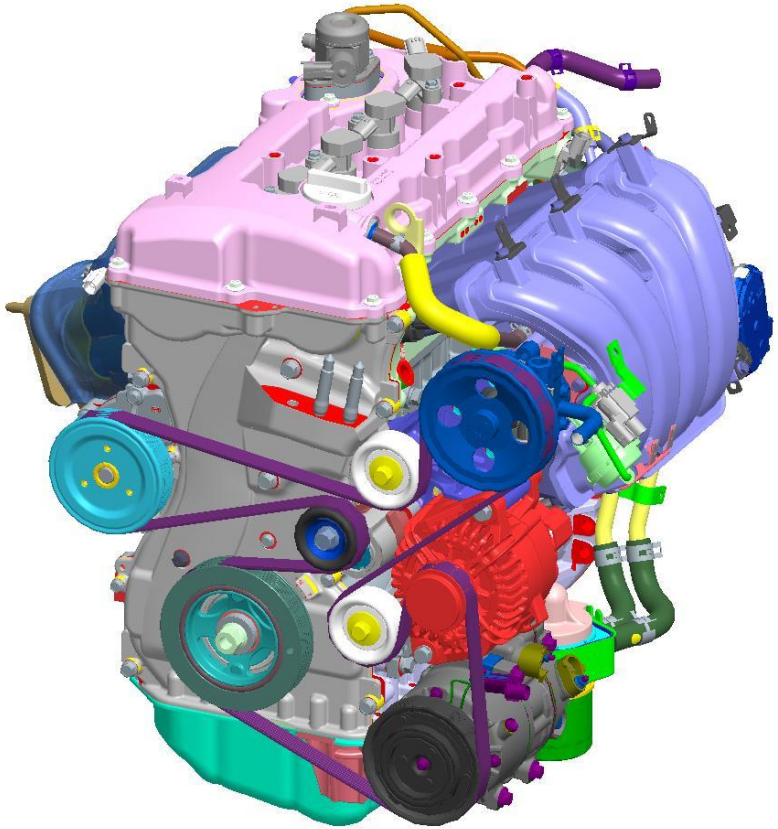
Theta (Θ) GDI Engine



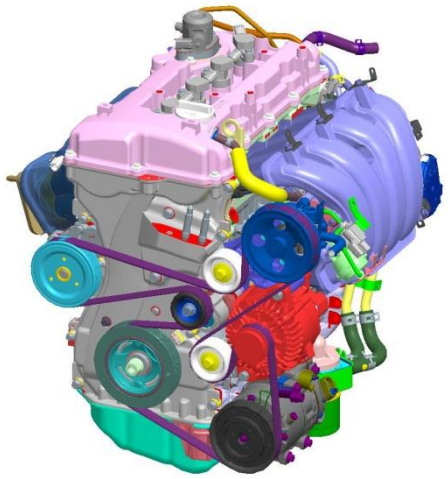
Theta (Θ) – II GDI Engine

Powertrain Variation

Category			Plant	Asan			HMMA
			Area	DOM('09.9)	GEN('09.12)	Aust. ('10.1)	NA('10.2)
Engine			Spec. / T/M	DOM	GEN	Aust.	YFA
GSL	Θ 2.0 LPI (Asan)	-	M5GF2	●			
			A5CF2	●			
	Θ-II 2.0 MPI (Asan)	161/19.8 (PS/kg.m)	M6GF2 (Ulsan)	●	●	●	
			A6MF1 (HPT)	●	●	●	
	Θ-II 2.4 MPI (Asan)	174/23.0 (PS/kg.m)	M6GF2 (Ulsan)		●		
			A6MF1 (HPT)		●		
	Θ-II 2.4 GDI (Hwasong)	200/25.2 (PS/kg.m)	M6GF2 (Ulsan)	● **('10.1)**		●	●
			A6MF2 (HPT)	● **('10.1)**		●	●
	Θ-II 2.0 T-GDI	TBD	**A6LF2** (HPT)				● **('10.10)**
Emission				06EM (GSL) EURO-5 (DSL)	**EURO-2/3/4 (GSL) EURO-3/5 (DSL)**	**EURO-4 (GSL) EURO-5 (DSL)**	**ULEV('10.2) SULEV('10.7)**

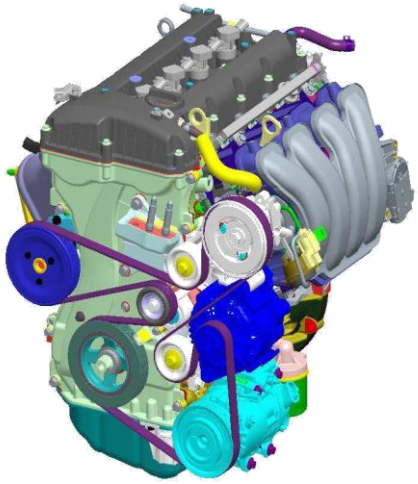
Theta (Θ) – II GDI Engine

Theta –II 2.4 GDI



Displacement	2,359 cc
Max. Power	200PS / 6,300rpm
Max. Torque	25.2kgf·m / 4,000rpm
Features	▪ High pressure fuel system ▪ Direct injection ▪ Dual CVVT ▪ Roller chain for timing system

Theta -II 2.0 MPI



Displacement	1,998 cc
Max. Power	161PS / 6,200rpm
Max. Torque	19.8kgf·m / 4,500rpm
Features	▪ Dual CVVT ▪ VIS is applied ▪ Low friction tappet ▪ Linear type oxygen sensor

Theta (Θ) – II GDI Engine

Comparison

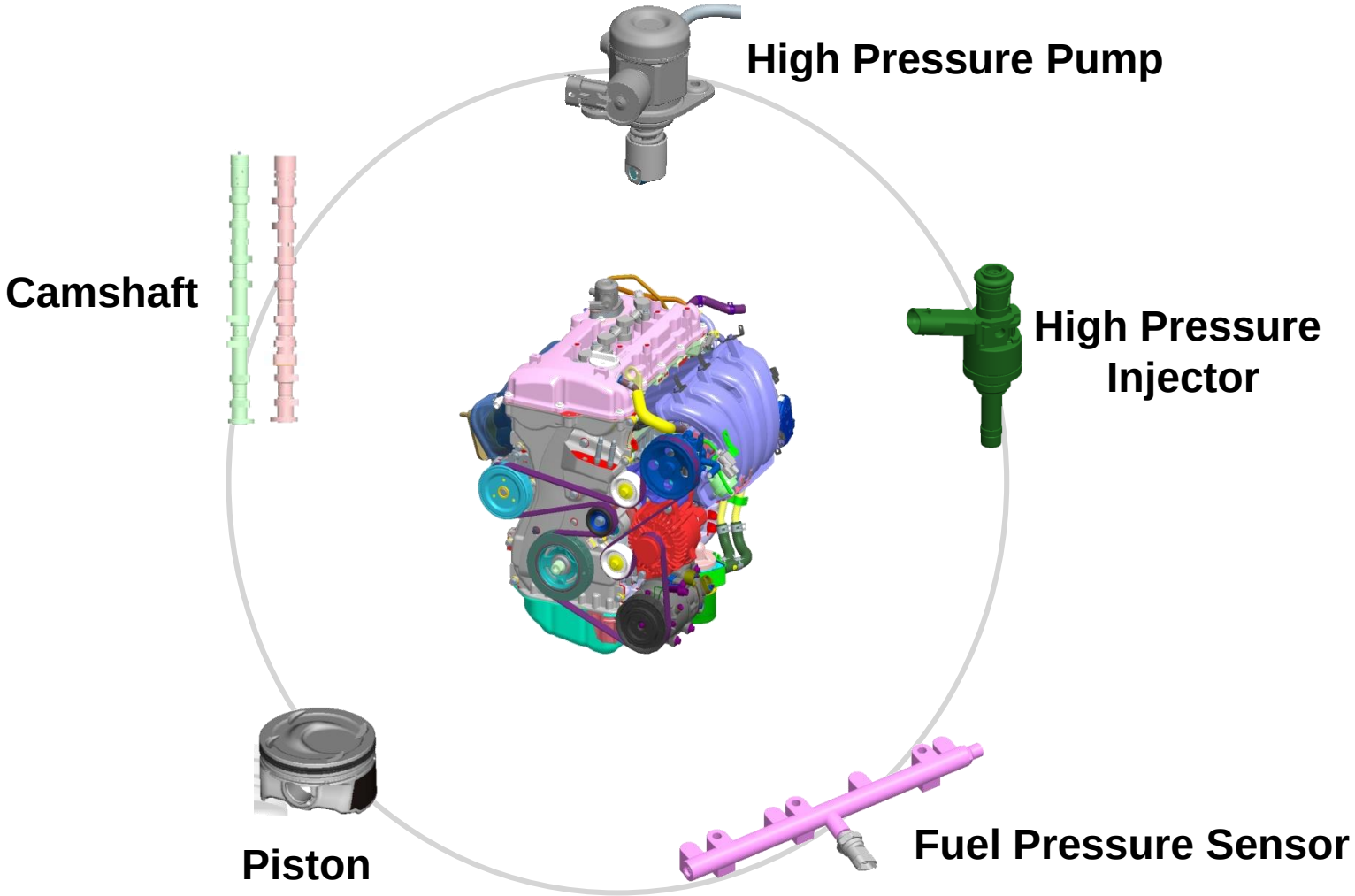
Items		2.4ℓ	
		GDI (YF)	MPI (NF)
Displacement (cc)		2,359	←
Compression ratio		11.3	10.5
Injection type		Direct injection (to cylinder)	Port injection
Bore × Stroke (mm)		88 × 97	←
Stroke / Bore ratio		1.10	←
Max. Power (ps)		200(+13%)	177
Max. Torque (kgf・m)		25.2(+10%)	23.0
Fuel consumption (g/kwh)		330 (+2%)	337
Fuel Pressure	High line	Max. : 135bar(Idle : 40bar)	-
	Low line	4.5bar	3.5bar
Timing Chain		Roller Chain	Silent Chain

Comparison

Items	2.4ℓ	
	GDI (YF)	MPI (NF)
Piston cooling jet	Applied	-
Piston Pin	Full Floating	Pressurized
Piston	bowl	flat
Cylinder Head	Features an injector mounting hole	-
Injector	High pressure injection	Low pressure injection
Fuel Pressure Sensor	Max. 250bar	-
Oil cooler	Applied	-
Spark Plug	M12 Iridium	M14 Iridium
Injection Control	Multi injection	Single injection
EMS	Continental (Siemens)	←
Oxygen Sensor	S1:Linear + S2:Zirconia	S1:Zirconia + S2:Zirconia

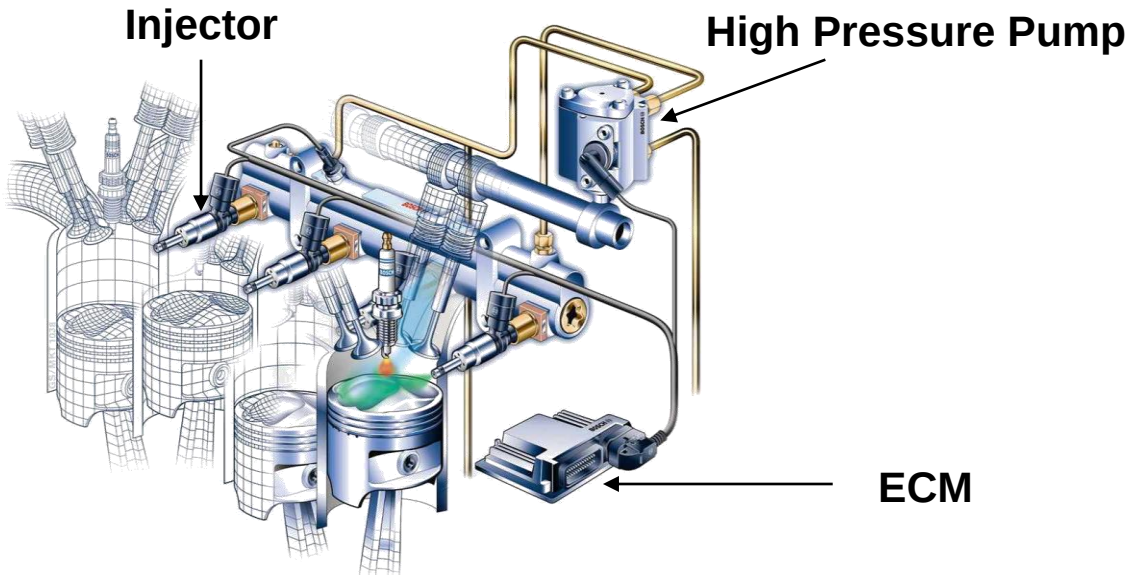
Theta (Θ) – II GDI Engine

Main components



Effect of GDI

Effect



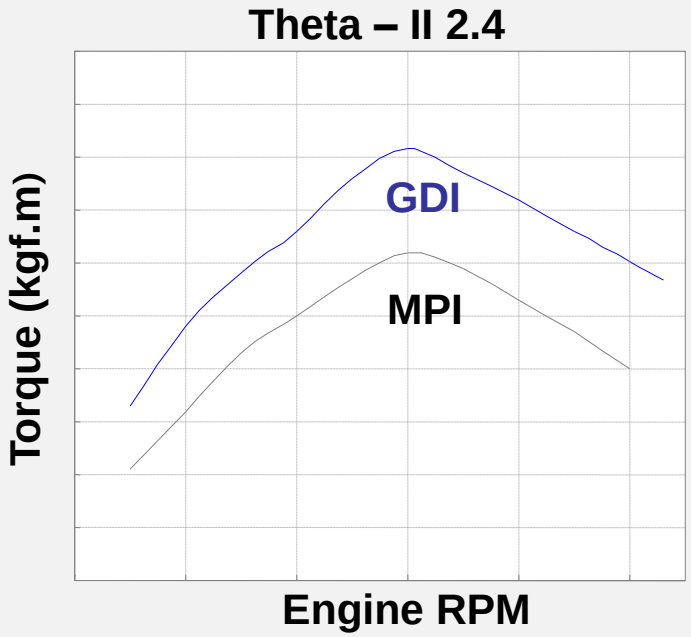
- **Direct injection :**

  Improved performance (13%), Decreased fuel consumption(2%), Reduced emission(50%)

Theta (Θ) – II GDI Engine

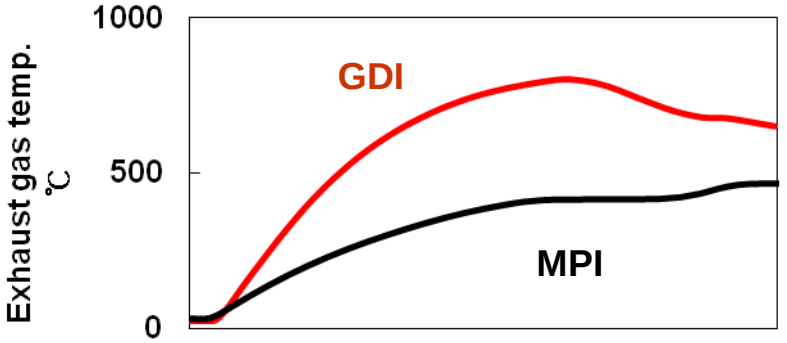
Effect of GDI

- **Improved performance : 6~14%**
  - Direct injection → Vaporizing → Lower intake air temp.
    → higher air density and increased charge efficiency
    → improved torque
  - Reduced knocking and improved performance at low speed

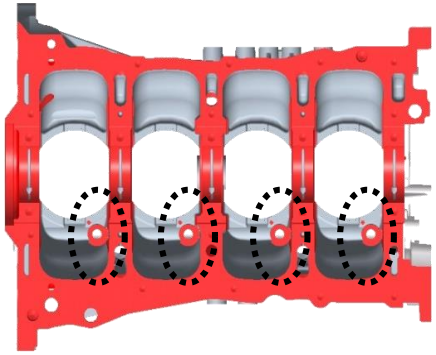


- **Decreased fuel consumption : 3~5%**
  - Increased compression ratio
  - Optimized gear ratio

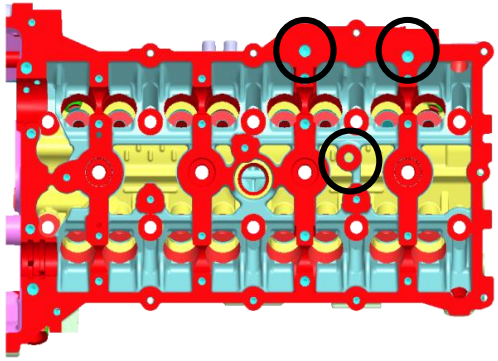
- **Reduced Emission : 50%**
  - Reduced catalytic warm-up time by multi-injection



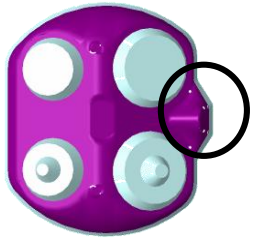
Cylinder Block and Head



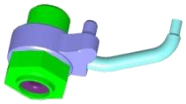
Cylinder Block



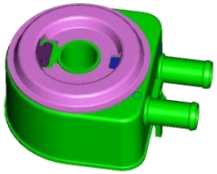
Cylinder Head



GDI Combustion Chamber

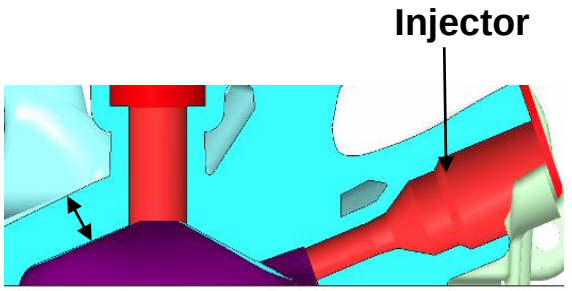


Cooling Jet



Oil Cooler

Oil Filter

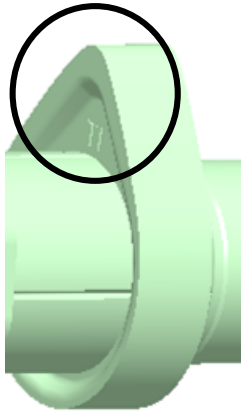


Injector Mounting

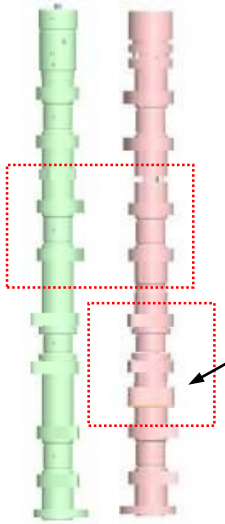
▶ **Cylinder head bolt torque**

Step	Step 1	Step 2	Step 3
Tightening torque and angle	3.5kgf·m	90˚	90˚

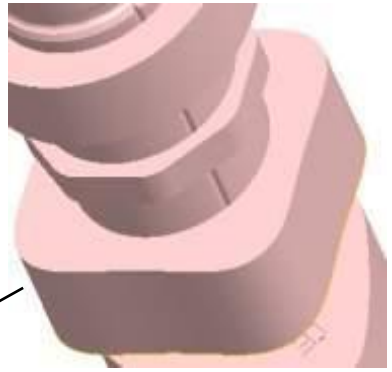
Camshaft and HP Pump Bracket



Slotted

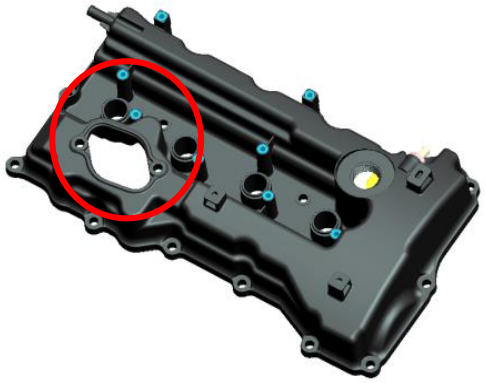


[Camshaft]



High pressure pump driving lobe

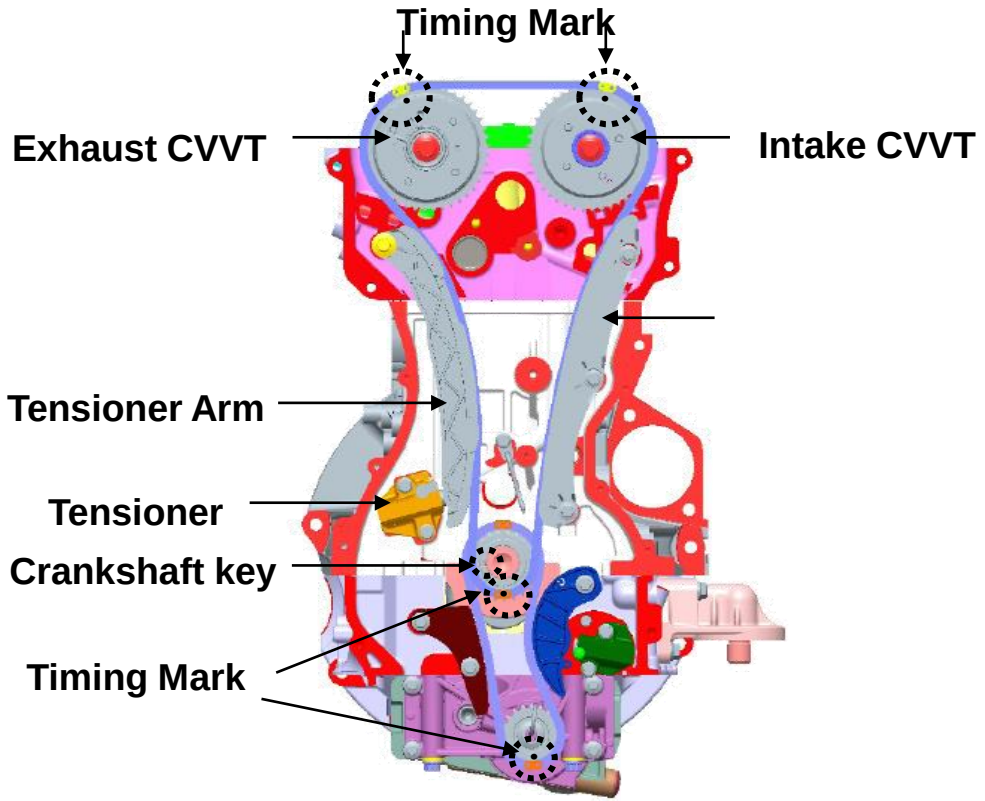
HP Pump Bracket



Cylinder Head Cover

- Added cam lobe for high pressure pump
- Slotted cam love for reducing weight
- Fuel pressure is made by camshaft
- Added bracket and hole on cylinder head cover for HP pump

Timing System



Intake CVVT

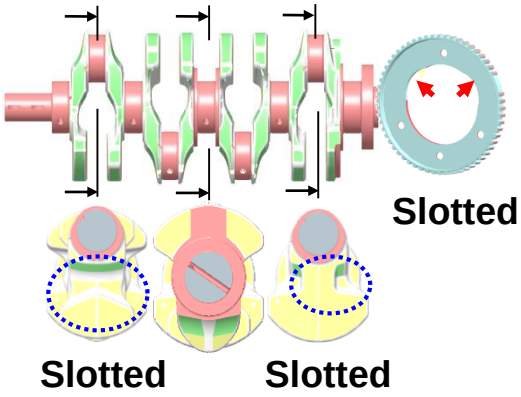
Exhaust CVVT

Timing Chain

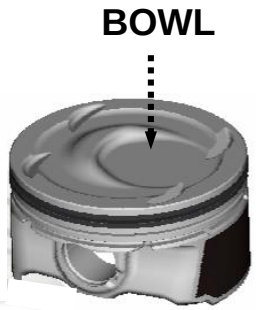
- Timing chain : Changed to roller chain, which is more resistant against soot.
- CVVT assembly gears were also redesigned so that they are driven by roller chain

Theta (Θ) – II GDI Engine

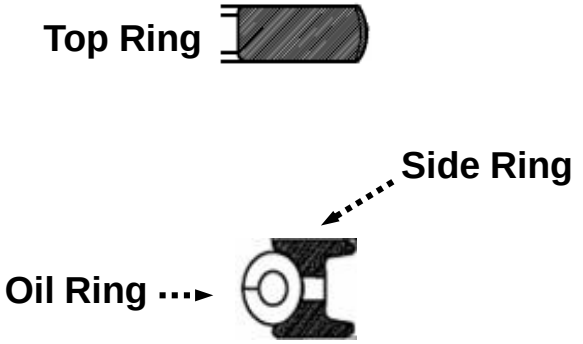
Moving System



Crankshaft



Piston

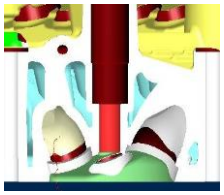


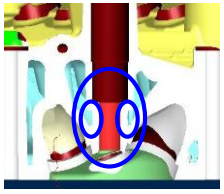
Piston Ring

Changed items

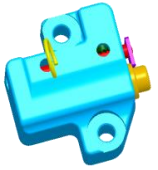
MPI

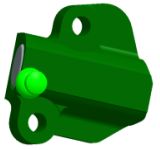
GDI



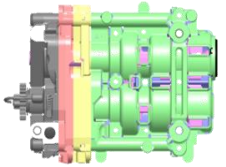


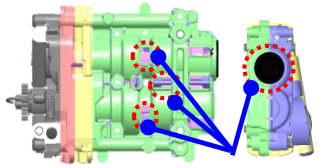
Spark plug (M14 → M12)





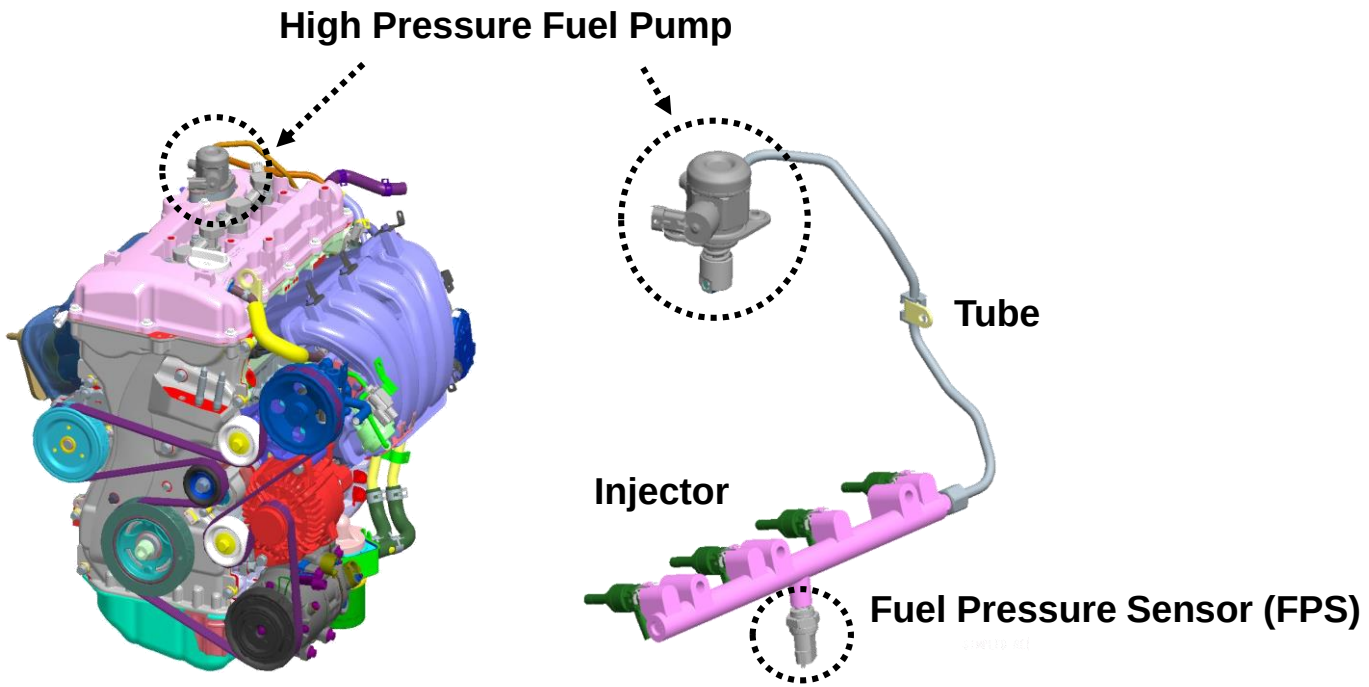
Chain tensioner





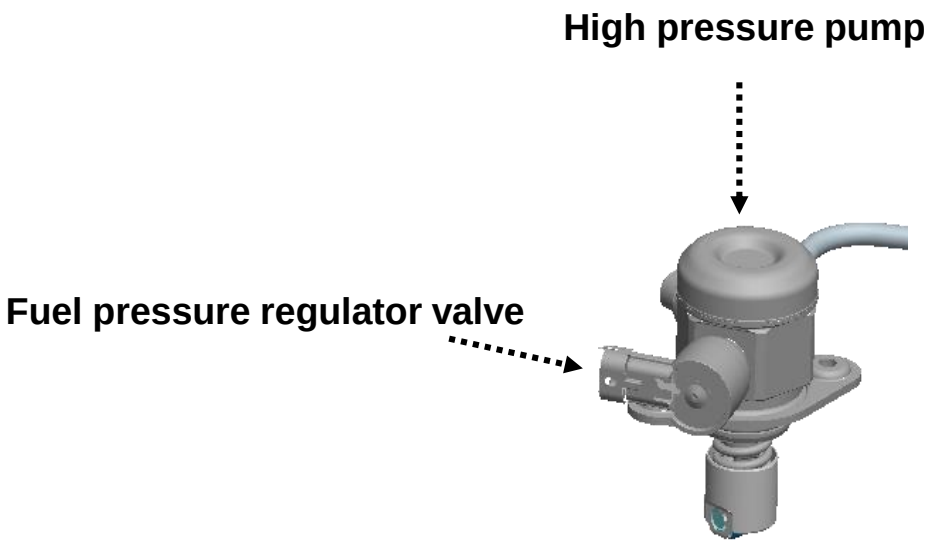
BSM

GDI Fuel System



- Fuel tank(low pressure pump) → High pressure pump → Fuel rail → Injector
- Fuel pressure : Low pressure : 4.5bar, High pressure : 135bar

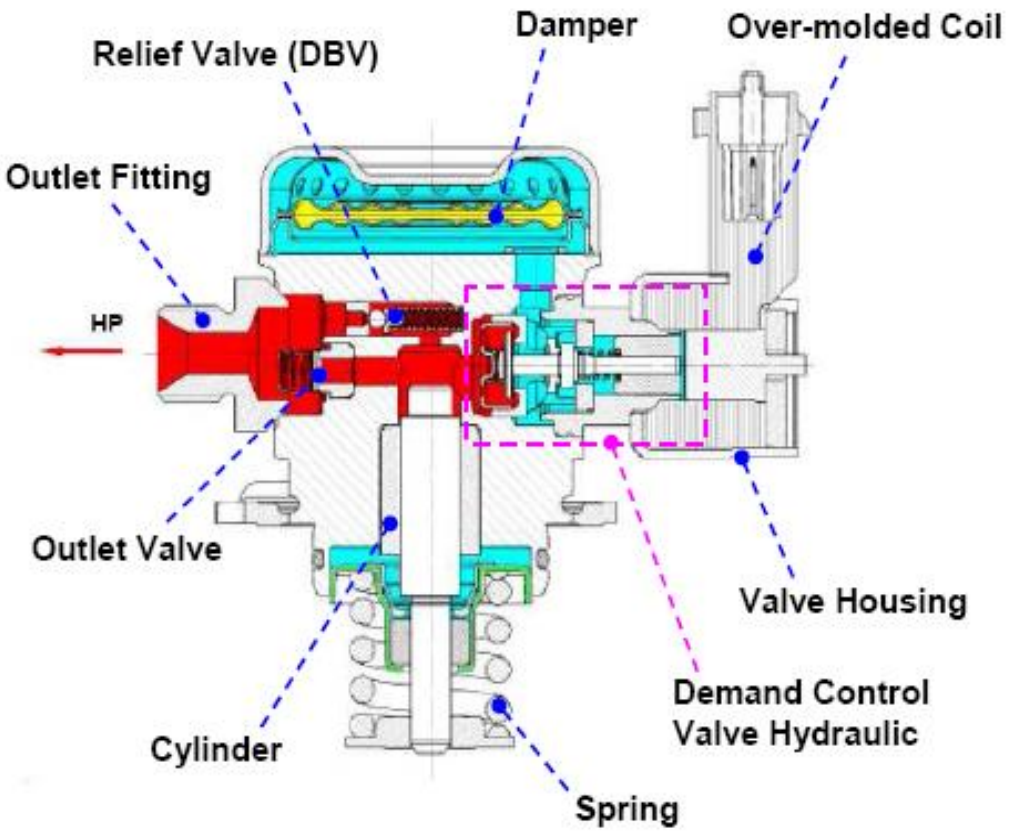
GDI Fuel System – HP Pump & Fuel Pressure Regulator Valve

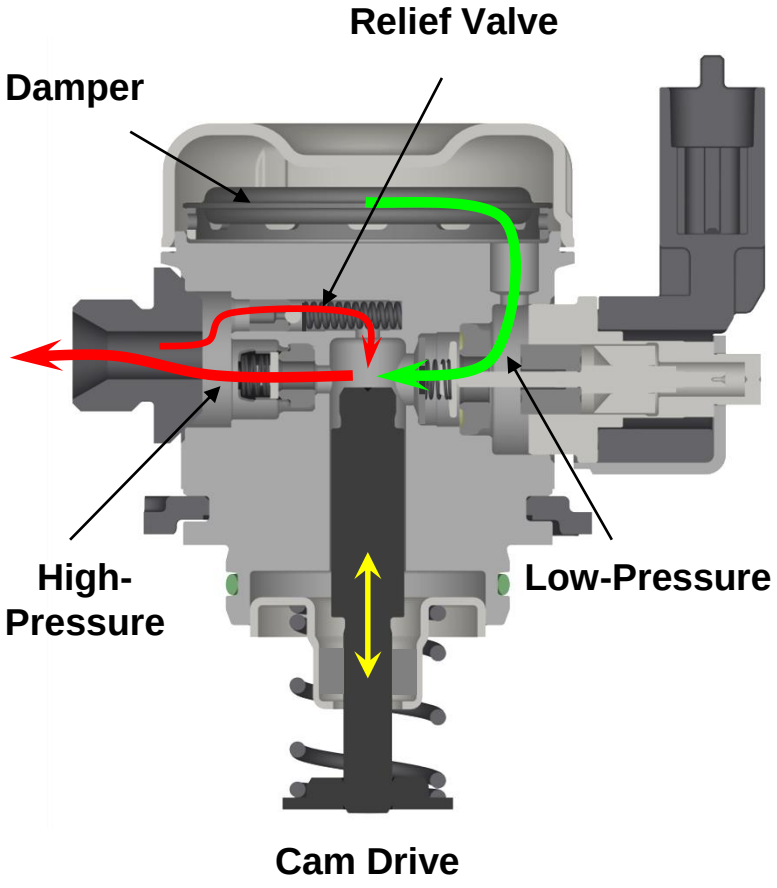


- Rated pressure : 135bar
- Max. flow : 125L/h
- Piston type : 1 piston
- Stroke : 3.5mm
- 0.9 cc/cam revolution
- FPRV resistance : 0.5Ω
- Supplier : Kefico

Engine RPM	Idle	1,500	6,300	Fail
Fuel Pressure (bar)	40	90~100	135	4.5

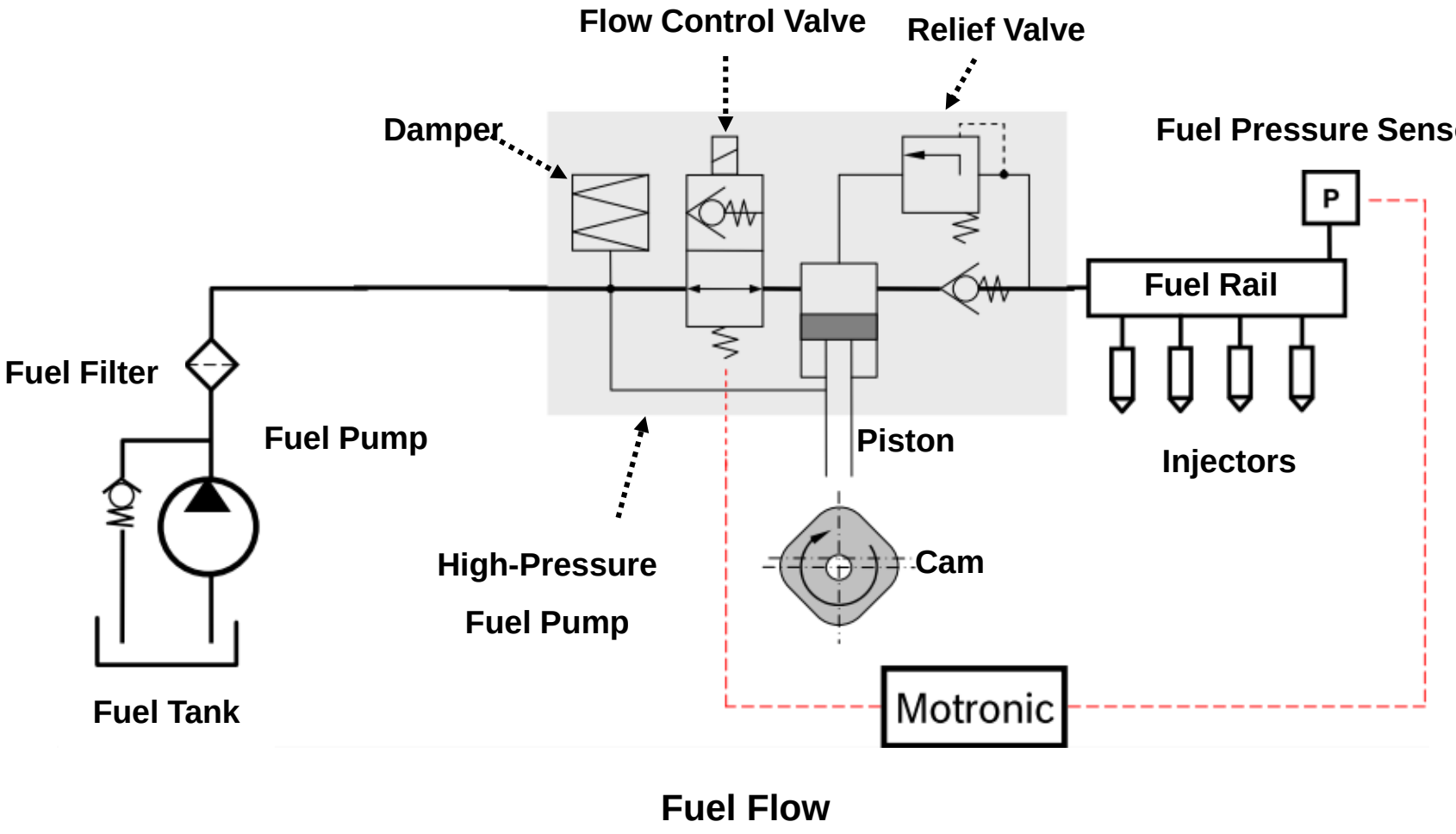
GDI Fuel System – HP Pump & Fuel Pressure Regulator Valve



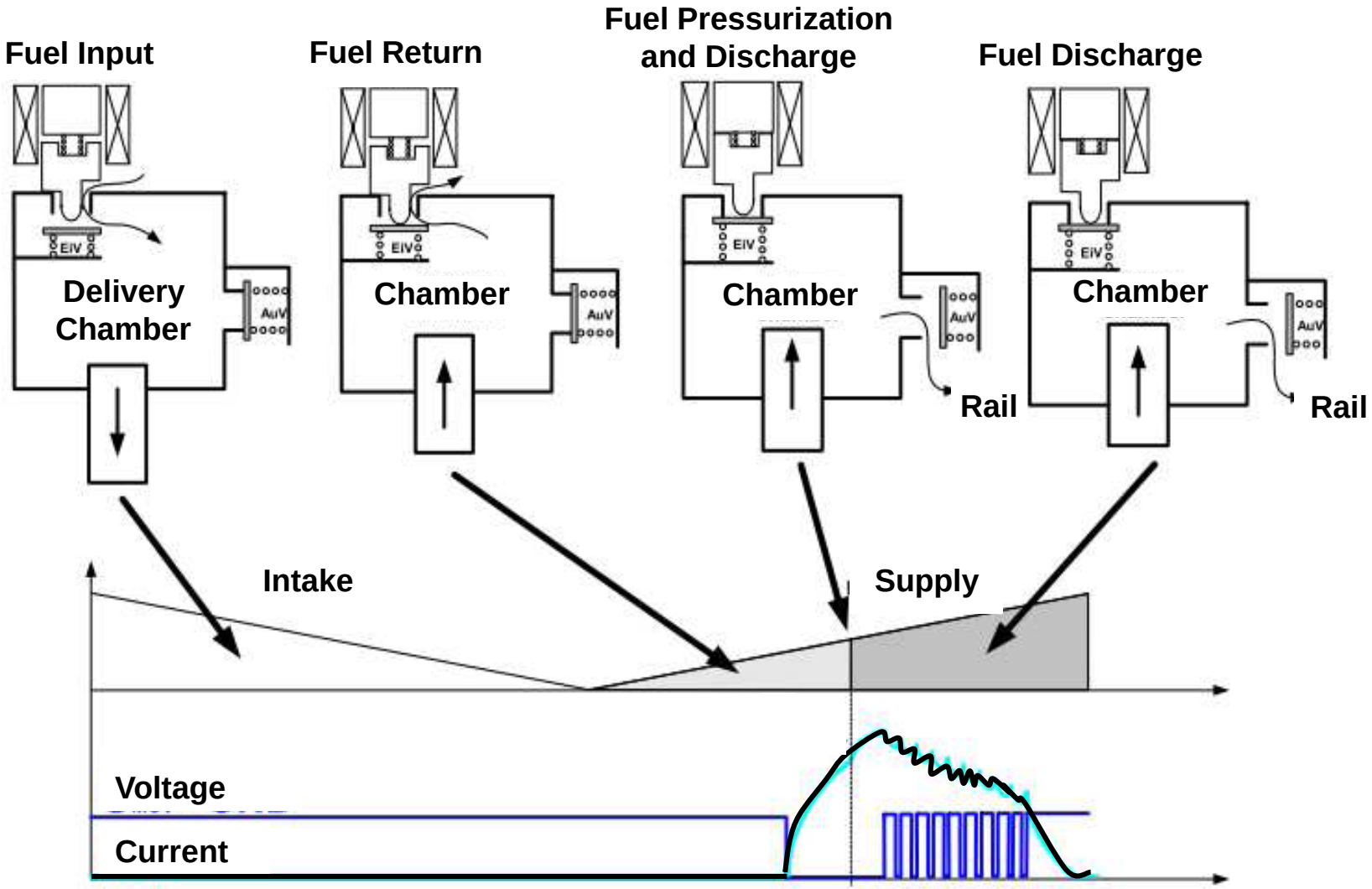


High-Pressure Pump Structure

GDI Fuel System – HP Pump & Fuel Pressure Regulator Valve

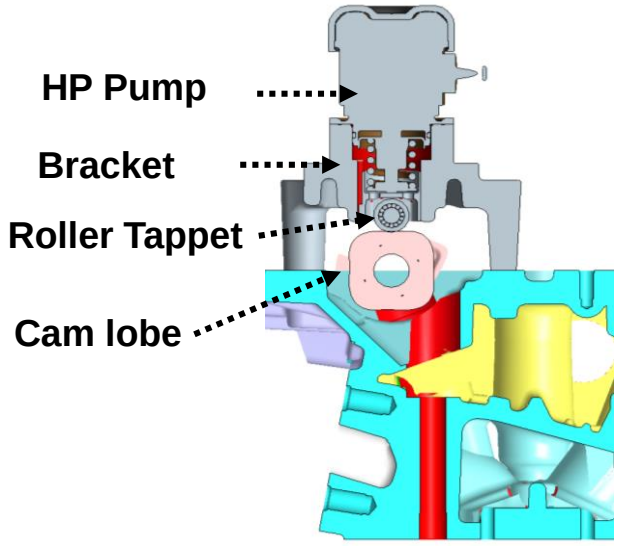


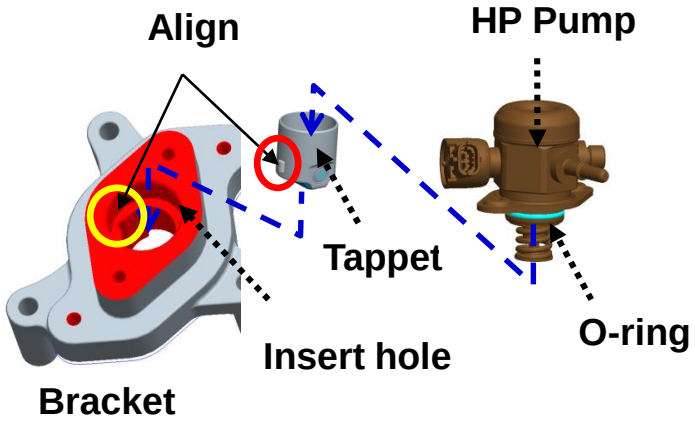
GDI Fuel System – HP Pump & Fuel Pressure Regulator Valve



High-Pressure Pump Mechanism

GDI Fuel System – HP Pump & Fuel Pressure Regulator Valve





HP pump assemble method

① Set lobe of HP pump to BDC

② Coat the tappet with engine oil

③ Coat the insert hole of bracket with engine oil

④ Coat the O-ring with engine oil

⑤ Align tappet mark and bracket mark and insert

⑥ Tighten 2 bolts simultaneously or loose fit and then tighten (Tightening torque : 1.3~1.5kgf·m)

※ Don't reuse bolt

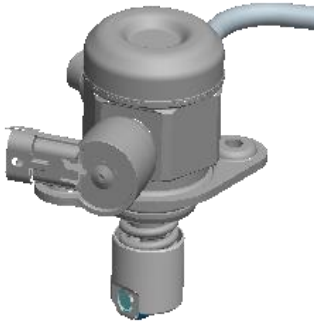
※ Whenever installing HP pump, use new O-ring

GDI Fuel System – HP Pump & Fuel Pressure Regulator Valve

※ It is possible to crank 18,000 stroke without fuel

ex) If cranking is 300rpm, 18,000/4lobe× 300 = 15mins

∴ Never crank for more than 15 minutes without fuel

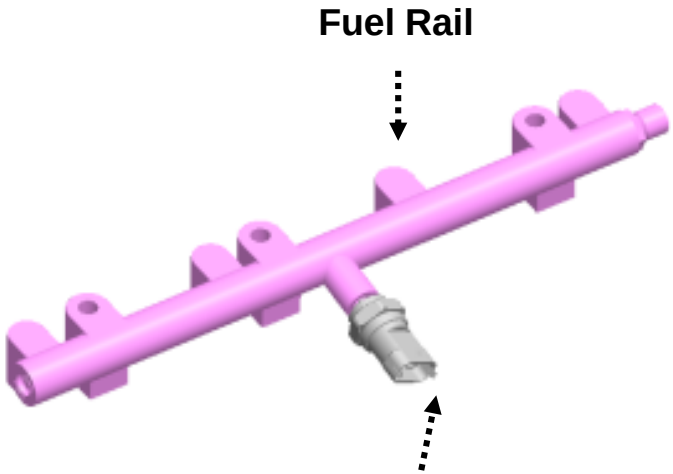


If cranking time excess than the limit time, durability is lowing

because internal lubricant coating is worn out

GDI Fuel System – Injector

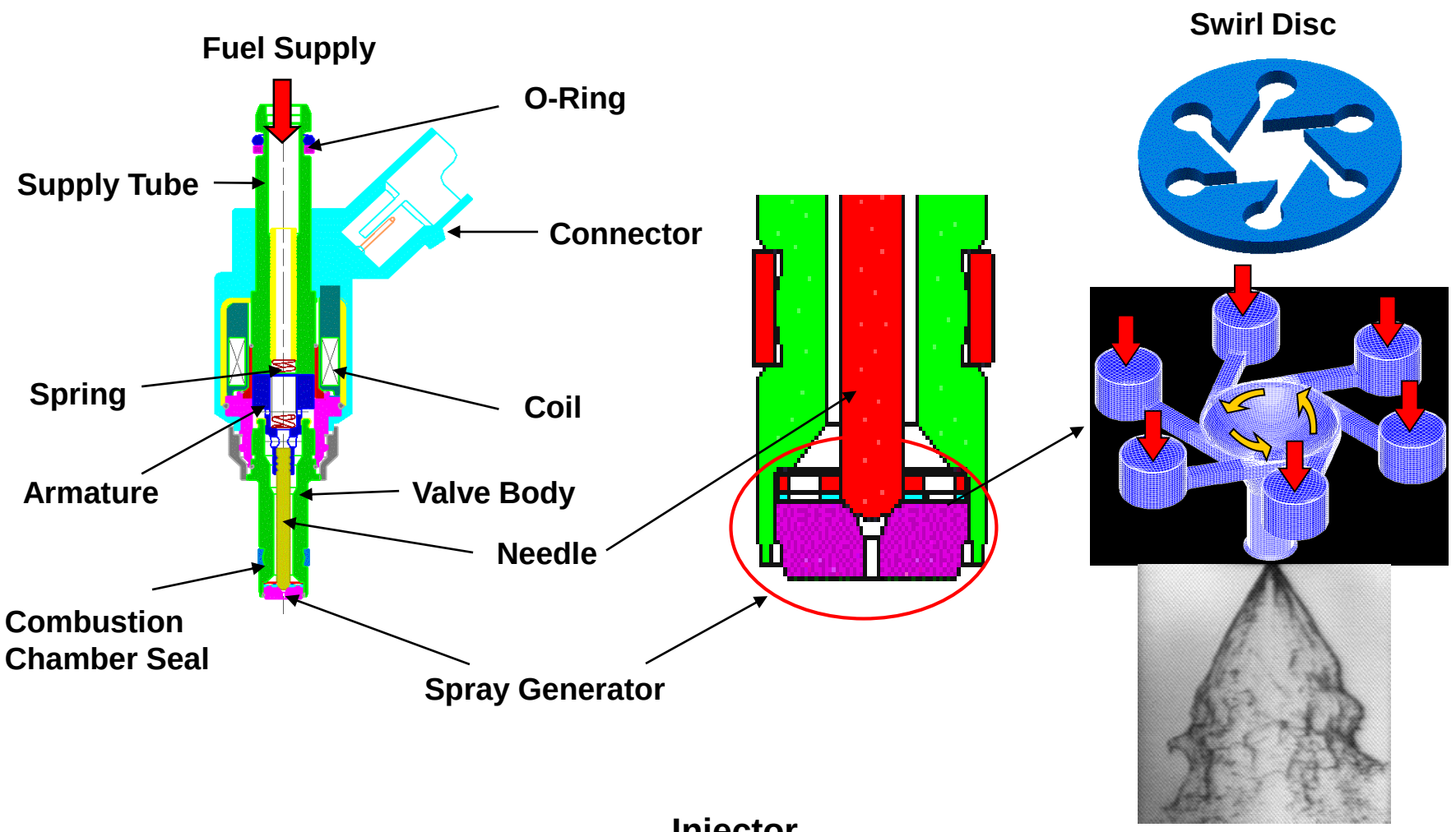
Injector Hole



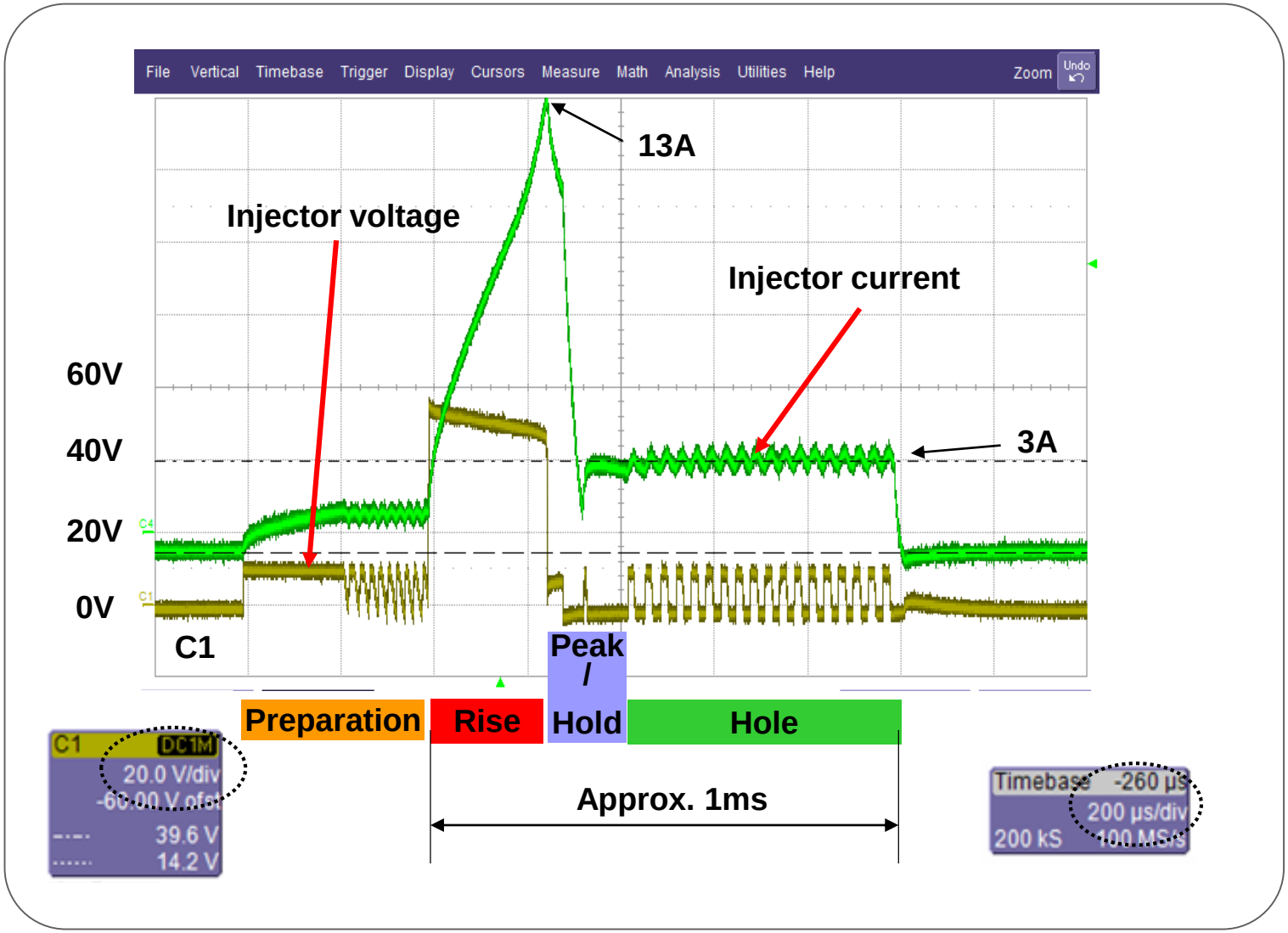
- 6 Hole
- Operating pressure : 165bar
- Flow: 14.7g/s (at 100bar)
- Supplier : Continental

- SUS
- FPS : 250 Bar
- Supplier : Continental

GDI Fuel System – Injector

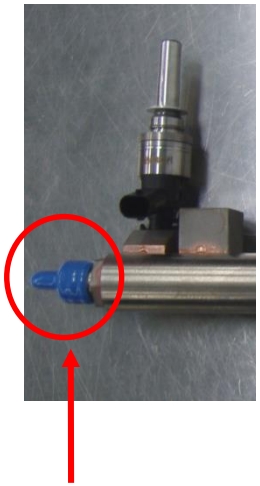


GDI Fuel System – Injector

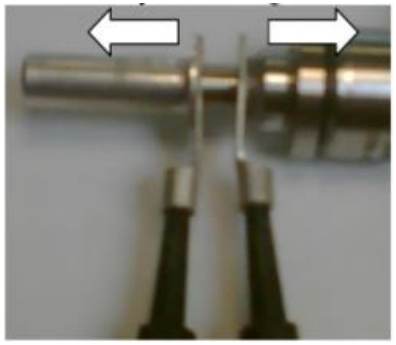


GDI Fuel System – Injector

Injector protect cap



Rail protect cap



Whenever removing cap,
Use expansion pliers

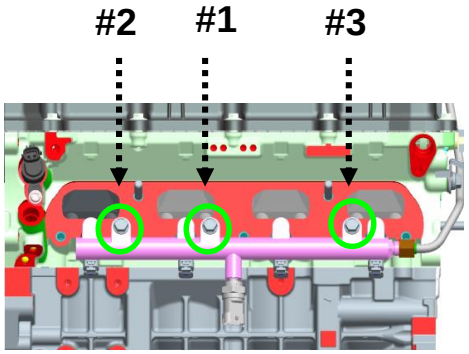
Injector protect cap

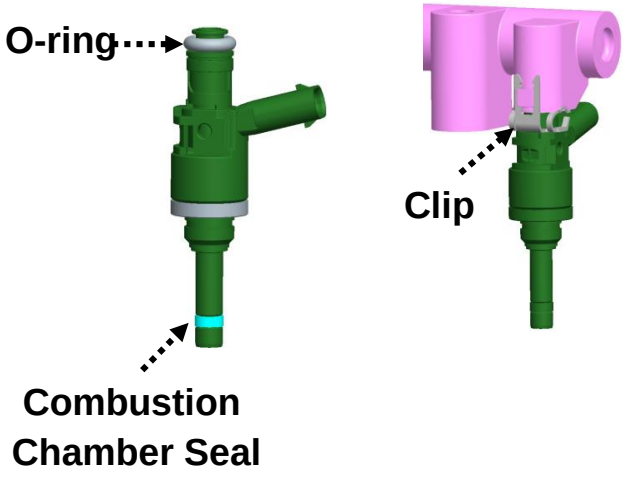
① After removing the injector cap, you must complete the installation within one hour.

② Leaving an injector unprotected (without a cap) for an extended duration of time allows the seal to expand and makes it difficult to insert and install the injector.

③ If the thread has expanded, replace the protection cap to compress the seal.

GDI Fuel System – Injector





Injector assemble method

① Remove the injector caps.

② Coat the O-ring with engine oil

③ Assemble the fuel rail by tightening bolts in following order and in accordance with tightening torque (1.9~2.4kgf·m)

Caution

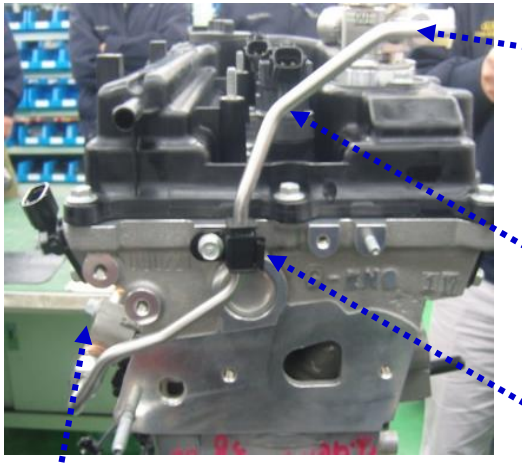
① Do not reuse clips, O-ring and bolts

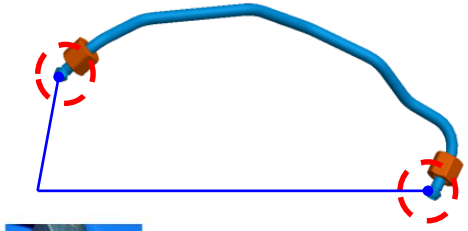
② When inserting the injector into the head, be careful not to damage the injector tip

③ Do not use a fuel rail assembly that has been dropped.

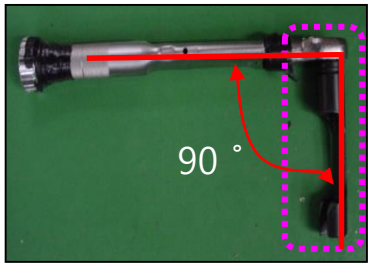
④ When storing injector and rail, install protect cap

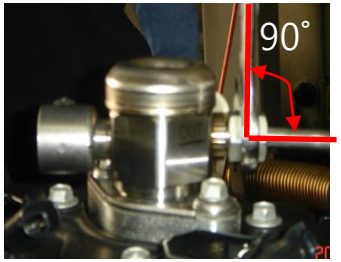
GDI Fuel System – High Pressure Tube





Protect cap





HP tube tightening torque	3.0±0.3 kgf·m
Clip bolt tightening torque	1.0±0.2 kgf·m

Assemble procedure

① Position the HP tube and tighten the nut by hands

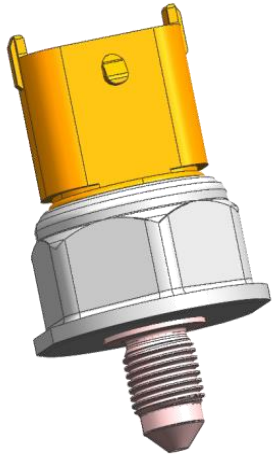
② Install the clip (using torque wrench)

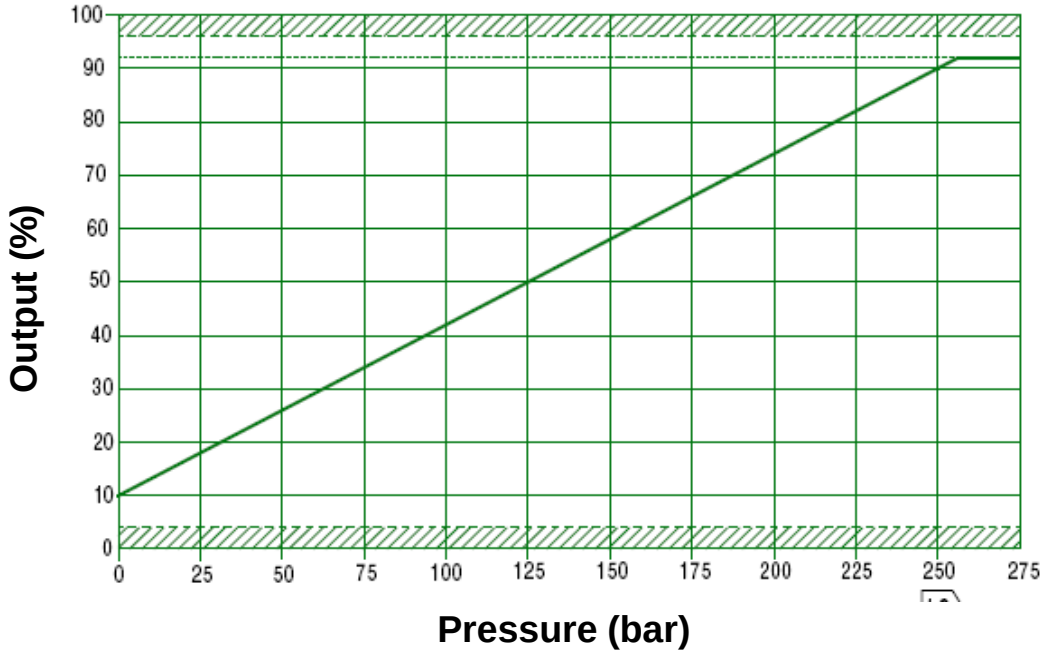
③ Tighten the tube nut (using torque wrench)

※ Remove protect cab before assembling

※ When repairing system, use new tube.

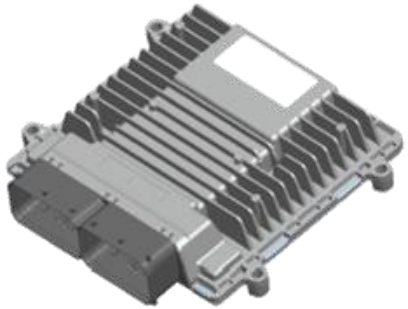
GDI Fuel System – High Pressure Sensor

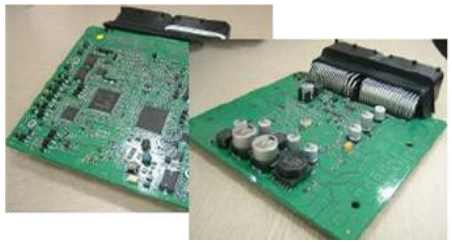




- Range of measurement : 250 bar
- Supply current : 5~12mA
- Supply voltage : 5V

ECM





ECM Specifications

① Automatic Transmission + Immobilizer

② Automatic Transmission + No Immobilizer

③ Manual Transmission + Immobilizer

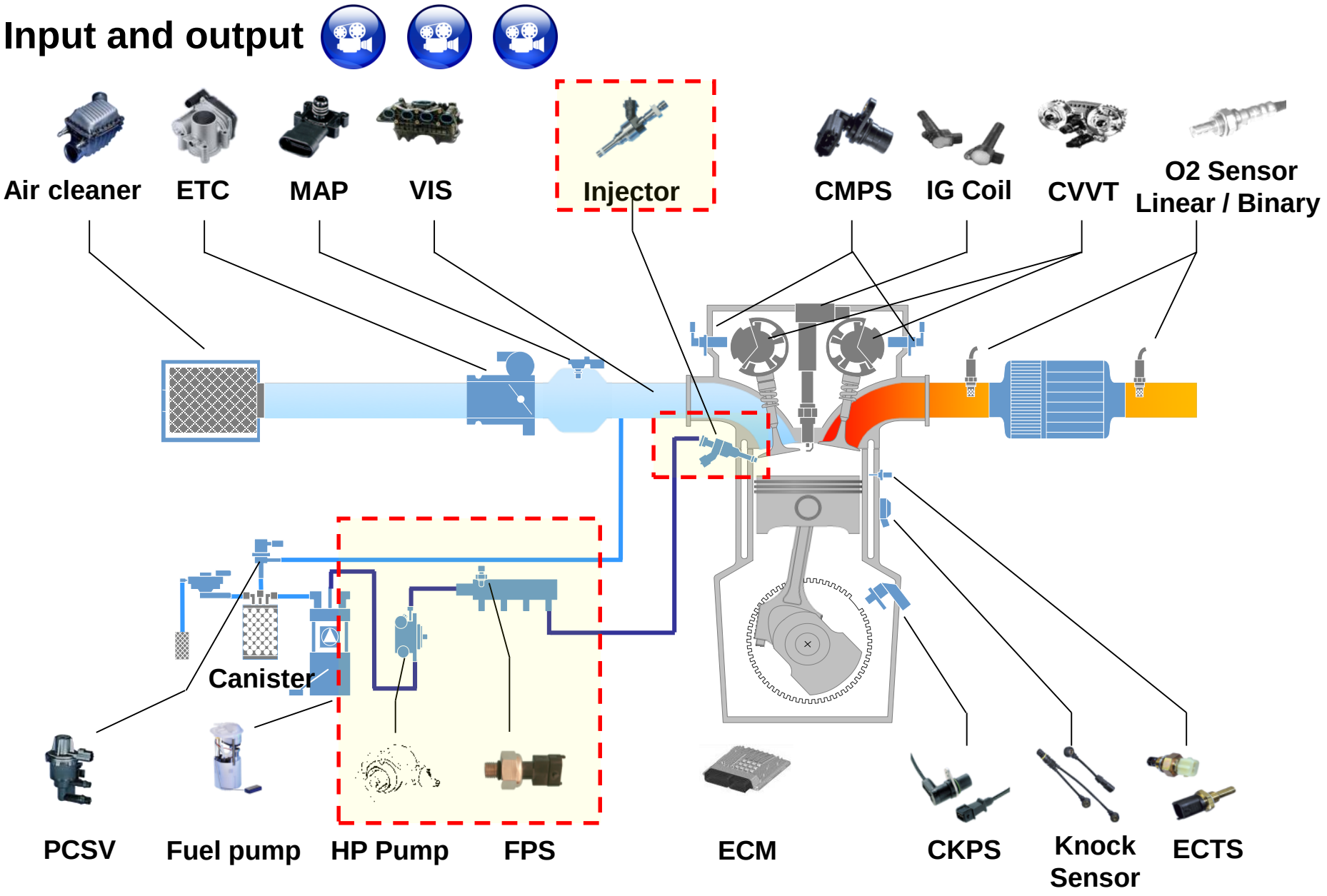
④ Manual Transmission + No Immobilizer

Item	Specification
EMS	Continental
CPU	32bit
Model	SIM2K-240
Pins	196 pin
Weight	1050g
Housing	Aluminum Die Cast
Injector Driver	DC to DC 55V
Dimensions	212×215×38
Location	Engine Room (near the battery)
Operating Temperatures	-40℃ ~ 105℃

ECM Specifications

Theta (Θ) – II GDI Engine

Input and output



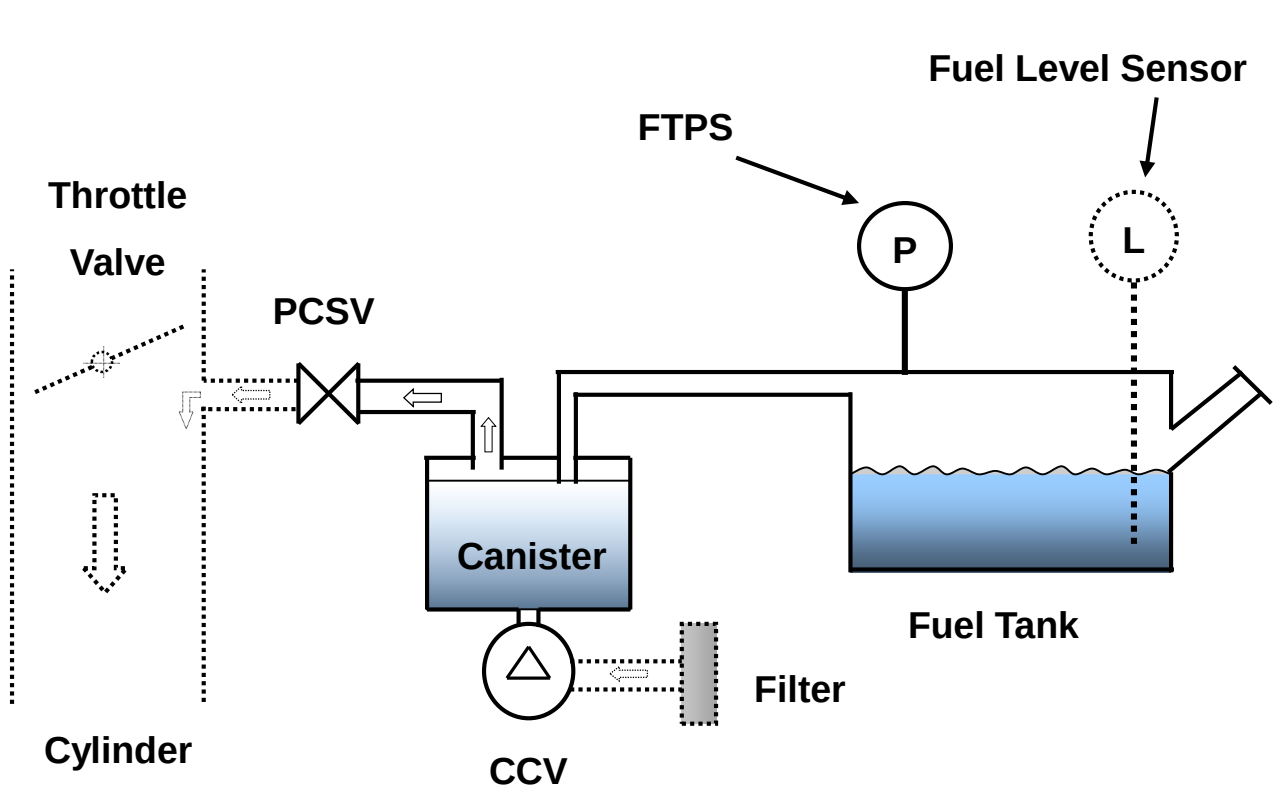
Theta (Θ) – II GDI Engine

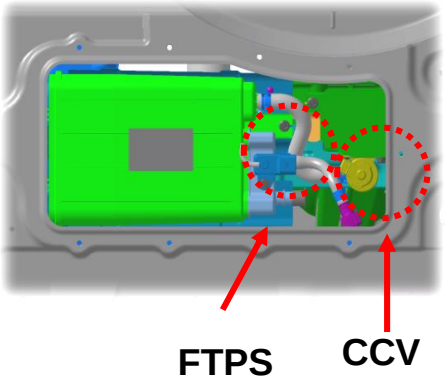
Injection Timing

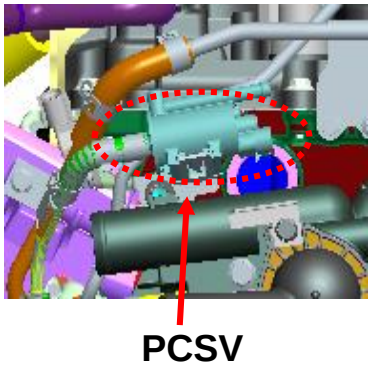
Crank Angle		720 ˚	540 ˚	360 ˚	180 ˚	0 ˚(TDC)
Cycle		Power	Exhaust	Intake	Compression	
GDI	Normal driving			**Fuel Injection**		
	At cranking				**Fuel Injection**	
	Catalytic Converter Heating			**Fuel Injection**		
MPI Fuel Injection			**Fuel Injection**			

- **Normal driving : injection at intake stroke → For good air/fuel mixture**
- **Cranking : injection at compression stroke → For making rich condition near spark plug**
- **Heating catalytic converter : injection at intake and compression stroke**

Evaporation control







Evaporation control

Leakage Testing Mode Conditions

① Engine Coolant Temperature > 50℃

② Ambient Temperature > -10℃

③ Time after starting > engine 100 revolutions

④ Fuel Level: 15% ~ 85%

⑤ No malfunctions/errors (No DTC).

⑥ Battery Voltage: > 10V

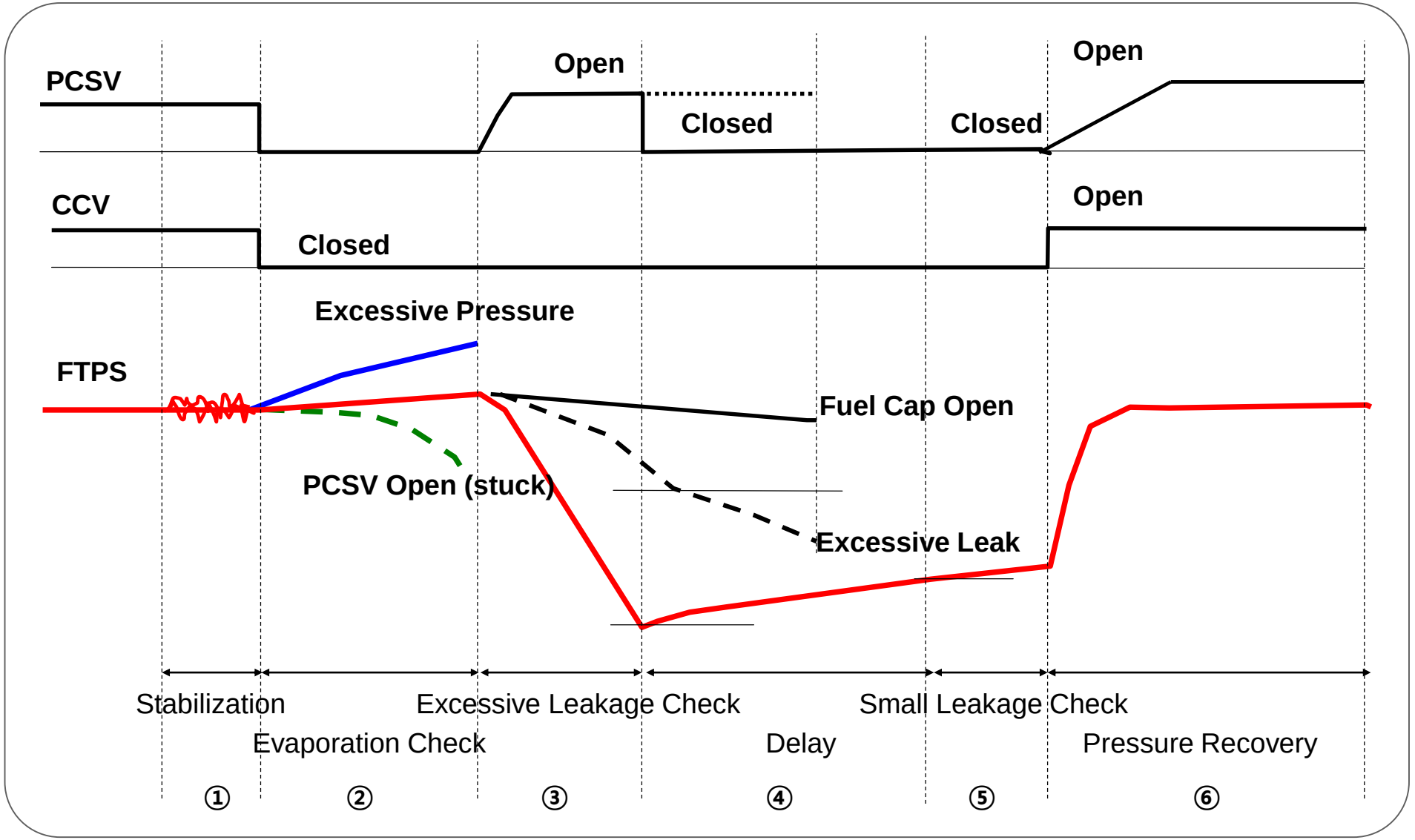
⑦ Upon a leakage test failure, the system retries after 60 seconds.

※ Detect fault : Diameter > 1mm

※ Diagnosis Time: During 30sec at idle condition, after satisfying leakage testing mode conditions

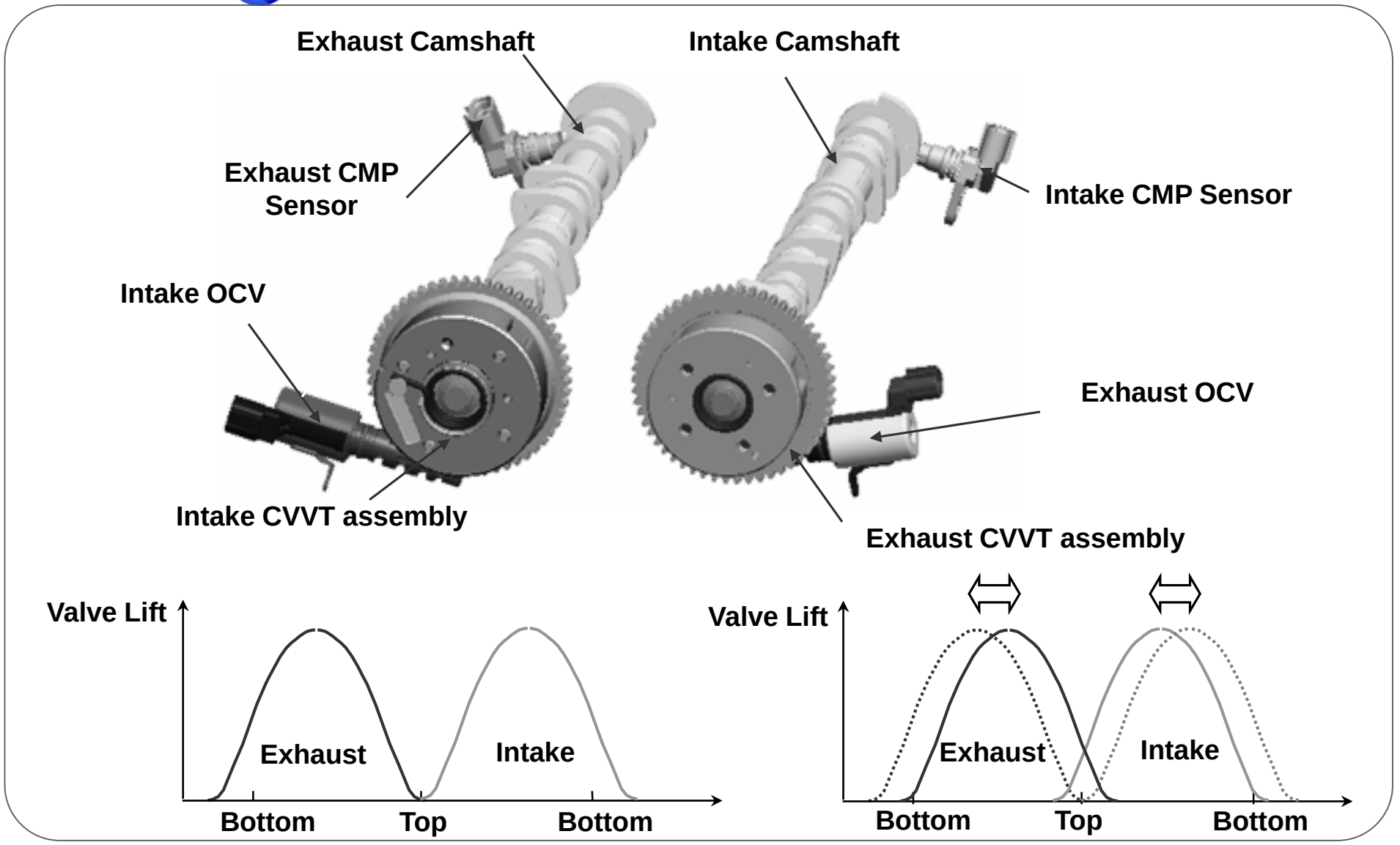
※ Warning lamp on condition: Second driving cycle

Evaporation control



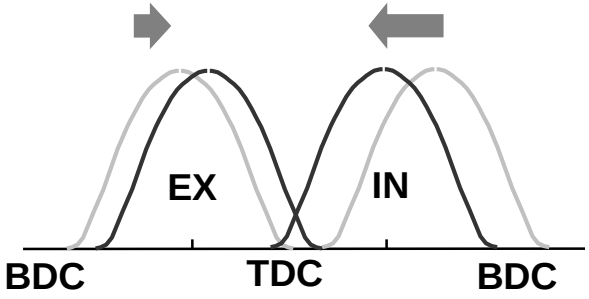
Theta (Θ) – II GDI Engine

Dual CVVT



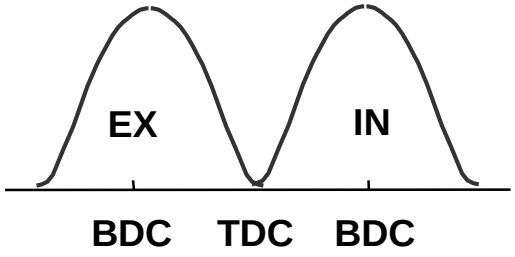
Theta (Θ) – II GDI Engine

Dual CVVT



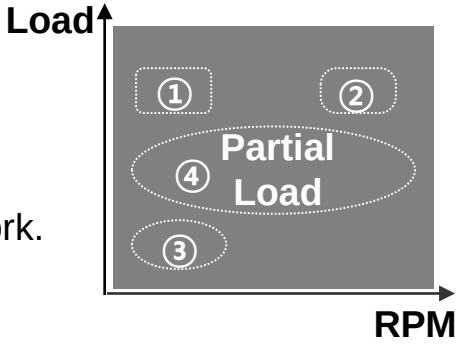
① Low Speed / High Load

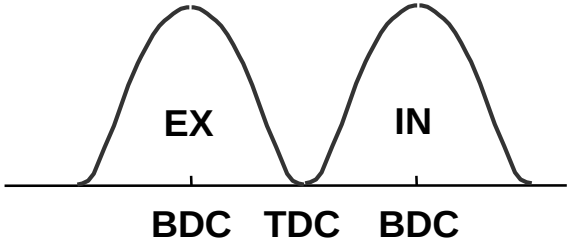
- Intake backflow prevention (improved volumetric efficiency)
- Increased expansion/contraction work.



③ Low Speed / Load

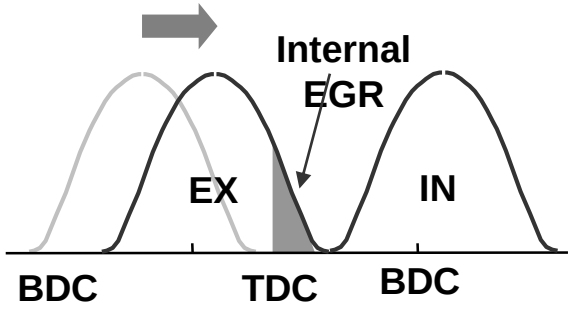
- Stable combustion.
- Reduced valve overlap





② High Speed / Load

-Improved volumetric efficiency.



④ Partial Load

- Massive internal EGR (increased fuel efficiency, reduced NOx).
- Reduced pumping loss
- Increased expansion work.
- Reduced HC.