection

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

d. Post Injection

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

Modification basis	
Application basis	
Affected VIN	

(3) Fuel Pressure Control

▶ Fuel Pressure

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

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

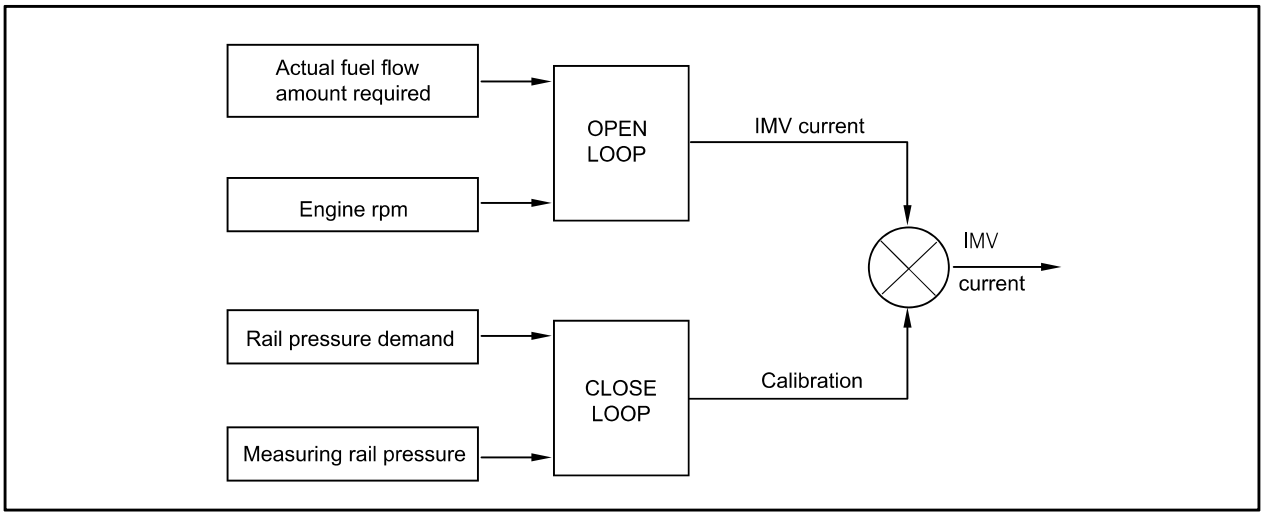
- When engine speed and load are high
  The degree of turbulence is very great and the fuel can be injected at very high pressure in order to optimize combustion.
- When engine speed and load are low
  The degree of turbulence is low. If injection pressure is too high, the nozzle's penetration will be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

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

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

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

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



(4) Injection Timing Control

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

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

▶ **Pilot injection timing control**

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

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

▶ **Main injection timing control**

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

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

Modification basis	
Application basis	
Affected VIN	

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

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

(5) Fuel Control

A. Main Flow Control

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

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

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

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

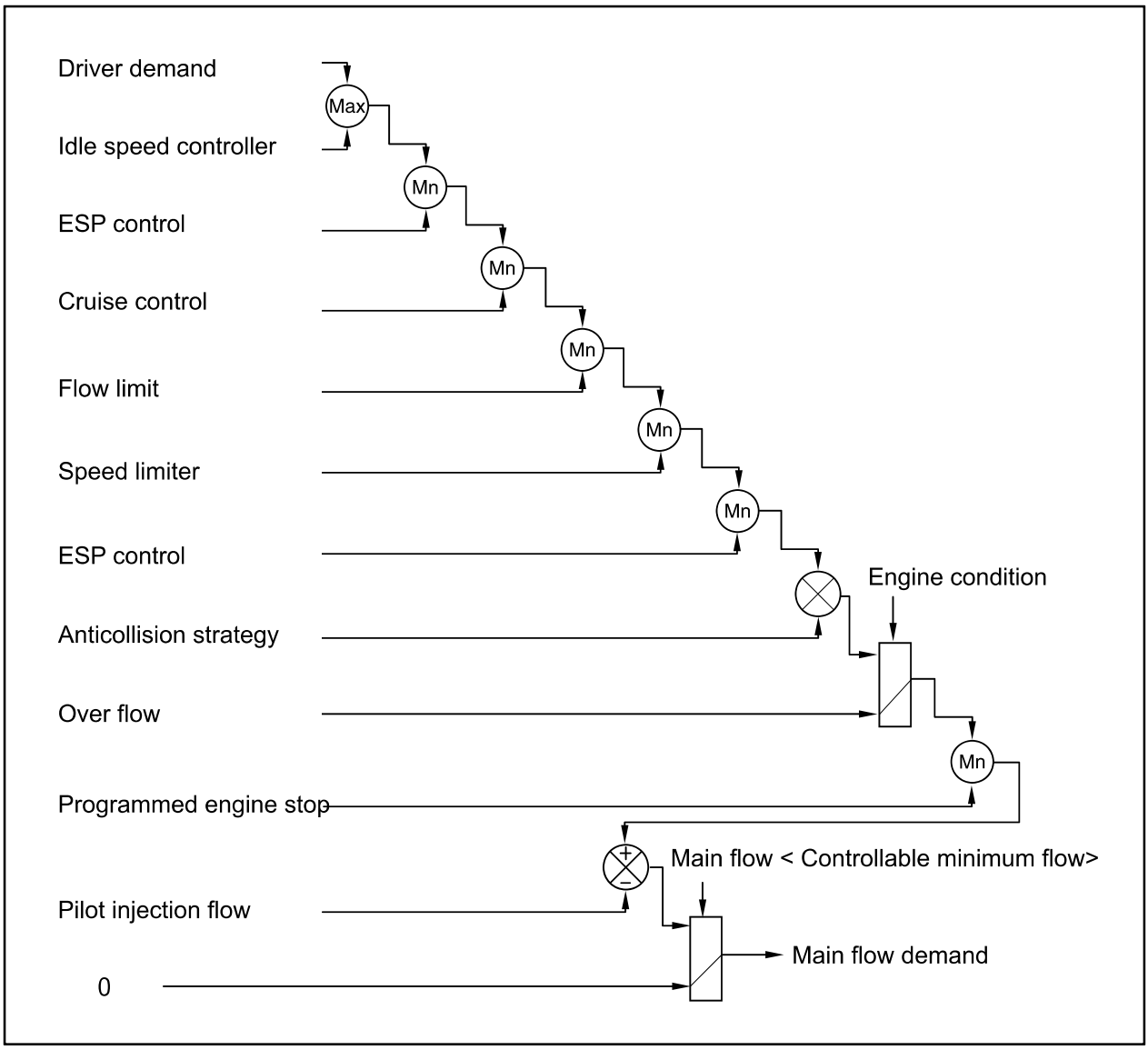
As soon as the injected fuel becomes lower than the flow limit determined by the ESP system, the antagonistic torque (engine brake) transmitted to the drive wheels exceeds the adherence capacity of the vehicle and there is therefore a risk of the drive wheels locking.
The system thus chooses the greater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

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

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

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

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



B. Driver Demand

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

Modification basis	
Application basis	
Affected VIN	

C. Idle Speed Controller

The idle speed controller consists of 2 principal modules:

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

D. Flow Limitation

The flow limitation strategy is based on the following strategies:

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

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

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

E. Superchager Flow Demand

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

F. Pilot Flow Control

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

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

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

G. Cylinder Balancing Strategy

▶ Balancing of the point to point flows

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

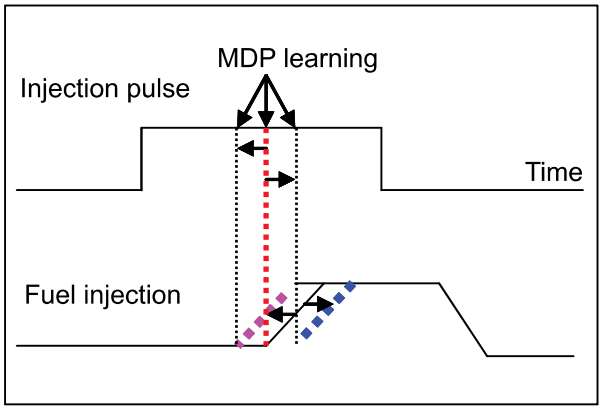
The instantaneous speeds on two successive injections are first calculated.
The difference between these two instantaneous speeds is then calculated.
Finally, the time to be added to the main injection pulse for the different injectors is determined.
For each injector, this time is calculated according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

▶ Detection of an injector which has stuck closed

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

Modification basis	
Application basis	
Affected VIN	

(6) MDP Learning Control



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

A. MDP Learning

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

B. Purpose of MDP learning

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

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

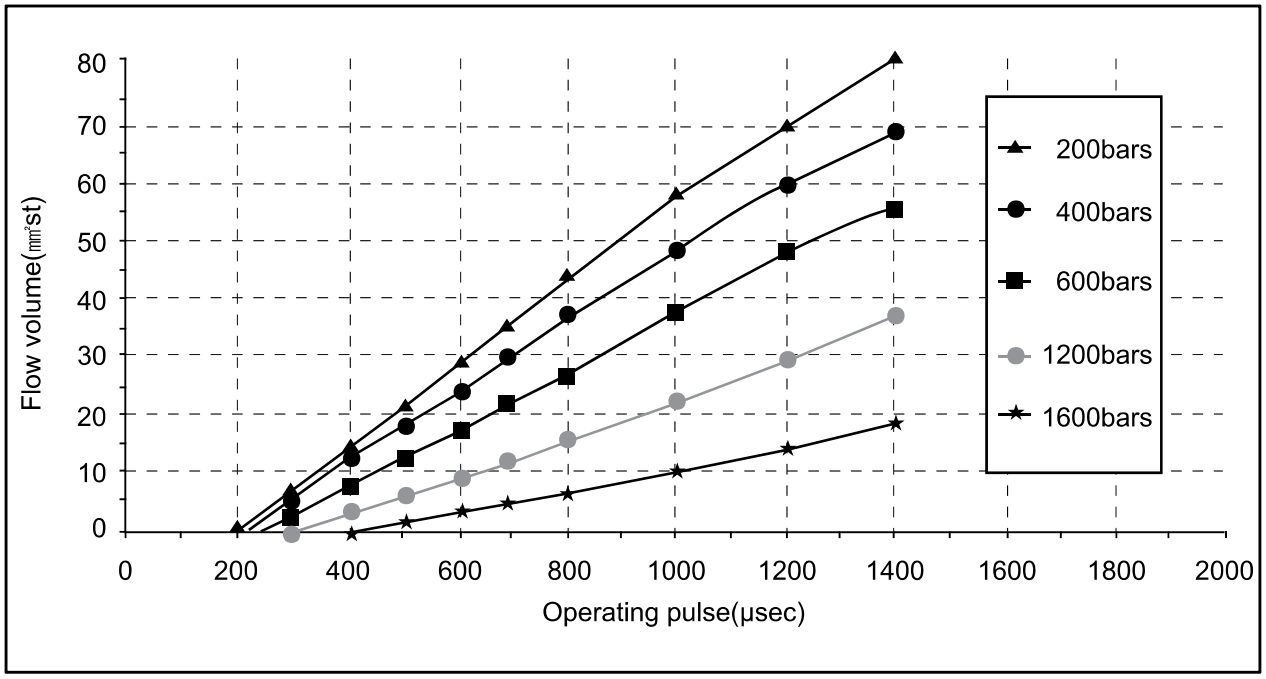
C. Learning Conditions

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

CAUTION

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

D. Injector characteristic curve for rail pressure



Modification basis	
Application basis	
Affected VIN	

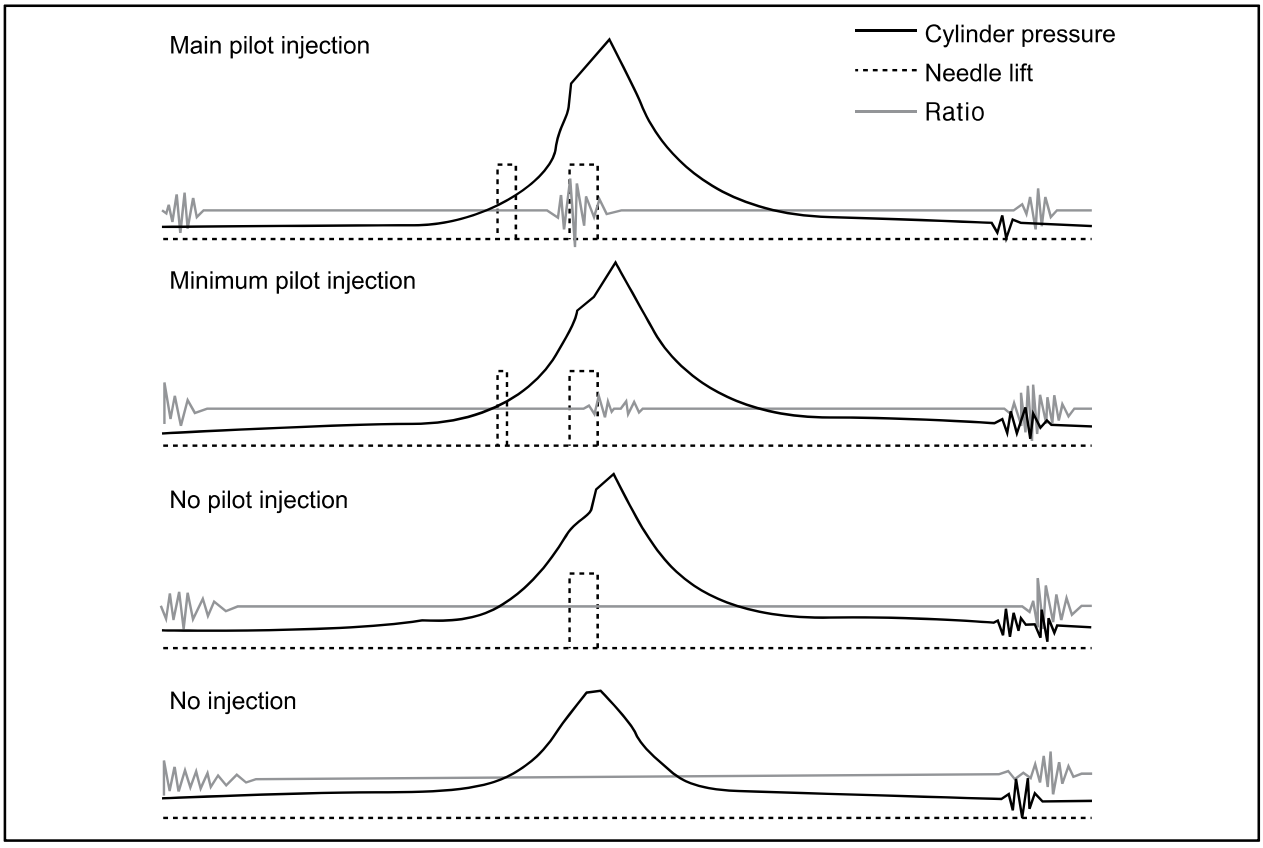
(7) Knocking Control

A. Resetting the pilot injection

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

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

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



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

B. Detection of leaks in the cylinders

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

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

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

C. Detection of an accelerometer fault

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

Modification basis	
Application basis	
Affected VIN	

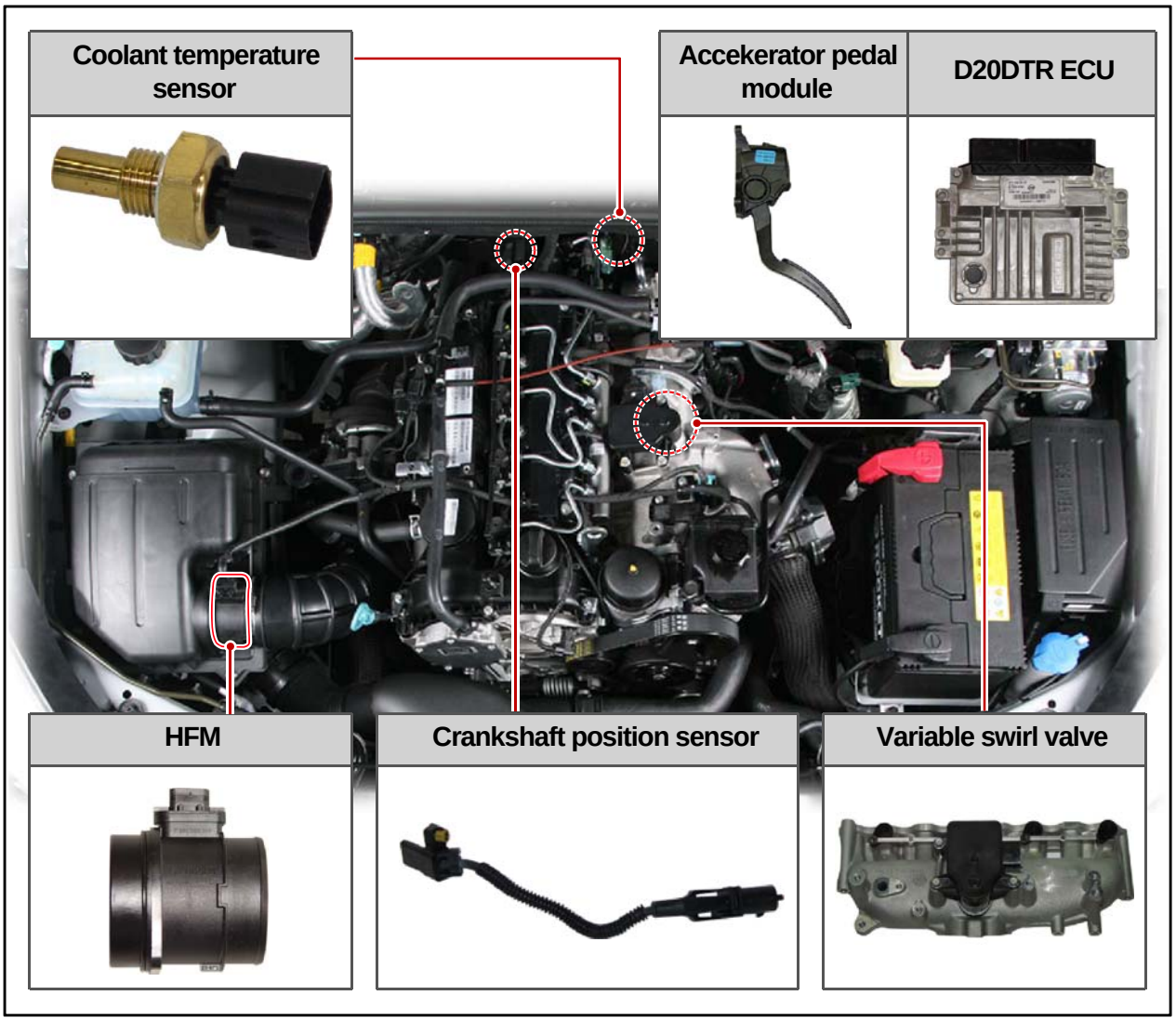
(8) Swirl control

A. Overview

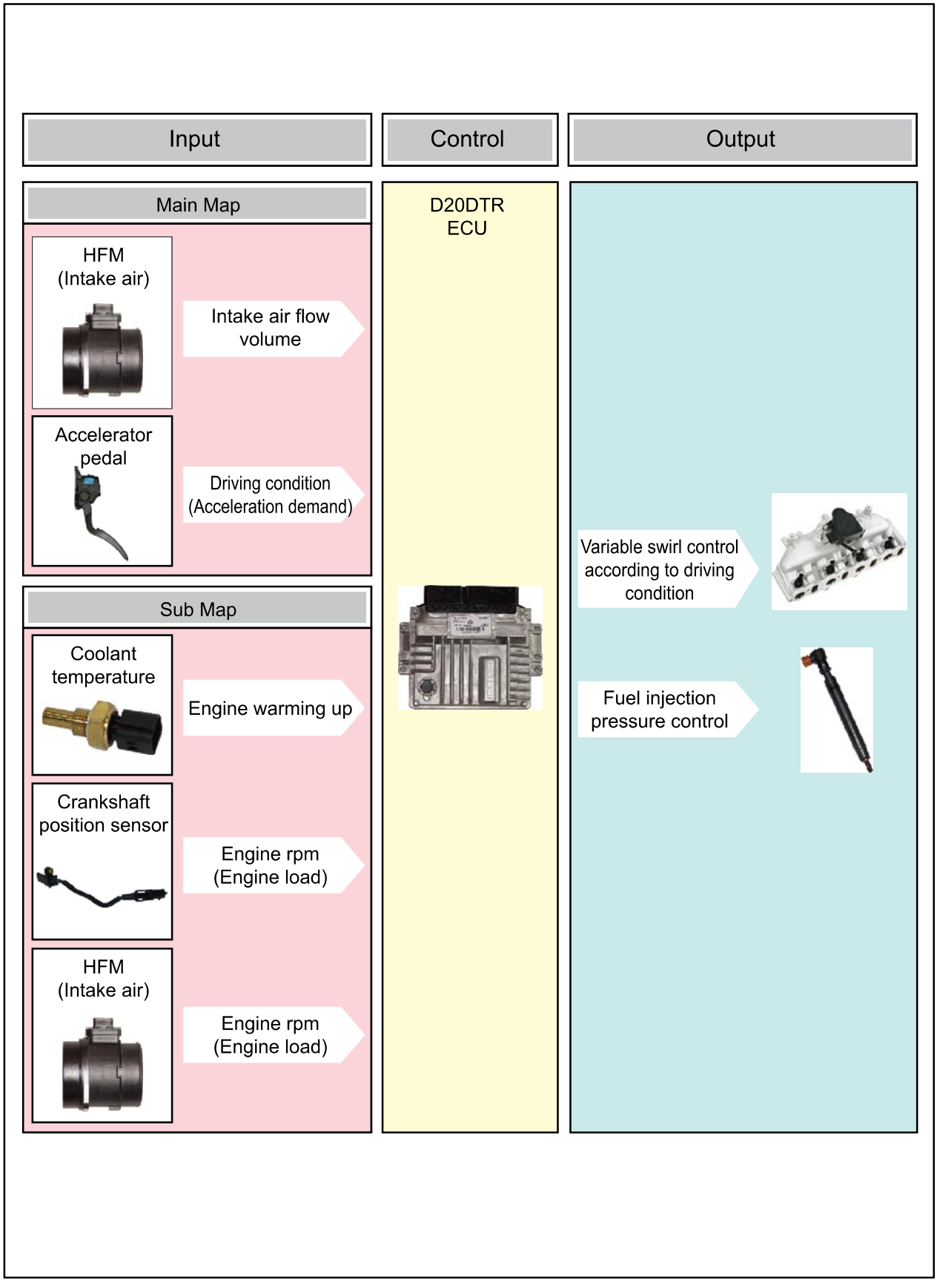
▶ Variable swirl valve

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

▶ Components

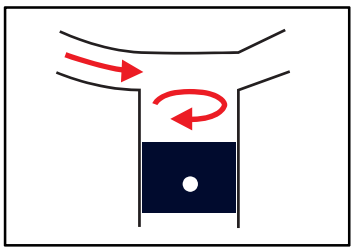


B. Input/Output for variable swirl valve

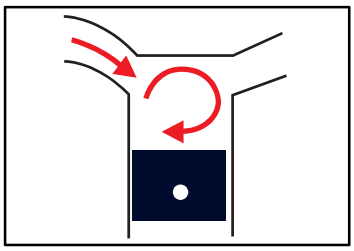


Modification basis	
Application basis	
Affected VIN	

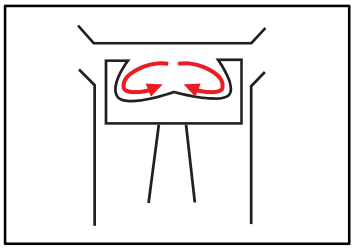
C. Types of swirl



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



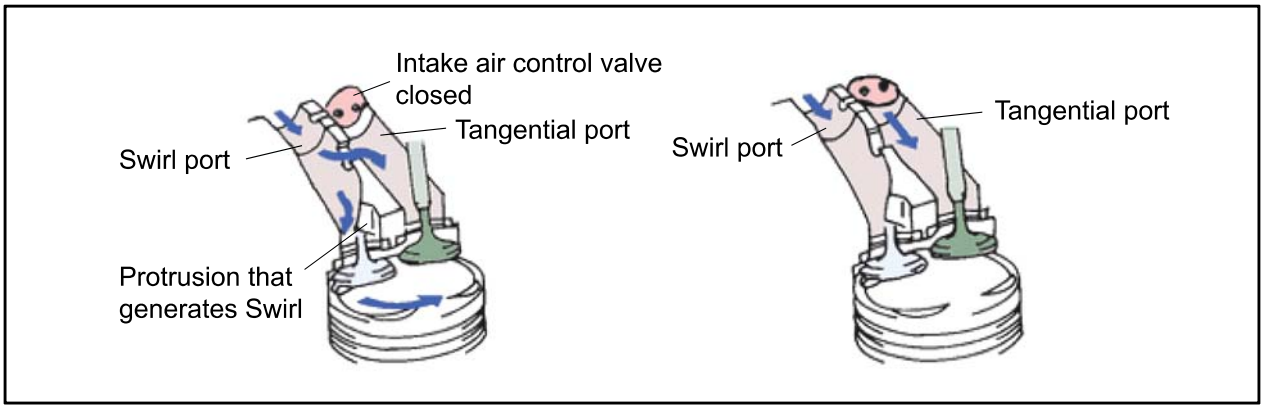
Tumble: Tumble is the vertical air flows in cylinder due to the vertical intake air port



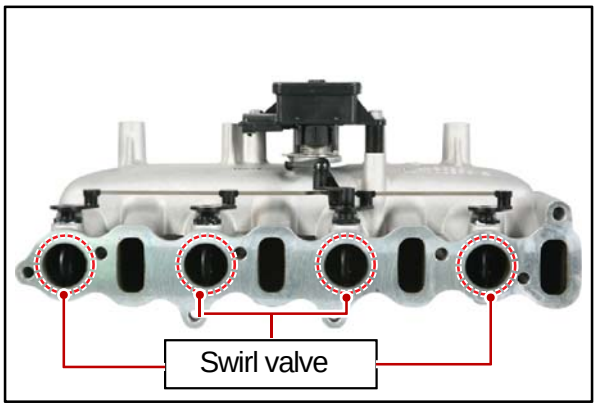
Tumble: Tumble is the vertical air flows in cylinder due to the vertical intake air port

D. Swirl control

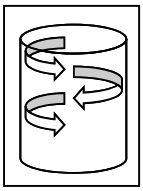
In DI type diesel engine, the liquefied fuel is injected into the cylinder directly. If the fuel is evenly distributed in short period, the combustion efficiency could be improved. To get this, there should be good air flow in cylinder. In general, there are two intake ports, swirl port and tangential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



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



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



NOTE

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

E. Features

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

F. Relationship between swirl and fuel injection pressure

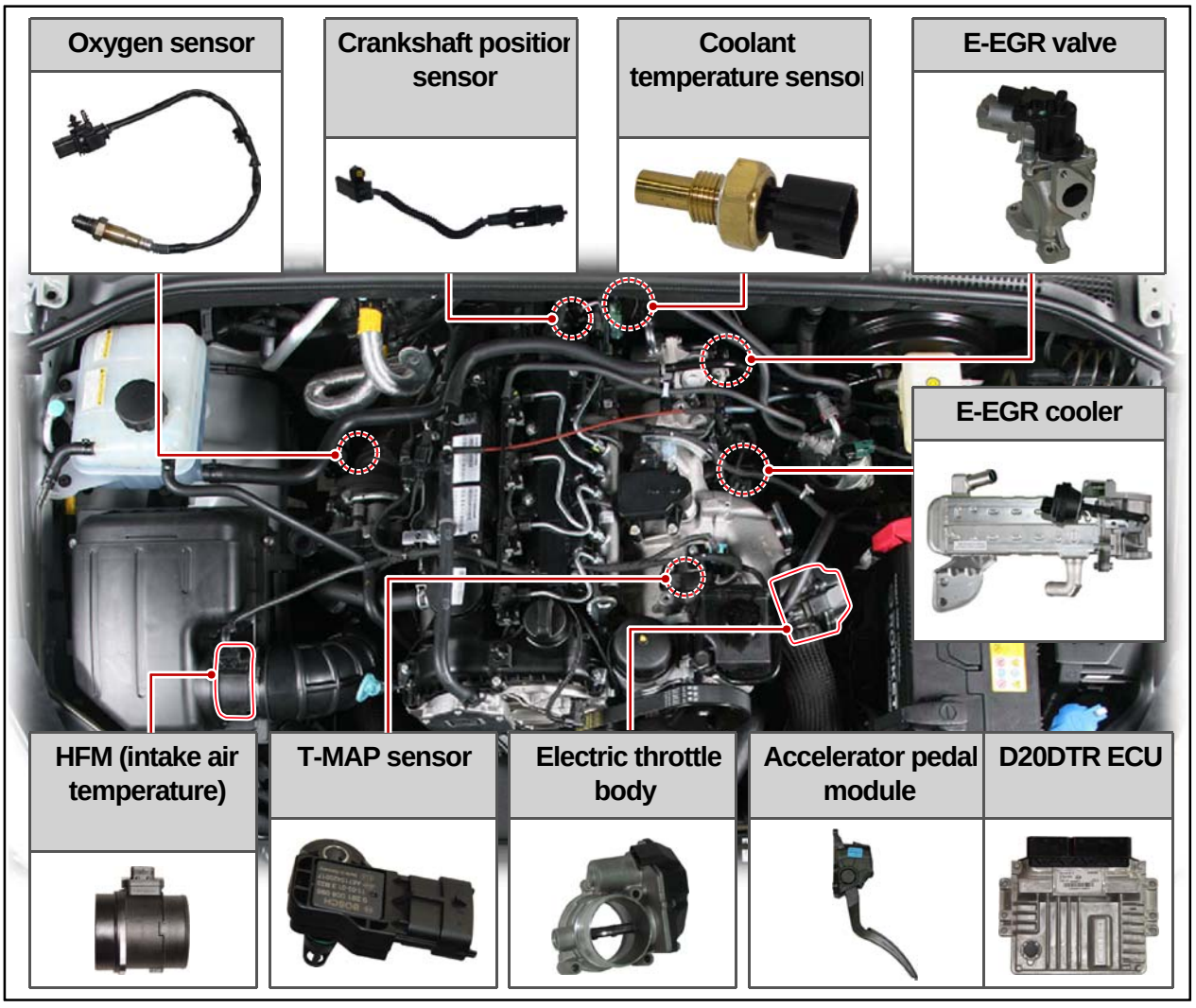
The injector for DI engine uses the multi hole design. For this vehicle, there are 8 holes in injector. If the swirl is too strong, the injection angles might be overlapped and may cause the increased PM and insufficient engine power. Also, if the injection pressure is too high during strong swirl, the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

(9) EGR control

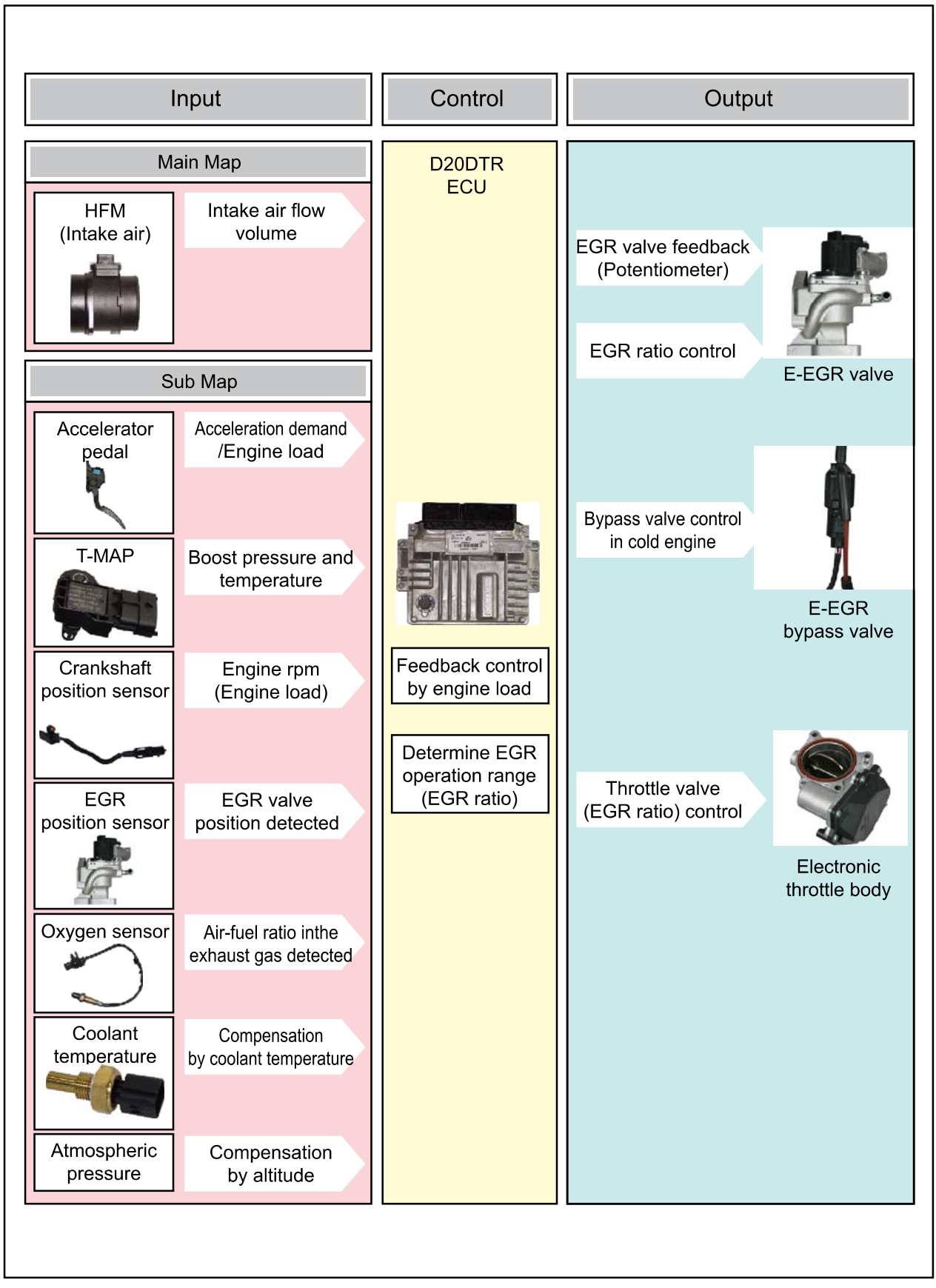
A. Overview

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

B. Components



C. Input/Output of E-EGR system

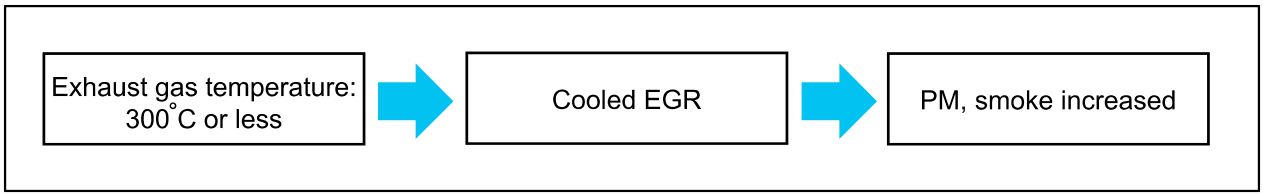


Modification basis	
Application basis	
Affected VIN	

D. Bypass control for EGR cooler

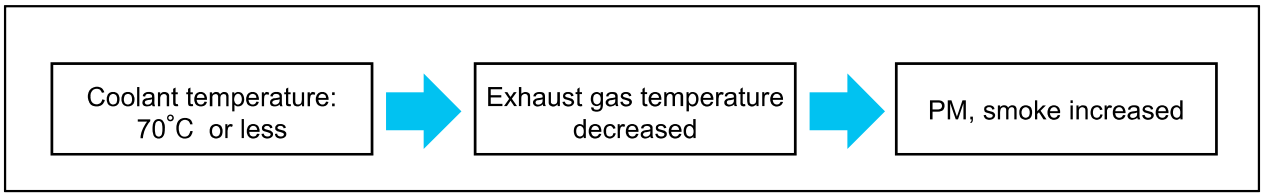
▶ Cooler temperature

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



▶ Exhaust gas temperature

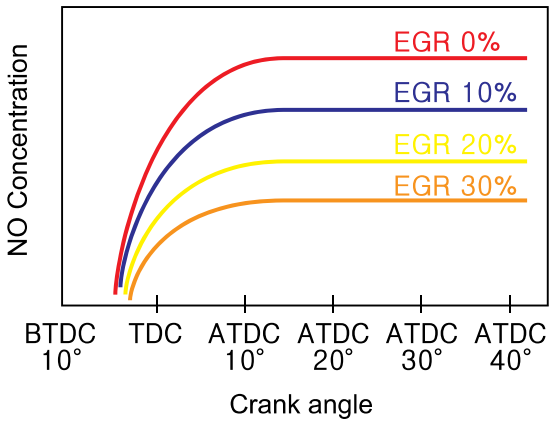
When the exhaust gas temperature is below 300℃, the exhaust gas is bypassed the EGR cooler. Otherwise, PM could be increased due to too low exhaust gas temperature.



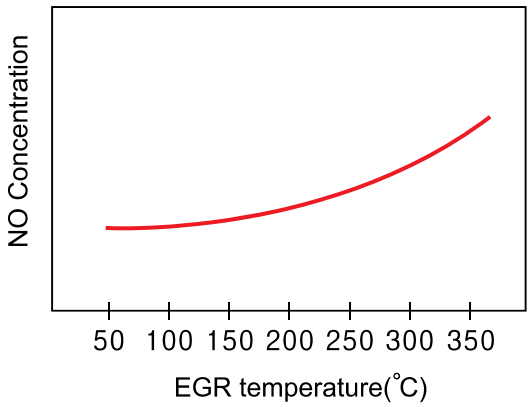
E. Control elements for EGR system

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

F. Features



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



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

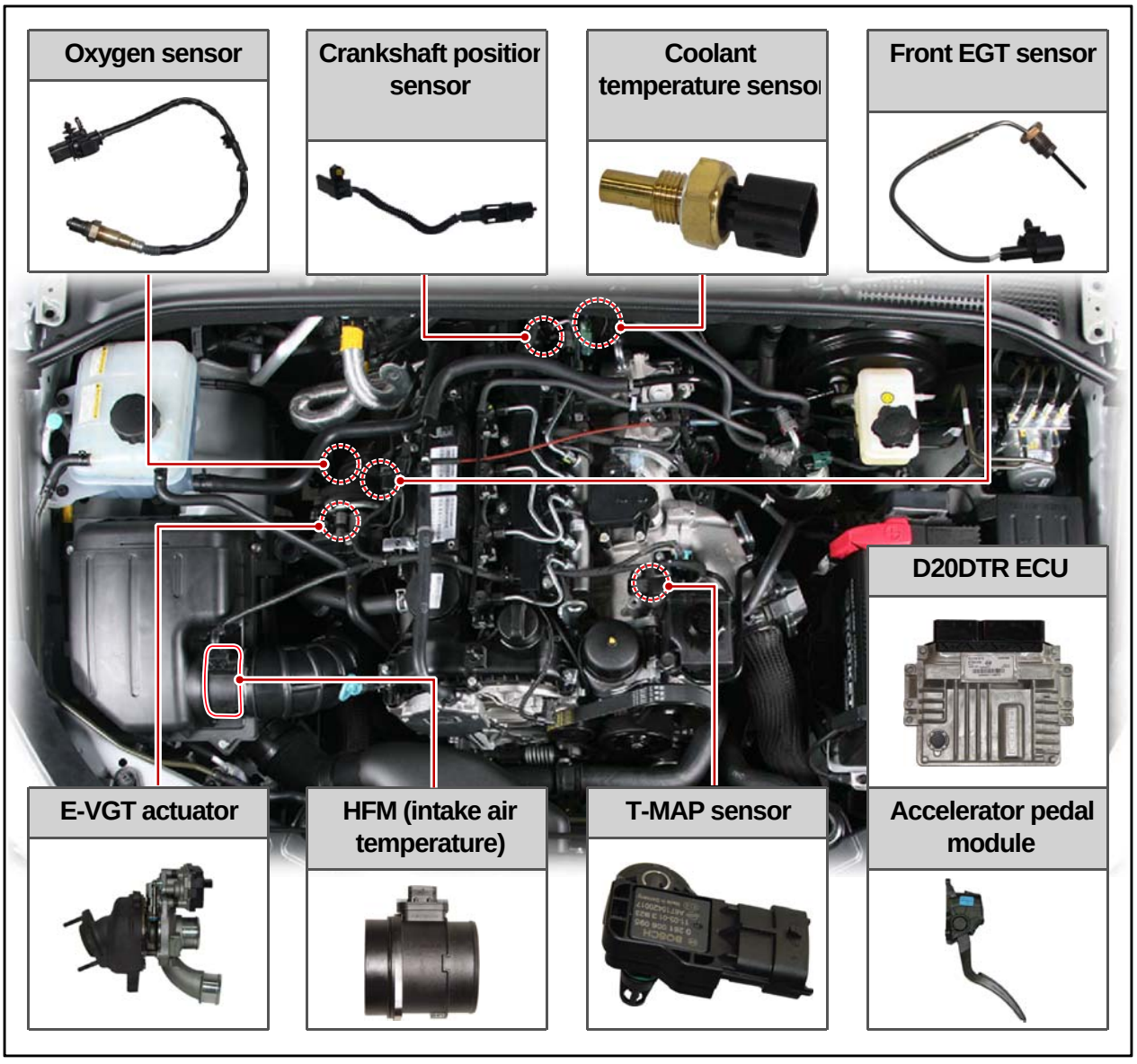
Modification basis	
Application basis	
Affected VIN	

(10) E-VGT control

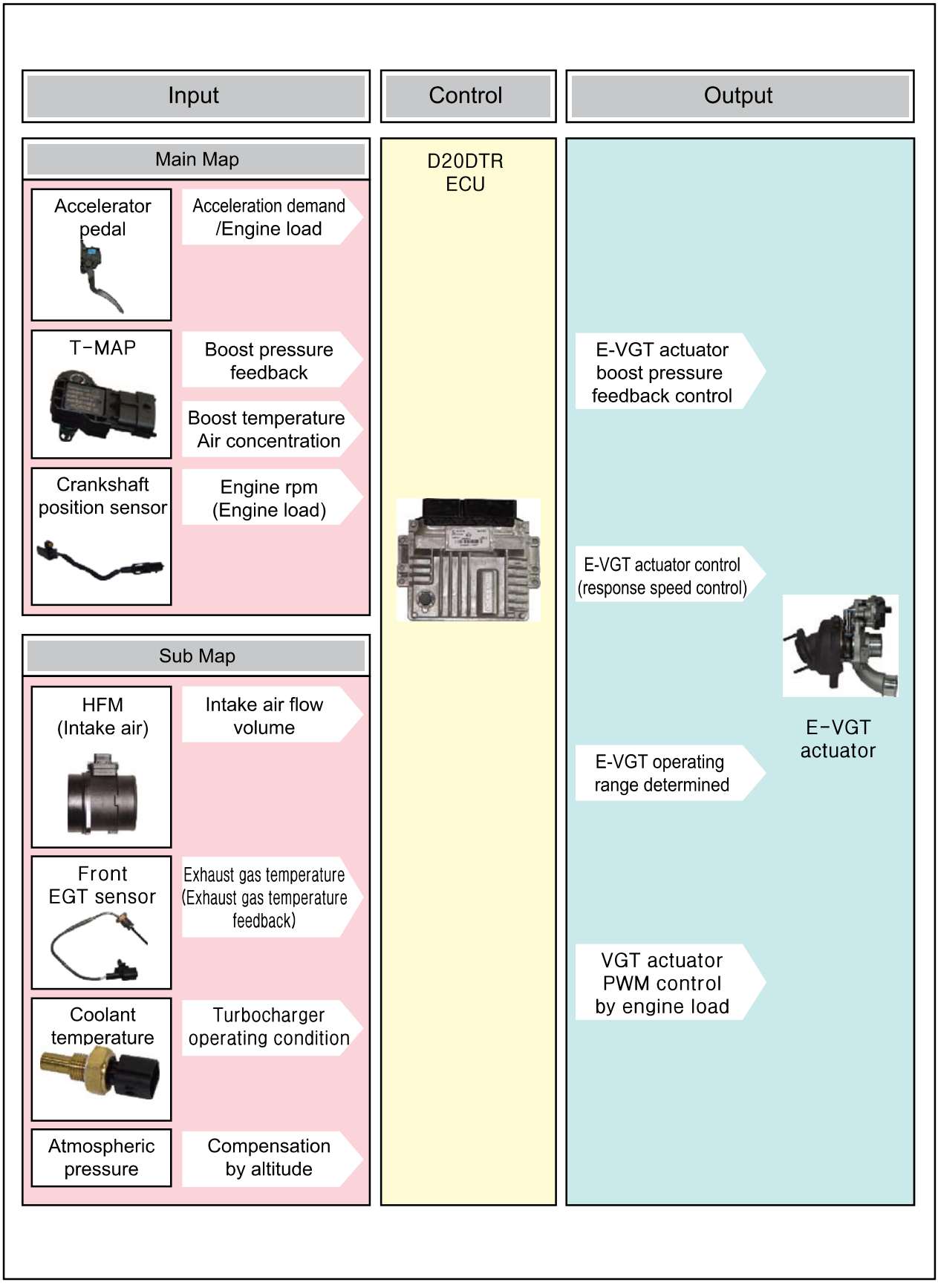
A. Overview

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

B. Components



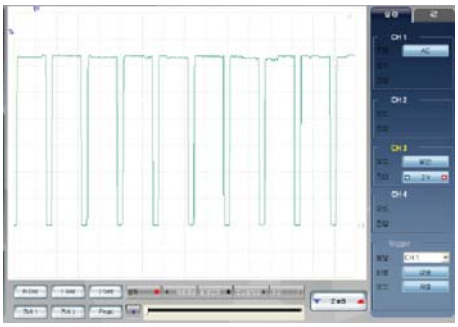
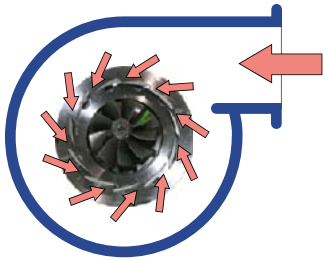
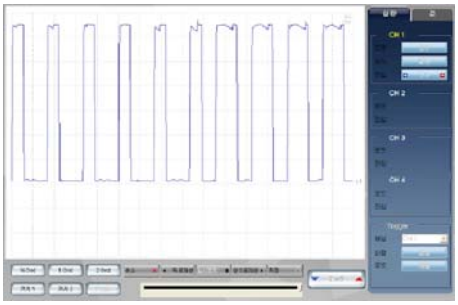
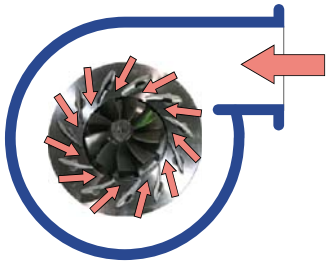
C. Input/Output for E-VGT system



Modification basis	
Application basis	
Affected VIN	

D. E-VGT system control

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

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

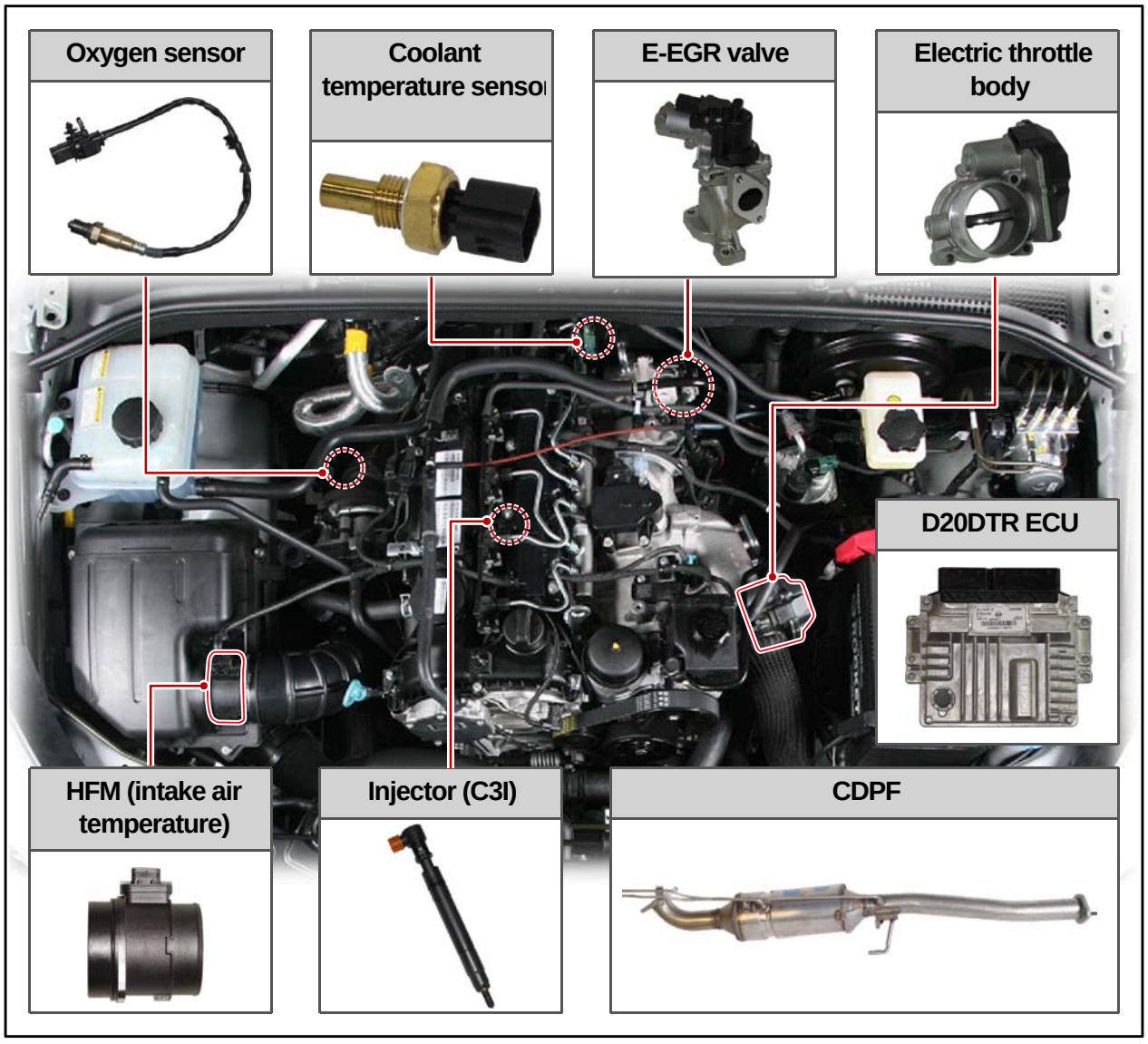
(11) Wide band oxygen sensor control

A. Overview

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

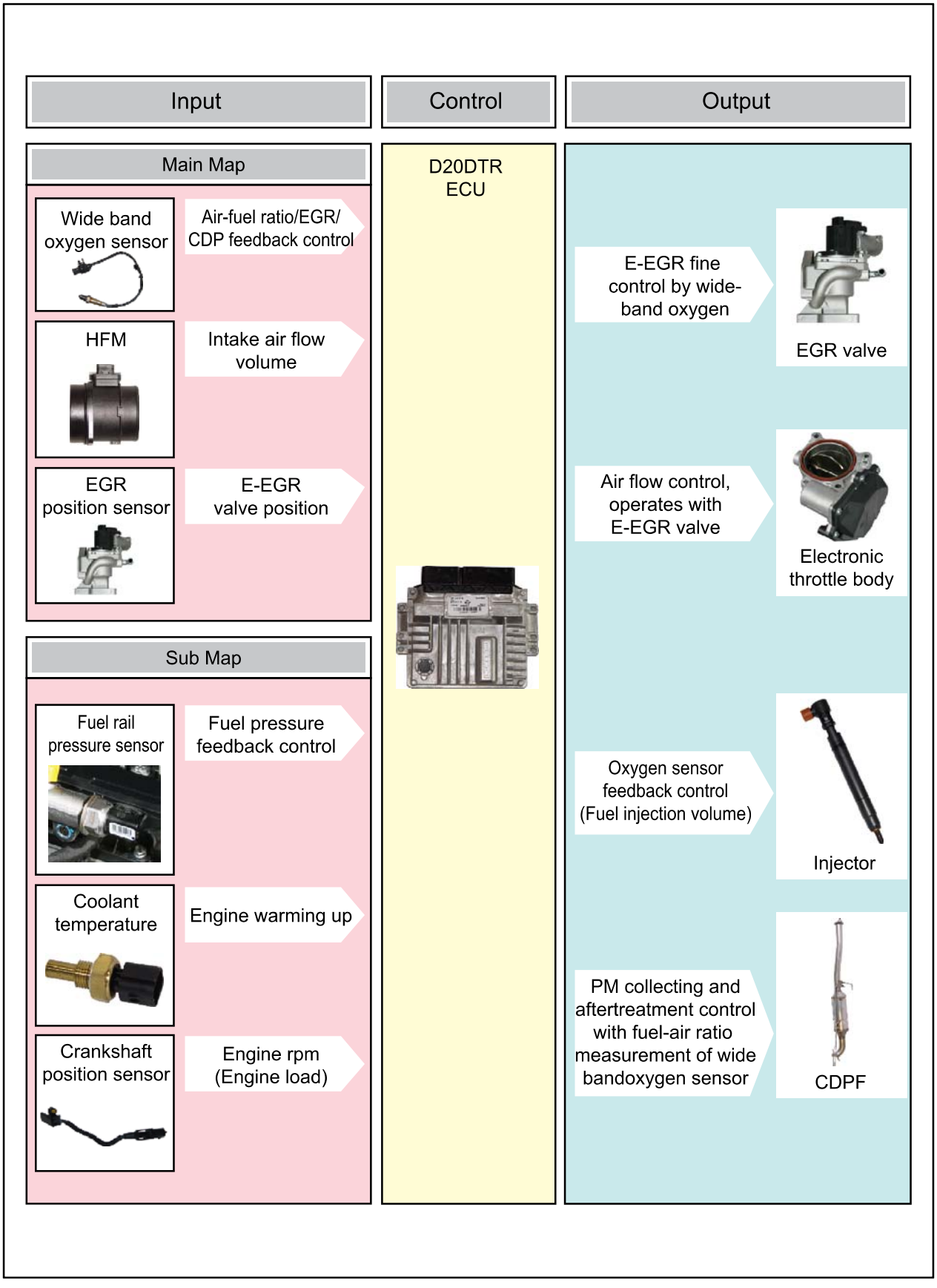
- The wide band oxygen sensor measures the oxygen density in exhaust gas and sends it to ECU to control the EGR more precisely.

B. Components



Modification basis	
Application basis	
Affected VIN	

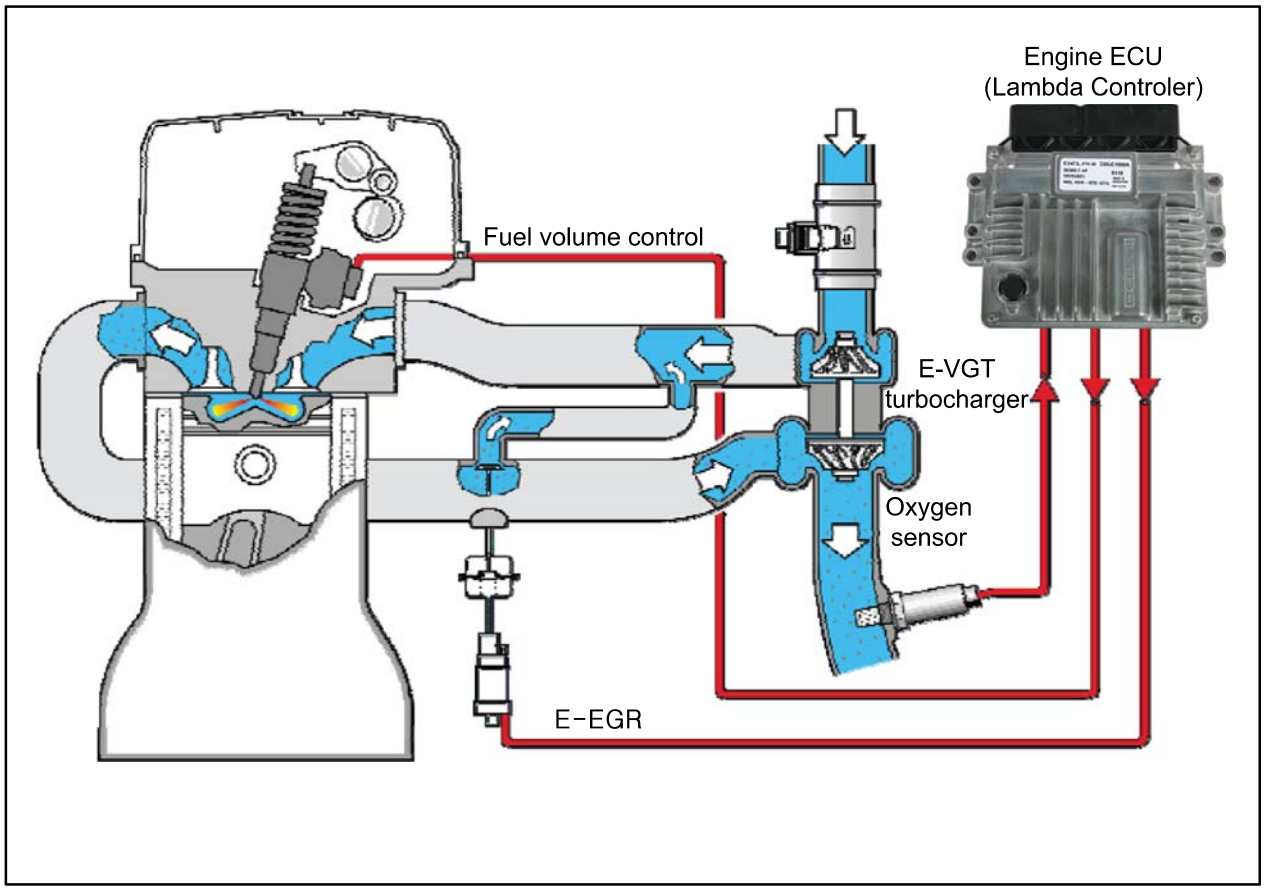
C. Input/Output for oxygen sensor



Modification basis	
Application basis	
Affected VIN	

D. Oxygen sensor control

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



Modification basis	
Application basis	
Affected VIN	

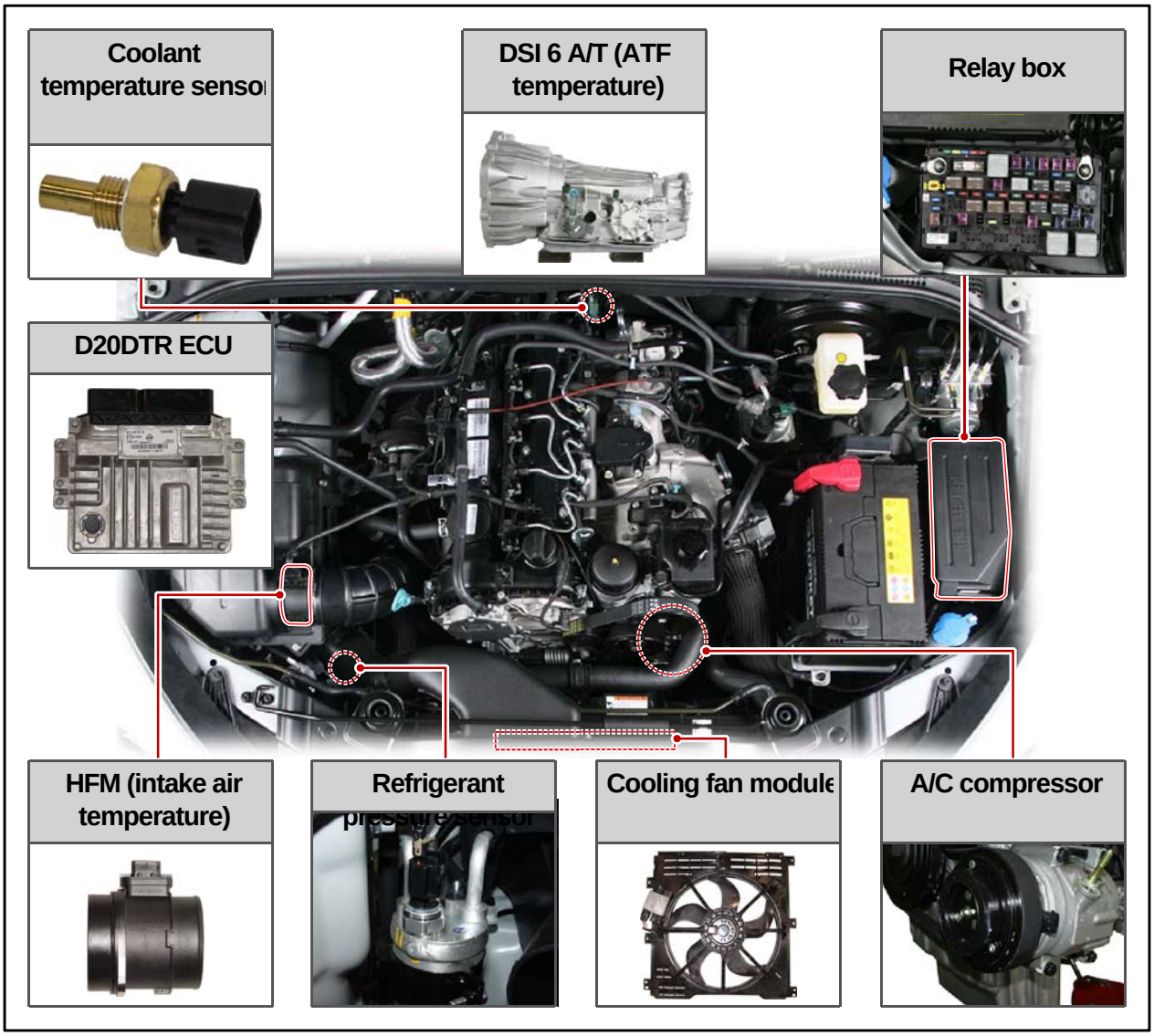
(12) Cooling fan control

A. Overview of cooling fan and A/C compressor

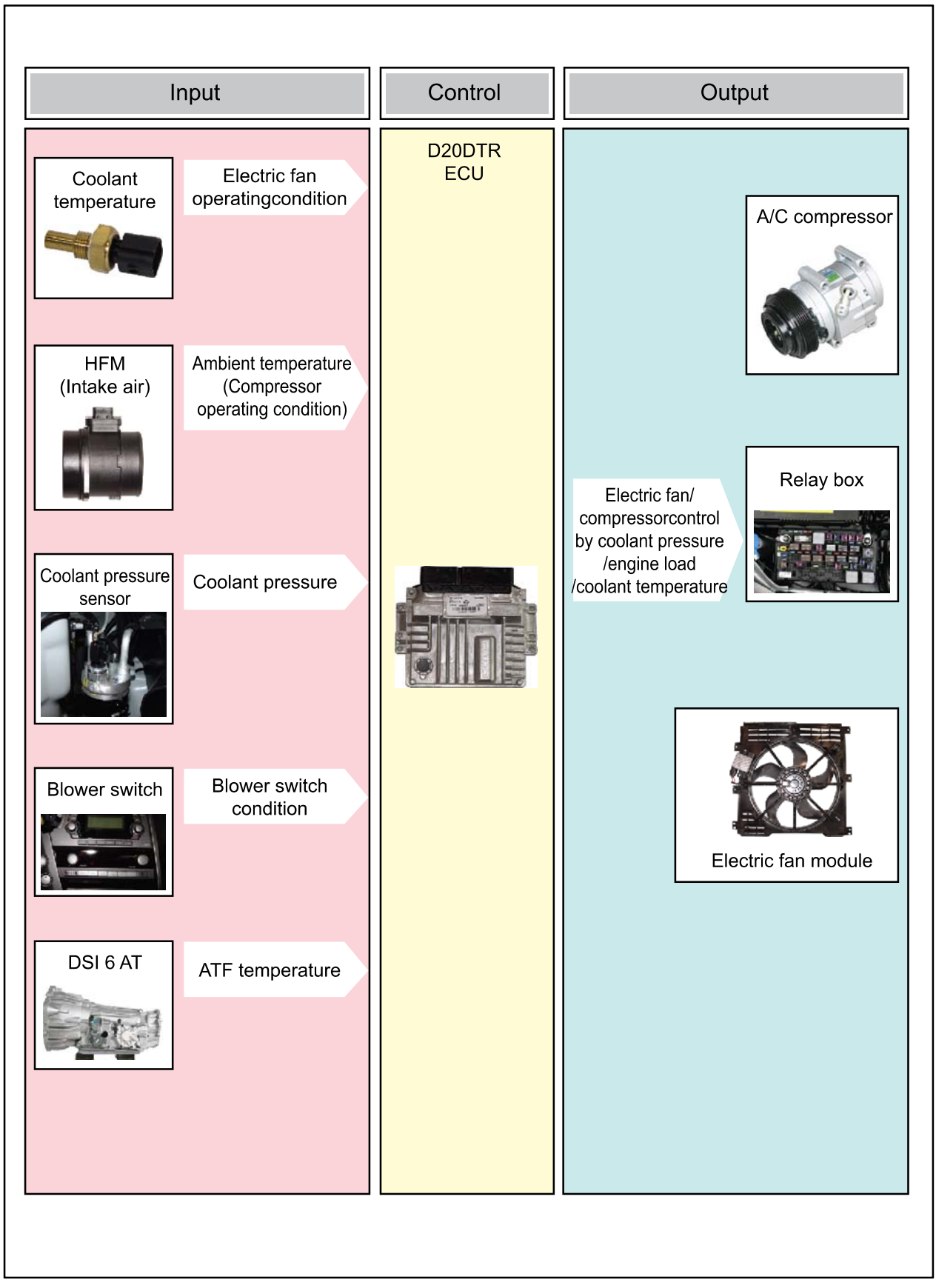
The cooling system maintains the engine temperature at an efficient level during all engine operating conditions. The water pump draws the coolant from the radiator. The coolant then circulates through water jackets in the engine block, the intake manifold, and the cylinder head. When the coolant reaches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

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

B. Components



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



Modification basis	
Application basis	
Affected VIN	

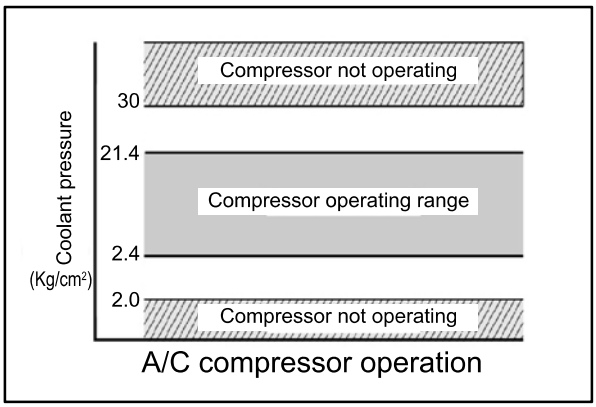
D. Cooling fan and A/C compressor control

▶ Conditions for cooling fan

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

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

▶ A/C compressor OFF conditions



A/C compressor operation

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

▶ Output voltage according to refrigerant pressure

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

▶ Cooling fan controls according to ATF

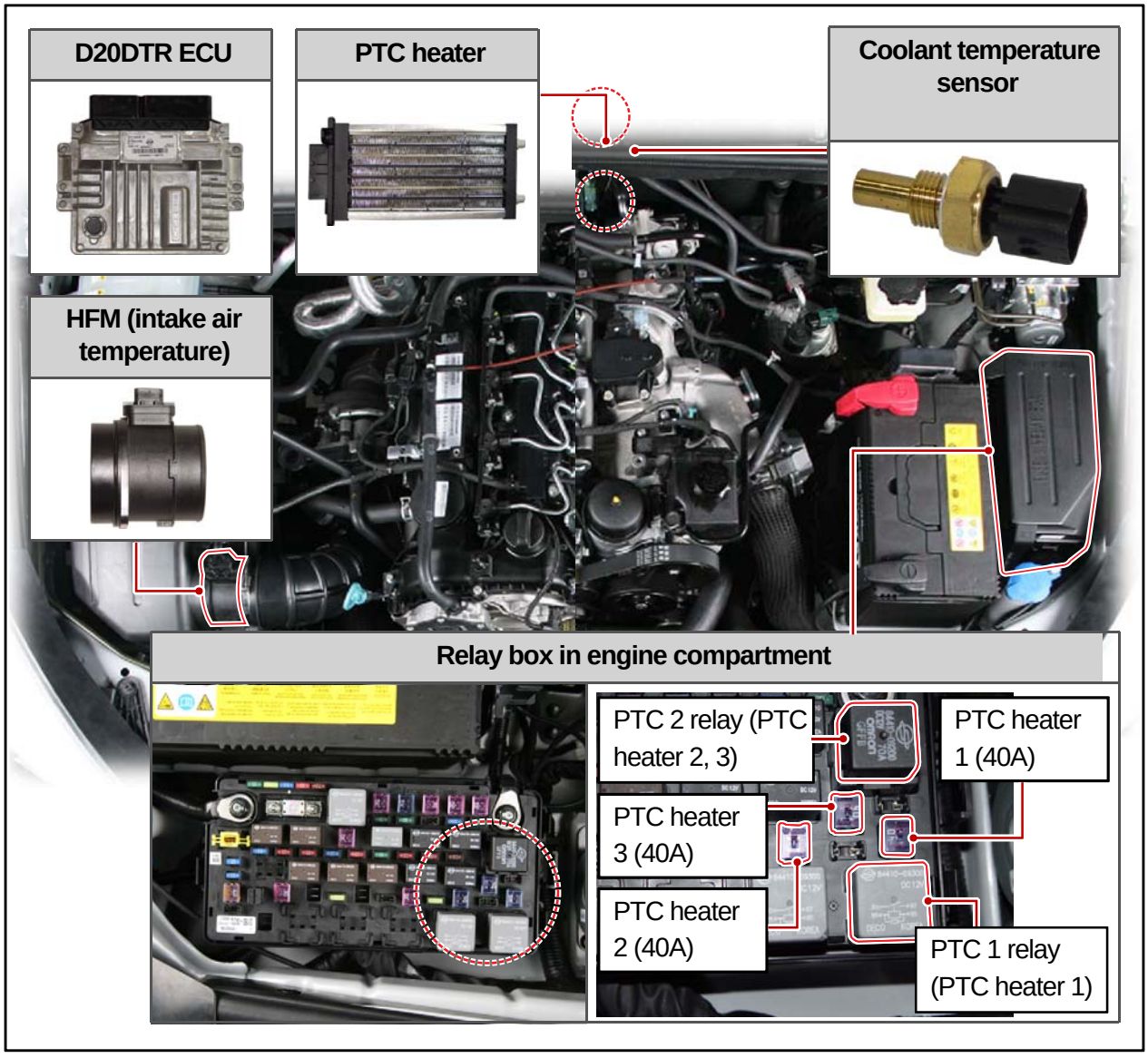
ATF temperature	Fan condition	Remark
Over 110˚C	High speed	-

(13) High speed

A. Overview

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

B. Components

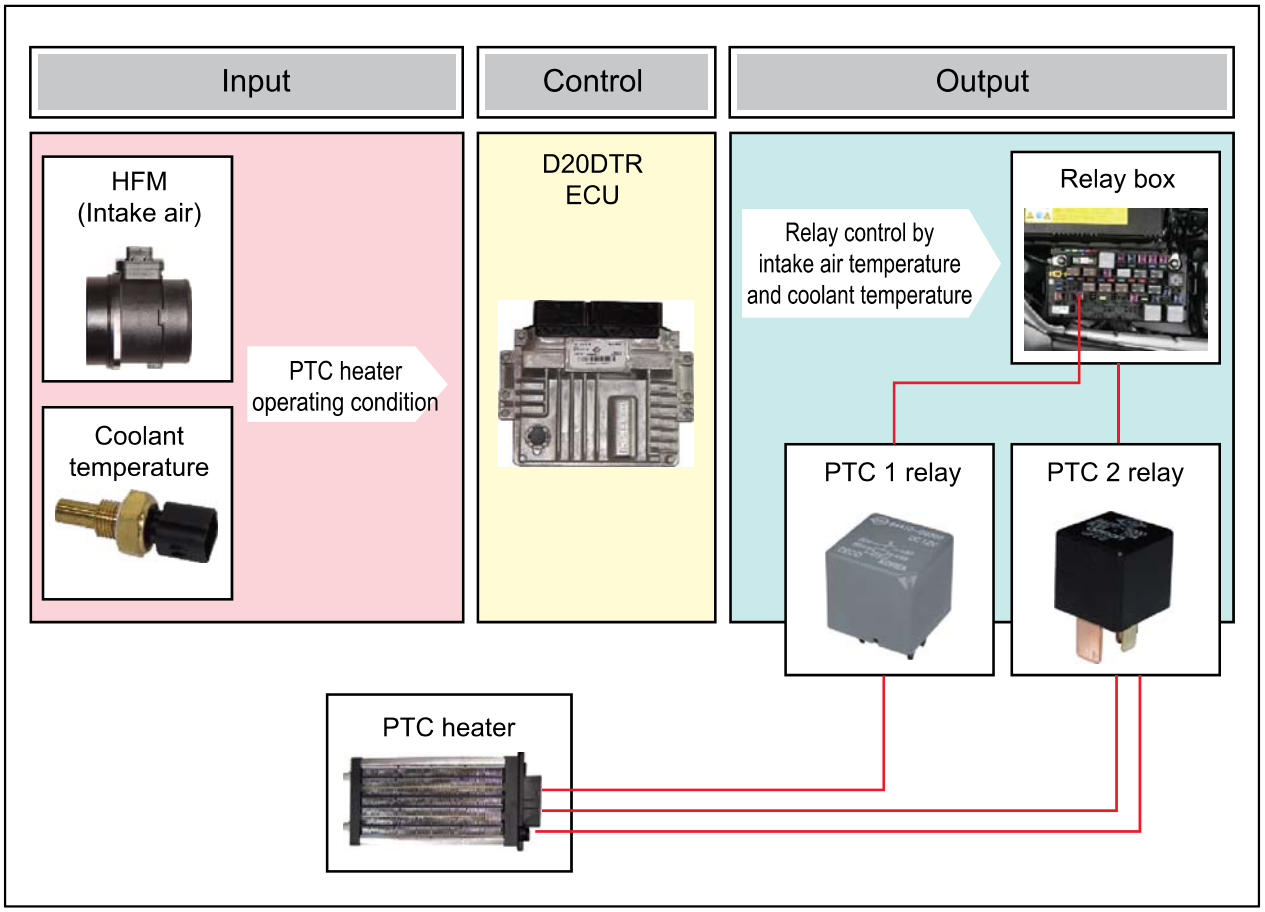


Modification basis	
Application basis	
Affected VIN	

C. Operation process

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

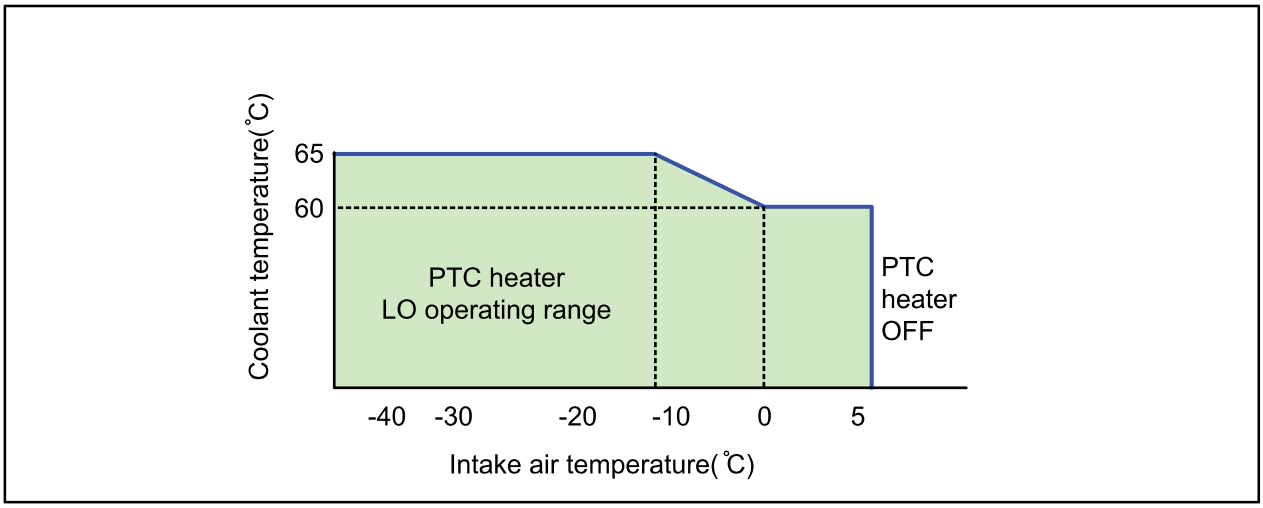
Operation process: reaches at a certain temperature→high resistance→low current→less heat radiation→temperature down→high resistance→high current→temperature up



D. Control conditions

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

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



Modification basis	
Application basis	
Affected VIN	

(14) Immobilizer control

A. Overview

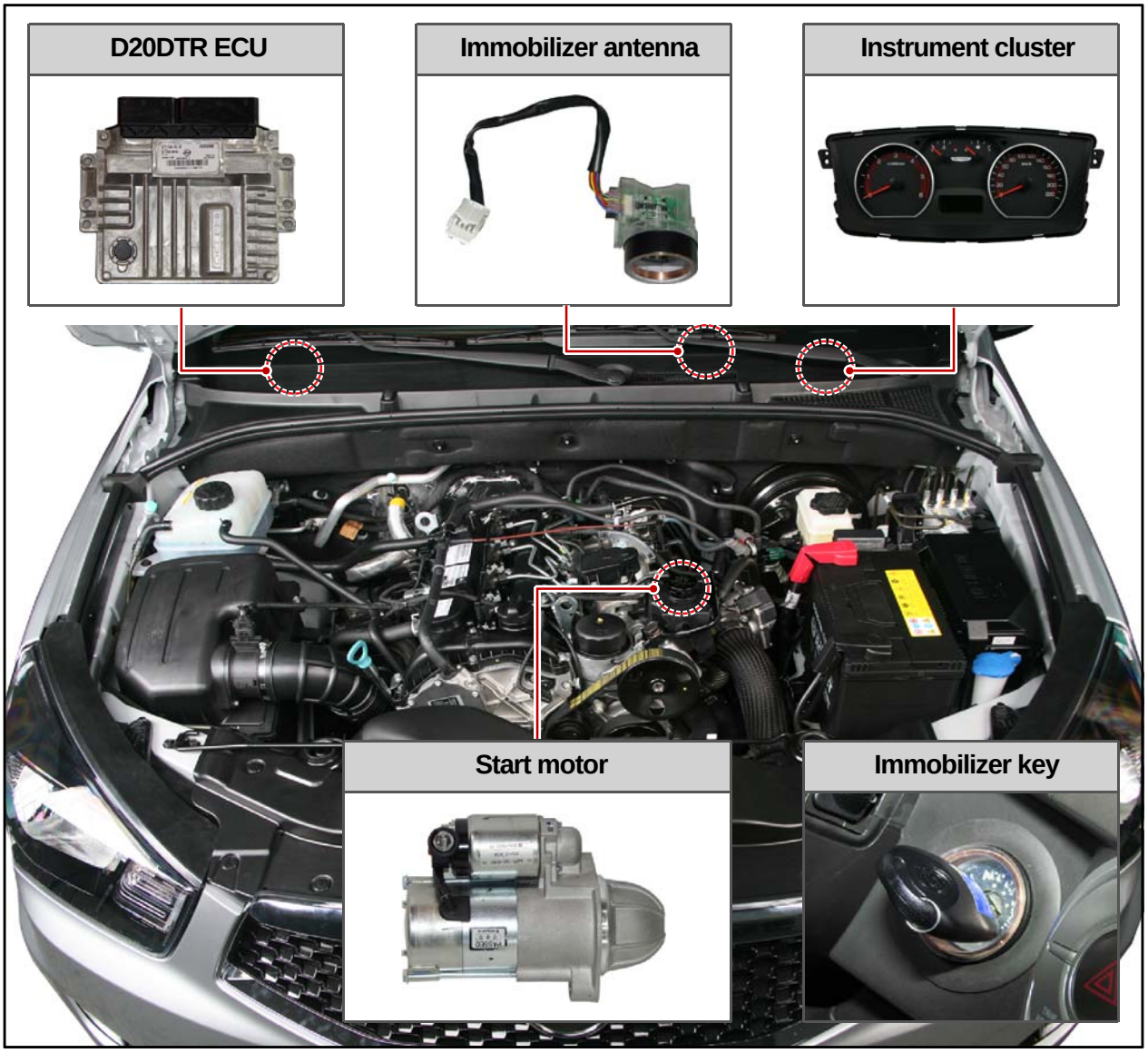
The Immobilizer System provides an additional theft deterrent to the vehicle in which it is installed and prevents it from being started by unauthorized persons. The transponder integrated in the key and the engine control unit have the same code. When the ignition key with the integrated transponder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

NOTE

For details, refer to Chapter "Immobilizer".

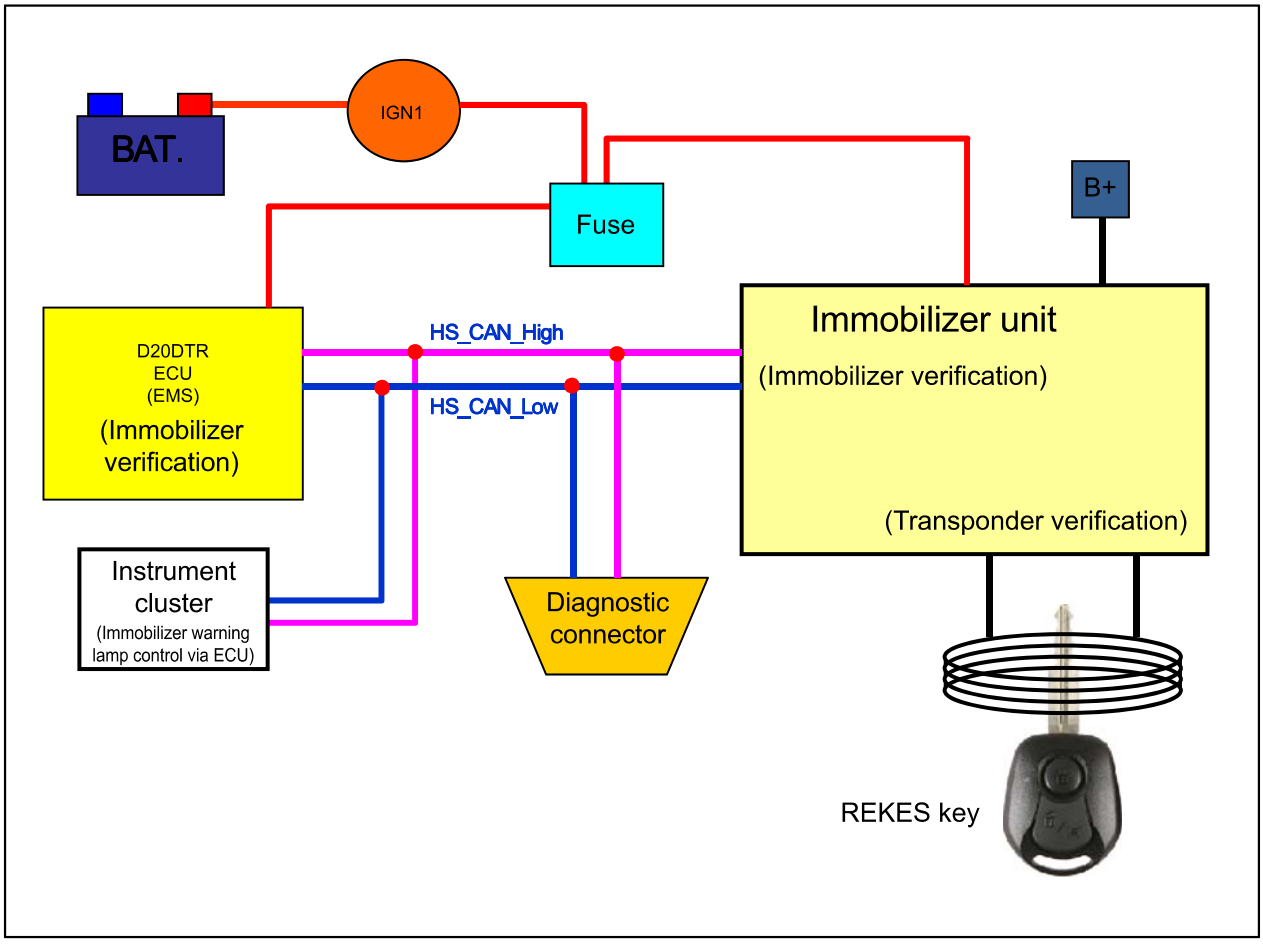
B. Components

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



▶ Key approval process

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



Modification basis	
Application basis	
Affected VIN	

(15) CDPF control

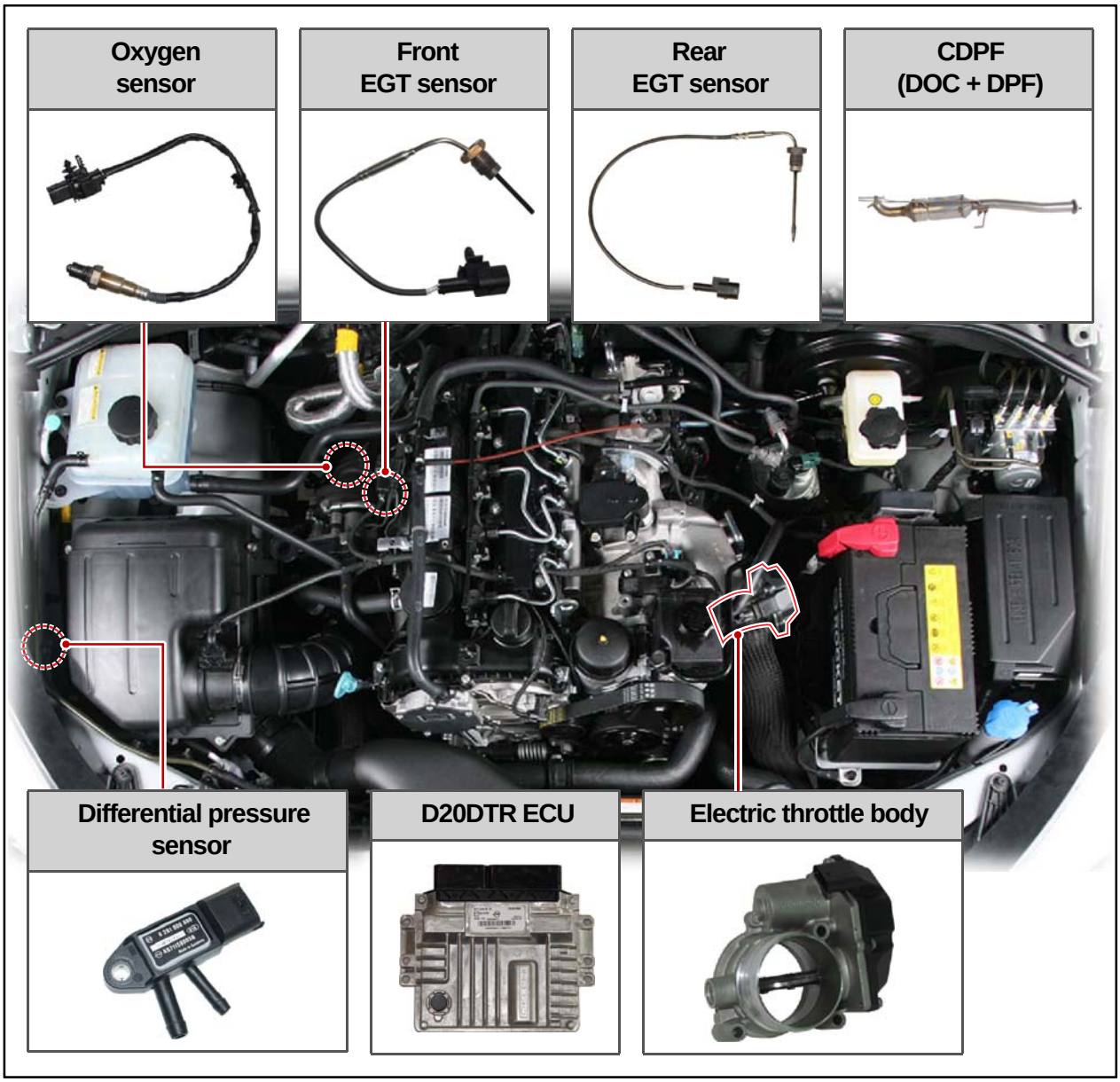
A. Overview

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

NOTE

For details, refer to Chapter "CDPF".

B. Components



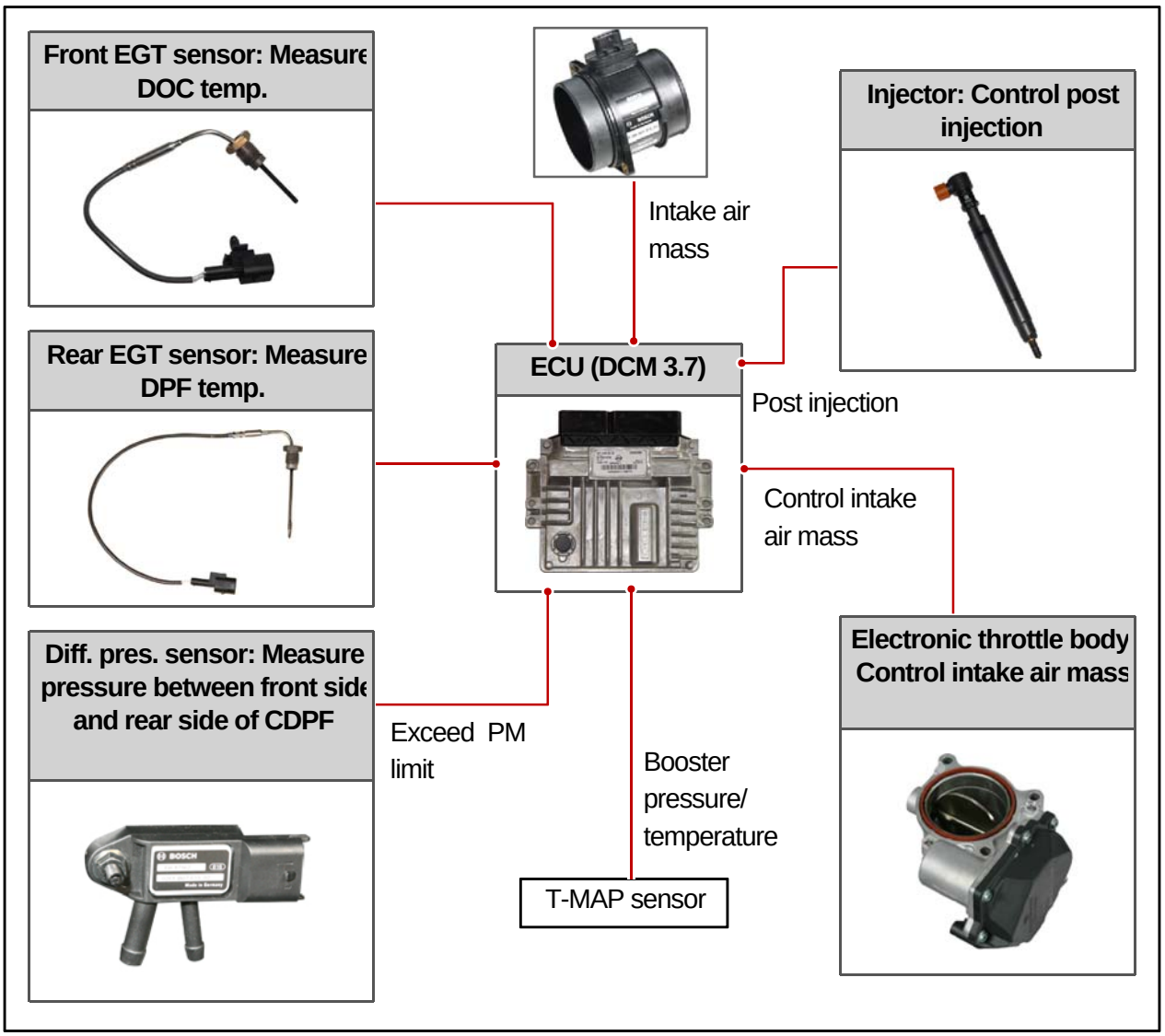
C. Input/Output for CDPF control

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

Modification basis	
Application basis	
Affected VIN	

D. Operation process

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



E. Cautions

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

▶ Use only specified engine oil (Low Ash Oil)

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

▶ Issue with normal engine oil

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

▶ Benefit for specified engine oil

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

▶ Problems when using unspecified engine oil

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

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

Modification basis	
Application basis	
Affected VIN	

3) Input/Output for CAN communication