ED Engine

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Objectives	To understand line-up of ED engine system. To understand gamma engine system To understand the troubleshooting method

ED has 4 types of engine. 2 for gasoline (gamma 1.6, beta-2.0). 2 for Diesel CRDI (U-1.6, D-2.0). Gamma gasoline engine is used for Cerato F/L. It is following engine for alpha II. Beta 2.0 engine is changed a little. U engine is applied for Cerato F/L and D engine is used for KM(Sportage), MG(magentis), UN(Carens).

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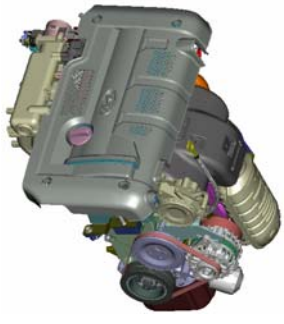
All gasoline engine (Beta 2.0, Gamma 1.6) has a CVVT system. U-1.6 VGT and D-2.0 VGT are EURO IV emission engine which has additional components compared with EURO III emission engine.

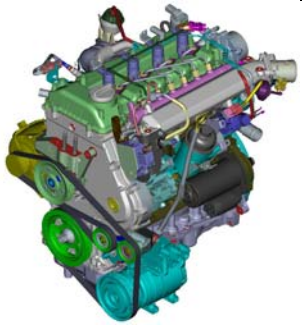
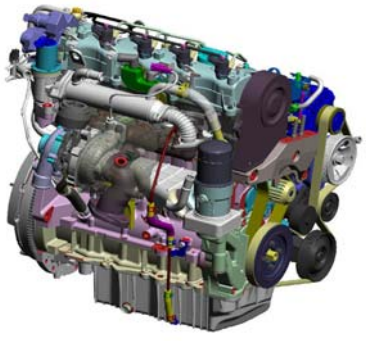
1. System introduction

1-1 Engine line-up

Item		Gasoline	
		Gamma 1.6L	**Beta 2.0L**
Fuel Injection type		MPI	MPI
Displacement (cc)		1,591	1,975
Bore x Stroke (mm)		77.0 x 85.44	82.0 x 93.5
Timing system		Chain	Belt
Performance	**Output max.**	118	143
	Torque max.	15.4	19.0
Appearance			

wrong!

Item		Diesel	
		U-1.6L	**D-2.2L**
Fuel Injection type		CRDi (1600 bar)	CRDi (1600 bar)
Displacement (cc)		1,582	1,991
Bore x Stroke (mm)		75 x 77.2	83.0 x 92
Timing system		Chain	Belt
Performance	**Output max.**	116	140
	Torque max.	26.5	31

Appearance		

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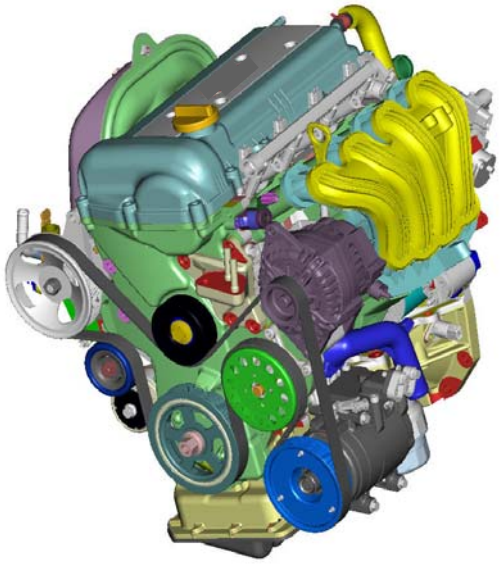
2. Gamma 1.6L engine

2.1 General information

Gamma engine called alpha III is following of alpha II. Many mechanical components are changed but EMS is same as alpha II. gamma engine use BOSCH EMS.
Below things are gamma's main features :



1) Reverse position for intake, exhaust manifold
   - Similar as the theta engine intake manifold is locate forward to improve cooling efficiency and repair ability.

2) Offset crank shaft applied by 10mm
   - To increase inertia moment offset crank shaft is used.

3) High pressure casting aluminum block and ladder frame
   - To increase coherence add more ribs and cylinder blo made from aluminum.

4) Serpentine belt
   - One belt type driving belt is applied.

5) Timing chain
   - Timing chain rotate intake and exhaust camshaft at the same time same as theta.

6) CVVT
   - Denso CVVT is applied. (Beta, gamma, theta CVVT are same mechanically but operating range is different.

7) Direct driven valve train [solid tappet]
   - MLA (Mechanical Lash Adjuster) type valve train is applied.

8) Plastic intake manifold
   - Length/Cross-sectional shape is optimized for enhancing torque at all rpm zone.
   - As the material is changed (aluminum plastic), the air flowing resistance is enhanced so the output and torque is increased

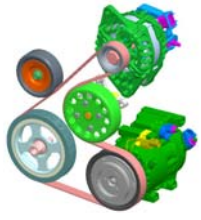
9) Stainless steel exhaust manifold

- Stainless steel exhaust manifold is applied to prevent from cooling down the exhaust gas temperature quickly.

2.2 Specification

NO	ITEM		UNIT	1.6L CVVT	REMARKS
1	DISPLACEMENT		cc	1591	
2	BORE		mm	77	
3	STROKE		mm	85.44	
4	STROKE / BORE RATIO		-	1.11	
5	VALVE NO./ CYL.		-	4	
6	CAM ARRANGEMENT		-	DOHC	
7	COMPRESSION RATIO		-	10.5	
8	COMBUSTION CHAMBER		-	Pentroof (In&Ex squish)	
9	ENG. DRY WEIGHT(AT/MT)]		kg	96.6 / 102.8	
10	VALVE TIMING	IN (BTDC/ABDC)	DEG	-10/63, D:236	
		EX(BBDC/ATDC)	DEG	40/3, D:223	
11	MAX. POWER		PS / rpm	118 / 6200	
12	MAX. TORQUE		Kgm / rpm	15.4 / 4200	
13	ENG. RATED SPEED		rpm	6200	
14	PISTON MEAN SPEED		m/s	17.7	
15	FUEL SYSTEM		-	MPI	
16	FUEL		Liter	45	

2.3 Main features



Serpentine belt

Timing chain

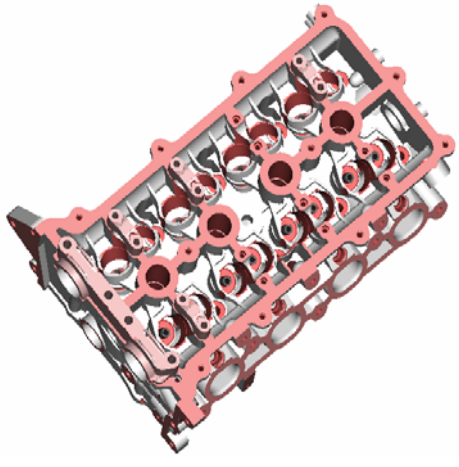
EX manifold

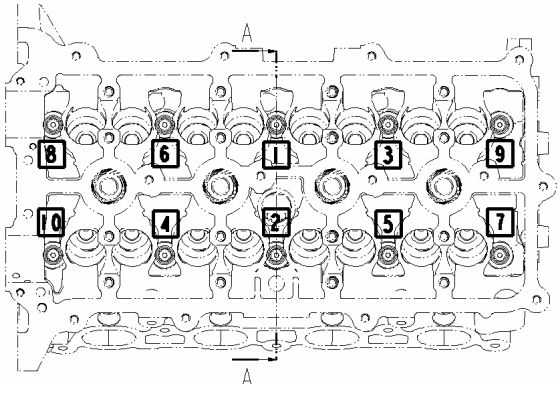
CVVT

HLA (Shimless type)

Item	Effect						Remark
	Performance	Emission	NVH	Weight	Cost	Endurance	
Al cylinder block	●			●			
Reverse In/Ex Mani	●	●	●	●			
CVVT	●	●					
Solid Tappet	●				●		
Timing Chain						●	
Serpentine belt			●	●		●	
Intergrated ECU/TCU					●		
SUS Ex/Mani	●	●				●	
Ladder Frame			●				
Offset crank	●						

2.4 Cylinder head





Tightening sequence

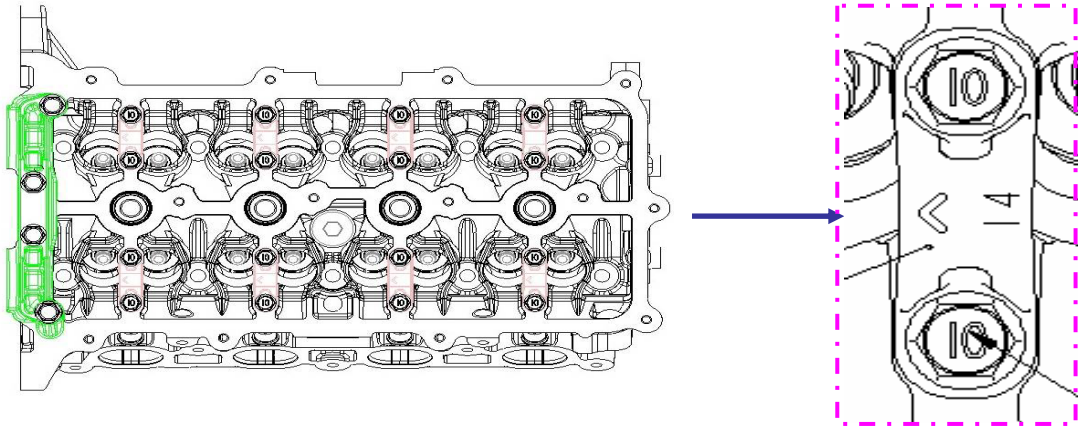
- AC2B-T7 aluminum
- Weight : 9.5kg

- Tightening torque : 2.0kgf-m + 90˚ + 100˚

2.4.1 Cylinder head bolt

Above picture shows cylinder head bolt of gamma (left) and theta (right) engine. When an assembling or disassembling use 10mm double hexagon socket. If use hexagon socket then head bolt screw thread is damaged. For reference in case of theta use 12mm double hexagon socket.

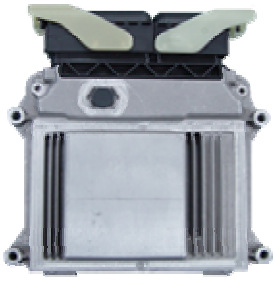
2.5 Camshaft cap



There is an arrow mark on camshaft cap. When assembling let that arrow mark face to timing chain side.

2.6 PCM

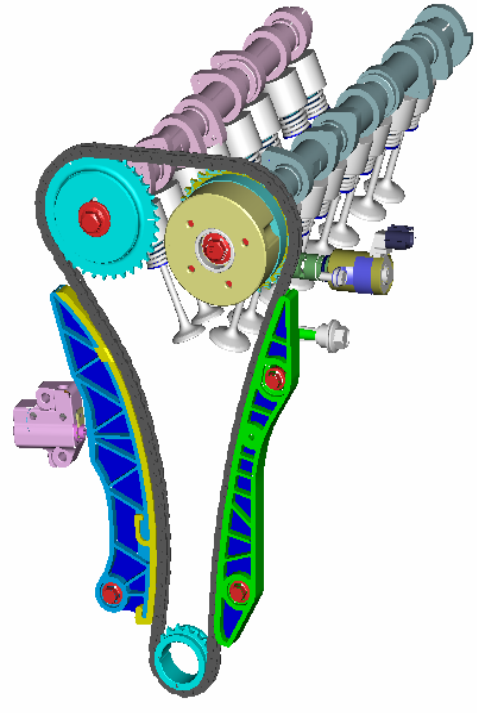
Main features of M7.9.8 are 2 chips CPU, 400MHz internal clock, waterproof, 24 channel A/D converter, 2 CAN Module, 154 pin connector, wheel speed sensor interface integrated, 768K flash memory and so on.

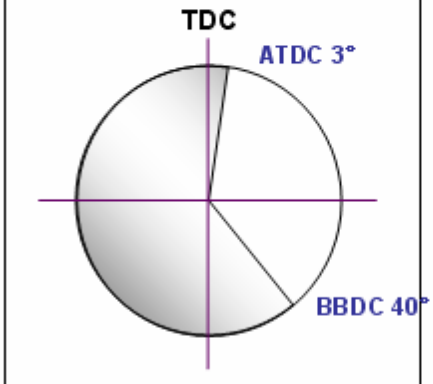
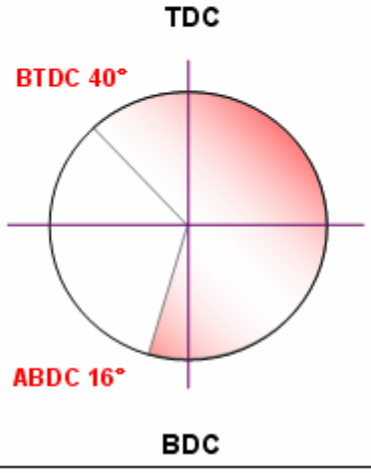
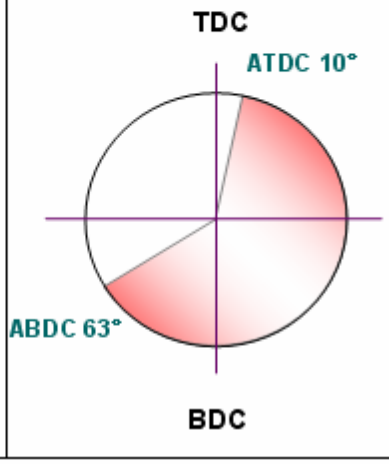


To make communication to PCM with hi-scan pro, you must use can interface module since CAN communication protocol is used instead of KWP2000 for DTC only in Gasoline engine. Using can protocol communication speed is increased from 10kbps to 38.4kbps. There are two terminals for CAN communication in 16 OBD 2 connector. So when you try communication, you must use this.

2.7 Valve train

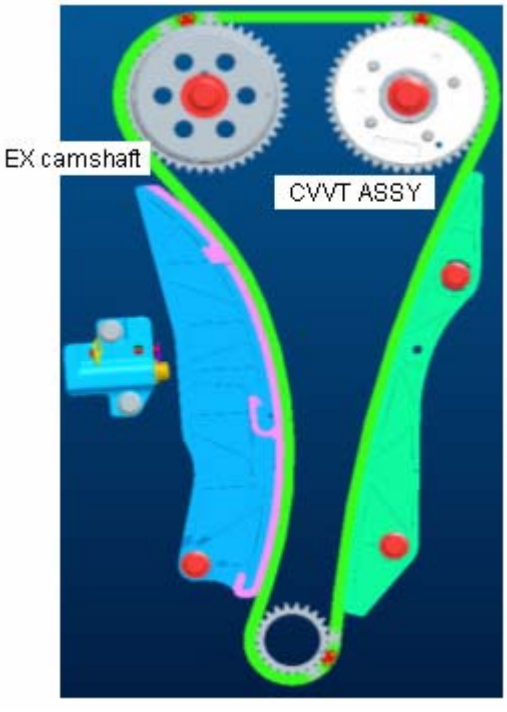
1) CVVT
   - Type : vane type
   - Angle : 50˚(Retard ~ Advanced)
   - CVVT common using (alpha, beta. Theta)
2) TIMING DRIVE
   - Timing chain (Bush chain, pitch:8mm)
   - Ratchet type oil pressure auto tensioner
3) CAMSHAFT
   - Weight : 1.700kg (Intake)
   - Hollow camshaft
4) TAPPET
   - Shim-less mechanical tappet (MLA)



Exhaust Valve	Intake Valve	
Duration : 223 °	Duration : 236 °	
	Full Advance	Full Retard
		

2.7.1 Timing chain system

- By employing low noise chain, the chain meshing noise and crashing noise are reduced
- Reinforcing timing chain cover strength and enhancing the sounds
- The endurance is enhanced by changing the timing chain
- By employing variable valve timing system, the torque for low or middle speed is optimized and fuel efficiency is enhanced



2.7.2 Installing method for timing chain and auto tensioner

1) Dispose the crank axis sprocket half-circle key to the horizontal line of the cylinder block assembling surface to align with 1st cylinder top dead center.
2) Meet the TDC mark of the intake·/ exhaust cam shaft sprocket to the upper surface of the cylinder head. (There are two marks on the cam shaft sprocket surface. Between them, align to the '□' TDC mark. Note: '●' : Timing Chain Mark)
3) Turn the timing chain to meet the crank axis sprocket timing mark ('●') to the middle position of the colored link of the chain.

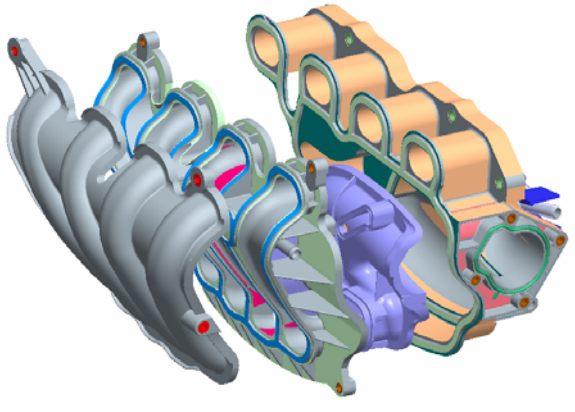
4) Meet the intake·/ exhaust cam shaft sprocket timing mark (‘●’) to the middle position of the colored link of the chain.
5) Install the timing chain guide (A).
6) Install the timing chain guide (B).
7) Install the auto tensioner after fixing it with a fixing pin by pushing the rod of the auto tensioner thoroughly.
8) After the fixing pin is removed, check the timing chain whether it is properly installed or not.
9) After turn the crank axis shaft with two rotations, check the timing chain mark.

[Remark]

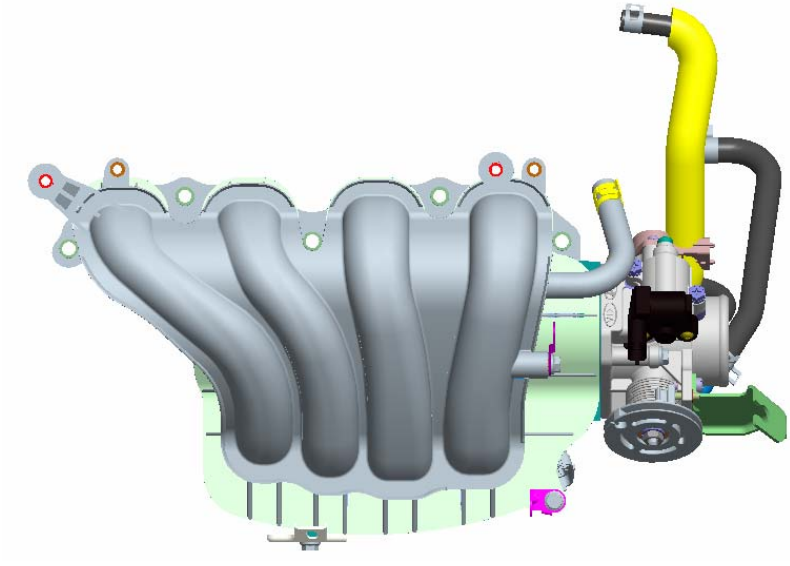
- When the timing chain is installed, do not apply excess force (to prevent the timing chain link being distorted)

2.8 Intake manifold

- Length / Cross-sectional shape is optimized for enhancing torque at all rpm zone.
- As the material is changed (aluminum plastic), the air flowing resistance is enhanced so the output and torque is increased



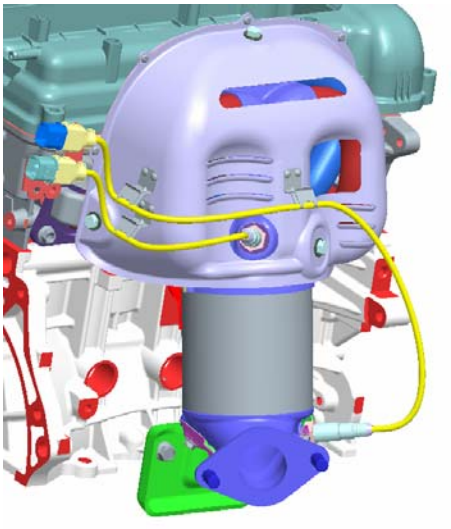
The intake manifold is a pipe system for leading the air into the cylinder with reducing the resistance of air flow.
The intake manifold applied to the Theta engine by being made of plastic material has lower resistance in air flow than the manifold made of aluminum so that the intake efficiency is enhanced and the total weight of engine is being lightened to get enhanced fuel efficiency.

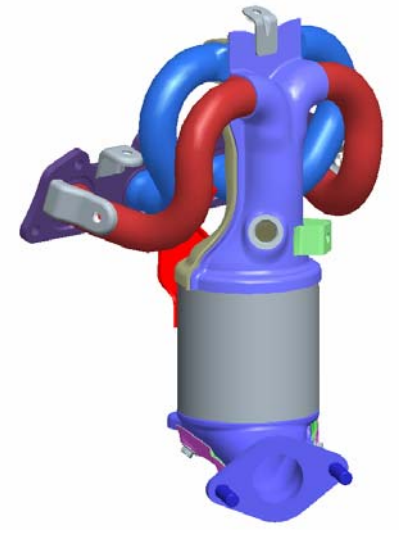


2.9 Exhaust manifold

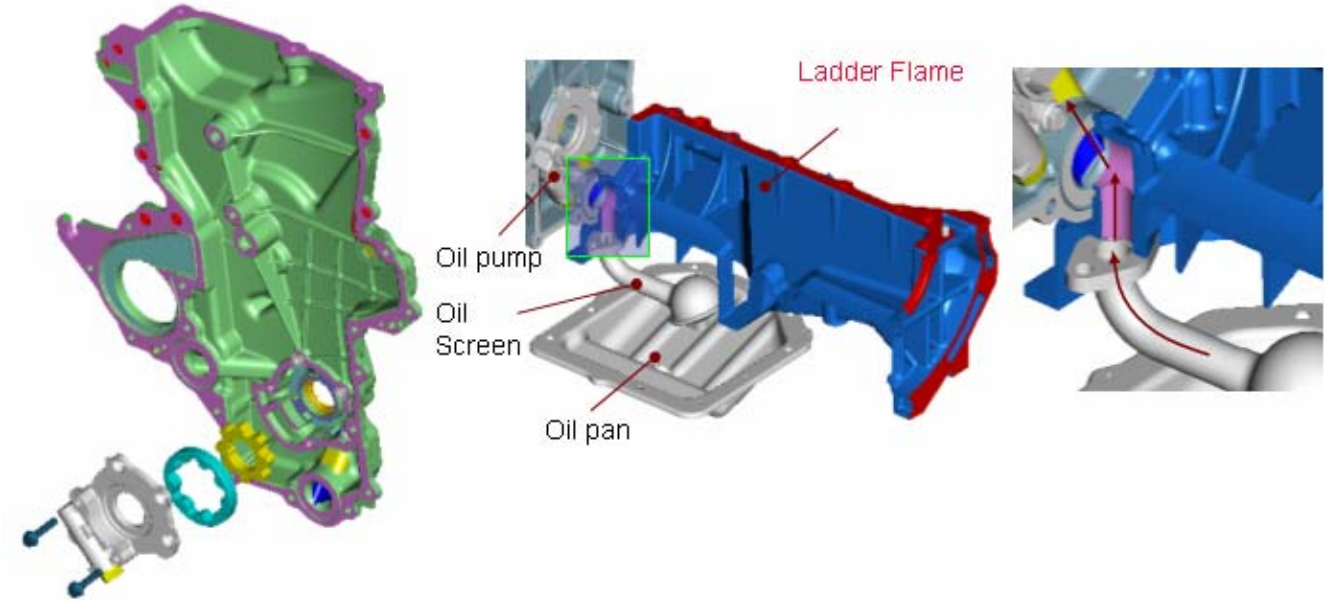
- Length / Cross-sectional shape are optimized for enhancing torque at all rpm zone.
- As the material is changed (iron cast □ stainless steel), heat resistance is enhanced.

This is device for gathering and exhausting the combusted gas in the cylinder through the exhaust pipe. Generally, this is made of cast iron. However, for theta engine, the exhaust manifold is made of stainless and optimized in the length and cross-sectional area. As a result, the heat resistance is enhanced.

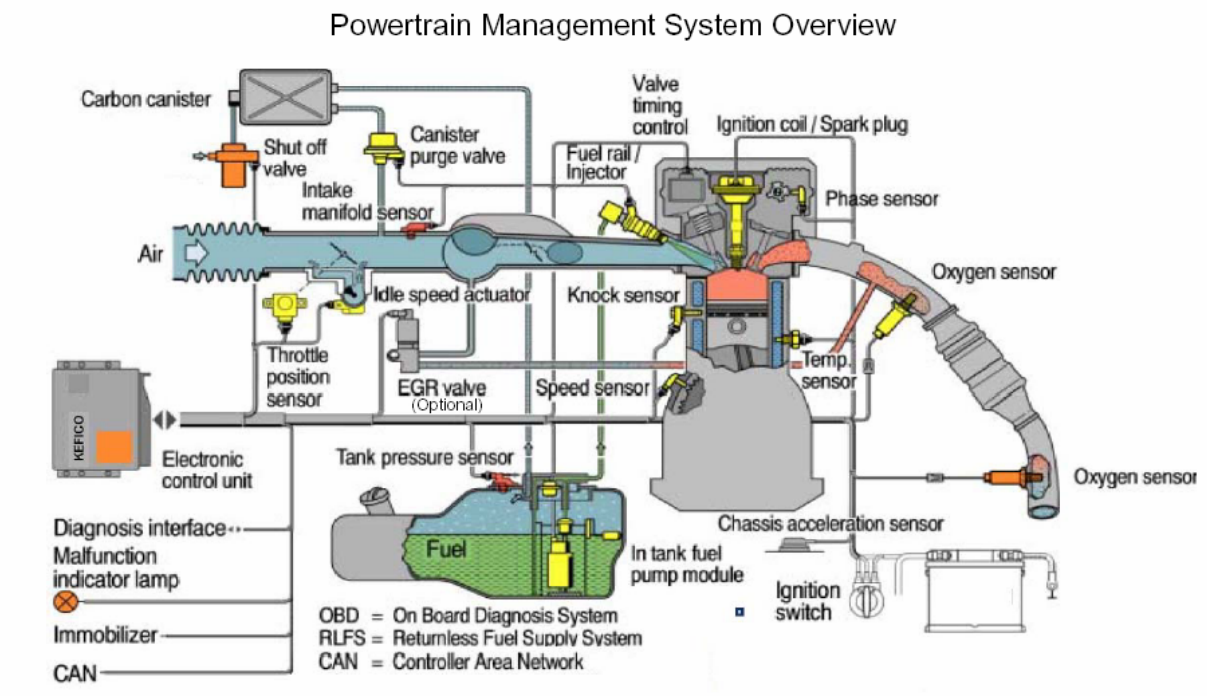




2.10 Oil pump



2.11 EMS


Powertrain Management System Overview
Carbon canister
Shut off valve
Canister purge valve
Intake manifold sensor
Valve timing control
Ignition coil / Spark plug
Fuel rail / Injector
Phase sensor
Air
Oxygen sensor
Idle speed actuator
Knock sensor
Throttle position sensor
EGR valve (Optional)
Speed sensor
Temp. sensor
KEFICO
Electronic control unit
Tank pressure sensor
Oxygen sensor
Diagnosis interface
Malfunction indicator lamp
Fuel
Chassis acceleration sensor
In tank fuel pump module
Ignition switch
Immobilizer
CAN
OBD = On Board Diagnosis System
RLFS = Returnless Fuel Supply System
CAN = Controller Area Network

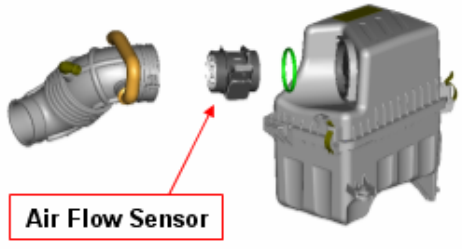
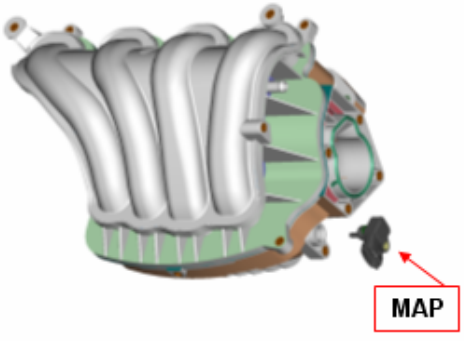
3. Changed items for gamma and beta

3.1 Air flow sensor

Gamma and beta engine have a MAP (Mass Air Pressure) sensor for detecting air volume. In case of LD CVVT engine has an MAF (Mass Air Flow) sensor and non-CVVT engine is MAP. But in ED all gasoline engine have a MAP sensor.

LD	ED
AIR FLOW sensor	MAP sensor
	
Direct detecting type	Indirect detecting type

	Before	After
Shape		
Pin	5 pin	4 pin

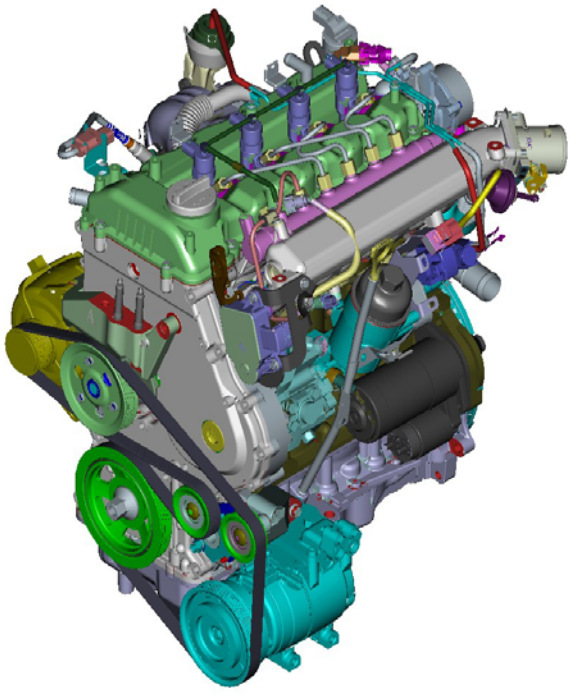
	Before	After
Assembling		
Assembling sequence	A/CLEANER BOX + O-RING + AFS + BOLT 2ea + AIR DUCT + CLAMP	IN/MANI + MAP + BOLT 1ea

3.2 TPS (Throttle Position Sensor)

Insert type (before) ⇨

Lever type

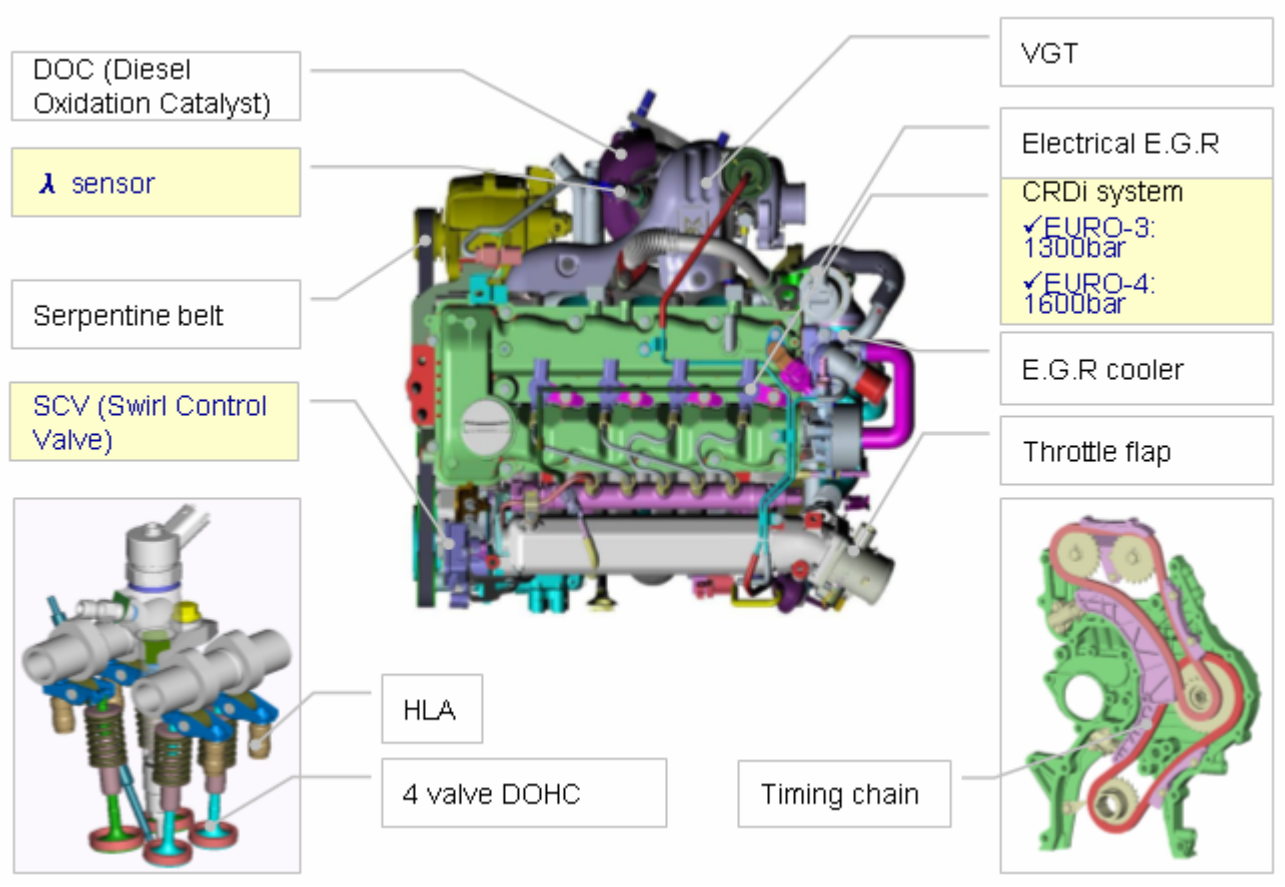
4. U-1.6 EURO IV engine



Engine		U-1.5 (EURO 4)	U-1.6 (EURO 4)
Main feature	Cylinder	4 cylider	
	Displacement (cc)	1,493	1,582
	Bore (mm)	75	77.2
	Stroke (mm)	84.5	
	Valve type	DOHC-4 valve	
	Cam operating	Chain	
	Injection	CRDi (1600bar)	
Max. output (PS)		112	117
Max. torque (kgxm)		24.5	26.5

In ED euro IV emission engine is applied. Compare with euro III emission engine to meet the more restrict emission regulation added some components like as VGT, SCV(Swirl Control Valve), lambda sensor, IQA(Injection Quantity Adaptation) injectors and so on. Main features are below:

(1) DOHC I type 4valve Cyl. Turbo intercooler
(2) CRDi system (1600bar)
(3) Electrical EGR & EGR cooler
(4) VGT (Variable Geometry Turbo
(5) Timing chain
(6) Serpentine belt
(7) Bed plate
(8) SCV (Swirl control Valve)
(9) Throttle flap
(10) Lambda sensor



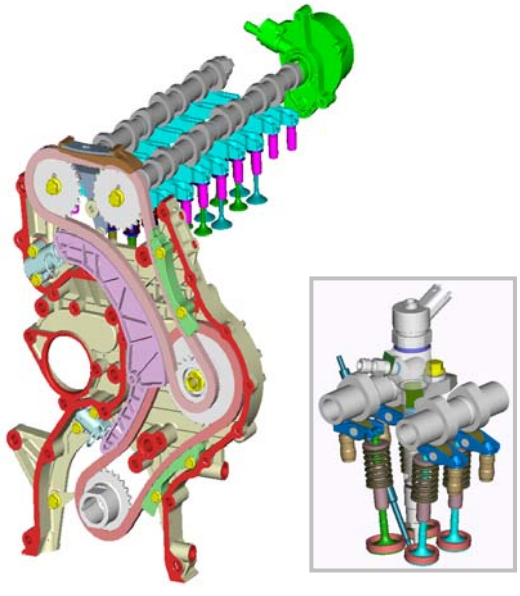
4.1 Timing system

- DOHC 4 Valve

- VALVE operating type:
  : END PIVOT ROLLER SWING ARM

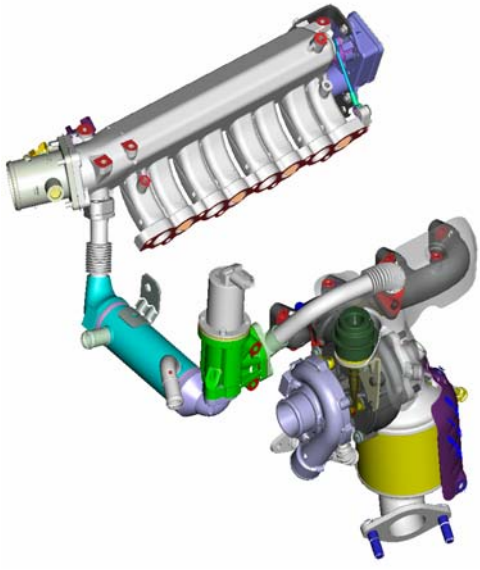
- CAM operating type : 2 Chains

- Hollow camshaft

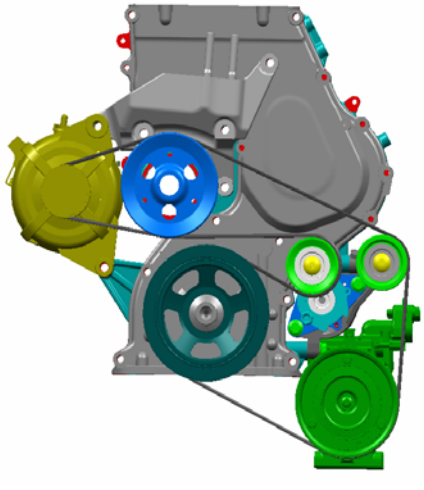
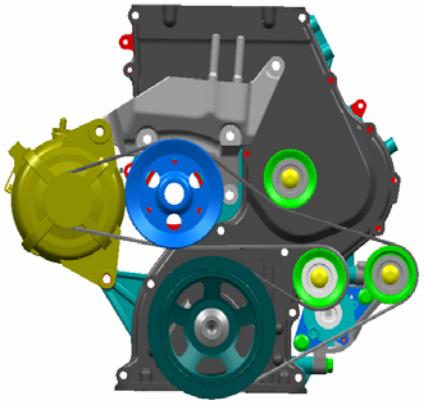


4.2 Intake exhaust manifold

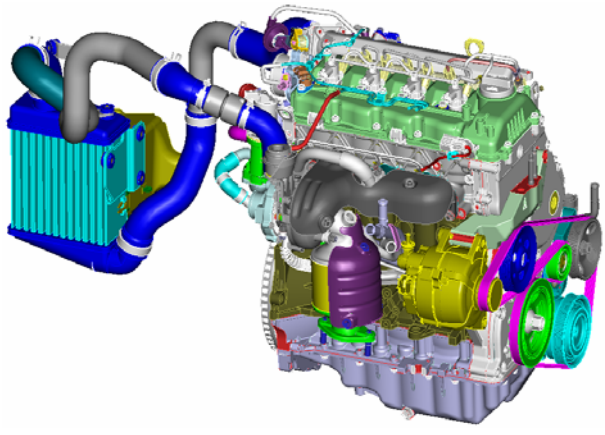
(1) VGT
(2) SCV (Swirl Control Valve)
(3) Electrical EGR VALVE
(4) WCC (Warm-up Catalytic Converter)
(5) EGR COOLER



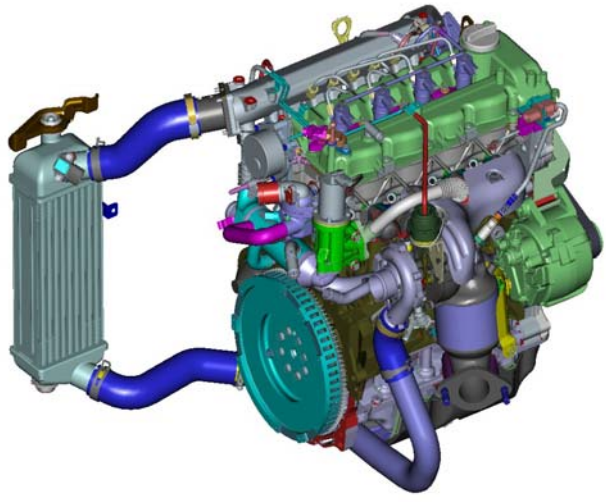
5.3 Driving belt (serpentine belt)

	With A/C	Without A/C
Appearance		

4.4 Intercooler system



LD **U1.5 VGT**



ED **U1.6 VGT EURO-4**

4.5 Changed items compared with LD U-1.5 (EURO-3)

	Item	Changed thing	Remark
Increased displacement	Cylinder block	Bore increased (Φ75 → Φ77.2)	
	Cylinder head gasket	Changed shape	
	Piston	Diameter increased (Φ75 → Φ77.2)	
EURO-4 (Performance, emmission)	CRDi	Injection pressure increased (1350bar → 1600bar)	U1.5 EURO-4 Common parts
	EGR cooler	Applied (Φ54)	
	SCV(Swirl Control Valve)	Applied	
	Lambda sensor	Applied	

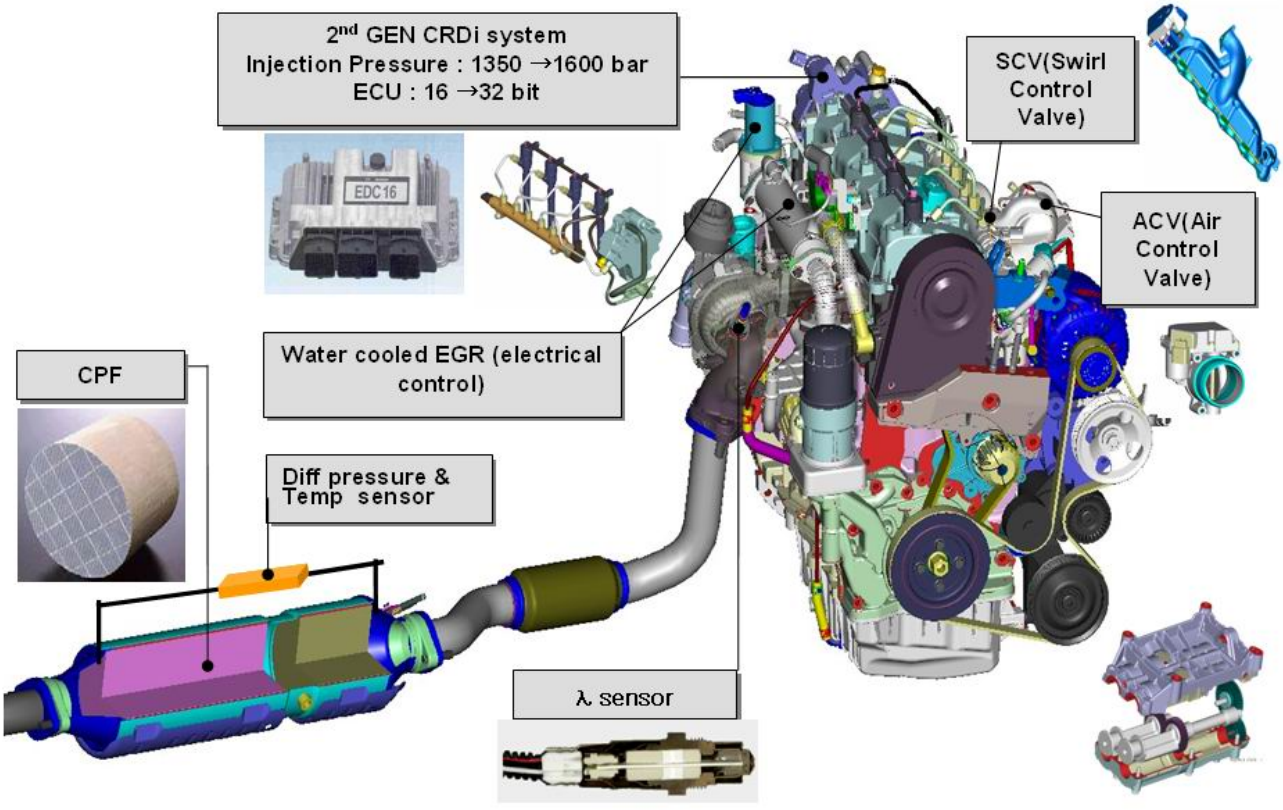
5. D-2.0L CRDi

5.1 Comparison of EURO-3, EURO-4

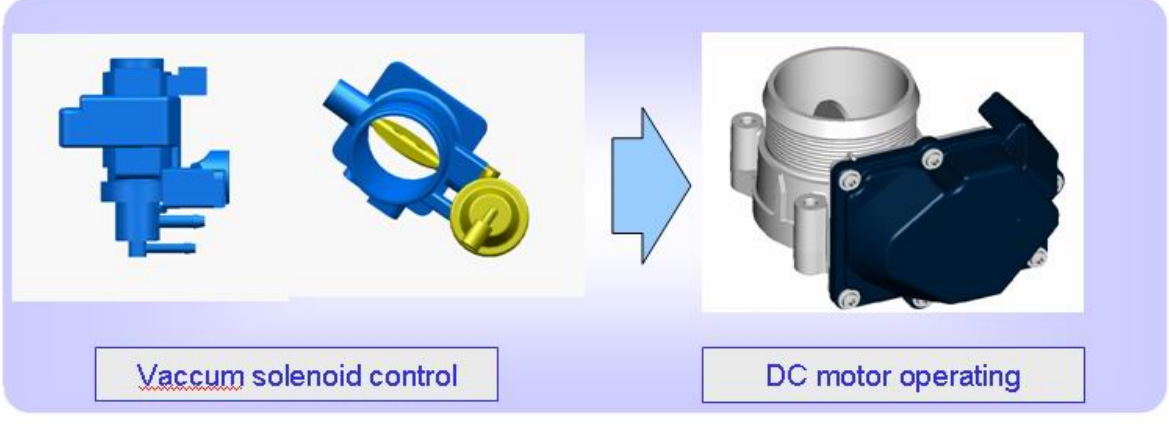
EURO-3	EURO-4
(1) 1st GEN CRDi 1350 bar 16-bit ECU	(1) 2nd GEN CRDi 1600 bar, 32-bit ECU λ control
(2) Mechanical EGR	(2) Cooled Electrical EGR (3) Swirl control valve : ETC
(3) Turbo charger	(4) VGT (5) CPF(Catalyzed Particulate Filter)

Items		EURO-III	EURO-IV		Remark
Emission regulation	CO	0.64g/km	0.50g/km		
	Nox	0.50g/km	0.25g/km		
	HC	0.56g/km	0.30g/km		
	PM	0.05g/km	0.025g/km		
	soot	15%	10%		
ECM	Speed	16 bit CPU	32 bit CPU		
	Pins	121	154		
	Location	Internal	Engine room		Depending on vehicle
λ(Oxygen) sensor		X	O		For EGR control
CPF(Catalyzed Particulary Filter)		X	U-Eng	-	Reduce PM
			D-Eng	O	
CPF Diff pressure & temp sensor		X	U-Eng	-	Detect internal pressure & temp
		X	D-Eng	O	
SCV(Swirl Control Valve)		X	O		Reduce smoke during low-mid
Fuel temp sensor		X	O		
Rail pressure control	MPROM	O	O		Inlet control – A, J Eng
	PCV(Pressure Control Valve)	X	O		Outlet control – D Eng
Injector	Multi-injection	1 Pilot, 1 Main	2 Pilot, 1 Main,2 Post		D-Eng: 2 Post injection
	Pressure	250~1350bar	250~1600bar		
	type	Classfied (C1,C2,C3)	7-code (IQA)		
Throttle flap control	Control time	Key off (NVH reduced)	-Key off (NVH reduced) -always (support EGR)		Close the throttle when a key is off to prevent from dieseling.
	way	ON/OFF	PWM control (300Hz)		

5.2 System Layout (EURO-4)



5.3 ACV (Air Control Valve)

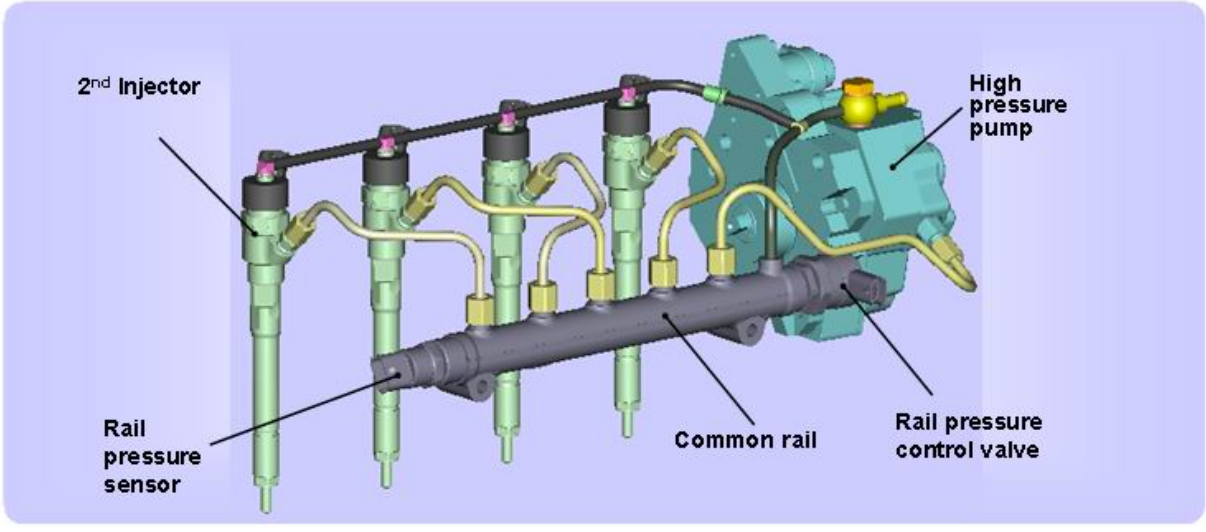


Effect

- Reducing exhaust gas (by DC motor => increasing responsibility
- Reducing component (simple component)

5.4 2nd Generation CRDi System

● CRDi system (Injection pressure : 1600 bar)

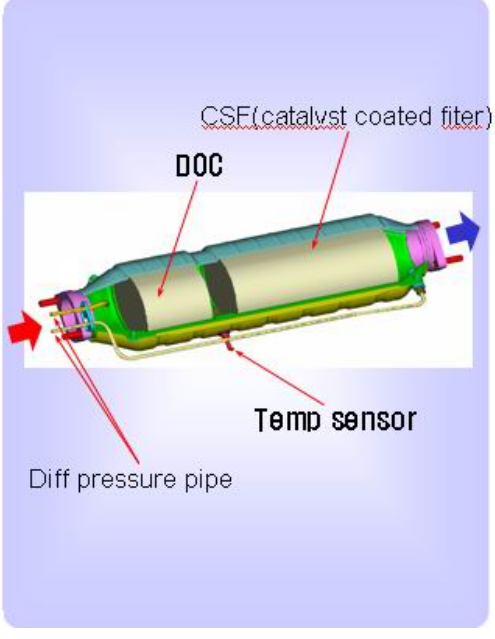


● Effect

■ 1600bar high pressure injection => Fuel injection volume optimizing control

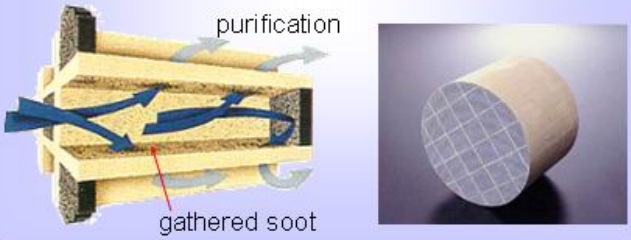
5.5 CPF (Catalyzed Particulate Filter)

● system



● Principle

Burning a soot by post injection & oxidating a soot by using activation of coated catalyst (using NO2)

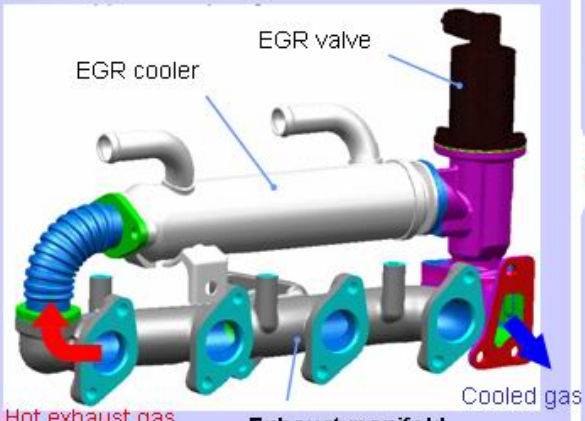


● Effect

■ purification efficiency : over 90%

5.6 Water cooled EGR (electrical control)

System



EGR cooler

- type : water cooled
- efficiency : over 53%
- length : 210 mm
- diameter : Φ54 mm
- weight : 0.98 kg

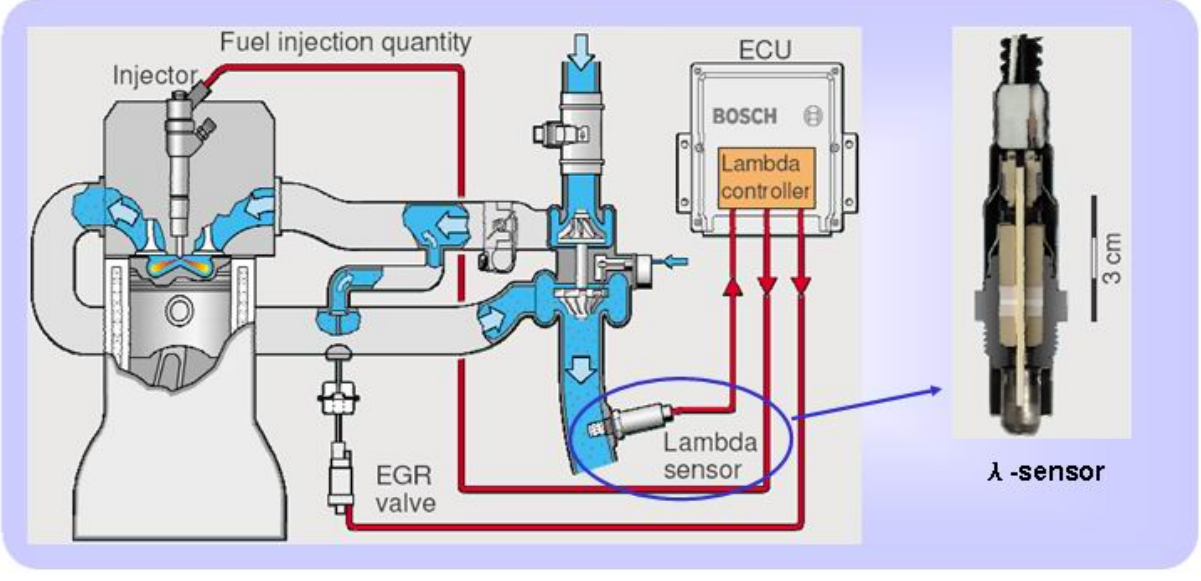
Electrical EGR valve

- type : linear solenoid
- diameter : Φ 22mm
- Max flow vol.
  : 88 ± 8 kg/hr (at 85%)
- Control signal : PWM (140 Hz)
- Control voltage: 13.5 V

Effect

- EGR cooler ☞ reducing temp of hot exhaust gas & increasing vol. of recirculating gas ☞ NOx & PM reduced
- Electrical EGR valve ☞ deviation 50% redueced ☞ accurate EGR control

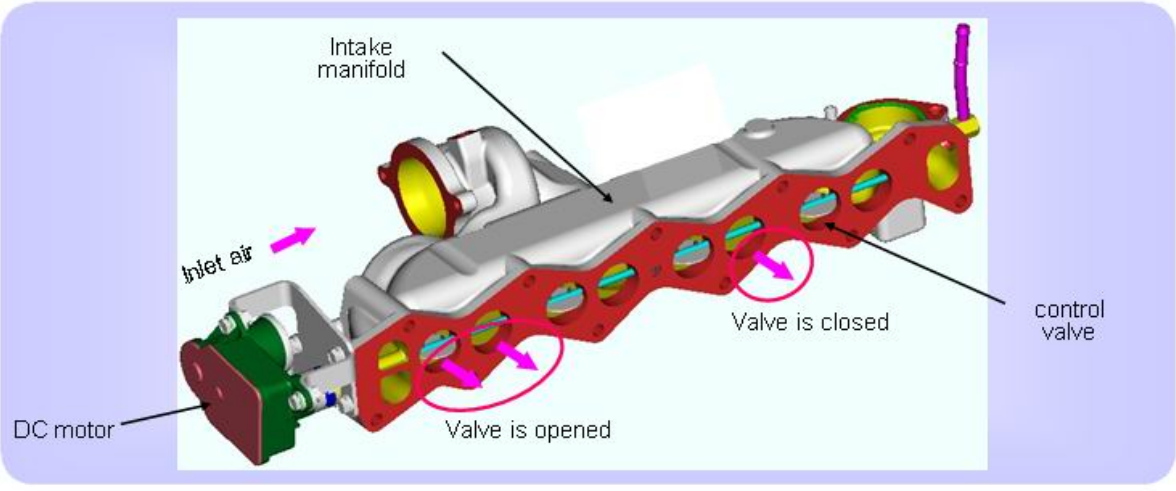
5.7 λ sensor



Effect

- EGR feedback control → accurate exhaust gas control (10~20% additional reducing)

5.8 SCV(Swirl Control Valve)



Effect

■ Optimizing the inlet air volume depending on driving condition

☞ Mid-low speed→ valve closed → increasing swirl → reducing exhaust gas

high speed → valve opened → increasing inlet air flow → increasing torque

5.9 Input & Output