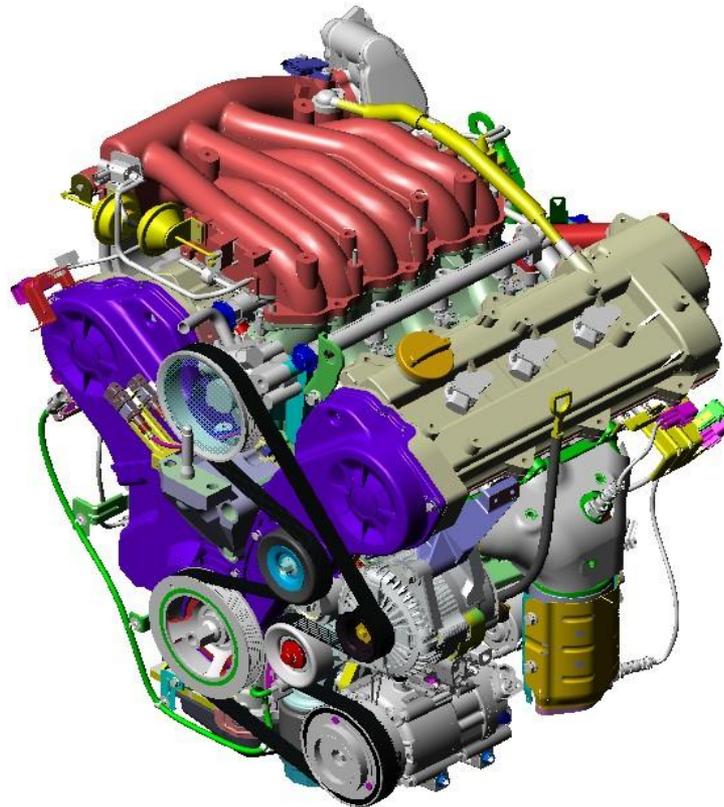
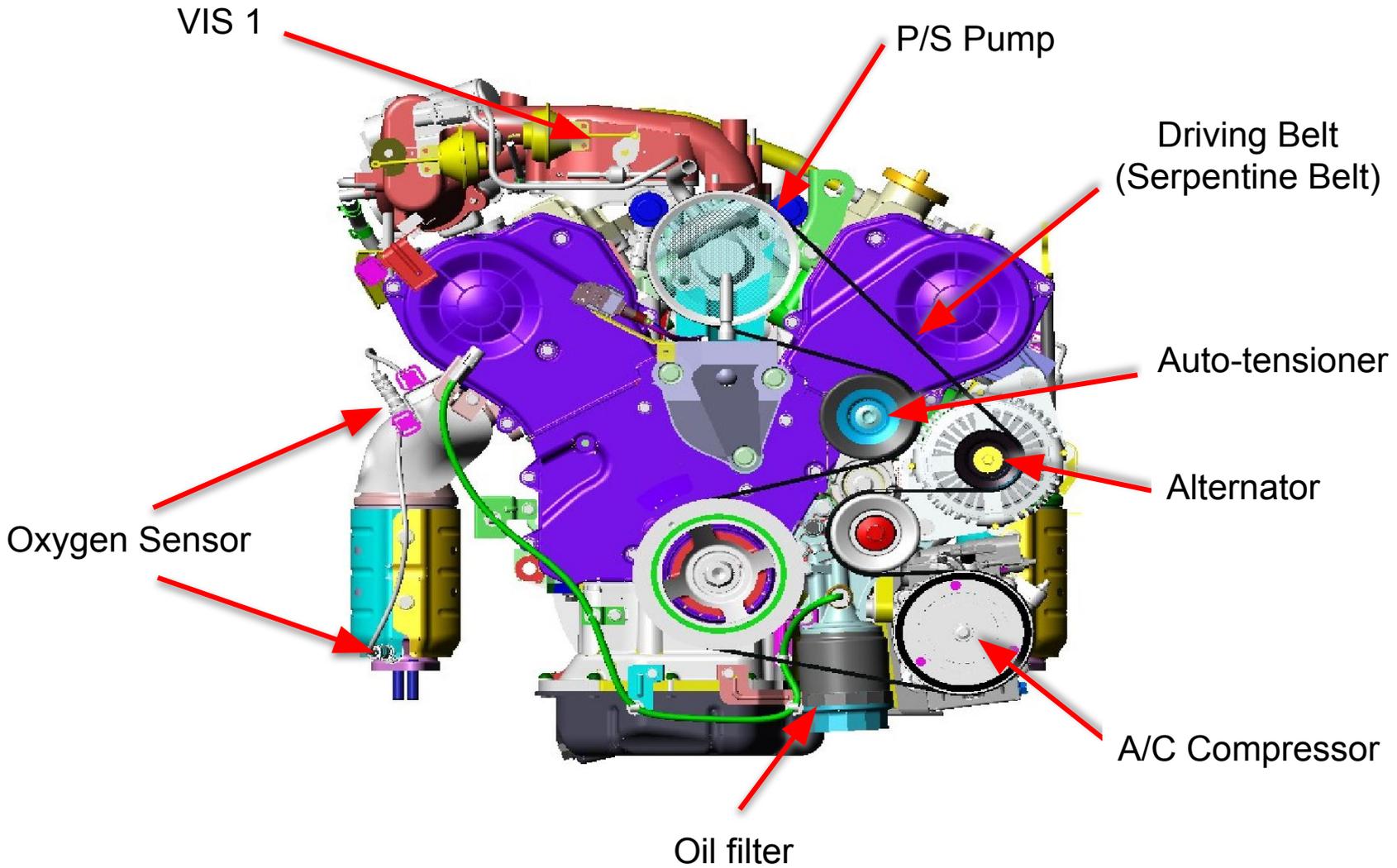
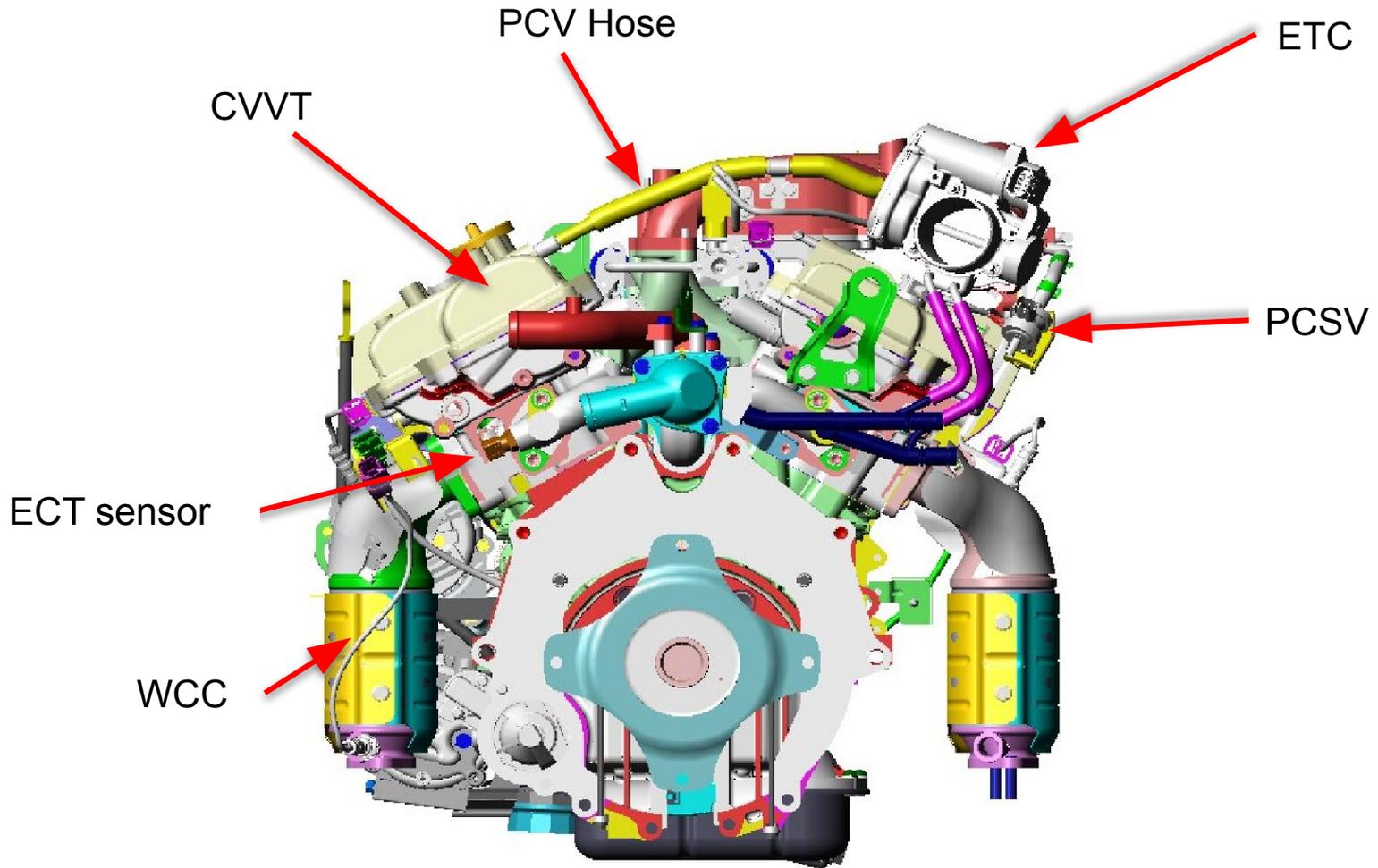
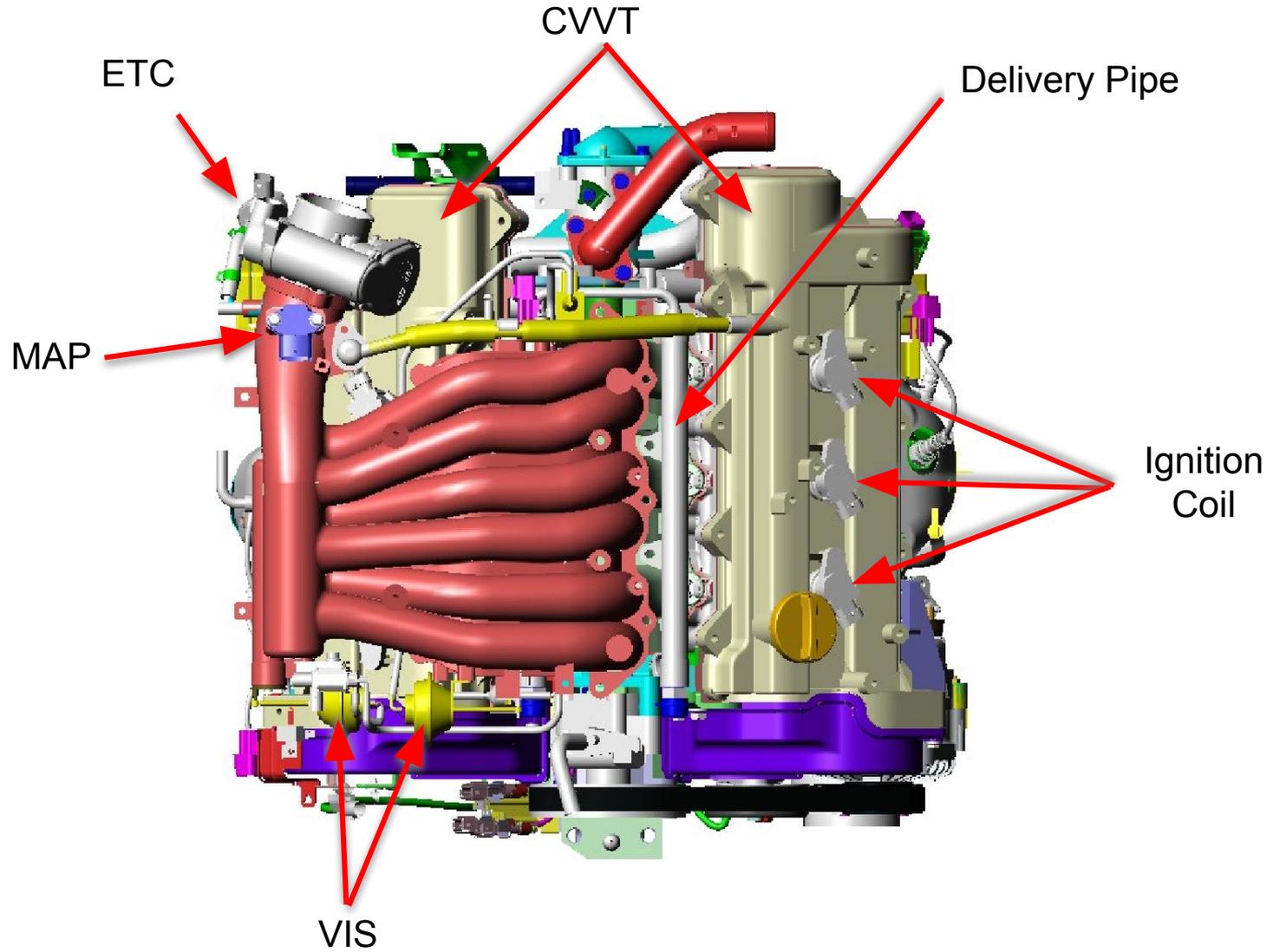


CM MU(μ)

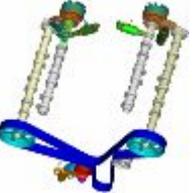
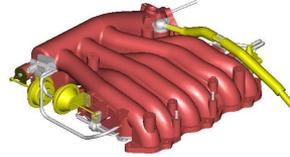
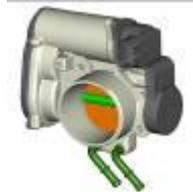


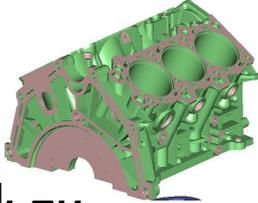
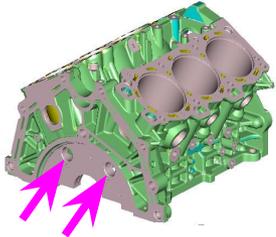
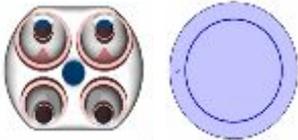
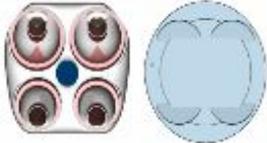


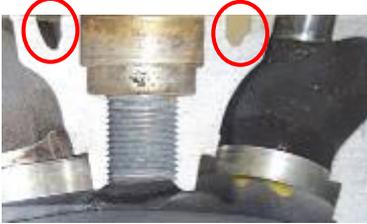
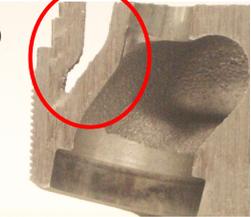


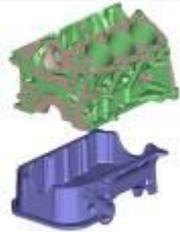
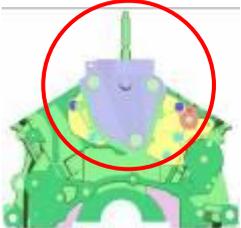
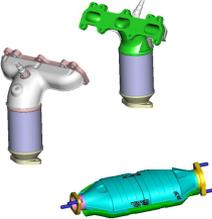
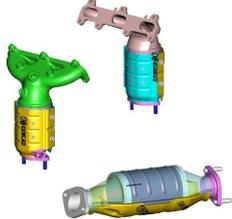
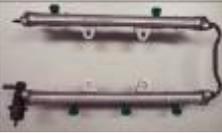
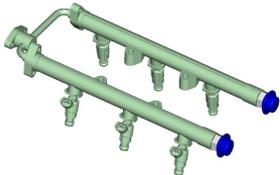


Contents	μ- 2.7	Contents	μ- 2.7
Capacity(cc)	2,656	Fuel pressure (kg/cm ²)	3.8
Compression Ratio	10.4	Fuel tank (L)	75
Camshaft type	DOHC(4 Valve)	Ignition timing	BTDC 10° ± 5
Max. Power (Ps/rpm)	192/6,000	Thermostat open/max	82 °C / 95 °C
Max. Torque (Kg.m/rpm)	25.5/4,200	Engine Oil (L)	4.5
Idle speed (rpm)	650±100	Engine Coolant (L)	8.2
Bore(mm) × Stroke(mm)	86.7 × 75	Ignition order	1-2-3-4-5-6
Valve system	MLA(Shim-less)	Cooling system	Inlet control
ETC	Standard	Oxygen Sensor	Zirconia
EMS	Delphi		

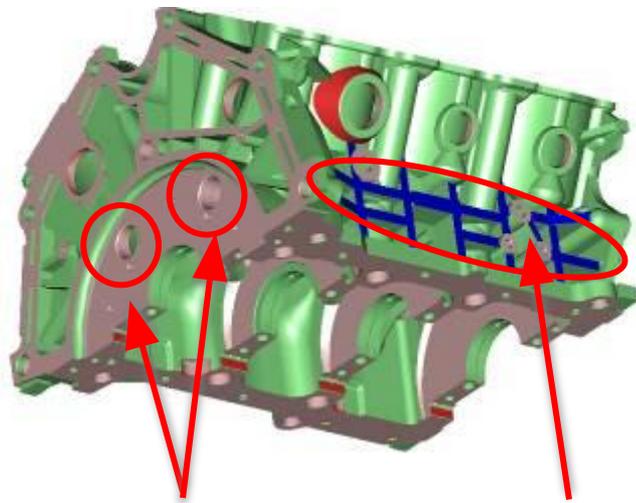
Changed Item		DELTA	MU
Appearance			
Performance, fuel consumption	Valve Train	<ul style="list-style-type: none"> • Non-CVVT • HLA 	<ul style="list-style-type: none"> • CVVT • MLA • Duplex +Tensioner 
	Intake	<ul style="list-style-type: none"> • VIS : 3 step 	<ul style="list-style-type: none"> • VIS : 3 step 
		<ul style="list-style-type: none"> • Throttle Body 	<ul style="list-style-type: none"> • ETC 

Changed Item		DELTA	MU
Performance, fuel consumption	Ignition Coil	<ul style="list-style-type: none"> • 2 Tower type 	<ul style="list-style-type: none"> • Cigar type 
	C/BLOCK : Less pumping loss	<ul style="list-style-type: none"> • No hole on BULKHEAD 	<ul style="list-style-type: none"> • <u>2 holes</u> on BULKHEAD 
	Compression Ratio (CR) & Squish Area	<ul style="list-style-type: none"> • CR=10.0  <p>SQUISH : IN/EX direction</p>	<ul style="list-style-type: none"> • <u>CR=10.4</u>  <p>SQUISH : IN/EX & , <u>FRT/RR</u> direction</p>
	Piston	<ul style="list-style-type: none"> • Piston load : 5.3kgf (Sn coating) 	<ul style="list-style-type: none"> • Piston load : 3.3kgf (Sn coating + <u>Graphite</u> coating) 

Changed Item		DELTA	MU
Cooling	Cylinder Head (Long reach spark plug)	<p>Spark plug size : M14X19</p> 	<ul style="list-style-type: none"> • <u>Water jacket size up</u> (Spark plug size : M14X<u>26.5</u>) <p>Size-up</p> 
Reliability	Alternator position	<ul style="list-style-type: none"> • Cabin side 	<ul style="list-style-type: none"> • Front side 
Cost Down	ECM	<ul style="list-style-type: none"> • Separated ECM/TCM 	<ul style="list-style-type: none"> • Integrated ECM/TCM 

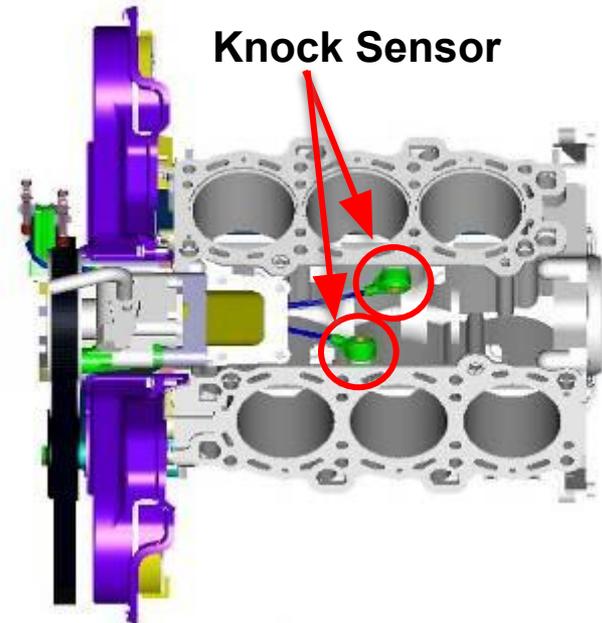
Changed Item		DELTA	MU
Noise	Increased P/T combine force		<ul style="list-style-type: none"> • Reinforced block (More RIBs) 
	Engine Support Bracket		
Emission	Catalytic Converter	<ul style="list-style-type: none"> • WCC; 2*0.5ℓ • Oval UCC (2*0.9ℓ) 	<ul style="list-style-type: none"> • WCC; 2*0.6ℓ • COVER added • Round UCC (2*0.76ℓ) 
	Fuel pipe	<ul style="list-style-type: none"> • Return type 	<ul style="list-style-type: none"> • Returnless ty 

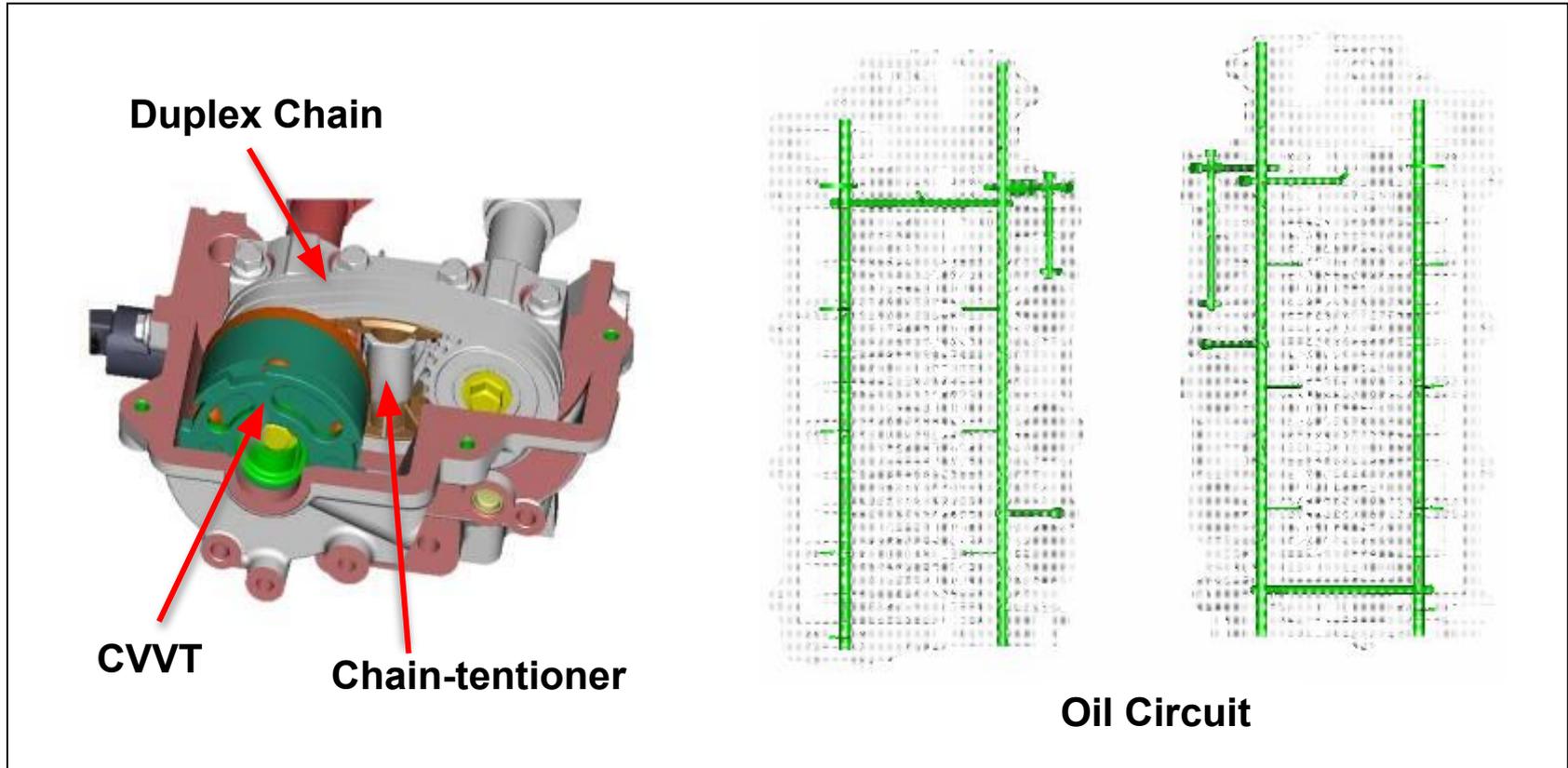
- ▶ Press Fit type liner (Aluminum block)
- ▶ 2 Ventilation Holes – Decreased pumping loss



2 Ventilation Holes

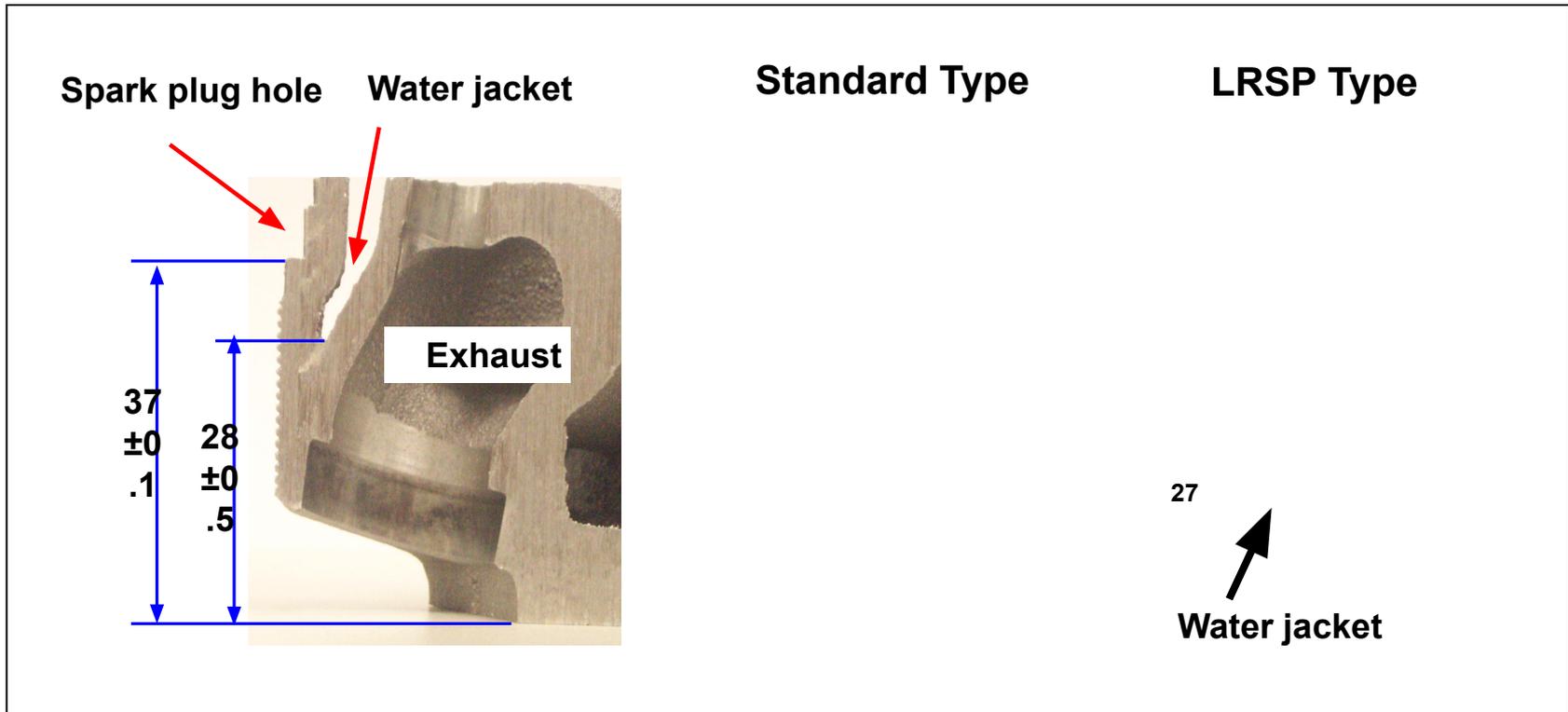
Added ribs





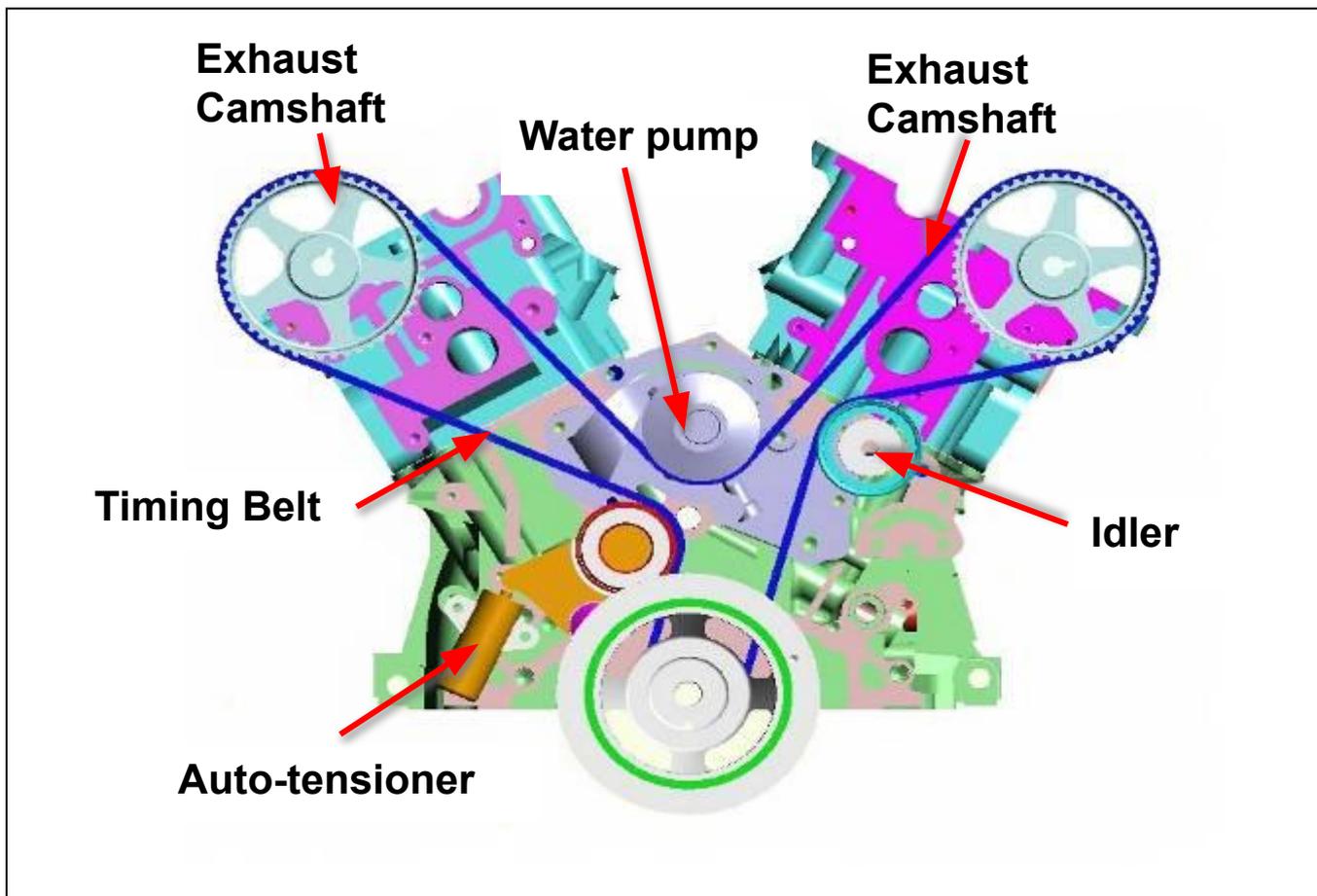
▶ Oil circuit for CVVT (Improved response)

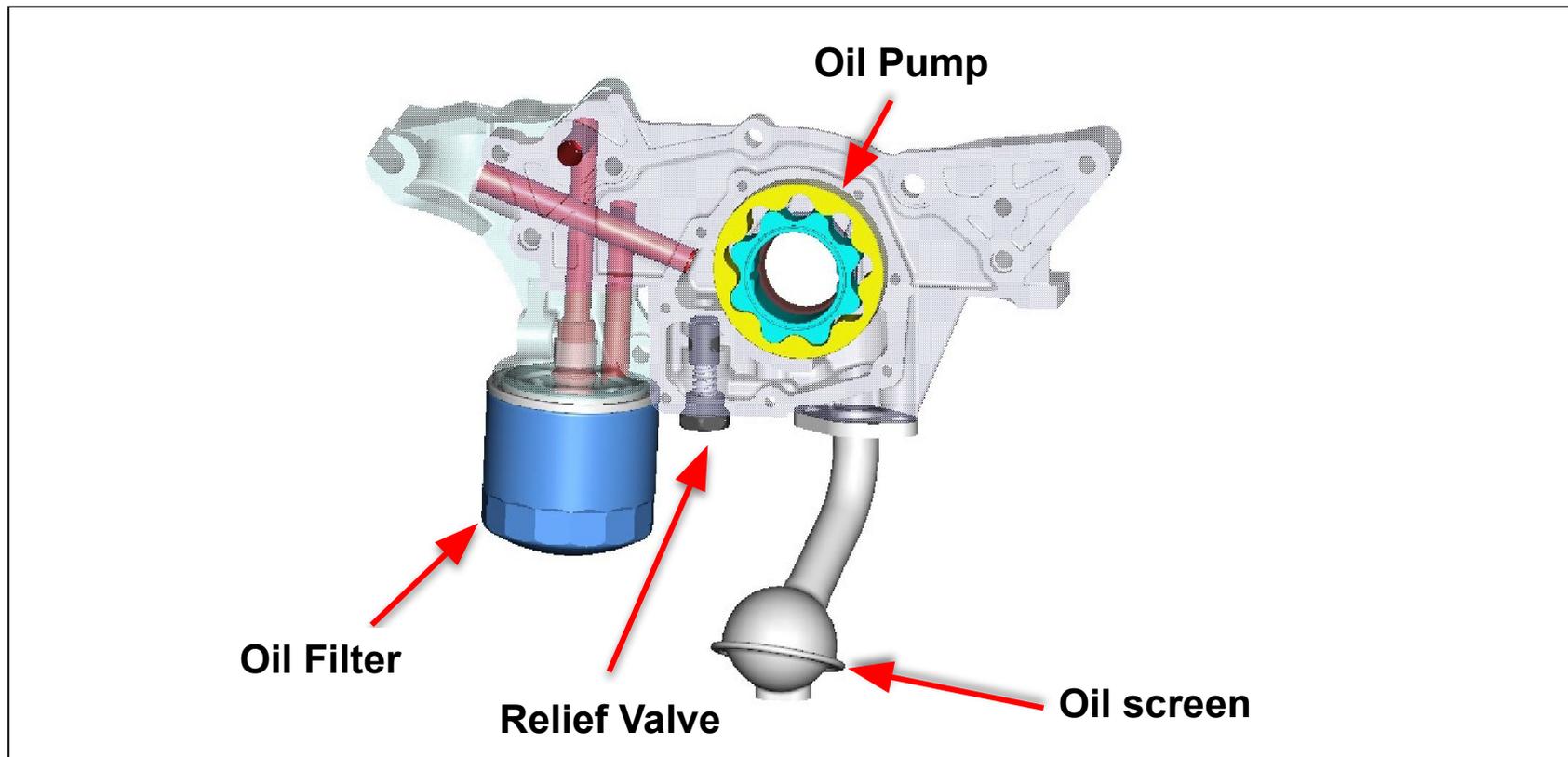
▶ Oil circuit for chain tensioner



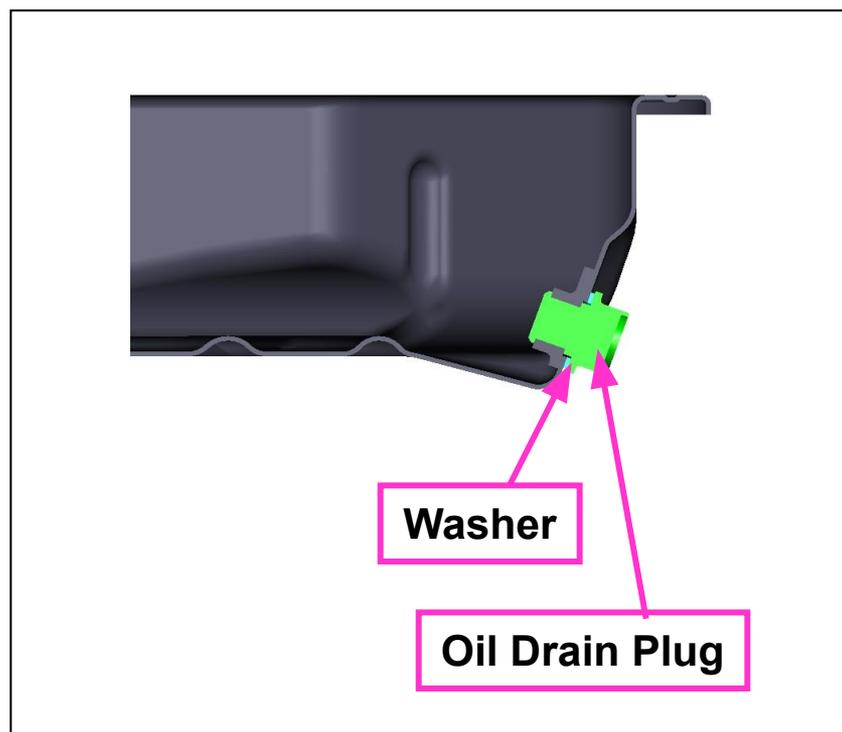
- ▶ **Changed Water Jacket : Improved a cooling efficiency
(Increased valve durability)**
- * **LRSP : Long Reach Spark Plug**
- ▶ **Iridium spark plug (Durability :10 years, 100,000 mile)**

- ▶ Connected crankshaft and exhaust camshafts
- ▶ Timing Belt – Improved durability and reduced noise



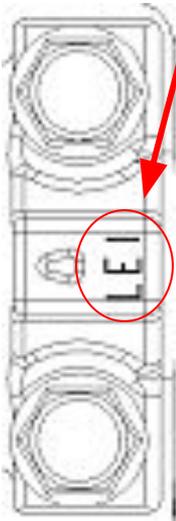
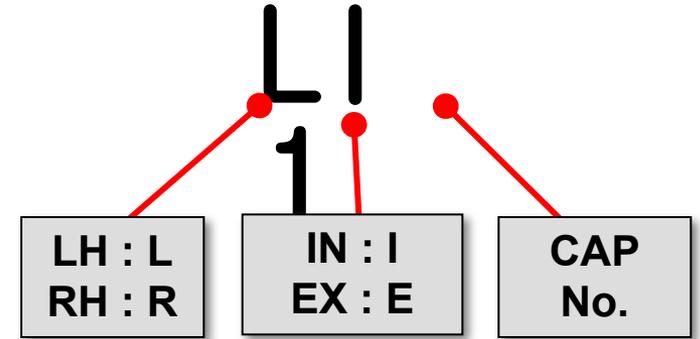
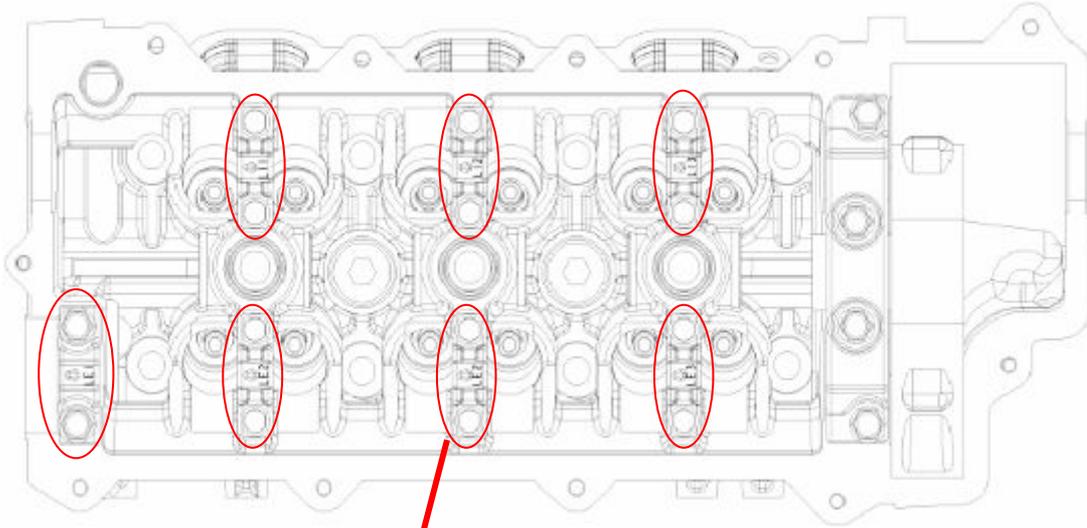


- ▶ **Connected with crankshaft**
- ▶ **Oil pressure at idle (hot condition) : around 1 bar**
- ▶ **Relief valve : 5.5 ± 0.5 bar**

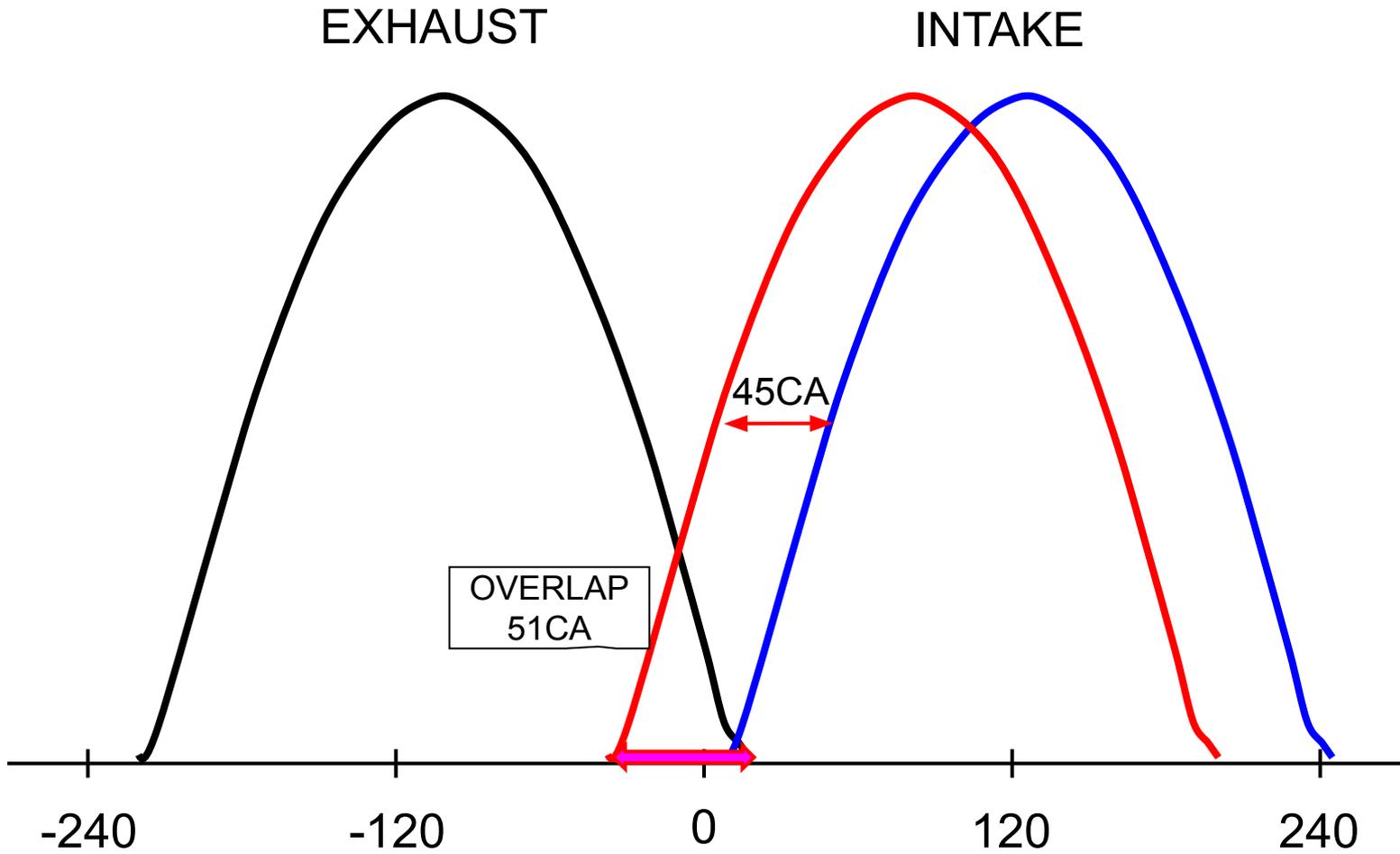


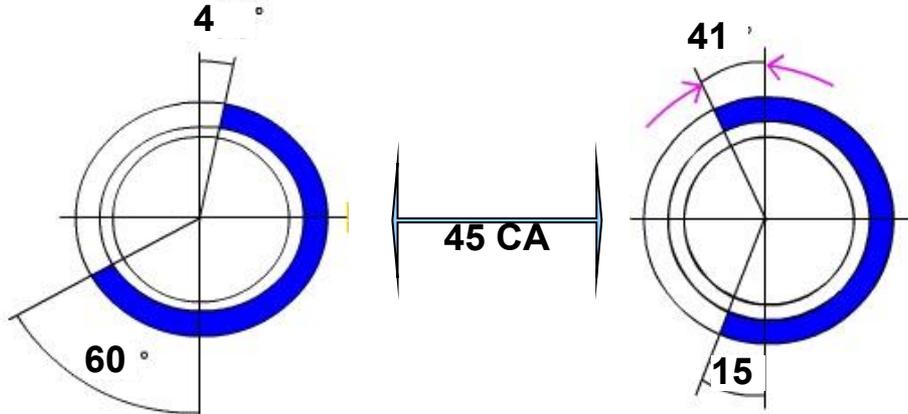
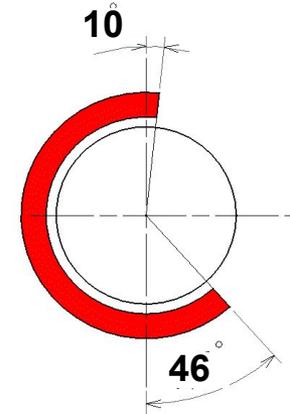
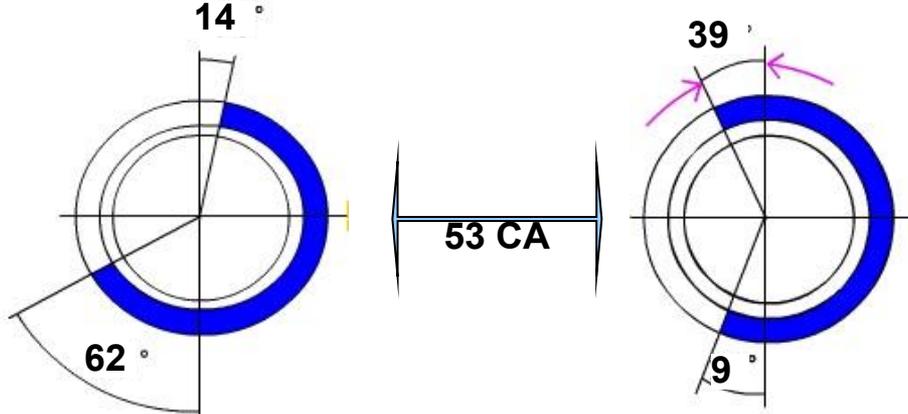
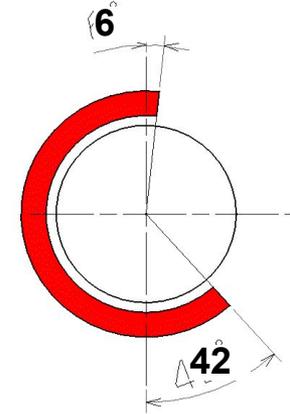
- ▶ - When replacing engine oil, washer must be replaced together
(Supplied oil filter and washer have different parts number)
- Drain Plug tightening torque : 3.5~4.5 Kgf

Camshaft cap

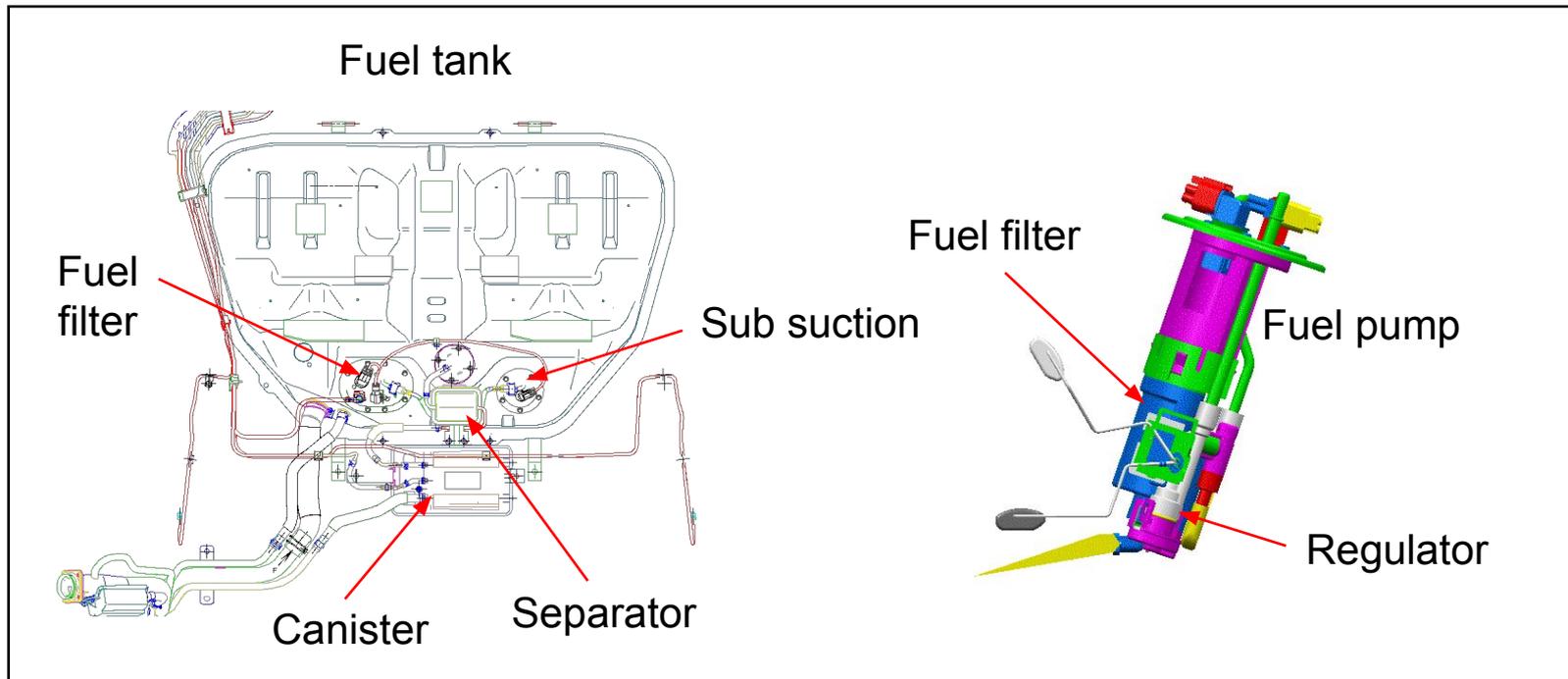
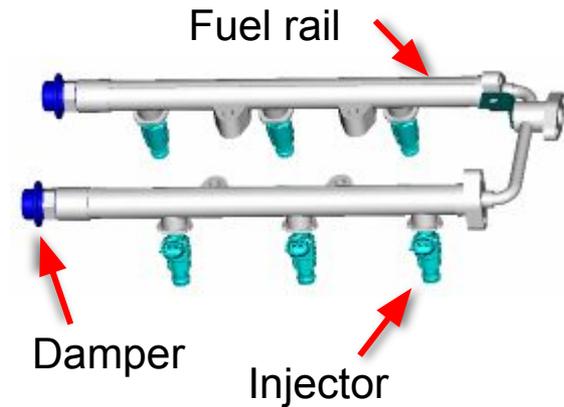


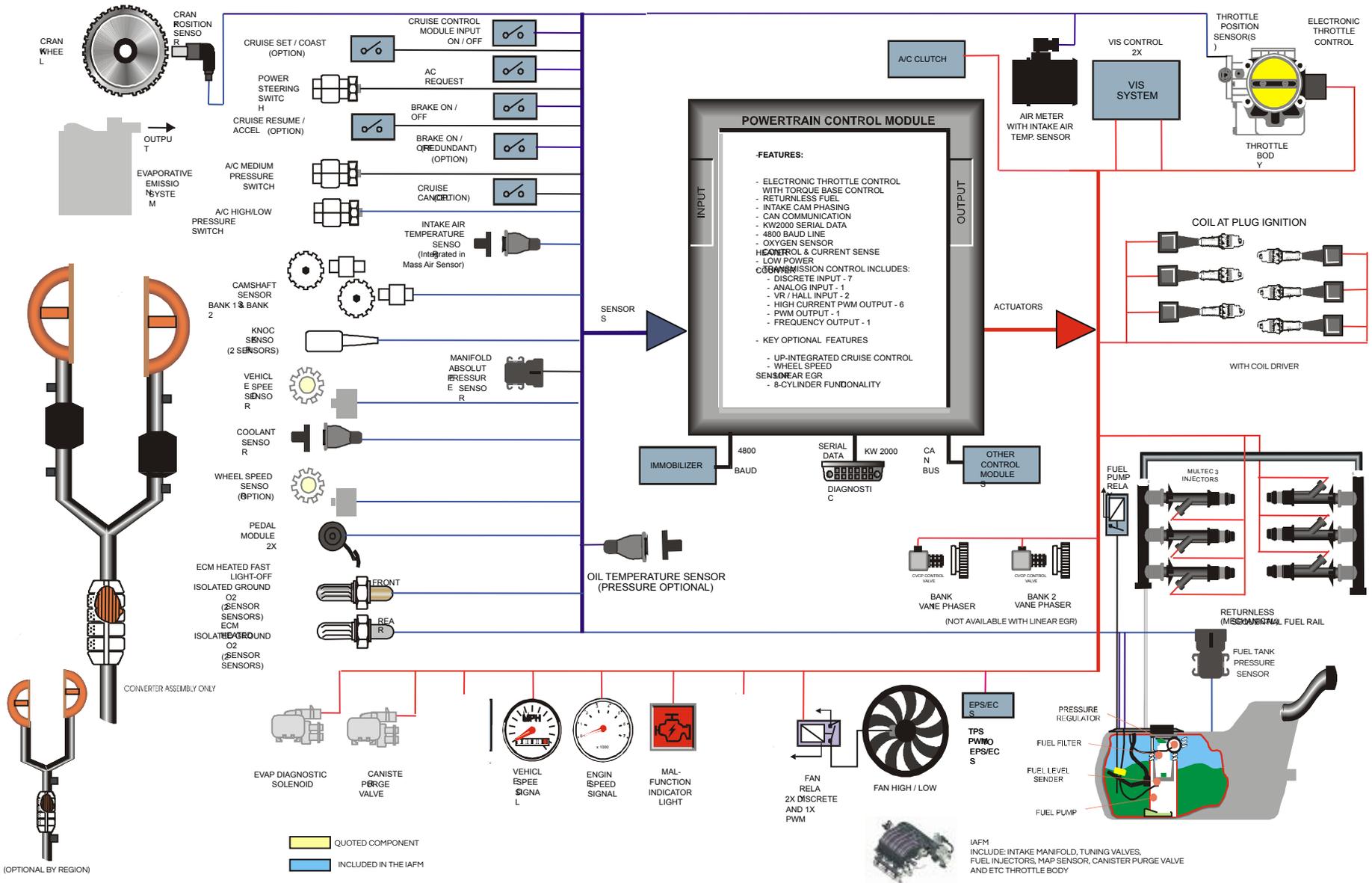
NO	LH		RH	
	IN	EXH	IN	EXH
1	LI1	LE1	RI1	RE1
2	LI2	LE2	RI2	RE2
3	LI3	LE3	RI3	RE3
4	-	LE4	-	RE4



Engine	Intake Valve Timing	Exhaust Valve
<p>Mu Engine</p>		
<p>Lambda Engine</p>		

- Type : RLFS(Return Less Fuel System)
- Regulated fuel pressure : 3.8kg/cm²
- Fuel tank capacity : 75 L
- Fuel cut speed at full load : 6688rpm
- Damper on the fuel rail to prevent pulsation





(OPTIONAL BY REGION)

Specification

Ignition timing	BTDC $10^{\circ} \pm 5^{\circ}$			
Idle rpm	A/CON OFF		A/CON ON	
	P/N	D	P/N	D
	650 ± 100	650 ± 100	650 ± 100	650 ± 100
EMS	Delphi/ 32bit ECU			
CKPS	VR type (Engine can start even in case of CKP failure)			
CMPS	Hall IC type			
Ignition	DLI (firing order : 2-3-4-5-6-1)			
Cooling Fan	Low/High speed control			
CAN	PCM-ESP-4WD			
MAF (IAT built-in type)	Hot film type 5PIN (3PIN :MAF, 2PIN:ATS)			
O2 sensor	Zirconia type (4EA)			

Control logic

A/CON S/W	A/CON Pressure	Vehicle Speed (KPH)	Coolant Temperature (°C)					
			-30	40	95	100	105	
ON	$P \geq 15.5 \text{ kgf/cm}^2$	ALL	OFF	HIGH				
	$15.5 \text{ kgf/cm}^2 > P \geq 12 \text{ kgf/cm}^2$	$V < 45$	OFF	LOW		HIGH		
		$45 \leq V < 80$	OFF			LOW	HIGH	
		$80 < V$	OFF					HIGH
	$12 \text{ kgf/cm}^2 > P \geq 6 \text{ kgf/cm}^2$	$V < 45$	OFF		LOW	HIGH		
		$45 \leq V < 80$	OFF			LOW	HIGH	
		$80 < V$	OFF					HIGH
	$6 \text{ kgf/cm}^2 > P$	ALL	OFF					HIGH
OFF		$V < 45$	OFF			LOW	HIGH	
		$45 \leq V < 80$	OFF			LOW	HIGH	
		$80 < V$	OFF					HIGH

- Fan logic of a vehicle without A/CON is equal to an **A/CON S/W OFF** situation.
- If **ECT over 118°C**, Compressor is Off. (temp. hys. : 7°C)
- When engine rpm is 0 & IG is on, fan must turn off.

Failsafe

Failure Case	Fan Running Condition
A/CON Pressure Sensor	The case which the output voltage is $\leq 0.5V$ or $4.5V \leq$, then follows A/CON off case & turn off the A/CON compressor.
Vehicle Speed Sensor	When a vehicle speed sensor is breakdown, fan control is followed by the case of $V < 45KPH$.
Water Temperature Sensor	When a water temperature sensor is breakdown, fan speed fixes to high.

Part Name	δ -ENGINE	μ -ENGINE	λ -ENGINE
1. ECU	Siemens	Delphi	Delphi
2. MAF	Siemens	Delphi	Delphi
3. MAP Sensor	Kefico	Kefico	Kefico
4. ETC / Throttle Body	Motonic (Throttle Body)	Delphi (ETC)	Delphi (ETC)
5. Fuel Rail	Motonic	Motonic	Delphi
6. VIS SOL	Hyundai Autonet	Hyundai Autonet	Delphi
7. IG. Coil	Bearu/ DensoPungsung	Searim Tech	Denso Pungsung
8. Harness IG. Coil	Searim Tech (Seawon)	Searim Tech (Seawon)	Delphi
9. Spark Plug	Searim/ Woojin	Woojin	Woojin
10. Injector	Kefico	Kefico	Delphi
11. Harness Injector	Borim	Kyungsin	Delphi Packad
12. Oxygen Sensor	NTK(Woojin)	NTK(Woojin)	Delphi
13. CKP Sensor	Siemens VDO	Delphi	Delphi

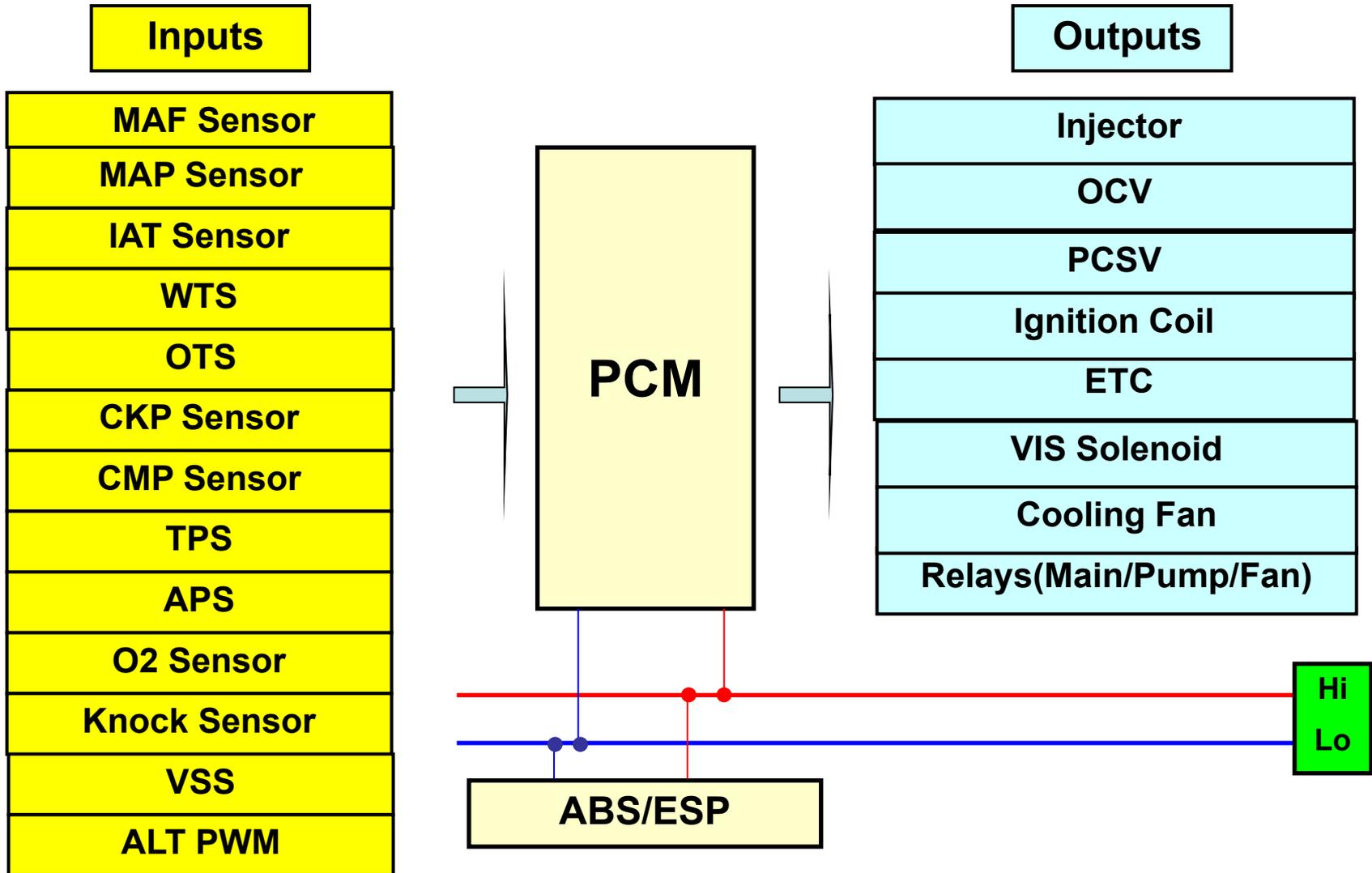
Part Name	δ -ENGINE	μ -ENGINE	λ -ENGINE
14. CMP Sensor	Siemens VDO	Delphi	Delphi
15. Purge sol. Valve	Inji	Kefico	Delphi
16. Knock Sensor	Inji	Kefico	Delphi
17. Water Temp. Sensor	Korea/Inji	Inji	Inji
18. Oil Pressure SW	Inji	Inji	Inji
19. Oil Temp. Sensor	-	Inji	Inji
20. TPS	Motonic	Delphi	Delphi
21. ISCA	Kefico	-	-
22. Starter	Valeo Mando	Valeo Mando	Delco Reami
23. Alternator	Valeo Mando	Denso Pungsung	Denso Pungsung

For Mu engine

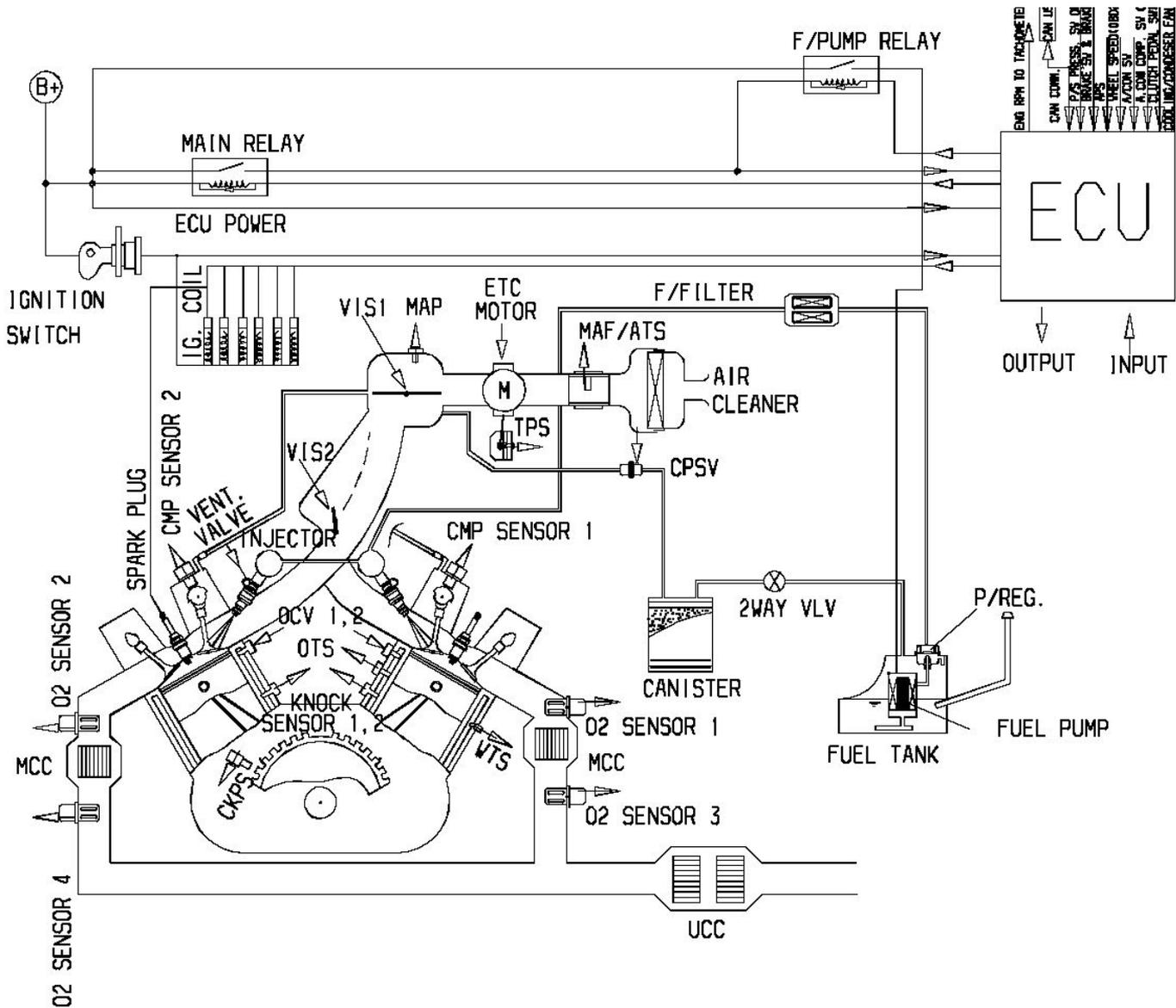
Part Name	Supplier	Part Number	Remark
1. MAF	Delphi	28164-3C100	Same as Lamda
2. MAP Sensor	Kefico	39300-38200	Same as Lamda
3. ETC	Delphi	35100-3E100	-
4. Fuel Injector	Kefico	35310-23600	-
5. VIS SOL	Hyundai Autonet	39460-37000	-
6. IG. Coil	Searim Tech	27301-3E100	-
7. Spark Plug	Woojin	18840-11051	-
8. Oxygen Sensor	NTK(Woojin)	39210-3E110	-
9. CKP Sensor	Delphi	39180-3E100	-
10. CMP Sensor	Delphi	39350-3E110(RH) 39350-3E120(LH)	-
11. PCSV	Kefico	28910-3E100	-
12. Knock Sensor	Kefico	39250-3E110	-
13. WTS	Inji	39220-38030	Same as Lamda
14. OPS	Inji	94750-37000	-
15. OTS	Inji	39220-3C100	-

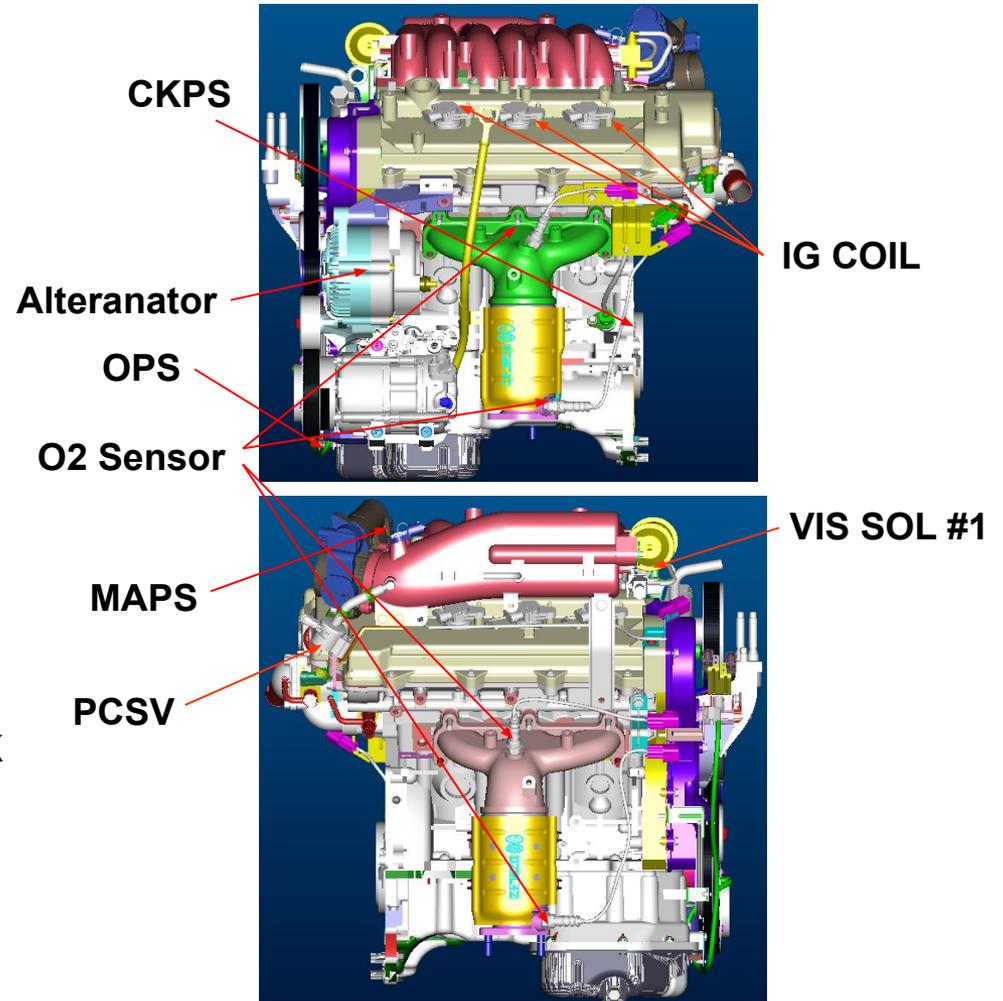
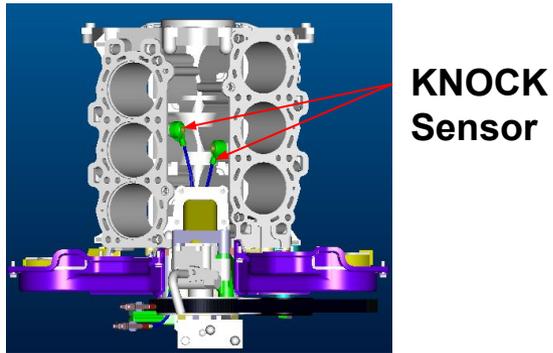
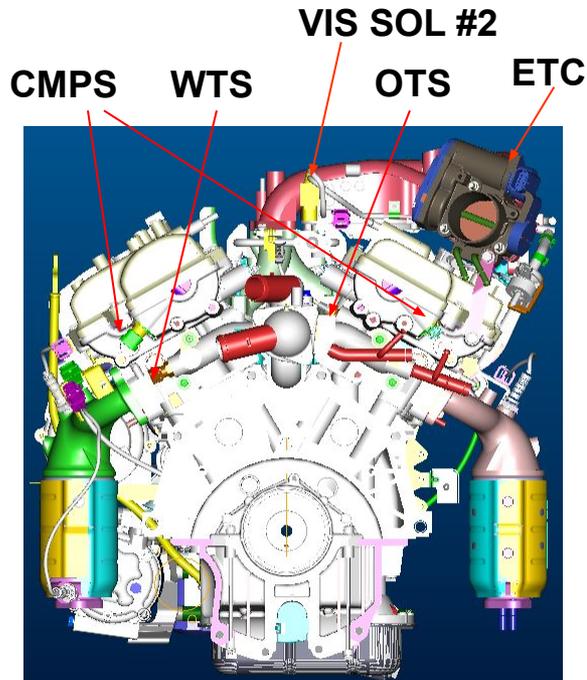
For Lamda engine (reference data)

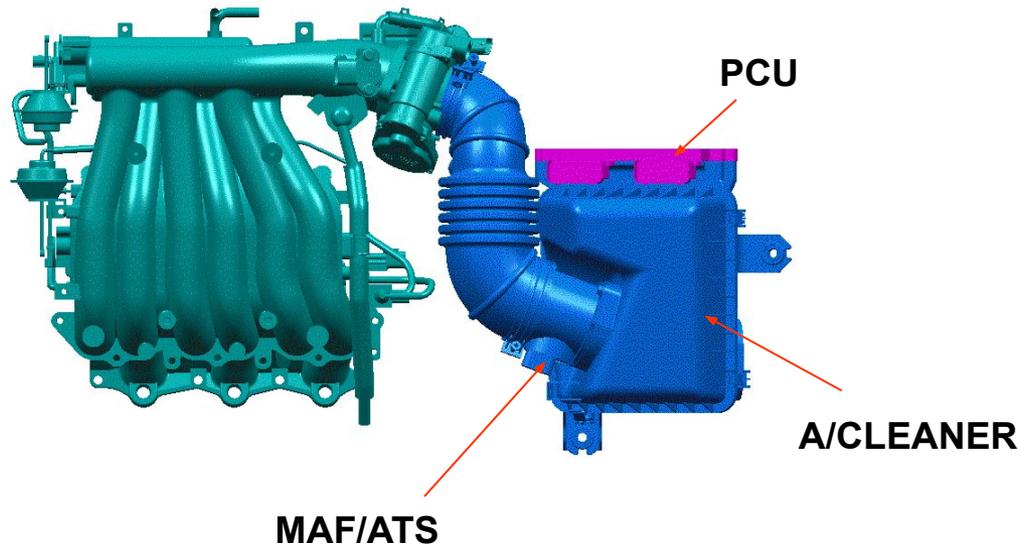
No.	P/Name	P/No.	Maker	ES-Spec	Remarks
1	Ignition Coil	27301-3C000	Denso	ES27310-14	
2	Condensor	27325-37400	Daedong	-	Sigma C/O
3	Spark Plug	27410-23700	Woojin	JIS B 8031	Theta C/O
4	Sensor assy-MAF	28164-3C100	Delphi	ES28164-10	
5	ETC Actuator	35100-3C200	Delphi	ES35100-08	
6	Fuel Rail assy	35304-3C300	Delphi	ES35304-04	Surge tank PI.
		35304-3C400	Delphi		Surge tank AI
7	Injector assy-Fuel	35310-3C000	Delphi	ES35310-09	
8	MAP Sensor	39300-38200	Delphi	ES39330-06	Sirius/Sigma와 C/O
9	Valve-Canistor Purge Control	28910-3C100	Delphi	ES28910-04	
10	Vis Solenoid Valve	39460-3C000	Inji Con.	-	
11	PCM	39110-3C800	Delphi	ES39110-43	
12	O2 Sensor	39210-3C000Ω	Delphi	ES39210-10	
13	ETS	39220-38030	Inji Con.	ES94650-09	Sirius/Sigma와 C/O
14	Crank Angle Sensor	39310-3C100	Delphi	ES39310-05	
15	CAM Sensor	39318-3C100	Delphi	ES39350-05	
16	Knock Sensor	39320-3C000	Delphi	ES39250-02	
17	Sensor-Oil Pressure	39220-3C100	Inji Con.	ES94750-02	
18	Switch & Brkt Assy-Oil Temp.	94710-3C100	Inji Con.	ES39220-01	



EMS System Diagram









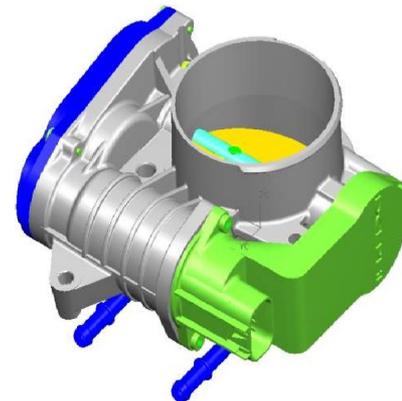
ETC(Electronic Throttle Control) system consists of ETC DC motor, throttle body, throttle position sensor and APS.

Both APS and TPS have 2 sensors such as APS1, APS2 and TPS1, TPS2

One of the biggest advantage using ETC system is fine controlling in idle. Throttle valve is directly controlled by DC motor without idle control devices such as ISA or step motor.

Delphi ETC has following features ;

- Fine idle control
- Easy application for cruise control
- Deicing function
- Quick response
- Reduced operating noise
- DC motor operating voltage : 8~16.5V
- TPS operating voltage : 4.5~5.5V



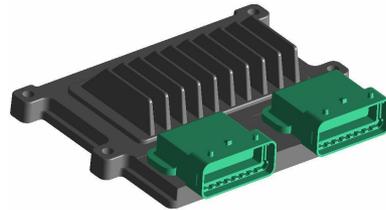
System layout

APS1,2



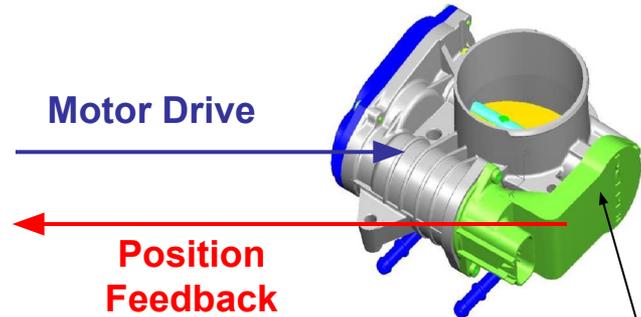
Driver's
intension

PCM



Electronic Throttle Body

Motor Drive



Position
Feedback
(TPS1,2)

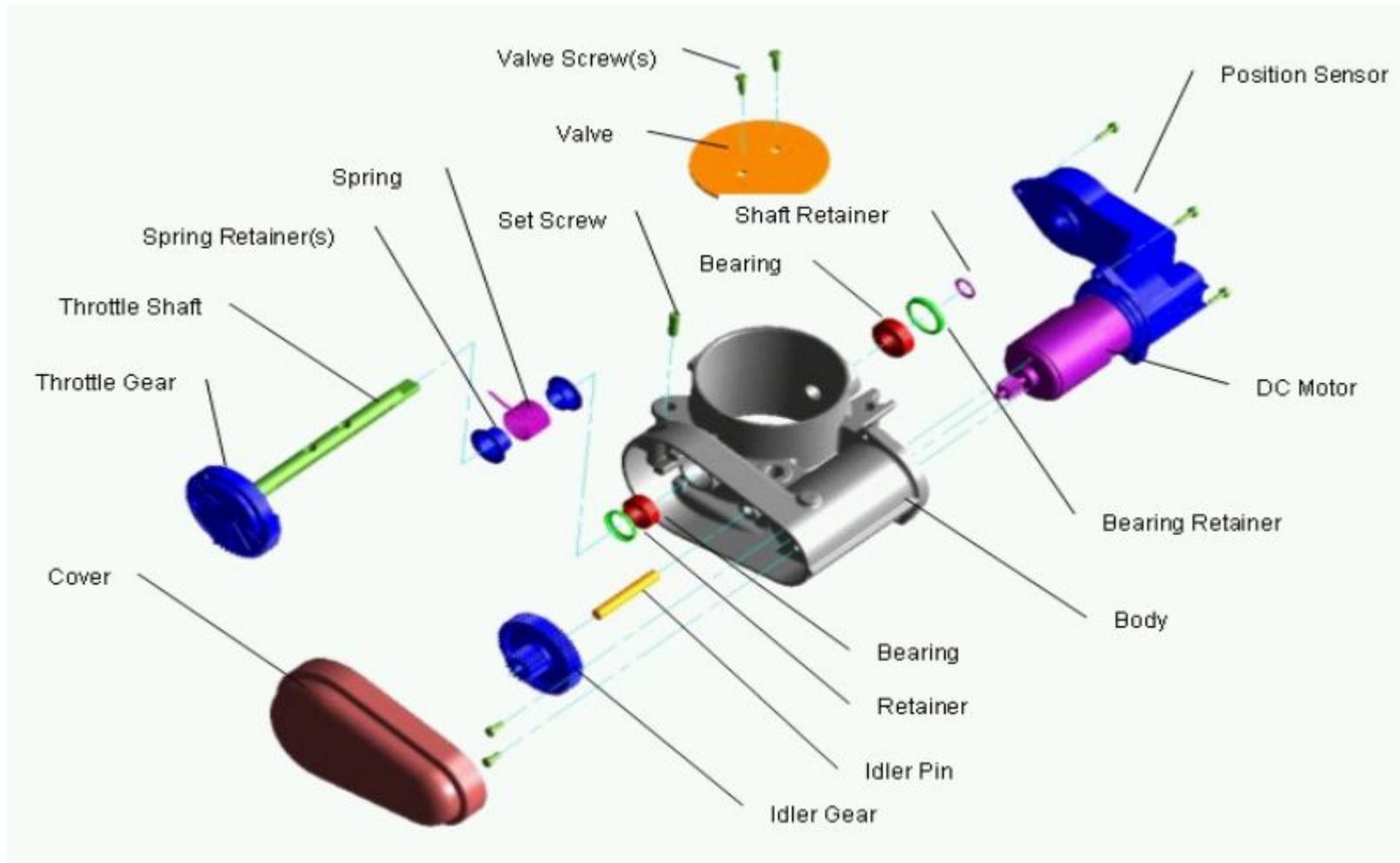
Position sensor

CAN

Torque
reduction
request

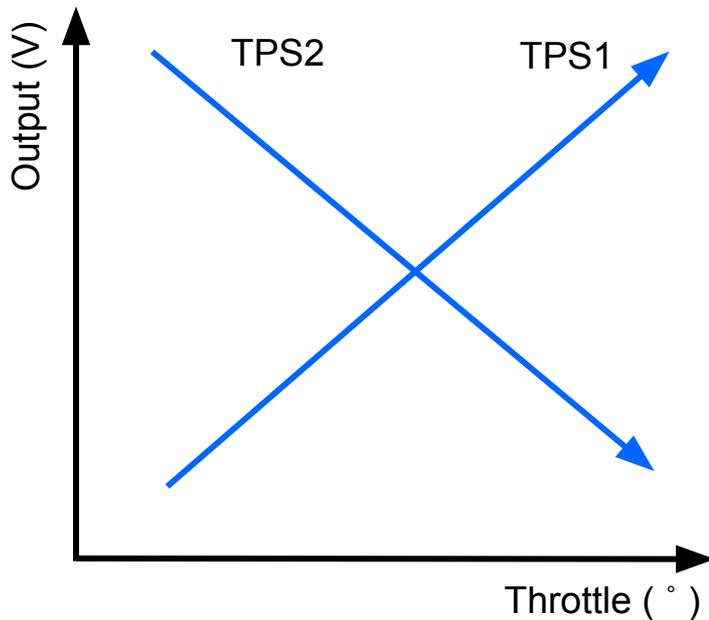


ESP unit



TPS characteristics

Two TPS outputs (TPS1 and TPS2) are used for ETC system. TPS 1 starts from 0 to 5 voltage unlike TPS2 which starts form 5 to 0 voltage oppositely.

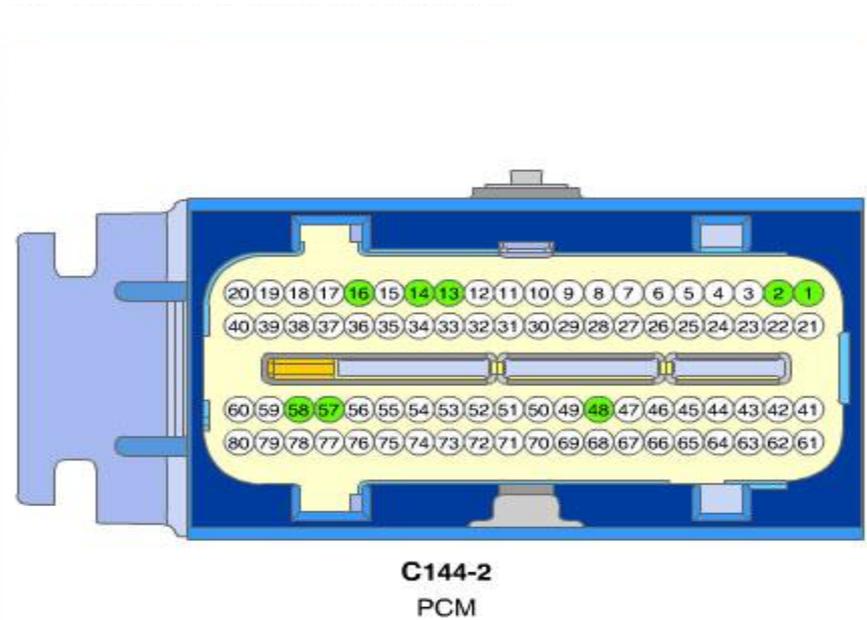
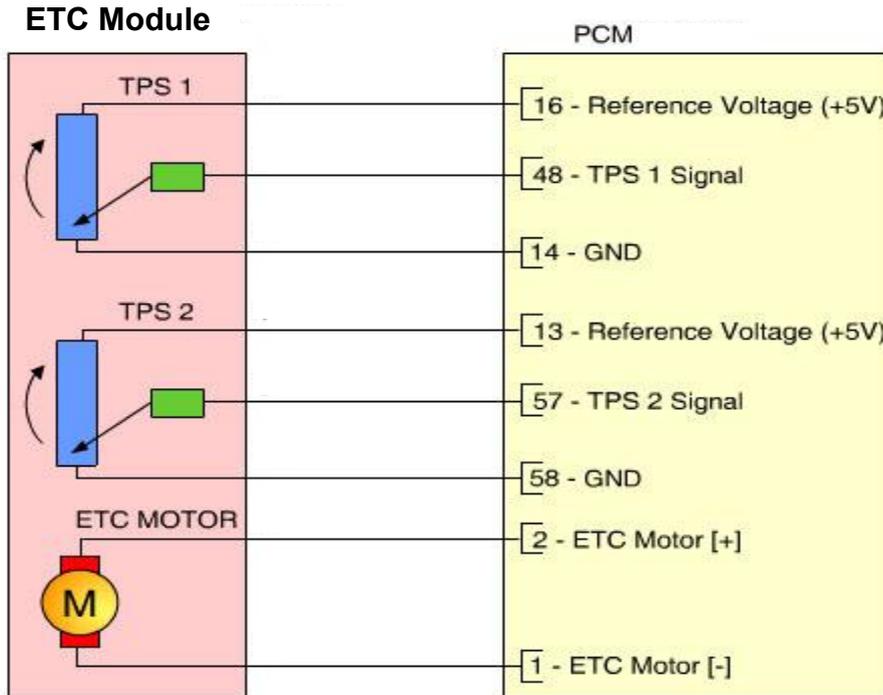


Throttle Position	Valve Angle	TPS1 Output	TPS2 Output
Minimum mechanical position	3°	10% (0.5V)	90% (4.5V)
Minimum Controllable Position	3.5°	10.5% (0.525 V)	89.5% (4.475V)
Default Position	17°	22.5% (1.125V)	77.5% (3.875V)
Maximum Mechanical Position	90°	88% (4.4V)	12% (0.6V)

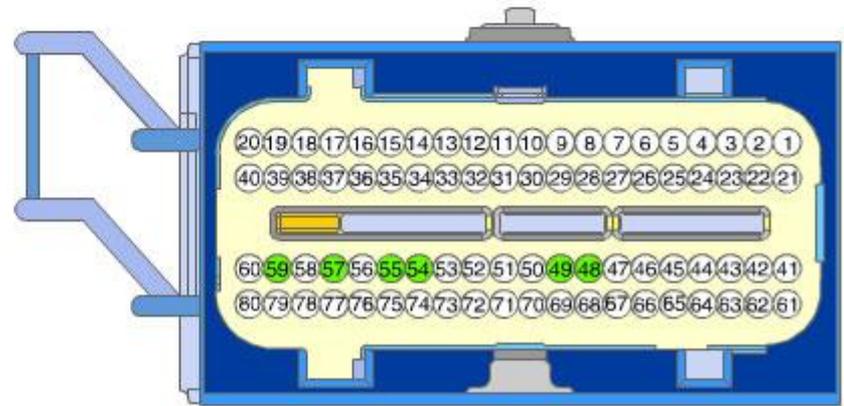
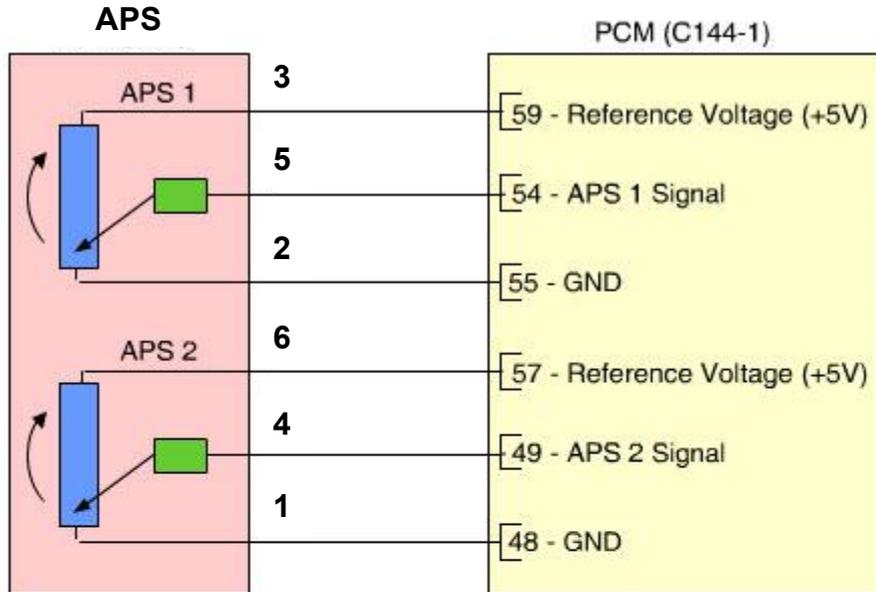
APS characteristics

APS1 is the main signal and APS2 is a back-up. APS2 output is the half of APS1. APS1 shows 0.7~0.8V but APS2 shows 0.29 ~ 0.46V at idle.

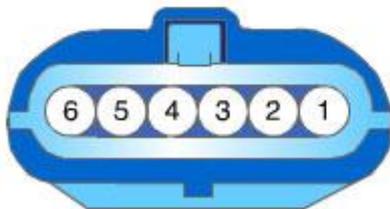
Pin assignment



Pin assignment



C144-1
PCM



APS

There are four main limp-home functions in Delphi EMS

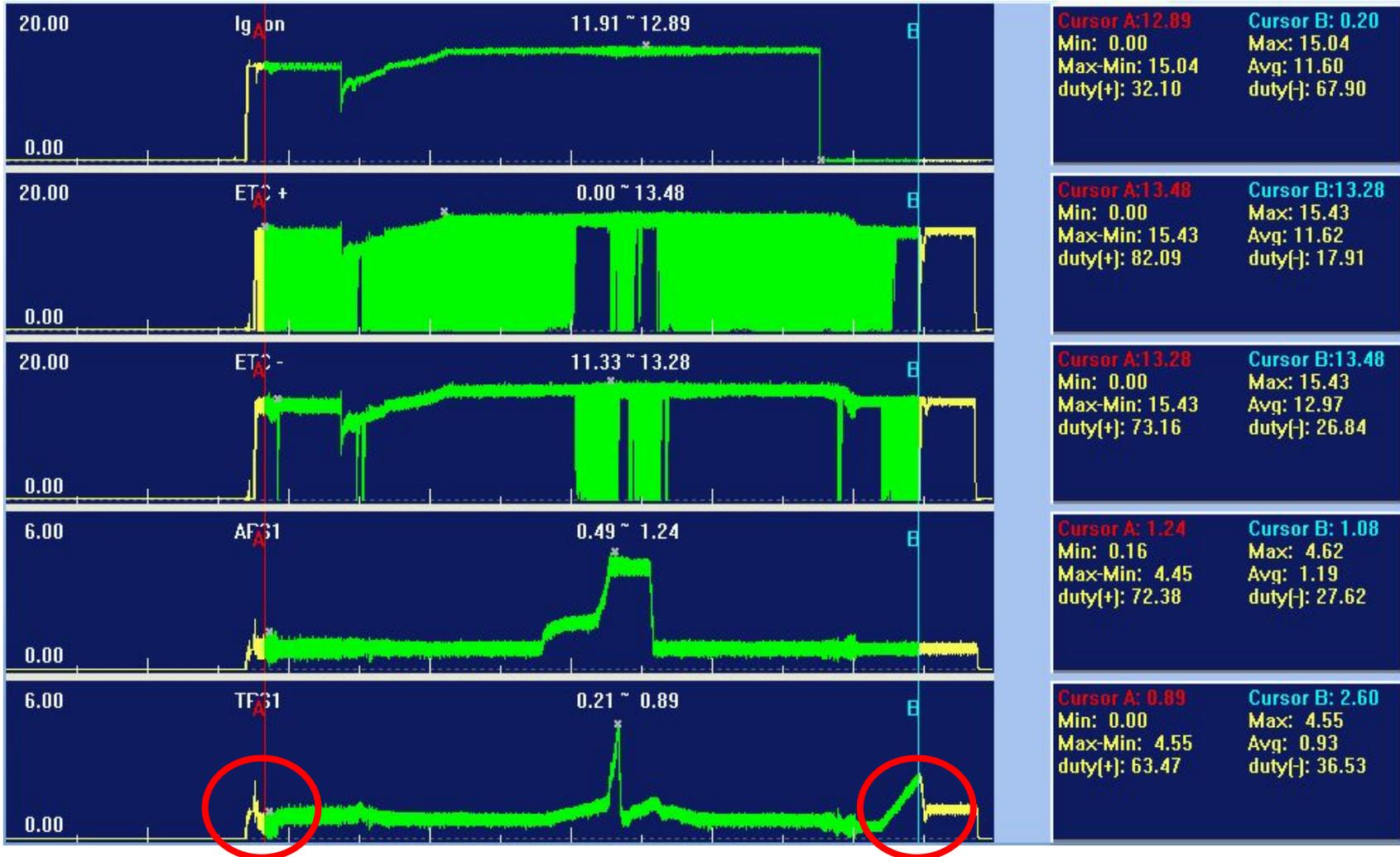
- Forced idle
- Limited performance
- Power management
- Engine shut down

Forced idle is followed when ECM doesn't know about driver's intention or A/D converter failure or ECM internal controller problem happens. When ECM goes to forced idle mode, any acceleration movement can not increase engine rpm. Rpm just sets to idle.

Regarding **limited performance**, when APS1 sensor has a failure APS2 becomes an alternative of APS1 and ETC system goes to limit performance condition. With this, increasing engine rpm is a little delayed even you depress to WOT. Engine rpm is limited about 2500.

Unlike forced idle, **power management** is followed mainly from TPS failure. Since now ECM doesn't have any information from TPS, engine rpm and MAF value are used for feedback control. Under this power management condition, fuel cutting for specified cylinder and ignition timing retard happens resulting in rough idling and fluctuating. engine rpm is limited by 1800..

Engine shut down generally happens when you have TPS or DC motor problem **with MAP&MAF failure**. When this problem is detected, engine immediately shuts down.



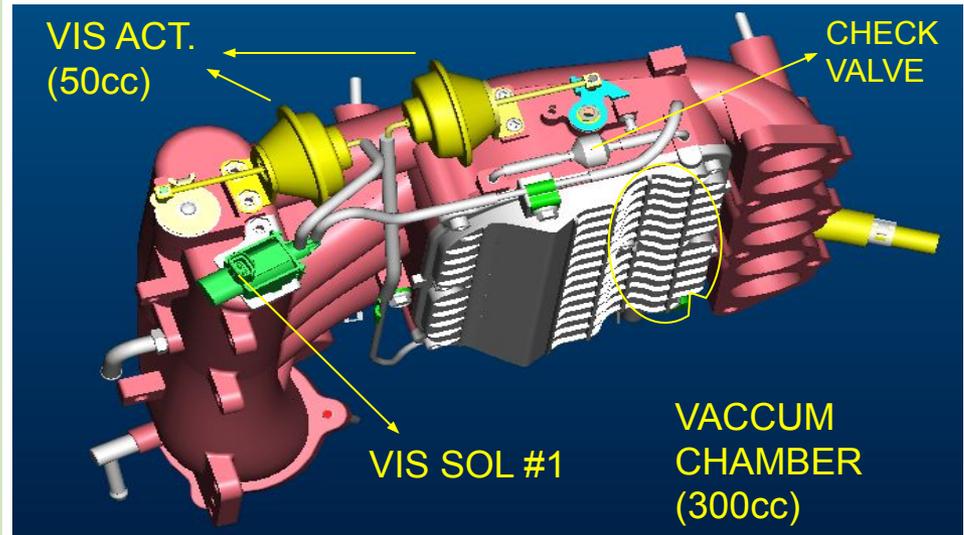
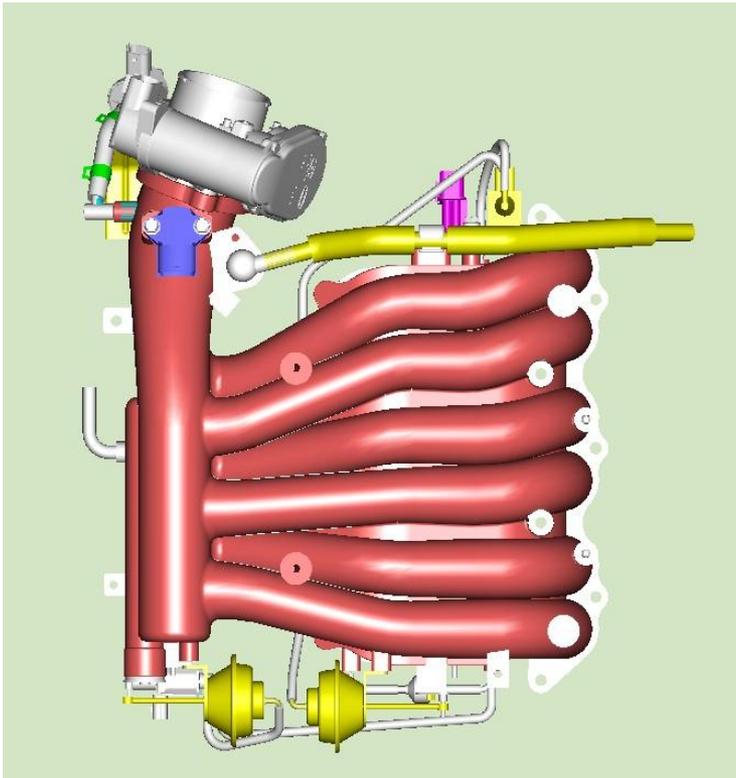
Every time when you make ignition on, ETC goes to initializing for close (Point A). Generally it opens 15% of TPS value. In output voltage of TPS it becomes 1.1 ~ 1.2V. After ignition off then now ETC goes to open initializing. Throttle valve is forced to open from normal to 2.6v.(Point B)

1.2 CURRENT DATA		45/74
* ENGINE SPEED	1893 rpm	▲ ▼
* ACCEL POS.1 VOLTAGE	4.04 V	
* INJECTION TIME-CYL1	5.1 mS	
* INJECTION TIME-CYL2	0.6 mS	
* INJECTION TIME-CYL3	5.1 mS	
* INJECTION TIME-CYL4	0.6 mS	
* INJECTION TIME-CYL5	5.1 mS	
* INJECTION TIME-CYL6	0.6 mS	
<input type="button" value="FIX"/> <input type="button" value="SCRN"/> <input type="button" value="FULL"/> <input type="button" value="PART"/> <input type="button" value="GRPH"/> <input type="button" value="HELP"/>		

1.1 DIAGNOSTIC TROUBLE CODES
P2106 ETC SYS.-FORCED LIMIT POW.
P1295 ETC SYSTEM POWER MANAGEMEN
NUMBER OF DTC : 2 ITEMS
<input type="button" value="PART"/> <input type="button" value="ERAS"/> <input type="button" value="DTAL"/> <input type="button" value="HELP"/>

1.2 CURRENT DATA		45/74
* ENGINE SPEED	1483 rpm	▲ ▼
* ACCEL POS.1 VOLTAGE	0.80 V	
* INJECTION TIME-CYL1	0.6 mS	
* INJECTION TIME-CYL2	0.6 mS	
* INJECTION TIME-CYL3	6.2 mS	
* INJECTION TIME-CYL4	0.6 mS	
* INJECTION TIME-CYL5	0.6 mS	
* INJECTION TIME-CYL6	6.1 mS	
<input type="button" value="FIX"/> <input type="button" value="SCRN"/> <input type="button" value="FULL"/> <input type="button" value="PART"/> <input type="button" value="GRPH"/> <input type="button" value="HELP"/>		

1.2 CURRENT DATA		44/74
* ENGINE SPEED	1634 rpm	▲ ▼
* THROTTLE POS.1 VOLT.	4.88 V	
* ACCEL POS.1 VOLTAGE	0.80 V	
* INJECTION TIME-CYL1	0.6 mS	
* INJECTION TIME-CYL2	5.7 mS	
* INJECTION TIME-CYL3	0.6 mS	
* INJECTION TIME-CYL4	5.7 mS	
* INJECTION TIME-CYL5	0.6 mS	
<input type="button" value="FIX"/> <input type="button" value="SCRN"/> <input type="button" value="FULL"/> <input type="button" value="PART"/> <input type="button" value="GRPH"/> <input type="button" value="HELP"/>		



VIS-1

VIS-2

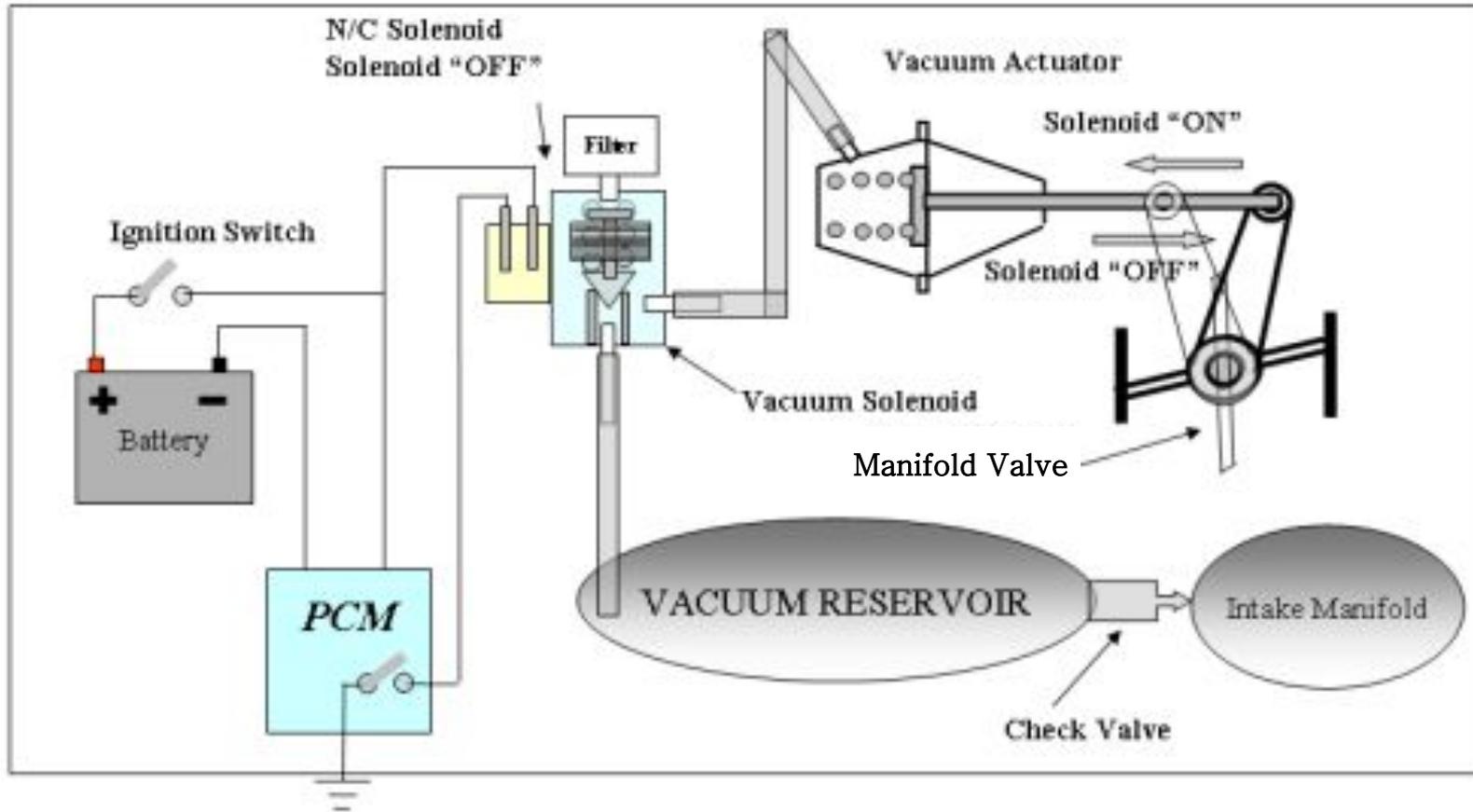
VIS-1

VIS-2

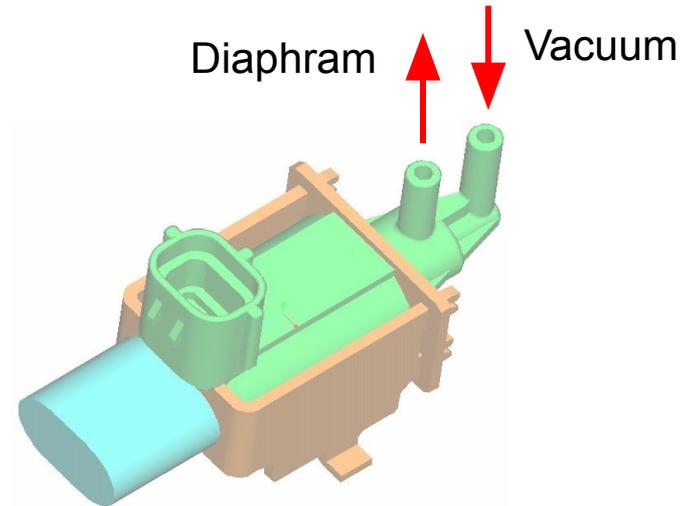


- VIS-1 : for low/middle rpm range
- VIS-2 : for high rpm range

System layout



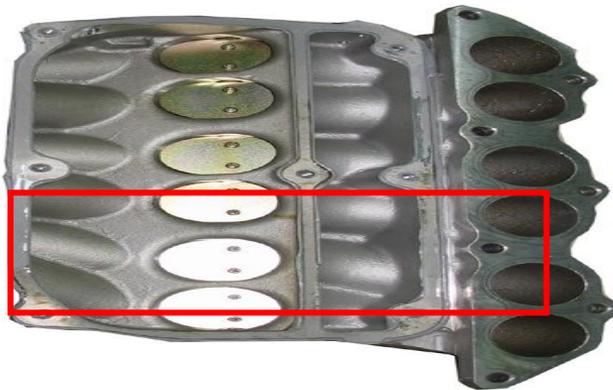
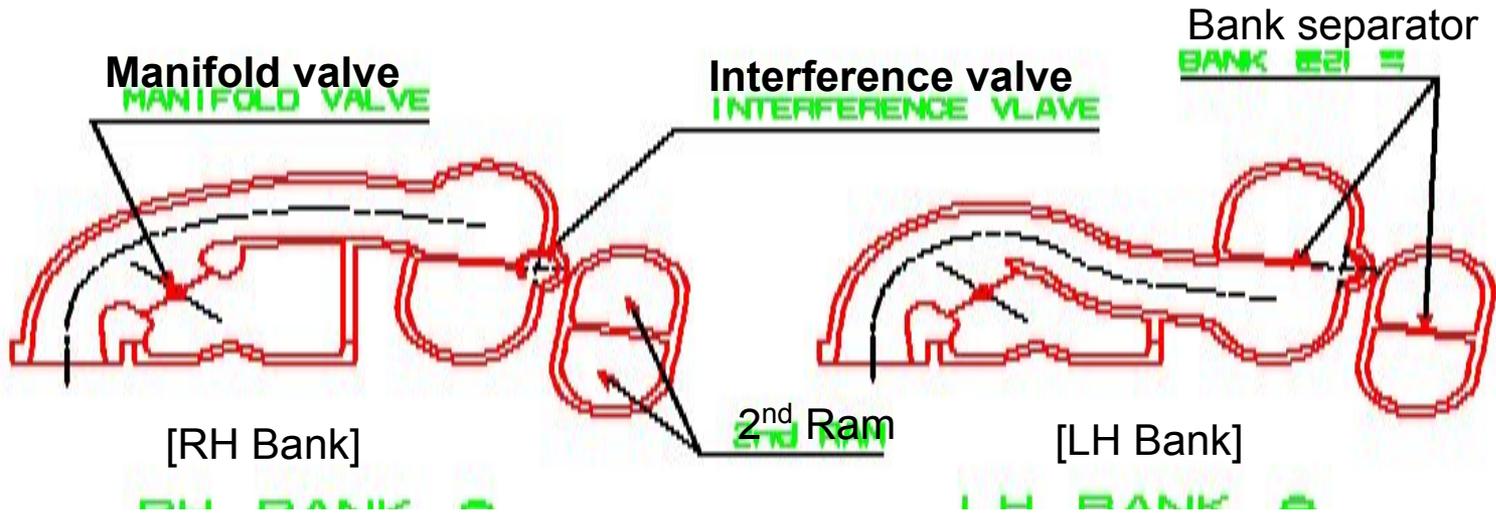
Solenoid



Technical feature

- Type : 3 way valve
- Coil resistance : $32 \pm 3 \Omega$ (at 20°C)

Construction

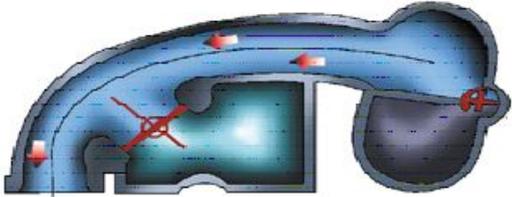
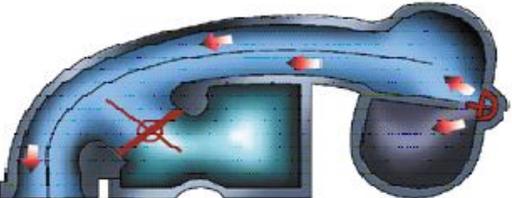
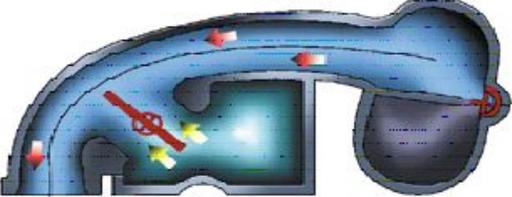


Manifold valve



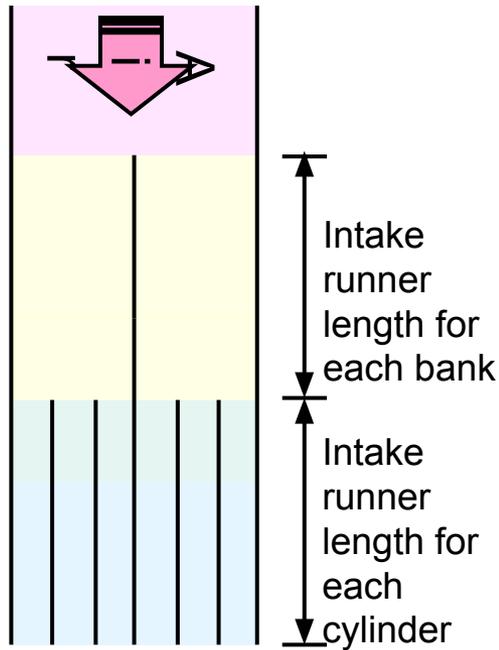
Vacuum chamber

Operating principle

Engine speed	Operation	
Low		<ul style="list-style-type: none"> - Separate surge tank (Interference valve close) - Avoid suction interference of each back (Manifold valve close)
Middle		<ul style="list-style-type: none"> - connect surge tank (Interference valve open) and use cylinder pressure pulsation
High		<ul style="list-style-type: none"> - Maximize intake efficiency and reduce intake resistance by opening the interference valve and the manifold valve

Operating principle

From Throttle valve

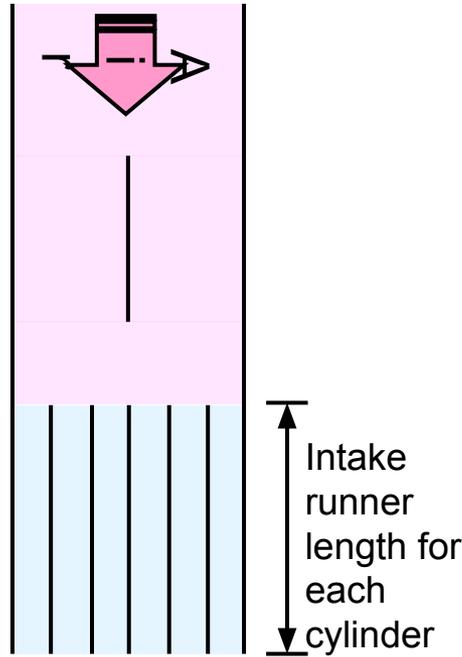


#1 #3 #5 #2 #4 #6

IV is closed

MV is closed

From Throttle valve

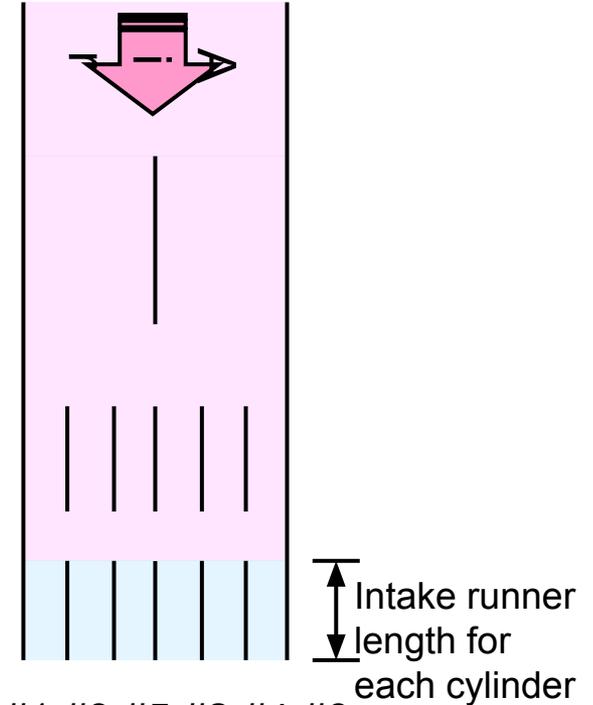


#1 #3 #5 #2 #4 #6

IV is opened

MV is closed

From Throttle valve

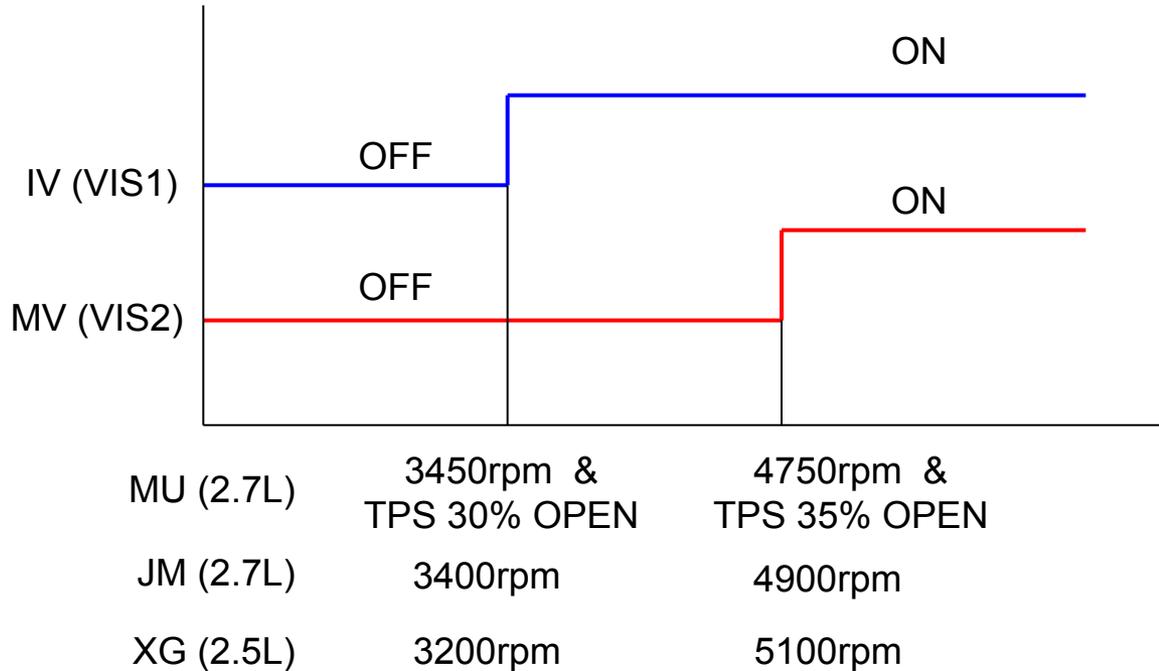


#1 #3 #5 #2 #4 #6

IV is opened

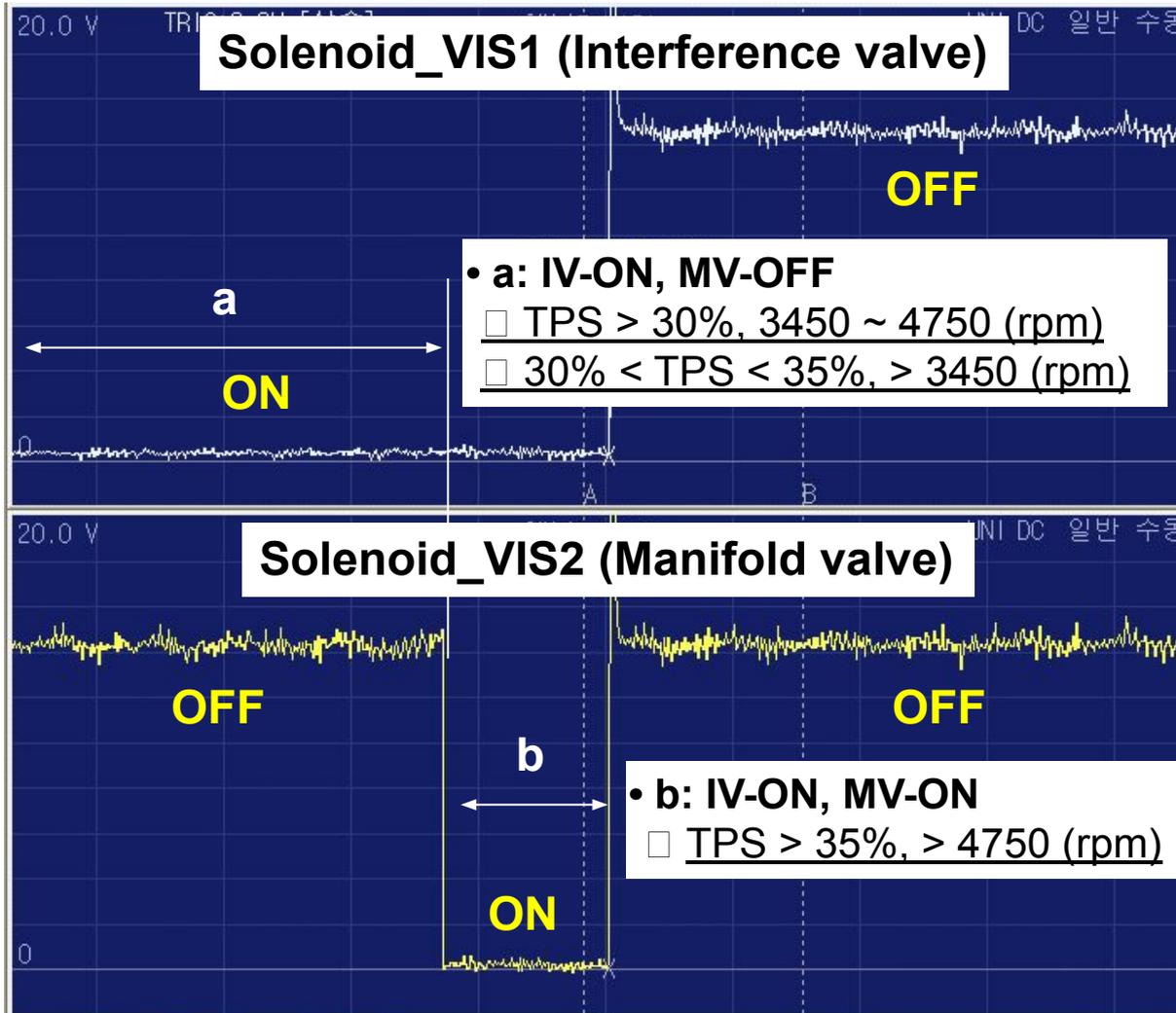
MV is opened

Control logic



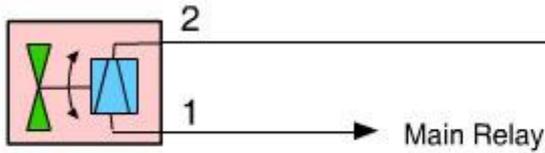
- Initial position Both valve for IV & MV is closed(at no power supply)
- IV = Inteference valve mounted in surge tank (VOLUME CONTROL)
- MV = Manifold valve mounted in in-mani (RUNNER CONTROL)

Solenoid output (Sudden acceleration)

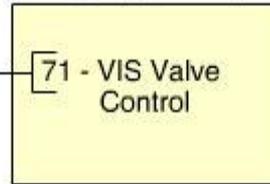


Pin assignment

VIS Valve 1

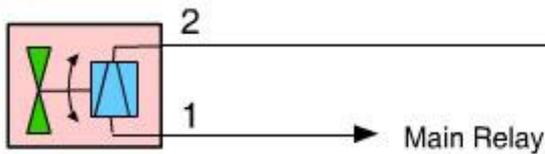


PCM (C144-1)



Terminal	Connected to	Function
1	Main Relay	Battery voltage (B+)
2	PCM C144-1 (71)	VIS Valve control

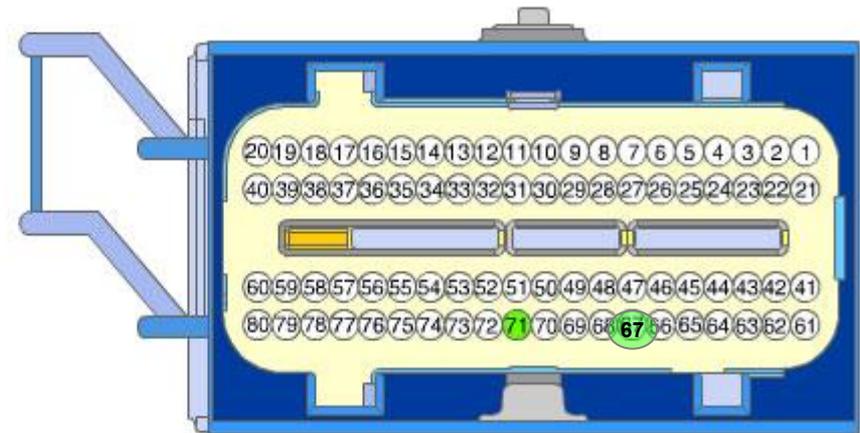
VIS Valve 2



PCM (C144-1)

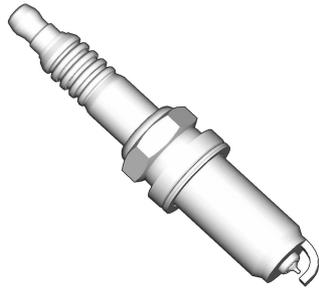


Terminal	Connected to	Function
1	Main Relay	Battery voltage (B+)
2	PCM C144-1 (67)	VIS Valve control

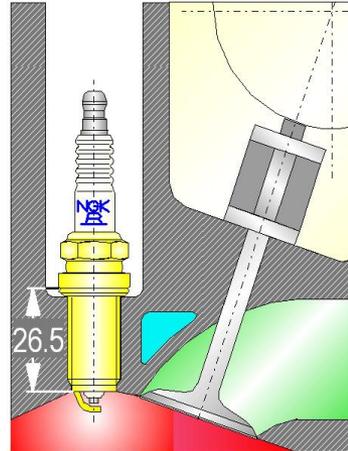


C144-1

PCM



[Long reach type]



Technical feature

- Type : Long reach type
Iridium spark plug (Unleaded)
Nikel spark plug (Leaded)
- Screw size : M14x1.25, HEX 16
- Screw length : $\Phi 19 \times 26.5\text{mm}$

Advantages of long reach spark plug

- Better anti-knocking function
- Lean air flow mapping available
- Better water cooling □ Mapping for higher performance
- Enhanced durability of exhaust valves
- Better fuel consumption & emission



- Output voltage : 0.4V~200V
- Available engine rpm : 55~7000 rpm
- Air Gap : 1 ± 0.5 mm
- Resistance : $825 \pm 100 \Omega$

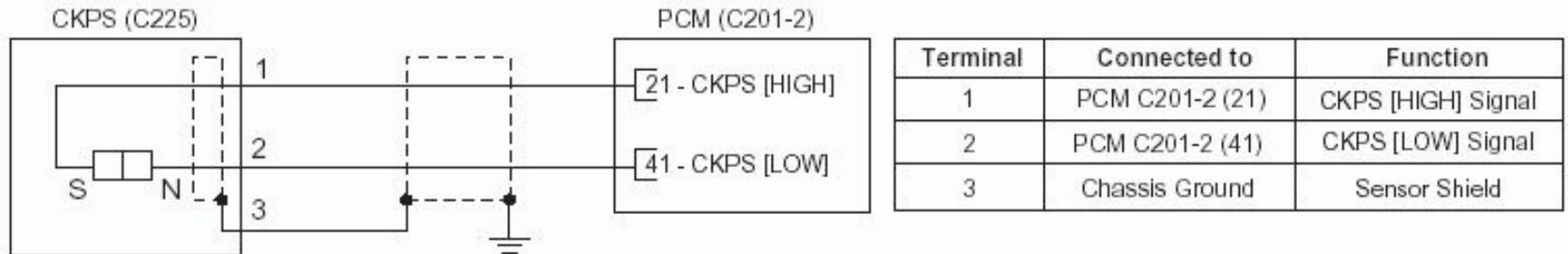


[Location]

CKP sensor is inductive type sensor and it is mounted in the cylinder block. There are 2 missing teeth out of 60 teeth on the ton wheel.

In case of Mu engine with Delphi EMS, engine can start without CKP signal. CMP1 and CMP2 signals are used for synchronizing check.

Pin assignment

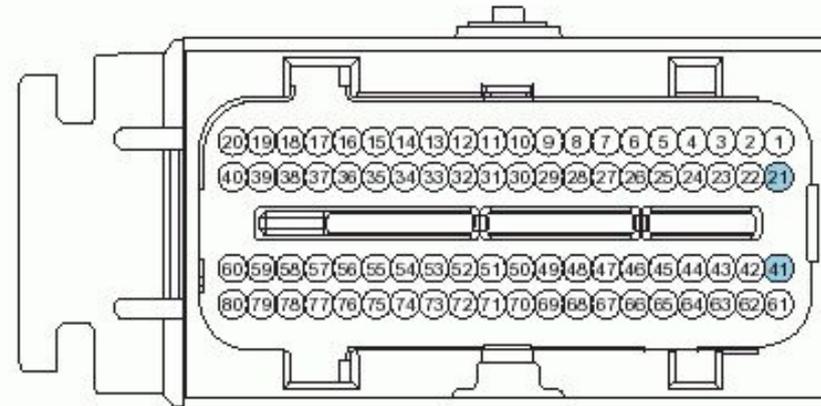


[HARNESS CONNECTORS]



C225

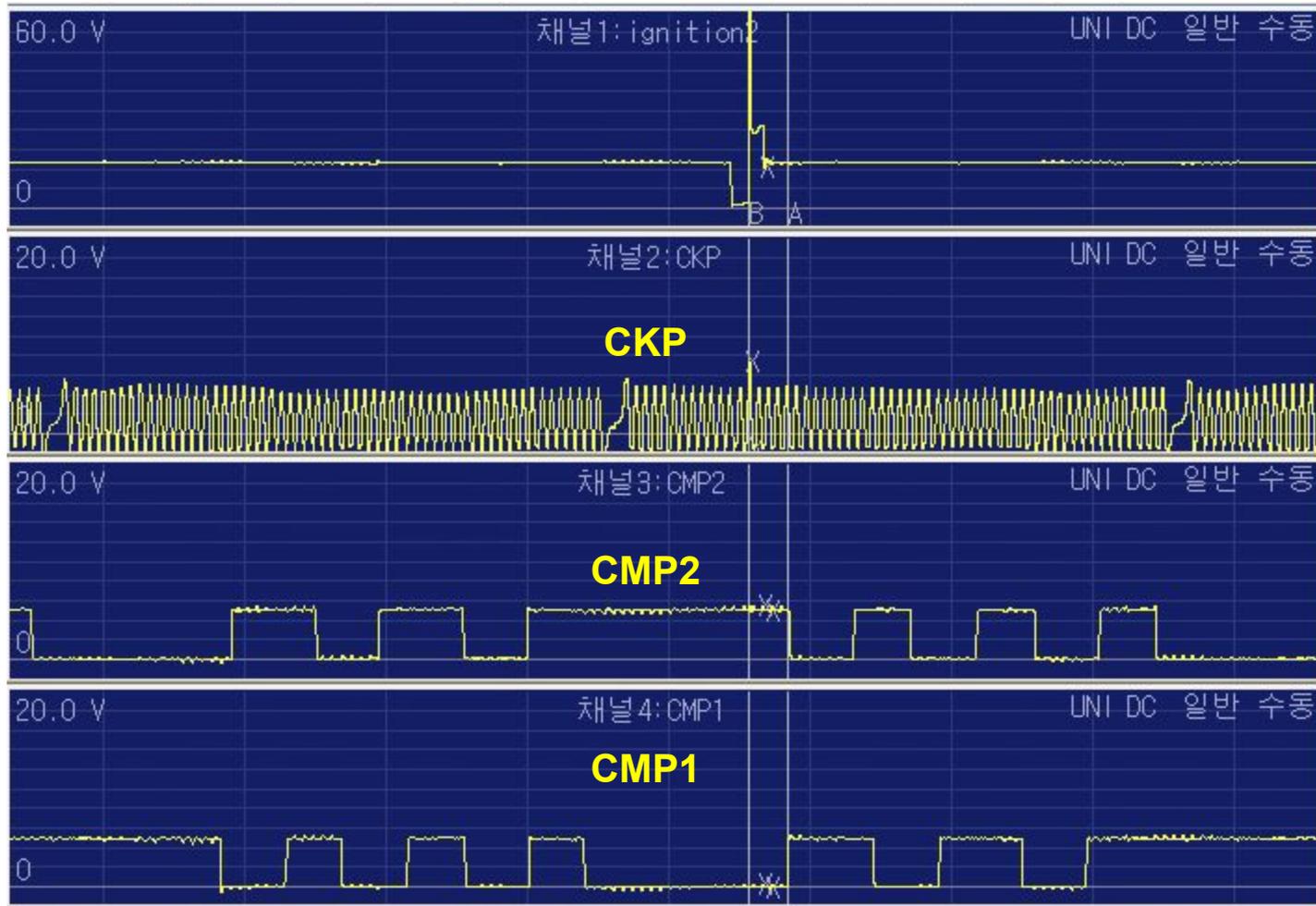
CKPS

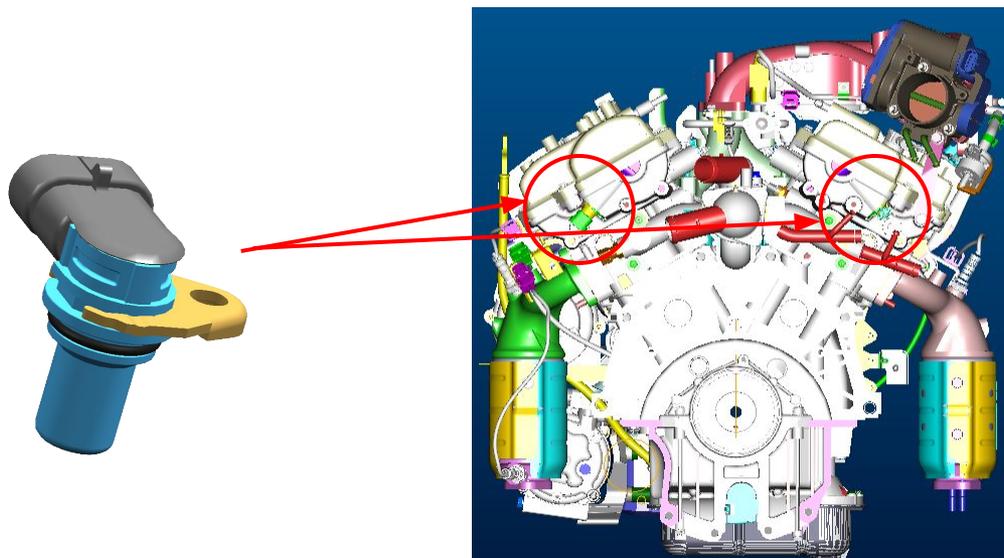


C201-2

PCM

Sensor output





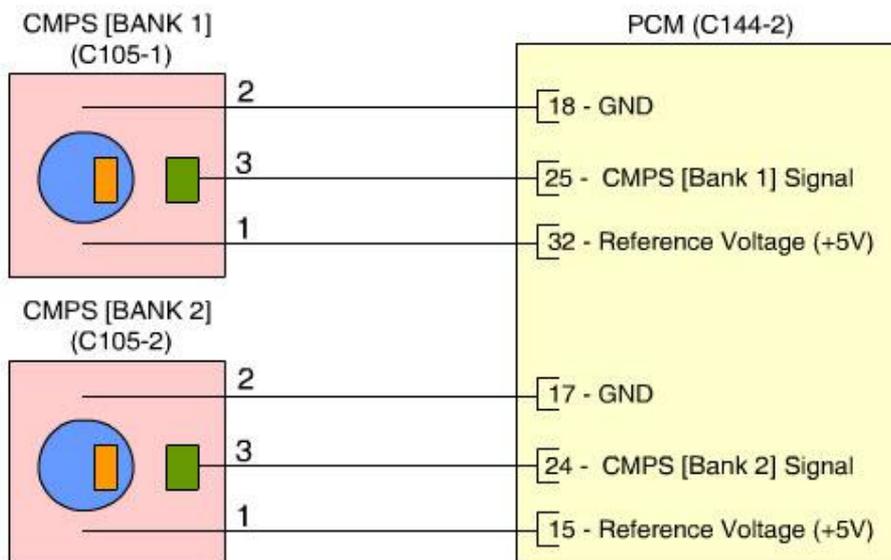
[CMP sensor target wheel]

There are two camshaft position sensors. CMP1(Right bank) is used as a main signal.

It is a **hall IC type sensor** to detects the camshaft. When this sensor has some problems then all CVVT activation are prohibited since this sensor is the main feedback sensor to check CVVT correct operation.

Air gap is 1.0 ± 0.5 mm

Pin assignment



CMPS [BANK 1]

Terminal	Connected to	Function
1	PCM C144-2 (32)	Reference Voltage (+5V)
2	PCM C144-2 (18)	Sensor ground
3	PCM C144-2 (25)	CMPS [Bank 1] control

CMPS [BANK 2]

Terminal	Connected to	Function
1	PCM C144-2 (15)	Reference Voltage (+5V)
2	PCM C144-2 (17)	Sensor ground
3	PCM C144-2 (24)	CMPS [Bank 2] control

[HARNESS CONNECTORS]



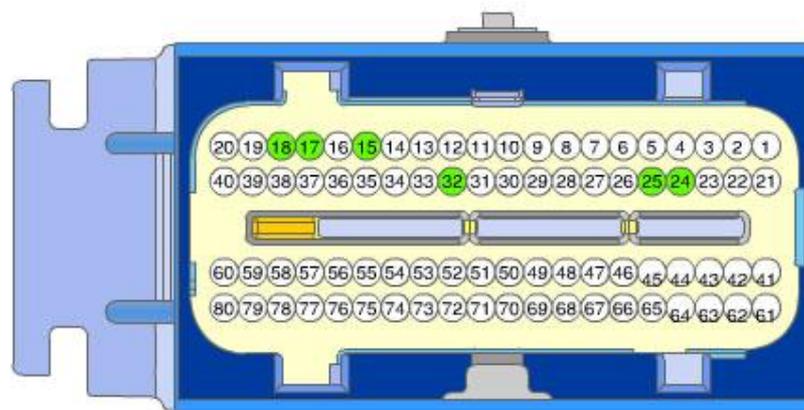
C105-1

CMPS [BANK 1]



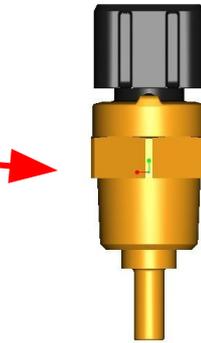
C105-2

CMPS [BANK 2]



C144-2

PCM



Technical Feature

- Type : NTC thermistor
- Operating Temp.: -40°C~130°C
- Resistance : -20°C : 15.48kΩ
- 20°C : 2.54kΩ
- 80°C : 0.3222kΩ
- 85°C : 48.4 kΩ
- 110°C : 24.0 kΩ

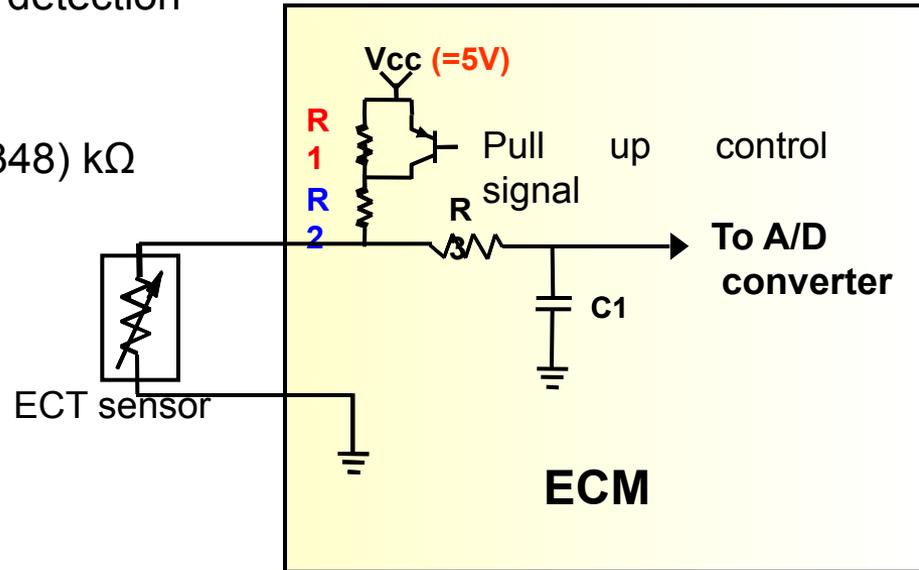
To cluster

ECT sensor is used for fuel injection amount control and cooling fan control.

During cold engine operation the PCM increases the fuel injection duration and controls the ignition timing using the information of engine coolant temperature to avoid engine stalling and improve drivability.

Signal characteristic

1. The switch control signal will be shared with ATF Temp. Sensor.
2. More accurate high temperature detection
3. $R1 = 3.65\text{ K}\Omega$, $R2 = 348\ \Omega$
4. TR On : $348\ \Omega$, Off : $(3.65 + 0.348)\text{ k}\Omega$



Unlike other conventional type controlling, pull up resistance of the sensing circuit is changeable by transistor switching function of ECM.

As shown in the picture, pull up resistance is changed by TR operation and the TR control signal will be shared with ATF Oil Temp. Sensor.

Signal characteristic

PCM controls the switching TR according to the temperature condition.

1) $ECT \leq 50 \text{ }^\circ\text{C}$, $OTS \leq 80 \text{ }^\circ\text{C}$: TR OFF $\square (3.65 + 0.348) \text{ k}\Omega$

2) $ECT \geq 50 \text{ }^\circ\text{C}$, $OTS \leq 80 \text{ }^\circ\text{C}$: TR ON \leftrightarrow OFF (Pulse)

TR ON (for ECT)



TR OFF (for OTS)

3) $ECT \leq 50 \text{ }^\circ\text{C}$, $OTS \geq 80 \text{ }^\circ\text{C}$: TR ON \leftrightarrow OFF (Pulse)

TR ON (for OTS)

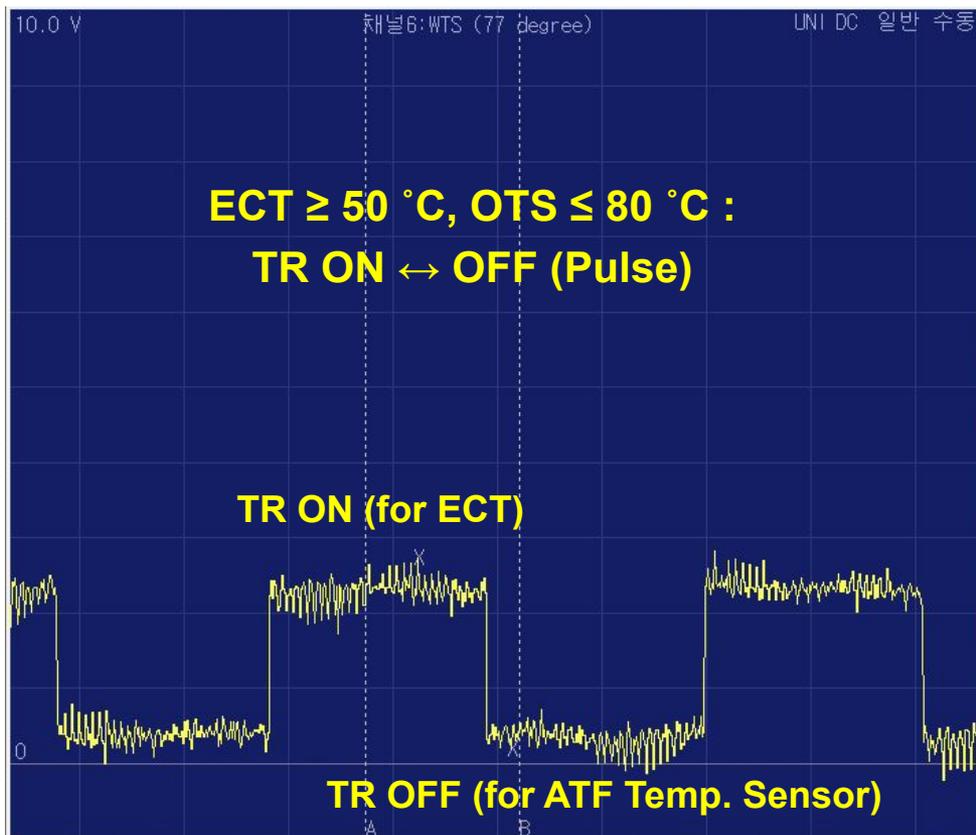


TR OFF (for ECT)

4) $ECT \geq 50 \text{ }^\circ\text{C}$, $OTS \geq 80 \text{ }^\circ\text{C}$: TR ON $\square 348 \text{ }\Omega$

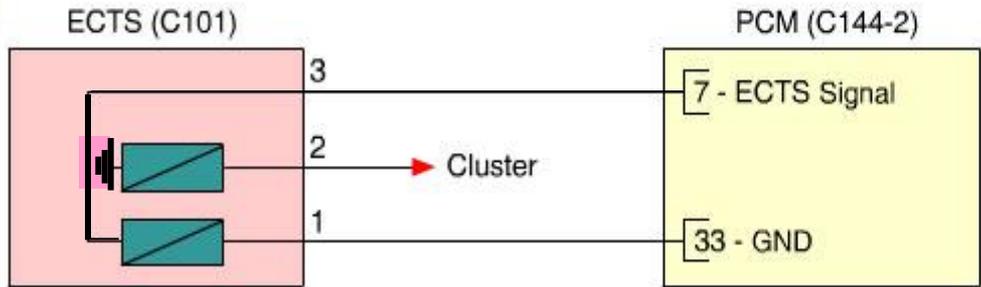
* ECT : Engine Coolant Temperature, OTS : Oil Temperature Sensor

Sensor output



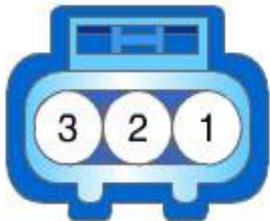
[ECT : 77 °C]

Pin assignment



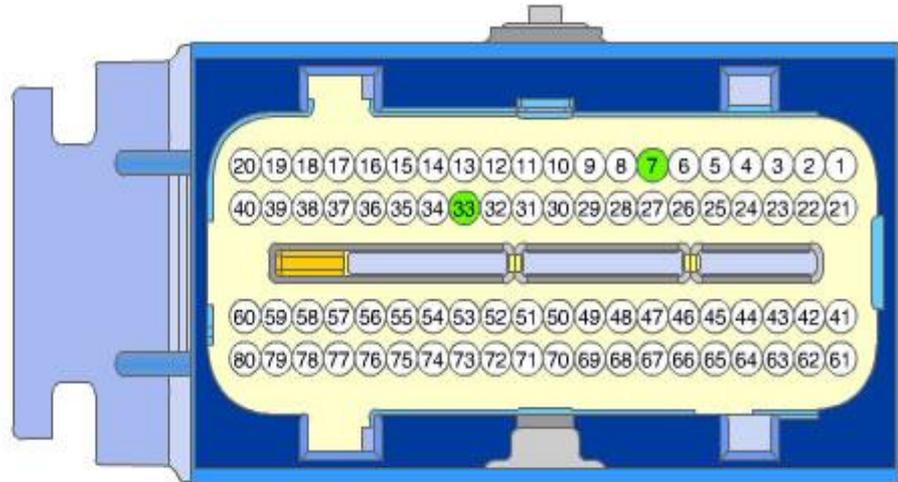
Terminal	Connected to	Function
1	PCM C144-2 (33)	Sensor ground
2	Cluster	-
3	PCM C144-2 (7)	ECTS Signal

[HARNESS CONNECTORS]



C101

ECTS



C144-2

PCM



MAF sensor outputs frequency (Hz) according to the intake air amount.

Frequency generator is assembled in sensor and this frequency is used for sensor output signal for better controlling and preventing electrical noise interference.

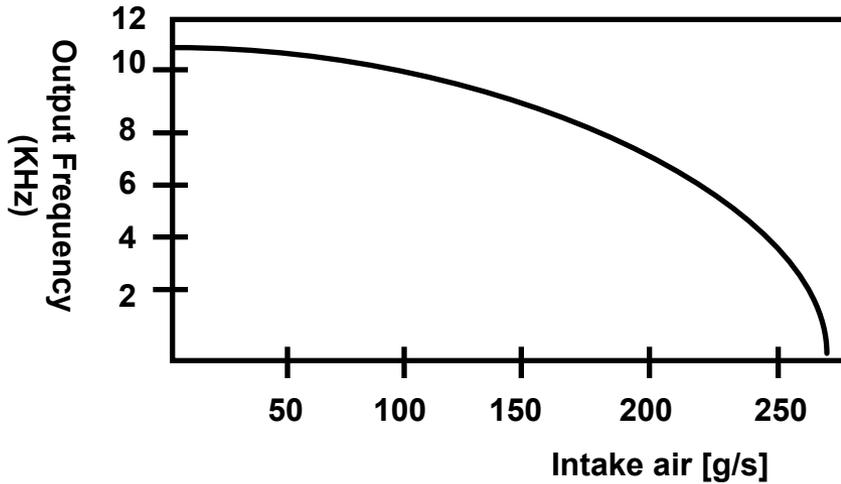
IAT sensor is assembled with MAF sensor.



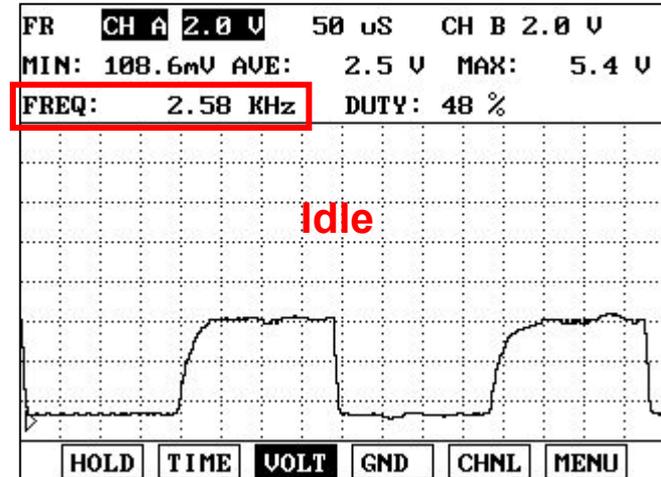
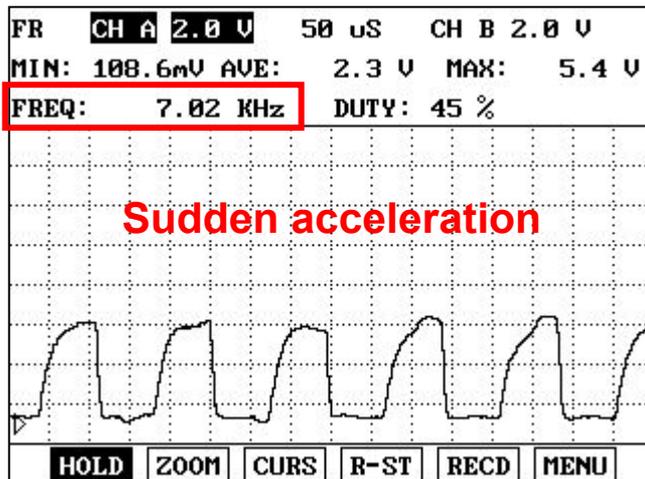
Technical Feature

- Measurable flow : ~ 250g/s
- Frequency : 0.7~12kHz
- Operating voltage : MAF : 9~16V
IAT : 5V

Output characteristics



FLOW (g/s)	NOMINAL FREQ. OUT (Hz)
3.5	2617
5	2958
6.5	3241
9	3653
12	4024
16	4399
20	4704
30	5329
40	5897
55	6553
75	7240
100	7957
135	8738
185	9644
250	10590



Failsafe

1. **When MAP sensor is normal** : replaced by MAP sensor
2. **When MAP sensor is failed** : replace by mapping data of intake air amount according to throttle angle and Engine rpm

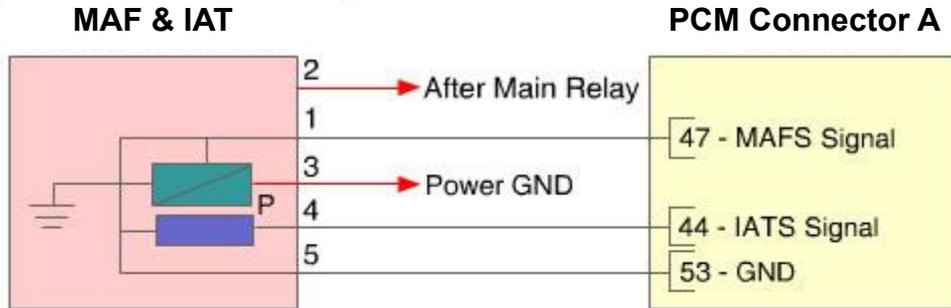
1.2 CURRENT DATA		06/74
MASS AIR FLOW	0.1 g/s	▲
INT. AIR TEMP. SNSR	-40.0°C	■
MAP SENSOR	270.1mmHg	
BAROMETIC PRESS.	750.2mmHg	
ENGINE SPEED	713 rpm	
TARGET IDLE RPM	700 rpm	
ENGINE STATE-IDLE	ON	
VEHICLE SPEED	0 Km/h	▼

1.1 DIAGNOSTIC TROUBLE CODES
P0113 INTAKE AIR TEMP.-HI INPUT
P1111 INTAKE AIR TEMP CIRC. HIGH
P0102 AIR FLOW SIG.-LOW INPUT

NUMBER OF DTC : 3 ITEMS

[[When MAF sensor connector is open]]

Pin assignment

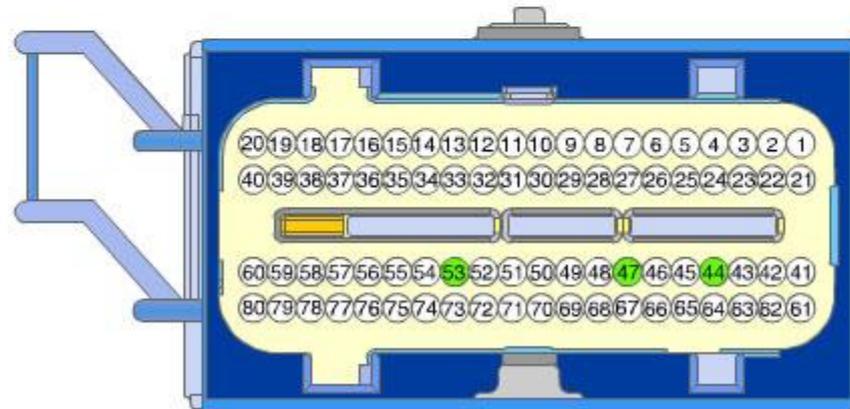


Terminal	Connected to	Funtion
1	PCM C144-1 (47)	MAFS Signal
2	Main Relay	Battery Voltage (B+)
3	Chassis Ground	Ground
4	PCM C144-1 (44)	IATS Signal
5	PCM C144-1 (53)	Sensor Ground

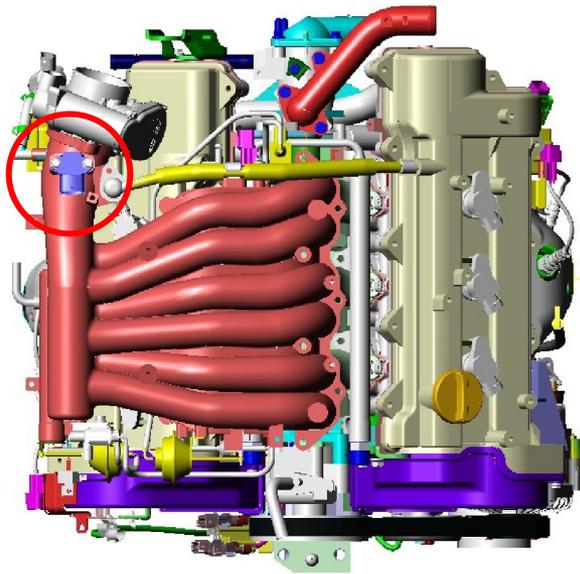
[HARNESS CONNECTORS]



MAF & IAT



PCM Connector A



MAP (Manifold Absolute Pressure) sensor is installed on the surge tank. It detects the absolute pressure in surge tank and send it to ECM.

In case of WOT, some delay between the MAF sensor signal output and the real intake air flow (Transient Range), MAP sensor value replaces the MAF signal at those condition.

Also when MAF sensor failure is detected by ECM, MAP sensor is altered as an main sensor.

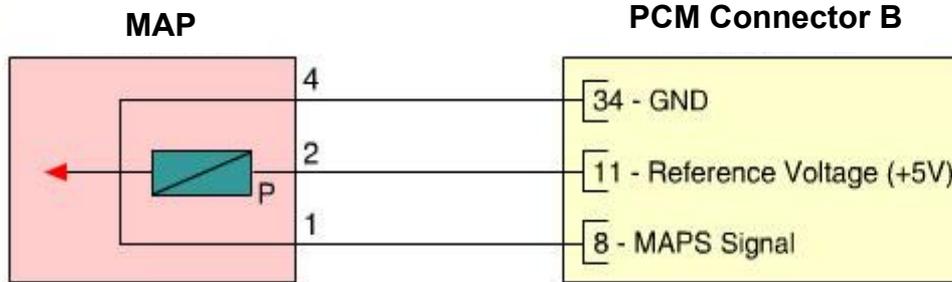
Technical features



- Sensor Type : Piezo Resistive
- Pressure range : 20 ~ 107 kPa
- Temperature range : -40°C ~ 130°C
- Supply voltage : 5 V ± 0.25 V
- Output voltage : 0.789 ~ 4.224V

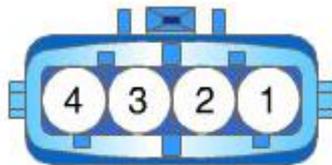


Pin assignment

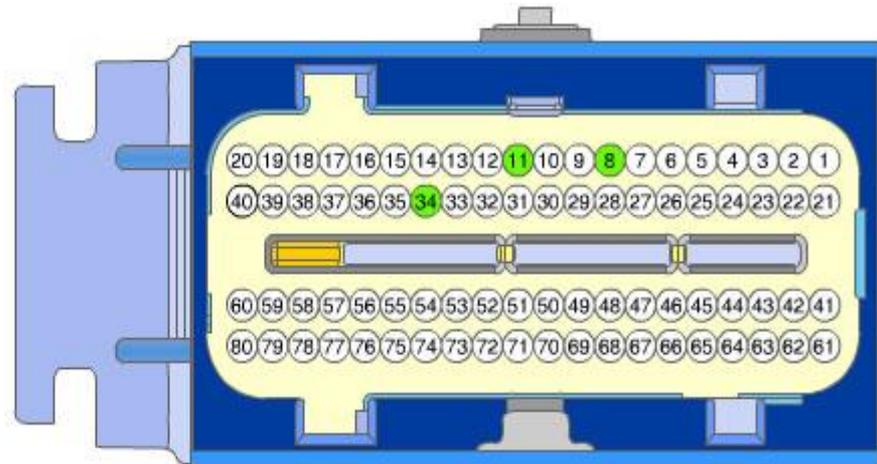


Terminal	Connected to	Function
1	PCM C144-2 (8)	MAPS Signal
2	PCM C144-2 (11)	Reference Voltage (+5V)
3	-	-
4	PCM C144-2 (34)	Sensor ground

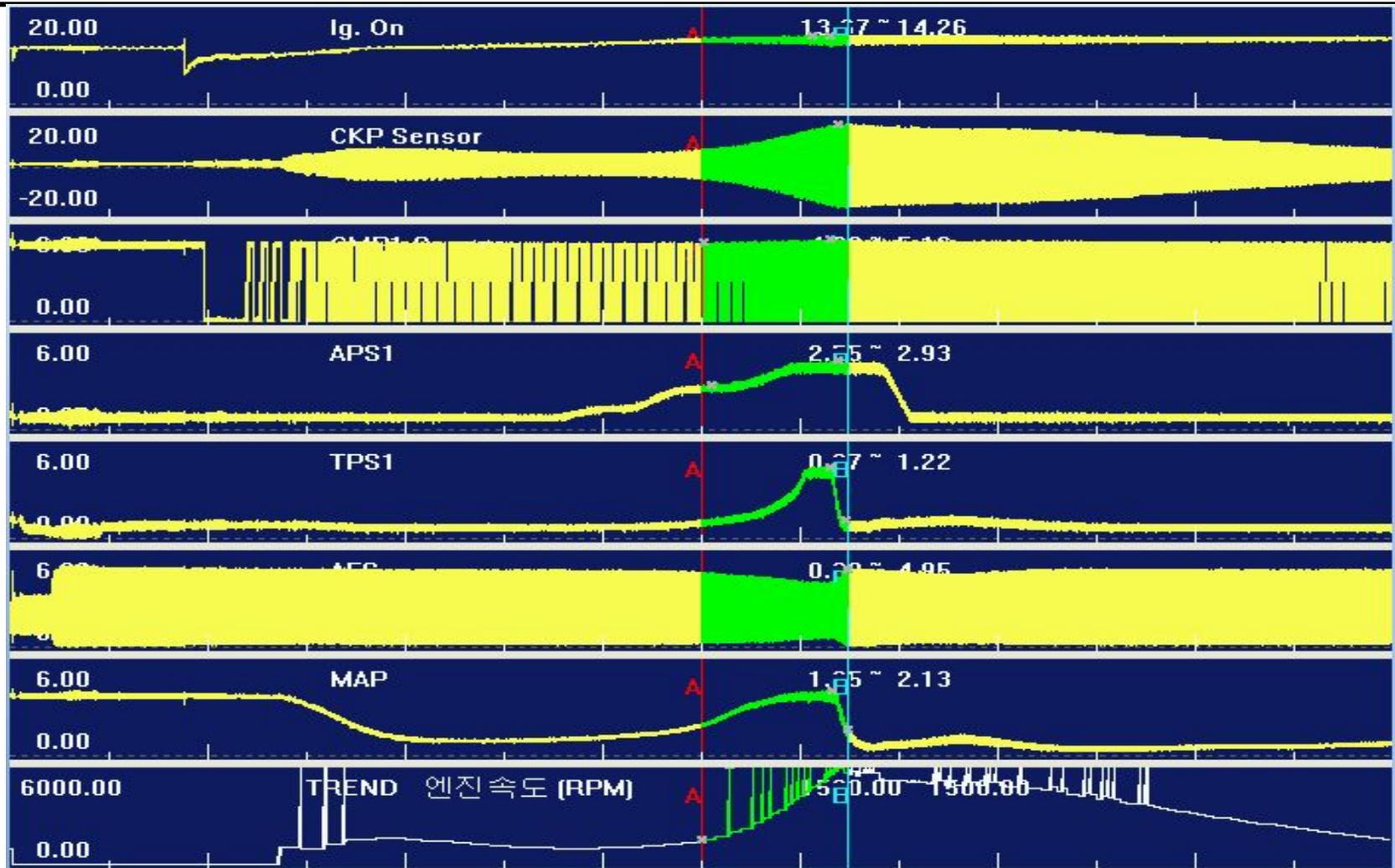
[HARNESS CONNECTORS]



MAP



PCM Connector B



When ECM reaches a transient range such as sudden acceleration or deceleration, MAF value is not reliable so MAP sensor signal is used instead of MAF's.

Point A to B is kind of transient range example.

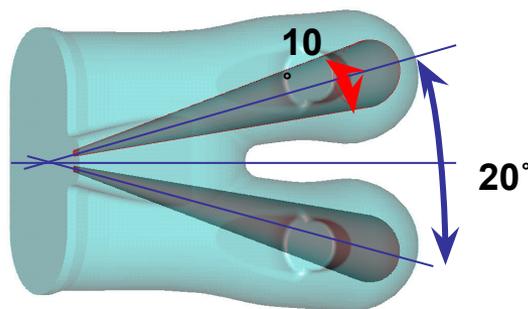
Failsafe

1.2 CURRENT DATA		08/74
MASS AIR FLOW	3.8 g/s	▲
INT. AIR TEMP. SNSR	24.0 °C	■
MAP SENSOR	0.0 mmHg	
BAROMETIC PRESS.	757.7mmHg	
ENGINE SPEED	723 rpm	
TARGET IDLE RPM	687 rpm	
ENGINE STATE-IDLE	ON	
VEHICLE SPEED	0 Km/h	▼

1.1 DIAGNOSTIC TROUBLE CODES
P0113 INTAKE AIR TEMP.-HI INPUT
P1111 INTAKE AIR TEMP CIRC. HIGH
P0102 AIR FLOW SIG.-LOW INPUT

NUMBER OF DTC : 3 ITEMS

[[When MAP sensor connector is open]]



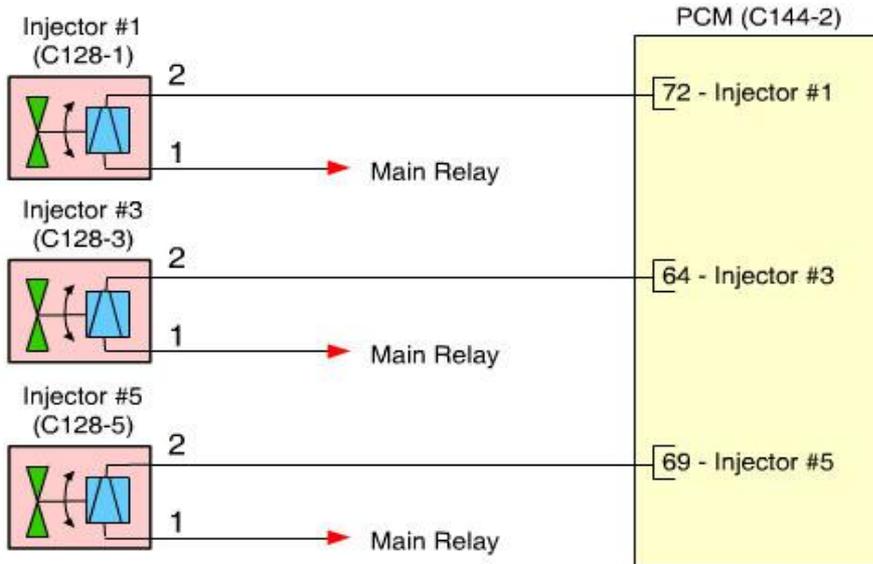
Technical features

- EV6 (Kefico) : 4 Hole, 2 Spray
- Flow rate: 150g/min
- Spray Pattern - Cone angle : 10°
- Spray Angle : 20°
- Coil resistance : 12 ~ 14.5 Ω

Engine speed limit

Engine speed limit by injection fuel cut is only available at driving range in case of AT.
RPM Limit at P or N is done by ETC throttle control.

Pin assignment



Injector #1

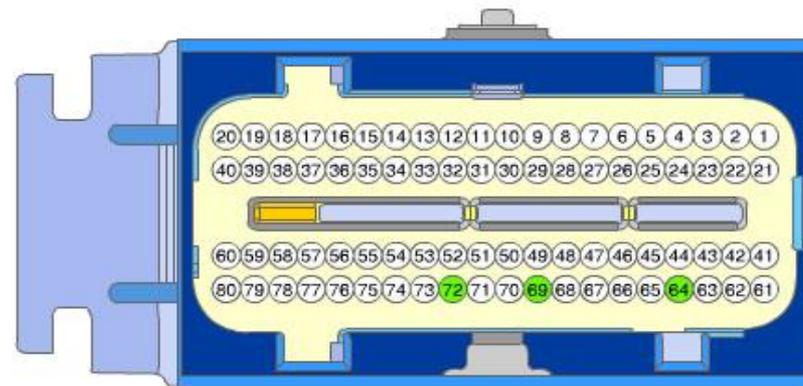
Terminal	Connected to	Function
1	Main Relay	Battery Voltage (B+)
2	PCM C144-2 (72)	Injector #1 control

Injector #3

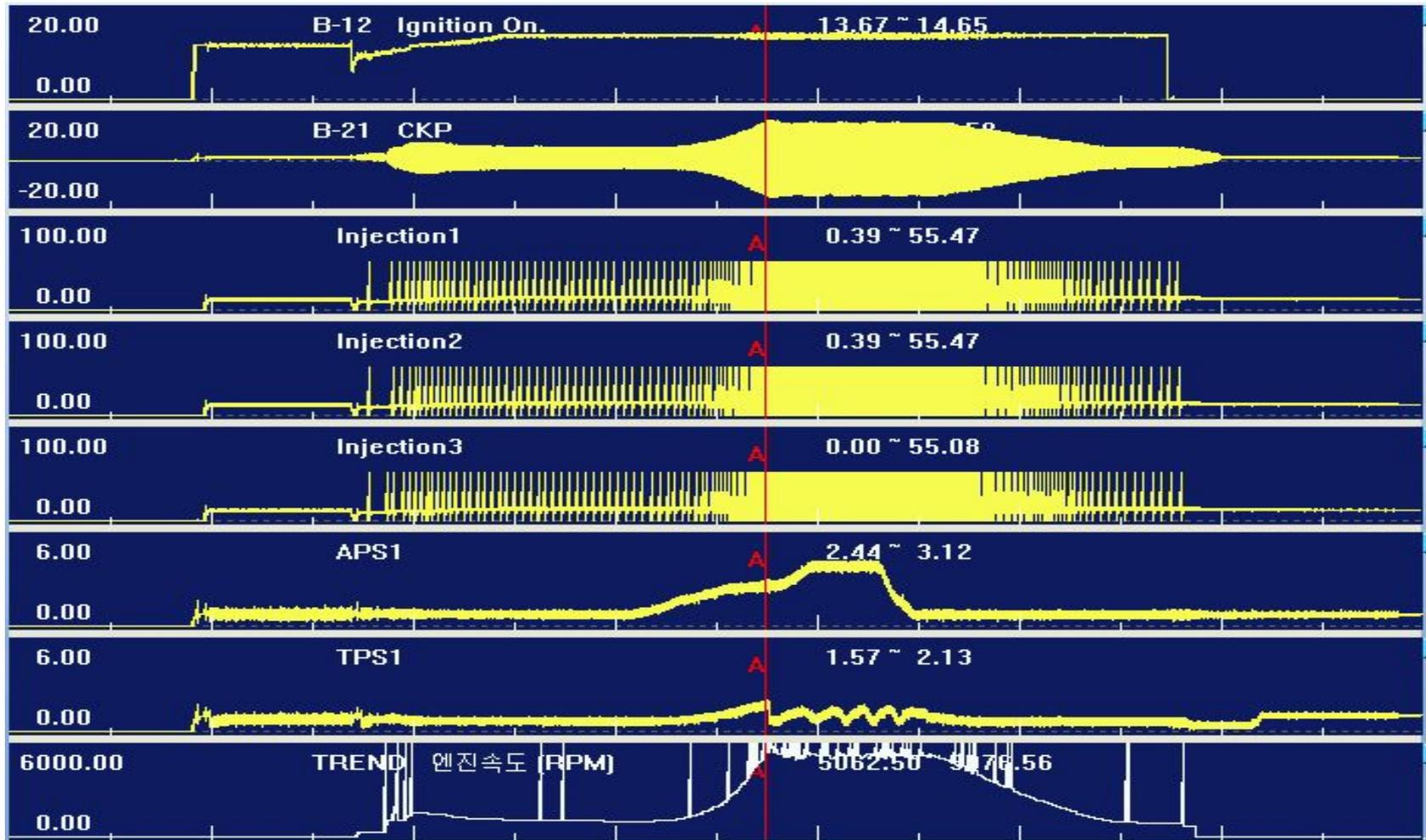
Terminal	Connected to	Function
1	Main Relay	Battery Voltage (B+)
2	PCM C144-2 (64)	Injector #3 control

Injector #5

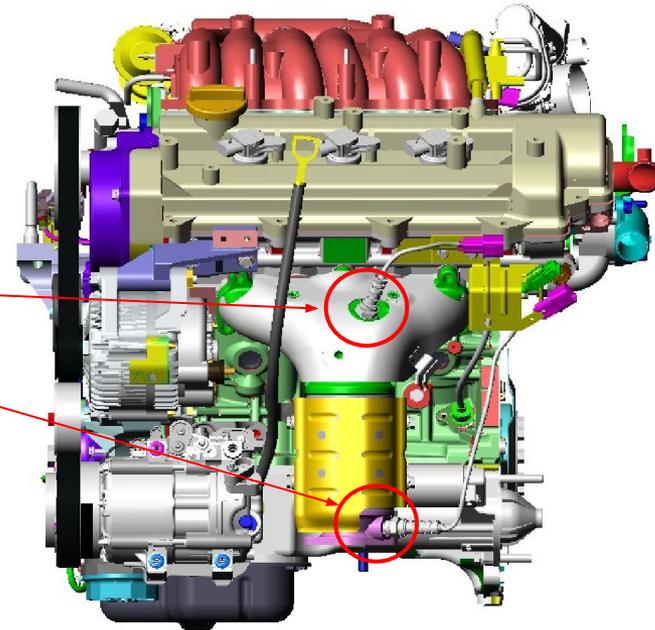
Terminal	Connected to	Function
1	Main Relay	Battery Voltage (B+)
2	PCM C144-2 (69)	Injector #5 control



C144-2
PCM



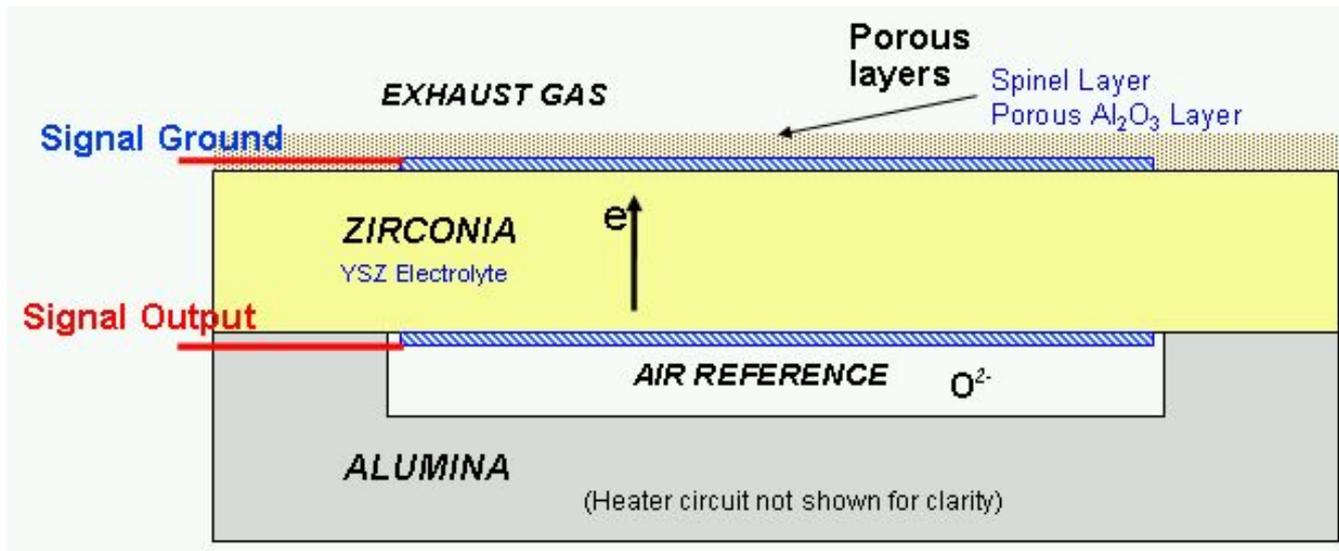
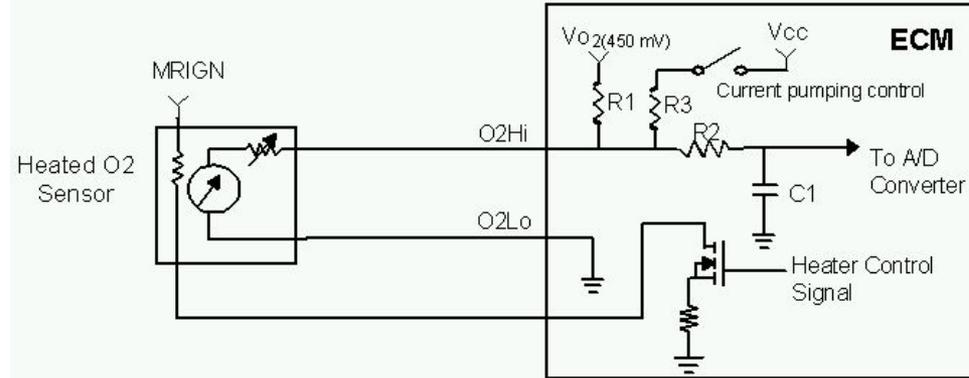
Injector fuel cut at high rpm is not available at idling (AT: P&N, MT: Neutral position). Because ETC controls throttle valve instead to limit engine speed less than 5000rpm under this condition. However injector fuel cut is available at driving range and engine speed limit is 6,800rpm.



Zirconia type oxygen sensor with a current pumping method to create reference chamber is installed. This type has been already applying to Lamda engine.

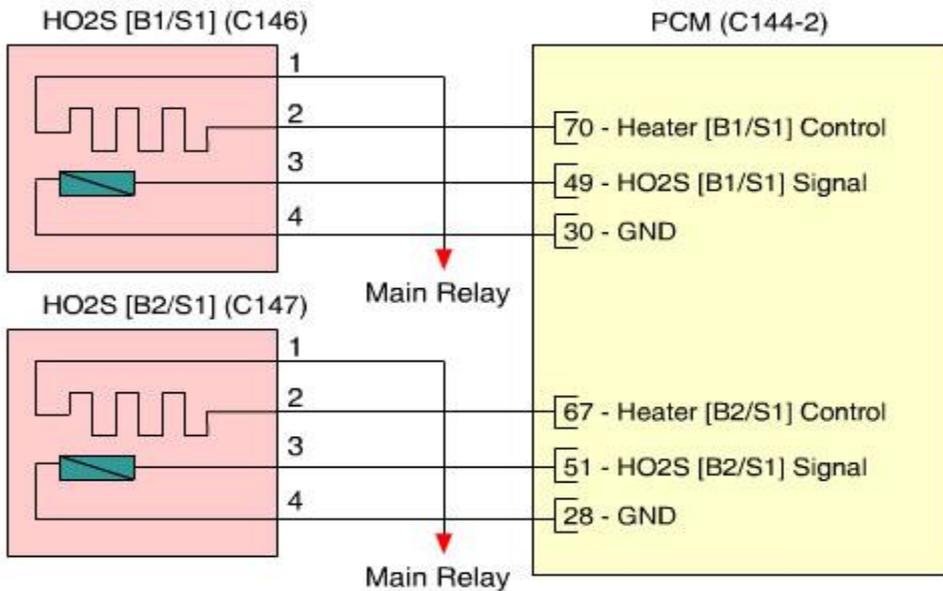
Each bank has 2 oxygen sensors.

Operating principle



When ECM supply current through signal output line which is about $7 \sim 10 \mu\text{A}$, air reference chamber is charged with oxygen ion from exhaust gas through zirconia material. This is the another characteristics in zirconia. When current is applied it can transfer oxygen ion. Current supplying line is shared with oxygen sensor signal line.

Pin assignment

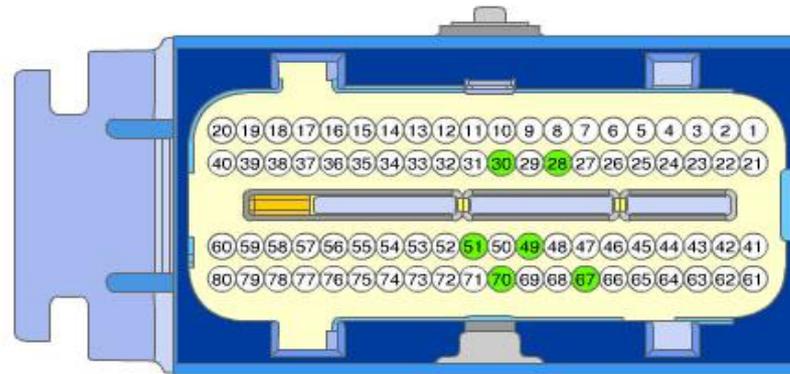


HO2S [B1/S1]

Terminal	Connected to	Function
1	Main Relay	Battery Voltage (B+)
2	PCM C144-2 (70)	Heater [B1/S1] Control
3	PCM C144-2 (49)	HO2S [B1/S1] Signal
4	PCM C144-2 (30)	Sensor ground

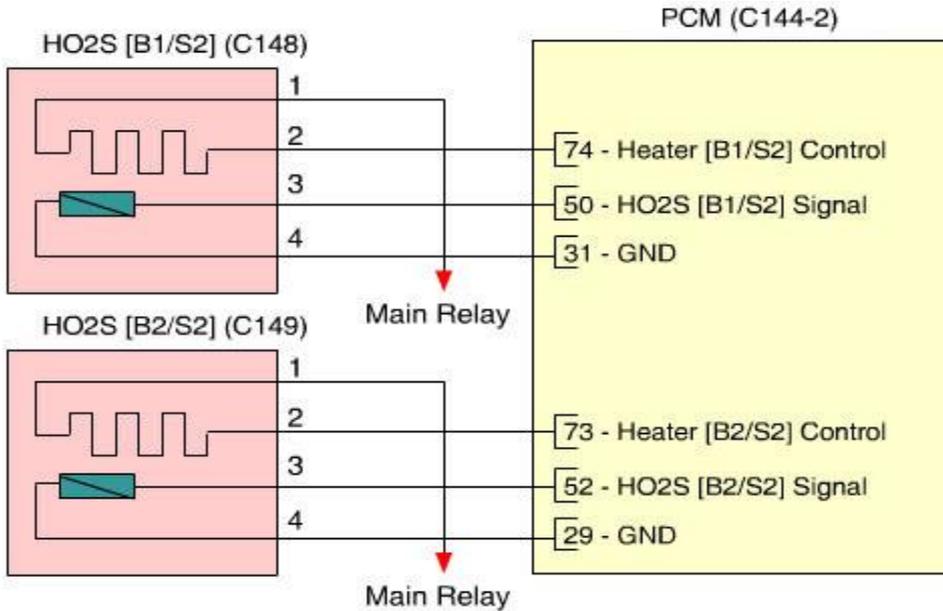
HO2S [B2/S1]

Terminal	Connected to	Function
1	Main Relay	Battery Voltage (B+)
2	PCM C144-2 (67)	Heater [B2/S1] Control
3	PCM C144-2 (51)	HO2S [B2/S1] Signal
4	PCM C144-2 (28)	Sensor ground



C144-2
PCM

Pin assignment

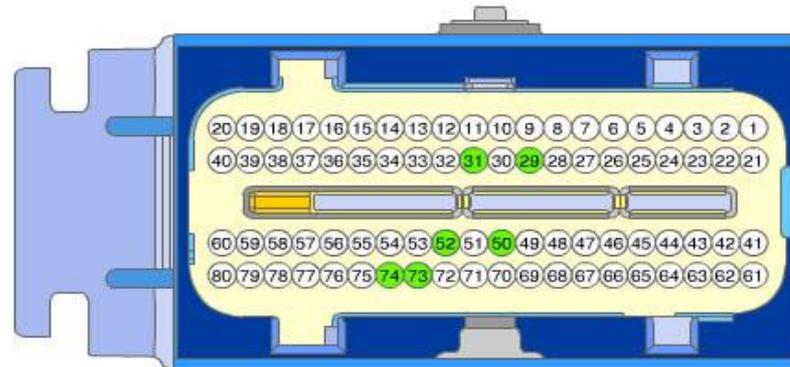


HO2S [B1/S2]

Terminal	Connected to	Function
1	Main Relay	Battery Voltage (B+)
2	PCM C144-2 (74)	Heater [B1/S2] Control
3	PCM C144-2 (50)	HO2S [B1/S2] Signal
4	PCM C144-2 (31)	Sensor ground

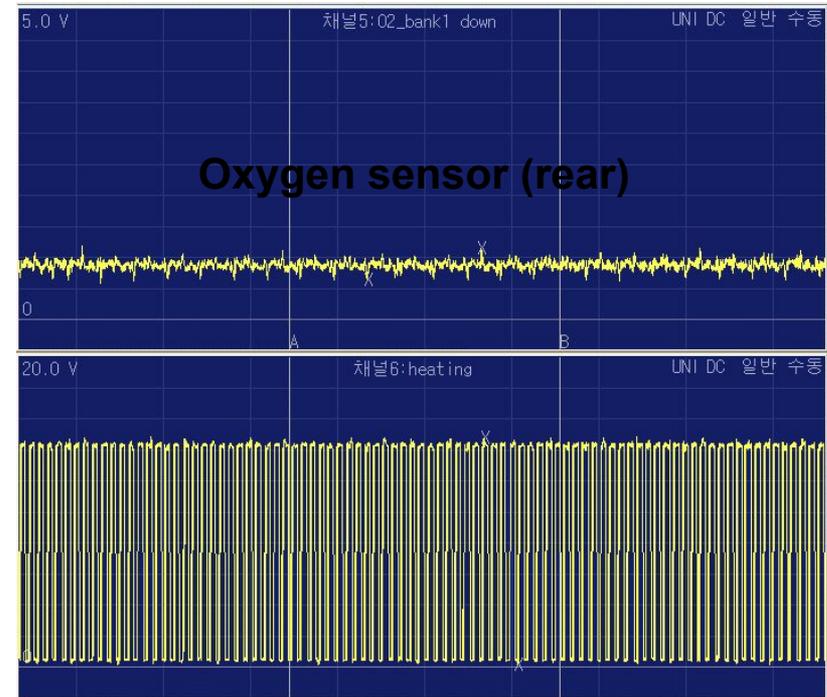
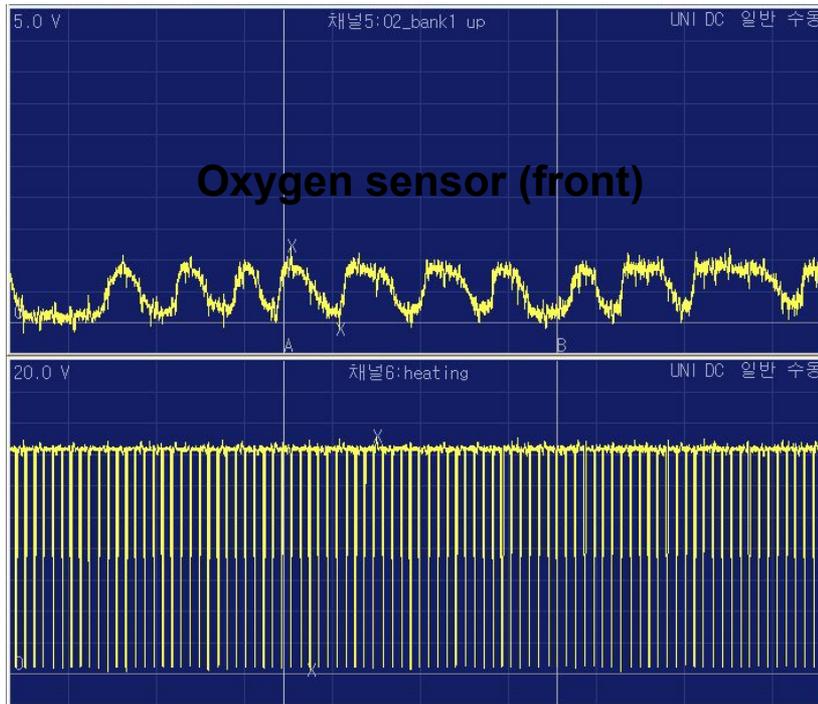
HO2S [B2/S2]

Terminal	Connected to	Function
1	Main Relay	Battery Voltage (B+)
2	PCM C144-2 (73)	Heater [B2/S2] Control
3	PCM C144-2 (52)	HO2S [B2/S2] Signal
4	PCM C144-2 (29)	Sensor ground

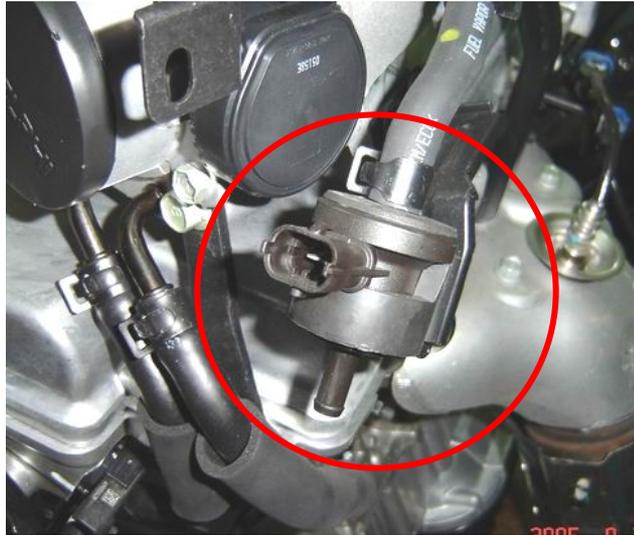


C144-2
PCM

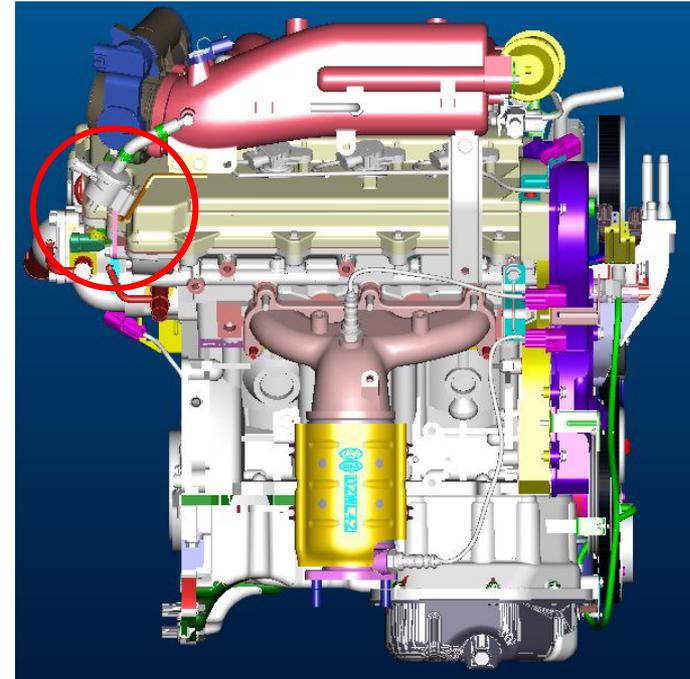
Sensor output



Even reference chamber is created by electrically, oxygen sensor waveform is same as the one without pumping mechanism. Rear Oxygen sensor shows linear waveform with a good catalytic converter.



**Purge solenoid valve
(Filter built-in type)**

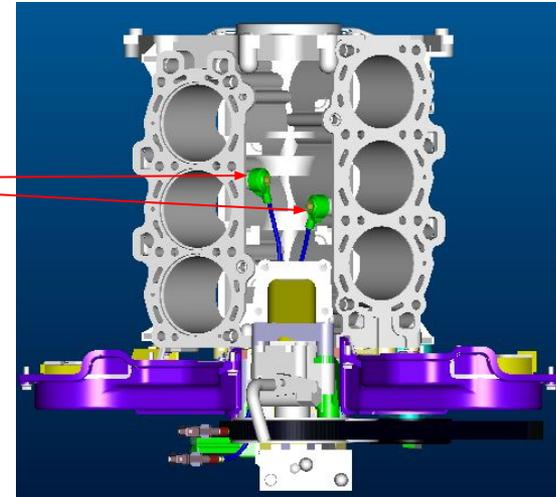


Technical Feature

- Normally closed valve
- Max. flow : 6.5 m³/h
- Control type : Duty basis
- Frequency : up to 30 Hz
- Coil resistance : 16±2 Ω

One of the common problems in fuel controlling is from leakage through PCSV. Mainly this leakage happens from foreign material stuck in PCSV.

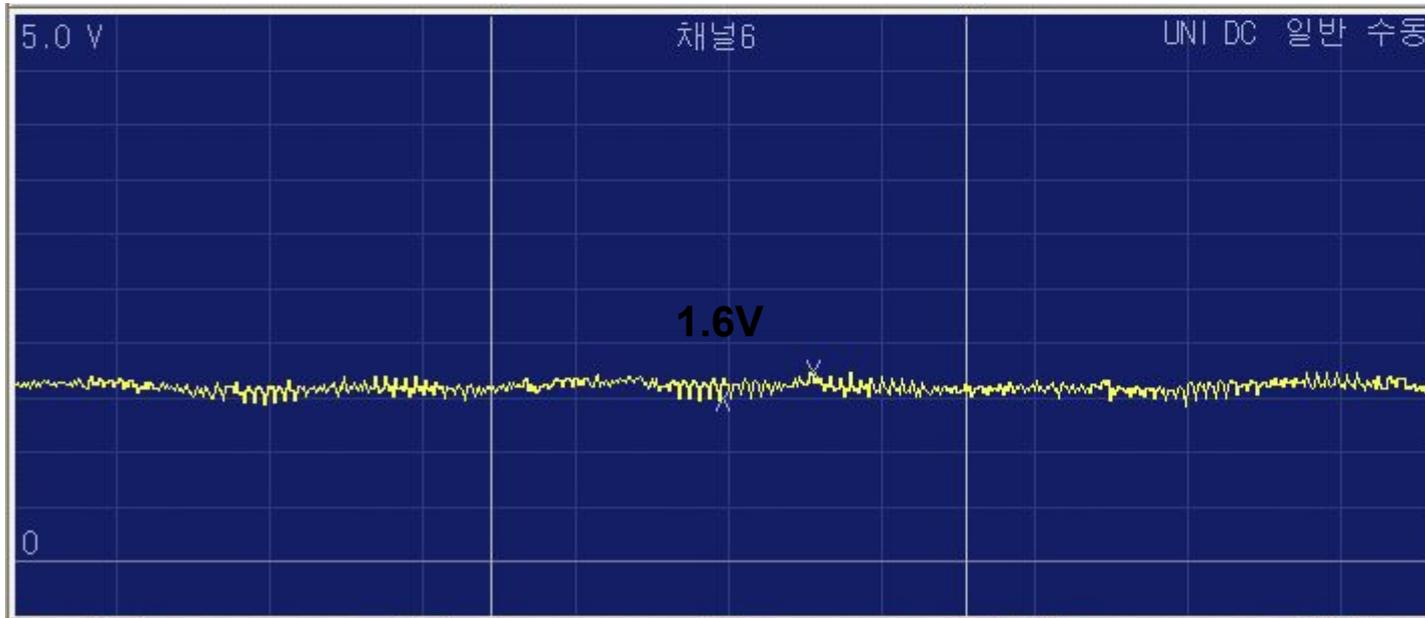
To prevent this abnormal leakage, **PCSV adopts pre filter inside.**



When knock is detected, ECM retards the ignition timing to certain range.

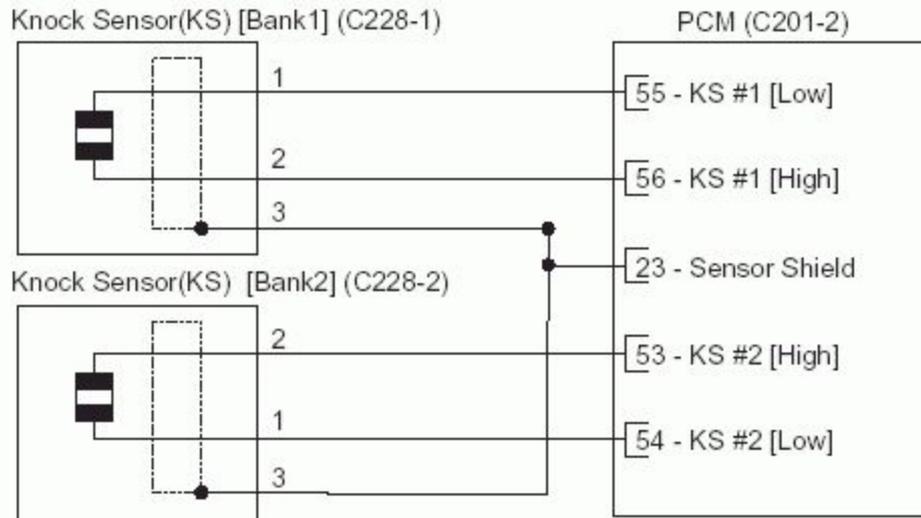
If knocking disappears after retarding ignition timing, ECM will advance the ignition timing to improve engine power and torque.

Sensor output



[Knock sensor output at engine idle]

Pin assignment



KS [Bank1]

Terminal	Connected to	Function
1	PCM C201-2 (55)	KS #1 [Low] signal
2	PCM C201-2 (56)	KS #1 [High] signal
3	PCM C201-2 (23)	Shield ground

KS [Bank2]

Terminal	Connected to	Function
1	PCM C201-2 (54)	KS #2 [Low] signal
2	PCM C201-2 (53)	KS #2 [High] signal
3	PCM C201-2 (23)	Shield ground

[HARNESS CONNECTORS]



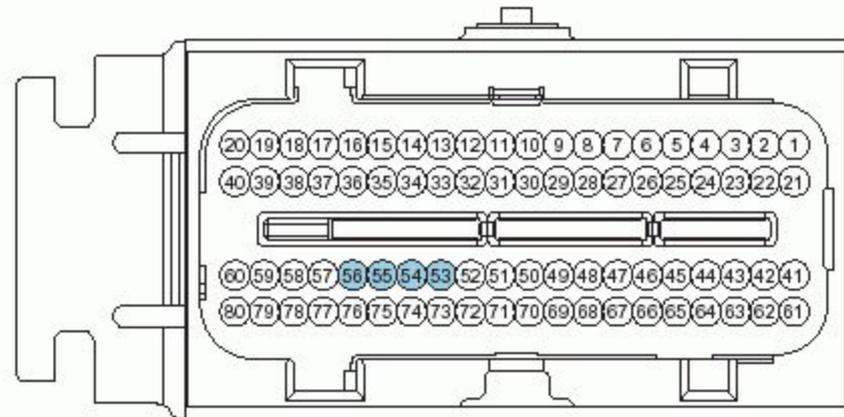
C228-1

KS [Bank1]



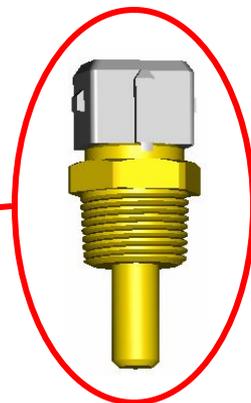
C228-2

KS [Bank2]



C201-2

PCM

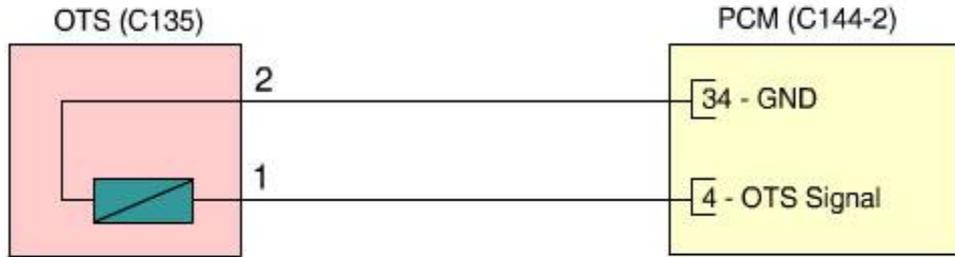


Technical feature

- Type : NTC thermistor
- Operating Temp. : -40°C ~170°C
- Resistance : - 20°C : 16.52kΩ
 20°C : 2.45 kΩ
 80°C : 0.2889kΩ

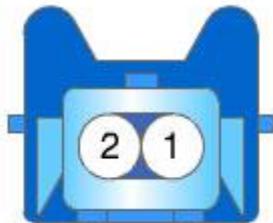
It is Installed on the cylinder block and detects the oil temperature for the fine OCV (Oil Control Valve) control of CVVT system according to the temperature variation.

Pin assignment



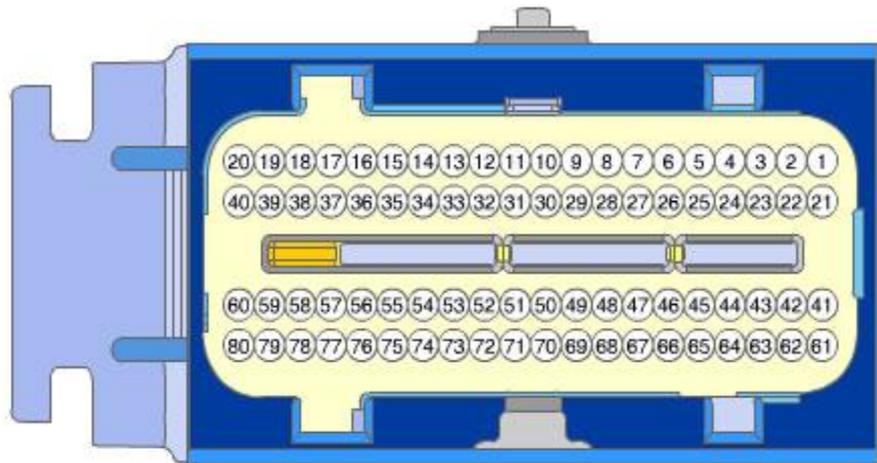
Terminal	Connected to	Function
1	PCM C144-2 (4)	OTS Signal
2	PCM C144-2 (34)	Sensor ground

[HARNESS CONNECTORS]



C135

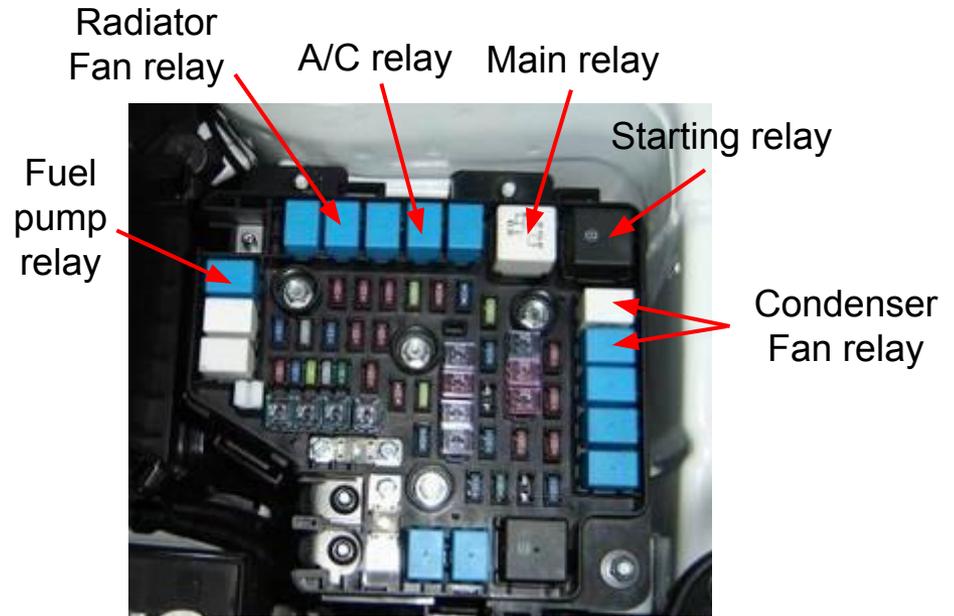
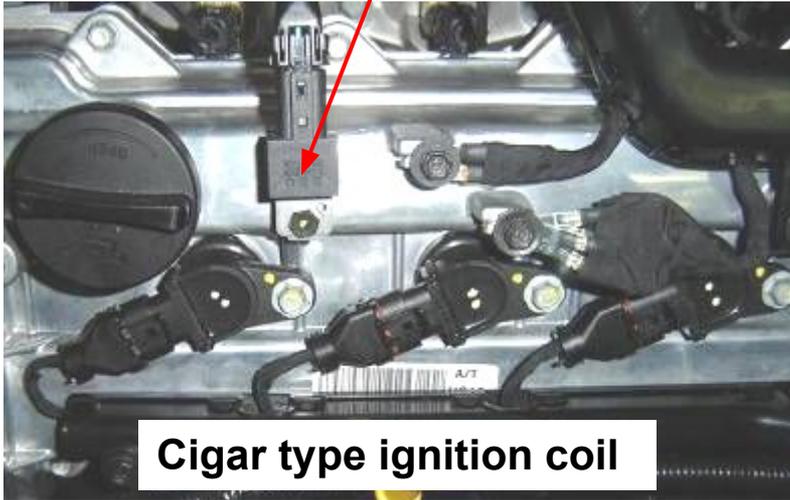
OTS



C144-2

PCM

Ignition capacitor (for noise removal)



Ignition coil is the same type as Theta's. It is a cigar type stick coil with individual ignition controlling. Spark plug is iridium type for long life time.