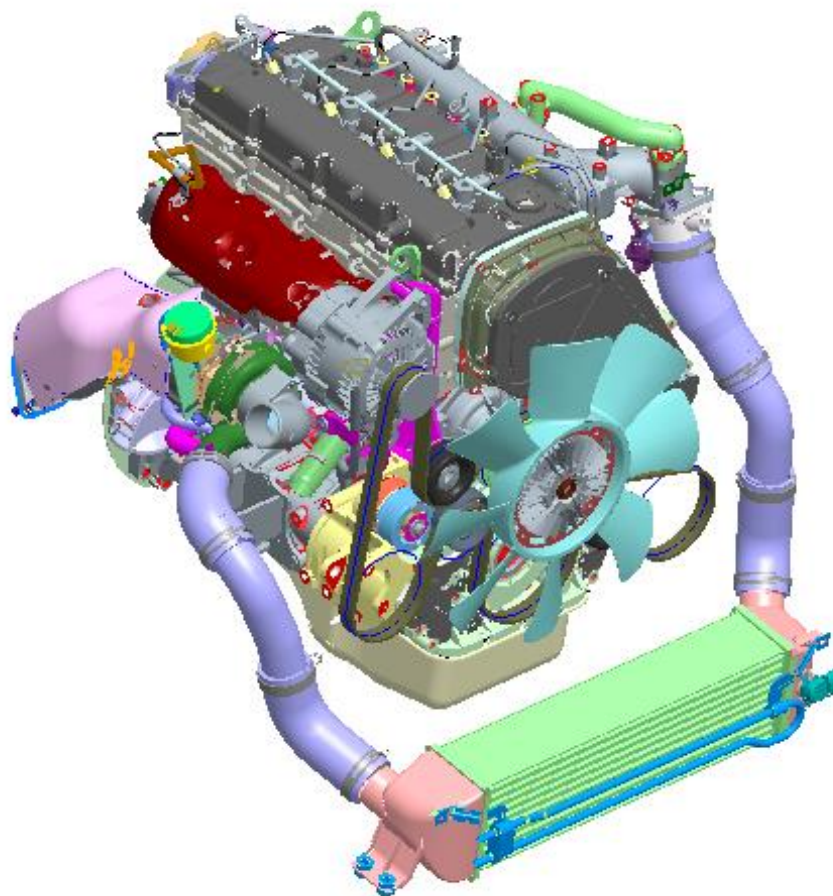


Engine



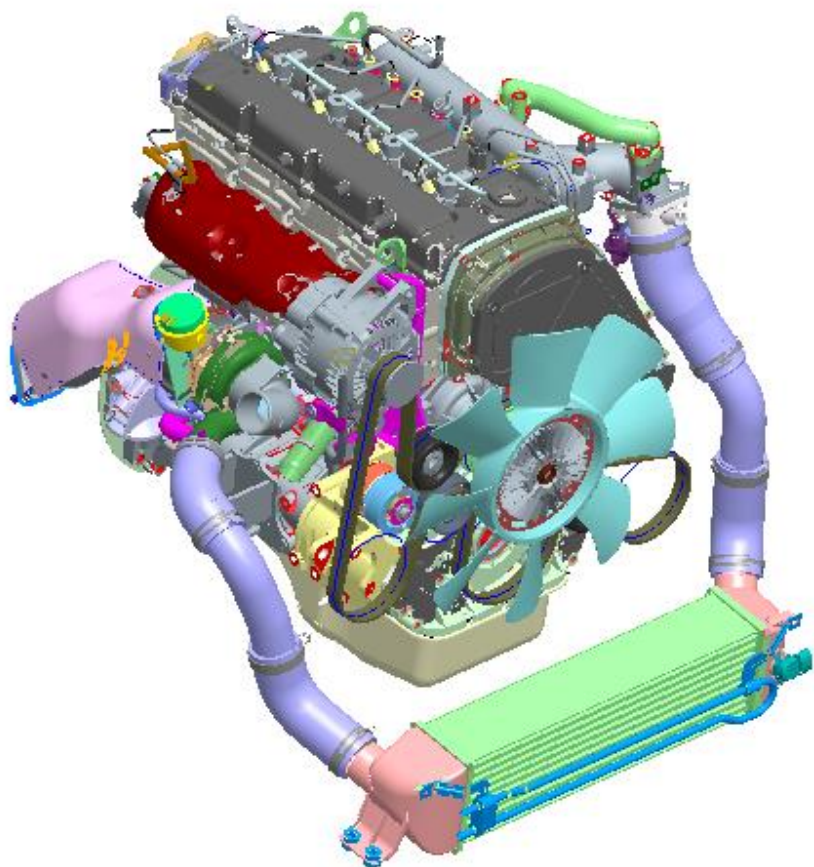
Power train Application

Engine		Transmission	Power/Torque (PS/kgf m)	EU (LHD/RHD)		GEN (LHD/RHD)		AUST. (RHD)	
				WGN (8P)	VAN (2/5P)	WGN (9/12P)	VAN (2/5P)	WGN (8P)	VAN (2/5P)
Diesel	A-2.5 VGT	M5SR1	170 / 40.0 (WGT : 136/35.0)	● (VGT/ WGT)	● (VGT/ WGT)	●	●	●	●
		A5SR2		-	-	●	●	●	●
	D4BH TCI-2.5	M5TR1	100 / 23.0	-	-	●	●	-	-
		AW30-43		-	-	●	-	-	-
Gasoline	Θ-2.4 FR	M5TR1	175 / 23.2	-	-	●	●	●	●
		AW30-40		-	-	● (9P ONLY)	-	●	-

Note 1)  VGT (Variable Geometry Turbo charger) only

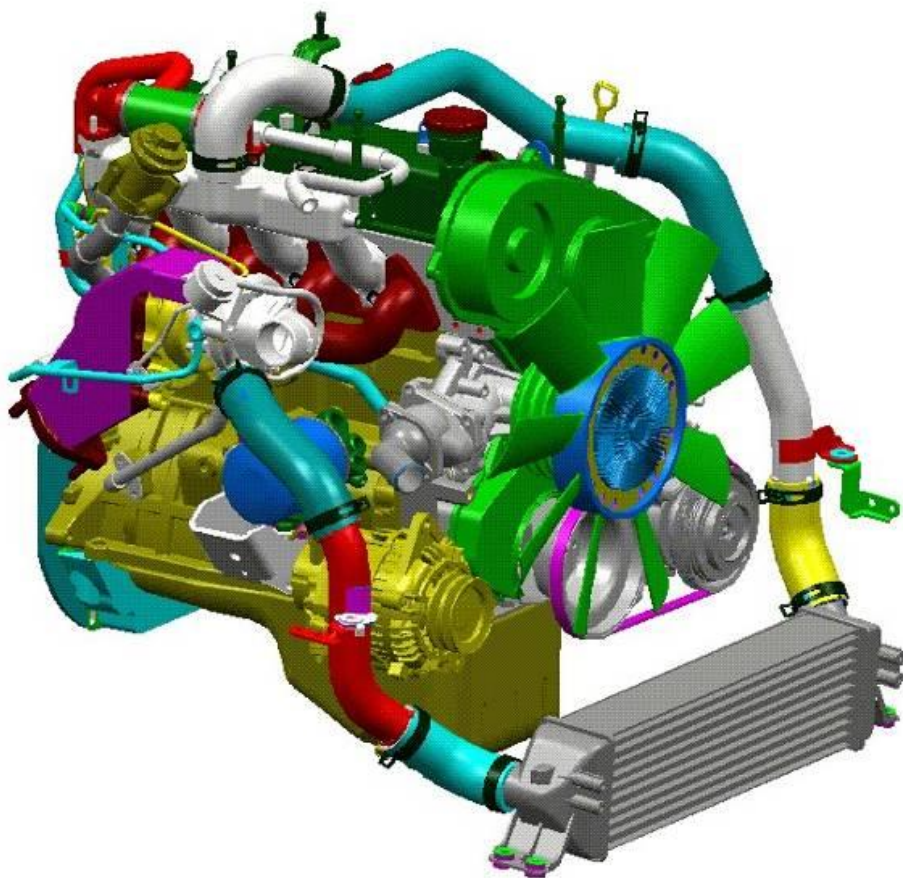
Note 2) WGT: Europe only (for lower engine power)

C/Rail A - engine



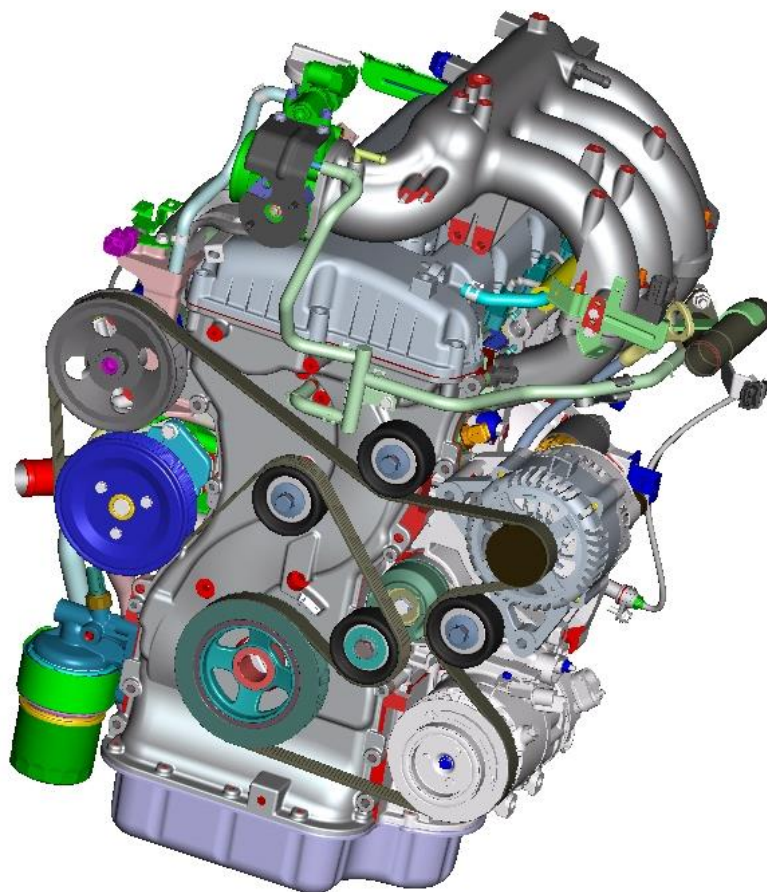
Engine	A – 2.5 VGT	A – 2.5 WGT
Displacement (cc)	2497	2497
Max. Power (PS / RPM)	170 / 3800	136 / 3800
Max. Torque (kgf·m / RPM)	40.0 / 2000	35.0 / 2000
Feature	<ul style="list-style-type: none"> • Timing Chain • 2nd generation C/Rail (1600bar) • Increased power → 30 PS (vs A1) – VGT • Electrical EGR • Duty control Turbocharger - WGT • BOSCH C/Rail • Serpentine belt • Air dam type intercooler • EGR cooler • Lambda sensor is Installed 	

D4BH TCI – 2.5



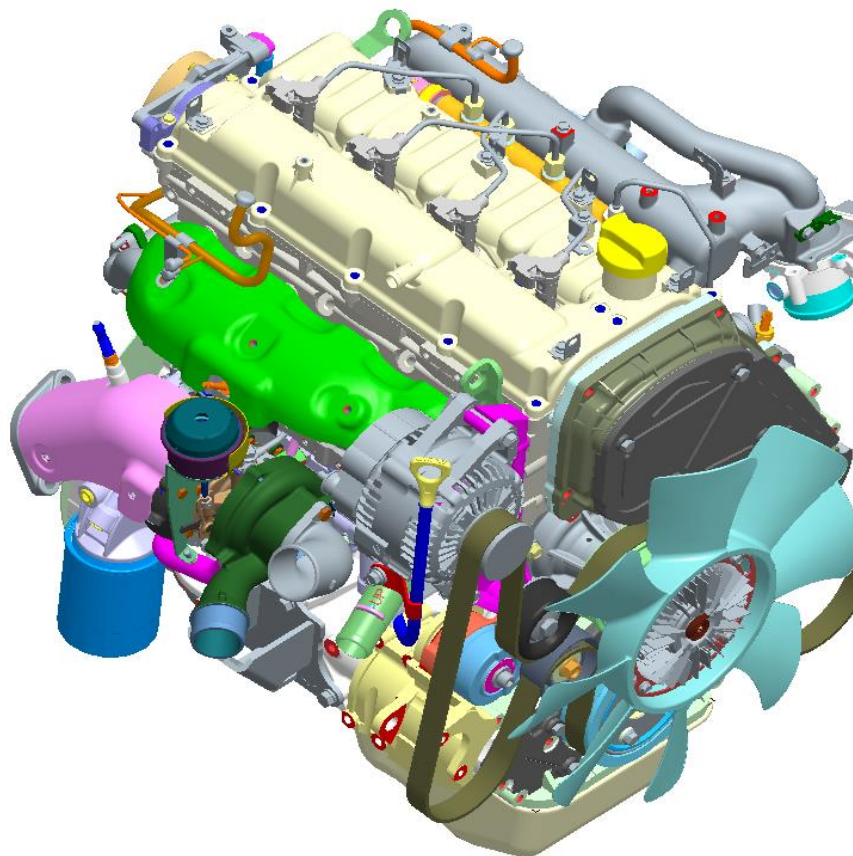
Engine	D4BH TCI – 2.5
Displacement (cc)	2476
Max. Power (PS / RPM)	100 / 3800
Max. Torque (kgf-m / RPM)	23.0 / 2000
Feature	<ul style="list-style-type: none"> • Air dam type intercooler • Balance-shaft for improving NVH • Covec – F • EGR and Cooler • Satisfied Euro 3 emission

Theta 2.4 engine



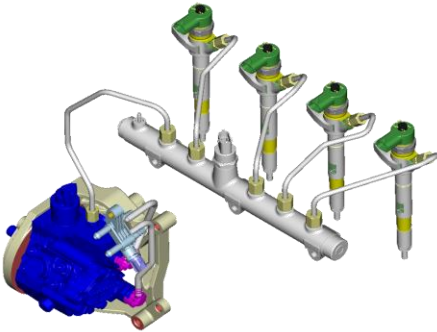
Engine	Theta – 2.4 CVVT
Displacement (cc)	2359
Max. Power (PS / RPM)	175 / 6000
Max. Torque (kgf·m / RPM)	23.2 / 4250
Feature	<ul style="list-style-type: none"> • Reduced engine weight → 22Kg (vs A1) • Increased power → 39 PS (vs A1) • Timing Chain • CVVT • FF type theta engine

A- 2.5 Engine



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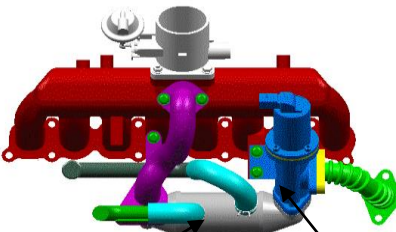
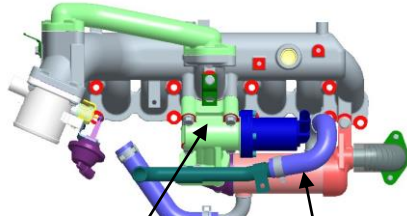

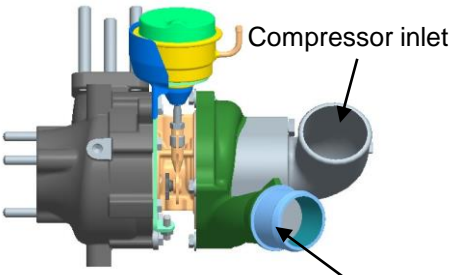
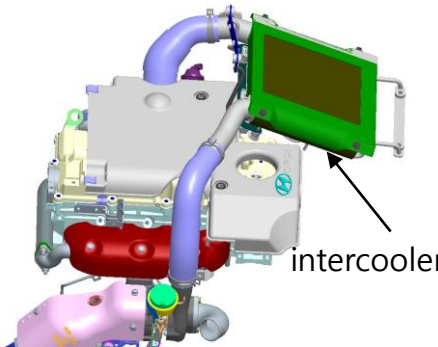
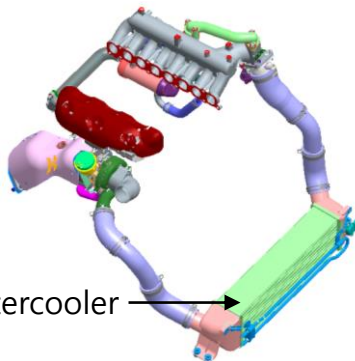
Comparison (TQ vs A1)

System	Item	A1-WGT EURO – 3	TQ VGT EURO – 4	Remarks
Fuel system / EMS	Injector	CRIP1 / 6-HOLE	CRIP2.2 / 8-HOLE (IQA)	
	Max. Rail pressure	1350bar	1600bar +PRV 	
	ECM	16 bit	32 bit	
	H/P Pump	CP3.2	CP1H	
	λ – Sensor	×	Added λ – Sensor	• λ – Sensor is used for compensating amount of injection

TQ - ENGINE

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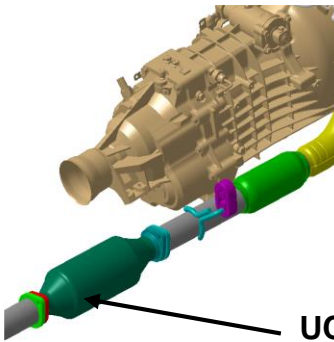
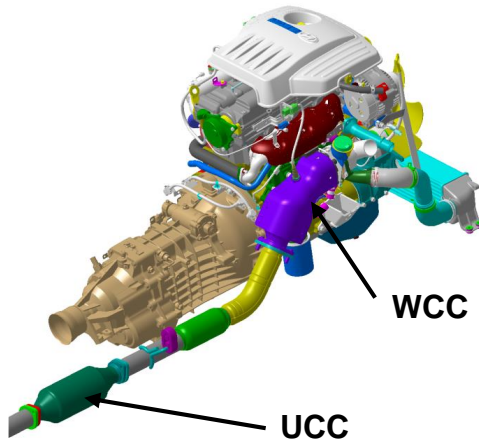
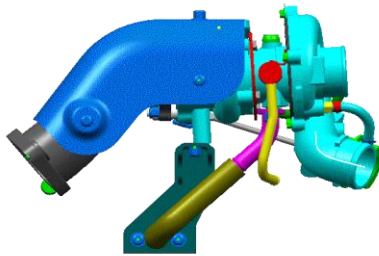
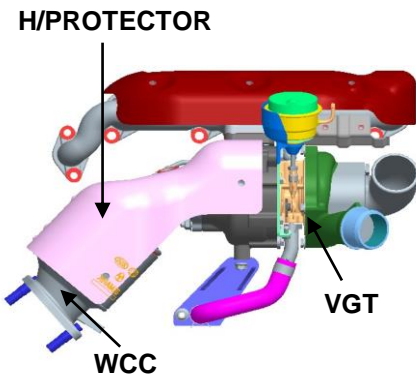
Comparison (TQ vs A1)

System	Item	A1-WGT EURO – 3	TQ VGT EURO – 4	Remarks
Intake / Exhaust system	EGR cooler and Valve	 EGR COOLER EGR Valve	 EGR Valve EGR cooler	<ul style="list-style-type: none"> •EGR valve location is changed
	Turbocharger		 Compressor inlet Compressor outlet	<ul style="list-style-type: none"> ▪Changed turbocharger (WGT → VGT) → improved torque at low rpm → Reduced emission → Improved performance
	Intercooler	 intercooler	 intercooler	<ul style="list-style-type: none"> • Air dam type → improved efficiency • Increased capacity (4.2ℓ→5.7ℓ)

TQ - ENGINE

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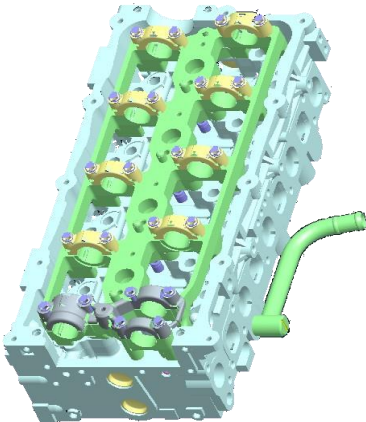
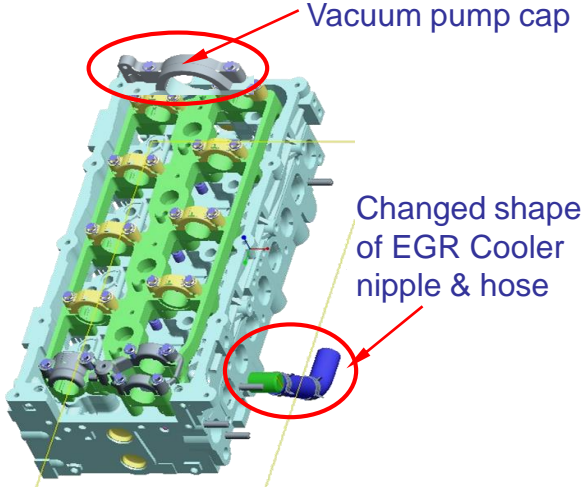
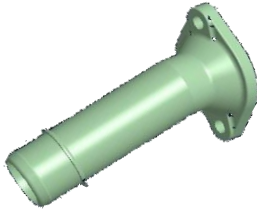

Comparison (TQ vs A1)

System	Item	A1-WGT EURO – 3	TQ VGT EURO – 4	Remarks
Intake / Exhaust system	Catalytic Converter	 UCC	 WCC UCC	<ul style="list-style-type: none"> • Added Warm up Catalytic Converter (WCC) → MT only ※ Euro 4 : WCC+UCC (M/T only) Euro 3 : UCC only Euro 2 : without catalytic converter
	Exhaust layout		 H/PROTECTOR WCC VGT	<ul style="list-style-type: none"> ▪ VGT • EX FITTING(WCC) • H/PROTECTOR

TQ - ENGINE

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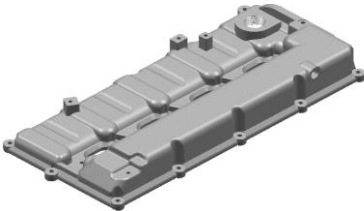
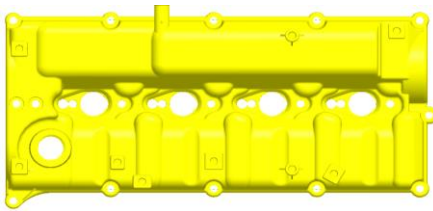

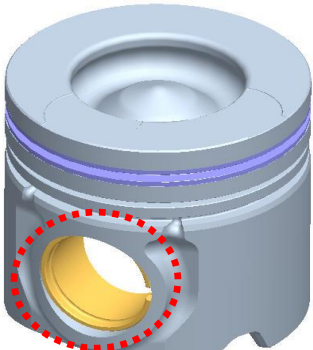
Comparison (TQ vs A1)

System	Item	A1-WGT EURO – 3	TQ VGT EURO – 4	Remarks
Head / cooling	Head		 <p>Vacuum pump cap</p> <p>Changed shape of EGR Cooler nipple & hose</p>	<ul style="list-style-type: none"> • Vacuum pump is moved to alternator
	Water inlet fitting			

TQ - ENGINE

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Comparison (TQ vs A1)

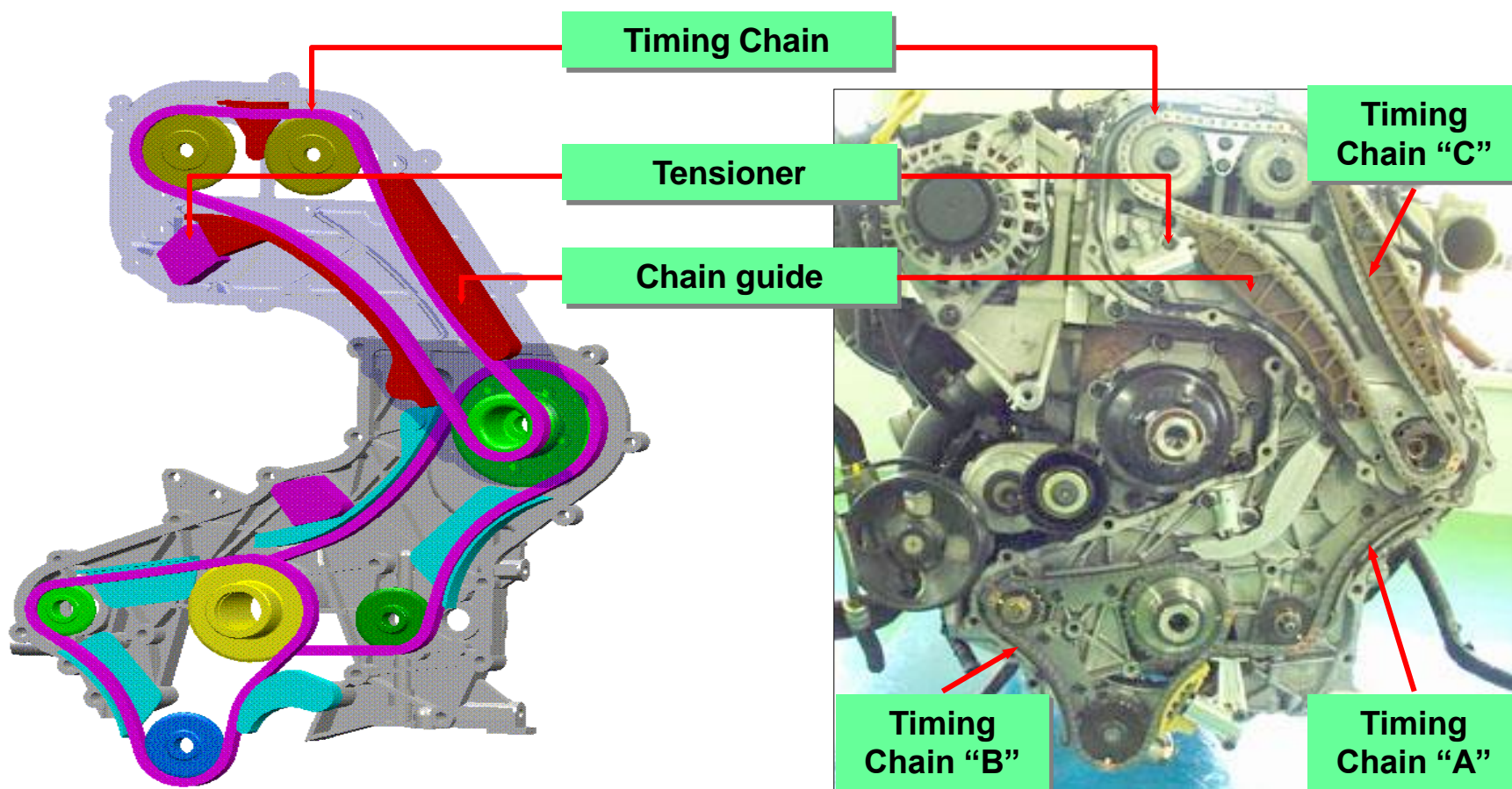
System	Item	A1-WGT EURO – 3	TQ VGT EURO – 4	Remarks
Head / cooling	Head cover			<ul style="list-style-type: none"> • Changed material (Aluminum → Plastic) ▪ Oil separator is removed
Moving	Piston			<ul style="list-style-type: none"> • Changed combustion chamber for satisfying emission regulation • Adopted piston bushing - improved stiffness

Comparison (TQ vs A1)

contents		Model	
		A1 [A-WGT]	TQ [A-VGT(EURO-4)]
High Pump	Max. Fuel pressure	1350 bar	1600 bar
	Max. Supplied capacity	677mm3/rev	843mm3/rev
	type	CP3.2	CP1H
Injector	type	Classified injector	IQA injector
	Max. No of Injection	2~3 times	3~4 times
	Max. pressure of injection	1350 bar	1600 bar
	Min. amount of injection	1.5 mm3/st	1.0 mm3/st
	Min. interval of injection	1.8 ms	0.8 ms
Common rail	Max. pressure	1350 bar	1600 bar
	Pressure control	Inlet control	Inlet / Outlet control
ECM	CPU	16 bit	32 bit
	No of PIN	121 PIN	154 PIN

Timing Chain

- Maintenance free timing chain and chain guide adapted
- Composed by 3 chains : A, B and C
- Shorten engine length

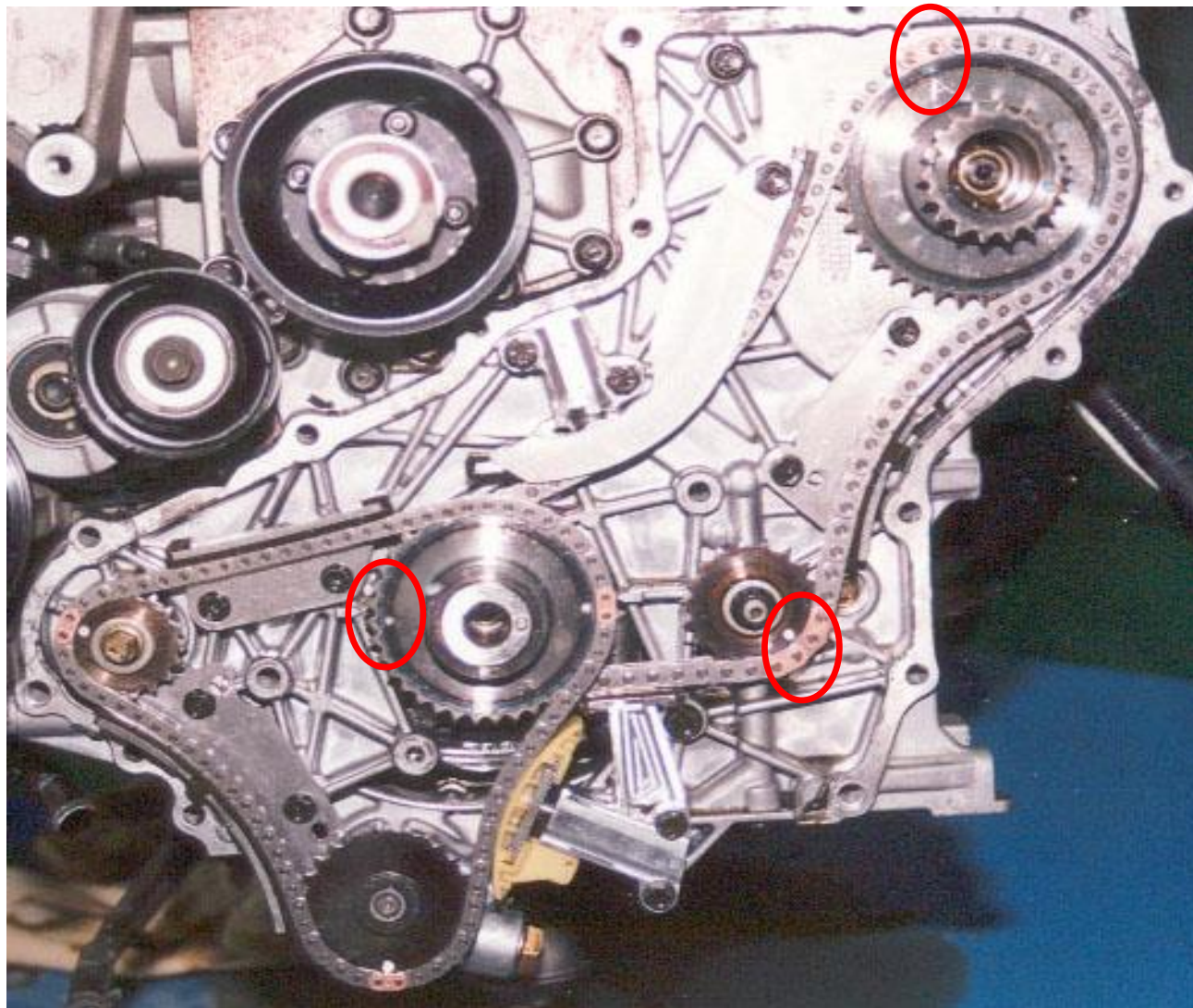


TQ - ENGINE

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Timing Chain "A "

- Drive crankshaft pulley, high pressure pump and RH balance shaft

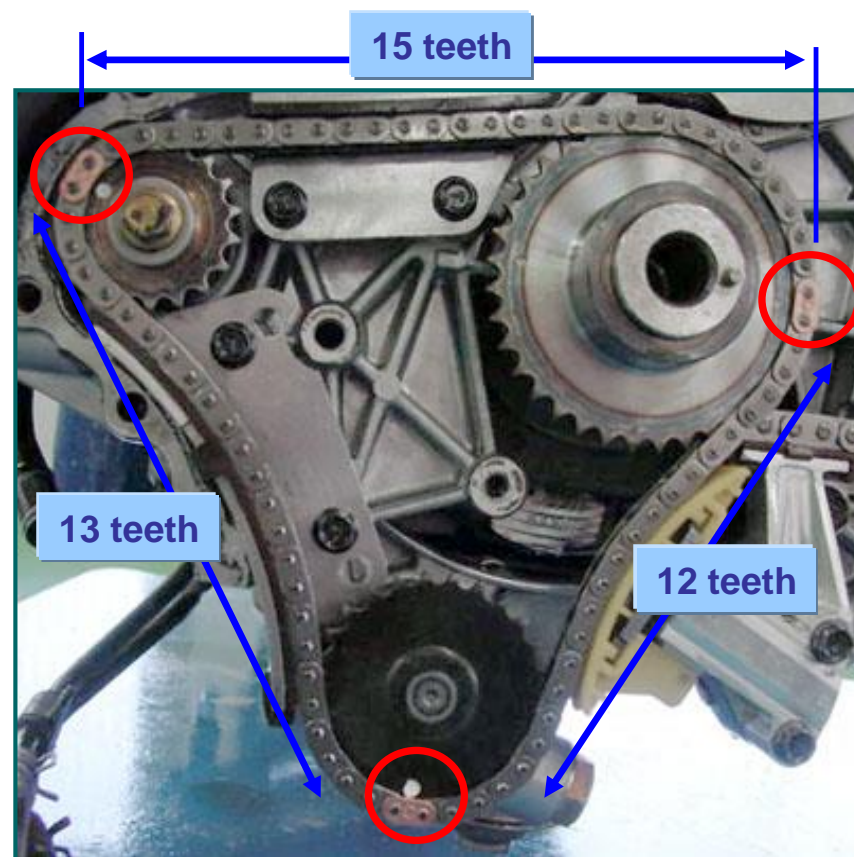
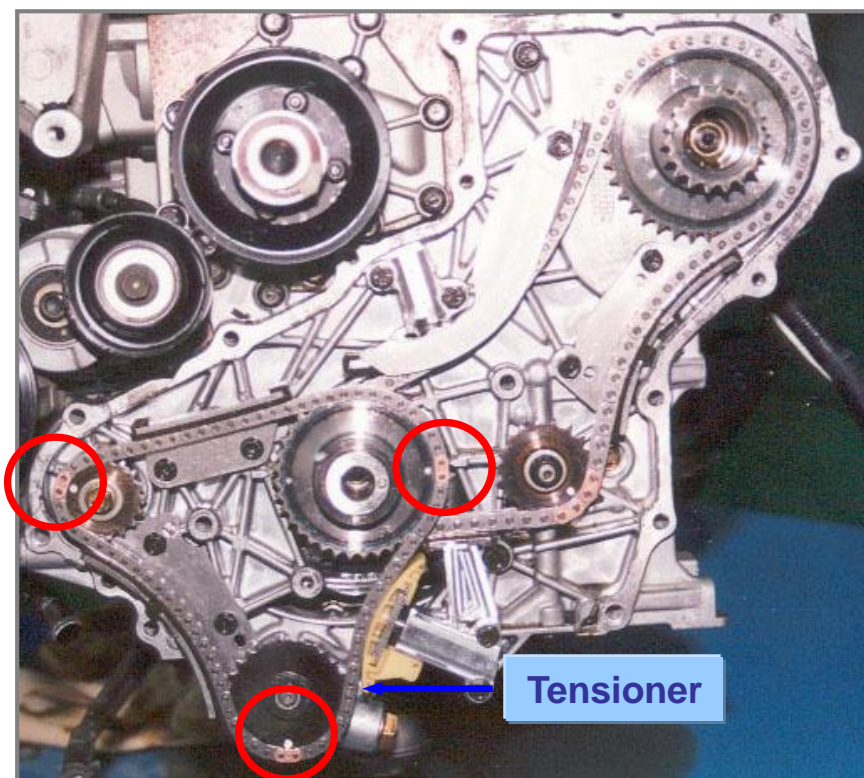


TQ - ENGINE

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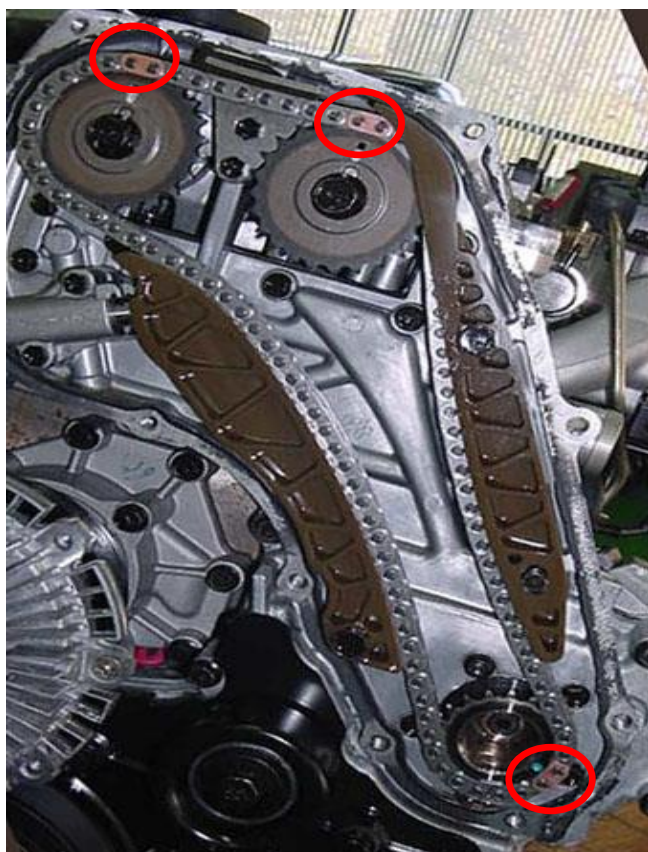
Timing Chain "B "

- Drive Crankshaft pulley, oil pump and LH balance shaft pulley
- Aligned all timing mark together in initial installation
- Proper lubrication for timing chain and chain guide

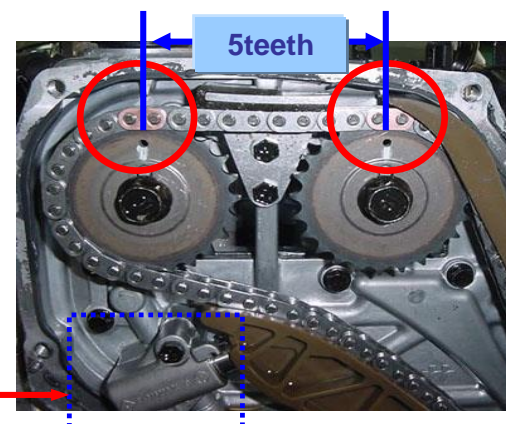


Timing Chain "C "

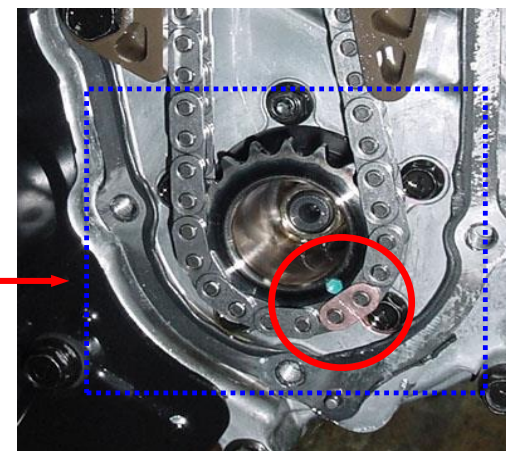
- Drive high pressure pump intake and exhaust cam sprocket



Auto Tensioner

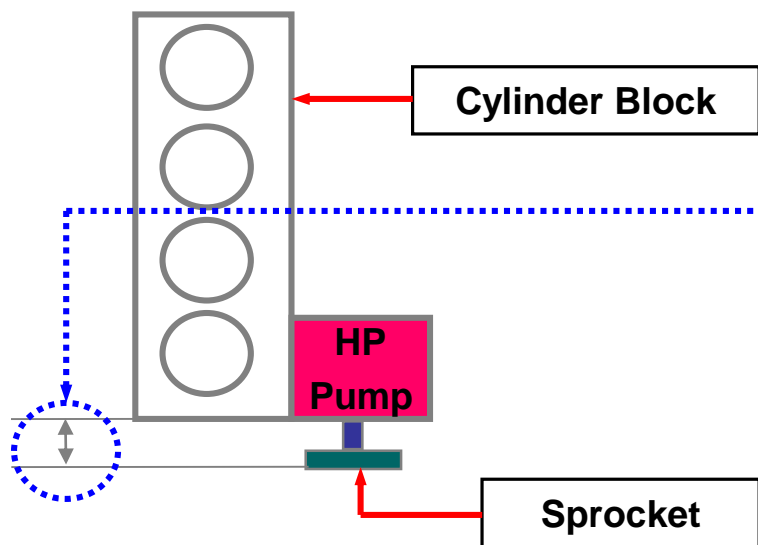


High Pressure Pump sprocket



Caution for timing chain

- Replacing work for timing chain A and B is not possible in condition of engine installation while timing chain C is possible.
- Alignment between each sprocket and timing belt should be in spec. especially in timing chain "C".
- There are 3 types of high pressure pump sprocket supplied related to high pressure pump. Every time when you are in replacing work, you have to check the clearance between high pressure pump end and pump sprocket end and choose the right size of sprocket for proper installation.



Color	Thickness (mm)	Sprocket
Blue	34.2-35.0	A
White	33.4-34.2	B
Red	35.0-35.8	C

Data Analysis (Idling Condition)










▶ Data Analysis - TQ / 2008 / D 2.5 CRDI / ENGINE			▶ Data Analysis - TQ / 2008 / D 2.5 CRDI / ENGINE		
Ignition Switch	ON	-	Air Mass Flow Max. Plausible	58.7	kg/h
Battery Positive Voltage	14.2	V	Air Mass Flow per Cylinder	642.4	mg/st
Fuel Quantity	9.0	mm3	Intake Air Temperature Sensor	53	°C
Desired injection Quantity of Main	7.5	mm3	Intake Air Temperature Sensor	1902	mV
Desired injection Quantity of Pilot 1	0.4	mm3	EGR Actuator	5	%
Desired injection Quantity of Pilot 2	0.4	mm3	Barometric Pressure	988	hPa
Desired injection Quantity of Post 1	0.0	mm3	Engine Coolant Temperature	83	°C
Fuel Rail Pressure	274.5	bar	Clutch Switch (M/T only)	ON	-
Target Rail Pressure	284.3	bar	Neutral Gear Switch(M/T only)	OFF	-
Rail Pressure Regulator(Rail)	20	%	Brake Switch 2	OFF	-
Rail Pressure Regulator(Pump)	38	%	Brake Switch 1	OFF	-
Fuel Temperature Sensor	40	°C	Accelerator Pedal Position Sensor	0	%
Fuel Temperature Sensor	2451	mV	Accelerator Pedal Position Sensor-1	765	mV
Tips	Fix	Full	Tips	Fix	Full
Graph	Record	Function	Graph	Record	Function

▶ Data Analysis - TQ / 2008 / D 2.5 CRDI / ENGINE			▶ Data Analysis - TQ / 2008 / D 2.5 CRDI / ENGINE		
Accelerator Pedal Position Sensor-2	373	mV	Boost Pressure Sensor	1627	mV
Accelerator Pedal Position Full Signal	NORMAL	-	VGT Actuator	66	%
A/C Switch	ON	-	Throttle Flap Actuator	5	%
A/C Compressor Relay	ON	-	Malfunction Indicator Lamp(MIL)	OFF	-
A/C Compressor	ON	-	Oxygen Sensor Subtraction Voltage	941	mV
A/C Pressure	1765	mV	Lambda(Oxygen Sensor)	4.9	-
Blower Switch	ON	-	Oxygen Sensor Temperature	678	°C
Fan-Low Speed	OFF	-	Oxygen Sensor Heater Duty	39	%
Fan-High Speed	ON	-	Oxygen Sensor State of Adaption	ADJ.COM...	-
Glow Relay	OFF	-	Vehicle Speed Sensor	0	km/h
Glow Lamp	OFF	-	Actual Vehicle Accelerator	0.0	m/s2
PTC Heater Realy	OFF	-	Shift Position(Only A/T)	0	-
Boost Pressure Sensor	1029	hPa	Engine Speed	781	RPM
Tips	Fix	Full	Tips	Fix	Full
Graph	Record	Function	Graph	Record	Function

TQ - ENGINE

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Data Analysis

▶ Data Analysis - TQ / 2008 / D 2.5 CRDI / ENGINE								
Vehicle Speed Sensor	0	km/h						
Actual Vehicle Accelerator	0.0	m/s2						
Shift Position(Only A/T)	0	-						
Engine Speed	781	RPM						
Engine Load	23	%						
Engine Torque	24.7	Nm						
Target Engine Torque	-17.6	Nm						
Current Value of frictional Torque	4	%						
Current value of Inner Torque	10	%						
Desired Value Of Inner Torque	10	%						
Immobilizer application status	SUPPORT...	-						
Immobilizer Indicator Lamp	OFF	-						
MT/AT Recognition Status	A/T	-						
Tips			Fix		Full		Graph	
Record			Function					

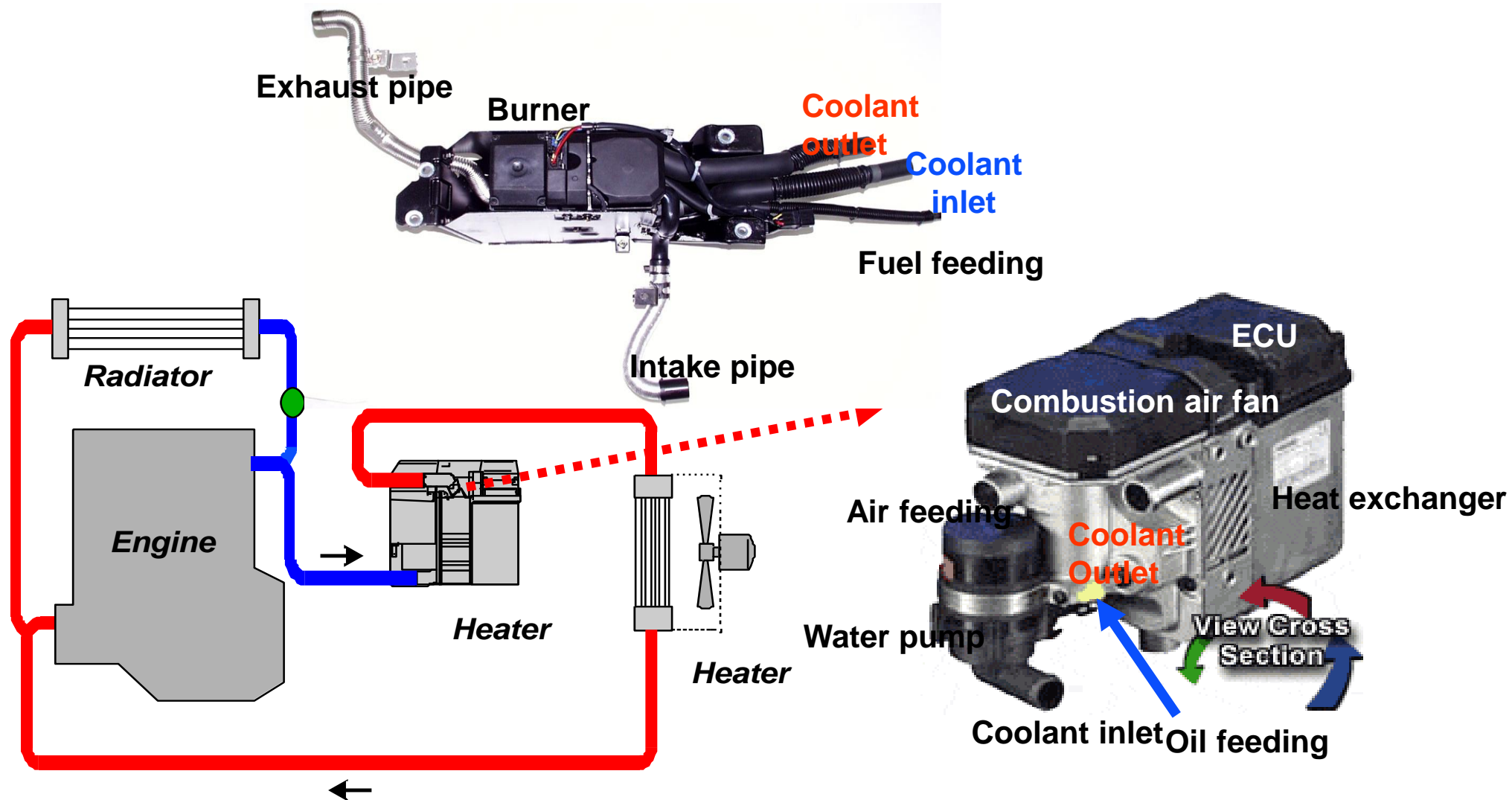
Actuation Test

▶ Data Analysis - TQ / 2008 / D 2.5 CRDI / ENGINE							
Vehicle Speed Sensor	0	km/h					
Actual Vehicle Accelerator	0.0	m/s2					
Shift Position(Only A/T)	0	-					
Engine Speed	779	RPM					
Engine Load	22	%					
Engine Torque	24.7	Nm					
▶ Actuation Test							
A/C Compressor Relay		<div>Duration Until Stop Button</div> <div>Condition IG. ON/ENG.OFF</div> <div>Result</div>					
Engine Check Lamp(MIL)							
Auxiliary Heater Relay							
Cooling Fan Relay-High							
Cooling Fan Relay-Low							
Glow Indicator Lamp							
Start	Stop				Function		

▶ Data Analysis - TQ / 2008 / D 2.5 CRDI / ENGINE							
Vehicle Speed Sensor	0	km/h					
Actual Vehicle Accelerator	0.0	m/s ²					
Shift Position(Only A/T)	0	-					
Engine Speed	780	RPM					
Engine Load	23	%					
Engine Torque	22.4	Nm					
▶ Actuation Test							
Glow Relay		<div>Duration Until Stop Button</div> <div>Condition IG. ON/ENG.OFF</div> <div>Result</div>					
Immobilizer Lamp							
VGT Actuator							
Exhaust Gas Recirculation Solenoid Valve							
Throttle Valve Actuator							
Fuel Pressure Regulator Valve(Pump)							
Start	Stop				Function		

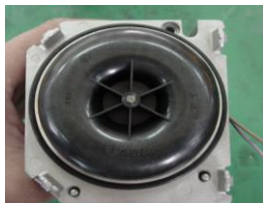
▶ Data Analysis - TQ / 2008 / D 2.5 CRDI / ENGINE							
Vehicle Speed Sensor	0	km/h					
Actual Vehicle Accelerator	0.0	m/s2					
Shift Position(Only A/T)	0	-					
Engine Speed	780	RPM					
Engine Load	23	%					
Engine Torque	22.4	Nm					
▶ Actuation Test							
VGT Actuator		<div>Duration Until Stop Button</div> <div>Condition IG. ON/ENG.OFF</div> <div>Result</div>					
Exhaust Gas Recirculation Solenoid Valve							
Throttle Valve Actuator							
Fuel Pressure Regulator Valve(Pump)							
Fuel Pressure Regulator Valve(Rail)							
O2 Sensor Heater							
Start	Stop					Function	

Burner Type Heating System Layout



TQ - ENGINE

Burner



Combustion air fan



Internal temp. sensor

Air-inlet

Evaporator

Warm water outlet

Water-inlet

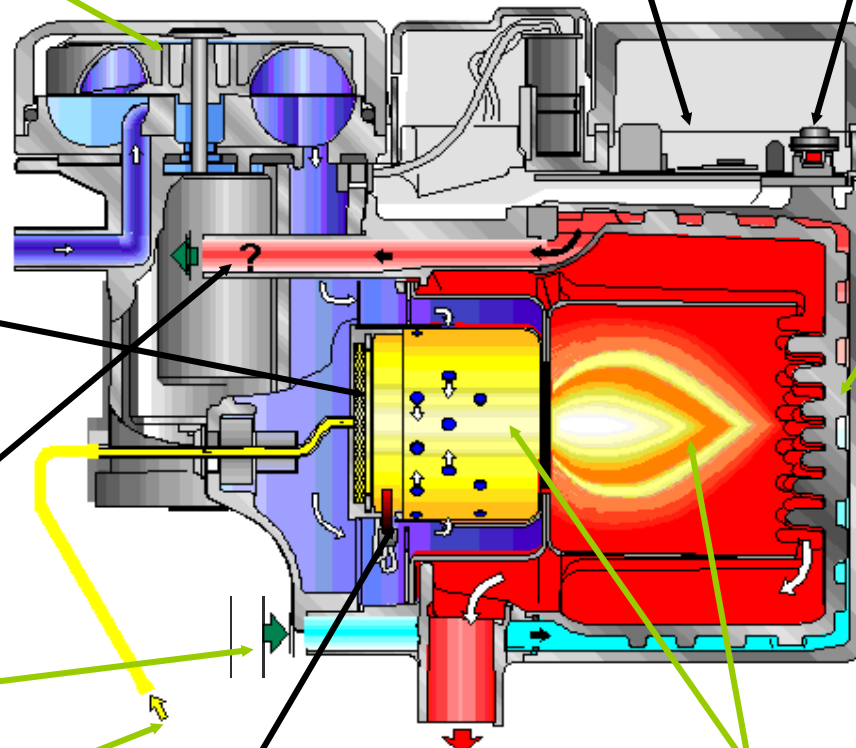
Fuel inlet by dosing pump

Glow plug

Exhaust gas out

Burning chamber

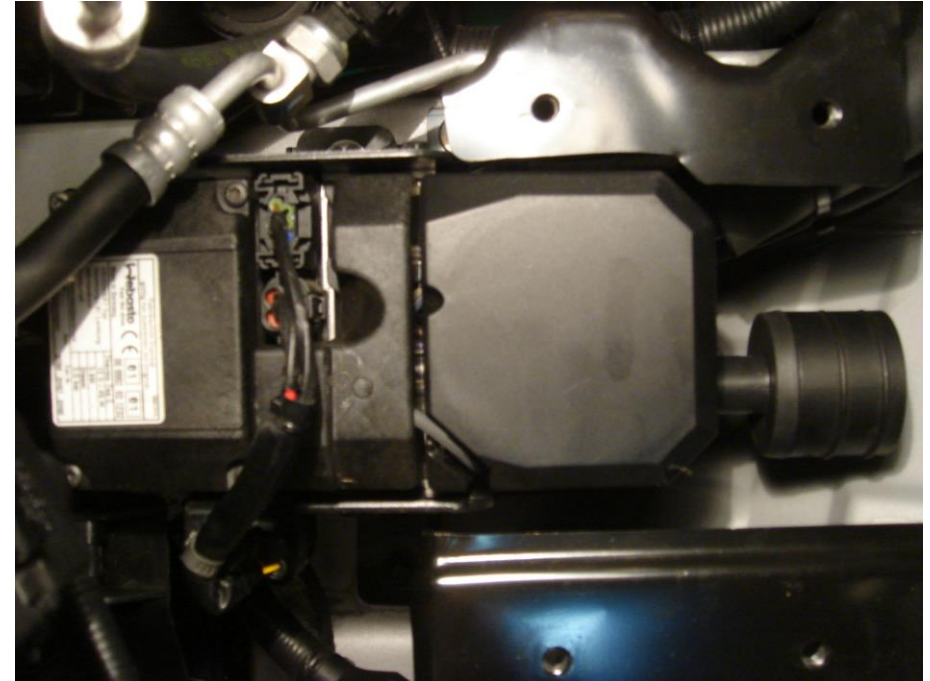
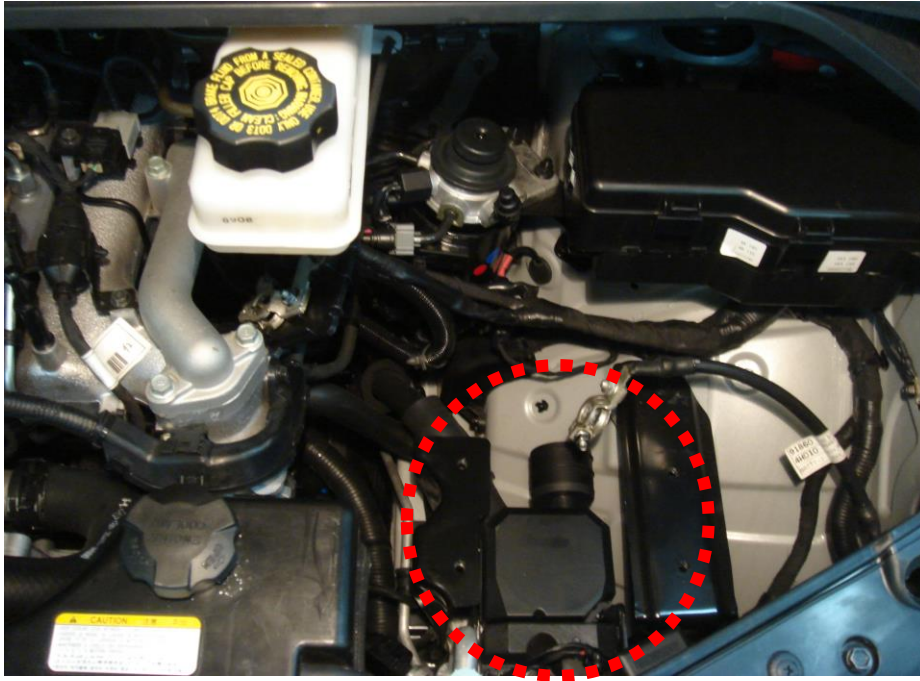
Heat-exchanger



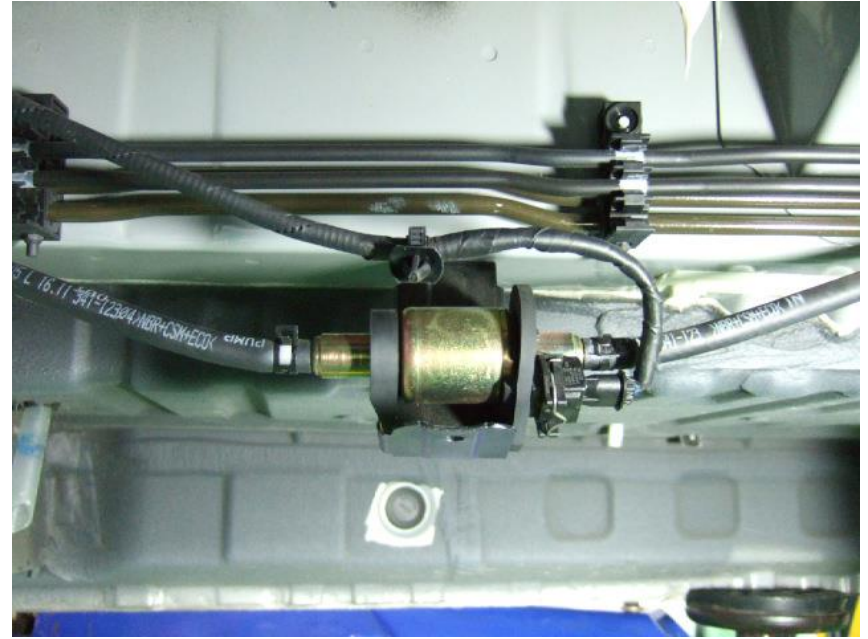
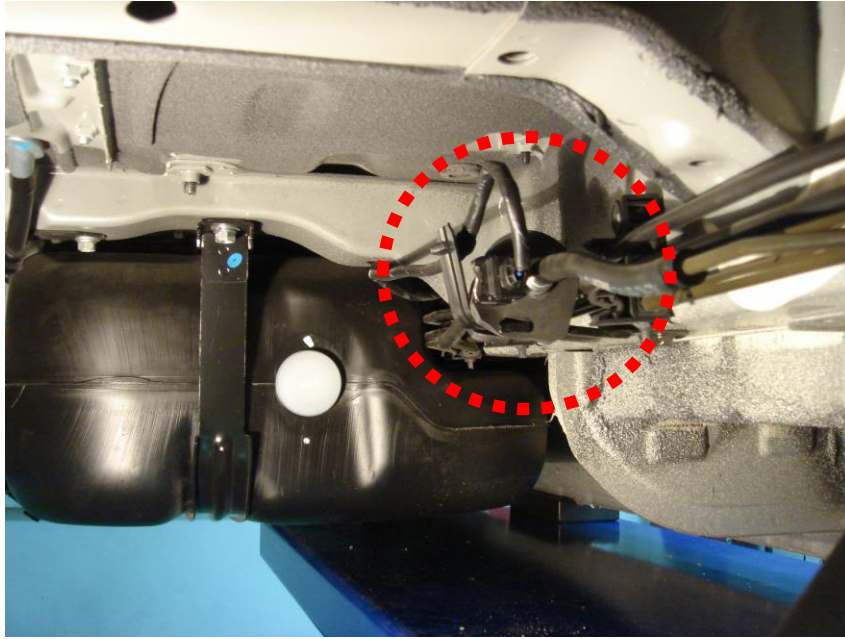
TQ - ENGINE

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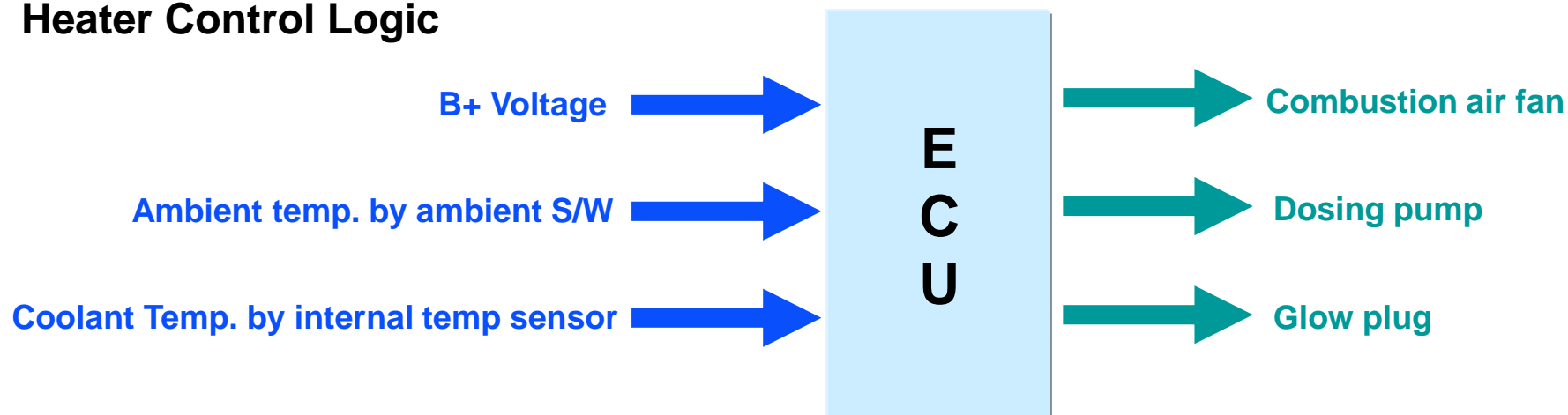
Burner Type Heating System Location - Burner



Burner Type Heating System Location – Dosing Pump (Fuel Motor)



Heater Control Logic



Operating Condition

1. Operating condition : below coolant temp. 78°C & ambient temp. 2°C
2. Working procedure
 - ① Cleaning : combustion air fan & glow plug on (for 30sec)
 - ② Pre-filling : dosing pump on (for 3sec)
 - ③ Combustion : glow plug, combustion air fan, dosing pump on (for 121sec)
 - ④ Full load : combustion air fan, dosing pump 100% on

Specification	Full mode	Half mode
Heater capacity	5.0kW	2.5kW
Power consumption	0.63l/h	0.32l/h
Fuel consumption	37W	13W

Off Condition

1. When engine off

- ① Dosing pump stop
- ② Cleaning operating : burn out remain fuel inside burner 100%, combustion air fan & water pump on
- ③ Other parts are stopped

2. When coolant temp. over 78°C

- ① Dosing pump stop
- ② Cleaning operating : burn out remain fuel inside burner 100%, combustion air fan & water pump on
- ③ Water pump working but other parts are stopped

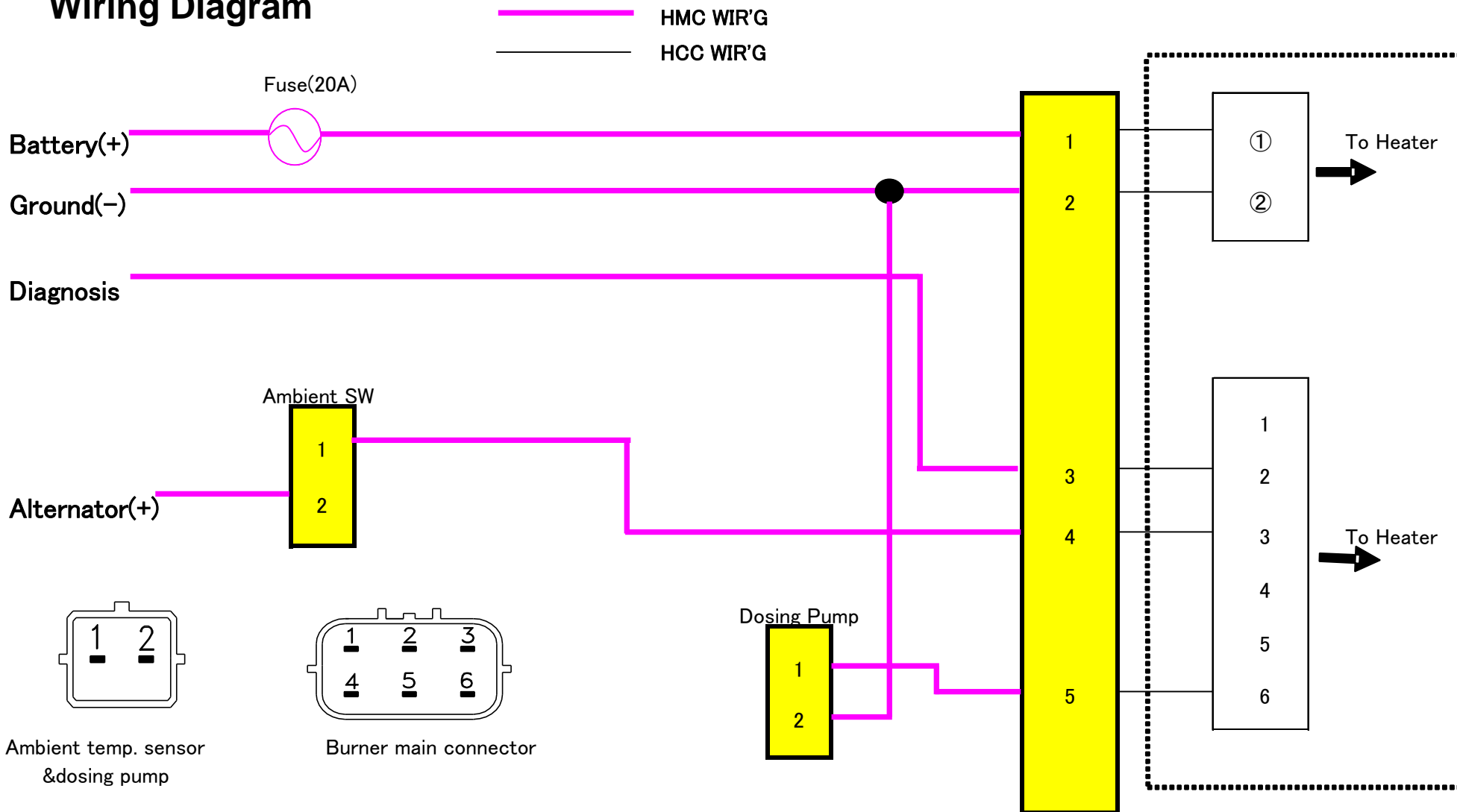
What is cleaning

**** Purpose of cleaning : Burning out remain fuel and foreign material after combustion then emit exhaust gas**

※ When engine off burner operating noise can be occurred but that is normal sound (cleaning sound)

- Engine off during full load operation : cleaning time – **175 sec**
- Engine off during half load operation : cleaning time – **100sec**

Wiring Diagram



DTC & Data Analysis

► DTC Analysis - TQ / 2008 / D 2.5 CRDI / BHEATER

No DTC present at this time.

► Data Analysis

Engine Coolant Te...	44.00	°C	Operating Voltage	14.1	V
Under Voltage Thr...	9.5	V	Combustion Air Fan...	0	%
Dosing Pump Status	0	%	Glow Plug Status	0	%
Combustion Air Fan	OFF	-	Glow Plug	OFF	-
Dosing Pump	OFF	-	Vehicle Air Fan	OFF	-

Tips Fix Normal Graph Record Function

Actuation Test

► Data Analysis - TQ / 2008 / D 2.5 CRDI / BHEATER

Engine Coolant Temperature Sensor	50.00	°C
Operating Voltage	14.0	V
Under Voltage Threshold	9.5	V
Combustion Air Fan Status	0	%
Dosing Pump Status	0	%
Glow Plug Status	0	%

► Actuation Test

Heating	Duration	Until Stop Button
Water Pump	Condition	ENG. RUN
Combustion Air Fan	Result	
Glow Plug		
Dosing Pump		
Prefilling		

Tips Fix Full Graph Record Function



► Data Analysis - TQ / 2008 / D 2.5 CRDI / BHEATER

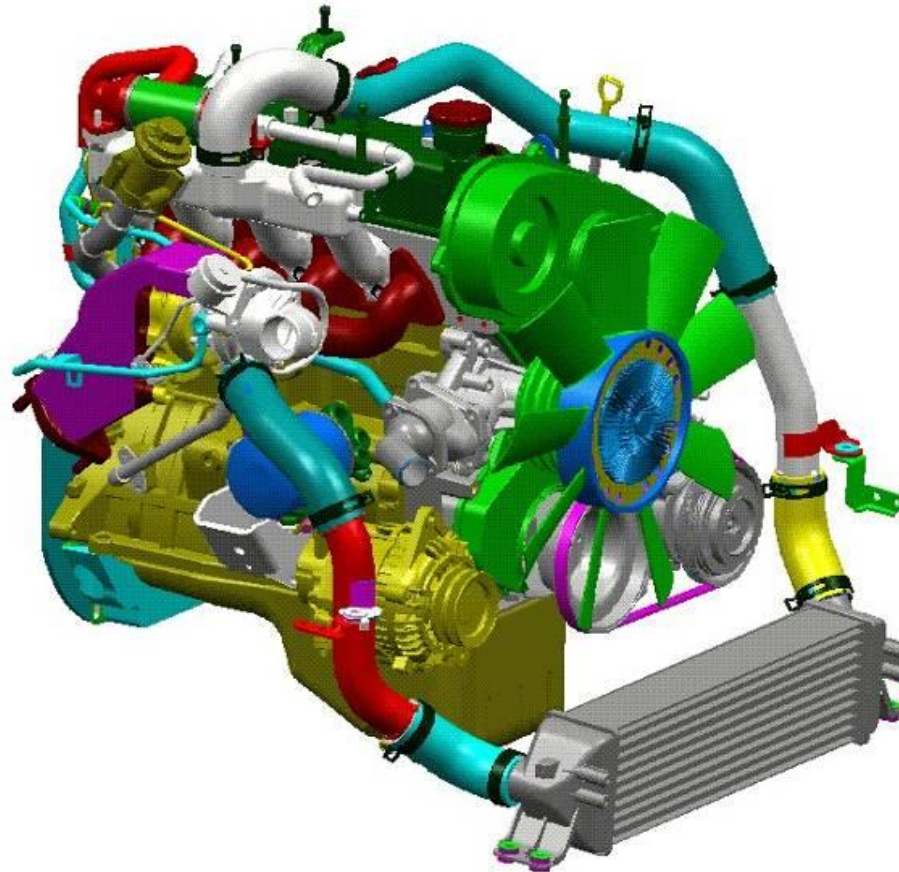
Engine Coolant Temperature Sensor	57.00	°C
Operating Voltage	13.5	V
Under Voltage Threshold	9.5	V
Combustion Air Fan Status	14	%
Dosing Pump Status	0	%
Glow Plug Status	54	%

► Actuation Test

Heating	Duration	Until Stop Button
Water Pump	Condition	ENG. RUN
Combustion Air Fan	Result	FAIL
Glow Plug		
Dosing Pump		
Prefilling		

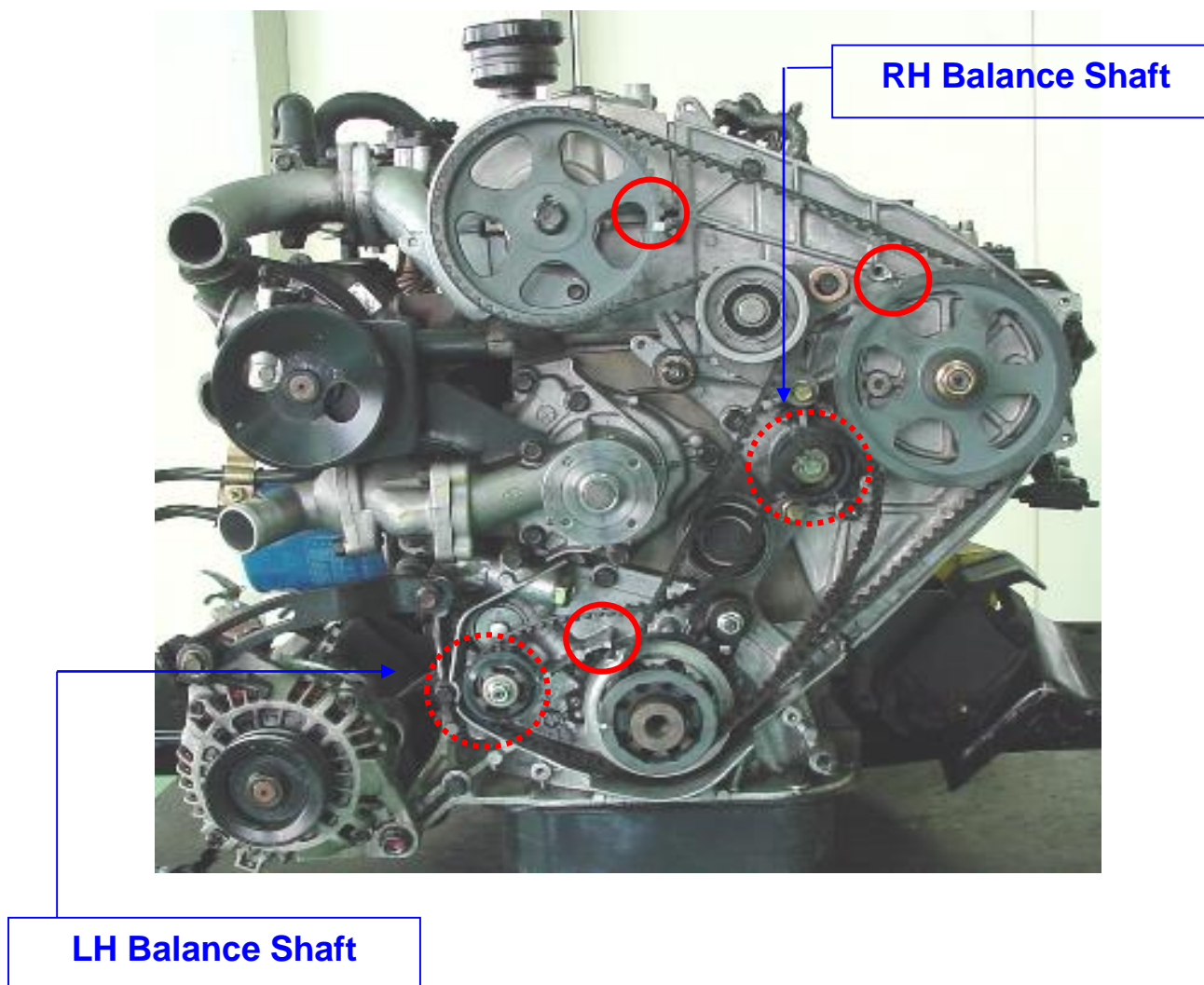
Start Stop Function

D4BH TCI Engine

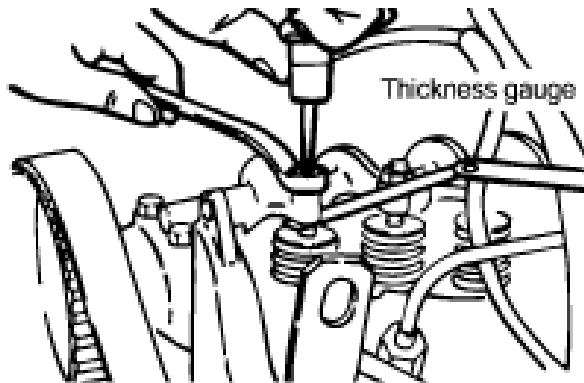
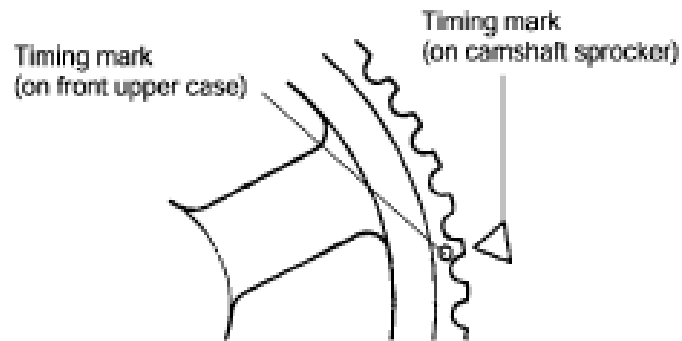


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Timing Belt

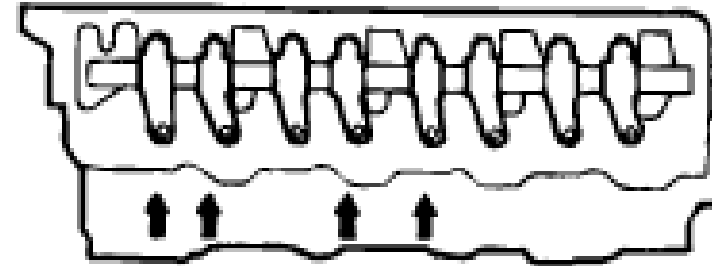


Valve Clearance



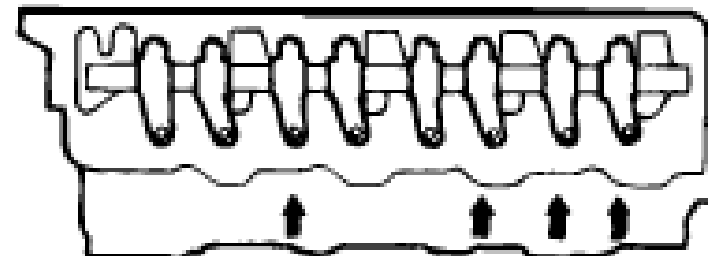
[A]

No. 1 No. 1 No. 1 No. 1
Exh. Int. Exh. Int. Exh. Int. Exh. Int.



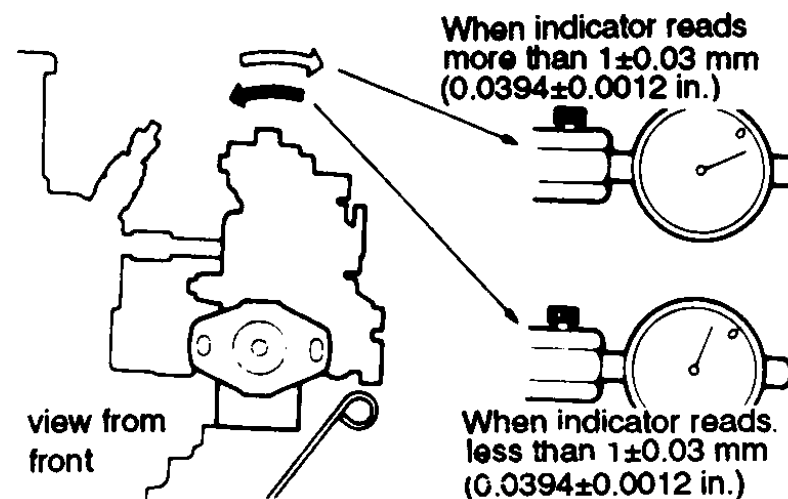
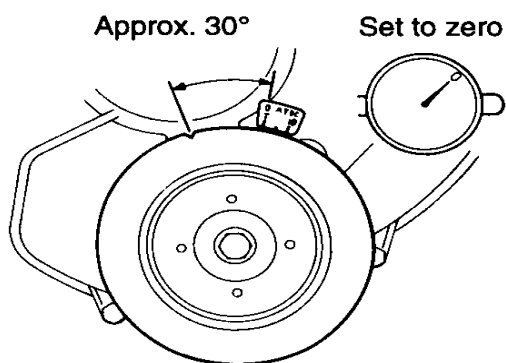
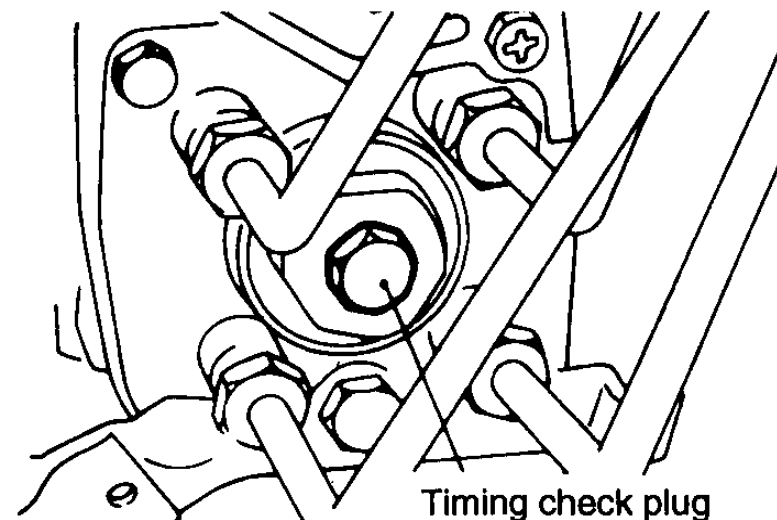
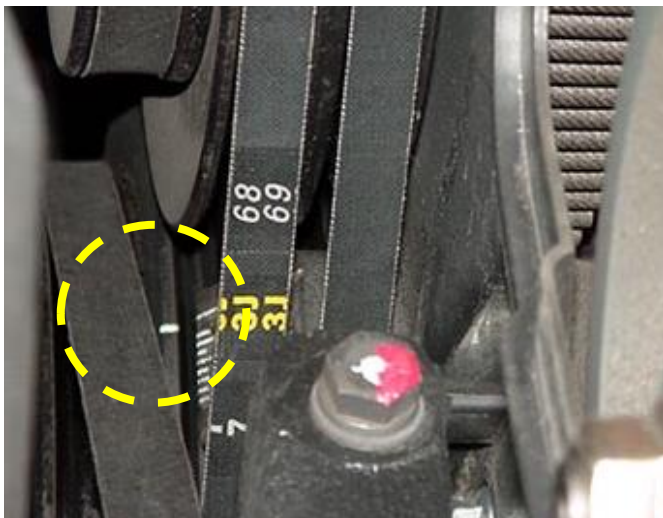
[B]

No. 1 No. 2 No. 3 No. 4
Exh. Int. Exh. Int. Exh. Int. Exh. Int.

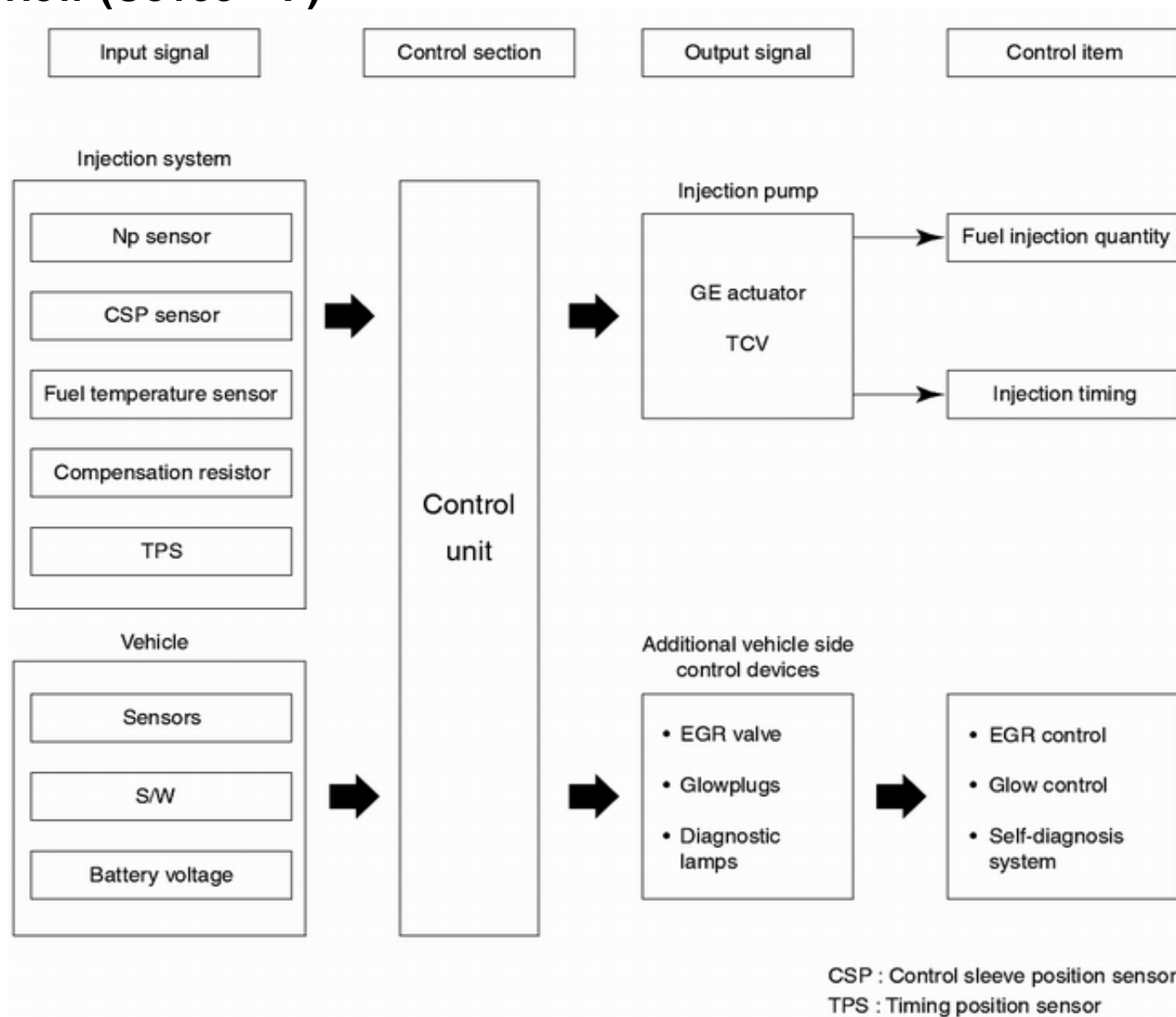


Standard Value : 0.25mm

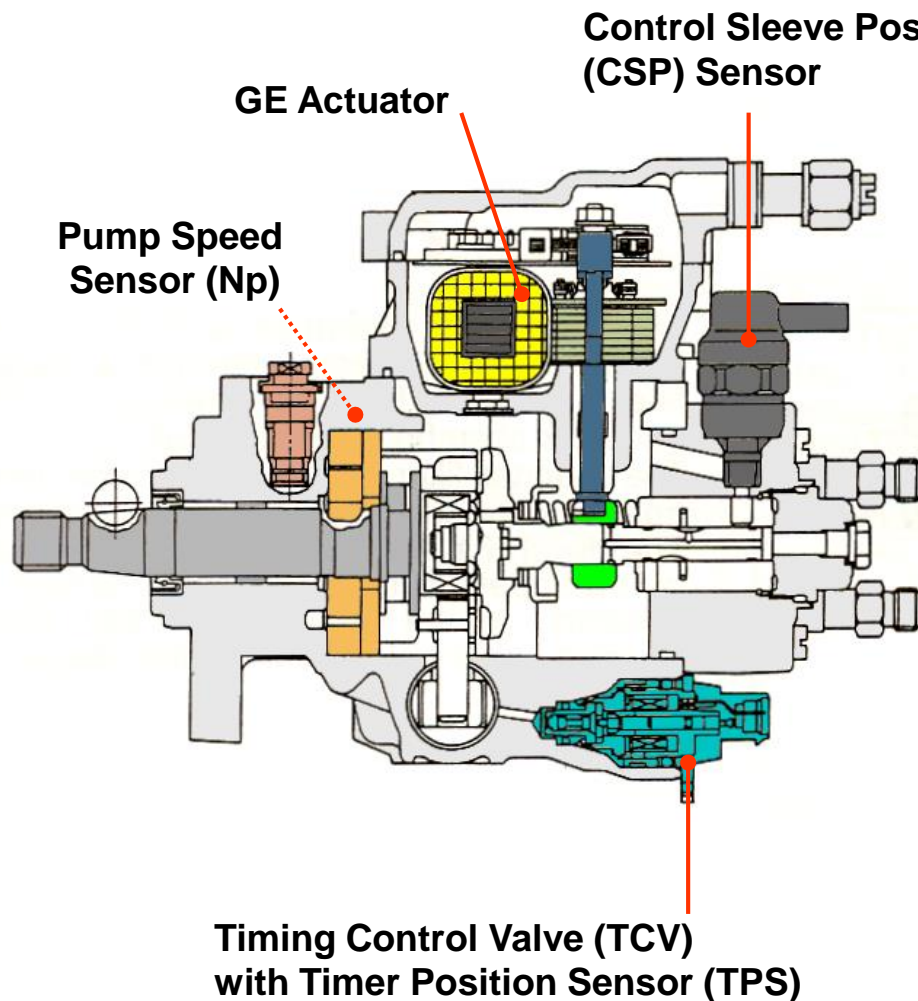
Injection Timing Adjustment



System Overview (Covec – F)



System components



Injection system

- Pump speed Sensor (Np)
- Control Sleeve Position Sensor (CSP)
- Fuel Temp. Sensor
- Compensation Resistor
- Timing Position Sensor

Vehicle

- Sensors
- Switches
- Battery voltage

Engine Control Module

Injection pump

- GE Actuator
- Timing Control Valve (TCV)

Additional Control

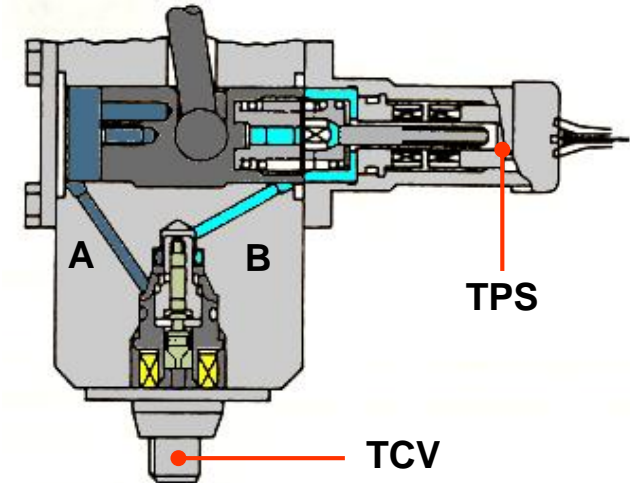
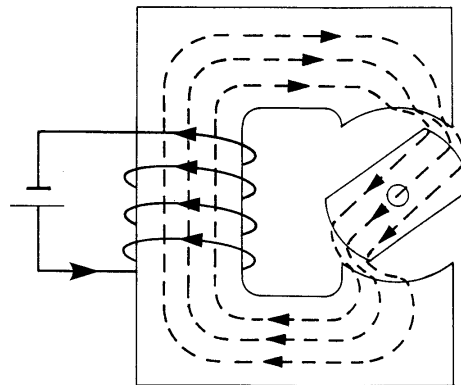
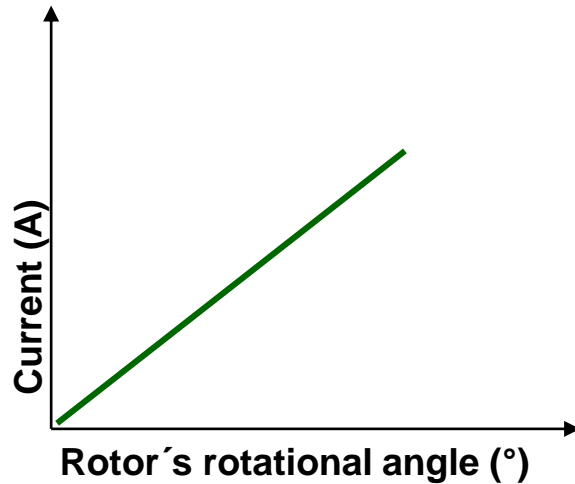
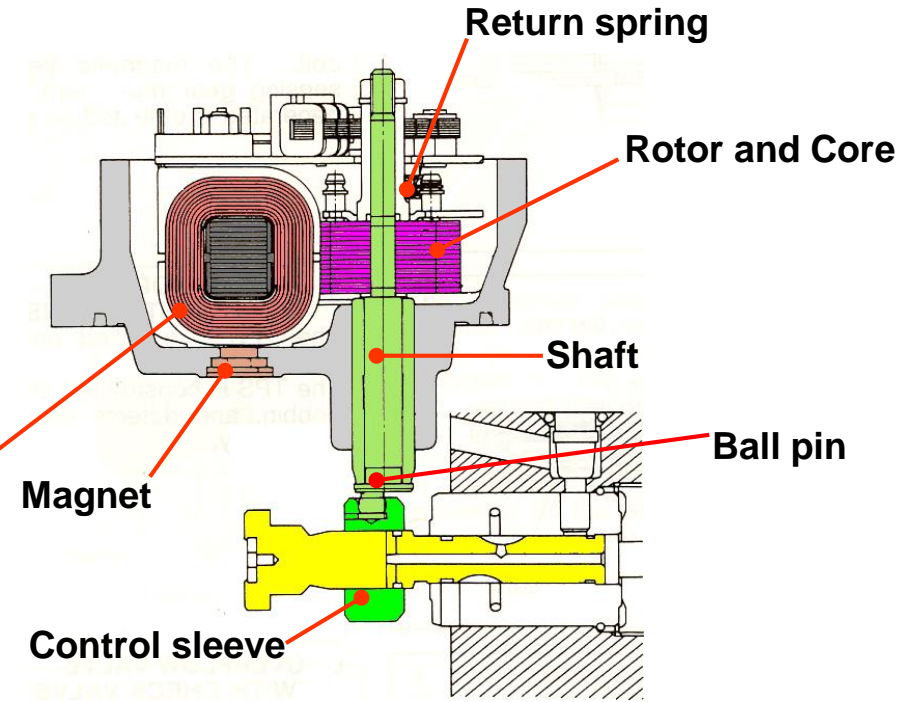
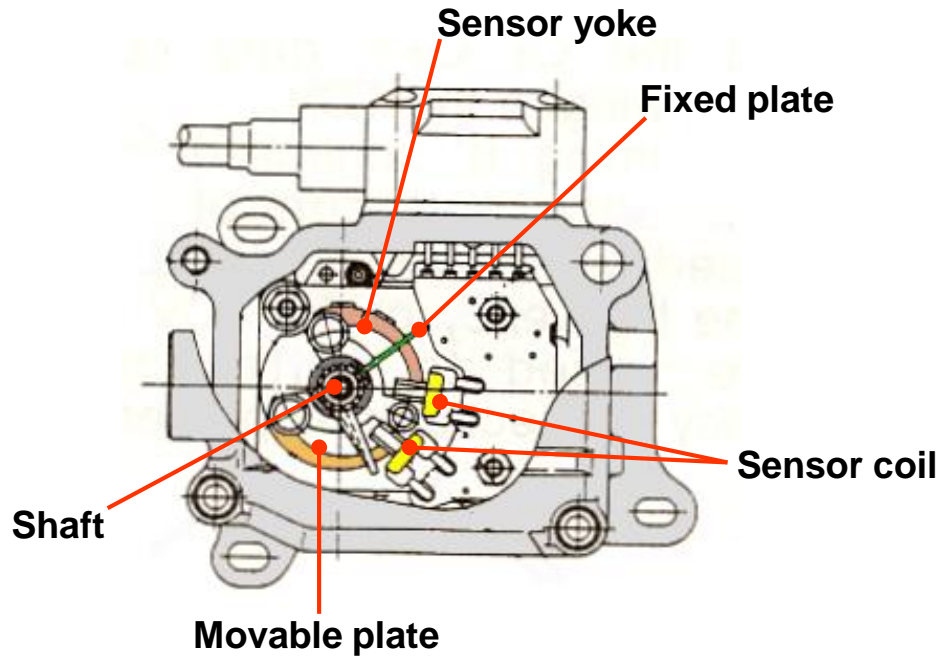
- EGR valve
- Glowplugs
- MIL

- Fuel injection quantity
- Injection timing

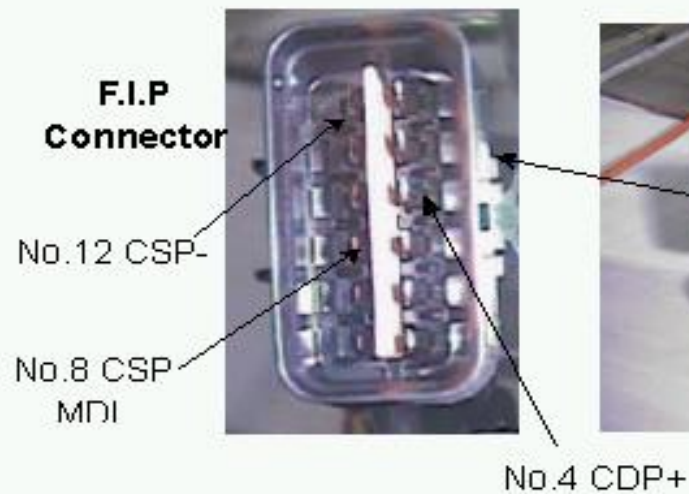
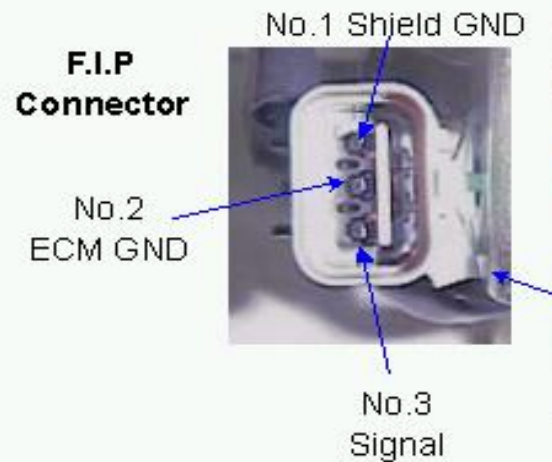
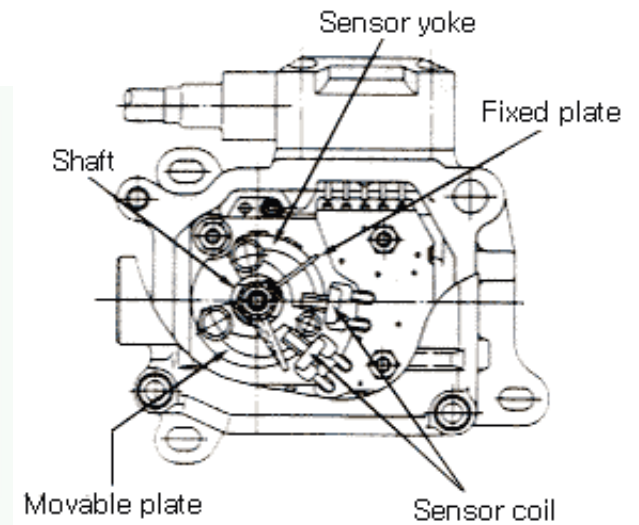
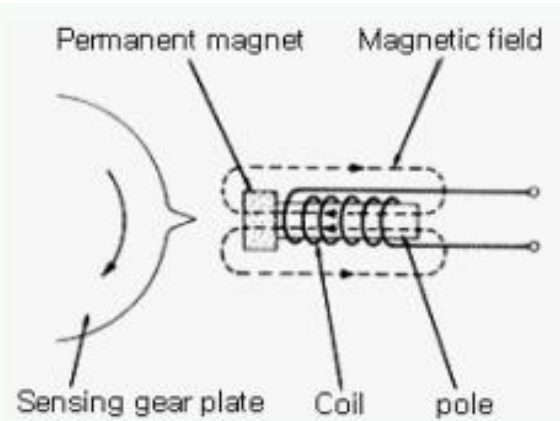
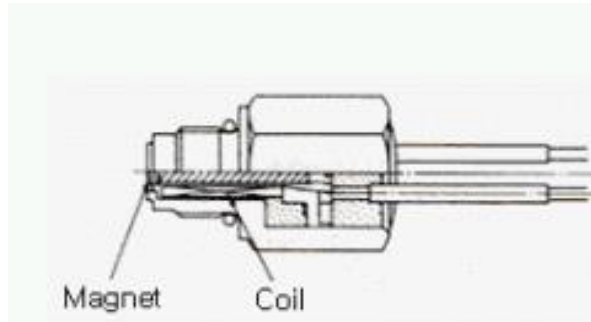
- EGR control
- Glow control
- Diagnosis

TQ - ENGINE

GE - Actuator, TCV and TPS



NP sensor, CSP



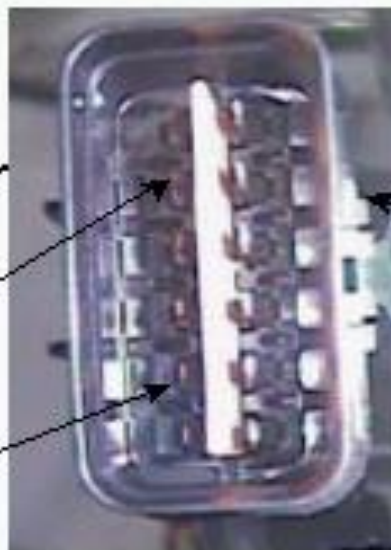
TQ - ENGINE

Fuel Temperature Sensor, Fuel Cut Valve

**F.I.P
Connector**

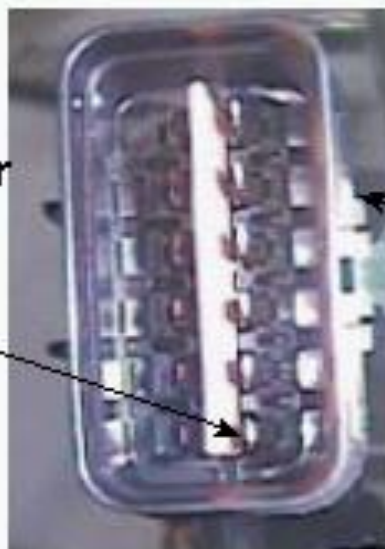
No. 11 Ground

**No. 7 Fuel
temperature
sensor signal**



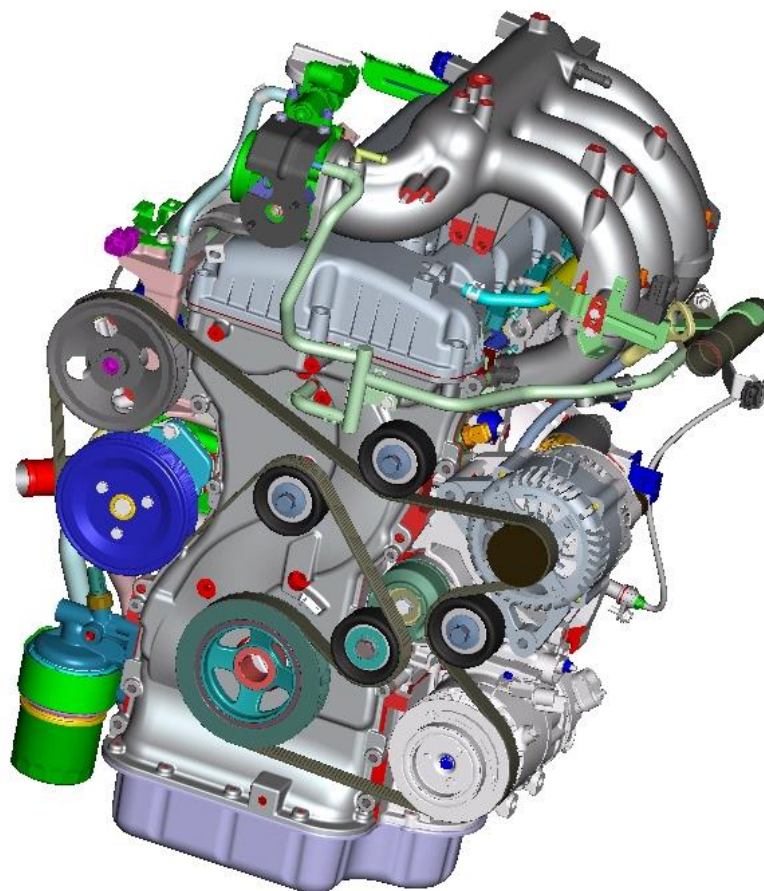
**F.I.P
Connector**

**No.1 FC
Valve**



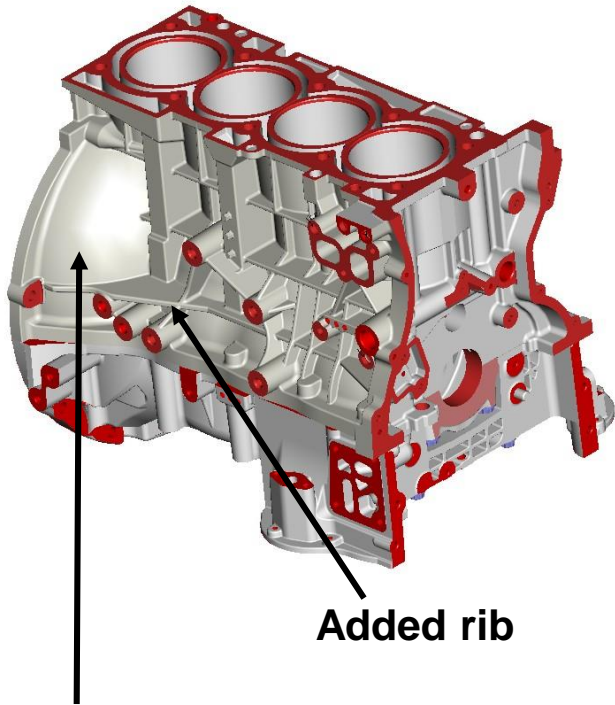
Fuel Cut Valve

Theta 2.4L Engine

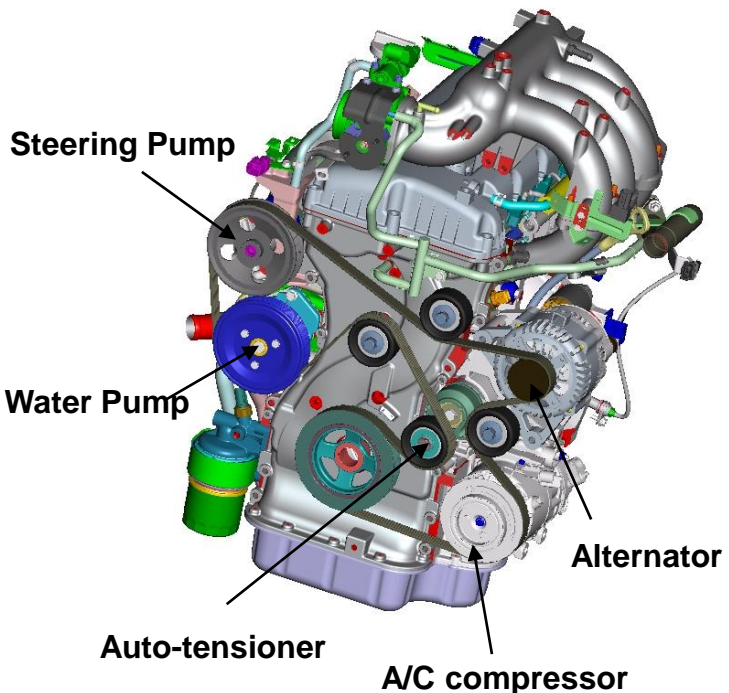


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Changing Items

SYSTEM	Main Features	Figure
Aluminum Block	<p>► Main Feature</p> <ul style="list-style-type: none"> - light weight : Aluminum cylinder block - High Stiffness : Added rib and adopted cone-shaped type cohesion face with T/M → Reduced vibration and noise - FR type theta engine is adopted firstly 	 <p>Added rib</p> <p>Cone-shaped type</p>

Changing Items

SYSTEM	Main Features	Figure
Driving Belt	<p>► Main Features</p> <ul style="list-style-type: none"> - Intake manifold is changed (Plastic → Aluminum) - Throttle body with ISA instead of ETC - MAP is used instead of MAF - Exhaust manifold is changed (Stainless steel → Cast iron) - Location of Oil filter is changed - Alternator and steering pump are moved - Reduce tension of driving belt 	 <p>Steering Pump</p> <p>Water Pump</p> <p>Auto-tensioner</p> <p>A/C compressor</p> <p>Alternator</p>