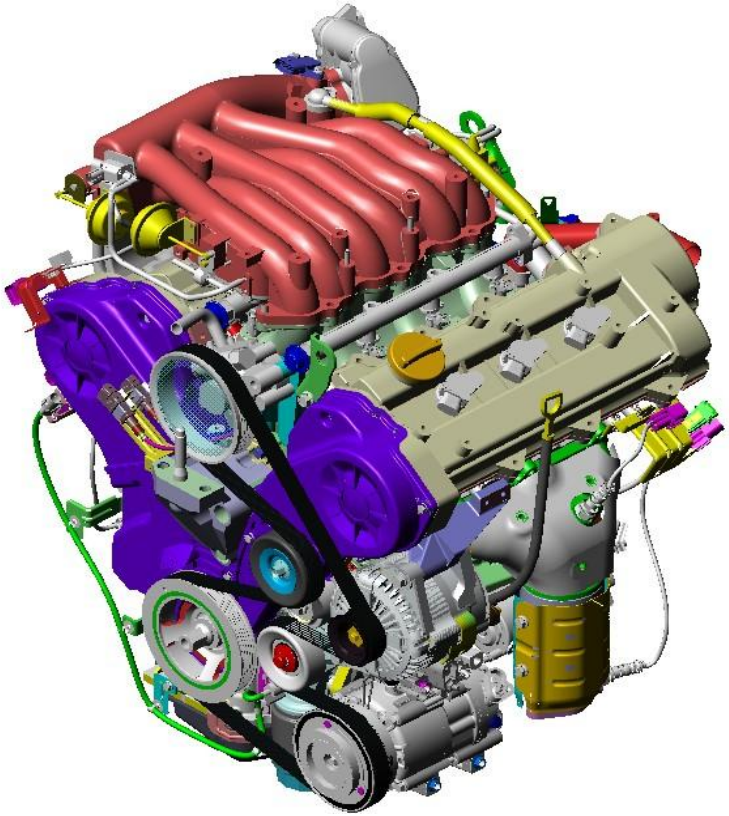
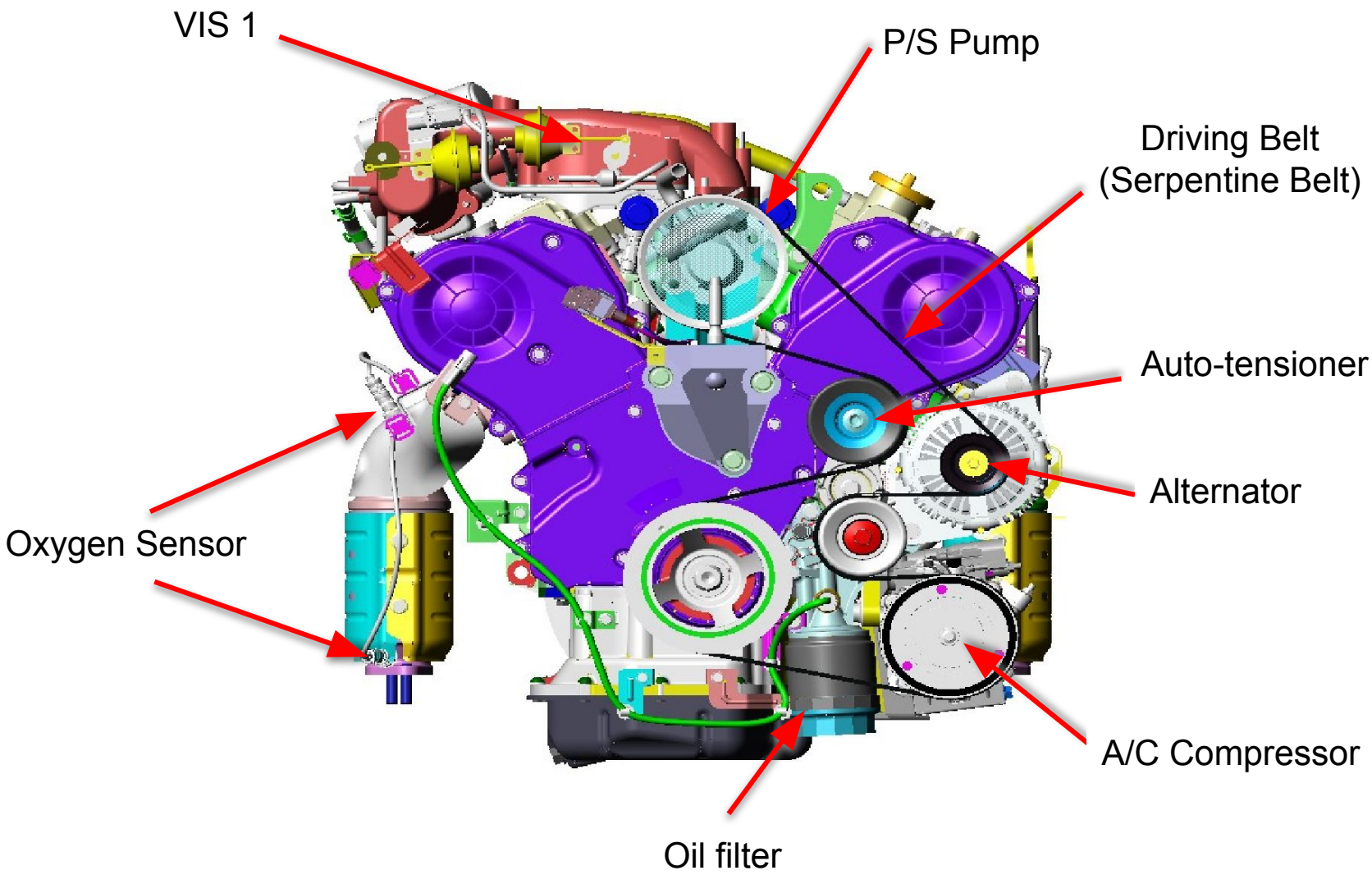
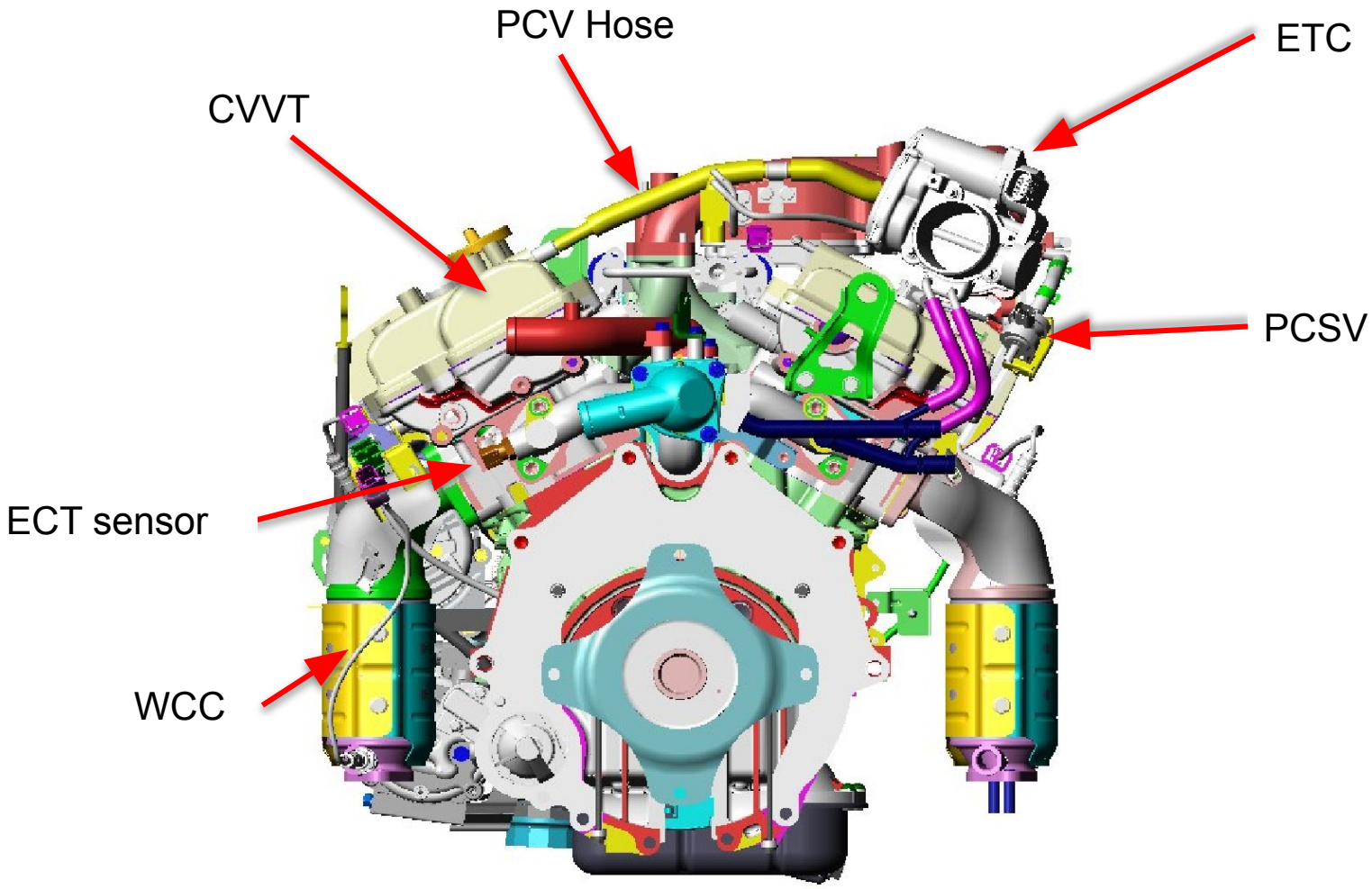
CM
MU(μ)



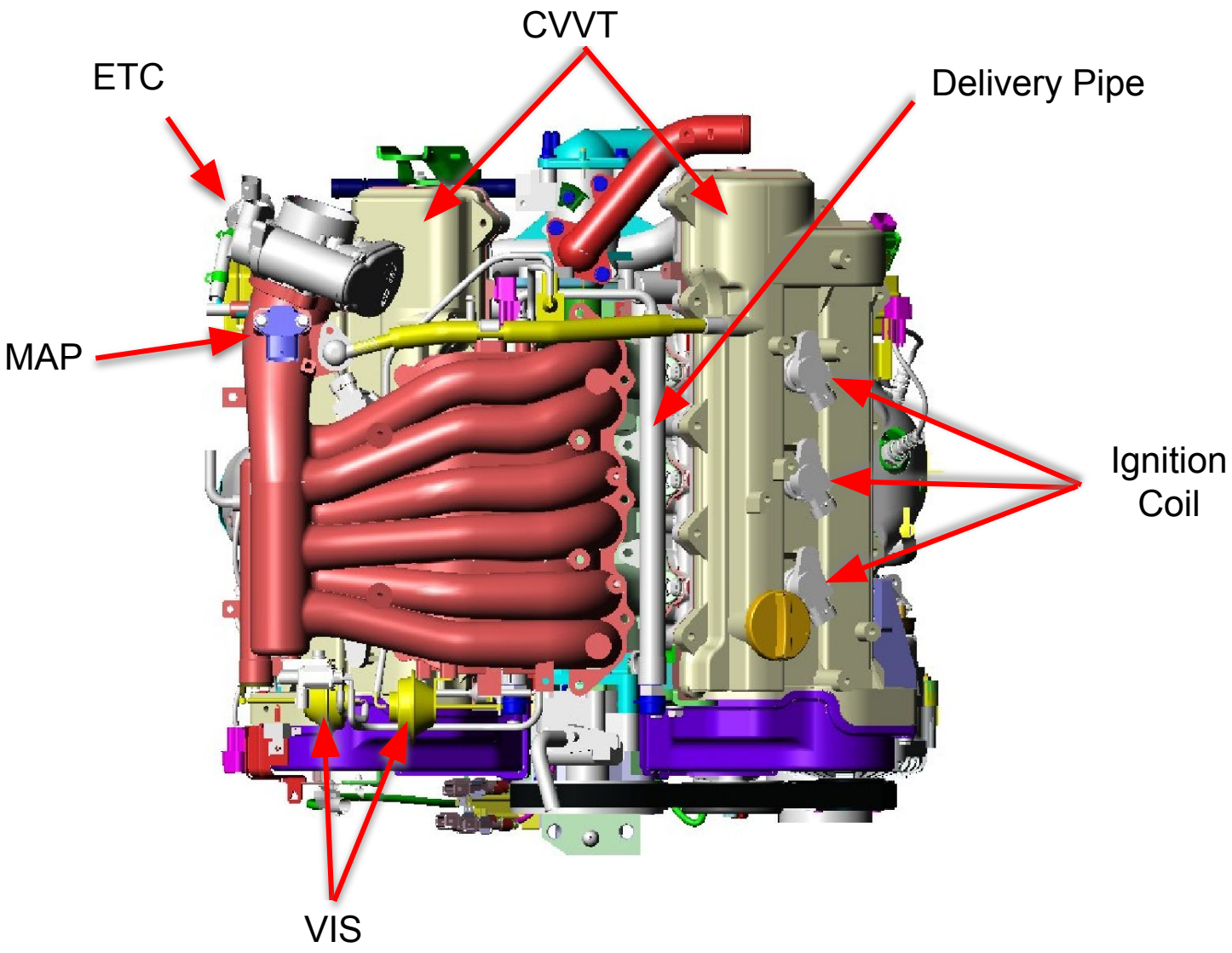
Front View


VIS 1
P/S Pump
Driving Belt
(Serpentine Belt)
Auto-tensioner
Alternator
Oxygen Sensor
A/C Compressor
Oil filter

Rear View



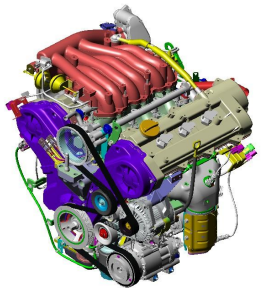
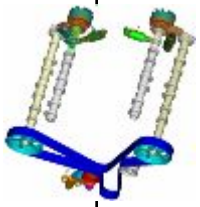
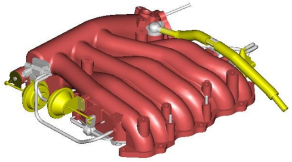
Top View



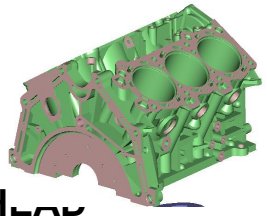
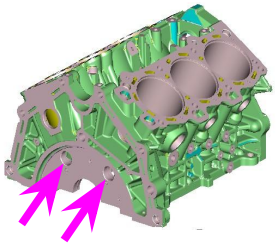
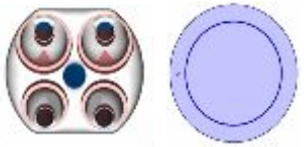
Specification

Contents	μ- 2.7	Contents	μ- 2.7
Capacity(cc)	**2,656**	**Fuel pressure (kg/㎠)**	**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**		

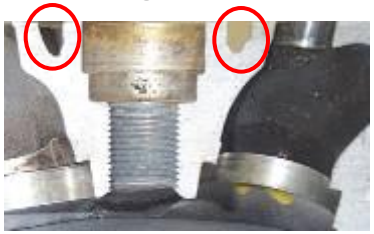
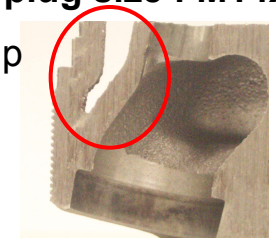
Comparison between Delta and Mu

Changed Item		DELTA	MU
Appearance			
Performance, fuel consumption	Valve Train	• **Non-CVVT** • **HLA** 	**CVVT** MLA **Duplex +Tensioner** 
	Intake	• **VIS : 3 step** 	**IS : 3 step** 
		• **Throttle Body** 	**ETC** 

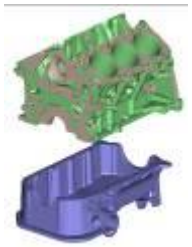
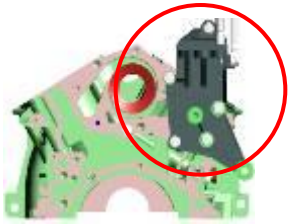
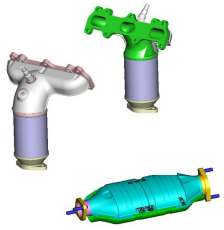
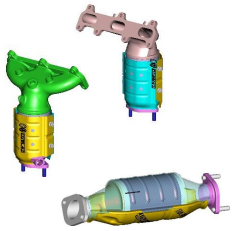
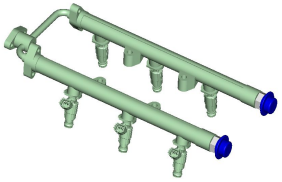
Comparison between Delta and Mu

Changed Item		DELTA	MU
Performance, fuel consumption	Ignition Coil	• **2 Tower type** 	• **Cigar type** 
	C/BLOCK : Less pumping loss	• **No hole on BULKHEAD** 	• 2 holes **on BULKHEAD** 
	Compression Ratio (CR) & Squish Area	• **CR=10.0**  **SQUISH : IN/EX direction**	• CR=10.4  **SQUISH : IN/EX &,** FRT/RR direction
	Piston	• **Piston load : 5.3kgf (Sn coating)** 	• **Piston load : 3.3kgf (Sn coating + Graphite coating)** 

Comparison between Delta and Mu

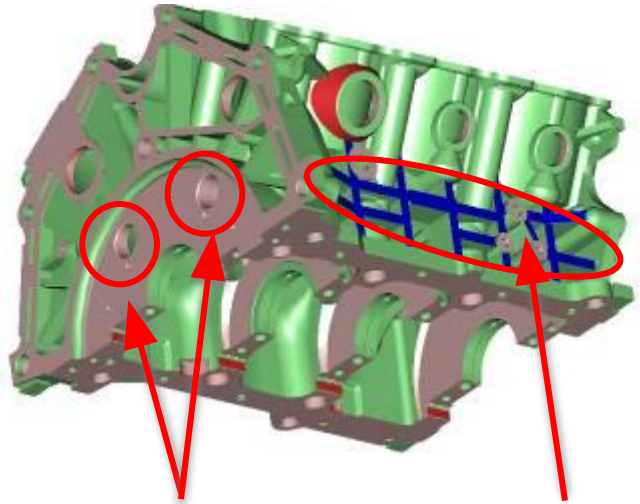
Changed Item		DELTA	MU
Cooling	Cylinder Head (Long reach spark plug)	**Spark plug size : M14X19** 	• Water jacket size up **(Spark plug size : M14X26.5)** Size-up 
Reliability	Alternator position	• **Cabin side** 	• **Front side** 
Cost Down	ECM	• **Separated ECM/TCM** 	• **Integrated ECM/TCM** 

Comparison between Delta and Mu

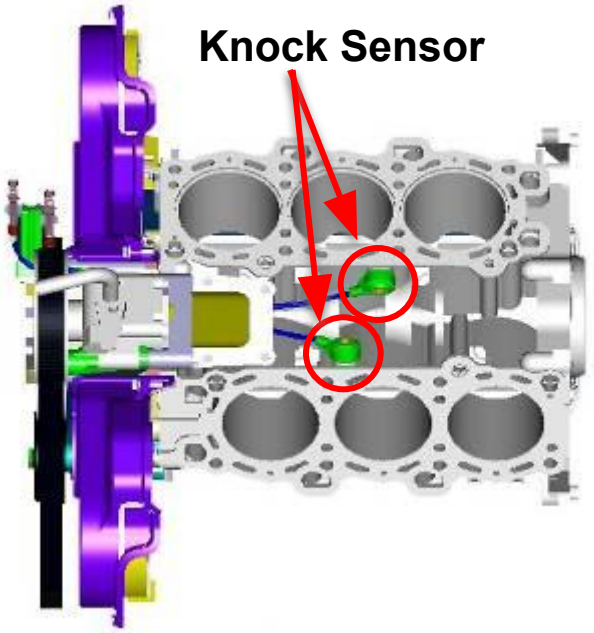
Changed Item		DELTA	MU
Noise	Increased P/T combine force		• **Reinforced block** (More RIBs) 
	Engine Support Brocket		
Emission	Catalystic Converter	• **WCC; 2*0.5ℓ** • **Oval UCC (2*0.9ℓ)** 	• **WCC; 2*0.6ℓ** • **COVER added** • **Round UCC (2*0.76ℓ)** 
	Fuel pipe	• **Return type** 	• **Returnless ty** 

Cylinder Block

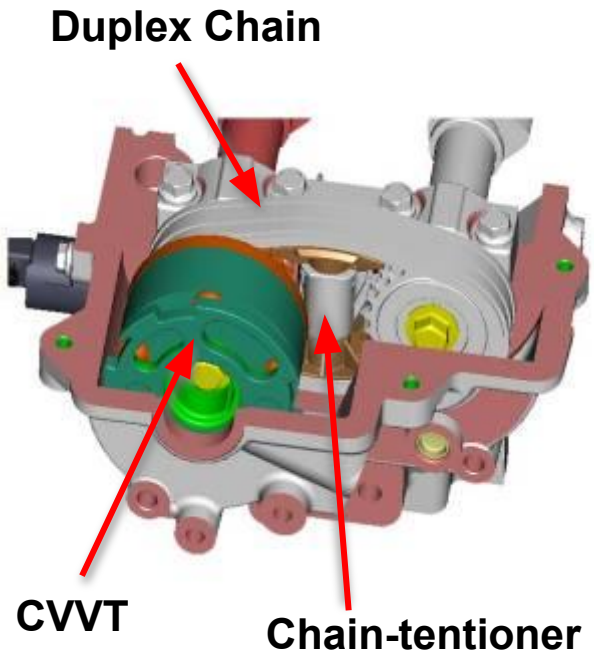
- Press Fit type liner (Aluminum block)
- 2 Ventilation Hall – Decreased pumping loss



2 Ventilation Holes Added ribs



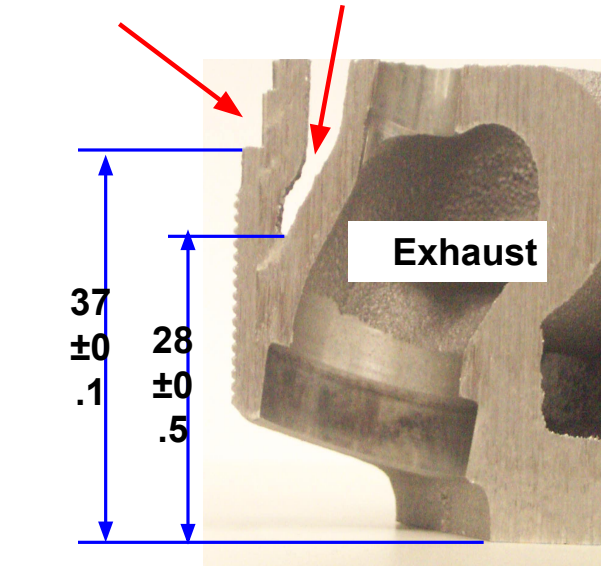
Cylinder Head



Oil Circuit

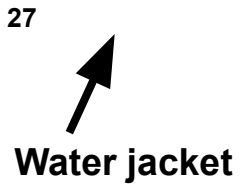
- Oil circuit for CVVT (Improved response)
- Oil circuit for chain tensioner

Cylinder Head



Standard Type

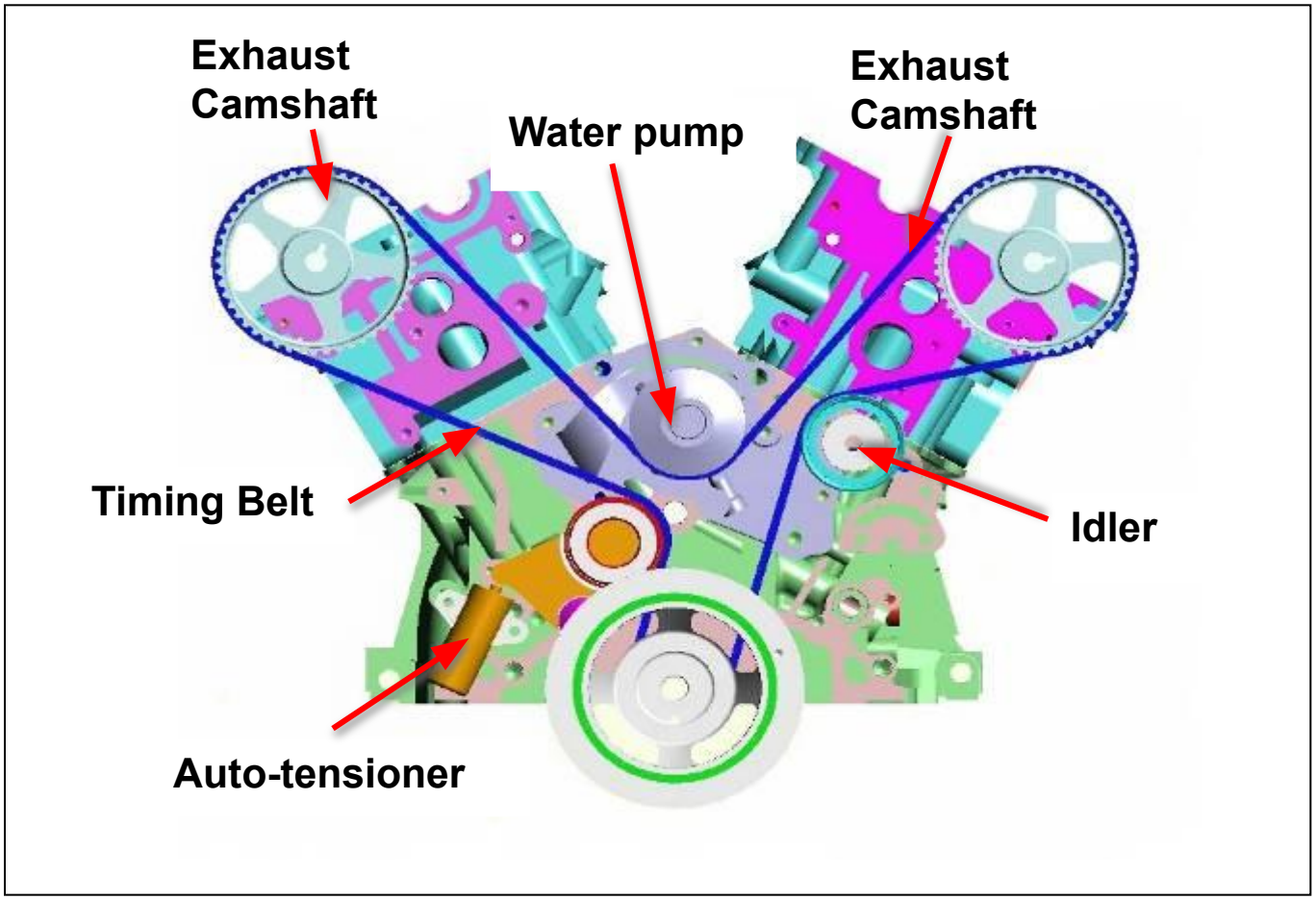
LRSP Type



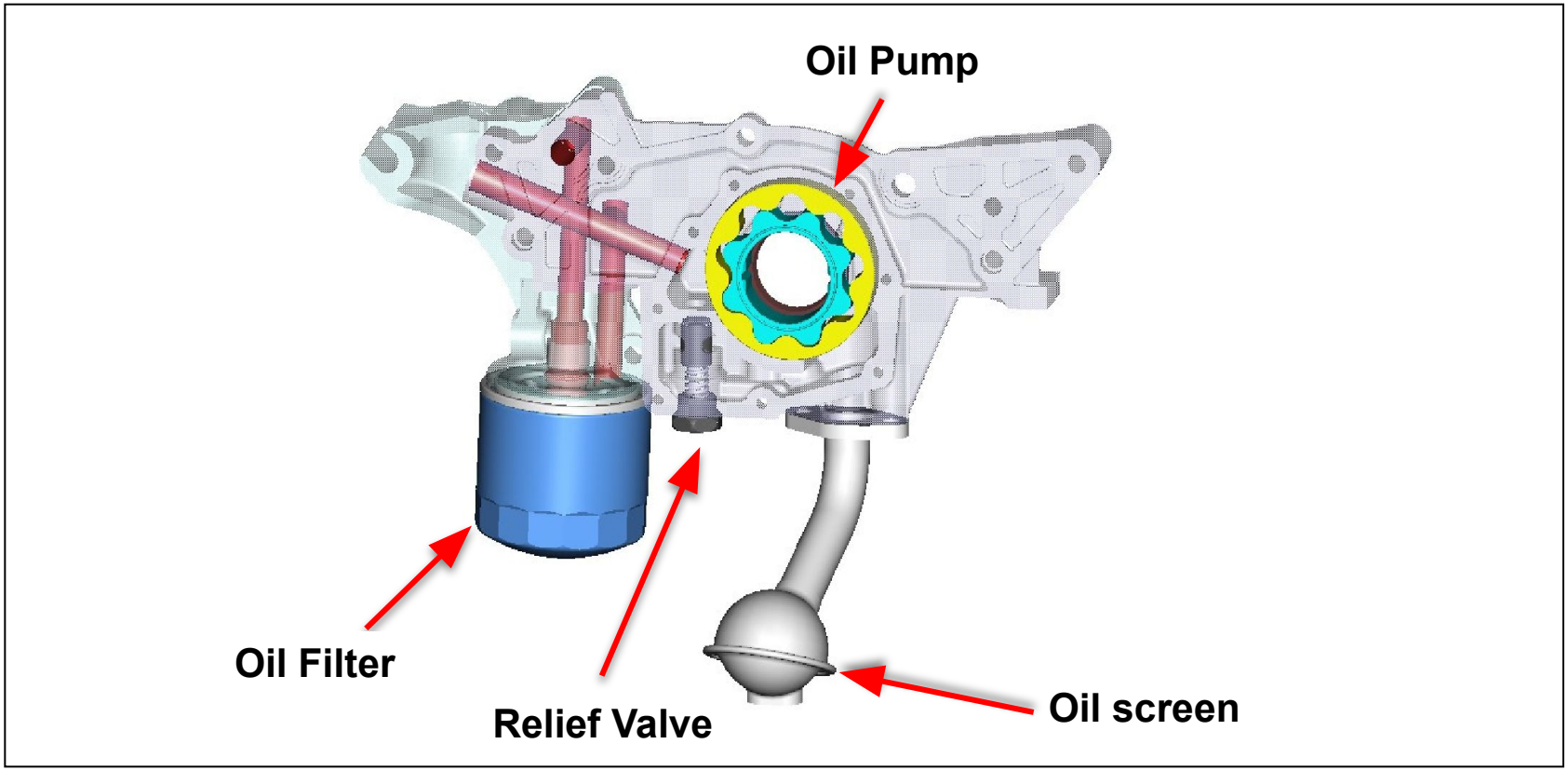
- Changed Water Jacket : Improved a cooling efficiency
  (Increased valve durability)
  * LRSP : Long Reach Spark Plug
- Iridium spark plug (Durability :10 years, 100,000 mile)

Timing Belt

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

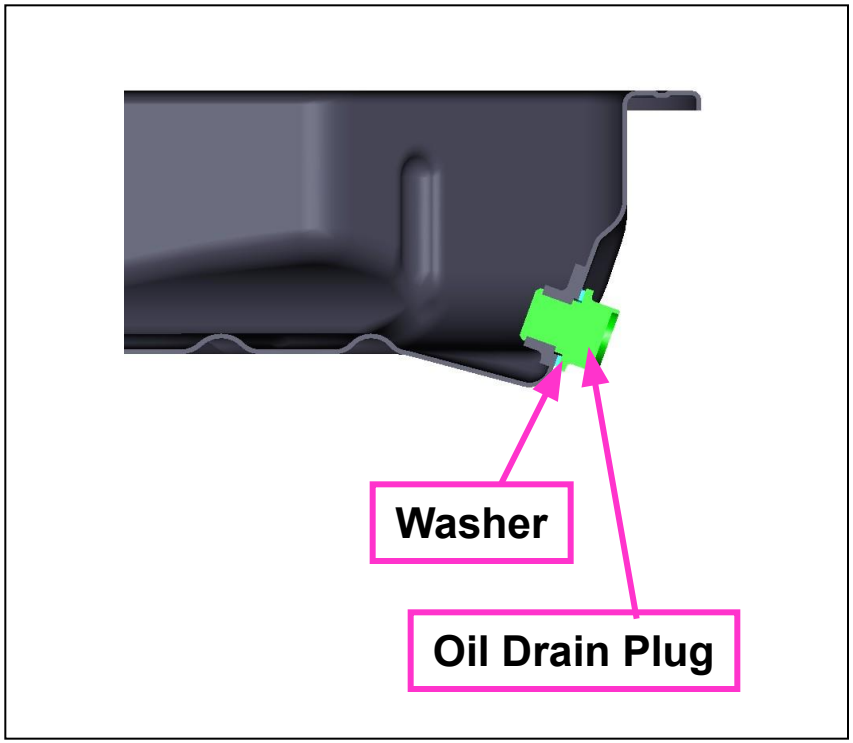


Lubrication



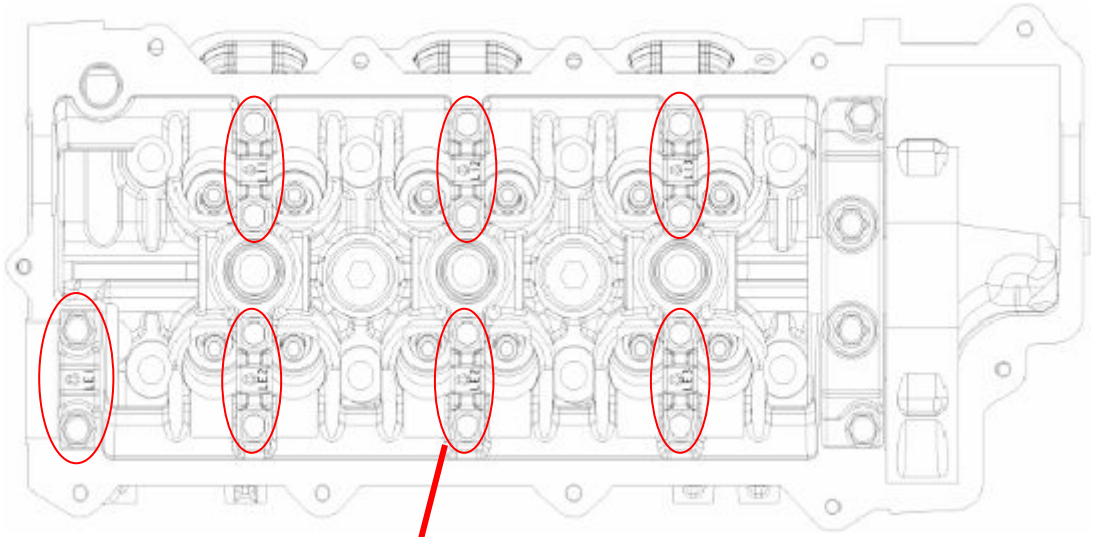
- Connected with crankshaft
- Oil pressure at idle (hot condition) : around 1 bar
- Relief valve : 5.5 ± 0.5 bar

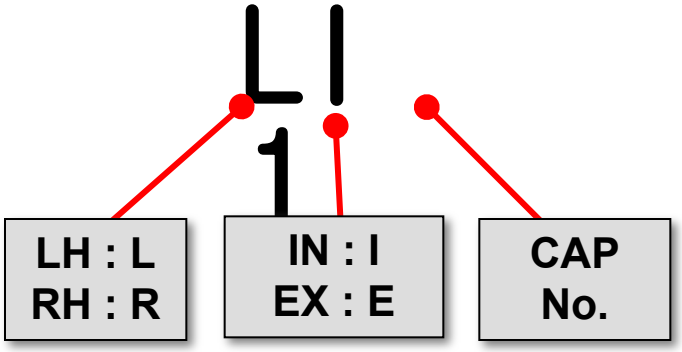
Handling & Caution

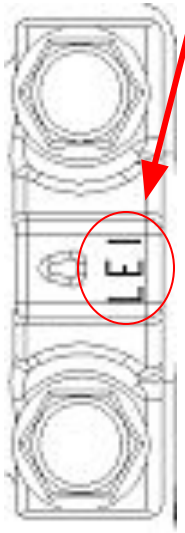


▸ - When replacing engine oil, washer must be replaced together
(Supplied oil filter and washer have different parts number)
- Drain Plug tightening torque : 3.5~4.5 Kgf

Camshaft cap

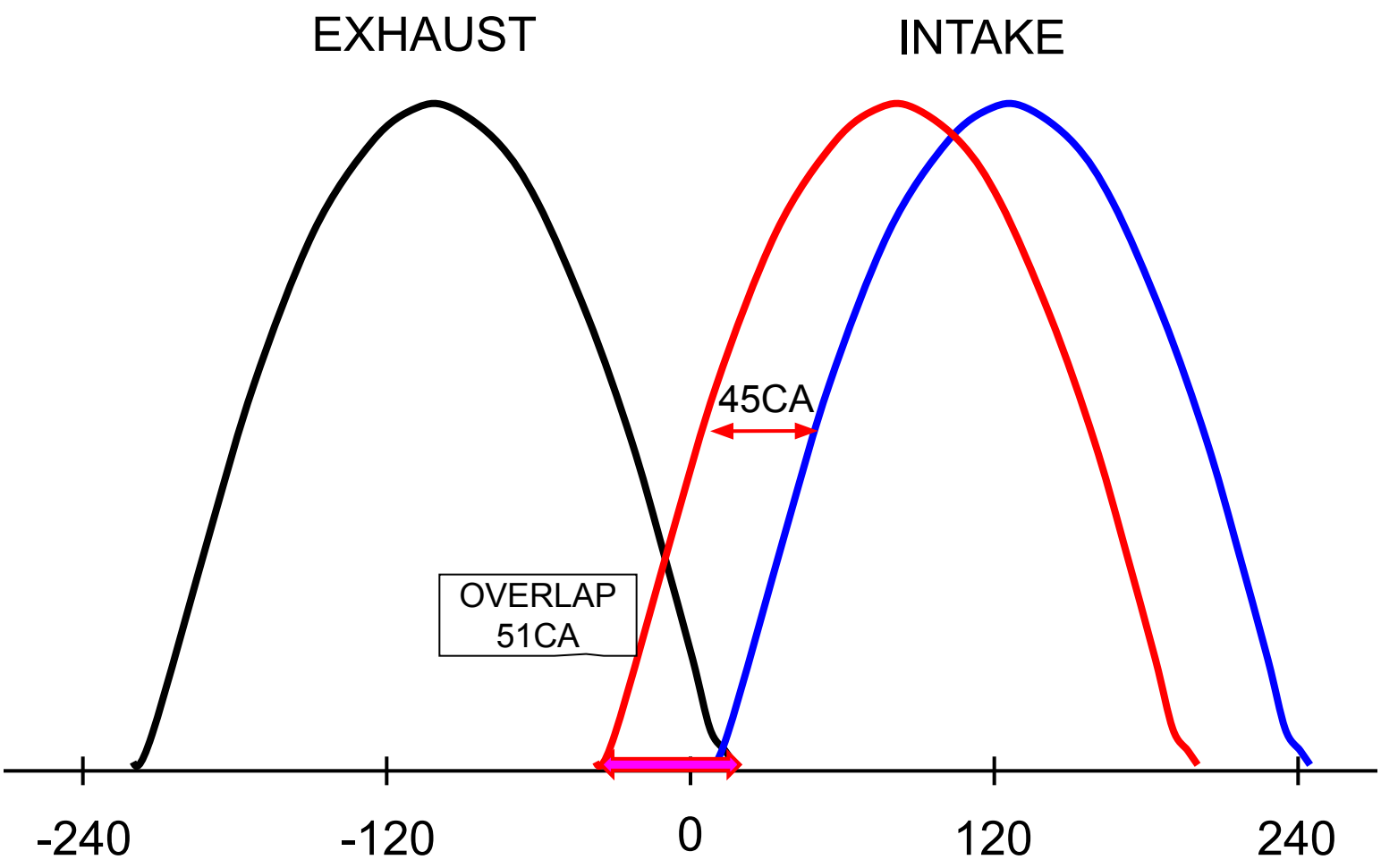




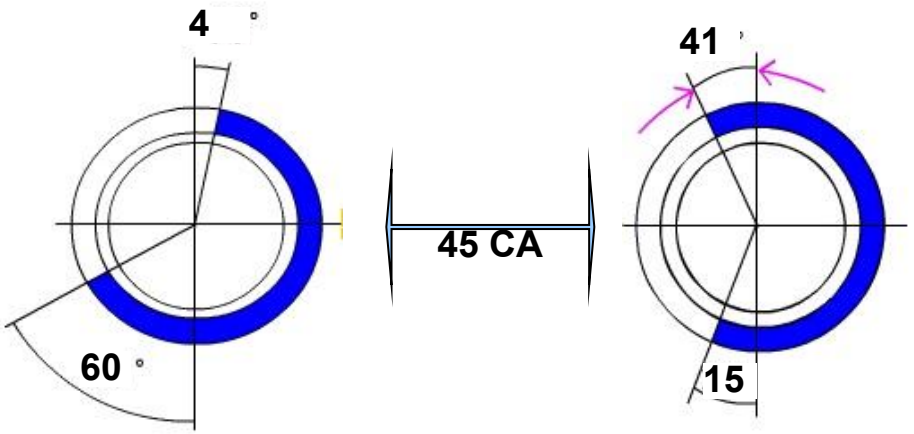
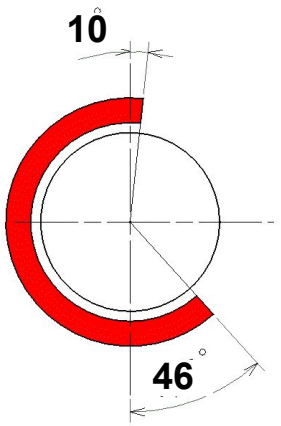
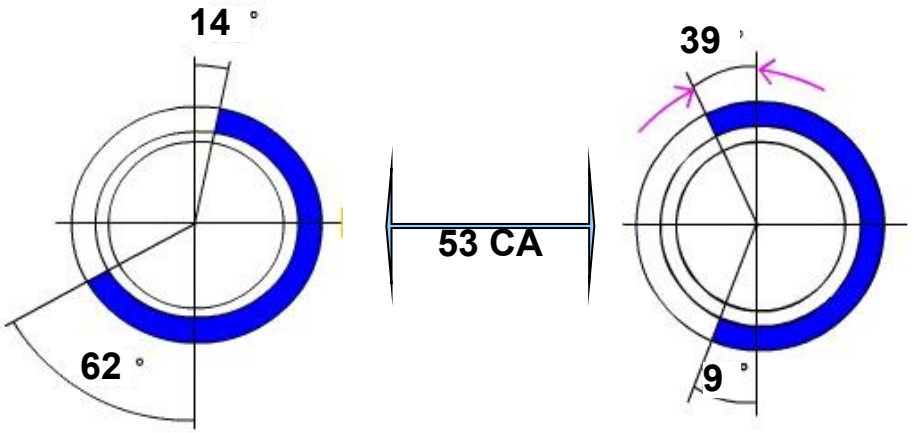
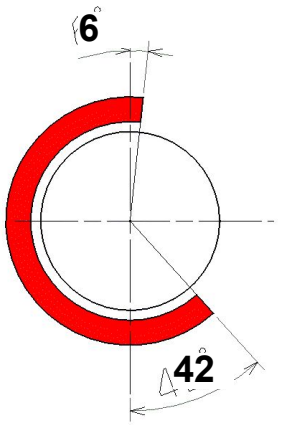


NO	LH		RH	
	IN	EXH	IN	EXH
1	LI1	LE1	RI1	RE1
2	LI2	LE2	RI2	RE2
3	LI3	LE3	RI3	RE3
4	-	LE4	-	RE4

CVVT – Valve Timing

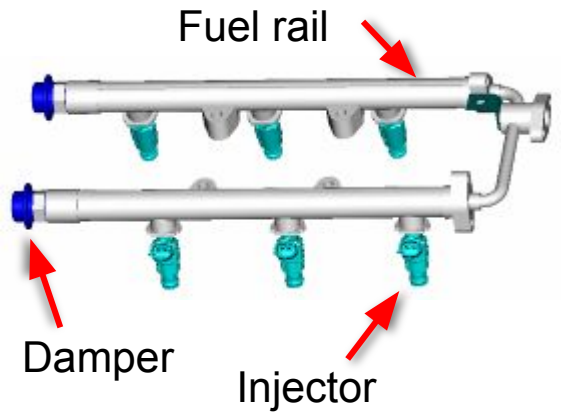


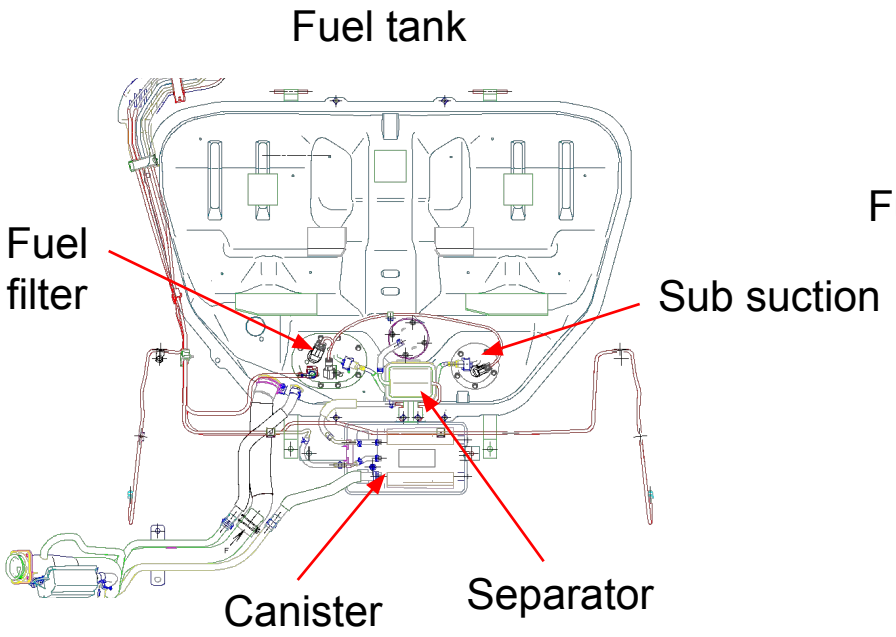
CVVT – Valve Timing Comparision

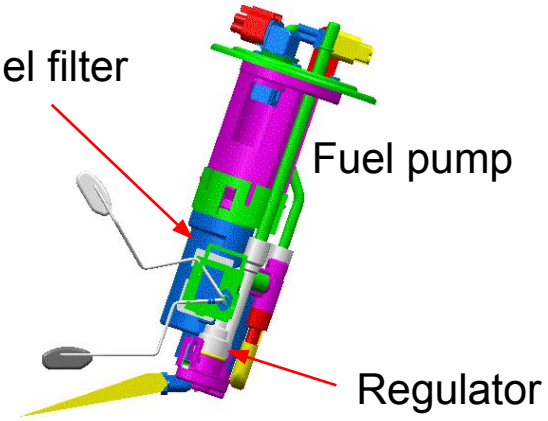
Engine	Intake Valve Timing	Exhaust Valve
Mu Engine		
Lambda Engine		

Fuel System – RLFS

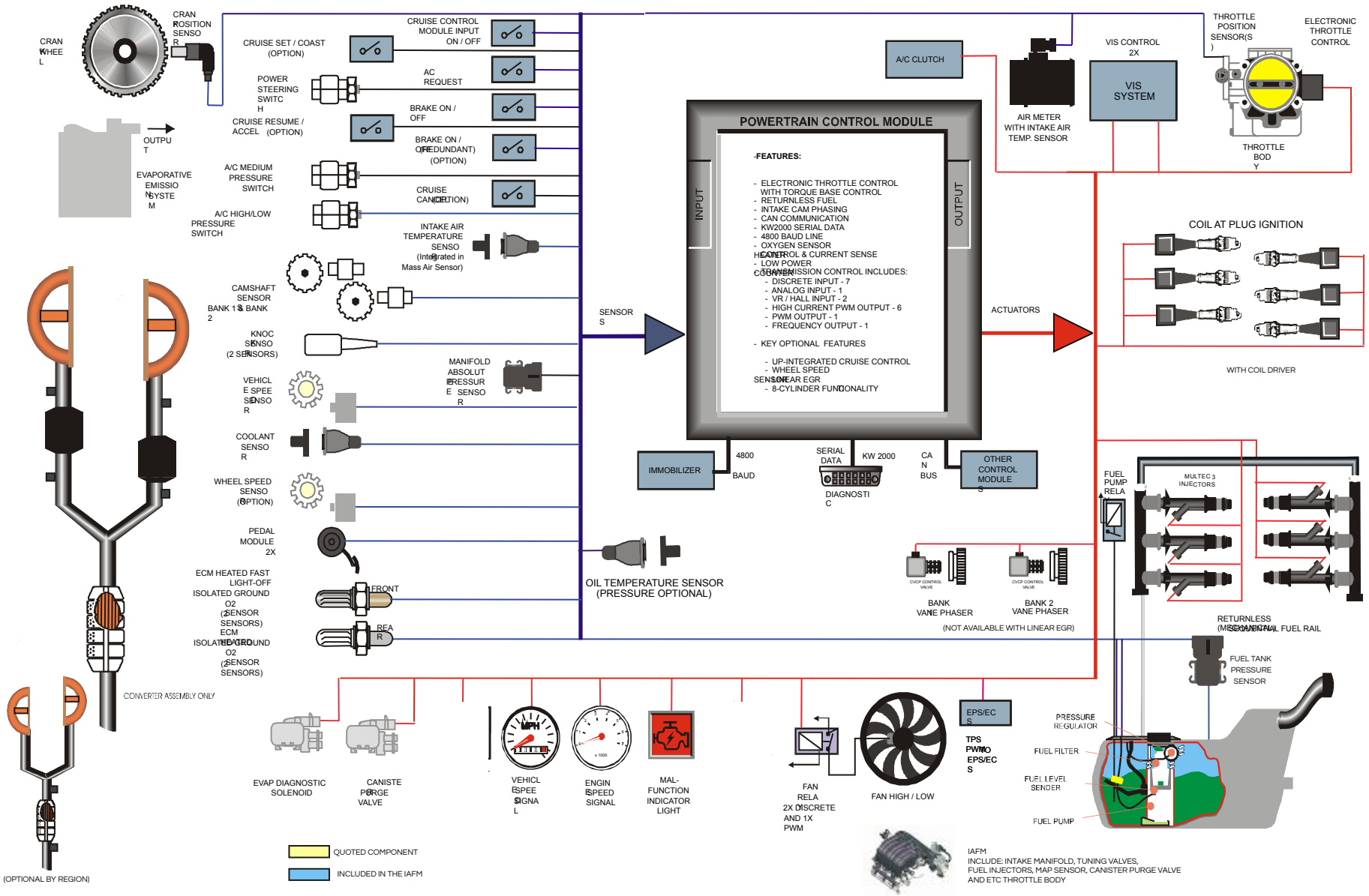
- Type : RLFS(Return Less Fuel System)
- Regulated fuel pressure : 3.8kg/cm^2
- Fuel tank capacity : 75 L
- Fuel cut speed at full load : 6688rpm
- Damper on the fuel rail to prevent pulsation







EMS Control


CRANKSHAFT WHEEL
CRANKSHAFT POSITION SENSOR
OUTPUT
EVAPORATIVE EMISSIONS SYSTEM
CRUISE SET / COAST (OPTION)
POWER STEERING SWITCH
CRUISE RESUME / ACCEL (OPTION)
A/C MEDIUM PRESSURE SWITCH
A/C HIGH/LOW PRESSURE SWITCH
CRUISE CONTROL MODULE INPUT ON / OFF
A/C REQUEST
BRAKE ON / OFF
BRAKE ON / OFF (REDUNDANT) (OPTION)
CRUISE CANCEL (OPTION)
INTAKE AIR TEMPERATURE SENSOR (Integrated in Mass Air Sensor)
CAMSHAFT SENSOR BANK 1 & BANK 2
KNOCK SENSORS (2 SENSORS)
VEHICLE SPEED SENSOR
COOLANT SENSOR
WHEEL SPEED SENSOR (OPTION)
PEDAL MODULE 2X
ECM HEATED FAST LIGHT-OFF ISOLATED GROUND O2 (2 SENSOR SENSORS)
ECM HEATED ISOLATED GROUND O2 (2 SENSOR SENSORS)
FRONT
REAR
MANIFOLD ABSOLUTE PRESSURE SENSOR
CONVERTER ASSEMBLY ONLY
(OPTIONAL BY REGION)
SENSORS
POWERTRAIN CONTROL MODULE
INPUT
OUTPUT
FEATURES:
- ELECTRONIC THROTTLE CONTROL WITH TORQUE BASE CONTROL
- RETURNLESS FUEL
- INTAKE CAM PHASING
- CAN COMMUNICATION
- KW2000 SERIAL DATA
- 4800 BAUD LINE
- OXYGEN SENSOR HEATER CONTROL & CURRENT SENSE
- LOW POWER COMBINATION
- EMISSION CONTROL INCLUDES:
  - DISCRETE INPUT - 7
  - ANALOG INPUT - 1
  - VR / HALL INPUT - 2
  - HIGH CURRENT PWM OUTPUT - 6
  - PWM OUTPUT - 1
  - FREQUENCY OUTPUT - 1
- KEY OPTIONAL FEATURES
  - UP-INTEGRATED CRUISE CONTROL
  - WHEEL SPEED SENSOR
  - LINEAR EGR
  - 8-CYLINDER FUNCTIONALITY
IMMOBILIZER
4800 BAUD
SERIAL DATA
KW 2000
DIAGNOSTIC
CAN BUS
OTHER CONTROL MODULES
OIL TEMPERATURE SENSOR (PRESSURE OPTIONAL)
ACTUATORS
A/C CLUTCH
AIR METER WITH INTAKE AIR TEMP. SENSOR
VIS CONTROL 2X
VIS SYSTEM
THROTTLE POSITION SENSOR(S)
ELECTRONIC THROTTLE CONTROL
THROTTLE BODY
COIL AT PLUG IGNITION
WITH COIL DRIVER
FUEL PUMP RELAY
MULTEC 3 INJECTORS
BANK 1 VANE PHASER
BANK 2 VANE PHASER
(NOT AVAILABLE WITH LINEAR EGR)
RETURNLESS (MECHANICAL) FUEL RAIL
FUEL TANK PRESSURE SENSOR
PRESSURE REGULATOR
FUEL FILTER
FUEL LEVEL SENDER
FUEL PUMP
EVAP DIAGNOSTIC SOLENOID
CANISTER PURGE VALVE
VEHICLE SPEED SIGNAL
ENGINE SPEED SIGNAL
MAL-FUNCTION INDICATOR LIGHT
FAN RELAY 2X DISCRETE AND 1X PWM
FAN HIGH / LOW
EPS/ECS
TPS PWM TO EPS/ECS
IAFM
INCLUDE: INTAKE MANIFOLD, TUNING VALVES, FUEL INJECTORS, MAP SENSOR, CANISTER PURGE VALVE AND ETC THROTTLE BODY
QUOTED COMPONENT
INCLUDED IN THE IAFM

Specification

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

Cooling Fan Control

Control logic

A/CON S/W	A/CON Pressure	Vehicle Speed (KPH)	Coolant Temperature (℃)					
			-30	40	95	100	105	
ON	P ≥ 15.5 kgf/㎠	ALL	OFF	HIGH				
	15.5 kgf/㎠ > P ≥ 12kgf/㎠	V<45	OFF	LOW		HIGH		
		45≤V<80	OFF			LOW	HIGH	
		80<V	OFF					HIGH
	12 kgf/㎠ > P ≥ 6kgf/㎠	V<45	OFF		LOW	HIGH		
		45≤V<80	OFF			LOW	HIGH	
		80<V	OFF					HIGH
	6kgf/㎠ > P	ALL	OFF					HIGH
OFF		V<45	OFF			LOW	HIGH	
		45≤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℃**, Compressor is Off. (temp. hys. : 7℃)
- When engine rpm is 0 & IG is on, fan must turn off.

Cooling Fan Control

Failsafe

Failure Case	Fan Running Condition
A/CON Pressure Sensor	The case which the output voltage is ≤ 0.5V or 4.5V≤ , 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 fixs to high.

EMS Components Parts List

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

EMS Components Parts List

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

EMS Components Parts List

For Mu enigine

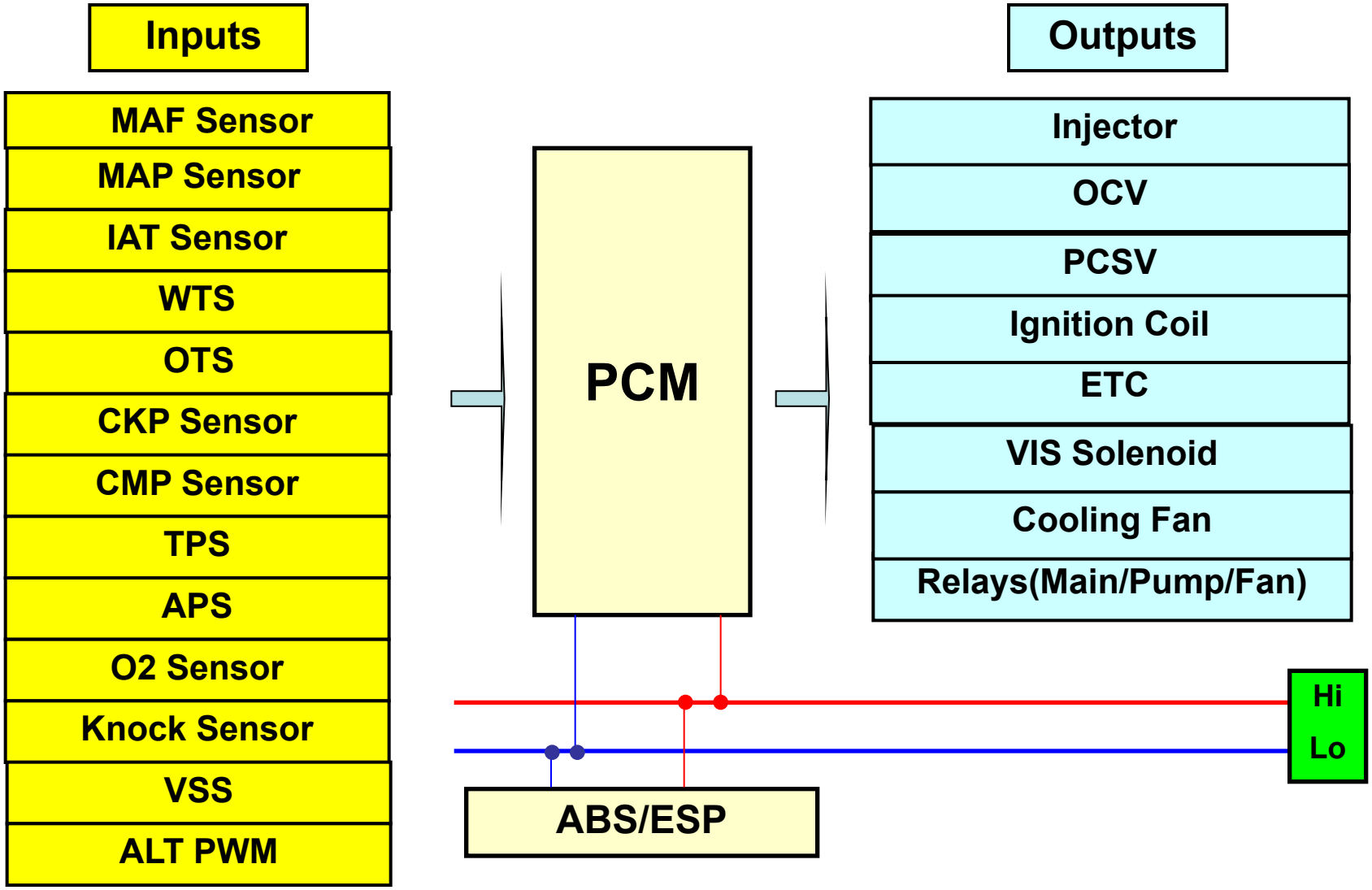
Part Name	Supplier	Part Number	Remark
1. MAF	Delphi	28164-3C100	Same as Lamda
2. MAP Sensor	Kefico	39300-38200	Same as Lamda
3. ETC	Delphi	35100-3E100	-
4. Fuel Injector	Kefico	35310-23600	-
5. VIS SOL	Hyundai Autonet	39460-37000	-
6. IG. Coil	Searim Tech	27301-3E100	-
7. Spark Plug	Woojin	18840-11051	-
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	-

EMS Components Parts List

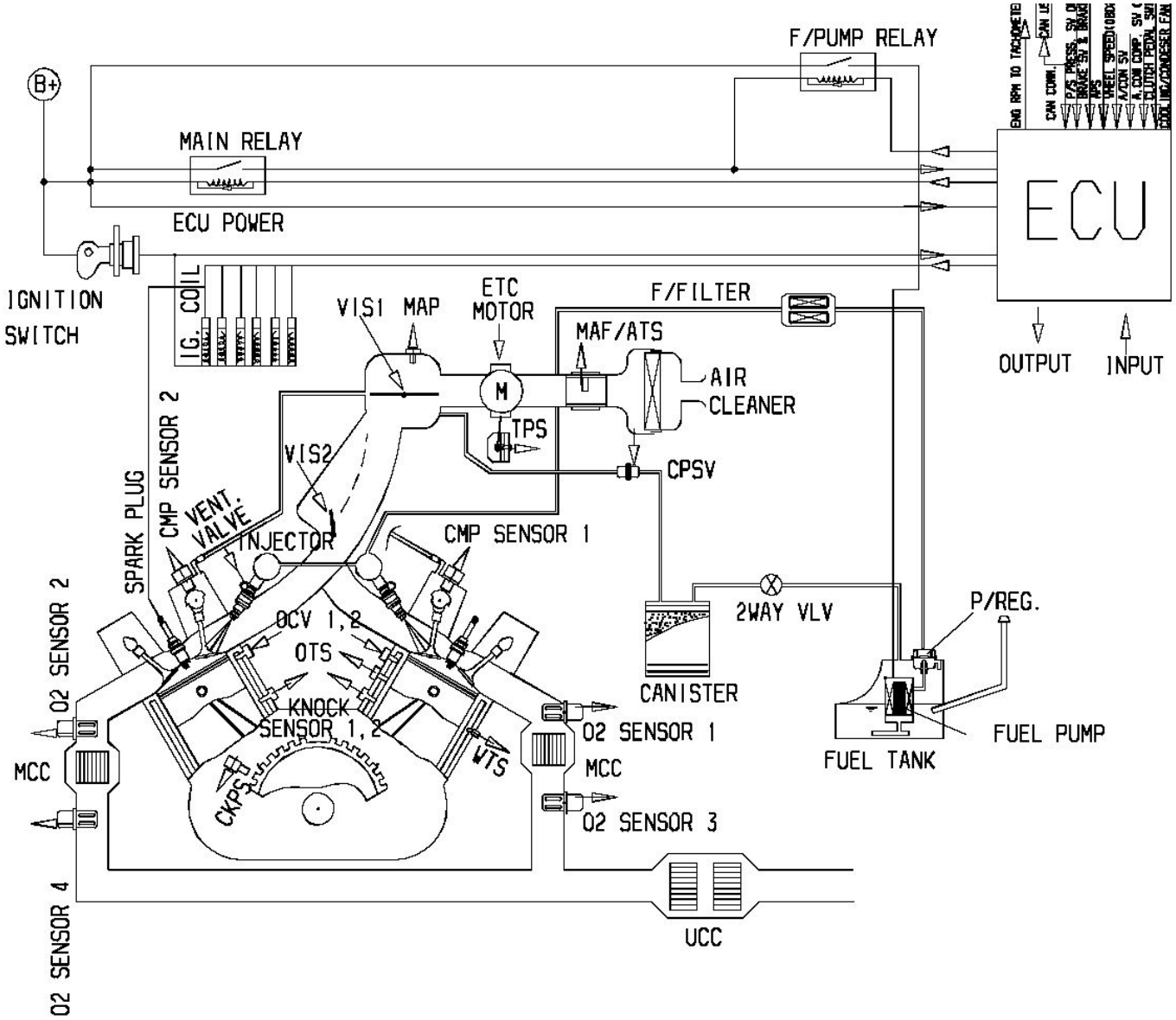
For Lamda enigine (reference data)

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 Pl.
		35304-3C400	Delphi		Surge tank Al
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	39210-3C000외	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	

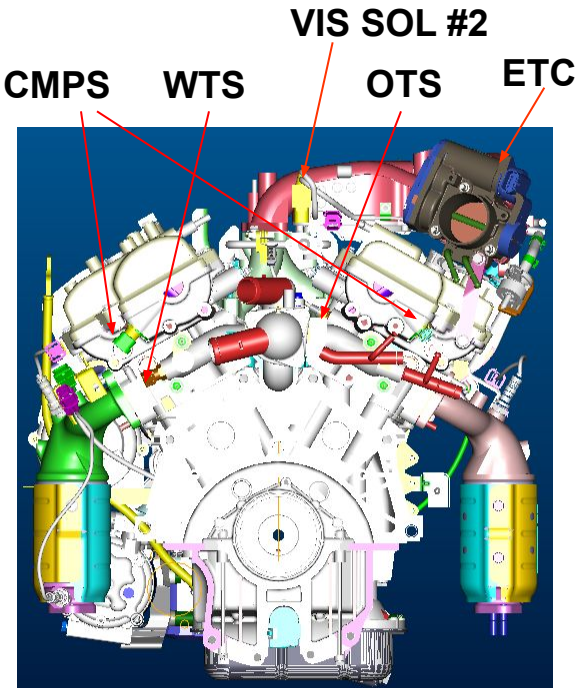
EMS Components

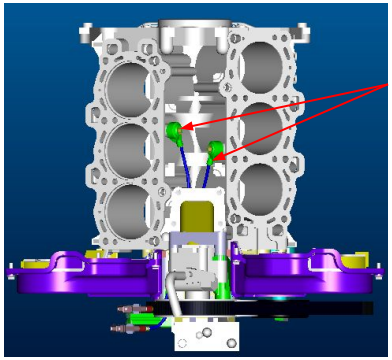


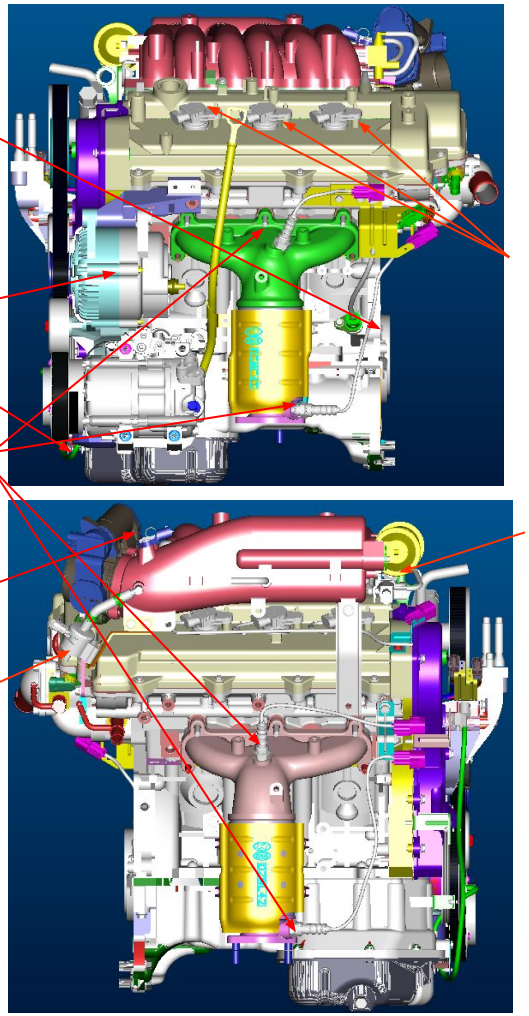
EMS System Diagram



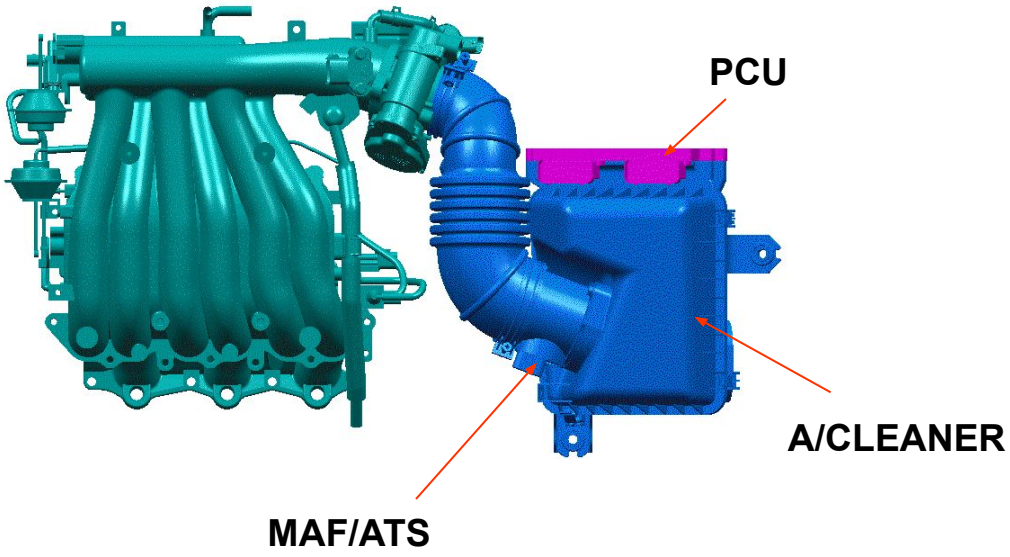
EMS Components







EMS Components



ETC System

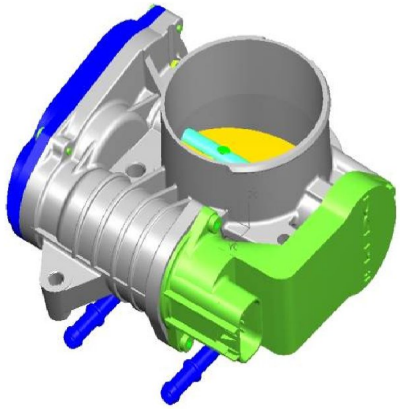
ETC(Electronic Throttle Control) system consists of ETC DC motor, throttle body, throttle position sensor and APS.

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

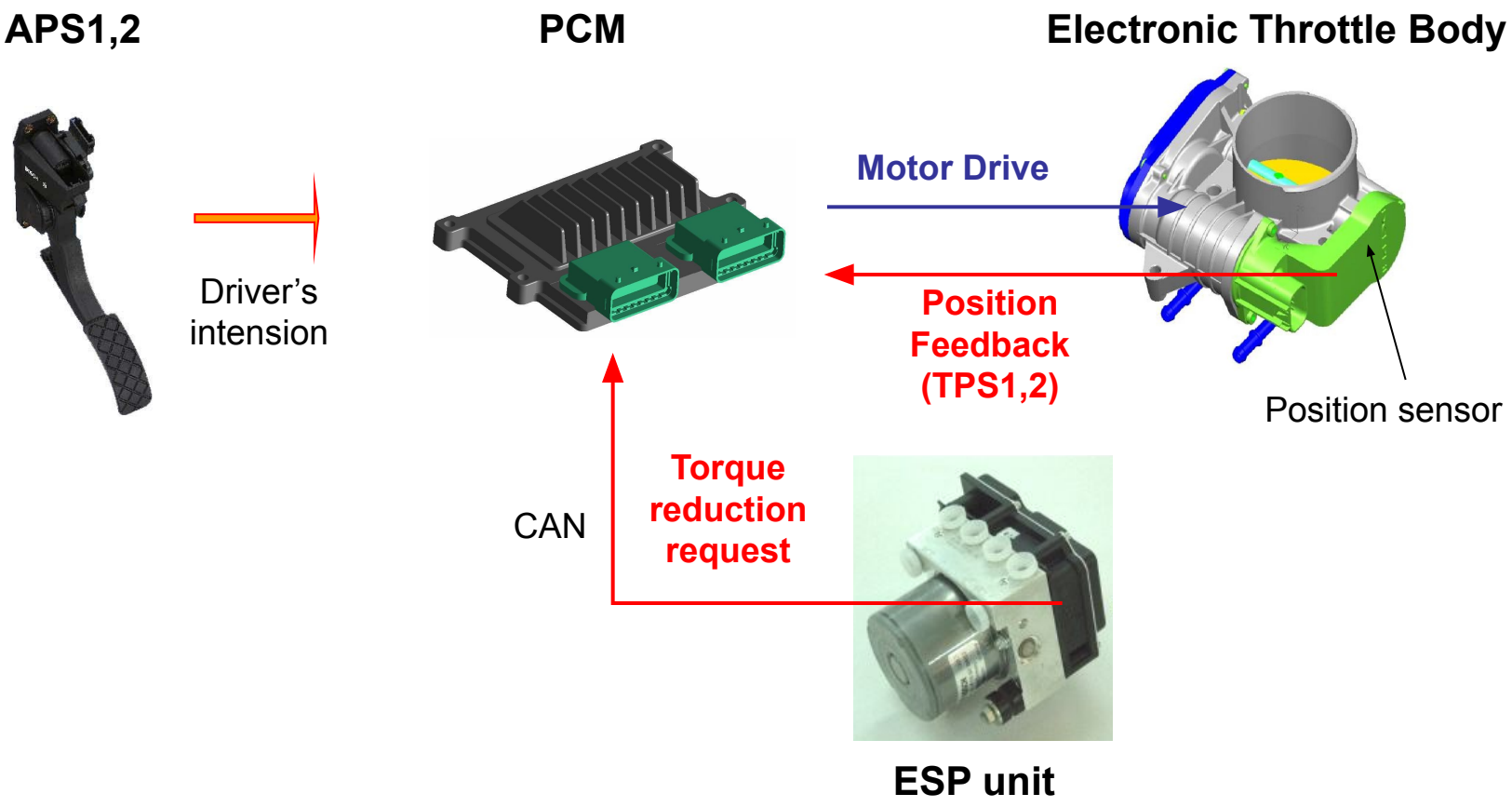
One of the biggest advantage using ETC system is fine controlling in idle. Throttle valve is directly controlled by DC motor without idle control devices such as ISA or step motor.

Delphi ETC has following features ;

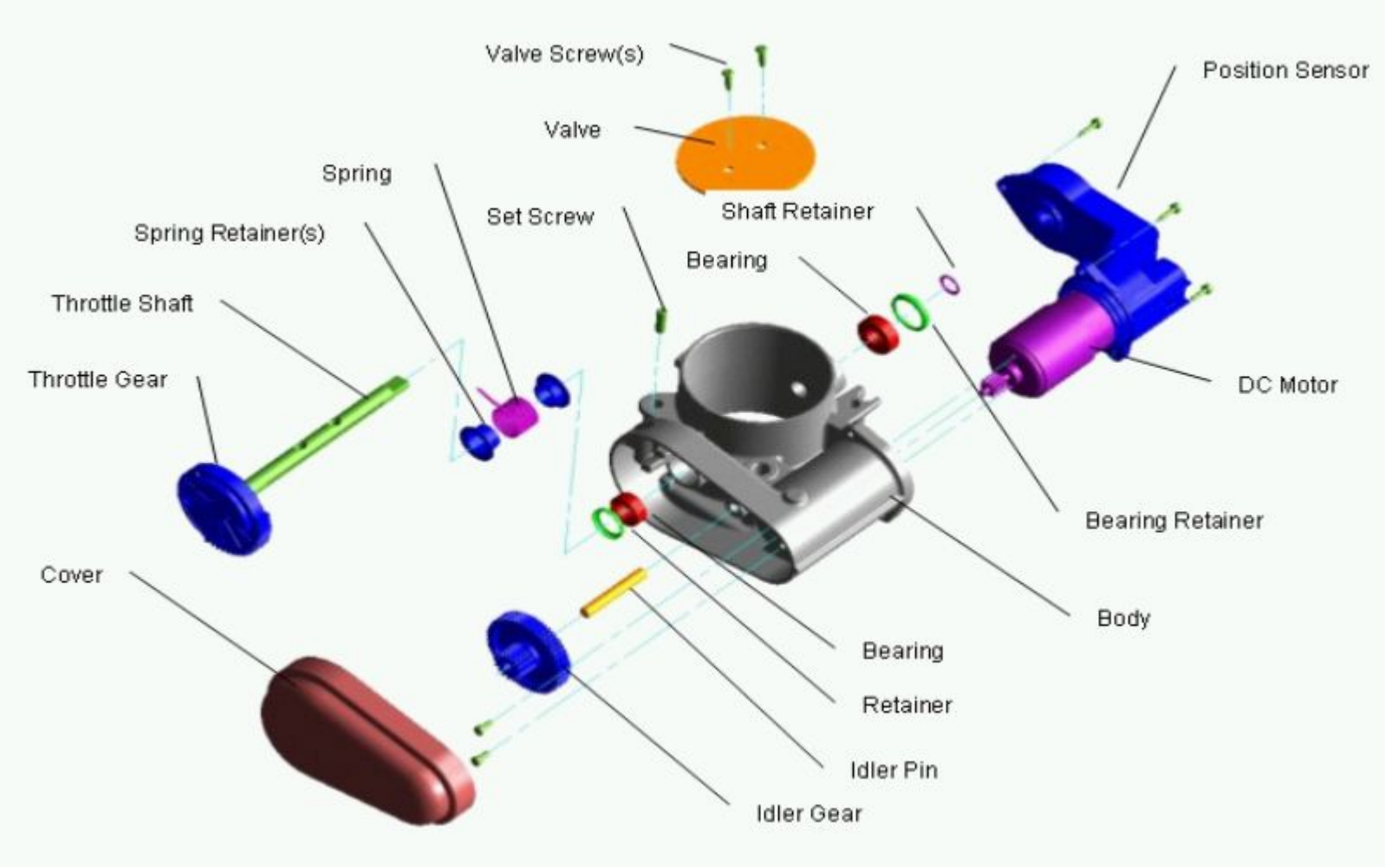
- Fine idle control
- Easy application for cruise control
- Deicing function
- Quick response
- Reduced operating noise
- DC motor operating voltage : 8~16.5V
- TPS operating voltage : 4.5~5.5V



System layout

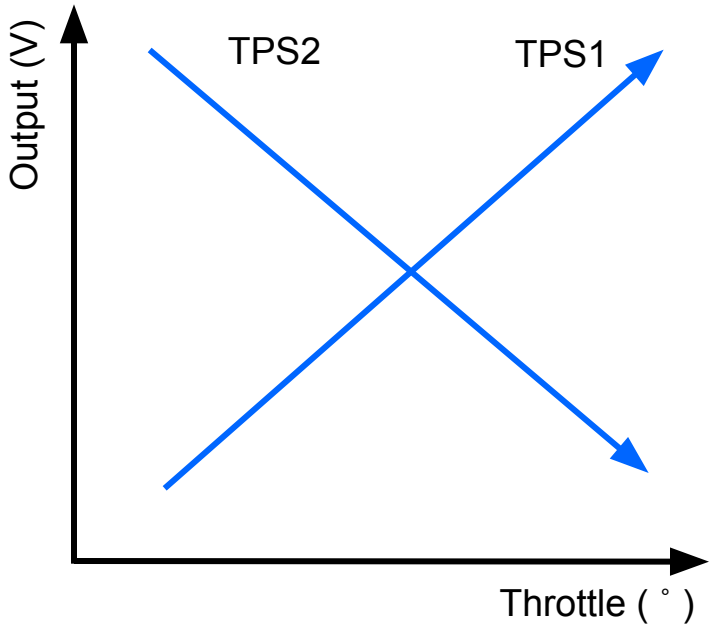


Construction



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.



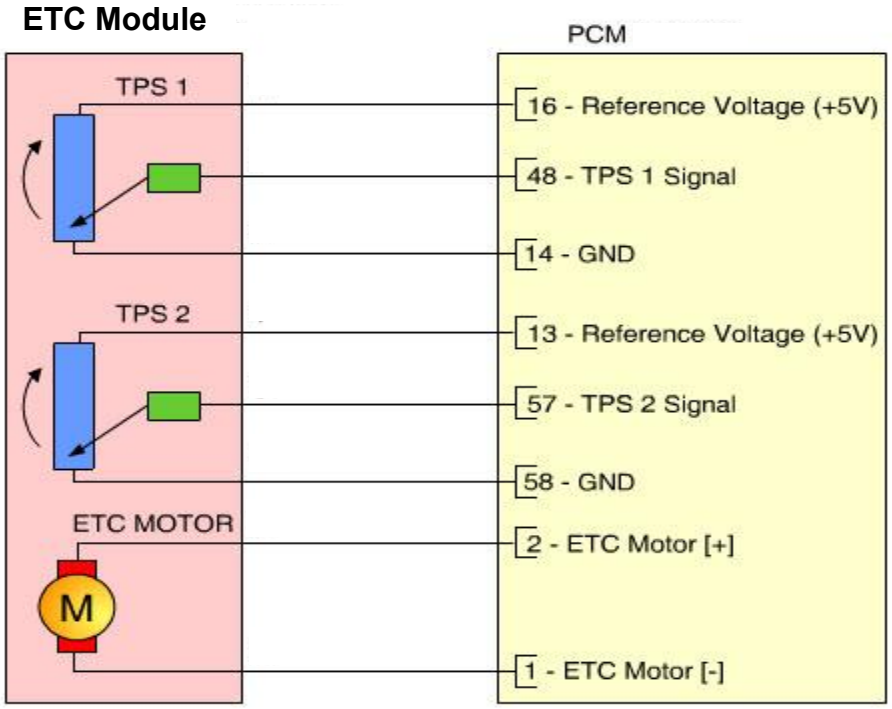
Throttle Position	Valve Angle	TPS1 Output	TPS2 Output
Minimum mechanical position	**3°**	**10% (0.5V)**	**90% (4.5V)**
Minimum Controllable Position	**3.5°**	**10.5% (0.525 V)**	**89.5% (4.475V)**
Default Position	**17°**	**22.5% (1.125V)**	**77.5% (3.875V)**
Maximum Mechanical Position	**90°**	**88%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

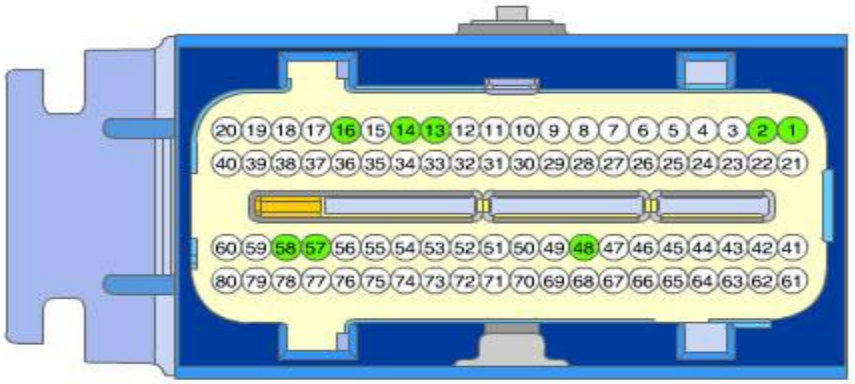
APS characteristics

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.

ETC System - TPS

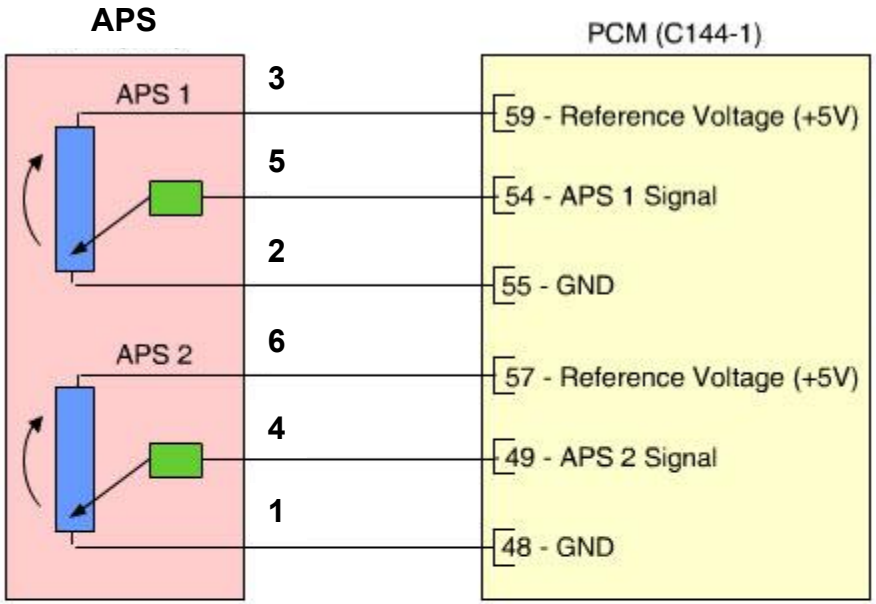
Pin assignment

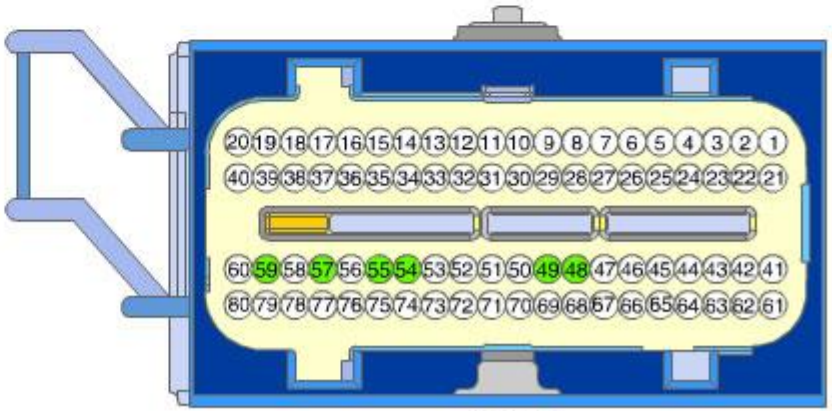


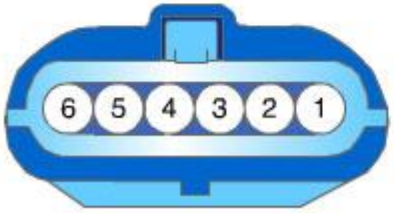


C144-2
PCM

Pin assignment







APS

Failsafe

There are four main limphome 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 intension 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.

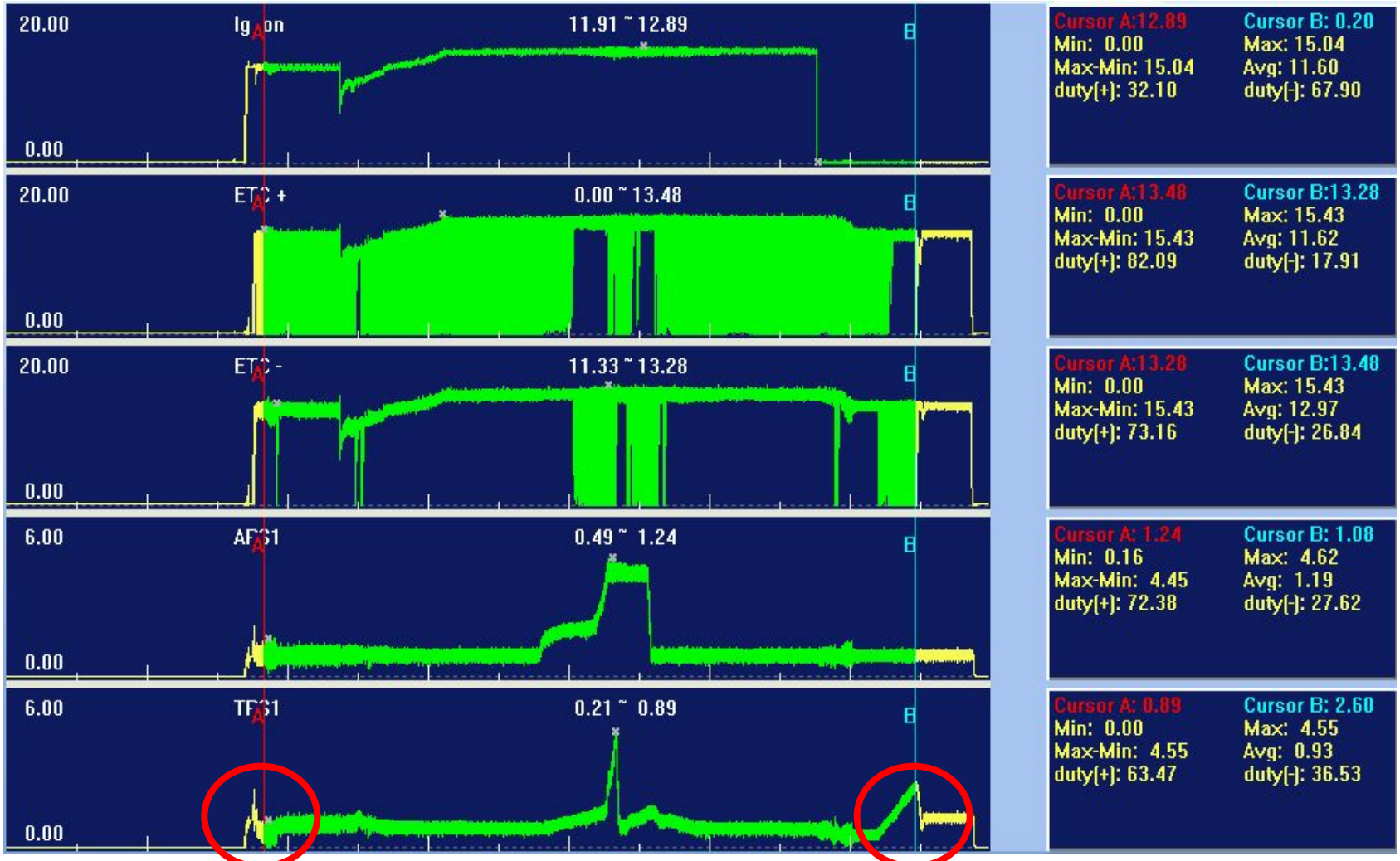
Regarding **limited performance**, when APS1 sensor has a failure APS2 becomes an alternative of APS1 and ETC system goes to limit performance condition. With this, increasing engine rpm is a little delayed even you depress to WOT. Engine rpm is limited about 2500.

Failsafe

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 igntion timing retard happens resulting in rough idling and fluctuating. engine rpm is limited by 1800..

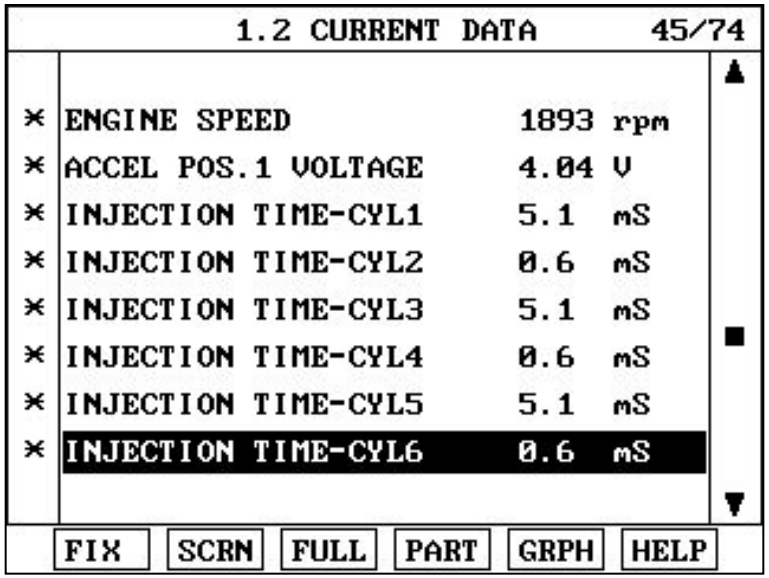
Engine shut down generally happens when you have TPS or DC motor problem **with MAP&MAF failure**. When this problem is detected, engine immediately shuts down.

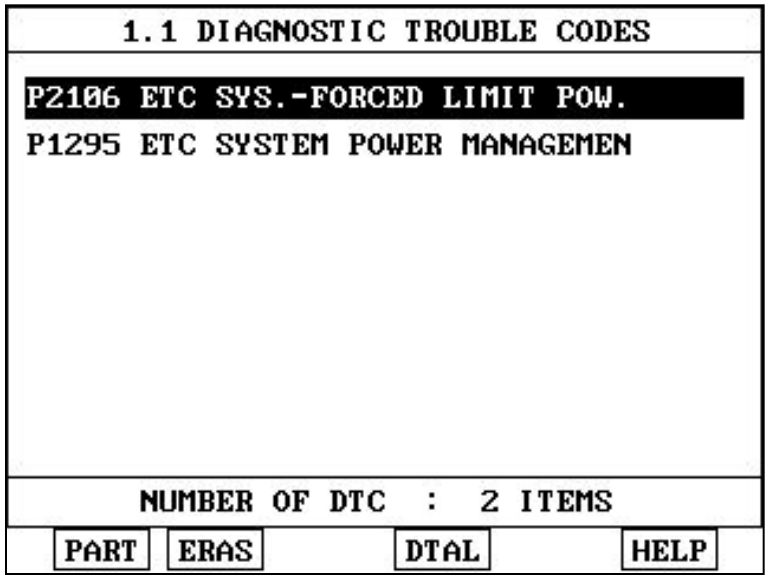
ETC System - Initializing

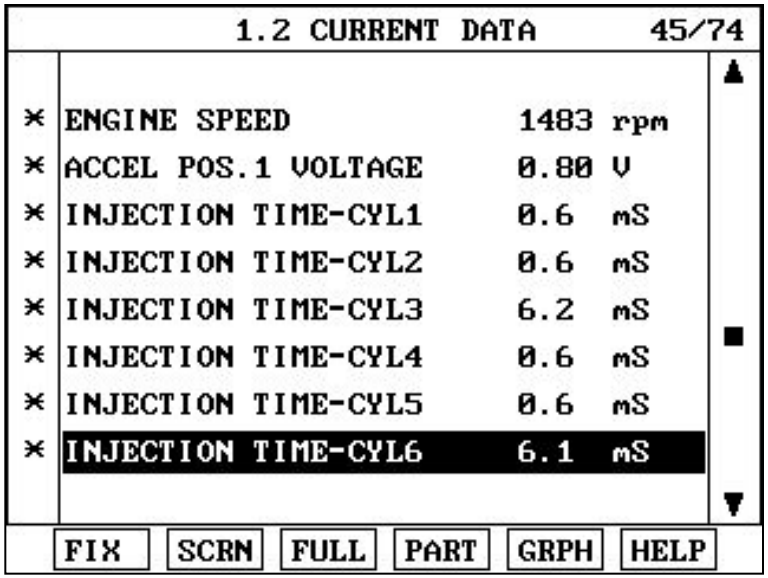


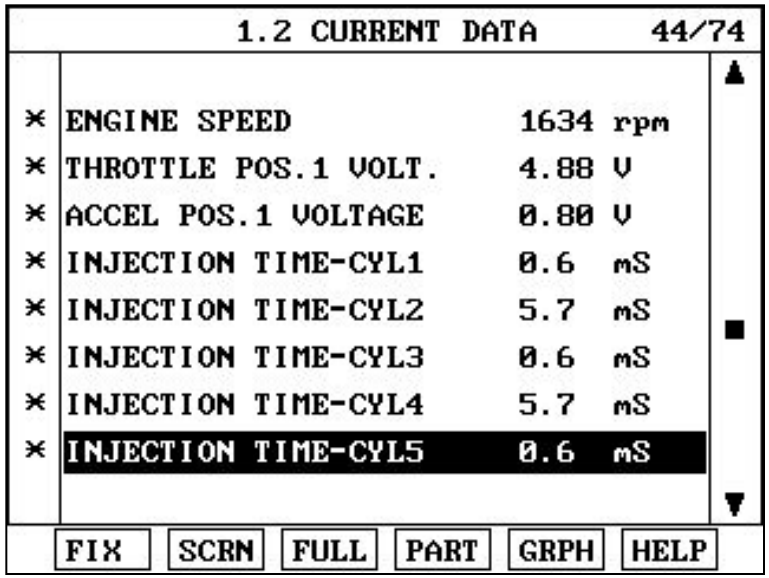
Every time when you make ignition on, ETC goes to initializing for close (Point A). Generally it opens 15% of TPS value. In output voltage of TPS it becomes 1.1 ~ 1.2V. After ignition off then now ETC goes to open initializing. Throttle valve is forced to open from normal to 2.6v.(Point B)

ETC System - Power Management

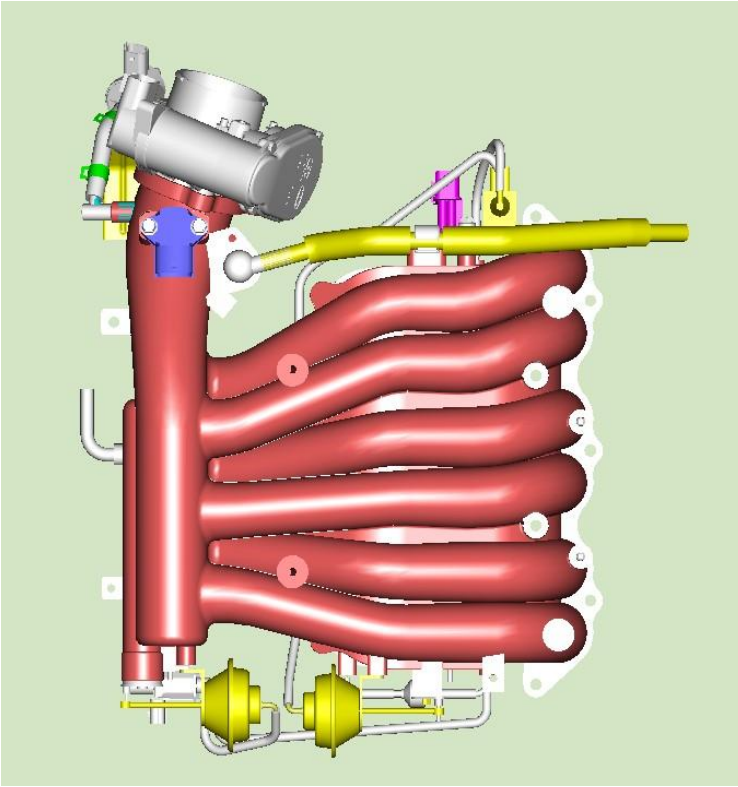




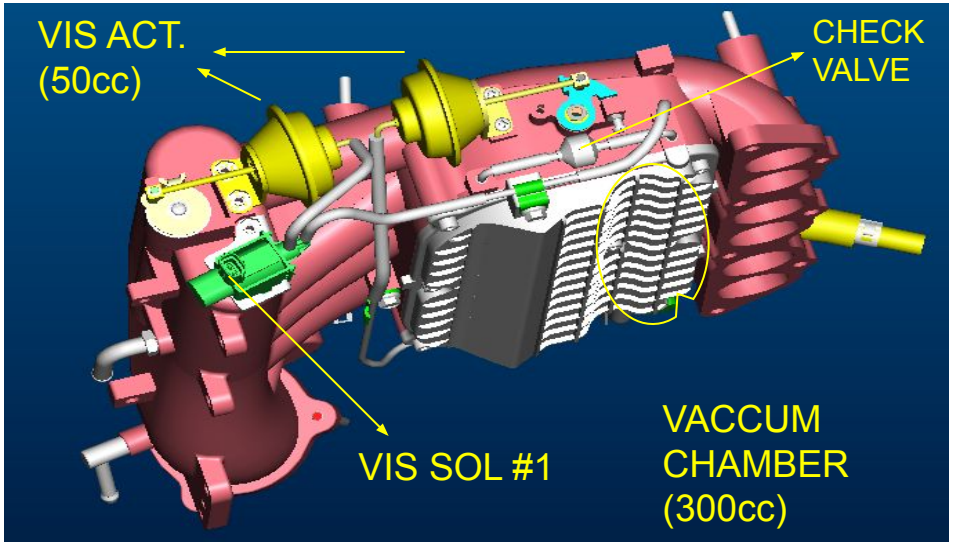


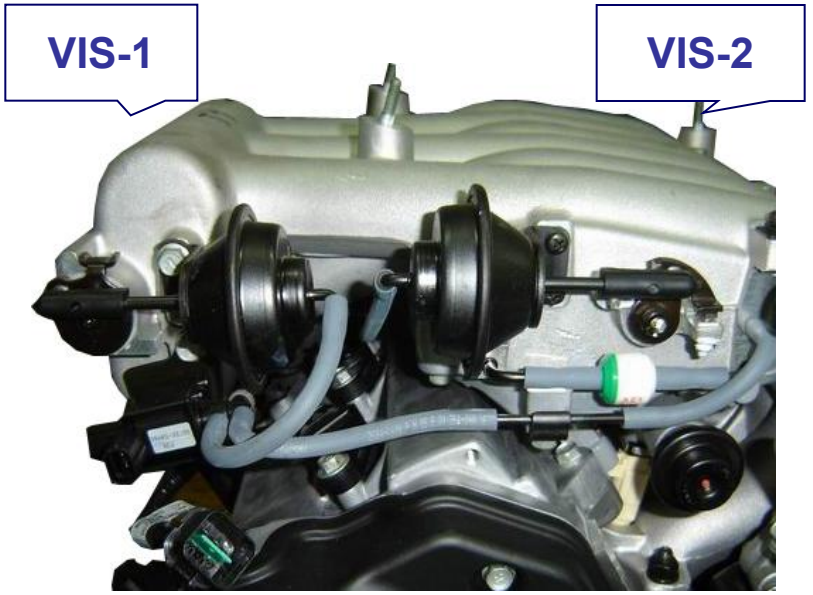


VIS (Variable Intake System)



VIS-1 VIS-2

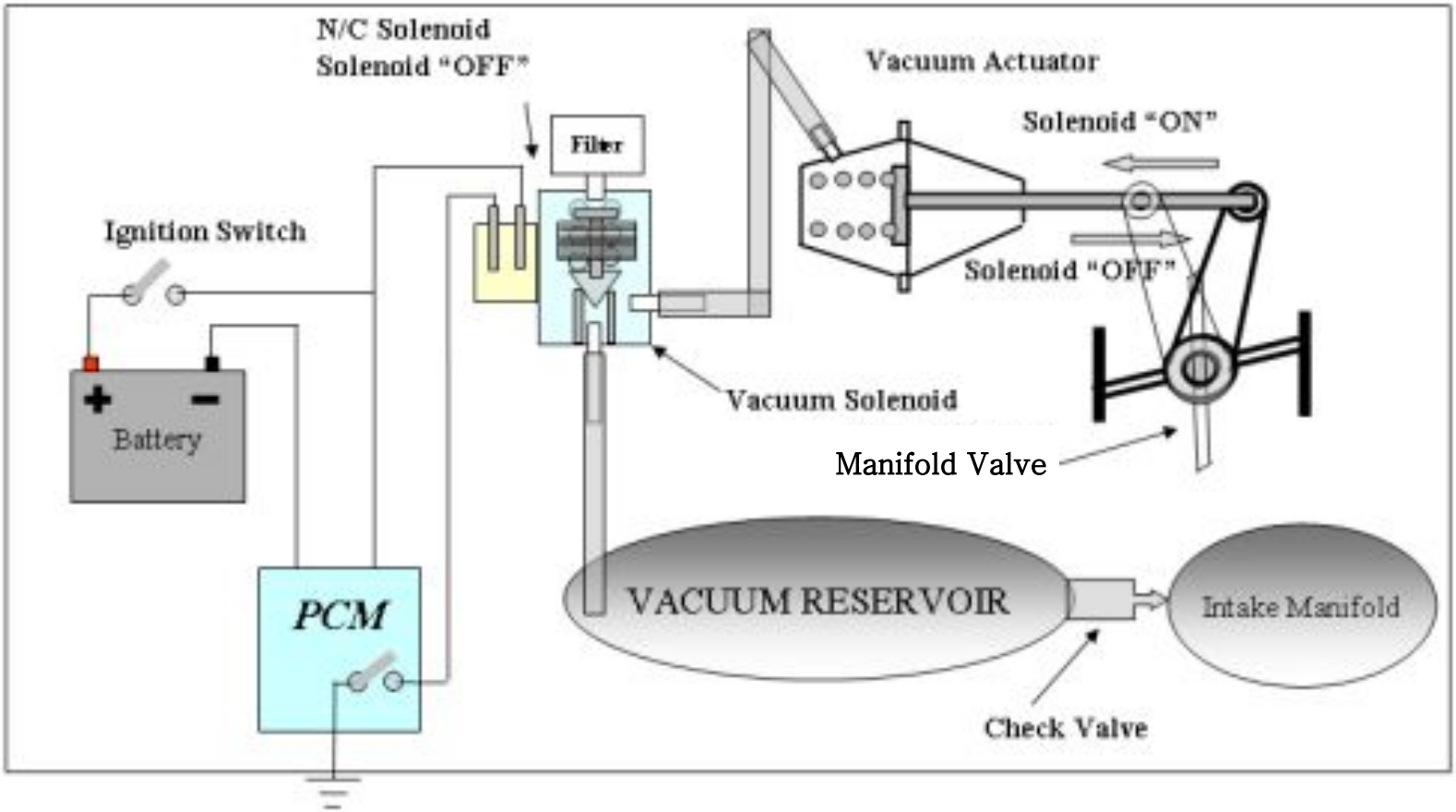




- VIS-1 : for low/middle rpm range
- VIS-2 : for high rpm range

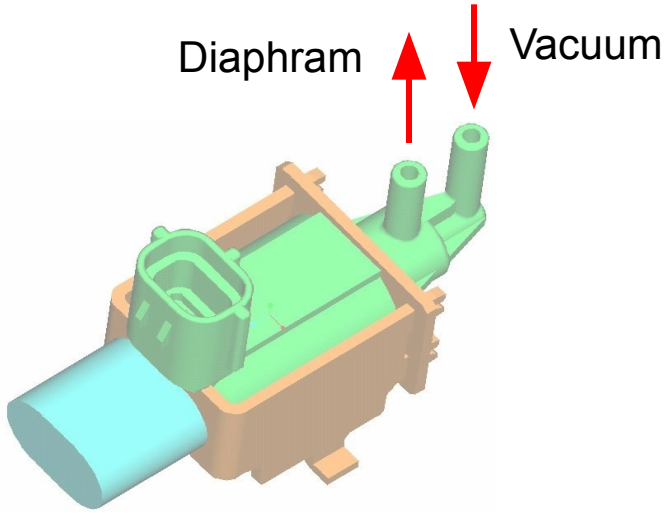
VIS (Variable Intake System)

System layout



VIS (Variable Intake System)

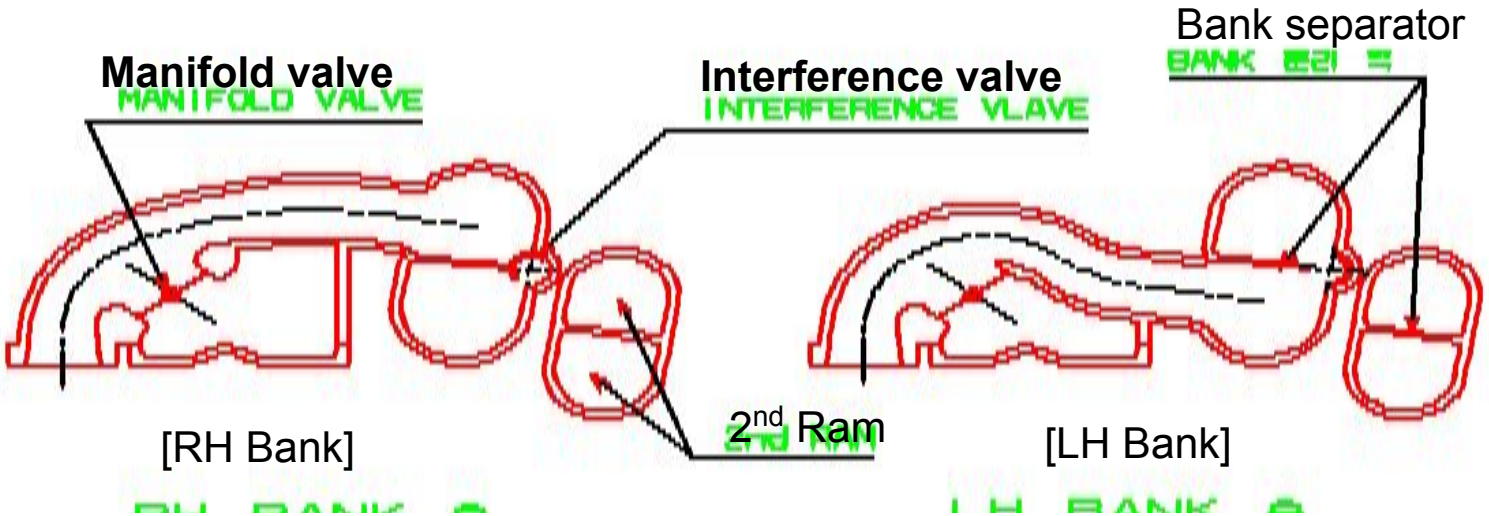
Solenoid

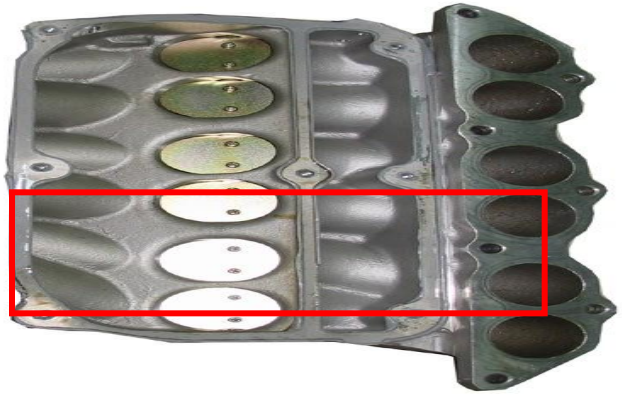


Technical feature

- Type : 3 way valve
- Coil resistance : 32±3 Ω (at 20℃)

Construction



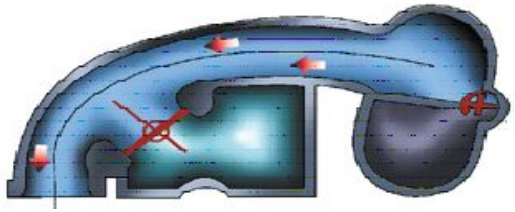
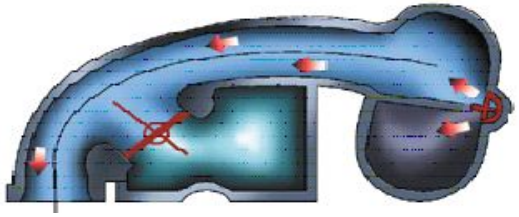
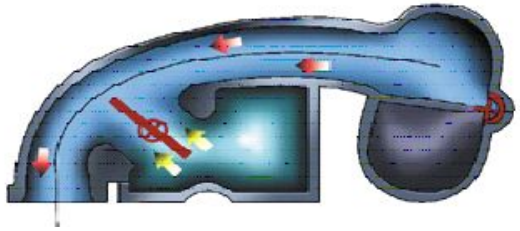


Manifold valve

Vacuum chamber

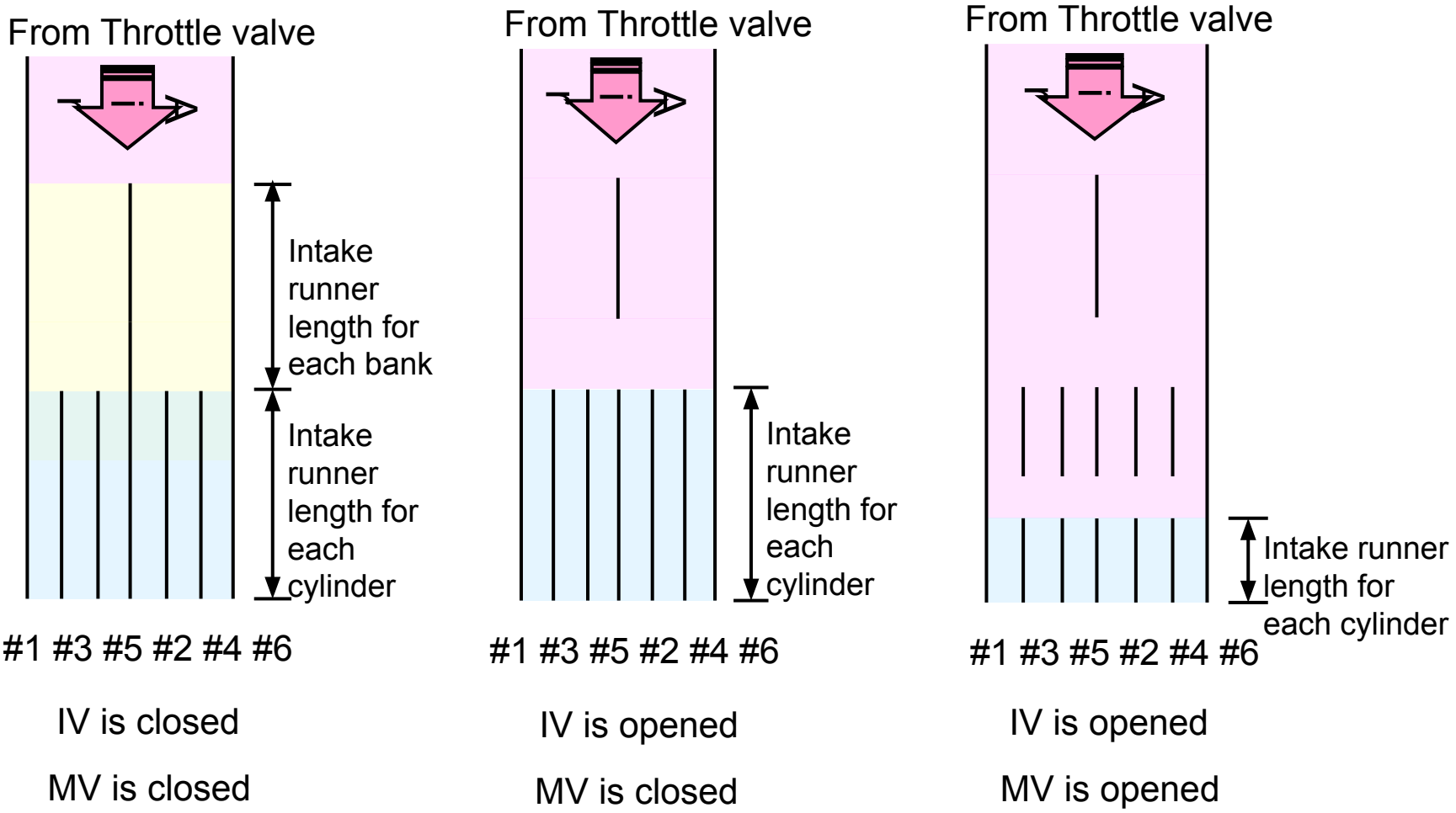
VIS (Variable Intake System)

Operating principle

Engine speed	Operation	
Low		- Separate surge tank (Interference valve close) - Avoid suction interference of each back (Manifold valve close)
Middle		- connect surge tank (Interference valve open) and use cylinder pressure pulsation
High		- Maximize intake efficience and reduce intake resistance by openning the interference valve and the manifold valve

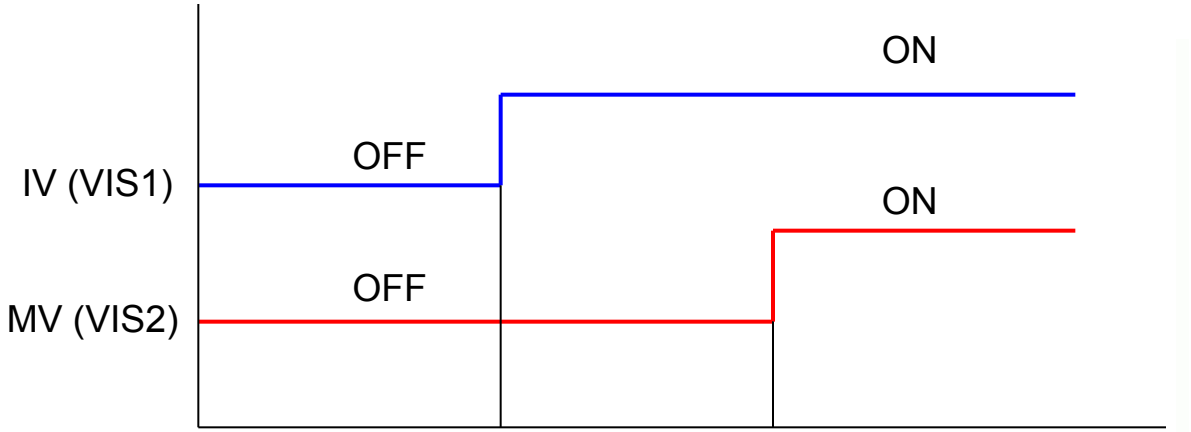
VIS (Variable Intake System)

Operating principle



VIS (Variable Intake System)

Control logic

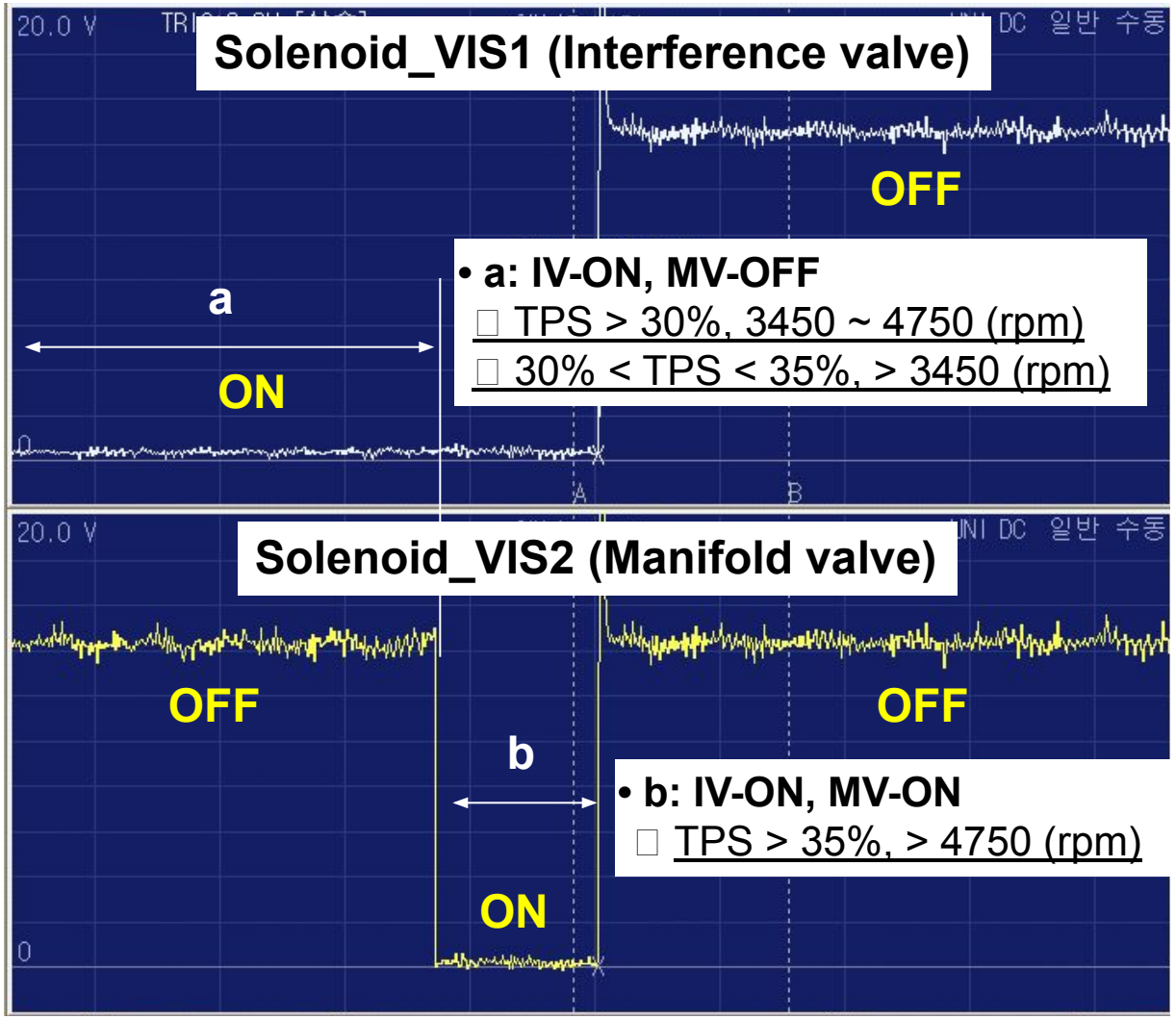


MU (2.7L)	3450rpm & TPS 30% OPEN	4750rpm & TPS 35% OPEN
JM (2.7L)	3400rpm	4900rpm
XG (2.5L)	3200rpm	5100rpm

- 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)

VIS (Variable Intake System)

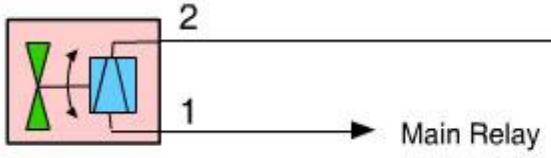
Solenoid output (Sudden acceleration)



VIS (Variable Intake System)

Pin assignment

VIS Valve 1

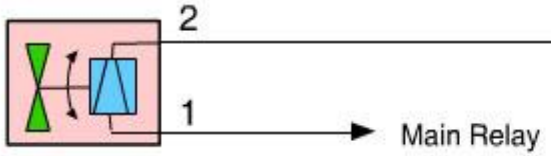


PCM (C144-1)

71 - VIS Valve Control

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

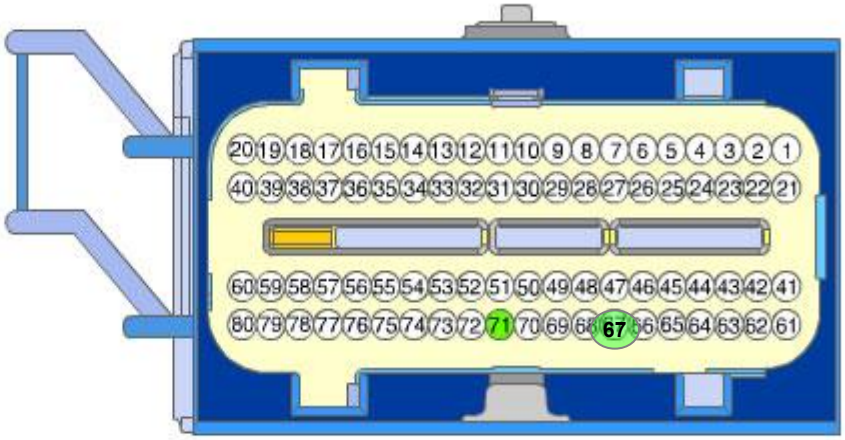
VIS Valve 2



PCM (C144-1)

67 - VIS Valve Control

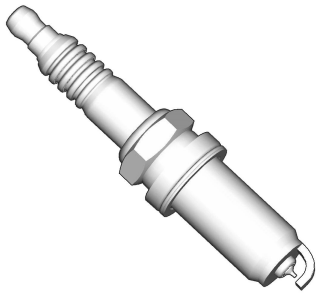
Terminal	Connected to	Funtion
1	Main Relay	Battery voltage (B+)
2	PCM C144-1 **(67)**	VIS Valve control



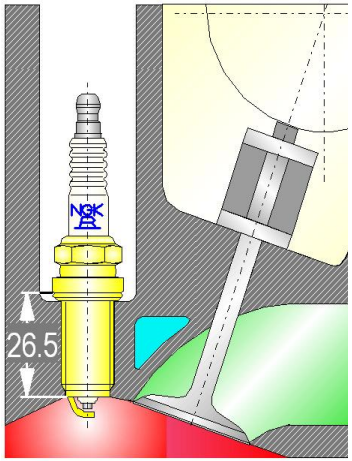
C144-1

PCM

Spark Plug (long reach type)



[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 : Φ19 x 26.5mm

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

CKP Sensor

- Output voltage : 0.4V~200V
  - Available engine rpm : 55~7000 rpm
  - Air Gap : 1±0.5mm
  - Resitance : 825 ± 100 Ω

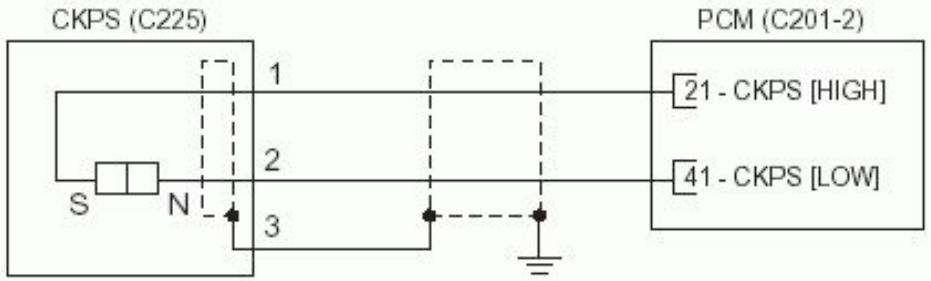
[Location]

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.

CKP Sensor

Pin assignment

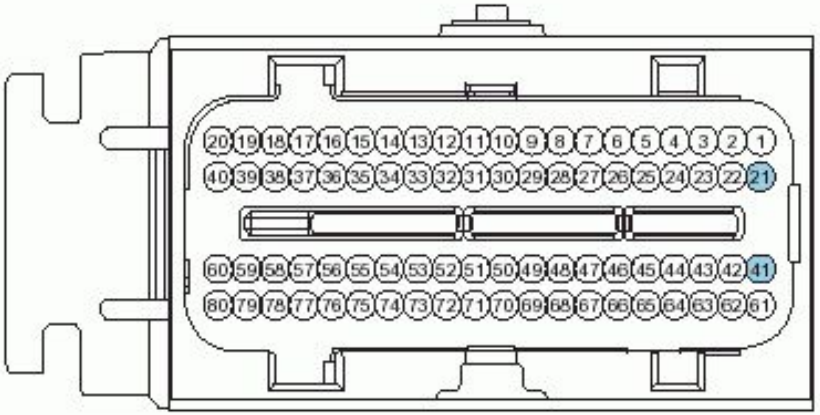


Terminal	Connected to	Function
1	PCM C201-2 (21)	CKPS [HIGH] Signal
2	PCM C201-2 (41)	CKPS [LOW] Signal
3	Chassis Ground	Sensor Shield

[HARNESS CONNECTORS]

C225

CKPS

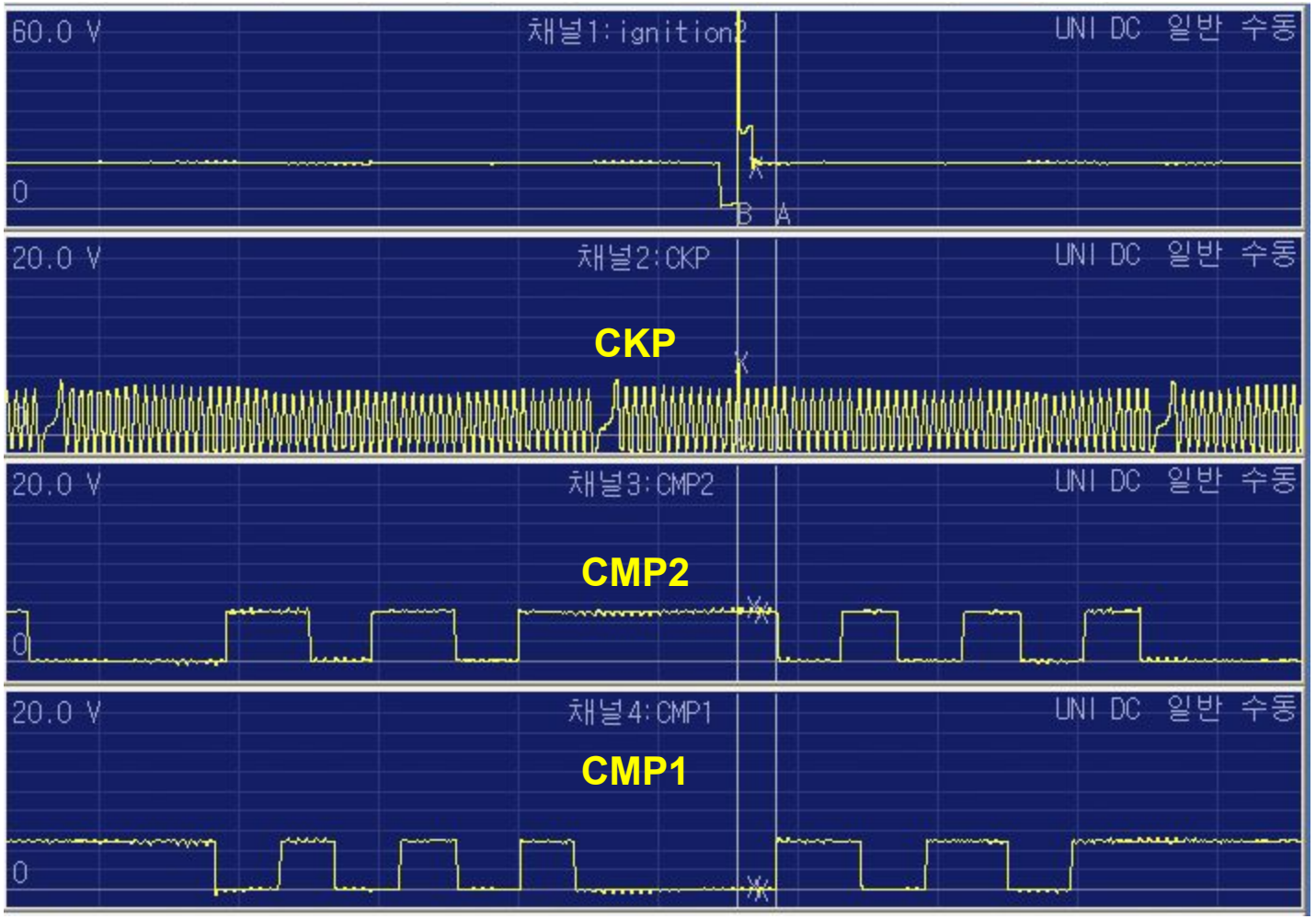


C201-2

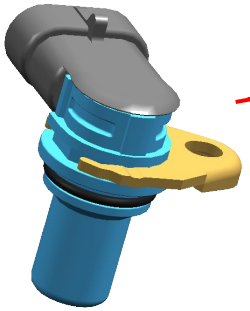
PCM

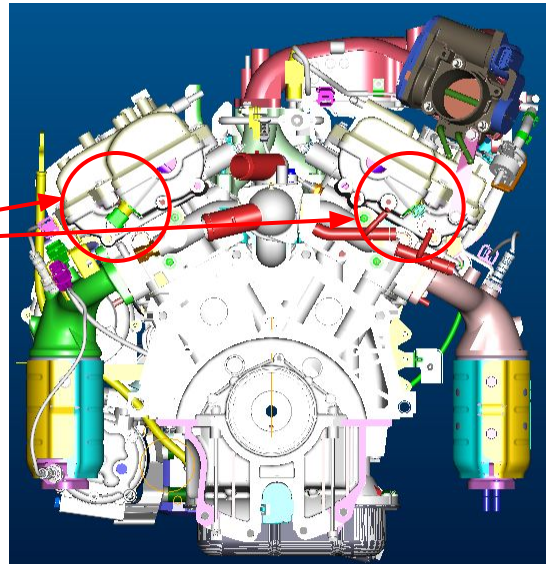
CKP Sensor

Sensor output



CMP Sensor





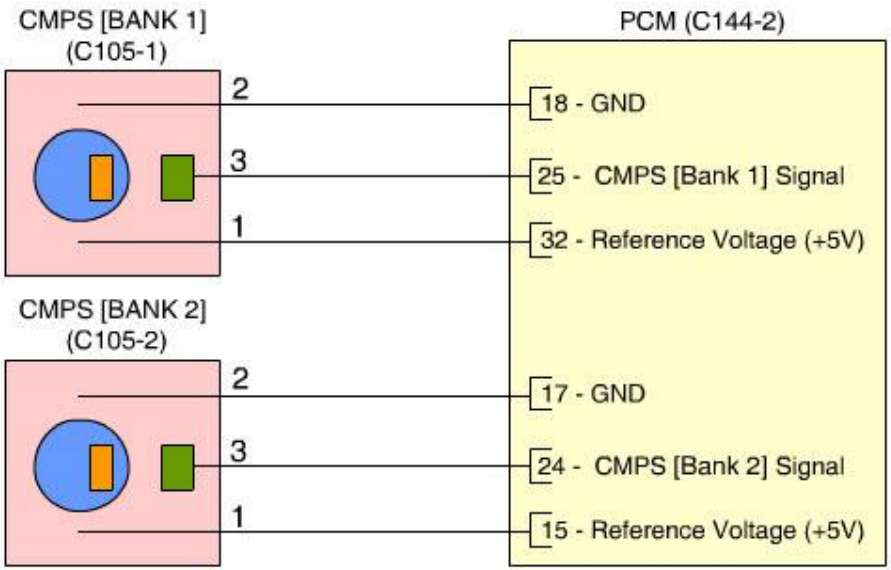
[CMP sensor target wheel]

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 is1.0±0.5 mm

Pin assignment



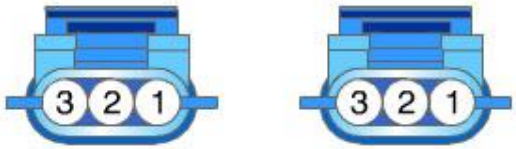
CMPS [BANK 1]

Terminal	Connected to	Funtion
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	Funtion
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]

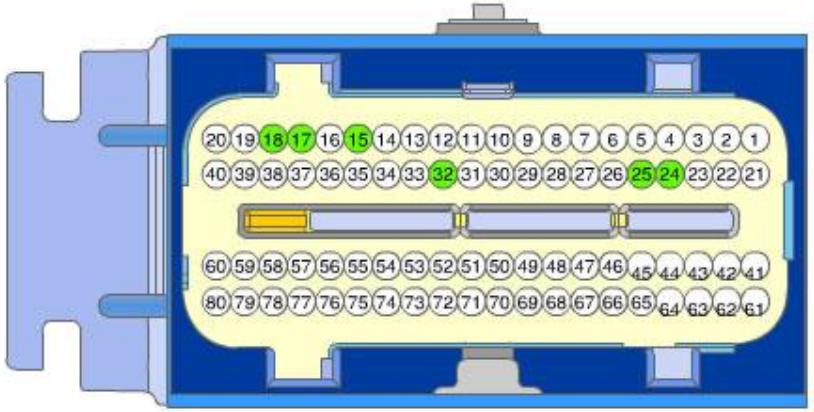


C105-1

CMPS [BANK 1]

C105-2

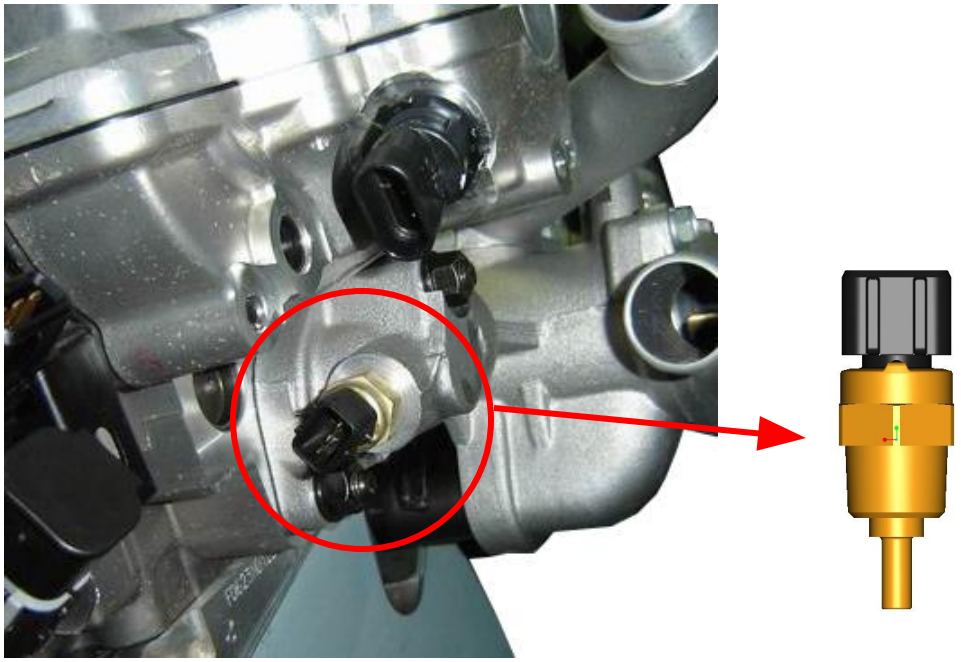
CMPS [BANK 2]



C144-2

PCM

ECT Sensor



Technical Feature

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

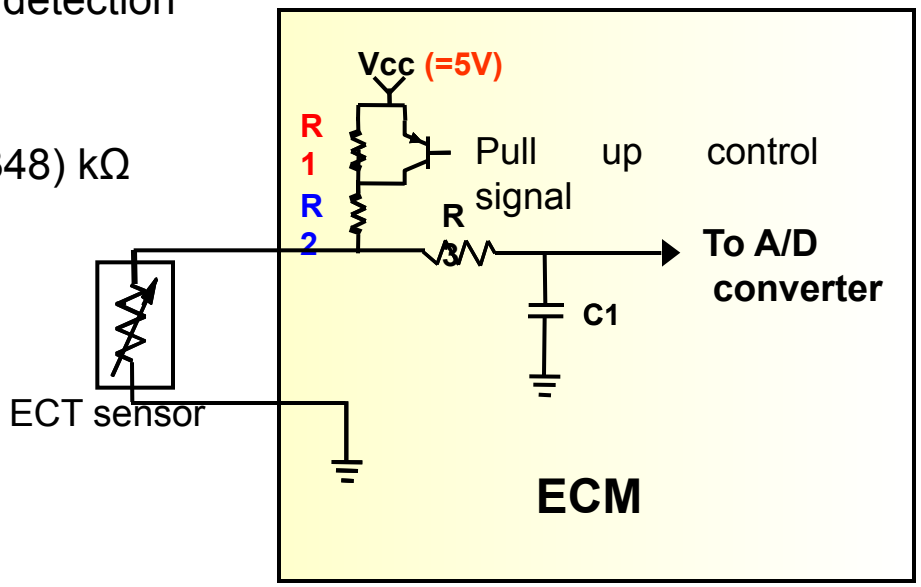
ECT sensor is used for fuel injection amount control and cooling fan control.

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.

ECT Sensor

Signal characteristic

1. The switch control signal will be shared with ATF Temp. Sensor.
2. More accurate high temperature detection
3. R1 = 3.65 KΩ , R2 = 348 Ω
4. TR On : 348 Ω, Off : (3.65 + 0.348) kΩ



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.

ECT Sensor

Signal characteristic

PCM controls the switching TR according to the temperature condition.

1) ECT ≤ 50 ˚C, OTS ≤ 80 ˚C : TR OFF □(3.65 + 0.348) kΩ

2) ECT ≥ 50 ˚C, OTS ≤ 80 ˚C : TR ON ↔ OFF (Pulse)

TR ON (for ECT)

TR OFF (for OTS)

3) ECT ≤ 50 ˚C, OTS ≥ 80 ˚C : TR ON ↔ OFF (Pulse)

TR ON (for OTS)

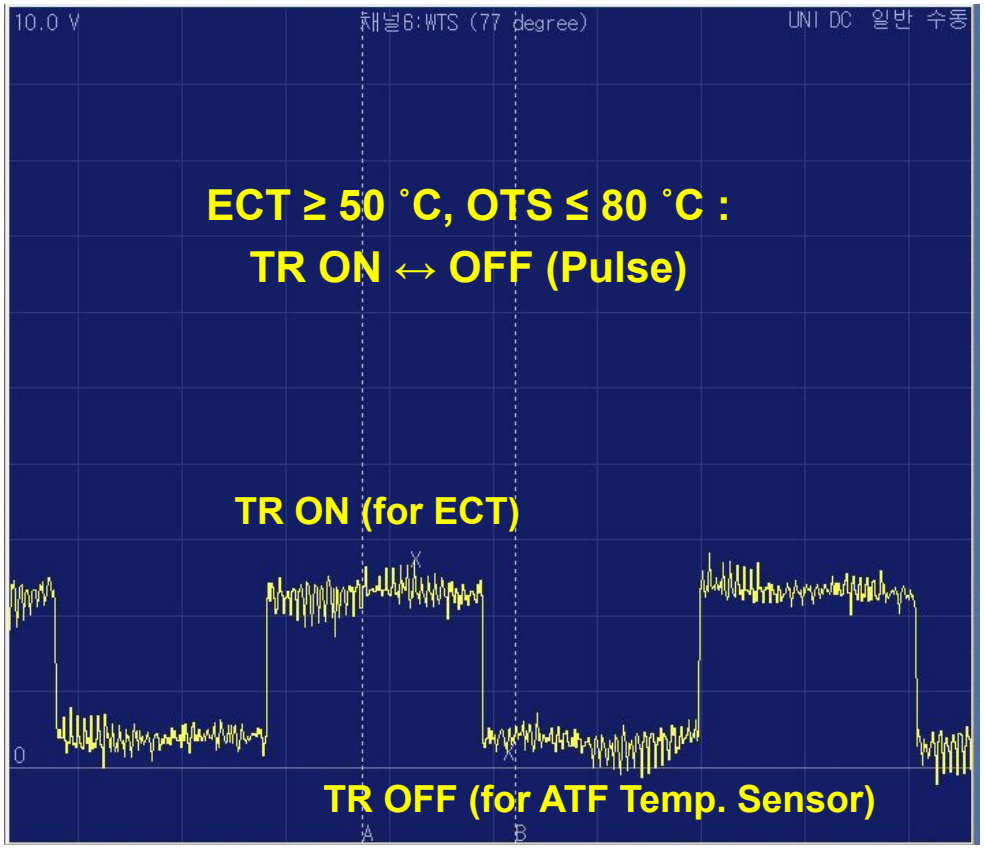
TR OFF (for ECT)

4) ECT ≥ 50 ˚C, OTS ≥ 80 ˚C : TR ON □ 348 Ω

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

ECT Sensor

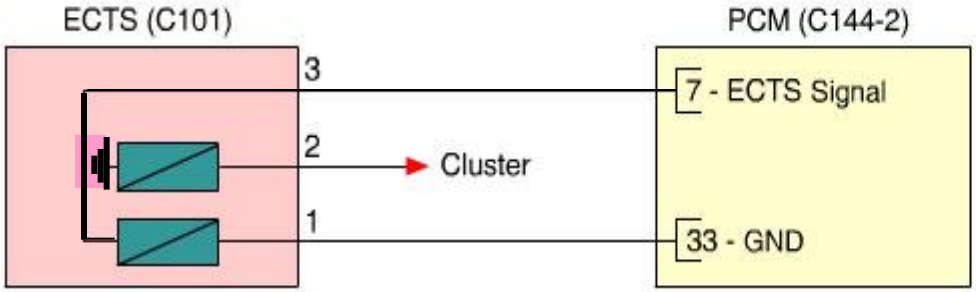
Sensor output



[ECT : 77 ˚C]

ECT Sensor

Pin assignment

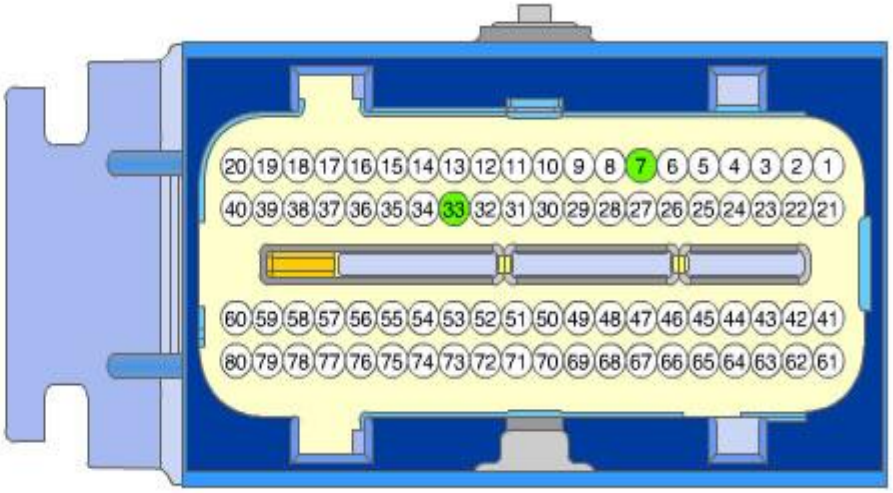


Terminal	Connected to	Funtion
1	PCM C144-2 (33)	Sensor ground
2	Cluster	-
3	PCM C144-2 (7)	ECTS Signal

[HARNESS CONNECTORS]

C101

ECTS



C144-2

PCM

MAF Sensor

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.

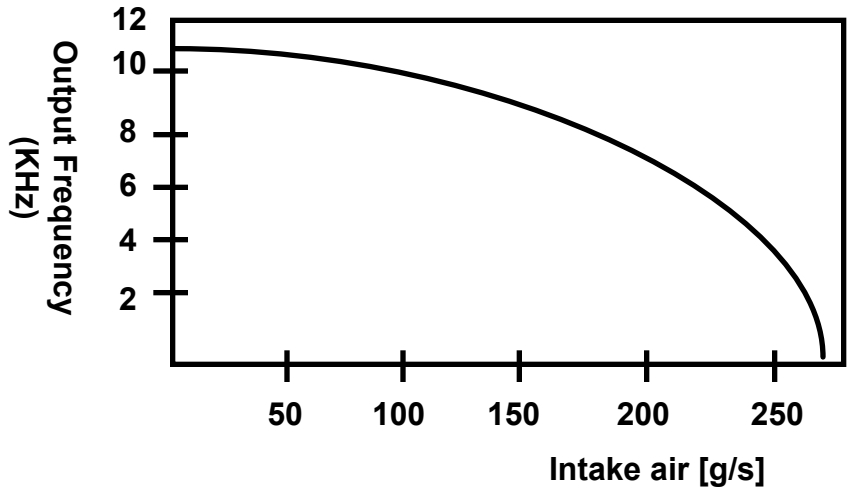
IAT sensor is assembled with MAF sensor.

Technical Feature

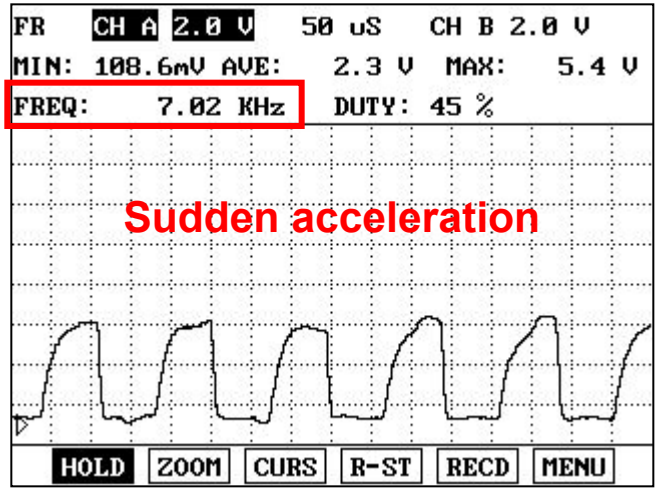
- Measurable flow : ~ 250g/s
- Frequency : 0.7~12kHz
- Operating voltage : MAF : 9~16V
  IAT : 5V

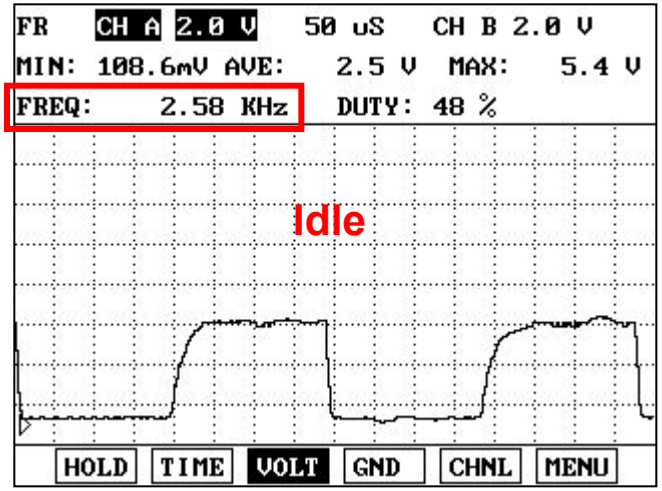
MAF Sensor

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

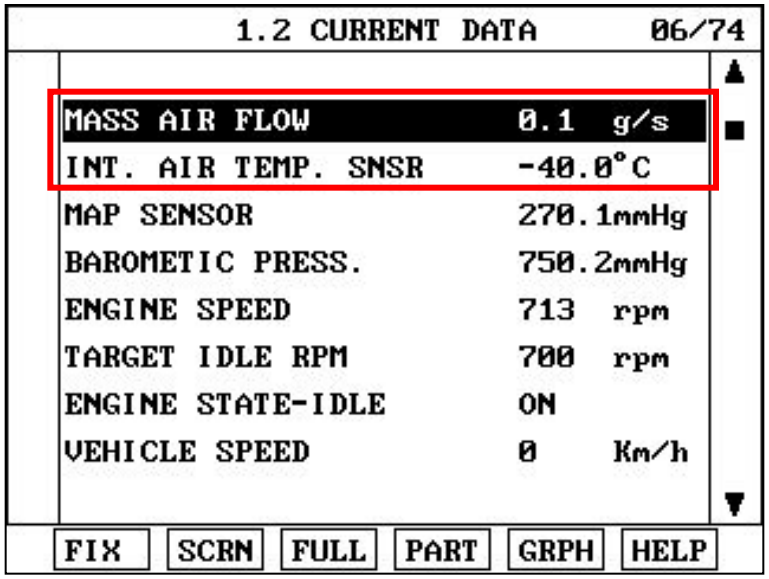


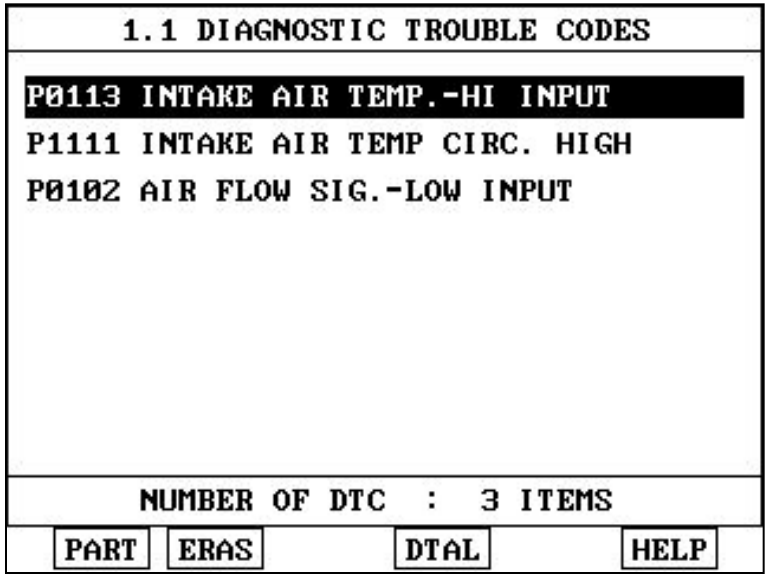


MAF Sensor

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



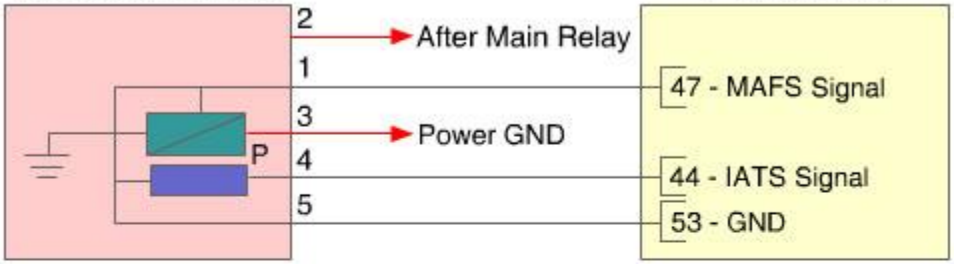


[[When MAF sensor connector is open]

MAF Sensor

Pin assignment

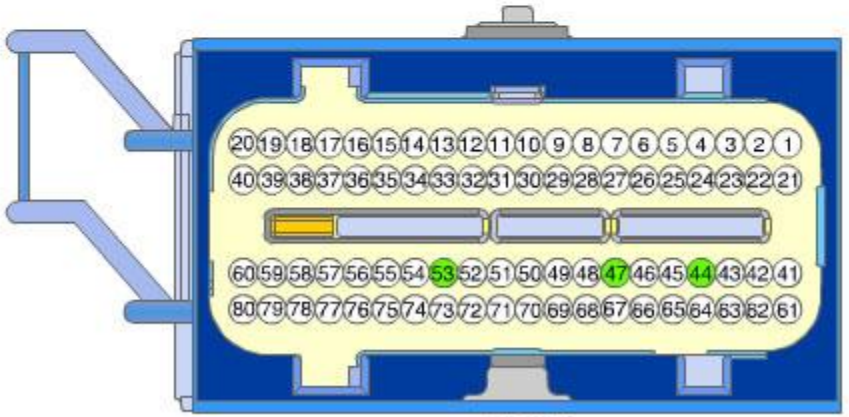
MAF & IAT **PCM Connector A**



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

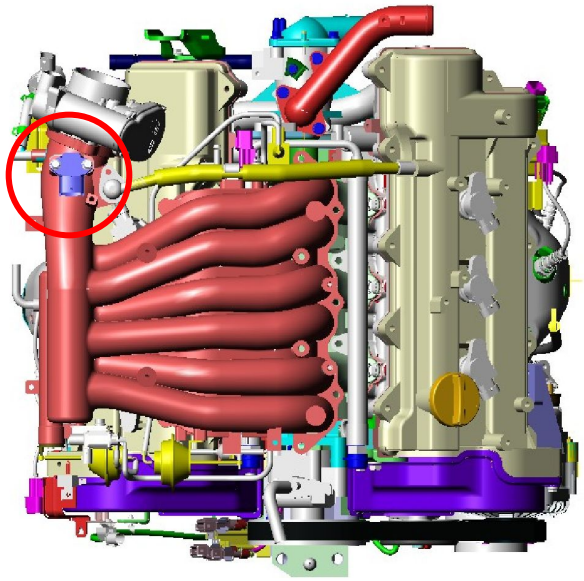
[HARNESS CONNECTORS]

MAF & IAT



PCM Connector A

MAP Sensor



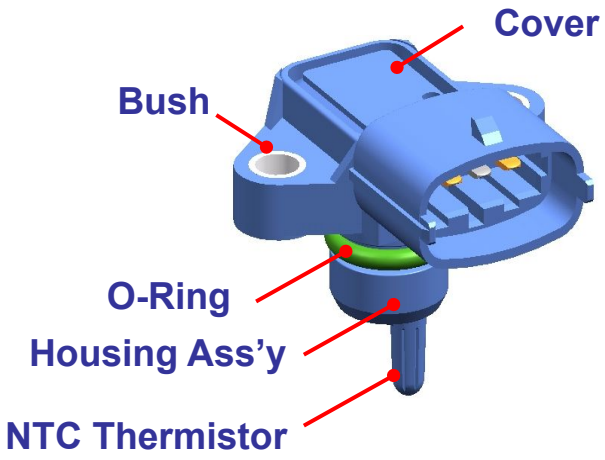
MAP (Manifold Absolute Pressure) sensor is installed on the surge tank. It detects the absolute pressure in surge tank and send it to ECM.

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.

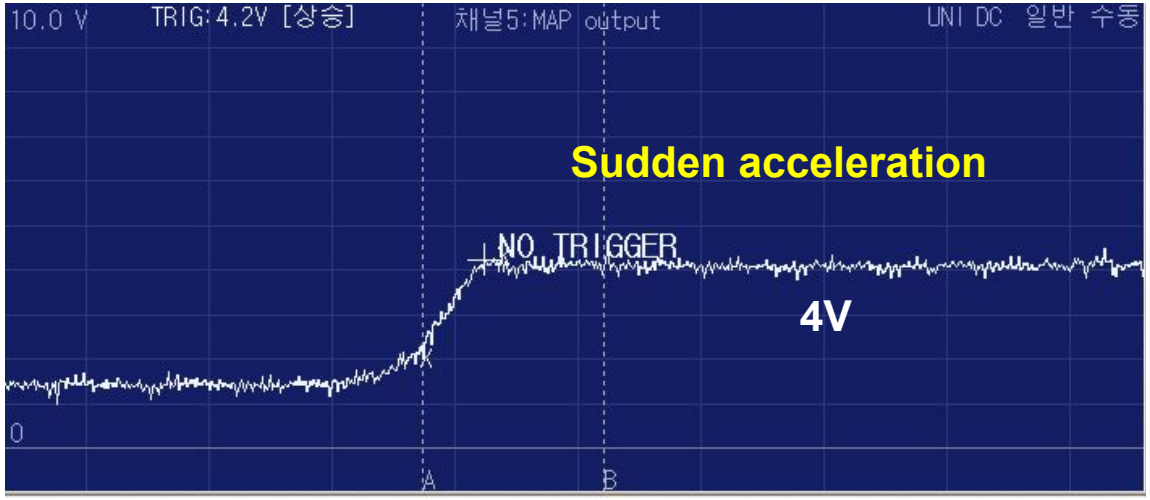
Also when MAF sensor failure is detected by ECM, MAP sensor is altered as an main sensor.

MAP Sensor

Technical features

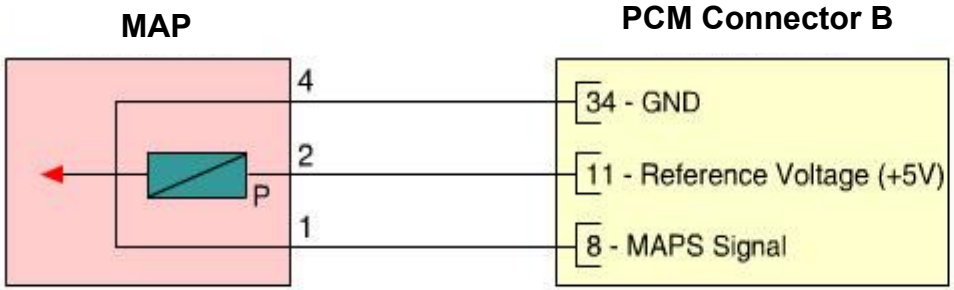


- Sensor Type : Piezo Resistive
- Pressure range : 20 ~ 107 kPa
- Temperature range : -40℃ ~ 130℃
- Supply voltage : 5 V ± 0.25 V
- Output voltage : 0.789 ~ 4.224V



MAP Sensor

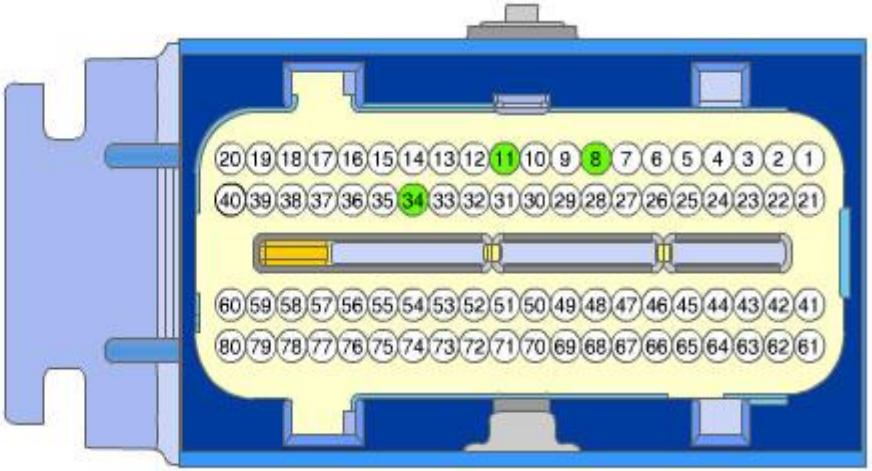
Pin assignment



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

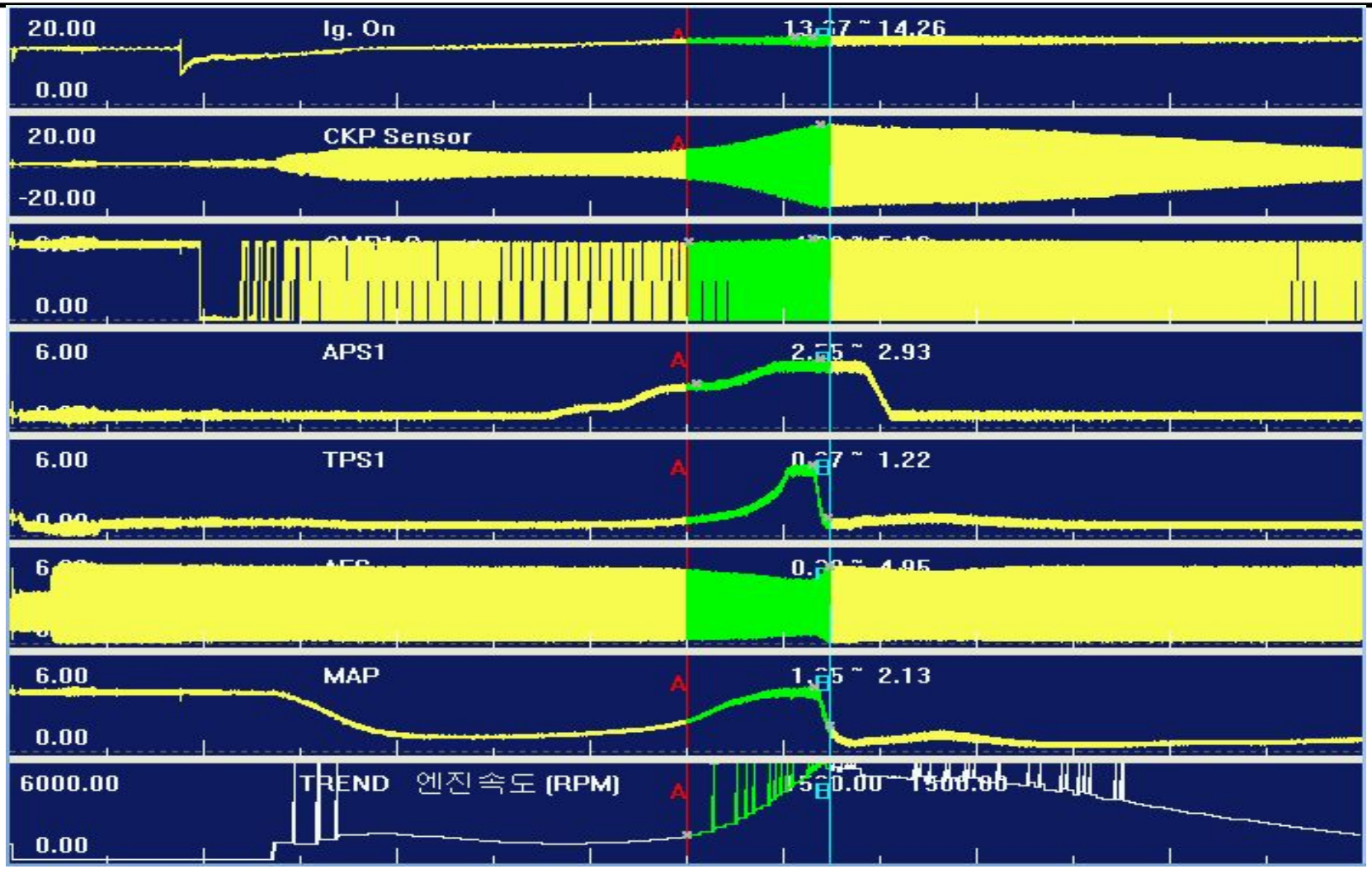
[HARNESS CONNECTORS]

MAP



PCM Connector B

MAP Sensor

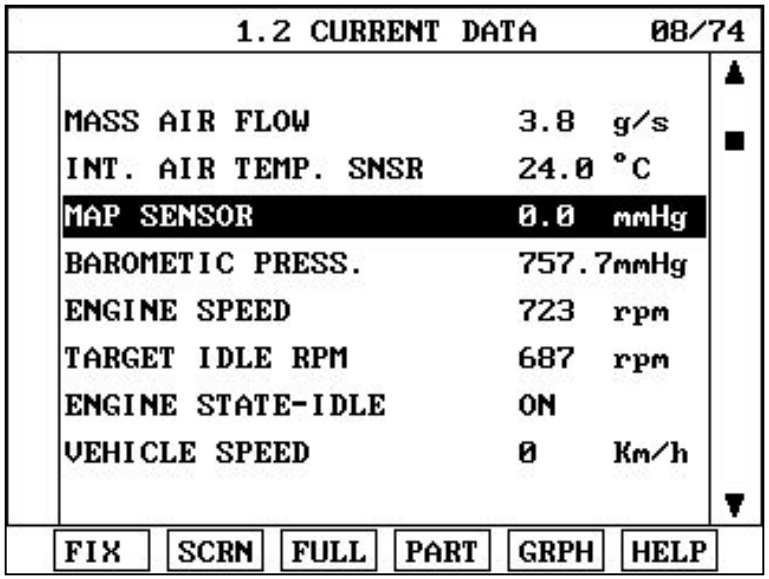


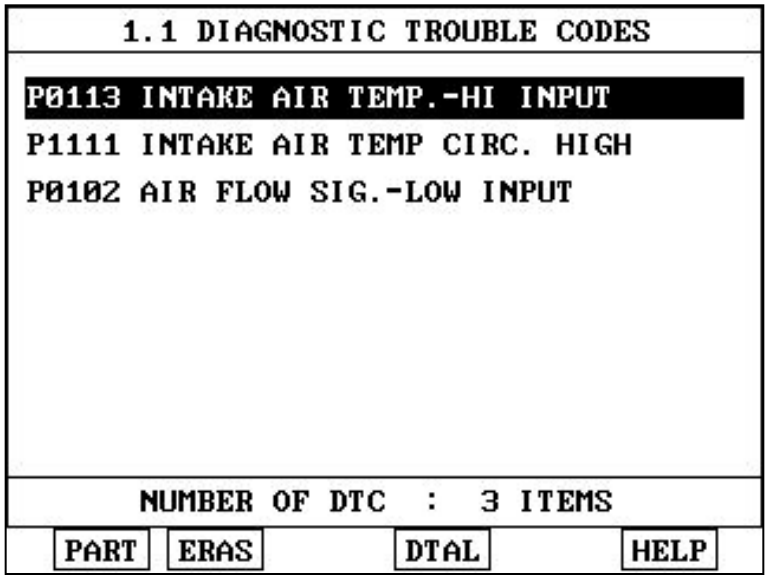
When ECM reaches a transient range such as sudden acceleration or deceleration, MAF value is not reliable so MAP sensor signal is used instead of MAF's.

Point A to B is kind of transient range example.

MAP Sensor

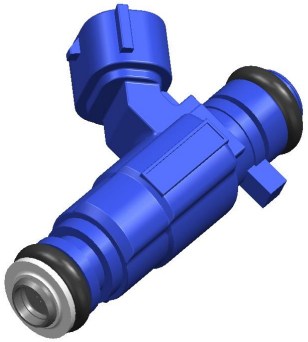
Failsafe

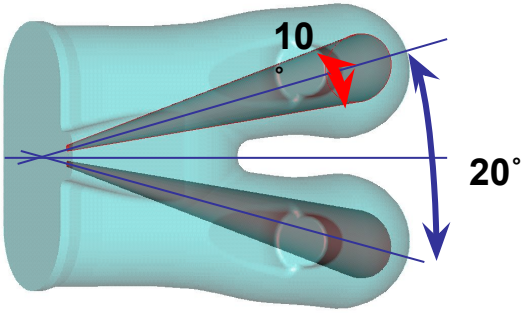




[[When MAP sensor connector is open]

Injecter





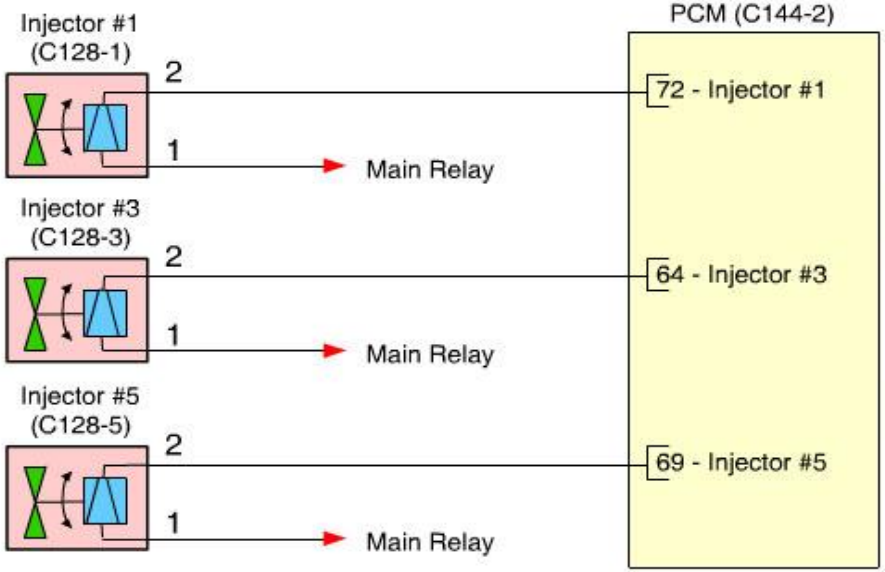
Technical features

- 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

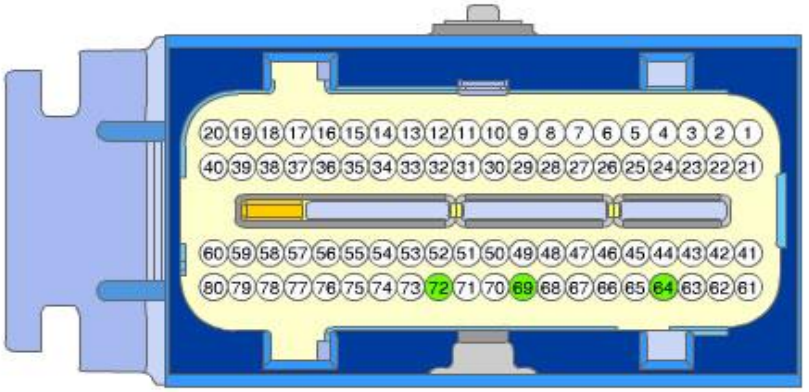
Terminal	Connected to	Funtion
1	Main Relay	Battery Voltage (B+)
2	PCM C144-2 (72)	Injector #1 control

Injector #3

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

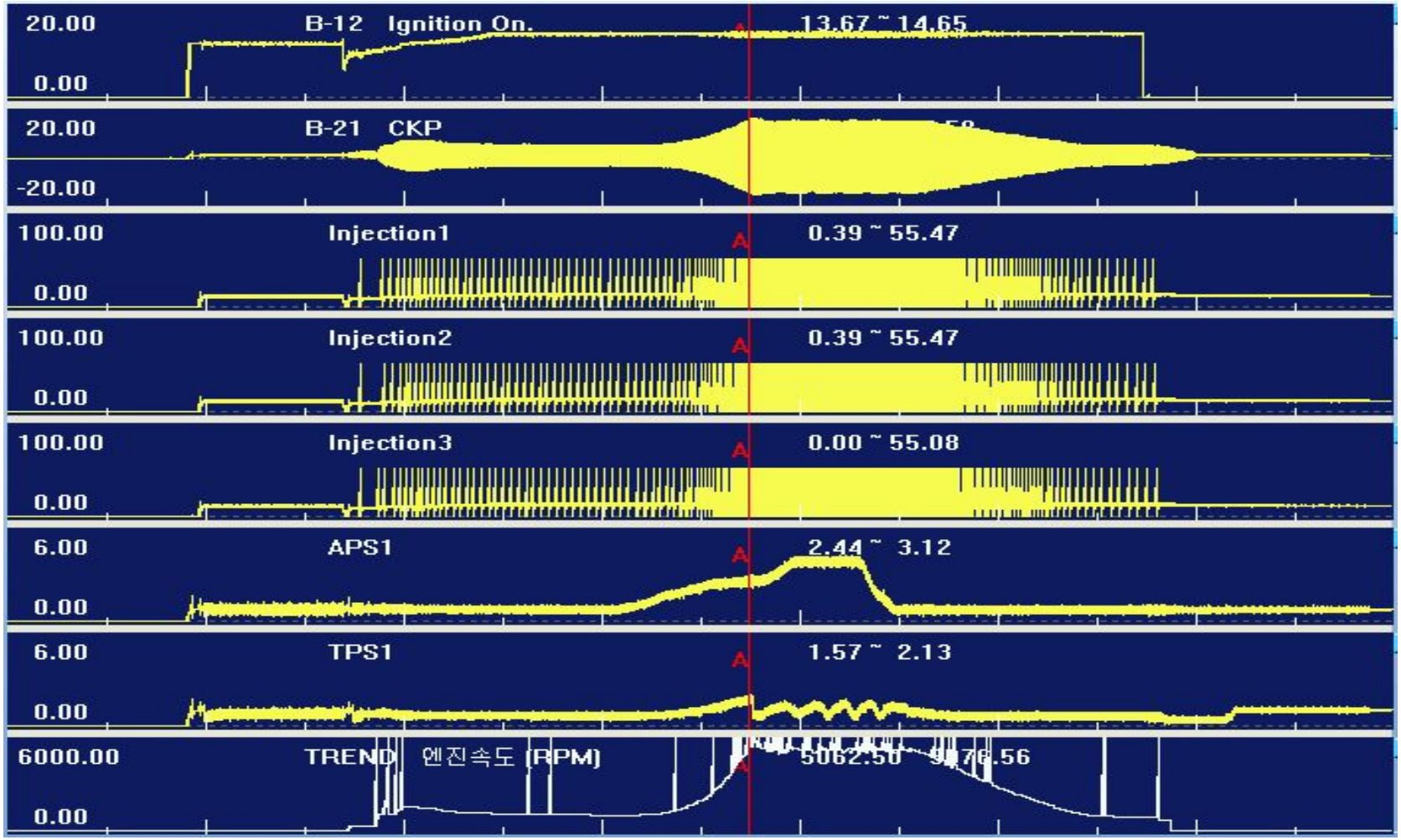
Injector #5

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



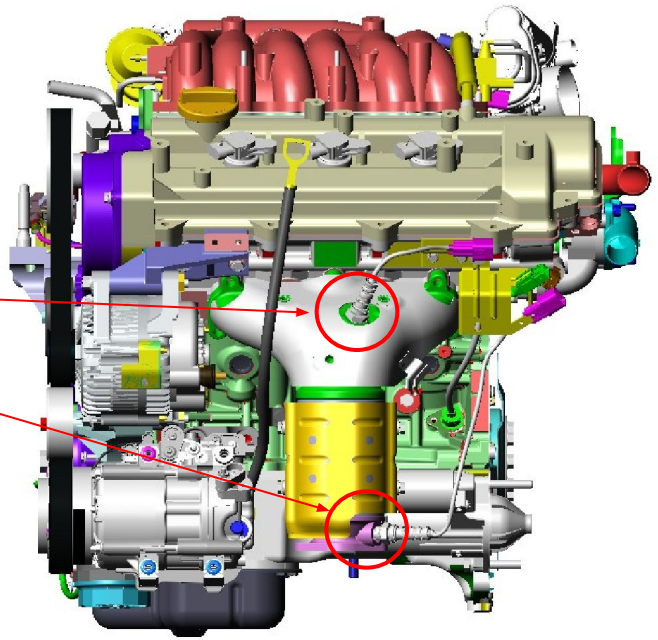
C144-2
PCM

RPM Limit



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.

Oxygen Sensor

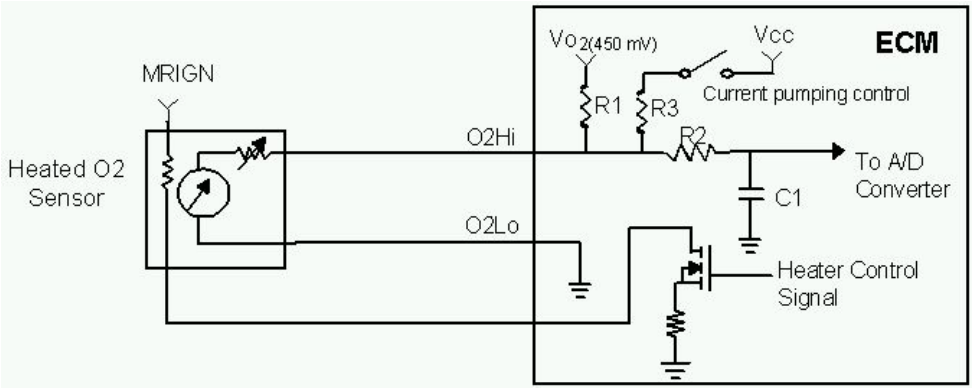


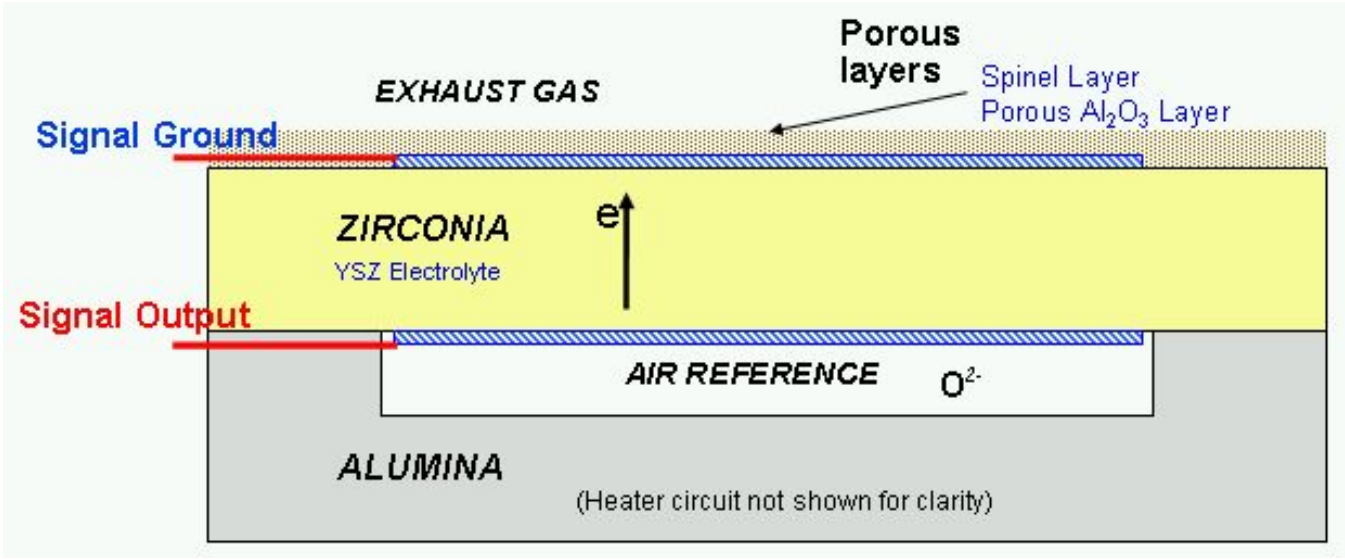
Zirconia type oxygen sensor with a **current pumping method** to create reference chamber is installed. This type has been already applying to Lamda engine.

Each bank has 2 oxygen sensors.

Oxygen Sensor

Operating principle

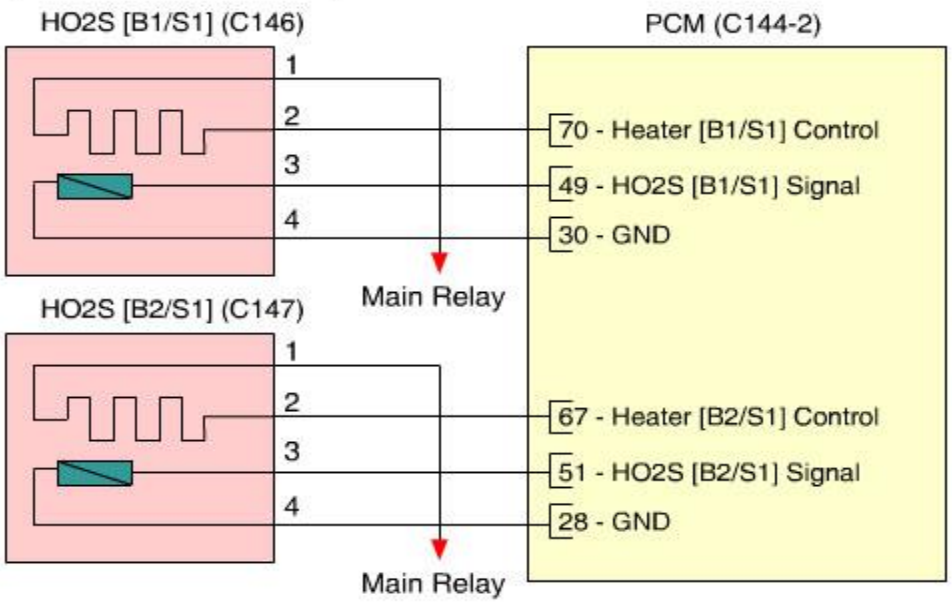




When ECM supply current through signal output line which is about 7 ~ 10 μA, air reference chamber is charged with oxygen ion from exhaust gas through zirconia material. This is the another characteristics in zirconia. When current is applied it can transfer oxygen ion. Current supplying line is shared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

Oxygen Sensor - Front

Pin assignment

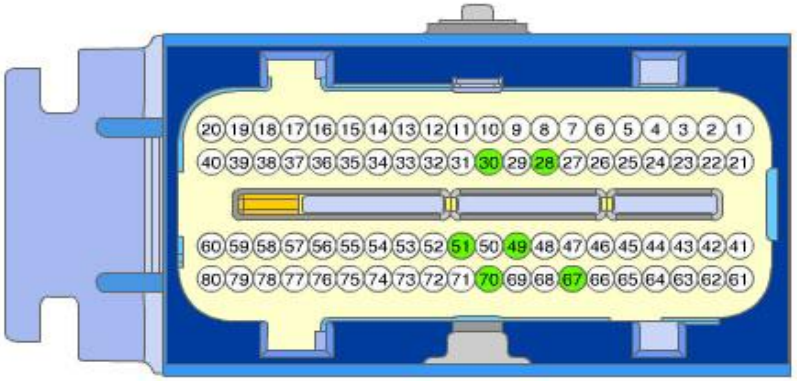


HO2S [B1/S1]

Terminal	Connected to	Funtion
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]

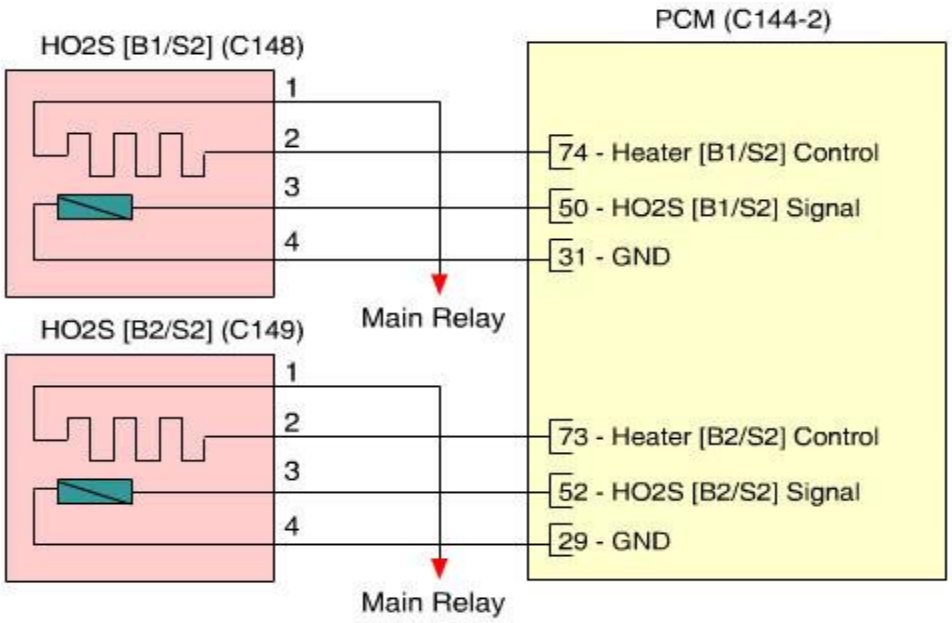
Terminal	Connected to	Funtion
1	Main Relay	Battery Voltage (B+)
2	PCM C144-2 (67)	Heater [B2/S1] Control
3	PCM C144-2 (51)	HO2S [B2/S1] Signal
4	PCM C144-2 (28)	Sensor ground



C144-2
PCM

Oxygen Sensor - Rear

Pin assignment

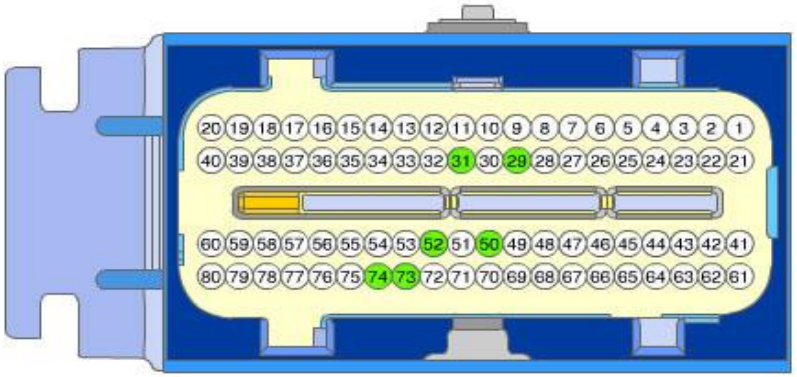


HO2S [B1/S2]

Terminal	Connected to	Funtion
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]

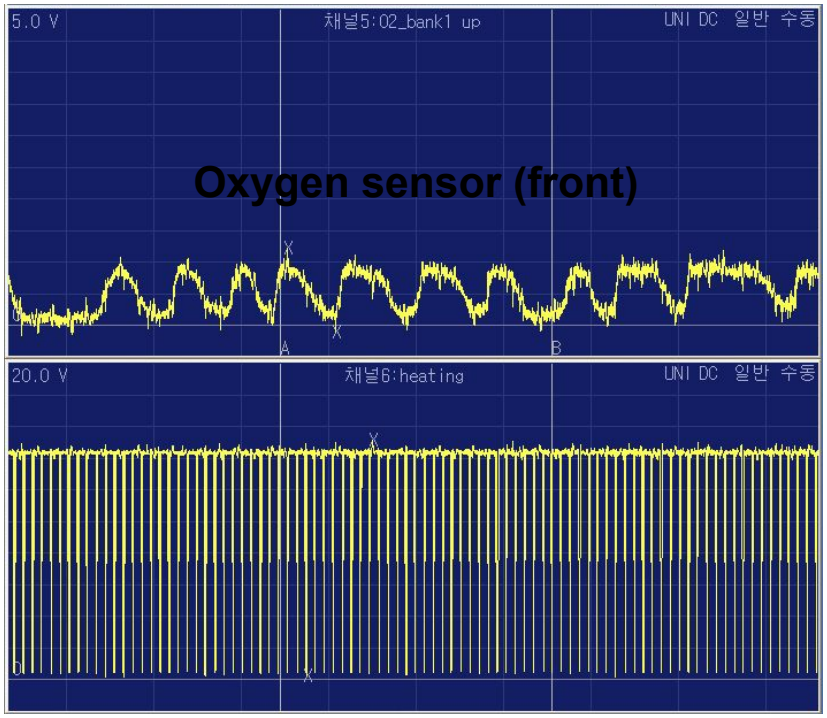
Terminal	Connected to	Funtion
1	Main Relay	Battery Voltage (B+)
2	PCM C144-2 (73)	Heater [B2/S2] Control
3	PCM C144-2 (52)	HO2S [B2/S2] Signal
4	PCM C144-2 (29)	Sensor ground

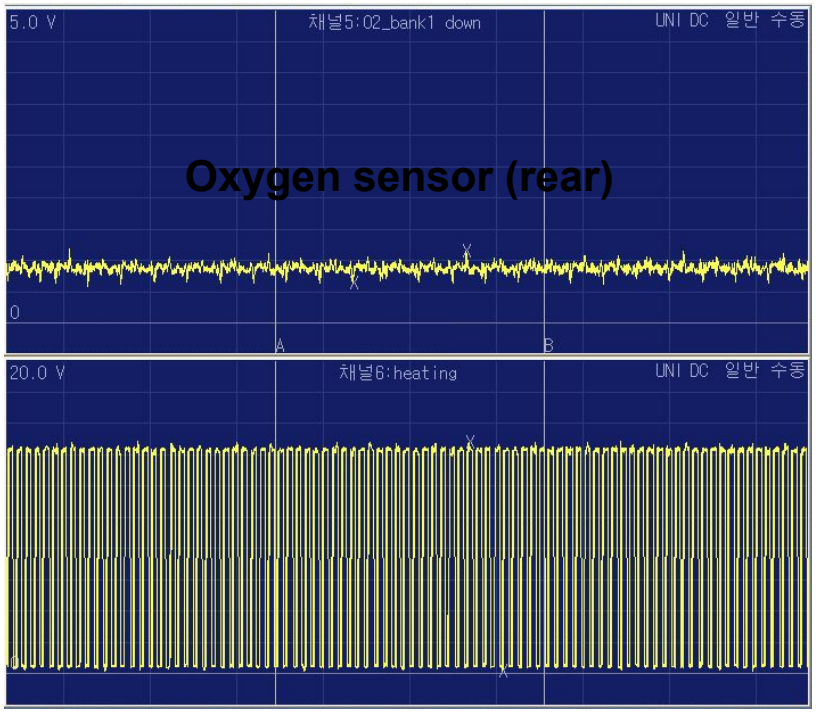


C144-2
PCM

Oxygen Sensor

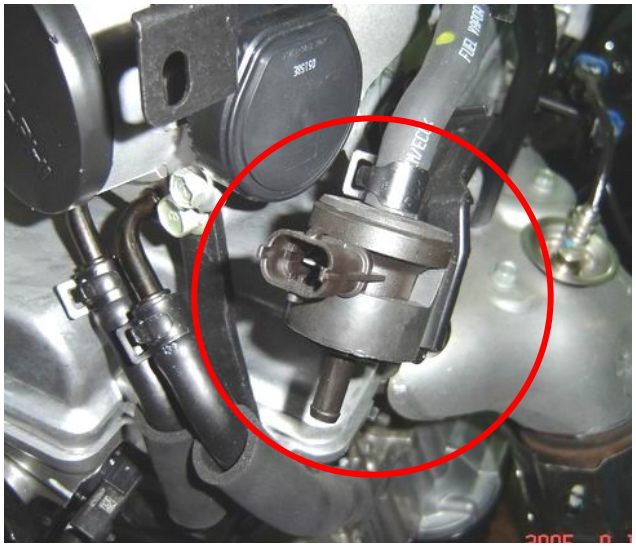
Sensor output



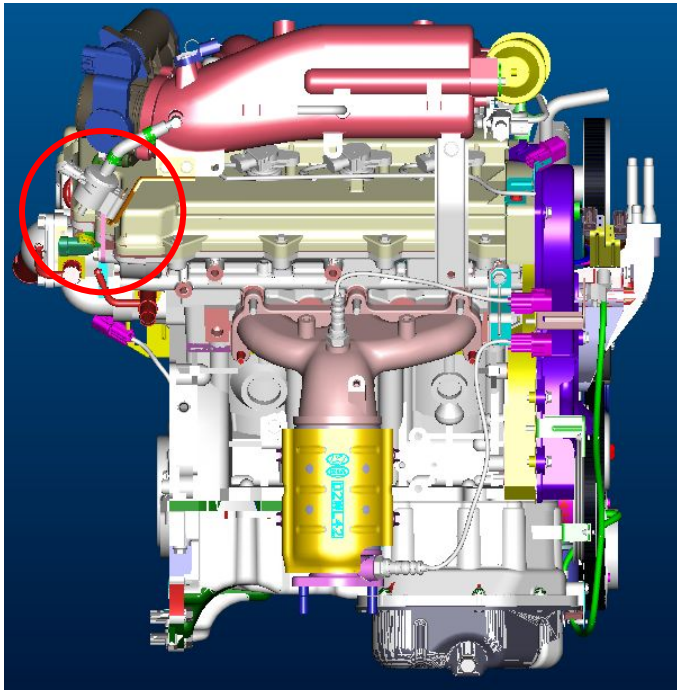


Even reference chamber is created by electrically, oxygen sensor waveform is same as the one without pumping mechanism. Rear Oxygen sensor shows liner waveform with a good catalytic converter.

PCSV (Purge Control Solenoid Valve)



Purge solenoid valve
(Filter built-in type)



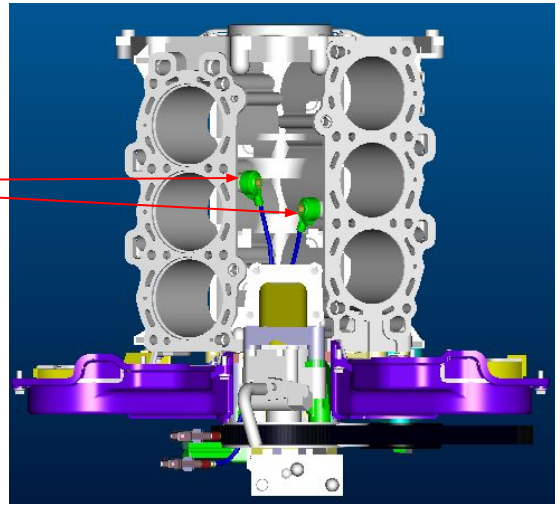
One of the common problems in fuel controlling is from leakage through PCSV. Mainly this leakage happens from foreign material stuck in PCSV.

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

Technical Feature

- Normally closed valve
- Max. flow : 6.5 m^3/h
- Control type : Duty basis
- Frequency : up to 30 Hz
- Coil resistance : 16±2 Ω

Knock Sensor

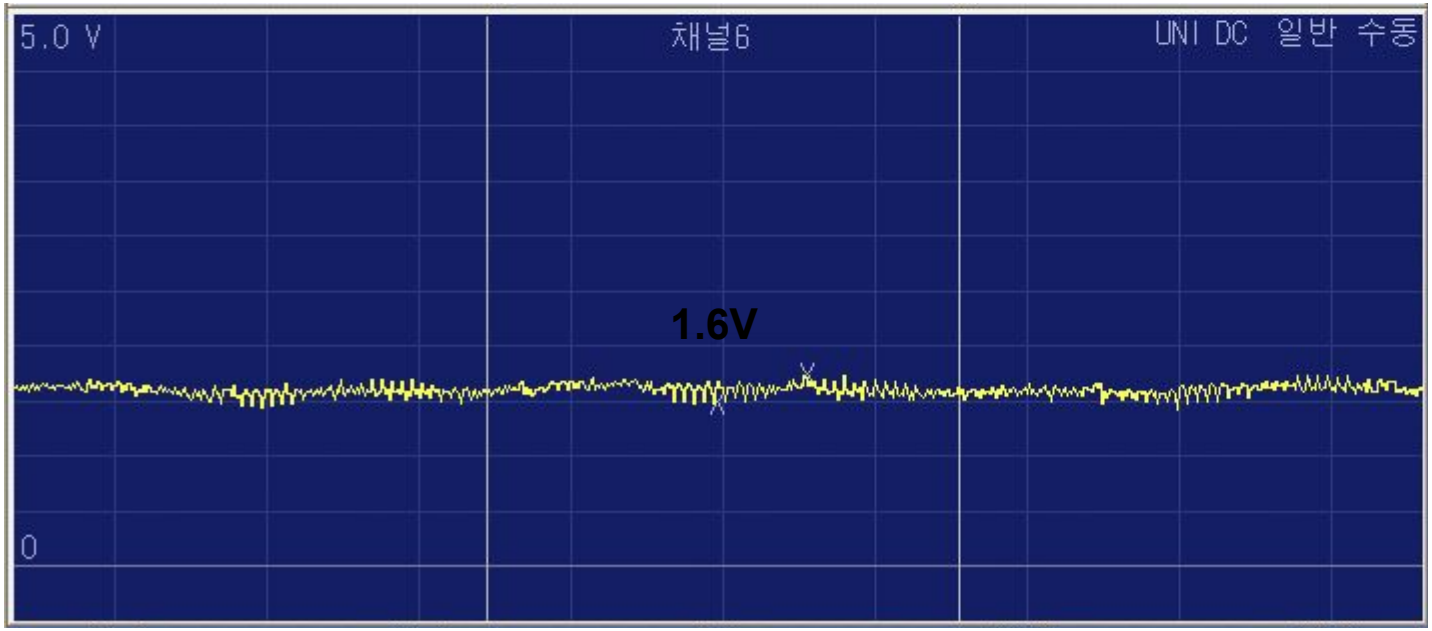


When knock is detected, ECM retards the ignition timing to certain range.

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

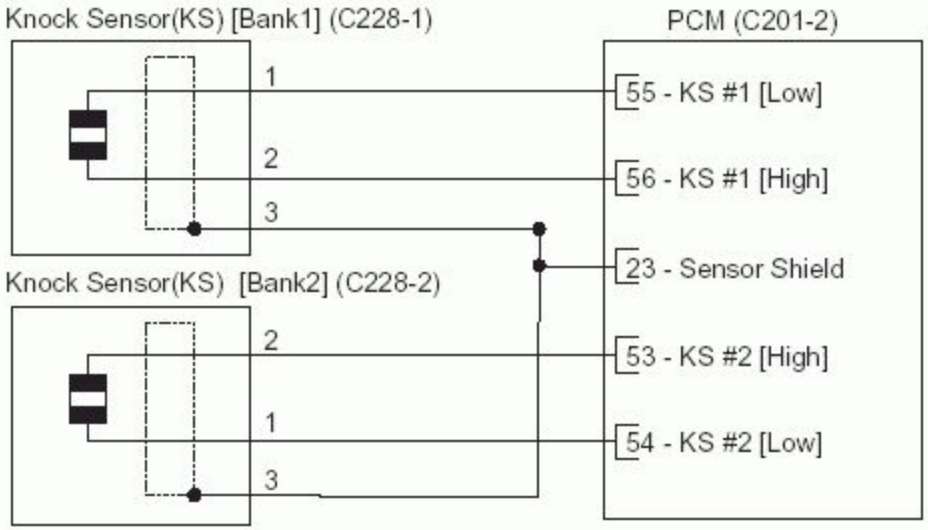
Knock Sensor

Sensor output



[Knock sensor output at engine idle]

Pin assignment



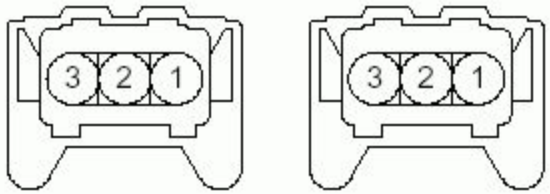
KS [Bank1]

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]

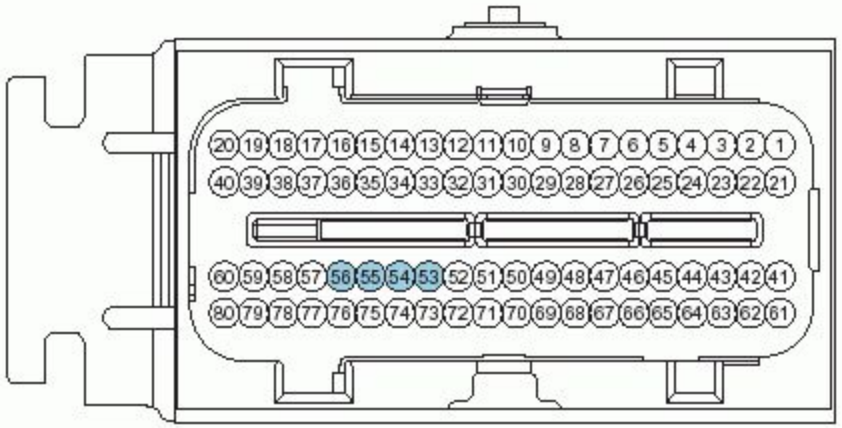


C228-1

KS [Bank1]

C228-2

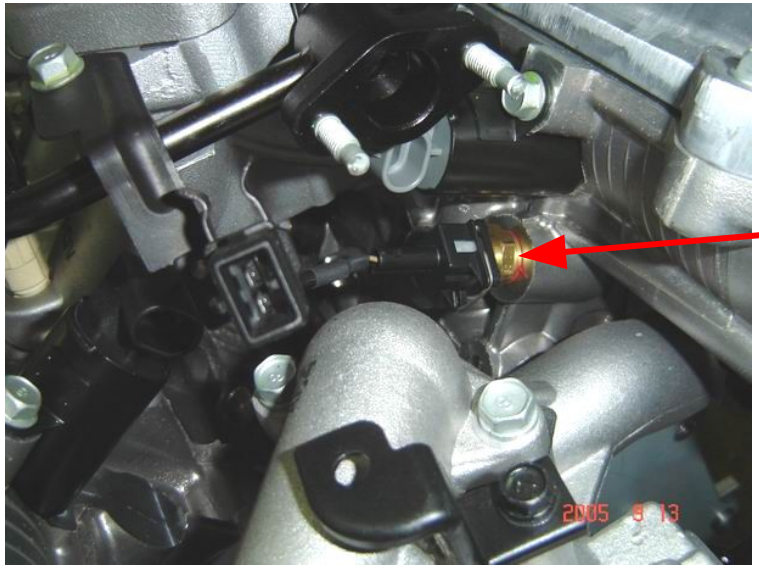
KS [Bank2]

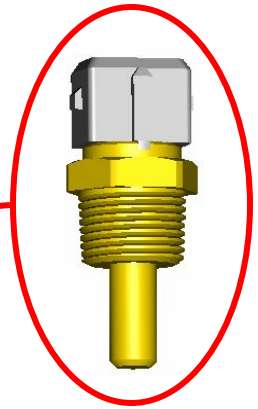


C201-2

PCM

Oil Temp. Sensor





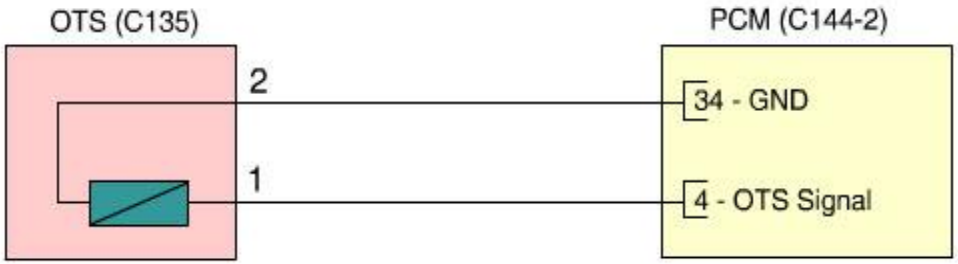
Technical feature

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

Oil Temp. Sensor

Pin assignment

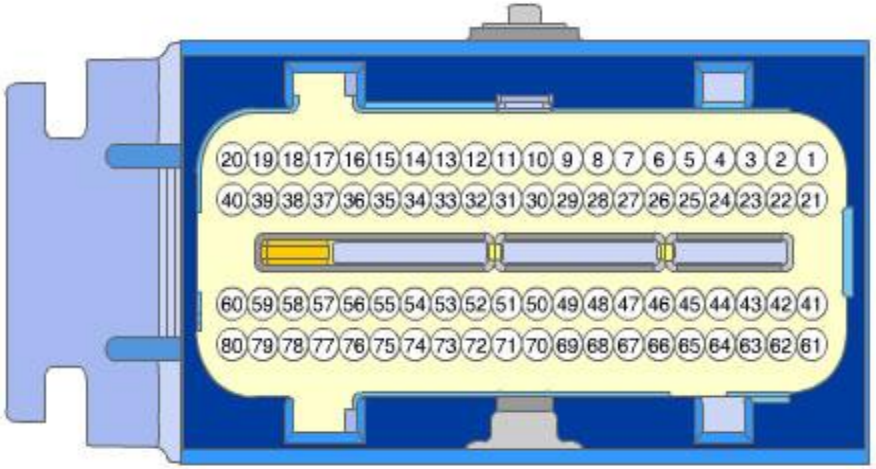


Terminal	Connected to	Funtion
1	PCM C144-2 (4)	OTS Signal
2	PCM C144-2 (34)	Sensor ground

[HARNESS CONNECTORS]

C135

OTS

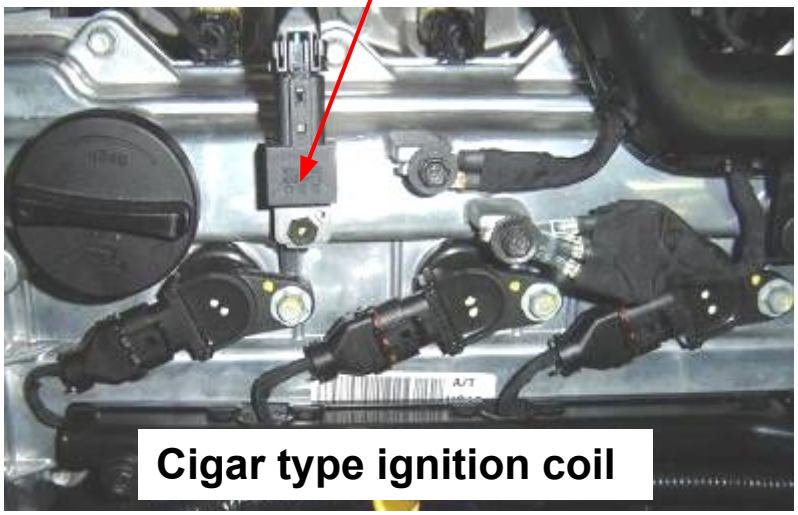


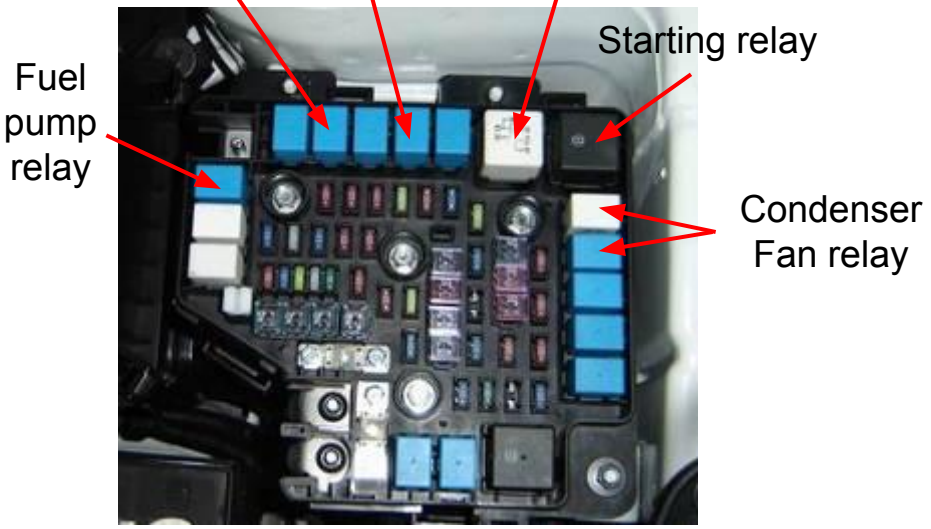
C144-2

PCM

Other Components

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.